U.S. Navy Marine Species Density Database Phase III

for the

Hawaii-Southern California Training and Testing Study Area

Technical Report

October 13, 2017

U.S. Navy Marine Species Density Database Phase III for the Hawaii-Southern California Training and Testing Study Area

Technical Report

October 13, 2017

Sean Hanser
Naval Facilities Engineering Command, Pacific

Elizabeth Becker, Phil Thorson, Mike Zickel
ManTech

Graphics: Ryan Hoopes
ManTech

Input provided by:

Commander, U.S. Pacific Fleet

Naval Facilities Engineering Command Pacific

Naval Undersea Warfare Center, Code 1151

The recommended citation for this report is as follows:

U.S. Department of the Navy. (2017). U.S. Navy Marine Species Density Database Phase III for the Hawaii-Southern California Training and Testing Study Area. NAVFAC Pacific Technical Report. Naval Facilities Engineering Command Pacific, Pearl Harbor, HI. 274 pp.

ACKNOWLEDGMENTS

The density data included in the Navy Marine Species Density Database (NMSDD) Phase III for the HSTT Study Area and described in this technical report came from multiple scientists working in study areas throughout the Pacific. Density estimates would not exist without the dedication of the marine mammal and sea turtle observers, principal investigators, and survey crews who worked hard collecting the data used for the density estimates included here. We thank them and the many study area experts and Navy biologists who provided input on the data incorporated into the NMSDD Phase III, including (in alphabetical order):

- Robin Baird (Cascadia Research Collective)
- Jay Barlow (NOAA, NMFS, Southwest Fisheries Science Center)
- Jason Benda (NUWC, Division Newport)
- Scott Benson (NOAA, NMFS, Southwest Fisheries Science Center)
- Amanda Bradford (NOAA, NMFS, Pacific Islands Fisheries Science Center)
- John Calambokidis (Cascadia Research Collective)
- Jim Carretta (NOAA, NMFS, Southwest Fisheries Science Center)
- Andrew DiMatteo (NAVFAC Atlantic, U.S. Navy)
- Tomo Eguchi (NOAA, NMFS, Southwest Fisheries Science Center)
- Karin Forney (NOAA, NMFS, Southwest Fisheries Science Center)
- Chip Johnson (U.S. Pacific Fleet, U.S. Navy)
- Erin Oleson (NOAA, NMFS, Pacific Islands Fisheries Science Center)
- Julie Rivers (U.S. Pacific Fleet, U.S. Navy)
- Laura Sparks (NUWC, Division Newport)
- Robert Uyeyama (NAVFAC Pacific, U.S. Navy)

Finally, many thanks to Marisha Apodaca, Karyn Palma, and Kerin Van Hoosear (ManTech) for their help formatting, editing, and producing this report.

EXECUTIVE SUMMARY

The purpose of the U.S. Navy's Marine Species Density Database (NMSDD) Technical Report is to document the process used to derive density estimates for marine mammal and sea turtle species occurring in the Hawaii-Southern California Testing and Training Study Area, and to provide a summary of species-specific and area-specific density estimates incorporated into the NMSDD. The following discussion summarizes improvements that have been made in the density estimation process for Phase III of the Navy's Tactical Training Theater Assessment and Planning Program process. The availability of additional systematic survey data, as well as improvements to habitat modeling methods used to estimate species density, have resulted in substantial improvements to the NMSDD Phase III as summarized below.

Hawaii Range Complex. New survey data collected within the Exclusive Economic Zone of the Hawaiian Islands (2010) and Palmyra Atoll/Kingman Reef (2011–2012) allowed the National Marine Fisheries Service Southwest Fisheries Science Center (SWFSC) to update their Central Pacific habitat-based density models and implement new grid-based predictions which eliminated interpolation artifacts (Forney et al., 2015). The 2010 Hawaiian Islands Exclusive Economic Zone survey data were also used to estimate updated uniform densities that include new sea-state specific estimates of trackline detection probability (Bradford et al., 2017). Density estimates for the Hawaii Range Complex study area were updated for all species sighted during the 2010 survey. In addition, new spatially-explicit density layers were developed for several island-associated stocks (false killer whale, melon-headed whale, spinner dolphin, pantropical spotted dolphin, and common bottlenose dolphin) based on published abundance estimates and range boundaries (i.e., Aschettino, 2010; Baird et al., 2009; Hill et al., 2011; Oleson et al., 2013; Tyne et al., 2014), to more accurately reflect the distribution patterns of these island-associated populations.

Southern California. Additional survey data collected in 2009 off Southern California allowed SWFSC to update their California Current Ecosystem habitat-based density models using improved methods that incorporated species-specific and segment-specific estimates of both effective strip width and trackline detection probability (Becker et al., 2016). Density predictions from the updated models are grid-based and provide finer spatial resolution than the models used for Phase II. Phase III includes spatially-explicit density predictions for two additional species (common bottlenose dolphin and long-beaked common dolphin) that could not be modeled in this way in Phase II. In 2014, SWFSC conducted an additional systematic survey in the California Current Ecosystem; these data were used to update geographically stratified density estimates using a multiple-covariate line-transect approach that included new estimates of trackline detection probability (Barlow 2016). In order to improve the estimates off Baja California for the Navy's Phase III analyses, density estimates and coefficients of variation derived by Ferguson and Barlow (2003) were recalculated based on the extent of the acoustic modeling footprint and were also corrected for new estimates of trackline detection probability. Additional SOCAL Phase III improvements include the incorporation of winter/spring habitat-based density models for three species (Becker et al., 2017) and winter/spring uniform density estimates for an additional three species (Campbell et al., 2015) based on line-transect sighting data collected during the Southern California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises. In addition, new seasonal gray whale density estimates were developed based on line-transect data collected off Southern California (Jefferson et al., 2014). Spatially-explicit density estimates for the coastal stock of common bottlenose dolphin (Carretta, 2012) were used to more accurately reflect the distribution patterns of this nearshore population. With the exception of a few species for which updated winter/spring estimates are not available, all density estimates for the SOCAL study area were updated.

Elimination of Level 4–5 data sources. Given the representative acoustic modeling study areas established for Hawaii-Southern California Testing and Training Phase III, the Navy was able to eliminate the use of all Level 4–5 data sources (i.e., the least preferred sources of density data as noted in Table 3-1). Given the uncertainty associated with predictions from relative environmental suitability models, and the sometimes orders-of-magnitude difference in relative environmental suitability estimates as compared to validated estimates derived from years of survey data (U.S. Department of the Navy, 2015), this represents a substantial improvement to the Phase III NMSDD.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

˚C	degrees Celsius
AOR	Area of Responsibility
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CCE	California Current Ecosystem
CENPAC	Central Pacific
CV	Coefficient of Variation
DPS	distinct population segment
EEZ	Exclusive Economic Zone
ESA	Endangered Species Act
FR	Federal Register
HRC	Hawaii Range Complex
HSTT	Hawaii-Southern California Training and Testing
INRMP	Integrated Natural Resource Management Plan
IWC	International Whaling Commission
km	kilometer(s)
km^2	square kilometer(s)
m	meter(s)
mi.	mile(s)
MMPA	Marine Mammal Protection Act
N	North
Navy	U.S. Department of the Navy
nm	nautical mile(s)
NMFS	National Marine Fisheries Service
NMSDD	Navy Marine Species Density Database
NODE	Navy OPAREA Density Estimates
NUWC	Naval Undersea Warfare Center
OPAREA	Operating Area
PIFSC	Pacific Islands Fisheries Science Center
RES	Relative Environmental Suitability
SCI	San Clemente Island
SMRU Ltd.	Sea Mammal Research Unit, Limited (at University of St. Andrews)
SOCAL	Southern California
SWSFC	Southwest Fisheries Science Center
SYSCOMS	System Commands
TAP	Tactical Training Theater Assessment and Planning Program
U.S.	United States
U.S.C.	United States Code
W	West

This Page Intentionally Left Blank

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, and Executive Order 12114 (Environmental Effects Abroad of Major Federal Actions), the U.S. Department of the Navy (Navy) takes responsibility for reviewing and evaluating the potential environmental impacts of conducting at-sea training and testing. 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, which is the number of animals present per unit area. This report includes a description of the currently-available density data used in the “Phase III” quantitative impact analysis for each marine mammal and sea turtle species present in the Navy’s Hawaii-Southern California Training and Testing (HSTT) Study Area. Phase III is the third implementation of the Navy’s Tactical Training Theater Assessment and Planning Program (TAP). TAP is a comprehensive, integrated process to preserve access to and use of Navy training ranges, testing ranges, and operating areas (OPAREAs) by addressing encroachment and environmental compliance issues. In addition to preserving access and use of ranges, TAP’s purpose is to comply thoroughly with environmental laws.

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 the HSTT Study Areas as appropriate. Information on which species are found in the Study Area is provided in Table 4-1.

A significant amount of effort is required to collect and analyze survey data in order to produce a marine species density estimate. Unlike surveys for terrestrial wildlife, many marine species spend much of their time submerged, and are not easily observed on the surface. Therefore, the computed density of marine species must also take into account an estimate of the number of animals likely to be present but not observed, as compared to the animals that are actually spotted on these surveys. The uncertainty of such estimates decreases with an increasing number of observations. 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 or data that can be used to calculate densities 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 & Forney, 2007; Barlow, 2010; Calambokidis et al., 2008). These methods usually produce a single value for density that is an averaged estimate across very large geographical areas, such as waters within the U.S. EEZ off California, Oregon, and Washington (referred to as a "uniform" density estimate). This is the general approach applied in estimating cetacean abundance in the NMFS stock assessment reports. The disadvantage of these methods is that they do not provide information on varied concentrations of species in sub-regions of very large areas, and do not estimate density for other seasons or timeframes that were not surveyed. More recently, a newer method called spatial habitat modeling has been used to estimate cetacean densities that address some of these shortcomings (e.g., Barlow et al., 2009; Becker et al., 2010; 2012a; 2014; Becker et al., 2016; Ferguson et al., 2006; Forney et al., 2012; 2015; Redfern et al., 2006). (Note that spatial habitat models are also referred to as "species distribution models" or "habitat-based density models.") These models estimate density as a continuous function of habitat variables (e.g., sea surface temperature, seafloor depth) and thus, within the study area that was modeled, densities can be predicted at all locations where these habitat variables can be measured or estimated. Spatial habitat models therefore allow estimates of cetacean densities on finer scales than traditional line-transect or mark-recapture analyses.

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 (CV) 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. When the CV exceeds 1.0, the estimate is very uncertain. For example, a CV of 0.85 would indicate high uncertainty in the population estimate. The CV does not capture the full extent of uncertainty in an estimate. For example, since cetacean distributions often shift in response to oceanic variability (Becker et al., 2012a), the uncertainty associated with movements of animals into or out of an area due to changing environmental conditions is much larger than is indicated by the CV.

The methods used to estimate pinniped at-sea densities are typically different than those used for cetaceans, because pinnipeds are not limited to the water and spend a significant amount of time on land (e.g., at rookeries). Pinniped abundance is generally estimated via shore counts of animals on land at known haul-out sites or by counting number of pups weaned at rookeries and applying a correction factor to estimate the abundance of the population (for example Harvey et al., 1990; Jeffries et al., 2003; Lowry, 2002; Sepulveda et al., 2009). Estimating in-water densities from land-based counts 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, breeding cycles, and seasonal variation. Data such as age class, sex class, and seasonal variation 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 in-water density estimate for each species in a different location, which enables analyses of in-water stressors resulting from at-sea Navy testing or training activities. In addition to using shore counts to estimate pinniped density, traditional line-transect derived estimates are also used, particularly in open ocean areas.

Ideally, density data would be available for all species throughout the study area year-round, in order to best estimate the impacts of Navy activities on marine species. However, in many places, poor weather conditions and high sea states prevent the completion of comprehensive year-round surveys. Even with surveys that are completed, poor conditions may result in lower sighting rates for species that would typically be sighted with greater frequency under favorable conditions. Lower sighting rates preclude having an acceptably low uncertainty in the density estimates. A high level of uncertainty, indicating a low level of confidence in the density estimate, is typical for species that are rare or difficult to sight. In areas where survey data are limited or non-existent, known or inferred associations between marine habitat features and (the likelihood of) the presence of specific species are sometimes used to predict densities in the absence of actual animal sightings. 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 the densities for all protected marine species 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, the Navy needed to review, critically assess, and prioritize existing density estimates from multiple sources, requiring the development of a systematic method for selecting the most appropriate density estimate for each combination of 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).

Uncertainty, as used in this report, is an indication of variation in an estimate that is unique to each data source and is dependent on how the values were derived. 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 describe 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 the Fleets and Systems Commands and are incorporated into Navy environmental compliance documents. The Navy completed the first NMSDD and published a final report describing the density data used in the “Phase II” 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) (U.S. Department of the Navy, 2015). The Pacific Fleet Study Areas addressed in the 2015 report included the HSTT Study Area, the Mariana Islands Training and Testing Study Area, the Northwest Training and Testing Study Area, and the Gulf of Alaska Temporary Maritime Activities Area Study Area. For the “Phase III” analyses, each of these four study areas is addressed in a separate technical report. This technical report provides further details on Navy protocol and how it was implemented for each marine mammal and sea turtle species present in the Navy’s HSTT Study Area.

2 NAVY MARINE SPECIES DENSITY DATABASE PROTOCOL

2.1 *DENSITY ESTIMATION METHODS AND RELATIVE UNCERTAINTY*

For every region and species there is a broad range of data that the Navy evaluated in order to select the best available density values for incorporation into the NMSDD. Assessing the quality of the data available and their associated level of uncertainty was key to the Navy's approach for selecting the best sources of marine species density data, as described below.

Marine species density is the number of individuals that are present per unit area, typically per square kilometer (km^2). 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. ”Distance sampling” describes methods that are used to estimate the density or abundance of biological populations given the assumption that many of the target species will not be detected during a survey (Buckland et al., 2001). The most common type of distance sampling is line-transect sampling, which characterizes the probability of visually detecting an animal or group of animals from a survey transect line to quantify and estimate the number of individuals missed. The result generally provides one single average density estimate for each species 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 each 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: (1) designed-based, (2) stratified-designed based, and (3) 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 direct survey sighting data are limited or non-existent. In some cases, extrapolation from neighboring regional density estimates or population/stock assessments into areas with no density estimates 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, and result in more certainty in the extrapolated estimates. This includes an extrapolation of no occurrence based on other sources of data, such as the NMFS stock assessment reports or expert judgment. Following is a short summary of each of the 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 methods can also rely on passive acoustic detections of animals typically obtained from a towed hydrophone during a concurrent visual survey (e.g., Barlow & Taylor, 2005). 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 typically 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.

2.1.2 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 of this method is that geographically stratified density estimates provide a better indication of a species' distribution within the study area, because it generates one density estimate value for each stratum. 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 impact assessments that are geographically specific, the benefits of understanding the species geographic variability generally outweighs the increased uncertainty in the estimate.

2.1.3 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. Spatial models, also referred to as "species distribution models" or "habitat-based density 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. The advantage of this method is that the resulting density estimates are spatially defined, typically at the resolution of the environmental data used for model development, and thus show variation in species density and distribution. 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) model for the Atlantic Ocean and the Southwest Fisheries Science Center (SWFSC) density models for the Pacific Ocean. Since this method of density estimation yields the best value estimation with the least uncertainty, it is the preferred data source when available.

2.1.4 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 empirical survey data, information on known or inferred associations between marine habitat features and (the likelihood of) the presence of specific species have been used to predict densities using model-based approaches. These habitat suitability models include 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 suitability of a given environment. 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 based on the values of the environmental variables, 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., 2012), hereafter referred to as the Kaschner et al. RES model or Kaschner et al. marine mammal density models, and the SMRU Ltd. model. Predictions from the SMRU Ltd. model are preferred over the Kaschner et al. model because the SMRU Ltd. version used separately derived population abundance estimates to constrain the global density estimates from the RES model. Given that uncertainty is very high, and results can substantially diverge from adjacent empirically-based results (or don't correspond to densities measured from surveyed areas), this method of density estimation is the least preferred type of data source.

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, density data are not available 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 & Forney, 2007) and density spatial models (e.g., Forney et al., 2012) are available for many of these species. Some of these surveyed areas overlap with Navy OPAREAs; however, 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 of the HSTT Study Area. 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 used to develop 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 & Anderson, 1998). 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.

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 largely by (1) spatial resolution and (2) uncertainty in the estimate. As depicted in Figure 2-1 for the NMSDD, modeling methods are ranked as follows:

(A) Density estimates from spatial models will be used when available. As described in Section 2.1.1, spatial models provide the best source of density data at the finest spatial scales and yield information on variation in species density and distribution useful for environmental planning efforts.

–For the U.S. EEZ on the west coast and around the Hawaiian Islands, SWFSC models for the California Current Ecosystem (CCE) and the Central Pacific (CENPAC) were used.

(B) If no density spatial model based estimates were available, the following were 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). Although stratified designed-based estimates typically have higher uncertainty due to fewer sightings available for the smaller strata, geographically stratified density estimates provide a better indication of a species' distribution within the study area.

(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 from SMRU Ltd. (2012) or Kaschner et al. (2006). As described in Section 2.1.3, these are the least preferred sources of density data given their very coarse spatial resolution (global estimates) and high uncertainty. Based on

the Navy's hierarchal approach, these data should be used only when other sources of density data are not available. Density estimates from RES models had to be used for the Navy's Phase II analyses; however, given the representative acoustic modeling study areas established for HSTT Phase III, the Navy was able to eliminate the use of RES data, thereby improving the density data used for Phase III acoustic modeling. In addition to the specific acoustic modeling study areas, density estimates available for the entirety of Hawaii Range Complex (HRC) and Southern California (SOCAL) Range Complex are also shown on the maps included in this report, and thus RES data remaining from the Phase II analyses are still depicted on the maps.

(C) As mentioned in Section 2.1, in some cases extrapolation from neighboring regional density estimates or population/stock assessments into areas with no density estimates (or only estimates from RES models) is appropriate based on expert opinion.

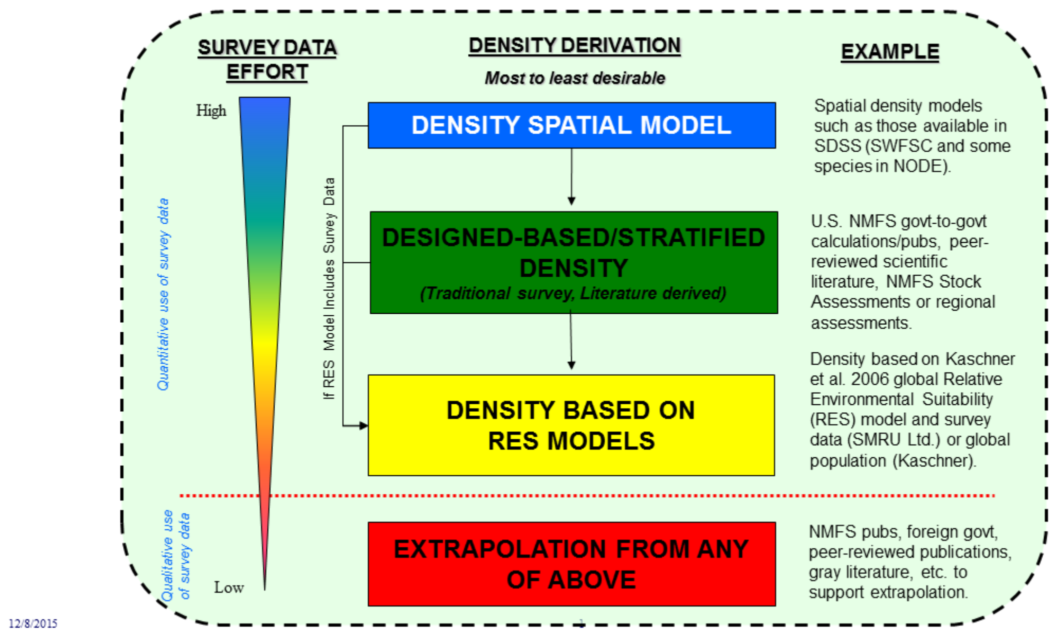


Figure 2-1: Graphical Depiction of Methods of Density Data Derivation and How They Rank in Guiding the Determination of What Density Data to Include in the NMSDD

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 and made publically available via web-based services from Duke University at http://seamap.env.duke.edu/models/.

In an effort to coordinate across the Navy's OPAREAs and establish a consistent approach to select the best available density estimates, data for each species are compiled 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 off Baja, California, Mexico
3) SMRU Ltd., RES model estimates (everywhere else)

The resulting density data file in Figure 2-1 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 waters off Baja California, Mexico, and are depicted as an area of uniform density directly south of the U.S. EEZ. Data from the SMRU Ltd. RES model were selected for the remaining areas shown on the map because no other density data were available. The hierarchical data selection process ensures that the highest ranking and thus best available estimate is used for each species considered and that there is only one representative density value for each geographic location. The hierarchical ranking process is applied on a species-by-species basis since available data sources often vary by species. The results are species-specific density data files that are compilations of density data from potentially multiple sources, are defined seasonally where possible, and provide density values per season for each geographic area of interest.

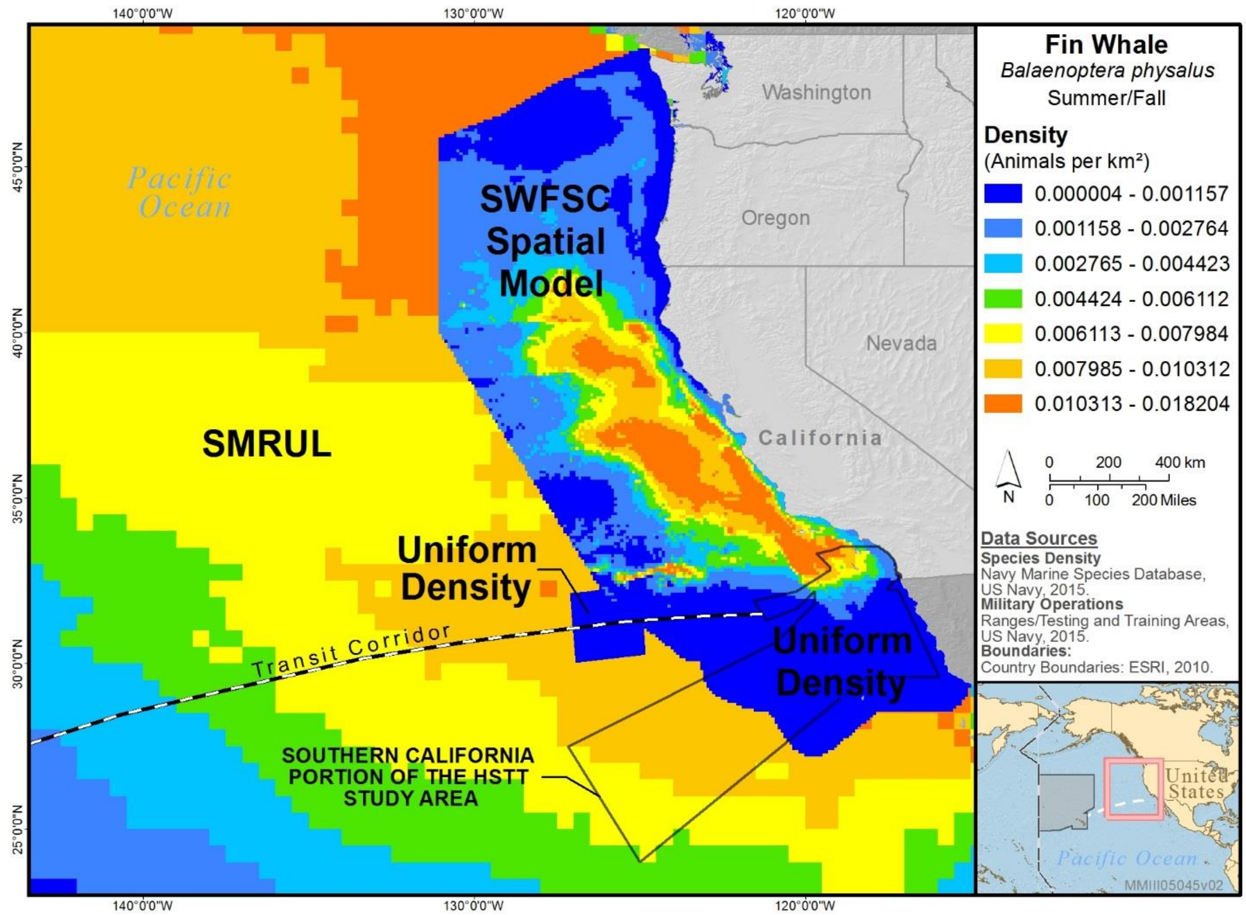


Figure 2-2: Example of a Combined NMSDD Density Data File

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 that best represents the expected distribution and density for that species.

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 regional environmental analyses (e.g., Pacific and Atlantic Environmental Impact Statements) 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 is 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 B 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 (Newport, Rhode Island) 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.

Uncertainty is characterized in different ways by the original density data provider, and these estimates are preserved in the file format for use in the effects modeling (U.S. Department of the Navy, *In Progress*). Additional metadata fields other than the ones listed in Appendix B can be used to incorporate and retain these values.

3 NAVY MARINE SPECIES DENSITY DATABASE PHASE III – OVERALL METHODS AND SOURCES IMPLEMENTED

The following sections describe the HSTT Study Area for which density data have been compiled and incorporated into the NMSDD Phase III. Available density data sources are also described. A summary of the improvements that have been made to the NMSDD from Phase II to Phase III is provided in the Executive Summary.

3.1 Hawaii-Southern California Training and Testing Study Area

The HSTT Study Area includes three existing range complexes: the SOCAL Range Complex, HRC, and Silver Strand Training Complex. In addition to these range complexes, the Study Area also includes a notional route to represent Navy transit from one range complex to another, and an area of the Study Area that overlaps with the Point Mugu Sea Range. Other than the area of overlap, the Point Mugu Sea Range is not part of the HSTT Study Area (Figure 3-1). In this report, the discussion of species' densities is presented under two headings: HRC and SOCAL. Throughout this report, the "HRC" heading refers to the Hawaii portion of the HSTT Study Area, and the "SOCAL" heading refers to the Southern California portion of the HSTT Study Area. Given that spatial models developed by SWFSC were the preferred source of density data incorporated into the NMSDD (see Section 2.2.1), the SWFSC California Current Ecosystem and Central Pacific study areas are shown in Figure 3-1. The Papahanaumokuakea Marine National Monument is also shown in relation to the Hawaii Range Complex.

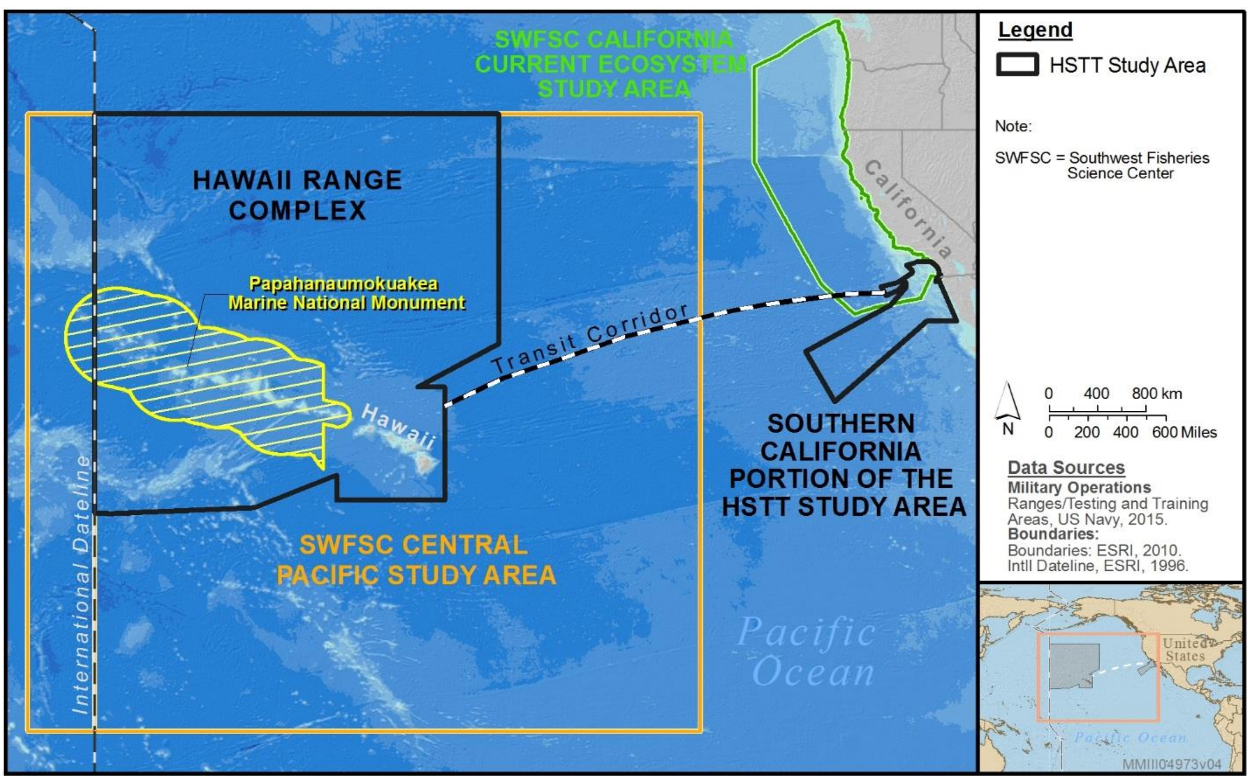


Figure 3-1: Hawaii-Southern California Training and Testing Study Area

Based on the sound sources modeled in the Navy's effects analysis for Phase III, acoustic modeling study areas were established to best characterize Navy training and testing and capture the range of environmental conditions within the HSTT Study Area (Figure 3-2). There are two acoustic modeling study areas that encompass each of the main OPAREAs, and three representative transit corridor study areas. Two of the representative transit corridor study areas are located within the notional route representing Navy transit between SOCAL and HRC, one in the western portion of the route and another in the eastern portion of the route, to ensure that the full range of environmental conditions were evaluated. A third representative transit corridor study area was placed to the west of the Hawaii OPAREA to ensure that Navy transit to Guam was also assessed. Density updates were focused on the acoustic modeling study areas shown in Figure 3-2 because these areas represent where most training and testing occur within the Hawaiian OPAREA and around the main Hawaiian Islands, as well as within 250 nm of the west coast.

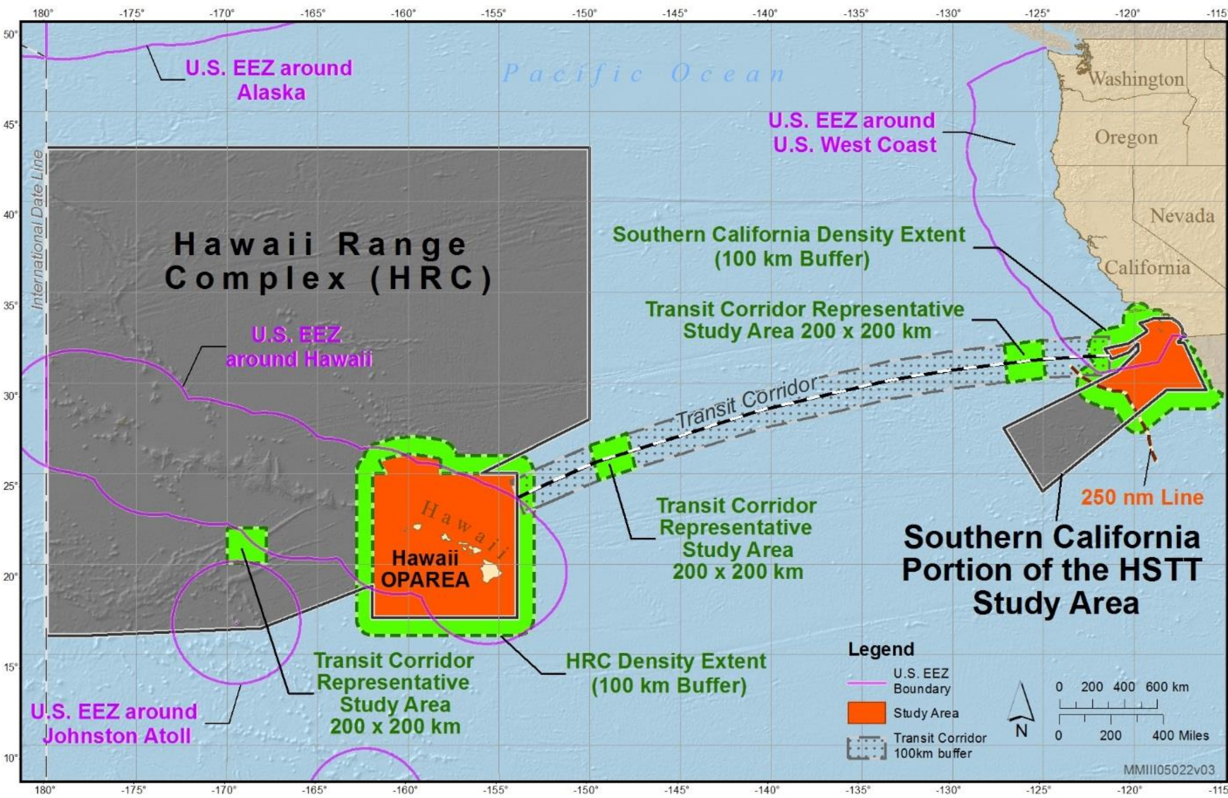


Figure 3-2: Representative Acoustic Modeling Study Areas for the Hawaii-Southern California Training and Testing Study Area (boundaries shown in light green). The U.S. EEZ boundaries are shown in purple.

Density data for the Phase III analyses were thus updated specifically for the acoustic modeling study areas and not for the entirety of HRC and SOCAL. As noted in Section 2.2.1, this allowed the Navy to eliminate the least preferred sources of density data (i.e., Level 4–5 data as shown in Table 3-1), thereby improving the quality and reducing the uncertainty of data used for Phase III acoustic modeling. It is important to note that the figures included in the species-specific sections (Sections 5−12) include density estimates available for the entirety of HRC and SOCAL, and thus portray data from the previous

Phase II analyses. While for some species these data differ substantially from the updated Phase III data shown for the acoustic modeling study areas, the Phase II data were not used in the current acoustic analyses, but are portrayed on the density figures for completeness.

Table 3-1: Hierarchy of Density Data Sources

Level	Sources
Level 1 (Most Preferred)	Peer reviewed and/or published studies of density spatial models that provide spatially-explicit density estimates or values derived from these sources
Level 2	Peer reviewed and/or published studies of stratified designed-based density estimates or values derived from these sources
Level 3	Peer reviewed and/or published studies of designed-based density estimates or values derived from these sources
Level 4	St. Andrew's RES Model (SMRU Ltd., 2012)
Level 5 (Least Preferred)	Kaschner et al. RES Model (Kaschner et al., 2006)

3.2 APPLICATION OF THE NAVY MARINE SPECIES DENSITY DATABASE PROTOCOL

NMSDD shapefiles for the HSTT Study Area 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 NMFS' 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 different data sources may be relied upon. To select marine species density estimates, 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 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.

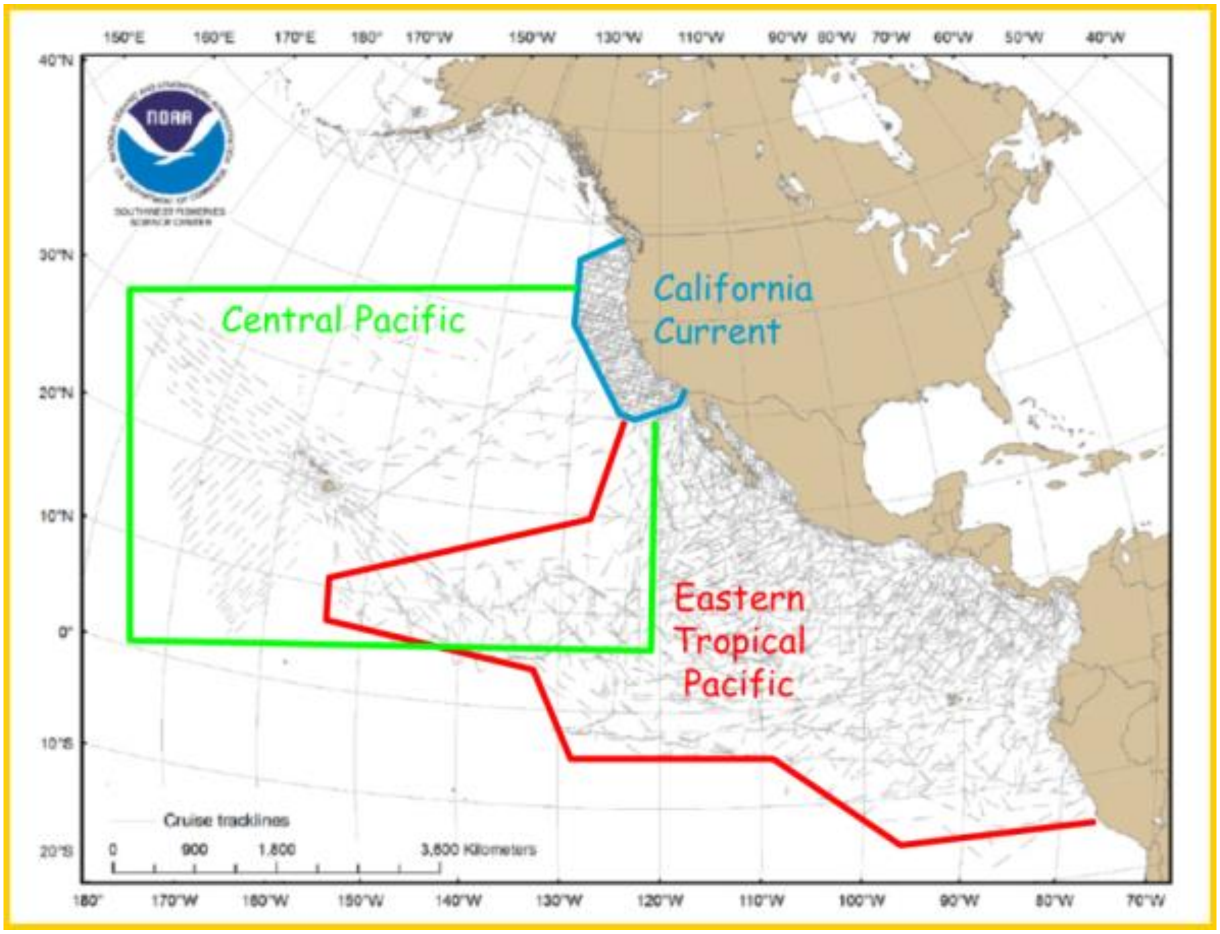
The NMSDD protocol was applied when selecting the best available marine species density for each study area. For the HSTT Study Area, Level 1 data (habitat-based density models; see Table 3-1) were available for multiple species/species groups within the NMFS SWFSC/PIFSC survey areas off the U.S. west 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).

Information on the data density sources available for the HSTT Study Area 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 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 were estimated from systematic line-transect shipboard surveys conducted by NMFS SWFSC and PIFSC (Figure 3-3). As noted in Section 2.2.1, these sources of density data are the most preferred. The SWFSC/PIFSC surveys are typically conducted in summer/fall (roughly July–November) and cover three major study areas: (1) the CCE (waters off the U.S. west coast between the shore and approximately 300 nautical miles [nm] offshore), (2) the CENPAC (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 CCE and the Central North Pacific overlap a large portion of the HSTT Study Area. Although they do not overlap, the two SWFSC study areas approach each other at the western edge of the CCE study area and the eastern edge of the Central North Pacific study area.



Source for transect lines: Hamilton et al. 2009

Figure 3-3: Transect coverage for surveys conducted by the Southwest Fisheries Science Center between 1986 and 2006 in three broad study areas in the eastern North Pacific.

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 has been developing predictive habitat-based density models for cetaceans in the CCE for more than 15 years. Habitat variables used in the density models have included temporally dynamic environmental measures (e.g., sea surface temperature, mixed layer depth) derived from remotely sensed sources or collected *in situ* during the line-transect surveys, as well as more static geographical measures (e.g., water depth, bathymetric slope). The CCE habitat models have received extensive validation using a variety of methods including cross validation (Barlow et al., 2009; Becker et al., 2010; Forney, 2000; Forney et al., 2012), predictions on novel data sets (Barlow et al., 2009; Becker et al., 2012a; Becker et al., 2014; Forney et al., 2012), and expert opinion (Barlow et al., 2009; Forney et al., 2012).

For the Navy's Phase II analyses, model predictions from the then-current CCE model predictions (Becker et al., 2012b) were provided to the Navy in ArcGIS format and incorporated into the NMSDD

(U.S. Department of the Navy, 2015). These models were developed using six years of systematic line-transect data collected in the CCE between 1991 and 2008 (Becker et al., 2012b). Model results were provided 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.).

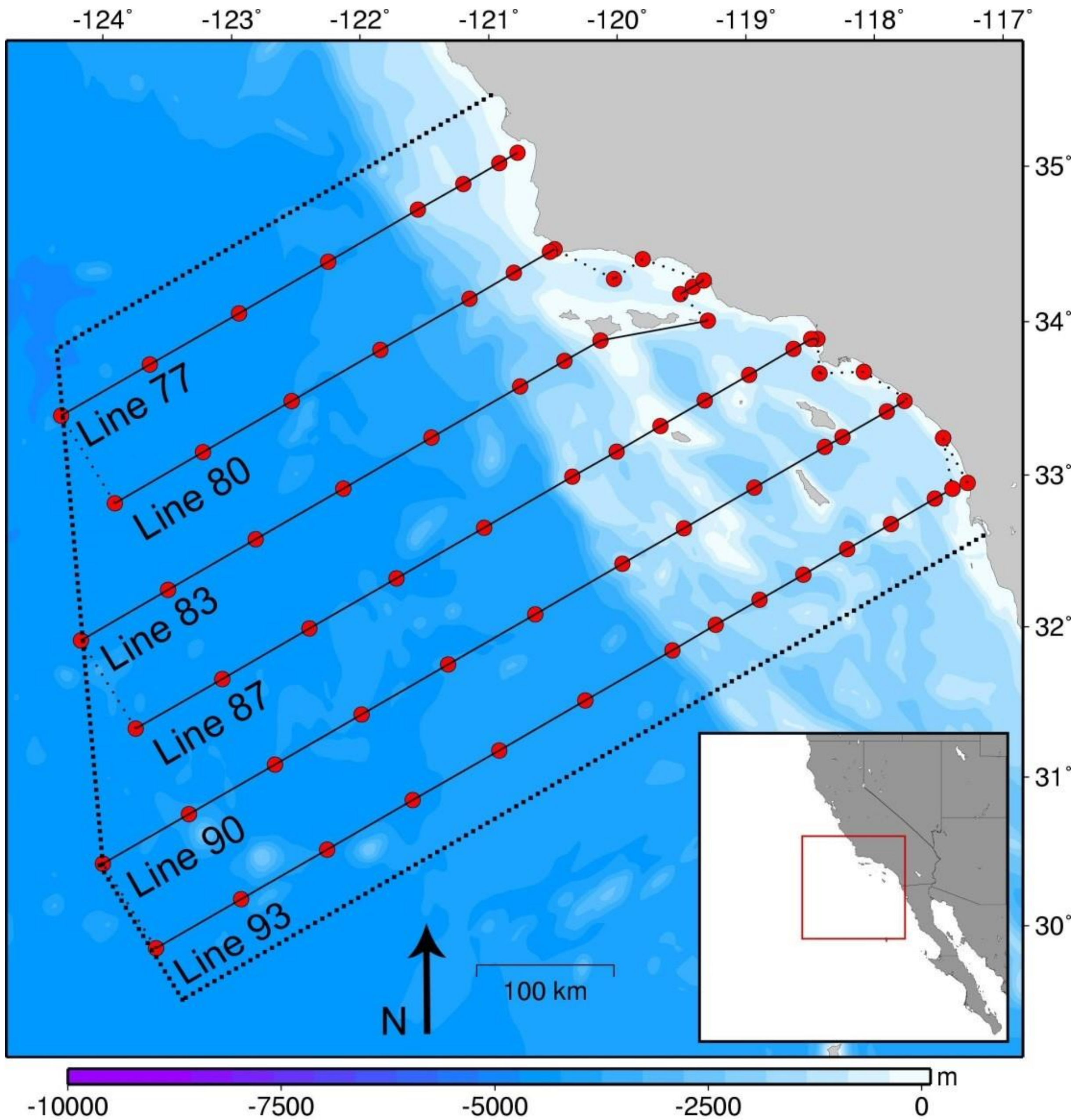
More recently, in support of the Navy's Phase III NMSDD needs described in this report, improved methods were used to develop a new set of CCE habitat-based density models that included an additional set of survey data collected in 2009 in waters off Southern California (Becker et al., 2016). Sighting data from the combined 1991–2009 survey data enabled the development of models for two additional species, long-beaked common dolphin (*Delphinus capensis*) and common bottlenose dolphin (*Tursiops truncatus*). Within the CCE study area, density predictions for distinct 8-day composites covering the entire survey periods (1991–2009) were averaged to produce spatial grids of average species density at 10 km x 10 km resolution, as well as spatially-explicit measures of uncertainty (Becker et al., 2016). Final model predictions were provided to the Navy in ArcGIS format and incorporated into the NMSDD for their current Phase III analyses.

Habitat-Based Density Models for Southern California (CalCOFI Models)

This data source is the top tier (Level 1) in the hierarchy of density data.

California Cooperative Oceanic Fisheries Investigations (CalCOFI) were formed in 1949 as a partnership of the California Department of Fish & Wildlife, National Oceanic and Atmospheric Administration (NOAA) Fisheries Service, and Scripps Institution of Oceanography. The original CalCOFI goal was to study the ecological aspects of the sardine collapse off California, but the focus has expanded to study the physical and biological marine environment off the California coast. CalCOFI cruises are conducted quarterly along predetermined track lines off southern and central California, and hydrographic and biological data are collected at established water sampling stations as well as while transiting between stations (Figure 3-4). Marine mammal sighting data have been collected using line-transect methods on the cruises since 2004.

Becker et al. (2017) used CalCOFI sighting data collected during winter and spring between 2005 and 2015 to provide the first habitat-based density models for three species with sufficient sample sizes for modeling: humpback whale, short-beaked common dolphin, and Dall's porpoise. Model results provided fine scale (10 km) density predictions for these species during the cool seasons. Density predictions for distinct 8-day composites covering the entire survey period (2005–2015) were averaged to produce spatial grids of average species density at 10 km^2 resolution, as well as spatially-explicit measures of uncertainty (Becker et al., 2017). Final model predictions were provided to the Navy in ArcGIS format and incorporated into the NMSDD for their current Phase III analyses.



Source: Campbell et al. (2015)

Figure 3-4: CalCOFI Transect Lines (Solid Black Lines) and Sampling Stations (Red Dots)

NMFS SWFSC/PIFSC 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 originally developed for cetaceans in the Central North Pacific based on cetacean survey data collected by the SWFSC in 1997–2006 (Becker et al., 2012c). 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 included temporally dynamic environmental measures (e.g., sea surface temperature, sea surface chlorophyll) and more static geographical measures (e.g., distance to land). 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 for use in their Phase II analyses (U.S. Department of the Navy, 2015).

More recently, in support of the Navy's Phase III NMSDD needs described in this report, spatial predictions of cetacean densities and measures of uncertainty were developed using additional survey data collected by SWFSC/PIFSC in 2010 within the Hawaiian Islands EEZ and in 2011 and 2012 in waters surrounding Palmyra Atoll/Kingman Reef (Forney et al., 2015). The combined 1997–2012 survey data were used to update the previous Central North Pacific models, and new grid-based prediction methods provided finer-scale information on the distribution and density of cetaceans in this study area. Final model predictions were provided to the Navy in ArcGIS format and incorporated into the NMSDD for their current Phase III analyses.

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.

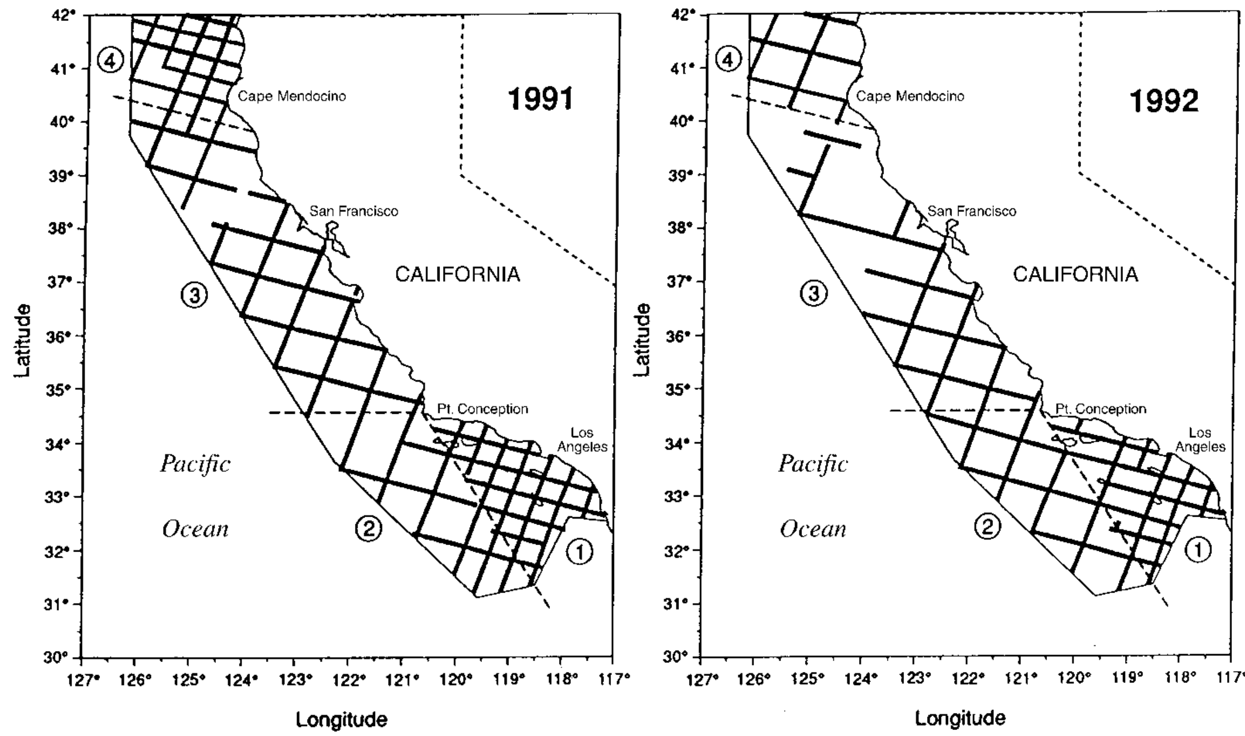
Summer/Fall Shipboard Surveys. Ship-based line-transect surveys were conducted by NMFS SWFSC in their CCE study area from July through November 1991, 1993, 1996, 2001, 2005, and 2008. In 2009, an additional line-transect survey was conducted from September to December that focused on waters off Southern California. 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.

Cetacean density estimates for the CCE study area (1,141,800 km^2) are typically stratified into four geographic regions: waters off (1) 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). Barlow and Forney (2007) used a multiple-covariate line-transect approach (Marques & Buckland, 2003) to derive uniform density estimates for each of these four regions for 19 species, as well as *Kogia* spp. and *Mesoplodon* spp. For those species for which habitat-density models could not be developed (due to insufficient sample sizes), these stratified uniform density estimates were used by the Navy for their Phase II analyses (U.S. Department of the Navy, 2015).

In the summer and fall of 2014, an additional survey was conducted by SWFSC in the CCE study area. The same survey methods and survey design were used as the prior 1991–2008 surveys, and similar analytical methods were used to estimate density for the four geographic regions described above (Barlow, 2016). However, the new analysis included new estimates of trackline detection probability based on a method developed by Barlow (2015) and incorporated new methods for selecting detection function covariates based on results presented by Barlow et al. (2011). In addition, data from the 1991 to 2008 surveys were re-analyzed using the new methods to provide more accurate estimates (Barlow, 2016). For those species for which habitat-density models could not be developed (due to insufficient sample sizes), these new stratified uniform density estimates were incorporated into the NMSDD and used by the Navy for their current Phase III analyses.

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 3-5). 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. Barlow et al. (2009) provided a summary of the geographically stratified winter/spring density estimates derived from these survey data. Although these estimates are based on survey data collected more than 20 years ago, for some species they represent the best available estimates for the winter/spring season. Rough weather conditions in the CCE make it difficult to collect shipboard line-transect data year-round, and few studies have assessed cetacean density and distribution in winter and spring. In the absence of more recent data, and for those species for which abundance and distribution patterns are known to vary seasonally, these stratified uniform density estimates were used by the Navy for their Phase II analyses (U.S. Department of the Navy, 2015).

More recently, line-transect analyses of data collected during ship surveys off Southern California (Campbell et al., 2015) and aerial surveys focused off San Clemente Island (SCI) (Jefferson et al., 2014) provide uniform density estimates for selected species in winter/spring. These are described below and have been incorporated into the NMSDD and used by the Navy for their current Phase III analyses.



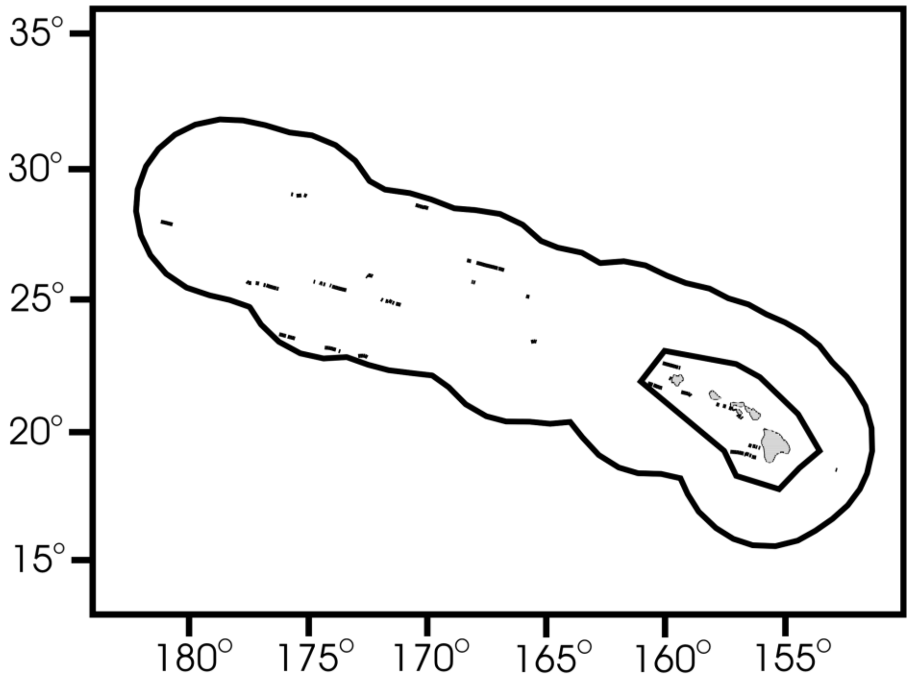
Source: Forney et al. 1995

Figure 3-5: 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.

<u>**NMFS SWFSC/PIFSC Line-Transect Density Estimates for the Hawaiian Exclusive Economic Zone**</u>

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 3-6). Barlow (2006) provided line-transect abundance estimates for 19 cetacean species based on a multiple covariate approach (Marques & Buckland, 2003); estimates were stratified based on the geographic strata shown in Figure 3-6. For those species for which habitat-density models could not be developed (due to insufficient sample sizes), these stratified uniform density estimates were used by the Navy for their Phase II analyses (U.S. Department of the Navy, 2015).



Source: Barlow 2006

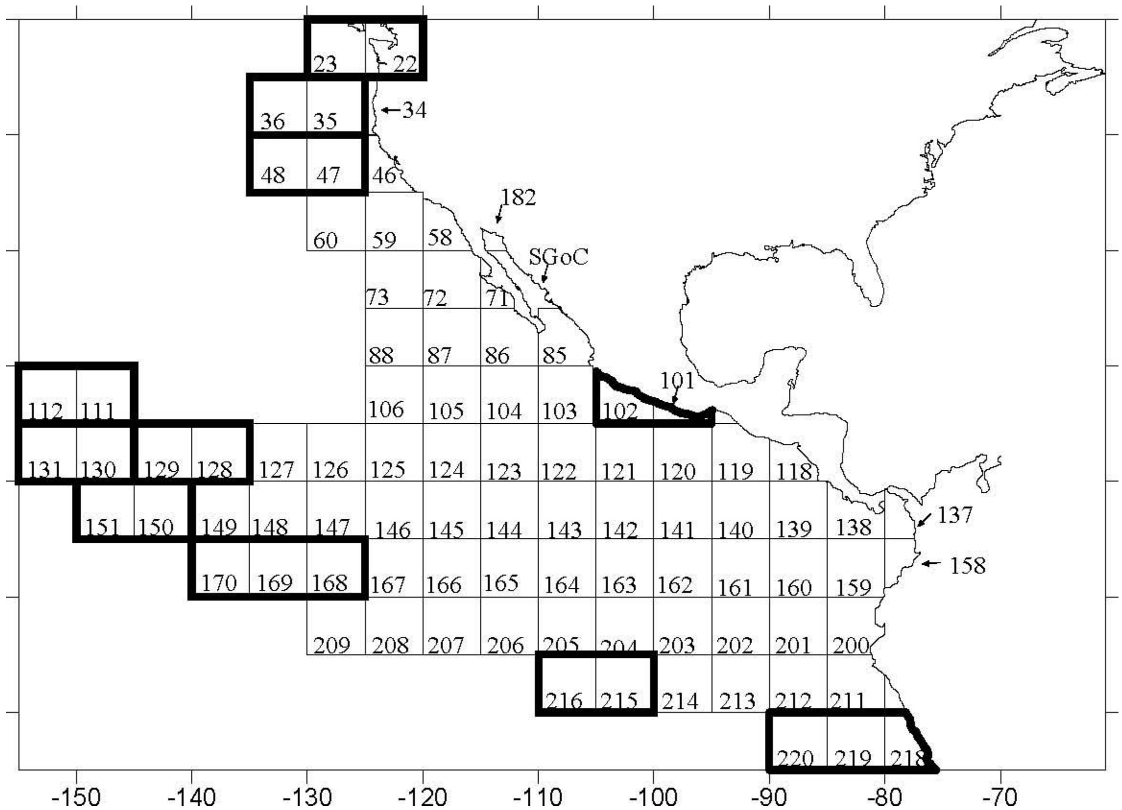
Figure 3-6: Study Area for the Shipboard Line-Transect Survey Conducted by NMFS SWFSC in 2002. Bold lines show the two strata used for abundance analysis: (1) Main Hawaiian Islands stratum and (2) Outer Exclusive Economic Zone stratum. Fine lines show search effort in Beaufort sea states of 0–2.

In the summer and fall of 2010, an additional survey was conducted collaboratively by SWFSC and PIFSC in the Hawaiian EEZ using the same survey methods and survey design as the prior 2002 survey. A multiple-covariate line-transect approach (Marques & Buckland, 2003) was used to derive uniform density estimates from these survey data (Bradford et al., 2017). The new analysis also included new estimates of trackline detection probability based on a method developed by Barlow (2015). For those species for which habitat-density models could not be developed (due to insufficient sample sizes), these new uniform density estimates were incorporated into the NMSDD and used by the Navy for their current Phase III analyses.

<u>**NMFS SWFSC Line-Transect Density Estimates for the Eastern Pacific Ocean**</u>

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

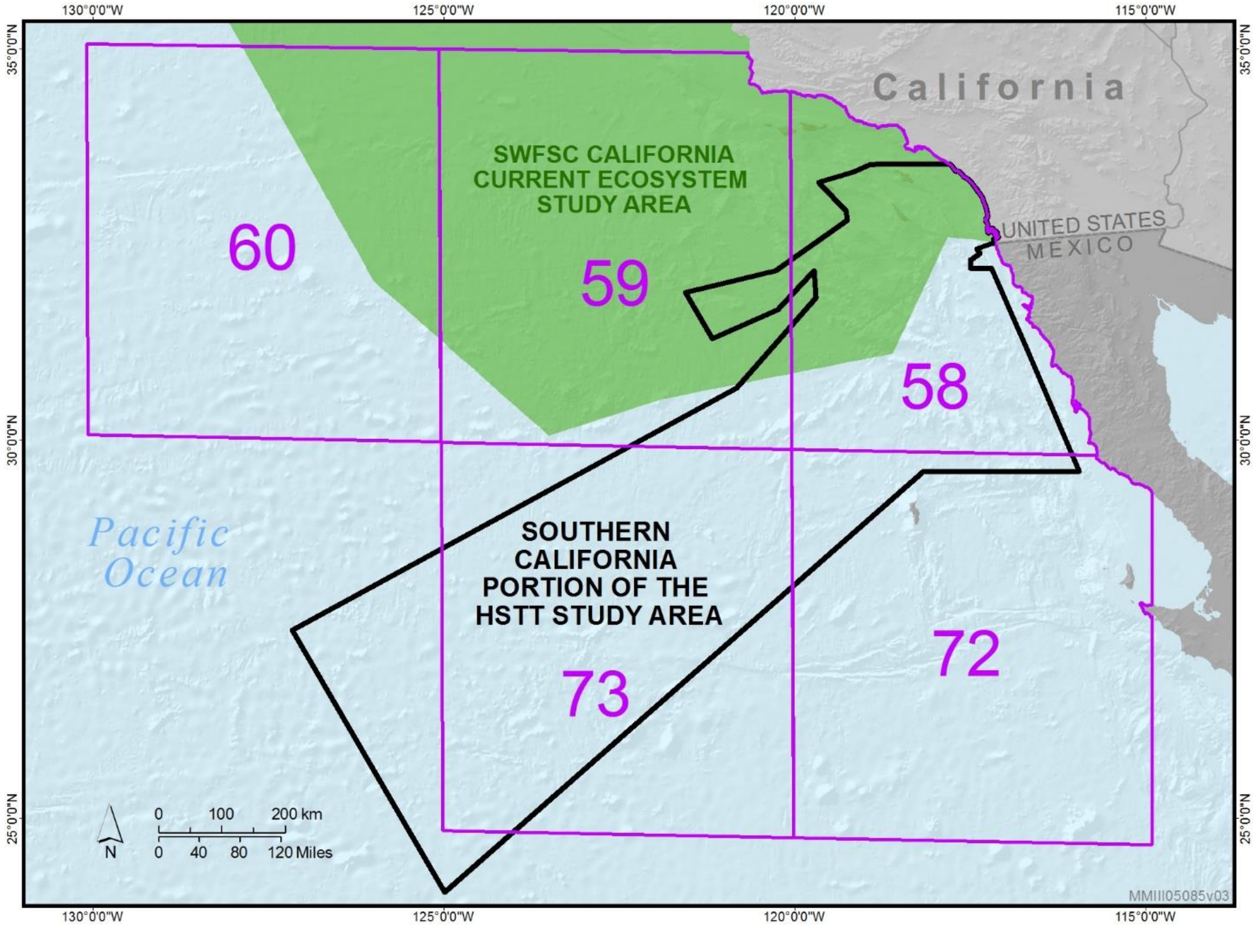
Ferguson and Barlow (2003) provided broad-scale line-transect abundance estimates for cetaceans in the eastern Pacific based on nine NMFS SWFSC shipboard surveys conducted between 1986 and 1996. Their study area encompassed more than 25 million km^2, and included SWFSC's CCE, CENPAC, and Eastern Tropical Pacific study areas. Density estimates were stratified geographically by 5-degree squares of latitude and longitude (Figure 3-7). 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), and these stratified uniform density estimates were used by the Navy for their Phase II analyses (U.S. Department of the Navy, 2015).



Source: Ferguson and Barlow 2003

Figure 3-7: Geographic Strata Used by Ferguson and Barlow (2003) for Density Estimation

The acoustic modeling footprint used for the Phase III analyses is encompassed within strata numbers 58, 59, 72, and 73 (Figure 3-8). While the majority of stratum 58 is included in the SWFSC CCE study area and sighting data included in the analyses by Barlow (2016) and Becker et al. (2016), density and CVs for strata numbers 59, 72, and 73 were re-calculated for use in the Phase III analyses. Density estimates were corrected for updated g(0) estimates provided by Barlow (2015) using the average Beaufort sea state value for on-effort transects within the strata contributing to density estimates and the mean g(0) for that Beaufort value (i.e., 3.5). These new uniform density estimates were incorporated into the NMSDD and used by the Navy for their current Phase III analyses.



Source: Modified from Ferguson and Barlow 2003

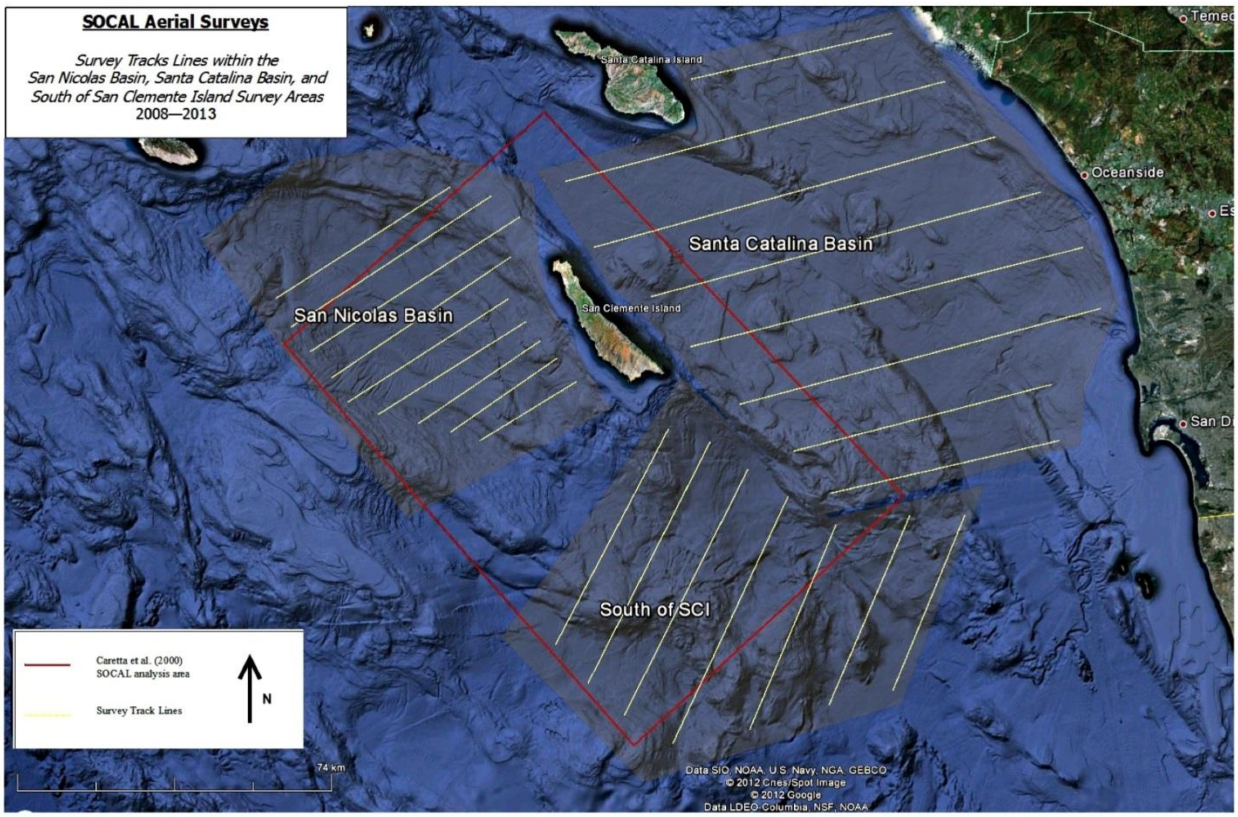
Figure 3-8: SWFSC Geographic Strata Used for HSTT Density Estimation

Additional Line-Transect Density Estimates for Regions within the HSTT Study Area

In addition to the National Oceanic and Atmospheric Administration line-transect density estimates described above, additional peer-reviewed published studies of designed-based estimates (Level 2; see Table 3-1) were used.

Southern California CalCOFI Ship Surveys. Douglas et al. (2014) provided seasonal density estimates for the 11 most commonly encountered cetaceans during 16 CalCOFI surveys conducted between 2004 and 2008. These estimates were not corrected for animals missed on the trackline and are thus considered biased low. Campbell et al. (2015) used line-transect analyses to estimate seasonal density for the six most commonly encountered cetaceans (short-beaked common dolphin, Pacific white-sided dolphin, Dall's porpoise, and blue, fin, and humpback whales) during 37 CalCOFI surveys conducted between 2004 and 2013. Campbell et al. (2015) applied correction factors for trackline detection probability that were derived for SWFSC ship surveys (Barlow, 1995). Given the different observer configuration on the CalCOFI surveys (two observers searching for animals with 7x binoculars compared to three observers, two that use 25X binoculars, on the SWFSC surveys), the Campbell et al. (2015) estimates are still likely biased low. However, they currently provide the most recent winter/spring estimates for Pacific white-sided dolphin, blue whale, and fin whale in Southern California waters.

Southern California Bight/San Clemente Island Aerial Surveys. Navy-funded aerial surveys were conducted in the vicinity of SCI from 2008 to 2013 (Figure 3-9). Jefferson et al. (2014) used aerial survey data collected from 2008 to 2013 to estimate density for marine mammal species in two main survey areas (Santa Catalina and San Nicolas Basins) in the Southern California Bight. Density estimates were stratified by warm (May–October) and cool (November–April) seasons.



Source: Jefferson et al. (2014)

Figure 3-9: SWFSC Geographic Strata Used for HSTT Density Estimation

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., 2017) and Alaska (Muto et al., 2017). These Stock Assessment Reports provide uniform abundance estimates for recognized stocks of marine mammals within broad geographic strata.

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. (Note that a Level 5 density source, Kaschner et al. (2006) is described first below, because the Level 4 source, SMRU Ltd. (2012) is based on improvements to the Kaschner et al. (2006) 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.

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 global population estimates 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., 2012). 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. 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 over the Kaschner et al. (2006) models 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, which was not possible with the Kaschner et al. (2006) model. For the purpose of environmental impact 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 modeling the potential exposure of each species to Navy sound sources in the HSTT Study Area 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, 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 the HSTT Study Area is provided in Table 4-1. All species included in Table 4-1 had density estimates revised and updated for Phase III, either for the entire species and all seasons, for specific stocks or geographic areas (HRC, SOCAL), or for select seasons. Given the representative acoustic modeling study areas established for HSTT Phase III, the Navy was able to eliminate the use of all Level 4–5 data sources (i.e., the least preferred sources of density data as noted in Table 3-1), thereby improving the quality and reducing the uncertainty of data used for Phase III acoustic modeling.

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 density data used for different regions within the HSTT Study Area, and (3) maps of the estimated species density in the Study Area. 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 used by NMFS (Carretta et al., 2017) for most species; however, NMFS has recently identified distinct population segments (DPSs) for a few species to refine management and listing under the ESA (e.g., humpback whales and green sea turtles). For those stocks and DPSs that are Threatened or Endangered, the Navy needs to be aware of stock structure and the likelihood of interacting with a particular stock or DPS. When an individual marine mammal or sea turtle is observed, it may be quite difficult to define which stock or DPS it belongs to if the geographic ranges of two or more stocks overlap, 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.

Table 4-1: Species with Hawaii-Southern California Training and Testing Study Area Density Estimates Included in the NMSDD Phase III[1]

Taxonomic Name	Common Name	HSTT HRC	HSTT SOCAL
Cetaceans (Order Cetacea)			
Baleen Whales (Suborder Mysticeti)			
Balaenoptera acutorostrata	Common or dwarf minke whale	X	X
Balaenoptera borealis	Sei whale	X	X
Balaenoptera edeni	Bryde's whale	X	X
Balaenoptera musculus	Blue whale	X	X
Balaenoptera physalus	Fin whale	X	X
Eschrichtius robustus	Gray whale		X
Megaptera novaeangliae	Humpback whale	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]
Kogia sima	Dwarf sperm whale	X	X[2]
Physeter macrocephalus	Sperm whale	X	X
Dolphins (Family Delphinidae)			
Delphinus capensis	Long-beaked common dolphin		X
Delphinus delphis	Short-beaked common dolphin		X
Feresa attenuata	Pygmy killer whale	X	
Globicephala macrorhynchus	Short-finned pilot whale	X	X
Grampus griseus	Risso's dolphin	X	X
Lagenodelphis hosei	Fraser's dolphin	X	
Lagenorhynchus obliquidens	Pacific white-sided dolphin		X
Lissodelphis borealis	Northern right whale dolphin		X
Orcinus orca	Killer whale	X	X
Peponocephala electra	Melon-headed whale	X	
Pseudorca crassidens	False killer whale	X	
Stenella attenuata	Pantropical spotted dolphin	X	
Stenella coeruleoalba	Striped dolphin	X	X
Stenella longirostris	Spinner dolphin	X	
Steno bredanensis	Rough-toothed dolphin	X	
Tursiops truncatus	Common bottlenose dolphin	X	X

Taxonomic Name	Common Name	HSTT HRC	HSTT SOCAL
Porpoises (Family Phocoenida)			
Phocoenoides dalli	Dall's porpoise		X
Beaked Whales (Family Ziphiidae)			
Berardius bairdii	Baird's beaked whale		X
Indopacetus pacificus	Longman's beaked whale	X	
Mesoplodon carlhubbsi	Hubbs' beaked whale		X[3]
Mesoplodon densirostris	Blainville's beaked whale	X	X[3]
Mesoplodon ginkgodens	Ginkgo-toothed beaked whale		X[3]
Mesoplodon perrini	Perrin's beaked whale		X[3]
Mesoplodon peruvianus	Pygmy beaked whale		X[3]
Mesoplodon stejnegeri	Stejneger's beaked whale		X[3]
Ziphius cavirostris	Cuvier's beaked whale	X	X[3]
Pinnipeds (Order Carnivora[4], Suborder Pinnipedia)			
Arctocephalus townsendi	Guadalupe fur seal		X
Callorhinus ursinus	Northern fur seal		X
Mirounga angustirostris	Northern elephant seal		X
Neomonachus schauinslandi	Hawaiian monk seal	X	
Phoca vitulina	Harbor seal		X
Zalophus californianus	California sea lion		X
Sea Turtles (Order Testudines, Suborder Cryptodira)			
Chelonia mydas	Green sea turtle	X[4]	X
Eretmochelys imbricata	Hawksbill sea turtle	X[4]	
Caretta caretta	Loggerhead sea turtle	X[4]	
Lepidochelys olivacea	Olive ridley sea turtle	X[4]	
Dermochelys coriacea	Leatherback sea turtle	X[4]	X[1]

[1] Species for which existing data do not support the derivation of study-area specific density estimates do not have values included in the NMSDD Phase III. They are indicated in the table as an acknowledgement of possible occurrence without a density assigned. Blank cells indicate lack of expected regular occurrence within a given area.

[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*).

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

4.1.1 SPECIES CONSIDERED BUT NOT INCLUDED

Spatially explicit, absolute at-sea density estimates of the type needed for quantitative analysis of impacts are not available for several taxa of concern to the Navy and trustee agencies, specifically ESA-listed sea birds and ESA-listed marine fishes.

To the Navy's knowledge, the data needed to create spatially-explicit, absolute at-sea density estimates for the three ESA-listed fish species, scalloped hammerhead shark (*Sphyrna lewini*), steelhead (*Oncorhynchus mykiss*), and Gulf grouper (*Mycteroperca jordani*), in the HSTT Study Area do not exist nor could they be readily created. As such, density estimates for fishes are not included in this technical report.

Little or no telemetry data are available for the five ESA-listed sea birds expected to be in offshore areas of the HSTT Study Area, the California least tern (*Sternula antillarum browni*), Hawaiian petrel (*Pterodroma sandwichensis*), short-tailed albatross (*Phoebastria albatrus*), marbled murrelet (*Brachyramphus marmoratus*), and Newell's shearwater (*Puffinus auricularis newelli*), though population estimates do exist for some of these species. However, without robust information on distribution patterns, too many assumptions would need to be made to produce reasonable density estimates for these species and, as such, they are excluded from this report. Further, even though population estimates exist for some of these species, they do not provide specific in-water density estimates needed for the NMSDD. USFWS has produced relative density models for guilds of sea birds, but these relative abundance models cannot be used for quantitative take estimation.

4.2 DENSITY DATA FOR THE HSTT STUDY AREA

4.2.1 TABLES

Information on the sources of density data are summarized in the text. The density values used in the NMSDD Phase III are reported in a table that appears in each species description. 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 table should be viewed concurrently with the density maps (Section 4.2.2).

The majority of density estimates used in the NMSDD Phase III 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.

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 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 United States Code [U.S.C.] §670a–670o) to maintain an Integrated Natural Resource Management Plan (INRMP) for each installation and associated submerged lands operated by the Department of Defense. In these cases, the Navy's data were analyzed for inclusion in the NMSDD Phase III.

4.2.2 MAPS

Maps from the Geographic Information System database used in NMSDD Phase III are provided for each species. 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. Therefore, there are gray whale density maps for SOCAL, but not a map for HRC. As noted in Section 3.2, shapefiles for the NMSDD Phase III 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 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.

Density data for the Phase III analyses were updated specifically for the acoustic modeling study areas and not for the entirety of HRC and SOCAL. As noted in Section 2.2.1, this strategy allowed the Navy to eliminate the least preferred sources of density data, thereby improving the quality and reducing the uncertainty of data used for Phase III acoustic modeling. As described in Section 3.1, two modeling study areas were established that encompassed each of the main OPAREAs, as well as three representative transit corridor study areas. The boundaries of these modeling study areas are shown in white on each of the maps, and labeled accordingly (i.e., "HRC Density Extent," "Southern California Density Extent," and "Transit Corridor Representative Study Area"). In addition to the specific acoustic modeling study areas, density estimates available for the entirety of HRC and SOCAL are also shown on the maps. For some portions of HRC and SOCAL, values from the least preferred sources (i.e., the RES models) remain. While for some species these data differ substantially from the updated Phase III data shown for the acoustic modeling study areas, the Phase II data were not used in the current acoustic analyses, but are portrayed on the density figures for completeness. Since the range of density values displayed on the map legends represents the range of density values throughout the HSTT Study Area, the density values must be viewed in the context of the range of density estimates for each species.

The maps of species density should be interpreted with caution. 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. 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. As noted in Section 4, the density table 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.

The HSTT Study Area is depicted in two separate maps (one that shows the western portion of the Study Area, including HRC, and one that shows the eastern portion, including SOCAL). Representative transit corridor study areas, one in the eastern portion and two in the western portion of the HSTT Study Area, were selected along the transit corridor to represent the range of different habitats that could occur. These areas are labeled as “Transit Corridor: Representative Study Area” and assigned specific density estimates.

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., 2015; Leatherwood et al., 1988). In some cases, they do approach ships, affording good identification (Leatherwood et al., 1988; Perrin et al., 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., 2015; 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., 2015). 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., 2015; Leatherwood et al., 1988). If only the back is seen, the species could also be mistaken for a beaked whale (Jefferson et al., 2015; Leatherwood et al., 1988).

The 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., 2017). 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., 2017). 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.

HRC. Minke whales are heard regularly during the winter around Kauai (Rankin & Barlow, 2007) and on the hydrophone array at Pacific Missile Range Facility (Martin & Kok, 2011; Martin et al., 2015), but they are observed extremely rarely on vessel or aerial surveys. This difficulty in observation probably accounts for the fact that very little data are available to describe this species distribution in HRC and the western half of the transit corridor. For the Phase III analyses, the Navy used a density estimate of 0.00423 animals/km^2 (CV = NA) that was acoustically derived from hydrophones using correction factors for autumn, winter, and spring (Martin, 2015; Martin & Matsuyama, 2015). These data represent an improvement to the NMSDD from Phase II, when RES data from Kaschner et al. (2006) were used for these seasons. RES data from Kaschner et al. (2006) are shown in the remainder of HRC outside the boundaries of the acoustic modeling study areas.

Minke whales are thought to be more abundant in 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 & Herman, 1997). In the summer, minke whales are likely absent from low-productivity tropical waters (Jefferson et al., 2015; Perrin et al., 2009). During two separate line-transect surveys of the Hawaii EEZ during summer and fall, minke whales were only seen and/or acoustically detected during the fall months (Barlow, 2006; Bradford et al., 2017). Therefore, a density of zero is used for summer in HRC and the western portion of the transit corridor.

SOCAL. Density values for minke whales are available for SOCAL for all seasons from SWFSC reports, memoranda, and scientific literature. In the winter and spring, the density of minke whales is estimated as 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 (CV = 0.62) in Barlow et al. (2009). In the summer and fall, minke whale density increases to 0.00068 animals/km^2 (CV = 1.60) in waters off Southern California (Barlow, 2016). This provides an update to the density estimate used previously in the Navy's Phase II analyses as the updated Barlow (2016) estimate is based on a multiple-covariate line-transect approach using survey data collected between 1991 and 2014 and incorporates new estimates of trackline detection probability derived by Barlow (2015). Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint and resulted in a minke whale density estimate of 0.00061 (CV = 0.51). In the Baja area, the same value is used for all seasons.

Table 5-1: Summary of Density Values for Minke Whale in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.00423	0	0.00423	0.00423
W. Transit Corridor	0.00423	0	0.00423	0.00423
E. Transit Corridor	0.00028	0.00068	0.00068	0.00028
SOCAL	0.00028	0.00068	0.00068	0.00028
Baja	0.00061	0.00061	0.00061	0.00061

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.

