Pacific Navy Marine Species Density Database

Revised[1] Final Northwest Training and Testing Technical Report

Version

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[1] This version provides updated density estimates for the Pacific harbor seal in the Northwest Training and Testing Study Area.

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ACRONYM LIST

AOR	**Area of Responsibility**
CCE	**California Current Ecosystem**
EA	**Environmental Assessment**
EIMS	**Environmental Information Management System**
EIS	**Environmental Impact Statement**
GAM	**Generalized Additive Model**
GIS	**Geographic Information System**
GLM	**Generalized Linear Model**
GOA	**Gulf of Alaska**
HRC	**Hawaii Range Complex**
HSTT	**Hawaii-Southern California Training and Testing**
INRMP	**Integrated Natural Resource Management Plan**
IUCN	**International Union for Conservation of Nature**
IWC	**International Whaling Commission**
MITT	**Mariana Islands Training and Testing**
NAVSEA	**Naval Sea Systems Command**
nm	**nautical miles**
NMML	**National Marine Mammal Laboratory**
NMFS	**National Marine Fisheries Service**
NMSDD	**Navy Marine Species Density Database**
NODEs	**Navy OPAREA Density Estimates**
NWTT	**Northwest Training and Testing**
PIFSC	**Pacific Islands Fisheries Science Center**
RES	**Relative Environmental Suitability**
SEAFAC	**Southeast Alaska Acoustic Measurement Facility**
SDSS	**Spatial Decision Support System**
SOCAL	**Southern California**
SMRU Ltd.	**Sea Mammal Research Unit, Limited (at University of St. Andrews)**
SSTC	**Silver Strand Training Complex**
SWFSC	**Southwest Fisheries Science Center**
TMAA	**Temporary Maritime Activities Area**
U.S.	**United States**

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1 BACKGROUND

To ensure compliance with United States (U.S.) regulations including the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), the National Environmental Policy Act (NEPA), and Executive Order 12114 (Environmental Effects Abroad of Major Federal Actions), the U.S. Navy (Navy) takes responsibility for reviewing and evaluating the potential environmental impacts of conducting at-sea training and testing operations. All marine mammals in the United States are protected under the MMPA, and some species receive additional protection under the ESA. As stipulated by the MMPA and ESA, information on the species and numbers of protected marine species is required in order to estimate the number of animals that might be affected by a specific activity. The Navy performs quantitative analyses to estimate the number of marine mammals and sea turtles that could be affected by at-sea training and testing activities. A key element of this quantitative impact analysis is knowledge of the abundance and concentration (density) of the species in specific areas where those activities will occur. The most appropriate unit of metric for this type of analysis is density or the number of animals present per unit area. This report includes a description of the currently-available density data used in the quantitative impact analysis for each marine mammal and sea turtle species present in the Navy's Pacific 3rd and 7th Fleet's Area of Responsibility (AOR).

NOTE: The density data are organized by species and presented in groups of related taxa within Sections 5 through 12 of this report. Within each individual species section, density data are described for each of the Pacific Fleet Study Areas as appropriate. Information on which species are found in each of the Study Areas is provided in Table 4-1.

Estimating marine species density requires a significant amount of effort to collect and analyze survey data to produce a usable estimate. Unlike surveys for terrestrial wildlife, many marine species spend much of their time submerged, and are not easily observed. In order to collect enough sighting data to make reasonable density estimates, multiple observations are required, often in areas that are not easily accessible (e.g., far offshore). National Marine Fisheries Service (NMFS) is the primary agency responsible for estimating marine mammal and sea turtle density within the U.S. Exclusive Economic Zone (EEZ). Other independent researchers often publish density data for key species in specific areas of interest. For example, population structure and abundance data for island-associated populations of cetaceans in Hawaiian waters are collected by various non-NMFS researchers (e.g., Baird et al. 2009; McSweeney et al. 2007).

For most cetacean species, abundance is estimated using line-transect surveys or mark-recapture studies (e.g., Barlow and Forney 2007; Calambokidis et al. 2008; Barlow 2010). The result usually provides one single density estimate value, for each species, across broad geographic areas, such as waters within the U.S. EEZ off California, Oregon, and Washington. This is the general approach applied in estimating cetacean abundance in the NMFS stock assessment reports. Though the single value provides a good average estimate of abundance (total number of individuals) for a specified area, it does not provide information on the species distribution or concentrations within that area, and does not estimate density for other timeframes/seasons that were not surveyed. More recently, spatial habitat modeling has been used to estimate cetacean densities (Ferguson et al. 2006; Redfern et al. 2006;

Barlow et al. 2009; Becker et al. 2010, 2012a,b,c; Forney et al. 2012). These models estimate cetacean density as a continuous function of habitat variables (e.g., sea surface temperature, seafloor depth, etc.) and thus allow predictions of cetacean densities on finer spatial scales than traditional line-transect or mark-recapture analyses. Within the study area that was modeled, densities can be predicted wherever these habitat variables can be measured or estimated.

Uncertainty in published density estimates is typically large because of the low number of sightings available for their derivation. Uncertainty is typically expressed by the coefficient of variation of the estimate, which is derived using standard statistical methods and describes the amount of variation with respect to the population mean. It is expressed as a fraction or sometimes a percentage and can range upward from zero, indicating no uncertainty, to high values. For example, a coefficient of variation of 0.85 would indicate high uncertainty in the population estimate. When the coefficient of variation exceeds 1.0, the estimate is very uncertain. The uncertainty associated with movements of animals into or out of an area (due to factors such as availability of prey or changing oceanographic conditions) is much larger than is indicated by the coefficient of variation.

The methods used to estimate pinniped at-sea densities are typically different than those used for cetaceans. Pinniped abundance is generally estimated via shore counts of animals at known haul-out sites or number of pups weaned at rookeries (e.g., Harvey et al. 1990; Jeffries et al. 2003; Lowry 2002; Sepulveda et al. 2009). Translating these numbers to in-water densities is difficult given the variability in foraging ranges, migration, and haul-out behavior between species and within each species, and is driven by factors such as age class, sex class, and seasonal variation. These data are often used in conjunction with abundance estimates from known haul-out sites to assign an in-water abundance estimate for a given area. The total abundance divided by the area of the region provides a representative density estimate for each species in a given location.

Ideally, density data would be available for all species for all areas in all seasons of the year, in order to best estimate the impacts of Navy activities on marine species. However, in many places poor weather conditions and high sea states prohibit the completion of comprehensive year-round surveys. In areas where survey data are limited or non-existent, known or inferred habitat associations are sometimes used to predict densities. Consequently, there is no single source of density data for every area, species, and season because of the fiscal costs, resources, and effort involved in providing enough survey coverage to sufficiently estimate density. The amount of effort required to collect and analyze data to estimate marine species density for the Navy's Study Areas is beyond the scope of any single organization or beyond any feasible means for the Navy. Therefore, to characterize marine species density for large oceanic regions such as the Navy's Study Areas, the Navy needed to review and critically assess existing density estimates from multiple sources, requiring the development of a systematic method for selecting the most appropriate value for each species, area, and season. The resulting compilation and structure of the selected marine species density data resulted in the Navy Marine Species Density Database (NMSDD).

Each source of data may use different methods to estimate density, of which, uncertainty in the estimate can be directly related to the method applied. As noted above, uncertainty in published density

estimates is typically large because of the low number of sightings collected during large survey efforts. Uncertainty characterization is an important consideration in marine mammal density estimation and some methods inherently result in greater uncertainty than others. Therefore, in selecting the best density estimate for a species, area, and time, it is important to select the data source that used a method that provides the most certainty for the geographic area. The beginning of this report provides a summary of the protocol that the Navy developed to inform the database manager on how the data sources compare to each other and to provide guidance on the most appropriate source to use for the specific area. These data are compiled by Atlantic Fleet, Pacific Fleet, and NAVSEA and are incorporated for Navy effects analysis in the NMSDD. This technical report provides further details on this protocol and how it was implemented for each marine mammal and sea turtle species present in the Navy's Pacific 3rd and 7th Fleet's AORs.

2 NAVY MARINE SPECIES DENSITY DATABASE PROTOCOL

2.1 DENSITY ESTIMATION METHODS AND RELATIVE UNCERTAINTY

Marine species density is the number of individuals that are present per unit area, typically per square kilometer. Statistically, density estimation of marine species, in particular, marine mammals and sea turtles, is very difficult because of the large amount of survey effort required, often spanning multiple years, and the resulting low number of observed sightings. Line-transect (the most common type of "distance sampling") methods typically focus on characterizing the probability of visually detecting an animal or group of animals to quantify and estimate the number of individuals missed. The result generally provides one single average density estimate for each species (unless stratification is performed), for the entire survey coverage extent, and usually is constrained to a specific timeframe or season. The estimate does not provide information on the species distribution or concentrations within that area, and does not estimate density for other timeframes/seasons that were not surveyed.

To quantify how species density varies geographically requires stratifying survey effort into smaller sub-regions during the density estimation process. There are several methods that can be applied to accomplish this and all will affect the uncertainty in the estimate differently. Three commonly used methods of density estimation using direct survey sighting data and distance sampling theory are considered here. They are designed-based density estimates, stratified-designed based density estimates, and estimates from density spatial models. Another suite of models, Relative Environmental Suitability (RES) models (also known as Environmental Envelope or Habitat Suitability Index models), use known or inferred habitat associations to predict densities, typically in areas where survey data are limited or non-existent. Following is a short summary of each of these density estimation methods.

2.1.1 DESIGNED-BASED DENSITY ESTIMATE

Designed-based density estimation uses line-transect survey data and usually involves distance sampling theory (Buckland et al. 2001) to estimate density for the entire survey extent. Systematic line-transect surveys can be conducted from both ships and aircraft; however, the time period available for sighting an animal is much shorter for aerial surveys as compared to ship surveys, and therefore more aerial survey effort may be required in order to obtain enough sightings to estimate densities. Conversely,

aerial surveys can cover a much larger area in a shorter period of time than ship surveys. Line-transect surveys are typically designed from the ground up with intent to survey and estimate density for a specific geographic area, hence the term "designed-based." This is the method of abundance estimation used for the NMFS marine mammal stock assessment reports. Values in the literature may be reported as abundance for the survey area, for which a density estimate can be inferred if the area is specified.

2.1.1 STRATIFIED DESIGNED-BASED DENSITY ESTIMATE

Stratified designed-based density estimates use the same survey data and methods as the designed-based method, but the study area is stratified into sub-regions and densities estimated specific to each sub-region. The advantage with this method is that geographically stratified density estimates provide a better indication of a species' distribution within the study area. The disadvantage is that the uncertainty is typically high compared to the designed-based estimate because each sub-region estimate is based on a smaller stratified segment of the overall survey effort. For impacts assessments that are geographically specific, the benefits of understanding the species geographic variability generally outweighs the increased uncertainty in the estimate.

2.1.2 SPATIAL MODELS

Spatial models estimate cetacean density as a continuous function of habitat variables (e.g., sea surface temperature, seafloor depth, etc.) and thus allow density predictions on finer spatial scales than designed-based or stratified designed-based methods. Models are developed using line-transect survey data collected in accordance with NMFS protocol and standards, and density estimates derived for divided segments in accordance with distance sampling theory (Buckland et al. 2001). These segments are fitted to environmental explanatory variables typically using a Generalized Additive Model (GAM). The advantage of this method is that the resulting density estimate is spatially defined (i.e., varies based on the animals geographic distribution and concentration) with little effect on increasing uncertainty. For geographic-specific impact assessments, this is the most preferred method of density estimation, and has been applied for many of the species in the Navy OPAREA Density Estimates (NODEs) and the Southwest Fisheries Science Center (SWFSC) density models. Since this method of density estimation yields the best value estimation with the least uncertainty, it is the preferred data source when available.

2.1.3 DENSITY BASED ON RELATIVE ENVIRONMENTAL SUITABILITY MODELS

The three methods described above estimate density directly from survey sighting data in conjunction with distance sampling theory. However, the majority of the world's oceans have not been surveyed in a manner that supports quantifiable density estimation of marine mammals and sea turtles. In the absence of survey data, information on species occurrence and known or inferred habitat associations have been used to predict densities using model-based approaches. These habitat suitability models include Relative Environmental Suitability (RES) models (also known as Environmental Envelope or Habitat Suitability Index models). Habitat suitability models can be used to understand the possible extent and relative expected concentration of a marine species distribution. These models are derived from an assessment of the species occurrence in association with evaluated environmental explanatory variables that results in defining the RES. A fitted model that quantitatively describes the relationship of

occurrence with the environmental variables can be used to estimate unknown occurrence in conjunction with known habitat suitability. Abundance can thus be estimated for each RES value, providing a means to estimate density for areas that have not been surveyed. Two recognized methods and sources of density estimation for marine mammals are considered here: the Kaschner et al. (2006) global density estimates and the Sea Mammal Research Unit, Limited at University of St. Andrews (SMRU Ltd.) global density estimates (SMRU Ltd. *in prep*).

2.2 OVERARCHING DATA SOURCE SELECTION AND IMPLEMENTATION GUIDELINES

Ideally, marine species sighting data would be collected for the specific area and time period of interest and density estimates derived accordingly. However, as mentioned above, there is no single source of density data for every species and season necessary for Navy impact analyses because of the fiscal costs, resources, and effort involved providing enough survey coverage to sufficiently estimate density. Therefore, depending on the region, species, and season of interest, there may be little to no density data available or multiple estimates derived from different methods. For example, relative to many other areas of the world's oceans, waters off the U.S. west coast have been surveyed extensively for the purpose of estimating cetacean abundance; both stratified designed-based (e.g., Barlow and Forney 2007) and density spatial models (e.g., Forney et al. 2012) are available for many of these species. In contrast, very little survey data are available for other regions that encompass the Navy's AOR. For example, systematic line-transect survey data are extremely limited in the Mariana Islands Study Area, particularly in the offshore areas. Most survey efforts in this region are localized and very close to shore, thus making it impossible to directly quantify the density of most species known to occur in the offshore regions. In these cases, some sort of extrapolated density estimate or prediction from a RES model needs to be used, both of which inherently include a high degree of uncertainty.

The methods the data source provider uses in developing the density estimate directly affect the level of inherent uncertainty in the estimate. As described above, if the density estimate for a geographic area is based on sighting data from a direct survey effort, the inherent uncertainty is comparatively low when compared to a RES-based estimate for a geographic area that has never been surveyed. Further, marine mammal surveys are typically conducted during one or two seasons because in many places poor weather conditions and high sea states prohibit the completion of winter surveys. So for the same species in the same region, one density estimation method may provide a better value for one season and a different method for the other seasons. Understanding these methods and how they affect the quality of the resulting density estimate is important to making an informed decision about which species-specific estimates are implemented in the NMSDD for each geographic area and season.

All density estimates are subject to a level of uncertainty. Further, many of the sources of uncertainty and the data themselves are not independent, which complicates standard analytical methods for estimating variance. Density estimates and predictions from ecological models should always be considered an approximation to truth (Burnham and Anderson 1998); even the best estimate of marine mammal density is really a model representation of the value(s) of concentration where these animals might occur. Each model is limited to the variables and assumptions considered by the original data source provider. No mathematical model representation of any biological population is perfect, and with

regards to marine mammal biodiversity, any single model will not completely explain the results considered.

In summary, for every region and species there is a broad range of available data of varying qualities that the Navy needs to evaluate in order to select the best values for incorporation into the NMSDD. Therefore, in order to provide a systematic structure for data source selection, the Navy established a hierarchal approach for ranking density estimates as described below.

2.2.1 HIERARCHAL APPROACH FOR RANKING DENSITY ESTIMATES

Some methods of density estimation are better than others and can produce a more accurate estimate with decreased uncertainty. Therefore, when there are multiple data sources available, the data selection process can be driven by the accuracy of those methods. As depicted in Figure 2-1 for the NMSDD, modeling methods are ranked as follows:

A) Density spatial model based estimates will be used when available.

- For the U.S. EEZ on the west coast and around the Hawaiian Islands, SWFSC models for the California Current Ecosystem and the Central Pacific could be used.

B) If no density spatial model based estimates are available, the following can be used in order of preference:

1) Density estimates using designed-based methods incorporating line-transect survey data and involving spatial stratification (i.e., estimates split by depth strata or arbitrary survey sub-regions)

2) Density estimates using designed-based methods incorporating only line-transect survey data (i.e., regional density estimate, stock assessment report)

3) Density estimates derived using a RES model in conjunction with survey data from SMRU Ltd. (SMRU Ltd. *in prep*) (primary) or in conjunction with a global population estimate from Kaschner et al.'s (2006) density data.

C) In some cases extrapolation from neighboring regional density estimates or population/stock assessments is appropriate based on expert opinion. In many cases this may be preferred over using RES models because of discrepancies identified by local expert knowledge. This includes an extrapolation of no occurrence based on other sources of data, such as the NMFS stock assessment reports or expert judgment.

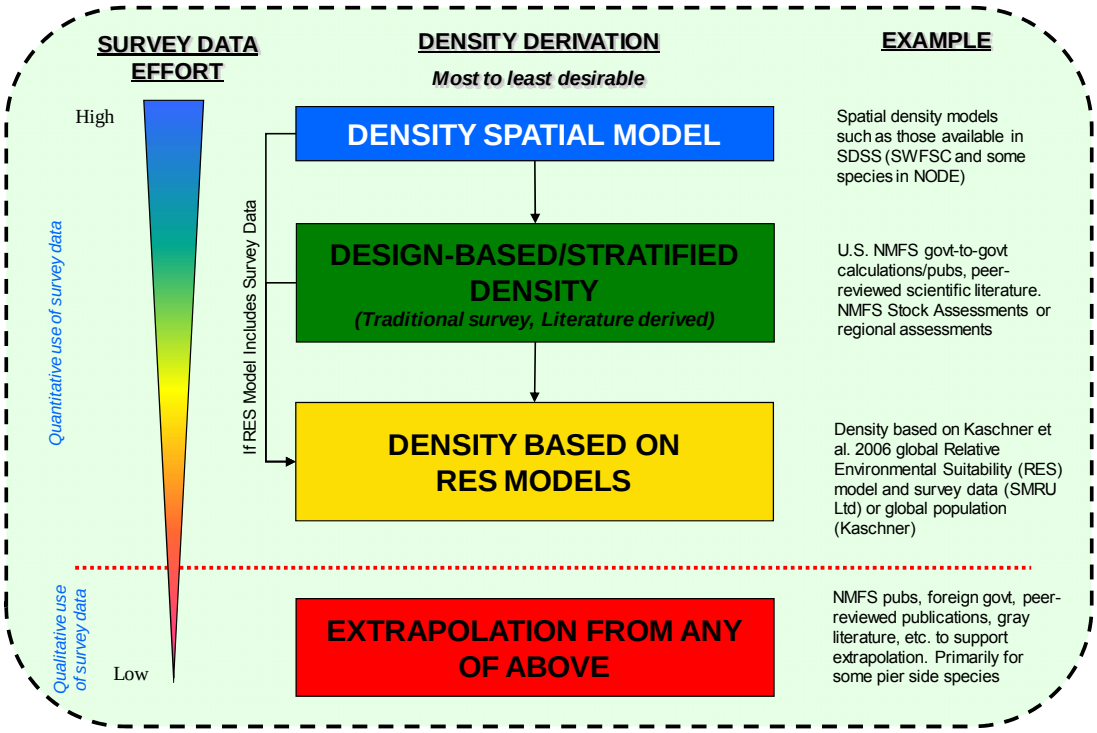

Figure 2-1: Graphical Depiction of Methods of Density Data Derivation and How They Rank in Guiding the Determination of What Density Data to Include in the NMSDD

2.2.2 NAVY MARINE SPECIES DENSITY DATABASE DENSITY DATA COMPILATION AND INTEGRATION

Density data incorporated into the NMSDD and subsequently used as input for the Navy's acoustic effects modeling are centrally managed at Naval Facilities Engineering Command, Atlantic through the Environmental Information Management System (EIMS).

In an effort to coordinate across the Fleets, data for each species are compiled to include the best available estimate of density for each specific area by season using the hierarchical approach outlined in Figure 2-1 as a guideline for selection.

For example, consider the density data file for fin whale (*Balaenoptera physalus*) in the eastern North Pacific during summer and fall:

Density data sources are ranked in order based on the methods outlined in Section 2.2.1 and Figure 2-1. They are:

1) SWFSC spatial models (U.S. EEZ)
2) SWFSC stratified designed-based estimates for two areas off Baja, California, Mexico
3) SMRU Ltd., global habitat based models (everywhere else)

The resulting density data file in Figure 2-2 shows the designated geographic location of density estimates integrated from the sources chosen above. Since the SWFSC density spatial model is the most

desirable data source for geographic areas where such models are available, these data are used in lieu of any other sources for this species and season (Figure 2-2). As is evident in Figure 2-2, the SWFSC model provides spatially-explicit density estimates within the U.S. EEZ. Stratified designed-based density estimates were available for two areas off Baja California, Mexico, and these are depicted as two areas of uniform density directly south of the U.S. EEZ. Data from the SMRU Ltd. model appears everywhere else. This ensures that there is only one representative density value for each geographic location. The results are species-specific density data files that are compilations of density data from potentially multiple sources for each species in a given geographic sub-area, defined seasonally where possible, and provide density values per season for each geographic area of interest.

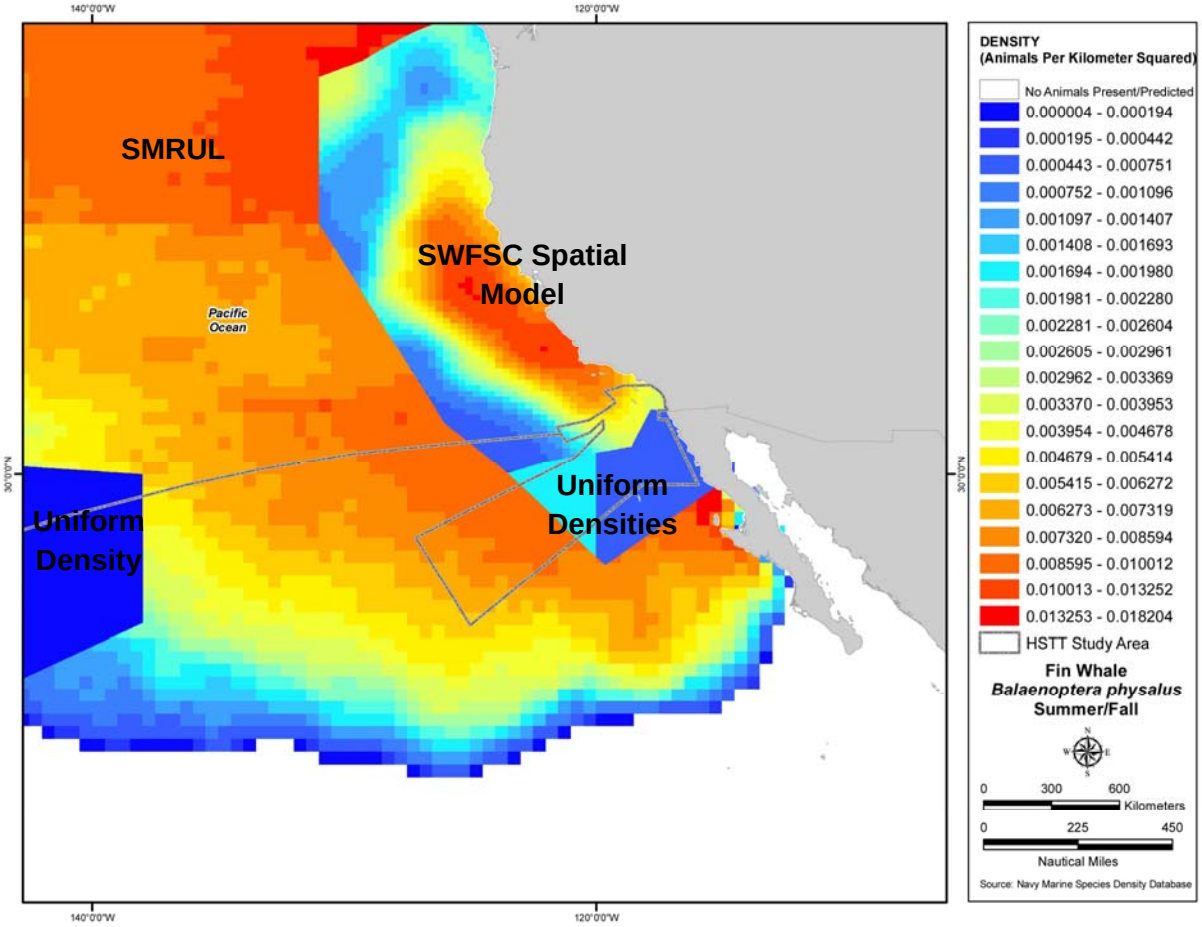

Figure 2-2: Example of a Combined NMSDD Density Data File

If species-specific density data are not available, the density value of a surrogate species or season can be used as a proxy value. A surrogate species is a species with similar morphology, behavior, and habitat preferences. A surrogate season is a season the best represents the expected distribution and density for that species. For some species for which density data are not available and abundance is expected to be extremely low (i.e., approaching zero), a minimum density estimate (e.g., 0.00001 animals/km^2) will be assigned to represent the potential for a species to be present.

Pacific Fleet, Atlantic Fleet, and System Commands (SYSCOMS) are each responsible for reviewing and including the best available density data for their AOR in an ArcGIS compatible format with associated metadata for inclusion into the master Atlantic and Pacific datasets. There is continual coordination between Pacific Fleet, Atlantic Fleet, and SYSCOMS to ensure consistency between various projects and commands across the Navy. Pacific Fleet, Atlantic Fleet, and SYSCOMS are also each responsible for developing the supporting documentation on the methods of implementation for data included in the NMSDD.

2.2.3 METHODS FOR SEASONAL DESIGNATION

Seasons are defined by the available data and the minimum number of timeframes that characterize the species distribution over one year. The number of timeframe designations could vary based on the detail of the available data. This could be designated by the traditional four seasons, warm and cold seasons, breeding and feeding seasons, monthly or smaller increments.

The dataset with the most seasonal classifications determines the number of seasonal density data files that need to be developed. A separate density data file is required for each season designation. In instances of combining a species for which there is an annual density estimate and a seasonally parsed density estimate, multiple density data files may be developed based on the seasonal category. For example, a species density dataset with four seasonal classifications is merged with a density dataset with an annual classification. The annual data need to be repeated for all four seasons and each repeated value must have the same season start and end dates as the season classification. There should be no overlapping time frames or geographic areas represented by the density data within the combination of the multiple datasets.

The ultimate result is a series of density data files that spatially and temporally have density values that span the species expected distribution for the entire year. The number of density data files for a given species are defined by the data region of greatest detail (i.e., the greatest number of seasonal timeframe designations) and may result in geographic partitioning and multiple density data files for a single species if seasonal definitions differ for oceanic areas.

2.2.4 FILE FORMAT AND MANAGEMENT

All density estimates need to be in an ArcGIS compatible format for integration with the Navy effects analysis model. All data are clipped to the National Geospatial-Intelligence Agency 1:250,000 coastline data for the coastal boundary. At a minimum, the metadata fields listed in Appendix A are to be included in the database file (.dbf) for all density values in the density data files.

The file format and structure standards are managed by the Naval Undersea Warfare Center modeling team in collaboration with Naval Facilities Engineering Command, Atlantic. By keeping the data in the same file format, new data can easily be added to future iterations of the species density data files. All density data files are to be loaded on EIMS for distribution and file management. This central location will ensure that the end user is using the correct, most up-to-date file available.

Uncertainty may be characterized in many different ways by the original density data provider, and are cataloged and preserved in the file format for potential later use. Additional metadata fields other than the ones listed in Appendix A can be used to incorporate and retain these values.

3 NAVY MARINE SPECIES DENSITY DATABASE – PACIFIC FLEET DENSITY DATABASE OVERALL METHODS AND SOURCES IMPLEMENTED

The following sections describe the Pacific Fleet Study Areas for which density data have been compiled and incorporated into the NMSDD. Available density data sources are also described. Pacific Fleet Study Areas addressed in this report include the Hawaii-Southern California Training and Testing (HSTT) Study Area, the Mariana Islands Training and Testing (MITT) Study Area, the Northwest Training and Testing (NWTT) Study Area, and the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA) Study Area.

3.1 PACIFIC FLEET STUDY AREAS

3.1.1 HAWAII-SOUTHERN CALIFORNIA TRAINING AND TESTING STUDY AREA

The Hawaii-Southern California Training and Testing (HSTT) Study Area includes three existing range complexes: the Southern California (SOCAL) Range Complex, Hawaii Range Complex (HRC), and Silver Strand Training Complex (SSTC). In addition to these range complexes, the Study Area also includes a vessel transit corridor, a route typically used by the Navy to traverse from one range complex to another (Figure 3-1).

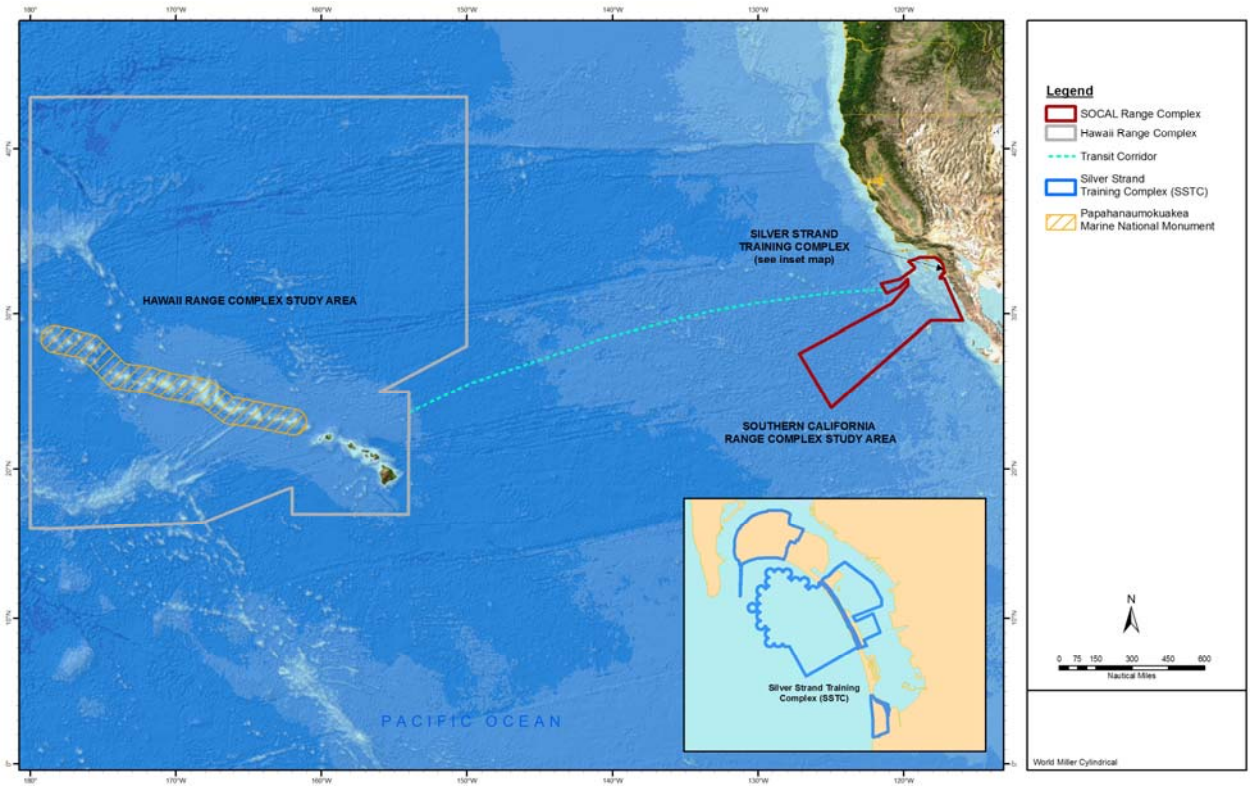

Figure 3-1: Hawaii-Southern California Training and Testing Study Area

3.1.2 MARIANA ISLANDS TRAINING AND TESTING STUDY AREA

The Mariana Islands Training and Testing (MITT) Study Area includes the existing Mariana Islands Range Complex (MIRC), additional areas on the high seas, and a transit corridor between the MIRC and the Hawaii Range Complex starting at the International Date Line where training and testing activities may occur (Figure 3-2). A representative region was selected to model the transit corridor, referred to as the "Transit Corridor: Representative Study Area" on all the density figures. The MIRC is the only Navy range complex in the Study Area.

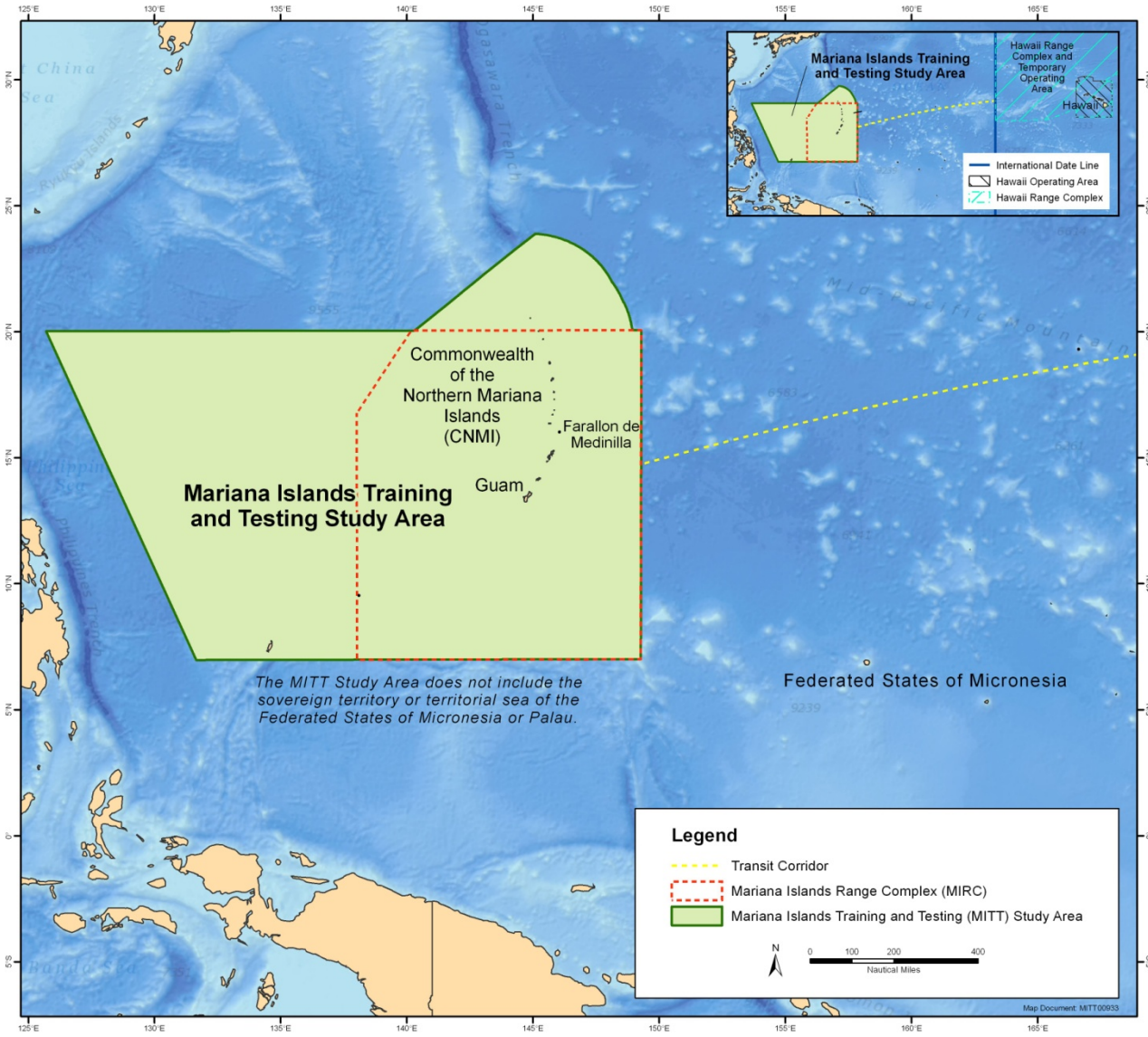

Figure 3-2: Mariana Islands Training and Testing Study Area

3.1.3 NORTHWEST TRAINING AND TESTING STUDY AREA

The Northwest Training and Testing (NWTT) Study Area is composed of established maritime operating and warning areas in the eastern North Pacific Ocean region, including the Strait of Juan de Fuca, Puget Sound, and Western Behm Canal in Southeast Alaska. The area includes air and water space within and outside Washington state waters, and outside state waters of Oregon and Northern California, as well as state waters of Alaska. The Study Area includes four existing range complexes and facilities: the Northwest Training Range Complex (NWTRC), the Keyport Range Complex, Carr Inlet Operations Area, and the Southeast Alaska Acoustic Measurement Facility (SEAFAC). In addition to these range complexes, the Study Area also includes Navy pierside locations where sonar maintenance and testing occurs as part of overhaul, modernization, maintenance, and repair activities at Navy piers at Naval Base (NAVBASE) Kitsap Bremerton, NAVBASE Kitsap Bangor, and Naval Station Everett (Figure 3-3). Given the complexity of the NWTT Study Area, it was divided into three distinct geographic and functional subdivisions to aid in the identification of density data and for subsequent Navy effects modeling: (1) NWTT Offshore, (2) NWTT Inland Waters, and (3) NWTT Western Behm Canal, Alaska.

3.1.4 GULF OF ALASKA TEMPORARY MARITIME ACTIVITIES AREA STUDY AREA

The Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA) Study Area is composed of surface and subsurface ocean training areas and overlying airspace that includes the majority of Warning Area 612 (W-612) (Figure 3-4). The TMAA is situated south of Prince William Sound and east of Kodiak Island. The northern boundary of the TMAA is located approximately 24 nm (44 km) south of the shoreline of the Kenai Peninsula, which is the largest proximate landmass. The Seamount Habitat Protection Areas shown on Figure 3-4 were established under various Fisheries Management Plans developed by Regional Fishery Management Councils and implemented by NMFS for the protection of fisheries. Seamounts are isolated underwater mountains rising 900 to 3,000 m above the surrounding ocean bottom and thus provide a unique habitat for both deep-sea and shallow-water organisms. Upwelling often occurs around seamounts because currents push cold water from the depths up the slopes of the seamounts, bringing fresh nutrients to the surface.

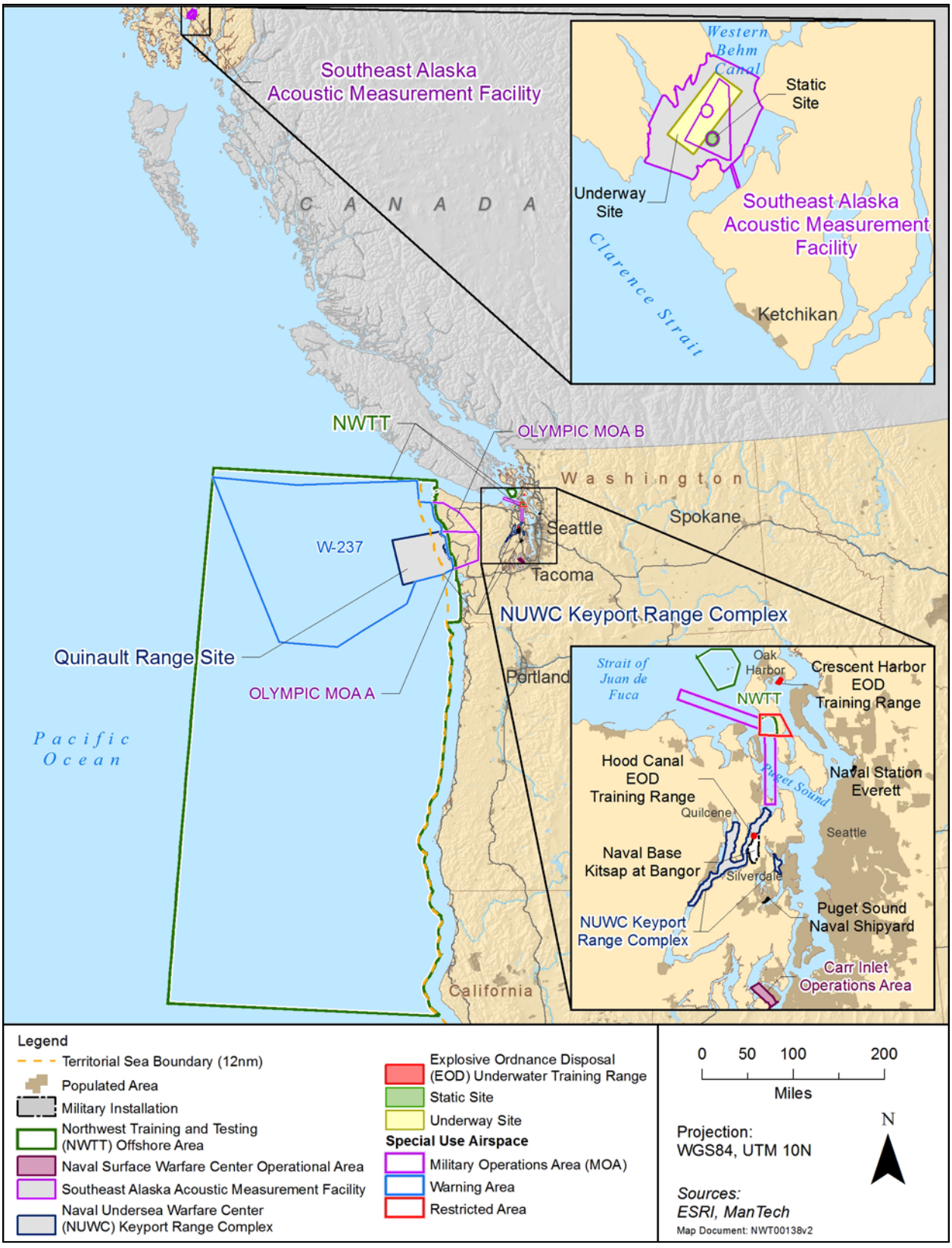

Figure 3-3: **Northwest Training and Testing Study Area**

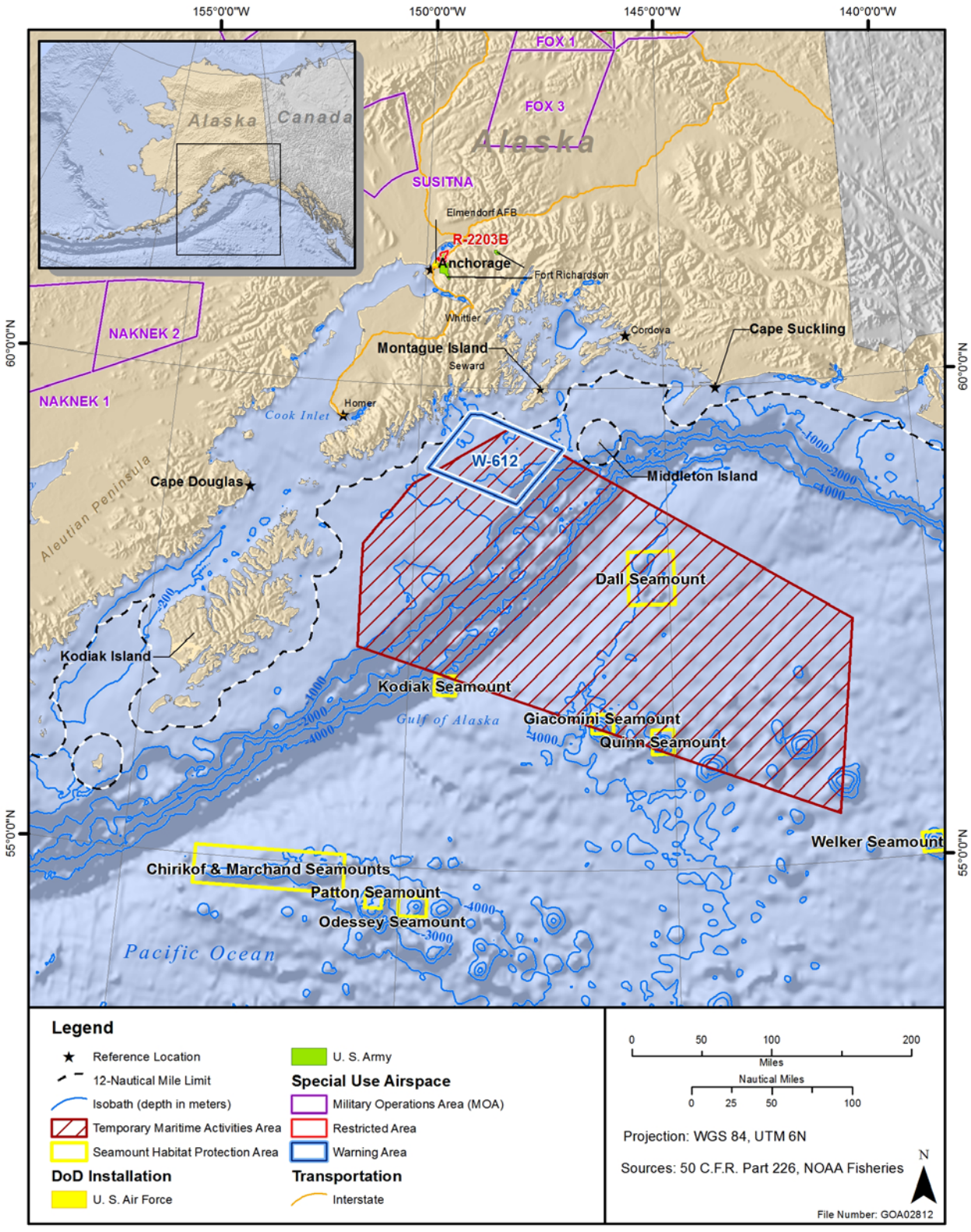

Figure 3-4: Gulf of Alaska Temporary Maritime Activities Area Study Area

3.2 APPLICATION OF THE NAVY MARINE SPECIES DENSITY DATABASE PROTOCOL TO PACIFIC FLEET DENSITY DATABASE

NMSDD shapefiles for the Pacific Fleet Study Areas are currently stratified by four seasons:

Winter: December–February
Spring: March–May
Summer: June–August
Fall: September–November

However, density data were rarely available at this temporal resolution. Marine mammal surveys are typically conducted during only one or two seasons because rough weather conditions in winter/spring make it difficult to collect shipboard line-transect data. Off California, for example, much of the data that exist for winter/spring have been collected during aerial surveys. In this case, ship survey data provide the best estimates for summer/fall, while aerial survey data provide the best estimates for winter/spring. Further, the current NMSDD seasonal stratification approach is not appropriate for every project region. Ideally, seasonal strata would be based on the greatest differences in oceanographic conditions for a given study area. For example, off the U.S. west coast, the "warm-water period" is generally considered June–November and the "cool-water period" January–April, while December and May are considered periods of transition. In this case, given the seasonal periods used for the NMSDD, the warm-water period fits nicely into the summer/fall strata, while the cool-water and transitional periods are both included in the winter/spring strata. In this example, given limitations in the available survey data, the "summer/fall" estimate will populate both the "summer" and "fall" shapefiles and the "winter/spring" estimate will populate both the "winter" and "spring" shapefiles. In the case of an annual density estimate, it will be repeated for all four seasons.

For each area and season, the Navy's goal is to identify the best available density estimate, and thus may rely on different data sources. To select marine species density estimates for the Pacific Fleet Study Areas, the Navy established a data hierarchy based on available data (Table 3-1). These levels were established consistent with the hierarchal approach for ranking density estimates as described above in Section 2.2.1. When appropriate, the most preferred density values may be those extrapolated from Levels 1 through 3 below. As described in Section 2.2.1, extrapolation from neighboring regional density estimates or population/stock assessments is appropriate based on expert opinion and is preferred over using RES models because of discrepancies identified by local expert knowledge.

The different data sources are described in more detail in the following sections.

Table 3-1: Hierarchy of Density Data Sources for Pacific Fleet Study Areas

Level 1 (Most Preferred)	Peer reviewed published studies of density spatial models that provide spatially-explicit density estimates
Level 2	Peer reviewed published studies of stratified designed-based density estimates
Level 3	Peer reviewed published studies of designed-based density estimates
Level 4	St. Andrew's RES Model (SMRU Ltd. *in prep*)
Level 5 (Least Preferred)	Kaschner et al. RES Model (Kaschner et al. 2006)

The NMSDD protocol was applied when selecting the best available marine species density for the 3rd and 7th Fleets' AORs. For the HSTT Study Area, Level 1 data (habitat-based density models; see Table 3-1) were available for multiple species/species groups within the NMFS SWFSC survey areas off the U.S. west coast and Hawaii for the summer/fall seasons. For other species, seasons, and areas (e.g., Baja, Mexico), stratified line-transect density estimates (i.e., Level 2 data) were available. For a small number of species for the winter/spring seasons, and for a small portion of the HSTT Study Area that extended west of the SWFSC survey area, density estimates were extrapolated from stratified line-transect density estimates. Based on expert opinion from scientists at the SWFSC, for these HSTT cases for which Level 1–3 density estimates were not available, extrapolated density estimates were considered more representative of expected densities than those generated from the lower level sources (i.e., Level 4 and 5 data).

In contrast, there were no Level 1 or 2 data (habitat-based density models or stratified designed-based density estimates; see Table 3-1) available for the MITT Study Area, and Level 3 data (designed-based density estimates) were available for only a few species. Prior to 2007, when the Navy conducted the first comprehensive marine mammal survey of waters off the Mariana Islands, there was little information available on the occurrence of marine mammals in the MITT Study Area, and much of what was known came from whaling records, stranding records, and anecdotal sighting reports. Some sighting data were available from scientific surveys conducted in the western and central Pacific, although most of these efforts focused on waters off Japan, Taiwan, the Philippines, and lower latitude regions (Darling and Mori 1993; Dolar et al. 2006; Ohizumi et al. 2002; Wang et al. 2001; Yang et al. 1999), and provide limited to no data specific to the Study Area. Based on expert opinion from scientists at the PIFSC, for some species known to occur in the MITT Study Area, stratified line-transect estimates from SWFSC surveys off Hawaii were considered more representative of expected densities than those generated from the lower level sources. Further, given the absence of seasonal density data for this region, and the lower seasonal variability generally expected for low-productivity tropical waters typified by the MITT Study Area, density estimates for most species are provided on an annual basis. The exception is for blue, fin, sei (*Balaenoptera edeni*), minke (*Balaenoptera acutorostrata*), and humpback whales (*Megaptera novaeangliae*), which are likely absent from low-productivity tropical waters in the summer

(Jefferson et al. 2008; Perrin and Brownell 2009), and were assigned a zero density estimate for this season.

Given the different oceanographic regions encompassed by the NWTT Study Area, a variety of sources were used to populate the strata developed for density estimation. Level 1 data (habitat-based density models; see Table 3-1) were available for multiple species/species groups within the NMFS SWFSC survey areas off the U.S. west coast (i.e., the Oregon/Washington and Northern California strata). Level 2 and Level 3 data (stratified designed-based and design-based density estimates; see Table 3-1) were also available for these areas. Level 3 data were available for a limited number of species north of the NMFS SWFSC survey areas, but for most species for which Level 1–3 density estimates were not available, extrapolated density estimates from the SWFSC Oregon/Washington stratum were considered more representative of expected densities than those generated from the lower level sources (i.e., Level 4 and 5 data; Ferguson et al. 2011). Level 3 data were available for some species within the Inland Waters strata and for other species, sighting data in concert with expert opinion were used to develop density estimates for this region. Density estimates developed in support of a Navy Draft Environmental Assessment for SEAFAC/Western Behm Canal Environmental Assessment (EA; U.S. Department of the Navy 2010b) were used for the NWTT Western Behm Canal stratum.

Marine mammal survey data in the offshore waters of the Gulf of Alaska TMAA Study Area are limited, as most survey efforts have been localized and nearshore. The Navy conducted the first comprehensive marine mammal survey of waters in the Study Area from 10 to 20 April 2009 (Rone et al. 2009). The Navy funded a second systematic survey of the Study Area that occurred from 23 June to 18 July 2013 (Rone et al. 2014). Sighting data were sufficient to derive Level 2 density estimates for seven species (Rone et al. 2014). Density estimates developed in support of a Navy Environmental Impact Statement/Overseas Environmental Impact Statement for training activities in the Gulf of Alaska TMAA (U.S. Department of the Navy 2009) were used for other species. For those species for which there was a complete lack of density data (i.e., sei whale and Stejneger's beaked whale), Level 4 data were used.

In January 2011, NOAA developed a Cetacean Density and Distribution Mapping Working Group to create regional cetacean density and distribution maps that are species and time-specific, using line-transect survey data and habitat-based density models. These data have been placed on a public website (http://www.st.nmfs.noaa.gov/cetsound/). Density values incorporated into the NMSDD are consistent with those species, areas, and seasons for which NOAA's Working Group has provided specific density values.

Information on the data density sources available for each of the Pacific Fleet Study Areas is included in the next section.

3.3 INFORMATION ON DENSITY DATA SOURCES CONSIDERED AND INCLUDED

3.3.1 LEVEL 1–LEVEL 3 DATA SOURCES

Consistent with the hierarchal approach for ranking density estimates as described above in Section 2.2.1. and the established levels summarized in Table 3-1, the majority of Level 1 through Level 3 data (see Table 3-1) used to describe cetacean densities within the HSTT Study Area, as well as the majority

of the offshore region of the NWTT Study Area, were estimated from systematic line-transect shipboard surveys conducted by NMFS SWFSC from 1986 to 2008 (Figure 3-5). As noted in Section 2.2.1, these sources of density data are the most preferred. The SWFSC surveys are typically conducted in summer/fall (roughly July–November) and cover three major study areas: (1) the California Current Ecosystem (waters off the U.S. west coast between the shore and approximately 300 nm offshore), (2) the Central Pacific (waters north of the equator between the International Date Line and approximately 130° west [W] longitude), and (3) the Eastern Tropical Pacific (waters extending from the U.S.-Mexico Border south to Peru and west to approximately 130°W longitude). Data from these surveys have been used to develop spatial density models and to estimate densities using line-transect analyses as described below. The study areas used to develop spatial density models for the California Current Ecosystem and the Central North Pacific overlap a large portion of the HSTT Study Area, as well as the NWTT Offshore Study Area (Figure 3-6). Although they do not overlap, the two SWFSC study areas approach each other at the western edge of the California Current Ecosystem study area and the eastern edge of the Central North Pacific study area.

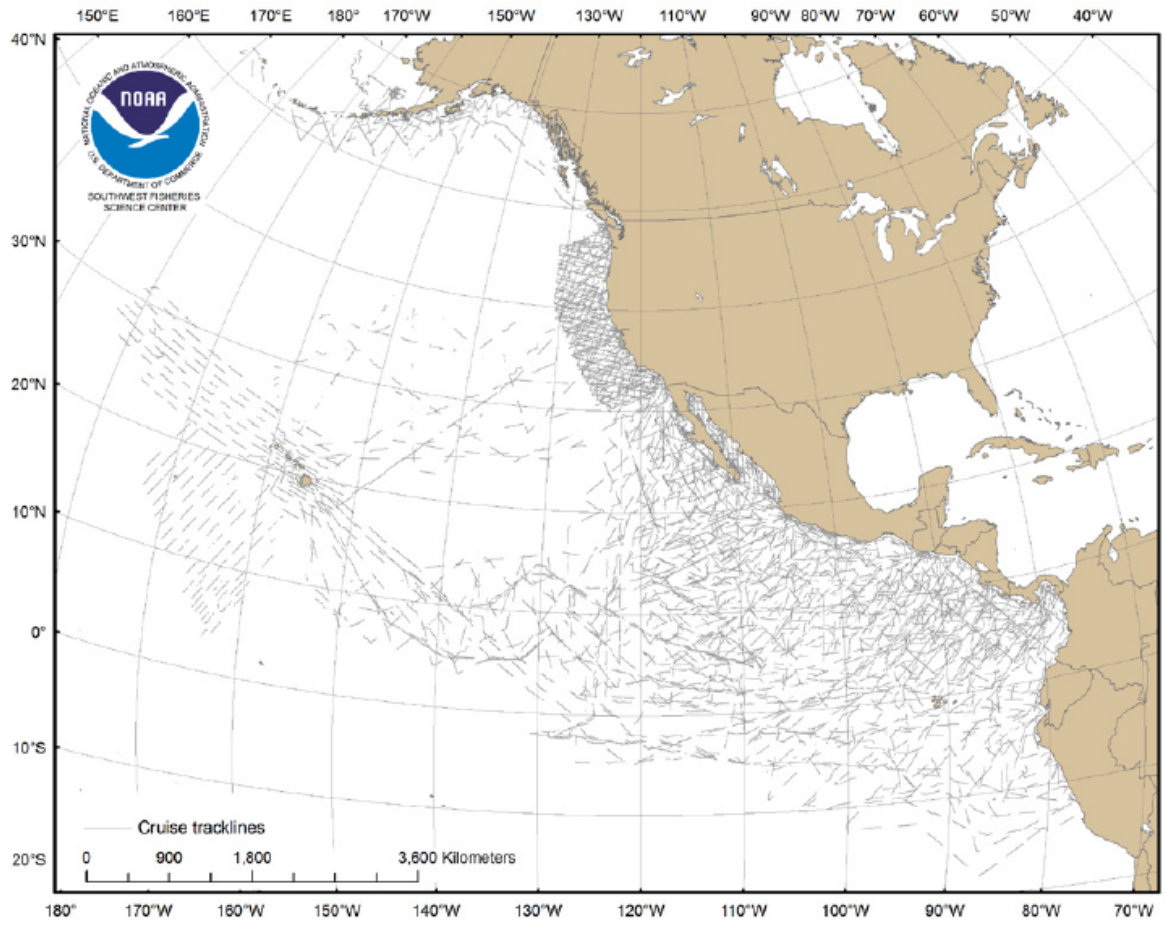

Figure 3-5: Transects Surveyed by the Southwest Fisheries Science Center from 1986 to 2008. From Hamilton et al. (2009).

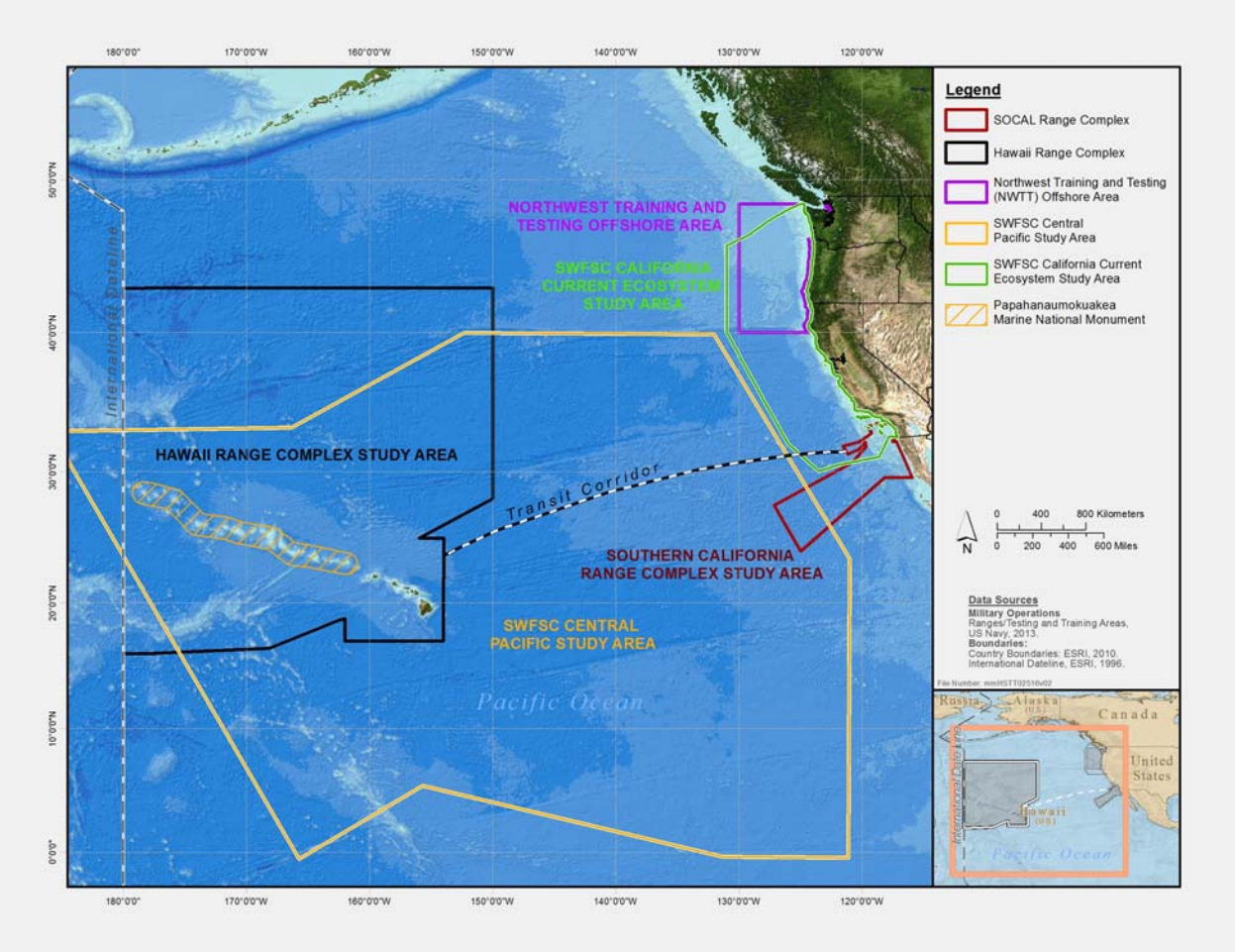

Figure 3-6: NMFS' California Current Ecosystem Study Area and Central Pacific Study Area Overlaid on the Pacific Fleet HSTT and NWTT Offshore Study Areas. Note that the NMFS study areas do not completely cover either of the Navy's Study Areas.

NMFS SWFSC Habitat-Based Density Models for the California Current Ecosystem (CCE Models)

This data source is the top tier (Level 1) in the hierarchy of density data. SWFSC used data from four ship-based cetacean and ecosystem assessment surveys to develop habitat-based density models and predict density for 11 cetacean species and one species guild in the California Current Ecosystem (CCE). All data used for modeling were collected by SWFSC during summer through fall in 1991, 1993, 1996, and 2001 using line-transect survey methods aboard large oceanographic vessels. Habitat variables used in the density models included temporally dynamic environmental measures (e.g., sea surface temperature) and more static geographical measures (e.g., water depth, bathymetric slope) (Becker et al. 2010). Models were validated based on an additional SWFSC survey conducted during summer through fall 2005 (Barlow et al. 2009; Forney et al. 2012). Model results were incorporated into a web-based system developed by Duke University (Best et al. 2012) called the Spatial Decision Support System (SDSS), which allows users to view model outputs within areas of interest as color-coded maps of cetacean density, and includes a table of densities and measures of precision (expressed as point-wise standard errors and log-normal 90% confidence intervals).

In 2010, the models were re-built using an additional set of line-transect survey data collected in summer/fall 2008 (Becker et al. 2012c). Data from the 2008 survey were pooled with the 1991–2005 data and habitat-based density models were developed using methods similar to those described for other CCE modeling efforts (Barlow et al. 2009; Becker et al. 2010, 2012a; Forney et al. 2012). Consistent with the previous CCE effort, models were built for striped dolphin (*Stenella coeruleoalba*), short-beaked common dolphin (*Delphinus delphis*), Risso's dolphin (*Grampus griseus*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), northern right whale dolphin (*Lissodelphis borealis*), Dall's porpoise (*Phocoenoides dalli*), sperm whale (*Physeter macrocephalus*), fin whale, blue whale (*Balaenoptera musculus*), humpback whale, Baird's beaked whale (*Berardius bairdii*), and a small beaked whale guild (including Cuvier's beaked whale [*Ziphius cavirostris*] and *Mesoplodon* spp.). The additional year of data provided increased sample sizes and a greater range of oceanic conditions for robust model development. Final model predictions were used to update the web-based SDSS and provided to the Navy in ArcGIS format. The SWFSC CCE habitat-based density models received further validation in a more recent study, which evaluated their ability to produce short-term forecasts of cetacean distribution in the CCE (Becker et al. 2012a).

NMFS SWFSC Habitat-Based Density Models for the Central North Pacific (CENPAC Models)

This data source is the top tier (Level 1) in the hierarchy of density data. Habitat-based density models were developed for cetaceans in the Central North Pacific, based on cetacean survey data collected by the SWFSC in 1997–2006 (Becker et al. 2012b). Cetacean sighting data were collected on systematic line-transect surveys in the temperate eastern Pacific, around Hawaii and other Pacific Islands, and in the eastern tropical Pacific west of 120 degrees longitude. Habitat variables, derived from satellite data, included sea surface temperature, sea surface chlorophyll, sea surface height root-mean-square, average primary productivity, distance to land, latitude, and longitude. Models were developed for ten cetacean species/species groups (pantropical spotted dolphin [*Stenella attenuata*], spinner dolphin [*Stenella longirostris*], striped dolphin, rough-toothed dolphin [*Steno bredanensis*], bottlenose dolphin [*Tursiops truncatus*], false killer whale [*Pseudorca crassidens*], short-finned pilot whale [*Globicephala macrorhynchus*], sperm whale, Bryde's whale (*Balaenoptera edeni*), and an "other dolphins" group which included short-beaked common dolphin and Pacific white-sided dolphin); uniform densities were estimated for five additional species/guilds that had too few sightings for modeling (Risso's dolphin, killer whale [*Orcinus orca*], pygmy killer whale [*Feresa attenuata*], *Kogia* spp., and a small beaked whale guild). The resulting species densities were provided to the Navy in ArcGIS format.

NMFS SWFSC Line-Transect Density Estimates for the California Current Ecosystem

This data source is one of the preferred (Level 2) sources of density data in the established hierarchy.

Summer/Fall Shipboard Surveys. As described above, ship-based line-transect surveys have been conducted by NMFS SWFSC in their CCE study area from July through November 1991, 1993, 1996, 2001, 2005, and 2008. Information on the search effort and number of species sighted during these surveys is reported in numerous NMFS SWFSC administrative reports, technical memoranda, and peer-reviewed publications. Barlow and Forney (2007) used a multiple-covariate line-transect approach

(Marques and Buckland 2003) to estimate densities from the 1991–2005 survey data. Cetacean density estimates for the CCE study area (1,141, 800 square kilometers [km^2]) were stratified into four geographic regions: (1) waters off Oregon and Washington (322,200 km^2 north of 42° north [N]); (2) northern California (258,100 km^2 south of 42°N and north of Point Reyes at 38°N); (3) central California (243,000 km^2 between Point Conception at 34.5°N and Point Reyes); and (4) southern California (318,500 km^2 south of Point Conception). Uniform density estimates for each of these four regions were provided for 19 species, as well as *Kogia* spp. and *Mesoplodon* spp. (Barlow and Forney 2007). Barlow et al. (2009) also provided a summary of the geographically stratified summer/fall estimates for those species for which habitat-density models could not be developed (due to insufficient sample sizes), as well as year-round estimates for harbor porpoise (*Phocoena phocoena*) and the California coastal stock of bottlenose dolphin. More recently, Barlow (2010) provided cetacean abundance estimates based on the 2008 survey data.

Winter/Spring Aerial Surveys. NMFS SWFSC conducted aerial surveys off California from March to April 1991 and February to April 1992. The surveys covered waters from the coast offshore to 150 nm offshore (Figure 3-7). Forney et al. (1995) provided cetacean density estimates derived by standard line-transect analyses; these estimates were stratified by four geographic regions within the aerial survey study area (Figure 3-7). Barlow et al. (2009) also provided a summary of the geographically stratified winter/spring density estimates.

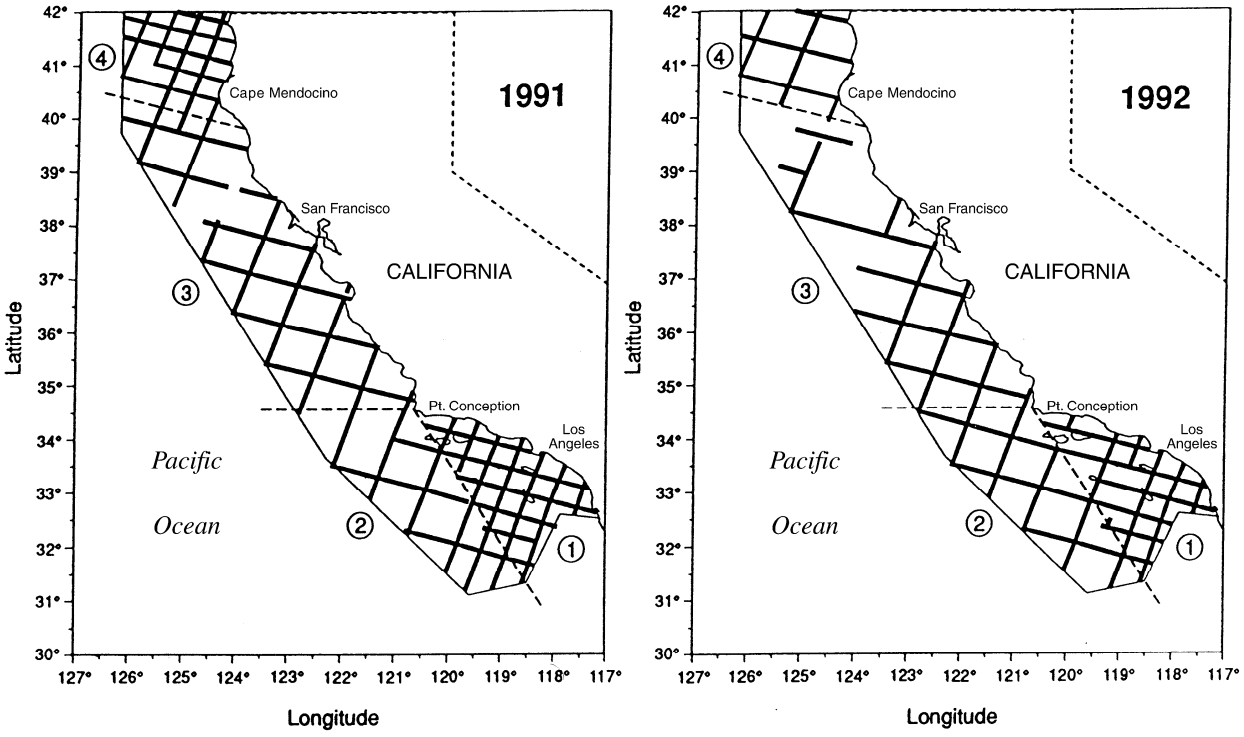

Figure 3-7: Completed Transects (Solid Lines) for the Aerial Surveys Conducted by NMFS SWFSC off California in March–April 1991 and February–April 1992. The geographic strata used for density estimation are shown by broken lines, with stratum numbers shown in circles. From Forney et al. (1995).

NMFS SWFSC Line-Transect Density Estimates for the Hawaiian Exclusive Economic Zone

This data source is one of the preferred (Level 2) sources of density data in the established hierarchy.

NMFS SWFSC conducted a ship-based line-transect survey in summer/fall (August–November) 2002 covering U.S. EEZ waters surrounding Hawaii, including all of the Northwest Hawaiian Islands (Figure 3-8). Barlow (2006) provided line-transect abundance estimates for 19 cetacean species based on a multiple covariate approach (Marques and Buckland 2003); estimates were stratified based on the geographic strata shown in Figure 3-8.

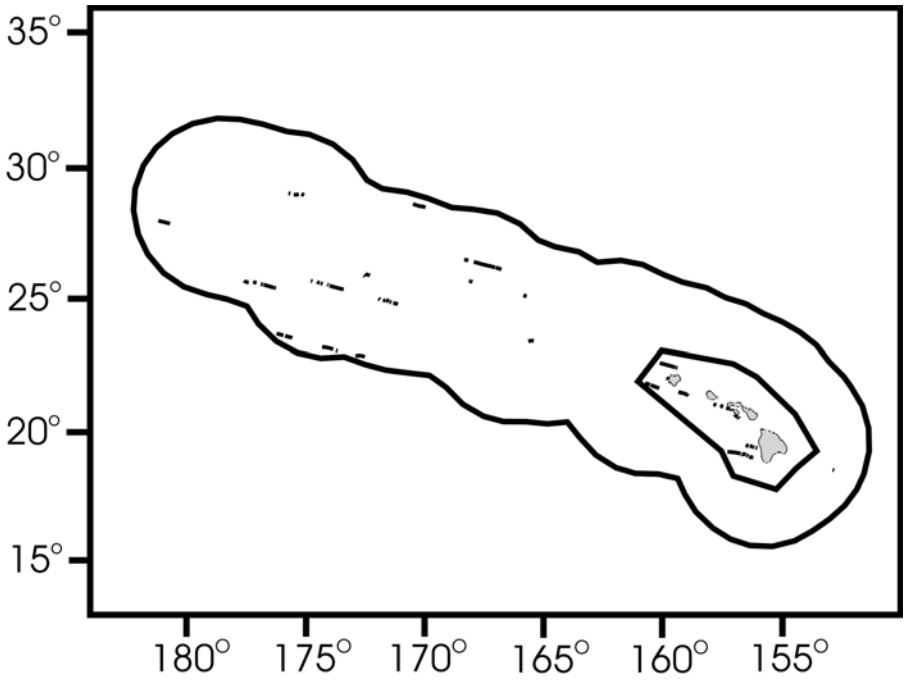

Figure 3-8: Study Area for the Shipboard Line-Transect Survey Conducted by NMFS SWFSC in 2002. Bold lines show the two strata used for abundance analysis: (1) Main Hawaiian Islands stratum and (2) Outer Exclusive Economic Zone stratum. Fine lines show search effort in Beaufort sea states of 0–2 conditions. From Barlow (2006).

NMFS SWFSC Line-Transect Density Estimates for the Eastern Pacific Ocean

This data source is one of the preferred (Level 2) sources of density data in the established hierarchy.

Ferguson and Barlow (2003) provided broad-scale line-transect abundance estimates for cetaceans in the eastern Pacific based on nine NMFS SWFSC shipboard surveys conducted between 1986 and 1996. Their study area encompassed more than 25 million km^2, and included SWFSC's CCE, Central Pacific, and Eastern Tropical Pacific study areas. Density estimates were stratified geographically by 5-degree squares of latitude and longitude (Figure 3-9). Although they are at relatively large spatial resolution, the stratified estimates provide density estimates for areas not covered by some of the other published reports (e.g., Baja, Mexico).

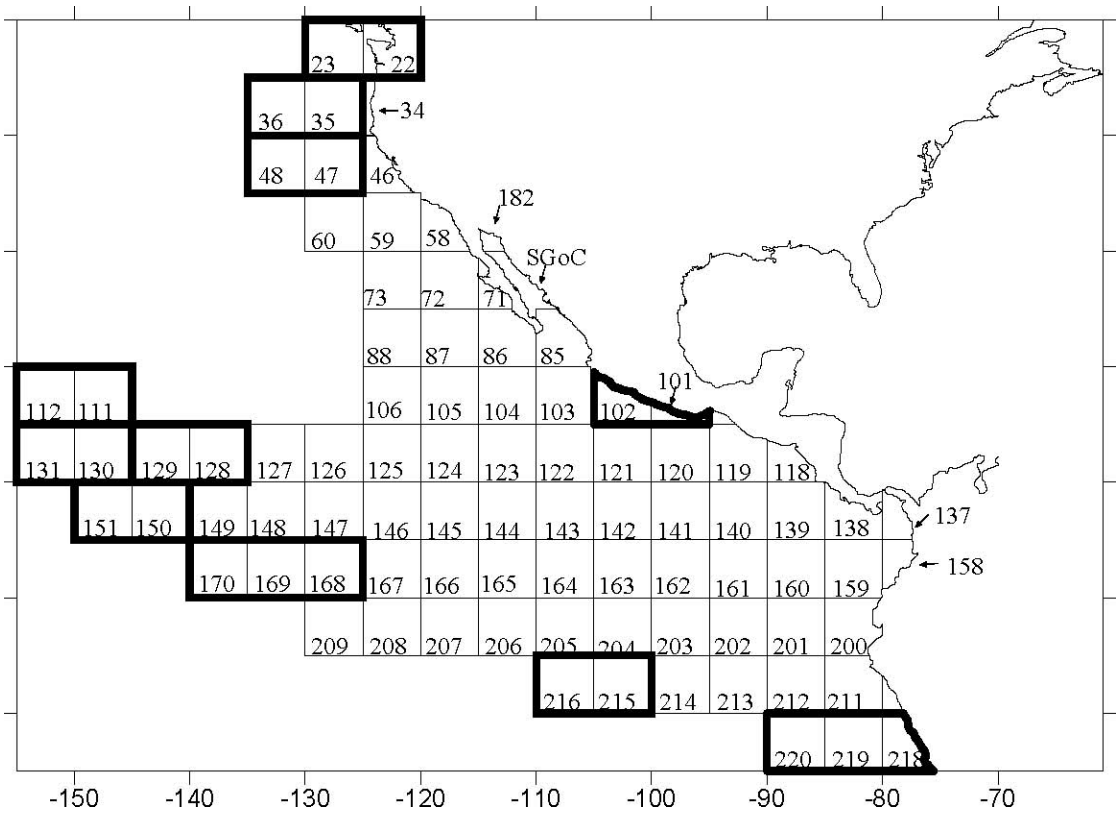

Figure 3-9: Geographic Strata Used for Density Estimation by Ferguson and Barlow (2003)

Navy Line-Transect Density Estimates for the Mariana Islands Region

This data source is one of the preferred (Level 3) sources of density data in the established hierarchy.

In the MITT Study Area there is a paucity of systematic survey data and little is known about the stock structure of the majority of marine mammal species in the region. The Navy conducted the first comprehensive marine mammal survey of waters off Guam and the Commonwealth of the Northern Mariana Islands from 13 January to 13 April 2007 (Fulling et al. 2011; Figure 3-10). The survey was conducted using systematic line-transect survey protocol consistent with that used by NMFS SWFSC (Barlow 2003, 2006). Both visual and acoustic detection methods were used during the survey (Fulling et al. 2011; Norris et al. 2012). The majority of the survey was conducted in high sea states (i.e., Beaufort sea state > 4), but 13 cetacean species were observed. Fulling et al. (2011) provided line-transect abundance estimates for 12 cetacean species using standard methods (Buckland et al. 2001). Norris et al. (2012) used modified line-transect methods to estimate minke whale (*Balaenoptera acutorostrata*) density based on passive acoustic detections from the 2007 survey.

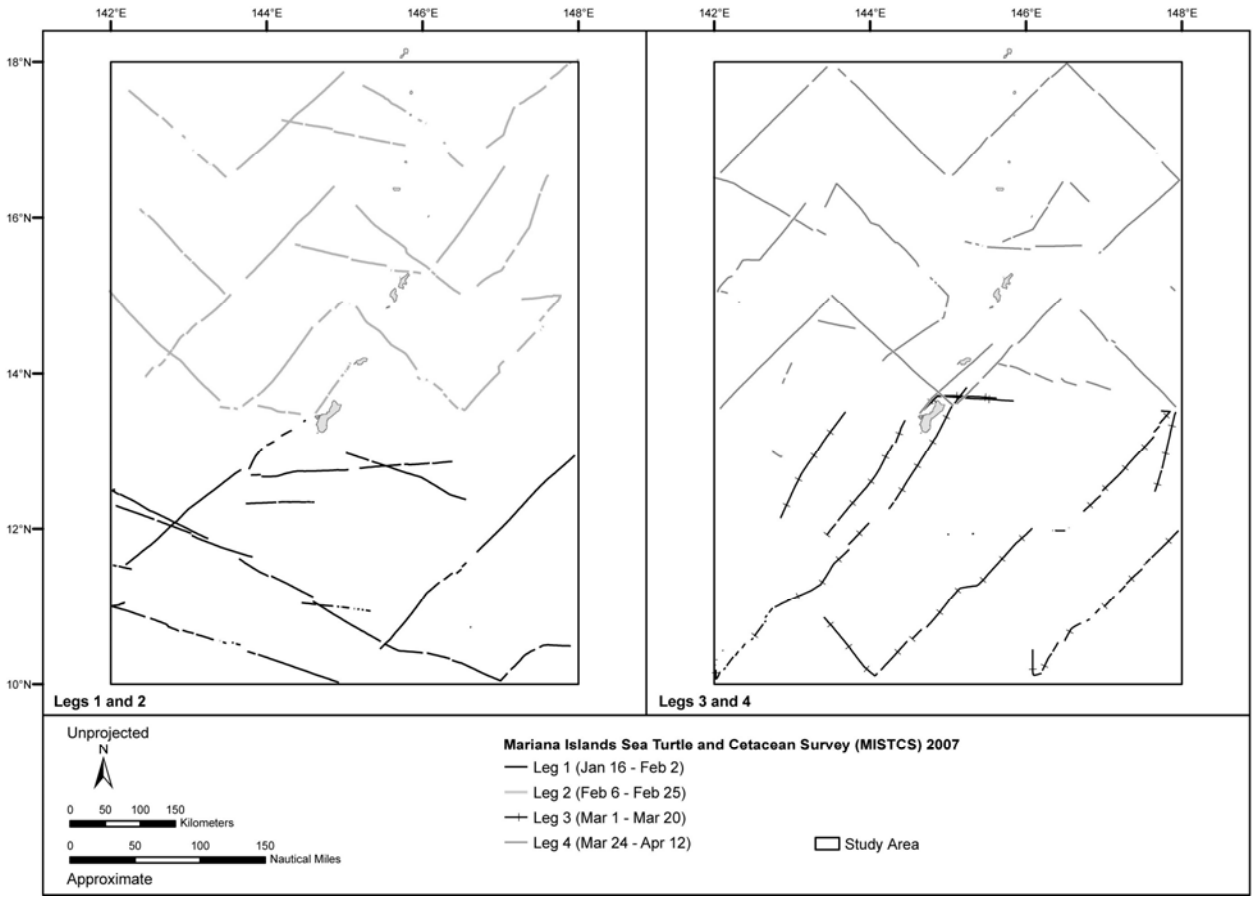

Figure 3-10: Transect Lines Completed During the 2007 Mariana Islands Survey. From Fulling et al. (2011).

Navy Line-Transect Density Estimates for Hood Canal and Dabob Bay

This data source is one of the preferred (Level 3) sources of density data in the established hierarchy.

The Navy conducted an opportunistic marine mammal vessel line-transect survey in Hood Canal and Dabob Bay during September and October 2011 (U.S. Department of the Navy 2012). Marine mammal sighting data collected during the surveys included species identification, GPS animal locations relative to vessel position, and detailed behavioral notes. Data from the line-transect surveys were used to derive density estimates for harbor porpoise.

An aerial survey completed in 2013 has resulted in estimates of density for harbor porpoise and harbor seal for all parts of Puget Sound (Smultea et al. 2014), and further surveys planned for 2014 should allow other species and seasons to be estimated. These density estimates will be incorporated into future versions of the NMSDD.

Navy Line-Transect Density Estimates for the Gulf of Alaska Temporary Maritime Activities Area

This data source is one of the preferred (Level 2) sources of density data in the established hierarchy.

The Navy has conducted two comprehensive marine mammal surveys of waters in the TMAA Study Area. The first survey was conducted from 10 to 20 April 2009 using systematic line-transect survey protocol, and both visual and acoustic detection methods were used (Rone et al. 2009). Sighting data were sufficient to derive line-transect density estimates (Level 3) for fin and humpback whales (Rone et al. 2009). During the second Gulf of Alaska Line-Transect Survey (GOALS II) that occurred from 23 June to 18 July 2013, both visual and acoustic data were collected in four strata that were designed to encompass the four distinct habitats within the TMAA (Figure 3-11). Rone et al. (2014) provided stratified line-transect abundance estimates for fin, humpback, blue, sperm, and killer whales, as well as Dall's porpoise and northern fur seals. Density estimates from the GOALS II survey were incorporated into the NMSDD for these species, including fin and humpback whales since the new estimates were geographically stratified (Level 2) and more precise than the 2009 estimates for these two species.

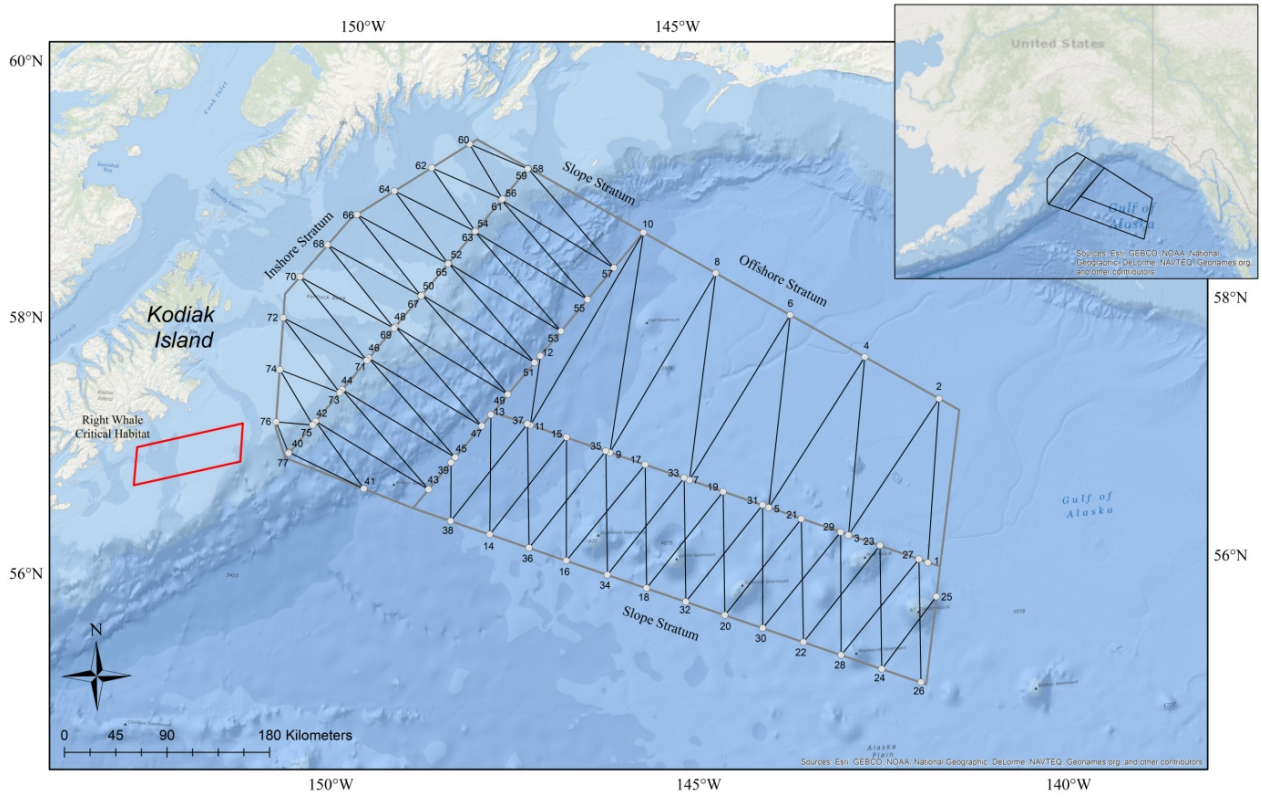

Figure 3-11: Survey strata and tracklines for the 2013 GOALS II survey. From Rone et al. (2014).

Additional Line-Transect Density Estimates for Regions within the Navy's Pacific AOR

In addition to the NOAA and Navy line-transect density estimates described above, additional peer-reviewed published studies of design-based estimates (Level 2; see Table 3-1) were used. For the NWTT Study Area, these included line-transect ship surveys off the northern Washington coast between 1995 and 2002 (Calambokidis et al. 2004), ship and aerial line-transect surveys conducted off the Oregon and

Washington coasts between April 1989 and September 1990 (Green et al. 1992), and aerial line-transect surveys in Oregon and Washington offshore waters in 1992 (Green et al. 1993).

Jefferson et al. (in preparation) provides updated estimates for most marine mammal species in the Southern California Bight from recent years, and Jefferson (2012) provides estimates of density for Dall's porpoise for SE Alaskan waters adjacent to Behm Canal. Both sources of density estimates will be considered in future versions of the NMSDD.

NMFS Stock Assessment Reports for the Pacific

This data source is one of the preferred (Level 3) sources of density data in the established hierarchy.

In addition to the above, density estimates are available from NMFS Stock Assessment Reports for the Pacific (Carretta et al. 2011a) and Alaska (Allen and Angliss 2011). These Stock Assessment Reports provide uniform abundance estimates for recognized stocks of marine mammals within broad geographic strata.

Density Estimates Derived in Support of ESA, MMPA, NEPA and EO 12114 Compliance Documents

This data source uses a preferred source of density data in the established hierarchy. As noted at the bottom of Table 3-1, often it is necessary to extrapolate appropriate density values from Levels 1–3 when study area-specific data are not available.

In the absence of existing density data, the Navy and other entities often need to develop unique methods for deriving study-area specific density estimates in order to assess potential impacts in compliance with the ESA, MMPA, NEPA and EO 12114. For example, in order to assess potential impacts on cetaceans from Navy training and testing operations in the Point Mugu Sea Range, a separate analysis was conducted that combined survey data from various platforms and various time periods to estimate densities specific to the Sea Range (U.S. Department of the Navy 2002 – Marine Mammal Technical Report). Depending on the study area, the time period(s), and the assumptions used to generate the estimates, these data can provide representative density estimates when other data do not exist, particularly since they have been reviewed by NMFS. Examples of some of the sources reviewed for the NMSDD are provided below. These are included within this section (presented in chronological order) as they all rely primarily on Level 2 or Level 3 density data sources.

Marine Mammal and Sea Turtle Density Estimates for Pacific Northwest Waters (U.S. Department of the Navy 2007). The U.S. Department of the Navy prepared a report to document the best available marine mammal and sea turtle density estimates for Pacific Northwest waters in support of the Northwest Training Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS; U.S. Department of the Navy 2010a). Two main project areas were considered in this report: waters off the coast of Washington, Oregon, and Northern California, and Inland Waters that included the Strait of Juan de Fuca, Haro Strait, the Strait of Georgia, and Puget Sound. For the Inland Waters, harbor porpoise density estimates were derived from aerial line-transect surveys conducted by the National Marine Mammal Laboratory in 2002 and 2003 (Laake 2007). Density estimates for other

cetacean species known to occur in the Inland Waters region were not available. In order to provide a rough estimate of abundance for other cetacean species sighted during the surveys (Dall's porpoise and minke whale), data from the 2002–2003 surveys were prorated relative to harbor porpoise.

EA for a Marine Geophysical Survey in Southeast Asia (LGL Limited 2008). In order to assess potential impacts on cetaceans from a seismic survey in southeast Asia, LGL Limited (2008) estimated densities using effort and sighting data from Yang et al. (1999) and Wang et al. (2001), and derived correction factors for detection bias (both f(0) and g(0)) from a variety of sources. Since the Yang et al. (1999) and Wang et al. (2001) surveys were conducted predominantly in areas with steep slopes and complex bathymetry, LGL Limited (2008) incorporated density estimates for cetaceans in deep water areas of the Eastern Tropical Pacific derived by Ferguson and Barlow (2003). They then calculated an overall weighted density estimate representing complex bathymetry and slope habitat (~8%) and deep, flat, or gently sloping bottom habitat (~92%). For baleen whales not sighted during these surveys, they used 10% of the abundance estimates for Bryde's whales calculated by Shimada et al. (2008) for areas in the northwestern Pacific. There is uncertainty regarding how representative these density data are to the MITT Study Area; however, in the absence of any other density data in this region, the density estimates provided by LGL Limited provide a reasonable approximation given their habitat assumptions (i.e., a mix of bathymetry but primarily deep water habitat) and use of actual sighting data.

Marine Mammal Density and Depth Distribution Report prepared in support of the Gulf of Alaska Training Activities Draft Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS; Appendix E) (U.S. Department of the Navy 2009). The U.S. Department of the Navy prepared a Marine Mammal Density and Depth Report in support of an EIS/OEIS that assessed potential environmental effects associated with training activities in the Gulf of Alaska Temporary Maritime Activities Area (TMAA). At the time, the only density estimates available for the TMAA were those derived for fin and humpback whales based on data collected during the Navy's first systematic ship survey in 2009 (Rone et al. 2009; see "Navy Line-Transect Density Estimates for the Gulf of Alaska Temporary Maritime Activities Area" above for more information). Due to the lack of study-area specific sighting data for most species, density estimates for many species were derived based on data collected from various surveys (cetaceans) and shore counts (pinnipeds) conducted within the Gulf of Alaska.

Marine Mammal Occurrence/Density Report prepared in support of Navy activities at the Southeast Alaska Acoustic Measurement Facility (U.S. Department of the Navy 2010b). The U.S. Department of the Navy prepared a Marine Mammal Occurrence/Density Report in support of a NEPA document that assessed potential environmental effects associated with ongoing and proposed Research, Development, Test, and Evaluation and training activities at SEAFAC. SEAFAC is located within Western Behm Canal, a large, deep, protected fjord about 12 miles (mi.) north of Ketchikan, Alaska. Due to the lack of study-area specific sighting data, for purposes of establishing marine mammal density in the SEAFAC region, density estimates were derived based on data collected from various surveys (cetaceans) and shore counts (pinnipeds) conducted within Southeast Alaska and the Gulf of Alaska.

EA for a Low-Energy Marine Geophysical Survey in the Western Tropical Pacific Ocean (LGL Limited 2011). In order to assess potential impacts on marine mammals from a seismic survey in the western

tropical Pacific Ocean, LGL Limited (2011) estimated densities of species with known or suspected occurrence in the region. The study area included waters within the U.S. EEZ of Wake Island, as well as in surrounding International Waters, and encompassed the study area used by the Navy to represent conditions within the MITT transit corridor. LGL Limited (2011) used effort-weighted mean densities for the Mariana Islands (Fulling et al. 2011, see above) and the outer EEZ of Hawaii (Barlow 2006, see above) to represent the best available estimates for this region.

3.3.2 LEVEL 4–LEVEL 5 DATA SOURCES

The Level 4–5 data sources are the least preferred sources of density data as noted in Table 3-1. These data sources are based on environmental suitability models.

Kaschner et al. Marine Mammal Density Models

This data source is one of the least preferred (Level 5) sources of density data in the established hierarchy (note that a Level 4 density source is described below, because it is based on improvements to the Kaschner et al. [2006] models).

Based on a synthesis of existing observations about the relationships between basic environmental conditions and species presence, Kaschner et al. (2006) used environmental suitability models to predict the average annual range of a marine mammal species on a global level. Habitat preferences were based on sea surface temperature, bathymetry, and distance to nearest land or ice edge. These data were then used to characterize species distribution and relative concentration on a global oceanic scale at 0.5° grid cell resolution. To transform the RES values to density estimates, published estimates of global population were used to compute a mean annual global population estimate. Kaschner et al. (2006) then prorated the global abundance estimates using the RES values as an index of relative concentration (i.e., so that if one was to sum up all of the cells, the result would be the mean global population). One of the disadvantages of this method is that it is difficult to validate the results because much of the area covered has never been surveyed and uncertainty was qualitatively assessed. In the Pacific, Kaschner et al.'s (2006) predicted distributions for many species do not correspond well with known distributions (Ferguson et al. 2011). Some of the discrepancies between the Kaschner et al. (2006) model predictions and known species distributions could be due to the difference between the "fundamental niche" and the "realized niche" (Hutchinson 1957); the fundamental niche describes all environments that permit a species to survive, while the realized niche is the species observed distribution which results from interspecific and intraspecific dynamics, interactions with the physical environment, and historical events.

Sea Mammal Research Unit Limited (SMRU Ltd.) Marine Mammal Density Model

This data source is one of the least preferred (Level 4) sources of density data in the established hierarchy.

SMRU Ltd. developed a global density model using a different approach for 45 species of marine mammals (SMRU Ltd. *in prep*). The SMRU Ltd. model used the seasonally defined RES values (Kaschner et al. 2006) described above and developed a relationship between the RES values and empirical density

data in order to generate predictions of density for locations where no surveys have been conducted. A thorough literature search for survey data was undertaken to identify ship-based and/or aerial surveys of marine mammals. Survey data were collated on a global level and included surveys since 1980, although most surveys included in the analysis were post-1990. Models relating density (from surveys) to RES values were constructed using Generalized Linear Models (GLMs). Initial model fitting used only the summer season data for the Northern and Southern hemispheres. The summer RES values were passed through the fitted equations to give predicted densities for all 0.5° grid-cells. This, coupled with database values for the area of water within each cell, gave a 'global abundance' estimate. Seasonal predictions were made by allocating this global abundance in accordance with the seasonal RES values and the model coefficients. This approach ensured that the total global abundance of a species did not change between seasons. The advantage of this approach is that SMRU Ltd. used actual density data from a number of sources and developed a model fit to the RES value to make the predictions. This method allowed for the uncertainly in each cell to be quantitatively assessed. For the purpose of environmental impacts assessment, when available, this method of density estimation is preferred over Kaschner et al.'s (2006) density model.

4 INDIVIDUAL SPECIES' DENSITY PROFILES

The remainder of this document provides the density profiles that are being used by the Navy for modelling the potential exposure of each species to Navy sound sources in the Pacific Fleet Study Areas based on the data sources and selection methods described in Sections 2 and 3. Species are presented in groups of related taxa: baleen whales, sperm whales, delphinids, porpoises, beaked whales, beluga whale, pinnipeds, and sea turtles. Within each group, species are presented in alphabetical order by their scientific name; hence the scientific names are presented before the common names. This organization scheme keeps closely-related species together. Information on which species are found in each of the Pacific Fleet Study Areas is provided in Table 4-1.

Table 4-1: Species with Pacific Fleet Study Area Density Estimates Included in the NMSDD[1]

Taxonomic Name	Common Name	HSTT HRC	HSTT SOCAL	MITT	NWTT Offshore	NWTT Inland Waters	NWTT Western Behm Canal	GOA
Cetaceans (Order Cetacea)								
Baleen Whales (Suborder Mysticeti)								
Balaenoptera acutorostrata	Common or dwarf minke whale	X	X	X	X	X	X	X
Balaenoptera borealis	Sei whale	X	X	X	X			X
Balaenoptera edeni	Bryde's whale	X	X	X				
Balaenoptera musculus	Blue whale	X	X	X	X			X
Balaenoptera omurai	Omura's whale			X				
Balaenoptera physalus	Fin whale	X	X	X	X		X	X
Eschrichtius robustus	Gray whale		X		X	X		X
Eubalaena japonica	North Pacific right whale							X
Megaptera novaeangliae	Humpback whale	X	X	X	X	X	X	X
Toothed Whales (Suborder Odontoceti)								
Sperm Whales (Family Physeteridae (sperm whale) and Family Kogiidae (pygmy and dwarf sperm whale)								
Kogia breviceps	Pygmy sperm whale	X	X[2]	X	X[2]			
Kogia sima	Dwarf sperm whale	X	X[2]	X	X[2]			
Physeter macrocephalus	Sperm whale	X	X	X	X			X
Dolphins (Family Delphinidae)								
Delphinapterus leucas	Beluga whale							X
Delphinus capensis	Long-beaked common dolphin		X					
Delphinus delphis	Short-beaked common dolphin	X	X		X			
Feresa attenuata	Pygmy killer whale	X		X				
Globicephala macrorhynchus	Short-finned pilot whale	X	X	X	X			
Grampus griseus	Risso's dolphin	X	X	X	X			X
Lagenodelphis hosei	Fraser's dolphin	X		X				
Lagenorhynchus obliquidens	Pacific white-sided dolphin	X5	X		X	X	X	X

Table 4-1: Species with Pacific Fleet Study Area Density Estimates Included in the NMSDD[1] (continued)

Taxonomic Name	Common Name	HSTT HRC	HSTT SOCAL	MITT	NWTT Offshore	NWTT Inland Waters	NWTT Western Behm Canal	GOA
Lissodelphis borealis	Northern right whale dolphin		X		X			X
Orcinus orca	Killer whale	X	X	X	X	X	X	X
Peponocephala electra	Melon-headed whale	X		X				
Pseudorca crassidens	False killer whale	X		X				
Stenella attenuata	Pantropical spotted dolphin	X		X				
Stenella coeruleoalba	Striped dolphin	X	X	X	X			
Stenella longirostris	Spinner dolphin	X		X				
Steno bredanensis	Rough-toothed dolphin	X		X				
Tursiops truncatus	Common bottlenose dolphin	X	X	X	X			
Porpoises (Family Phocoenida)								
Phocoena phocoena	Harbor porpoise				X	X	X	X
Phocoenoides dalli	Dall's porpoise		X		X	X	X	X
Beaked Whales (Family Ziphiidae)								
Berardius bairdii	Baird's beaked whale		X		X		X[6]	X
Indopacetus pacificus	Longman's beaked whale	X		X				
Mesoplodon densirostris	Blainville's beaked whale	X	X[3]	X	X[3]			
Mesoplodon ginkgodens	Ginkgo-toothed beaked whale		X[3]	X	X[3]			
Mesoplodon stejnegeri	Stejneger's beaked whale		X[3]		X[3]			X
Ziphius cavirostris	Cuvier's beaked whale	X	X3	X	X3		X6	X

Table 4-1: Species with Pacific Fleet Study Area Density Estimates Included in the NMSDD[1] (continued)

Taxonomic Name	Common Name	HSTT HRC	HSTT SOCAL	MITT	NWTT Offshore	NWTT Inland Waters	NWTT Western Behm Canal	GOA
Beluga and Narwhal (Family Monodontidae)								
Delphinapterus leucas	Beluga whale							X
Pinnipeds (Order Carnivora[7], Suborder Pinnipedia)								
Arctocephalus townsendi	Guadalupe fur seal		X					
Callorhinus ursinus	Northern fur seal		X		X		X	X
Mirounga angustirostris	Northern elephant seal		X		X	X	X	X
Monachus schauinslandi	Hawaiian monk seal	X						
Phoca vitulina	Harbor seal		X		X	X	X	X
Zalophus californianus	California sea lion		X		X	X		
Eumetopias jubatus	Steller sea lion				X	X	X	X
Sea Turtles (Order Testudines, Suborder Cryptodira)								
Chelonia mydas	Green sea turtle	X[4]	X	X				
Eretmochelys imbricata	Hawksbill sea turtle	X[4]		X				
Caretta caretta	Loggerhead sea turtle	X[4]		X				
Lepidochelys olivacea	Olive ridley sea turtle	X[4]		X				
Dermochelys coriacea	Leatherback sea turtle	X[4]	X	X	X			

[1] Species for which existing data do not support the derivation of study-area specific density estimates may not have values included in the NMSDD.

[2] Study Area density estimates are represented by a genus (*Kogia* spp.).

[3]Study Area density estimates are represented by a small beaked whale guild (includes Cuvier's beaked whale and beaked whales of the genus *Mesoplodon*). In addition to the species listed above, the small beaked whale guild includes Hubb's beaked whale (*Mesoplodon carlhubbsi*), Perrin's beaked whale (*M. perrini*), and pygmy beaked whale (*M. peruvianus*).

[4] Study Area density estimates are represented by a "sea turtle guild" (Section 12.1.6).

[5] Pacific white-sided dolphin may occur in the HRC transit corridor.

[6] Extensive line-transect surveys by NMML in SE Alaskan waters over many years have never sighted this species in the inshore waters, so it is doubtful that they occur there; however, the source of density estimates used for NWTT Western Behm Canal (i.e., U.S. Department of the Navy 2010b) included the species and it was therefore included here. Changes to future versions of the NMSDD will be made as appropriate.

[7] The sea otter, which is found in some parts of SOCAL, NWTT, and Alaskan waters, is not included here because density estimates were not available.

There are three elements in each species profile: (1) species-specific information related to stock structure and detection in the field, (2) information on the data used for each Pacific Fleet Study Area,

and (3) maps of the estimated species density in the Study Areas. Each of these elements is described in more detail below. In a few cases, one of the elements may be expanded or removed based on special circumstances for that species.

4.1 SPECIES DESCRIPTIONS

For each species, a brief description of the general appearance and notable identifying characteristics is provided. The description is not meant to be a detailed profile of the species, but conveys the ease or challenges of detecting and identifying the species in the field. This information provides a context for the information on species presence. Species that have a low likelihood of being seen or a high likelihood of being confused with other species lead to higher levels of uncertainty in estimates of their density. Scientists are often conservative in classifying a marine mammal or sea turtle seen in the field, unless there is a high level of certainty. This conservative approach leads to observations that cannot be positively classified to species and thus fall into general groups such as "unidentified large cetacean" or guilds such as "*Kogia* species" (for the pygmy sperm whale [*Kogia breviceps*] and dwarf sperm whale [*Kogia sima*]). Those species that are more difficult to sight or identify are more likely than others to have large number of observations fall into the general groups. Challenges to identifying animals in the field can thus be an impediment to obtaining enough sighting data to enable the estimation of species-specific density or abundance; in these cases density is sometimes estimated for broader taxa (e.g., "small beaked whales," *Mesoplodon* spp.).

Within each species description, information on stocks recognized by NMFS and the International Whaling Commission IWC (for large whales) is also presented. Stocks are the management unit for NMFS (Carretta et al. 2011a), and in the case of stocks that are Threatened or Endangered, the Navy needs to be aware of stock structure and the likelihood of interacting with a particular stock. When an individual marine mammal is observed, it may be quite difficult to define which stock it belongs to if stock structure overlaps, as it does for species such as killer whales and bottlenose dolphins. When possible, densities are provided for specific stocks, but for the majority of cases, densities are reported for the species as a whole.

4.2 DENSITY DATA FOR EACH PACIFIC FLEET STUDY AREA

4.2.1 TABLES

Information on the sources of density data and density values used are reported in two tables that appear in each species description. The first table indicates the source of the data for the major regions in each Study Area. The second table provides the density values used in the NMSDD. Due to the different sources of density data and their inherent limitations, the precision of the density estimates is variable. Specific uniform density values are provided for designed-based estimates. If a quantitative density range is provided, this indicates that more than one uniform density estimate was applied to the region (e.g., where there may be stratified density estimates applicable to different portions of the region). For density spatial models or RES models for which density values vary throughout the range, a letter is used to indicate the model source. In all cases, given the different data sources and their

associated spatial resolution, the tables should be viewed concurrently with the density maps (Section 4.2.2).

The majority of density estimates used in the NMSDD come from the sources and methods described in Sections 2 and 3 of this document. In some cases, density for a particular species could not be characterized by the data available from these sources. In those cases, information from scientific literature was used to derive a density estimate. This method relied mainly on information provided in peer-reviewed publications. In all cases the data sources were prioritized based on the descriptions in Sections 2.2.1 and 3.2 to ensure consistency with the hierarchical approach established to select density values.

It is important to note that while NMFS study areas align with EEZs of the United States, they do not cover the entirety of the Navy's Study Areas. Therefore, other data sets are necessary to describe the entirety of Pacific Fleet Study Areas even when a NMFS model or uniform density exists from some species in that study area (for example, see Figure 2-2). Typically, given the absence of density data for many regions, the global RES models (Kaschner et al. 2006; SMRU Ltd. *in prep*) are used to fill in the portions within the Pacific Fleet Study Areas.

In some cases, the Navy has the most comprehensive and recent data on the presence of a species in a range complex. For example, the Navy has been collecting data on sea turtles in locations within the HRC for more than a decade. The data are collected for natural resource management purposes and to satisfy the requirement of the Sikes Act (16 U.S.C. § 670a–670o) to maintain an Integrated Natural Resource Management Plan for each installation operated by the Department of Defense. In these cases, the Navy's data were analyzed for inclusion in the NMSDD.

4.2.2 MAPS

Maps from the GIS database used in NMSDD are provided for each species. Only areas relevant to the Pacific Fleet Study Areas are illustrated and maps are only supplied for areas where a species is expected to occur. If a species does not occur in an area, a map will not be provided. For example, gray whales (*Eschrichtius robustus*) do not occur in HRC, but they do migrate through SOCAL and the offshore region of NWTT. Therefore, there are gray whale density maps for SOCAL and NWTT, but not a map for HRC. As noted in Section 2, shapefiles for the NMSDD are currently stratified by four seasons; however, density data are rarely available at this temporal resolution. Therefore, for some species there may be a map for every season, but for many species, seasons will be combined or there will only be one annual map. If there is a difference in density values between seasons in the Pacific Fleet Study Areas, then a map will be provided for the seasons that differ. Seasons whose predicted densities are the same will be combined into one map that is labelled appropriately. Maps are not provided for seasons for which study area densities are expected to be zero.

The maps of species density should be interpreted with caution. In the NMSDD, the Navy started with the global density models provided by SMRU Ltd. (*in prep*) and Kaschner et al. (2006) and where possible replaced these values with density estimates from preferred sources consistent with the established hierarchy (see Sections 2.2.1 and 3.2). This process leaves values from the global models remaining for

some portions of the Study Areas. Since the range of density values displayed on the map legends represents the range of density values throughout the Pacific Fleet Study Areas, the density values must be viewed in the context of the range of density estimates for each species.

Since the global models predict habitat suitability, they may not be consistent with values based on field data. Even designed-based and spatial models may differ by orders of magnitude at the borders of their predictive areas, because of differences in assumptions, ecological variables used in the models, and other factors. These differences between data sources can cause incongruities in density values displayed on maps. Ultimately, the Navy is most concerned with having the highest quality data in the areas where Navy exercises take place and where animals may be exposed to sound generated from Navy activities. For many of these areas, marine mammal and sea turtle densities are currently characterized in a satisfactory manner by the models available; however, there are ongoing efforts to improve density datasets, and the Navy will incorporate improved estimates into the NMSDD as they become available.

To ensure consistent representation throughout the report, a density classification scheme was developed for each species across all project areas and all seasons, so that readers can compare estimates between project areas. This species-specific classification system ensures that density values for each species are accounted for in one layer using Natural Breaks with 7 density classes. For the NWTT Inland waters area, some of the species densities are very low and if the same classification for the other areas was used, all of the data would be one color. In order to be able to show density differences between each Inland Water stratum, different shades of blue were used. This allowed the Inland Waters area to be colored blue, which represents the lowest density value in the classification colors, but still shows each stratum's density. Although for these species the Inland Waters scheme is on a different scale, it is still within the overall color scheme for the species, and still represents the lower density range for the species. As noted above in Section 4.2.1, the density tables should be viewed concurrently with the density maps, particularly if one is interested in a specific value that may be presented in the table but represented by a range of values on the map.

In most cases, there is a separate map for each Study Area. For the HSTT Study Area, the transit corridor was split in the middle to create two separate figures, one that shows the western half of the Study Area including HRC and one that shows the eastern half of the Study Area including SOCAL. For both the HSTT and MITT Study Areas, representative areas were selected along the transit corridors to represent the range of different habitats that could occur along the corridors. For HSTT, this includes two representative areas in the eastern half of the transit corridor and two in the western half. For MITT, the representative area includes both island (Wake Island) and open ocean habitats. These are labeled as “Transit Corridor: Representative Study Area” and assigned specific density estimates in each of the HSTT and MITT Study Area maps.

5 BALEEN WHALES

5.1 BALEEN WHALES SPECIES PROFILES

5.1.1 *BALAENOPTERA ACUTOROSTRATA*, COMMON AND DWARF MINKE WHALE

Minke whales are a species whose presence can be challenging to quantify, because they are difficult to observe on visual surveys. They can move quickly over sustained distances (Ford et al. 2005), their blow is cryptic and relatively small, and they do not raise their flukes when diving (Jefferson et al. 2008; Leatherwood et al. 1988). In some cases, they do approach ships, affording good identification (Leatherwood et al. 1988; Perrin and Brownell 2009). Common minke whales are the smallest baleen whale in the North Pacific (Leatherwood et al. 1988). Their body shape is distinctive for a rorqual whale, because they have a sleek body and a pointed head. Their dorsal fin is tall and falcate for a baleen whale. The coloration is distinctive with a dark back, white belly, swathes and streaks of intermediate color on the sides, and a white band on the pectoral fins (Jefferson et al. 2008; Leatherwood et al. 1988). Dwarf minke whales, which occur only in the Southern Hemisphere, have an all white pectoral fin and the white extends onto the shoulder (Jefferson et al. 2008). At a distance the species could be mistaken for other baleen whales, such as a fin whale, sei whale (*Balaenoptera borealis*), or Bryde's whale (Jefferson et al. 2008; Leatherwood et al. 1988). If only the back is seen, the species could also be mistaken for a beaked whale (Jefferson et al. 2008; Leatherwood et al. 1988).

The International Whaling Commission (IWC) recognizes three stocks of minke whales in the North Pacific: (1) the Sea of Japan/East China Sea, (2) the rest of the western Pacific west of 180°N, and (3) the "remainder of the Pacific" (Donovan 1991). These broad designations basically reflect a lack of knowledge about the population structure of minke whales in the North Pacific (Carretta et al. 2011a). NMFS has designated three stocks of minke whale in the North Pacific: (1) the Hawaii stock, (2) the California/Oregon/Washington stock, and (3) the Alaska stock (Carretta et al. 2011a). The three NMFS stocks primarily fall into the IWC's "remainder of the Pacific" stock. Density values for the HSTT Study Area are presented for the species as a whole. While animals in SOCAL or HRC could presumably be assigned to a stock, animals in the transit corridor could belong to the Hawaiian stock or California/Oregon/Washington stock. Little is known about the stock structure of minke whales in the MITT Study Area, but presumably whales in this area are members of the IWC's "rest of the western Pacific west of 180°N" stock. Minke whales in the Western Behm Canal portion of the NWTT Study Area belong to the Alaska stock, while animals in the Offshore and Inland Waters regions are part of the California/Oregon/Washington stock. Minke whales in the GOA Study Area are members of the Alaska stock.

HRC. Minke whales are heard regularly during the winter around Kauai (Rankin et al. 2007) and on the hydrophone array at Pacific Missile Range Facility (S. Martin pers. comm.), but they are observed extremely rarely on vessel or aerial surveys. This difficulty in observation probably accounts for the fact that no literature and very little data are available to describe this species distribution in the HRC and the western half of the transit corridor. For these reasons, the RES data from Kaschner et al. (2006) are used for autumn, winter, and spring. Minke whales are thought to be more abundant in the HRC during the cool seasons (Barlow 2006). Some degree of cool season presence in HRC would follow the pattern

of some other baleen whales species such as humpback, fin, and sei whales (Barlow 2006; Craig and Herman 1997). In the summer, minke whales are likely absent from low-productivity tropical waters (Jefferson et al. 2008; Perrin and Brownell 2009); therefore, a density of zero is used for that season in the HRC and the western portion of transit corridor. The zero value region (the white polygon on the summer map) replaces a portion of the Kaschner et al. (2006) predicted values in the southern portion of the HRC.

SOCAL. Density values for minke whales are available for SOCAL for all seasons from SWFSC reports, memoranda, and the scientific literature. Data do not exist for the eastern half of the transit corridor; therefore, RES data from Kaschner et al. (2006) are used for all seasons in the transit corridor. In the winter and spring, the density of minke whales is 0.00028 animals/km^2 off of the entire coast of California (this value is reported as 0.0003 animals/km^2 in Forney et al. 1995 and is restated as 0.00028 animals/km^2 in Barlow, Ferguson et al. 2009). In the summer and fall, minke whale density increases to 0.00072 animals/km^2 along the coast of California, Oregon, and Washington (Barlow and Forney 2007). Ferguson and Barlow (2003) provide density values for the inner and outer Baja Extension area. In the Baja area, the same values are used for all seasons. In the Southern California Bight, data for minke whales are arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

MITT. During the Navy's 2007 line-transect survey of the waters off Guam and the Commonwealth of the Northern Mariana Islands, sea states were typically high and there were no sightings of minke whales. However, the survey included passive acoustic monitoring using a towed array system, and resulted in 29 unique acoustic detections of minke whales (Norris et al. 2011). Recent line-transect analyses of these acoustic detections resulted in a density estimate of 0.00059 animals/km^2 in the Study Area (Norris et al. 2011). Methods for estimating density from acoustic detections are currently being developed and numerous assumptions are associated with the calculations. However, despite the caveats inherent in the analysis (e.g., average group size estimates, g(0) estimates, etc.), these data provide the best available density estimates for the minke whale in the MITT Study Area. In the MITT transit corridor, estimates from LGL Limited (2008; see Section 3.3) were used in the absence of Study-Area specific data. These data were used to characterize minke whale density in fall, winter, and spring.

As noted above for HRC, minke whales are likely absent from low-productivity tropical waters in the summer (Jefferson et al. 2008; Perrin and Brownell 2009); therefore, a density of zero is used for that season in the MITT and associated transit corridor study areas.

NWTT Offshore. Density values for minke whales are available for the SWFSC Oregon/Washington and Northern California offshore strata for summer/fall (Barlow and Forney 2007) and for the latter stratum for winter/spring (Forney et al. 1995). Density data are not available for the NWTT Offshore area north of the SWFSC strata (refer to Figure 3-6), so data from the SWFSC Oregon/Washington stratum (summer/fall) and Northern California stratum (winter/spring) were used as representative estimates.

NWTT Inland Waters. Published density estimates for minke whales in the Inland Waters are not available. Based on ship surveys conducted in the summer and fall from 1991 to 2008, it is estimated

that 147 minke whales (coefficient of variation = 0.68) occur in the offshore waters of Washington and Oregon (Barlow 2010). Minke whales appear to establish home ranges in the inland waters of Washington (Dorsey 1983; Dorsey et al. 1990). Minke whales are reported in the inland waters year-round, although the majority of the records are from March through November (Calambokidis and Baird 1994). Minke whales are sighted primarily in the Strait of Juan de Fuca and San Juan Islands area, and are relatively rare in Puget Sound south of Admiralty Inlet (Washington Department of Fish and Wildlife 2008). There are no known sightings of minke whales in Hood Canal or Dabob Bay.

Two minke whales were seen during 1996 aerial surveys in Washington and British Columbia inland waters (Calambokidis et al. 1997), but no abundance estimates were made. Aerial line-transect surveys were conducted by the National Marine Mammal Laboratory in 2002 and 2003 for the purpose of estimating harbor porpoise abundance off the coasts of Oregon, Washington, and southern British Columbia, as well as portions of the inland waters (Laake 2007). Survey effort was limited to sea state conditions of Beaufort 0–2 and cloud cover less than 25 percent. In the inland waters, the aerial surveys covered Washington and British Columbian waters in the Strait of Juan de Fuca, San Juan Islands, Gulf Islands, and Strait of Georgia (Laake 2007). In order to provide a rough estimate of abundance for other cetacean species sighted during the surveys, data from the 2002–2003 surveys were prorated relative to harbor porpoise (U.S. Department of the Navy 2007). The number of minke whale sightings from these surveys was insufficient to derive regionally-stratified estimates of abundance, so a single density estimate of 0.02 animals/km^2 was calculated for the Strait of Juan de Fuca and San Juan Islands region. This density estimate is similar to Williams and Thomas (2007) minke whale density estimate for inshore coastal waters in the Strait of Georgia (0.01 animals/km^2). Given the sighting data summarized above, 10% of this estimate was assigned to Puget Sound waters (0.002 animals/km^2), and a minimum density estimate assigned to Hood Canal and Dabob Bay (0.000001 animals/km^2). Minke whales are observed year-round and these are thus considered year-round estimates.

NWTT Western Behm Canal, Alaska. For the Western Behm Canal, density estimates for all seasons were taken from the Marine Mammal Occurrence/Density Report prepared in support of a NEPA document for Navy activities at SEAFAC (U.S. Department of the Navy 2010b).

GOA. The limited number of minke whale sightings (3) during the Navy's 2013 survey of the Study Area precluded the derivation of a line-transect density estimate (Rone et al. 2014). Based on sighting data from Waite (2003), the Department of the Navy (2009) derived a year-round density estimate for minke whale of 0.0006 animals/km^2. In the absence of better information, this density estimate is considered the best available metric for this species in this area.

Table 5-1: Sources of Density Values Used for Minke Whale

Location	Spring	Summer	Fall	Winter
HRC	K	0	K	K
W. Transit Corridor	K	0	K	K
E. Transit Corridor	K	K	K	K
SOCAL	L	L	L	L
MITT	L	L	L	L
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	L and LD	L and LD	L and LD	L and LD
NWTT Inland Waters	LD	LD	LD	LD
Western Behm Canal	LD	LD	LD	LD
GOA	LD	LD	LD	LD

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 5-2: Summary of Density Values for Minke Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	S	0	S	S
W. Transit Corridor	S	0	S	S
E. Transit Corridor	S	S	S	S
SOCAL	0.00028	0.00072	0.00072	0.00028
Inner Baja Extension	0.0002	0.0002	0.0002	0.0002
Outer Baja Extension	0.0003	0.0003	0.0003	0.0003
MITT	0.00059	0	0.00059	0.00059
MITT Transit Corridor	0.00003	0	0.00003	0.00003
NWTT Offshore	0.00028	0.0003–0.0007	0.0003–0.0007	0.00028
NWTT Inland Waters	0.000001–0.02	0.000001–0.02	0.000001–0.02	0.000001–0.02
Western Behm Canal	0.0003	0.0008	0.0005	0.0003
GOA	0.0006	0.0006	0.0006	0.0006

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

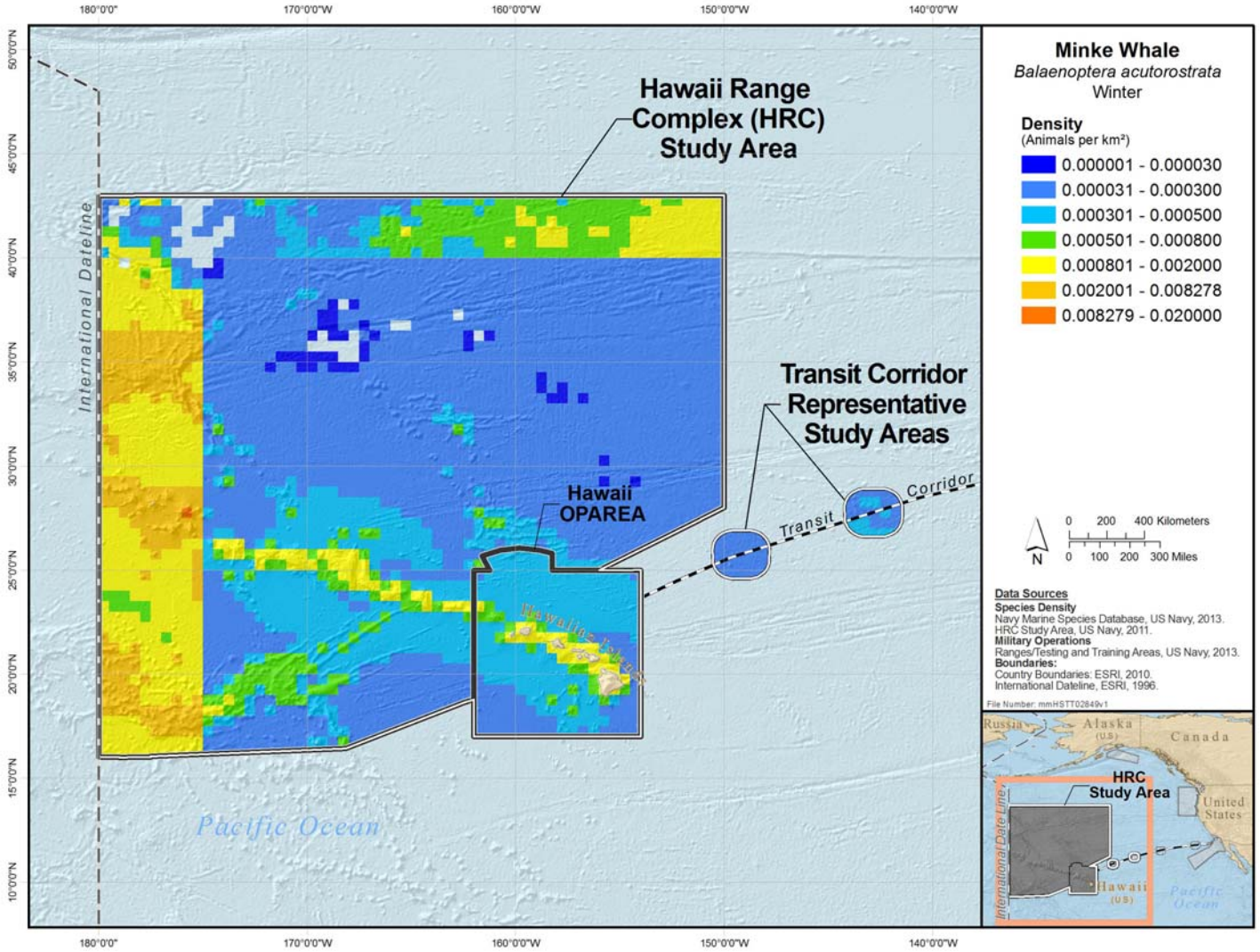

Figure 5-1: Winter Distribution of Minke Whale in HRC and the Western Portion of the Transit Corridor

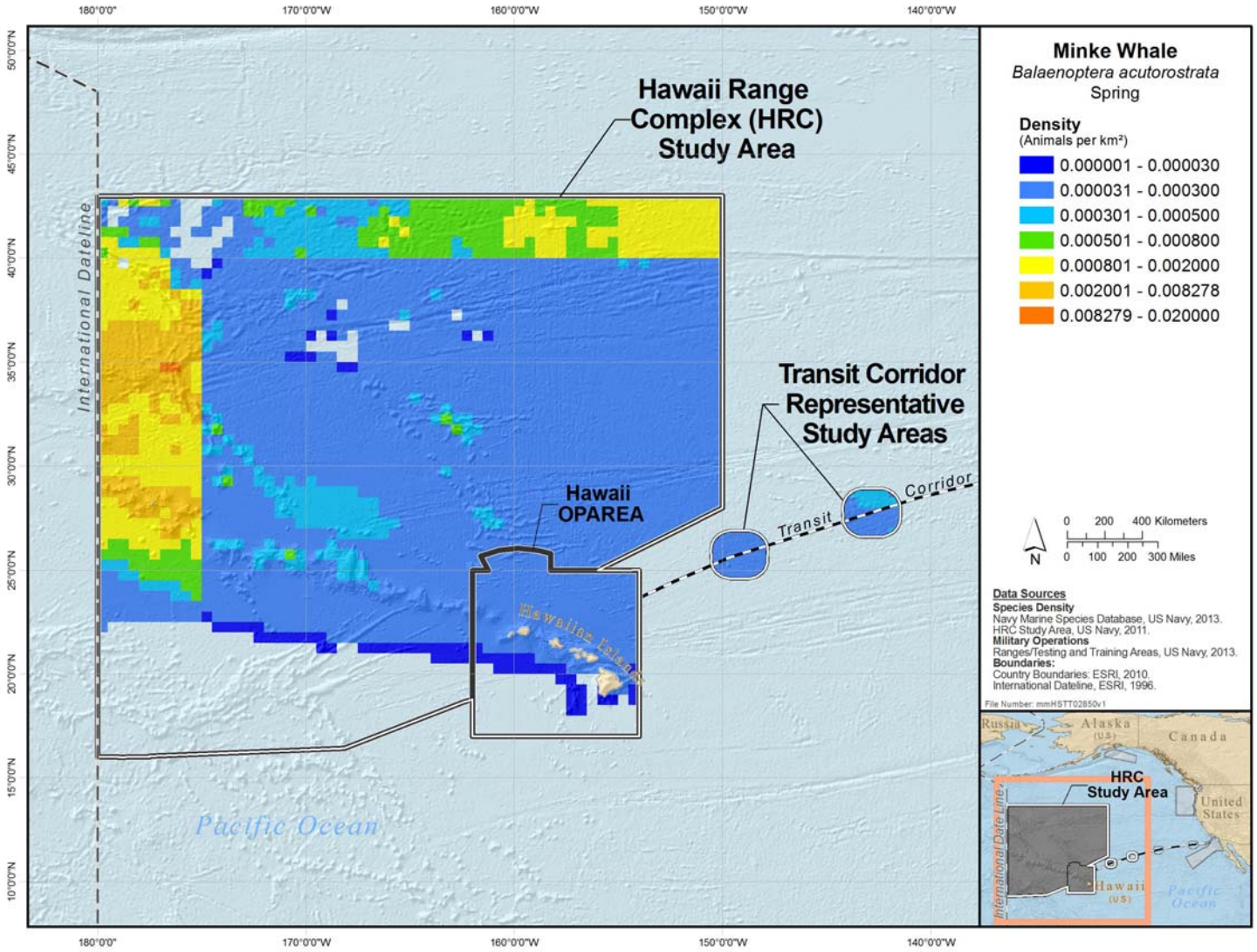

Figure 5-2: Spring Distribution of Minke Whale in HRC and the Western Portion of the Transit Corridor

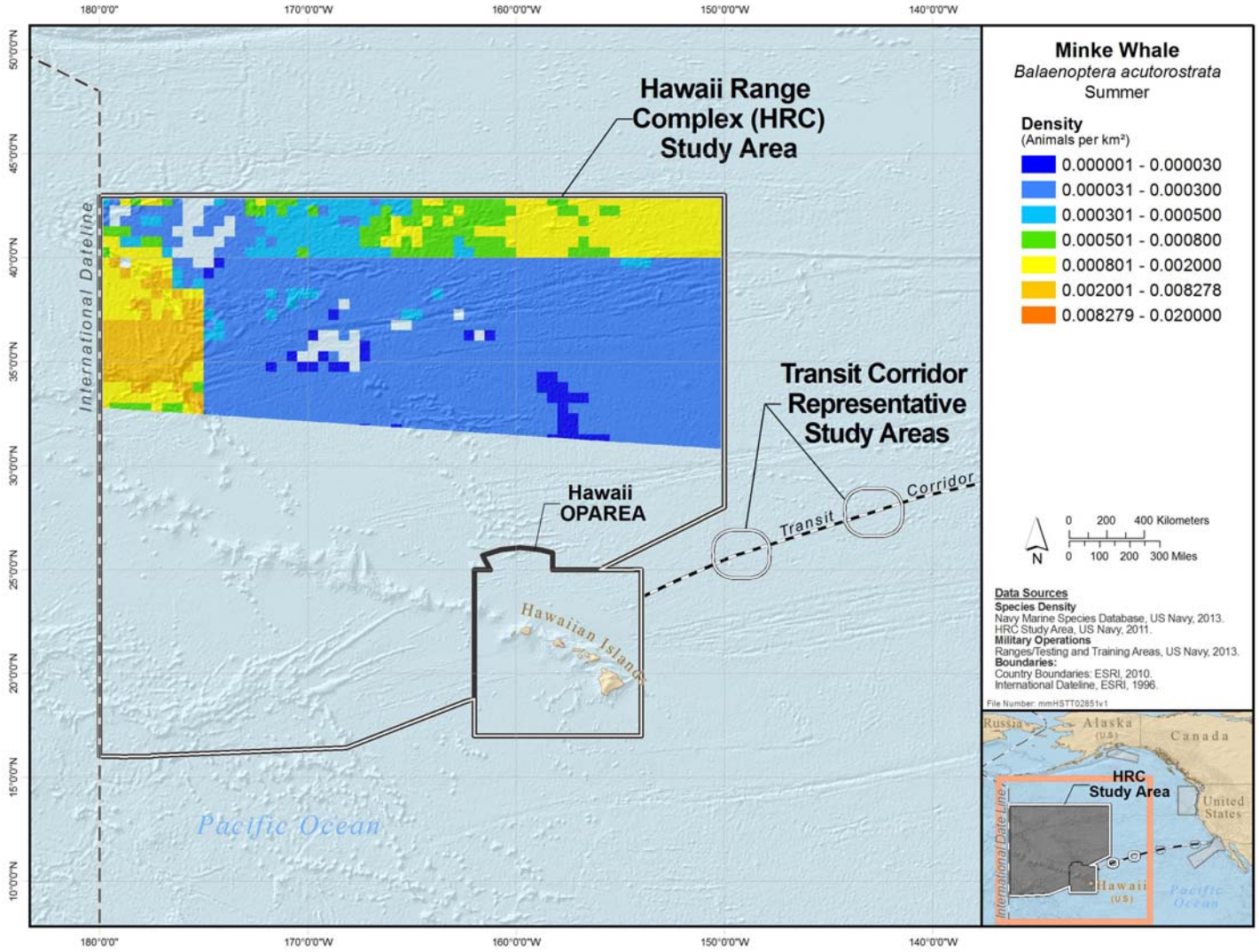

Figure 5-3: Summer Distribution of Minke Whale in HRC and the Western Portion of the Transit Corridor

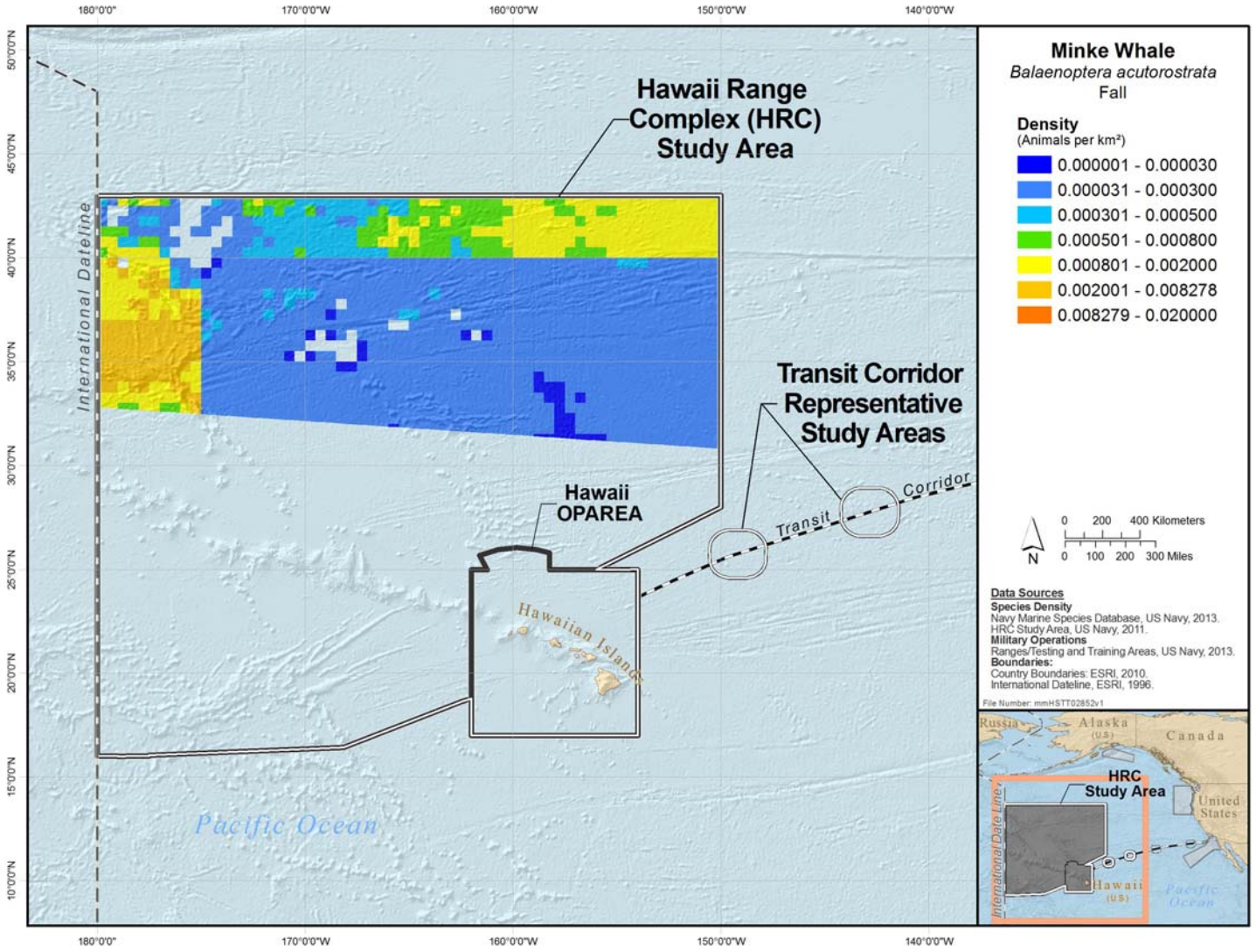

Figure 5-4: Fall Distribution of Minke Whale in HRC and the Western Portion of the Transit Corridor

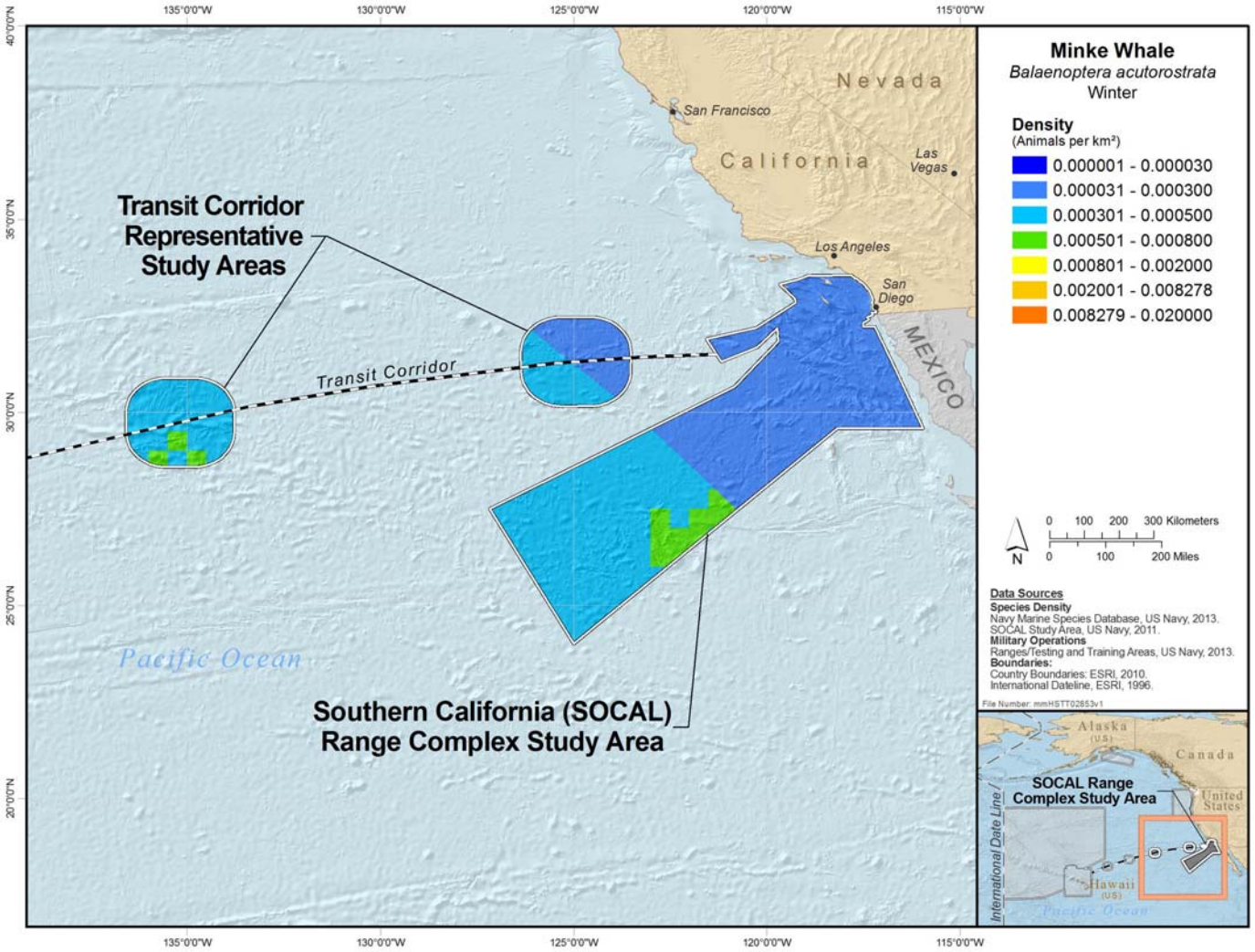

Figure 5-5: Winter Distribution of Minke Whale in SOCAL and the Eastern Portion of the Transit Corridor

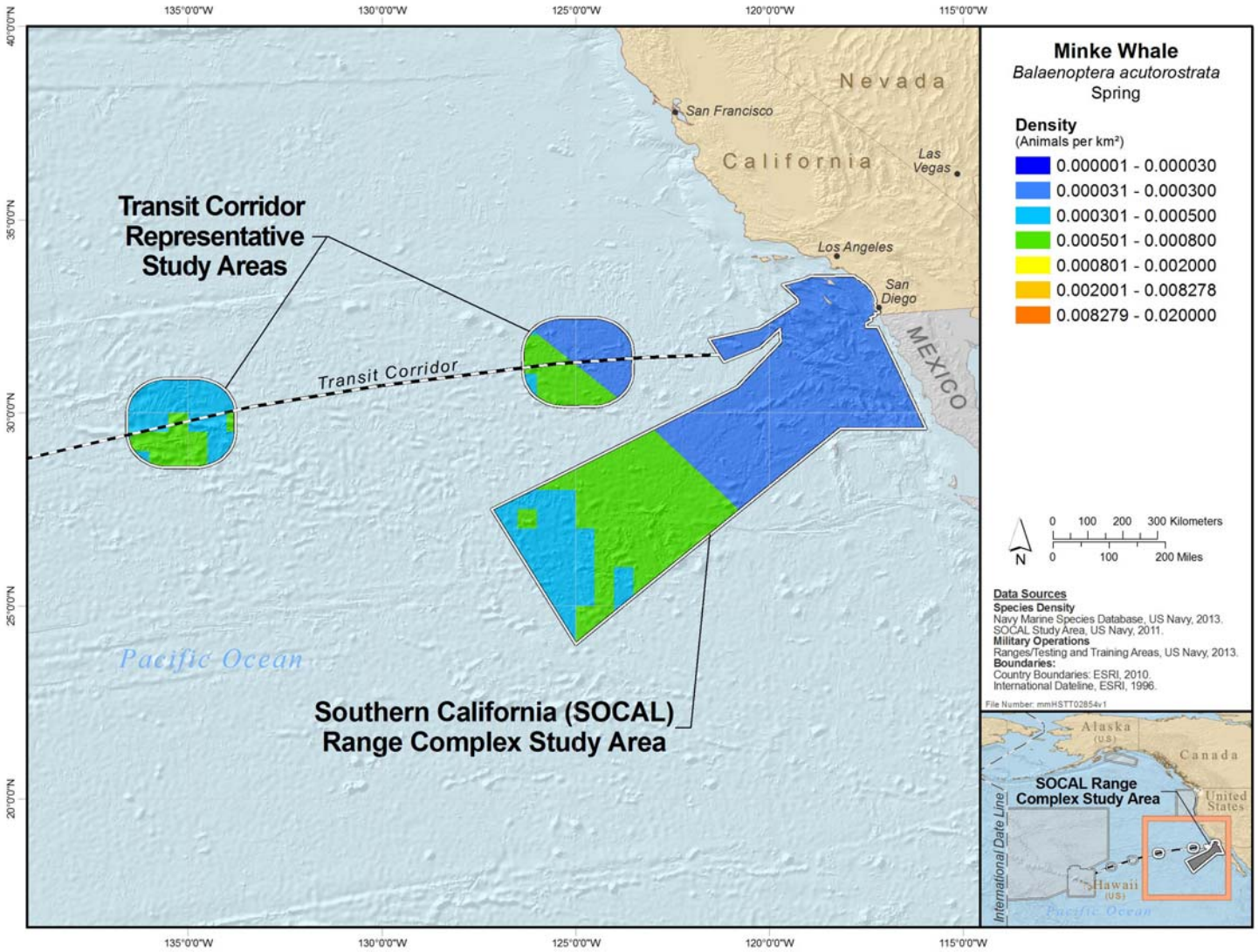

Figure 5-6: Spring Distribution of Minke Whale in SOCAL and the Eastern Portion of the Transit Corridor

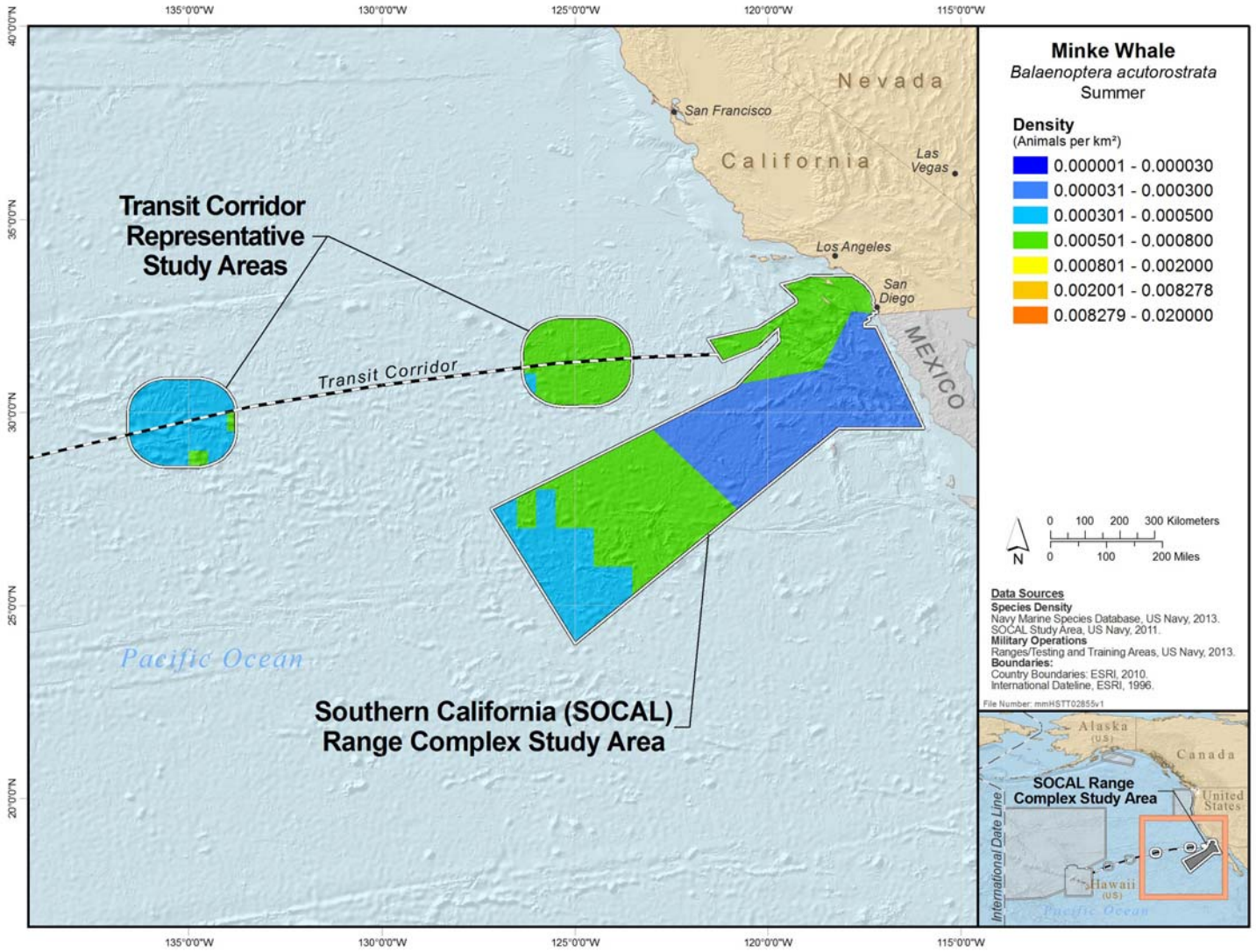

Figure 5-7: Summer Distribution of Minke Whale in SOCAL and the Eastern Portion of the Transit Corridor

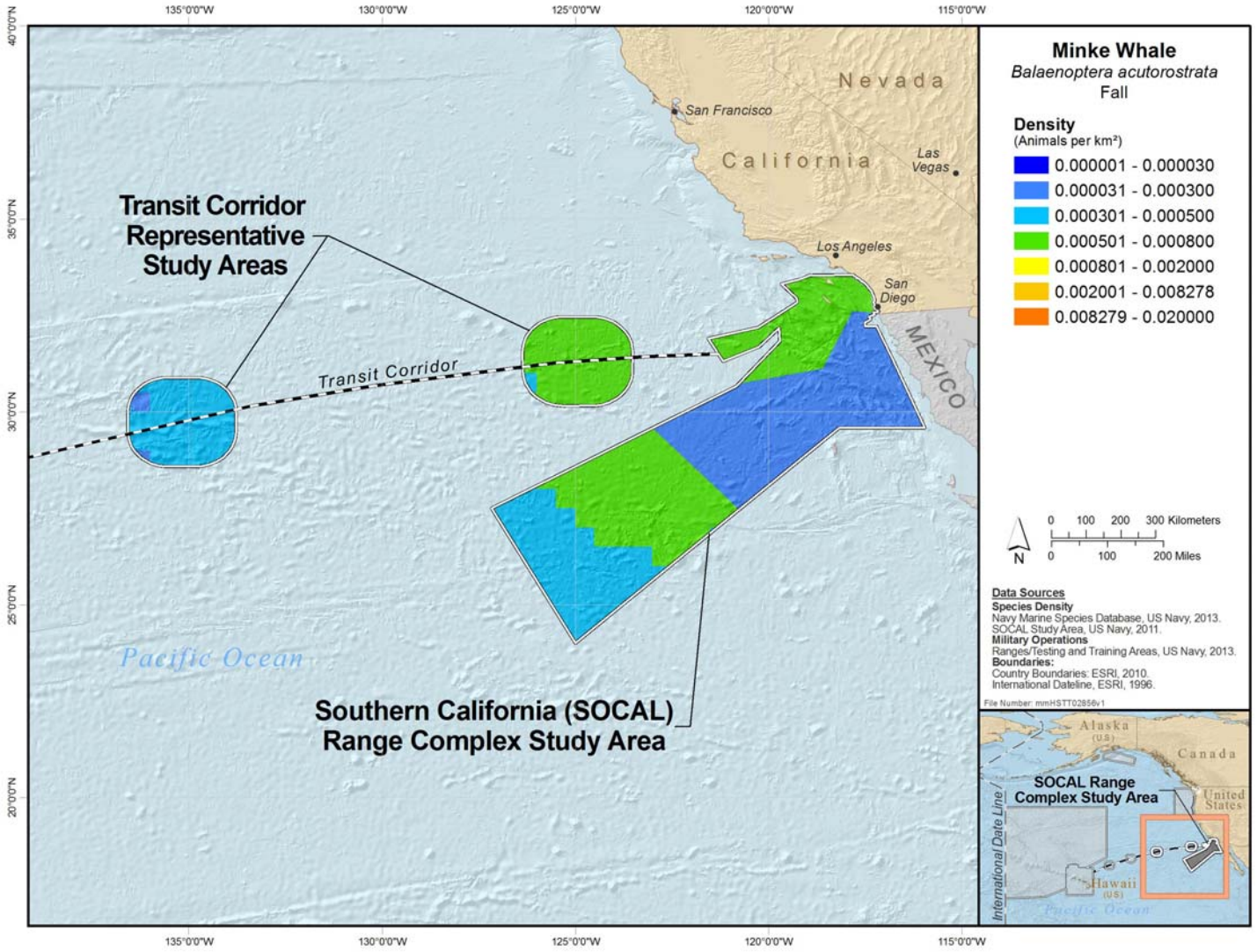

Figure 5-8: Fall Distribution of Minke Whale in SOCAL and the Eastern Portion of the Transit Corridor

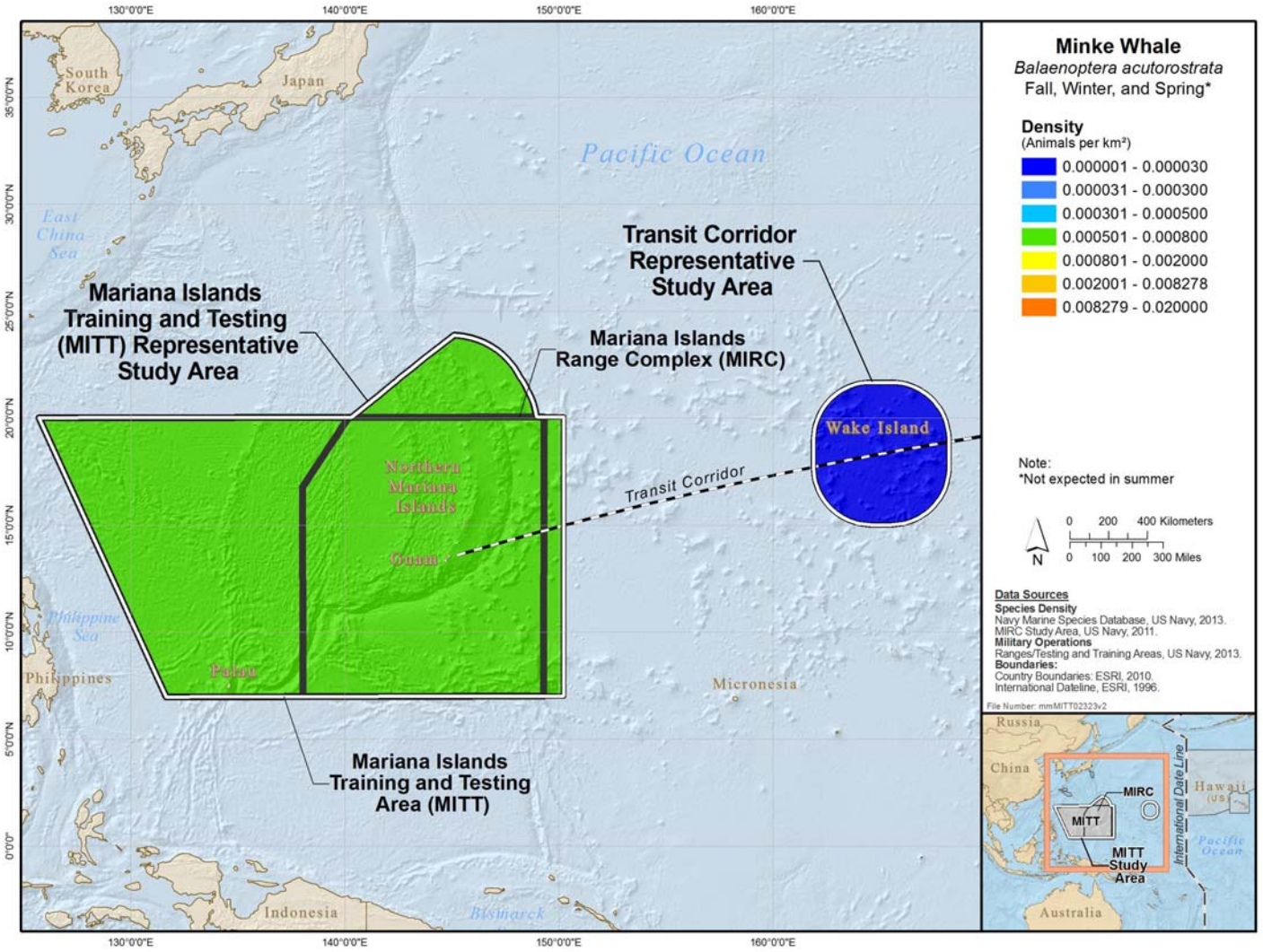

Figure 5-9: Fall, Winter, and Spring Distribution of Minke Whale in MITT and the Associated Transit Corridor Study Areas

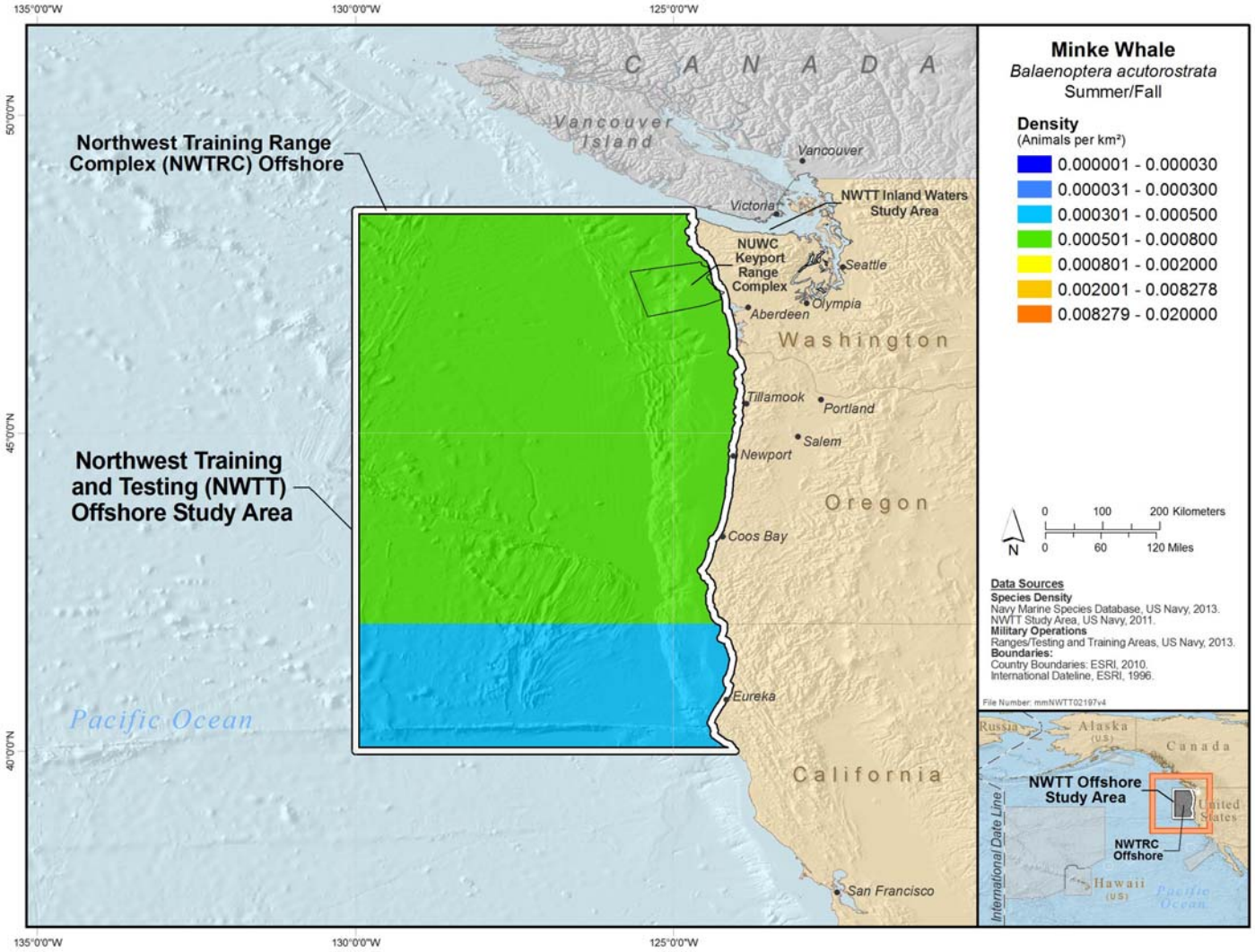

Figure 5-10: Summer/Fall Distribution of Minke Whale in the Offshore Portion of NWTT

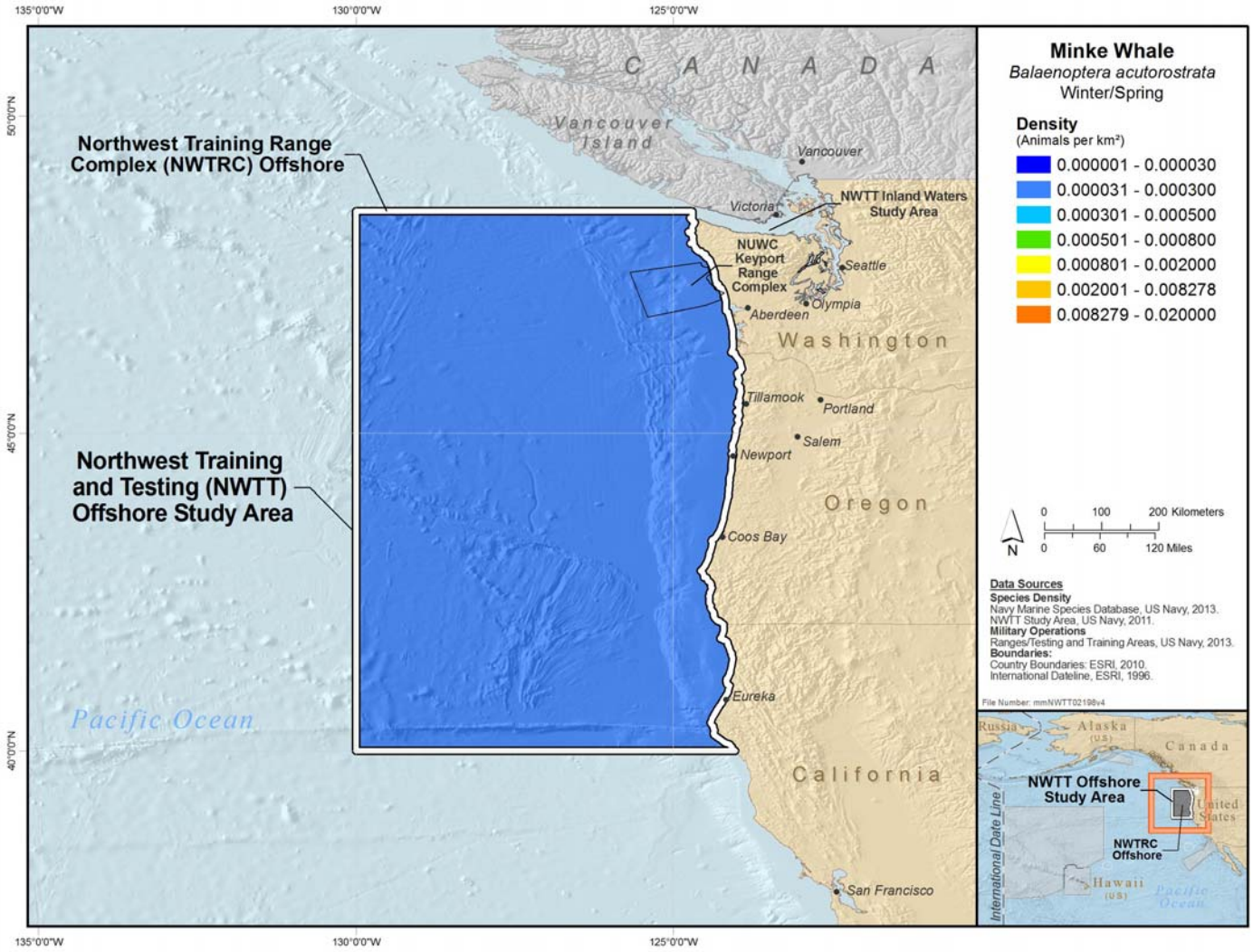

Figure 5-11: Winter/Spring Distribution of Minke Whale in the Offshore Portion of NWTT

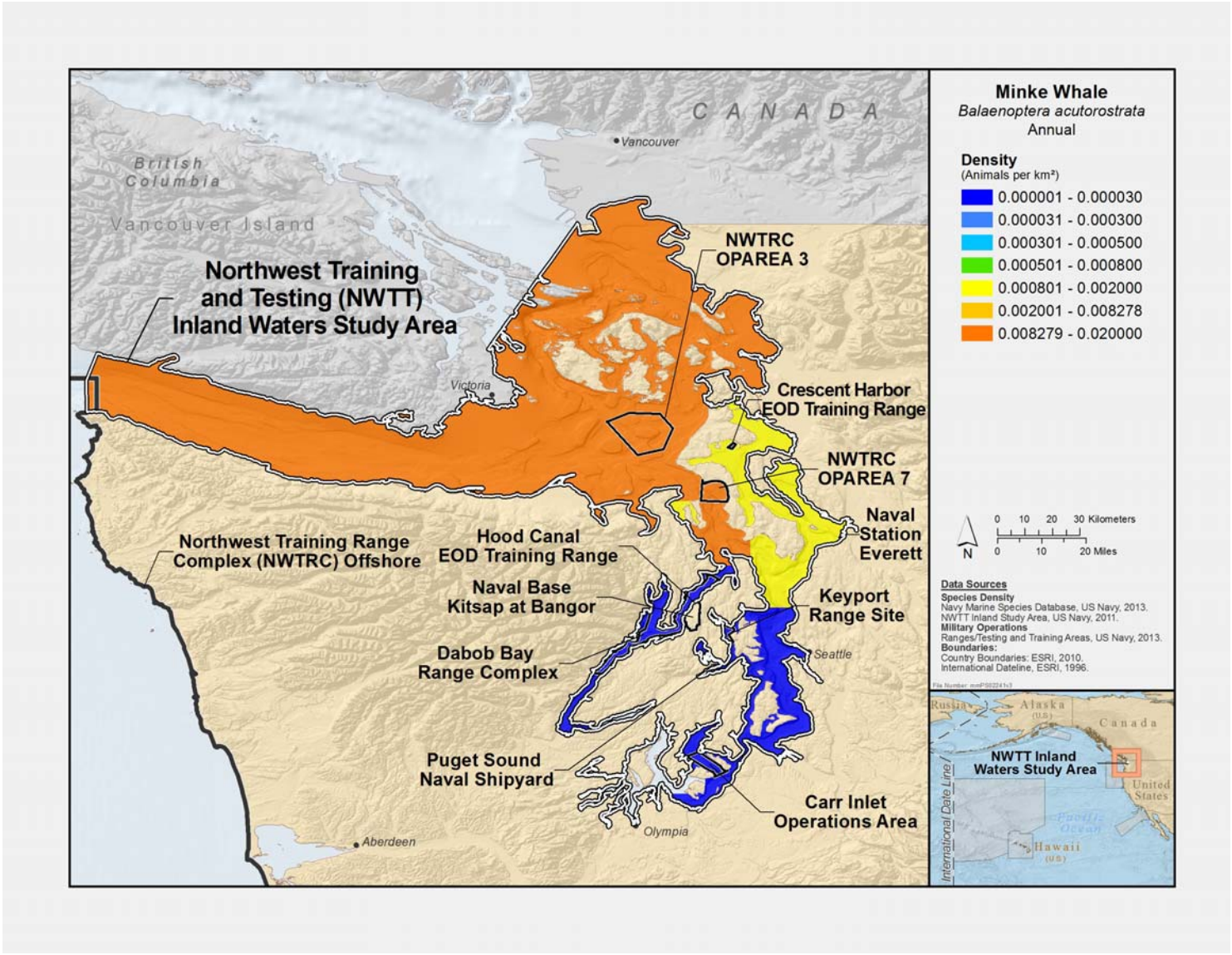

Figure 5-12: Annual Distribution of Minke Whale in the Inland Waters Portion of NWTT

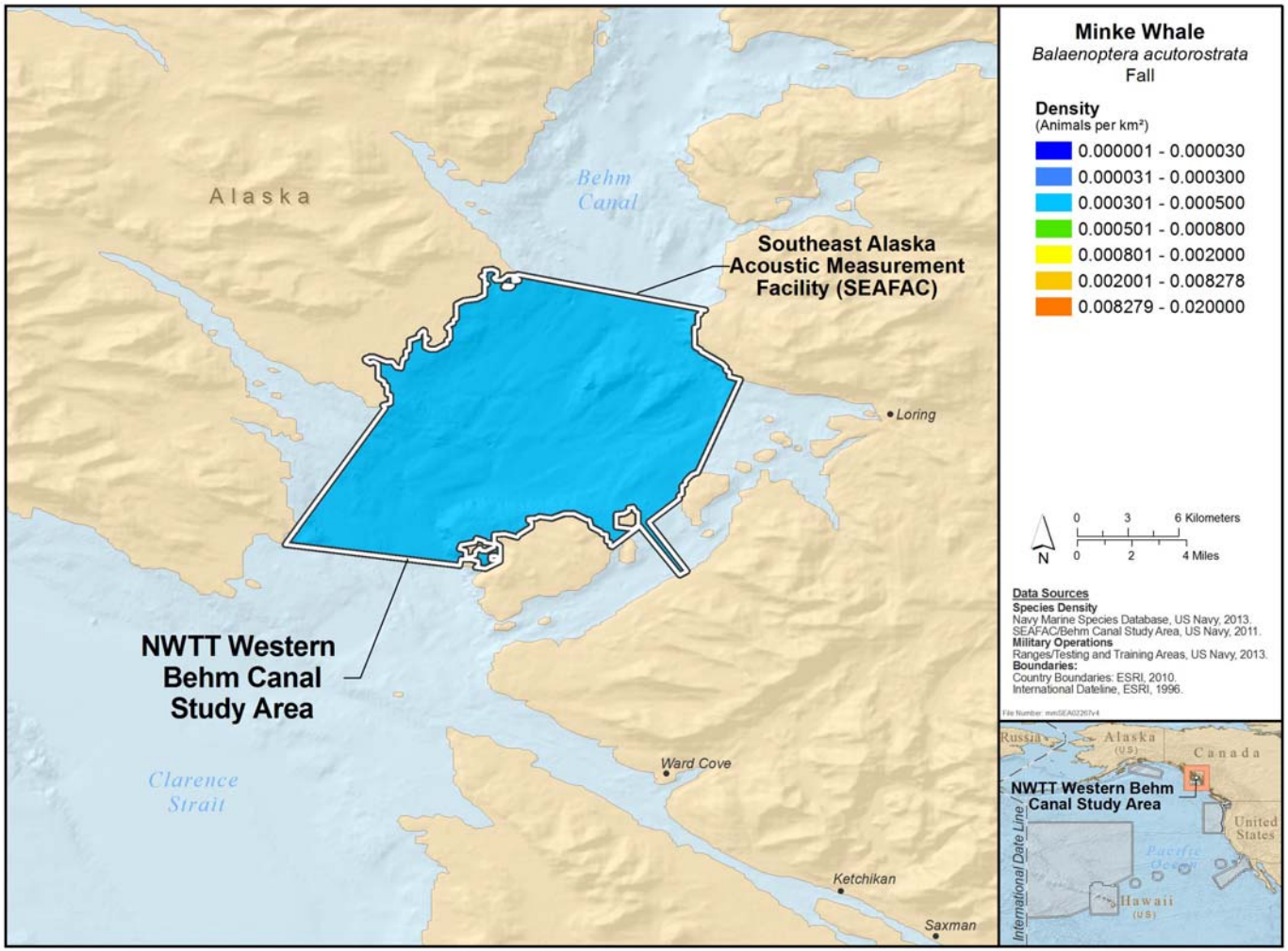

Figure 5-13: Fall Distribution of Minke Whale in the Western Behm Canal Portion of NWTT

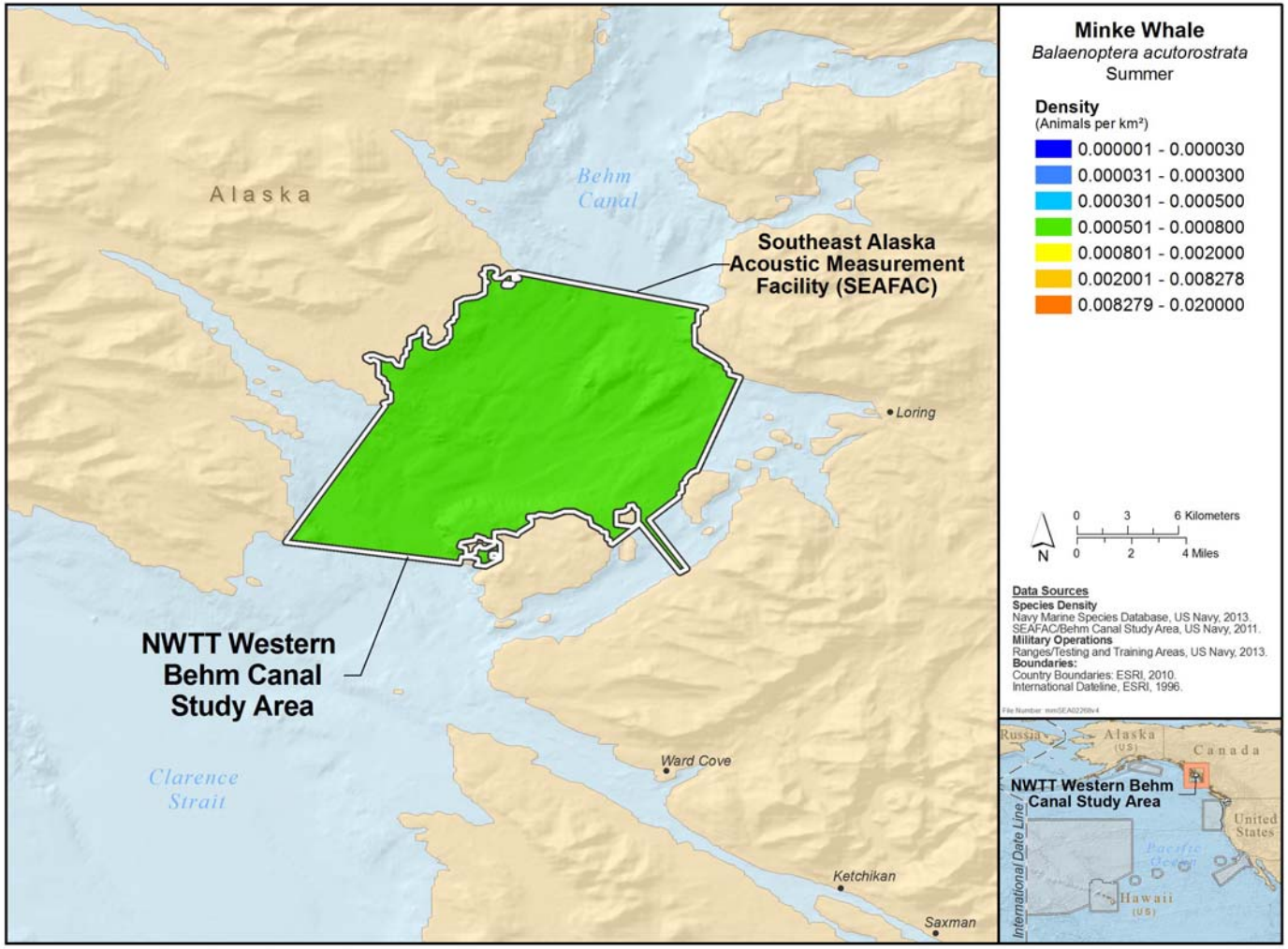

Figure 5-14: Summer Distribution of Minke Whale in the Western Behm Canal Portion of NWTT

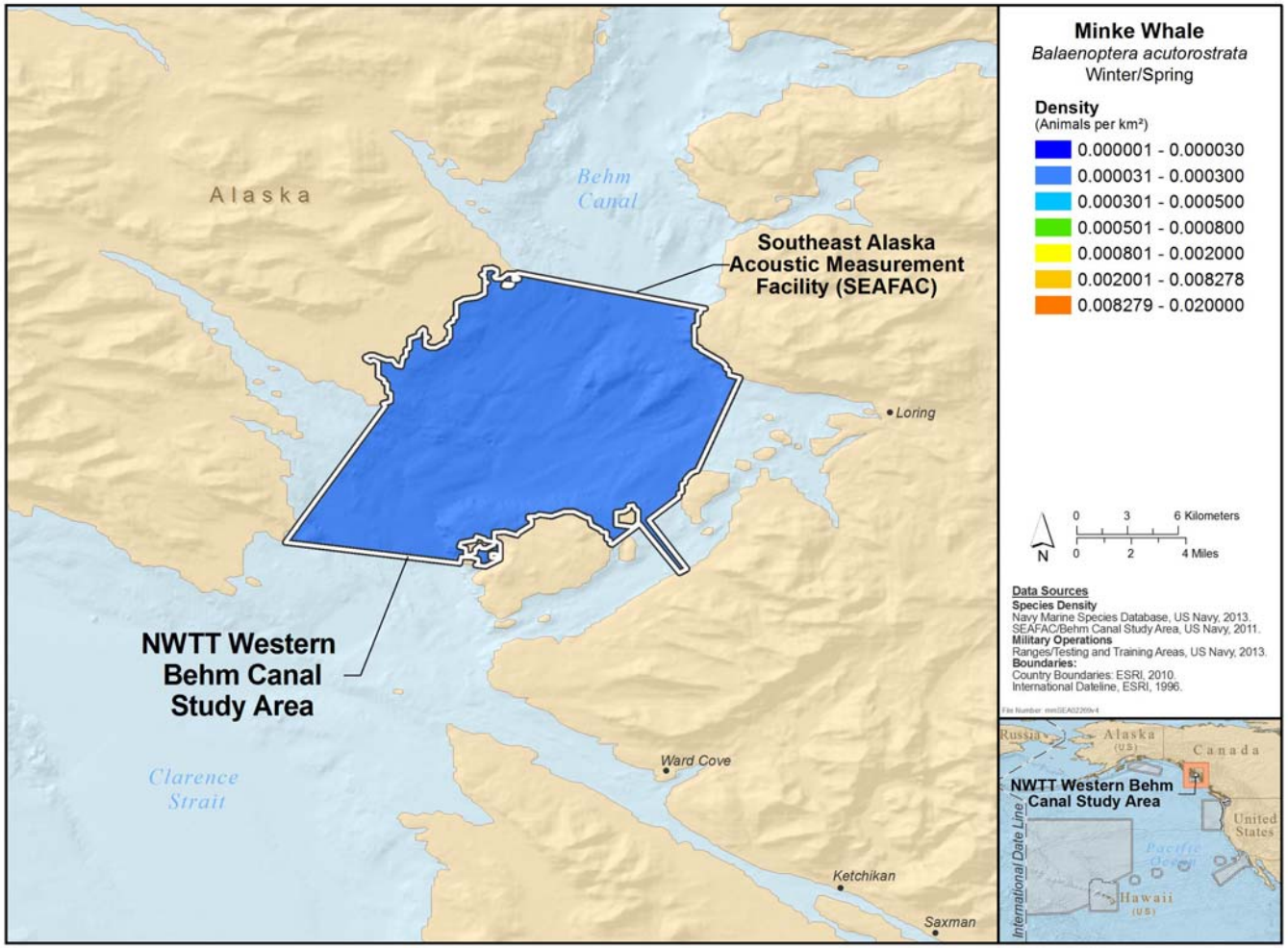

Figure 5-15: Winter/Spring Distribution of Minke Whale in the Western Behm Canal Portion of NWTT

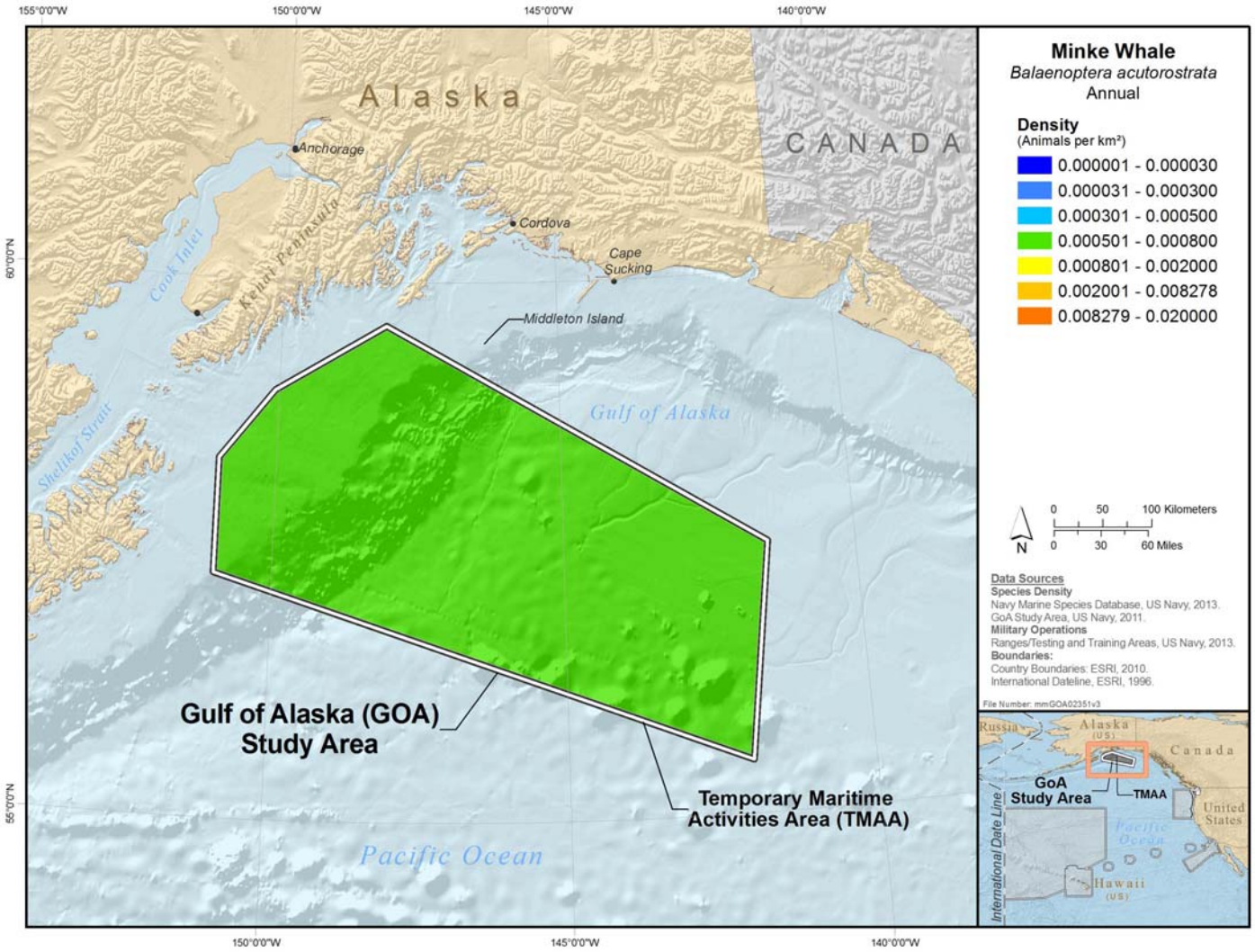

Figure 5-16: Annual Distribution of Minke Whale in the GOA Study Area

5.1.2 *BALAENOPTERA BOREALIS*, SEI WHALE

Sei whales are relatively large, dark-colored baleen whales. Sei whales are more common in colder waters, and are nearly absent from tropical zones, particularly in the summer (Jefferson et al. 2008; Perrin and Brownell 2009). They are a species that can be difficult to identify positively from a distance, because of their superficial similarity to fin and Bryde's whales (Jefferson et al. 2008; Leatherwood et al. 1988). For this reason, sei whales may often be underrepresented in data from visual surveys; with their identity unresolved, they are relegated to the 'unidentified rorqual' or 'unidentified large whale' categories. NMFS recognizes two stocks of sei whales in the U.S. Pacific, the Eastern North Pacific stock and the Hawaii stock (Carretta et al. 2011a). Density values for the HSTT Study Area are presented for the species as a whole. While animals in SOCAL or HRC could presumably be assigned to a stock, animals in the transit corridor could belong to the either stock. The IWC only recognizes one stock of sei whales in the North Pacific. Little is known about the stock structure of sei whales in the MITT Study Area. Sei whales present in the Offshore region of the NWTT Study Area belong to the Eastern North Pacific stock.

HRC. Sei whales are seen infrequently near HRC, and are reported to be more abundant in the HRC during the cool seasons (Barlow 2006; Smultea et al. 2010). Barlow et al. (2009) report a uniform density value for sei whales that is applicable to the HRC and western portion of the transit corridor. This value is used for winter, spring, and fall. In the summer, sei whales are likely absent from low productivity tropical waters (Jefferson et al. 2008); therefore, a density of zero is used for that season in the HRC and the western portion of the transit corridor. The uniform density region (the light green polygon on the fall, winter, spring map, and the white polygon on the summer map) replaces a portion of the Kaschner et al. (2006) predicted values in the southern portion of the HRC.

SOCAL. Density values for sei whales are available for SOCAL for all seasons from the scientific literature. Data do not exist for the eastern half of the transit corridor; therefore, the global RES model from SMRU Ltd. (*in prep*) is used for all seasons. Barlow and Forney (2007) provide a uniform density estimate for California, Oregon, and Washington. This number is also applied to Baja since no values were found in the literature and both RES models portrayed distributions which departed from the quantitative information of Barlow and Forney (2007) and general perceptions of the distribution of sei whales. In the Southern California Bight, data for sei whales are arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

MITT. Sei whales were considered to be extralimital in the MITT Study Area until the Navy's 2007 systematic survey, when sei whales were sighted on 16 separate occasions. Eleven of these were on-effort sightings, resulting in a density estimate of 0.00029 animals/km^2 (CV = 0.49) (Fulling et al. 2011).

Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data were used to characterize sei whale density in fall, winter, and spring.

As noted above for HRC, sei whales are likely absent from low-productivity tropical waters in the summer (Jefferson et al. 2008; Perrin and Brownell 2009); therefore, a density of zero is used for that season in the MITT and associated transit corridor study areas.

