U.S. Navy Marine Species Density Database Phase IV

for the

Hawaii-California Training and Testing Study Area

Technical Report

January 2024

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Elizabeth Becker, Mike Zickel
Graphics: Ryan Hoopes
ManTech International Corporation

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EXECUTIVE SUMMARY

The purpose of the United States (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-California Testing and Training (HCTT) 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 IV of the Navy's at-sea environmental planning process. The availability of additional systematic survey data (partially funded by the Navy), improvements to habitat modeling methods used to estimate species density, updated abundance estimates, and more detailed seasonal distribution information have resulted in substantial improvements to the NMSDD Phase IV as summarized below.

Hawaiian Islands Exclusive Economic Zone. New survey data collected by the National Marine Fisheries Service (NMFS) within the Exclusive Economic Zone (EEZ) of the Hawaiian Islands during the summer and fall of 2017 and the winter of 2020 supported the derivation of updated cetacean density estimates from both design- and model-based analyses (Becker et al., 2022b; Becker et al., 2021; Bradford et al., 2021). The winter sighting data also enabled an examination of seasonal differences in the abundance and distribution of cetaceans and supported the development of a new habitat-based density model for humpback whale (*Megaptera novaeangliae*) that provided monthly density predictions for this species (Becker et al., 2022b). New habitat-based density models were also developed for the pelagic and insular stocks of pantropical spotted dolphins (*Stenella attenuata)*, the pelagic stock of common bottlenose dolphins (*Tursiops truncatus*), the pelagic stock of false killer whale (*Pseudorca crassidens)*, striped dolphins (*Stenella coeruleoalba)*, rough-toothed dolphins (*Steno bredanensis)*, Risso's dolphins (*Grampus griseus)*, short-finned pilot whales (*Globicephala macrorhynchus)*, sperm whale (*Physeter macrocephalus)* and Bryde's whales (*Balaenoptera edeni*) (Becker et al., 2022b; Becker et al., 2021). The models developed for both pantropical spotted and common bottlenose dolphins were stock specific, and thus more informative for management applications than the previous models built for these species that did not differentiate between stocks. The new models represent an improvement to the models available for Phase III (Forney et al., 2015), because they more accurately accounted for bias in group size estimates and variation in detection probabilities, provided finer-scale density predictions (~9 km x 9 km resolution vs. the previous ~25 km x 25 km resolution), and they better accounted for uncertainty in the resulting abundance estimates. The additional sighting data also provided an opportunity to update design-based estimates for the majority of species using the most current detection functions and new estimates of trackline detection probabilities that consider the effect of survey sighting conditions (Bradford et al., 2021).

A new abundance estimate for Hawaiian monk seal (*Neomonachus schauinslandi*), the only pinniped in Hawaii, was published in the 2020 stock assessment report (Carretta et al., 2021) and was used to update density estimates in Hawaiian waters. In addition, densities were estimated for individual islands using island-specific abundances instead of calculating separate uniform densities for the Main Hawaiian Islands (MHI) and Northwest Hawaiian Islands (NWHI). Separate densities were derived for each portion of the archipelago in offshore (>200 meters [m] deep) waters based on the separate abundance estimates for the MHI and NWHI; a single offshore density for all islands was estimated in Phase III.

A guild was used previously to estimate sea turtle densities in Hawaii due to limited species-specific abundance and distribution data. The guild was essentially a proxy for all five sea turtle species potentially occurring in Hawaiian waters. However, following the Navy's acoustic effects analysis, to determine takes by species the predicted exposures were distributed among the five species in proportion to the number of fisheries interactions reported by the longline fishery off Hawaii. The assumption was that the number of fishery interactions correlated positively with species occurrence and likelihood of exposure to acoustic stressors.

Given the need to assign take by species, for Phase IV the sea turtle guild was replaced by species-specific estimates derived from the Phase III guild, and densities were estimated in both nearshore (< 100 m depth contour) and offshore (> 100 m depth contour) regions of the Study Area. In nearshore waters, the Navy assumed 99 percent of sea turtles were green sea turtles (*Chelonia mydas)*, 0.9 percent were hawksbill sea turtles (*Eretmochelys imbricata*), and 0.1 percent were olive ridley sea turtles (*Lepidochelys olivacea)* based on unpublished Navy data. Offshore (> 100 m depths), species-specific densities were based on NMFS' data on interaction with the longline fishery from 2010 - 2020. This dataset is updated from Phase III and spans a longer time.

California. Additional survey data collected in summer and fall of 2014 and 2018 off the U.S. West Coast allowed NMFS, Southwest Fisheries Science Center (SWFSC) to update their California Current Ecosystem (CCE) habitat-based density models, which provided robust estimates of density and distribution for 14 cetacean species and a small beaked whale guild (Becker et al., 2020a; Becker et al., 2020b). Sample sizes were sufficient to develop the first model-based density estimates for minke whale (*B. acutorostrata*) in this study area. Model improvements were recognized from additional sighting data collected in 2018 off the continental shelf and slope, and the inclusion of a broader range of habitat conditions. In addition, recently-developed techniques for deriving more comprehensive estimates of uncertainty in SDM predictions (Miller et al., 2022) were used to provide variance estimates for the model-based abundance estimates. The model-based analyses provided updated density estimates for summer and fall for most cetacean species occurring off California and within the HCTT Study Area.

Habitat-based density models specific to winter/spring were developed for five cetacean species for waters off Southern California using 2005-2020 California Cooperative Oceanic Fisheries Investigations (CalCOFI) shipboard survey data (Becker et al., In Prep.). To produce density estimates for the Navy HCTT study areas north of the CalCOFI survey region, and for species for which winter/spring density data were not available, both the CalCOFI winter/spring models and the CCE summer/fall models were used to derive winter/spring estimates for waters off the U.S. West Coast using techniques designed to avoid spatial and temporal extrapolation (Becker et al., In Prep.). For many species, the model predictions represent the first spatially resolved density estimates for winter and spring in this study area.

Density estimates for all pinniped species off California were revised by integrating updated abundance estimates, seasonal haul-out factors (if applicable), and more localized distribution areas defining new strata. For several species with haul-out sites in the HCTT Study Area, the strata representing their distribution areas were more closely linked to haul-out sites and species' ranges from those sites than Phase III densities, which were extrapolated into offshore areas. Publications describing haul-out-behavior and distances traveled from haul-out and breeding sites based on telemetry data were cited and used to support strata definitions. Temporal strata were defined based on migration and haul-out behavior, allowing monthly density estimates for all species. With the northward expansion of the HCTT Study Area, density estimates for Steller sea lion (*Eumetopias jubatus*) (Eastern DPS) and southern sea otter (*Enhydra lutris neris*) were needed in Phase IV. Steller sea lion densities were based on counts by Lowry et al. (2021). Sea otter densities were derived along the California coastline north of Point Conception and around San Nicolas Island based on recent data published by Hatfield et al. (2019) and Yee et al. (2020), respectively.

Densities for loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*) sea turtles were added in Phase IV; densities were not estimated for either species in Phase III. The loggerhead sea turtle density was based on a NMFS survey in 2015 (Eguchi et al., 2018) during a strong El Nino when there were anomalously warm sea surface temperatures in the Southern California Bight (Bond et al., 2015), and should only apply during similar conditions. Since density estimates must be provided for only annual, seasonal, or monthly timeframes, the loggerhead density was limited to September and October, when warmest sea surface temperatures typically occur off Southern California. During the remainder of the year, loggerheads would not be expected to occur off California. Leatherback sea turtle densities were derived primarily from Benson et al. (2020) and in collaboration with NMFS scientists (Benson, 2022). Additional data on the movements of green sea turtles off California have become available since Phase III (Crear et al., 2017; Eguchi et al., 2020; Hanna, 2021), including telemetry data showing a transit in deep offshore waters of the Southern California Bight. However, the data were not sufficient to estimate a density, and, as in Phase III, green sea turtle density estimates are limited to San Diego Bay.

Baja California Peninsula, Mexico. To improve density estimates for Phase IV, the Navy funded an analysis to develop habitat-based density models for the Southern California Current, an ecologically meaningful study area that extends from Point Conception to the tip of the Baja California Peninsula. Models were developed for long- and short-beaked common dolphins (*Delphinus delphis delphis and D. d. bairdii*), Risso's dolphin, Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), striped dolphin, common bottlenose dolphin, sperm whale, blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), and humpback whale, and provided the first spatially-explicit estimates of average species density and abundance for waters off the Baja California Peninsula (Becker et al., 2022a). These models represent a major improvement over density estimates previously used for management purposes in waters west of the Baja California Peninsula, because they provide finer-scale density predictions (9 km x 9 km grid resolution vs. the 5° x 5° grid resolution available for density estimates used in Phase III), and improved, spatially explicit estimates of uncertainty.

Phase III density estimates for pinnipeds were extrapolated along the Baja California Peninsula, Mexico. For Phase IV, density estimates were refined by defining strata based on recent survey data as well as migration and haul-out behavior, and densities were derived only for the four species with potential or documented occurrence off the Baja California Peninsula, Mexico: Northern elephant seal (*Mirounga angustirostris*), harbor seal (*Phoca vitulina*), California sea lion (Zalophu*s californianus*), and Guadalupe fur seal (*Arctocephalus townsendi*). Density estimates off the Baja California Peninsula, Mexico were derived for all sea turtle species based on published research and collaboration with NMFS (e.g. Seminoff et al., 2014); although, several densities off the peninsula applied only to areas south of the Study Area and are not depicted in figures, but they are provided in tables.

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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
HCTT	Hawaii-California Training and Testing
HRC	Hawaii Range Complex
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
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

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 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 (number of animals) 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 (typically expressed as the number of animals per km^2).

This report includes a description of the currently available density data used in the “Phase IV” quantitative impact analysis for each marine mammal and sea turtle species present in the Navy’s Hawaii-California Training and Testing (HCTT) Study Area. Phase IV is the fourth implementation of the Navy’s at-sea environmental planning process, which consists of a comprehensive, integrated process to preserve access to and use of Navy at-sea training ranges, testing ranges, and operating areas (OPAREAs) by addressing encroachment and environmental compliance issues. In addition to preserving access to and use of the Navy’s ranges, the purpose of at-sea environmental planning is to comply thoroughly with environmental laws and regulations.

For most cetacean species, abundance is estimated using line-transect analyses (Barlow, 2016; Barlow & Forney, 2007; Bradford et al., 2021), mark-recapture studies (Calambokidis et al., 2008), or more recently, habitat-based density models or species distribution models (SDMs) (Becker et al., 2016; Becker et al., 2018; Becker et al., 2020a; Becker et al., 2022a; Forney et al., 2015). SDMs estimate cetacean density as a continuous function of habitat variables (e.g., sea surface temperature, water depth), allowing density estimates to be made on finer spatial and temporal scales that are more useful for impact assessments. 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., during breeding). Pinniped abundance is generally estimated via shore counts of animals on land at known haul-out sites or by counting the number of pups weaned at rookeries and applying a correction factor to estimate the abundance of the population. With the Navy’s analysis focused on in-water acoustic impacts, an in-water abundance for pinniped species must be inferred from the shore-based abundance where actual in-water survey data are not available. To calculate an in-water density, the species’ region-specific abundance is calculated and divided by a defined distribution area. Abundance estimates for sea turtle species have been derived from in-water survey data in selected areas (e.g. Garrison et al., 2019), but often rely on published abundance and distribution data from nesting sites.

For all marine species, a significant amount of effort is required to collect and analyze data to produce a density estimate. The Navy has been a leader in funding research aimed specifically at increasing our understanding of marine mammal species density and distribution patterns, including supporting systematic surveys, tagging and acoustic studies, and improvements to methods used to derive density estimates. Ideally, density data would be available for all marine species throughout all the Navy's study areas year-round, in order to best estimate the potential impacts of Navy activities. However, 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. 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), a GIS-based inventory of the best available marine species density data for each of the Navy's study areas. The Navy's protocol for selecting the best available density estimates is based on an established hierarchal approach that is described in detail in past density technical reports (U.S. Department of the Navy, 2015, 2017).

The density data selection process ensures that the 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 for each geographic area of interest. NMSDD GIS files for the HCTT Study Area are currently stratified by four seasons (Winter: December–February; Spring: March–May; Summer: June–August; Fall: September–November), although density data are not always available at this temporal scale. For example, SDMs developed for the California Current Ecosystem have been used to produce density surfaces for a combined "summer/fall" period (Becker et al., 2020a), and are thus used to represent both summer and fall in the NMSDD. For gray whale and some of the pinniped species, monthly density estimates were available and incorporated into the NMSDD.

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 mean density estimate. As used in this report, uncertainty 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.

To maintain and update accurate density data on the marine species in the Navy's study areas, a partnership between the National Marine Fisheries Service (NMFS), scientific experts, and the Navy has resulted in continual improvements to the NMSDD, from its initial development in 2008 to the present. The availability of additional systematic survey data, as well as improvements to spatial habitat modeling methods used to estimate species density, have resulted in substantial improvements to the NMSDD during the last 15 years. The current Phase IV improvements are summarized in the Executive Summary and highlighted in Appendix A, which provides a detailed comparison of densities developed for Phase III (U.S. Department of the Navy, 2017) with those more recently developed and described in this report for Phase IV.

NOTE: The density data are organized by species and presented in groups of related taxa within Sections 4 through 11 of this report. Within each individual species section, density data are described for the HCTT Study Areas as appropriate. Information on which species are found in the Study Area is provided in Table 3-1.

2 NMSDD HCTT STUDY AREA AND MAIN DATA SOURCES USED

The following sections describe the HCTT Study Area for which density data have been compiled and incorporated into the NMSDD Phase IV, and a summary of the main sources of Phase IV density data. Improvements that have been made to the density data included in the NMSDD from Phase III to Phase IV are summarized in the Executive Summary and noted as relevant within the individual species sections included in Chapters 4-10. A detailed comparison of the density data used in Phase III with those used in Phase IV is provided in Appendix A.

2.1 HAWAII-CALIFORNIA TRAINING AND TESTING STUDY AREA

To better support military readiness and to provide comprehensive and consistent environmental documentation for areas offshore of California in Phase IV, the Navy expanded the Southern California portion of the Phase III Hawaii-Southern California Training and Testing (HSTT) Study Area to include the Northern California (NOCAL) Range Complex, the Point Mugu Sea Range (PMSR) off Central California, and additional areas adjacent to the existing Southern California (SOCAL) Range Complex. The HCTT Study Area includes these additional areas as well as three existing range complexes included in the previous HSTT Study Area: the SOCAL Range Complex, Hawaii Range Complex (HRC), and Silver Strand Training Complex (SSTC) (Figure 2-1). In addition, both the HSTT and HCTT Study Areas included three representative transit corridor study areas to represent Navy transit from one range complex to another. 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. In addition to the areas included in the Phase III HSTT Density Technical Report (U.S. Department of the Navy, 2017), this report thus includes density data for the additional areas included in Phase IV (Figure 2-2).

Throughout this report, “HRC” refers to the Hawaii portion of the HCTT Study Area, and “CAL-BCPM” refers to the California and Baja, California Peninsula Mexico portion of the HCTT Study Area.

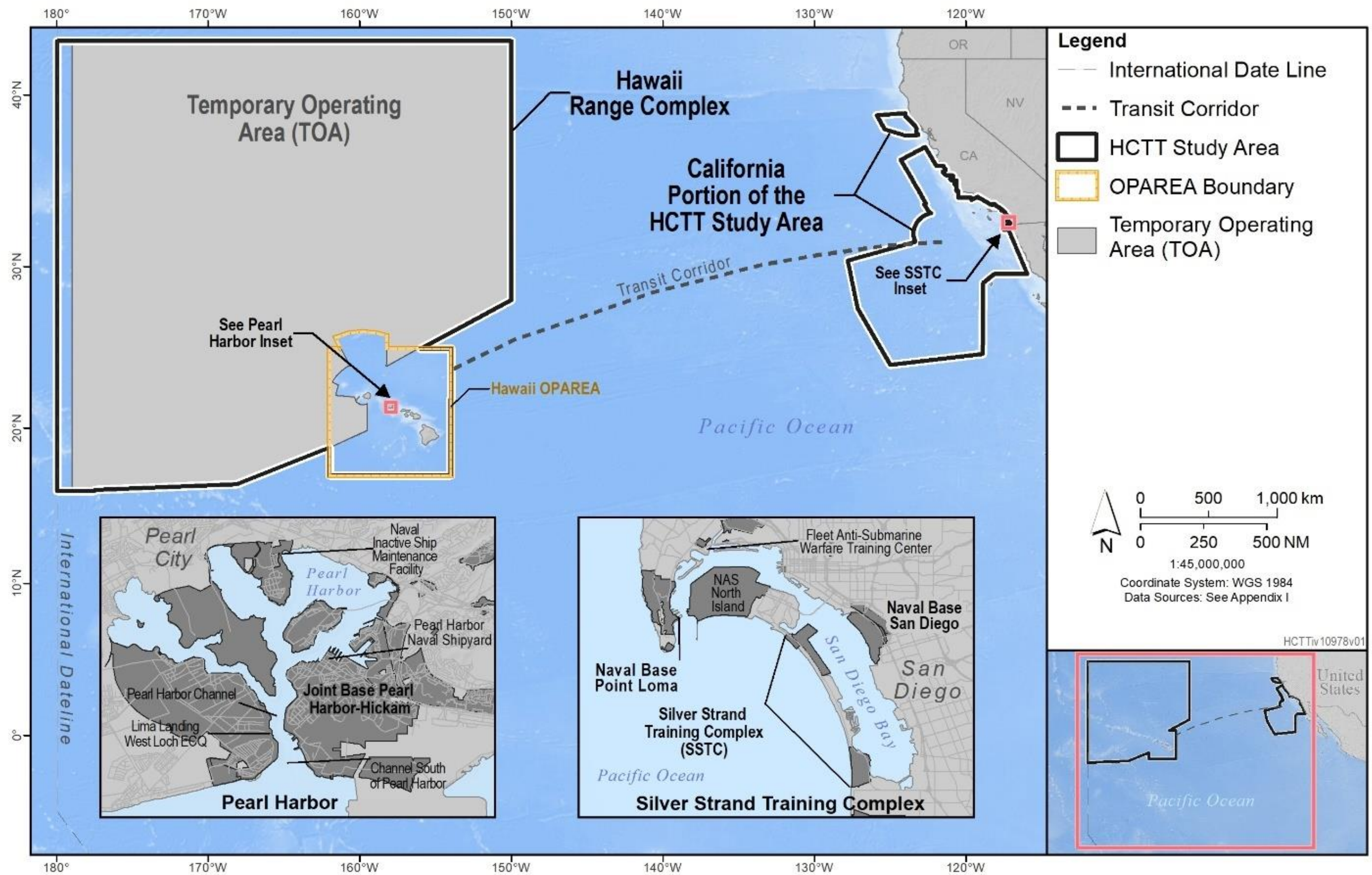

Figure 2-1: Hawaii-California Training and Testing (HCTT) Study Area

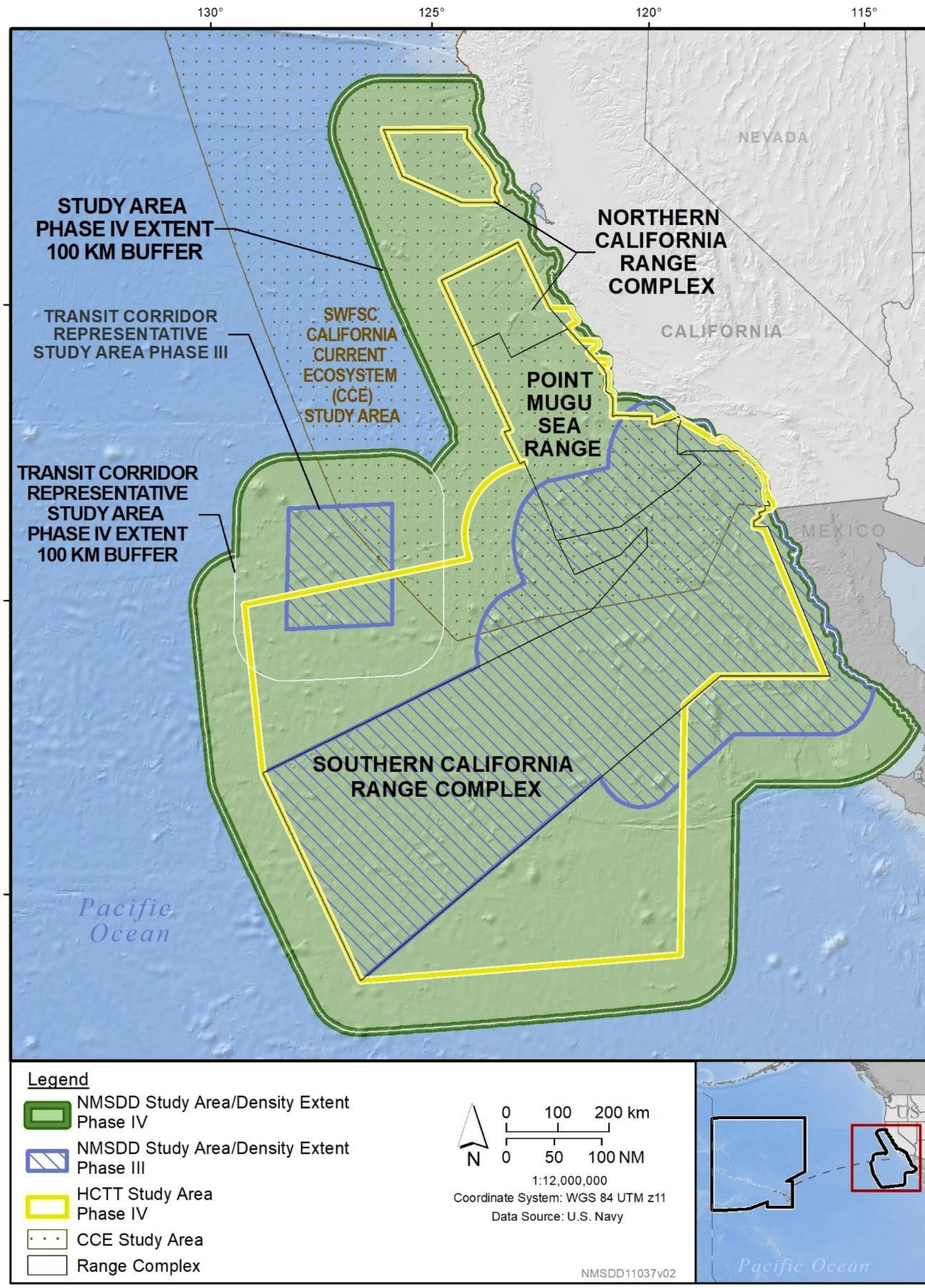

Figure 2-2: Comparison of HSTT (Phase III) and HCTT (Phase IV) Study Areas with Density Extents

2.2 PHASE IV DENSITY DATA

The main sources of density data incorporated into the NMSDD and used for the Navy's Phase IV analyses are described below.

2.2.1 CETACEANS

The majority of data used to describe cetacean densities within the HCTT Study Area were estimated from systematic line-transect shipboard surveys conducted by NMFS SWFSC and PIFSC. The SWFSC/PIFSC surveys are typically conducted in summer/fall (roughly July–November) and cover two major study areas relevant to the HCTT Study Area: (1) the California Current Ecosystem (CCE), which includes waters off the U.S. West Coast between the shore and approximately 300 nautical miles [nm] offshore, and 2) the Hawaiian Islands Exclusive Economic Zone (EEZ), which includes waters within the entire EEZ, but with increased survey effort often focused on areas around the Main Hawaiian Islands. Data from these surveys have been used to develop habitat-based density models and to derive design-based density estimates using line-transect analyses as described below.

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

Summer/Fall

SWFSC has been developing predictive habitat-based density models for cetaceans in the CCE for more than 20 years. Habitat variables used in the density models have included temporally dynamic environmental measures (e.g., sea surface temperature, mixed layer depth), 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). One of the greatest strengths of the SWFSC dataset is the broad, consistent survey coverage of the CCE study area over multiple years, which has supported continual improvements in the development of both robust habitat-based density models and design-based estimates (e.g., Barlow & Forney, 2007; Becker et al., 2020b).

For the Navy's Phase III 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 seven years of systematic line-transect data collected in the CCE between 1991 and 2009 (Becker et al., 2012b). Model results were provided for striped dolphin (*Stenella coeruleoalba*), short-beaked common dolphin (*Delphinus delphis delphis*), long-beaked common dolphin (*Delphinus delphis bairdii*), common bottlenose dolphin (*Tursiops truncatus*), 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 (*Balaenoptera physalus)*, blue whale (*Balaenoptera musculus*), humpback whale (*Megaptera novaeangliae*), 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 IV NMSDD needs described in this report, improved methods were used to develop a new set of CCE habitat-based density models that included two additional sets of survey data collected in 2014 and 2018 (Becker et al., 2020a). In addition to the models developed previously for the 13 species and guild listed above, sample sizes were sufficient to develop the first model-based density estimates for minke whale (*B. acutorostrata*) in this study area. Model improvements were recognized from additional sighting data collected in 2018 off the continental shelf and slope, and the inclusion of a broader range of habitat conditions. In addition, recently-developed techniques for deriving more comprehensive estimates of uncertainty in SDM predictions (Miller et al., 2022) were used to provide variance estimates for the model-based abundance estimates. The model-based analyses provided updated density estimates for summer and fall for most cetacean species occurring off California and within the HCTT Study Area. Within the CCE study area, density predictions for daily composites of relevant environmental predictors covering the more recent survey periods (1996–2018) 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., 2020a). Final model predictions were provided to the Navy in ArcGIS format and incorporated into the NMSDD for the current Phase IV analyses.

For those species for which there were not sufficient sample sizes to produce habitat-based density models, design-based estimates derived from the 1991-2014 SWFSC ship surveys (Barlow, 2016) were used (given the heterogeneity in effort during the 2018 SWFSC ship survey (Henry et al., 2020), these data could not be used for design-based estimation).

Winter/Spring

As noted above, habitat-based density models have been developed for many cetacean species in the CCE using systematic survey data collected off the U.S. West Coast since 1991. Most of this survey effort has been limited to the summer and fall months, because weather conditions off the majority of the U.S. West Coast make systematic ship-based surveys difficult to conduct during winter and spring. In waters off southern California, California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises have been conducted quarterly along predetermined track lines since 1949, with a primary focus of collecting hydrographic and biological data at established water sampling stations, as well as while transiting between stations. Marine mammal sighting data have been collected using line-transect methods on the CalCOFI cruises since 2004, allowing for the derivation of seasonal design-based cetacean density estimates (Campbell et al., 2015).

For the Navy's Phase III analyses, 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 Phase III analyses.

More recently, additional CalCOFI survey data collected from 2015–2020 provided an opportunity to update the winter/spring models previously developed for humpback whale, short-beaked common dolphin, and Dall's porpoise, and to develop new models for fin whale and Pacific white-sided dolphin (Becker et al., In Prep.) Habitat-based density models specific to winter and spring were developed for these five cetacean species for waters off southern/central California using the 2005–2020 CalCOFI shipboard survey data (Becker et al., In Prep.). However, model predictions only covered the winter/spring CalCOFI study area, which extends out to only 125 degrees W longitude and north to 38 degrees N latitude (Becker et al., 2017). To produce density estimates for the Navy HCTT study areas north of the CalCOFI survey region, and for species for which winter/spring density data were not available, both the CalCOFI winter/spring models and the CCE summer/fall models were used to derive winter/spring estimates for waters off the U.S. West Coast using techniques designed to avoid spatial and temporal extrapolation (Becker et al., In Prep.). Separate winter (December-February) and spring (March-May) model predictions were made using daily environmental composites covering the five most recent years of the analysis (2017-2021) for striped dolphin, short-beaked common dolphin, long-beaked common dolphin, common bottlenose dolphin, Risso's dolphin, Pacific white-sided dolphin, northern right whale dolphin, Dall's porpoise, minke whale, and fin whale. For many species, the model predictions represent the first spatially resolved density estimates for winter and spring in the CCE study area. For humpback whale, winter and spring model predictions were merged with predictions from a finer-scale nearshore model that has received extensive cross validation (Forney et al. In Prep.), thus providing the most robust predictions available for this species.

Abrahms et al. (2019) developed an ensemble model to predict year-round blue whale habitat suitability in the CCE. To derive blue whale winter and spring density estimates, probability of occurrence predictions for winter and spring based on Abrahms et al. (2019) were scaled by summer/fall abundance predictions from the CCE models (Becker et al., 2020a).

NMFS SWFSC/PIFSC Habitat-Based Density Models for the Hawaiian Islands EEZ (HI EEZ Models)

In support of the Navy's Phase III analysis, spatial predictions of cetacean densities and measures of uncertainty were developed using survey data collected by SWFSC/PIFSC in the Central North Pacific in 1997–2006, within the Hawaiian Islands EEZ in 2002 and 2010, and in waters surrounding Palmyra Atoll/Kingman Reef in 2011 and 2012 (Forney et al., 2015). The combined 1997–2012 survey data were used to update previous Central North Pacific/HI EEZ models (Becker et al., 2012c), and new grid-based prediction methods provided density estimates of cetaceans in this study area at ~25 km x 25 km spatial resolution and monthly time scales. The monthly model predictions were averaged across the course of the survey periods and provided to the Navy in ArcGIS format for incorporation into the NMSDD Phase III analyses.

New survey data collected by NMFS (partially funded by the Navy) within the HI EEZ during the summer and fall of 2017 and the winter of 2020 supported the derivation of updated cetacean density estimates from both design- and model-based analyses (Becker et al., 2021; Becker et al., 2022b; Bradford et al., 2021). The winter sighting data also enabled an examination of seasonal differences in the abundance and distribution of cetaceans, and supported the development of a new habitat-based density model for humpback whale that provided monthly density predictions for this species (Becker et al., 2022b). New habitat-based density models were also developed for the pelagic and insular stocks of pantropical spotted dolphins (*Stenella attenuata*), the pelagic stock of common bottlenose dolphins, the pelagic stock of false killer whale (*Pseudorca crassidens*), striped dolphins, rough-toothed dolphins (*Steno bredanensis*), Risso's dolphins, short-finned pilot whales (*Globicephala macrorhynchus*), sperm whale, and Bryde's whales (*Balaenoptera edeni*) (Becker et al., 2021; Becker et al., 2022b). The models developed for both pantropical spotted and common bottlenose dolphins were stock specific, and thus more informative for management applications than the previous models built for these species that did not differentiate between stocks. The new models represent an improvement to the models available for Phase III (Forney et al., 2015), because they more accurately accounted for bias in group size estimates and variation in detection probabilities, provided finer-scale density predictions (~9 km x 9 km resolution vs. the previous ~25 km x 25 km resolution), and they better accounted for uncertainty in the resulting abundance estimates. The additional sighting data also provided an opportunity to update design-based estimates for the majority of species using the most current detection functions and new estimates of trackline detection probabilities that consider the effect of survey sighting conditions (Bradford et al., 2021).

Sighting data collected from systematic ship surveys within the central Pacific between 1986 and 2017, including the three Hawaiian Islands EEZ surveys in 2002, 2010, and 2017, supported the development of a habitat-based density model specific to the Hawaii Pelagic Stock of false killer whale (*Pseudorca crassidens*), and a design-based estimate specific to the Northwestern Hawaiian Islands Stock (Becker et al., 2021; Bradford et al., 2020). This represents a substantial improvement from Phase III, when the density estimates were not stock specific.

Baja California Peninsula, Mexico.

As shown in Figure 2-2, both the previous Phase III HSTT and current Phase IV HCTT Study Areas include waters off the Baja California Peninsula, Mexico. For the Phase III analysis, cetacean density estimates for these waters were available from broad-scale design-based estimates based on nine NMFS SWFSC shipboard surveys conducted between 1986 and 1996 (Ferguson & Barlow, 2003). Their study area encompassed more than 25 million km^2, and included portions of SWFSC's CCE, Central Pacific, and Eastern Tropical Pacific study areas. Density estimates were stratified geographically by 5-degree squares of latitude and longitude, and despite their large spatial resolution, were the only available density estimates for most cetaceans off the Baja California Peninsula at that time. For the Navy's Phase III analyses, the Ferguson and Barlow (2003) 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., mean Beaufort value = 3.5).

In order to improve density estimates for Phase IV, the Navy helped to fund the 2018 SWFSC ship survey that covered waters along the west coast of southern Canada (Vancouver Island), the west coast of the United States, and Baja California out to a distance of approximately 200 nautical miles offshore (Henry et al., 2020). The 2018 survey was conducted as part of the Pacific Marine Assessment Program for Protected Species (PacMAPPS), a collaborative effort between NOAA Fisheries, the U.S. Navy, and BOEM to collect data necessary to produce updated abundance estimates for cetaceans in the CCE study area. For the purpose of improving density estimates for waters off the Baja California Peninsula, the Navy funded an analysis to develop habitat-based density models for the Southern California Current, an ecologically meaningful study area that extends from Point Conception to the tip of the Baja California Peninsula. Models were developed for long- and short-beaked common dolphins, Risso's dolphin, Pacific white-sided dolphin, striped dolphin, common bottlenose dolphin, sperm whale, blue whale, fin whale, and humpback whale, and provided the first spatially-explicit estimates of average species density and abundance for waters off the Baja California peninsula (Becker et al., 2022a). These models represent a major improvement over density estimates previously used for management purposes in waters west of the Baja California Peninsula, because they provide finer-scale density predictions (9 km x 9 km grid resolution vs. the 5° x 5° grid resolution available for density estimates used in Phase III), and improved, spatially explicit estimates of uncertainty.

For those species with insufficient sample sizes to develop habitat-based density models, the Ferguson and Barlow (2003) density estimates were corrected for updated g(0) estimates provided by Barlow (2015) as described above for the Phase III analyses, but using additional strata to cover the expanded HCTT Study Area off the Baja California Peninsula (see Figure 2-2).

2.2.2 Pinnipeds

Pinniped density estimates are not model-based and are essentially calculated as an abundance divided by an area. Phase IV densities for pinnipeds relied on published data on the occurrence and distribution of the species, including data from telemetry studies, that enabled the Navy to define spatial strata with greater precision and better represent species' distribution than in Phase III. Greater precision in density estimates was achieved by tailoring species' spatial distributions to create more representative spatial strata. For example, harbor seal abundance estimates were derived for each island in the Channel islands based on counts by Lowry et al. (2021) over the four years from 2016 – 2019. These island-specific abundance estimates were used to calculate densities that more closely aligned with the tendency for harbor seals to remain closer to traditional haulout sites and in nearshore waters.

Temporal variations in species-specific distribution patterns were also incorporated into density estimates to more accurately match migration and haul-out behaviors unique to each species. Monthly varying densities were calculated for northern fur seal and northern elephant seal and temporal strata defined by unique monthly ranges to represent breeding and non-breeding seasons were used for harbor seal, California sea lion, Guadalupe fur seal, and Steller sea lion. For northern fur seals, monthly varying densities captured this species relatively rapid fluctuation in abundance along the West Coast as migrating fur seals from the larger Eastern Pacific stock enter the Study Area near the end of their migration and then begin their return trip shortly thereafter.

For all pinniped species, in-water abundance estimates were derived by factoring in haulout behavior, represented as an average percentage of time in the water. The in-water percentage can vary by season (non-breeding and breeding), age (pup, juvenile, and adult), sex, and location. Not all species have data available to incorporate all these variations; however, as available, these data were used to tailor in-water abundance estimates for each season, age, class, and location to estimate the species in-water abundance and calculate an in-water density estimate. Spatial strata were developed specifically for each species based on published and unpublished data on habitat preferences. The primary factors defining spatial strata were bathymetry and distance from shore. Published ranges defining species' distributions were available for Guadalupe fur seal, California sea lion, and sea otter, and were used in their respective density calculations.

2.2.3 Sea Turtles

Phase IV densities for sea turtles relied on published and unpublished data on the occurrence and distribution of species and on expert opinion from sea turtle researchers in California and Hawaii. Data reported by Benson et al. (2020) supported density estimates for leatherback sea turtles off California, and Eguchi et al. (2018) provided a density for loggerhead sea turtles in the Southern California Bight during anomalously warm sea surface temperatures. Densities were not estimated for either species off California in Phase III. Green sea turtles densities in San Diego Bay were revised based on new distribution predictions by Eguchi et al. (2020). There were insufficient data to estimate green sea turtle densities in the Southern California Bight; however, unpublished telemetry data and reports of a potential population around Santa Catalina Island are noted. In addition, a new density estimate was derived for green sea turtles off the BCPM.

In the Hawaiian Islands, sea turtle densities were based on unpublished Navy survey data, the same data used for Phase III. A sea turtle guild was used in Phase III to represent all five species collectively, because species identification during the aerial surveys was not possible. However, the Navy's acoustic impacts analysis requires species-specific density estimates. To derive individual densities for the five sea turtle species, the Navy made assumptions on the likelihood of occurrence based on habitat preferences and observations for a nearshore stratum (extending from shore to the 100 m depth contour) and an offshore stratum (beyond the 100 m depth contour) using NMFS longline fisheries bycatch data. Based on these assumptions, 99 percent of sea turtles in the nearshore waters were estimated to be green sea turtles, which is consistent with habitat preferences, estimated population sizes, and observations. In the offshore stratum, loggerhead and olive ridley sea turtles were estimated to make up approximately two thirds of bycatch from 2010 – 2020, which translated into the highest sea turtle density estimates beyond the 100 m depth contour.

3 INDIVIDUAL SPECIES' DENSITY PROFILES PHASE IV

The remainder of this document describes the density data that were incorporated into the NMSDD and are being used by the Navy for modelling the potential exposure of each species to Navy sound sources in the HCTT Study Area. 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 HCTT Study Area is provided in Table 3-1.

There are three elements in each species profile: (1) species-specific information related to stock structure, (2) information on the density data used for different regions within the HCTT 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.

3.1 SPECIES DESCRIPTIONS

Within each species description, information on stocks recognized by NMFS is provided. Stocks are the management unit used by NMFS for most species (Carretta et al., 2022); 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. In the field, it may be quite difficult to define which stock or DPS an individual or group of animals belongs to, particularly if the geographic ranges of two or more stocks overlap, as it does for species such as humpback whales, killer whales, and bottlenose dolphins. In these cases, it is challenging to obtain a stock- or DPS-specific density estimate. When possible, densities are provided for specific stocks, but for most cases, density estimates are reported for the species as a whole.

3.2 TABLES

The sources of density data are summarized in the text and the density values used in the NMSDD Phase IV are reported in a table that appears in each species description. Specific uniform density values are provided for designed-based estimates as well as pinnipeds, sea otter, and sea turtles. 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). When density data were provided by species distribution models, the letter "S" is used to indicate that density values vary spatially throughout the study area. In all cases, given the different data sources and their varying spatial resolution, the table should be viewed concurrently with the density maps (described in the next section).

Table 3-1: Species with Hawaii-California Training and Testing Study Area Density Estimates Included in the NMSDD Phase IV[1]

Taxonomic Name	Common Name	HCTT HRC	HCTT CAL-BCPM
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 delphis bairdii	Long-beaked common dolphin		X
Delphinus delphis 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	BCPM only
Stenella attenuata	Pantropical spotted dolphin	X	BCPM only
Stenella coeruleoalba	Striped dolphin	X	X
Stenella longirostris	Spinner dolphin	X	
Steno bredanensis	Rough-toothed dolphin	X	
Tursiops truncatus	Common bottlenose dolphin	X	X
Porpoises (Family Phocoenida)			
Phocoenoides dalli	Dall's porpoise		X
Phocoena phocoena	Harbor porpoise		X
Beaked Whales (Family Ziphiidae)			
Berardius bairdii	Baird's beaked whale		X

Taxonomic Name	Common Name	HCTT HRC	HCTT CAL-BCPM
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
Pinnipeds (Order Carnivora, Family 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
Eumetopias jubatus	Steller sea lion		X
Sea Otters (Order Carnivora, Family Mustilidae)			
Enhydra lutris neris	Southern sea otter		X
Sea Turtles (Order Testudines, Suborder Cryptodira)			
Chelonia mydas	Green sea turtle	X	X
Eretmochelys imbricata	Hawksbill sea turtle	X	
Caretta caretta	Loggerhead sea turtle	X	X
Lepidochelys olivacea	Olive ridley sea turtle	X	
Dermochelys coriacea	Leatherback sea turtle	X	X

[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 IV. 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*).

The majority of density estimates used in the NMSDD Phase IV come from peer-reviewed publications that are cited in this report. In some cases, density estimates for a particular species are not specifically provided by published sources but can be derived based on the information included in the scientific literature. In all cases the sources and methods used to derive the estimates are summarized in this report.

3.3 MAPS

Maps from the Geographic Information System database used in NMSDD Phase IV are provided for each species. Maps are only presented for areas where a species is expected to occur. For example, gray whales (*Eschrichtius robustus*) do not regularly occur in Hawaii, but they do migrate through waters off the U.S. West Coast. Therefore, there are gray whale density maps for the eastern portion of the HCTT study area, but not a map for Hawaii. As noted in Section 1, shapefiles for the NMSDD Phase IV are currently stratified by four seasons; however, density data are rarely available at this temporal resolution. Therefore, for many species seasons will be combined or there will be only one annual map. For the few species for which monthly density estimates are available (e.g., humpback whales in Hawaii, northern fur seal), monthly maps are provided. Maps are not provided for seasons for which study area densities are expected to be zero. Except as noted in the individual species sections, the figures show density estimates as a range of values instead of a single value to standardize the legend across all figures for the species.

Density estimates for the HCTT Study Area are depicted in two separate maps: “HRC” refers to the Hawaii portion of the HCTT Study Area, and “CAL-BCPM” refers to the California and Baja California Peninsula, Mexico portion of the HCTT Study Area. Representative areas along the transit corridor linking California and Hawaii, one in the eastern portion and two in the western portion of the HCTT Study Area, were selected to represent the range of different habitats that could occur in the corridor. These areas are labeled as “Transit Corridor: Representative Study Area” on the maps.

4 BALEEN WHALES

4.1 *BALAENOPTERA ACUTOROSTRATA*, COMMON OR DWARF MINKE WHALE

NMFS has designated three stocks of minke whale in the U.S. North Pacific: (1) the Hawaii stock, (2) the California/Oregon/Washington stock, and (3) the Alaska stock (Carretta et al., 2022). Minke whales in HRC or CAL-BCPM are considered to belong to their respective separate stocks, while animals in the transit corridor could belong to either stock.

HRC. For the Phase III analyses, the Navy used a density estimate that was acoustically derived from hydrophones at the Pacific Missile Range Facility off the northwest coast of Kauai (Martin, 2015; Martin & Matsuyama, 2015). This was considered the best available density estimate at the time given the lack of on-effort sighting data from available Hawaiian Islands EEZ line-transect surveys. More recently, Bradford et al. (2021) reported a uniform density value for minke whales of 0.00018 animals/km^2 (CV = 1.05). This estimate is based on multiple-covariate line-transect analyses of sighting data collected on three surveys of waters within the Hawaiian Islands EEZ in 2002, 2010, and 2017, when minke whales were sighted while on systematic effort. The Bradford et al. (2021) estimate for 2017 is applicable to the HRC study area and western portion of the transit corridor for winter, spring, and fall.

In the summer, minke whales are likely absent from low-productivity tropical waters (Jefferson et al., 2015; Perrin et al., 2009), and based on acoustic data, it is likely that in summer they have migrated north out of Hawaiian waters to feed (Martin et al., 2022). During three 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; Bradford et al., 2021). Therefore, a density of zero is used for summer in HRC and the western portion of the transit corridor.

CAL-BCPM. In support of the Navy's Phase IV NMSDD, improved methods were used to develop a new set of CCE habitat-based density models that included two additional sets of survey data collected in 2014 and 2018, which provided sufficient sample sizes to develop the first model-based density estimates for minke whale in this study area (Becker et al., 2020a). Model predictions yielded spatially explicit density estimates for minke whale off the U.S. West Coast for summer and fall, thus providing a major improvement to the uniform density estimate used for Phase III. Density estimates from the minke whale model were applied to the portion of the Navy's CAL-BCPM 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.

To produce density estimates for the cool season, the CCE minke whale model was used to derive separate winter and spring estimates for waters off the U.S. West Coast using techniques designed to avoid spatial and temporal extrapolation (Becker et al., In Prep.). These estimates represent an improvement from Phase III, when stratified uniform density estimates based on aerial line-transect data collected in winter and spring of 1991 and 1992 were used (Forney et al., 1995). The new model-based analyses provide spatially explicit estimates which better capture species distribution patterns, they are based on more recent survey data, and they better account for trackline detection probabilities (Becker et al., In Prep.). Density estimates from the minke whale model predictions were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for winter and spring.

Ferguson and Barlow (2003) provide density values for areas off BCPM. For the Navy's Phase IV analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the HCTT acoustic modeling footprint and resulted in a minke whale density estimate of 0.00054 animals/km^2 (CV = 0.42). In the BCPM waters, the same value is used for all seasons since seasonally specific values are not currently available.