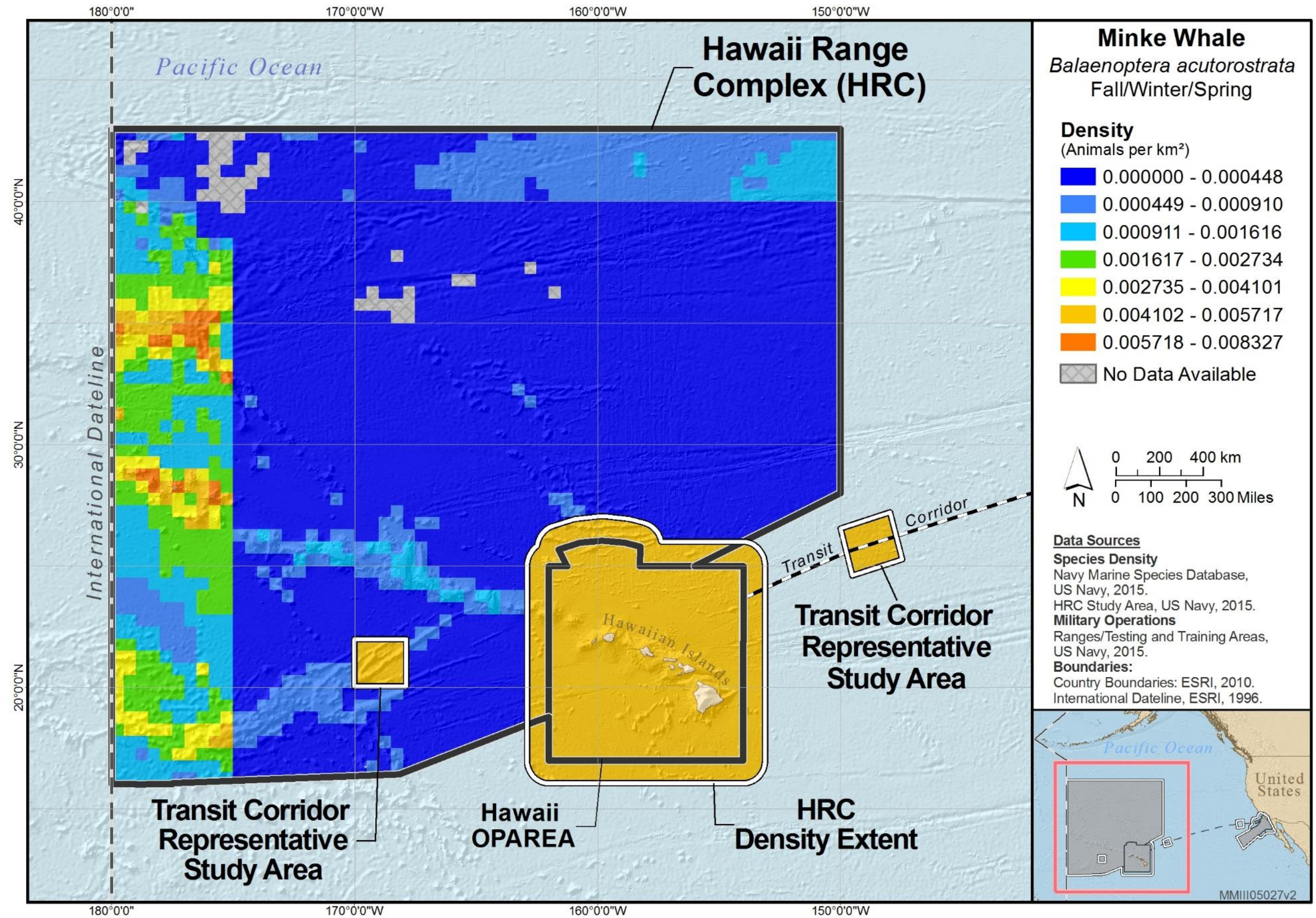


Figure 5-1: Annual Distribution of Minke Whale in HRC and the Western Portion of the Transit Corridor

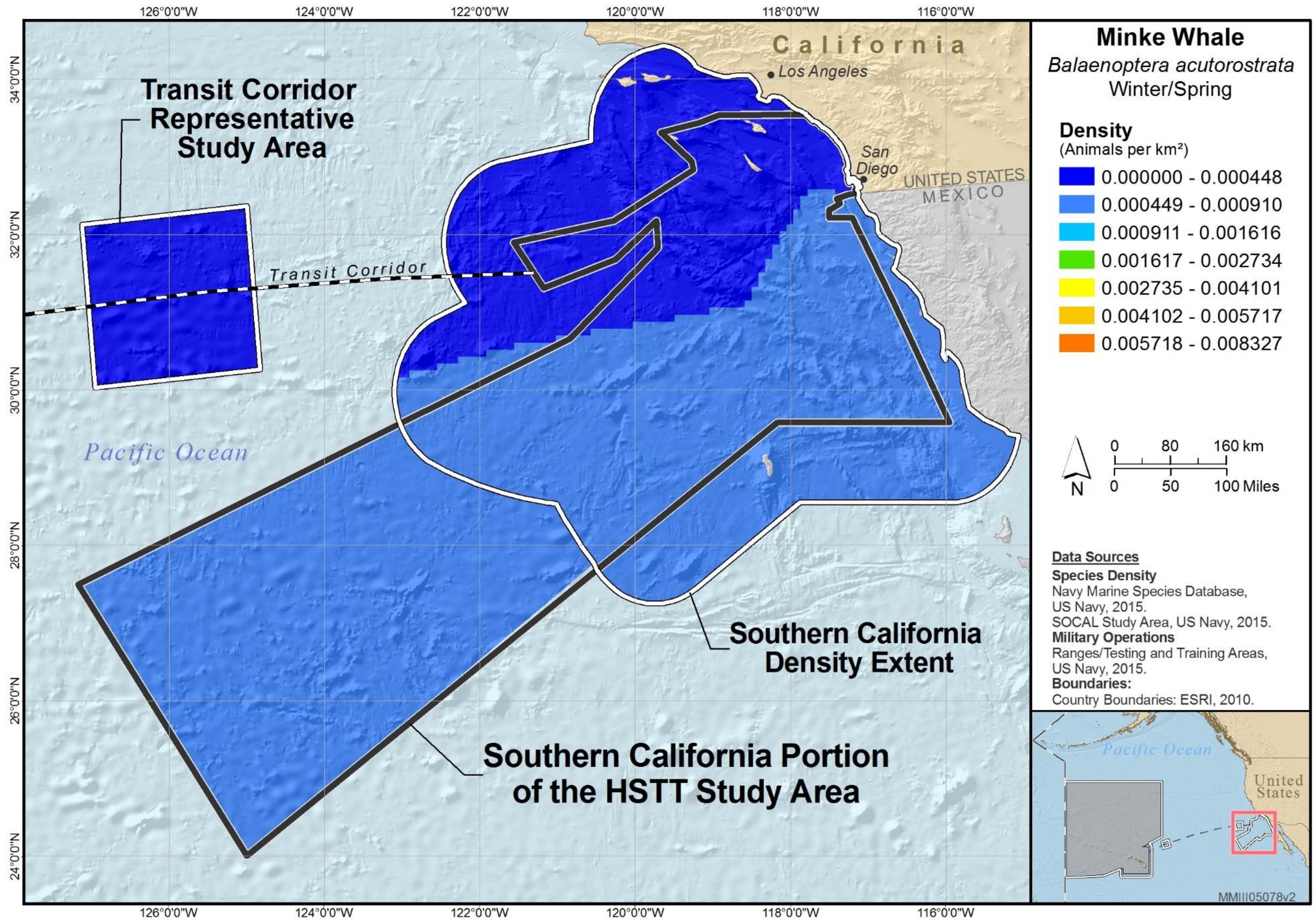


Figure 5-2: Winter/Spring Distribution of Minke Whale in SOCAL and the Eastern Portion of the Transit Corridor

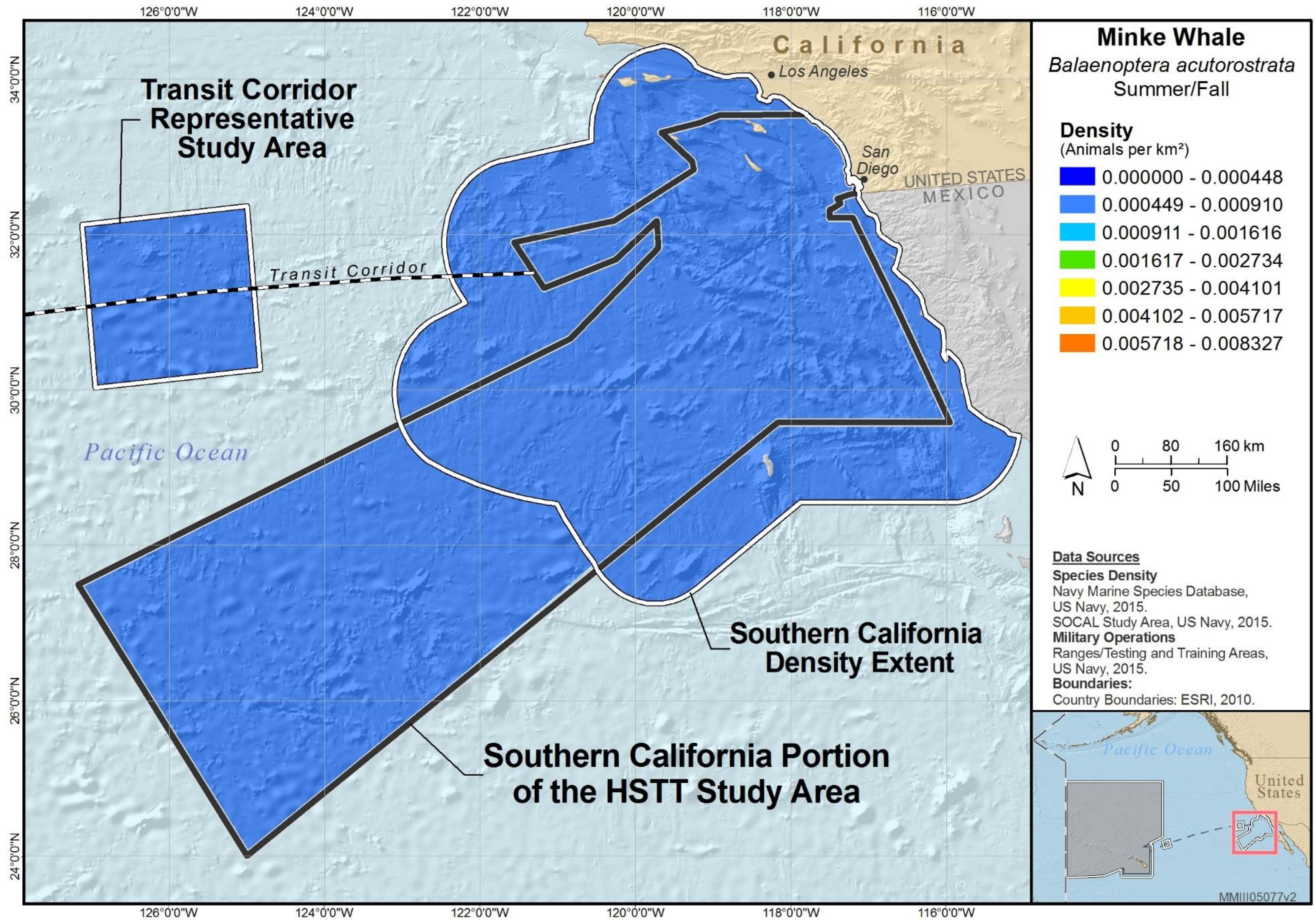


Figure 5-3: Summer/Fall Distribution of Minke Whale in SOCAL and the Eastern Portion of the Transit Corridor

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., 2015; Perrin et al., 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., 2015; 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., 2017). 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.

HRC. Sei whales are seen infrequently near HRC, and are reported to be more abundant in the area during the cool seasons (Barlow, 2006). Bradford et al. (2017) report a uniform density value for sei whales of 0.00016 animals/km^2 (CV = 0.90) that is applicable to the HRC study area and western portion of the transit corridor. This provides an update to the density estimate used previously in the Navy's Phase II analyses as it is based on multiple-covariate line-transect analyses of survey data collected in the Hawaiian Islands EEZ in 2010 and incorporates new estimates of trackline detection probability derived by Barlow (2015). This value is used for winter, spring, and fall. Outside the boundaries of the acoustic modeling study areas are density data used in the Phase II analyses, including a uniform estimate from Barlow et al. (2009) that is similar to the Bradford et al. (2017) estimate, as well as Kaschner et al. (2006) predicted RES values in the northern portion of HRC.

In the summer, sei whales are likely absent from low productivity tropical waters (Jefferson et al., 2015), and during two separate line-transect surveys of the Hawaiian Islands EEZ during summer and fall, sei whales were only seen during the fall months (Barlow, 2006; Bradford et al., 2017). Therefore, a density of zero is used for summer in HRC and western portion of the transit corridor.

SOCAL. Density values for sei whales are available for SOCAL from scientific literature. In the summer and fall, Barlow (2016) provides a sei whale density estimate of 0.00005 animals/km^2 (CV = 0.85) for waters off central and Southern California. This provides an update to the density estimate used previously in the Navy's Phase II analyses as the updated Barlow (2016) estimate is based on a multiple-covariate line-transect approach using survey data collected between 1991 and 2014 and incorporates new estimates of trackline detection probability derived by Barlow (2015). This number is also applied to SOCAL in winter/spring and to all seasons in waters off Baja since no season- or region-specific values were available in the literature. Outside the boundaries of the acoustic modeling study areas, RES data from Kaschner et al. (2006) are shown for the remainder of the SOCAL Range Complex.

Table 5-2: Summary of Density Values for Sei Whale in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.00016	0	0.00016	0.00016
W. Transit Corridor	0.00016	0	0.00016	0.00016
E. Transit Corridor	0.00005	0.00005	0.00005	0.00005
SOCAL	0.00005	0.00005	0.00005	0.00005
Baja	0.00005	0.00005	0.00005	0.00005

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.

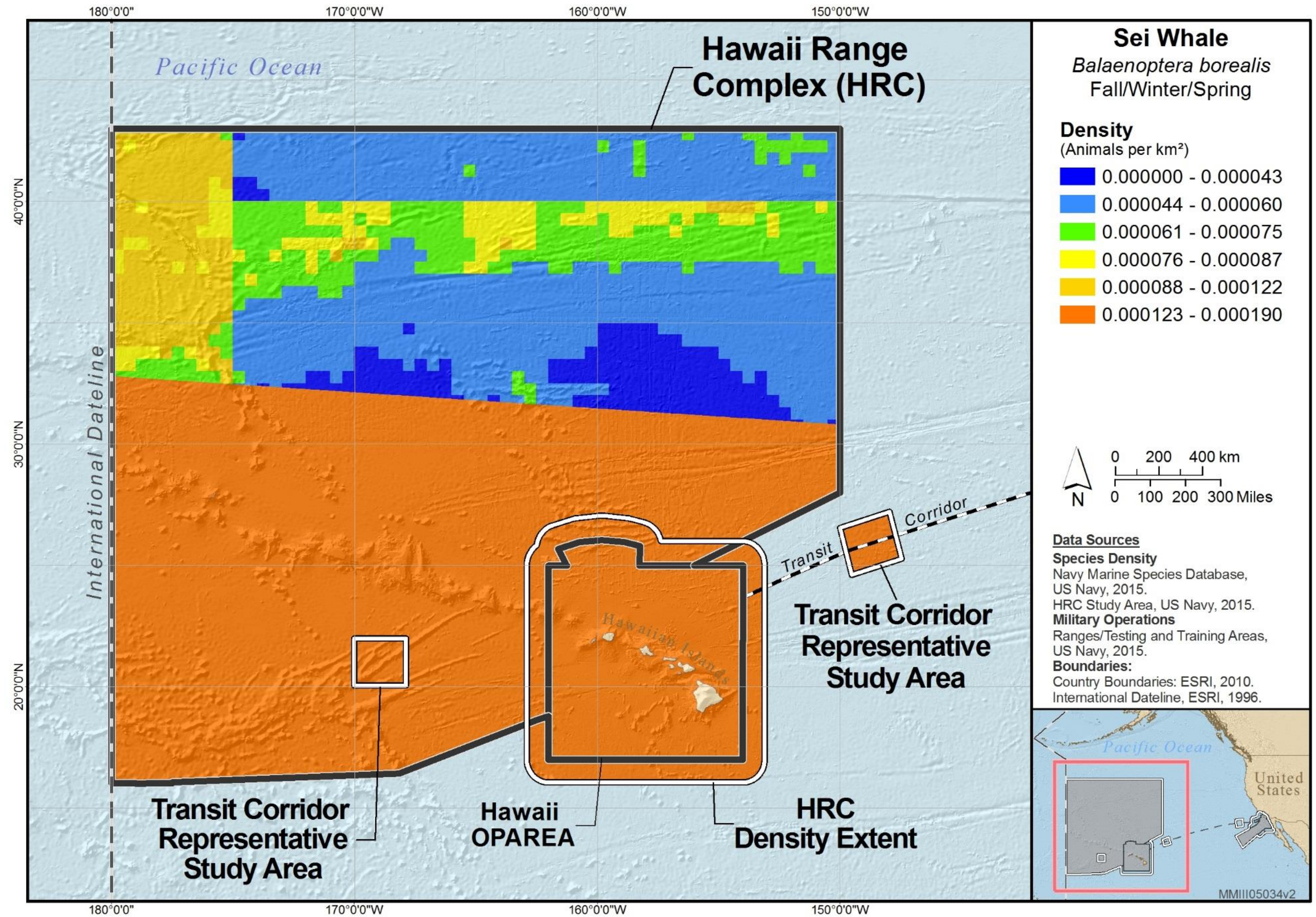


Figure 5-4: Fall/Winter/Spring Distribution of Sei Whale in HRC and the Western Portion of the Transit Corridor

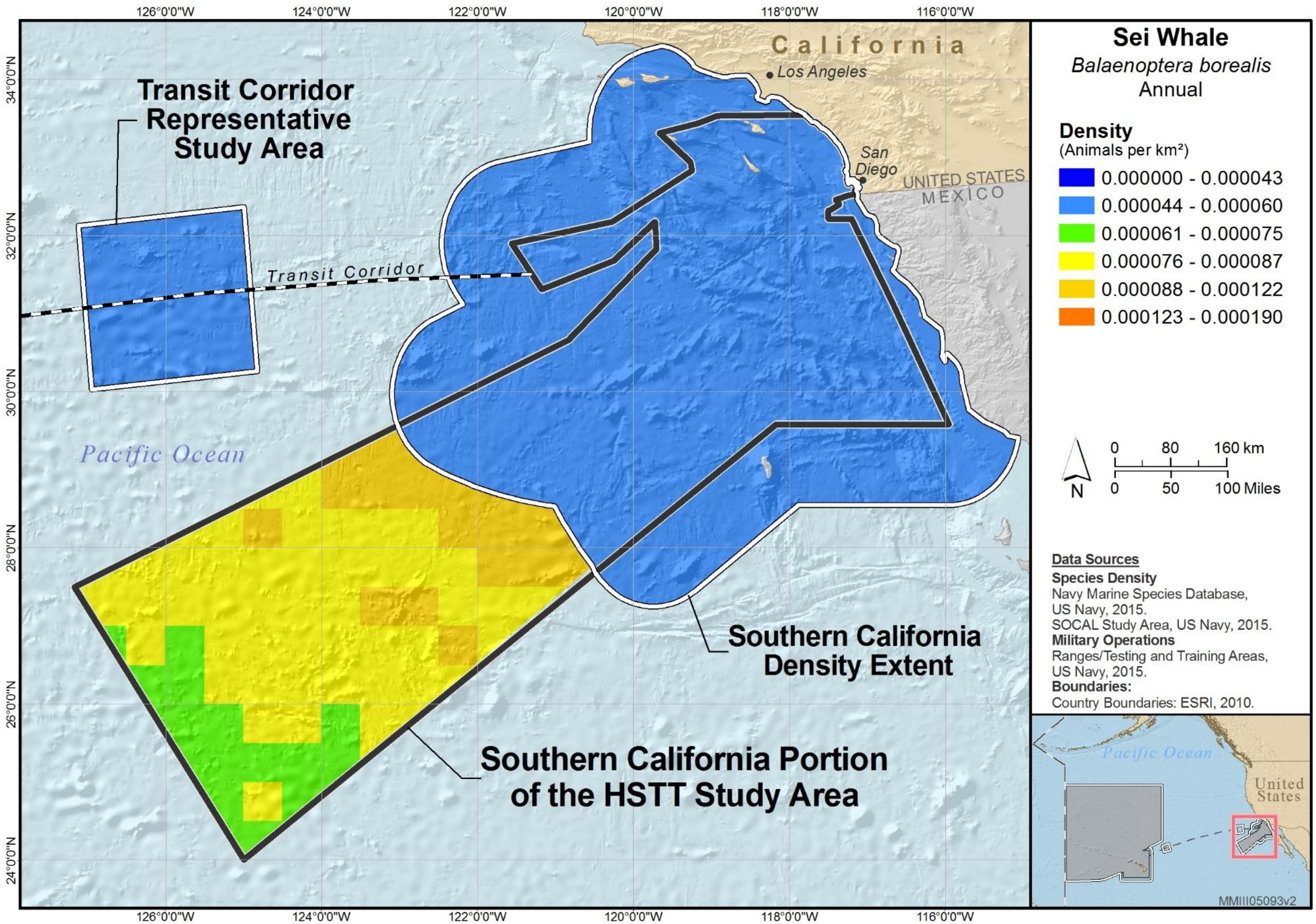


Figure 5-5: Annual Distribution of Sei Whale in SOCAL and the Eastern Portion of the Transit Corridor

5.1.3 *BALAENOPTERA EDENI*, BRYDE'S WHALE

Bryde's whale is a baleen whale typically found only in tropical and warm temperate waters (Kato & Perrin, 2009; Leatherwood et al., 1988). Off Southern California, sightings and acoustic detections have increased over the last 10 years (Kerosky et al., 2012; Smultea et al., 2012), indicating a potential northern shift in distribution (Kerosky et al., 2012). Bryde's whales have been sighted and acoustically detected in Southern California waters in all seasons, although they are most common in summer and fall (Barlow & Forney, 2007; Barlow, 2016; Debich et al., 2015; Kerosky et al., 2012; Smultea et al., 2012). Based on acoustic detections it has recently been confirmed that Bryde's whales also occur in Hawaiian waters year-round (Helble et al., 2016; Martin & Matsuyama, 2015). Bryde's whales can be difficult to identify positively from a distance, because of their superficial similarity to sei and Omura's whales (Jefferson et al., 2015). Positive identification of the species requires a clear view 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., 2015; 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., 2017). 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., 2017).

HRC. The Phase II NMSDD included the first CENPAC habitat-based density model for Bryde's whales based on systematic survey data collected from 1997 to 2006 (Becker et al., 2012c). More recently, Forney et al. (2015) updated the CENPAC habitat-based models of cetacean densities using additional survey data collected within the Hawaiian Islands EEZ in 2010 and in waters surrounding Palmyra Atoll/Kingman Reef in 2011 and 2012. In addition, improved modeling methods were used that allowed model predictions to be applied directly on a 25 km × 25 km spatial grid. These models cover the entire HRC and provide representative density values for the two western transit corridor study areas. The updated CENPAC Bryde's whale spatial model was applied to all seasons for HRC and the transit corridor.

SOCAL. Barlow (2016) provides a Bryde's whale density estimate of 0.00002 animals/km^2 (CV = 1.05) for waters off central and Southern California in summer and fall. This provides an update to the density estimate used previously in the Navy's Phase II analyses as the updated Barlow (2016) estimate is based on a multiple-covariate line-transect approach using survey data collected between 1991 and 2014 and incorporates new estimates of trackline detection probability derived by Barlow (2015). This number is also applied to SOCAL in winter/spring and to all seasons in waters off Baja since no season- or region-specific values were available in the literature.

Table 5-3: Summary of Density Values for Bryde's Whale in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	0.00002	0.00002	0.00002	0.00002
SOCAL	0.00002	0.00002	0.00002	0.00002
Baja	0.00002	0.00002	0.00002	0.00002

The units for numerical values are animals/km^2. S = spatial model with various density values throughout the range.

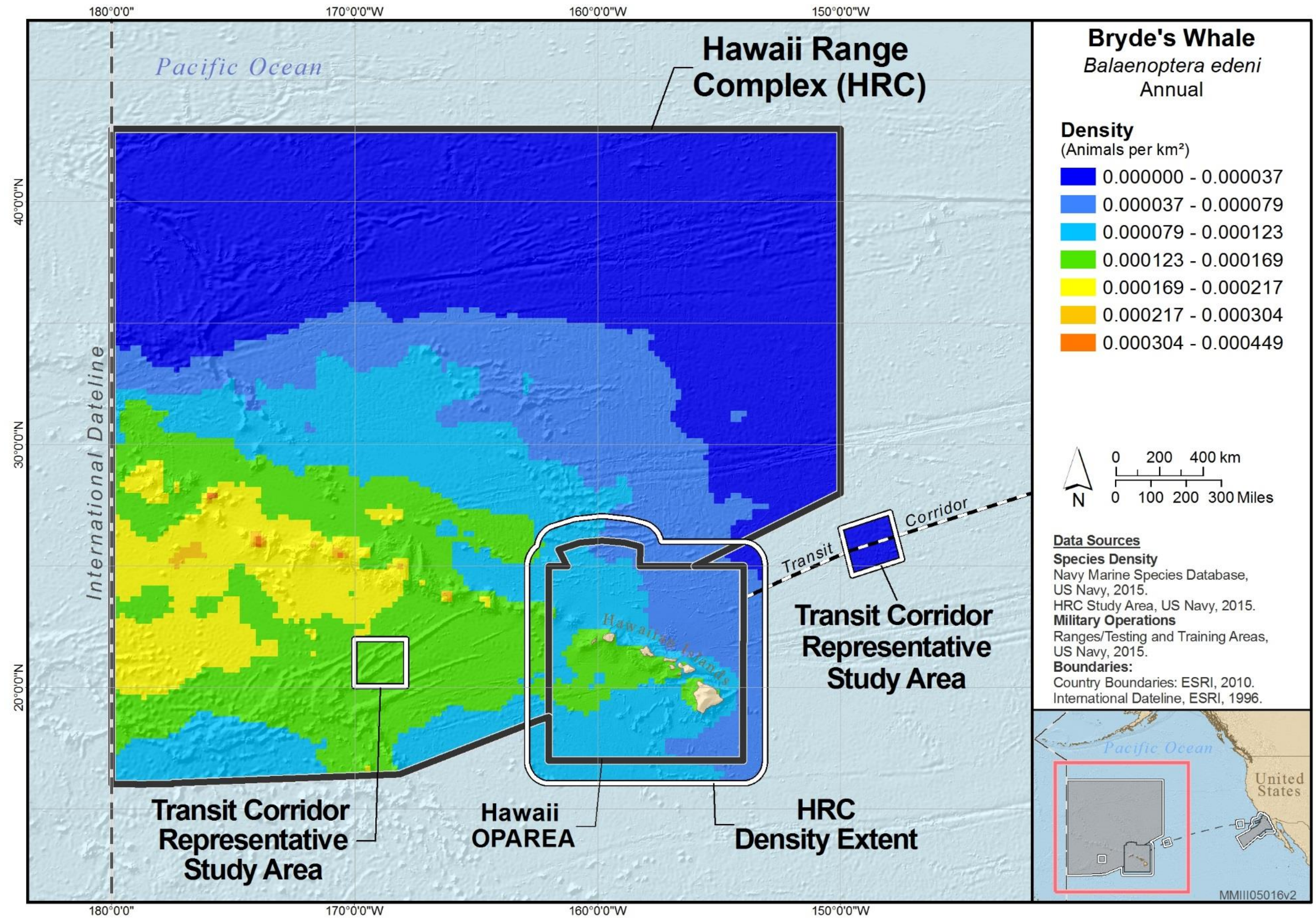


Figure 5-6: Annual Distribution of Bryde's Whale in HRC and the Western Portion of the Transit Corridor

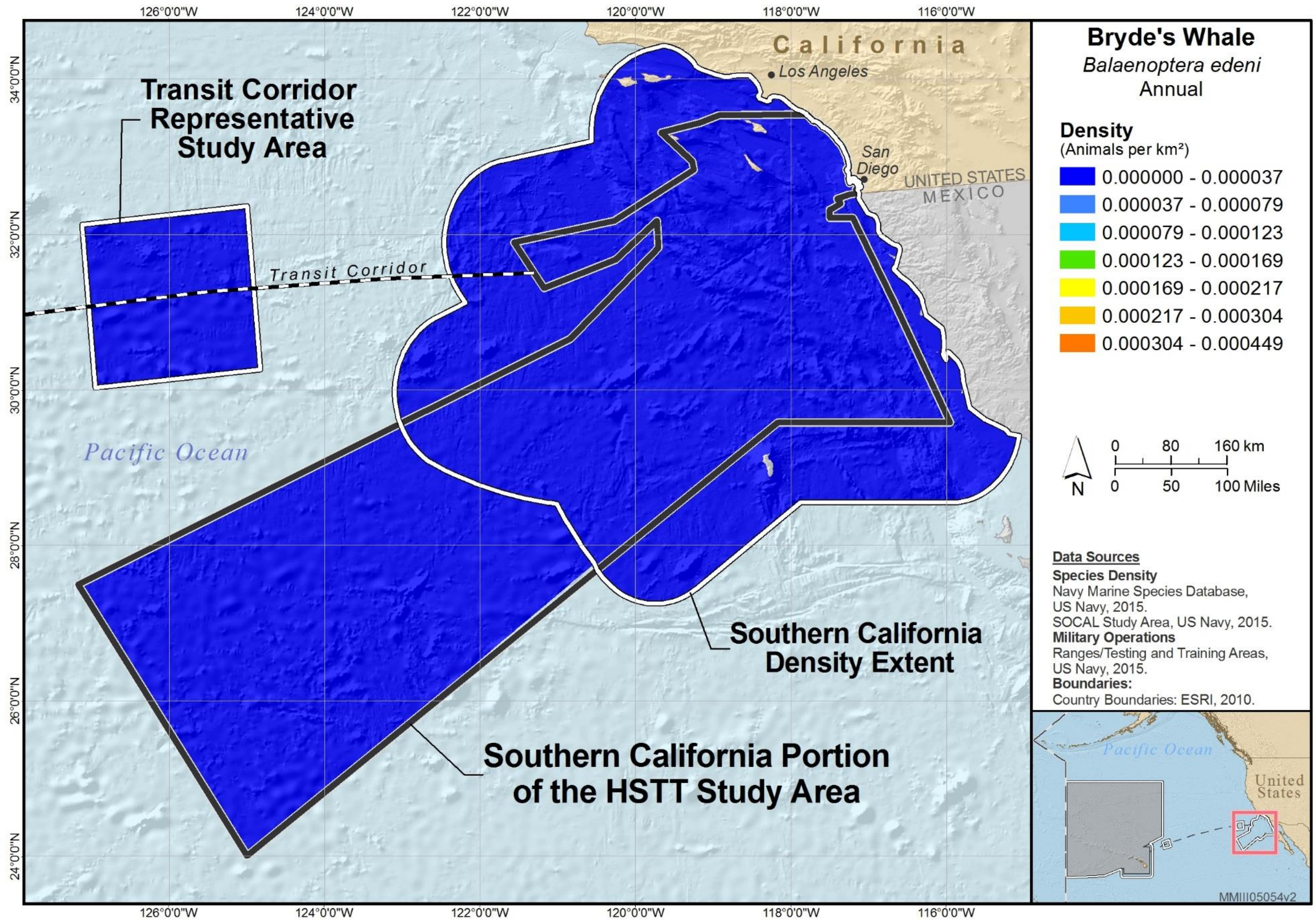


Figure 5-7: Annual Distribution of Bryde's Whale in SOCAL and the Eastern Portion of the Transit Corridor

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., 2015). 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., 2015; 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., 2015; Leatherwood et al., 1988). There are four subspecies of blue whale, but only *Balaenoptera musculus* is found in the North Pacific (Muto et al., 2017). 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., 2017). 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., 2017). 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 HRC and in the western portion of the transit corridor would most likely be members of the Central North Pacific stock.

HRC. Bradford et al. (2017) report a uniform density value for blue whales of 0.00005 animals/km^2 (CV = 1.09) that is applicable to the HRC study area and western portion of the transit corridor. This provides an update to the density estimate used previously in the Navy's Phase II analyses as it is based on multiple-covariate line-transect analyses of survey data collected in the Hawaiian Islands EEZ in 2010 and incorporates new estimates of trackline detection probability derived by Barlow (2015). This value is used for winter, spring, and fall. Outside the boundaries of the acoustic modeling study areas are Kaschner et al. (2006) density data that were used in the Phase II analyses.

Blue whale vocalizations are heard from acoustic listening stations north of the Main Hawaiian Islands during the cool seasons (Nosal, 2015) as well as other times of the year (Stafford et al., 2001). In the summer, blue whales are considered absent in HRC, and blue whales were not sighted during a 2002 line-transect survey of the Hawaiian Islands EEZ during summer and fall (Barlow, 2006). During a follow-up survey in 2010, blue whales were seen within the Hawaiian Islands EEZ only during the fall months (Bradford et al., 2017). Therefore, a density of zero is used for that season in HRC and the western portion of the transit corridor.

SOCAL. The Phase II NMSDD included a CCE habitat-based density model for blue whales based on systematic survey data collected from 1991 to 2008 (Becker et al., 2012b). The model provided spatially-explicit density estimates off the U.S. west coast for summer and fall. More recently, Becker et al. (2016) updated the CCE habitat-based models of cetacean densities using additional survey data collected primarily off Southern California in 2009. In addition, improved modeling methods were used that allowed species-specific and segment-specific estimates of both effective strip width and trackline detection probability to be incorporated into the models based on the recorded viewing conditions on that segment using coefficients estimated by Barlow et al. (2011) for effective strip width and

Barlow (2015) for trackline detection probability. Density predictions from the updated models are grid-based at a pixel resolution of 10 km x 10 km, providing finer spatial resolution and eliminating interpolation artifacts sometimes present in the previous CCE models (Becker et al., 2016). Density estimates from the updated blue whale model were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for summer and fall.

Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint and were also corrected for new estimates of trackline detection probability derived by Barlow (2015). The resulting blue whale uniform density estimate of 0.00161 animals/km^2 (CV = 0.42) was used for summer and fall. Given the overlap of the Ferguson and Barlow strata used to recalculate densities (refer to Figure 3-7), this value is also applicable to the remainder of the SOCAL Range Complex for summer and fall.

Campbell et al. (2015) provide the most recent winter/spring density estimates for blue whales in Southern California waters and their seasonally stratified line-transect estimate of 0.00007 animals/km^2 (CV = 1.20) was applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the Campbell et al. study area, as well as the eastern portion of the transit corridor. In the absence of winter/spring density data off Baja, the Campbell et al. (2015) uniform density estimate was also applied to the Baja portion of the Navy's SOCAL acoustic modeling study area for these seasons. Outside the boundaries of the acoustic modeling study areas, RES data from SMRU Ltd. (2012) are shown for the remainder of the SOCAL Range Complex.

Table 5-4: Summary of Density Values for Blue Whale in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.00005	0	0.00005	0.00005
W. Transit Corridor	0.00005	0	0.00005	0.00005
E. Transit Corridor	0.00007	S	S	0.00007
SOCAL	0.00007	S	S	0.00007
Baja	0.00007	0.00161	0.00161	0.00007

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.

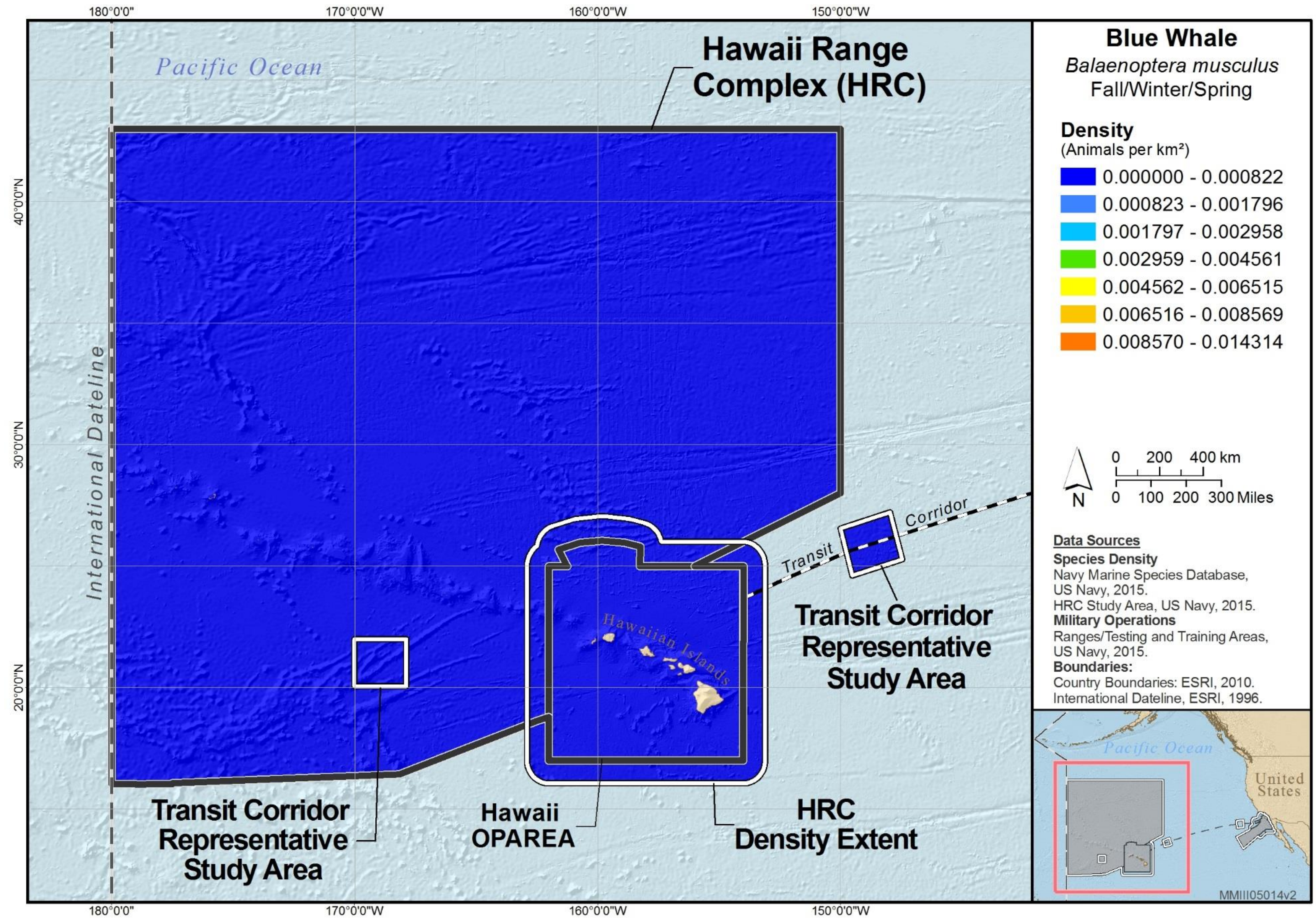


Figure 5-8: Fall/Winter/Spring Distribution of Blue Whale in HRC and the Western Portion of the Transit Corridor

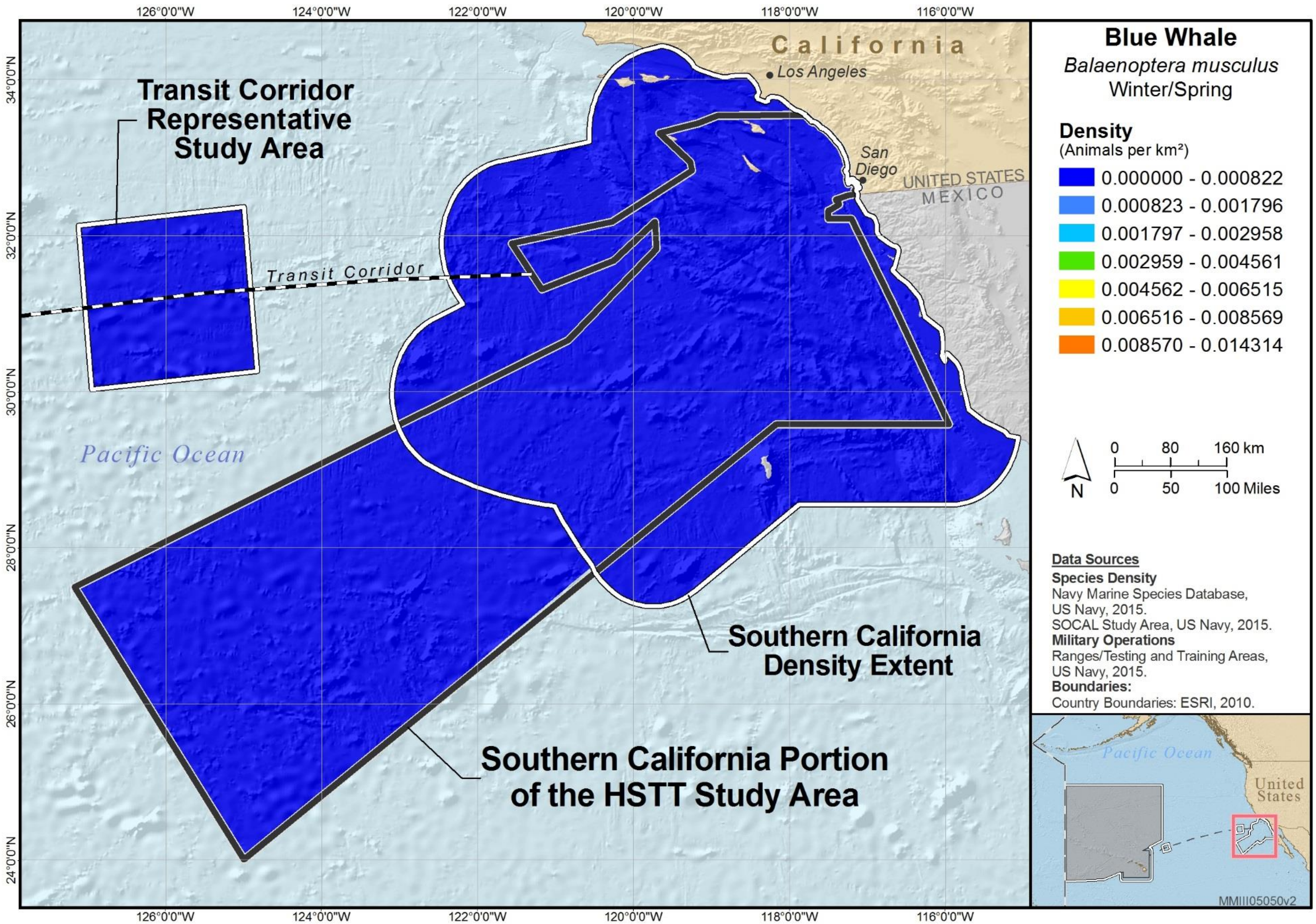


Figure 5-9: Winter/Spring Distribution of Blue Whale in SOCAL and the Eastern Portion of the Transit Corridor

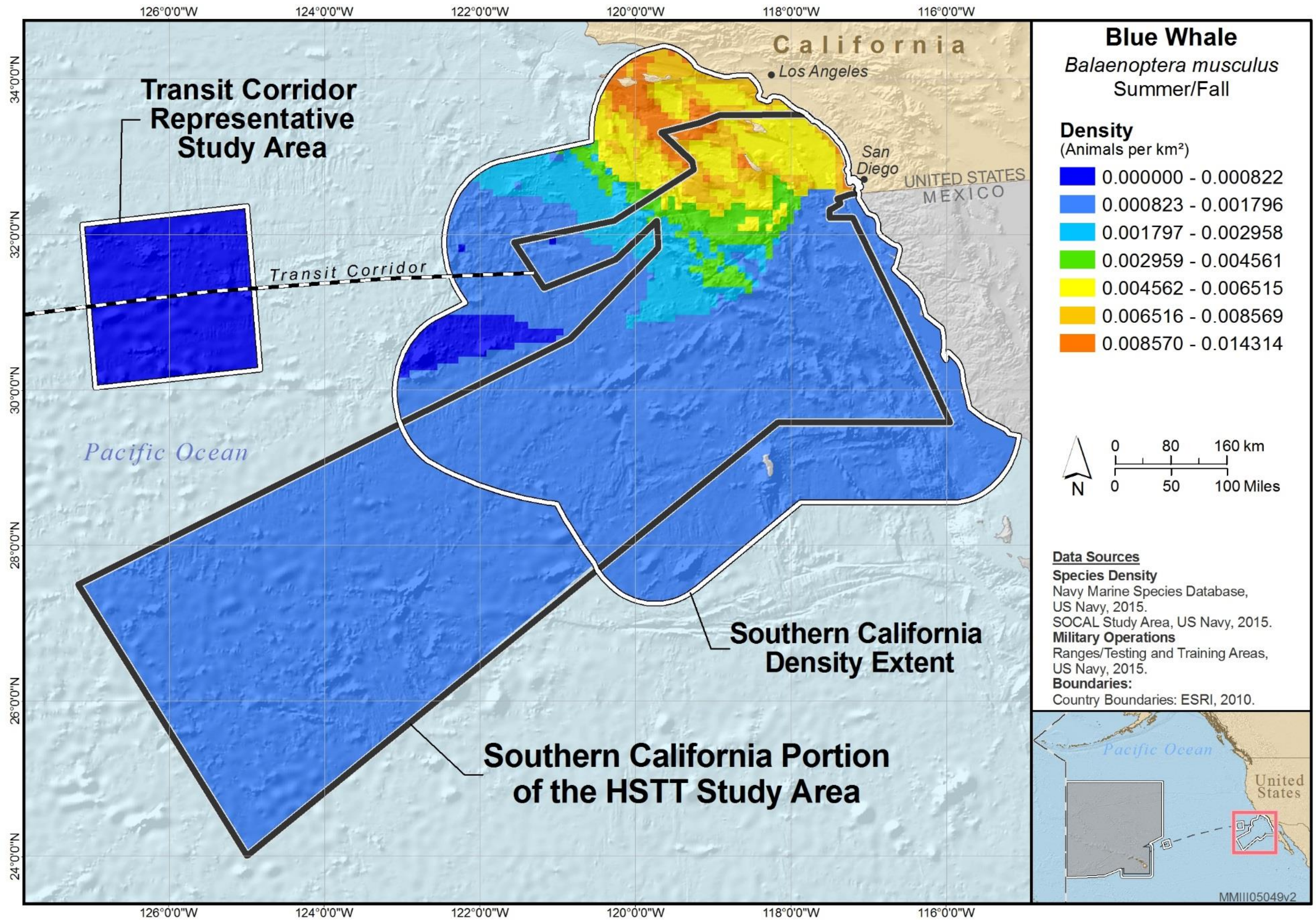


Figure 5-10: Summer/Fall Distribution of Blue Whale in SOCAL and the Eastern Portion of the Transit Corridor

5.1.5 *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., 2015). 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., 2015; 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 Northeast Pacific stock, the California/Oregon/Washington stock, and the Hawaii stock (Carretta et al., 2017). 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.

HRC. Bradford et al. (2017) report a uniform density value for fin whales of 0.00006 animals/km^2 (CV = 1.05) that is applicable to the HRC study area and western portion of the transit corridor. This provides an update to the density estimate used previously in the Navy's Phase II analyses as it is based on multiple-covariate line-transect analyses of survey data collected in the Hawaiian Islands EEZ in 2010 and incorporates new estimates of trackline detection probability derived by Barlow (2015). This value is used for winter, spring, and fall. Outside the boundaries of the acoustic modeling study areas, RES data from SMRU Ltd. (2012) are shown for the remainder of HRC.

Fin whales have been recorded from hydrophone sites near Hawaii at all times of the year (McDonald & 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. In summer, fin whales are likely absent from HRC, and during two separate line-transect surveys of the Hawaiian Islands EEZ during summer and fall, fin whales were only seen during the fall months (Barlow, 2006; Bradford et al., 2017). Therefore, a density of zero is used for summer in 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 United States (Moore & Barlow, 2011). The Phase II NMSDD included a CCE habitat-based density model for fin whales based on systematic survey data collected from 1991 to 2008 (Becker et al., 2012b). The model provided spatially-explicit density estimates off the U.S. west coast for summer and fall. More recently, Becker et al. (2016) updated the CCE habitat-based models of cetacean densities using additional survey data collected primarily off Southern California in 2009. In addition, improved modeling methods were used that allowed species-specific and segment-specific estimates of both effective strip width and trackline detection probability to be incorporated into the models based on the recorded viewing conditions on that segment using coefficients estimated by Barlow et al. (2011) for effective strip width and Barlow (2015) for trackline detection probability. Density predictions from the updated models are grid-based at a pixel resolution of 10 km x 10 km, providing finer spatial resolution and eliminating interpolation artifacts sometimes present in the previous CCE models (Becker et al., 2016). Density estimates from the updated fin whale model were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for summer and fall.

Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint and were also corrected for new estimates of trackline detection probability derived by Barlow (2015). The resulting fin whale uniform density estimate of 0.00024 animals/km^2 (CV = 0.58) was used for summer and fall. Given the overlap of the Ferguson and Barlow strata used to recalculate densities (refer to Figure 3-7), this value is also applicable to the remainder of the SOCAL Range Complex for summer and fall.

Campbell et al. (2015) provide the most recent winter and spring density estimates for fin whales in Southern California waters and their seasonally stratified line-transect estimates of 0.00065 animals/km^2 (CV = 0.42) for winter and 0.00181 animals/km^2 (CV = 0.46) for spring were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the Campbell et al. study area, as well as the eastern portion of the transit corridor. In the absence of winter/spring density data off Baja, the Campbell et al. (2015) uniform density estimates were also applied to the Baja portion of the Navy's SOCAL acoustic modeling study area for these seasons. Outside the boundaries of the acoustic modeling study areas, RES data from SMRU Ltd. (2012) are shown for the remainder of the SOCAL Range Complex.

Table 5-5: Summary of Density Values for Fin Whale in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.00006	0	0.00006	0.00006
W. Transit Corridor	0.00006	0	0.00006	0.00006
E. Transit Corridor	S	S	S	S
SOCAL	0.00181	S	S	0.00065
Baja	0.00181	0.00024	0.00024	0.00065

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.

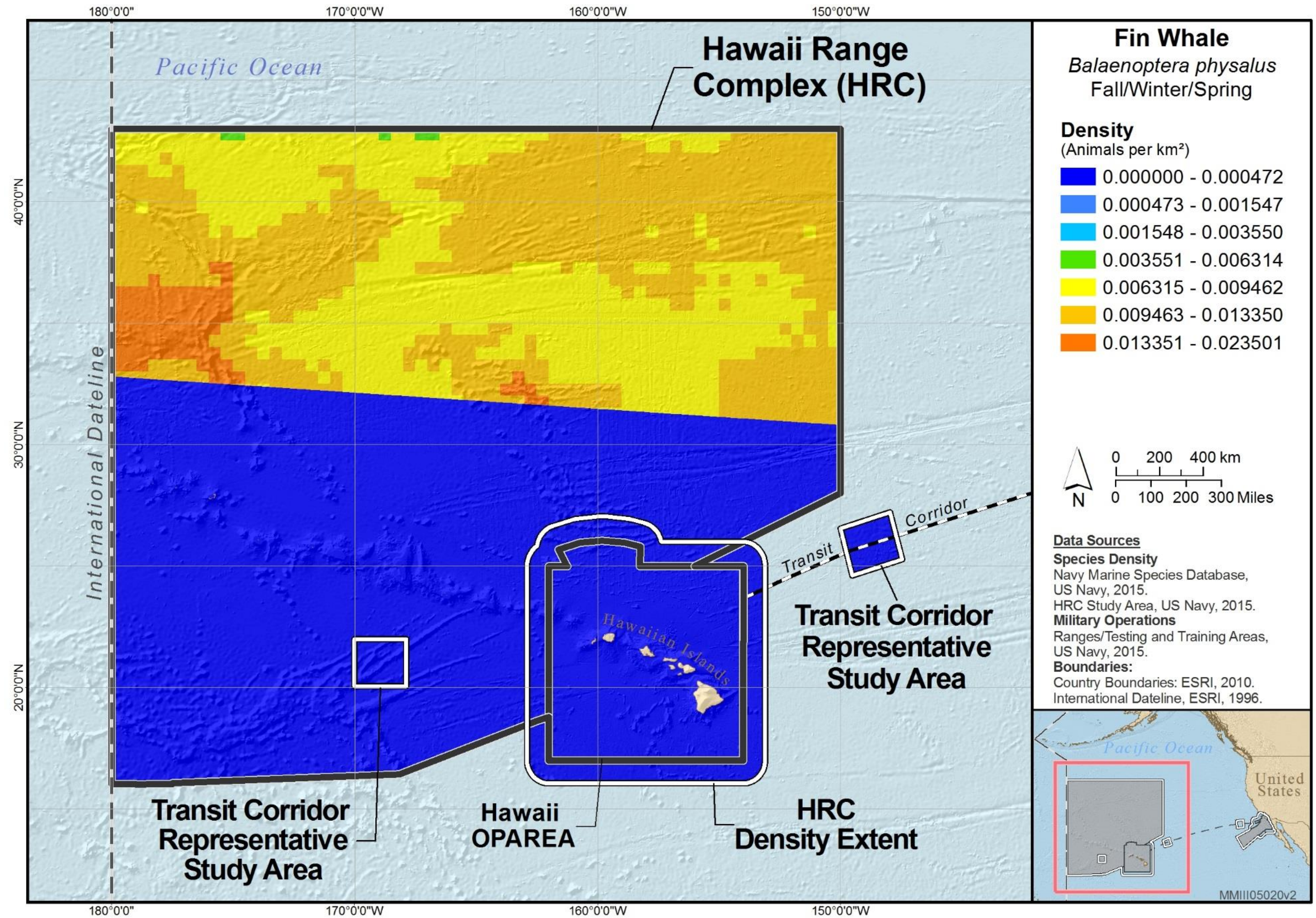


Figure 5-11: Fall/Winter/Spring Distribution of Fin Whale in HRC and the Western Portion of the Transit Corridor

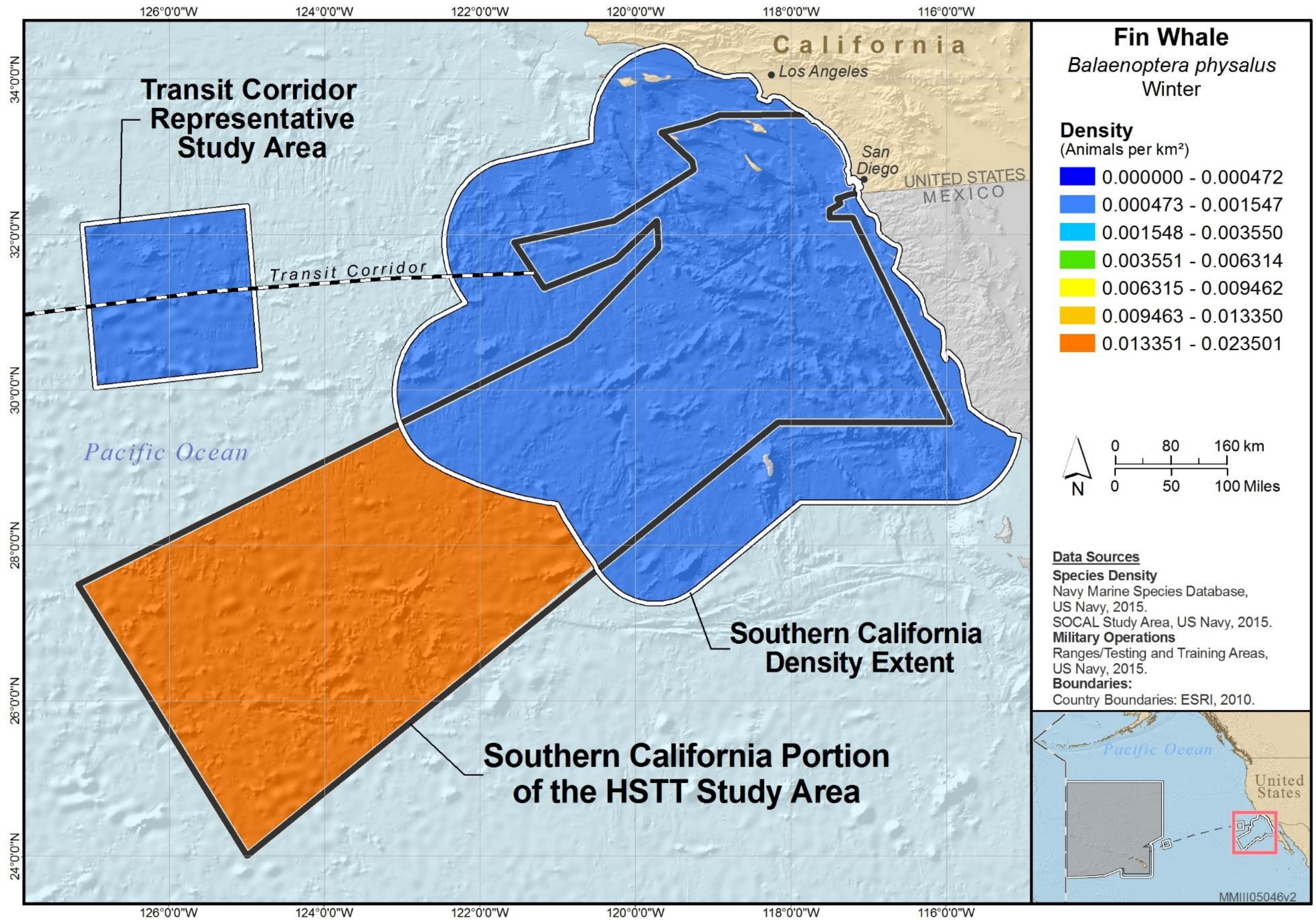


Figure 5-12: Winter Distribution of Fin Whale in SOCAL and the Eastern Portion of the Transit Corridor

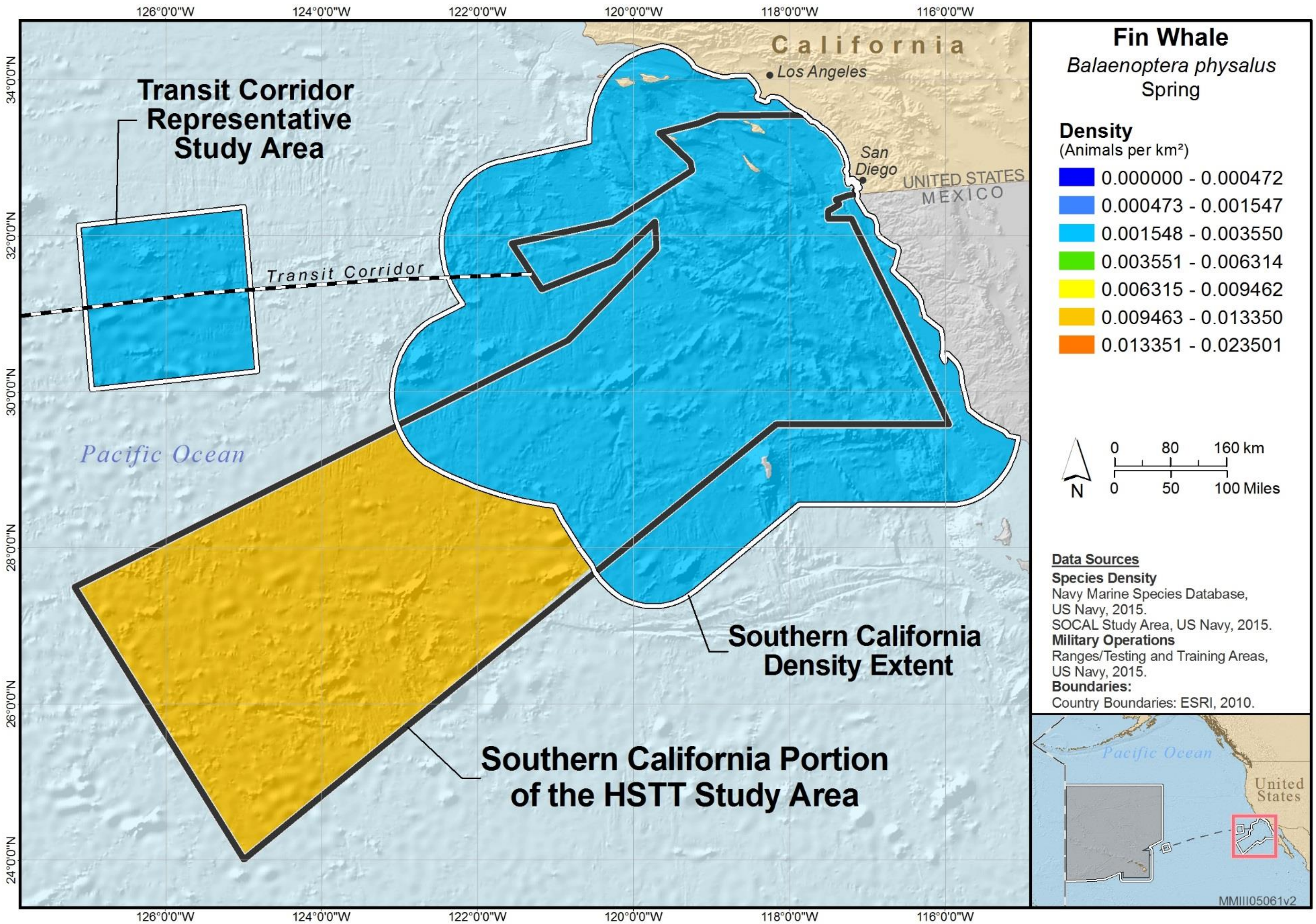


Figure 5-13: Spring Distribution of Fin Whale in SOCAL and the Eastern Portion of the Transit Corridor

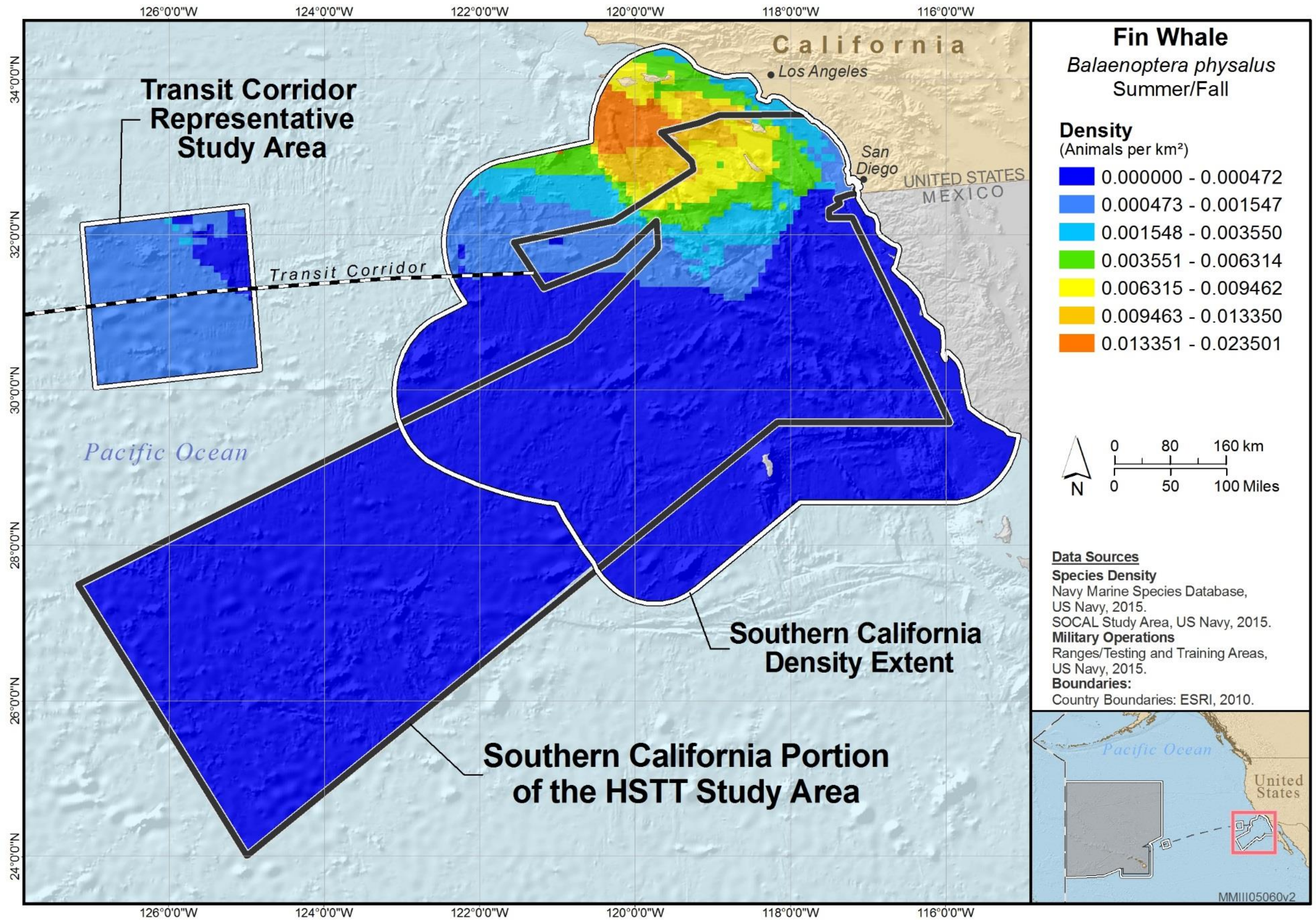


Figure 5-14: Summer/Fall Distribution of Fin Whale in SOCAL and the Eastern Portion of the Transit Corridor

5.1.6 *Eschrichtius robustus*, Gray Whale

The gray whale is distinctive in appearance, with a small dorsal hump and many barnacles and irregularities on their skin, which is a uniform light gray (Jones et al., 1984). 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 (Carretta et al., 2017); 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., 2013; Mate et al., 2015). 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). 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 Phase III. Density values in the NMSDD Phase III 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 & Wolman, 1971). They pass through the SOCAL 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., 2017). Photo-identification, telemetry, and genetic studies suggest that the Pacific Coast Feeding Group is demographically distinct (Calambokidis et al., 2010; Frasier et al., 2011; Mate et al., 2010). 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., 2017).

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

SOCAL. The majority of population data for gray whales is from shore counts as they pass established stations on the west coast of North America (for example Rugh et al., 2005; Shelden & Laake, 2002). On their southward migration, gray whales pass in more offshore waters after they reach Point Conception in Santa Barbara County, California and cut across the Southern California Bight on their way south to the breeding area along Baja California (Jones & Swartz, 2002). Shelden and Laake (2002) estimated that, along the coast, 95.24 percent of gray whales were within 2.24 nm of the coast during migration and 4.76 percent were between 2.25 and 20 nm from the coast. In order to generate more spatially-explicit density estimates, the Navy identified density regions for gray whales consistent with the literature. An inshore region was designated that extended across the Southern California Bight (i.e., from Point Conception to just south of the United States-Mexico border (Dailey et al., 1993) to approximately 5 nm west of the Channel Islands. An offshore region was designated that extended an additional 20 nm to the west (i.e., 25 nm west of the Channel Islands). To the south, an inshore area was established from shore to 2.25 off the Baja coast, and an offshore region from 2.25 to 20 nm from the coast.

Jefferson et al. (2014) provide density estimates for gray whales in the Southern California Bight from 18 line-transect aerial surveys conducted between 2008 and 2013. Separate “warm” and “cold” season density estimates were provided for the Santa Catalina Basin and the San Nicolas Basin, used to roughly approximate the Southern California Bight inshore and offshore regions established for the NMSDD. In winter/spring, Jefferson et al. (2014) provide an estimate of 0.01791 animals/km^2 (CV = 0.29) for the Santa Catalina Basin and 0.01066 animals/km^2 (CV = 0.76) for the San Nicolas Basin. For summer/fall, an overall study area density estimate of 0.00059 animals/km^2 (CV = 0.13) was presented (Jefferson et al., 2014) and used conservatively for both the inshore and offshore areas. In the absence of region-specific data, these values were also used for the study area off Baja.

Table 5-6: Summary of Density Values for Gray Whale in the Hawaii-Southern California Training and Testing 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: shore to 5 nm west of Channel Islands	0.01791	0.00059	0.00059	0.01791
SOCAL : 5–25 nm west of Channel Islands	0.01066	0.00059	0.00059	0.01066
Baja: shore to 2.25 nm west	0.01791	0.00059	0.00059	0.01791
Baja: 2.25 nm–20 nm west	0.01066	0.00059	0.00059	0.01066

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

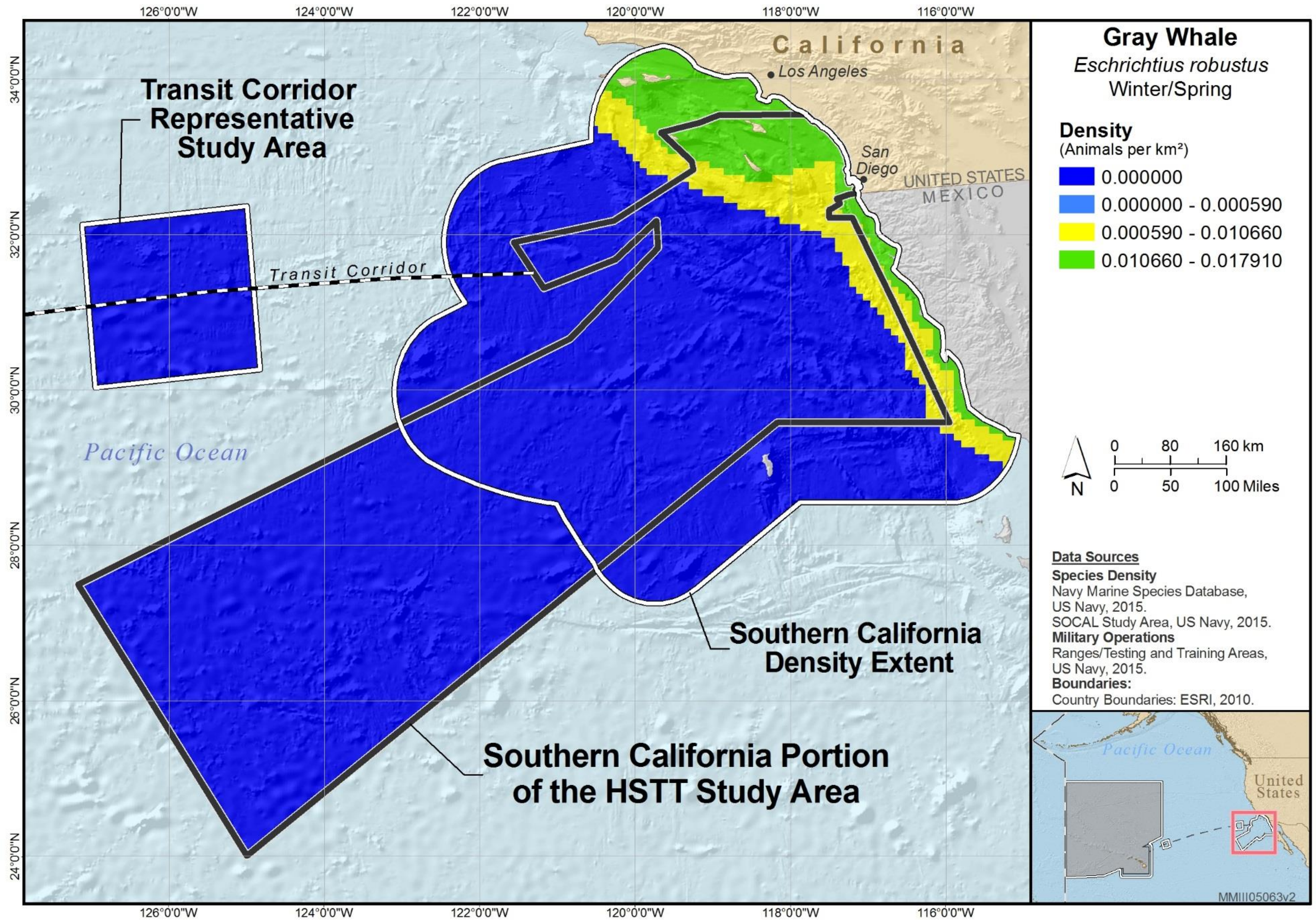


Figure 5-15: Winter/Spring Distribution of Gray Whale in SOCAL and the Eastern Portion of the Transit Corridor

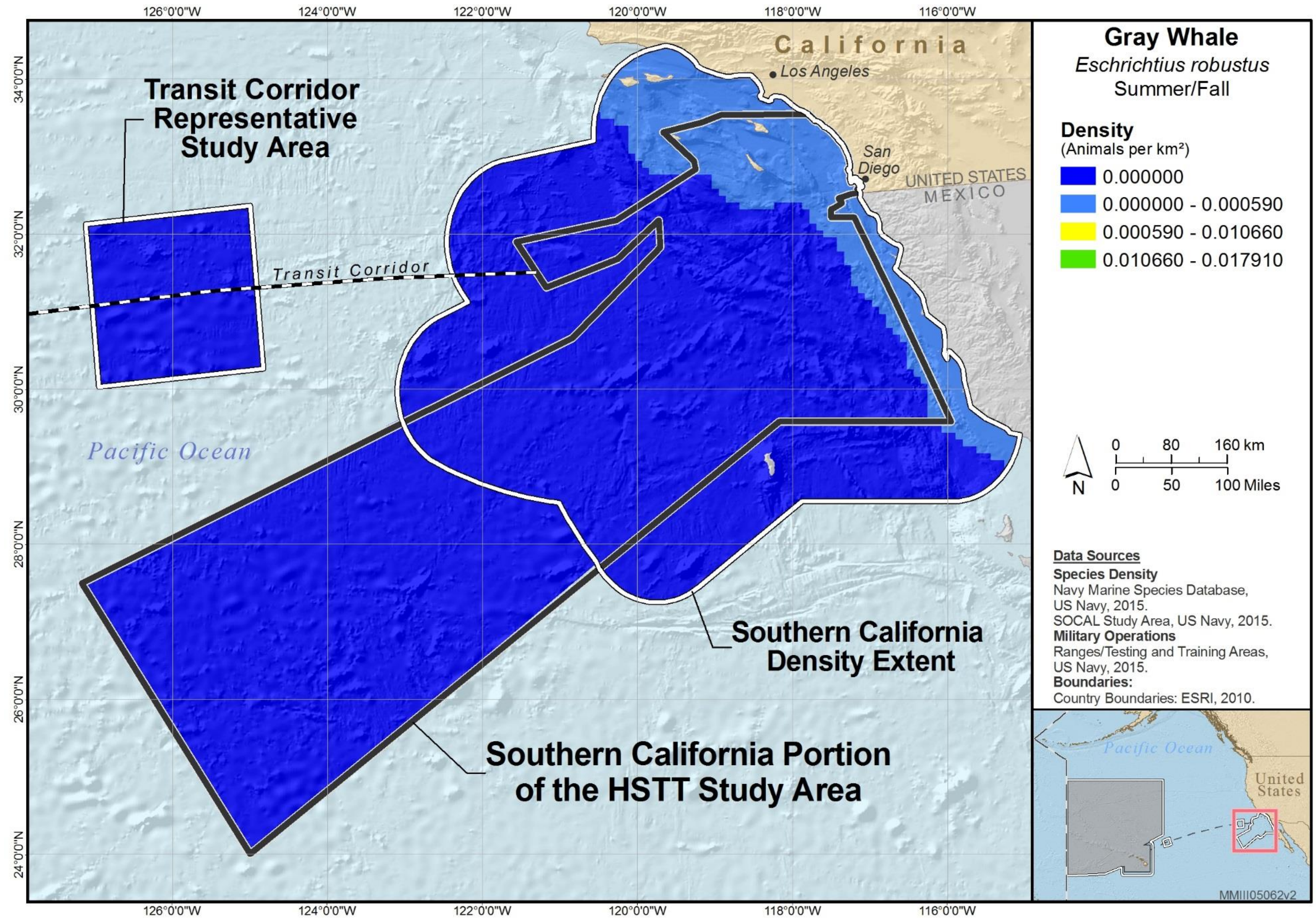


Figure 5-16: Summer/Fall Distribution of Gray Whale in SOCAL and the Eastern Portion of the Transit Corridor

5.1.7 *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., 2010). 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., 2010; 2011). 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; Wade et al., 2011; 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 & Mickelsen, 1999), and the last sightings in Southern California waters are likely to be the sightings off SCI in 1992 (Carretta et al., 1994) and the sighting off Baja California in 1996 (Gendron et al., 1999). Given their small population size, the expected likelihood of a North Pacific right whale being in waters within the Navy's HSTT Study Area is so small that the species is not included in the Navy's density database for these regions.

5.1.8 *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). In the Pacific, NMFS previously divided humpback whales into four stocks (Carretta et al., 2017): (1) the Central North Pacific stock, consisting of winter and spring populations of the Hawaiian Islands that migrate to northern British Columbia and Alaska, the Gulf of Alaska, the Bering Sea, and Aleutian Islands; (2) the Western North Pacific stock, consisting of winter and spring populations off Asia that migrate to Russia and the Bering Sea and Aleutian Islands; (3) the California, Oregon, Washington, and Mexico stock, consisting of winter and spring populations in coastal Central America and coastal Mexico that migrate to coastal California and to British Columbia in summer and fall; and (4) the American Samoa stock, with largely undocumented feeding areas as far south as the Antarctic Peninsula (Carretta et al., 2017; Muto et al., 2017). On October 11, 2016, NMFS's Final Rule was published (81 Federal Register [FR] 62259) to discard the current stock designations and divide the species into 14 DPSs worldwide, four of which occur in the North Pacific: (1) Western North Pacific, (2) Hawaii, (3) Mexico, and (4) Central America.

Humpback whales of the Mexico DPS are listed as threatened and those from the Central America DPS are listed as endangered under the ESA (National Marine Fisheries Service, 2016). Together these two DPSs are considered the California, Oregon, and Washington stock of humpback whales and are listed as depleted under the MMPA (Carretta et al., 2017; National Marine Fisheries Service, 2016). The California, Oregon, Washington stock of humpback whales are present in the Southern California portion of the HSTT Study Area as they migrate northward from their winter breeding grounds in Mexico and

Central America and then again when migrating southward in their return from feeding areas along the U.S west coast, British Colombia, and Alaska.

NMFS has designated humpback whales present in Hawaii in the winter and spring as part of the Central North Pacific stock given they migrate in the summer and early fall to feed in northern British Columbia and Alaska, the Gulf of Alaska, the Bering Sea, and Aleutian Islands (Muto et al., 2017). Pursuant to the ESA, NMFS has designated the population of humpback whales that breed in Hawaii as the Hawaii DPS (National Marine Fisheries Service, 2016). These humpback whales are not listed as either threatened or endangered under the ESA given that the population is believed to have fully recovered and has an abundance greater than the estimated pre-whaling population (Barlow et al., 2011; Bettridge et al., 2015; Muto et al., 2017; National Marine Fisheries Service, 2016; Wade et al., 2016).

HRC. Hawaii is the best-known migratory destination for North Pacific humpback whales to mate and give birth (Craig & Herman, 1997; Dawbin, 1966). Data 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 (2006). 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 (Muto et al., 2017). 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, and was used for the remainder of the HRC acoustic modeling study area. These estimates were also used to conservatively estimate density for fall. Outside the boundaries of the acoustic modeling study areas and the Hawaiian Islands EEZ, RES data from Kaschner et al. (2006) are shown for the remainder of HRC. In the summer, humpback whales are absent from tropical waters (Barlow, 2006; Craig & Herman, 1997); therefore, a density of zero is used for this season.

SOCAL. The Phase II NMSDD included a CCE habitat-based density model for humpback whales based on systematic survey data collected from 1991 to 2008 (Becker et al., 2012b). The model provided spatially-explicit density estimates off the U.S. west coast for summer and fall. More recently, Becker et al. (2016) updated the CCE habitat-based models of cetacean densities using additional survey data collected primarily off Southern California in 2009. In addition, improved modeling methods were used that allowed species-specific and segment-specific estimates of both effective strip width and trackline detection probability to be incorporated into the models based on the recorded viewing conditions on that segment using coefficients estimated by Barlow et al. (2011) for effective strip width and Barlow (2015) for trackline detection probability. Density predictions from the updated models are grid-based at a pixel resolution of 10 km x 10 km, providing finer spatial resolution and eliminating interpolation artifacts sometimes present in the previous CCE models (Becker et al., 2016). Density estimates from the updated humpback whale model were applied to the portion of the Navy’s SOCAL acoustic modeling study area that overlaps the SWFSC’s CCE study area, as well as the eastern portion of the transit corridor for summer and fall.

Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint and were also corrected for new estimates of trackline detection probability derived by Barlow (2015). The resulting humpback whale uniform density estimate of 0.00020 animals/km^2 (CV = 0.40) was used for summer and fall. Given the overlap of the Ferguson and Barlow strata used to recalculate densities (refer to Figure 3-7), this value is also applicable to the remainder of the SOCAL Range Complex for summer and fall.

Becker et al. (2017) provide the first winter/spring habitat-based density models for humpback whales in Southern California waters. Density predictions from the models are grid-based at a pixel resolution of 10 km x 10 km, and were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the Becker et al. study area. Campbell et al. (2015) provide uniform density estimates for humpback whales based on line-transect data collected in winter and spring, and their seasonally stratified line-transect estimates of 0.00107 animals/km^2 (CV = 0.41) for winter and 0.00192 animals/km^2 (CV = 0.51) for spring were applied to the eastern portion of the transit corridor. In the absence of winter/spring density data off Baja, the Campbell et al. (2015) uniform density estimates were also applied to the Baja portion of the Navy's SOCAL acoustic modeling study area for these seasons. Outside the boundaries of the acoustic modeling study areas, RES data from Kaschner et al. (2006) are shown for the remainder of the SOCAL Range Complex for winter and spring.

Table 5-7: Summary of Density Values for Humpback Whale in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC inner EEZ	0.0211	0	0.0211	0.0211
HRC outer EEZ	0.0025	0	0.0025	0.0025
W. Transit Corridor	0.0025	0	0.0025	0.0025
E. Transit Corridor	0.00192	S	S	0.00107
SOCAL	S	S	S	S
Baja	0.00192	0.00020	0.00020	0.00107

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.