NWTT Offshore. Density values for sei whales are available for the SWFSC Oregon/Washington and Northern California offshore strata for summer/fall (Barlow and Forney 2007). Density data are not available for the NWTT Offshore area north of the SWFSC strata (refer to Figure 3-6), so data from the SWFSC Oregon/Washington stratum were used as representative summer/fall estimates. In winter and spring, there is an absence of sei whale sighting data and no sei whale detections were made at two Navy-funded offshore passive acoustic monitoring devices between June 2008 and June 2009, or January through November 2011 (Širović et al. 2012a, b). In the winter, sei whales return to the lower latitudes to calve (Horwood 2009), so the lack of sighting data in winter is not surprising. Based on whaling records from British Columbia, Canada, from 1908 through 1967, sei whales were historically not present in the northeast Pacific from November to March, and peak numbers of animals were killed in July (Gregr et al. 2000). Based on the historic whaling data, and lack of recent sighting records or acoustic detections, sei whales were assigned a zero density estimate for winter/spring.

NWTT Inland Waters. Sei whales are considered rare/extralimital in the Inland Waters including Puget Sound. A sei whale washed ashore west of Port Angeles in the Strait of Juan de Fuca during September 2003 (Preston 2003), but this is considered an unusual event.

NWTT Western Behm Canal, Alaska. Sei whales are not expected to occur within the SEAFAC region of the Study Area since it is well inland of the areas normally inhabited by sei whales.

GOA. Estimates of sei whale abundance in the eastern North Pacific based on survey data are not available and there are no density data specific to the Gulf of Alaska. During the 2013 GOALS II survey, although sei whales were acoustically detected there were no confirmed visual sightings, and the limited acoustic data prohibited the derivation of line-transect density estimates (Rone et al. 2014). In the absence of survey data, density data from the St. Andrews University RES global model were used (note that sei whales were predicted to be absent from the GOA Study Area in winter, when they would be expected to be further south).

Table 5-3: Sources of Density Values Used for Sei Whale

Location	Spring	Summer	Fall	Winter
HRC	L	0	L	L
W. Transit Corridor	L	0	L	L
E. Transit Corridor	SMRU	SMRU	SMRU	SMRU
SOCAL	L	L	L	L
MITT	L	L	L	L
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	LD	L and LD	L and LD	LD
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	SMRU	SMRU	SMRU	SMRU

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 5-4: Summary of Density Values for Sei Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0.00019	0	0.00019	0.00019
W. Transit Corridor	0.00019	0	0.00019	0.00019
E. Transit Corridor	S	S	S	S
SOCAL	0.00009	0.00009	0.00009	0.00009
Inner Baja Extension	0.00009	0.00009	0.00009	0.00009
Outer Baja Extension	0.00009	0.00009	0.00009	0.00009
MITT	0.00029	0	0.00029	0.00029
MITT Transit Corridor	0.00013	0	0.00013	0.00013
NWTT Offshore	0	0.00012–0.00018	0.00012–0.00018	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	S	S	S	S

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

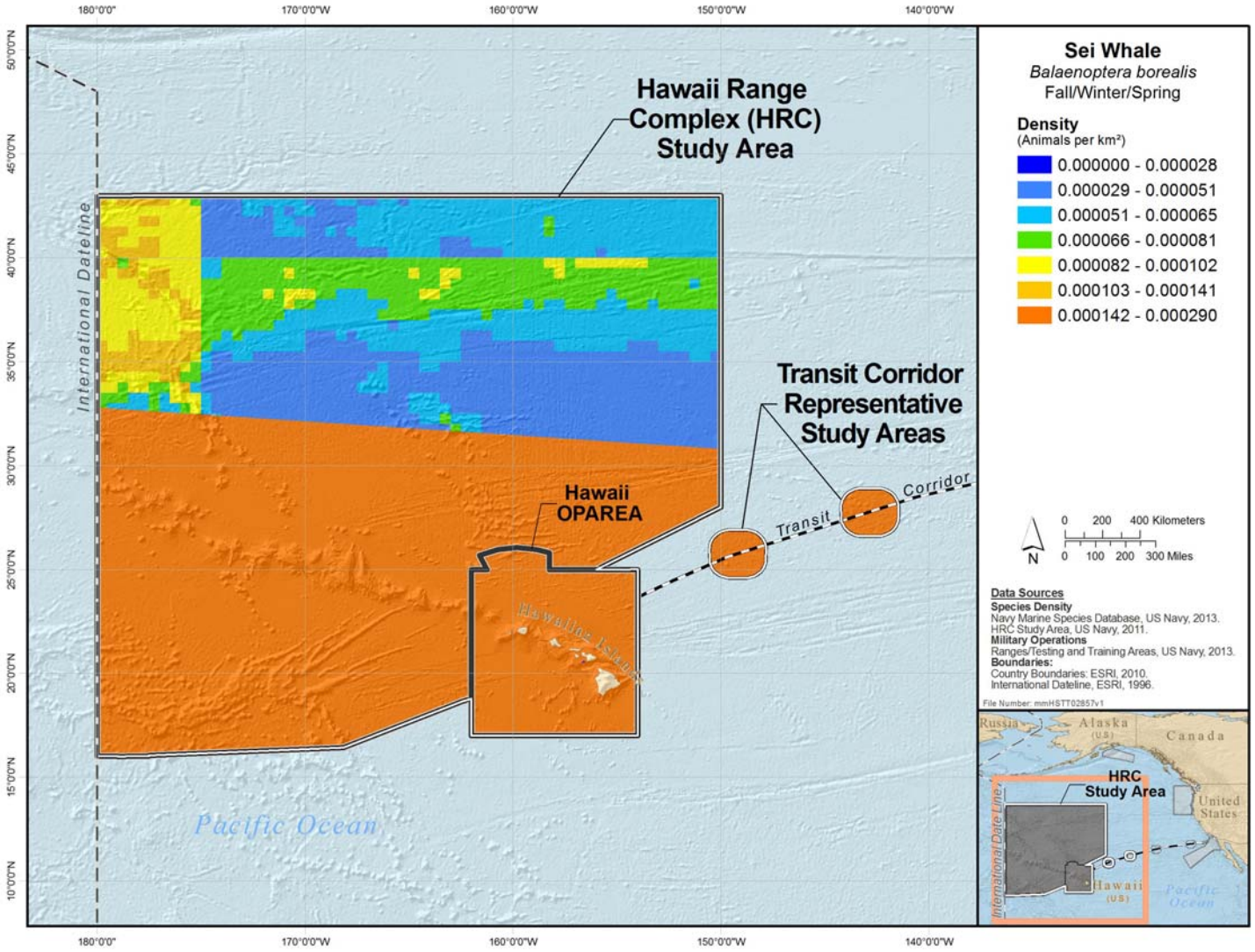

Figure 5-17: Fall, Winter, Spring Distribution of Sei Whale in HRC and the Western Portion of the Transit Corridor

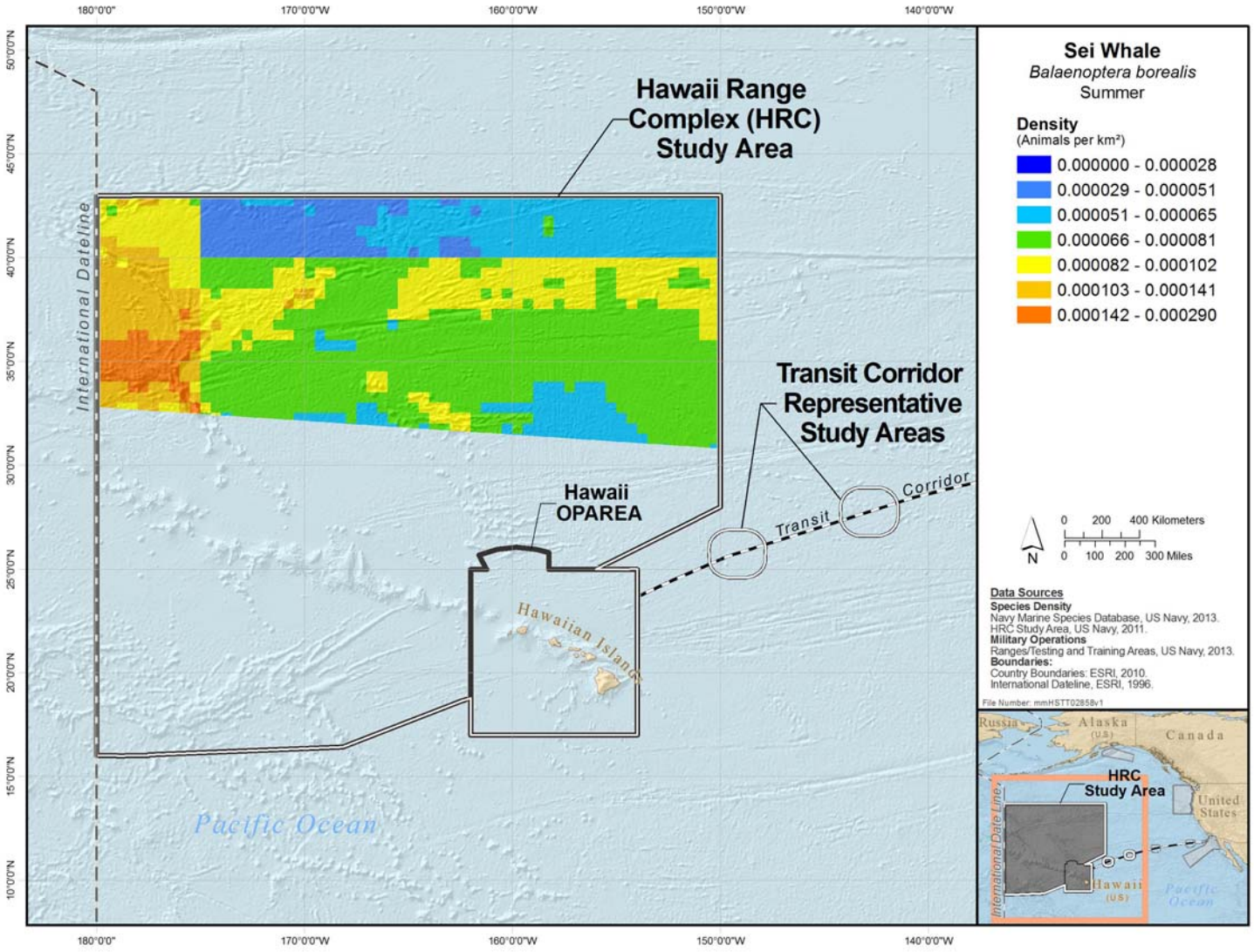

Figure 5-18: Summer Distribution of Sei Whale in HRC and the Western Portion of the Transit Corridor

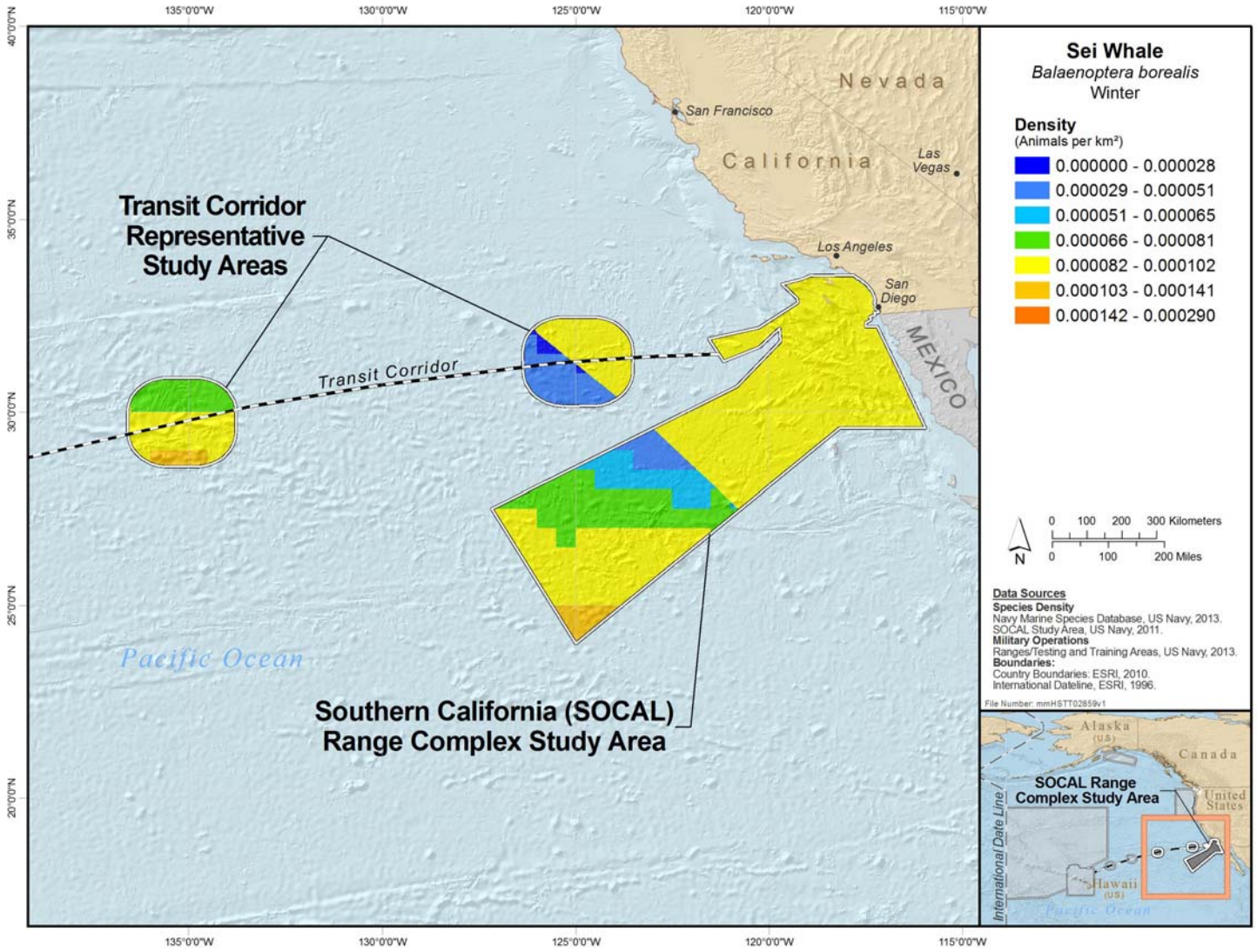

Figure 5-19: Winter Distribution of Sei Whale in SOCAL and the Eastern Portion of the Transit Corridor

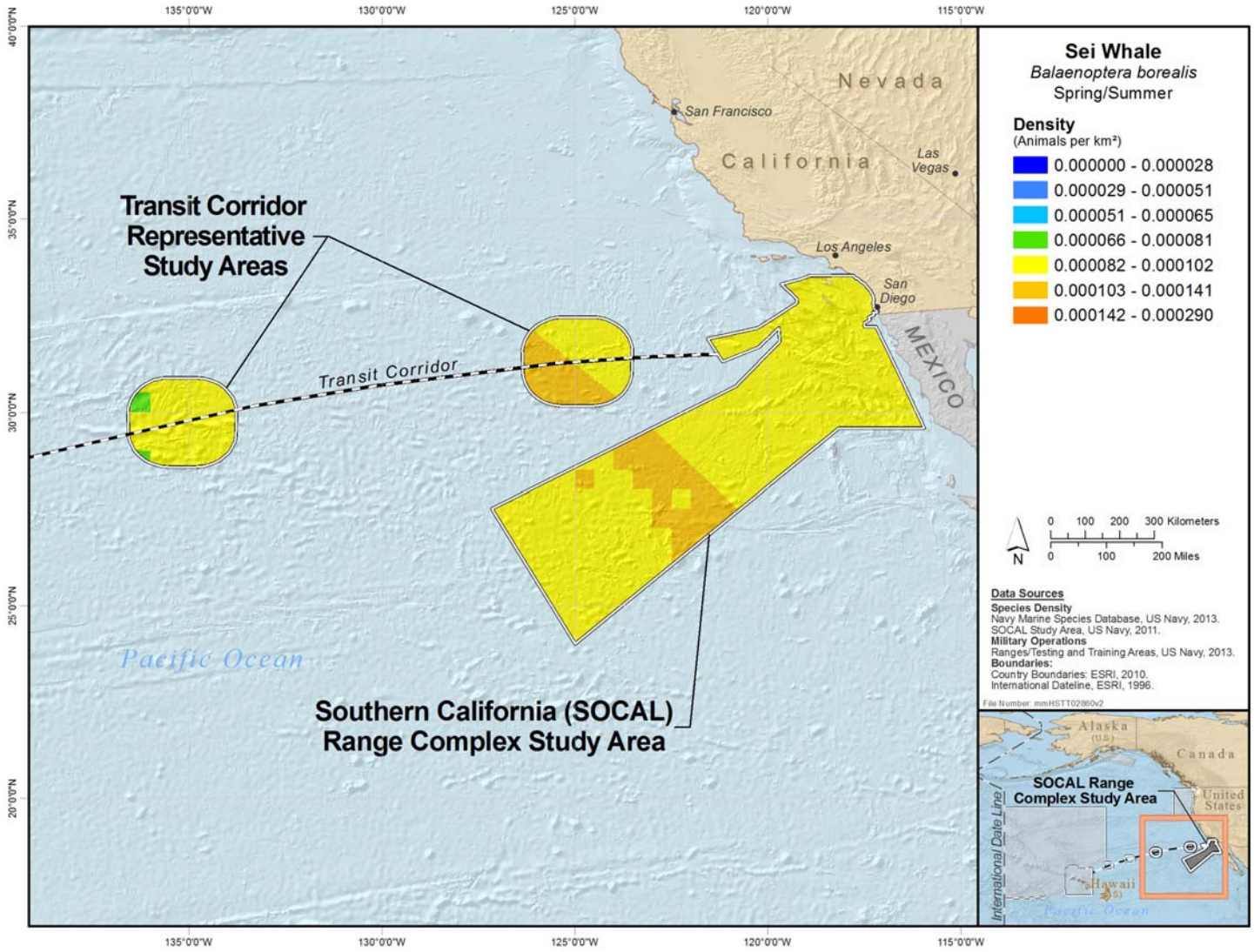

Figure 5-20: Spring/Summer Distribution of Sei Whale in SOCAL and the Eastern Portion of the Transit Corridor

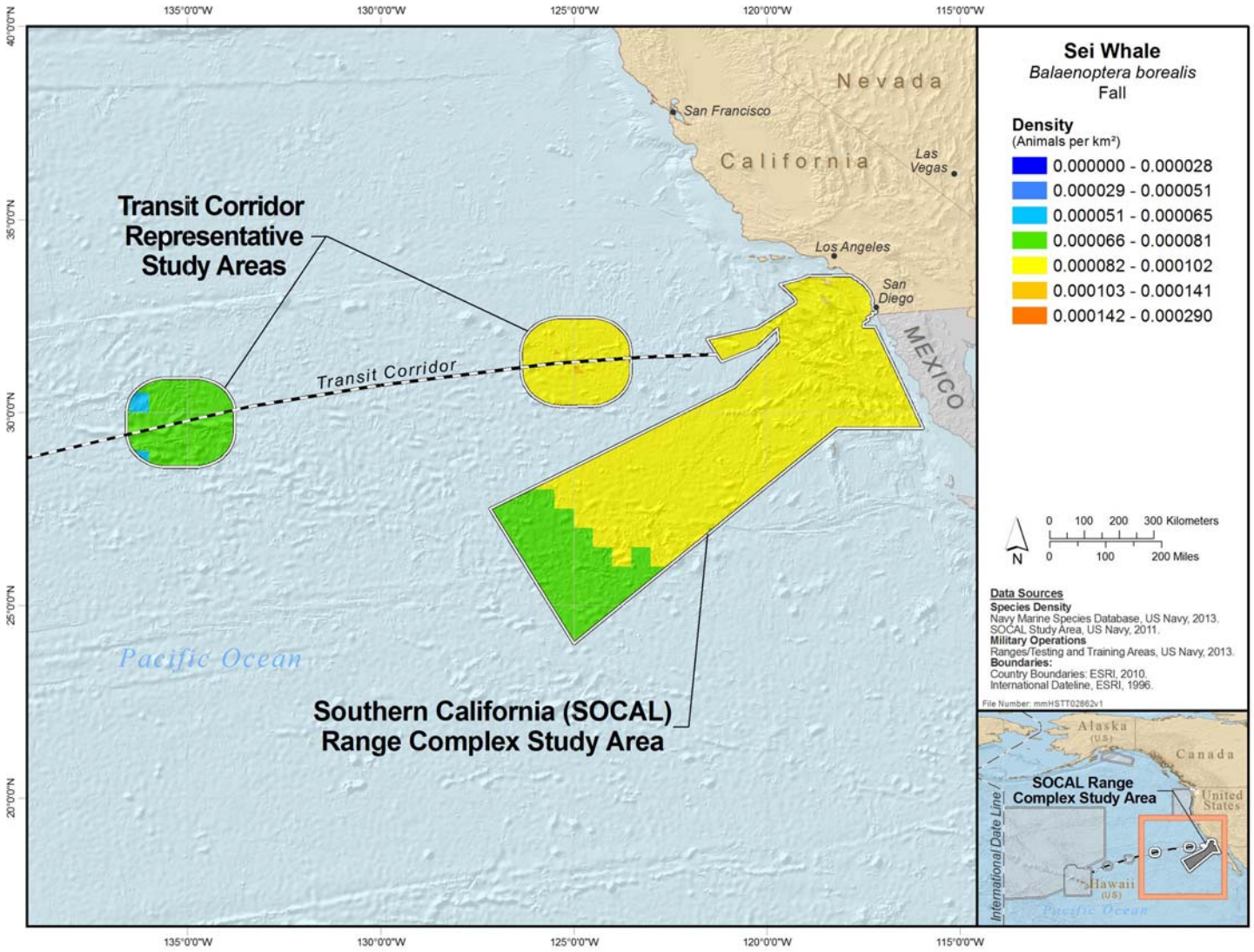

Figure 5-21: Fall Distribution of Sei Whale in SOCAL and the Eastern Portion of the Transit Corridor

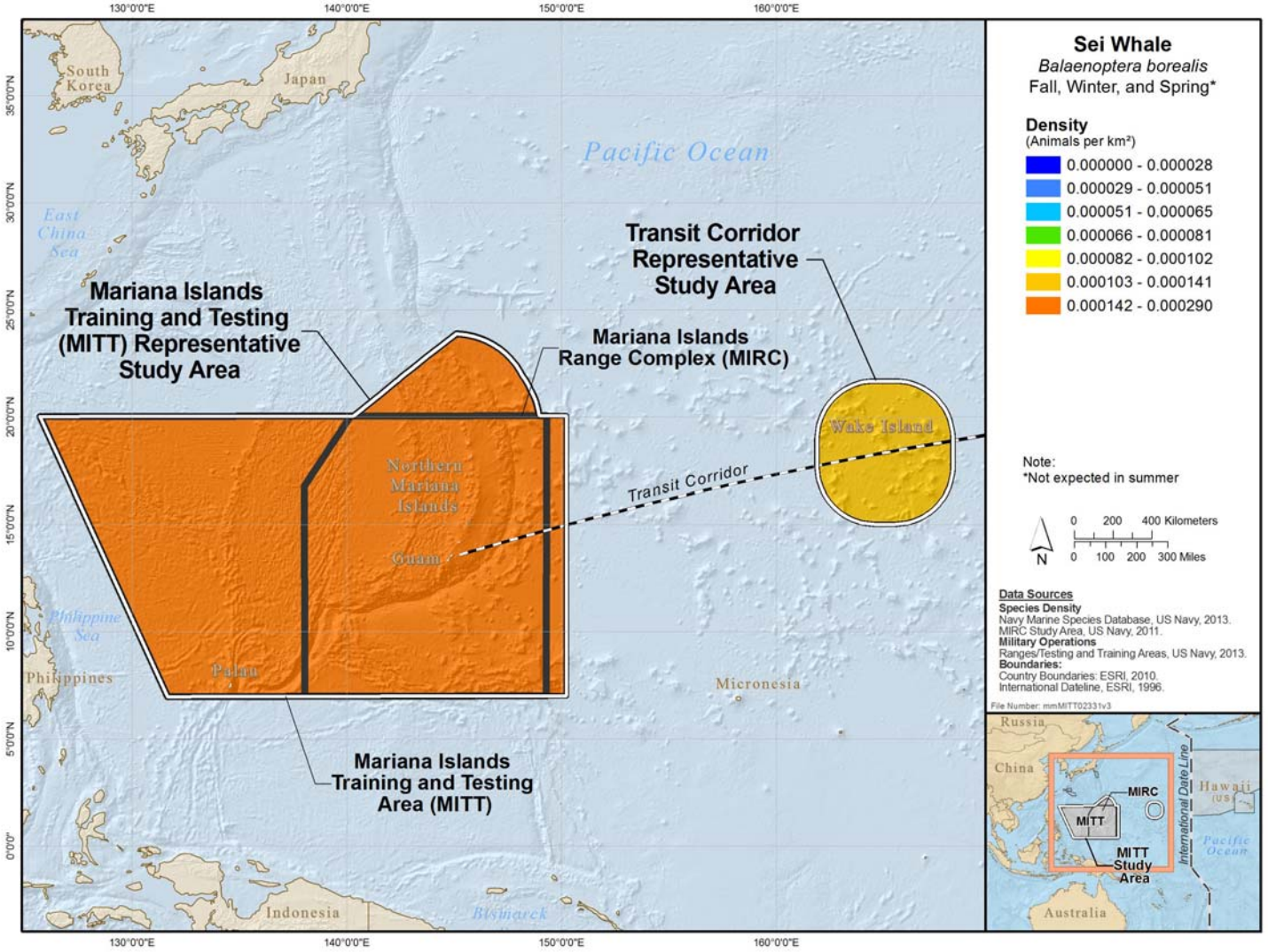

Figure 5-22: Fall, Winter, and Spring Distribution of Sei Whale in MITT and the Associated Transit Corridor

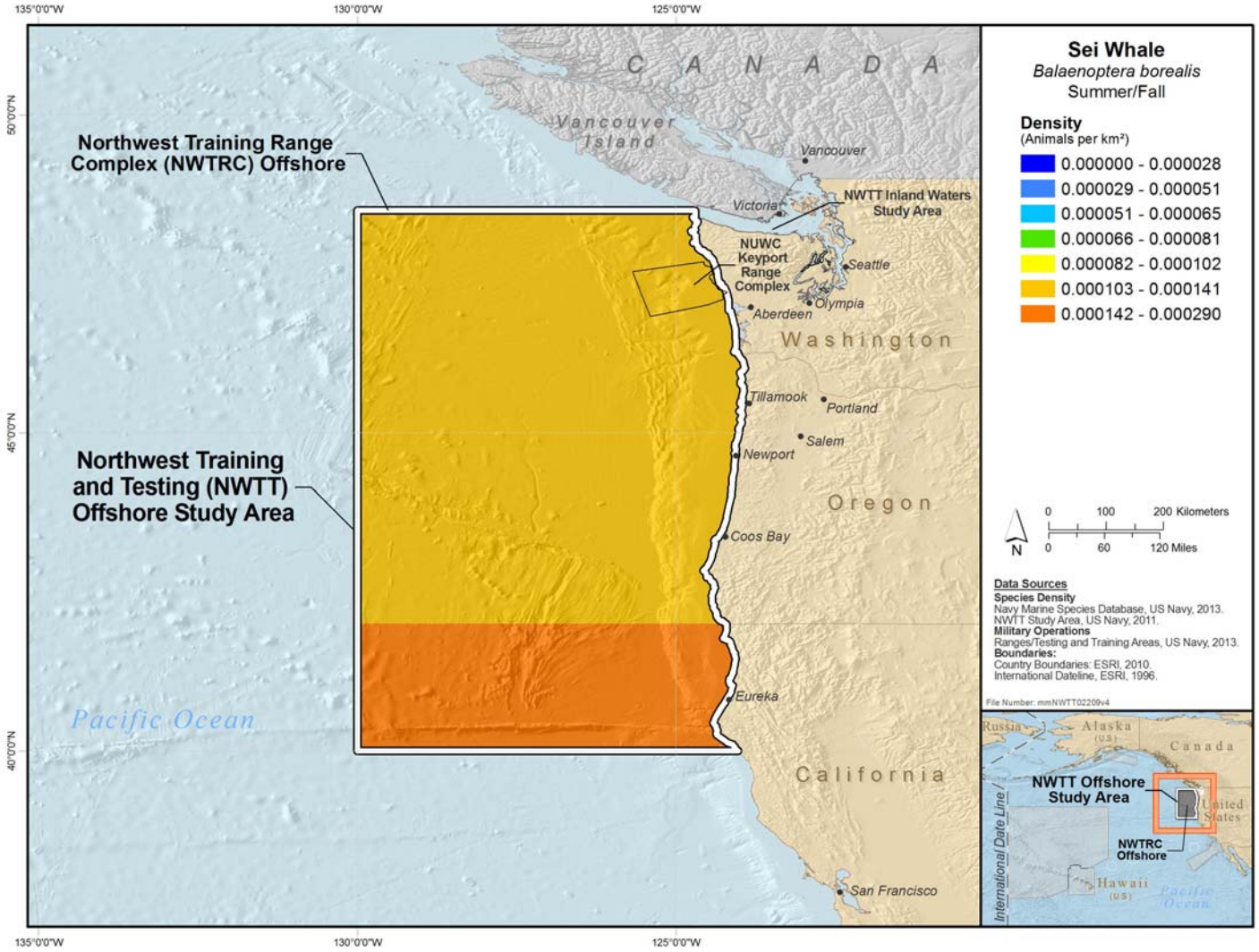

Figure 5-23: Summer/Fall Distribution of Sei Whale in the Offshore Portion of NWTT

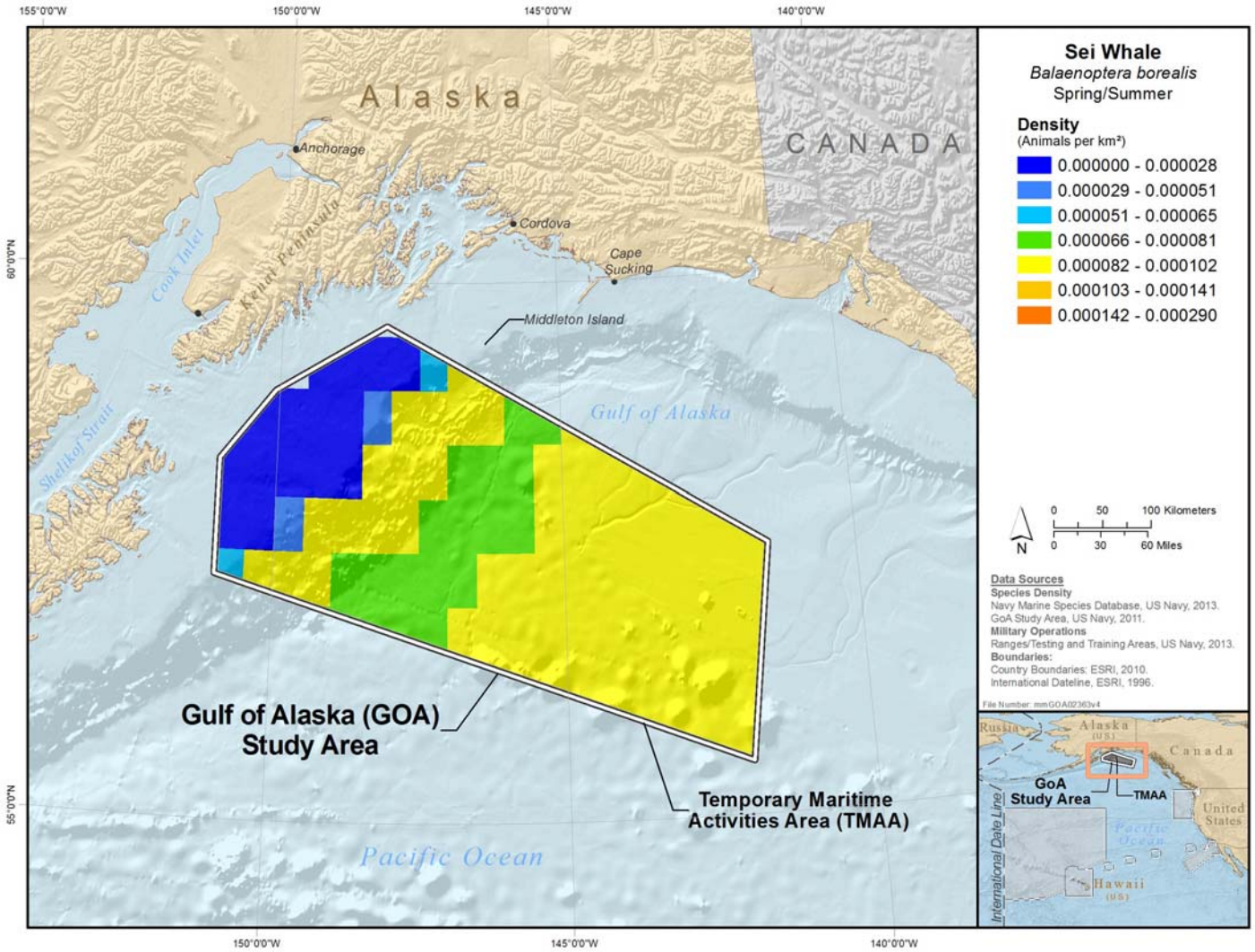

Figure 5-24: Spring/Summer Distribution of Sei Whale in the GOA Study Area

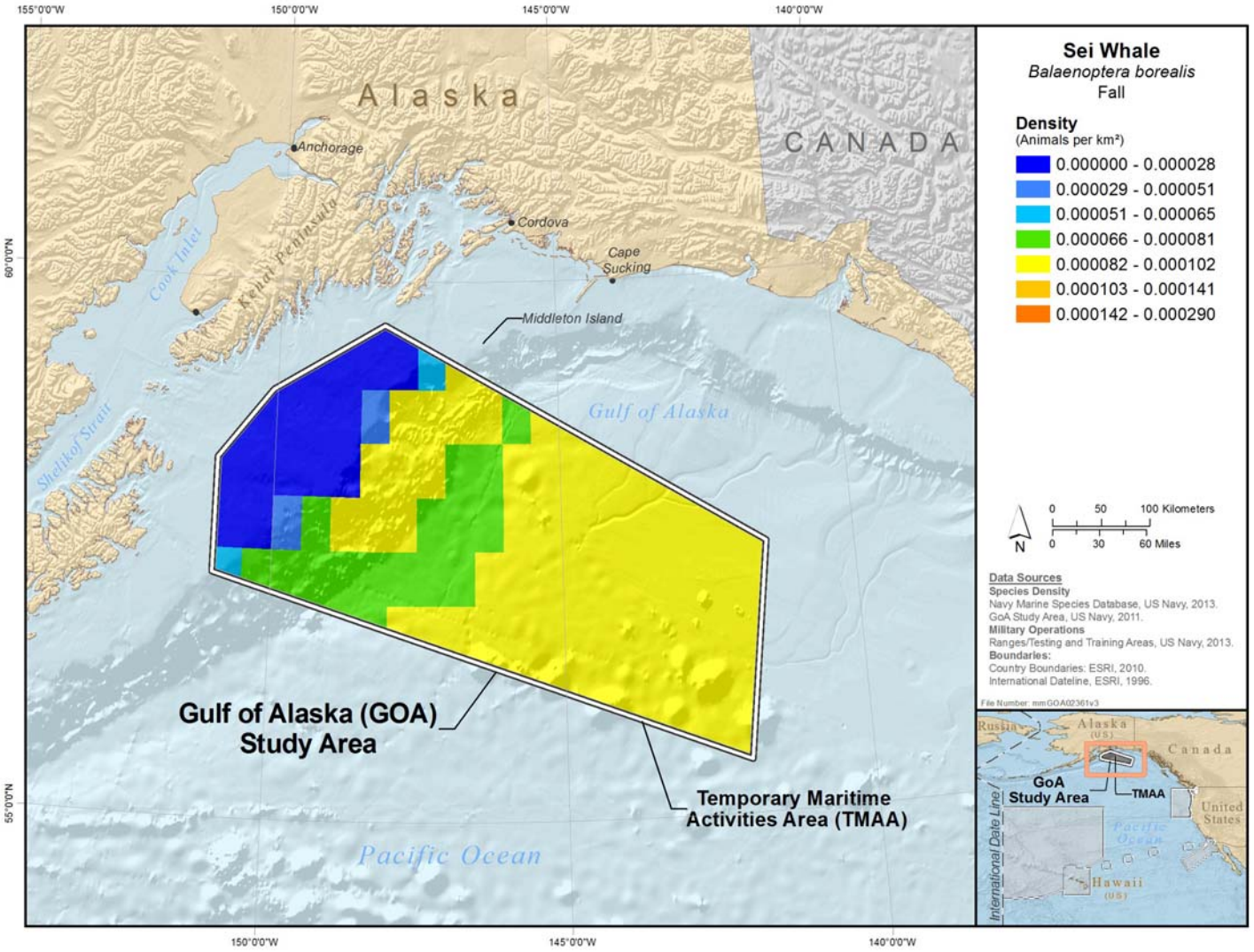

Figure 5-25: Fall Distribution of Sei Whale in the GOA Study Area

5.1.3 *BALAENOPTERA EDENI*, BRYDE'S WHALE

Bryde's are a baleen whale found only in tropical and warm temperate waters (Kato and Perrin 2009; Leatherwood et al. 1988). Bryde's whales are a species that can be difficult to identify positively from a distance, because of their superficial similarity to sei and Omura's whales (Jefferson et al. 2008). Positive identification of the species requires clear identification of three rostral ridges in front of the blowhole. The difficulty of observing this feature is confounded by the fact that Bryde's whales are rapid swimmers and are not easy to view closely from a vessel (Jefferson et al. 2008; Leatherwood et al. 1988). For these reasons, Bryde's whales may often be underrepresented in data from visual surveys; they are included primarily in the 'unidentified rorqual' or 'unidentified large whale' categories. NMFS recognizes two stocks of Bryde's whales in the U.S. Pacific, the Eastern Tropical Pacific stock and the Hawaii stock (Carretta et al. 2011a). Density values for the HSTT Study Area are presented for the species as a whole. While animals in SOCAL or HRC could presumably be assigned to a stock, animals in the transit corridor could belong to either stock. The IWC recognizes a complex suite of Bryde's whale stocks in the Pacific; there are three stocks the North Pacific (eastern, western, and East China Sea), three stocks in the South Pacific (eastern, western and Solomon Islands), and one cross-equatorial stock, called the Peruvian stock (Carretta et al. 2011a). Little is known about the stock structure of Bryde's whales in the MITT Study Area.

HRC. Sufficient data were collected during NMFS's large ship visual surveys before 2010 to create a CENPAC habitat-based density model for Bryde's whales (Becker et al. 2012b). This model covers the south portion of the HRC and the entire transit corridor to western edge of U.S. EEZ. The CENPAC model is applied to all seasons for the HRC and the entire transit corridor.

SOCAL. Barlow and Forney (2007) provide a uniform density for Bryde's whales for California, Oregon, and Washington. This number is also applied to Baja since no values were found in the literature and the RES model portrayed distributions which departed from the quantitative information provided by Barlow and Forney (2007) and general perceptions of the distribution of Bryde's whales. As stated above, the CENPAC model was used for the entire transit corridor. There was a small sliver of area between the CENPAC model area and the SOCAL study area that needed to be addressed for consistency and modeling purposes. The uniform density of 0.00001 animals/km^2 from Barlow and Forney (2007) was assigned to that area. The uniform density value agreed well with the CENPAC model for Bryde's whales in that area (0.000013 vs. 0.00001 animals/km^2), and the RES models disagreed significantly with the CENPAC and literature values. In the Southern California Bight, data for Bryde's whales are arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

MITT. Bryde's whales were identified 18 times during the Navy's 2007 survey of the MITT Study Area (Fulling et al. 2011). They were observed in groups of one to three, with several sightings including calves. Sixteen of these were on-effort sightings, resulting in a density estimate of 0.00041 animals/km^2 (CV = 0.45) (Fulling et al. 2011). Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data were used to characterize annual Bryde's whale density.

NWTT. Based on sighting data collected by SWFSC during systematic surveys in the northeast Pacific between 1986 and 2005, there were no sightings of Bryde's whales north of about 38°N (Hamilton et al. 2009). Consequently, for the SWFSC Oregon/Washington and Northern California strata, Bryde's whale was assigned a zero density estimate based on ship surveys conducted in these waters between 1991 and 2008 (Barlow 2010). An unprecedented stranding of a Bryde's whale occurred in Puget Sound in January 2010 (Cascadia Research 2010a), followed by another in December the same year (Cascadia Research 2010b). Both animals were immature and in poor nutritional condition, suggesting that they were beyond the species' normal range. The occurrence of Bryde's whale within the NWTT Study Area is considered extralimital as all regions within the Study Area are outside the normal range of this species' distribution.

GOA. This species is not expected to occur in the GOA Study Area.

Table 5-5: Sources of Density Values Used for Bryde's Whale

Location	Spring	Summer	Fall	Winter
HRC	CENPAC	CENPAC	CENPAC	CENPAC
W. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
E. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
SOCAL	L	L	L	L
MITT	L	L	L	L
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	L	L	L	L
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 5-6: Summary of Density Values for Bryde's Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	S	S	S	S
SOCAL	0.00001	0.00001	0.00001	0.00001
Inner Baja Extension	0.00001	0.00001	0.00001	0.00001
Outer Baja Extension	0.00001	0.00001	0.00001	0.00001
MITT	0.00041	0.00041	0.00041	0.00041
MITT Transit Corridor	0.00030	0.00030	0.00030	0.00030
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

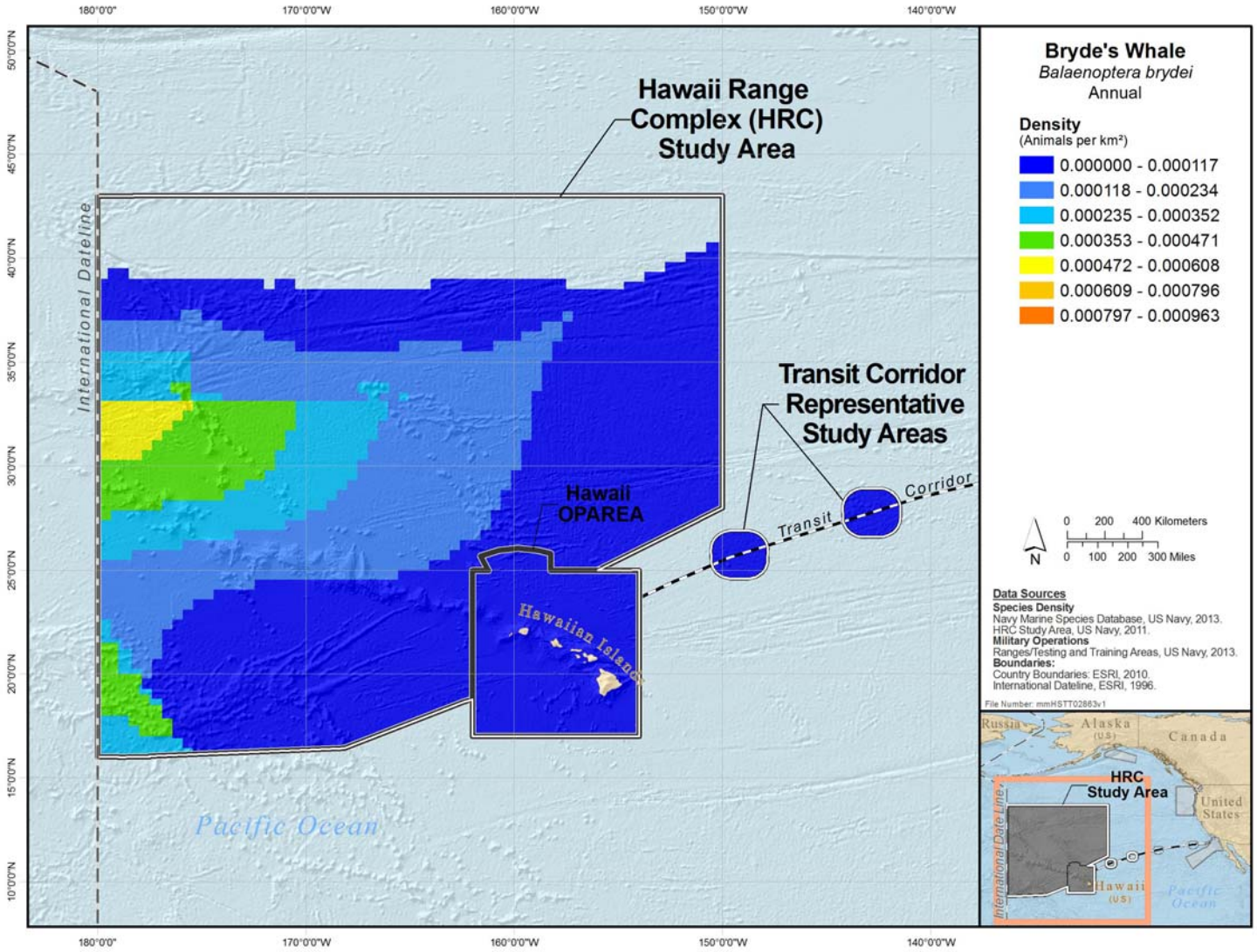

Figure 5-26: Year-Round Distribution of Bryde's Whale in HRC and the Western Portion of the Transit Corridor

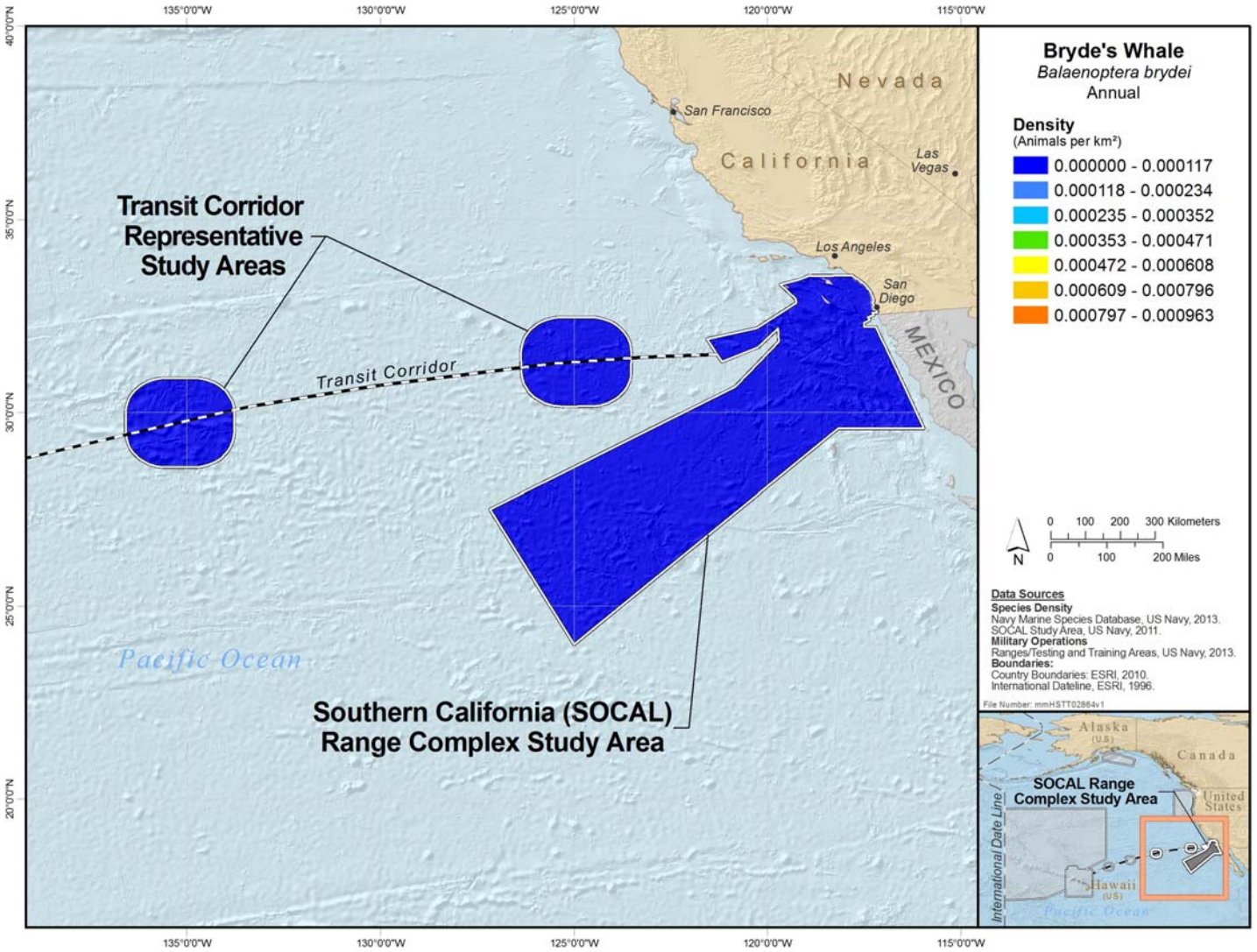

Figure 5-27: Year-Round Distribution of Bryde's Whale in SOCAL and the Eastern Portion of the Transit Corridor

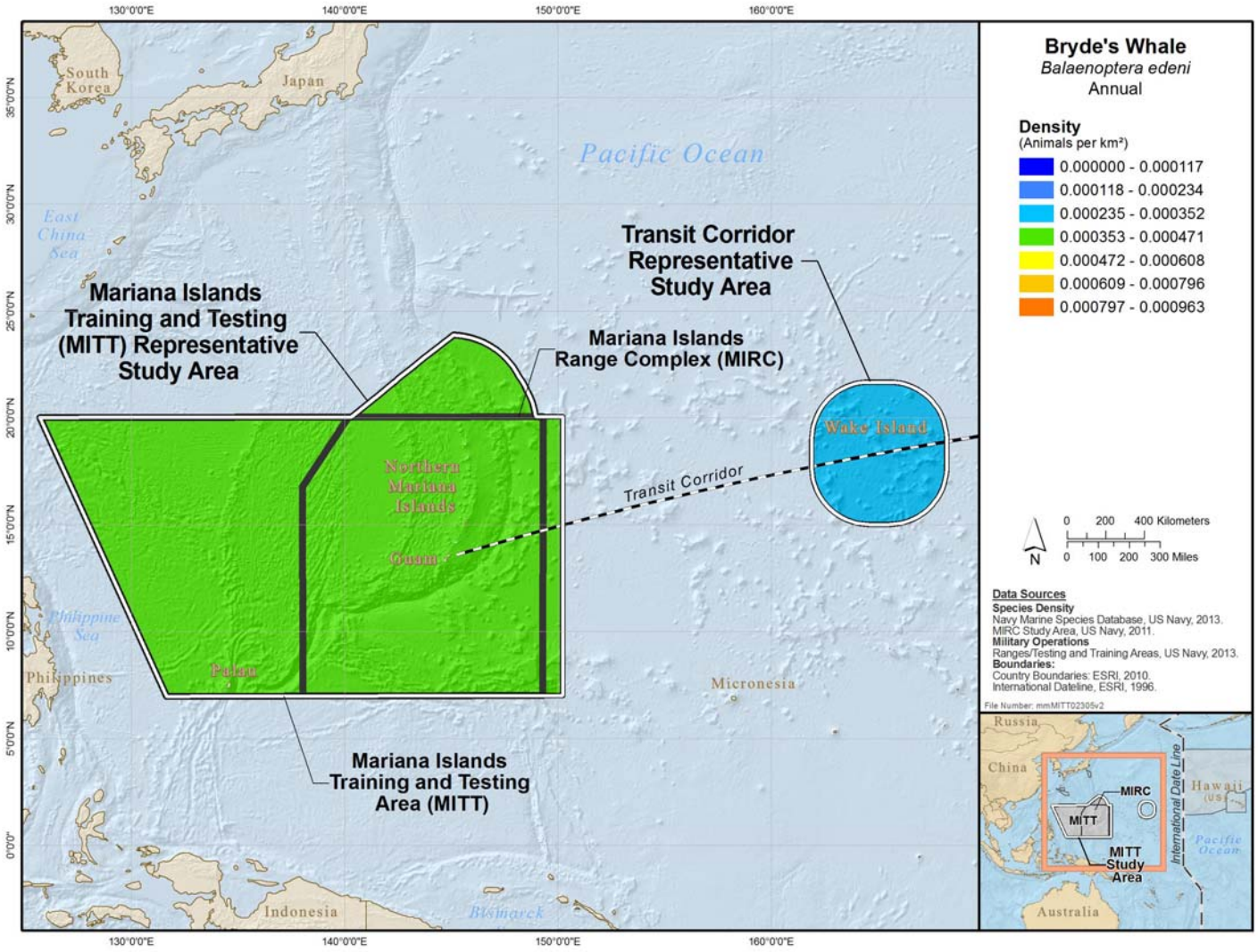

Figure 5-28: Year-Round Distribution of Bryde's Whale in MITT and the Associated Transit Corridor Study Areas

5.1.4 *BALAENOPTERA MUSCULUS*, BLUE WHALE

Blue whales are relatively easy to observe and identify in the field. They are the largest baleen whale, their blow is tall and distinctive, and their color is mottled, light gray-blue compared to the dark gray to black of the other large baleen whales (Jefferson et al. 2008). The dorsal fin is set far back on the body and is reduced in size—it may be present only as a small bump (Jefferson et al. 2008; Leatherwood et al. 1988). From a distance or in backlight, blue whales could be mistaken for fin whales, but a close view will dispel misidentification (Jefferson et al. 2008; Leatherwood et al. 1988). There are four subspecies of blue whale, but only *Balaenoptera musculus musculus* is found in the North Pacific (Allen et al. 2011). Because they are readily identifiable, density values for blue whales are available in the literature and NMFS reports for areas that have been surveyed.

The IWC recognizes a single stock of blue whales in the North Pacific, while NMFS recognizes two stocks: an Eastern North Pacific stock and a Central North Pacific stock (Carretta et al. 2011a). The Eastern North Pacific stock includes animals found in the eastern North Pacific from the northern Gulf of Alaska to the eastern tropical Pacific (Carretta et al. 2011a). Density values for the HSTT Study Area are presented for the species as a whole. Theoretically, most of the blue whales in SOCAL and in the eastern portion of the transit corridor belong to the Eastern North Pacific stock. Blue whales in the HRC and in the western portion of the transit corridor would most likely be members of the Central North Pacific stock. NMFS considers blue whales found in the MITT Study Area as part of the Central North Pacific stock (Carretta et al. 2011a) due to differences in call types with the Eastern North Pacific stock (Stafford 2003; Stafford et al. 2001). Blue whales in the NWTT Study Area belong to the Eastern North Pacific stock. Blue whales from either stock could occur in the GOA Study Area.

HRC. There are no sightings of blue whales close to Hawaii in recent history, but their vocalizations are heard from acoustic listening stations north of the Main Hawaiian Islands during the cool seasons (W. Au pers. comm.) as well as other times of the year (Stafford et al. 2001). The lack of sightings of blue whales combined with the knowledge that they are present to some limited degree led the Navy to use density values from the Eastern Tropical Pacific from Wade and Gerrodette (1993). The value is low (0.000074 animals/km^2), but represents a presence of blue whales that is applicable to the HRC and western portion of the transit corridor. This value is used for winter, spring, and fall. In the summer, blue whales are likely absent from the HRC (Barlow 2006); therefore, a density of zero is used for that season in the HRC and the western portion of the transit corridor. This area of zero density in summer seems to contrast sharply with the global model around the area, but it should be noted that the values in blue are of the lowest density values in the range of density values.

SOCAL. NMFS has been able to develop a CCE habitat-based density model for blue whales. This model provides the distribution off the west coast for summer and fall. Ferguson and Barlow (2003) also provide uniform densities specifically for the inner (0.005 animals/km^2) and outer (0.0035 animals/km^2) Baja Extension areas for summer and fall. A single uniform density of 0.00011 animals/km^2 is used from Forney et al. (1995) for the SOCAL and Baja study areas in winter and spring. Data do not exist for the eastern half of the transit corridor; therefore, RES data from SMRU Ltd. (*in prep*) are used for all seasons in the transit corridor.

In the Southern California Bight, data for blue whales are arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

MITT. There are no recent sighting records for the blue whale in the MITT Study Area, although this area is in the distribution range for this species (Reilly et al. 2008). Blue whales would be most likely to occur in the MITT Study Area during the winter, although none were observed during the Navy's systematic survey conducted from January to April 2007 (Fulling et al. 2011). To provide a density estimate for this species, density estimates and associated CVs derived by Ferguson and Barlow (2003) for the eastern tropical Pacific were re-calculated for those strata having sea surface temperature and chlorophyll concentrations similar to the MITT Study Area. This included Ferguson and Barlow's (2003) strata 122–131 (extending west of 105°W between 5 and 10°N) and 141–151 (extending west of 95°W between 10 and 15°N). The resulting density estimate of 0.00001 (CV = 1.00) was used for the MITT Study Area and associated transit corridor for fall, winter, and spring.

Blue whales are likely absent from low-productivity tropical waters in the summer (Jefferson et al. 2008; Perrin and Brownell 2009); therefore, a density of zero is used for that season in the MITT and associated transit corridor study areas.

NWTT Offshore. The U.S. west coast is a known feeding area for blue whales during summer and fall (Calambokidis et al. 2009), although primary occurrence for this species is south of 44°N (Hamilton et al. 2009; Forney et al. 2012). As noted above for SOCAL, NMFS developed a CCE habitat-based density model for blue whales which provides spatially-explicit density estimates off the U.S. west coast for summer and fall. Barlow and Forney (2007) also provided stratified uniform density estimates for blue whales for California, Oregon, and Washington in summer/fall. In the absence of other data, their summer/fall uniform density estimate for Oregon/Washington offshore waters was used for the area north of the SWFSC survey area (refer to Figure 3-6). Uniform density values for blue whale are available for the Northern California offshore stratum for winter/spring (Forney et al. 1995; Barlow et al. 2009). Winter/spring density data are not available for strata to the north; however, Navy-funded acoustic monitoring studies have detected blue whales along the Washington coast between August and February (Širović et al. 2011, 2012a, b). Given these data, which confirm the presence of blue whales in these offshore waters in winter/spring, but in fewer numbers than summer/fall, and their predominantly more southerly distribution, a density estimate an order of magnitude lower than the winter/spring California estimate was assigned to the offshore waters north of California.

NWTT Inland Waters. Blue whales are not expected to occur within the Inland Waters region of the Study Area since it is well inland of the areas normally inhabited by blue whales.

NWTT Western Behm Canal, Alaska. Blue whales are not expected to occur within the Western Behm Canal region of the Study Area since it is well inland of the areas normally inhabited by blue whales.

GOA. Blue whale calls have been acoustically detected in the Gulf of Alaska from mid-July to mid-December, with peak occurrence from August through November (Moore et al. 2006). Although there were no blue whale sightings during the Navy-funded survey of the Study Area in April 2009 (Rone et al. 2009), there were five blue whale sightings during the 2013 GOALS II survey (Rone et al. 2014). Based on

pooled sightings from all strata and incorporation of prorated estimates for unidentified large whale species, an overall blue whale density estimate for the Study Area was calculated as 0.0005 (CV = 1.22). Since all sightings occurred in the seamount stratum, the resulting density estimate for this stratum was 0.002 (CV = 1.22) (Rone et al. 2014).

Table 5-7: Sources of Density Values Used for Blue Whale

Location	Spring	Summer	Fall	Winter
HRC	L	0	L	L
W. Transit Corridor	L	0	L	L
E. Transit Corridor	SMRU	SMRU	SMRU	SMRU
SOCAL	L	CCE	CCE	L
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	L and LD	CCE and LD	CCE and LD	L and LD
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	L	L	L	L

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 5-8: Summary of Density Values for Blue Whale in the Pacific Fleet Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.000074	0	0.000074	0.000074
W. Transit Corridor	0.000074	0	0.000074	0.000074
E. Transit Corridor	S	S	S	S
SOCAL	0.00011	S	S	0.00011
Inner Baja Extension	0.00011	0.005	0.005	0.00011
Outer Baja Extension	0.00011	0.0035	0.0035	0.00011
MITT	0.00001	0.00001	0.00001	0.00001
MITT Transit Corridor	0.00001	0.00001	0.00001	0.00001
NWTT Offshore	0.00011–0.00001	S and 0.00020	S and 0.00020	0.00011–0.00001
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0.0005–0.002	0.0005–0.002	0.0005–0.002	0.0005–0.002

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

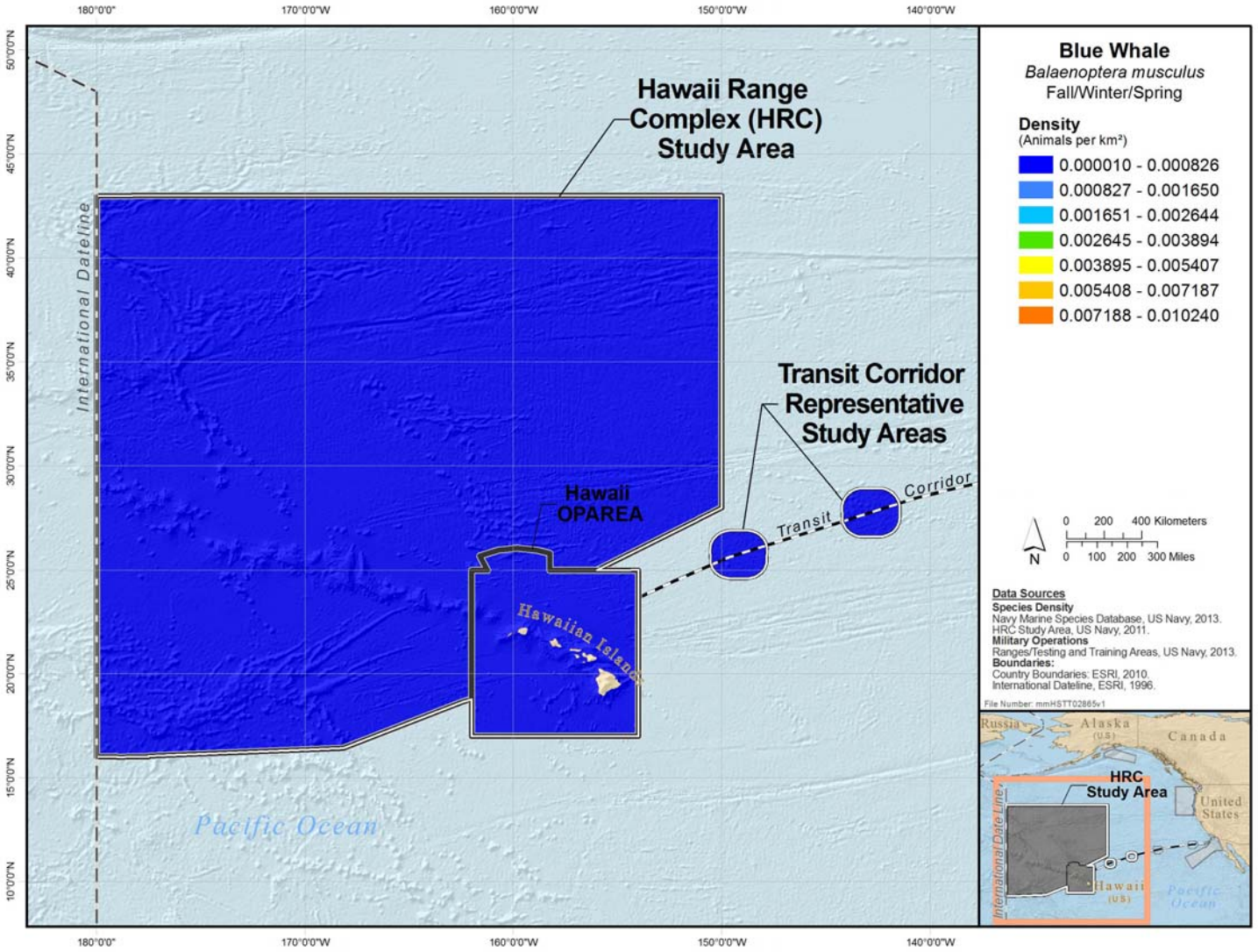

Figure 5-29: Winter, Spring, and Fall Distribution of Blue Whale in HRC and the Western Portion of the Transit Corridor

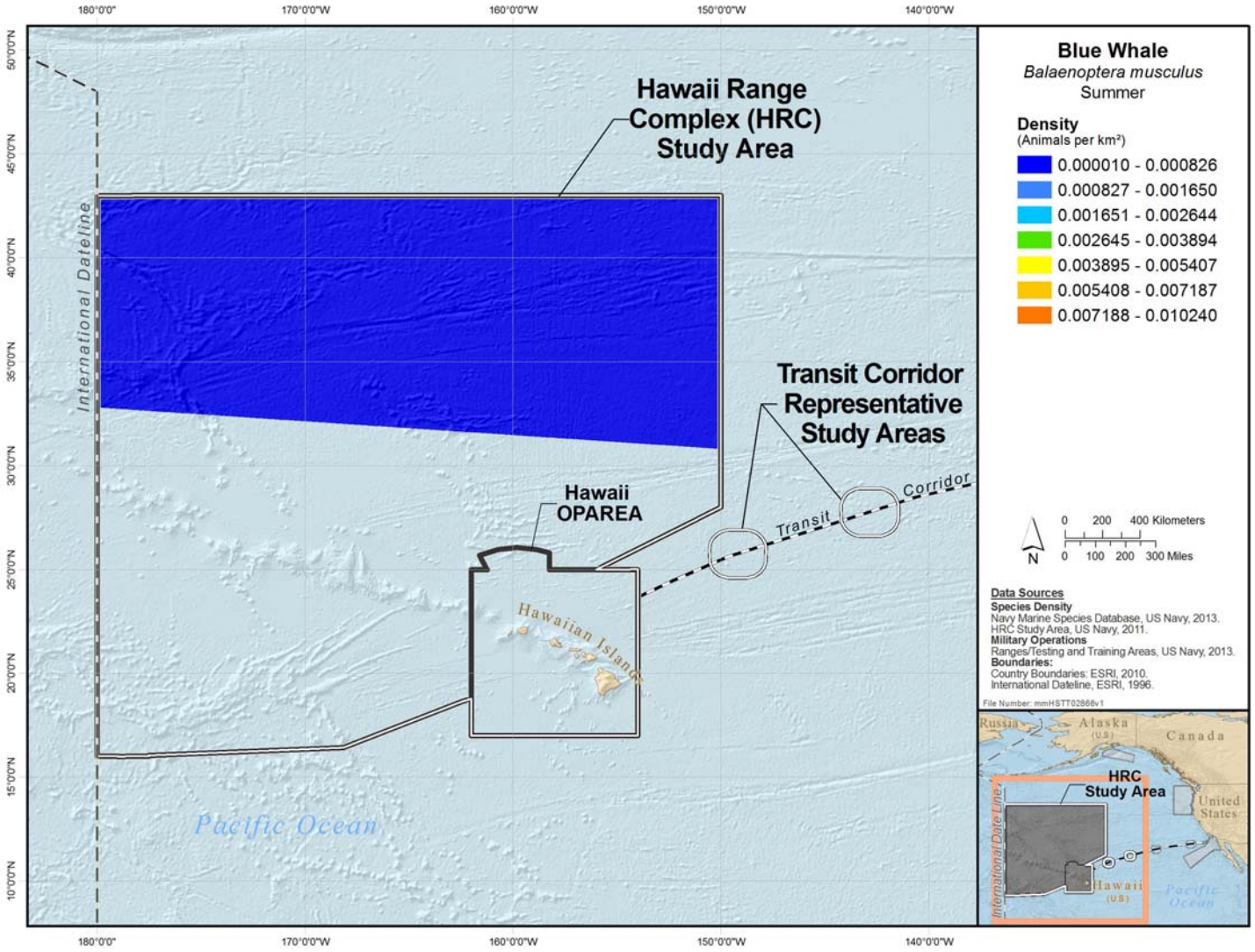

Figure 5-30: Summer Distribution of Blue Whale in HRC and the Western Portion of the Transit Corridor

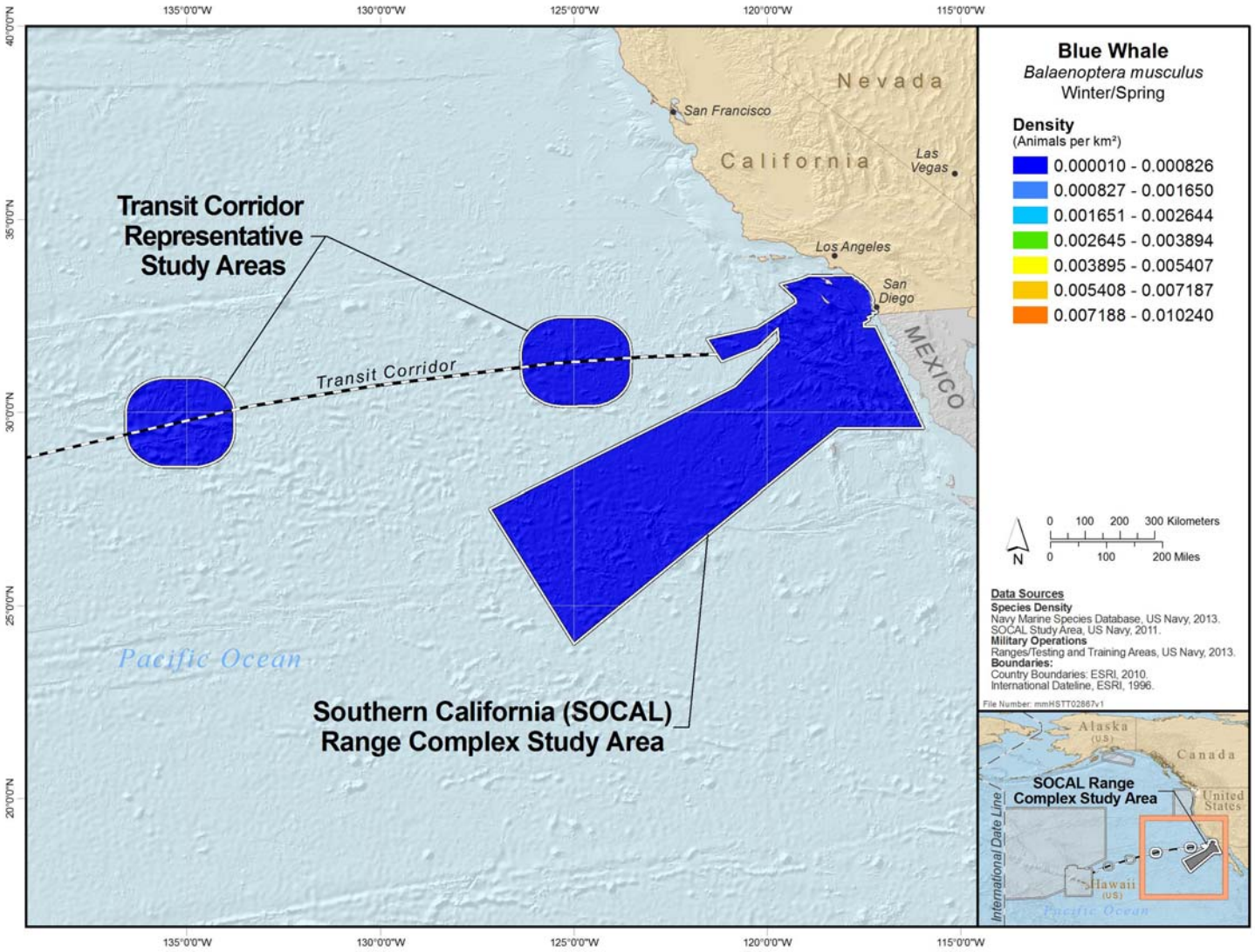

Figure 5-31: Winter/Spring Distribution of Blue Whale in SOCAL and the Eastern Portion of the Transit Corridor

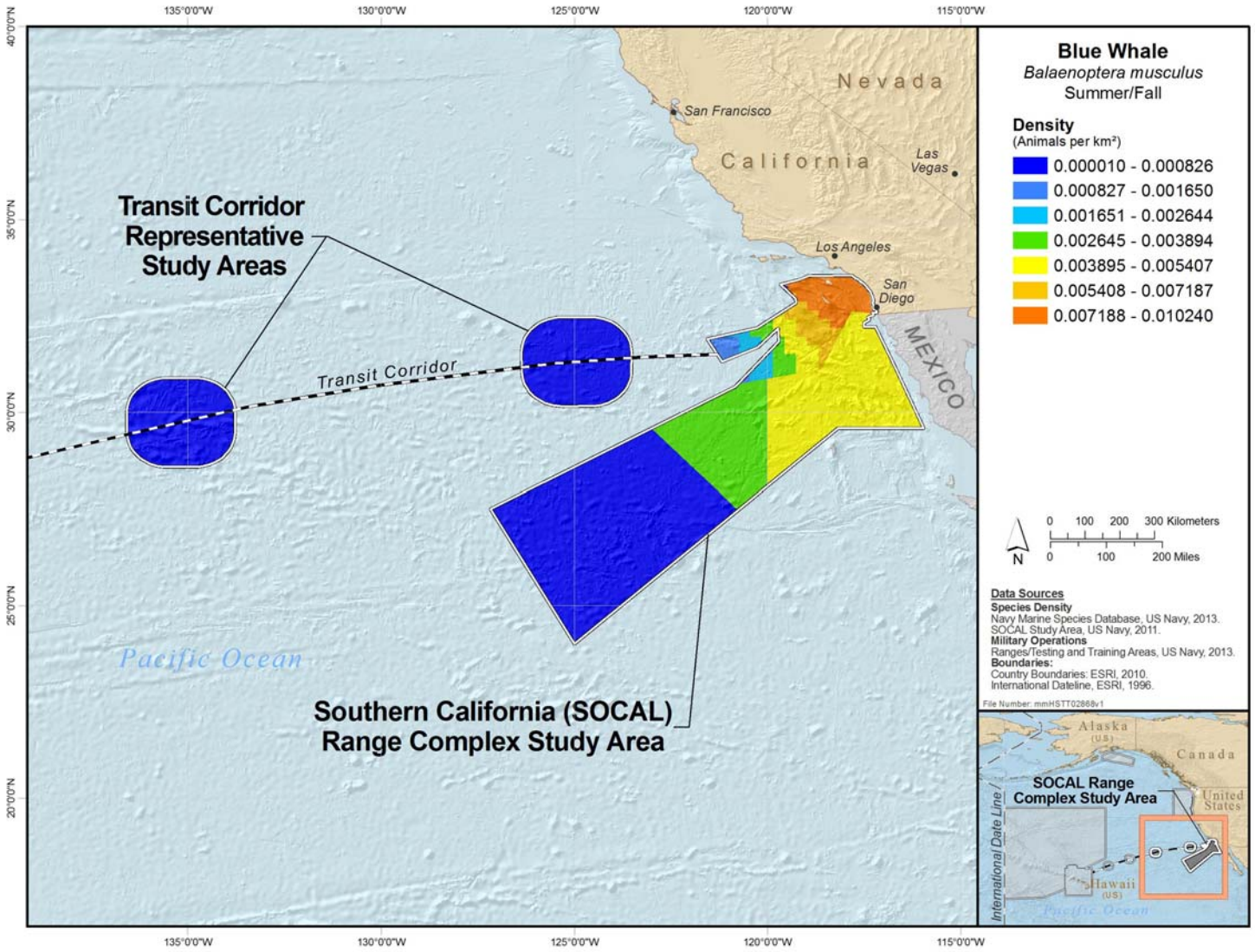

Figure 5-32: Summer/Fall Distribution of Blue Whale in SOCAL and the Eastern Portion of the Transit Corridor

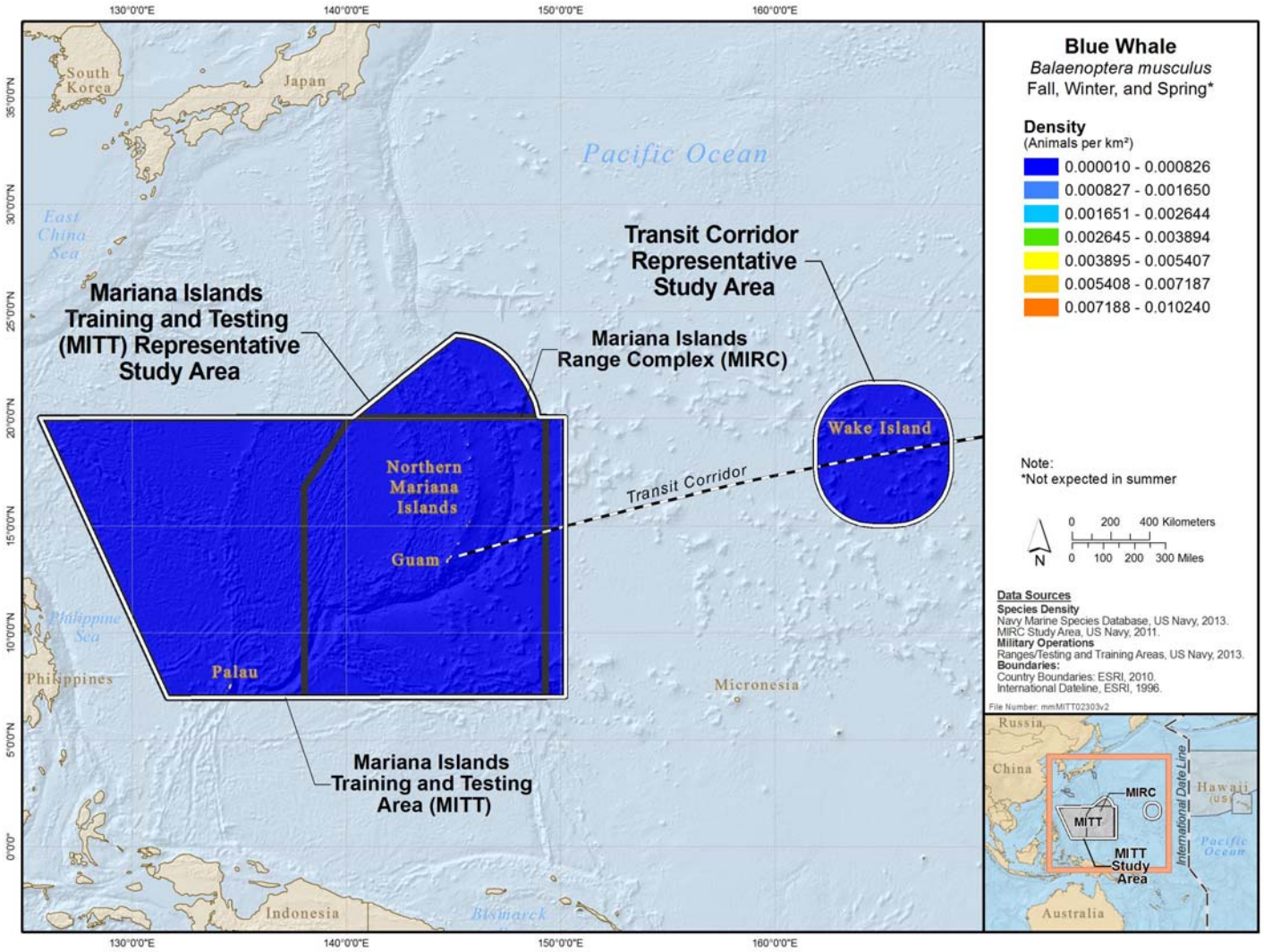

Figure 5-33: Fall, Winter, and Spring Distribution of Blue Whale in MITT and the Associated Transit Corridor Study Areas

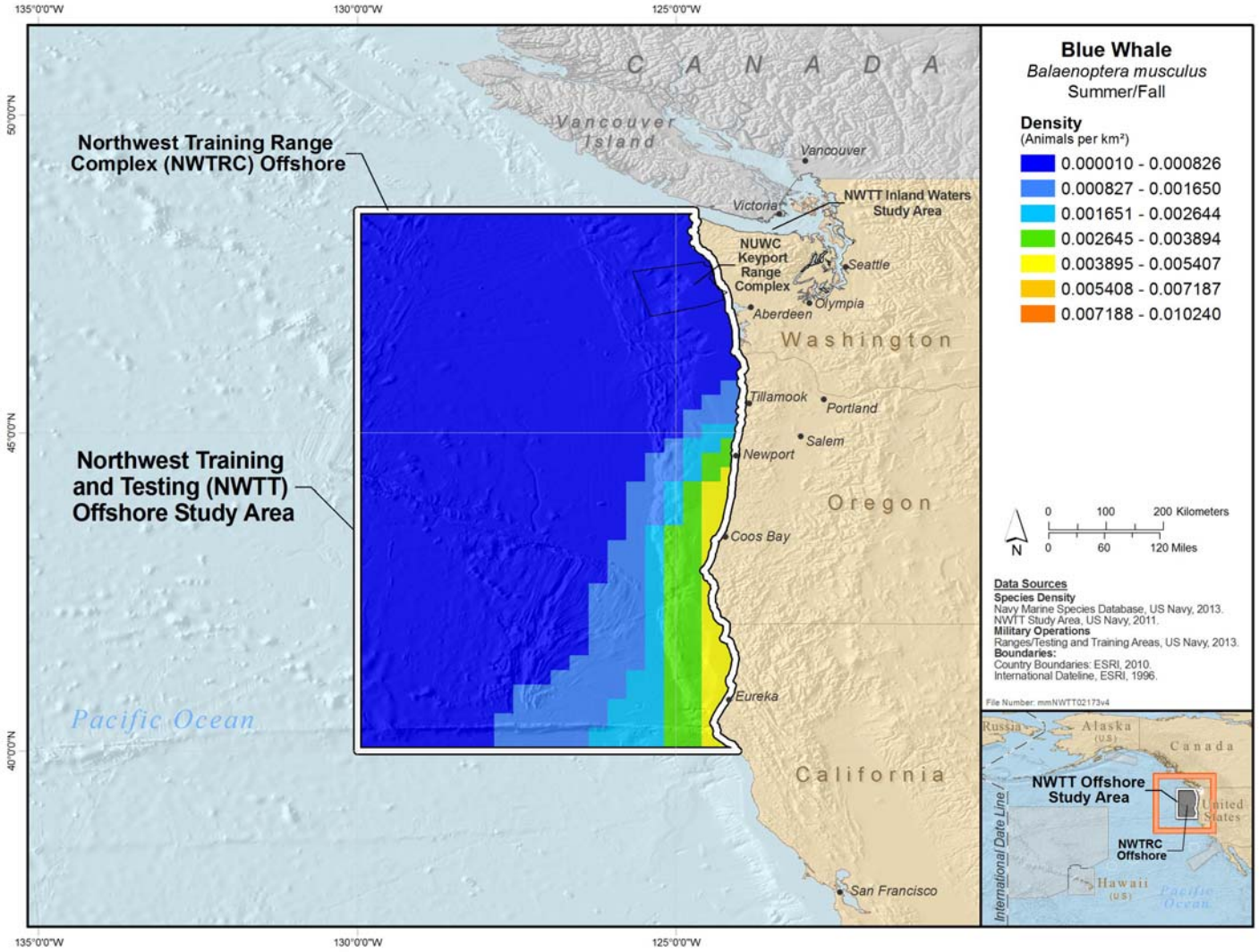

Figure 5-34: Summer/Fall Distribution of Blue Whale in the Offshore Portion of the NWTT Study Area

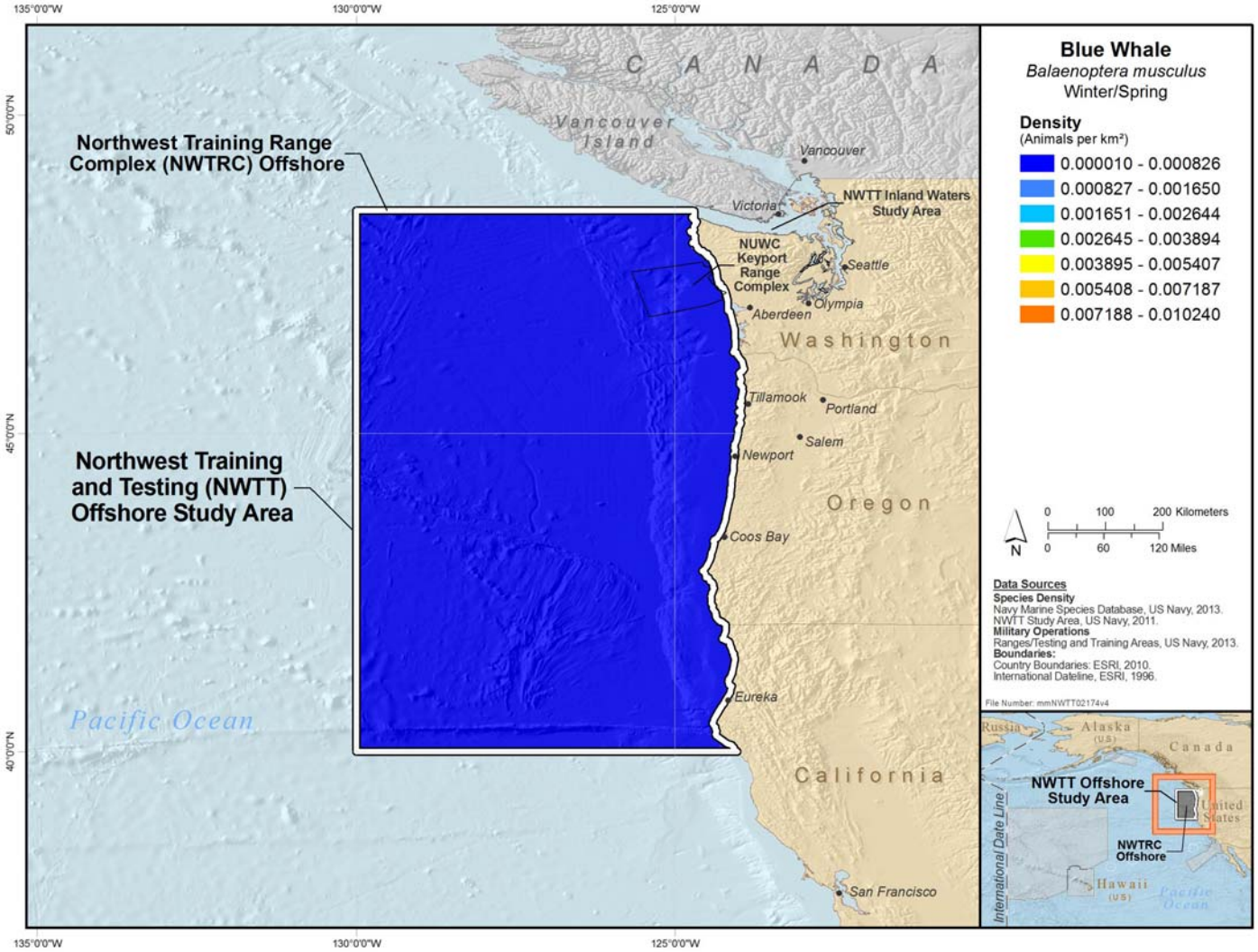

Figure 5-35: Winter/Spring Distribution of Blue Whale in the Offshore Portion of the NWTT Study Area

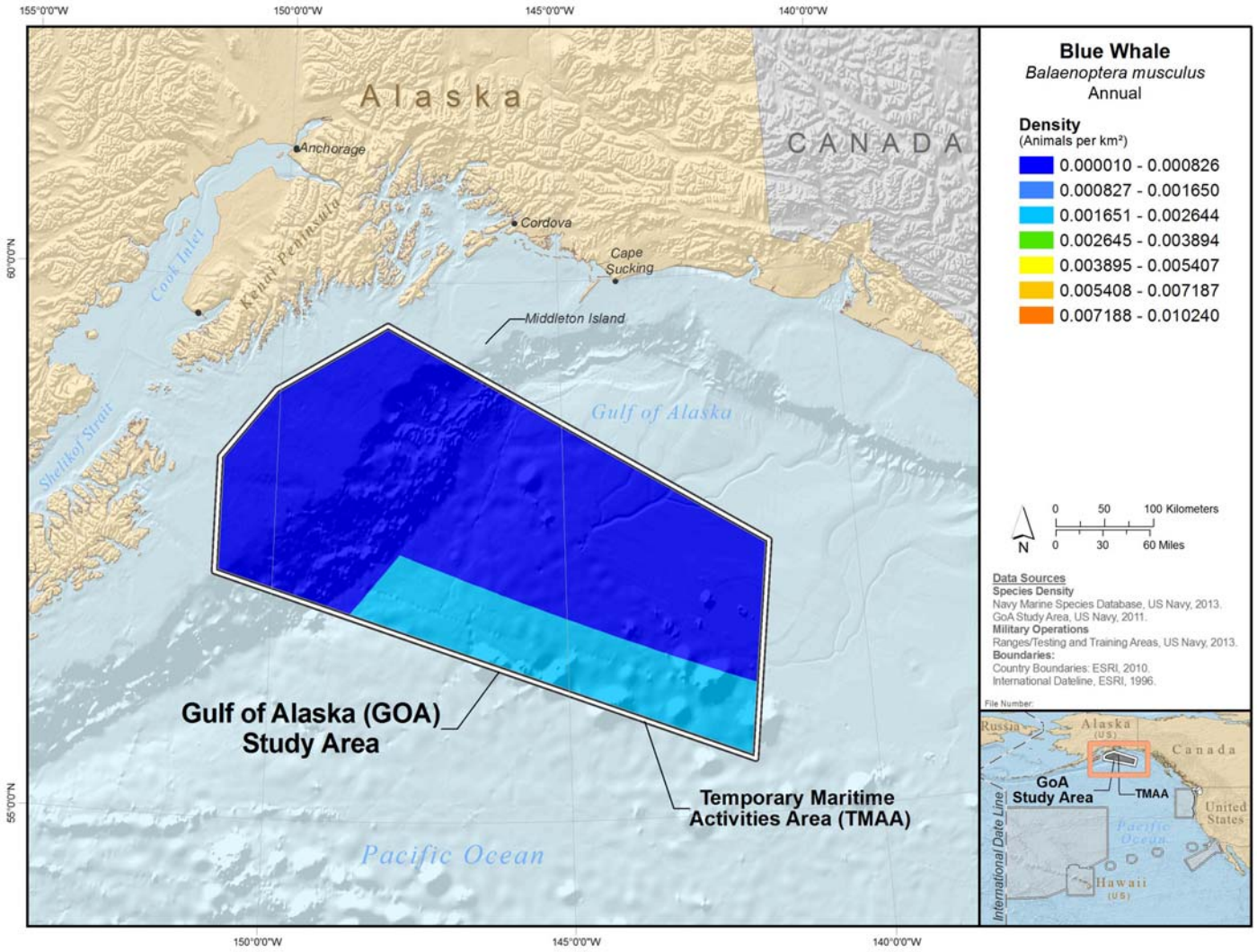

Figure 5-36: Annual Distribution of Blue Whale in the GOA Study Area

5.1.5 *BALAENOPTERA OMURAI*, OMURA'S WHALE

Until recently, all medium-sized baleen whales were considered members of one of two species, Bryde's whale or sei whale. However, at least three genetically-distinct types of these whales are now known, including the so-called pygmy or dwarf Bryde's whales (*Balaenoptera brydei*) (Kato and Perrin 2008; Rice 1998). In 2003, a new species, Omura's whale (*Balaenoptera omurai*), was first described from records from the Philippines, eastern Indian Ocean, Indonesia, Sea of Japan, and the Solomon Islands (Wada et al. 2003). Whales in the Solomon Islands were found to be distinct from Bryde's whales found in the offshore waters of the western North Pacific and the East China Sea (Wada and Numachi 1991; Yoshida and Kato 1999). Later it became evident that the term "pygmy Bryde's whale" had been mistakenly used for specimens of *Balaenoptera omurai* (Reeves et al. 2004). Given the general paucity of data on this species, nothing is known of the stock structure of Omura's whale.

Little is known of the geographic range of Omura's whale since few sightings of this species have been confirmed. Omura's whale is known to occur in the tropical and subtropical waters of the western Pacific and eastern Indian Oceans (Jefferson et al. 2008). It generally occurs alone or in pairs, and has been sighted primarily over the continental shelf in nearshore waters (Jefferson et al. 2008).

HRC. This species has not been observed in the HRC or western portion of the transit corridor.

SOCAL. This species has not been observed in SOCAL or the eastern portion of the transit corridor.

MITT. Given the relatively recent identification of this species and the lack of confirmed sighting data, the range of Omura's whale is poorly known. However, the International Union for Conservation of Nature (IUCN) shows that the distribution of this species extends into the MITT Study Area (Reilly et al. 2008). There are no reliable estimates of the global population size of Omura's whale, nor are there abundance estimates specific to the MITT Study Area. In the absence of density data, the Navy followed an approach consistent with LGL Limited (2008) and used a density estimate of 10% of the study area-specific density estimate for Bryde's whale for both the MITT and associated transit corridor study areas. These values are used to characterize year-round density of Omura's whale.

NWTT. This species has not been observed in any of the regions that comprise the NWTT Study Area.

GOA. This species has not been observed in the GOA Study Area, and it is considered to be outside of the specie's range.

Table 5-9: Sources of Density Values Used for Omura's Whale

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 5-10: Summary of Density Values for Omura's Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
MITT	0.00004	0.00004	0.00004	0.00004
MITT Transit Corridor	0.00004	0.00004	0.00004	0.00004
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

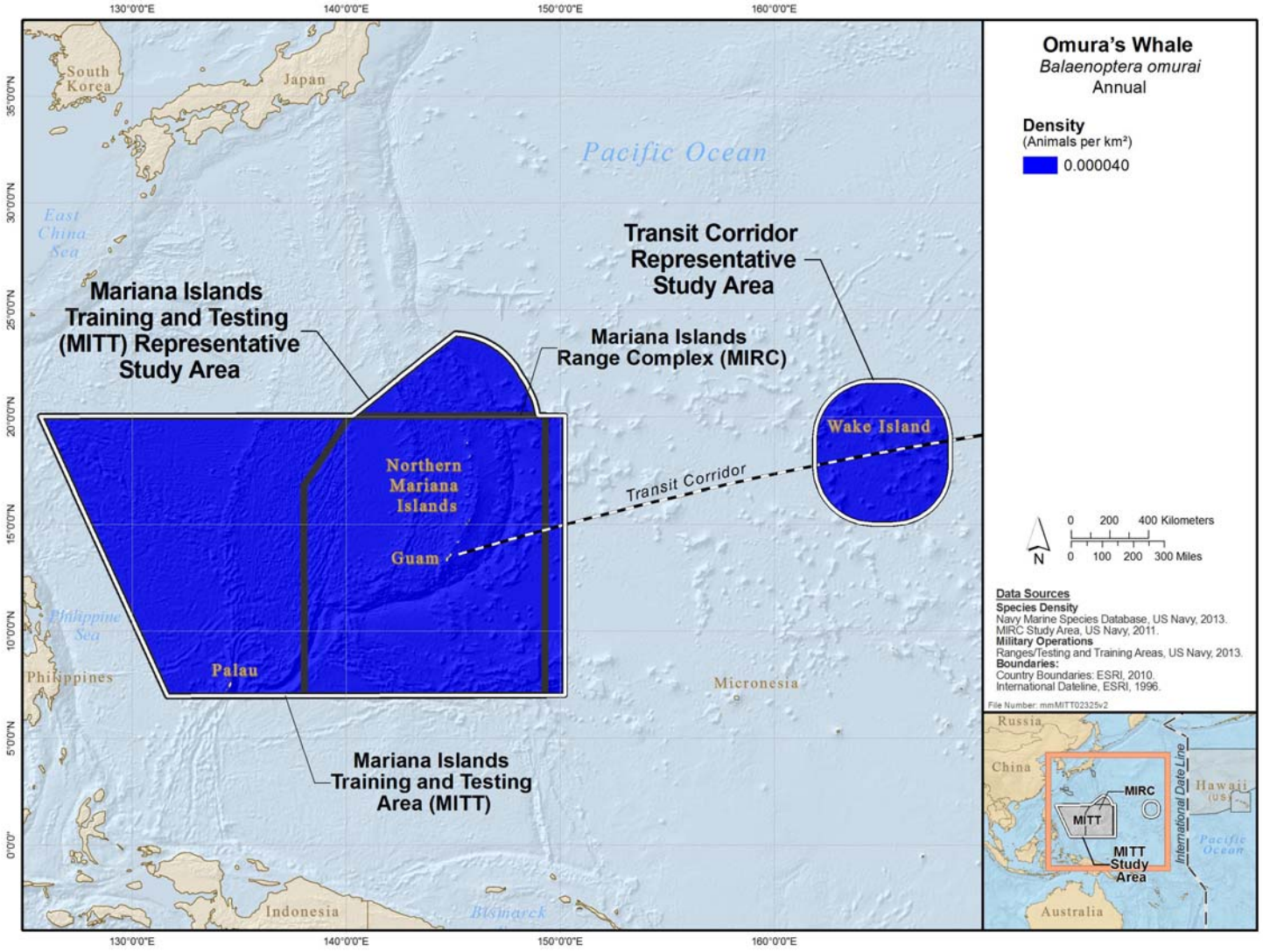

Figure 5-37: Annual Distribution of Omura's Whale in MITT and the Associated Transit Corridor Study Areas

5.1.6 *BALAENOPTERA PHYSALUS*, FIN WHALE

Fin whales are, overall, the second largest baleen whale species, and they are almost black in color, except for a bright white right lip, whitish belly, and light chevron and streaks on the back (Jefferson et al. 2008). They are sometimes observed with blue whales (Aguilar 2009), but the difference in color makes the species relatively distinguishable. Fin whales can be difficult to identify positively from a distance, because of their superficial similarity to sei and Bryde's whales (Jefferson et al. 2008; Leatherwood et al. 1988). For these reasons, fin whales may often be underrepresented in data from visual surveys, because they may fall into the 'unidentified rorqual' or 'unidentified large whale' categories. NMFS recognizes three stocks of fin whales in U.S. Pacific waters: the Alaskan stock, the California/Oregon/Washington stock, and the Hawaii stock (Carretta et al. 2011a). The range of the Alaska stock ostensibly does not overlap with the HSTT Study Area. Density values for the HSTT Study Area are presented for the species as a whole. Fin whales in SOCAL or HRC are clearly from the separate stocks, but it is not clear where in the transit corridor one stock merges into the other. The IWC only recognizes two stocks of fin whales in the North Pacific: the East China Sea stock and the rest of the North Pacific. Little is known about the stock structure of fin whales in the MITT Study Area. In the NWTT Study Area, fin whales in the Offshore or Western Behm Canal regions are likely from the California/Oregon/Washington and Alaska stocks, respectively. Fin whales in the GOA Study Area belong to the Alaska stock.

HRC. Fin whales are seen extremely rarely in HRC. A recent sighting was a lengthy encounter by a Navy contractor off the north east shore of Kauai in February 2010 (P. Cross pers. comm.). In addition, a fin whale was sighted off the island of Lanai in 2013 (R. Baird pers. comm.). Fin whales have been recorded from hydrophone sites near Hawaii at all times of the year (McDonald and Fox 1999; Moore et al. 1998), with an apparent minimum during May, June, and July (Moore et al. 1998). It is difficult to tell where the calling fin whales are with respect to the Hawaiian Islands, and many of the callers are expected to be quite distant. Given the lack of an actual reported density of fin whales for Hawaii, a density value needed to be derived for the Navy's use. Barlow (2003) reported a minimum abundance estimate of 174 fin whales for an "outer EEZ" stratum for Hawaii (this is the area that covers all of the EEZ except for the area within 140 km of the Main Hawaiian Islands). The Navy has divided the abundance by the area of the Hawaiian EEZ (212,892 km^2 for the Main Island stratum + 2,240,024 km^2 for the outer EEZ stratum = 2,452,916 km^2) to arrive at a density of 0.0000709 fin whales/km^2. That value is applied to the HRC and western portion of the transit corridor for winter, spring, and fall. In summer, fin whales are likely absent from the HRC (Barlow 2006); therefore, a density of zero is used for that season in the HRC and the western portion of the transit corridor.

SOCAL. There is a well-documented increasing trend in fin whale numbers off the west coast of the U.S. (Moore and Barlow 2011). NMFS has been able to develop a CCE habitat-based density model for fin whales. This model provides the distribution off the west coast for summer and fall. Ferguson and Barlow (2003) also provide uniform densities specifically for the inner and outer Baja Extension areas for summer and fall. A single uniform density is used from Forney et al. (1995) for the SOCAL and Baja study areas in winter and spring. Data do not exist for the eastern half of the transit corridor; therefore, RES data from SMRU Ltd. (*in prep*) are used for all seasons in the transit corridor. It is important to note that

the high densities predicted by the SMRU Ltd. model contrast sharply with the uniform density values from the literature during winter/spring. In the Southern California Bight, data for fin whales are arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

MITT. Fin whales are typically not expected south of 20°N during summer, and are not likely to occur near Guam (Miyashita et al. 1996; National Marine Fisheries Service 2006). Miyashita et al. (1996) presented a compilation of at-sea sighting results by species, from commercial fisheries vessels in the Pacific Ocean from 1964 to 1990. For fin whales in August, Miyashita et al. reported no sightings south of 20°N, and significantly more sightings north of 40°N. However, they also showed limited search effort south of 20°N. There were no fin whale sightings during the winter 2007 survey of the Study Area (Fulling et al. 2011). During systematic surveys in the eastern tropical Pacific from 1986 to 2005, there have been far fewer sightings of fin whales than blue whales south of 30°N (Hamilton et al. 2009). Therefore, to provide a conservative density estimate for fin whales, the blue whale density estimate was used (i.e., density estimates and associated CVs derived by Ferguson and Barlow (2003) for blue whales were re-calculated for those strata having sea surface temperature and chlorophyll concentrations similar to the MITT Study Area). The density estimate of 0.00001 (CV = 1.00) was used for the MITT Study Area and associated transit corridor for fall, winter, and spring.

Fin whales are likely absent from low-productivity tropical waters in the summer (Jefferson et al. 2008; Perrin and Brownell 2009); therefore, a density of zero is used for that season in the MITT and associated transit corridor study areas.

NWTT Offshore. Fin whales occur year-round off the U.S. west coast (Moore et al. 1998, Barlow and Forney 2007, Oleson et al. 2009, Širović et al. 2011, 2012a, b). As noted above for SOCAL, NMFS developed a CCE habitat-based density model for fin whales which provides spatially-explicit density estimates off the U.S. west coast for summer and fall (Becker et al. 2012c). Barlow and Forney (2007) also provide stratified uniform density estimates for fin whales for California, Oregon, and Washington in summer/fall. In the absence of other data, their estimate for Oregon/Washington offshore waters was used for the area north of the SWFSC strata (refer to Figure 3-6) for summer/fall. Uniform density values for fin whale are available for the Northern California offshore stratum for winter/spring (Forney et al. 1995; Barlow et al. 2009). Winter/spring density data are not available for areas north of this stratum. In the absence of any other data and with consideration of occurrence data during these seasons (e.g., Moore et al. 1998, Oleson et al. 2009, Širović et al. 2012a, b), density estimates from SWFSC for the Northern California stratum in winter/spring (Forney et al. 1995) were used as representative density estimates for the northern area.

NWTT Inland Waters. Fin whales are currently extremely rare within the Inland Waters. Strandings reported within Puget Sound have all been individuals struck by ships, and they presumably were carried on the bow into the sound (Norman et al. 2004).

NWTT Western Behm Canal, Alaska. For the Western Behm Canal, density estimates for all seasons were taken from the Marine Mammal Occurrence/Density Report prepared in support of a NEPA document for Navy activities at SEAFAC (U.S. Department of the Navy 2010b).

GOA. Fin whales have been acoustically detected in the Gulf of Alaska year-round (Moore et al. 2006, Stafford et al. 2007, Baumann-Pickering et al. 2012b). During a recent (June and July 2013) Navy-funded line-transect survey in and around the TMAA, sighting data were collected from four survey strata designed to sample the diverse habitat present in the GOA Study Area. Abundance estimates for unidentified large whales were prorated among blue, fin, and humpback whales within each stratum and proportionately incorporated into each species density estimate, resulting in the following density estimates for fin whales: 0.71 (CV = 0.49) inshore stratum, 0.021 (CV = 0.27) offshore stratum, 0.005 (CV = 0.39) seamount stratum, and 0.14 (CV = 0.21) slope stratum (Rone et al. 2014).

Table 5-11: Sources of Density Values Used for Fin Whale

Location	Spring	Summer	Fall	Winter
HRC	LD	0	LD	LD
W. Transit Corridor	LD	0	LD	LD
E. Transit Corridor	SMRU	SMRU	SMRU	SMRU
SOCAL	L	CCE	CCE	L
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	L and LD	CCE and LD	CCE and LD	L and LD
NWTT Inland Waters	0	0	0	0
Western Behm Canal	LD	LD	LD	LD
GOA	L	L	L	L

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 5-12: Summary of Density Values for Fin Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0.0000709	0	0.0000709	0.0000709
W. Transit Corridor	0.0000709	0	0.0000709	0.0000709
E. Transit Corridor	S	S	S	S
SOCAL	0.00019	S	S	0.00019
Inner Baja Extension	0.00019	0.0005	0.0005	0.00019
Outer Baja Extension	0.00019	0.0018	0.0018	0.00019
MITT	0.00001	0.00001	0.00001	0.00001
MITT Transit Corridor	0.00001	0.00001	0.00001	0.00001
NWTT Offshore	0.0002	S and 0.0009	S and 0.0009	0.0002
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0.010	0.010	0.010	0.010
GOA	0.005–0.071	0.005–0.071	0.005–0.071	0.005–0.071

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

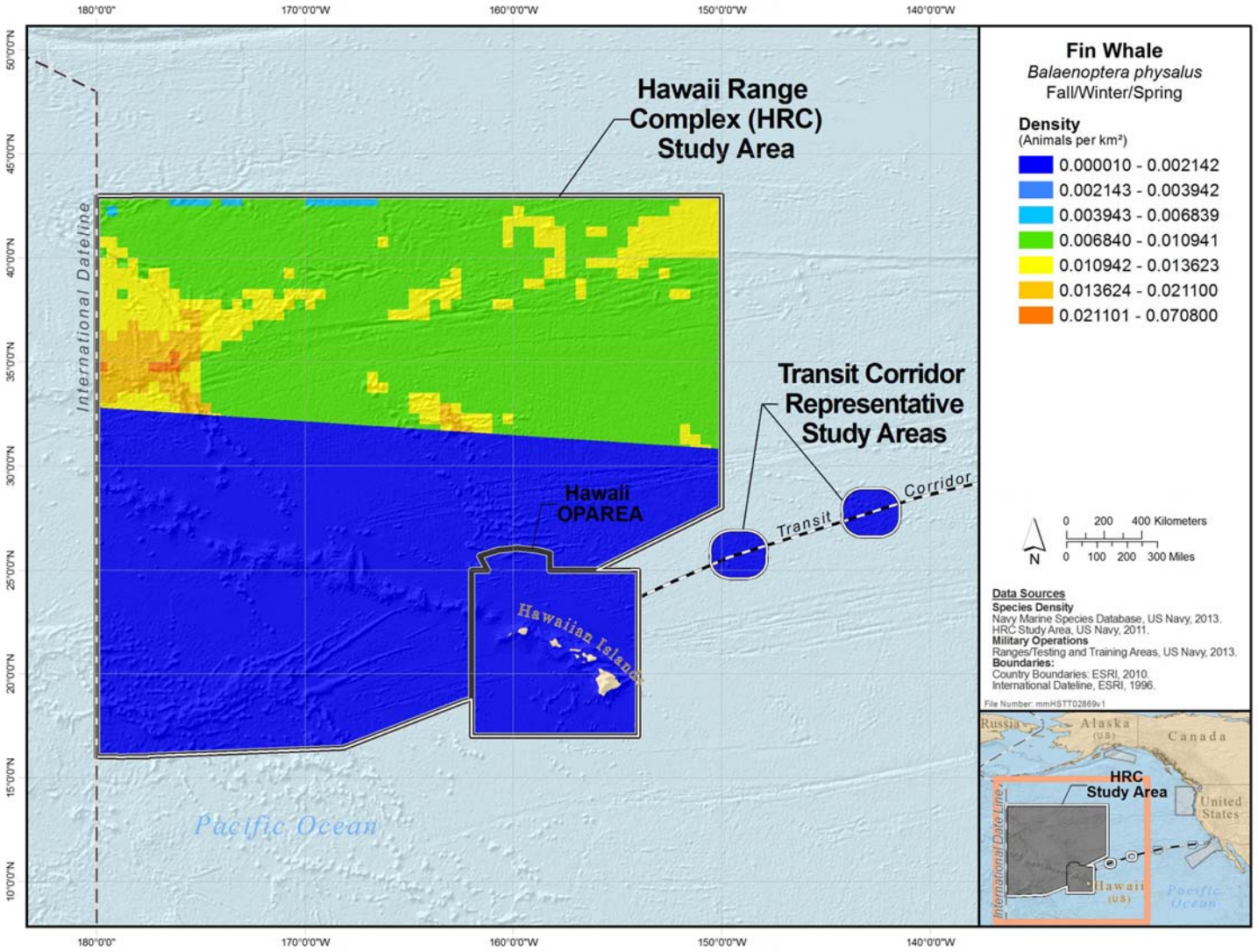

Figure 5-38: Winter, Spring, and Fall Distribution of Fin Whale in HRC and the Western Portion of the Transit Corridor

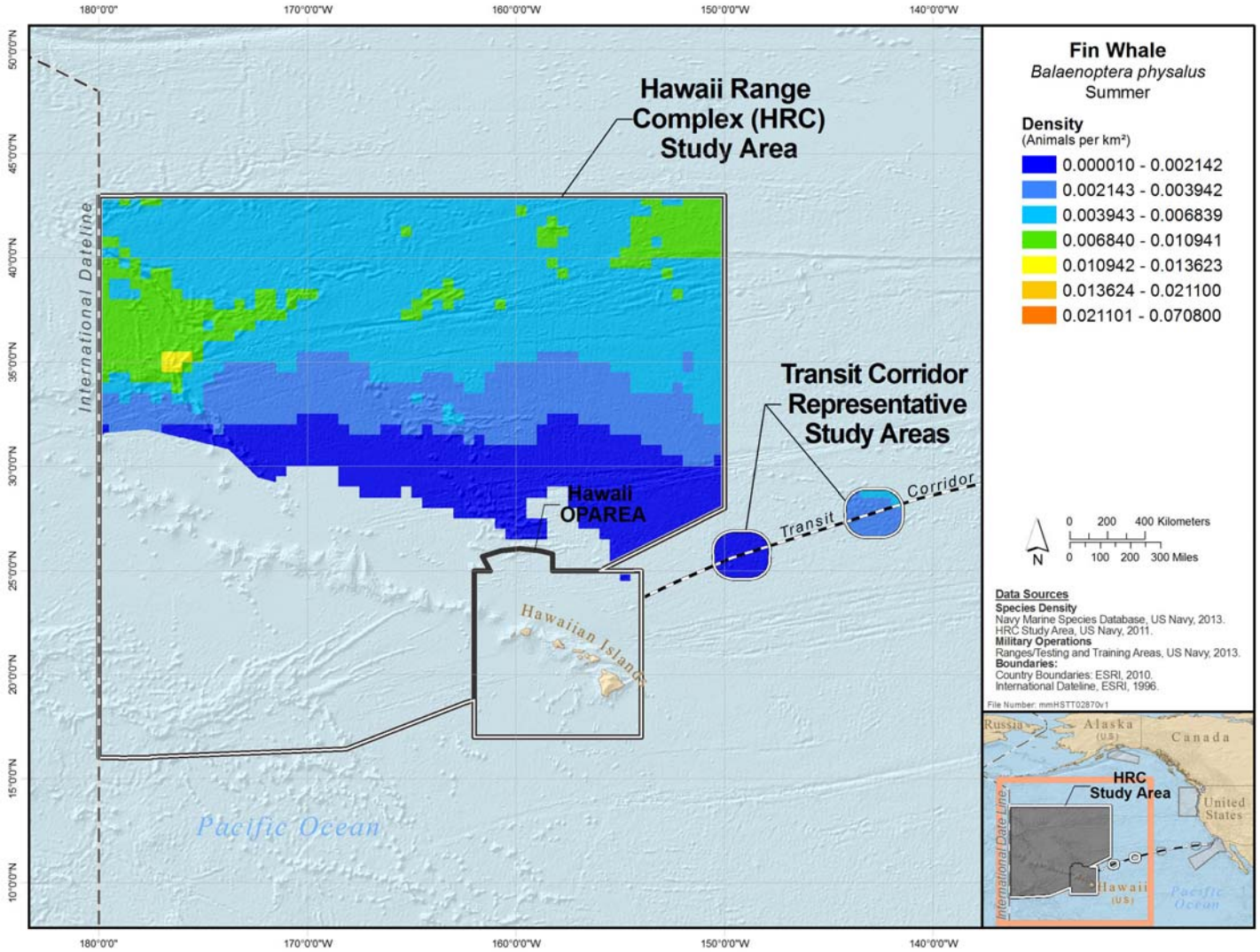

Figure 5-39: Summer Distribution of Fin Whale in HRC and the Western Portion of the Transit Corridor

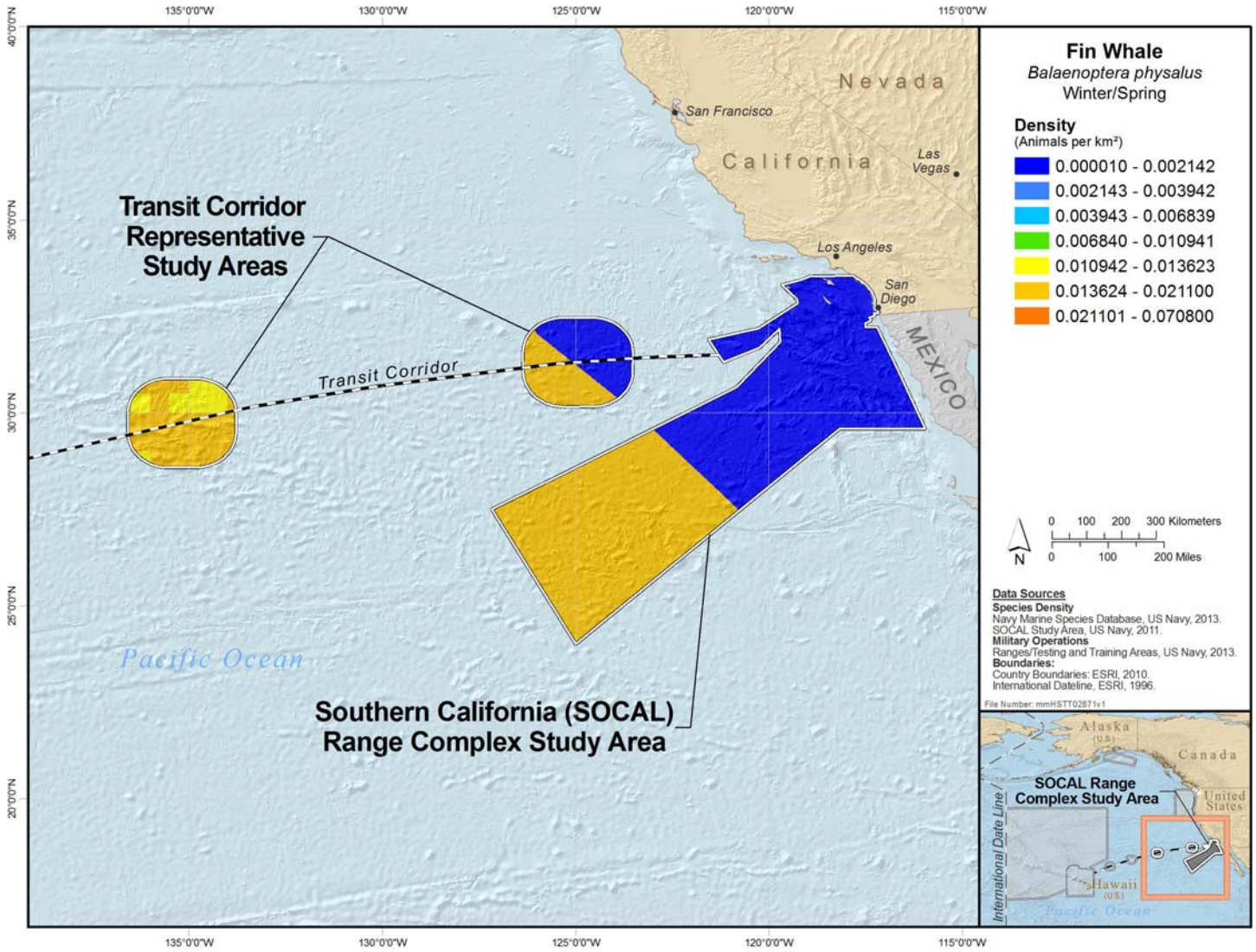

Figure 5-40: Winter/Spring Distribution of Fin Whale in SOCAL and the Eastern Portion of the Transit Corridor

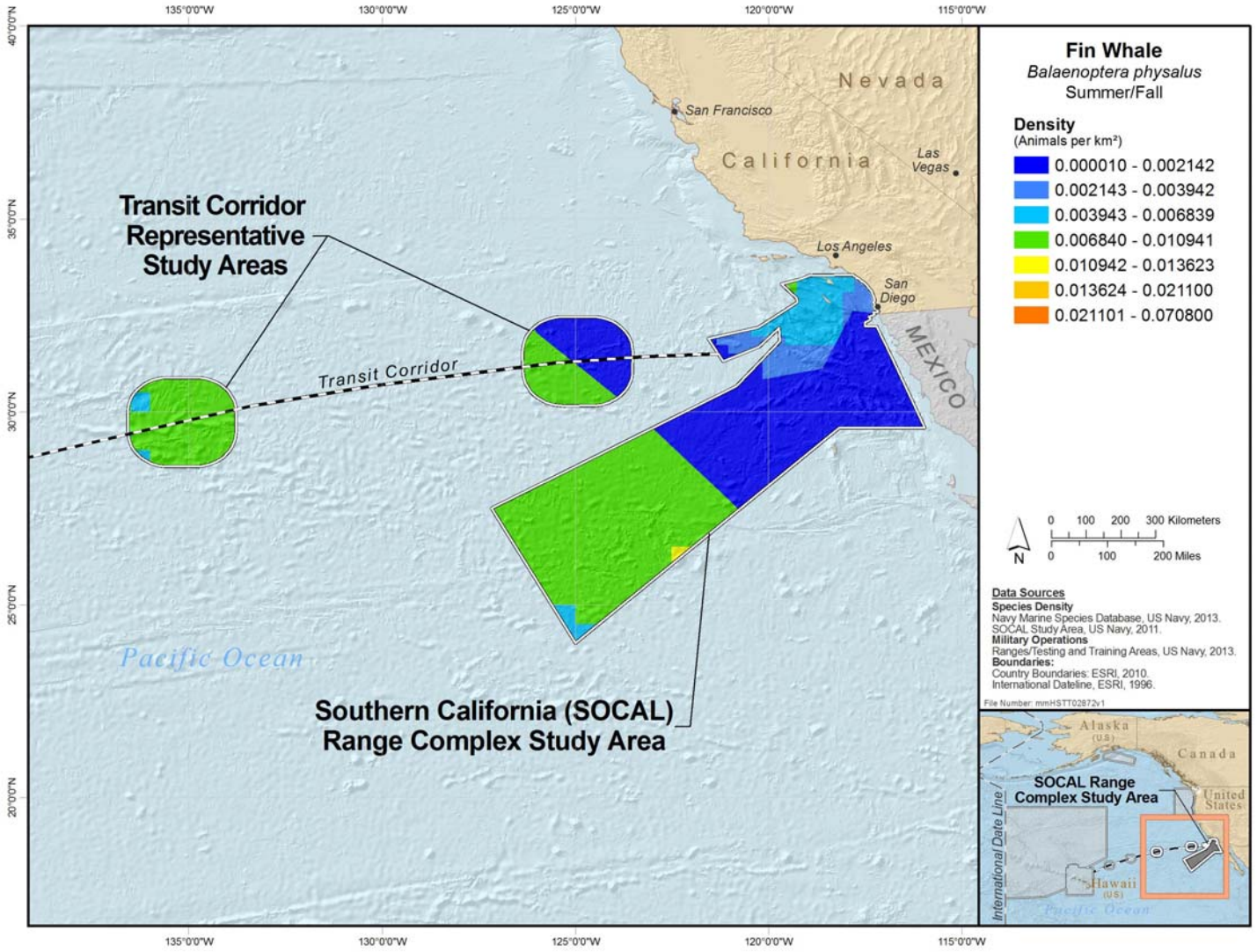

Figure 5-41: Summer/Fall Distribution of Fin Whale in SOCAL and the Eastern Portion of the Transit Corridor

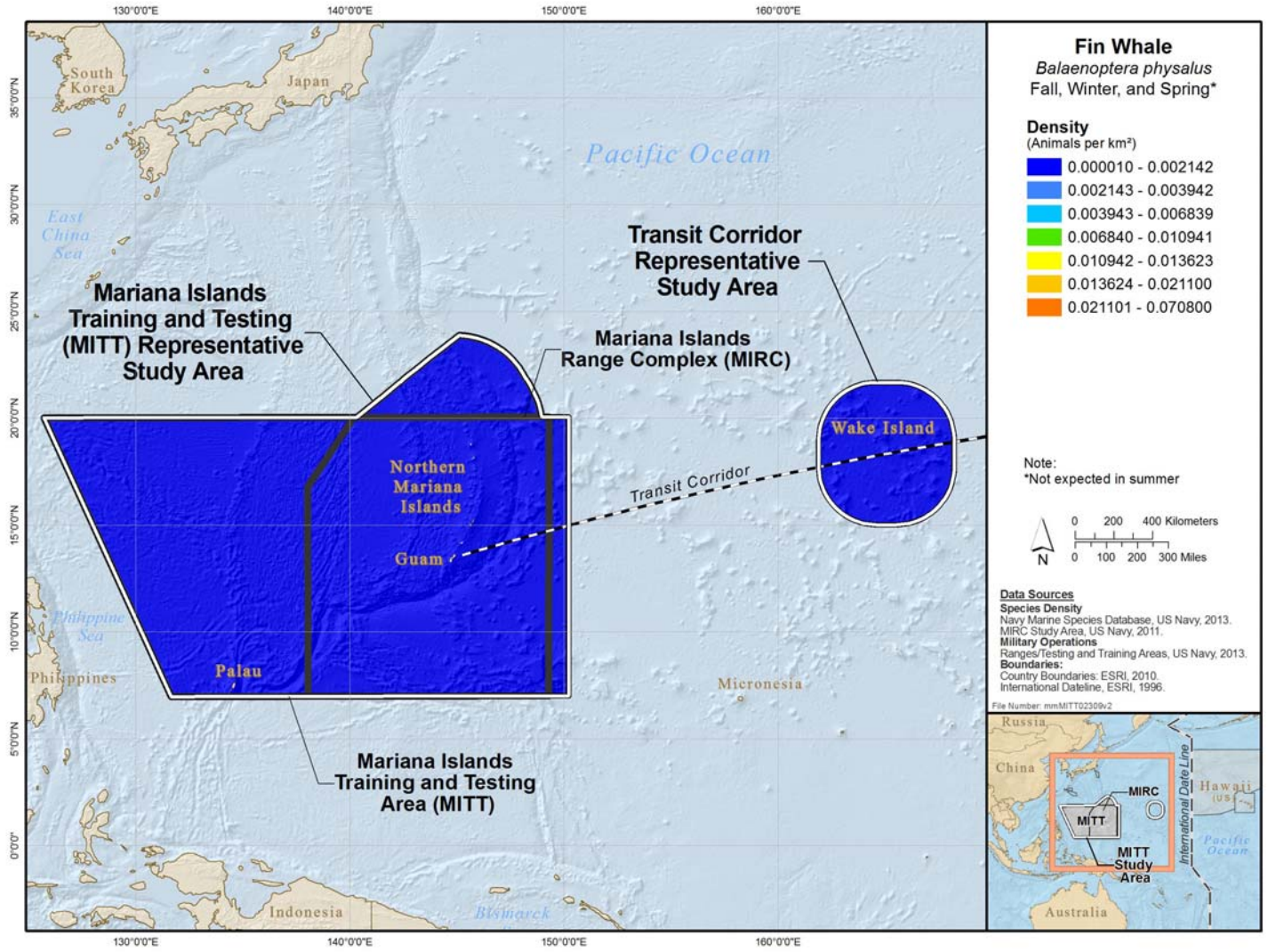

Figure 5-42: Fall, Winter, and Spring Distribution of Fin Whale in MITT and the Associated Transit Corridor Study Areas

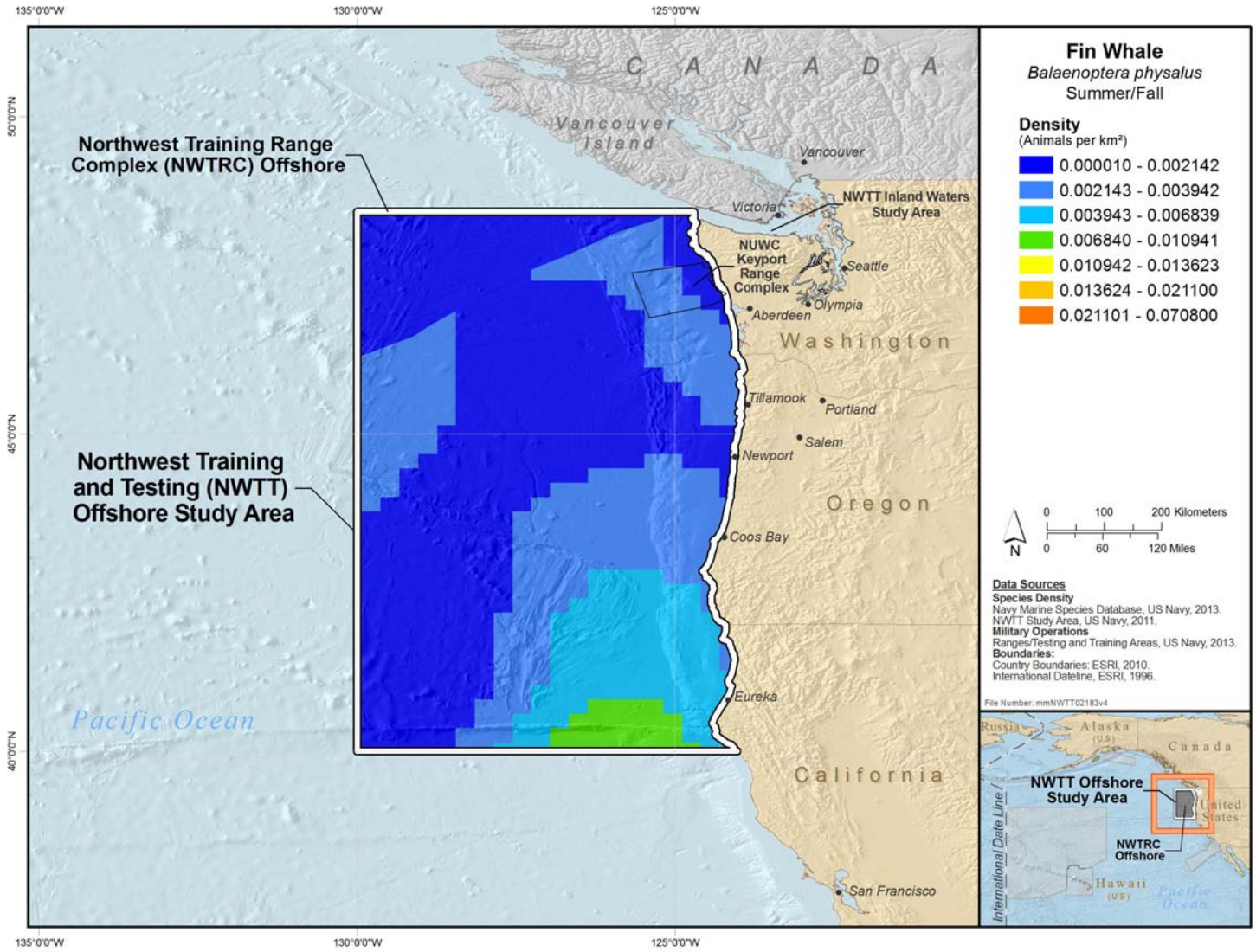

Figure 5-43: Summer/Fall Distribution of Fin Whale in the Offshore Portion of the NWTT Study Area

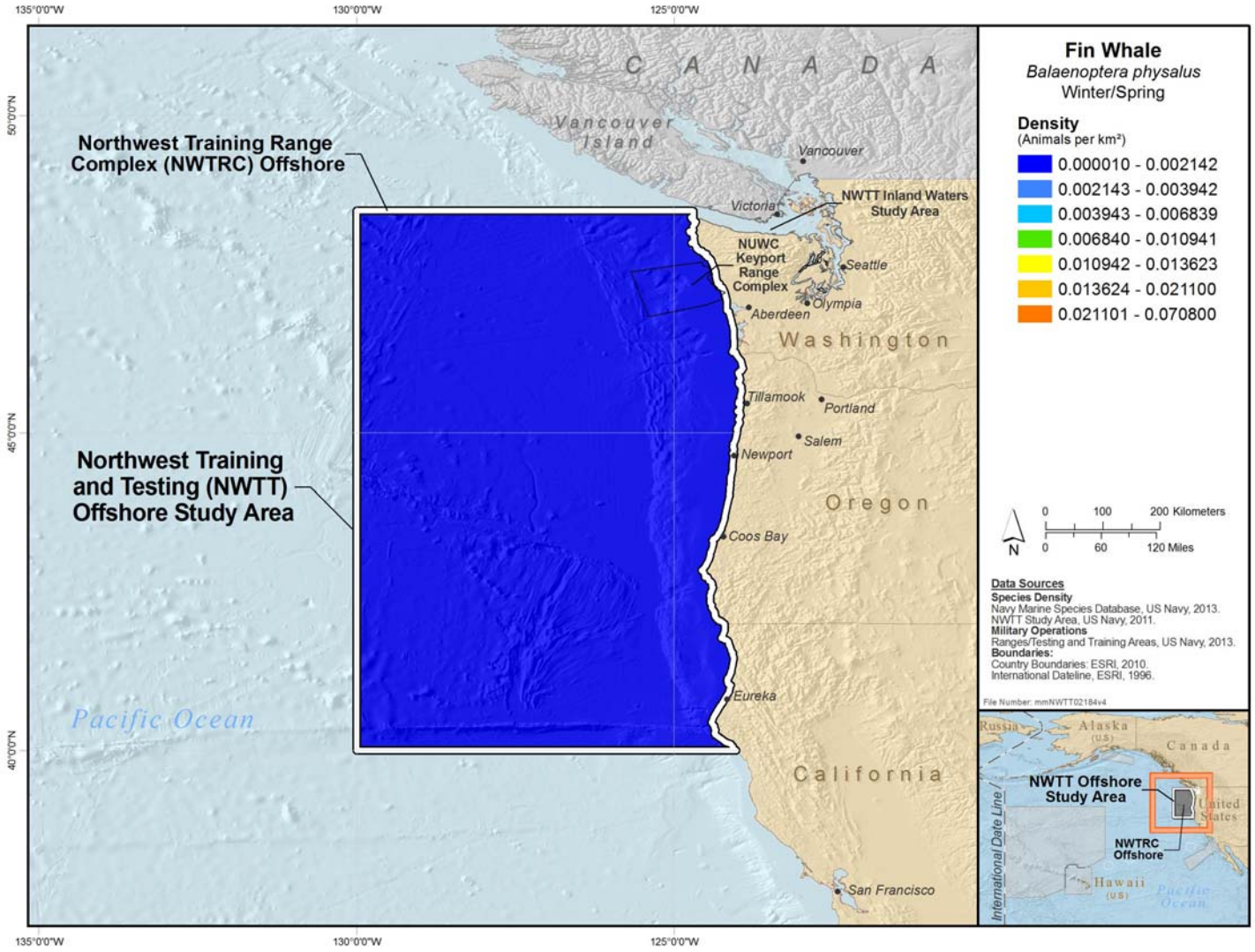

Figure 5-44: Winter/Spring Distribution of Fin Whale in the Offshore Portion of the NWTT Study Area

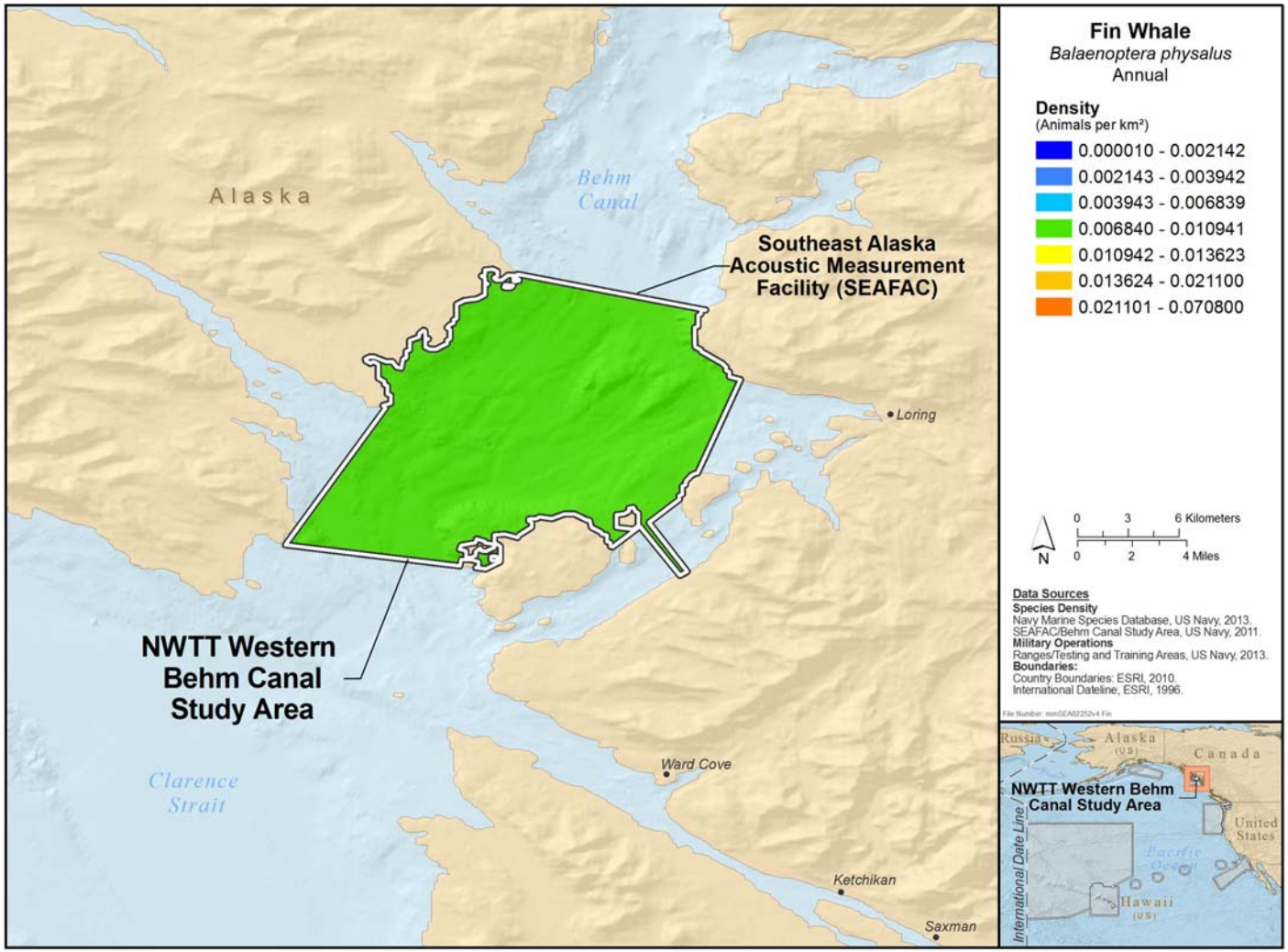

Figure 5-45: Annual Distribution of Fin Whale in the Western Behm Canal Portion of the NWTT Study Area

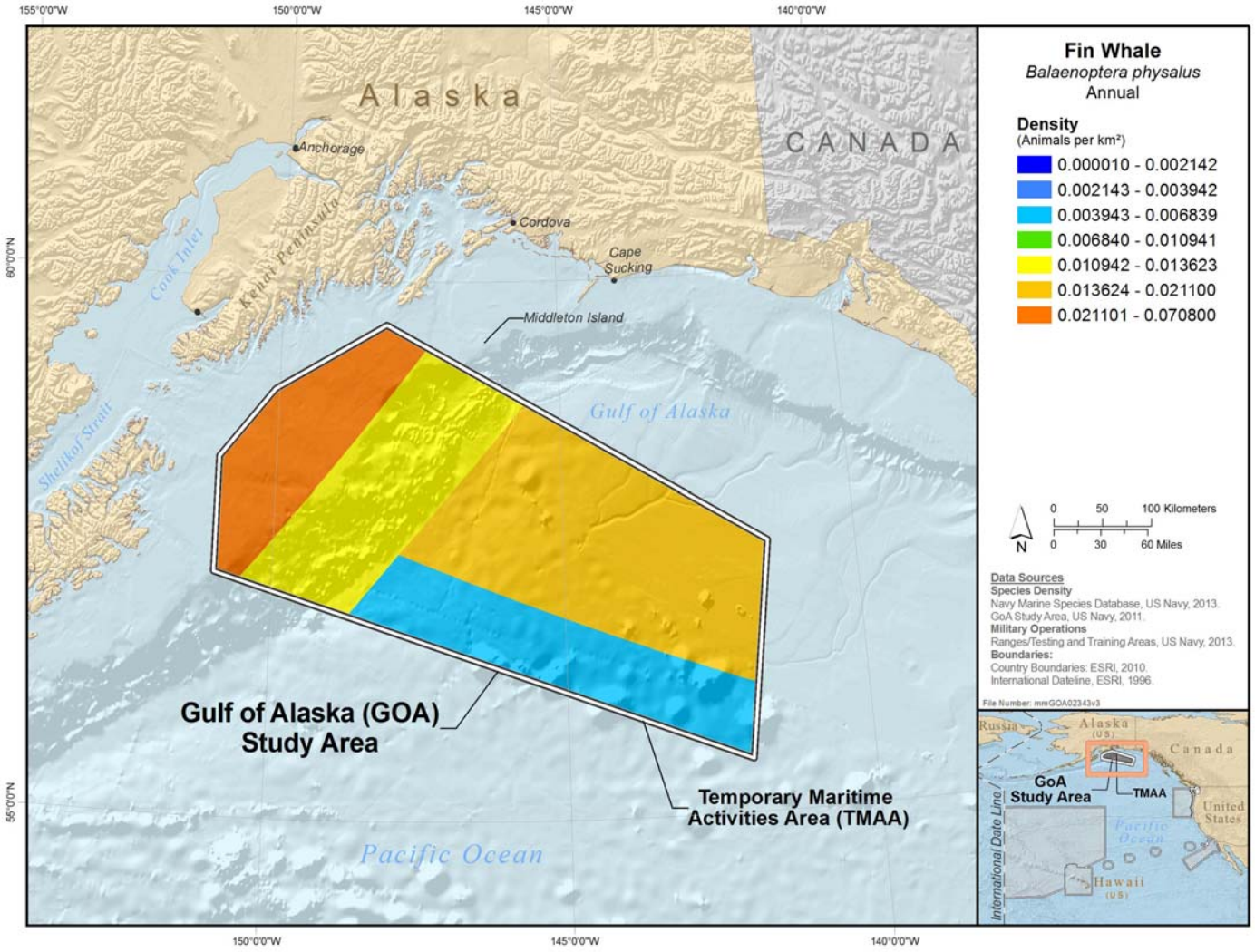

Figure 5-46: Annual Distribution of Fin Whale in the GOA Study Area

5.1.7 *ESCHRICHTIUS ROBUSTUS*, GRAY WHALE

The gray whale is distinctive in appearance, with a small dorsal hump and many barnacles and irregularities on their skin, and color, which is a uniform light gray (Jones et al. 1984; Jefferson et al. 2008). NMFS recognizes two stocks of gray whales in the North Pacific: the larger Eastern North Pacific stock and the highly endangered Western North Pacific stock or "Korean" stock (Carretta et al. 2011a); the IWC also recognizes the same two stocks. Until recently these two stocks were considered exclusive from each other, but recent satellite tagging and photo mark-recapture data have suggested that there is some exchange of individuals (Mate et al. 2011). Further, photo-catalog comparisons of eastern and western North Pacific gray whale populations suggest that there is more exchange between the western and eastern populations than previously thought, since "Sakhalin" whales were sighted off Santa Barbara, California; British Columbia, Canada; and Baja California, Mexico (Weller et al. 2013). For stock assessment purposes, NMFS currently uses an abundance of 19,126 animals for the eastern population (Carretta et al. 2013). In contrast, the most recent estimate of the western population is 155 individuals (International Union for Conservation of Nature 2012). While it is possible that sightings of western population animals might be included in the data used to estimate gray whale density in the Eastern North Pacific, given the current paucity of data regarding the western population, as well as the very low population numbers, separate density estimates for the western population were not included in the NMSDD. Density values in the NMSDD are thus presumed to apply to the Eastern North Pacific stock of gray whales.

Eastern North Pacific gray whales are a nearshore species that migrate from feeding areas in the Bering and Chukchi Seas and the coast of the Alaskan Bight, British Columbia, and the Pacific Northwest to breeding areas in Baja California, Mexico (Jones et al. 1984; Rice and Wolman 1971). They pass through SOCAL, the offshore region of the NWTT Study Area, and the GOA Study Area during their migration.

A group of a few hundred gray whales known as the Pacific Coast Feeding Group feeds along the Pacific coast between Southeast Alaska and southern California throughout the summer and fall (Calambokidis et al. 2002). This group of whales has generated uncertainty regarding the stock structure of the Eastern North Pacific population (Carretta et al. 2013). Photo-identification, telemetry, and genetic studies suggest that the Pacific Coast Feeding Group is demographically distinct (Calambokidis et al. 2010; Mate et al. 2010; Frasier et al. 2011). Currently, the Pacific Coast Feeding Group is not treated as a distinct stock in the NMFS Stock Assessment Reports, but this may change in the future based on new information (Carretta et al. 2013).

HRC. This species is not expected to occur in the HRC or in the transit corridor.

SOCAL. The majority of population data for gray whales is from counts as they pass counting stations on the west coast of North America (for example Rugh et al. 2005; Shelden and Laake 2002). Carretta et al. (2000) provide some density values for gray whale around San Clemente Island (SCI) in the Southern California Bight. They divide their study area into inshore and offshore regions. Inshore was within 3 nm of SCI; offshore was a 7,830 km^2 area primarily south and west of SCI; an area in the heart of the SOCAL range. The density for inshore was 0.115 animals/km^2, and the density offshore was 0.032 animals/km^2. Carretta et al. (2000) also provided an overall density of 0.051 animals/km^2. They note gray whales are

seen only January–April; therefore, zero density values will be used for summer and fall seasons for SOCAL.

On their southward migration, gray whales pass in more offshore waters after they reach Point Conception in Central California and cut across the California Bight on their way south to the breeding area along Baja California (Jones and Swartz 2002). The Navy uses Carretta et al.'s (2000) inshore value for an area from across the California Bight from Point Conception (at 34°26′53″N, 120°28′17″W [34.448113°N, 120.471439°W]) to the bottom of the Baja Extension and from the shore of California to 5 nm west of the Channel Islands. The Navy uses Carretta et al.'s (2000) offshore values for an area that extends west beyond the previously-defined area for 20 nm. To cover the west coast of the United States, the Navy created a 20 nm wide zone along the coast from the California/Oregon border down to Point Conception. Shelden and Laake (2002) estimated that, along the coast, 95.24% of gray whales were within 2.24 nm of the coast during migration and 4.76% were between 2.25 and 20 nm from the coast. Using Carretta et al.'s (2000) overall density of 0.051 and splitting the value using these percentages, the zone from 0 to 2.25 nm from the coast was assigned a density of 0.051 x 0.9524 = 0.0485724 animals/km^2 and the zone from 2.25 to 20 nm was assigned a density of 0.051 x 0.0476 = 0.0024276 animals/km^2 for winter/spring.

Jefferson et al. (in preparation) provides updated estimates for many species, including gray whales, in the Southern California Bight from recent years, and these density estimates will be considered in future versions of the NMSDD.

MITT. This species is not expected to occur in the MITT Study Area or associated transit corridor.

NWTT Offshore. Consistent with the approach used for SOCAL (see above), two zones were created to represent gray whale density during their winter/spring migration within the Offshore region of the NWTT Study Area: (1) a zone from 0 to 2.25 nm from the coast with a density of 0.0485724 animals/km^2 and (2) a zone from 2.25 to 20 nm with a density of 0.0024276 animals/km^2. Calambokidis et al. (2002) provided an abundance estimate of approximately 180 Pacific Coast Feeding Group individuals between the California border and Southeast Alaska during March–November 1998. These animals thus represent roughly 0.9 percent of the current abundance estimate of 19,126 animals in the Eastern North Pacific stock (Carretta et al. 2013). This percentage (0.009) was applied to Carretta et al.'s (2000) overall gray whale density estimate of 0.051, yielding an estimate of 0.000459 animals/km^2. In fall 2012, Navy-funded satellite tags were attached to 11 Pacific Coast Feeding Group gray whales and data from the tagged whales indicate a nearshore continental shelf distribution (< 38 km from shore; Mate 2013). Based on these data, the summer/fall density estimate was applied to the entire zone used to describe gray whale distribution patterns (i.e., from the coast to 20 nm offshore).

NWTT Inland Waters. As described above for SOCAL, Carretta et al. (2000) provided an overall density estimate of 0.051 animals/km^2. Based on sightings from Orca Network, an online forum available to the public to report and compile marine mammal sightings (http://www.orcanetwork.org), it was conservatively assumed that during the winter/spring migration period, 10% of the migrating whales may occur in the Strait of Juan de Fuca and the San Juan Islands (0.0051 animals/km^2), while fewer

whales would be found within Puget Sound (10% of the San Juan estimate = 0.00051 animals/km^2), and even fewer within Hood Canal/Dabob Bay (0.00001 animals/km^2), as verified by sightings recorded by the Orca Network. During summer/fall, it was conservatively assumed that 30% of the Pacific Coast Feeding Group of gray whales (approximately 200 animals) may occur within the Strait of Juan de Fuca and the San Juan Islands (0.000136 animals/km^2), while fewer whales would be found within Puget Sound (10% of the San Juan estimate = 0.0000136 animals/km^2), and even fewer within Hood Canal/Dabob Bay (0.00001 animals/km^2), as verified by sightings recorded by the Orca Network.

NWTT Western Behm Canal, Alaska. Gray whales were not observed during 1991–2007 surveys of the inland waters of Southeast Alaska (Dahlheim et al. 2009), and they are considered extralimital in this region of the NWTT Study Area.

GOA. Gray whales are found along the shore in the northern Gulf of Alaska during their migrations between the breeding and feeding grounds. The southbound migration begins in early October, when gray whales move from the Bering Sea through the Unimak Pass and along the coast of the Gulf of Alaska (Braham 1984). The southbound migration continues into the winter season between October and January. Migration of gray whales past Kodiak Island peaks in mid-December (Rugh et al. 2001). During the northbound migration, the peak of migration in the Gulf of Alaska is in mid-April (Braham 1984). As noted above, although most gray whales migrate to the Bering Sea to feed, some Pacific Coast Feeding Group whales do not complete the migration, but instead remain to feed in coastal waters in the Gulf of Alaska (Gosho et al. 2011). One group consisting of an estimated 25 gray whales was sighted off Kodiak Island in July 2013 (outside the TMAA) during the off-effort portion of the GOALS II survey (Rone et al. 2014).

Consistent with the approach used for SOCAL (see above), two zones were created to represent gray whale density in the GOA Study Area: (1) a zone from 0 to 2.25 nm from the coast with a density of 0.0485724 animals/km^2 and (2) a zone from 2.25 to 20 nm with a density of 0.0024276 animals/km^2. Sighting data recorded on the Cetacean Density and Distribution Mapping Working Group website (http://www.st.nmfs.noaa.gov/cetsound/) indicate that gray whales have been sighted in the Gulf of Alaska in June, July, and August, and are expected to occur there year-round. Based on this information, and in the absence of a density estimate for summer, the winter/spring estimates were considered to represent the best available density year-round.

Table 5-13: Sources of Density Values Used for Gray Whale

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	L	L	L	L
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	L	LD	LD	L
NWTT Inland Waters	LD	LD	LD	LD
Western Behm Canal	0	0	0	0
GOA	LD	LD	LD	LD

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 5-14: Summary of Density Values for Gray Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL: shore to 5 nm west of Channel Islands	0.115	0	0	0.115
SOCAL : 5–25 nm west of Channel Islands	0.032	0	0	0.032
Inner Baja Extension (approximately)	0.115	0	0	0.115
Outer Baja Extension (approximately)	0.032	0	0	0.032
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore: 0–2.25 nm from shore	0.04857	0.00045	0.00045	0.04857
NWTT Offshore: 2.25–20 nm from shore	0.00243	0.00045	0.00045	0.00243
NWTT Inland Waters	0.000001–0.0051	0.000001–0.00014	0.000001–0.00014	0.000001–0.0051
Western Behm Canal	0	0	0	0
GOA: 0–2.25 nm from shore	0.04857	0.04857	0.04857	0.04857
GOA: 2.25–20 nm from shore	0.00243	0.00243	0.00243	0.00243

The units for numerical values are animals/km^2. 0 = species is not expected to be present.

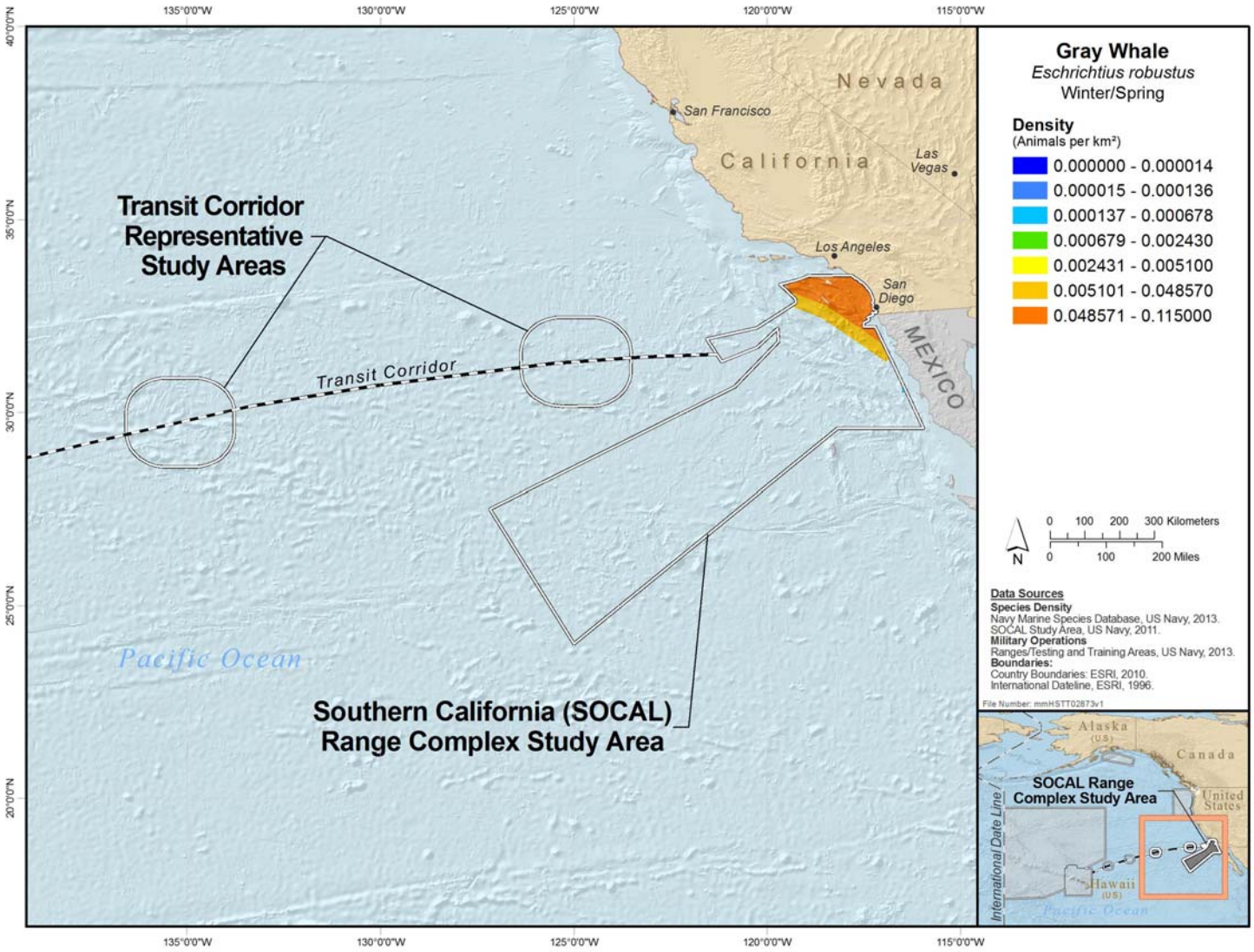

Figure 5-47: Winter/Spring Distribution of Gray Whale in SOCAL and the Eastern Portion of the Transit Corridor

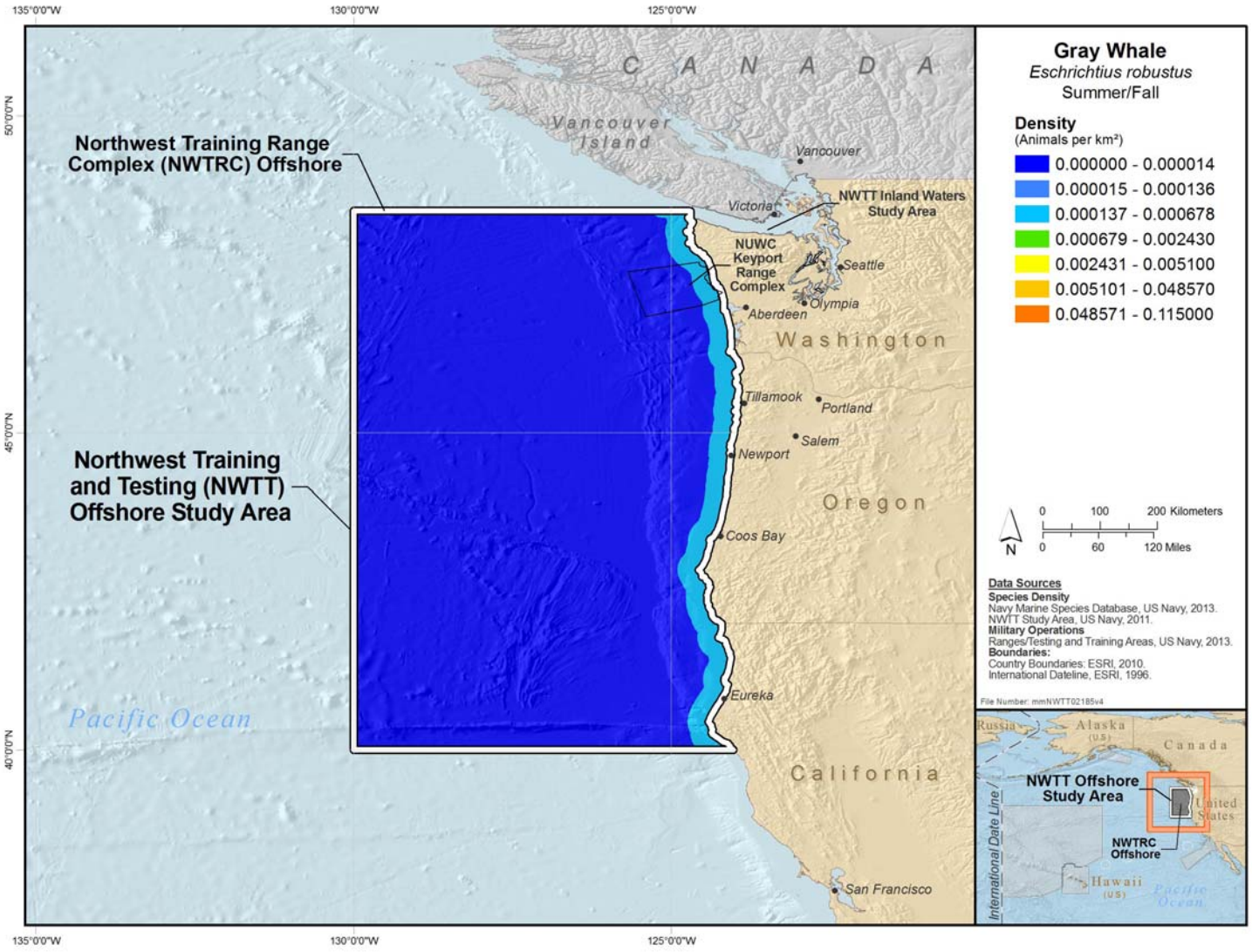

Figure 5-48: Summer/Fall Distribution of Gray Whale in the Offshore Portion of the NWTT Study Area

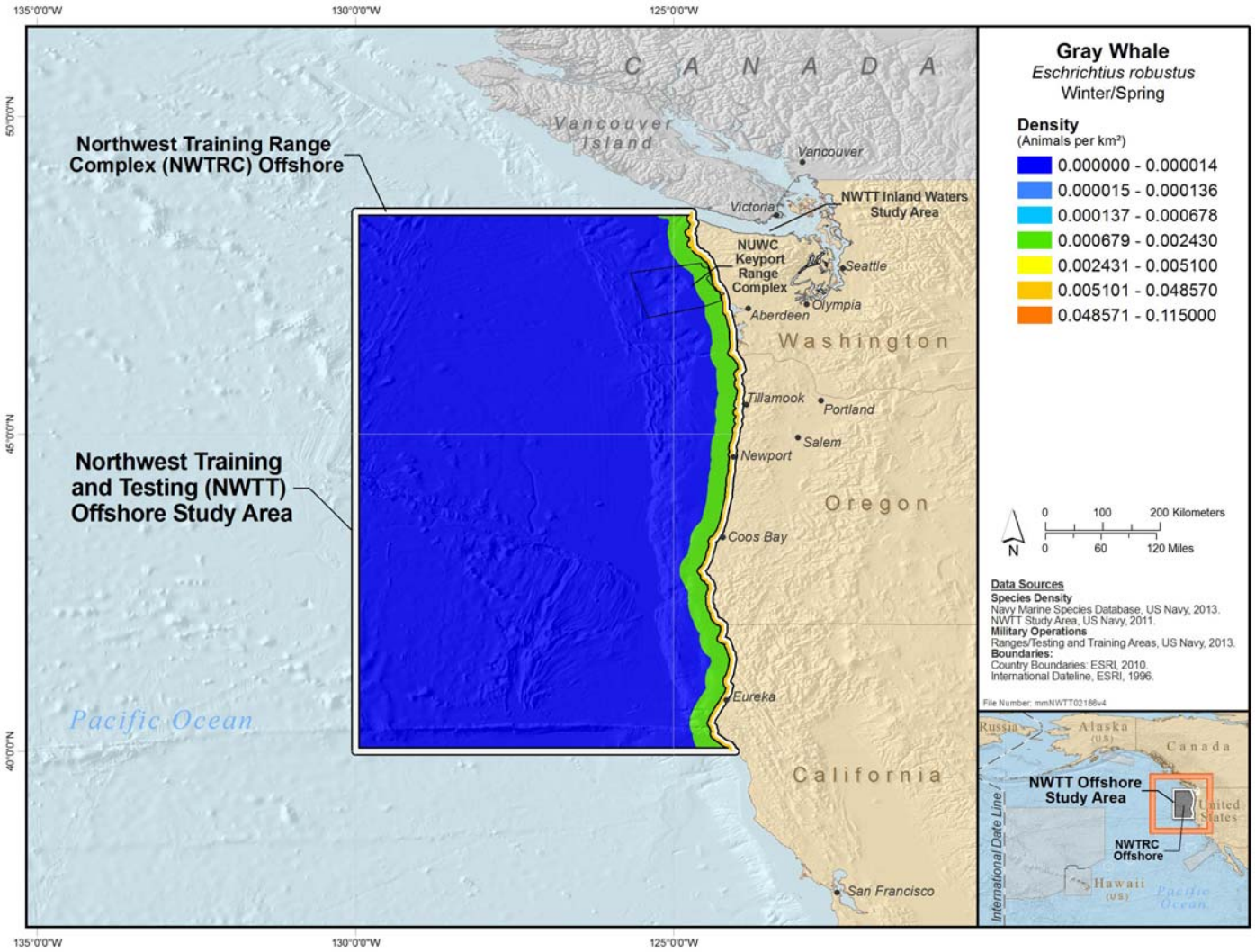

Figure 5-49: Winter/Spring Distribution of Gray Whale in the Offshore Portion of the NWTT Study Area

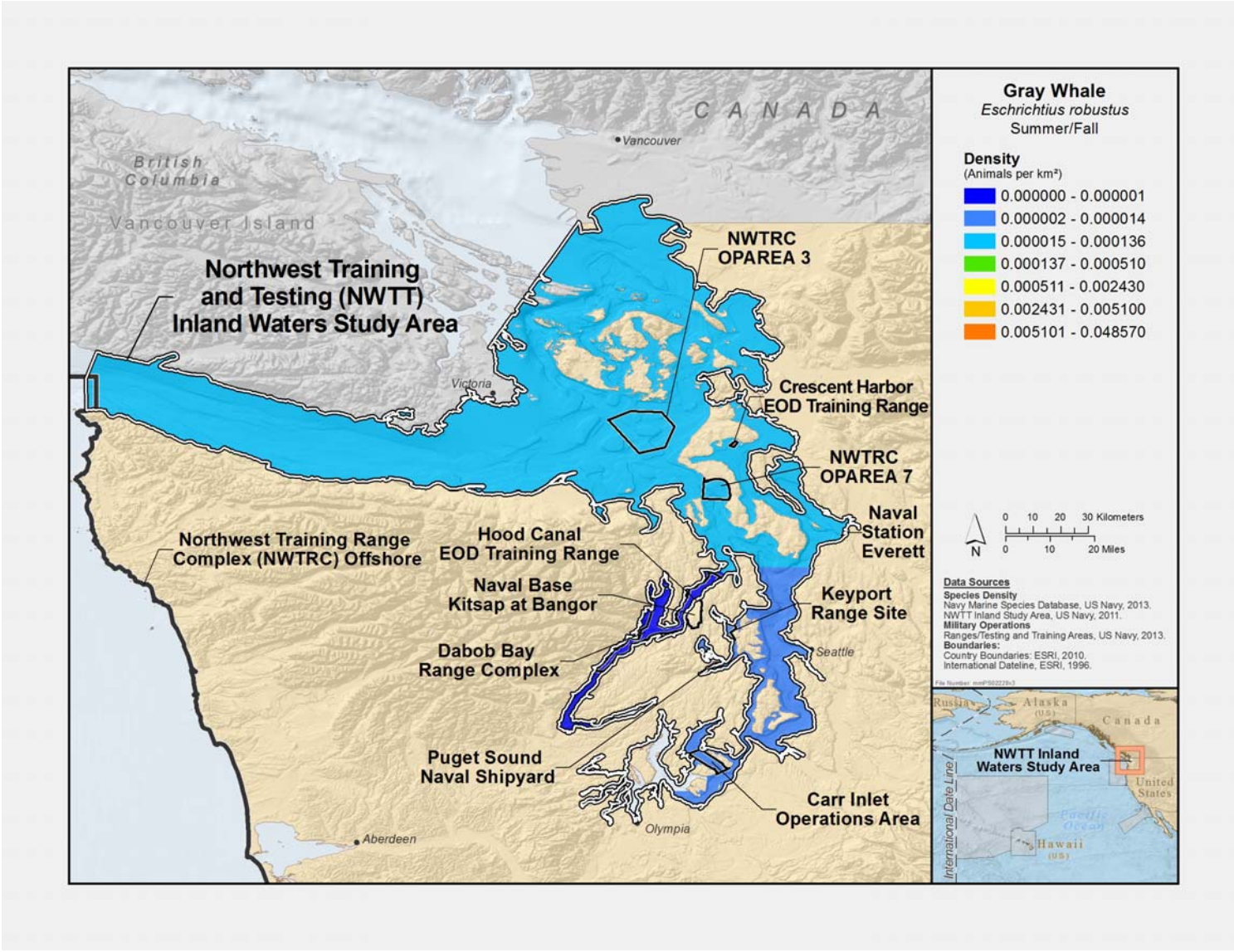

Figure 5-50: Summer/Fall Distribution of Gray Whale in the Inland Waters Portion of the NWTT Study Area

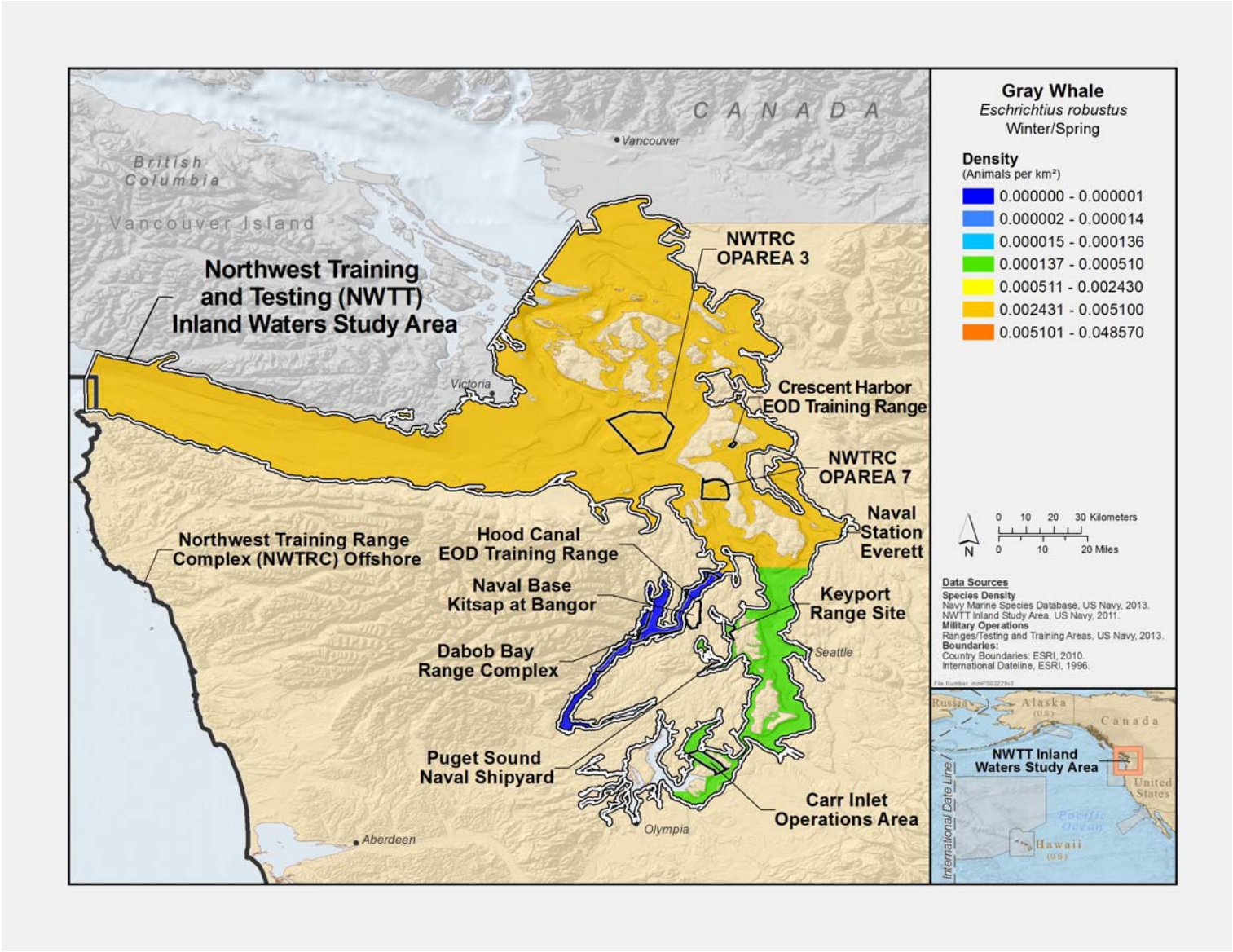

Figure 5-51: Winter/Spring Distribution of Gray Whale in the Inland Waters Portion of the NWTT Study Area

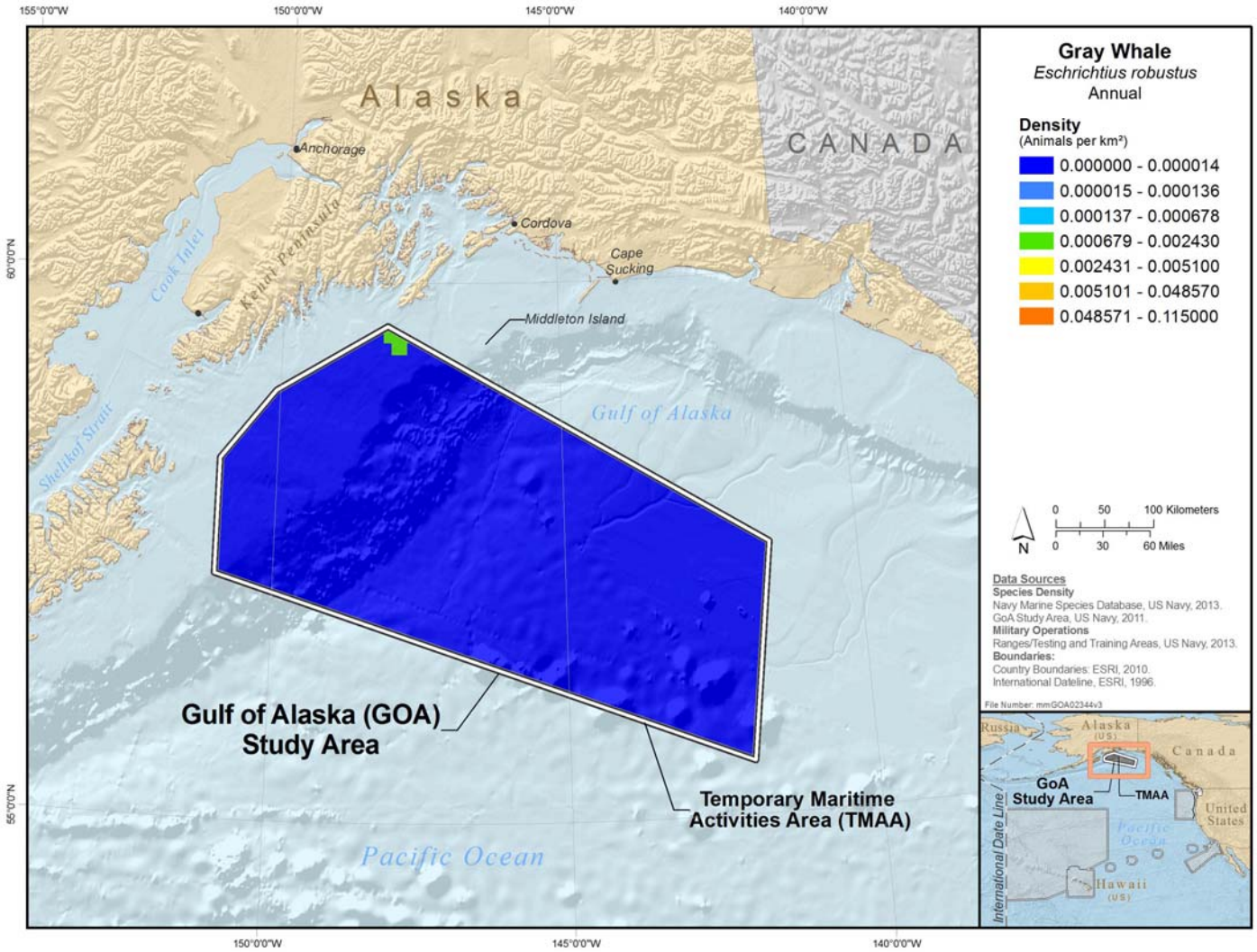

Figure 5-52: Annual Distribution of Gray Whale in the GOA Study Area

5.1.8 *EUBALAENA JAPONICA*, NORTH PACIFIC RIGHT WHALE

Once abundant enough to support a whaling industry, the North Pacific right whale (*Eubalaena japonica*) is now apparently the most endangered whale species in the world (Wade et al. 2011b). The most recent estimated population for the North Pacific right whale is between 28 and 31 individuals and although this estimate may be reflective of a Bering Sea subpopulation, the total eastern North Pacific population is unlikely to be much larger (Wade et al. 2011a, b). Because of the low population numbers in the North Pacific, few individuals have been observed, and until recently sightings have occurred primarily in the Okhotsk Sea and the eastern Bering Sea (Brownell et al. 2001; Wade et al. 2006, 2011b, Zerbini et al. 2010). Although there are historical sightings of North Pacific right whales in Hawaii and California, recent sightings are extremely rare. The last documented sighting of a right whale in Hawaii was 1996 (Salden and Mickelsen 1999), and the last sightings in Southern California waters are likely to be the sightings off San Clemente Island in 1992 (Carretta et al. 1994) and the sighting off Baja California in 1996 (Gendron et al. 1999). Right whales were not detected during recent passive acoustic monitoring in waters off the state of Washington (Širović et al. 2012b); however, there have been some recent sightings near the NWTT Study Area. In June 2013, a single right whale was sighted in waters north of the NWTT Study Area off Haida Gwaii, British Columbia (Hume 2013). Approximately four months later (October 2013) another (different) right whale was sighted with a group of humpback whales off the entrance to the Strait of Juan de Fuca in Canadian waters (Pynn 2013). Given their small population size, the expected likelihood of a North Pacific right whale being in waters within the Navy's HSTT, MITT, or NWTT Study Areas is so small that the species is not included in the Navy's density database for these regions.

GOA. Habitat modeling using historic whaling records suggests that the Gulf of Alaska currently provides suitable habitat for North Pacific right whales, although this has not been validated empirically (Gregr 2011). From the 1960s through 2002, there were only two documented sightings of North Pacific right whales in the Gulf of Alaska. In March 1979, there was an opportunistic sighting near Yakutat Bay in the eastern Gulf of Alaska (Shelden et al. 2005). A single North Pacific right whale was sighted southeast of Kodiak Island in July 1998 during an aerial survey and, subsequently, two passive acoustic recorders were placed in the northern Gulf of Alaska near Kodiak Island (Waite et al. 2003). Recordings from these instruments, and an additional five placed in the central Gulf of Alaska in 2000–2001, were later analyzed for North Pacific right whale calls. Very few right whale calls were positively identified, and all were detected on the westernmost recorder in the Gulf of Alaska during August and September (Moore et al. 2006).

From 2004 to 2006, there were an additional four sightings of North Pacific right whales in the Gulf of Alaska, all in the Barnabus Trough region on Albatross Bank, southeast of Kodiak Island (Wade et al. 2011a, b). These sightings triple the number of sightings in the Gulf of Alaska over the last 40 years and suggest that this area represents important habitat for the remaining animals in this population (Wade et al. 2011a). A portion of this area, located to the west/southwest of the GOA Study Area, was designated as critical habitat in 2006 (National Marine Fisheries Service 2013a). During a marine mammal survey in July 2012, a lone North Pacific right whale was seen approximately 64 km south of the Study Area in deep water, approximately 130 mi. east of Kodiak Island (Matsuoka et al. 2013). In July

2013, during the GOALS II survey, three North Pacific right whales were acoustically detected in the Barnabus Trough region on Albatross Bank, southeast of Kodiak Island (Rone et al. 2014). This is the same area as the 2004–2006 sightings noted above. Given their current extremely low population numbers, but in order to acknowledge their potential presence in the GOA Study Area, based on the sighting data summarized above, North Pacific right whales were assigned a minimum population estimate for this area of 0.00001 animals/km^2.

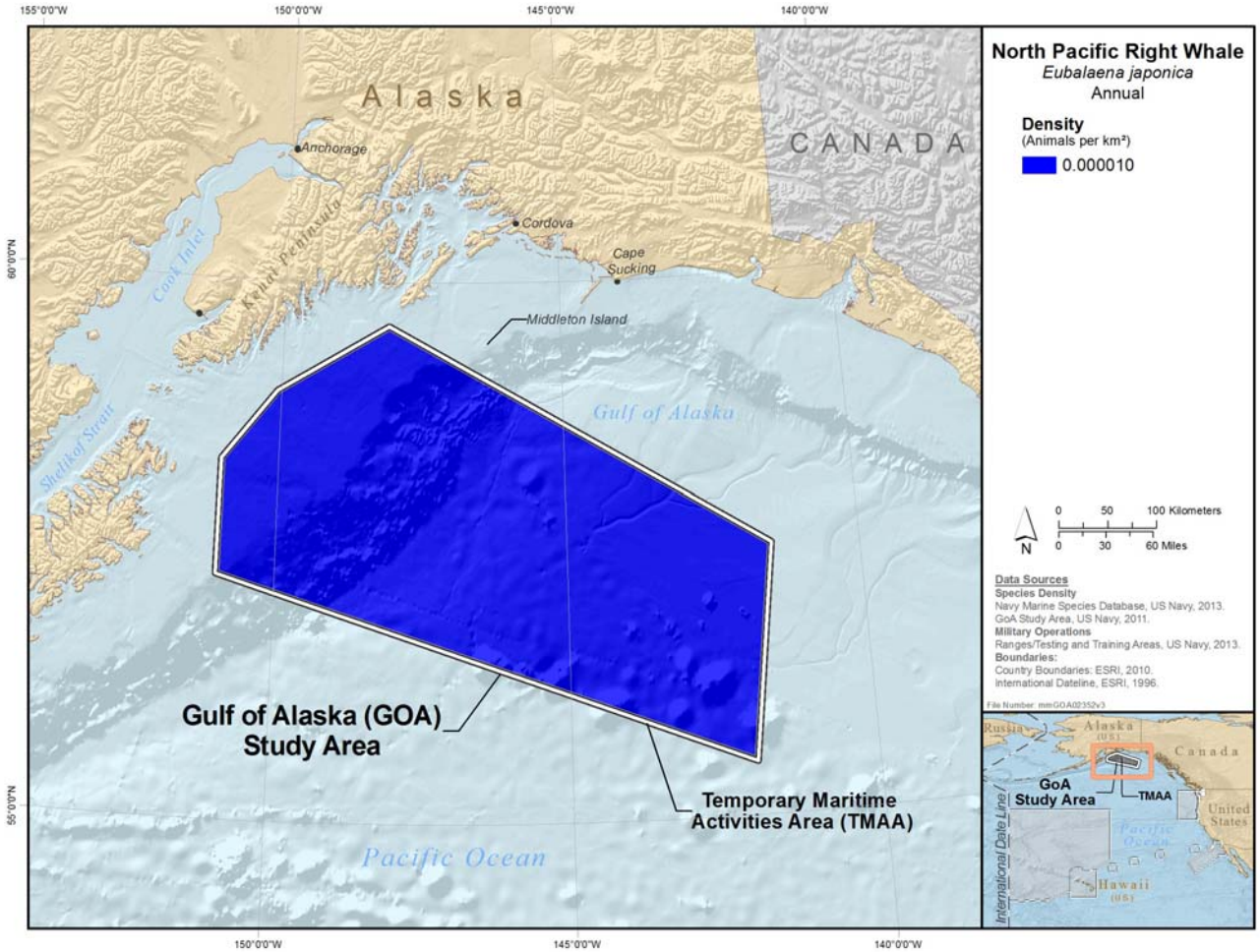

Figure 5-53: Annual Distribution of North Pacific Right Whale in the GOA Study Area

5.1.9 *MEGAPTERA NOVAEANGLIAE*, HUMPBACK WHALE

Humpback whales are a relatively easily-identified species of baleen whale, because of notable morphological features and behaviors they exhibit. They have long pectoral flippers that are white underneath, they have a fairly distinctive dorsal fin that they arch high out of the water when they dive, they often raise their flukes in the air when they dive, and they exhibit surface-active behaviors such as breaching or slapping their tail or fins on the water (Clapham 2000). Their significant presence in Hawaii and SOCAL has meant that some useable data are available for their presence near shore. Relatively little is known about humpback presence in the open ocean. In the Pacific, humpback whales have been divided into four stocks in U.S. waters by NMFS (Carretta et al. 2011a): the California/Oregon/Washington stock, the Central North Pacific stock, the Western North Pacific stock, and the American Samoa stock. Density values for the HSTT Study Area are presented for the species as a whole. While humpback whales in SOCAL are primarily from the California/Oregon/Washington stock, individuals in HRC could be from the Central North Pacific stock or the Western North Pacific stock. Humpback whales observed in the transit corridor are likely to be a mix of the California/Oregon/Washington stock and the Central North Pacific stock. Humpback whales in the MITT Study Area are most likely part of the Western North Pacific stock. Within the NWTT Study Area, both the Central North Pacific stock (Western Behm Canal) and the California, Oregon, and Washington stock (Offshore and Inland Waters) occur. Whales from both the Central North Pacific and Western North Pacific stocks occur in the GOA Study Area. The IWC recognizes one large stock of humpback whales in the North Pacific.

HRC. Hawaii is the best-known migratory destination for North Pacific humpback whales to mate and give birth (Craig and Herman 1997; Dawbin 1966). Data do exist in a limited form to quantify the distribution of humpback whales around the Hawaiian Islands. Mobley et al. (2001) summarized the largest data set quantifying humpback whale distribution. From this report, they provided a winter and spring density of 0.0211 humpback whales/km^2 for an inner Main Hawaiian Islands stratum similar to Barlow (2003, also see the section on fin whales). To arrive at a density estimate for the outer Hawaiian EEZ, the Navy used the “best” estimate of the stock size, 10,103 whales, from the Stock Assessment Report for the Central North Pacific stock (Allen and Angliss 2011). From this total stock number, the Navy subtracted Mobley et al.’s (2001) inner Hawaii EEZ estimate of 4,492 to get 5,611 whales in the outer EEZ. When this number is divided by the area of the outer EEZ (2,240,024 km^2 from Barlow [2006]), this provides a density of 0.0025 animals/km^2 for the Hawaiian EEZ outside of Mobley et al.’s (2001) inner Hawaii stratum. These two strata do not cover the entire HRC, so for the unaddressed area and a portion of the transit corridor the RES data set from Kaschner et al. (2006) is used for winter and spring. In the summer and fall, humpback whales are absent from tropical waters (Barlow 2006; Craig and Herman 1997); therefore, a density of zero is used for those seasons in the HRC. While it is known that humpback whales are not found near Hawaii in summer and most of fall, the actual presence of the various stocks of humpback whales is not known in the pelagic North Pacific. Therefore, the RES model from Kaschner et al. (2006) is thought to be a possible representation of the humpback whales’ presence. The zero density around HRC contrasts with the RES model, but it is important to note that the projected densities from the RES model are relatively low. Allowing the RES model to represent

humpback whale presence is a conservative approach for the resource that probably overestimates the likelihood of humpback whales encountering Navy training in HRC in the summer and fall. The winter/spring map for HRC presents the known higher concentrations of humpbacks around the Hawaiian Islands, especially the Main Hawaiian Islands (Mobley et al. 2001). The RES model from Kaschner et al. (2006) represented the presence of humpback whale in pelagic zones around HRC, but did not provide for a specific concentration around the Hawaiian Islands; therefore, literature-derived values were used instead of the RES model.

SOCAL. NMFS has been able to develop a CCE habitat-based density model for humpback whales in southern California. This model provides the distribution off the west coast for summer and fall. Ferguson and Barlow (2003) also provide uniform densities of 0.0004 animals/km^2 for the entire Baja Extension for summer and fall. A single uniform density of 0.00121 animals/km^2 is used from Forney et al. (1995) for the SOCAL and Baja study areas in winter and spring. Data do not exist for the eastern half of the transit zone; therefore, RES data from Kaschner et al. (2006) are used for all seasons in the transit zone. In the Southern California Bight, data for humpback whales is arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

MITT. Humpback whales have been sighted during the Navy's routine aerial surveys of Fernando de Medinilla on several occasions, including two sightings in 2006 (January and March), both close to the island, and another sighting in February 2007, 18 mi. (29 km) north of Saipan (Vogt 2008). During a ship survey in the Study Area (January–April 2007), humpback whales were observed in both deep (2,625–3,940 ft. [800–1,200 m]) and shallow (1,234 ft. [374 m]) waters northeast of Saipan (Fulling et al. 2011). Acoustic detections of humpback song were also made during these sightings as well as on other occasions (Fulling et al. 2011). These observations suggest that there could be a small wintering population of humpback whales in the MITT Study Area, although additional research is needed for confirmation (Fulling et al. 2011; Ligon et al. 2011). Unfortunately, the limited sighting data do not allow for density estimation. In the absence of study-area specific data, estimates from LGL Limited (2008; see Section 3.3) were used to characterize humpback whale density in both the MITT and associated transit corridor study areas for fall, winter, and spring. Humpback whales are likely absent from low-productivity tropical waters in the summer (Jefferson et al. 2008; Perrin and Brownell 2009); therefore, a density of zero is used for that season.

NWTT Offshore. The California, Oregon, and Washington stock of humpback whales uses the waters off the west coast of the United States as a summer feeding ground. They are present off the northern California coast mainly between April and December and off the Oregon and Washington coasts mainly from May through November (Dohl et al. 1983; Green et al. 1992; Forney and Barlow 1998; Calambokidis et al. 2004, 2010). Visual surveys and acoustic monitoring studies have detected humpbacks along the Washington coast year-round, with peak occurrence during the summer and fall (Oleson et al. 2009). Recordings from two Navy-funded offshore passive acoustic monitoring devices also indicate that humpback whales are most common between September and December (Širović et al. 2012a, 2012b). Photo-identification studies suggest that whales feeding in this region are part of a small

sub-population that primarily feeds from central Washington to southern Vancouver Island (Calambokidis et al. 2004, 2008). In winter and spring (roughly January–March), most whales are further south on their breeding grounds and are likely not as abundant in the Offshore regions of the Study Area during these times.