Table 4-1: Summary of Density Values for Minke Whale in the Hawaii-California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.00018	0	0.00018	0.00018
W. Transit Corridor	0.00018	0	0.00018	0.00018
E. Transit Corridor	S	S	S	S
CAL	S	S	S	S
BCPM	0.00054	0.00054	0.00054	0.00054

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

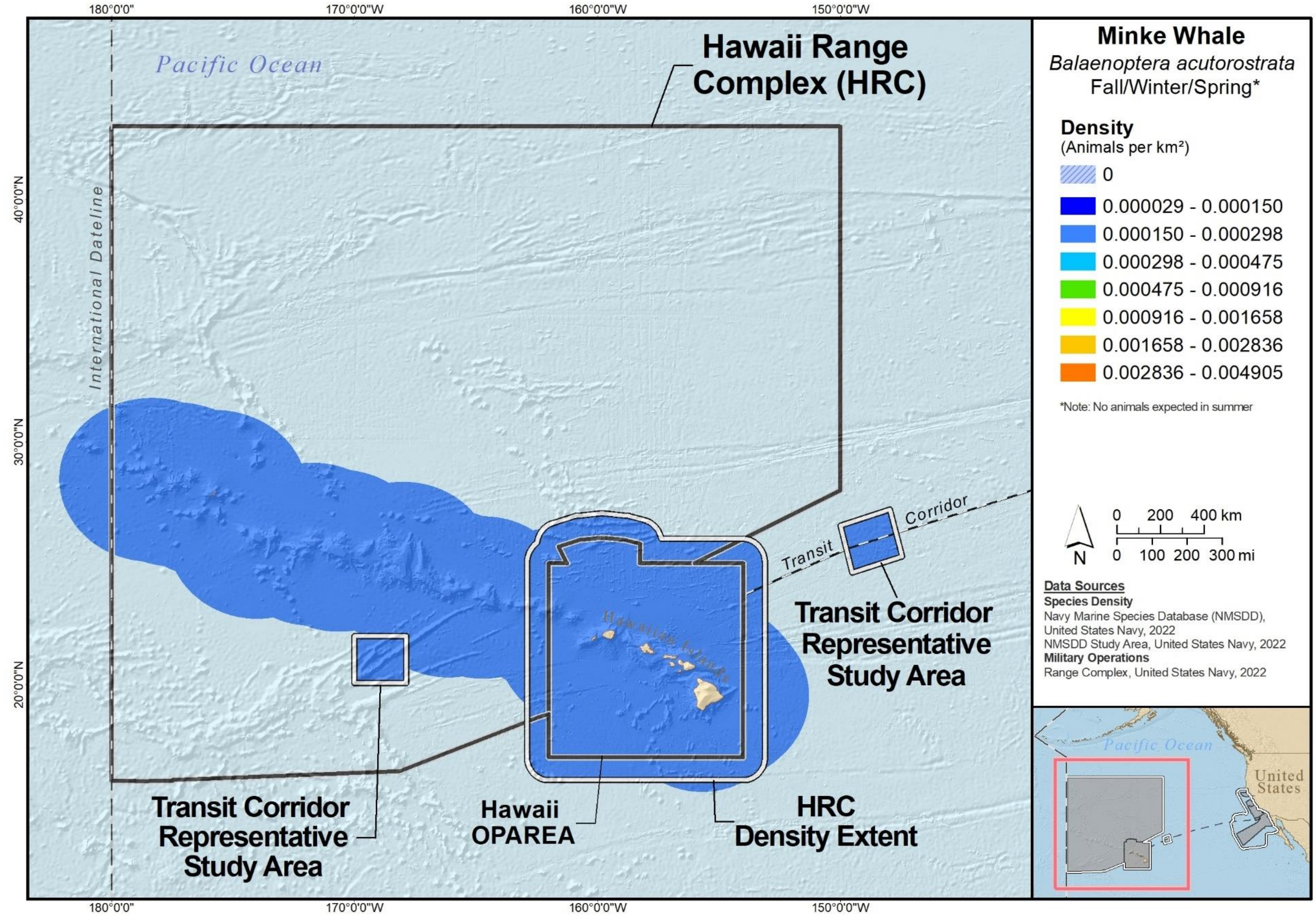

Figure 4-1: Fall/Winter/Spring Distribution of Minke Whale in HRC and the Western Portion of the Transit Corridor

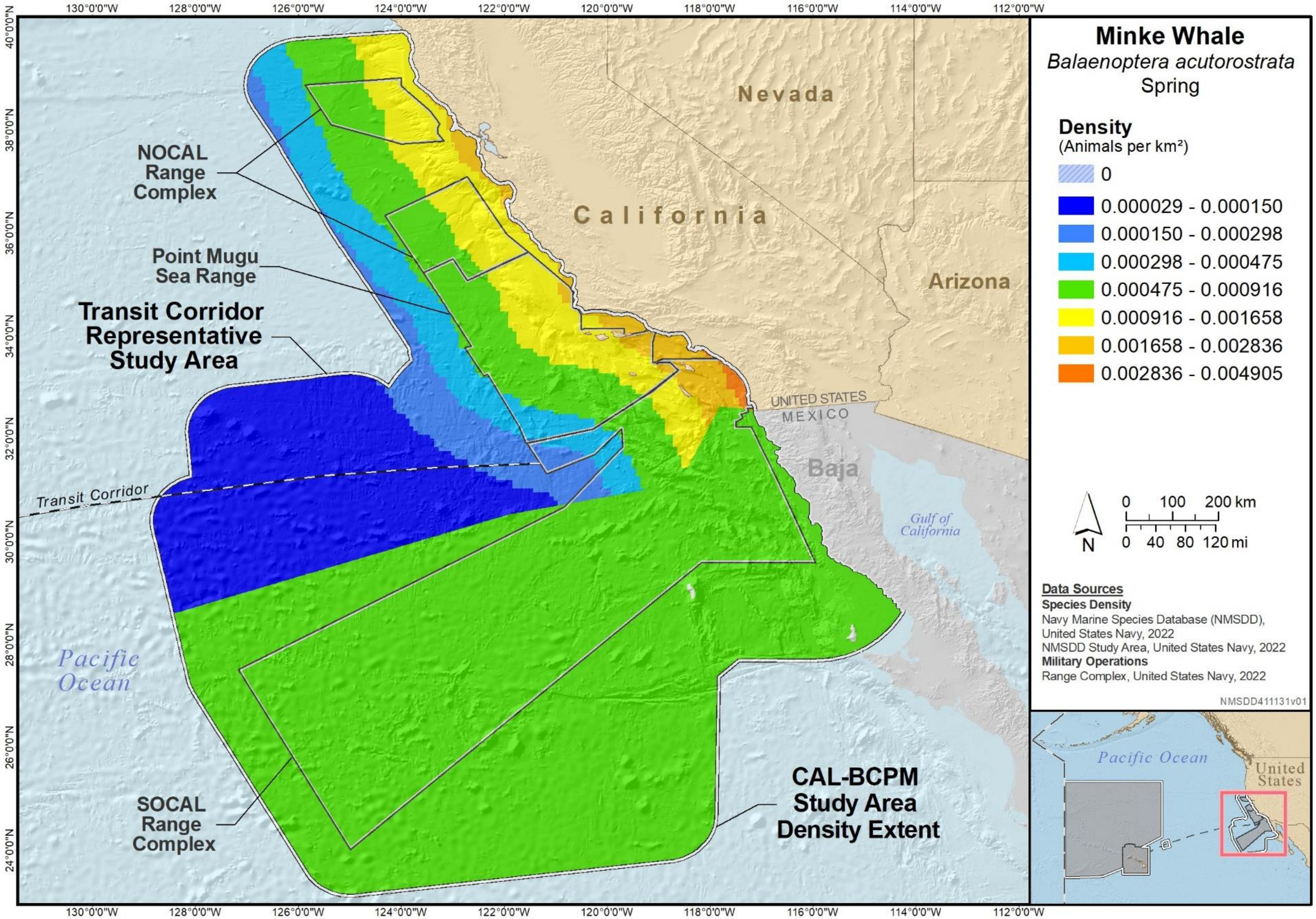

Figure 4-2: Spring Distribution of Minke Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

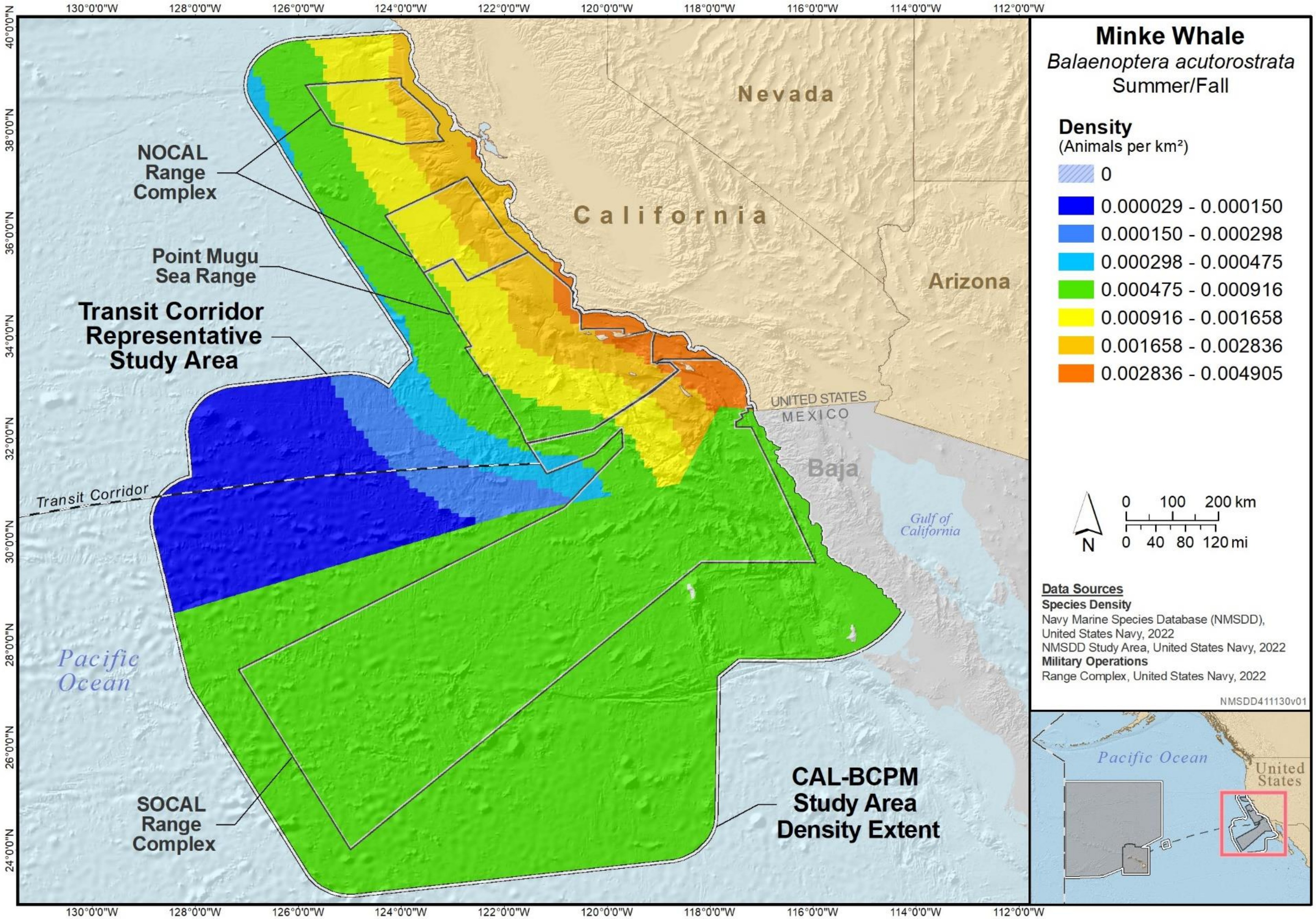

Figure 4-3: Summer/Fall Distribution of Minke Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

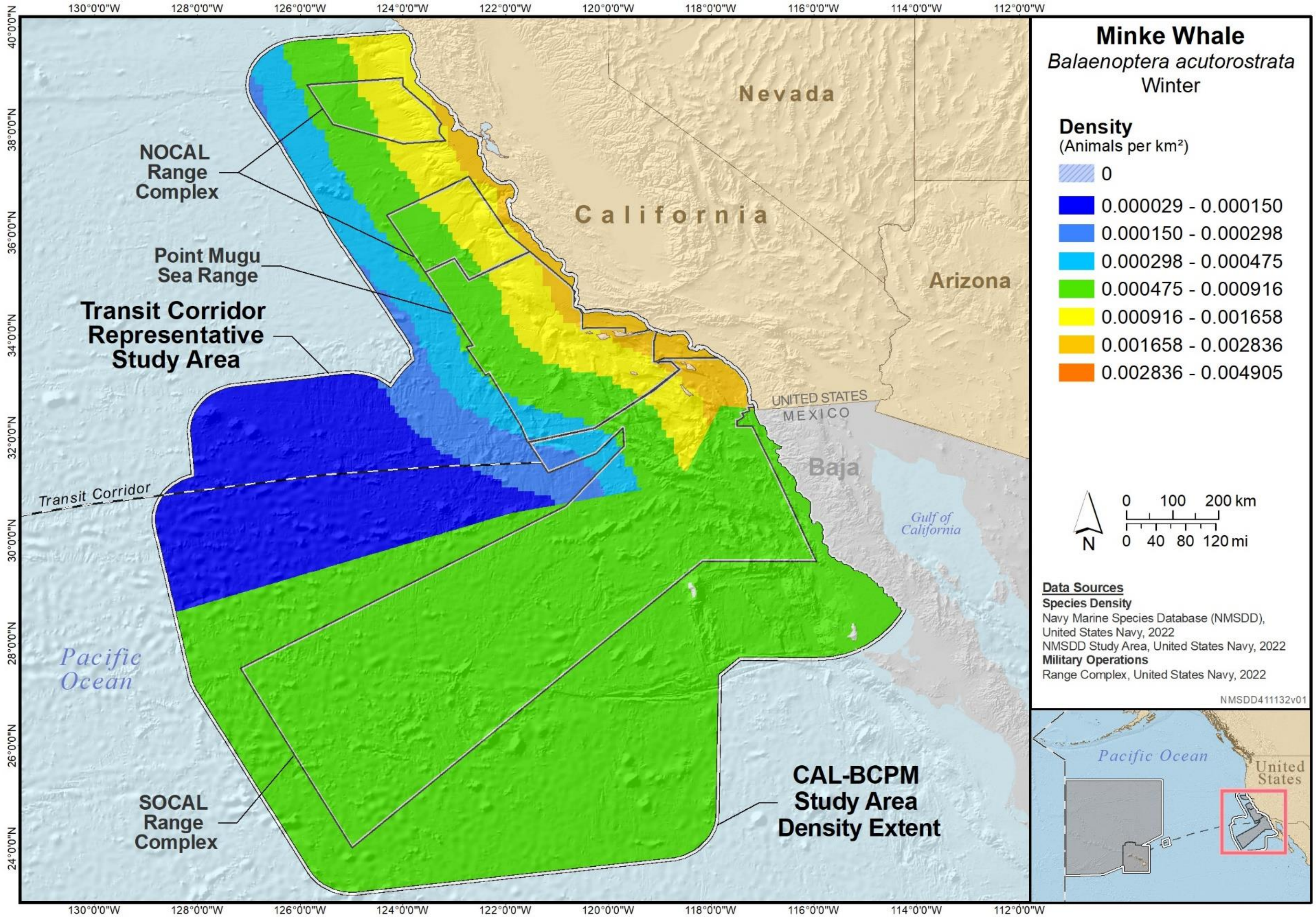

Figure 4-4: Winter Distribution of Minke Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

4.2 *BALAENOPTERA BOREALIS*, SEI WHALE

NMFS recognizes three stocks of sei whales within the U.S. Pacific EEZ: (1) the Hawaii stock, (2) the California/Oregon/Washington stock, and (3) the Alaska stock (Carretta et al., 2022). The Hawaiian stock includes animals found within the Hawaiian Islands EEZ and in adjacent high seas waters. Sei whales in HRC or CAL-BCPM are considered to belong to their respective separate stocks, while animals in the transit corridor could belong to 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. (2021) report a uniform density value for sei whales of 0.00016 animals/km^2 (CV = 0.84) that is applicable to the HRC study area and western portion of the transit corridor. This is the same density estimate used previously in the Navy's Phase III analyses, but it is more precise (i.e., lower CV) because it was based on a more current detection function and new estimates of trackline detection probabilities that consider the effect of survey sighting conditions. This value is used for winter, spring, and fall.

In the summer, sei whales are likely absent from low productivity tropical waters (Jefferson et al., 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.

CAL-BCPM. Barlow (2016) provided a sei whale density estimate of 0.0001 animals/km^2 (CV = 1.05) for waters off central California in summer and fall based on survey data collected between 1991 and 2014. This density estimate was applied to waters south of Point Reyes (38°N), and the eastern portion of the transit corridor, and BCPM year-round since no season- or region-specific values are currently available. For California waters north of Point Reyes, Barlow (2016) provided a sei whale density estimate of 0.0003 animals/km^2 (CV = 0.52) that was applied to the portion of the HCTT Study area north of 38°N year-round.

Table 4-2: Summary of Density Values for Sei Whale in the Hawaii-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	0.0001	0.0001	0.0001	0.0001
CAL	0.0001/0.0003	0.0001/0.0003	0.0001/0.0003	0.0001/0.0003
BCPM	0.0001	0.0001	0.0001	0.0001

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

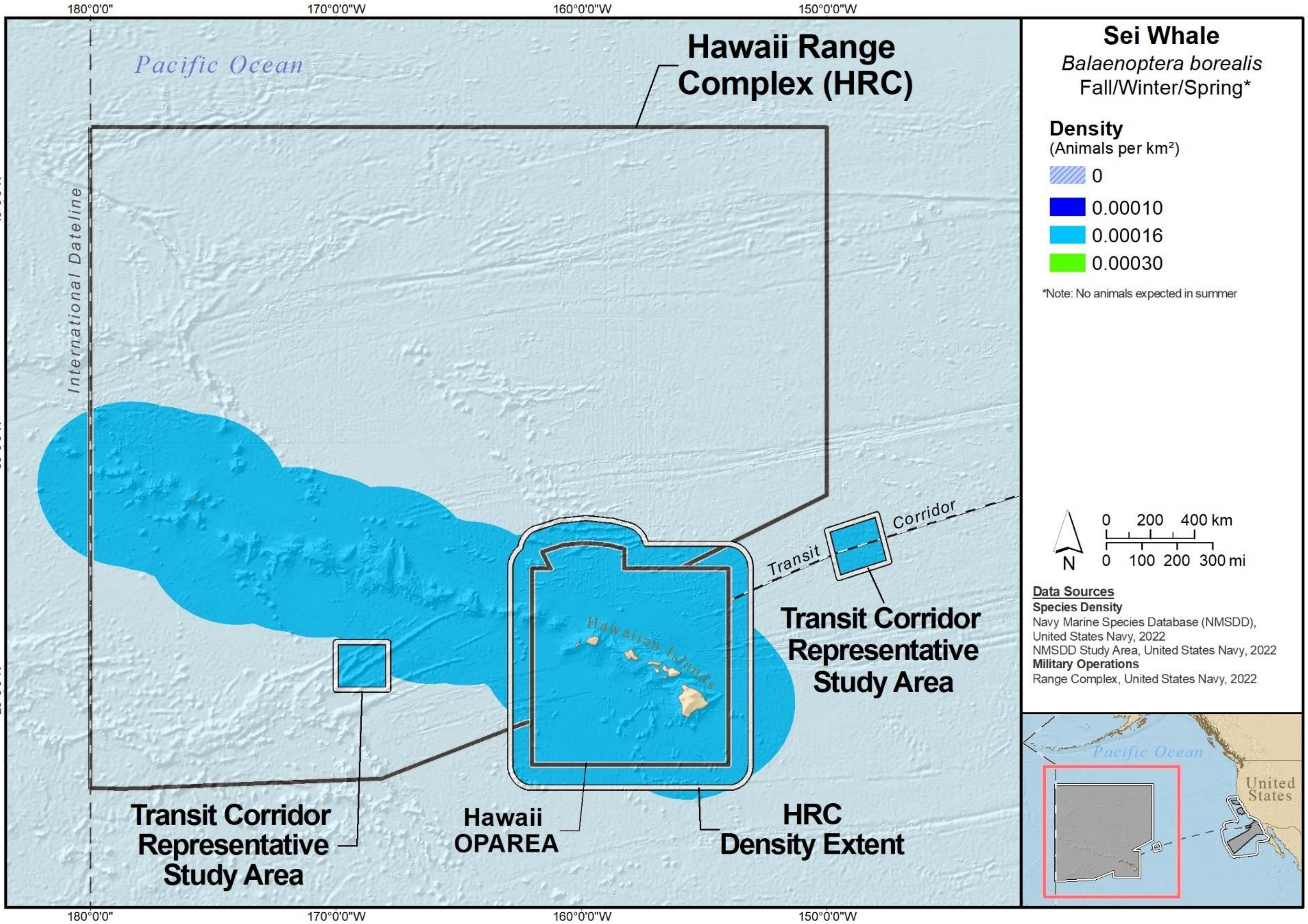

Figure 4-5: Fall/Winter/Spring Distribution of Sei Whale in HRC and the Western Portion of the Transit Corridor

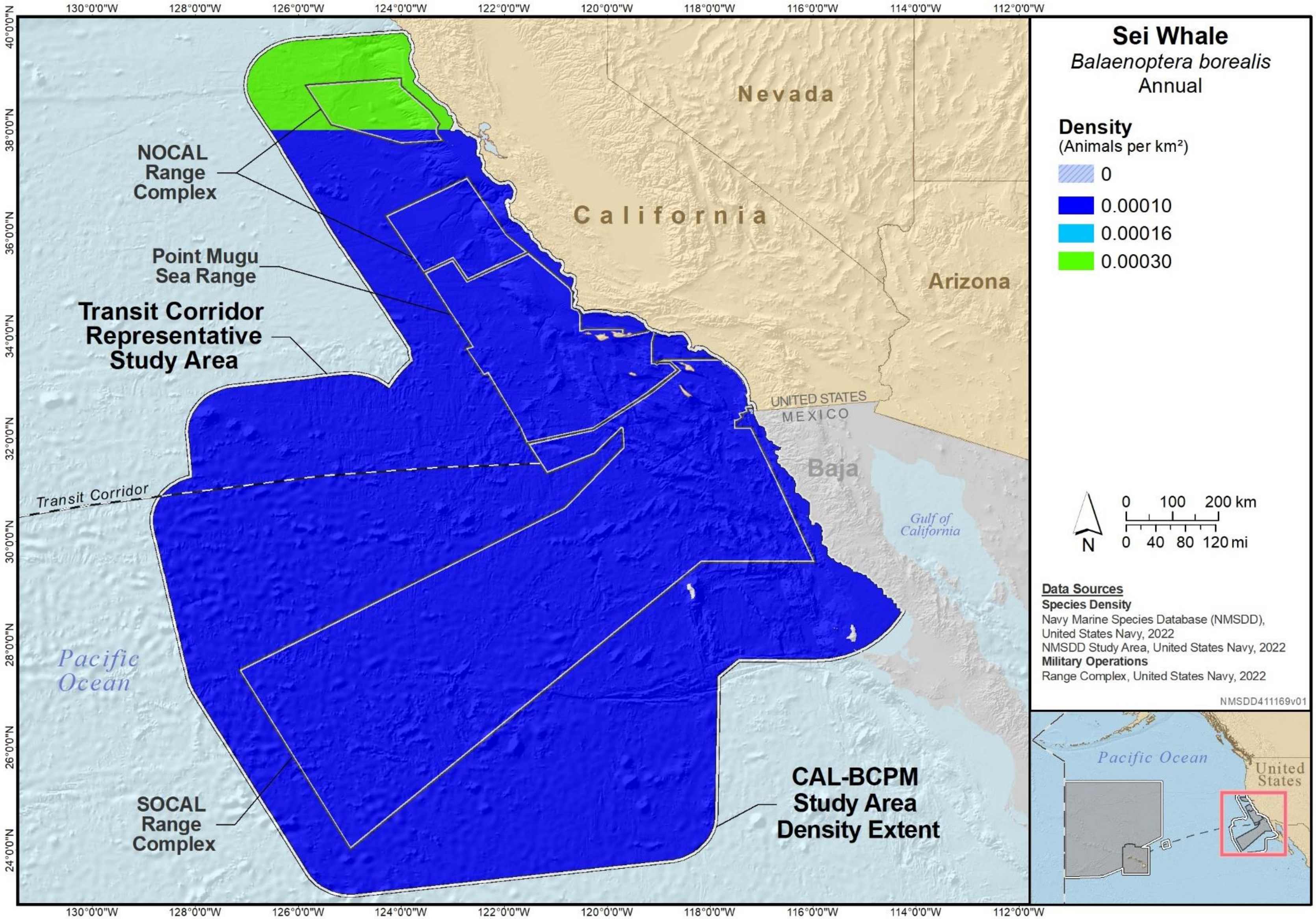

Figure 4-6: Annual Distribution of Sei Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

4.3 *Balaenoptera edeni*, Bryde's Whale

NMFS recognizes two stocks of Bryde's whales in the U.S. Pacific, the Eastern Tropical Pacific stock (whales found east of 150° W, including the Gulf of California and waters off California) and the Hawaii stock (Carretta et al., 2022). Bryde's whales in HRC or CAL-BCPM are considered to belong to their respective separate stocks, with the transition at 150° W longitude as defined by NMFS.

HRC. New survey data collected by NMFS within the Exclusive Economic Zone of the Hawaiian Islands supported the derivation of updated Bryde's whale density estimates from model-based analyses (Becker et al., 2022b). The new habitat-based density model for Bryde's whale represents an improvement to the model available for Phase III (Forney et al., 2015) because it more accurately accounted for bias in group size estimates and variation in detection probabilities, and provided finer-scale density predictions (~9 km x 9 km resolution vs. the previous ~25 km x 25 km resolution) that better accounted for uncertainty. The updated Bryde's whale spatial model was applied to all seasons for the acoustic modeling areas associated with HRC and western portion of the transit corridor.

CAL/BCPM. Barlow (2016) provided a Bryde's whale density estimate of 0.00005 animals/km^2 (CV = 1.05) for waters off central California in summer and fall based on survey data collected between 1991 and 2014. This density estimate was applied to CAL-BCPM and the eastern portion of the transit corridor year-round since no season- or region-specific values are currently available.

Table 4-3: Summary of Density Values for Bryde's Whale in the Hawaii-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	0.00005	0.00005	0.00005	0.00005
CAL	0.00005	0.00005	0.00005	0.00005
BCPM	0.00005	0.00005	0.00005	0.00005

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

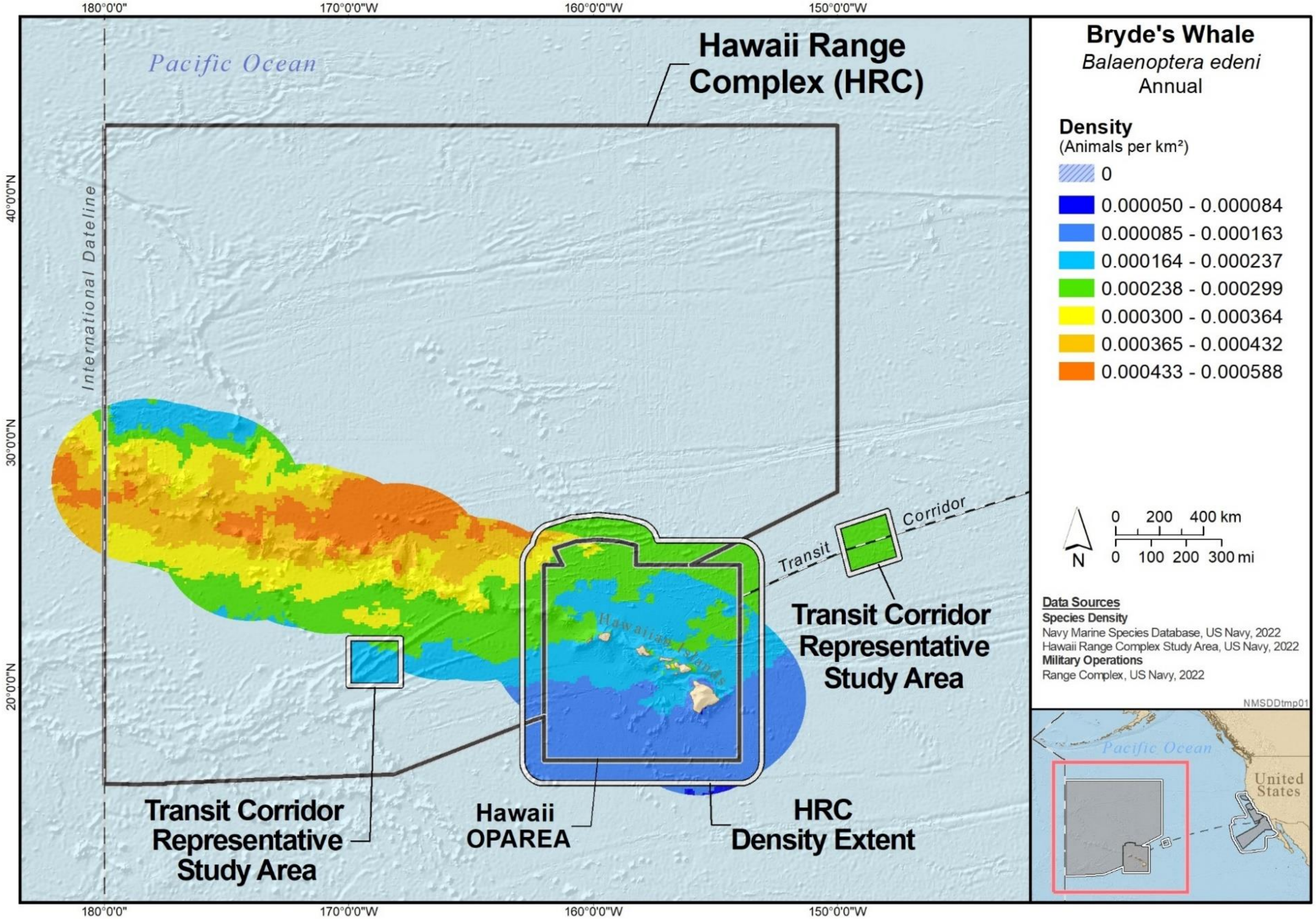

Figure 4-7: Annual Distribution of Bryde's Whale in HRC and the Western Portion of the Transit Corridor

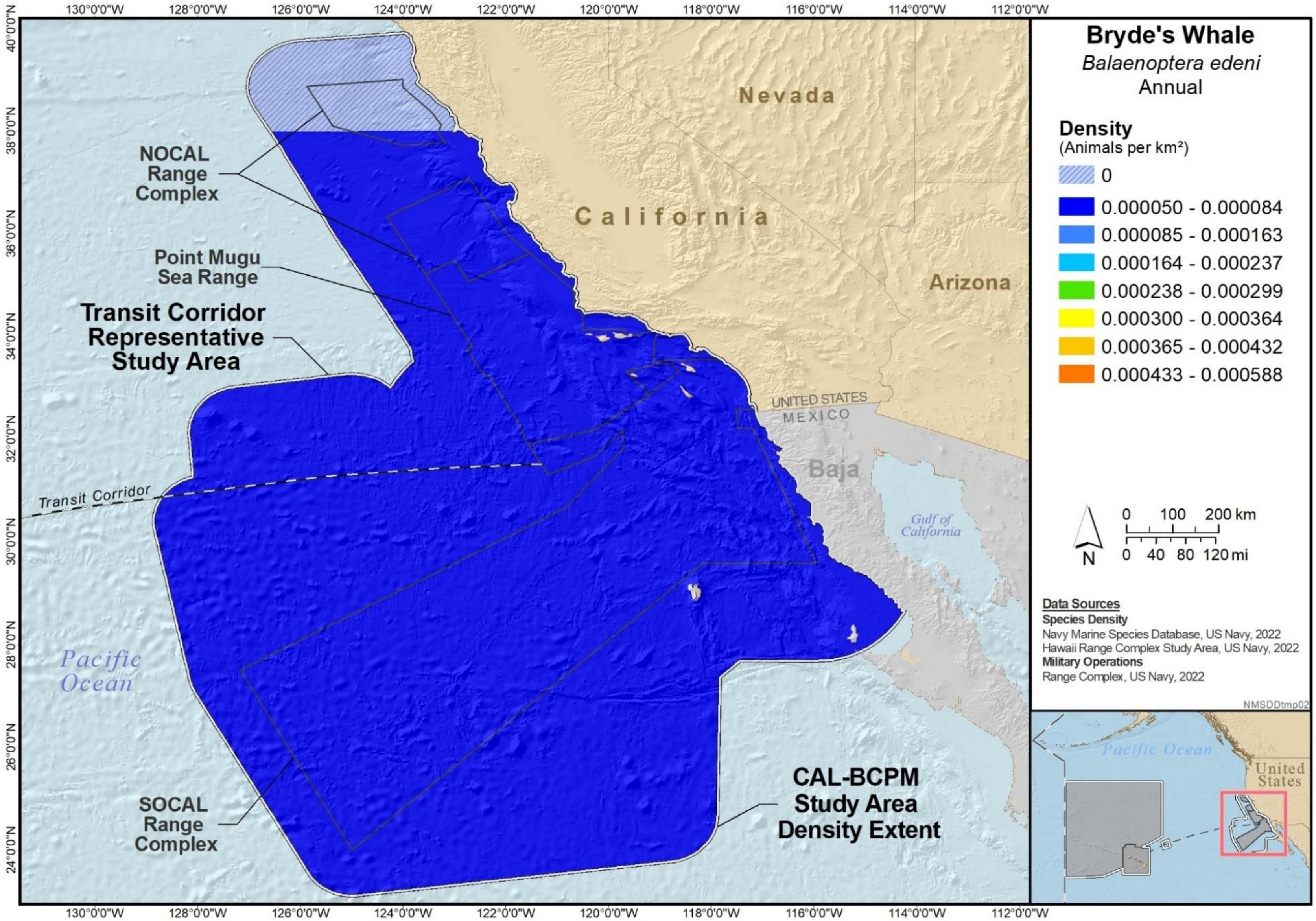

Figure 4-8: Annual Distribution of Bryde's Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

4.4 *Balaenoptera musculus*, Blue Whale

NMFS currently recognizes two stocks of blue whales in the North Pacific: an Eastern North Pacific stock and a Central North Pacific stock (Carretta et al., 2022). Theoretically, most of the blue whales in CAL-BCPM and 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 0.00006 animals/km^2 (CV = 1.12) that is applicable to the HRC study area and western portion of the transit corridor. This is similar to the density estimate used previously in the Navy's Phase III analyses (0.00005 animals/km^2) but it is based on a more current detection function and new estimates of trackline detection probabilities that consider the effect of survey sighting conditions. This value is used for winter, spring, and fall.

In the summer, blue whales are considered absent in HRC, and blue whales were not sighted during systematic surveys of the Hawaiian Islands EEZ during summer and fall of 2002 or 2017 (Barlow, 2006). During a summer/fall line-transect survey in 2010, blue whales were seen within the Hawaiian Islands EEZ, but only during the fall months (Bradford et al., 2017). Therefore, a density of zero is used for summer in HRC and the western portion of the transit corridor.

CAL-BCPM. The Phase III NMSDD included data from a CCE habitat-based density model for blue whales based on systematic survey data collected from 1991 to 2009 (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 models were updated to include additional systematic survey data collected in summer and fall of 2014 and 2018 (Becker et al., 2020a). Model improvements were recognized from additional sighting data collected off the continental shelf and slope, and the inclusion of a broader range of habitat conditions. In addition, recently developed techniques for deriving estimates of uncertainty (Miller et al., 2022) were used to provide more comprehensive variance estimates for the model-based predictions. Density estimates from the updated blue whale model were applied to the portion of the Navy's CAL-BCPM 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.

Abrahms et al. (2019) developed an ensemble model to predict year-round blue whale habitat suitability in the CCE. To derive blue whale winter and spring density estimates, probability of occurrence predictions for winter and spring based on Abrahms et al. (2019) were scaled by summer/fall abundance predictions from Becker et al. (2020a) to produce separate winter (December – February) and spring (March-May) density estimates. These estimates represent an improvement to the Campbell et al. (2015) winter/spring uniform density estimates used in Phase III, because they provide spatially-explicit density values which better capture species distribution patterns. Density estimates from the blue whale model predictions were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for winter and spring.

To improve density estimates for Phase IV, the Navy funded an analysis to develop habitat-based density models for the Southern California Current, an ecologically meaningful study area that extends from Point Conception to the tip of the Baja California Peninsula. Resulting models provide the first spatially explicit estimates of blue whale density for waters off the Baja California Peninsula (Becker et al., 2022a), and were applied to the HCTT study area south of the U.S./Mexico border. These density estimates represent a major improvement over density estimates previously used for Phase III (Ferguson & Barlow, 2003), because they are based on more recent survey data, they provide finer-scale density predictions (9 km x 9 km grid resolution vs. the 5° x 5° grid resolution available for density estimates used in Phase III), and improved, spatially explicit estimates of uncertainty. Model-derived density estimates were applied to the BCPM region year-round since seasonally specific values are not currently available.

Table 4-4: Summary of Density Values for Blue Whale in the Hawaii-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
CAL	S	S	S	S
BCPM	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.

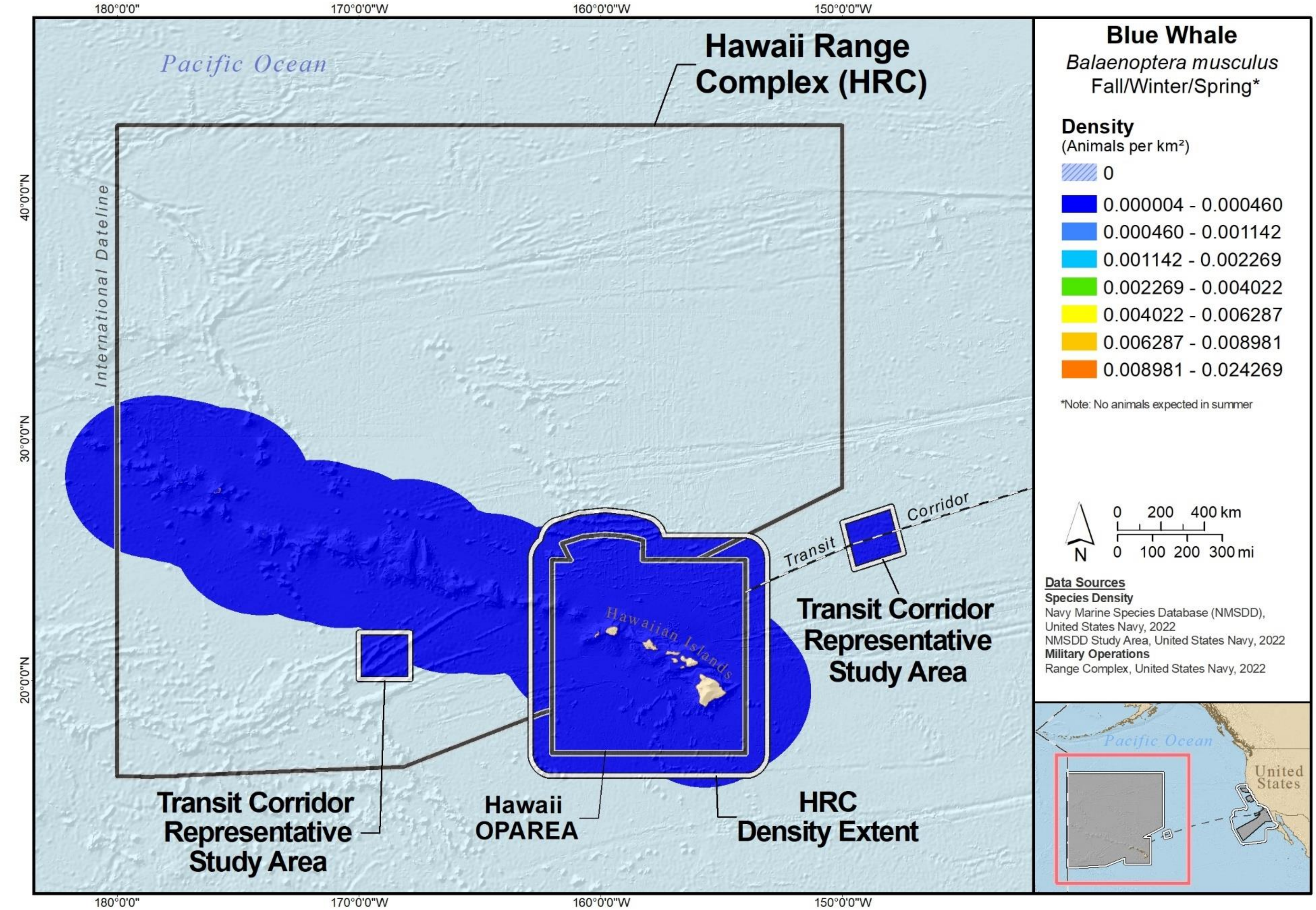

Figure 4-9: Fall/Winter/Spring Distribution of Blue Whale in HRC and the Western Portion of the Transit Corridor

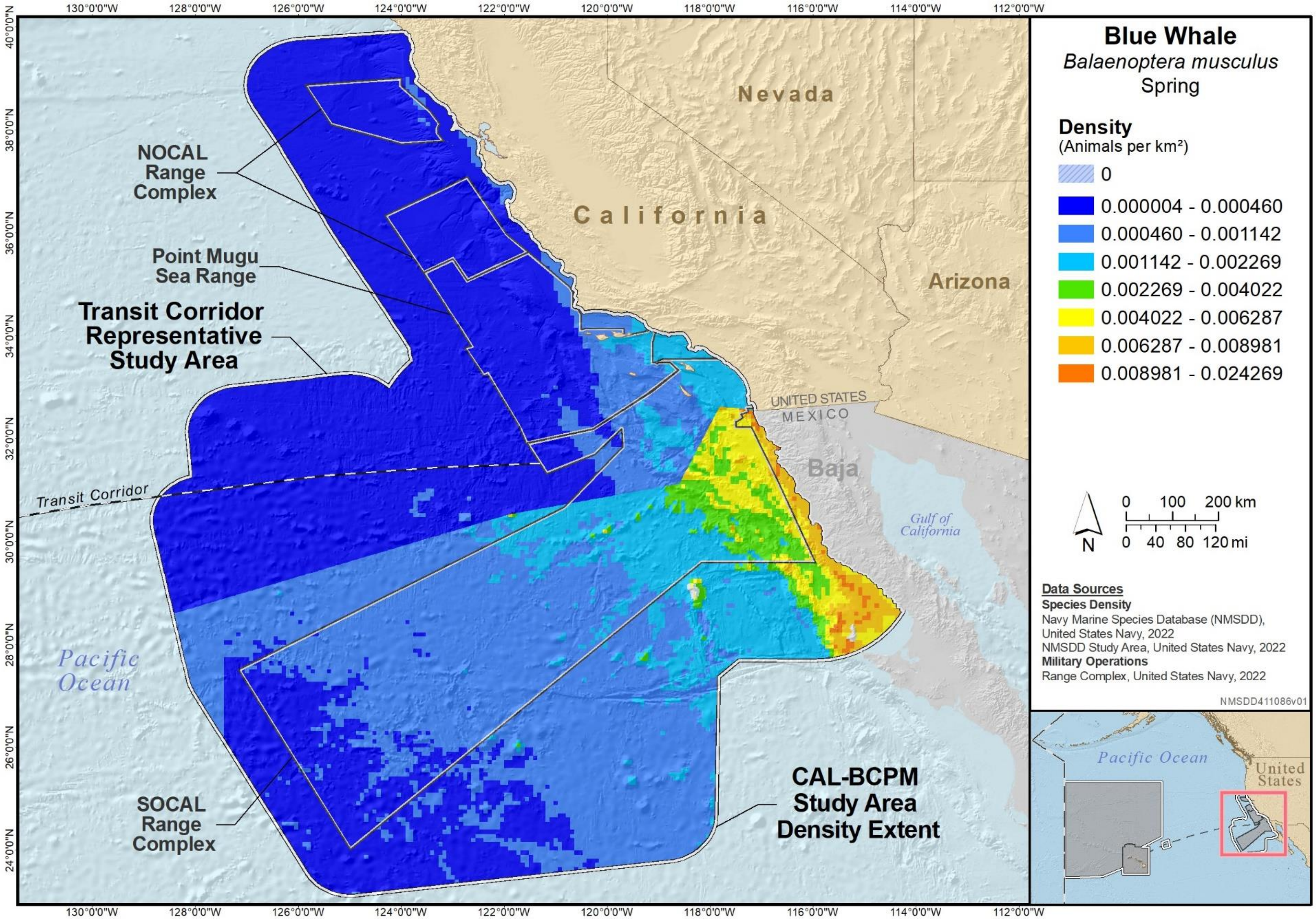

Figure 4-10: Spring Distribution of Blue Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

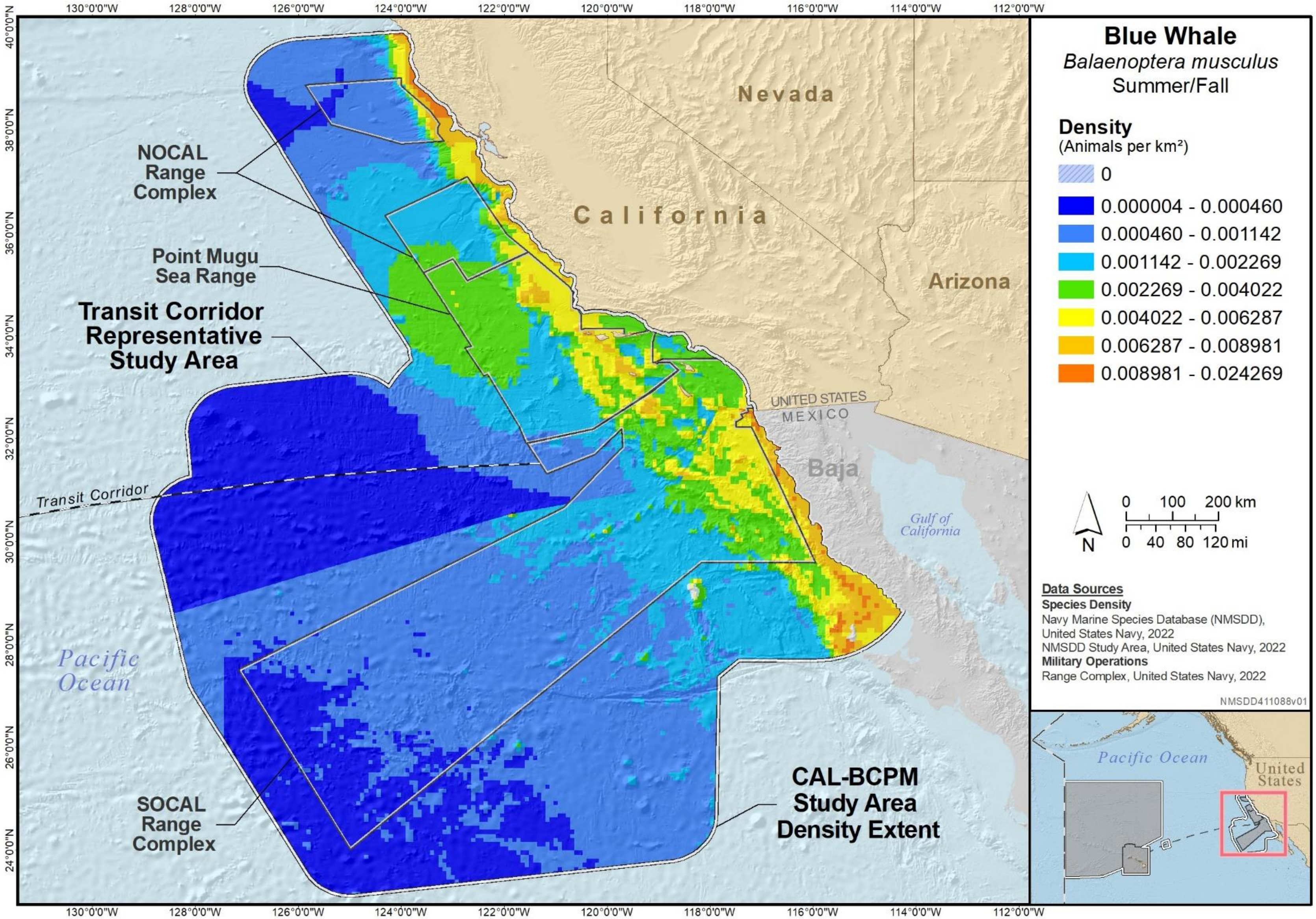

Figure 4-11: Summer/Fall Distribution of Blue Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

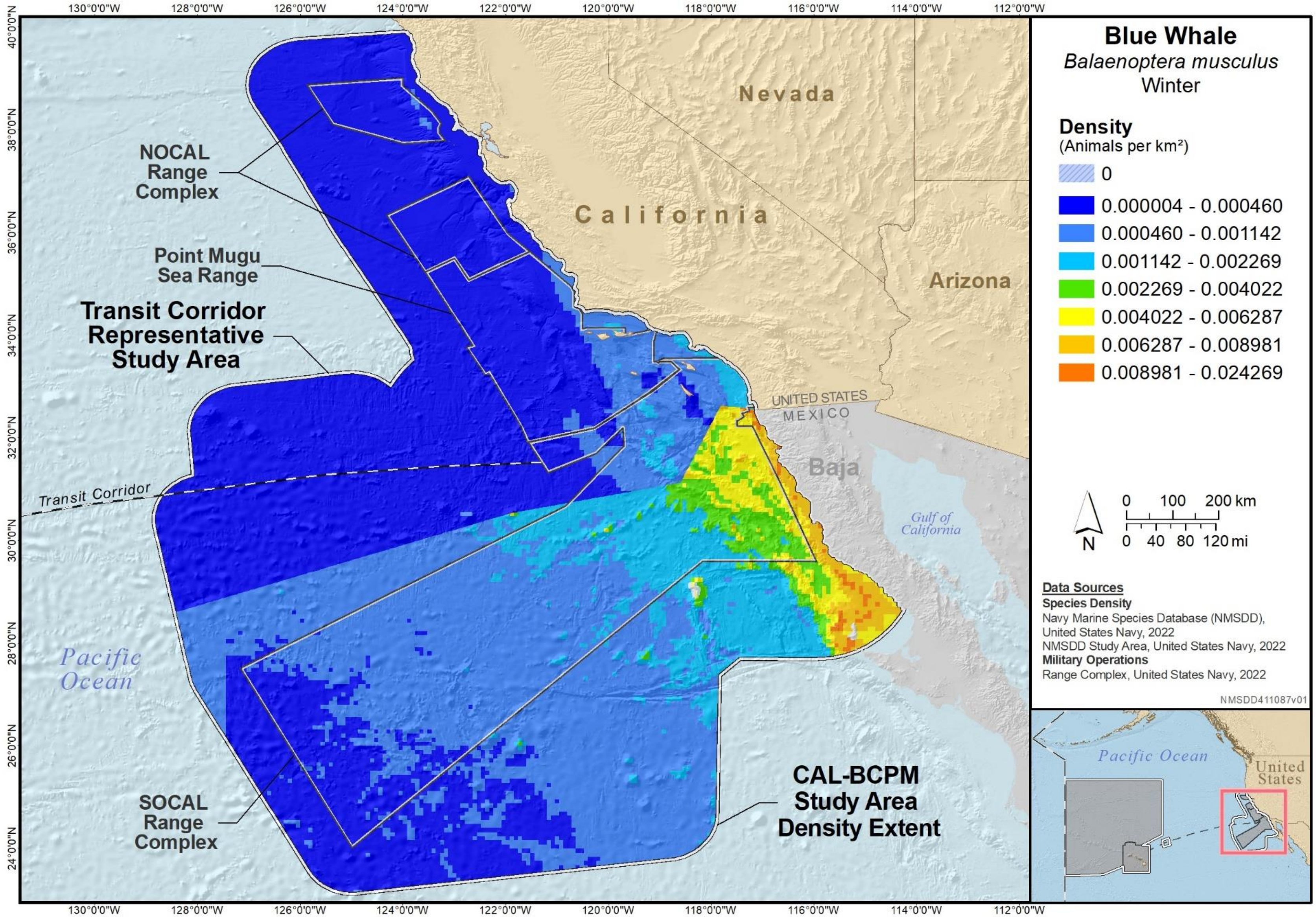

Figure 4-12: Winter Distribution of Blue Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

4.5 *BALAENOPTERA PHYSALUS*, FIN WHALE

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., 2022). The range of the Northeast Pacific stock ostensibly does not overlap with the HCTT Study Area (Young, 2022). Fin whales in HRC or CAL-BCPM are considered to belong to their respective separate stocks, but it is not clear where in the transit corridor one stock may overlap with the other.