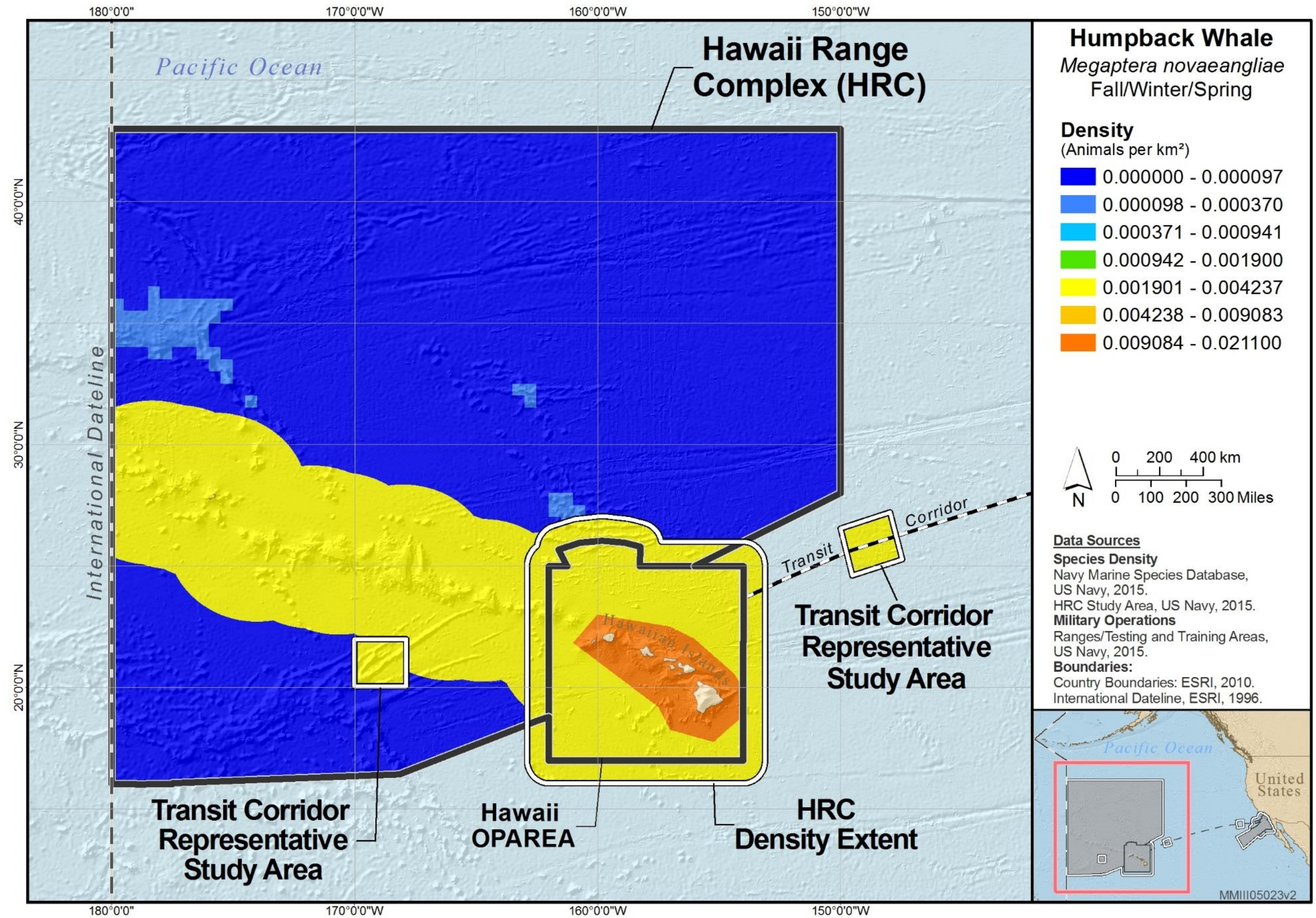


Figure 5-17: Fall/Winter/Spring Distribution of Humpback Whale in HRC and the Western Portion of the Transit Corridor

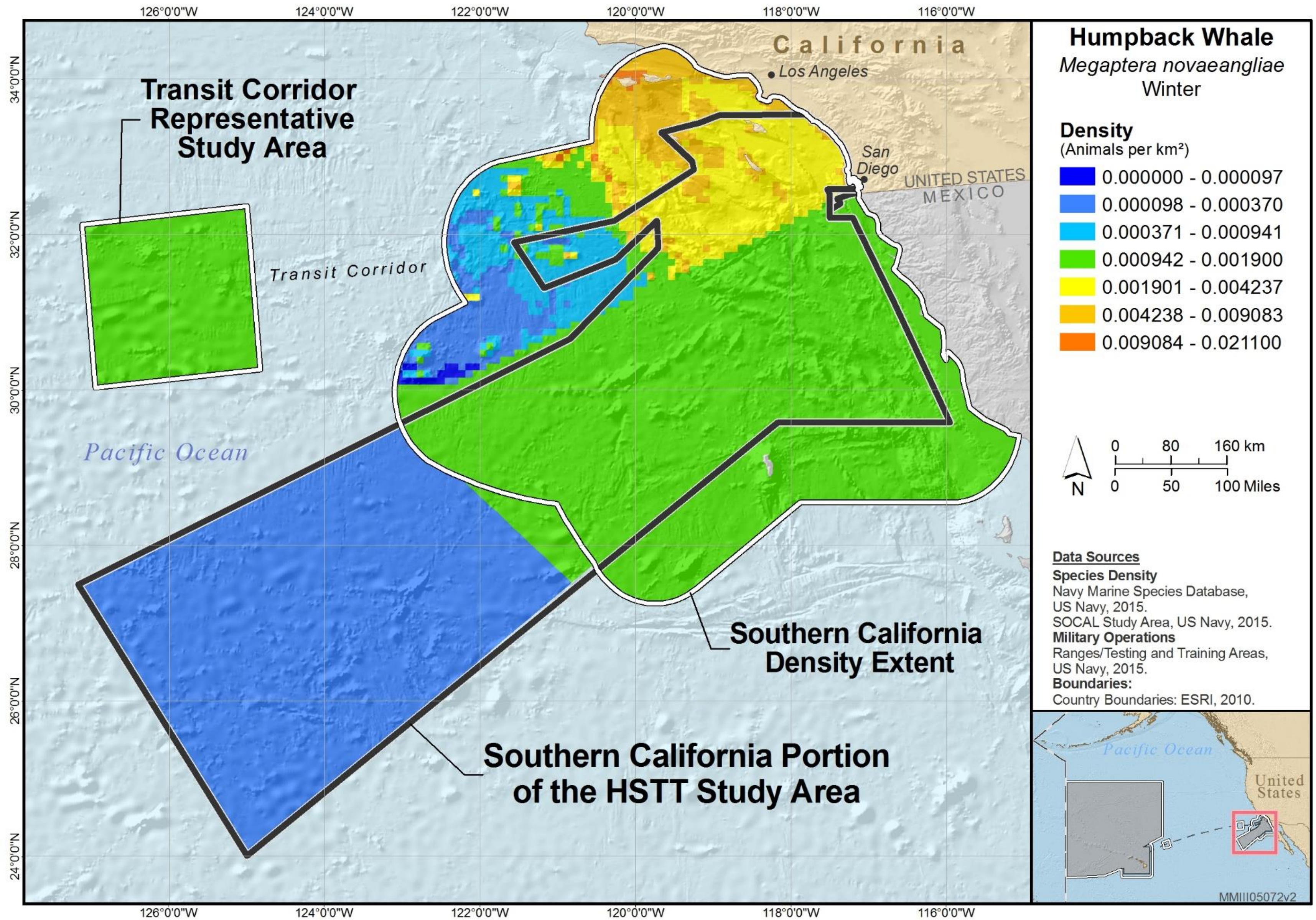


Figure 5-18: Winter Distribution of Humpback Whale in SOCAL and the Eastern Portion of the Transit Corridor

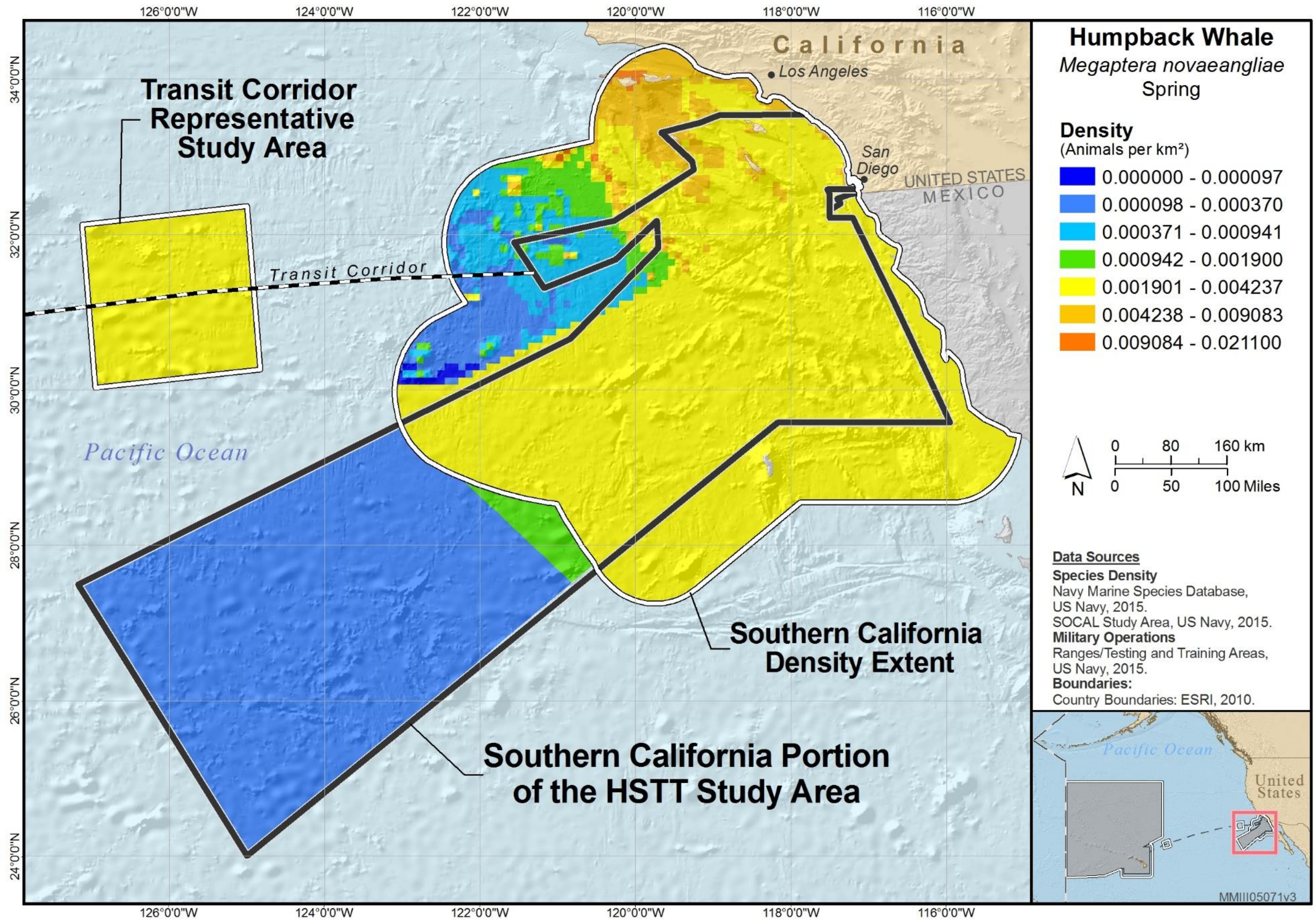


Figure 5-19: Spring Distribution of Humpback Whale in SOCAL and the Eastern Portion of the Transit Corridor

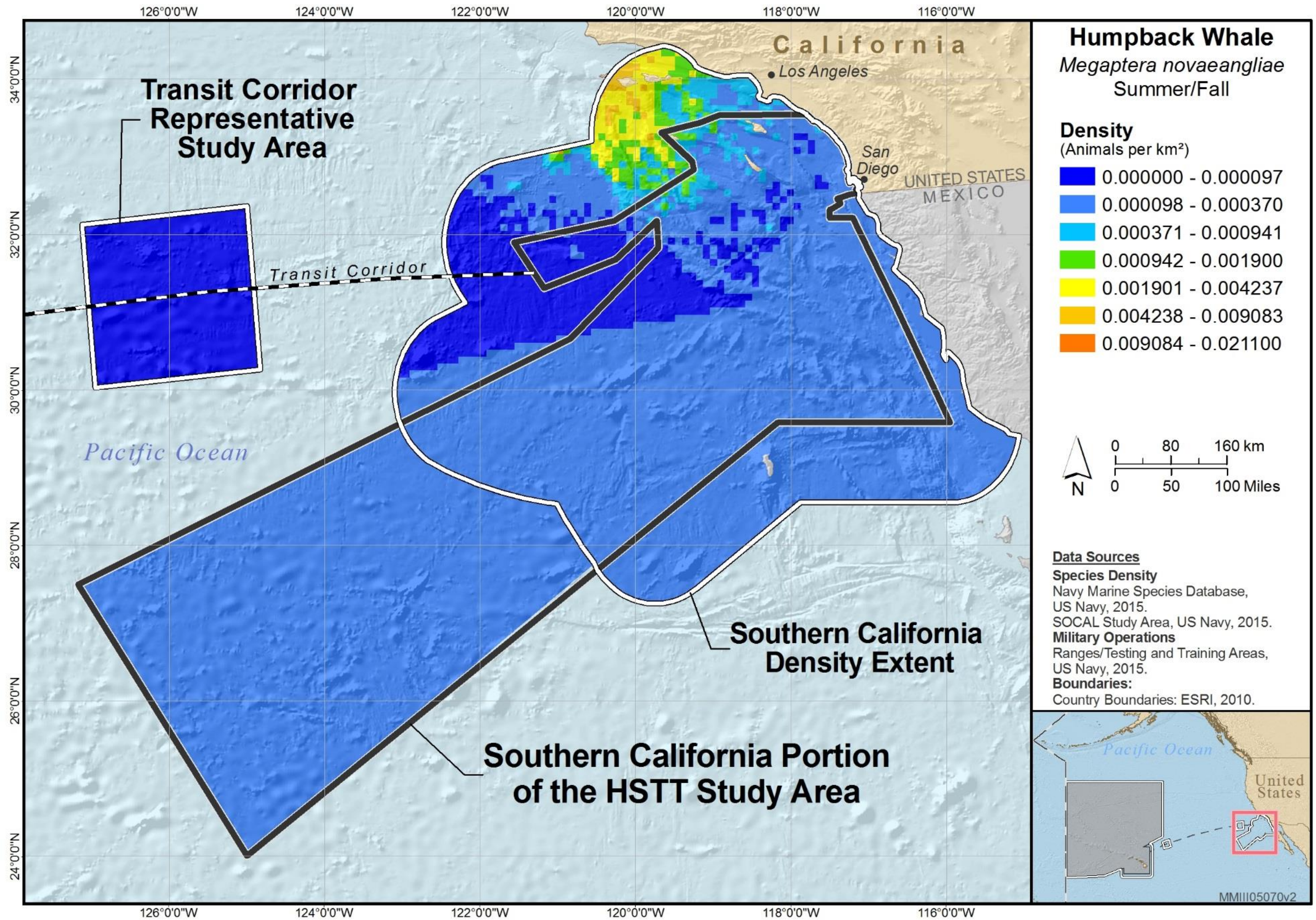


Figure 5-20: Summer/Fall Distribution of Humpback Whale in SOCAL and the Eastern Portion of the Transit Corridor

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., 2017). 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 for 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 & Forney, 2007; Ferguson & 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. The IWC does not recognize stock structure for *Kogia* species.

Since density values for SOCAL are provided for *Kogia* as a genus (Barlow & Forney, 2007; Ferguson & 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 numbers, but more diffusely distributed (less dense population) than other toothed whales (Barlow, 2006). There were no pygmy sperm whale sightings during the 2010 NMFS systematic survey of the Hawaiian Islands EEZ, but there were enough sightings during the 2002 survey to provide a density estimate of 0.00291 animals/km^2 (CV = 1.12) (Barlow, 2006). This value is also applied to the western portion of the transit corridor. Available data are insufficient to identify any seasonal patterns in the distribution of pygmy sperm whales, so the density estimate is considered to be a year-round estimate. Outside the boundaries of the acoustic modeling study areas are density data used in the Phase II analyses, including the Barlow (2006) uniform density values, as well as Kaschner et al. (2006) predicted RES values in the northern portion of HRC. The RES global model (Kaschner et al., 2006) predicts a much lower density of pygmy sperm whales around Hawaii than density calculated from actual observations.

SOCAL. The majority of field sightings of *Kogia* in SOCAL are likely to have been pygmy sperm whales (Carretta et al., 2017). As previously indicated, *Kogia* species are treated as a genus in SOCAL by scientists who have published species density estimates. In the summer and fall, Barlow (2016) provides a stratified uniform density estimate for *Kogia* of 0.00159 animals/km^2 (CV = 1.21) for waters off Southern California. This provides an update to the density estimate used previously in the Navy's Phase II analyses as the updated Barlow (2016) estimate is based on a multiple-covariate line-transect approach using survey data collected between 1991 and 2014 and incorporates new estimates of trackline detection probability derived by Barlow (2015). Available data are insufficient to identify any seasonal patterns in the distribution of pygmy sperm whales, so this estimate is also applied to SOCAL in winter/spring. Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint and resulted in a *Kogia* density estimate of 0.00366 (CV = 1.00). In the Baja area, the same value is used for all seasons. Given the overlap of the Ferguson and Barlow strata used to recalculate densities (refer to Figure 3-7), this value is also applicable to the remainder of the SOCAL Range Complex.

Table 6-1: Summary of Density Values for Pygmy Sperm Whale in the Hawaii-Southern California Training and Testing Study Area

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	0.00159	0.00159	0.00159	0.00159
SOCAL	0.00159	0.00159	0.00159	0.00159
Baja	0.00366	0.00366	0.00366	0.00366

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

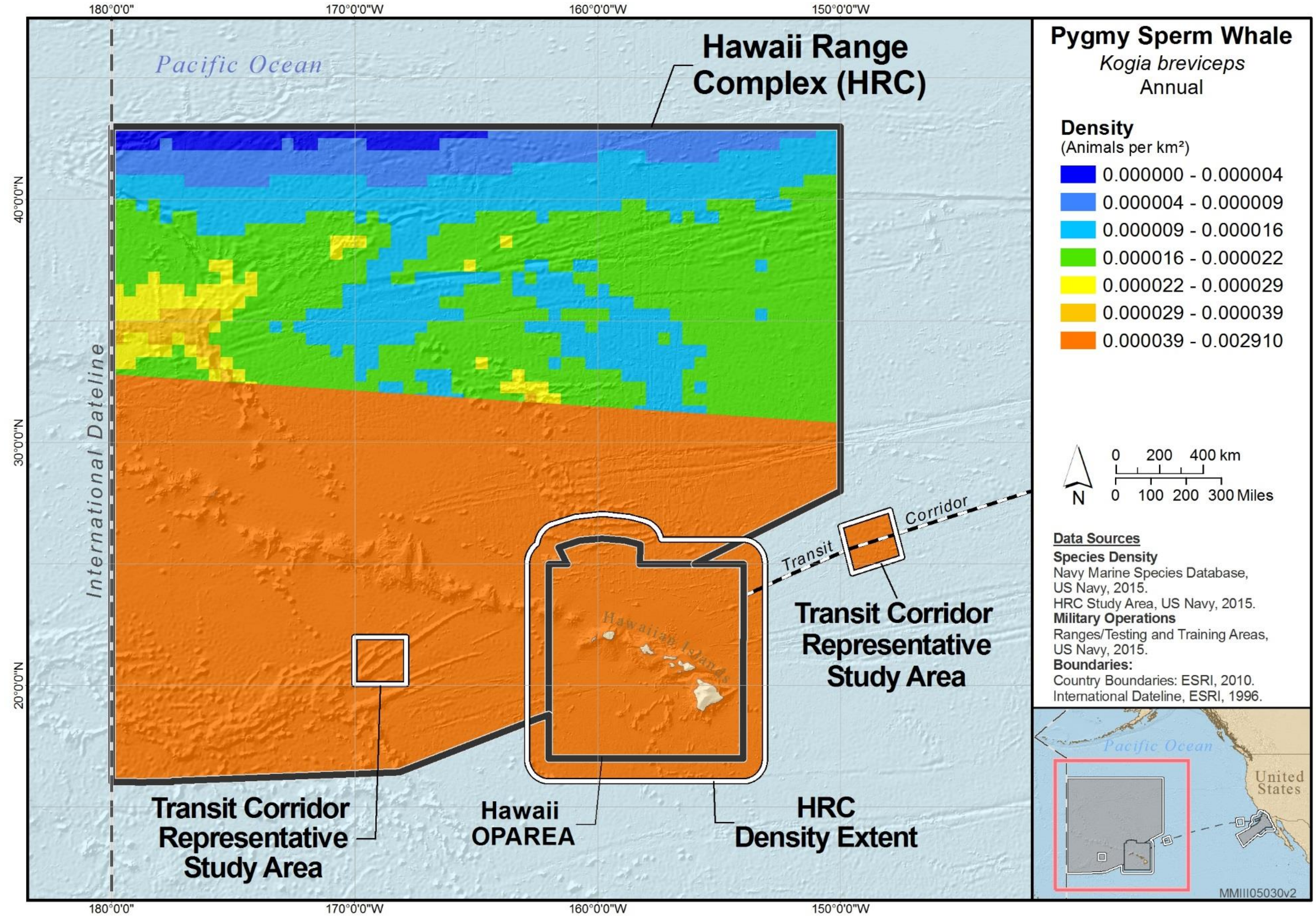


Figure 6-1: Annual Distribution of Pygmy Sperm Whale in HRC and the Western Portion of the Transit Corridor

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., 2017). 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 separate density estimates for each species (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 & Forney, 2007; Ferguson & 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. The IWC does not provide stock structure of *Kogia* species.

Since density values for SOCAL are provided for *Kogia* as a genus (Barlow & Forney, 2007; Ferguson & 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 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 HRC (Barlow, 2006). There was only one off-effort dwarf sperm whale sighting during the 2010 NMFS systematic survey of the Hawaiian Islands EEZ, but there were enough sightings during the 2002 survey to provide a density estimate of 0.00714 animals/km^2 (CV = 0.74) (Barlow, 2006). This value is also applied to the western portion of the transit corridor. Available data are insufficient to identify any seasonal patterns in the distribution of dwarf sperm whales, so this is considered a year-round estimate. Outside the boundaries of the acoustic modeling study areas are density data used in the Phase II analyses, including the Barlow (2006) uniform, as well as Kaschner et al. (2006) predicted RES values in the northern portion of HRC. The RES global model (Kaschner et al., 2006) predicts a much lower density of pygmy sperm whales around Hawaii than density calculated from actual observations.

SOCAL. This species is not often seen off the west coast of the United States (Barlow & Forney, 2007; Willis & Baird, 1998), but may be present in fair numbers. As previously indicated, *Kogia* species are treated as a genus in SOCAL by scientists who have published species density estimates. In the summer and fall, Barlow (2016) provides a stratified uniform density estimate for *Kogia* of 0.00159 animals/km^2 (CV = 1.21) for waters off Southern California. This provides an update to the density estimate used previously in the Navy's Phase II analyses as the updated Barlow (2016) estimate is based on a multiple-covariate line-transect approach using survey data collected between 1991 and 2014 and incorporates new estimates of trackline detection probability derived by Barlow (2015). Available data are insufficient to identify any seasonal patterns in the distribution of dwarf sperm whales, so this estimate is also applied to SOCAL in winter/spring. Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint and resulted in a *Kogia* density estimate of 0.00366 (CV = 1.00). In the Baja area, the same value is used for all seasons. Given the overlap of the Ferguson and Barlow strata used to recalculate densities (refer to Figure 3-7), this value is also applicable to the remainder of the SOCAL Range Complex.

Table 6-2: Summary of Density Values for Dwarf Sperm Whale in the Hawaii-Southern California Training and Testing Study Area

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	0.00159	0.00159	0.00159	0.00159
SOCAL	0.00159	0.00159	0.00159	0.00159
Baja	0.00366	0.00366	0.00366	0.00366

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

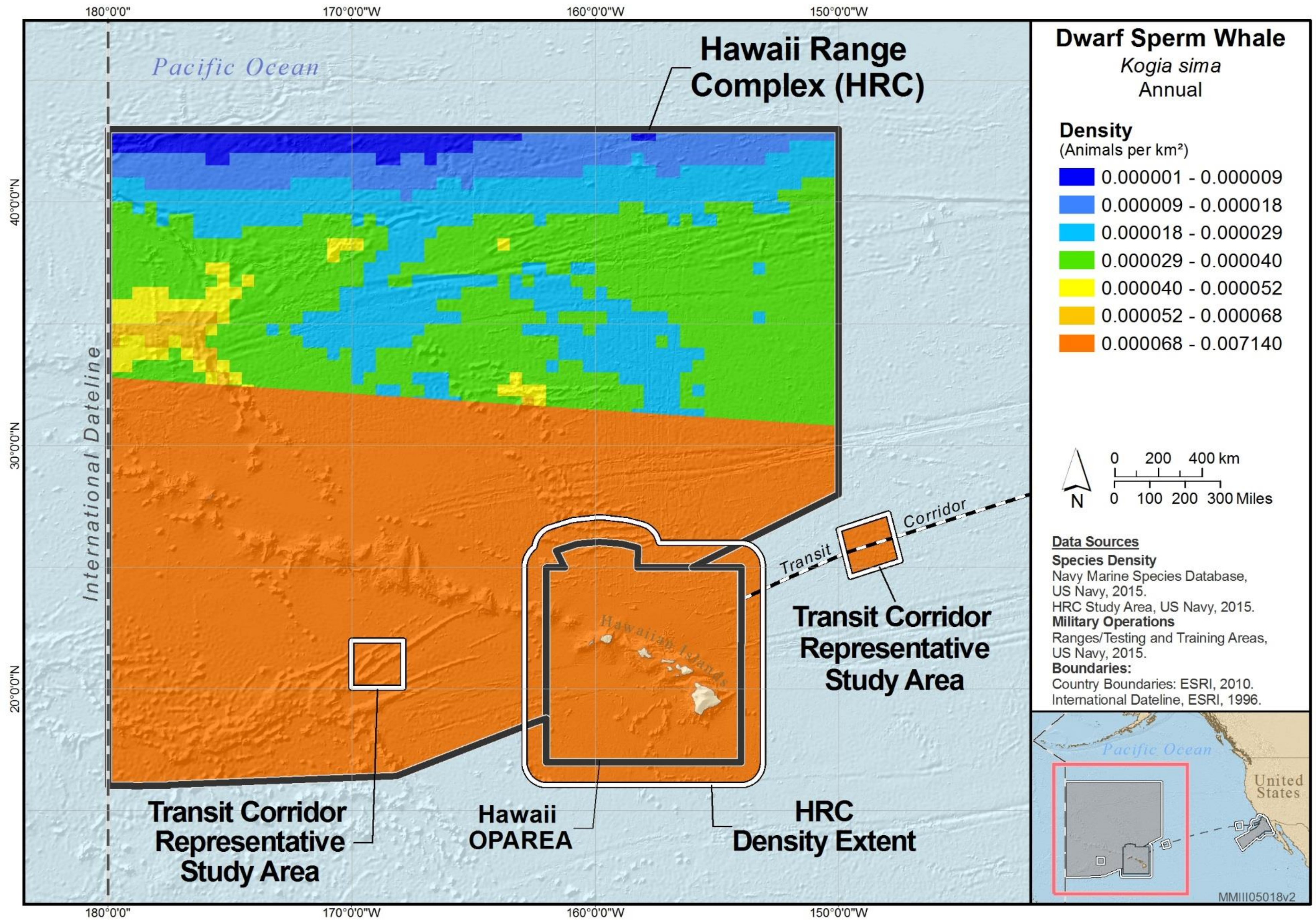


Figure 6-2: Annual Distribution of Dwarf Sperm Whale in HRC and the Western Portion of the Transit Corridor

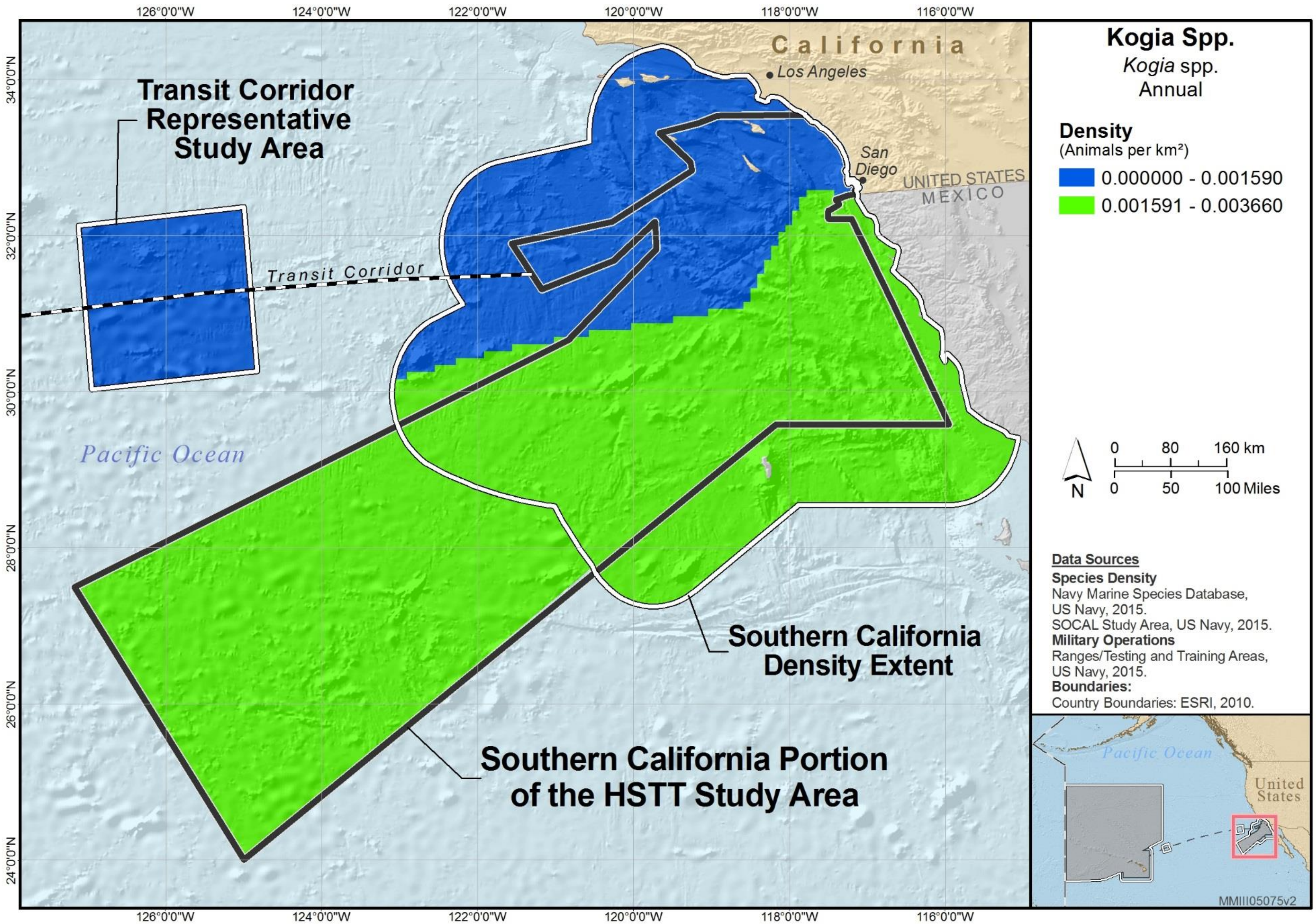


Figure 6-3: Annual Distribution of *Kogia* (Pygmy Sperm Whale and Dwarf Sperm Whale) in SOCAL and the Eastern Portion of the Transit Corridor

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 & 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., 2017). 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., 2017) and are based on a phylogeographic approach to defining stock structure (Dizon et al., 1992). Since the HRC and SOCAL range complexes match the Hawaii stock 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 Hawaii 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., 2017).

HRC. The Phase II NMSDD included the first CENPAC habitat-based density model for sperm whales based on systematic survey data collected from 1997 to 2006 (Becker et al., 2012c). More recently, Forney et al. (2015) updated the CENPAC habitat-based models of cetacean densities using additional survey data collected within the Hawaiian Islands EEZ in 2010 and in waters surrounding Palmyra Atoll/Kingman Reef in 2011 and 2012. In addition, improved modeling methods were used that allowed model predictions to be applied directly on a 25 km × 25 km spatial grid. These models cover the entire HRC and provide representative density values for the two western transit corridor study areas. The updated CENPAC sperm whale spatial model was applied to all seasons for HRC and the western portion of the transit corridor.

SOCAL. The Phase II NMSDD included a CCE habitat-based density model for sperm whales based on systematic survey data collected from 1991 to 2008 (Becker et al., 2012b). The model provided spatially-explicit density estimates off the U.S. west coast for summer and fall. More recently, the CCE habitat-based density model for sperm whale was updated using methods described in Becker et al. (2016). Improved modeling methods were used that allowed species-specific and segment-specific estimates of both effective strip width and trackline detection probability to be incorporated into the models based on the recorded viewing conditions on that segment using coefficients estimated by Barlow et al. (2011) for effective strip width and Barlow (2015) for trackline detection probability. Density predictions from the updated models are grid-based at a pixel resolution of 10 km x 10 km, providing finer spatial resolution and eliminating interpolation artifacts sometimes present in the previous CCE models (Becker et al., 2016). Density estimates from the updated sperm whale model were applied to the portion of the Navy’s SOCAL acoustic modeling study area that overlaps the SWFSC’s CCE study area, as well as the eastern portion of the transit corridor for summer and fall.

Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint and were also corrected for new estimates of trackline detection probability derived by Barlow (2015). The resulting sperm whale uniform density estimate of 0.00036 animals/km^2 (CV = 0.39) was used for all seasons. Given the overlap of the Ferguson and Barlow strata used to recalculate densities (refer to Figure 3-7), this value is also applicable to the remainder of the SOCAL Range Complex.

There are currently no updated sperm whale density estimates available for the winter and spring seasons in Southern California waters, so the Phase II NMSDD uniform density value of 0.00338 animals/km^2 (CV = 0.99) was used for the Navy's SOCAL acoustic modeling study area, as well as the eastern portion of the transit corridor for winter and spring. This value is a uniform density estimate derived by Forney et al. (1995) as reported in Barlow et al. (2009).

Table 6-3: Summary of Density Values for Sperm Whale in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	0.00338	S	S	0.00338
SOCAL	0.00338	S	S	0.00338
Baja	0.00036	0.00036	0.00036	0.00036

The units for numerical values are animals/km^2. S = spatial model with various density values throughout the range.

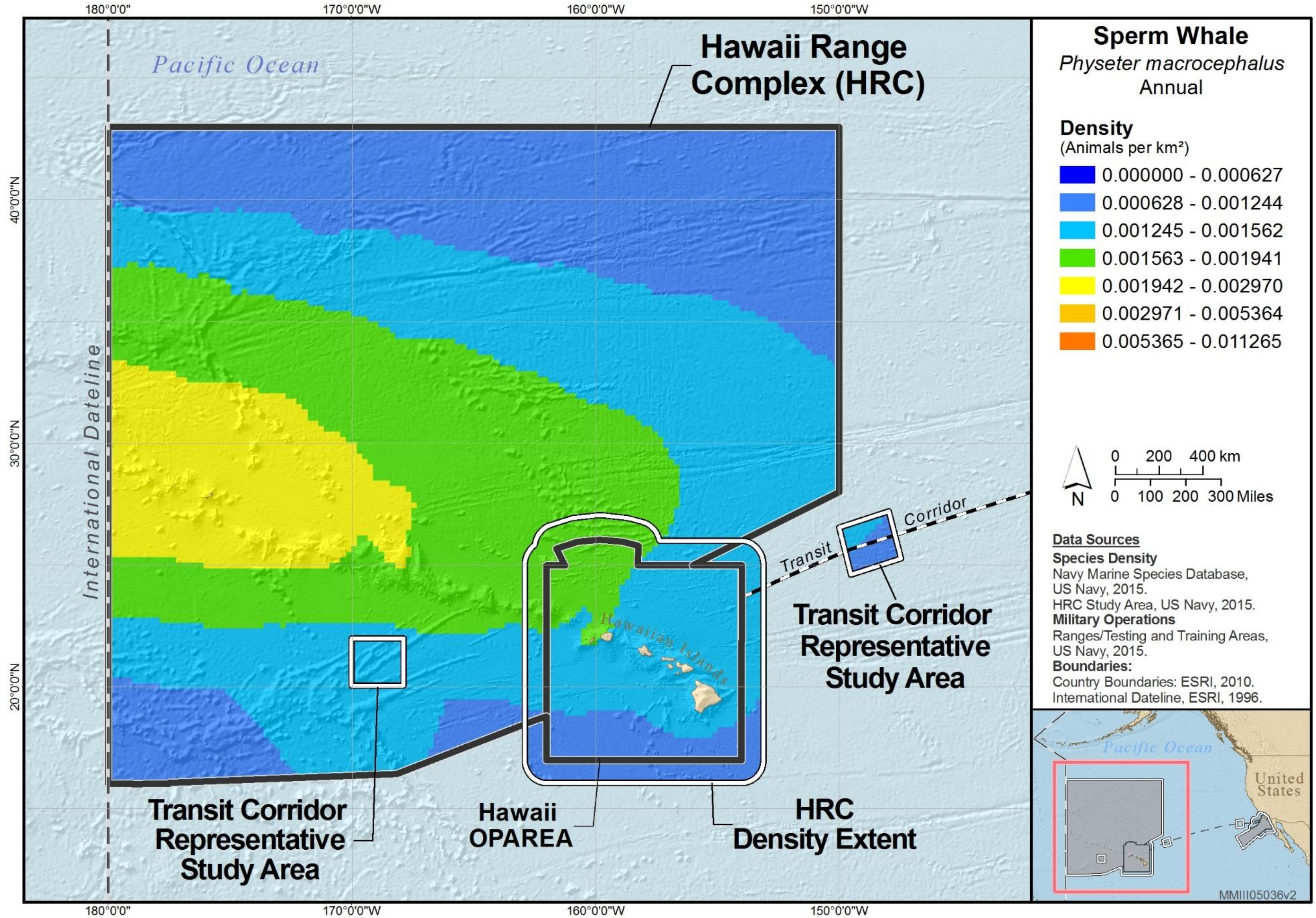


Figure 6-4: Annual Distribution of Sperm Whale in HRC and the Western Portion of the Transit Corridor

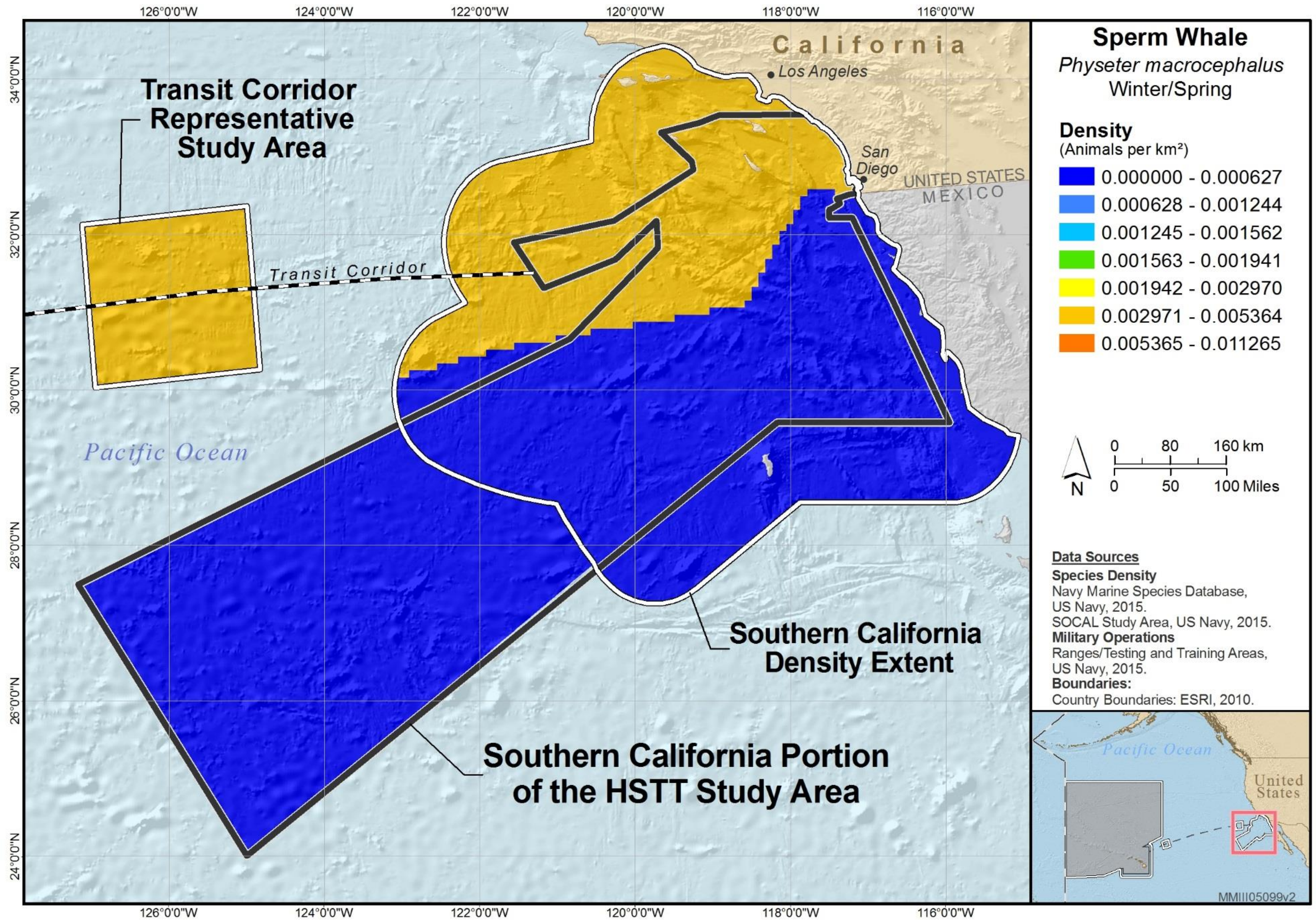


Figure 6-5: Winter/Spring Distribution of Sperm Whale in SOCAL and the Eastern Portion of the Transit Corridor

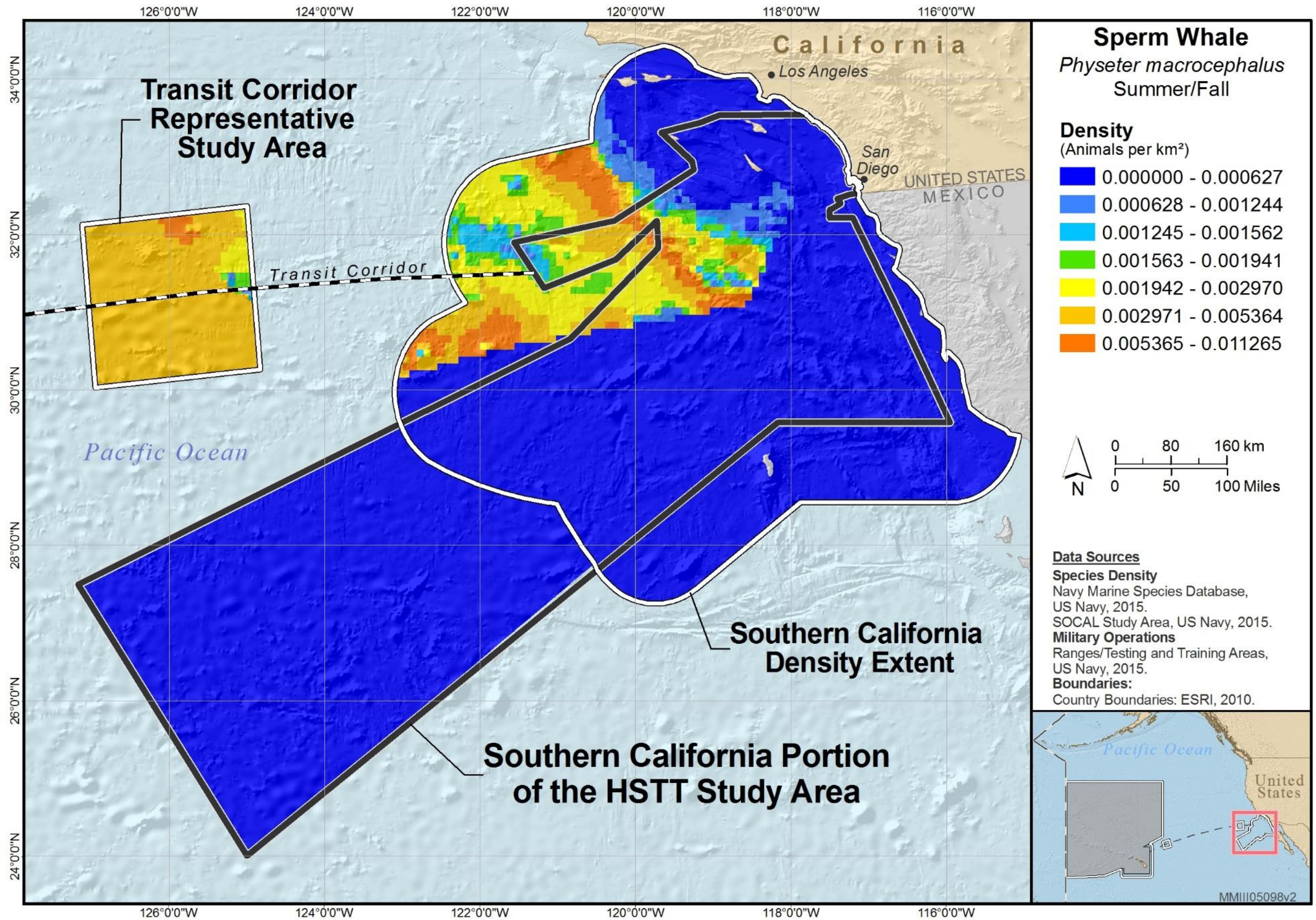


Figure 6-6: Summer/Fall Distribution of Sperm Whale in SOCAL and the Eastern Portion of the Transit Corridor

7 DELPHINIDS (DOLPHINS)

7.1 DELPHINID SPECIES PROFILES

This family includes a wide variety of species found in the Hawaii-Southern California Training and Testing Study Area, 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[1]

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 (Jefferson et al., 2015; Muto et al., 2017); 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 (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). The long-beaked common dolphin is known to exhibit seasonal shifts in abundance (mainly north/south) throughout its range off California and Baja, Mexico (Carretta et al., 2011; Heyning & Perrin, 1994). NMFS recognizes a single stock (a California stock) of long-beaked common dolphins (Carretta et al., 2011). 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., 2011).

HRC. This species is not expected to occur in HRC or the transit corridor (Hamilton et al., 2009).

SOCAL. A habitat-based density model was not available for Phase II of the NMSDD, so stratified uniform density estimates were used for the SWFSC CCE study area (Barlow & Forney, 2007) and for waters off Baja (Ferguson & Barlow, 2003). More recently, Becker et al. (2016) was able to develop a CCE habitat-based density model for long-beaked common dolphin based on survey data collected off the U.S. west coast from 1991 to 2008, and off Southern California in 2009. The model provides spatially-explicit density estimates off the U.S. west coast for summer and fall. The model was built using improved methods that allowed species-specific and segment-specific estimates of both effective strip width and trackline detection probability to be incorporated into the models based on the recorded viewing conditions on that segment using coefficients estimated by Barlow et al. (2011) for effective

[1] Recently, the Society for Marine Mammalogy's Committee on Taxonomy has lumped all common dolphins back into the single species, *D. delphis*. Long-and short-beaked common dolphins are still recognized as separate subspecies, *D. delphis bairdii* and *D. delphis delphis*, respectively.

strip width and Barlow (2015) for trackline detection probability. Density predictions from the updated models are grid-based at a pixel resolution of 10 km x 10 km (Becker et al., 2016). Density estimates from the long-beaked common dolphin model were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for all seasons.

Gerrodette and Eguchi (2011) used line-transect data collected off Baja, California between 1986 and 2006 to develop a habitat model for long-beaked common dolphin. They used a hierarchical Bayesian line-transect habitat model to estimate density as a function of depth, and found that along the west coast of Baja, California, long-beaked common dolphins occur primarily inshore of the 250 meter isobath. The median of the posterior distribution of density for depths from 1 to 3,000 meters (m) was used to provide spatially-explicit density estimates for long-beaked common dolphin in waters off Baja for all seasons.

Table 7-1: Summary of Density Values for Long-Beaked Common Dolphin in the Hawaii-Southern California Training and Testing 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	S	S
Baja	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.

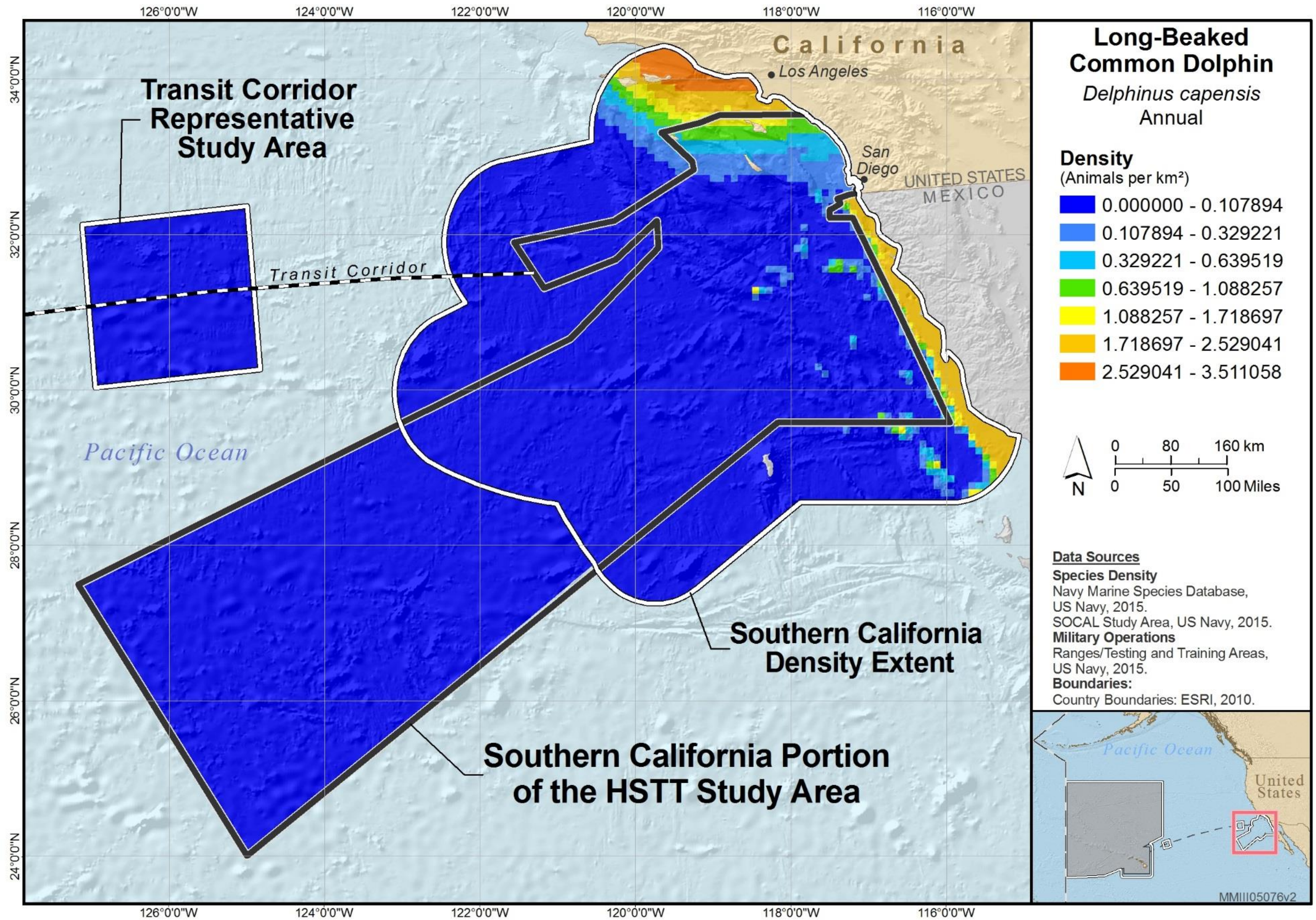


Figure 7-1: Annual Distribution of Long-Beaked Common Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

7.1.2 *DELPHINUS DELPHIS*, SHORT-BEAKED COMMON DOLPHIN[2]

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., 2015). Short-beaked common dolphins can occur in large groups, sometimes numbering more than 1,000 individuals (Forney & 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., 2015). NMFS recognizes a California/Oregon/Washington stock of short-beaked common dolphins in the U.S. EEZ (Carretta et al., 2017). In SOCAL, this stock is the one that is observed. In the transit corridor, they may not be members of a stock managed by NMFS. Like the long-beaked common dolphin, 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., 2017). Density values for the HSTT Study Area are presented for the species as a whole. Historically, common dolphins, short-beaked in particular, have been one of the species most impacted by fisheries bycatch (Julian & Beeson, 1998; Moore et al., 2009; Read et al., 1988).

HRC. This species is not expected to occur within the HRC study area or western portion of the transit corridor (Hamilton et al., 2009).

SOCAL. The Phase II NMSDD included a CCE habitat-based density model for short-beaked common dolphin based on systematic survey data collected from 1991 to 2008 (Becker et al., 2012b). The model provided spatially-explicit density estimates off the U.S. west coast for summer and fall. More recently, Becker et al. (2016) updated the CCE habitat-based models of cetacean densities using additional survey data collected primarily off Southern California in 2009. In addition, improved modeling methods were used that allowed species-specific and segment-specific estimates of both effective strip width and trackline detection probability to be incorporated into the models based on the recorded viewing conditions on that segment using coefficients estimated by Barlow et al. (2011) for effective strip width and Barlow (2015) for trackline detection probability. Density predictions from the updated models are grid-based at a pixel resolution of 10 km x 10 km, providing finer spatial resolution and eliminating interpolation artifacts sometimes present in the previous CCE models (Becker et al., 2016). Density estimates from the updated short-beaked common dolphin model were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for summer and fall.

Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the

[2] Recently, the Society for Marine Mammalogy's Committee on Taxonomy has lumped all common dolphins back into the single species, *D. delphis*. Long-and short-beaked common dolphins are still recognized as separate subspecies, *D. delphis bairdii* and *D. delphis delphis*, respectively.

acoustic modeling footprint and were also corrected for new estimates of trackline detection probability derived by Barlow (2015). The resulting short-beaked common dolphin uniform density estimate of 0.45049 animals/km^2 (CV = 0.25) was used for all seasons. Given the overlap of the Ferguson and Barlow strata used to recalculate densities (refer to Figure 3-7), this value is also applicable to the remainder of the SOCAL Range Complex.

Becker et al. (2017) provide the first winter/spring habitat-based density models for short-beaked common dolphins in southern California waters. Density predictions from the models are grid-based at a pixel resolution of 10 km x 10 km, and were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the Becker et al. study area. Campbell et al. (2015) provide uniform density estimates for short-beaked common dolphins based on line-transect data collected in winter and spring, and their seasonally stratified line-transect estimates of 0.94740 animals/km^2 (CV = 0.45) for winter and 0.15570 animals/km^2 (CV = 0.32) for spring were applied to the eastern portion of the transit corridor.

Table 7-2: Summary of Density Values for Short-Beaked Common Dolphin in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0.15570	S	S	0.94740
SOCAL	S	S	S	S
Baja	0.45049	0.45049	0.45049	0.45049

The units for numerical values are animals/km^2. S = spatial model with various density values throughout the range.

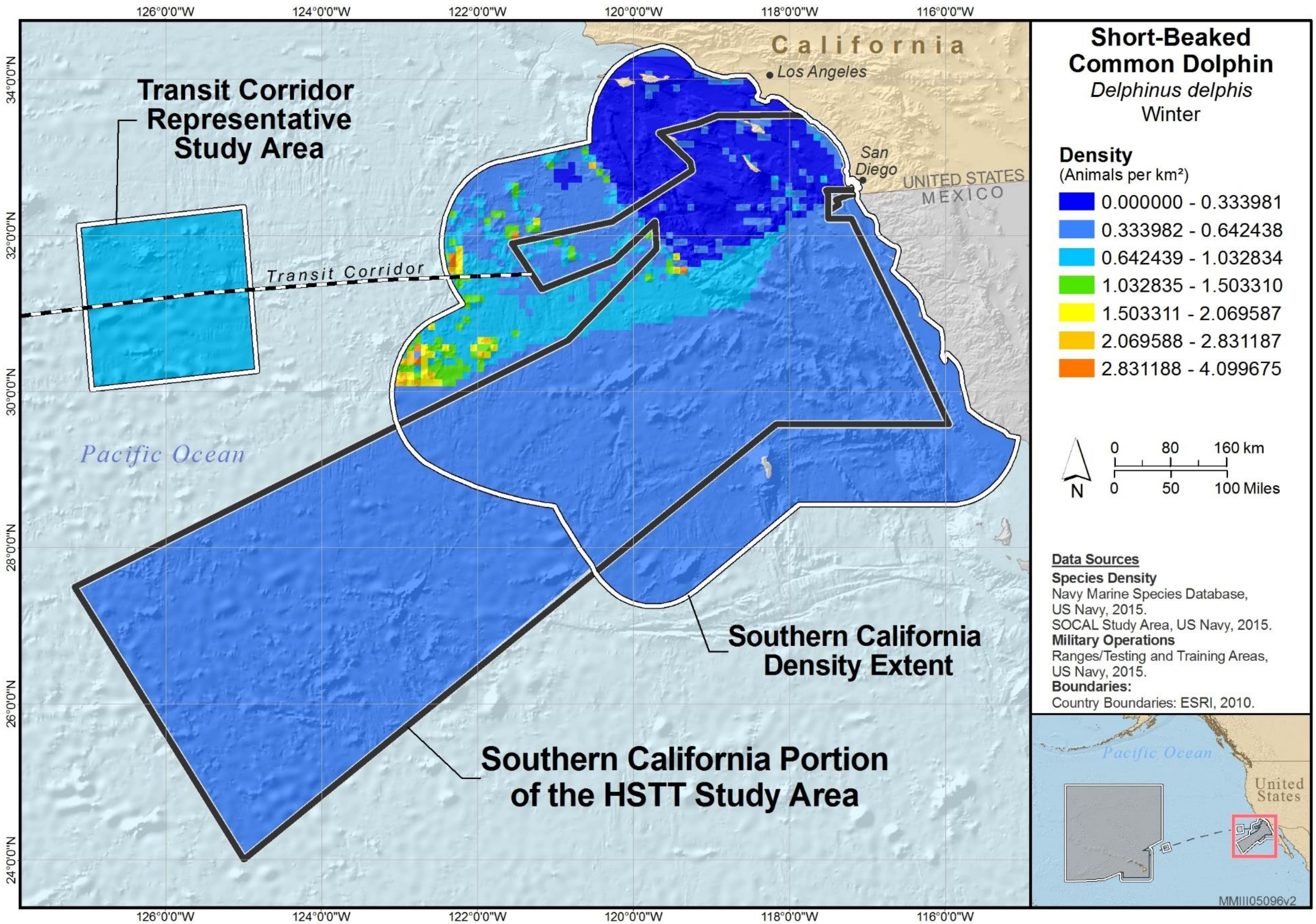


Figure 7-2: Winter Distribution of Short-Beaked Common Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

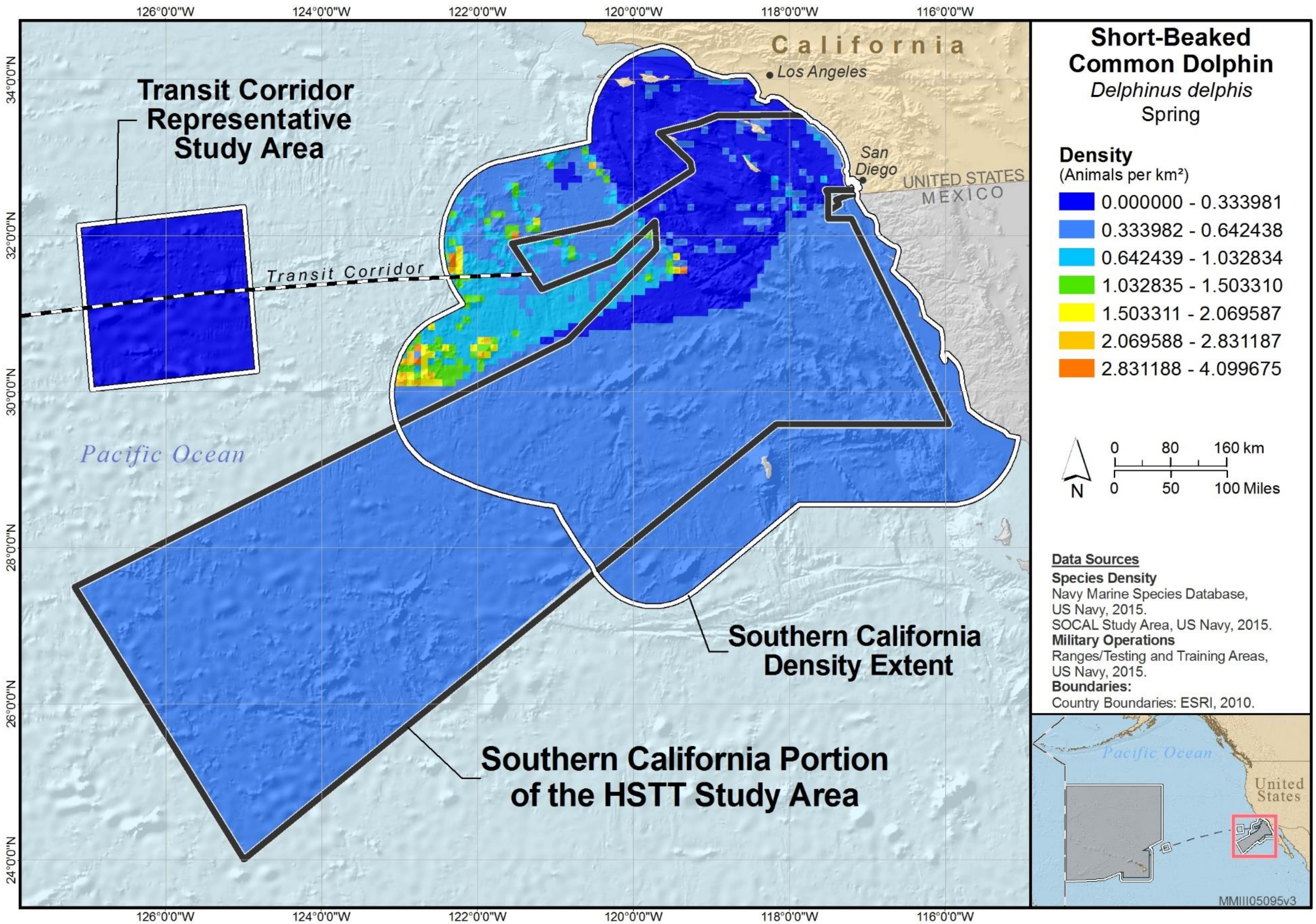


Figure 7-3: Spring Distribution of Short-Beaked Common Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

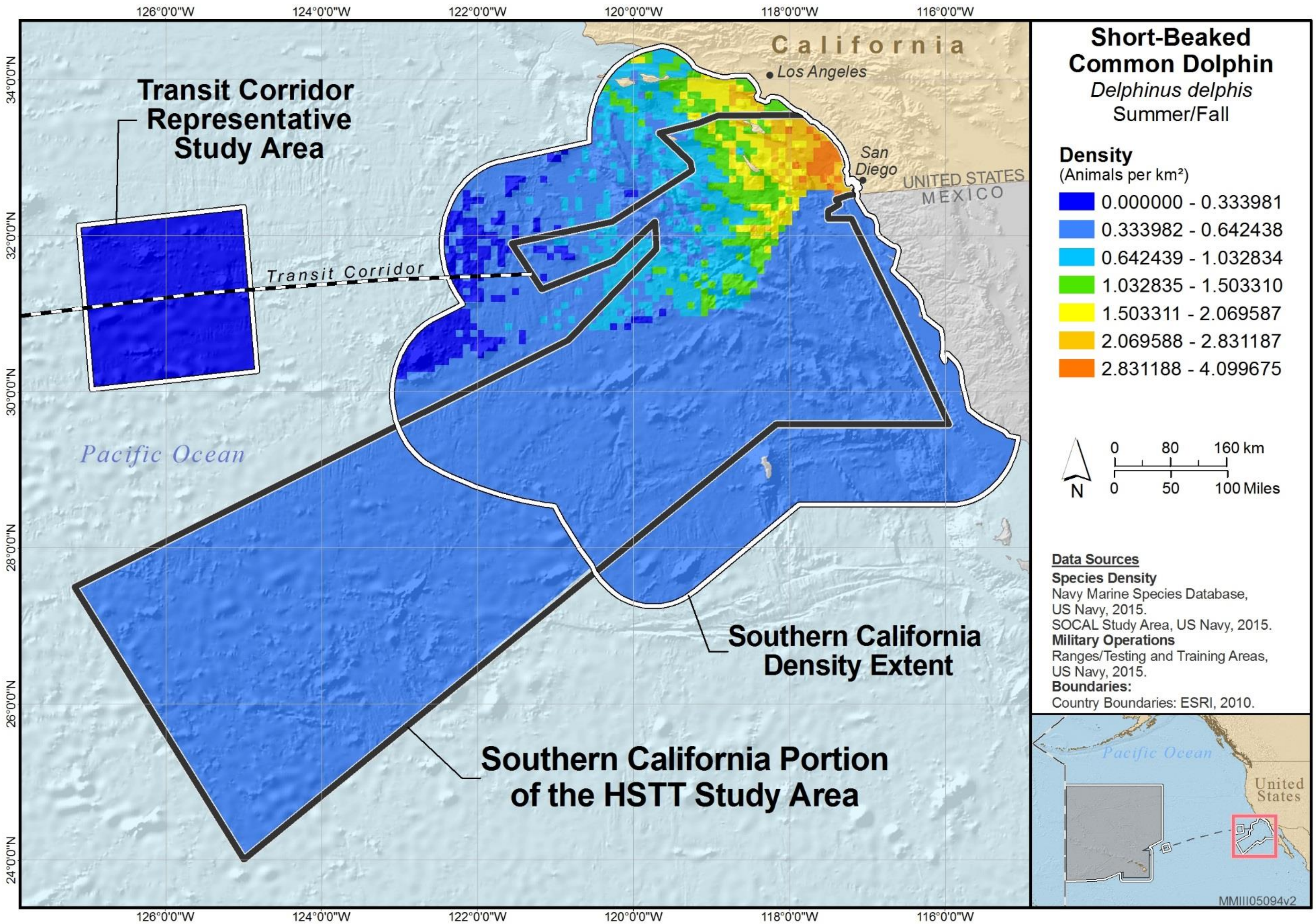


Figure 7-4: Summer/Fall Distribution of Short-Beaked Common Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

7.1.3 *FERESA ATTENUATA*, PYGMY KILLER WHALE

Pygmy killer whales are part of a group of species generally referred to by fishers 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., 2015). 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., 2015; Leatherwood et al., 1988). The pygmy killer whale 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., 2015; 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, 2011; 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., 2017). Density values for the HSTT Study Area are presented for the species as a whole.

HRC. Bradford et al. (2017) report a uniform density value for pygmy killer whales of 0.0044 animals/km^2 (CV = 0.53) that is applicable to the HRC study area and western portion of the transit corridor. This provides an update to the density estimate used previously in the Navy’s Phase II analyses as it is based on multiple-covariate line-transect analyses of survey data collected in the Hawaiian Islands EEZ in 2010 and incorporates new estimates of trackline detection probability derived by Barlow (2015). Since the species is expected to have regular presence in Hawaii (McSweeney et al., 2009), this is considered a year-round estimate. Outside the boundaries of the acoustic modeling study areas are density data used in the Phase II analyses, including the Barlow (2006) uniform, as well as Kaschner et al. (2006) predicted RES values in the northern portion of HRC.

SOCAL. This tropical species is not typically observed in SOCAL, but one group of 27 animals was seen off Southern California during the SWFSC 2014 survey, most likely due to the unusually warm oceanographic conditions during the survey (Barlow, 2016). The on-effort sighting allowed for the derivation of the first pygmy killer whale density estimate for Southern California waters based on a multiple-covariate line-transect approach that incorporated new estimates of trackline detection probability (Barlow, 2015). The uniform density estimate of 0.00072 animals/km^2 (CV = 1.11) was incorporated into the NMSDD Phase III for summer and fall, and represents a conservative value given that this species is not expected to regularly occur in the area. Density estimates from the Kaschner et al. (2006) RES model are shown for the remainder of the SOCAL Range Complex.

Table 7-3: Summary of Density Values for Pygmy Killer Whale in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.0044	0.0044	0.0044	0.0044
W. Transit Corridor	0.0044	0.0044	0.0044	0.0044
E. Transit Corridor	0	0.00072	0.00072	0
SOCAL	0	0.00072	0.00072	0
Baja	0	0.00072	0.00072	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.

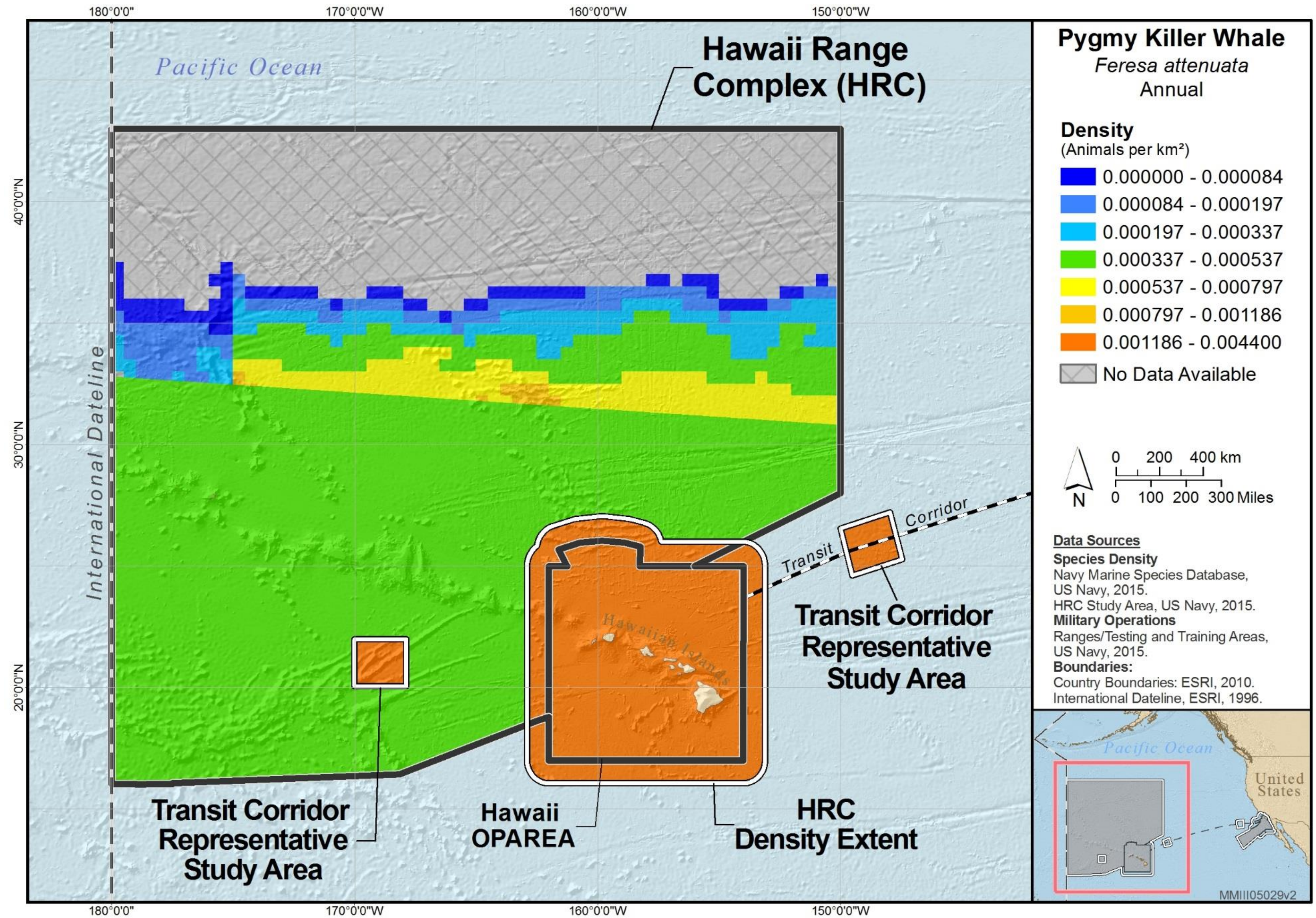


Figure 7-5: Annual Distribution of Pygmy Killer Whale in HRC and the Western Portion of the Transit Corridor

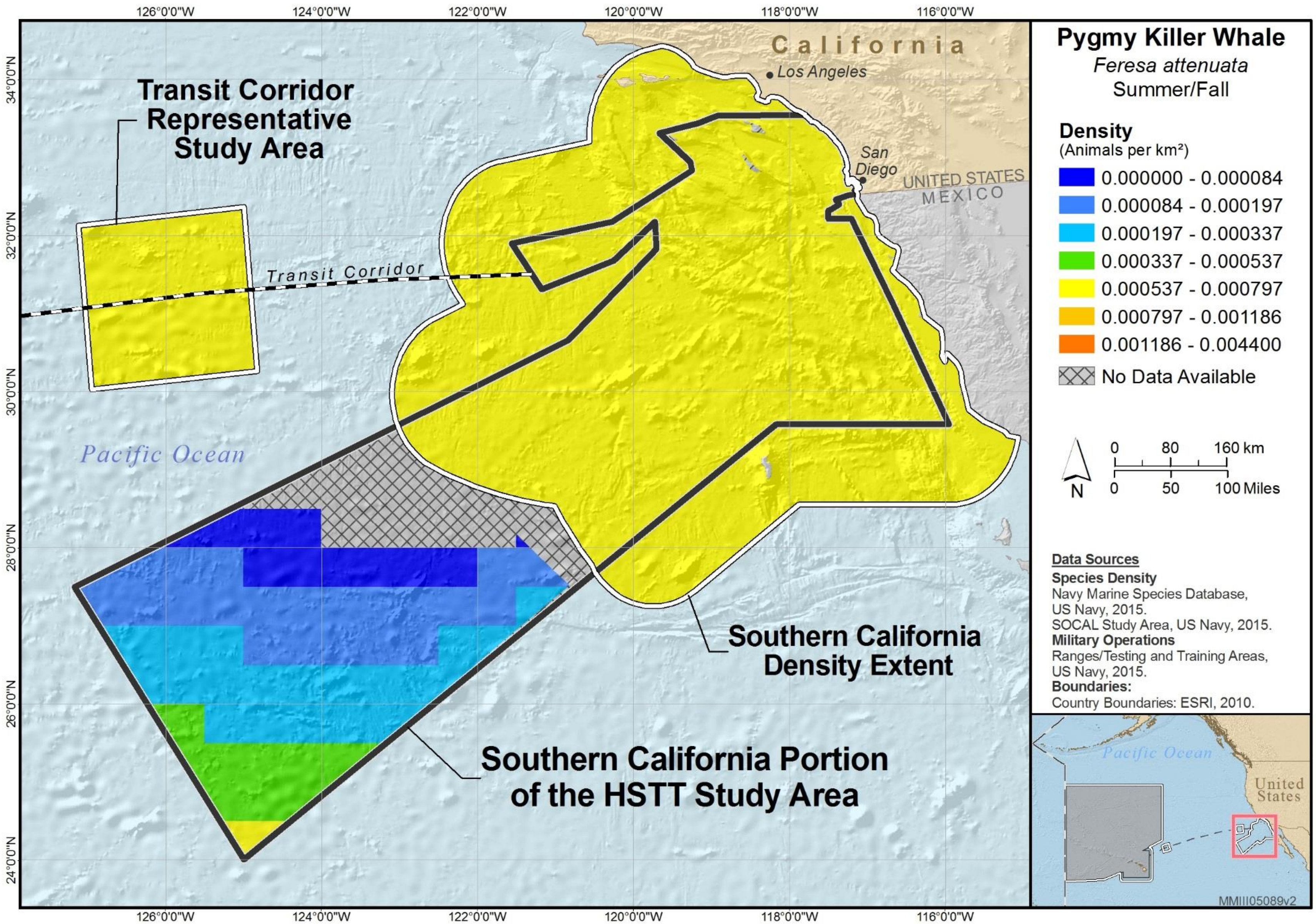


Figure 7-6: Summer/Fall Distribution of Pygmy Killer Whale in SOCAL and the Eastern Portion of the Transit Corridor

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., 2015). 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., 2015). 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 whale, and even humpback and gray whales (Bernard & 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., 2017). 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.

HRC. The Phase II NMSDD included the first CENPAC habitat-based density model for short-finned pilot whales based on systematic survey data collected from 1997 to 2006 (Becker et al., 2012c). More recently, Forney et al. (2015) updated the CENPAC habitat-based models of cetacean densities using additional survey data collected within the Hawaiian Islands EEZ in 2010 and in waters surrounding Palmyra Atoll/Kingman Reef in 2011 and 2012. In addition, improved modeling methods were used that allowed model predictions to be applied directly on a 25 km × 25 km spatial grid. These models cover the entire HRC and provide representative density values for the two western transit corridor study areas. The updated CENPAC short-finned pilot whale spatial model was applied to all seasons for HRC and the western portion of the transit corridor.

SOCAL. Barlow (2016) provides a short-finned pilot whale density estimate of 0.00126 animals/km^2 (CV = 0.74) for waters off Southern California. This provides an update to the density estimate used previously in the Navy's Phase II analyses as the updated Barlow (2016) estimate is based on a multiple-covariate line-transect approach using survey data collected between 1991 and 2014 and incorporates new estimates of trackline detection probability derived by Barlow (2015). This value was used to represent density year-round. Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint and were also corrected for new estimates of trackline detection probability derived by Barlow (2015). The resulting short-finned pilot whale uniform density estimate of 0.00038 animals/km^2 (CV = 0.71) was used for all seasons. Given the overlap of the Ferguson and Barlow strata used to recalculate densities (refer to Figure 3-7), this value is also applicable to the remainder of the SOCAL Range Complex.

Table 7-4: Summary of Density Values for Short-Finned Pilot Whale in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	0.00126	0.00126	0.00126	0.00126
SOCAL	0.00126	0.00126	0.00126	0.00126
Baja	0.00038	0.00038	0.00038	0.00038

The units for numerical values are animals/km^2. S = spatial model with various density values throughout the range.

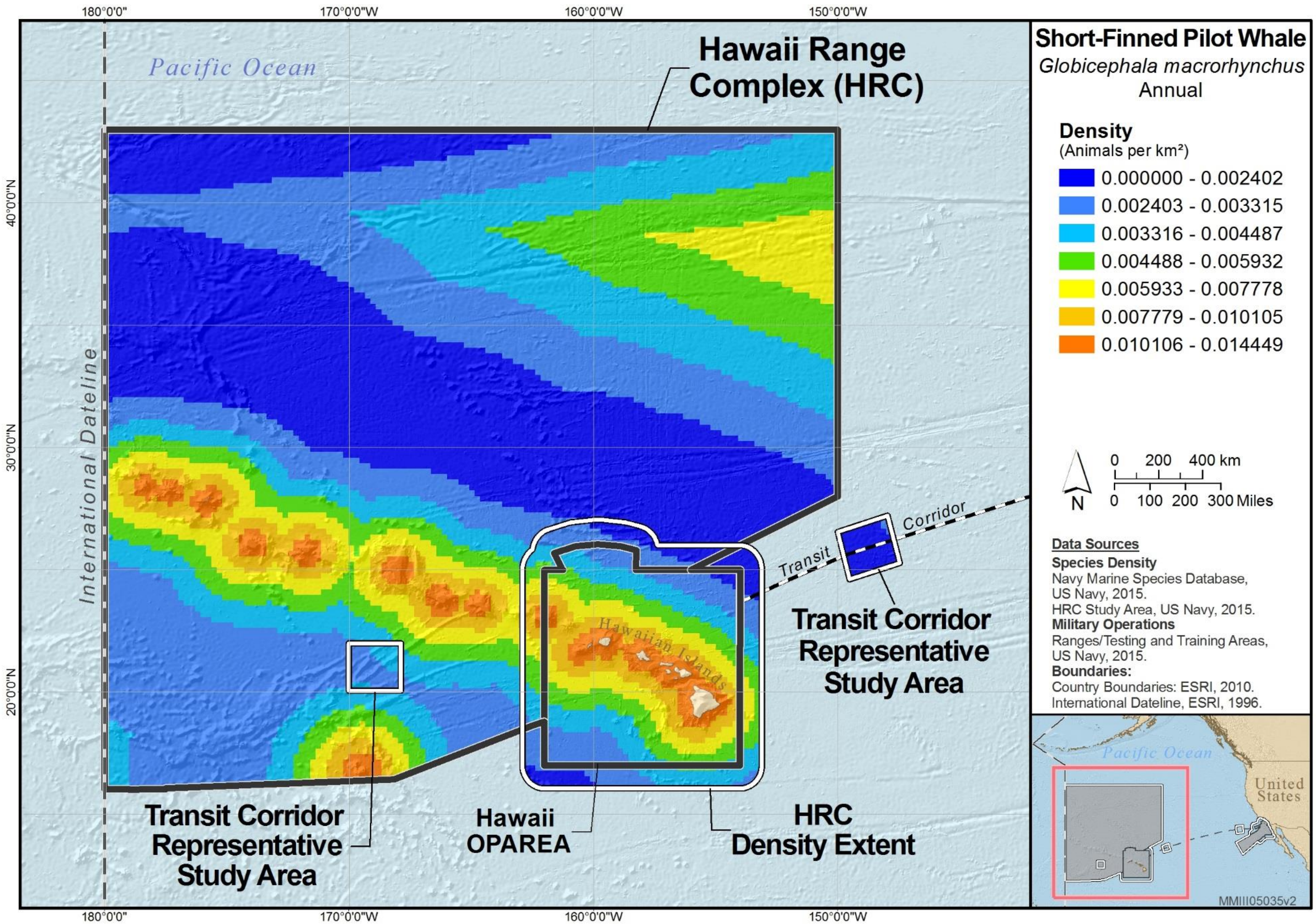


Figure 7-7: Annual Distribution of Short-Finned Pilot Whale in HRC and the Western Portion of the Transit Corridor

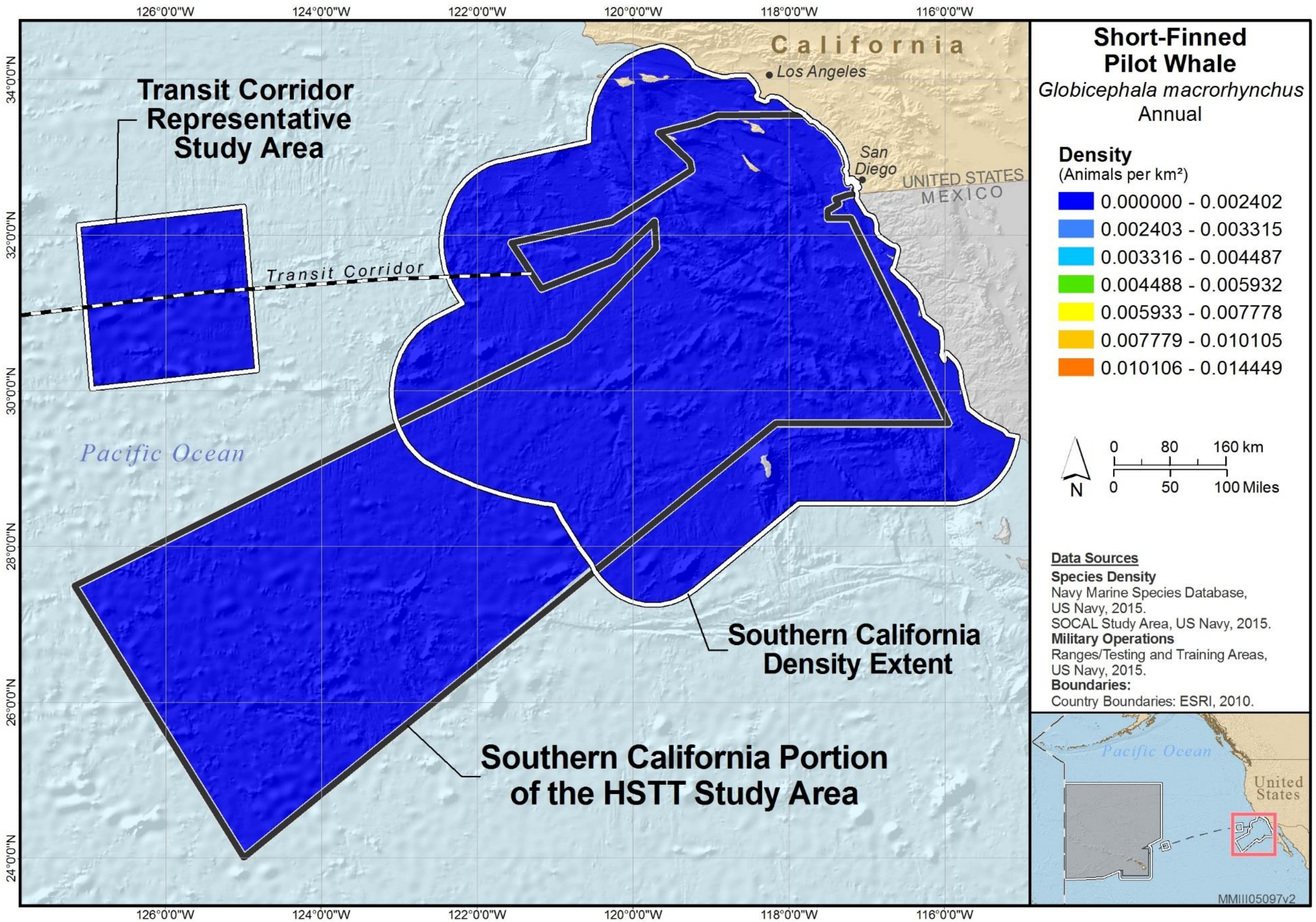


Figure 7-8: Annual Distribution of Short-Finned Pilot Whale in SOCAL and the Eastern Portion of the Transit Corridor

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., 2015; 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 & 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., 2015; 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., 2017). 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.

HRC. Bradford et al. (2017) report a uniform density value for Risso's dolphin of 0.0047 animals/km^2 (CV = 0.43) that is applicable to the HRC study area and western portion of the transit corridor. This provides an update to the density estimate used previously in the Navy's Phase II analyses as it is based on multiple-covariate line-transect analyses of survey data collected in the Hawaiian Islands EEZ in 2010 and incorporates new estimates of trackline detection probability derived by Barlow (2015). This value is applied to all seasons for both HRC and the western portion of the transit corridor. Outside the boundaries of the acoustic modeling study areas, RES data from SMRU et al. (2012) are shown for the remainder of HRC.

SOCAL. After the 1982–1983 El Niño event, Risso's dolphins' presence in SOCAL increased (Shane, 1995). The Phase II NMSDD included a CCE habitat-based density model for Risso's dolphin based on systematic survey data collected from 1991 to 2008 (Becker et al., 2012b). The model provided spatially-explicit density estimates off the U.S. west coast for summer and fall. More recently, the CCE habitat-based density model for Risso's dolphin was updated using methods described in Becker et al. (2016). Improved modeling methods were used that allowed species-specific and segment-specific estimates of both effective strip width and trackline detection probability to be incorporated into the models based on the recorded viewing conditions on that segment using coefficients estimated by Barlow et al. (2011) for effective strip width and Barlow (2015) for trackline detection probability. Density predictions from the updated models are grid-based at a pixel resolution of 10 km x 10 km, providing finer spatial resolution and eliminating interpolation artifacts sometimes present in the previous CCE models (Becker et al., 2016). Density estimates from the updated Risso's dolphin model were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for summer and fall.

Forney et al. (1995) divided waters off 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 collected in winter and spring. Barlow et al. (2009) provided these uniform densities for Risso's dolphins in each region. The species declines in density moving from south to north. The Navy applied the Southern California Bight stratum density estimate of 0.2029 animals/km^2 (CV = 0.405) to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the stratum and the Outer Southern California Waters stratum density estimate of 0.0100 animals/km^2 (CV = 0.990) to the remaining portion of the acoustic modeling study area and eastern portion of the transit corridor for winter and spring.

Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint and were also corrected for new estimates of trackline detection probability derived by Barlow (2015). The resulting Risso's dolphin uniform density estimate of 0.00532 animals/km^2 (CV = 0.38) was used for all seasons. Given the overlap of the Ferguson and Barlow strata used to recalculate densities (refer to Figure 3-7), this value is also applicable to the remainder of the SOCAL Range Complex.

Table 7-5: Summary of Density Values for Risso's Dolphin in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.0047	0.0047	0.0047	0.0047
W. Transit Corridor	0.0047	0.0047	0.0047	0.0047
E. Transit Corridor	0.0100–0.2029	S	S	0.0100–0.2029
SOCAL	0.0100–0.2029	S	S	0.0100–0.2029
Baja	0.00532	0.00532	0.00532	0.00532

The units for numerical values are animals/km^2. S = spatial model with various density values throughout the range.