As noted above for SOCAL, NMFS developed a CCE habitat-based density model for humpback whales which provides spatially-explicit density estimates off the U.S. west coast for summer and fall (Becker et al. 2012c). Calambokidis et al. (2004) provided line-transect uniform density estimates for humpback whales for waters off the northern coast of Washington in summer in an area that overlaps the nearshore portion of the NWTT Offshore Study Area north of the SWFSC survey area (refer to Figure 3-6). Given the distribution of the apparent sub-population noted above (i.e., from central Washington to southern Vancouver Island), the Calambokidis et al. (2004) estimate was used as a conservative estimate for the area north of the SWFSC survey area in summer/fall. Winter/spring density estimates for humpback whales off California are based on line-transect aerial surveys conducted in March and April 1991 and 1992 (Forney et al. 1995; Barlow et al. 2009). Based on a statistical comparison of winter and summer abundance estimates, Forney and Barlow (1998) found no significant seasonal difference in humpback whale abundance off California. Off the coast of Washington, humpback whales are known to be present in winter but in much fewer numbers than in summer and fall (Širović et al. 2012a). Given these seasonal comparisons, the winter offshore density estimate of humpback whales off the coast of Washington was assumed to be an order of magnitude lower than the California winter estimate.

NWTT Inland Waters. Humpback whales were common in inland Washington waters prior to the whaling period, but few sightings had been reported in this area until recently, when the number of humpback whale sightings increased. Since 2001, opportunistic sightings of cetaceans in inland waters have been reported to the Orca Network, an online forum available to the public to report and compile marine mammal sightings (http://www.orcanetwork.org). Based on a review of this database, most humpback whale sightings occur in the Strait of Juan de Fuca and in the San Juan Island area, with only occasional sightings in Puget Sound proper and only one recorded sighting in the Hood Canal and Dabob Bay area. From January 2003 through July 2012, there was an average of 6.6 humpback whale sightings per year reported to the Orca Network. A review of these Puget Sound opportunistic sightings indicates that humpback whales usually occur as individuals or in pairs. Although sightings have been reported during every month of the year, opportunistic sightings in the inland waters occur primarily from April through July.

Published density estimates for humpback whales in the inland waters are not available. Based on line-transect abundance estimates for offshore waters of Oregon and Washington (Barlow and Forney 2007), and consideration of opportunistic sightings recorded by the Orca Network, it was conservatively assumed that the spring to fall abundance estimate of humpback whales occurring within the Strait of Juan de Fuca and the San Juan Islands area would be 20% of the summer/fall offshore estimate (0.00014 animals/km^2), while fewer whales would be found within Puget Sound (10% of the Barlow and Forney 2007 estimate = 0.00007animals/km^2), and even fewer within Hood Canal and Dabob Bay (0.000001 animals/km^2).

Consistent with the conservative approach used for estimating spring/summer/fall abundance, the winter abundance estimate of humpback whales occurring within the Strait of Juan de Fuca and around the San Juan Islands was assigned a value of 20% of the assumed winter/spring offshore estimate (0.00002 animals/km^2), while fewer whales would be found within Puget Sound (10% of the offshore estimate = 0.00001 animals/km^2), and even fewer within Hood Canal and Dabob Bay (0.000001 animals/km^2).

NWTT Western Behm Canal, Alaska. For the Western Behm Canal, density estimates for all seasons were taken from the Marine Mammal Occurrence/Density Report prepared in support of a NEPA document for Navy activities at SEAFAC (U.S. Department of the Navy 2010b).

GOA. Based on both sighting data and acoustic detections, humpback whales are known to occur year-round in the Gulf of Alaska (Calambokidis et al. 2008, Stafford et al. 2007, Baumann-Pickering et al. 2012b). During a recent (June and July 2013) Navy-funded line-transect survey in and around the TMAA, sighting data were collected from four survey strata designed to sample the diverse habitat present in the GOA Study Area. Abundance estimates for unidentified large whales were prorated among blue, fin, and humpback whales within each stratum and proportionately incorporated into each species density estimate, resulting in the following density estimates for humpback whales: 0.129 (CV = 0.74) inshore stratum, 0.001 (CV = 0.76) offshore stratum, 0.001 (CV = 0.64) seamount stratum, and 0.0002 (CV = 1.03) slope stratum (Rone et al. 2014).

Table 5-15: Sources of Density Values Used for Humpback Whale

Location	Spring	Summer	Fall	Winter
HRC	L/LD/K	0	0	L/LD/K
W. Transit Corridor	K	K	K	K
E. Transit Corridor	K	K	K	K
SOCAL	L	CCE	CCE	L
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	L and LD	CCE, LD, and L	CCE, LD, and L	L and LD
NWTT Inland Waters	LD	LD	LD	LD
Western Behm Canal	LD	LD	LD	LD
GOA	L	L	L	L

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 5-16: Summary of Density Values for Humpback Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC inner EEZ	0.0211	0	0	0.0211
HRC outer EEZ	0.0025	0	0	0.0025
HRC "remainder"	S	0	0	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	S	S	S	S
SOCAL	0.00121	S	S	0.00121
Inner Baja Extension	0.00121	0.0004	0.0004	0.00121
Outer Baja Extension	0.00121	0.0004	0.0004	0.00121
MITT	0.00089	0.00089	0.00089	0.00089
MITT Transit Corridor	0.00089	0.00089	0.00089	0.00089
NWTT Offshore	0.0001–0.0012	S and 0.0214	S and 0.0214	0.0001–0.0012
NWTT Inland Waters	0–0.00014	0–0.00014	0–0.00014	0–0.00002
Western Behm Canal	0.0081	0.0117	0.0180	0.0081
GOA	0.0002–0.129	0.0002–0.129	0.0002–0.129	0.0002–0.129

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

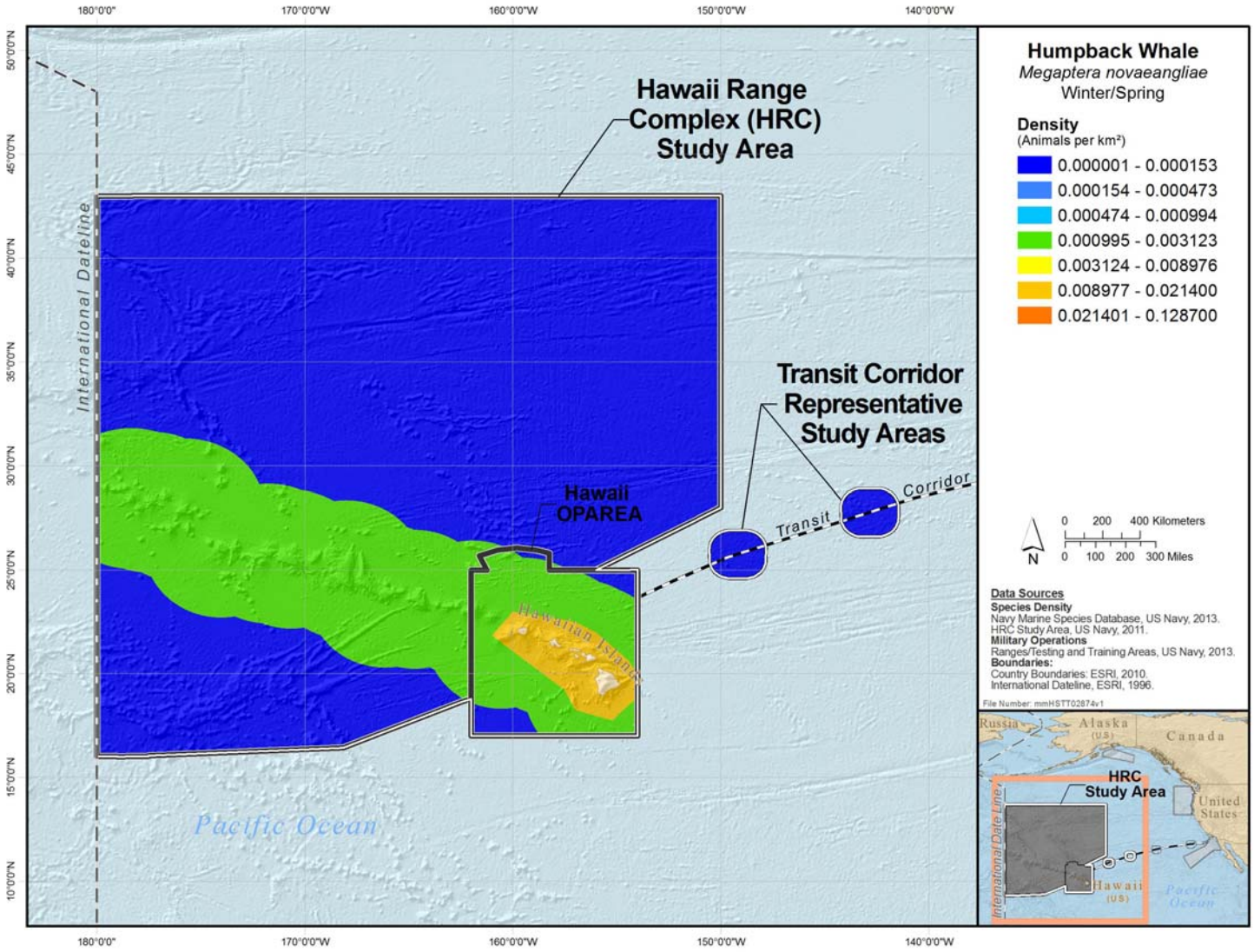

Figure 5-54: Winter/Spring Distribution of Humpback Whale in HRC and the Western Portion of the Transit Corridor

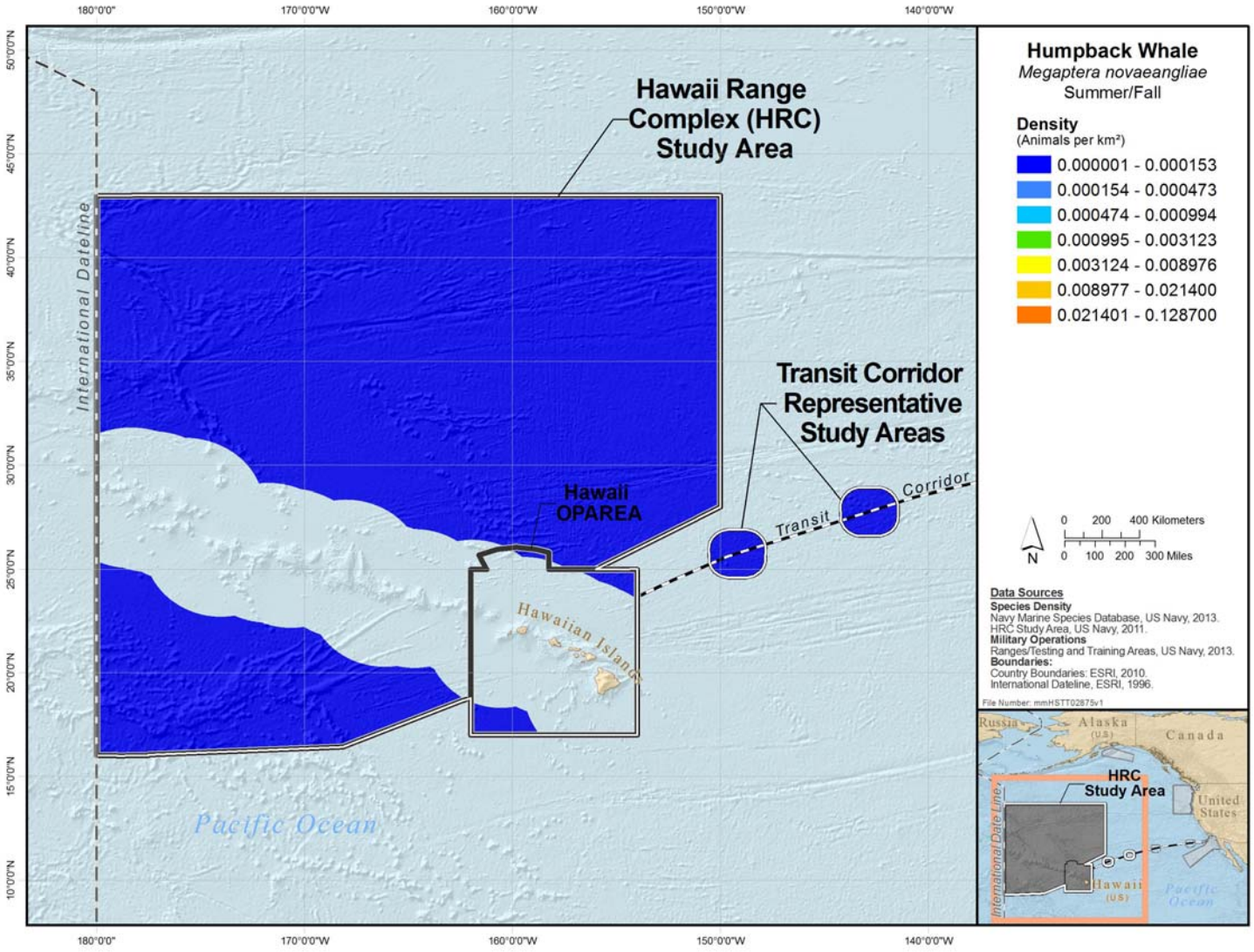

Figure 5-55: Summer/Fall Distribution of Humpback Whale in HRC and the Western Portion of the Transit Corridor

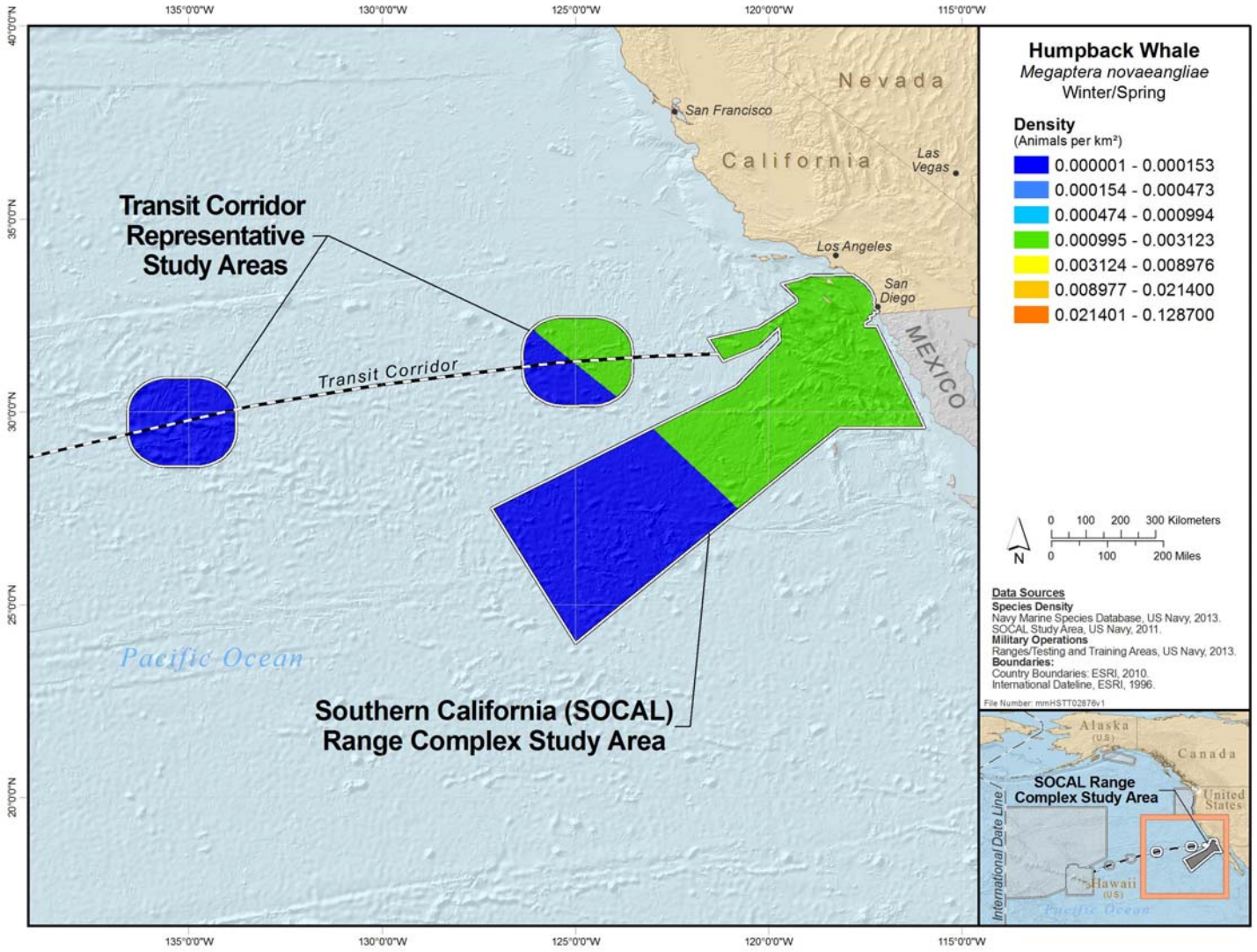

Figure 5-56: Winter/Spring Distribution of Humpback Whale in SOCAL and the Eastern Portion of the Transit Corridor

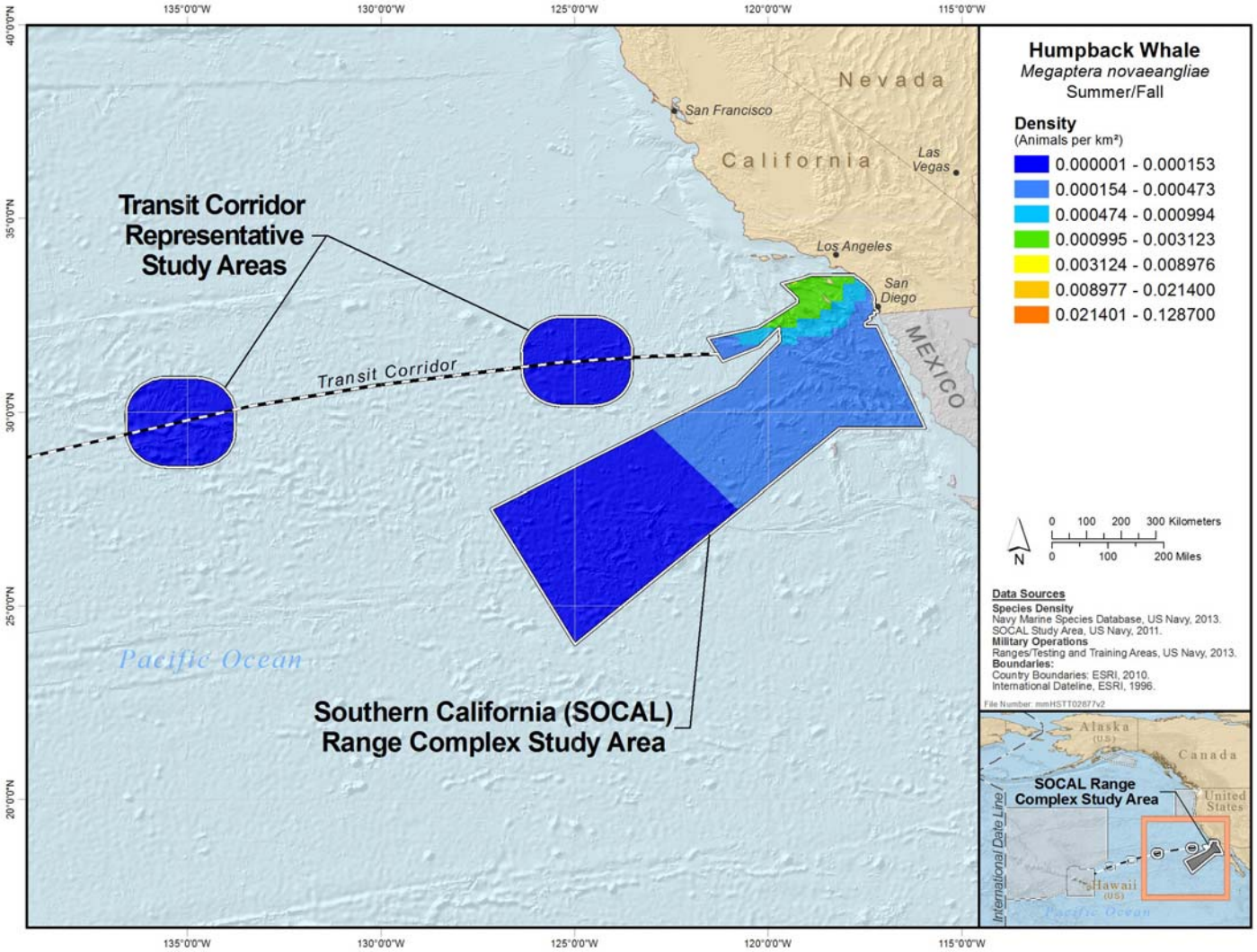

Figure 5-57: Summer/Fall Distribution of Humpback Whale in SOCAL and the Eastern Portion of the Transit Corridor

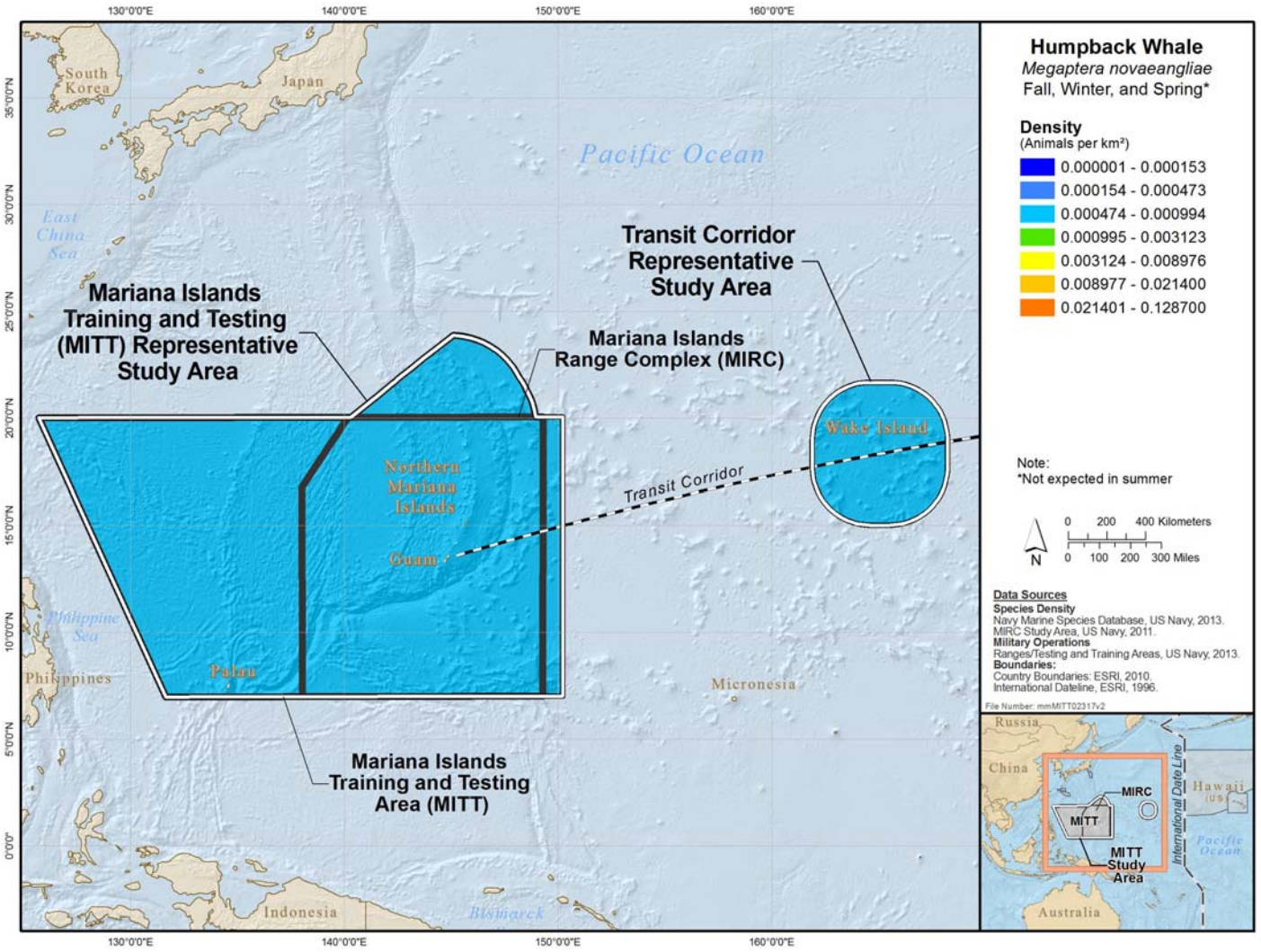

Figure 5-58: Fall, Winter, and Spring Distribution of Humpback Whale in MITT and the Associated Transit Corridor Study Areas

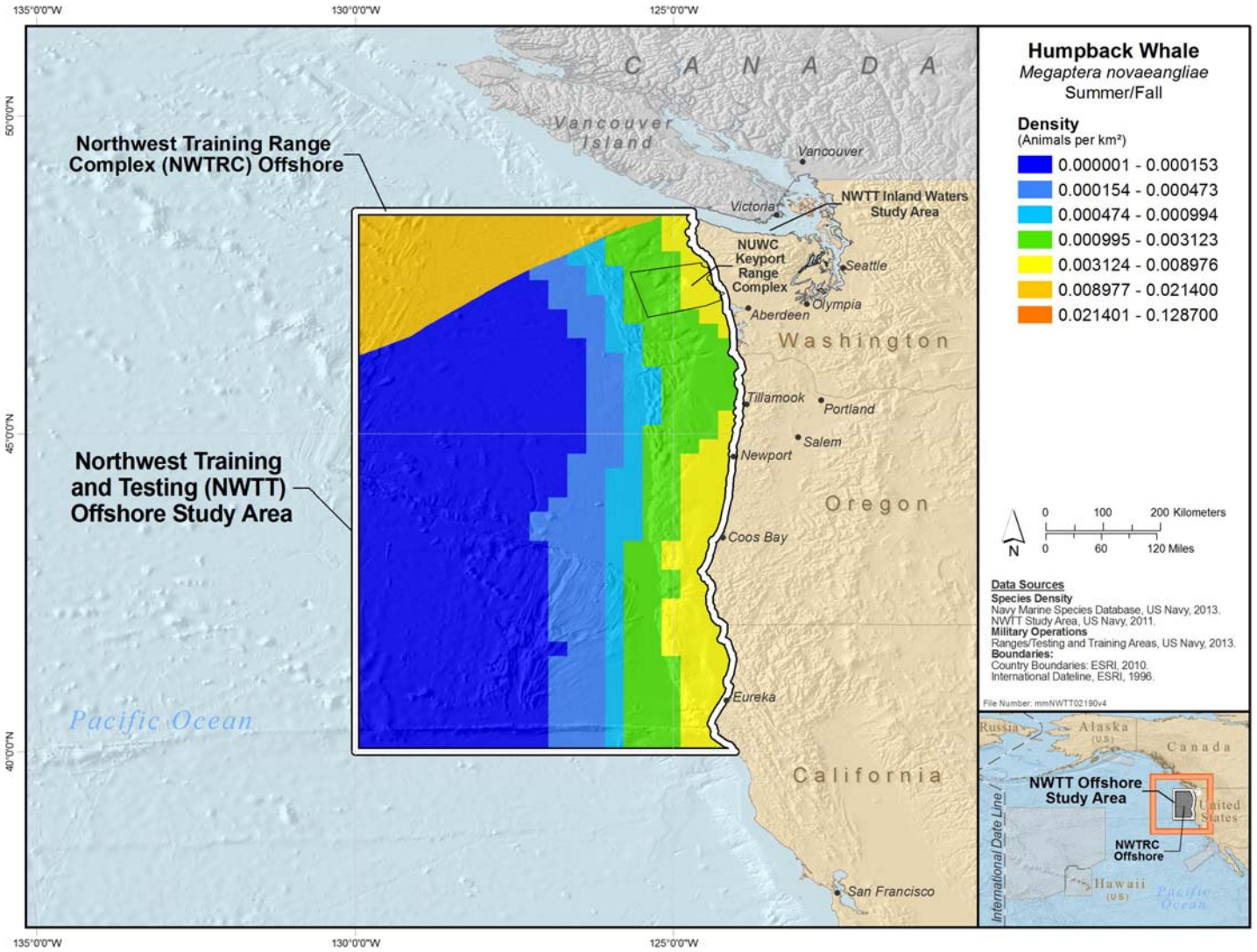

Figure 5-59: Summer/Fall Distribution of Humpback Whale in the Offshore Portion of the NWTT Study Area

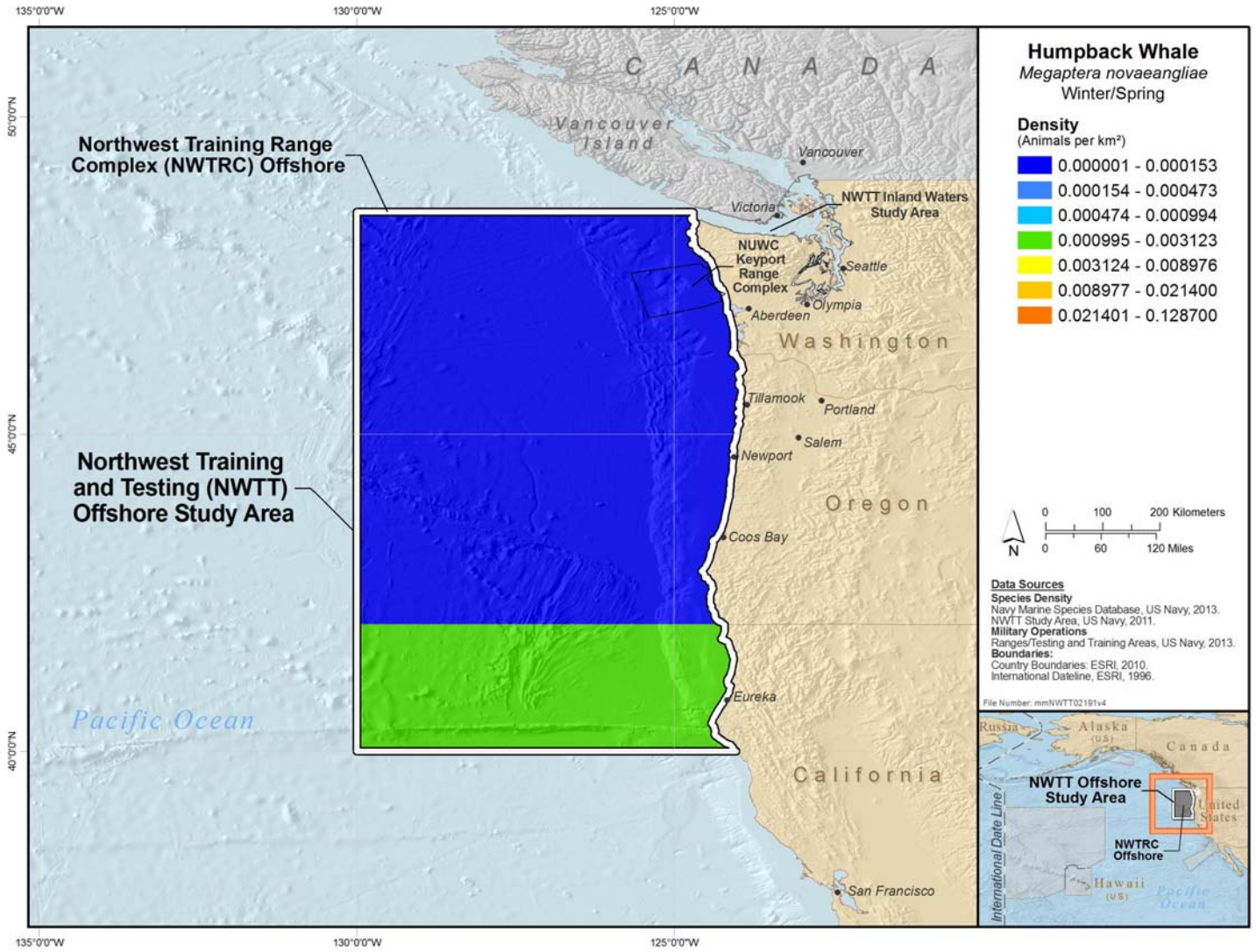

Figure 5-60: Winter/Spring Distribution of Humpback Whale in the Offshore Portion of the NWTT Study Area

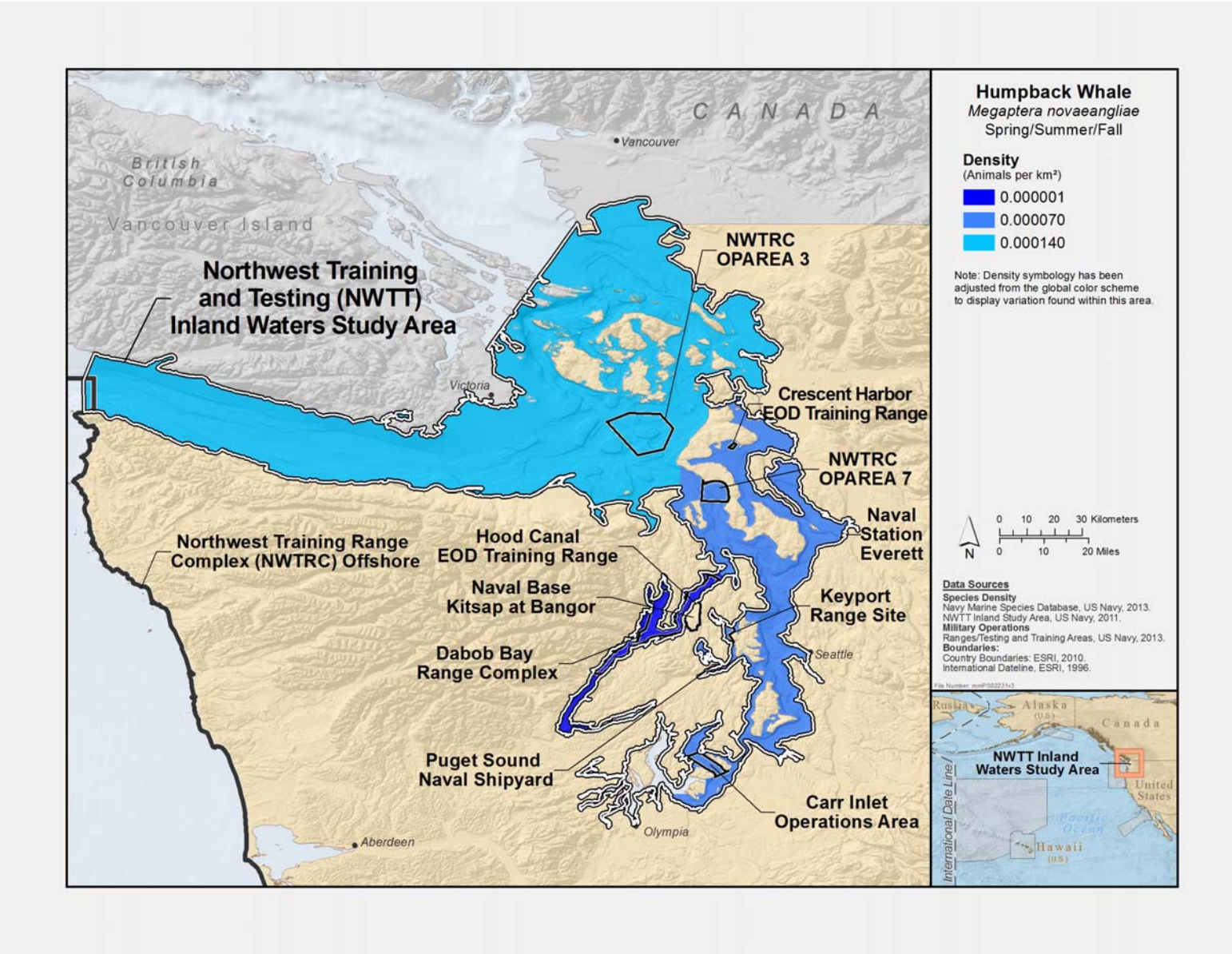

Figure 5-61: Spring, Summer, and Fall Distribution of Humpback Whale in the Inland Waters Portion of the NWTT Study Area

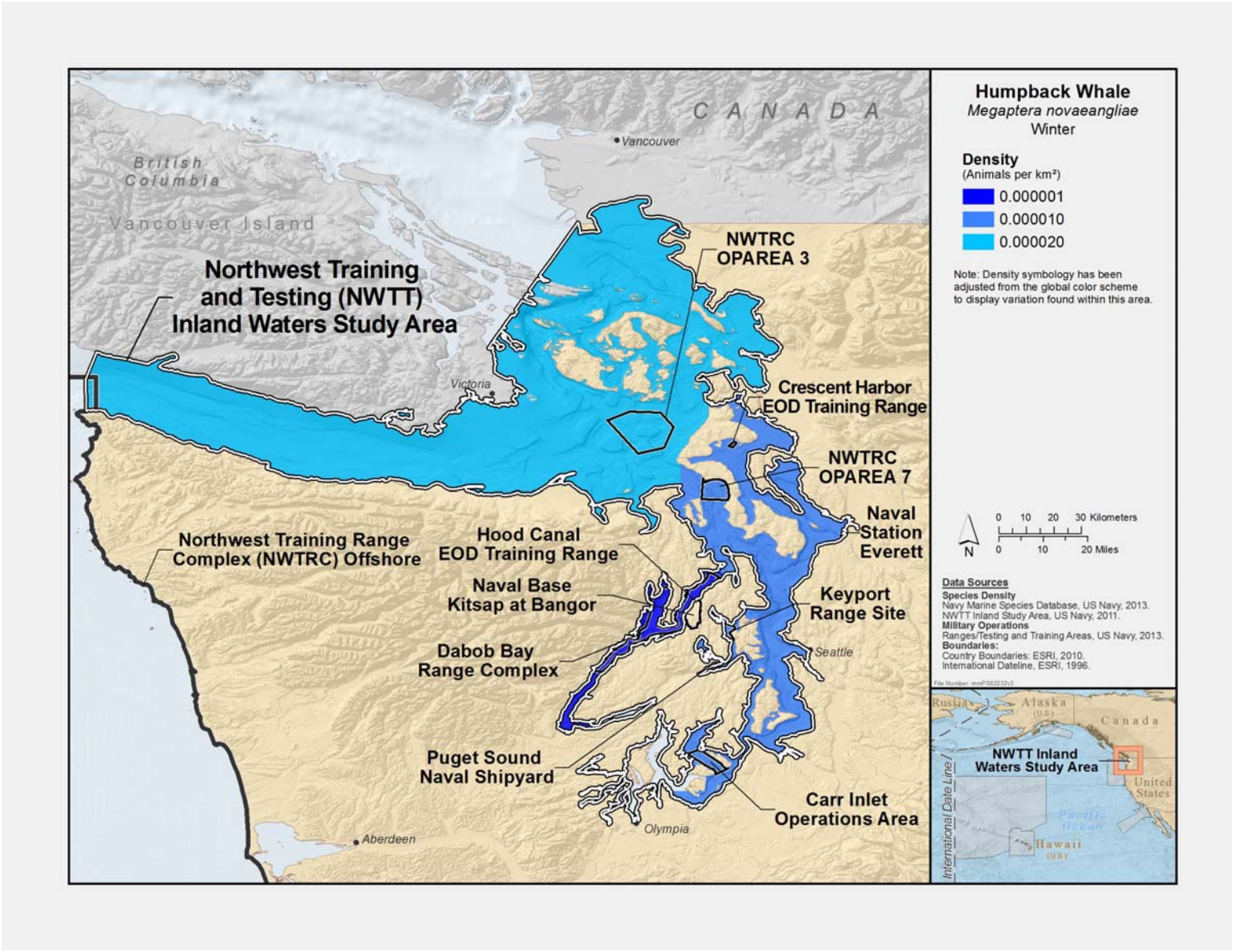

Figure 5-62: Winter Distribution of Humpback Whale in the Inland Waters Portion of the NWTT Study Area

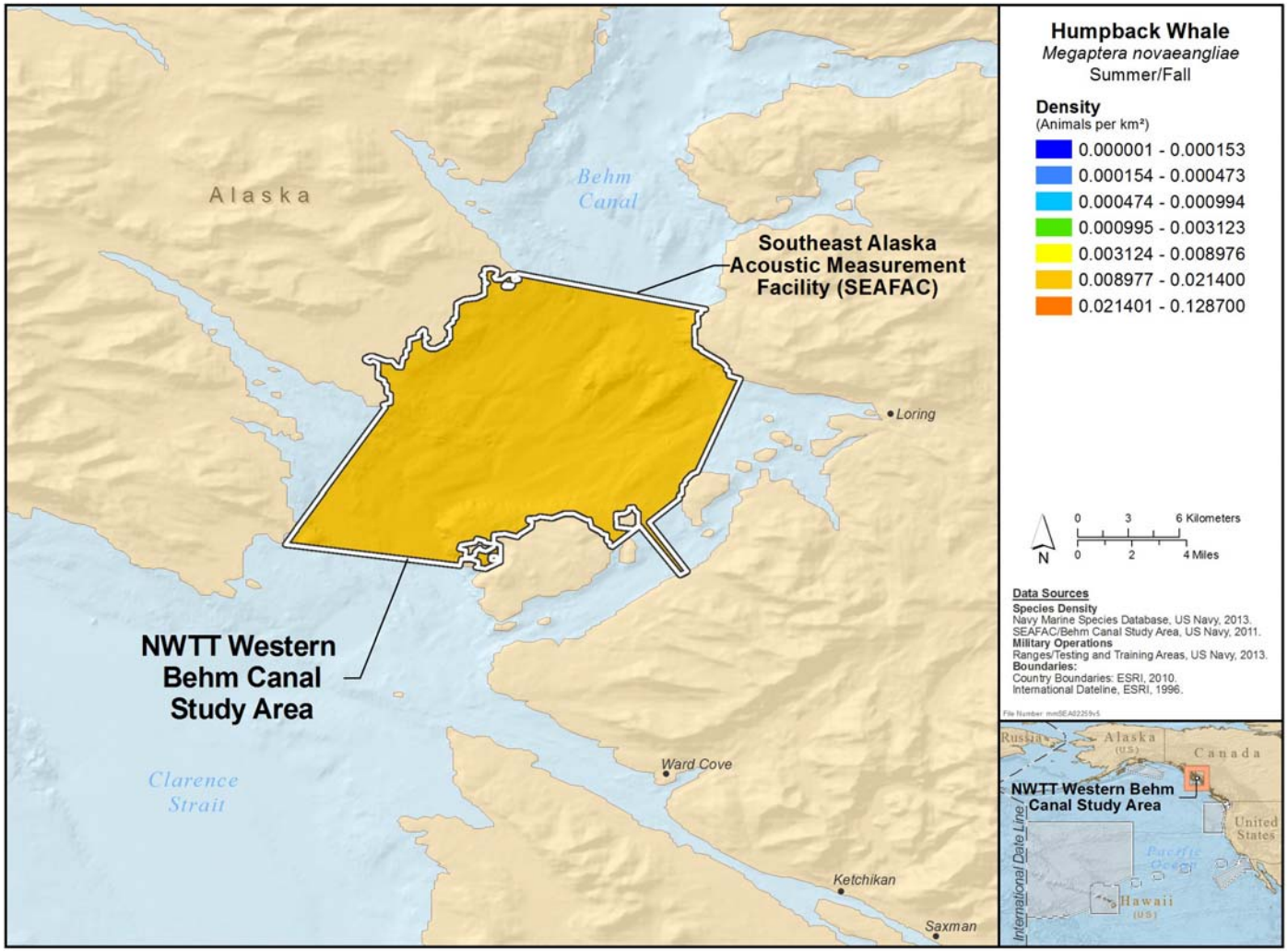

Figure 5-63: Summer/Fall Distribution of Humpback Whale in the Western Behm Canal Portion of the NWTT Study Area

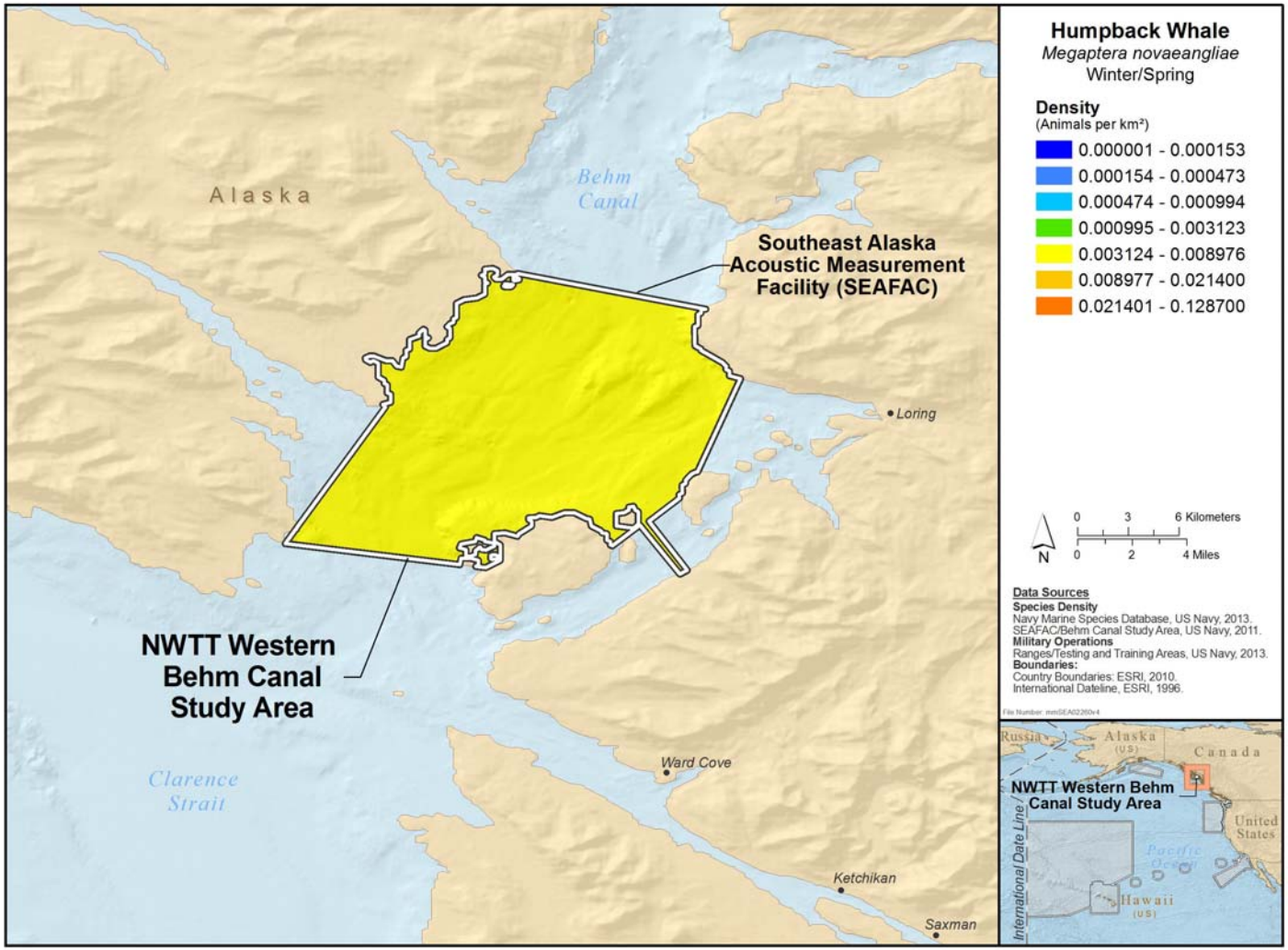

Figure 5-64: Winter/Spring Distribution of Humpback Whale in the Western Behm Canal Portion of the NWTT Study Area

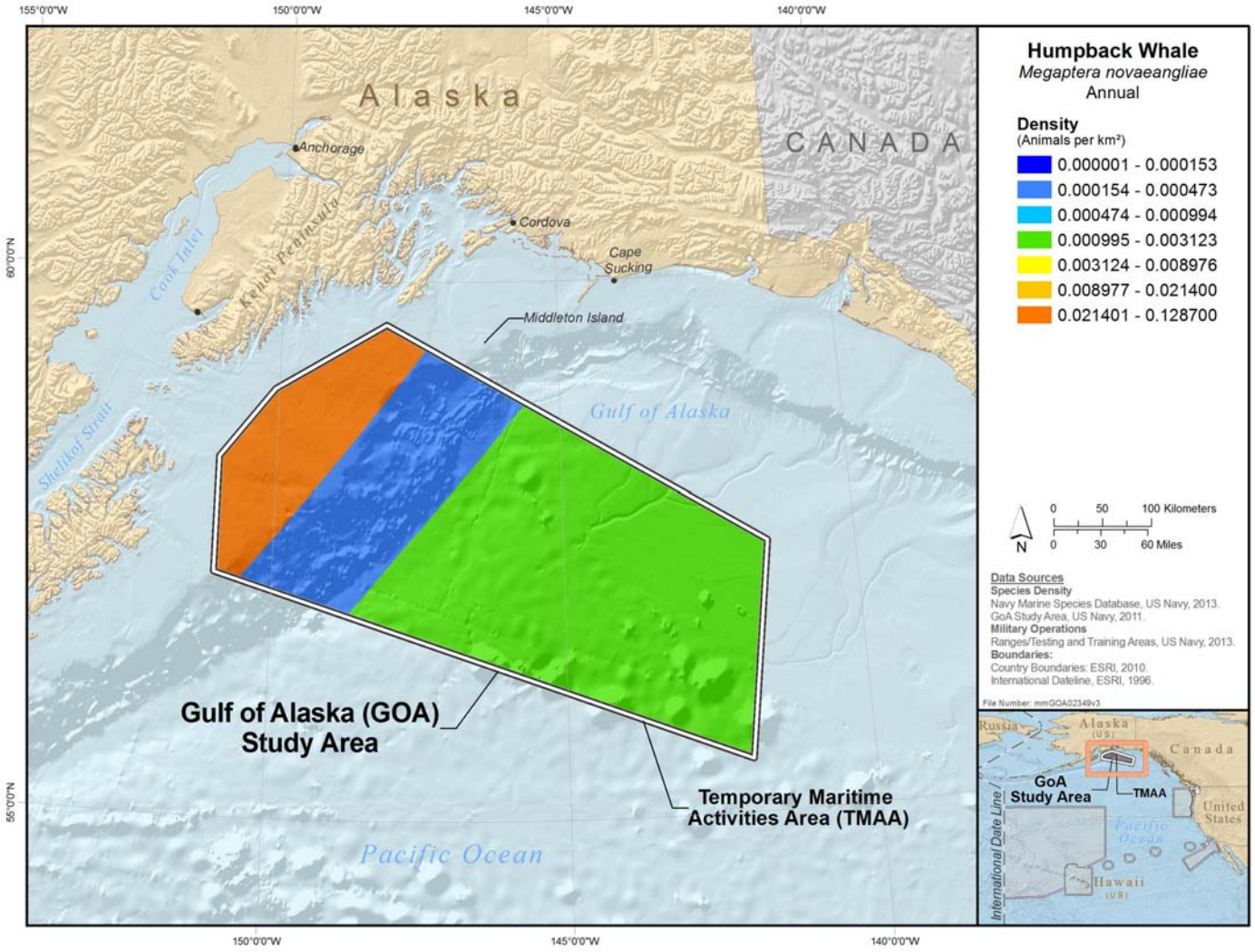

Figure 5-65: Annual Distribution of Humpback Whale in the GOA Study Area

6 SPERM WHALES

6.1 *SPERM WHALES SPECIES PROFILES*

6.1.1 *KOGIA BREVICEPS*, PYGMY SPERM WHALE

Pygmy sperm whales are small, dark, toothed whales that are difficult to distinguish in the field from the closely-related dwarf sperm whale (Leatherwood et al. 1988). Their small size and inconspicuous surfacing behavior make them difficult to sight in all but the lowest Beaufort sea states (Barlow 2006; Leatherwood et al. 1988). Pygmy sperm whales in U.S. Pacific waters have been divided into two stocks by NMFS: the California/Oregon/Washington stock, and the Hawaii stock (Carretta et al. 2011a). The two stocks are considered to be discrete from each other. Density values for the HSTT Study Area are presented differently for HRC and SOCAL. In HRC, scientists have been able to gather enough data on pygmy sperm whales and dwarf sperm whales to provide density estimates on each species separately (Barlow 2006). Fewer live sightings have occurred off the west coast of the United States, so NMFS is only able to provide density values for *Kogia* as a genus (Barlow and Forney 2007; Ferguson and Barlow 2003). Since range complexes match the stock structure, animals in SOCAL or HRC could be assigned to the stock in their respective areas. It is unclear where one stock transitions into the other along the transit corridor. Density values for the HSTT Study Area are presented for the species as a whole. Little is known about the stock structure of pygmy sperm whales in the MITT Study Area. Pygmy sperm whales in the NWTT Study Area belong to the California/Oregon/Washington stock. The IWC does not recognize stock structure for *Kogia* species.

Since density values for SOCAL and the NWTT Offshore strata are provided for *Kogia* as a genus (Barlow and Forney 2007; Ferguson and Barlow 2003), study area density figures are presented following the density summaries for dwarf sperm whale.

HRC. Pygmy sperm whales are one of the species that strand the most frequently in HRC (Nitta 1991; West et al. 2009), so they are thought to be present in reasonably large number, but more diffusely distributed (less dense population) than other toothed whales (Barlow 2006). As stated above, enough sightings have occurred in HRC to allow for density estimation. A year-round density of 0.00714 animals/km^2 comes from Barlow (2006), which is an adjustment of Barlow (2003). This value is also applied to the western portion of the transit corridor. Note that the RES global model (Kaschner et al. 2006) that surrounds the uniform density value on the HRC density map predicts that there is a much-lower density of pygmy sperm whales around Hawaii than are calculated from observations. The red color on the map covers density values that span several orders of magnitude, so the range of values at the high end of the scale are not represented with color subtlety on the map.

SOCAL. The majority of sightings of *Kogia* in the field in SOCAL are likely to have been pygmy sperm whales (Carretta et al. 2011a). As previously indicated, *Kogia* species are treated as a genus in SOCAL by authors who have published species density estimates. Barlow and Forney (2007) provide stratified density estimates for the genus for the coast off California, Oregon, and Washington. Ferguson and Barlow (2003) provided a value of 0.0121 and 0.0031 animals/km^2 for the inner and outer Baja Extension respectively (which are the areas equivalent to their strata 58 and 59). Although the values given in the

report are for the pygmy sperm whale specifically, the Navy also applied these values to dwarf sperm whale. The uniform density estimates for SOCAL and the Baja Extension are used for all seasons. For the eastern portion of the transit corridor, the RES model from Kaschner et al. (2006) is used in all seasons. In the Southern California Bight, data for the *Kogia* guild is arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

MITT. There were no *Kogia* species sighted during the 2007 survey of the Marianas Study Area (Fulling et al. 2011). However, this species is difficult to detect in high sea states and more than half of this survey was conducted in rough conditions (i.e., Beaufort sea states greater than 4). There is only one stranding record available for *Kogia* in the Study Area and vicinity (Eldredge 1991, 2003; Kami and Lujan 1976; Reeves et al. 1999). During marine mammal monitoring for Valiant Shield 07, a group of three *Kogia* (dwarf or pygmy sperm whales) was observed about 8 nm east of Guam (Mobley 2007). In the absence of study area specific density data, and consistent with recommendations from scientists at PIFSC, line-transect estimates derived for Hawaiian waters (Barlow 2006) were used to represent the best available estimates for the MITT Study Area. Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual pygmy sperm whale density.

NWTT Offshore. As previously indicated, *Kogia* species are treated as a guild off the west coast of the United States (Barlow and Forney 2007). The majority of sightings of *Kogia* in the Offshore region of the NWTT Study Area are likely to have been pygmy sperm whales (Carretta et al. 2011a). Barlow and Forney (2007) provided stratified density estimates for *Kogia* spp. for waters off California, Oregon, and Washington; these were used for all seasons for both the Northern California and Oregon/Washington strata. In the absence of other data, and given the lack of information regarding seasonality (Carretta et al. 2013), the Barlow and Forney (2007) Oregon/Washington estimate was also used for the area north of the SWFSC strata (refer to Figure 3-6) for all seasons.

NWTT Inland Waters. Pygmy sperm whales are not expected to occur within the Inland Waters region of the NWTT Study Area and would be considered extralimital in this area.

NWTT Western Behm Canal, Alaska. Pygmy sperm whales are not expected to occur within Western Behm Canal and would be considered extralimital in this area.

GOA. Pygmy sperm whales are not expected to occur within the GOA Study Area.

Table 6-1: Sources of Density Values Used for Pygmy Sperm Whale

Location	Spring	Summer	Fall	Winter
HRC	L	L	L	L
W. Transit Corridor	L	L	L	L
E. Transit Corridor	K	K	K	K
SOCAL	G	G	G	G
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	G	G	G	G
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; G = covered by values for a guild of species from the literature instead of as a single species; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 6-2: Summary of Density Values for Pygmy Sperm Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0.00291	0.00291	0.00291	0.00291
W. Transit Corridor	0.00291	0.00291	0.00291	0.00291
E. Transit Corridor	S	S	S	S
SOCAL	0.00108	0.00108	0.00108	0.00108
Inner Baja Extension	0.0121	0.0121	0.0121	0.0121
Outer Baja Extension	0.0031	0.0031	0.0031	0.0031
MITT	0.00291	0.00291	0.00291	0.00291
MITT Transit Corridor	0.00176	0.00176	0.00176	0.00176
NWTT Offshore	0.00050–0.00123	0.00050–0.00123	0.00050–0.00123	0.00050–0.00123
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range. Numbers for SOCAL, the Baja Extension, and the NWTT Offshore areas apply to the *Kogia* guild.

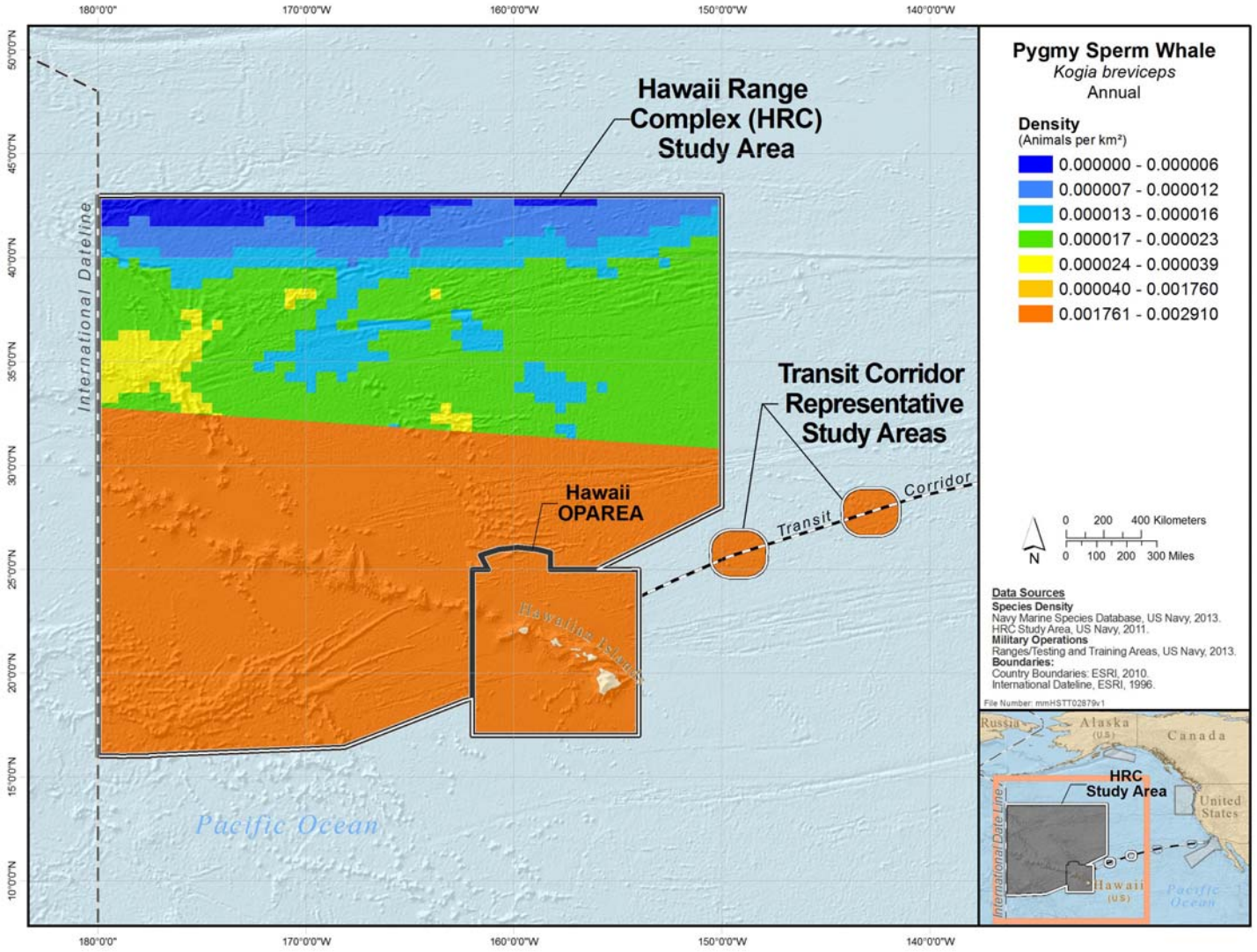

Figure 6-1: Annual Distribution of Pygmy Sperm Whale in HRC and the Western Portion of the Transit Corridor

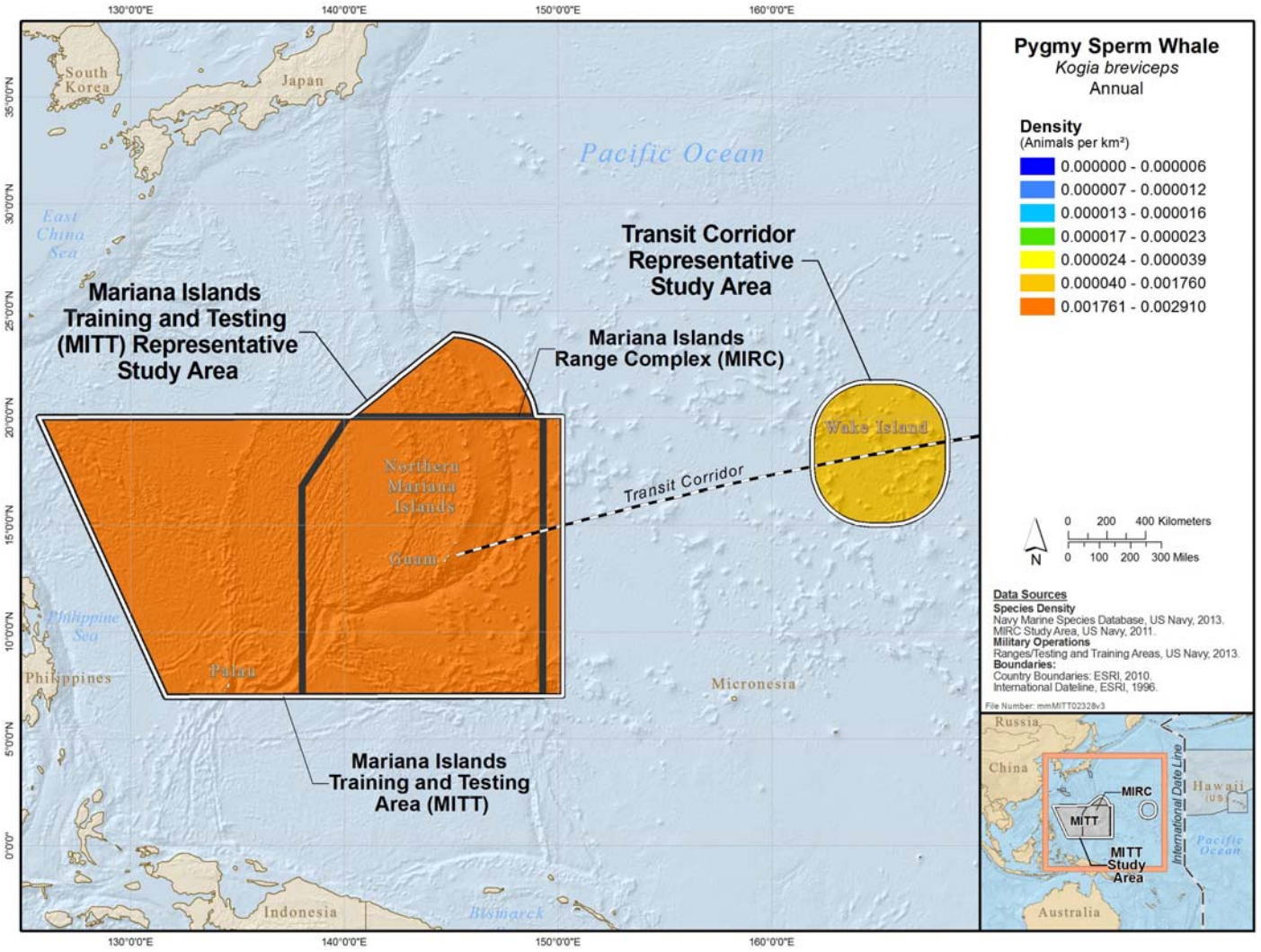

Figure 6-2: Annual Distribution of Pygmy Sperm Whale in MITT and the Associated Transit Corridor Study Areas

6.1.2 *KOGIA SIMA*, DWARF SPERM WHALE

Dwarf sperm whales are small, dark, toothed whales that look very similar to, but are smaller than the closely related pygmy sperm whale (Leatherwood et al. 1988; McAlpine 2009). Until viewed closely the species are difficult to tell apart. Their small size and slow, inconspicuous surfacing behavior makes them difficult to sight unless conditions are calm, although they sometimes rest for long periods of time at the water surface, making them more available for observation (Barlow 2006; McAlpine 2009). Dwarf sperm whales in U.S. Pacific waters have been divided into two stocks by NMFS: the California/Oregon/Washington stock, and the Hawaii stock (Carretta et al. 2011a). The two stocks are considered to be discrete and non-contiguous. Density values for the HSTT Study Area are presented differently for HRC and SOCAL. In HRC, scientists have been able to gather enough data on pygmy sperm whales and dwarf sperm whales to provide density estimates on each species separately (Barlow 2006). Fewer live sightings have occurred off the U.S. west coast, so NMFS is only able to provide density values for *Kogia* as a genus (Barlow and Forney 2007; Ferguson and Barlow 2003). Since range complexes match the stock structure, animals in SOCAL or HRC could be assigned to the stock in their respective areas. It is unclear where one stock transitions into the other along the transit corridor. Density values for the HSTT Study Area are presented for the species as a whole. Little is known about the stock structure of dwarf sperm whales in the MITT Study Area. Dwarf sperm whales in the NWTT Study Area belong to the California/Oregon/Washington stock. The IWC does not provide stock structure of *Kogia* species.

Since density values for SOCAL and the NWTT Offshore strata are provided for *Kogia* as a genus (Barlow and Forney 2007; Ferguson and Barlow 2003), study area density figures are presented following the density summaries for dwarf sperm whale.

HRC. Around the Main Hawaiian Islands, Baird (2005) found that the majority of observed *Kogia* groups that could be identified to species were dwarf sperm whales. Dwarf sperm whales strand less frequently in the HRC than pygmy sperm whales (Nitta 1991), and may be the more pelagic of the two species, as well as preferring warmer water (McAlpine 2009). Like their sister species, dwarf sperm whales are thought to be present in reasonably large numbers, but diffusely distributed in the HRC (Barlow 2006). As stated above, enough sightings have occurred in HRC to allow for density estimation. A year-round density of 0.00291 animals/km^2 comes from Barlow (2006). This value is also applied to the western portion of the transit corridor. The RES global model (Kaschner et al. 2006) that surrounds the uniform density value on the HRC density map predicts that there is a much-lower density of dwarf sperm whales around Hawaii than are calculated from observations.

SOCAL. This species is not often seen off the west coast of the United States (Barlow and Forney 2007; Willis and Baird 1998), but may be present in fair numbers. As previously indicated, *Kogia* species are treated as a genus in SOCAL by authors who have published species density estimates. Barlow and Forney (2007) provide stratified density estimates for the genus for the area off California, Oregon, and Washington. Ferguson and Barlow (2003) provide a value of 0.0121 and 0.0031 animals/km^2 for the inner and outer Baja Extension respectively (which are the areas equivalent to their strata 58 and 59). Although the values given in the report are for the pygmy sperm whale specifically, we also apply these

values to dwarf sperm whale. The uniform density estimates for SOCAL and the Baja Extension are used for all seasons. For the eastern portion of the transit corridor, the density of 0.0031 animals/km^2 from Ferguson and Barlow's (2003) stratum 60 is used, because it overlaps a portion of transit corridor and it is consistent with the densities for SOCAL and the Baja Extension. This value applies to all seasons. In the Southern California Bight, data for dwarf sperm whales is arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

MITT. There were no sightings of *Kogia* made during the 2007 survey of the Marianas Study Area (Fulling et al. 2011). However, similar to the pygmy sperm whale, this species is difficult to detect in high sea states and more than half of this survey was conducted in rough conditions (i.e., Beaufort sea states greater than 4). There is only one stranding record available for *Kogia* in the Study Area and vicinity (Eldredge 1991, 2003; Kami and Lujan 1976; Reeves et al. 1999). During marine mammal monitoring for Valiant Shield 07, a group of three *Kogia* (dwarf or pygmy sperm whales) was observed about 8 nm east of Guam (Mobley 2007). There was one sighting of a single dwarf sperm whale in the Marpi Reef area, northeast of Saipan, during small boat surveys conducted in August and early September 2011 (Hill et al. 2011). In the absence of study area specific density data, and consistent with recommendations from scientists at PIFSC, line-transect estimates derived for Hawaiian waters (Barlow 2006) were used to represent the best available estimates for the MITT Study Area. Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual dwarf sperm whale density.

NWTT Offshore. As previously indicated, *Kogia* species are treated as a genus off the west coast of the United States (Barlow and Forney 2007). The majority of sightings of *Kogia* in the Offshore region of the NWTT Study Area are likely to have been pygmy sperm whales (Carretta et al. 2011a); however, Barlow and Forney (2007) provided stratified density estimates for *Kogia* spp. for waters off California, Oregon, and Washington. In the absence of species-specific data, these were used for all seasons for both the Northern California and Oregon/Washington strata. In the absence of other data, and given the lack of information regarding seasonality (Carretta et al. 2013), the Barlow and Forney (2007) Oregon/Washington estimate was also used for the area north of the SWFSC strata (refer to Figure 3-6) for all seasons.

NWTT Inland Waters. Dwarf sperm whales are not expected to occur within the Inland Waters region of the NWTT Study Area and would be considered extralimital in this area.

NWTT Western Behm Canal, Alaska. Dwarf sperm whales are not expected to occur within Western Behm Canal and would be considered extralimital in this area.

GOA. Dwarf sperm whales are not expected to occur within the GOA Study Area.

Table 6-3: Sources of Density Values Used for Dwarf Sperm Whale

Location	Spring	Summer	Fall	Winter
HRC	L	L	L	L
W. Transit Corridor	L	L	L	L
E. Transit Corridor	L	L	L	L
SOCAL	G	G	G	G
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	G	G	G	G
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; G = covered buy values for a guild of species from the literature instead of as a single species; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 6-4: Summary of Density Values for Dwarf Sperm Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0.00714	0.00714	0.00714	0.00714
W. Transit Corridor	0.00714	0.00714	0.00714	0.00714
E. Transit Corridor	0.0031	0.0031	0.0031	0.0031
SOCAL	0.00108	0.00108	0.00108	0.00108
Inner Baja Extension	0.0121	0.0121	0.0121	0.0121
Outer Baja Extension	0.0031	0.0031	0.0031	0.0031
MITT	0.00714	0.00714	0.00714	0.00714
MITT Transit Corridor	0.00430	0.00430	0.00430	0.00430
NWTT Offshore	0.00050–0.00123	0.00050–0.00123	0.00050–0.00123	0.00050–0.00123
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. Numbers for SOCAL, the Baja Extension, and the NWTT Offshore areas apply to the *Kogia* guild.

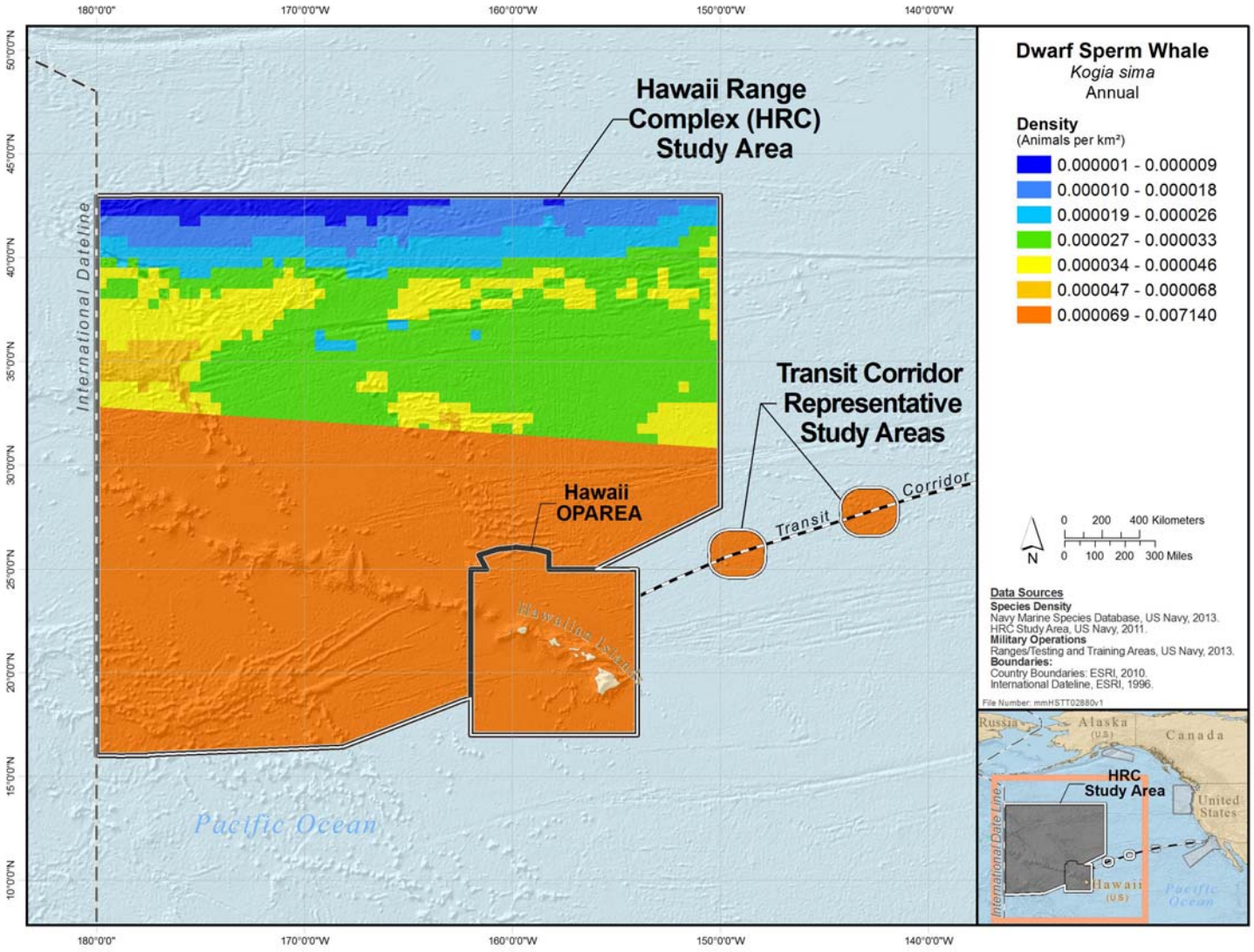

Figure 6-3: Annual Distribution of Dwarf Sperm Whale in HRC and the Western Portion of the Transit Corridor

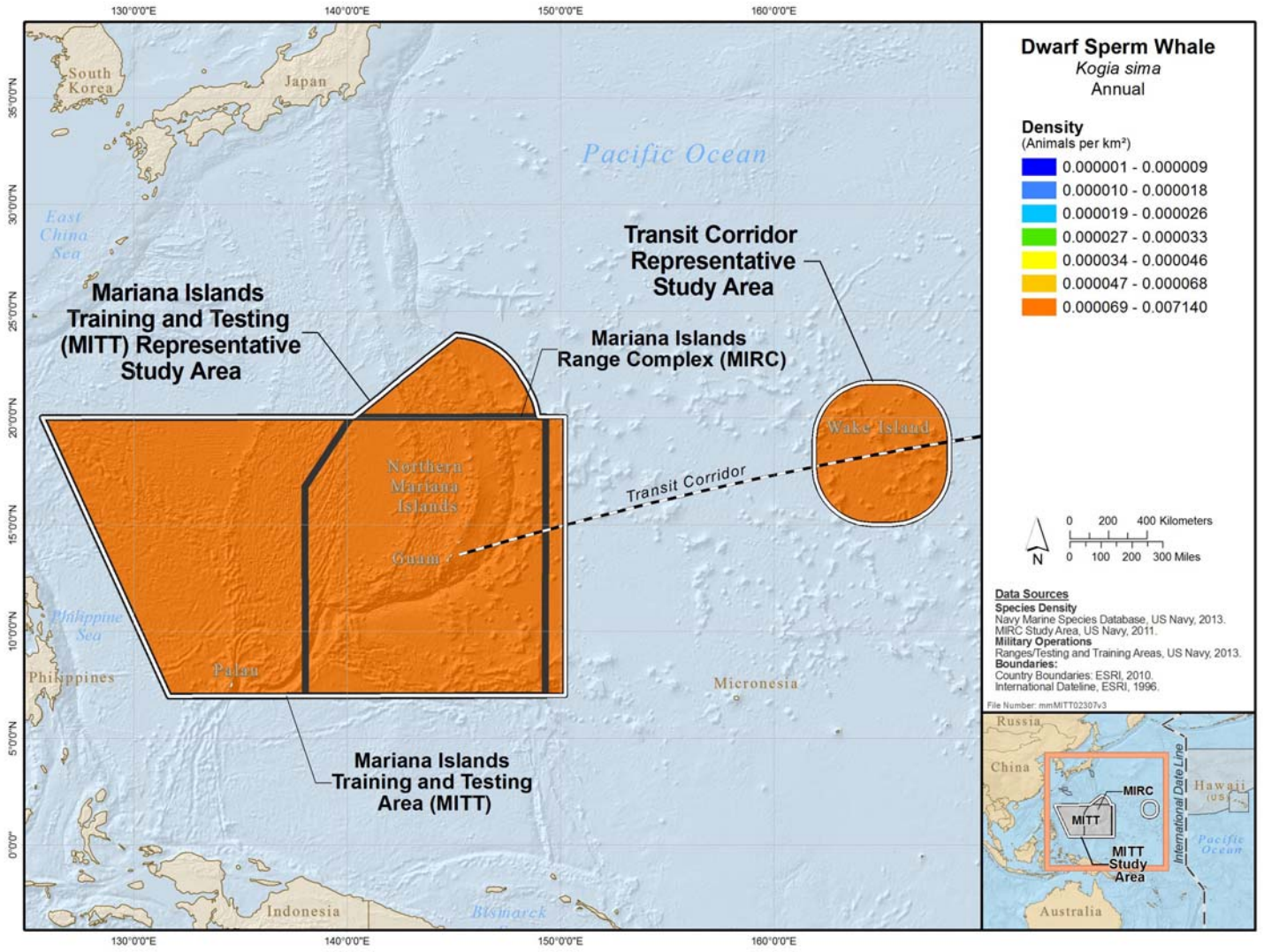

Figure 6-4: Annual Distribution of Dwarf Sperm Whale in MITT and the Associated Transit Corridor Study Areas

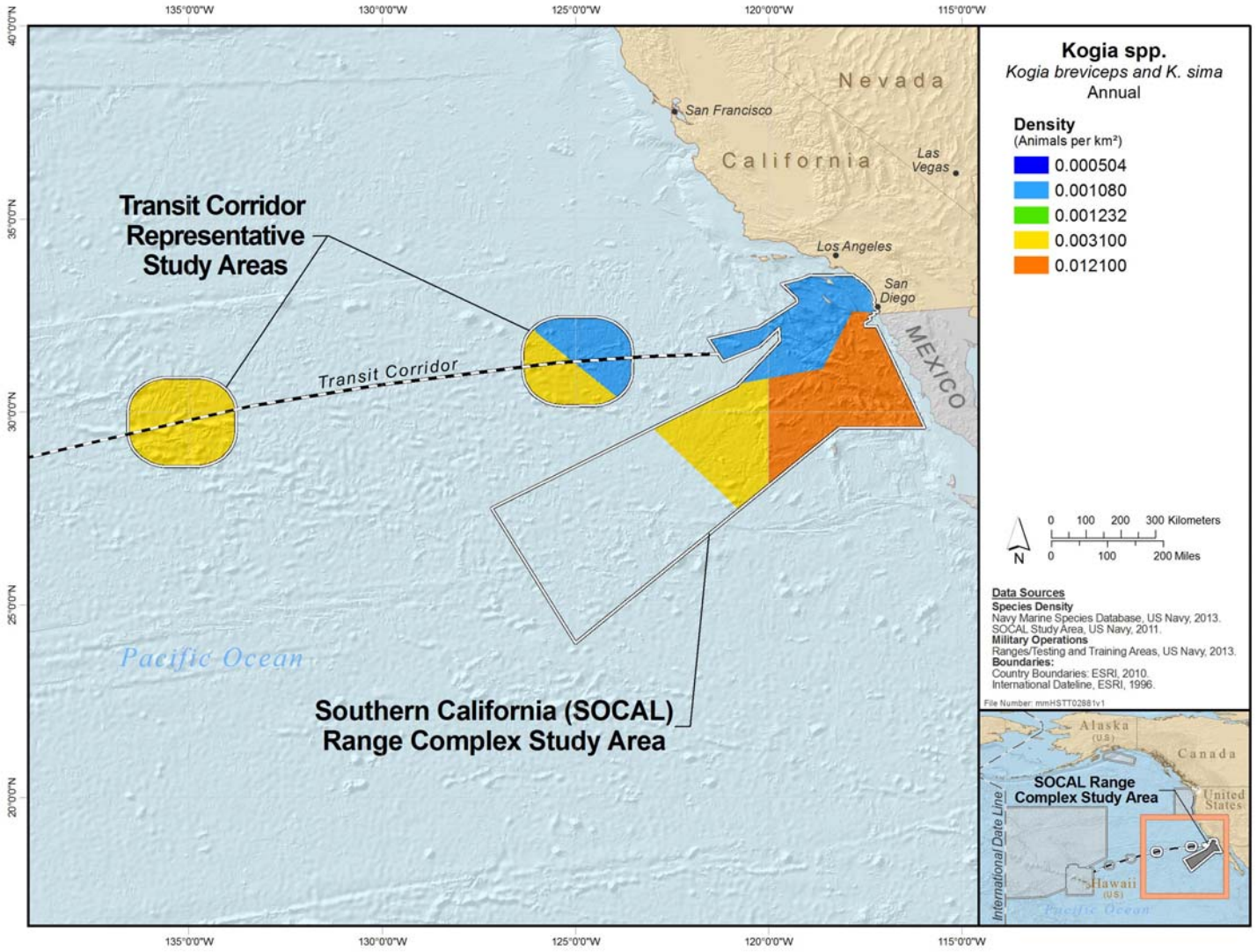

Figure 6-5: Annual Distribution of the Kogia Guild (Pygmy Sperm Whale and Dwarf Sperm Whale) in SOCAL and the Eastern Portion of the Transit Corridor

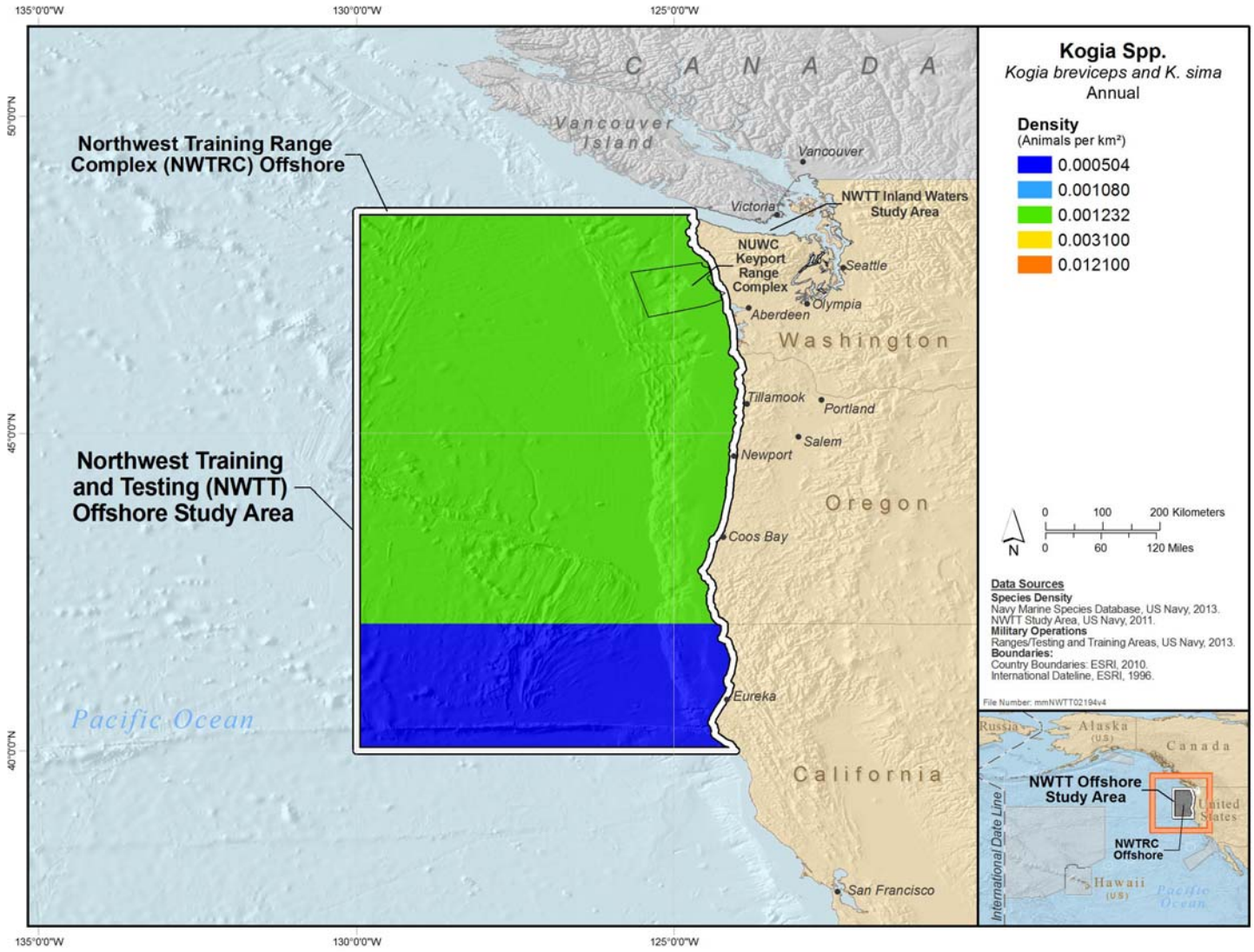

Figure 6-6: Annual Distribution of Kogia Guild (Pygmy Sperm Whale and Dwarf Sperm Whale) in the Offshore Portion of the NWTT Study Area

6.1.3 *PHYSETER MACROCEPHALUS*, SPERM WHALE

Sperm whales are the largest of the extant toothed whales and are one of the best studied species of whale in the world (Whitehead 2003). Their size, distinctive form, and angled "bushy" blow makes them one of the easiest species of whale to identify in the field (Leatherwood et al. 1988; Whitehead and Weilgart 2000). Sperm whales are one of the most-widely distributed species of marine mammal (Whitehead 2009). NMFS has divided sperm whales in the North Pacific into three stocks: the California/Oregon/Washington stock, the Hawaii stock, and the North Pacific stock (Carretta et al. 2011a). The North Pacific stock primarily uses the Gulf of Alaska and the Bering Sea. NMFS acknowledges the stocks are not entirely discrete, but they are thought to reflect population centers (Carretta et al. 2011a) and are based on a phylogeographic approach to defining stock structure (Dizon et al. 1992). Since the HRC and SOCAL range complexes match the stock for the Hawaiian and a portion of the California/Oregon/Washington stock, animals in SOCAL or HRC could be assigned to a stock while animals in the transit corridor could belong to the Hawaiian stock or California/Oregon/Washington stock. Density values for the HSTT Study Area are presented for the species as a whole. The IWC recognizes eastern North Pacific and western North Pacific management units of sperm whales (Carretta et al. 2011a). Although little is known about the stock structure of sperm whales in the MITT Study Area, they would presumably be included in the IWC western North Pacific management unit. Sperm whales occurring in the NWTT Offshore region of the Study Area belong to the California/Oregon/Washington stock. Animals from the North Pacific stock are those that are expected to occur in the GOA Study Area.

HRC. Because sperm whales are sightable and present in at least moderate numbers, NMFS has gathered enough sightings during surveys to make a CENPAC model for sperm whales (Becker et al. 2012b). This ecological model is applied for all four seasons in the HRC and virtually the full length of the transit corridor. The area of high sperm whale density in the upper left hand corner of the HRC map is predicted by the St. Andrews RES model (SMRU Ltd. *in prep*).

SOCAL. The large number of sperm whale sightings off the west coast during NMFS surveys (Hamilton et al. 2009) have provided enough data for NMFS to develop a CCE model for sperm whales (Becker et al. 2012c); this model is applicable to summer and fall seasons. Uniform density values from Ferguson and Barlow (2003) are used for the inner and outer Baja Extension strata for summer and fall. The entirety of the SOCAL study area (including Baja) is assigned a uniform density from Forney et al. (1995) for the winter and spring. There was a sliver of area between the southeastern edge of the CENPAC model and outer Baja Extension that was not covered by the models. For this area, the values from the St. Andrews RES model (SMRU Ltd. *in prep*) agreed with the winter/spring uniform density but contrasts sharply with the CCE model for summer/fall. In the Southern California Bight, data for sperm whales are arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

MITT. Whaling records demonstrate sightings of sperm whales year-round in the MITT Study Area (Townsend 1935). The sperm whale was the most-frequently sighted cetacean (21 sightings) during the Navy's 2007 survey with acoustic detections three times higher than visual detections (Fulling et al. 2011). Line-transect abundance estimates derived from these survey data yielded a density estimate of

0.00123 animals/km^2 (CV = 0.60) in the MITT Study Area (Fulling et al. 2011). Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual sperm whale density.

NWTT Offshore. Sperm whales have been detected acoustically year-round at offshore sites monitored from 2004 to 2008 off the Washington coast, with peak occurrence from April to August (Oleson et al. 2009). As mentioned above for SOCAL, NMFS developed a habitat-based density model for sperm whales based on sighting data collected during the summer and fall from 1991 to 2008 (Becker et al. 2012c); this model was applied to the Northern California and Oregon/Washington strata for summer/fall. Barlow and Forney (2007) also provide summer/fall stratified density estimates for sperm whales for California, Oregon, and Washington. Density data are not available for the area north of the SWFSC strata (refer to Figure 3-6), so data from the SWFSC Oregon/Washington stratum were used as representative summer/fall estimates. SWFSC also provides uniform density estimates for sperm whale for the Northern California offshore stratum for winter/spring (Forney et al. 1995; Barlow et al. 2009). Winter/spring density data are not available for strata to the north; however, Navy-funded acoustic monitoring studies have detected sperm whales in Washington offshore waters year-round (Širović et al. 2011, 2012a, b). Given these data, which confirm the presence of sperm whales in these offshore waters in winter/spring, the SWFSC Northern California stratum estimate was assigned to the offshore waters north of California for winter/spring.

NWTT Inland Waters. Sperm whales are not expected to occur within the Inland Waters region of the NWTT Study Area and would be considered extralimital in this area.

NWTT Western Behm Canal, Alaska. Sperm whales are not expected to occur within Western Behm Canal and would be considered extralimital in this area.

GOA. Acoustic surveys have detected the presence of sperm whales year-round in the Gulf of Alaska, although about twice as many are detected in summer as in winter (Mellinger et al. 2004, Moore et al. 2006). During a recent (June and July 2013) Navy-funded line-transect survey in and around the TMAA, sighting data were collected from four survey strata designed to sample the diverse habitat present in the GOA Study Area. During the survey there were 19 on-effort sightings of sperm whales and 241 acoustic detections from the towed hydrophone array, 174 of which were localized. Based on the localized acoustic detections, the following density estimates were derived for sperm whales: 0.0013 (CV = 0.36) offshore stratum, 0.00036 (CV = 0.55) seamount stratum, and 0.0033 (CV = 0.18) slope stratum (Rone et al. 2014). Rone et al. (2014) also provided density estimates derived from the visual sighting data; however, these were less precise than those derived from the acoustic detections and did not include estimates for the offshore stratum, so they were not used for impact assessment. There were no sperm whale sightings or acoustic detections within the inshore stratum, and 18 of the 19 sperm whale sightings occurred within the slope stratum (Rone et al. 2014).

Table 6-5: Sources of Density Values Used for Sperm Whale

Location	Spring	Summer	Fall	Winter
HRC	CENPAC	CENPAC	CENPAC	CENPAC
W. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
E. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
SOCAL	L	CCE	CCE	L
MITT	L	L	L	L
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	LD and L	CCE, LD, and L	CCE, LD, and L	LD and L
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	L	L	L	L

0 = species is not expected to be present; K = Kaschner RES Model global model; G = covered buy values for a guild of species from the literature instead of as a single species; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 6-6: Summary of Density Values for Sperm Whale in the Pacific Study Areas

Location	Spring	Summer	Fall	Winter
HRC	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	S	S	S	S
SOCAL	0.00338	S	S	0.00338
Inner Baja Extension	0.00338	0.0003	0.0003	0.00338
Outer Baja Extension	0.00338	0.0011	0.0011	0.00338
MITT	0.00123	0.00123	0.00123	0.00123
MITT Transit Corridor	0.00222	0.00222	0.00222	0.00222
NWTT Offshore	0.00338	S and 0.00139	S and 0.00139	0.00338
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0–0.0036	0–0.0036	0–0.0036	0–0.0036

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

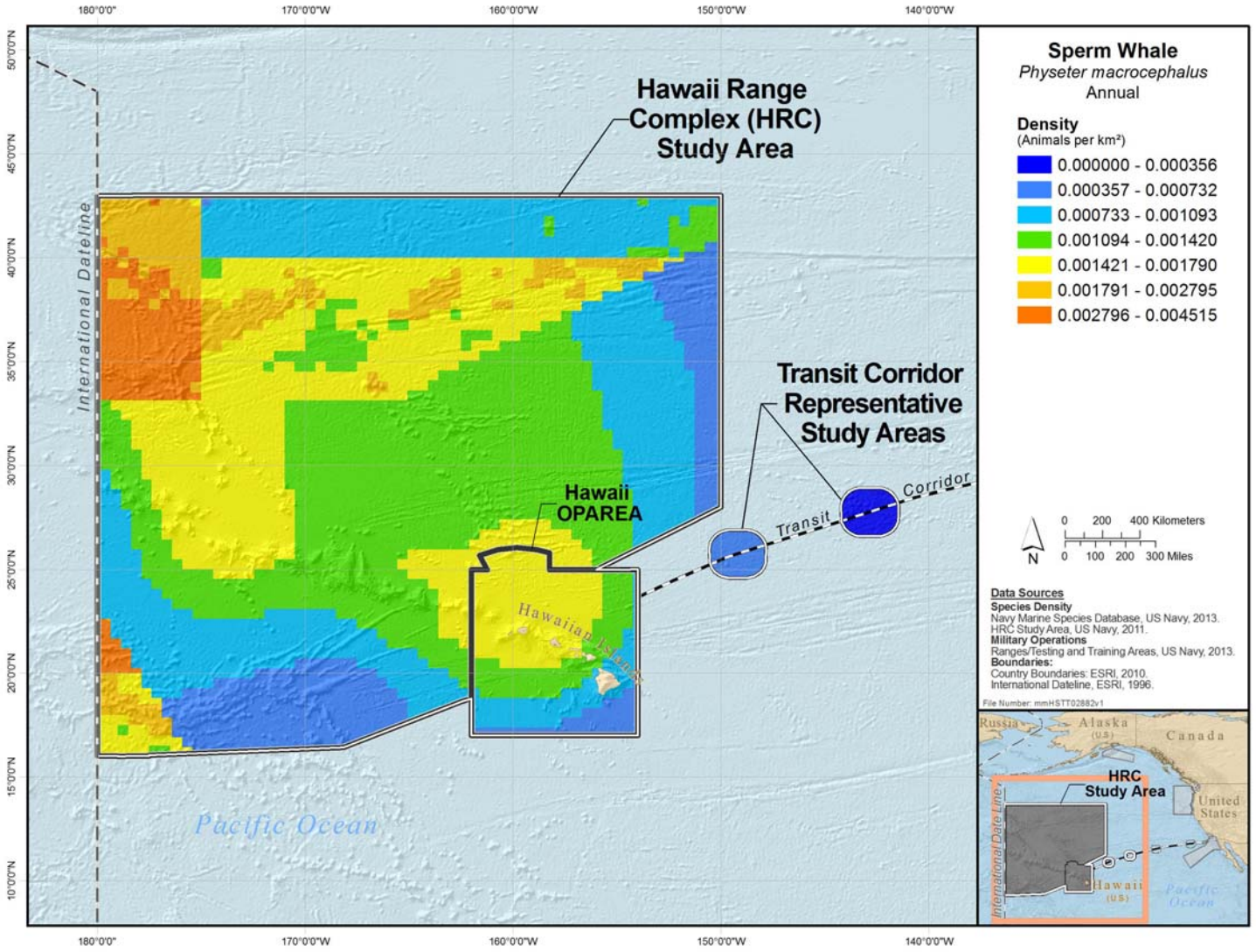

Figure 6-7: Annual Distribution of Sperm Whale in HRC and the Western Portion of the Transit Corridor

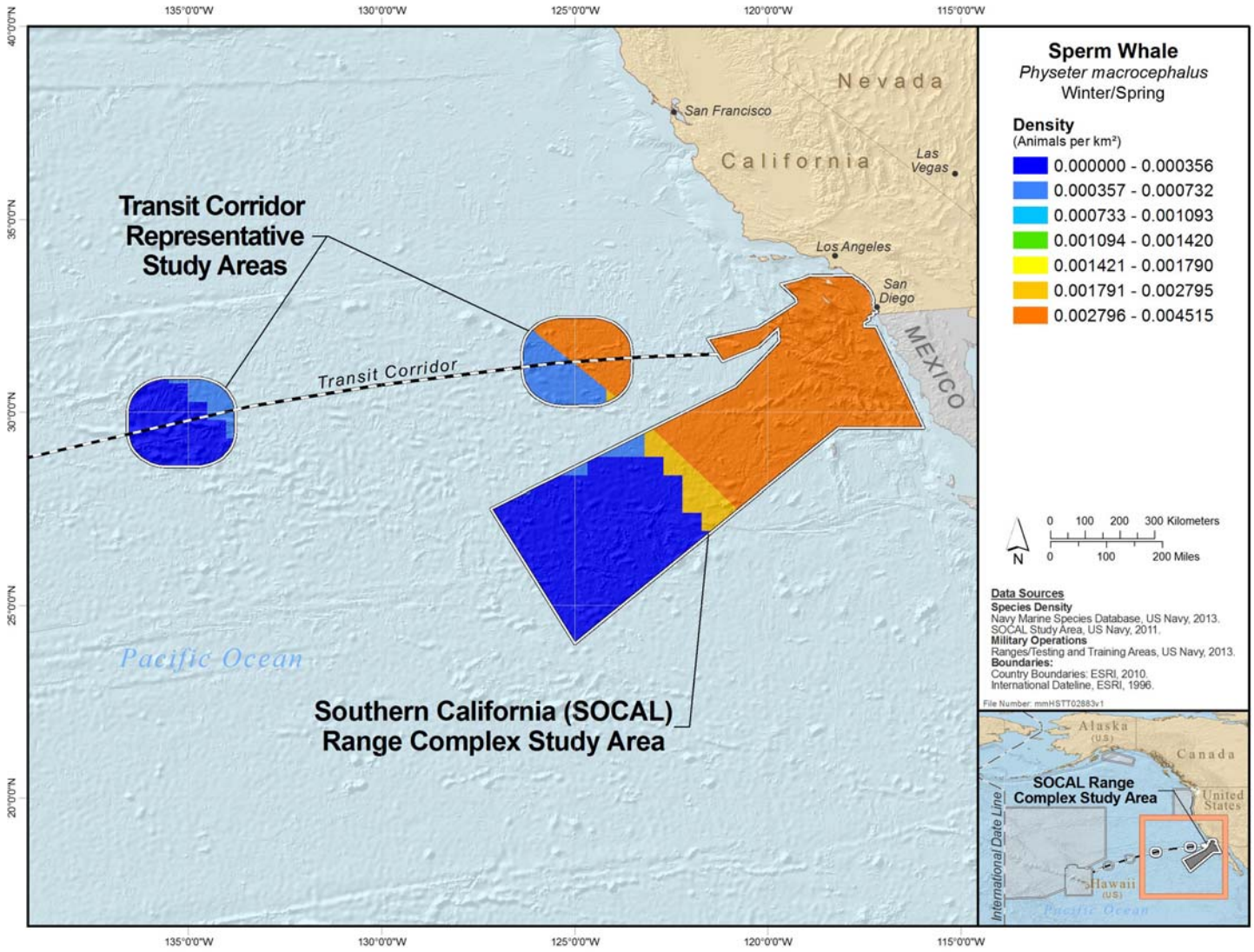

Figure 6-8: Winter/Spring Distribution of Sperm Whale in SOCAL and the Eastern Portion of the Transit Corridor

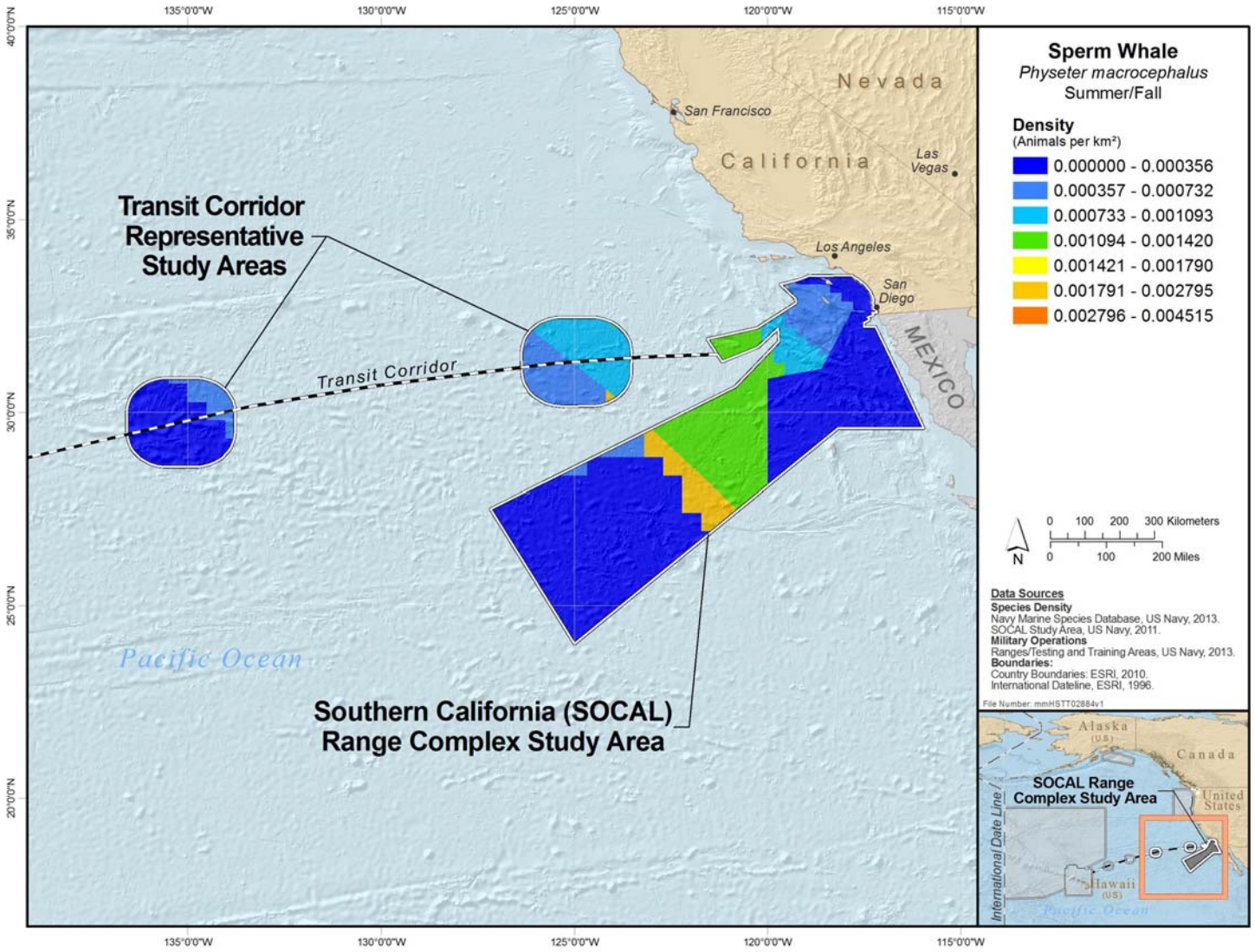

Figure 6-9: Summer/Fall Distribution of Sperm Whale in SOCAL and the Eastern Portion of the Transit Corridor

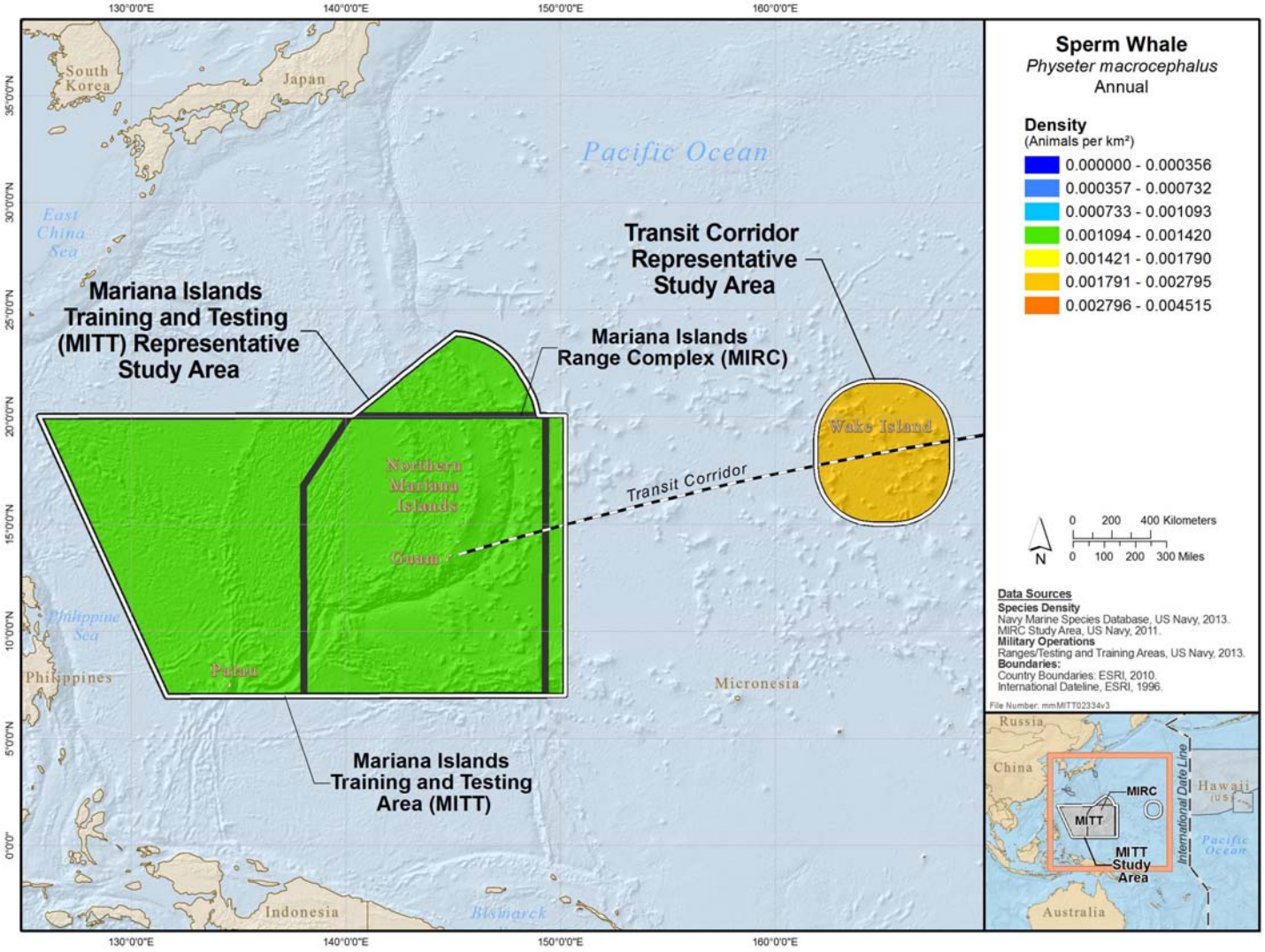

Figure 6-10: Annual Distribution of Sperm Whale in MITT and the Associated Transit Corridor Study Areas

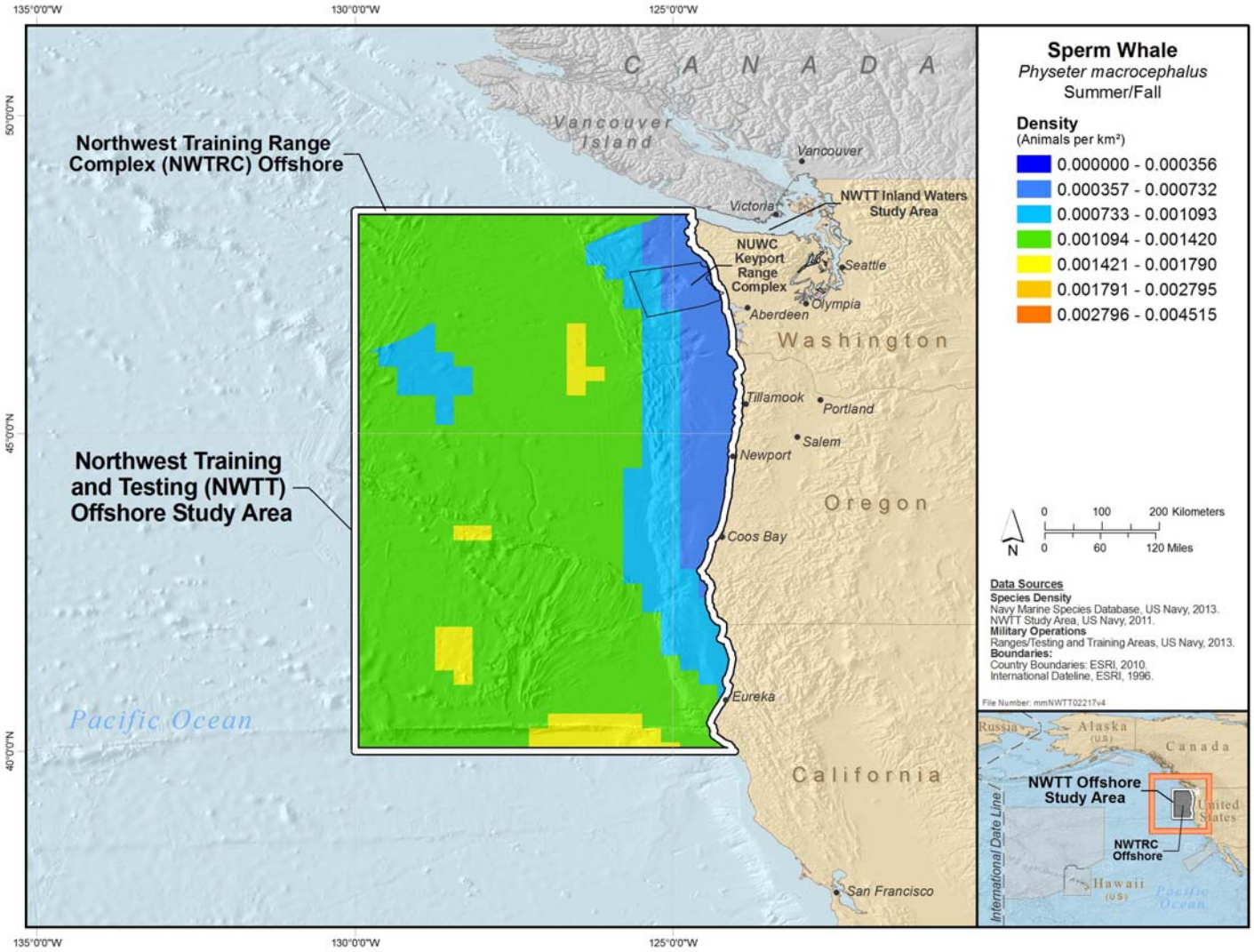

Figure 6-11: Summer/Fall Distribution of Sperm Whale in the Offshore Portion of the NWTT Study Area

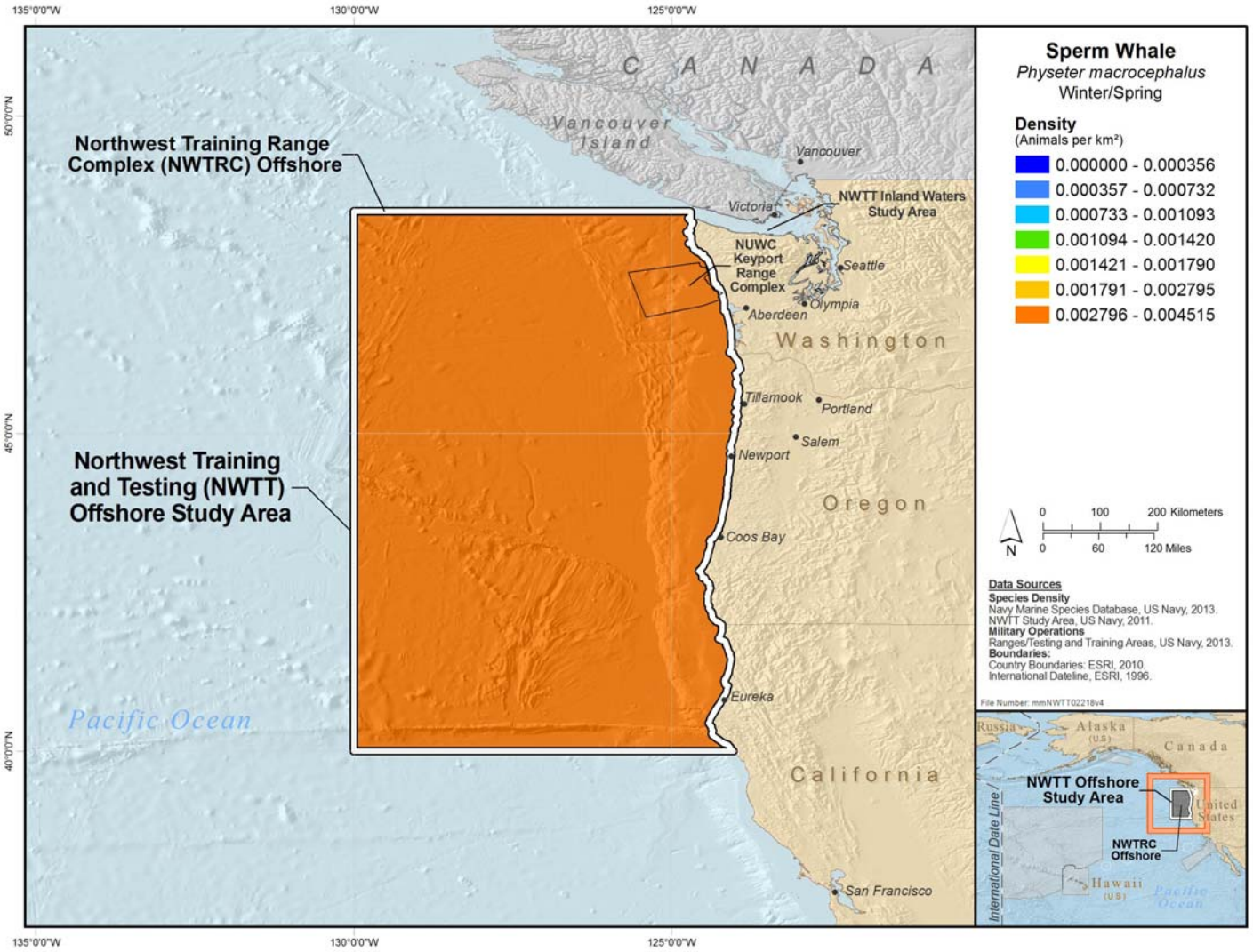

Figure 6-12: Winter/Spring Distribution of Sperm Whale in the Offshore Portion of the NWTT Study Area

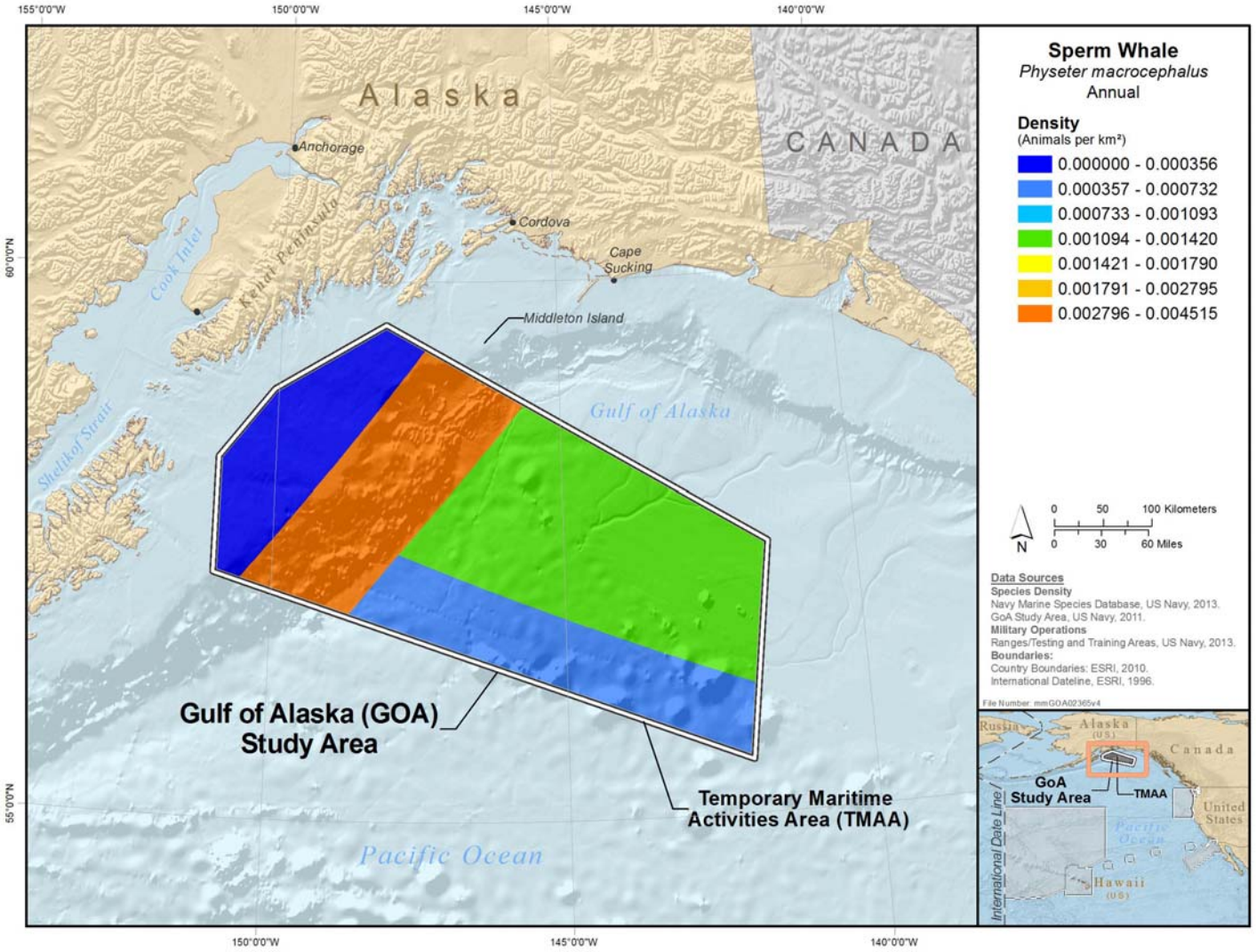

Figure 6-13: Annual Distribution of Sperm Whale in the GOA Study Area

7 DELPHINIDS (DOLPHINS)

7.1 DELPHINID SPECIES PROFILES

This family includes a wide variety of species found in the Pacific Fleet Study Areas including various dolphins, killer whales, pilot whales, false killer whales, pygmy killer whales, and melon-headed whales.

7.1.1 *DELPHINUS CAPENSIS*, LONG-BEAKED COMMON DOLPHIN

The long-beaked common dolphin (*Delphinus capensis*) is seen in the SOCAL parts of the HSTT Study Area, but typically occurs in fewer numbers than the abundant and closely-related short-beaked common dolphin (Jefferson et al. 2012). At a great distance, it can be confused with several of the other dolphin species, especially the short-beaked common dolphin (Allen et al. 2011). Both species of common dolphins have a distinctive hourglass pattern on the side of the body that is formed by two overlapping patches of light color (Allen et al. 2011; Jefferson et al. 2008); the anterior section of light color is most pronounced. The “V” in the hourglass falls just below the dorsal fin on the flank. This coloration will allow common dolphins to be separated from other dolphin species at moderate distances (Allen et al. 2011). When viewed up close, the long-beaked common dolphin is best distinguished by its shallow forehead, distinctive color pattern, and long rostrum, which is its namesake. Common dolphins were only separated into separate species in 1994 (Heyning and Perrin 1994; Rosel et al. 1994). Originally, the long-beaked individuals were recognized as a neritic form; in the Pacific this form occurred along the coast within the 100 fathom isobath in the Gulf of California and Baja (Leatherwood et al. 1988). NMFS recognizes a single stock (a California stock) of long-beaked common dolphins (Carretta et al. 2011a). All of the long-beaked common dolphins in SOCAL are presumed to be from this stock. For the purposes of managing eastern tropical Pacific tuna fisheries long-beaked ("Baja neritic") common dolphins are managed as part of the 'northern common dolphin' stock (Carretta et al. 2011a).

HRC. This species does not occur in the HRC or the western portion of the transit corridor (Hamilton et al. 2009).

SOCAL. Barlow and Forney (2007) divided the west coast of the United States into four geographic regions (Southern California, Central California, Northern California, and Oregon/Washington) for the purpose of providing stratified uniform density estimates based on line-transect data. They provided densities for long-beaked common dolphins in each region. The species declines in density moving from south to north (Barlow and Forney 2007). Ferguson and Barlow (2003) gave values for long-beaked common dolphins in both the inner and outer Baja Extension. The Navy applies values from both sources to all four seasons in the database. Long-beaked common dolphins have not been observed in the eastern portion of the transit corridor (Hamilton et al. 2009). The SOCAL density figure shows locations outside of the uniform density areas that the Kaschner et al. (2006) global RES model predicts is suitable habitat for long-beaked common dolphin far from the coast of the Americas, but observations do not support the species occurrence in those areas. The white areas that surround the transit corridor reflect the expectation of no long-beaked common dolphins in the transit corridor.

MITT. This species is not expected to occur in the MITT or associated transit corridor study areas.

NWTT. Waters off the central Californian coast are considered the northern range limit of long-beaked common dolphin, whose population extends south into Mexico (Carretta et al. 2011b). Two individuals were observed during summer 2011 in the Puget Sound, and in March 2012, a juvenile female long-beaked common dolphin was found dead in Little Skookum Inlet in southern Puget Sound (Cascadia Research 2012a). Ford et al. (2005) also presented recent sighting records for British Columbia. All of these records are considered unusual since the occurrence of long-beaked common dolphin within the NWTT Study Area is considered extralimital, as all regions within the Study Area are outside the normal range of this species' distribution.

GOA. This species is not expected to occur in the GOA Study Area.

Table 7-1: Sources of Density Values Used for Long-Beaked Common Dolphin

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	L	L	L	L
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; G = covered buy values for a guild of species from the literature instead of as a single species; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-2: Summary of Density Values for Long-Beaked Common Dolphin in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0.05504	0.05504	0.05504	0.05504
Inner Baja Extension	0.1676	0.1676	0.1676	0.1676
Outer Baja Extension	0.0783	0.0783	0.0783	0.0783
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

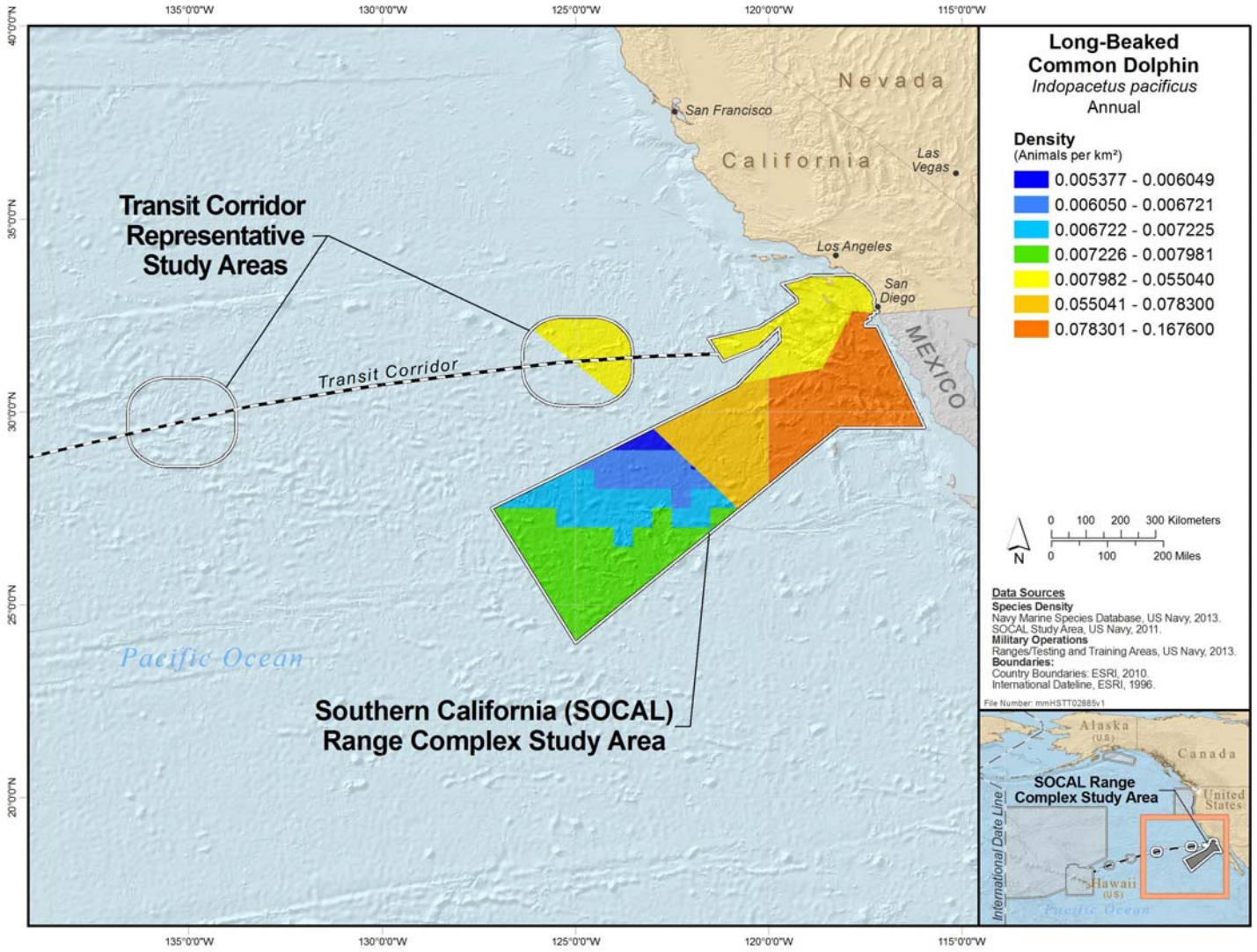

Figure 7-1: Annual Distribution of Long-Beaked Common Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

7.1.2 *DELPHINUS DELPHIS*, SHORT-BEAKED COMMON DOLPHIN

This species is encountered in a much broader portion of the Pacific than the closely related long-beaked common dolphin (Hamilton et al. 2009). Short-beaked common dolphins have the same sort of identification challenges in the field as described for the long-beaked common dolphins (see Section 7.1.1). When viewed up close, distinctive hourglass coloration on the flanks, the steep forehead, and a relatively short rostrum allow this species to be positively identified (Jefferson et al. 2008). Short-beaked common dolphins can occur in large groups, sometimes numbering more than 1,000 individuals (Forney and Barlow 1998; Leatherwood et al. 1988; Soldevilla et al. 2006). They are also known to occur in mixed-species groups with other toothed whales such as Pacific white-sided dolphins and pilot whales (*Globicephala* sp.), although the two species of common dolphin are not observed to co-occur in groups (Allen et al. 2011; Jefferson et al. 2008). NMFS recognizes a California/Oregon/Washington stock of short-beaked common dolphins in the U.S. EEZ (Carretta et al. 2011a). In SOCAL and the U.S. offshore waters of the NWTT Study Area, this stock is the one that is observed. In the transit corridor or near the HRC, they are not likely to be members of a stock managed by NMFS. Density values for the HSTT Study Area are presented for the species as a whole. Like the long-beaked common dolphins, this species is managed as part of the 'northern common dolphin' stock for the tropical Pacific tuna fishery in the eastern tropical Pacific (Carretta et al. 2011a). Historically, common dolphins, short-beaked in particular, have been one of the species most impacted by fisheries bycatch (Julian and Beeson 1998; Moore et al. 2009; Read et al. 1988).

HRC. Sufficient data were collected during NMFS's large ship visual surveys before 2010 to create a CENPAC habitat-based density model for short-beaked common dolphins. This model covers the HRC and the entire transit corridor from HRC to SOCAL. Short-beaked common dolphins have been observed in the open Pacific Ocean between Hawaii and the coast of the Americas, but no sightings of this species have occurred close to Hawaii (Hamilton et al. 2009). The CENPAC model reflects the fact that short-beaked common dolphins are not expected in high density in HRC. The yellow areas of density outside the blue area in the HRC density figure are areas of high density predicted by the Kaschner et al. (2006) global RES model and are outside the CENPAC model area.

SOCAL. Short-beaked common dolphins are the most-frequently observed species during Navy aerial surveys in SOCAL (Jefferson et al. 2012). NMFS has developed a CCE model for this species that applies to SOCAL for the summer and fall (Becker et al. 2012c). Uniform density values from Ferguson and Barlow (2003) are used for the inner and outer Baja Extension strata for summer and fall. Forney et al. (1995) divided California into four geographic regions (Southern California Bight, Outer Southern California Waters, Central California, Northern California) for the purpose of providing stratified uniform density estimates based on line-transect data. They provided uniform densities for winter and spring for short-beaked common dolphins in each region. The species declines in density moving from south to north. The Navy applies the densities for the Southern California Bight and the Outer Southern California Waters to the Baja extension in the winter and spring. There was a sliver of area between the southeastern edge of the CENPAC model and outer Baja Extension that was not covered by the models. For this area, the values from the SMRU, Ltd. RES model (SMRU Ltd. *in prep*) were sufficiently close to the CENPAC model and the uniform densities to use to fill in the area. Note that for the SOCAL

summer/fall map, the CCE model and CENPAC model project different densities where they meet at the edge of the U.S. Economic Exclusive Zone. Reconciling these models is an objective for NMFS and the Navy.

MITT. The range of short-beaked common dolphin may extend entirely across the tropical and temperate North Pacific (Heyning and Perrin 1994); however, this species prefers areas with large seasonal changes in surface temperature and thermocline depth (the point between warmer surface water and colder water) (Au and Perryman 1985). In tropical seas, they are typically sighted only in upwelling-modified waters such as those in the eastern tropical Pacific (Au and Perryman 1985; Ballance and Pitman 1998; Reilly 1990). The absence of known areas of major upwelling in the western tropical Pacific suggests that common dolphins will not be found there (Hammond et al. 2008). This species is thus not expected to occur in the MITT or associated transit corridor study areas.

NWTT Offshore. Short-beaked common dolphins are found off the U.S. west coast throughout the year, distributed between the coast and at least 345 mi. (556 km) from shore (Barlow 2010; Carretta et al. 2012). The short-beaked common dolphin is the most abundant cetacean species off California (Forney et al. 1995; Carretta et al. 2012); however, their abudance decreases dramatically north of about 40°N (Barlow et al. 2009; Forney et al. 2012; Becker et al. 2012b). However, short-beaked common dolphins are occasionally sighted in waters off Oregon and Washington, and one group of approximately 40 short-beaked common dolphins was sighted off northern Washington in 2005 at about 48°N (Forney 2007). As noted above for SOCAL, NMFS has developed a habitat-based density model for this species that applies to waters off the U.S. west coast for summer and fall (Becker et al. 2012c). Barlow and Forney (2007) also provide summer/fall stratified uniform density estimates for waters off California, Oregon, and Washington. In the absence of other data their estimate for the Oregon/Washington stratum was used to represent density in the area north of the SWFSC strata (refer to Figure 3-6). Forney et al. provided stratified uniform density estimates for short-beaked common dolphin off California, including the Northern California stratum, for winter/spring. Given the lack of sightings off Oregon and Washington during winter/spring (Green et al. 1992), in concert with seasonal predictions that show a southerly distribution shift of *Delphinus* spp. off California during the cooler period (Becker et al. in press), strata north of California were assigned a zero density estimate.

NWTT Inland Waters. This species is not expected to occur within the Inland Waters region of the NWTT Study Area.

NWTT Western Behm Canal, Alaska. This species is not expected to occur within the Western Behm Canal region of the NWTT Study Area.

GOA. This species is not expected to occur within the GOA Study Area.

Table 7-3: Sources of Density Values Used for Short-Beaked Common Dolphin

Location	Spring	Summer	Fall	Winter
HRC	CENPAC	CENPAC	CENPAC	CENPAC
W. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
E. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
SOCAL	L	CCE	CCE	L
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	L and LD	CCE and LD	CCE and LD	L and LD
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; G = covered buy values for a guild of species from the literature instead of as a single species; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-4: Summary of Density Values for Short-Beaked Common Dolphin in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	S	S	S	S
SOCAL	0.416–5.877	S	S	0.416–5.877
Inner Baja Extension	5.87691	1.309	1.309	5.87691
Outer Baja Extension	0.41609	0.3915	0.3915	0.41609
Southern California Bight	5.87691	S	S	5.87691
Outer Southern California Waters	0.41609	S	S	0.41609
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0–0.04577	S and 0.01414	S and 0.01414	0–0.04577
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

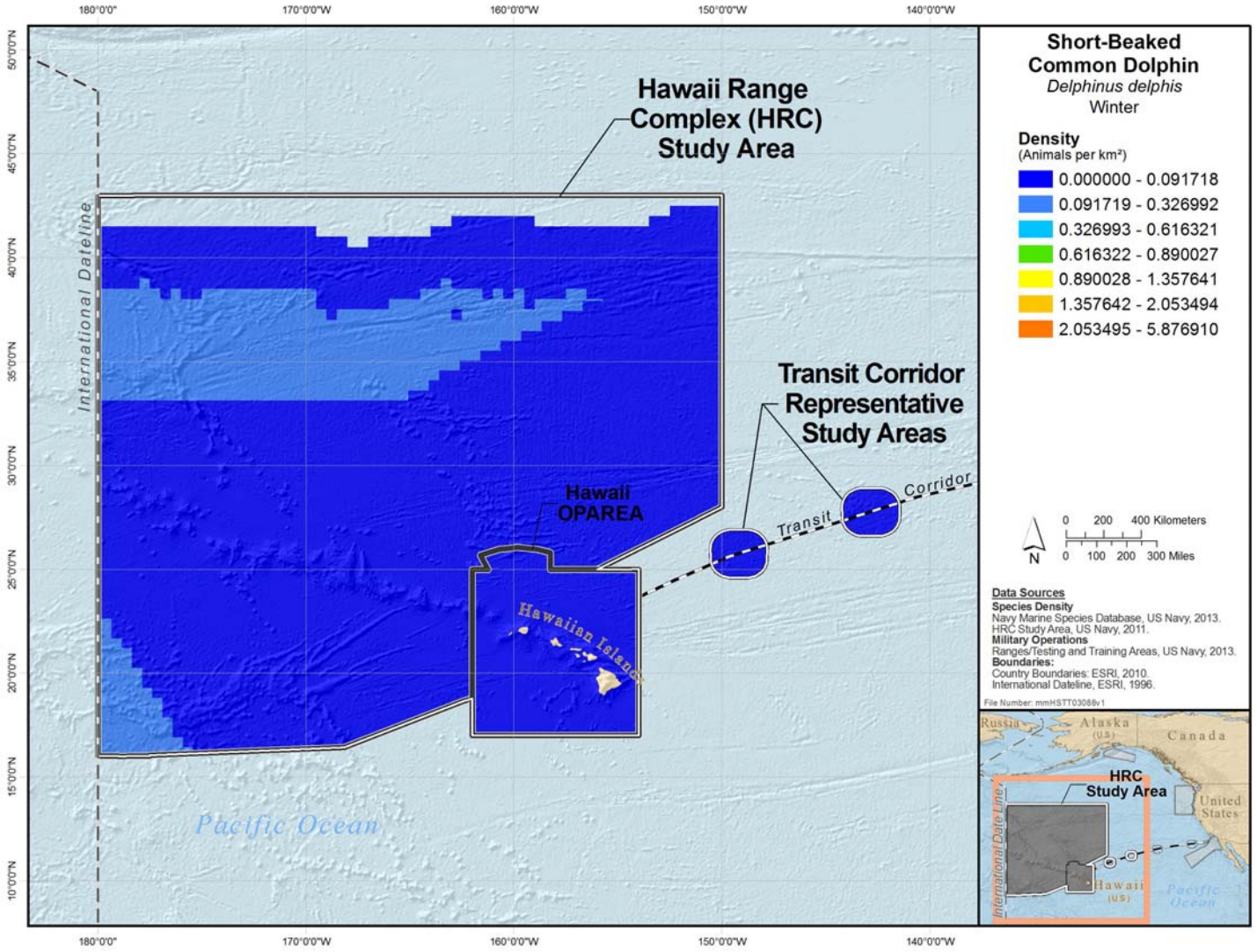

Figure 7-2: Winter Distribution of Short-Beaked Common Dolphin in HRC and the Western Portion of the Transit Corridor

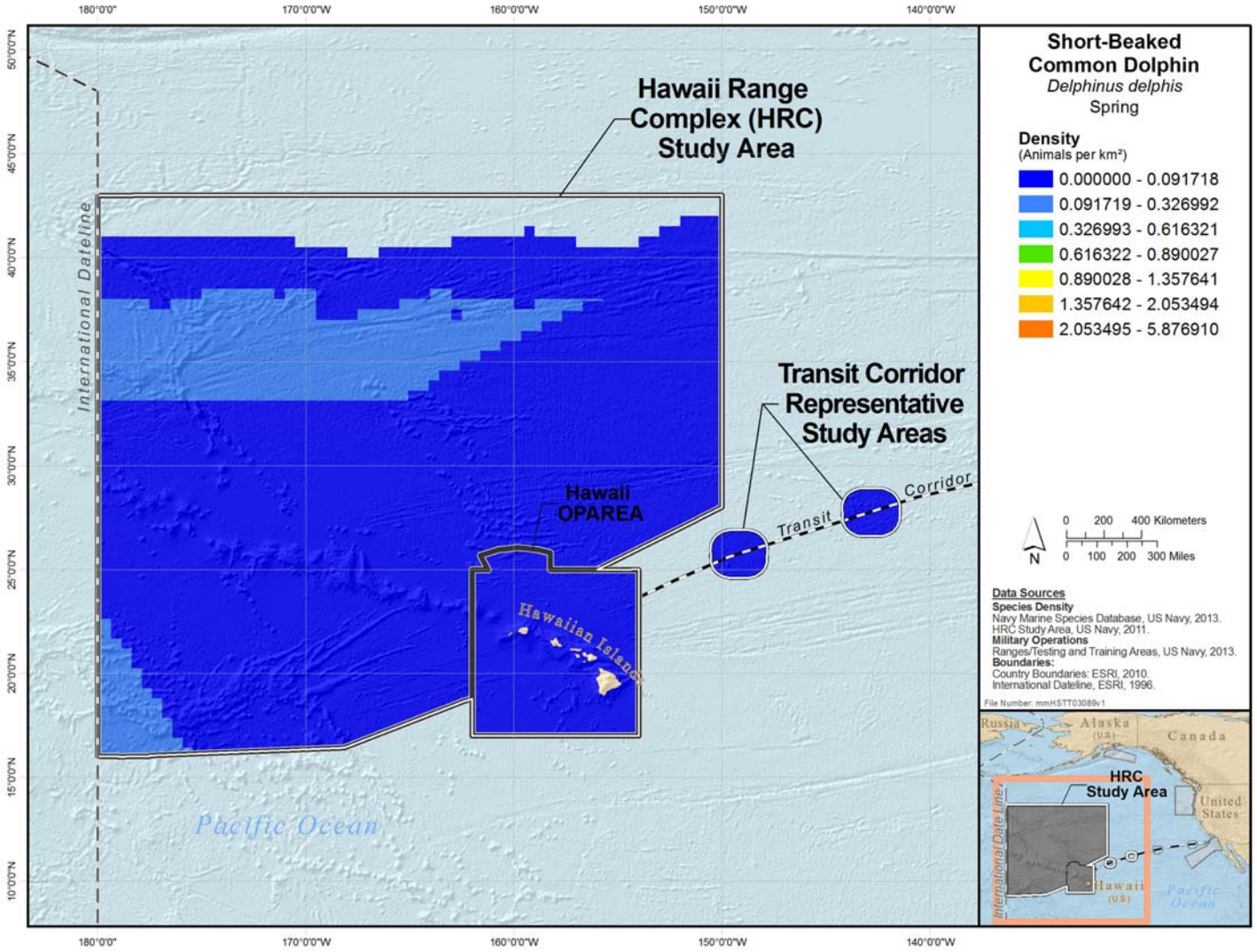

Figure 7-3: Spring Distribution of Short-Beaked Common Dolphin in HRC and the Western Portion of the Transit Corridor

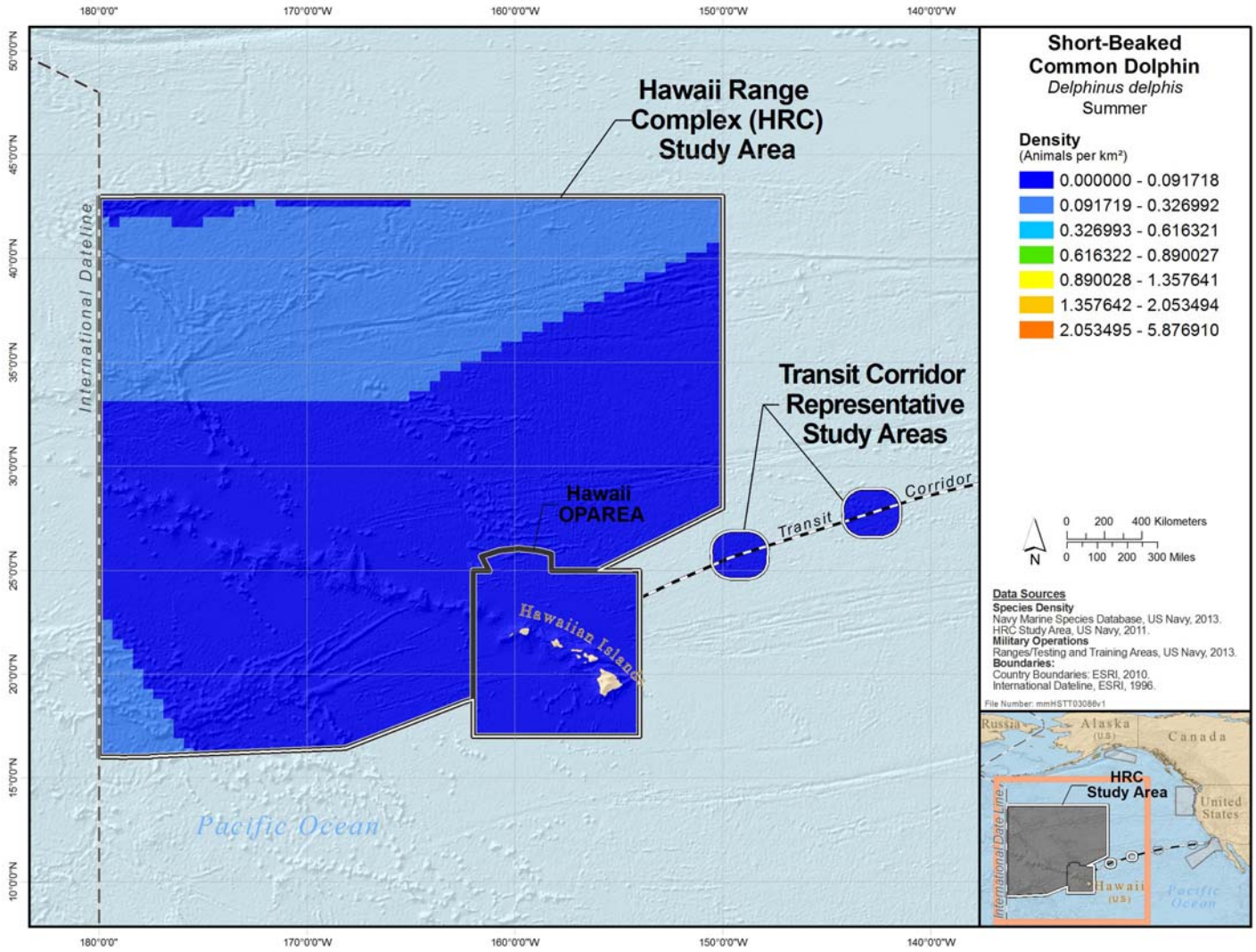

Figure 7-4: Summer Distribution of Short-Beaked Common Dolphin in HRC and the Western Portion of the Transit Corridor

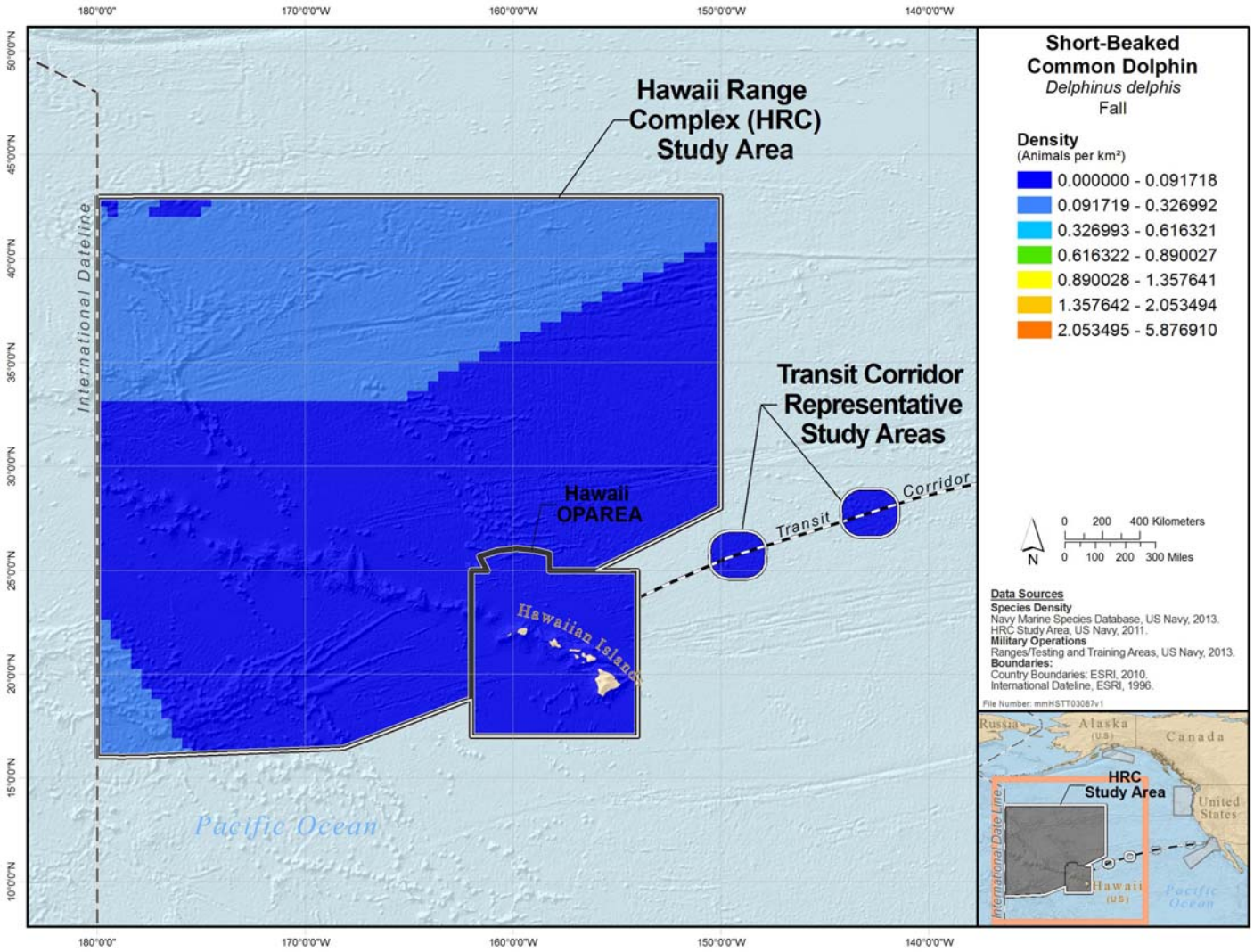

Figure 7-5: Fall Distribution of Short-Beaked Common Dolphin in HRC and the Western Portion of the Transit Corridor

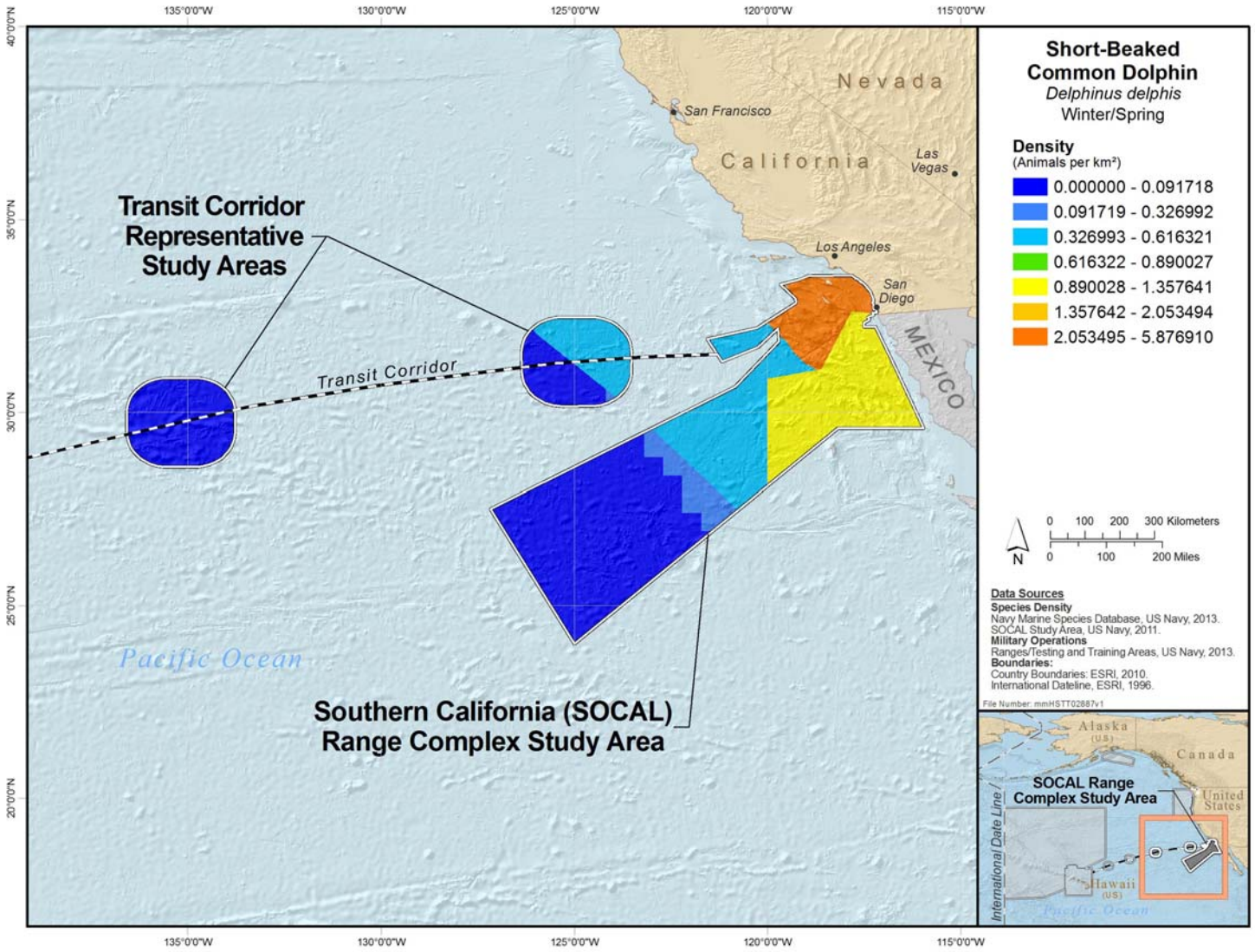

Figure 7-6: Winter/Spring Distribution of Short-Beaked Common Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

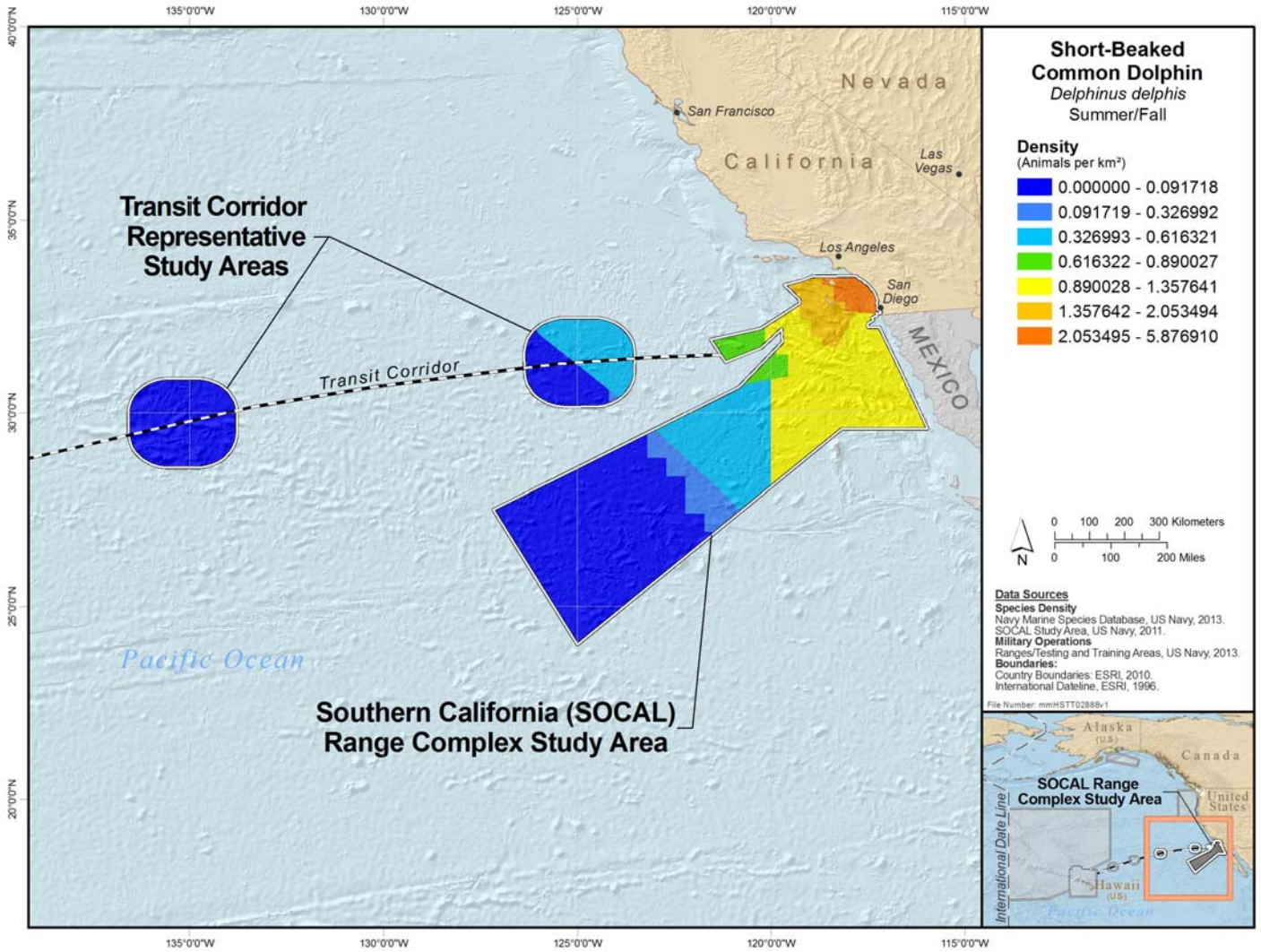

Figure 7-7: Summer/Fall Distribution of Short-Beaked Common Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

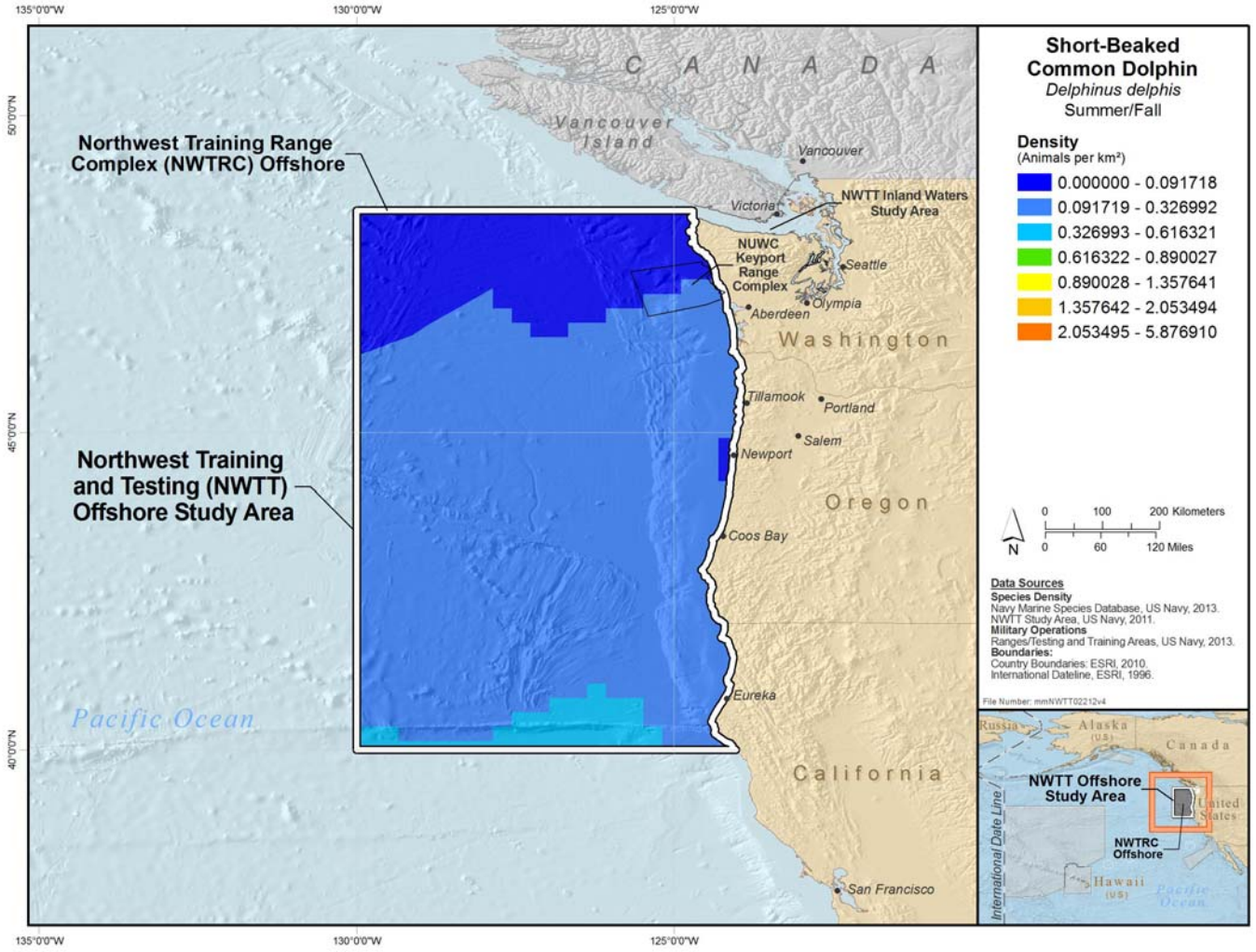

Figure 7-8: Summer/Fall Distribution of Short-Beaked Common Dolphin in the Offshore Portion of the NWTT Study Area

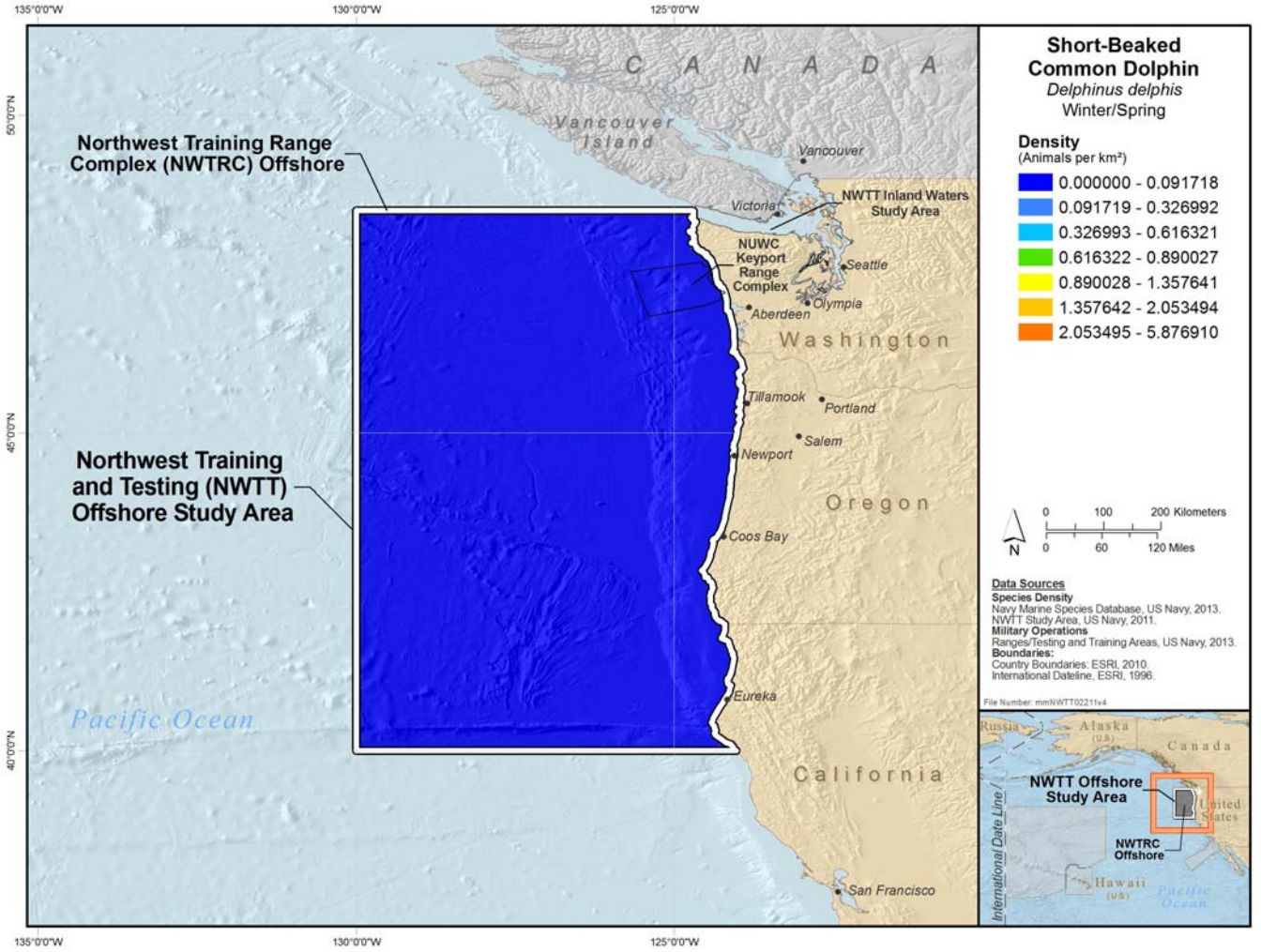

Figure 7-9: Winter/Spring Distribution of Short-Beaked Common Dolphin in the Offshore Portion of the NWTT Study Area

7.1.3 *FERESA ATTENUATA*, PYGMY KILLER WHALE

Pygmy killer whales are part of a group of species generally referred to by fishermen as "blackfish," which are small, dark, blunt-headed whales (Allen et al. 2011; Leatherwood et al. 1988). They are one of the smaller species recognized as blackfish, reaching only around 2.5 m when mature (Jefferson et al. 2008). The similarity among the blackfish species in the group can make identification at sea difficult. Pryor et al. (1965) described a pygmy killer whale as looking like a small false killer whale. This misidentification between the species is easy to make; one of the helpful distinguishing characteristics is the dark cape present on the pygmy killer whale (Baird 2010). When viewed from the side, the head of pygmy killer whales is rounded, similar to that of melon-headed whales or pilot whales. However, it is less triangular than that of melon-headed whales when viewed from above, and the lips are often white, making them distinguishable from pilot whales, if viewed relatively closely (Jefferson et al. 2008; Leatherwood et al. 1988). The pygmy killer whales has a rounded head, like other blackfish, but it has flippers with bluntly rounded tips and a prominent cape that does not dip low on the side, making it distinguishable (Jefferson et al. 2008; Leatherwood et al. 1988). When swimming in groups, pygmy killer whales may swim in long coordinated lines of simultaneously breathing animals. Pygmy killer whales are seen rarely, but some studies have been able to establish that they occur near shore around tropical islands, such as Hawaii (Baird et al. 2011b; McSweeney et al. 2009). Records also show that the species has been observed in pelagic zones of the eastern Tropical Pacific (Hamilton et al. 2009). NMFS recognizes a single Hawaiian stock of pygmy killer whales (Carretta et al. 2011a). Density values for the HSTT Study Area are presented for the species as a whole. Little is known about the stock structure of pygmy killer whales in the MITT Study Area.

HRC. Barlow (2006) provided a uniform density estimate for pygmy killer whales around Hawaii. Since the species is expected to have regular presence in Hawaii (McSweeney et al. 2009), Barlow's (2006) estimate is applied to all seasons for the HRC and western portion of the transit corridor.

SOCAL. This species has not been observed in SOCAL. The Kaschner et al. (2006) RES model data are used for densities in the eastern portion of the transit corridor (note that there were no density predictions for spring within the study area). Pygmy killer whale presence is expected to be low in this area (Hamilton et al. 2009).

MITT. There was only one pygmy killer whale sighting of a group of six animals during the Navy's 2007 survey of the MITT Study Area (Fulling et al. 2011). However, estimates of f(0) (a correction factor to account for the decreased probability of detecting an animal as its distance from the transect line increases) were made based on pooling the sightings of all blackfish (Fulling et al. 2011). Line-transect abundance estimates derived from these survey data yielded a density estimate of 0.00014 animals/km^2 (CV = 0.88) in the MITT Study Area (Fulling et al. 2011). Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These estimates were used to characterize annual pygmy killer whale density.

NWTT. This species is not expected to occur in any of the regions included in the NWTT Study Area.

GOA. This species is not expected to occur in the GOA Study Area.

Table 7-5: Sources of Density Values Used for Pygmy Killer Whale

Location	Spring	Summer	Fall	Winter
HRC	L	L	L	L
W. Transit Corridor	L	L	L	L
E. Transit Corridor	K	K	K	K
SOCAL	0	0	0	0
MITT	L	L	L	L
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-6: Summary of Density Values for Pygmy Killer Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0.00039	0.00039	0.00039	0.00039
W. Transit Corridor	0.00039	0.00039	0.00039	0.00039
E. Transit Corridor	S	S	S	S
SOCAL	0	0	0	0
Inner Baja Extension	0	0	0	0
Outer Baja Extension	0	0	0	0
MITT	0.00014	0.00014	0.00014	0.00014
MITT Transit Corridor	0.00006	0.00006	0.00006	0.00006
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

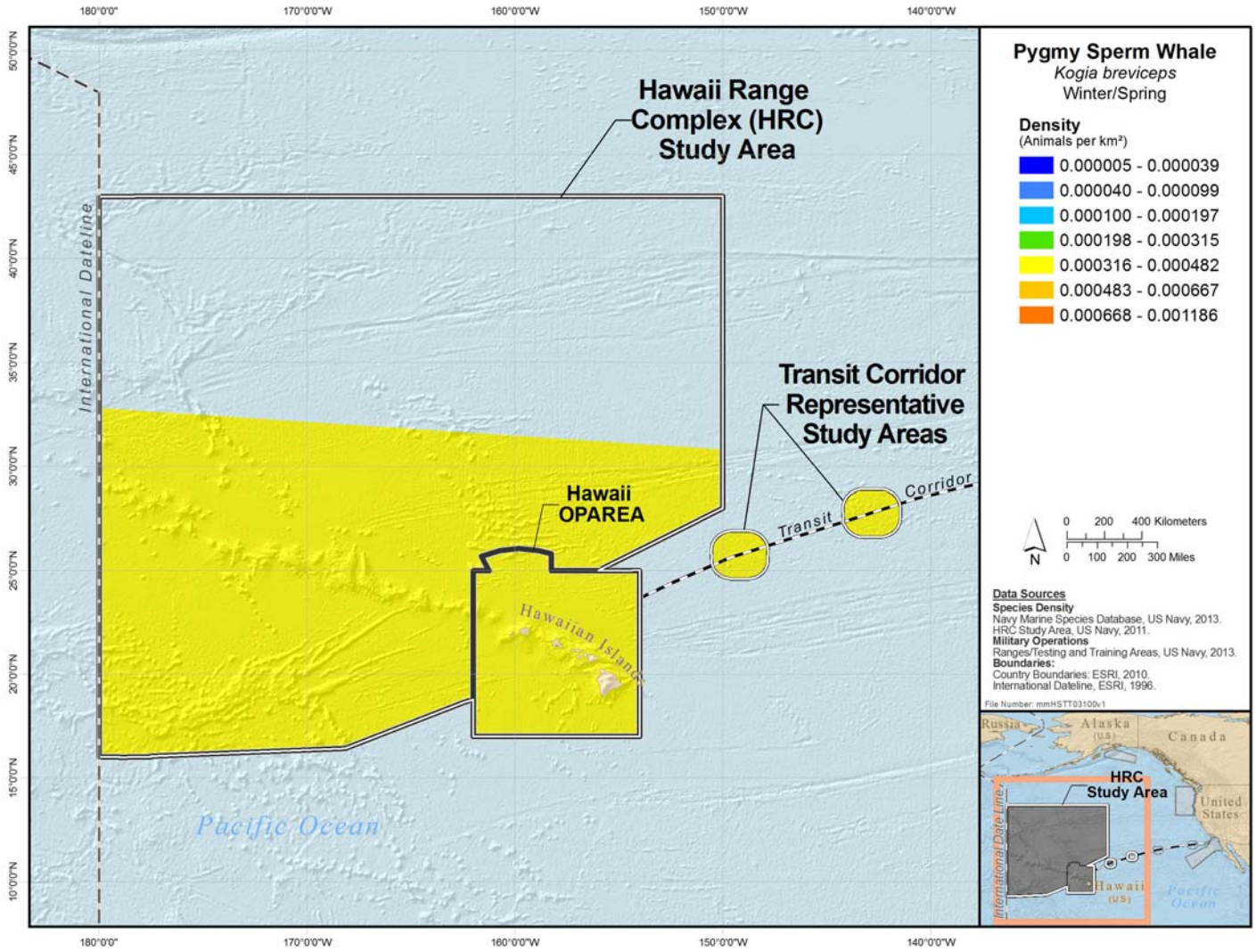

Figure 7-10: Winter/Spring Distribution of Pygmy Killer Whale in HRC and the Western Portion of the Transit Corridor

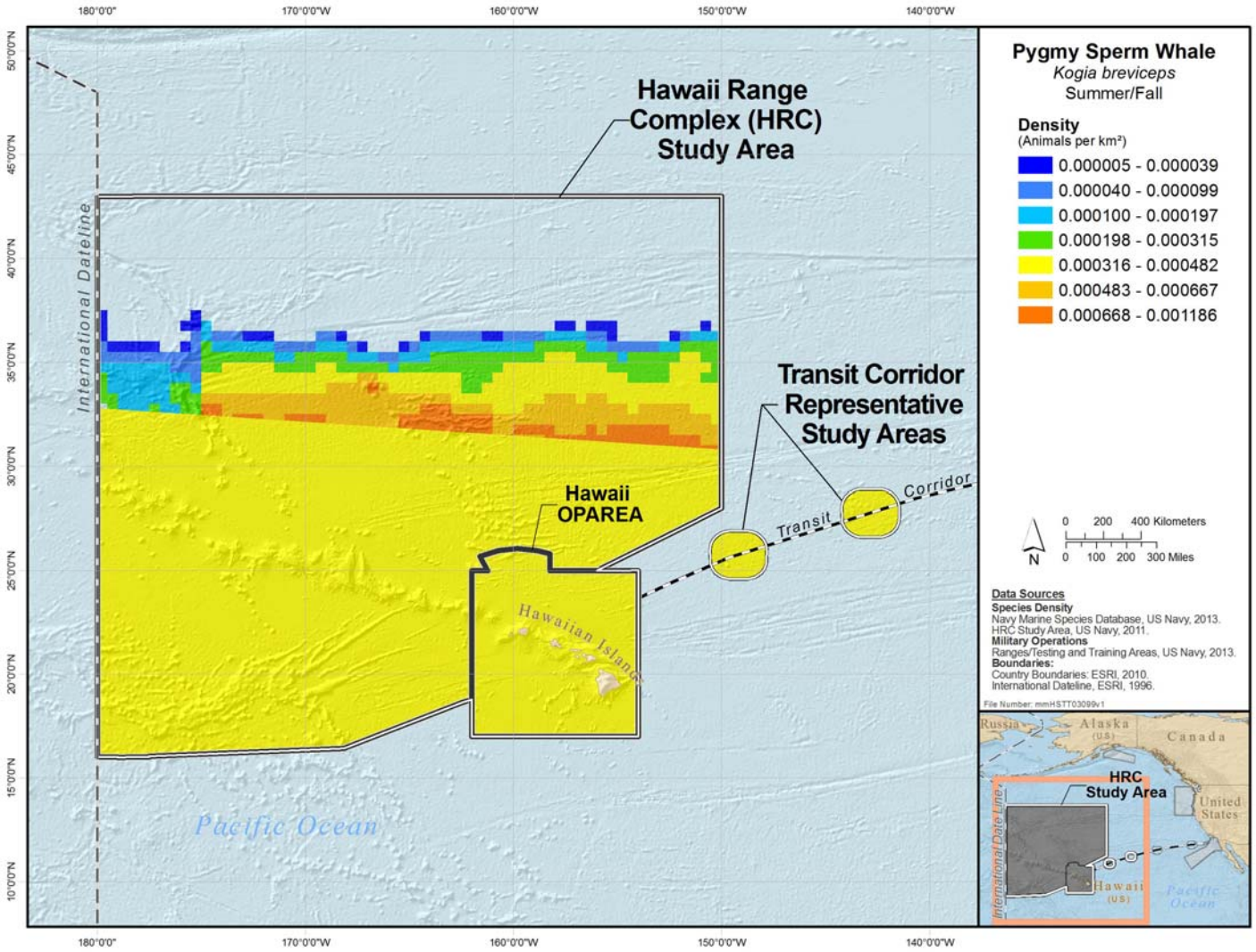

Figure 7-11: Summer/Fall Distribution of Pygmy Killer Whale in HRC and the Western Portion of the Transit Corridor

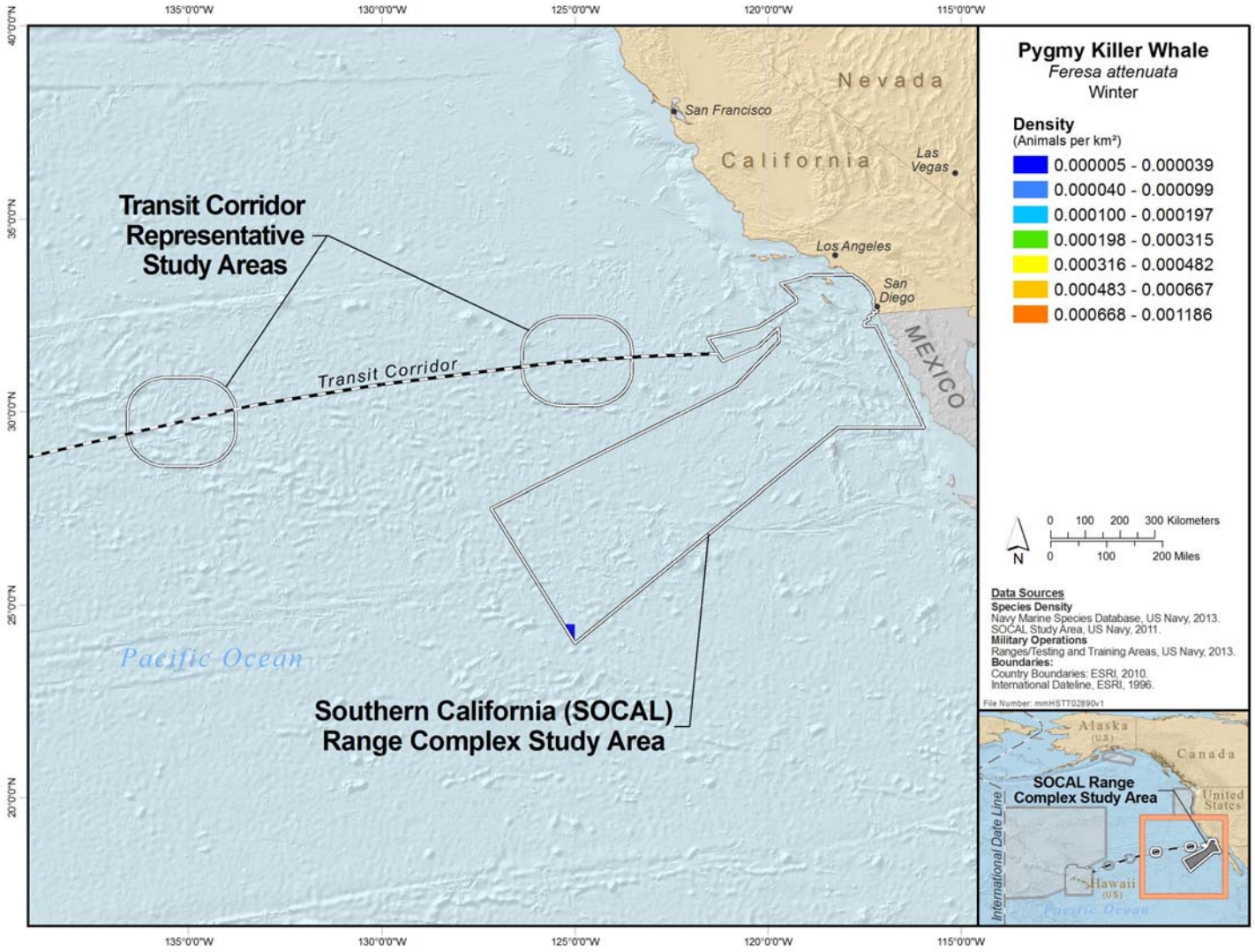

Figure 7-12: Winter Distribution of Pygmy Killer Whale in SOCAL and the Eastern Portion of the Transit Corridor

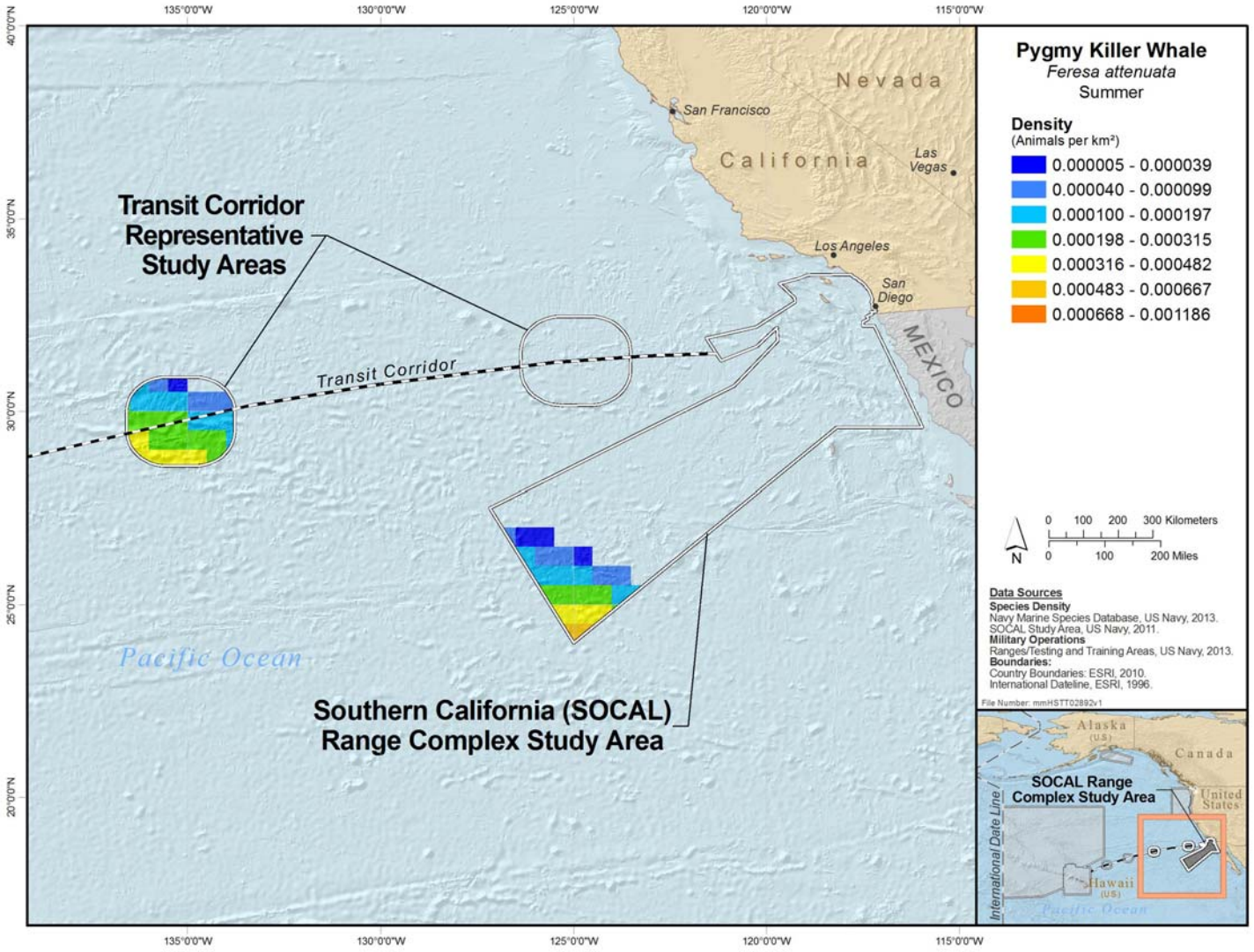

Figure 7-13: Summer Distribution of Pygmy Killer Whale in SOCAL and the Eastern Portion of the Transit Corridor

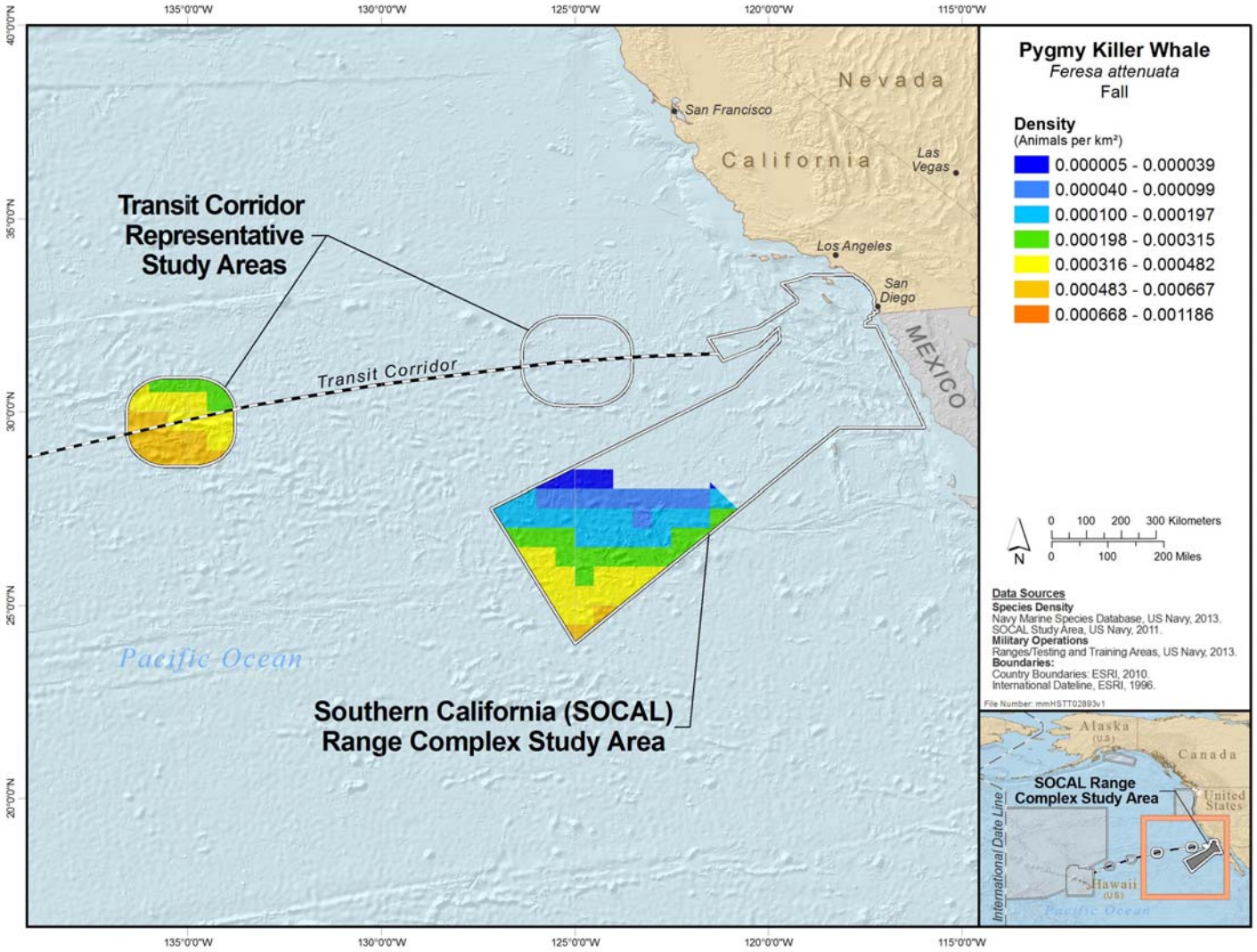

Figure 7-14: Fall Distribution of Pygmy Killer Whale in SOCAL and the Eastern Portion of the Transit Corridor

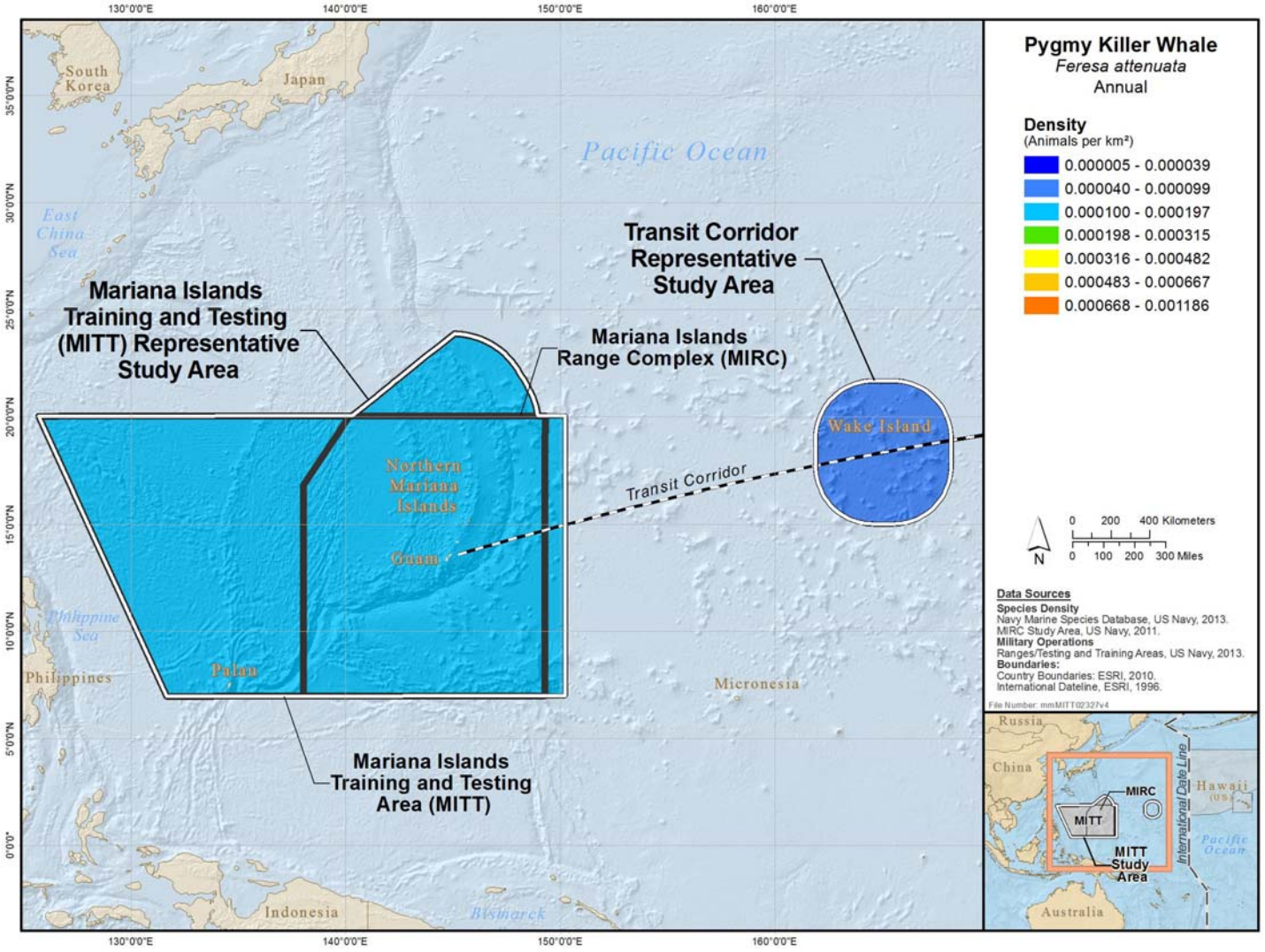

Figure 7-15: Annual Distribution of Pygmy Killer Whale in MITT and the Associated Transit Corridor Study Areas

7.1.4 *GLOBICEPHALA MACRORHYNCHUS*, SHORT-FINNED PILOT WHALE

Short-finned pilot whales are another species of small, dark, blunt-headed whales that are categorized into the grouping of "blackfish" (Allen et al. 2011; Leatherwood et al. 1988). Of the blackfish, this species is more easily identified than other species if certain features are observed. Their bulbous forehead lives up to the scientific name of genus; this feature is especially emphasized in adult males (Jefferson et al. 2008). They also have a dorsal fin that is located forward on the back, quite falcate, and very broad at the base (Allen et al. 2011; Jefferson et al. 2008). Younger individuals that do not have the well developed head and dorsal fin can be confused with false killer whales, melon-headed whales, or pygmy killer whales (Leatherwood et al. 1988). Pilot whales are sometimes seen associating with other species such as bottlenose dolphin, rough-toothed dolphin, pygmy killer whales, and even humpback and gray whales (Bernard and Reilly 1999; McSweeney et al. 2009). Short-finned pilot whales are one of the most frequently-encountered toothed whales near Hawaii (Barlow 2006; Mahaffy 2012). At one time they had a significant presence in SOCAL, too, but after the 1982–1983 El Niño event, very few pilot whales were observed off California and sightings of Risso's dolphins increased, possibly indicating a change in the marine mammal community in the area (Shane 1995). They are a species seen relatively frequently in the pelagic waters of the eastern Tropical Pacific (Hamilton et al. 2009). NMFS defines two stocks of short-finned pilot whales in the Pacific, a Hawaiian stock, and a California/Oregon/Washington stock (Carretta et al. 2011a). The close association of short-finned pilot whales with the Hawaiian Islands (Mahaffy 2012) means that individuals in HRC are from the Hawaii stock. Animals in SOCAL are expected to be from the California/Oregon/Washington stock, but it is not clear where one stock merges into another in the HSTT transit corridor. Density values for the HSTT Study Area are presented for the species as a whole. Animals that may occur in the Northern California portion of the NWTT Study Area belong to the California/Oregon/Washington stock.