HRC. Bradford et al. (2021) report a uniform density value for fin whales of 0.00008 animals/km^2 (CV = 0.99) that is applicable to the HRC study area and western portion of the transit corridor. This represents an improvement to the density estimate used previously in the Navy's Phase III analyses as it is based on multiple-covariate line-transect analyses of sighting data collected on three surveys of waters within the Hawaiian Islands EEZ in 2002, 2010, and 2017. The Bradford et al. (2021) estimate for the most recent year (2017) is used for winter, spring, and fall.

In summer, fin whales are likely absent from HRC, and during three separate line-transect surveys of waters within the Hawaiian Islands EEZ during summer and fall, fin whales were only seen during the fall months (Barlow, 2006; Bradford et al., 2017). Fin whales were not detected during the summer months of any year from 2011 to 2017 from passive acoustic recordings on an array of 14 hydrophones at the U.S. Navy Pacific Missile Range Facility off Kauai, Hawaii (Guazzo et al., 2021; Helble et al., 2020). Therefore, a density of zero is used for summer in HRC and the western portion of the transit corridor.

CAL-BCPM. The Phase III NMSDD included data from a CCE habitat-based density model for fin whales based on systematic survey data collected from 1991 to 2009 (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 models were updated to include additional systematic survey data collected in summer and fall of 2014 and 2018 (Becker et al., 2020a). Model improvements were recognized from additional sighting data collected off the continental shelf and slope, and the inclusion of a broader range of habitat conditions. In addition, recently developed techniques for deriving estimates of uncertainty (Miller et al., 2022) were used to provide more comprehensive variance estimates for the model-based predictions. There is a well-documented increasing trend in fin whale numbers off the west coast of the United States (Moore & Barlow, 2011; Nadeem et al. 2016), and a year covariate included in the fin whale model successfully captured this population trend (Becker et al., 2020a). Density estimates from the updated fin whale model were applied to the portion of the Navy's CAL-BCPM 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.

Habitat-based density models specific to winter/spring were recently developed for fin whales for waters off Southern California using 2005-2020 California Cooperative Oceanic Fisheries Investigations (CalCOFI) shipboard survey data (Becker et al., In Prep.). To produce density estimates for the Navy HCTT study areas north of the CalCOFI survey region, the CalCOFI model was used to derive separate winter and spring estimates for waters off the U.S. West Coast using techniques designed to avoid spatial and temporal extrapolation (Becker et al., In Prep.). These estimates represent an improvement to the

Campbell et al. (2015) winter and spring uniform density estimates used in Phase III because they provide spatially-explicit estimates which better capture species distribution patterns, they are based on more recent survey data, they better account for trackline detection probabilities, and they include bias corrections to account for unidentified large whales that were actually fin whales (Becker et al., In Prep.). Density estimates from the fin whale model predictions were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for winter and spring.

In order to improve density estimates for Phase IV, the Navy funded an analysis to develop habitat-based density models for the Southern California Current, an ecologically meaningful study area that extends from Point Conception to the tip of the Baja California Peninsula. Resulting models provide the first spatially explicit estimates of fin whale density for waters off the Baja California Peninsula (Becker et al., 2022a), and were applied to the HCTT study area south of the U.S./Mexico border. These density estimates represent a major improvement over density estimates previously used for Phase III (Ferguson & Barlow, 2003), because they are based on more recent survey data, they provide finer-scale density predictions (9 km x 9 km grid resolution vs. the 5° x 5° grid resolution available for density estimates used in Phase III), and improved, spatially explicit estimates of uncertainty. Model-derived density estimates were applied to the BCPM region year-round since seasonally specific values are not currently available.

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

Location	Spring	Summer	Fall	Winter
HRC	0.00008	0	0.00008	0.00008
W. Transit Corridor	0.00008	0	0.00008	0.00008
E. Transit Corridor	S	S	S	S
CAL	S	S	S	S
BCPM	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.

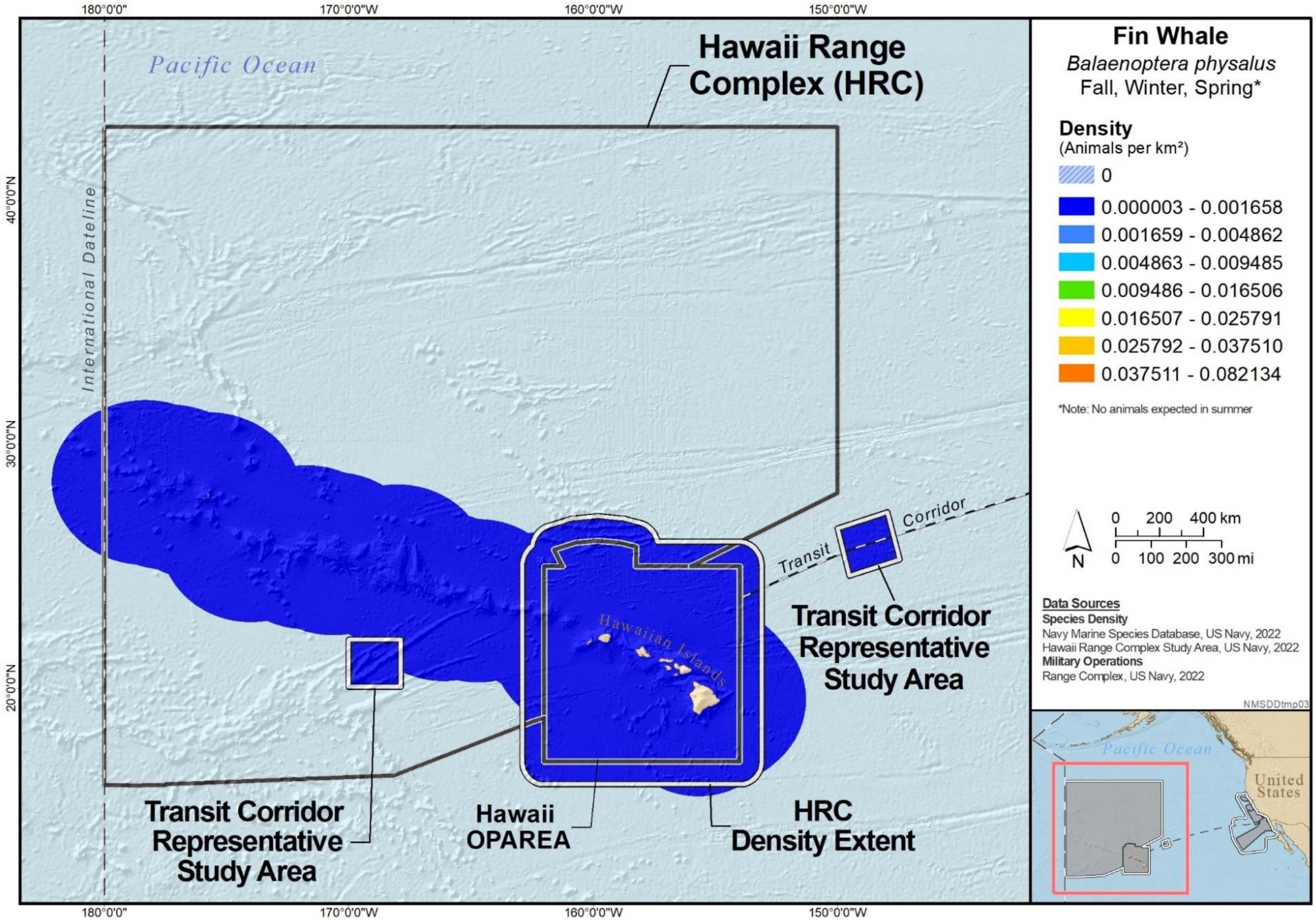

Figure 4-13: Fall/Winter/Spring Distribution of Fin Whale in HRC and the Western Portion of the Transit Corridor

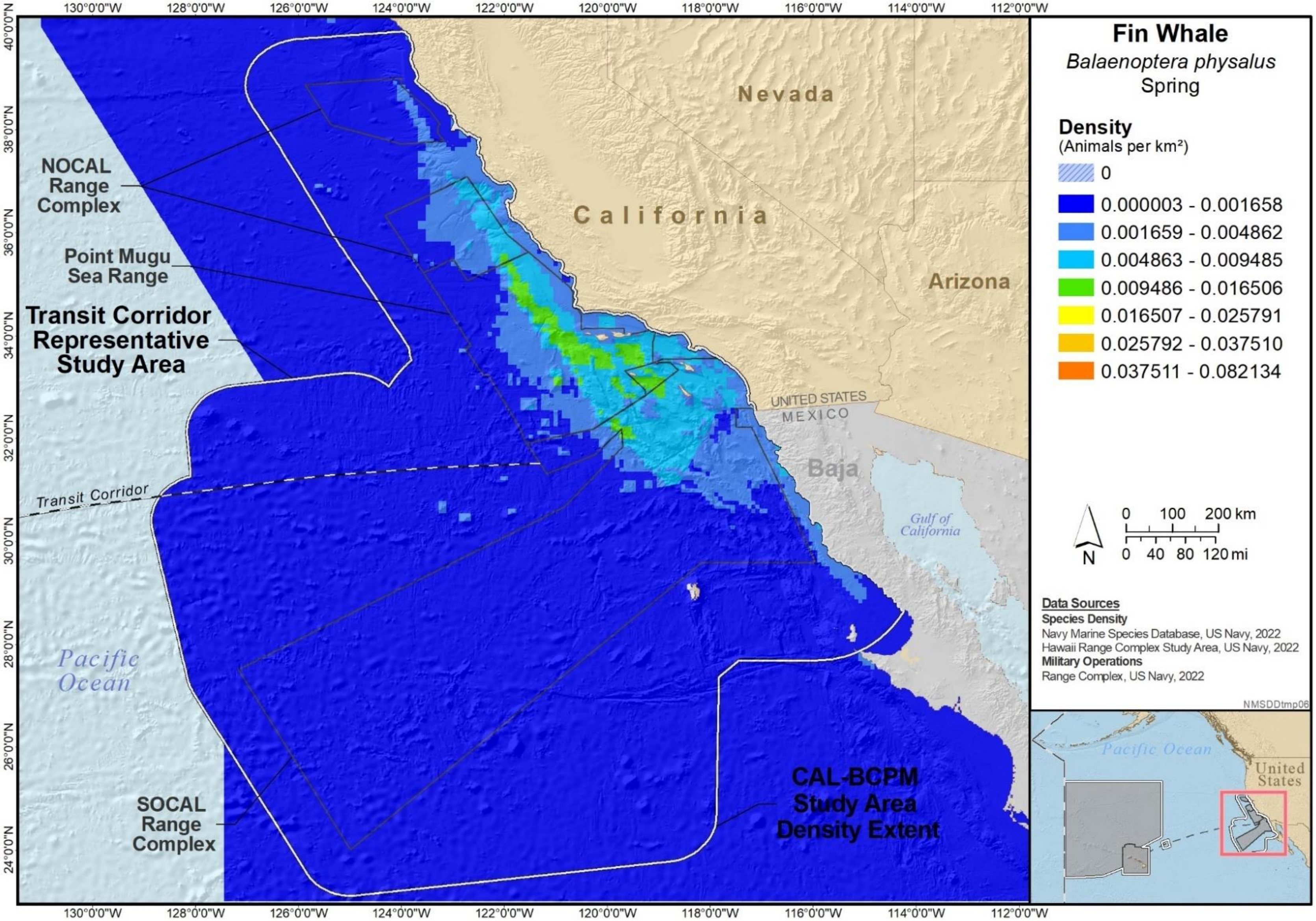

Figure 4-14: Spring Distribution of Fin Whale in CAL/BPCM and the Eastern Portion of the Transit Corridor

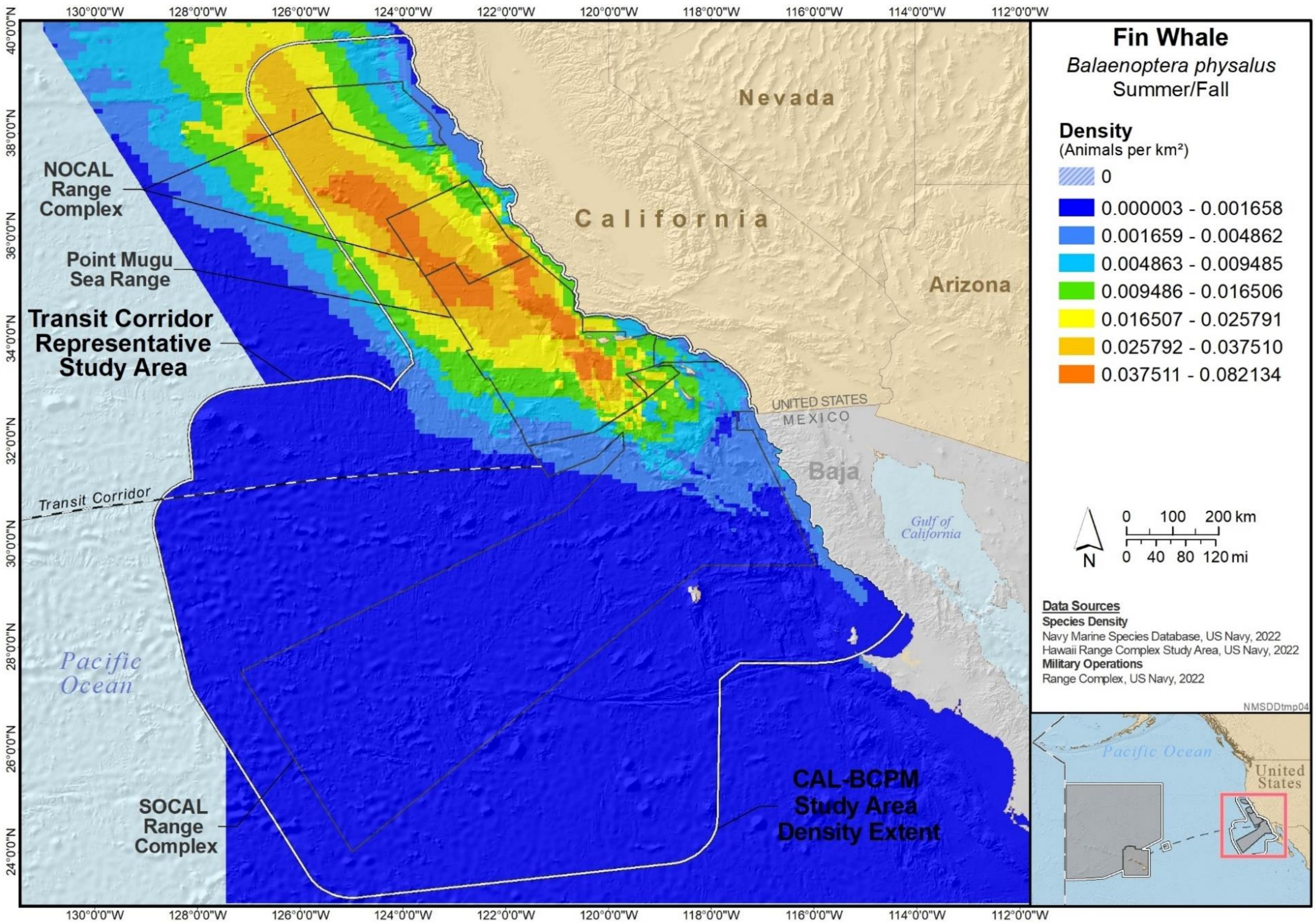

Figure 4-15: Summer/Fall Distribution of Fin Whale in CAL/BPCM and the Eastern Portion of the Transit Corridor

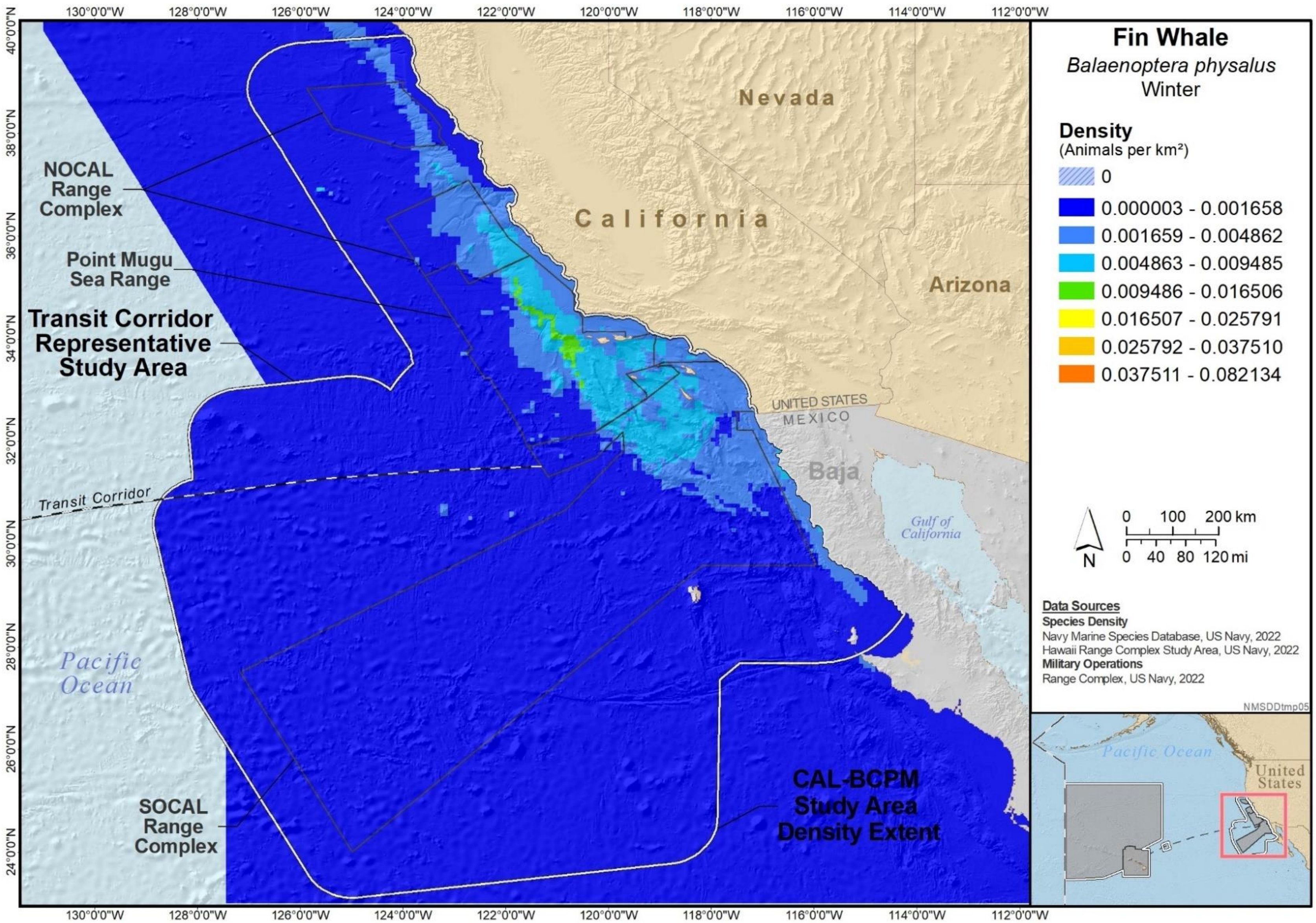

Figure 4-16: Winter Distribution of Fin Whale in CAL/BPCM and the Eastern Portion of the Transit Corridor

4.6 *ESCHRICHTIUS ROBUSTUS*, GRAY WHALE

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., 2022). Until recently, these two stocks were considered exclusive from each other, but recent satellite tagging, genetic studies, 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 IV. Density values in the NMSDD Phase IV 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 CAL-BCPM 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 regularly in HRC or in the transit corridor. There were two sightings of what appeared to be a juvenile gray whale off the island of Hawaii in February 2022, but this is the first recorded sighting of this species in the central Tropical Pacific and it is considered very unusual (Baird et al., 2022).

CAL-BCPM. DeAngelis et al. (2011) developed a migration model that provides monthly, spatially explicit predictions of gray whale abundance along the U.S. West Coast from December through June. These monthly density estimates apply to a “main migration corridor” that extends from the coast to 10 km offshore north of Point Conception. A zone from the main migration corridor out to 47 km offshore is designated as an area of “potential presence”. To derive a density estimate for this area, the Navy assumed that 1 percent of the population could be within the 47-km “potential presence” area during migration. Given the most recent stock assessment population estimate of 26,960 animals (Carretta et al., 2017), approximately 270 gray whales may use this corridor. Assuming the migration wave lasts 30 days, then 9 whales on average on any one day could occur in the "potential presence" area. The area from the main migration route offshore to 47 km from Point Conception to the Canadian border = 85,500 km^2, so density within this zone = 0.00011 whales/km^2. Based on recent analyses by Calambokidis et al. (*In Review*), the main migration corridor south of Point Conception was expanded to include most of the Southern California Bight rather than multiple routes as originally designated by DeAngelis et al. (2011).

From July–November, gray whale occurrence off the U.S. West Coast is expected to consist primarily of whales belonging to the PCFG. Calambokidis et al. (2012) provided an updated analysis of the abundance of the PCFG whales in the Pacific Northwest and recognized that this group forms a distinct feeding aggregation. Based on photograph mark-recapture techniques, Calambokidis et al. (2017) reported an abundance estimate for the PCFG of 243 animals, assuming their range extended from 41 degrees north latitude to 51 degrees north latitude. Assuming they can occur from shore to 10 miles offshore, the resulting density estimate is 0.0084 animals/km^2 (CV = NA). To be conservative, the Navy applied this estimate to the HCTT CAL Study Area north of Point Conception (34.45 degrees N). In the Southern California Bight south of Point Conception, Jefferson et al. (2014) provided density estimates for gray whales based on sighting data collected from 18 line-transect aerial surveys conducted between 2008 and 2013. For summer/fall, they reported an overall study area density estimate of 0.00059 animals/km^2 (CV = 0.13), which the Navy conservatively applied from shore to 25 nm west of the Channel Islands for July–November. In the absence of region-specific data, this value was also used for the HCTT study area off the Baja California Peninsula. In winter/spring, Jefferson et al. (2014) provided 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. These values were applied to the HCTT Study Area off the Baja California Peninsula for winter/spring, used roughly to approximate inshore (0–2.25 nm from shore) and offshore (2.25–20 nm from shore) migration corridors, respectively.

Table 4-6: Summary of Density Values for Gray Whale in the Hawaii-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
CAL: North of Point Conception	S	0.0084	0.0084	S
CAL: South of Point Conception	S	0.00059	0.00059	S
BCPM: shore to 2.25 nm west	0.01791	0.00059	0.00059	0.01791
BCPM: 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; S = spatial model with various density values throughout the range.

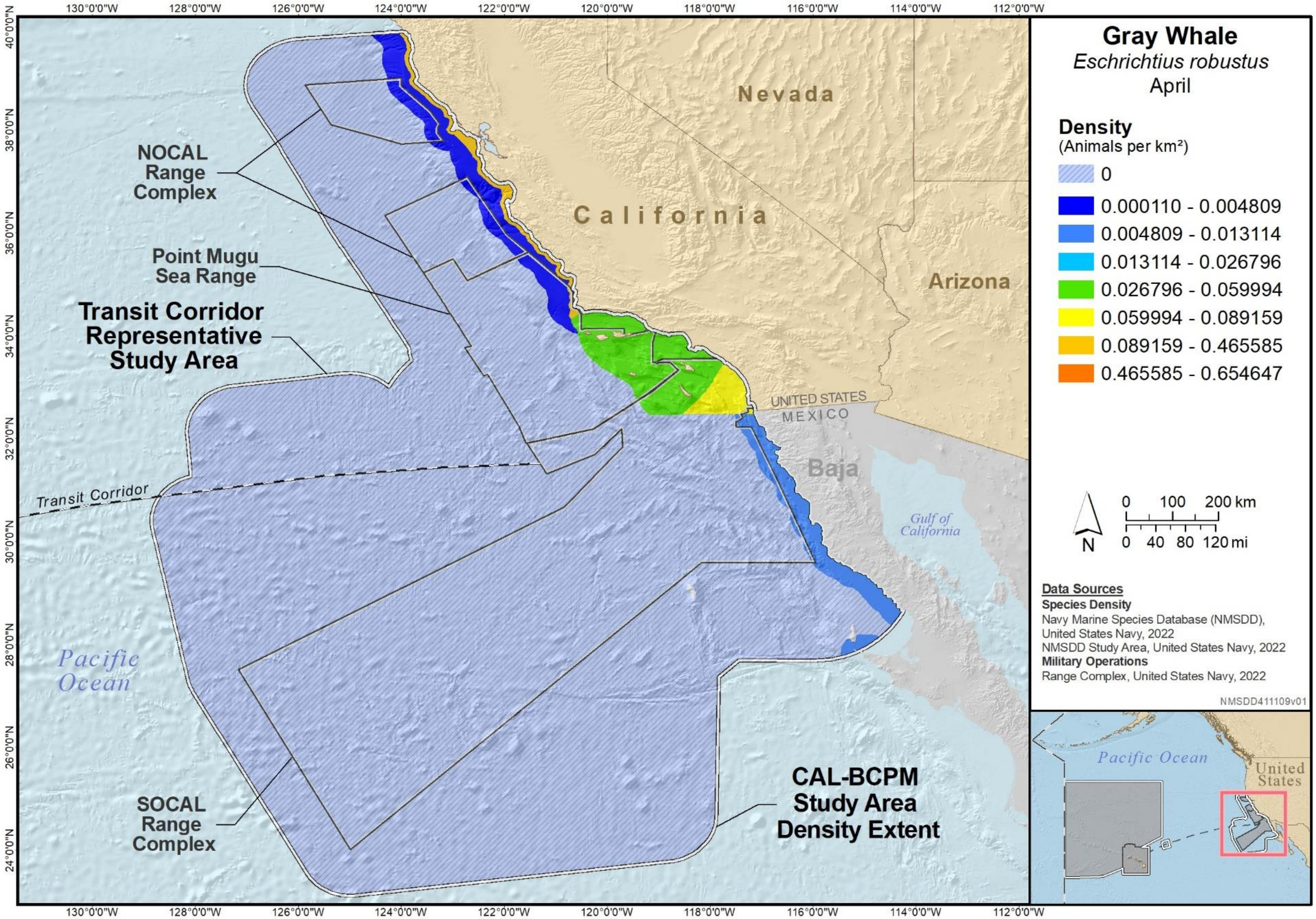

Figure 4-17: April Distribution of Gray Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

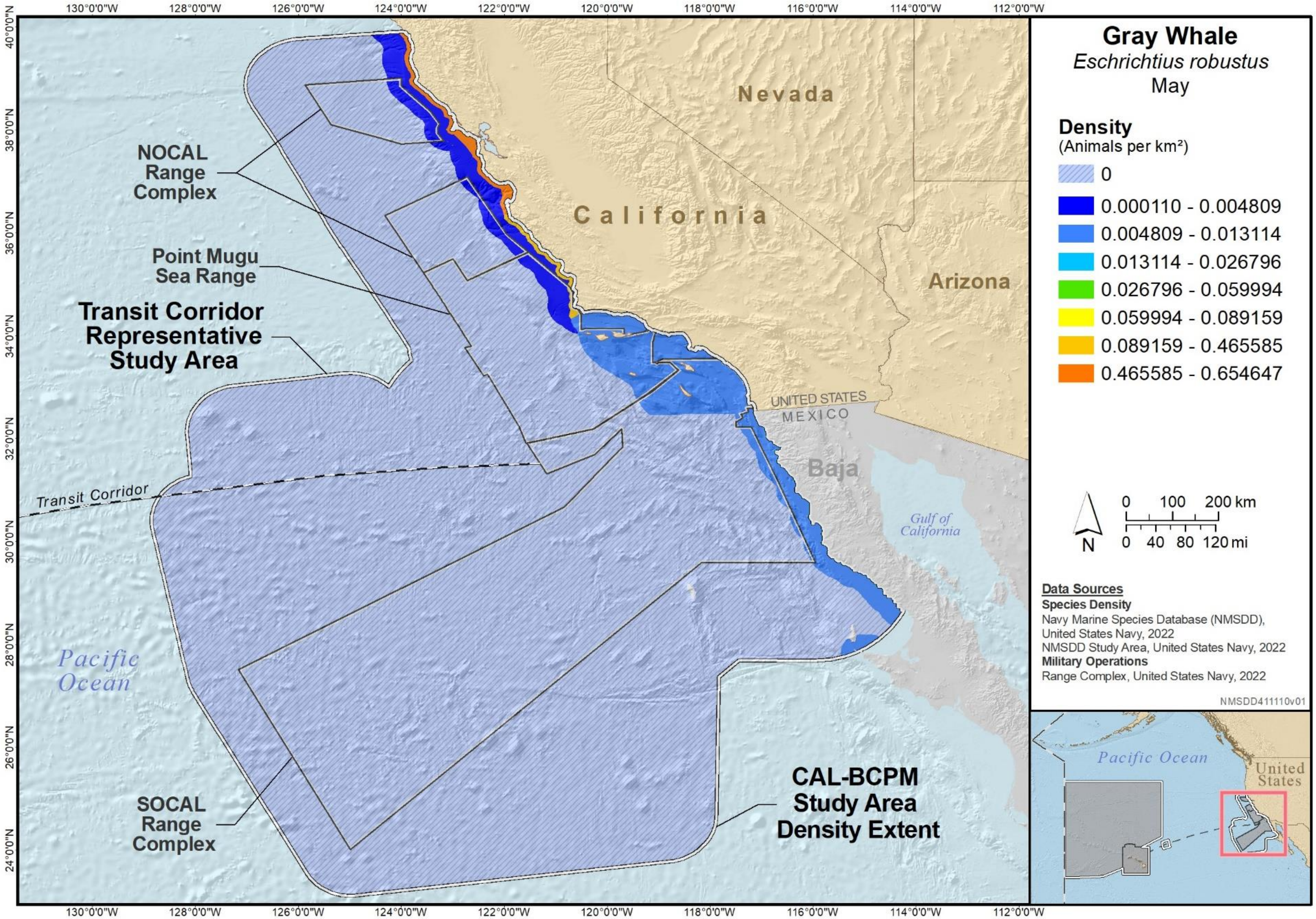

Figure 4-18: May Distribution of Gray Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

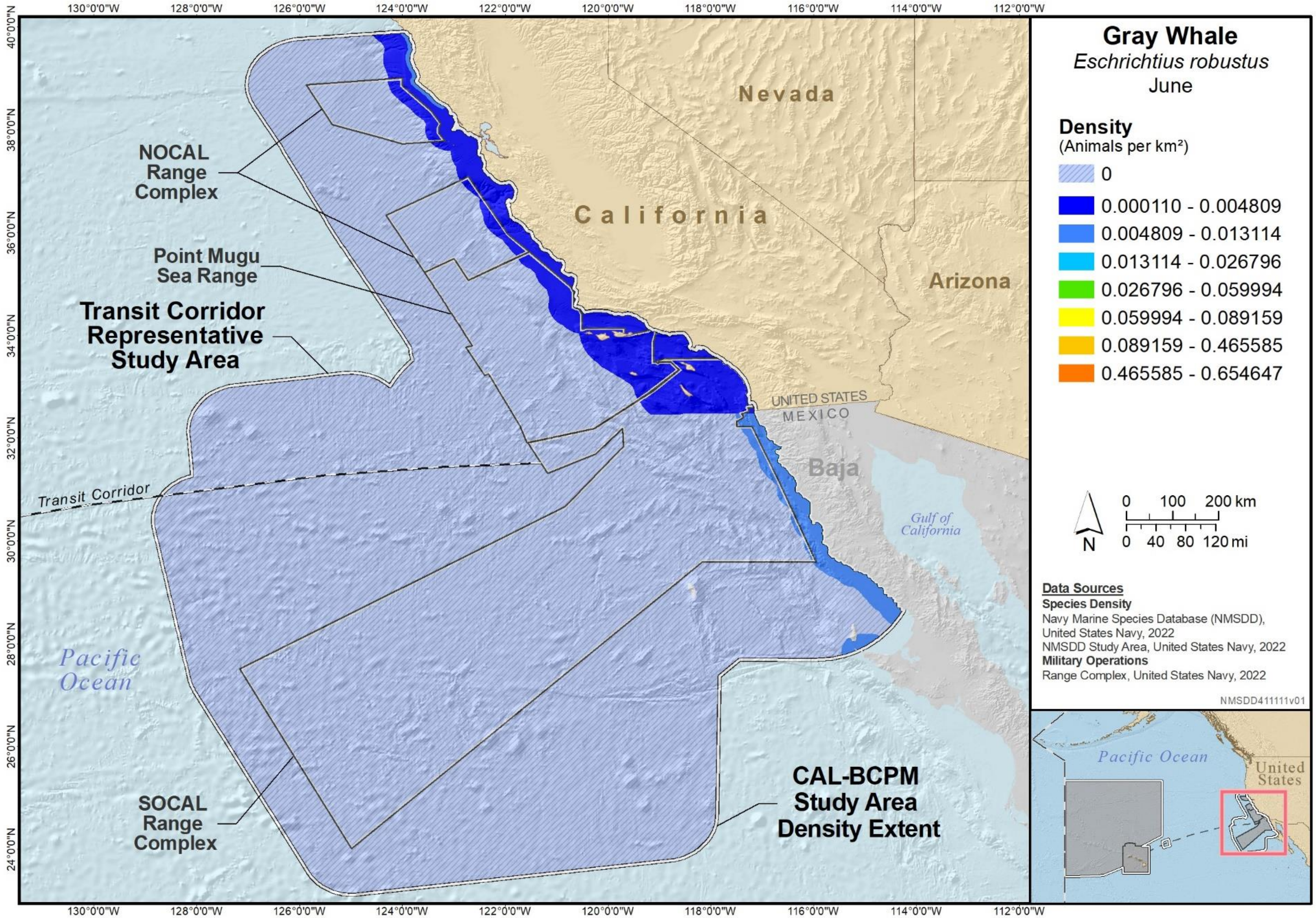

Figure 4-19: June Distribution of Gray Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

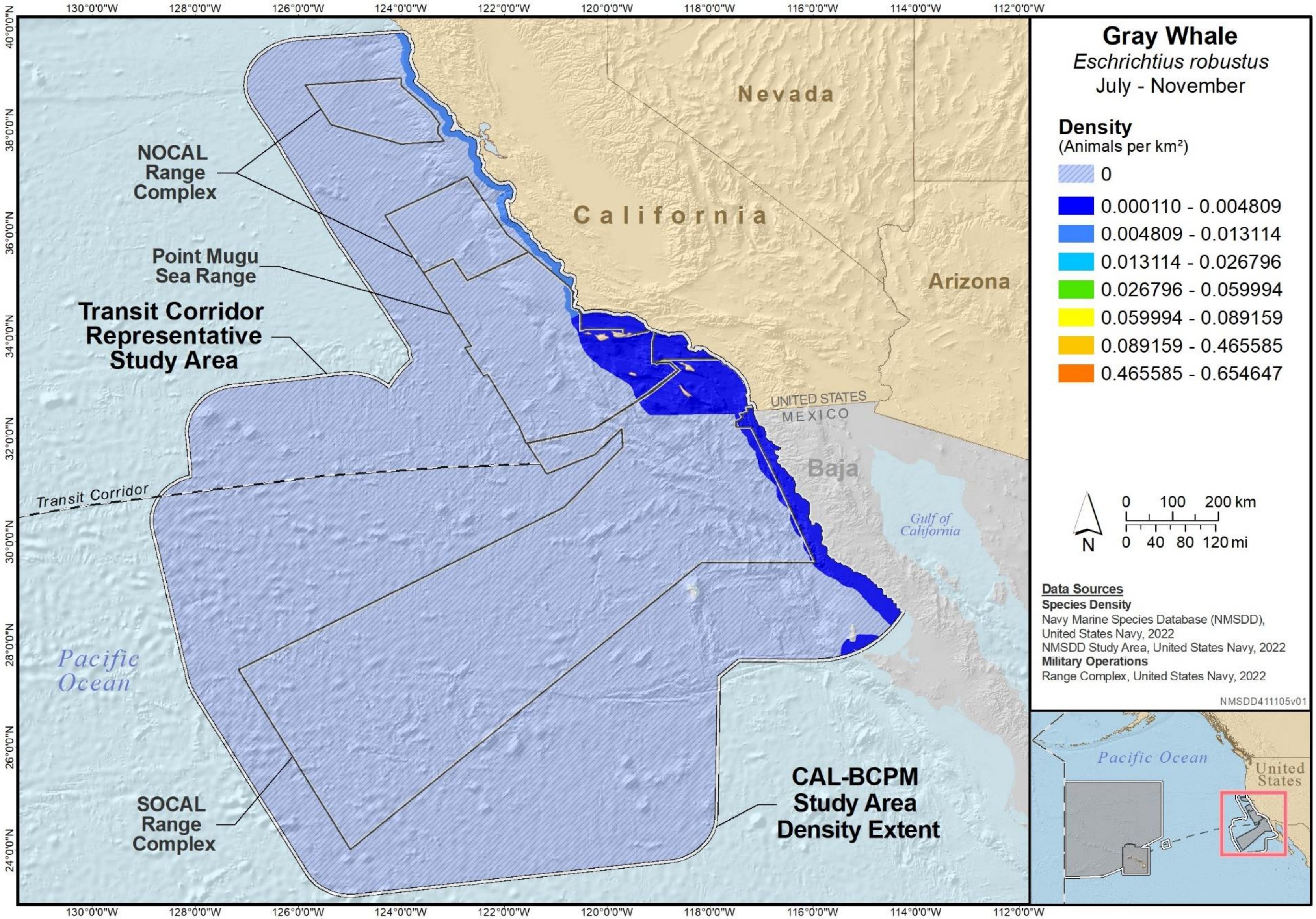

Figure 4-20: July-November Distribution of Gray Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

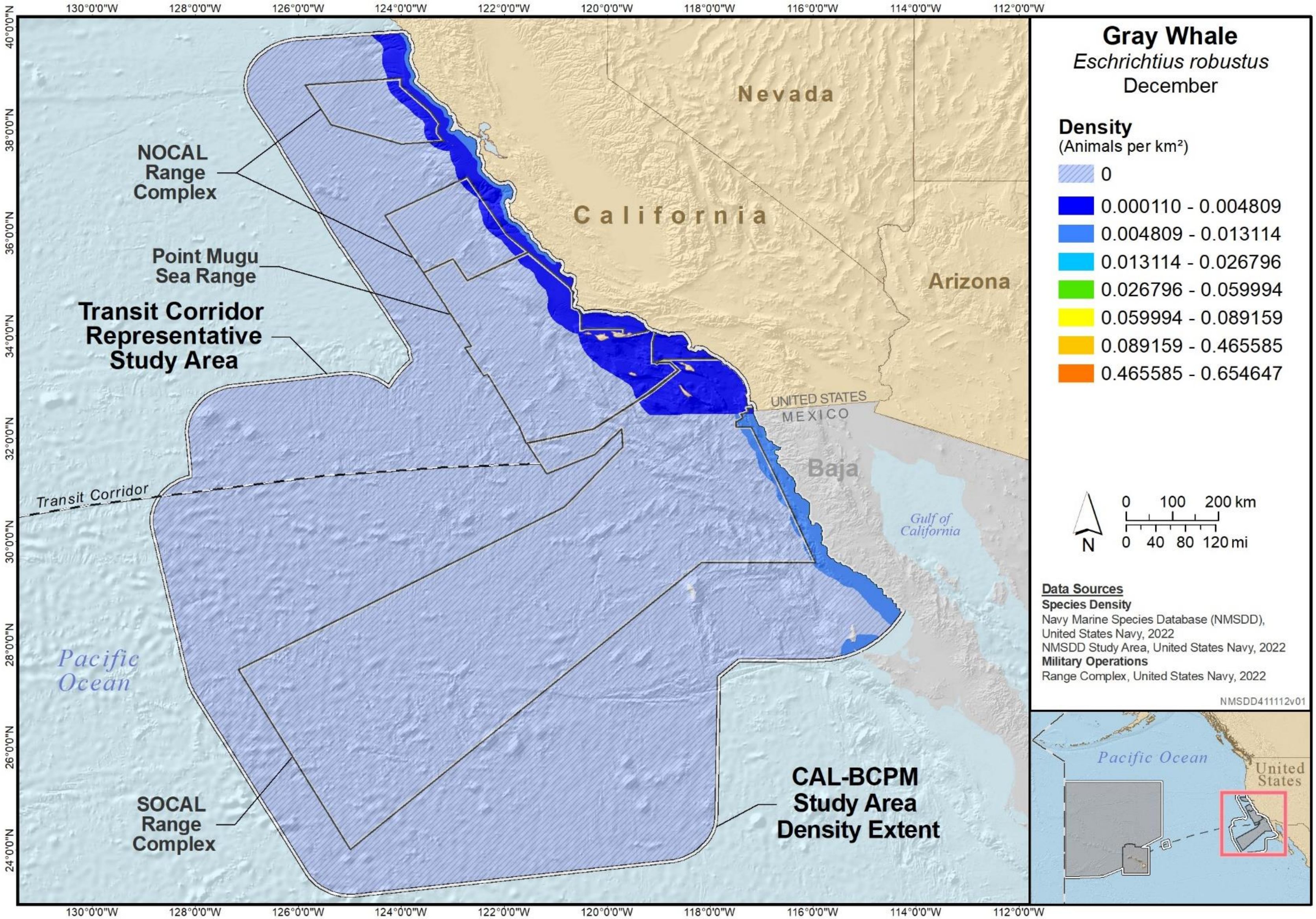

Figure 4-21: December Distribution of Gray Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

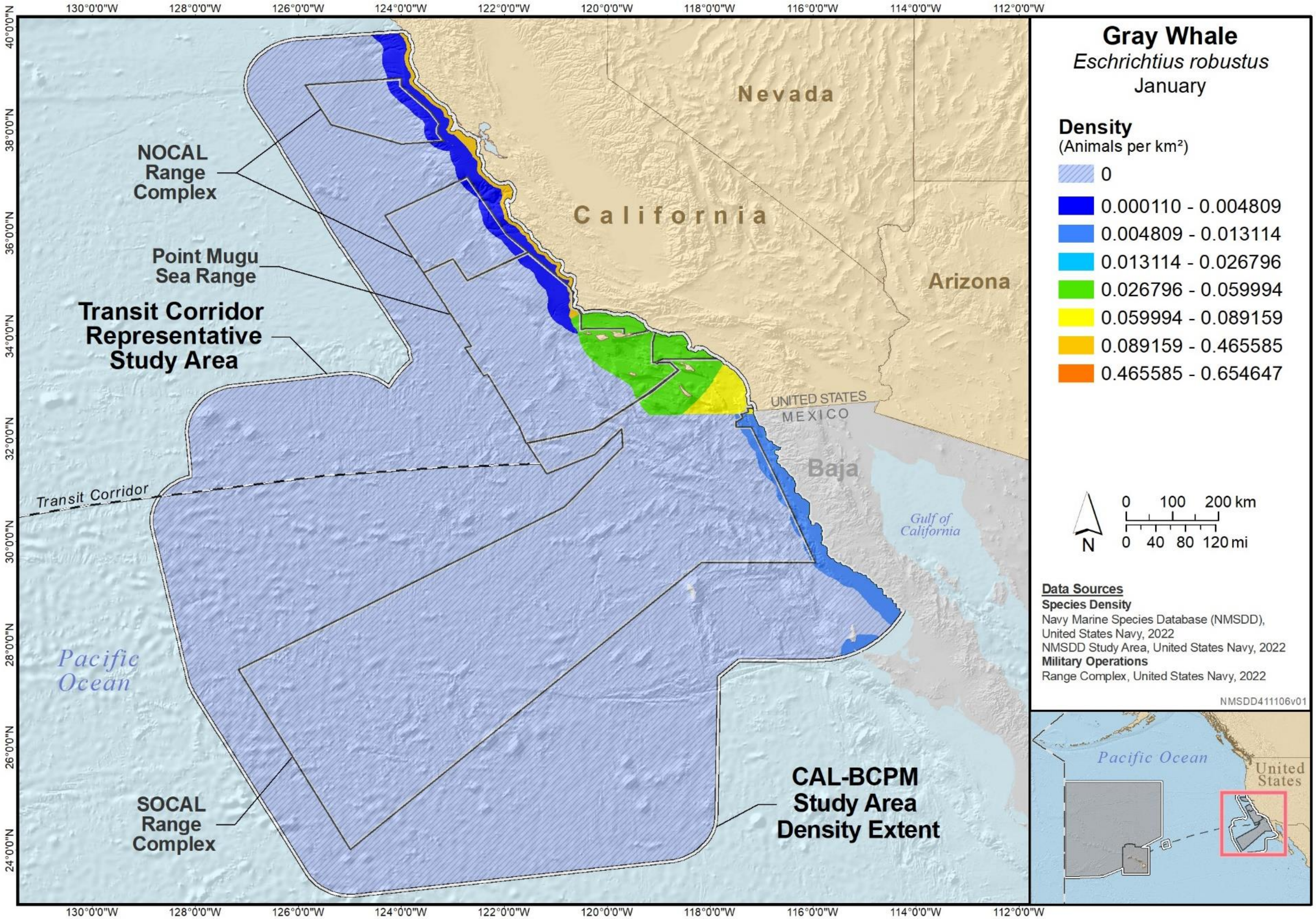

Figure 4-22: January Distribution of Gray Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

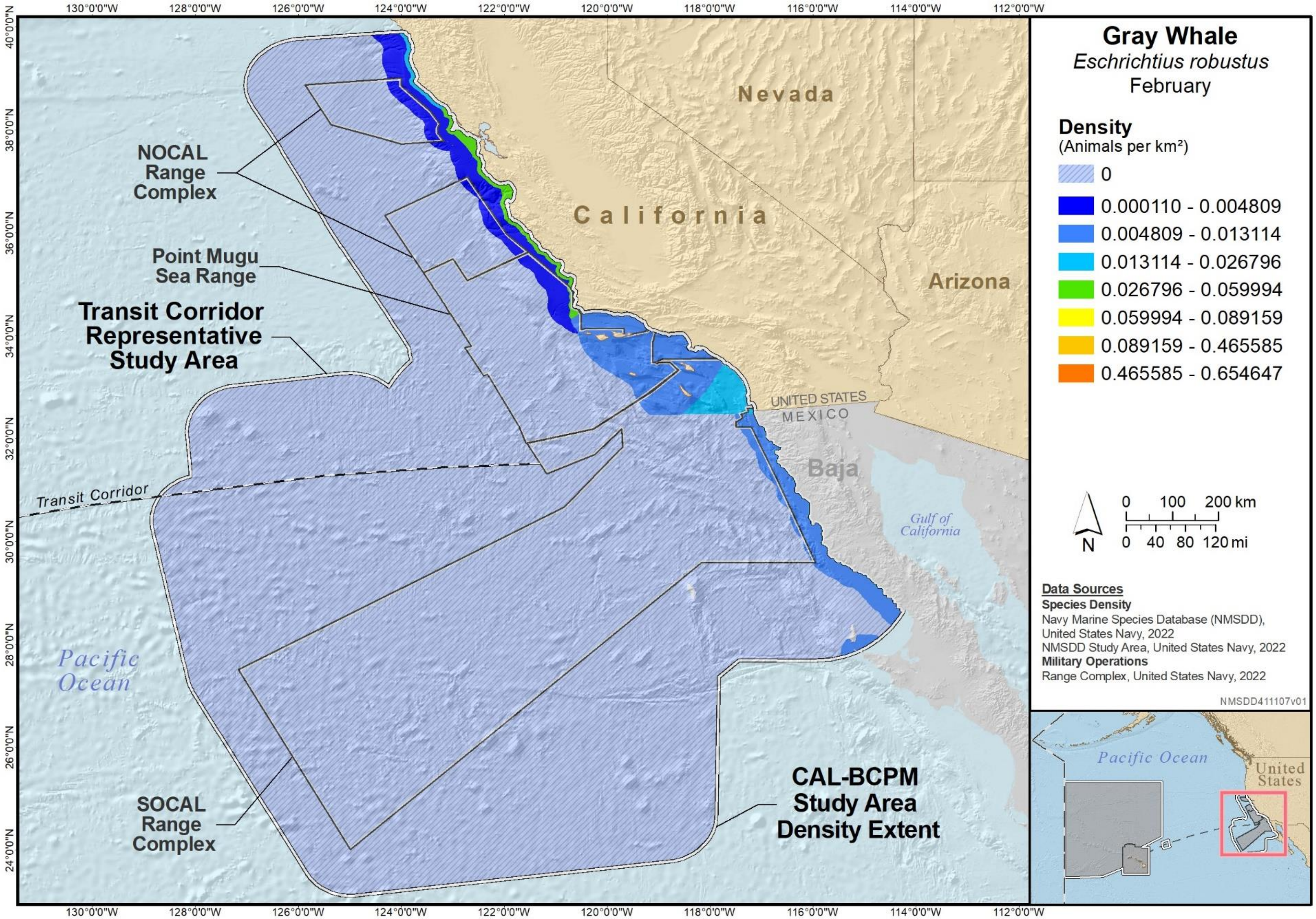

Figure 4-23: February Distribution of Gray Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

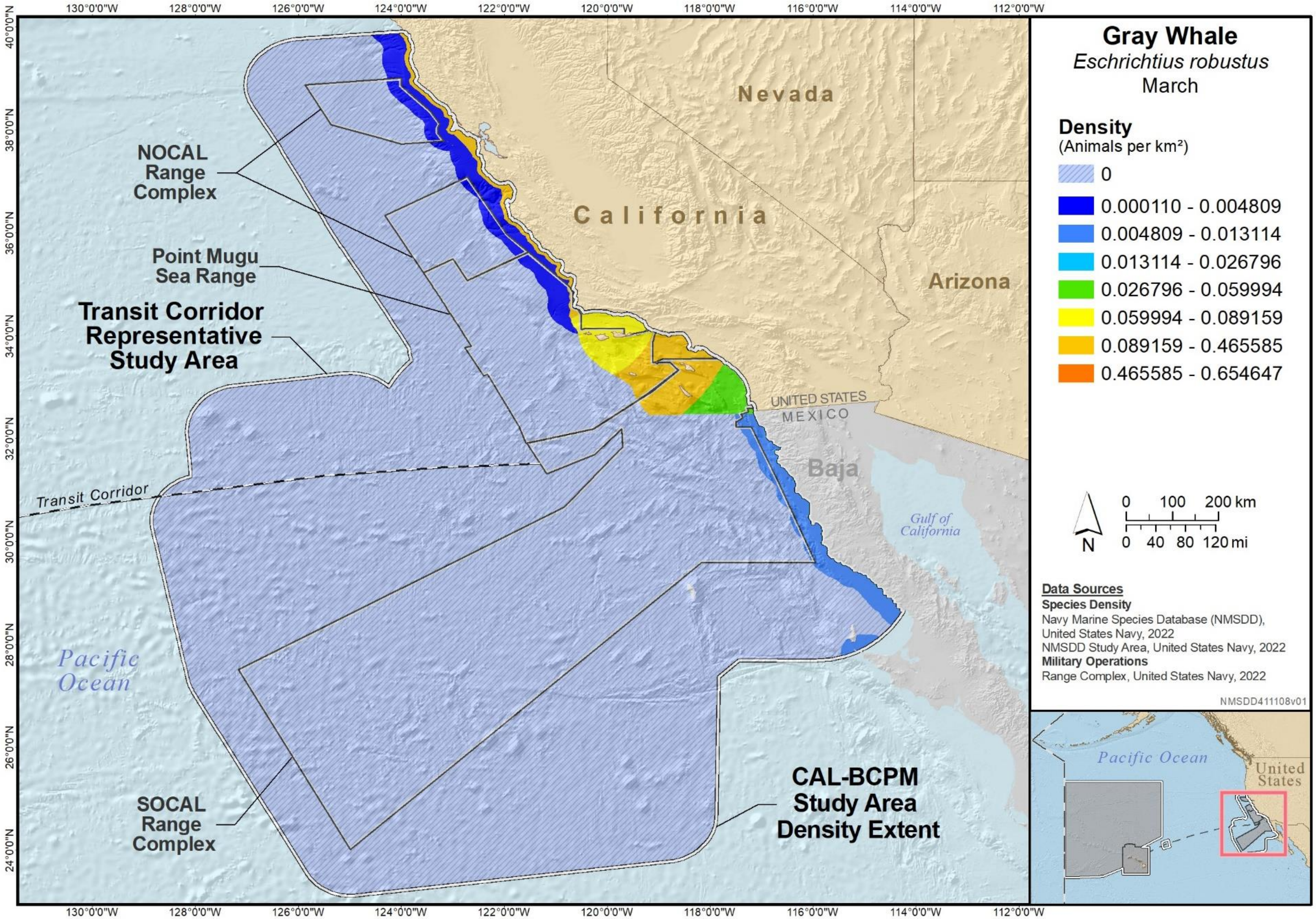

Figure 4-24: March Distribution of Gray Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

4.7 *MEGAPTERA NOVAEANGLIAE*, HUMPBACK WHALE

Humpback whales occur worldwide, with separate subspecies recognized for the North Pacific (*Megaptera novaeangliae kuzira*), the Atlantic (*M. n. novaeangliae*), and the Southern Hemisphere (*M. n. australis*). In all oceans, humpback whales are known to migrate seasonally from high latitude subarctic and temperate areas in the summer to low latitude subtropical and tropical areas in the winter (Barlow et al., 2011; Carretta et al., 2022). NMFS revised the ESA listing of humpback whales following a global Status Review and the identification of distinct population segments (DPSs). On September 8, 2016, NMFS's Final Rule was published (81 Federal Register 62259) to designate 14 DPSs worldwide, four of which occur in the North Pacific and were named based on their respective low latitude wintering areas: (1) Western North Pacific (listed as endangered under the ESA), (2) Hawaii (not listed), (3) Mexico (listed as threatened under the ESA), and (4) Central America (listed as endangered under the ESA). NMFS recently reevaluated the stock structure of humpback whales under the Marine Mammal Protection Act and designated five North Pacific stocks named based on their general wintering and summering area linkages: (1) Central America/Southern Mexico – California/Oregon/Washington, (2) Mainland Mexico – California/Oregon/Washington, (3) Mexico - North Pacific, (4) Hawaii, and (5) Western North Pacific (Carretta et al., 2023). Humpback whales occurring in the HRC belong to the Hawaii stock, while those occurring off CAL-BCPM belong mainly to the Central America/Southern Mexico – California/Oregon/Washington and Mainland Mexico – California/Oregon/Washington stocks (Curtis et al., 2022).