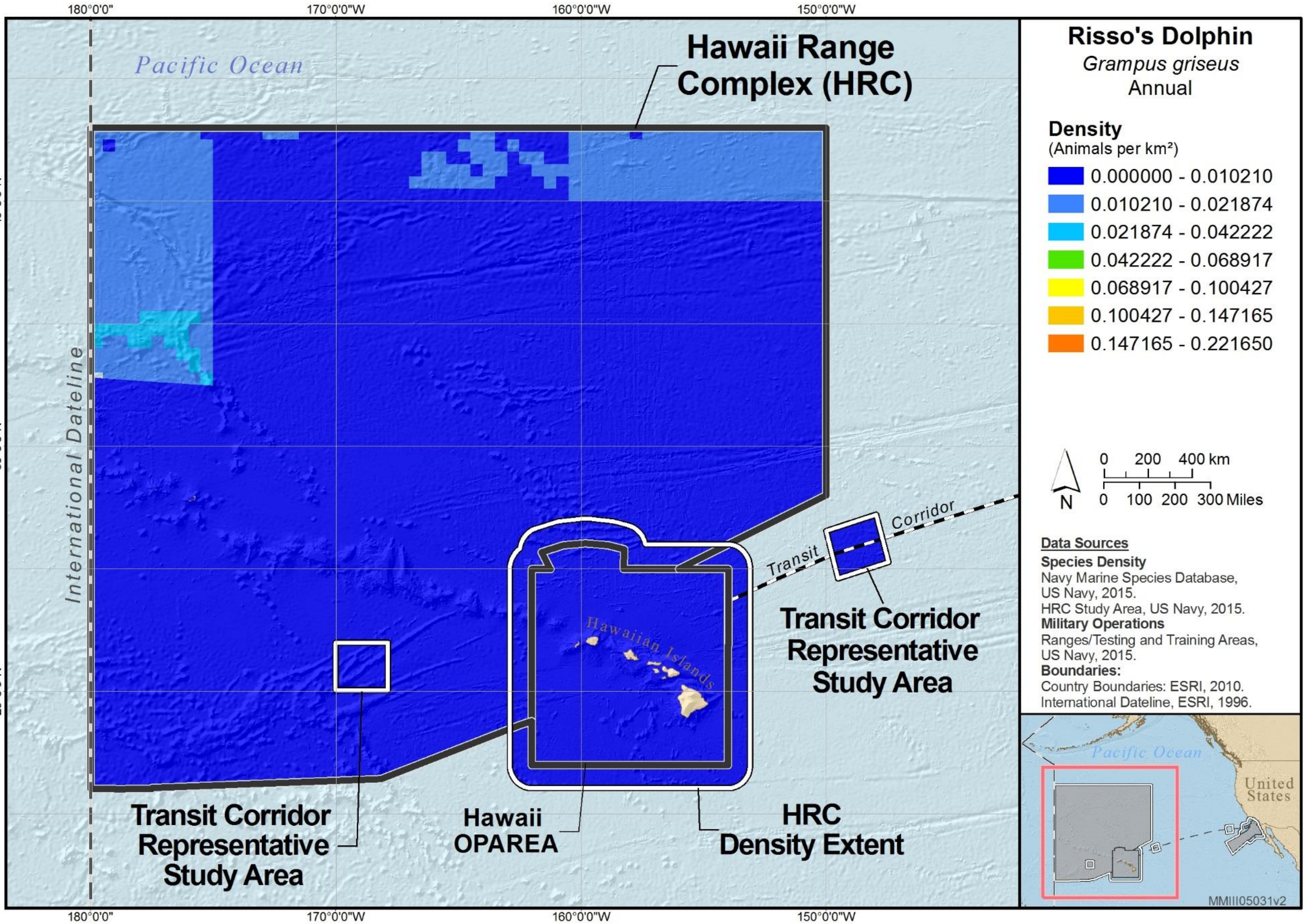


Figure 7-9: Annual Distribution of Risso's Dolphin in HRC and the Western Portion of the Transit Corridor

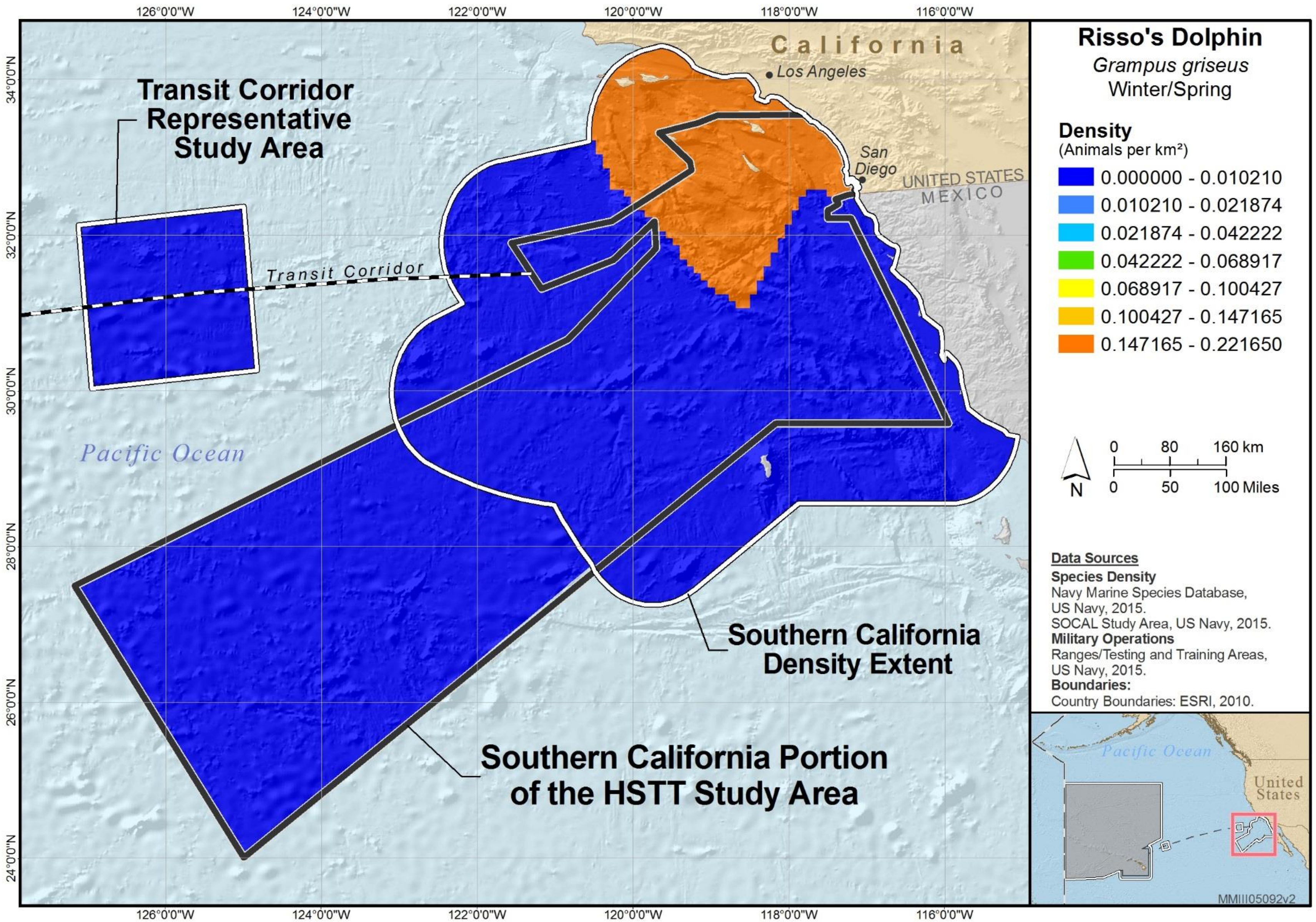


Figure 7-10: Winter/Spring Distribution of Risso's Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

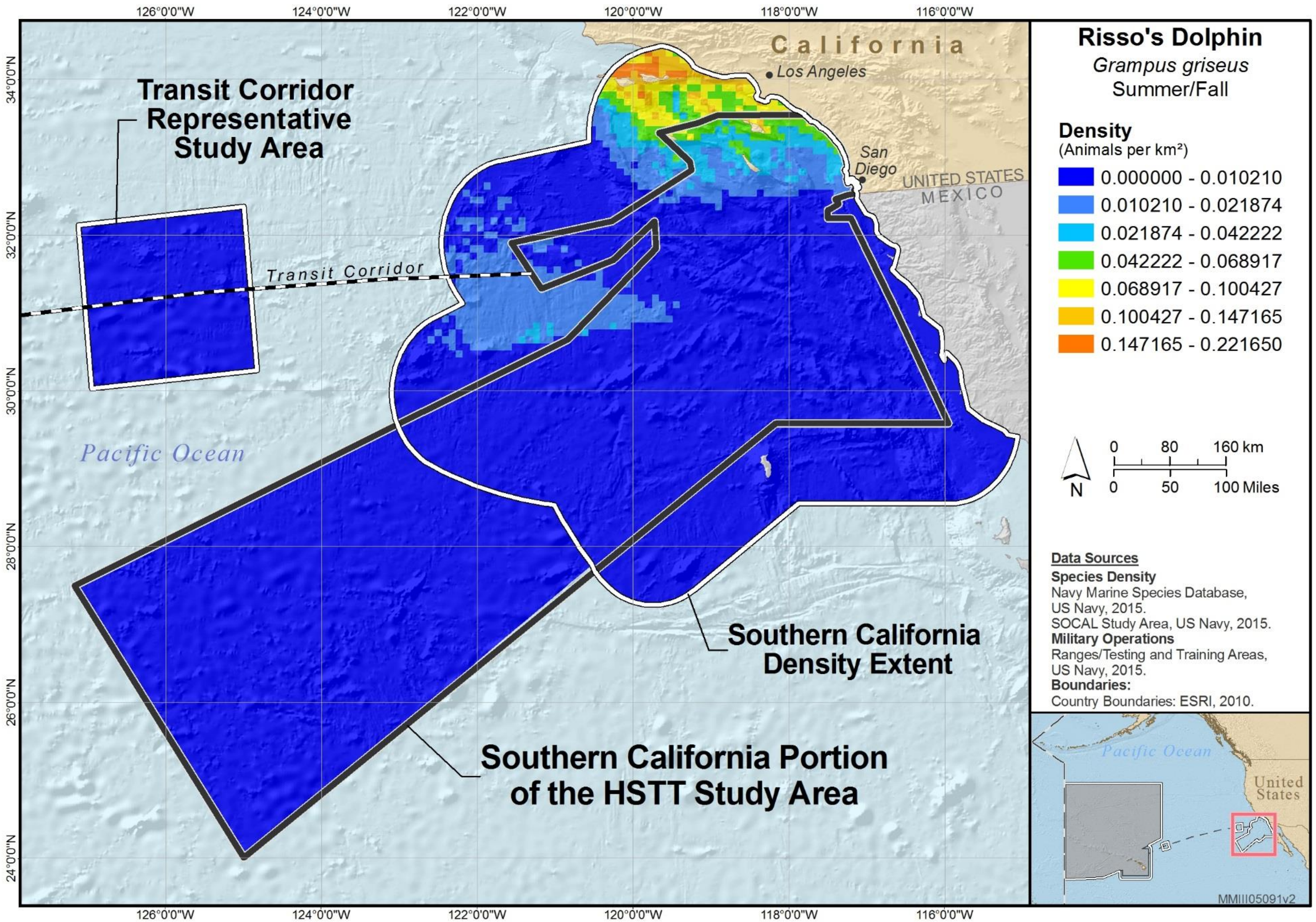


Figure 7-11: Summer/Fall Distribution of Risso's Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

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, 2008). When viewed clearly, the species should be readily identifiable. They have a body that is stocky, often described as particularly "robust" (Jefferson et al., 2015; 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, 2008; Jefferson et al., 2015). 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., 2015; Kiszka et al., 2011; Leatherwood et al., 1988). NMFS recognizes a single Hawaiian stock of Fraser's dolphins in U.S. waters (Carretta et al., 2017).

HRC. Bradford et al. (2017) report a uniform density value for Fraser's dolphin of 0.0210 animals/km^2 (CV = 0.66) that is applicable to the HRC study area and western portion of the transit corridor. This provides an update to the density estimate used previously in the Navy's Phase II analyses as it is based on multiple-covariate line-transect analyses of survey data collected in the Hawaiian Islands EEZ in 2010 and incorporates new estimates of trackline detection probability derived by Barlow (2015). This value is applied to all seasons for both HRC and the western portion of the transit corridor. Outside the boundaries of the acoustic modeling study areas, RES data from Kaschner et al. (2006) are shown for the remainder of HRC.

SOCAL. This species has not been observed on NMFS surveys in the SOCAL area (Hamilton et al., 2009) and they are not expected to occur there or in the eastern portion of the transit corridor.

Table 7-6: Summary of Density Values for Fraser's Dolphin in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC outer	0.0210	0.0210	0.0210	0.0210
W. Transit Corridor	0.0210	0.0210	0.0210	0.0210
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
Baja	0	0	0	0

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

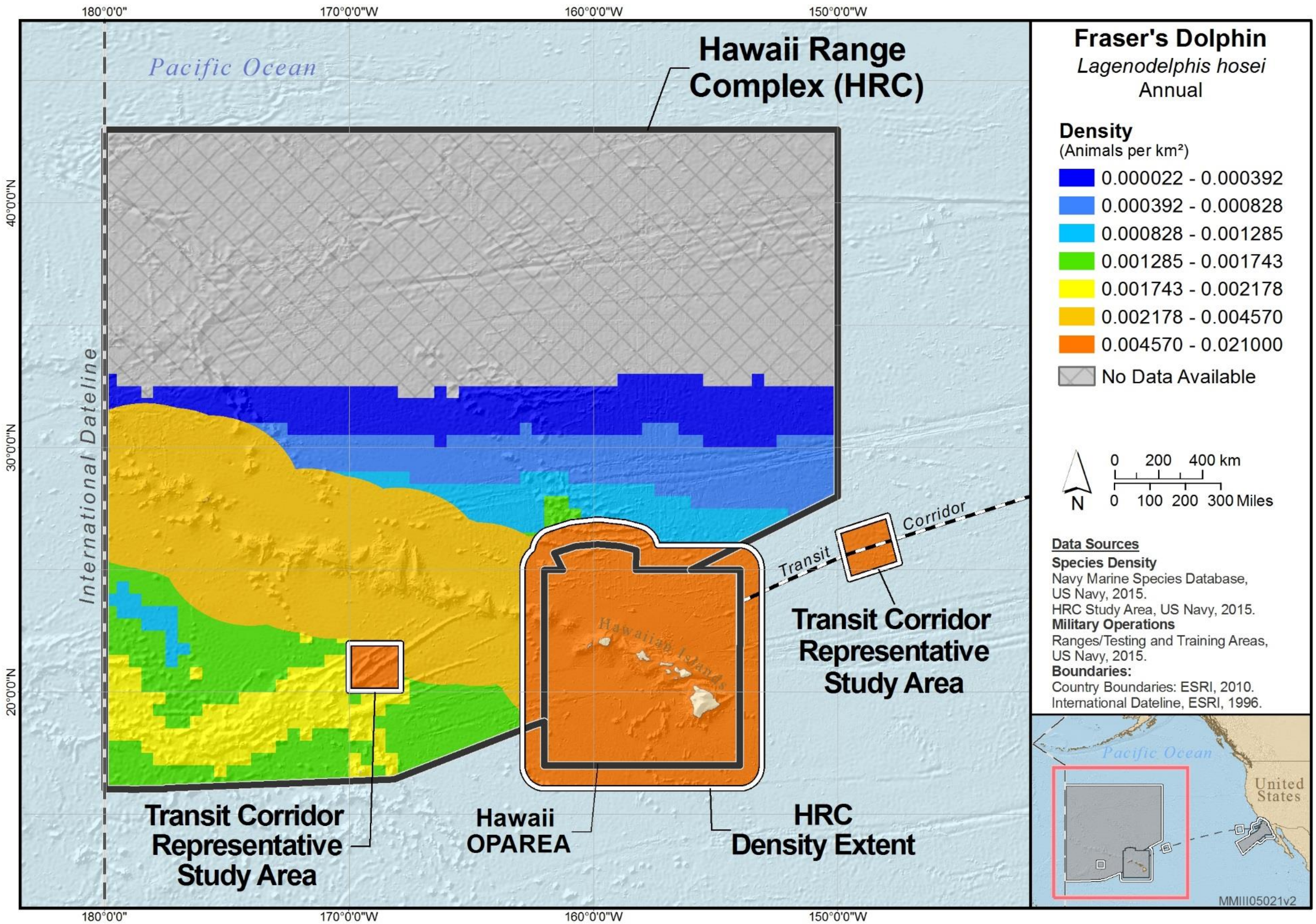


Figure 7-12: Annual Distribution of Fraser's Dolphin in HRC and the Western Portion of the Transit Corridor

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., 2015). 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., 2015). 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*) (Baird & Stacey, 1991; Black, 2009; Brownell et al., 1999; Leatherwood et al., 1988). Two stocks of Pacific white-sided dolphin are recognized by NMFS (Carretta et al., 2017). 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 2016. 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., 2017). Density values for the HSTT Study Area are presented for the species as a whole.

HRC. This species is not expected to occur within the HRC study area or western portion of the transit corridor (Hamilton et al., 2009).

SOCAL. The Phase II NMSDD included a CCE habitat-based density model for Pacific white-sided dolphin based on systematic survey data collected from 1991to 2008 (Becker et al., 2012b). The model provided spatially-explicit density estimates off the U.S. west coast for summer and fall. More recently, Becker et al. (2016) updated the CCE habitat-based models of cetacean densities using additional survey data collected primarily off Southern California in 2009. In addition, improved modeling methods were used that allowed species-specific and segment-specific estimates of both effective strip width and trackline detection probability to be incorporated into the models based on the recorded viewing conditions on that segment using coefficients estimated by Barlow et al. (2011) for effective strip width and Barlow (2015) for trackline detection probability. Density predictions from the updated models are grid-based at a pixel resolution of 10 km x 10 km, providing finer spatial resolution and eliminating interpolation artifacts sometimes present in the previous CCE models (Becker et al., 2016). Density estimates from the updated Pacific white-sided dolphin model were applied to the portion of the Navy’s SOCAL acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for summer and fall.

Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint and were also corrected for new estimates of trackline detection probability derived by Barlow (2015). The resulting Pacific white-sided dolphin uniform density estimate of 0.00690 animals/km^2 (CV = 0.72) was used for all seasons. Given the overlap of the Ferguson and Barlow strata used to recalculate densities (refer to Figure 3-7), this value is also applicable to the remainder of the SOCAL Range Complex.

Campbell et al. (2015) provide the most recent winter and spring density estimates for Pacific white-sided dolphins in Southern California waters. Their seasonally stratified line-transect estimates of 0.07010 animals/km^2 (CV = 0.44) for winter and 0.10056 animals/km^2 (CV = 0.36) for spring were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the Campbell et al. (2015) study area, as well as the eastern portion of the transit corridor.

Table 7-7: Summary of Density Values for Pacific White-Sided Dolphin in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0.10056	S	S	0.07010
SOCAL	0.10056	S	S	0.07010
Baja	0.00690	0.00690	0.00690	0.00690

The units for numerical values are animals/km^2. S = spatial model with various density values throughout the range.

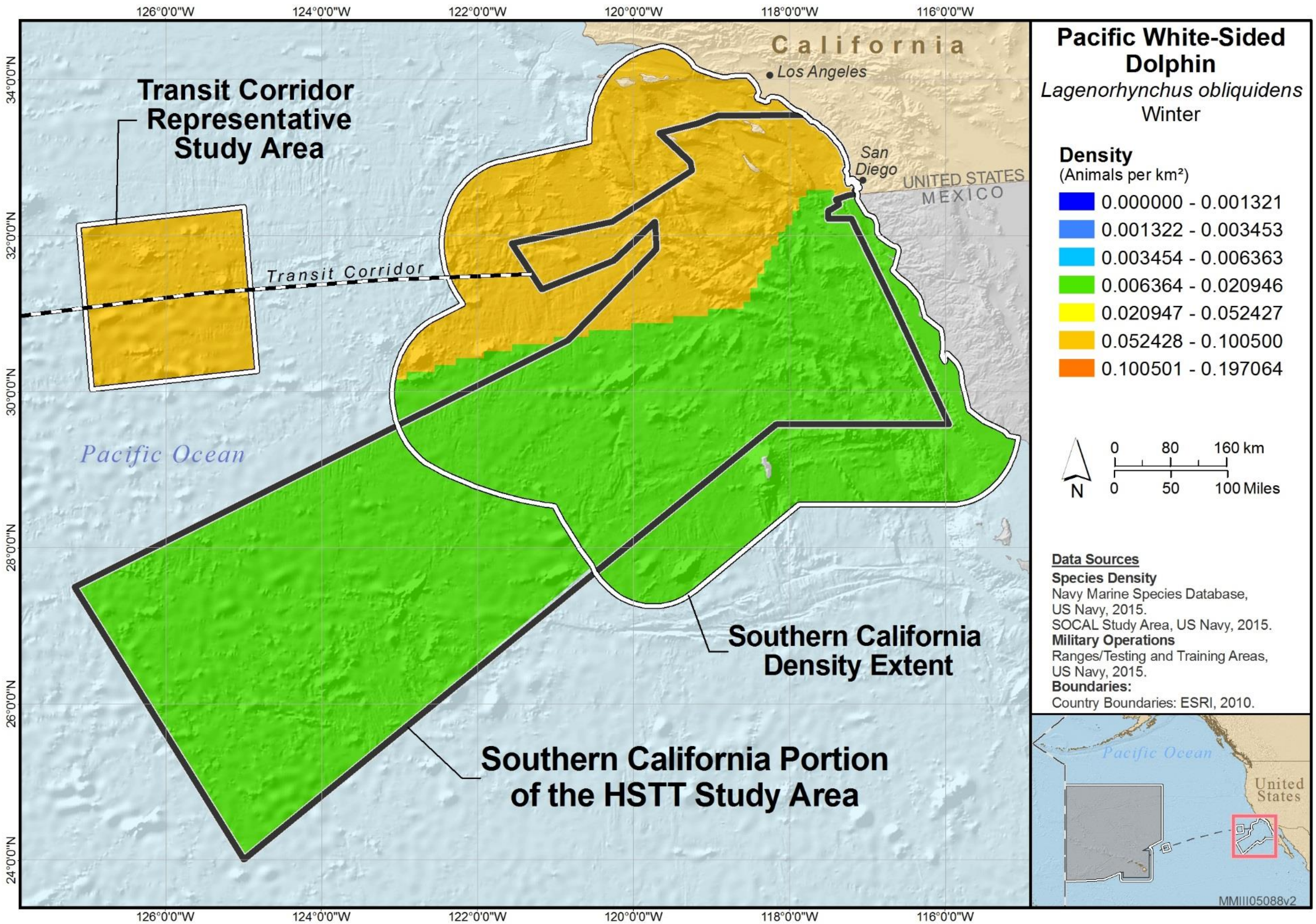


Figure 7-13: Winter Distribution of Pacific White-Sided Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

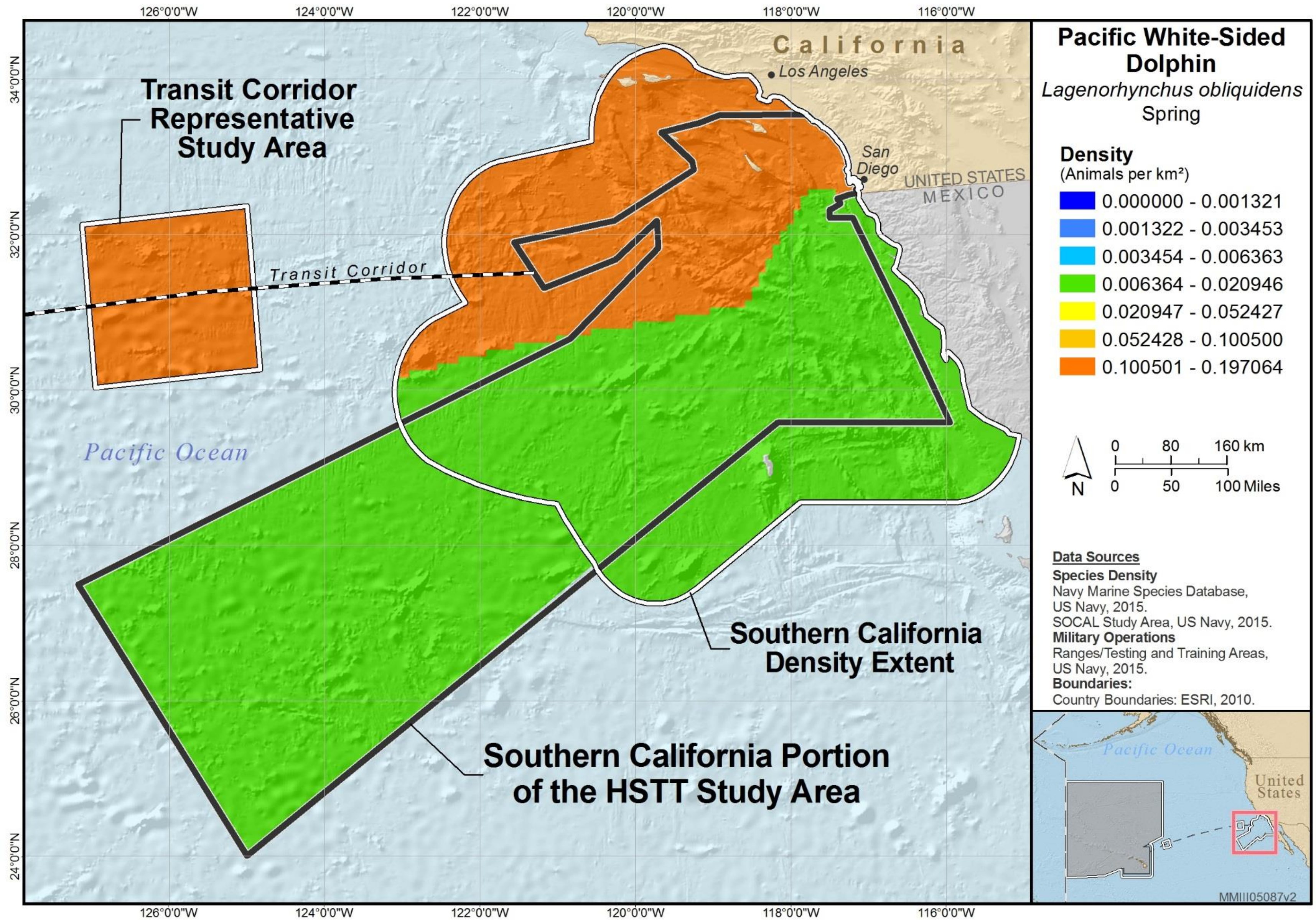


Figure 7-14: Spring Distribution of Pacific White-Sided Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

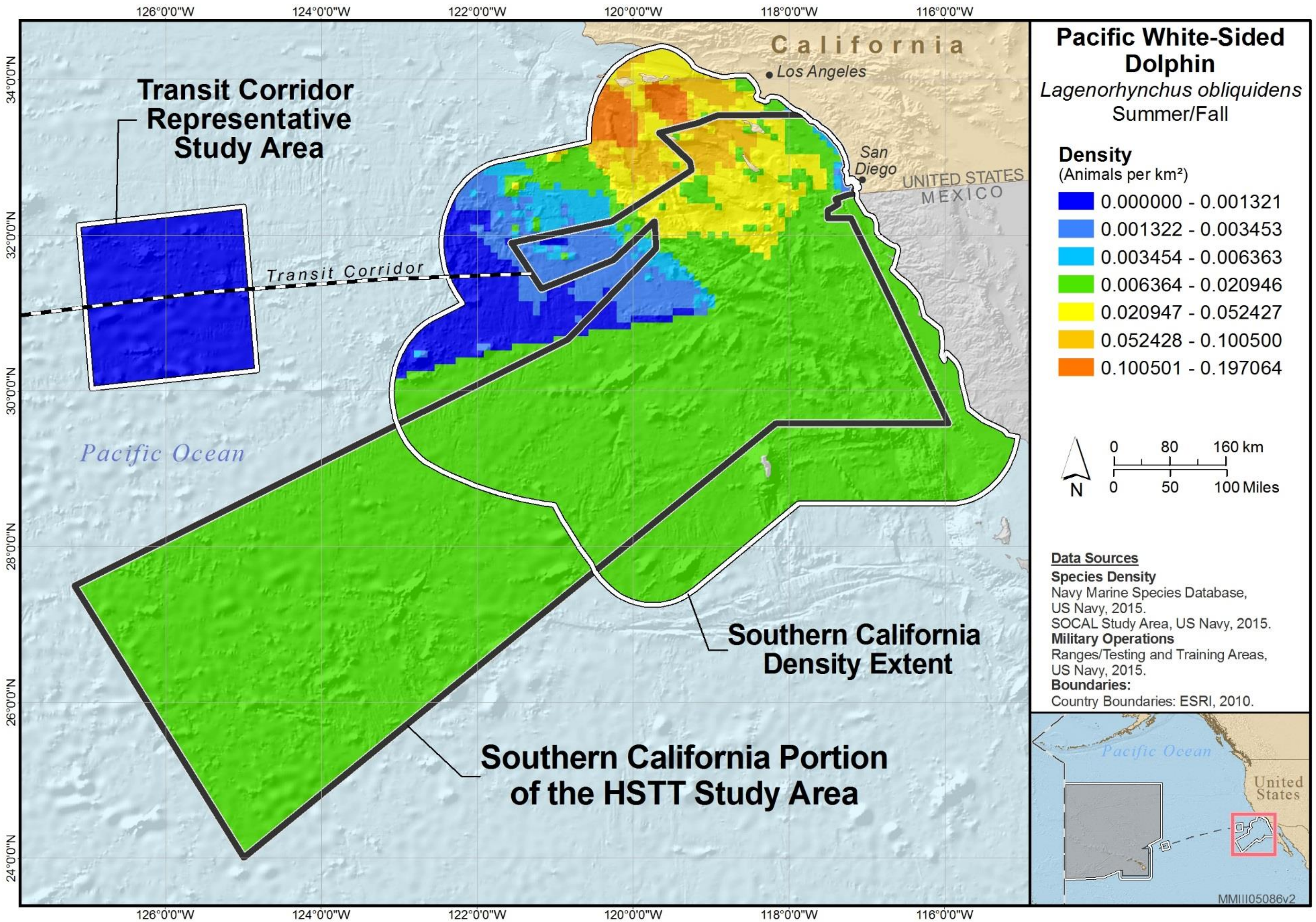


Figure 7-15: Summer/Fall Distribution of Pacific White-Sided Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

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., 2015; 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 & 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., 2015). At a distance, when they are porpoising, they could be mistaken for a group of traveling sea lions (Jefferson et al., 2015; 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., 2017).

HRC. This species is not expected to occur within the HRC study area or western portion of the transit corridor (Hamilton et al., 2009).

SOCAL. The Phase II NMSDD included a CCE habitat-based density model for northern right whale dolphin based on systematic survey data collected from 1991 to 2008 (Becker et al., 2012b). The model provided spatially-explicit density estimates off the U.S. west coast for summer and fall. More recently, Becker et al. (2016) updated the CCE habitat-based models of cetacean densities using additional survey data collected primarily off Southern California in 2009. In addition, improved modeling methods were used that allowed species-specific and segment-specific estimates of both effective strip width and trackline detection probability to be incorporated into the models based on the recorded viewing conditions on that segment using coefficients estimated by Barlow et al. (2011) for effective strip width and Barlow (2015) for trackline detection probability. Density predictions from the updated models are grid-based at a pixel resolution of 10 km x 10 km, providing finer spatial resolution and eliminating interpolation artifacts sometimes present in the previous CCE models (Becker et al., 2016). Density estimates from the updated northern right whale dolphin model were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for summer and fall.

Forney et al. (1995) divided waters off 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 collected in winter and spring. Barlow et al. (2009) provided these uniform densities for northern right whale dolphins in each region. The Navy applied the Southern California Bight stratum density estimate of 0.13782 animals/km^2 (CV = 0.369) to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the stratum and the Outer Southern California Waters stratum density estimate of 0.13948 animals/km^2 (CV = 0.871) to the remaining portion of the acoustic modeling study area and eastern portion of the transit corridor for winter and spring.

Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint and were also corrected for new estimates of trackline detection probability derived by Barlow (2015). The resulting northern right whale dolphin uniform density estimate of 0.00645 animals/km^2 (CV = 1.84) was used for all seasons. Given the overlap of the Ferguson and Barlow strata used to recalculate densities (refer to Figure 3-7), this value is also applicable to the remainder of the SOCAL Range Complex.

Table 7-8: 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	0.1378-0.1395	S	S	0.1378-0.1395
SOCAL	0.1378-0.1395	S	S	0.1378-0.1395
Baja	0.00645	0.00645	0.00645	0.00645

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.

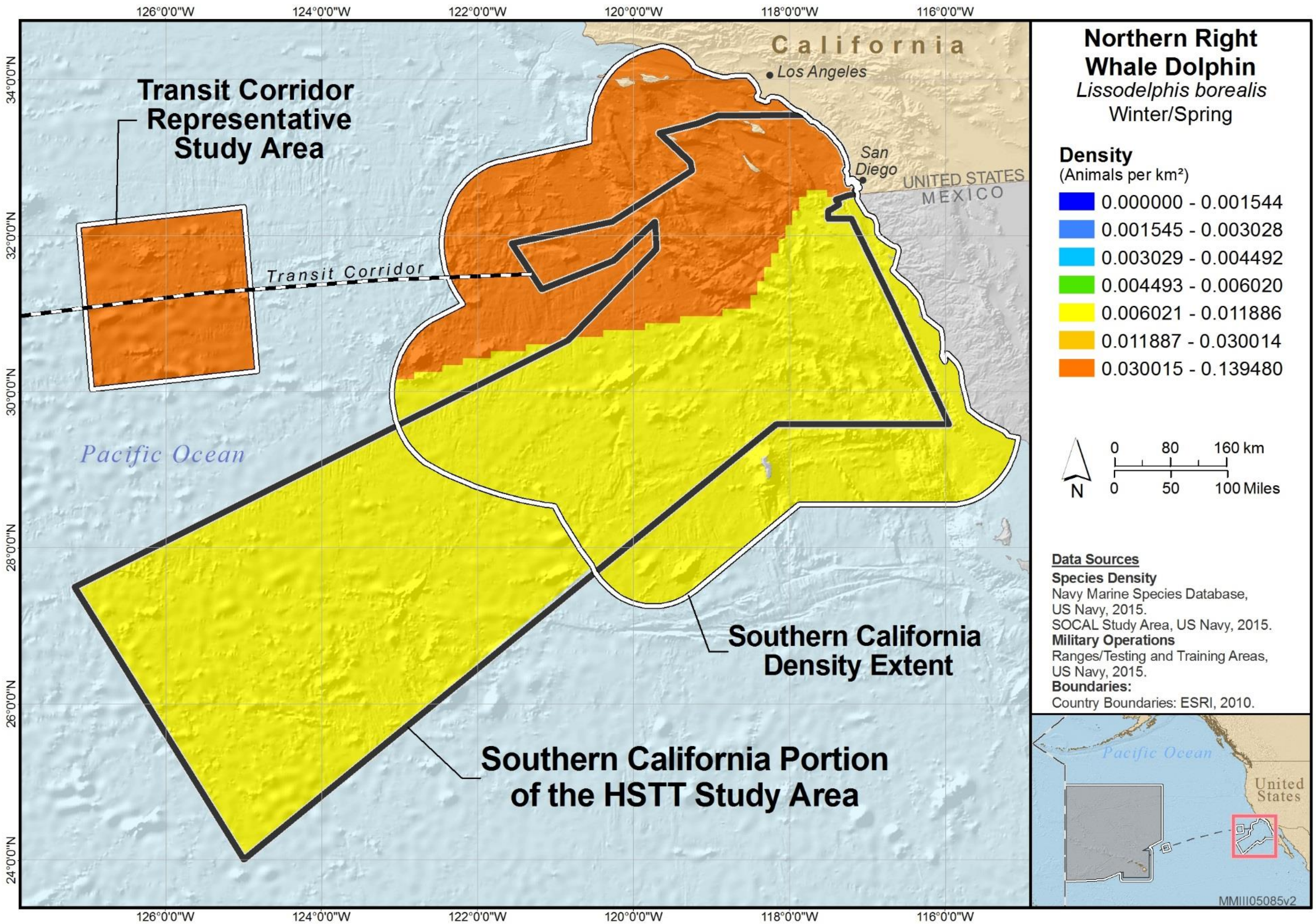


Figure 7-16: Winter/Spring Distribution of Northern Right Whale Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

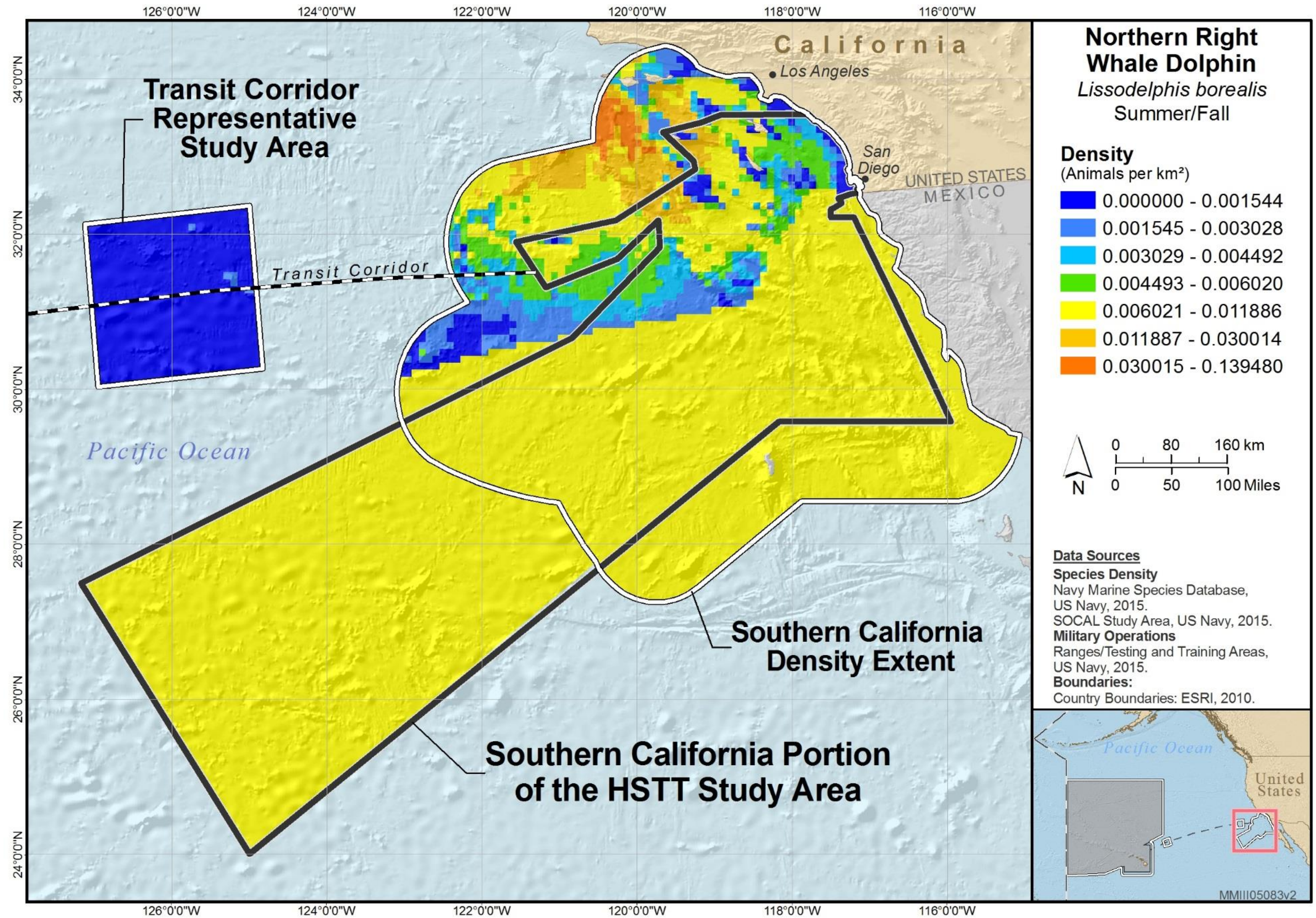


Figure 7-17: Summer/Fall Distribution of Northern Right Whale Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

7.1.9 *Orcinus orca*, Killer Whale

Killer whales are top predators that are found throughout the world's oceans (Dahlheim & Heyning, 1999; Jefferson et al., 2015). 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., 2009; Foote et al., 2011; Kasamatsu et al., 2000; Pitman & 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). 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., 2015). 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 (Carretta et al., 2017; Muto et al., 2017).

In SOCAL, the stocks that may be found in 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. Killer whales sighted in HRC are most likely animals from the Hawaii stock. In the transit corridor, the West Coast Transient stock is the likely stock that would be encountered.

HRC. Bradford et al. (2017) report a uniform density estimate for killer whale of 0.00006 animals/km^2 (CV = 0.96) that is applicable to the HRC study area and western portion of the transit corridor. This provides an update to the density estimate used previously in the Navy's Phase II analyses as it is based on multiple-covariate line-transect analyses of survey data collected in the Hawaiian Islands EEZ in 2010 and incorporates new estimates of trackline detection probability derived by Barlow (2015). This value is applied to all seasons for both HRC and the western portion of the transit corridor. Outside the boundaries of the acoustic modeling study areas are density data used in the Phase II analyses, including the Barlow (2006) uniform density estimate, as well as SMRU Ltd. (2012) predicted RES values in the northern portion of HRC. The RES global model (Kaschner et al., 2006) predicts a higher density of killer whales around Hawaii than density estimated from actual observations.

SOCAL. Density values for killer whales are available for SOCAL for all seasons from SWFSC reports, memoranda, and scientific literature. In the winter and spring, the density of killer whales is estimated as 0.00025 (CV = 0.689) animals/km^2 off the entire coast of California (Barlow et al., 2009; Forney et al., 1995). In the summer and fall, killer whale density has been recently estimated at 0.00013 animals/km^2 (CV = 0.93) in waters off Southern California (Barlow, 2016). This provides an update to the summer/fall density estimate used previously in the Navy's Phase II analyses as the updated Barlow (2016) estimate is based on a multiple-covariate line-transect approach using survey data collected between 1991 and 2014 and incorporates new estimates of trackline detection probability derived by Barlow (2015). Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint and resulted in a killer whale density estimate of 0.00009 (CV = 1.00). In the Baja area, the same value is used for all seasons.

Table 7-9: Summary of Density Values for Killer Whale in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.00006	0.00006	0.00006	0.00006
W. Transit Corridor	0.00006	0.00006	0.00006	0.00006
E. Transit Corridor	0.00025	0.00013	0.00013	0.00025
SOCAL	0.00025	0.00013	0.00013	0.00025
Baja	0.00009	0.00009	0.00009	0.00009

The units for numerical values are animals/km^2.

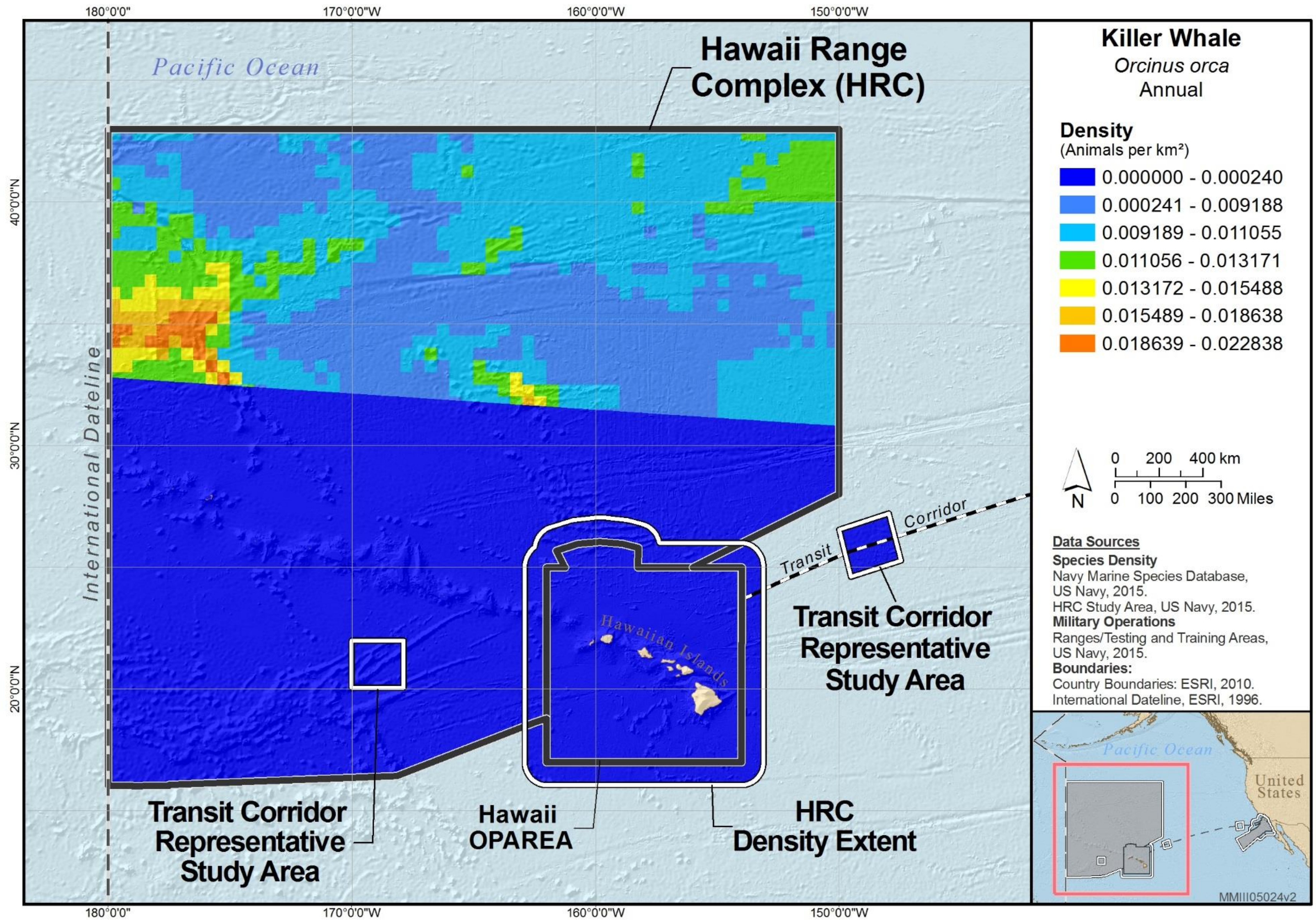


Figure 7-18: Annual Distribution of Killer Whale in HRC and the Western Portion of the Transit Corridor

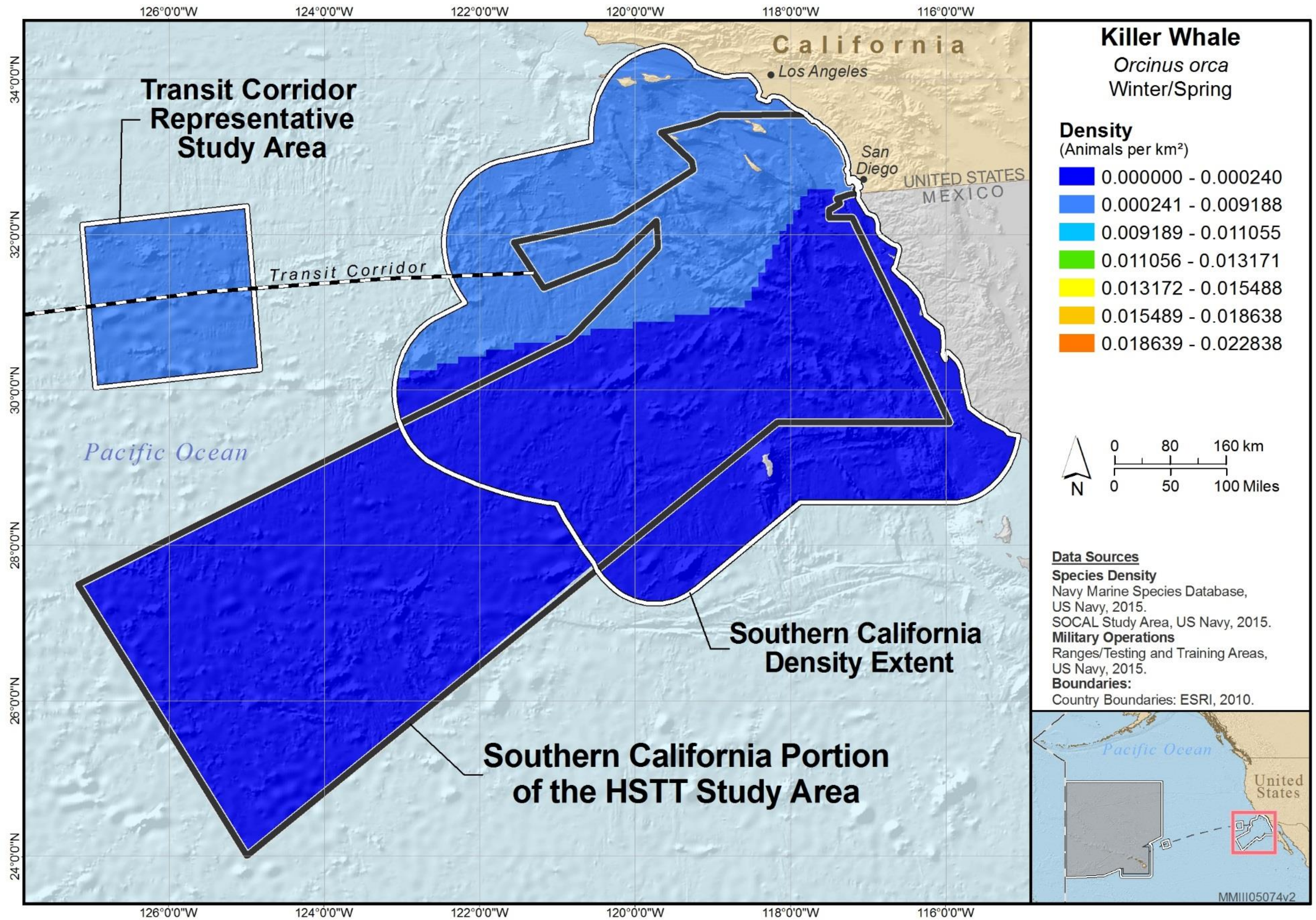


Figure 7-19: Winter/Spring Distribution of Killer Whale in SOCAL and the Eastern Portion of the Transit Corridor

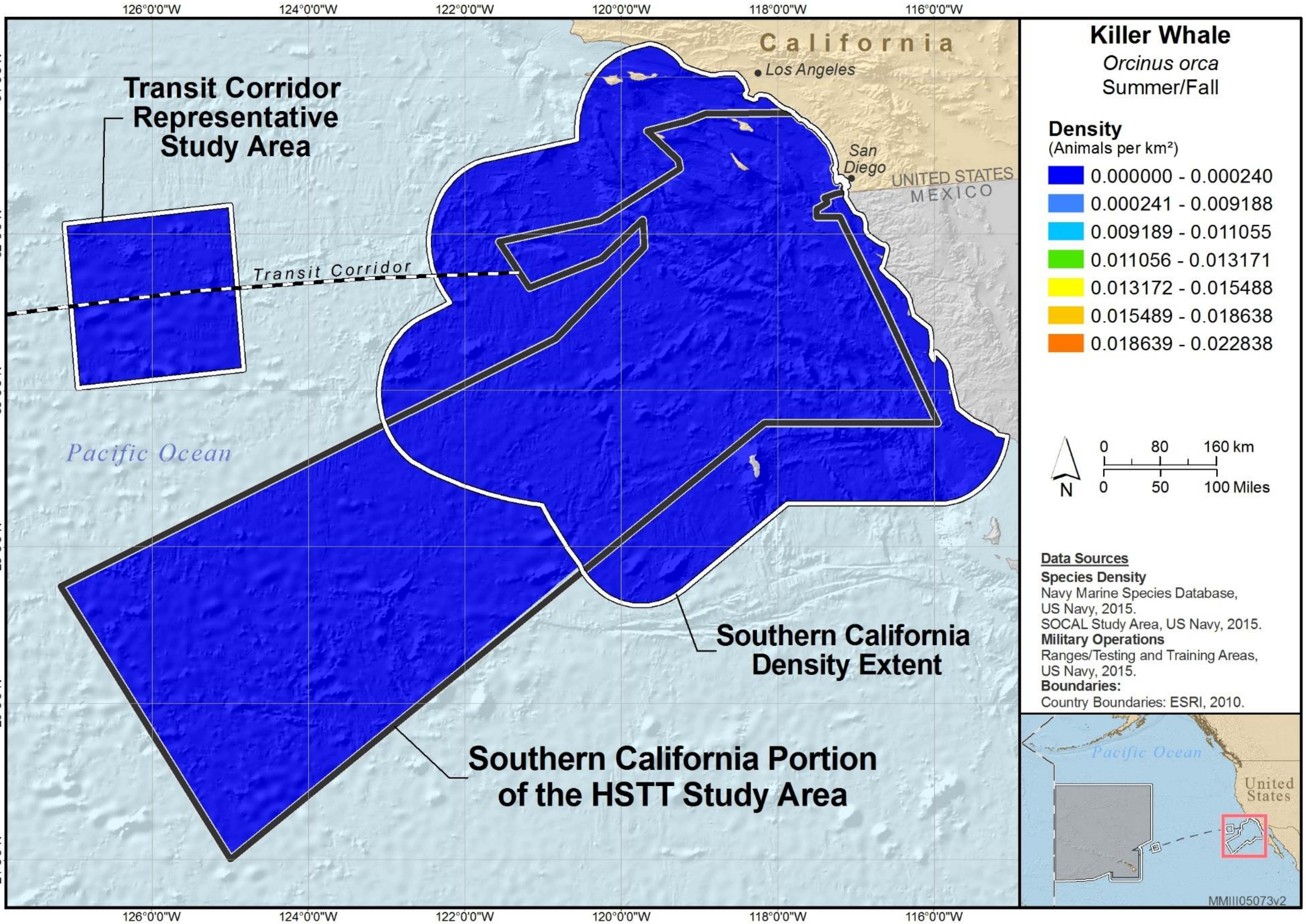


Figure 7-20: Summer/Fall Distribution of Killer Whale in SOCAL and the Eastern Portion of the Transit Corridor

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., 2015). Good lighting is required to see the color subtleties. Melon-headed whales 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., 2015; 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., 2011). NMFS recognizes two Pacific management stocks within the Hawaiian Islands EEZ: (1) the Kohala Resident stock, which includes animals off the Kohala peninsula and west coast of Hawaii Island in less than 2,500 m of water; and (2) the Hawaiian Islands stock, which includes animals in waters throughout the Hawaiian Islands EEZ and adjacent high seas, including the area occupied by the Kohala resident stock (Carretta et al., 2017). Given published abundance estimates and range boundaries for these stocks (Aschettino, 2010; Carretta et al., 2017; Oleson et al., 2013), the Navy was able to develop stock-specific density estimates for melon-headed whales.

HRC: Kohala Resident Stock. Aschettino (2010) used a photo-identification catalog of melon-headed whales encountered between 2002 and 2009 to calculate a mark-recapture abundance estimate for the Kohala Resident stock of 447 (CV = 0.12). Given this stock's boundaries (i.e., the area from the coast out to the 2,500-m isobath off the Kohala Peninsula and west coast of Hawaii), the approximate range area was calculated as 4,460.46 km^2, resulting in a density estimate of 0.100 animals/km^2. This estimate was applied to the area encompassing the range of the Kohala Resident stock. Inclusion of this new spatially-explicit density layer more accurately reflects the distribution of this island-associated population and represents an improvement to the NMSDD for Phase III.

HRC: Hawaiian Islands Stock. Aschettino (2010) used a photo-identification catalog of melon-headed whales encountered between 2002 and 2009 to calculate a mark-recapture abundance estimate for the Hawaiian Islands stock of 5,794 (CV = 0.20). Given the area of waters within the Hawaiian Islands EEZ (2,474,581.74 km^2), the resulting density estimate for the Hawaiian Islands stock of melon-headed whales is 0.002 animals/km^2. This value is applied to all seasons for both HRC and the western portion of the transit corridor. Outside the boundaries of the acoustic modeling study areas are density data used in the Phase II analyses, including the Barlow (2006) uniform density estimate, as well as SMRU Ltd. (2012) predicted RES values in the northern portion of HRC.

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

Table 7-10: Summary of Density Values for Melon-Headed Whale, Kohala Resident Stock, in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC: Insular stock range	0.100	0.100	0.100	0.100
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
Baja	0	0	0	0

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

Table 7-11: Summary of Density Values for Melon-Headed Whale, Hawaiian Islands Stock, in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.002	0.002	0.002	0.002
W. Transit Corridor	0.002	0.002	0.002	0.002
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
Baja	0	0	0	0

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

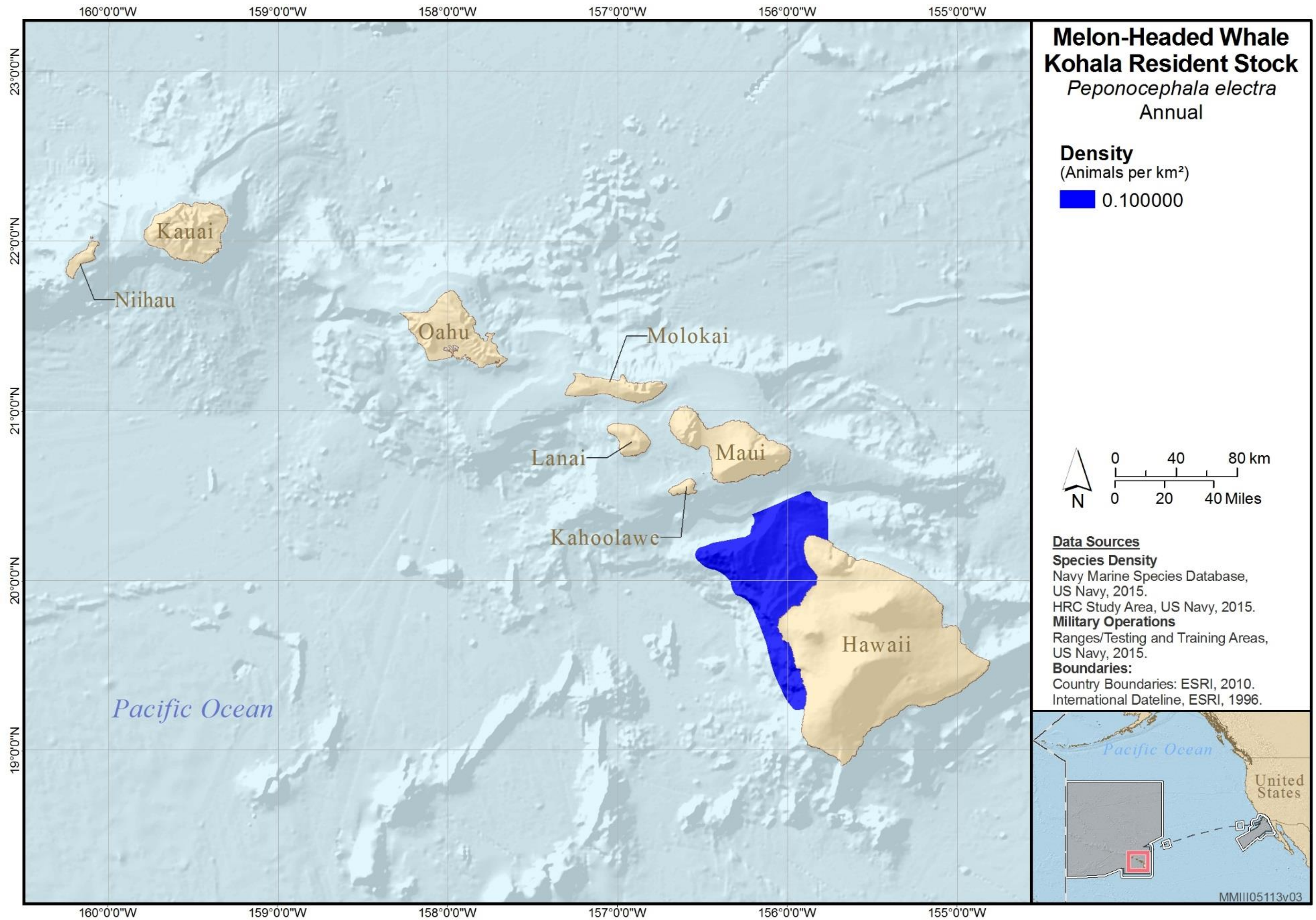


Figure 7-21: Annual Distribution of Melon-Headed Whale Kohala Resident Stock in HRC and the Western Portion of the Transit Corridor

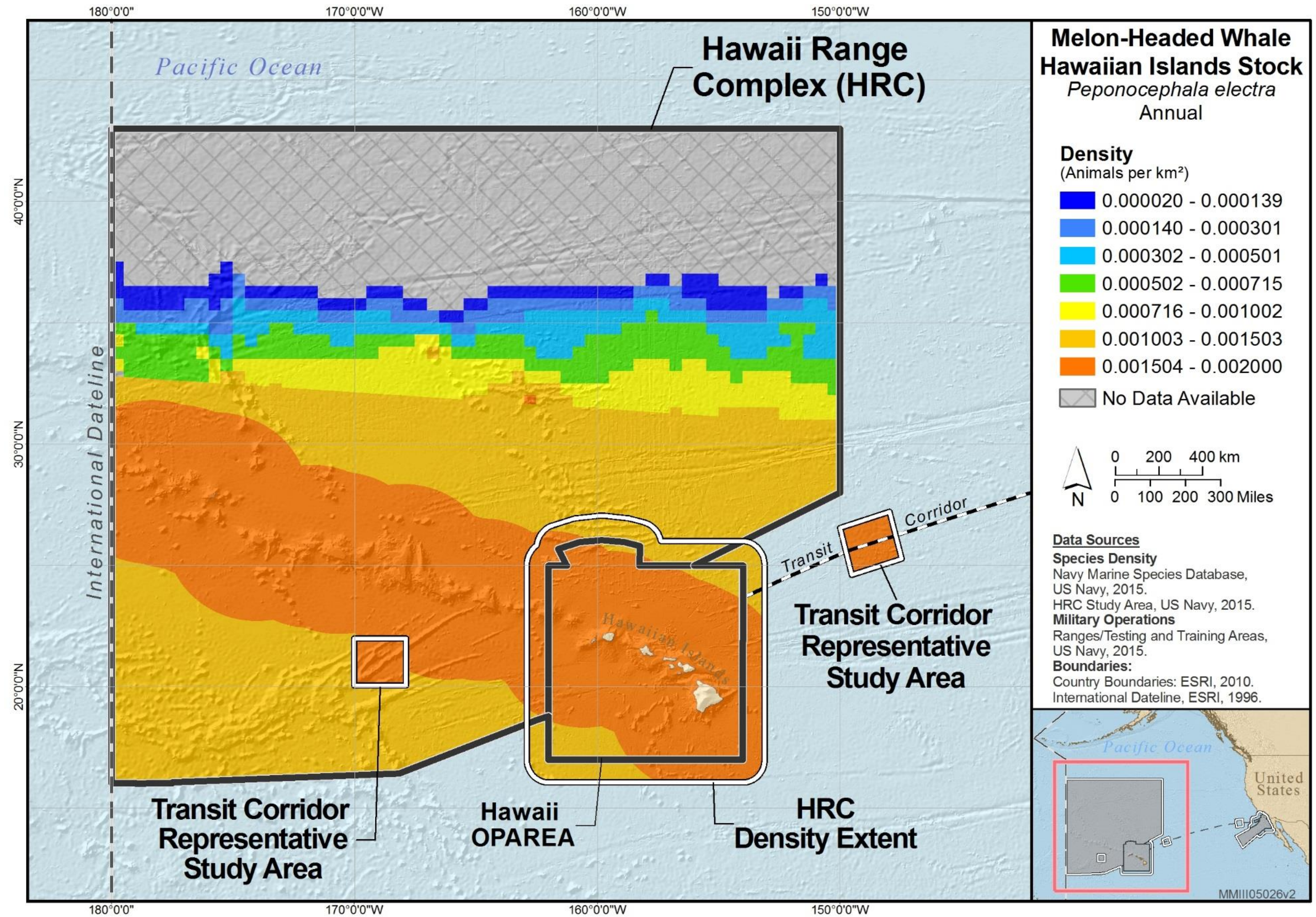


Figure 7-22: Annual Distribution of Melon-Headed Whale Hawaiian Islands Stock in HRC and the Western Portion of the Transit Corridor

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., 2015; 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., 2015; 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., 2015). 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 & 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 & 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, 2010). There appears to be overlap among ranges to some degree. NMFS currently recognizes three stocks of false killer whale in Hawaiian waters: the Main Hawaiian Islands insular stock, the Hawaii pelagic stock, and the Northwestern Hawaiian Islands stock (Carretta et al., 2017). There are two additional stocks recognized outside of Hawaiian waters including the Palmyra Atoll stock, which includes animals found within the U.S. EEZ of Palmyra Atoll, and the American Samoa stock, which includes animals found within the U.S. EEZ of American Samoa. The three Hawaiian stocks have overlapping ranges, but given published abundance estimates and range boundaries for the Main Hawaiian Islands insular stock (Carretta et al., 2015; Oleson et al., 2010), the Navy was able to develop a stock-specific density estimate for this population.

HRC: Main Hawaiian Islands Insular Stock. Based on recent publications (Baird et al., 2013; Carretta et al., 2017; Oleson et al., 2010), the current abundance estimate for the Main Hawaiian Islands insular stock of false killer whales is 151 (CV = 0.20). The stock's boundaries were updated in 2016 based primarily on satellite telemetry data, and are defined by a 72 km minimum convex polygon encompassing the Main Hawaiian Islands(Bradford et al., 2015). The approximate range area was calculated as 185,198.07 km^2, resulting in a density estimate of 0.000796 animals/km^2. This estimate was applied to the area encompassing the range of the Main Hawaiian Islands insular stock. The Navy applied this estimate to all seasons. Inclusion of this new spatially-explicit density layer more accurately reflects the distribution of this island-associated population and represents an improvement to the NMSDD for Phase III.

HRC: Hawaii Pelagic and Northwestern Hawaiian Islands Stocks. The Phase II NMSDD included the first CENPAC habitat-based density model for false killer whales based on systematic survey data collected from 1997 to 2006 (Becker et al., 2012c). More recently, Forney et al. (2015) updated the CENPAC habitat-based models of cetacean densities using additional survey data collected within the Hawaiian Islands EEZ in 2010 and in waters surrounding Palmyra Atoll/Kingman Reef in 2011 and 2012. In addition, improved modeling methods were used that allowed model predictions to be applied directly on a 25 km × 25 km spatial grid. These models cover the entire HRC and provide representative density values for the two western transit corridor study areas. Given the transect coverage on the surveys that contributed data to the habitat models, the majority of the false killer whale sightings were from the Hawaii Pelagic and Northwestern Hawaiian Islands stocks. The Navy thus used the updated CENPAC false killer whale spatial model to represent these stocks and applied the model to all seasons for HRC and the western portion of the transit corridor. Since animals seen within 40 km of each of the main Hawaiian Island are considered to belong to the Main Hawaiian Islands insular stock, these areas were assigned zero values in the habitat-based density model layer.

SOCAL. Strandings and sightings of false killer whales have been recorded in Southern California and north, but these have generally been considered extralimital. During the unusually warm oceanographic conditions in 2014, whale watching boats photographed false killer whales in Southern California waters, but there were none sighted during the SWFSC systematic survey that year (Barlow, 2016). Since this species has not been observed in SOCAL during any of the NMFS ship surveys, no density estimates are available. Further, given their extralimital occurrence, a zero density was assigned to waters in SOCAL.

Table 7-11: Summary of Density Values for False Killer Whale, Main Hawaiian Islands Insular Stock, in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC: Insular stock range	0.000796	0.000796	0.000796	0.000796
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
Baja	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.

Table 7-12: Summary of Density Values for False Killer Whale, Hawaii Pelagic and Northwestern Hawaiian Islands Stocks, in the Hawaii-Southern California Training and Testing 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
Baja	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.

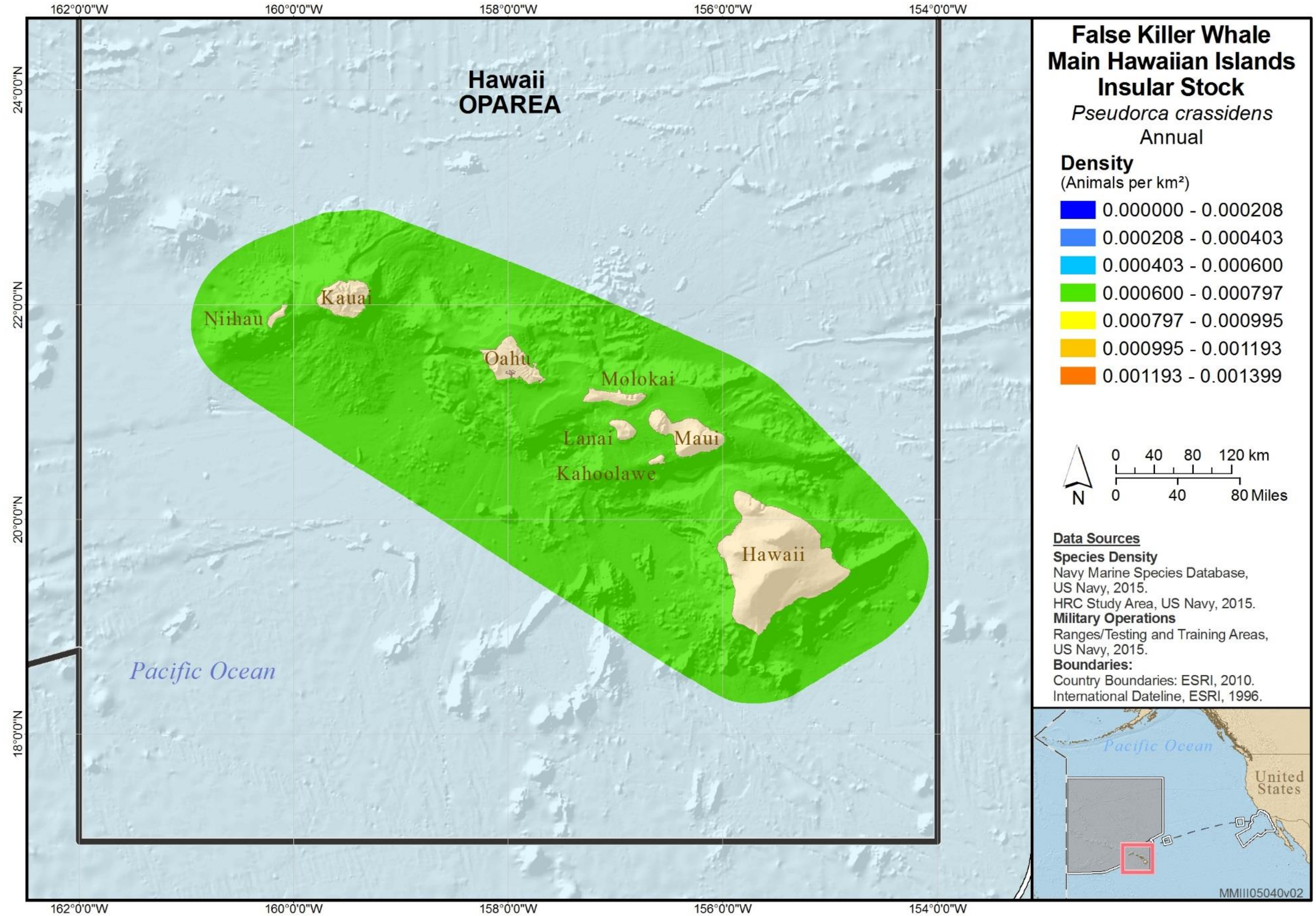


Figure 7-23: Annual Distribution of False Killer Whale Main Hawaiian Islands Insular Stock in HRC and the Western Portion of the Transit Corridor

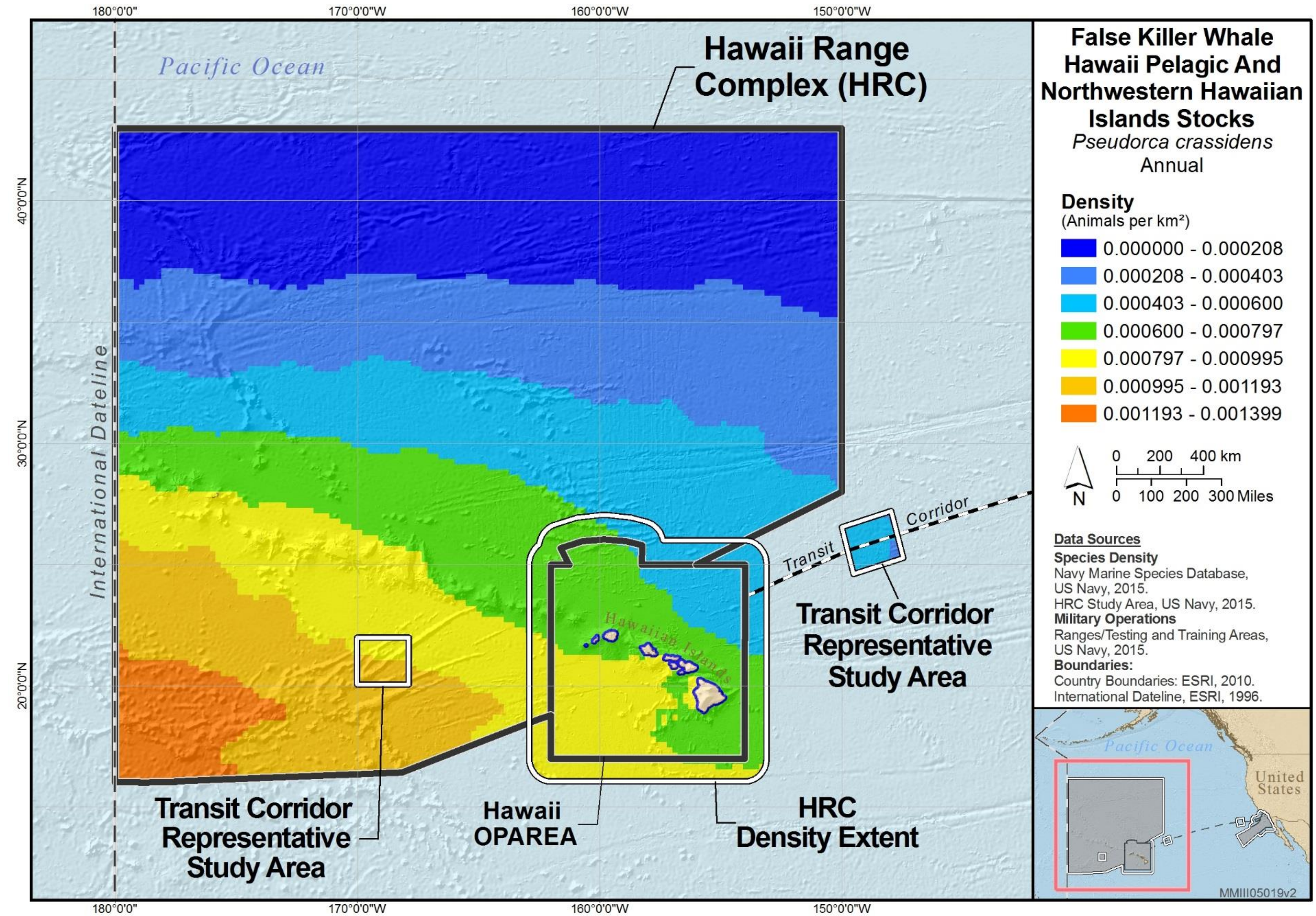


Figure 7-24: Annual Distribution of False Killer Whale Hawaii Pelagic and Northwestern Hawaiian Islands Stocks in HRC and the Western Portion of the Transit Corridor

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., 2015; Perrin et al., 2009). 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., 2015; 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., 2015). 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., 2015). 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., 2015; 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 (Baird, 2015). NMFS recognizes four management stocks within the U.S. EEZ of the Hawaiian Islands: (1) the Oahu stock, (2) the 4-Islands stock, (3) the Hawaii Island stock, and (4) the Hawaii Pelagic stock (Carretta et al., 2017). Given published range boundaries for these stocks (Carretta et al., 2017; Oleson et al., 2013), and estimating average stock density based on spotted dolphin density estimates for the North Pacific, the Navy was able to develop stock-specific density estimates for pantropical spotted dolphins.

HRC: Oahu Stock. Based on an average of spotted dolphin density in the North Pacific, in concert with this stock's range boundaries (i.e., extending from the coast out to 20 km of Oahu), the resulting density estimate of 0.072 animals/km^2 (CV = 0.45) was applied to the area encompassing the range of the Oahu stock. The Navy applied this estimate to all seasons. Inclusion of this new spatially-explicit density layer more accurately reflects the distribution of this island-associated population and represents an improvement to the NMSDD for Phase III.

HRC: 4-Islands Stock. Based on an average of spotted dolphin density in the North Pacific, in concert with this stock's range boundaries (i.e., within 20 km of the island group formed by Maui, Molokai, Lanai, and Kahoolawe and their adjacent waters), the resulting density estimate of 0.061 animals/km^2 (CV = 0.48) was applied to the area encompassing the range of the 4-Islands stock. The Navy applied this estimate to all seasons. Inclusion of this new spatially-explicit density layer more accurately reflects the distribution of this island-associated population and represents an improvement to the NMSDD for Phase III.

HRC: Hawaii Island Stock. Based on an average of spotted dolphin density in the North Pacific, in concert with this stock's range boundaries (i.e., within 65 km from Hawaii Island), the resulting density estimate of 0.061 animals/km^2 (CV = 0.48) was applied to the area encompassing the range of the Hawaii Island stock. The Navy applied this estimate to all seasons. Inclusion of this new spatially-explicit density layer more accurately reflects the distribution of this island-associated population and represents an improvement to the NMSDD for Phase III.

HRC: Hawaii Pelagic Stock. The Phase II NMSDD included the first CENPAC habitat-based density model for pantropical spotted dolphins based on systematic survey data collected from 1997 to 2006 (Becker et al., 2012c). More recently, Forney et al. (2015) updated the CENPAC habitat-based models of cetacean densities using additional survey data collected within the Hawaiian Islands EEZ in 2010 and in waters surrounding Palmyra Atoll/Kingman Reef in 2011 and 2012. In addition, improved modeling methods were used that allowed model predictions to be applied directly on a 25 km × 25 km spatial grid. These models cover the entire HRC and provide representative density values for the two western transit corridor study areas. Given the transect coverage on the surveys that contributed data to the habitat models, the majority of the spotted dolphin sightings were from the Hawaii Pelagic stock. The Navy thus used the updated CENPAC pantropical spotted dolphin spatial model to represent this stock and applied the model to all seasons for HRC and the western portion of the transit corridor. Since the Hawaii pelagic stock includes spotted dolphins inhabiting the waters throughout the Hawaiian Islands EEZ outside of the insular stock areas, these areas were assigned zero values in the habitat-based density model layer.

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

Table 7-13: Summary of Density Values for Pantropical Spotted Dolphin, Oahu Stock, in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
Stock range*	0.072	0.072	0.072	0.072
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
Baja	0	0	0	0

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

*The stock range is only a portion of the HRC; it is not the entire HRC.

Table 7-14: Summary of Density Values for Pantropical Spotted Dolphin, 4-Islands Stock, in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
Stock range*	0.061	0.061	0.061	0.061
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
Baja	0	0	0	0

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

*The stock range is only a portion of the HRC; it is not the entire HRC.

Table 7-15: Summary of Density Values for Pantropical Spotted Dolphin, Hawaii Island Stock, in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
Stock range*	0.061	0.061	0.061	0.061
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
Baja	0	0	0	0

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

*The stock range is only a portion of the HRC; it is not the entire HRC.

Table 7-16: Summary of Density Values for Pantropical Spotted Dolphin, Hawaii Pelagic Stock, in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
Stock Range	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
Baja	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.