In Japanese waters, two stocks (northern and southern) have been identified based on pigmentation patterns and head shape differences of adult males (Kasuya et al. 1988). The southern stock of short-finned pilot whales is probably the stock associated with the Mariana Islands area (Kasuya et al. 1988).

HRC. NMFS has a CENPAC habitat-based density model for long-finned pilot whales. This model covers the HRC and the entire transit corridor from HRC to SOCAL. The model is applied to all seasons. The range of density values for short-finned pilot whales on the HRC map is not as large as the total range of global density values; therefore, some of the colors for higher densities values are not present on the HRC map.

SOCAL. Barlow and Forney (2007) provide a uniform density of 0.00031 pilot whales/km^2 for the entirety of the California/Oregon/Washington coast for summer and fall. This value is also applied to the two portions of the Baja extension as well as the sliver of area between the CENPAC and California Current Ecosystem that is not covered by the CENPAC model or the NMFS survey area. These values were used to represent density year-round.

In the Southern California Bight, data for short-finned pilot whales is arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

MITT. During the Navy's 2007 survey of the Study Area, there were a total of 5 sightings of short-finned pilot whales with group size ranging from 5 to 43 individuals (Fulling et al. 2011). However, only four of the sightings were on-effort and consistent with recommendations from scientists at PIFSC, line-transect estimates derived for Hawaiian waters (Barlow 2006) were used to represent the best available estimates for the MITT Study Area. Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual density for short-finned pilot whale.

NWTT Offshore. Along the U.S. west coast, short-finned pilot whales are most abundant south of Point Conception, California (Reilly and Shane 1986; Carretta et al. 2012). Stranding records for this species from Oregon and Washington waters are considered to be beyond the normal range of this species rather than an extension of its range (Norman et al. 2004). Barlow and Forney (2007) provided summer/fall stratified uniform density estimates for waters off California, Oregon, and Washington. Consistent with what is known of their distribution and due to the associated lack of sightings, the Barlow and Forney (2007) estimate for the Oregon/Washington stratum was zero; this estimate was also used to represent density in the area north of this stratum (refer to Figure 3-6). These values were used to represent density year-round.

NWTT Inland Waters. This species is not expected to occur within the Inland Waters region of the NWTT Study Area.

NWTT Western Behm Canal, Alaska. This species is not expected to occur within the Western Behm Canal region of the NWTT Study Area.

GOA. Although pilot whales have been observed in Alaskan waters in the past, this appears to be extralimital, and this species is not expected to occur within the GOA Study Area.

Table 7-7: Sources of Density Values Used for Short-Finned Pilot Whale

Location	Spring	Summer	Fall	Winter
HRC	CENPAC	CENPAC	CENPAC	CENPAC
W. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
E. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
SOCAL	L	L	L	L
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	LD	L and LD	L and LD	LD
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-8: Summary of Density Values for Short-Finned Pilot Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	S	S	S	S
SOCAL	0.00031	0.00031	0.00031	0.00031
Inner Baja Extension	0.00031	0.00031	0.00031	0.00031
Outer Baja Extension	0.00031	0.00031	0.00031	0.00031
MITT	0.00362	0.00362	0.00362	0.00362
MITT Transit Corridor	0.00211	0.00211	0.00211	0.00211
NWTT Offshore	0–0.000713	0–0.000713	0–0.000713	0–0.000713
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

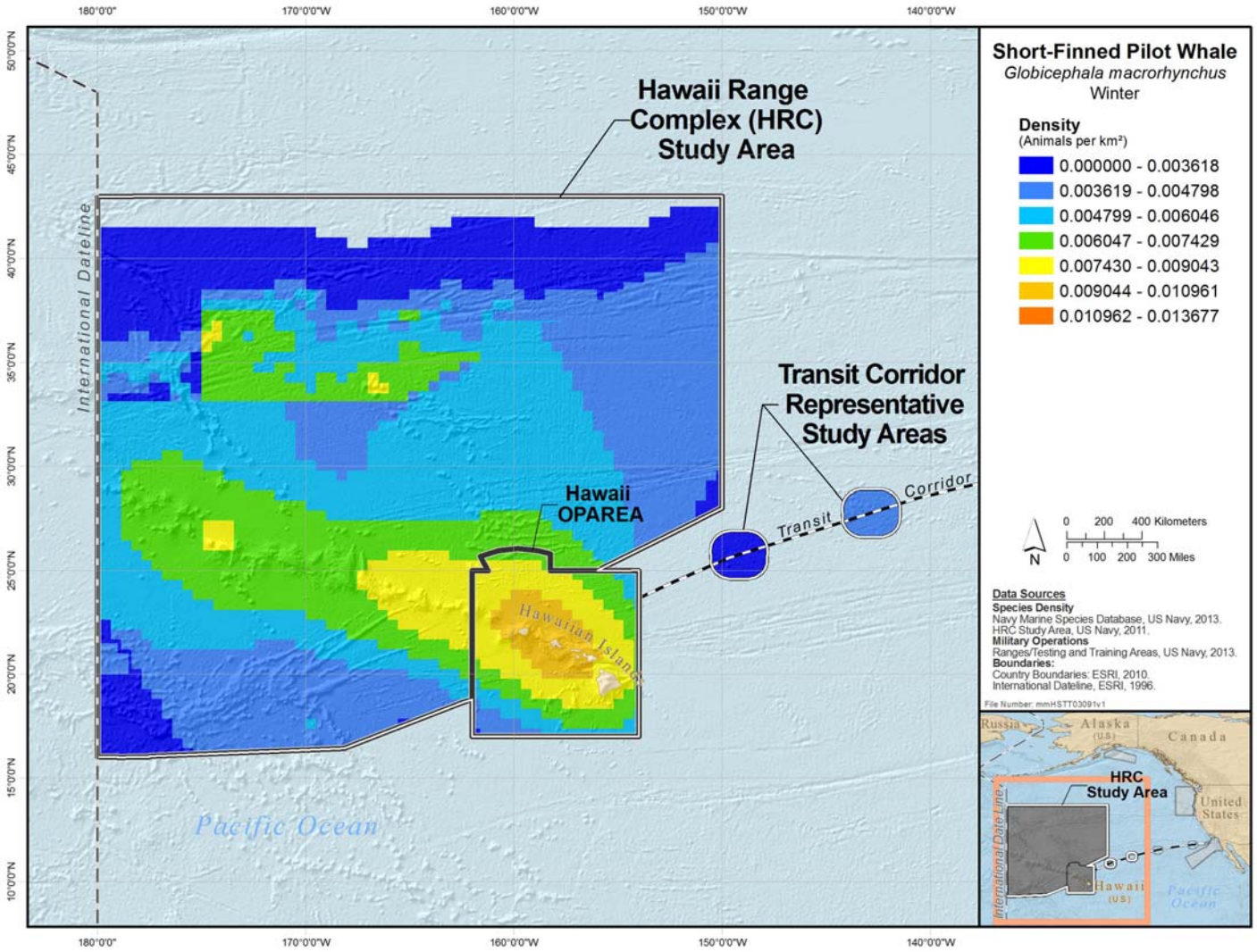

Figure 7-16: Winter Distribution of Short-Finned Pilot Whale in HRC and the Western Portion of the Transit Corridor

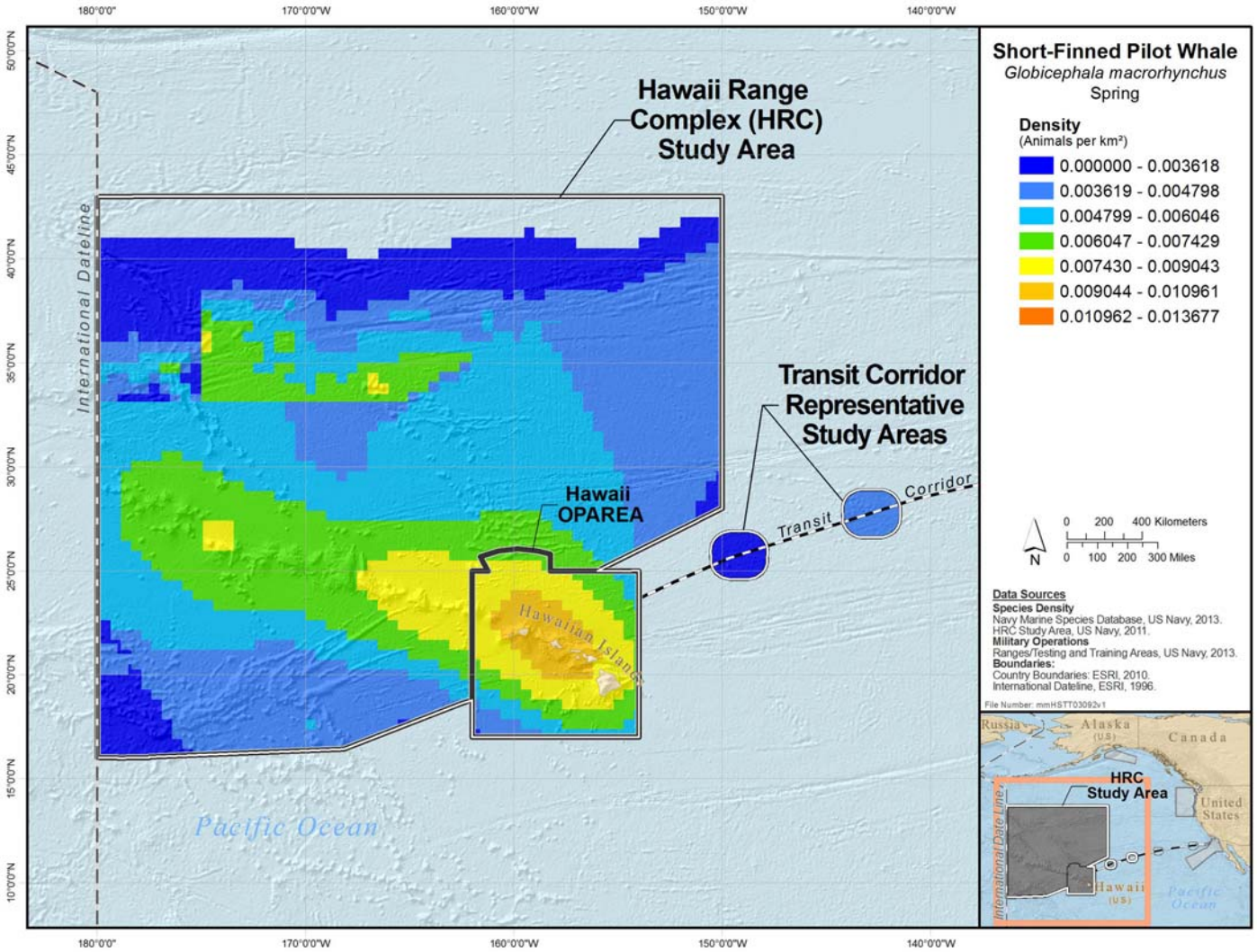

Figure 7-17: Spring Distribution of Short-Finned Pilot Whale in HRC and the Western Portion of the Transit Corridor

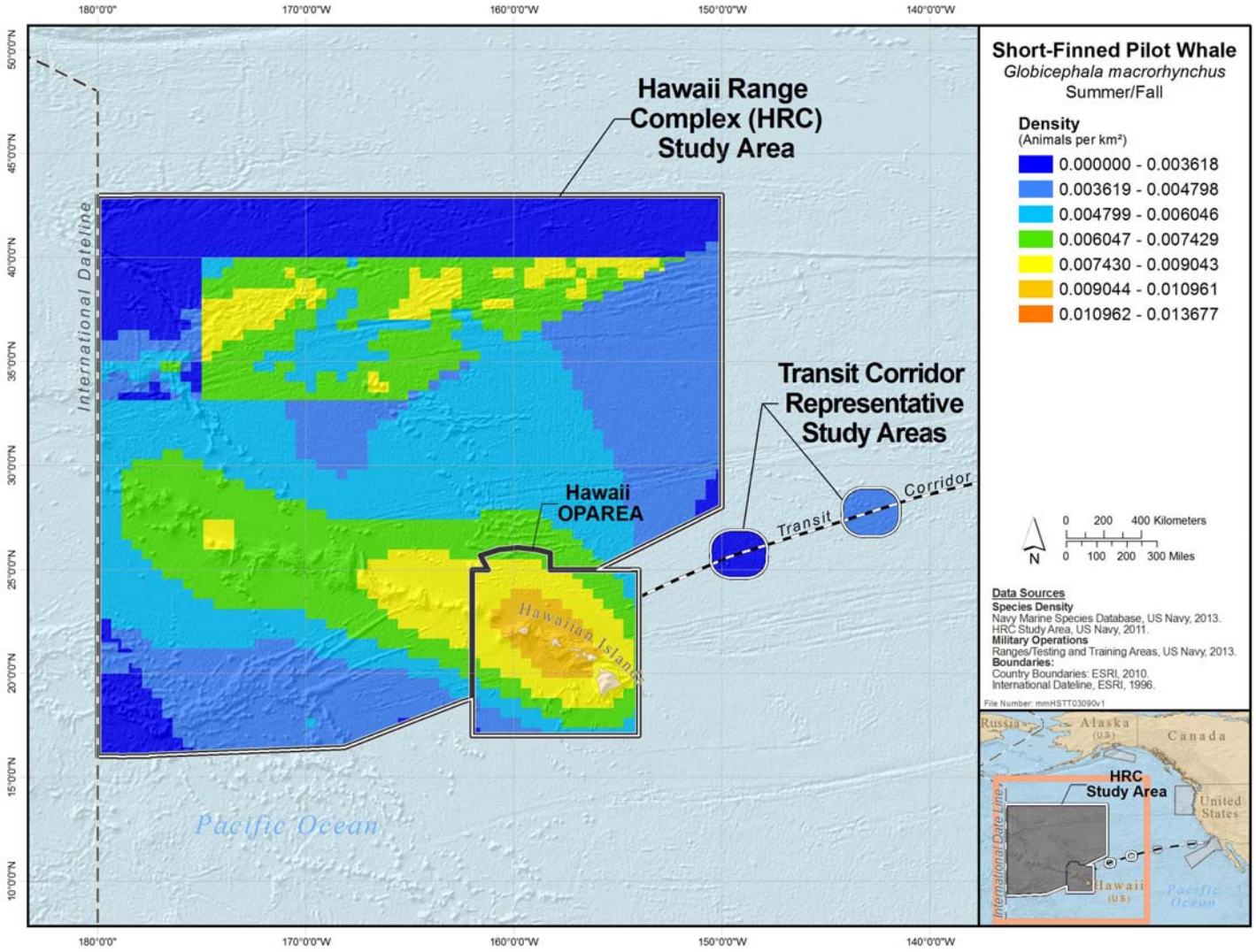

Figure 7-18: Summer/Fall Distribution of Short-Finned Pilot Whale in HRC and the Western Portion of the Transit Corridor

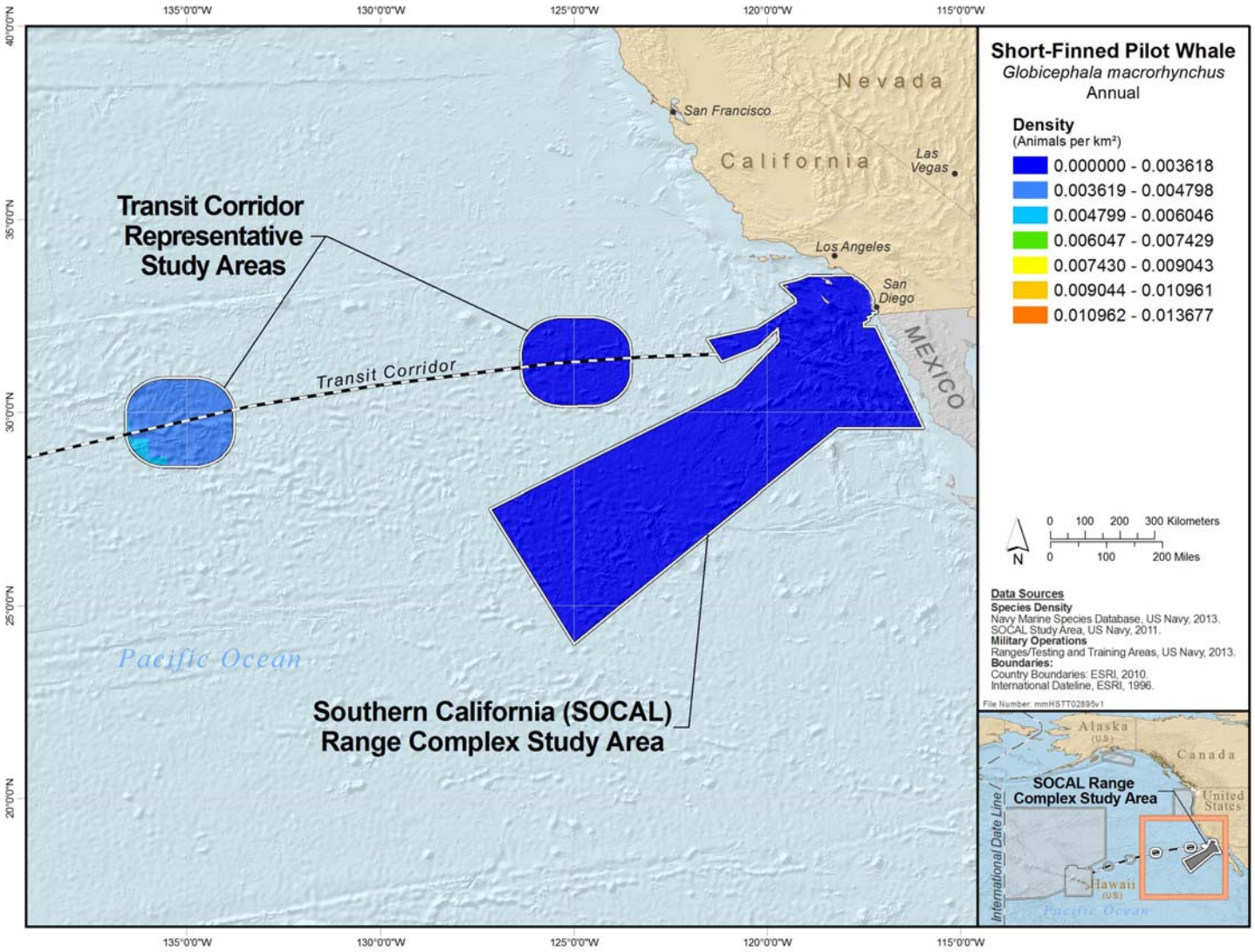

Figure 7-19: Annual Distribution of Short-Finned Pilot Whale in SOCAL and the Western Portion of the Transit Corridor

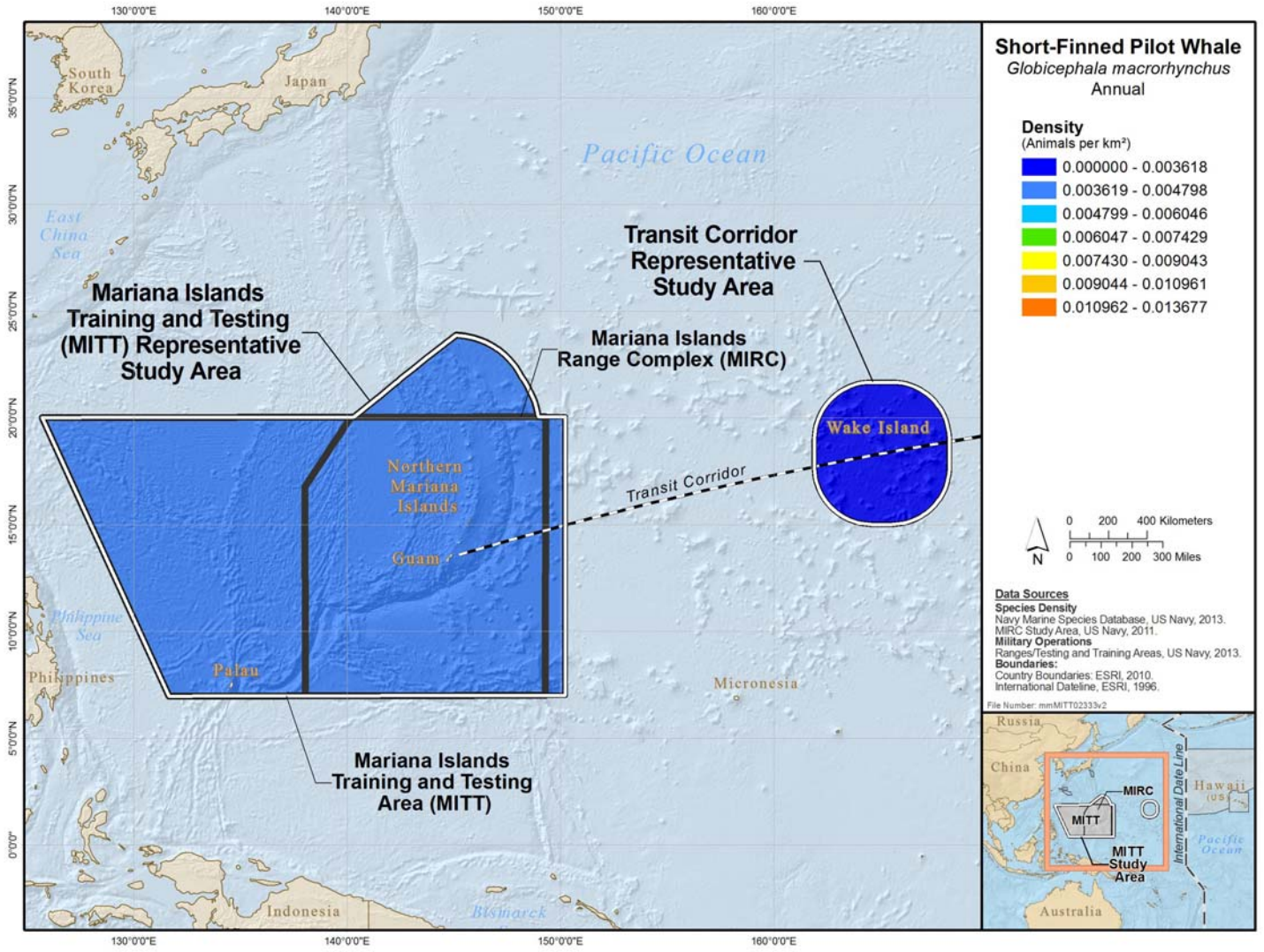

Figure 7-20: Annual Distribution of Short-Finned Pilot Whale in MITT and the Associated Transit Corridor Study Areas

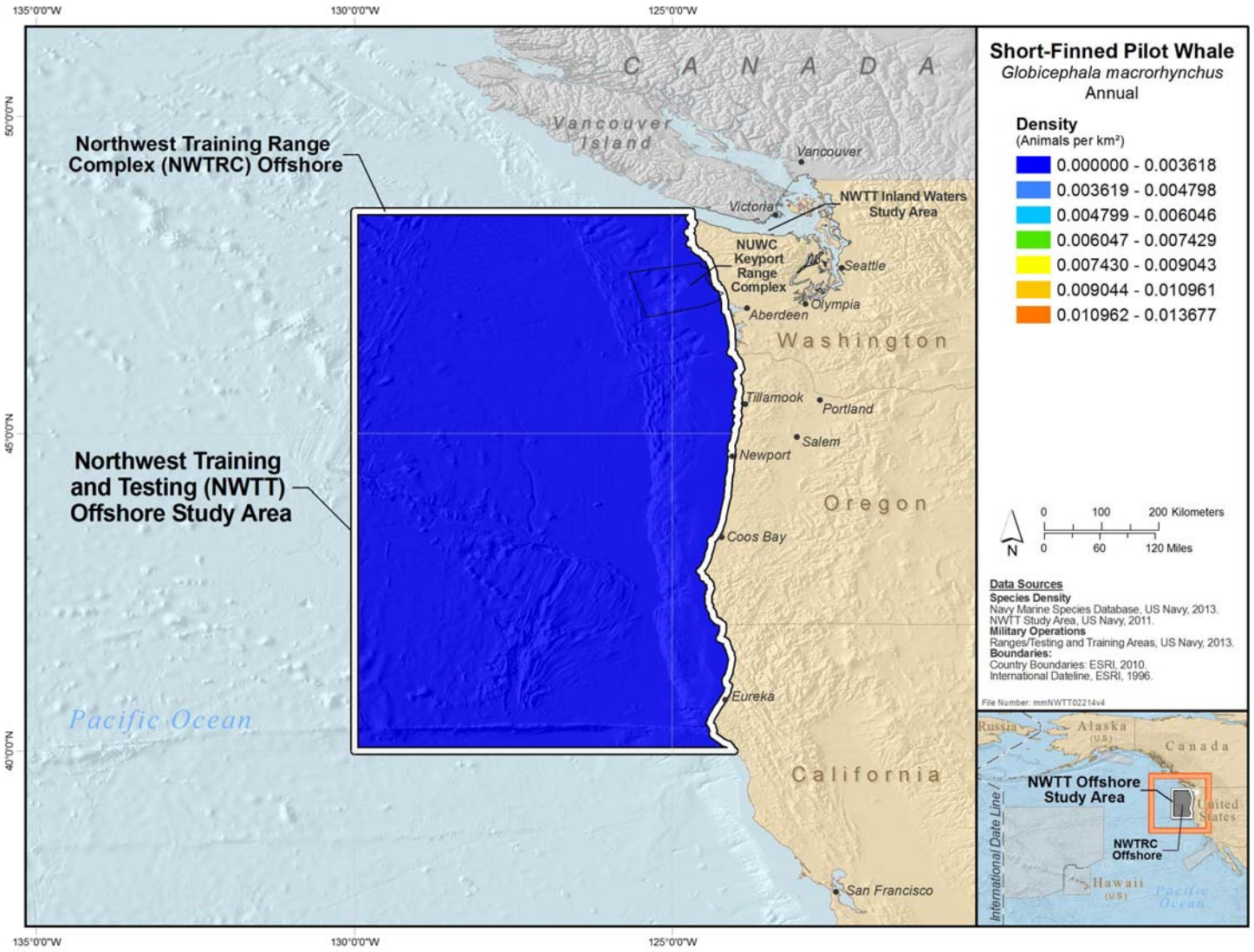

Figure 7-21: Annual Distribution of Short-Finned Pilot Whale in the Offshore Portion of the NWTT Study Area

7.1.5 *GRAMPUS GRISEUS*, RISSO'S DOLPHIN

This distinctive dolphin is one of the easiest dolphin species to identify even from a long distance. They typically appear to be lighter gray than other dolphins or even white in color because the body of a mature individual is covered with scratches and scars that are light gray to white in color (Jefferson et al. 2008; Kruse et al. 1999). The scars are hypothesized to be caused by conspecifics (MacLeod 1998) and the squid that are common prey of Risso's dolphins (Clarke and Young 1998). They also have one of the tallest dorsal fins with respect to body size of any cetacean (Baird 2009b). One of the few species that could be confused with Risso's dolphins from a distance could be killer whales because of the height of the dorsal fin (Leatherwood et al. 1988). It is not unusual for Risso's dolphins to be seen in mixed species groups, particularly with Pacific white-sided dolphins and/or northern right whale dolphins (Jefferson et al. 2008; Leatherwood et al. 1988). During Navy monitoring in SOCAL they have been observed with bottlenose dolphins and sperm whales (Hanser et al. 2010; Smultea et al. 2011). NMFS defines two stocks of Risso's dolphins in the Pacific, a Hawaiian stock, and a California/Oregon/Washington stock (Carretta et al. 2011a). While animals sighted in SOCAL or near HRC could presumably be assigned to their respective stocks, animals in the transit corridor could belong to the Hawaiian stock or the California/Oregon/Washington stock, as it is not clear where one stock merges into another. Density values for the HSTT Study Area are presented for the species as a whole. Little is known about the stock structure of Risso's dolphins in the MITT Study Area. Animals that occur in the Offshore region of the NWTT Study Area belong to the California/Oregon/Washington stock.

HRC. Although Risso's dolphins are seen around Hawaii, sightings are not common (Barlow 2006; Hamilton et al. 2009). Barlow (2006) calculated a uniform density estimate of 0.00097 dolphins/km^2. This value is applied to all seasons for both the HRC and the western portion of the transit corridor.

SOCAL. After the 1982–1983 El Niño event, Risso's dolphins' presence in SOCAL increased (Shane 1995). The now-common presence of Risso's dolphins in SOCAL has allowed NMFS to develop a CCE model for this species (Becker et al. 2012c). This model is applied to summer and fall. Ferguson and Barlow (2003) provided summer/fall uniform densities for the inner and outer Baja extension. Forney et al. (1995) divided the California into four geographic regions (Southern California Bight, Outer Southern California Waters, Central California, Northern California) to provide stratified uniform density estimates based on line-transect data. They provided uniform densities for the winter and spring for Risso's dolphins in each region. The species declines in density moving from south to north. The Navy applied the densities for the Southern California Bight and the Outer Southern California Waters to the Baja extension in the winter and spring. The St. Andrews RES model (SMRU Ltd. *in prep*) is used for the eastern portion of the transit corridor for all seasons.

MITT. Occurrence of this species is well known in deep open ocean waters off Hawaii, and in other locations in the Pacific (Au and Perryman 1985; Carretta et al. 2010; Leatherwood et al. 1980; Miyashita 1993; Miyashita et al. 1996; Wang et al. 2001). On 30 March 2010, during an oceanographic survey of waters in Micronesia and the Commonwealth of the Northern Mariana Islands, there was a single Risso's dolphin sighting of 3 individuals, at approximately 17°N, more than 60 nm north of FDM (Oleson and Hill 2010). There were no Risso's dolphin sightings during the Navy's 2007 systematic survey of the Study

Area (Fulling et al. 2011). In the absence of study area specific density data, and consistent with recommendations from scientists at PIFSC, line-transect estimates derived for Hawaiian waters (Barlow 2006) were used to represent the best available estimates for the MITT Study Area. Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual density for Risso's dolphin.

NWTT Offshore. Risso's dolphin exhibits apparent seasonal shifts in distribution off the U.S. west coast, with movements from California waters north into Oregon and Washington waters in spring and summer (Green et al. 1992; Forney and Barlow 1998; Soldevilla et al. 2008). They were the most commonly-sighted odontocete during aerial surveys in Oregon and Washington offshore waters in the late 1980s (Green et al. 1992), and were sighted frequently off the Washington coast in summer and fall during ship surveys in 1996, 2001, and 2005 (Barlow and Forney 2007). However, they have been sighted infrequently during recent surveys (Oleson et al. 2009). Based on systematic survey data and acoustic studies conducted in offshore waters of the Study Area during the last 10 years, there appears to be high interannual variability in the occurrence of this species (Oleson et al. 2009; Barlow 2010), although acoustic detections of Risso's dolphins have been made year-round in waters off Washington (Oleson et al. 2009).

As noted above for SOCAL, NMFS developed a CCE habitat-based density model for Risso's dolphin that provides spatially-explicit density estimates off the U.S. west coast for summer and fall (Becker et al. 2012b). Barlow and Forney (2007) also provided stratified uniform density estimates for Risso's dolphin for California, Oregon, and Washington in summer/fall. In the absence of other data, their estimate for Oregon/Washington offshore waters was used for the area north of the SWFSC strata (refer to Figure 3-6). Stratified uniform density estimates for Risso's dolphin are available for waters off California for winter/spring (Forney et al. 1995; Barlow et al. 2009). The total abundance for the Central and Northern California strata were used to generate a density estimate for these combined areas (22,343 animals/154,198 km^2 = 0.1449 animals/km^2). Green et al. (1993) provided a uniform density estimate for waters offshore Oregon and Washington in winter/spring; this value was used for areas north of California for this seasonal period.

NWTT Inland Waters. This species is not expected to occur within the Inland Waters region of the NWTT Study Area. Inland water stranding records for this species include a March 1975 report for Discovery Bay in the eastern Strait of Juan de Fuca (Everitt et al. 1979) and another near Port Angeles in October 1987 (Osborne et al. 1988). Two reported sightings of juvenile Risso's dolphins took place in late 2011 (Cascadia Research 2011), and a pair of Risso's dolphins was sighted in Puget Sound during aerial surveys in 2013 (Smultea and Bacon 2013); however, these sightings are considered very unusual, as the species is considered extralimital to the Study Area and occurrence is highly unlikely.

NWTT Western Behm Canal, Alaska. This species is not expected to occur within the Western Behm Canal region of the NWTT Study Area.

GOA. There are few records of Risso's dolphins in the GOA Study Area. These have recently been considered to be outside their normal range, although this is uncertain (Jefferson et al. 2014). Risso's

dolphins have been sighted near Chirikof Island (southwest of Kodiak Island) and offshore in the Gulf of Alaska, just south of the Study Area boundary (Braham 1983, Consiglieri et al. 1980). There is no NMFS management stock for this species recognized for Alaska waters. Further, NOAA's Cetacean Density and Distribution Mapping Working Group (http://www.st.nmfs.noaa.gov/cetsound/) considers the occurrence of Risso's dolphin in the Gulf of Alaska as "unknown"; however, they are listed as a species potentially occurring there. To acknowledge the potential presence of Risso's dolphin in the GOA Study Area, at least occasionally, a minimum density estimate of 0.00001 animals/km^2 was assigned.

Table 7-9: Sources of Density Values Used for Risso's Dolphin

Location	Spring	Summer	Fall	Winter
HRC	L	L	L	L
W. Transit Corridor	L	L	L	L
E. Transit Corridor	SMRU	SMRU	SMRU	SMRU
SOCAL	L	CCE	CCE	L
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	L and LD	CCE and LD	CCE and LD	L and LD
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	LD	LD	LD	LD

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-10: Summary of Density Values for Risso's Dolphin in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0.00097	0.00097	0.00097	0.00097
W. Transit Corridor	0.00097	0.00097	0.00097	0.00097
E. Transit Corridor	S	S	S	S
SOCAL	0.0100–0.2029	S	S	0.0100–0.2029
Inner Baja Extension	0.20294	0.018	0.018	0.018
Outer Baja Extension	0.00997	0.0084	0.0084	0.0084
Southern California Bight	0.20294	S	S	0.20294
Outer Southern California Waters	0.00997	S	S	0.00997
MITT	0.00097	0.00097	0.00097	0.00097
MITT Transit Corridor	0.00046	0.00046	0.00046	0.00046
NWTT Offshore	0.03085–0.14490	S and 0.01322	S and 0.01322	0.03085–0.14490
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0.00001	0.00001	0.00001	0.00001

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density

values throughout the range.

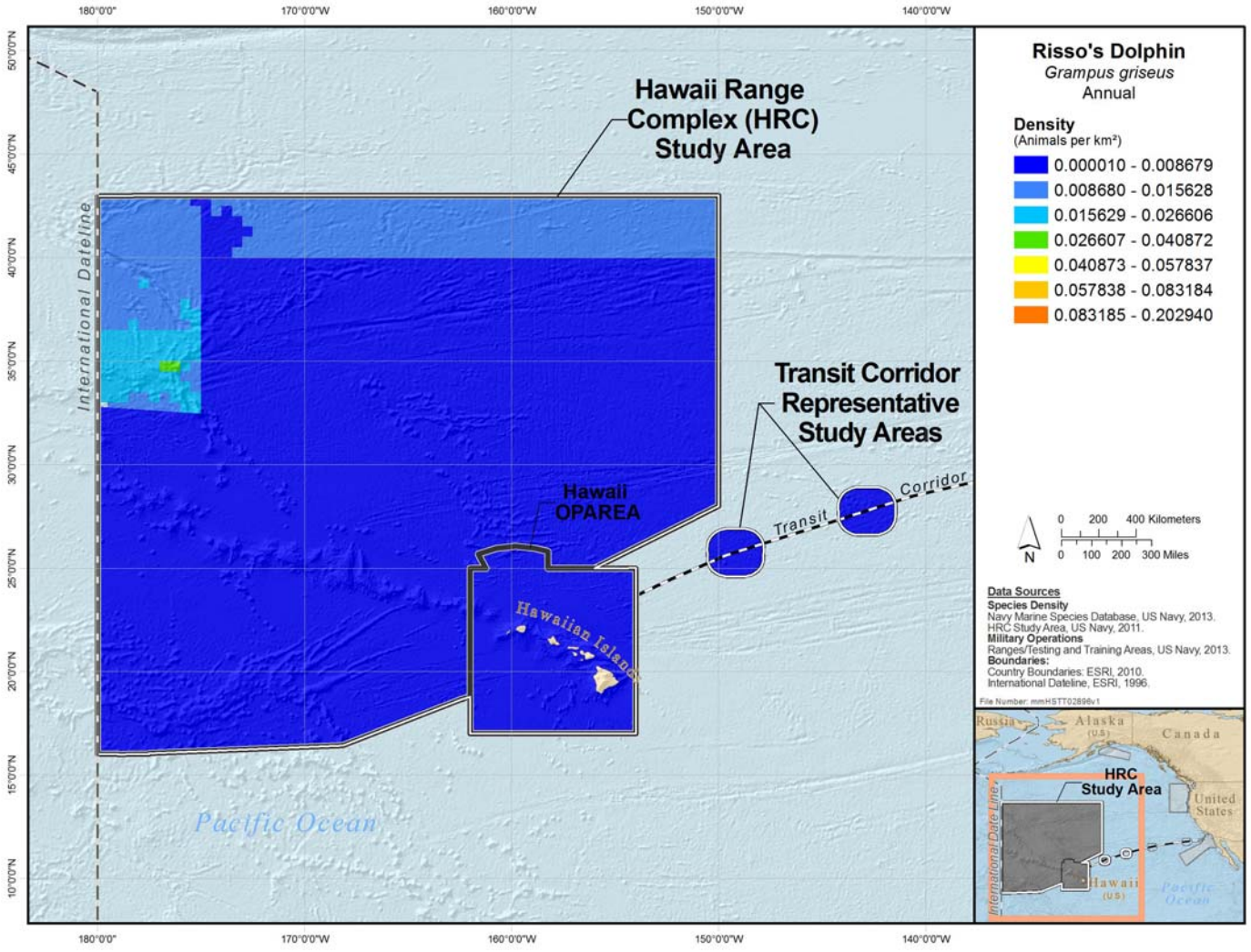

Figure 7-22: Annual Distribution of Risso's Dolphin in HRC and the Western Portion of the Transit Corridor

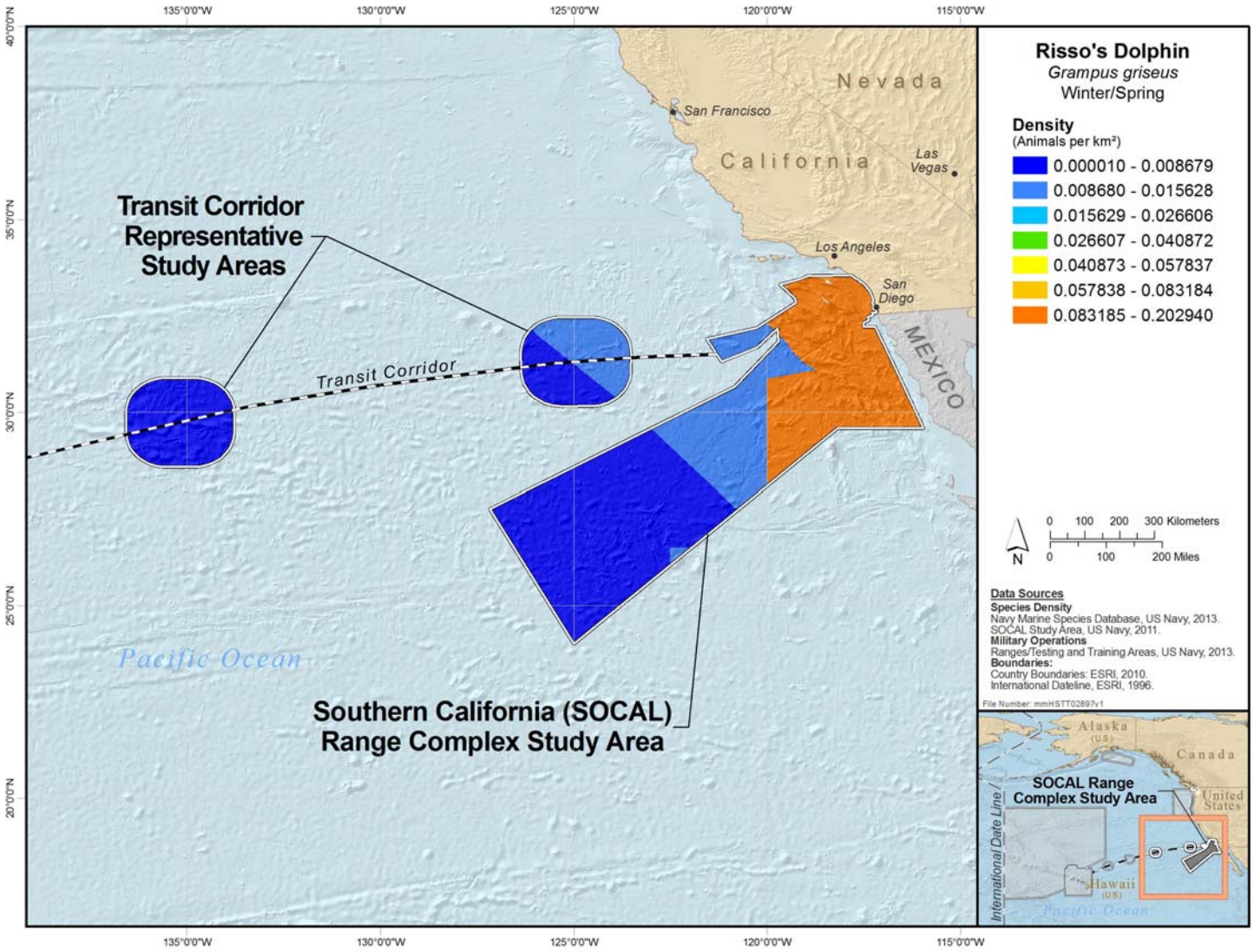

Figure 7-23: Winter/Spring Distribution of Risso's Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

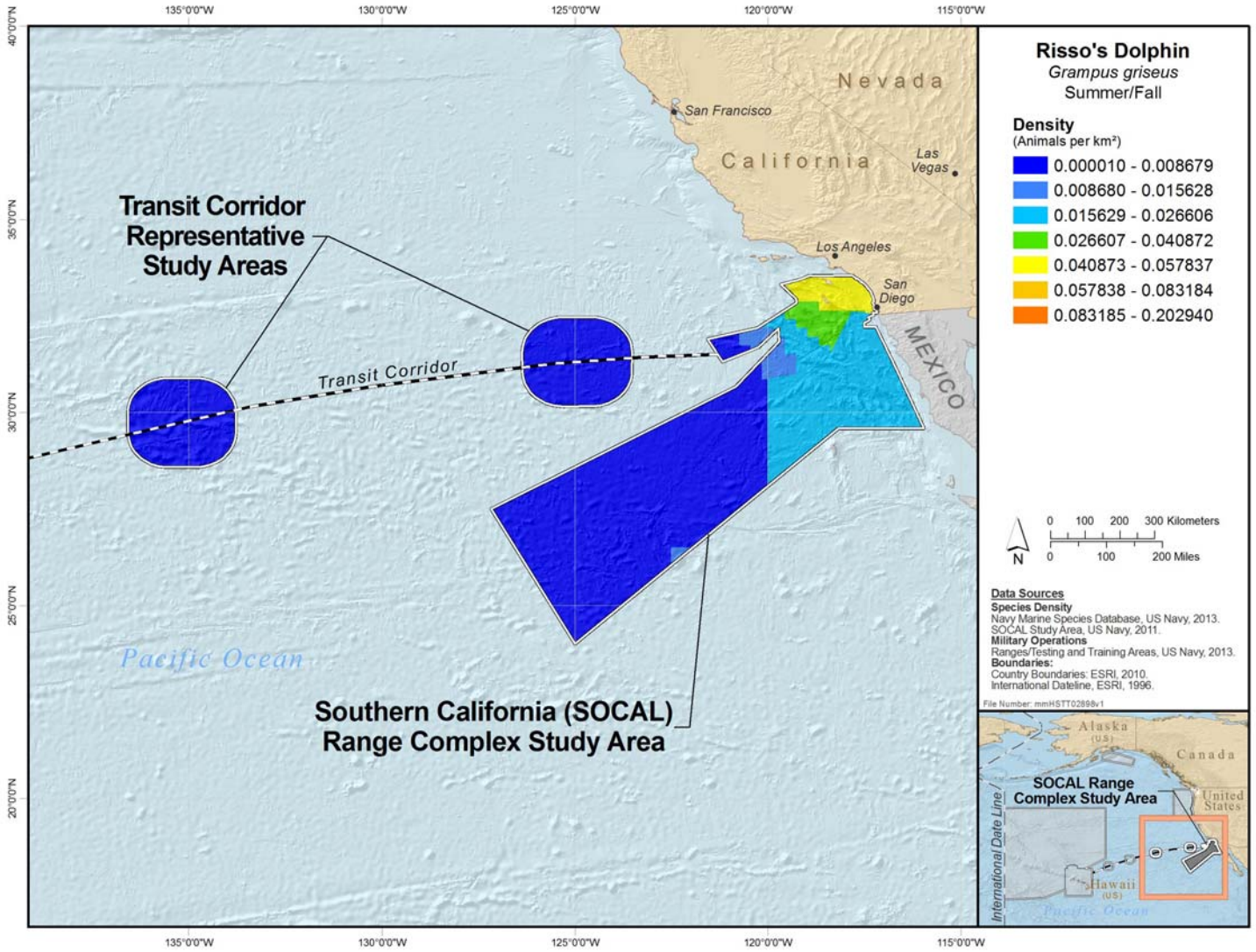

Figure 7-24: Summer/Fall Distribution of Risso's Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

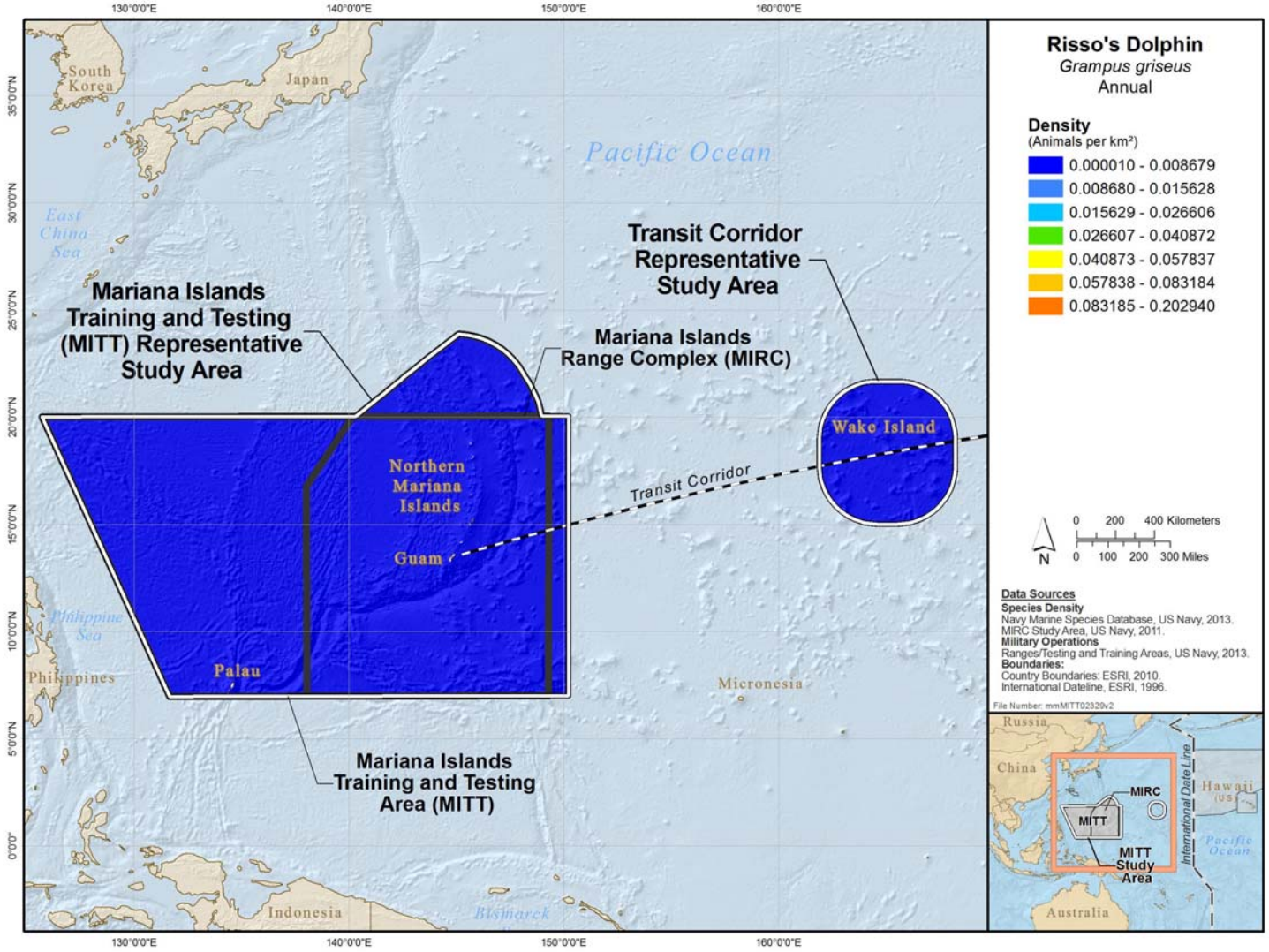

Figure 7-25: Annual Distribution of Risso's Dolphin in MITT and the Associated Transit Corridor Study Areas

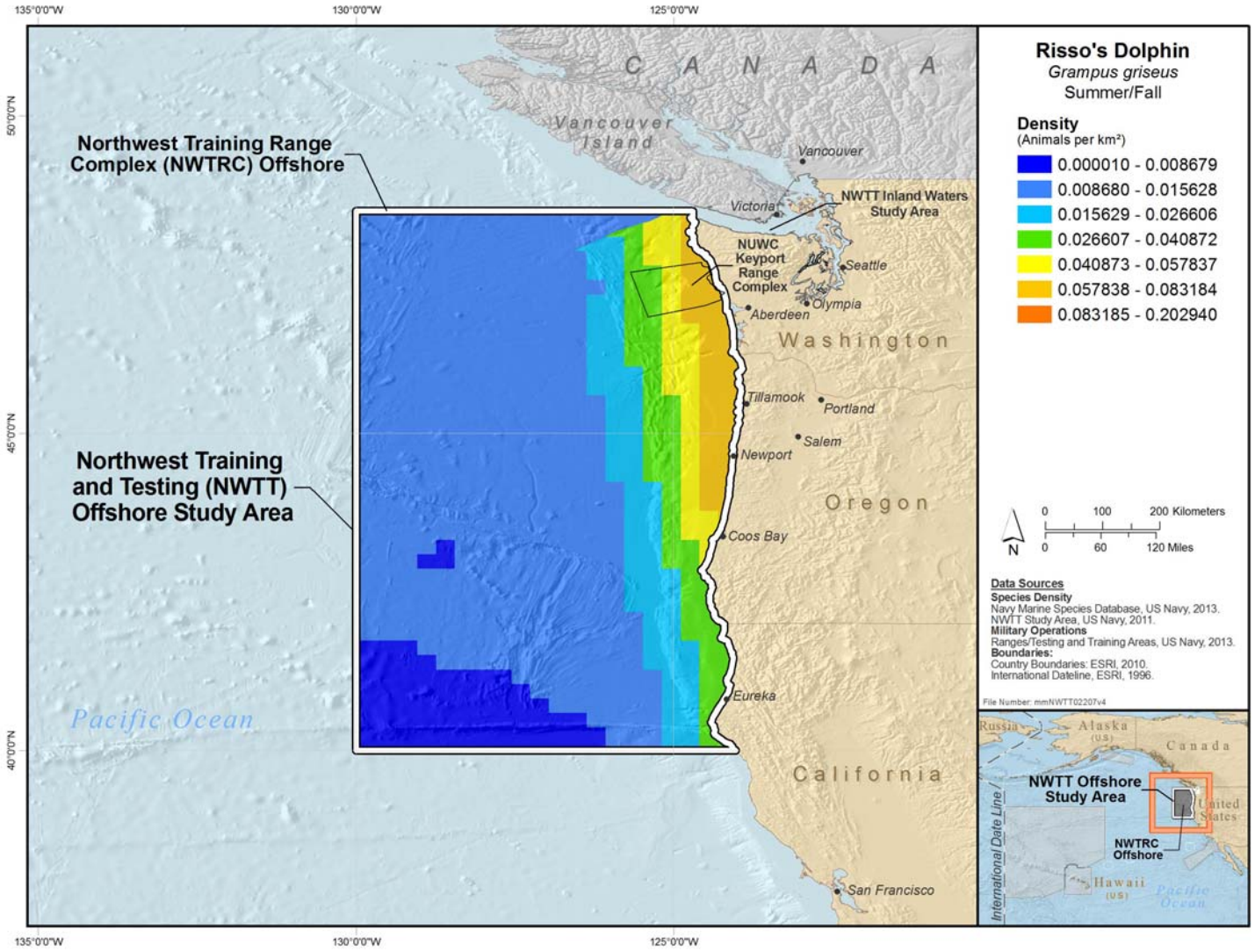

Figure 7-26: Summer/Fall Distribution of Risso's Dolphin in the Offshore Portion of the NWTT Study Area

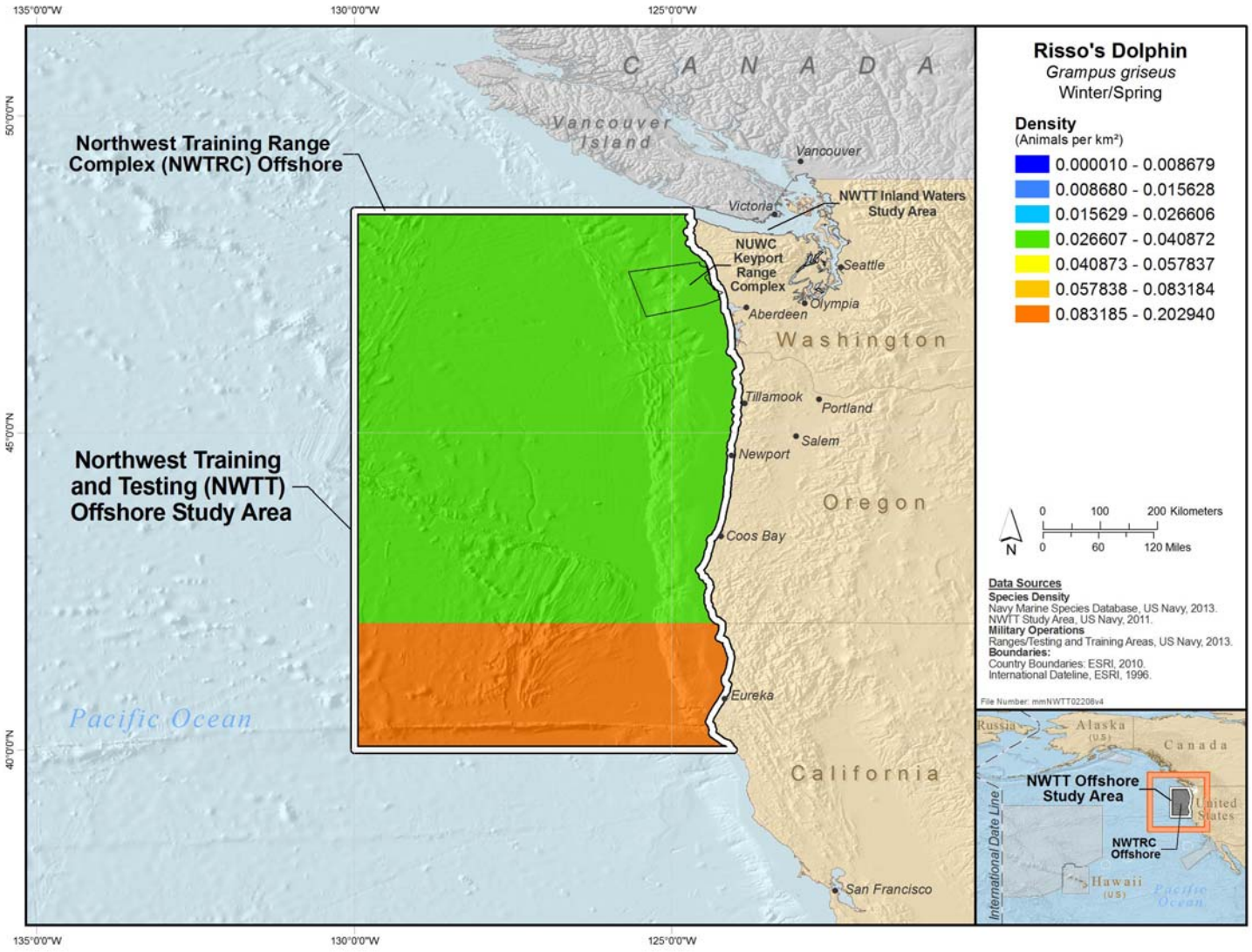

Figure 7-27: Winter/Spring Distribution of Risso's Dolphin in the Offshore Portion of the NWTT Study Area

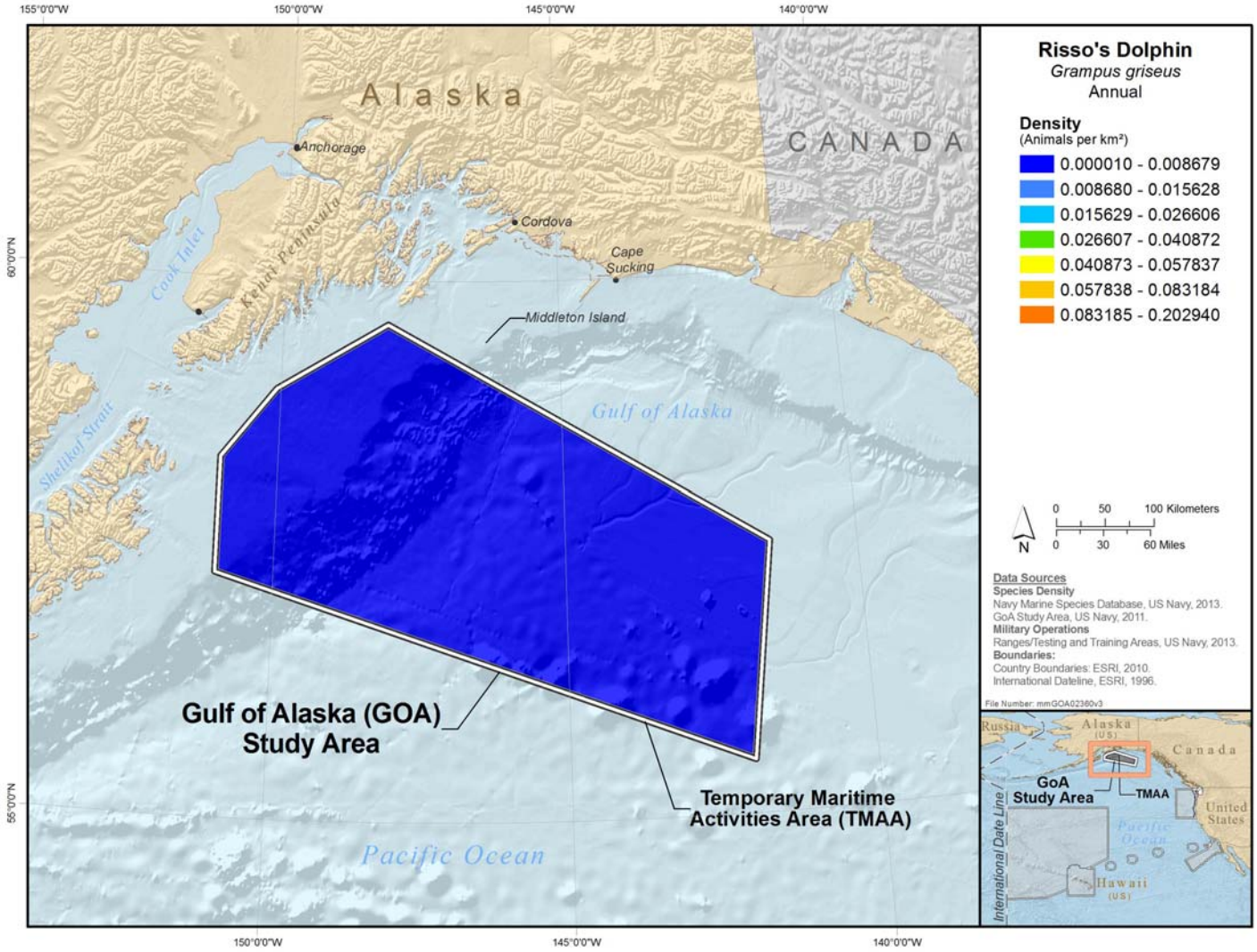

Figure 7-28: Annual Distribution of Risso's Dolphin in the GOA Study Area

7.1.6 *LAGENODELPHIS HOSEI*, FRASER'S DOLPHIN

Fraser's dolphin (*Lagenodelphis hosei*) is a tropical species of dolphin about which little is known. The species was described based on a skeleton in 1956. An actual intact specimen was not identified until 1971 (Dolar 2009). When viewed clearly, the species should be readily identifiable. They have a body that is stocky, often described as particularly "robust" (Jefferson et al. 2008; Leatherwood et al. 1988) with a short beak and very small appendages. They have a dark band running from the eyes and beak to the anus (Dolar 2009; Jefferson et al. 2008). At a distance the striping could cause confusion with striped dolphins, but the dark stripe on the Fraser's dolphin is broad, especially in adult males, and the body is much more stocky (Leatherwood et al. 1988). Fraser's dolphin have been observed in very large groups, greater than 1,000 individuals, and may be seen in mixed species groups with various species including Risso's, pantropical spotted, striped, and spinner dolphins, melon-headed whales, pilot whales, false killer whales, and sperm whales (Jefferson et al. 2008; Kiszka et al. 2011b; Leatherwood et al. 1988). NMFS recognizes a single Hawaiian stock of Fraser's dolphins in U.S. waters (Carretta et al. 2011a). Little is known about the stock structure of Fraser's dolphin in the MITT Study Area.

HRC. Barlow (2003; 2006) provided density estimates for Fraser's dolphin in the Hawaiian EEZ. In the NMFS studies, the species has not been seen near the Hawaiian Islands (Barlow 2003; Hamilton et al. 2009). Barlow's 2006 estimate is a correction to the 2003 estimate in the outer stratum of the Hawaiian EEZ, and it is a uniform density estimate. Within the inner Hawaii NMFS strata, Fraser's dolphins have not been observed, so they are thought not to be present. Because of the lack of information about the Fraser's dolphin, the Navy relies on the Kaschner et al. (2006) RES model for predicting the density of Fraser's dolphin in the western portion of the transit corridor.

SOCAL. This species has not been observed on NMFS surveys in the SOCAL area (Hamilton et al. 2009), but little is known about Fraser's dolphins' true distribution, so the Navy relies on the Kaschner et al. RES model (2006) for predicting the density of Fraser's dolphin in the eastern Pacific.

MITT. There were no Fraser's dolphin sightings during the Navy's 2007 systematic survey of the Study Area (Fulling et al. 2011), and there are no abundance estimates for Fraser's dolphin in the region. In the absence of study area specific density data, and consistent with recommendations from scientists at PIFSC, line-transect estimates derived for Hawaiian waters (Barlow 2006) were used to represent the best available estimates for the MITT Study Area. Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual density for Fraser's dolphin.

NWTT. This species is not expected to occur in any of the regions within the NWTT Study Area.

GOA. This species is not expected to occur in the GOA Study Area.

Table 7-11: Sources of Density Values Used for Fraser's Dolphin

Location	Spring	Summer	Fall	Winter
HRC	L	L	L	L
W. Transit Corridor	K	K	K	K
E. Transit Corridor	K	K	K	K
SOCAL	K	K	K	K
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-12: Summary of Density Values for Fraser's Dolphin in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
Hawaii inner stratum	0.0000	0.0000	0.0000	0.0000
HRC outer	0.00417	0.00417	0.00417	0.00417
W. Transit Corridor	S	S	S	S
E. Transit Corridor	S	S	S	S
SOCAL	S	S	S	S
Inner Baja Extension	S	S	S	S
Outer Baja Extension	S	S	S	S
MITT	0.00417	0.00417	0.00417	0.00417
MITT Transit Corridor	0.00252	0.00252	0.00252	0.00252
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

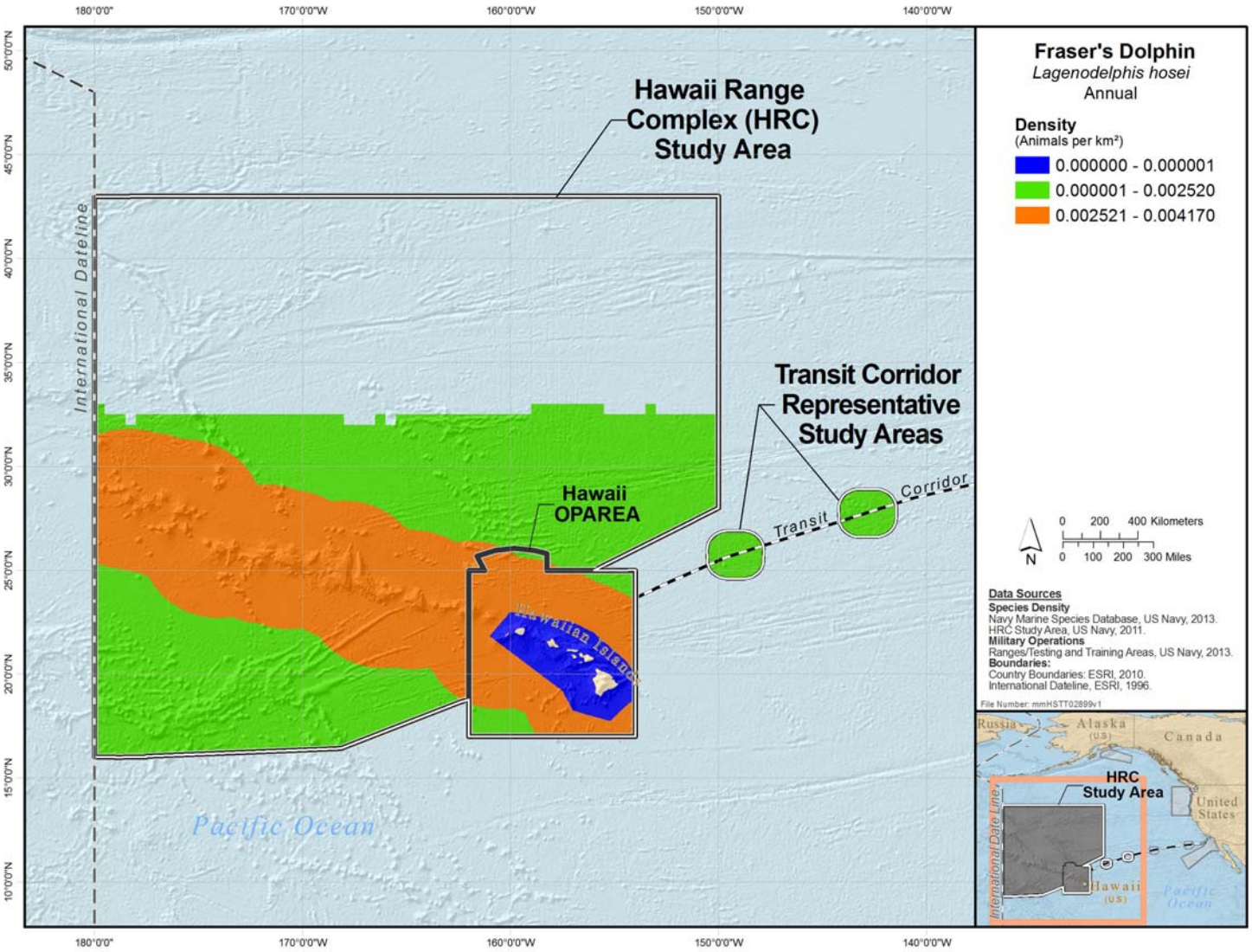

Figure 7-29: Annual Distribution of Fraser's Dolphin in HRC and the Western Portion of the Transit Corridor

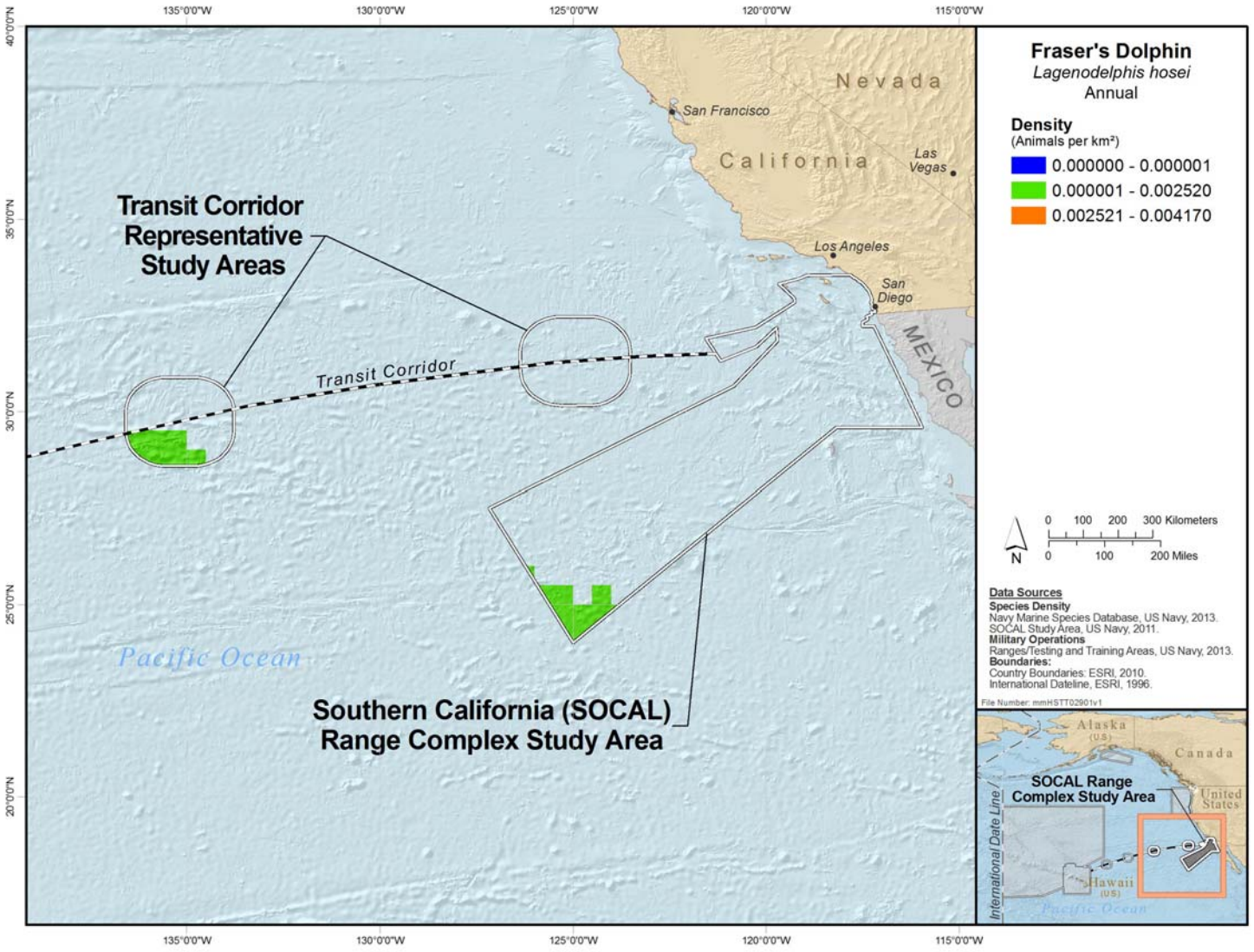

Figure 7-30: Annual Distribution of Fraser's Dolphin in SOCAL and the Western Portion of the Transit Corridor

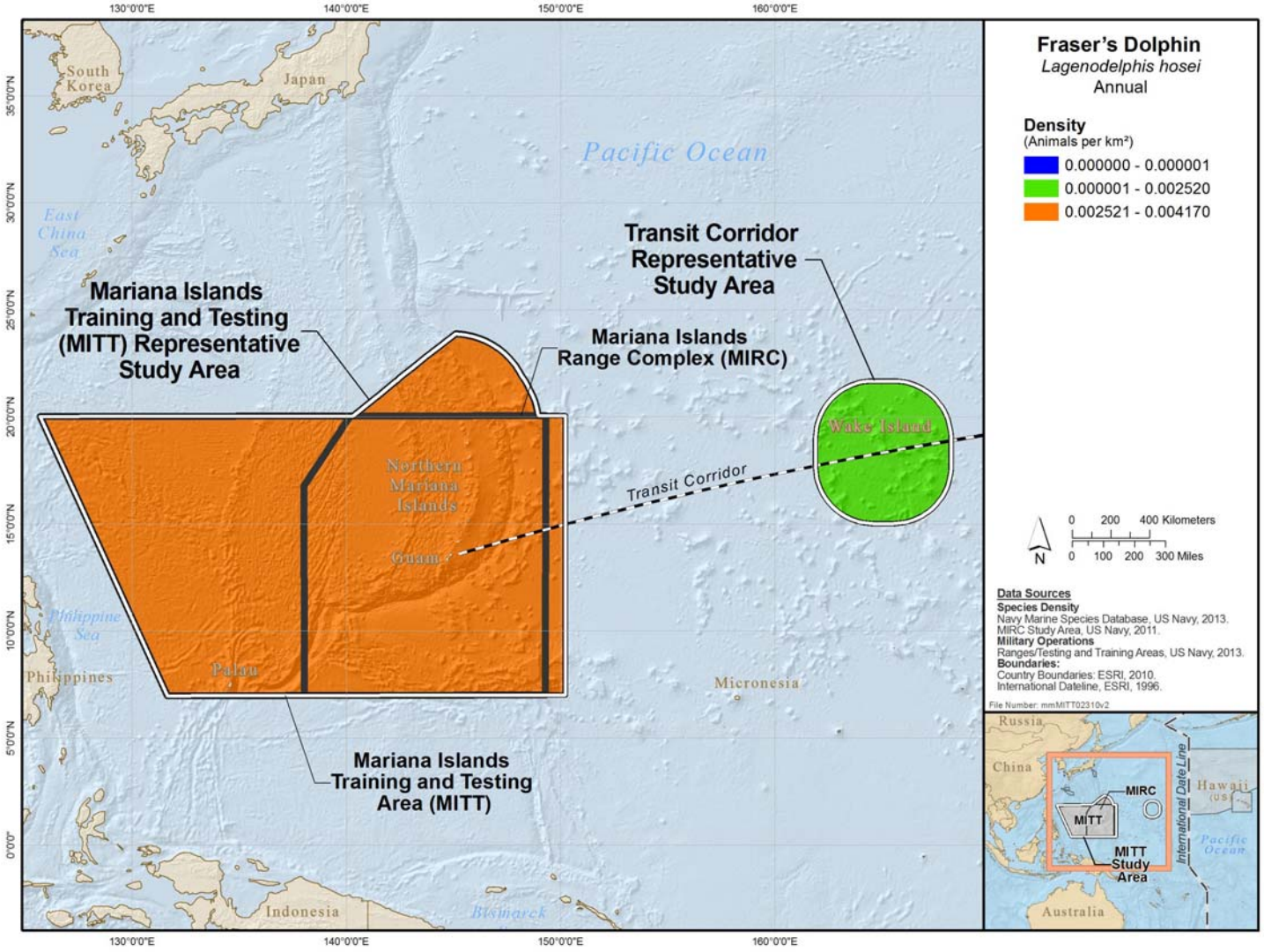

Figure 7-31: Annual Distribution of Fraser's Dolphin in MITT and the Associated Transit Corridor Study Areas

7.1.7 *LAGENORHYNCHUS OBLIQUIDENS*, PACIFIC WHITE-SIDED DOLPHIN

This small-bodied dolphin with a small, but distinctive beak is found in the temperate waters of the North Pacific (Jefferson et al. 2008). It is primarily seen off the slope and shelf along the west coast of North America (Hamilton et al. 2009). The coloration of Pacific white-sided dolphins is distinctive, bold, and complex. The white belly is separated from the gray patch on the side by a thin black line and the dorsal side has a "suspenders" pattern that flows from the rostrum over the shoulder to the flank (Black 2009; Brownell et al. 1999). The dorsal fin is distinctive because it is strongly curved or hooked, particularly in older individuals, in which the fin takes on a lobate shape (Allen et al. 2011; Jefferson et al. 2008). Although the diagnostic coloration and the shape of the fin should make this species relatively easy to identify, they could be mistaken for three species in their range: common dolphins (*Delphinus* sp.) and Dall's porpoise (Leatherwood et al. 1988). At a distance, a rapidly-moving group of Pacific white-sided dolphins could be mistaken for a large group of either species of common dolphin. The "rooster-tail" splashes made by the dorsal fins of Pacific white-sided dolphins are similar to the splashes typically made by Dall's porpoises (Leatherwood et al. 1988). What often gives away the identity of Pacific white-sided dolphins is their acrobatic behavior (Black 2009; Brownell et al. 1999). They are often seen in groups with a wide variety of marine mammals, including California sea lions (*Zalophus californianus*) (Black 2009; Brownell et al. 1999; Leatherwood et al. 1988; Stacey and Baird 1991). Two stocks of Pacific white-sided dolphin are recognized by NMFS (Carretta et al. 2011a). One is a complex of units (the California/Oregon/Washington, Northern and Southern stocks) that contains two forms of the species, which should ostensibly be separate stocks. The area between 33°N and 36°N seems to be the overlap area of the two forms, which is in the vicinity of the Southern California Bight and northern Baja California; this area overlaps directly with SOCAL. Until the difference between the two forms can be recognized in the field, the two stocks will be managed as a single unit (Carretta et al. 2011a). The second stock recognized by NMFS is the North Pacific stock that covers the west coast of Canada, the Gulf of Alaska, and the area around the Aleutian Islands (Carretta et al. 2011a). Density values for the HSTT Study Area are presented for the species as a whole.

HRC. NMFS has developed a CENPAC model for an "other dolphins" group that included both Pacific white-sided and short-beaked common dolphins (Becker et al. 2012b). The Navy uses it for all seasons for both the HRC and the western portion of the transit corridor. The higher densities predicted in areas south of about 20°N represent only short-beaked common dolphins. The high density areas to the north of the CENPAC model area are predicted densities from the Kaschner et al. RES model (2006).

SOCAL. NMFS also developed a CCE model for Pacific white-sided dolphin (Becker et al. 2012c). This model is applied to summer and fall. Ferguson and Barlow (2003) provided summer/fall uniform densities for the inner and outer Baja extension. Forney et al. (1995) divided waters off California into four geographic regions (Southern California Bight, Outer Southern California Waters, Central California, Northern California) for the purpose of providing stratified uniform density estimates based on line-transect data. They provide uniform densities for the winter and spring for Pacific white-sided dolphins in each region. The species increases in density moving from south to north. The Navy applied the densities for the Southern California Bight and the Outer Southern California Waters to the Baja extension in the winter and spring. The CENPAC model is used for the eastern portion of the transit

corridor for all seasons. In the sliver of area between where the CENPAC and CCE model do not meet, the Kaschner et al. (2006) RES model was used to provide density estimates for summer/fall. The CENPAC and CCE models agree to a greater degree for summer/fall than the uniform densities and the CENPAC model during winter/spring.

MITT. This species is not expected to occur in the MITT or associated transit corridor study areas.

NWTT Offshore. Pacific white-sided dolphins occur year-round in the Offshore region of the NWTT Study Area, with increased abundance in the summer/fall (Barlow 2010; Forney and Barlow 1998; Oleson et al. 2009). As noted above for SOCAL, NMFS developed a CCE habitat-based density model for Pacific white-sided dolphins which provides spatially-explicit density estimates off the U.S. west coast for summer and fall (Becker et al. 2012c). Barlow and Forney (2007) also provided stratified uniform density estimates for Pacific white-sided dolphins for California, Oregon, and Washington in summer/fall. In the absence of other data, their estimate for Oregon/Washington offshore waters was used for the area north of the SWFSC strata (refer to Figure 3-6) for summer/fall. Uniform density estimates for Pacific white-sided dolphin are available for the Northern California offshore stratum for winter/spring (Forney et al. 1995; Barlow et al. 2009). Green et al. (1993) provided a uniform density estimate for waters offshore Oregon and Washington in winter/spring; this value was used for these waters for this seasonal period.

NWTT Inland Waters. Pacific white-sided dolphins are known to enter the inshore passes of British Columbia and Washington, and have been encountered in the Strait of Juan de Fuca and the Strait of Georgia (Norman et al. 2004; Osborne et al. 1988; Stacey and Baird 1991). Small groups have also been seen in Haro Strait off San Juan Island. Pacific white-sided dolphins are extremely rare in Puget Sound, with only one stranding in southern Puget Sound recorded in the 1980s (Osborne et al. 1988) and two incidental sightings reported to the Orca Network in recent years. Published density estimates for Pacific white-sided dolphins in the inland waters are not available. Based on line-transect abundance estimates for offshore waters of Oregon and Washington (Barlow and Forney 2007), and consideration of opportunistic sightings recorded by the Orca Network, it was conservatively assumed that the summer/fall abundance estimate of Pacific white-sided dolphins occurring within the Strait of Juan de Fuca and the San Juan Islands area would be 10% of the summer/fall offshore estimate (0.00248 animals/km^2). Since abundance is expected to decrease in winter/spring, density estimates were reduced by an order of magnitude for this seasonal period. Since Pacific white-sided dolphins are rarely sighted within Puget Sound or Hood Canal and Dabob Bay, a minimum density estimate was assigned to these strata (0.000001 animals/km^2).

NWTT Western Behm Canal, Alaska. For the Western Behm Canal, density estimates for all seasons were taken from the Marine Mammal Occurrence/Density Report prepared in support of a NEPA document for Navy activities at SEAFAC (U.S. Department of the Navy 2010b).

GOA. Pacific white-sided dolphins occur regularly year-round throughout the Gulf of Alaska, with peak abundance between July and August (U.S. Department of the Navy 2006). Cetacean surveys near the Kenai Peninsula, within Prince William Sound and around Kodiak Island in summer 2003, reported

sighting two large groups (an average group size of 56) just off the Kenai Peninsula (Waite 2003). During the April 2009 survey of the Study Area, Pacific white-sided dolphins were sighted only once (a group of 60 individuals), although the location of the sighting was outside the Study Area and inside the shelf break to the southeast of Kodiak Island (Rone et al. 2009). Pacific white-sided dolphins were not sighted during the Navy's 2013 survey of the Study Area (Rone et al. 2014). Based on sighting data from Waite (2003), the Department of the Navy (2009) derived a year-round density estimate Pacific white-sided dolphins of 0.0208 animals/km^2.

Table 7-13: Sources of Density Values Used for Pacific White-Sided Dolphin

Location	Spring	Summer	Fall	Winter
HRC	CENPAC	CENPAC	CENPAC	CENPAC
W. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
E. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
SOCAL	L	CCE	CCE	L
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	L and LD	CCE and LD	CCE and LD	L and LD
NWTT Inland Waters	LD	LD	LD	LD
Western Behm Canal	LD	LD	LD	LD
GOA	LD	LD	LD	LD

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-14: Summary of Density Values for Pacific White-Sided Dolphin in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	S	S	S	S
SOCAL	0.0573–0.2945	S	S	0.0573–0.2945
Inner Baja Extension	0.05732	0.0017	0.0017	0.05732
Outer Baja Extension	0.29447	0.033	0.033	0.29447
Southern California Bight	0.05732	S	S	0.05732
Outer Southern California Waters	0.29447	S	S	0.29447
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0.1035–0.7505	S and 0.0248	S and 0.0248	0.1035–0.7505
NWTT Inland Waters	0–0.00025	0–0.00248	0–0.00248	0–0.00025
Western Behm Canal	0.0849	0.0075	0.0075	0.0849
GOA	0.0208	0.0208	0.0208	0.0208

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

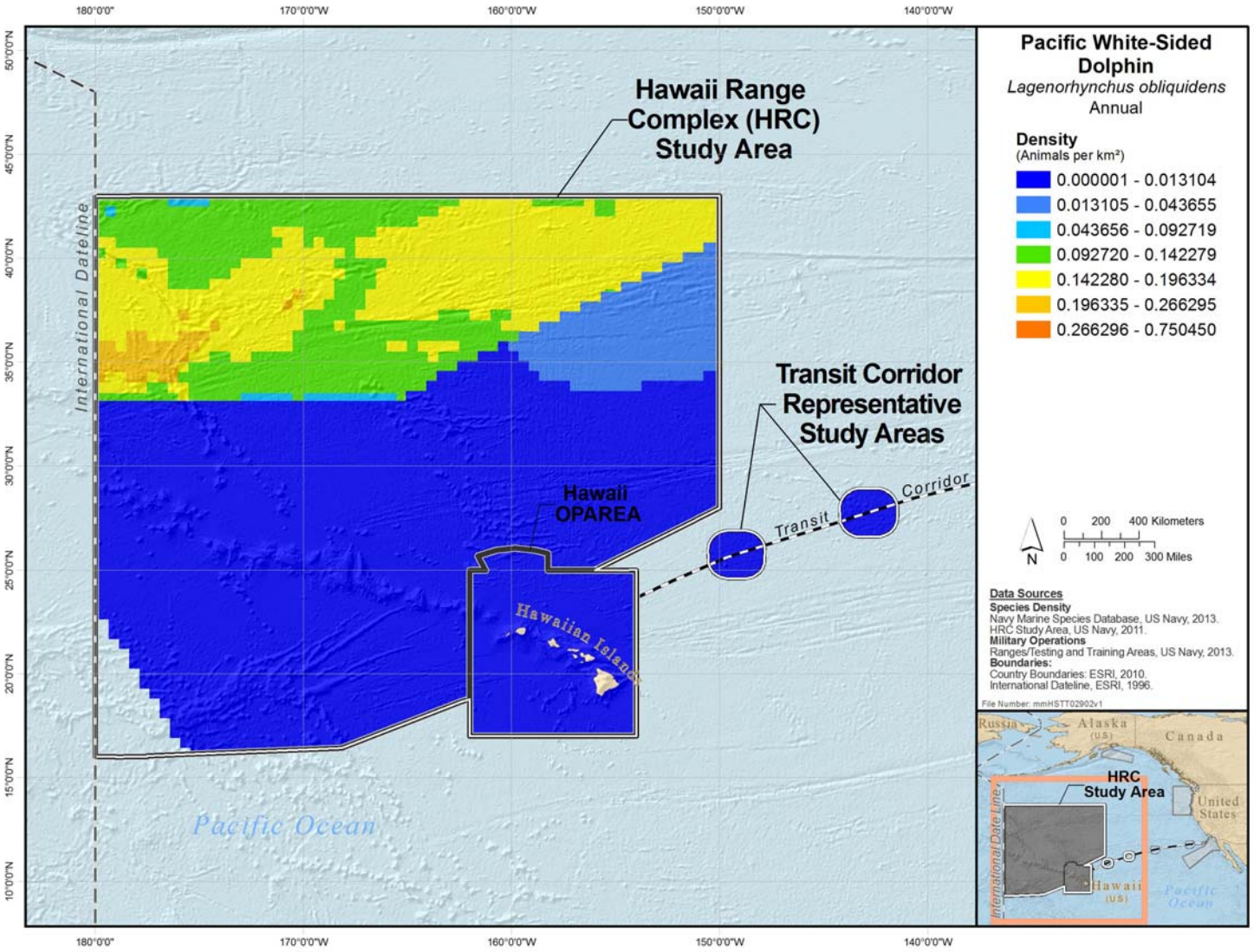

Figure 7-32: Annual Distribution of Pacific White-Sided Dolphin in HRC and the Western Portion of the Transit Corridor

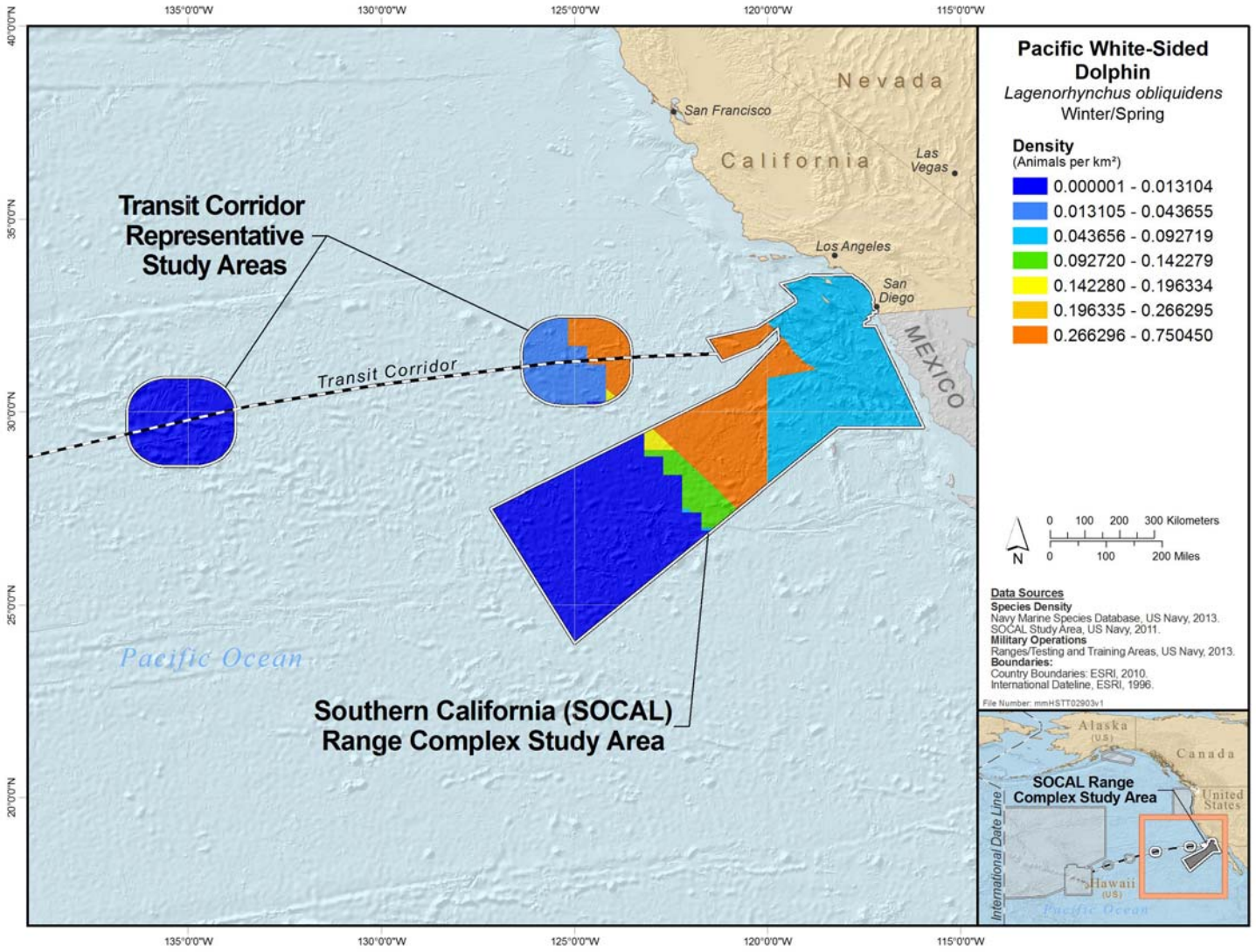

Figure 7-33: Winter/Spring Distribution of Pacific White-Sided Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

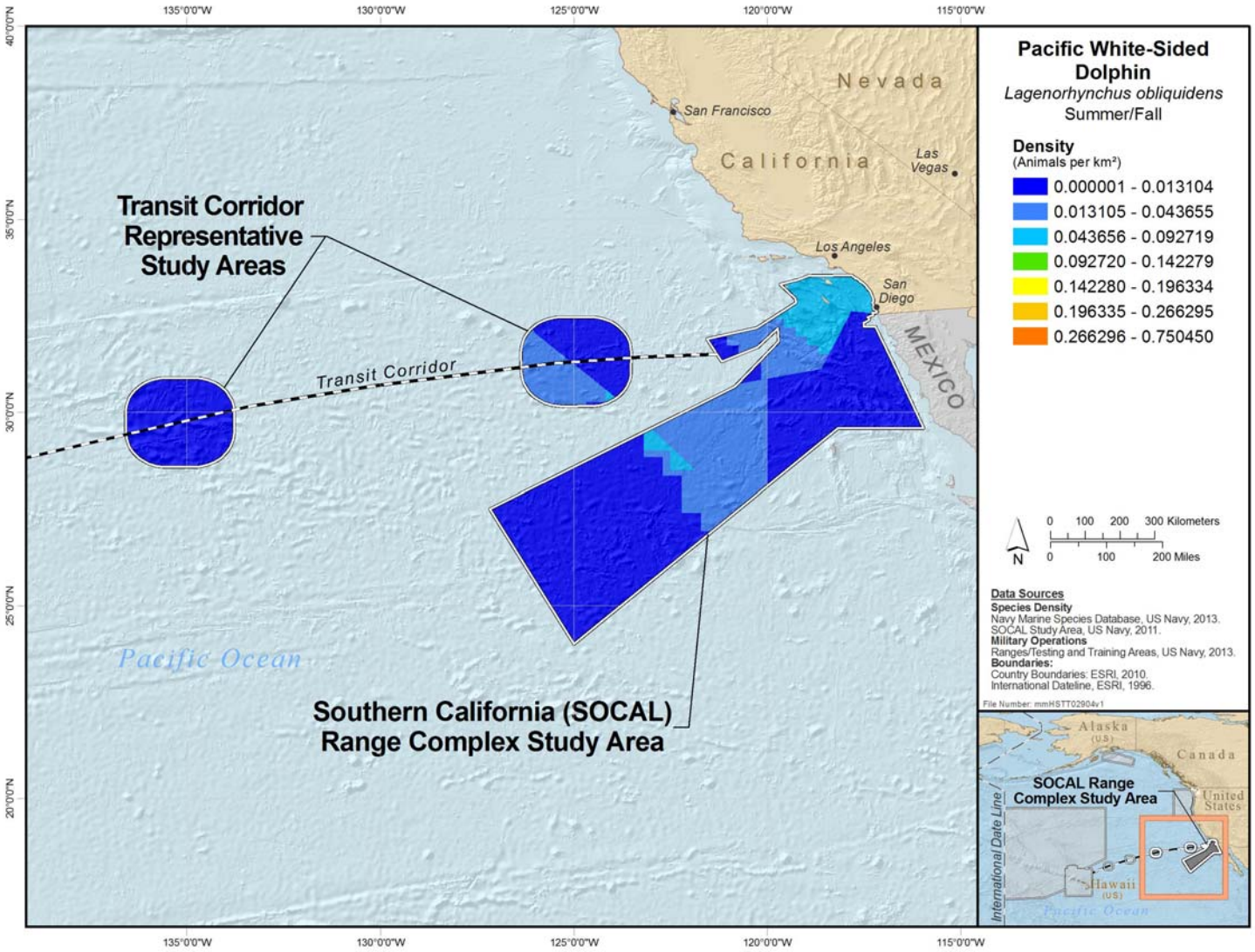

Figure 7-34: Summer/Fall Distribution of Pacific White-Sided Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

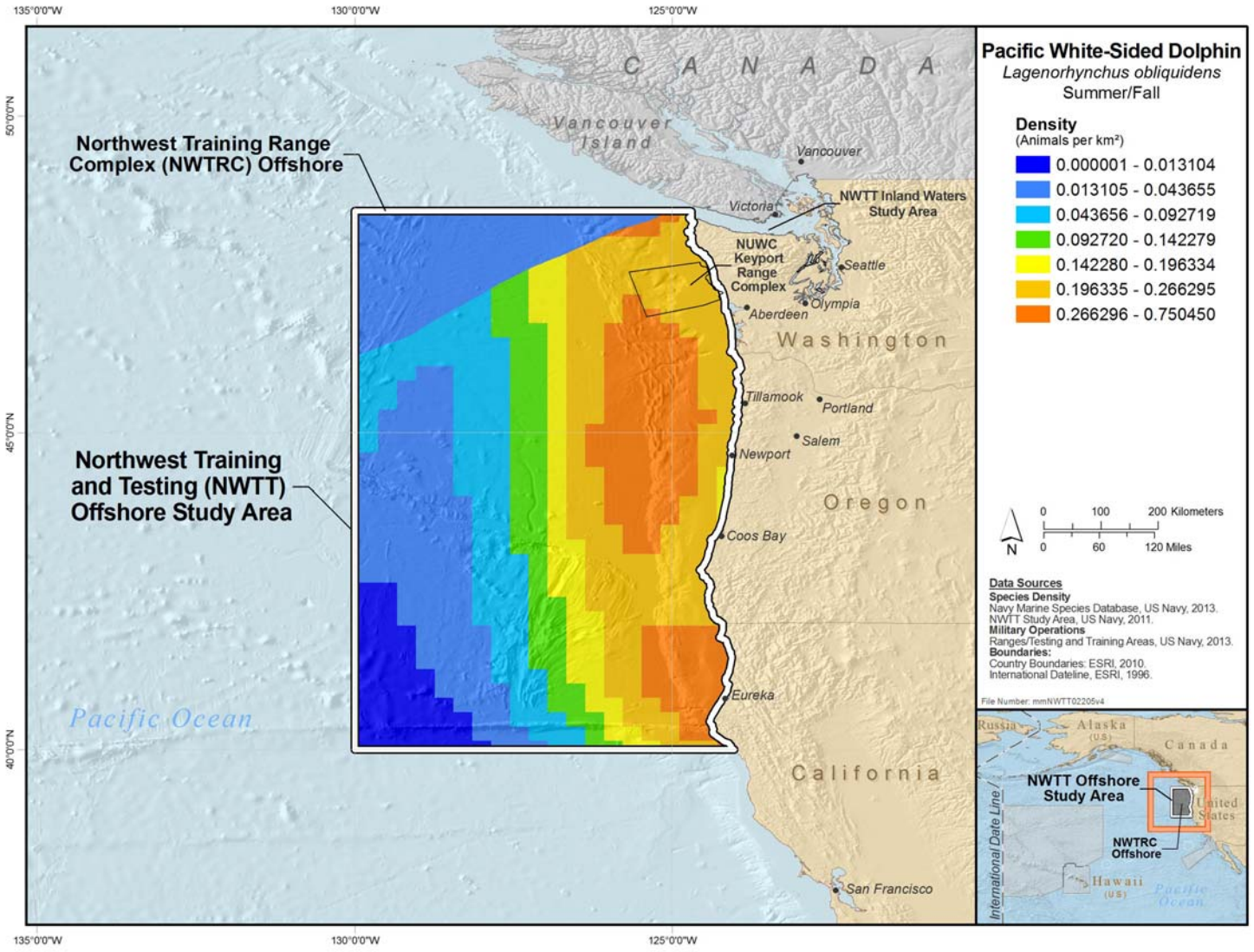

Figure 7-35: Summer/Fall Distribution of Pacific White-Sided Dolphin in the Offshore Portion of the NWTT Study Area

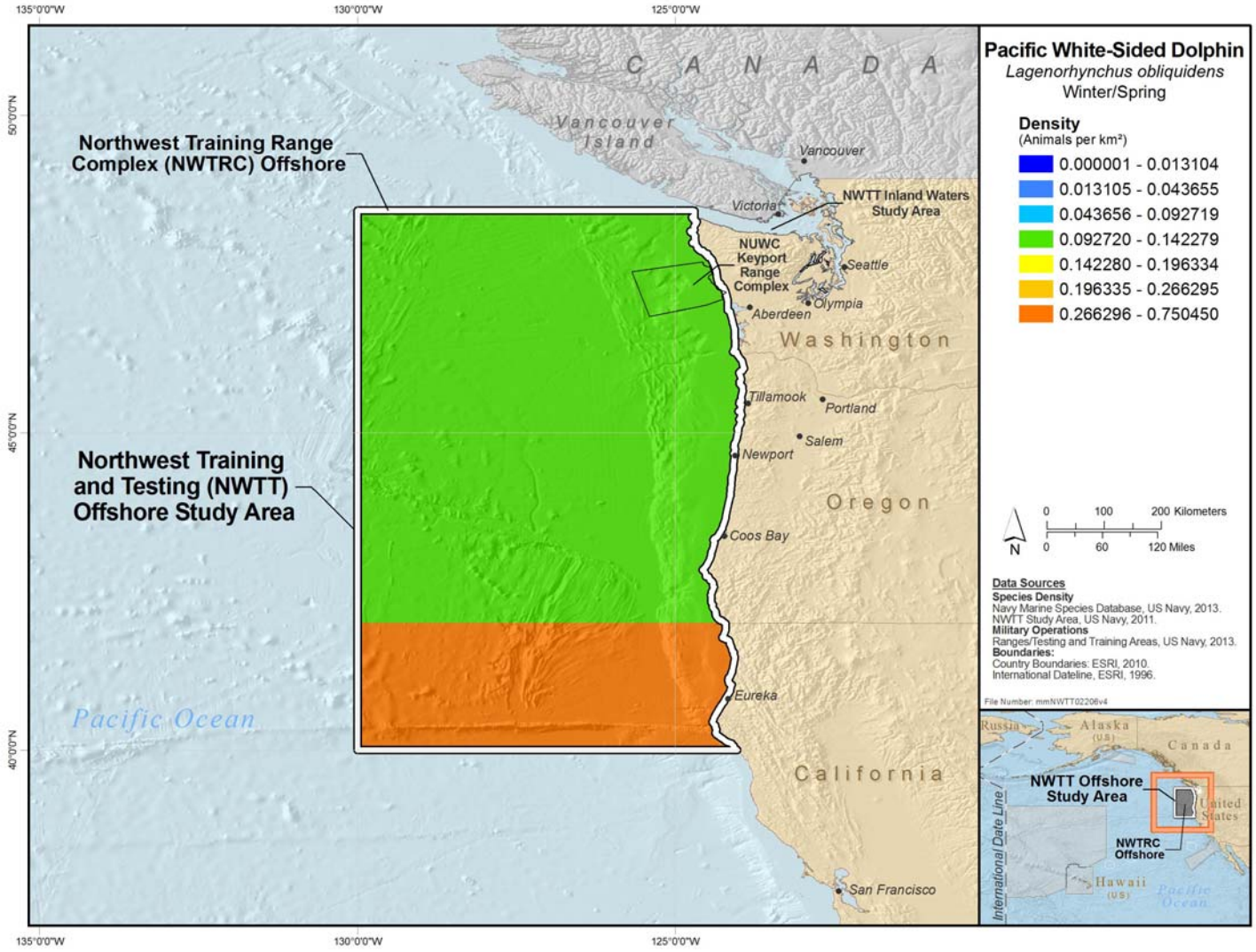

Figure 7-36: Winter/Spring Distribution of Pacific White-Sided Dolphin in the Offshore Portion of the NWTT Study Area

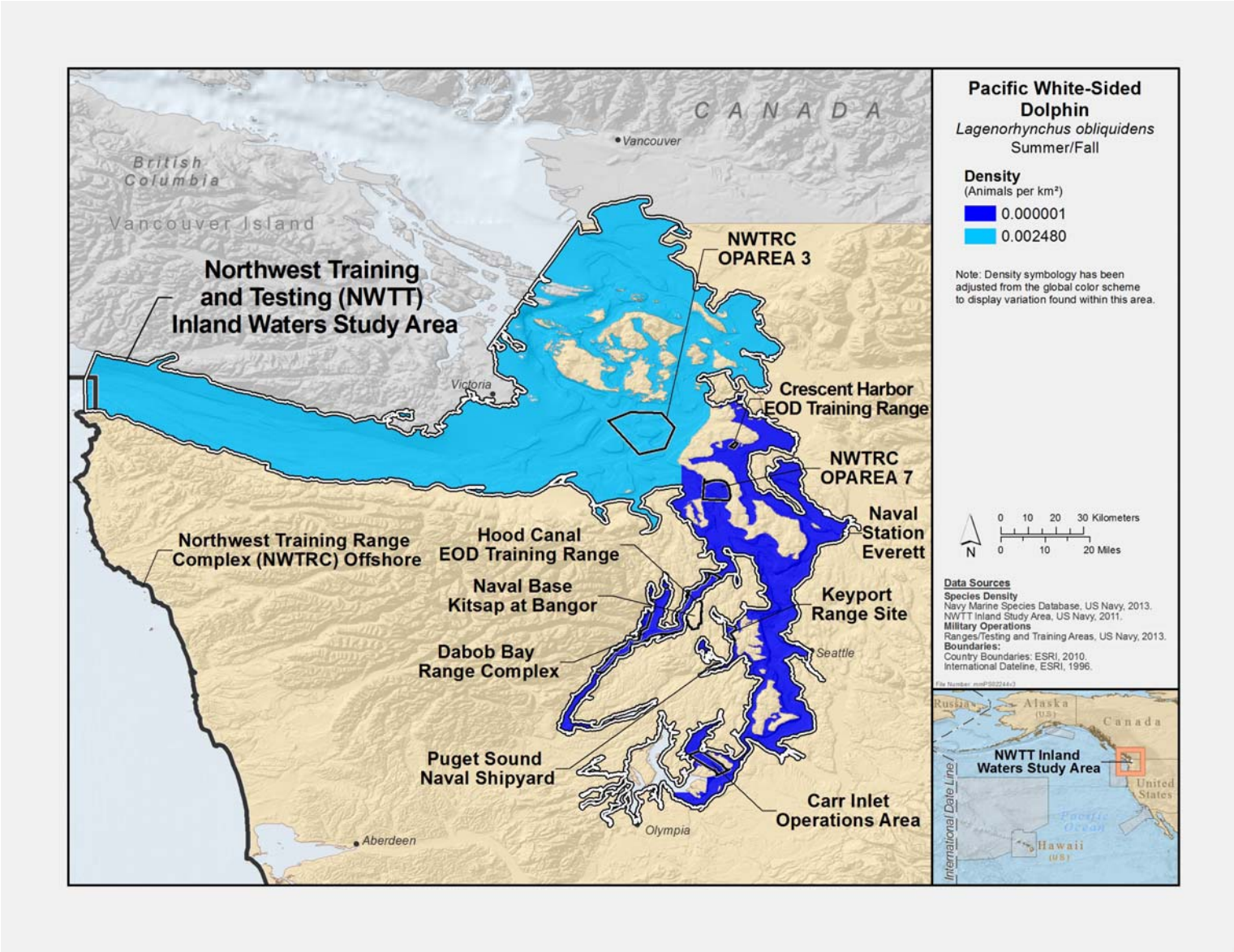

Figure 7-37: Summer/Fall Distribution of Pacific White-Sided Dolphin in the Inland Waters Portion of the NWTT Study Area

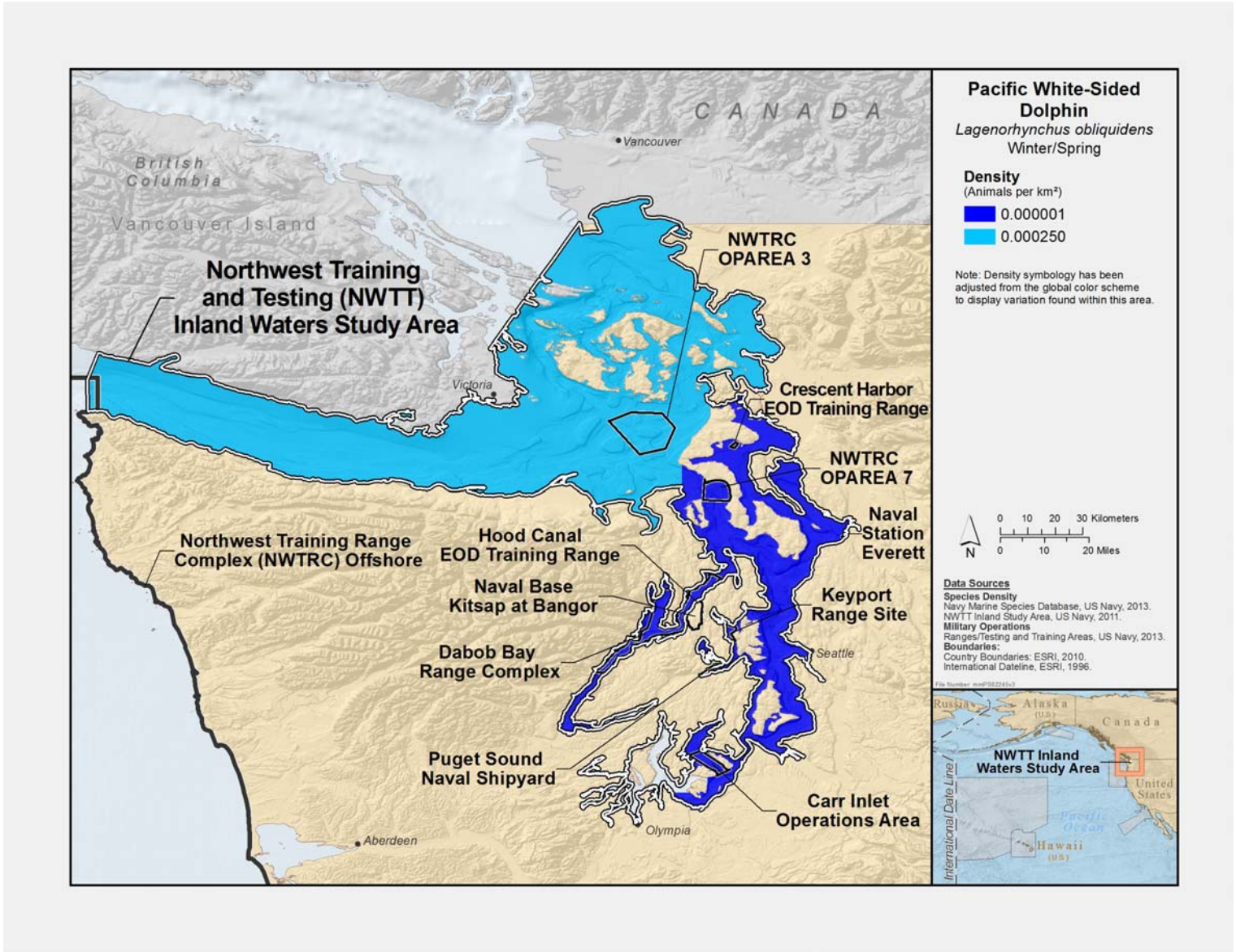

Figure 7-38: Winter/Spring Distribution of Pacific White-Sided Dolphin in the Inland Waters Portion of the NWTT Study Area

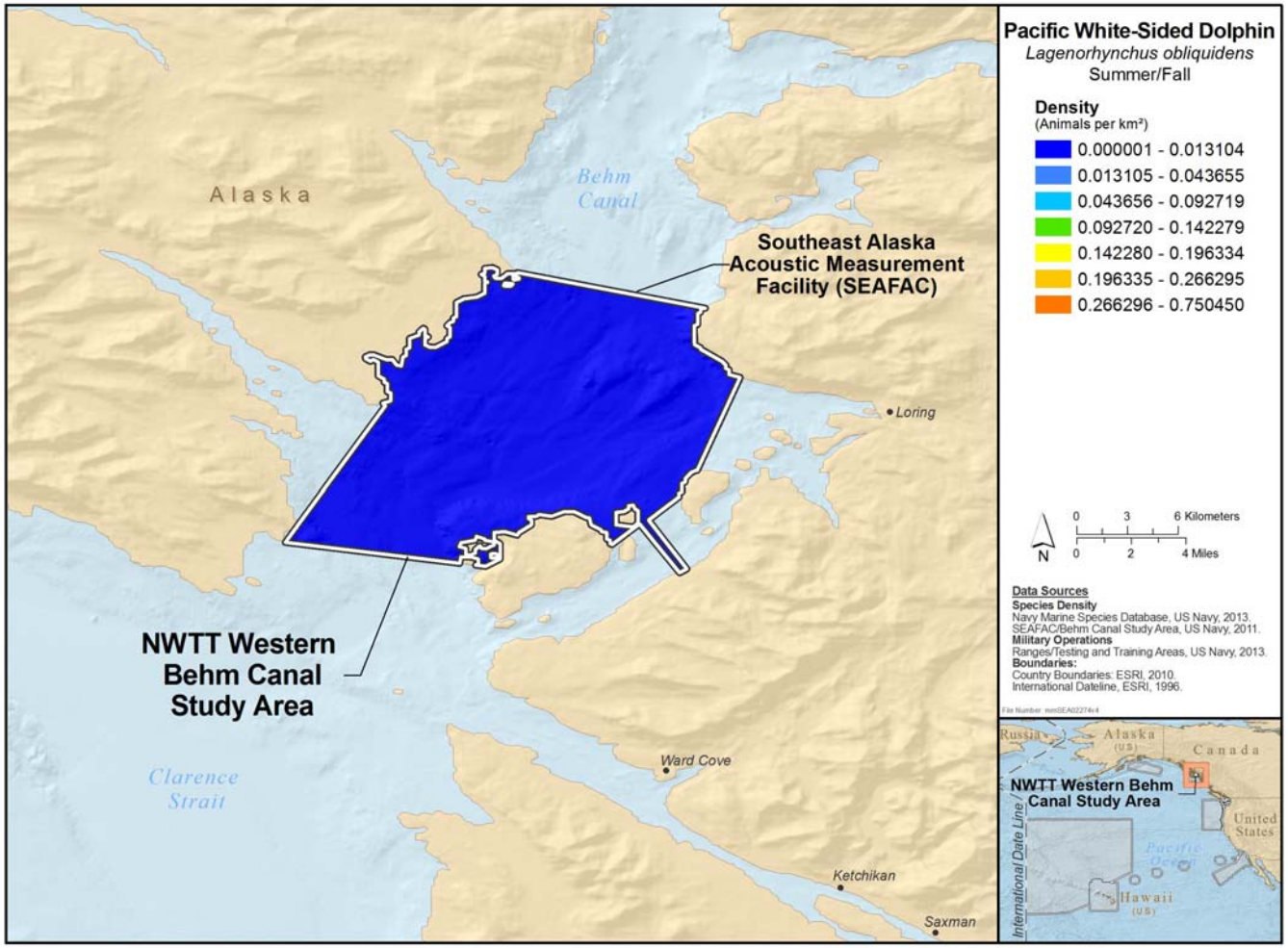

Figure 7-39: Summer/Fall Distribution of Pacific White-Sided Dolphin in the Western Behm Canal Portion of the NWTT Study Area

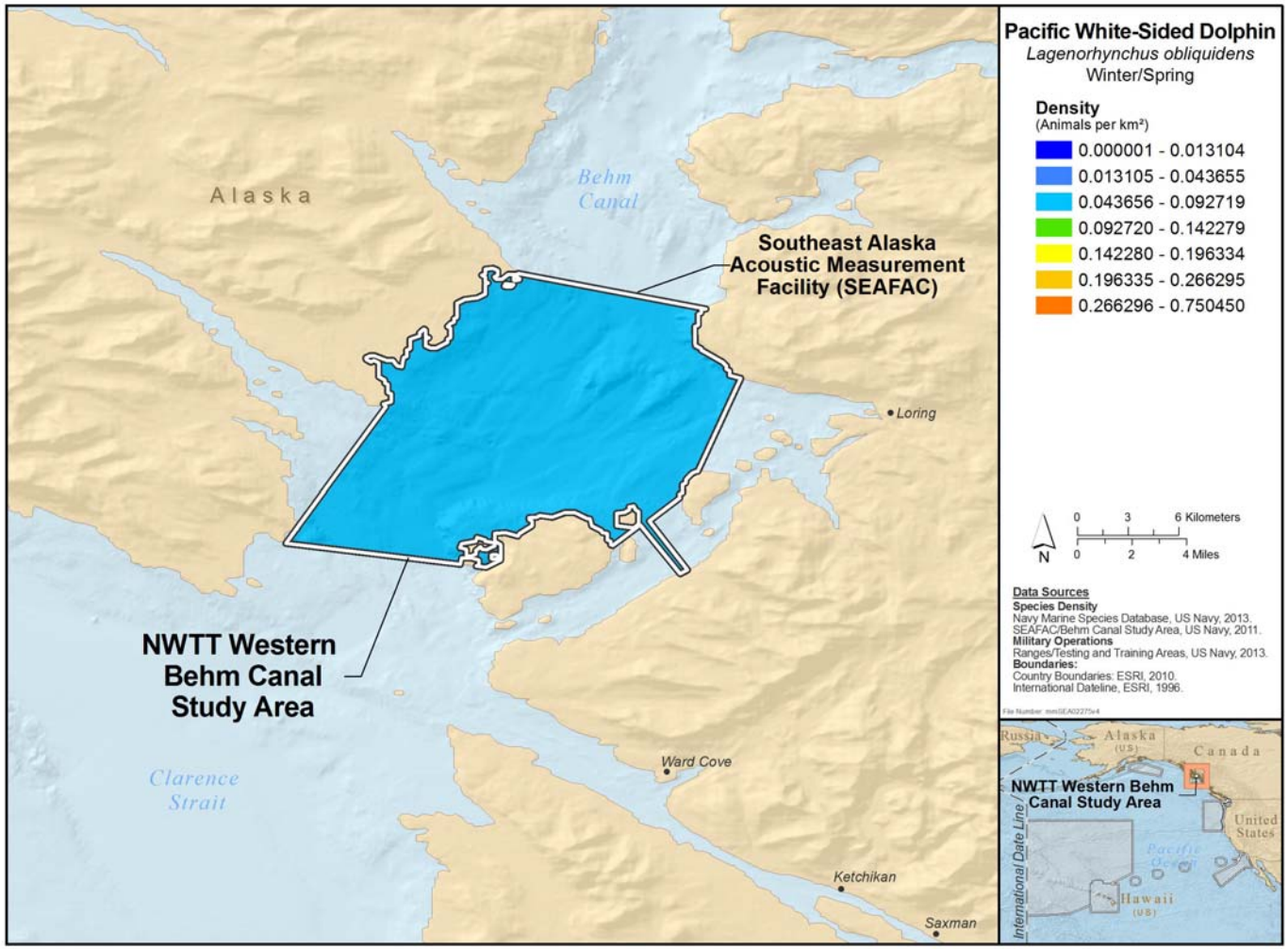

Figure 7-40: Winter/Spring Distribution of Pacific White-Sided Dolphin in the Western Behm Canal Portion of the NWTT Study Area

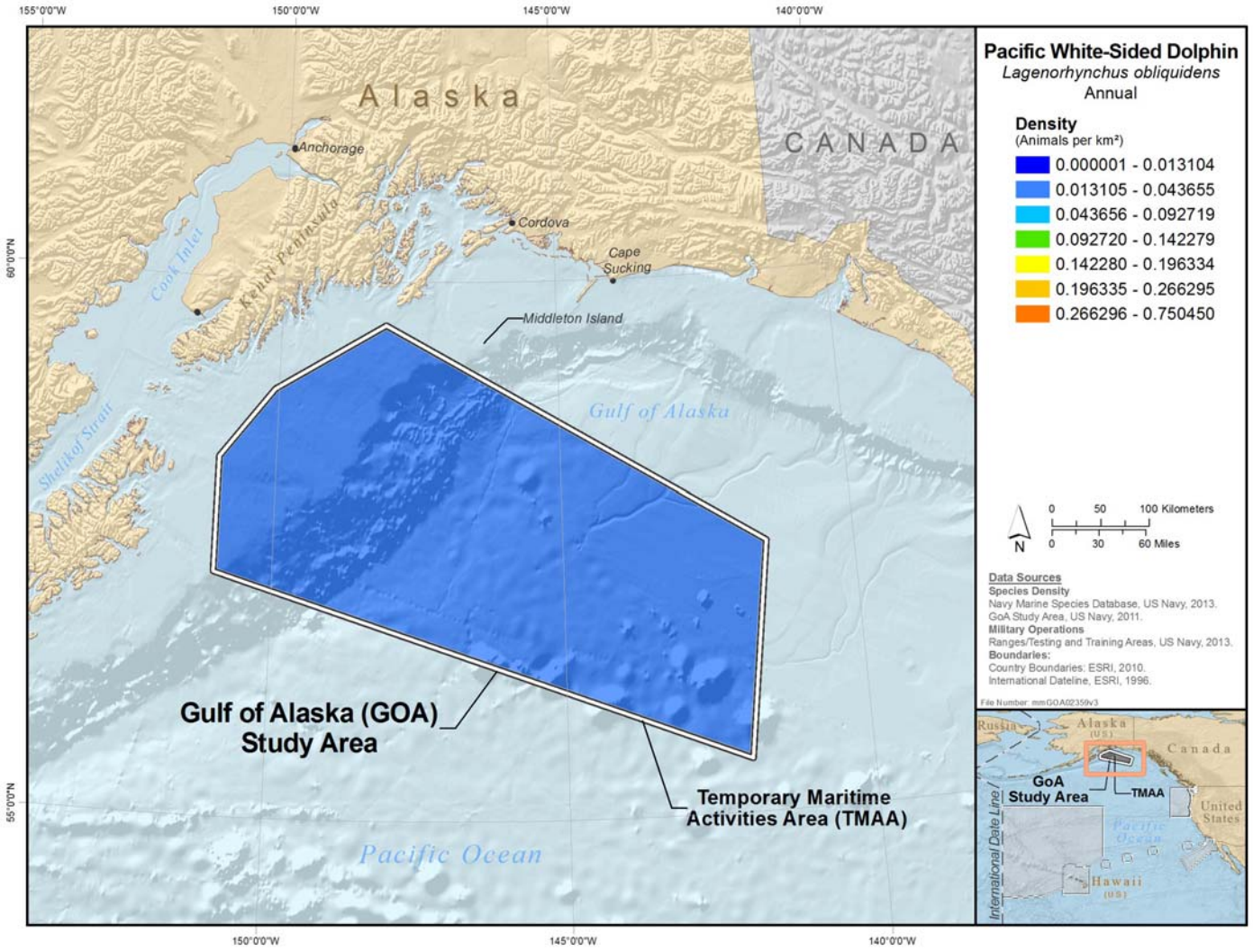

Figure 7-41: Annual Distribution of Pacific White-Sided Dolphin in the GOA Study Area

7.1.8 *LISSODELPHIS BOREALIS*, NORTHERN RIGHT WHALE DOLPHIN

The northern right whale dolphin is an unusual-looking cetacean because it has a long, svelte body, no dorsal fin, and small flukes and pectoral fins (Jefferson et al. 2008; Leatherwood et al. 1988). They are all black with a small amount of white on the belly and tail. The uniqueness of this species' appearance makes them unlikely to be mistaken for any other species in their range, if seen clearly. The northern right whale dolphin is a temperate species found across the Pacific (Lipsky 2009). It appears more in Southern California in the cool months (Soldevilla et al. 2006) and is not seen frequently in Canadian waters (Baird and Stacey 1991). The lack of a dorsal fin means they cause minimal disturbance at the surface of the water, therefore, they may be difficult to observe in elevated Beaufort sea states (Jefferson et al. 2008). At a distance, when they are porpoising, they could be mistaken for a group of traveling sea lions (Jefferson et al. 2008; Leatherwood et al. 1988). They are seen in groups with a wide variety of marine mammals, including California sea lions, but their most frequent associates are Pacific white-sided dolphins, Risso's dolphins, and common dolphins (*Delphinus* sp.) (Allen et al. 2011; Leatherwood et al. 1988). A single stock of northern right whale dolphins, the California/Oregon/Washington stock, is recognized by NMFS (Carretta et al. 2011a).

HRC. This species has not been observed in HRC or the transit corridor (Hamilton et al. 2009).

SOCAL. NMFS has developed a CCE model for the northern right whale dolphin (Becker et al. 2012c). This model is applied to summer and fall. Ferguson and Barlow (2003) provided summer/fall uniform densities for the inner and outer Baja extension. Forney et al. (1995) divided waters off California into four geographic regions (Southern California Bight, Outer Southern California Waters, Central California, Northern California) for the purpose of providing stratified uniform density estimates based on line-transect data. They provided uniform densities for the winter and spring for northern right whale dolphin in each region. The species generally increases in abundance when moving north from the Southern California Bight. The Navy applied the densities for the Southern California Bight and the Outer Southern California Waters to the Baja extension in winter and spring. In the Southern California Bight, data for northern right whale dolphin are arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

MITT. This species is not expected to occur in the MITT or associated transit corridor study areas.

NWTT Offshore. Survey data suggest that, at least in the eastern North Pacific, seasonal inshore-offshore and north-south movements are related to prey availability, with peak abundance in the Southern California Bight during winter and distribution shifting northward into Oregon and Washington as water temperatures increase during late spring and summer (Leatherwood and Walker 1979; Barlow 1995; Forney et al. 1995; Forney and Barlow 1998). As noted above for SOCAL, NMFS developed a CCE habitat-based density model for northern right whale dolphins that provides spatially-explicit density estimates off the U.S. west coast for summer and fall (Becker et al. 2012c). Barlow and Forney (2007) also provide stratified uniform density estimates for northern right whale dolphin for California, Oregon, and Washington in summer/fall. In the absence of other data, their estimate for Oregon/Washington offshore waters was used for the area north of the SWFSC strata (refer to Figure 3-6) for summer/fall. A uniform density estimate for northern right whale dolphin is available for the Northern California

offshore stratum for winter/spring (Forney et al. 1995; Barlow et al. 2009). In the absence of other density data, this value was also used for the offshore areas to the north.

NWTT Inland Waters. Northern right whale dolphins are relatively common off the Washington coast, but based on a lack of sighting records, this species is not expected to occur within the Inland Waters region of the NWTT Study Area.

NWTT Western Behm Canal, Alaska. Northern right whale dolphins are not expected to occur within the Western Behm Canal region of the NWTT Study Area.

GOA. There are two sighting records of northern right whale dolphins in the Gulf of Alaska, but these are considered extremely rare/extralimital (National Oceanic and Atmospheric Administration 2012b, U.S. Department of the Navy 2006). There is no NMFS management stock for this species recognized for Alaska waters. Further, NOAA's Cetacean Density and Distribution Mapping Working Group (http://www.st.nmfs.noaa.gov/cetsound/) considers the occurrence of northern right whale dolphin in the Gulf of Alaska as "unknown"; however, they are listed as a species potentially occurring there. To acknowledge the potential presence of northern right whale dolphin in the GOA Study Area, a minimum density estimate of 0.00001 animals/km^2 was assigned.

Table 7-15: Sources of Density Values Used for Northern Right Whale Dolphin

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	L	CCE	CCE	L
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	L and LD	CCE and LD	CCE and LD	L and LD
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	LD	LD	LD	LD

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-16: Summary of Density Values for Northern Right Whale Dolphin in the HSTT Study Area

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	**	S	S	**
Inner Baja Extension	0.13782	0.0168	0.0168	0.13782
Outer Baja Extension	0.13948	0.008	0.008	0.13948
Southern California Bight	0.13782	S	S	0.13782
Outer Southern California Waters	0.13948	S	S	0.13948
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0.05767	S and 0.01937	S and 0.01937	0.05767
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0.00001	0.00001	0.00001	0.00001

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range; ** = estimates are location specific: see estimates for Southern California Bight and Outer Southern California Waters.

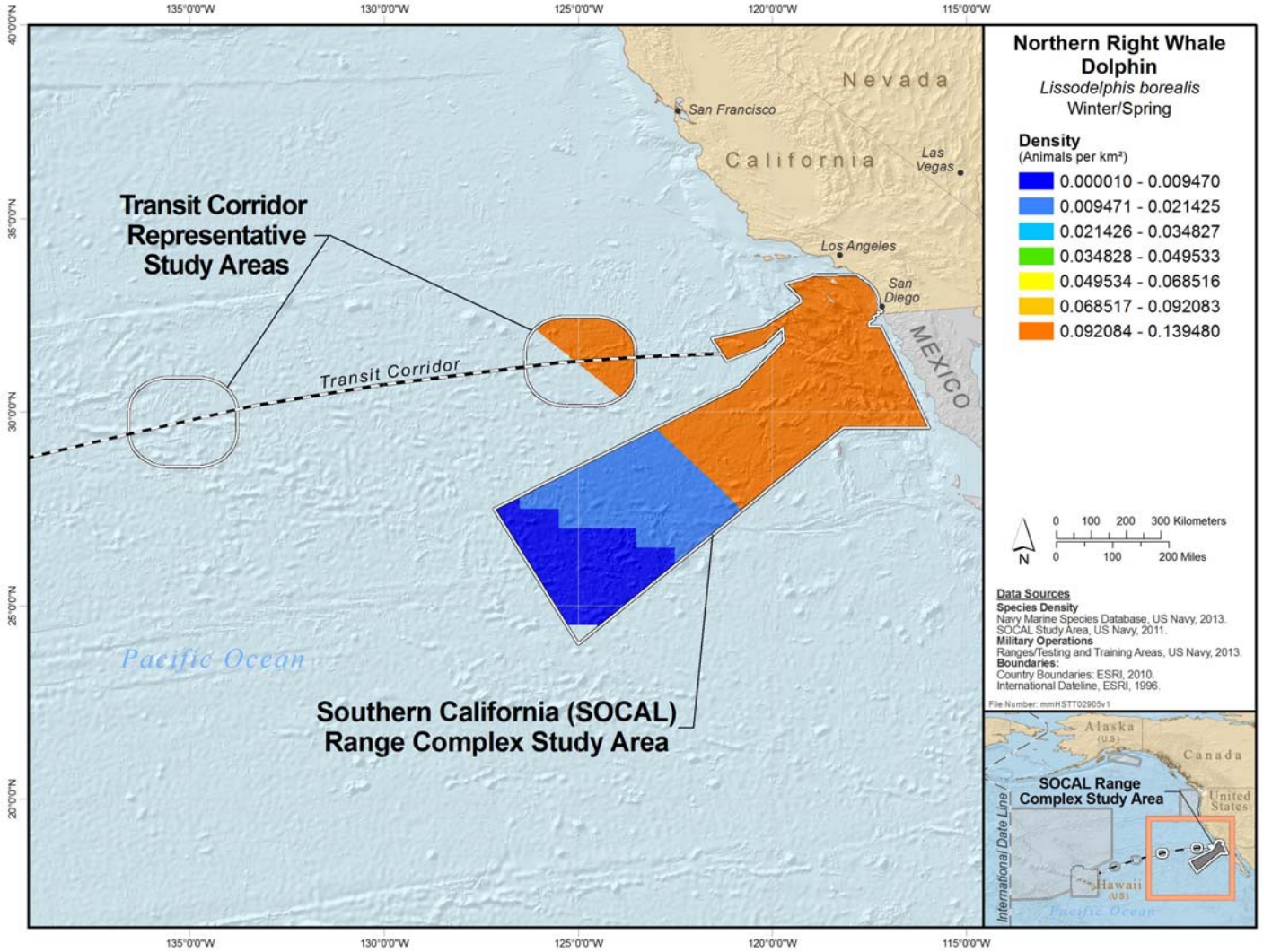

Figure 7-42: Winter/Spring Distribution of Northern Right Whale Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

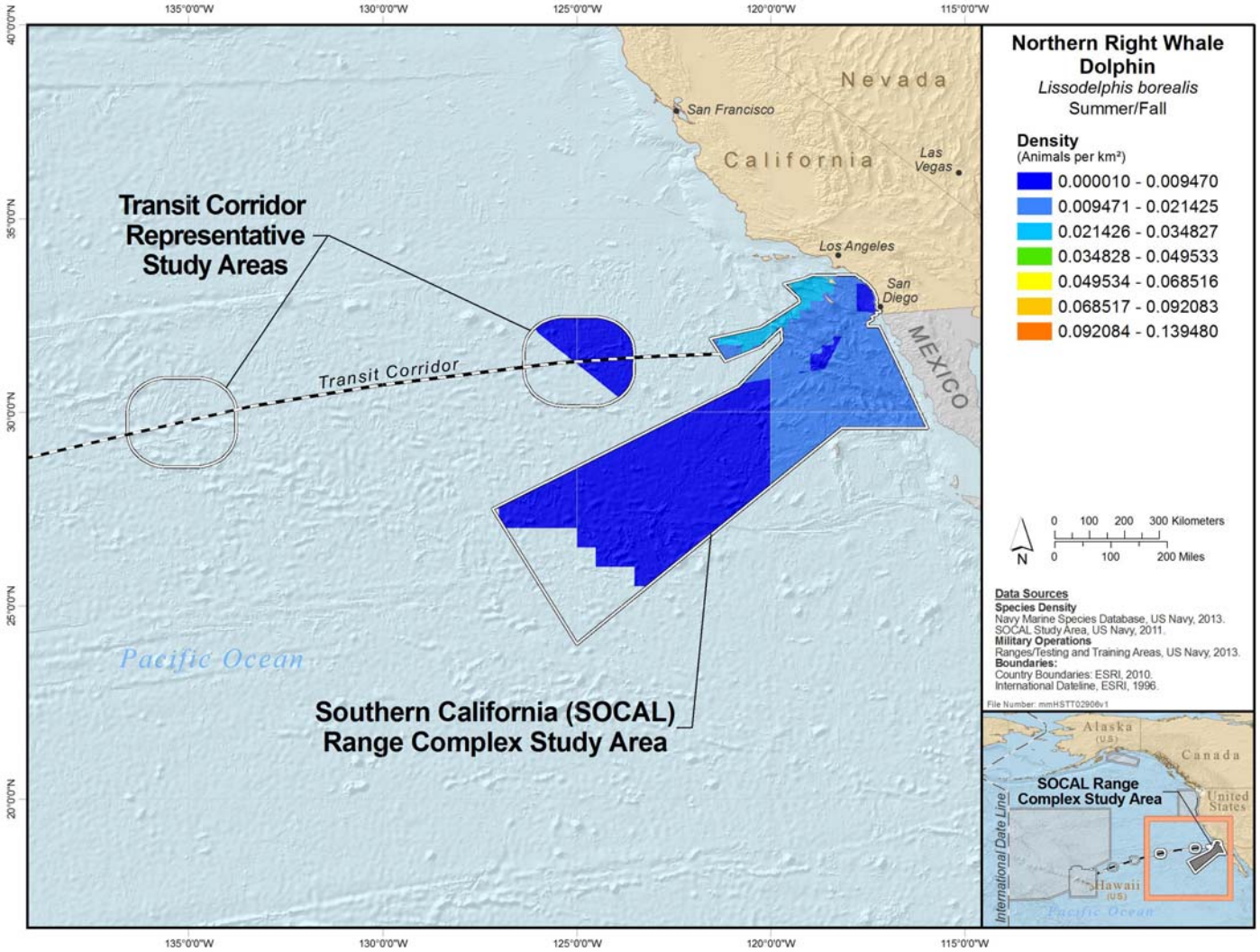

Figure 7-43: Summer/Fall Distribution of Northern Right Whale Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

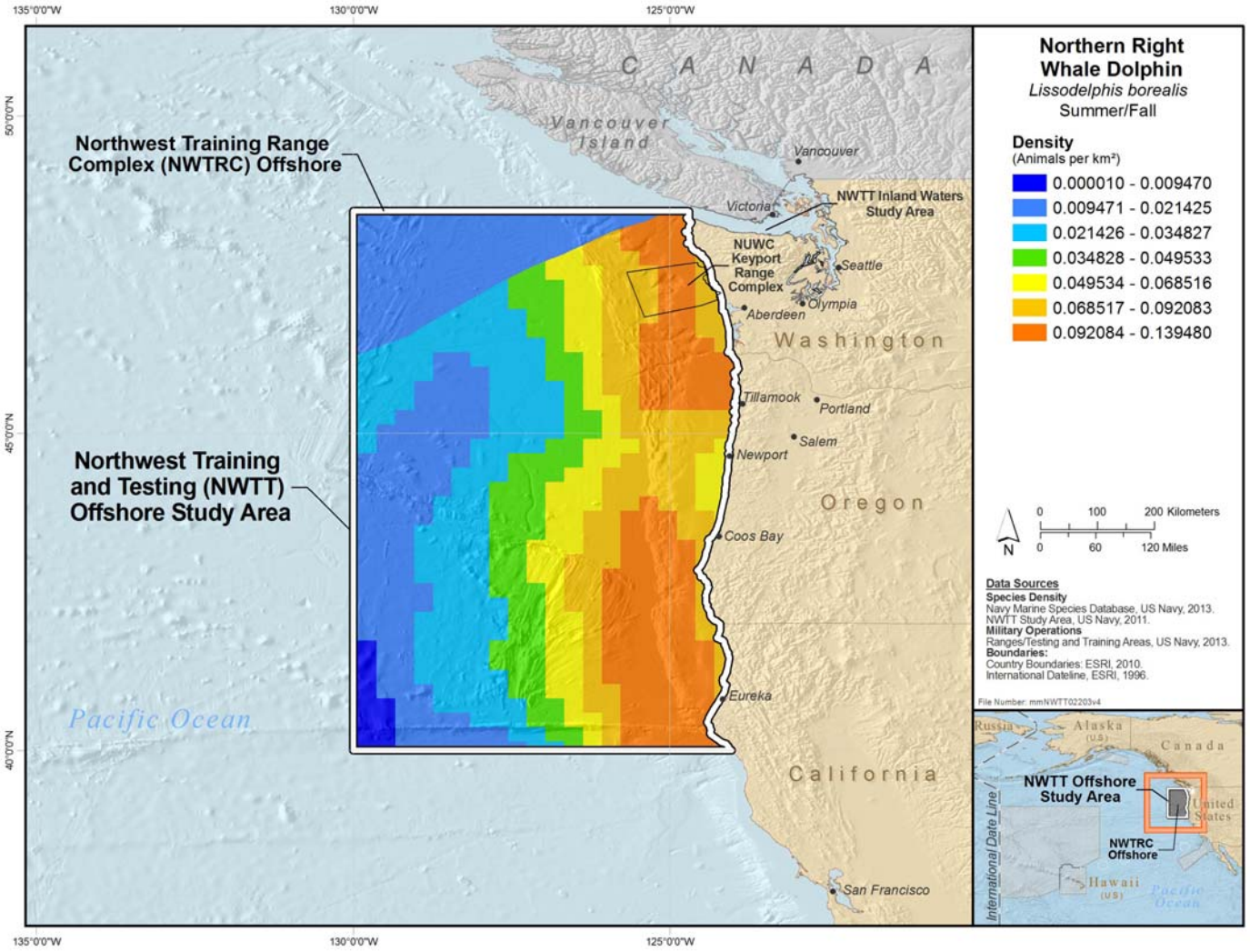

Figure 7-44: Summer/Fall Distribution of Northern Right Whale Dolphin in the Offshore Portion of the NWTT Study Area

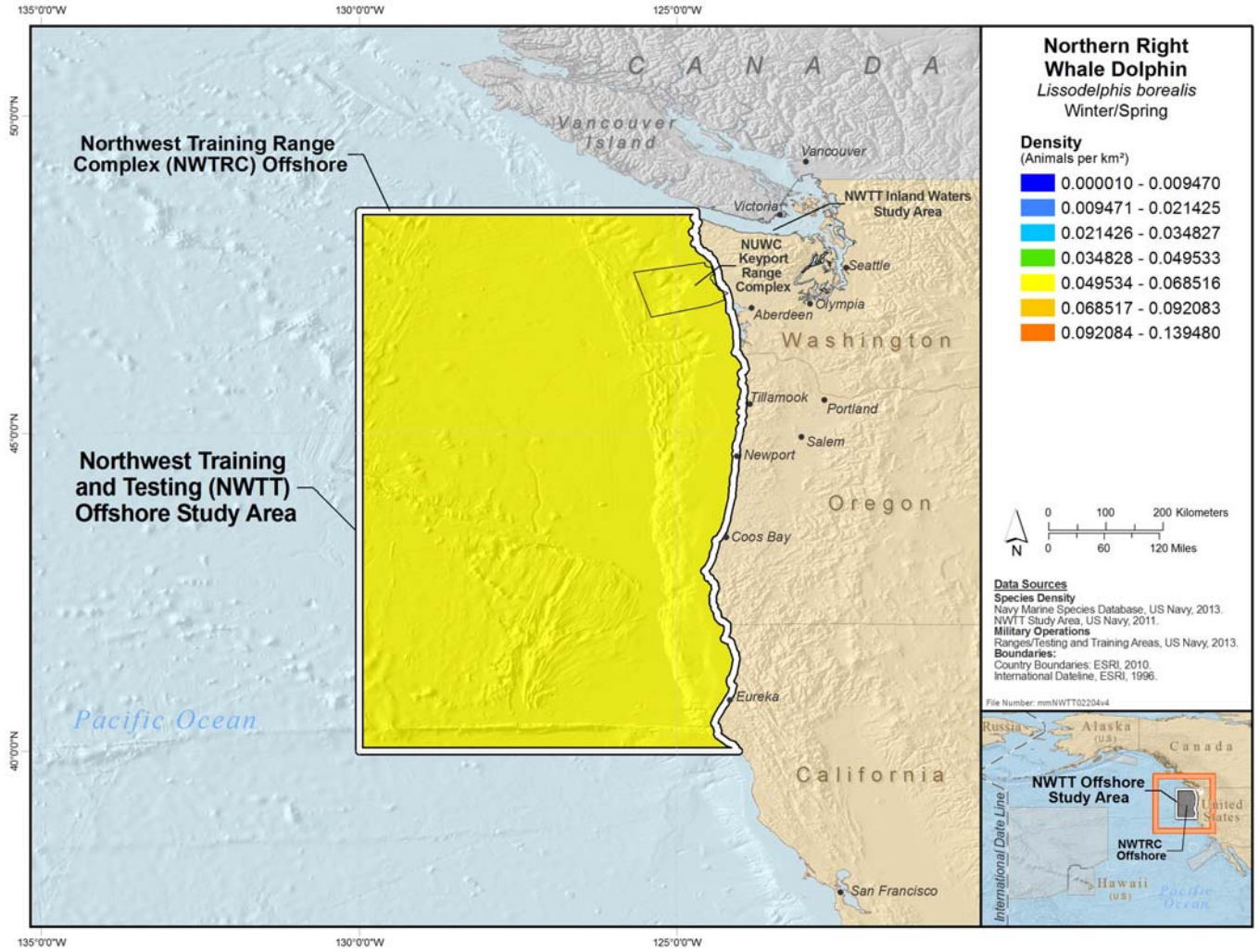

Figure 7-45: Winter/Spring Distribution of Northern Right Whale Dolphin in the Offshore Portion of the NWTT Study Area

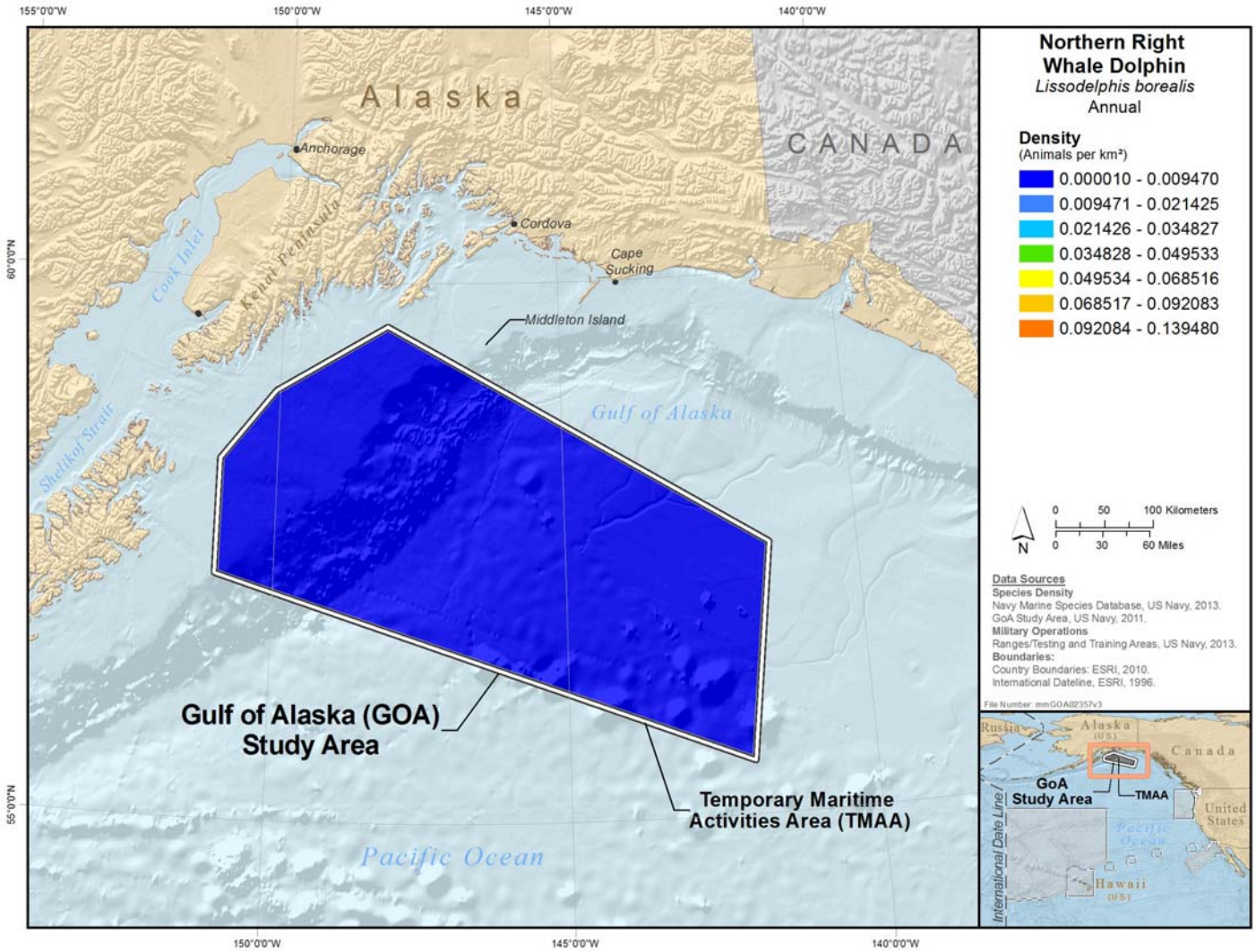

Figure 7-46: Annual Distribution of Northern Right Whale Dolphin in the GOA Study Area

7.1.9 *ORCINUS ORCA*, KILLER WHALE

Killer whales are top predators that are found throughout the world's oceans (Dahlheim and Heyning 1999; Jefferson et al. 2008). The structure of the division of groups within the species is complex and has a strong bearing on the range, behavior, foraging strategy, and physiology of each type of killer whale (Baird 2000; Foote et al. 2011; Foote et al. 2009; Kasamatsu et al. 2000; Pitman and Durban 2012). A single species of killer whale is currently recognized, but strong and increasing evidence indicates the possibility of several different species of killer whales worldwide, many of which are currently called "ecotypes" (Ford 2008; Morin et al. 2010). The different geographic forms of killer whale are distinguished by distinct social and foraging behaviors and other ecological traits. In the North Pacific, these recognizable geographic forms are variously known as ''residents,'' ''transients," and "offshores" (Baird 2000; Barrett Lennard et al. 1996; Hoelzel et al. 2007). Killer whales' physical profile is unmistakable. They have a tall dark dorsal fin, a robust black body with a striking patch of white behind the eye, a white lower jaw, and lighter-colored "saddle patch" behind the dorsal fin (Jefferson et al. 2008). They are unlikely to be mistaken for any other species, except possibly Risso's dolphins if only the dorsal fins are seen from a distance or false killer whales if only females (which are smaller than males) and juveniles are encountered (Leatherwood et al. 1988).

Eight killer whale stocks are recognized within the Pacific U.S. EEZ, including (1) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock (Prince William Sound through the Aleutian Islands and Bering Sea); (2) the AT1 Transient stock (Alaska from Prince William Sound through the Kenai Fjords); (3) the Alaska resident stock (Southeast Alaska to the Aleutian Islands and Bering Sea); (4) the Northern Resident stock (British Columbia through part of Southeast Alaska); (5) the West Coast Transient stock (Alaska through California); (6) the Offshore stock (Southeast Alaska through California); (7) the Southern Resident stock (mainly within the inland waters of Washington State and southern British Columbia, but also in coastal waters from British Columbia through California); and (8) the Hawaii stock (Allen and Angliss 2012; Carretta et al. 2012).

In SOCAL, the stocks that may interact with the SOCAL range complex are the Offshore stock and the West Coast Transient stock. Animals from these stocks pass through the area, but do not occupy it for any ongoing period of time. The Hawaii stock could interact with Navy training in the HRC. In the transit corridor, the West Coast Transient stock is the likely stock that would be encountered. Little is known about the stock structure of killer whales in the MITT Study Area. In the Offshore region of the NWTT Study Area, three stocks of killer whale may occur: the West Coast Transient stock, the Offshore stock, and the Southern Resident stock (Carretta et al. 2012), although Northern Resident killer whales may be found infrequently in waters off Washington (Allen and Angliss 2012). The West Coast Transient stock and the Southern Resident stocks are the two that occur in the Inland Waters region of the Study Area, although individuals of the Northern Resident stock occasionally venture into the area. The Alaska Resident and West Coast Transient stocks are the stocks most likely to occur in the Western Behm Canal region, although individuals of the Northern Resident stock may occasionally venture into the area. Killer whales most likely to occur in the GOA Study Area based on dominant distribution patterns include the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock and the Alaska Resident stock; while

whales from the AT1 Transient stock and the Offshore stock could also occur in the GOA Study Area, occurrence is considered rare and infrequent, respectively.

HRC. Sightings of killer whales in HRC are a rare event. Barlow (2006) calculated a uniform density for killer whales that the Navy applied to all seasons in HRC and in the eastern portion of the transit corridor. The HRC density figure demonstrates that the St. Andrews global model (SMRU Ltd. *in prep*) predicts that much of the remainder of the Study Area is suitable for sustaining a high density of killer whales, but the data do not support that level of killer whale presence in tropical or subtropical areas.

SOCAL. Barlow and Forney (2007) provided a summer/fall uniform density for the NMFS California/Oregon/Washington survey area. Ferguson and Barlow (2003) calculated a uniform density for an area that correlates with the entire Baja extension (inner and outer) for summer/fall. Forney et al. (1995) calculated a uniform density for winter/spring that the Navy applies to the SOCAL area and the Baja extension. In the eastern portion of the transit corridor, the Navy calculated a mean value for warm and cool seasons from the literature. This approach is supported by Forney and Wade (2006). Like the HRC map, the density maps for SOCAL demonstrate that the St. Andrews global model (SMRU Ltd. *in prep*) predicts that much of the remainder of the Study Area is suitable for sustaining a high density of killer whales, but the data suggest a much lower level of killer whale presence. In the Southern California Bight, data for killer whales are arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

MITT. Although killer whales are found in tropical waters and the open ocean, they are most numerous in coastal waters and at higher latitudes (Dahlheim and Heyning 1999; Forney and Wade 2006). Killer whales have been sighted in the MITT Study Area (Eldredge 1991; Rock 1993; Wenninger 2010); however, there were no killer whale sightings during the Navy's 2007 systematic survey of the Study Area (Fulling et al. 2011). In the absence of study area specific density data, and consistent with recommendations from scientists at PIFSC, line-transect estimates derived for Hawaiian waters (Barlow 2006) were used to represent the best available estimates for the MITT Study Area. Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual killer whale density.

NWTT Offshore. Due to the difficulties associated with reliably distinguishing the different stocks of killer whales from at-sea sightings, density estimates for the Offshore region of the NWTT Study Area are presented for the species as a whole. Barlow and Forney (2007) provided stratified uniform density estimates for waters off California, Oregon, and Washington for summer/fall. Their estimate for Oregon/Washington offshore waters was also used for the area north of the SWFSC strata (refer to Figure 3-6). Uniform density values for killer whale are available for the Northern California offshore stratum for winter/spring (Forney et al. 1995; Barlow et al. 2009). In the absence of other density data, this value was also used for areas north of this stratum for winter/spring.

NWTT Inland Waters. As noted above, the Southern Resident and West Coast Transient stocks are the two that are most likely to occur in the Inland Waters region of the NWTT Study Area. The Southern Resident stock is a trans-boundary stock including killer whales in inland Washington and southern

British Columbia waters. Photo-identification of individual whales through the years has resulted in a substantial understanding of this stock's structure, behaviors, and movements in inland waters. The current abundance estimate for this stock is 87 whales (Carretta et al. 2013). Average seasonal residency patterns based on sighting data collected from January 2003 through December 2009 (Hanson and Emmons, *in prep*) were used in concert with sighting data maintained by the Whale Museum to provide density estimates of Southern Resident Killer Whale for the inland waters. Hanson and Emmons (*in prep*) presented the percentage of time the Southern Resident pods spent within the inland waters on a monthly basis. Their monthly sighting data were used to establish residency patterns for four seasonal periods. The mean percentage of each three-month period was used to estimate the average number of animals present in the inland waters assuming a total population of 88 animals. Sighting data from the Whale Museum's Southern Resident Killer Whale sighting database were then used to determine distribution patters within each of the four seasons.

Consistent with the approach taken by Hanson and Emmons, data from January 2003 onward were used, and included only those database sightings positively identified as Southern Residents. Monthly sightings from all years combined were plotted using ArcGIS and overlaid on the Study Area strata. Geographic strata used for density estimation were developed consistent to the degree possible with designated critical habitat strata (NMFS 2008; see Fig. 7 on page II-38). Sightings by stratum were then calculated in ArcGIS and exported to Excel in order to estimate the percentage of sightings occurring monthly in each of the Study Area strata. The total number of animals estimated per season within each stratum, divided by the area of each stratum, provided an estimate of seasonal density for each of the strata.

Data from Houghton et al. (*in prep*) were used to estimate seasonal occurrence patterns of transient killer whales in the Inland Waters. Based on sighting data collected over a 7-year period (2004–2010), Houghton et al. (*in prep*) presented the number of unique occurrences within inland waters on a monthly basis for five geographic strata. Their monthly occurrence data, in concert with their average group size estimate for the 2004–2010 period (5.16 animals), were used to estimate the average number of individuals occurring within the inland waters on a seasonal basis. Seasonal density was estimated based on the area of each of the strata used by Houghton et al. (*in prep*).

NWTT Western Behm Canal, Alaska. For the Western Behm Canal, density estimates for all seasons were taken from the Marine Mammal Occurrence/Density Report prepared in support of a NEPA document for Navy activities at SEAFAC (U.S. Department of the Navy 2010b). Density estimates were provided for both the Alaska Resident and West Coast Transient stocks.

GOA. Killer whales are reasonably common in most of Alaskan waters. There were a total of 21 killer whale sightings of 138 total animals during a recent (June and July 2013) Navy-funded line-transect survey in and around the TMAA. During the survey, sighting data were collected from four survey strata designed to sample the diverse habitat present in the GOA Study Area, and resulted in the following density estimates for killer whales: 0.005 (CV = 0.60) inshore stratum, 0.002 (CV = 0.77) offshore stratum, 0.002 (CV = 0.77) seamount stratum, and 0.020 (CV = 1.93) slope stratum (Rone et al. 2014).