HRC. New survey data collected by NMFS within the Hawaiian Islands EEZ during the winter of 2020 supported the derivation of updated cetacean density estimates from model-based analyses (Becker et al., 2022b). The winter sighting data supported both the analysis of seasonal differences in the abundance and distribution of cetaceans, and enabled the development of a new habitat-based density model for humpback whale that provided monthly density predictions for this species (Becker et al., 2022b). The average monthly density surface maps are generally consistent with documented humpback whale arrival and departure dates in the Hawaiian Islands EEZ, with peak abundance observed in late February through early April (e.g., Craig & Herman, 1997; Johnston et al., 2007; Mobley et al., 2001). The model-based abundance estimates show peak numbers of humpback whales present in the Hawaiian Islands EEZ in March, with few whales present from June through October. The new humpback whale model provides the first fine-scale (9 km x 9 km grid) monthly estimates of density and abundance for this species within waters of the Hawaiian Islands EEZ and represents a substantial improvement to the density data used in Phase III, which consisted of uniform density estimates for two strata: (1) an inner Main Hawaiian Islands stratum, and (2) the remainder of the Hawaiian Islands EEZ.

CAL-BCPM. The Phase III NMSDD included data from a CCE habitat-based density model for humpback whales based on systematic survey data collected from 1991 to 2009 (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 models were updated to include additional systematic survey data collected in summer and fall of 2014 and 2018 (Becker et al., 2020a). Model improvements were recognized from additional sighting data collected off the continental shelf and slope, and the inclusion of a broader range of habitat conditions. In addition, recently developed techniques for deriving estimates of uncertainty (Miller et al., 2022) were used to provide more comprehensive variance estimates for the model-based predictions. There is a well-documented increasing trend in humpback whale numbers off the west coast of the United States (Barlow et al., 2011; Calambokidis & Barlow, 2020), and a year covariate included in the humpback whale model successfully captured this population trend (Becker et al., 2020a). Density estimates from the updated humpback whale model were applied to the portion of the Navy's CAL-BCPM 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.

To support management efforts for humpback whales along the California coast, Forney et al. (In Prep.) recently developed a fine-scale (3 km x 3 km) habitat-based density model for shelf and slope regions of the CCE based on survey and sighting data collected by SWFSC during 2005-2014. The model was parametrized using dynamic habitat variables and bathymetry data, and validation with independent data sets show that it successfully captured seasonal migration patterns during 2009-2020, including the unusual persistent year-round whale presence during the marine heat wave of 2014-2016. Model-based humpback whale density estimates for 2016-2020 were then averaged to provide representative winter (December-February) and spring (March-May) density surfaces. For regions west of the Forney et al. (In Prep.) model predictions, the CCE humpback whale model for summer/fall was used to derive separate winter and spring estimates for waters off the U.S. West Coast using techniques designed to avoid spatial and temporal extrapolation (Becker et al., In Prep.). These winter and spring model predictions were merged with predictions from the Forney et al. (In Prep.) finer-scale nearshore model predictions, thus providing the most robust predictions currently available for this species. The merged humpback whale model predictions were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for winter and spring.

To improve density estimates for Phase IV, the Navy funded an analysis to develop habitat-based density models for the Southern California Current, an ecologically meaningful study area that extends from Point Conception to the tip of the Baja California Peninsula. Resulting models provide the first spatially explicit estimates of humpback whale density for waters off the Baja California Peninsula (Becker et al., 2022a), and were applied to the HCTT study area south of the U.S./Mexico border. These density estimates represent a major improvement over density estimates previously used for Phase III (Ferguson & Barlow, 2003), because they are based on more recent survey data, they provide finer-scale density predictions (9 km x 9 km grid resolution vs. the 5° x 5° grid resolution available for Phase III density estimates), and improved, spatially-explicit estimates of uncertainty. Model-derived density estimates were applied to the BCPM region year-round since seasonally specific values are not currently available.

Table 4-7: Summary of Density Values for Humpback Whale in the Hawaii-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
CAL	S	S	S	S
BCPM	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.

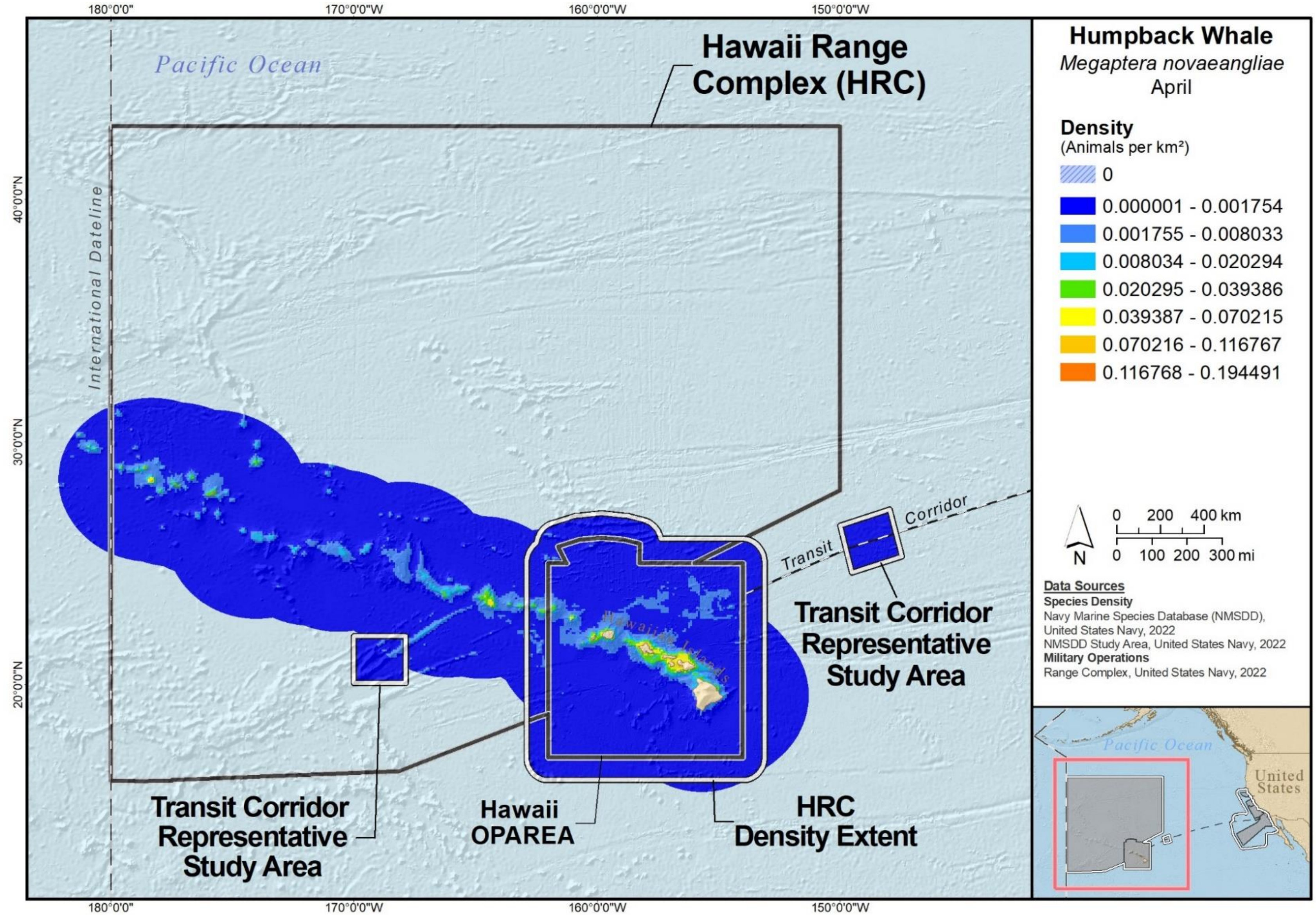

Figure 4-25: April Distribution of Humpback Whale in HRC and the Western Portion of the Transit Corridor

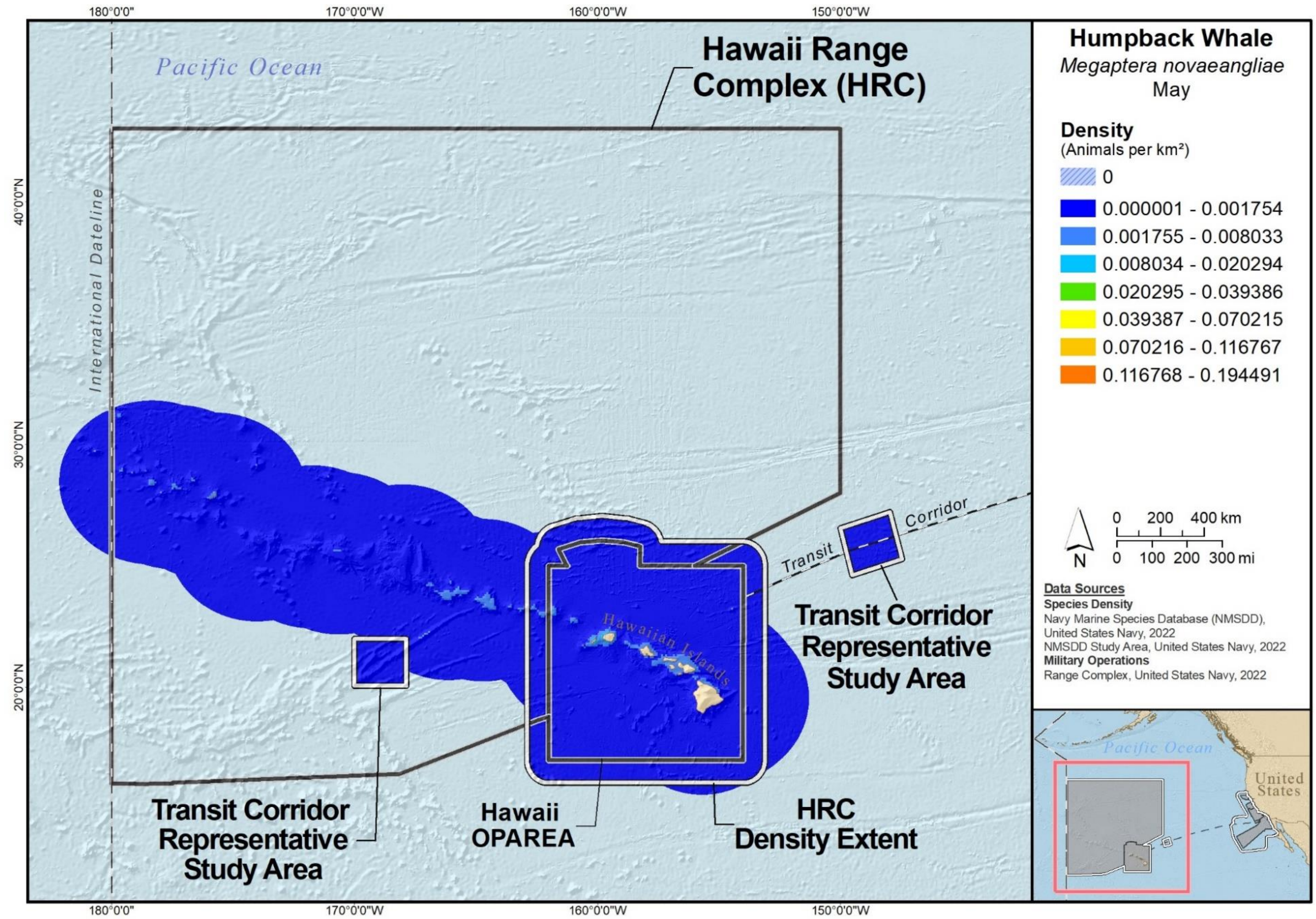

Figure 4-26: May Distribution of Humpback Whale in HRC and the Western Portion of the Transit Corridor

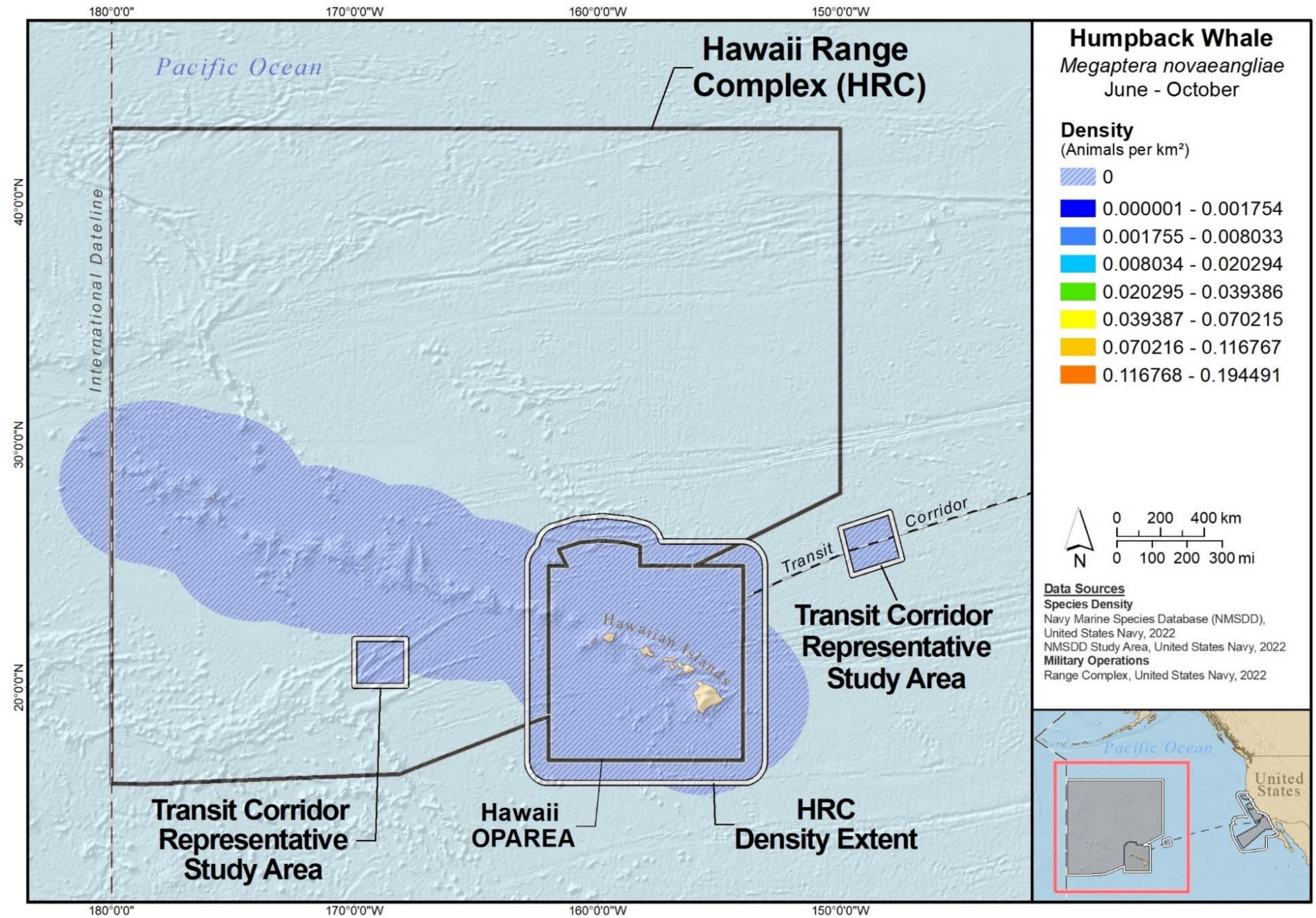

Figure 4-27: June-October Distribution of Humpback Whale in HRC and the Western Portion of the Transit Corridor

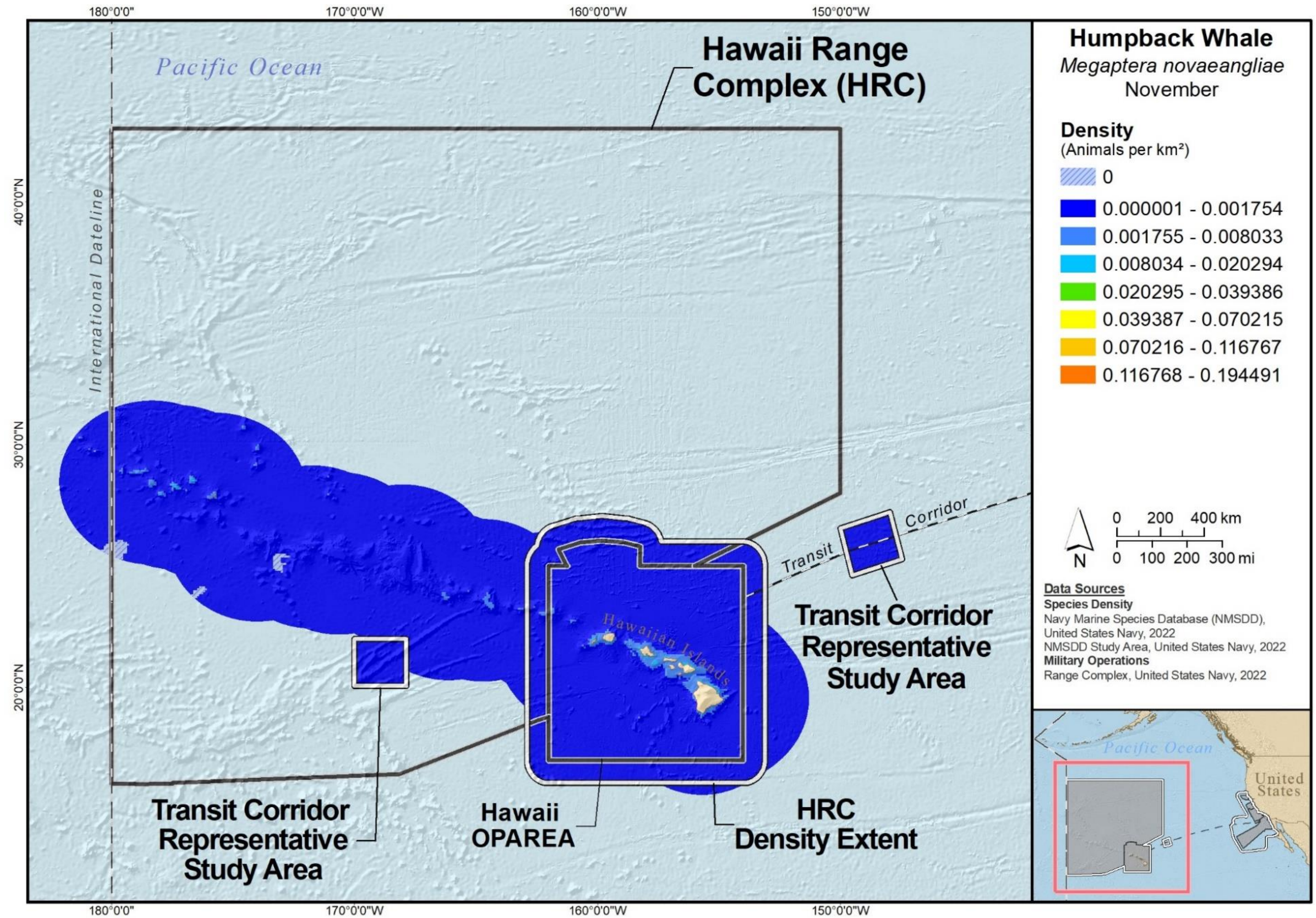

Figure 4-28: November Distribution of Humpback Whale in HRC and the Western Portion of the Transit Corridor

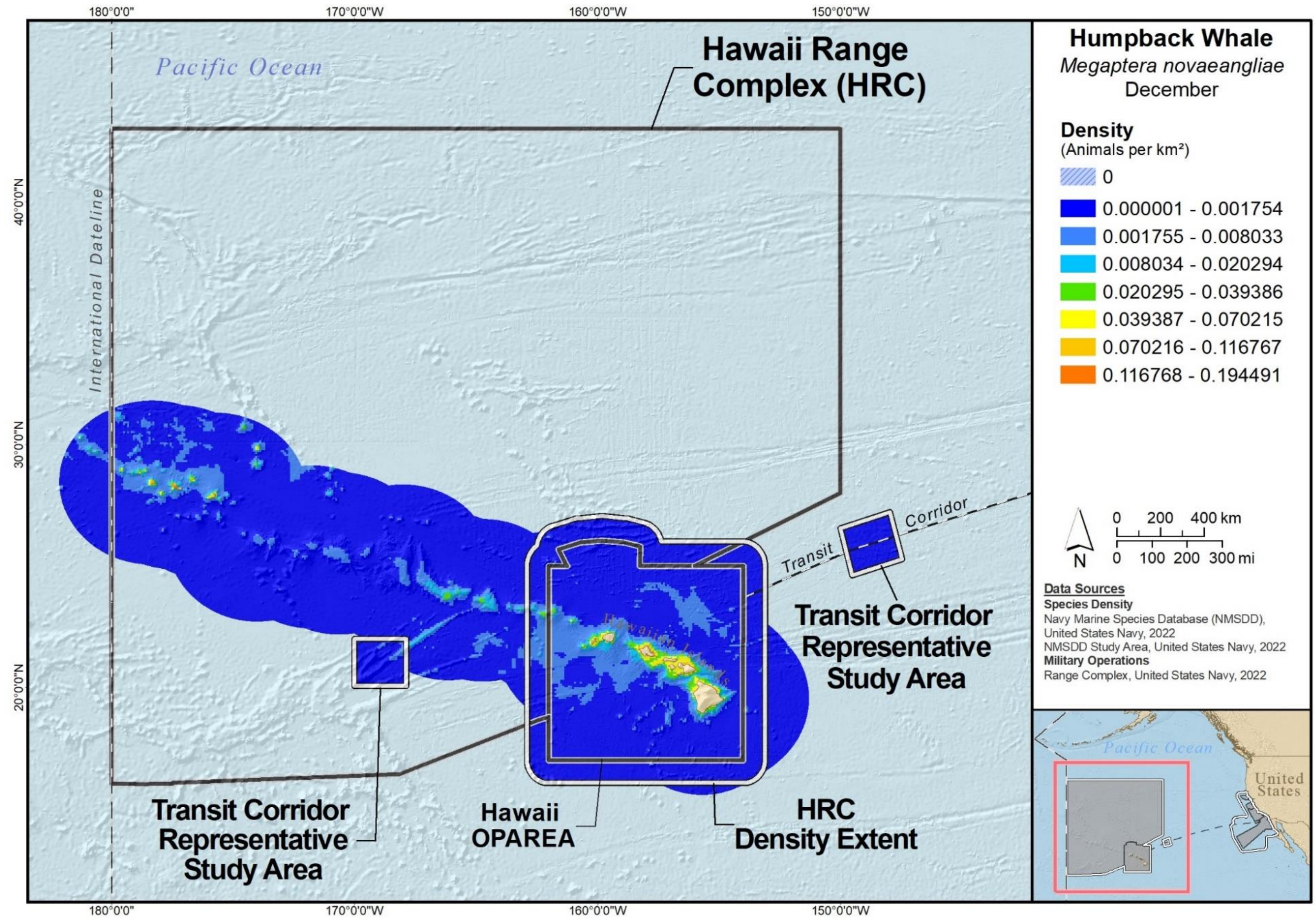

Figure 4-29: December Distribution of Humpback Whale in HRC and the Western Portion of the Transit Corridor

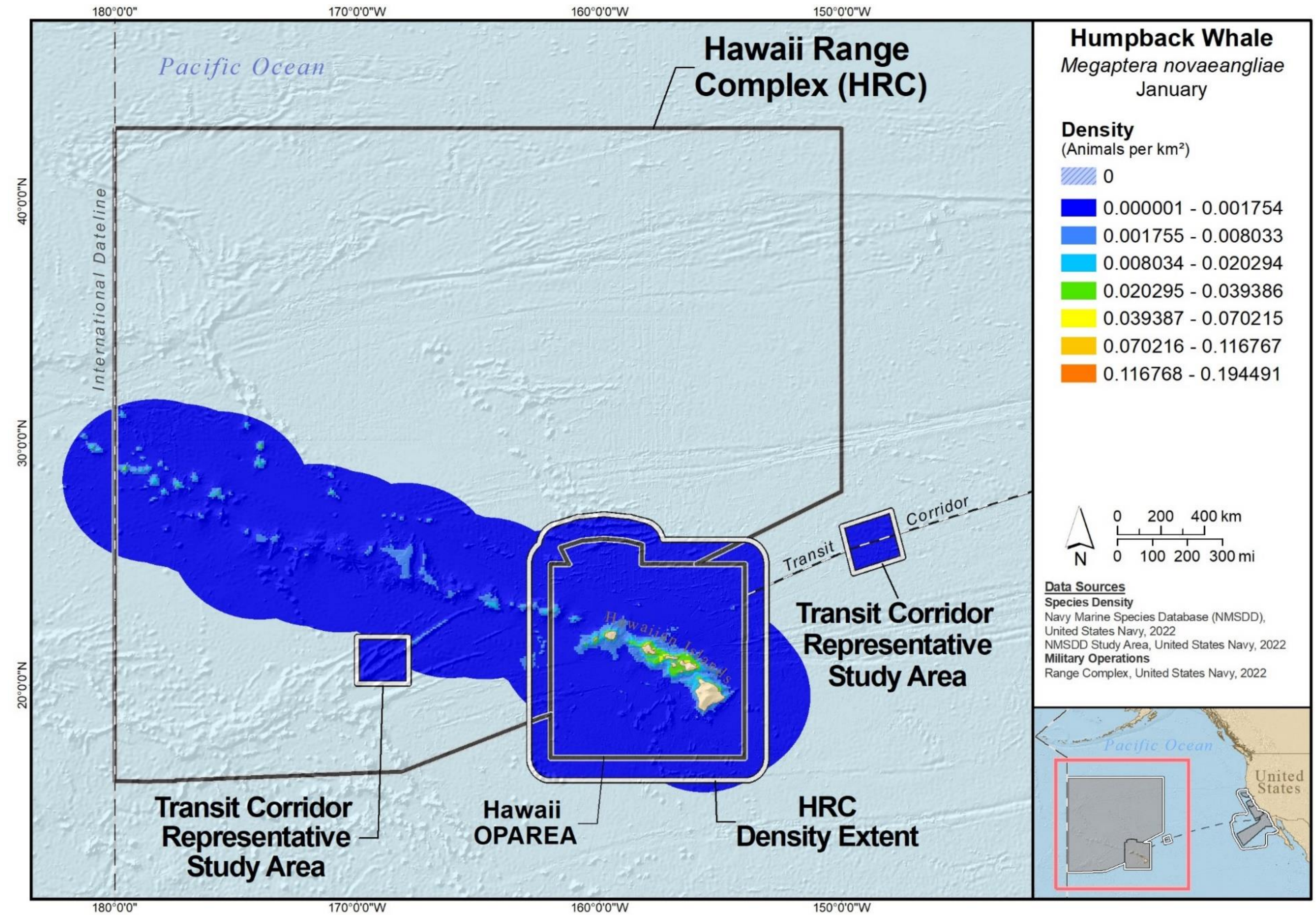

Figure 4-30: January Distribution of Humpback Whale in HRC and the Western Portion of the Transit Corridor

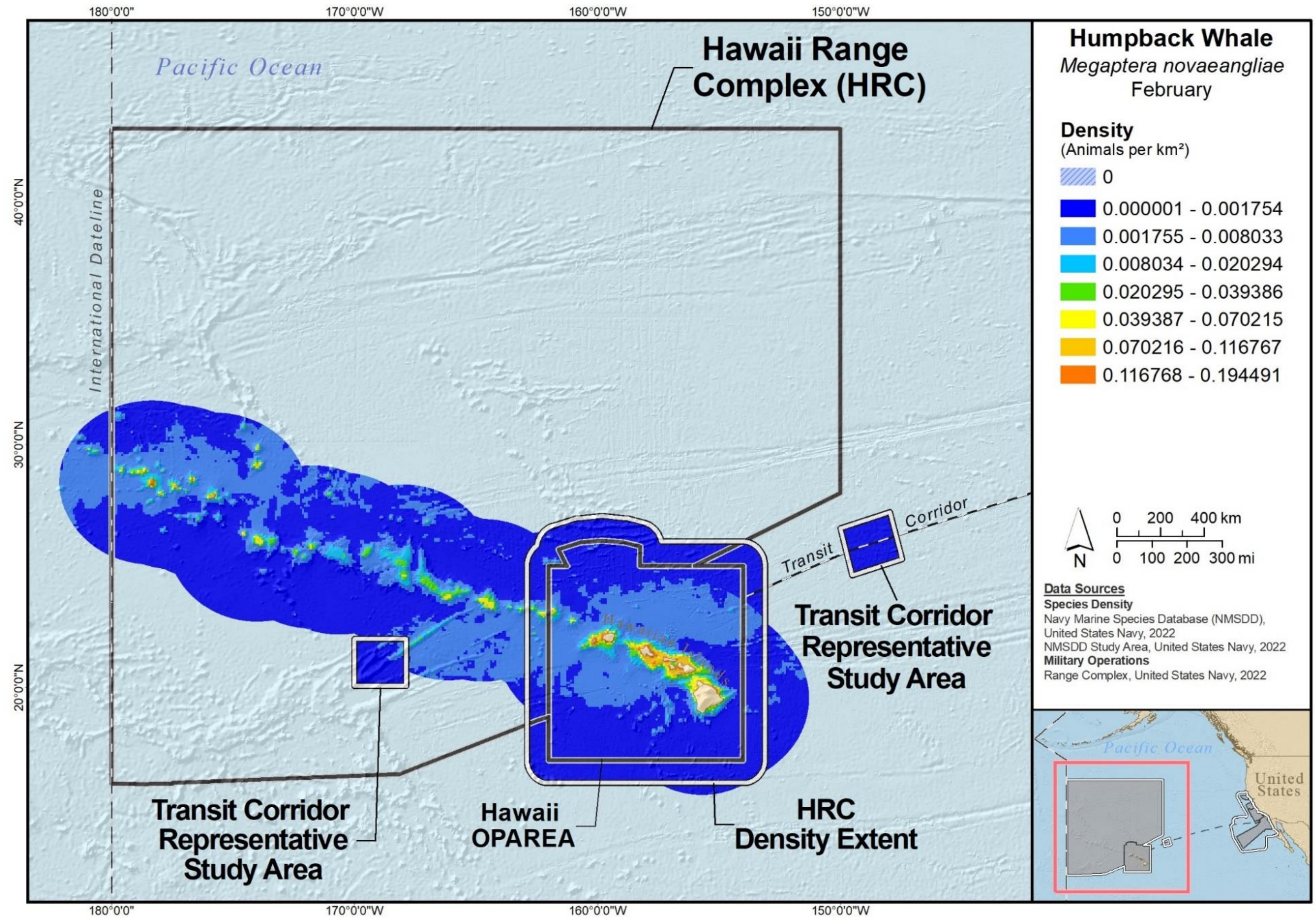

Figure 4-31: February Distribution of Humpback Whale in HRC and the Western Portion of the Transit Corridor

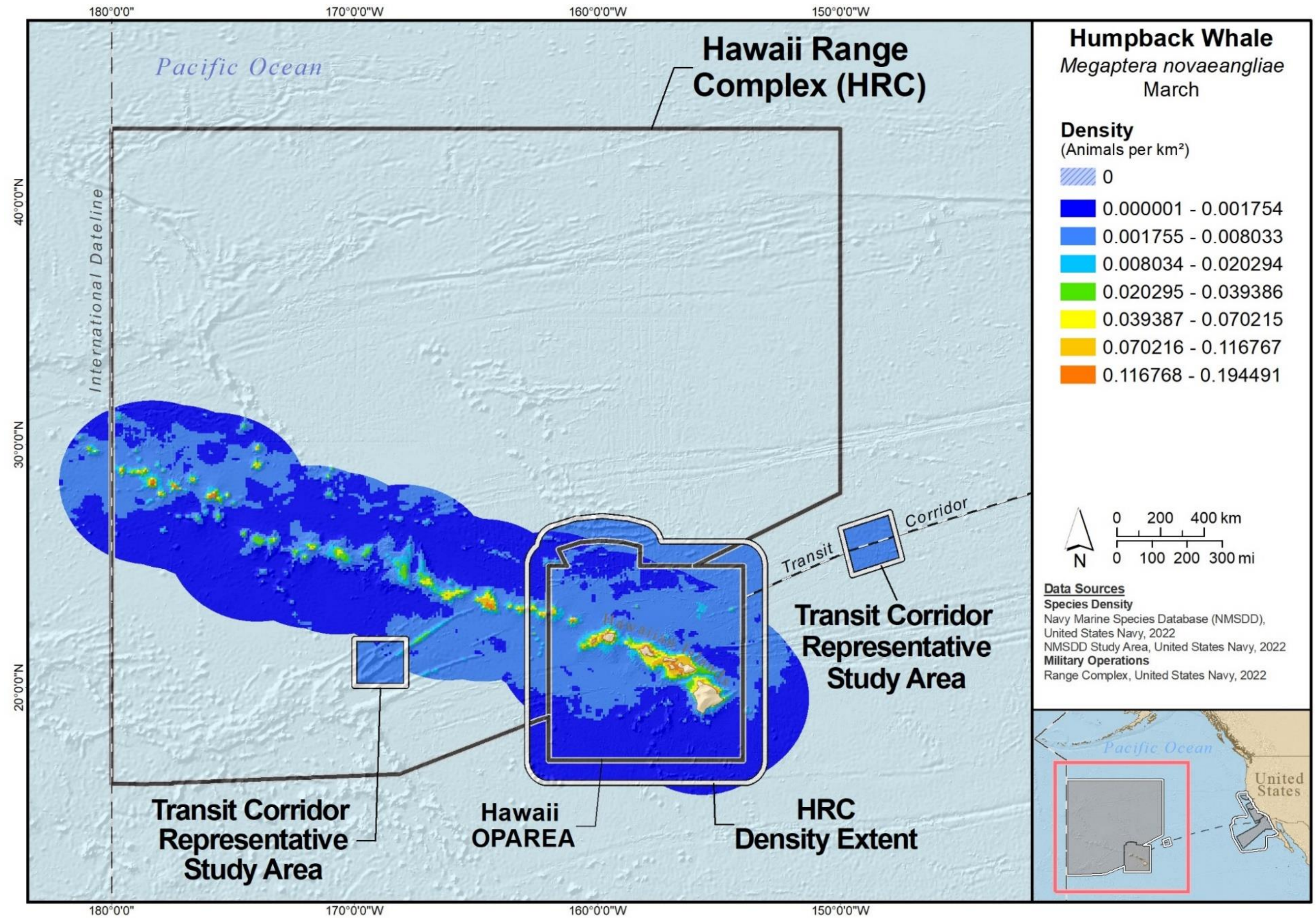

Figure 4-32: March Distribution of Humpback Whale in HRC and the Western Portion of the Transit Corridor

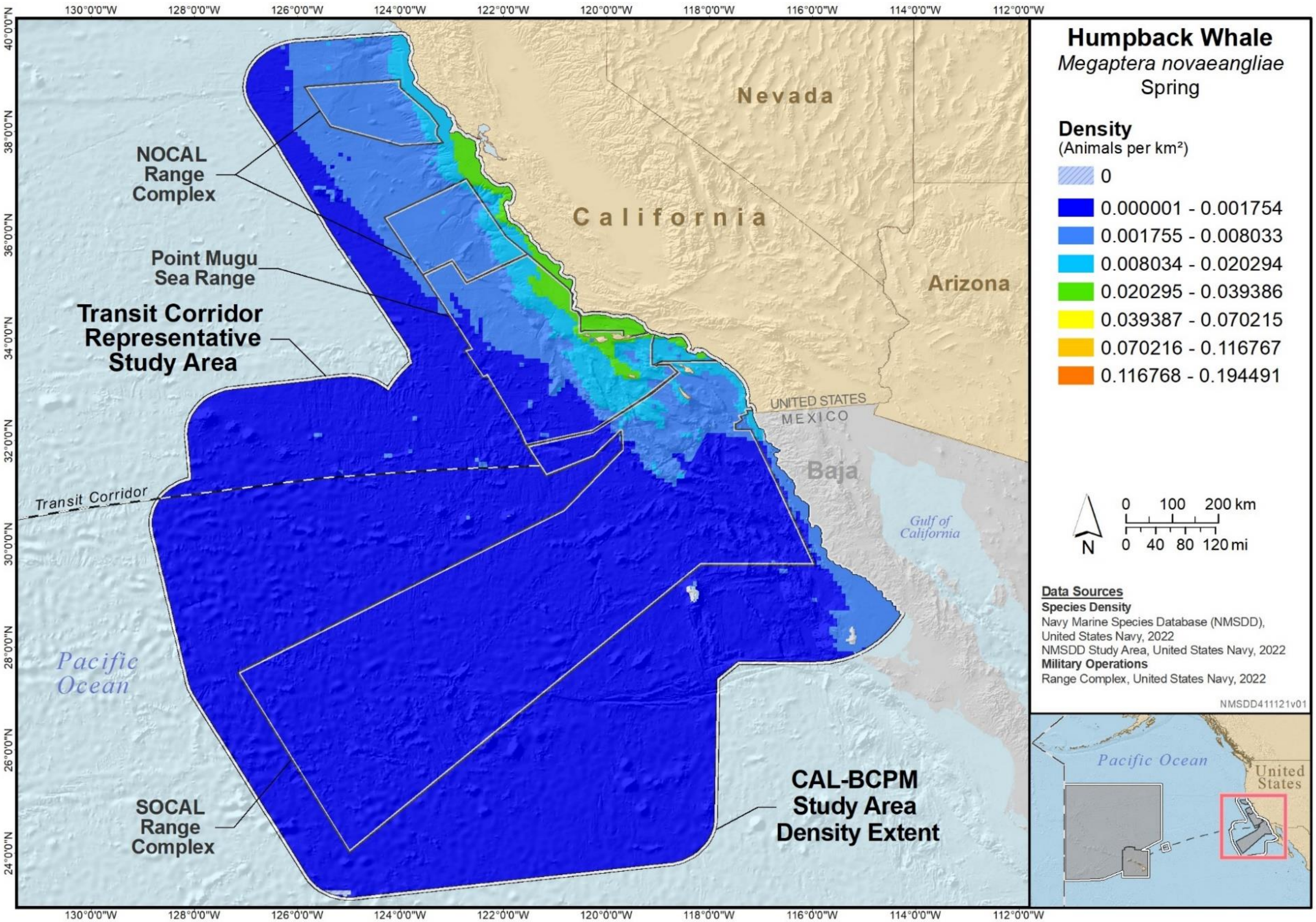

Figure 4-33: Spring Distribution of Humpback Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

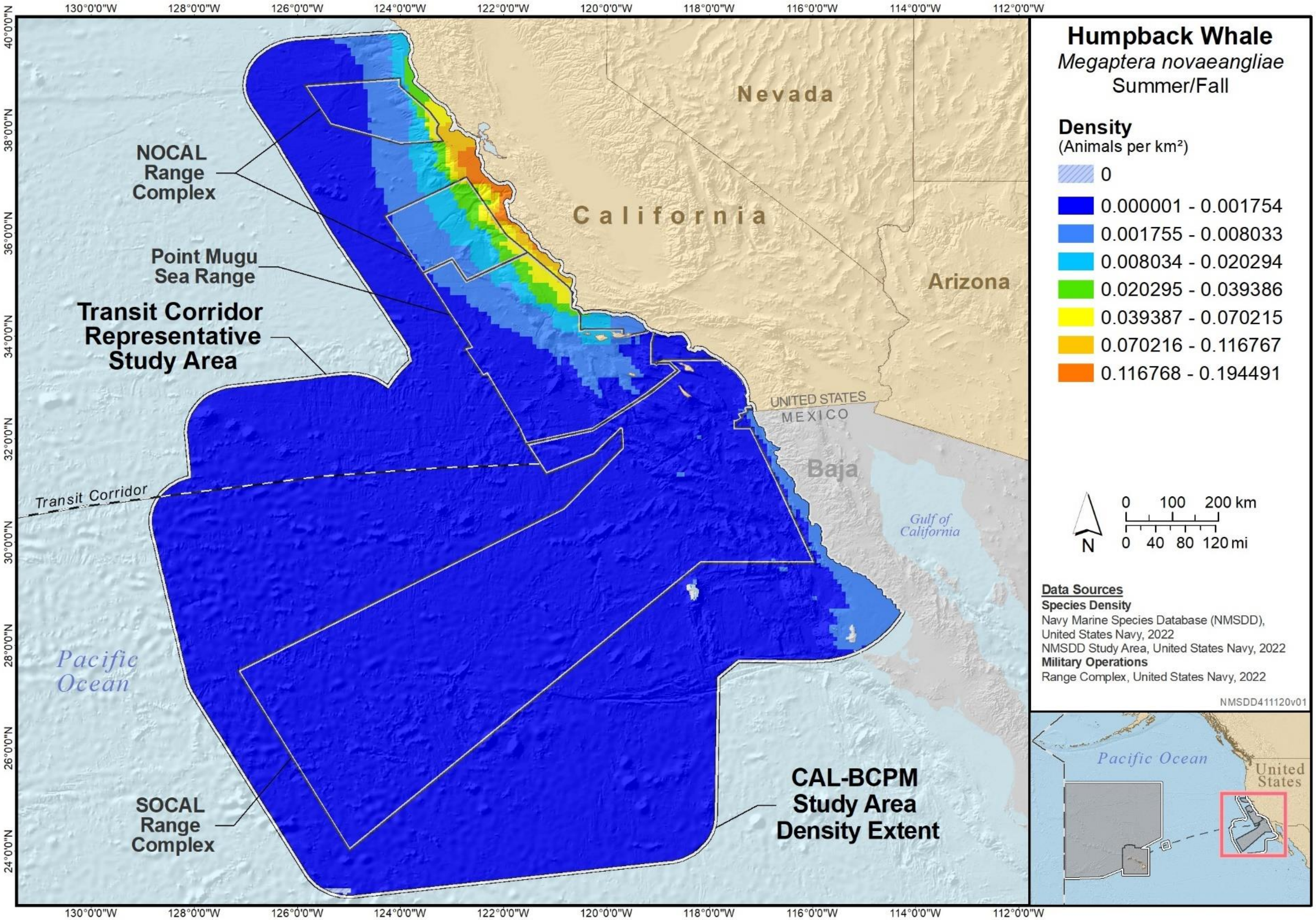

Figure 4-34: Summer/Fall Distribution of Humpback Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

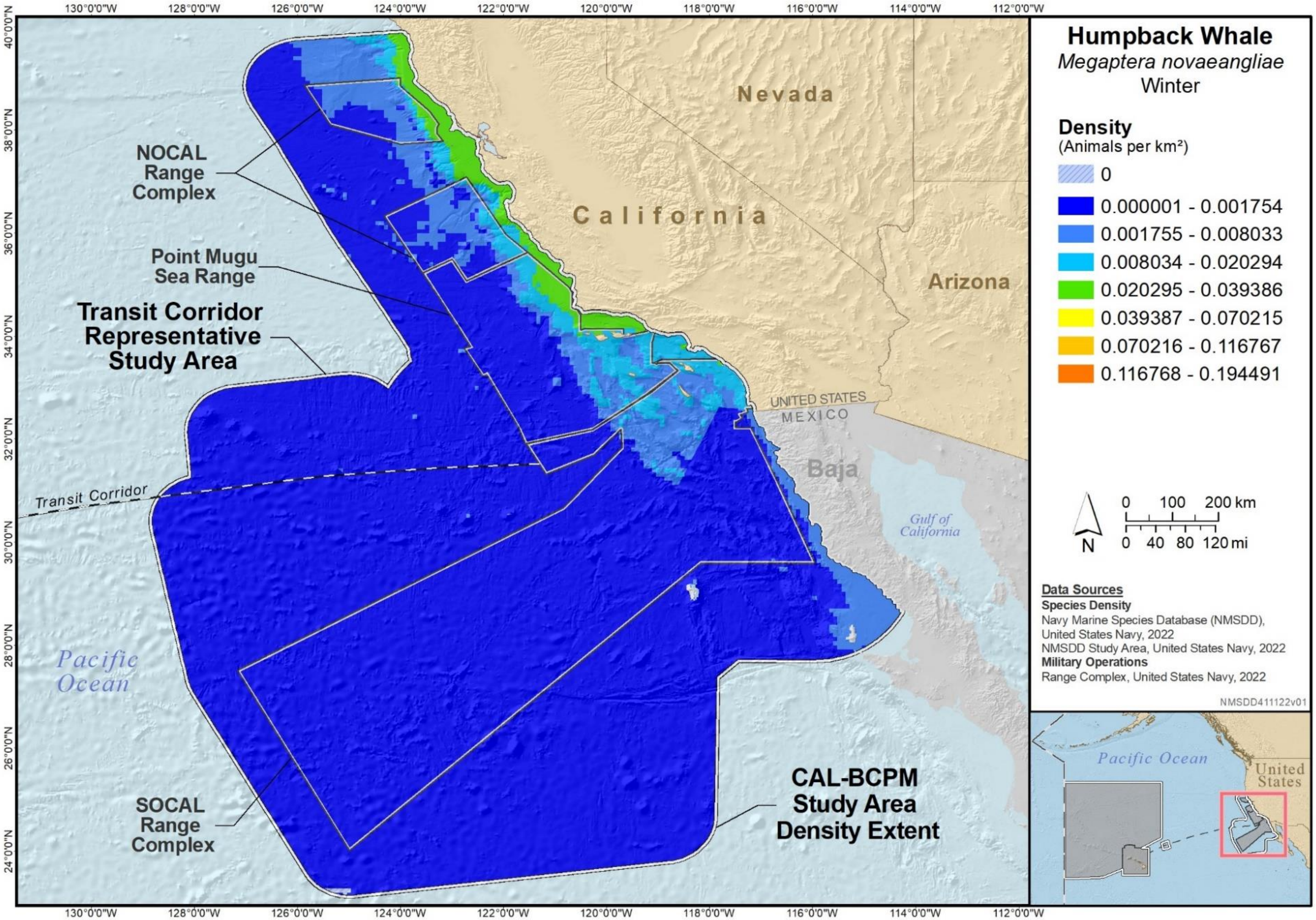

Figure 4-35: Winter Distribution of Humpback Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

5 SPERM WHALES

5.1 *KOGIA BREVICEPS*, PYGMY SPERM WHALE

In U.S. Pacific waters, NMSF currently defines two stocks of pygmy sperm whales: the California/Oregon/Washington stock, and the Hawaii stock (Carretta et al., 2022). The two stocks are considered discrete from each other. Density values for the HCTT Study Area are presented differently for HRC and CAL-BCPM. 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 U.S. West Coast, so NMFS is only able to provide density values for *Kogia* as a genus (Barlow, 2016; Barlow & Forney, 2007; Ferguson & Barlow, 2003). Pygmy sperm whales in HRC or CAL-BCPM are considered to belong to their respective separate stocks, but it is unclear where one stock transitions into the other along the transit corridor.