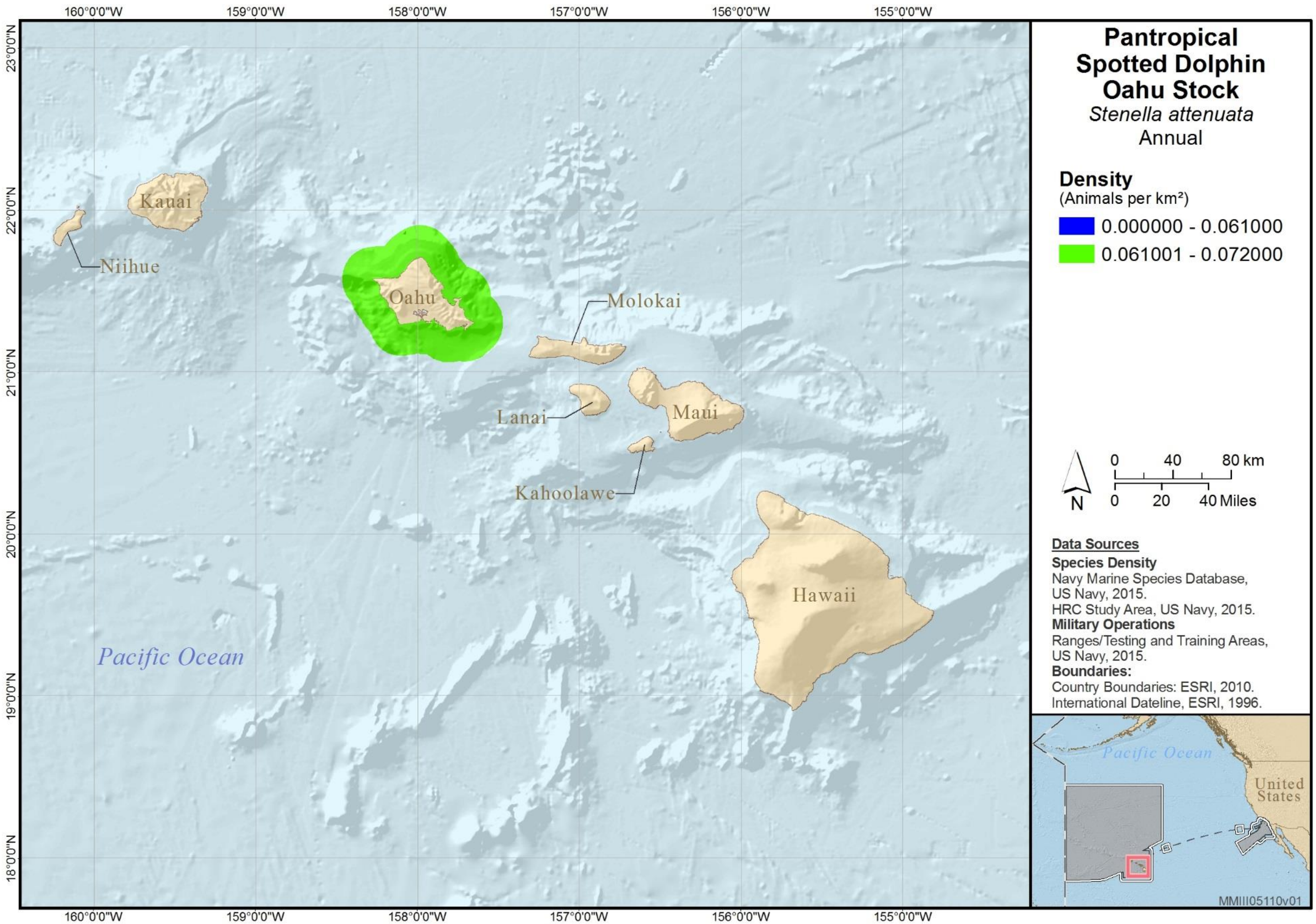


Figure 7-25: Annual Distribution of Pantropical Spotted Dolphin Oahu Stock in HRC and the Western Portion of the Transit Corridor

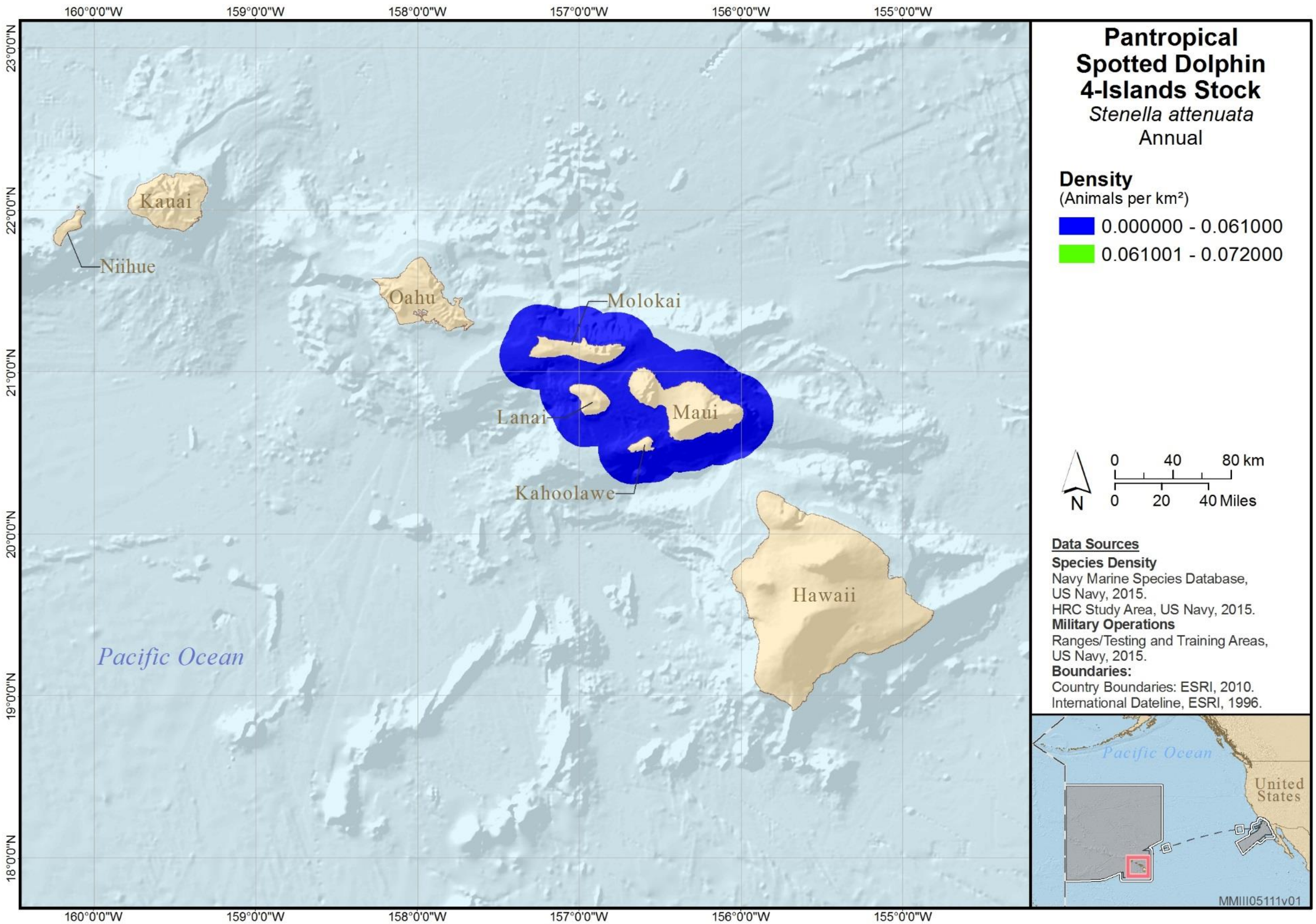


Figure 7-26: Annual Distribution of Pantropical Spotted Dolphin 4-Islands Stock in HRC and the Western Portion of the Transit Corridor

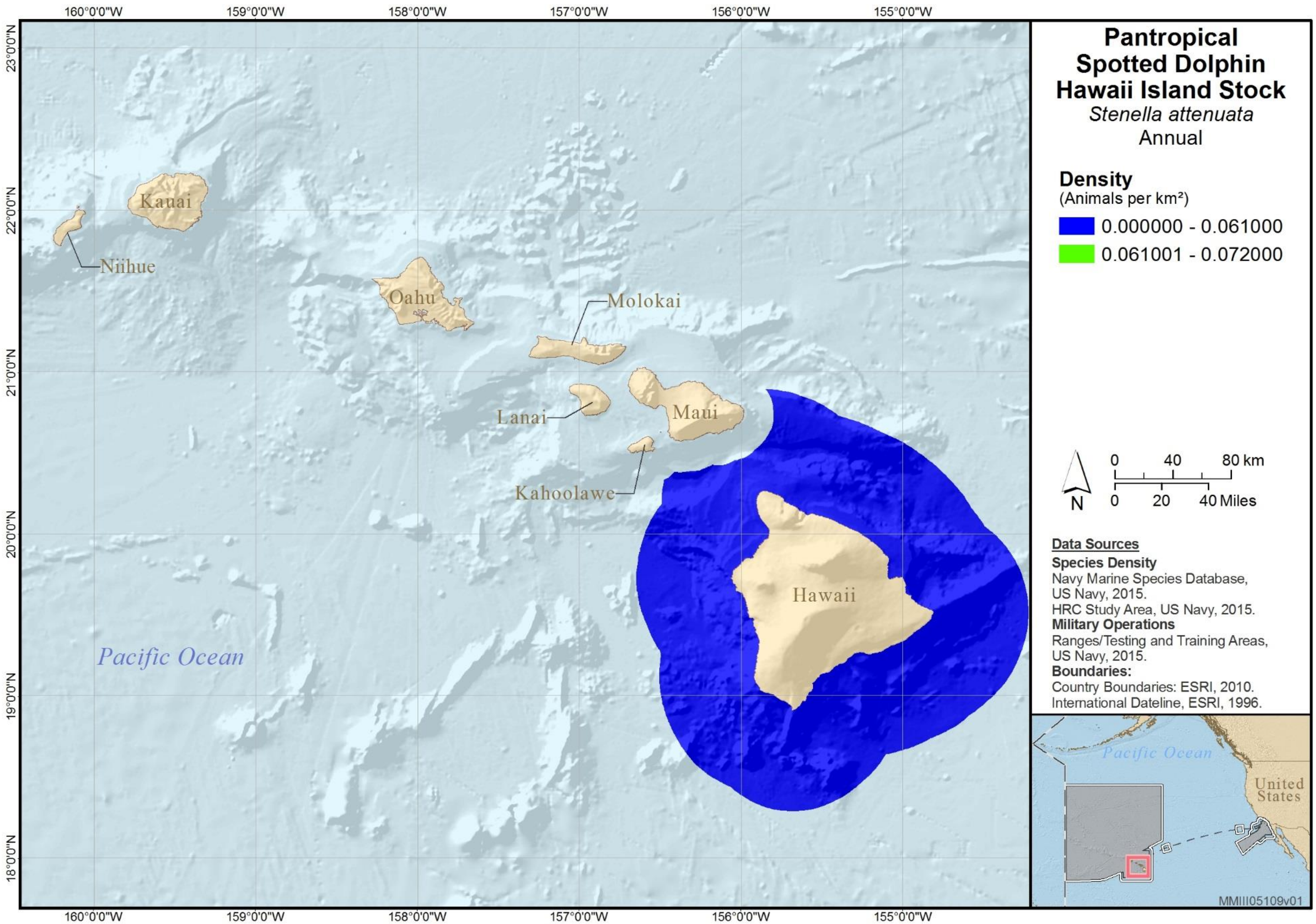


Figure 7-27: Annual Distribution of Pantropical Spotted Dolphin Hawaii Island Stock in HRC and the Western Portion of the Transit Corridor

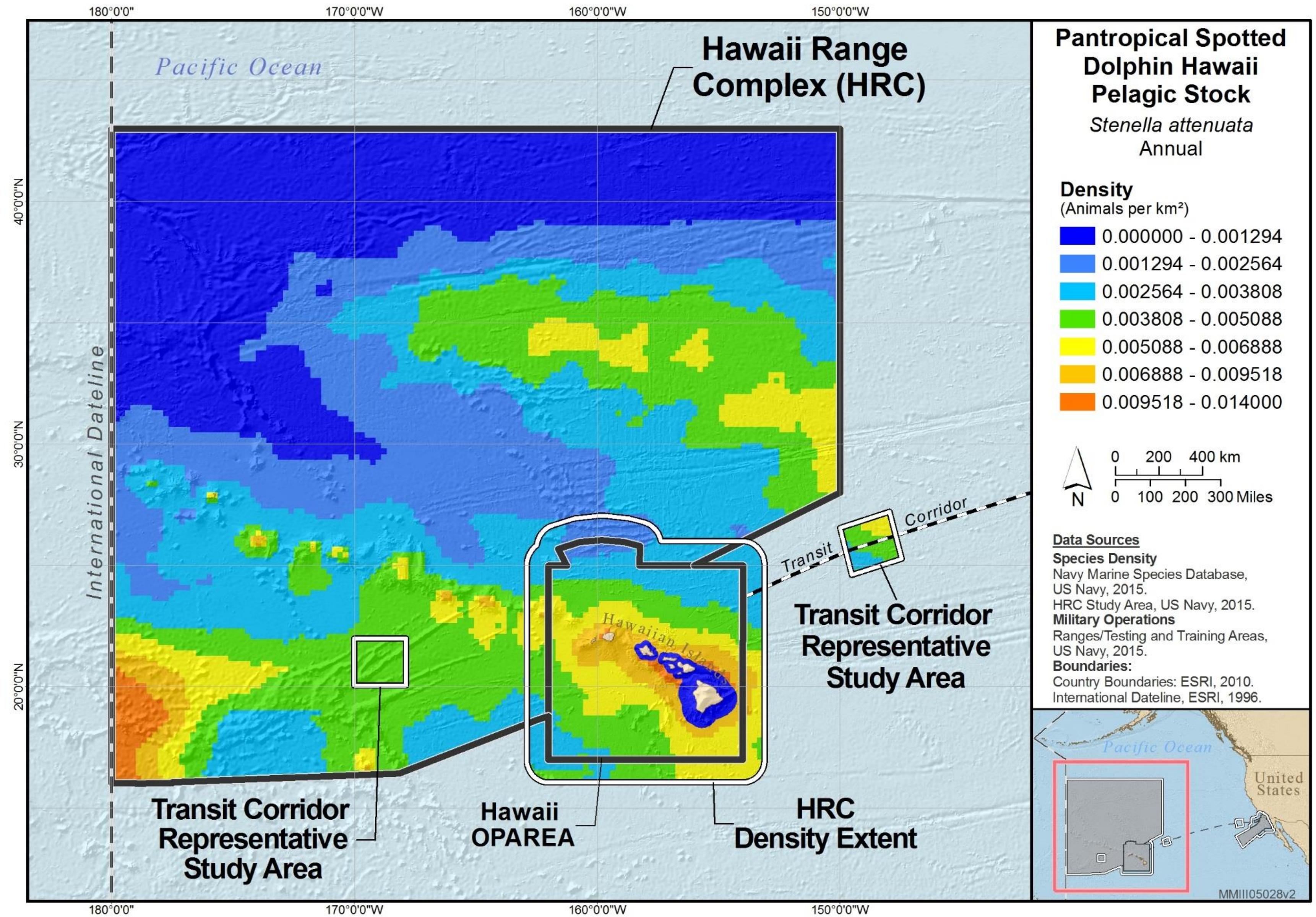


Figure 7-28: Annual Distribution of Pantropical Spotted Dolphin Hawaii Pelagic Stock in HRC and the Western Portion of the Transit Corridor

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., 2015). 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., 2015). 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., 2015). 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., 2015; 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 & Perrin, 1999). NMFS recognizes a Hawaiian stock of striped dolphins and a California/Oregon/Washington stock (Carretta et al., 2017). 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 & Kasuya, 1993).

HRC. The Phase II NMSDD included the first CENPAC habitat-based density model for striped dolphin based on systematic survey data collected from 1997 to 2006 (Becker et al., 2012c). More recently, Forney et al. (2015) updated the CENPAC habitat-based models of cetacean densities using additional survey data collected within the Hawaiian Islands EEZ in 2010 and in waters surrounding Palmyra Atoll/Kingman Reef in 2011 and 2012. In addition, improved modeling methods were used that allowed model predictions to be applied directly on a 25 km × 25 km spatial grid. These models cover the entire HRC and provide representative density values for the two western transit corridor study areas. The updated CENPAC striped dolphin spatial model was applied to all seasons for HRC and the western portion of the transit corridor.

SOCAL. The Phase II NMSDD included a CCE habitat-based density model for striped dolphin based on systematic survey data collected from 1991 to 2008 (Becker et al., 2012b). The model provided spatially-explicit density estimates off the U.S. west coast for summer and fall. More recently, Becker et al. (2016) updated the CCE habitat-based models of cetacean densities using additional survey data collected primarily off Southern California in 2009. In addition, improved modeling methods were used that allowed species-specific and segment-specific estimates of both effective strip width and trackline detection probability to be incorporated into the models based on the recorded viewing conditions on that segment using coefficients estimated by Barlow et al. (2011) for effective strip width and Barlow (2015) for trackline detection probability. Density predictions from the updated models are grid-based at a pixel resolution of 10 km x 10 km, providing finer spatial resolution and eliminating interpolation artifacts sometimes present in the previous CCE models (Becker et al., 2016). Density estimates from the updated striped dolphin model were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for all seasons.

Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint and were also corrected for new estimates of trackline detection probability derived by Barlow (2015). The resulting striped dolphin uniform density estimate of 0.13823 animals/km^2 (CV = 0.31) was used for all seasons. Given the overlap of the Ferguson and Barlow strata used to recalculate densities (refer to Figure 3-7), this value is also applicable to the remainder of the SOCAL Range Complex.

Table 7-17: Summary of Density Values for Striped Dolphin in the Hawaii-Southern California Training and Testing Study Area

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	S	S	S	S
Baja	0.13823	0.13823	0.13823	0.13823

The units for numerical values are animals/km^2; S = spatial model with various density values throughout the range.

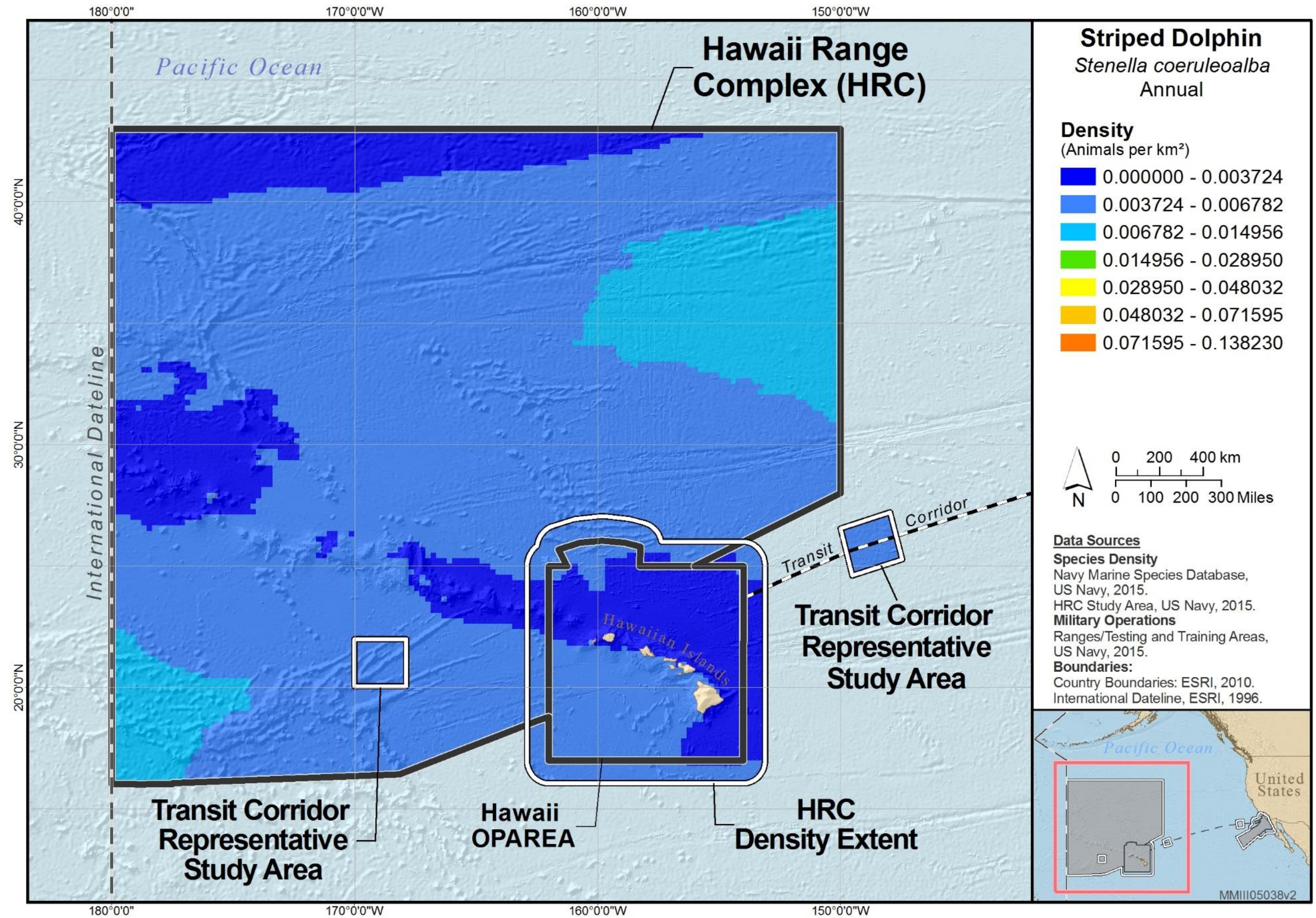


Figure 7-29: Annual Distribution of Striped Dolphin in HRC and the Western Portion of the Transit Corridor

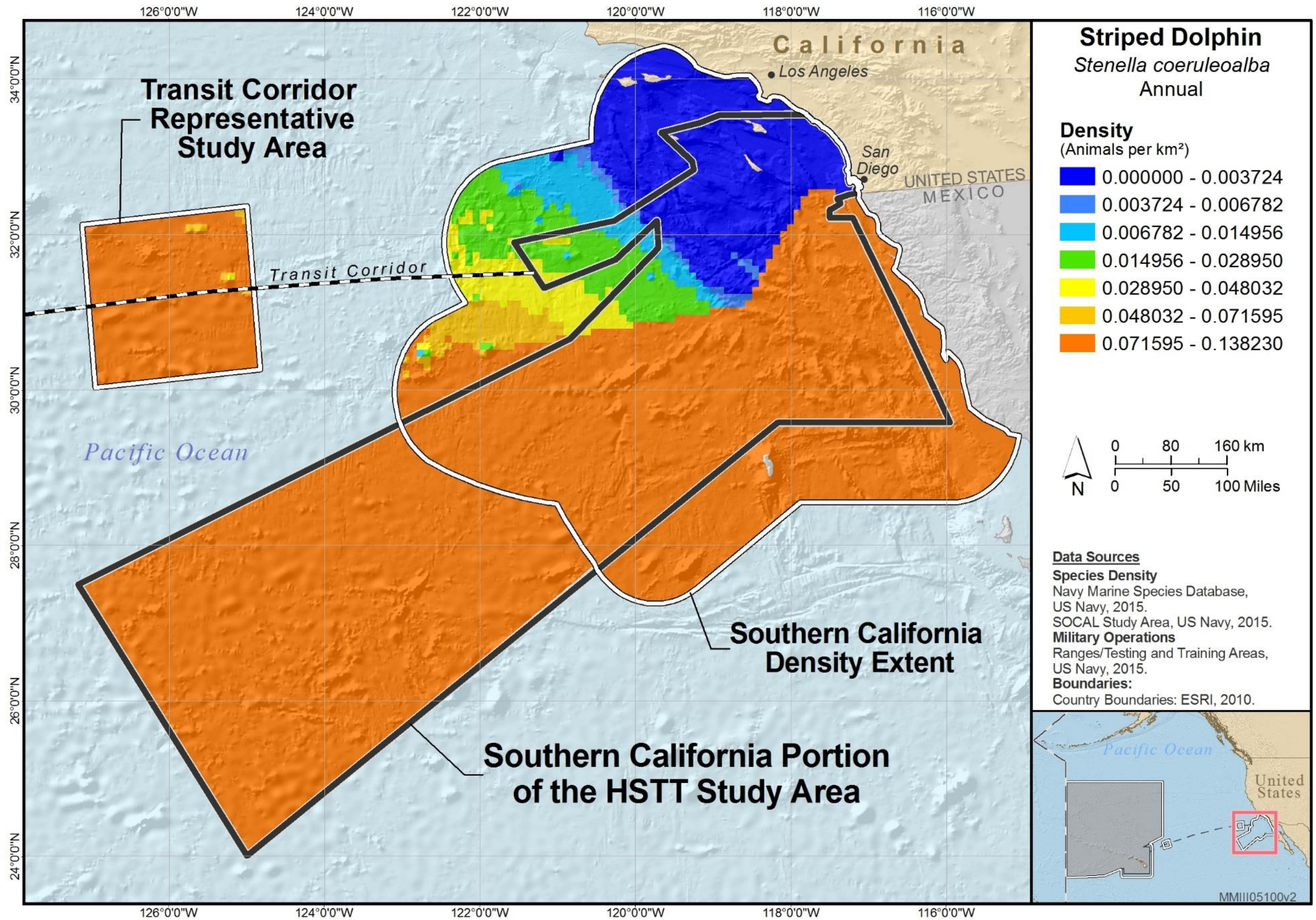


Figure 7-30: Annual Distribution of Striped Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

7.1.14 *STENELLA LONGIROSTRIS*, SPINNER DOLPHIN

This well-known tropical dolphin is small-bodied and has a very long beak (Jefferson et al., 2015). Adult males develop a post-anal "hump" in what is otherwise a thin tail stock (Allen et al., 2011; Jefferson et al., 2015). 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* 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., 2015; 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 & Dohl, 1980; Norris et al., 1994). Spinner dolphins do associate with other species; a common association is with pantropical spotted dolphins (Jefferson et al., 2015; Kiszka et al., 2011; 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 et al., 2009). NMFS recognizes a stock complex of spinner dolphins for the Hawaiian Islands (Carretta et al., 2017). The complex includes a Hawaii Island stock, Oahu/4-islands stock, a Kauai/Niihau stock, a Pearl and Hermes Reef stock, a Midway Atoll/Kure stock, and a Hawaii Pelagic stock. Spinner dolphins in the eastern tropical Pacific are managed separately (Carretta et al., 2017). The Pearl and Hermes Reef and Midway Atoll/Kure stocks are not expected to occur within the HRC study area. Abundance estimates are available for the Hawaii Island, Oahu/4-islands, and Kauai/Niihau stocks (Hill et al., 2011; Tyne et al., 2014), and in concert with established range boundaries, the Navy was able to develop stock-specific density estimates for these populations.

HRC: Hawaii Island Stock. Based on recent analyses (Tyne et al., 2014), the current abundance estimate for the Hawaii Island stock of spinner dolphins is 631 (CV = 0.09). Given this stock's boundaries (i.e., extending from the coast out to 10 nm from shore), the approximate range area was calculated as 9,498.85 km^2, resulting in a density estimate of 0.066 animals/km^2. This estimate was applied to the area encompassing the range of the Hawaii Island stock. The Navy applied this estimate to all seasons. Inclusion of this new spatially-explicit density layer more accurately reflects the distribution of this island-associated population and represents an improvement to the NMSDD for Phase III.

HRC: Oahu/4-islands Stock. Based on recent analyses (Hill et al., 2011), the current abundance estimate for the Oahu/4-islands stock of spinner dolphins is 355 (CV = 0.09). Given this stock's boundaries (i.e., extending from the coasts of the islands out to 10 nm from shore), the approximate range area was calculated as 15,387.57 km^2, resulting in a density estimate of 0.023 animals/km^2. This estimate was applied to the area encompassing the range of the Oahu/4-islands stock. The Navy applied this estimate to all seasons. Inclusion of this new spatially-explicit density layer more accurately reflects the distribution of this island-associated population and represents an improvement to the NMSDD for Phase III.

HRC: Kauai/Niihau Stock. Based on recent analyses (Hill et al., 2011), the current abundance estimate for the Kauai/Niihau stock of spinner dolphins is 611 (CV = 0.20). Given this stock's boundaries (i.e., extending from the coasts of the islands out to 10 nm from shore), the approximate range area was calculated as 6,214.22 km^2, resulting in a density estimate of 0.097 animals/km^2. This estimate was applied to the area encompassing the range of the Kauai/Niihau stock. The Navy applied this estimate to all seasons. Inclusion of this new spatially-explicit density layer more accurately reflects the distribution of this island-associated population and represents an improvement to the NMSDD for Phase III.

HRC: Hawaii Pelagic Stock. The Phase II NMSDD included the first CENPAC habitat-based density model for spinner dolphins based on systematic survey data collected from 1997 to 2006 (Becker et al., 2012c). More recently, Forney et al. (2015) updated the CENPAC habitat-based models of cetacean densities using additional survey data collected within the Hawaiian Islands EEZ in 2010 and in waters surrounding Palmyra Atoll/Kingman Reef in 2011 and 2012. In addition, improved modeling methods were used that allowed model predictions to be applied directly on a 25 km × 25 km spatial grid. These models cover the entire HRC and provide representative density values for the two western transit corridor study areas. Given the transect coverage on the surveys that contributed data to the habitat models, the majority of the spinner dolphin sightings were from the Hawaii Pelagic stock. The Navy thus used the updated CENPAC spinner dolphin spatial model to represent this stock and applied the model to all seasons for HRC and the western portion of the transit corridor. Since animals seen within 10 nm of each of the main Hawaiian Islands are considered to belong to the insular stocks described above, these areas were assigned zero values in the habitat-based density model layer.

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

Table 7-18: Summary of Density Values for Spinner Dolphin, Hawaii Island Stock, in the HSTT Study Area

Location	Spring	Summer	Fall	Winter
Stock range*	0.066	0.066	0.066	0.066
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
Baja	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.

*The stock range is only a portion of the HRC; it is not the entire HRC.

Table 7-19: Summary of Density Values for Spinner Dolphin, Oahu/4-islands Stock, in the HSTT Study Area

Location	Spring	Summer	Fall	Winter
Stock range*	0.023	0.023	0.023	0.023
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
Baja	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.
*The stock range is only a portion of the HRC; it is not the entire HRC.

Table 7-20: Summary of Density Values for Spinner Dolphin, Kauai/Niihau Stock, in the HSTT Study Area

Location	Spring	Summer	Fall	Winter
Stock range	0.097	0.097	0.097	0.097
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
Baja	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.
*The stock range is only a portion of the HRC; it is not the entire HRC.

Table 7-21: Summary of Density Values for Spinner Dolphin, Hawaii Pelagic Stock, 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
Baja	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.

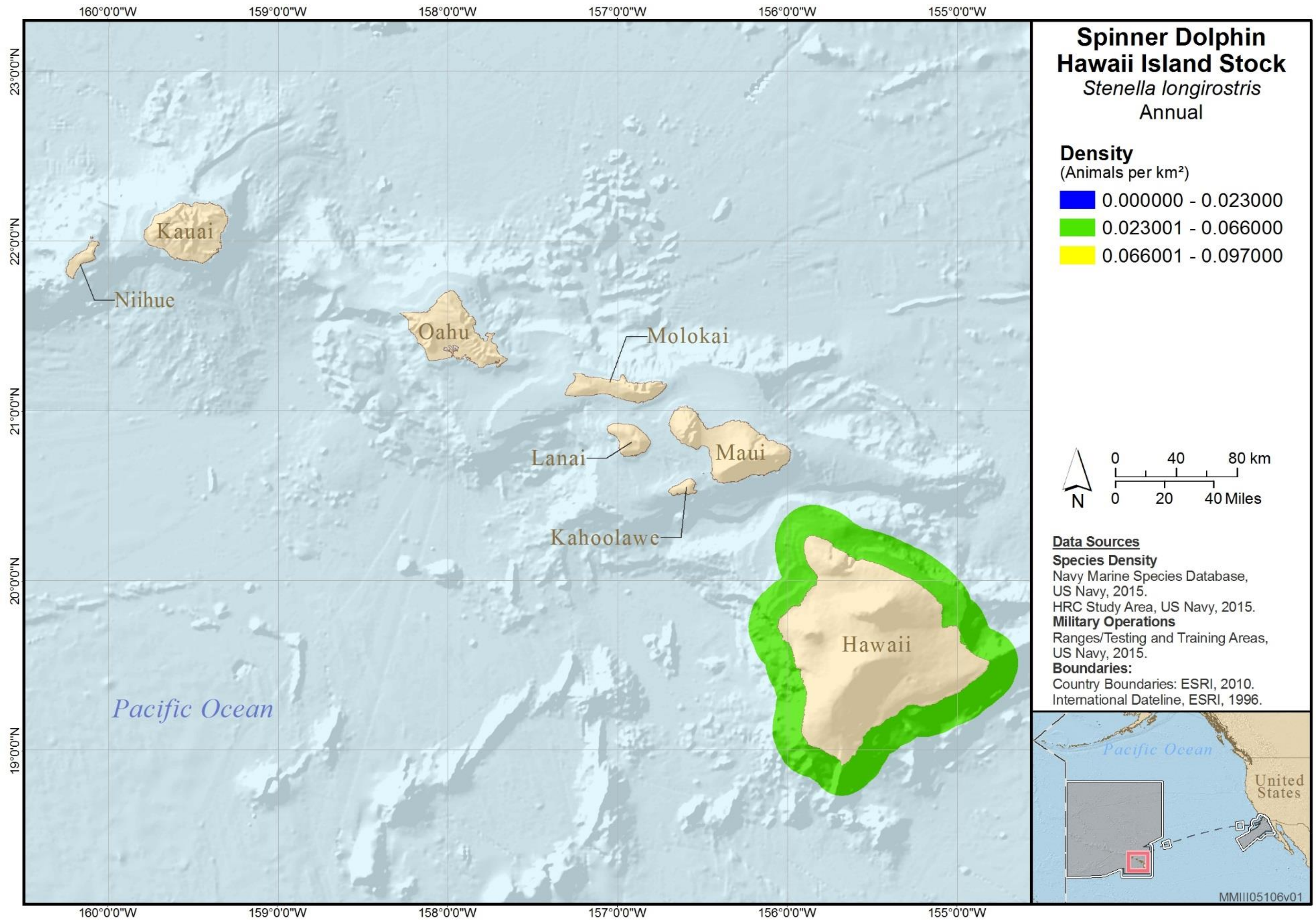


Figure 7-31: Annual Distribution of Spinner Dolphin Hawaii Island Stock in HRC and the Western Portion of the Transit Corridor

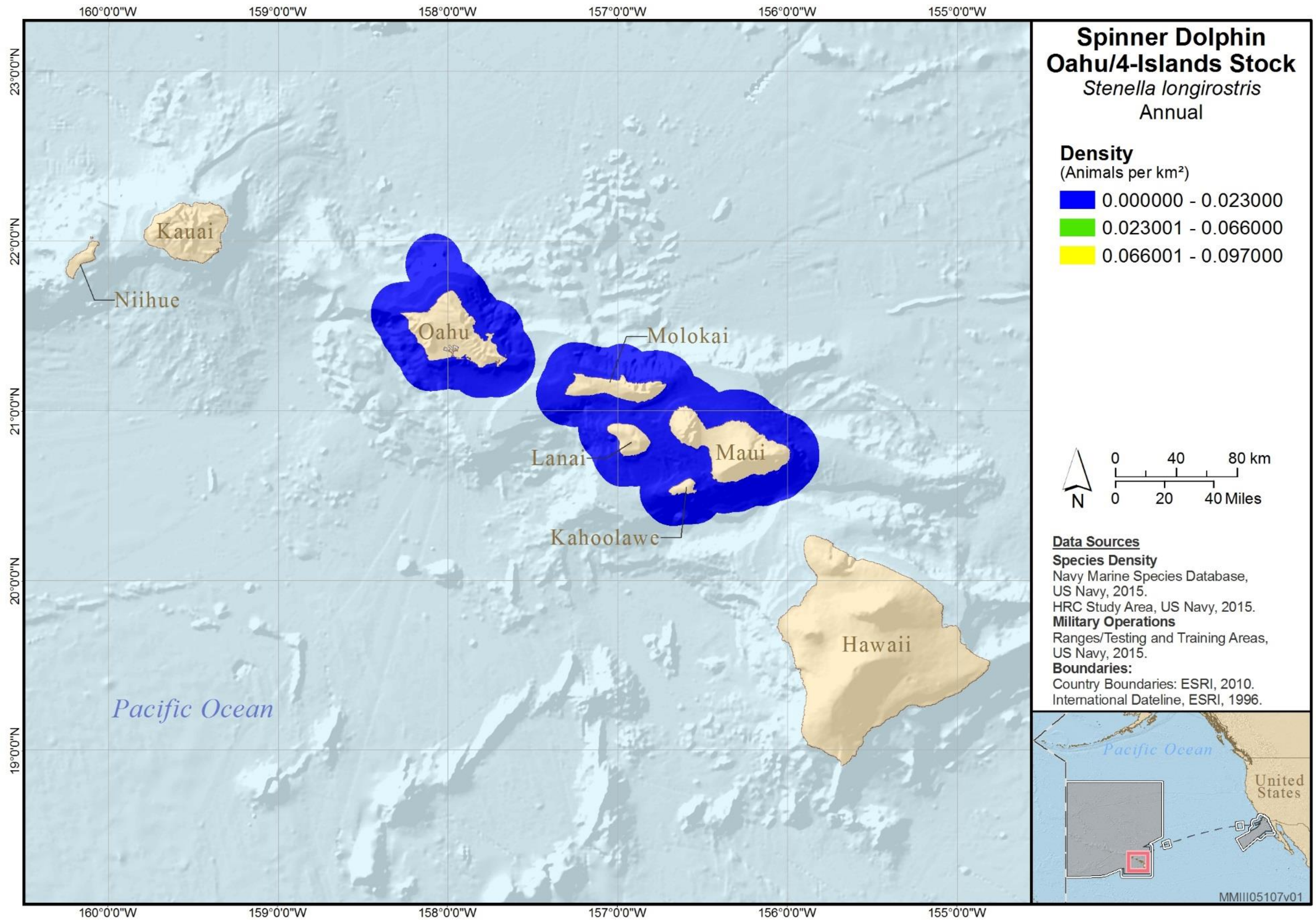


Figure 7-32: Annual Distribution of Spinner Dolphin Oahu/4-Islands Stock in HRC and the Western Portion of the Transit Corridor

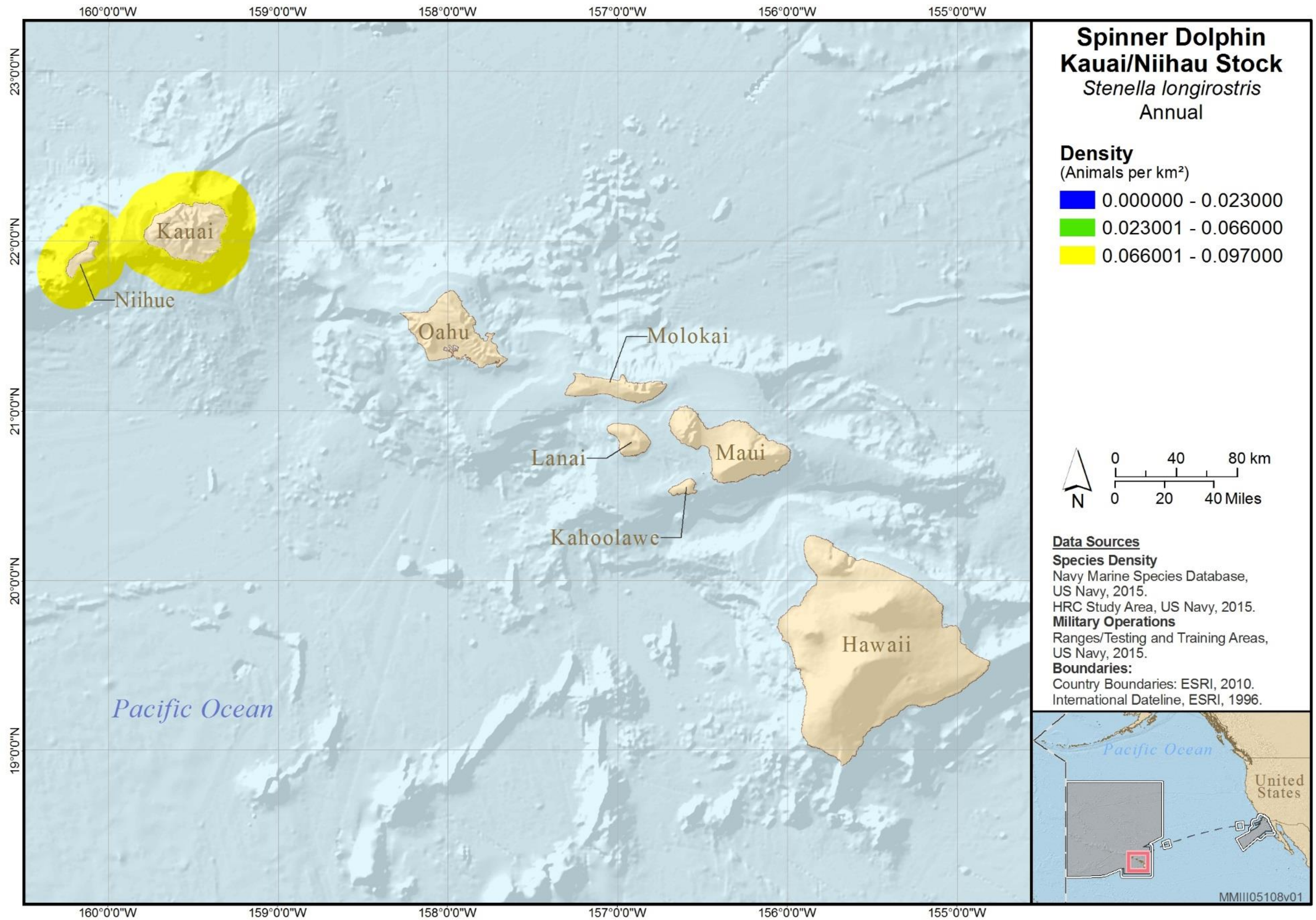


Figure 7-33: Annual Distribution of Spinner Dolphin Kauai/Niihau Stock in HRC and the Western Portion of the Transit Corridor

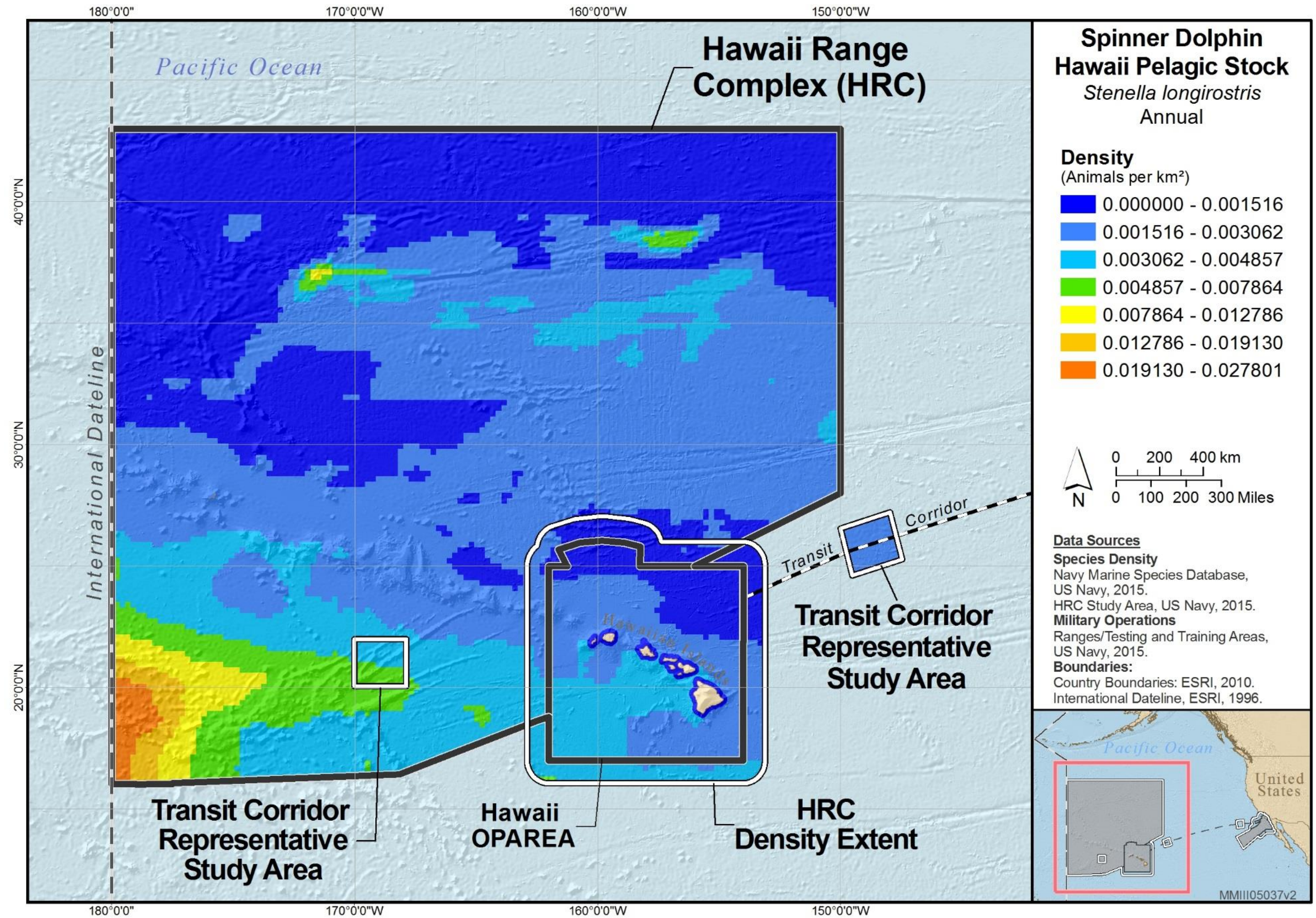


Figure 7-34: Annual Distribution of Spinner Dolphin Hawaii Pelagic Stock in HRC and the Western Portion of the Transit Corridor

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., 2015; 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., 2015; 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, 2009–2014). 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., 2017).

HRC. The Phase II NMSDD included the first CENPAC habitat-based density model for rough-toothed dolphin based on systematic survey data collected from 1997 to 2006 (Becker et al., 2012c). More recently, Forney et al. (2015) updated the CENPAC habitat-based models of cetacean densities using additional survey data collected within the Hawaiian Islands EEZ in 2010 and in waters surrounding Palmyra Atoll/Kingman Reef in 2011 and 2012. In addition, improved modeling methods were used that allowed model predictions to be applied directly on a 25 km × 25 km spatial grid. These models cover the entire HRC and provide representative density values for the two western transit corridor study areas. The updated CENPAC rough-toothed dolphin spatial model was applied to all seasons for HRC and the western portion of the transit corridor.

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

Table 7-22: Summary of Density Values for Rough-Toothed Dolphin in the Hawaii-Southern California Training and Testing 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
Baja	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.

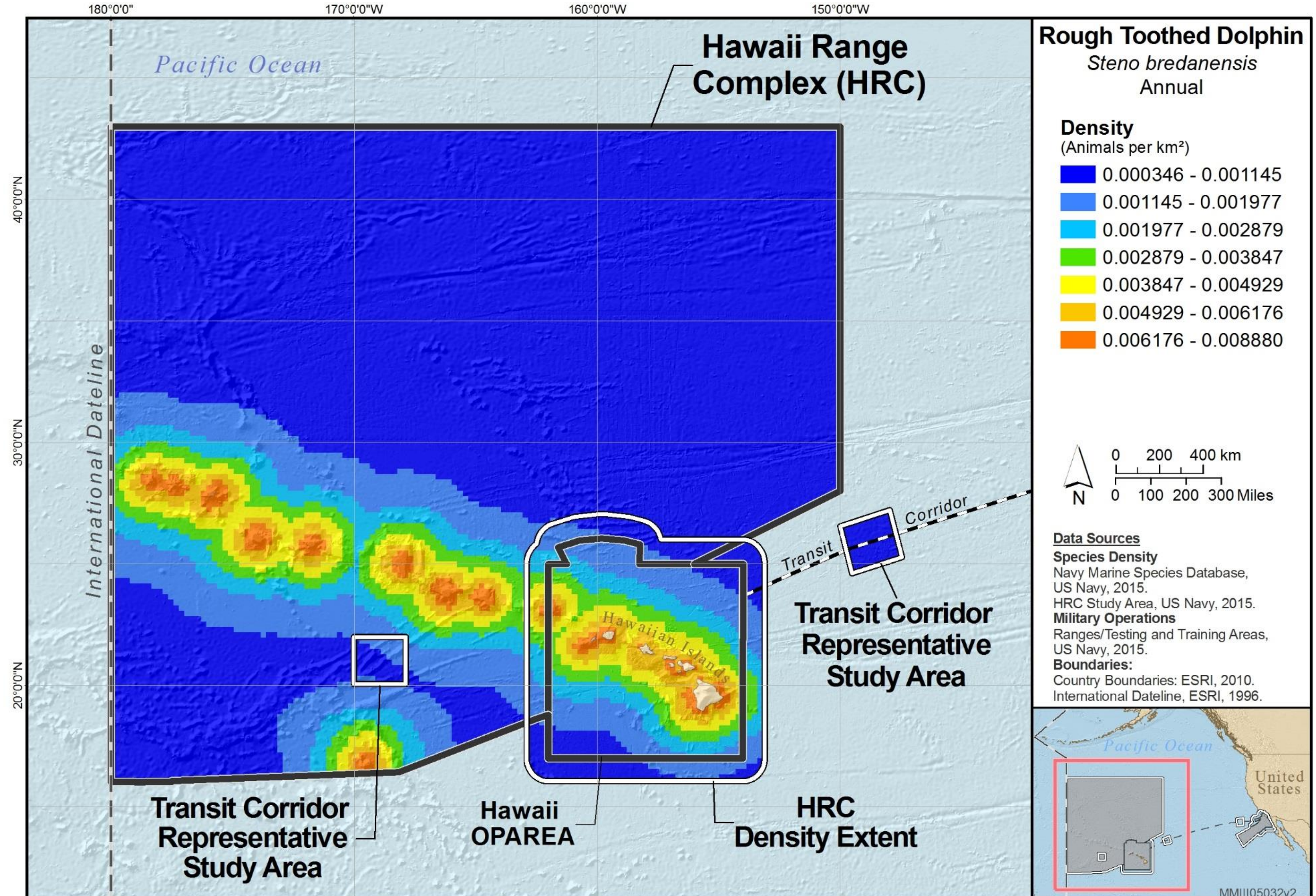


Figure 7-35: Annual Distribution of Rough-Toothed Dolphin in HRC and the Western Portion of the Transit Corridor

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 counter shaded with white (occasionally with a pinkish tinge) sometimes on the ventral side (Allen et al., 2011; Jefferson et al., 2015). 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., 2015; 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., 2015). 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 & 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., 2011; Leatherwood et al., 1988; Querouil et al., 2008; Wells & 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 et al., 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., 2017). The Hawaiian Islands Stock Complex includes an Oahu stock, a 4-islands stock, a Kauai/Niihau stock, a Hawaii Island stock, and a Hawaii Pelagic stock. Abundance estimates are available for the Oahu, 4-islands, Kauai/Niihau, and Hawaii Island stocks (Baird et al., 2009) and, in concert with established range boundaries, the Navy was able to develop stock-specific density estimates for these populations. In SOCAL, density values are separated out by the coastal and offshore stocks.

HRC: Oahu Stock. Based on recent analyses (Baird et al., 2009), the current abundance estimate for the Oahu stock of common bottlenose dolphins is 743 (CV = 0.54). Given this stock’s boundaries (i.e., extending from the coast of the island out to the 1,000 m isobath), the approximate range area was calculated as 3,972.86 km^2, resulting in a density estimate of 0.187 animals/km^2. This estimate was applied to the area encompassing the range of the Oahu stock (note that since the 1,000 m isobath does not separate Oahu from the 4-Islands region, the boundary between these stocks runs approximately equidistant between the 500 m isobaths around Oahu and the 4- Islands region). The Navy applied this estimate to all seasons. Inclusion of this new spatially-explicit density layer more accurately reflects the distribution of this island-associated population and represents an improvement to the NMSDD for Phase III.

HRC: 4-islands Stock. Based on recent analyses (Baird et al., 2009), the current abundance estimate for the 4-islands stock of common bottlenose dolphins is 191 (CV = 0.24). Given this stock's boundaries (i.e., extending from the coast of the island out to the 1,000 m isobath), the approximate range area was calculated as 11,069.20 km^2, resulting in a density estimate of 0.017 animals/km^2. This estimate was applied to the area encompassing the range of the 4-islands stock (note that since the 1,000 m isobath does not separate Oahu from the 4-islands region, the boundary between these stocks runs approximately equidistant between the 500 m isobaths around Oahu and the 4- Islands region). The Navy applied this estimate to all seasons. Inclusion of this new spatially-explicit density layer more accurately reflects the distribution of this island-associated population and represents an improvement to the NMSDD for Phase III.

HRC: Kauai/Niihau Stock. Based on recent analyses (Baird et al., 2009), the current abundance estimate for the Kauai/Niihau stock of common bottlenose dolphins is 184 (CV = 0.11). Given this stock's boundaries (i.e., extending from the coast of the island out to the 1,000 m isobath), the approximate range area was calculated as 2,820.28 km^2, resulting in a density estimate of 0.065 animals/km^2. This estimate was applied to the area encompassing the range of the Kauai/Niihau stock. The Navy applied this estimate to all seasons. Inclusion of this new spatially-explicit density layer more accurately reflects the distribution of this island-associated population and represents an improvement to the NMSDD for Phase III.

HRC: Hawaii Island Stock. Based on recent analyses (Baird et al., 2009), the current abundance estimate for the Hawaii Island stock of common bottlenose dolphins is 128 (CV = 0.13). Given this stock's boundaries (i.e., extending from the coast of the island out to the 1,000 m isobath), the approximate range area was calculated as 4,652.37 km^2, resulting in a density estimate of 0.028 animals/km^2. This estimate was applied to the area encompassing the range of the Hawaii Island stock. The Navy applied this estimate to all seasons. Inclusion of this new spatially-explicit density layer more accurately reflects the distribution of this island-associated population and represents an improvement to the NMSDD for Phase III.

HRC: Hawaii Pelagic Stock. The Phase II NMSDD included the first CENPAC habitat-based density model for common bottlenose dolphins based on systematic survey data collected from 1997 to 2006 (Becker et al., 2012c). More recently, Forney et al. (2015) updated the CENPAC habitat-based models of cetacean densities using additional survey data collected within the Hawaiian Islands EEZ in 2010 and in waters surrounding Palmyra Atoll/Kingman Reef in 2011 and 2012. In addition, improved modeling methods were used that allowed model predictions to be applied directly on a 25 km × 25 km spatial grid. These models cover the entire HRC and provide representative density values for the two western transit corridor study areas. Given the transect coverage on the surveys that contributed data to the habitat models, the majority of the common bottlenose dolphin sightings were from the Hawaii Pelagic stock. The Navy thus used the updated CENPAC common bottlenose dolphin spatial model to represent this stock and applied the model to all seasons for HRC and the western portion of the transit corridor. Since animals seen within the 1,000 m isobaths of each of the main Hawaiian Islands are considered to belong to the insular stocks described above, these areas were assigned zero values in the habitat-based density model layer.

SOCAL: **California/Oregon/Washington Offshore Stock.** A habitat-based density model was not available for Phase II of the NMSDD, so stratified uniform density estimates were used for the SWFSC CCE study area (Barlow & Forney, 2007) and for waters off Baja (Ferguson & Barlow, 2003). More recently, Becker et al. (2016) was able to develop a CCE habitat-based density model for the offshore stock of common bottlenose dolphin based on survey data collected off the U.S. west coast from 1991 to 2008, and off Southern California in 2009. The model provides spatially-explicit density estimates off the U.S. west coast for summer and fall. The model was built using improved methods that allowed species-specific and segment-specific estimates of both effective strip width and trackline detection probability to be incorporated into the models based on the recorded viewing conditions on that segment using coefficients estimated by Barlow et al. (2011) for effective strip width and Barlow (2015) for trackline detection probability. Density predictions from the updated models are grid-based at a pixel resolution of 10 km x 10 km (Becker et al., 2016). Density estimates from the common bottlenose dolphin model were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for summer and fall.

There are currently no updated common bottlenose density estimates available for the winter and spring seasons in Southern California waters, so the Phase II NMSDD uniform density value of 0.06836 animals/km^2 (CV = 0.501) was used for the Navy's SOCAL acoustic modeling study area, as well as the eastern portion of the transit corridor for winter and spring. This value is a uniform density estimate derived by Forney et al. (1995) as reported in Barlow et al. (2009).

Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint and were also corrected for new estimates of trackline detection probability derived by Barlow (2015). The resulting common bottlenose dolphin uniform density estimate of 0.00843 animals/km^2 (CV = 0.40) was used for all seasons. Given the overlap of the Ferguson and Barlow strata used to recalculate densities (refer to Figure 3-7), this value is also applicable to the remainder of the SOCAL Range Complex.

SOCAL: **California Coastal Stock.** This stock is found within approximately 1 km from the shore primarily from Monterey, California to Ensenada, Baja Mexico (Defran & Weller, 1999). Photo identification studies have shown that although this stock stays very close to shore, individuals are highly mobile and routinely travel north and south within this range (Hwang et al., 2014). Recent photo identification analyses suggest that separate California coastal and coastal Northern Baja California stocks exist, with very limited mixing between them (Defran et al., 2015). Carretta (2012) developed spatially-explicit density estimates for the California Coastal stock of common bottlenose dolphin based on a set of aerial surveys conducted between 1990 and 2000 (Carretta et al., 1998). On-effort sightings were used to estimate density for individual 10 km^2 grid cells located within 1 km from the shore. The Navy applied these estimate to all seasons. Inclusion of this new spatially-explicit density layer more accurately reflects the distribution of this coastal population and represents an improvement to the NMSDD for Phase III. Based on a comparison of mark-recapture abundance estimates, the California Coastal Stock of bottlenose dolphins appeared to be stable from 1987 to 2005 (Dudzik et al., 2006). However, more recent photo identification surveys in the San Diego area from 2009−2011 suggest the population may be increasing (Weller et al., 2016). The new abundance estimates of 453−515 are the highest to date, and include previously undocumented individuals (Weller et al., 2016). Further study is necessary to determine if this is a true increase in population or a result of interannual variation, movement of animals north from Mexican waters, or survey effort/duration.

Dudzik et al. (2006) provide a uniform density of 0.3612 dolphins/km^2 within 1 km of the coast and this value was applied to the Baja California coast.

Table 7-23: Summary of Density Values for Common Bottlenose Dolphin, Oahu Stock, in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
Stock range*	0.187	0.187	0.187	0.187
W. Transit Corridor	0	0	0	0

The units for numerical values are animals/km^2. S = spatial model with various density values throughout the range.
*The stock range is only a portion of the HRC; it is not the entire HRC.

Table 7-24: Summary of Density Values for Common Bottlenose Dolphin, 4-Islands Stock, in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
Stock range*	0.017	0.017	0.017	0.017
W. Transit Corridor	0	0	0	0

The units for numerical values are animals/km^2. S = spatial model with various density values throughout the range.
*The stock range is only a portion of the HRC; it is not the entire HRC

Table 7-25: Summary of Density Values for Common Bottlenose Dolphin, Kauai/Niihau Stock, in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
Stock range*	0.065	0.065	0.065	0.065
W. Transit Corridor	0	0	0	0

The units for numerical values are animals/km^2. S = spatial model with various density values throughout the range.
*The stock range is only a portion of the HRC; it is not the entire HRC

Table 7-26: Summary of Density Values for Common Bottlenose Dolphin, Hawaii Island Stock, in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
Stock range*	0.028	0.028	0.028	0.028
W. Transit Corridor	0	0	0	0

The units for numerical values are animals/km^2. S = spatial model with various density values throughout the range.
*The stock range is only a portion of the HRC; it is not the entire HRC

Table 7-27: Summary of Density Values for Common Bottlenose Dolphin, Hawaii Pelagic Stock, in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	S	S	S	S
W. Transit Corridor	S	S	S	S

The units for numerical values are animals/km^2. S = spatial model with various density values throughout the range.

Table 7-28: Summary of Density Values for the California/Oregon/Washington Offshore Stock of Common Bottlenose Dolphin in the SOCAL Portion of the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
E. Transit Corridor	0.06836	S	S	0.06836
SOCAL	0.06836	S	S	0.06836
Baja	0.00843	0.00843	0.00843	0.00843

The units for numerical values are animals/km^2. S = spatial model with various density values throughout the range.

Table 7-29: Summary of Density Values for the California Coastal Stock of Common Bottlenose Dolphin in the SOCAL Portion of the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
< 1 km from California Coast	S	S	S	S
< 1 km from Coast, Baja California	0.3612	0.3612	0.3612	0.3612

The units for numerical values are animals/km^2. S = spatial model with various density values throughout the range.

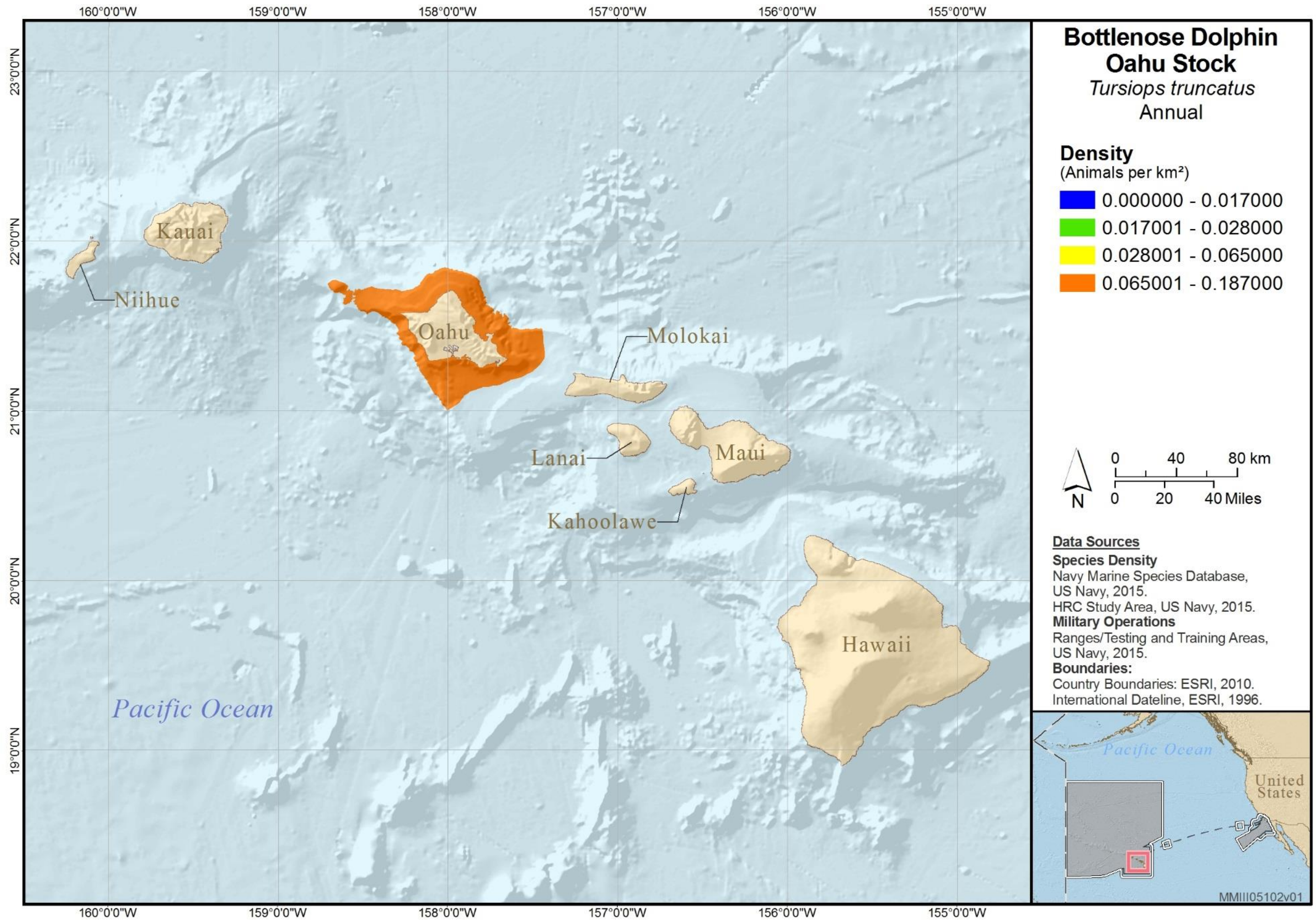


Figure 7-36: Annual Distribution of Common Bottlenose Dolphin Oahu Stock in HRC and the Western Portion of the Transit Corridor

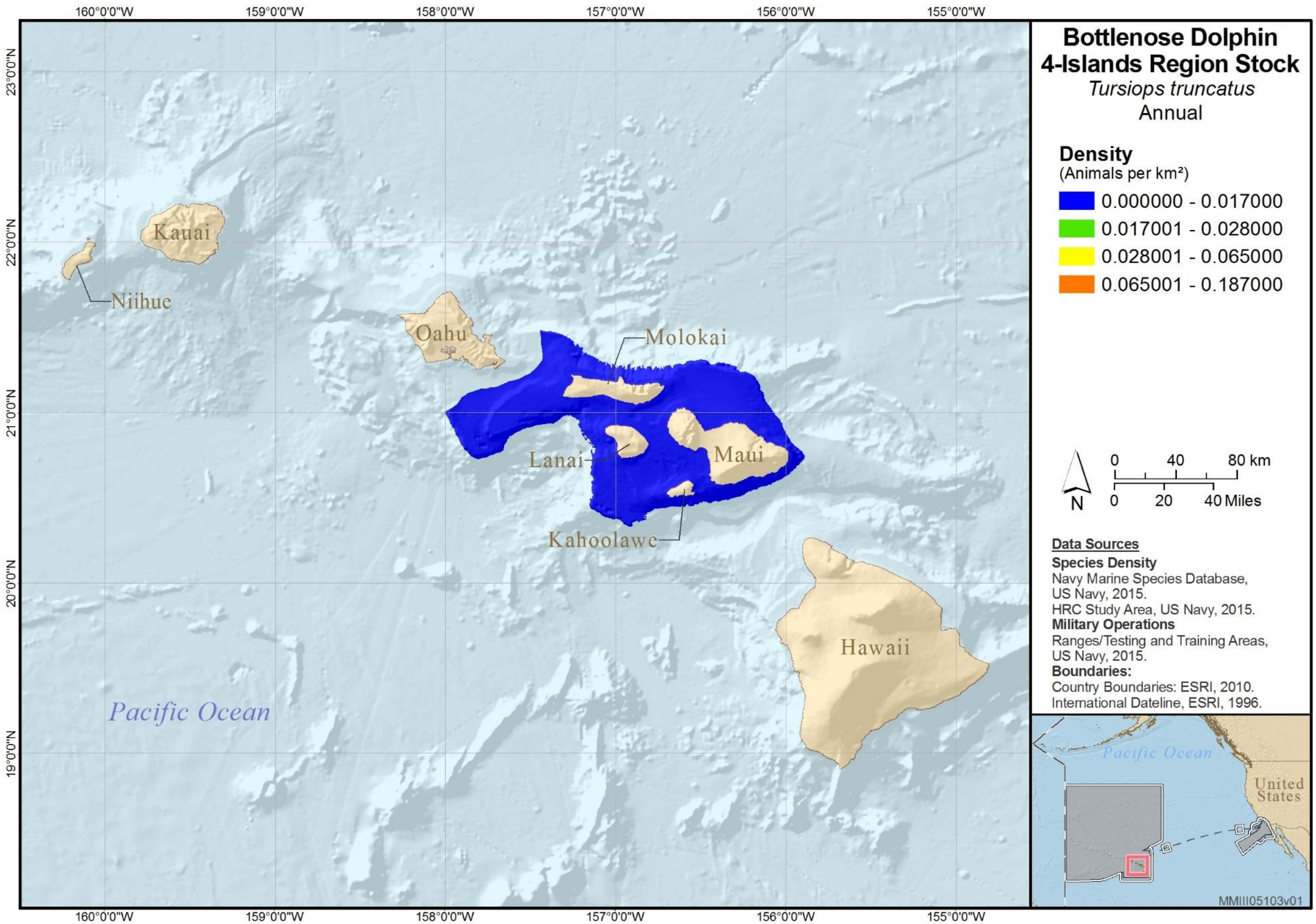


Figure 7-37: Annual Distribution of Common Bottlenose Dolphin 4-Islands Region Stock in HRC and the Western Portion of the Transit Corridor

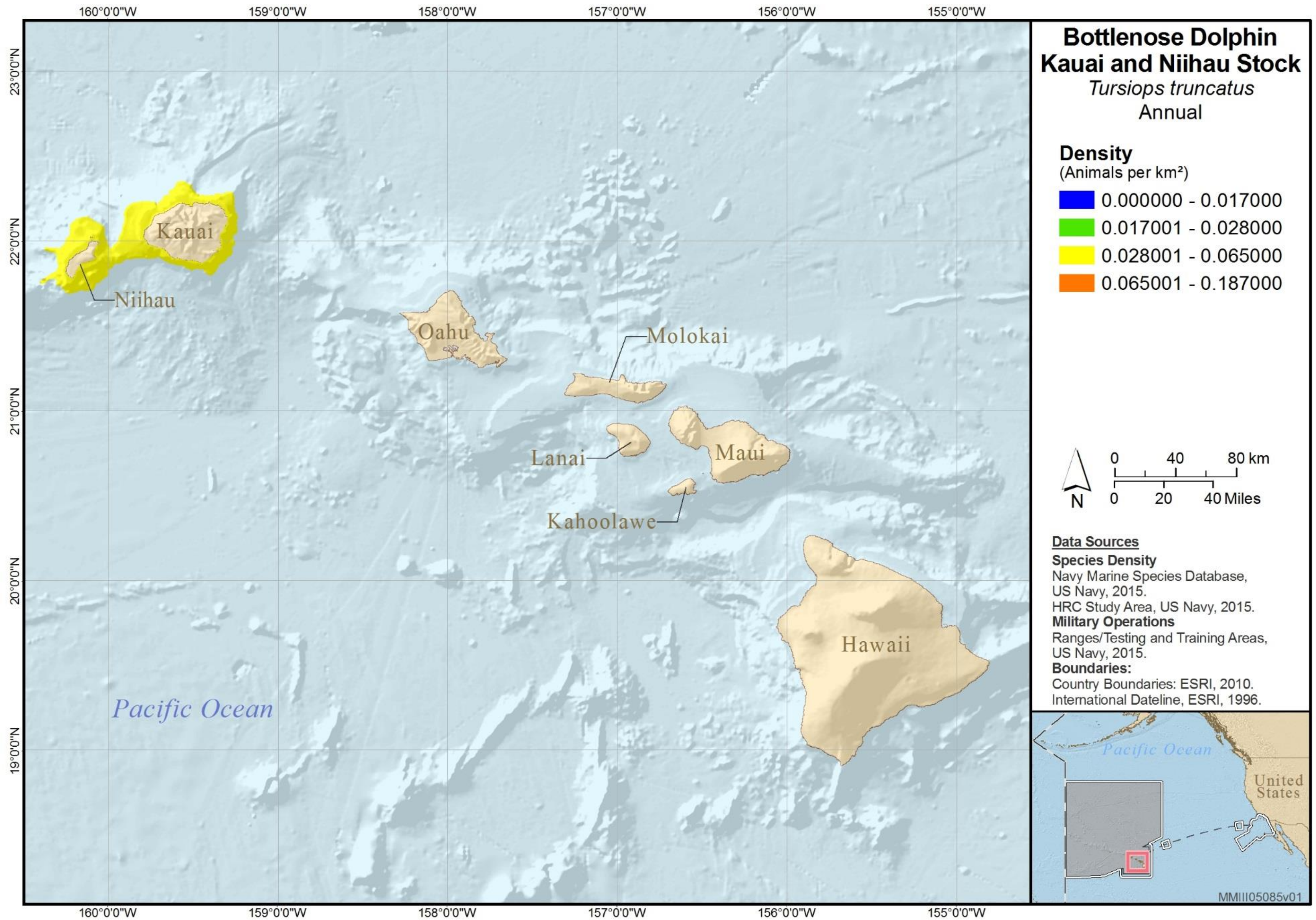


Figure 7-38: Annual Distribution of Common Bottlenose Dolphin Kauai/Niihau Stock in HRC and the Western Portion of the Transit Corridor

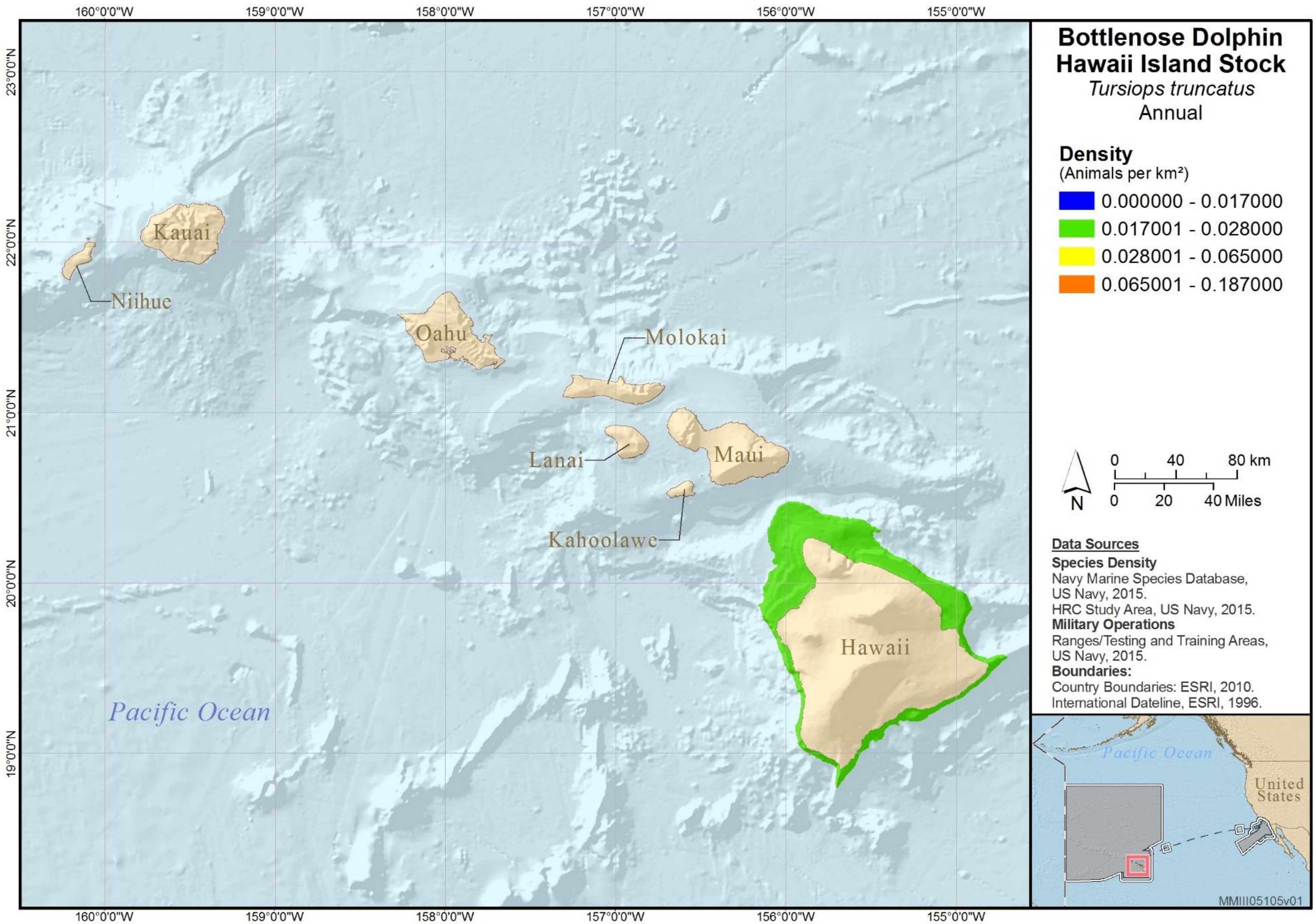


Figure 7-39: Annual Distribution of Common Bottlenose Dolphin Hawaii Island Stock in HRC and the Western Portion of the Transit Corridor

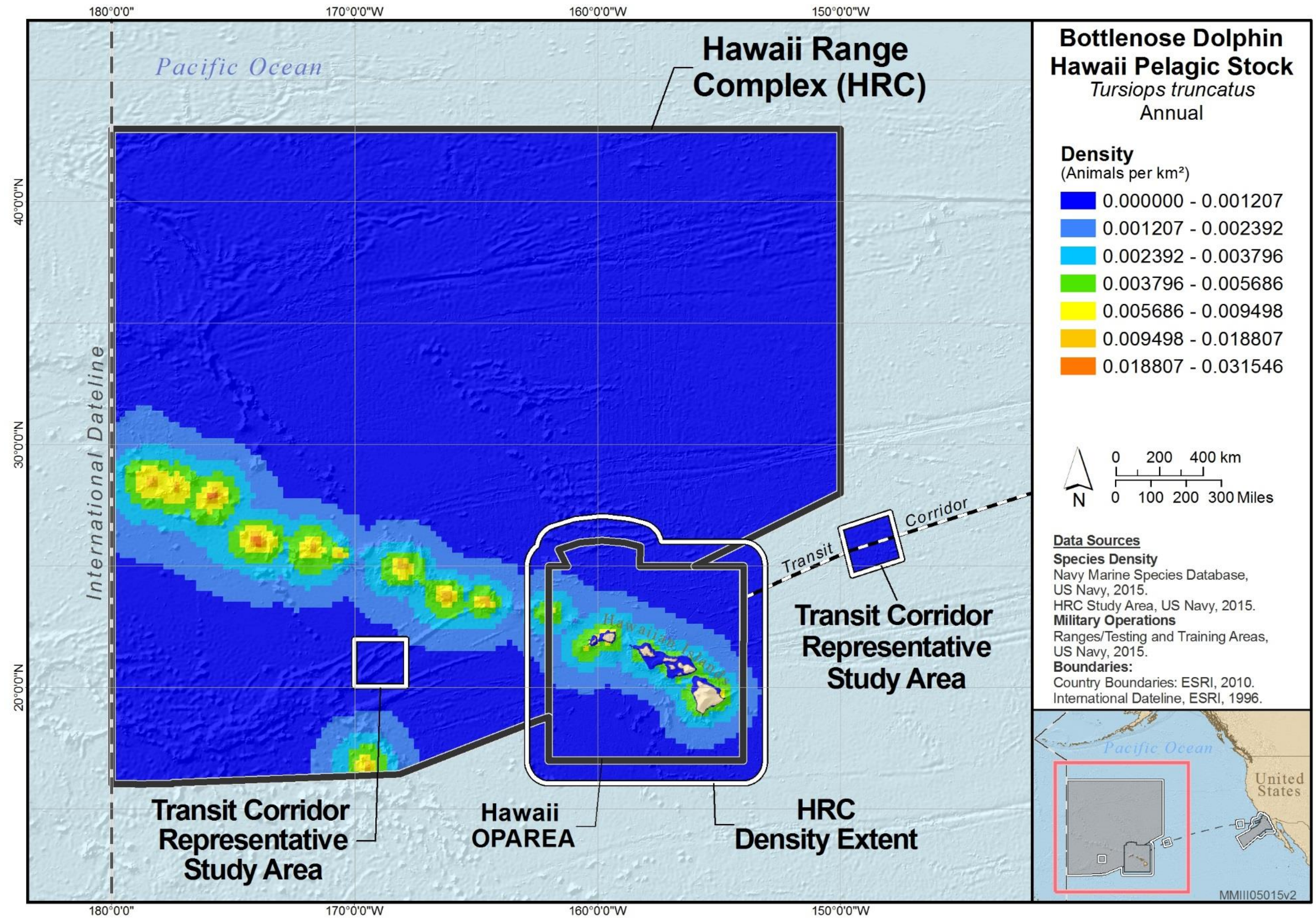


Figure 7-40: Annual Distribution of Common Bottlenose Dolphin Hawaii Pelagic Stock in HRC and the Western Portion of the Transit Corridor

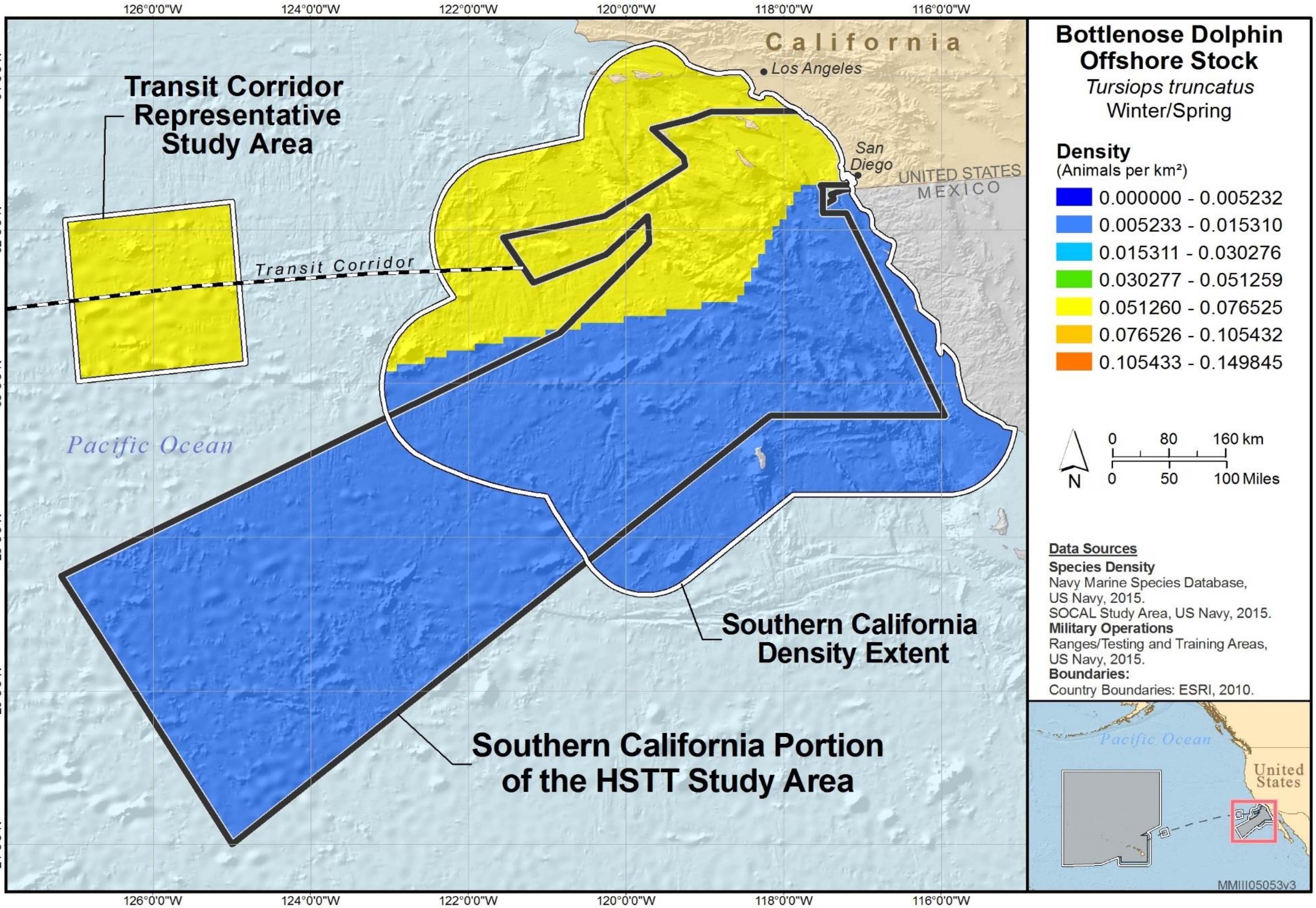


Figure 7-41: Winter/Spring Distribution of the California/Oregon/Washington Offshore Stock of Common Bottlenose Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

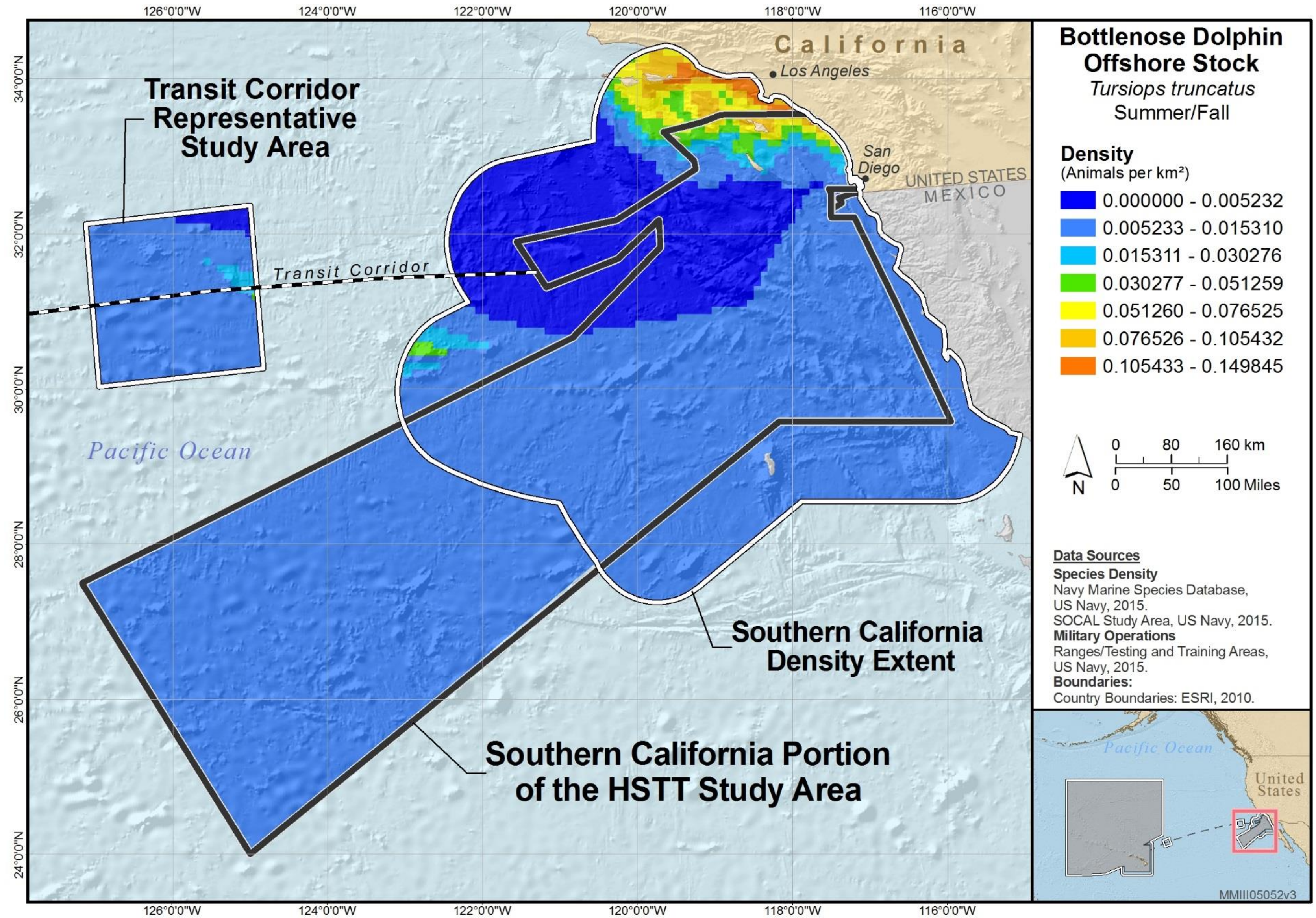


Figure 7-42: Summer/Fall Distribution of the California/Oregon/Washington Offshore Stock of Common Bottlenose Dolphin in SOCAL and the Eastern Portion of the Transit Corridor

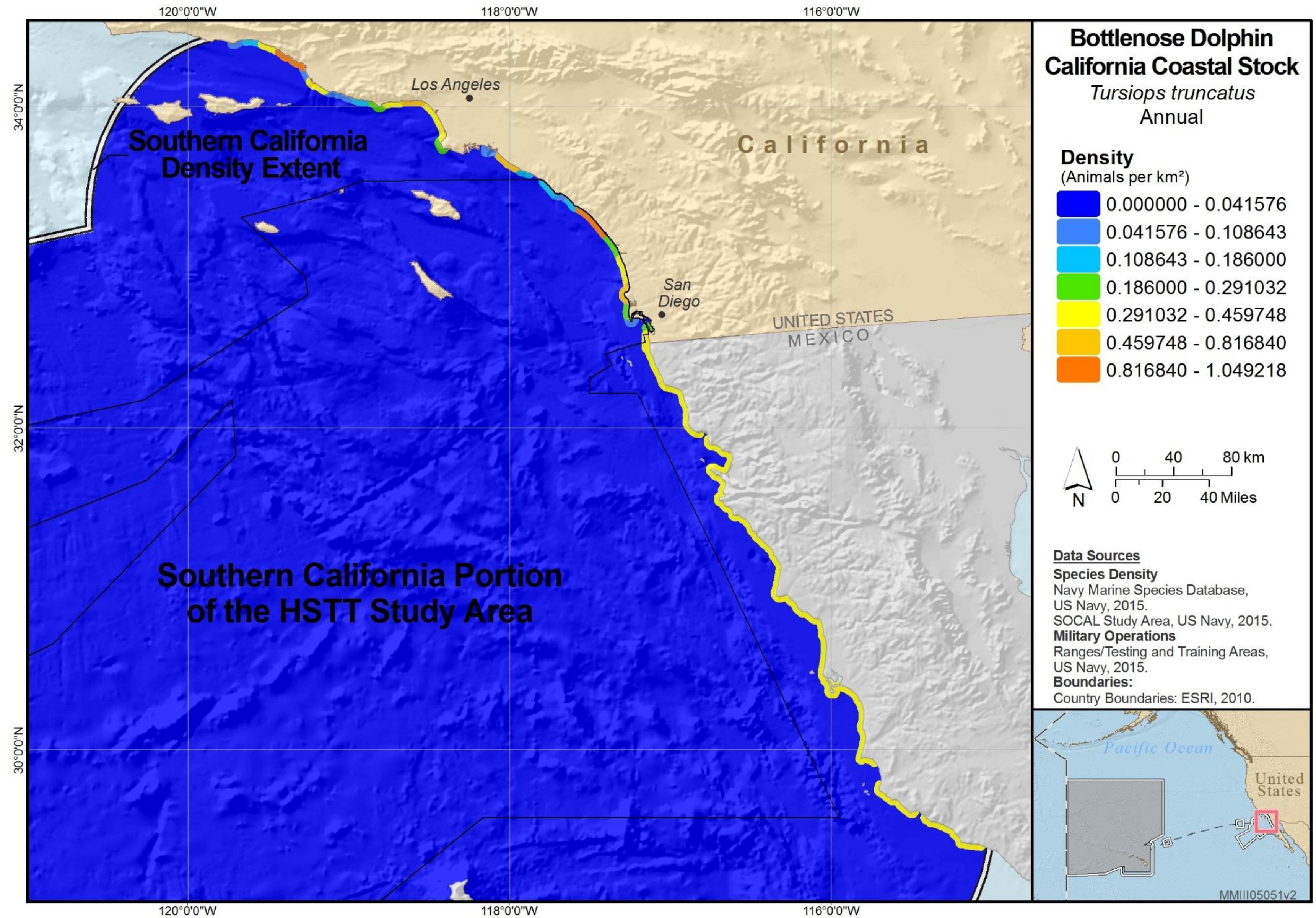


Figure 7-43: Annual Distribution of the California Coastal Stock of Common Bottlenose Dolphin in SOCAL

8 PORPOISES

8.1 *PORPOISE SPECIES PROFILES*

This group is represented by two species, the harbor porpoise (*Phocoena phocoena*) and Dall's porpoise (*Phocoenoides dalli),* both found off the west coast of North America. Stocks of harbor porpoise are found along the Pacific coast of the United States but their southernmost boundary is considered Point Conception (Carretta et al., 2017; Hamilton et al., 2009), north of the SOCAL study area. Therefore, the only species of porpoise included in the HSTT NMSDD for Phase III is Dall's porpoise.