Table 7-17: Sources of Density Values Used for Killer Whale

Location	Spring	Summer	Fall	Winter
HRC	L	L	L	L
W. Transit Corridor	L	L	L	L
E. Transit Corridor	LD	LD	LD	LD
SOCAL	L	L	L	L
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	L and LD	L and LD	L and LD	L and LD
NWTT Inland Waters	LD	LD	LD	LD
Western Behm Canal	LD	LD	LD	LD
GOA	L	L	L	L

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-18: Summary of Density Values for Killer Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0.00014	0.00014	0.00014	0.00014
W. Transit Corridor	0.00014	0.00014	0.00014	0.00014
E. Transit Corridor	0.000195	0.000425	0.000425	0.000195
SOCAL	0.00025	0.00071	0.00071	0.00025
Inner Baja Extension	0.00025	0.0004	0.0004	0.00025
Outer Baja Extension	0.00025	0.0004	0.0004	0.00025
MITT	0.00014	0.00014	0.00014	0.00014
MITT Transit Corridor	0.00009	0.00009	0.00009	0.00009
NWTT Offshore	0.00025–0.0016	0.00025–0.0016	0.00025–0.0016	0.00025–0.0016
NWTT Inland Waters: Southern Resident	S	S	S	S
NWTT Inland Waters: Transient	S	S	S	S
Western Behm Canal: Alaska Resident	0.0153	0.0050	0.0349	0.0050
Western Behm Canal: Transient	0.0020	0.0057	0.0041	0.0020
GOA	0.005–0.020	0.005–0.020	0.005–0.020	0.005–0.020

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

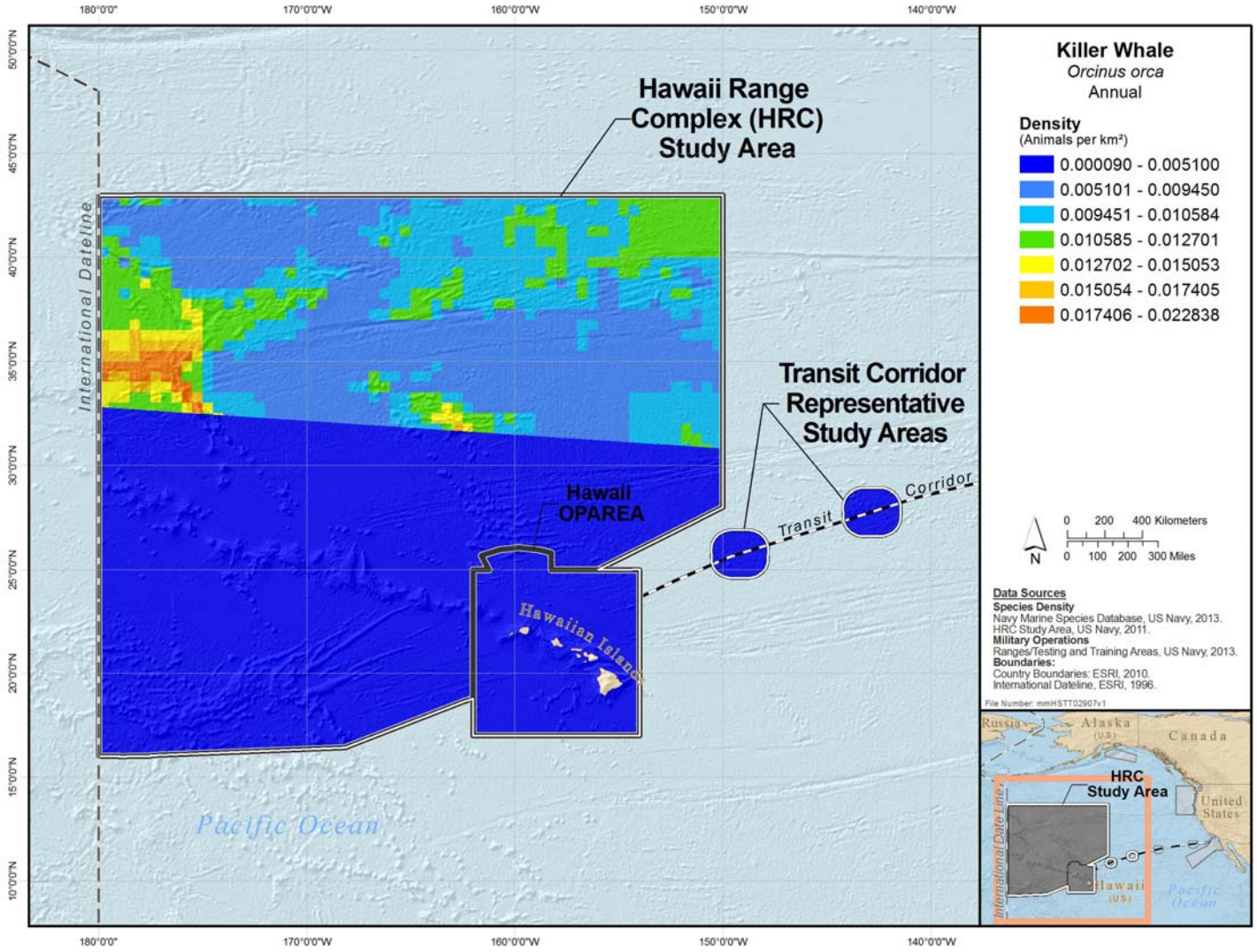

Figure 7-47: Annual Distribution of Killer Whale in HRC and the Western Portion of the Transit Corridor

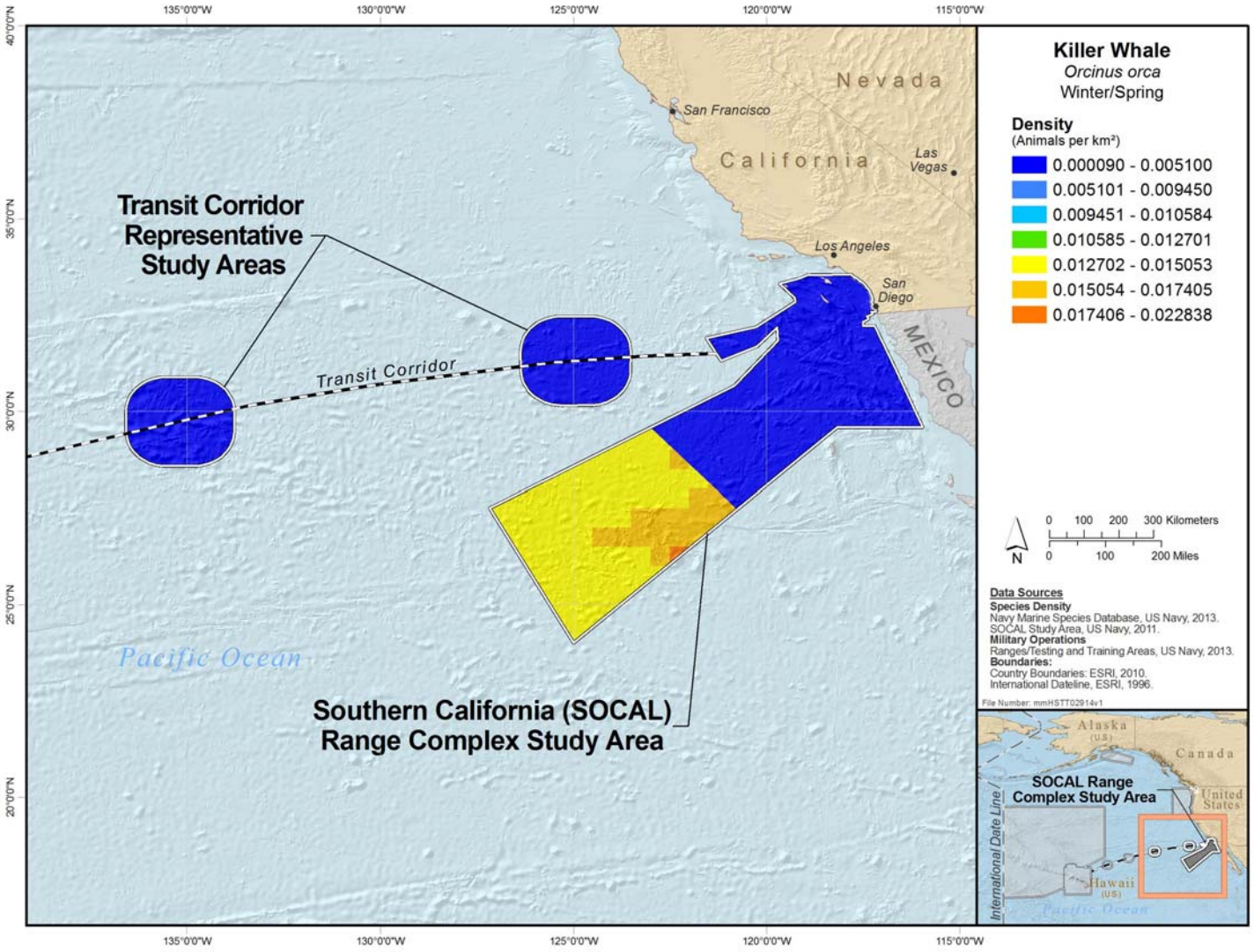

Figure 7-48: Winter/Spring Distribution of Killer Whale in SOCAL and the Eastern Portion of the Transit Corridor

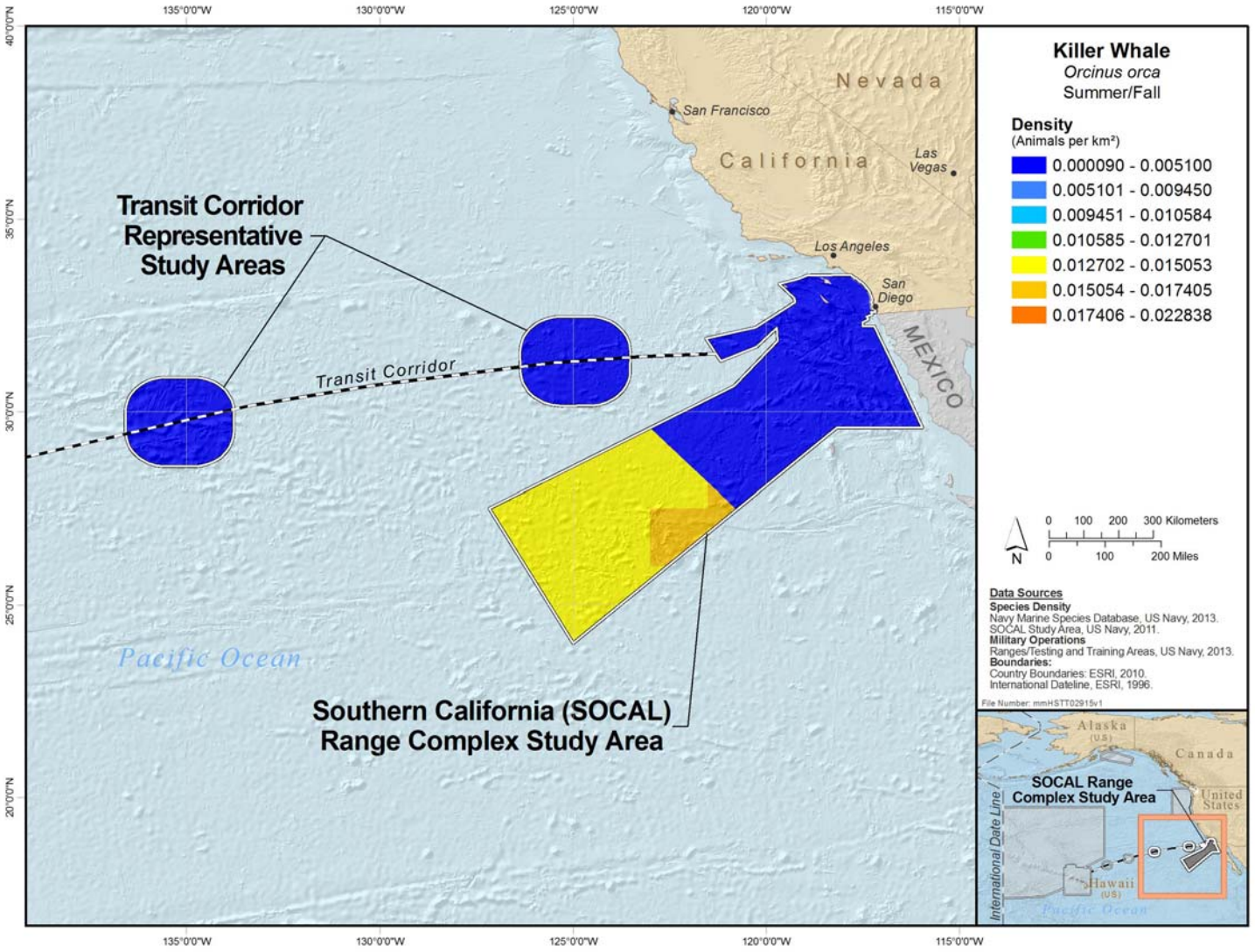

Figure 7-49: Summer/Fall Distribution of Killer Whale in SOCAL and the Eastern Portion of the Transit Corridor

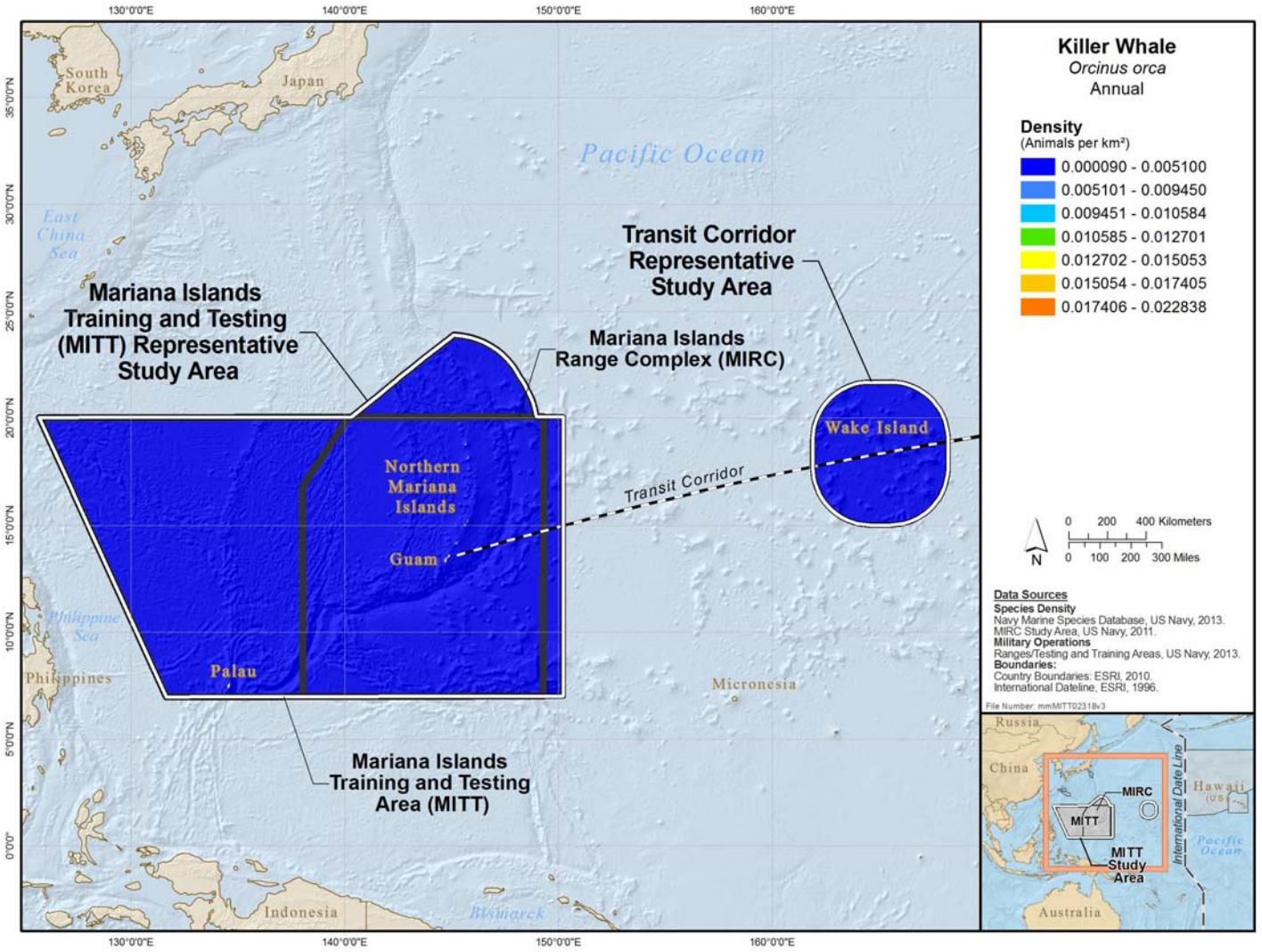

Figure 7-50: Annual Distribution of Killer Whale in MITT and the Associated Transit Corridor Study Areas

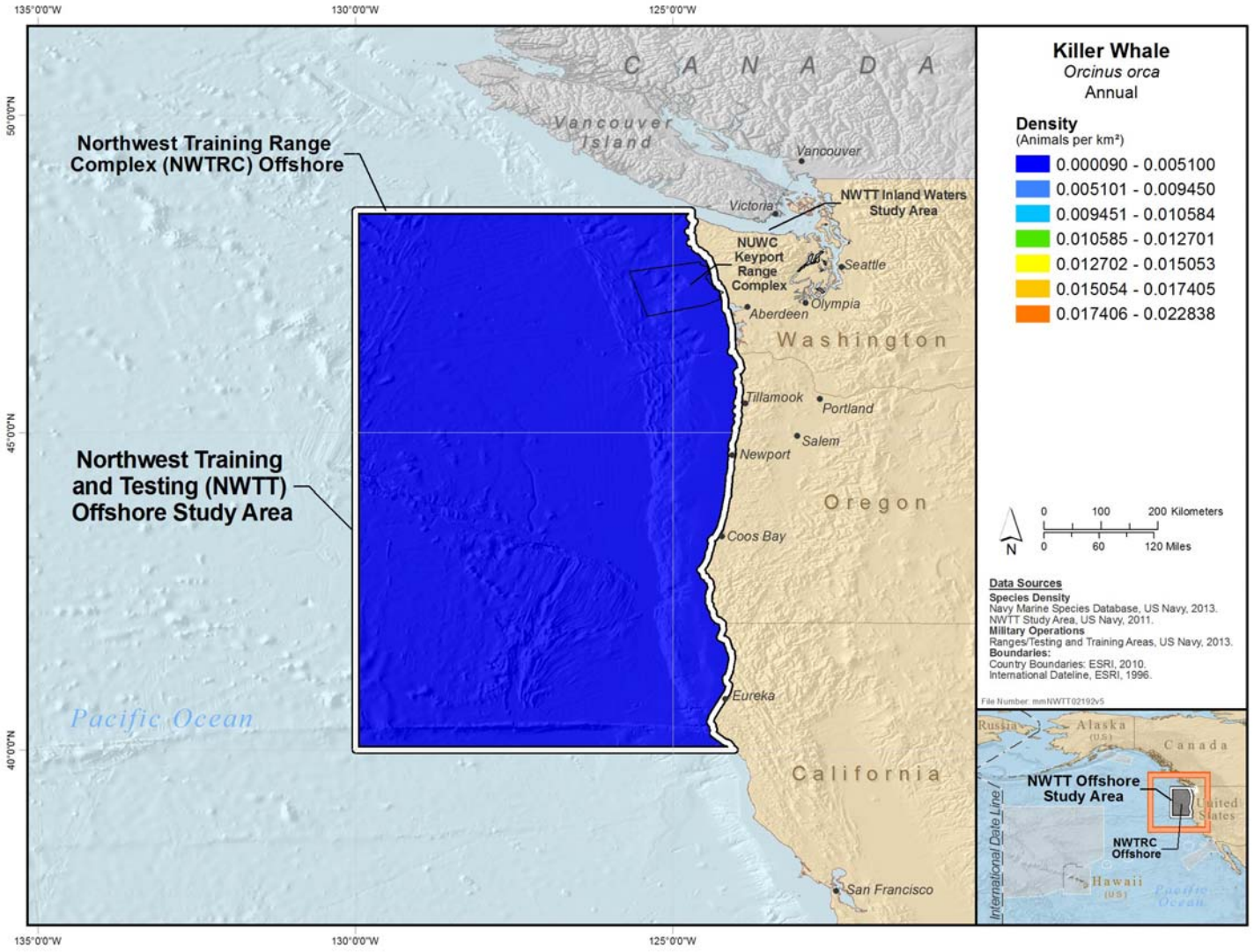

Figure 7-51: Annual Distribution of Killer Whale in the Offshore Portion of the NWTT Study Area

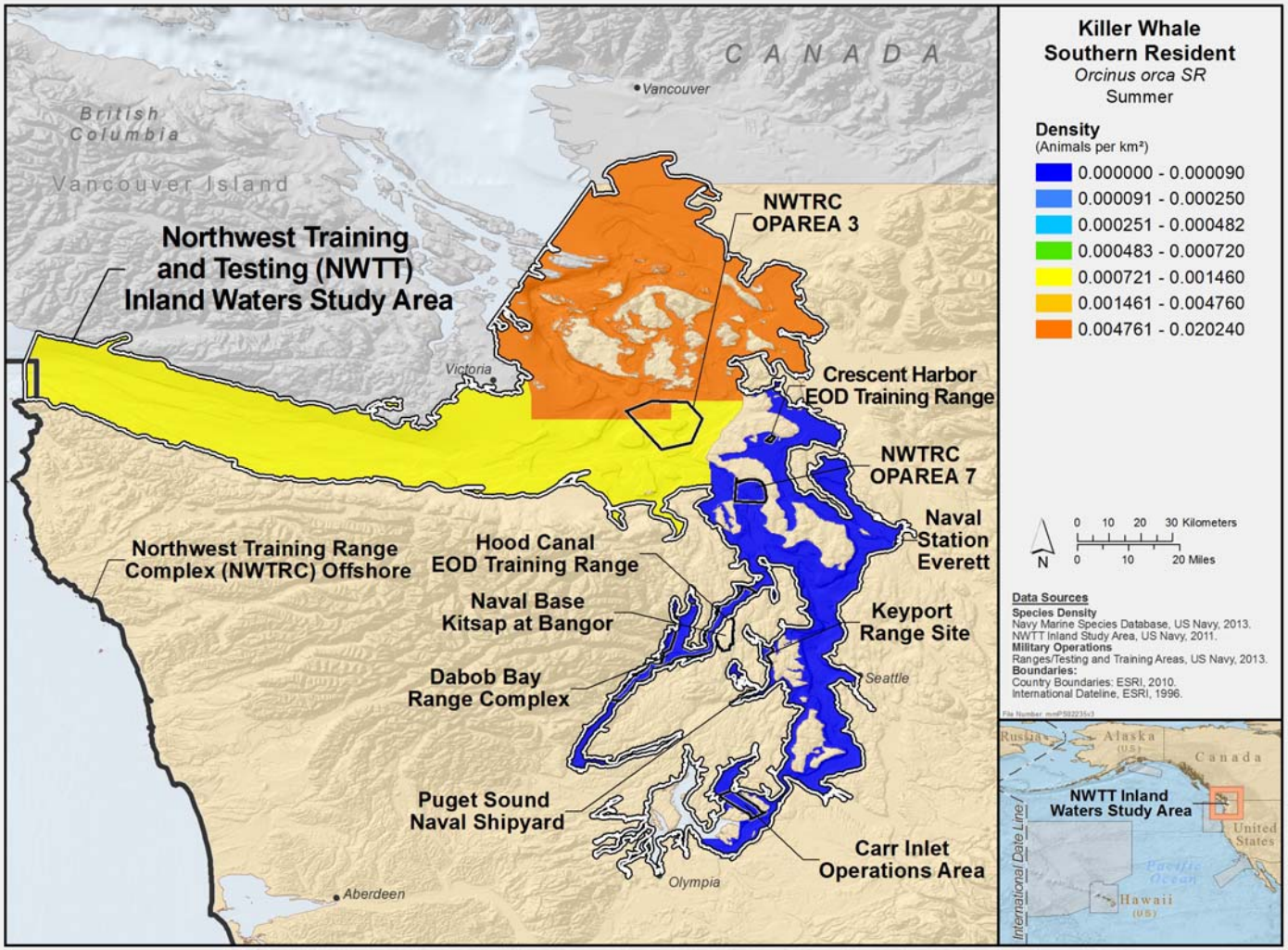

Figure 7-52: Summer Distribution of Southern Resident Killer Whale in the Inland Waters Portion of the NWTT Study Area

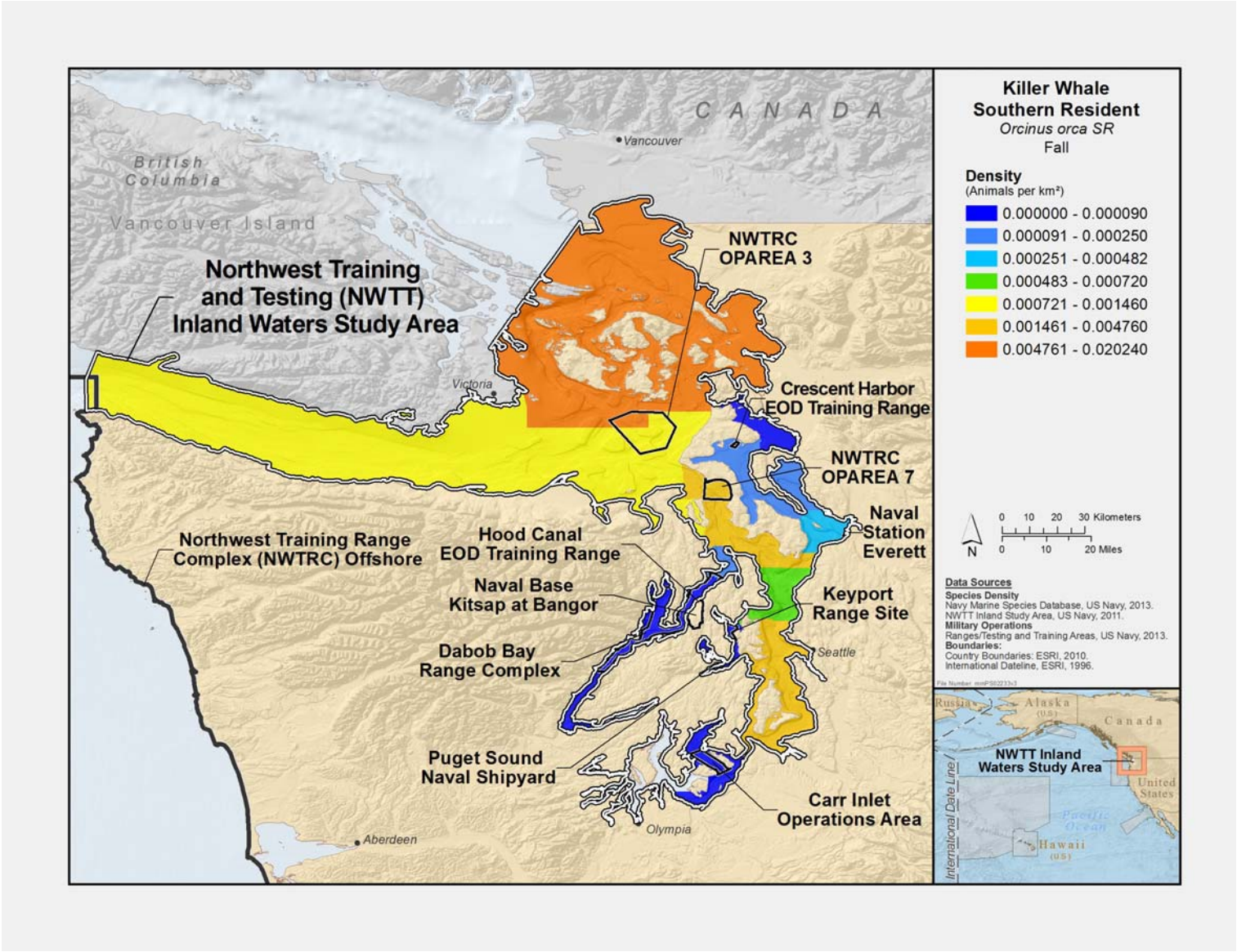

Figure 7-53: Fall Distribution of Southern Resident Killer Whale in the Inland Waters Portion of the NWTT Study Area

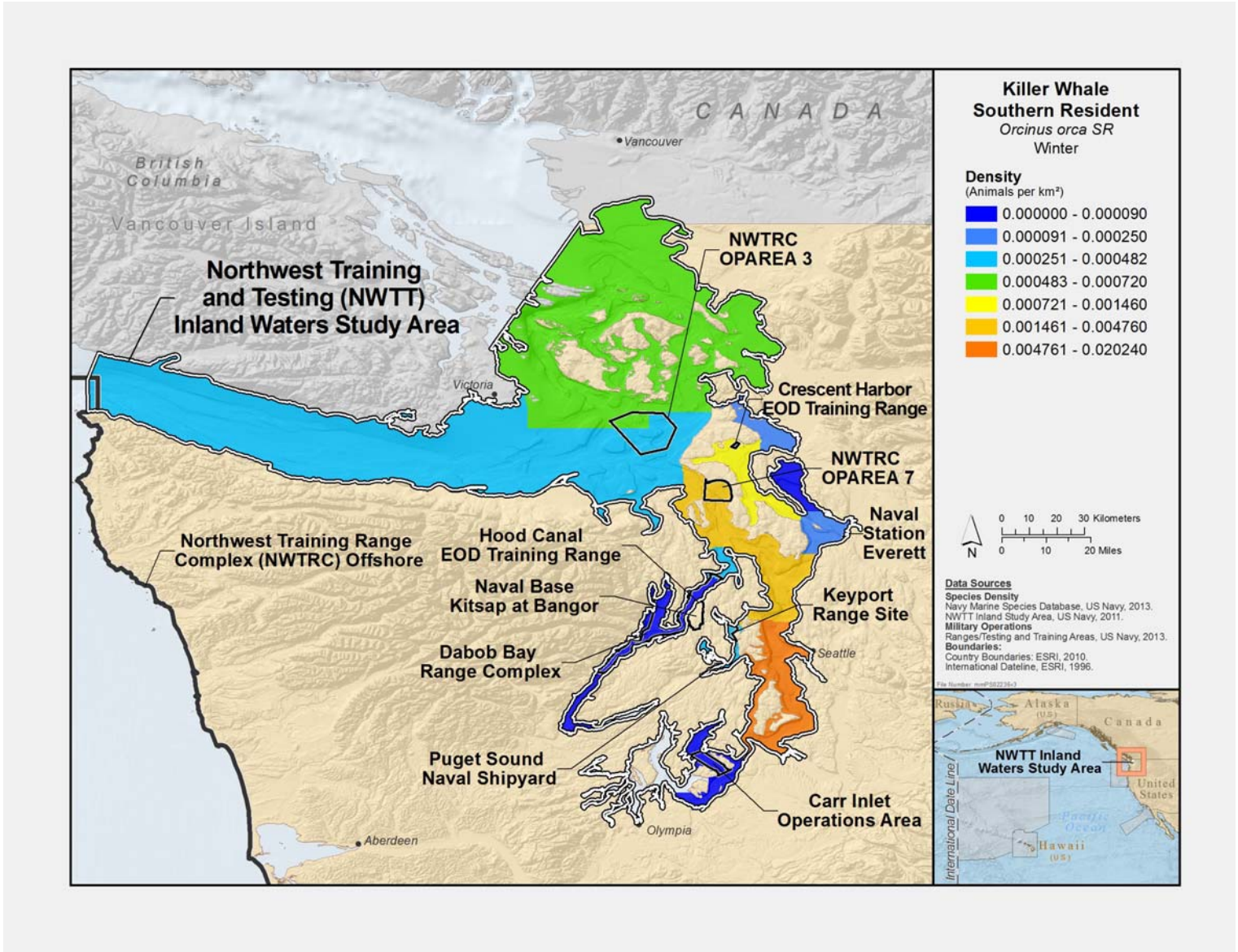

Figure 7-54: Winter Distribution of Southern Resident Killer Whale in the Inland Waters Portion of the NWTT Study Area

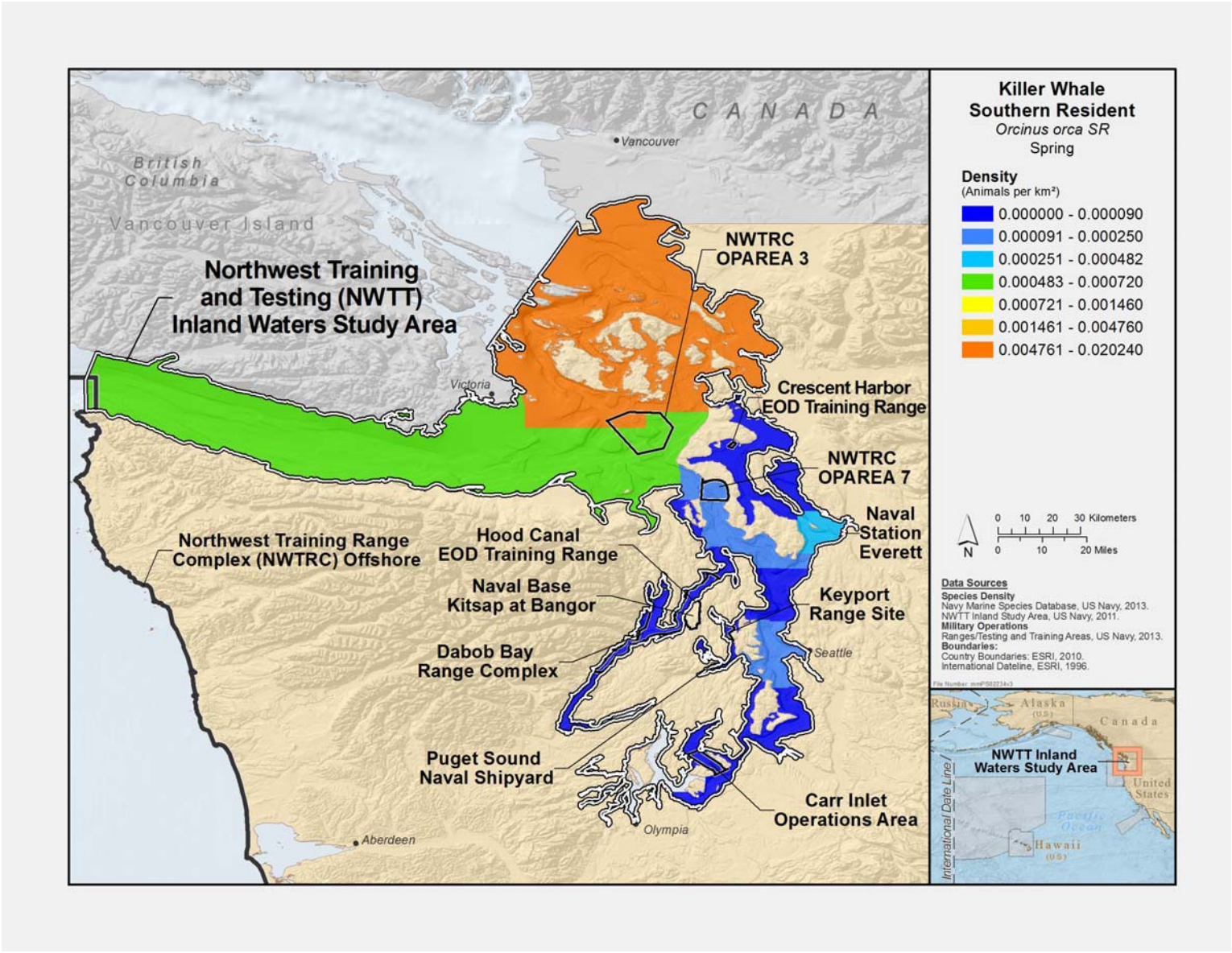

Figure 7-55: Spring Distribution of Southern Resident Killer Whale in the Inland Waters Portion of the NWTT Study Area

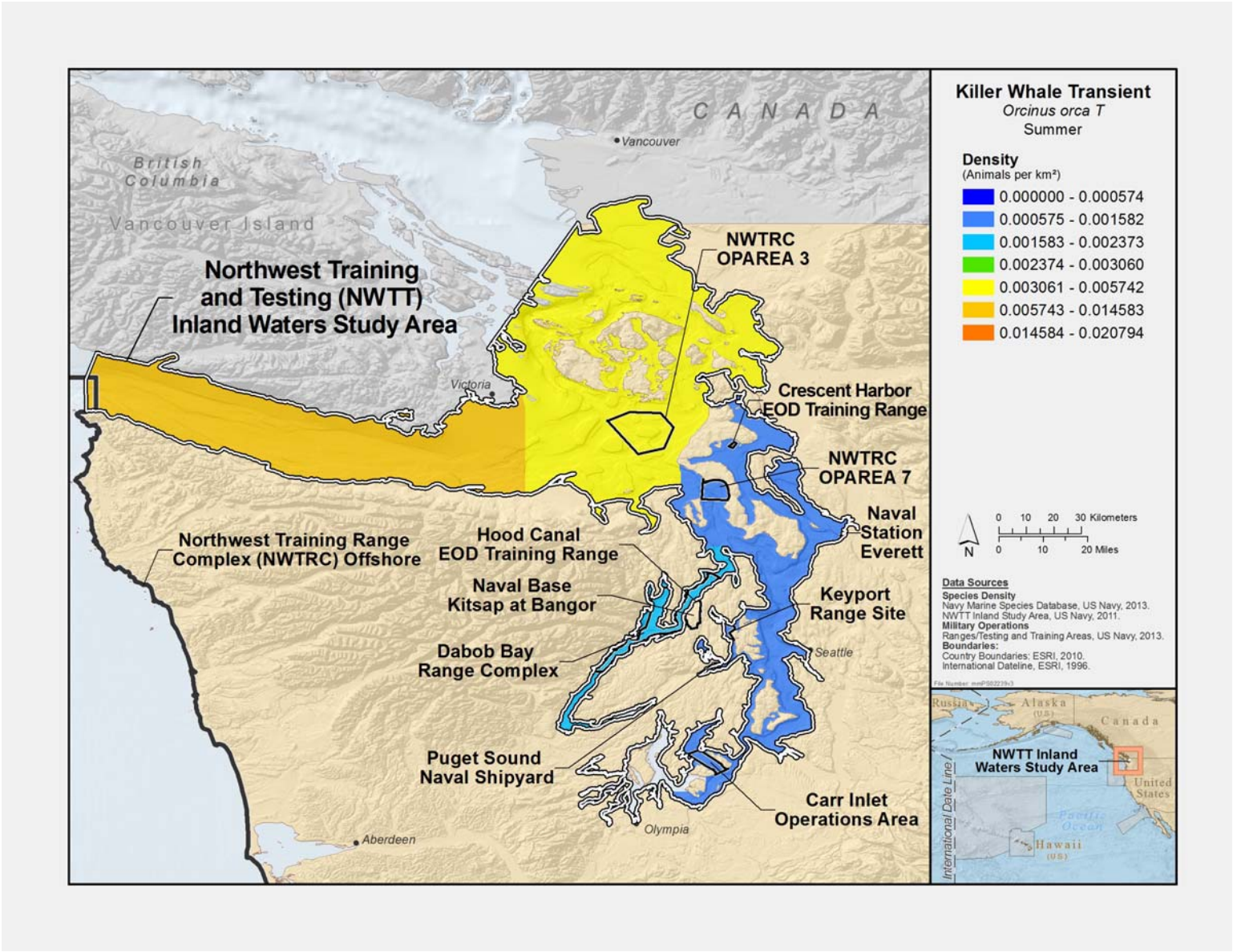

Figure 7-56: Summer Distribution of Transient Killer Whale in the Inland Waters Portion of the NWTT Study Area

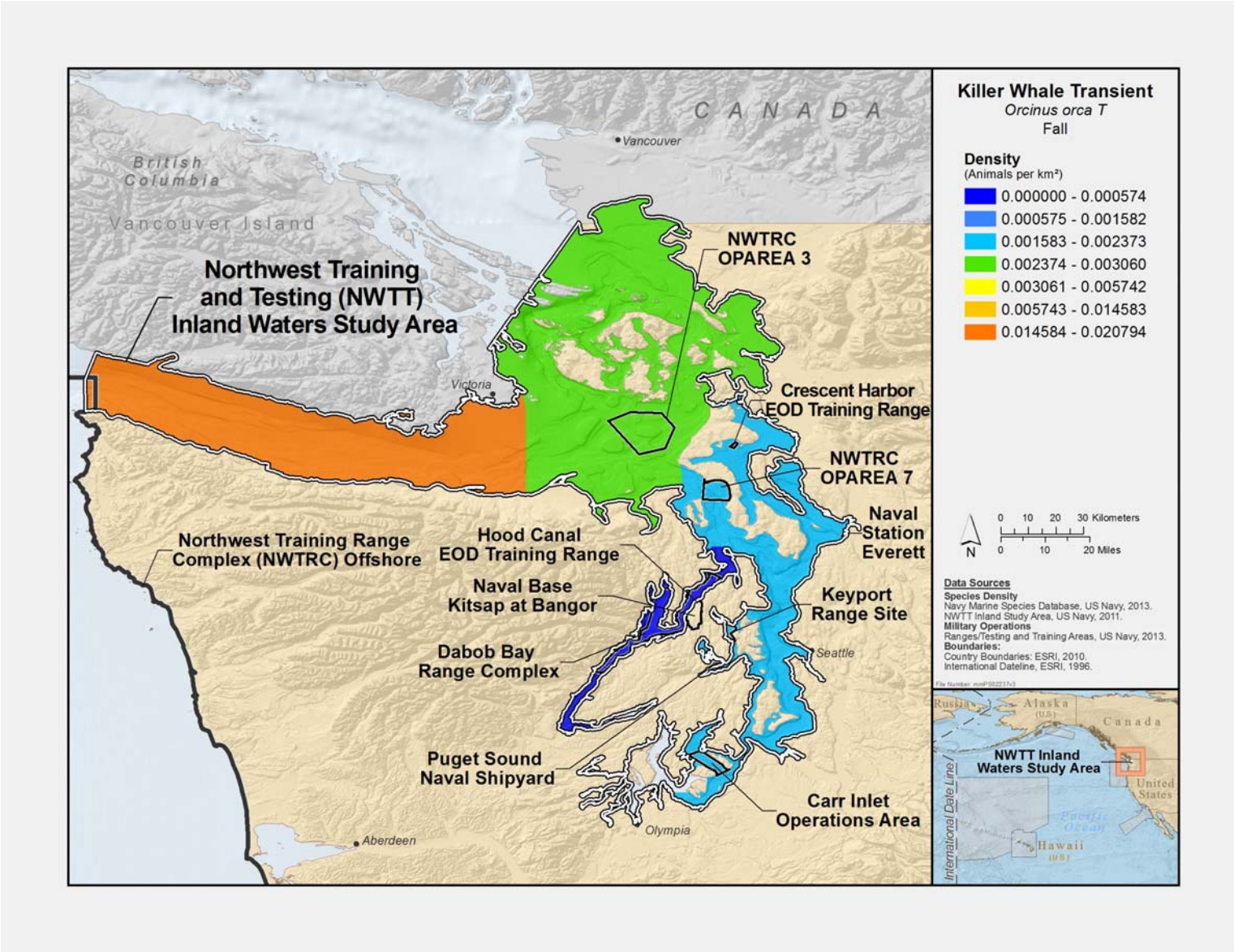

Figure 7-57: Fall Distribution of Transient Killer Whale in the Inland Waters Portion of the NWTT Study Area

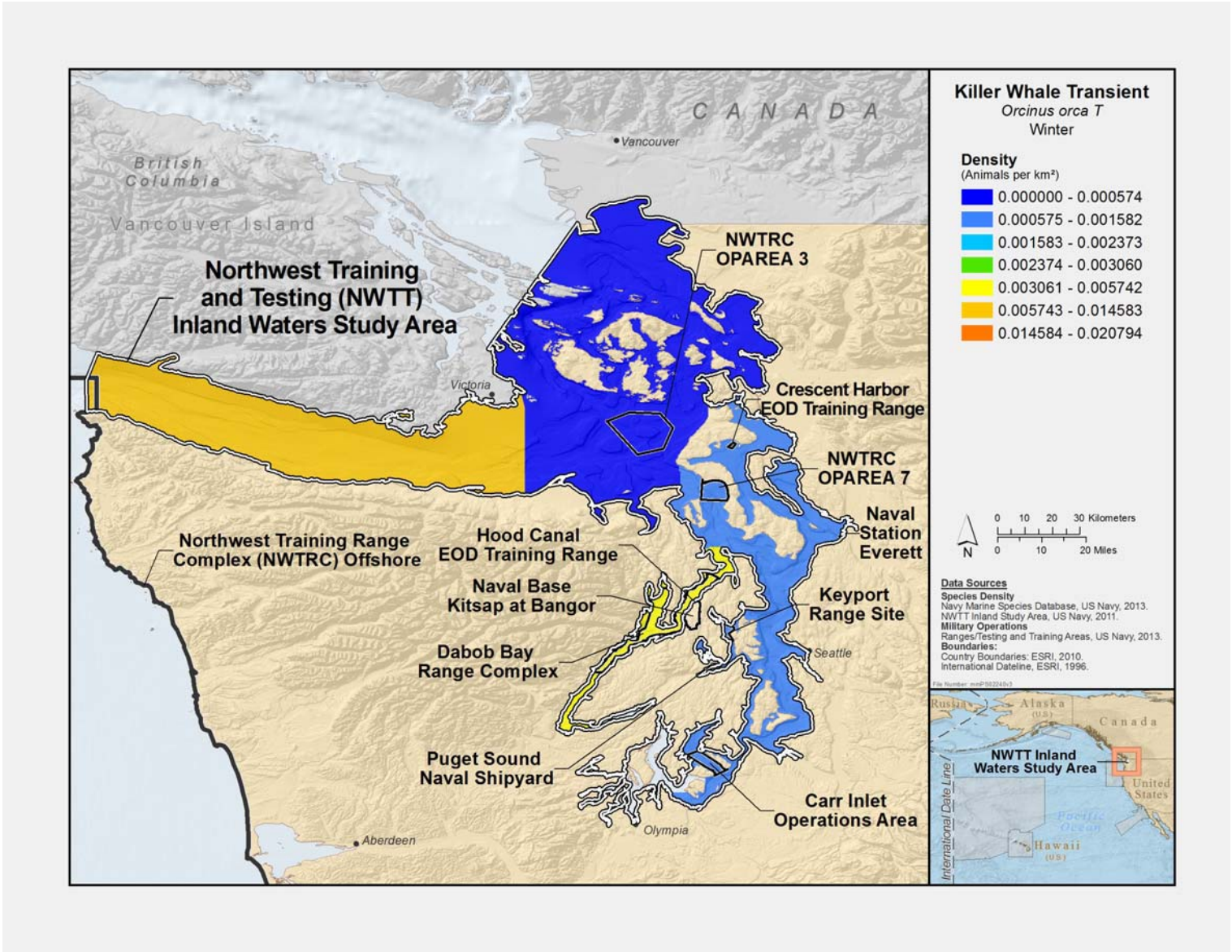

Figure 7-58: Winter Distribution of Transient Killer Whale in the Inland Waters Portion of the NWTT Study Area

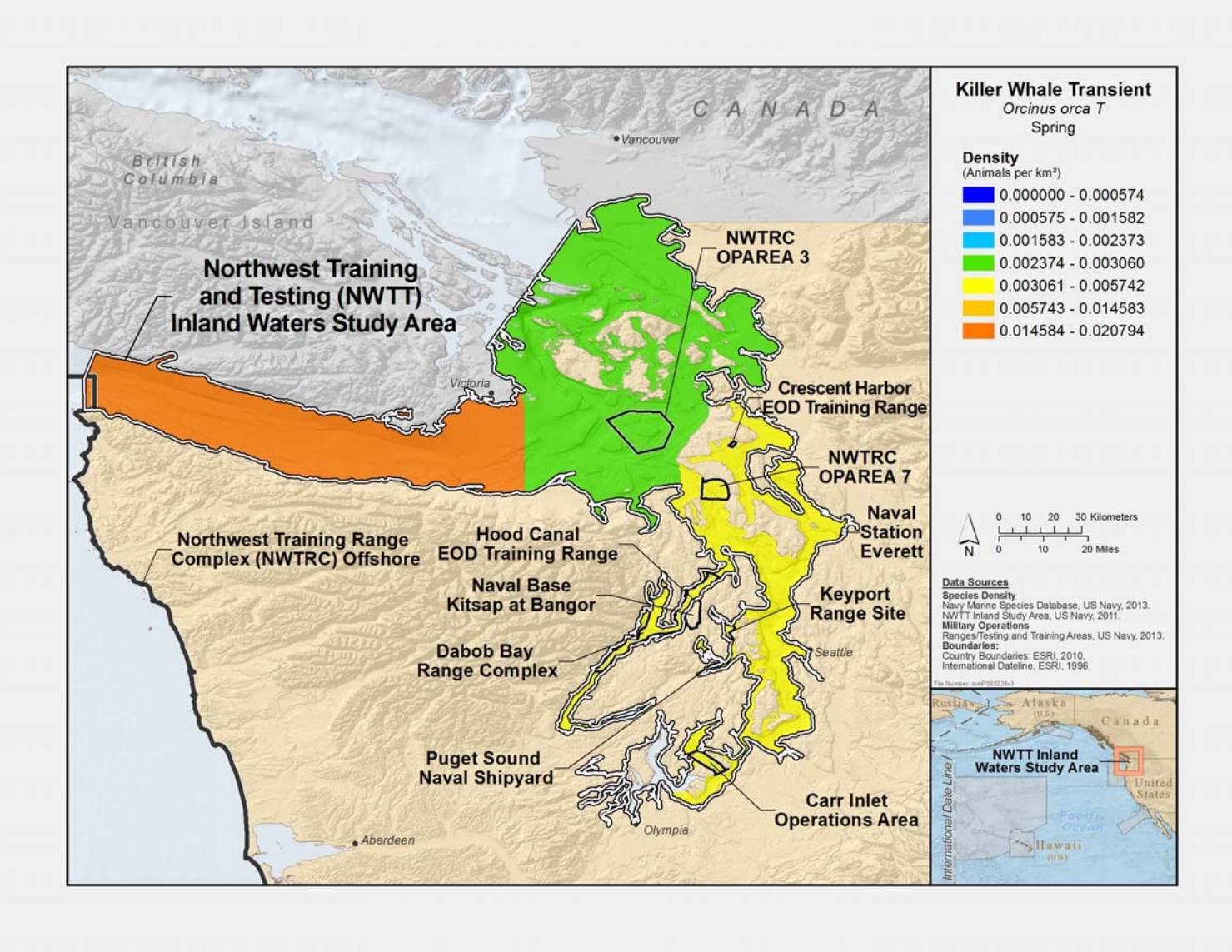

Figure 7-59: Spring Distribution of Transient Killer Whale in the Inland Waters Portion of the NWTT Study Area

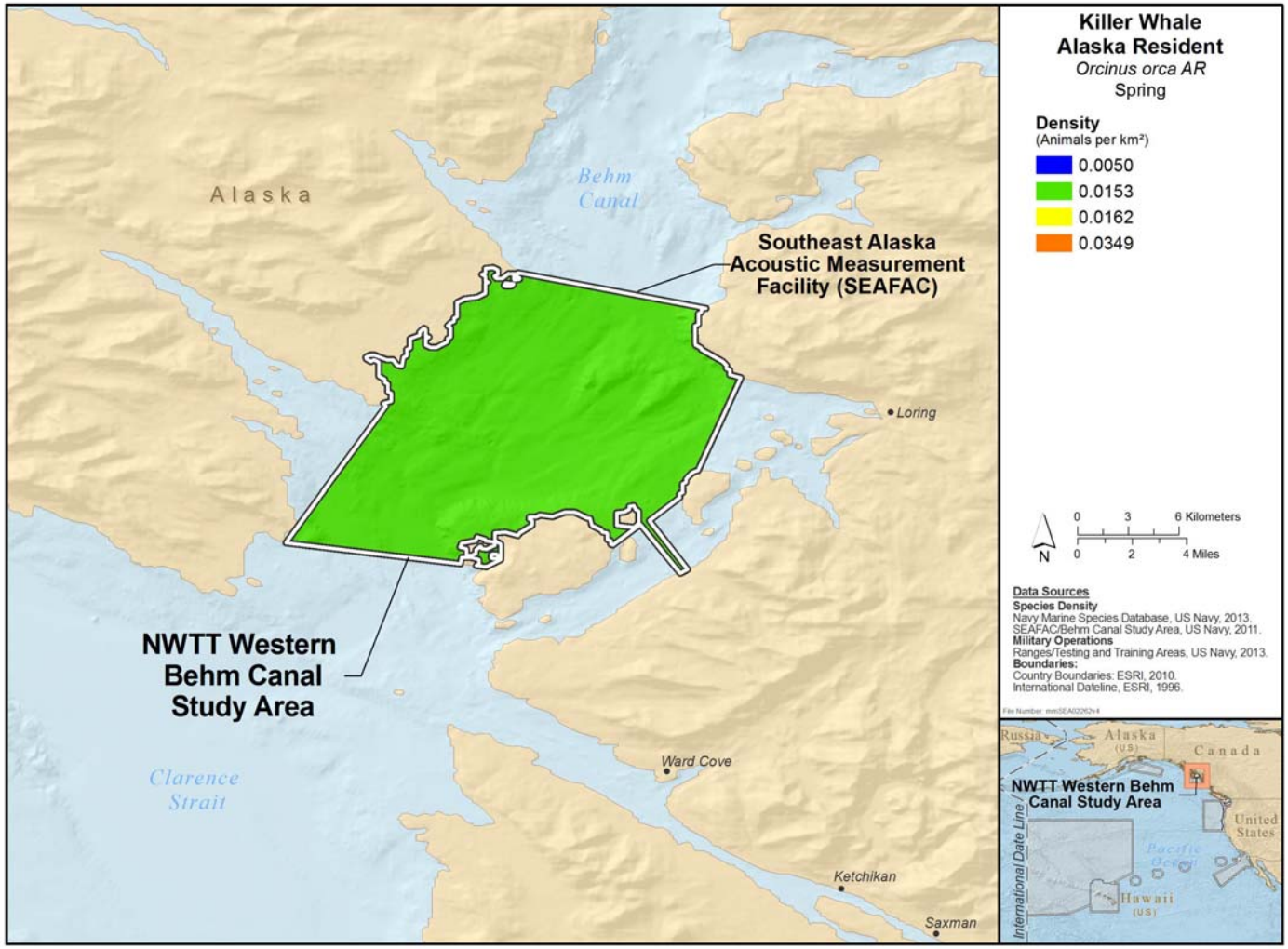

Figure 7-60: Spring Distribution of Alaska Resident Killer Whale in the Western Behm Canal Portion of the NWTT Study Area

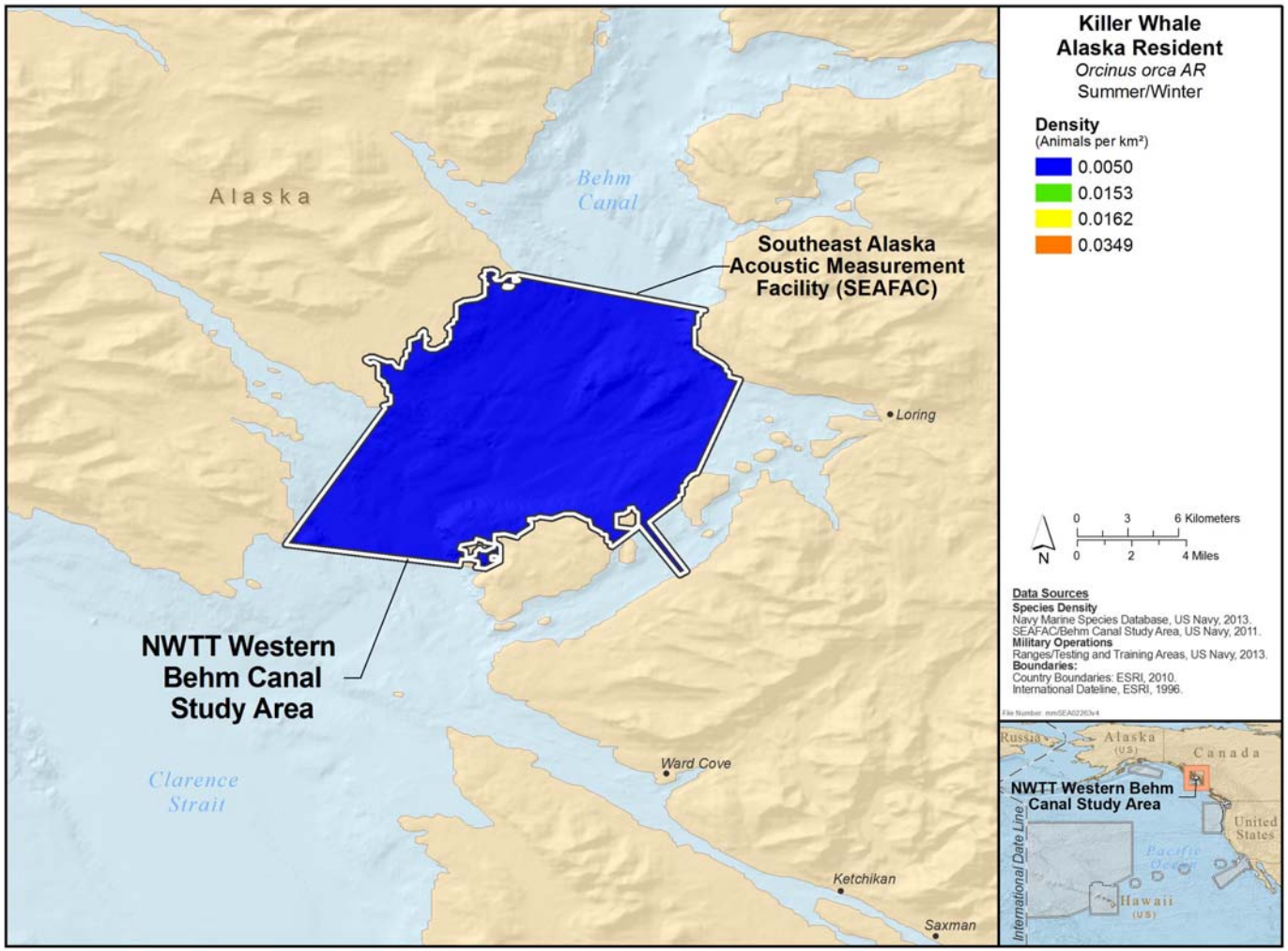

Figure 7-61: Summer and Winter Distribution of Alaska Resident Killer Whale in the Western Behm Canal Portion of the NWTT Study Area

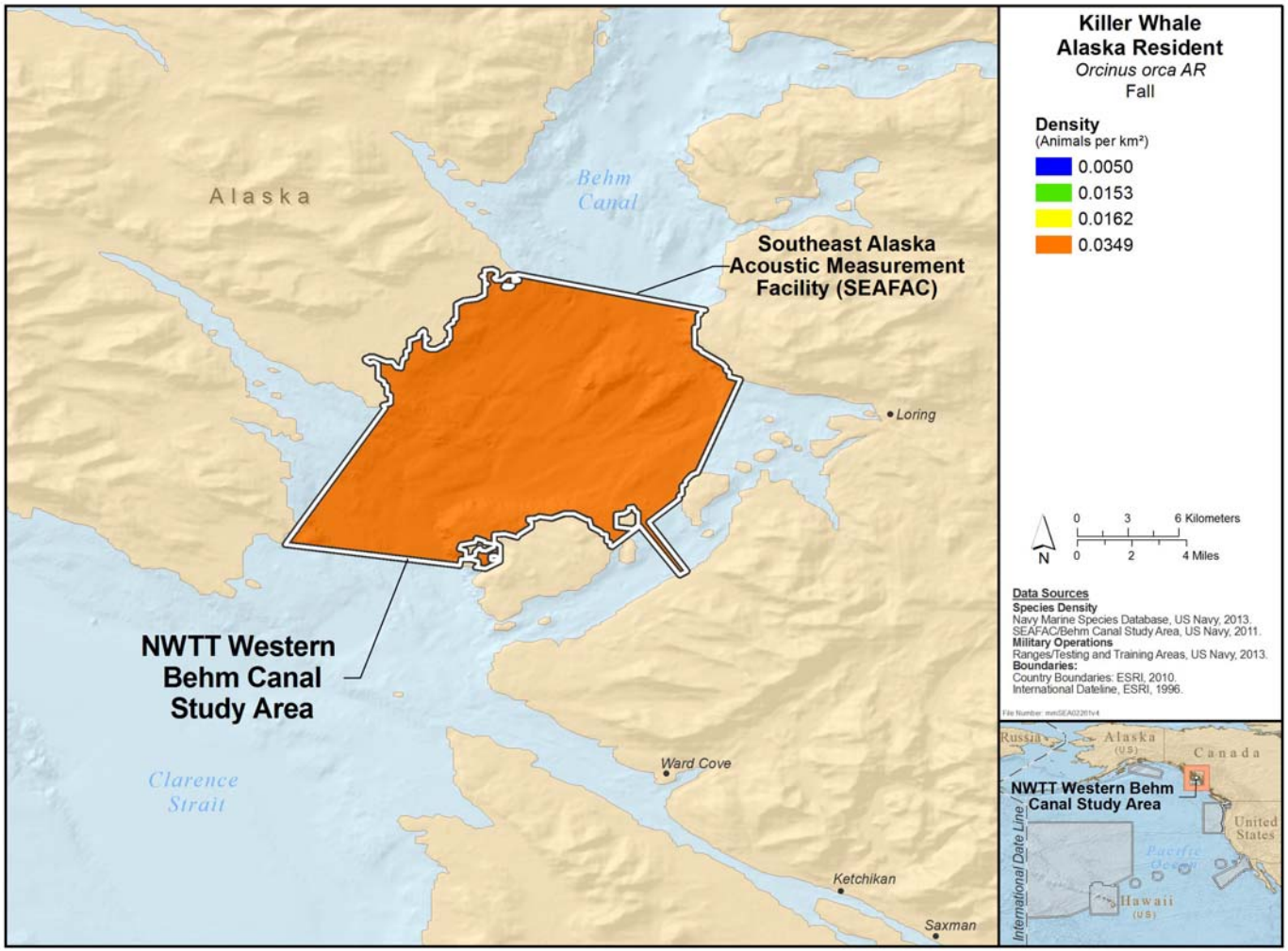

Figure 7-62: Fall Distribution of Alaska Resident Killer Whale in the Western Behm Canal Portion of the NWTT Study Area

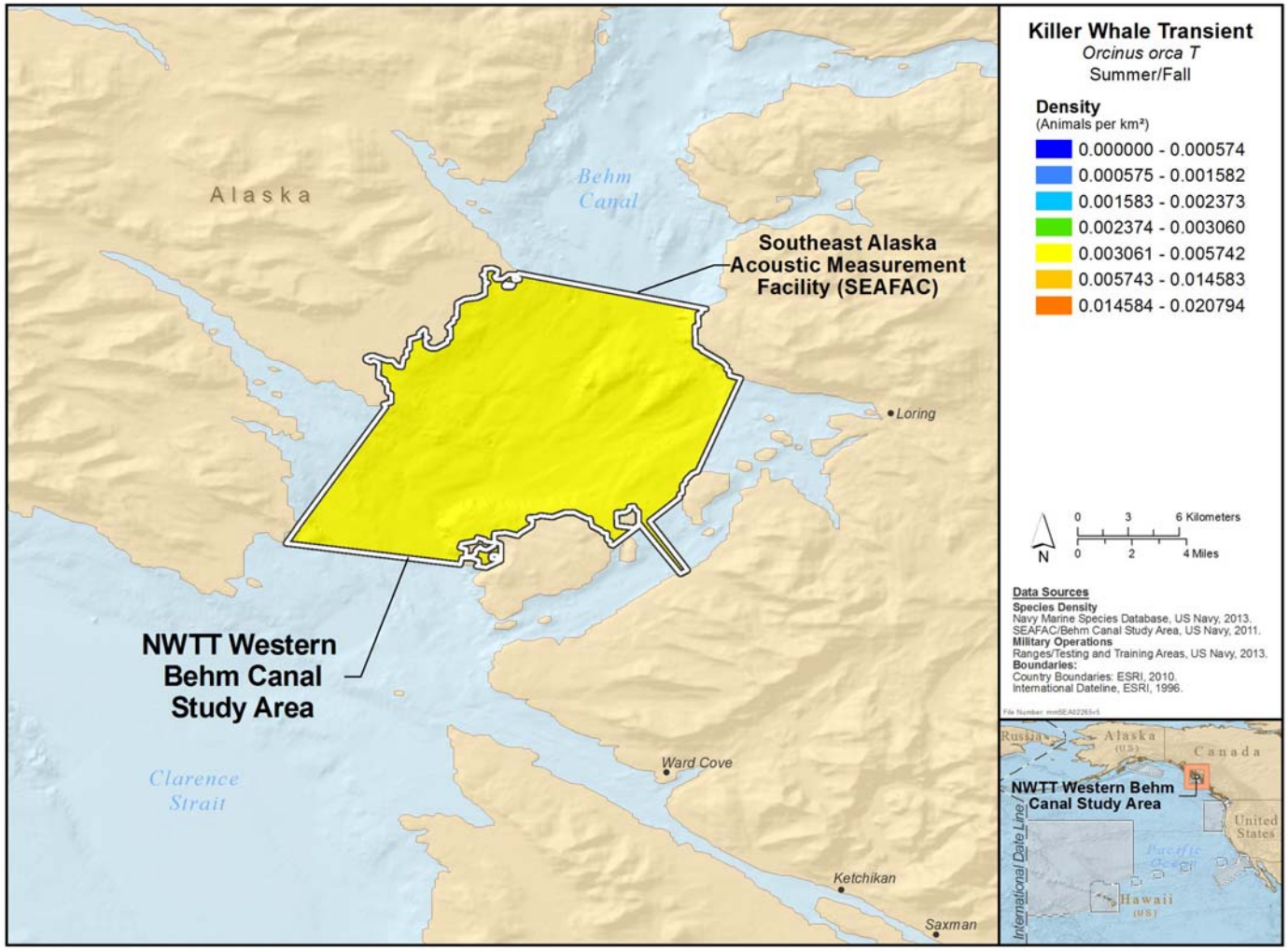

Figure 7-63: Summer/Fall Distribution of Transient Killer Whale in the Western Behm Canal Portion of the NWTT Study Area

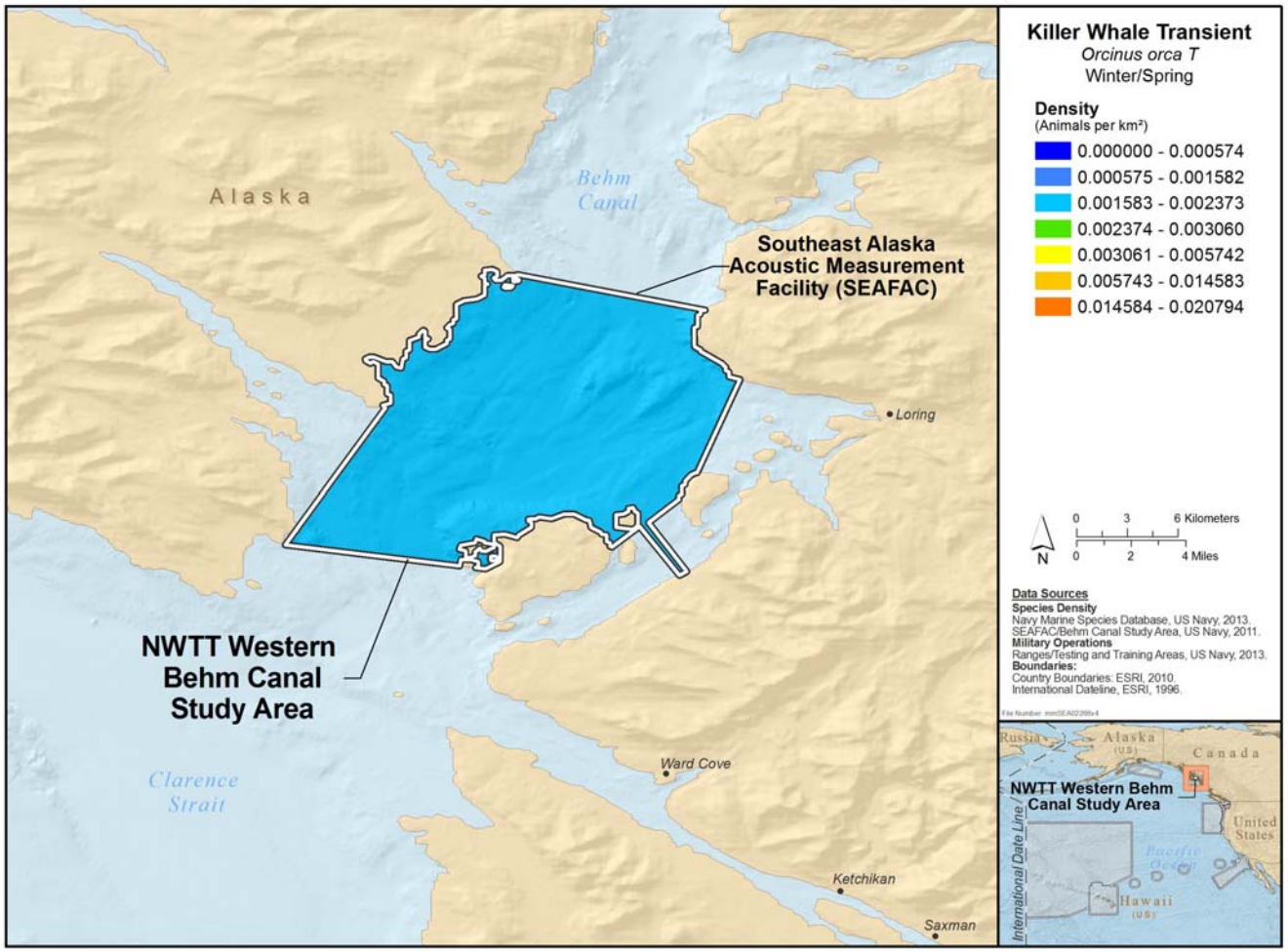

Figure 7-64: Winter/Spring Distribution of Transient Killer Whale in the Western Behm Canal Portion of the NWTT Study Area

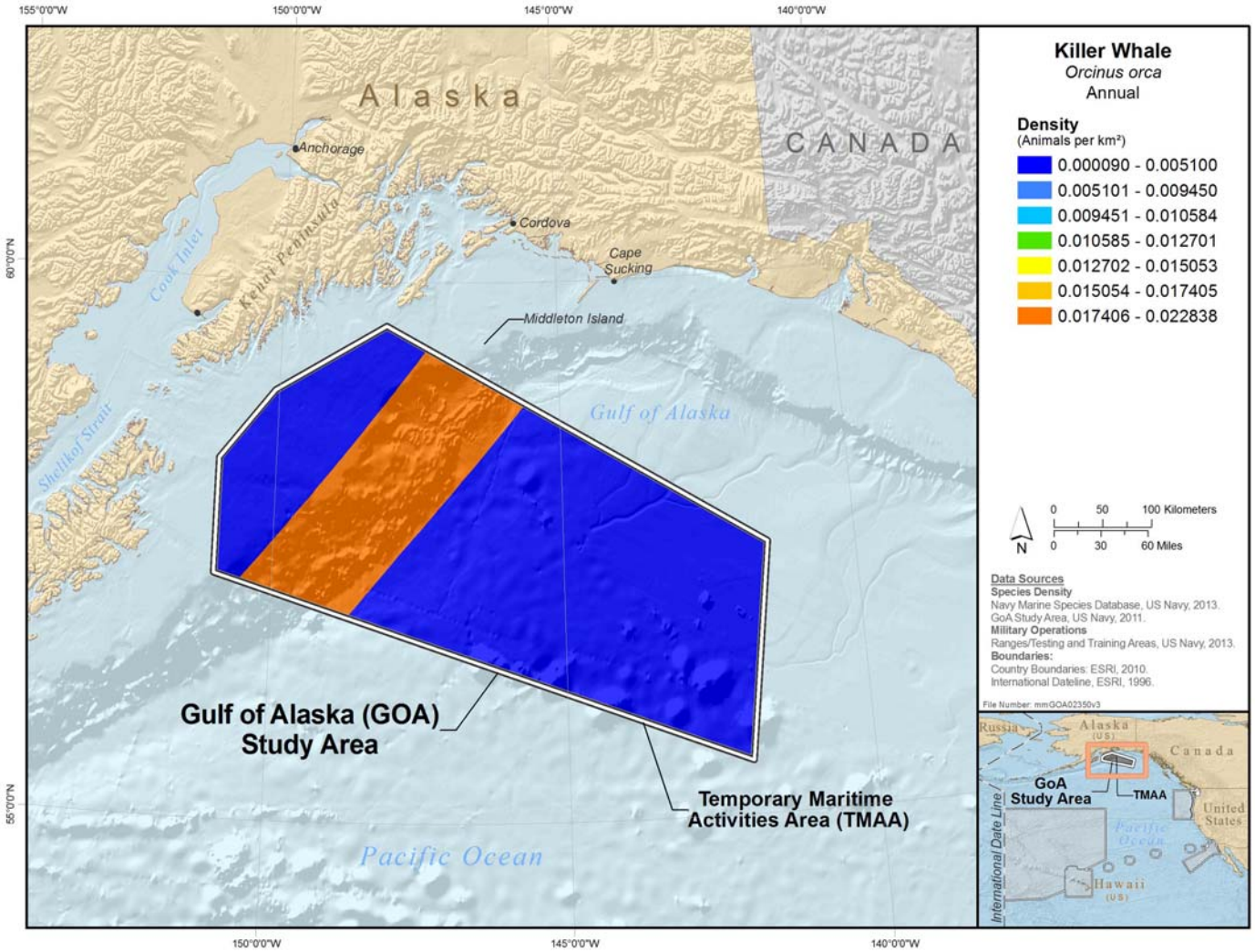

Figure 7-65: Annual Distribution of Killer Whale in the GOA Study Area

7.1.10 *PEPONOCEPHALA ELECTRA*, MELON-HEADED WHALE

Melon headed whales are one of the species that fall into the group known as "blackfish." They fit the definition for the group ideally because they are small, dark, and have a rounded head (Allen et al. 2011; Leatherwood et al. 1988). Adults do not have a beak (though newborns have a slight one), nor do they have a strongly bulbous melon like pilot whales or false killer whales (Allen et al. 2011). Their coloration is actually more charcoal gray than black, and they have subtle variation in color across their body including a dark cape and face and a lighter patch on the belly (Jefferson et al. 2008). Good lighting is required to see the color subtleties. Melon-headed whales do have lighter colored lips, somewhat like the pygmy killer whale, but the white area is usually more extensive on the lower jaw on pygmy killer whales (Leatherwood et al. 1988). Despite having these identifying characteristics, they require relatively close examination for positive identification. For that reason, melon-headed whales are easily confused with false killer whales and especially pygmy killer whales (Jefferson et al. 2008; Leatherwood et al. 1988). What may add to the confusion is the fact that the melon-headed whale is typically smaller than a false killer whale, but similar in size to a pygmy killer whale. Melon-headed whales are a species that can be found in association with other dolphins, such as Fraser's dolphin, spinner dolphin, rough-toothed dolphin, and common bottlenose dolphin (Allen et al. 2011; Kiszka et al. 2011b). NMFS recognizes a single stock, the Hawaiian stock, of melon-headed whales as a management unit (Carretta et al. 2011a). Numbers presented for HRC densities are presumed to be from that stock. Little is known about the stock structure of melon-headed whales in the MITT Study Area.

HRC. Barlow et al. (2006) calculated a uniform density for melon-headed whale in HRC from NMFS large vessel surveys. The Navy applied the density to all seasons and the western portion of the transit corridor.

SOCAL. This species has not been observed in SOCAL or the eastern portion of the transit corridor (Hamilton et al. 2009).

MITT. Based on sighting data from the Navy's 2007 survey, there were an estimated 2,455 (CV = 0.70) melon-headed whales in the Study Area (Fulling et al. 2011). This estimate is very similar to the abundance estimate for the Hawaiian stock of melon-headed whale, derived from a 2002 shipboard survey of the entire Hawaiian Islands U.S. Pacific EEZ, of 2,950 animals (CV = 1.17) (Barlow 2006). The density estimate of 0.00428 animals/km^2 derived by Fulling et al. (2011) was used for the MITT Study Area. Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual melon-headed whale density.

NWTT. This species is not expected to occur in any of the regions included in the NWTT Study Area.

GOA. This species is not expected to occur in the GOA Study Area.

Table 7-19: Sources of Density Values Used for Melon-Headed Whale

Location	Spring	Summer	Fall	Winter
HRC	L	L	L	L
W. Transit Corridor	L	L	L	L
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
MITT	L	L	L	L
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-20: Summary of Density Values for Melon-Headed Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0.00120	0.00120	0.00120	0.00120
W. Transit Corridor	0.00120	0.00120	0.00120	0.00120
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
Inner Baja Extension	0	0	0	0
Outer Baja Extension	0	0	0	0
MITT	0.00428	0.00428	0.00428	0.00428
MITT Transit Corridor	0.00267	0.00267	0.00267	0.00267
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

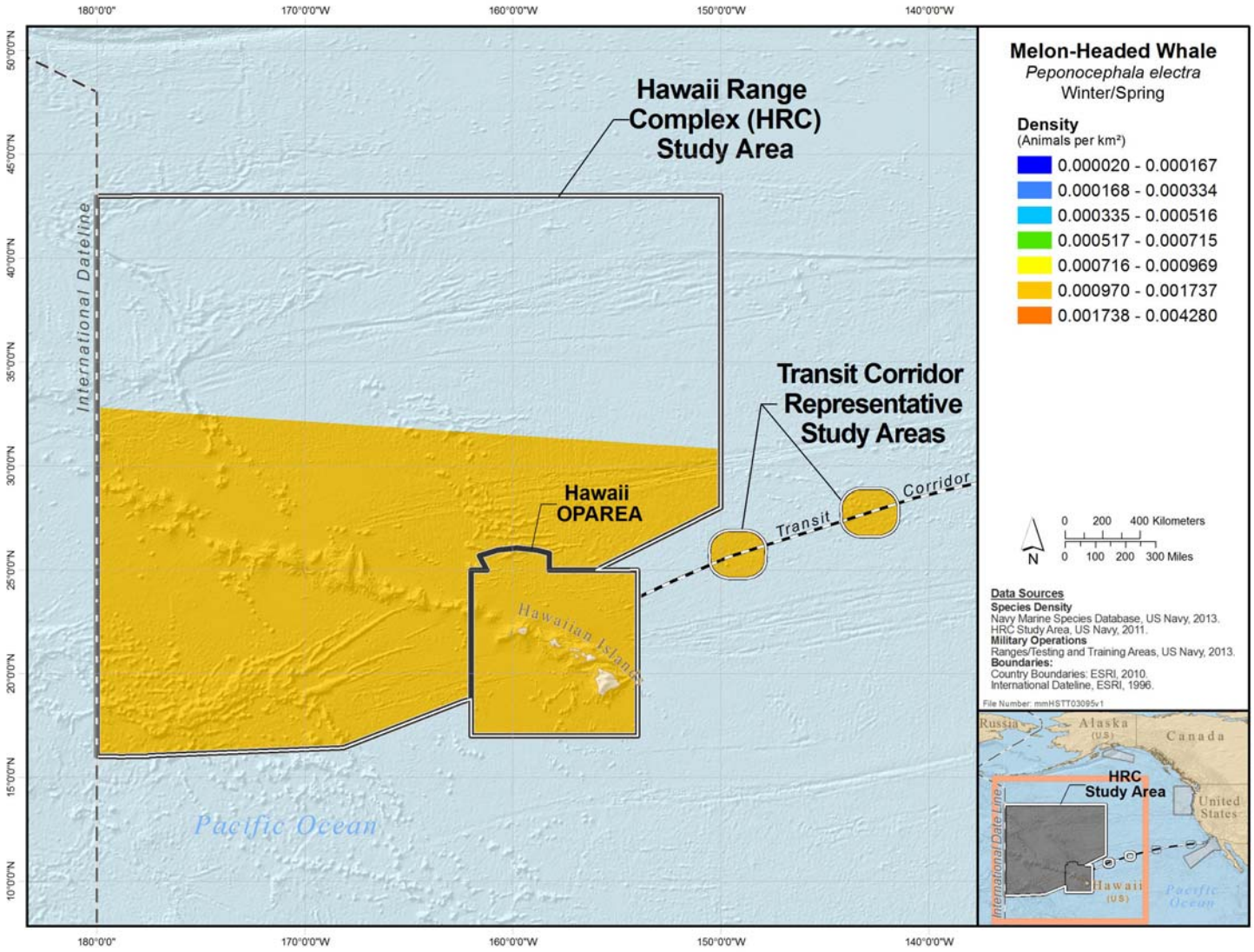

Figure 7-66: Winter/Spring Distribution of Melon-Headed Whale in HRC and the Western Portion of the Transit Corridor

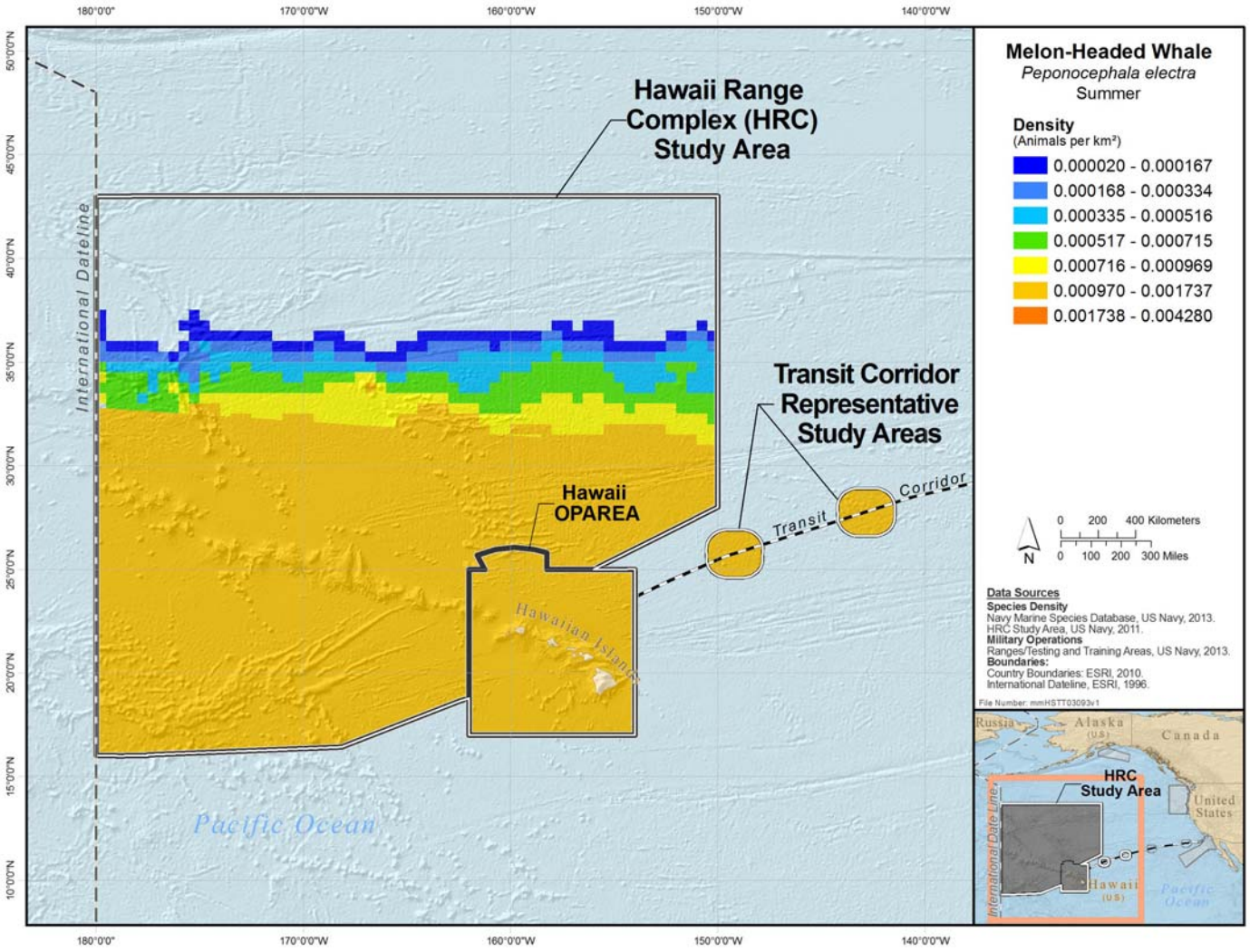

Figure 7-67: Summer Distribution of Melon-Headed Whale in HRC and the Western Portion of the Transit Corridor

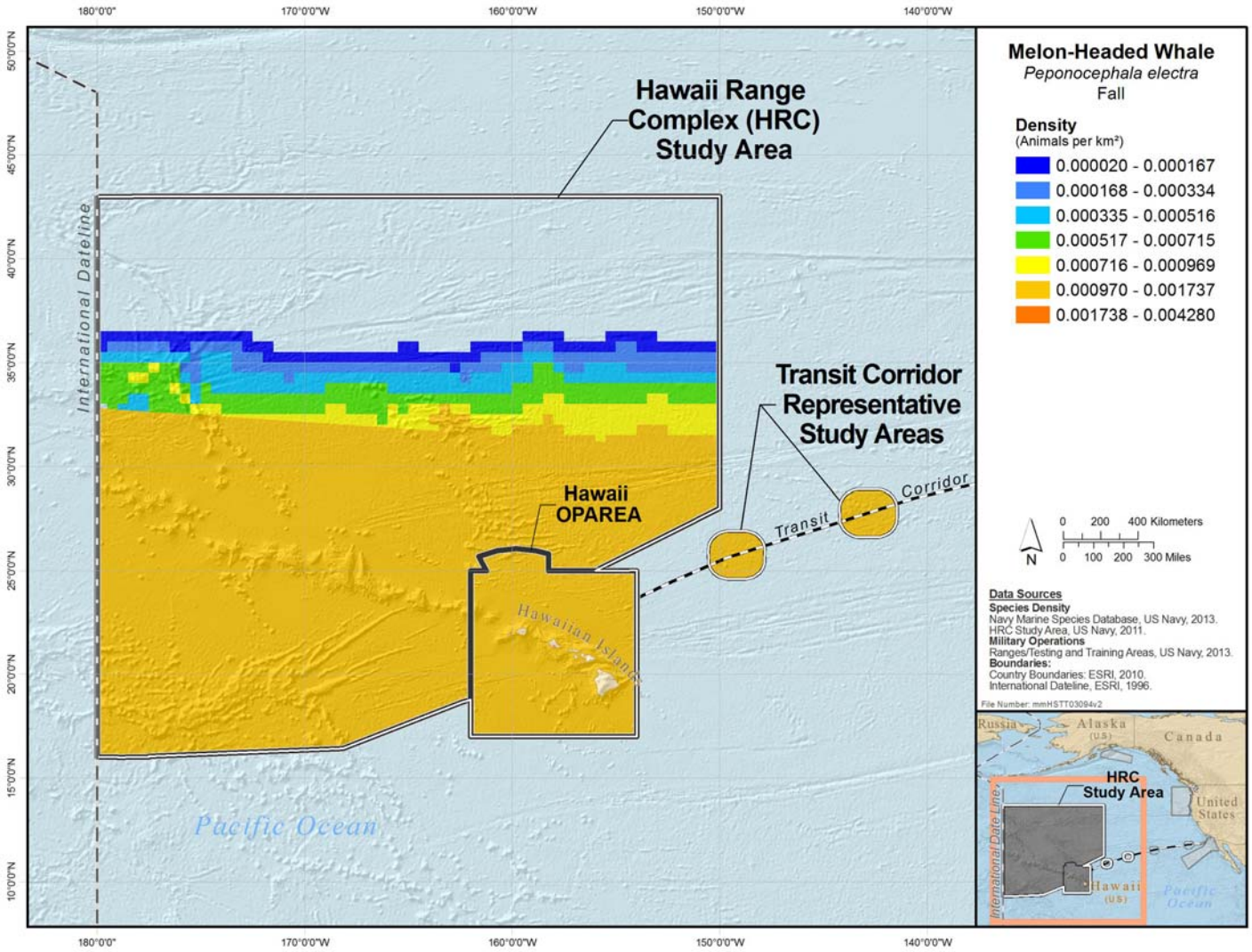

Figure 7-68: Fall Distribution of Melon-Headed Whale in HRC and the Western Portion of the Transit Corridor

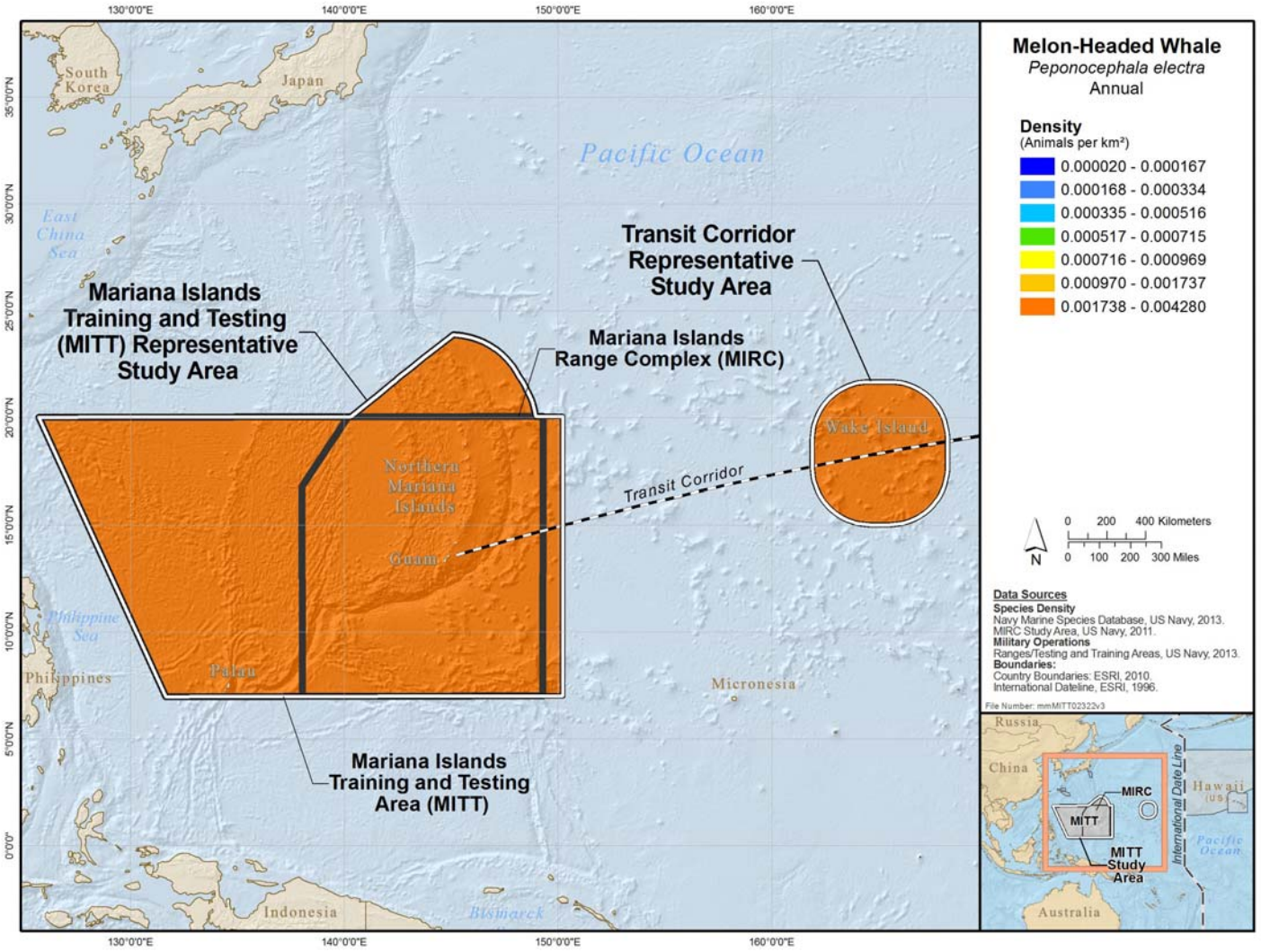

Figure 7-69: Annual Distribution of Melon-Headed Whale in MITT and the Associated Transit Corridor Study Areas

7.1.11 *PSEUDORCA CRASSIDENS*, FALSE KILLER WHALE

False killer whales are the quintessential "blackfish," they are a relatively small cetacean that is almost entirely black and have a rounded melon (Jefferson et al. 2008; Leatherwood et al. 1988). Like the melon-headed whale, they do not have a beak. Due to the similarity among blackfish, false killer whales can be confused with pilot whales (*Globicephala* sp.), melon-headed whales, and pygmy killer whales (Baird 2010; Jefferson et al. 2008; Leatherwood et al. 1988). Close attention to the shape of the body, which is relatively slender, as well as the shape of the head and the shape and position of the dorsal fin are necessary to tell the blackfish apart (Jefferson et al. 2008). The best feature is actually the shape of the flippers, which have an S-shape in false killer whales. Observers at sea may have an opportunity to view the entirety of a false killer whale because they are known to be acrobatic (Baird 2009a; Leatherwood et al. 1988; Odell and Miller McClune 1999).

False killer whales are one of the largest of the dolphins (Allen et al. 2011), and are a top-order predator that feeds on large pelagic fish like mahi-mahi, as well as deep water prey such as squid (Odell and Miller McClune 1999). They are found throughout the world in tropical and temperate oceans (Baird 2009a). In Hawaii, false killer whales have been found to have populations that adhere to particular ranges (Baird et al. 2008a; Baird et al. 2010). There appears to be overlap among ranges to some degree. NMFS recognizes a stock complex of false killer whales for the Pacific Islands region (Carretta et al. 2011a). The complex includes a Hawaii Pelagic stock, a Hawaii Insular stock, and a Palmyra Atoll stock. The Palmyra Atoll stock would have little to no interaction with activities in the HRC. Density values provided are for the species as a whole and do not reflect individual stocks. Little is known about the stock structure of false killer whales in the MITT Study Area.

HRC. NMFS developed a CENPAC model for the false killer whale (Becker et al. 2012b). The Navy applied this model to all seasons for HRC and the western portion of the transit corridor. The NMFS CENPAC model predicts higher density levels for false killer whales in the HRC than the global RES model from Kaschner et al. (2006), which is the blue region to the north of the yellow and orange high density center around the Northwest Hawaiian Islands on the HRC density figure. The higher-density region predicted by the NMFS model for false killer whales north of the Northwestern Hawaiian Islands was confirmed through multiple sightings during a recent 2010 survey (Bradford et al. 2012). Further validation of the model-based densities will be important when these survey data have been fully processed and become available for additional analyses.

SOCAL. Strandings and sightings of false killer whales have been recorded in Southern California and north, but these have generally been considered extralimital. This species has not been observed in SOCAL during any of the NMFS ship surveys (Hamilton et al. 2009); therefore, zero density was assigned to the west coast of the United States. The CENPAC model was applied to all seasons in the eastern portion of the transit corridor. A density value of 0.00000 for false killer whales comes from Ferguson and Barlow (2003) for the portion of the NMFS survey that correlates with the Baja extension. In the sliver of area where the NMFS CENPAC and CCE study areas do not meet, values from the CENPAC model were extended to cover the area, as those values were best aligned with other density values in adjacent areas.

MITT. During the Navy's 2007 survey of the Study Area, false killer whales were sighted 10 times in groups ranging from 2 to 26 individuals and several including calves (Fulling et al. 2011). Based on sighting data from the 2007 survey, there were an estimated 0.00111 animals/km^2 (CV = 0.74) false killer whales in the MITT Study Area (Fulling et al. 2011). Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual false killer whale density.

NWTT. This species is not expected to occur in any of the regions included in the NWTT Study Area.

GOA. This species is not expected to occur in the GOA Study Area.

Table 7-21: Sources of Density Values Used for False Killer Whale

Location	Spring	Summer	Fall	Winter
HRC	CENPAC	CENPAC	CENPAC	CENPAC
W. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
E. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
SOCAL	0/L	0/L	0/L	0/L
MITT	L	L	L	L
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-22: Summary of Density Values for False Killer Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	S	S	S	S
SOCAL	0	0	0	0
Inner Baja Extension	0.00000	0.00000	0.00000	0.00000
Outer Baja Extension	0.00000	0.00000	0.00000	0.00000
MITT	0.00111	0.00111	0.00111	0.00111
MITT Transit Corridor	0.00057	0.00057	0.00057	0.00057
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

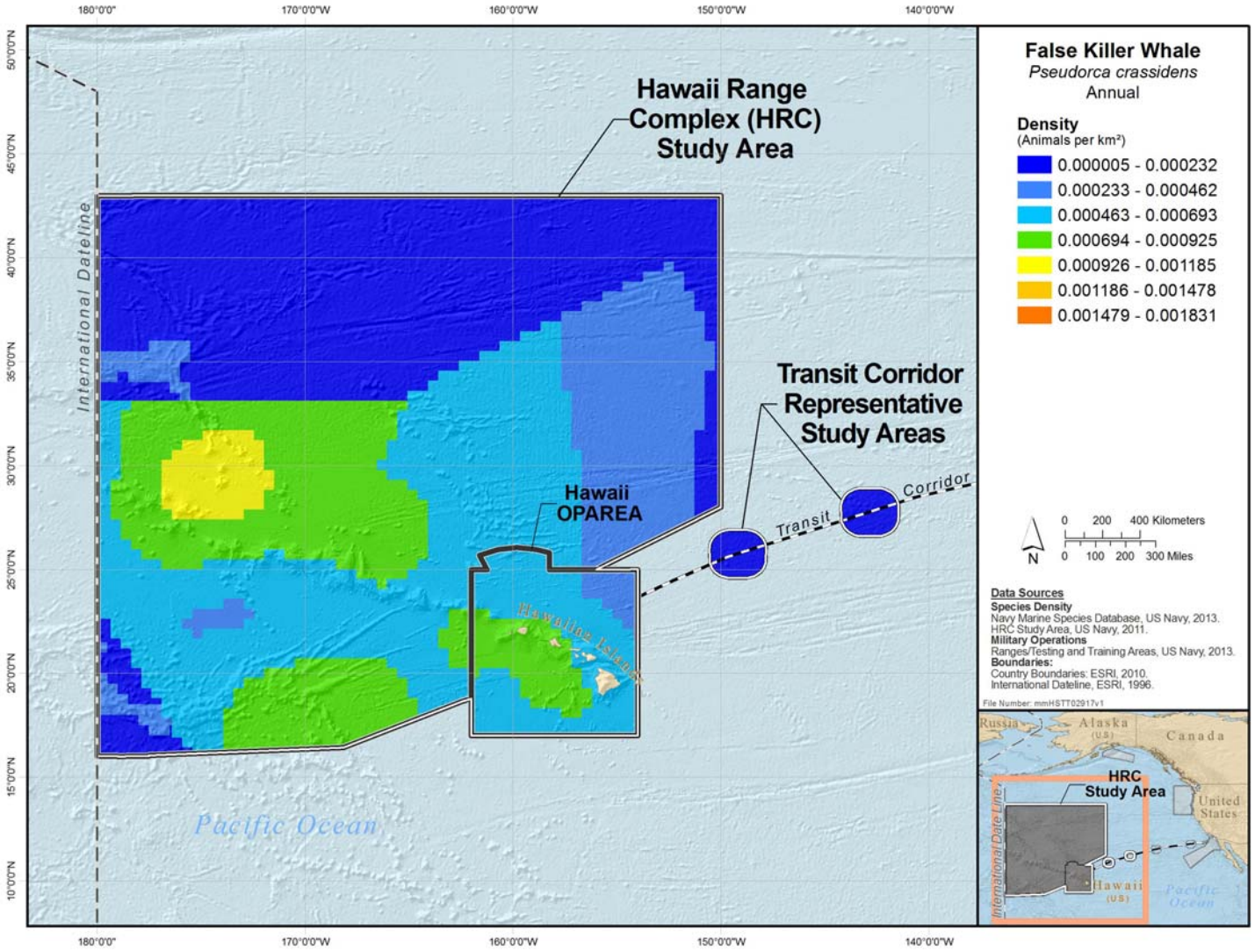

Figure 7-70: Annual Distribution of False Killer Whale in HRC and the Western Portion of The Transit Corridor

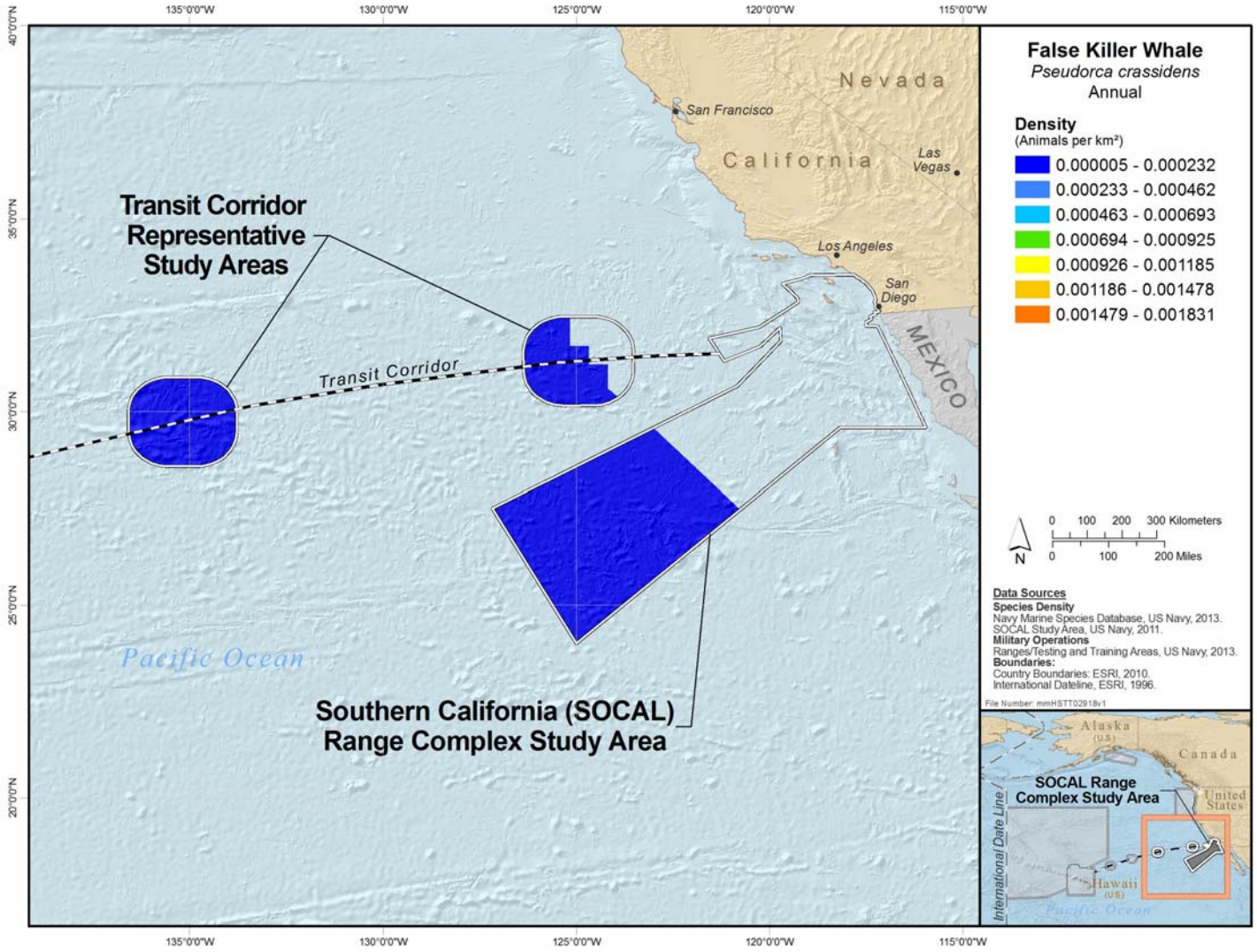

Figure 7-71: Annual Distribution of False Killer Whale in SOCAL and the Eastern Portion of the Transit Corridor

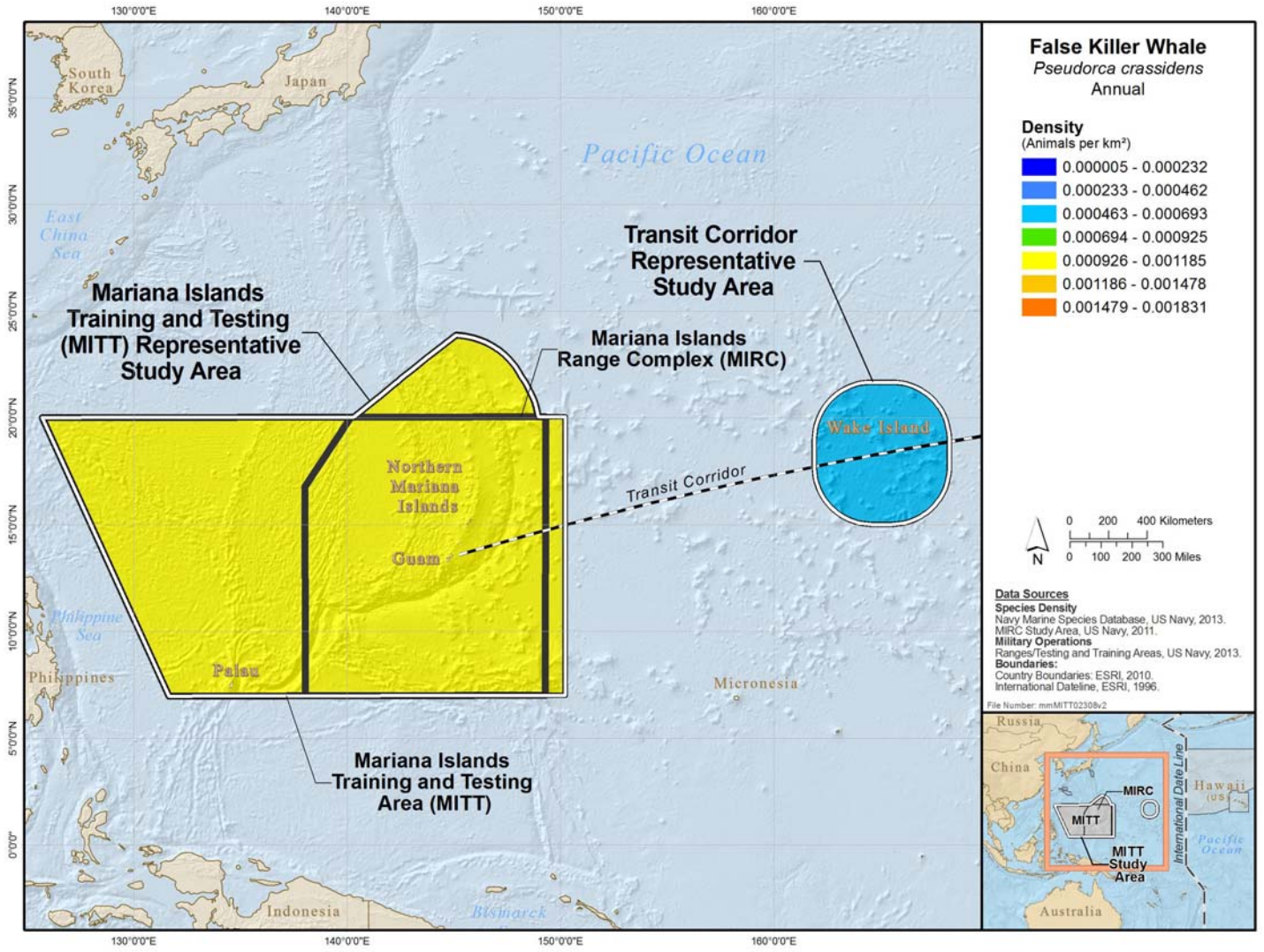

Figure 7-72: Annual Distribution of False Killer Whale in MITT and the Associated Transit Corridor Study Areas

7.1.12 *STENELLA ATTENUATA*, PANTROPICAL SPOTTED DOLPHIN

As the name suggests, pantropical spotted dolphins are found in the tropics and subtropics across the world's oceans (Jefferson et al. 2008; Perrin 2009a). This is a long-beaked dolphin that is found both near shore and in oceanic zones; there are coloration and body shape differences associated with the different zones (Jefferson et al. 2008; Leatherwood et al. 1988). Spotting on the dolphins is highly variable, develops and increases with age, and may not be a particularly good indicator of the species identification in the field (Allen et al. 2011; Jefferson et al. 2008). The dark cape on the back and white on the lips and the tip of rostrum (which also develops with age) are better indicators of species identification (Allen et al. 2011; Jefferson et al. 2008). Spotted dolphins could be mistaken for a number of dolphin species including spinner dolphins and bottlenose dolphins; they move and jump like striped dolphins and common dolphins (*Delphinus* spp.) when seen from a distance (Allen et al. 2011; Jefferson et al. 2008; Leatherwood et al. 1988). To make things slightly more challenging for field identification, pantropical spotted dolphins associate often with spinner dolphins (Gross et al. 2009; Psarakos et al. 2003) and sometimes with bottlenose dolphins (R. Baird pers. comm.). NMFS recognizes a single Hawaiian stock of pantropical spotted dolphins in U.S. waters (Carretta et al. 2011a). Spotted dolphins in the HRC and the western portion of the transit corridor are presumed to be from the Hawaiian stock. In the eastern tropical Pacific, pantropical spotted dolphins have suffered large mortality from the tuna fishing industry (Archer et al. 2004; Perrin 2009a). Spotted dolphins in the eastern part of the transit corridor are likely to be from populations not managed directly by NMFS. Density values for the HSTT Study Area are presented for the species as a whole. Little is known about the stock structure of pantropical spotted dolphins in the MITT Study Area.

HRC. NMFS developed a CENPAC model for pantropical spotted dolphin (Becker et al. 2012b). The Navy applied this model to all seasons for HRC and the western portion of the transit corridor.

SOCAL. This species has not been observed in SOCAL (Hamilton et al. 2009); therefore, zero density was assigned to the west coast of the United States. The CENPAC model was applied to all seasons in the eastern portion of the transit corridor.

MITT. Pantropical spotted dolphins were sighted throughout the Study Area during the Navy's 2007 ship survey in waters with a variable bottom depth, ranging from 374 to 18,609 ft. (113 to 5,639 m) (Fulling et al. 2011). Group size ranged from 1 to 115 individuals. There were multiple sightings that included young calves, and one mixed species aggregation with melon-headed whales and another with an unidentified *Balaenoptera* species. These pantropical spotted dolphins were identified as the offshore morphotype. Based on the 2007 survey data, there were an estimated 0.0226 animals/km^2 (CV = 0.70) in the MITT Study Area (Fulling et al. 2011). Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual pantropical spotted dolphin density.

NWTT. This species is not expected to occur in any of the regions included in the NWTT Study Area.

GOA. This species is not expected to occur in the GOA Study Area.

Table 7-23: Sources of Density Values Used for Pantropical Spotted Dolphin

Location	Spring	Summer	Fall	Winter
HRC	CENPAC	CENPAC	CENPAC	CENPAC
W. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
E. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
SOCAL	0	0	0	0
MITT	L	L	L	L
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-24: Summary of Density Values for Pantropical Spotted Dolphin in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	S	S	S	S
SOCAL	0	0	0	0
Inner Baja Extension	0	0	0	0
Outer Baja Extension	0	0	0	0
MITT	0.0226	0.0226	0.0226	0.0226
MITT Transit Corridor	0.01132	0.01132	0.01132	0.01132
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

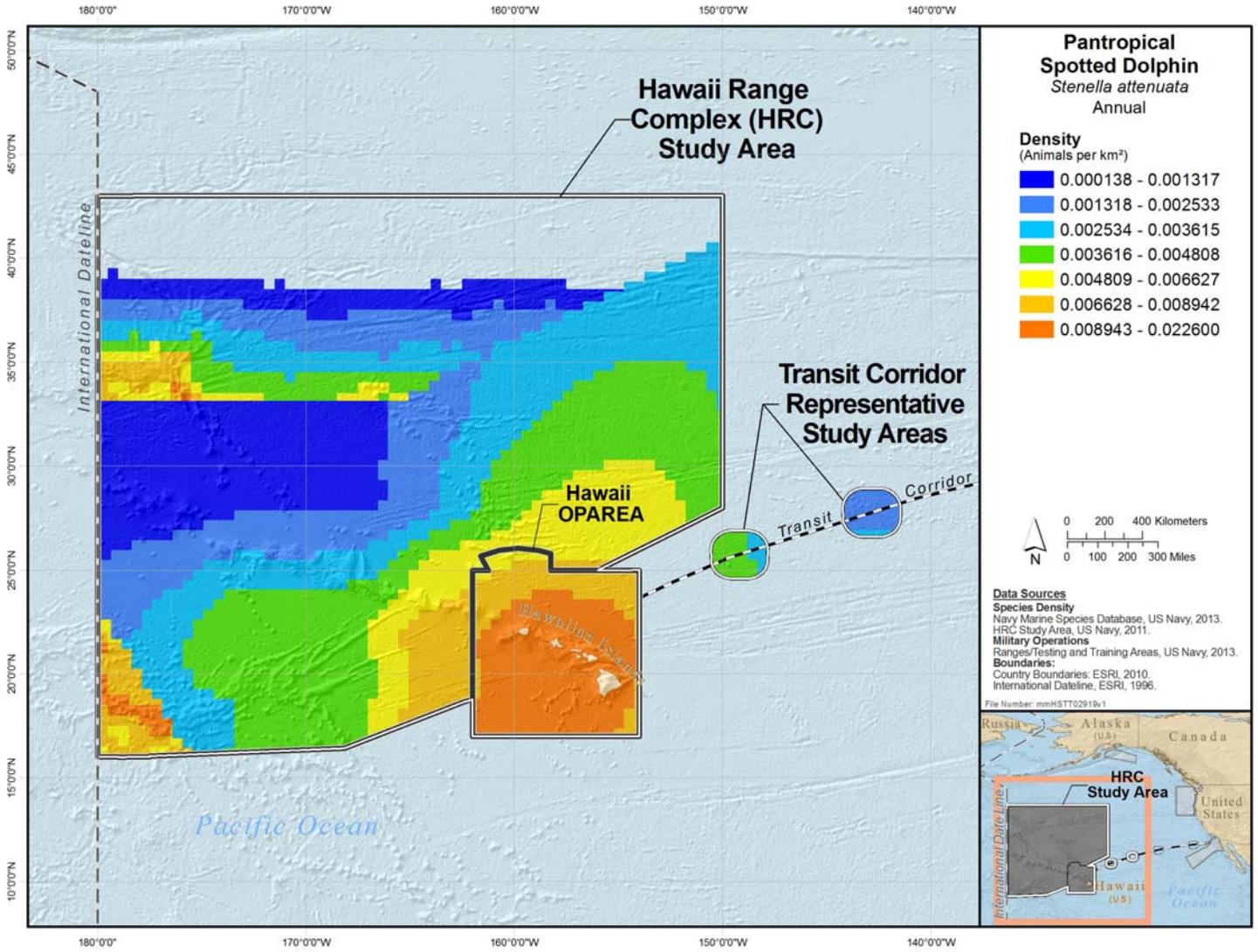

Figure 7-73: Annual Distribution of Pantropical Spotted Dolphin in HRC and the Western Portion of the Transit Corridor

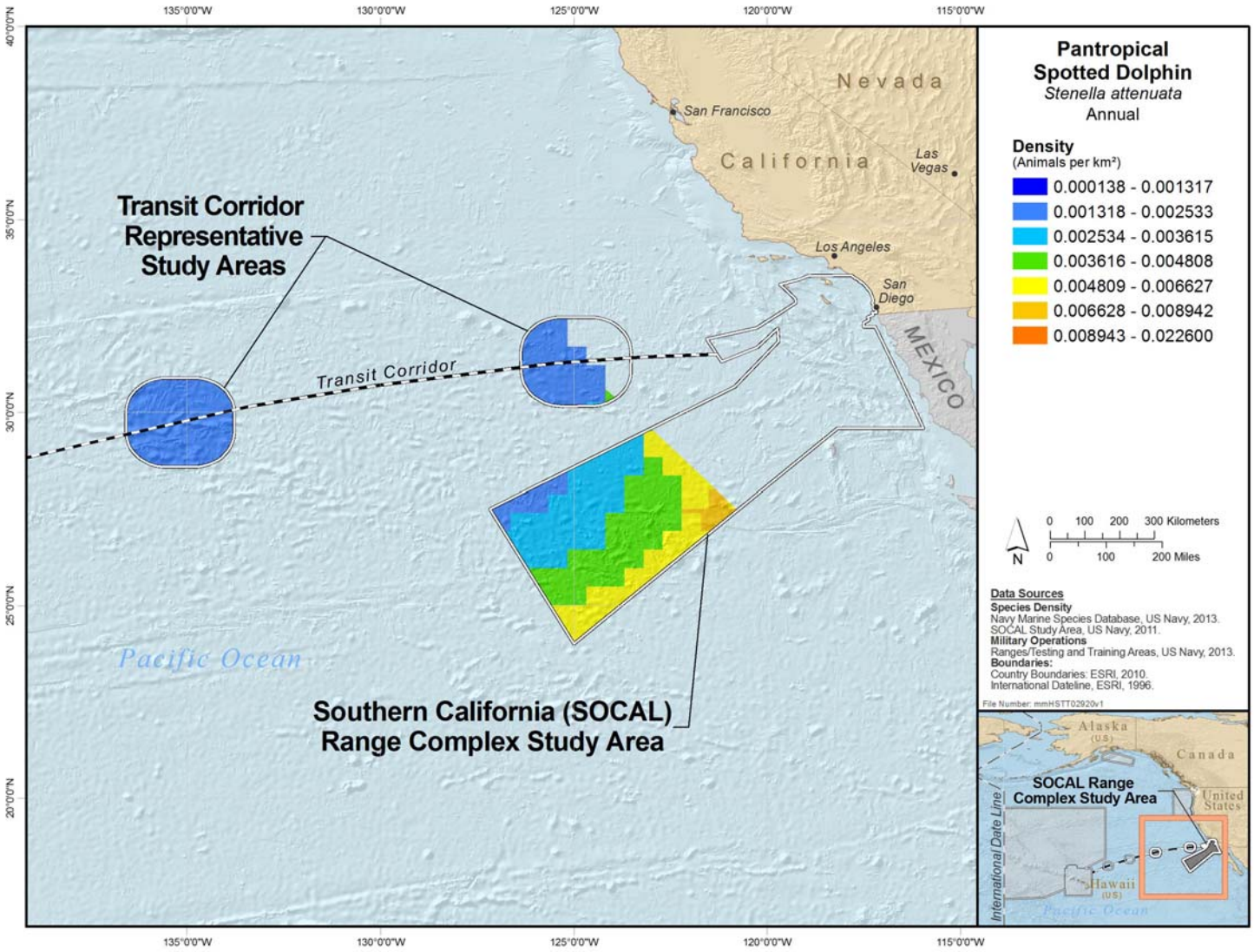

Figure 7-74: Annual Distribution of Pantropical Spotted Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

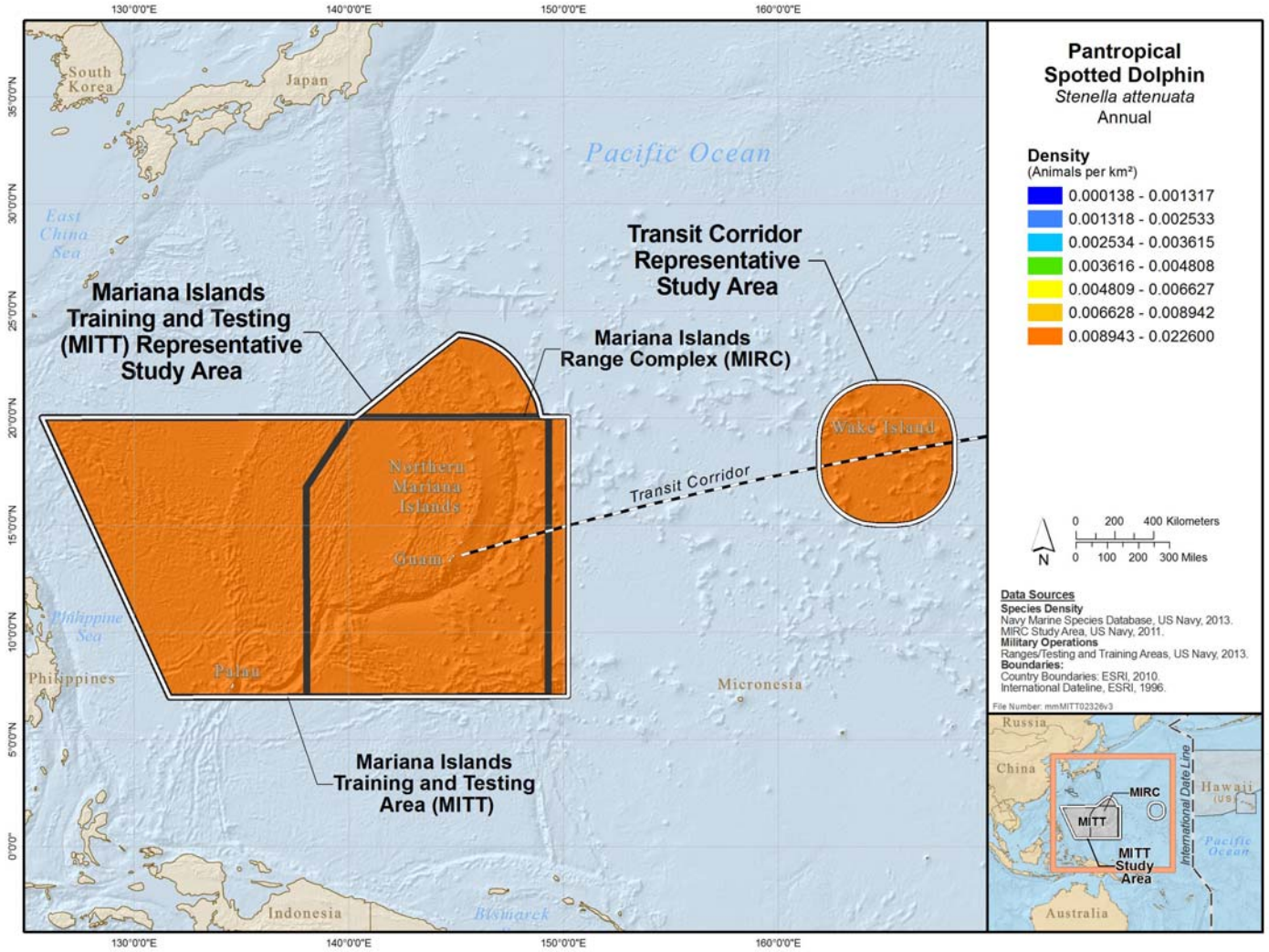

Figure 7-75: Annual Distribution of Pantropical Spotted Dolphin in MITT and the Associated Transit Corridor Study Areas

7.1.13 *STENELLA COERULEOALBA*, STRIPED DOLPHIN

Striped dolphins are primarily pelagic and are typically found past the continental shelf (Archer 2009). They have a similar appearance to spinner, spotted, and common dolphins (Jefferson et al. 2008). Their beak is moderate in length and is therefore distinguishable from the longer beak of the spinner dolphin and long-beaked common dolphin (Jefferson et al. 2008). They have a color pattern on their face and sides that allows them to be distinguished from other dolphins. A blaze of light color on the side of the body extends up into the dark cape, and dark stripes from the rostrum extend back to the anus and down to the front of the pectoral fin (Jefferson et al. 2008). There is some literature reporting striped dolphins mixing with other species (Querouil et al. 2008), but it may not be a common occurrence in many places. Striped dolphins may be difficult to observe, because they are notorious for avoiding vessels (Jefferson et al. 2008; Leatherwood et al. 1988), or at least not bow riding, if a group is approached (Archer 2009). These behavioral features may cause this species to be under-represented in some data sets, but there are some behaviors that allow the species to be more easily identified at sea. The species will perform leaps from the water and move at high speeds away from vessels; they will perform a unique behavior called "roto-tailing," which is a rotation of the tail while jumping (Archer and Perrin 1999). NMFS recognizes a Hawaiian stock of striped dolphins and a California/Oregon/Washington stock (Carretta et al. 2011a). Density values for the HSTT Study Area are presented for the species as a whole. While animals in SOCAL or HRC could presumably be assigned to a stock, animals in the transit corridor could belong to either stock. In the western North Pacific, three migratory stocks are provisionally recognized (Kishiro and Kasuya 1993). Little is known about the stock structure of striped dolphins in the MITT Study Area. Animals occurring in the Offshore region of the NWTT Study Area belong to the California/Oregon/Washington stock.

HRC. NMFS developed a CENPAC model for striped dolphin (Becker et al. 2012b). The Navy applied this model to all seasons for HRC and the western portion of the transit corridor. The global RES model from St. Andrews (SMRU Ltd. *in prep*) predicts a higher concentration of striped dolphins to the northwest of the CENPAC study area. These values contrast sharply with the low density predicted by the CENPAC habitat-based density model.

SOCAL. NMFS has been able to develop a CCE habitat-based density model for striped dolphins (Becker et al. 2012c). The Navy applied this model for all four seasons. Ferguson and Barlow (2003) provided uniform densities for the Baja Extension. These values are used for all four seasons. For the sliver of area where the CENPAC and CCE models do not meet near the Baja Extension, the St. Andrew's RES model (SMRU Ltd. *in prep*) was retained. There is a notable disagreement in densities between the western edge of the NMFS CCE model and the eastern edge of the CENPAC model. Reconciling these models is an objective for NMFS and the Navy. In the Southern California Bight, data for striped dolphin are arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

MITT. Prior to the Navy's 2007 survey of the Study Area (Fulling et al. 2011), striped dolphins were only known from one stranding that occurred in July 1985 (Eldredge 1991, 2003). However, striped dolphins were sighted throughout the Study Area during the 2007 survey in waters with variable bottom depth,

ranging from 7,749 to 24,835 ft. (2,348 to 7,526 m) (Fulling et al. 2011). There was at least one sighting over the Mariana Trench, southeast of Saipan. Group size ranged from 7 to 44 individuals, and several sightings included calves. Based on the 2007 survey data, there were an estimated 0.00616 striped dolphins/km^2 (CV = 0.54) in the MITT Study Area (Fulling et al. 2011). Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual striped dolphin density.

NWTT Offshore. Striped dolphin encounters increase in deep, relatively warmer waters off the U.S. west coast (Becker et al. 2012c), and their abundance decreases north of about 42°N (Barlow et al. 2009; Becker et al. 2012c; Forney et al. 2012). Although striped dolphins typically do not occur north of California, there are a few sighting records off Oregon and Washington (Von Saunder and Barlow 1999; Barlow 2003; Barlow 2010). Strandings are documented along the coasts of Oregon, Washington, and British Columbia (Kellogg and Scheffer 1947; Kenyon and Scheffer 1949; Cowan and Guiguet 1952; Scheffer 1960). Occurrences north of California may be related to incidents of warm water moving northward (Baird et al. 1993; Norman et al. 2004). As noted above for SOCAL, NMFS developed a CCE habitat-based density model for striped dolphin, which provides spatially-explicit density estimates off the U.S. west coast for summer and fall (Becker et al. 2012c). Barlow and Forney (2007) also provide summer/fall stratified uniform density estimates for waters off California, Oregon, and Washington. Their uniform estimate for Oregon/Washington was used to represent density for the area north of the SWFSC strata (refer to Figure 3-6). Striped dolphins were not sighted during winter/spring line-transect aerial surveys conducted off California in March and April 1991 and 1992 (Forney et al. 1995), nor were they sighted off Oregon or Washington during systematic surveys from April 1989 to September 1990 (Green et al. 1992) or from March to May 1992 (Green et al. 1993). Given their affinity for warm water, striped dolphins are not expected this far north in winter/spring, and were thus assigned a zero density estimate in offshore waters for this seasonal period.

NWTT Inland Waters. Striped dolphins are not expected to occur within the Inland Waters region of the Study Area.

NWTT Western Behm Canal, Alaska. Striped dolphins are not expected to occur within the Western Behm Canal region of the Study Area.

GOA. Striped dolphins are not expected to occur in the GOA Study Area.

Table 7-25: Sources of Density Values Used for Striped Dolphin

Location	Spring	Summer	Fall	Winter
HRC	CENPAC	CENPAC	CENPAC	CENPAC
W. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
E. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
SOCAL	CCE	CCE	CCE	CCE
MITT	L	L	L	L
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	0	CCE and LD	CCE and LD	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-26: Summary of Density Values for Striped Dolphin in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
Hawaii inner stratum	S	S	S	S
HRC outer	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	S	S	S	S
SOCAL	S	S	S	S
Inner Baja Extension	0.0033	0.0033	0.0033	0.0033
Outer Baja Extension	0.0372	0.0372	0.0372	0.0372
MITT	0.00616	0.00616	0.00616	0.00616
MITT Transit Corridor	0.00584	0.00584	0.00584	0.00584
NWTT Offshore	0	S and 0.00005	S and 0.00005	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

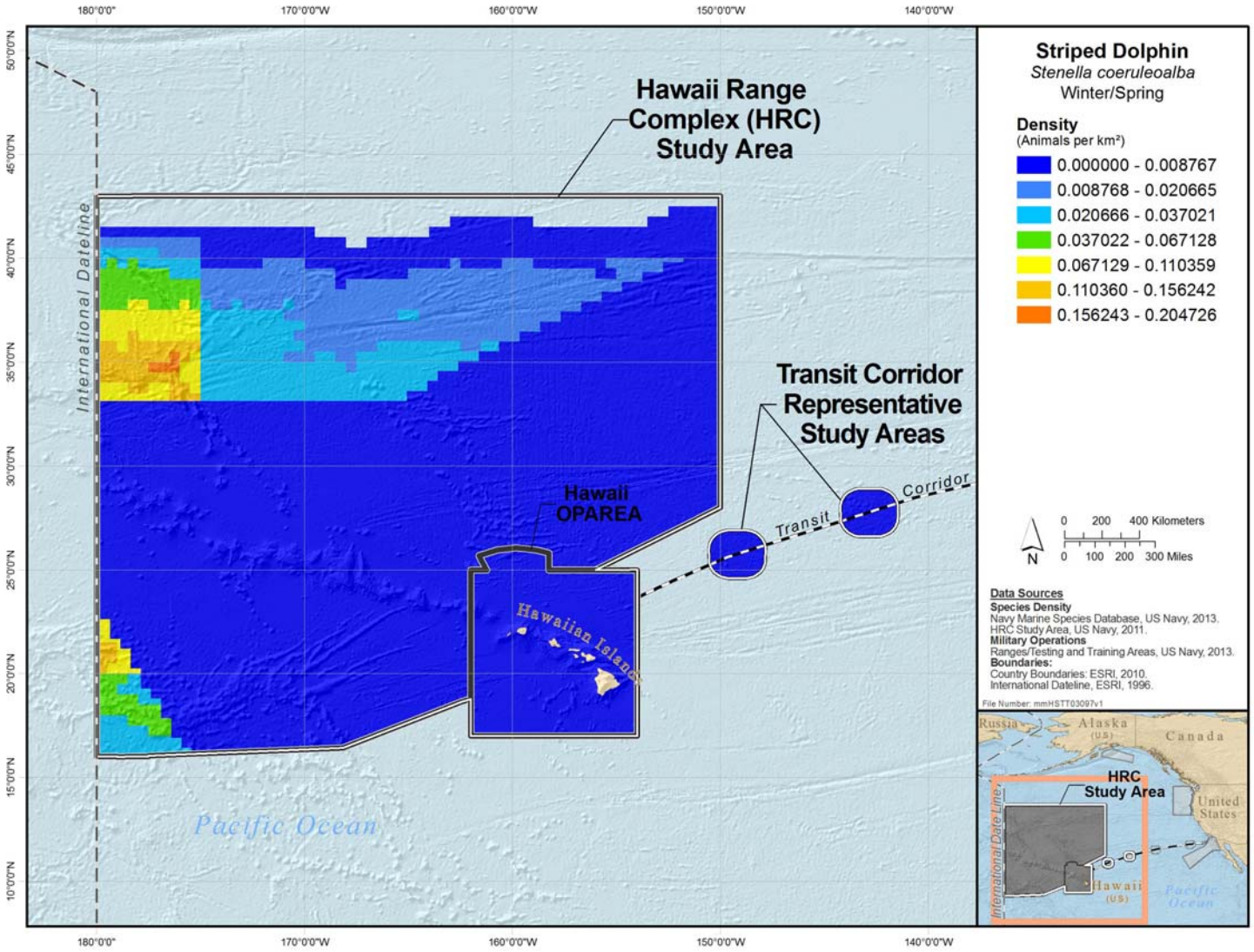

Figure 7-76: Winter/Spring Distribution of Striped Dolphin in HRC and the Western Portion of the Transit Corridor

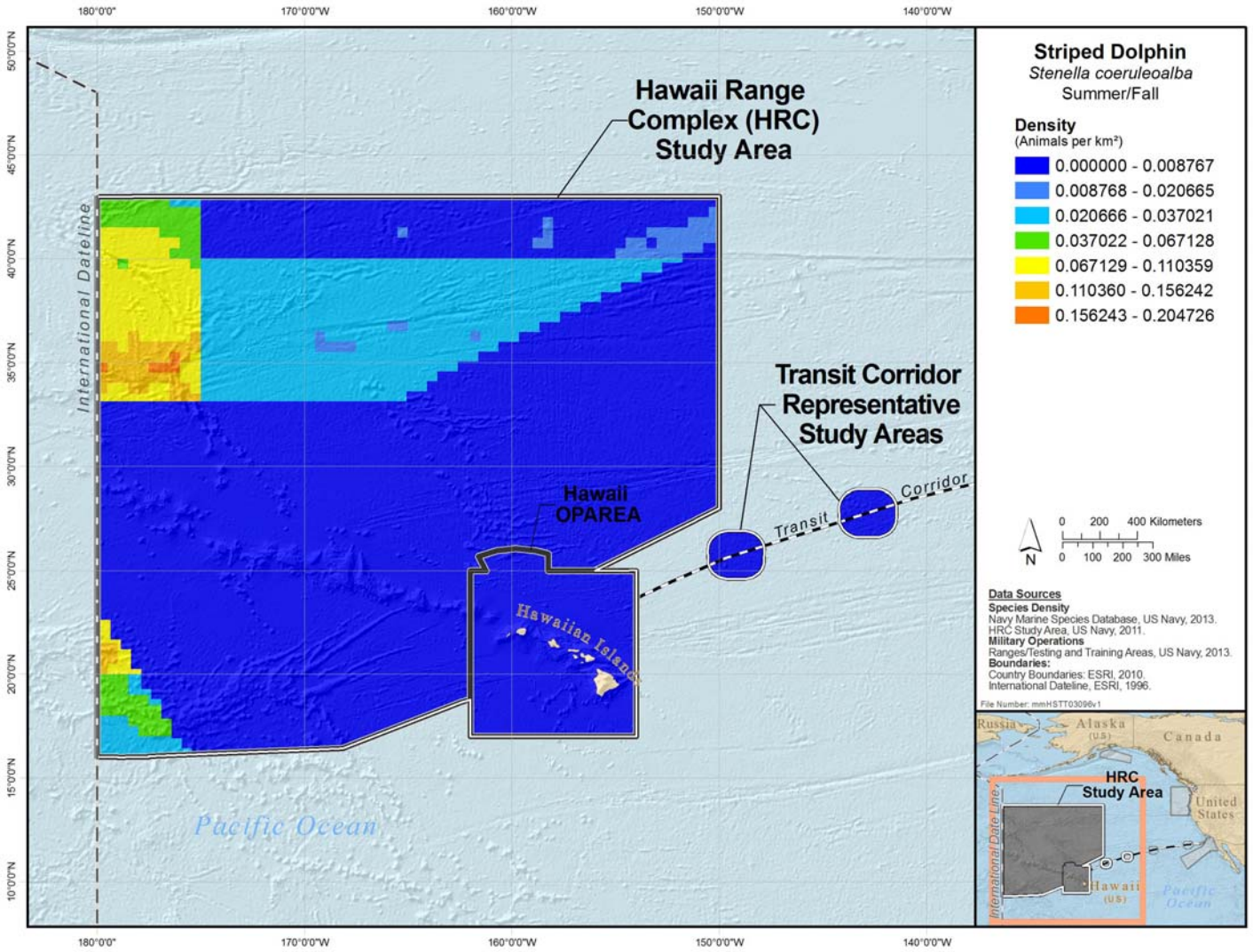

Figure 7-77: Summer/Fall Distribution of Striped Dolphin in HRC and the Western Portion of the Transit Corridor

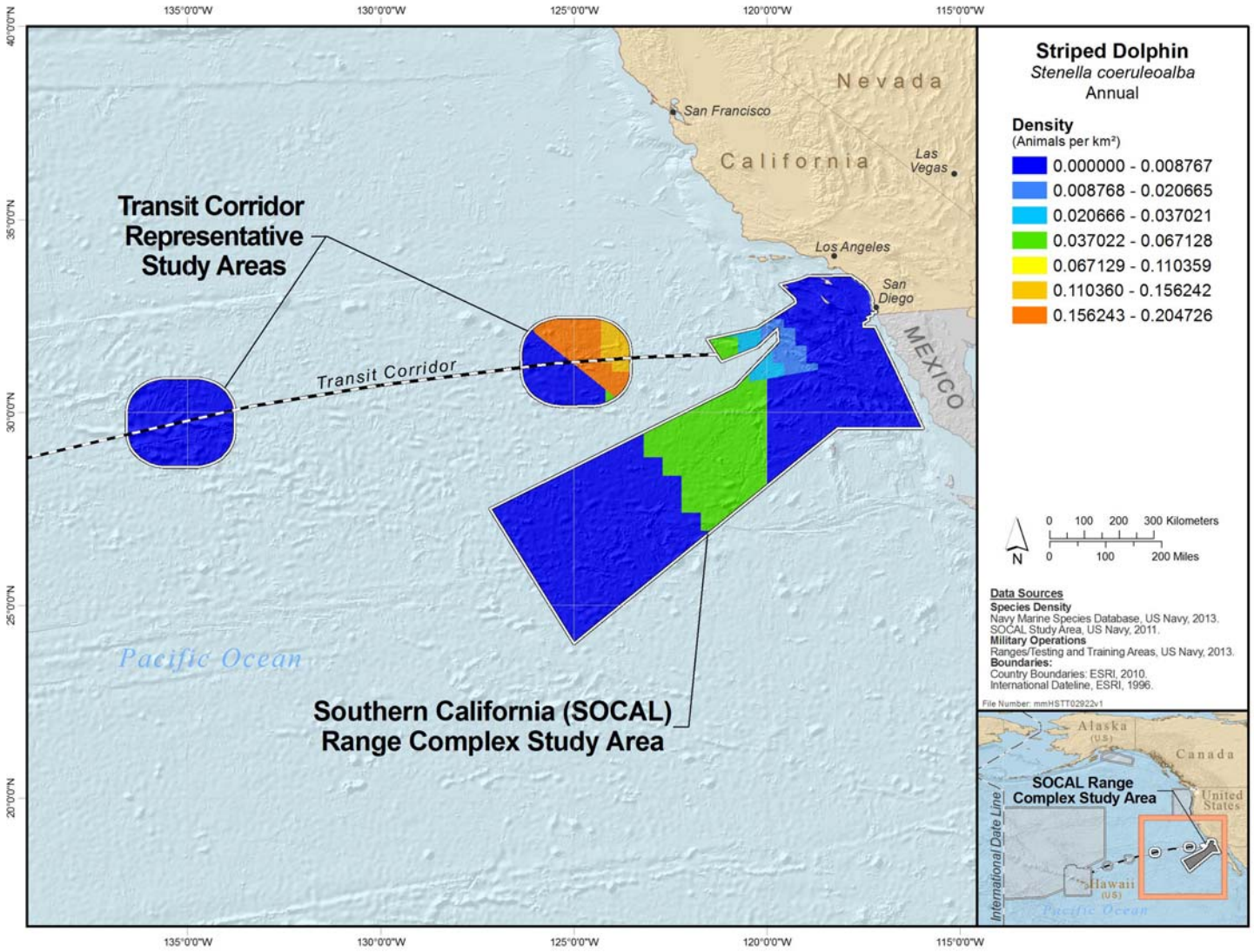

Figure 7-78: Annual Distribution of Striped Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

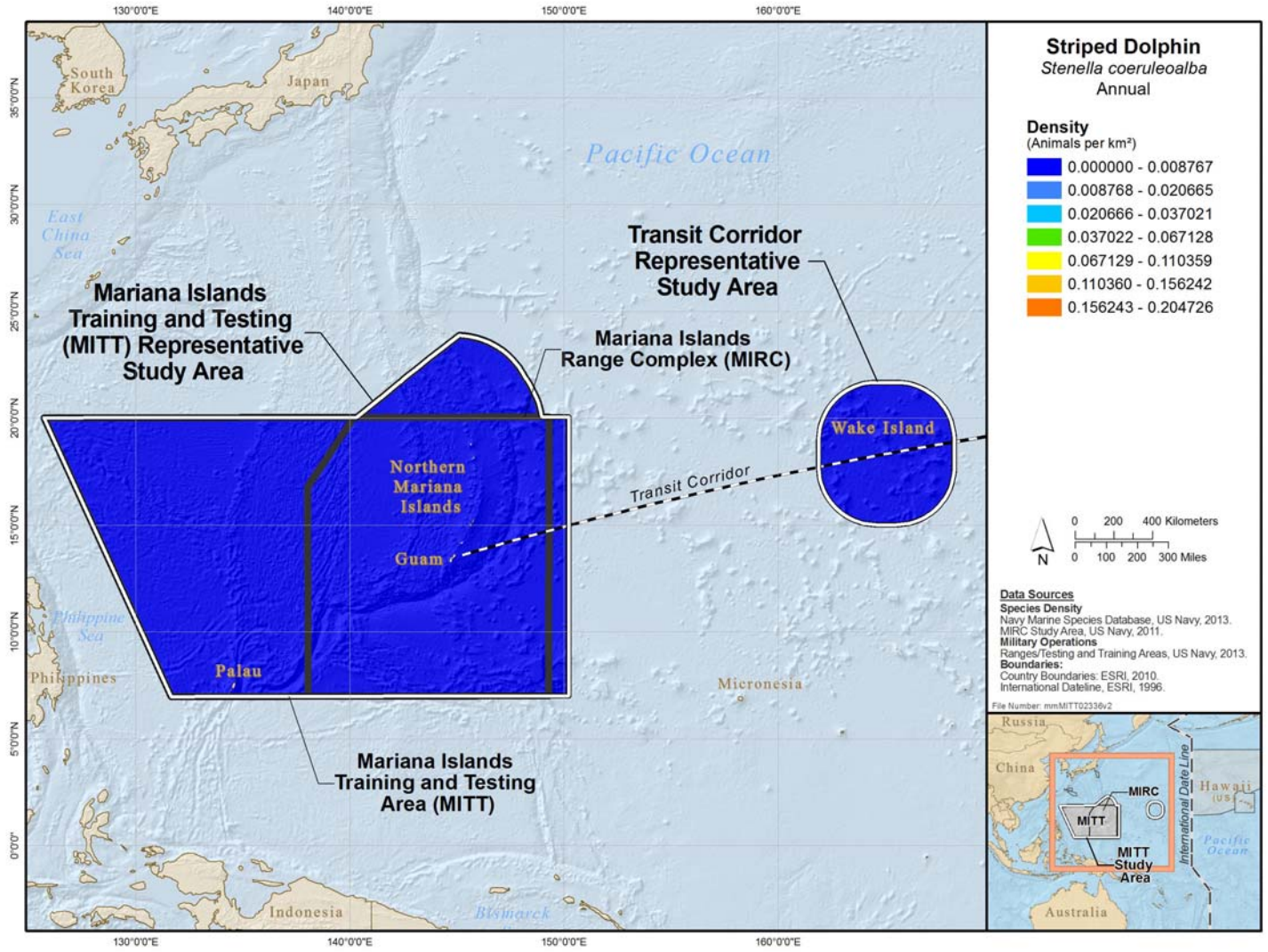

Figure 7-79: Annual Distribution of Striped Dolphin in MITT and the Associated Transit Corridor Study Areas

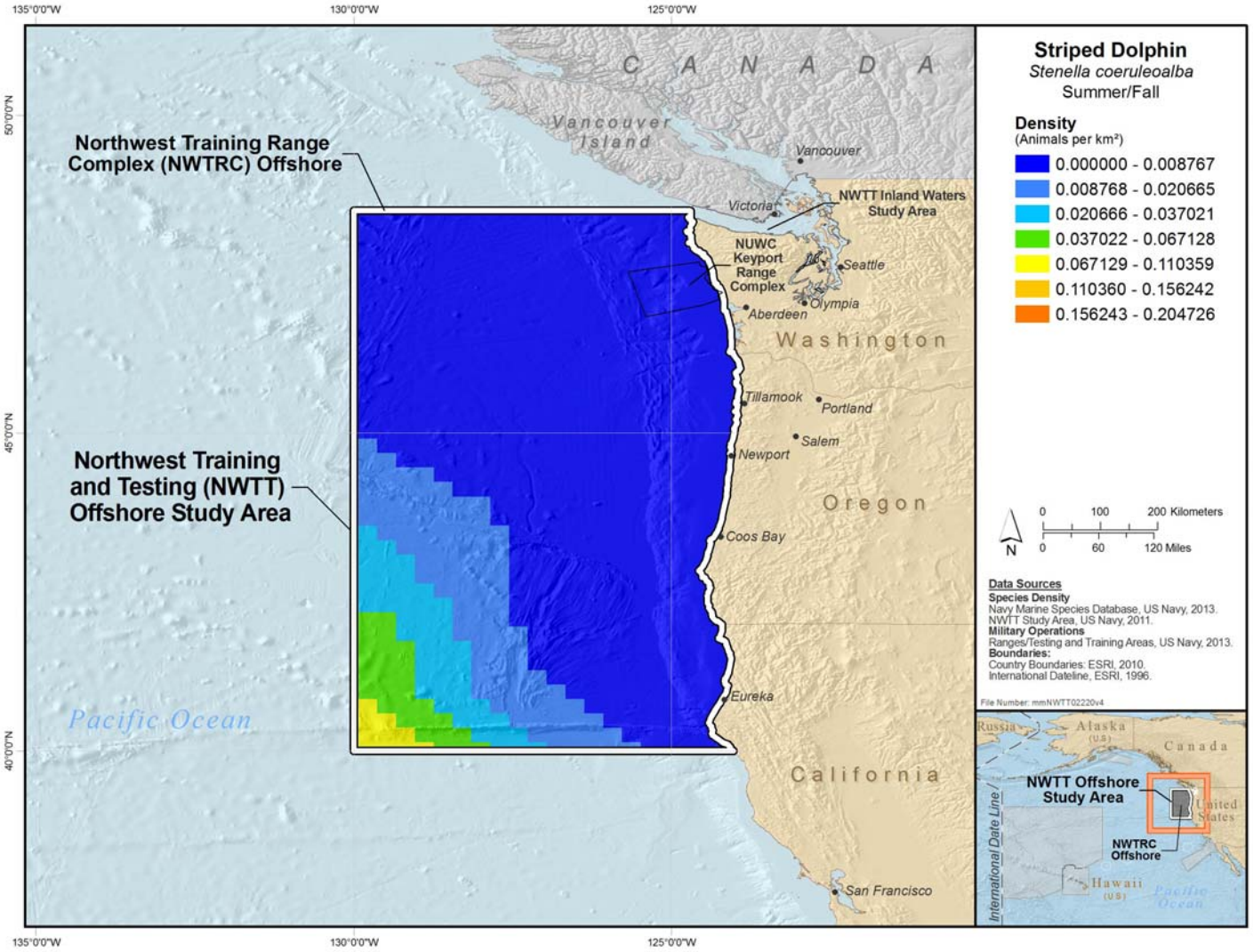

Figure 7-80: Summer/Fall Distribution of Striped Dolphin in the Offshore Portion of the NWTT Study Area

7.1.14 *STENELLA LONGIROSTRIS*, SPINNER DOLPHIN

This well-known tropical dolphin is small-bodied and has a very long beak (Jefferson et al. 2008). Adult males develop a post-anal "hump" in what is otherwise a thin tail stock (Allen et al. 2011; Jefferson et al. 2008). The spinner dolphins have an erect, triangular dorsal fin, which is relatively unique in shape when compared to other dolphin species (Leatherwood et al. 1988). These morphological features serve to make the spinner dolphin distinguishable from other dolphins in their range that they could be mistaken for, including bottlenose dolphin, spotted dolphin, striped dolphin, common dolphin (*Delphinus* spp.), and Fraser's dolphin. The general basic color of spinner dolphins is gray above and white below, with an intermediate side, but a great deal of regional variation in color is observed in this species and four subspecies are recognized: *Stenella longirostris longirostris* in oceanic waters throughout the world, *Stenella longirostris orientalis* in the offshore eastern tropical Pacific, *Stenella longirostris centroamericana* in the coastal eastern tropic Pacific, and *Stenella longirostris roseiventris* off Southeast Asia and northern Australia (Jefferson et al. 2008; Norris et al. 1994). One of the things that distinguishes this species most clearly from other species is the behavior that is their namesake. The various twisting, spinning leaps they perform, as well as many other conspicuous surface behaviors have been described in detail (Fish et al. 2006; Norris and Dohl 1980; Norris et al. 1994). Spinner dolphins do associate with other species; a common association is with pantropical spotted dolphins (Jefferson et al. 2008; Kiszka et al. 2011a; Psarakos et al. 2003).

In Hawaii spinner dolphins populations can be partitioned into subpopulations that are associated with a particular island or group of islands (Andrews et al. 2010; Karczmarski et al. 2005; Perrin 2009b). NMFS recognizes a stock complex of spinner dolphins for the Hawaiian Islands (Carretta et al. 2011a). The complex includes an Oahu/Four-islands stock, a Kauai/Niihau stock, a Pearl and Hermes Reef stock, a Midway Atoll/Kure stock, and a Hawaii Pelagic stock. Also in the Pacific, NMFS manages an American Samoa spinner dolphin stock. Spinner dolphins in the eastern tropical Pacific are managed separately (Carretta et al. 2011a). Abundance estimates are not available for the separate stocks. Density values for the HSTT Study Area are presented for the species as a whole.

Little is known about the stock structure of spinner dolphins in the MITT Study Area. However, based on recent sighting data (HDR 2011; Hill et al. 2011; Ligon et al. 2011; Oleson and Hill 2010) and what is known of the Hawaiian Islands stocks, it is likely that there are both island-associated and pelagic populations of spinner dolphins in the MITT Study Area. In 2012 and 2013, sightings of spinner dolphins off Guam and Saipan support the existence of island-associated populations (HDR 2012; Hill et al. 2013). In 2013, during surveys around Tinian and Pagan in the Commonwealth of the Northern Mariana Islands, there were a large number of spinner dolphin sightings in association with these islands, also suggestive of island-associated populations there (U.S. Department of the Navy 2014).

HRC. NMFS developed a CENPAC model for spinner dolphin (Becker et al. 2012b). The Navy applied this model to all seasons for HRC and the western portion of the transit corridor.

SOCAL. This species has not been observed on NMFS surveys in the SOCAL area or the eastern portion of the transit corridor (Hamilton et al. 2009).

MITT. Although there are multiple sighting records of spinner dolphins around the Mariana Islands (Hill et al. 2013; HDR 2012; HDR 2011; Hill et al. 2011; Ligon et al. 2011; Oleson and Hill 2010), no abundance estimate is available for the region. The only systematic line-transect survey of the Study Area was the Navy's 2007 survey for which there was only one sighting of this species (Fulling et al. 2011), and a robust abundance estimate was not possible. Consistent with recommendations from scientists at PIFSC, the Navy assumed that both an island(s)-associated spinner dolphin population within 10 nm of all the islands and a pelagic spinner dolphin population exist. For the island-associated spinner dolphins, the Navy used line-transect estimates derived by Barlow (2006) for waters in a main Hawaiian Islands stratum (0.00699 animals/km^2). For the pelagic population, the Navy used line-transect estimates derived by Barlow (2006) for waters in an offshore Hawaiian EEZ stratum (0.00083 animals/km^2). Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual spinner dolphin density.

NWTT. This species is not expected to occur in any of the regions included in the NWTT Study Area.

GOA. This species is not expected to occur in the GOA Study Area.

Table 7-27: Sources of Density Values Used for Spinner Dolphin

Location	Spring	Summer	Fall	Winter
HRC	CENPAC	CENPAC	CENPAC	CENPAC
W. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-28: Summary of Density Values for Spinner Dolphin in the HSTT Study Area

Location	Spring	Summer	Fall	Winter
HRC	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
Inner Baja Extension	0	0	0	0
Outer Baja Extension	0	0	0	0
MITT (within 10 nm of islands)	0.00699	0.00699	0.00699	0.00699
MITT (> 10 nm of islands)	0.00083	0.00083	0.00083	0.00083
MITT Transit Corridor	0.00187	0.00187	0.00187	0.00187
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

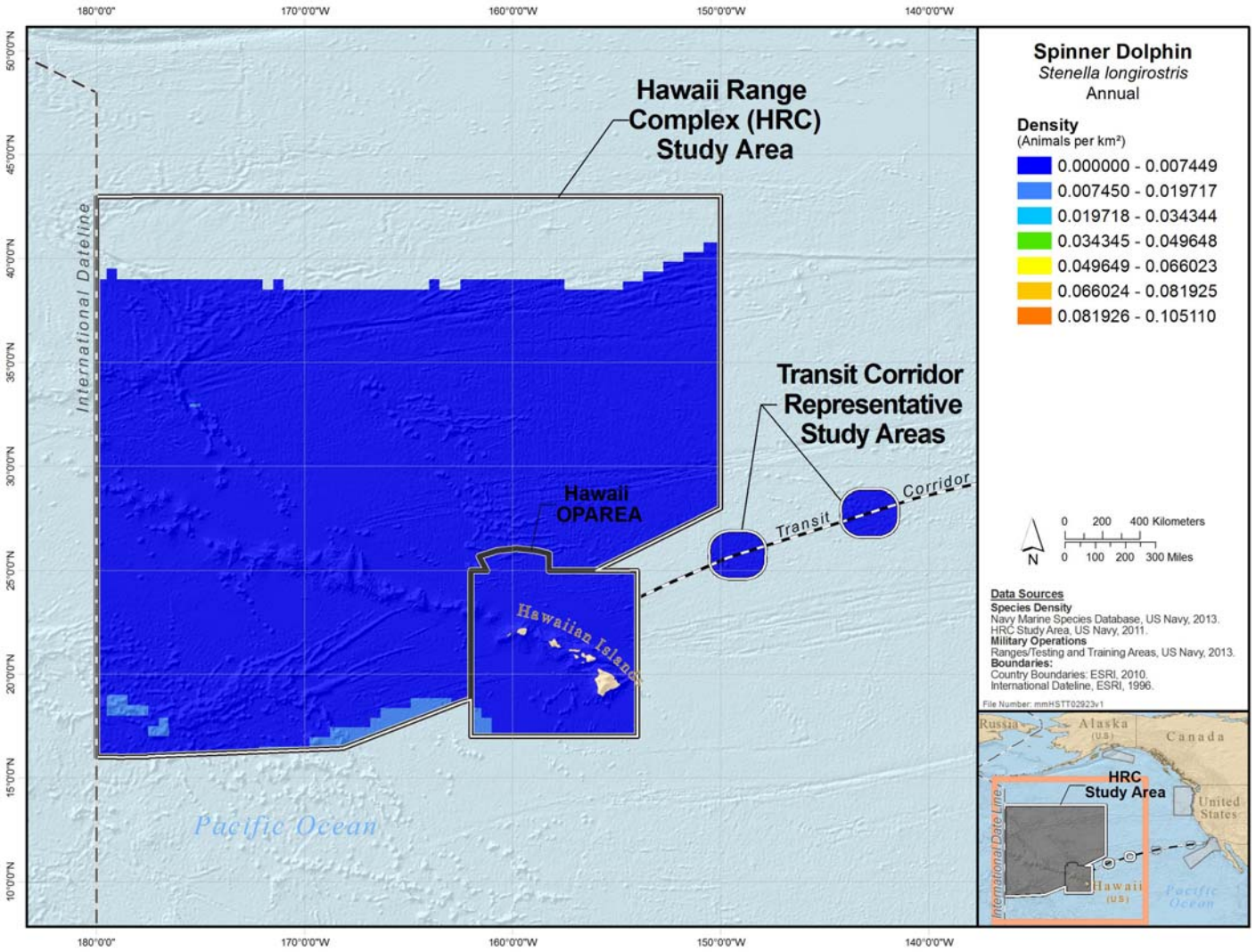

Figure 7-81: Annual Distribution of Spinner Dolphin in HRC and the Western Portion of the Transit Corridor

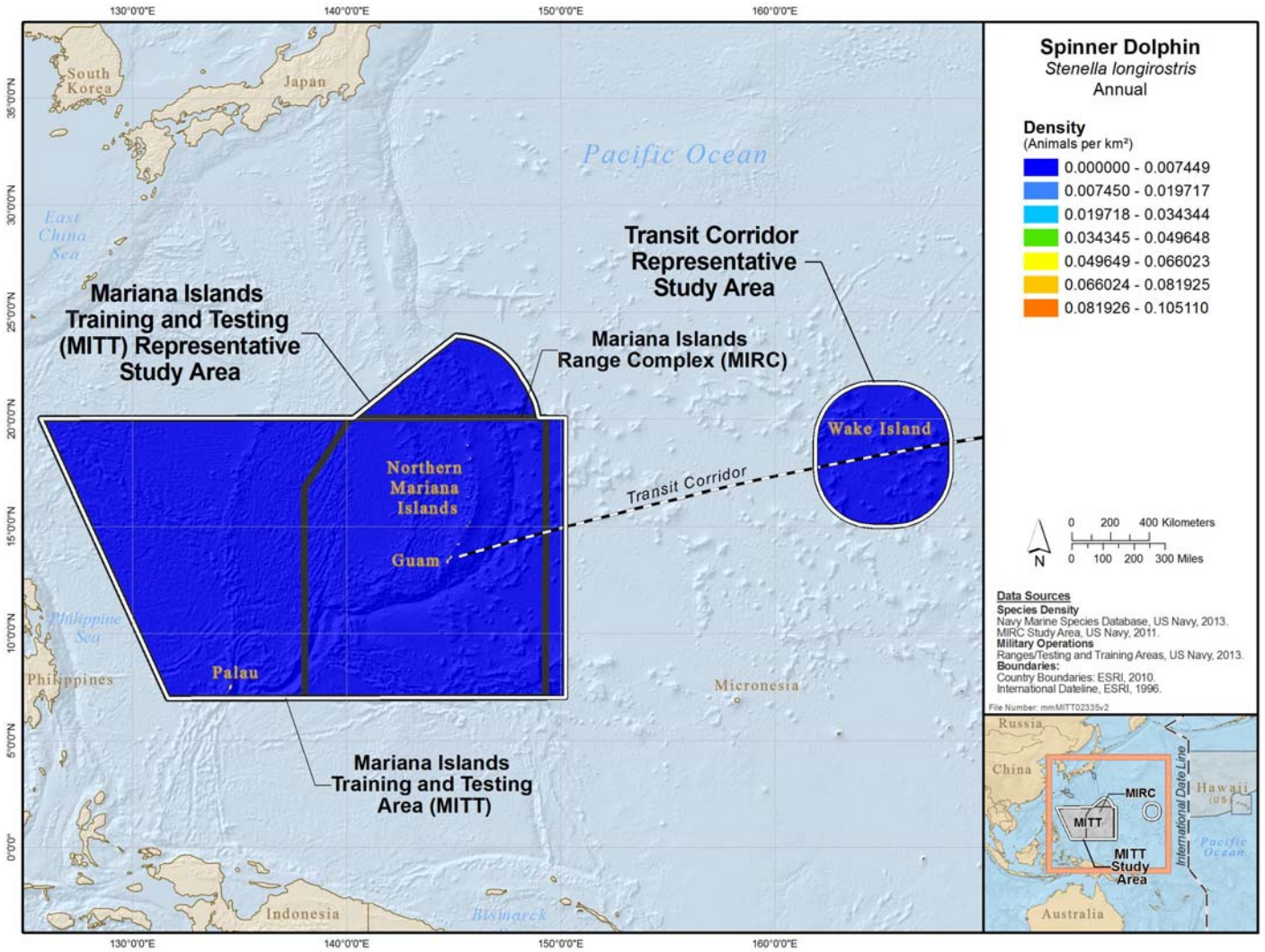

Figure 7-82: Annual Distribution of Spinner Dolphin in MITT and Associated Transit Corridor Study Areas

7.1.15 *STENO BREDANENSIS*, ROUGH-TOOTHED DOLPHIN

This dolphin is found in offshore waters of the tropics around the world (Baird et al. 2008b; Jefferson et al. 2008; Leatherwood et al. 1988). Rough-toothed dolphins are somewhat unusual looking for a dolphin as they have a gently-sloping melon instead of a rounded area in front of the eyes. There is no crease between the melon and beak, as there are in most dolphins, and this shape gives the head a conical appearance (Jefferson et al. 2008; Leatherwood et al. 1988). Rough-toothed dolphins are dark gray in color with a darker cape. Often they have a white (often with a pinkish tinge) coloration on the belly that can make irregular patches of white/pink color around the mouth, head, and lower sides of the body (Leatherwood et al. 1988). They are acrobatic and jump out of the water with regularity, but landings are less graceful than other dolphins and look more like flops or breaches that humpback whales perform (Hanser pers. obs). Because of their gray color they can be confused with bottlenose dolphins and pantropical spotted dolphins, and their aerial behavior can appear to be like spinner dolphins from a distance (Leatherwood et al. 1988). Closer observation of the coloration and the head shape will resolve identification issues.

Deep waters are close to shore in Hawaii, and this has facilitated studies of rough-toothed dolphin movements and site fidelity (Baird et al. 2008b). Rough-toothed dolphins may have fidelity to areas associated with specific islands, feeding areas, or depth profiles. NMFS recognizes two Pacific management stocks: the Hawaiian stock and the American Samoa stock (Carretta et al. 2011a). Little is known about the stock structure of rough-toothed dolphins in the MITT Study Area.

HRC. NMFS developed a CENPAC model for rough-toothed dolphins (Becker et al. 2012b). The Navy applied this model to all seasons for HRC and the western portion of the transit corridor.

SOCAL. This species has not been observed in SOCAL (Hamilton et al. 2009); therefore, zero density was assigned to the west coast of the United States. The CENPAC model was applied to all seasons in the eastern portion of the transit corridor. For the sliver of area between the CENPAC model and the California Current ecosystem area, the Kaschner et al. (2006) RES model values were retained, because they were similar to the CENPAC model values.

MITT. During the Navy's 2007 survey of the Study Area, there were two sightings of rough-toothed dolphins, both in groups of nine individuals, with calves present in one sighting (Fulling et al. 2011). However, only one of the sightings was on-effort and consistent with recommendations from scientists at PIFSC, line-transect estimates derived for Hawaiian waters (Barlow 2006) were used to represent the best available estimates for the MITT Study Area. Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual rough-toothed dolphin density.

NWTT. This species is not expected to occur in any of the regions included in the NWTT Study Area.

GOA. This species is not expected to occur in the GOA Study Area.

Table 7-29: Sources of Density Values Used for Rough-Toothed Dolphin

Location	Spring	Summer	Fall	Winter
HRC	CENPAC	CENPAC	CENPAC	CENPAC
W. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
E. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
SOCAL	0	0	0	0
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-30: Summary of Density Values for Rough-Toothed Dolphin in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	S	S	S	S
SOCAL	0	0	0	0
Inner Baja Extension	0	0	0	0
Outer Baja Extension	0	0	0	0
MITT	0.00355	0.00355	0.00355	0.00355
MITT Transit Corridor	0.00185	0.00185	0.00185	0.00185
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

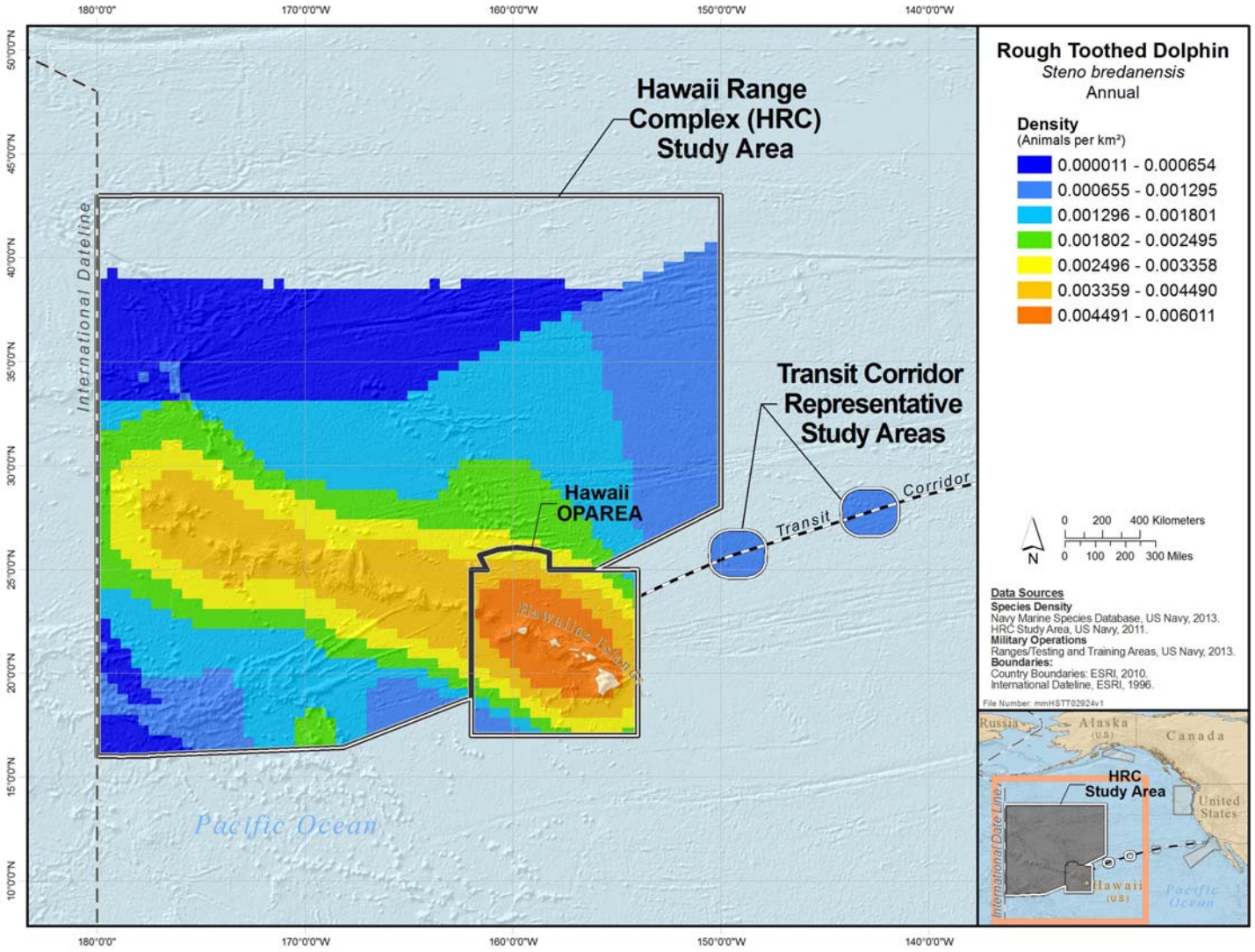

Figure 7-83: Annual Distribution of Rough-Toothed Dolphin in HRC and the Western Portion of the Transit Corridor

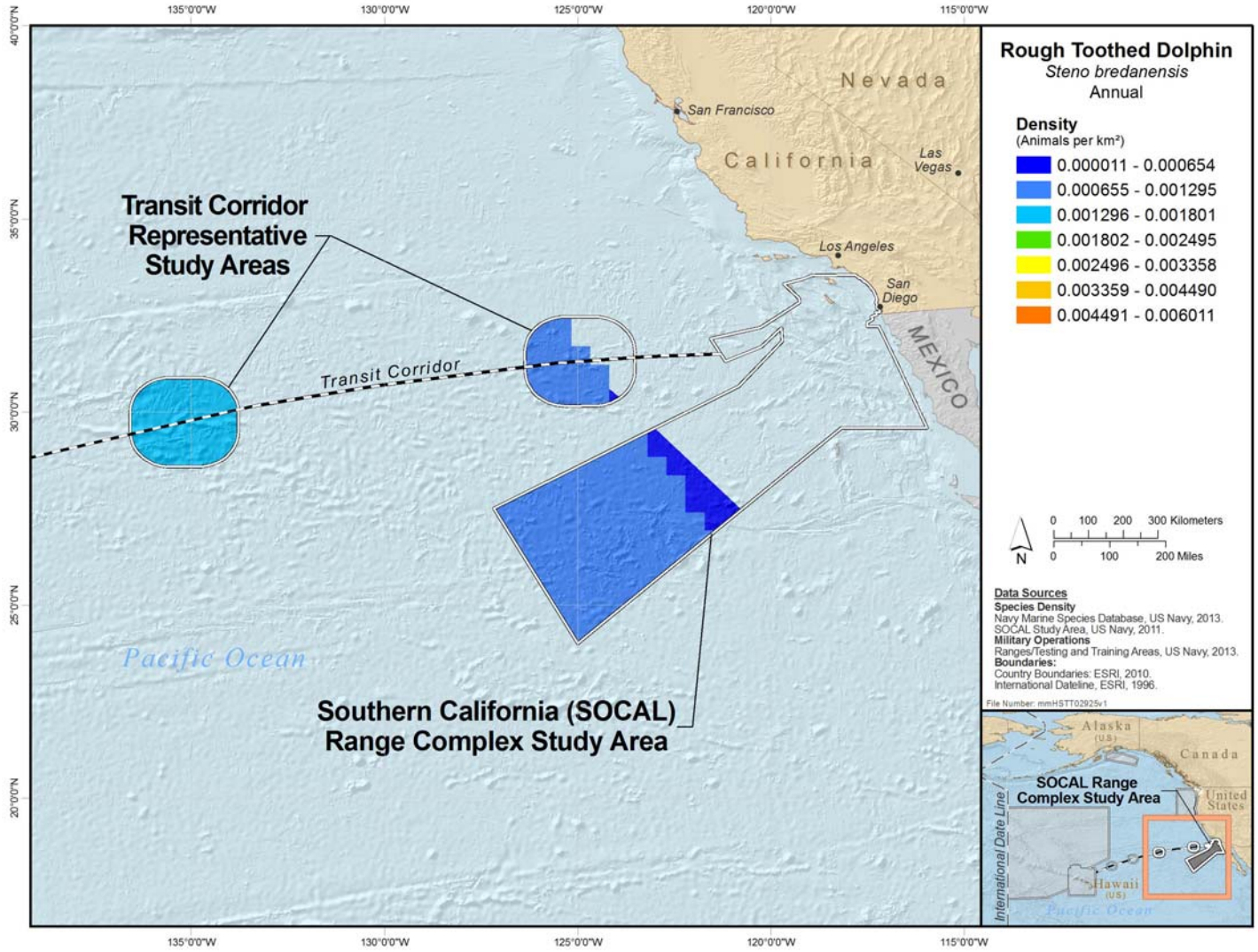

Figure 7-84: Annual Distribution of Rough-Toothed Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

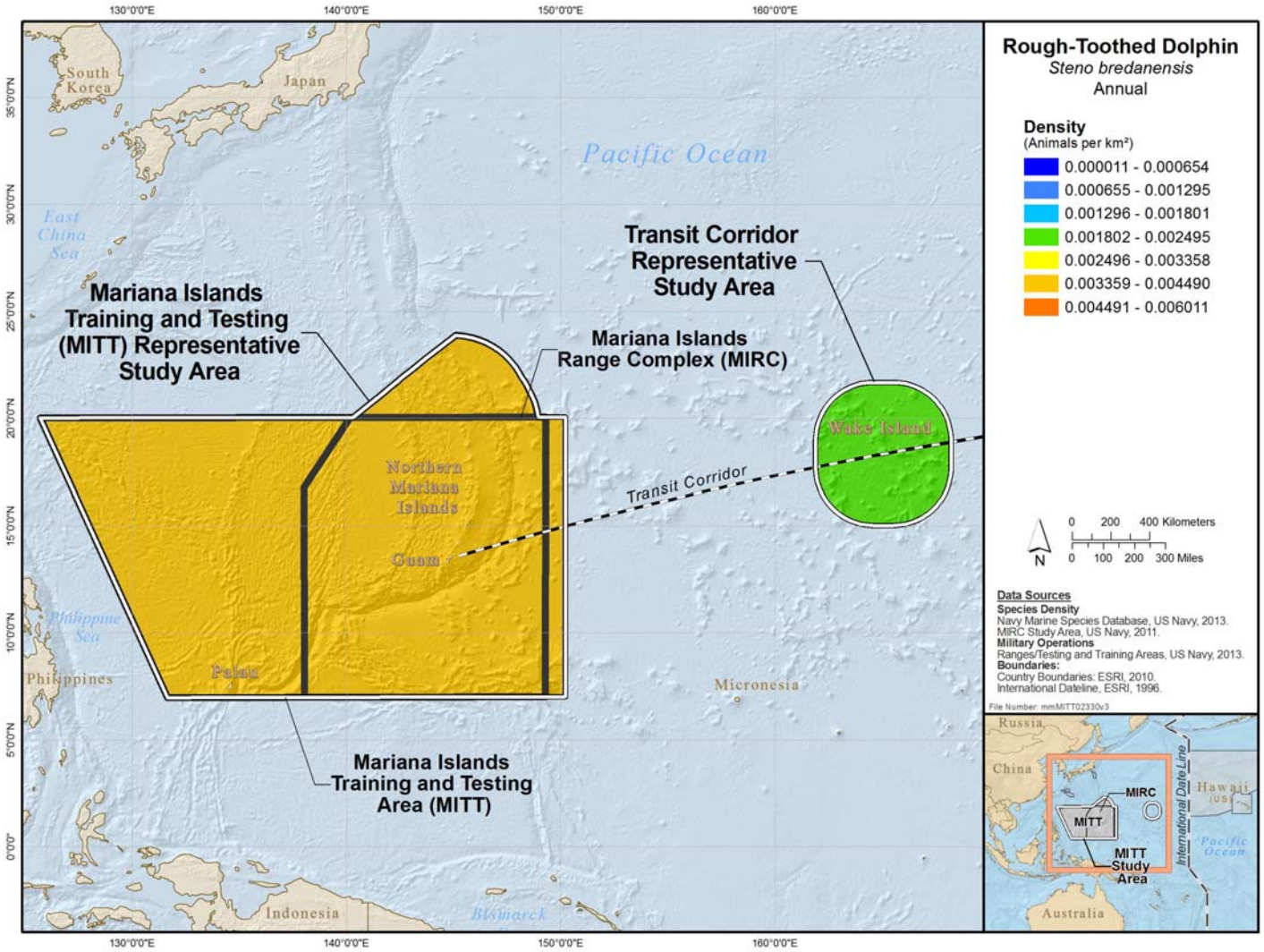

Figure 7-85: Annual Distribution of Rough-Toothed Dolphin in MITT and the Associated Transit Corridor Study Areas

7.1.16 *TURSIOPS TRUNCATUS*, COMMON BOTTLENOSE DOLPHIN

The common bottlenose dolphin is the "standard" dolphin envisioned by the general public from the media and public exhibits. They have the most generalized color scheme of any dolphin; they are primarily gray countershaded with white (occasionally with a pinkish tinge) sometimes on the ventral side (Allen et al. 2011; Jefferson et al. 2008). Their body is robust and powerfully built, the beak is a moderate length, and their dorsal fin is prominent, falcate, and pointed (Allen et al. 2011; Jefferson et al. 2008; Leatherwood et al. 1988). The general similarity of bottlenose dolphins to many other dolphins means that they can be confused with a variety of species, most often rough-toothed dolphins and pantropical spotted dolphins (Leatherwood et al. 1988). Bottlenose dolphins are so widespread in tropical and temperate waters, that the degree to which the species can be mistaken with other dolphins often depends on where one is in the world (Jefferson et al. 2008). It is unclear if misidentifications systematically tend to overestimate sightings in favor of bottlenose dolphins or in favor of species other than bottlenose dolphins. The best field protocols clearly are ones that quantify the uncertainty of sightings or categorize species as unidentified, unless the species can be established with high certainty.

Bottlenose dolphins are strongly social and often associate with other marine mammal species (Connor et al. 2000; Scott and Chivers 1990). Species can include spotted dolphins, spinner dolphins, common dolphins, Risso's dolphins, pilot whales, humpback whales, and California sea lions (Deakos et al. 2010; Hanser et al. 2010; Kiszka et al. 2011a; Leatherwood et al. 1988; Querouil et al. 2008; Wells and Scott 1999). Bottlenose dolphin populations have a complex structure. The basic division in populations is often between offshore and coastal forms (Baird et al. 1993; Wells and Scott 1999). There may be more or less population structure in differing areas. NMFS recognizes two stocks and one stock complex of bottlenose dolphins in U.S. waters: a Hawaiian Island Stock Complex, a California/Oregon/Washington Offshore stock, and a California Coastal stock (Carretta et al. 2011a). The Hawaiian Islands Stock Complex includes an Oahu stock, a Four-islands stock, a Kauai/Niihau stock, a Hawaii Island stock, and a Hawaii Pelagic stock. Abundance estimates are not available for the separate stocks. Ostensibly, the Navy has potential to interact with all of the stocks defined by NMFS. Density values for the HRC and the transit corridor are presented for the species as a whole. In SOCAL, density values are separated out by the coastal and offshore stocks. Little is known about the stock structure of bottlenose dolphins in the MITT Study Area. Bottlenose dolphins occurring in the Offshore region of the NWTT Study Area belong to the California/Oregon/Washington Offshore stock.

HRC. NMFS developed a CENPAC model for the common bottlenose dolphin (Becker et al. 2012b). The Navy applied this model to all seasons for HRC and the western portion of the transit corridor. The model applies to the species as a whole, and not to individual stocks within the Hawaiian Island Stock Complex. The area of high density to the northwest of the Hawaiian Islands is predicted by the St. Andrew's global RES model (SMRU Ltd. *in prep*) and is in contrast to the CENPAC model.

SOCAL. For the California/Oregon/Washington Offshore stock of bottlenose dolphins, Barlow and Forney (2007) provided summer/fall uniform density estimates in the NMFS study area for strata defined as the Southern California Bight, Central California, Northern California, and

Oregon/Washington. Summer and fall data for the Baja extension comes from Ferguson and Barlow (2003). Forney et al. (1995) provided cool season uniform density estimates for the Southern California Bight and Central California up to the California/Oregon border. The CENPAC model is used for the eastern portion of the transit corridor. In theory the California/Oregon/Washington Offshore stock of bottlenose dolphins is found in the eastern part of the transit corridor. On the winter/spring map for SOCAL, there is a fair amount of disagreement between the uniform density of the offshore stock in the Southern California Bight and the surrounding models. In the Southern California Bight, data for the California/Oregon/Washington Offshore stock of bottlenose dolphins is arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

For the California Coastal stock of bottlenose dolphins, Dudzik et al. (2006) provide a uniform density of 0.3612 dolphins/km^2 within 1 km of the coast from Baja to San Francisco in all four seasons.

MITT. During the Navy's 2007 survey of the Study Area, there were a total of four sightings (three on-effort) of bottlenose dolphins, including two mixed-species aggregations: one included sperm whales (with calves) logging at the surface and another involved short-finned pilot whales and rough-toothed dolphins (Fulling et al. 2011). Consistent with recommendations from scientists at PIFSC, line-transect estimates derived for Hawaiian waters (Barlow 2006) were used to represent the best available estimates for the MITT Study Area. Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual common bottlenose dolphin density.

NWTT Offshore. During surveys off the U.S. west coast, offshore bottlenose dolphins were generally found at distances greater than 1.86 mi. (3 km) from the coast and were most abundant off southern California (Barlow 2010). Based on sighting data collected by SWFSC during systematic surveys in the Northeast Pacific between 1986 and 2005, there were few sightings of offshore bottlenose dolphins north of about 40°N (Hamilton et al. 2009). As noted above for SOCAL, Barlow and Forney (2007) provided summer/fall stratified uniform density estimates for waters offshore California, Oregon, and Washington. Due to a lack of sightings this far north, their estimate for waters off Oregon/Washington was zero; this was applied to the area north of the SWFSC strata (refer to Figure 3-6). Forney et al. (1995) provided winter/spring stratified uniform density estimates for waters off California. For the cool water period, all strata north of California were assigned a zero density estimate.

NWTT Inland Waters. Common bottlenose dolphins are considered extralimital in Washington inland waters; only three sightings and one stranding of bottlenose dolphins have been documented in Puget Sound since 2004 (Cascadia Research 2011).

NWTT Western Behm Canal, Alaska. This species is not expected to occur within the Western Behm Canal region of the NWTT Study Area.

GOA. This species is not expected to occur within the GOA Study Area.

Table 7-31: Sources of Density Values Used for Common Bottlenose Dolphin

Location	Spring	Summer	Fall	Winter
HRC	CENPAC	CENPAC	CENPAC	CENPAC
W. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
E. Transit Corridor	CENPAC	CENPAC	CENPAC	CENPAC
SOCAL	L	L	L	L
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	L and LD	L and LD	L and LD	L and LD
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 7-32: Summary of Density Values for Common Bottlenose Dolphin in the HRC and MITT Study Areas

Location	Spring	Summer	Fall	Winter
HRC	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	S	S	S	S
MITT	0.00131	0.00131	0.00131	0.00131
MITT Transit Corridor	0.00077	0.00077	0.00077	0.00077

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

Table 7-33: Summary of Density Values for the California/Oregon/Washington Offshore Stock of Common Bottlenose Dolphin in the SOCAL Portion of the HSTT Study Area and the Offshore Portion of the NWTT Study Area

Location	Spring	Summer	Fall	Winter
Oregon/Washington	0.00000	0.00000	0.00000	0.00000
Northern California to Oregon Border	0.00062	0.00052	0.00052	0.00062
Southern California Bight	0.06836	0.00575	0.00575	0.06836
Inner Baja Extension	0.06836	0.006	0.006	0.06836
Outer Baja Extension	0.06836	0.0022	0.0022	0.06836

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

Table 7-34: Summary of Density Values for the California Coastal Stock of Common Bottlenose Dolphin in the SOCAL Portion of the HSTT Study Area

Location	Spring	Summer	Fall	Winter
< 1 km from Coast, Baja to San Francisco	0.3612	0.3612	0.3612	0.3612

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

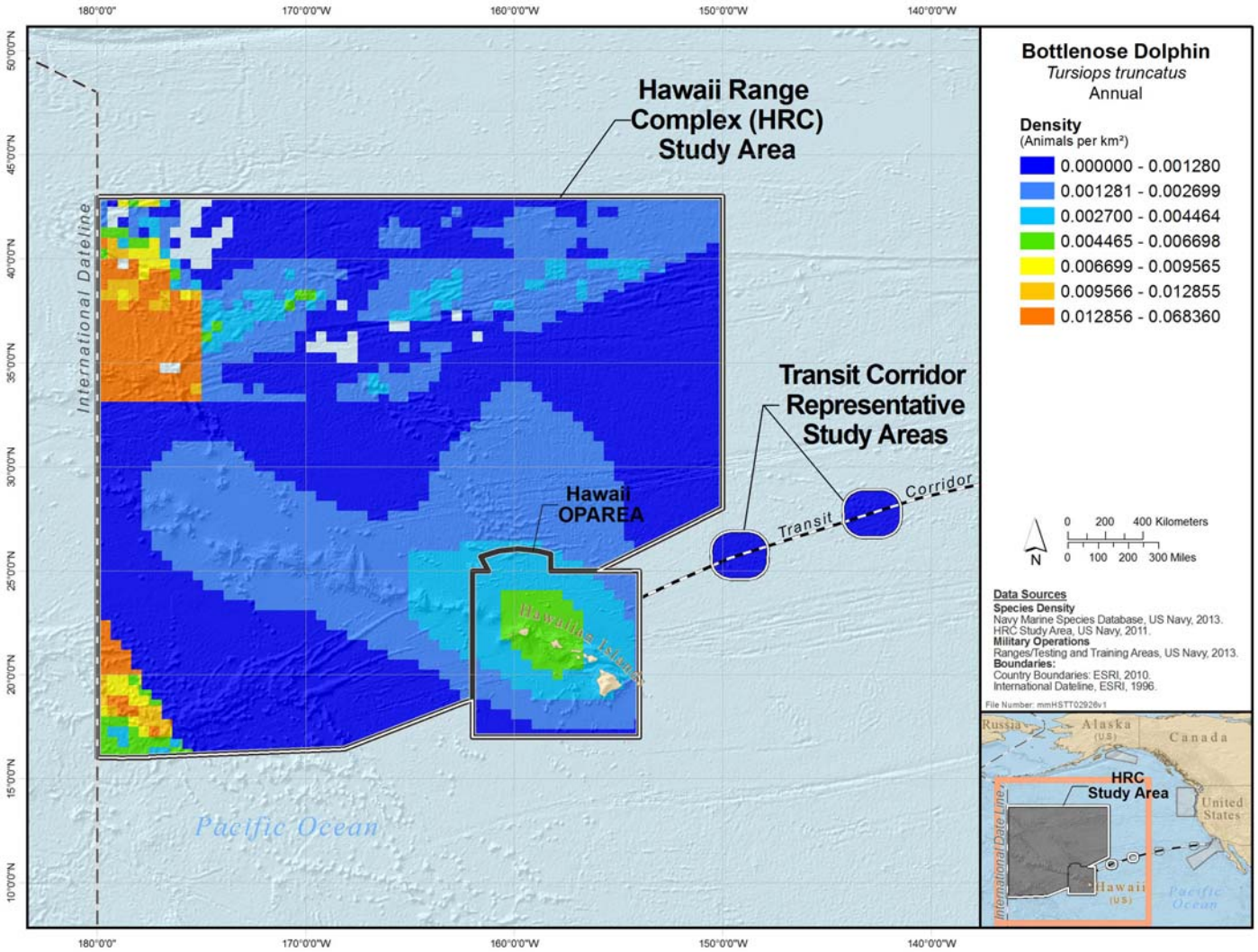

Figure 7-86: Annual Distribution of Common Bottlenose Dolphin in HRC and the Western Portion of the Transit Corridor

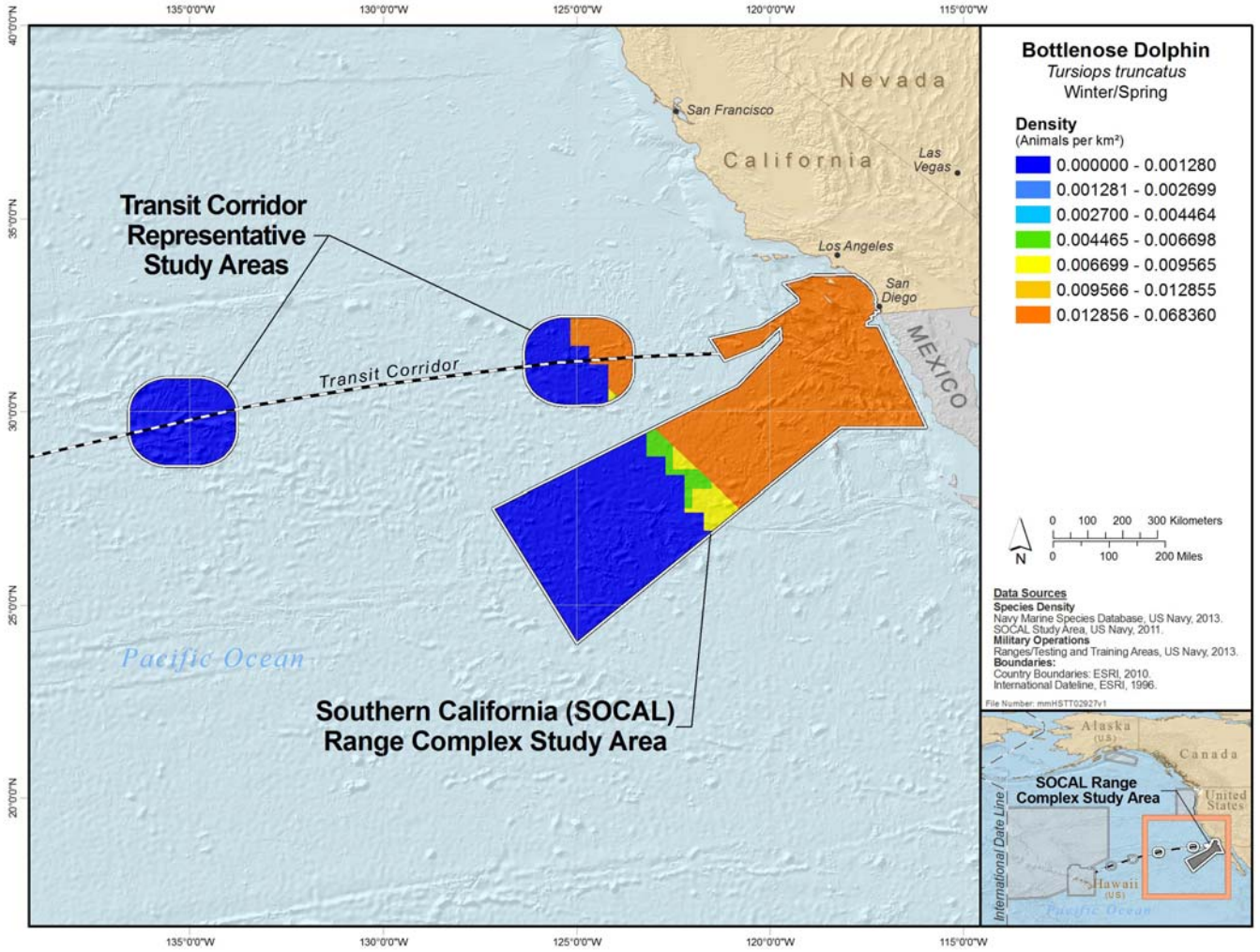

Figure 7-87: Winter/Spring Distribution of the California/Oregon/Washington Offshore Stock of Common Bottlenose Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

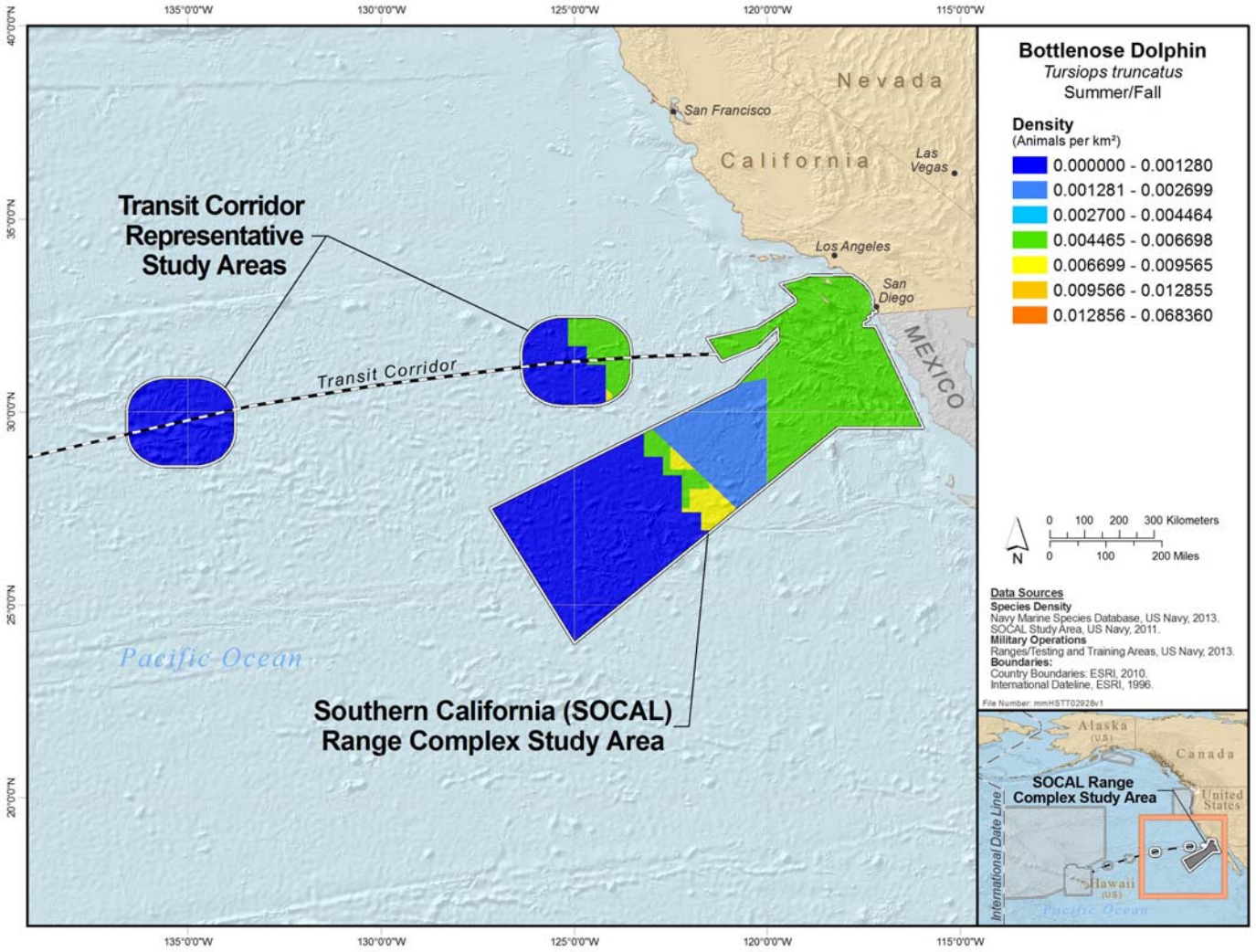

Figure 7-88: Summer/Fall Distribution of The California/Oregon/Washington Offshore Stock of Common Bottlenose Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

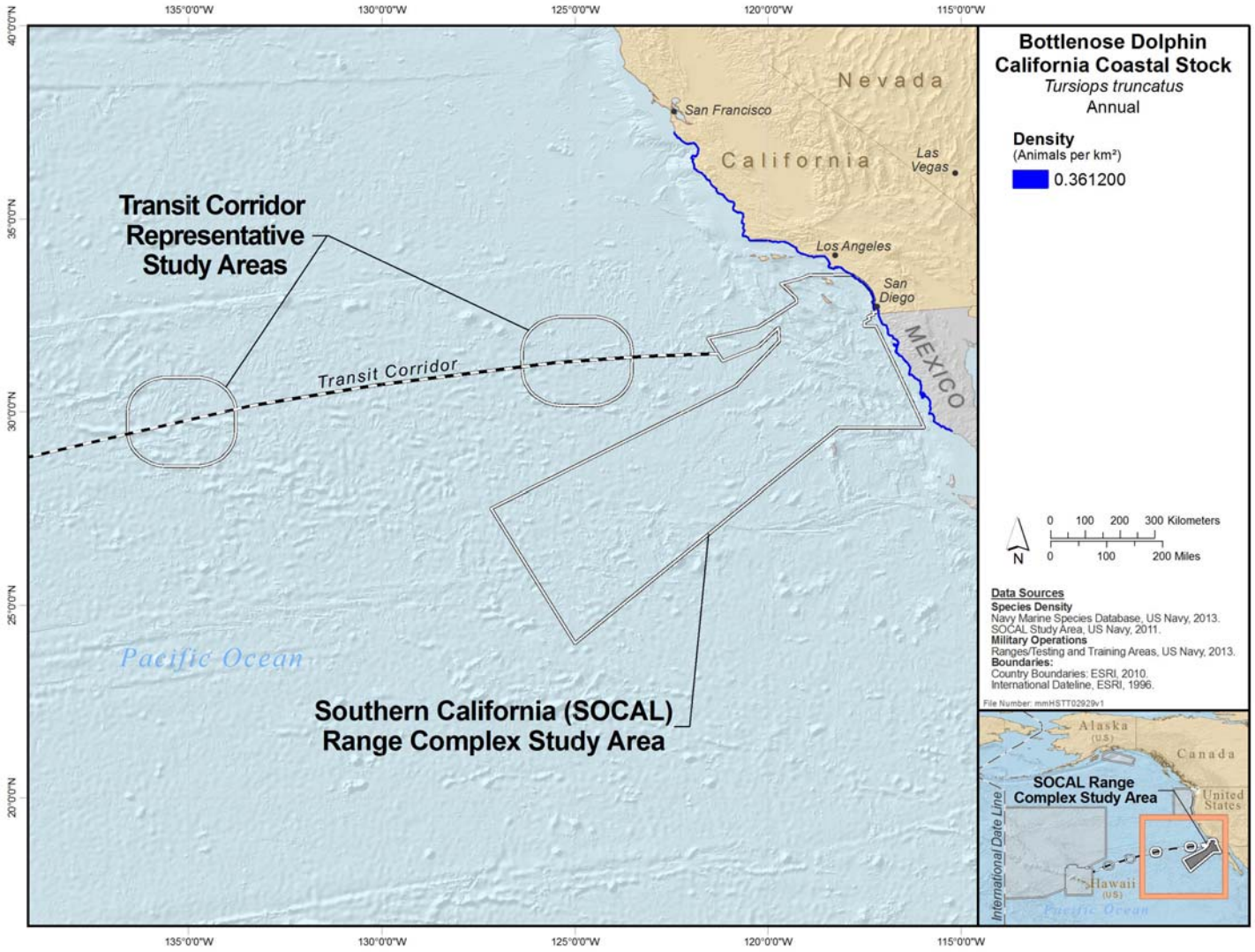

Figure 7-89: Annual Distribution of the California Coastal Stock of Common Bottlenose Dolphin in SOCAL

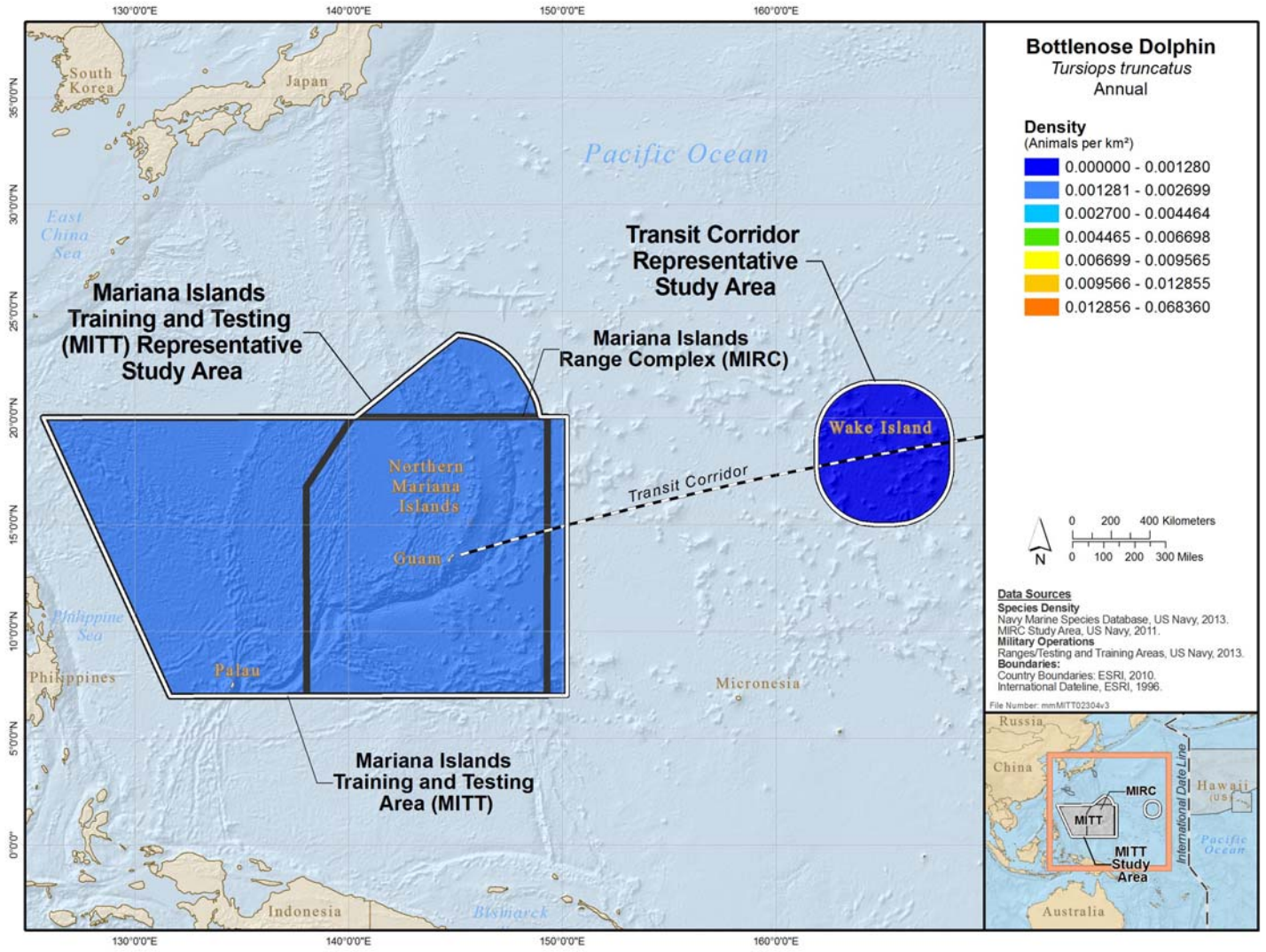

Figure 7-90: Annual Distribution of Common Bottlenose Dolphin in MITT and the Associated Transit Corridor Study Areas

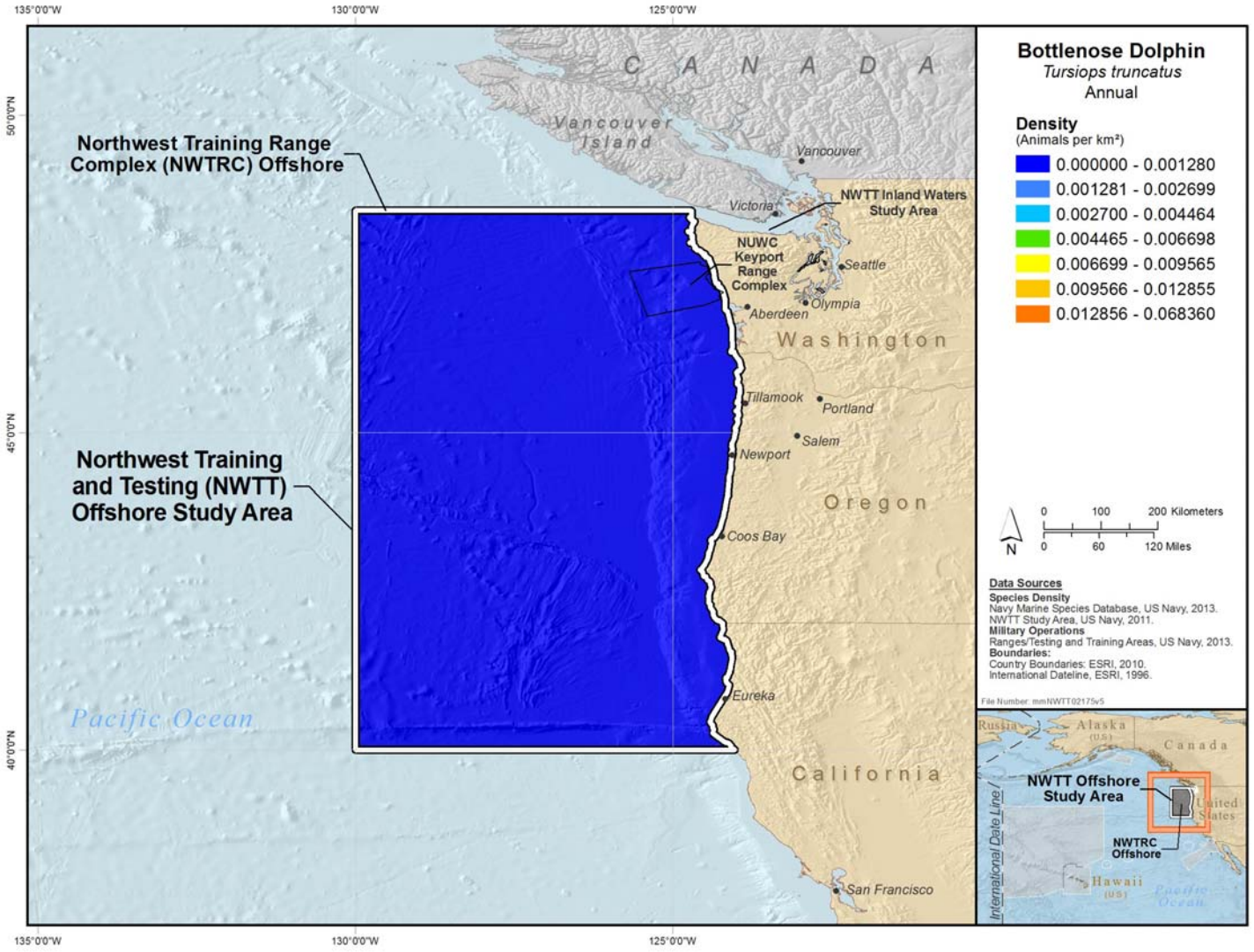

Figure 7-91: Annual Distribution of Common Bottlenose Dolphin in the Offshore Portion of the NWTT Study Area

8 PORPOISES

8.1 PORPOISE SPECIES PROFILES

This group is represented by two species, and they are both found off the west coast of North America.