Since density values for CAL-BCPM are provided for *Kogia* as a genus, study area density figures are presented following the density summaries for dwarf sperm whale.

HRC. Bradford et al. (2021) report a uniform density value for pygmy sperm whales of 0.01719 animals/km^2 (CV = 0.64) that is applicable to the HRC study area and western portion of the transit corridor. This represents an improvement to the density estimate used previously in the Navy's Phase III analyses as it is based on multiple-covariate line-transect analyses of sighting data collected on three surveys of waters within the Hawaiian Islands EEZ in 2002, 2010, and 2017. The Bradford et al. (2021) estimate for the most recent year (2017) is a year-round estimate, since available data are insufficient to identify any seasonal patterns in the distribution of pygmy sperm whales.

CAL-BCPM. The majority of field sightings of *Kogia* in the CCE are likely to have been pygmy sperm whales (Carretta et al., 2022). As noted above, *Kogia* species are treated as a genus in the CCE by scientists who have published species density estimates for this study area. 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, 0.00654 animals/km^2 (CV = 0.61) for waters off Central California, and 0.00094 animals/km^2 (CV = 1.43) for waters off Northern California. Available data are insufficient to identify any seasonal patterns in the distribution of pygmy sperm whales, so these estimates are considered to represent year-round density. For the Phase III analysis, the same estimate for Southern California was used; however, given the expanded HCTT Study Area, the estimates for the additional strata off California were entered into the NMSDD for the Phase IV analyses.

Ferguson and Barlow (2003) provide density values for areas off BCPM. For the Navy's Phase IV analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the HCTT acoustic modeling footprint and resulted in a *Kogia* density estimate of 0.00405 animals/km^2 (CV = 0.71). In the BCPM waters, the same value is used for all seasons since seasonally specific values are not currently available.

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

Location	Spring	Summer	Fall	Winter
HRC	0.01719	0.01719	0.01719	0.01719
W. Transit Corridor	0.01719	0.01719	0.01719	0.01719
E. Transit Corridor	0.00159	0.00159	0.00159	0.00159
CAL: North	0.00094	0.00094	0.00094	0.00094
CAL: Central	0.00654	0.00654	0.00654	0.00654
CAL: South	0.00159	0.00159	0.00159	0.00159
BCPM	0.00405	0.00405	0.00405	0.00405

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.

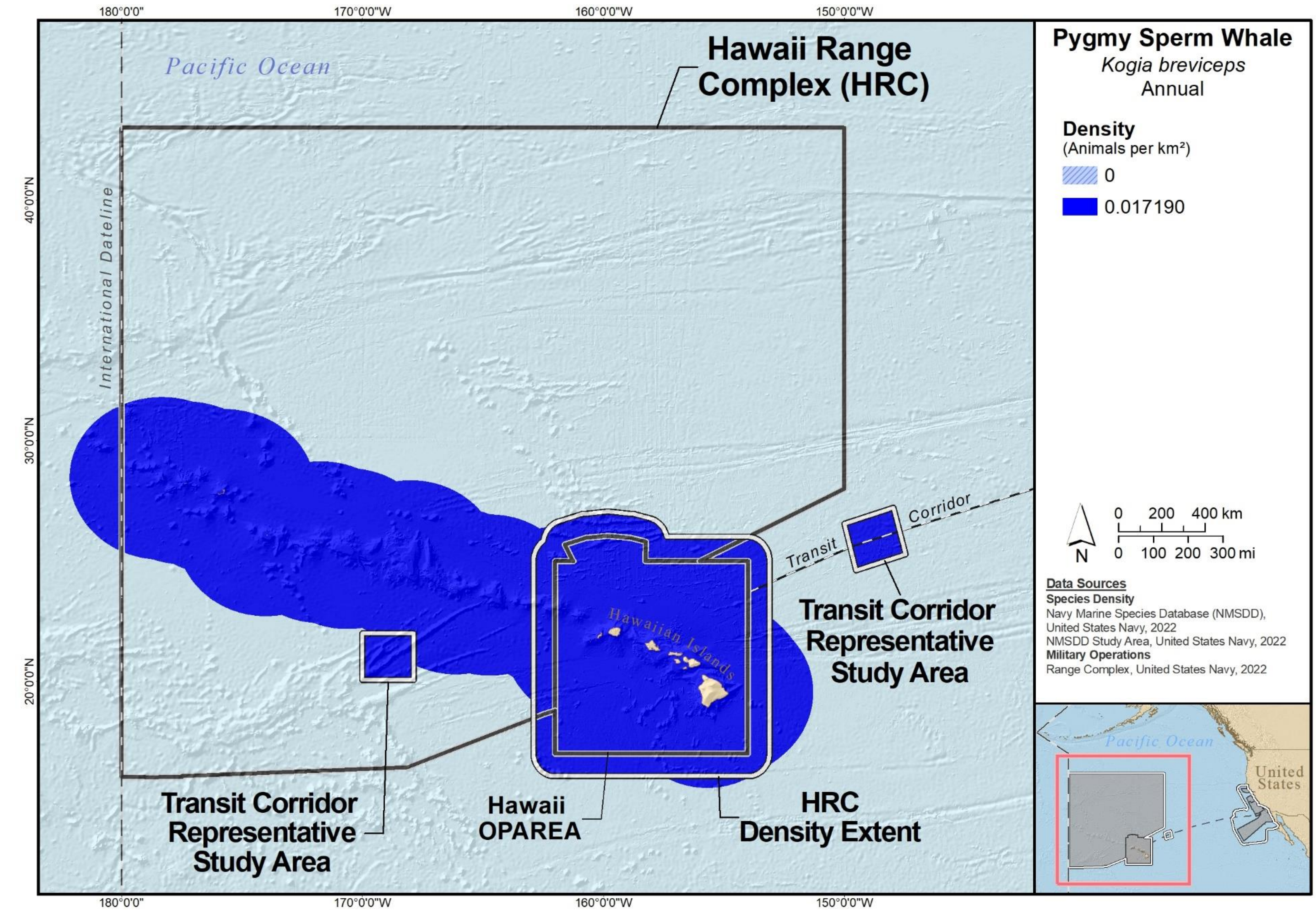

Figure 5-1: Annual Distribution of Pygmy Sperm Whale in HRC and the Western Portion of the Transit Corridor

5.2 *KOGIA SIMA*, DWARF SPERM WHALE

In U.S. Pacific waters, NMFS currently defines two stocks of dwarf sperm whales: the California/Oregon/Washington stock, and the Hawaii stock (Carretta et al., 2022). The two stocks are considered discrete from each other. Density values for the HCTT Study Area are presented differently for HRC and CAL-BCPM. 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 U.S. West Coast, so NMFS is only able to provide density values for *Kogia* as a genus (Barlow, 2016; Barlow & Forney, 2007; Ferguson & Barlow, 2003). Dwarf sperm whales in HRC or CAL-BCPM are considered to belong to their respective separate stocks, but it is unclear where one stock transitions into the other along the transit corridor.

Since density values for CAL-BCPM are provided for *Kogia* as a genus, study area density figures are presented following the density summaries for dwarf sperm whale.

HRC. Bradford et al. (2021) report a uniform density value for dwarf sperm whales of 0.0153 animals/km^2 (CV = 0.78) that is applicable to the HRC study area and western portion of the transit corridor. This represents an improvement to the density estimate used previously in the Navy's Phase III analyses as it is based on multiple-covariate line-transect analyses of sighting data collected on three surveys of waters within the Hawaiian Islands EEZ in 2002, 2010, and 2017. The Bradford et al. (2021) estimate is for the same year (2002) used previously in Phase III, but the more recent design-based estimate has been updated using a current detection function and new estimates of trackline detection probabilities that consider the effect of survey sighting conditions (Bradford et al., 2021). Since available data are insufficient to identify any seasonal patterns in the distribution of dwarf sperm whales, it is a year-round estimate.

CAL-BCPM. As noted above for pygmy sperm whale, dwarf sperm whales are not often seen off the west coast of the United States, and *Kogia* species are treated as a genus in the CCE by scientists who have published species density estimates for this study area (Barlow, 2016). 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, 0.00654 animals/km^2 (CV = 0.61 for waters off Central California, and 0.00094 animals/km^2 (CV = 1.43) for waters off Northern California. Available data are insufficient to identify any seasonal patterns in the distribution of dwarf sperm whales, so these estimates are considered to represent year-round density. For the Phase III analysis, the same estimate for Southern California was used; however, given the expanded HCTT Study Area, the estimates for the additional strata off California were entered into the NMSDD for the Phase IV analyses.

Ferguson and Barlow (2003) provide density values for areas off BCPM. For the Navy's Phase IV analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the HCTT acoustic modeling footprint and resulted in a *Kogia* density estimate of 0.00405 animals/km^2 (CV = 0.71). In the BCPM waters, the same value is used for all seasons since seasonally specific values are not currently available.

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

Location	Spring	Summer	Fall	Winter
HRC	0.0153	0.0153	0.0153	0.0153
W. Transit Corridor	0.0153	0.0153	0.0153	0.0153
E. Transit Corridor	0.00159	0.00159	0.00159	0.00159
CAL: North	0.00094	0.00094	0.00094	0.00094
CAL: Central	0.00654	0.00654	0.00654	0.00654
CAL: South	0.00159	0.00159	0.00159	0.00159
BCPM	0.00405	0.00405	0.00405	0.00405

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.

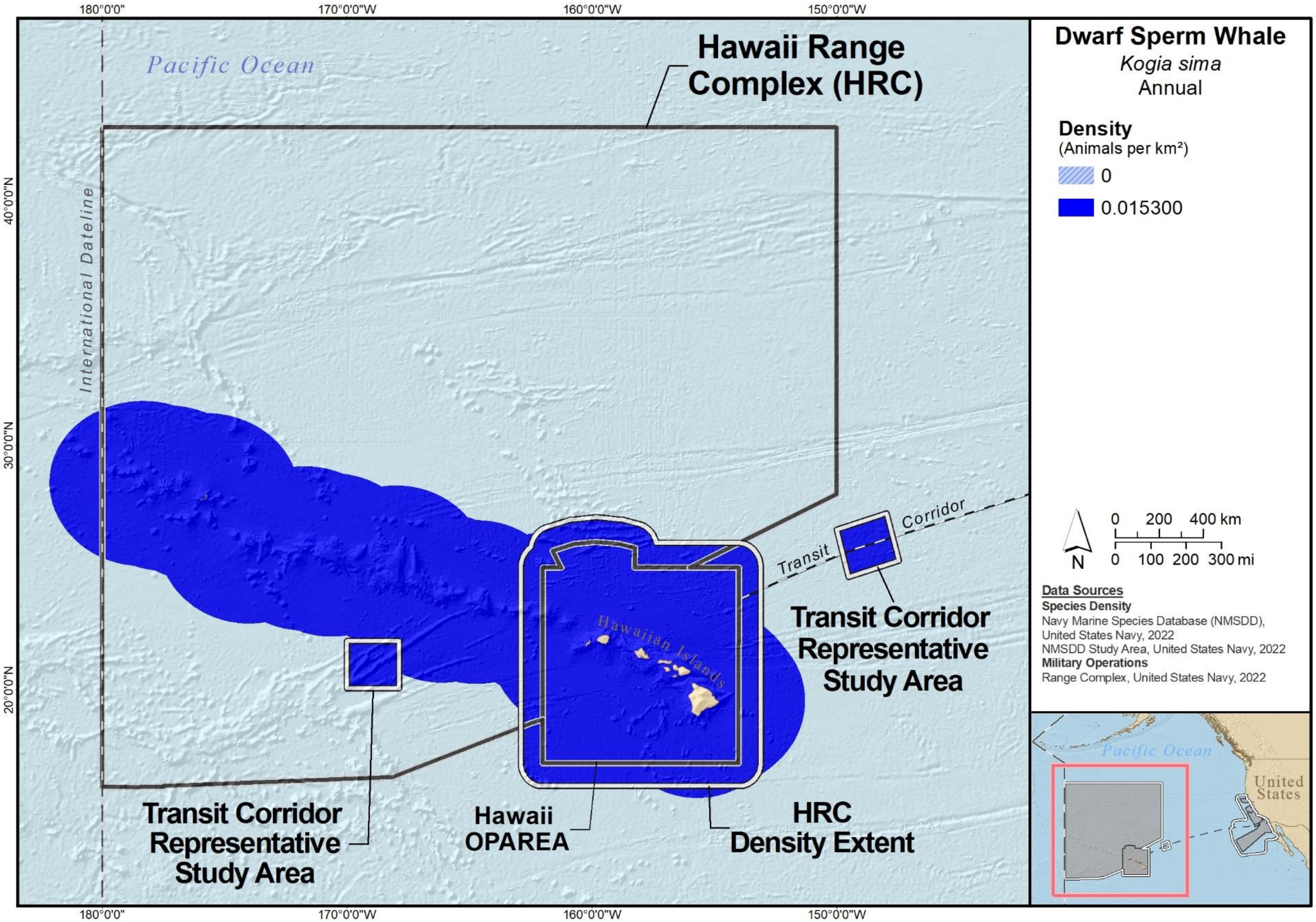

Figure 5-2: Annual Distribution of Dwarf Sperm Whale in HRC and the Western Portion of the Transit Corridor

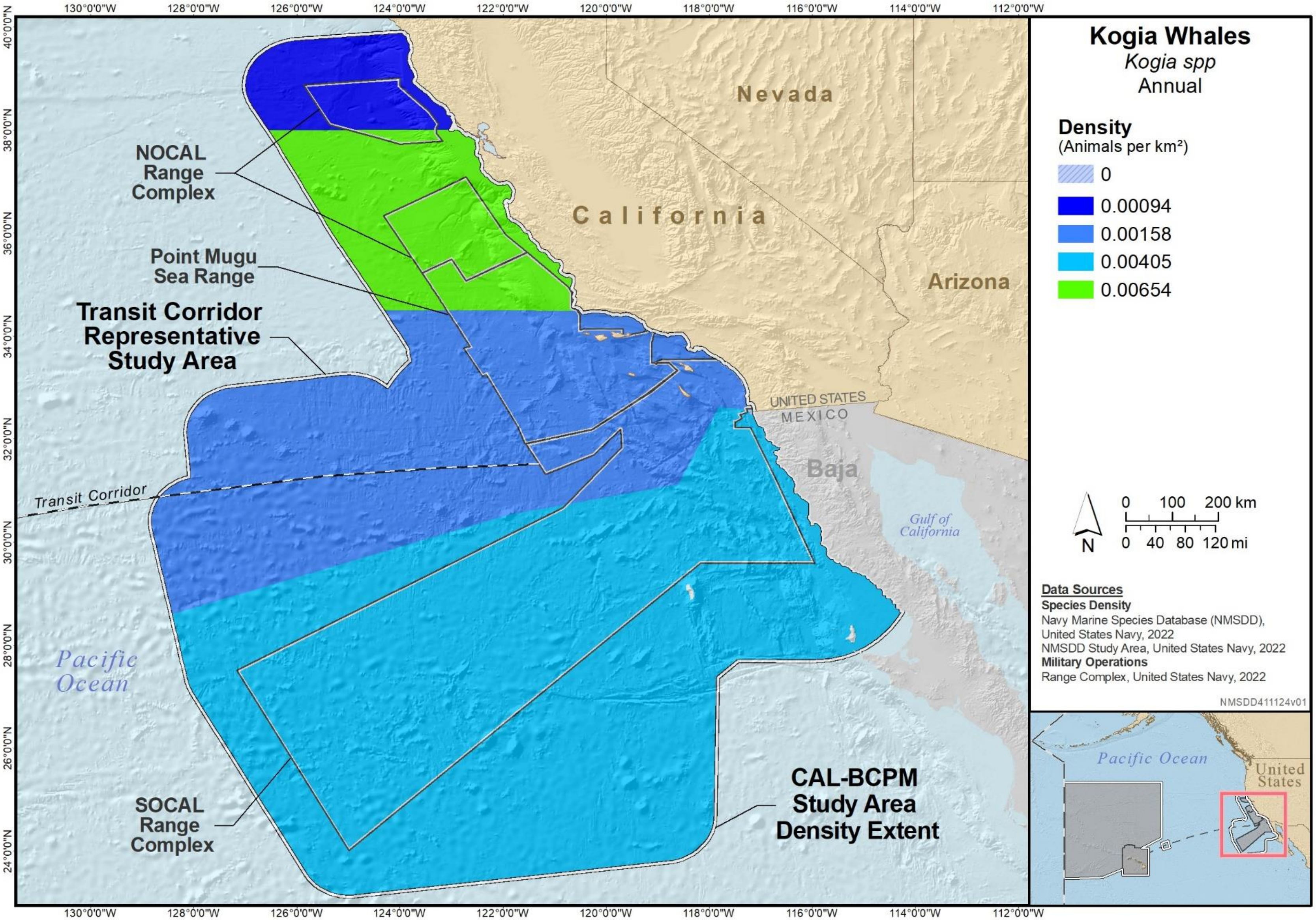

Figure 5-3: Annual Distribution of *Kogia* spp. in CAL-BCPM and the Eastern Portion of the Transit Corridor

5.3 *Physeter macrocephalus,* Sperm Whale

NMFS recognizes three stocks of sperm whales in the North Pacific: the California/Oregon/Washington stock, the Hawaii stock, and the Alaska stock (Carretta et al., 2022). Sperm whales in HRC or CAL-BCPM are considered to belong to their respective separate stocks, but it is not clear where in the transit corridor one stock may overlap with the other.

HRC. New survey data collected by NMFS within the Exclusive Economic Zone of the Hawaiian Islands supported the derivation of updated sperm whale density estimates from model-based analyses (Becker et al., 2021). The new habitat-based density model for sperm whale represents an improvement to the model available for Phase III (Forney et al., 2015) because it more accurately accounted for variation in detection probabilities and provided finer-scale density predictions (~9 km x 9 km resolution vs. the previous ~25 km x 25 km resolution) that better accounted for uncertainty. The updated sperm whale spatial model was applied to all seasons for the acoustic modeling areas associated with HRC and the western portion of the transit corridor.

CAL-BCPM. The Phase III NMSDD included data from a CCE habitat-based density model for sperm whales based on systematic survey data collected from 1991 to 2009 (Becker et al., 2012b). The model provided spatially explicit density estimates off the U.S. West Coast for summer and fall. More recently, using methods described in Becker et al. (2020b), the CCE habitat-based density model for sperm whale was updated to include additional systematic survey data collected in summer and fall of 2014. Unlike other SDMs developed for this species in the CCE study area, the final model included an interaction term between latitude and mixed layer depth, and provided improved predictions of sperm whale distribution patterns at a pixel resolution of 10 km x 10 km. Density estimates from this sperm whale model were applied to the portion of the Navy's CAL-BCPM 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. Based on acoustic data, there is not a strong seasonal signal in sperm whale occurrence in the California Current (Posdaljian et al., In. Prep.), so the modeled estimates are used to represent year-round occurrence.

In order to improve density estimates for Phase IV, the Navy funded an analysis to develop habitat-based density models for the Southern California Current, an ecologically meaningful study area that extends from Point Conception to the tip of the Baja California Peninsula. Resulting models provide the first spatially explicit estimates of sperm whale density for waters off the Baja California Peninsula (Becker et al., 2022a), and were applied to the HCTT study area south of the U.S./Mexico border. These density estimates represent a major improvement over density estimates previously used for Phase III (Ferguson & Barlow, 2003), because they are based on more recent survey data, they provide finer-scale density predictions (9 km x 9 km grid resolution vs. the 5° x 5° grid resolution available for density estimates used in Phase III), and improved, spatially explicit estimates of uncertainty. Model-derived density estimates were applied to the BCPM region year-round since seasonally specific values are not currently available.

Table 5-3: Summary of Density Values for Sperm Whale in the Hawaii-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
CAL	S	S	S	S
BCPM	S	S	S	S

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

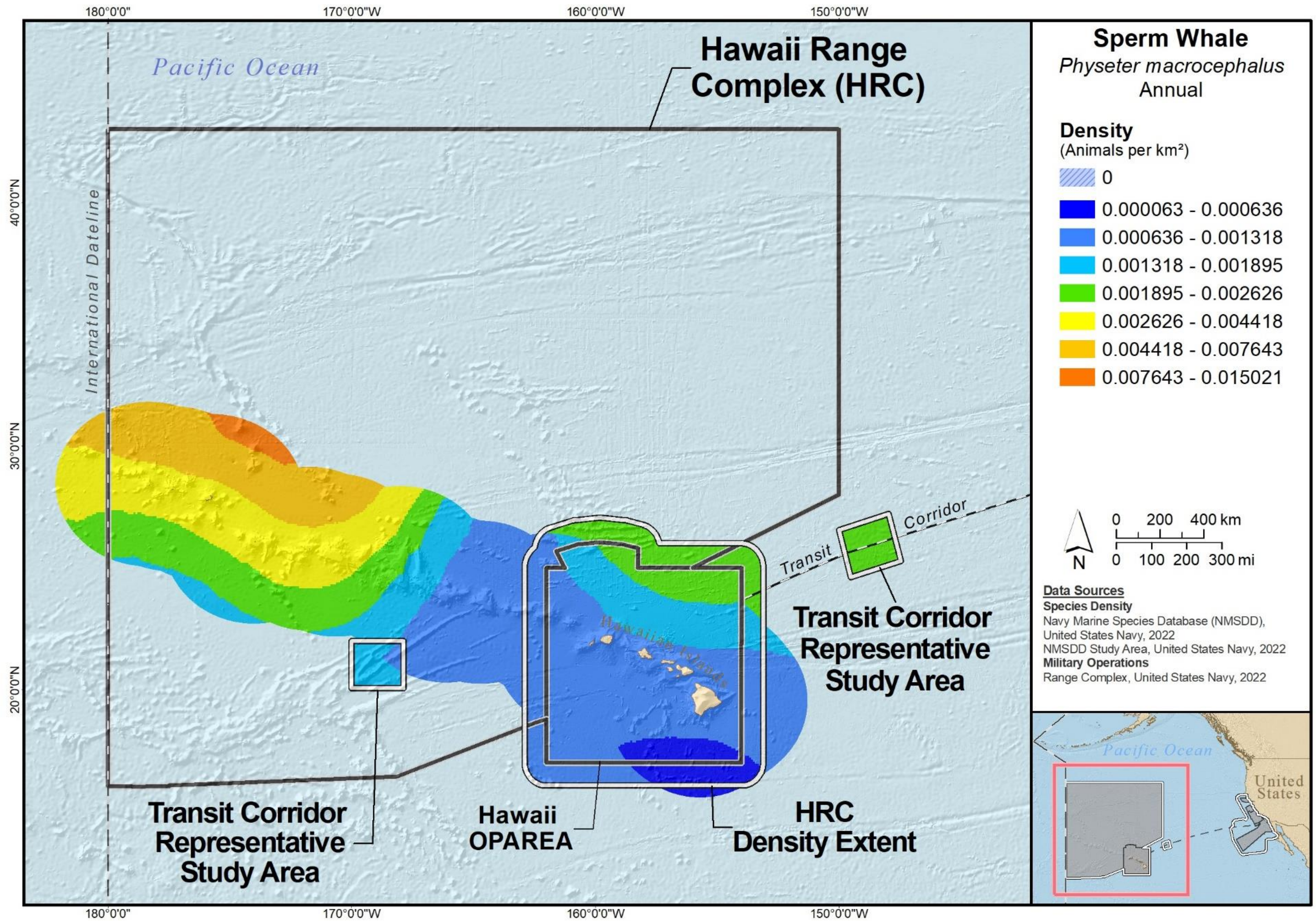

Figure 5-4: Annual Distribution of Sperm Whale in HRC and the Western Portion of the Transit Corridor

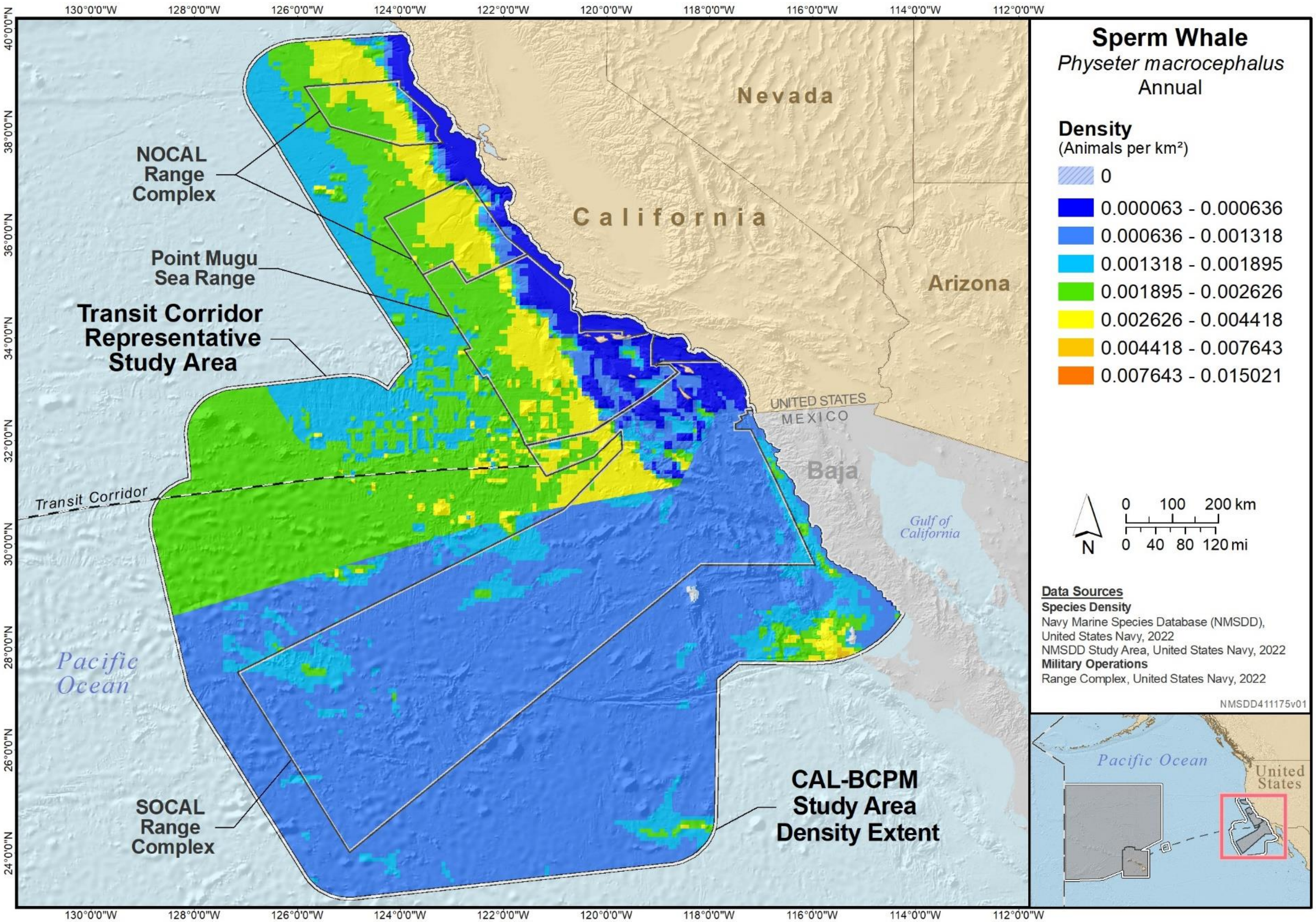

Figure 5-5: Annual Distribution of Sperm Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

6 DELPHINIDS (DOLPHINS)

6.1 *Delphinus delphis bairdii*, Long-Beaked Common Dolphin[1]

NMFS recognizes a single California stock of long-beaked common dolphins (Carretta et al., 2022). All the long-beaked common dolphins in the CAL-BCPM portion of HCTT 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 western portion of the transit corridor (Hamilton et al., 2009).

CAL-BCPM. The Phase III NMSDD included data from a CCE habitat-based density model for long-beaked common dolphins based on systematic survey data collected from 1991 to 2009 (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 models were updated to include additional systematic survey data collected in summer and fall of 2014 and 2018 (Becker et al., 2020a). Model improvements were recognized from additional sighting data collected off the continental shelf and slope, and the inclusion of a broader range of habitat conditions. In addition, recently developed techniques for deriving estimates of uncertainty (Miller et al., 2022) were used to provide more comprehensive variance estimates for the model-based predictions. Density estimates from the updated long-beaked common dolphin model were applied to the portion of the Navy's CAL-BCPM 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.

Given that many cetacean species exhibit substantial seasonal variability in abundance and distribution in the CCE (e.g. Becker et al., 2017; Forney & Barlow, 1998), and the limited systematic survey data available for winter/spring, the CCE long-beaked common dolphin model for summer/fall was used to derive separate winter and spring estimates for waters off the U.S. West Coast using techniques designed to avoid spatial and temporal extrapolation (Becker et al., In Prep.). These estimates represent an improvement from Phase III, when the summer/fall estimates were used for all seasons. The new model-based analyses provide spatially explicit estimates which better capture species distribution patterns in the cool seasons (Becker et al., In Prep.). The long-beaked common dolphin model predictions were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for winter and spring.

In order to improve density estimates for Phase IV, the Navy funded an analysis to develop habitat-based density models for the Southern California Current, an ecologically meaningful study area that extends from Point Conception to the tip of the Baja California Peninsula. Resulting models provide

[1] The Society for Marine Mammalogy's Committee on Taxonomy currently recognizes all common dolphins as a single species, *D. delphis*. Long-and short-beaked common dolphins are still recognized as separate subspecies, *D. delphis bairdii* and *D. delphis delphis*, respectively. In the future it is possible that they will again be recognized as separate species, but additional taxonomic analyses are required.

spatially explicit estimates of long-beaked common dolphin density for waters off the Baja California Peninsula (Becker et al., 2022a), and were applied to the HCTT study area south of the U.S./Mexico border. These density estimates represent a major improvement over density estimates previously used for Phase III (Gerrodette & Eguchi, 2011), because they are based on more recent survey data, they provide finer-scale density predictions (9 km x 9 km grid resolution vs. the 5° x 5° grid resolution available for density estimates used in Phase III), and improved, spatially explicit estimates of uncertainty. Model-derived density estimates were applied to the BCPM region year-round since seasonally specific values are not currently available.

Table 6-1: Summary of Density Values for Long-Beaked Common Dolphin in the Hawaii-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
CAL	S	S	S	S
BCPM	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.

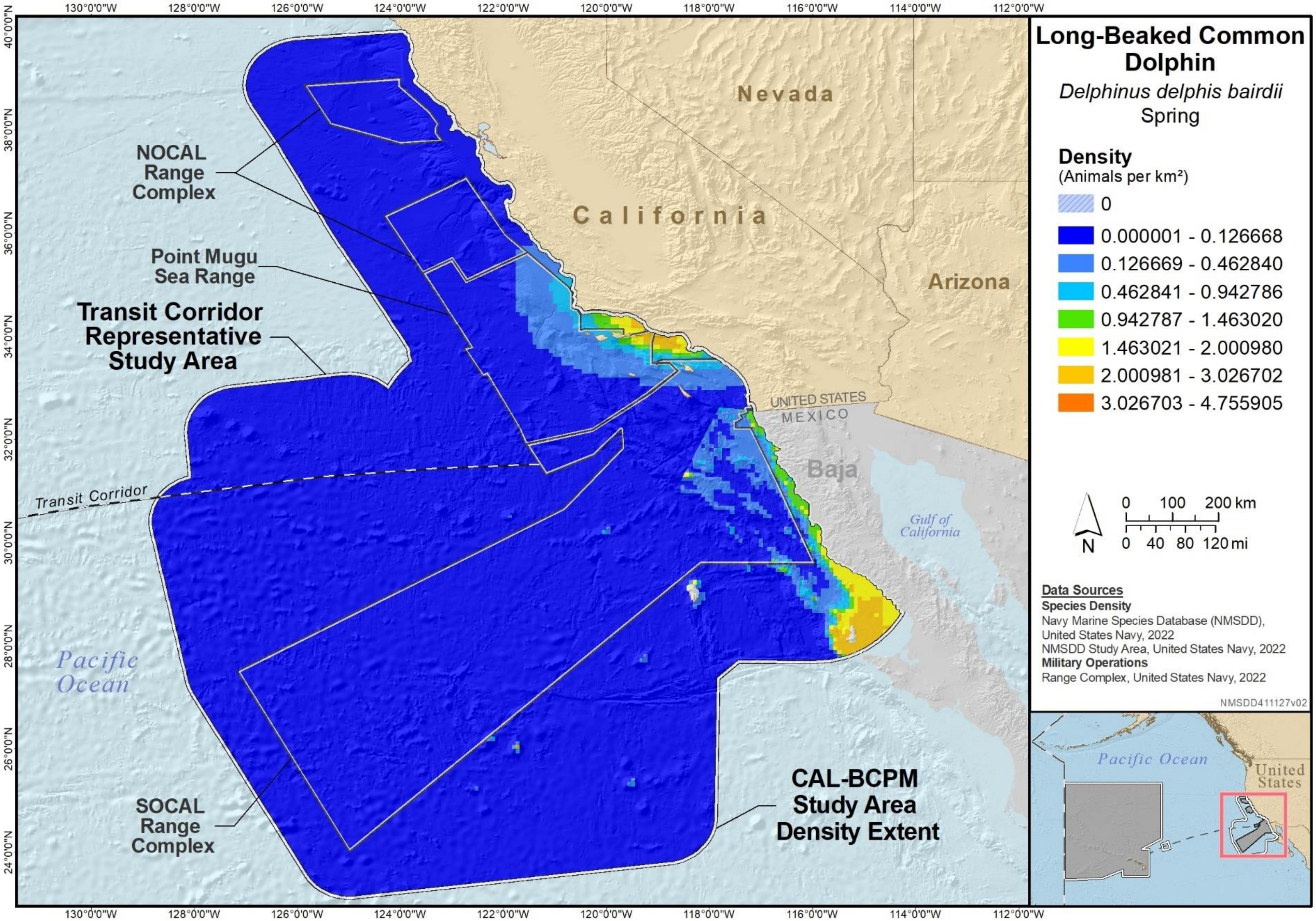

Figure 6-1: Spring Distribution of Long-Beaked Common Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

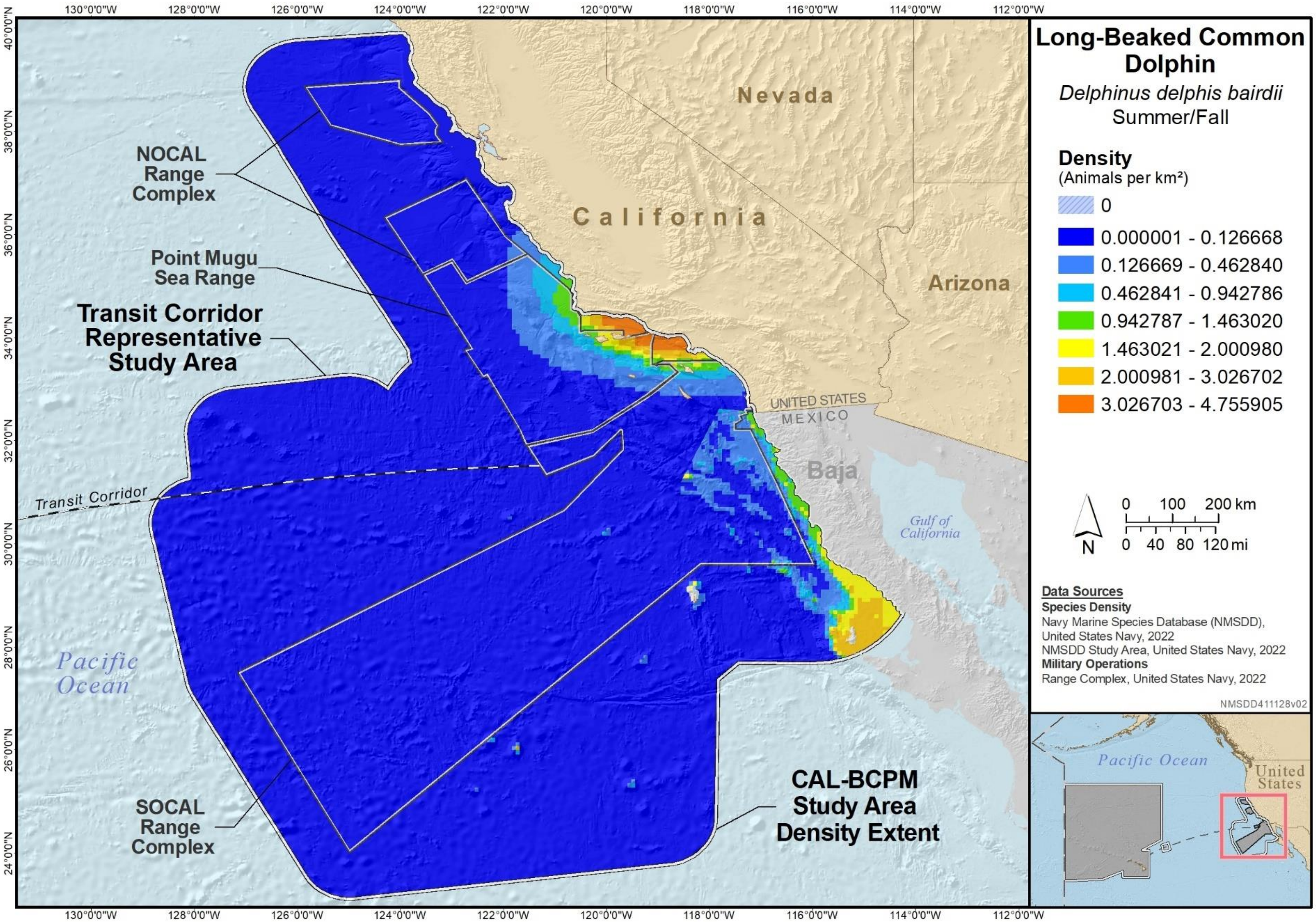

Figure 6-2: Summer/Fall Distribution of Long-Beaked Common Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

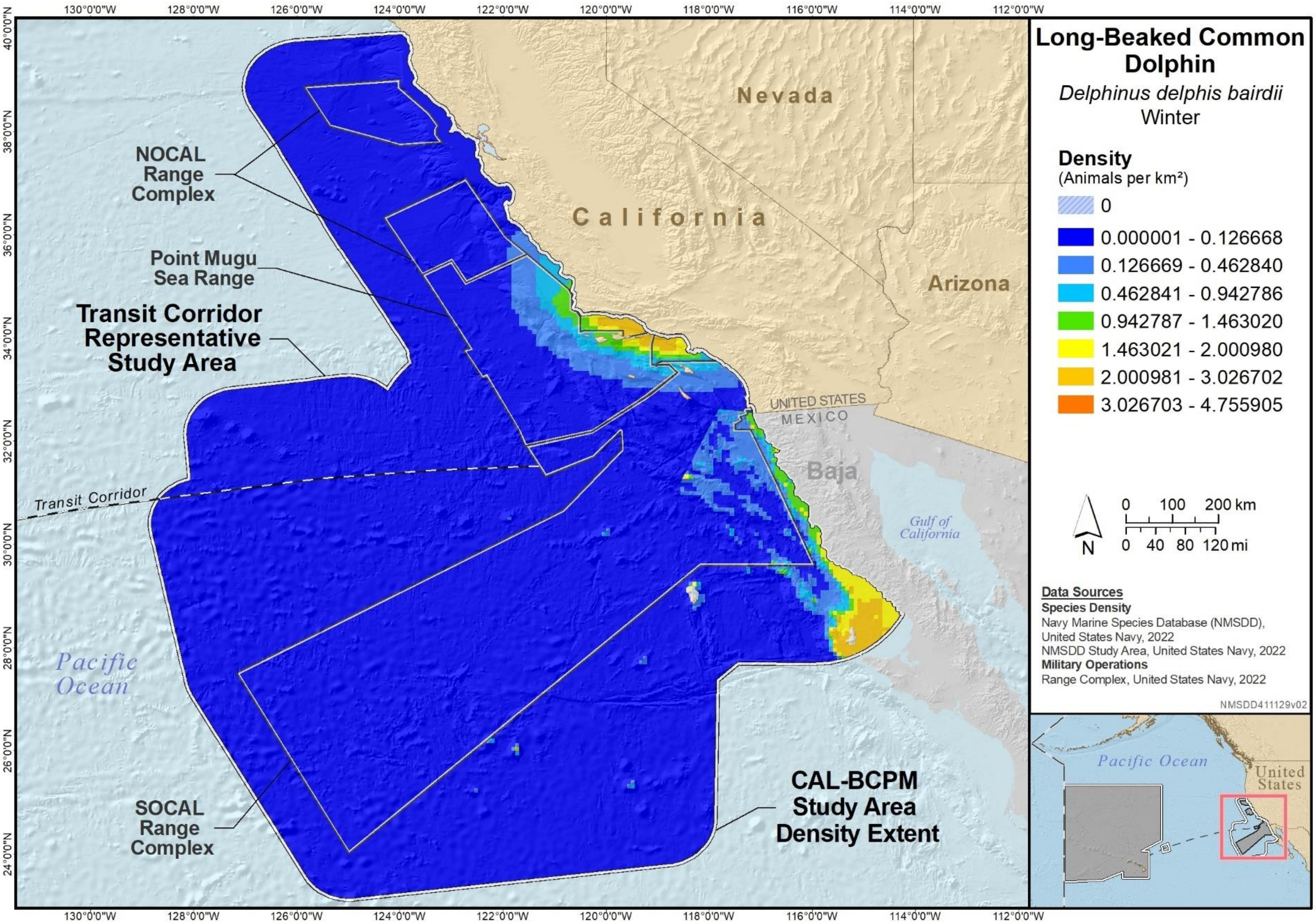

Figure 6-3: Winter Distribution of Long-Beaked Common Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

6.2 *Delphinus delphis delphis*, Short-Beaked Common Dolphin[2]

NMFS recognizes a California/Oregon/Washington stock of short-beaked common dolphins in the U.S. EEZ (Carretta et al., 2022). This stock is the one that is expected to occur in CAL-BCPM, although off California there also may be an extension of the "northern common dolphin" stock managed separately for the tropical Pacific tuna fishery in the eastern tropical Pacific (Carretta et al., 2022).

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

CAL-BCPM. The Phase III NMSDD included data from a CCE habitat-based density model for short-beaked common dolphins based on systematic survey data collected from 1991 to 2009 (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 models were updated to include additional systematic survey data collected in summer and fall of 2014 and 2018 (Becker et al., 2020a). Model improvements were recognized from additional sighting data collected off the continental shelf and slope, and the inclusion of a broader range of habitat conditions. In addition, recently developed techniques for deriving estimates of uncertainty (Miller et al., 2022) were used to provide more comprehensive variance estimates for the model-based predictions. Density estimates from the updated short-beaked common dolphin model were applied to the portion of the Navy's CAL-BCPM 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.