8.1.1 *PHOCOENOIDES DALLI*, DALL'S PORPOISE

Dall's porpoise is a robust cetacean that is somewhat larger than the harbor porpoise (Jefferson et al., 2015). 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., 2015). 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., 2015). 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., 2015; 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 & 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 & 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 & 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 & Jefferson, 1999).

NMFS defines two stocks for Dall's porpoise, an Alaska stock and a California/Oregon/Washington stock (Carretta et al., 2017). 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 oceanic conditions (Becker et al., 2014; Becker et al., 2016; Forney, 2000). The California/Oregon/Washington stock is the group that is expected on the SOCAL range.

HRC. This species is not expected to occur within HRC or the western portion of the transit corridor (Hamilton et al., 2009).

SOCAL. The Phase II NMSDD included a CCE habitat-based density model for Dall's porpoise based on systematic survey data collected from 1991 to 2008 (Becker et al., 2012b). The model provided spatially-explicit density estimates off the U.S. west coast for summer and fall. More recently, Becker et al. (2016) updated the CCE habitat-based models of cetacean densities using additional survey data collected primarily off Southern California in 2009. In addition, improved modeling methods were used that allowed species-specific and segment-specific estimates of both effective strip width and trackline detection probability to be incorporated into the models based on the recorded viewing conditions on that segment using coefficients estimated by Barlow et al. (2011) for effective strip width and Barlow (2015) for trackline detection probability. Density predictions from the updated models are grid-based at a pixel resolution of 10 km x 10 km, providing finer spatial resolution and eliminating interpolation artifacts sometimes present in the previous CCE models (Becker et al., 2016). Density estimates from the updated Dall's porpoise model were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for summer and fall.

Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint. The resulting Dall's porpoise uniform density estimate of 0.00420 animals/km^2 (CV = 0.58) was used for all seasons. Given the overlap of the Ferguson and Barlow strata used to recalculate densities (refer to Figure 3-7), this value is also applicable to the remainder of the SOCAL Range Complex.

Becker et al. (2017) provide the first winter/spring habitat-based density models for Dall's porpoise in southern California waters. Density predictions from the models are grid-based at a pixel resolution of 10 km x 10 km, and were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the Becker et al. study area. Campbell et al. (2015) provide uniform density estimates for Dall's porpoise based on line-transect data collected in winter and spring, and their seasonally stratified line-transect estimates of 0.02710 animals/km^2 (CV = 0.32) for winter and 0.05584 animals/km^2 (CV = 0.22) for spring were applied to the eastern portion of the transit corridor.

Table 8-1: Summary of Density Values for Dall's Porpoise in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0.05584	S	S	0.02710
SOCAL	S	S	S	S
Baja	0.00420	0.00420	0.00420	0.00420

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.

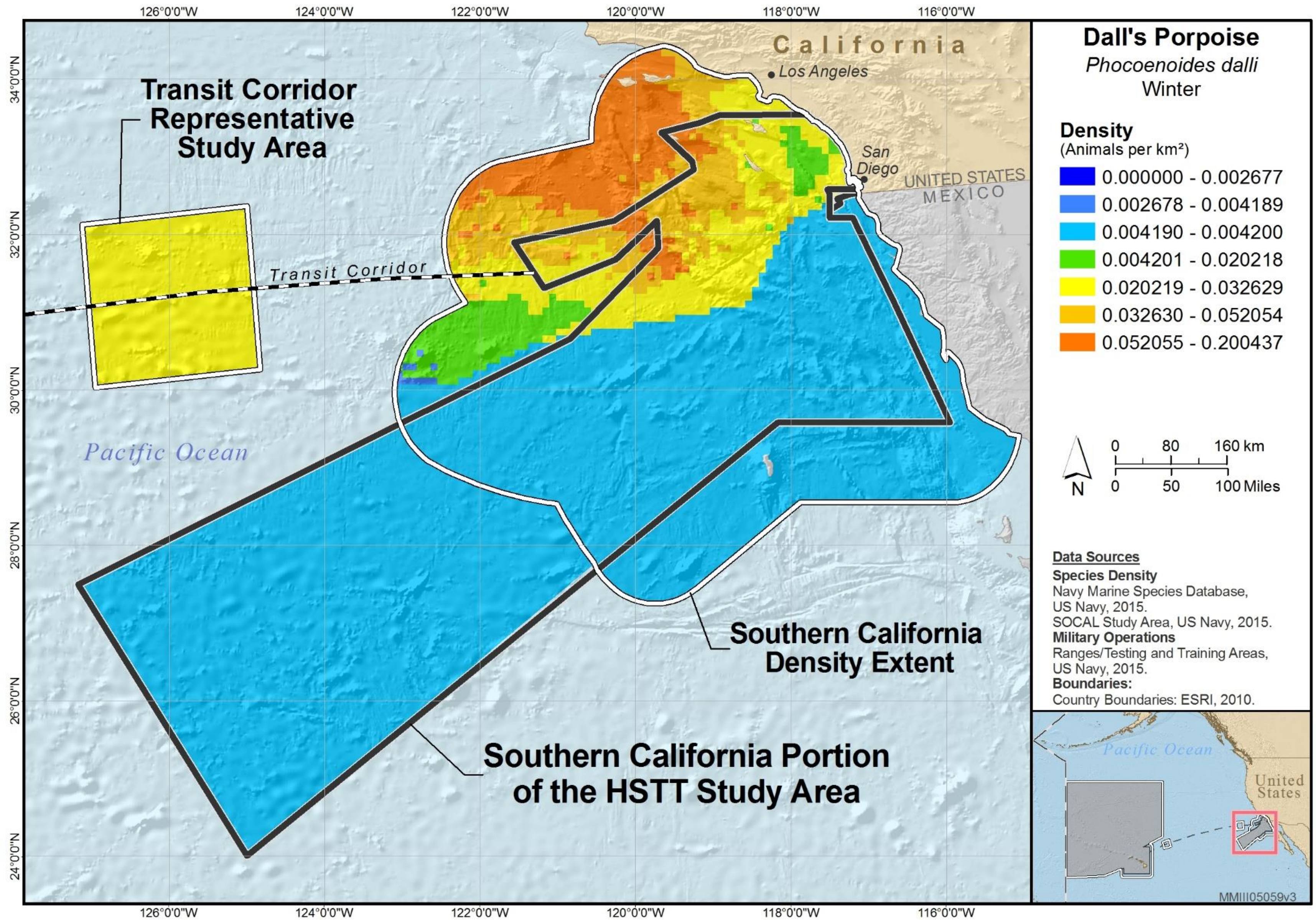


Figure 8-1: Winter Distribution of Dall's Porpoise in SOCAL and the Eastern Portion of the Transit Corridor

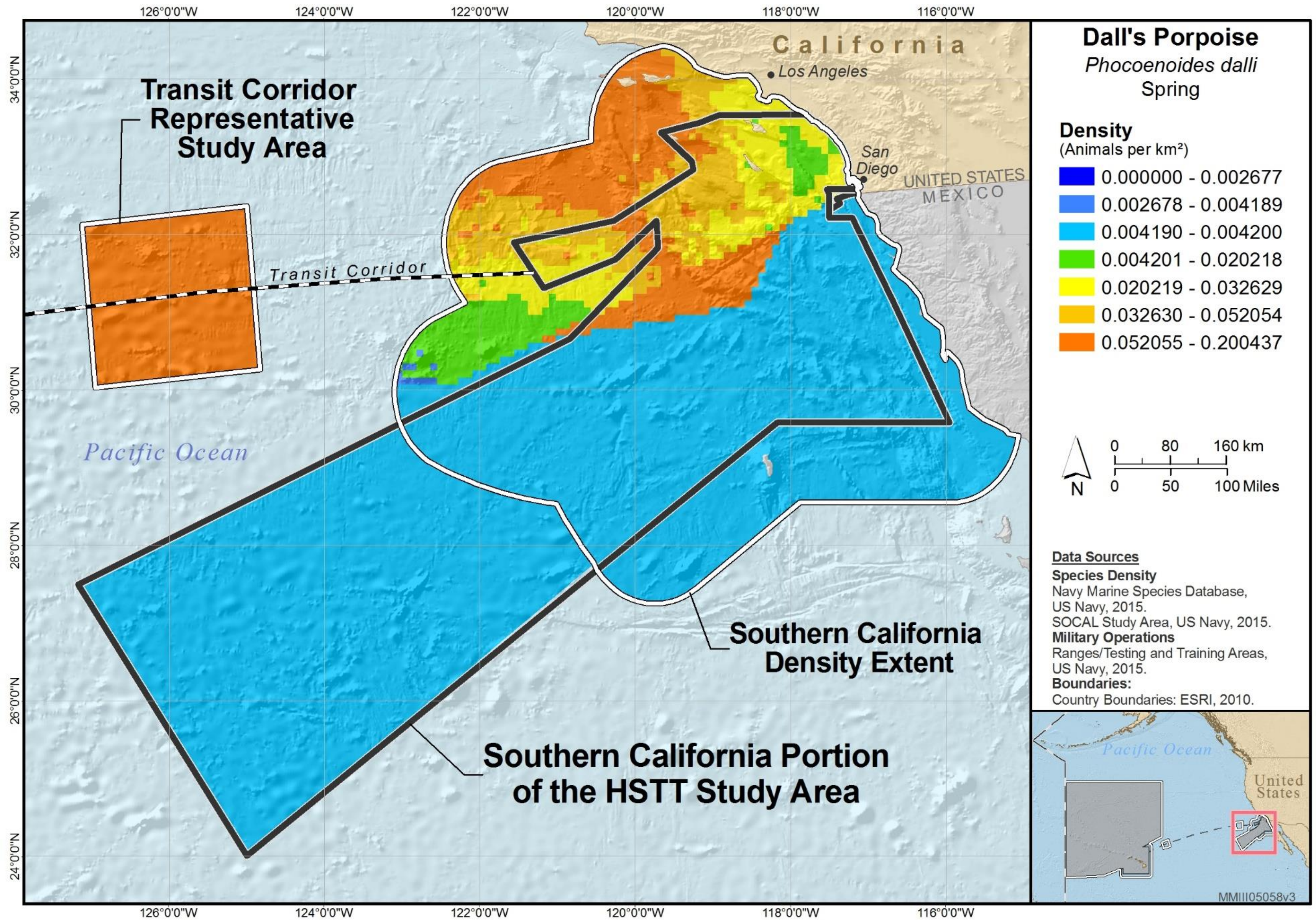


Figure 8-2: Spring Distribution of Dall's Porpoise in SOCAL and the Eastern Portion of the Transit Corridor

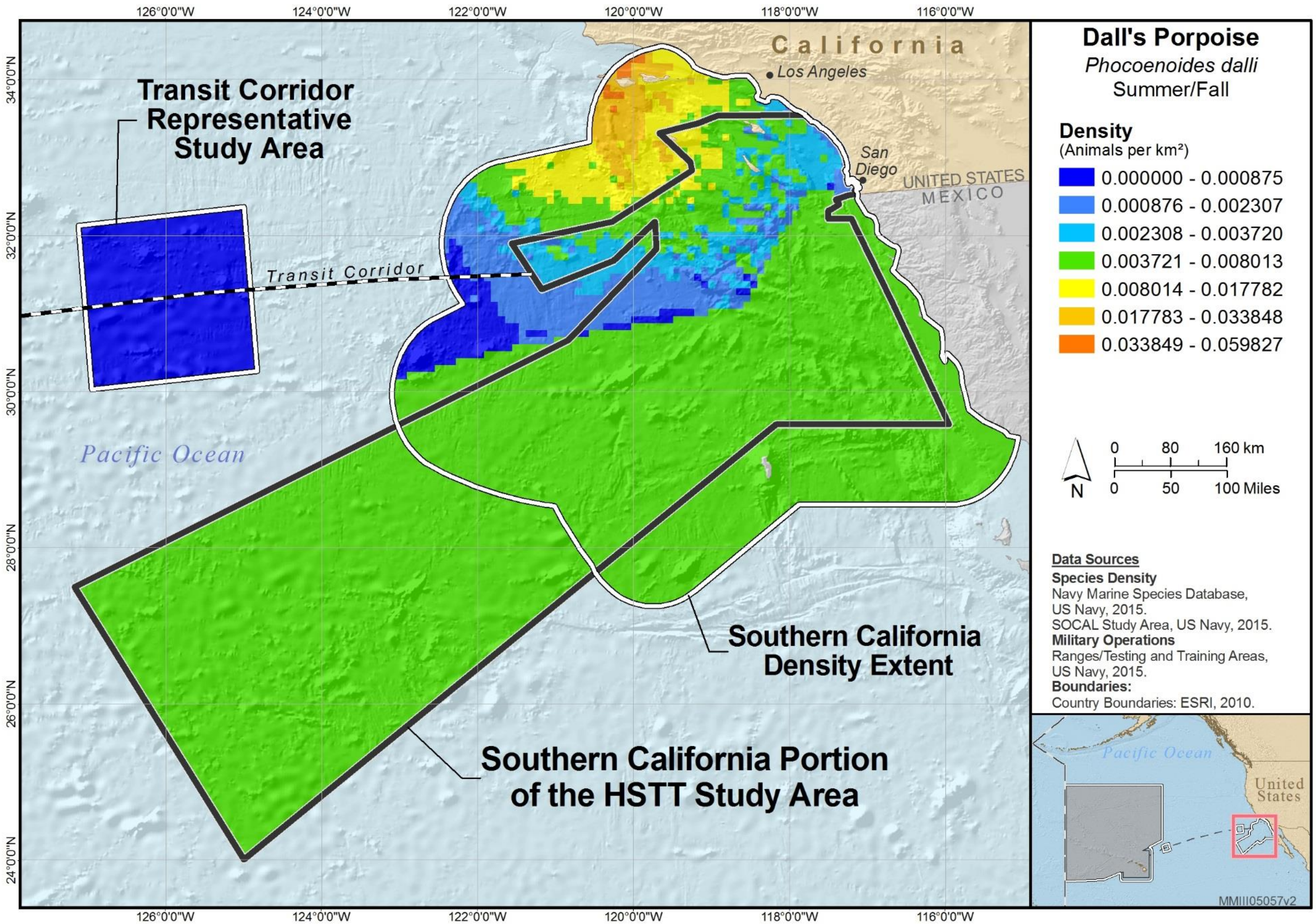


Figure 8-3: Summer/Fall Distribution of Dall's Porpoise in SOCAL and the Eastern Portion of the Transit Corridor

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, 2008). These difficulties result in having few sightings for a number of species and questionable identification in many cases for the 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 OPAREAs.

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. 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 CCE. This guild is used to represent density for the SOCAL Study Area.

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., 2015). They are found only in North Pacific temperate waters up to the vicinity of drift ice in the Bering Sea (Jefferson et al., 2015; Leatherwood et al., 1988). Baird's beaked whale may prefer continental shelf and sea mount habitat (Jefferson et al., 2015). 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., 2015; 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., 2015; 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., 2015). In contrast to minke whales and many other beaked whale species, Baird's beaked whales often occur in large groups (Baird et al., 2008c; Leatherwood et al., 1988). The groups are often tight knit with the animals aligned like a "log jam" (Jefferson et al., 2015). 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., 2017). The latter stock is expected to be the population that occurs within SOCAL, while the Alaska stock is likely to be the population in the eastern part of the SOCAL transit corridor. Density values for the HSTT Study Area are presented for the species as a whole.

HRC. This species is not expected to occur in 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. The Phase II NMSDD included a CCE habitat-based density model for Baird's beaked whales based on systematic survey data collected from 1991 to 2008 (Becker et al., 2012b). The model provided spatially-explicit density estimates off the U.S. west coast for summer and fall. More recently, the CCE habitat-based density model for Baird's beaked whale was updated using methods described in Becker et al. (2016). Improved modeling methods were used that allowed species-specific and segment-specific estimates of both effective strip width and trackline detection probability to be incorporated into the models based on the recorded viewing conditions on that segment using coefficients estimated by Barlow et al. (2011) for effective strip width and Barlow (2015) for trackline detection probability. Density predictions from the updated models are grid-based at a pixel resolution of 10 km x 10 km, providing finer spatial resolution and eliminating interpolation artifacts sometimes present in the previous CCE models (Becker et al., 2016). Density estimates from the updated Baird's beaked whale model were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for all seasons.

Ferguson and Barlow (2003) provide density values for areas off Baja. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the acoustic modeling footprint and were also corrected for new estimates of trackline detection probability derived by Barlow (2015). The resulting Baird's beaked whale uniform density estimate of 0.00008 animals/km^2 (CV = 1.00) was used for all seasons. Given the overlap of the Ferguson and Barlow strata used to recalculate densities (refer to Figure 3-7), this value is also applicable to the remainder of the SOCAL Range Complex.

Table 9-1: Summary of Density Values for Baird's Beaked Whale in the Hawaii-Southern California Training and Testing Study Area

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	S	S	S	S
Baja	0.00008	0.00008	0.00008	0.00008

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.

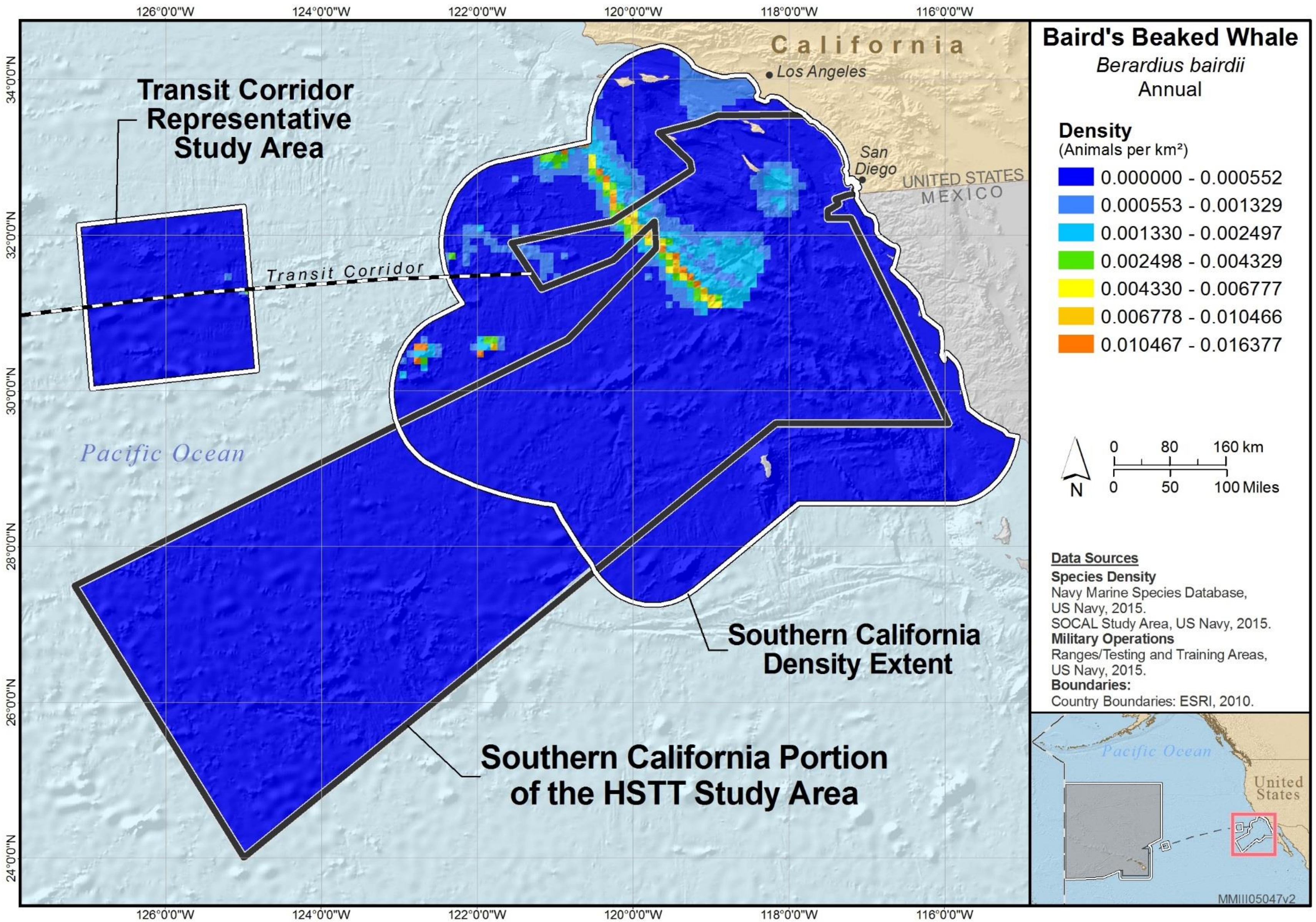


Figure 9-1: Annual Distribution of Baird's Beaked Whale in SOCAL and the Eastern Portion of the Transit Corridor

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., 2015). 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 seen regularly 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 et al., 2006). Only one stock of Longman's beaked whale is recognized by NMFS, and it is around Hawaii (Carretta et al., 2017). However, this simple stock structure may be the result of a lack of knowledge about the species.

HRC. Bradford et al. (2017) report a uniform density value for Longman's beaked whale of 0.0031 animals/km^2 (CV = 0.66) that is applicable to the HRC study area and western portion of the transit corridor. This provides an update to the density estimate used previously in the Navy's Phase II analyses as it is based on multiple-covariate line-transect analyses of survey data collected in the Hawaiian Islands EEZ in 2010 and incorporates new estimates of trackline detection probability derived by Barlow (2015). This value is applied to all seasons for both HRC and the western portion of the transit corridor. Outside the boundaries of the acoustic modeling study areas are density data used in the Phase II analyses, including the Barlow (2006) uniform, as well as Kaschner et al. (2006) predicted RES values in the northern portion of HRC. The RES global model (Kaschner et al., 2006) predicts a much higher density of Longman's beaked whales around Hawaii than density calculated from actual observations.

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

Table 9-2: Summary of Density Values for Longman's Beaked Whale in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.0031	0.0031	0.0031	0.0031
W. Transit Corridor	0.0031	0.0031	0.0031	0.0031
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0
Baja	0	0	0	0

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

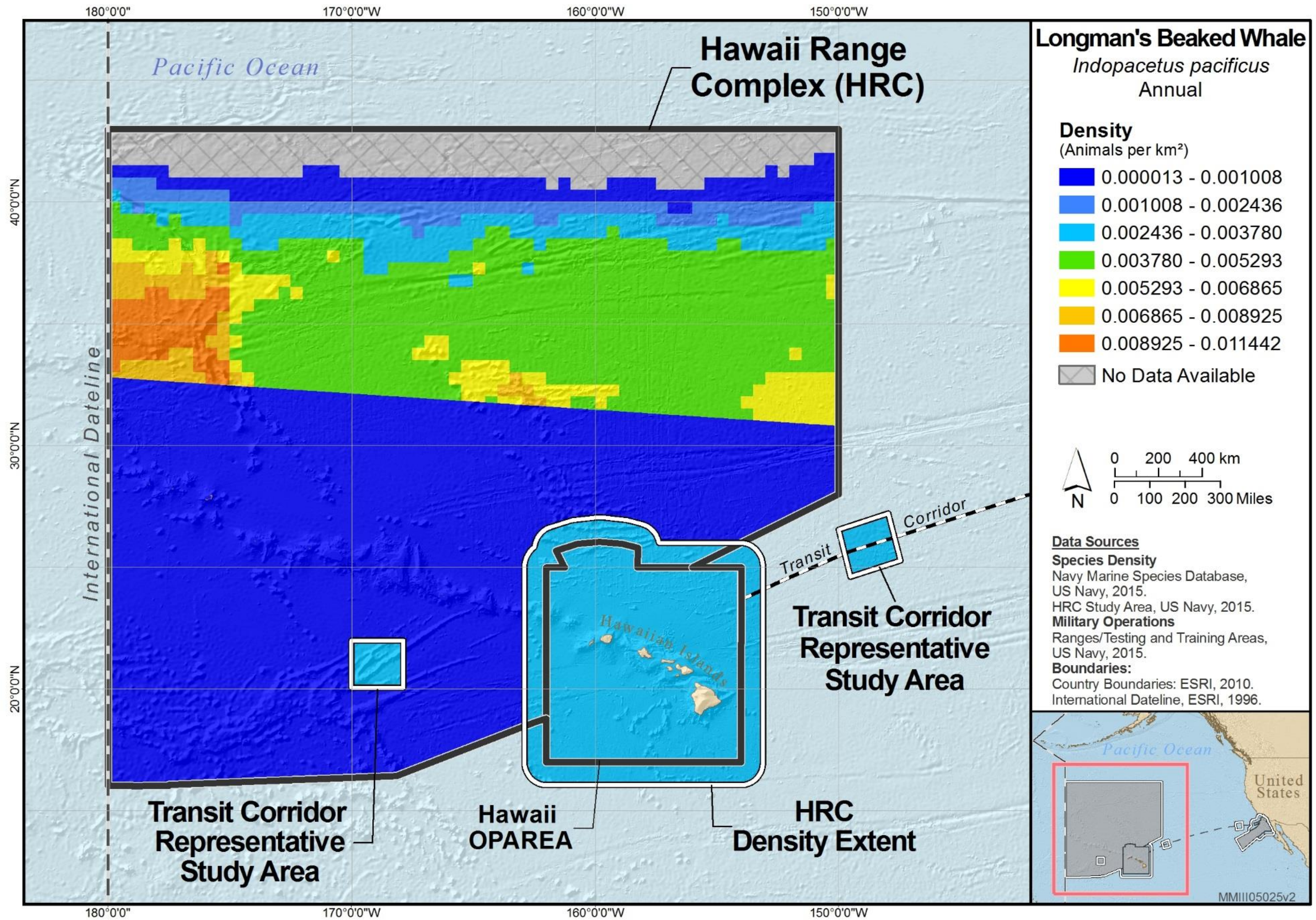


Figure 9-2: Annual Distribution of Longman's Beaked Whale in HRC and the Western Portion of the Transit Corridor

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, 2008). 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., 2015; Pitman, 2008). The general coloration is counter shaded 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., 2015; Leatherwood et al., 1988; Pitman, 2008). 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., 2015; Leatherwood et al., 1988). When viewed at close range, it is clear that Cuvier's beaked whale has 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., 2017). It is unclear where the Hawaii stock transitions into the California/Oregon/Washington Mesoplodont Beaked Whale stock along the transit corridor.

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., 2011). Presumably both groups are encompassed in the Hawaii stock and are found in the western portion of the transit corridor. Bradford et al. (2017) report a uniform density value for Blainville's beaked whale of 0.00086 animals/km^2 (CV = 1.13) that is applicable to the HRC study area and western portion of the transit corridor. This provides an update to the density estimate used previously in the Navy's Phase II analyses as it is based on multiple-covariate line-transect analyses of survey data collected in the Hawaiian Islands EEZ in 2010 and incorporates new estimates of trackline detection probability derived by Barlow (2015). This value is applied to all seasons for both HRC and the western portion of the transit corridor. Outside the boundaries of the acoustic modeling study areas are density data used in the Phase II analyses, including the Barlow (2006) uniform, as well as Kaschner et al. (2006) predicted RES values in the northern portion of HRC.

SOCAL. This species is addressed in the small beaked whale guild for SOCAL and the eastern portion of the transit corridor (Section 9.1.7).

Table 9-3: Summary of Density Values for Blainville's Beaked Whale in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.00086	0.00086	0.00086	0.00086
W. Transit Corridor	0.00086	0.00086	0.00086	0.00086
E. Transit Corridor	G	G	G	G
SOCAL	G	G	G	G
Baja	G	G	G	G

The units for numerical values are animals/km^2. G = this species is part of the small beaked whale guild in SOCAL.

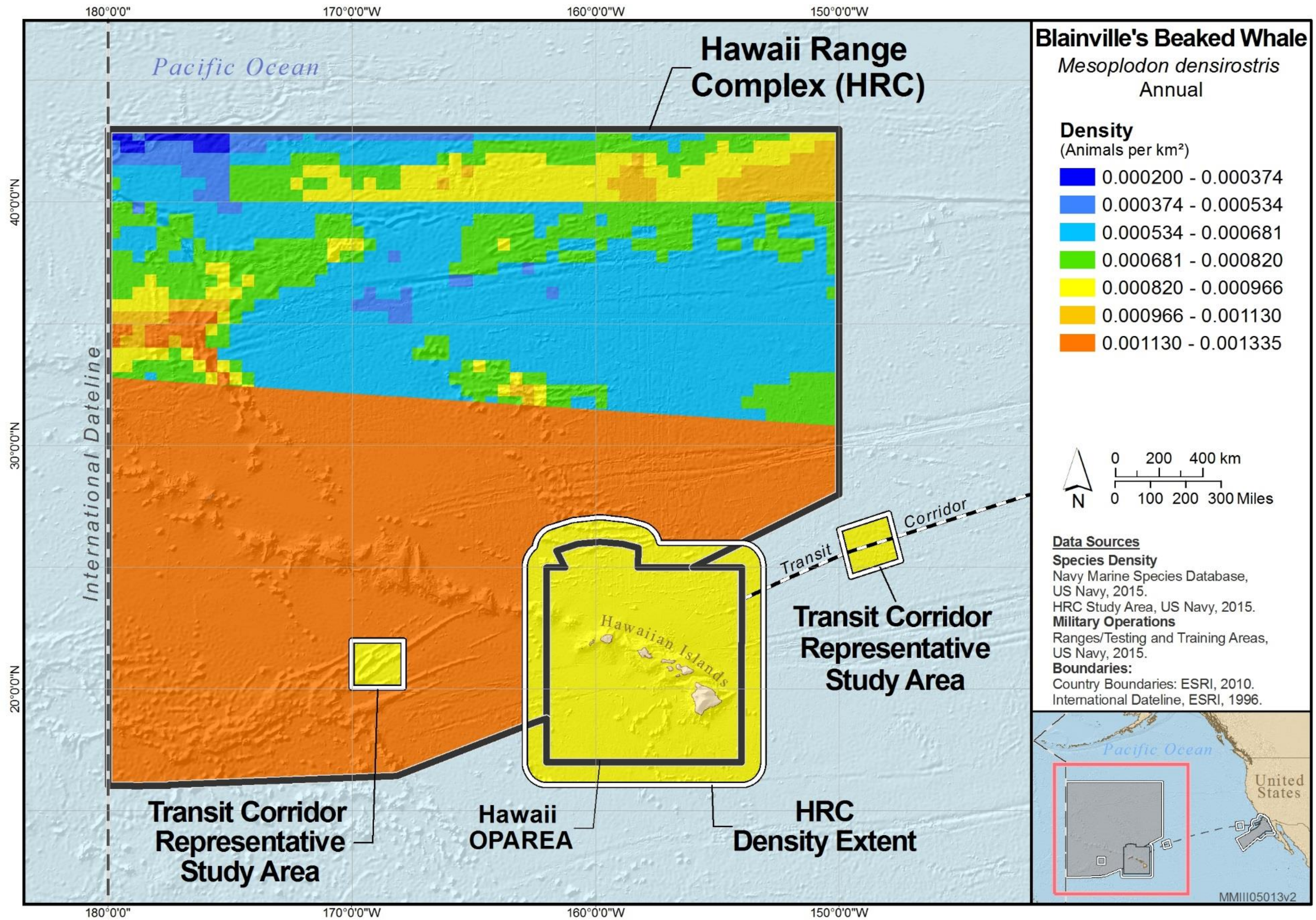


Figure 9-3: Annual Distribution of Blainville's Beaked Whale in HRC and the Western Portion of the Transit Corridor

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, 1989b; Palacios, 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).

HRC. This species is not expected to occur within HRC or the western portion of the transit corridor (Hamilton et al., 2009; Taylor et al., 2008).

SOCAL. This species is addressed in the small beaked whale guild for SOCAL and the eastern portion of the transit corridor (Section 9.1.7).

Table 9-4: Summary of Density Values for Ginkgo-Toothed Beaked Whale in the Hawaii-Southern California Training and Testing Study Area

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
Baja	G	G	G	G

The units for numerical values are animals/km^2. 0 = species is not expected to be present; G = this species is part of the small beaked whale guild in SOCAL.

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 & Perez, 1985; MacLeod et al., 2006). 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 & 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 & Perez, 1985; MacLeod et al., 2006; Mead, 1989a).

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 (Carretta et al., 2017; Muto et al., 2017). In SOCAL, Stejneger's beaked whales are part of the California, Oregon, and Washington *Mesoplodon* spp. stock.

HRC. This species is not expected to occur in HRC or the western part of the transit corridor (Muto et al., 2017).

SOCAL. This species is addressed in the small beaked whale guild for SOCAL and the eastern portion of the transit corridor.

Table 9-5: Summary of Density Values for Stejneger's Beaked Whale in the Hawaii-Southern California Training and Testing Study Area

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
Baja	G	G	G	G

The units for numerical values are animals/km^2. 0 = species is not expected to be present; G = this species is part of the small beaked whale guild in SOCAL.

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., 2015; Leatherwood et al., 1988). Like other beaked whales, their 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., 2015; Leatherwood et al., 1988). Their jaw line only curves gently and is upturned at the gape (Jefferson et al., 2015). 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 & Mead, 2009; Jefferson et al., 2015). 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., 2015; 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., 2017). 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., 2012b; Forney et al., 2012). 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.

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). Bradford et al. (2017) report a uniform density value for Cuvier's beaked whale of 0.00030 animals/km^2 (CV = 0.69) that is applicable to the HRC study area and western portion of the transit corridor. This provides an update to the density estimate used previously in the Navy's Phase II analyses as it is based on multiple-covariate line-transect analyses of survey data collected in the Hawaiian Islands EEZ in 2010 and incorporates new estimates of trackline detection probability derived by Barlow (2015). This value is applied to all seasons for both HRC and the western portion of the transit corridor. Outside the boundaries of the acoustic modeling study areas are density data used in the Phase II analyses, including the Barlow (2006) uniform, as well as Kaschner et al. (2006) predicted RES values in the northern portion of HRC.

SOCAL. This species is addressed in the small beaked whale guild for SOCAL and the eastern portion of the transit corridor.

Table 9-6: Summary of Density Values for Cuvier's Beaked Whale in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.00030	0.00030	0.00030	0.00030
W. Transit Corridor	0.00030	0.00030	0.00030	0.00030
E. Transit Corridor	G	G	G	G
SOCAL	G	G	G	G
Baja	G	G	G	G

The units for numerical values are animals/km^2. G = this species is part of the small beaked whale guild in SOCAL.

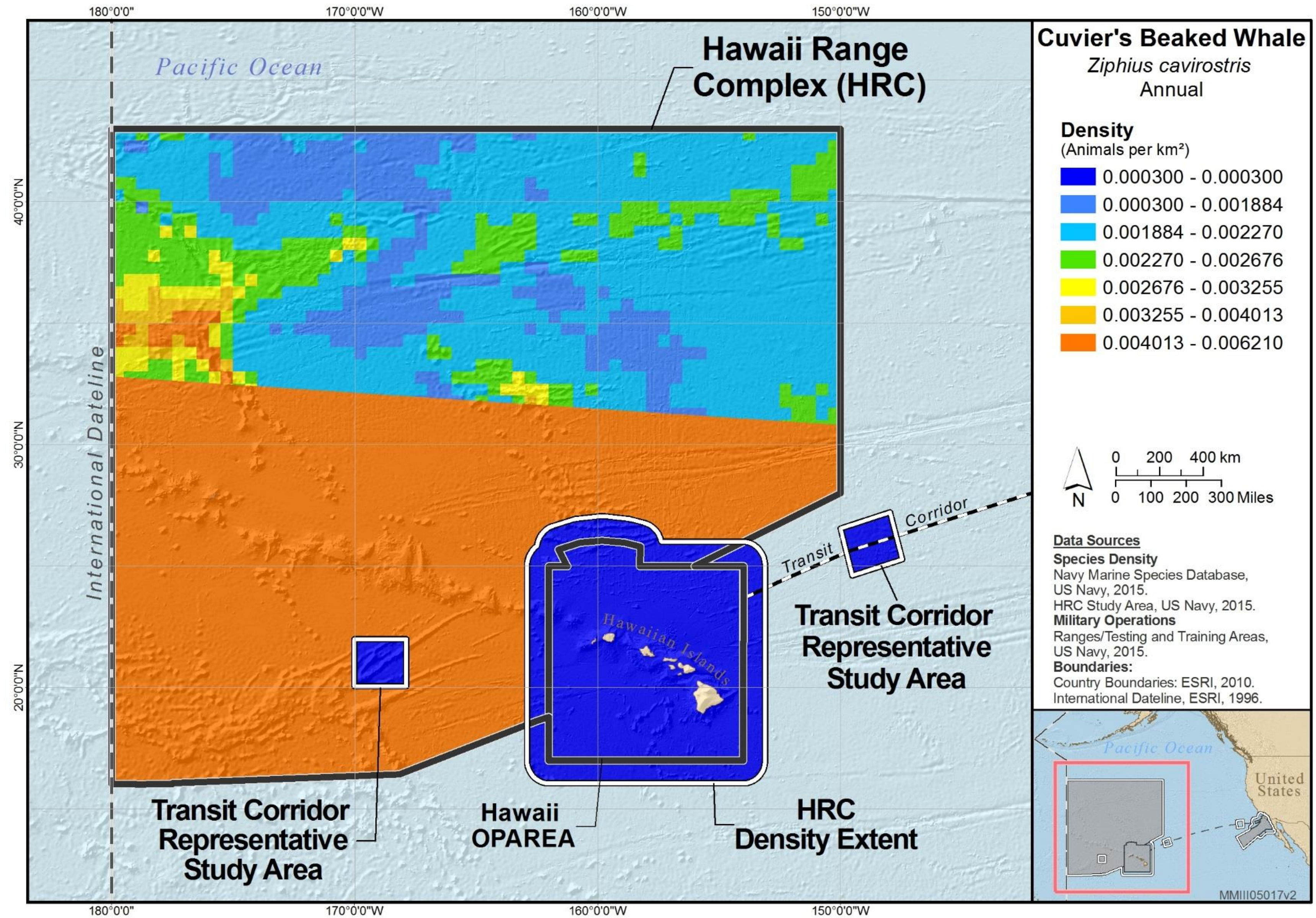


Figure 9-4: Annual Distribution of Cuvier's Beaked Whale in HRC and the Western Portion of the Transit Corridor

9.1.7 Small Beaked Whale Guild

To increase sample sizes for modeling, NMFS has developed habitat-based density models for a small beaked whale guild in the CCE (Becker et al., 2012b; Forney et al., 2012). The small beaked whale guild includes 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 CCE: Hubbs' 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 HRC and are addressed as individual species in their respective sections. The other five beaked whale species are not expected to occur in HRC or the western portion of the transit corridor (Hamilton et al., 2009).

SOCAL. The Phase II NMSDD included a CCE habitat-based density model for the guild of small beaked whales based on systematic survey data collected from 1991 to 2008 (Becker et al., 2012b). The model provided spatially-explicit density estimates off the U.S. west coast for summer and fall. More recently, the CCE habitat-based density model for the small beaked whale guild was updated using methods described in Becker et al. (2016). Improved modeling methods were used that allowed species-specific and segment-specific estimates of both effective strip width and trackline detection probability to be incorporated into the models based on the recorded viewing conditions on that segment using coefficients estimated by Barlow et al. (2011) for effective strip width and Barlow (2015) for trackline detection probability. Density predictions from the updated models are grid-based at a pixel resolution of 10 km x 10 km, providing finer spatial resolution and eliminating interpolation artifacts sometimes present in the previous CCE models (Becker et al., 2016). Density estimates from the updated small beaked whale model were applied to the portion of the Navy's SOCAL acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for all seasons.

In the summer and fall, density for *Mesoplodon* spp. has been recently estimated at 0.00217 animals/km^2 (CV = 0.59) in waters off Southern California (Barlow, 2016). This estimate is based on a multiple-covariate line-transect approach using survey data collected between 1991 and 2014 and incorporates new estimates of trackline detection probability derived by Barlow (2015). Since this estimate is based on recent line-transect survey data that includes sightings of all Mesoplodont species within the Navy's acoustic modeling study area, it was applied to the area south of the SWFSC's CCE study area for all seasons.

Table 9-7: Summary of Density Values for the Small Beaked Whale Guild in the Hawaii-Southern California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	***	***	***	***
W. Transit Corridor	***	***	***	***
E. Transit Corridor	S	S	S	S
SOCAL	S	S	S	S
Baja	0.00217	0.00217	0.00217	0.00217

The units for numerical values are animals/km^2. 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.

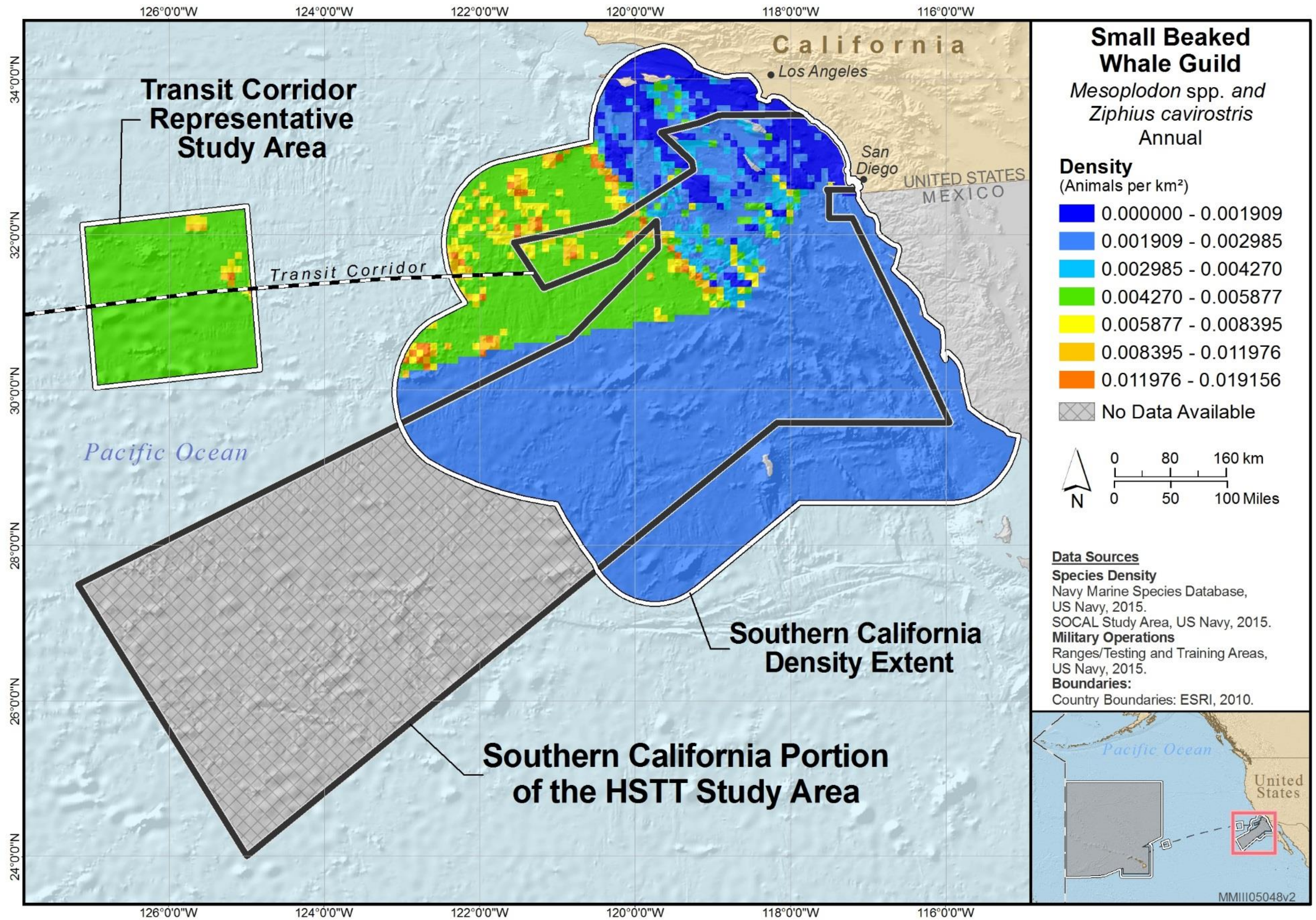


Figure 9-5: Annual Distribution of the Small Beaked Whale Guild in SOCAL and the Eastern Portion of the Transit Corridor

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 narwhal'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., 2015). These species occur in arctic and subarctic regions of the Northern Hemisphere and are not expected to occur within the HSTT 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 haul-outs or number of pups weaned at rookeries (for example Harvey et al., 1990; Jeffries et al., 2003; Lowry, 2002; Lowry et al., 2014; 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 II data set, because they represent the current best estimate, even though they are several years old. Pinniped values for the open ocean are virtually non-existent; therefore, density values for the transit corridor, if applicable depending on the species, have a high degree of uncertainty. Only one pinniped species, the Hawaiian monk seal (*Neomonachus schauinslandi*), occurs in Hawaii. As many as six pinniped species occur within the SOCAL Study Area: Pacific harbor seal (*Phoca vitulina*), northern elephant seal (*Mirounga angustirostris*), California sea lion (*Zalophus californianus*), northern fur seal (*Callorhinus ursinus*), Guadalupe fur seal (*Arctocephalus townsendi*), and Steller sea lion (*Eumetopias jubatus*). Steller sea lions are rarely sighted in Southern California waters; there have not been any documented interactions with any California fisheries in over two decades, and they are not expected to be present in the Study Area.

11.1.1 *ARCTOCEPHALUS TOWNSENDI*, GUADALUPE FUR SEAL

Guadalupe fur seals (*Arctocephalus townsendi*) were once plentiful on the California coast, ranging from the 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, 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 & DeLong, 1999). Since then, a small group has persisted in that area (Aurioles-Gamboa et al., 2010). Although the population has been growing, the species is still listed as threatened under the ESA.

NMFS recognizes a single stock of Guadalupe fur seals, all derived from the remnant population that remained on Guadalupe Island off the coast of central Baja, Mexico (Carretta et al., 2014). The stock assessment for this species was last updated in 2000. From June through July, adult males come to shore for the breeding season and then most move north to forage. From June through April, adult females with dependent pups make regular foraging trips from rookeries. Pups are weaned in spring (Gallo-Reynoso et al., 2008; Yochem et al., 1987). Density values for Guadalupe fur seals in SOCAL are based on the most recent population estimate of 20,084 fur seals from a 2010 survey, which recorded 17,581 fur seals from Guadalupe Island and 2,503 from San Benito Island (Urrutia & Dziendzielewski, 2012)[3].

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

SOCAL. To determine the density of Guadalupe fur seals in the Southern California area, the entire population (20,084 seals) was divided by the area of the Navy SOCAL Modeling Area. 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. For Guadalupe fur seals, the cool season is defined as September–May, and the warm water season is defined as June–August. This is slightly different than for other pinniped species. Warm (Summer/Fall) and cool (Winter/Spring) densities were calculated by estimating the percentage of the population occurring at sea for each season, 15 percent for the cool season and 50 percent for the warm season, and then dividing by the area of the Navy SOCAL Modeling Area (Barlow, 2010; Yochem et al., 1987):

Cool season: 20,084 x 0.15/361,872 km^2= 0.0083 fur seals/km^2

Warm season 20,084 x 0.50/361,872 km^2= 0.0278 fur seals/km^2

As conservative estimates, the Navy also applied these values to the portion of the acoustic modeling study area off Baja and the eastern portion of the transit corridor. Density estimates from the Kaschner et al. (2006) RES model are shown for the remainder of the SOCAL Range Complex.

---

[3] Preliminary results of new unpublished research were provided to the Navy in the summer of 2017 that further refined the state of knowledge of Guadalupe fur seal distribution in the Southern California portion of the HSTT Study Area (Norris, 2017). The offshore routes of satellite-tagged Guadalupe fur seals indicate that foraging and transiting fur seals are truly pelagic in the Study Area, occurring primarily beyond the continental shelf break (identified as the 3,000 m isobath) off of Southern California and the Baja Peninsula. Guadalupe fur seals did not occur shoreward of the 3,000 m isobath in significant numbers (Norris, 2017). Furthermore, the offshore routes chosen by Guadalupe fur seals show that the fur seals are transitory when in the Study Area as they pass through the outermost regions of the Southern California portion and transit corridor of the HSTT Study Area on their way to pelagic waters in the central and eastern North Pacific.

Table 11-1: Summary of Density Values for Guadalupe Fur Seal in the Hawaii-Southern California Training and Testing Study Area

Location	Density (Animals/km^2)			
	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0.0083	0.0278	0.0278	0.0083
SOCAL	0.0083	0.0278	0.0278	0.0083
Baja	0.0083	0.0278	0.0278	0.0083

0 = species is not expected to be present.

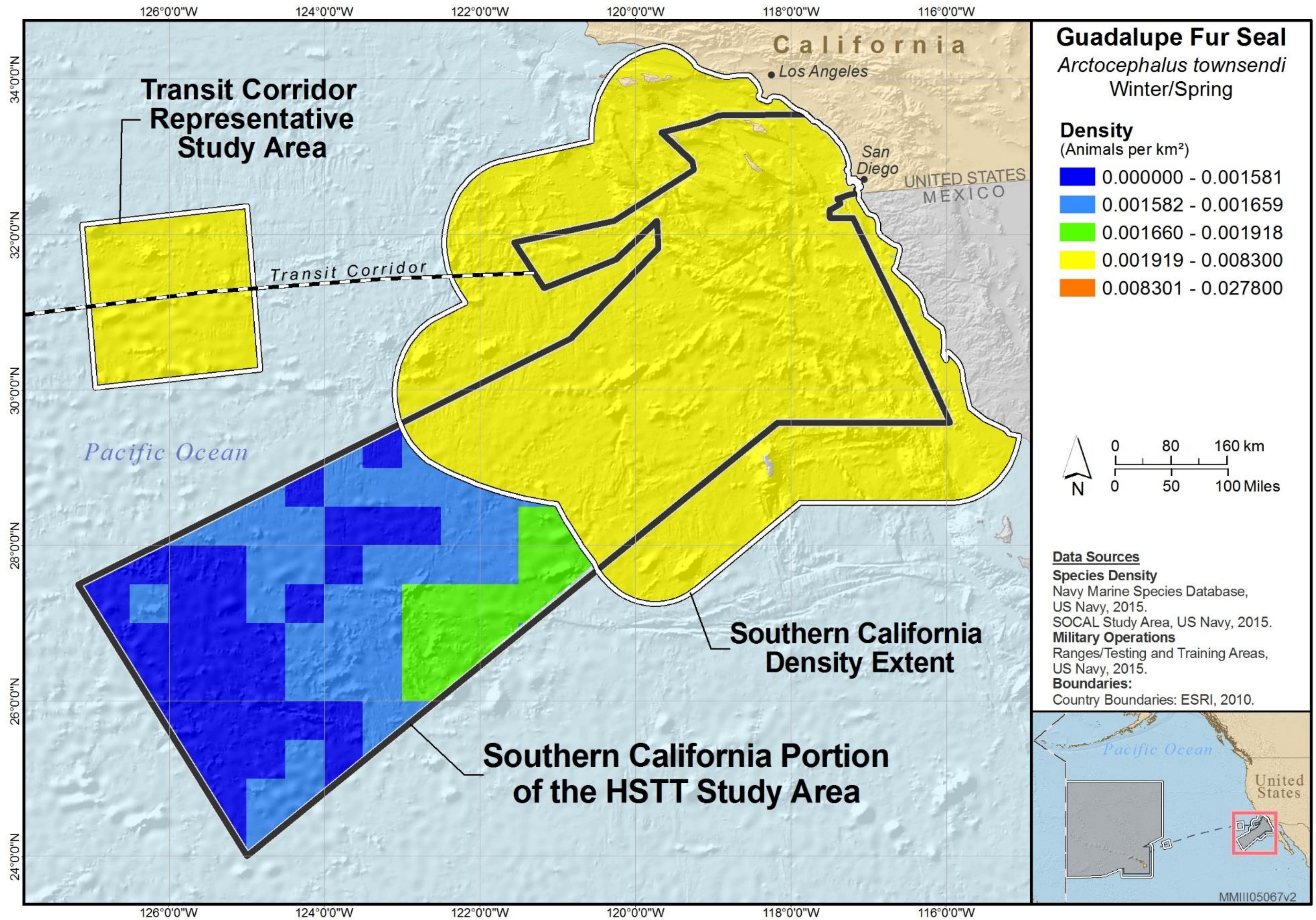


Figure 11-1: Winter/Spring Distribution of Guadalupe Fur Seal in SOCAL and the Eastern Portion of the Transit Corridor

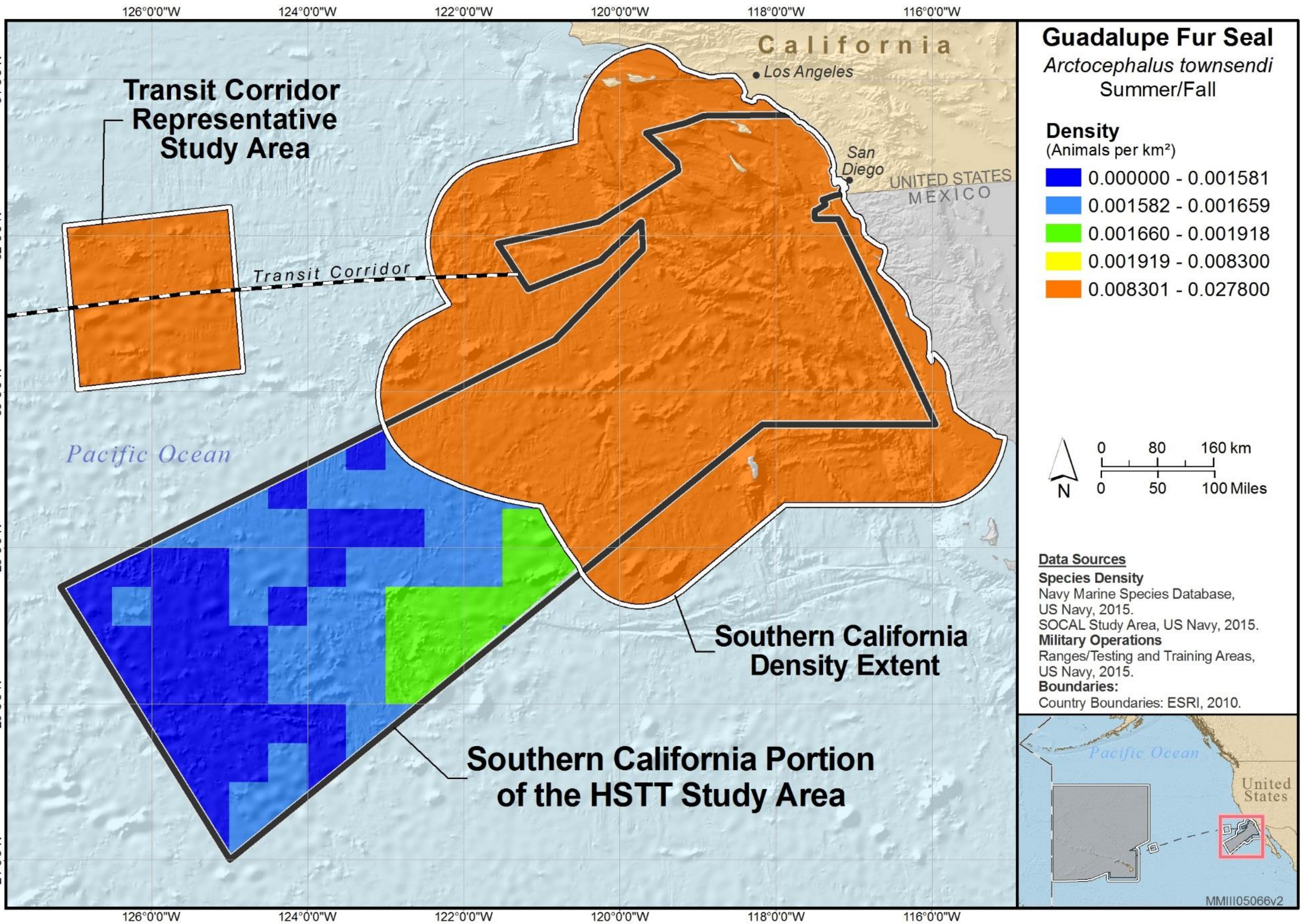


Figure 11-2: Summer/Fall Distribution of Guadalupe Fur Seal in SOCAL and the Eastern Portion of the Transit Corridor

11.1.2 *CALLORHINUS URSINUS*, NORTHERN FUR SEAL

Northern fur seals occur from Southern California north to the Bering Sea and west to Japan (Carretta et al., 2015). The population of northern fur seals occurring in U.S. waters is comprised of two main stocks recognized by NMFS: the California Stock, which includes seals from San Miguel Island and the Farallon Islands, and the Eastern Pacific Stock, which occurs primarily in Alaskan waters (Carretta et al., 2015). During the breeding season, approximately 74 percent of the world's population of northern fur seals is found on the Pribilof Islands in the southern Bering Sea (Call et al., 2008; Towell et al., 2006; Zeppelin & Ream, 2006). A small breeding population, less than 1 percent of the total population, is found on San Miguel Island off Southern California and the Farallon Islands off central California (Carretta et al., 2015; Stewart et al., 1993).

During the breeding season, adult males are on shore between June and August, with some remaining ashore through November. Adult females come to shore from June through November. Following the breeding season, both males and females are at sea for seven to eight months (Carretta et al., 2015; Hassrick et al., 2007). After leaving breeding grounds, pups may remain at sea for 22 months before returning to their rookery.

The population of northern fur seals from San Miguel Island has been growing in size, although it has experienced strong fluctuations associated with events like El Niño that produce changes in oceanographic conditions that have, in the past, affected the number of males and females that return to breeding sites, and reduced coastal upwelling, which can affect the availability of prey (Carretta et al., 2015; Melin et al., 2012). The population of northern fur seals at San Miguel Island is estimated at 13,384 seals, based on counts made in 2013. The San Miguel Island population includes seals from Adam's Cove on the mainland and the offshore islet, Castle Rock. Only seals from the San Miguel Island population are likely to occur in waters off Southern California.

HRC. Northern fur seals are not expected to occur in the HRC or the western portion of the transit corridor.

SOCAL. To arrive at density values for the SOCAL study area, the Navy used NMFS' San Miguel Island population estimate of 13,384 northern fur seals and a highly conservative assumption that most of that population would remain in the NMFS Southern California Stratum. Seasonal estimates of the percentage of northern fur seals potentially at sea during warm (15 percent) and cool (50 percent) seasons were derived from published literature (Antonelis et al., 1990; Ream et al., 2005; Roppel, 1984). The warm (Summer/Fall) and cool (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 Stratum:

Summer/Fall: (13,384 x 0.15)/318,541 km^2 = 0.0063 northern fur seals/km^2

Winter/Spring: (13,384 x 0.50)/318,541 km^2 = 0.0210 northern fur seals/km^2

The Navy also applied these values to the portion of the acoustic modeling study area off Baja and the eastern portion of the transit corridor. Density estimates from the Kaschner et al. (2006) RES model are shown for the remainder of the SOCAL Range Complex.

Table 11-2: Summary of Density Values for Northern Fur Seal in the Hawaii-Southern California Training and Testing Study Area

Location	Density (Animals/km^2)			
	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0.0210	0.0063	0.0063	0.0210
SOCAL	0.0210	0.0063	0.0063	0.0210
Baja	0.0210	0.0063	0.0063	0.0210

0 = species is not expected to be present; S = spatial model with various density values throughout the range.

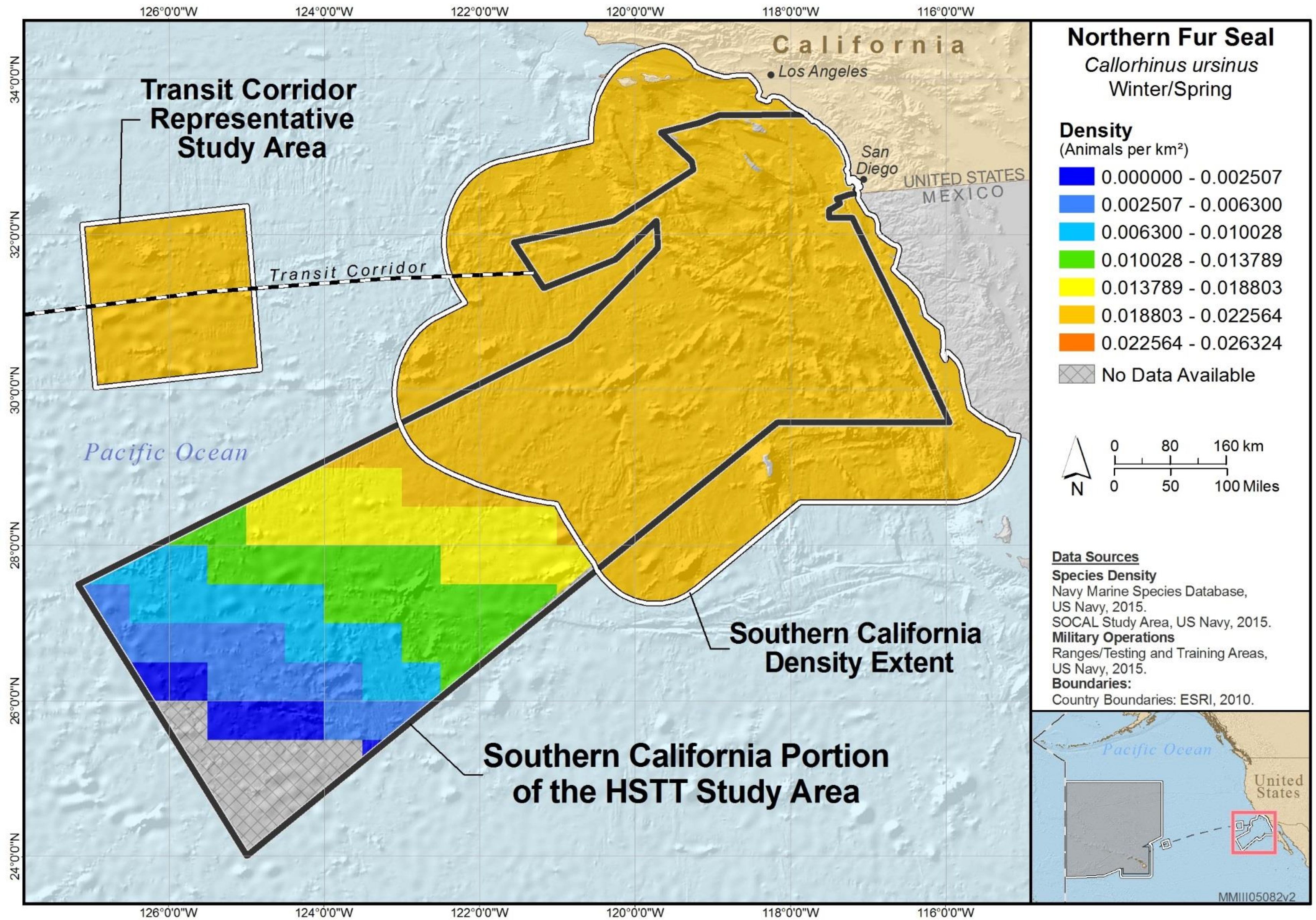


Figure 11-3: Winter/Spring Distribution of Northern Fur Seal in SOCAL and the Eastern Portion of the Transit Corridor

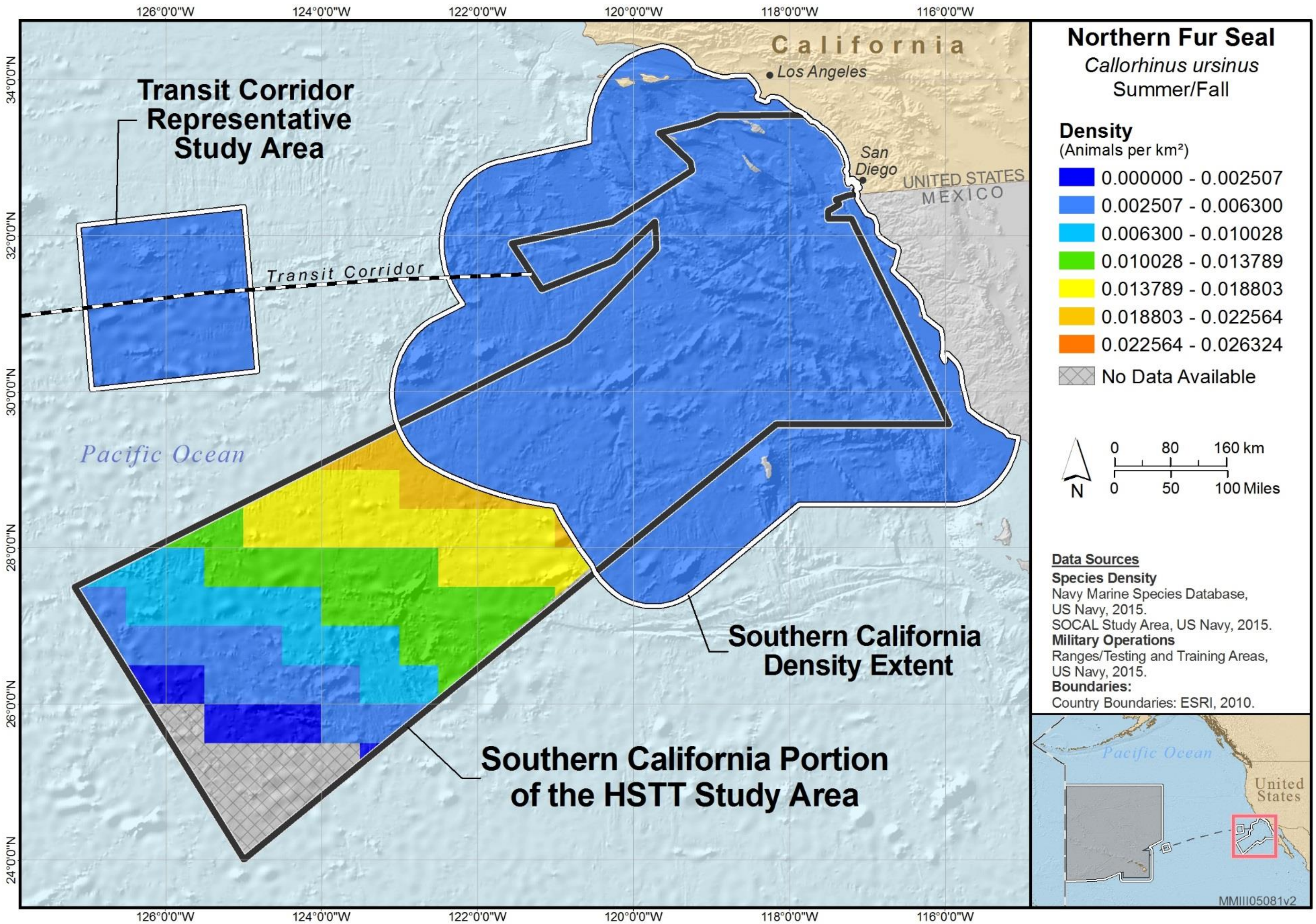


Figure 11-4: Summer/Fall Distribution of Northern Fur Seal in SOCAL and the Eastern Portion of the Transit Corridor

11.1.3 *MIROUNGA ANGUSTIROSTRIS*, NORTHERN ELEPHANT SEAL

This highly sexually dimorphic seal is found only in the eastern North Pacific (Jefferson et al., 2015). Both sexes are relatively large and have a large head. 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 & Allen, 1999). One stock of elephant seals, the California Breeding Stock, is recognized by NMFS in U.S. waters (Carretta et al., 2017). 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. Northern elephant seals are not expected to occur in the HRC or the western portion of the transit corridor (other than occasional extralimital records).

SOCAL. Carretta et al. (2015) estimate there are 179,000 northern elephant seals in the California stock. During the December–March breeding season, adult females spend about 28 days on shore for breeding and nursing their pups; adult and sub-adult males spend the entire three months on shore for breeding. Juveniles forage at sea and generally move north of SOCAL with the exception of seals originating from Guadalupe Island. From March through June, adult females and juveniles return to shore to molt, and adult and sub-adult males forage in the North Pacific around the Gulf of Alaska. Weaned pups leave for their first trip to sea in April and May. From July through August, males move onshore to molt, and adult females and juveniles forage at sea, and from September through November, juveniles haul out for about 30 days. Northern elephant seals are submerged about 88 percent of their time at sea.

To arrive at density values for the Southern California Portion of the HSTT Study Area, the Navy started with NMFS's stock assessment abundance of 179,000 animals (Carretta et al., 2015; Lowry et al., 2014). However, not all of this population is likely to occur exclusively within the Southern California portion of the HSTT Study Area. 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 SCI. Given that Lowry's (2002) field effort was in 2001, and with an estimated annual growth rate from NMFS of 1.7 percent per year for the past 10 years, 18,430 was adjusted to 21,563 seals to represent the California breeding stock of northern elephant seals likely to occur within the Southern California portion of the HSTT Study Area.

Lowry et al. (2014) estimated that 10,990 elephant seals were born in 2010, the latest year data were available, on the three islands, with the vast majority born on San Nicolas Island. Large rookeries also occur on San Miguel and Santa Rosa islands, however, both islands are located at least 30 nm north of the Study Area, and elephant seals from those islands are expected to move northward after breeding and away from the Study Area (Le Boeuf et al., 2000). Based on an average annual growth rate of 1.1 percent for Santa Barbara, San Nicolas, and San Clemente islands combined, Lowry et al. (2014) proposed using a multiplier of 4.4 to estimate the total elephant seal abundance for the three islands within or adjacent to the Study Area. Therefore, for 10,990 pups and a multiplier of 4.4, the total population is estimated at 48,356 elephant seals.

While this abundance estimate is more than double the estimate derived from Lowry (2002), the three rookeries considered in this analysis are located at the northern boundary of the Study Area, and the seals are widely known to migrate northward after breeding. Based on these documented movement patterns, the seals would spend very little time in the Study Area and much of that time would be on land. The in-water density estimate included in the NMSDD is based on the assumption that the 21,563 elephant seals considered to represent the California stock would remain in the Study Area, and thus still represents a conservative value.

Seasonal estimates of the population of northern elephant seals potentially at sea during the warm season (75 percent) and cool season (50 percent) were derived from published literature (Le Boeuf & Laws, 1994; Worthy et al., 1992). Density estimates for the warm (summer/fall) and cool (winter/spring) seasons were calculated by taking the SOCAL population estimate (21,563) and adding an estimate of the population from Mexico (15,083, as discussed below) to arrive at a total abundance of 36,646 seals. The total abundance estimate was multiplied by the percent of seals at sea for each season and then divided by the area of the Navy's SOCAL Modeling Area (361,872 km^2).

Summer/fall: (36,646 x 0.75)/361,872 km^2 = 0.0760 seals/km^2

Winter/Spring: (36,646 x 0.50)/361,872 km^2 = 0.0506 seals/km^2

The Navy also applied these values to the portion of the acoustic modeling study area off Baja and the eastern portion of the transit corridor. Density estimates from the Kaschner et al. (2006) RES model are shown for the remainder of the SOCAL Range Complex (Figure 11-5).

Satellite telemetry data tracking 209 female northern elephant seals from 2004–2010 show that seals leaving breeding colonies at Año Nuevo, CA and Islas San Benito, Mexico migrated northwest into the North Pacific (Robinson et al., 2012). The majority of tracks (195) were from the Año Nuevo colony, which is located approximately 400 miles (mi.) north of the HSTT Study Area and is not considered in the density calculations. The remaining 14 tracks were from the San Benito colony.

Estimating transit times for northern elephant seals moving north from the Isla San Benito, Mexico to forage north of latitude 38° N, can provide additional insight into seasonal density estimates. From Isla San Benito, the seals would need to travel approximately 700 km to move north of the SOCAL Range Complex. Using an estimated swim speed of 1.0 m/sec (Hassrick et al., 2007), the time to move through the SOCAL Range Complex is about eight days. Because seals would not necessarily travel along a direct route, a more conservative estimate would be about 10 days to transit the SOCAL Range Complex. Assuming the return trip also takes 10 days, the total amount of time in the SOCAL Range Complex would be approximately 27 percent of the post breeding migration and 9.5 percent of the post molt migration for adult females. Adult males would spend approximately 15 percent of their post breeding migration and 17 percent of their post molt migration within the SOCAL Range Complex (DeLong & Stewart, 1991; Le Boeuf & Laws, 1994; Robinson et al., 2012). Unfortunately, there are little data on current population estimates at the rookeries and haul-out sites in Mexico and no data on movements of juvenile elephant seals. Without these data, a more refined abundance estimate than the general increase mentioned above cannot be calculated.

Table 11-3: Summary of Density Values for Northern Elephant Seal in the Hawaii-Southern California Training and Testing Study Area

Location	Density (Animals/km^2)			
	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0.0506	0.0760	0.0760	0.0506
SOCAL	0.0506	0.0760	0.0760	0.0506
Baja	0.0506	0.0760	0.0760	0.0506

0 = species is not expected to be present.

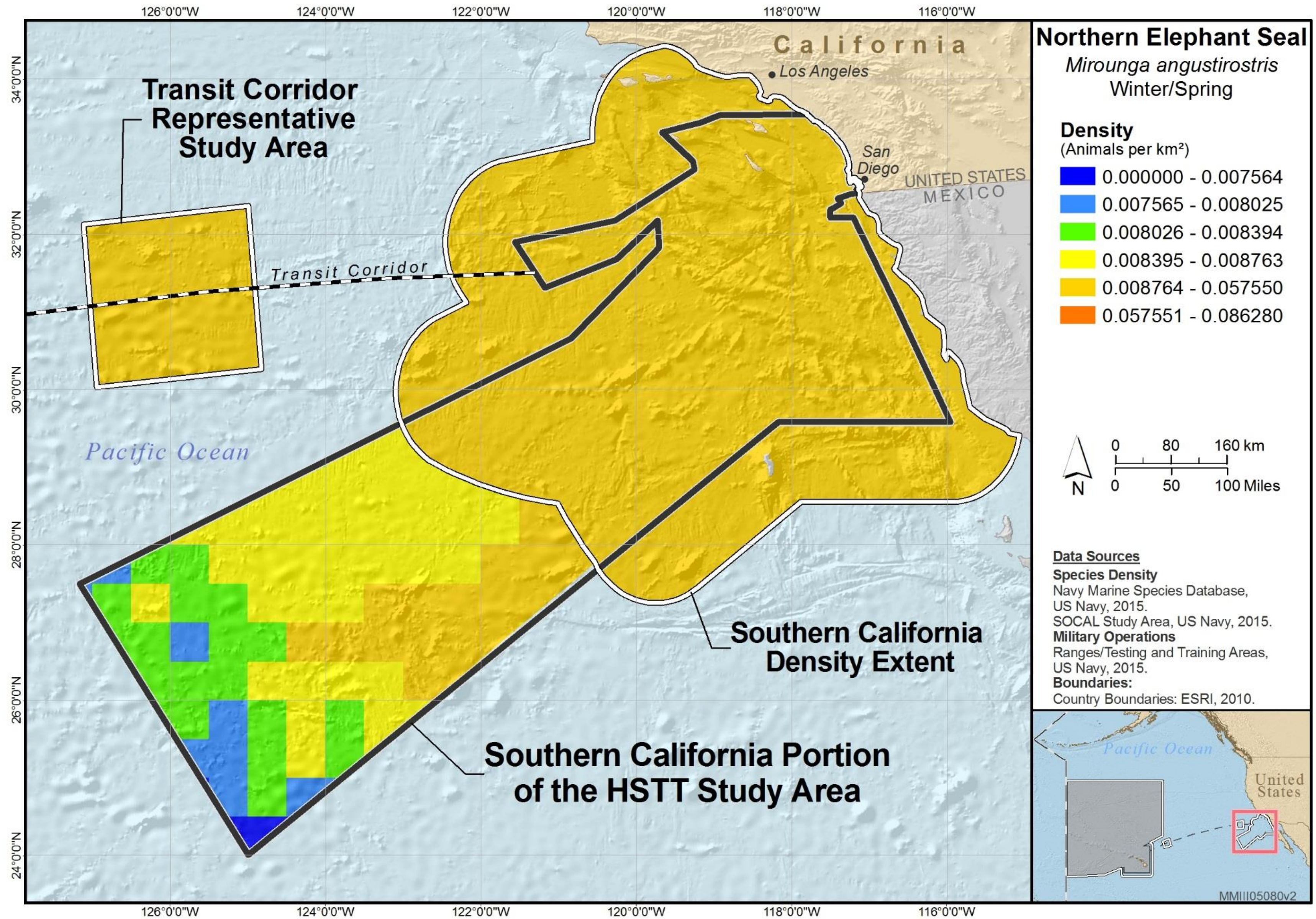


Figure 11-5: Winter/Spring Distribution of Elephant Seal in SOCAL and the Eastern Portion of the Transit Corridor

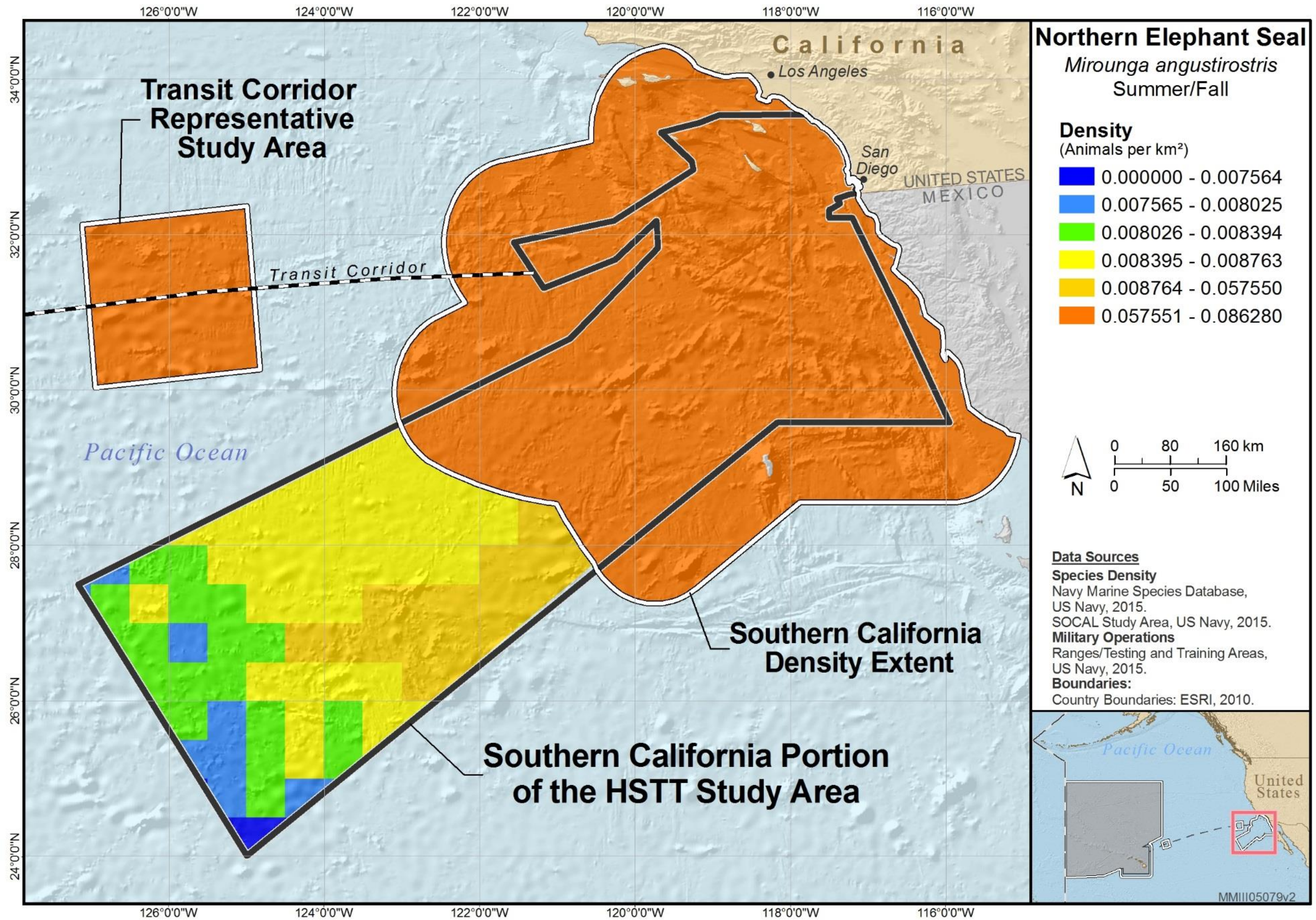


Figure 11-6: Summer/Fall Distribution of Elephant Seal in SOCAL and the Eastern Portion of the Transit Corridor

11.1.4 *NEOMONACHUS 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 & Johanos, 2004; Baker et al., 2011; Baker et al., 2016), 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 percent per year (Baker et al., 2011). The species represents a single stock (Carretta et al., 2017). To improve species conservation, NMFS designated critical habitat throughout the Hawaiian Islands in 2015 (80 FR 50925).

HRC. Little in-water occurrence or density data exist for monk seals. The 2013 NMFS stock assessment report provided an estimate for the total population of 1,209 monk seals (Carretta et al., 2014). The 2014 and 2015 stock assessment reports revised the total population abundance down to 1,153 and 1,112, respectively (Carretta et al., 2015; Carretta et al., 2016).