8.1.1 *PHOCOENA PHOCOENA*, HARBOR PORPOISE

The harbor porpoise is a diminutive cetacean that is found in temperate continental shelf waters of the North Pacific (Read 1999). It is dark and stocky porpoise that can be quite rotund because of high blubber mass (Allen et al. 2011; Jefferson et al. 2008). They are the smallest cetacean on the ocean side of the west coast of North America; adults are never longer than 1.8–2 m (Allen et al. 2011; Jefferson et al. 2008). The dorsal fin is short and triangular with a wide base and is set mid-way down the back, and the body is generally counter-shaded (Jefferson et al. 2008). This is in contrast to the only species that is likely to be confused with harbor porpoise: Dall's porpoise. Dall's porpoise is dramatically black and white in color, and the dorsal fin is farther forward on the back and it forms more of an upright to forward-inclined triangle (Jefferson et al. 2008; Leatherwood et al. 1988). The behavior of Dall's porpoise and harbor porpoise are usually strongly contrasting. Harbor porpoises are inconspicuous and retiring (Leatherwood et al. 1988). Often they avoid vessels (Read 1999) and emerge quietly at the surface of the water when they are moving slowly (Jefferson et al. 2008). Dall's porpoises on the other hand often approach vessels and kick up a "rooster tail" when they surface at high speeds (Leatherwood et al. 1988). The inconspicuous behavior of harbor porpoises can make then difficult to observe in the field when sea states increase above Beaufort 2 or 3 (Palka 1996).

Stocks of harbor porpoises are finely divided on the Pacific coast of the United States. Nine separate stocks are defined by NMFS: the Bering Sea stock, the Gulf of Alaska stock, the Southeast Alaska stock, the Washington Inland Waters stock, the Northern Oregon/Washington Coastal stock, the Northern California/Southern Oregon stock, the San Francisco-Russian River stock, the Monterey Bay stock, and the Morro Bay stock (Carretta et al. 2011a). The Morro Bay stock is the southernmost stock and the range of that stock terminates at Point Conception; therefore, this is the only stock that interacts with the SOCAL range. At the same time, all effects to this stock would be diffuse or indirect, because it is north of the actual SOCAL range. Harbor porpoise from four of the nine stocks may occur in the NWTT Study Area, including the Southeast Alaska, Washington Inland Waters, Northern Oregon/Washington Coast, and Northern California/Southern Oregon stocks. Harbor porpoise from both the Gulf of Alaska and Southeast Alaska stocks may occur in the GOA Study Area.

HRC. This species is not expected to occur in the HRC or the western portion of the transit corridor.

SOCAL. Carretta et al. (2009) estimated harbor porpoise abundance in California waters based on aerial survey data. They provided stratified uniform density estimates based on the depth contours of the continental shelf. The zones are < 90 m, 90–200 m, and > 200 m depth. Values in the < 90 m contour apply up to the surf line. The same values are used in all four seasons. The values from Carretta et al. (2009) are applied to the area north of Point Conception to Morro Bay. The higher density values along the west coast of North America are from the St. Andrews global RES model (SMRU Ltd. *in prep*).

This species is not expected to occur in the eastern portion of the transit corridor (Hamilton et al. 2009).

MITT. This species is not expected to occur in the MITT or associated transit corridor study areas.

NWTT Offshore. The harbor porpoise is a common species in the nearshore coastal waters of the NWTT Offshore Study Area year-round (Green et al. 1992; Osmek et al. 1996, 1998; Carretta et al. 2009; Oleson et al. 2009). As noted above for SOCAL, harbor porpoise are distributed from the shore out to roughly the 200 m isobath (Carretta et al. 2009). Aerial line-transect surveys were conducted by the National Marine Mammal Laboratory in 2002 and 2003 for the purpose of estimating harbor porpoise abundance off the coasts of Oregon, Washington, and southern British Columbia, as well as portions of the inland waters (Laake, unpublished data 2007). Survey effort was limited to sea state conditions of Beaufort 0–2 and cloud cover less than 25 percent. For the Offshore regions of the NWTT Study Area, species-specific strata were developed for harbor porpoise extending from the coast to the 200 m isobath, with horizontal divisions consistent with stock boundaries (Carretta et al. 2013). Data from Carretta et al. (2009) were used for the San Francisco-Russian River stock (0.997 animals/km^2). Estimates from Laake (unpublished data 2007) were used for the Northern Oregon/Washington Coast stock (0.6935 animals/km^2). For the Northern California/Southern Oregon stock, combined data from Carretta et al. (2009) and Laake (unpublished data 2007) were used (1.6716 animals/km^2).

NWTT Inland Waters. Abundance estimates for the Washington Inland Waters stock of harbor porpoise (east of Cape Flattery) is 10,682 individuals (coefficient of variation = 0.38; Carretta et al. 2013), based on data from aerial surveys conducted in 2002 and 2003 (Laake, unpublished data 2007). Harbor porpoise are known to occur in the Strait of Juan de Fuca and the San Juan Island area year-round (Calambokidis and Baird 1994). Harbor porpoises were historically one of the most commonly observed marine mammal in Puget Sound; however there has been a decline in sightings within Puget Sound since the 1940s, and no harbor porpoise sightings were recorded during multiple surveys conducted as part of the Puget Sound Ambient Monitoring Program from 1992 to 1998 (Nysewander et al. 2005; Washington Department of Fish and Wildlife 2008). Since 1999, the Puget Sound Ambient Monitoring Program data and stranding data have documented increasing numbers of harbor porpoise in Puget Sound, indicating that the species may be returning to the area (Washington Department of Fish and Wildlife 2008).

Recent published density estimates for harbor porpoise throughout the inland Washington waters are not available. As noted above for the Offshore region of the NWTT Study Area, aerial line-transect surveys were conducted in 2002 and 2003 to estimate harbor porpoise abundance; in the inland waters, the surveys covered Washington and British Columbian waters in the Strait of Juan de Fuca, San Juan Islands, Gulf Islands, and Strait of Georgia (Laake, unpublished data 2007). To estimate the total average number of animals sighted in each region, the number of sightings of each species was multiplied by the average group size. For harbor porpoise, estimates of mean group size were available on a region-specific basis for each year. Based on the average density estimates provided by Laake (unpublished data 2007), weighted averages were derived to provide separate density estimates for the eastern portion of the Strait of Juan de Fuca and San Juan Islands region (2.1 animals/km^2), as well as for the western portion of the Strait of Juan de Fuca (1.0 animals/km^2).

The Navy conducted recent vessel line-transect surveys in Hood Canal and Dabob Bay and density estimates for harbor porpoise were derived from these data (U.S. Department of the Navy 2012). Given the lack of systematic survey data in other portions of Puget Sound, the Dabob Bay estimate was considered the most representative for Puget Sound, particularly given the recent survey data. All inland water density values for harbor porpoise are considered year-round estimates.

The Navy recently supported line-transect aerial surveys of all of Puget Sound proper. Data from these surveys will be used to produce density estimates for harbor porpoises in different parts of Puget Sound, and it is expected that these data will be incorporated into future versions of the NMSDD.

NWTT Western Behm Canal, Alaska. For the Western Behm Canal, density estimates for all seasons were taken from the Marine Mammal Occurrence/Density Report prepared in support of a NEPA document for Navy activities at SEAFAC (U.S. Department of the Navy 2010b). New estimates of harbor porpoise density in Southeast Alaska, including areas adjacent to Behm Canal, are currently being prepared by the National Marine Mammal Laboratory, and it is expected that these data will be incorporated into future versions of the NMSDD.

GOA. The most recent abundance estimates for harbor porpoise stocks that may occur in the GOA Study Area are as follows: Gulf of Alaska stock = 31,046 individuals (CV = 0.21) and Southeast Alaska stock = 11,146 individuals (CV = 0.24; Allen and Angliss 2013). These estimates were derived from aerial survey data collected in summer 1997 in Southeast Alaska and 1998 in the Gulf of Alaska and include correction factors for both perception and availability bias (Hobbs and Waite 2010). Data derived from Hobbs and Waite (2010) were used to characterize harbor porpoise density in the GOA Study Area year-round, based on their published depth distribution as characterized by the strata in Table 8-2.

Table 8-1: Sources of Density Values Used for Harbor Porpoise

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	L	L	L	L
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	L and LD	L and LD	L and LD	L and LD
NWTT Inland Waters	L and LD	L and LD	L and LD	L and LD
Western Behm Canal	LD	LD	LD	LD
GOA	LD	LD	LD	LD

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 8-2: Summary of Density Values for Harbor Porpoise in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
California north of Pt. Conception inside 90 m isobath	0.9591	0.9591	0.9591	0.9591
California north of Pt. Conception 90–200 m isobaths	0.0617	0.0617	0.0617	0.0617
California north of Pt. Conception > 200 m isobaths	0	0	0	0
Inner Baja Extension	0	0	0	0
Outer Baja Extension	0	0	0	0
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0.69350–1.67163	0.69350–1.67163	0.69350–1.67163	0.69350–1.67163
NWTT Inland Waters	0.149–2.1123	0.149–2.1123	0.149–2.1123	0.149–2.1123
Western Behm Canal	0.0259	0.0238	0.0249	0.0238
GOA inside 100 m isobath	0.4547	0.4547	0.4547	0.4547
GOA from 100 to 200 m isobaths	0.0473	0.0473	0.0473	0.0473
GOA from 200 to 1,000 m isobaths	0.00001	0.00001	0.00001	0.00001
GOA > 1,000 m isobath	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

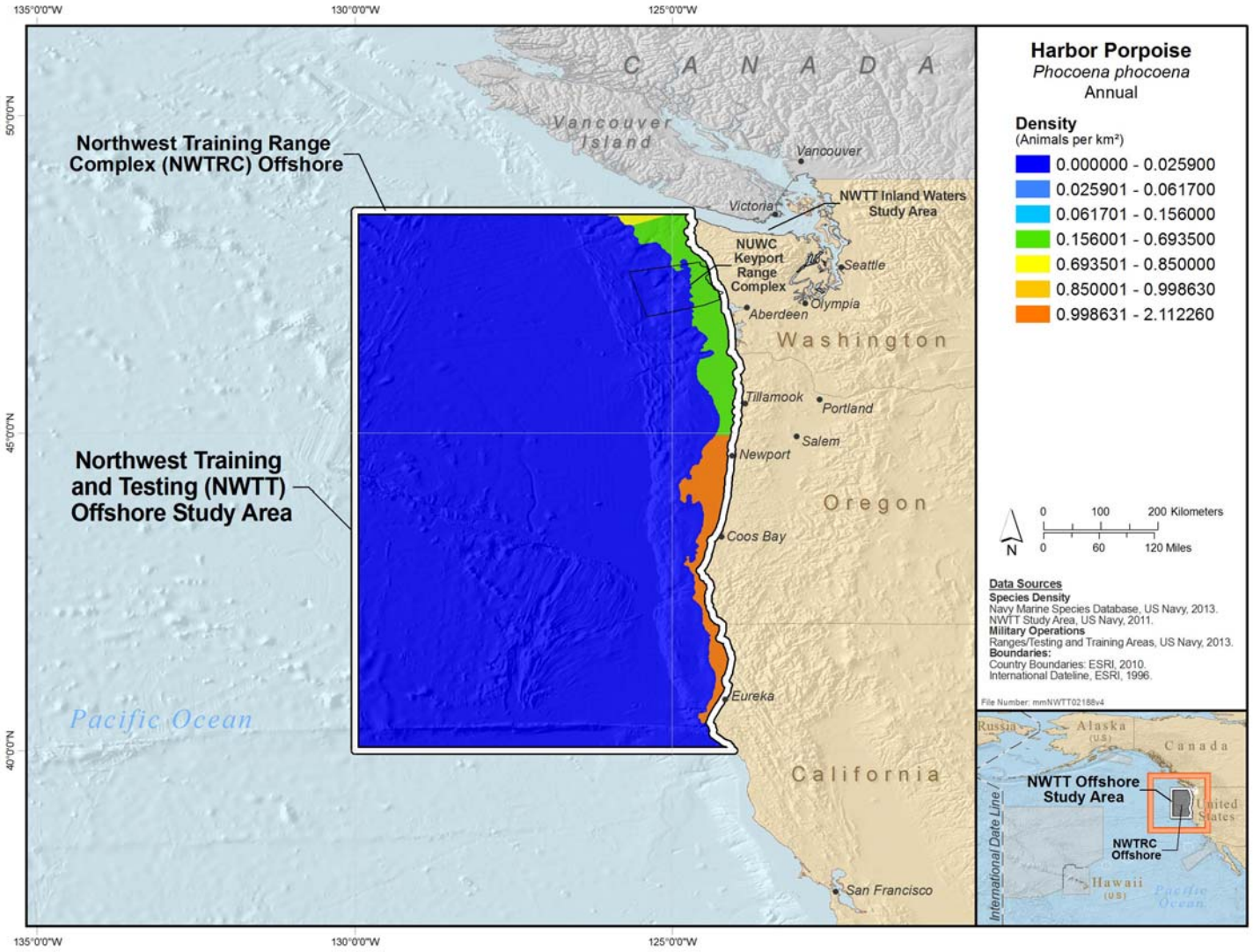

Figure 8-1: Annual Distribution of Harbor Porpoise in the Offshore Portion of the NWTT Study Area

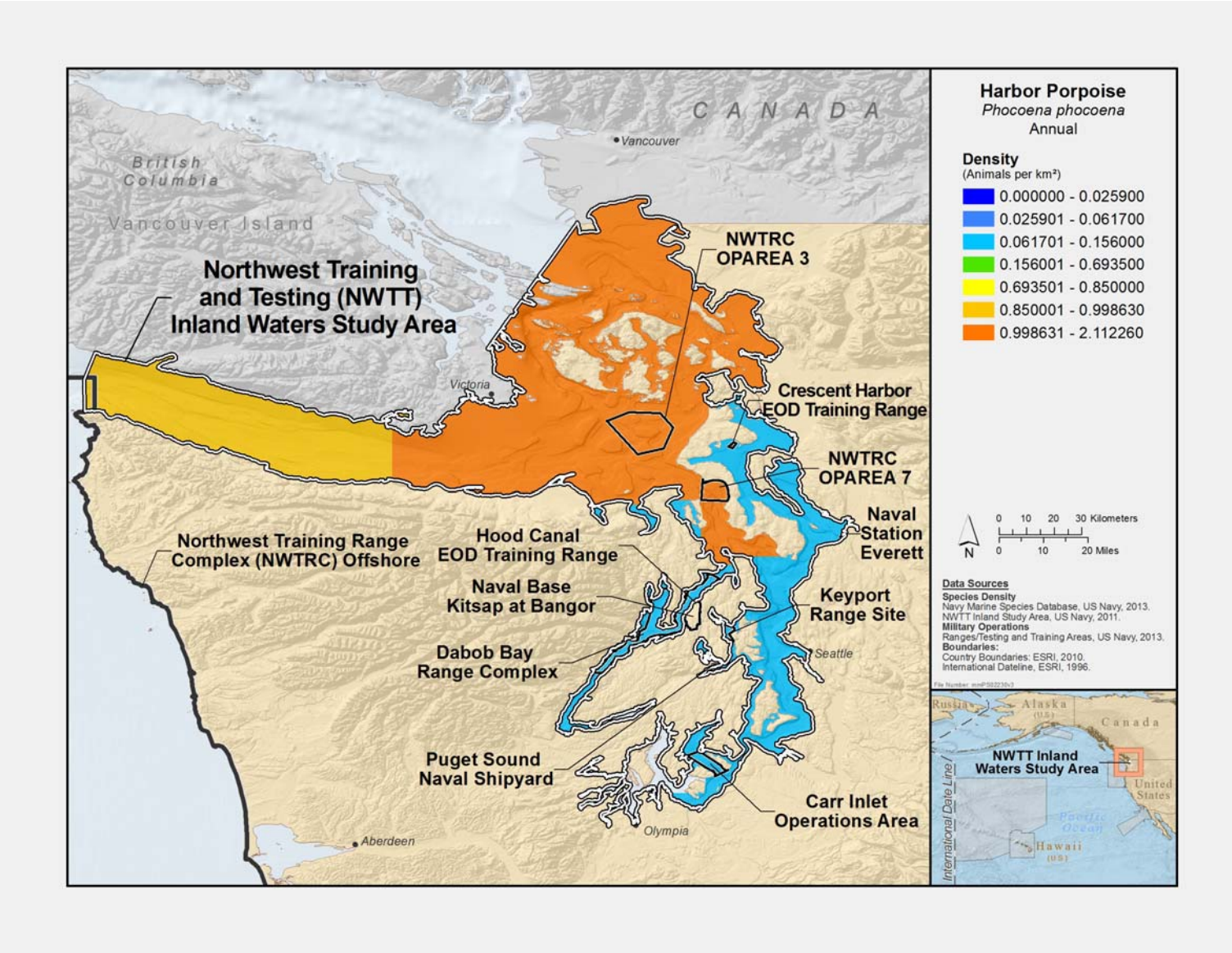

Figure 8-2: Annual Distribution of Harbor Porpoise in the Inland Waters Portion of the NWTT Study Area

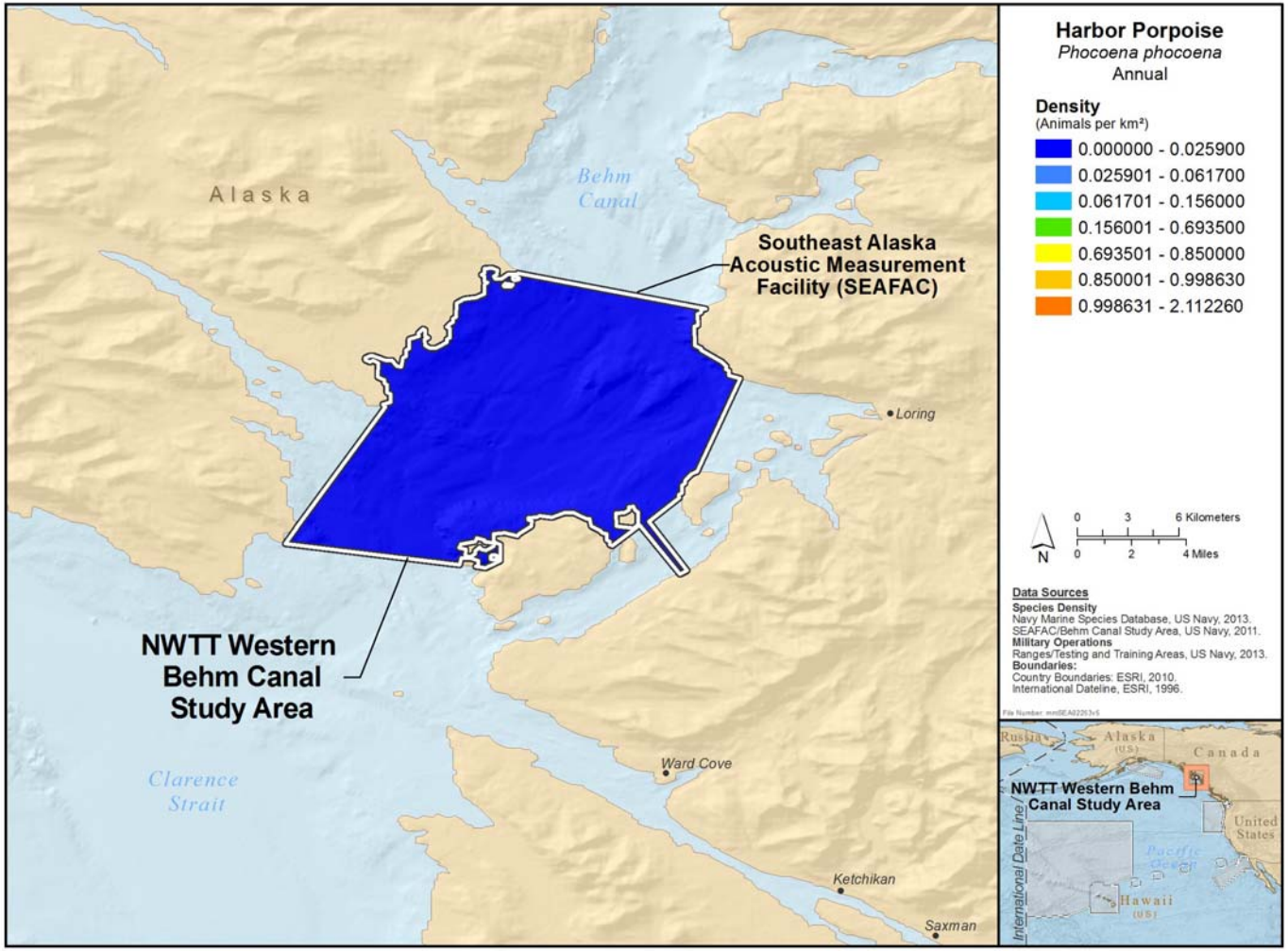

Figure 8-3: Annual Distribution of Harbor Porpoise in the Western Behm Canal Portion of the NWTT Study Area

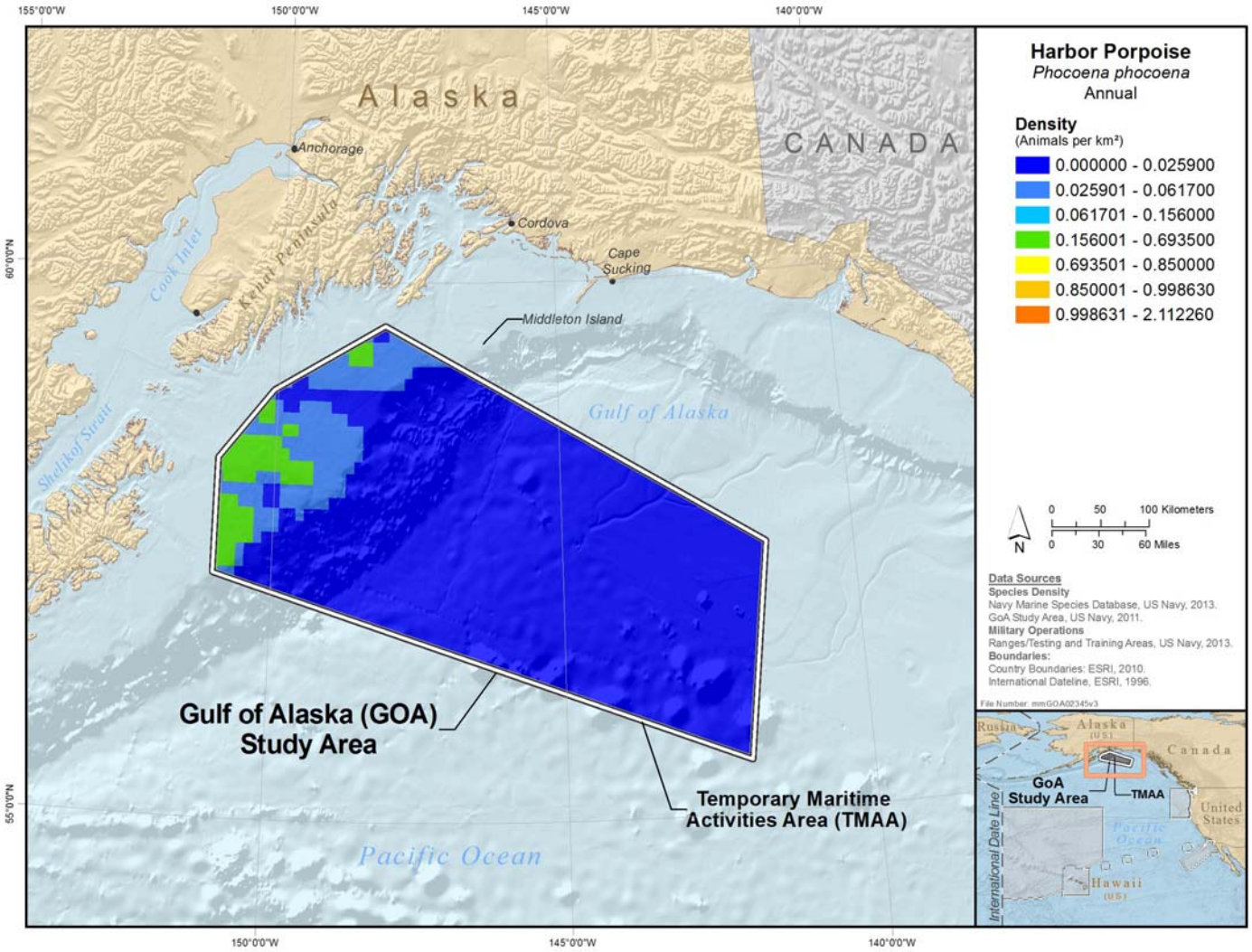

Figure 8-4: Annual Distribution of Harbor Porpoise in the GOA Study Area

8.1.2 *PHOCOENOIDES DALLI*, DALL'S PORPOISE

Dall's porpoise is a robust cetacean that is somewhat larger than the harbor porpoise (Jefferson et al. 2008). They have an extremely stocky build with the body particularly humped in the middle of the back and tapering quickly toward the head and at the peduncle (Allen et al. 2011; Leatherwood et al. 1988). Dall's porpoises are black with large lateral white patches, as well as white on the upper portion of the dorsal fin and the trailing edge of the flukes (Jefferson et al. 2008). The tail fluke is unusual in that it will either have a flat trailing edge or even a forward canted trailing edge (Jefferson et al. 2008). The dorsal fin is farther forward than on the harbor porpoise, and it forms an upright triangle with the front side curving or leaning forward, more so in adult males (Jefferson et al. 2008; Leatherwood et al. 1988). Dall's porpoise could be mistaken for harbor porpoise or Pacific white-sided dolphin in the field, until observed at closer range (Allen et al. 2011; Leatherwood et al. 1988). The coloration and body shape will dispel any misidentification. Dall's porpoise often move quickly and cause a spray when they break the surface of the water (Houck and Jefferson 1999); this splash is similar to the spray at times caused by Pacific white-sided dolphins. When moving more slowly, the roll of the back of Dall's porpoise can look like a harbor porpoise if the white of the dorsal fin is not visible due to inadequate lighting.

The behavior of the Dall's porpoise and the harbor porpoise are very different in most circumstances. Dall's porpoise approach boats readily (Houck and Jefferson 1999) and are not shy. They are one of the fastest cetaceans and they like to keep pace with vessels and weave back and forth in front of the bow (Allen et al. 2011; Houck and Jefferson 1999). Moving in front of a pressure wave from humpback, gray, blue, and fin whales has also been reported for Dall's porpoise (Allen et al. 2011; Houck and Jefferson 1999).

NMFS defines two stocks for Dall's porpoise, an Alaska stock and a California/Oregon/Washington stock (Carretta et al. 2011a). Dall's porpoise presence in SOCAL is dynamic; their distribution shifts south into SOCAL when the water temperatures are cool; therefore, their presence is not constant, but dependent on climatic conditions (Forney and Barlow 1998; Becker et al. 2014). The California/Oregon/Washington stock is the group that is expected on the SOCAL range and in the Offshore and Inland Water portions of the NWTT Study Area. Animals occurring in Western Behm Canal and the GOA Study Area belong to the Alaska stock.

HRC. This species is not expected to occur in the HRC or the transit corridor.

SOCAL. For summer and fall, NMFS has defined a CCE model for Dall's porpoise (Becker et al. 2012c). A uniform density for the outer Baja extension comes from Ferguson and Barlow (2003), and a uniform density estimate of 0.00228 animals/km^2 for the inner Baja extension was calculated from Table 5 in Barlow and Forney (2007). Forney et al. (1995) divided waters off California into four geographic regions (Southern California Bight, Outer Southern California Waters, Central California, Northern California) for the purpose of providing stratified density estimates based on line-transect data. They provided uniform densities for Dall's porpoise for winter and spring in each region. The species increases in density moving from south to north. The Navy applied the densities for the Southern California Bight and the Outer Southern California Waters to the Baja extension in the winter and spring. In the Southern California

Bight, data for Dall's porpoise is arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

This species is not observed in the eastern portion of the transit corridor (Hamilton et al. 2009); therefore, the area around the transit corridor is assigned a zero which is shown by the white area on the map.

MITT. This species is not expected to occur in the MITT or associated transit corridor study areas.

NWTT Offshore. As noted above for SOCAL, NMFS developed a CCE habitat-based density model for Dall's porpoise which provides spatially-explicit density estimates off the U.S. west coast for summer and fall (Becker et al. 2012c). Calambokidis et al. (2004) provided line-transect uniform density estimates for Dall's porpoise for waters off the northern coast of Washington in summer in an area that overlaps the nearshore portion of the Navy's Offshore Study Area. Their estimate was used for the area north of the SWFSC strata (refer to Figure 3-6) for summer/fall. Winter/spring density estimates for Dall's porpoise off California are based on line-transect aerial surveys conducted in March and April 1991 and 1992 (Forney et al. 1995; Barlow et al. 2009). Their estimate for the Northern California stratum was applied to the Oregon/Washington stratum and the area to the north for winter/spring.

NWTT Inland Waters. Dall's porpoise occur off the Washington coast and in the inland waters year-round, but abundance and distribution is seasonally variable (Green et al. 1992; Nysewander et al. 2005; Washington Department of Fish and Wildlife 2008). There were multiple Dall's porpoise sightings in Puget Sound from aerial surveys conducted during winter (1993–2008) and summer (1992–1999) as part of the Puget Sound Ambient Monitoring Program (Nysewander et al. 2005; Washington Department of Fish and Wildlife 2008); however, abundance estimates were not derived from these data. Aerial line-transect surveys were conducted by the National Marine Mammal Laboratory in 2002 and 2003 for the purpose of estimating harbor porpoise abundance off the coasts of Oregon, Washington, and southern British Columbia, as well as portions of the inland waters (Laake 2007). Survey effort was limited to sea state conditions of Beaufort 0–2 and cloud cover less than 25 percent, and in the inland waters, covered Washington and British Columbia waters in the Strait of Juan de Fuca, San Juan Islands, Gulf Islands, and Strait of Georgia (Laake 2007). In order to provide a rough estimate of abundance for other cetacean species sighted during the surveys, data from the 2002–2003 surveys were prorated relative to harbor porpoise (ManTech-SRS 2007). The number of Dall's porpoise sightings from these surveys was sufficient to derive separate density estimates for the eastern portion of the Strait of Juan de Fuca and San Juan Islands region (0.39 animals/km^2), as well as for the western portion of the Strait of Juan de Fuca (0.55 animals/km^2). These estimates are similar to those derived by Williams and Thomas (2007) for inshore coastal waters in the Strait of Georgia (0.19 animals/km^2; coefficient of variation = 0.46).

Based on sighting data collected during aerial surveys conducted as part of the Puget Sound Ambient Monitoring Program (Nysewander et al. 2005; Washington Department of Fish and Wildlife 2008), the distribution of Dall's porpoise in the inland waters is generally concentrated in the Strait of Juan de Fuca and San Juan Island region, particularly in the summer months. There was only one Dall's porpoise sighting recorded for Hood Canal in the summer; however, the sighting was at the extreme northern

portion of the canal (Nysewander et al. 2005; Washington Department of Fish and Wildlife 2008). Further, the Navy has conducted recent vessel line-transect surveys and other monitoring efforts in Hood Canal and Dabob Bay and Dall's porpoise were not seen (U.S. Department of the Navy 2011). In consideration of these data, as well as opportunistic sightings recorded by the Orca Network, it was assumed that 10% of the density estimate for the eastern portion of the Strait of Juan de Fuca and San Juan Islands region estimate would be applicable to Puget Sound waters (0.039 animals/km^2). Based on the lack of any recent sightings in Hood Canal proper and Dabob Bay, a minimum density estimate was assigned to these areas (0.000001 animals/km^2). Dall's porpoise are observed year-round and although seasonal changes in abundance and distribution are apparent, data are insufficient to derive seasonal estimates. Therefore, these are considered year-round estimates.

NWTT Western Behm Canal, Alaska. For the Western Behm Canal, density estimates for all seasons were taken from the Marine Mammal Occurrence/Density Report prepared in support of a NEPA document for Navy activities at SEAFAC (U.S. Department of the Navy 2010b). New estimates of abundance of Dall's porpoise in Southeast Alaska (Jefferson 2012), including areas adjacent to Behm Canal, will be considered in future versions of the NMSDD.

GOA. Dall's porpoise is common in the Gulf of Alaska and in most waters of the state. During a recent (June and July 2013) Navy-funded line-transect survey in and around the TMAA there were 320 sightings of 859 individual Dall's porpoise. The sighting data were collected from four survey strata designed to sample the diverse habitat present in the GOA Study Area, and resulted in the following density estimates for Dall's porpoise: 0.214 (CV = 0.50) inshore stratum, 0.028 (CV = 0.52) offshore stratum, 0.011 (CV = 0.41) seamount stratum, and 0.133 (CV = 0.36) slope stratum (Rone et al. 2014).

Table 8-3: Sources of Density Values Used for Dall's Porpoise

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	L	CCE	CCE	L
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	L and LD	CCE, L, and LD	CCE, L, and LD	L and LD
NWTT Inland Waters	LD	LD	LD	LD
Western Behm Canal	LD	LD	LD	LD
GOA	L	L	L	L

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 8-4: Summary of Density Values for Dall's Porpoise in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0.0112–0.0342	S	S	0.0112–0.0342
Inner Baja Extension	0.03417	0.00228	0.00228	0.00228
Outer Baja Extension	0.01123	0.0036	0.0036	0.29447
Southern California Bight	0.03417	S	S	0.05732
Outer Southern California Waters	0.01123	S	S	0.29447
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0.0416	S and 0.0397	S and 0.0397	0.0416
NWTT Inland Waters	0–0.55179	0–0.55179	0–0.55179	0–0.55179
Western Behm Canal	0.1215	0.0876	0.0707	0.0707
GOA	0.011–0.214	0.011–0.214	0.011–0.214	0.011–0.214

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

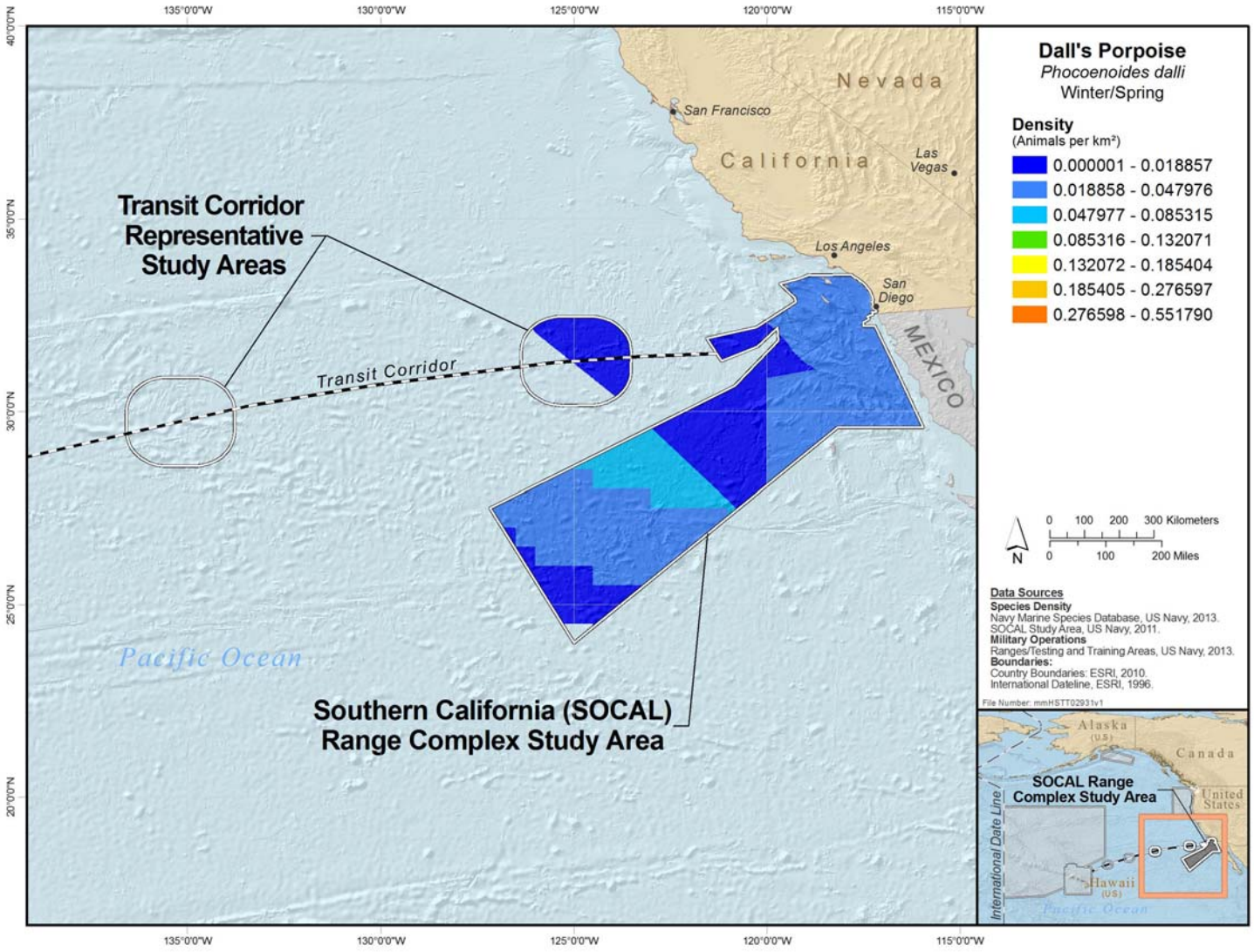

Figure 8-5: Winter/Spring Distribution of Dall's Porpoise in SOCAL and the Eastern Portion of the Transit Corridor

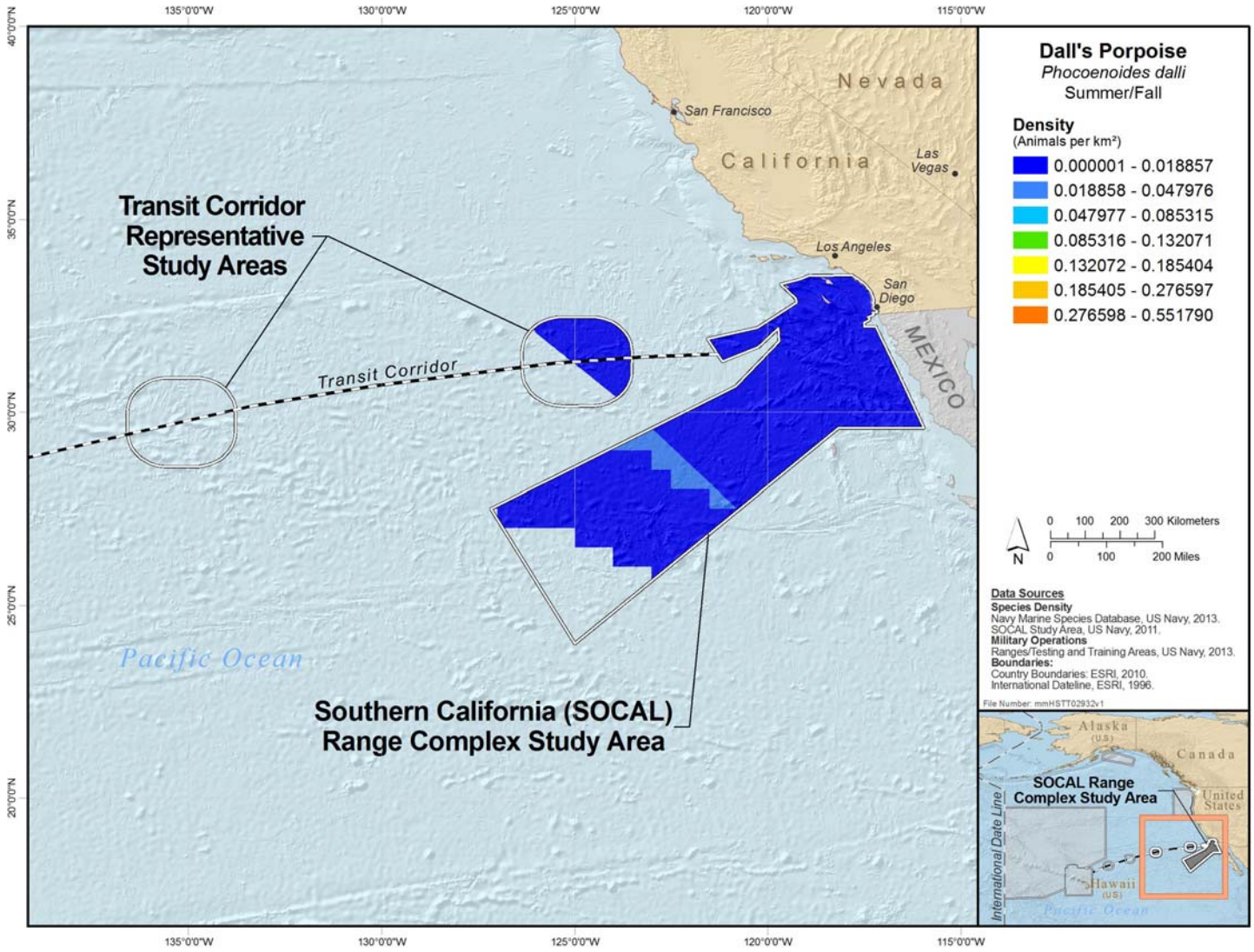

Figure 8-6: Summer/Fall Distribution of Dall's Porpoise in SOCAL and the Eastern Portion of the Transit Corridor

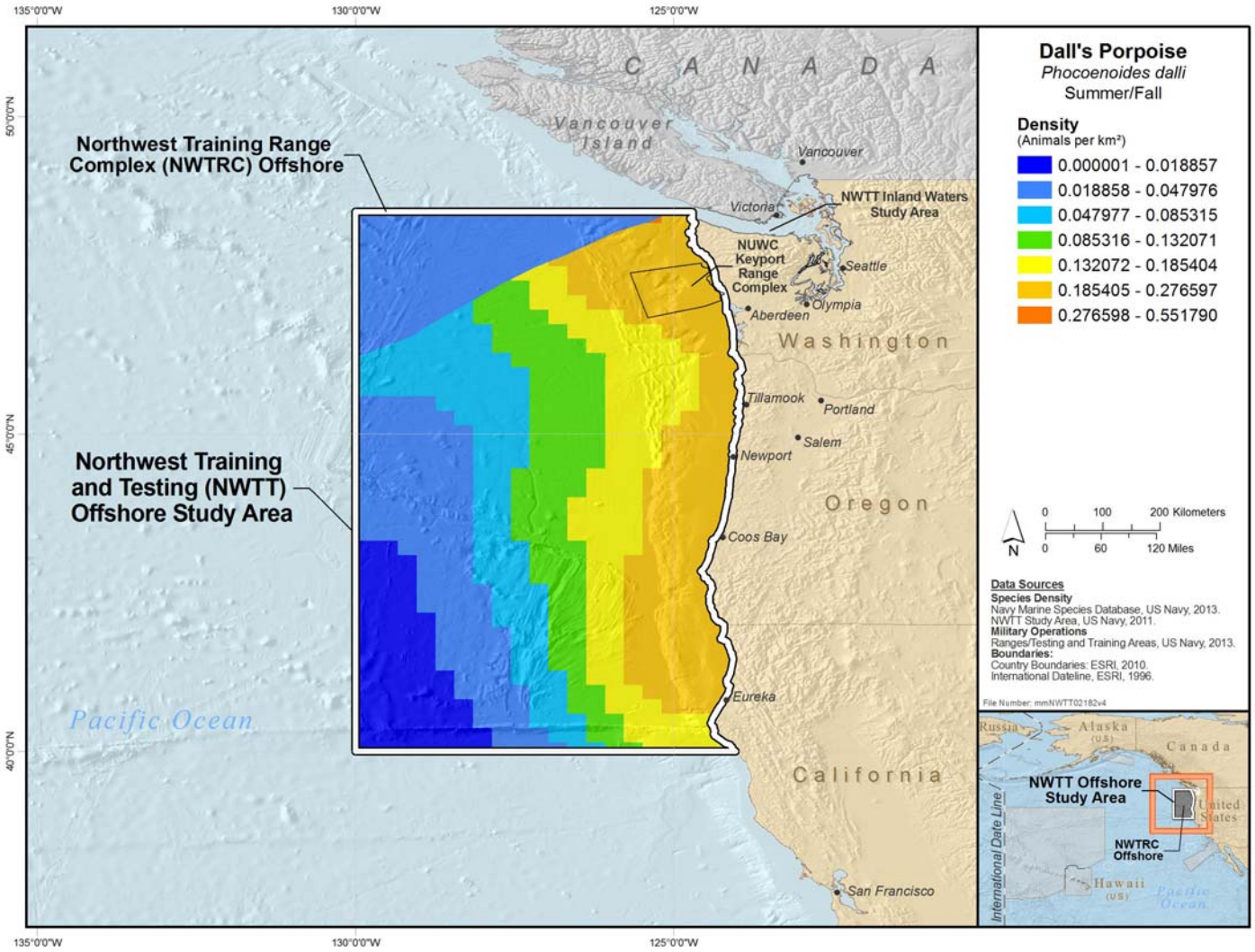

Figure 8-7: Summer/Fall Distribution of Dall's Porpoise in the Offshore Portion of the NWTT Study Area

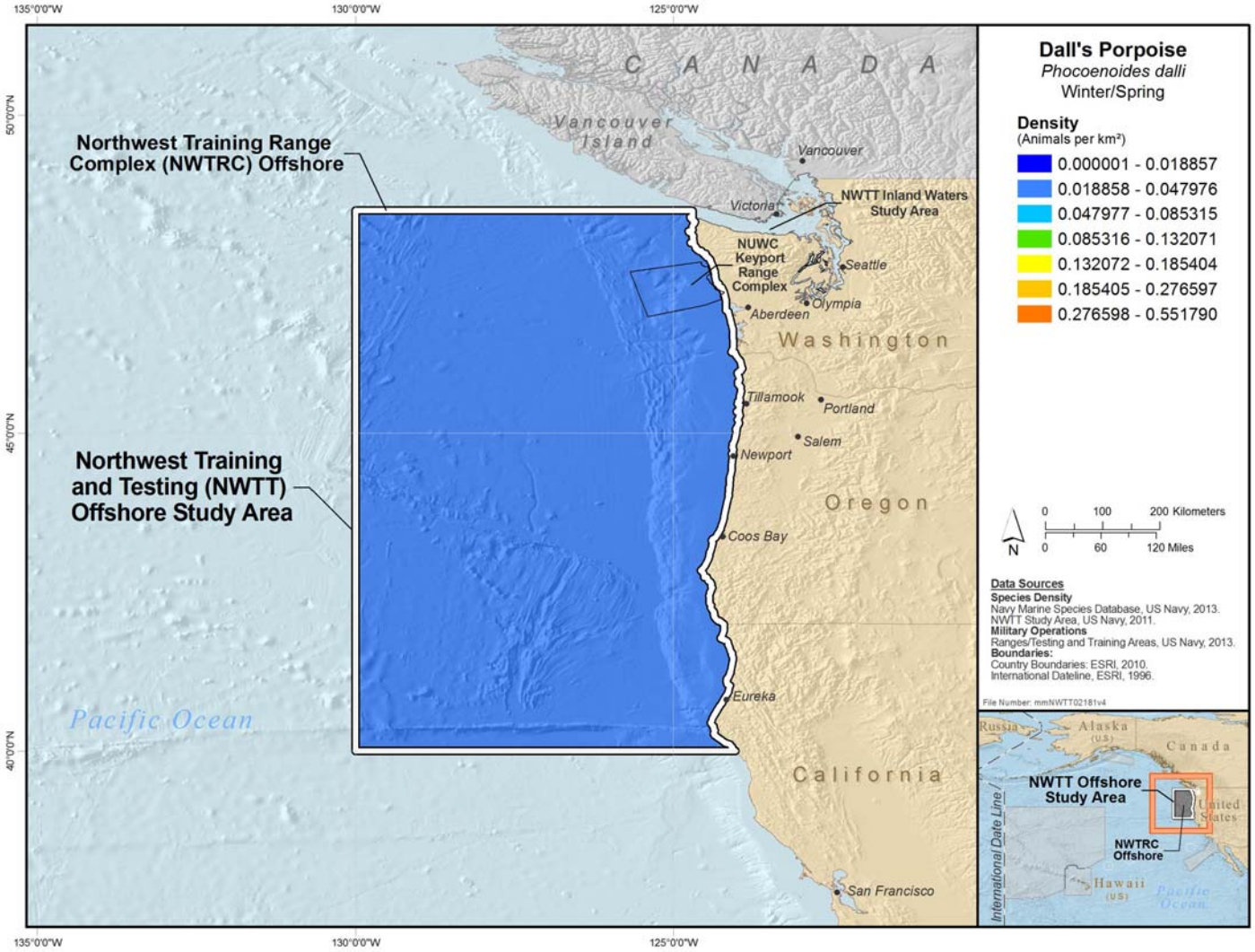

Figure 8-8: Winter/Spring Distribution of Dall's Porpoise in the Offshore Portion of the NWTT Study Area

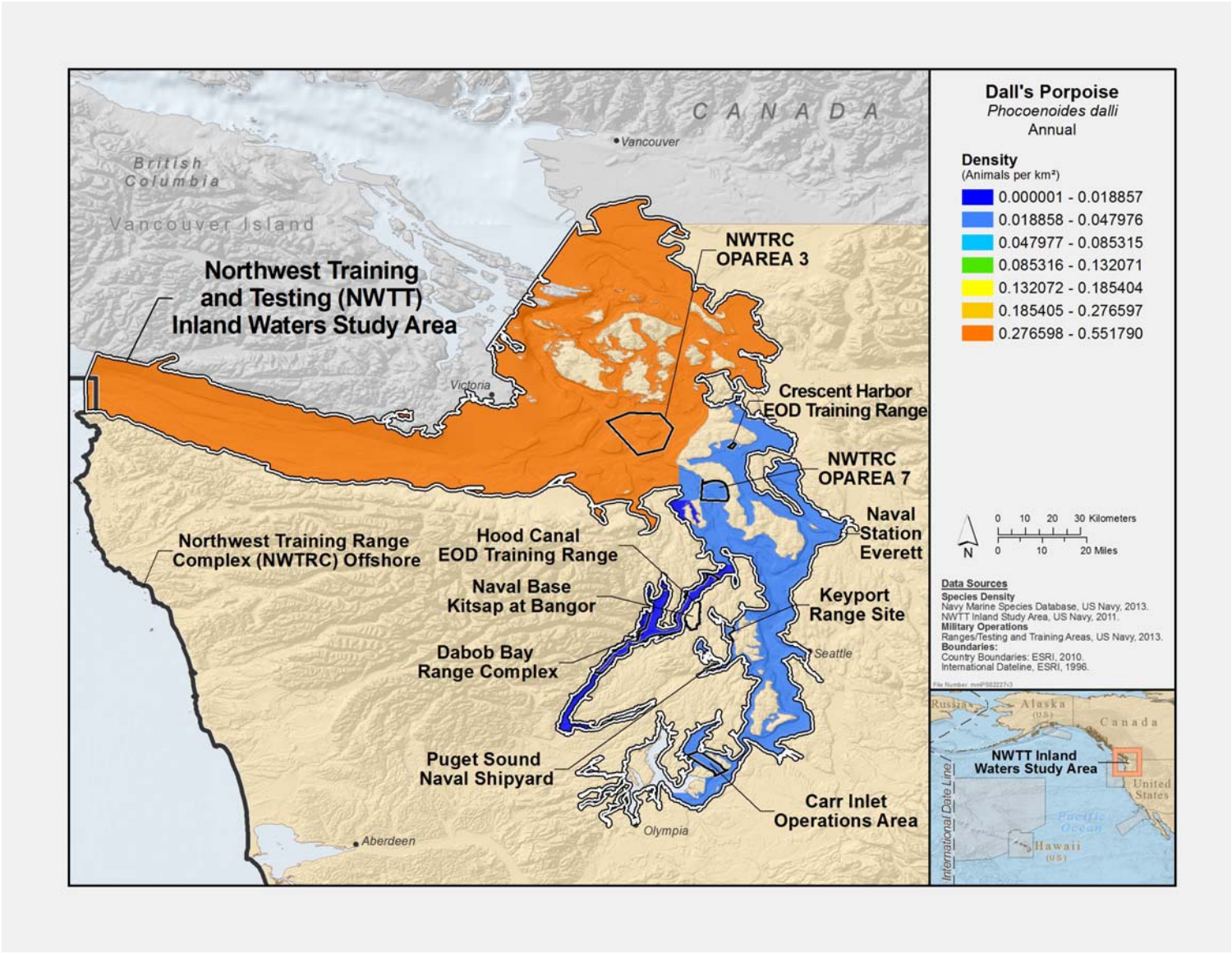

Figure 8-9: Annual Distribution of Dall's Porpoise in the Inland Waters Portion of the NWTT Study Area

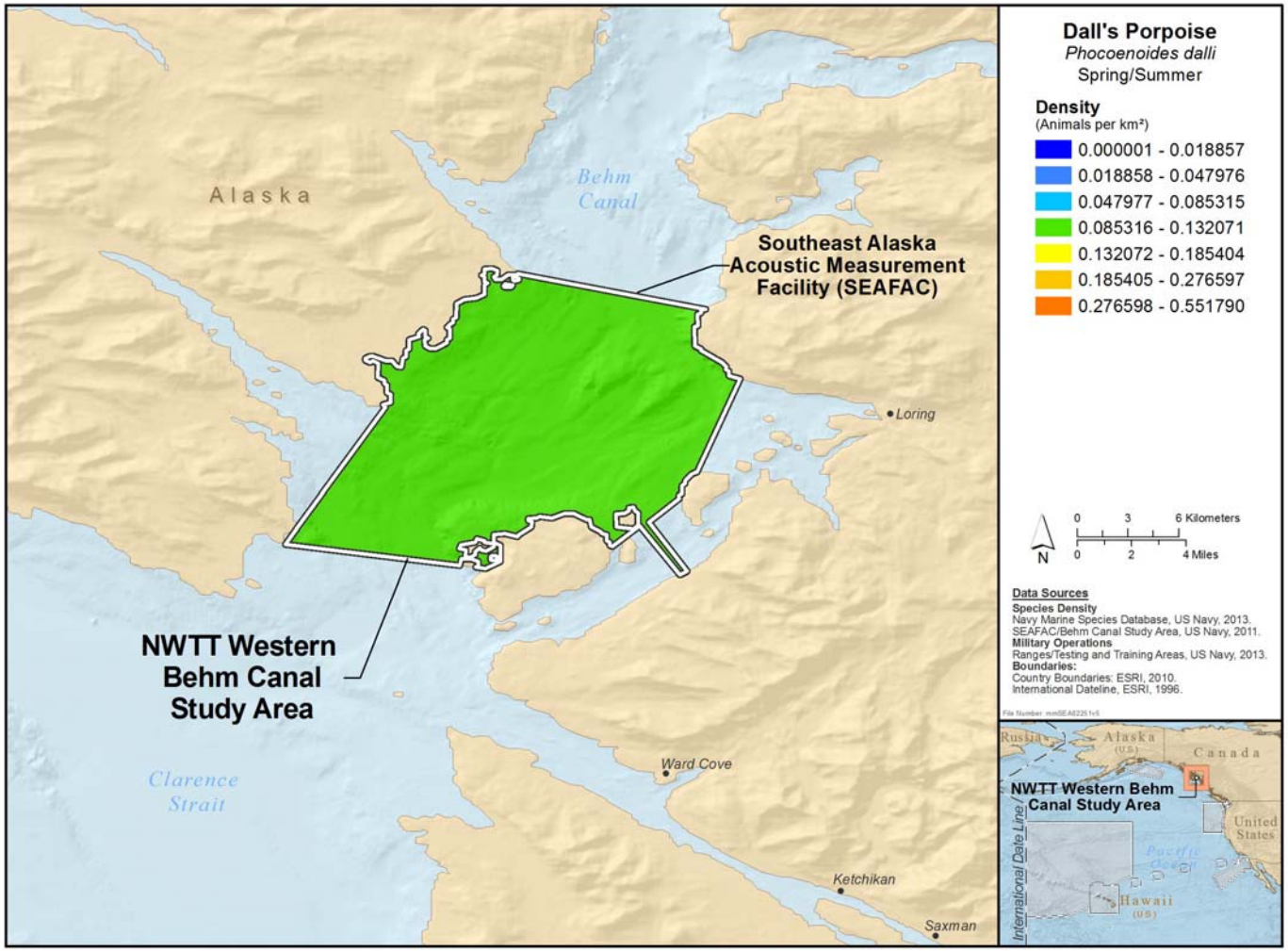

Figure 8-10: Spring/Summer Distribution of Dall's Porpoise in the Western Behm Canal Portion of the NWTT Study Area

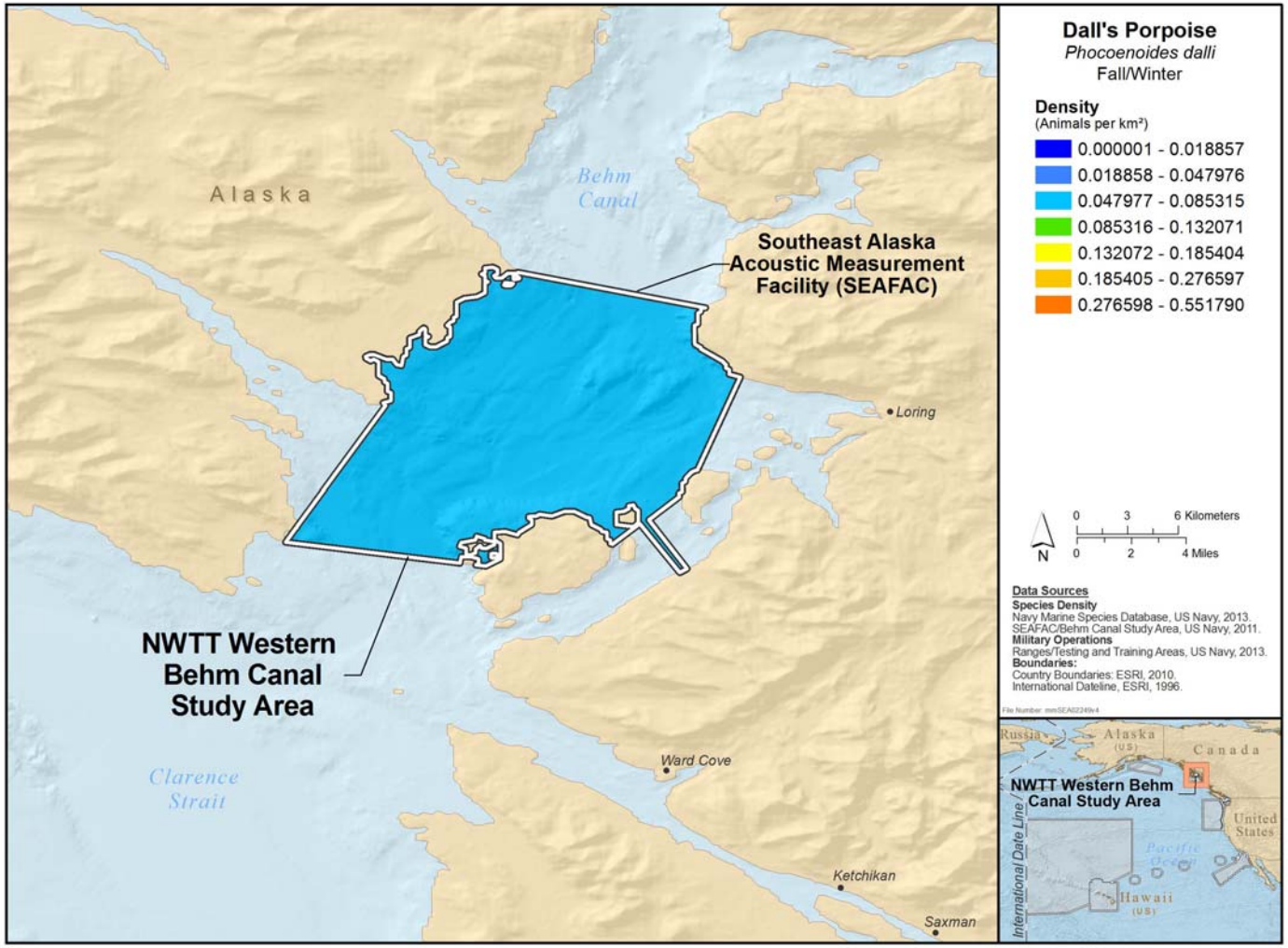

Figure 8-11: Fall/Winter Distribution of Dall's Porpoise in the Western Behm Canal Portion of the NWTT Study Area

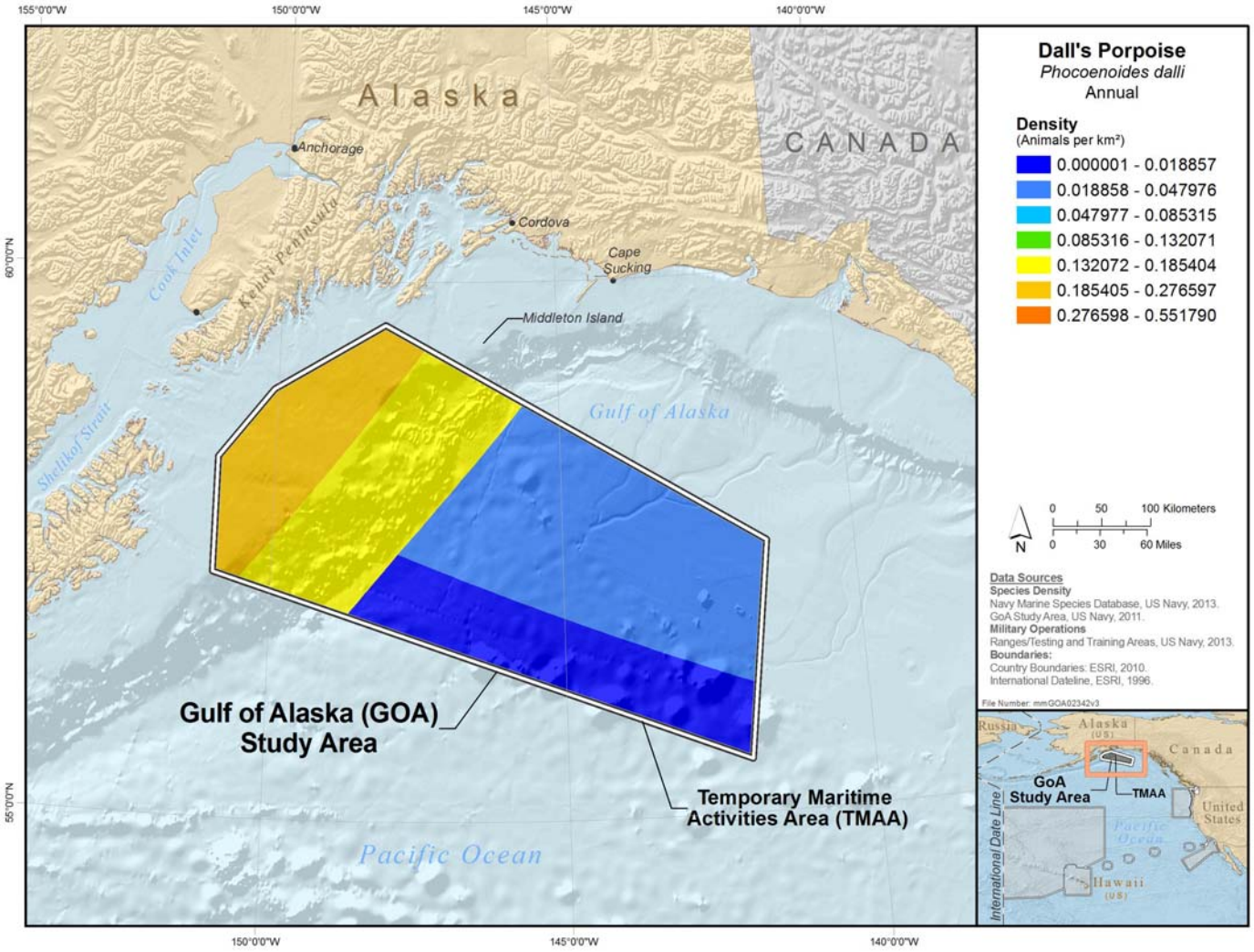

Figure 8-12: Annual Distribution of Dall's Porpoise in the GOA Study Area

9 BEAKED WHALES

9.1 BEAKED WHALE SPECIES PROFILES

This group of species is problematic in terms of establishing values for the marine mammal density database. Beaked whales are notoriously difficult to detect and identify at sea because of their short surfacing series relative to long dive times (Baird et al. 2006; Barlow 1999), low profile (Barlow et al. 2006), and likely avoidance of vessels (Heyning 1989; Pitman 2009). These difficulties result in having few sightings for a number of species and questionable identification in many cases for the beaked whales that are seen. Researchers have addressed these problems primarily by pooling the data into groups either by family or at least size. Although this dilutes the actual knowledge for a particular species, it allows for a more robust sense of the presence of beaked whales in general. This is a better solution than not estimating the degree of presence until sufficient data exist, because the Navy needs to be able to quantify to some degree its interactions with all species of concern in its operating areas.

The range of a number of beaked whales is still very much a mystery for some areas. In Hawaii, scientists believe they have recordings of more species of beaked whale than have been observed (Baumann-Pickering et al. 2010; McDonald et al. 2009), but without sightings this is only grounds for scientific hypothesizing at this time. Therefore, there are only three species of beaked whale in the marine mammal and sea turtle density database for Hawaii, Cuvier's beaked whale, Blainville's beaked whale (*Mesoplodon densirostris*), and Longman's beaked whale (*Indopacetus pacificus*). NMFS has sufficient data for these species that at least a uniform density can be provided for each species.

There are a myriad of beaked whales known or suspected to be present off the U.S. west coast. Data are sufficient for estimating densities only for Baird's beaked whale. A guild of small beaked whales has been created by NMFS to represent seven species of beaked whale that are seen or successfully identified very rarely in the California Current ecosystem. This guild is used to represent density for both the SOCAL and the Offshore region of the NWTT Study Area.

In the MITT Study Area, the same three beaked whale species known to occur in Hawaiian waters are assumed to occur in this region (Cuvier's beaked whale, Blainville's beaked whale, and Longman's beaked whale). In addition, based on what is currently known about its distribution range, the ginkgo-toothed beaked whale (*Mesoplodon ginkgodens*) is also assumed to have possible occurrence in the MITT Study Area. Cuvier's beaked whales have been sighted in the MITT Study Area (Mobley 2007; U.S. Department of the Navy 2014). The newly-recognized Deraniyagala's beaked whale (*M. hotaula*) may also occur in this area. It appears to be a tropical species of the Indian and Pacific oceans, but its actual range is very poorly known (Dalebout et al. 2014). Until this is clarified, it should be considered that this species might occur in the Marianas, although density data are not available. There were two Mesoplodon whale sightings during the Navy's 2007 survey of the Study Area, but they were not identified to the species level (Fulling et al. 2011). Since Blainville's beaked whale is probably the most common and abundant tropical species of *Mesoplodon* (Jefferson et al. 2008), it is likely to occur in the MITT Study Area. The ginkgo-toothed beaked whale is known only from strandings in tropical waters of the Pacific and Indian Oceans (Mead 1989; Palacios and Mate 1996), and there are no occurrence records for this species in the Study Area. However, this area is within the known distribution range for

this species (Taylor et al. 2008). Although the full extent of Longman's beaked whale distribution is not fully understood, there have been many recorded sightings at various locations in tropical waters of the Pacific and Indian Oceans (Afsal et al. 2009; Dalebout et al. 2002; Dalebout et al. 2003; Moore 1972). Until additional data are available to improve our understanding of beaked whale abundance and distribution, particularly in the Mariana Islands region, the Navy populated the density database with values for these four species.

As noted above, beaked whales are some of the most poorly understood of cetaceans, and there have been only limited sightings within the GoA Study Area. There are currently three beaked whale species confirmed to occur in the GOA Study Area for which the Navy entered values into the density database: Baird's, Cuvier's, and Stejneger's (*Mesoplodon stejnegeri*) beaked whales.

9.1.1 *BERARDIUS BAIRDII*, BAIRD'S BEAKED WHALE

This large, dark colored beaked whale is the largest whale in the family Ziphiidae (Jefferson et al. 2008). They are found only in North Pacific temperate waters up to the vicinity of drift ice in the Bering Sea (Jefferson et al. 2008; Leatherwood et al. 1988). Baird's beaked whale may prefer continental shelf and sea mount habitat (Jefferson et al. 2008). The species can be elusive and difficult to approach (Minamikawa et al. 2007). They have a long rostrum and a slender body, giving them a relatively unique profile for a large beaked whale. Their small but obvious dorsal fin is two-thirds of the way along the body and is typically rounded at the tip (Jefferson et al. 2008; Leatherwood et al. 1988). They often have scars all over their body, like Risso's dolphin, which are thought to come from the pair of protruding teeth at the front of the lower jaw of conspecifics; both sexes have the tusks (Balcomb 1989).

In the field, Baird's beaked whale is less likely to be confused with other beaked whales that occur in their range than they are of being confused with minke whales from a distance (Jefferson et al. 2008; Leatherwood et al. 1988). Fortunately, the surfacing behavior of Baird's beaked whale allows the unique shape of their head to be seen, as they often lift it out of the water as they surface (Jefferson et al. 2008). In contrast to minke whales and many other beaked whale species, Baird's beaked whales often occur in large groups (Jefferson et al. 2008; Leatherwood et al. 1988). The groups are often tight knit with the animals aligned like a 'log jam' (Jefferson et al. 2008). This group behavior may sometimes make a group of Baird's beaked whales mistaken for a group of sperm whales logging at the surface (Leatherwood et al. 1988).

Two stocks of Baird's beaked whale are recognized by NMFS, an Alaska stock, which covers a large part of the North Pacific, and a California/Oregon/Washington stock that is found primarily in the CCE (Carretta et al. 2011a). The latter stock is expected to be the population that occurs within SOCAL and the Offshore region of the NWTT Study Area, while the Alaska stock is likely to be the population in the eastern part of the SOCAL transit corridor and the GOA Study Area. Density values for the HSTT Study Area are presented for the species as a whole.

HRC. This species is not expected to occur in the HRC or the western part of the transit corridor. There are no sightings of this species from NMFS surveys west of 131°W (Hamilton et al. 2009).

SOCAL. For the summer and fall, NMFS has developed a CCE model for Baird's beaked whale (Becker et al. 2012c). A uniform density estimate for the inner Baja extension and outer Baja extension are provided by Ferguson and Barlow (2003). The Navy applied the model and the Baja densities to all four seasons. A uniform density value from Barlow and Forney (2007) was applied to all four seasons for the eastern portion of the transit corridor. In the Southern California Bight, data for Baird's beaked whale are arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

MITT. This species is not expected to occur in the MITT or associated transit corridor study areas. There are no sightings of this species from NMFS surveys west of 131°W (Hamilton et al. 2009).

NWTT Offshore. As noted above for SOCAL, NMFS developed a CCE habitat-based density model for Baird's beaked whale which provides spatially-explicit density estimates off the U.S. west coast for summer and fall (Becker et al. 2012c). Stratified uniform density estimates for Baird's beaked whale are also available for the Oregon/Washington and Northern California offshore strata for summer/fall (Barlow and Forney 2007). Density data are not available for the area north of the SWFSC survey area (refer to Figure 3-6), so data from the SWFSC Oregon/Washington stratum were used as representative summer/fall estimates. Since there are no known seasonal abundance patterns of Baird's beaked whale in the Study Area, these estimates were also used to characterize density in winter/spring.

NWTT Inland Waters. This species is not expected to occur within the Inland Waters region of the NWTT Study Area.

NWTT Western Behm Canal, Alaska. For the Western Behm Canal, density estimates for all seasons were taken from the Marine Mammal Occurrence/Density Report prepared in support of a NEPA document for Navy activities at SEAFAC (U.S. Department of the Navy 2010b). However, extensive surveys of nearly all of the inshore waters of Southeast Alaska from 1991-2012 did not produce any sightings of Baird's beaked whales. This strongly suggests that the species does not occur in Western Behm Canal and estimates for this Study Area may be revised in future versions of the NMSDD.

GOA. There were only six on-effort sightings of Baird's beaked whales during the Navy's 2013 survey of the Study Area, so the limited number of observations precluded the derivation of a line-transect density estimate (Rone et al. 2014). Based on sighting data from Waite (2003), the Department of the Navy (2009) derived a year-round density estimate for Baird's beaked whale of 0.0005 animals/km^2.

Table 9-1: Sources of Density Values Used for Baird's Beaked Whale

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	L	L	L	L
SOCAL	CCE/L	CCE/L	CCE/L	CCE/L
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	LD	CCE and LD	CCE and LD	LD
NWTT Inland Waters	0	0	0	0
Western Behm Canal	LD	LD	LD	LD
GOA	LD	LD	LD	LD

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 9-2: Summary of Density Values for Baird's Beaked Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0.00040	0.00040	0.00040	0.00040
SOCAL	S	S	S	S
Inner Baja Extension	0.00000	0.00000	0.00000	0.00000
Outer Baja Extension	0.0002	0.0002	0.0002	0.0002
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	S and 0.001614	S and 0.001614	S and 0.001614	S and 0.001614
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0.0005	0.0005	0.0005	0.0005
GOA	0.0005	0.0005	0.0005	0.0005

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

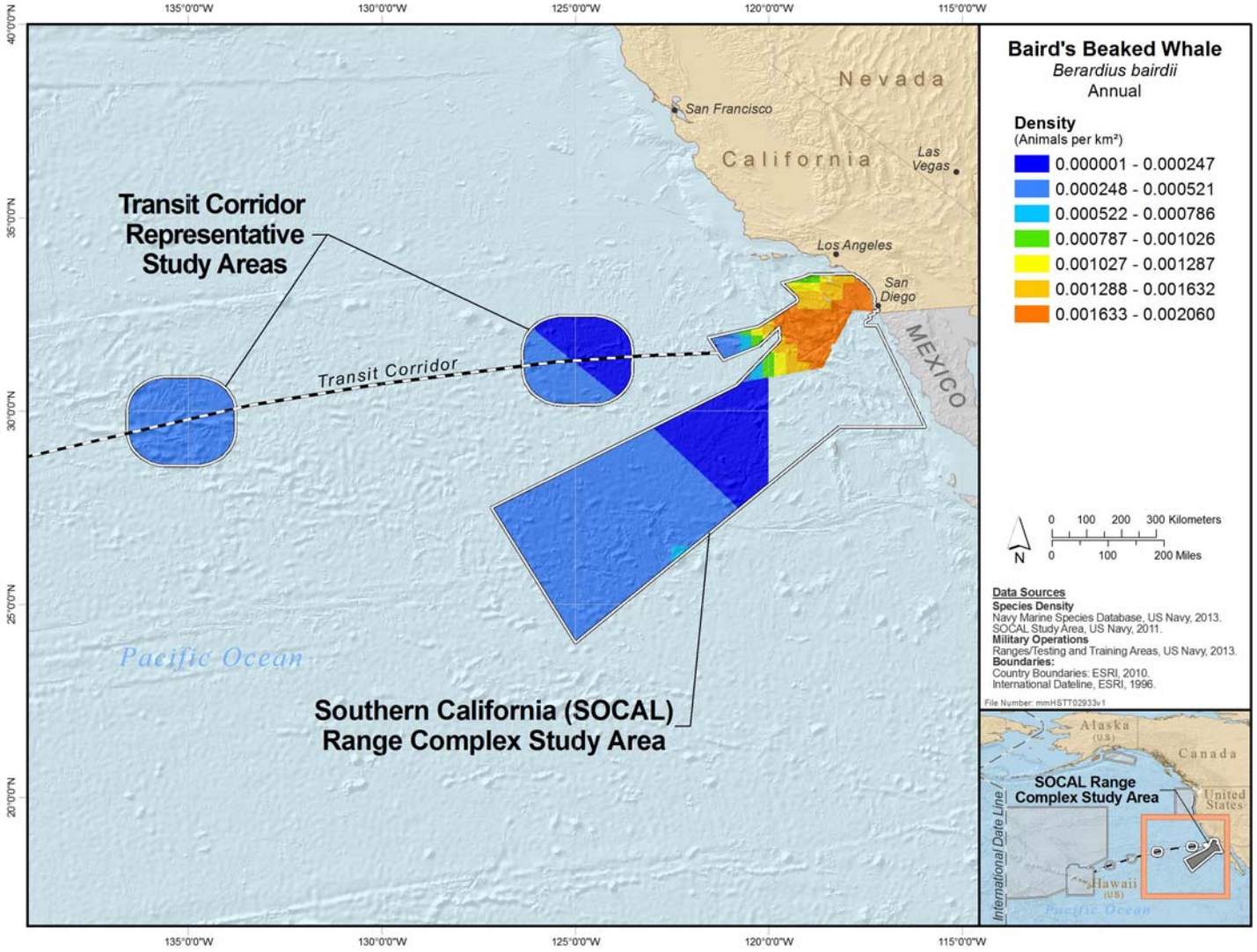

Figure 9-1: Annual Distribution of Baird's Beaked Whale in SOCAL and the Eastern Portion of the Transit Corridor

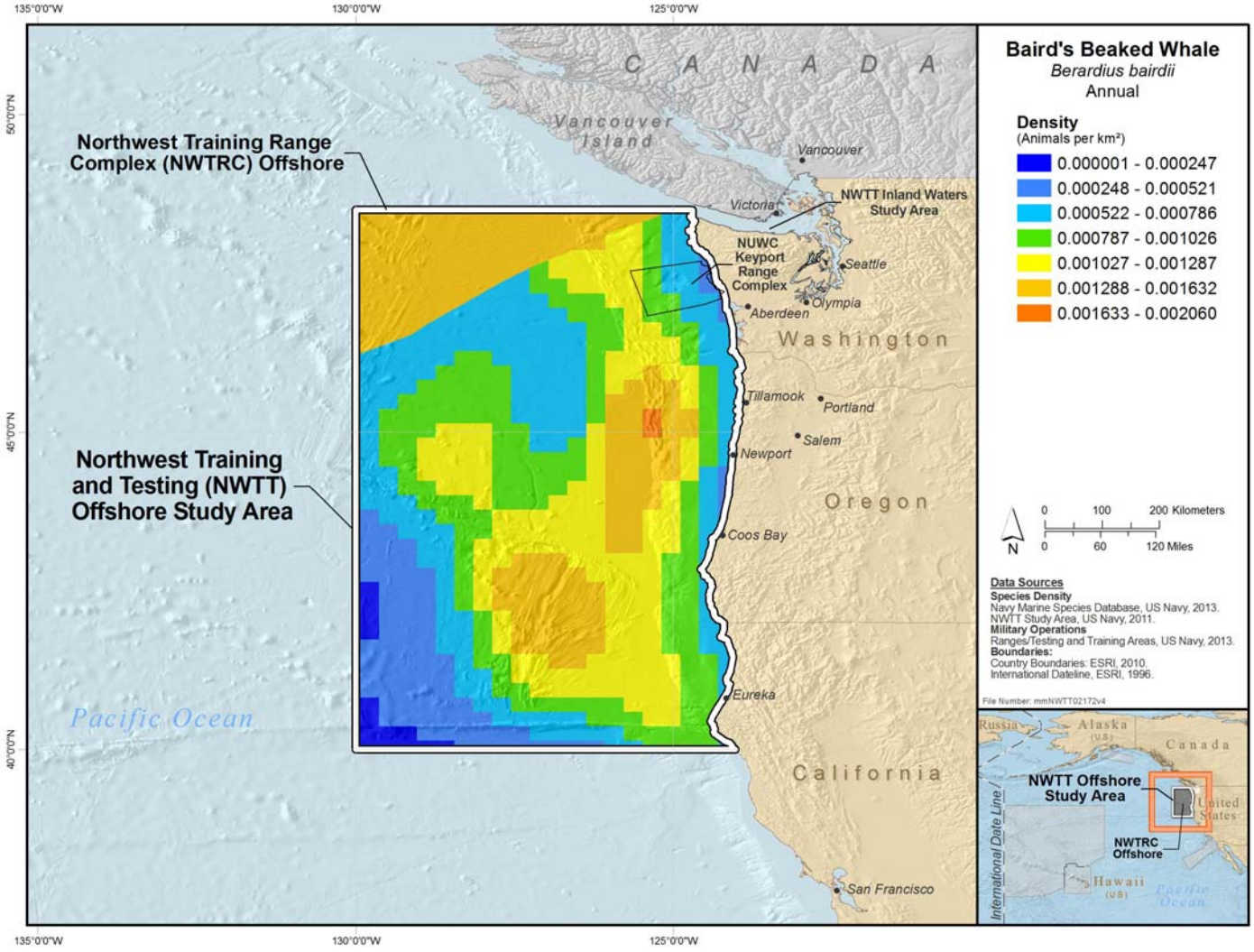

Figure 9-2: Annual Distribution of Baird's Beaked Whale in the Offshore Portion of the NWTT Study Area

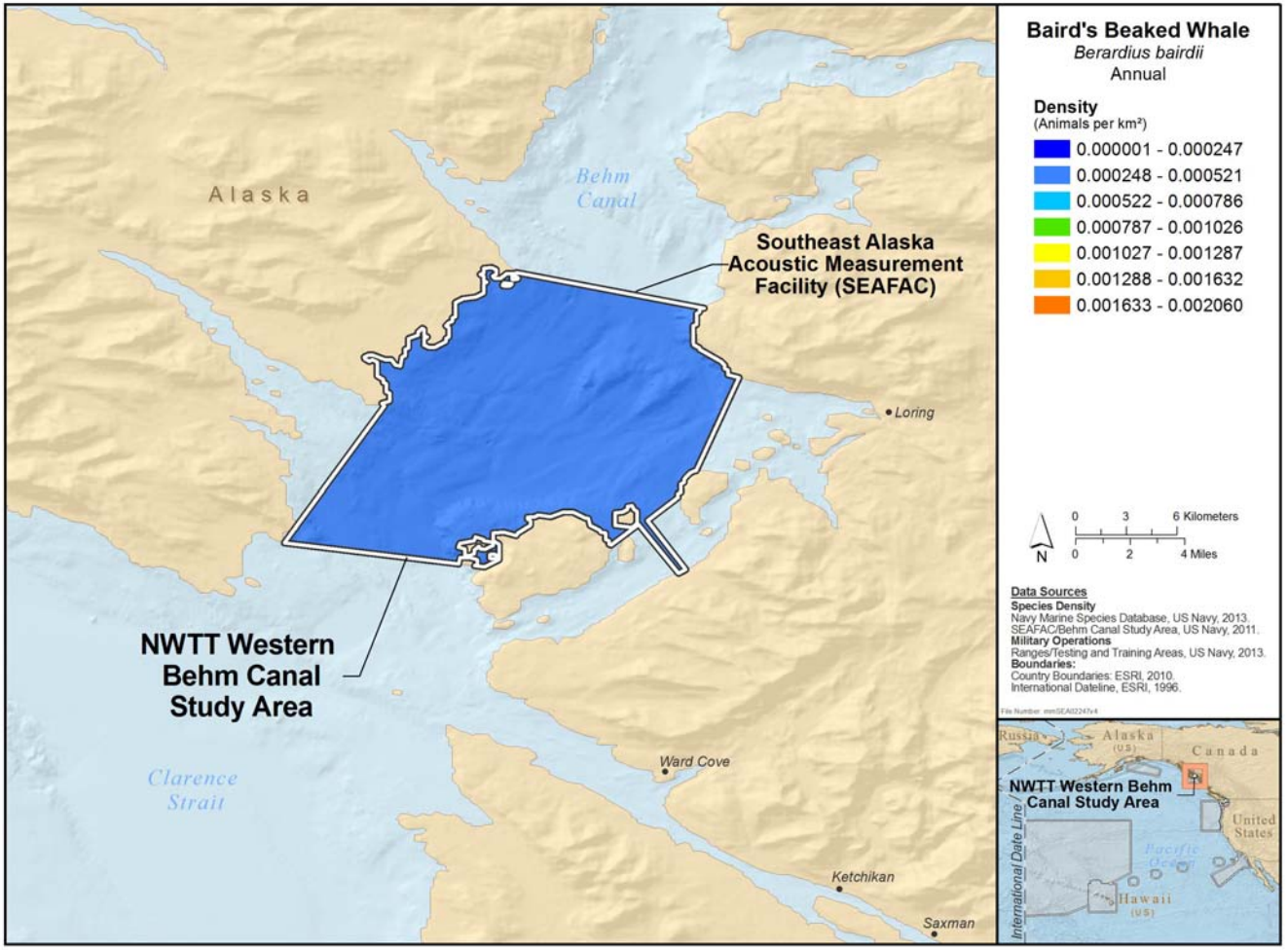

Figure 9-3: Annual Distribution of Baird's Beaked Whale in the Western Behm Canal Portion of the NWTT Study Area

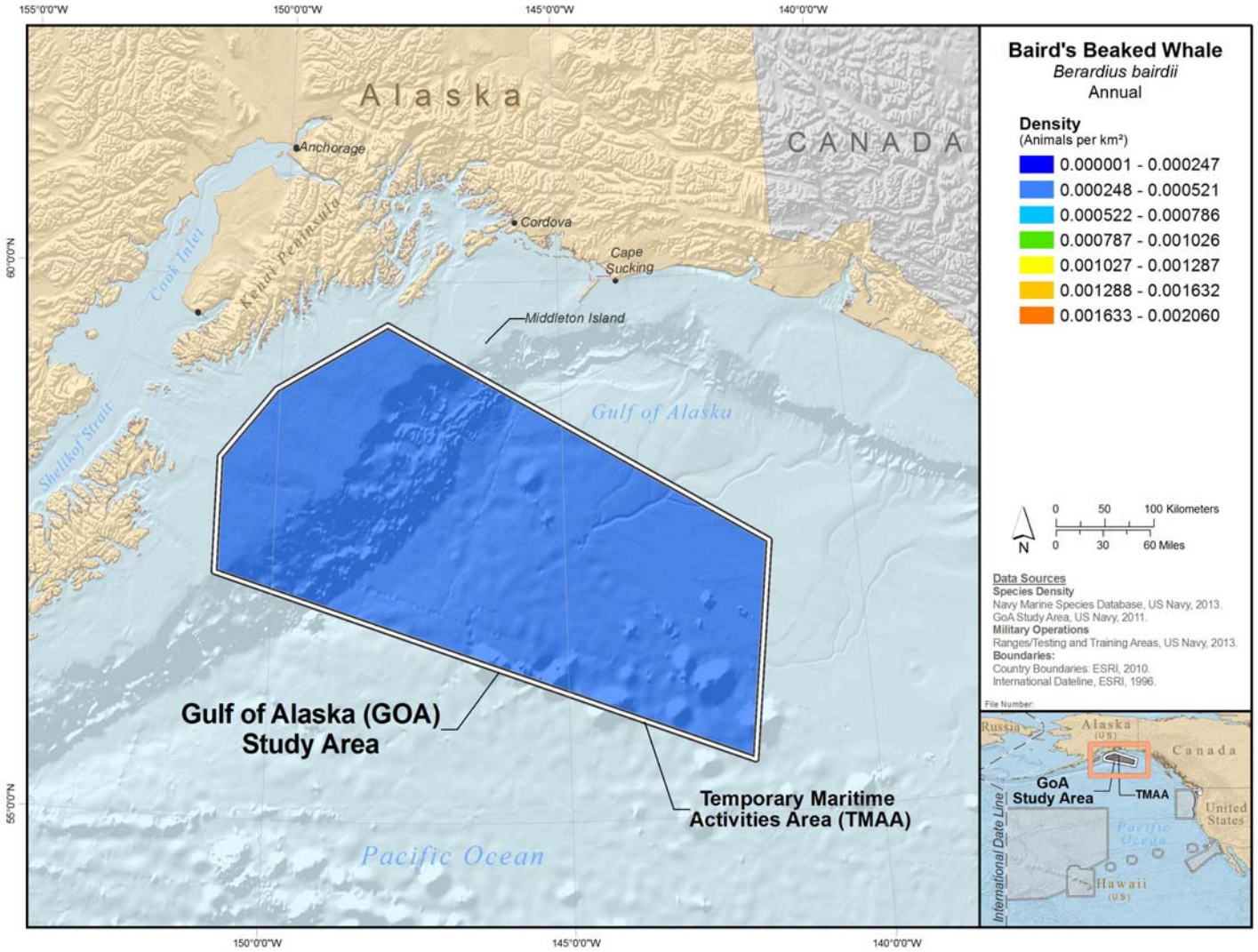

Figure 9-4: Annual Distribution of Baird's Beaked Whale in the GOA Study Area

9.1.2 *INDOPACETUS PACIFICUS*, LONGMAN'S BEAKED WHALE

Longman's beaked whale is a prime example of a whale species that is often misidentified. Until recently this species was only described from skulls (Dalebout et al. 2003). Scientists became aware in the 1990s that sightings in the tropics which were previously identified as *Hyperoodon* sp. were actually *Indopacetus* (Pitman et al. 1999). Little is known about Longman's beaked whale. It is a large beaked whale, but not as big as Baird's beaked whale. The species' color ranges from brown to blue-gray, and it has a somewhat bulging forehead and a moderately long, tubular beak. The area from the rostrum to the blowhole is lighter colored than the rest of the body (Dalebout et al. 2003; Jefferson et al. 2008). This species is unlikely to be confused with most other species in its range if seen closely. It could be confused with Baird's beaked whale in the northern part of its range, but that is well to the north of the HSTT Study Area. The species is not often seen near the Hawaiian Islands, but one specimen stranded in 2010 on Maui (Jensen et al. 2011). NMFS observers saw large groups of Longman's beaked whale near the Northwest Hawaii Islands during a 2010 large vessel survey of the Hawaiian EEZ (J. Cotton pers. comm.; Rankin et al. 2011). Like Baird's beaked whale, Longman's beaked whale may occur more often in groups larger than 11 individuals (MacLeod and D'Amico 2006). Only one stock of Longman's beaked whale is recognized by NMFS, and it is around Hawaii (Carretta et al. 2011a). However, this simple stock structure may be the result of a lack of knowledge about the species. Nothing is known about the stock structure of Longman's beaked whale in the MITT Study Area.

HRC. Barlow (2006) provided a uniform density for Longman's beaked whale in NMFS' Hawaii study area. This value is applied to HRC in all seasons and the western portion of the transit corridor in all seasons.

SOCAL. This species has not been observed by NMFS in the SOCAL or eastern part of the transit corridor (Hamilton et al. 2009).

MITT. There were no sightings of Longman's beaked whale during the Navy's 2007 survey of the Study Area (Fulling et al. 2011). In the absence of study area specific density data, and consistent with recommendations from scientists at PIFSC, line-transect estimates derived for Hawaiian waters (Barlow 2006) were used to represent the best available estimates for the MITT Study Area. Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual Longman's beaked whale density.

NWTT. This species is not expected to occur in any of the regions included in the NWTT Study Area.

GOA. This species is not expected to occur in the GOA Study Area.

Table 9-3: Sources of Density Values Used for Longman's Beaked Whale

Location	Spring	Summer	Fall	Winter
HRC	L	L	L	L
W. Transit Corridor	L	L	L	L
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 9-4: Summary of Density Values for Longman's Beaked Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0.00041	0.00041	0.00041	0.00041
W. Transit Corridor	0.00041	0.00041	0.00041	0.00041
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
Inner Baja Extension	0	0	0	0
Outer Baja Extension	0	0	0	0
MITT	0.00041	0.00041	0.00041	0.00041
MITT Transit Corridor	0.00025	0.00025	0.00025	0.00025
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

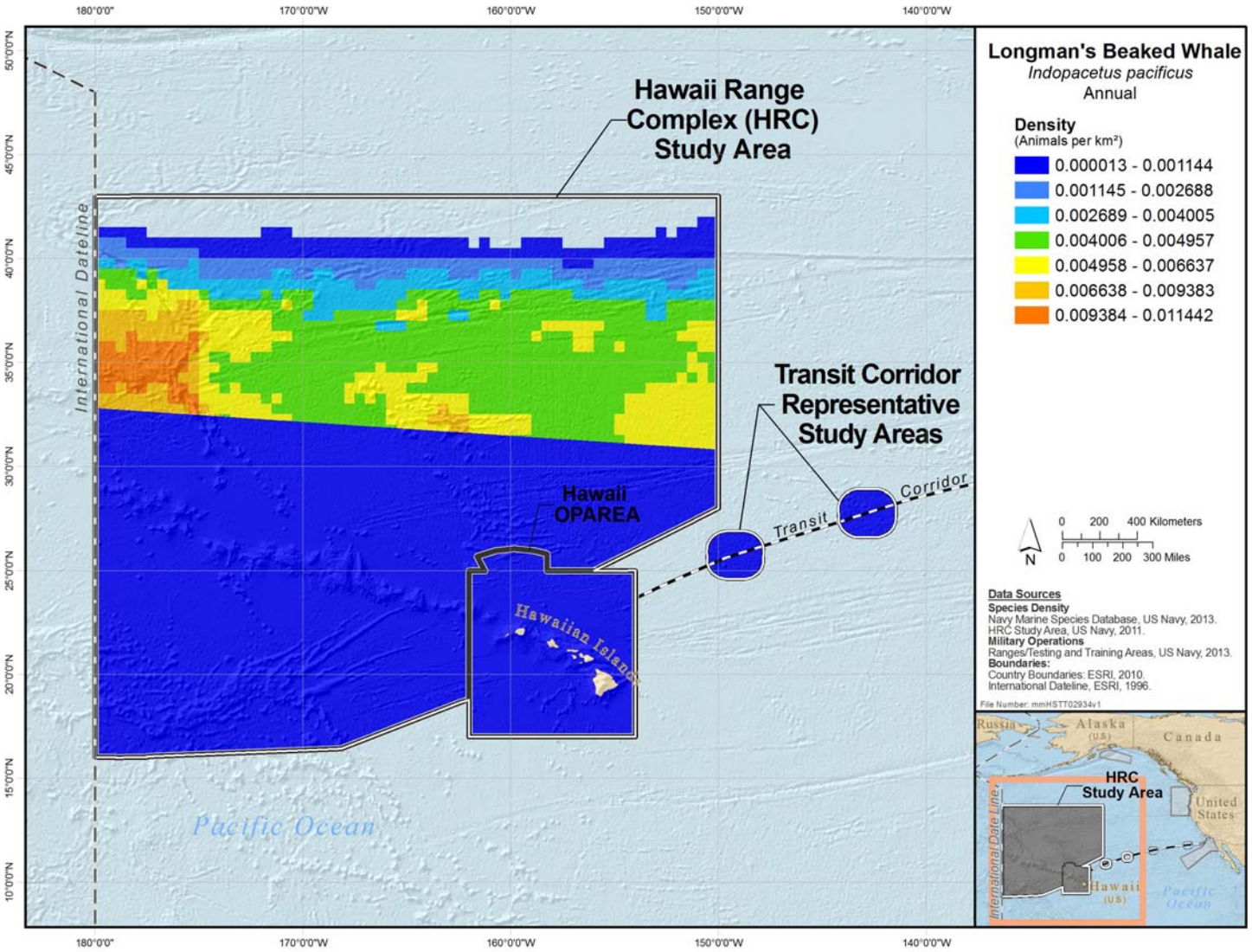

Figure 9-5: Annual Distribution of Longman's Beaked Whale in HRC and the Western Portion of the Transit Corridor

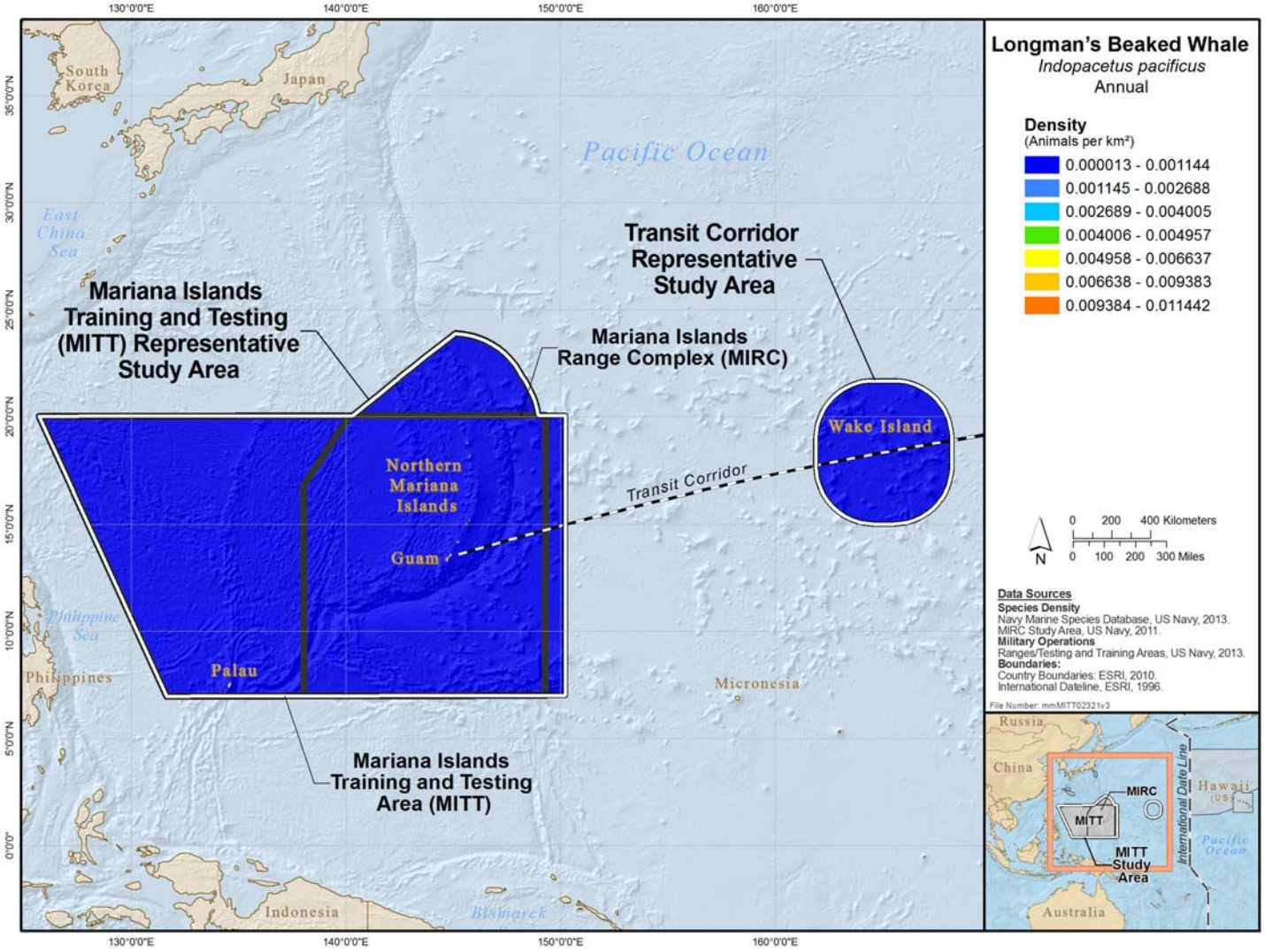

Figure 9-6: Annual Distribution of Longman's Beaked Whale in MITT and the Associated Transit Corridor Study Areas

9.1.3 *MESOPLODON DENSIROSTRIS*, BLAINVILLE'S BEAKED WHALE

Blainville's beaked whale is found in warm temperate and tropical waters around the world (Pitman 2009). The shape of the body is typical for mesoplodonts with a spindle-shaped torso, small dorsal fin two-thirds of the way along the body, a relatively small head, and small pectoral fins (Jefferson et al. 2008; Pitman 2009). The general coloration is countershaded brown or gray with many scars from cookie cutter sharks (*Isistius brasiliensis*). The lower jaw is the most distinctive identifying feature of Blainville's beaked whale. The posterior half of the lower jaw is arched in all sexes and age groups. In adult males, the arches of the jaw extend above the melon and large teeth, or tusks, erupt from the jaw and protrude above the head at a 45° angle (Jefferson et al. 2008; Leatherwood et al. 1988; Pitman 2009). The unusual shape of the jaw makes adult males reasonably distinguishable at sea, but young individuals and females may be difficult to identify positively. The species is most likely to be misidentified with other mesoplodonts and Cuvier's beaked whale, whose range overlaps significantly with Blainville's beaked whale (Jefferson et al. 2008; Leatherwood et al. 1988). When viewed at close range, it is clear that Cuvier's beaked whale will have a more straight jaw line and a more bulbous head than Blainville's beaked whale (Leatherwood et al. 1988), but other mesoplodonts can cause significant identification problems, especially for younger individuals and females.

NMFS recognizes a stock for Blainville's beaked whale around Hawaii, as well as recognizing the species as a member of the California/Oregon/Washington Mesoplodont Beaked Whale stock of six species (Carretta et al. 2011a). It is unclear where the Hawaii stock transitions into the California/Oregon/Washington Mesoplodont Beaked Whale stock along the transit corridor. Little is known about the stock structure of Blainville's beaked whale in the MITT Study Area.

HRC. For Hawaii, evidence exists to suggest that there are island-associated groups of Blainville's beaked whales that have strong site fidelity (McSweeney et al. 2007; Schorr et al. 2010), and there may be an offshore population associated with Hawaii (Baird et al. 2011a). Presumably both groups are encompassed in the Hawaii stock and are found in the western portion of the transit corridor. Barlow (2006) provided a uniform density for Blainville's beaked whale in NMFS' Hawaii study area. This value is applied to HRC in all seasons and the western portion of the transit corridor in all seasons. In HRC and the western part of the transit corridor, density values are presented for the species as a whole. The white polygon at the eastern edge of the HRC map is where data were removed for the eastern portion of the transit corridor because Blainville's beaked whales are part of the small beaked whale guild and that data are treated separately in Section 9.1.6.

SOCAL. This species is addressed in the small beaked whale guild for SOCAL and the eastern portion of the transit corridor (Section 9.1.6).

MITT. There were two *Mesopolodon* whale sightings during the Navy's 2007 survey of the Study Area, but they were not identified to the species level (Fulling et al. 2011). In the absence of study area specific density data, and consistent with recommendations from scientists at PIFSC, line-transect estimates derived for Hawaiian waters (Barlow 2006) were used to represent the best available estimates for Blainville's beaked whale in the MITT Study Area. Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to

characterize annual Blainville's beaked whale density.

NWTT Offshore. This species is addressed in the small beaked whale guild for the Offshore portion of the NWTT Study Area (Section 9.1.6).

NWTT Inland Waters. This species is not expected to occur in the Inland Waters portion of the NWTT Study Area.

NWTT Western Behm Canal, Alaska. This species is not expected to occur in the Western Behm Canal portion of the NWTT Study Area.

GOA. This species is not expected to occur in the GOA Study Area.

Table 9-5: Sources of Density Values Used for Blainville's Beaked Whale

Location	Spring	Summer	Fall	Winter
HRC	L	L	L	L
W. Transit Corridor	L	L	L	L
E. Transit Corridor	G	G	G	G
SOCAL	G	G	G	G
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	G	G	G	G
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS; G = this species is part of the small beaked whale guild in SOCAL and NWTT Offshore. For a complete description of data sets refer to Section 3.

Table 9-6: Summary of Density Values for Blainville's Beaked Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0.00117	0.00117	0.00117	0.00117
W. Transit Corridor	0.00117	0.00117	0.00117	0.00117
E. Transit Corridor	G	G	G	G
SOCAL	G	G	G	G
Inner Baja Extension	G	G	G	G
Outer Baja Extension	G	G	G	G
MITT	0.00117	0.00117	0.00117	0.00117
MITT Transit Corridor	0.00070	0.00070	0.00070	0.00070
NWTT Offshore	G	G	G	G
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range; G = this species is part of the small beaked whale guild in SOCAL and NWTT Offshore.

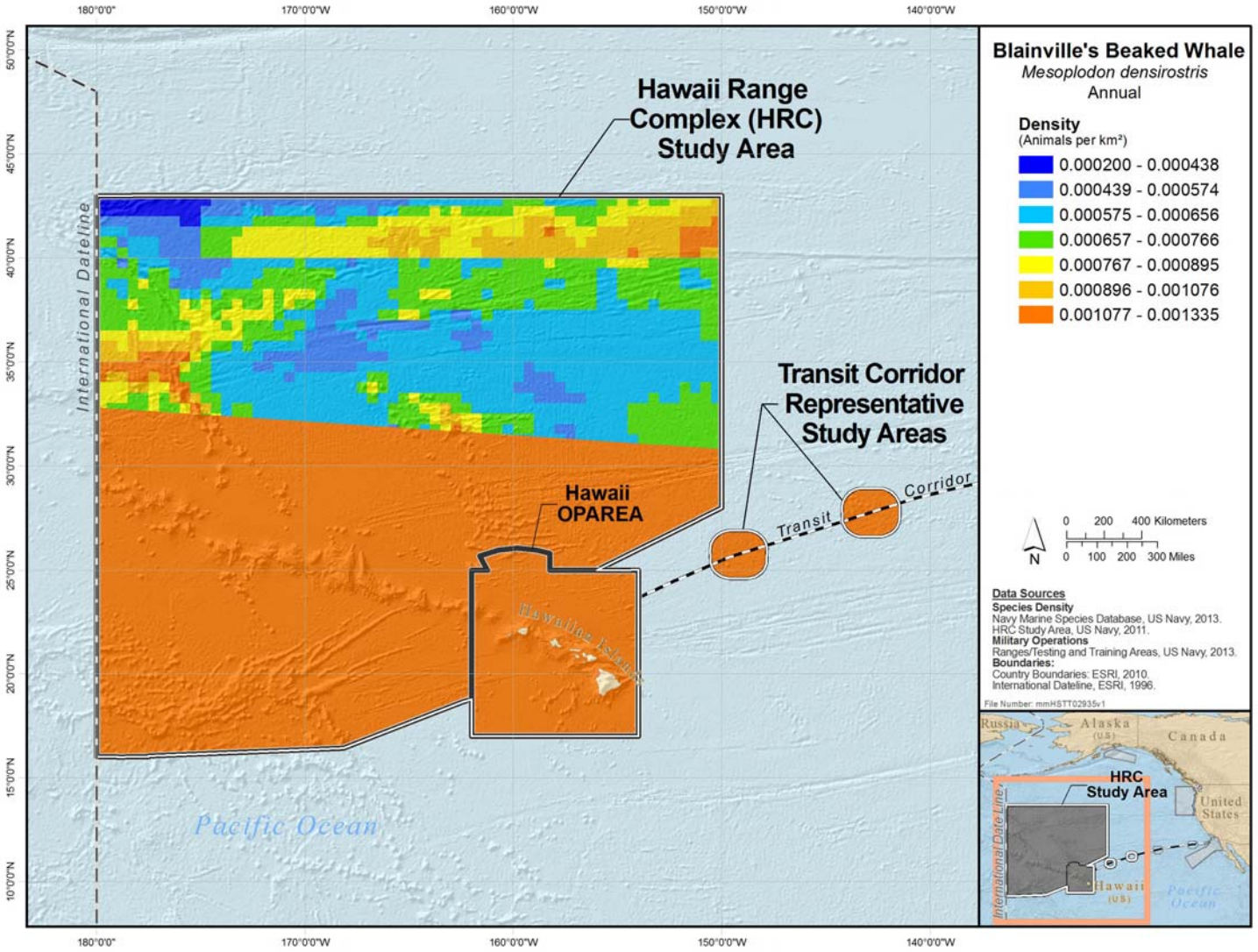

Figure 9-7: Annual Distribution of Blainville's Beaked Whale in HRC and the Western Portion of the Transit Corridor

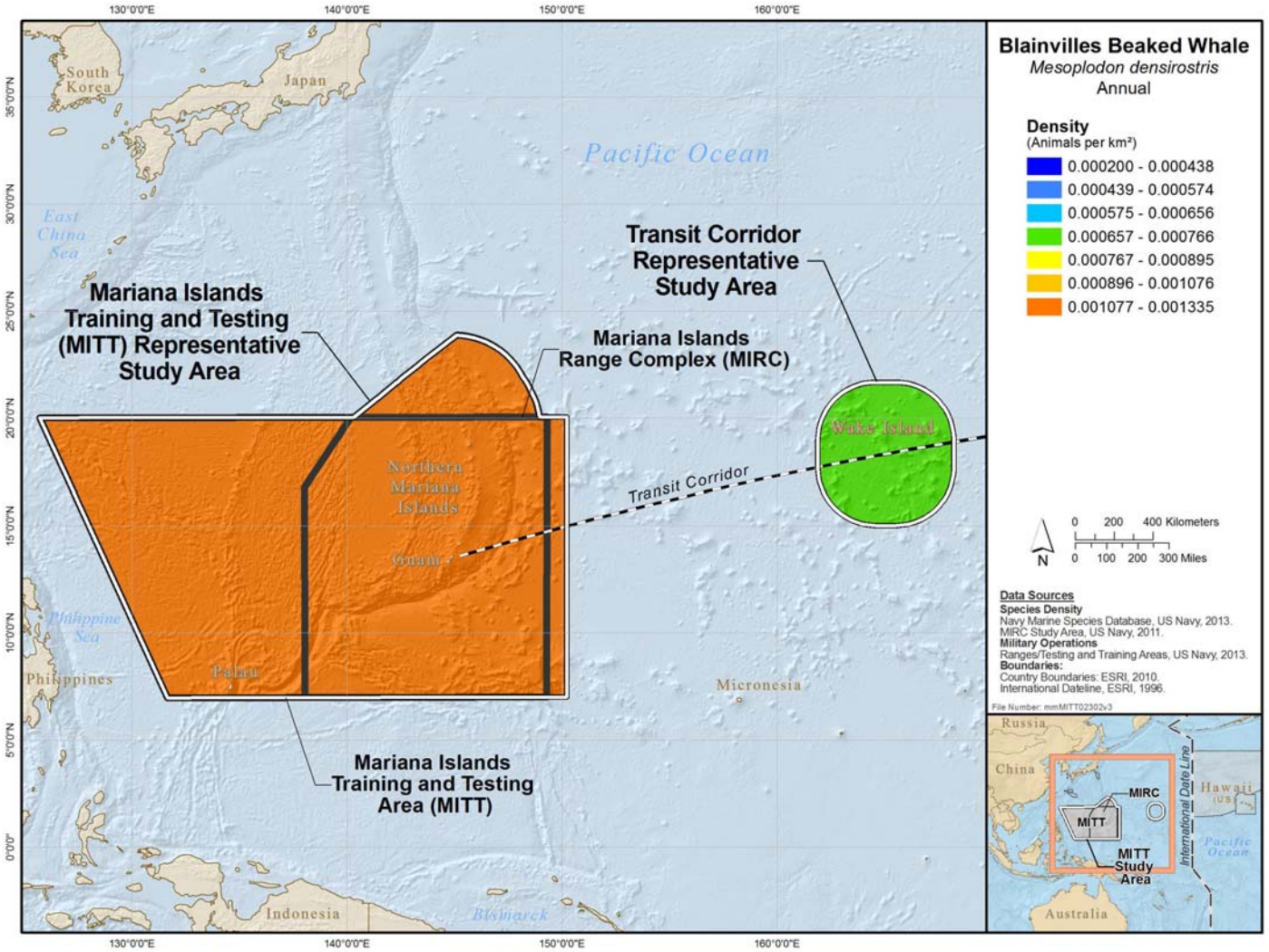

Figure 9-8: Annual Distribution of Blainville's Beaked Whale in MITT and the Associated Transit Corridor Study Areas

9.1.4 *MESOPLODON GINKGODENS*, GINKGO-TOOTHED BEAKED WHALE

The ginkgo-toothed beaked whale is known only from strandings and a few unconfirmed sightings in tropical waters of the Pacific and Indian Oceans (Mead 1989; Palacios and Mate 1996). Due to the similarities between the species, the ginkgo-toothed beaked whale may be virtually indistinguishable at sea from some other *Mesoplodon* species. The newly-recognized Deraniyagla's beaked whale (*M. hotaula*) is very similar in external appearance and skull morphology to *M. ginkgodens*, and the two species would likely require detailed examination of the cleaned skull, or molecular analyses to distinguish them (see Dalebout et al. 2014). *Mesoplodon hotaula* appears to be a more tropical species than *M. ginkgodens*, but the actual ranges of both species are not well known, and may in fact overlap. Due to the difficulty in distinguishing the different *Mesoplodon* species from one another, the ginkgo-toothed beaked whale has been combined with other *Mesoplodon* species to make up the California, Oregon, and Washington stock (Carretta et al. 2010). There is not a Hawaiian stock of this species recognized by NMFS, and its distribution is not currently thought to include the Hawaiian Islands (Taylor et al. 2008). Little is known of the stock structure of ginkgo-toothed beaked whales in the MITT Study Area.

HRC. This species is not known to occur in the HRC or in the western portion of the HSTT transit corridor.

SOCAL. This species is addressed in the small beaked whale guild for SOCAL and the eastern portion of the transit corridor (Section 9.1.6).

MITT. There were two *Mesopolodon* whale sightings during the Navy's 2007 survey of the Study Area, but they were not identified to the species level (Fulling et al. 2011). Because ginko-toothed beaked whale densities are poorly characterized throughout the oceans, estimated values from *Mesopolodon* sp. for other areas were a basis for calculating densities in MITT. To provide a density estimate for this species, density estimates and associated CVs derived by Ferguson and Barlow (2003) for *Mesoplodon* sp. in the eastern tropical Pacific were re-calculated for those strata having sea surface temperature and chlorophyll concentrations similar to the MITT Study Area. This included Ferguson and Barlow's (2003) strata 122-131 (extending west of 105°W between 5 and 10°N) and 141–151 (extending west of 95°W between 10 and 15°N). The resulting density estimate of 0.00093 (CV = 0.41) was used for the MITT Study Area and associated transit corridor.

NWTT Offshore. This species is addressed in the small beaked whale guild for the Offshore portion of the NWTT Study Area (Section 9.1.6).

NWTT Inland Waters. This species is not expected to occur in the Inland Waters portion of the NWTT Study Area.

NWTT Western Behm Canal, Alaska. This species is not expected to occur in the Western Behm Canal portion of the NWTT Study Area.

GOA. This species is not expected to occur in the GOA Study Area.

Table 9-7: Sources of Density Values Used for Ginkgo-Toothed Beaked Whale

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	G	G	G	G
SOCAL	G	G	G	G
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	G	G	G	G
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS; G = this species is part of the small beaked whale guild in SOCAL and NWTT Offshore. For a complete description of data sets refer to Section 3.

Table 9-8: Summary of Density Values for Ginkgo-Toothed Beaked Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	G	G	G	G
SOCAL	G	G	G	G
Inner Baja Extension	G	G	G	G
Outer Baja Extension	G	G	G	G
MITT	0.00093	0.00093	0.00093	0.00093
MITT Transit Corridor	0.00093	0.00093	0.00093	0.00093
NWTT Offshore	G	G	G	G
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range; G = this species is part of the small beaked whale guild in SOCAL and NWTT Offshore.

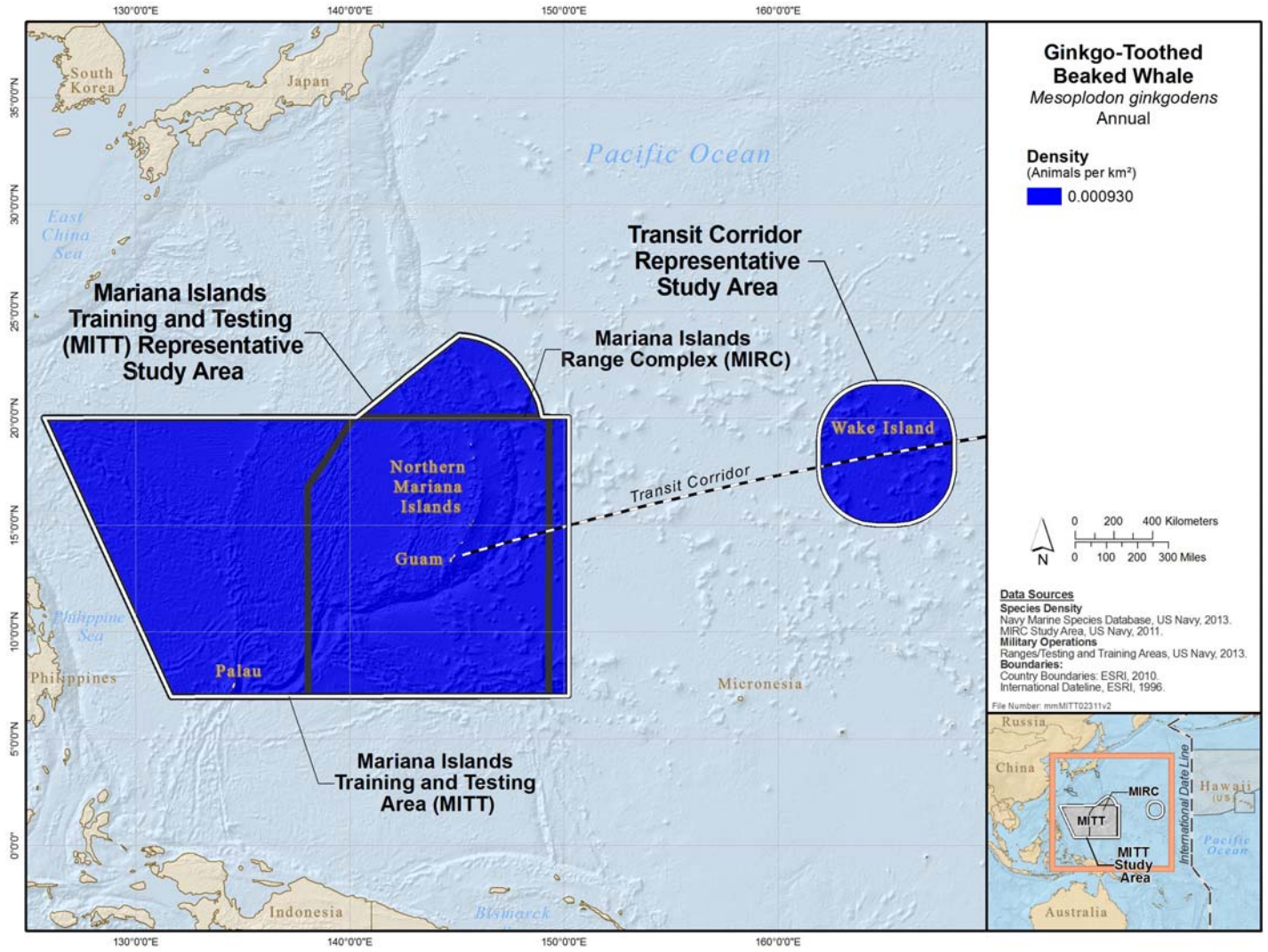

Figure 9-9: Annual Distribution of Ginkgo-Toothed Beaked Whale in MITT and the Associated Transit Corridor Study Areas

9.1.5 *MESOPLODON STEJNEGERI*, STEJNEGER'S BEAKED WHALE

Stejneger's beaked whale is rarely seen at sea and stranded specimens provide the majority of information on their distribution. Stejneger's beaked whale appears to prefer cold temperate and subpolar waters, and is by far the most common species of mesoplodont that occurs in Alaskan waters (Loughlin and Perez 1985, MacLeod et al. 2006a). This species has been observed in waters ranging in depth from 730 to 1,560 m on the steep slope of the continental shelf (Loughlin and Perez 1985). The farthest south this species has been recorded in the eastern Pacific is Cardiff, California (33°N), but this is considered an extralimital occurrence (Loughlin and Perez 1985, MacLeod et al. 2006a, Mead 1989).

Two of the three *Mesoplodon* stocks that NMFS recognizes include Stejneger's beaked whale (1) all *Mesoplodon* species off California, Oregon, and Washington, and (2) an Alaska stock of Stejneger's beaked whale (Allen and Angliss 2013; Carretta et al. 2013a). In the SOCAL and NWTT Offshore Study Areas, Stejneger's beaked whales are part of the California, Oregon, and Washington *Mesoplodon* spp. stock. Stejneger's beaked whales that occur in the GOA Study Area belong to the Alaska stock.

HRC. This species is not expected to occur in the HRC or the western part of the transit corridor.

SOCAL. This species is addressed in the small beaked whale guild for SOCAL and the eastern portion of the transit corridor.

NWTT Offshore. This species is addressed in the small beaked whale guild for the Offshore portion of the NWTT Study Area.

NWTT Inland Waters. This species is not expected to occur in the Inland Waters portion of the NWTT Study Area.

NWTT Western Behm Canal, Alaska. This species is not known to occur in the Inland Waters portion of the NWTT Study Area (U.S. Department of the Navy 2010b).

GOA. There were six acoustic detections of Stejneger's beaked whale during the Navy's 2013 survey of Study Area, but no visual observations, so a line-transect density estimate could not be derived from the sighting data (Rone et al. 2014). There is currently no reliable abundance estimate for the Alaska stock of Stejneger's beaked whale (Allen and Angliss 2013), and no density data specific to the GOA Study Area; therefore, predictions from the global RES model from SMRU Ltd. (*in prep*) were used for all seasons.

Table 9-9: Sources of Density Values Used for Stejneger's Beaked Whale

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	G	G	G	G
SOCAL	G	G	G	G
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	G	G	G	G
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	SMRU	SMRU	SMRU	SMRU

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS; G = this species is part of the small beaked whale guild in SOCAL and NWTT Offshore. For a complete description of data sets refer to Section 3.

Table 9-10: Summary of Density Values for Stejneger's Beaked Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	G	G	G	G
SOCAL	G	G	G	G
Inner Baja Extension	G	G	G	G
Outer Baja Extension	G	G	G	G
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	G	G	G	G
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	S	S	S	S

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range; G = this species is part of the small beaked whale guild in SOCAL and NWTT Offshore.

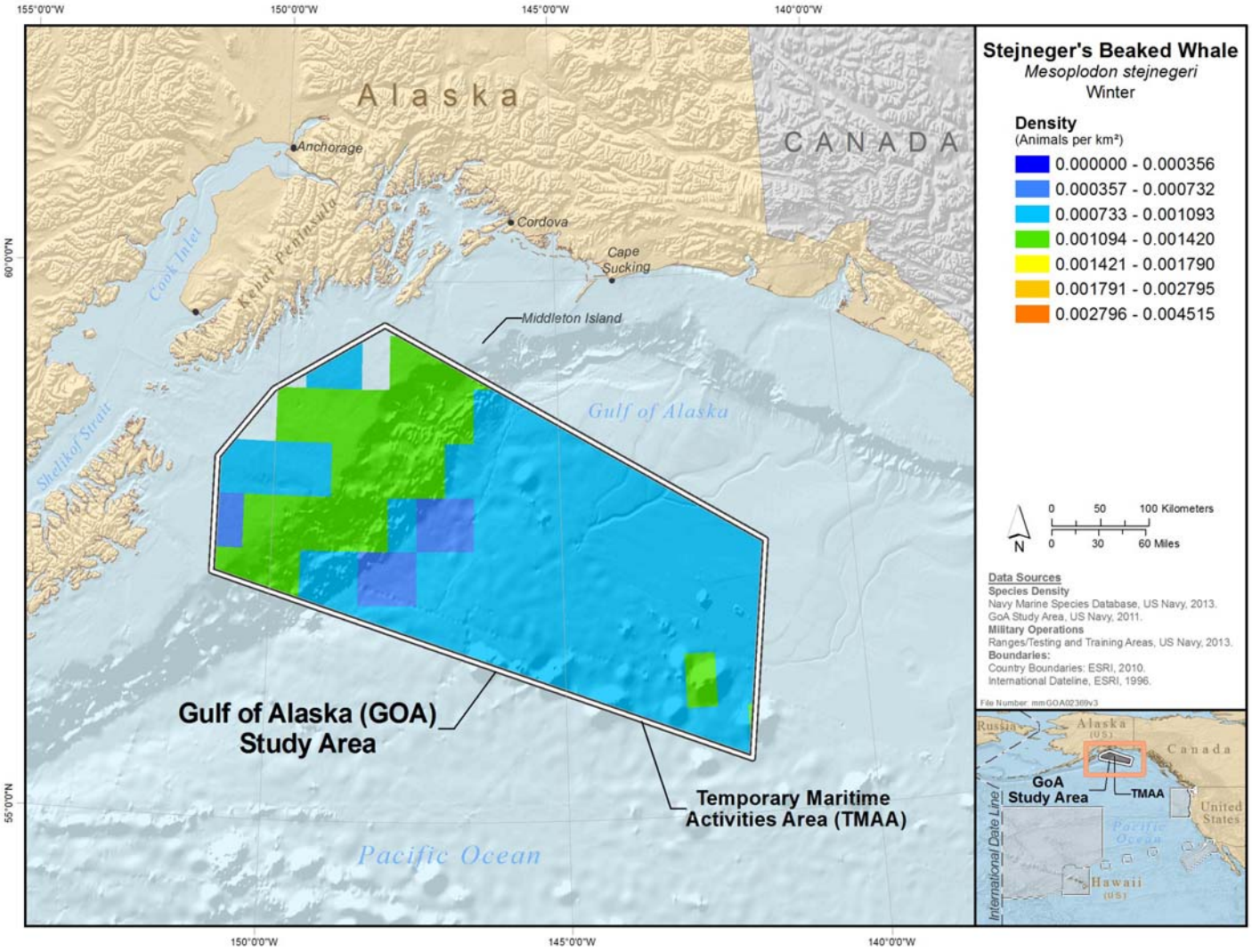

Figure 9-10: Winter Distribution of Stejneger's Beaked Whale in the GOA Study Area

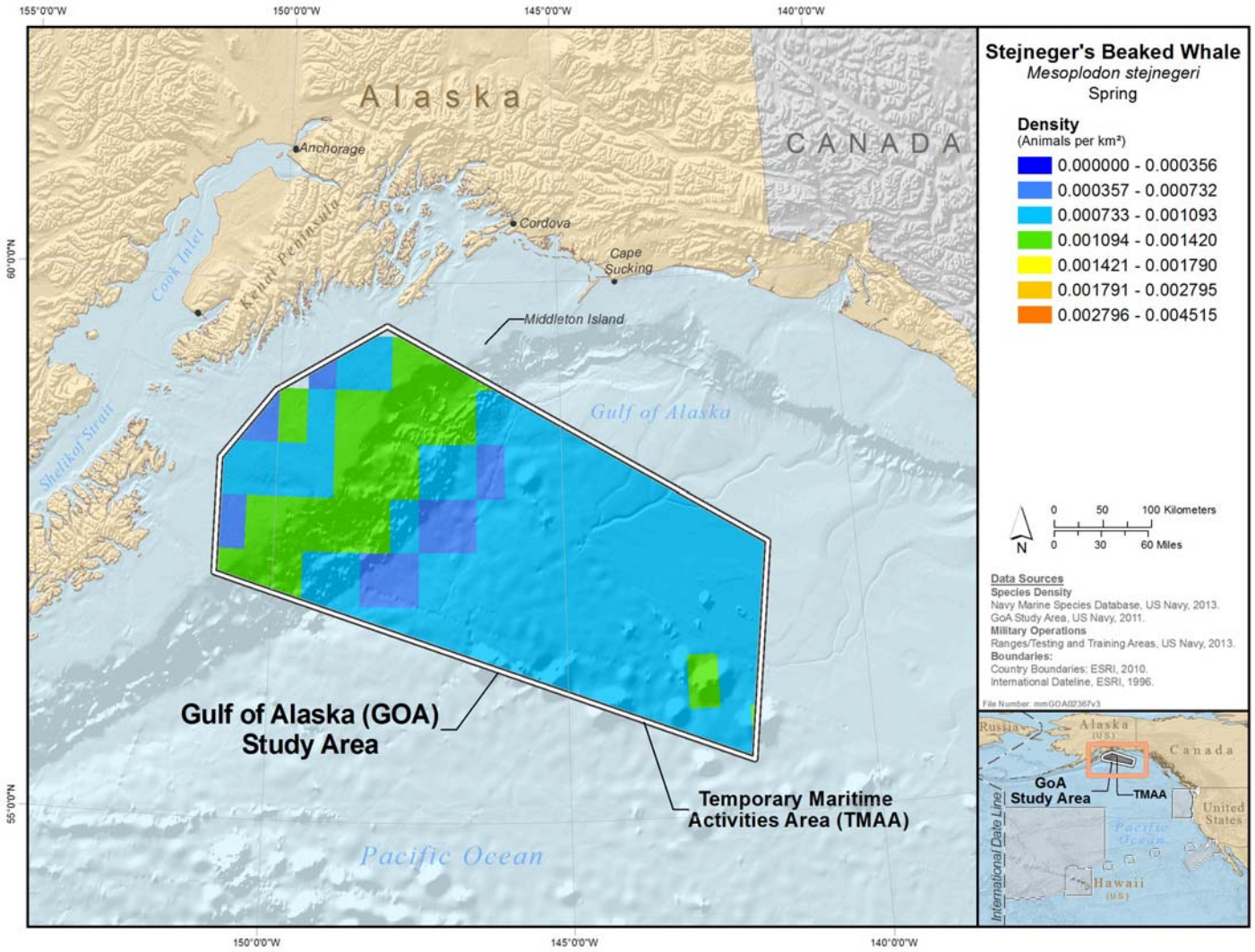

Figure 9-11: Spring Distribution of Stejneger's Beaked Whale in the GOA Study Area

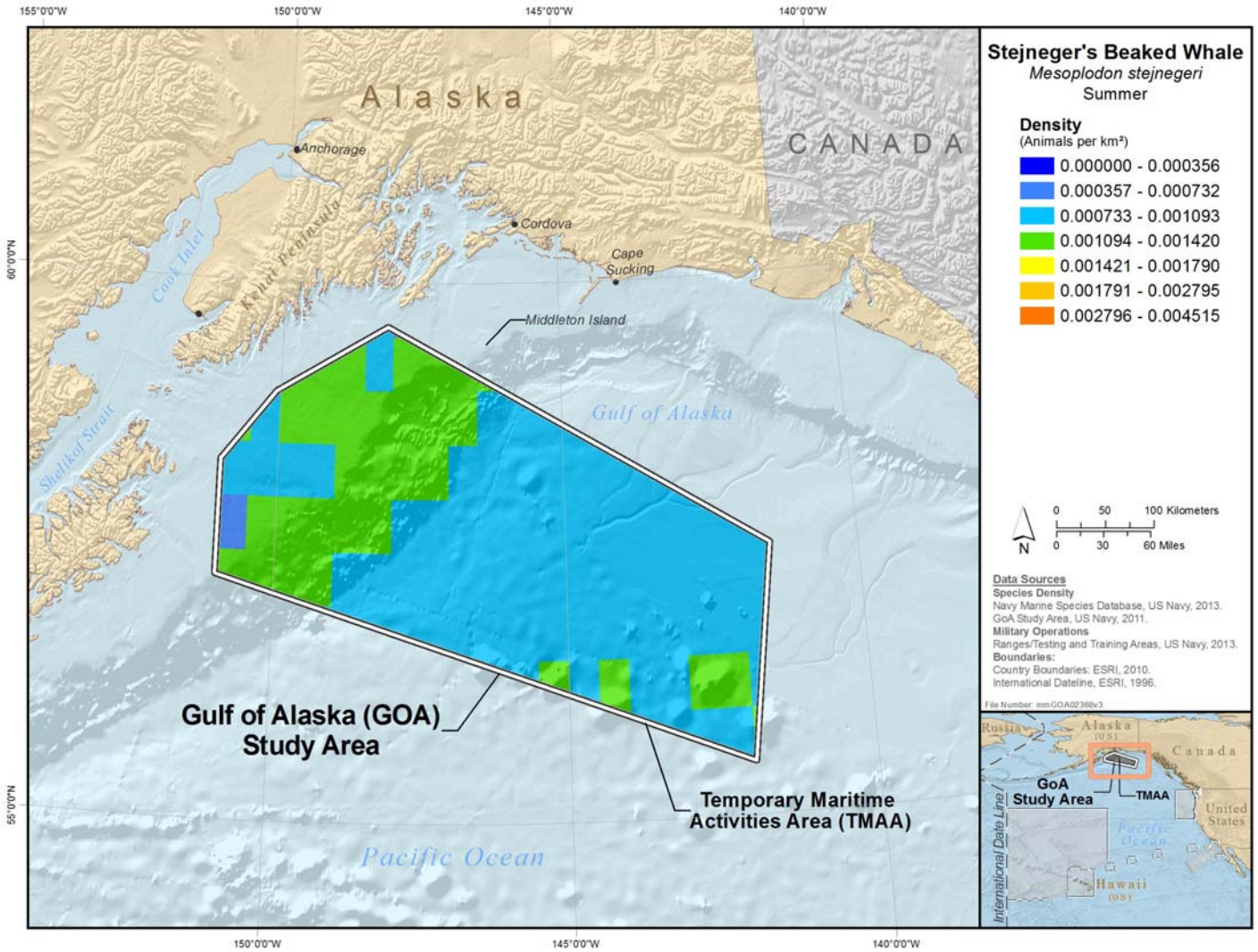

Figure 9-12: Summer Distribution of Stejneger's Beaked Whale in the GOA Study Area

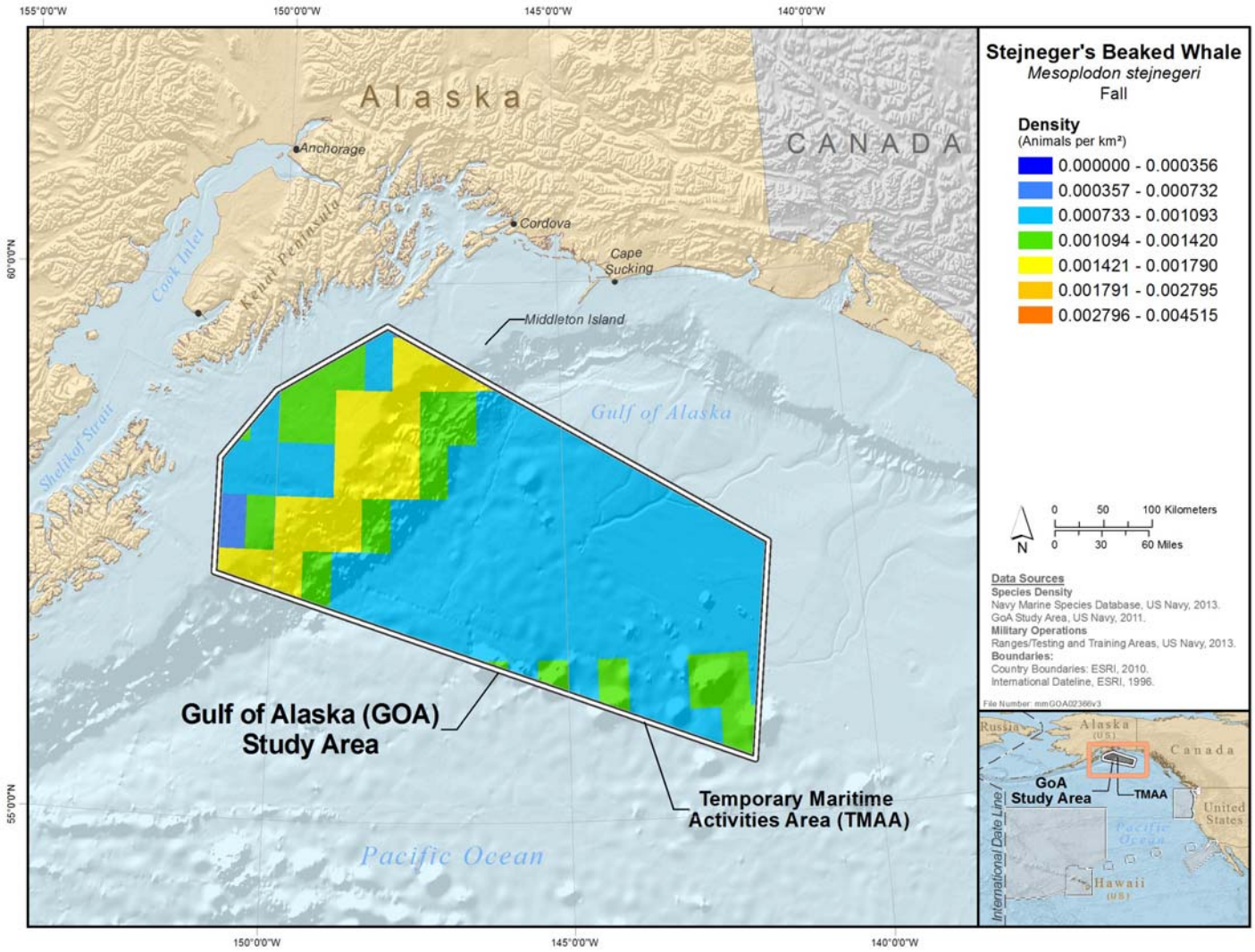

Figure 9-13: Fall Distribution of Stejneger's Beaked Whale in the GOA Study Area

9.1.6 *ZIPHIUS CAVIROSTRIS*, CUVIER'S BEAKED WHALE

This beaked whale is the most cosmopolitan of the beaked whales with a presence in all oceans except the polar seas (Heyning 1989). Cuvier's beaked whale is a "robust" version of the typical beaked whale form (Jefferson et al. 2008; Leatherwood et al. 1988). Like other beaked whales the dorsal fin is small, falcate, and sits two-thirds of the way back on the length of the body. They have a stubby beak and a gently sloped to bulbous head which is pronounced in adult males (Jefferson et al. 2008; Leatherwood et al. 1988). Their jaw line only curves gently and is upturned at the gape (Jefferson et al. 2008). The color can be slate gray to brown and is lighter or white around the head and on the back anterior to the blowhole, especially so in adult males, which may appear completely white around the head and anterior body. Their blow is diffuse and angled forward and they actively avoid boats, so they can be quite difficult to observe at sea, except in calm sea states (Heyning and Mead 2009; Jefferson et al. 2008). When observed they can be mistaken for other beaked whales, but the robustness of the body and fact that they have one of the shortest beaks of any beaked whale makes them reasonably distinguishable (Jefferson et al. 2008; Leatherwood et al. 1988). Their body color, particularly their head, is lighter than most other cetaceans, making them easier to identify than other beaked whales (Leatherwood et al. 1988). Cuvier's beaked whale is also one of the most active of the beaked whales when at the surface (Leatherwood et al. 1988).

There are three stocks of Cuvier's beaked whale recognized by NMFS: an Alaska stock, a California/Oregon/Washington stock, and a Hawaii stock (Carretta et al. 2011a). Although there is a separate stock off California/Oregon/Washington, NMFS included Cuvier's beaked whale in the habitat-based density model for the small beaked whale guild for the CCE study area (Becker et al. 2012c). While animals in SOCAL or HRC could presumably be assigned to a stock, animals in the transit corridor could belong to the Hawaiian stock or California/Oregon/Washington stock. Little is known about the stock structure of Cuvier's beaked whale in the MITT Study Area. In the NWTT Study Area, Cuvier's beaked whales occurring in the Offshore region belong to the California/Oregon/Washington stock while those occurring in the GOA Study Area belong to the Alaska stock.

HRC. Like Blainville's beaked whale, Cuvier's beaked whale appears to have groups that exhibit high site fidelity around certain islands and have a year-round presence (McSweeney et al. 2007). In HRC and the western part of the transit corridor, density values are presented for the species. Barlow (2006) provided a uniform density for Cuvier's beaked whale in NMFS' Hawaii study area. This value is applied to HRC in all seasons and the western portion of the transit corridor in all seasons. The white polygon at the eastern edge of the HRC map is where data were removed for the eastern portion of the transit corridor because Cuvier's beaked whales are part of the small beaked whale guild habitat model developed by NMFS and those data are treated separately in Section 9.1.6.

SOCAL. This species is addressed in the small beaked whale guild for SOCAL and the eastern portion of the transit corridor.

MITT. During marine mammal monitoring for Valiant Shield 07, a single Cuvier's beaked whale was observed about 65 nm south of Guam at the edge of the Mariana Trench (Mobley 2007). This species was also heard and positively sighted near Pagan, in the Commonwealth of the Northern Mariana

Islands, during a 2013 marine mammal survey of the coastal waters of that island (U.S. Department of the Navy 2014). One ziphiid whale was observed in deep water during the Navy's 2007 survey of the Study Area, but was not identified to the species level (Fulling et al. 2011). In the absence of study area specific density data, and consistent with recommendations from scientists at PIFSC, line-transect estimates derived for Hawaiian waters (Barlow 2006) were used to represent the best available estimates for the MITT Study Area. Density estimates from LGL Limited (2011; see Section 3.3) were used for the MITT transit corridor. These data sources were used to characterize annual Cuvier's beaked whale density.

NWTT Offshore. This species is addressed in the small beaked whale guild for the Offshore portion of the NWTT Study Area (Section 9.1.6).

NWTT Inland Waters. This species is not expected to occur in the Inland Waters portion of the NWTT Study Area.

NWTT Western Behm Canal, Alaska. For the Western Behm Canal, year-round density estimates were taken from the Marine Mammal Occurrence/Density Report prepared in support of a NEPA document for Navy activities at SEAFAC (U.S. Department of the Navy 2010b). However, extensive surveys of nearly all of the inshore waters of Southeast Alaska from 1991-2012 did not produce any sightings of Cuvier's beaked whales. This strongly suggests that the species does not occur in Western Behm Canal and estimates for this Study Area may be revised in future versions of the NMSDD.

GOA. There was only one sighting of a single Cuvier's beaked whale during the Navy's 2013 survey of the Study Area, and this single visual observation precluded the derivation of a line-transect density estimate (Rone et al. 2014). Based on sighting data from Waite (2003), the Department of the Navy (2009) derived a year-round density estimate for Cuvier's beaked whale of 0.0022 animals/km^2.

Table 9-11: Sources of Density Values Used for Cuvier's Beaked Whale

Location	Spring	Summer	Fall	Winter
HRC	L	L	L	L
W. Transit Corridor	L	L	L	L
E. Transit Corridor	G	G	G	G
SOCAL	G	G	G	G
MITT	LD	LD	LD	LD
MITT Transit Corridor	LD	LD	LD	LD
NWTT Offshore	G	G	G	G
NWTT Inland Waters	0	0	0	0
Western Behm Canal	LD	LD	LD	LD
GOA	LD	LD	LD	LD

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3. G = this species is part of the small beaked whale guild in SOCAL and NWTT Offshore.

Table 9-9: Summary of Density Values for Cuvier's Beaked Whale in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0.00621	0.00621	0.00621	0.00621
W. Transit Corridor	0.00621	0.00621	0.00621	0.00621
E. Transit Corridor	G	G	G	G
SOCAL	G	G	G	G
Inner Baja Extension	G	G	G	G
Outer Baja Extension	G	G	G	G
MITT	0.00621	0.00621	0.00621	0.00621
MITT Transit Corridor	0.00374	0.00374	0.00374	0.00374
NWTT Offshore	G	G	G	G
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0.0022	0.0022	0.0022	0.0022
GOA	0.0022	0.0022	0.0022	0.0022

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range; G = this species is part of the small beaked whale guild in SOCAL and NWTT Offshore.

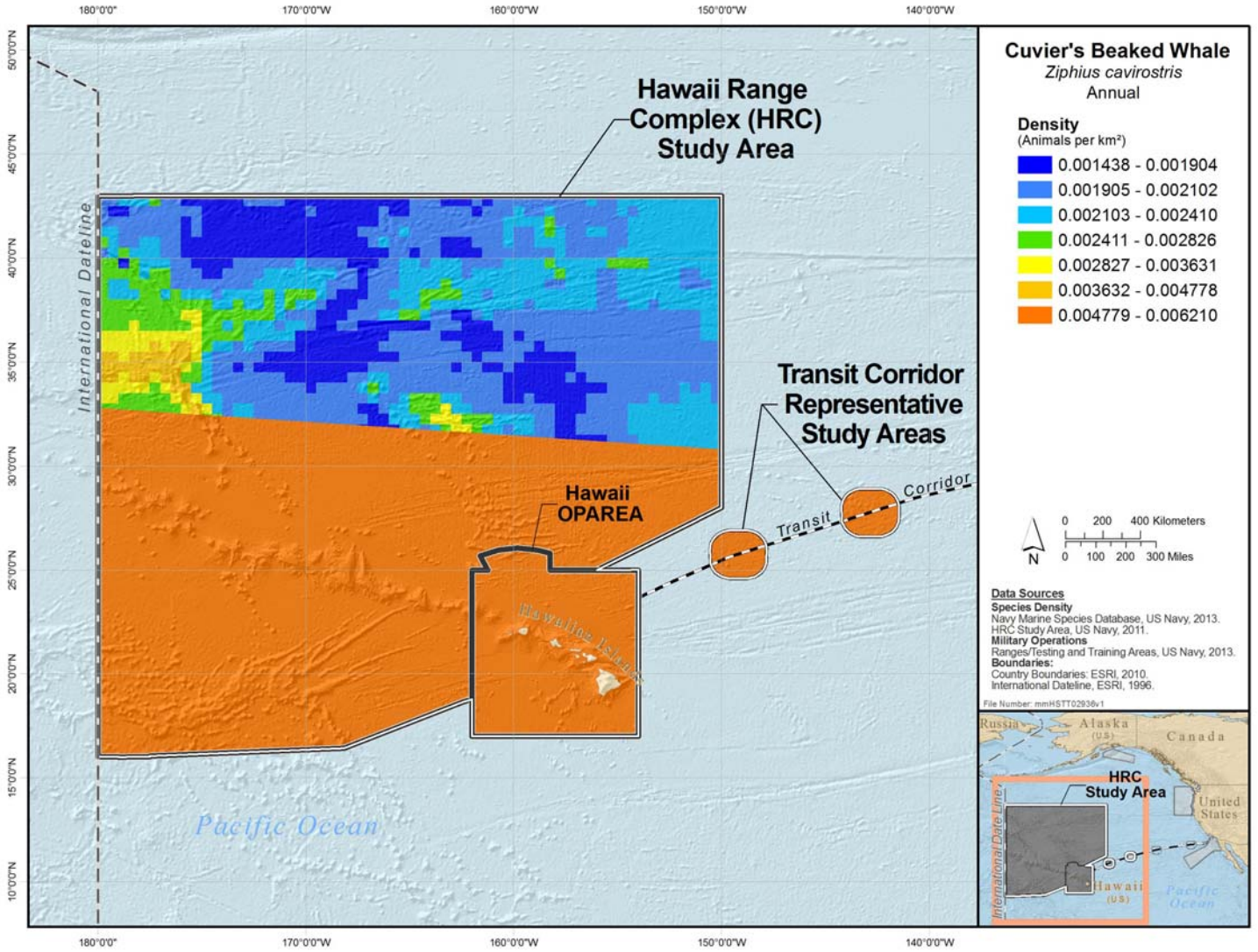

Figure 9-14: Annual Distribution of Cuvier's Beaked Whale in HRC and the Western Portion of the Transit Corridor

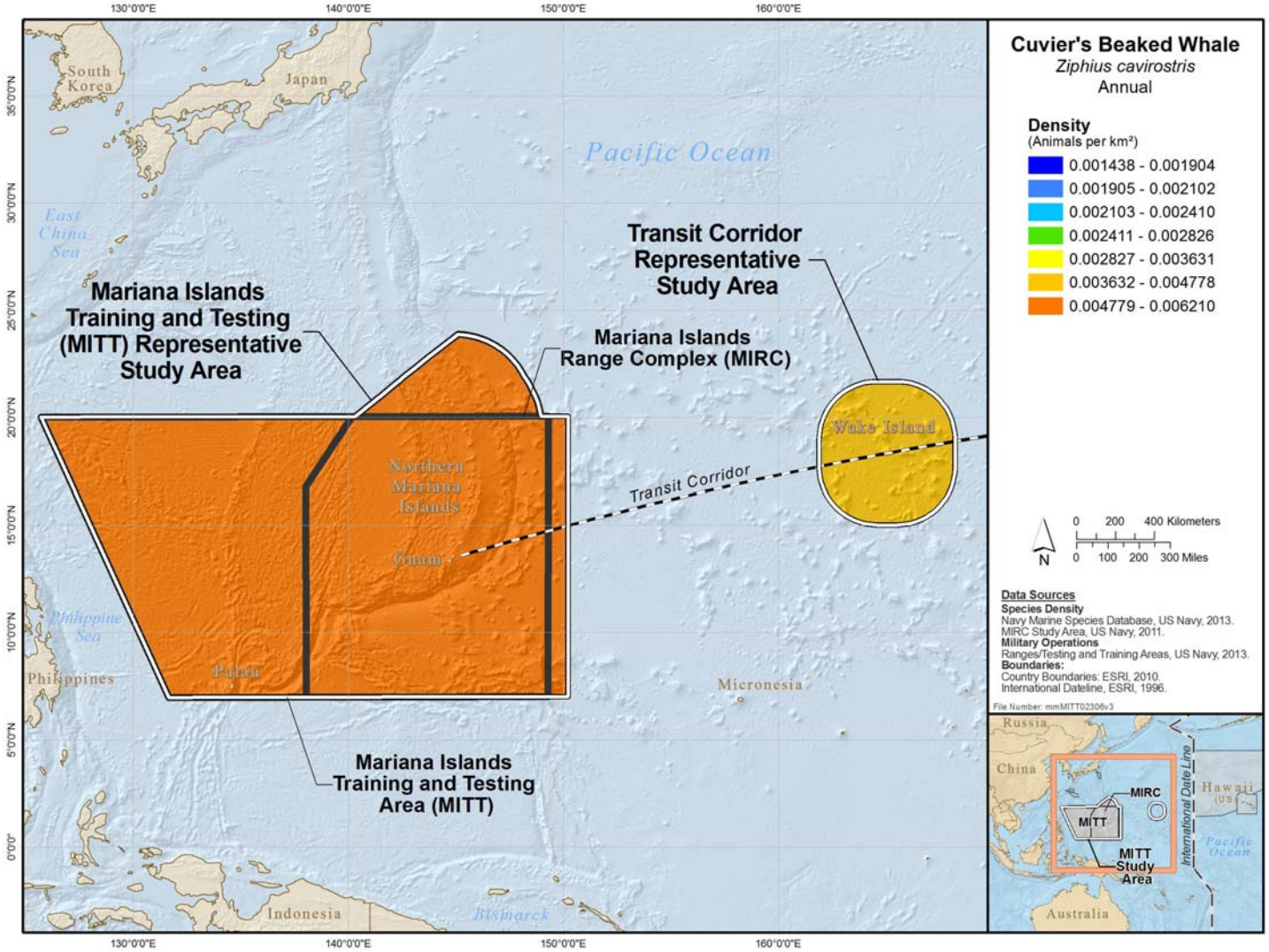

Figure 9-15: Annual Distribution of Cuvier's Beaked Whale in MITT and the Associated Transit Corridor Study Areas

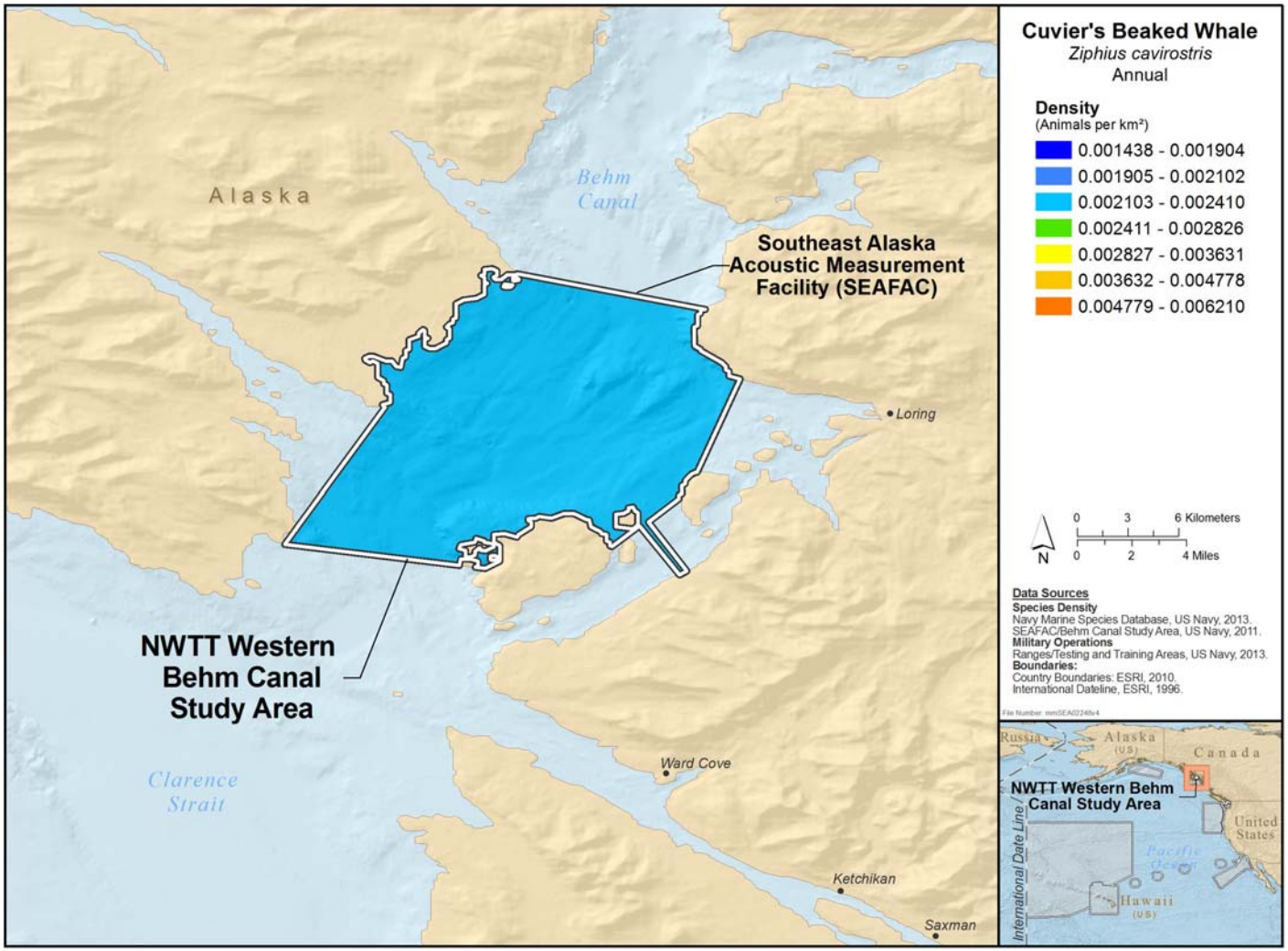

Figure 9-16: Annual Distribution of Cuvier's Beaked Whale in the Western Behm Canal Portion of the NWTT Study Area

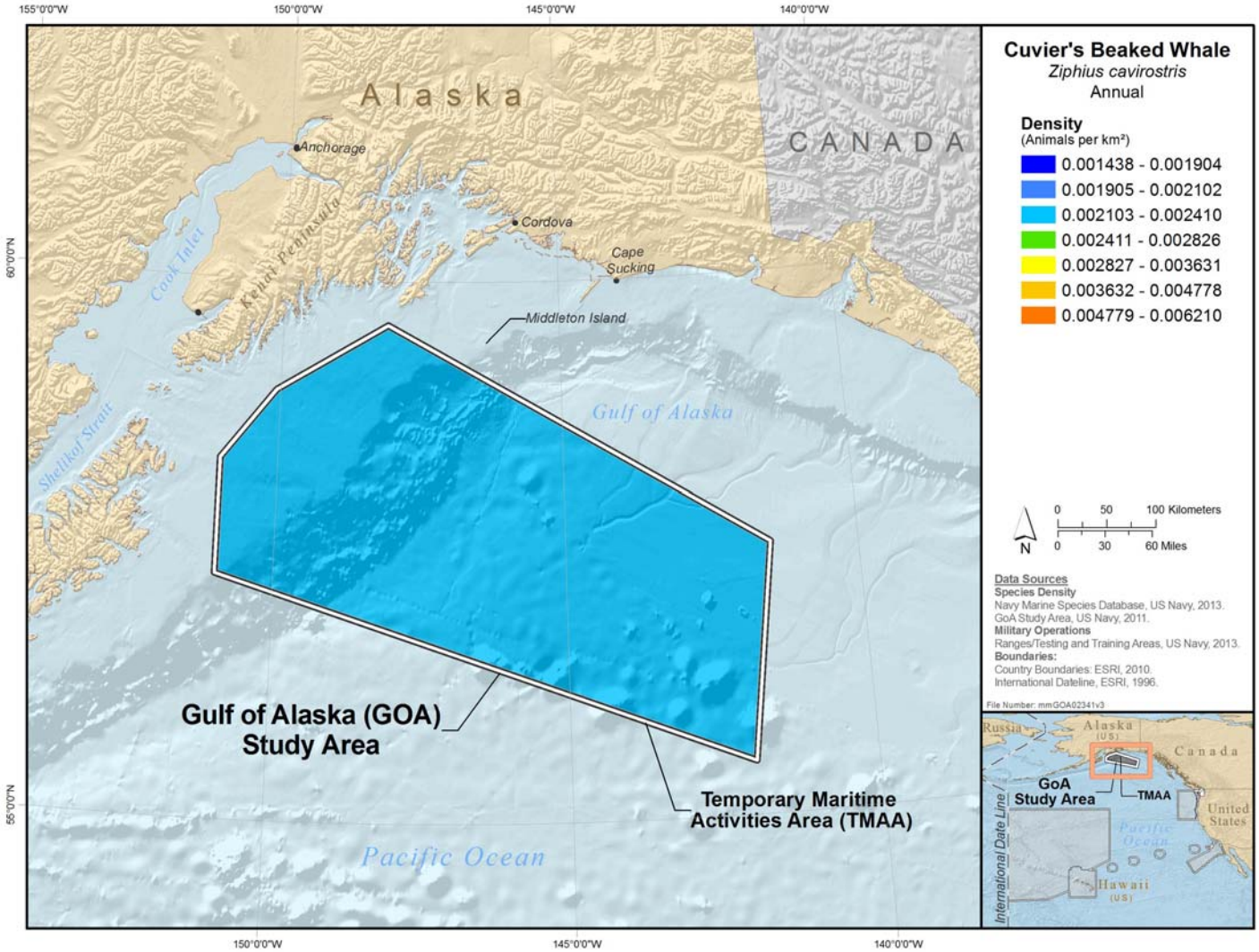

Figure 9-17: Annual Distribution of Cuvier's Beaked Whale in the GOA Study Area

9.1.7 SMALL BEAKED WHALE GUILD

To increase sample sizes for modeling, NMFS developed a habitat-based density model for a small beaked whale guild in the California Current Ecosystem (Becker et al. 2012c). The small beaked whale guild included Cuvier's beaked whale and beaked whales of the genus *Mesoplodon,* as well as unidentified small beaked whales. It is assumed that this model is representative of the group of seven beaked whales known to occur in the California Current Ecosystem: Hubb's beaked whale (*Mesoplodon carlhubbsi*), Blainville's beaked whale, ginkgo-toothed beaked whale, Perrin's beaked whale (*Mesoplodon perrini*), pygmy beaked whale (aka Peruvian, *Mesoplodon peruvianus*), Stejneger's beaked whale, and Cuvier's beaked whale. Most of these species are rarely seen and difficult to identify.

HRC. Of the seven species in the small beaked whale guild, Blainville's and Cuvier's beaked whale occur in the HRC and are addressed as individual species in their respective sections. The other five beaked whale species are not expected to occur in the HRC or the western portion of the transit corridor (Hamilton et al. 2009).

SOCAL. NMFS has defined a CCE model for the small beaked whale guild (Becker et al. 2012c). The Navy applied this model to all seasons. A uniform density estimate of 0.00041 whales/km^2 for the inner Baja extension and the eastern portion of the transit corridor is used from Barlow and Forney (2007) for all four seasons. There is no surrounding global RES model (Kaschner et al. 2006; SMRU Ltd. *in prep*) in the SOCAL figure, because the small beaked whale guild is a unique grouping used by NMFS. Densities presented for SOCAL and the eastern portion of the transit corridor are for the guild collectively.

In the Southern California Bight, data for the small beaked whale guild are arranged so that values are zero within 3 nm of the mainland. Non-zero density values extend to the shoreline of islands of the California and Baja coast.

MITT. Of the seven species in the small beaked whale guild, Blainville's, ginkgo-toothed, and Cuvier's beaked whale may occur in the MITT Study Area and are addressed as individual species in their respective sections.

NWTT Offshore. As noted above for SOCAL, NMFS developed a CCE habitat-based density model for a small beaked whale guild, which provides spatially-explicit density estimates off the U.S. west coast for summer and fall (Becker et al. 2012c). Barlow and Forney (2007) also provided stratified uniform density estimates for small beaked whales for California, Oregon, and Washington in summer/fall. Density data are not available for the area north of the SWFSC strata (refer to Figure 3-6), so data from the SWFSC Oregon/Washington stratum were used as representative estimates. Since there are no known seasonal abundance patterns of small beaked whales in the Study Area, these estimates were used to characterize density year-round.

NWTT Inland Waters. Species included in the small beaked whale guild are not expected to occur in the Inland Waters portion of the NWTT Study Area.

NWTT Western Behm Canal, Alaska. No beaked whale species are expected in the inshore waters of Southeast Alaska, of which Western Behm Canal is a part – see above for individual species descriptions.

GOA. Of the seven species in the small beaked whale guild, it is considered that only Baird's, Stejneger's, and Cuvier's beaked whales occur in the GOA Study Area and these are all addressed as individual species in their respective sections.

Table 9-13: Sources of Density Values Used for the Small Beaked Whale Guild

Location	Spring	Summer	Fall	Winter
HRC	***	***	***	***
W. Transit Corridor	***	***	***	***
E. Transit Corridor	L	L	L	L
SOCAL	CCE/L	CCE/L	CCE/L	CCE/L
MITT	***	***	***	***
MITT Transit Corridor	***	***	***	***
NWTT Offshore	CCE/LD	CCE/LD	CCE/LD	CCE/LD
NWTT Inland Waters	0	0	0	0
Western Behm Canal	***	***	***	***
GOA	***	***	***	***

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS; *** = a small beaked whale guild is not used to define densities for this area/season. For a complete description of data sets refer to Section 3.

Table 9-10: Summary of Density Values for the Small Beaked Whale Guild in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	***	***	***	***
W. Transit Corridor	***	***	***	***
E. Transit Corridor	0.00041	0.00041	0.00041	0.00041
SOCAL	S	S	S	S
Inner Baja Extension	0.00041	0.00041	0.00041	0.00041
Outer Baja Extension	0.00041	0.00041	0.00041	0.00041
MITT	***	***	***	***
MITT Transit Corridor	***	***	***	***
NWTT Offshore	S and 0.00135	S and 0.00135	S and 0.00135	S and 0.00135
NWTT Inland Waters	0	0	0	0
Western Behm Canal	***	***	***	***
GOA	***	***	***	***

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range; *** = a small beaked whale guild is not used to define densities for this area/season.

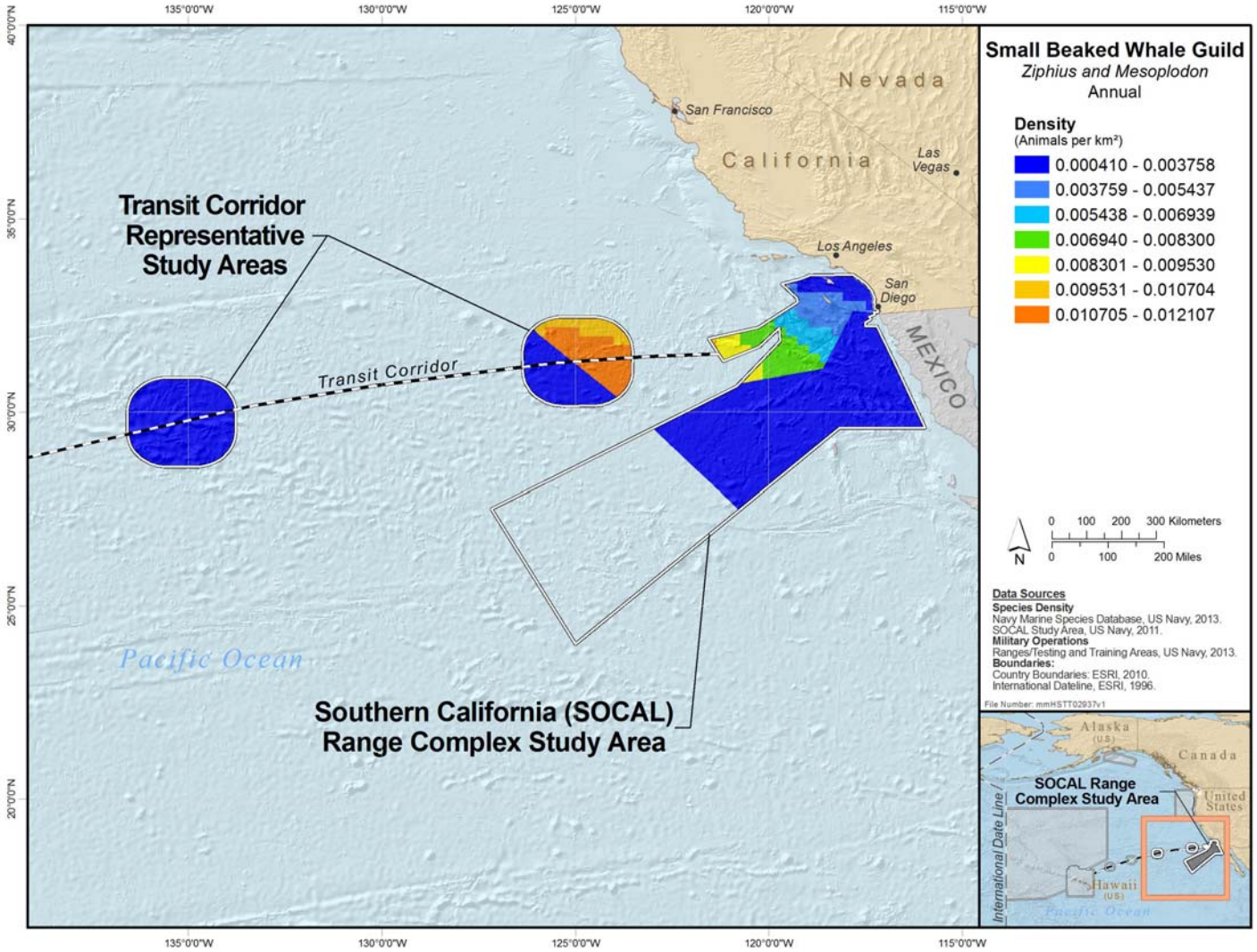

Figure 9-18: Annual Distribution of the Small Beaked Whale Guild in SOCAL and the Eastern Portion of the Transit Corridor

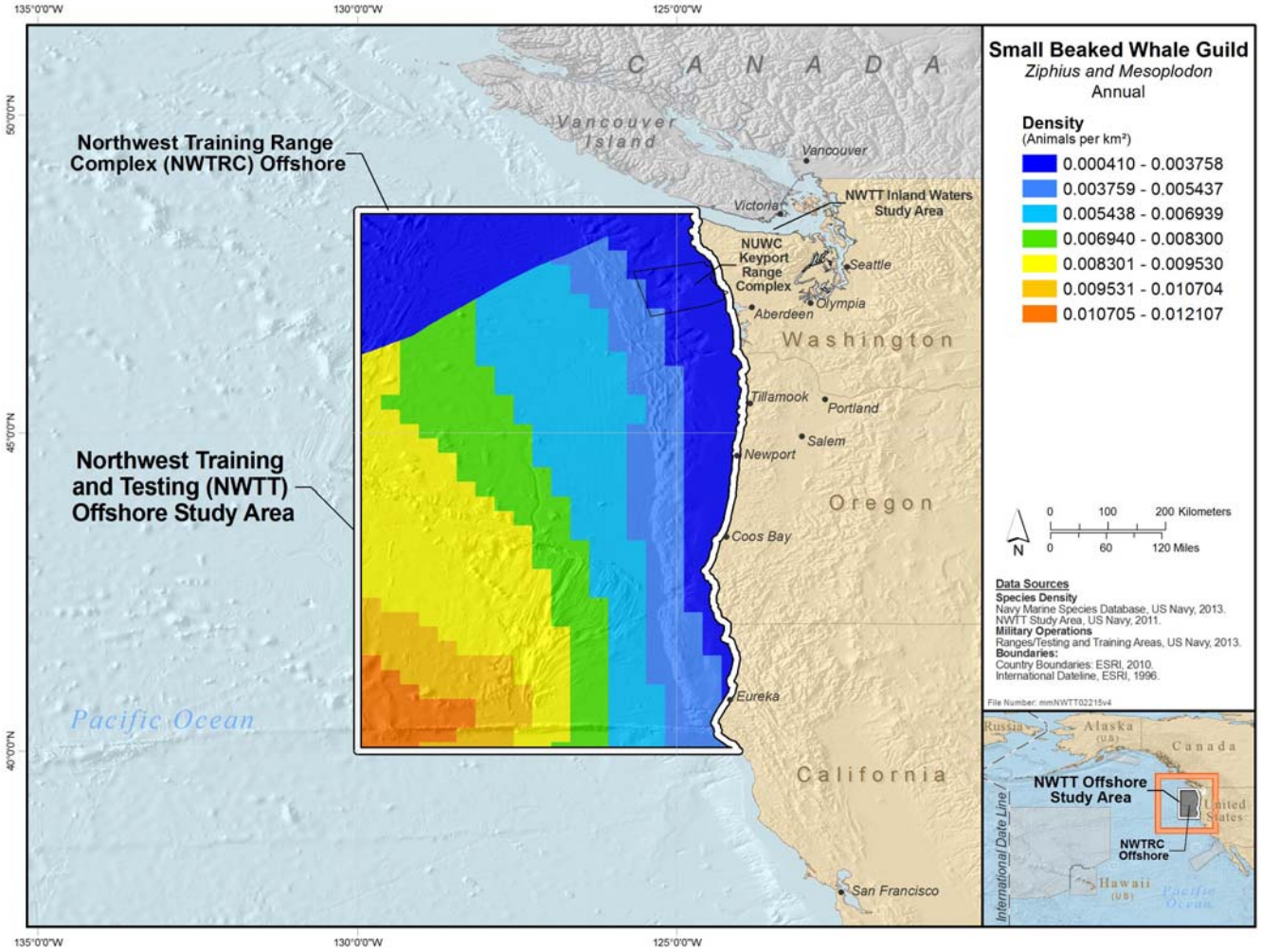

Figure 9-19: Annual Distribution of the Small Beaked Whale Guild in the Offshore Portion of the NWTT Study Area

10 MONODONTIDS (NARWAL AND BELUGA)

This family includes only two species in two genera, the narwhal (*Monodon monoceros*) and the beluga or white whale (*Delphinapterus leucas*). "Monodontid" means "one tooth" and was clearly named after the narwal's long, single tusk. Both species are small (<6 m long) stocky whales that have no dorsal fins and flippers that are broad and rounded (Jefferson et al. 2008). These species occur in arctic and subarctic regions of the Northern Hemisphere and are not expected to occur within any of the Navy's Study Areas in the Pacific. However, based on their occurrence in the Cook Inlet, beluga whales could possibly have extralimital occurrence in the GOA Study Area.

There were 28 reported sightings of beluga whales in the GOA region from 1936 to 2000; however, all of these sightings were in the Cook Inlet or in very nearshore locations outside of the Study Area (Goetz et al. 2012, Laidre et al. 2000). The Cook Inlet stock of beluga whales was listed as Endangered under the ESA on 22 October 2008 and was designated as Depleted under the MMPA. Rugh et al. (2010) found evidence that the Cook Inlet stock has exhibited range contraction towards the northeast, and that sightings in the southern inlet, closest to the Gulf of Alaska, have decreased. Critical habitat was designated for the Cook Inlet stock effective 11 April 2011 (National Oceanic and Atmospheric Administration 2011a), but the areas designated are far from the GOA Study Area. Based on this information and the regulatory definition of the stock as those beluga whales confined to the waters of Cook Inlet (National Oceanic and Atmospheric Administration 2007, 2008), this stock of beluga whales is not expected to be present in the GOA Study Area. Due to the paucity of beluga whale sightings in the Gulf of Alaska (Laidre et al. 2000), the occurrence of this species within the GOA Study Area is considered extralimital (see also Goetz et al. 2012; Rugh et al. 2010). However, to acknowledge the potential presence of a beluga whale in the GOA Study Area, a minimum density estimate of 0.00001 animals/km^2 was assigned.

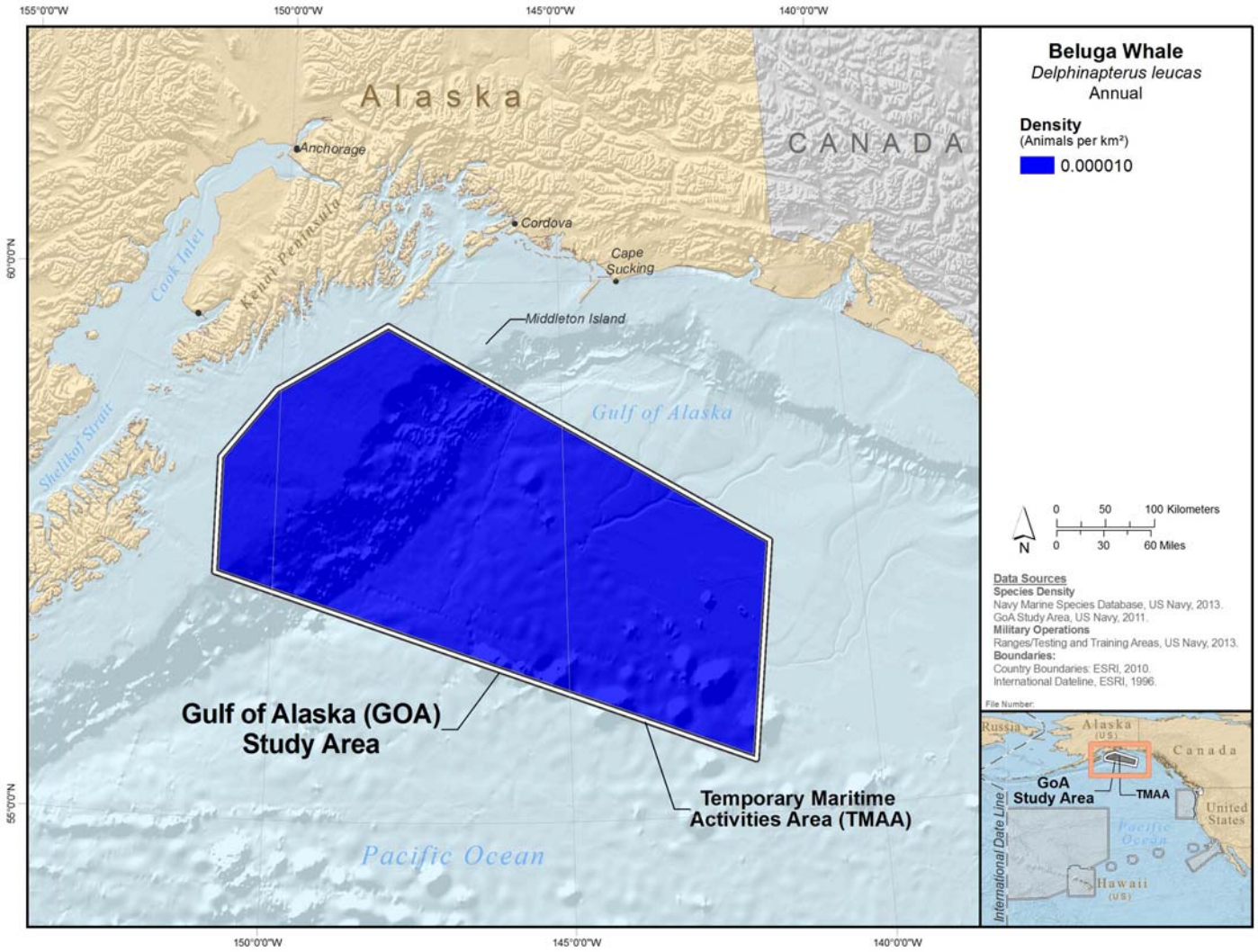

Figure 10-1: Annual Distribution of Beluga Whale in the GOA Study Area

11 PINNIPEDS (SEALS AND SEA LIONS)

11.1 PINNIPED SPECIES PROFILES

Pinnipeds present a special challenge within the Navy's marine mammal density data set. Many studies assess pinniped numbers by counting individuals at haulouts or number of pups weaned at rookeries (e.g., Harvey et al. 1990; Jeffries et al. 2003; Lowry 2002; Sepulveda et al. 2009). Translating these numbers to in-water densities is difficult. For this reason, some of the values used in the current data set are retained from the TAP Phase 1 data set, because they represent the current best estimate, even though they are at least five years old. The transit corridor is a new feature in the TAP Phase 2 EIS and pinniped values for the open ocean are virtually non-existent; therefore, density values for the transit corridor, if used, are preliminary. Only one species, the Hawaiian monk seal (*Monachus schauinslandi*), occurs in Hawaii. No pinniped species are known to occur in the MITT Study Area, while as many as six pinniped species occur within the SOCAL and NWTT Offshore Study Areas.

11.1.1 *ARCTOCEPHALUS TOWNSENDI*, GUADALUPE FUR SEAL

Guadalupe fur seals (*Arctocephalus townsendi*) were once plentiful on the California coast, ranging from Gulf of the Farallones near San Francisco, to the Revillagigedo Islands, Mexico (Aurioles-Gamboa et al. 1999), but they were over-harvested in the 19th century to near extinction. After being protected, the population grew slowly and mature individuals of the species were observed occasionally in the California Bight starting in the 1960s (Stewart et al. 1993), and in 1997 a female and pup were observed on San Miguel Island (Melin and DeLong 1999). Since then, a small group has persisted in that area (Aurioles-Gamboa et al. 2010). Guadalupe fur seals could potentially be confused with the other two otariids that occur in the Southern California Bight: the California sea lion and the northern fur seal (*Callorhinus ursinus*). The Guadalupe fur seal most often rests in a different position at sea, is typically darker in color, and the shape of the muzzle is longer and more pointed than that of the California sea lion (Jefferson et al. 2008). Northern fur seals and Guadalupe fur seals are both dark and have similar facial structures. Closer viewing of the subtleties of the shape of the nose and hair on the foreflippers is needed to tell the species apart (Jefferson et al. 2008). NMFS recognizes a single stock of Guadalupe fur seal, all of which is derived from the remnant population that remained on Guadalupe Island off the coast of central Baja, Mexico (Carretta et al. 2011a). The population has been growing, but the species is still listed as Threatened under the ESA. The stock assessment for this species was last updated in 2000. Density values for Guadalupe fur seals in SOCAL are presented for the species as a whole.

HRC. This species is not expected to occur in the HRC or in the transit corridor.

SOCAL. Density values for the Guadalupe fur seal are the same as those used for the 2008 SOCAL EIS. To determine the density of Guadalupe fur seals in the southern California area, the entire population size was divided by the area of the SOCAL range complex. The SOCAL Range Complex extends to just north of Isla Guadalupe, so a majority of the range of the Guadalupe fur seal is in the SOCAL range complex. Including the entire population in the density estimation is a conservative approach for the purposes of calculating the likelihood of exposure to sound. Summer/fall and winter/spring densities were derived from Gallo-Reynoso (1994). Guadalupe fur seal densities were averaged to warm and cold water seasons

by summing monthly densities and dividing by six months. Warm season is defined slightly differently than for other species in the density database; the cool water season is defined as September–May, and the warm water season is defined as June–August. Density values for the Baja Extension are covered by the Kaschner et al. (2006) global RES model. Note that the conservative approach toward Guadalupe fur seals gives higher densities in SOCAL than projected by the global RES model. The species is not expected in the eastern portion of the transit corridor.

MITT. This species is not expected to occur in the MITT or associated transit corridor study areas.

NWTT Offshore. As described above, the majority of the stock occurs south of the NWTT Study Area. Recently there have been annual strandings in Oregon and Washington, and Guadalupe fur seals are therefore considered "seasonal migrants" within the offshore portion of the Study Area. Given their sporadic occurrence and low numbers, however, there are not enough data to determine densities in this region.

NWTT Inland Waters. This species is not expected to occur in the inland waters portion of the NWTT Study Area.

NWTT Western Behm Canal, Alaska. This species is not expected to occur in the Western Behm Canal portion of the NWTT Study Area.

GOA. This species is not expected to occur in the GOA Study Area.

Table 11-1: Sources of Density Values Used for Guadalupe Fur Seal

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	LD/K	LD/K	LD/K	LD/K
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets, refer to Section 3.

Table 11-2: Summary of Density Values for Guadalupe Fur Seal in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0.004	0.007	0.007	0.004
Inner Baja Extension	S	S	S	S
Outer Baja Extension	S	S	S	S
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

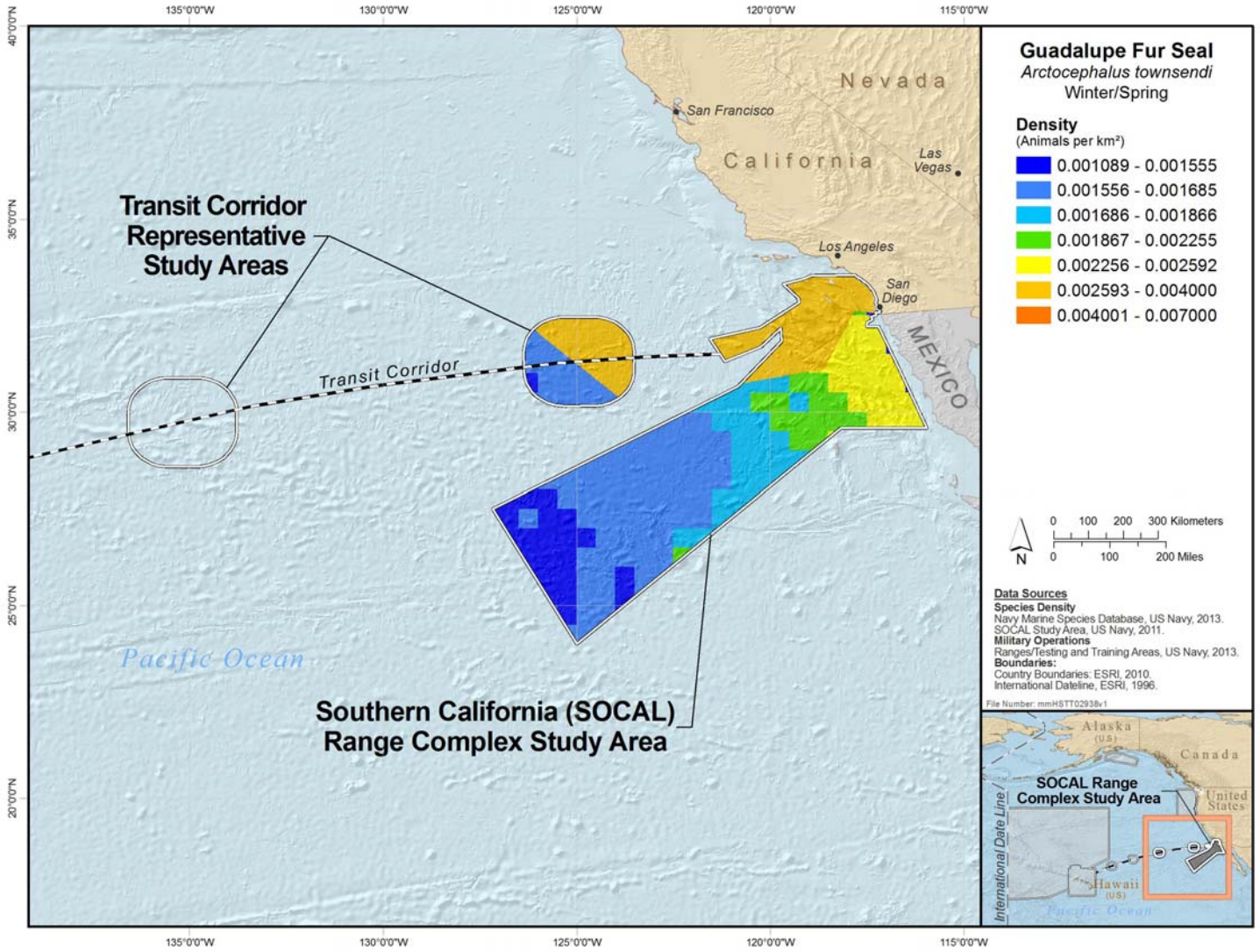

Figure 11-1: Winter/Spring Distribution of Guadalupe Fur Seal in SOCAL and the Eastern Portion of the Transit Corridor

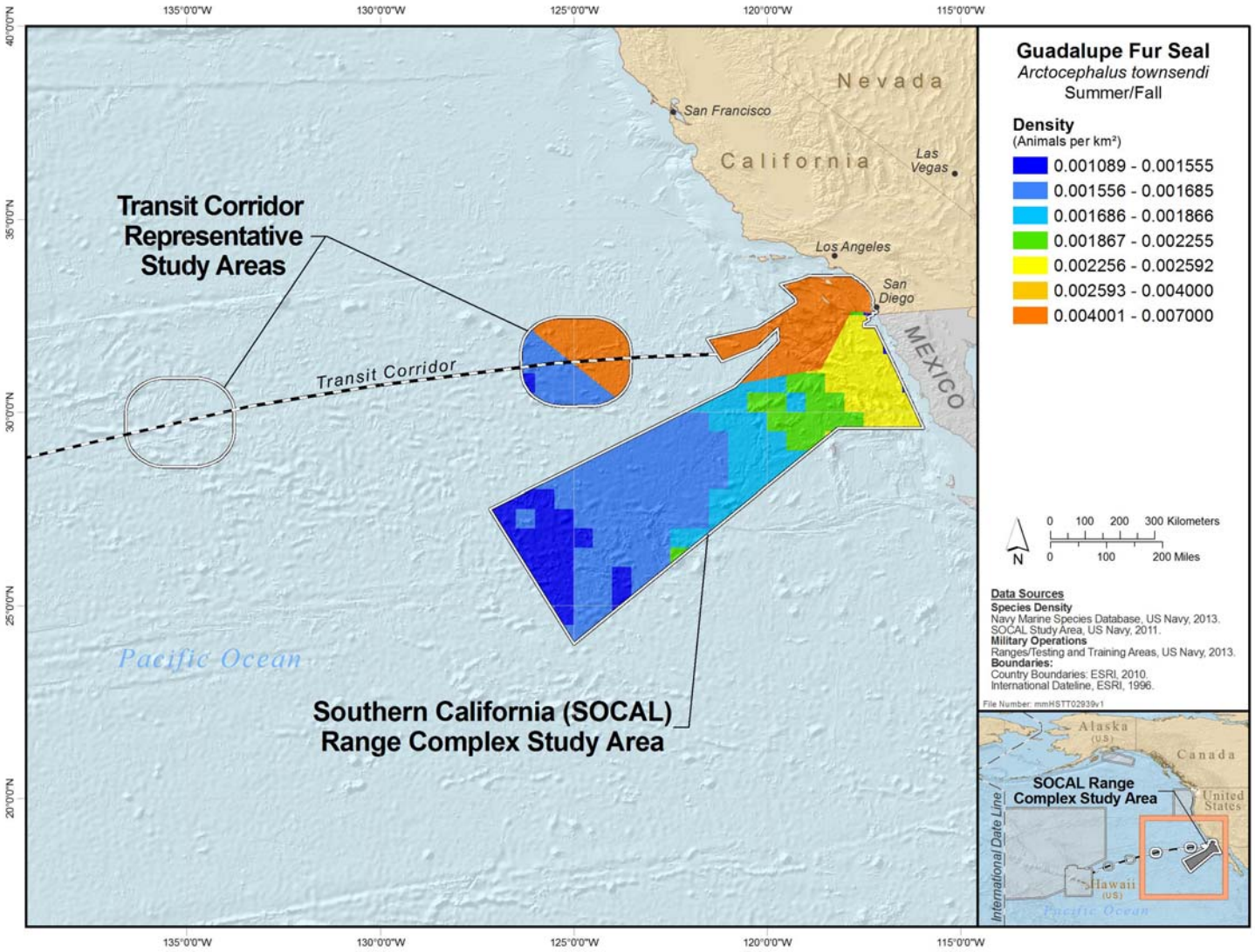

Figure 11-2: Summer Distribution of Guadalupe Fur Seal in SOCAL and the Eastern Portion of the Transit Corridor

11.1.2 *CALLORHINUS URSINUS*, NORTHERN FUR SEAL

The northern fur seal is another pinniped that was heavily harvested at various times in its history, although management was more carefully executed over time than for most other marine mammal species (Gentry 2009; Roppel 1984). The population is comprised of two main stocks recognized by NMFS (Carretta et al. 2011a). The majority of the world's population of northern fur seals uses rookeries on the Pribilof Islands in the southern Bering Sea (Call et al. 2008; Towell et al. 2006; Zeppelin and Ream 2006). This stock is recognized as the Eastern Pacific Stock by NMFS (Carretta et al. 2011a), and is in decline (Towell et al. 2006). A small breeding population of northern fur seals established on San Miguel Island in the Channel Islands of California was discovered in the 1960s (Stewart et al. 1993). The population has been growing in size, although it has experienced strong fluctuations associated with events like El Niño (Melin et al. 2008). The population of northern fur seals in California is called the San Miguel Island Stock by NMFS (Carretta et al. 2011a). Density values are presented for the San Miguel Island Stock.