Habitat-based density models specific to winter/spring were recently developed for short-beaked common dolphin for waters off Southern California using 2005-2020 California Cooperative Oceanic Fisheries Investigations (CalCOFI) shipboard survey data (Becker et al., In Prep.). This model is an update to the Becker et al. (2017) model used in Phase III that was based on 2005-2015 data and provided the first winter/spring habitat-based density models for short-beaked common dolphins in Southern California waters. To produce density estimates for the Navy HCTT study areas north of the CalCOFI survey region, the more recent CalCOFI model was used to derive separate winter and spring estimates for waters off the entire U.S. West Coast using techniques designed to avoid spatial and temporal extrapolation (Becker et al., In Prep.). Density estimates from the short-beaked common dolphin model predictions were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for winter and spring.

In order to improve density estimates for Phase IV, the Navy funded an analysis to develop habitat-based density models for the Southern California Current, an ecologically meaningful study area that extends from Point Conception to the tip of the Baja California Peninsula. Resulting models provide the first spatially explicit estimates of short-beaked common dolphin density for waters off the Baja

[2] The Society for Marine Mammalogy's Committee on Taxonomy currently recognizes all common dolphins as a single species, *D. delphis*. Long-and short-beaked common dolphins are still recognized as separate subspecies, *D. delphis bairdii* and *D. delphis delphis*, respectively. In the future it is possible that they will again be recognized as separate species, but additional taxonomic analyses are required.

California Peninsula (Becker et al., 2022a), and were applied to the HCTT study area south of the U.S./Mexico border. These density estimates represent a major improvement over density estimates previously used for Phase III (Ferguson & Barlow, 2003), because they are based on more recent survey data, they provide finer-scale density predictions (9 km x 9 km grid resolution vs. the 5° x 5° grid resolution available for density estimates used in Phase III), and improved, spatially explicit estimates of uncertainty. Model-derived density estimates were applied to the BCPM region year-round since seasonally specific values are not currently available.

Table 6-2: Summary of Density Values for Short-Beaked Common Dolphin in the Hawaii-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
CAL	S	S	S	S
BCPM	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.

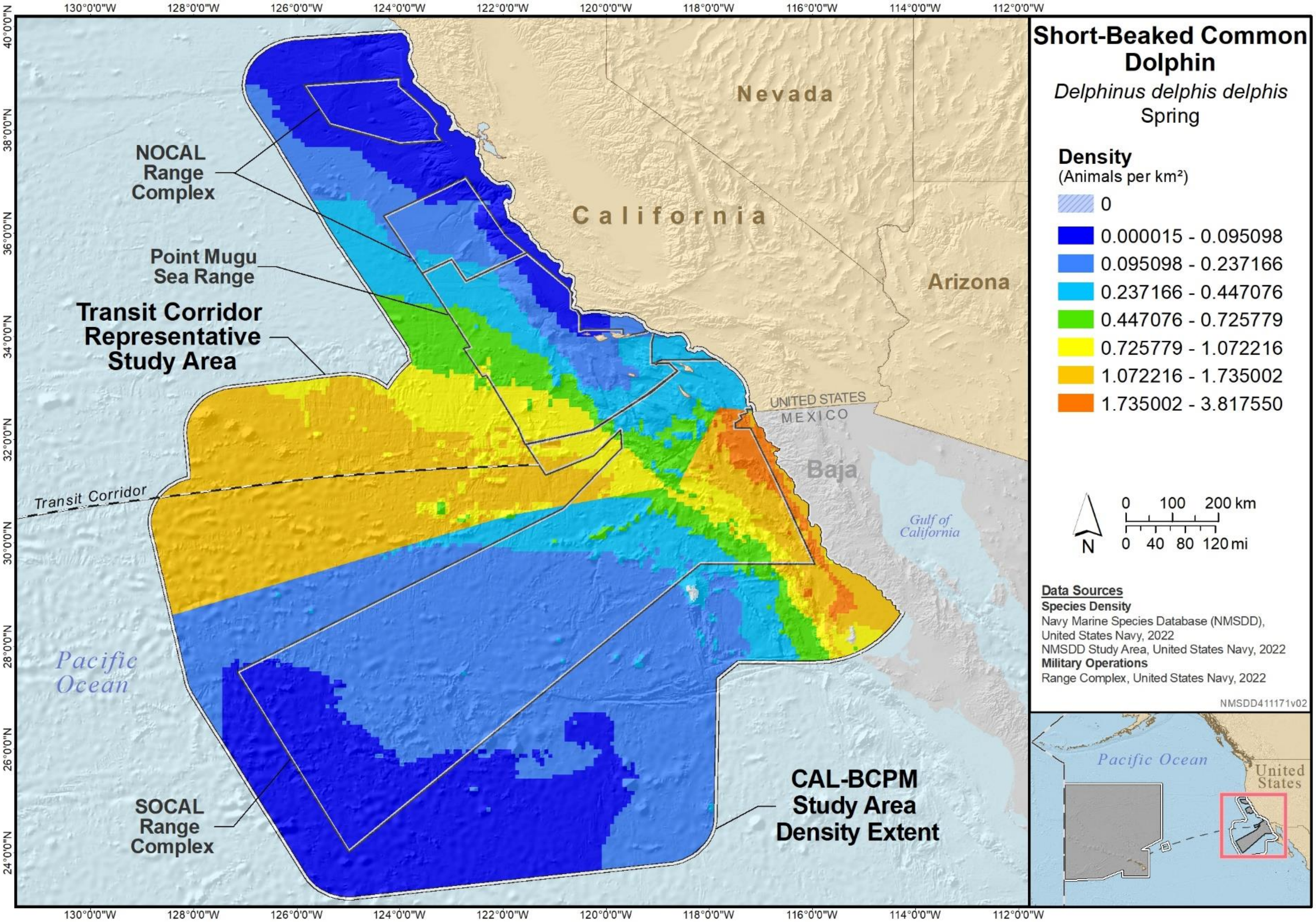

Figure 6-4: Spring Distribution of Short-Beaked Common Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

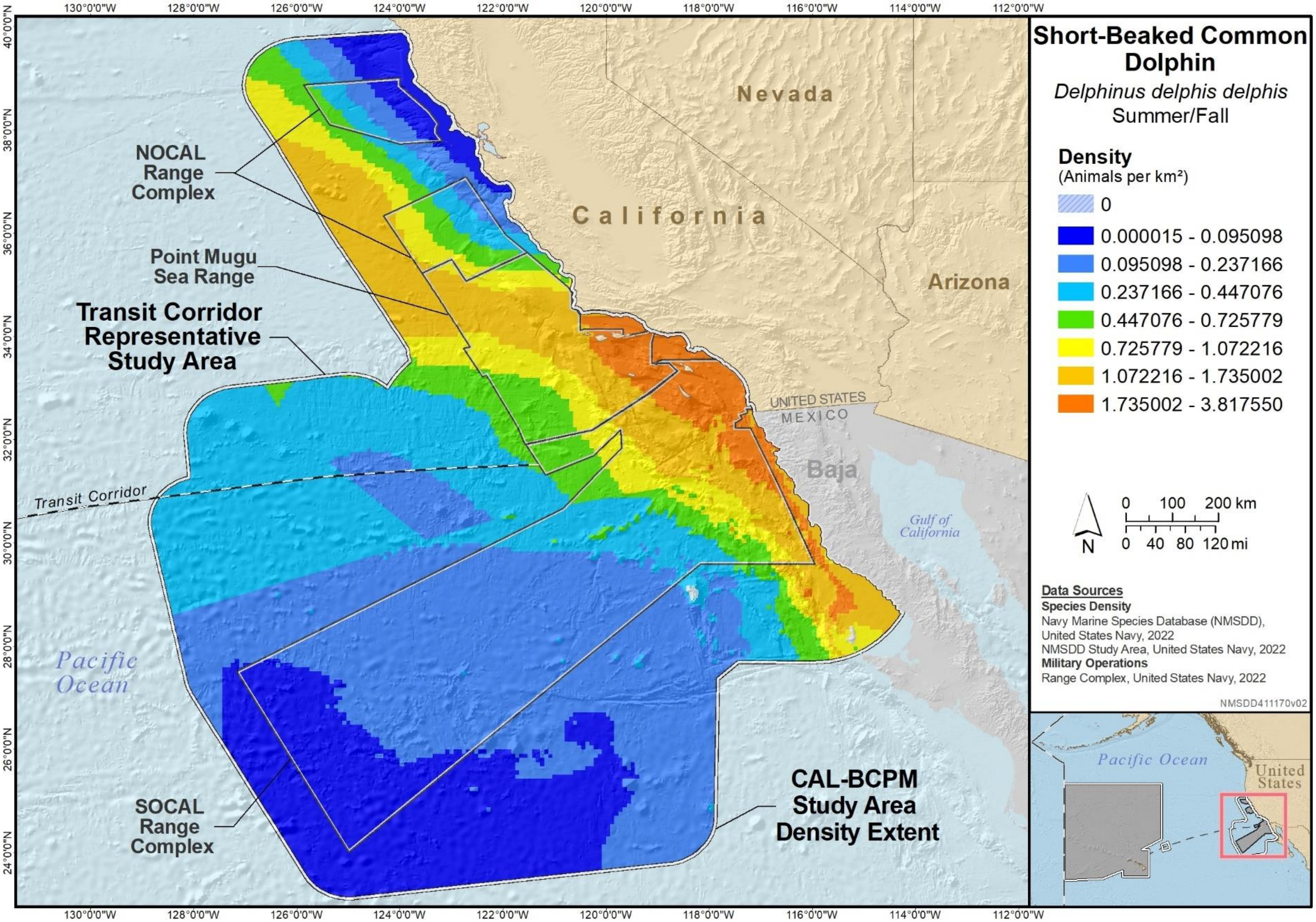

Figure 6-5: Summer/Fall Distribution of Short-Beaked Common Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

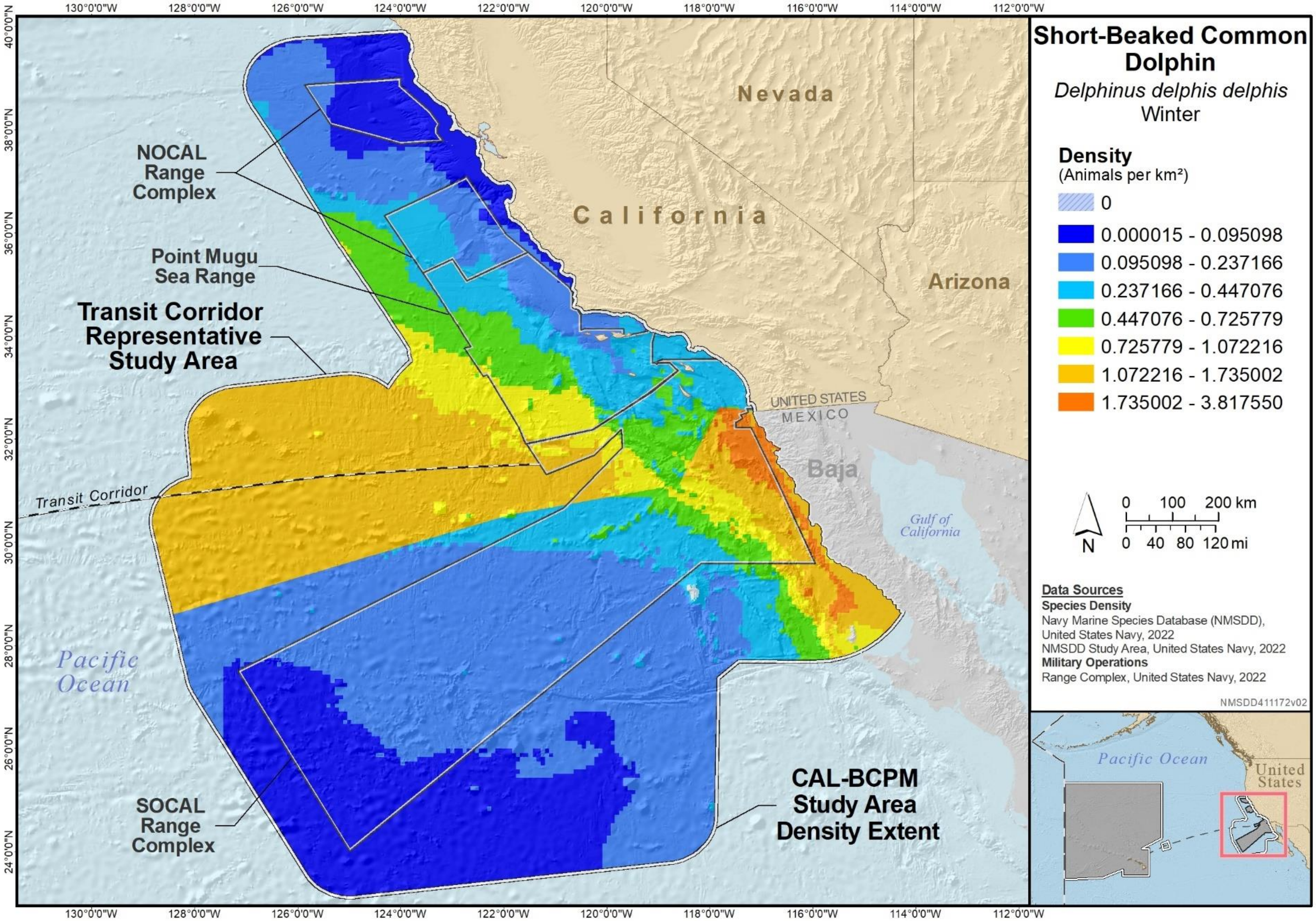

Figure 6-6: Winter Distribution of Short-Beaked Common Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

6.3 *Feresa attenuata*, Pygmy Killer Whale

NMFS recognizes a single Hawaiian stock of pygmy killer whales (Carretta et al., 2022).

HRC. Bradford et al. (2021) report a uniform density value for pygmy killer whales of 0.0042 animals/km^2 (CV = 0.75) that is applicable to the HRC study area and western portion of the transit corridor. This represents an improvement to the density estimate used previously in the Navy's Phase III analyses as it is based on multiple-covariate line-transect analyses of sighting data collected on three surveys of waters within the Hawaiian Islands EEZ in 2002, 2010, and 2017. The Bradford et al. (2021) estimate for the most recent year (2017) is considered a year-round estimate since available data are insufficient to identify any seasonal patterns in the distribution of pygmy killer whales.

CAL-BCPM. This tropical species is not typically observed off California, 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 IV for summer and fall, and represents a conservative value given that this species is not expected to regularly occur in the area (this was the same value used in Phase III).

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

Location	Spring	Summer	Fall	Winter
HRC	0.0042	0.0042	0.0042	0.0042
W. Transit Corridor	0.0042	0.0042	0.0042	0.0042
E. Transit Corridor	0	0.00072	0.00072	0
CAL	0	0.00072	0.00072	0
BCPM	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.

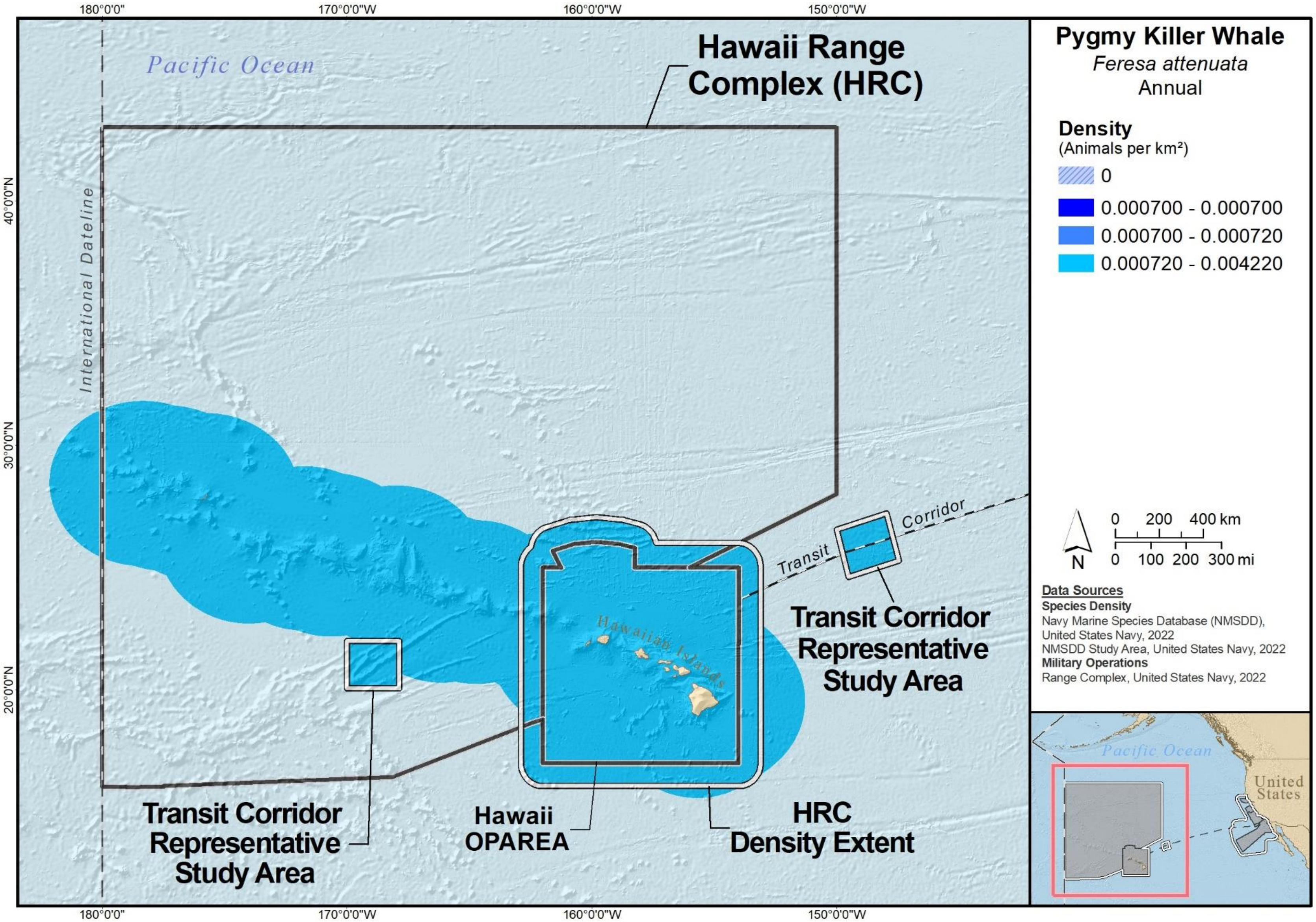

Figure 6-7: Annual Distribution of Pygmy Killer Whale in HRC and the Western Portion of the Transit Corridor

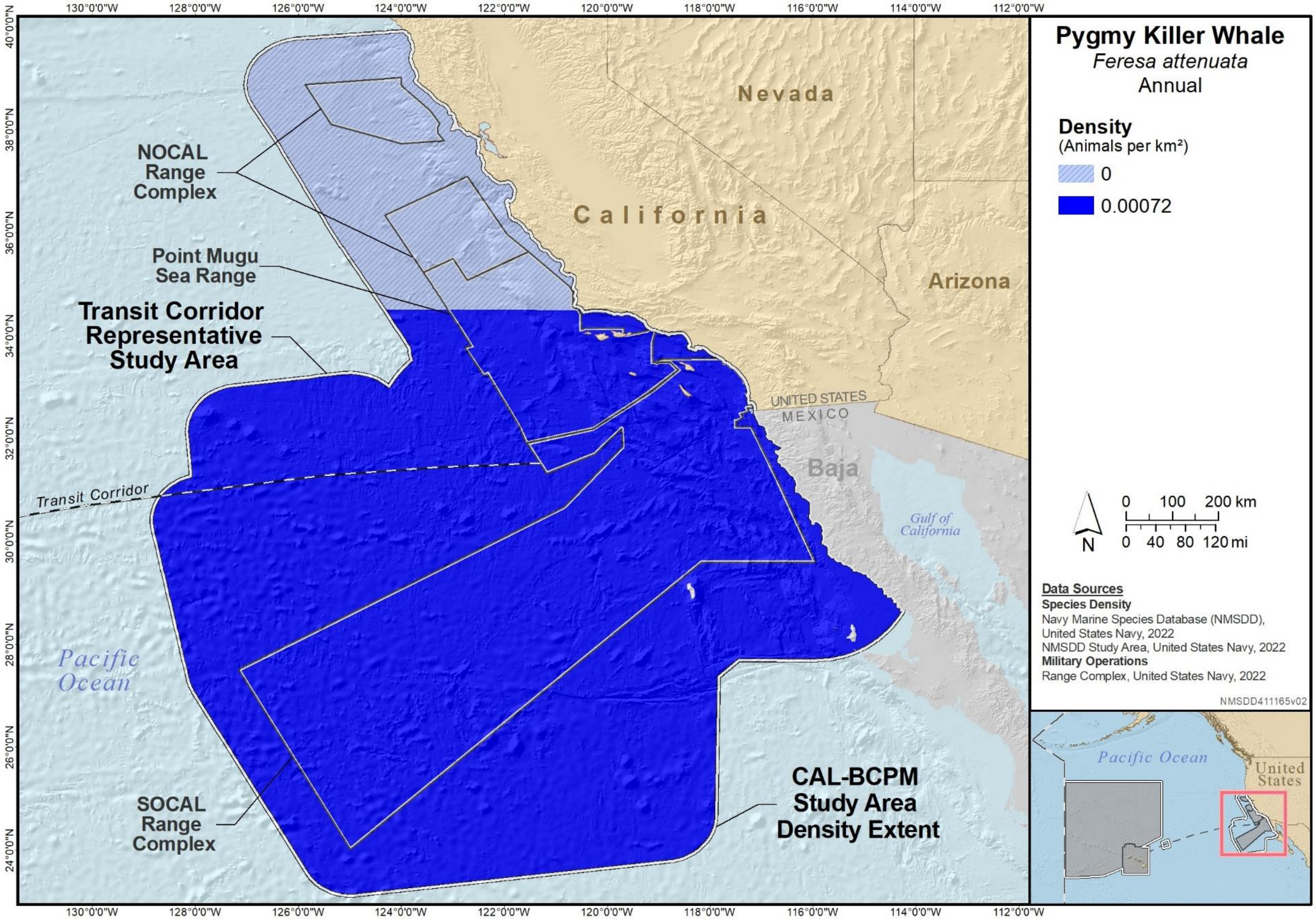

Figure 6-8: Summer/Fall Distribution of Pygmy Killer Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

6.4 *Globicephala macrorhynchus*, Short-Finned Pilot Whale

NMFS defines two stocks of short-finned pilot whales in the U.S. Pacific EEZ, a Hawaiian stock, and a California/Oregon/Washington stock (Carretta et al., 2022). 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 CAL-BCPM are expected to be from the California/Oregon/Washington stock, but it is not clear where one stock merges into another in the transit corridor.

HRC. New survey data collected by NMFS within the Exclusive Economic Zone of the Hawaiian Islands supported the derivation of updated short-finned pilot whale density estimates from model-based analyses (Becker et al., 2022b). The new habitat-based density model for short-finned pilot whale represents an improvement to the model available for Phase III (Forney et al., 2015) because it more accurately accounted for bias in group size estimates and variation in detection probabilities and provided finer-scale density predictions (~9 km x 9 km resolution vs. the previous ~25 km x 25 km resolution) that better accounted for uncertainty. The updated short-finned pilot whale spatial model was applied to all seasons for the acoustic modeling areas associated with HRC and the two western representative transit corridors.

CAL-BCPM. Barlow (2016) provides a stratified uniform density estimate for short-finned pilot whale of 0.00126 animals/km^2 (CV = 0.74) for waters off Southern California, 0.00075 animals/km^2 (CV = 0.94) for waters off Central California, and 0.00056 animals/km^2 (CV = 0.84) for waters off Northern California. In the absence of seasonally specific data, these values were used to represent density year-round. For the Phase III analysis, the same estimate for Southern California was used; however, given the expanded HCTT Study Area, the estimates for the additional strata off California were entered into the NMSDD for the Phase IV analyses.

Ferguson and Barlow (2003) provide density values for areas off BCPM. For the Navy's Phase IV analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the HCTT acoustic modeling footprint and resulted in a short-finned pilot whale density estimate of 0.00021 animals/km^2 (CV = 0.71). In the BCPM waters, the same value is used for all seasons since no seasonally specific values are currently available.

Table 6-4: Summary of Density Values for Short-Finned Pilot Whale in the Hawaii-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
CAL: North	0.00056	0.00056	0.00056	0.00056
CAL: Central	0.00075	0.00075	0.00075	0.00075
CAL: South	0.00126	0.00126	0.00126	0.00126
BCPM	0.00021	0.00021	0.00021	0.00021

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

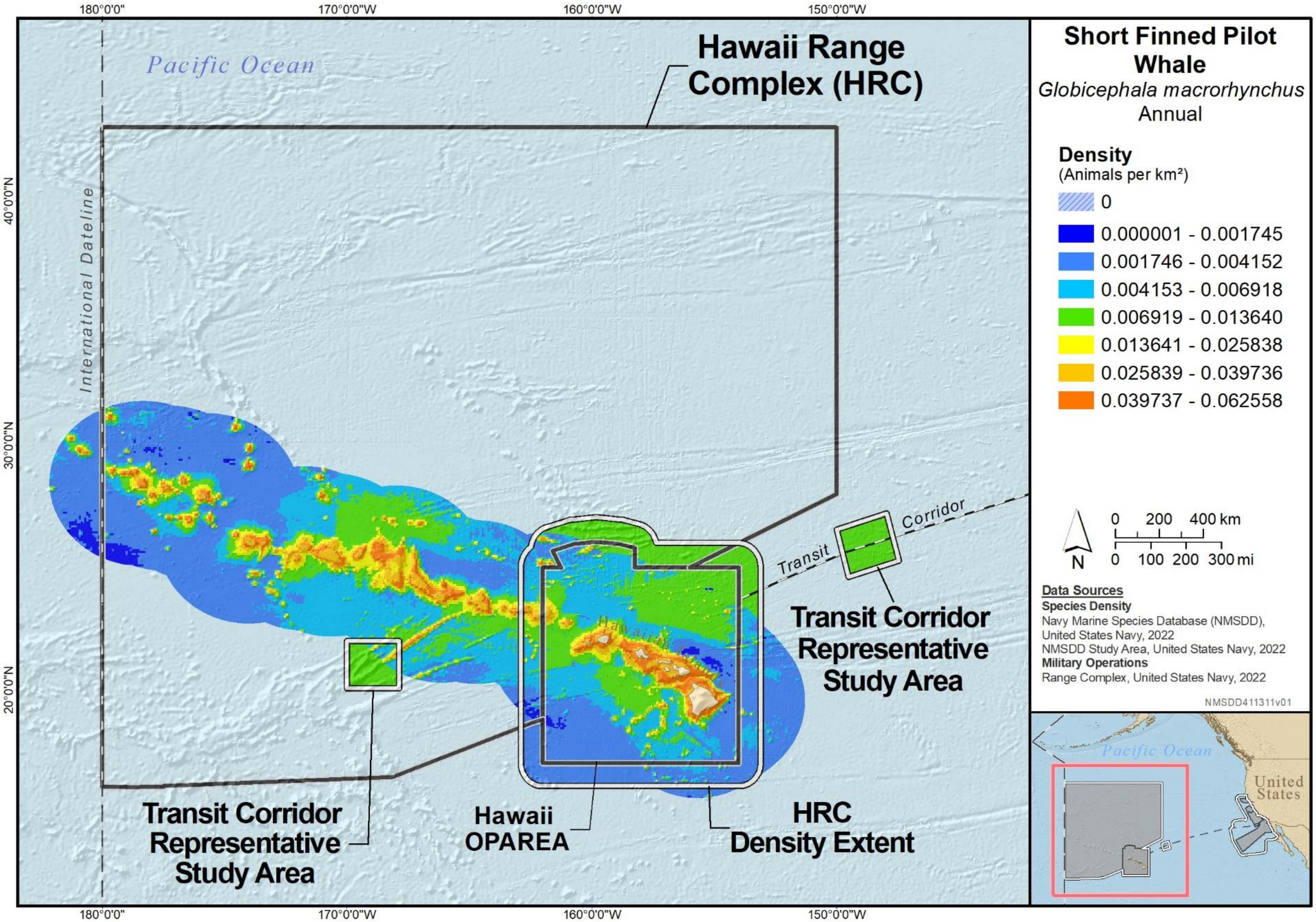

Figure 6-9: Annual Distribution of Short-Finned Pilot Whale in HRC and the Western Portion of the Transit Corridor

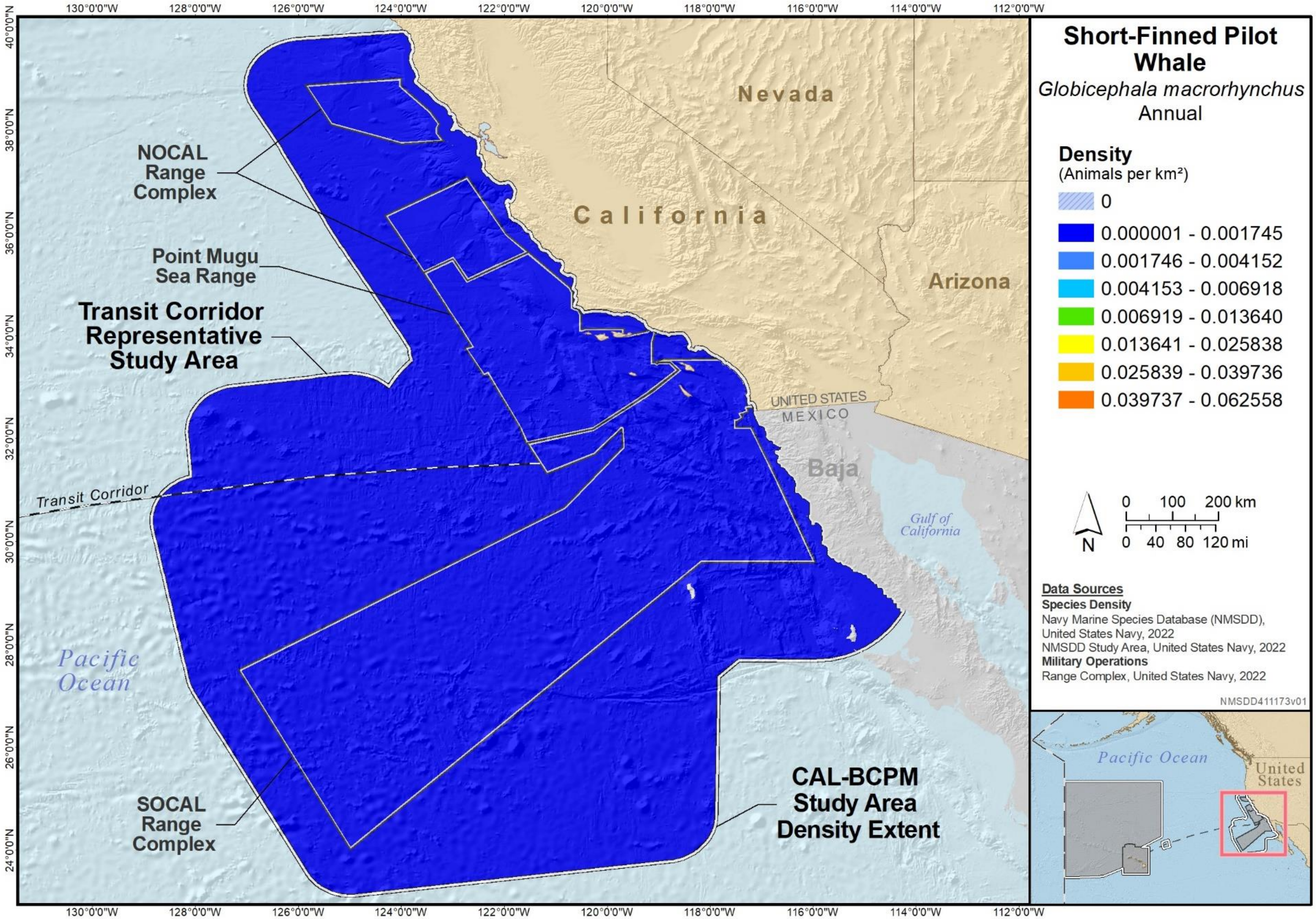

Figure 6-10: Annual Distribution of Short-Finned Pilot Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

6.5 *GRAMPUS GRISEUS*, RISSO'S DOLPHIN

NMFS defines two stocks of Risso's dolphins in the Pacific, a Hawaiian stock, and a California/Oregon/Washington stock (Carretta et al., 2022). While animals sighted in HRC or off California could presumably be assigned to their respective stocks, animals in the transit corridor could belong to either stock, as it is not clear where one stock merges into another.

HRC. New survey data collected by NMFS within the Exclusive Economic Zone of the Hawaiian Islands supported the derivation of the first habitat-based density models for Risso's dolphin in this study area (Becker et al., 2022b; Becker et al., 2021). The new habitat-based density models for Risso's dolphin represent a substantial improvement to the uniform density values used in Phase III (Bradford et al., (2017) because they provide spatially-explicit density and uncertainty predictions at ~9 km x 9 km resolution. The most recent model (Becker et al., 2022b) was applied to all seasons for the acoustic modeling areas associated with HRC and the western portion of the transit corridor.

CAL-BCPM. The Phase III NMSDD included data from a CCE habitat-based density model for Risso's dolphins based on systematic survey data collected from 1991 to 2009 (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 models were updated to include additional systematic survey data collected in summer and fall of 2014 and 2018 (Becker et al., 2020a). Model improvements were recognized from additional sighting data collected off the continental shelf and slope, and the inclusion of a broader range of habitat conditions. In addition, recently developed techniques for deriving estimates of uncertainty (Miller et al., 2022) were used to provide more comprehensive variance estimates for the model-based predictions. Density estimates from the updated Risso's dolphin model were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area north of Point Conception (34.45 degrees N), as well as the eastern portion of the transit corridor for summer and fall.

Given that many cetacean species exhibit substantial seasonal variability in abundance and distribution in the CCE (e.g., Becker et al., 2017; Forney & Barlow, 1998), and the limited systematic survey data available for winter/spring, the CCE Risso's dolphin model for summer/fall was used to derive separate winter and spring estimates for waters off the U.S. West Coast using techniques designed to avoid spatial and temporal extrapolation (Becker et al., In Prep.). These estimates represent an improvement from Phase III, when stratified uniform density estimates based on aerial line-transect data collected in winter and spring of 1991 and 1992 were used (Forney et al., 1995). The new model-based analyses provide spatially explicit estimates which better capture species distribution patterns, they are based on more recent survey data, and they better account for trackline detection probabilities (Becker et al., In Prep.). Density estimates from the Risso's dolphin model predictions were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for winter and spring.

In order to improve density estimates for Phase IV, the Navy funded an analysis to develop habitat-based density models for the Southern California Current, an ecologically meaningful study area that extends from Point Conception to the tip of the Baja California Peninsula. Resulting models provide the first spatially explicit estimates of Risso's dolphin density for waters off the Baja California Peninsula (Becker et al., 2022a), and were applied to the HCTT study area south of Point Conception. These density estimates represent a major improvement over density estimates previously used for Phase III (Ferguson & Barlow, 2003), because they are based on more recent survey data, they provide finer-scale density predictions (9 km x 9 km grid resolution vs. the 5° x 5° grid resolution available for density estimates used in Phase III), and improved, spatially explicit estimates of uncertainty. Model-derived density estimates were applied to the BCPM region year-round since seasonally specific values are not currently available.

Table 6-5: Summary of Density Values for Risso's Dolphin in the Hawaii-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
CAL	S	S	S	S
BCPM	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.

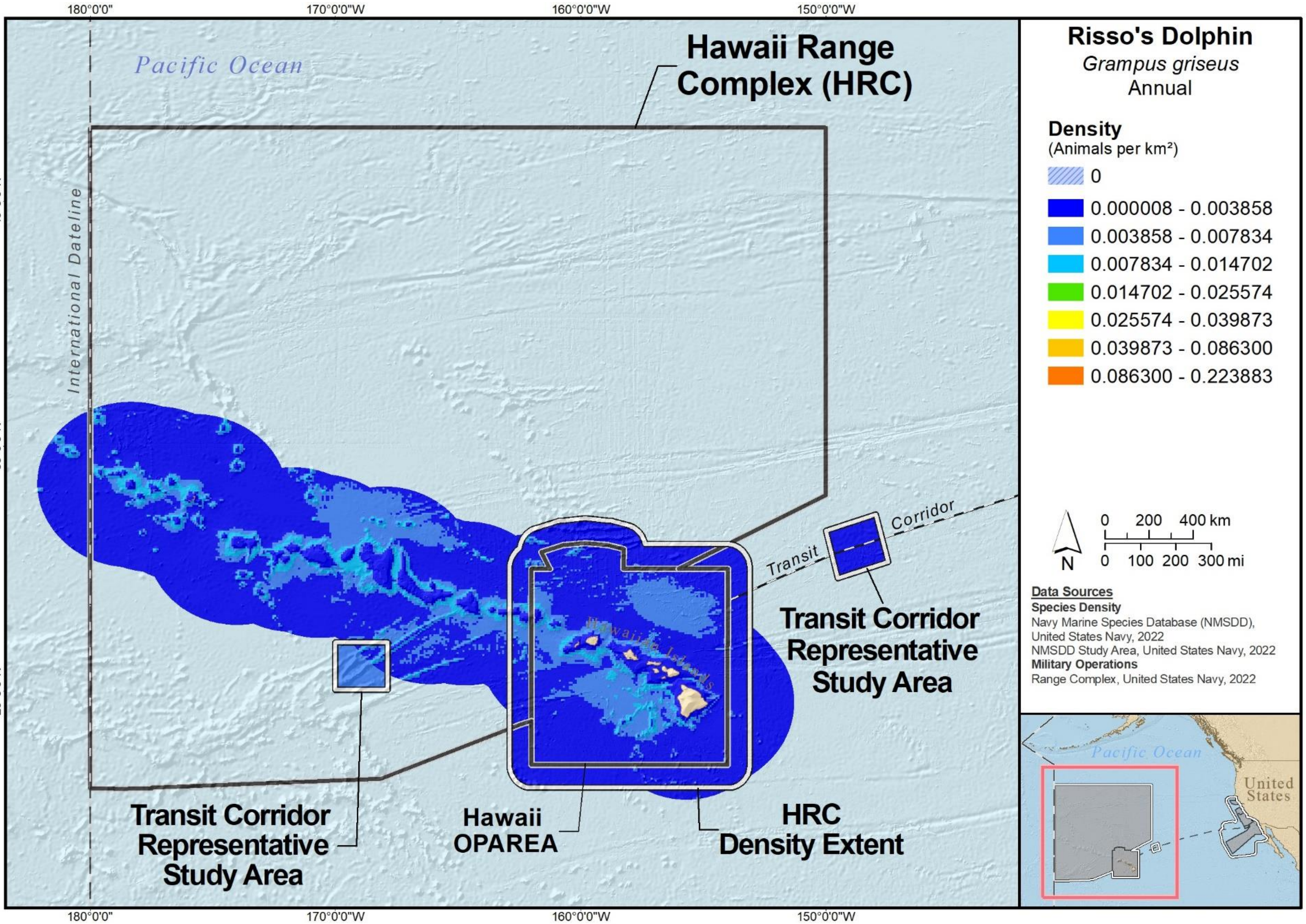

Figure 6-11: Annual Distribution of Risso's Dolphin in HRC and the Western Portion of the Transit Corridor

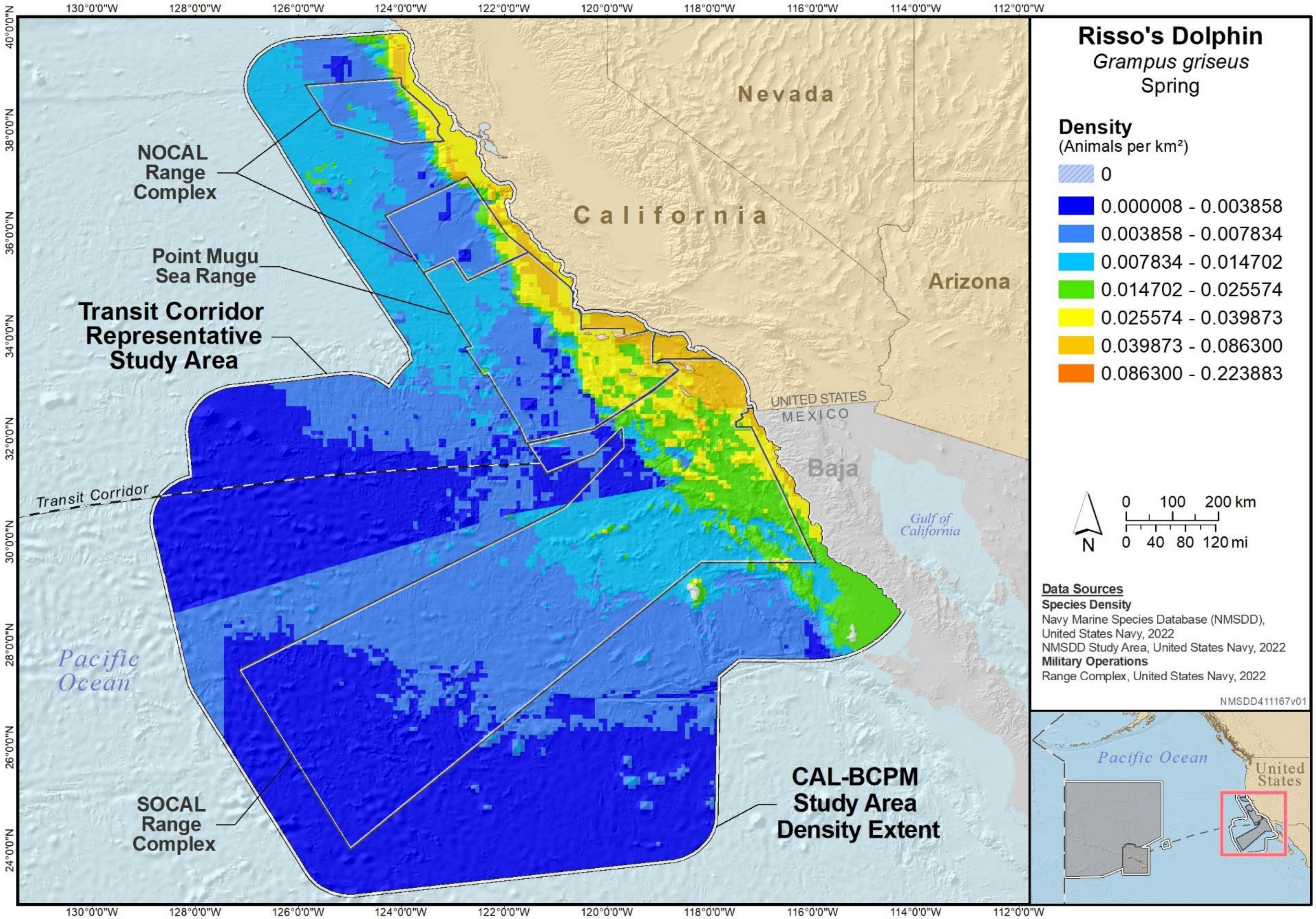

Figure 6-12: Spring Distribution of Risso's Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

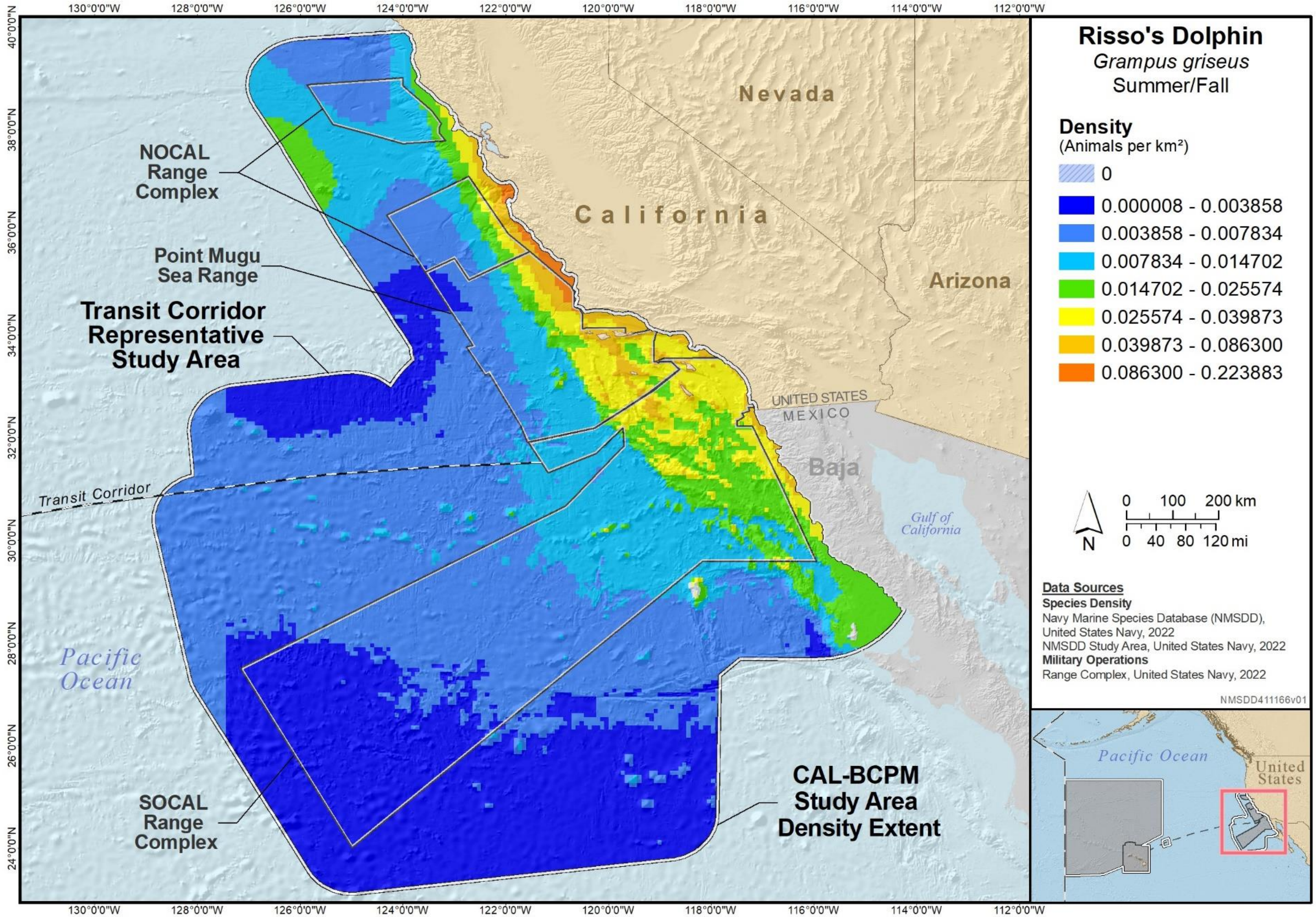

Figure 6-13: Summer/Fall Distribution of Risso's Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

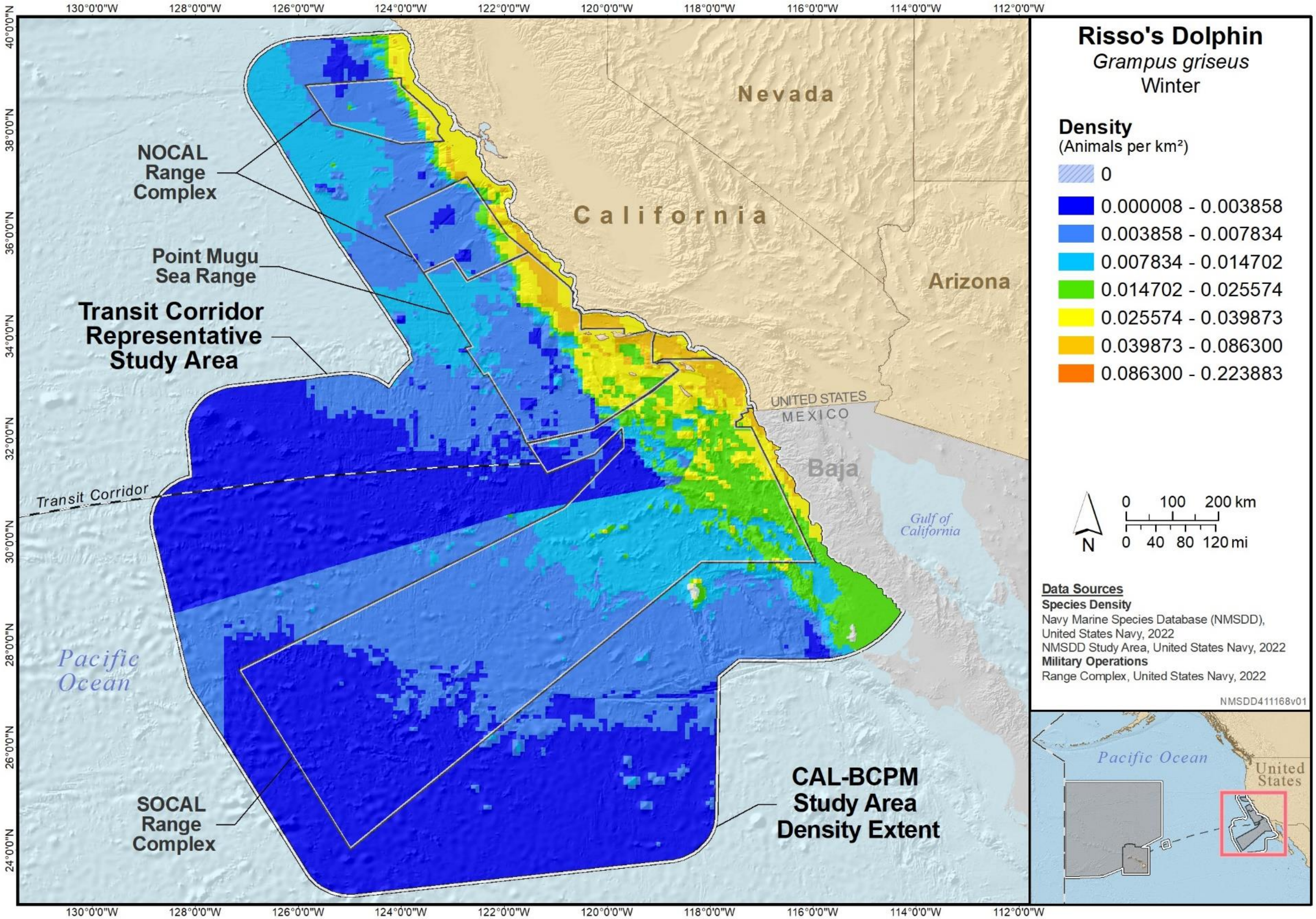

Figure 6-14: Winter Distribution of Risso's Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

6.6 *LAGENODELPHIS HOSEI*, FRASER'S DOLPHIN

NMFS recognizes a single Hawaiian stock of Fraser's dolphins in U.S. waters (Carretta et al., 2022).