The Navy and NMFS Pacific Islands Fisheries Science Center (PIFSC) engaged in discussions on likely revisions to the abundance estimate based on continuing surveys and improved methods of estimating abundance, particularly for more remote subpopulations in the Northwest Hawaiian Islands. Based on these discussions, the overall abundance in the Hawaiian Islands was expected to increase in the coming years; however, only projected estimates based on preliminary data were available at the time, and the Navy decided to use the most recent published abundance estimate from the 2015 NMFS stock assessment report of 1,112 seals (Carretta et al., 2016).

Subsequently, Baker et al. (2016) published results suggesting an apparent trend of increasing Hawaiian monk seal abundance. The authors estimated abundance values of 1,291 in 2013; 1,309 in 2014; and 1,324 in 2015. While the data are encouraging and indicate that recent trends in declining abundance appear to have reversed, the authors caution that continuing surveys are needed to confirm that the population is truly rebounding. The abundance estimate of 1,112 monk seals used by the Navy to predict potential impacts is lower than the abundances reported by Baker et al. (2016); however, these more recent data were not available when then Navy's modeling process began.

The abundance estimate of 1,112 seals is the sum of the estimated abundances at the six most studied Northwest Hawaiian Islands sub-populations, an extrapolation of counts at Necker and Nihoa islands, and an estimate of minimum abundance in the Main Hawaiian Islands (Carretta et al., 2015). Preliminary population trends indicate that the population in the Northwest Hawaiian Islands is in decline and the smaller populations in the Main Hawaiian Islands and Necker and Nihoa islands are increasing (Carretta et al., 2015; Carretta et al., 2016).

The assumption was made that all of the seals are within the Hawaiian Islands EEZ. The critical habitat designation revised by NMFS in 2015 identified the 200 m isobaths at both the Northwest Hawaiian Islands and the Main Hawaiian Islands as the seaward extent of critical habitat for monk seal (see 80 FR 50925).

Out of the total population, 179 seals are estimated to live in the Main Hawaiian Islands. The area extending out to the 200 m isobath around the Main Hawaiian Islands from Ka'ula Islet to the Island of Hawaii is approximated to be 6,630 km^2. The Navy estimates that 90 percent of the population (161 seals) occurs inside the 200 m isobath. A haul-out factor of 39 percent was used, also based on communications between the Navy and NMFS (Wilson et al., In Review).

Annual: [(179 seals x 0.90)/6,630 km^2] x 0.61= 0.01482 seals/km^2

The remaining 933 seals live in the Northwest Hawaiian Islands. The ocean area extending seaward to the 200 m isobath around the Northwest Hawaiian Islands from Nihoa up to Kure Atoll is approximated at 6,142 km^2. For the density calculation, the Navy considered 90 percent of the population (840 seals) to be within the 200 m isobath.

Annual: [(933 seals x 0.90)/6,142 km^2] x 0.61= 0.0834 seals/km^2

The remaining 121 seals (i.e., the 10 percent not considered to occur within the 200 m isobath) were considered to be in the ocean area beyond the 200 m isobath but within the U.S. EEZ, which extends out to 200 nm from shore. The ocean area used to calculate the density is estimated to be 2,461,994 km^2.

Annual: (1,112 seals x 0.10)/2,461,994 km^2 x 0.61= 0.00003 seals/km^2

A separate monk seal density estimate was calculated for Pearl Harbor, the site of a major Navy and Air Force Joint Base. Navy records from mid-2009 to mid-2010 indicate that two Hawaiian monk seals were sighted 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. The density of seals on any given day is derived by calculating

Annual: 1 seal/21 km^2/30 days average in a month = 0.00159 seals/km^2/day.

Monk seals are not expected to occur in the western portion of the transit corridor.

SOCAL. This species is not expected to occur in SOCAL or the eastern portion of the transit corridor.

Table 11-4: Summary of Density Values for Hawaiian Monk Seal in the Hawaii-Southern California Training and Testing Study Area

Location	Density (Animals/km²)			
	Spring	Summer	Fall	Winter
Maine Hawaiian Islands within 200 m isobaths	0.01482	0.01482	0.01482	0.01482
Northwest Hawaiian Islands within 200 m isobath	0.0834	0.0834	0.0834	0.0834
Study Area beyond 200 m isobath out to U.S. EEZ	0.00003	0.00003	0.00003	0.00003
Pearl Harbor	0.00159	0.00159	0.00159	0.00159
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0

0 = species is not expected to be present.

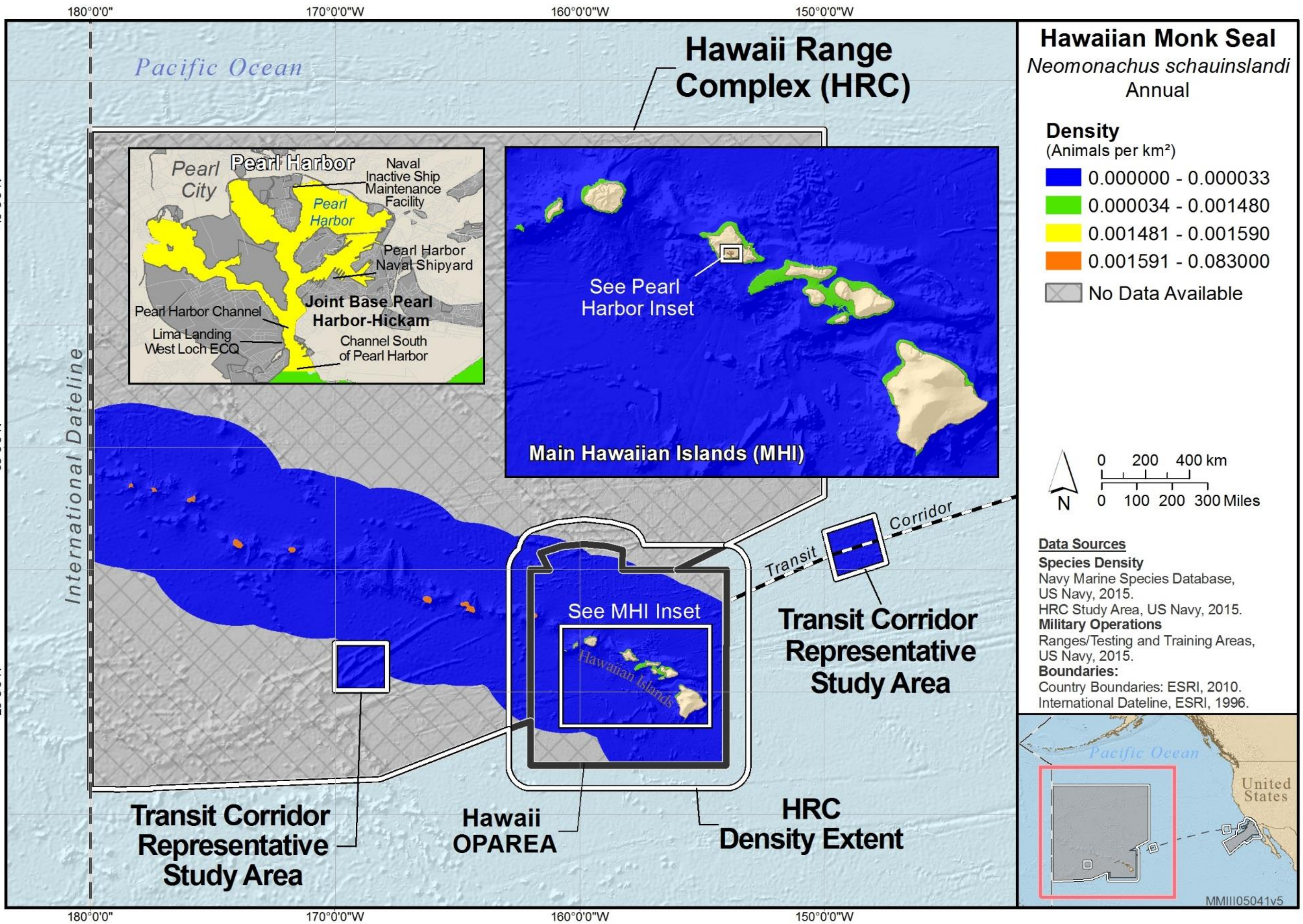


Figure 11-7: Annual Distribution of Hawaiian Monk Seal in HRC and the Western Portion of the Transit Corridor

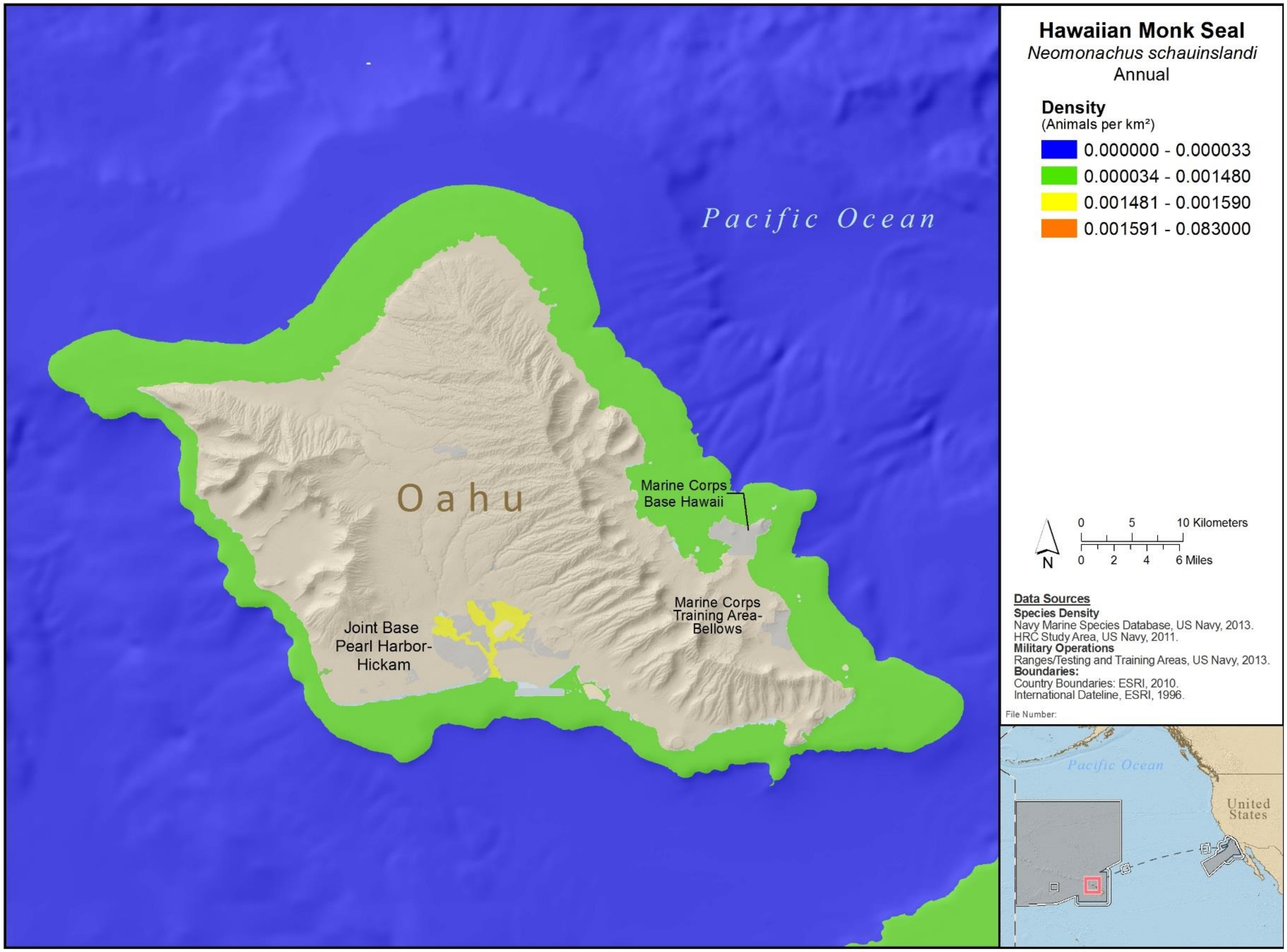


Figure 11-8: Distribution of Hawaiian Monk Seal around the Island of Oahu. Pearl Harbor is the major harbor on the south shore of Oahu.

11.1.5 *PHOCA VITULINA*, PACIFIC 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., 2015). It is one of the most adaptable seals and can haul out in a variety of terrestrial environments (Riedman & Estes, 1990); in some locations, such as Alaska, it can even occupy freshwater lakes. *Phoca vitulina richardsi* is the eastern Pacific subspecies (Riedman & Estes, 1990) that would be encountered in SOCAL, the Pacific Northwest, and the Gulf of Alaska. NMFS recognizes 17 harbor seal stocks along the U.S. Pacific coast including Alaska (Carretta et al., 2017; Muto et al., 2017). There are 12 stocks present in Alaska waters and 5 stocks occurring in Washington, Oregon, and California waters. Species from the California stock would be expected in SOCAL (Carretta et al., 2017).

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

SOCAL. Carretta et al. (2015) estimate there are 30,968 (CV=0.157) harbor seals in the California stock. From January to May, dependent harbor seal pups are present at haul-out locations, but many have left by May. The range of pupping dates varies with location, with more northerly locations having later pupping dates. From May to June, juveniles and adults spend more time on shore to molt.

(Eguchi & Harvey, 2005) reported dive durations of 4.8 (± 0.8) minutes for females and 5.5 (± 0.6) minutes for males. In the San Juan Islands, Wilson et al. (2014) recorded dives of 2.5 (± 1.8)-5.2(± 1.2) minutes with short surface intervals of 0.7–0.8 minutes for foraging dives. Harbor seals spend 78–87 percent of their time submerged while foraging at sea.

The Navy's estimate for the Southern California population of harbor seals was calculated as 22 percent of the California stock (U.S. Department of the Navy, 2015). Based on an abundance of 30,968 animals, the population for Southern California is estimate at 6,813 seals. Seasonal abundance for the Southern California population of harbor seal was estimated at 39 percent for the warm season and 85.5 percent for the cold season, based on data provided in Eguchi (2015) and Yochem et al. (1987). Density estimates for the warm and cold seasons were 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 Stratum (318,541 km^2).

Summer/fall: (6,813 x 0.39)/318,541 km^2 = 0.0083 seals/km^2

Spring/winter: (6,813 x 0.855)/318,541 km^2 = 0.0183 seals/km^2

Since harbor seals generally occur within 50 mi. of their haul-out sites, the Navy applied these estimates from the coast offshore, including a 50 mi. buffer around all known haul-out sites from islands within the acoustic modeling study areas (Lowry & Carretta, 2003). Zero density was assigned to waters outside this buffer, including the eastern portion of the transit corridor.

Table 11-5: Summary of Density Values for Harbor Seal in the Hawaii-Southern California Training and Testing Study Area

Location	Density (Animals/km^2)			
	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0.0183	0.0083	0.0083	0.0183
Baja	0.0183	0.0083	0.0083	0.0183

0 = species is not expected to be present.

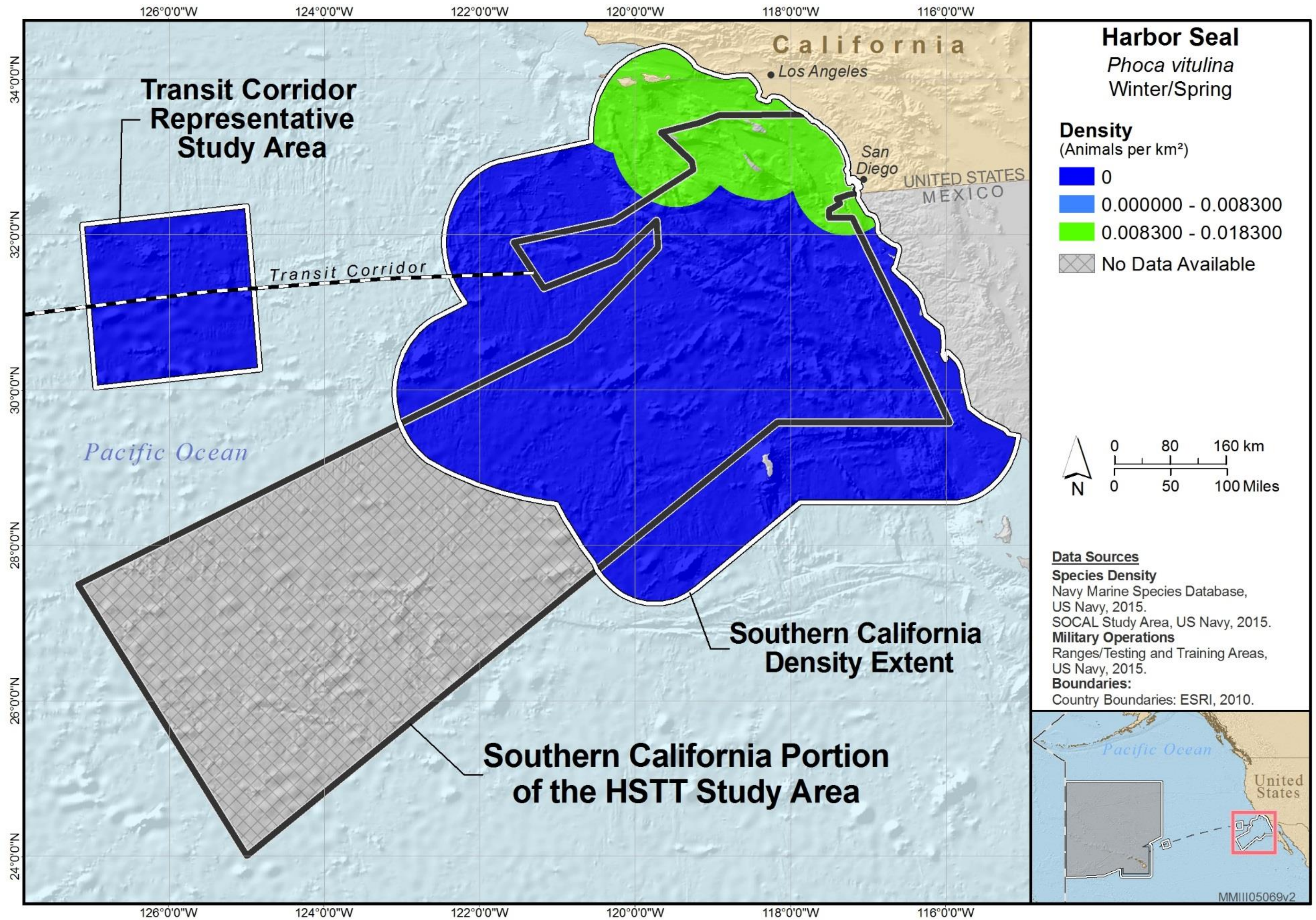


Figure 11-9: Winter/Spring Distribution of Harbor Seal in SOCAL and the Eastern Portion of the Transit Corridor

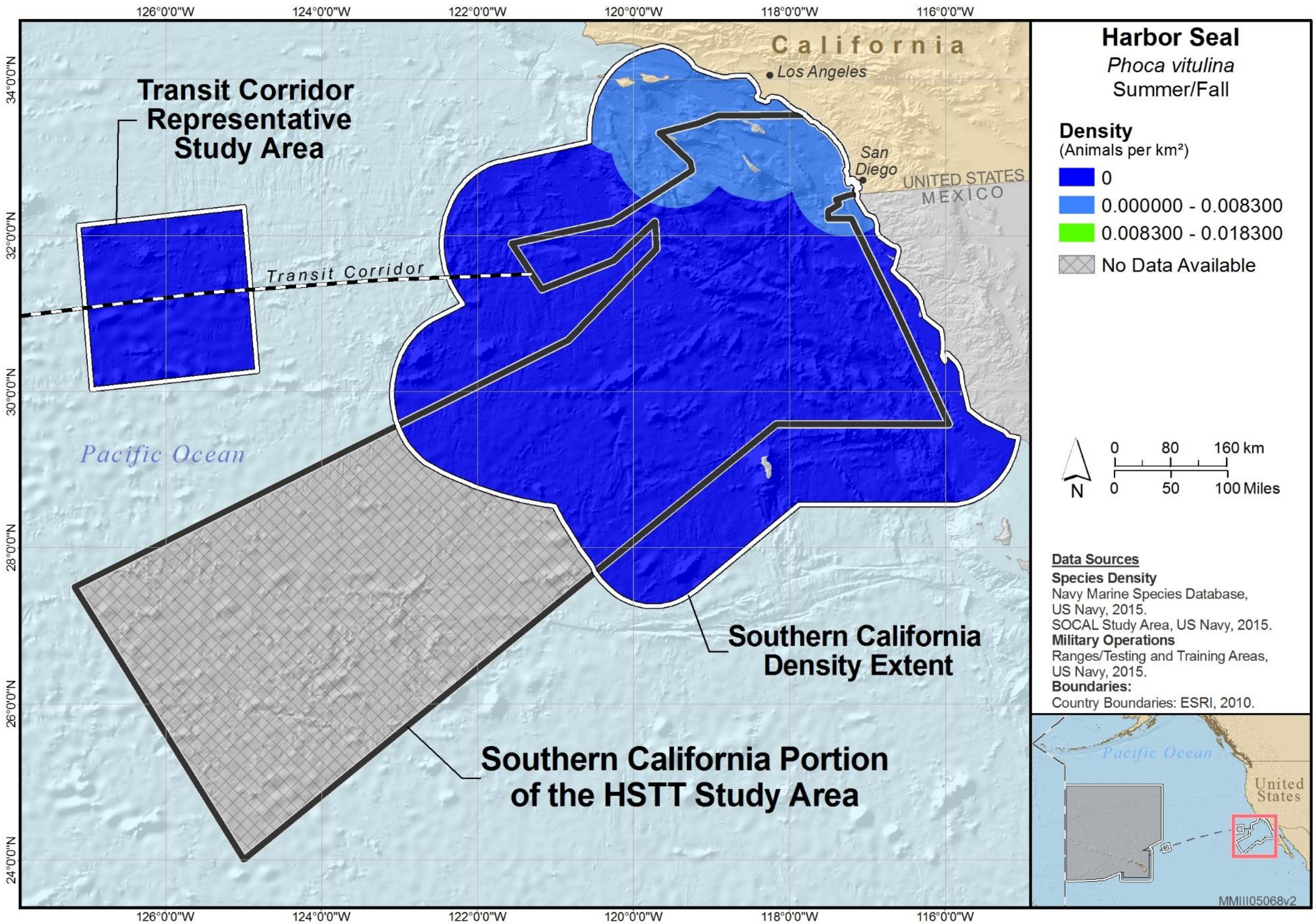


Figure 11-10: Summer/Fall Distribution of Harbor Seal in SOCAL and the Eastern Portion of the Transit Corridor

11.1.6 *ZALOPHUS CALIFORNIANUS*, CALIFORNIA SEA LION

The California sea lion (*Zalophus californianus*) is an abundant pinniped found along the Pacific coast of North America from the Gulf of Alaska to Southern Mexico (Jefferson et al., 2015). NMFS's stock assessment report estimates an abundance of 296,750 animals in the single U.S. stock (Carretta et al., 2015).

Throughout the year, adult female California sea lions alternate between nursing their pup on shore and foraging at sea. Females spend approximately 67 to 77 percent of their time at sea (Kuhn & Costa, 2014; Melin & DeLong, 2000) and generally move north from breeding and haul-out sites when foraging. Dependent pups and some juveniles may also be present. The pupping season begins in March and extends through the following May. Some dependent pups are still present when the next pupping season begins in May, but many have left pupping sites by then or earlier depending on food availability. Males are on shore during the summer breeding season (May through July) and then most move north of the Channel Islands to forage off central and northern California up to the Gulf of Alaska (Lowry & Forney, 2005; Maniscalco et al., 2004).

HRC. California sea lions are not expected to occur in the HRC or the western portion of the transit corridor.

SOCAL. Studies on the foraging behavior of adult lactating females from San Nicolas and San Miguel Islands, and adult and sub-adult males from the Monterey Bay area, showed that California sea lions generally move north of San Nicolas Island to forage (Kuhn, 2006; Kuhn & Costa, 2014; Melin et al., 2008; Melin et al., 2012; National Oceanic and Atmospheric Administration, 2016; Testa, 2012). The two largest rookeries, composing approximately 67 to 69 percent of all California sea lions, are on San Nicolas Island, which is located at the northern extent of the Southern California portion of the HSTT Study Area, and on San Miguel Island, located approximately 100 km north of the SOCAL OPAREA. Therefore, it is reasonable to conclude that the majority of the California sea lion population moves north of the Southern California portion of the HSTT Study Area to forage. Adult female sea lions tracked from rookeries on SCI, located within the SOCAL OPAREA, mostly remain in Southern California waters (Lowry & Forney, 2005).

Sea lions born on islands along the western Baja California coast, Mexico (Western Baja California Stock) make up approximately 9 percent of all sea lions. Individuals from this stock would likely move north through the Southern California portion of the HSTT Study Area to forage. Population counts from 2010 through 2012 on the western Baja coast were used to derive a population estimate of 33,447 individuals in the Western Baja California Stock (Urrutia & Dziendzielewski, 2012). The sea lion population from SCI, located within the SOCAL OPAREA, is estimated to be 7,248 animals (1,679 pups x 4.317 correction factor in 2013) (Lowry, 2015). Based on these population counts, an abundance of 40,695 sea lions is used to estimate densities for the Southern California portion of the HSTT Study Area.

Based on Lowry and Forney (2005), approximately 47 percent of the population are potentially in the Southern California portion of the HSTT Study Area during the cool season (Winter/Spring) and 53 percent are present during the warm season (Summer/Fall). The seasonal density estimates were calculated by taking the 47 and 53 percent, respectively, of the population estimate (40,695) and dividing by the area of the Navy's SOCAL Modeling Area (361,872 km^2).

Winter/Spring: (40,695 x 0.47)/361,872 km^2 = 0.0529 sea lions/km^2

Summer/Fall: (40,695 x 0.53)/361,872 km^2 = 0.0596 sea lions/km^2

The Navy also applied these values to the portion of the acoustic modeling study area off Baja and the eastern portion of the transit corridor. Density estimates from the Kaschner et al. (2006) RES model are shown for the remainder of the SOCAL Range Complex.

California sea lions are the only pinnipeds that occur regularly in San Diego Bay, so a separate density estimate for San Diego Bay was used in the Navy's acoustics effects model. Between February 2007 and June 2011, the Navy conducted five cold season surveys and six warm season surveys of San Diego Bay and waters adjacent to the Silver Strand Training Complex (Graham & Saunders, 2015). California sea lions were the only pinniped observed during the surveys, and no sea lions were seen south of the Coronado Island Bridge. During the warm season (May through October), California sea lions are engaged in breeding, nursing, and molting, which require more haul-out time than during the cool season (November through April). Density estimates for both hauled-out and in-water sea lions reflect this behavior. Graham and Saunders (2015) estimated both in-water only densities and combined densities for in-water and hauled-out sea lions; however, for analyzing potential impacts from underwater acoustics and explosives, only in-water density estimates were used. For both the warm and cool season, the in-water density estimate for north San Diego Bay is 13 sea lions/km^2 (Graham & Saunders, 2015).

Cool and Warm Periods North San Diego Bay: 169 sea lions/13 km^2 = 13 sea lions/km^2

Differences in nearshore and offshore sea lion abundance were observed in waters off the Silver Strand Training Complex. As in North San Diego Bay, Graham and Saunders (2015) estimated both in-water only densities and combined densities for in-water and hauled-out sea lions; however, only in-water density estimates were used. The in-water offshore density was estimated at 2.17 individuals/km^2 and the nearshore density was 3.45 individuals/km^2.

Offshore Silver Strand Training Complex: 76 sea lions/35 km^2 = 2.17 sea lions/km^2

Nearshore Silver Strand Training Complex: 147 sea lions/42.6 km^2 = 3.45 sea lions/km^2

Table 11-6: Summary of Density Values for California Sea Lion in the Hawaii-Southern California Training and Testing Study Area

Location	Density (Animals/km^2)			
	Spring	Summer	Fall	Winter
HRC	0	0	0	0
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0.0529	0.0596	0.0596	0.0529
North San Diego Bay	13.0	13.0	13.0	13.0
Offshore Silver Strand Training Complex	2.17	2.17	2.17	2.17
Nearshore Silver Strand Training Complex	3.45	3.45	3.45	3.45
Baja	0.0529	0.0596	0.0596	0.0529

0 = species is not expected to be present.

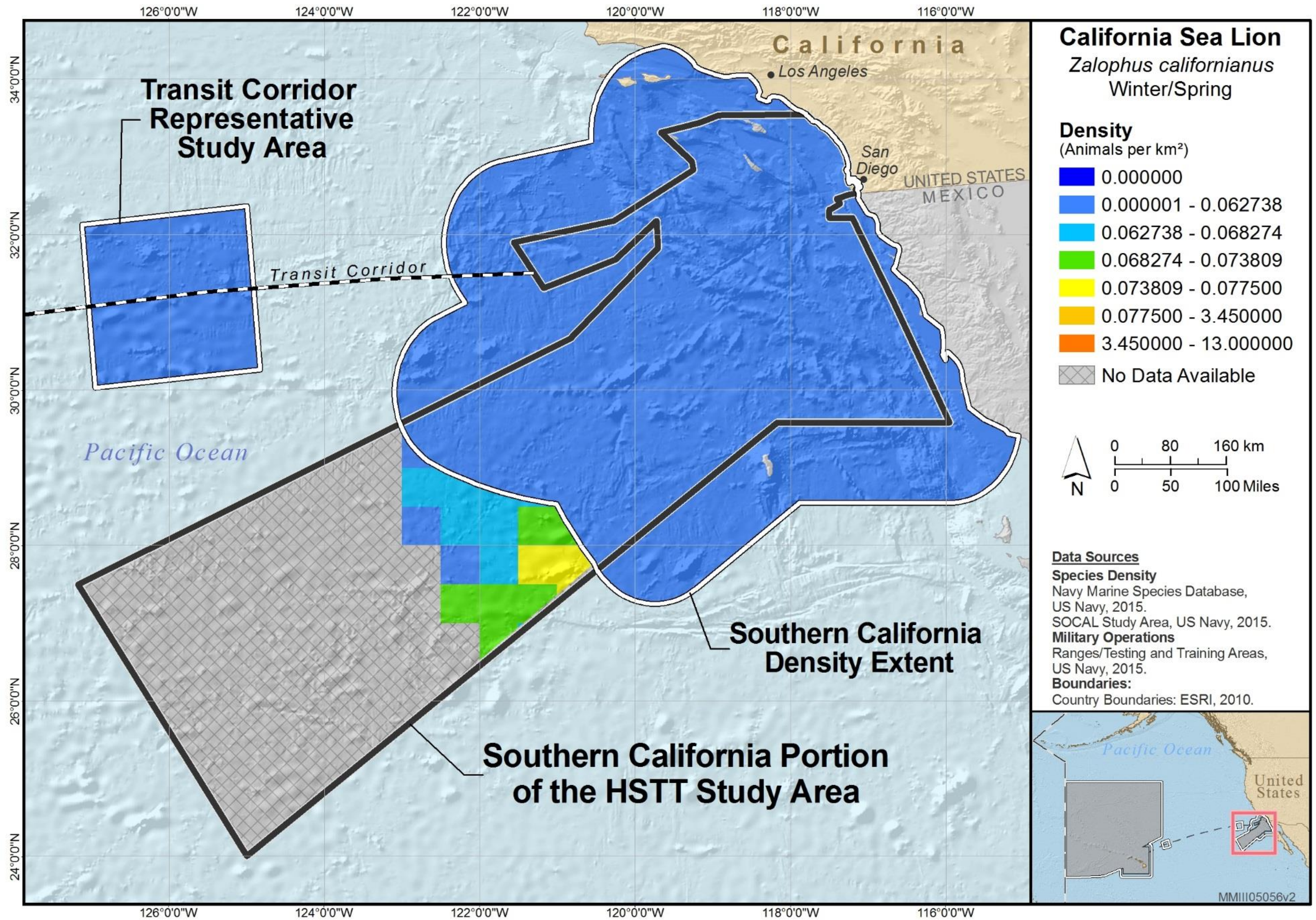


Figure 11-11: Winter/Spring Distribution of California Sea Lion in SOCAL and the Eastern Portion of the Transit Corridor

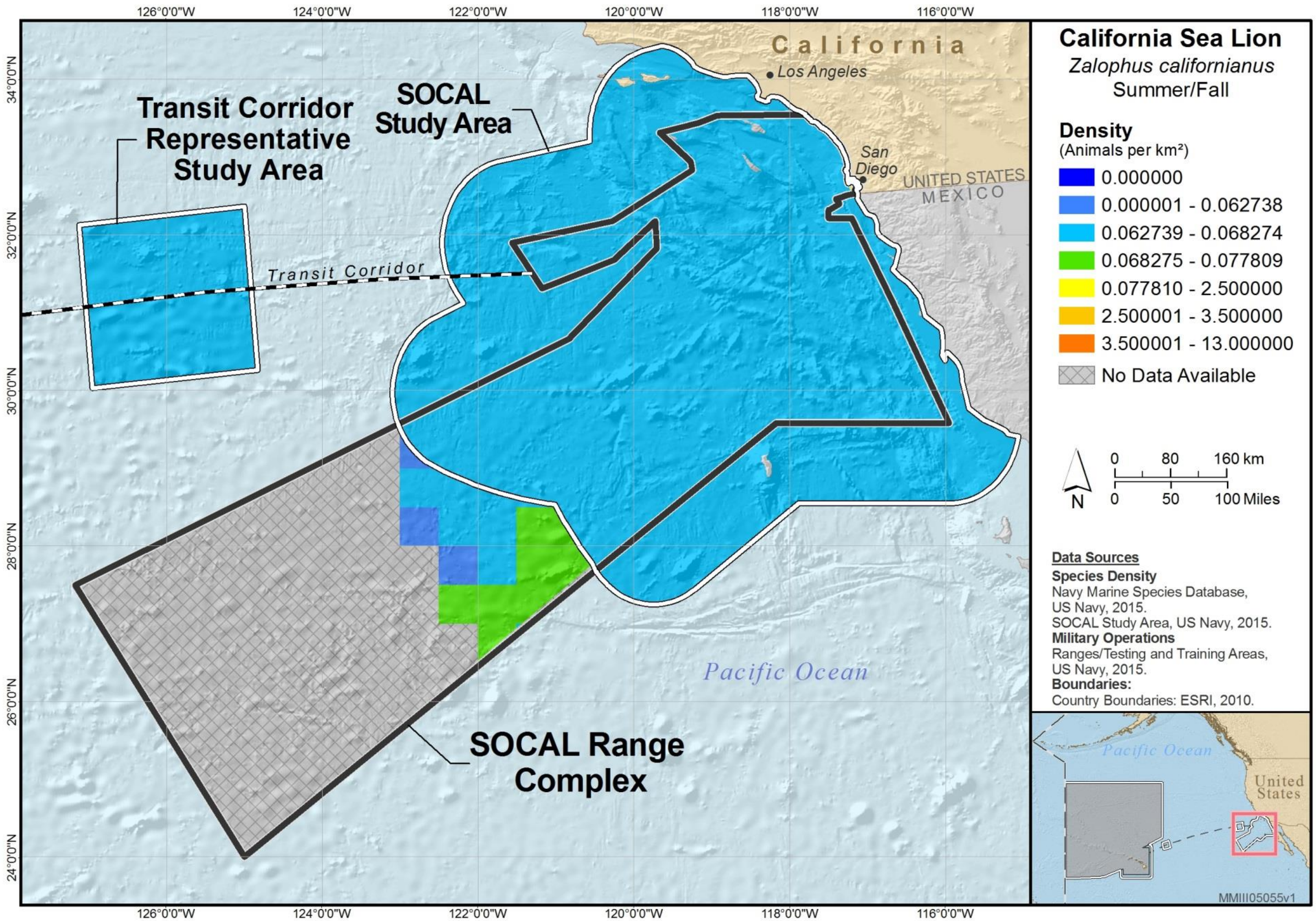


Figure 11-12: Summer/Fall Distribution of California Sea Lion in SOCAL and the Eastern Portion of the Transit Corridor

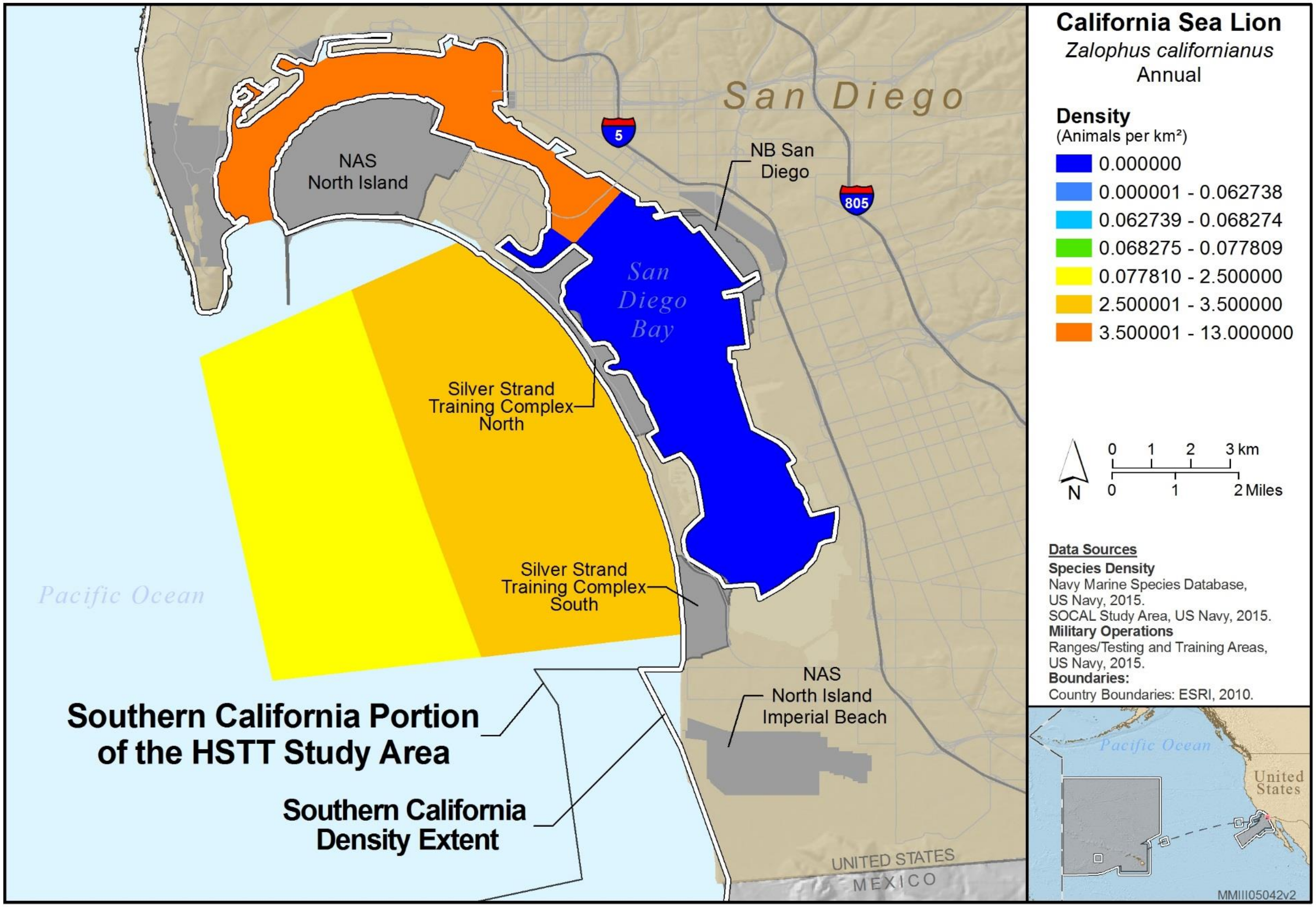


Figure 11-13: Annual Distribution of California Sea Lion in San Diego Bay and Nearshore and Offshore Waters Adjacent to the Silver Strand Training Complex

12 SEA TURTLES

12.1 SEA TURTLE SPECIES PROFILES

Sea turtles are a group of marine reptiles whose species are either threatened or endangered (Lutz & 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 (Blumenthal et al., 2009; Eguchi et al., 2010; Gaos & Yañez, 2008; Gaos et al., 2011; Shillinger et al., 2008; Whiting & 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 (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 (Bartol & Ketten, 2006; Donoso & Dutton, 2010). 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 (Aschettino et al., 2013; Smultea et al., 2008).

Abundance data sufficient to estimate density specific to green turtles are available from scientific literature for San Diego Bay (Eguchi et al., 2010), otherwise no other in-water data are published for SOCAL. A recent aerial survey conducted by NMFS SWFSC in the Southern California Bight resulted in 215 loggerhead turtle (*Caretta caretta*) sightings (Eguchi, 2015). In 2015, El Niño Southern Oscillation (ENSO) conditions and other related large scale ocean-atmosphere interactions resulted in anomalously warm water temperatures in the eastern North Pacific. The warmer waters are thought to have contributed to the high number of sightings. The data are preliminary and insufficient to provide a robust density estimate at this time. Once analyzed, these data may support a warm season density estimate for loggerhead turtles in the Southern California Bight. No leatherback turtles (*Dermochelys coriacea*) were sighted during the aerial survey; however, when water temperatures are cooler in winter and spring or perhaps during La Nina years, it is conceivable that leatherback turtles would occur in SOCAL (Roe et al., 2014).

HRC density estimates are derived entirely from Navy data. Because of the relative dominance of the system by green turtles and the techniques used to observe sea turtles, it is necessary to combine green turtles and hawksbill turtles, the two species that are likely to be seen, into a sea turtle group to estimate densities in the HRC. Conceivably, leatherback and loggerhead turtles could migrate near the Hawaiian Islands, but they are so rarely seen it would not be possible to accurately estimate their presence.

12.1.1 *CARETTA CARETTA*, LOGGERHEAD SEA TURTLE

The loggerhead turtle is found in temperate to tropical regions, generally between 40°N and 40°S in the Atlantic, Pacific, and Indian Oceans and in the Mediterranean Sea (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2007). Loggerhead turtles have adapted to a wide variety of habitats and can be found hundreds of miles offshore, as well inshore in areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers (Dodd, 1988).

Most loggerheads observed in the eastern North Pacific Ocean are believed to come from nesting beaches in Japan where the nesting season extends from late May to August (Conant et al., 2009; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1998a). Juvenile loggerheads originating from nesting beaches in Japan migrate through the North Pacific Transition Zone on their way to important foraging habitats in Baja California, Mexico, and are likely to occur in the transit corridor between the HRC and SOCAL Range Complex (Bowen et al., 1995; Kobayashi et al., 2008). The highest densities of loggerheads can be found in the North Pacific Transition Zone just north of Hawaii (Polovina et al., 2000).

The loggerhead turtle is known to occur at sea in the Southern California portion of the Study Area, but does not nest on Southern California beaches. Loggerhead turtles prefer waters where the sea surface temperature is between 15 and 25 degrees Celsius (°C). Loggerheads are generally not found in waters colder than 15°C, so the area north of the 15°C isotherm is considered an area of rare occurrence (Polovina et al., 2004).

In general, loggerhead turtle sightings off Southern California and southwestern Baja California increase in summer, peaking from July to September (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1998a; Stinson, 1984). However, during El Niño events, water temperatures in the eastern North Pacific become warmer, and foraging loggerheads from Mexican waters may expand their range northward into Southern California waters (Etnoyer et al., 2006). Waters in this portion of the Study Area are considered an area of occurrence during the warm-water period. The area of occurrence during the cold-water period extends north to the 18°C isotherm.

An aerial survey conducted in October 2015 under strong El Niño conditions recorded 215 sightings of loggerhead turtles in the Southern California Bight, indicating this species is present in SOCAL during the warm season (summer/fall) (Eguchi, 2015). El Niño conditions in the eastern North Pacific coupled with other large scale ocean-atmosphere circulations in the western tropical Pacific resulted in anomalously warm sea surface temperatures in the region and affected the ranges of numerous marine species (Bond et al., 2015). While it is too early to determine how the higher-than-average sea surface temperatures in the eastern North Pacific may have affected loggerhead abundance in SOCAL, it is possible that the number of sightings would be atypical under neutral ENSO conditions and that an abundance estimate based on these sightings would be biased high except during a strong El Niño phase. The 2015 survey data need to be analyzed further before estimates of seasonal abundance and density can be made for SOCAL. In consultation with NMFS' SWFSC, NMFS agreed it would be premature to estimate loggerhead sea turtle densities at this time (Eguchi, 2015).

Loggerhead turtles also forage offshore of the Baja Peninsula and migrate between Japan and the eastern North Pacific and are likely to occur in the transit corridor (Bowen et al., 1995; Etnoyer et al., 2006; Kobayashi et al., 2008).

HRC. This species is analyzed under the sea turtle guild in HRC. There is currently not enough known about the occurrence of loggerhead turtles in the western portion of the transit corridor to provide a reasonable in-water density estimate. Transoceanic migrations between Japan and Baja California, Mexico suggest that loggerheads may be present.

SOCAL. Loggerheads are known to forage off the coast of Baja California, Mexico and occur offshore of Southern California during the warm-water season. However, so little is known about loggerhead presence at sea in SOCAL that no reasonable estimate can be made for in-water density at this time. There is currently not enough known about the occurrence of loggerhead turtles in the eastern portion of the transit corridor to provide a reasonable in-water density estimate. Transoceanic migrations between Japan and Baja California, Mexico suggest that loggerheads may be present.

Table 12-1: Summary of Density Values for Loggerhead Sea Turtle in the Hawaii-Southern California Training and Testing Study Area

Location	Density (Animals/km^2)			
	Spring	Summer	Fall	Winter
HRC	SG	SG	SG	SG
W. Transit Corridor	ID	ID	ID	ID
E. Transit Corridor	0	ID	ID	0
SOCAL	0	ID	ID	0

0 = species is not expected to be present; SG = Species is analyzed under the sea turtle guild in HRC. ID = Species are known to occur in the area, but data are insufficient to estimate density.

12.1.2 *CHELONIA MYDAS*, GREEN SEA TURTLE

Green turtles are found in all of the world's oceans, but primarily in the tropics (Ernst et al., 1994). In April 2016, NMFS and the USFWS identified 11 DPSs for green sea turtles worldwide (81 FR 20057). Three DPSs are listed as endangered under the ESA and the remaining eight are listed as threatened. Green sea turtles occurring in the Study Area would either be from the Central North Pacific DPS or the East Pacific DPS.

In California, the species is rarely seen at sea, but there is a "resident" group of green turtles in San Diego Bay (Bredvik et al., 2015; Eguchi et al., 2010). In contrast to California, green turtles are often seen in the water in Hawaii and basking on some beaches (Whittow & 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 also migrate between island groups through deeper waters (Craig et al., 2004; Rice & Balazs, 2008). In Hawaii, the population status of green turtles has been improving, with larger numbers of turtles recorded near the Main Hawaiian Islands with some areas possibly approaching carrying capacity (Chaloupka & Balazs, 2007; Chaloupka et al., 2009).

HRC. This species is analyzed under the sea turtle guild in HRC. This species is not expected to occur in the western portion of the transit corridor.

SOCAL. Densities could only be derived for San Diego Bay. While green turtles are known to occur offshore in the SOCAL Range Complex (Eguchi et al., 2010; Himes-Cornell, 2015), so little is known about their presence in SOCAL that no reasonable density estimate could be made. Eguchi et al. (2010) discuss a mark recapture study of green turtles in San Diego Bay from December 1990 to March 2009. The highest abundance reported is 61 turtles during the 2002/2003 season. The Navy uses this value as a conservative estimate of the number of turtles present in San Diego Bay. In winter and spring, the turtles are limited to the southernmost portion of the Bay (Eguchi et al., 2010; Eguchi, 2015). By taking the abundance estimate and dividing by the area of the southern portion of San Diego Bay, the Navy arrives at a cold season (winter/spring) density estimate.

In summer and fall when water temperatures throughout the Bay are warmer, some turtles likely expand their range into the northern portion of the Bay and may even migrate out of the Bay into offshore waters. However, the majority of turtles remain in the southern portion of the Bay (Bredvik et al., 2015; Eguchi, 2015). To account for the wider distribution, the Navy assumes 5 percent, or 3 turtles, would be present in the northern portion of the Bay and the remaining 95 percent, or 58 turtles, would remain in the southern portion. By taking these abundance estimates and dividing by the area of the northern portion of San Diego Bay the Navy arrives at a warm season (summer/fall) density estimate.

Table 12-2: Summary of Density Values for Green Sea Turtle in the Hawaii-Southern California Training and Testing Study Area

Location	Density (Animals/km^2)			
	Spring	Summer	Fall	Winter
HRC	SG	SG	SG	SG
W. Transit Corridor	0	0	0	0
E. Transit Corridor	0	0	0	0
SOCAL	0	ID	ID	0
San Diego Bay North	0	0.0839866	0.0839866	0
San Diego Bay South	9.576138	9.105181	9.105181	9.576138
Baja	0	0	0	0

0 = species is not expected to be present; SG = Species is analyzed under the sea turtle guild in HRC. ID = Species are known to occur in the area, but data are insufficient to estimate density.

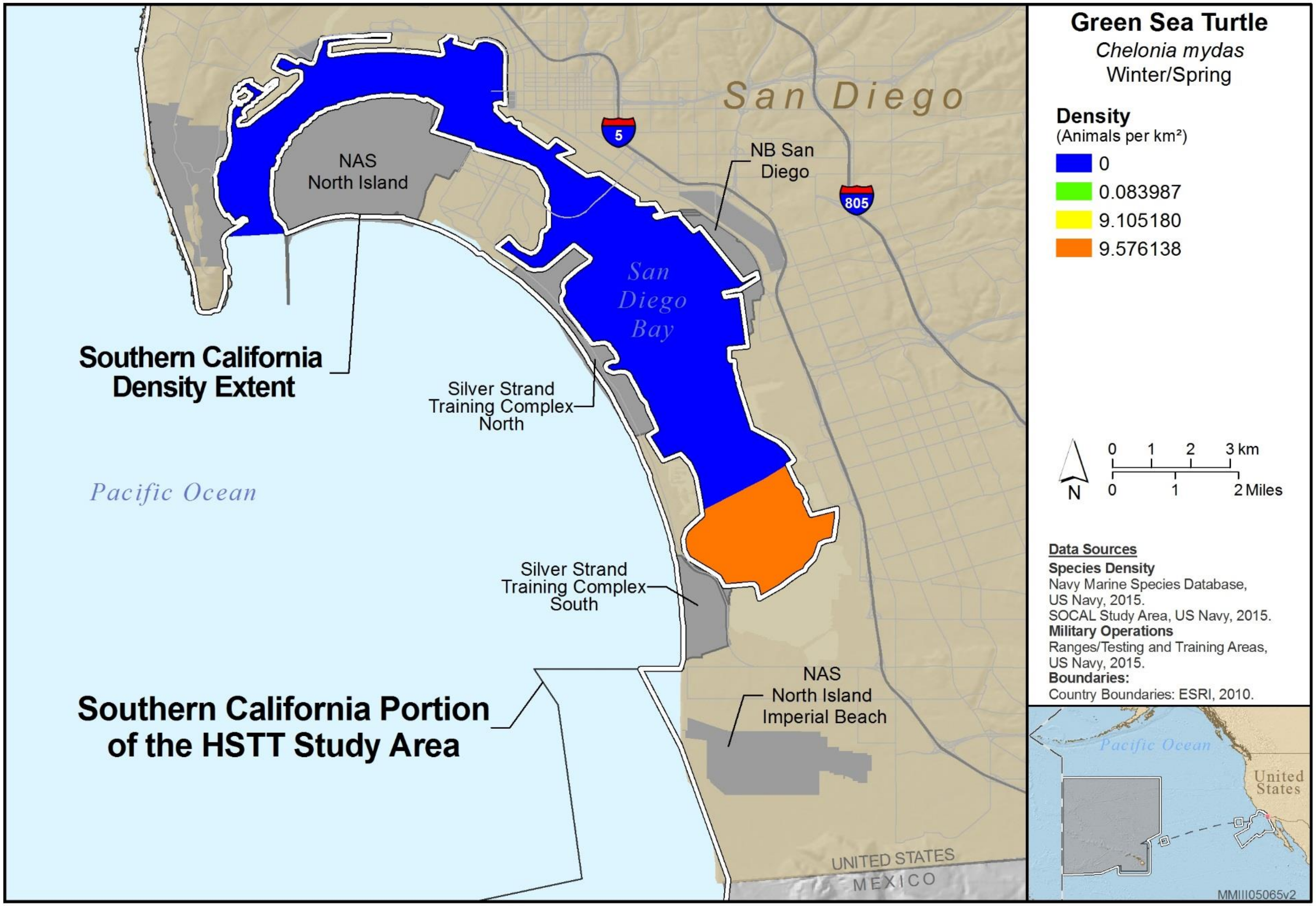


Figure 12-1: Winter/Spring Distribution of Green Sea Turtle in San Diego Bay

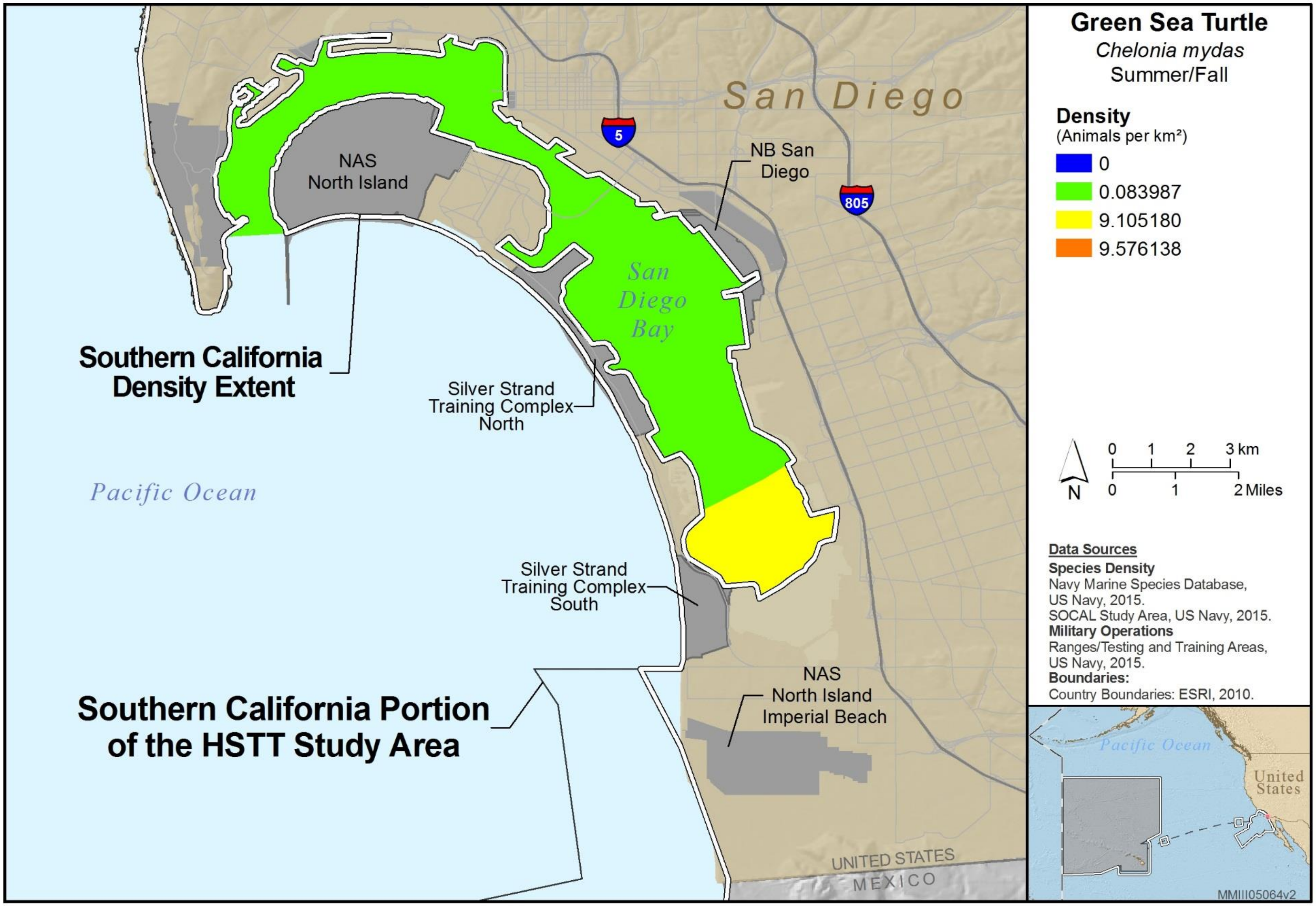


Figure 12-2: Summer/Fall Distribution of Green Sea Turtle in San Diego Bay

12.1.3 *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 (Hebshi et al., 2008; Myers & Hays, 2006; National Marine Fisheries Service & 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 temperatures than other sea turtle species. Thermoregulatory adaptations such as a counter-current heat exchange system, high oil content, and large body size allow leatherbacks to maintain a core body temperature higher than that of the surrounding water. (Hughes et al., 1998; James & Mrosovsky, 2004). In a study analyzing the movements of 135 leatherbacks fitted with satellite tracking tags, the turtles were found to inhabit waters with sea surface temperatures ranging from 11.3 to 31.7°C (mean of 24.7°C) (Bailey et al., 2012). The study also found that oceanographic features such as mesoscale eddies, convergence zones, and areas of upwelling attracted foraging leatherbacks because these features are often associated with aggregations of prey. Hebshi et al. (2008) analyzed telemetry data from 126 leatherbacks identifying migratory patterns and associations with similar oceanographic features such as current boundaries and stationary fronts. The data recorded year-long, transoceanic migrations from nesting beaches in the western North Pacific to the CCE. Adult leatherback turtles forage in temperate and subpolar regions in all oceans, and migrate to tropical nesting beaches located between 30°N and 20°S. Nesting beaches are widely distributed, but primarily occur on isolated mainland beaches in tropical regions of the Atlantic and Pacific oceans, with fewer in the tropical Indian Ocean. Nesting also takes place on temperate beaches in the southwest Indian Ocean (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1992), and to a lesser degree on offshore islands. Leatherbacks migrate from western Pacific Ocean nesting beaches to forage in the CCE of the U.S. Pacific (Benson et al., 2007; Hebshi et al., 2008; Kobayashi et al., 2008). Leatherback turtles leaving nesting beaches in the eastern Pacific Ocean off Mexico and Costa Rica generally migrate south into the southern hemisphere and forage in waters off Peru and Chile (Benson et al., 2011; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013). An aerial survey conducted in October 2015 in the Southern California Bight did not record any leatherback turtle sightings (Eguchi, 2015).

The leatherback turtle occurs in offshore areas surrounding the Hawaiian Islands beyond the 100 m isobath; shoreward of the 100 m isobath is an area of rare leatherback occurrence. Leatherback turtles are regularly sighted by fishers in offshore waters surrounding the Hawaiian Islands, generally beyond the 3,800 foot depth contour, and especially at the southeastern end of the island chain and off the northern coast of Oahu (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1998c). Sightings and reported interactions with the Hawaii longline fishery occur around seamounts above the Northwestern Hawaiian Islands from 35°N to 45°N and 175°W to 180°W (Skillman & Balazs, 1992; Skillman & Kleiber, 1998). Bailey et al. (2012) used tracking data for 135 individual leatherbacks and data on longline fishing effort to predict areas, or “hot spots,” where leatherback turtles in the Pacific Ocean are most likely to be at risk of bycatch. The study identified areas of relative high use by leatherback turtles that varied seasonally and correlated with likely migration routes. Higher use areas in the vicinity of the Hawaiian Islands were mainly south of the Islands from January through March, distinctly to the south from July through September, and to the southeast from October through December. From April through June, areas of higher use were centered on the Hawaiian Islands with a slightly greater intensity of use northeast of the Islands. Although leatherback bycatches are documented off Hawaii, leatherback-stranding events on Hawaiian beaches are uncommon. Since 1982, only five leatherback strandings have been reported in the Hawaiian Islands. The data presented by Bailey et al. (2012) also support the potential occurrence of leatherback turtles from the western Pacific in the Transit Corridor primarily from April through June and October through December. Areas of highest use off Southern California are predicted from July through September.

HRC. This species is analyzed under the sea turtle guild in HRC. There is currently not enough known about the occurrence of leatherback turtles in the western portion of the transit corridor to provide a reasonable in-water density estimate.

SOCAL. There is currently not enough known about the occurrence of leatherback turtles at sea in SOCAL, or in the eastern portion of the transit corridor to provide a reasonable in-water density estimate.

Table 12-3: Summary of Density Values for Leatherback Sea Turtle in the Hawaii-Southern California Training and Testing Study Area

Location	Density (Animals/km^2)			
	Spring	Summer	Fall	Winter
HRC	SG	SG	SG	SG
W. Transit Corridor	ID	0	0	ID
E. Transit Corridor	ID	ID	ID	0
SOCAL	ID	ID	ID	0

0 = species is not expected to be present; SG = Species is analyzed under the sea turtle guild in HRC. ID = Species are known to occur in the area, but data are insufficient to estimate density. Estimates of occurrence (i.e., either “0” or “ID”) for the Transit Corridor and SOCAL are based on Figure 1 and Figure 3 in Benson et al. (2011).

12.1.4 *Eretmochelys imbricata*, Hawksbill Sea Turtle

Hawksbill turtles were one of the first turtles protected under the ESA (Ernst et al., 1994). The species had been harvested aggressively for its beautiful shell and as a source of food. The hawksbill remains endangered throughout the world. Fewer than 10 females make up the nesting population on Baja California, Mexico. No nests have been documented off the U.S. west coast (Van Houtan et al., 2016). Worldwide, hawksbill turtles have not shown the same upward population trend seen with green turtles. The small nesting population of fewer than 20 females in the Hawaiian Islands may be increasing, but not enough data are available to confirm either an increasing or decreasing population trend. In comparison to female abundance from 20 to 100 years ago, the population has declined (Lutz et al., 2002). Strandings and observations of hawksbill turtles in Hawaii are uncommon.

HRC. This species is analyzed under the sea turtle guild in the HRC. This species may occur in the western portion of the transit corridor in the vicinity of the Hawaiian Islands. There is currently not enough known about the occurrence of hawksbill turtles in the western portion of the transit corridor to provide a reasonable in-water density estimate.

SOCAL. This species is not expected to occur in SOCAL. There is currently not enough known about the occurrence of hawksbill turtles in the eastern portion of the transit corridor to provide a reasonable in-water density estimate.

Table 12-4: Summary of Density Values for Hawksbill Sea Turtle in the Hawaii-Southern California Training and Testing Study Area

Location	Density (Animals/km^2)			
	Spring	Summer	Fall	Winter
HRC	SG	SG	SG	SG
W. Transit Corridor	ID	ID	ID	ID
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0

0 = species is not expected to be present; SG = Species is analyzed under the sea turtle guild in HRC. ID = Species are known to occur in the area, but data are insufficient to estimate density.

12.1.5 *LEPIDOCHELYS OLIVACEA*, OLIVE RIDLEY SEA TURTLE

The olive ridley turtle is known as an open-ocean species, but can be found in coastal areas. Olive ridley turtles are found worldwide in tropical and subtropical waters of the south Atlantic, Indian, and South Pacific oceans, preferring sea surface temperatures between 23 and 30 °C (Polovina et al., 2004). Distribution is patchy in offshore areas, corresponding with large-scale, dynamic ocean conditions, including oceanic currents and shifting upwelling zones, as well as sea surface temperature (Eguchi et al., 2007; Montero et al., 2016). Even though there are no current estimates of worldwide abundance, the olive ridley is considered the most abundant of the world's sea turtles. The number of olive ridley turtles occurring in the eastern tropical Pacific Ocean is estimated at 1.39 million (Eguchi et al., 2007). This estimate corresponds with increases in nesting populations observed over recent decades in the eastern tropical Pacific (Eguchi et al., 2007). Montero et al. (2016) found that olive ridley occurrence is positively correlated with sea surface temperatures between 26 and 30°C, relatively low concentrations of chlorophyll-*a*, and the presence of floating debris. While abundance and density estimates are available for waters off Mexico and Costa Rica, olive ridley turtles are not likely to occur in the cooler waters off Southern California.

Rare instances of nesting occur in the Hawaiian Islands, with the first olive ridley nest documented in 1985 at Paia, Maui. A second nest was recorded in Hilo, Hawaii, in 2002, and a third nest was recorded at Marine Corps Base Hawaii in Kaneohe Bay in 2009 (Marine Corps Base Hawaii, 2011).

HRC. This species is analyzed under the sea turtle guild in HRC. There is currently not enough known about the occurrence of olive ridley turtles in the western portion of the transit corridor to provide a reasonable in-water density estimate.

SOCAL. There are few documented occurrences of olive ridley sea turtles in waters off the U.S. Pacific coast (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1998b), and there is currently not enough known about the occurrence of olive ridley turtles in SOCAL to provide a reasonable in-water density estimate. However, based on sea surface temperature preferences, this species is not expected to occur in SOCAL. There is currently not enough known about the occurrence of olive ridley turtles in the eastern portion of the transit corridor to provide a reasonable in-water density estimate.

Table 12-5: Summary of Density Values for Olive Ridley Sea Turtle in the Hawaii-Southern California Training and Testing Study Area

Location	Density (Animals/km^2)			
	Spring	Summer	Fall	Winter
HRC	SG	SG	SG	SG
W. Transit Corridor	ID	ID	ID	ID
E. Transit Corridor	0	0	0	0
SOCAL	0	0	0	0

0 = species is not expected to be present; SG = Species is analyzed under the sea turtle guild in HRC.
ID = Species are known to occur in the area, but data are insufficient to estimate density.

12.1.6 Sea Turtle Guild

Some survey methods, such as aerial surveys, that are used to collect data on the occurrence of sea turtles make it very difficult for scientists to distinguish between turtle species. To account for the known occurrence of multiple sea turtle species in the HRC and the lack of species specific occurrence data, a sea turtle guild composed of green and hawksbill turtles was created to estimate sea turtle densities in the HRC. In theory, the guild also encompasses leatherback, olive ridley, and loggerhead turtles, but these species have not been identified during the collection of Navy monitoring data. While the analysis of survey data applies to sea turtles in general, it is thought to apply primarily to green turtles, which account for nearly all sightings. Also, the number of observations of hawksbill turtles would be so low as to render the data unusable for estimating density. By considering the hawksbill and green turtle sightings together, a more powerful result can be provided for sea turtles as a guild.

HRC. The Navy conducted aerial surveys for strandings of marine mammals in Hawaii under the monitoring program from 2009–2013, and incidentally observed sea turtles were also documented. Turtles can be spotted from a plane or helicopter during surveys (for example, see Smultea & Mobley, 2009 for survey protocol). Because the surveys are intended to identify stranded animals, only nearshore areas were surveyed. The Navy treats the aerial surveys as strip transects (Buckland et al., 2001) with an effective strip width of 2 km (1.2 mi.). Based on the number of turtles observed and the area of the strip transect, the Navy calculated the density of sea turtles for the nearshore waters of each island that was surveyed. A g(0) factor is applied to account for the number of turtles that are present but not observed, because the turtles are either camouflaged or too deep below the surface to be seen (Buckland et al., 2001). The Navy made a conservative estimate of g(0) = 0.9, meaning that only 10 percent of the turtles actually present were at the surface of the water or shallow enough to be seen from an aerial platform. Ninety percent were assumed to be present but not observable during the survey.

Coastline surveys that recorded turtle sightings are 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 with data was used. Density values are applied out to the 100 m (330 feet) isobath around all of the islands. This is considered a conservative estimate of the shallow habitat preferred 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 show that there is movement of green turtles between islands, but it is an uncommon event associated with migration (Rice & Balazs, 2008). To address the area of the HRC beyond the 100 m isobath, the Navy reduced the mean density value by two orders of magnitude. In one area between Lanai and Molokai where the 100 m isobaths around each island were nearly in contact, the Navy used a step-wise gradient of three density zones in place of the reduced mean density value.

As a requirement under the Sikes Act (16 U.S.C. §670a–670o), the Navy maintains an INRMP for Pearl Harbor. Natural resource monitoring occurs under the INRMP. As a result, the Navy has data specific to Pearl Harbor from in-water surveys for marine resources, including sea turtles (Hanser et al., In Prep.).

The duration of the data set considered here is from 2000 to 2011. Navy scientists divided Pearl Harbor into numbered sections and calculated in-water turtle densities for strip transects performed in each section (Figure 12-3). 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. The sea turtle guild is not used for the western portion of the transit corridor.

Sea turtles were not evenly distributed in Pearl Harbor. The turtles tend to concentrate along the margins of the channel leading into Pearl Harbor compared to other locations, and more turtles occurred in the channel south of Pearl Harbor in the cool season (November to April) than during the warm season (Hanser et al., In Prep.). Within Pearl Harbor, the turtles were encountered more frequently in the western loch than in either the eastern or middle lochs.

SOCAL. The sea turtle guild is not used for SOCAL or the eastern portion of the transit corridor.

Table 12-6: Summary of Density Values for the Sea Turtle Guild in the Hawaii-Southern California Training and Testing Study Area

Location	Density (Animals/km^2)
	Year-Round
Kauai	0.2786
Lanai	0.4491
Molokai	0.1624
Oahu	1.1252
Other Islands	0.4288
Beyond 100 m isobath	0.0043
Pearl Harbor	S

S = spatial model with various density values throughout the range.

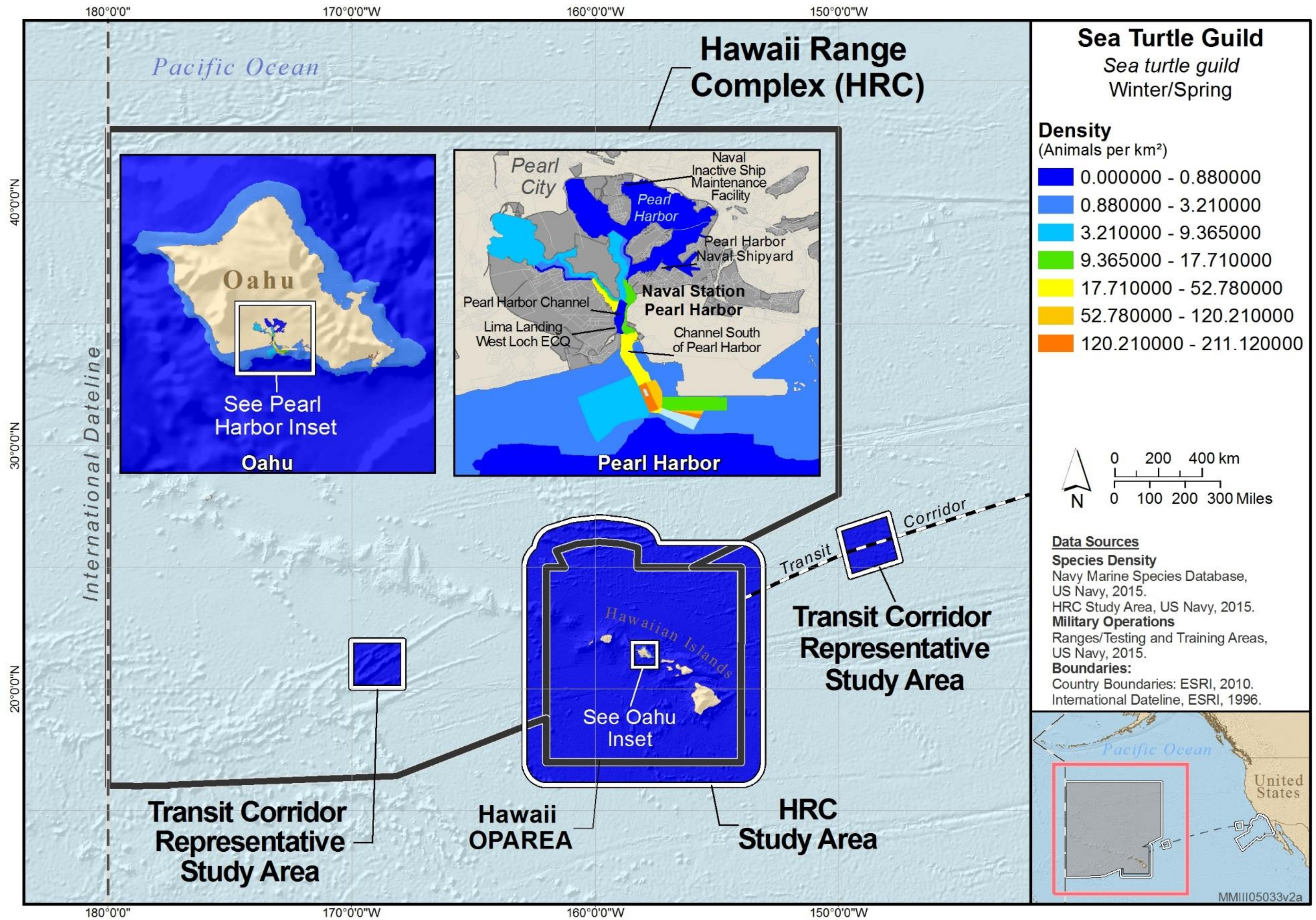


Figure 12-3: Winter/Spring Distribution of Sea Turtles in the Sea Turtle Guild in Hawaii Range Complex

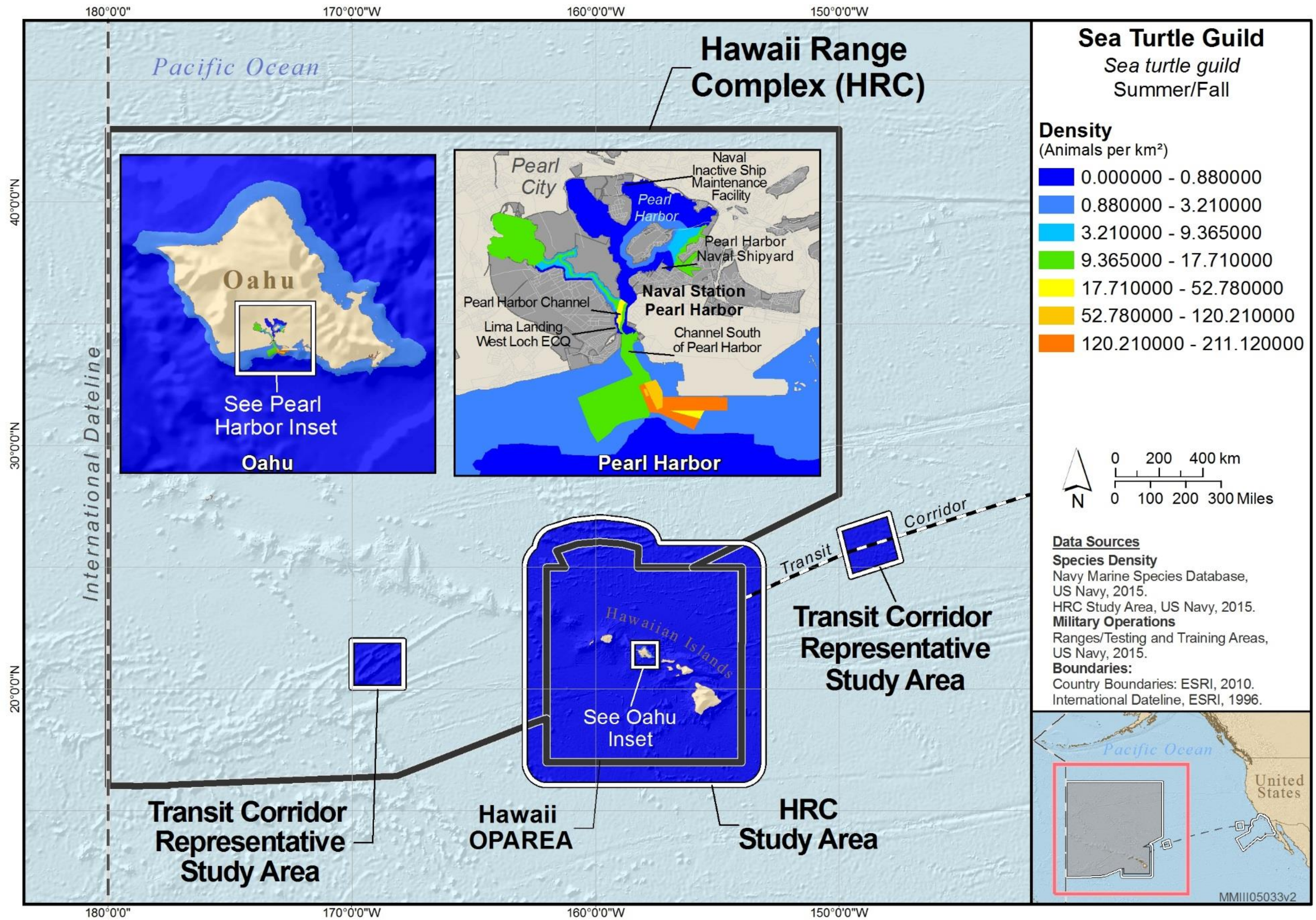


Figure 12-4: Summer/Fall Distribution of Sea Turtles in the Sea Turtle Guild in Hawaii Range Complex

13 CONCLUSION

The density estimates provided in this report represent an agreed-upon set of values that were used in modeling the effects from Navy Phase III sound sources to marine species. These data have been updated since the Navy's Phase II analyses (U.S. Department of the Navy, 2015), but still represent a snapshot in time, so that as science progresses and better estimates become available, the NMSDD will be updated for use in future Navy modeling efforts. 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 changes 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 OPAREAs, 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.

This Page Intentionally Left Blank

14 LITERATURE CITED

Aguilar, A. (2009). Fin whale, *Balaenoptera physalus*. In W. F. Perrin, B. Wursig & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 433–437). Amsterdam, Netherlands: Academic Press.

Allen, S. G., J. Mortenson, & S. Webb. (2011). *Field Guide to Marine Mammals of the Pacific Coast*. Berkeley, CA: University of California Press.

Andrews, K. R., L. Karczmarski, W. W. L. Au, S. H. Rickards, C. A. Vanderlip, B. W. Bowen, E. G. Grau, & R. J. Toonen. (2010). Rolling stones and stable homes: social structure, habitat diversity and population genetics of the Hawaiian spinner dolphin (*Stenella longirostris*). *Mol Ecol, 19*(4), 732–748.

Antonelis, G. A., B. S. Stewart, & W. F. Perryman. (1990). Foraging characteristics of female northern fur seals (*Callorhinus ursinus*) and California sea lions (*Zalophus californianus*). *Canadian Journal of Zoology, 68*, 150–158.

Antonelis, G. A., J. D. Baker, T. C. Johanos, R. C. Braun, & A. L. Harting. (2006). Hawaiian monk seal (*Monachus schauinslandi*): Status and conservation issues. *Atoll Research Bulletin, 543*, 75–101.

Archer, F. I., II, & W. F. Perrin. (1999). *Stenella coeruleoalba*. *Mammalian Species, 603*, 1–9.

Archer, F. I., II. (2009). Striped dolphin, *Stenella coeruleoalba*. In W. F. Perrin, B. Wursig & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 1127–1129). Academic Press.

Aschettino, J. M. (2010). *Population size and structure of melon-headed whales (Peponocephala electra) around the main Hawaiian Islands: Evidence of multiple populations based on photographic data.* (Master of Science Master's thesis). Hawaii Pacific University.

Aschettino, J. M., M. W. Richie, & R. K. Uyeyama. (2013). *Hawaii Range Complex Marine Mammal and Sea Turtle Underwater Detonation Monitoring Report for 2 and 4 April, 2013*. Pearl Harbor, HI.

Aurioles-Gamboa, D., C. J. Hernandez-Camacho, & E. Rodriguez-Krebs. (1999). Notes on the southernmost records of the Guadalupe fur seal, *Arctocephalus townsendi*, in Mexico. *Marine Mammal Science, 15*(2), 581–583.

Aurioles-Gamboa, D., F. Elorriaga-Verplancken, & C. J. Hernandez-Camacho. (2010). The current population status of Guadalupe fur seal (*Arctocephalus townsendi*) on the San Benito Islands, Mexico. *Marine Mammal Science, 26*(2), 402–408.

Bailey, H., S. R. Benson, G. L. Shillinger, S. J. Bograd, P. H. Dutton, S. A. Eckert, S. J. Morreale, F. V. Paladino, T. Eguchi, D. G. Foley, B. A. Block, R. Piedra, C. Hitipeuw, R. F. Tapilatu, & J. R. Spotila. (2012). Identification of distinct movement patterns in Pacific leatherback turtle populations influenced by ocean conditions. *Ecological Applications, 22*(3), 735–747.

Baird, R. W., & P. J. Stacey. (1991). Status of Risso's dolphin, *Grampus griseus*, in Canada. *Canadian Field-Naturalist, 105*(233–242).

Baird, R. W., E. L. Walters, & P. J. Stacey. (1993). Status of the bottlenose dolphin, *Tursiops truncatus* with special reference to Canada. *Canadian Field-Naturalist, 107*(4), 466–480.

Baird, R. W. (2000). The killer whale: foraging specializations and group hunting. In J. Mann, R. C. Connor, P. L. Tyack & H. Whitehead (Eds.), *Cetacean Societies; Field Studies of Dolphins and Whales* (pp. 127–153). Chicago, IL: University of Chicago Press.

Baird, R. W. (2005). Sightings of dwarf (*Kogia sima*) and pygmy (*K. breviceps*) sperm whales from the main Hawaiian Islands. *Pacific Science, 59*, 461–466.

Baird, R. W., G. S. Schorr, D. L. Webster, D. J. McSweeney, & S. D. Mahaffy. (2006). *Studies of beaked whale diving behavior and odontocete stock structure in Hawaii in March/April 2006* (Report prepared under Contract No. AB133F-06-CN-0053). Olympia, WA: Cascadia Research Collective.

Baird, R. W., A. M. Gorgone, D. J. McSweeney, D. B. Webster, D. R. Salden, M. H. Deakos, A. D. Ligon, G. Schorr, J. Barlow, & S. D. Mahaffy. (2008a). False killer whales (*Psuedorca crassidens*) around the main Hawaiian Islands: Long-term site fidelity, inter-island movements, and association patterns. *Marine Mammal Science, 24*(3), 591–612.

Baird, R. W., D. L. Webster, S. D. Mahaffy, D. J. McSweeney, G. S. Schorr, & A. D. Ligon. (2008b). Site fidelity and association patterns in a deep-water dolphin: Rough-toothed dolphins (*Steno bredanensis*) in the Hawaiian Archipelago. *Marine Mammal Science, 24*(3), 535–553.

Baird, R. W., D. L. Webster, G. S. Schorr, D. J. McSweeney, & J. Barlow. (2008c). Diel variation in beaked whale diving behavior. *Marine Mammal Science, 24*(3), 630–642.

Baird, R. W. (2009a). False killer whale *Pseudorca crassidens*. In W. F. Perrin, B. Wursig & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 405–406). Academic Press.

Baird, R. W. (2009b). Risso's dolphin, *Grampus griseus*. In W. F. Perrin, B. Wursig & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 975–976). San Diego, CA: Academic Press.

Baird, R. W., A. M. Gorgone, D. J. McSweeney, A. D. Ligon, M. H. Deakos, D. L. Webster, G. S. Schorr, K. K. Martien, D. R. Salden, & S. D. Mahaffy. (2009). Population structure of island-associated dolphins: Evidence from photo-identification of common bottlenose dolphins (*Tursiops truncatus*) in the Main Hawaiian Islands. *Marine Mammal Science, 25*(2), 251–274.

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. *Aquatic Mammals, 36*(3), 326–327.

Baird, R. W. (2011). Short Note: Open-Ocean Movements of a Satellite-Tagged Blainville’s Beaked Whale (*Mesoplodon densirostris*): Evidence for an Offshore Population in Hawai‘i? *Aquatic Mammals, 37*(4), 506–511.

Baird, R. W., G. S. Schorr, D. L. Webster, S. D. Mahaffy, D. J. McSweeney, M. B. Hanson, & R. D. Andrews. (2011). Open-ocean movements of a satellite-tagged Blainville's beaked whale (*Mesoplodon densirostris*): evidence for an offshore population in Hawaii? *Aquatic Mammals, 37*(4), 506–511.

Baird, R. W., E. M. Oleson, J. Barlow, A. D. Ligon, A. M. Gorgone, & S. D. Mahaffy. (2013). Evidence of an Island-Associated Population of False Killer Whales (*Pseudorca crassidens*) in the Northwestern Hawaiian Islands. *Pacific Science, 67*(4), 513–521.

Baird, R. W. (2015). [Personal communication with Dr. Robin W. Baird, Research Biologist, Cascadia Research Collective].