The northern fur seal is one of three species (the other two are the Guadalupe fur seal and the California sea lion that can be mistaken for each other when seen at sea in the Southern California Bight. The California sea lion is most different from the northern fur seal in appearance, because the northern fur seal is usually darker than the California sea lion and its nose is short and pointed, while the California sea lion's snout is longer and dog-like (Jefferson et al. 2008). Northern fur seals and Guadalupe fur seals are more difficult to tell apart because they are both dark, have similar facial structures, and exhibit similar resting behavior at the surface of the water (Jefferson et al. 2008).

HRC. This species is not expected to occur in the HRC or in the western portion of the transit corridor.

SOCAL. To arrive at density values for the SOCAL range complex, the Navy used NMFS' San Miguel Island Stock population estimate of 9,968 northern fur seals (Carretta et al. 2011a) and a highly conservative assumption that most of that population would remain in the Southern California strata defined by NMFS (area of 318,541 km^2) (Barlow 2010). Seasonal estimates of the percentage of northern fur seals potentially at-sea during warm (15%) and cold season (50%) were derived from published literature (Antonelis et al. 1981; Ream et al. 2005; Roppel 1984). Summer/fall and winter/spring density estimates were calculated by taking the population estimate multiplied by the percentage of the population at sea for each season and dividing by the area of the NMFS Southern California strata (e.g., summer/fall: [9,968 x 15%]/318,541 = 0.00469 fur seals/km^2). There is some degree of presence of northern fur seals in the eastern portion of the transit corridor. To represent fur seal densities in that location and in the Baja Extension, the Kaschner et al. (2006) global RES model estimates were used.

MITT. This species is not expected to occur in the MITT or associated transit corridor study areas.

NWTT Offshore. To estimate the number of fur seals foraging in the eastern North Pacific south of the Aleutian Islands from December to May (post-breeding/pupping season), adult females plus non-breeding immature males and females from the Eastern North Pacific Stock (644,158; NMFS 2007, Allen and Angliss 2011) were added to the entire stock from San Miguel Island (9,968; Carretta et al. 2011a) for a total of 654,126 fur seals. Adult males from the Pribilof Islands were excluded, as they forage in the

Gulf of Alaska. The geographic area of occurrence was estimated at 6,165,000 km^2. Density was then calculated by dividing the total number of animals by the geographic region for an estimate of 0.106 fur seals/km^2 for the period of December–May.

To determine density for the rest of the year (June–October) when only immature non-breeding fur seals would be present (adult breeding seals would be returning to the rookeries), the number of animals was adjusted to remove adult females. The total number of adult females was estimated at 147,641 which, when subtracted from the total determined above (654,126) results in 506,485 fur seals. Density was then calculated by dividing the total number of animals by the geographic region for an estimate of 0.082 fur seals/km^2 for the period of June–November.

NWTT Inland Waters. The northern fur seal is a highly oceanic species. Some individuals, mostly juveniles, make their way into the Strait of Juan de Fuca and Puget Sound each year (Everitt et al. 1979), albeit not in large numbers or with any regularity. Inland waters are an area of rare occurrence for this species and therefore were assigned a zero density estimate in the inshore portion of the NWTT Study Area.

NWTT Western Behm Canal, Alaska. For the Western Behm Canal, density estimates for all seasons were taken from the Marine Mammal Occurrence/Density Report prepared in support of a NEPA document for Navy activities at SEAFAC (U.S. Department of the Navy 2010b).

GOA. During a recent (June and July 2013) Navy-funded line-transect survey in and around the TMAA there were 69 on-effort sightings of 74 individual northern fur seals. The sighting data were collected from four survey strata designed to sample the diverse habitat present in the GOA Study Area, and resulted in the following density estimates for northern fur seal: 0.015 (CV = 0.28) inshore stratum, 0.017 (CV = 0.35) offshore stratum, 0.006 (CV = 0.31) seamount stratum, and 0.004 (CV = 0.39) slope stratum (Rone et al. 2014).

Table 11-3: Sources of Density Values Used for Northern Fur Seal

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	K	K	K	K
SOCAL	LD/K	LD/K	LD/K	LD/K
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	LD	LD	LD	LD
NWTT Inland Waters	0	0	0	0
Western Behm Canal	LD	LD	LD	LD
GOA	L	L	L	L

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 11-4: Summary of Density Values for Northern Fur Seal in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	S	S	S	S
SOCAL	0.01565	0.00469	0.00469	0.01565
Inner Baja Extension	S	S	S	S
Outer Baja Extension	S	S	S	S
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0.10600	0.08200	0.08200	0.10600
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0.1555	0.1180	0.1180	0.1555
GOA	0.004–0.017	0.004–0.017	0.004–0.017	0.004–0.017

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

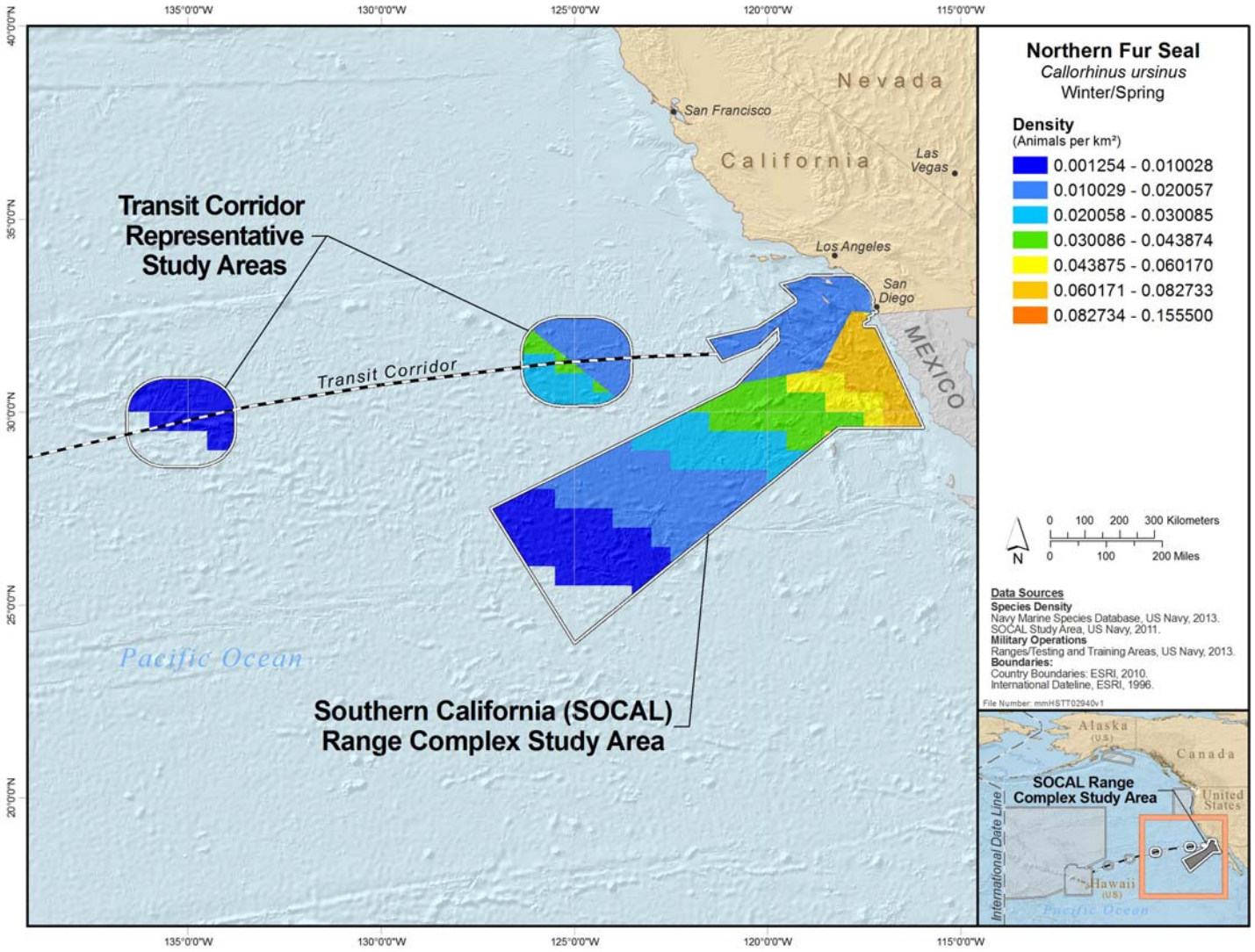

Figure 11-3: Winter/Spring Distribution of Northern Fur Seal in SOCAL and the Eastern Portion of the Transit Corridor

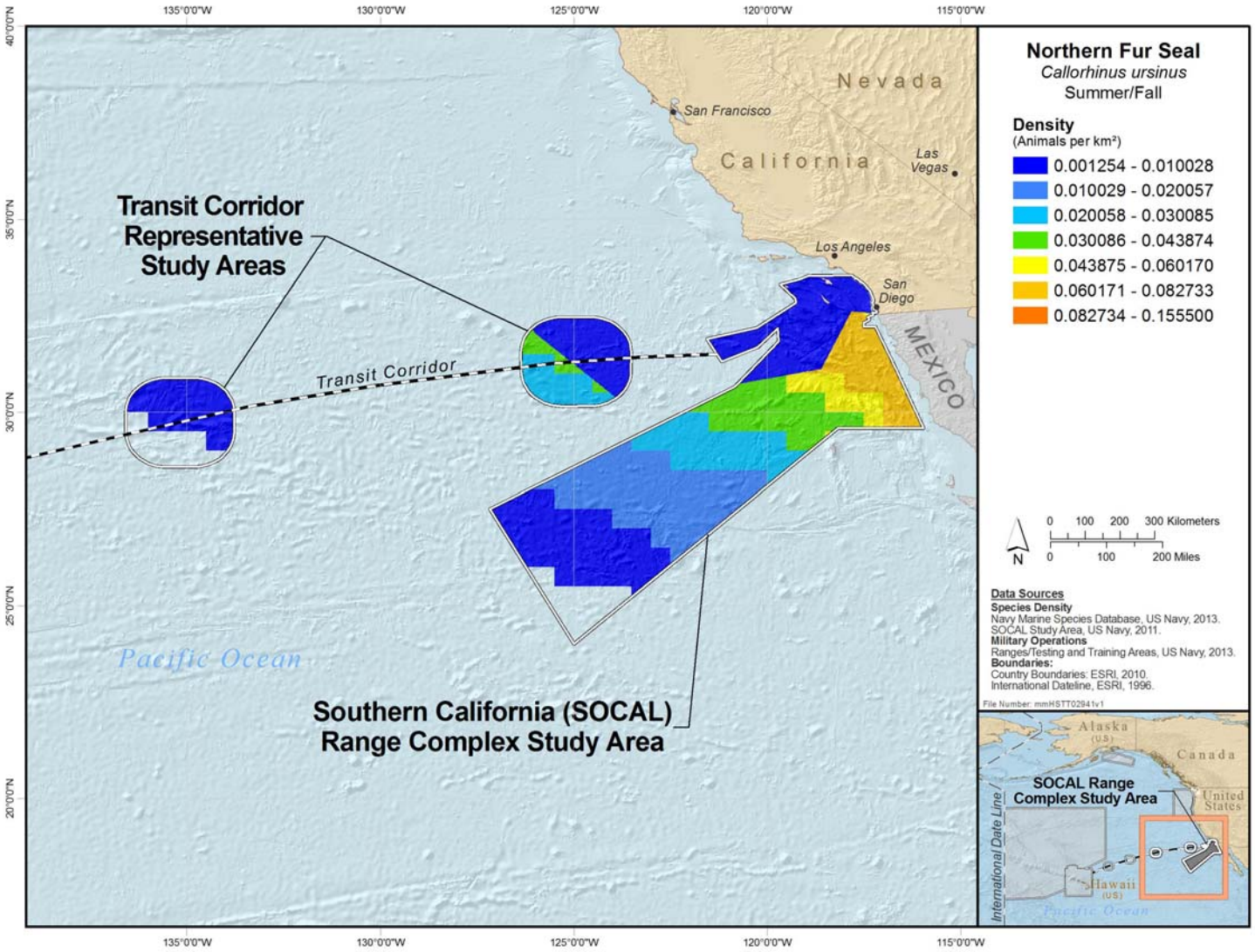

Figure 11-4: Summer/Fall Distribution of Northern Fur Seal in SOCAL and the Eastern Portion of the Transit Corridor

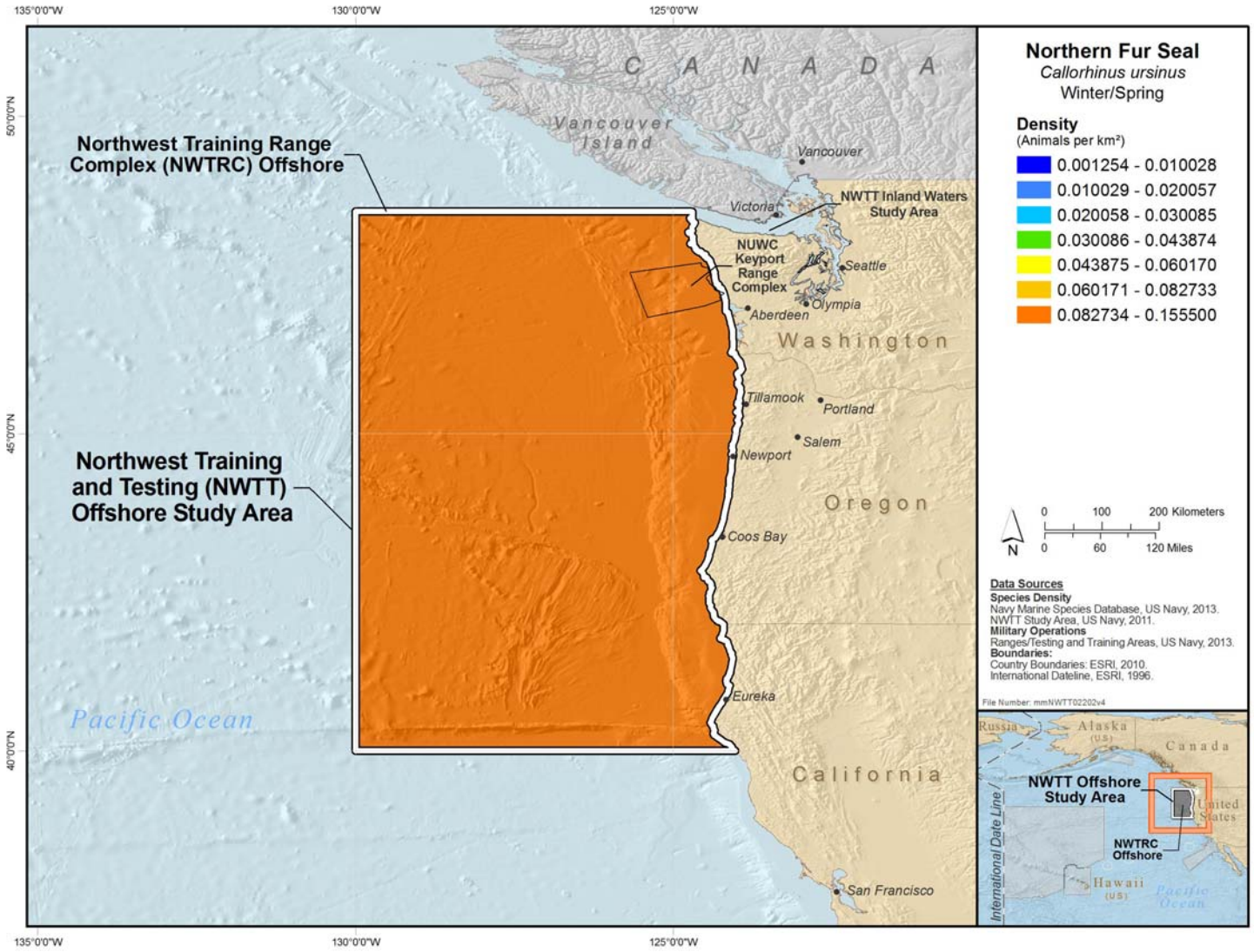

Figure 11-5: Winter/Spring Distribution of Northern Fur Seal in the Offshore Portion of NWTT

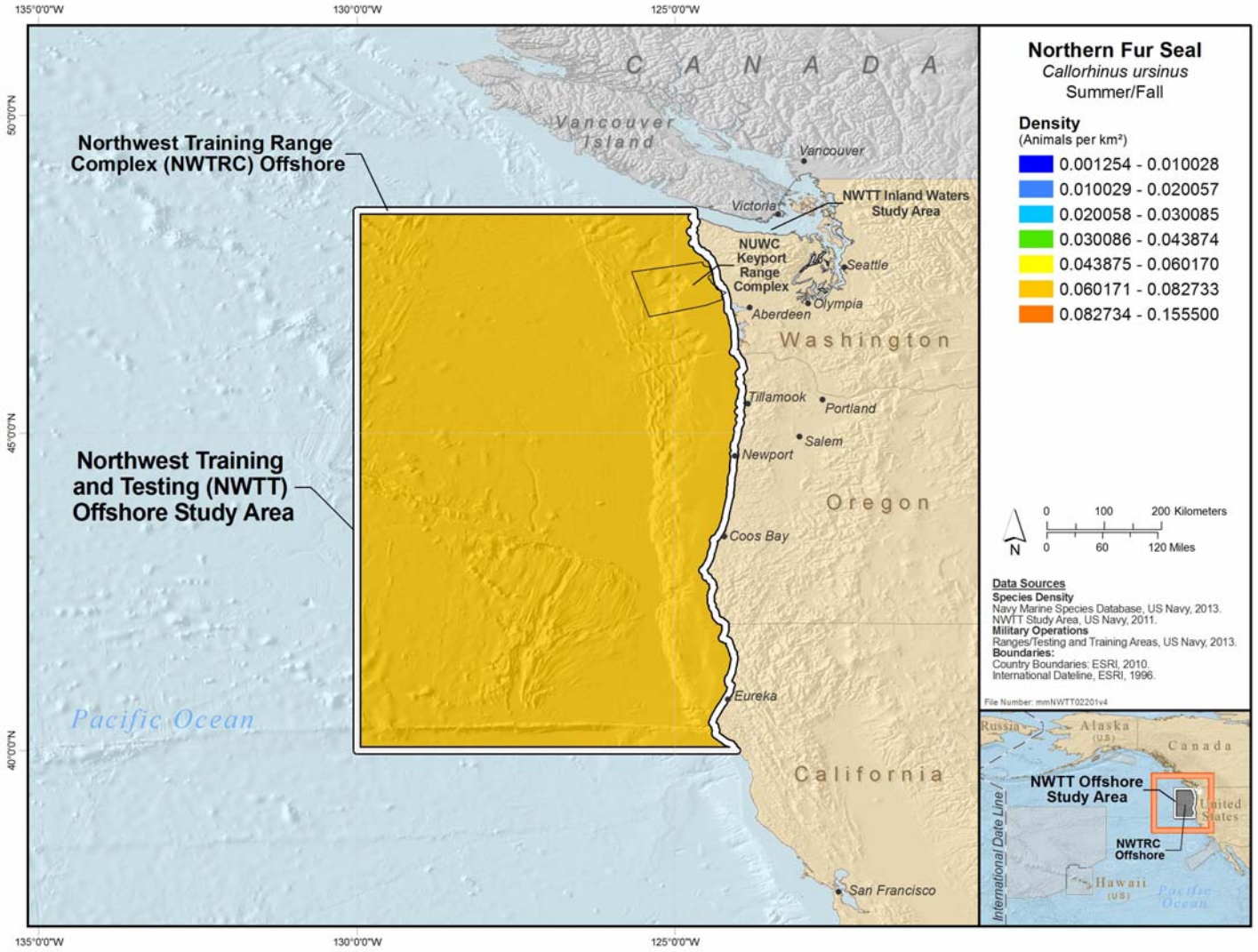

Figure 11-6: Summer/Fall Distribution of Northern Fur Seal in the Offshore Portion of NWTT

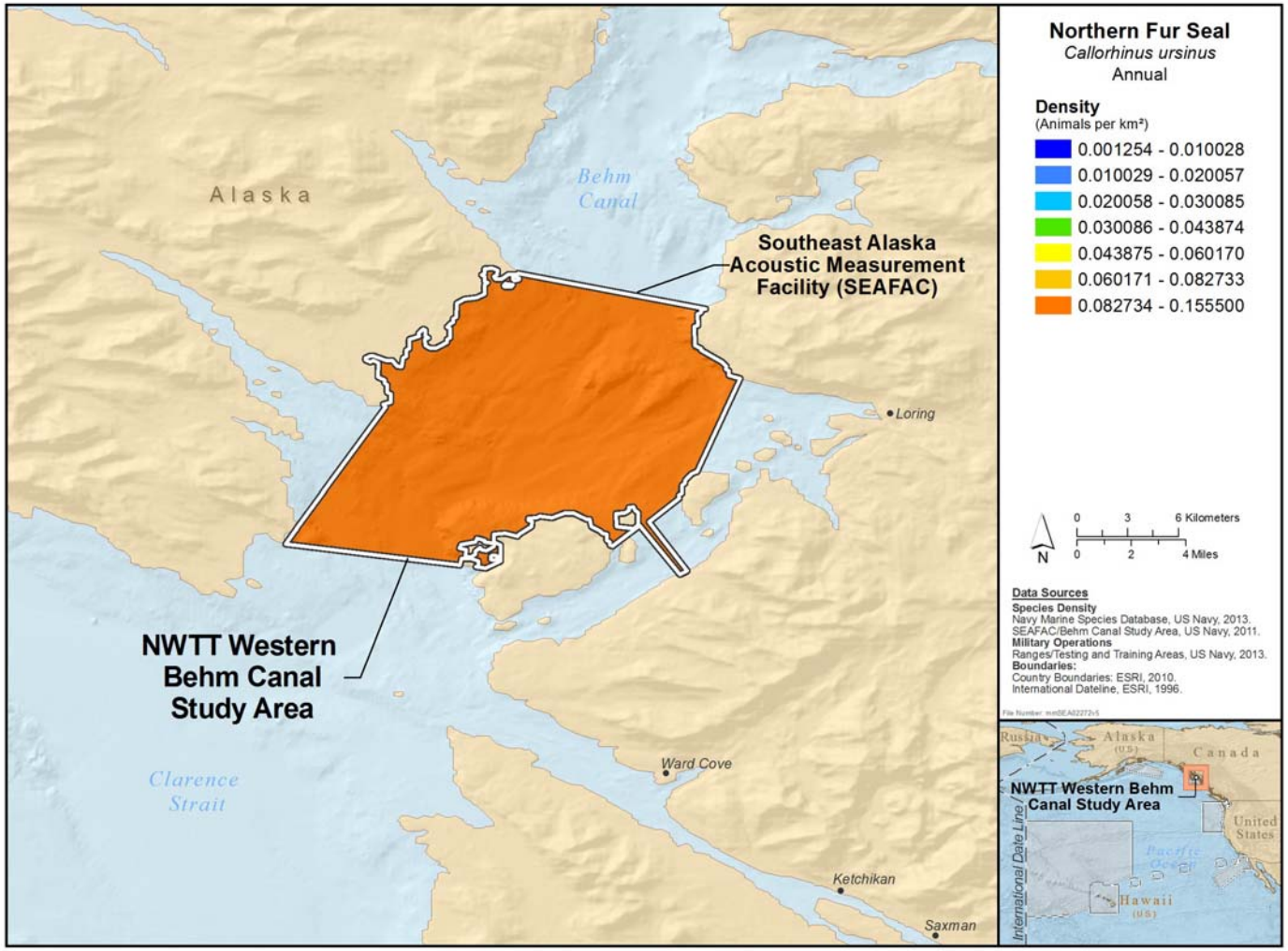

Figure 11-7: Annual Distribution of Northern Fur Seal in the Western Behm Canal Portion of NWTT

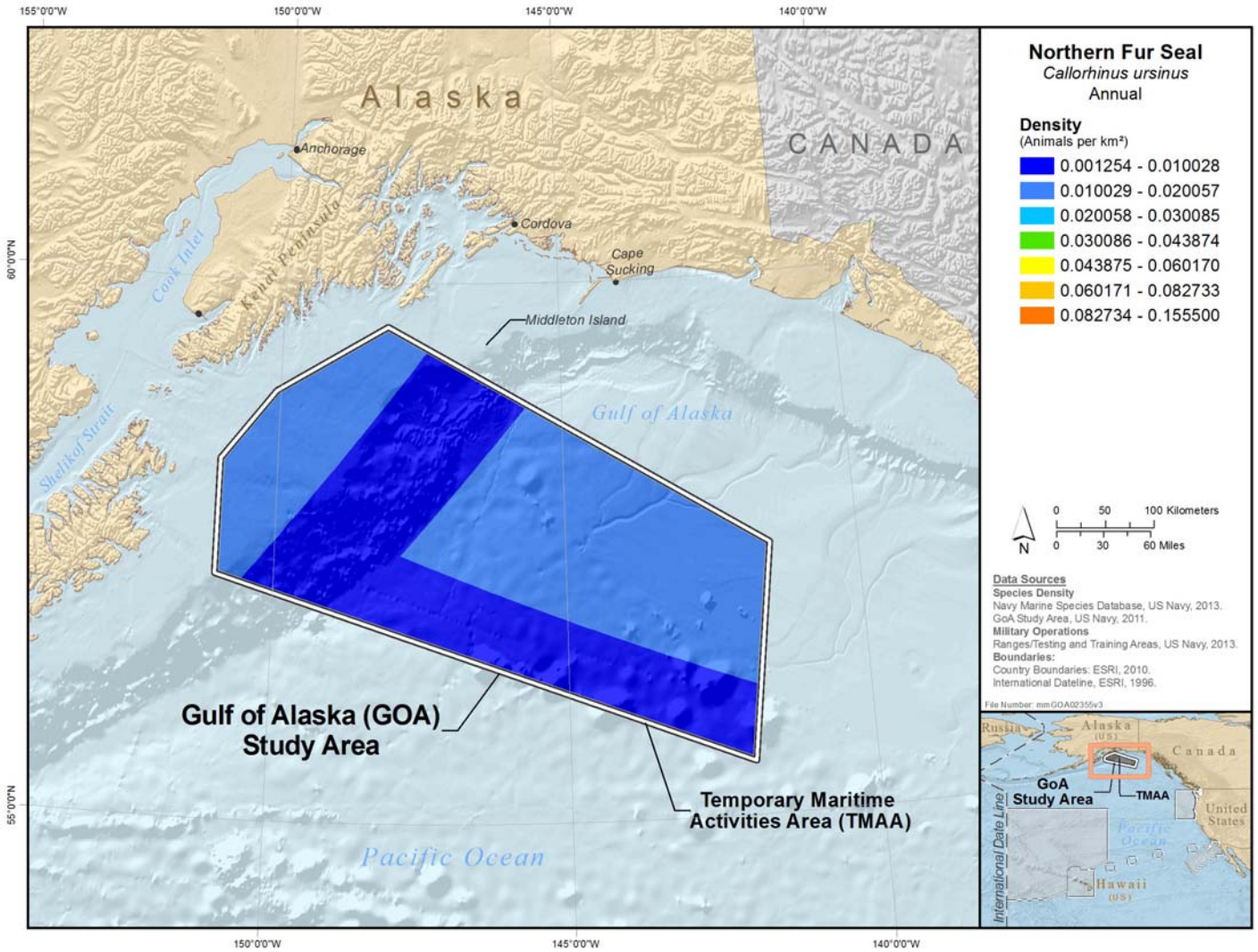

Figure 11-8: Annual Distribution of Northern Fur Seal in the GOA Study Area

11.1.3 *MIROUNGA ANGUSTIROSTRIS*, NORTHERN ELEPHANT SEAL

This highly sexually dimorphic seal is found only in the eastern North Pacific (Jefferson et al. 2008). Both sexes are relatively large and have a large head. Their distinctive profile makes them unlikely to be confused with other species that their range overlaps with. Only young individuals could be mistaken for a sea lion or fur seal at sea if viewed quickly or from a distance. Northern elephant seals (*Mirounga angustirostris*) have made a remarkable recovery from overharvesting in the 1800s that caused a genetic bottleneck for the species (Hoelzel et al. 2002; Stewart et al. 1993; Sydeman and Allen 1999). One stock of elephant seals, the California Breeding Stock, is recognized by NMFS in U.S. waters (Carretta et al. 2011a). There is a Baja California population that is separate from the California Breeding Stock (Mesnick et al. 1998). Density values are presented for the species as a whole.

HRC. This species is not expected to occur in the HRC or in the western portion of the transit corridor (other than occasional extralimital records).

SOCAL. To arrive at density values for the SOCAL range complex, the Navy started with NMFS's stock assessment abundance (124,000 animals) (Carretta et al. 2011a). However, not all of this population is likely to occur exclusively within the SOCAL range complex portion of California. Taking island specific population estimates from Lowry (2002), an estimate of 18,430 northern elephant seals was calculated for Santa Barbara Island, San Nicolas Island, and San Clemente Island. Given that Lowry's field effort was in 2001, and with an estimated annual growth rate from NMFS of 11.7% per year for the past 10 years, 18,430 was adjusted to 21,563 used to represent the portion of northern elephant seals within SOCAL. A seasonal estimate for northern elephant seals potentially at-sea during warm (75%) and cold seasons (50%) was derived from published literature (Le Boeuf and Laws 1994; Worthy et al. 1992). A warm and cool season density estimate was calculated by taking the SOCAL population estimate (21,563) multiplied by the percent at sea for each season and divided by the area of the NMFS Southern California strata (318,541 km^2) (Carretta et al. 2011a) (e.g., summer/fall: [21,563 x 75%]/318,541 km^2 = 0.05078 seals/km^2). There is some degree of presence of northern elephant seals in the pelagic portion of the North Pacific. To represent elephant seal densities in the northern Pacific and in the Baja Extension, the Kaschner et al. (2006) global RES model estimates were used.

MITT. This species is not expected to occur in the MITT or associated transit corridor study areas.

NWTT Offshore. Based on a figure of female foraging range provided in Le Boeuf et al. (2000), the geographic area of elephant seal occurrence was estimated at 2,032,000 km^2 (U.S. Department of the Navy 2008). In December–May, offshore occurrence would include some adult females (would be onshore for breeding/pupping and molting 33% of that time), adult males (would be onshore for breeding for about 50% of that time), and juveniles (on shore for 15% of that time) (Le Boeuf 1972; Le Boeuf and Laws 1994). Starting with a total estimate of 124,000 seals in the stock (Carretta et al. 2011a), and subtracting the number of adult males (75% of males on shore or foraging north in the Gulf of Alaska: 4,620), adult females (33% of females on shore: 11,731), juveniles (15% of juveniles on shore: 11,516) and pups (all on shore: 35,549), the density for December–May was calculated as 60,924 seals/2,032,000 km^2, or 0.030 elephant seals/km^2.

In June–November, offshore occurrence would include all elephant seals except 15% of adult males and 15% of juveniles for that time. A total of 124,000 seals in the stock (Carretta et al. 2011a), and subtracting the number of adult males (75% of males on shore or foraging in the GOA: 852) and juveniles (15% of juveniles on shore: 11,516), the estimated abundance offshore would be 107,864. Therefore, density in June–November would be 107,864 seals/2,032,000 km^2, or 0.053 elephant seals/km^2.

NWTT Inland Waters. The geographic areas used to estimate density were based on Figure 1 from Jeffries et al. (2003; note that the dots in the figure show harbor seal haul-out sites, not elephant seal haulouts). The inland waters stratum was divided into 5 regions: Strait of Juan de Fuca (Region 3), San Juan Islands (Region 4), Eastern Bays (Region 5), Puget Sound (Region 6), and Hood Canal (Region 7). Areas 3 and 4 (Strait of Juan de Fuca and the San Juan Islands) were merged into one region and areas 5, 6, and 7 (Eastern Bays, Puget Sound, and Hood Canal) were merged into a separate region based on known haulouts. The area of each of these merged regions was calculated and the number of animals known to use haulouts in each of the regions was divided by that region's area.

For the greater Puget Sound, Eastern Bays, and Hood Canal area, the minimum density estimate of 0.00001 was applied, as there are no known haulouts in these areas. The minimum density estimate acknowledges that the species can or does occur in the region, but these occurrences are infrequent. For the Strait of Juan de Fuca and the San Juan Islands region, the abundance of northern elephant seals was estimated at 37 animals. This abundance was divided by the area of the Strait of Juan de Fuca and the San Juan Islands region (6,120.78 km^2) for an annual density estimate of 0.0063 seals/km^2.

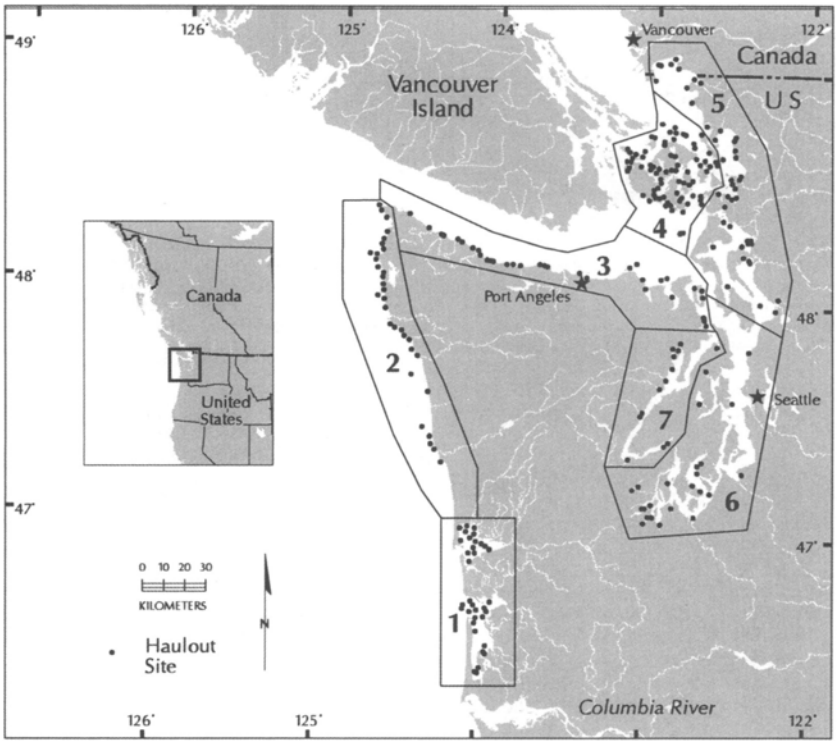

Figure 11-9: The Inland Waters Strata for Northern Elephant Seal Consists of Areas 3, 4, 5, 6, and 7 Only

NWTT Western Behm Canal, Alaska. For the Western Behm Canal, density estimates for all seasons were taken from the Marine Mammal Occurrence/Density Report prepared in support of a NEPA document for Navy activities at SEAFAC (U.S. Department of the Navy 2010b).

GOA. The California stock of elephant seals breeds at rookeries located along the California coast. Based on information collected from extensive satellite tagging studies, only male elephant seals migrate as far north as the GOA during foraging trips (Le Boeuf et al. 2000). Adult males are present at the California rookeries from December through February for mating, and again from May to August during molting.

To estimate density for the GOA Study Area, population information for the California stock was required. The California elephant seal population has been steadily increasing over time (Carretta et al. 2013). To account for males at rookeries not counted and an increase in the population since 2005, the number of males and juveniles reported in the 2009 stock assessment report (3,815) was doubled to 7,630. The number of male elephant seals (7,630) was multiplied by the percent area of the TMAA compared to the GOA Large Marine Ecosystem as defined by NOAA (approximately 1,396,800 km^2, not including inland passages; TMAA = 0.0625 of this area) for a total of 477 elephant seals. Density was then calculated as 475 seals/87,250 km^2, or 0.0055/km^2, which is applicable to the entire TMAA for March-April and September-November. Because all elephant seal adult males are not at-sea at the same time, this value is probably an over-estimate.

Elephant seal densities were averaged to warm water (summer/fall) and cold water (winter/spring) seasons to provide data suitable for acoustic modeling. To do so, monthly densities were summed and divided by the number of months in each season. The warm water density for elephant seals was 0.0022/km^2 and the cold water density was 0.0024/km^2.

Table 11-5: Sources of Density Values Used for Northern Elephant Seal

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	K	K	K	K
SOCAL	LD/K	LD/K	LD/K	LD/K
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	LD	LD	LD	LD
NWTT Inland Waters (Eastern Bays/Puget Sound/Hood Canal)	LD	LD	LD	LD
NWTT Inland Waters (Strait of Juan de Fuca/San Juan Islands)	LD	LD	LD	LD
Western Behm Canal	LD	LD	LD	LD
GOA	LD	LD	LD	LD

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 11-6: Summary of Density Values for Northern Elephant Seal in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	S	S	S	S
SOCAL	0.03385	0.05078	0.05078	0.03385
Inner Baja Extension	S	S	S	S
Outer Baja Extension	S	S	S	S
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0.030	0.053	0.053	0.030
NWTT Inland Waters (Eastern Bays/Puget Sound/Hood Canal)	0.00001	0.00001	0.00001	0.00001
NWTT Inland Waters (Strait of Juan de Fuca/San Juan Islands)	0.006	0.006	0.006	0.006
Western Behm Canal	0.0024	0.0022	0.0022	0.0024
GOA	0.0024	0.0022	0.0022	0.0024

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

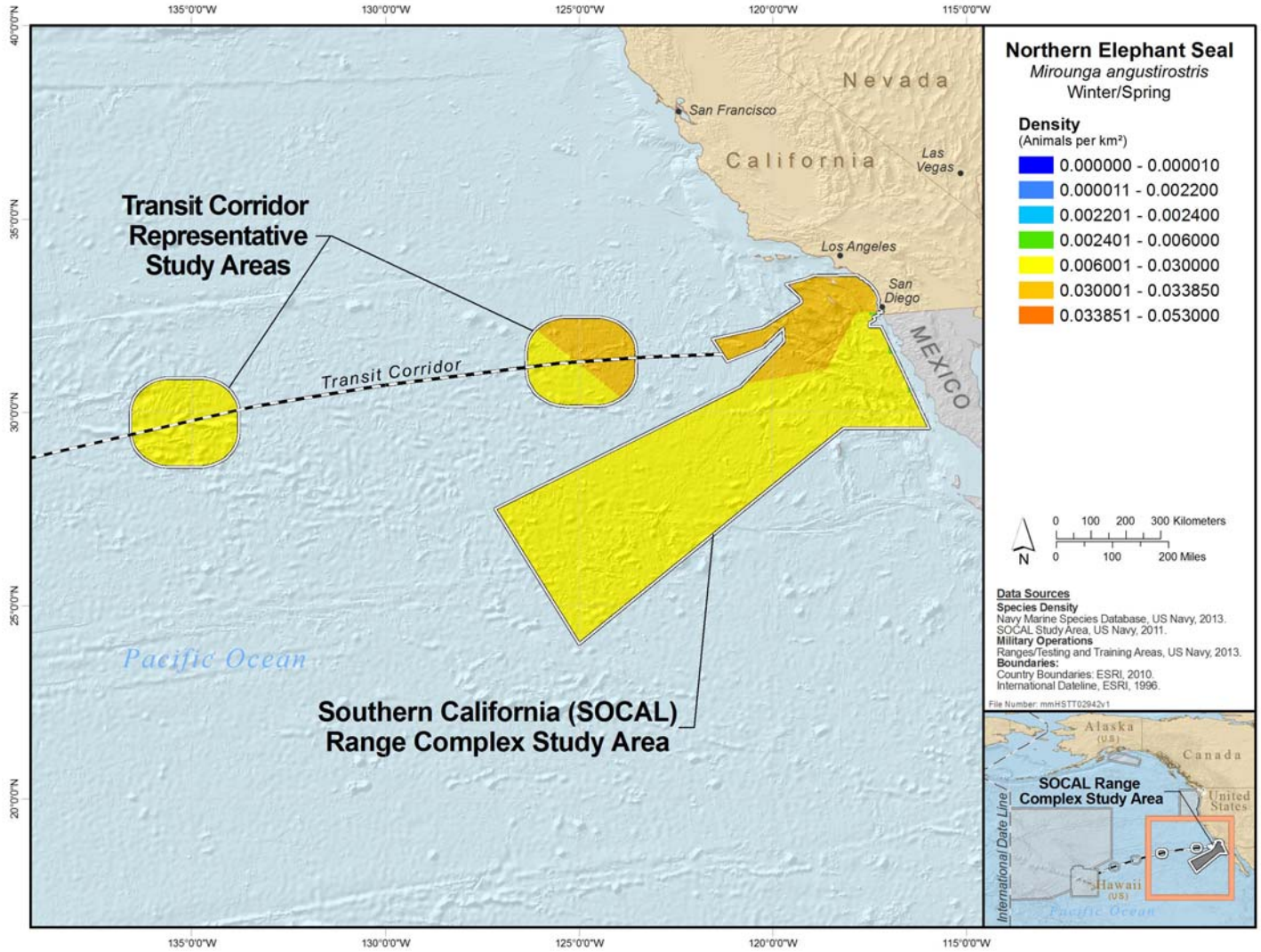

Figure 11-10: Winter/Spring Distribution of Elephant Seal in SOCAL and the Eastern Portion of the Transit Corridor

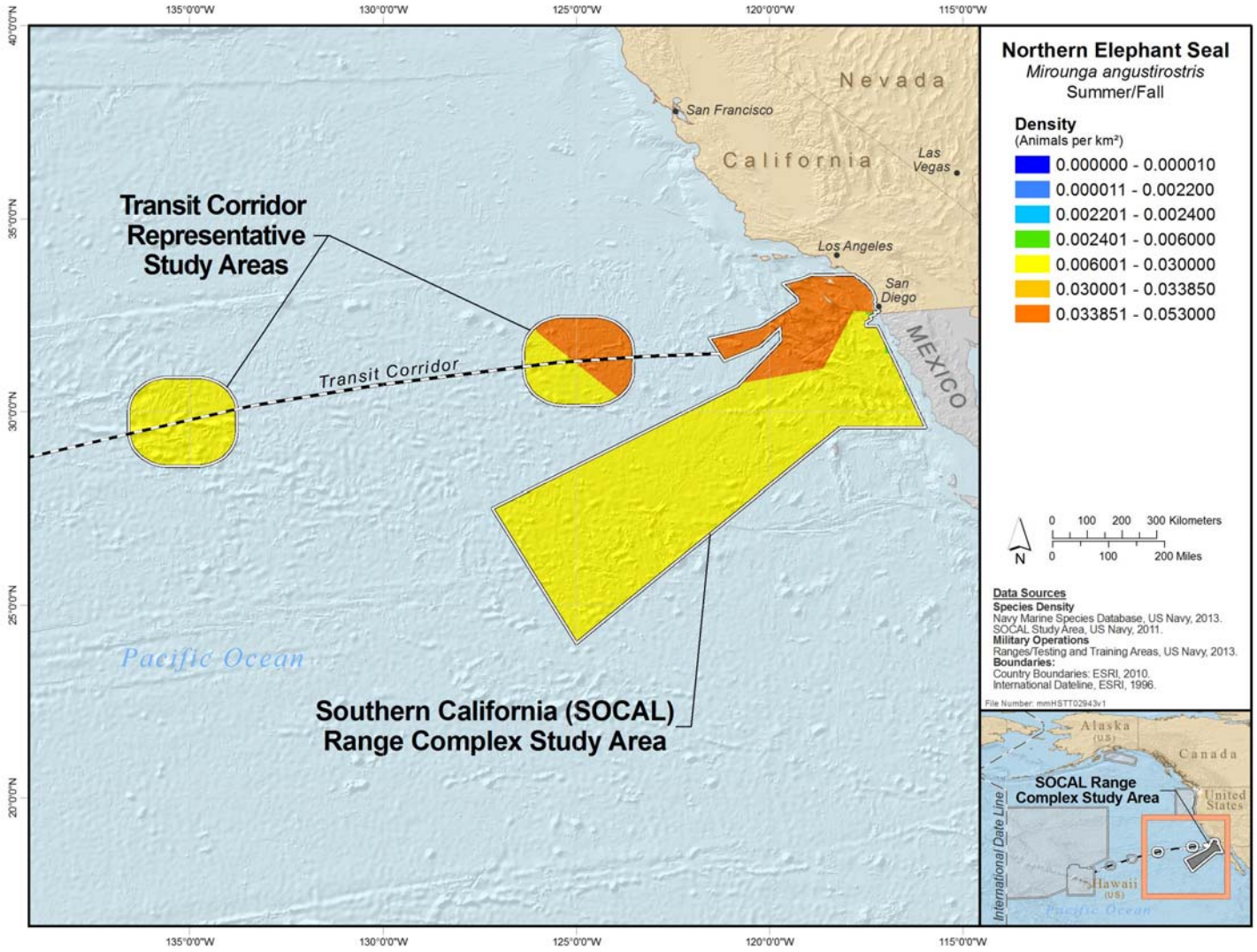

Figure 11-11: Summer/Fall Distribution of Elephant Seal in SOCAL and the Eastern Portion of the Transit Corridor

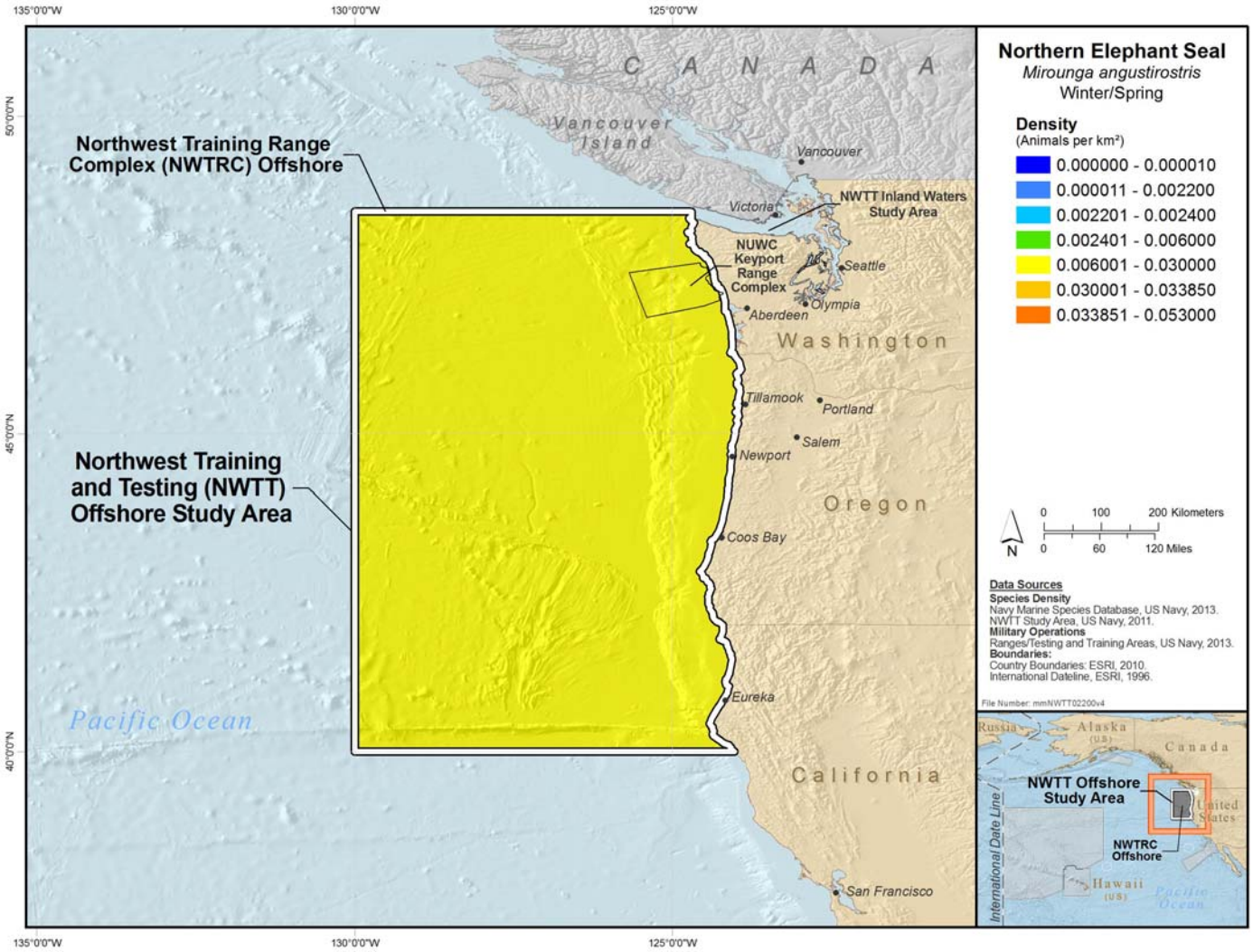

Figure 11-12: Winter/Spring Distribution of Northern Elephant Seal in the Offshore Portion of NWTT

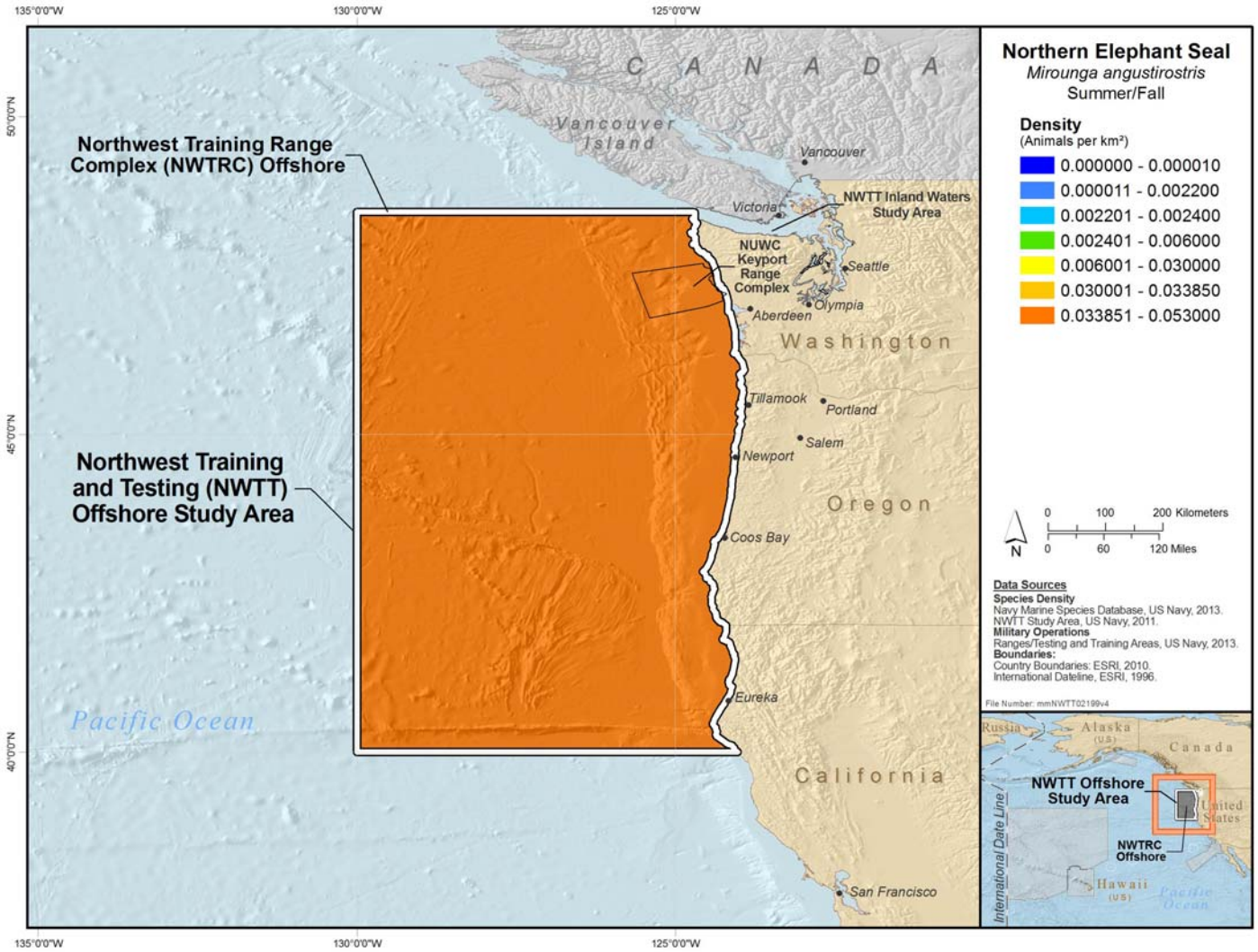

Figure 11-13: Summer/Fall Distribution of Northern Elephant Seal in the Offshore Portion of NWTT

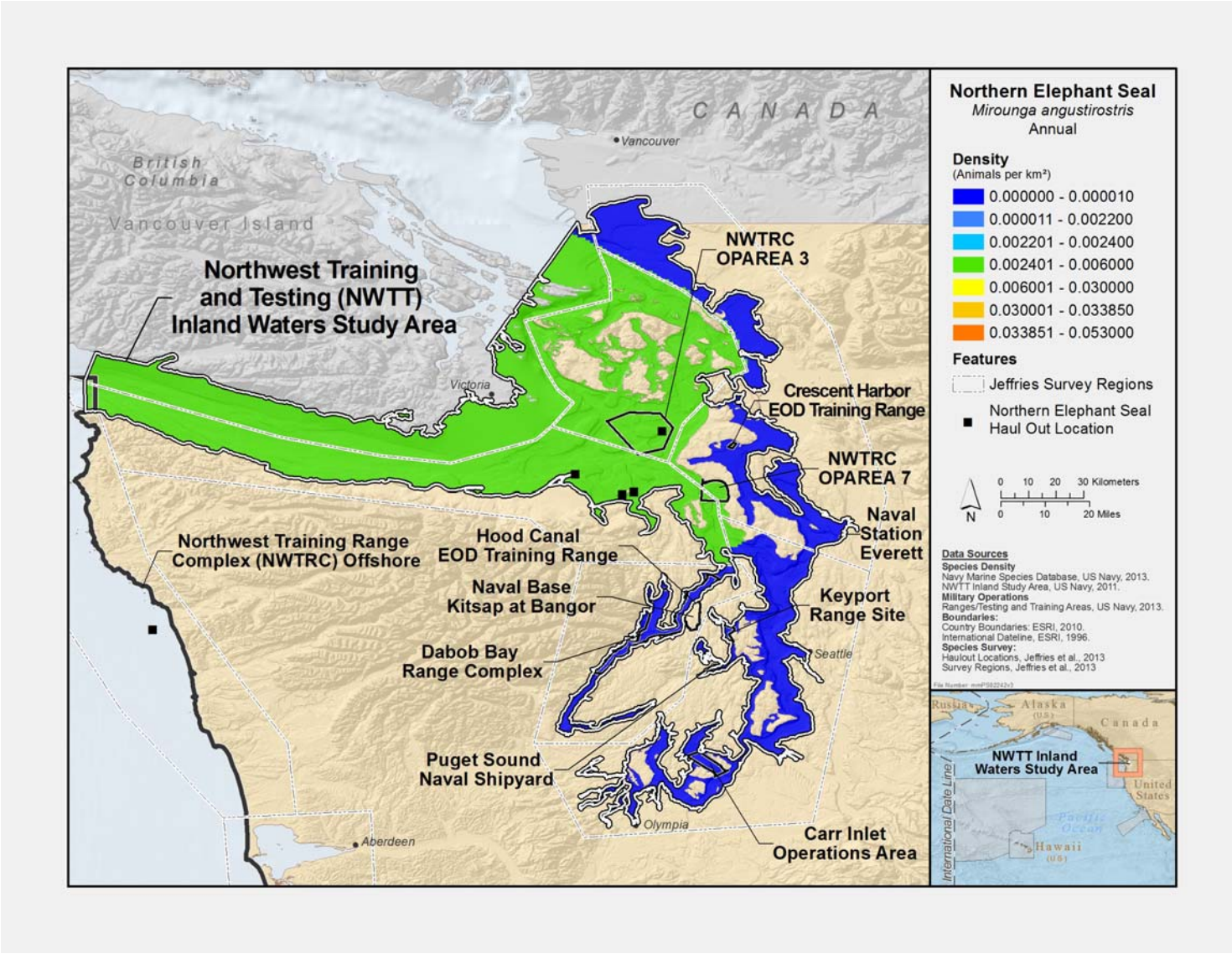

Figure 11-14: Annual Distribution of Northern Elephant Seal in the Inland Waters Portion of NWTT

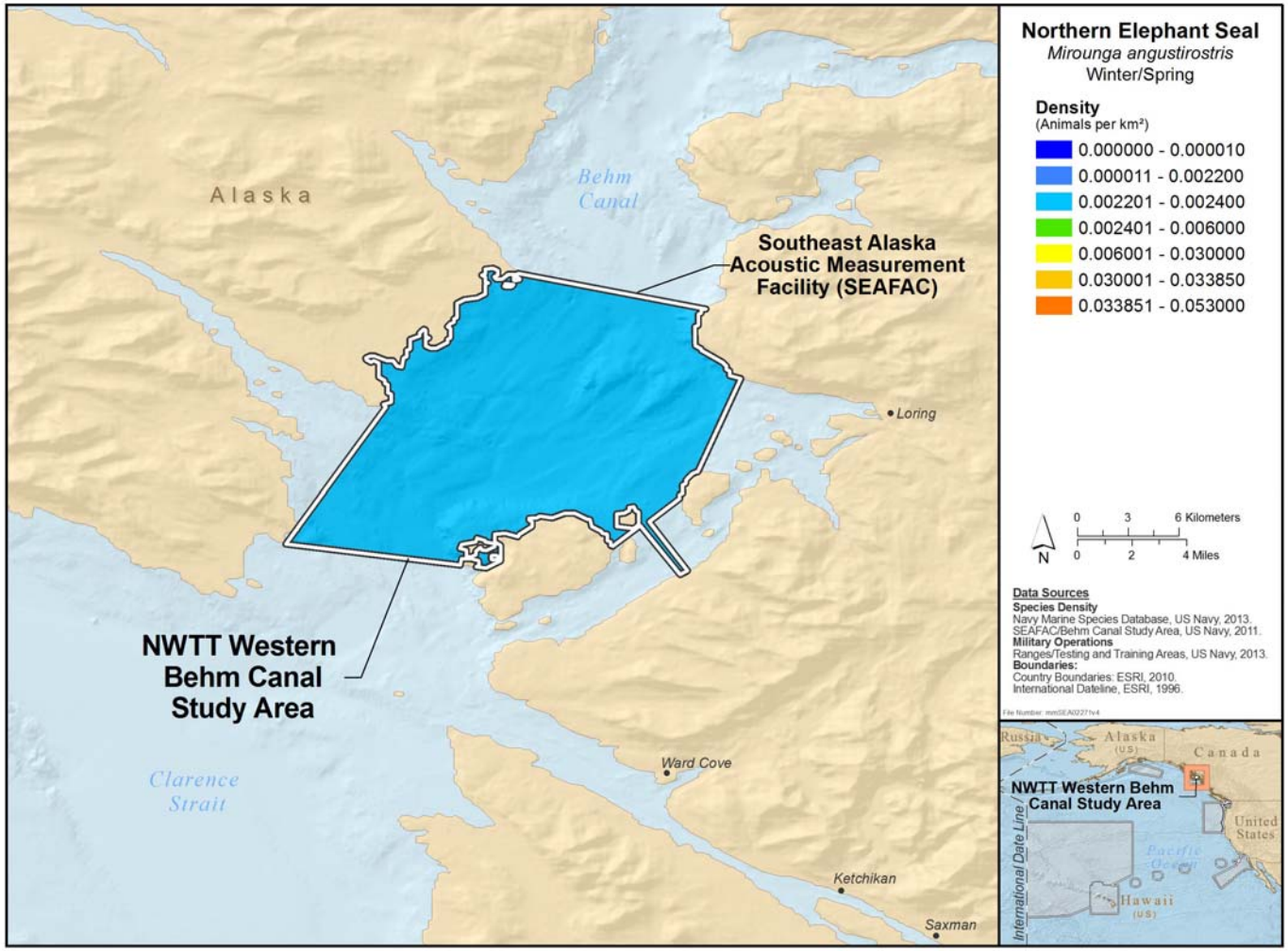

Figure 11-15: Winter/Spring Distribution of Northern Elephant Seal in the Western Behm Canal Portion of NWTT

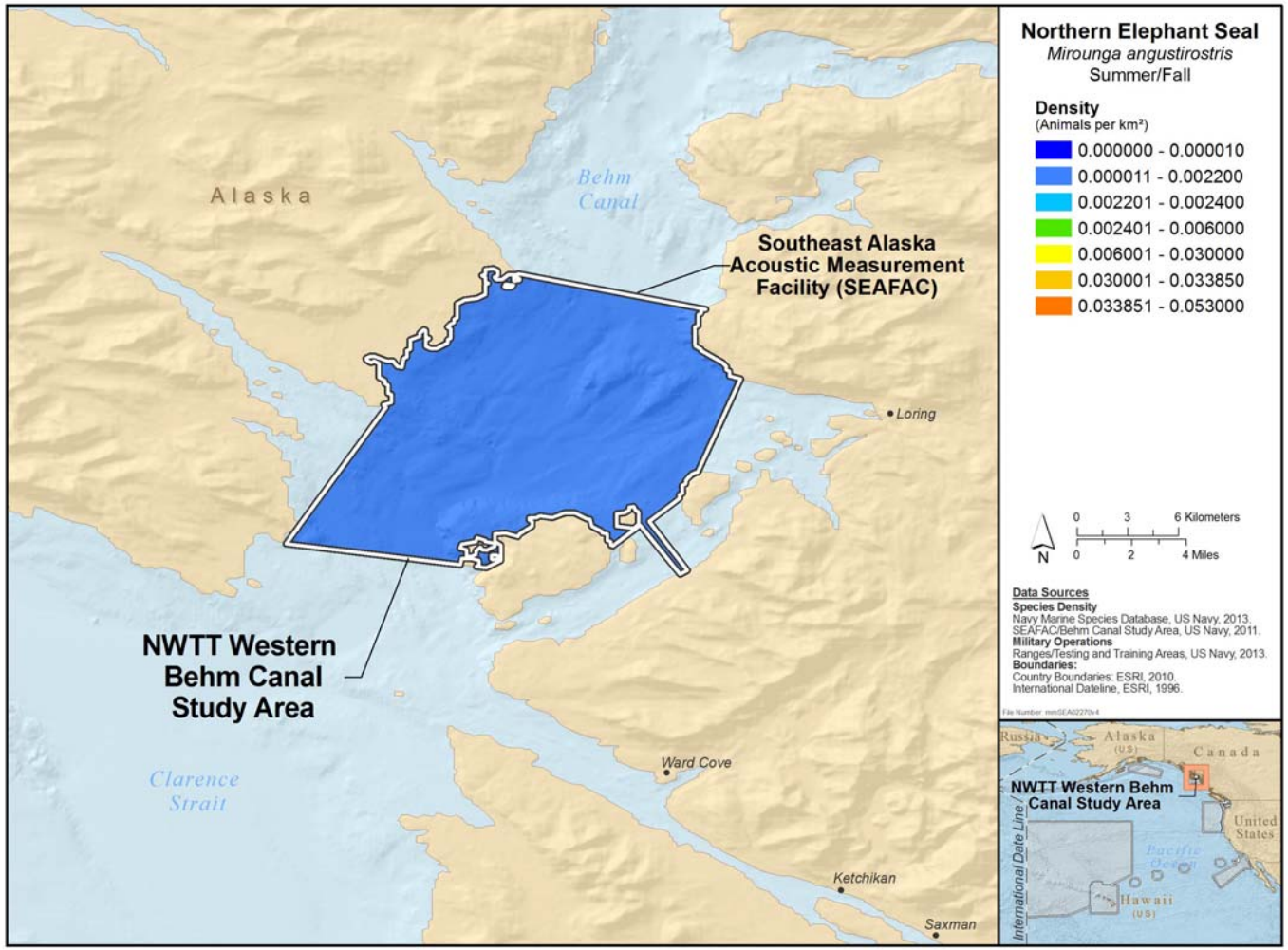

Figure 11-16: Summer/Fall Distribution of Northern Elephant Seal in the Western Behm Canal Portion of NWTT

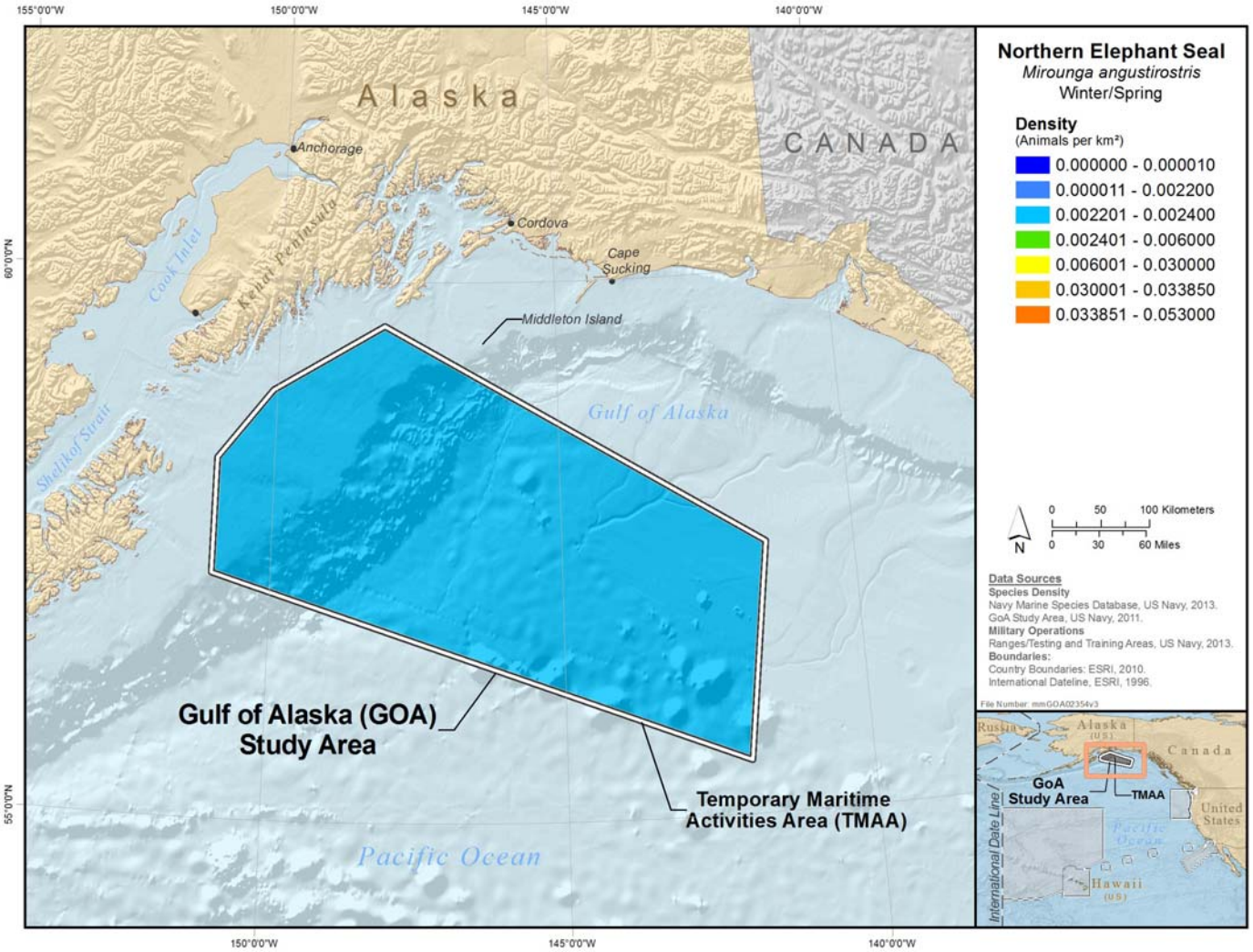

Figure 11-17: Winter/Spring Distribution of Northern Elephant Seal in the GOA Study Area

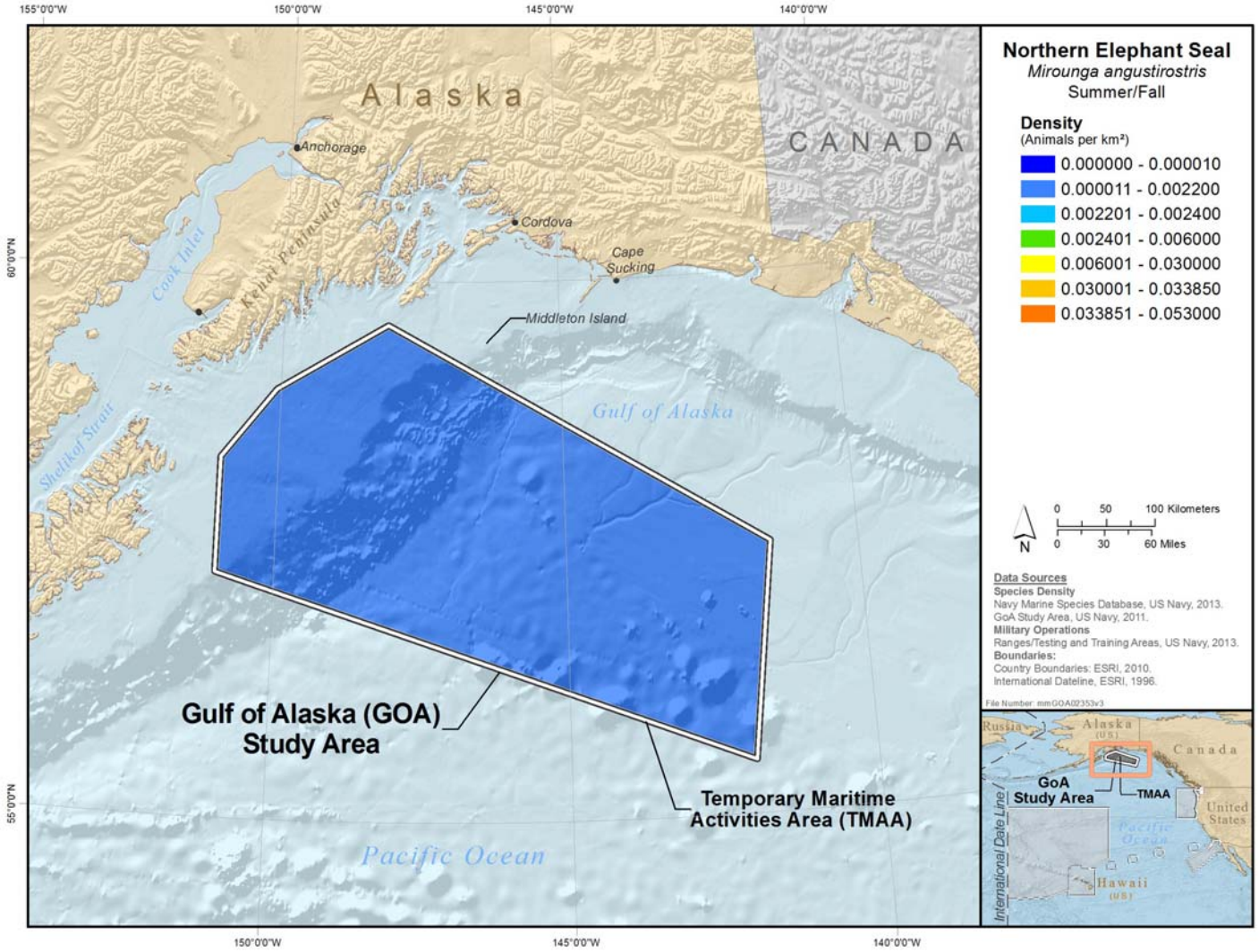

Figure 11-18: Summer/Fall Distribution of Northern Elephant Seal in the GOA Study Area

11.1.4 *MONACHUS SCHAUINSLANDI*, HAWAIIAN MONK SEAL

The Hawaiian monk seal is one of the world's most endangered seals and is the only pinniped regularly found in the HRC (Lowry et al. 2011). Their small population is growing in the Main Hawaiian Islands (Baker et al. 2011; Baker and Johanos 2004), while the numbers are in decline in the Northwest Hawaiian Islands (Antonelis et al. 2006). Overall the species is declining at a rate of about 4% per year (Baker et al. 2011). The species represents a single stock (Carretta et al. 2011a). To improve species conservation, NMFS has recently proposed defining broad areas of critical habitat throughout the Hawaiian Islands (Federal Register Vol. 76, No. 106, Thursday, June 2, 2011).

HRC. Little in-water occurrence or density data exist for monk seals. To estimate the density of the species in HRC, an extremely conservative approach was used by the Navy. The stock assessment report provides the best estimate of total population size for the species as 1,161 seals (Carretta et al. 2011a). The assumption was made that all of the seals are within the Hawaiian EEZ. The proposed rule for revising monk seal critical habitat (Federal Register Vol. 76, No. 106, Thursday, June 2, 2011) suggests the 500 m depth contour as the outer edge of critical habitat from the Main Hawaiian Islands. Given that monk seals are likely to be found more in this area than outside of it, the Navy placed 90% of the population (1,044.9 seals) inside the 500 m contour and divided by the area (32,171.14 km^2), obtaining the density 0.03247 seals/km^2. The Navy placed 10% of the population (116.1 seals) outside of the 500 m isobaths and divided by the area (2,474,592.98 km^2) to obtain 0.0000469 seals/km^2. As stated previously, for the Navy's purposes this approach is extremely conservative, because it assumes the entire population is in the water. Baker and Johanos' data for the Northwest Hawaiian Islands suggests that 2–3 seals are in the water for every one that is hauled out (Baker and Johanos 2004). Additionally, the conservative approach assigns monk seals to have a presence even in the remote pelagic corners of the HRC.

A special monk seal density value was calculated for Pearl Harbor, the site of a major Navy and Air Force Joint Base. Navy records of sightings from mid-2009 to mid-2010 indicated that two seals were seen swimming in Pearl Harbor over a 12-month period. Monk seal sightings are a rare event in Pearl Harbor, but the presence of some seals could go undetected or unreported. The Navy chose to make the conservative estimate that one seal is in the harbor every month. Pearl Harbor is approximately 21 km^2 in area (Smith et al. 2006). The density of seals on any given day is arrived at by calculating 1 seal/21 km^2/30 days average in a month = 0.00159 seals/km^2/day.

Monk seals do not occur in the western portion of the transit corridor. In Figure 11-19, the density that corresponds with the red color is not obvious, because it is inside Pearl Harbor on the island of Oahu. An expanded view of Oahu and Pearl Harbor is shown in Figure 11-20.

SOCAL. This species is not expected to occur in SOCAL or in the transit corridor.

MITT. This species is not expected to occur in the MITT or associated transit corridor.

NWTT. This species is not expected to occur in the NWTT Study Area.

GOA. This species is not expected to occur in the GOA Study Area.

Table 11-7: Sources of Density Values Used for Hawaiian Monk Seal

Location	Spring	Summer	Fall	Winter
HRC	LD/N	LD/N	LD/N	LD/N
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; N = Navy-collected data; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets, refer to Section 3.

Table 11-8: Summary of Density Values for Hawaiian Monk Seal in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC inside 500 m isobaths	0.03247	0.03247	0.03247	0.03247
HRC outside 500 m isobaths	0.0000469	0.0000469	0.0000469	0.0000469
Pearl Harbor	0.00159	0.00159	0.00159	0.00159
W. Transit Zone	0	0	0	0
E. Transit Zone	0	0	0	0
SOCAL	0	0	0	0
Inner Baja Extension	0	0	0	0
Outer Baja Extension	0	0	0	0
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

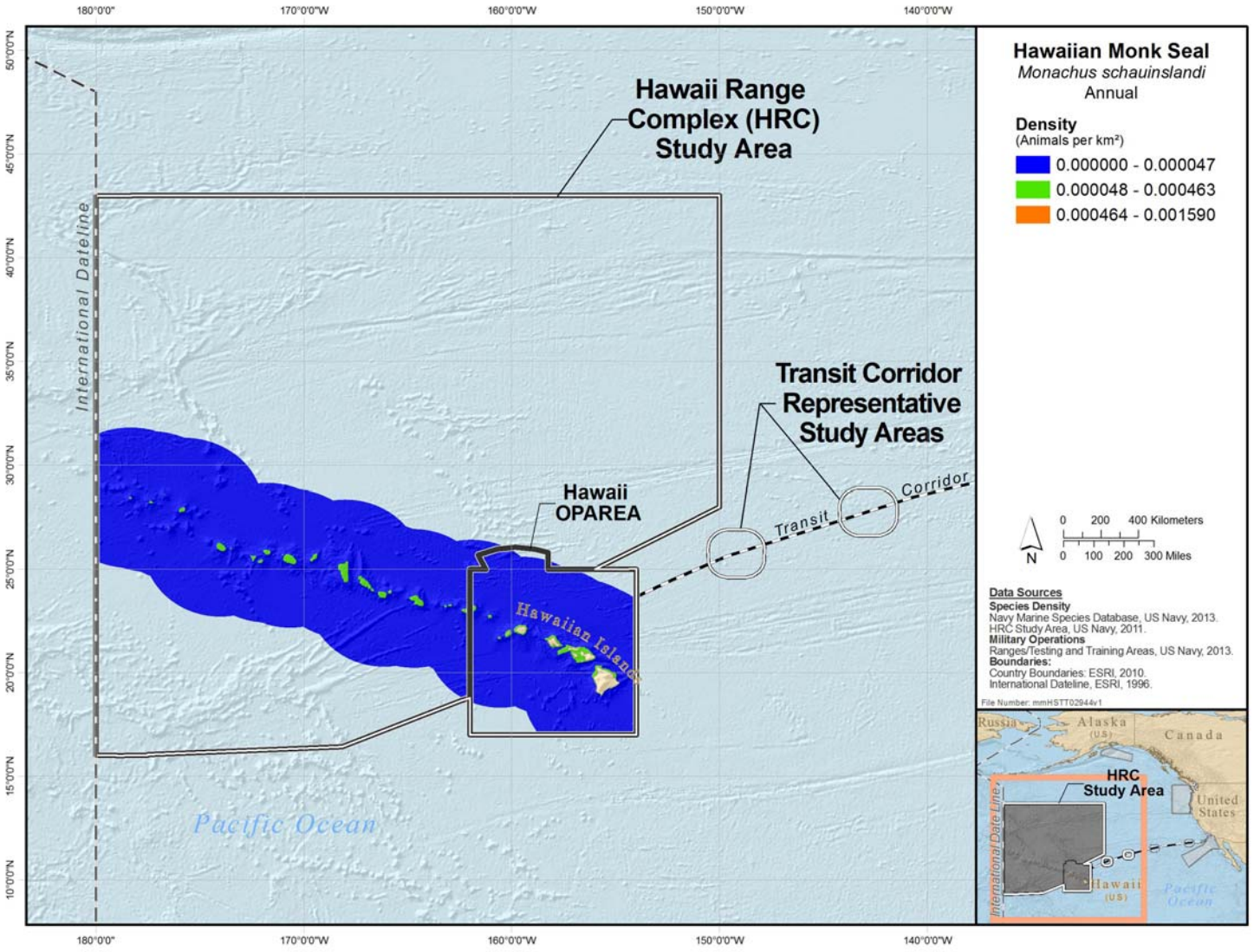

Figure 11-19: Annual Distribution of Hawaiian Monk Seal in HRC and the Western Portion of the Transit Corridor

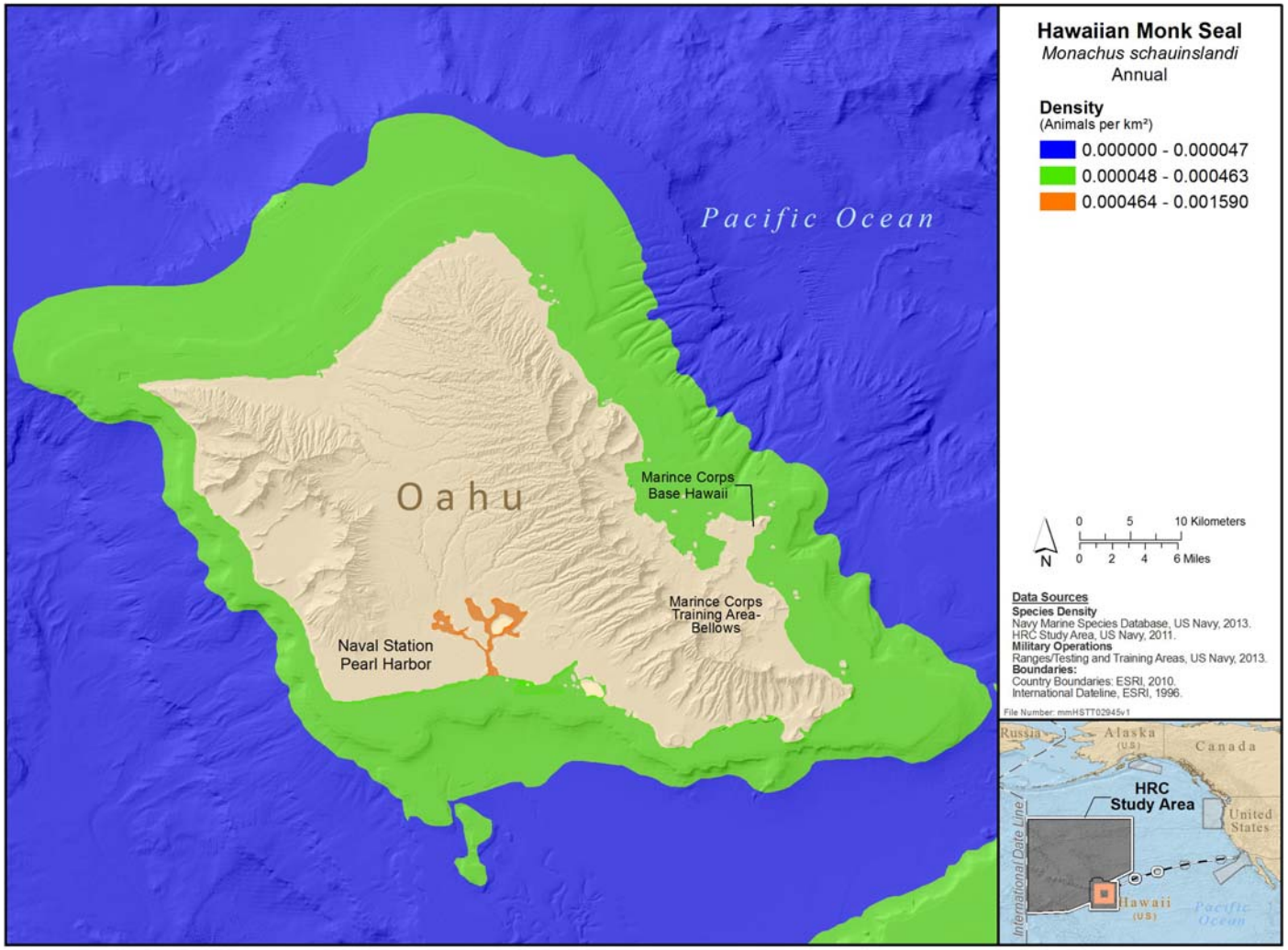

Figure 11-20: Distribution of Hawaiian Monk Seal around the Island of Oahu. Pearl Harbor is the major harbor on the south shore of Oahu

11.1.5 *PHOCA VITULINA*, HARBOR SEAL

The harbor seal (*Phoca vitulina*) is a small seal that is found in the near shore environment of much of the Northern Hemisphere (Jefferson et al. 2008). It is one of the most adaptable seals and can haul out in a variety of terrestrial environments (Riedman 1990); in some locations, such as Alaska, it can even occupy freshwater lakes. At sea, the species is easily recognizable because it is the smallest seal on the west coast of the United States, and the coat has a patchy dark gray and white pattern. Five subspecies are recognized, and *Phoca vitulina richardsi* is the eastern Pacific subspecies (Riedman 1990). Therefore, *P. v. richardsi* would be encountered in SOCAL, the Pacific Northwest, and the Gulf of Alaska. NMFS recognizes 17 harbor seal stocks along the U.S. west coast including Alaska (Allen and Angliss 2014, Carretta et al. 2014). There are 12 stocks present in Alaska waters and 5 stocks occurring in Washington, Oregon, and California waters. The latter include 1) Oregon/Washington Coast; 2) California; 3) Washington Northern Inland Waters (including Puget Sound north of the Tacoma Narrows Bridge, the San Juan Islands, and the Strait of Juan de Fuca); 4) Southern Puget Sound (south of the Tacoma Narrows Bridge); and 5) Hood Canal (Carretta et al. 2014).

HRC. This species is not expected to occur in the HRC or in the western portion of the transit corridor.

SOCAL. To arrive at in-water density values for the SOCAL range complex, the Navy started with NMFS's stock assessment abundance (34,233 animals) for the California Stock of harbor seals (Carretta et al. 2011a). However, not all of these harbor seals reside in the Southern California area, so an estimate of harbor seals in the SOCAL area was derived from published literature (Lowry et al. 2008). Lowry et al. provided estimates of harbor seal population for Northern California (9,591), Central California (10,954), and Southern California (5,788). The Southern California value is 22% of the total for the three areas reported by Lowry et al. (2008). The Navy took 22% of the NMFS 2010 stock assessment population estimate (34,233, Carretta et al. 2011a) to represent the current SOCAL harbor seal population (7,524 harbor seals). Seasonal estimates for Pacific harbor seals of the percentage of the population potentially at-sea during warm (39%) and cold seasons (85.5%) were taken from published literature (Harvey and Goley 2011; Yochem et al. 1987). Using the SOCAL population estimate, a warm and cool season density estimate was calculated by multiplying the population estimate by the percent of the population at sea for each season and dividing by the area of the NMFS Southern California strata (318,541 km^2) (Carretta et al. 2011a) (e.g., summer/fall: [7,524 x 39%]/318,541 km^2 = 0.0092 seals/km^2). St. Andrew's global RES model data (SMRU Ltd. *in prep*) were used for other areas near the California coast.

Harbor seals do not occur in the eastern portion of the transit corridor.

MITT. This species is not expected to occur in the MITT or associated transit corridor.

NWTT Offshore. Calambokidis et al. (2004) reported that harbor seals were observed within 40 km of shore. Therefore, density was only derived for this small area of the offshore portion of the NWTT Study Area. Washington-Oregon coast abundance in 1999 was 16,165 (CV=0.10) animals (Jeffries et al. 2003; Carretta et al. 2011a). To account for animals which are missed during the aerial survey haul-out counts, a correction factor of 1.53 was applied (Huber et al. 2001), resulting in a total abundance of 24,732 animals (Carretta et al. 2011a). To determine the in-water density estimate, a secondary correction

factor of 0.35 (Huber et al. 2001) was applied to the total abundance estimate to account for harbor seals spending many hours in any given day hauled out. This correction factor removes a small percentage of the population from the water to account for haul-out behavior. Applying this correction factor resulted in an in-water density estimate of 8,656 harbor seals. The geographic area for the 40 km "strip" of the coastal portion of NWTT Offshore was estimated to be 31,000 km^2. The in-water density estimate was divided by this area calculation to result in a density estimate of 0.279 seals/km^2. This estimate was incorporated into the NMSDD.

NWTT Inland Waters. Harbor seal density was derived from Jeffries et al. (2003) and Huber et al. (2001) for all inland water areas except Hood Canal. In Hood Canal, harbor seal density was derived from Jeffries et al. (2003) and London et al (2012). Jeffries et al. (2003) split the waters of Washington State into 7 geographic regions. Two regions encompass the outer coast: Coastal Estuaries (Region 1) and Olympic Coast (Region 2). The remaining 5 regions represent the inland waters: Strait of Juan de Fuca (Region 3), San Juan Islands (Region 4), Eastern Bays (Region 5), Puget Sound (Region 6), and Hood Canal (Region 7). The inland waters regions were used in the estimation of the inland water densities.

The counts of harbor seals surveyed by region in 1999 from haul-out surveys (Jeffries et al. 2003) was corrected to account for animals in the water which were missed during the survey counts. For all areas except Hood Canal, the survey correction factor of 1.53 was applied (Huber et al. 2001). For Hood Canal, a survey correction factor of 5.0 was applied (derived from London et al. 2012). The corrected abundance for each region was then divided by the area of that respective region resulting in density estimates for the Strait of Juan de Fuca (1.1948 seals/km^2), the San Juan Islands (3.1799 seals/km^2), Eastern Bays (2.2062 seals/km^2), Puget Sound (1.219 seals/km^2), and Hood Canal (9.918 seals/km^2). It is important to note that these density estimates assume that 100% of the population is in the water 100% of the time. These estimates were incorporated into the NMSDD and are recognized as conservative (i.e., high) numbers, given this species' haul-out behavior.

To account for harbor seals spending many hours in any given day hauled out, a haul-out correction factor can be applied. For Hood Canal, a correction factor of 0.80 can be applied and a correction factor of 0.35 (Huber et al. 2001) can be used for all other areas. The application of the appropriate haul-out correction factor removes a small percentage of the population from the water to account for the haul-out behavior in that region. If this correction factor is applied, the in-water density estimates for harbor seals would be as follows: Strait of Juan de Fuca (0.4182 seals/km^2), San Juan Islands (1.1130 seals/km^2), Eastern Bays (0.7722 seals/km^2), Puget Sound (0.4267 seals/km^2), and Hood Canal (7.934 seals/km^2).

NWTT Western Behm Canal, Alaska. For the Western Behm Canal, density estimates for all seasons were taken from the Marine Mammal Occurrence/Density Report prepared in support of a NEPA document for Navy activities at SEAFAC (U.S. Department of the Navy 2010b).

GOA. Harbor seals are distributed throughout coastal areas of the North Pacific. Their distribution is largely tied to suitable beaches for hauling out, pupping and molting, and areas offering good foraging and protection from predators such as killer whales. Most harbor seals are non-migratory. Satellite-tracking studies of movements of adults and pups near Kodiak Island and elsewhere in the GOA indicate

that mean distance between haul out and at-sea foraging was 10-25 km for juveniles and 5-10 km for adults (e.g., Lowry et al. 2001; Rehberg and Small 2001), and nearly all locations were in waters <200 m deep, with an apparent preference for depths 20-100 m (Frost et al. 2001). The coastal distribution and limitation to shallower depths make it likely that harbor seals would not regularly occur within the TMAA. For modeling purposes, however, a density of 0.00001 animals/km^2 was used to represent the occasional transit of harbor seals through the GOA Study Area.

Table 11-9: Sources of Density Values Used for Harbor Seal

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	LD/SA	LD/SA	LD/SA	LD/SA
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	LD	LD	LD	LD
NWTT Inland Waters (Strait of Juan de Fuca)	LD/N	LD/N	LD/N	LD/N
NWTT Inland Waters (San Juan Islands)	LD/N	LD/N	LD/N	LD/N
NWTT Inland Waters (Eastern Bays)	LD/N	LD/N	LD/N	LD/N
NWTT Inland Waters (Puget Sound)	LD/N	LD/N	LD/N	LD/N
NWTT Inland Waters (Hood Canal)	LD/N	LD/N	LD/N	LD/N
Western Behm Canal	LD	LD	LD	LD
GOA	LD	LD	LD	LD

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; N = Navy-collected data; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 11-10: Summary of Density Values for Harbor Seal in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0.0202	0.0092	0.0092	0.0202
Inner Baja Extension	S	S	S	S
Outer Baja Extension	S	S	S	S
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0.279	0.279	0.279	0.279
NWTT Inland Waters (Strait of Juan de Fuca)	1.1948	1.1948	1.1948	1.1948
NWTT Inland Waters (San Juan Islands)	3.1799	3.1799	3.1799	3.1799
NWTT Inland Waters (Eastern Bays)	2.2062	2.2062	2.2062	2.2062
NWTT Inland Waters (Puget Sound)	1.219	1.219	1.219	1.219
NWTT Inland Waters (Hood Canal)	9.918	9.918	9.918	9.918
Western Behm Canal	0.29	0.29	0.29	0.29
GOA	0.00001	0.00001	0.00001	0.00001

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

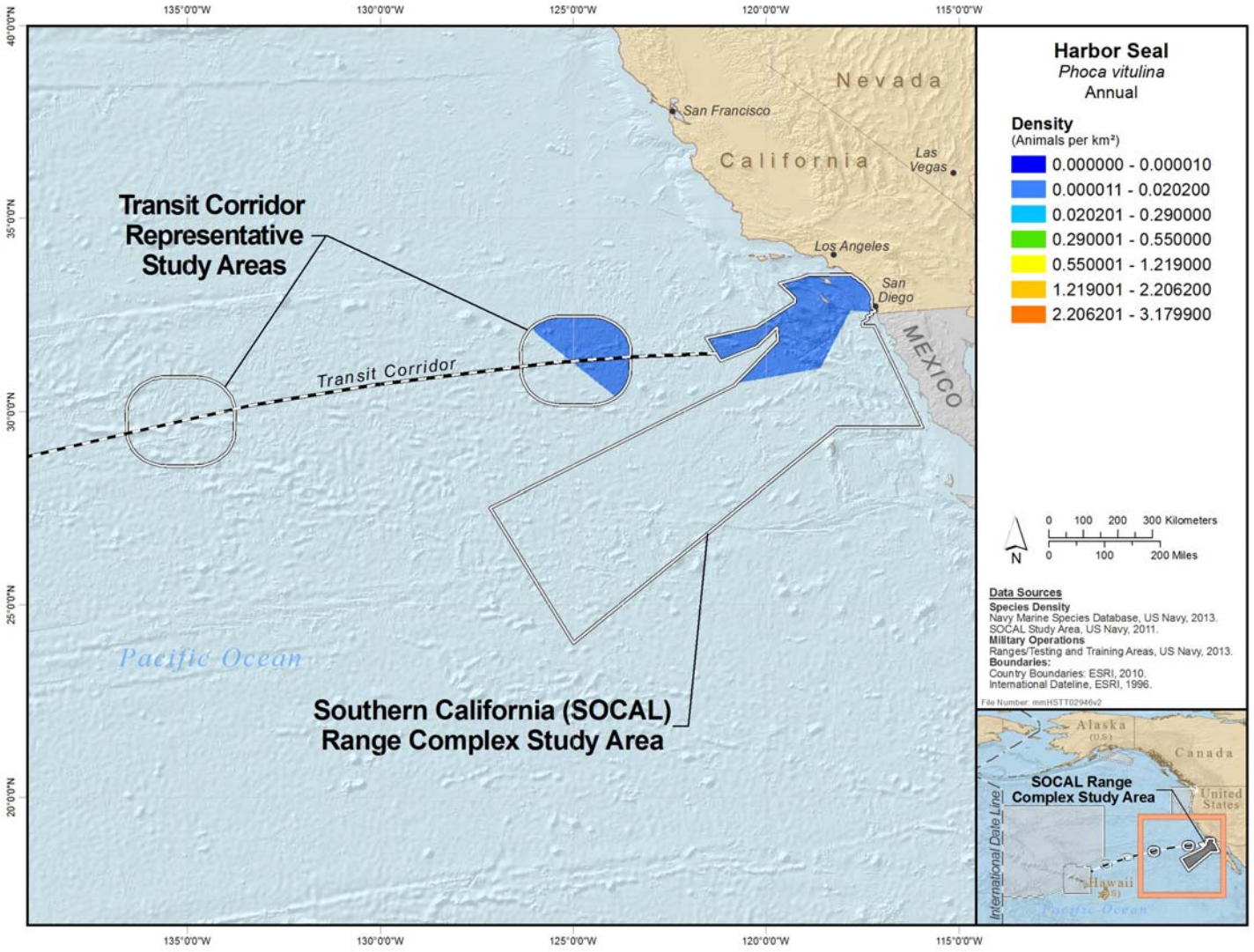

Figure 11-21: Annual distribution of Harbor Seal in SOCAL and the Eastern Portion of the Transit Corridor

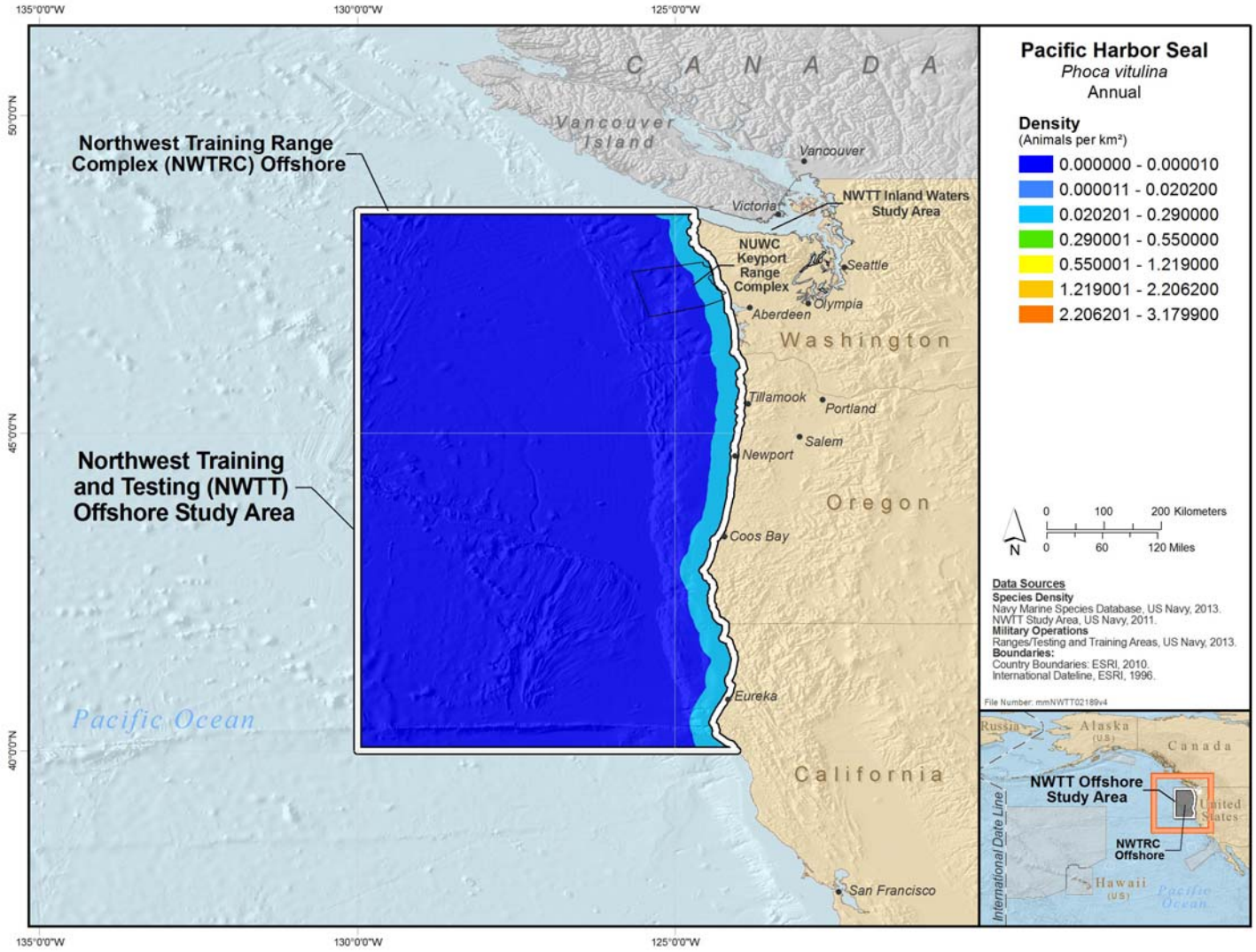

Figure 11-22: Annual Distribution of Pacific Harbor Seal in the Offshore Portion of NWTT

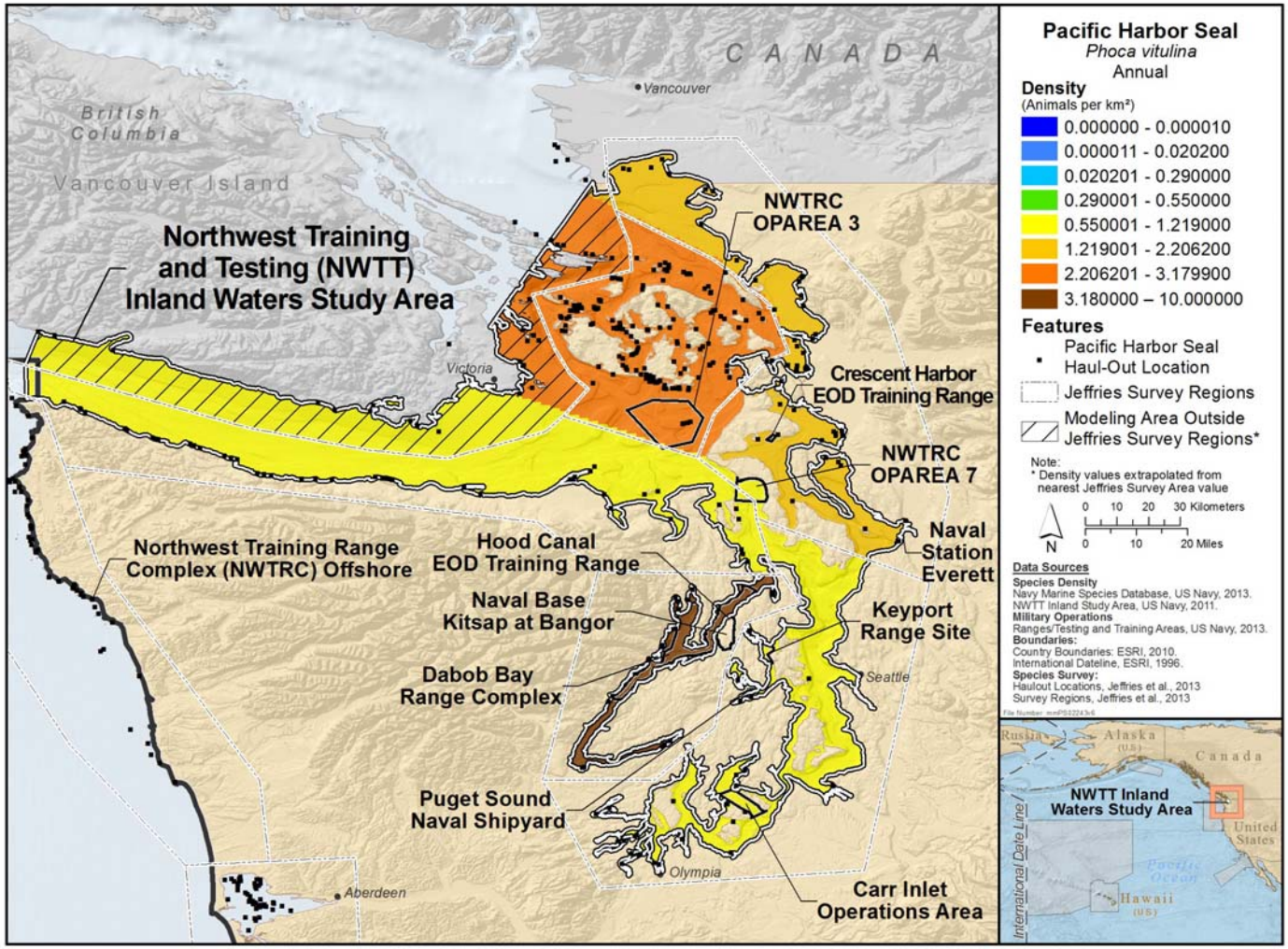

Figure 11-23: Annual Distribution of Pacific Harbor Seal in the Inland Waters Portion of NWTT

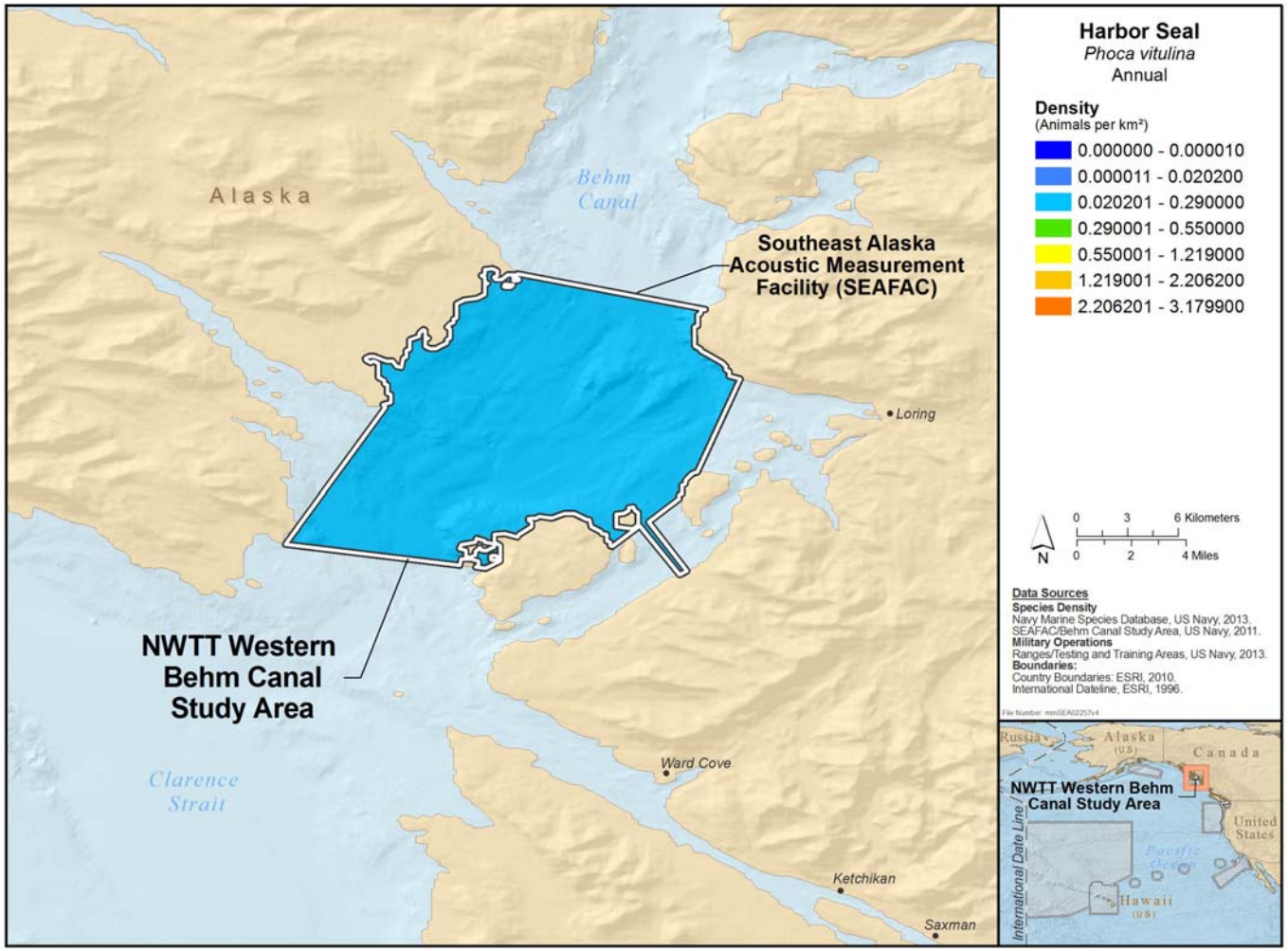

Figure 11-24: Annual Distribution of Pacific Harbor Seal in the Western Behm Canal Portion of NWTT

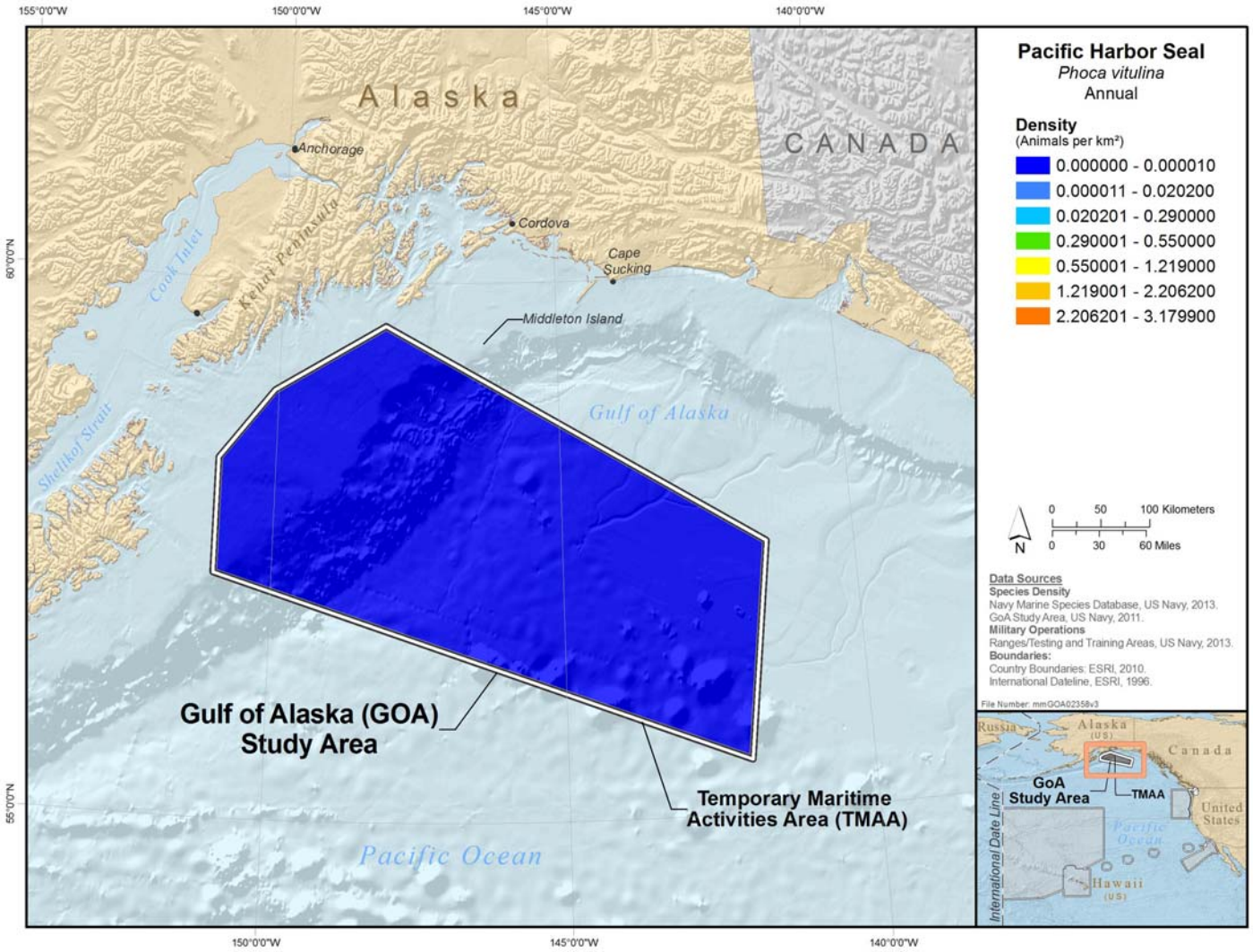

Figure 11-25: Annual Distribution of Pacific Harbor Seal in the GOA Study Area

11.1.6 *ZALOPHUS CALIFORNIANUS*, CALIFORNIA SEA LION

The California sea lion is an abundant pinniped found along the west coast of North America from the Gulf of Alaska to Southern Mexico (Jefferson et al. 2008). It is involved in significant fisheries interactions on the west coast of the United States (Carretta et al. 2011a). California sea lions could potentially be confused with three other otariids that share their range: the Guadalupe fur seal, the northern fur seal, and the Steller sea lion (*Eumetopias jubatus*). The California sea lion and the Steller sea lion have more dog-like muzzles, while northern fur seals and Guadalupe fur seals have pointed faces. Steller sea lions are generally much lighter in color than California sea lions, especially when wet or in the water. Being able to see the difference between the species may require close viewing (Jefferson et al. 2008). The fur seals are also darker than the sea lions. Steller sea lion adults are larger than California sea lion adults. Male California sea lions are uniquely identifiable audibly by their in-air vocalization, which is a repeated raspy bark (Riedman 1990; Schusterman and Gentry 1971).

The California sea lion (*Zalophus californianus*) is now considered to be a full species, separated from the Galapagos sea lion (*Z. wollebaeki*) and the extinct Japanese sea lion (*Z. japonicus*) (Carretta et al. 2011a). The California sea lion ranges from southern Mexico to Alaska (Riedman 1990) and is the species encountered in SOCAL, the Pacific Northwest, and the Gulf of Alaska. NMFS recognizes one stock of California sea lions (Carretta et al. 2011a).

HRC. This species is not expected to occur in the HRC or in the western portion of the transit corridor.

SOCAL. To arrive at in-water density values for California sea lions on the SOCAL range complex, the Navy used NMFS's stock assessment abundance (238,000 animals) (Carretta et al. 2011a). Using the highly conservative assumption that most of that population remains in the Southern California strata as defined by NMFS (Barlow 2010), which has an area of 318,541 km^2. A seasonal estimate for California sea lions potentially at-sea during cold seasons (47%) was provided by Lowry and Forney (2005). A cool season density estimate was then calculated by taking the population estimate multiplied by percent of the population at sea and divided by the NMFS Southern California strata area (e.g., cool season: [238,000 x 47%]/318,541 km^2 = 0.3512 sea lions/km^2). For a summer/fall density estimate, results from Navy funded aerial monitoring within the SOCAL range complex from 2008 to 2011 were used based on observations of at-sea California sea lions. Estimates derived using line-transect methodology resulted in a density of 0.1443 California sea lions/km^2 (Jefferson et al. 2012).

California sea lions are the only pinnipeds that occur regularly in San Diego Bay. Between February 2007 and June 2011, the Navy conducted five cold season samplings and six summer/fall samplings of San Diego Bay to count marine mammals. Only California sea lions were observed, and no sea lions were seen south of the Coronado Island Bridge. To calculate densities, the Navy divided the mean number of sea lions observed in each season by the area of North and Central San Diego Bay combined (17.9 km^2) (Allen 1999).

California sea lions do not occur in the eastern portion of the transit corridor.

MITT. This species is not expected to occur in the MITT or associated transit corridor.

NWTT Offshore. Between December and May, adult males and juveniles move away from the rookeries and migrate into the waters of the northwest. Jeffries et al. (2000) estimated that 3,000–5,000 California sea lions migrate into the area during this period. To determine density of California sea lions in the offshore portion of NWTT, the geographic area of occurrence was estimated at 150,000 km^2. The number of California sea lions (5,000) was divided by the area to result in a winter/spring density estimate of 0.033 sea lions/km^2.

In the summer/fall period, lower numbers of California sea lions would be expected in the region, as adult males are typically at rookeries for breeding. Therefore, the abundance of California sea lions during this period was estimated to be 3,000 animals (the lower of the Jeffries et al. [2000] estimate noted above). Similar to the winter/spring period, the abundance was divided by the geographic area of occurrence to result in a summer/fall estimate of 0.020 sea lions/km^2.

NWTT Inland Waters. For purposes of estimating California sea lion density in the inland waters, the initial strata were assumed to be the same as those described above for harbor seals. However, Region 3 and 4 (Strait of Juan de Fuca and the San Juan Islands) were merged into one stratum and Regions 5 and 6 (Eastern Bays and Puget Sound) were combined into another stratum, while Region 7 (Hood Canal) was left as a separate stratum. California sea lions are present all months except for July; therefore, a zero density estimate was assigned to California sea lions for this month. The densities presented represent the highest number that would be expected during the peak winter months (approximately December–February) when this species is present in the largest numbers in the inland waters. To determine density, the number of animals known to use haulouts in each stratum was identified. The numbers of California sea lions for each region was then divided by the area of that respective region to give total density estimates for Strait of Juan de Fuca/San Juan Islands (0.676 seals/km^2), Eastern Bays/Puget Sound (0.1266 seals/km^2), and Hood Canal (0.279 seals/km^2).

NWTT Western Behm Canal, Alaska. Densities were not estimated for the California sea lion because of insufficient data. There have been reported sightings in the SEAFAC study area (Maniscalco et al. 2004); however, there are not enough data to determine densities. The majority of the stock occurs south of the SEAFAC study area.

GOA. California sea lions breed in the Channel Islands in the southern California Bight and south into Baja California. Males migrate after the breeding season north to nearshore waters of Washington, Oregon, and British Columbia (some immature males will remain in northern feeding areas year round). Females generally do not migrate as far north as males. California sea lions have been documented at several locations in Alaska (Maniscalco et al. 2004), including Southeast Alaska, the Kenai Peninsula and as far north and west at St. Paul Island in the Bering Sea. There were a total of 52 animals documented between 1963 and 2003, and they were observed during all seasons of the year. Their presence in the GOA Study Area is likely extremely low, both due to the rare nature of the occurrence and the species preference for nearshore habitat. For modeling purposes, a density of 0.00001 animals/ km^2 is used to represent the occasional transit of California sea lions through the GOA Study Area.

Table 11-11: Sources of Density Values Used for California Sea Lion

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	L/N/K	L/N/K	L/N/K	L/N/K
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	LD	LD	LD	LD
NWTT Inland Waters (Strait of Juan de Fuca/San Juan Islands)	LD/N	LD/N	LD/N	LD/N
NWTT Inland Waters (Eastern Bays/Puget Sound)	LD/N	LD/N	LD/N	LD/N
NWTT Inland Waters (Hood Canal)	LD/N	LD/N	LD/N	LD/N
Western Behm Canal	0	0	0	0
GOA	LD	LD	LD	LD

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; N = Navy-collected data; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 11-12: Summary of Density Values for California Sea Lion in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0.3512	0.1443	0.1443	0.3512
North and Central San Diego Bay	2.5140	5.7542	5.7542	2.5140
Inner Baja Extension	S	S	S	S
Outer Baja Extension	S	S	S	S
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0.033	0.020	0.033	0.020
NWTT Inland Waters (Strait of Juan de Fuca/San Juan Islands)	0.676	0.676	0.676	0.676
NWTT Inland Waters (Eastern Bays/Puget Sound)	0.1266	0.1266	0.1266	0.1266
NWTT Inland Waters (Hood Canal)	0.279	0.279	0.279	0.279
Western Behm Canal	0	0	0	0
GOA	0.00001	0.00001	0.00001	0.00001

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

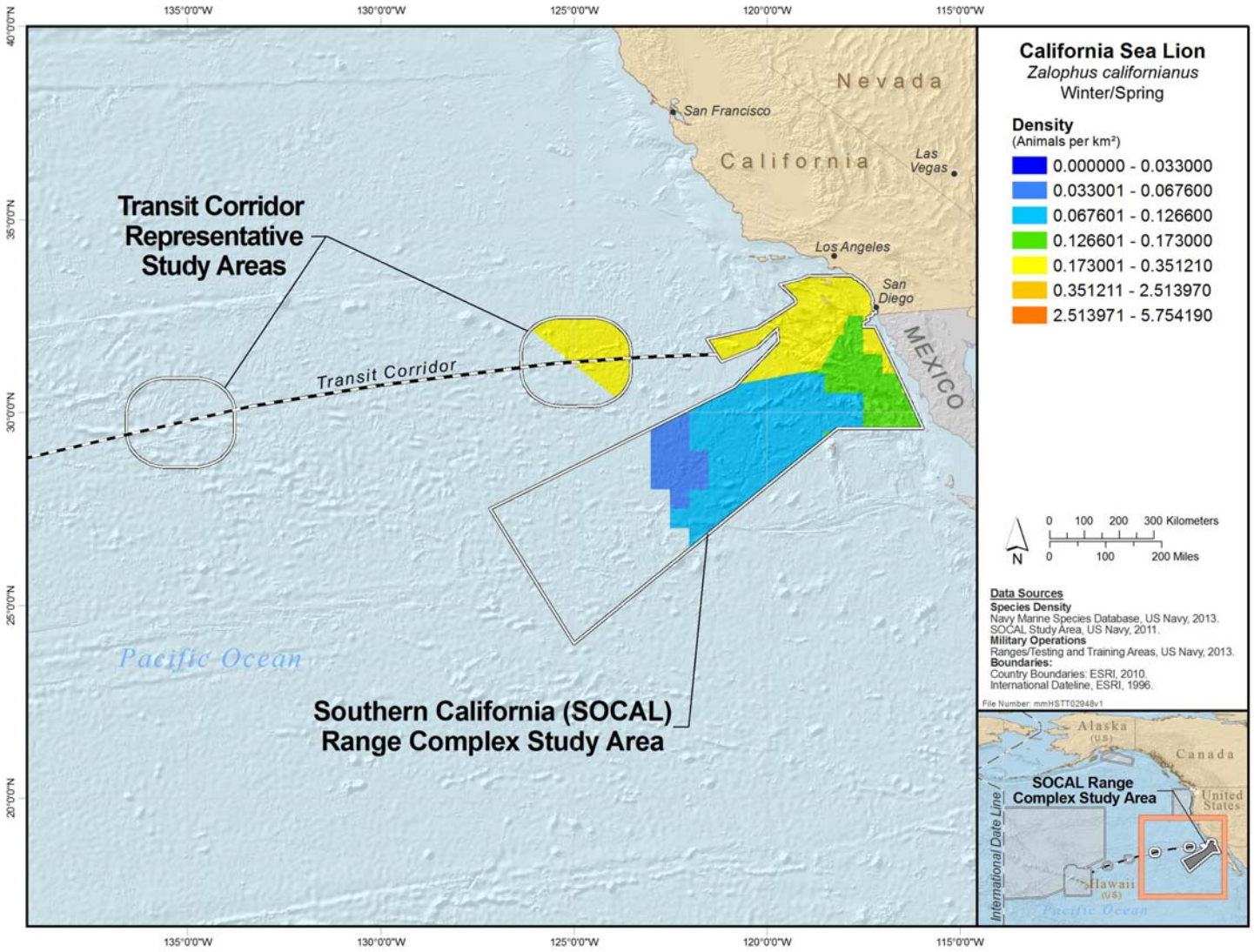

Figure 11-26: Winter/Spring Distribution of California Sea Lion in SOCAL and the Eastern Portion of the Transit Corridor

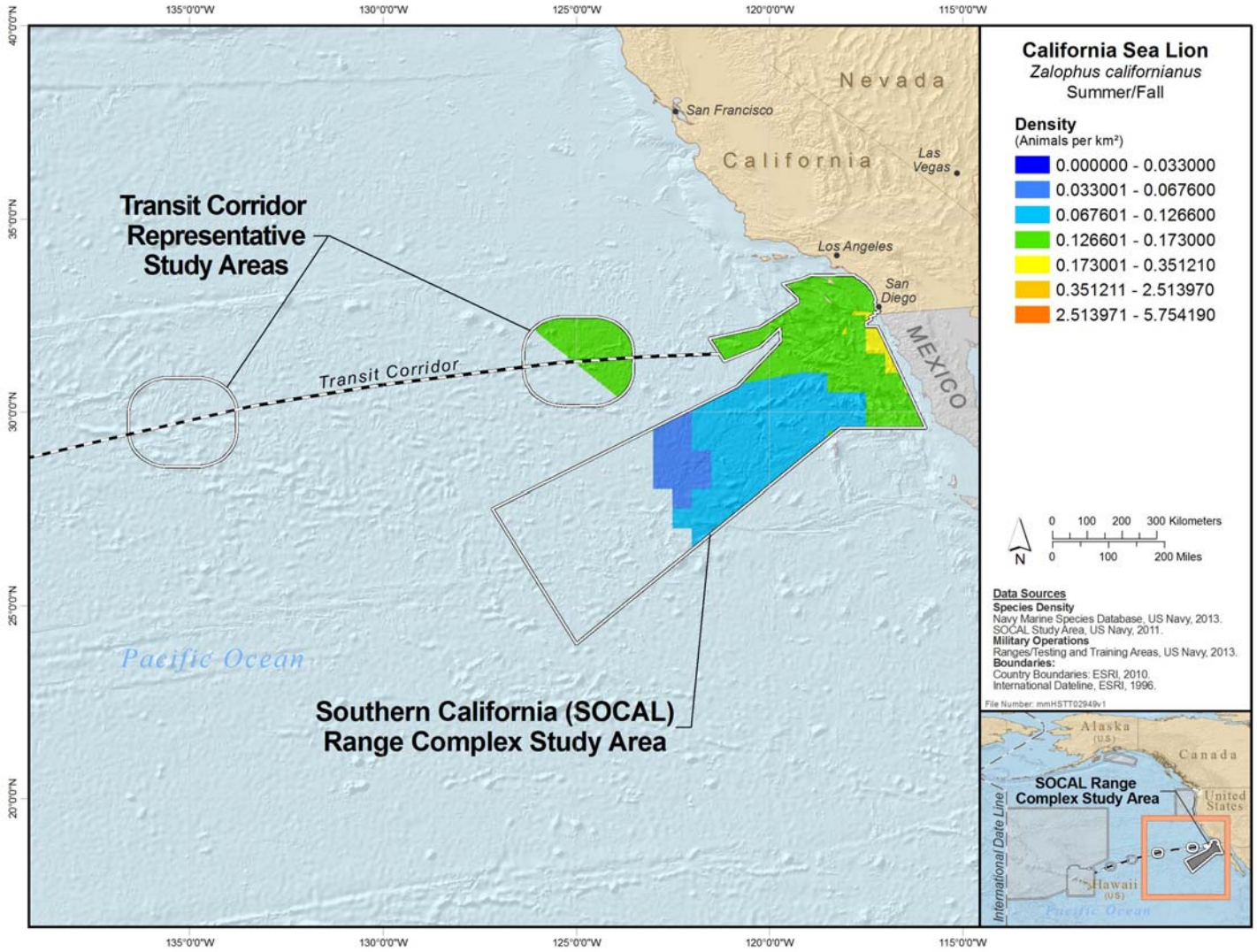

Figure 11-27: Summer/Fall Distribution of California Sea Lion in SOCAL and the Eastern Portion of the Transit Corridor

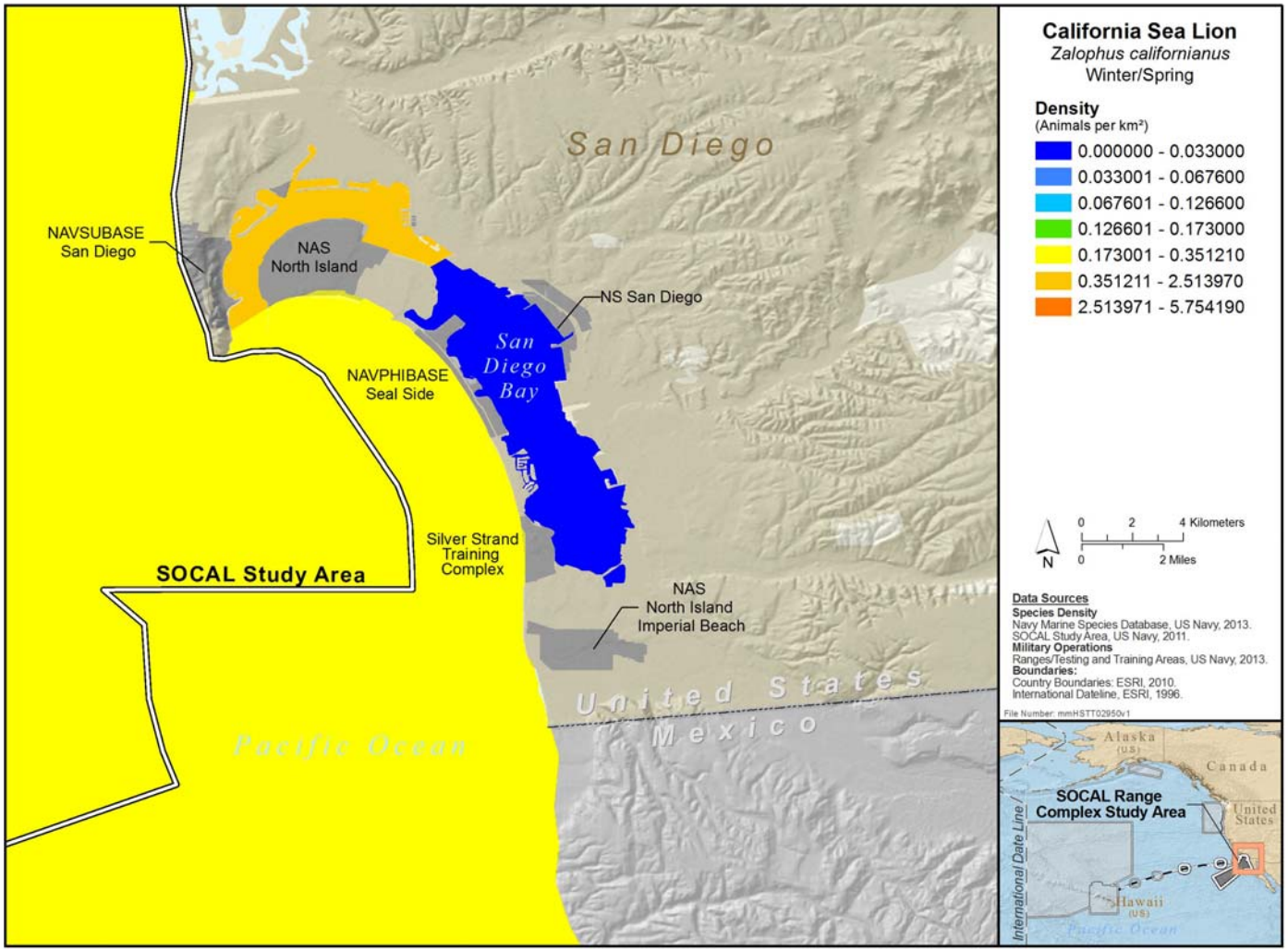

Figure 11-28: Winter/Spring Distribution of California Sea Lion in San Diego Bay on the East Edge of the SOCAL Range

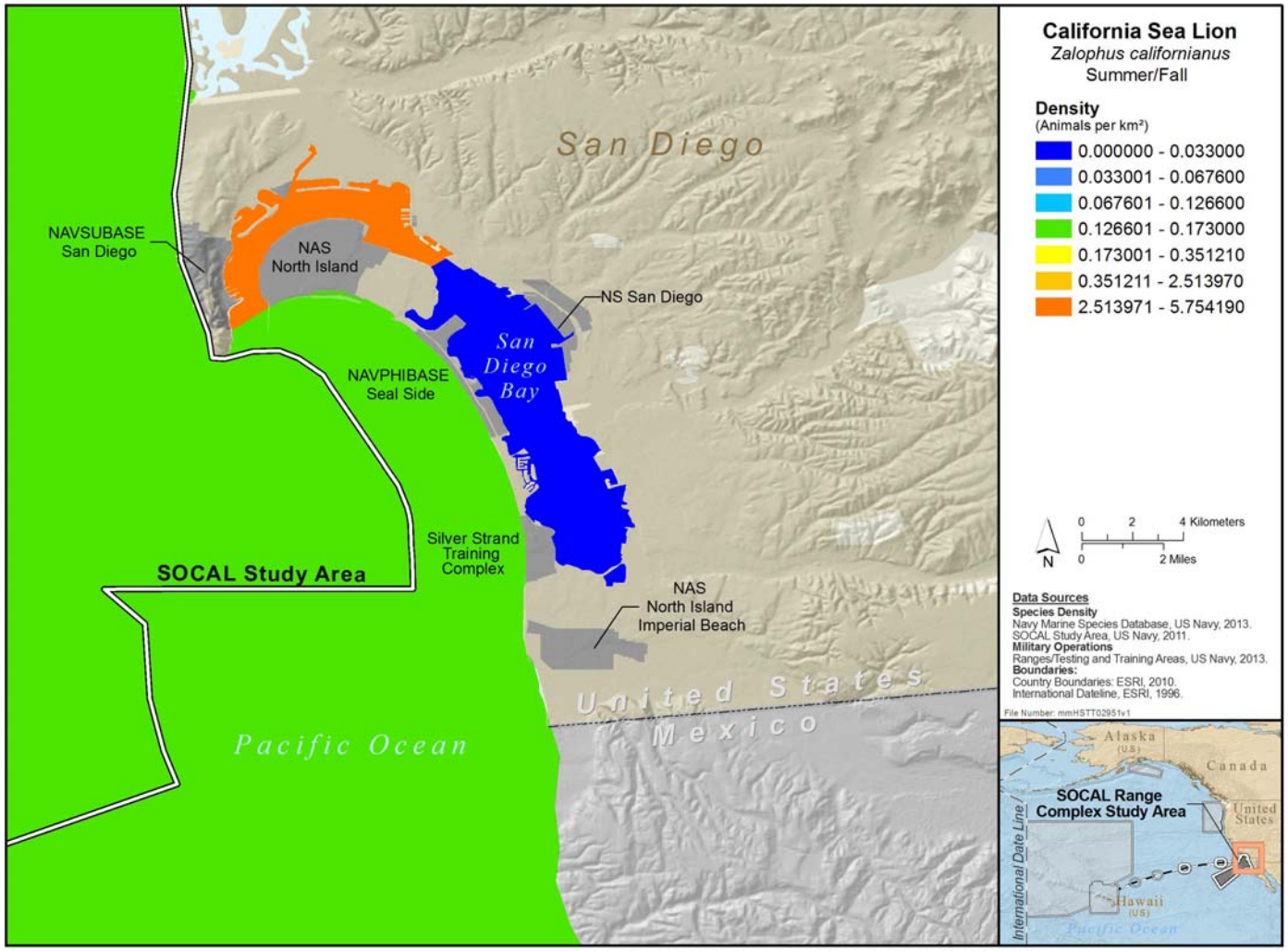

Figure 11-29: Summer/Fall Distribution of California Sea Lion in San Diego Bay on the East Edge of the SOCAL Range

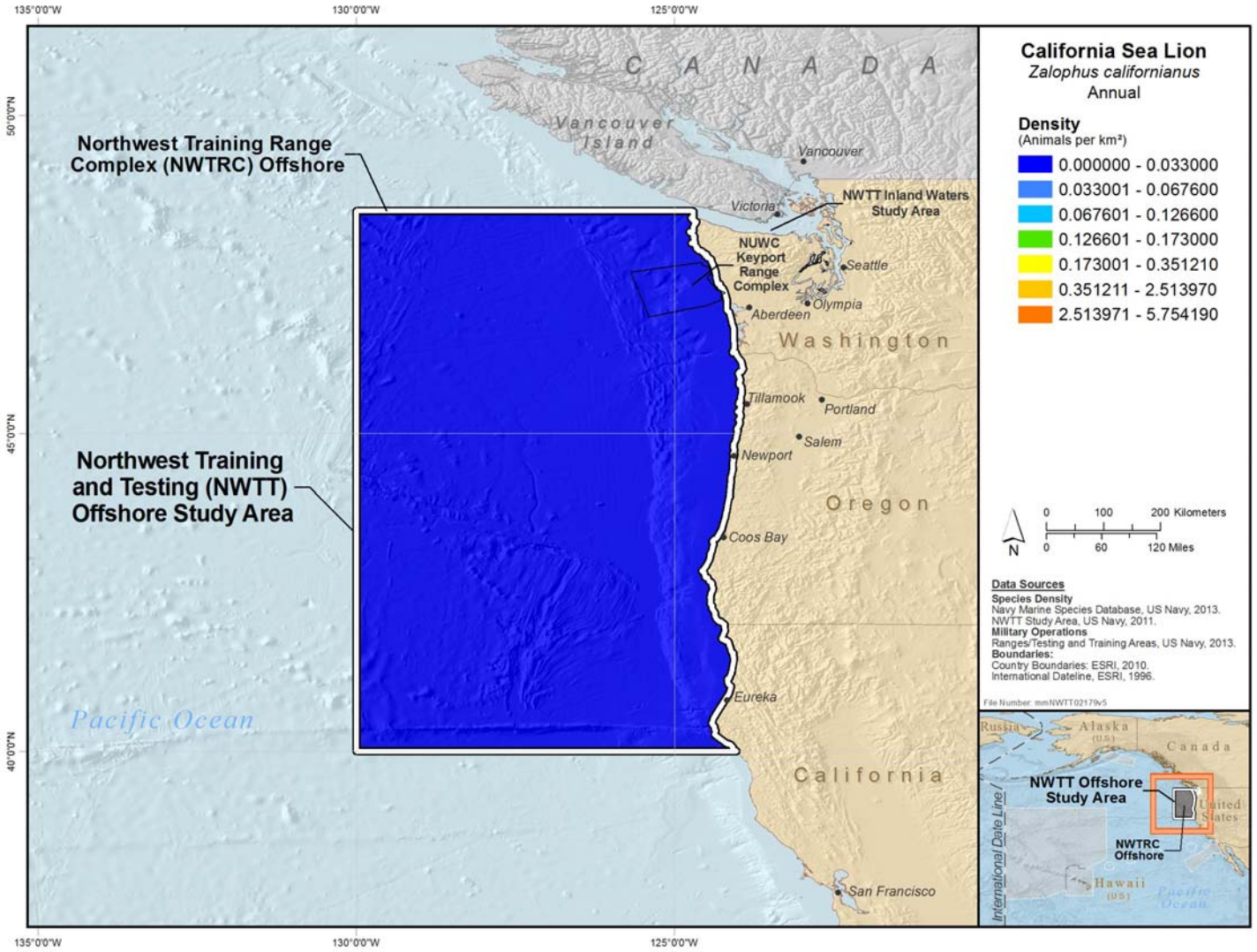

Figure 11-30: Annual Distribution of California Sea Lion in the Offshore Portion of NWTT

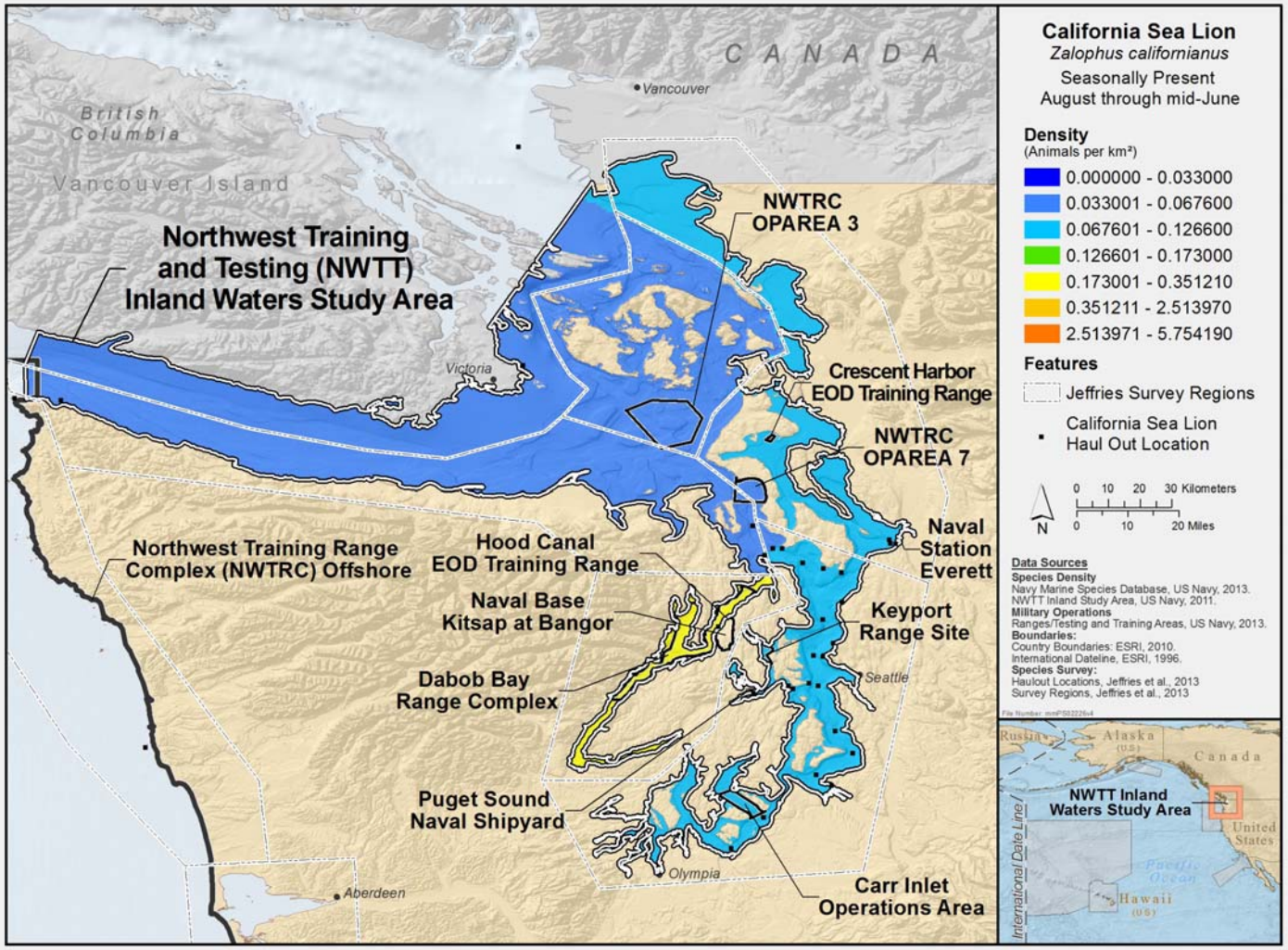

Figure 11-31: Annual Distribution of California Sea Lion in the Inland Waters Portion of NWTT

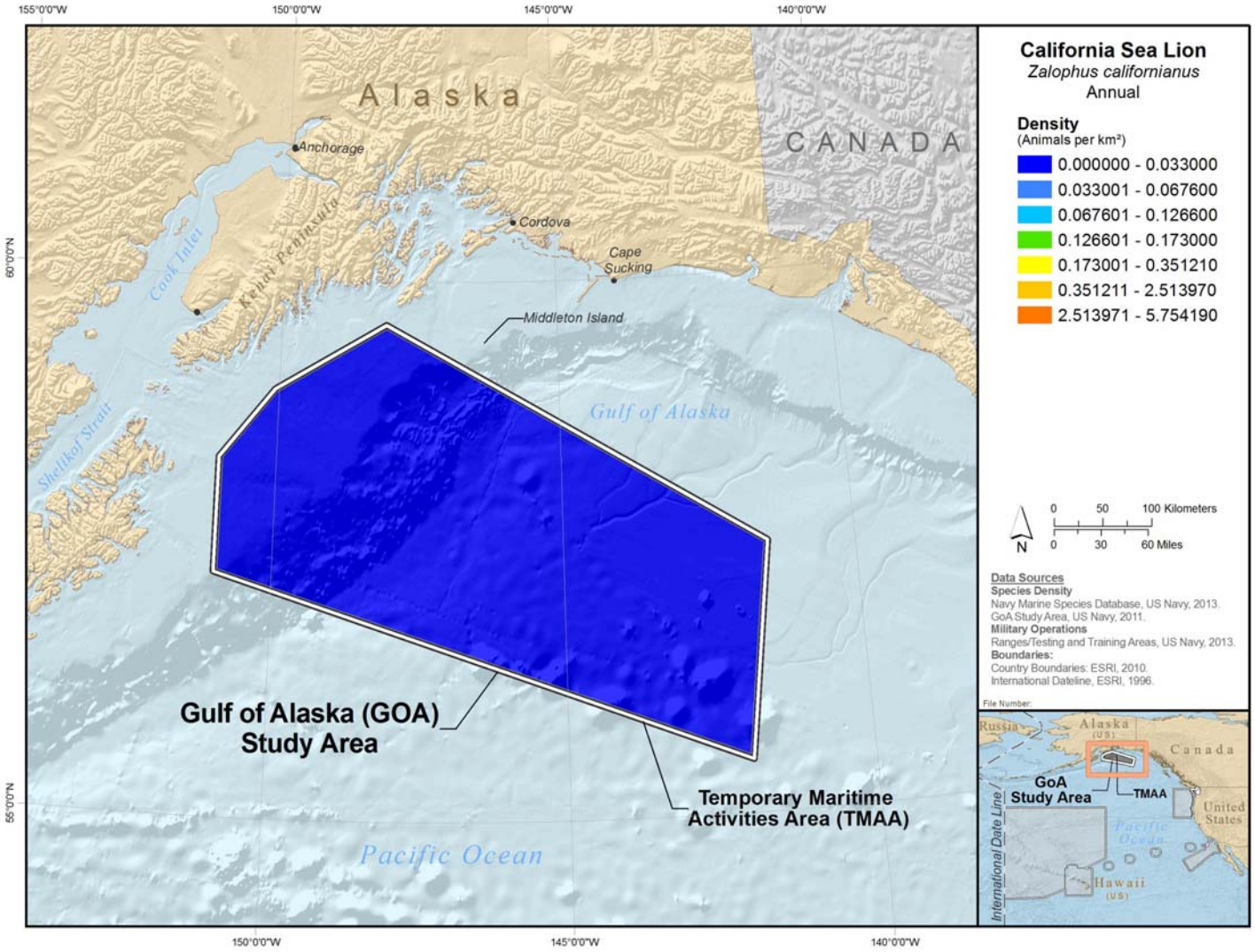

Figure 11-32: Annual Distribution of California Sea Lion in the GOA Study Area

11.1.7 *EUMETOPIAS JUBATUS*, STELLER SEA LION

Steller sea lions range along the North Pacific Rim from northern Japan to California, with centers of abundance and distribution in the Gulf of Alaska and Aleutian Islands. The species is not known to migrate, but individuals disperse widely outside of the breeding season. In the North Pacific, NMFS has designated two Steller sea lion stocks: (1) the Western U.S. stock, consisting of populations at and west of Cape Suckling, Alaska (144°W longitude); and (2) the Eastern U.S. stock, consisting of populations east of Cape Suckling, Alaska. The latter stock is the one expected to occur in the study area, and to which the density estimates apply. The population of the Eastern U.S. stock has been growing, but it is still listed as Threatened under the ESA.

HRC. This species is not expected to occur in the HRC or in the western portion of the transit corridor.

SOCAL. This species is not expected to occur in the SOCAL range complex or eastern portion of the transit corridor.

MITT. This species is not expected to occur in the MITT or associated transit corridor.

NWTT Offshore. To determine the density of Steller sea lions in the offshore portion of the NWTT Study Area, the geographic range of the Eastern U.S. stock of Steller sea lions was considered and the area of that range was estimated at 1,244,000 km^2 (NMFS 2006b). As a conservative estimate, the highest stock estimate of 72,224 animals was used. This population estimate was multiplied by 25%, as an estimate of the percentage of the population at sea (Bonnell and Bowlby 1992), which results in an estimate of 18,056 Steller sea lions. Density was calculated as the estimated number of Steller sea lions at sea (18,056) divided by the area (1,244,000 km^2), which results in a density of 0.0145/km^2. This density estimate was considered as a uniform distribution throughout the Eastern U.S. stock range.

NWTT Inland Waters. For the purpose of estimating densities of Steller sea lions, the initial strata were assumed to be the same as those described above for harbor seals. However, Regions 3 and 4 (Strait of Juan de Fuca and the San Juan Islands) were merged into one stratum and Regions 5 and 6 (Eastern Bays and Puget Sound) were combined into another stratum, while Region 7 (Hood Canal) was left as a separate stratum. Steller sea lions are present all months except for June, July, August, and September. The densities presented represent the highest numbers that would be expected during the peak winter months (approximately December–February) when this species is present in the largest numbers in the inland waters. To determine density, the number of animals known to use haulouts in each stratum was identified. The number of Steller sea lions for each region was then divided by the area of that respective region to give total density estimates for the Strait of Juan de Fuca/San Juan Islands (0.935 seals/km^2), Eastern Bays/Puget Sound (0.0368 seals/km^2), and Hood Canal 0.0251 seals/km^2).

NWTT Western Behm Canal, Alaska. For the Western Behm Canal, density estimates for all seasons were taken from the Marine Mammal Occurrence/Density Report prepared in support of a NEPA document for Navy activities at SEAFAC (U.S. Department of the Navy 2010b).

GOA. Pinniped at-sea density is not generally calculated, because they are counted much more easily while on shore. Therefore, to determine Steller sea lion densities in the GOA Study Area, two sets of

parameters were identified – the specific area and the number of animals. The area of the TMAA is approximately 87,250 km^2, which represents 6.25% of the entire GOA Large Marine Ecosystem as defined by NOAA (approximately 1,396,800 km^2, not including inland passages). To determine the number of Steller sea lions in the GOA Large Marine Ecosystem, counts of adult, juvenile and pups at rookeries in the GOA (pups = 4,518, non-pups = 13,892; data from 2004-2005), southeast Alaska (n=20,793, data from 2005) and British Columbia (n=15,402, data from 2002) were combined for a total of 54,605 animals (Angliss and Allen 2009). These are considered minimum counts, as they were not corrected for animals not counted because they were at sea. Bonnell and Bowlby (1992) estimated that 25% of the Steller sea lion population was feeding at sea at any given time. Therefore, 13,651 animals (54,605 * 0.25) would be expected to be feeding at-sea in the GOA LME. To estimate the number within the TMAA, the number of Steller sea lions in the entire GOA (13,651) was multiplied by the percent area of the TMAA compared to the GOA Large Marine Ecosystem (0.0625) for a total of 853 Steller sea lions. Density was then calculated as 853 animals/87,250 km^2, or 0.0098/km2, which is applicable to the entire Study Area year round.

Table 11-13: Sources of Density Values Used for Steller Sea Lion

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	LD	LD	LD	LD
NWTT Inland Waters (Strait of Juan de Fuca/San Juan Islands)	LD	LD	LD	LD
NWTT Inland Waters (Eastern Bays/Puget Sound)	LD	LD	LD	LD
NWTT Inland Waters (Hood Canal)	LD	LD	LD	LD
Western Behm Canal	LD	LD	LD	LD
GOA	LD	LD	LD	LD

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; N = Navy-collected data; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 11-14: Summary of Density Values for Steller Sea Lion in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
North and Central San Diego Bay	0	0	0	0
Inner Baja Extension	0	0	0	0
Outer Baja Extension	0	0	0	0
MITT	0	0	0	0
MITT Transit Corridor	0	0	0	0
NWTT Offshore	0.0145	0.0145	0.0145	0.0145
NWTT Inland Waters (Strait of Juan de Fuca/San Juan Islands)	0.935	0.935	0.935	0.935
NWTT Inland Waters (Eastern Bays/Puget Sound)	0.0368	0.0368	0.0368	0.0368
NWTT Inland Waters (Hood Canal)	0.0251	0.0251	0.0251	0.0251
Western Behm Canal	0.0098	0.0098	0.0098	0.0098
GOA	0.0098	0.0098	0.0098	0.0098

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

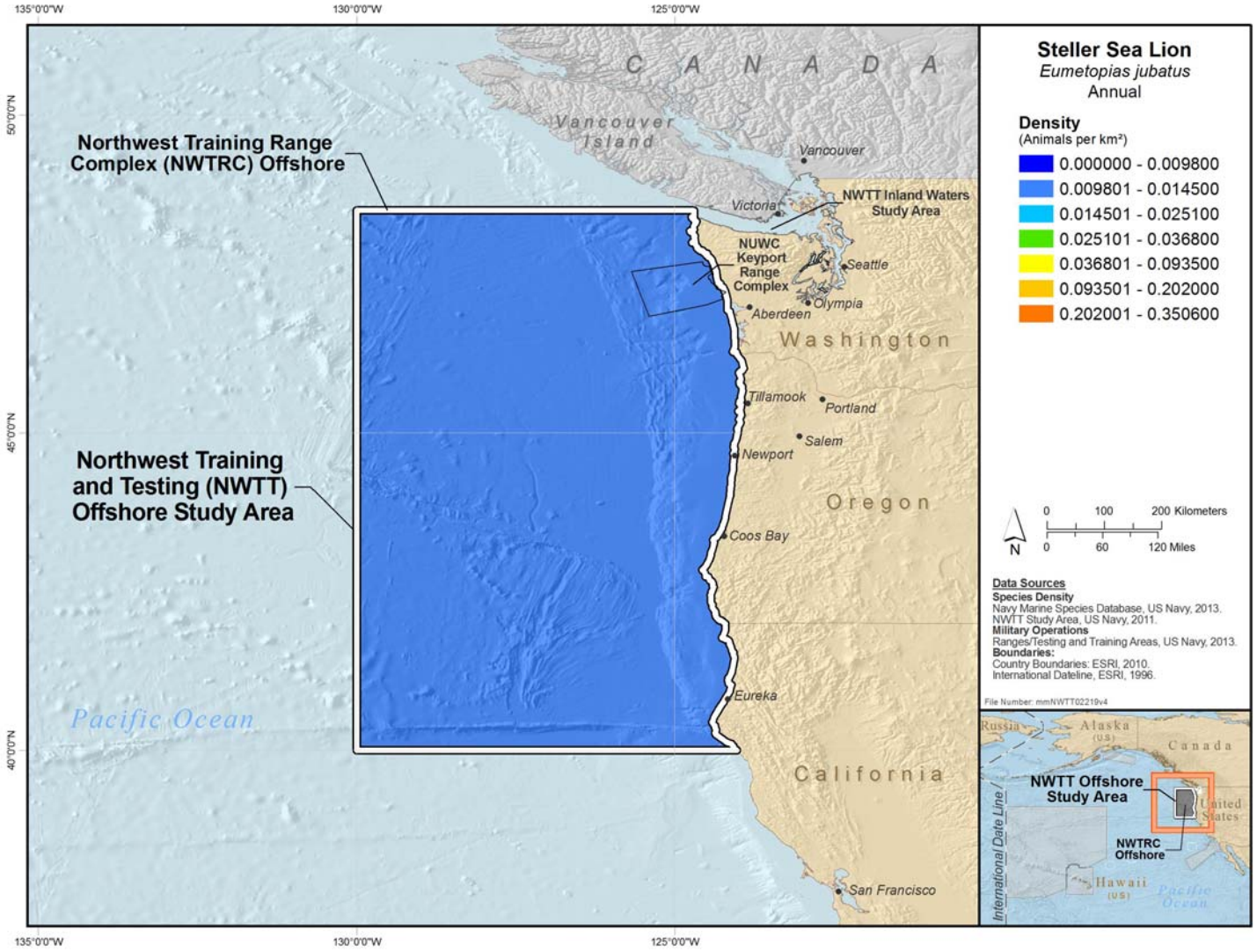

Figure 11-33: Annual Distribution of Steller Sea Lions in the Offshore Portion of NWTT

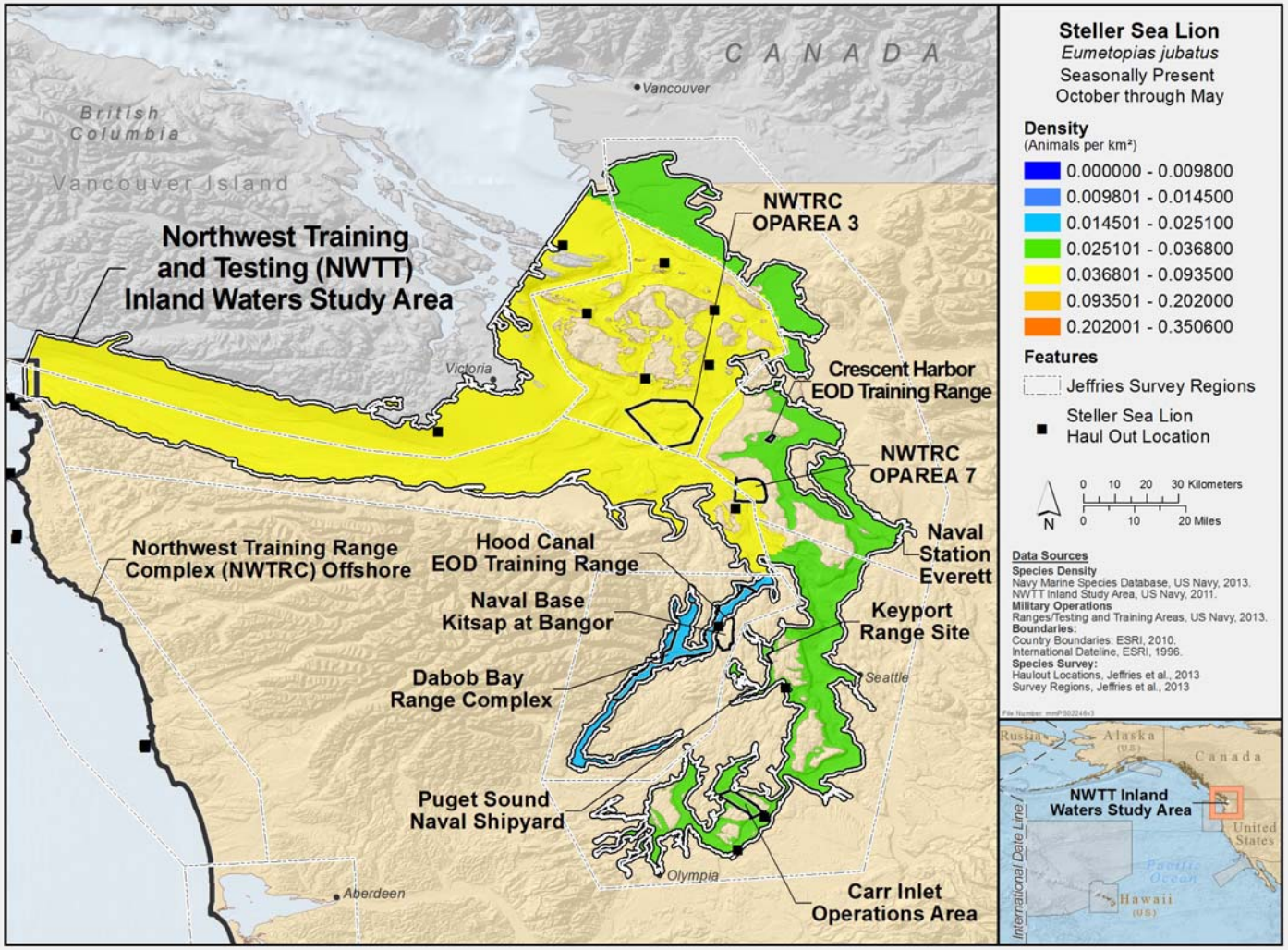

Figure 11-34: Annual Distribution of Steller Sea Lions in the Inland Waters Portion of NWTT

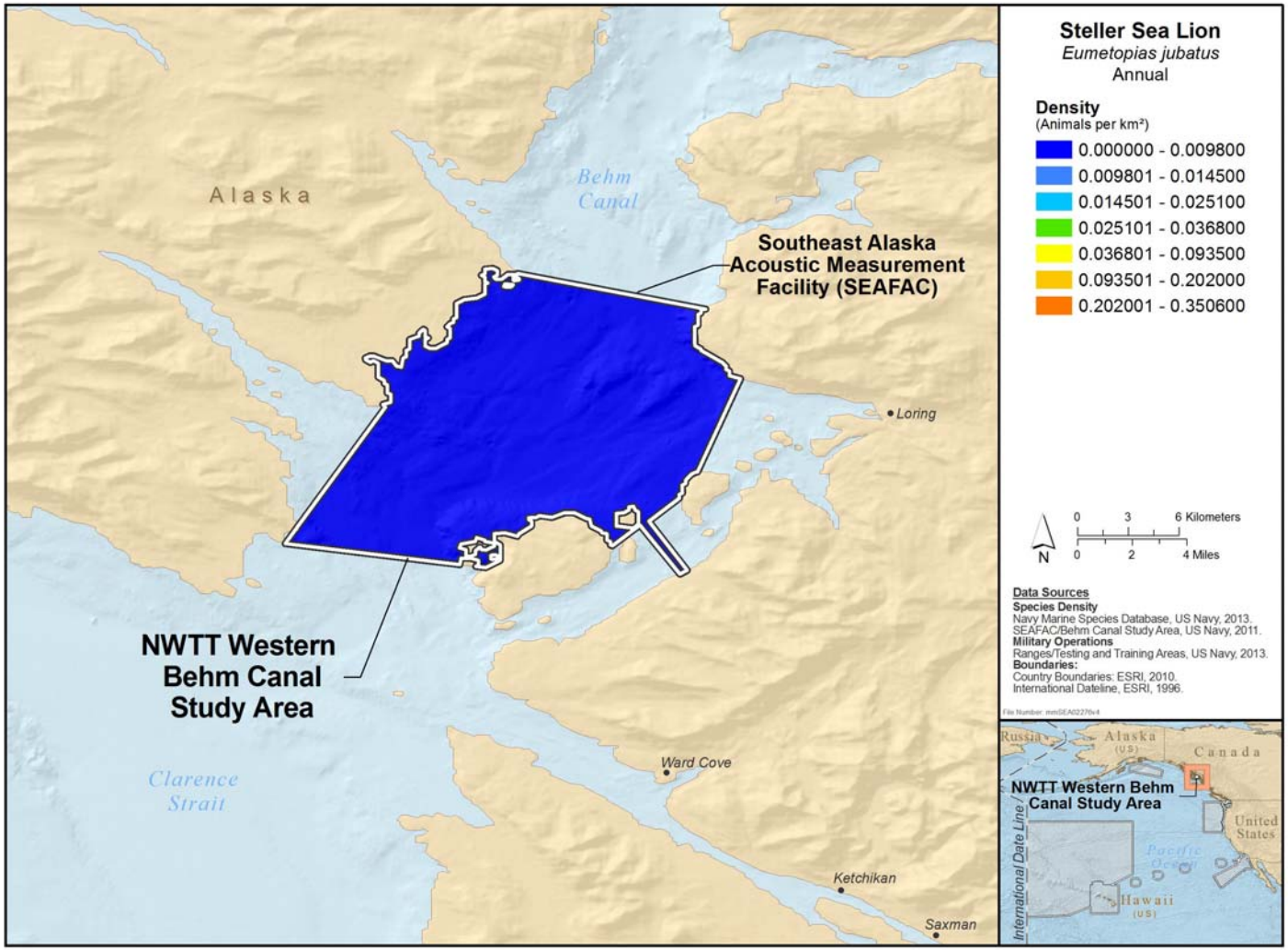

Figure 11-35: Annual Distribution of Steller Sea Lion in the Western Behm Canal Portion of NWTT

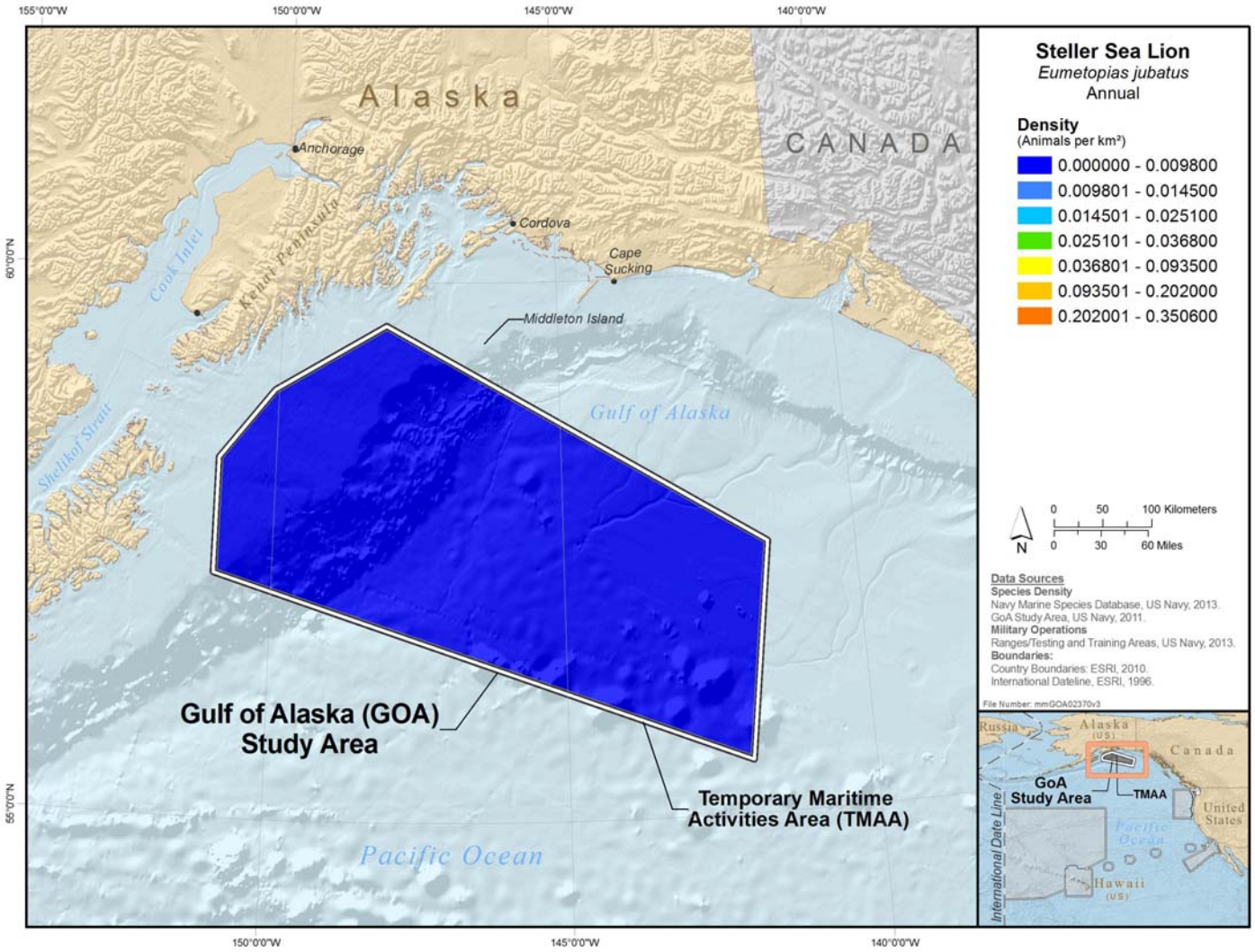

Figure 11-36: Annual Distribution of Steller Sea Lion in the GOA Study Area

12 SEA TURTLES

12.1 SEA TURTLE SPECIES PROFILES

Sea turtles are a group of marine reptiles whose species are listed as either Threatened or Endangered (Lutz and Musick 1997; Spotila 2004). There is a tremendous paucity of in-water occurrence data for sea turtles. Although tagging studies of individual turtles have been performed (e.g., Blumenthal et al. 2009; Gaos et al. 2011; Shillinger et al. 2008; Whiting and Miller 1998; Witt et al. 2010), there is little assessment of the general presence of turtles in an area beyond their use of beaches. Many studies assess turtle numbers by counting nesting individuals or number of eggs (e.g., Cheng et al. 2008; Hitipeuw et al. 2007; Honarvar et al. 2008; Lopez-Castro et al. 2004; Patino-Martinez et al. 2008) or by recording bycatch (e.g., Donoso and Dutton 2010; Koch et al. 2006). In-water densities cannot be estimated realistically from data collected on the beach. In many cases, the Navy has had to rely on data sets obtained by Navy biologists during monitoring activities. Data specific to green turtles were available for San Diego harbor from the scientific literature; otherwise no other in-water data are published for SOCAL. HRC density estimates are derived entirely from Navy data. Estimates for the MITT Study Area are derived from scientific literature and Navy monitoring and surveying efforts.

Because of the relative dominance of the system by green turtles and the techniques used for viewing sea turtles, it is necessary to lump the two species that are likely to be seen, green turtles (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*), into one generic sea turtle guild for HRC densities. Conceivably, leatherback (*Dermochelys coriacea*), olive ridley (*Lepidochelys olivacea*), and loggerhead turtles (*Caretta caretta*) could pass through the HSTT and MITT Study Areas during migration, but they are so rarely seen that the degree of their presence cannot be estimated at this time.

12.1.1 *CHELONIA MYDAS*, GREEN SEA TURTLE

Green sea turtles are found in all of the world's oceans, but primarily in the tropics (Ernst et al. 1994). In California, the species is rarely seen at sea, but there is a "resident" group of green turtles in San Diego Bay (Eguchi et al. 2010; Lemons et al. 2011). In contrast to California, green turtles are often seen in the water in Hawaii, as well as basking on some beaches (Whittow and Balazs 1982). Juvenile and adult green turtles spend a great deal of their time resting and foraging in relatively shallow nearshore waters (Blumenthal et al. 2010; Brill et al. 1995; Hazel et al. 2009), but they do perform migrations between island groups (Craig et al. 2004; Rice and Balazs 2008). In Hawaii, the status of green turtles has been improving, with larger numbers of turtles recorded near the Main Hawaiian Islands and some areas possibly approaching carrying capacity (Chaloupka and Balazs 2007). Green turtles are by far the most abundant sea turtle found throughout the Marianas archipelago. Long-term information regarding nesting population trends in Guam or Commonwealth of the Northern Mariana Islands is not available. There is, however, some indication that the Marianas may provide more important foraging nearshore habitat than nesting (Kolinski et al. 2001; Pultz et al. 1999). Table 12-1 indicates the sources for density values used for green turtles. Following descriptions of each individual range complex, Table 12-12 presents the density values used within each portion of the range complexes.

HRC. This species is treated under the sea turtle guild in HRC.

SOCAL. Densities could only be derived for San Diego Bay. So little is known about green turtle presence at sea in SOCAL, that no reasonable estimate could be made for in-water density. Eguchi et al. (2010) discuss a mark recapture study of green turtles in San Diego Bay. The highest abundance they report was 61 turtles during 2002 and 2003. The Navy uses this as a conservative ceiling of the number of turtles present. By taking that abundance estimate and dividing by the area of the entire San Diego Bay in summer and the area of the south part of the Bay (where the turtles limit their movements) in winter, the Navy arrives at summer/fall and winter/spring density estimates.

MITT. Green turtles are expected to occur year round in all shelf waters of the MITT Study Area from Farallon de Medinilla (FDM) to Guam. Aerial surveys conducted by the Guam Division of Aquatic and Wildlife Resources indicate the presence of a year-round resident population in Guam's nearshore waters (Kolinski et al. 2001; National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998a; Pultz et al. 1999). Around the larger islands, green turtle occurrence is concentrated in waters less than 328 ft. (100 m) deep, approximately 11.8 animals per km^2 (4.6 square miles [$mi.^2$]). It is at these water depths where green turtle foraging and resting habitats (e.g., fringing reefs, reef flats, and seagrass beds) are usually found. Although there may not be long-term data available for Guam or the Commonwealth of the Northern Mariana Islands, data from other Pacific regions show that green sea turtles have shown strong site fidelity to nearshore foraging habitats for extended periods of time (Balazs and Chaloupka 2004). Beyond the shelf break, green turtle occurrence is low/unknown, and assumed to be approximately 1 animal per 2.558 km^2 (0.988 $mi.^2$). Nesting females and early juveniles are known to move through oceanic waters of the Marianas chain during their reproductive and developmental migrations (Kolinski et al. 2006), but likely not in large numbers.

NWTT Offshore. The green turtle is globally distributed and generally found in tropical and subtropical waters along continental coasts and islands between latitudes 30°N and 30° south (S) (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b). In the eastern North Pacific, green turtles have been sighted from Baja California to southern Alaska, but they most commonly occur from San Diego southward (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b). Increased numbers of stranded East Pacific green turtles have been reported along the coasts of California, Oregon, and Washington during associated El Niño events (Stinson 1984). Additionally, between 1960 and 1998, of the nine green sea turtle occurrences in Alaska (as reported in Hodge and Wing 2000), four were carcasses, one was cold-stressed, and the remaining four were sightings. Therefore, the NWTT Offshore region is considered to be outside the normal range for green sea turtles.

NWTT Inland Waters. For similar reasons as described above for the offshore portion of NWTT, green sea turtles are not expected to occur in the inland waters portion of the NWTT Study Area.

NWTT Western Behm Canal, Alaska. Green sea turtles are not expected to occur in the Western Behm Canal portion of the NWTT Study Area.

GOA. Green sea turtles are not expected to occur in the GOA Study Area.

Table 12-1: Sources of Density Values Used for Green Sea Turtle

Location	Spring	Summer	Fall	Winter
HRC	G	G	G	G
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	LD	LD	LD	LD
MITT	LD and N	LD and N	LD and N	LD and N
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
NWTT Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; N = Navy-collected data; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS; G = This species is treated under the sea turtle guild in HRC. For a complete description of data sets refer to Section 3.

Table 12-2: Summary of Density Values for Green Sea Turtle in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	G	G	G	G
W. Transit Corridor	N/A	N/A	N/A	N/A
E. Transit Corridor	N/A	N/A	N/A	N/A
SOCAL	N/A	N/A	N/A	N/A
San Diego Bay entire	1.618293	1.618293	N/A	N/A
San Diego Bay south	N/A	N/A	0.3779	0.3779
Inner Baja Extension	N/A	N/A	N/A	N/A
Outer Baja Extension	N/A	N/A	N/A	N/A
MITT (nearshore Guam)	0.2968	0.2968	0.2968	0.2968
MITT (nearshore Tinian and other islands)	11.8	11.8	11.8	11.8
MITT (pelagic and Transit Corridor)	0.000391	0.000391	0.000391	0.000391
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
NWTT Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; G = This species is treated under the sea turtle guild in HRC; N/A = sufficient data are not available or location is not applicable; S = spatial model with various density values throughout the range.