HRC. Bradford et al. (2021) report a uniform density value for Fraser's dolphin of 0.01673 animals/km^2 (CV = 0.70) that is applicable to the HRC study area and western portion of the transit corridor. This represents an improvement to the density estimate used previously in the Navy's Phase III analyses as it is based on multiple-covariate line-transect analyses of sighting data collected on three surveys of waters within the Hawaiian Islands EEZ in 2002, 2010, and 2017. The Bradford et al. (2021) estimate for the most recent year (2017) is considered a year-round estimate since available data are insufficient to identify any seasonal patterns in the distribution of Fraser's dolphins.

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

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

Location	Spring	Summer	Fall	Winter
HRC	0.01673	0.01673	0.01673	0.01673
W. Transit Corridor	0.01673	0.01673	0.01673	0.01673
E. Transit Corridor	0	0	0	0
CAL	0	0	0	0
BCPM	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.

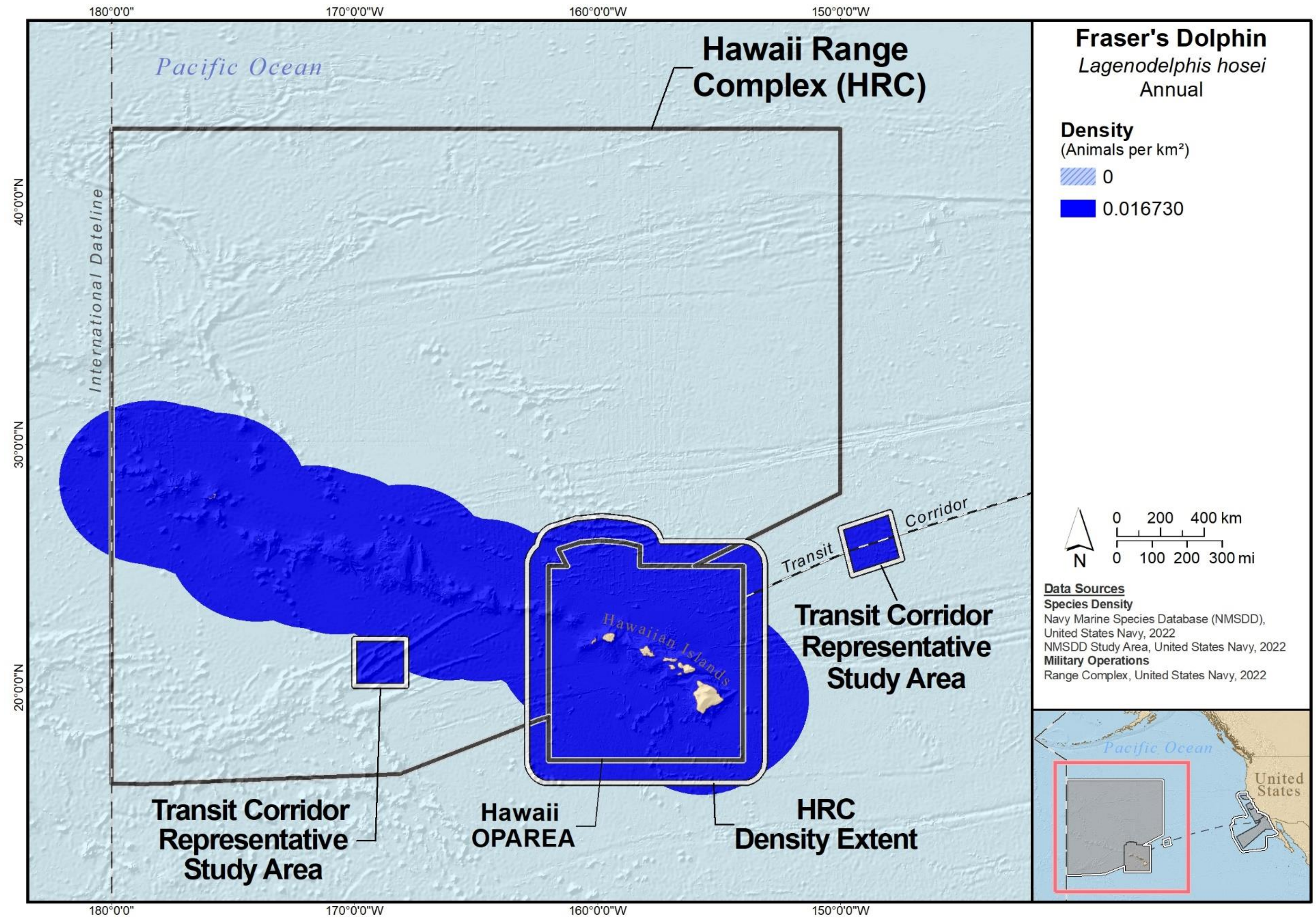

Figure 6-15: Annual Distribution of Fraser's Dolphin in HRC and the Western Portion of the Transit Corridor

6.7 *LAGENORHYNCHUS OBLIQUIDENS*, PACIFIC WHITE-SIDED DOLPHIN

Two stocks of Pacific white-sided dolphin are recognized by NMFS (Carretta et al., 2022). 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 CAL-BCPM. Until the difference between the two forms can be recognized in the field, the two stocks will be managed as a single unit (Carretta et al., 2022). The second stock recognized by NMFS is the North Pacific stock that does not occur in the HCTT Study Area (Young, 2022).

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

CAL-BCPM. The Phase III NMSDD included data from a CCE habitat-based density model for Pacific white-sided dolphins based on systematic survey data collected from 1991 to 2009 (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 models were updated to include additional systematic survey data collected in summer and fall of 2014 and 2018 (Becker et al., 2020a). Model improvements were recognized from additional sighting data collected off the continental shelf and slope, and the inclusion of a broader range of habitat conditions. In addition, recently developed techniques for deriving estimates of uncertainty (Miller et al., 2022) were used to provide more comprehensive variance estimates for the model-based predictions. Density estimates from the updated Pacific white-sided dolphin model were applied to the portion of the Navy's CAL-BCPM 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.

Given that many cetacean species exhibit substantial seasonal variability in abundance and distribution in the CCE (e.g., Becker et al., 2017; Forney & Barlow, 1998), and the limited systematic survey data available for winter/spring, the CCE Pacific white-sided dolphin model for summer/fall was used to derive separate winter and spring estimates for waters off the U.S. West Coast using techniques designed to avoid spatial and temporal extrapolation (Becker et al., In Prep.). For Phase III, uniform density estimates derived by Campbell et al. (2015) for Southern California waters were used for winter and spring, but these estimates did not include waters north of approximately 35 degrees N, and they did not capture the distribution of this species in largely shelf and slope waters. The new Pacific white-sided dolphin model predictions were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for winter and spring.

In order to improve density estimates for Phase IV, the Navy funded an analysis to develop habitat-based density models for the Southern California Current, an ecologically meaningful study area that extends from Point Conception to the tip of the Baja California Peninsula. Resulting models provide the first spatially explicit estimates of Pacific white-sided dolphin density for waters off the Baja California peninsula (Becker et al., 2022a), and were applied to the HCTT study area south of the U.S./Mexico border. These density estimates represent a major improvement over density estimates previously used for Phase III (Ferguson & Barlow, 2003), because they are based on more recent survey data, they provide finer-scale density predictions (9 km x 9 km grid resolution vs. the 5° x 5° grid resolution available for density estimates used in Phase III), and improved, spatially explicit estimates of uncertainty. Model-derived density estimates were applied to the BCPM region year-round since seasonally specific values are not currently available.

Table 6-7: Summary of Density Values for Pacific White-Sided Dolphin in the Hawaii-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
CAL	S	S	S	S
BCPM	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.

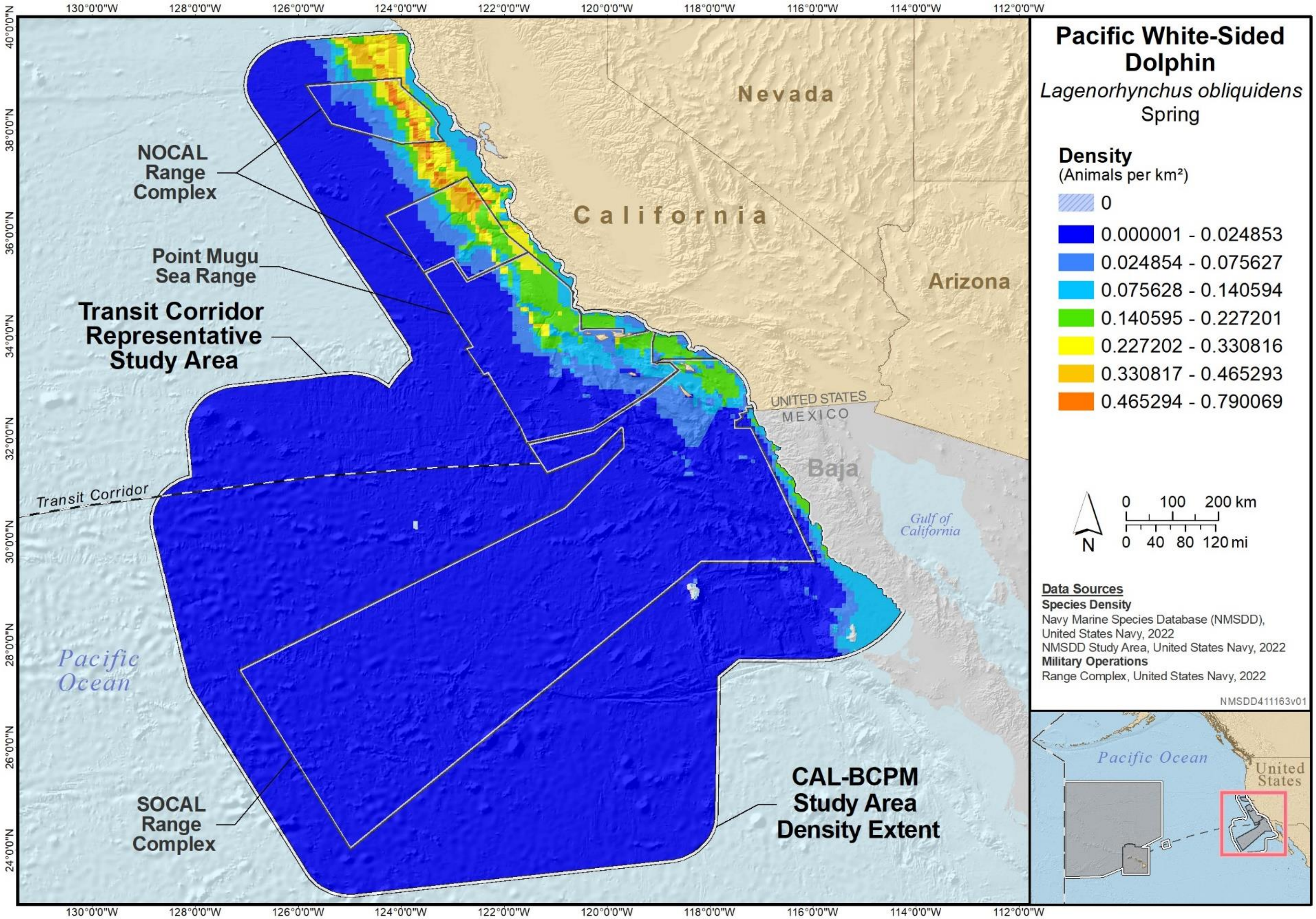

Figure 6-16: Spring Distribution of Pacific White-Sided Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

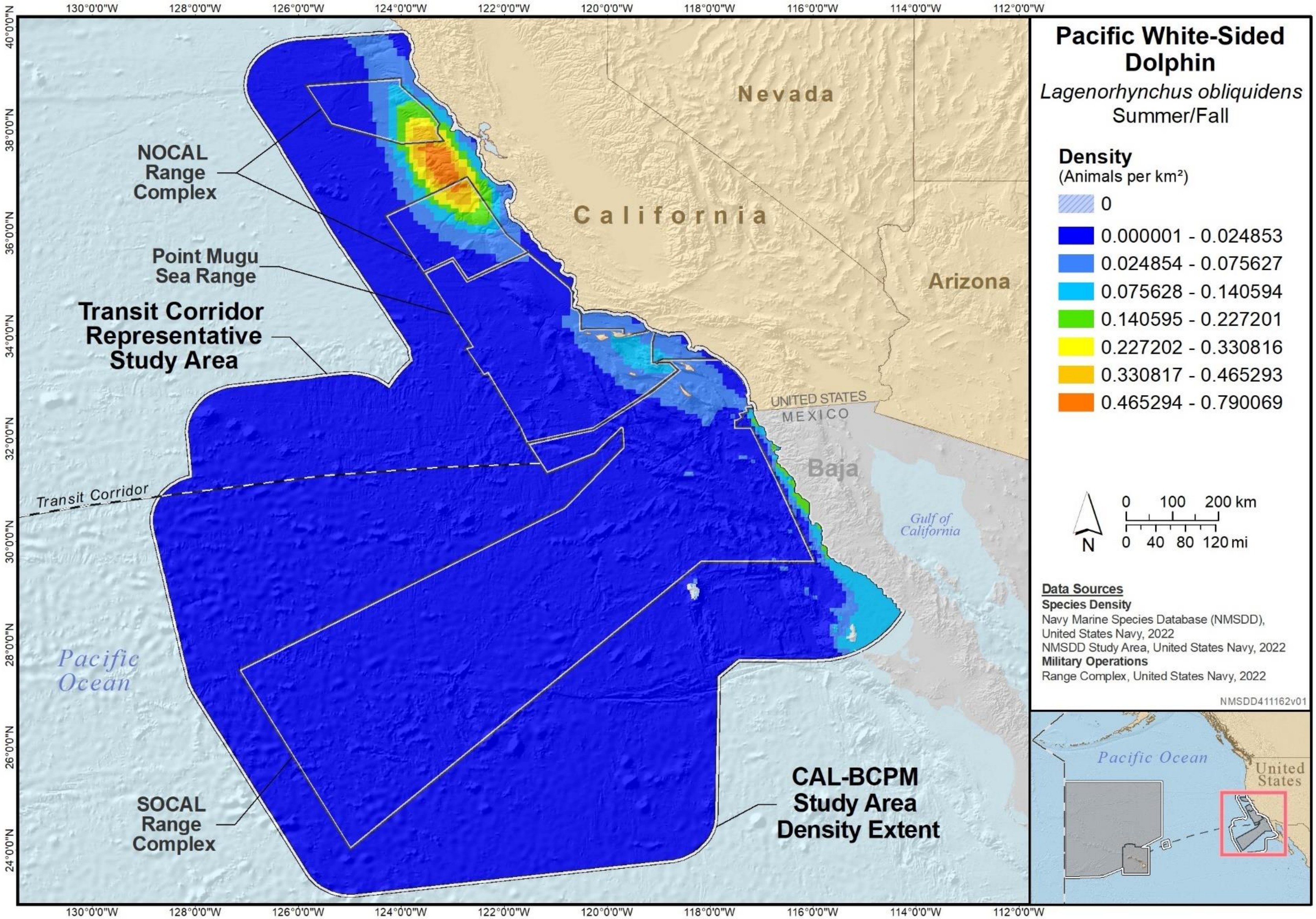

Figure 6-17: Summer/Fall Distribution of Pacific White-Sided Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

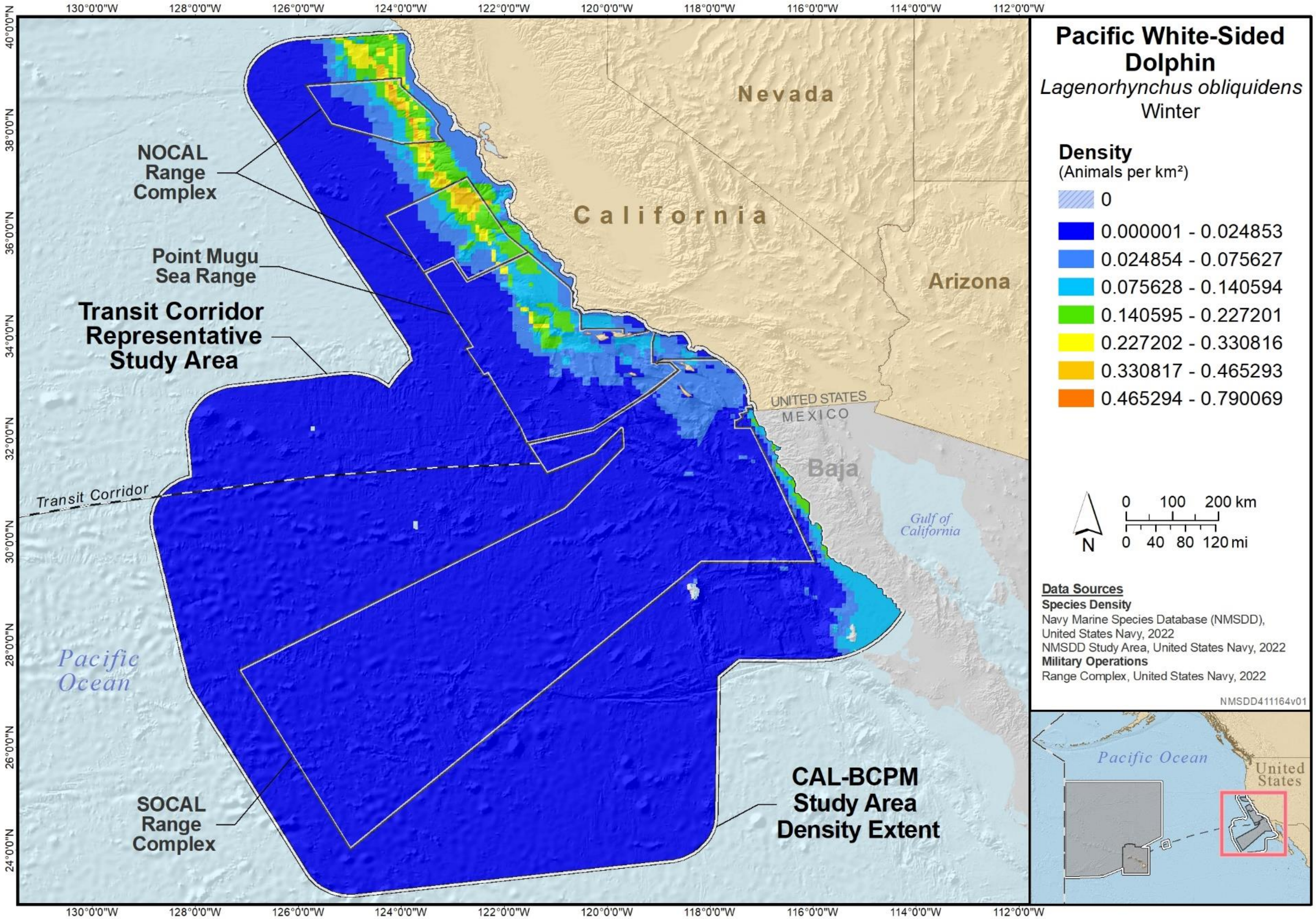

Figure 6-18: Winter Distribution of Pacific White-Sided Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

6.8 *LISSODELPHIS BOREALIS*, NORTHERN RIGHT WHALE DOLPHIN

A single stock of northern right whale dolphins, the California/Oregon/Washington stock, is recognized by NMFS (Carretta et al., 2022).

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

CAL-BCPM. The Phase III NMSDD included data from a CCE habitat-based density model for northern right whale dolphins based on systematic survey data collected from 1991 to 2009 (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 models were updated to include additional systematic survey data collected in summer and fall of 2014 and 2018 (Becker et al., 2020a). Model improvements were recognized from additional sighting data collected off the continental shelf and slope, and the inclusion of a broader range of habitat conditions. In addition, recently developed techniques for deriving estimates of uncertainty (Miller et al., 2022) were used to provide more comprehensive variance estimates for the model-based predictions. Density estimates from the updated northern right whale dolphin model were applied to the portion of the Navy's CAL-BCPM 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.

Given that many cetacean species exhibit substantial seasonal variability in abundance and distribution in the CCE (e.g., Becker et al., 2017; Forney & Barlow, 1998), and the limited systematic survey data available for winter/spring, the CCE northern right whale dolphin model for summer/fall was used to derive separate winter and spring estimates for waters off the U.S. West Coast using techniques designed to avoid spatial and temporal extrapolation (Becker et al., In Prep.). These estimates represent an improvement from Phase III, when stratified uniform density estimates based on aerial line-transect data collected in winter and spring of 1991 and 1992 were used (Forney et al., 1995). The new model-based analyses provide spatially explicit estimates which better capture species distribution patterns, they are based on more recent survey data, and they better account for trackline detection probabilities (Becker et al., In Prep.). The northern right whale dolphin model predictions were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for winter and spring.

Ferguson and Barlow (2003) provide density values for areas off BCPM. For the Navy's Phase IV analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the HCTT acoustic modeling footprint and resulted in a northern right whale dolphin density estimate of 0.00357 animals/km^2 (CV = 1.84). In the BCPM waters, the same value is used for all seasons since seasonally specific values are not currently available.

Table 6-8: Summary of Density Values for Northern Right Whale Dolphin in the Hawaii-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
CAL	S	S	S	S
BCPM	0.00357	0.00357	0.00357	0.00357

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

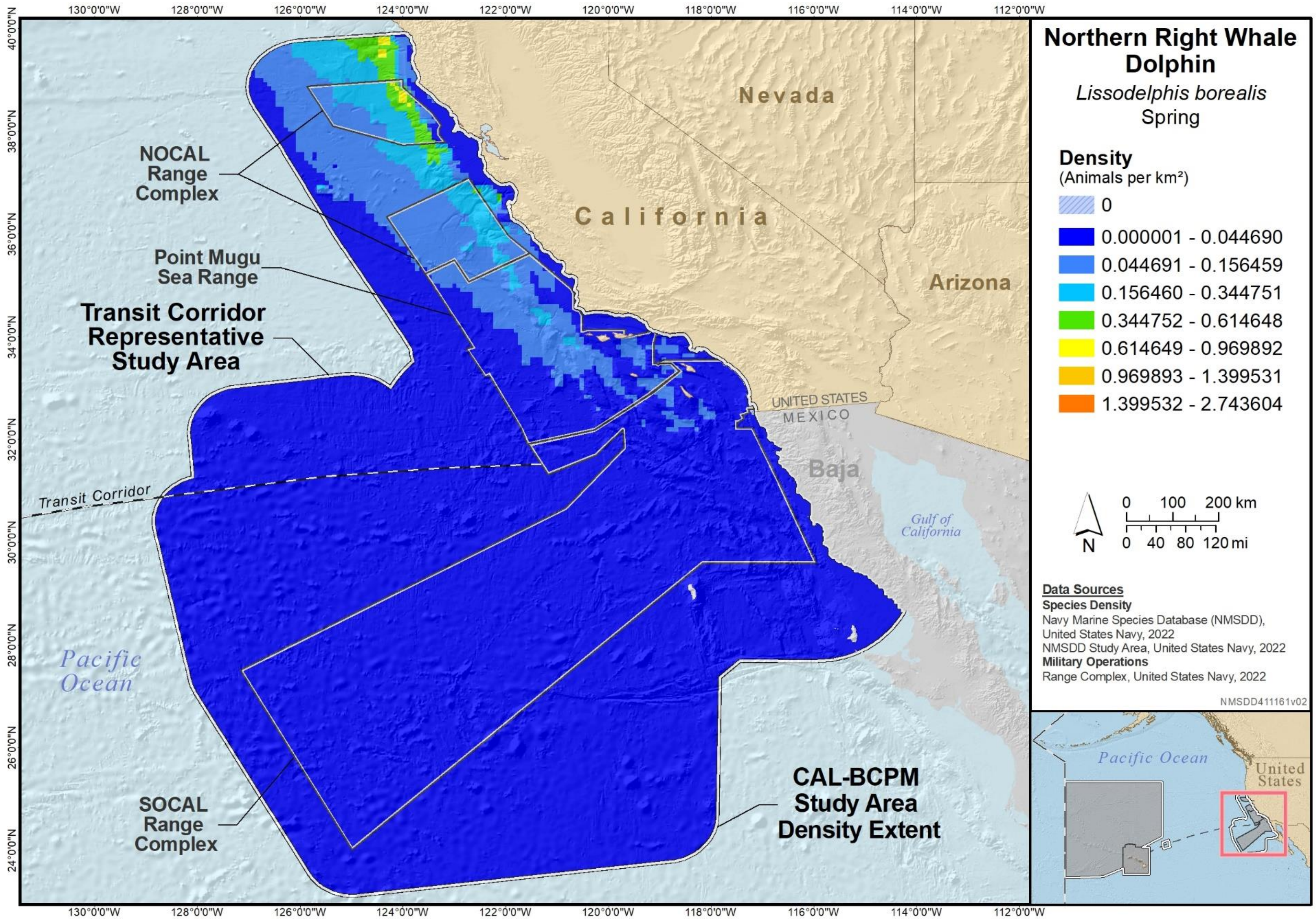

Figure 6-19: Spring Distribution of Northern Right Whale Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

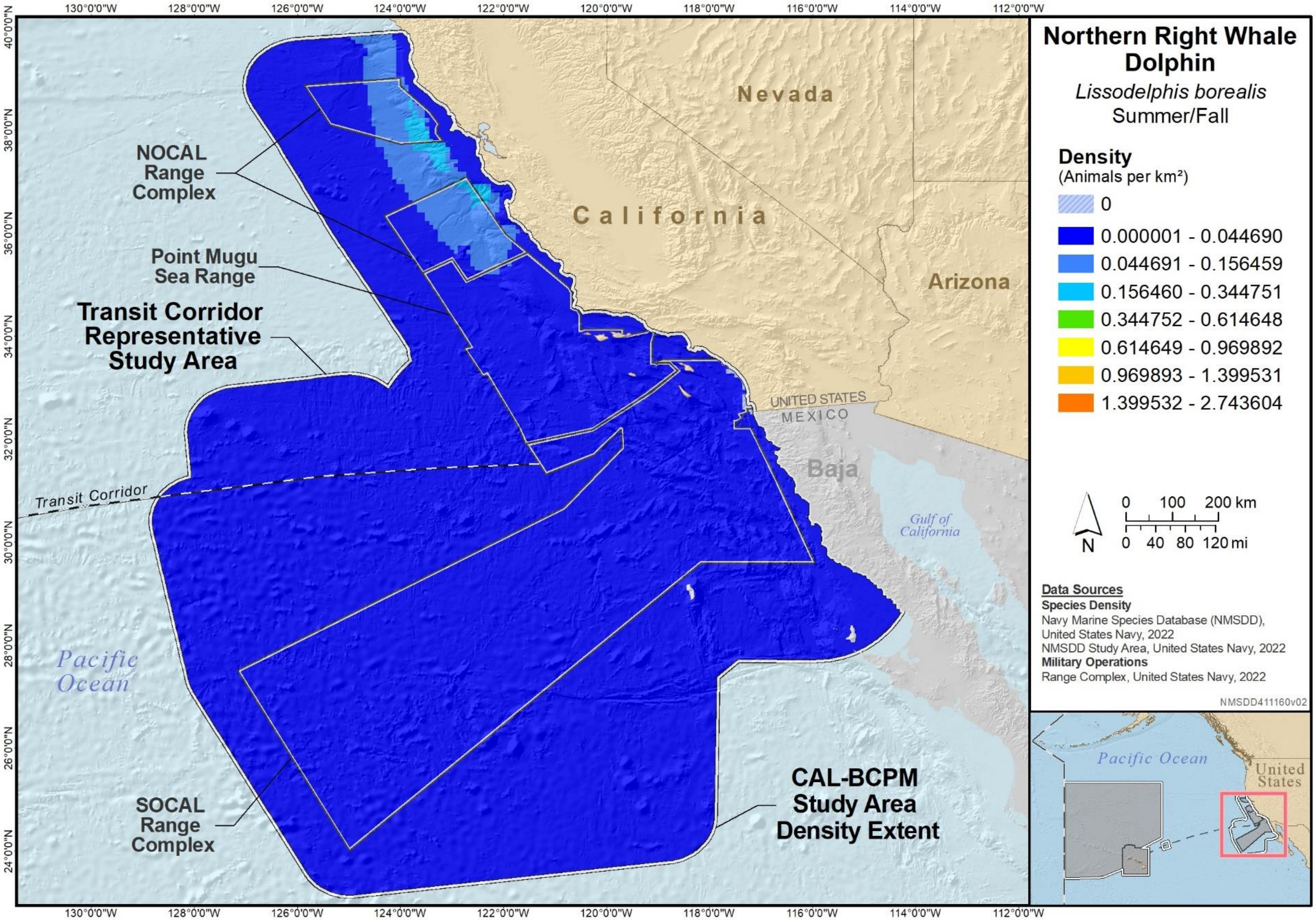

Figure 6-20: Summer/Fall Distribution of Northern Right Whale Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

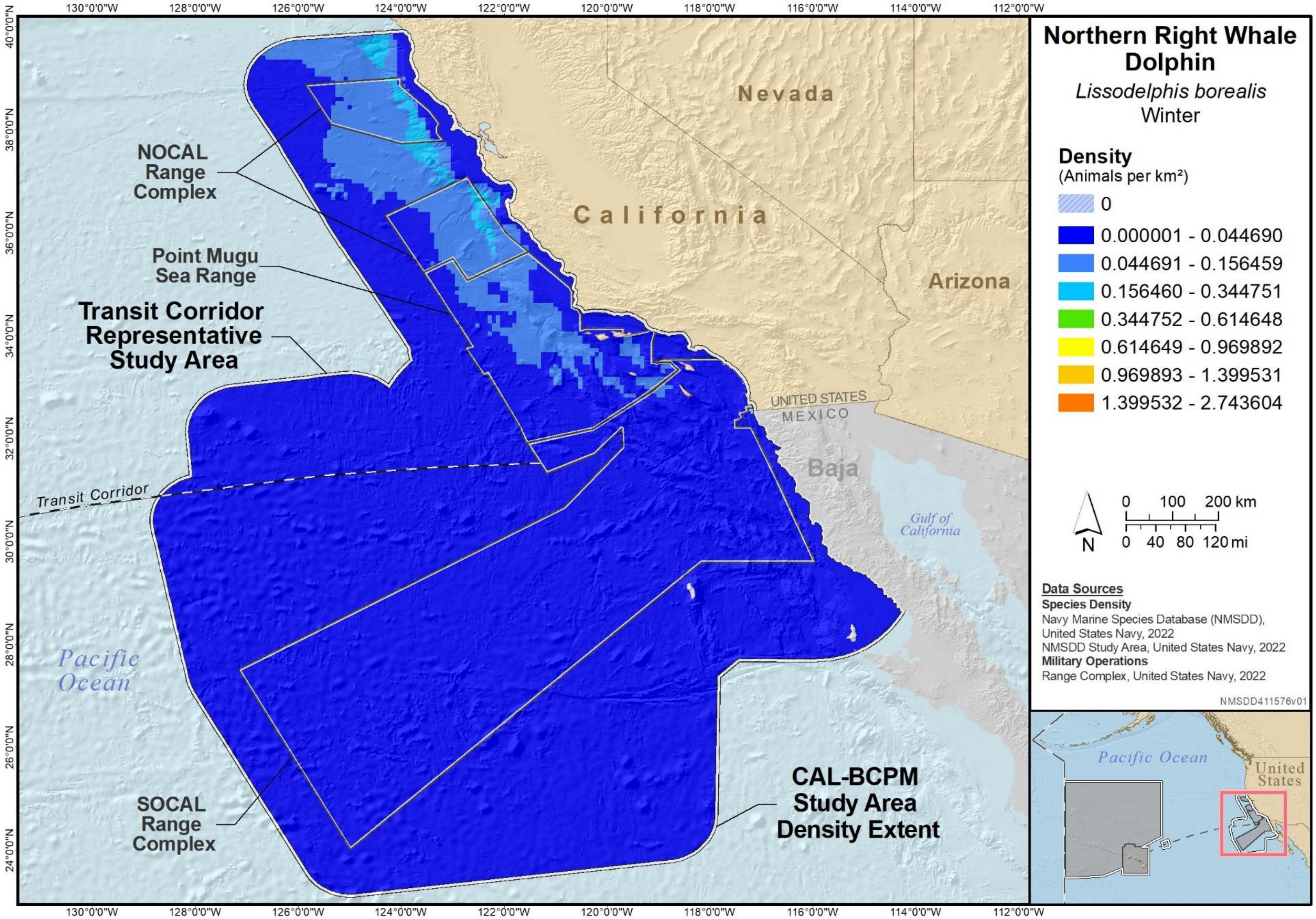

Figure 6-21: Winter Distribution of Northern Right Whale Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

6.9 *ORCINUS ORCA*, KILLER WHALE

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 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).

Eight killer whale stocks are recognized within the Pacific U.S. EEZ, including (1) the Eastern North Pacific Alaska Resident stock - occurring from Southeast Alaska to the Bering Sea, (2) the Eastern North Pacific Northern Resident stock – occurring from British Columbia through Alaska, (3) the Eastern North Pacific Southern Resident stock – occurring mainly within the inland waters of Washington State and southern British Columbia but extending from central California into southern Southeast Alaska, (4) the West Coast Transient stock - occurring from Alaska through California, (5) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock - occurring from southeast Alaska to the Bering Sea, (6) the AT1 Stock – found only in Prince William Sound, (7) the Eastern North Pacific Offshore stock - occurring from Alaska through California, and (8) the Hawaiian stock (Carretta et al., 2022). Three separate pods comprise the Southern Resident stock, identified as the J, K, and L pods (Ford et al., 2000).

Killer whales sighted in HRC are most likely animals from the Hawaiian stock. Off CAL-BCPM, the stocks most likely to occur are the Offshore and the West Coast Transient stocks, although members of the Southern Resident Stock may seasonally be found off central and northern California.

HRC. Bradford et al. (2021) report a uniform density value for killer whale of 0.00007 animals/km^2 (CV = 1.06) that is applicable to the HRC study area and western portion of the transit corridor. This represents an improvement to the density estimate used previously in the Navy's Phase III analyses as it is based on multiple-covariate line-transect analyses of sighting data collected on three surveys of waters within the Hawaiian Islands EEZ in 2002, 2010, and 2017. The Bradford et al. (2021) estimate for the most recent year (2017) is considered a year-round estimate since available data are insufficient to identify any seasonal patterns in the distribution of killer whales.

CAL-BCPM. A combination of movement data (from both visual observations and satellite-linked tags) and detections from stationary acoustic recorders have provided information on the distribution of the Southern Resident stock of killer whale in waters off the U.S. West Coast (Hanson et al., 2018). These data have been used to develop state space movement models that provide estimates of the probability of occurrence (or relative density) of Southern Residents outside the Salish Sea, where they typically spend the majority of their time (Hanson et al., 2018). Since the total number of animals that comprise each pod is known, the relative density estimates were used in association with the total abundance estimates to derive absolute density estimates (i.e., number of animals/km^2) in U.S. West Coast waters. Of the three pods, the K and L pods appear to have a more extensive and seasonally variable offshore coastal distribution, with rare sightings as far south as Monterey Bay, California (Carretta et al., 2019; Ford et al., 2000; Hanson et al., 2018). Based on the Hanson et al. (2018) analyses, members of the K and L pods may occur within the northern coastal portion of the HCTT study area from January to May, with zero density expected the rest of the year.

Due to the difficulties associated with reliably distinguishing the different stocks of killer whales from at-sea sightings, density estimates for the rest of the stocks are presented as a whole (i.e., includes the Offshore and West Coast Transient stocks). Barlow (2016) provides a stratified uniform density estimate for killer whale of 0.00013 animals/km^2 (CV = 0.93) for waters off Southern California, 0.00041 animals/km^2 (CV = 1.24) for waters off Central California, and 0.00051 animals/km^2 (CV = 1.12) for waters off Northern California. In the absence of seasonally specific data, these values were used to represent density year-round. For the Phase III analysis, the same estimate for Southern California was used; however, given the expanded HCTT Study Area, the estimates for the additional strata off California were entered into the NMSDD for the Phase IV analyses.

Ferguson and Barlow (2003) provide density values for areas off BCPM. For the Navy's Phase IV analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the HCTT acoustic modeling footprint and resulted in a killer whale density estimate of 0.00005 animals/km^2 (CV = 1.00). In the BCPM waters, the same value is used for all seasons since seasonally specific values are not currently available.

Table 6-9: Summary of Density Values for Killer Whale in the Hawaii-California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.00007	0.00007	0.00007	0.00007
W. Transit Corridor	0.00007	0.00007	0.00007	0.00007
E. Transit Corridor	0.00013	0.00013	0.00013	0.00013
CAL: North	0.00051	0.00051	0.00051	0.00051
CAL: Central	0.00041	0.00041	0.00041	0.00041
CAL: South	0.00013	0.00013	0.00013	0.00013
BCPM	0.00005	0.00005	0.00005	0.00005
Southern Resident Stock: CAL	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.

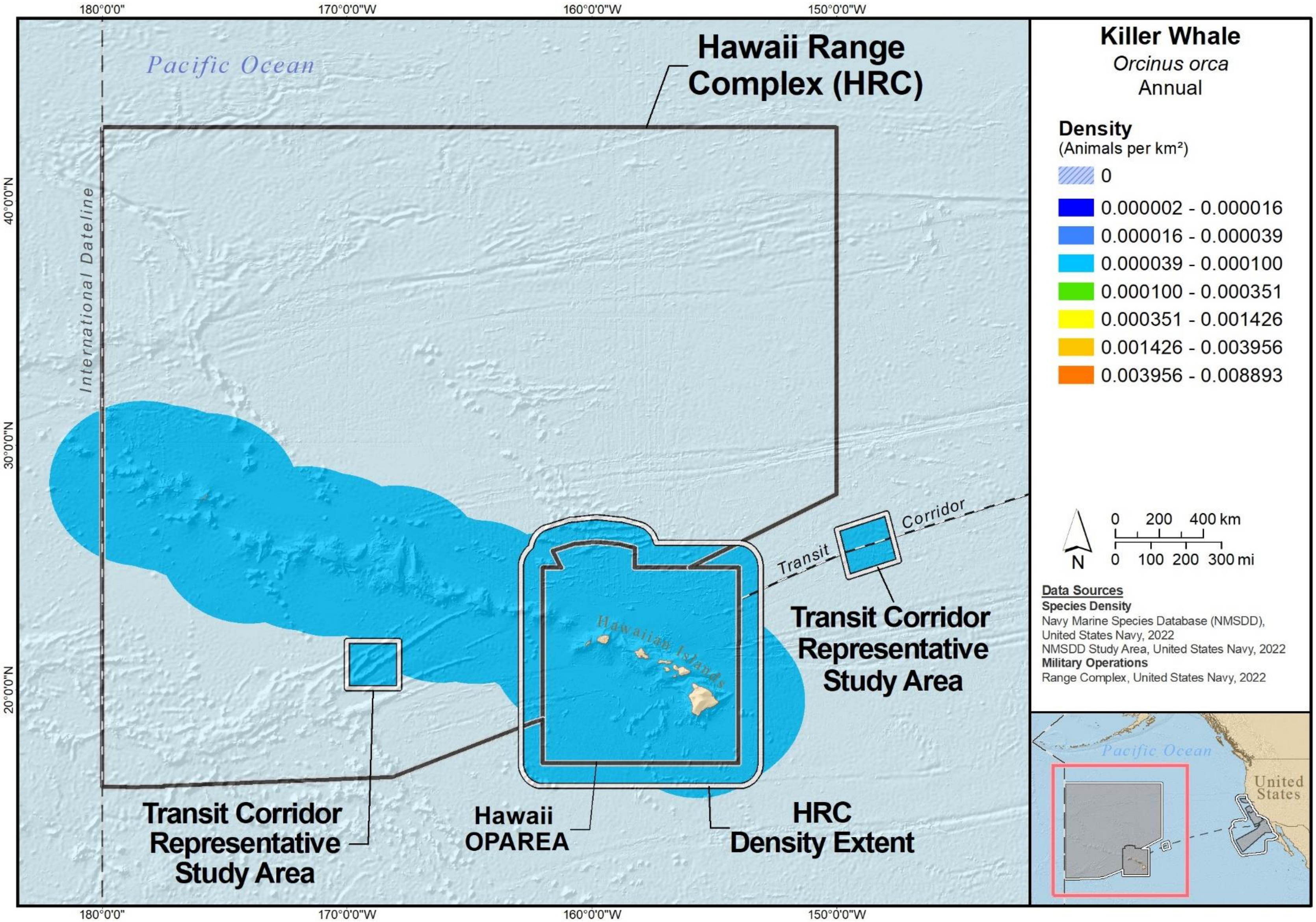

Figure 6-22: Annual Distribution of Killer Whale in HRC and the Western Portion of the Transit Corridor

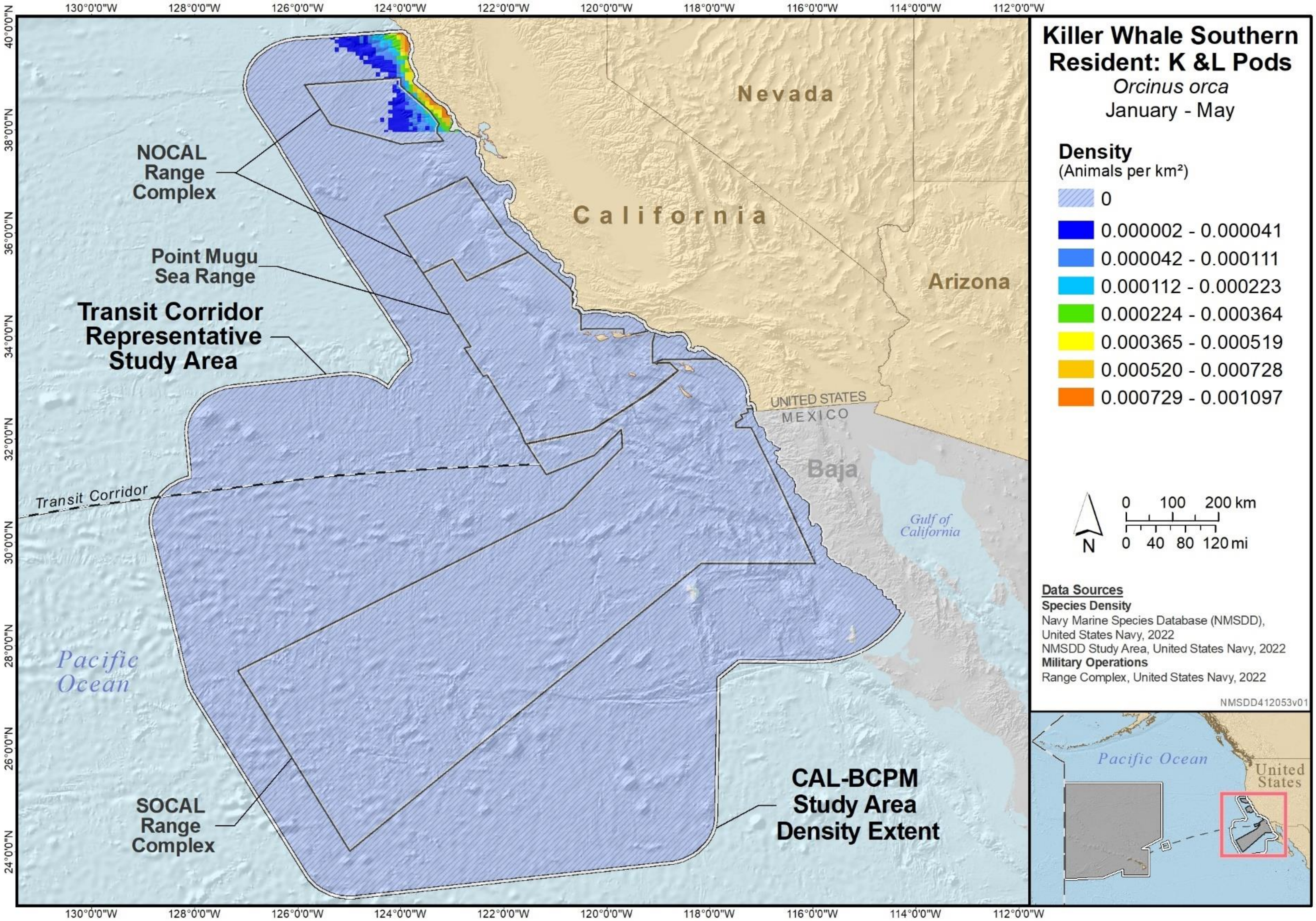

Figure 6-23: January to May Distribution of Killer Whale Southern Resident Stock in CAL-BCPM and the Eastern Portion of the Transit Corridor

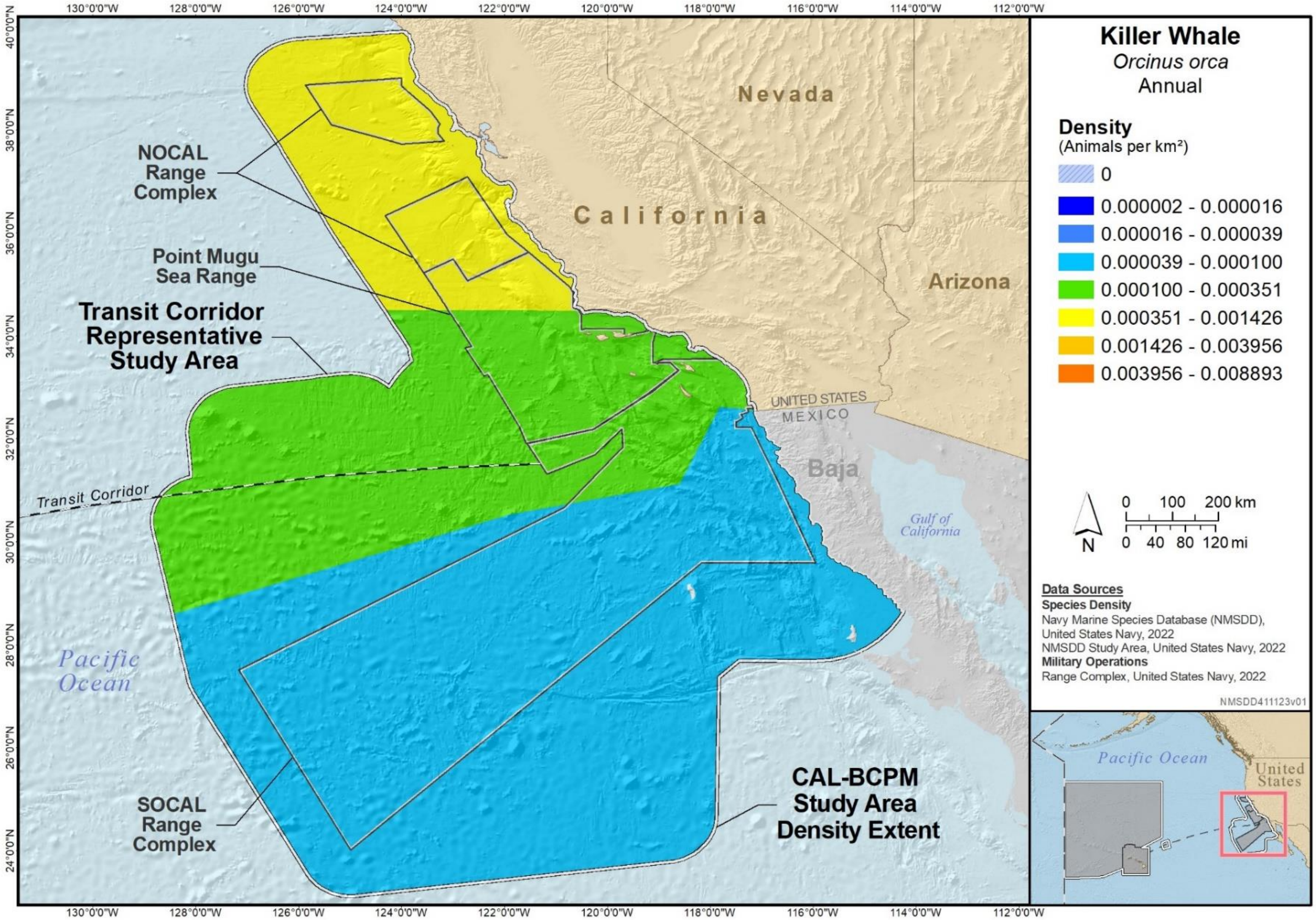

Figure 6-24: Annual Distribution of Killer Whale (all stocks) in CAL-BCPM and the Eastern Portion of the Transit Corridor

6.10 *PEPONOCEPHALA ELECTRA*, MELON-HEADED WHALE

NMFS recognizes two Pacific melon-headed whale 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., 2022). 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.