Baker, J. D., & T. C. Johanos. (2004). Abundance of the Hawaiian monk seal in the main Hawaiian Islands. *Biological Conservation, 116*(1), 103–110.

Baker, J. D., A. L. Harting, T. A. Wurth, & T. C. Johanos. (2011). Dramatic shifts in Hawaiian monk seal distribution predicted from divergent regional trends. *Marine Mammal Science, 27*(1), 78–93.

Baker, J. D., A. L. Harting, T. C. Johanos, & C. L. Littnan. (2016). Estimating Hawaiian monk seal range-wide abundance and associated uncertainty. *Endangered Species Research, 31*, 317–324.

Balcomb, K. C. (1989). Baird's beaked whale — *Ziphius cavirostris* (Stejneger, 1883) and Arnoux's beaked whale — *Berardius arnuxii* (Duvernoy, 1851). In S. H. Ridgway & R. Harrison (Eds.), *Volume 4: River Dolphins and the Larger Toothed Whales* (Vol. 6, pp. 261–288). San Diego, CA: Academic Press.

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 Pobability for Long-Diving Whales. In G. W. Garner (Ed.), *Marine Mammal Survey aand Assesment Methods* (pp. 209–221). Rotterdam, Netherlands: Balkema.

Barlow, J., & B. L. Taylor. (2005). Estimates of sperm whale abundance in the northeastern temperate Pacific from a combined acoustic and visual survey. *Marine Mammal Science, 21*(3), 429–445.

Barlow, J. (2006). Cetacean abundance in Hawaiian waters estimated from a Summer–Fall survey in 2002. *Marine Mammal Science, 22*(2), 446–464.

Barlow, J., M. C. Ferguson, W. F. Perrin, L. Ballance, T. Gerrodette, G. Joyce, C. D. MacLeod, K. Mullin, D. L. Palka, & G. Waring. (2006). Abundance and densities of beaked and bottlenose whales (family Ziphiidae). *Journal of Cetacean Research and Management, 7*(3), 263–270.

Barlow, J., & K. A. Forney. (2007). Abundance and population density of cetaceans in the California Current ecosystem. *Fishery Bulletin, 105*, 509–526.

Barlow, J., M. C. Ferguson, E. A. Becker, J. V. Redfern, K. A. Forney, I. L. Vilchis, P. C. Fiedler, T. Gerrodette, & L. T. Ballance. (2009). *Predictive Modeling of Cetacean Densities in the Eastern Pacific Ocean* (NOAA Technical Memorandum NMFS-SWFSC-444). La Jolla, CA: Southwest Fisheries Science Center.

Barlow, J. (2010). *Cetacean Abundance in the California Current Estimated from a 2008 Ship-Based Line-Transect Survey* (NOAA Technical Memorandum NMFS-SWFSC-456). La Jolla, CA: Southwest Fisheries Science Center.

Barlow, J., J. Calambokidis, E. A. Falcone, C. S. Baker, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, R. LeDuc, D. K. Mattila, T. J. Quinn, II, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán R, P. Wade, D. Weller, B. H. Witteveen, & M. Yamaguchi. (2011). Humpback whale abundance in the North Pacific estimated by photographic capture-recapture with bias correction from simulation studies. *Marine Mammal Science, 27*(4), 793–818.

Barlow, J. (2015). Inferring trackline detection probabilities, g(0), for cetaceans from apparent densities in different survey conditions. *Marine Mammal Science, 31*(3), 923–943.

Barlow, J. (2016). *Cetacean Abundance in the California Current Estimated from Ship-based Line-transect Surveys in 1991–2014.* (NOAA Administrative Report NMFS-SWFSC-LJ-1601). La Jolla, CA: Southwest Fisheries Science Center.

Barrett Lennard, L. G., J. K. B. Ford, & K. A. Heise. (1996). The mixed blessing of echolocation: Differences in sonar use by fish-eating and mammal-eating killer whales. *Animal Behaviour, 51*, 553–565.

Bartol, S. M., & D. R. Ketten. (2006). *Turtle and Tuna Hearing* (Sea Turtle and Pelagic Fish Sensory Biology: Developing Techniques to Reduce Sea Turtle Bycatch in Longline Fisheries: NOAA Technical Memorandum NMFS-PIFSC-7). Honolulu, HI: Pacific Islands Fisheries Science Center.

Baumann-Pickering, S., L. K. Baldwin, A. E. Simonis, M. A. Roche, M. L. Melcon, J. A. Hildebrand, E. M. Oleson, R. W. Baird, G. S. Schorr, D. L. Webster, & D. J. McSweeney. (2010). *Characterization of Marine Mammal Recordings from the Hawaii Range Complex*. Monterey, CA: Naval Postgraduate School.

Becker, E. A., K. A. Forney, M. C. Ferguson, D. G. Foley, R. C. Smith, J. Barlow, & J. V. Redfern. (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.

Becker, E. A., D. G. Foley, K. A. Forney, J. Barlow, J. V. Redfern, & C. L. Gentemann. (2012a). Forecasting cetacean abundance patterns to enhance management decisions. *Endangered Species Research, 16*, 97–112.

Becker, E. A., K. A. Forney, M. C. Ferguson, J. Barlow, & J. V. Redfern. (2012b). *Predictive Modeling of Cetacean Densities in the California Current Ecosystem based on Summer/Fall Ship Surveys in 1991–2008* (NOAA Technical Memorandum NMFS-SWFSC-499). La Jolla, CA: Southwest Fisheries Science Center.

Becker, E. A., K. A. Forney, D. G. Foley, & J. Barlow. (2012c). *Density and Spatial Distribution Patterns of Cetaceans in the Central North Pacific based on Habitat Models* (NOAA Technical Memorandum NMFS-SWFSC-490). La Jolla, CA: Southwest Fisheries Science Center.

Becker, E. A., K. A. Forney, D. G. Foley, R. C. Smith, T. J. Moore, & J. Barlow. (2014). Predicting seasonal density patterns of California cetaceans based on habitat models. *Endangered Species Research, 23*(1), 1–22.

Becker, E. A., K. A. Forney, P. C. Fiedler, J. Barlow, S. J. Chivers, C. A. Edwards, A. M. Moore, & J. V. Redfern. (2016). Moving Towards Dynamic Ocean Management: How Well Do Modeled Ocean Products Predict Species Distributions? *Remote Sensing, 8*(2), 149.

Becker, E. A., K. A. Forney, B. J. Thayre, A. J. Debich, G. S. Campbell, K. Whitaker, A. B. Douglas, A. Gilles, R. Hoopes, & J. A. Hildebrand. (2017). Habitat-Based Density Models for Three Cetacean Species off Southern California Illustrate Pronounced Seasonal Differences. *Frontiers in Marine Science, 4*(121), 1–14.

Benson, S. R., K. A. Forney, J. T. Harvey, J. V. Carretta, & P. H. Dutton. (2007). Abundance, distribution, and habitat of leatherback turtles (*Dermochelys coriacea*) off California, 1990–2003. *Fishery Bulletin, 105*(3), 337–347.

Benson, S. R., T. Eguchi, D. G. Foley, K. A. Forney, H. Bailey, C. Hitipeuw, B. P. Samber, R. F. Tapilatu, V. Rei, & P. Ramohia. (2011). Large-scale movements and high-use areas of western Pacific leatherback turtles, Dermochelys coriacea. *Ecosphere, 2*(7), art84.

Bernard, H. J., & S. B. Reilly. (1999). Pilot whales, *Globicephala* Lesson, 1828. In S. H. Ridgway & R. Harrison (Eds.), *Handbook of Marine Mammals* (Vol. 6, pp. 245–280). San Diego, CA: Academic Press.

Bettridge, S., C. S. Baker, J. Barlow, P. J. Clapham, M. Ford, D. Gouveia, D. K. Mattila, R. M. Pace, III, P. E. Rosel, G. K. Silber, & P. R. Wade. (2015). *Status Review of the Humpback Whale (Megaptera novaeangliae) under the Endangered Species Act* (NOAA Technical Memorandum NMFS-SWFSC-540). La Jolla, CA: Southwest Fisheries Science Center.

Black, N. A. (2009). Pacific white-sided dolphin, *Lagenorhynchus obliquidens*. In W. F. Perrin, B. Wursig & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 817–819). Academic Press.

Blumenthal, J. M., T. J. Austin, J. B. Bothwell, A. C. Broderick, G. Ebanks-Petrie, J. R. Olynik, M. F. Orr, J. L. Solomon, M. J. Witt, & B. J. Godley. (2009). Diving behavior and movements of juvenile hawksbill turtles, *Eretmochelys imbricata,* on a Caribbean coral reef. *Coral Reefs, 28*(1), 55–65.

Blumenthal, J. M., T. J. Austin, J. B. Bothwell, A. C. Broderick, G. Ebanks-Petrie, J. R. Olynik, M. F. Orr, J. L. Solomon, M. J. Witt, & B. J. Godley. (2010). Life in (and out of) the lagoon: fine-scale movements of green turtles tracked using time-depth recorders. *Aquatic Biology, 9*, 113–121.

Bond, N. A., M. F. Cronin, H. Freeland, & N. Mantua. (2015). Causes and impacts of the 2014 warm anomaly in the northeast Pacific. *Geophysical Research Letters, 42*(9), 3414–3420.

Bowen, B. W., F. A. Abreu-Grobois, G. H. Balazs, N. Kamezaki, C. J. Limpus, & R. J. Ferl. (1995). Trans-Pacific migrations of the loggerhead turtle (*Caretta caretta*) demonstrated with mitochondrial DNA markers. *Proceedings of the National Academy of Sciences of the United States of America, 92*, 3731–3734.

Bradford, A. L., E. A. Oleson, R. W. Baird, C. H. Boggs, K. A. Forney, & N. C. Young. (2015). *Revised Stock Boundaries for False Killer Whales (Psuedorca crassidens) in Hawaiian Waters* (NOAA Technical Memorandum NMFS-PIFSC-47). Honolulu, HI: Pacific Islands Fisheries Science Center.

Bradford, A. L., K. A. Forney, E. M. Oleson, & J. Barlow. (2017). Abundance estimates of cetaceans from a line-transect survey within the U.S. Hawaiian Islands Exclusive Economic Zone. *Fishery Bulletin, 115*(2), 129–142.

Bredvik, J. J., S. E. Graham, & B. Saunders. (2015). *Progress Report: Evaluation of Fine Scale Movements of East Pacific Green Sea Turtles in San Diego Bay*. Prepared for Commander, Naval Installations Command and Commander, U.S. Pacific Fleet. Submitted to Naval Facilities Engineering Command (NAVFAC) Southwest, California, September 2015.

Brill, R. W., G. H. Balazs, K. N. Holland, R. K. C. Chang, S. Sullivan, & J. C. George. (1995). 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. *Journal of Experimental Marine Biology and Ecology, 185*(2), 203–218.

Brownell, R. L., Jr., W. A. Walker, & K. A. Forney. (1999). Pacific white-sided dolphin, *Lagenorhynchus obliquidens* Gill, 1865. In S. H. Ridgway & R. Harrison (Eds.), *Handbook of Marine Mammals* (Vol. 6: The second book of dolphins and the porpoises, pp. 57–84). Academic Press.

Brownell, R. L., Jr., P. J. Clapham, T. Miyashita, & T. Kasuya. (2001). Conservation status of North Pacific right whales. *Journal of Cetacean Research and Management, Special Issue 2*, 269–286.

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, & L. Thomas. (2001). *Introduction to Distance Sampling: Estimating Abundance of Biological Populations*. Oxford, UK: Oxford University Press.

Burnham, K. P., & D. R. Anderson. (1998). *Model Selection and Multi-Model Inference: A Practical Information-Theoretic Approach*. New York, NY: Springer-Verlag.

Calambokidis, J., J. D. Darling, V. Deecke, P. Gearin, M. Gosho, W. Megill, C. M. Tombach, D. Goley, C. Toropova, & B. Gisborne. (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., E. A. Falcone, T. J. Quinn, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, R. LeDuc, D. Mattila, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán R., D. Weller, B. H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, & N. Maloney. (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). Olympia, WA: Cascadia Research.

Calambokidis, J., J. L. Laake , & A. Klimek. (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).

Call, K. A., R. R. Ream, D. Johnson, J. T. Sterling, & R. G. Towell. (2008). 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.

Campbell, G. S., L. Thomas, K. Whitaker, A. B. Douglas, J. Calambokidis, & J. A. Hildebrand. (2015). Inter-annual and seasonal trends in cetacean distribution, density and abundance off southern California. *Deep Sea Research Part II: Topical Studies in Oceanography, 112*, 143–157.

Carretta, J. V., M. S. Lynn, & C. A. LeDuc. (1994). Right whale (*Eubalaena Glacialis*) sighting off San Clemente Island, California. *Marine Mammal Science, 10*(1), 101–105.

Carretta, J. V., K. A. Forney, & J. L. Laake. (1998). Abundance of southern California coastal bottlenose dolphins estimated from tandem aerial surveys. *Marine Mammal Science, 14*(4), 655–675.

Carretta, J. V., K. A. Forney, M. S. Lowry, J. Barlow, J. Baker, D. Johnston, B. Hanson, R. L. Brownell, Jr., J. Robbins, D. Mattila, K. Ralls, M. M. Muto, D. Lynch, & L. Carswell. (2010). *U.S. Pacific Marine Mammal Stock Assessments: 2009* (NOAA Technical Memorandum NMFS-SWFSC-453). La Jolla, CA: Southwest Fisheries Science Center.

Carretta, J. V., K. A. Forney, E. Oleson, K. Martien, M. M. Muto, M. S. Lowry, J. Barlow, J. Baker, B. Hanson, D. Lynch, L. Carswell, R. L. Brownell, J. Robbins, D. K. Mattila, K. Ralls, & M. C. Hill. (2011). *U.S. Pacific Marine Mammal Stock Assessments: 2010* (NOAA Technical Memorandum NMFS-SWFSC-476). La Jolla, CA: Southwest Fisheries Science Center.

Carretta, J. V. (2012). *Spatially explicit density estimates for the California Coastal Stock of bottlenose dolphin, Tursiops truncatus*. Unpublished raw data.

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 Assessment* (NOAA Technical Memorandum NMFS-SWFSC-532). La Jolla, CA: Southwest Fisheries Science Center.

Carretta, J. V., E. Oleson, D. W. Weller, A. R. Lang, K. A. Forney, J. Baker, M. M. Muto, B. Hanson, A. J. Orr, H. Huber, M. S. Lowry, J. Barlow, J. Moore, D. Lynch, L. Carswell, & R. L. Brownell. (2015). *U.S. Pacific Marine Mammal Stock Assessments: 2014* (NOAA Technical Memorandum NMFS-SWFSC-549). La Jolla, CA: Southwest Fisheries Science Center.

Carretta, J. V., E. M. Oleson, J. Baker, D. W. Weller, A. R. Lang, K. A. Forney, M. M. Muto, B. Hanson, A. J. Orr, H. Huber, M. S. Lowry, J. Barlow, J. E. Moore, D. Lynch, L. Carswell, & R. L. Brownell Jr. (2016). *U.S. Pacific Marine Mammal Stock Assessments: 2015*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Carretta, J. V., E. M. Oleson, J. Baker, D. W. Weller, A. R. Lang, K. A. Forney, M. M. Muto, B. Hanson, A. J. Orr, H. Huber, M. S. Lowry, J. Barlow, J. E. Moore, D. Lynch, L. Carswell, & R. L. Brownell, Jr. (2017). *U.S. Pacific Marine Mammal Stock Assessments: 2016* (NOAA Technical Memorandum NMFS-SWFSC-561). La Jolla, CA: Southwest Fisheries Science Center.

Chaloupka, M., & G. H. Balazs. (2007). Using Bayesian state-space modelling to assess the recovery and harvest potential of the Hawaiian green sea turtle stock. *Ecological Modeling, 205*, 93–109.

Chaloupka, M., G. H. Balazs, & T. M. Work. (2009). Rise and fall over 26 years of a marine epizootic in Hawaiian green sea turtles. *Journal of Wildlife Diseases, 45*(4), 1138–1142.

Cheng, I.-J., P. H. Dutton, C. L. Chen, H. C. Chen, & J. W. Shea. (2008). Comparison of the genetics and nesting ecology of two green turtle rookeries. *Journal of Zoology, 276*(4), 375–384.

Clapham, P. J. (2000). The humpback whale: seasonal feeding and breeding in a baleen whale. In J. Mann, R. C. Connor, P. L. Tyack & H. Whitehead (Eds.), *Cetacean Societies: field studies of dolphins and whales* (pp. 173–196). University of Chicago Press.

Clarke, M., & R. Young. (1998). Description and analysis of cephalopod beaks from stomachs of six species of odontocete cetaceans stranded on Hawaiian shores. *Journal of the Marine Biolgoical Association of the United Kingdom, 78*(2), 623–641.

Conant, T. A., P. H. Dutton, T. Eguchi, S. P. Epperly, C. C. Fahy, M. H. Godfrey, S. L. MacPherson, E. E. Possardt, B. A. Schroeder, J. A. Seminoff, M. L. Snover, C. M. Upite, & B. E. Witherington. (2009). *Loggerhead sea turtle (Caretta caretta) 2009 status review under the U.S. Endangered Species Act. Report of the Loggerhead biological review team to the National Marine Fisheries Service. August 2009*.

Connor, R. C., R. S. Wells, J. Mann, & A. J. Read. (2000). The bottlenose dolphin; Social relationships in a fission-fusion society. In J. Mann, R. C. Connor, P. L. Tyack & H. Whitehead (Eds.), *Cetacean Societies; Field Studies of Dolphins and Whales* (pp. 91–126). Chicago, IL: University of Chicago Press.

Craig, A. S., & L. M. Herman. (1997). Sex differences in site fidelity and migration of humpback whales (*Megaptera novaeangliae*) to the Hawaiian Islands. *Canadian Journal of Zoology*, 1923–1933.

Craig, P., D. Parker, R. Brainard, M. Rice, & G. Balazs. (2004). Migrations of green turtles in the central South Pacific. *Biological Conservation, 116*(3), 433–438.

Dahlheim, M. E., & J. E. Heyning. (1999). Killer whale, *Orcinus orca* (Linnaeus, 1758). In S. H. Ridgway & R. Harrison (Eds.), *Handbook of Marine Mammals* (Vol. 6, pp. 281–322). San Diego, CA: Academic Press.

Dailey, M. D., D. J. Reish, & J. W. Anderson. (1993). *Ecology of the Southern California Bight: A Synthesis and Interpretation*. Los Angeles, CA: University of California Press.

Dalebout, M. L., G. J. B. Ross, C. S. Baker, R. C. Anderson, P. B. Best, V. G. Cockcroft, H. L. Hinsz, V. Peddemors, & R. L. Pitman. (2003). Appearance, distribution and genetic distinctiveness of Longman's beaked whale, *Indopacetus pacificus*. *Marine Mammal Science, 19*(3), 421–461.

Dalebout, M. L., S. C. Baker, D. Steel, K. Thompson, K. M. Robertson, S. J. Chivers, W. F. Perrin, M. Goonatilake, C. A. R., J. G. Mead, C. W. Potter, L. Thompson, D. Jupiter, & T. K. Yamada. (2014). Resurrection of *Mesoplodon hotaula* Deraniyagala 1963: A new species of beaked whale in the tropical Indo-Pacific. *Marine Mammal Science, 30*(3), 1081–1108.

Dawbin, W. H. (1966). The seasonal migratory cycle of humpback whales. In K. S. Norris (Ed.), *Whales, Dolphins and Porpoises* (pp. 145–170). Berkeley, CA: University of California Press.

Deakos, M. H., B. K. Branstetter, L. Mazzuca, D. Fertl, & J. R. Mobley, Jr. (2010). Two unusual interactions between bottlenose dolphin (*Tursiops truncatus*) and a humpback whale (*Megaptera novaeangliae*) in Hawaiian Waters. *Aquatic Mammals, 36*(2), 121–128.

Debich, A. J., S. Baumann-Pickering, A. Sirovic, J. A. Hildebrand, A. L. Alldredge, R. S. Gottlieb, S. T. Herbert, S. C. Johnson, A. C. Rice, L. K. Roche, B. J. Thayre, J. S. Trickey, L. M. Varga, & S. M. Wiggins. (2015). *Passive Acoustic Monitoring for Marine Mammals in the SOCAL Naval Training Area Dec 2012–Jan 2014* (MPL Technical Memorandum #552). La Jolla, CA: Marine Physical Laboratory, Scripps Institution of Oceanography.

Defran, R. H., & D. W. Weller. (1999). Occurrence, distribution, site fidelity, and school size of bottlenose dolphins (*Tursiops truncatus*) off San Diego, California. *Marine Mammal Science, 15*(2), 366–380.

Defran, R. H., M. Caldwell, E. Morteo, A. Lang, & M. Rice. (2015). *Possible Stock Structure of Coastal Bottlenose Dolphins off Baja California and California Revealed by Photo-Identification Research* (Bulletin of the Southern California Academy of Sciences).

DeLong, R. L., & B. S. Stewart. (1991). Diving patterns of northern elephant seal bulls. *Marine Mammal Science, 7*(4), 369–384.

Dizon, A. E., C. Lockyer, W. F. Perrin, D. P. DeMaster, & J. Sisson. (1992). Rethinking the stock concept: a phylogeographic approach. *Conservation Biology, 6*(1), 24–36.

Dodd, C. K., Jr. (1988). *Synopsis of the Biological Data on the Loggerhead Sea Turtle, Caretta caretta (Linnaeus 1758)*. Washington, DC: U.S. Fish and Wildlife Service.

Dolar, M. L. L. (2008). Fraser's dolphin, *Lagenodelphis hosei*. In W. F. Perrin, B. Wursig & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (pp. 485–487). San Diego, CA: Academic Press.

Donoso, M., & P. H. Dutton. (2010). Sea turtle bycatch in the Chilean pelagic longline fishery in the southeastern Pacific: Opportunities for conservation. *Biological Conservation, 143*(11), 2672–2684.

Donovan, G. P. (1991). A review of IWC stock boundaries. *Reports of the International Whaling Commission, Special Issue 13*, 39–68.

Douglas, A. B., J. Calambokidis, L. M. Munger, M. S. Soldevilla, M. C. Ferguson, A. M. Havron, D. L. Camacho, G. S. Campbell, & J. A. Hildebrand. (2014). Seasonal distribution and abundance of cetaceans off Southern California estimated from CalCOFI cruise data from 2004 to 2008. *Fishery Bulletin, 112*(2–3), 198–220.

Dudzik, K. J., K. M. Baker, & D. W. Weller. (2006). *Mark-Recapture Abundance Estimate of California Coastal Stock Bottlenose Dolphins: February 2004 to April 2005* (NOAA Administrative Report LJ-06-02C). La Jolla, CA: Southwest Fisheries Science Center.

Eckert, K. L. (1995). Anthropogenic threats to sea turtles. In K. A. Bjorndal (Ed.), *Biology and Conservation of Sea Turtles* (Revised ed., pp. 611–612). Washington, DC: Smithsonian Institution Press.

Eguchi, T., & J. T. Harvey. (2005). Diving Behavior of the Pacific Harbor Seal (*Phoca vitulina richardii*) in Monterey Bay, California. *Marine Mammal Science, 21*(2), 283–295.

Eguchi, T., T. Gerrodette, R. L. Pitman, J. A. Seminoff, & P. H. Dutton. (2007). At-sea density and abundance estimates of the olive ridley turtle, *Lepidochelys olivacea,* in the eastern tropical Pacific. *Endangered Species Research, 3*(2), 191–203.

Eguchi, T., J. A. Seminoff, R. A. LeRoux, P. H. Dutton, & D. L. Dutton. (2010). Abundance and survival rates of green turtles in an urban environment—coexistence of humans and an endangered species. *Marine Biology, 157*, 1869–1877.

Eguchi, T. (2015, 2 November 2015). [SOCAL sea turtle abundance. Personal communication between Tomoharu Eguchi (NMFS SWFSC) and Mike Zickel (ManTech) via email].

Ernst, C. H., J. E. Lovich, & R. W. Barbour. (1994). *Turtles of the United States and Canada*. Washington, DC: Smithsonian Institution Press.

Etnoyer, P., D. Canny, B. R. Mate, L. E. Morgan, J. G. Ortega-Ortiz, & W. J. Nichols. (2006). Sea-surface temperature gradients across blue whale and sea turtle foraging trajectories off the Baja California Peninsula, Mexico. *Deep Sea Research Part II: Topical Studies in Oceanography, 53*(3), 340–358.

Ferguson, M. C., & J. Barlow. (2003). *Addendum: Spatial Distribution and Density of Cetaceans in the Eastern Tropical Pacific Ocean Based on Summer/Fall Research Vessel Surveys in 1986–96* (U.S. Department of Commerce NOAA Administrative Report LJ-01-04). La Jolla, CA: Southwest Fisheries Science Center.

Ferguson, M. C., J. Barlow, P. Feidler, S. B. Reilly, & T. Gerrodette. (2006). Spatial models of delphinid (family Delphinidae) encouter rate and group size in the eastern Pacific Ocean. *Ecological Modelling, 193*, 645–662.

Ferguson, M. C., J. Barlow, R. Brownell, & R. Pitman. (2011). *Identifying Areas of Biological Importance to Cetaceans in Data-Poor Regions*. National Marine Fisheries Service.

Fish, F. E., A. J. Nicastro, & D. Weihs. (2006). Dynamics of the aerial maneuvers of spinner dolphins. *Journal of Experimental Biology, 209*(4), 590–598.

Foote, A. D., J. Newton, S. B. Piertney, E. Willerslev, & M. T. P. Gilbert. (2009). Ecological, morphological and genetic divergence of sympatric North Atlantic killer whale populations. *Mol Ecol, 18*(24), 5207–5217.

Foote, A. D., P. A. Morin, J. W. Durban, E. Willerslev, L. Orlando, & M. T. P. Gilbert. (2011). Out of the Pacific and Back Again: Insights into the Matrileineal History of Pacific Killer Whale Ecotypes. *PLoS ONE, 6*(9).

Ford, J. K. B., G. M. Ellis, D. R. Matkin, K. C. Balcomb, D. Briggs, & A. B. Morton. (2005). Killer whale attacks on minke whales: Prey capture and antipredator tactics. *Marine Mammal Science, 21*(4), 603–618.

Ford, J. K. B. (2008). Killer whale, *Orcinus orca*. In W. F. Perrin, B. Wursig & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 650–657). San Diego, CA: Academic Press.

Forney, K. A., J. Barlow, & J. V. Carretta. (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., & J. Barlow. (1998). Seasonal patterns in the abundance and distribution of California cetaceans, 1991—1992. *Marine Mammal Science, 14*(3), 460–489.

Forney, K. A. (2000). Environmental models of cetacean abundance: reducing uncertainty in population trends. *Conservation Biology, 14*(3), 1271–1286.

Forney, K. A., M. C. Ferguson, E. A. Becker, P. C. Fiedler, J. V. Redfern, J. Barlow, I. L. Vilchis, & L. T. Ballance. (2012). Habitat-based spatial models of cetacean density in the eastern Pacific Ocean. *Endangered Species Research, 16*(2), 113–133.

Forney, K. A., E. A. Becker, D. G. Foley, J. Barlow, & E. M. Oleson. (2015). Habitat-based Models of Cetacean Density and Distribution in the Central North Pacific. *Endangered Species Research, 27*, 1–20.

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*(1), 39–48.

Gallo-Reynoso, J. P., A. L. Figueroa-Carranza, & J. B. Le Boeuf. (2008). Foraging behavior of lactating Guadalupe fur seal females *Avances en el Estudio de los Mamíferos de México* (Publicaciones Especiales ed., Vol. III, pp. 595–614). A.C. Mexico D.F.: Asociación Mexicana de Mastozoologí.

Gaos, A. R., & I. L. Yañez. (2008). Where have the Eastern Pacific Hawksbills Gone?! *SWoT Report-State of the World's Sea Turtles, III*, 18–19.

Gaos, A. R., R. L. Lewison, I. L. Yanez, B. P. Wallace, M. J. Liles, W. J. Nichols, A. Baquero, C. R. Hashbun, M. Vasquez, J. Urteaga, & J. A. Seminoff. (2011). Shifting the life-history paradigm: discovery of novell habitat use by hawksbill turtles. *Biology Letters, 8*, 54–56.

Gendron, D., S. Lanham, & M. Carwardine. (1999). North Pacific right whale (*Eubalaena glacialis*) sighting South of Baja California. *Aquatic Mammals, 25*(1), 31–34.

Gerrodette, T., & T. Eguchi. (2011). Precautionary design of a marine protected area based on a habitat model. *Endangered Species Research, 15*, 159–166.

Graham, S. E., & B. Saunders. (2015). *Occurrence, Distribution, and Population Estimates of Marine Mammals near Silver Strand Training Complex and San Diego Bay, CA* (Prepared for Commander, Pacific Fleet. Submitted to Naval Facilities Engineering Command (NAVFAC) Southwest, California, February 2015). San Diego, CA: SPAWAR Systems Center Pacific.

Gross, A., J. Kiszka, O. Van Canneyt, P. Richard, & V. Ridoux. (2009). A preliminary study of habitat and resource partitioning among co-occuring tropical dolphins around Mayotte, southwest Indian Ocean. *Estuarine, Coastal and Shelf Science, 84*(3), 367–374.

Hamilton, T. A., J. V. Redfern, J. Barlow, L. T. Ballance, T. Gerrodette, R. S. Holt, K. A. Forney, & B. L. Taylor. (2009). *Atlas of Cetacean Sightings for Southwest Fisheries Science Center Cetacean and Ecosystem Surveys: 1986–2005* (NOAA Technical Memorandum NMFS-SWFSC-440). La Jolla, CA: Southwest Fisheries Science Center.

Hanser, S., M. Shoemaker, R. Uyeyama, & S. Watwood. (2010). *Cruise Report, Marine Species Monitoring and Lookout Effectiveness Study, Unit Level Training, July 2010, SOCAL Range Complex*. Pearl Harbor, HI: United States Pacific Fleet.

Hanser, S. F. (2009–2014). *Personal observations from Hawaii and the Commonwealth of the Northern Mariana Islands. October 2009 to May 2014*.

Hanser, S. F., S. H. Smith, & R. K. Uyeyama. (In Prep.). *Estimates of Sea Turtle Presence in and Adjacent to Pearl Harbor, Hawaii and Observations of Green Sea Turtle Behavior*. Pearl Harbor, HI: Naval Facilities Engineering Command, Pacific.

Harvey, J. T., R. F. Brown, & B. R. Mate. (1990). Abundance and Distribution of Harbor Seals (*Phoca vitulina*) in Oregon, 1975–1983. *Northwestern Naturalist, 71*(3), 65–71.

Hassrick, J. L., D. E. Crocker, R. L. Zeno, S. B. Blackwell, D. P. Costa, & B. J. Le Boeuf. (2007). Swimming speed and foraging strategies of northern elephant seals. *Deep Sea Research Part II: Topical Studies in Oceanography, 54*(3), 369–383.

Hays, G. C., G. J. Marshall, & J. A. Seminoff. (2007). Flipper beat frequency and amplitude changes in diving green turtles, *Chelonia mydas*. *Marine Biology, 150*(5), 1003–1009.

Hazel, J., I. R. Lawler, & M. Hamann. (2009). Diving at the shallow end: Green turtle behaviour in near-shore foraging habitat. *Journal of Experiemental Marine Biology and Ecology, 371*(1), 84–92.

Hebshi, A. J., D. C. Duffy, & K. D. Hyrenbach. (2008). Associations between seabirds and subsurface predators around Oahu, Hawaii. *Aquatic Biology, 19*(3), 89–98.

Helble, T. A., E. E. Henderson, G. R. Ierley, & S. W. Martin. (2016). Swim track kinematics and calling behavior attributed to Byrde's whales on the Navy's Pacific Missile Range Facility. *Journal of the Acoustical Society of America*.

Heyning, J. E. (1989). Cuvier's beaked whale, *Ziphius cavirostris* G. Cuvier, 1823. In S. H. Ridgway & R. Harrison (Eds.), *Handbook of Marine Mammals* (Vol. 4, pp. 289–308). San Diego, CA: Academic Press.

Heyning, J. E., & W. F. Perrin. (1994). Evidence for two species of common dolphins (Genus *Delphinus*) from the eastern north Pacific. *Contributions in Science, 442*, 1–35.

Heyning, J. E., & J. G. Mead. (2009). Cuvier's beaked whale, *Ziphius cavirostris*. In W. F. Perrin, B. Wursig & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 294–295). Academic Press.

Hill, M., A. D. Ligon, M. H. Deakos, U. Adam, E. Norris, & E. M. Oleson. (2011). *Cetacean Surveys of Guam and CNMI Waters: August–September, 2011* (MIRC Survey Report FY2011). Honolulu, HI: Pacific Islands Fisheries Science Center.

Himes-Cornell, A. (2015). *Industry Perceptions of Measures to Affect Access to Quota Shares, Active Participation, and Lease Rates in the Bering sea and Aleutian Islands Crab Fisheries* (NOAA Technical Memorandum NMFS-AFSC-304). Seattle, WA: Alaska Fisheries Science Center.

Hitipeuw, C., P. H. Dutton, S. Benson, J. Thebu, & J. Bakarbessy. (2007). Population status and internesting movement of leatherback turtles, *Dermochelys coriacea*, nesting on the northwest coast of Papua, Indonesia. *Chelonian Conservation and Biology, 6*(1), 28–36.

Hoelzel, A. R., R. C. Fleischer, C. Campagna, B. J. Le Boeuf, & G. Alvord. (2002). Impact of a population bottleneck on symmetry and genetic diversity in the northern elephant seal. *Journal of Evolutionary Biology, 15*(4), 567–575.

Honarvar, S., M. P. O'Connor, & J. R. Spotila. (2008). Density-dependent effects on hatching success of the olive ridley turtle, *Lepidochelys olivacea*. *Oecologia, 157*(2), 221–230.

Houck, W. J., & T. A. Jefferson. (1999). Dall's Porpoise, *Phocoenoides dalli* (True, 1885). In S. H. Ridgway & R. Harrison (Eds.), *Handbook of Marine Mammals Vol 6: The second book of dolphins and porpoises* (pp. 443–472). San Diego, CA: Academic Press.

Hughes, G. R., P. Luschi, R. Mencacci, & F. Papi. (1998). The 7000-km oceanic journey of a leatherback turtle tracked by satellite. *Journal of Experimental Marine Biology and Ecology, 229*, 209–217.

Hutchinson, G. E. (1957). Concluding remarks. *Cold Spring Harbor Symposium on Quantitative Biology, 22*, 415–427.

Hwang, A., R. H. Defran, M. Bearzi, D. Maldini, C. A. Saylan, A. R. Lang, K. J. Dudzik, O. R. Guzon-Zatarain, D. L. Kelly, & D. W. Weller. (2014). Coastal Range and Movements of Common Bottlenose Dolphins off California and Baja California, Mexico. *Bulletin of the Southern California Academy of Science, 113*(1), 1–13.

James, M. C., & N. Mrosovsky. (2004). Body temperatures of leatherback turtles (*Dermochelys coriacea*) in temperate waters off Nova Scotia, Canada. *Canadian Journal of Zoology, 82*, 1302–1306.

Jefferson, T. A., M. A. Smultea, & J. Black. (2012). *Density and Abundance of Marine Mammals in the Navy's Southern California Range Complex, off San Diego County, in 2008–2011*. Pearl Harbor, HI: U.S. Department of the Navy.

Jefferson, T. A., M. A. Smultea, & C. A. Bacon. (2014). Southern California Bight marine mammal density and abundance from aerial surveys, 2008–2013. *Journal of Marine Animals and Their Ecology, 7*(2), 14–30.

Jefferson, T. A., M. A. Webber, & R. L. Pitman. (2015). *Marine Mammals of the World: A Comprehensive Guide to Their Identification* (2nd ed.): Academic Press.

Jeffries, S., H. Huber, J. Calambokidis, & J. Laake. (2003). Trends and Status of Harbor Seals in Washington State: 1978–1999. *The Journal of Wildlife Management, 67*(1), 207–218.

Jensen, B. A., J. T. Saliki, S. Sanchez, D. S. Rotstein, G. A. Levine, T. D. Schofield, & K. L. West. (2011). *First central Pacific cases of morbillivirus in Hawaiian cetaceans*. Paper 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., S. L. Swartz, & S. Leatherwood. (1984). *The Gray Whale, Eschrichtius robustus*. Orlando, FL: Academic Press.

Jones, M. L., & S. L. Swartz. (2002). Gray whale, *Eschrichtius robustus*. In W. F. Perrin, B. Wursig & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (pp. 524–536). San Diego, CA: Academic Press.

Julian, F., & M. Beeson. (1998). Estimates of marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990–1995. *Fishery Bulletin, 96*(2), 271–284.

Karczmarski, L., B. Wursig, G. Gailey, K. W. Larson, & C. Vanderlip. (2005). Spinner dolphins in a remote Hawaiian atoll: social grouping and population structure. *Behavioural Ecology, 16*(4), 675–685.

Kasamatsu, F., K. Matsuoka, & T. Hakamada. (2000). Interspecific relationships in density among the whale community in the Antarctic. *Polar Biology, 23*(7), 466–473.

Kaschner, K., R. Watson, A. W. Trites, & D. Pauly. (2006). Mapping world-wide distributions of marine mammal species using a relative environmental suitability (RES) model. *Marine Ecology Progress Series, 316*, 285–310.

Kato, H., & W. F. Perrin. (2009). Bryde's whales, *Balaenoptera edeni/brydei*. In W. F. Perrin, B. Wursig & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 158–163). San Diego, CA: Academic Press.

Kerosky, S. M., A. Širović, L. K. Roche, S. Baumann-Pickering, S. M. Wiggins, & J. A. Hildebrand. (2012). Bryde's whale seasonal range expansion and increasing presence in the Southern California Bight from 2000 to 2010. *Deep Sea Research Part I: Oceanographic Research Papers, 65*, 125–132.

Kishiro, T., & T. Kasuya. (1993). Review of Japanese dolphin drive fisheries and their status. *Report of the International Whaling Commision, 43*, 439–452.

Kiszka, J., W. F. Perrin, C. Pusineri, & V. Ridoux. (2011). What drives island-associated tropical dolphins to form mixed-species associations in the southwest Indian Ocean? *Journal of Mammalogy, 92*(5), 1105–1111.

Kobayashi, D. R., J. J. Polovina, D. M. Parker, N. Kamezaki, I.-J. Cheng, I. Uchida, P. H. Dutton, & G. H. Balazs. (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 Experiemental Marine Biology and Ecology, 356*(1), 96–114.

Kruse, S., D. K. Caldwell, & M. C. Caldwell. (1999). Risso's dolphin, *Grampus griseus* (G. Cuvier, 1812). In S. H. Ridgway & R. Harrison (Eds.), *Handbook of Marine Mammals* (Vol. 6, pp. 183–212). San Diego, CA: Academic Press.

Kuhn, C. E. (2006). Measuring at sea feeding to understand the foraging behavior of pinnipeds. *California Sea Grant College Program*.

Kuhn, C. E., & D. P. Costa. (2014). Interannual variation in the at-sea behavior of California sea lions (*Zalophus californianus*). *Marine Mammal Science, 30*(4), 1297–1319.

Le Boeuf, B. J., & R. M. Laws. (1994). *Elephant seals: an introduction to the genus*: University of California Press: Berkeley/Los Angeles, CA.

Le Boeuf, B. J., D. E. Crocker, D. P. Costa, S. B. Blackwell, P. M. Webb, & D. S. Houser. (2000). Foraging ecology of northern elephant seals. *Ecological Monographs, 70*(3), 353–382.

Leatherwood, S., R. R. Reeves, W. F. Perrin, & W. E. Evans. (1988). *Whales, Dolphins, and Porpoises of the Eastern North Pacific and Adjacent Arctic Waters: A Guide to Their Identification*. New York, NY: Dover Publications, Inc.

Lipsky, J. D. (2009). Right whale dolphins, *Lissodelphis borealis* and *L. peronii*. In W. F. Perrin, B. Wursig & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 958–962). Amsterdam, Netherlands: Academic Press.

Lopez-Castro, M. C., R. Carmona, & W. J. Nichols. (2004). Nesting characteristics of the olive ridley turtle (*Lepidochelys olivacea*) in Cabo Pulmo, southern Baja California. *Marine Biology, 145*(4), 811–820.

Loughlin, T. R., & M. A. Perez. (1985). *Mesoplodon stejengeri*. *Mammalian Species, 250*, 1–6

Lowry, L. F., D. W. Laist, W. G. Gilmartin, & G. A. Antonelis. (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.

Lowry, M. (2015). [Personal communication between P. Townson (ManTech International Corporation) and M. Lowry (NMFS SWFSC)].

Lowry, M. S. (2002). *Counts of Northern Elephant Seals at Rookeries in the Southern California Bight: 1981–2001* (NOAA Technical Memorandum NMFS-SWFSC-345). U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Lowry, M. S., & J. V. Carretta. (2003). *Pacific Harbor Seal, Phoca vitulina richardii, Census in California During May–July 2002* (NOAA Technical Memorandum NMFS-SWFSC-353). La Jolla, CA: Southwest Fisheries Science Center.

Lowry, M. S., & K. A. Forney. (2005). Abundance and distribution of California sea lions (*Zalophus californianus*) in central and northern California during 1998 and summer 1999. *Fishery Bulletin, 103*(2), 331–343.

Lowry, M. S., R. Condit, B. Hatfield, S. G. Allen, R. Berger, P. A. Morris, B. J. Le Boeuf, & J. Reiter. (2014). Abundance, distribution, and population growth of the northern elephant seal (*Mirounga angustirostris*) in the United States from 1991 to 2010. *Aquatic Mammals, 40*(1), 20–31.

Lutz, P. L., & J. A. Musick. (1997). *The Biology of Sea Turtles*. New York, NY: CRC Press.

Lutz, P. L., J. A. Musick, & J. Wyneken. (2002). *The Biology of Sea Turtles* (Vol. 2). New York, NY: CRC Press.

MacLeod, C. D. (1998). Intraspecific scarring in odontocete cetaceans: an indicator of male 'quality' in aggressive social interactions. *Journal of Zoology, 244*, 71–77.

MacLeod, C. D., W. F. Perrin, R. Pitman, J. Barlow, L. Ballance, A. D'Amico, T. Gerrodette, G. Joyce, K. D. Mullin, D. L. Palka, & G. T. Waring. (2006). Known and inferred distributions of beaked whale species (Ziphiidae: Cetacea). *Journal of Cetacean Research and Management, 7*(3), 271–286.

Mahaffy, S. D. (2012). *Site Fidelity, Associations and Long-Term Bonds of Short-Finned Pilot Whales off the Island of Hawaii.* (Master's Thesis). Retrieved from http://pdxscholar.library.pdx.edu/open_access_etds/320/

Maniscalco, J. M., K. Wynne, K. W. Pitcher, M. B. Hanson, S. R. Melin, & S. Atkinson. (2004). The occurrence of California sea lions (*Zalophus californianus*) in Alaska. *Aquatic Mammals, 30*(3), 427–433.

Marine Corps Base Hawaii. (2011). *Marine Corps Base Hawaii Integrated Natural Resources Management Plan (MCB Hawaii INRMP) Update (2012–2016)*. Sustainable Resources Group International, Inc.

Marques, F. F. C., & S. T. Buckland. (2003). Incorporating covariates into standard line transect analyses. *Biometrics, 59*(4), 924–935.

Martin, S. W., & T. Kok. (2011). *Report on Analysis for Marine Mammals Before, During and After the February 2011 Submarine Commanders Course Training Exercise*. U.S. Navy Pacific Fleet.

Martin, S. W. (2015). [Personal communication with Stephen W. Martin, National Marine Mammal Foundation, Shelter Island, San Diego, CA].

Martin, S. W., C. R. Martin, B. M. Matsuyama, & E. E. Henderson. (2015). Minke whales (*Balaenoptera acutorostrata*) respond to navy training. *Journal of the Acoustical Society of America, 137*(5), 2533–2541.

Martin, S. W., & B. Matsuyama. (2015). *Suspected Bryde's Whales Detected, Localized, and Tracked using Recorded Data from the Pacific Missile Range Facility, Hawaii*. U.S. Navy Pacific Fleet.

Mate, B., B. Lagerquist, & L. Irvine. (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).

Mate, B., A. Bradford, G. Tsidulko, & V. Ilyashenko. (2013). *Late-Feeding Season Movements of a Western North Pacific Gray Whale off Sakhalin Island, Russia and Subsequent Migration into the Eastern North Pacific* (Paper SC/63/BRG23 presented to the International Whaling Commission Scientific Committee).

Mate, B. R., V. Y. Ilyashenko, A. L. Bradford, V. V. Vertyankin, G. A. Tsidulko, V. V. Rozhnov, & L. M. Irvine. (2015). Critically endangered western gray whales migrate to the eastern North Pacific. *Biology Letters, 11*(4), 1–4.

McAlpine, D. F. (2009). Pygmy and dwarf sperm whales, *Kogia breviceps* and *K. sima*. In W. F. Perrin, B. Wursig & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 936–938). Academic Press.

McDonald, M. A., & C. G. Fox. (1999). Passive acoustic methods applied to fin whale population density estimation. *Journal of Acoustical Society of America, 105*(5), 2643–2651.

McDonald, M. A., J. A. Hildebrand, S. M. Wiggins, D. W. Johnston, & J. J. Polovina. (2009). An acoustic survey of beaked whales at Cross Seamount near Hawaii. *The Journal of the Acoustical Society of America, 125*(2), 624–627.

McSweeney, D. J., R. W. Baird, & S. D. Mahaffy. (2007). Site fidelity, associations, and movements of Cuvier's (*Ziphius Cavirostris*) and Blainville's (*Mesoplodon Densirostris*) beaked whales off the island of Hawaii. *Marine Mammal Science, 23*(3), 666–687.

McSweeney, D. J., R. W. Baird, S. D. Mahaffy, D. L. Webster, & G. S. Schorr. (2009). Site fidelity and association patterns of a rare species: Pygmy killer whales (*Feresa attenuata*) in the main Hawaiian Islands. *Marine Mammal Science, 25*(3), 557–572.

Mead, J. G. (1989a). Beaked whales of the genus *Mesoplodon*. In S. H. Ridgway & R. Harrison (Eds.), *Handbook of Marine Mammals* (Vol. 4, pp. 349–430). San Diego, CA: Academic Press.

Mead, J. G. (1989b). Bottlenose whales: *Hyperoodon ampullatus* (Forster, 1770) and *Hyperoodon planifrons* Flower, 1882. In S. H. Ridgway & R. Harrison (Eds.), *Handbook of Marine Mammals* (Vol. 4: River dolphins and the larger toothed whales, pp. 321–348). San Diego, CA: Academic Press.

Melin, S. R., & R. L. DeLong. (1999). Observations of a Guadalupe fur seal (*Arctocephalus townsendi*) female and pup at San Miguel Island, California. *Marine Mammal Science, 15*(3), 885–887.

Melin, S. R., & R. L. DeLong. (2000). *At-sea distribution and diving behavior of California sea lion females from San Miguel Island, California* (Proceedings of the Fifth California Islands Symposium). U.S. Department of the Interior, Minerals Management Service.

Melin, S. R., R. L. DeLong, & D. B. Siniff. (2008). The effects of El Niño on the foraging behavior of lactating California sea lions (*Zalophus californianus californianus*) during the nonbreeding season. *Canadian Journal of Zoology, 86*(3), 192–206.

Melin, S. R., J. T. Sterling, R. R. Ream, R. G. Towell, T. Zeppelin, A. J. Orr, B. Dickerson, N. Pelland, & C. E. Kuhn. (2012). *A Tale of Two Stocks: Studies of Northern Fur Seals Breeding at the Northern and Southern Extent of the Range*. (0008-4301; 1480-3283). Alaska Fisheries Science Center (AFSC).

Mesnick, S. L., M. D. G. Rivas, & B. J. Le Boeuf. (1998). Northern elephant seals in the Gulf of California, Mexico. *Marine Mammal Science, 14*(1), 171–178.

Minamikawa, S., T. Iwasaki, & T. Kishiro. (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.

Mobley, J. R., S. Spitz, & R. Grotefendt. (2001). *Abundance of Humpback Whales in Hawaiian Waters: Results of 1993–2000 Aerial Surveys*. Hawaiian Islands Humpback Whale National Marine Sanctuary, Department of Land and Natural Resources, State of Hawaii.

Montero, J. T., R. O. Martinez-Rincon, S. S. Heppell, M. Hall, & M. Ewal. (2016). Characterizing environmental and spatial variables associated with the incidental catch of olive ridley (*Lepidochelys olivacea*) in the Eastern Tropical Pacific purse-seine fishery. *Fisheries Oceanography, 25*(1), 1–14.

Moore, J. E., B. P. Wallace, R. L. Lewison, R. Zydelis, T. M. Cox, & L. B. Crowder. (2009). A review of marine mammal, sea turtle and seabird bycatch in USA fisheries and the role of policy in shaping management. *Marine Policy, 33*(3), 435–451.

Moore, J. E., & J. Barlow. (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*, 1–11.

Moore, S. E., K. M. Stafford, M. E. Dahlheim, C. G. Fox, H. W. Braham, J. J. Polovina, & D. E. Bain. (1998). Seasonal variation in reception of fin whale calls at five geographic areas in the north Pacific. *Marine Mammal Science, 14*(3), 617–627.

Morin, P. A., F. I. Archer, A. D. Foote, J. Vilstrup, E. E. Allen, P. Wade, J. Durban, K. Parsons, R. Pitman, L. Li, P. Bouffard, S. C. Abel Nielsen, M. Rasmussen, E. Willerslev, M. T. Gilbert, & T. Harkins. (2010). Complete mitochondrial genome phylogeographic analysis of killer whales (*Orcinus orca*) indicates multiple species. *Genome Res, 20*(7), 908–916.

Muto, M. M., V. T. Helker, R. P. Angliss, B. A. Allen, P. L. Boveng, J. M. Breiwick, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, R. G. Towell, P. R. Wade, J. M. Waite, & A. R. Zerbini. (2017). *Alaska Marine Mammal Stock Assessments, 2016* (NOAA Technical Memorandum NMFS-AFSC-323). Seattle, WA: National Marine Mammal Laboratory.

Myers, A. E., & G. C. Hays. (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 Marine Fisheries Service, & U.S. Fish and Wildlife Service. (1992). *Recovery Plan for Leatherback Turtles Dermochelys coriacea in the U.S. Caribbean, Atlantic and Gulf of Mexico* Washington, DC: National Marine Fisheries Service.

National Marine Fisheries Service, & U.S. Fish and Wildlife Service. (1998a). *Recovery Plan for U.S. Pacific Populations of the Loggerhead Turtle (Caretta caretta)*. Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service, & U.S. Fish and Wildlife Service. (1998b). *Recovery Plan for U.S. Pacific Populations of the Olive Ridley Turtle (Lepidochelys olivacea)*. Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service, & U.S. Fish and Wildlife Service. (1998c). *Recovery Plan for U.S. Pacific Populations of the Leatherback Turtle (Dermochelys coriacea)*. Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service, & U.S. Fish and Wildlife Service. (2007). *Loggerhead Sea Turtle (Caretta caretta) 5-year review: Summary and Evaluation*. Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service, & U.S. Fish and Wildlife Service. (2013). *Leatherback Turtle (Dermochelys coriacea) 5 Year Review: Summary and Evaluation*. Silver Spring, MD: NMFS Office of Protected Resources and USFWS Southeast Region.

National Marine Fisheries Service. (2016). *Post-Delisting Monitoring Plan for Nine Distinct Population Segments of the Humpback Whale (Megaptera novaeangliae) DRAFT*. Silver Spring, MD.

National Oceanic and Atmospheric Administration. (2016). 2013–2016 California Sea Lion Unusual Mortality Event in California. Retrieved from http://www.nmfs.noaa.gov/pr/health/mmume/californiasealions2013.htm

Nitta, E. (1991). *The marine mammal stranding network for Hawaii: An overview* (Marine Mammal Strandings in the United States, NOAA Technical Report NMFS 98). Silver Spring, MD: National Marine Fisheries Service.

Norris, K. S., & T. P. Dohl. (1980). Behavior of the Hawaiian spinner dolphin, *Stenella longirostris*. *Fishery Bulletin, 77*(4), 821–849.

Norris, K. S., B. Wursig, R. S. Wells, & M. Würsig. (1994). The Hawaiian Spinner Dolphin (pp. 408). Berkeley, CA: University of California Press.

Norris, T. (2017, 11 July, 2017). [Personal communication via email between Tenaya Norris (The Marine Mammal Center) and Conrad Erkelens (Mantech International Corporation) on Guadalupe fur seal abundance and distribution].

Nosal, E. (2015). [Personal Communication with Eva-Marie Nosal, Associate Professor, Department of Ocean and Resources Engineering, University of Hawaii].

Odell, D. K., & K. M. McClune. (1999). False killer whale—*Pseudorca crassidens* (Owen, 1846). In S. H. Ridgway & S. R. Harrison (Eds.), *Handbook of Marine Mammals, vol. 6: The Second Book of Dolphins and the Porpoises* (Vol. 6, pp. 213–244). New York, NY: Academic Press.

Oleson, E. M., C. H. Boggs, K. A. Forney, M. B. Hanson, D. R. Kobayashi, B. L. Taylor, P. R. Wade, & G. M. Ylitalo. (2010). *Status Review of Hawaiian Insular False Killer Whales (Pseudorca crassidens) under the Endangered Species Act*. U.S. Department of Commerce.

Oleson, E. M., R. W. Baird, K. K. Martien, & B. L. Taylor. (2013). *Island-associated stocks of odontocetes in the main Hawaiian Islands: A synthesis of available information to facilitate evaluation of stock structure* (PIFSC Working Paper WP-13-003). Pacific Islands Fisheries Science Center.

Palacios, D. M. (1996). On the Specimen of the Ginkgo-Toothed Beaked Whale, *Mesoplodon ginkgodens*, from the Galapagos Islands. *Marine Mammal Science, 12*(3), 444–446.

Patino-Martinez, J., A. Marco, L. Quinones, & B. Godley. (2008). Globally significant nesting of the leatherback turtle (*Dermochelys coriacea*) on the Caribbean coast of Colombia and Panama. *Biological Conservation, 141*(8), 1982–1988.

Perrin, W. F., C. S. Baker, A. Berta, D. J. Boness, R. L. Brownell, Jr., M. L. Dalebout, D. P. Domning, R. M. Hamner, T. A. Jefferson, J. G. Mead, D. W. Rice, P. E. Rosel, J. Y. Wang, & T. Yamada. (2009). Marine Mammal Species and Subspecies. Retrieved from http://www.marinemammalscience.org/index.php?option=com_content&view=article&id=420&Itemid=280

Pitman, R. (2008). Mesoplodont whales (*Mesoplodon spp.*). In W. F. Perrin, B. Wursig & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 721–726). Amsterdam, Netherlands: Academic Press.

Pitman, R. L., D. M. Palacios, P. L. R. Brennan, B. J. Brennan, K. C. Balcomb, & T. Miyashita. (1999). Sightings and possible identity of a bottlenose whale in the tropical Indo-Pacific: *Indopacetus pacificus*. *Marine Mammal Science, 15*(2), 531–549.

Pitman, R. L., & J. W. Durban. (2012). Cooperative hunting behavior, prey selectivity and prey handling by pack ice killer whales (*Orcinus orca*), type B, in Antarctic Peninsula waters. *Marine Mammal Science, 28*(1), 16–36.

Polovina, J. J., D. R. Kobayashi, D. M. Parker, M. P. Seki, & G. H. Balazs. (2000). Turtles on the edge: movement of loggerhead turtles (*Caretta caretta*) along oceanic fronts, spanning longline fishing grounds in the central North Pacific, 1997–1998. *Fisheries Oceanography, 9*(1), 71–82.

Polovina, J. J., G. H. Balazs, E. A. Howell, D. M. Parker, M. P. Seki, & P. H. Dutton. (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.

Pryor, T., K. Pryor, & K. S. Norris. (1965). Observations on a pygmy killer whale (*Feresa attenuata* Gray) from Hawaii. *Journal of Mammalogy, 46*(3), 450–461.

Psarakos, S., D. L. Herzing, & K. Marten. (2003). Mixed-species associations between Pantropical spotted dolphins (*Stenella attenuata*) and Hawaiian spinner dolphins (*Stenella longirostris*) off Oahu, Hawaii. *Aquatic Mammals, 29*, 390–395.

Querouil, S., M. A. Silva, I. Cascao, S. Magalhães, M. I. Seabra, M. A. Machete, & R. S. Santos. (2008). Why do dolphins form mixed-species associations in the Azores? *Ethology, 114*(12), 1183–1194.

Rankin, S., & J. Barlow. (2007). Sounds recorded in the presence of Blainville's beaked whales, *Mesoplodon densirostris*, near Hawaii. *The Journal of Acoustical Society of America, 122*(1), 42–45.

Rankin, S., S. Baumann-Pickering, T. Yack, & J. Barlow. (2011). Description of sounds recorded from Longman's beaked whale, *Indopacetus pacificus*. *Journal of Acoustical Society of America, 130*(5), EL339–EL344.

Read, A. J., K. Van Waerebeek, J. C. Reyes, J. S. McKinnon, & L. C. Lehman. (1988). The exploitation of small cetaceans in coastal Peru. *Biological Conservation, 46*(1), 53–70.

Ream, R. R., J. T. Sterling, & T. R. Loughlin. (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, 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. G. Torres, & F. Werner. (2006). Techiques for cetacean-habitat modeling. *Marine Ecology Progress Series, 310*, 271–295.

Rice, D. W., & A. A. Wolman. (1971). *The Life History and Ecology of the Gray Whale* (Vol. 3). Lawrence, KS: The American Society of Mammologists.

Rice, M. R., & G. H. Balazs. (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.

Riedman, M. L., & J. A. Estes. (1990). *The Sea Otter (Enhydra lutris): Behavior, Ecology, and Natural History*. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service.

Robinson, P. W., D. P. Costa, D. E. Crocker, J. P. Gallo-Reynoso, C. D. Champagne, M. A. Fowler, C. Goetsch, K. T. Goetz, J. L. Hassrick, L. A. Huckstadt, C. E. Kuhn, J. L. Maresh, S. M. Maxwell, B. I. McDonald, S. H. Peterson, S. E. Simmons, N. M. Teutschel, S. Villegas-Amtmann, & K. Yoda. (2012). Foraging behavior and success of a mesopelagic predator in the northeast Pacific Ocean: Insights from a data-rich species, the northern elephant seal. *PLoS ONE, 7*(5), e36728.

Roe, J. H., S. J. Morreale, F. V. Paladino, G. L. Shillinger, S. R. Benson, S. A. Eckert, H. Bailey, P. S. Tomillo, S. J. Bograd, & T. Eguchi. (2014). Predicting bycatch hotspots for endangered leatherback turtles on longlines in the Pacific Ocean. *Proceedings of the Royal Society of London B: Biological Sciences, 281*(1777).

Roppel, A. Y. (1984). *Management of northern fur seals on the Pribilof Islands, Alaska, 1786–1981*: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Rosel, P. E., A. E. Dizon, & J. E. Heyning. (1994). Genetic analysis of sympatric morphotypes of common dolphins (genus *Delphinus*). *Marine Biology, 119*(2), 159–167.

Rugh, D. J., R. C. Hobbs, J. A. Lerczak, & J. M. Breiwick. (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.

Salden, D. R., & J. Mickelsen. (1999). Rare sighting of a North Pacific right whale (*Eubalaena glacialis*) in Hawaii. *Pacific Science, 53*(4), 341–345.

Schorr, G. S., R. W. Baird, M. B. Hanson, D. L. Webster, D. J. McSweeney, & R. D. Andrews. (2010). Movements of satellite-tagged Blainville's beaked whales off the island of Hawaii. *Endangered Species Research, 10*, 203–213.

Scott, M. D., & S. J. Chivers. (1990). Distribution and herd structure of bottlenose dolphins in the eastern tropical Pacific Ocean. In S. Leatherwood & R. R. Reeves (Eds.), *The Bottlenose Dolphin* (pp. 387–402). Academic Press.

Sepulveda, M., P. Inosrtoza, M. J. Perez-Alvarez, D. Oliva, & R. Moraga. (2009). Seasonal variation in the abundance of South American sea lions *Otaria flavescens* (Shaw, 1800) in Chanaral Island, Reserva Nacional Pinguino de Humboldt, Chile. *Revista de Biologia Marina y Oceanografia, 44*(3), 685–689.

Shane, S. H. (1995). Relationship between pilot whales and Risso's dolphins at Santa Catalina Island, California, U.S.A. *Marine Ecology Progress Series, 123*, 5–11.

Shelden, K. E. W., & J. L. Laake. (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.

Shillinger, G. L., D. M. Palacios, H. Bailey, S. J. Bograd, A. M. Swithenbank, P. Gaspar, B. P. Wallace, J. R. Spotila, F. V. Paladino, R. Piedra, S. A. Eckert, & B. A. Block. (2008). Persistent leatherback turtle migrations present opportunities for conservation. *PLoS Biol, 6*(7), 1408–1416.

Skillman, R. A., & G. H. Balazs. (1992). Leatherback turtle captured by ingestion of squid bait on swordfish longline. *Fishery Bulletin, 90*(4), 807–808.

Skillman, R. A., & P. Kleiber. (1998). *Estimation of Sea Turtle Take and Mortality in the Hawaii-based Longline Fishery, 1994–1996* (NOAA Technical Memorandum NMFS-SWFSC-257). La Jolla, CA: Southwest Fisheries Science Center.

SMRU Ltd. (2012). *Supporting Documentation for Global Predicted Density Data. Unpublished Sea Mammal Research Unit (SMRU) Ltd. report*. Scottish Oceans Institute, University of St. Andrews, Scotland. St Andrews, Fife, KY16 8LB, UK.

Smultea, M. A., J. L. Hopkins, & A. M. Zoidis. (2008). *Marine Mammal and Sea Turtle Monitoring Survey in Support of Navy Training Exercises in the Hawai'i Range Complex November 11–17, 2007*. Oakland, CA.

Smultea, M. A., & J. R. Mobley, Jr. (2009). *Aerial Survey Monitoring of Marine Mammals and Sea Turtles in conjunction with SCC OPS Navy Exercises off Kauai, 18–21 August 2008, Final Report, May 2009*. Submitted to Naval Facilities Engineering Command Pacific (NAVFAC), EV2 Environmental Planning, Pearl Harbor, HI. Prepared by Marine Mammal Research Consultants, Honolulu, HI, and Smultea Environmental Sciences, LLC., Issaquah, WA, under Contract No. N62742-08-P-1942.

Smultea, M. A., C. E. Bacon, & J. S. D. Black. (2011). *Aerial Survey Marine Mammal Monitoring off Southern California in Conjunction with US Navy Major Training Events (MTE), July 27- August 3 and September 23–28, 2010—Final Report, June 2011*. Prepared for Commander, U.S. Pacific Fleet, Pearl Harbor, HI. Submitted to Naval Facilities Engineering Command Pacific (NAVFAC), EV2 Environmental Planning, Pearl Harbor, HI, 96860 3134, under Contract No. N00244-10-C-0021 issued to University of California, San Diego, 7835 Trade St., San Diego, CA 92121. Submitted by Smultea Environmental Sciences (SES), Issaquah, WA, 98027, www.smultea.com, under Purchase Order No. 10309963.

Smultea, M. A., A. B. Douglas, C. E. Bacon, T. A. Jefferson, & L. Mazzuca. (2012). Bryde's whale (*Balaenoptera brydei/edeni*) sightings in the southern California bight. *Aquatic Mammals, 38*(1), 92–97.

Soldevilla, M. S., S. M. Wiggins, J. Calambokidis, A. Douglas, E. M. Oleson, & J. A. Hildebrand. (2006). Marine mammal monotoring and habitat investigations during CalCOFI surveys. *California Cooperative Oceanic Fisheries Investigations Reports, 47*, 79–91.

Spotila, J. R. (2004). *Sea Turtles: A Complete Guide to Their Biology, Behavior, and Conservation*. Baltimore, MD: John Hopkins University Press.

Stafford, K. M., S. L. Nieukirk, & G. G. Fox. (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., P. K. Yochem, R. L. DeLong, & G. A. Antonelis. (1993). Trends in abundance and status of pinnipeds on the Southern California Channel Islands. In F. G. Hochberg (Ed.), *Third California Islands Symposium: Recent Advances in Research on the California Islands* (pp. 501–516). Santa Barbara, CA: 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.* (Master of Science in Biological Sciences Thesis). San Diego State University.

Sydeman, W. J., & S. G. Allen. (1999). Pinniped population dynamics in central California: Correlations with sea surface temperature and upwelling indices. *Marine Mammal Science, 15*(2), 446–461.

Taylor, B. L., R. Baird, J. Barlow, S. M. Dawson, J. Ford, J. G. Mead, G. Notarbartolo di Sciara, P. Wade, & R. L. Pitman. (2008). *Mesoplodon ginkgodens*. *IUCN Red List of Threatened Species, Version 2011.2*.

Testa, J. W. (2012). *Fur seal investigations, 2010–2011* (NOAA Technical Memorandum NMFS-AFSC-241). La Jolla, CA: Southwest Fisheries Science Center.

Towell, R. G., R. R. Ream, & A. E. York. (2006). Decline in northern fur seal (*Callorhinus ursinus*) pup production on the Pribilof Islands. *Marine Mammal Science, 22*(2), 486–491.

Tyne, J. A., K. H. Pollock, D. W. Johnston, & L. Bejder. (2014). Abundance and survival rates of the Hawaii Island associated spinner dolphin (*Stenella longirostris*) stock. *PLoS ONE, 9*(1), e86132.

U.S. Department of the Navy. (2015). *U.S. Navy Marine Species Density Database for the Pacific Ocean* (NAVFAC Pacific Technical Report). Pearl Harbor, HI: Naval Facilities Engineering Command Pacific.

Urrutia, Y. S., & G. H. Dziendzielewski. (2012). *Diagnóstico de la vulnerabilidad de las cuatro especies de pinnípedos (lobo marino, lobo fino, foca de Puerto y elefante marino) en México, frente al cambio climático global*. Documento de el Fondo Sectorial SEMARNAT-CONACYT (FONSEC-SEMARNAT).

Van Houtan, K. S., D. L. Francke, S. Alessi, T. T. Jones, S. L. Martin, L. Kurpita, C. S. King, & R. W. Baird. (2016). The developmental biogeography of hawksbill sea turtles in the North Pacific. *Ecology and Evolution, 6*(8), 2378–2389.

Wade, P. R., M. P. Heide-Jorgensen, K. E. W. Shelden, J. Barlow, J. Carretta, J. W. Durban, R. G. LeDuc, L. Munger, S. Rankin, A. Sauter, & C. Stinchcomb. (2006). Acoustic detection and satellite-tracking leads to discovery of rare concentration of endangered North Pacific right whales. *Biology Letters, 2*, 417–419.

Wade, P. R., A. Kennedy, R. LeDuc, J. Barlow, J. Carretta, K. Shelden, W. Perryman, R. Pitman, K. Robertson, B. Rone, J. C. Salinas, A. Zerbini, R. L. Brownell, Jr., & P. J. Clapham. (2010). The world's smallest whale population? *Biology Letters, 7*(1), 83–85.

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. (2011). Rare detections of North Pacific right whales in the Gulf of Alaska, with observations of their potential prey. *Endangered Species Research, 13*(2), 99–109.

Wade, P. R., T. J. Quinn II, J. Barlow, C. S. Baker, A. M. Burdin, J. Calambokidis, P. J. Clapham, E. A. Falcone, J. K. B. Ford, C. M. Gabriele, D. K. Mattila, L. Rojas-Bracho, J. M. Straley, & B. Taylor. (2016). *Estimates of abundance and migratory destination for North Pacific humpback whales in* *both summer feeding areas and winter mating and calving areas* (Paper SC/66b/IA/21 presented to the International Whaling Commission Scientific Committee).

Weller, D. W., S. Bettridge, R. L. Brownell, J. L. Laake, M. J. Moore, P. E. Rosel, B. L. Taylor, & P. R. Wade. (2013). *Report of the National Marine Fisheries Service Gray Whale Stock Identification Workshop* (NOAA Technical Memorandum NMFS-SWFSC-507). La Jolla, CA: Southwest Fisheries Science Center.

Weller, D. W., G. S. Campbell, A. Debich, A. G. Kesaris, & R. H. Defran. (2016). *Mark-Recapture Abundance Estimate of California Coastal Stock Bottlenose Dolphins: November 2009 to April 2011* (NOAA Technical Memorandum NMFS-SWFSC-563). La Jolla, CA: Southwest Fisheries Science Center.

Wells, R. S., H. L. Rhinehart, P. Cunningham, J. Whaley, M. Baran, C. Koberna, & D. P. Costa. (1999). Long distance offshore movements of bottlenose dolphins. *Marine Mammal Science, 15*(4), 1098–1114.

Wells, R. S., & M. D. Scott. (1999). Bottlenose dolphin, *Tursiops truncatus* (Montagu, 1821). In S. H. Ridgway & R. Harrison (Eds.), *Handbook of Marine Mammals, Volume 6: The Second Book of Dolphins and the Porpoises* (pp. 137–182). San Diego, CA: Academic Press.

West, K. L., W. A. Walker, R. W. Baird, W. White, G. Levine, E. Brown, & D. Schofield. (2009). Diet of pygmy sperm whales (*Kogia breviceps*) in the Hawiian Archipelago. *Marine Mammal Science, 25*(4), 931–943.

Whitehead, H., & L. Weilgart. (2000). The sperm whale; Social females and roving males. In J. Mann, R. C. Connor, P. L. Tyack & H. Whitehead (Eds.), *Cetacean Societies; Field Studies of Dolphins and Whales* (pp. 154–172). Chicago, IL: University of Chicago Press.

Whitehead, H. (2003). *Sperm Whales Social Evolution in the Ocean*. Chicago, IL: University of Chicago Press.

Whitehead, H. (2009). Sperm whale, *Physeter macrocephalus*. In W. F. Perrin, B. Wursig & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 1091–1097). Academic Press.

Whiting, S. D., & J. D. Miller. (1998). Short term foraging ranges of adult green turtles (*Chelonia mydas*). *Journal of Herpetology, 32*(3), 330–337.

Whittow, G. C., & G. H. Balazs. (1982). Basking behavior of the Hawaiian green turtle (*Chelonia mydas*). *Pacific Science, 36*(2), 129–139.

Willis, P. M., & R. W. Baird. (1998). Status of the Dwarf Sperm Whale. *Kogia simus*, with Special Reference to Canada. *Canadian Field-Naturalist, 112*(1), 114–125.

Wilson, K., M. Lance, S. Jeffries, & A. Acevedo-Gutierrez. (2014). Fine-scale variability in harbor seal foraging behavior. *PLoS ONE, 9*(4), e92838.

Wilson, K., A. Read, & C. Littnan (In Review, September 10, 2015). [Movements and Home Ranges of Monk Seals in the Main Hawaiian Islands].

Witt, M. J., L. A. Hawkes, M. H. Godfrey, B. J. Godley, & A. C. Broderick. (2010). Predicting the impacts of climate change on a globally distributed species: the case of the loggerhead turtle. *Journal of Experimental Biology, 213*(6), 901–911.

Worthy, G. A. J., P. A. Morris, D. P. Costa, & B. J. Le Boeuf. (1992). Molt energetics of the northern elephant seal. *Journal of Zoology, 227*, 257–265.

Yochem, P. K., B. S. Stewart, R. L. DeLong, & D. P. DeMaster. (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.

Zeppelin, T. K., & R. R. Ream. (2006). 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.

Zerbini, A. N., P. J. Clapham, & M. P. Heide-Jørgensen. (2010). *Migration, wintering destinations and habitat use of North Pacific right whales (Eubalaena japonica)* (North Pacific Research Board:

Project 720-Final Report). Seattle, WA: National Marine Mammal Laboratory, Greenland Institute of Natural Resources.

APPENDIX A GLOSSARY OF TERMS

Abundance: Total number of individuals in a given area.

California Current System: The California Current is the eastern limb of the North Pacific gyre that moves southward along the western coast of North America, extending from British Columbia to Baja California. Similar to other eastern boundary current systems, the California Current System is characterized by episodic upwelling events and corresponding high levels of primary productivity.

California Current Ecosystem (CCE) Study Area: A study area defined by National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Southwest Fisheries Science Center (SWFSC) that encompasses waters off the United States (U.S.) west coast between the shore and approximately 300 nautical miles offshore.

California Current Ecosystem Models: CCE habitat-based density models developed by SWFSC. The CCE models are defined by the Navy as top tier (Level 1) data sources because they 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.

Central Pacific (CENPAC) Models: CENPAC habitat-based density models developed by Southwest Fisheries Science Center. The CENPAC models are defined by the Navy as top tier (Level 1) data sources because they 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.

Central Pacific Study Area: A study area defined by SWFSC that encompasses waters from the equator to 43° north latitude between 175° east and 135° west longitude.

Cetacean: A marine mammal included in the taxonomic order Cetacea that includes whales, dolphins, and porpoises.

Coefficient of variation (CV): The CV is a measure used to express uncertainty in published density estimates, and is calculated by dividing the standard error of the estimate by the best available density point estimate (i.e., the ratio of the standard error to the mean). A CV can be expressed as a fraction or a percentage and ranges 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.

Density: The number of animals present per unit area, typically expressed as number of animals per square kilometer.

Designed-based density estimates: A type of estimation that uses line-transect survey data and usually involves distance sampling theory to estimate density for the entire survey extent.

Distance sampling: A widely used technique for estimating the size of a population. Observers travel the length of line transects (or use points) to collect sighting data, with the objective of estimating the average density of objects within a region. In addition to counting occurrences, observers estimate the distance of the object from the path. This results in an estimate of the way in which detectability increases from probability 0 (far from the path) and approaches 1 (near the path). Using the raw count and this probability function, one can arrive at an estimate of the population size (distance sampling theory is described in detail in (Buckland et al., 2001).

Eastern Tropical Pacific Study Area: A study area defined by SWFSC that encompasses waters extending from the U.S.-Mexico border south to Peru, and west to approximately 130° west longitude.

Exclusive Economic Zone (EEZ): The EEZ is a sea zone prescribed by the United Nations Convention on the Law of the Sea over which a state has special rights regarding the exploration and use of marine resources. The United States EEZ extends no more than 200 nautical miles from the territorial sea baseline and is adjacent to the 12 nautical mile territorial sea of the United States, including the Commonwealth of Puerto Rico, Guam, American Samoa, the U.S. Virgin Islands, the Commonwealth of the Northern Mariana Islands, and any other territory or possession over which the United States exercises sovereignty.

Fundamental niche: All of the environments in which a species can theoretically survive, absent competition from other species.

Habitat suitability models: Models that use information on species occurrence and known or inferred habitat associations to predict densities. These models are used typically when survey data are unavailable. (Also known as relative environmental suitability models or habitat suitability index models).

Haul-out site: Areas on land or ice used regularly by seals or sea lions between periods of foraging activity. Haul-out sites are used for mating, giving birth (termed "rookeries"), and rest. Other benefits of hauling-out may include predator avoidance, thermal regulation, social activity, and parasite reduction.

Hierarchy of Density Data Sources for the Hawaii-Southern California Training and Testing Study Area:

The Navy ranked density data sources from most to least preferable, as follows:

- Level 1 (Most Preferred): Peer-reviewed published studies of density spatial models that provide spatially-explicit density estimates (i.e., habitat-based density models)
- Level 2: Peer-reviewed published studies of stratified designed-based density estimates (i.e., stratified line-transect density estimates)
- Level 3: Peer-reviewed published studies of designed-based density estimates
- Level 4: St. Andrew's Relative Environmental Stability (RES) Model (Sea Mammal Research Unit, Limited [SMRU Ltd.] 2012), used for species for which density data are completely lacking
- Level 5 (Least Preferred): Kaschner et al. RES Model (Kaschner et al., 2006)

Level 4 and 5 data sources are based on environmental suitability models.

Kaschner et al. (2006) Marine Mammal Density Models: Kaschner et al. (2006) developed relative environmental suitability models to predict the average annual range of a marine mammal species on a global level. Habitat preferences based on sea surface temperature, bathymetry, and distance to nearest land or ice edge were used to characterize species distribution and relative concentration on a global oceanic scale at 0.5° grid cell resolution. Published estimates of global population were then used to transform the relative concentrations to density estimates. One of the disadvantages of these models is that validating the results is difficult because much of the area covered by the models has never been surveyed. This is the least preferred (Level 5) source of density data.

Line-transect: A path along which one counts and records occurrences of a target species. In a line-transect survey, the observers count occurrences as well as estimate the distance of the object from the path. (See distance sampling.)

Marine mammal stock: The MMPA defines a marine mammal "stock" as "a group of marine mammals of the same species or smaller taxon in a common spatial arrangement that interbreed when mature." For management purposes under the MMPA, a stock is considered an isolated population or group of individuals within a whole species that is found in the same area.

Mark-recapture: A method commonly used to estimate the size of a population. Typically a portion of the population is captured, marked, and released. Later, another portion is captured and the number of marked individuals within the sample is counted. Since the number of marked individuals within the second sample should be proportional to the number of marked individuals in the whole population, an estimate of the total population size can be obtained. Mark-recapture techniques for cetaceans use photographs to "capture" a proportion of the population, and distinctive physical features (e.g., humpback flukes) are used as the "marks" for comparison to subsequent photographs.

Mysticete: A whale of the suborder Mysticeti ("baleen whales"), characterized by a symmetrical skull, paired blowholes, and rows of baleen plates for feeding on zooplankton.

NMFS SWFSC Habitat-Based Density Models: Spatially-explicit models that 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. (See CCE Models and CENPAC Models).

Odontocete: A whale or dolphin in the suborder Odontoceti ("toothed whales"), characterized by an asymmetrical skull, a single blowhole, and rows of teeth, feeding primarily on fish, squid, and crustaceans.

Pacific Coast Feeding Group: A group of a few hundred gray whales that feed along the Pacific coast between southeast Alaska and Southern California during the summer and fall. At present, these animals are not treated as distinct from the Eastern North Pacific population.

Pinniped: A marine mammal included in the taxonomic order Carnivora that includes the extant families Odobenidae (whose only living member is the walrus), Otariidae (the eared seals: sea lions and fur seals), and Phocidae (the earless, or true seals).

Potential Biological Removal (PBR): PBR is defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population.

Realized niche: The portion of the fundamental niche in which species live. Due to factors such as interspecific and intraspecific dynamics, and lack of resources, the realized niche is typically smaller than the fundamental niche.

Relative Environmental Suitability models: Also known as Environmental Envelope or Habitat Suitability Index models, RES models can be used to understand the possible extent and relative expected concentration of a marine species distribution. (See Kaschner et al. (2006) Marine Mammal Density Models.)

Seamounts: Seamounts are underwater mountains that rise from the ocean floor but do not reach the surface. They provide a unique habitat for both deep-sea and shallow-water organisms.

Seasons: While most people are familiar with the traditional four calendar seasons, the Navy Marine Species Density Database (NMSDD) shapefiles for the Study Area were separated into four seasonal periods as follows:

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

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

Shapefiles: This is a simple, nontopological ESRI (Environmental Systems Research Institute) format used to store geometric location and attribute information of geographic features.

Sea Mammal Research Unit, Limited (SMRU Ltd.), global habitat-based models: This is one of the least preferred (Level 4) source of density data. Data for 45 species of marine mammals were determined by developing a relationship between the Kaschner RES values (See Kaschner et al. (2006) Marine Mammal Density Models) and empirical density data. That relationship is then used to generate density predictions for locations where no surveys have been conducted.

Southern California Bight: Geographic region defined as the coastal and offshore area between Point Conception and a point just south of the United States-Mexico border. The California Channel Islands are included within the Southern California Bight. Due to the major bend in the coast (the “bight”) in this area, the coast curves from northwest to southeast.

Southwest Fisheries Science Center: One of the six science centers under the purview of NOAA, NMFS.

Spatial Decision Support System: Web-based system developed by Duke University that allows users to view model outputs within areas of interest as color-coded maps of cetacean density; it also includes a table of densities and measures of precision.

Spatial Models: Spatial models are those for which density predictions are spatially defined (i.e., density varies based on a species geographic distribution and concentration), and are typically based on a species relationship with habitat features (see NMFS SWFSC Habitat-Based Density Models).

St. Andrews University RES global model: See SMRU Ltd., global habitat-based models.

Stratified designed-based density estimates: 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 are estimated specific to each sub-region.

Stock Assessment Reports (SARs): NMFS prepares annual stock assessment reports for marine mammals that occur in waters under U.S. jurisdiction. The U.S. Fish and Wildlife Service prepares SARs for marine mammals under their jurisdiction (manatees, polar bears, sea otters, and walruses). Each SAR includes a description of the stock's geographic range, a minimum population estimate, current population trends, current and maximum productivity rates, "Potential Biological Removal" levels, status of the stock, estimates of annual human-caused mortality and serious injury by source, and descriptions of other factors that may be causing a decline or impeding the recovery of strategic stocks.

Surrogate species: Species with similar morphology, behavior, and habitat preferences to the species whose density is being determined. The density values of a surrogate species are used when species-specific density data are unavailable.

Systematic line-transect surveys: Line-transect surveys in which the lines are systematically spaced (versus randomly placed). Systematic survey designs are often preferred over random placement because they provide better spatial coverage and can be designed to ensure that the lines do not coincide with a regular spatial feature (e.g., sampling along an isobath where bias can be introduced into the sampling).

This Page Intentionally Left Blank

APPENDIX B METADATA DICTIONARY

Field name	Type	Description
UID	Long	Unique ID Field for species per study area. This field is created prior to coming to NUWC but populated by NUWC as it is specific to modeling.
SPECIES	Text254	Species common name (no apostrophes or special characters)
SPECIES_2	Text254	Species scientific name (no apostrophes or special characters)
MONTH_NUMB	Long	Month number 01-12 if you are going to use, if not make 'null'
MONTH_NAME	Text50	Month name January-December if you are going to use, if not make 'null'
STUDY	Text254	Source/study information
STRATUM	Text50	Stratum name
MODEL_TYPE	Text50	Identifies what type of model was used to calculate density (e.g., habitat based density model, etc.)
DENSITY	Double	Density value
UNCERTAINTY	Double	Numerical uncertainty value (CV)
UNCER_QUAL	Text254	Qualitative uncertainty value (description of uncertainty when numerical value is not present or to describe additional qualitative information).
MODEL_VERS	Text50	Not needed for NAEMO modeling but may be used for density creators/publishers for their own internal model tracking. If not used calculate as 'null'
NAEMO_VERS	Long	Identifies version of data - NAEMO specific. Populate as '01' or 'null'
SEASON	Text50	To be populated to capture season information, i.e., Spring, Summer, Fall, Winter. if you are not going to use make 'null'
AREA_SQKM	Float	Area in square kilometers. Area must be calculated in features prior to delivery and projection must be documented in metadata
ABUNDANCE	Double	Calculated as 'AREA_SQKM'*'DENSITY' per cell and is used as a metric in the QAQC process and to aid in understanding the density values.

*ArcGIS built in attributes table fields not included in data dictionary but will be auto generated (Shape_Leng, Shape_Area, ObjectID, and Shape)

Feature/layer naming convention

- Feature/layer names must include the species common name and season or month when determined necessary by Navy. If multiple stocks of the same species are to be modeled then an additional method of identification will need to be developed.

Seasonal feature/layer creation and additional attribute table information:

- Species with seasonal distributions: Create 4 layers, one for each season, Spring, Summer, Fall, or Winter
    - Populate the SEASON field as, Spring, Summer, Fall, or Winter
    - Duplicate seasonal density data were necessary to accommodate the Cold and Warm classification
    - Duplicate seasonal density data were necessary to accommodate multiple seasons, i.e., Spring, Summer, Fall, and not Winter

- Species with annual distribution: Create 4 layers, one for each season, Spring, Summer, Fall, or Winter

  - Duplicate the annual layer for each of the four seasons so there are four separate seasonal layers for each species that hold identical annual density information across all four seasons, i.e., Blue_whale_spring, Blue_whale_summer, Blue_whale_fall, Blue_whale_winter

- Species with monthly distribution: Create 12 layers, one for each month, i.e., Blue_whale_01, Blue_whale_02, Blue_whale_03, etc.

Other Notes

Restrict All Special Characters from text fields:

Commas ,
Apostrophes ‘
Dashes -
Periods .

MONTH_NAME and MONTH_NUMB Fields

Should be NULL unless needed to do temporal resolution

Projection:

Features should be delivered in WGS84.

Coastline:

Minimum coastline resolution of 250k should be used (e.g., for Phase III SOCAL the NGA 75k coastline was used with manual removal of bays and inlets by NUWC was performed).

Grid:

Grid size should reflect resolution of the model; however, efforts should be made to align grid cells with existing NMSDD data if possible.