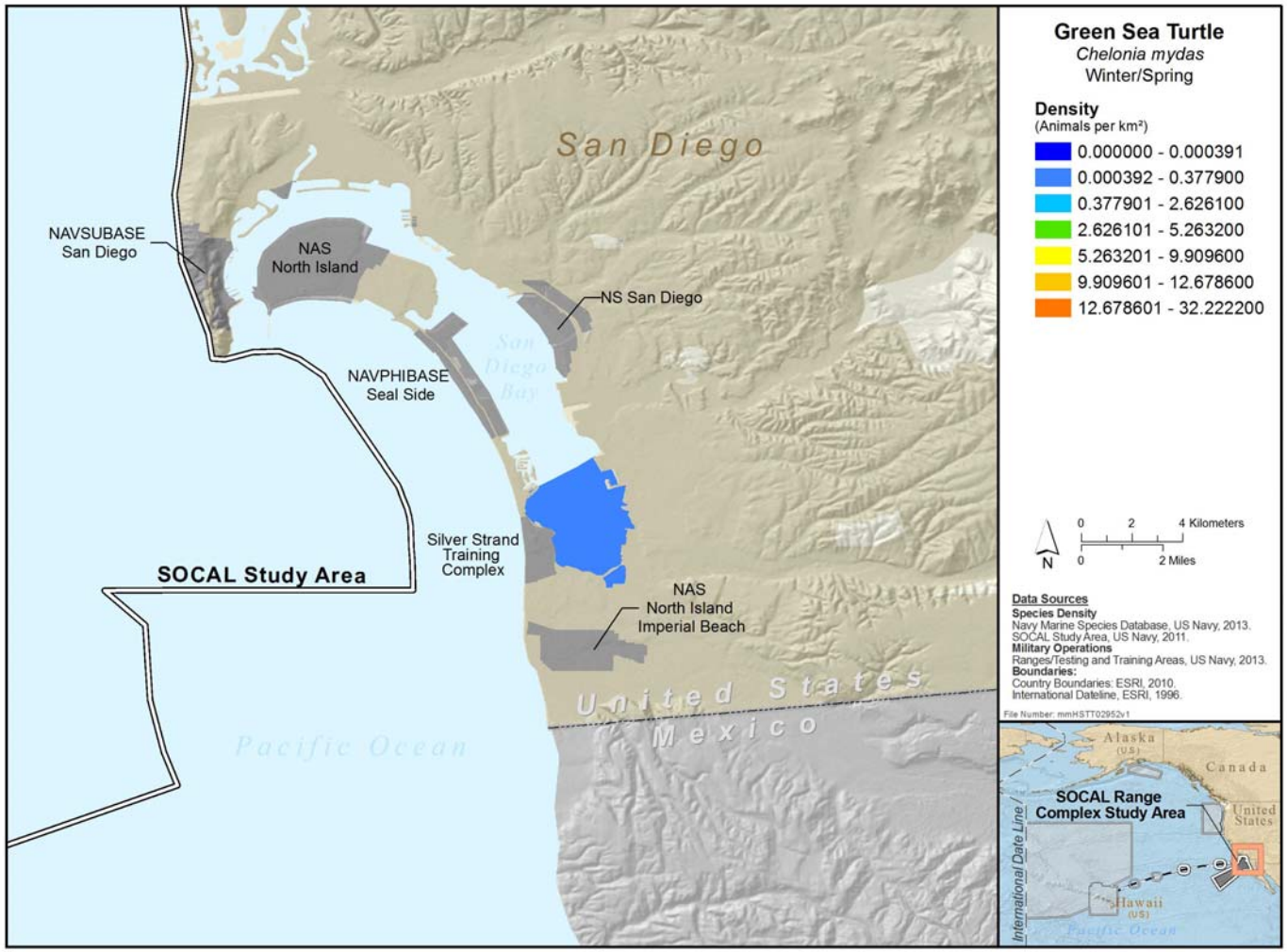

Figure 12-1: Winter/Spring Distribution of Green Sea Turtle in San Diego Bay

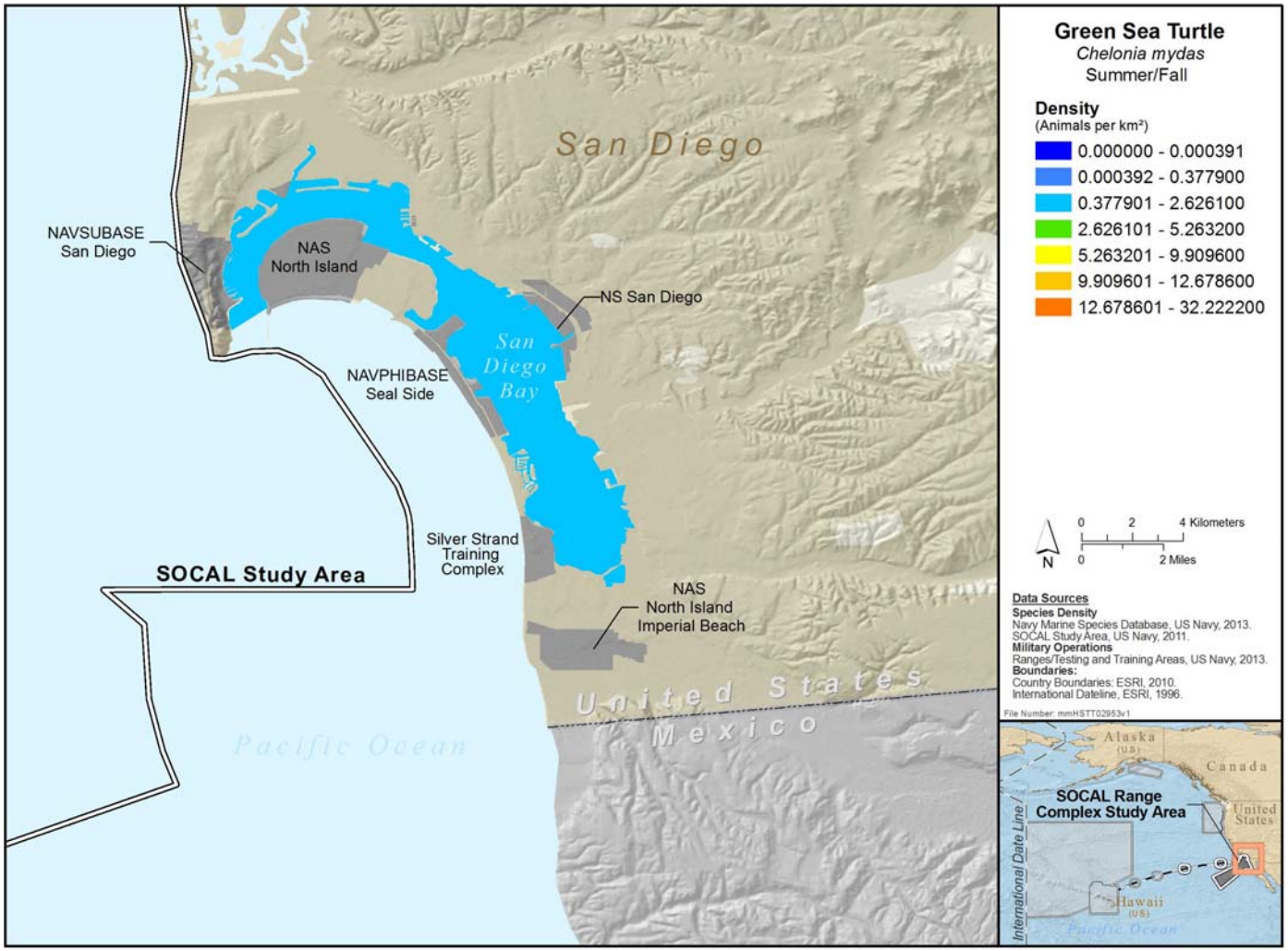

Figure 12-2: Summer/Fall Distribution of Green Sea Turtle in San Diego Bay

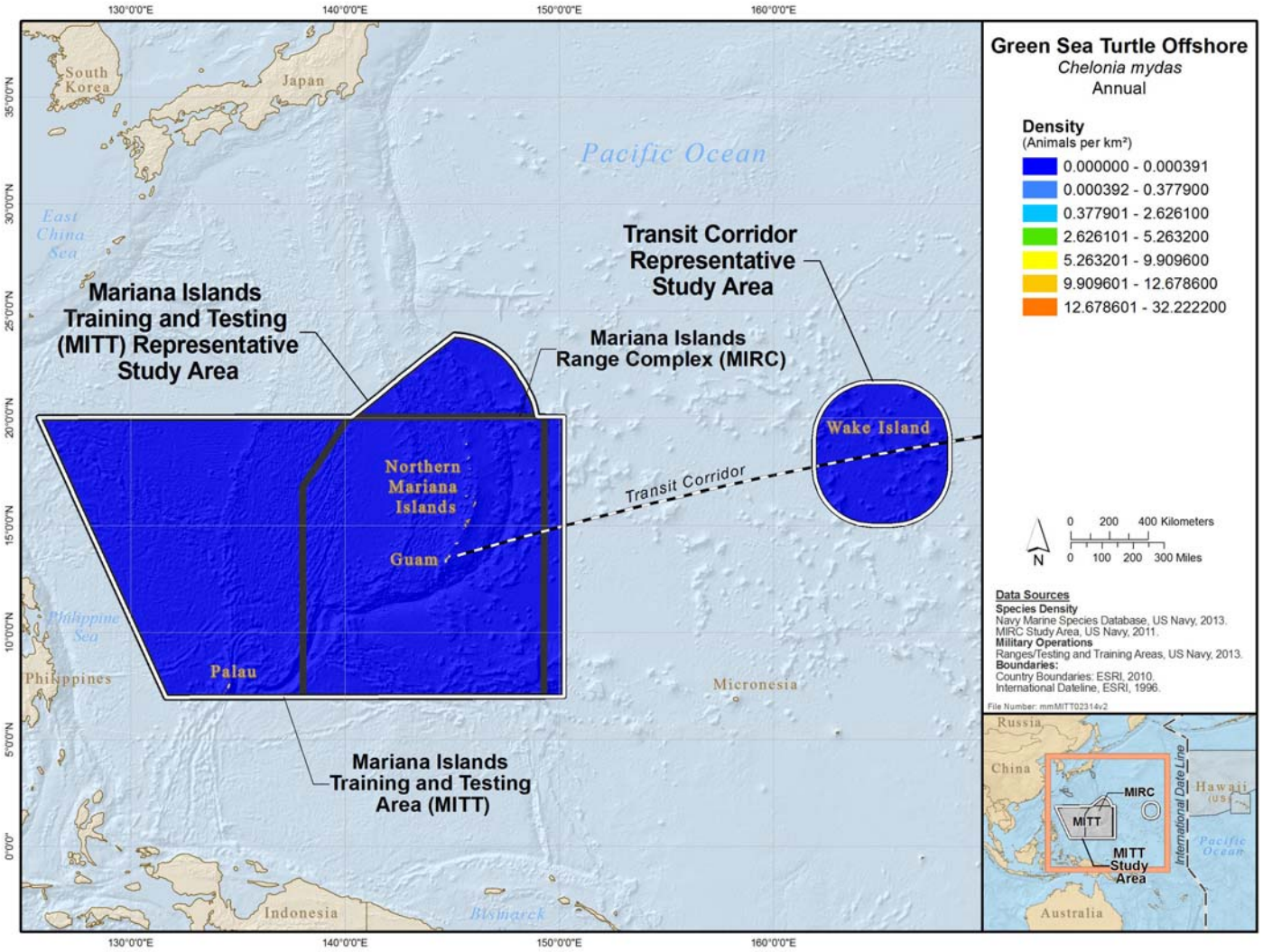

Figure 12-3: Annual Offshore Distribution of Green Sea Turtle in MITT and Associated Transit Corridor

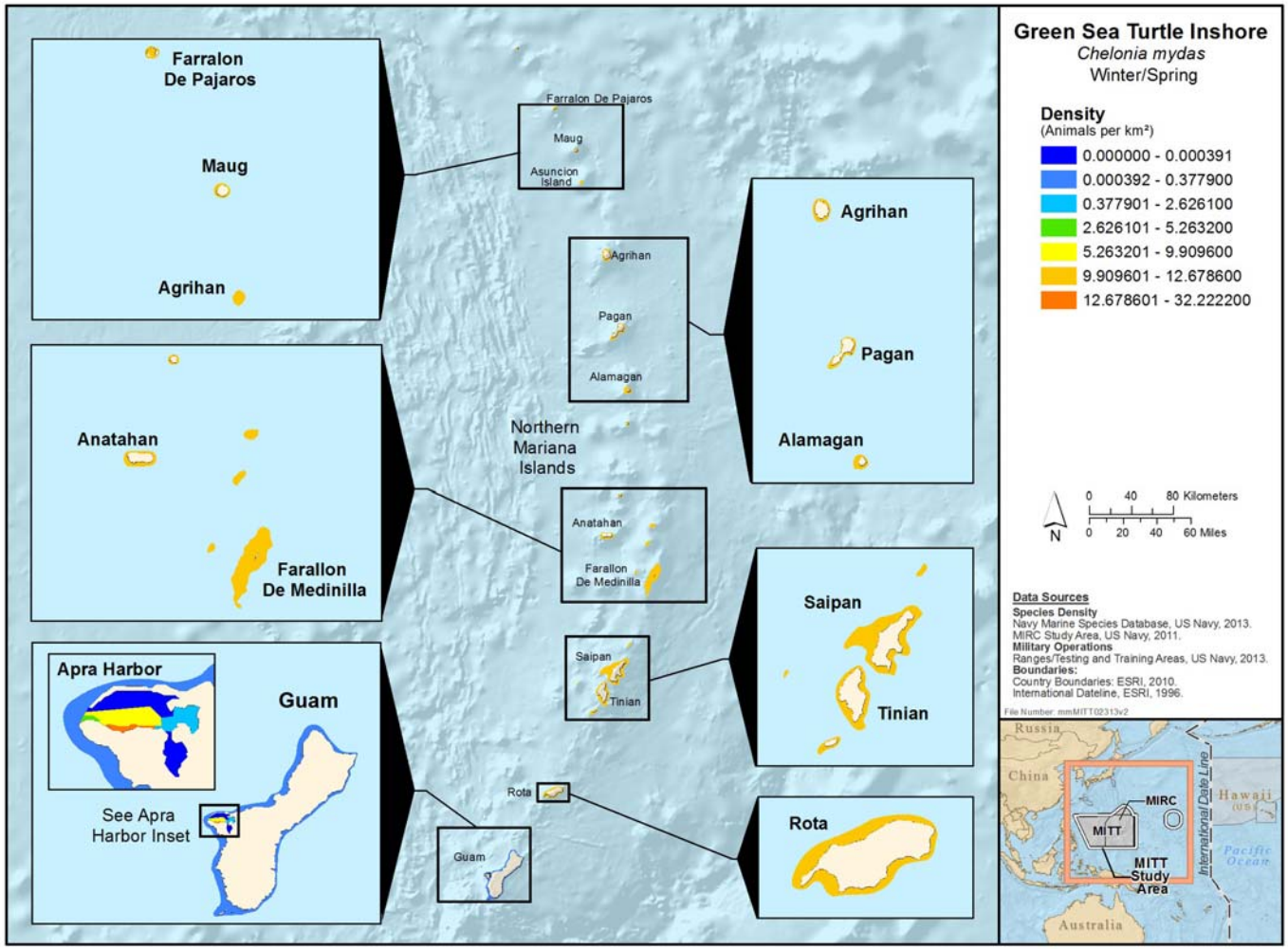

Figure 12-4: Winter/Spring Inshore Distribution of Green Sea Turtle in MITT

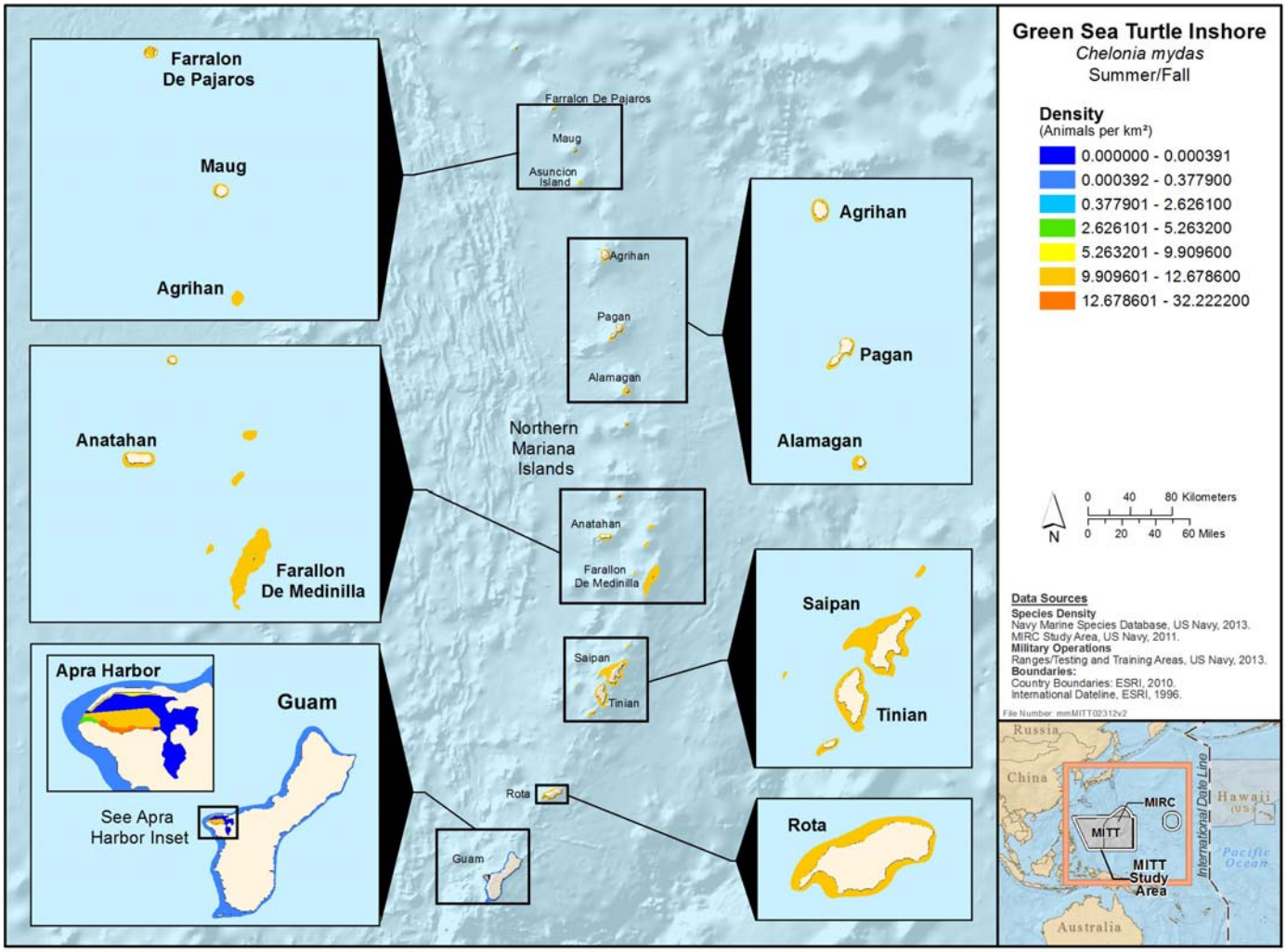

Figure 12-5: Summer/Fall Inshore Distribution of Green Sea Turtle in MITT

12.1.2 *ERETMOCHELYS IMBRICATA*, HAWKSBILL TURTLE

Hawksbill turtles were one of the first turtles protected under the Endangered Species Act (Ernst et al. 1994). The species was harvested aggressively for its beautiful shell and for food. It remains endangered throughout the world. The species is not observed in California (SWOT 2007). Worldwide, hawksbill turtles do not enjoy the same upward population trend as green turtles, although the small population that nests in the Hawaiian Islands may be increasing (National Marine Fisheries Service & U.S. Fish and Wildlife Service 2007c). Strandings and observations of hawksbill turtles in Hawaii are uncommon.

Although there are only a few recent hawksbill occurrence records in the MITT Study Area (U.S. Department of the Navy 2003), historical records indicate a likely presence of this species in the coastal waters surrounding the islands of the southern Marianas arc (i.e., from FDM south to Guam) (Kolinski et al. 2001). As a result, hawksbill turtles are expected to occur in all waters located inside the shelf break within the MITT Study Area, including within Guam's Apra Harbor. Since hawksbill turtles are critically endangered and do not occur in large numbers anywhere within the region, there are no areas of concentrated occurrence around Guam and the Commonwealth of the Northern Mariana Islands. In deeper waters beyond the shelf break, the occurrence of the hawksbill turtle is low/unknown. Table 12-3 indicates the sources for density values used for hawksbill turtles. Following are descriptions of each individual range complex.

Table 12-4 presents the density values used within each portion of the range complexes.

HRC. This species is treated under the sea turtle guild in HRC.

SOCAL. This species is not expected to occur in SOCAL or in the eastern portion of the transit corridor.

MITT. In all Navy surveys in Apra Harbor, Guam, and at four locations at Tinian (Babui, Chulu, Babui-Chulu, and Dangkolo), there were 88 sea turtles sighted. Of the 88 sightings, one was reported as possibly being a hawksbill, which represented approximately 1.136% of all sightings. For inshore waters surrounding Guam and the Commonwealth of the Northern Mariana Islands, the most recent green turtle density estimate (11.8 turtles per km^2) was used to generate an inshore density estimate for hawksbill turtles of 0.1342 turtles per km^2. Additional Navy surveys in 2008 and 2010 surrounding Farallon de Medinilla (FDM) report low but persistent sightings of hawksbills and these data were used to estimate an inshore density at FDM of 1.0734 turtles per km^2.

There are no known nesting beaches of hawksbills in the MITT Study Area, and regional nesters may only number in the hundreds (Gaos 2011; Limpus 2009). However, Miller's telemetry work (Miller et al. 1998) indicated that hawksbill turtles on breeding migrations move between Australia and neighboring countries including Vanuatu, Solomon Islands, Papua New Guinea, and Indonesia. Hawksbills may therefore occasionally transit the MITT Study Area. Naughton's survey work at Oroluk Atoll observed hawksbill turtles and green sea turtles with only 6% of sightings being hawksbills (Naughton 1991). The abundance estimate for pelagic green sea turtle density was used as a base and multiplied by 0.06 to generate an area density estimate.

NWTT. This species is not expected to occur in the NWTT Study Area.

GOA. This species is not expected to occur in the GOA Study Area.

Table 12-3: Sources of Density Values Used for Hawksbill Turtle

Location	Spring	Summer	Fall	Winter
HRC	G	G	G	G
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
MITT	LD and N	LD and N	LD and N	LD and N
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
NWTT Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; N = Navy-collected data; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS; G = This species is treated under the sea turtle guild in HRC; N/A = sufficient data are not available or location is not applicable. For a complete description of data sets refer to Section 3.

Table 12-4: Summary of Density Values for Hawksbill Turtle in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	G	G	G	G
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
MITT (nearshore FDM)	1.0734	1.0734	1.0734	1.0734
MITT (nearshore other islands)	0.1342	0.1342	0.1342	0.1342
MITT (pelagic and Transit Corridor)	0.000024	0.000024	0.000024	0.000024
NWTT Offshore	0	0	0	0
NWTT Inland Waters	0	0	0	0
NWTT Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; G = This species is treated under the sea turtle guild in HRC; N/A = sufficient data are not available or location is not applicable; S = spatial model with various density values throughout the range.

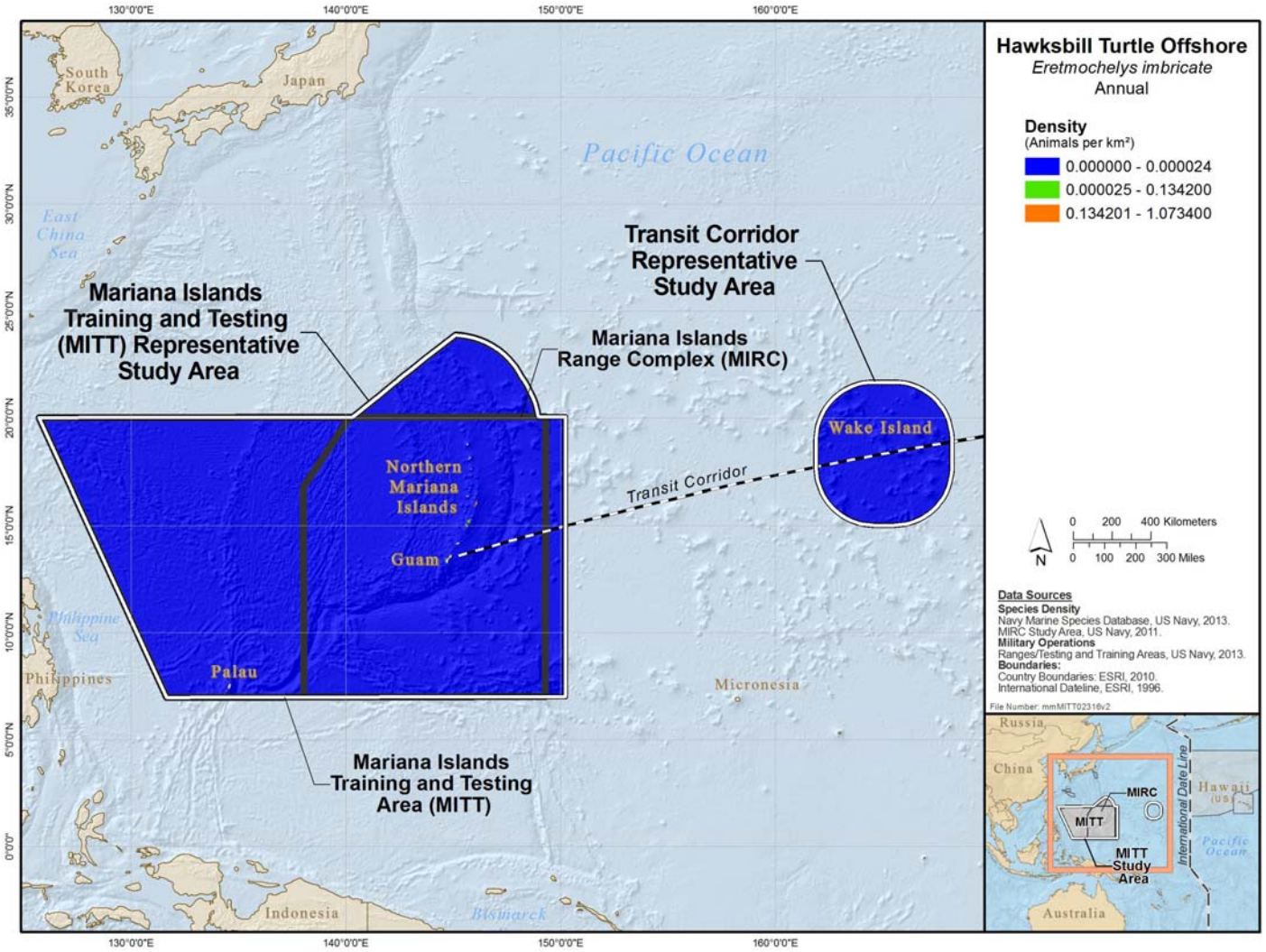

Figure 12-6: Annual Offshore Distribution of Hawksbill Turtle in MITT and Associated Transit Corridor Study Areas

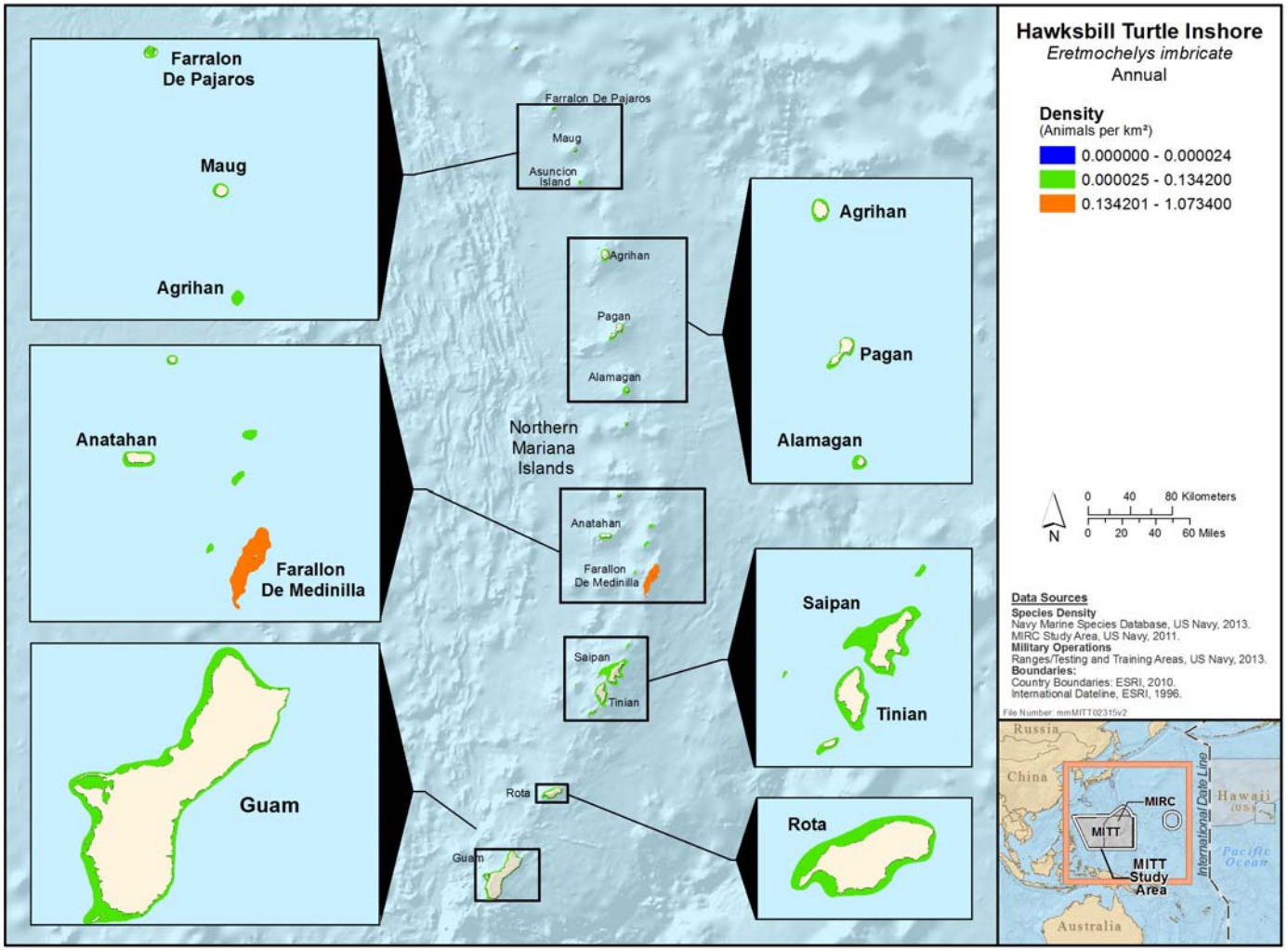

Figure 12-7: Annual Inshore Distribution of Hawksbill Turtle in MITT

12.1.3 *CARETTA CARETTA*, LOGGERHEAD SEA TURTLE

The loggerhead turtle is found in temperate to tropical regions and is generally found between 40°N and 40°S in the Atlantic, Pacific, and Indian Oceans and in the Mediterranean Sea (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007). In a September 2011 rulemaking, the NMFS and U.S. Fish and Wildlife Service determined that the loggerhead sea turtle is composed of nine distinct population segments, four listed as Threatened and five as Endangered under the ESA to be effective 24 October 2011. The loggerhead turtle has been separated into nine distinct populations under the distinct population segment policy. Four of these populations (Northwest Atlantic Ocean, South Atlantic Ocean, Southeast Indo-Pacific Ocean, and Southwest Indian Ocean) are listed as Threatened, with the other five (Northeast Atlantic Ocean, Mediterranean Sea, North Indian Ocean, North Pacific, and South Pacific) listed as Endangered.

The loggerhead turtle is found in habitats ranging from coastal estuaries to the open ocean (Dodd 1988). The species may be found hundreds of miles out to sea, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. Table 12-5 indicates the sources for density values used for loggerhead turtles. Following descriptions of each individual range complex, Table 12-6 presents the density values used within each portion of the range complexes.

HRC. This species is treated under the sea turtle guild in HRC.

SOCAL. Loggerheads are known to forage off the coast of Baja and therefore could occur in the SOCAL area. However, so little is known about loggerhead presence at sea in SOCAL, that no reasonable estimate could be made for in-water density.

MITT. There are no sighting, stranding, or nesting records for loggerhead turtles around Guam and the Commonwealth of the Northern Mariana Islands. As a result, loggerhead turtles are considered rare within the MITT Study Area. This species is more apt to be found in temperate waters of the North Pacific Ocean (i.e., north of 25°N) of countries such as Japan, China, Taiwan, northwestern Mexico, and the southwestern U.S. including Hawaii (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998b; Polovina et al. 2004). However, Guam and the Commonwealth of the Northern Mariana Islands are identified as being within the species' overall range (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007, Kobayashi et al. 2008). Also, the westward flowing current of the North Pacific Subtropical Gyre system, which late juvenile stage loggerheads use when returning to the western Pacific, passes through the Marianas region. For modeling purposes, a density of 0.000022 animals per km^2 (1 sea turtle per 45,454 km^2 [17,550 $mi.^2$]) is used to represent the occasional transit of the Study Area.

NWTT Offshore. In the eastern Pacific, loggerheads have been reported as far north as Alaska, and as far south as Chile (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007c). In the United States, occasional sightings are reported from the coasts of Washington and Oregon, but most records are of juveniles off the coast of California (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998a; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007c). Of the two loggerhead occurrences between 1960 and 1998 in Alaska reported by Hodge and Wing (2000), one was

a carcass and the other was a live sighting. Therefore, the NWTT Offshore region is considered to be outside the normal range for loggerhead sea turtles.

NWTT Inland Waters. For similar reasons as summarized above for the offshore portion of NWTT, loggerhead sea turtles are not expected to occur in the inland waters portion of the NWTT Study Area.

NWTT Western Behm Canal, Alaska. Loggerhead sea turtles are not expected to occur in the Western Behm Canal portion of the NWTT Study Area.

GOA. Loggerhead sea turtles are not expected to occur in the GOA Study Area.

Table 12-5: Sources of Density Values Used for Loggerhead Sea Turtle

Location	Spring	Summer	Fall	Winter
HRC	G	G	G	G
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
MITT	0 and L	0 and L	0 and L	0 and L
NWTT Offshore	0	0	0	0
NWTT Inshore	0	0	0	0
NWTT Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; N = Navy-collected data; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS; G = This species is treated under the sea turtle guild in HRC; N/A = sufficient data are not available or location is not applicable. For a complete description of data sets refer to Section 3.

Table 12-6: Summary of Density Values for Loggerhead Sea Turtle in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	G	G	G	G
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
MITT	0.000022	0.000022	0.000022	0.000022
NWTT Offshore	0	0	0	0
NWTT Inshore	0	0	0	0
NWTT Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; G = This species is treated under the sea turtle guild in HRC; N/A = sufficient data are not available or location is not applicable; S = spatial model with various density values throughout the range.

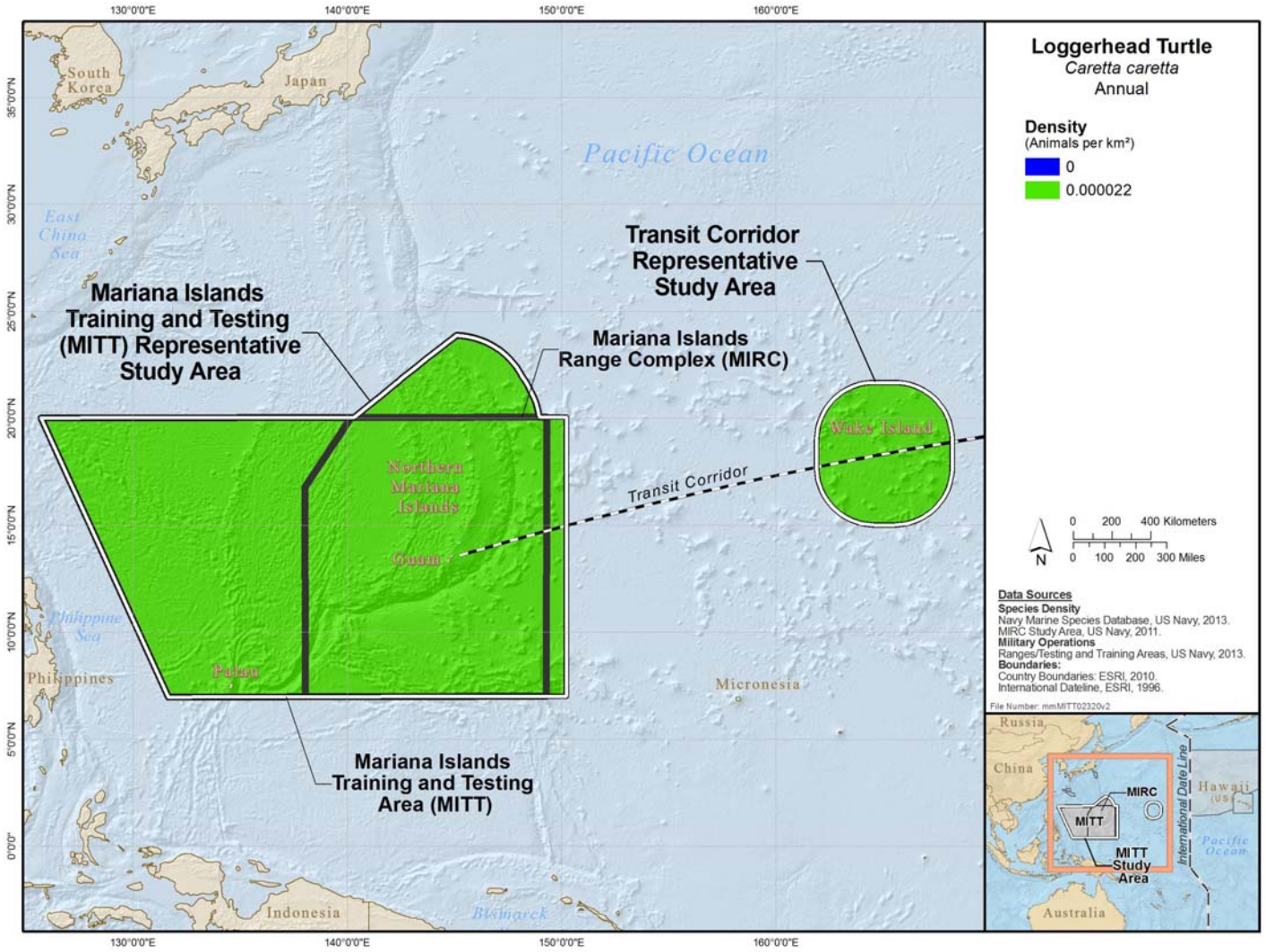

Figure 12-8: Annual Distribution of Loggerhead Sea Turtle in MITT and Associated Transit Corridor Study Areas

12.1.4 *LEPIDOCHELYS OLIVACEA*, OLIVE RIDLEY SEA TURTLE

The olive ridley turtle is known as an open-ocean species, but can be found in coastal areas. These animals are found in tropical waters of the South Atlantic, Indian, and Pacific Oceans. Olive ridleys are classified as Threatened under the ESA, although the Mexican Pacific coast nesting population is listed as Endangered. Even though there are no current estimates of worldwide abundance, the olive ridley is still considered the most abundant of the world's sea turtles. However, the number of olive ridley turtles occurring in U.S. territorial waters is believed to be small (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998c). Before the commercial exploitation of olive ridley turtles, this species was highly abundant in the eastern tropical Pacific Ocean, probably outnumbering all other sea turtle species combined (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998c). The decline of the species continues at several important nesting beaches in Central America and in India. Critical habitat has not been designated for the olive ridley. Table 12-7 indicates the sources for density values used for olive ridley turtles. Following descriptions of each individual range complex, Table 12-8 presents the density values used within each portion of the range complexes.

HRC. This species is treated under the sea turtle guild in HRC.

SOCAL. There are few documented occurrences of olive ridley sea turtles in waters off the west coast of the United States (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998b) and there is not enough known about olive ridley sea turtle presence at sea in SOCAL to provide a reasonable in-water density estimate.

MITT. The nearest in-water sightings of this species have occurred within the Yap Districts (Eckert et al. 1999; Pritchard and Plotkin 1995). It is possible that future occurrences could occur in the MITT Study Area and vicinity, as olive ridleys have been satellite-tracked through North Pacific waters as far south as 8°N during developmental migrations (Eguchi et al. 2007; Polovina et al. 2004). The occurrence of the olive ridley turtle is rare throughout the year in all waters surrounding Guam and the Commonwealth of the Northern Mariana Islands. For modeling purposes, a density of 0.000001 turtle per km^2 is used to represent the occasional transit of the Study Area by an olive ridley sea turtle.

NWTT Offshore. There are few documented occurrences of olive ridley sea turtles in waters off the west coast of the United States (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998b). In the eastern Pacific, the olive ridley typically occurs in tropical and subtropical waters as far south as Peru and as far north as California, but it was only twice documented as far north as Alaska between 1960 and 1998 (as carcasses) (Hodge and Wing 2000. Therefore, the NWTT Offshore region is considered to be outside the normal range for olive ridley sea turtles.

NWTT Inland Waters. For similar reasons as summarized above for the offshore portion of NWTT, olive ridley sea turtles are not expected to occur in the inland waters portion of the NWTT Study Area.

NWTT Western Behm Canal, Alaska. Olive ridley sea turtles are not expected to occur in the Western Behm Canal region of the NWTT Study Area.

GOA. Olive ridley sea turtles are not expected to occur in the GOA Study Area.

Table 12-7: Sources of Density Values Used for Olive Ridley Sea Turtle

Location	Spring	Summer	Fall	Winter
HRC	G	G	G	G
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
MITT	LD and N	LD and N	LD and N	LD and N
NWTT Offshore	0	0	0	0
NWTT Inshore	0	0	0	0
NWTT Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; N = Navy-collected data; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS; G = This species is treated under the sea turtle guild in HRC; N/A = sufficient data are not available or location is not applicable. For a complete description of data sets refer to Section 3.

Table 12-8: Summary of Density Values for Olive Ridley Sea Turtle in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	G	G	G	G
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
MITT	0.00001	0.00001	0.00001	0.00001
NWTT Offshore	0	0	0	0
NWTT Inshore	0	0	0	0
NWTT Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; G = This species is treated under the sea turtle guild in HRC; N/A = sufficient data are not available or location is not applicable; S = spatial model with various density values throughout the range.

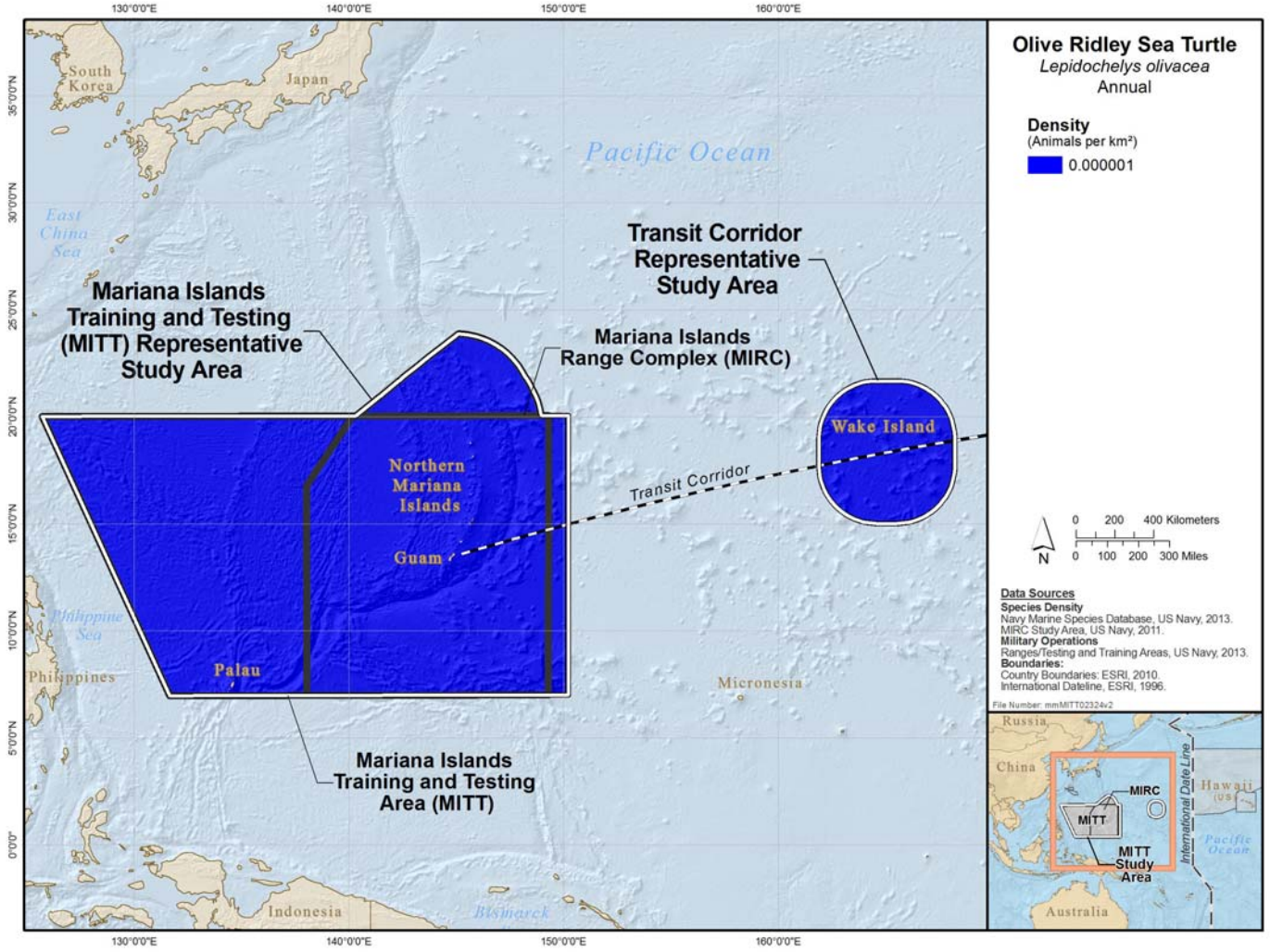

Figure 12-9: Annual Distribution of Olive Ridley Sea Turtle in MITT and Associated Transit Corridor Study Areas

12.1.5 *DERMOCHELYS CORIACEA*, LEATHERBACK SEA TURTLE

The leatherback turtle is the most widely distributed of all sea turtles, found from tropical to subpolar oceans, and nests on tropical and occasionally subtropical beaches (Gilman 2008; Myers and Hays 2006; National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992). Found from 71°N to 47°S, it has the most extensive adult range of any turtle (Eckert 1995). Leatherbacks are also the most migratory sea turtles and are able to tolerate colder water (thermoregulatory adaptations such as a counter-current heat exchange system, high oil content, and large body size allow them to maintain a core body temperature higher than that of the surrounding water) than other species (Hughes et al. 1998; James and Mrosovsky 2004). Adult leatherback turtles forage in temperate and subpolar regions in all oceans, and migrate to tropical nesting beaches between 30°N and 20°S. Leatherbacks have a wide nesting distribution, primarily on isolated mainland beaches in tropical oceans (mainly in the Atlantic and Pacific Oceans, with few in the Indian Ocean) and temperate oceans (southwest Indian Ocean) (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992), and to a lesser degree on some islands. Table 12-9 indicates the sources for density values used for leatherback turtles. Following descriptions of each individual range complex, Table 12-10 presents the density values used within each portion of the range complexes.

HRC. This species is treated under the sea turtle guild in HRC.

SOCAL. There is currently not enough known about leatherback sea turtle presence at sea in SOCAL to provide a reasonable in-water density estimate.

MITT. Of the three sea turtle species that have been sighted around Guam and the Commonwealth of the Northern Mariana Islands during marine surveys, the leatherback turtle is the least common (U.S. Department of the Navy 2003). This species is occasionally encountered in the deep, pelagic waters of the Marianas archipelago, although only a few occurrence records exist (Eckert et al. 1999). Recent NOAA satellite tracking of leatherback turtles departing from regional nesting habitats occasionally transit through MITT waters (Benson et al. 2011; Benson et al. 2007; Kobayashi et al. 2008). As for nearshore waters, Eldredge (2003) noted a rescue in 1978 of a 249 lb. (112.9 kg) leatherback from waters southeast of Cocos Island, Guam. From 1987 to 1989, divers reported seeing leatherbacks in the waters off Harnom Point, Rota; however, none have been seen in the area in recent times. Leatherbacks do not nest at any of the islands in Micronesia. As a result, the occurrence of leatherback turtles would be considered rare throughout the year in nearshore waters of the MITT Study Area.

Telemetry studies indicate high use areas for leatherback sea turtles between 28 and 44°N, occupying waters with sea surface temperatures of 15–24°C (approximately). Telemetry data from Benson et al. (2011 and 2007) indicate movement through MITT waters, but only occasionally. The assumption for this density estimate is that 6.5 percent of animals can transit through MITT from adjacent nesting areas. Using available nesting numbers (Hitipeuw et al. 2007), we can estimate the number of animals that may transit the MITT Study Area and then divide that number by the total area of the Study Area. Performing that estimation/calculation results in a density estimate of 0.00022 leatherback sea turtles per km^2.

NWTT Offshore. The leatherback sea turtle is documented to return annually (only in the summer and fall) to feed on jellyfish aggregations off the southern Oregon and California coasts (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b). It is likely that leatherbacks could travel farther north into Washington, British Columbia, and Alaska waters during these foraging expeditions. The range of densities (leatherbacks per km^2) was estimated off California based on 1990–2003 aerial surveys (Benson et al. 2007). Data from recent surveys in Washington and Oregon do not yet support density estimates, so the Northern California densities presented in Benson et al. (2007) were used as an estimate (0.003 leatherback per km^2) for leatherback sea turtle densities in Washington and Oregon waters as well. Densities derived from aerial surveys for areas off the California coast as reported in Benson et al. (2007) for Point Arena (0.0023) and Gulf of the Farallones (0.0036) were used in the NMSDD.

NWTT Inland Waters. The leatherback sea turtle is the only species of sea turtle regularly anticipated in the offshore portion of the NWTT Study Area. Sea turtles are occasionally sighted within the Strait of Juan de Fuca but are rare in Puget Sound (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998c, National Marine Fisheries Service 2007a) and are not expected to occur near any of the inshore action areas. While leatherback sea turtles are capable of foraging in inland waters, they prefer offshore areas for foraging. Therefore, the leatherback sea turtle is not expected in the inland waters portion of the NWTT Study Area.

NWTT Western Behm Canal, Alaska. The leatherback sea turtle is the only species of sea turtle anticipated in the offshore portion of the NWTT Study Area. However, Stinson's (1984) archival search of 363 sea turtles sighted along the Pacific coast from Baja California, Mexico to the Gulf of Alaska from 1917 to 1982 indicated that only 6 of the recorded leatherback sightings occurred in sightings in Alaskan waters. Hodge and Wing (2000) presented leatherback occurrences in Alaskan waters between 1960 and 1998. During this period, 19 sightings of leatherback turtles in Alaska waters have been recorded (11 were sightings, 3 were netted and released, 3 were netted and killed, and 2 were carcasses). While leatherback sea turtles are physically capable of foraging in Alaskan waters, they are rare in the area and prefer offshore waters to the south. Therefore, the leatherback sea turtle is not expected in the Western Behm Canal region of the NWTT Study Area.

GOA. The leatherback sea turtle is not expected to occur in the GOA Study Area.

Table 12-9: Sources of Density Values Used for Leatherback Sea Turtle

Location	Spring	Summer	Fall	Winter
HRC	G	G	G	G
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
MITT	LD and N	LD and N	LD and N	LD and N
NWTT Offshore (Washington, Oregon, and North Coast of California)	LD	LD	LD	LD
NWTT Offshore (Point Arena)	LD	LD	LD	LD
NWTT Offshore (Gulf of the Farallones)	LD	LD	LD	LD
NWTT Inshore	0	0	0	0
NWTT Western Behm Canal	0	0	0	0
GOA	0	0	0	0

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; N = Navy-collected data; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS; G = This species is treated under the sea turtle guild in HRC; N/A = sufficient data are not available or location is not applicable. For a complete description of data sets refer to Section 3.

Table 12-10: Summary of Density Values for Leatherback Sea Turtle in the Pacific Fleet Study Areas

Location	Spring	Summer	Fall	Winter
HRC	G	G	G	G
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
MITT	0.00022	0.00022	0.00022	0.00022
NWTT Offshore (Washington, Oregon, and North Coast of California)	0.003	0.003	0.003	0.003
NWTT Offshore (Point Arena)	0.0023	0.0023	0.0023	0.0023
NWTT Offshore (Gulf of the Farallones)	0.0036	0.0036	0.0036	0.0036
NWTT Inshore	0	0	0	0
Western Behm Canal	0	0	0	0
GOA	0	0	0	0

The units for numerical values are animals/km^2. 0 = species is not expected to be present; G = This species is treated under the sea turtle guild in HRC; N/A = sufficient data are not available or location is not applicable; S = spatial model with various density values throughout the range.

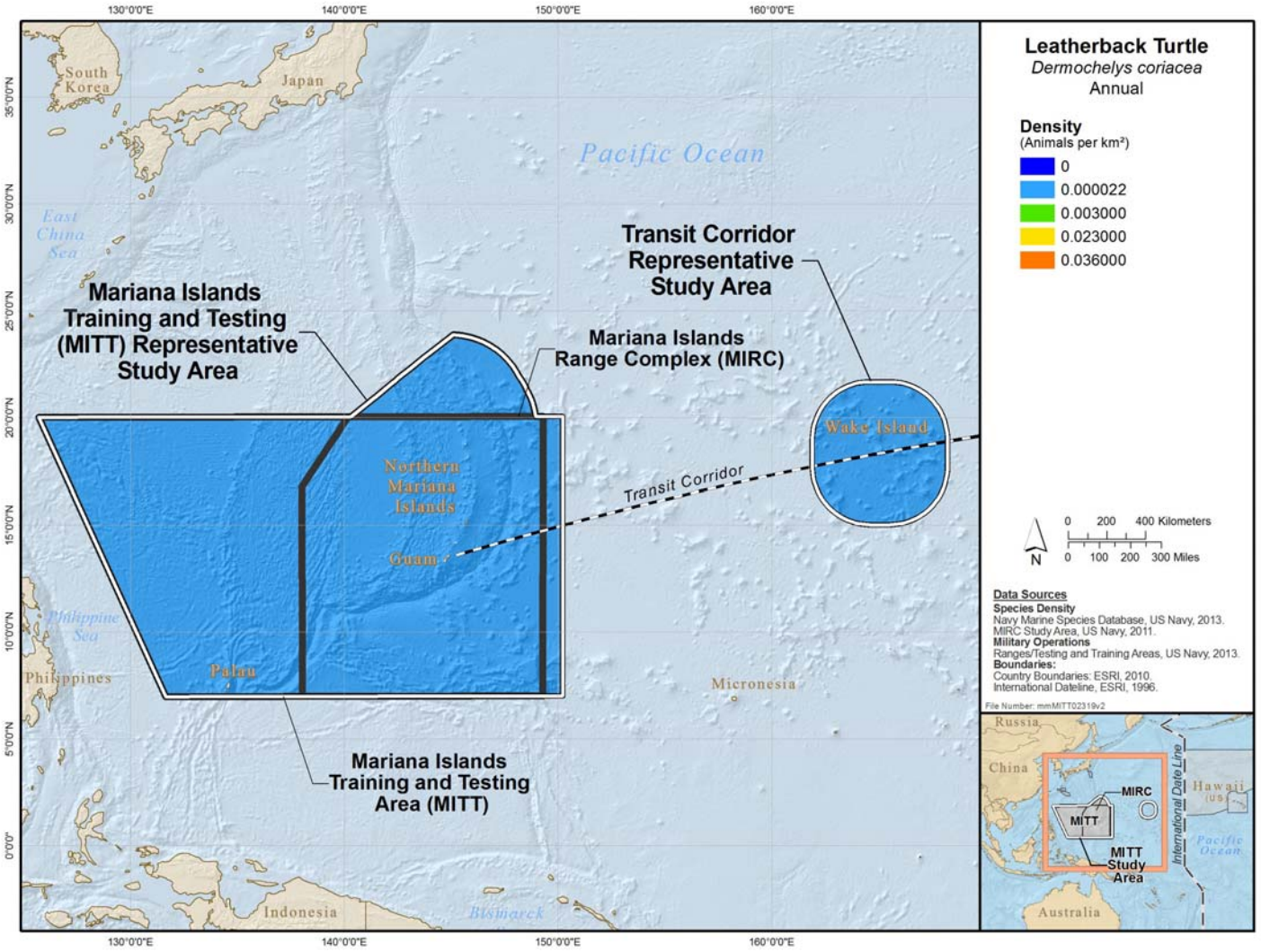

Figure 12-10: Annual Distribution of Leatherback Sea Turtle in MITT and Associated Transit Corridor Study Areas

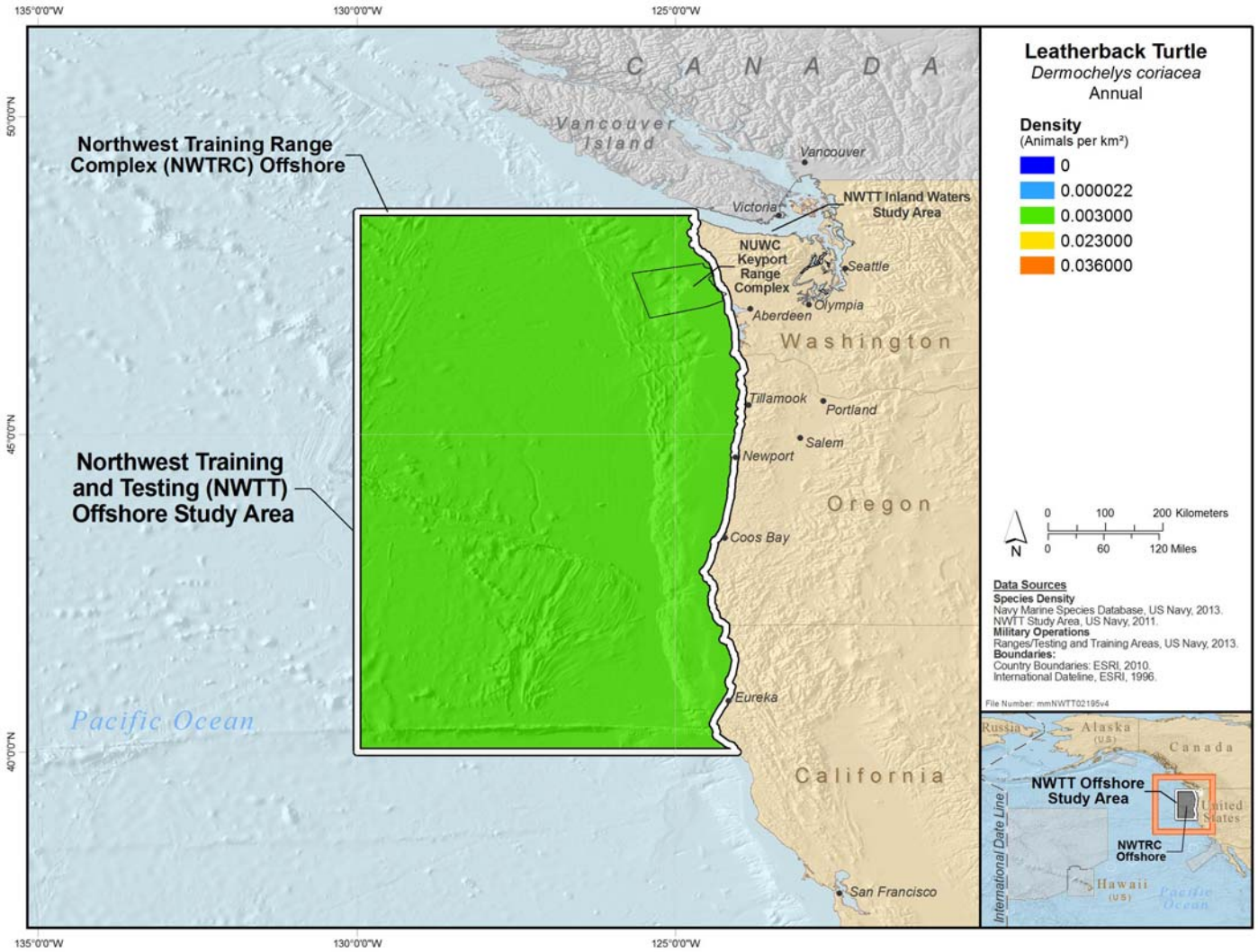

Figure 12-11: Annual Distribution of Leatherback Turtles in the Offshore Portion of NWTT

12.1.6 SEA TURTLE GUILD

This guild is applied to the sea turtles in HRC, because some of the methods of data collection, such as aerial surveys, do not allow the scientists to distinguish between turtle species. Also, the number of observations of hawksbill turtles would be so low as to render the data unusable. By considering the hawksbill and green turtle sightings together, a more powerful result can be provided for sea turtles as a guild. This guild considers all sea turtles in HRC, so in theory in encompasses leatherback, olive ridley, and loggerhead turtles, but these species have not been identified during the collection of Navy monitoring data. Table 12-11 indicates the sources for density values used for the sea turtle guild. Following descriptions of each individual range complex, Table 12-12 presents the density values used within each portion of the range complexes.

HRC. The Navy conducts aerial surveys for marine mammals and sea turtles in Hawaii annually as a requirement under a Letter of Authorization for at-sea training in the HRC. Turtles can be spotted from the plane or helicopter during surveys (for example, see Smultea and Mobley 2009 for survey protocol). Turtles were only observed near shore during coastline surveys. The Navy has treated the aerial surveys as strip transects (Buckland et al. 2001) with an effective strip width of 2 km (1.2 mi.). Given the number of turtles observed and the area of the strip transect, the Navy can calculate the density of sea turtles for each island that was circumnavigated. A factor needs to be considered that takes into account that only a portion of turtles that are actually there can be seen by observers, because the unobserved turtles are camouflaged or too deep in the water to be seen. In Distance Sampling, this factor is called g(0) (Buckland et al. 2001). The Navy made a conservative estimate of g(0)=0.9, in other words that only 10% of the turtles actually present were at the surface of the water or shallow enough to be seen from the aerial platform.

Coastline surveys for which there were turtle sightings recorded were available for the Islands of Kauai, Lanai, Molokai, and Oahu. For Islands that were not surveyed by plane, the mean density of the four islands that had data was applied. Density values were applied out to the 100 m (330 ft.) isobath around all of the islands. This is a conservative estimate of shallow area used by green turtles, because diving data suggest they remain well within the 100 m isobath (Blumenthal et al. 2010; Brill et al. 1995; Hays et al. 2007). Green turtles are the species expected to be seen most often in Hawaii, so the treatment of the data are biased toward that species. Tag data shows that there is movement of green turtles between islands, but it is an uncommon event associated with migration (Rice and Balazs 2008). To address the area of the HRC outside of the 100 m isobaths, the Navy used the mean density around the islands, reduced by two orders of magnitude. In one area between Lanai and Molokai where the 100 m isobaths around each island were close to each other but did not touch, the Navy created a step-wise gradient of three density zones.

As a requirement under the Sikes Act (16 U.S.C. § 670a–670o), the Navy maintains an Integrated Natural Resource Management Plan (INRMP) for Pearl Harbor. Natural resource monitoring occurs under the INRMP. As a result the Navy has a data set of in-water surveys for marine resources, including sea turtles. The duration of the data set considered here is from 2000 to 2011. Navy scientists divided Pearl Harbor into sections and calculated in-water turtle densities for strip transects performed in the

sections. The process is described in Hanser et al. (*in prep*). The densities provide a basic spatial map of sea turtle presence in Pearl Harbor. In areas where there was a gap between surveyed areas, the Navy extrapolated values in a step-wise gradient, as was done between the 100 m isobaths around the islands of Lanai and Molokai.

SOCAL. The species guild is not used for SOCAL.

MITT. The species guild is not used for MITT.

NWTT. The species guild is not used for NWTT.

GOA. The species guild is not used for GOA.

Table 12-11: Sources of Density Values Used for Sea Turtle Guild

Location	Spring	Summer	Fall	Winter
HRC	N	N	N	N
W. Transit Corridor	N/A	N/A	N/A	N/A
E. Transit Corridor	N/A	N/A	N/A	N/A
SOCAL	N/A	N/A	N/A	N/A
MITT	N/A	N/A	N/A	N/A
MITT Transit Corridor	N/A	N/A	N/A	N/A
NWTT	N/A	N/A	N/A	N/A
GOA	N/A	N/A	N/A	N/A

0 = species is not expected to be present; K = Kaschner RES Model global model; SMRU = St. Andrews University RES global model; L = scientific literature, NMFS technical memoranda, and NMFS technical reports; LD = a value that is derived from the literature; N = Navy-collected data; CCE = California Current Ecosystem habitat-based density model from NMFS; CENPAC = Central Pacific habitat-based density model from NMFS. For a complete description of data sets refer to Section 3.

Table 12-12: Summary of Density Values for Sea Turtle in the Pacific Fleet Study Areas

Location	Year Round
Kauai	0.2786
Lanai	0.4491
Molokai	0.1624
Oahu	1.1252
Other Islands	0.4288
Outside of 100 m isobath	0.00429
Pearl Harbor	S

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range.

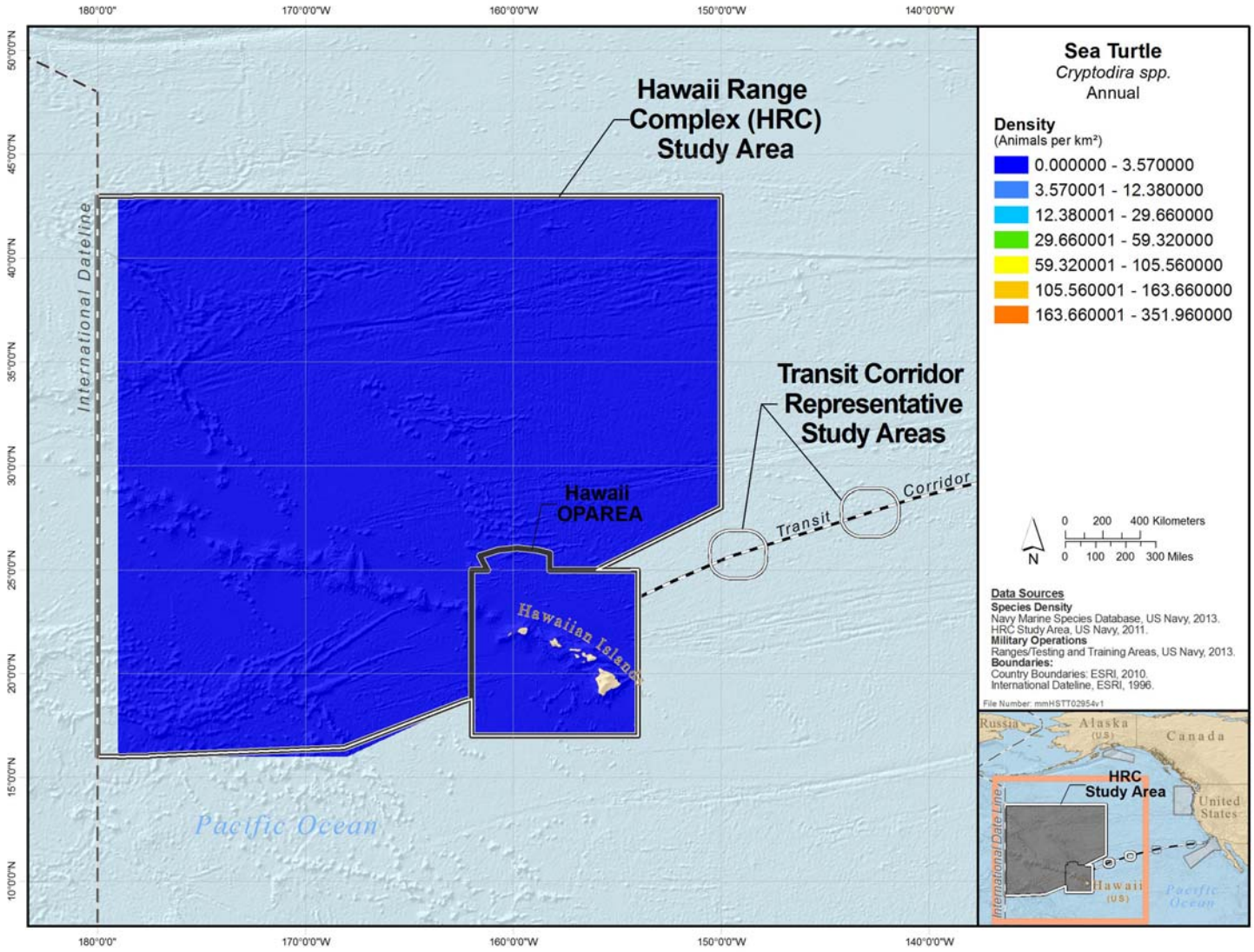

Figure 12-12: Annual Distribution of Sea Turtles in HRC

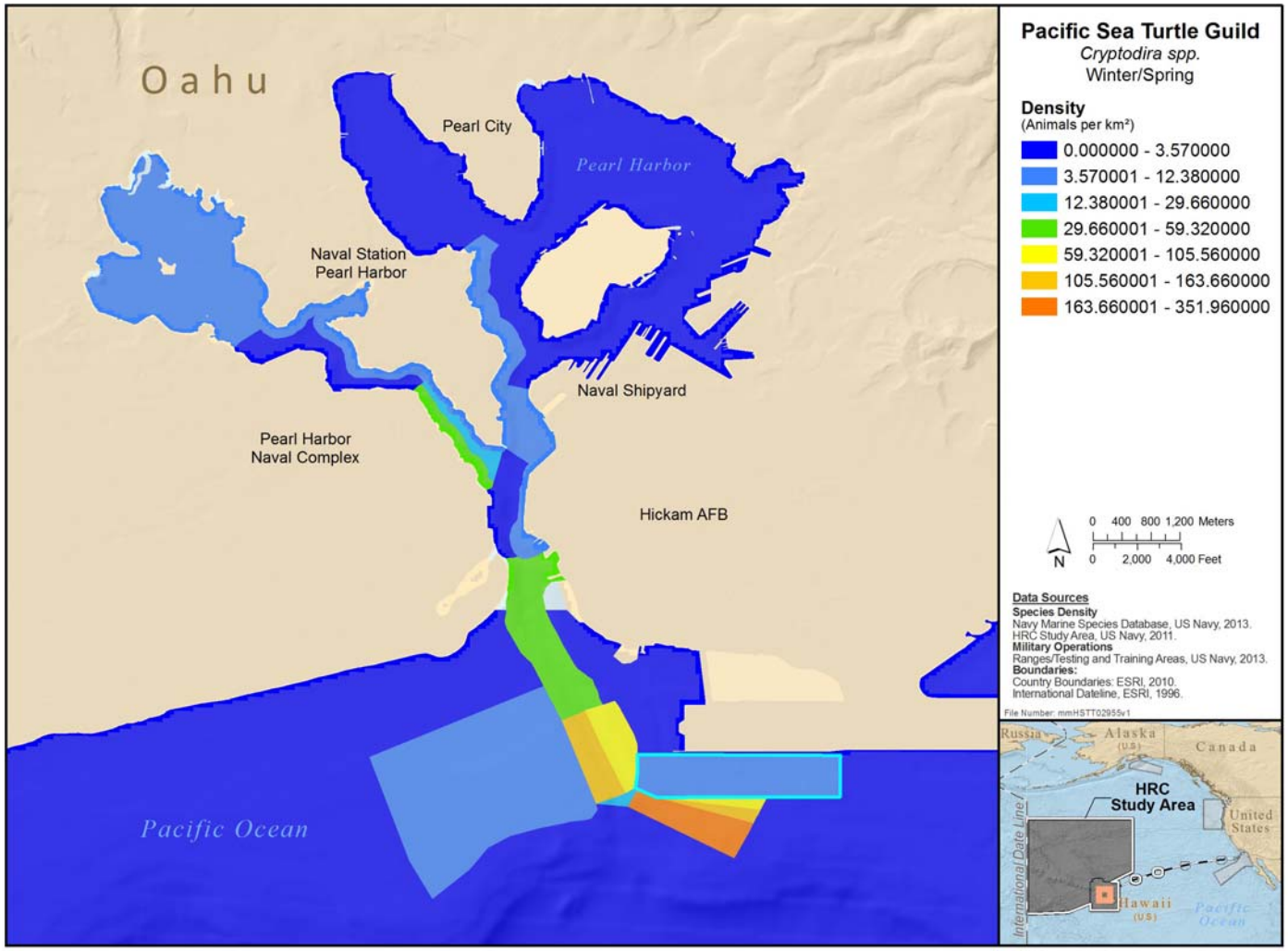

Figure 12-13: Winter/Spring Distribution of Sea Turtles in and near Pearl Harbor on the Island of Oahu, Hawaii

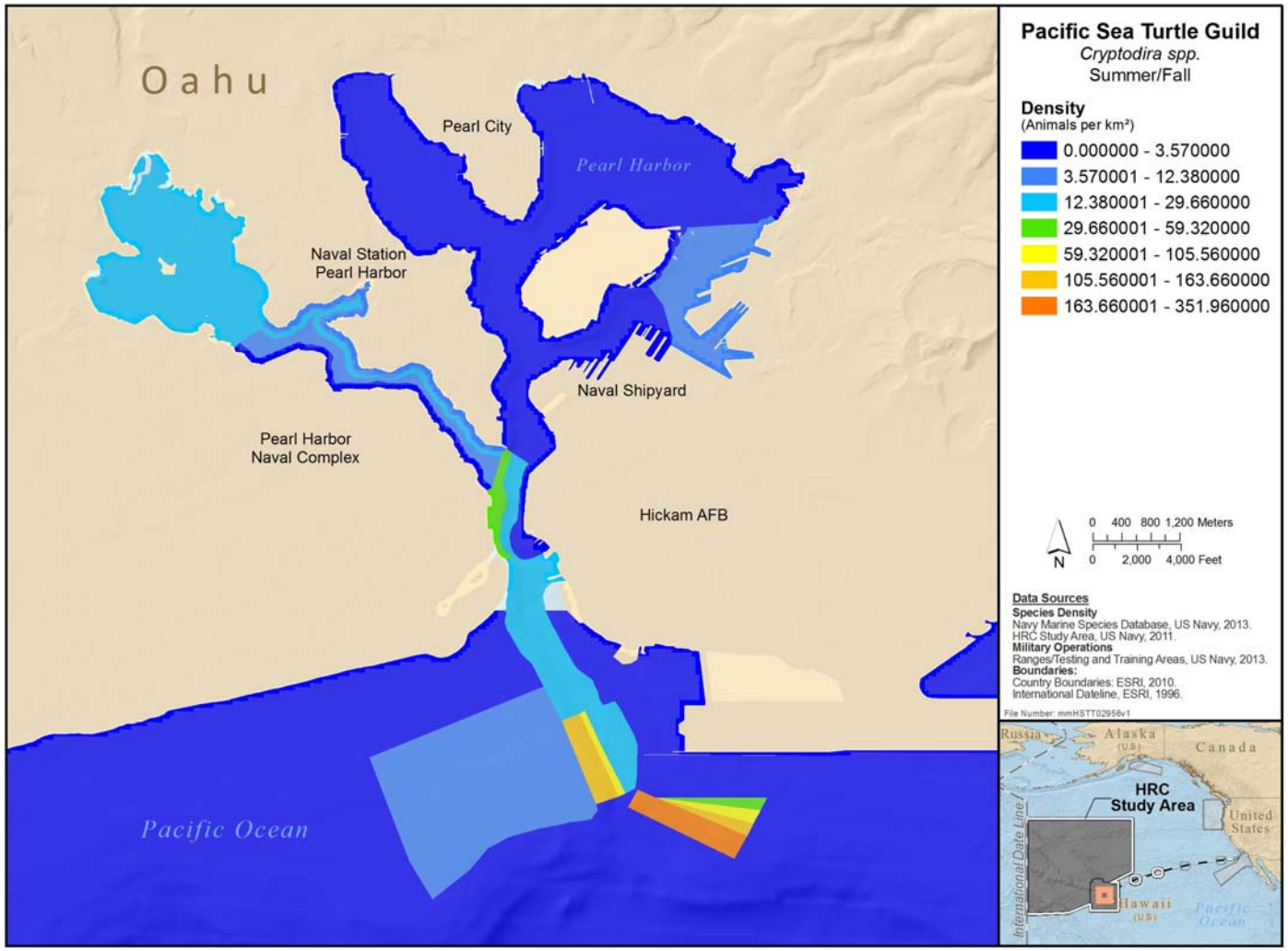

Figure 12-14: Summer/Fall Distribution of Sea Turtles in and near Pearl Harbor on the Island of Oahu, Hawaii

13 CONCLUSION

The NMSDD is a living document that will remain static until there is an agreed-upon set of density values to use in modeling the effects from Navy sound sources to marine species. Scientists from NMFS and the Navy have already identified many new methods and projects that will improve and expand the data in the NMSDD for the next time it is called upon as a data source. The ultimate goal is to arrive at accurate density estimates for every species. As suggested in the species descriptions, this may be very difficult to achieve for some species, and techniques other than line-transect sampling may be required. Even when estimates are achieved, they will need to be maintained through regular monitoring, because the size of marine species populations change over time and their distributions change with the large-scale dynamics in the world's oceans. It is an ambitious endeavor to maintain accurate information on all of the marine species in the Navy's Operating Areas, but a partnership between NMFS, scientific experts, and the Navy is more likely to achieve this goal because of pooled resources and expertise than any other partnership that has come before.

14 LITERATURE CITED

Afsal, V. V., Manojkumar, P. P., Yousuf, K. S. S. M., Anoop, B. and Vivekanandan, E. (2009). The first sighting of Longman's beaked whale, Indopacetus pacificus in the southern Bay of Bengal. [online]. *Marine Biodiversity Records*, 2, 1-3. Doi:10.1017/S1755267209990510

Aguilar, A. (2009). Fin whale, *Balaenoptera physalus* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 433–437). Amsterdam: Academic Press.

Allen, B. M. & Angliss, R. P. (2011). Alaska Marine Mammal Stock Assessments 2010 *NOAA Technical Memorandum NMFS-AFSC-223*. Seattle, Washington: National Marine Fisheries Service, Alaska Fisheries Science Center. Prepared by N. O. A. A. U.S. Department of Commerce.

Allen, B. M. & Angliss, R. P. (2012). Alaska Marine Mammal Stock Assessments 2011 *NOAA Technical Memorandum NMFS-AFSC-234*. Seattle, Washington: National Marine Fisheries Service, Alaska Fisheries Science Center. Prepared by N. O. A. A. U.S. Department of Commerce.

Allen, B. M. & Angliss, R.P. (2014). Alaska Marine Mammal Stock Assessments 2013, *NOAA Technical Memorandum NMFS-AFSC-277*. Seattle, Washington: National Marine Fisheries Service, Alaska Fisheries Science Center. Prepared by N. O. A. A. U.S. Department of Commerce.

Allen, L. G. (1999). Fisheries Inventory and Utilization of San Diego Bay, San Diego, California; Sampling Periods July 1994 to April 1999 *Final Report for Naval Facilities Engineering Command, Southwest and San Diego Unified Port District in Cooperation with the Nearshore Marine Fish Program*. Naval Facilities Engineering Command, Southwest. Prepared by N. F. E. C. Southwest.

Allen, S. G., Mortenson, J. & Webb, S. (2011). Field Guide to Marine Mammals of the Pacific Coast, *California Natural History Guides* (pp. 569). Berkeley, California: University of California Press.

Andrews, K. R., Karczmarski, L., Au, W. W. L., Rickards, S. H., Vanderlip, C. A., Bowen, B. W. (2010, Feb). Rolling stones and stable homes: social structure, habitat diversity and population genetics of the Hawaiian spinner dolphin (*Stenella longirostris*). [Article]. *Molecular Ecology, 19*(4), 732–748. 10.1111/j.1365-294X.2010.04521.x Retrieved from <Go to ISI>://WOS:000273953400010

Angliss, R.P. & Allen, B.M. (2009). Alaska marine mammal stock assessments, 2008. U.S. Department of Commerce, NOAA Technical. Memorandum. NMFSAFSC- 193. 258 pp.

Antonelis, G. A., Baker, J. D., Johanos, T. C., Braun, R. & Harting, A. L. (2006). Hawaiian monk seal (*Monachus schauinslandi*): status and conservation issues. *Atoll Research Bulletin, 543*(75-101).

Antonelis, G. A., Leatherwood, S. & Odell, D. K. (1981). Population growth and censuses of the northern elephant seal, *Mirounga angustirostris*, on the California Channel Islands, 1958–78. *Fishery Bulletin, 79*, 562–567.

Archer, F., Gerrodette, T., Chivers, S. & Jackson, A. (2004, Apr). Annual estimates of the unobserved incidental kill of pantropical spotted dolphin (*Stenella attenuata attenuata*) calves in the tuna purse-

seine fishery of the eastern tropical Pacific. [Article]. *Fishery Bulletin, 102*(2), 233–244. Retrieved from <Go to ISI>://WOS:000221182500001

Archer, F. I., II & Perrin, W. F. (1999). *Stenella coeruleoalba*. *Mammalian Species*(603), 1–9. Retrieved from http://www.jstor.org/stable/3504476

Archer, F. I. I. (2009). Striped dolphin, *Stenella coeruleoalba* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 1127–1129). Amsterdam: Academic Press.

Au, D. W. K. & Perryman, W. L. (1985). Dolphin habitats in the eastern tropical Pacific*. Fishery Bulletin*, 83, 623-643.

Aurioles-Gamboa, D., Elorriaga-Verplancken, F. & Hernandez-Camacho, C. J. (2010, Apr). The current population status of Guadalupe fur seal (*Arctocephalus townsendi*) on the San Benito Islands, Mexico. *Marine Mammal Science, 26*(2), 402–408. 10.1111/j.1748-7692.2009.00350.x Retrieved from <Go to ISI>://000276794500011

Aurioles-Gamboa, D., Hernandez-Camacho, C. J. & Rodriguez-Krebs, E. (1999, Apr). Notes on the southernmost records of the Guadalupe fur seal, *Arctocephalus townsendi*, in Mexico. *Marine Mammal Science, 15*(2), 581–583. Retrieved from <Go to ISI>://000079821000023

Baird, R. W. (2000). The killer whale: foraging specializations and group hunting J. Mann, R. C. Connor, P. L. Tyack and H. Whitehead (Eds.), *Cetacean Societies; Field Studies of Dolphins and Whales* (pp. 127–153). Chicago: University of Chicago Press.

Baird, R. W. (2005, 2005/07/01). Sightings of dwarf (*Kogia sima*) and pygmy (*K. breviceps*) sperm whales from the Main Hawaiian Islands. [doi: 10.1353/psc.2005.0031]. *Pacific Science, 59*(3), 461–466. 10.1353/psc.2005.0031 Retrieved from http://dx.doi.org/10.1353/psc.2005.0031

Baird, R. W. (2009a). False killer whale, *Pseudorca crassidens* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 405–406). Amsterdam: Academic Press.

Baird, R. W. (2009b). Risso's dolphin, *Grampus griseus* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 975–976). Amsterdam: Academic Press.

Baird, R. W. (2010). Pygmy killer whales (*Feresa attenuata*) or false killer whales (*Pseudorca crassidens*)? Identification of a group of small cetaceans seen off Ecuador in 2003. [Editorial Material]. *Aquatic Mammals, 36*(3), 326–327. 10.1578/am.36.3.2010.326 Retrieved from <Go to ISI>://WOS:000283452500014

Baird, R. W., Gorgone, A. M., McSweeney, D. J., Ligon, A. D., Deakos, M. H., Webster, D. L. (2009, Apr). Population structure of island-associated dolphins: Evidence from photo-identification of common bottlenose dolphins (*Tursiops truncatus*) in the main Hawaiian Islands. [Article]. *Marine Mammal Science, 25*(2), 251–274. 10.1111/j.1748-7692.2008.00257.x Retrieved from <Go to ISI>://WOS:000265228700001

Baird, R. W., Gorgone, A. M., McSweeney, D. J., Webster, D. L., Salden, D. R., Deakos, M. H. (2008a, Jul). False killer whales (Pseudorca crassidens) around the main Hawaiian Islands: Long-term site fidelity, inter-island movements, and association patterns. [Article]. *Marine Mammal Science, 24*(3), 591–612. 10.1111/j.1748-7692.2008.00200.x Retrieved from <Go to ISI>://WOS:000257799200009

Baird, R. W., Schorr, G. S., Webster, D. L., Mahaffy, S. D., McSweeney, D. J., Hanson, M. B. (2011a). Open-ocean movements of a satellite-tagged Blainville's beaked whale (*Mesoplodon densirostris*): evidence for an offshore population in Hawai'i? [Article]. *Aquatic Mammals, 37*(4), 506–511. 10.1578/am.37.4.2011.506 Retrieved from <Go to ISI>://WOS:000299541700008

Baird, R. W., Schorr, G. S., Webster, D. L., McSweeney, D. J., Hanson, M. B. & Andrews, R. D. (2010). Movements and habitat use of satellite-tagged false killer whales around the main Hawaiian Islands. *Endangered Species Research, 10*, 107–121.

Baird, R. W., Schorr, G. S., Webster, D. L., McSweeney, D. J., Hanson, M. B. & Andrews, R. D. (2011b, Oct). Movements of two satellite-tagged pygmy killer whales (*Feresa attenuata*) off the island of Hawai'i. [Article]. *Marine Mammal Science, 27*(4), E332-E337. 10.1111/j.1748-7692.2010.00458.x Retrieved from <Go to ISI>://WOS:000295938200006

Baird, R. W. & Stacey, P. J. (1991, Apr-Jun). Status of the northern right whale dolphin, *Lissodelphis borealis*, in Canada. [Article]. *Canadian Field-Naturalist, 105*(2), 243–250. Retrieved from <Go to ISI>://WOS:A1991GF65900013

Baird, R.W., Stacey, P.J., & Whitehead, H. (1993). Status of the striped dolphin, *Stenella coeruleoalba*, in Canada. Canadian Field-Naturalist, 107(4), 455–465.

Baird, R. W., Walters, E. L. & Stacey, P. J. (1993, Oct–Dec). Status of the bottlenose dolphin, *Tursiops truncatus*, with special reference to Canada. [Article]. *Canadian Field-Naturalist, 107*(4), 466–480. Retrieved from <Go to ISI>://WOS:A1993PG41500010

Baird, R. W., Webster, D. L., Mahaffy, S. D., McSweeney, D. J., Schorr, G. S. & Ligon, A. D. (2008b, Jul). Site fidelity and association patterns in a deep-water dolphin: Rough-toothed dolphins (*Steno bredanensis*) in the Hawaiian Archipelago. [Article]. *Marine Mammal Science, 24*(3), 535–553. 10.1111/j.1748-7692.2008.00201.x Retrieved from <Go to ISI>://WOS:000257799200006

Baird, R. W., Webster, D. L., McSweeney, D. J., Ligon, A. D., Schorr, G. S. & Barlow, J. (2006, Aug). Diving behaviour of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales in Hawai'i. [Article]. *Canadian Journal of Zoology, 84*(8), 1120–1128. 10.1139/z06-095 Retrieved from <Go to ISI>://WOS:000241526400007

Baker, J. D., Harting, A. L., Wurth, T. A. & Johanos, T. C. (2011, Jan). Dramatic shifts in Hawaiian monk seal distribution predicted from divergent regional trends. *Marine Mammal Science, 27*(1), 78–93. 10.1111/j.1748-7692.2010.00395.x Retrieved from <Go to ISI>://WOS:000285760200005

Baker, J. D. & Johanos, T. C. (2004, Mar). Abundance of the Hawaiian monk seal in the main Hawaiian Islands. *Biological Conservation, 116*(1), 103–110. 10.1016/s0006-3207(03)00181-2 Retrieved from <Go to ISI>://WOS:000188113500011

Balazs, G. H. & Chaloupka, M. (2004). Thirty-year recovery trend in the once depleted Hawaiian green sea turtle stock. *Biological Conservation*, 117, 491-498.

Balcomb, K. C. (1989). Baird's beaked whale — *Ziphius cavirostris* (Stejneger, 1883) and Arnoux's beaked whale — *Berardius arnuxii*. (Duvernoy, 1851) S. H. Ridgway and R. Harrison (Eds.), *Volume 4: River Dolphins and the Larger Toothed Whales* (Vol. 6, pp. 261–288). San Diego: Academic Press.

Ballance, L. T. & Pitman, R. L. (1998). Cetaceans of the western tropical Indian Ocean: Distribution, relative abundance, and comparisons with cetacean communities of two other tropical ecosystems. Marine Mammal Science, 14(3), 429-459.

Barlow, J. (1995). The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall of 1991. *Fishery Bulletin* 93: 1-14.

Barlow, J. (1999). Trackline detection probability for long-diving whales G. W. Garner, S. C. Amstrup, J. L. Laake, B. F. J. Manly, L. L. McDonald and D. G. Robertson (Eds.), *Marine Mammal Survey and Assessment Methods* (pp. 209–221). Rotterdam, Netherlands: Balkema Press.

Barlow, J. (2003). Cetacean abundance in Hawaiian waters during summer/fall 2002 [Administrative Report]. (LJ-03-13, pp. 20). La Jolla: Southwest Fisheries Science Center.

Barlow, J. (2006, Apr). Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. [Article]. *Marine Mammal Science, 22*(2), 446–464. 10.1111/j.1748-7692.2006.00032.x Retrieved from <Go to ISI>://000236527900014

Barlow, J. (2010). Cetacean Abundance in the California Current Estimated from a 2008 Ship-based Line-transect Survey *NOAA Technical Memorandum NMFS-SWFSC-456*. (SI-1391, pp. XX pp) National Marine Fisheries Service, Southwest Fisheries Science Center. Prepared by N. O. a. A. A. U.S. Department of Commerce.

Barlow, J., Ferguson, M. C., Becker, E. A., Redfern, J. V., Forney, K. A., Vilchis, I. L. (2009). Predictive modeling of cetacean densities in the eastern Pacific Ocean *NOAA Technical Memorandum NMFS-SWFSC-444*. (SI-1391, pp. 229 p) NOAA Fisheries, Southwest Fisheries Science Center. Prepared by S. E. R. a. D. P. U.S. Department of Defense.

Barlow, J., Ferguson, M. D., Perrin, W. F., Balance, L., Gerrodette, T., Joyce, G. (2006). Abundance and densities of beaked and bottlenose whales (family Ziphiidae). *Journal of Cetacean Research and Management, 7*(3), 263–270.

Barlow, J. & Forney, K. A. (2007). Abundance and population density of cetaceans in the California Current ecosystem. *Fishery Bulletin, 105*, 509–526.

Barrett Lennard, L. G., Ford, J. K. B. & Heise, K. A. (1996, Mar). The mixed blessing of echolocation: Differences in sonar use by fish-eating and mammal-eating killer whales. [Article]. *Animal Behaviour, 51*, 553–565. 10.1006/anbe.1996.0059 Retrieved from <Go to ISI>://WOS:A1996UD88800004

Bauman-Pickering, S., Simonis, A.E., Roch, M.A. McDonald, M.A., Solsona-Berga, A., Oleson, E.M., Wiggins, S.M., Brownell, R.L. Jr., & Hildebrand, J.A.. (2012). Spatio-temporal patterns of beaked whale echolocation signals in the North Pacific. International Whaling Commission, Panama City, Panama. SC/64/SM21.

Baumann-Pickering, S., Wiggins, S. M., Roth, E. H., Roch, M. A., Schnitzler, H. U. & Hildebrand, J. A. (2010, Jun). Echolocation signals of a beaked whale at Palmyra Atoll. [Article]. *Journal of the Acoustical Society of America, 127*(6), 3790–3799. 10.1121/1.3409478 Retrieved from <Go to ISI>://000278626500053

Becker, E. A., Foley, D. G., Forney, K. A., Barlow, J., Redfern, J. V. & Gentemann, C. L. (2012a). Forecasting cetacean abundance patterns to enhance management decisions. *Endangered Species Research, 16*(2), 97–112. 10.3354/esr00390 Retrieved from http://www.int-res.com/abstracts/esr/v16/n2/p97-112/

Becker, E. A., Forney, K. A., Ferguson, M.C., Barlow, J., Redfern, J.V. (2012c). Predictive modeling of cetacean densities in the California Current ecosystem based on summer/fall ship surveys in 1991–2008. U.S. Department of Commerce NOAA Technical Memorandum. NMFS-SWFSC-499.

Becker, E. A., Forney, K. A., Ferguson, M. C., Foley, D. G., Smith, R. C., Barlow, J. (2010). Comparing California Current cetacean-habitat models developed using *in situ* and remotely sensed sea surface temperature data. *Marine Ecology-Progress Series, 413*, 163–183. 10.3354/meps08696 Retrieved from <Go to ISI>://WOS:000281566900013

Becker, E. A., Forney, K. A., Foley, D. G. & Barlow, J. (2012b). Density and spatial distribution patterns of cetaceans in the central North Pacific based on habitat models *NOAA Technical Memorandum NMFS-SWFSC-490*. Prepared by NOAA. U.S. Department of Commerce.

Becker, E. A., Forney, K. A., Foley, D.G., Smith, R.C, Moore, T.J., & Barlow, J. (2014). Predicting seasonal density patterns of California cetaceans based on habitat models. Endangered Species Research 23:1-22.

Benson, S.R., Eguchi, T., Foley, D.G., Forney, K.A., Bailey, H., Hitipeuw, C., Samber, B.P., Tapilatu, R.F., Rei, V., Ramohia, P., Pita, J., & Dutton, P.H. (2011). Large-scale movements and high-use areas of western Pacific leatherback turtles, *Dermochelys coriacea*. *Ecosphere*. doi:10.1890/ES11-00053.1

Benson, S. R., Forney, K. A., Harvey, J. T., Carretta, J. V. & Dutton, P. H. (2007). Abundance, distribution, and habitat of leatherback turtles (*Dermochelys coriacea*) off California, 1990–2003. Fishery Bulletin, 105(3), 337–347.

Bernard, H. J. & Reilly, S. B. (1999). Pilot whales — *Globicephala* Lesson, 1828 S. H. Ridgway and R. Harrison (Eds.), *Volume 6: The Second Book of Dolphins and the Porpoises* (Vol. 6, pp. 245–279). San Diego: Academic Press.

Best, B. D., Halpin, P. N., Read, A. J., Fujioka, E., Good, C.P., LaBrecque, E.A., Schick, R.S., Roberts, J.J., Hazen, L.J., Qian, S.S. Palka, D.L., Garrison, L.P., & McLellan, W.A. (2012). Online cetacean habitat modeling system for the U.S. East Coast and Gulf of Mexico. *Endangered Species Research 18: 1–15*.

Black, N. A. (2009). Pacific white-sided dolphin; *Lagenorhynchus obliquidens* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 817–819). Amsterdam: Academic Press.

Blumenthal, J., Austin, T., Bothwell, J., Broderick, A., Ebanks-Petrie, G., Olynik, J. (2009). Diving behavior and movements of juvenile hawksbill turtles, *Eretmochelys imbricata*, on a Caribbean coral reef. *Coral Reefs, 28*(1), 55–65. 10.1007/s00338-008-0416-1 Retrieved from http://dx.doi.org/10.1007/s00338-008-0416-1

Blumenthal, J. M., Austin, T. J., Bothwell, J. B., Broderick, A. C., Ebanks-Petrie, G., Olynik, J. R. (2010). Life in (and out of) the lagoon: fine-scale movements of green turtles tracked using time-depth recorders. [Article]. *Aquatic Biology, 9*(2), 113–121. 10.3354/ab00222 Retrieved from <Go to ISI>://000278436000002

Bonnell, M.L. & Bowlby, C.E. (1992). Pinniped distribution and abundance off Oregon and Washington, 1989–1990 In: JJ Brueggeman (ed) Oregon and Washington Marine Mammal and Seabird Surveys. Minerals Management Service Contract Report 14-12-0001-30426.

Braham, H.W. (1983). Northern records of Risso's dolphin, *Grampus griseus*, in the northeast Pacific. *Canadian Field-Naturalist* 97:89-90.

Brill, R. W., Balazs, G. H., Holland, K. N., Chang, R. K. C., Sullivan, S. & George, J. C. (1995, Feb). Daily movements, habitat use, and submergence intervals of normal and tumor-bearing juvenile green turtles (*Chelonia mydas* L.) within a foraging area in the Hawaiian islands. [Article]. *Journal of Experimental Marine Biology and Ecology, 185*(2), 203–218. Retrieved from <Go to ISI>://A1995QJ01600005

Brownell, R.L., Jr., Clapham, P.J., Miyashita, T., & Kasuya, T. (2001). Conservation status of North Pacific right whales. Journal of Cetacean Research and Management (Special Issue 2):269-286.

Brownell, R. L., Walker, W. A. & Forney, K. A. (1999). Pacific white-sided dolphin — *Lagenorhynchus obliquidens* Gill, 1865 S. H. Ridgway and R. Harrison (Eds.), *Volume 6: The Second Book of Dolphins and the Porpoises* (Vol. 6, pp. 57–84). San Diego: Academic Press.

Buckland, S. T., Anderson, D. R., Burnham, K. P., Laake, J. L., Borchers, D. L. & Thomas, L. (2001). Introduction to Distance Sampling: Estimating Abundance of Biological Populations (pp. 448 pages). Oxford, U.K.: Oxford University Press.

Burnham, K. P. & Anderson, D. R. (1998). Model Selection and Multi-model Inference: A Practical Information-theoretic Approach (pp. 518 pp). New York: Springer-Verlag.

Calambokidis, J. & Baird, R.W. (1994). Status of marine mammals in the Strait of Georgia, Puget Sound, and Juan de Fuca Strait and potential human impacts. p 282–303 In: Review of the marine environment and biota of Strait of Georgia, Puget Sound, and Juan de Fuca Strait. Proceedings of the BC/Washington Symposium on the Marine Environment, January 13 and 14, 1994. (R.C.H. Wilson, R.J. Beamish, F. Aitkens, and J. Bell, Ed.). Canadian Technical Report of Fisheries and Aquatic Sciences No. 1948.

Calambokidis, J., Barlow, J., Ford, J.K.B., Chandler, T.E., & Douglas, A.B. (2009). Insights into the population structure of blue whales in the Eastern North Pacific from recent sightings and photographic identification. Marine Mammal Science, 25, 816–832.

Calambokidis, J., Darling, J. D., Deeke, V., Gearin, P. J., Gosho, M., Megill, W. (2002). Abundance, range and movements of a feeding aggregation of gray whales (*Eschrichtius robustus*) from California to southeastern Alaska in 1998. *Journal of Cetacean Research and Management, 4*(3), 267–276.

Calambokidis, J., Falcone, E.A., Quinn, T.J., Burdin, A.M., Clapham, P.J., Ford, J.K.B., Gabriele, C.M., LeDuc, R., Mattila, D., Rojas-Bracho, L., Straley, J.M., Taylor, B.L., Urbán, J., Weller, R., D., Witteveen, B.H., Yamaguchi, M., Bendlin, A., Camacho, D., Flynn, K., Havron, A., Huggins, J., Maloney, N., Barlow, J., & Wade, P.R. (2008). SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback whales in the North Pacific. Final report for Contract AB133F-03-RP-00078. Prepared by: Cascadia Research Collective for U.S. Dept of Commerce. May 2008.

Calambokidis, J., Laake, J.L., & Klimek, A. (2010). Abundance and population structure of seasonal gray whales in the Pacific Northwest, 1998–2008. Paper SC/62/BRG32 presented to the International Whaling Commission Scientific Committee. Available at: http://www.cascadiaresearch.org/reports/SC_62_BRG32.pdf

Calambokidis, J., Osmek, S., & Laake, J. L. (1997). Aerial surveys for marine mammals in Washington and British Columbia inside waters. Final Contract Report for Contract 52ABNF-6-00092, available from Cascadia Research Collective, Waterstreet Building 218 ½ West Forth Avenue, Olympia, Washington 98501.

Calambokidis, J., Steiger, G.H., Ellifrit, D.K., Troutman, B.L., & Bowlby, C.E. (2004). Distribution and abundance of humpback whales (*Megaptera novaeangliae*) and other marine mammals off the northern Washington coast. Fishery Bulletin, 102, 563–580.

Call, K. A., Ream, R. R., Johnson, D., Sterling, J. T. & Towell, R. G. (2008, Aug). Foraging route tactics and site fidelity of adult female northern fur seal (*Callorhinus ursinus*) around the Pribilof Islands. *Deep-Sea Research Part Ii-Topical Studies in Oceanography, 55*(16-17), 1883–1896. 10.1016/j.dsr2.2008.04-022 Retrieved from <Go to ISI>://000260287500019

Carretta, J.V., Chivers, S.J., & Perryman, W.L. (2011b). Abundance of the long-beaked common dolphin (*Delphinus capensis*) in California and western Baja California waters estimated from a 2009 ship-based line-transect survey. Bulletin of the Southern California Academy of Sciences 110(3): 152–164.

Carretta, J. V., Forney, K. A. & Benson, S. R. (2009). Preliminary estimates of harbor porpoise abundance in California waters from 2002 to 2007. (NOAA Technical Memorandum NMFS-SWFSC 435, pp. 10).

Carretta, J. V., Forney, K. A., Lowry, M. S., Barlow, J., Baker, J., Johnston, D., Carswell, L. (2010). U.S. Pacific Marine Mammal Stock Assessments: 2009. (*NOAA-TM-NMFS-SWFSC-453*, pp. 336). La Jolla, CA: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Carretta, J. V., Forney, K. A., Oleson, E., Martien, K., Muto, M. M., Lowry, M. S. (2011a). U.S. Pacific marine mammal stock assessments: 2010 *NOAA Technical Memorandum NMFS-SWFSC 476*. (pp. 352) U.S. Department of Commerce. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Carretta, J. V., Forney, K. A., Oleson, E., Martien, K., Muto, M. M., Lowry, M. S., Barlow, J., Baker, J., Hanson, B., Lynch, D., Carswell, L., Brownell, R.L. Jr., Robbins, J., Mattila, D. K. , Ralls, K., & Hill, M. C. (2012). U.S. Pacific marine mammal stock assessments: *2011 NOAA Technical Memorandum NMFS-SWFSC 488.*, U.S. Department of Commerce. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Carretta, J.V., E. Oleson, D.W. Weller, A.R. Lang, K.A. Forney, J. Baker, B. Hanson, K. Martien, M.M. Muto, A.J. Orr, H. Huber, M.S. Lowry, J. Barlow, D. Lynch, L. Carswell, R.L. Brownell Jr, & D.K. Mattila (2014). U.S. Pacific Marine Mammal Stock Assessments: 2013 *NOAA Technical Memorandum NMFS-SWFSC 532.*, U.S. Department of Commerce. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Carretta, J. V., Lowry, M. S., Stinchcomb, C. E., Lynne, M. S. & Cosgrove, R. E. (2000). Distribution and abundance of marine mammals at San Clemente Island and surrounding offshore waters: results from aerial and ground surveys in 1998 and 1999. (Southwest Fisheries Science Center Administrative Report LJ-00-02, pp. 43).

Carretta, J. V., Lynn, M. S. & Leduc, C. A. (1994, Jan). Right whale (*Eubalaena glacialis*) sighting off San Clemente Island, California. [Note]. *Marine Mammal Science, 10*(1), 101–105. 10.1111/j.1748-7692.1994.tb00394.x Retrieved from <Go to ISI>://WOS:A1994MZ84900010

Carretta, JV, KA Forney, MS Lowry, J Barlow, J Baker, D Johnston, B Hanson, MM Muto, D Lynch and L Carswell. (2009). U.S. Pacific Marine Mammal Stock Assessments: 2008. NOAA-TM-NMFS-SWFSC-434.

Carretta, J.V., Oleson, E., Weller, D.W., Lang, A.R., Forney, K.A. Baker, J., Hanson, B., Martien, K., Muto, M.M., Lowry, M.S., Barlow, J., Lynch, D., Carswell, L., Brownell, R.L. Jr, Mattila, D.K., & Hill, M.C. (2013). U.S. Pacific Marine Mammal Stock Assessments: 2012. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-SWFSC-504.

Cascadia Research (2010a). Unusual Strandings of Bryde's whales in Puget Sound (January 2010). Online at [http://www.cascadiaresearch.org/Strandings.htm]

Cascadia Research (2010b). Injured Bryde's whales in Puget Sound (6 December 2010), Cascadia Research. Online at [http://www.cascadiaresearch.org/Strandings.htm].

Cascadia Research (2011). Unusual Sightings of Risso's Dolphins in S. Puget Sound (30 December 2011), Cascadia Research. Online at [http://www.cascadiaresearch.org/Strandings.htm].

Chaloupka, M. & Balazs, G. H. (2007). Using Bayesian state-space modelling to assess the recovery and harvest potential of the Hawaiian green sea turtle stock. *Ecological Modelling, 205*, 93–109.

Cheng, I. J., Dutton, P. H., Chen, C. L., Chen, H. C., Chen, Y. H. & Shea, J. W. (2008, Dec). Comparison of the genetics and nesting ecology of two green turtle rookeries. *Journal of Zoology, 276*(4), 375–384. 10.1111/j.1469-7998.2008.00501.x Retrieved from <Go to ISI>://WOS:000261205800008

Clapham, P. J. (2000). The humpback whale; Seasonal feeding and breeding in a baleen whale J. Mann, R. C. Connor, P. L. Tyack and H. Whitehead (Eds.), *Cetacean Societies; Field Studies of Dolphins and Whales* (pp. 173–196). Chicago: University of Chicago Press.

Clarke, M. & Young, R. (1998, May). Description and analysis of cephalopod beaks from stomachs of six species of odontocete cetaceans stranded on Hawaiian shores. [Article]. *Journal of the Marine Biological Association of the United Kingdom, 78*(2), 623–641. Retrieved from <Go to ISI>://WOS:000074430400017

Connor, R. C., Wells, R. S., Mann, J. & Read, A. J. (2000). The bottlenose dolphin; Social relationships in a fission-fusion society J. Mann, R. C. Connor, P. L. Tyack and H. Whitehead (Eds.), *Cetacean Societies; Field Studies of Dolphins and Whales* (pp. 91–126). Chicago: University of Chicago Press.

Consiglieri, L. D., Braham, H. W., & Jones, M. L. (1980). Distribution and abundance of marine mammals in the Gulf of Alaska from the platform of opportunity programs, 1978-1979: Outer Continental Shelf Environmental Assessment Program Quarterly Report RU-68. 11 p.

Cowan, I.M. and Guiguet, C.J. (1952). Three cetacean records from British Columbia. Murrelet, 33(1): 10–11.

Craig, A. S. & Herman, L. M. (1997, Nov). Sex differences in site fidelity and migration of humpback whales (*Megaptera novaeangliae*) to the Hawaiian Islands. [Article]. *Canadian Journal of Zoology, 75*(11), 1923–1933. 10.1139/z97-822 Retrieved from <Go to ISI>://WOS:000070948200019

Craig, P., Parker, D., Brainard, R., Rice, M. & Balazs, G. (2004). Migrations of green turtles in the central South Pacific. *Biological Conservation, 116*(3), 433–438. Retrieved from http://www.sciencedirect.com/science/article/B6V5X-49273BM-2/2/9ab85377492e68d52fce46b90d26aa9f

Dahlheim, M. E. & Heyning, J. E. (1999). Killer whale — *Orcinus orca* (Linnaeus, 1758) S. H. Ridgway and R. Harrison (Eds.), *Volume 6: The Second Book of Dolphins and the Porpoises* (Vol. 6, pp. 281–322). San Diego: Academic Press.

Dahlheim, M. E., White, P. A., & Waite, J. M. (2009). Cetaceans of Southeast Alaska: Distribution and seasonal occurrence. J. Biogeogr. 36:410-426.

Dalebout, M.L. et al. (2014). Resurrection of *Mesoplodon hotaula* Deraniyagala, 1963: A new species beaked whale in the tropical Indo-Pacific. Marine Mammal Science: In press (DOI: 10.1111/mms.12113).

Dalebout, M. L., Ross, G. J. B., Baker, C. S., Anderson, R. C., Best, P. B., Cockcroft, V. G. (2003, Jul). Appearance, distribution, and genetic distinctiveness of Longman's beaked whale, *Indopacetus pacificus*. [Article]. *Marine Mammal Science, 19*(3), 421–461. 10.1111/j.1748-7692.2003.tb01314.x Retrieved from <Go to ISI>://WOS:000183992800001

Darling, J. D. & Mori, K. (1993). Recent observations of humpback whales (*Megaptera novaeangliae*) in Japanese waters off Ogasawara and Okinawa. Canadian Journal of Zoology, 71, 325-333.

Dawbin, W. H. (1966). The seasonal migratory cycle of humpback whales K. S. Norris (Ed.), *Whales, Dolphins and Porpoises* (pp. 145–170). Berkeley, California: University of California Press.

Deakos, M. H., Branstetter, B. K., Mazzuca, L., Fertl, D. & Mobley, J. R. (2010). Two unusual interactions between a bottlenose dolphin (*Tursiops truncatus*) and a humpback whale (*Megaptera novaeangliae*) in Hawaiian waters. [Article]. *Aquatic Mammals, 36*(2), 121–128. 10.1578/am.36.2.2010.121 Retrieved from <Go to ISI>://000283451200002

Dizon, A. E., Lockyer, C., Perrin, W. F., Demaster, D. P. & Sisson, J. (1992, Mar). Rethinking the stock concept: a phylogeographic approach. [Article]. *Conservation Biology, 6*(1), 24–36. 10.1046/j.1523-1739.1992.610024.x Retrieved from <Go to ISI>://WOS:A1992HM02900010

Dohl, T.P., Guess, R.C., Duman, M.L., & Helm, R.S. (1983). Cetaceans of central and northern California, 1980–1983: Status, abundance, and distribution. Volume III, Book 2. OCS Study MMS 84-0045. Los Angeles, California: Minerals Management Service.

Dolar, M. L. L. (2009). Fraser's dolphin, *Lagenodelphis hosei* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 469–471). Amsterdam: Academic Press.

Dolar, M. L., Perrin, W. F., Taylor, B. L., Kooyman, G. L. & M.N.R., A. (2006). Abundance and distributional ecology of cetaceans in the central Philippines. *Journal of Cetacean Research and Management*, 8(1), 93-111.

Donoso, M. & Dutton, P. H. (2010, Nov). Sea turtle bycatch in the Chilean pelagic longline fishery in the southeastern Pacific: Opportunities for conservation. [Article]. *Biological Conservation, 143*(11), 2672–2684. 10.1016/j.biocon.2010.07.011 Retrieved from <Go to ISI>://WOS:000283412300030

Donovan, G. P. (1991). A review of IWC stock boundaries. *Reports of the International Whaling Commission, Special Issue 13*, 39-68.

Dorsey, E.M. (1983). Exclusive adjoining ranges in individually identified minke whales (*Balaenoptera acutorostrata*) in Washington State. Canadian Journal of Zoology, 61, 174–181.

Dorsey, E.M., Stern, S.J., Hoelzel, A.R., & Jacobsen, J. (1990). Minke whales (*Balaenoptera acutorostrata*) from the west coast of North America: Individual recognition and small-scale site fidelity. Reports of the International Whaling Commission (Special Issue 12), 357–368.

Dudzik, K. J., Baker, K. M. & Weller, D. W. (2006). Mark-recapture abundance estimate of California coastal stock bottlenose dolphins: February 2004 to April 2005. (Southwest Fisheries Center Administrative Report LJ-06-02C, pp. 15).

Eguchi, T., Seminoff, J. A., LeRoux, R. A., Dutton, P. H. & Dutton, D. L. (2010, Aug). Abundance and survival rates of green turtles in an urban environment: coexistence of humans and an endangered

species. *Marine Biology, 157*(8), 1869–1877. 10.1007/s00227-010-1458-9 Retrieved from <Go to ISI>://WOS:000279836900017

Eldredge, L. G. (1991). Annotated Checklist of the Marine Mammals of Micronesia. *Micronesica*, 24(2), 217-230.

Eldredge, L. G. (2003). The marine reptiles and mammals of Guam. *Micronesica*, 35-36, 653-660.

Ernst, C. H., Lovich, J. E. & Barbour, R. W. (1994). Turtles of the United States and Canada (pp. 578 pp). Washington, D.C.: Smithsonian Institution Press.

Everitt, R.D., Fiscus, C.H., & DeLong, R.L. (1979). Marine mammals of northern Puget Sound and the Strait of Juan de Fuca: A report on investigations November 1, 1977–October 31, 1978. NOAA Technical Memorandum ERL-MESA-41: 1–191.

Ferguson, M. C. & Barlow, J. (2003). Addendum: Spatial distribution and density of cetaceans in the eastern tropical Pacific Ocean based on summer/fall research vessel surveys in 1986–96 *NOAA Administrative Report*. (pp. 99 p). La Jolla, California: NOAA Fisheries, Southwest Fisheries Science Center. Prepared by S. F. S. C. NOAA Fisheries.

Ferguson, M. C., Barlow, J., Brownell, R. & Pitman, R. (2011). Identifying areas of biological importance to cetaceans in data-poor regions. White paper summaring results from panel of "subject matter experts" (SMEs) to help identify marine mammal offshore bioloigcally important areas relevant to the U.S. Navy's use of Surveillance Towed Array Sensor Systems Low-Frequency Active (SURTASS LFA) Sonar.

Ferguson, M. C., Barlow, J., Feidler, P., Reilly, S. B. and Gerrodette, T. (2006). Spatial models of delphinid (family Delphinidae) encouter rate and group size in the eastern Pacific Ocean. *Ecological Modelling*, 193, 645-662.

Fish, F. E., Nicastro, A. J. & Weihs, D. (2006, Feb). Dynamics of the aerial maneuvers of spinner dolphins. [Article]. *Journal of Experimental Biology, 209*(4), 590–598. 10.1242/jeb.02034 Retrieved from <Go to ISI>://WOS:000236042200006

Foote, A. D., Morin, P. A., Durban, J. W., Willerslev, E., Orlando, L. & Gilbert, M. T. P. (2011, Sep). Out of the Pacific and Back Again: Insights into the Matrilineal History of Pacific Killer Whale Ecotypes. [Article]. *Plos One, 6*(9). e24980 10.1371/journal.pone.0024980 Retrieved from <Go to ISI>://WOS:000295260400028

Foote, A. D., Newton, J., Piertney, S. B., Willerslev, E. & Gilbert, M. T. P. (2009, Dec). Ecological, morphological and genetic divergence of sympatric North Atlantic killer whale populations. [Article]. *Molecular Ecology, 18*(24), 5207–5217. 10.1111/j.1365-294X.2009.04407.x Retrieved from <Go to ISI>://WOS:000272452700019

Ford, J. K. B. (2008). Killer whale *Orcinus orca*. In: Encyclopedia of Marine Mammals. W. F. Perrin, B. Würsig and J. G. M. Thewissen. San Diego, CA, Academic Press: 650–657.

Ford, J. K. B. (2005). First records of long-beaked common dolphins, *Delphinus capensis*, in Canadian waters. Canadian Field-Naturalist 119: 110-113.

Ford, J. K. B., Ellis, G. A., Matkin, D. R., Balcomb, K. C., Briggs, D. & Morton, A. B. (2005, Oct). Killer whale attacks on minke whales: Prey capture and antipredator tactics. [Article]. *Marine Mammal Science, 21*(4), 603–618. 10.1111/j.1748-7692.2005.tb01254.x Retrieved from <Go to ISI>://WOS:000232297400002

Forney, K. A. (2007). Preliminary Estimates of Cetacean Abundance Along the U.S. West Coast and Within Four National Marine Sanctuaries During 2005 *NOAA Technical Memorandum NMFS-SWFSC-406*. (SI-1391, pp. 27 pp) National Marine Fisheries Service, Southwest Fisheries Science Center. Prepared by N. O. a. A. A. U.S. Department of Commerce.

Forney, K. A. & Barlow, J. (1998). Seasonal patterns in the abundance and distribution of California cetaceans, 1991–1992. *Marine Mammal Science, 14*(3), 460–489.

Forney, K. A., Barlow, J. & Carretta, J. V. (1995). The abundance of cetaceans in California waters. Part II: Aerial surveys in winter and spring of 1991 and 1992. *Fishery Bulletin, 93*, 15–26.

Forney, K. A., Ferguson, M. C., Becker, E. A., Fiedler, P. C., Redfern, J. V., Barlow, J. (2012). Habitat-based spatial models of cetacean density in the eastern Pacific Ocean. *Endangered Species Research, 16*(2), 113–133. 10.3354/esr00393 Retrieved from http://www.int-res.com/abstracts/esr/v16/n2/p113-133/

Forney, K. A., Kobayashi, D. R., Johnston, D. W., Marchetti, J. A. & Marsik, M. G. (2011). What's the catch? Patterns of cetacean bycatch and depredation in Hawaii-based pelagic longline fisheries. [Article]. *Marine Ecology-an Evolutionary Perspective, 32*(3), 380–391. 10.1111/j.1439-0485.2011.00454.x Retrieved from <Go to ISI>://WOS:000293560400012

Forney, K. A. & Wade, P. R. (2006). Worldwide distribution and abundance of killer whales J. A. Estes, D. P. DeMaster, D. F. Doak, T. M. Williams and R. L. Brownell (Eds.), *Whales, Whaling, and Ocean Ecosystems* (pp. 145–162). Berkeley: University of California Press.

Frasier, T.R., S.M. Koroscil, B.N. White, & J.D. Darling. (2011). Assessment of population substructure in relation to summer feeding ground use in the eastern North Pacific gray whale. *Endangered Species Research* 14:39-48.

Frost, K.J., Simpkins, M.A. & Lowry, L.F. (2001). Diving behavior of subadult and adult harbor seals in Prince William Sound, Alaska. Marine Mammal Science 17:813-834.

Fulling, G. L., Thorson, P. H. & Rivers, J. (2011). Distribution and Abundance Estimates for Cetaceans in the Waters off Guam and the Commonwealth of the Northern Mariana Islands. Pacific Science, 65(3), 321-343. 10.2984/65.3.321

Gallo-Reynoso, J. P. (1994). *Factors affecting the population status of Guadalupe fur seal, Arctocephalus townsendi (Merriam, 1897), at Isla de Guadalupe, Baja California, México.* (PhD Dissertation). University of California, Santa Cruz, California.

Gaos, A. R., Lewison, R. L., Yañez, I. L., Wallace, B. P., Liles, M. J., Nichols, W. J. (2011, August 31, 2011). Shifting the life-history paradigm: discovery of novel habitat use by hawksbill turtles. *Biology Letters*. 10.1098/rsbl.2011.0603 Retrieved from http://rsbl.royalsocietypublishing.org/content/early/2011/08/23/rsbl.2011.0603.abstract

Gendron, D., Lanham, S. & Carwardine, M. (1999). North Pacific right whale (*Eubalaena glacialis*) sighting South of Baja California. *Aquatic Mammals, 25*(1), 31–34.

Gentry, R. L. (2009). Northern fur seal, *Callorhinus ursinus* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 788–791). Amsterdam: Academic Press.

Gilman, E. (2008). *Pacific Leatherback Conservation and Research Activities, Financing and Priorities*. (pp. 31). Honolulu, HI: The World Conservation Union and Western Pacific Fishery Management Council and IUCN.

Goetz, K.T., R. A. Montgomery, J. M. Ver Hoef, R. C. Hobbs, & D. S. Johnson. (2012). Identifying essential summer habitat of the endangered beluga whale *Delphinapterus leucas* in Cook Inlet, Alaska. *Endangered Species Research*, 16: 135-147.

Gosho, M., Gearin P., Jenkinson R., Laake L., Mazzuca L., Kubiak, D., Calambokidis J., Megill W., Gisborne B., Goley D., Tombach C., Darling J., & Deecke V. (2011). Movements and diet of gray whales (*Eschrichtius robustus*) off Kodiak Island, Alaska, 2002 – 2005. Paper SC/M11/AWMP2 presented to the International Whaling Commission AWMP workshop 28 March-1 April 2011.

Green, G. A., Brueggeman, J. J., Grotefendt, R. A., Bowlby, C. E., Bonnel, M. L., & Balcomb, K. C. III. (1992). Cetacean distribution and abundance off Oregon and Washington, 1989–1990. Los Angeles, CA, Minerals Management Service: 100.

Green, G.A., Grotefendt, R.A., Smultea, M.A., Bowlby, C.E., & Rowlett, R.A. (1993).Delphinid aerial surveys in Oregon and Washington offshore waters. Final report prepared for NMFS, Natl. Mar. Mammal Lab., Alaska Fish. Sci. Cent., 7600 Sand Point Way NE, Seattle, WA 98115. Contract No. 50ABNF200058.

Gregr, E.J. (2011). Insights into North Pacific right whale *Eubalaena japonica* habitat from historic whaling records. *Endangered Species Research*, Vol. 15: 223–239; doi: 10.3354/esr00381.

Gregr, E. J., Nichol, L., Ford, J.K.B., Ellis, G., & Trites, A.W. (2000). Migration and population structure of northeastern Pacific whales off coastal British Columbia: An analysis of commercial whaling records from 1908–1967. *Marine Mammal Science*, 16(4), 699–727.

Gross, A., Kiszka, J., Van Canneyt, O., Richard, P. & Ridoux, V. (2009, Sep). A preliminary study of habitat and resource partitioning among co-occurring tropical dolphins around Mayotte, southwest Indian Ocean. [Article; Proceedings Paper]. *Estuarine Coastal and Shelf Science, 84*(3), 367–374. 10.1016/j.ecss.2009.05.017 Retrieved from <Go to ISI>://WOS:000270122400011

Hamilton, T. A., Redfern, J. V., Barlow, J., Ballance, L. T., Gerrodette, T., Holt, R. S. (2009). Atlas of Cetacean Sightings for Southwest Fisheries Science Center Cetacean and Ecosystem Surveys: 1986–2005

NOAA Technical Memorandum NMFS-SWFSC-440. (pp. 77 pages) NOAA, NMFS, Southwest Fisheries Science Center.

Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K., Karczmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y., Wells, R.S. and Wilson, B. (2008). *Delphinus delphis*. In: *IUCN 2011. IUCN Red List of Threatened Species.* Version 2011.2. <www.iucnredlist.org>. Downloaded on 9 September 2011.

Hanser, S., Shoemaker, M., Uyeyama, R. & Watwood, S. (2010). Cruise Report, Marine Species Monitoring and Lookout Effectiveness Study, Unit Level Training, July 2010, SOCAL Range Complex. (pp. 13). Pearl Harbor, Hawaii: Commander United States Pacific Fleet. Prepared by Naval Facilities Engineering Command and Naval Undersea Warfare Center.

Hanser, S. F., Smith, S. H., Eguchi, T. & Uyeyama, R. K. (*in prep*). Estimates of sea turtle presence in and adjacent to Pearl Harbor, Hawaii and observations of green sea turtle behavior.

Hanson, M.B. & Emmons, C.K. (*in prep*). Annual residency patterns of southern resident killer whales in the inland waters of Washington and British Columbia.

Harvey, J. T., Brown, R. F. & Mate, B. R. (1990). Abundance and Distribution of Harbor Seals (*Phoca vitulina*) in Oregon, 1975–1983. *Northwestern Naturalist, 71*(3), 65–71. Retrieved from http://www.jstor.org/stable/3536774

Harvey, J. T. & Goley, D. (2011, Oct). Determining a correction factor for aerial surveys of harbor seals in California. [Article]. *Marine Mammal Science, 27*(4), 719–735. 10.1111/j.1748-7692.2010.00446.x Retrieved from <Go to ISI>://WOS:000295938200011

Hays, G. C., Marshall, G. J. & Seminoff, J. A. (2007, Feb). Flipper beat frequency and amplitude changes in diving green turtles, Chelonia mydas. [Article]. *Marine Biology, 150*(5), 1003–1009. 10.1007/s00227-006-0412-3 Retrieved from <Go to ISI>://000243658500025

Hazel, J., Lawler, I. R. & Hamann, M. (2009, Mar). Diving at the shallow end: Green turtle behaviour in near-shore foraging habitat. [Article]. *Journal of Experimental Marine Biology and Ecology, 371*(1), 84–92. 10.1016/j.jembe.2009.01.007 Retrieved from <Go to ISI>://000264557900010

HDR. (2011). Guam Marine Species Monitoring survey Vessel-Based Monitoring Surveys Winter 2011. (pp. 15). Prepared by HDR. Prepared for U.S. Department of the Navy NAVFAC Pacific.

HDR. (2012). Guam and Saipan Marine Species Monitoring Winter-Spring Survey, March 2012. (pp. 19). Prepared by HDR. Prepared for U.S. Department of the Navy, NAVFAC Pacific.

Heyning, J. E. (1989). Cuvier's beaked whale — *Ziphius cavirostris* (G. Cuvier, 1823) S. H. Ridgway and R. Harrison (Eds.), *Volume 4: River Dolphins and the Larger Toothed Whales* (Vol. 6, pp. 289–308). San Diego: Academic Press.

Heyning, J. E. & Mead, J. G. (2009). Cuvier's beaked whale, *Ziphius cavirostris* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 294–295). Amsterdam: Academic Press.

Heyning, J.E. & Perrin, W.F. (1994) Evidence for two species of common dolphin (genus *Delphinus*) from the eastern North Pacific. *Los Angeles County Museum of Natural History Contributions in Science*. 442:1-35

Hill, M., Ligon, A. D., Deakos, M. H., Ü, A., Norris, E. and Oleson, E. M. (2011). Cetacean Surveys of Guam and CNMI Waters: August–September 2011 (pp. 24).

Hill, M., A. Ligon, M. Deakos, A. Ü, A. Milette-Winfree and E. Oleson. (2013). Cetacean Surveys of Guam and CNMI Waters: May–July 2012 Including Individual Photo-Identification of Pilot Whales, Spinner Dolphins and Bottlenose Dolphins (2010–2012). PIFSC Data Report. Prepared for the U.S. Pacific Fleet Environmental Readiness Office: 40.

Hitipeuw, C., Dutton, P. H., Benson, S., Thebu, J. & Bakarbessy, J. (2007, May). Population status and internesting movement of leatherback turtles, *Dermochelys coriacea*, nesting on the northwest coast of Papua, Indonesia. [Article]. *Chelonian Conservation and Biology, 6*(1), 28–36. 10.2744/1071-8443(2007)6[28:psaimo]2.0.co;2 Retrieved from <Go to ISI>://WOS:000247162000004

Hobbs, R. C., & Waite, J.M. (2010). Abundance of harbor porpoise (*Phocoena phocoena*) in three Alaskan regions, corrected for observer errors due to perception bias and species misidentification, and corrected for animals submerged from view. *Fishery Bulletin*, U.S. 108(3):251-267.

Hodge, R. P. & Wing, B. L. (2000). Occurrences of marine turtles in Alaska waters: 1960–1998. Herpetological Review, 31(3), 148–151.

Hoelzel, A. R., Fleischer, R. C., Campagna, C., Le Boeuf, B. J. & Alvord, G. (2002, Jul). Impact of a population bottleneck on symmetry and genetic diversity in the northern elephant seal. [Article]. *Journal of Evolutionary Biology, 15*(4), 567–575. 10.1046/j.1420-9101.2002.00419.x Retrieved from <Go to ISI>://WOS:000176319800008

Honarvar, S., O'Connor, M. P. & Spotila, J. R. (2008, Aug). Density-dependent effects on hatching success of the olive ridley turtle, *Lepidochelys olivacea*. *Oecologia, 157*(2), 221–230. 10.1007/s00442-008-1065-3 Retrieved from <Go to ISI>://WOS:000257956000004

Horwood, J. (2009). Sei whale *Balaenoptera borealis*. In: Encyclopedia of Marine Mammals. W. F. Perrin, B. Wursig and J. G. M. Thewissen. San Diego, CA, Academic Press: 1001–1003.

Houck, W. J. & Jefferson, T. A. (1999). Dall's porpoise — *Phocoenoides dalli* (True, 1885) S. H. Ridgway and R. Harrison (Eds.), *Volume 6: The Second Book of Dolphins and the Porpoises* (Vol. 6, pp. 443–472). San Diego: Academic Press.

Houghton, J., Baird, R.W., C.K. Emmons, & Hanson, M.B. (*in prep*) Predator occurrence changes as prey abundance increases: studies of mammal-eating killer whales in southern British Columbia and Washington state from 1987 to 2010.

Huber, H. R., Jeffries, S.J., Brown, R. F., DeLong, R. L., & VanBlaricom, G. (2001). Correcting aerial survey counts of harbor seals (*Phoca vitulina richardsi*) in Washington and Oregon. Mar. Mammal Sci. 17(2):276-293.

Hughes, G. R., Luschi, P., Mencacci, R. & Papi, F. (1998). The 7000-km oceanic journey of a leatherback turtle tracked by satellite. *Journal of Experimental Marine Biology and Ecology, 229*, 209-217.

James, M. C. & Mrosovsky, N. (2004). Body temperatures of leatherback turtles (*Dermochelys coriacea*) in temperate waters off Nova Scotia, Canada. *Canadian Journal of Zoology, 82*, 1302-1306.

Hume, M. (2013). 'Miracle' whale leaves scientists elated – and relieved. The Globe and Mail, online newspaper article, June 21 2013. http://www.theglobeandmail.com/news/british-columbia/miracle-whale-leaves-scientists-elated-and-relieved/article12735936/

Hutchinson, G. E. (1957). Concluding remarks. *Cold Spring Harbor Symposium on Quantitative Biology, 22*, 415–427.

International Union for Conservation of Nature (IUCN). (2012). Report of the 11th Meeting of the Western Gray Whale Advisory Panel. Geneva, Switzerland. Available from http://www.iucn.org/wgwap/publications_and_reports/.

Jefferson, T. A. (2012). Dall's porpoise (*Phocoenoides dalli*) in Southeast Alaska: An assessment of abundance and population trends. Unpublished contract report to the National Marine Mammal Laboratory, US NMFS.

Jefferson, T. A., Smultea, M. A. & Black, J. (2012). Density and Abundance of Marine Mammals in the Navy's Southern California Range Complex, off San Diego County, in 2008–2011. (pp. 28 pp). Pearl Harbor, Hawaii: Department of the Navy, U.S. Pacific Fleet.

Jefferson, T. A., M. A. Smultea, and C. E. Bacon. (*in preparation*). Density and abundance of marine mammals in the Southern California Bight from aerial surveys, 2008-2012. Submitted to Bulletin of the Southern California Academy of Sciences.

Jefferson, T. A., Webber, M. A. & Pitman, R. L. (2008). Marine Mammals of the World; A Comprehensive Guide to their Identification (pp. 573 pp). London: Academic Press.

Jeffries, S., Huber, H., Calambokidis, J. & Laake, J. (2003, Jan). Trends and status of harbor seals in Washington state: 1978–1999. [Article]. *Journal of Wildlife Management, 67*(1), 207–218. 10.2307/3803076 Retrieved from <Go to ISI>://WOS:000181296200022

Jeffries, S.J., Gearin, P.J., Huber, H.R., Saul, D.L., & Pruett, D.A. (2000). Atlas of seal and sea lion haulout sites in Washington. Washington Department of Fish and Wild life, Wildlife Science Division, Olympia WA. 150 pp.

Jensen, B. A., Saliki, J. T., Sanchez, S., Rotstein, D. S., Levine, G. A., Schofield, T. D. (2011). First central Pacific cases of morbillivirus in Hawaiian cetaceans, *Presented at the Workshop on Science and Conservation of Hawaiian Odontocetes at the 19th Bienniel Conference on the Biology of Marine Mammals*. Tampa, Florida, November 27–December 2, 2011.

Jones, M. L. & Swartz, S. L. (2002). Gray whale, *Eschrichtius robustus* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (pp. 524–536). San Diego: Academic Press.

Jones, M. L., Swartz, S. L. & Leatherwood, S. (1984). The Gray Whale, *Eschrichtius robustus* (pp. 600 pp.). Orlando, Florida: Academic Press.

Julian, F. & Beeson, M. (1998, Apr). Estimates of marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990–1995. [Article]. *Fishery Bulletin, 96*(2), 271–284. Retrieved from <Go to ISI>://WOS:000072979800008

Kami, H. T. & Lujan R.J. (1976). Records of the Dwarf Sperm Whale *Kogia simus* Own from Guam. *Micronesica*, 12(2), 327-332.

Karczmarski, L., Wursig, B., Gailey, G., Larson, K. W. & Vanderlip, C. (2005, Jul–Aug). Spinner dolphins in a remote Hawaiian atoll: social grouping and population structure. [Article]. *Behavioral Ecology, 16*(4), 675–685. 10.1093/beheco/ari028 Retrieved from <Go to ISI>://WOS:000229856900001

Kasamatsu, F., Matsuoka, K. & Hakamada, T. (2000, Jul). Interspecific relationships in density among the whale community in the Antarctic. [Article]. *Polar Biology, 23*(7), 466–473. 10.1007/s003009900107 Retrieved from <Go to ISI>://WOS:000088181500004

Kaschner, K., Watson, R., Trites, A. W. & Pauly, D. (2006). Mapping world-wide distributions of marine mammal species using a relative environmental suitability (RES) model. [Review]. *Marine Ecology-Progress Series, 316*, 285–310. 10.3354/meps316285 Retrieved from <Go to ISI>://WOS:000239512600026

Kasuya, T., T. Miyashita, and F. Kasamatsu. (1988). Segregation of two forms of short-finned pilot whales off the Pacific Coast of Japan. *Scientific Reports of the Whales Research Institute*, 39:77-90.

Kato, H. & Perrin, W. F. (2008). Bryde's whales, *Balaenoptera edeni/brydei* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 158–163). Amsterdam: Academic Press.

Kellogg R. & Scheffer, V.B. (1947). Occurrence of Stenetla euphrosyne off the Oregon coast. Murrelet, 28: 9–10.

Kenyon, K.W. & Scheffer, V.B. (1949). A long-snouted dolphin from the Washington coast. Journal of Mammalogy, 30(3), 267–268.

Kishiro, T. and Kasuya T. (1993). Review of Japanese dolphin drive fisheries and their status. *Reports of the International Whaling Commission* 43, 439–452.

Kiszka, J., Perrin, W. F., Pusineri, C. & Ridoux, V. (2011a, Oct). What drives island-associated tropical dolphins to form mixed-species associations in the southwest Indian Ocean? [Article]. *Journal of Mammalogy, 92*(5), 1105–1111. 10.1644/10-mamm-a-376.1 Retrieved from <Go to ISI>://WOS:000296021600019

Kiszka, J., Simon-Bouhet, B., Martinez, L., Pusineri, C., Richard, P. & Ridoux, V. (2011b). Ecological niche segregation within a community of sympatric dolphins around a tropical island. [Article]. *Marine Ecology*

Progress Series, 433, 273–288. 10.3354/meps09165 Retrieved from <Go to ISI>://WOS:000292890400022

Kobayashi, D. R., Polovina, J. J., Parker, D. M., Kamezaki, N., Cheng, I. J., Uchida, I., Durron, P.H., and Balazs, G. H. (2008). Pelagic habitat characterization of loggerhead sea turtles, Caretta caretta, in the North Pacific Ocean (1997–2006): Insights from satellite tag tracking and remotely sensed data. *Journal of Experimental Marine Biology and Ecology, 356*(1-2), 96-114.

Koch, V., Nichols, W. J., Peckham, H. & de la Toba, V. (2006, Mar). Estimates of sea turtle mortality from poaching and bycatch in Bahia Magdalena, Baja California Sur, Mexico. *Biological Conservation, 128*(3), 327–334. 10.1016/j.biocon.2005.09.038 Retrieved from <Go to ISI>://WOS:000236096500005

Kolinski, S. P., Parker, D. M., Ilo, L. I. & Ruak, J. K. (2001). An Assessment of the Sea Turtles and Their Marine and Terrestrial Habitats at Saipan, Commonwealth of the Northern Mariana Islands. *Micronesica, 34*(1), 55-72.

Kruse, S., Caldwell, D. K. & Caldwell, M. C. (1999). Risso's dolphin — *Grampus griseus* (G. Cuvier, 1812) S. H. Ridgway and R. Harrison (Eds.), *Volume 6: The Second Book of Dolphins and the Porpoises* (Vol. 6, pp. 183–212). San Diego: Academic Press.

Laake, J. (2007). Harbor porpoise abundance in northwest waters. Unpublished manuscript. National Marine Mammal Laboratory. 10 pp.

Laidre, K.L., Shelden, K.E.W., Rugh, D.J., & Mahoney, B.A. (2000). Beluga, *Delphinapterus leucas*, distribution and survey effort in the Gulf of Alaska. *Marine Fisheries Review*, 62(3): 27-36.

Leatherwood, S. & Walker, W.A. (1979). The northern right whale dolphin *Lissodelphis borealis peale* in the eastern North Pacific. In: Behavior of Marine Animals. H. E. Winn and B. L. Olla, Plenum Press. 3: 85-141.

Leatherwood, S., Perrin, W. F., Kirby, V. L., Hubbs, C. L. and Dahlheim, M. (1980). Distribution and movements of Risso's dolphin, *Grampus griseus*, in the eastern North Pacific. *Fishery Bulletin*, 77(4), 951-963.

Le Boeuf, B. J. & Laws, R. M. (1994). Elephant seals: population ecology, behavior and physiology (pp. 414 pp.). Berkeley, California: University of California Press.

Le Boeuf, B.J., Crocker, D.E., Costa, D.P., Blackwell, S.B., Webb, P.M., & Houser, D.S. (2000). Foraging ecology of northern elephant seals. Ecological Monographs. 70:353-382.

Leatherwood, S., Reeves, R. R., Perrin, W. F. & Evans, W. E. (1988). Whales, Dolphins, and Porpoises of the Eastern North Pacific and Adjacent Arctic Waters; A Guide to their Identification. New York: Dover Publications, Inc.

Lemons, G., Lewison, R., Komoroske, L., Gaos, A., Lai, C. T., Dutton, P. (2011, Aug). Trophic ecology of green sea turtles in a highly urbanized bay: Insights from stable isotopes and mixing models. [Article].

Journal of Experimental Marine Biology and Ecology, 405(1-2), 25–32. 10.1016/j.jembe.2011.05.012 Retrieved from <Go to ISI>://WOS:000293047800004

LGL Ltd., environmental research associates. (2008). Environmental Assessment of a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in Southeast Asia, March–July 2009. Prepared for Lamont-Doherty Earth Observatory and National Science Foundation Division of Ocean Sciences. 215 pp.

LGL Ltd., environmental research associates. (2011). Environmental Assessment of a Low-Energy Marine Geophysical Survey by the R/V *Thompson* in the Western Tropical Pacific Ocean, November–December 2011. Prepared for Scripps Institution of Oceanography and National Science Foundation Division of Ocean Sciences. 188 pp.

Ligon, A. D., Deakos, M. H. and Adam, C. U. (2011). Small-boat cetacean surveys off Guam and Saipan, Mariana Islands, February–March 2010. (pp. 34). Prepared for Pacific Island Fisheries Science Center.

Limpus, C. J. (2009). A Biological Review of Australian Marine Turtles Hawksbill Turtle, *Eretmochelys imbricata* (Linnaeus). (pp. 54) Queensland Government Environmental Protection Agency.

Lipsky, J. D. (2009). Right whale dolphins; *Lissodelphis borealis, L. peronii* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 958–962). Amsterdam: Academic Press.

London J.M., J.M. Ver Hoef, S.J. Jeffries, M.M. Lance, & P.L. Boveng. (2012). Haul-Out Behavior of Harbor Seals (*Phoca vitulina*) in Hood Canal, Washington. PLoSONE 7(6): e38180. doi:10.1371/journal.pone.0038180.

Lopez-Castro, M. C., Carmona, R. & Nichols, W. J. (2004, Sep). Nesting characteristics of the olive ridley turtle (*Lepidochelys olivacea*) in Cabo Pulmo, southern Baja California. *Marine Biology, 145*(4), 811–820. 10.1007/s00227-004-1359-x Retrieved from <Go to ISI>://WOS:000224527600019

Lowry, L.F., Frost, K.J., Ver Hoef, J.M. & DeLong, R.A.. (2001). Movements of satellite-tagged subadult and adult harbor seals in Prince William Sound, Alaska. Marine Mammal Science 17(4): 835-861.

Lowry, M. S. (2002). Counts of northern elephant seals at rookeries in the Southern California Bight: 1981-2001. NOAA Technical Memorandum NMFS: NOAA-TM-NMFS-SWFSC-345. 63 pp.

Lowry, L.F., Laist, D. W., Gilmartin, W. G. & Antonelis, G. A. (2011). Recovery of the Hawaiian monk seal (*Monachus schauinslandi*): a review of conservation efforts, 1972 to 2010, and thoughts for the future. *Aquatic Mammals, 37*(3), 397–419. 10.1578/am.37.3.2011.397 Retrieved from <Go to ISI>://WOS:000295090400022

Lowry, M.S. (2002). Counts of Northern Elephant Seals at Rookeries in the Southern California Bight: 1981–2001 *NOAA Technical Memorandum NMFS-SWFSC-345*. (SI-1391, pp. 68 pp) NOAA Fisheries, Southwest Fisheries Science Center. Prepared by S. E. R. a. D. P. U.S. Department of Defense.

Lowry, M.S., Carretta, J.V. & Forney, K.A. (2008, Fall). Pacific harbor seal census in California during May–July 2002 and 2004. [Article]. *California Fish and Game, 94*(4), 180–193. Retrieved from <Go to ISI>://WOS:000263397800003

Lowry, M. S. & Forney, K. A. (2005). Abundance and distribution of California sea lions (*Zalophus californianus*) in central and northern California during 1998 and summer 1999. *Fishery Bulletin, 103*, 331–343.

Lutz, P. L. & Musick, J. A. (1997). The Biology of Sea Turtles (pp. 432). New York: CRC Press.

MacLeod, C. D. (1998, Jan). Intraspecific scarring in odontocete cetaceans: an indicator of male 'quality' in aggressive social interactions? [Article]. *Journal of Zoology, 244*, 71–77. 10.1111/j.1469-7998.1998.tb00008.x Retrieved from <Go to ISI>://WOS:000071914000008

MacLeod, C. D. & D'Amico, A. (2006). A review of beaked whale behaviour and ecology in relation to assessing and mitigating impacts of anthropogenic noise. [Article]. *Journal of Cetacean Research and Management, 7*(3), 211–221.

Mahaffy, S. D. (2012). *Site Fidelity, Associations and Long-term Bonds of Short-finned Pilot Whales Off the Island of Hawai'i.* (Master's Thesis). Portland State University, Portland, Oregon.

Maniscalco, J.M., Wynne, K., Pitcher, K.W., Hanson, M.B., Melin, S.R., & Atkinson, S. (2004). The occurrence of California sea lions (*Zalophus californianus*) in Alaska. Aquatic Mammals. 30:427-433.

ManTech-SRS Technologies. (2007). Marine mammal and sea turtle density estimates for the Pacific Northwest Study Area. Prepared for the U.S. Department of the Navy by ManTech-SRS Technologies, September 28, 2007. 38 pp.

Marques, F. F. C. & Buckland, S. T. (2003, Dec). Incorporating covariates into standard line transect analyses. [Article]. *Biometrics, 59*(4), 924–935. 10.1111/j.0006-341X.2003.00107.x Retrieved from <Go to ISI>://WOS:000187501100021

Mate, B. (2013). Offshore Gray Whale Satellite Tagging in the Pacific Northwest. Prepared for Commander, U.S. Pacific Fleet, Pearl Harbor, Hawaii. Submitted to Naval Facilities Engineering Command Northwest (NAVFAC NW), Silverdale, WA 98315-1101.

Mate, B., Bradford, A., Tsidulko, G., Vertyankin, V. & Ilyashenko, V. (2011). Late-feeding season movements of a western North Pacific gray whale off Sakhalin Island, Russia and subsequent migration into the Eastern North Pacific. (pp. 7 pp) Paper SC/63/BRG23 presented to the International Whaling Commission Scientific Committee.

Mate, B.R., Lagerquist, B., & Irvine, L. (2010). Feeding habitats, migration, and winter reproductive range movements derived from satellite-monitored radio tags on eastern North Pacific gray whales. Paper SC/62/BRG21 presented to the International Whaling Commission Scientific Committee. 22 pp.

McAlpine, D. F. (2009). Pygmy and dwarf sperm whales; *Kogia breviceps* and *K. sima* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 938–938). Amsterdam: Academic Press.

McDonald, M. A. & Fox, C. G. (1999, May). Passive acoustic methods applied to fin whale population density estimation. [Article]. *Journal of the Acoustical Society of America, 105*(5), 2643–2651. 10.1121/1.426880 Retrieved from <Go to ISI>://WOS:000080310200011

McDonald, M. A., Hildebrand, J. A., Wiggins, S. M., Johnston, D. W. & Polovina, J. J. (2009, Feb). An acoustic survey of beaked whales at Cross Seamount near Hawaii (L). [Article]. *Journal of the Acoustical Society of America, 125*(2), 624–627. 10.1121/1.3050317 Retrieved from <Go to ISI>://WOS:000264100600007

McSweeney, D. J., Baird, R. W. & Mahaffy, S. D. (2007, Jul). Site fidelity, associations, and movements of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales off the island of Hawai'i. [Article]. *Marine Mammal Science, 23*(3), 666–687. 10.1111/j.1748-7692.2007.00135.x Retrieved from <Go to ISI>://WOS:000247205900011

McSweeney, D. J., Baird, R. W., Mahaffy, S. D., Webster, D. L. & Schorr, G. S. (2009, Jul). Site fidelity and association patterns of a rare species: pygmy killer whales (*Feresa attenuata*) in the main Hawaiian Islands. [Article]. *Marine Mammal Science, 25*(3), 557–572. 10.1111/j.1748-7692.2008.00267.x Retrieved from <Go to ISI>://WOS:000268031000004

Mead, J. G. (1989). Beaked whales of the genus *Mesoplodon*. In S. H. Ridgway and R. Harrison (Eds.), *Handbook of Marine Mammals*, (Vol. 4, pp. 349-430). San Diego, CA: Academic Press.

Melin, S. R. & DeLong, R. L. (1999, Jul). Observations of a Guadalupe fur seal (*Arctocephalus townsendi*) female and pup at San Miguel Island, California. *Marine Mammal Science, 15*(3), 885–888. Retrieved from <Go to ISI>://000080863700022

Melin, S. R., Orr, A. J. & DeLong, R. L. (2008). The status of the northern fur seal population at San Miguel Island, California, 2006 and 2007 J. W. Testa (Ed.), *Fur Seal Investigations, 2006 and 2007, NOAA Technical Memorandum NMFS-AFSC-188*. (pp. 41–61). Anchorage, Alaska: National Marine Fisheries Service, Alaska Fisheries Science Center. Prepared by N. O. a. A. A. U.S. Department of Commerce.

Mellinger, D.K., Stafford, K.M., & Fox, C.G. (2004). Seasonal occurrence of sperm whale (*Physter marcrocephalus*) sounds in the Gulf of Alaska, 1999-2001. Marine Mammal Science 20:48-62.

Mesnick, S. L., Rivas, M. D. G. & Le Boeuf, B. J. (1998, Jan). Northern elephant seals in the Gulf of California, Mexico. [Article]. *Marine Mammal Science, 14*(1), 171–178. 10.1111/j.1748-7692.1998.tb00703.x Retrieved from <Go to ISI>://WOS:000071484600016

Miller, J.D., Dobbs, K.A., Limpus, C.J., Mattocks, N., and Landry Jr., A.M. (1998). Long-distance migrations by the hawksbill turtle, *Eretmochelys imbricata*, from north-eastern Australia. *Wildlife Research*. 25, 89-95.

Minamikawa, S., Iwasaki, T. & Kishiro, T. (2007). Diving behaviour of a Baird's beaked whale, *Berardius bairdii*, in the slope water region of the western North Pacific: First dive records using a data logger. *Fisheries Oceanography, 16*, 573–577.

Miyashita, T. (1993). Distribution and abundance of some dolphins taken in the North Pacific driftnet fisheries. *International North Pacific Fisheries Commission Bulletin*, 53(3), 435-450.

Miyashita, T., Kishiro, T., Higashi, N., Sato, F., Mori, K. and Kato, H. (1996). Winter distribution of cetaceans in the western North Pacific inferred from sighting cruises 1993-1995. *Reports of the International Whaling Commission,* 46, 437-442.

Mobley, J. R. (2007). *Marine Mammal Monitoring Surveys in Support of Valiant Shield Training Exercises (Aug. 13-17, 2007)–Final Report*. (pp. 12). Prepared for Commander, U.S. Pacific Fleet.

Mobley, J. R., Spitz, S., Grotefendt, R., Forstell, P., Frankel, A. & Bauer, G. (2001). Abundance of humpback whales in Hawaiian waters: results of 1993–2000 aerial surveys. *Report to the Hawaiian Islands Humpback Whale National Marine Sanctuary*. (pp. 16 pp) Hawaiian Islands Humpback Whale National Marine Sanctuary.

Mooney, T. A., Pacini, A. F. & Nachtigall, P. E. (2009, Aug). False killer whale (*Pseudorca crassidens*) echolocation and acoustic disruption: implications for longline bycatch and depredation. [Article]. *Canadian Journal of Zoology, 87*(8), 726–733. 10.1139/z09-061 Retrieved from <Go to ISI>://WOS:000270178300009

Moore, J. C. (1972). More skull characters of the beaked whale Indopacetus pacificus and comparative measurements of austral relatives. *Fieldiana Zoology*, 62, 1-19.

Moore, J. E. & Barlow, J. (2011). Bayesian state-space model of fin whale abundance trends from a 1991–2008 time series of line-transect surveys in the California Current. *Journal of Applied Ecology* 48:1195–1205.

Moore, J. E., Wallace, B. P., Lewison, R. L., Žydelis, R., Cox, T. M. & Crowder, L. B. (2009). A review of marine mammal, sea turtle and seabird bycatch in USA fisheries and the role of policy in shaping management. [doi: 10.1016/j.marpol.2008.09.003]. *Marine Policy, 33*(3), 435–451. Retrieved from http://www.sciencedirect.com/science/article/pii/S0308597X08001486

Moore, S. E., Stafford, K. M., Dahlheim, M. E., Fox, C. G., Braham, H. W., Polovina, J. J. (1998, Jul). Seasonal variation in reception of fin whale calls at five geographic areas in the North Pacific. [Article]. *Marine Mammal Science, 14*(3), 617–627. 10.1111/j.1748-7692.1998.tb00749.x Retrieved from <Go to ISI>://WOS:000074420500015

Moore, S.E., Stafford K. M., Mellinger D. K., Hildebrand J. A. (2006). Listening for large whales in the offshore waters of Alaska. *BioScience*. 56: 49–55.

Morin, P. A., Archer, F. I., Foote, A. D., Vilstrup, J., Allen, E. E., Wade, P., Durban, J., Parsons, K., Pitman, R., Li, L., Bouffard, P., Abel Nielsen, S. C., Rasmussen, M., Willerslev, E., Gilbert, M. T., & Harkins, T.

(2010). Complete mitochondrial genome phylogeographic analysis of killer whales (*Orcinus orca*) indicates multiple species. Genome Res 20(7): 908–916.

Myers, A. E. & Hays, G. C. (2006). Do leatherback turtles *Dermochelys coriacea* forage during the breeding season? A combination of data-logging devices provide new insights. *Marine Ecology Progress Series*, 322, 259-267.

National Oceanic and Atmospheric Administration. (2007). Endangered and Threatened Species: Proposed Endangered Status for Cook Inlet Beluga Whale. Federal Register, Vol. 72(76), Friday, 20 April 2007, 19854-19862.

National Oceanic and Atmospheric Administration. (2008). Endangered and Threatened Species: Endangered Status for Cook Inlet Beluga Whale. Federal Register, Vol. 73(205), Wednesday, 22 October 2008, 62919-62930.

National Oceanic and Atmospheric Administration. (2011). Endangered and Threatened Species: Designation of Critical Habitat for Cook Inlet Beluga Whale. Federal Register, Vol. 76(69), Monday, 11 April 2011, 20180-20214.

National Oceanic and Atmospheric Administration. (2012). Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Pile Replacement Project Federal Register, 77(83), 25408-25435.

National Oceanic and Atmospheric Administration. (2013). Endangered and Threatened Species; Delisting of the Eastern Distinct Population Segment of Steller Sea Lion under the Endangered Species Act; Amendment to Special Protection Measures for Endangered Marine Mammals. Federal Register 78 (206).

National Marine Fisheries Service and U.S. Fish and Wildlife Service. (1998a). Recovery Plan for U.S. Pacific Populations of the Leatherback Turtle (*Dermochelys coriacea*). (pp. 65). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. (1998b). Recovery Plan for U.S. Pacific Populations of the Olive Ridley Turtle (*Lepidochelys olivacea*). (pp. 52). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. (1998c). Recovery Plan for U.S. Pacific Populations of the Leatherback Turtle (*Dermochelys coriacea*). (pp. 65). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service (NMFS). (2006a). Draft conservation plan for the eastern Pacific stock of northern fur seal (*Callorhinus ursinus*). National Marine Fisheries Service, Juneau.

National Marine Fisheries Service (NMFS). (2006b). Recovery Plan for the Steller Sea Lion (*Eumetopias jubatus*). National Marine Fisheries Service, Silver Spring, MD. 325 pages.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. (2007a). Leatherback Sea Turtle (*Dermochelys coriacea*) 5-year Review: Summary and Evaluation. (pp. 79). Silver Spring, MD: National Marine Fisheries.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. (2007b). Green Sea Turtle (Chelonia mydas) 5-year Review: Summary and Evaluation. (pp. 102). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. (2007c). Loggerhead Sea Turtle (*Caretta caretta*) 5-year Review: Summary and Evaluation. (pp. 65). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service. (2008). Recovery Plan for Southern Resident Killer Whales (*Orcinus orca*). National Marine Fisheries Service, Northwest Region, Seattle, Washington.

National Marine Fisheries Service & U.S. Fish and Wildlife Service. (2007). Hawksbill Sea Turtle *Eretmochelys imbricata* 5-year review: Summary and Evaluation. In N. M. F. Service and U.S. F. a. W. Service (Eds.) (pp. 90). Silver Spring, MD.

National Marine Fisheries Service. (2013). Final Recovery Plan for the North Pacific Right Whale (*Eubalaena japonica*). National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD.

Nitta, E. (1991). The marine mammal stranding network for Hawaii: An overview J. E. Reynolds and D. K. Odell (Eds.), *Marine Mammal Strandings in the United States, NOAA Technical Report NMFS 98*. (pp. 56–62) National Marine Fisheries Service. Prepared by N. M. F. Service.

Norman, S.A., Bowlby, C.E., Brancato, M.S., Calambokidis, J., Duffield, D., Gearin, P.J., Gornall, T.A., Gosho, M.E., Hanson, B., Hodder, J., Jeffries, S.J., Lagerquist, B., Lambourn, D.M., Mate, B., Norberg, B., Osborne, R.W., Rash, J.A., Riemer, S., & Scordino, J. (2004). Cetacean strandings in Oregon and Washington between 1930 and 2002. Journal of Cetacean Research and Management, 6(1), 87–99.

Norris, K. S. & Dohl, T. P. (1980). Behavior of the Hawaiian spinner dolphin, *Stenella longirostris*. [Article]. *Fishery Bulletin, 77*(4), 821–849. Retrieved from <Go to ISI>://WOS:A1980KB52800006

Norris, K. S., Würsig, B., Wells, R. S. & Würsig, M. (1994). The Hawaiian Spinner Dolphin (pp. 408 pp). Berkeley, California: University of California Press.

Norris, T, S. Martin, T. Yack, J. Oswald, P. Gruden, L. Thomas, A. Cummins, S. Wiggins, J. Hildebrand, and E. Oleson. (2011). To Boing or Not to Boing? The Acoustic Behavior and Ecology of Minke Whales (*Balaenoptera acutorostrata*) near Subtropical North Pacific Islands. Poster presented at the 19th Biennial Conference on the Biology of Marine Mammals, Tampa, Florida, November 28–December 2, 2011.

Nysewander, D.R., Evenson, J.R., Murphie, B.L., & Cyra, T.A. (2005). Report of marine bird and mammal component, Puget Sound Ambient Monitoring Program, for July 1992 to December 1999 period.

Unpublished Report, Washington State Department of Fish and Wildlife, Wildlife Management Program, Olympia, Washington.

Odell, D. K. & Miller McClune, K. (1999). False killer whale — *Pseudorca crassidens* (Owen, 1846) S. H. Ridgway and R. Harrison (Eds.), *Volume 6: The Second Book of Dolphins and the Porpoises* (Vol. 6, pp. 213–243). San Diego: Academic Press.

Oleson, E.M., J. Calambokidis, E. Falcone, G. Schorr, & J.A. Hildebrand. (2009). Acoustic and visual monitoring of cetaceans along the outer Washington Coast. Technical Report for grant N0002407WX12527. Report # NPS-OC-09-001 issued by Naval Postgraduate School, Monterey, California. 45 pp.

Oleson, E. M. and Hill, M. C. (2010). 2010 Report to PACFLT: Report of Cetacean Surveys in Guam, CNMI, and the High-seas and Follow up on 2009 Main Hawaiian Islands Cetacean Survey NMFS-Pacific Islands Fisheries Science Center (Ed.). 29 pp.

Osborne, R., Calambokidis, J., & Dorsey, E.M. (1988). A guide to marine mammals of Greater Puget Sound. Anacortes, WA: Island Publishers.

Osmek, S.D., J. Calambokidis, J. Laake, P. Gearin, R. Delong, J. Scordino, S. Jeffries, & R. Brown. (1996). Assessment of the status of harbor porpoise (*Phocoena phocoena*) in Oregon and Washington Waters. December 1996. NOAA Technical Memorandum NMFS-AFSC-76.

Osmek, S.D., J. Calambokidis, & Laake, J.L. (1998). Abundance and distribution of porpoise and other marine mammals of the inside waters of Washington and British Columbia. In Proceedings of the Fourth Puget Sound Research Conference, Strickland, R., ed. Puget Sound Water Quality Action Team, Olympia, WA. 868-880 pp; March 12-13, 1998, Seattle, WA.

Palacios, D.M. and B.R. Mate. (1996). Attack by false killer whalres (Pseudorca crassidens) on sperm whales (*Physeter macrocephalus*) in the Galapagos Islands. *Marine Mammal Science*. 12:582-587.

Palka, D. (1996). Effects of Beaufort sea state on the sightability of harbor porpoises in the Gulf of Maine. *Reports of the International Whaling Commission, 46*, 575–582.

Patino-Martinez, J., Marco, A., Quinones, L. & Godley, B. (2008, Aug). Globally significant nesting of the leatherback turtle (*Dermochelys coriacea*) on the Caribbean coast of Colombia and Panama. *Biological Conservation, 141*(8), 1982–1988. 10.1016/j.biocon.2008.05.012 Retrieved from <Go to ISI>://WOS:000259389600006

Perrin, W. F. (2009a). Pantropical spotted dolphin, *Pseudorca crassidens* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 819–821). Amsterdam: Academic Press.

Perrin, W. F. (2009b). Spinner dolphin, *Stenella longirostris* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 1100–1103). Amsterdam: Academic Press.

Perrin, W. F. & Brownell, R. L. (2009). Minke whales, *Balaenoptera acutorostrata* and *B. bonaerensis* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 733–735). Amsterdam: Academic Press.

Pitman, R. (2009). Mesoplodont whales (*Mesoplodon* spp.) W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 721–726). Amsterdam: Academic Press.

Pitman, R. L. & Durban, J. W. (2012, Jan). Cooperative hunting behavior, prey selectivity and prey handling by pack ice killer whales (Orcinus orca), type B, in Antarctic Peninsula waters. [Article]. *Marine Mammal Science, 28*(1), 16–36. 10.1111/j.1748-7692.2010.00453.x Retrieved from <Go to ISI>://WOS:000298588300007

Pitman, R. L., Palacios, D. M., Brennan, P. L. R., Brennan, B. J., Balcomb, K. C. & Miyashita, T. (1999, Apr). Sightings and possible identity of a bottlenose whale in the tropical Indo-Pacific: *Indopacetus pacificus*? [Article]. *Marine Mammal Science, 15*(2), 531–549. 10.1111/j.1748-7692.1999.tb00818.x Retrieved from <Go to ISI>://WOS:000079821000016

Polovina, J. J., Balazs, G. H., Howell, E. A., Parker, D. M., Seki, M. P. & Dutton, P. H. (2004). Forage and migration habitat of loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) sea turtles in the central North Pacific Ocean. *Fisheries Oceanography*, 13(1), 36-51.

Preston, D. (2003). Sei Whale Carcass Provides Opportunity for Research. Northwest Indian Fisheries Commission, 29(3), 3–4.

Pritchard, P. C. H. & Plotkin, P. T. (1995). Olive ridley sea turtle, *Lepidochelys olivacea*. In P. T. Plotkin (Ed.), *National Marine Fisheries Service and U.S. Fish and Wildlife Service Status Reviews of Sea Turtles Listed under the Endangered Species Act of 1973*. (pp. 123-139). Silver Spring, MD: National Marine Fisheries Service.

Pryor, K. & Norris, K. S. (1965). Observations on a Pygmy Killer Whale (Feresa attenuata Gray) from Hawaii. *Journal of Mammalogy, 46*(3), 450–461. Retrieved from http://www.jstor.org/stable/1377633

Psarakos, S., Herzing, D. L. & Marten, K. (2003). Mixed-species associations between Pantropical spotted dolphins (*Stenella attenuata*) and Hawaiian spinner dolphins (*Stenella longirostris*) off Oahu, Hawaii. *Aquatic Mammals, 29*, 390–395.

Pultz, S., O'Daniel, D. O., Krueger, S. & McSharry, H. (1999). Marine Turtle Survey on Tinian, Mariana Islands. *Micronesica*, 31(2), 85-94.

Pynn, L. (2013). Rare whale sighting stuns B.C. researchers. The Vancouver Sun, 1 Nov 2013, accessed at http://www.vancouversun.com/technology/Rare+whale+sighting+stuns+researchers/9111771/story.html. on 4 Nov 2013.

Querouil, S., Silva, M. A., Cascao, I., Magalhaes, S., Seabra, M. I., Machete, M. A. (2008, Dec). Why do dolphins form mixed-species associations in the Azores? *Ethology, 114*(12), 1183–1194. 10.1111/j.1439-0310.2008.01570.x Retrieved from <Go to ISI>://WOS:000260823000005

Rankin, S., Baumann-Pickering, S., Yack, T. & Barlow, J. (2011, Nov). Description of sounds recorded from Longman's beaked whale, *Indopacetus pacificus*. [Article]. *Journal of the Acoustical Society of America, 130*(5), EL339-EL344. 10.1121/1.36460261 Retrieved from <Go to ISI>://WOS:000297486500011

Rankin, S., Norris, T. F., Smultea, M. A., Oedekoven, C., Zoidis, A. M., Silva, E. (2007, 2007/07/01). A visual sighting and acoustic detections of minke whales, *Balaenoptera acutorostrata* (Cetacea: Balaenopteridae), in nearshore Hawaiian waters. [doi: 10.2984/1534-6188(2007)61 395:AVSAAD 2.0.CO;2]. *Pacific Science, 61*(3), 395–398. 10.2984/1534-6188(2007)61[395:avsaad]2.0.co;2 Retrieved from http://dx.doi.org/10.2984/1534-6188(2007)61[395:AVSAAD]2.0.CO;2

Read, A. J. (1999). Harbor porpoise — *Phocoena phocoena* (Linnaeus, 1758) S. H. Ridgway and R. Harrison (Eds.), *Volume 6: The Second Book of Dolphins and the Porpoises* (Vol. 6, pp. 323–355). San Diego: Academic Press.

Read, A. J., Van Waerebeek, K., Reyes, J. C., McKinnon, J. S. & Lehman, L. C. (1988). The exploitation of small cetaceans in coastal Peru. [Article]. *Biological Conservation, 46*(1), 53–70. 10.1016/0006-3207(88)90108-5 Retrieved from <Go to ISI>://WOS:A1988Q050200004

Ream, R. R., Sterling, J. T. & Loughlin, T. R. (2005). Oceanographic features related to northern fur seal migratory movements. *Deep-Sea Research II, 52*, 823–843.

Redfern, J.V., M.C. Ferguson, E.A. Becker, K.D. Hyrenbach, C. Good, J. Barlow J, K. Kaschner, M.F. Baumgartner, K.A. Forney, L.T. Ballance, P. Fauchald, P. Halpin, T. Hamazaki, A.J. Pershing, S.S. Qian, A. Read, S.B. Reilly, L. Torres, & F. Werner. (2006). Techniques for cetacean-habitat modeling: a review. *Marine Ecology Progress*, 310, 271-295.

Reeves, R. R., Leatherwood, S. & Baird, R. W. (2009, Apr). Evidence of a Possible Decline since 1989 in False Killer Whales (*Pseudorca crassidens*) around the Main Hawaiian Islands. [Article]. *Pacific Science, 63*(2), 253–261. 10.2984/049.063.0207 Retrieved from <Go to ISI>://WOS:000265246100007

Reeves, R. R., Leatherwood, S., Stone, G. S. and Eldredge, L. G. (1999). *Marine Mammals in the Area Served by the South Pacific Regional Environment Programme (SPREP)* (pp. 48). New York, NY: Croom Helm.

Reeves, R. R., Perrin, W. F., Taylor, B. L., Baker, C. S. and Mesnick, S. L. (Eds.). (2004). *Report of the Workshop on Shortcomings of Cetacean Taxonomy in Relation to Needs of Conservation and Management, April 30 – May 2, 2004 La Jolla, California [Technical Memorandum].* (NOAA-TM-NMFS-SWFSC-363, pp. 94). La Jolla, CA: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Reeves, R.R., Stewart, B.S., Clapham, P.J., & Powell, J.A. (2002). National Audubon Society guide to marine mammals of the world. New York, New York: Alfred A. Knopf, Inc.

Rehberg, M and RJ Small. (2001). Dive behavior, haulout patterns, and movements of harbor seal pups in the Kodiak Archipelago, 1997-2000. Pp 209-238 In: Harbor seal investigations in Alaska, Annual Report, NOAA Grant NA87FX0300. Alaska Department of Fish and Game, Division of Wildlife Conservation.

Reilly, S. B. & Shane, S.H. (1986). Pilot whale. In. Marine Mammals of the Eastern North Pacific and Arctic Waters. D. Haley. Seattle, WA, Pacific Search Press, 132-139.

Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. and Zerbini, A.N. (2008). *Balaenoptera musculus*. In: IUCN 2011. *IUCN Red List of Threatened Species. Version 2011*.2. <www.iucnredlist.org>. Downloaded on 30 November 2011

Rice, D. W. (1998). *Marine mammals of the world: systematics and distribution*. (Special Publication Number 4, pp. 231). Lawrence, KS: Society for Marine Mammology.

Rice, D. W. & Wolman, A. A. (1971). The Life History and Ecology of the Gray Whale. In J. N. Layne and J. Knox Jones Jr. (Eds.), *Special Publication* (Vol. No. 3, pp. 142 pp.). Lawrence, Kansas: The American Society of Mammalogists.

Rice, M. R. & Balazs, G. H. (2008). Diving behavior of the Hawaiian green turtle (*Chelonia mydas*) during oceanic migrations. *Journal of Experimental Marine Biology and Ecology, 356*(1-2), 121–127. Retrieved from http://www.sciencedirect.com/science/article/B6T8F-4RSHRB2-1/2/0c573dfc732507c76fa2dbbf9a232845

Riedman, M. (1990). The Pinnipeds; Seals, Sea Lions, and Walruses (pp. 439 pp). Berkeley, California: University of California Press.

Rone, B.K., A.B. Douglas, P. Clapham, A. Martinez, L.J. Morse, A.N. Zerbini, & J. Calambokidis. (2009). Final Report for the April 2009 Gulf of Alaska Line-Transect Survey (GOALS) in the Navy Training Exercise Area. Prepared by NOAA and Cascadia Research Collective. 28 pp. Available from: http://www.cascadiaresearch.org.

Rone, B.K., A. B. Douglas, T. M. Yack, A. N. Zerbini, T. N. Norris, E. Ferguson, & J. Calambokidis. (2013). Draft: Preliminary Estimates for the Gulf of Alaska Line Transect Survey (GOALS) II: Marine Mammal Occurrence in the Temporary Maritime Activites Area (TMAA). Preliminary report prepared for the U.S. Navy, Pacific Fleet, Makalapa, Hawaii.

Rone, B.K., A.B. Douglas, T.M. Yack, A.N. Zerbini, T.N. Norris, E. Ferguson, and J. Calambokidis. (2014). Report for the Gulf of Alaska Line-Transect Survey (GOALS) II: Marine Mammal Occurrence in the Temporary Maritime Activities Area (TMAA). Submitted to Naval Facilities Engineering Command (NAVFAC) Pacific, Honolulu, Hawaii under Contract No. N62470-10-D-3011, Task Order 0022, issued to HDR Inc., San Diego, California. Prepared by Cascadia Research Collective, Olympia, Washington; Alaska Fisheries Science Center, Seattle, Washington; and Bio-Waves, Inc., Encinitas, California. April 2014.

Roppel, A. Y. (1984). Management of northern fur seals on the Pribilof Islands, Alaska 1786–1981 *NOAA Technical Memorandum NMFS-AFSC-4*. (pp. 32 pp). Seattle, Washington: National Marine Fisheries Service, Alaska Fisheries Science Center. Prepared by N. O. a. A. A. U.S. Department of Commerce.

Rosel, P. E., Dizon, A. E. & Heyning, J. E. (1994, May). Genetic analysis of sympatric morphotypes of common dolphins (genus *Delphinus*). [Article]. *Marine Biology, 119*(2), 159–167. 10.1007/bf00349552 Retrieved from <Go to ISI>://WOS:A1994NP59900001

Rugh, D. J., Hobbs, R. C., Lerczak, J. A. & Breiwick, J. M. (2005). Estimates of abundance of the eastern North Pacific stock of gray whales (*Eschrichtius robustus*) 1997–2002. *Journal of Cetacean Research and Management, 7*(1), 1–12.

Rugh, D.J., K.E.W. Shelden, & A. Schulman-Janiger. (2001). Timing of the gray whale southbound migration. *Journal of Cetacean Research and Management*, 3(1), 31-39.

Rugh, D.J., Shelden, K.E.W., & Hobbs, R.C. (2010). Range contraction in a beluga whale population. *Endangered Species Research*, 12: 69-75.

Salden, D. R. & Mickelsen, J. (1999). Rare sightings of a North Pacific right whale (Eubalaena glacialis) in Hawaii. *Pacific Science, 53*, 341–345.

Scheffer, V.B. (1960). A dolphin *Stenella* from Washington State. *Murrelet,* 41(2), 23.

Schorr, G. S., Baird, R. W., Hanson, M. B., Webster, D. L., McSweeney, D. J. & Andrews, R. D. (2010). Movements of satellite-tagged Blainville's beaked whales off the island of Hawai'i. *Endangered Species Research, 10*(1-3), 203–213.

Schusterman, R. J. & Gentry, R. L. (1971). Development of a fatted male phenomenon in California sea lions. *Developmental psychobiology, 4*(4), 333–338. 10.1002/dev.420040406 Retrieved from <Go to ISI>://MEDLINE:5170706

Scott, M. D. & Chivers, S. J. (1990). Distribution and herd structure of bottlenose dolphins in the Eastern Tropical Pacific Ocean S. Leatherwood and R. R. Reeves (Eds.), *The Bottlenose Dolphin* (pp. 387–402). San Diego: Academic Press, Inc.

Sepulveda, M., Inostroza, P., Perez-Alvarez, M. J., Oliva, D. & Moraga, R. (2009). Seasonal variation in the abundance of South American sea lions, *Otaria flavescens* (Shaw, 1800), in Chanaral Island, Reserva Nacional Pinguino de Humboldt, Chile. [Article]. *Revista De Biologia Marina Y Oceanografia, 44*(3), 685–689. Retrieved from <Go to ISI>://WOS:000273205000014

Shane, S. H. (1995, Jul). Relationship between pilot whales and Risso's dolphins at Santa Catalina Island, California, USA. [Article]. *Marine Ecology-Progress Series, 123*(1-3), 5–11. 10.3354/meps123005 Retrieved from <Go to ISI>://WOS:A1995RQ34100002

Shelden, K. E. W. & Laake, J. L. (2002). Comparison of the offshore distribution of southbound migrating gray whales from aerial survey data collected off Granite Canyon, California, 1976–96. *Journal of Cetacean Research and Management, 4*(1), 53–56.

Shelden, K.E.W., S.E. Moore, J.M. Waite, P.R. Wade, & D.J. Rugh. (2005). Historic and current habitat use by North Pacific right whales *Eubalaena japonica* in the Bering Sea and Gulf of Alaska. *Mammal Review*, 35(2), 129-155.

Shillinger, G. L., Palacios, D. M., Bailey, H., Bograd, S. J., Swithenbank, A. M., Gaspar, P. (2008, Jul). Persistent leatherback turtle migrations present opportunities for conservation. [Article]. *Plos Biology, 6*(7), 1408–1416. e17110.1371/journal.pbio.0060171 Retrieved from <Go to ISI>://000257971100013

Shimada, H., H. Okamura, T. Kitakado, and T. Miyashita. (2008). Abundance estimate of western North Pacific Bryde's whales for the estimation of additional variance and CLA application. Working Paper SC/60/FF12. Int. Whal. Comm., Cambridge, U.K. 32 p.

Širović, A., E.M. Oleson, J. Calambokidis, S. Baumann-Pickering, A. Cummins, S. Kerosky, L. Roche, A. Simonis, S. M. Wiggins, & J.A. Hildebrand. (2012a). Acoustic Monitoring for Marine Mammals off Washington. In: Oleson, E. and J. Hildebrand, eds. 2012. Marine mammal demographics off the outer Washington coast and near Hawaii. Prepared for U.S. Navy. Naval Postgraduate School, Monterey, CA. NPS-OC-12-001CR April 2012. 69 p.

Širović, A., J.A. Hildebrand, S. Baumann-Pickering, J. Buccowich, A. Cummins, S. Kerosky, L. Roche, A.S. Berga, & S. M. Wiggins. (2012b). Passive Acoustic Monitoring for Marine Mammals in the Northwest Training Range Complex 2011. Marine Physical Laboratory, Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA. MPL TECHNICAL MEMORANDUM: MPL-TM 535. 57 pp. IN: Department of the Navy (Navy). 2012. Annual Range Complex Monitoring Report- Year 2 For the U.S. Navy's Northwest Training Range Complex. July 1, 2012. Prepared by: Commander, U.S. Pacific Fleet, San Diego Detachment, San Diego, CA. Prepared for: Office of Protected Resources, National Marine Fisheries Service, Silver Spring, MD.

Smith, S. H., Deslarzes, K. J. P. & Brock, R. (2006). Characterization of Fish and Benthic Communities of Pearl Harbor and Pearl Harbor Entrance Channel, Hawaii. (pp. 73 pp). Pearl Harbor, Hawaii: Department of the Navy, Naval Facilities Engineering Services Center. Prepared by D. o. t. Navy.

SMRU Ltd. (*in prep*). Supporting Documentation for Global Predicted Density Data. Sea Mammal Research Unit Limited.

Smultea, M.A., & Bacon, C.E. (2013). Marine Mammal Aerial Density Surveys Conducted in the Pacific Northwest Inland Puget Sound Waters 30 August–4 September 2013. Preliminary Report. Prepared for Commander, U.S. Pacific Fleet, Pearl Harbor, HI. Submitted to Naval Facilities Engineering Command Northwest (NAVFAC NW), Silverdale, WA 98315-1101 under Contract No. N62470-10-D-3011-CPO issued to HDR, Inc., San Diego, CA 92123. 1 October 2013.

Smultea, M. A., Bacon, C.E. & Black, J. S. (2011). Aerial Survey Marine Mammal Monitoring off Southern California in Conjunction with U.S. Navy Major Training Event. (pp. 185). Pearl Harbor, Hawaii: Commander United States Pacific Fleet. Prepared by Smultea Environmental Sciences and HDR Inc.

Smultea, M.A., Bacon, C.E., & Jefferson, T.A. (2014). Marine Mammal Aerial Surveys Conducted in the Pacific Northwest, Inland Puget Sound Waters, 30 August – 4 September 2013. Draft Final Report. Prepared for Commander, U.S. Pacific Fleet, Pearl Harbor, Hawaii. Submitted to Naval Facilities Engineering Command Northwest (NAVFAC NW), Silverdale, WA 98315-1101 under Contract No. N62470-10-D-3011 issued to HDR, Inc., San Diego, CA 92123.

Smultea, M. A. & Mobley, J. R. (2009). Aerial Survey Monitoring of Marine Mammals and Sea Turtles in Conjunction with SCC OPS 08 Training Exercise off Kauai and Niihau, Hawaii, August 18–21, 2008 *Final Report Prepared for Commander Pacific Fleet, U.S. Navy*. (pp. 26 pp). Honolulu: Marine Mammal Research Consultants.

Soldevilla, M. S., Wiggins, S. M., Calambokidis, J., Douglas, A., Oleson, E. M. & Hildebrand, J. A. (2006, Dec). Marine mammal monitoring and habitat investigations during CalCOFI surveys. [Article; Proceedings Paper]. *California Cooperative Oceanic Fisheries Investigations Reports, 47*, 79–91. Retrieved from <Go to ISI>://WOS:000244222600006

Spotila, J. R. (2004). Sea Turtles: A Complete Guide to Their Biology, Behavior, and Conservation (pp. 240 pages). Baltimore, Maryland: Johns Hopkins University Press.

Stacey, P. J. & Baird, R. W. (1991, Apr–Jun). Status of the Pacific white-sided dolphin, *Lagenorhynchus obliquidens*, in Canada. [Article]. *Canadian Field-Naturalist, 105*(2), 219–232. Retrieved from <Go to ISI>://WOS:A1991GF65900011

Stafford, K. M., Mellinger, D.K., Moore, S.E., & Fox, C.G. (2007). Seasonal variability and detection range modeling of baleen whale calls in the Gulf of Alaska, 1999-2002. *Journal of the Acoustical Society of America* 122(6):3378-3390.

Stafford, K. M., Nieukirk, S. L. & Fox, G. G. (2001). Geographic and seasonal variation of blue whale calls in the North Pacific. *Journal of Cetacean Research Management, 3*(1), 65–76.

Stewart, B. S., Yochem, P. K., DeLong, L. R. & Antonelis, G. A. (1993). Trends in abundance and status of pinnipeds on the Southern California Channel Islands. F. G. Hochberg (Ed.), *Third California Islands Symposium: Recent Advances in Research on the California Islands* (pp. 501–516). Santa Barbara, California: Santa Barbara Museum of Natural History.

Stinson, M. L. (1984). Biology of Sea Turtles in San Diego Bay, California, and in the Northeastern Pacific Ocean. San Diego State University, San Diego, CA.

SWOT. (2007). The State of the World's Sea Turtles Report, Volume 3 R. B. Mast (Ed.), *The State of the World's Sea Turtles Report*. (Vol. 3, pp. 46 pp). Arlington, Virginia: State of the World's Sea Turtles.

Sydeman, W. J. & Allen, S. G. (1999, Apr). Pinniped population dynamics in central California: Correlations with sea surface temperature and upwelling indices. [Article]. *Marine Mammal Science, 15*(2), 446–461. 10.1111/j.1748-7692.1999.tb00812.x Retrieved from <Go to ISI>://WOS:000079821000010

Taylor, B.L., Baird, R., Barlow, J., Dawson, S.M., Ford, J., Mead, J.G., Notarbartolo di Sciara, G., Wade, P. and Pitman, R.L. (2008). *Mesoplodon ginkgodens*. In: IUCN 2011. *IUCN Red List of Threatened Species*. Version 2011.2. <www.iucnredlist.org>. Downloaded on 11 December 2011.

Towell, R. G., Ream, R. R. & York, A. E. (2006, Apr). Decline in northern fur seal (*Callorhinus ursinus*) pup production on the Pribilof Islands. [Article]. *Marine Mammal Science, 22*(2), 486–491. 10.1111/j.1748-7692.2006.00026.x Retrieved from <Go to ISI>://WOS:000236527900018

Townsend, C. H. (1935). The Distribution of Certain Whales As Shown by Logbook Records of American Whaleships. *Zoologica*, XIX(1), 3-40.

U.S. Department of the Navy. (2003). Integrated Natural Resources Management Plan Farallon De Medinilla and Tinian Military Lease Areas Commonwealth of the Northern Mariana Islands Plan Duration: FY03-12. (pp. 359). Prepared by P. Helber Hastert & Fee. Prepared for Commander, U.S. Naval Forces Marianas.

U.S. Department of the Navy. (2006). Marine Resources Assessment for the Gulf of Alaska Operating Area. Pacific Division. Naval Facilities Engineering Command, Pearl Harbor, Hawaii. Prepared by Geo-Marine, Inc. Plano, Texas.

U.S. Department of the Navy. (2007). Marine Mammal and Sea Turtle Density Estimates for Pacific Northwest Waters. Prepared my ManTech-SRS Technologies. 38 pp.

U.S. Department of the Navy. (2008). Request for letter of authorization for the incidental harassment of marine mammals resulting from navy training activities conducted within the Northwest Training Range Complex. Prepared for the Commander, U.S. Pacific Fleet. 426 pp.

U.S. Department of the Navy. (2009). Appendix E, Marine Mammal Density Report. Gulf of Alaska Navy Training Activities Draft Environmental Impact Statement/Overseas Environmental Impact Statement. 46 pp.

U.S. Department of the Navy. (2010a). Northwest Training Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement. Prepared by U.S. Pacific Fleet.

U.S. Department of the Navy. (2010b). Marine Mammal Occurrence/Density Report for the Southeast Alaska Acoustic Measurement Facility (SEAFAC). Prepared for Program Executive Office, Submarines, by Naval Facilities Engineering Command, Northwest and Naval Sea Systems Command. May.

U.S. Department of the Navy. (2011). Annual Range Complex Monitoring Report – Year 1, 12 November 2010–1 May 2011 for the U.S. Navy's Northwest Training Range Complex. Final, 1 July 2011.

U.S. Department of the Navy. (2012). Annual Range Complex Monitoring Report – Year 2, 2 May 2011–1 May 2012 for the U.S. Navy's Northwest Training Range Complex. Final, 1 July 2012.

U.S. Department of the Navy. (2014). Final CJMT Marine Mammal Survey Report. Prepared by Tetra Tech, Oakland, under contract to SEI and AECOM-TEC/JV, for U.S. Navy, NAVFAC Pacific. April 2014.

Vogt, S. (2008). *Fiscal Years 2007-2008 Annual Report for 61755NR410, Wildlife Surveys on Military Leased Lands, Farallon de Medinilla, Commonwealth fo the Northern Mariana Islands*. NAVFAC Pacific, Honolulu, HI.

Von Saunder, A. & Barlow, J. (1999). A Report of the Oregon, California and Washington Line-Transect Experiment (ORCAWALE) Conducted in West Coast Waters During Summer/Fall 1996: 49.

Wada, S. and K. Numachi. (1991). Allozyme analyses of genetic differentiation among the populations and species of the *Balaenoptera*. *Reports of International Whaling Commission Special Issue*, 13: 125-154.

Wada, S., M. Oishi and T. Yamada. (2003). A newly discovered species of living baleen whale. *Nature* 426: 278-281.

Wade, P. R. & Gerrodette, T. (1993). Estimates of cetacean abundance and distribution in the eastern tropical Pacific. *Reports of the International Whaling Commission, 43*, 477–493.

Wade, P.R., A. De Robertis, K. R. Hough, R. Booth, A. Kennedy, R. G. LeDuc, L. Munger, J. Napp, K. E. W. Shelden, S. Rankin, O. Vasquez, & C. Wilson. (2011a). Rare detections of North Pacific right whales in the Gulf of Alaska, with observations of their potential prey. Endangered Species Research, 13: 99-109.

Wade, P.R., A. Kennedy, R.G. LeDuc, J. Barlow, J.C. Carretta, K. Shelden, W. Perryman, R. Pitman, K. Robertson, B. Rone, J.C. Salinas, A. Zerbini, R.L. Brownell Jr., & P.J. Clapham. (2011b). The world's smallest whale population? Biology Letters, 7(1): 83–85.

Waite, J.M. (2003). Cetacean Assessment and Ecology Program: Cetacean Survey. *AFSC Quarterly Research Reports* July-Sept 2003.

Waite, J.M., K. Wynne, & D.K. Melliner. (2003). Documented sighting of a North Pacific right whale in the Gulf of Alaska and post-sighting acoustic monitoring. *Northwestern Naturalist*, 84 (1), 38-43.

Wang, J. Y., Yang, S. C. and Liao, H. C. (2001). Species composition, distribution and relative abundance of cetaceans in the waters of southern Taiwan: Implications for conservation and eco-tourism. *Journal of the National Parks of Taiwan*, 11(2), 136-158.

Washington Department of Fish and Wildlife (WDFW). (2008). Marine Bird and Mammal Component, Puget Sound Ambient Monitoring Program (PSAMP), 1992–2008. WDFW Wildlife Resources Data Systems.

Weller, D.W., Bettridge, S., Brownell, R.L., Jr., Laake, J.L., Moore, J.E., Rosel, P.E., Taylor, B.L and Wade, P. R. (2013). Report of the National Marine Fisheries Service gray whale stock identification workshop. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-SWFSC-507.

Wells, R. S. & Scott, M. D. (1999). Bottlenose dolphin – *Tursiops truncatus* (Montagu, 1821) S. H. Ridgway and R. Harrison (Eds.), *Volume 6: The Second Book of Dolphins and the Porpoises* (Vol. 6, pp. 137–182). San Diego: Academic Press.

Wenninger, P. (2010). *FY 2010 Annual Report Wildlife Surveys on Military Leased Lands, Farallon de Medinilla CNMI*. U.S. Department of the Navy Naval Base Guam Public Works Department. Prepared by P. Wenninger.

West, K. L., Walker, W. A., Baird, R. W., White, W., Levine, G., Brown, E. (2009, Oct). Diet of pygmy sperm whales (*Kogia breviceps*) in the Hawaiian Archipelago. [Article]. *Marine Mammal Science, 25*(4), 931–943. 10.1111/j.1748-7692.2009.00295.x Retrieved from <Go to ISI>://WOS:000271046600011

Whitehead, H. (2002). Estimates of the current global population size and historical trajectory for sperm whales. Marine Ecology Progress Series, 242, 295−304.

Whitehead, H. (2003). Sperm Whales; Social Evolution in the Ocean (pp. 431 pages). Chicago: University of Chicago Press.

Whitehead, H. (2009). Sperm whales; *Physeter macrocephalus* W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd Edition ed., pp. 1091–1097). Amsterdam: Academic Press.

Whitehead, H. & Weilgart, L. (2000). The sperm whale; Social females and roving males J. Mann, R. C. Connor, P. L. Tyack and H. Whitehead (Eds.), *Cetacean Societies; Field Studies of Dolphins and Whales* (pp. 154–172). Chicago: University of Chicago Press.

Whiting, S. D. & Miller, J. D. (1998, Sep). Short term foraging ranges of adult green turtles (*Chelonia mydas*). [Article]. *Journal of Herpetology, 32*(3), 330–337. Retrieved from <Go to ISI>://000075887400004

Whittow, G. C. & Balazs, G. H. (1982). Basking behavior of the Hawaiian green turtle (*Chelonia mydas*). [Article]. *Pacific Science, 36*(2), 129–139. Retrieved from <Go to ISI>://WOS:A1982PW97000001

Williams, R. & Thomas, L. (2007). Distribution and abundance of marine mamals in the coastal waters of British Columbia, Canada. Journal of Cetacean Research and Management, 9(1), 15–28.

Willis, P. M. & Baird, R. W. (1998, Jan–Mar). Status of the dwarf sperm whale, *Kogia simus*, with special reference to Canada. [Article]. *Canadian Field-Naturalist, 112*(1), 114–125. Retrieved from <Go to ISI>://WOS:000072550400015

Withrow, D.E., J.C. Cesarone, and J.L. Bengtson. (1999). Abundance and distribution of harbor seals (*Phoca vitulina richardsi*) for southern Southeast Alaska from Frederick Sound to the U.S./Canada border in 1998. AFSC Annual Report to the MMPA and ESA Implementation Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. pp. 119–150.

Witt, M. J., McGowan, A., Blumenthal, J. M., Broderick, A. C., Gore, S., Wheatley, D. (2010). Inferring vertical and horizontal movements of juvenile marine turtles from time-depth recorders. [Article]. *Aquatic Biology, 8*(2), 169–177. 10.3354/ab00221 Retrieved from <Go to ISI>://000276012500008

Worthy, G. A. J., Morris, P. A., Costa, D. P. & Boeuf, B. J. L. (1992). Moult energetics of the northern elephant seal (*Mirounga angustirostris*). *Journal of Zoology, 227*(2), 257–265. 10.1111/j.1469-7998.1992.tb04821.x Retrieved from http://dx.doi.org/10.1111/j.1469-7998.1992.tb04821.x

Yang, S., Liao, H., Pan, C. and Wang, J.Y. (1999). A survey of cetaceans in the waters of central-eastern Taiwan. *Asian Marine Biology* 19: 23-34.

Yochem, P. K., Stewart, B. S., DeLong, R. L. & DeMaster, D. P. (1987). Diel haul-out patterns and site fidelity of harbor seals (*Phoca vitulina richardsi*) on San Miguel Island, California, in Autumn. *Marine Mammal Science, 3*(4), 323–332. 10.1111/j.1748-7692.1987.tb00319.x Retrieved from http://dx.doi.org/10.1111/j.1748-7692.1987.tb00319.x

Yoshida, H. and Kato, H. (1999). Phylogenetic relationships of Bryde's whales in the western North pacific and adjacent waters inferred from mitochondrial DNA sequences. *Marine Mammal Science* 15:1269-1286.

Zeppelin, T. K. & Ream, R. R. (2006, Dec). Foraging habitats based on the diet of female northern fur seals (*Callorhinus ursinus*) on the Pribilof Islands, Alaska. *Journal of Zoology, 270*(4), 565–576. 10.1111/j.1469-7988.2006.00122.x Retrieved from <Go to ISI>://000242016700003

Zerbini, A.N., Clapham, P.J, and Heide-Jørgensen, M.P. (2010). Migration, wintering destinations and habitat use of North Pacific right whales (*Eubalaena japonica*). *North Pacific Research Board Final Report*, Project 720. 25 pp.

APPENDIX A METADATA DICTIONARY

c_square_c:

C-squares is a system for storage, querying, display, and exchange of "spatial data" locations and extents in a simple, text-based, human- and machine-readable format. It uses numbered (coded) squares on the earth's surface measured in degrees (or fractions of degrees) of latitude and longitude as fundamental units of spatial information, which can then be quoted as single squares (similar to a "global postcode") in which one or more data points are located, or be built up into strings of codes to represent a wide variety of shapes and sizes of spatial data "footprints" (for more, visit http://www.cmar.csiro.au/csquares/).

LAT: Numerical reference used for latitude in decimal degrees. Latitude gives the location of a place on Earth north or south of the equator, where 0 relates to the equator and 90 relates to the poles (+90 for the North Pole or -90 for the South Pole). Lines of Latitude are the horizontal lines shown running east-to-west on maps.

LON: Numerical reference used for longitude in decimal degrees. Longitude is the geographic coordinate for east-west measurement, ranging from 0 at the prime meridian to +180 eastward and −180 westward. By international convention, the modern Prime Meridian is one passing through Greenwich, London, United Kingdom, known as the International Meridian or Greenwich Meridian.

AREA: Size of each c-squares cell (kilometers squared)

SPECIES: Common species name

SPECIES_2: Scientific species name

AreaCode: c-squares value used for spatial join

> Textual reference used to refer to a numerical 0.5 degree resolution C-squares code. C-squares (acronym for the concise spatial query and representation system) is a system of geocodes (a type of global grid) that provides a basis for simple spatial indexing of geographic features or data (for more, visit http://www.cmar.csiro.au/csquares/).

SEASON: Representative timeframe for density data.

March–May (Northern hemisphere spring, Southern hemisphere autumn)

June–August (Northern hemisphere summer, Southern hemisphere winter)

September–November (Northern hemisphere autumn, Southern hemisphere spring)

December–February (Northern hemisphere winter, Southern hemisphere summer)

SST: Average sea surface temperature (degrees Celsius) per grid cell for NODES study

CHL: Average chlorophyll concentrations (milligrams per cubic meter) per grid cell for NODES study

DEPTH: Average depth (meters) per grid cell for NODES study

SLOPE: Average slope per grid cell for NODES study

SHELF: Average distance (meters) from shelf break

DENSITY: Numerical reference used for the predicted density per square kilometer that applies to the grid cell specified by the latitude and longitude. Density refers to the number of animals per kilometers squared per grid cell.

QualityDen: An assessment of error per grid cell

> For Kaschner's Study = qualitative assessment of error ranging from 1 = highest quality to 6 = lowest quality
>
> For St. Andrew's Study = Numerical reference used for the coefficient of variation for a given predicted density value. The coefficient of variation (commonly abbreviated to CV), is a measure of the degree of variability in a sample, useful when comparing different samples.

BEGDATE: Beginning date of the exact timeframe of the density data per grid cell.

ENDDATE: Ending date of the exact timeframe of the density data per grid cell.

STOCK: Indicates whether the density value is based on a stock assessment for NODES study only.

STUDY: Indicates the study that the density data are based on per grid cell.

RES: An index of the relative environmental suitability (RES) of each cell for a given species by relating quantified habitat preferences to locally averaged environmental conditions.

QUALITYRES: An assessment of error per grid cell

Shape_Leng: Auto generated length of polygon

Shape_Length: Auto generated length of polygon

Shape_Area: Auto generated area of polygon