HRC: Hawaiian Islands Stock. Bradford et al. (2021) report a uniform density value for the Hawaiian Islands stock of melon-headed whale of 0.01661 animals/km^2 (CV = 0.74) that is applicable to the HRC study area and western portion of the transit corridor. This represents an improvement to the density estimate used previously in the Navy's Phase III analyses as it is based on multiple-covariate line-transect analyses of sighting data collected on three surveys of waters within the Hawaiian Islands EEZ in 2002, 2010, and 2017. The Bradford et al. (2021) estimate for the most recent year (2017) is considered a year-round estimate since available data are insufficient to identify any seasonal patterns in the distribution of melon-headed whales.

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

Table 6-10: Summary of Density Values for Melon-Headed Whale in the Hawaii-California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC: Hawaiian Islands Stock (insular range)	0.100	0.100	0.100	0.100
HRC: Hawaiian Islands Stock	0.01661	0.01661	0.01661	0.01661
W. Transit Corridor: Hawaiian Islands Stock	0.01661	0.01661	0.01661	0.01661
E. Transit Corridor	0	0	0	0
CAL	0	0	0	0
BCPM	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.

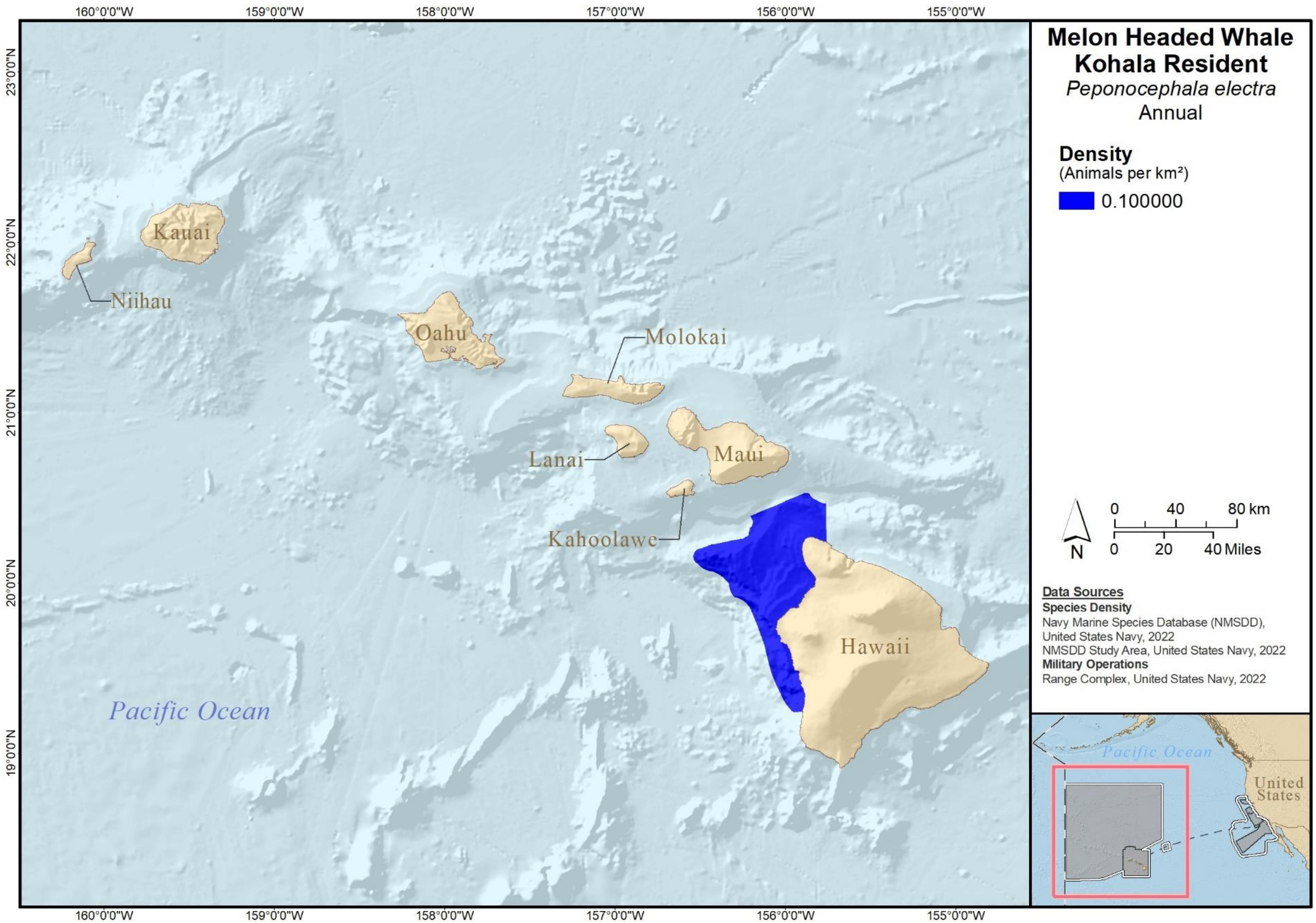

Figure 6-25: Annual Distribution of Melon-Headed Whale Kohala Resident in HRC and the Western Portion of the Transit Corridor

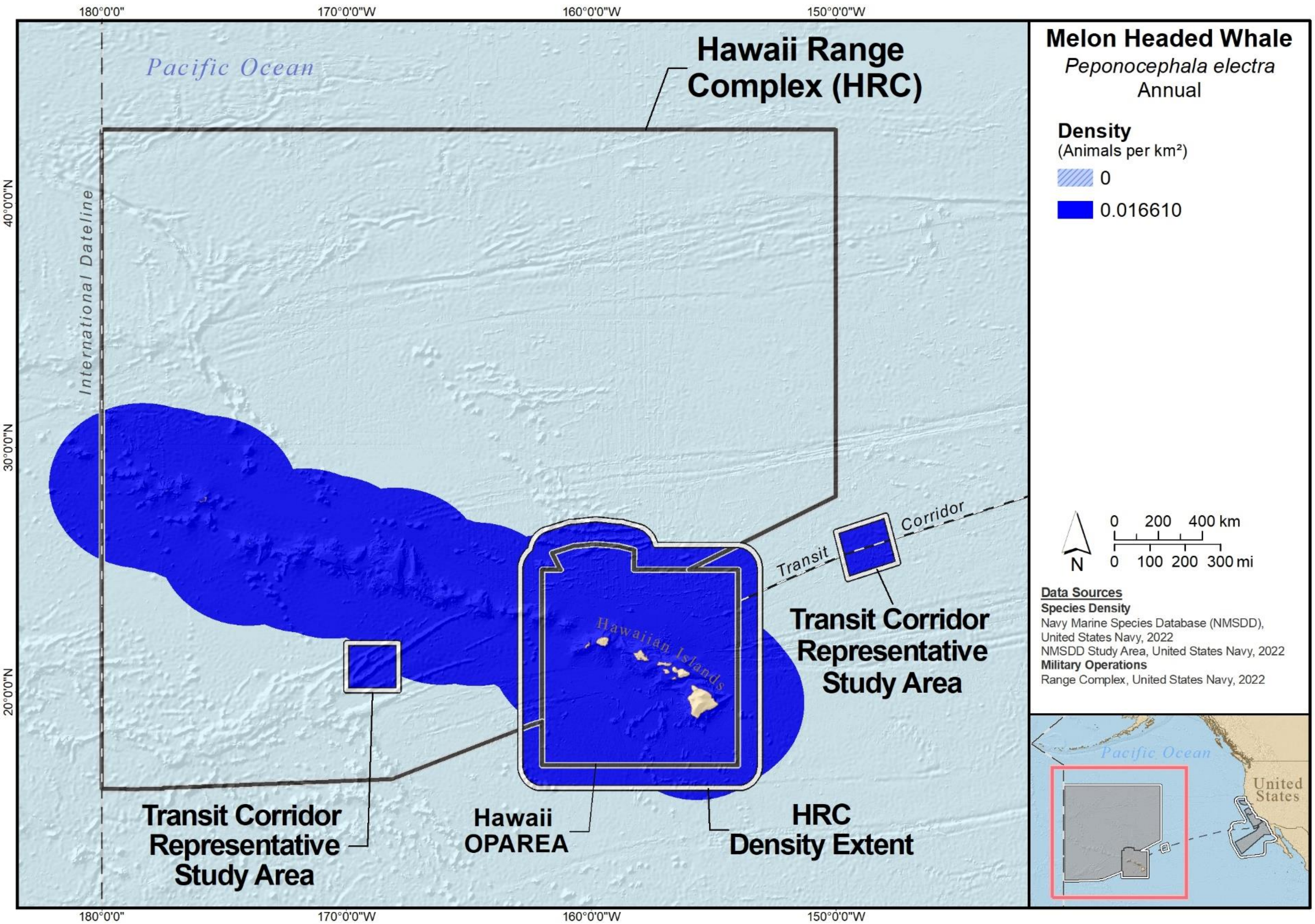

Figure 6-26: Annual Distribution of Melon-Headed Whale in HRC and the Western Portion of the Transit Corridor

6.11 *PSEUDORCA CRASSIDENS*, FALSE KILLER WHALE

NMFS currently recognizes three stocks of false killer whale in Hawaiian waters: the Main Hawaiian Islands insular stock, the Northwestern Hawaiian Islands stock, and the Hawaii pelagic stock (Carretta et al., 2022). 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.

HRC: Main Hawaiian Islands Insular Stock. Bradford et al. (2018) used photo-identification and mark-recapture methods to estimate annual abundance of the Main Hawaiian Islands insular stock of false killer whales from 2000 to 2015. The data came from both dedicated and opportunistic surveys around the Main Hawaiian Islands and thus may underestimate the true population abundance due to spatiotemporal sampling bias. However, the 2015 estimate of 167 animals (CV = 0.14) was within the range of the 16 annual estimates (144 to 187 animals) and similar to previously published multi-year aggregated estimates (Olesen et al., 2010). The resulting density estimate for this stock is 0.00057 animals/km^2 (CV = 0.14), which is applicable to the published range of this species which extends within a modified 72 km radius around the Main Hawaiian Islands (Carretta et al., 2022).

HRC: Northwestern Hawaiian Islands Stock. Bradford et al. (2020) provide abundance estimates for the Northwestern Hawaiian Islands Stock of false killer whale based on multiple-covariate line-transect analyses of sighting data collected on three surveys of waters within the Hawaiian Islands EEZ in 2002, 2010, and 2017. The Bradford et al. (2020) estimate (0.00106 animals/km^2, CV = 1.71) for the most recent year (2017) is considered a year-round estimate for this stock within its approximate 449,801 km^2 area range boundaries. This estimate represents a substantial improvement since Phase III, when density estimates for the Northwestern Hawaiian Islands and Hawaii Pelagic stocks were combined.

HRC: Hawaii Pelagic Stock. Sighting data collected from systematic ship surveys within the central Pacific between 1986 and 2017, including the three Hawaiian Islands EEZ surveys in 2002, 2010, and 2017, supported the development of a habitat-based density model specific to the Hawaii Pelagic Stock of false killer whale (Becker et al., 2021; Bradford et al., 2020). This represents a substantial improvement from Phase III, when the available density estimates were not stock specific (Forney et al., 2015). Improvements were also recognized because the new model more accurately accounted for bias in group size estimates and variation in detection probabilities, and provided finer-scale density predictions (~9 km x 9 km resolution vs. the previous ~25 km x 25 km resolution) that better accounted for uncertainty. The updated false killer whale spatial model was applied to all seasons for the acoustic modeling areas associated with HRC and the western portion of the transit corridor.

CAL-BCPM. 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 California waters during any of the NMFS ship surveys, no density estimates are available. Further, given their extralimital occurrence, a zero density was assigned to waters off California.

False killer whales do occur in waters off the BCPM within the HCTT Study Area (Hamilton et al., 2009). Ferguson and Barlow (2003) provide density values for areas off BCPM. For the Navy's Phase IV analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the HCTT acoustic modeling footprint and resulted in a false killer whale density estimate of 0.00242 animals/km^2 (CV = 0.71). In the BCPM waters, the same value is used for all seasons since seasonally specific values are not currently available.

Table 6-11: Summary of Density Values for False Killer Whale in the Hawaii-California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC: Main Hawaiian Islands Insular Stock (range specific)	0.00057	0.00057	0.00057	0.00057
HRC: Northwestern Hawaiian Islands Stock (range specific)	0.00106	0.00106	0.00106	0.00106
HRC: Hawaii Pelagic Stock	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	0	0	0	0
CAL	0	0	0	0
BCPM	0.00242	0.00242	0.00242	0.00242

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

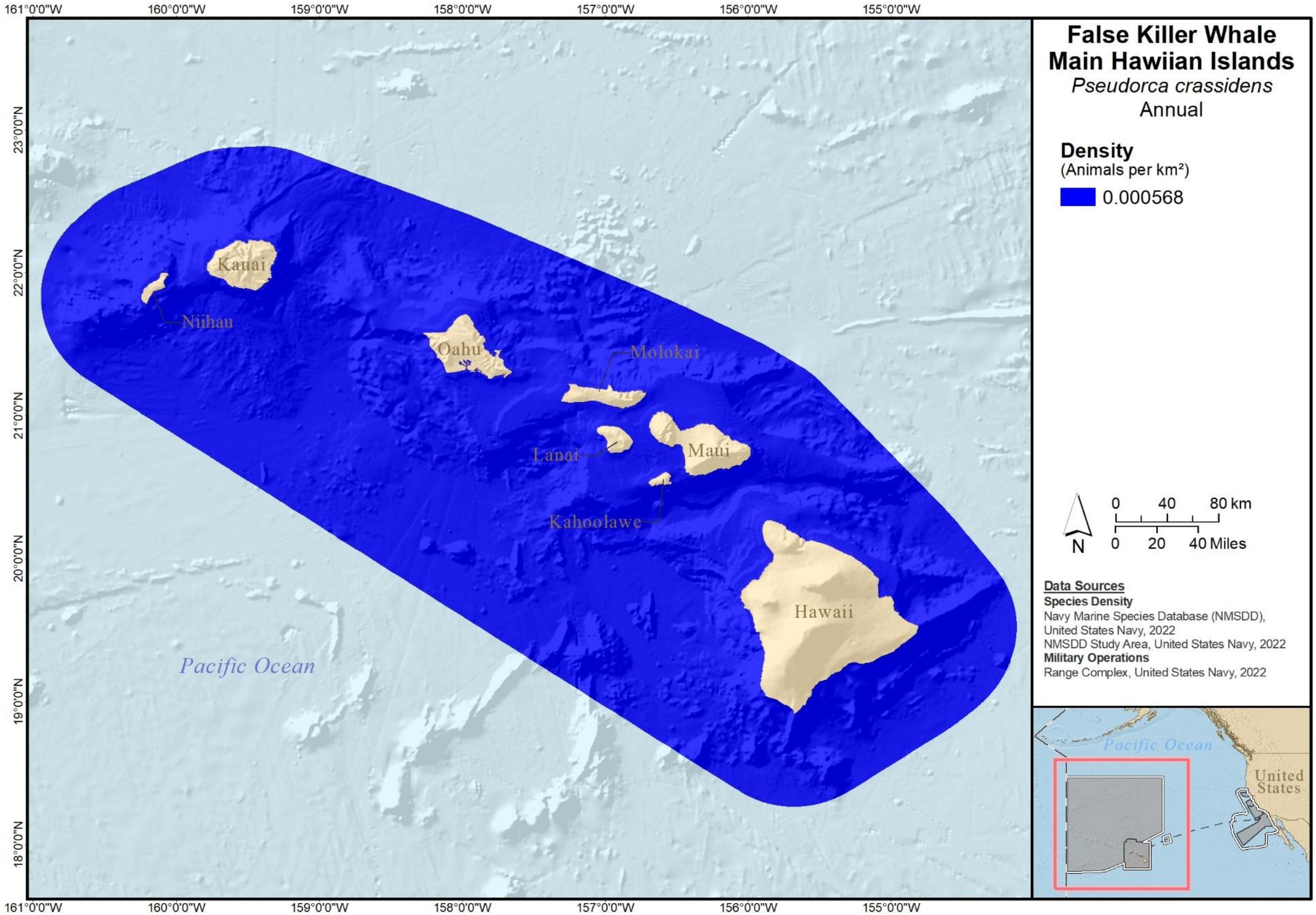

Figure 6-27: Annual Distribution of False Killer Whale Main Hawaiian Islands Stock in HRC and the Western Portion of the Transit Corridor

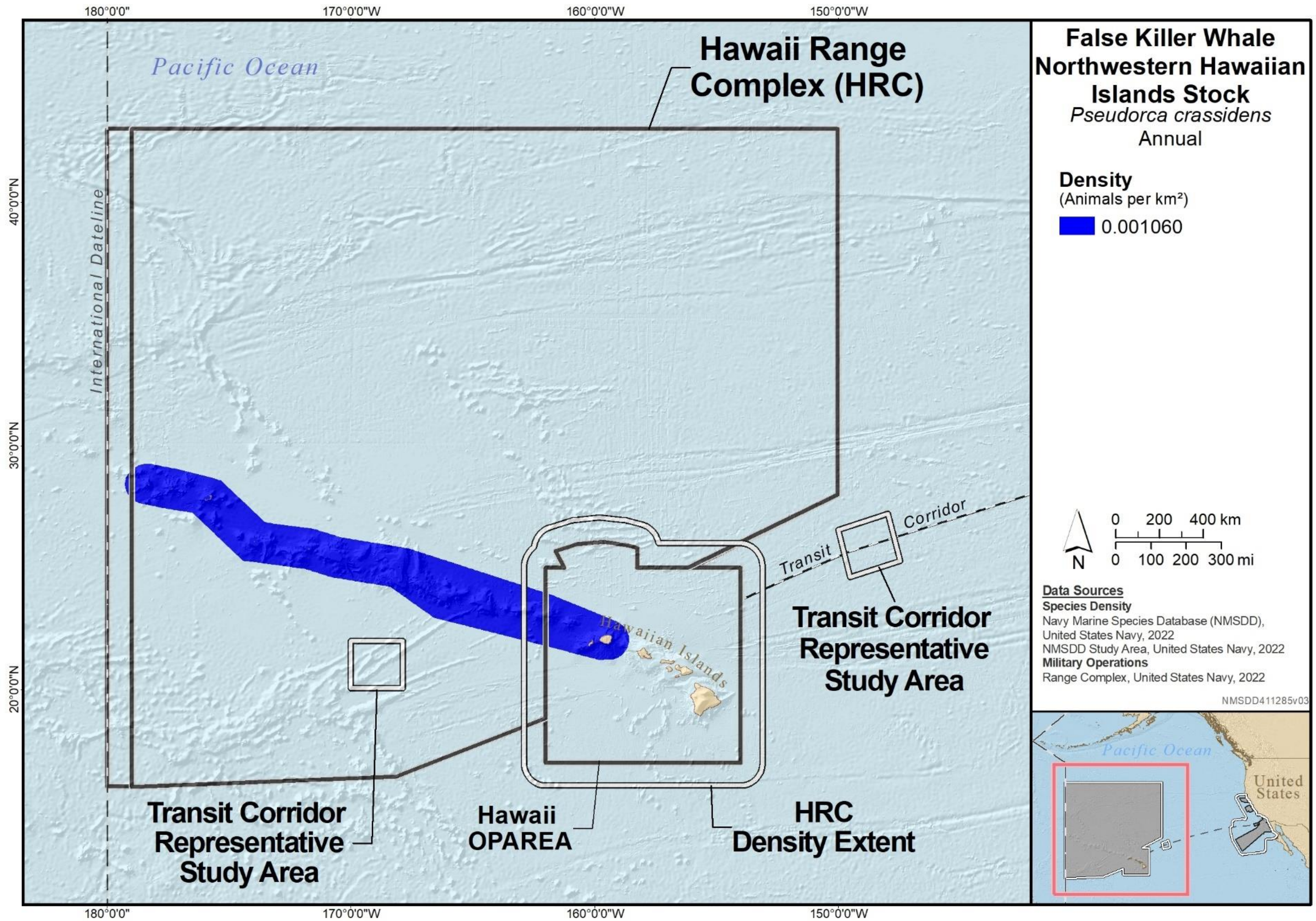

Figure 6-28: Annual Distribution of False Killer Whale Northwestern Hawaiian Islands Stock in HRC and the Western Portion of the Transit Corridor

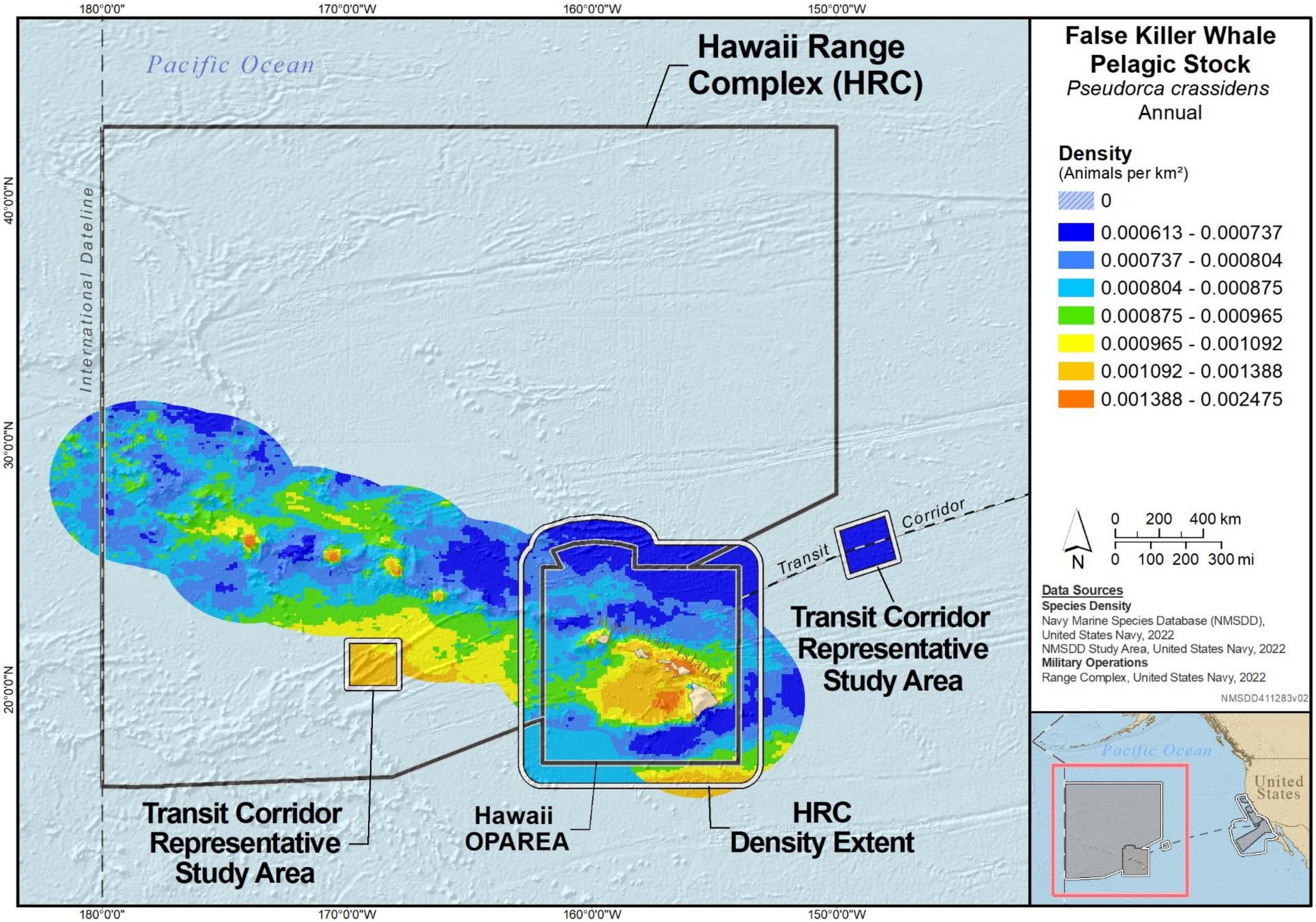

Figure 6-29: Annual Distribution of False Killer Whale Pelagic Stock in HRC and the Western Portion of the Transit Corridor

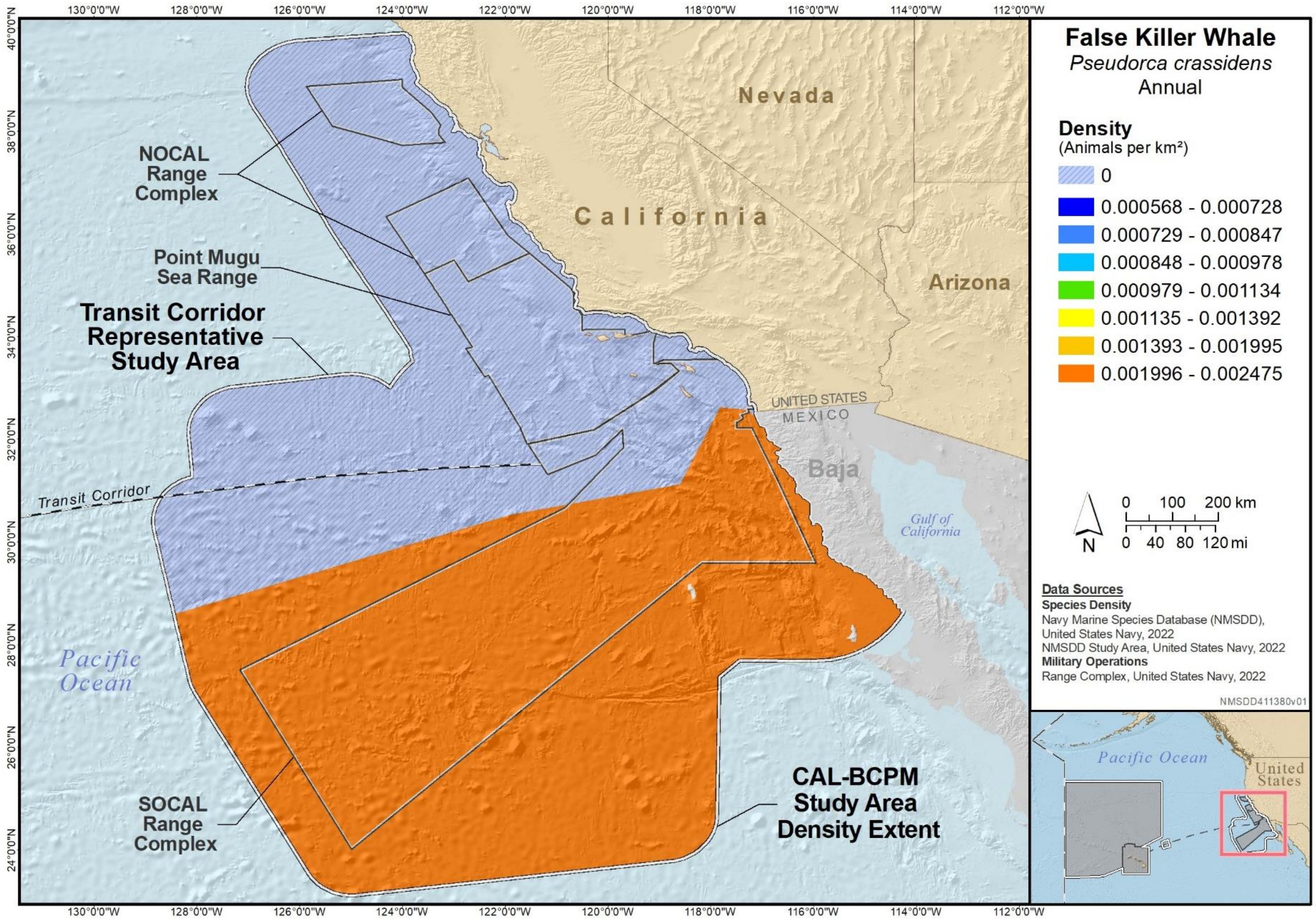

Figure 6-30: Annual Distribution of False Killer Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

6.12 *Stenella attenuata*, Pantropical Spotted Dolphin

NMFS recognizes four management stocks of pantropical spotted dolphin 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., 2022). Spotted dolphins in the eastern tropical Pacific are managed separately (Carretta et al., 2022).

HRC: Oahu/4-Islands/Hawaii Island Stocks. New survey data collected by NMFS within the Exclusive Economic Zone of the Hawaiian Islands, including the Main Hawaiian Islands, supported the derivation of the first habitat-based density model for the insular stocks of spotted dolphin in this study area (Becker et al., 2022b). The new habitat-based density model for the insular stocks of spotted dolphin represents an improvement to the uniform density values used in Phase III because it provides spatially explicit density estimates. The model was applied to all seasons within the range of the respective stock boundaries.

HRC: Hawaii Pelagic Stock. New survey data collected by NMFS within the Exclusive Economic Zone of the Hawaiian Islands supported the derivation of updated spotted dolphin density estimates from model-based analyses (Becker et al., 2022b). The new habitat-based density model for spotted dolphin represents an improvement to the model available for Phase III (Forney et al., 2015) because it more accurately accounted for bias in group size estimates and variation in detection probabilities, and provided finer-scale density predictions (~9 km x 9 km resolution vs. the previous ~25 km x 25 km resolution) that better accounted for uncertainty. In addition, the new spotted dolphin model is specific to the pelagic stock (i.e., it was developed using only those sightings of animals identified as belonging to the pelagic stock), while the previous models were not stock-specific, but based on all spotted dolphin sightings. The updated spotted dolphin spatial model was applied to all seasons for the acoustic modeling areas associated with HRC and the two western representative transit corridors.

CAL-BCPM. This species is not expected to occur in waters off California or the eastern portion of the transit corridor, but does occur in waters off the BCPM within the HCTT Study Area (Hamilton et al., 2009). Ferguson and Barlow (2003) provide density values for areas off BCPM. For the Navy's Phase IV analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the HCTT acoustic modeling footprint and resulted in a spotted dolphin density estimate of 0.08622 animals/km^2 (CV = 0.46). In the BCPM waters, the same value is used for all seasons since seasonally specific values are not currently available.

Table 6-12: Summary of Density Values for Pantropical Spotted Dolphin in the Hawaii-California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC: Oahu Insular Stock (range specific)	S	S	S	S
HRC: 4-Islands Insular Stock (range specific)	S	S	S	S
HRC: Hawaii Island Insular Stock	S	S	S	S
HRC: Hawaii Pelagic Stock	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	0	0	0	0
CAL	0	0	0	0
BCPM	0.08622	0.08622	0.08622	0.08622

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

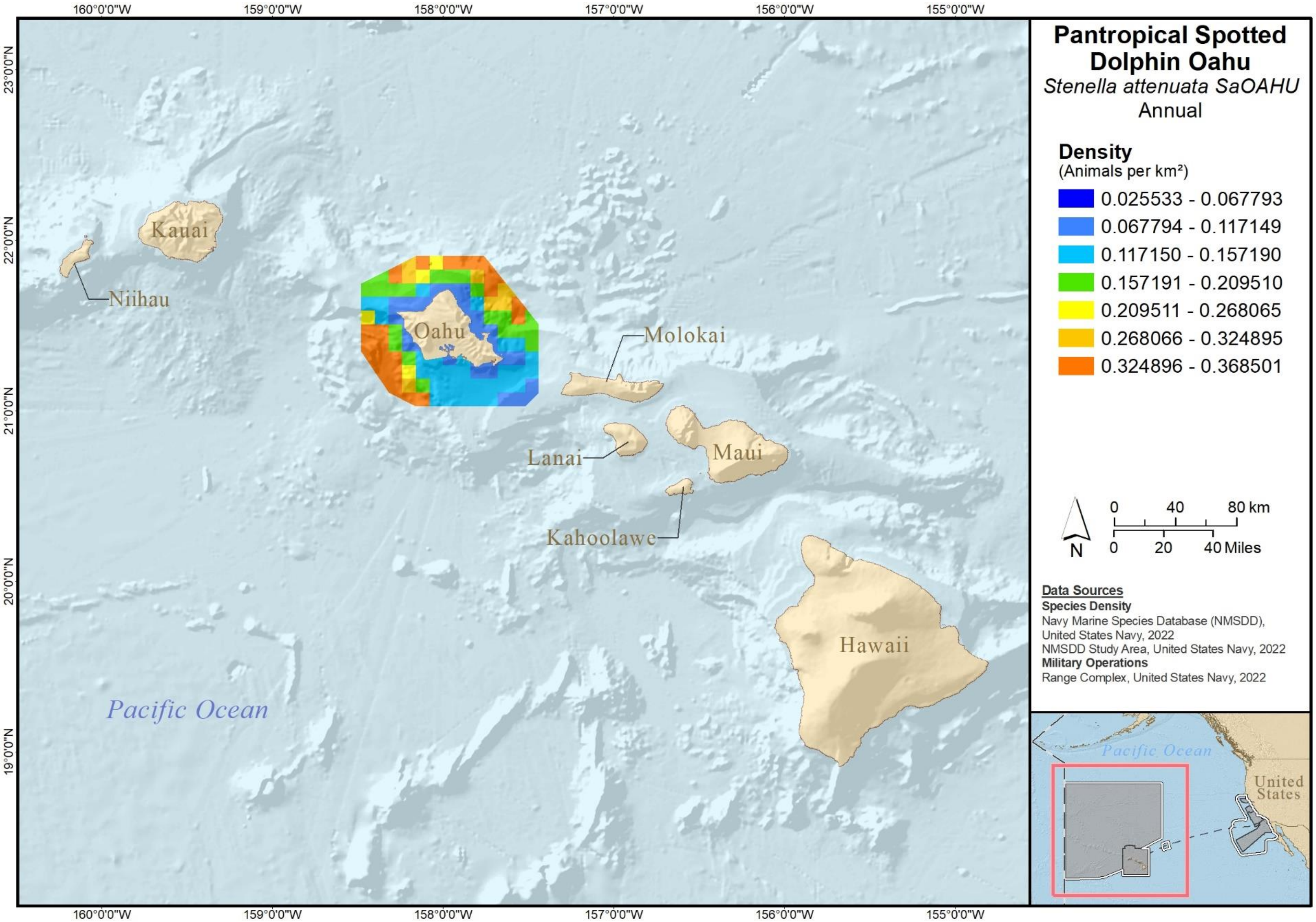

Figure 6-31: Annual Distribution of Pantropical Spotted Dolphin Oahu Stock in HRC and the Western Portion of the Transit Corridor

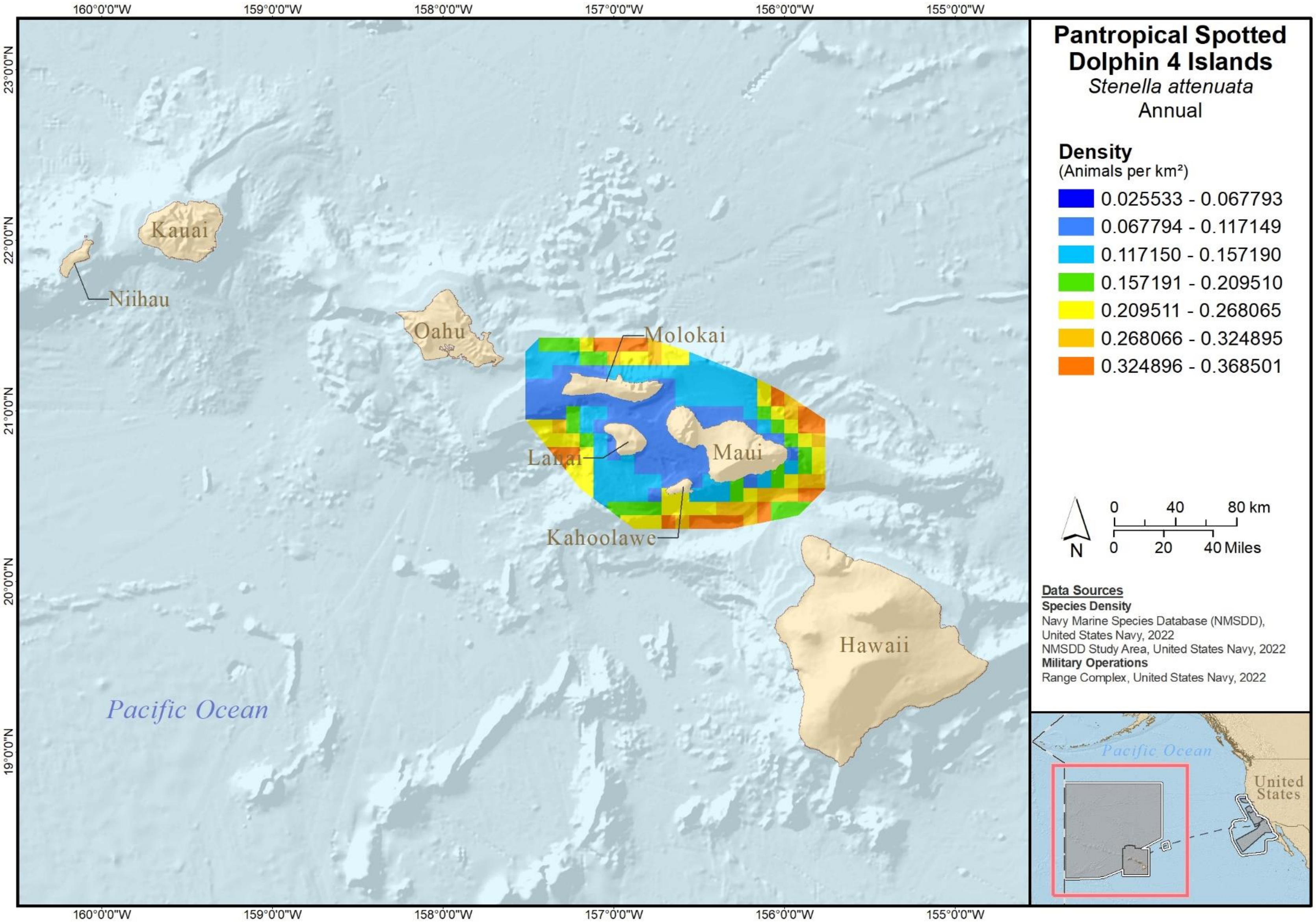

Figure 6-32: Annual Distribution of Pantropical Spotted Dolphin 4-Islands Stock in HRC and the Western Portion of the Transit Corridor

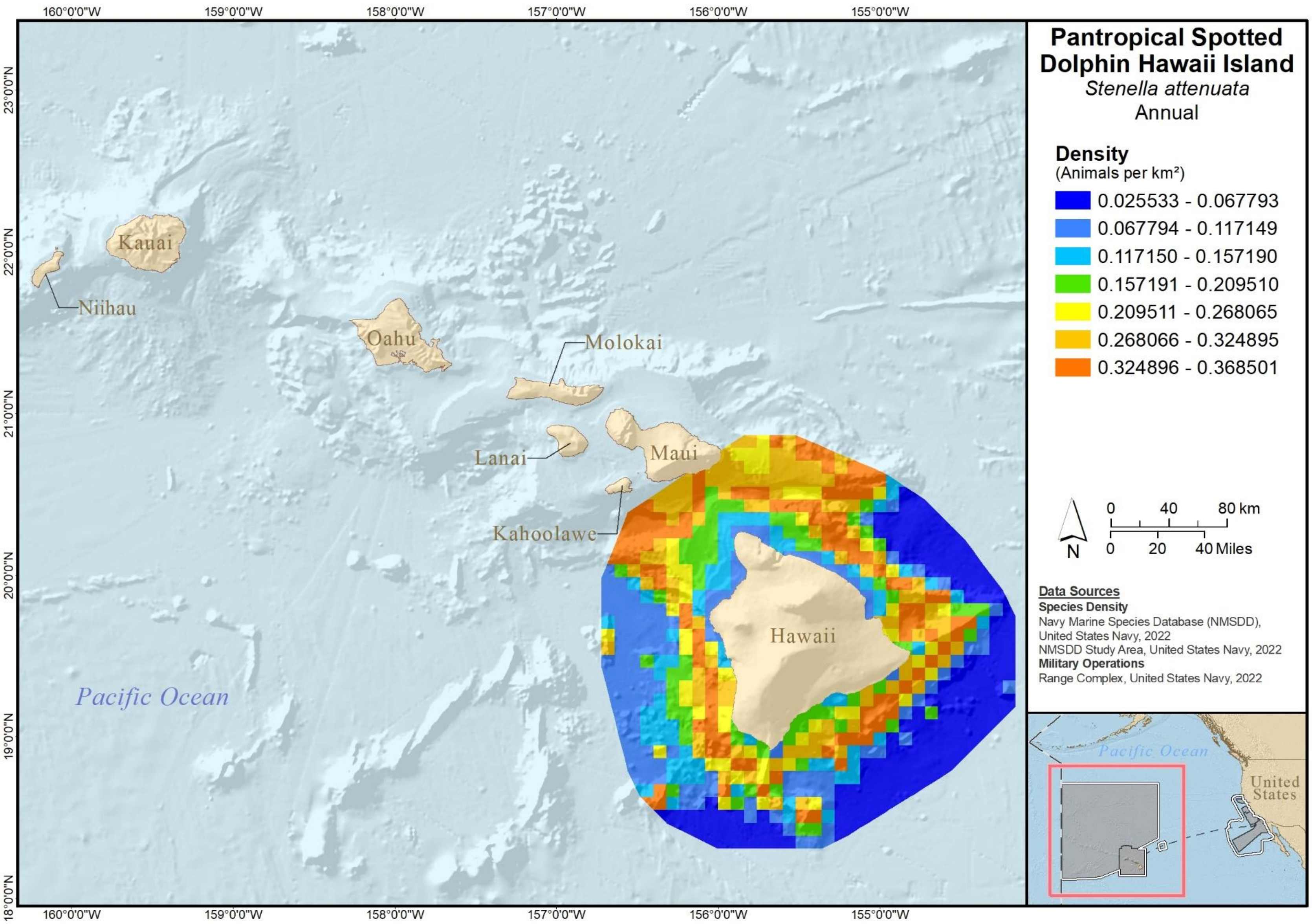

Figure 6-33: Annual Distribution of Pantropical Spotted Dolphin Hawaii Island Stock in HRC and the Western Portion of the Transit Corridor

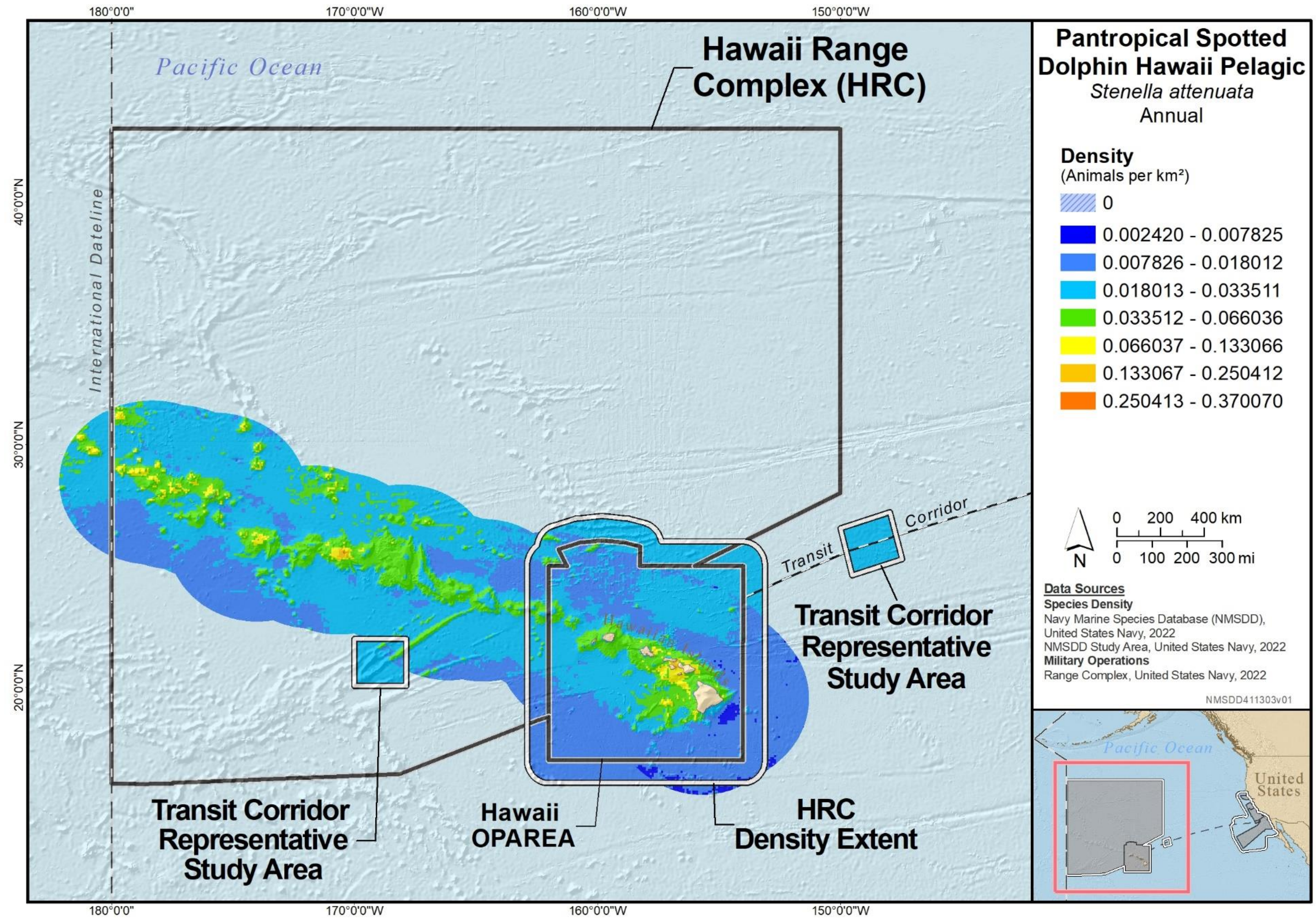

Figure 6-34: Annual Distribution of Pantropical Spotted Dolphin Hawaii Pelagic Stock in HRC and the Western Portion of the Transit Corridor

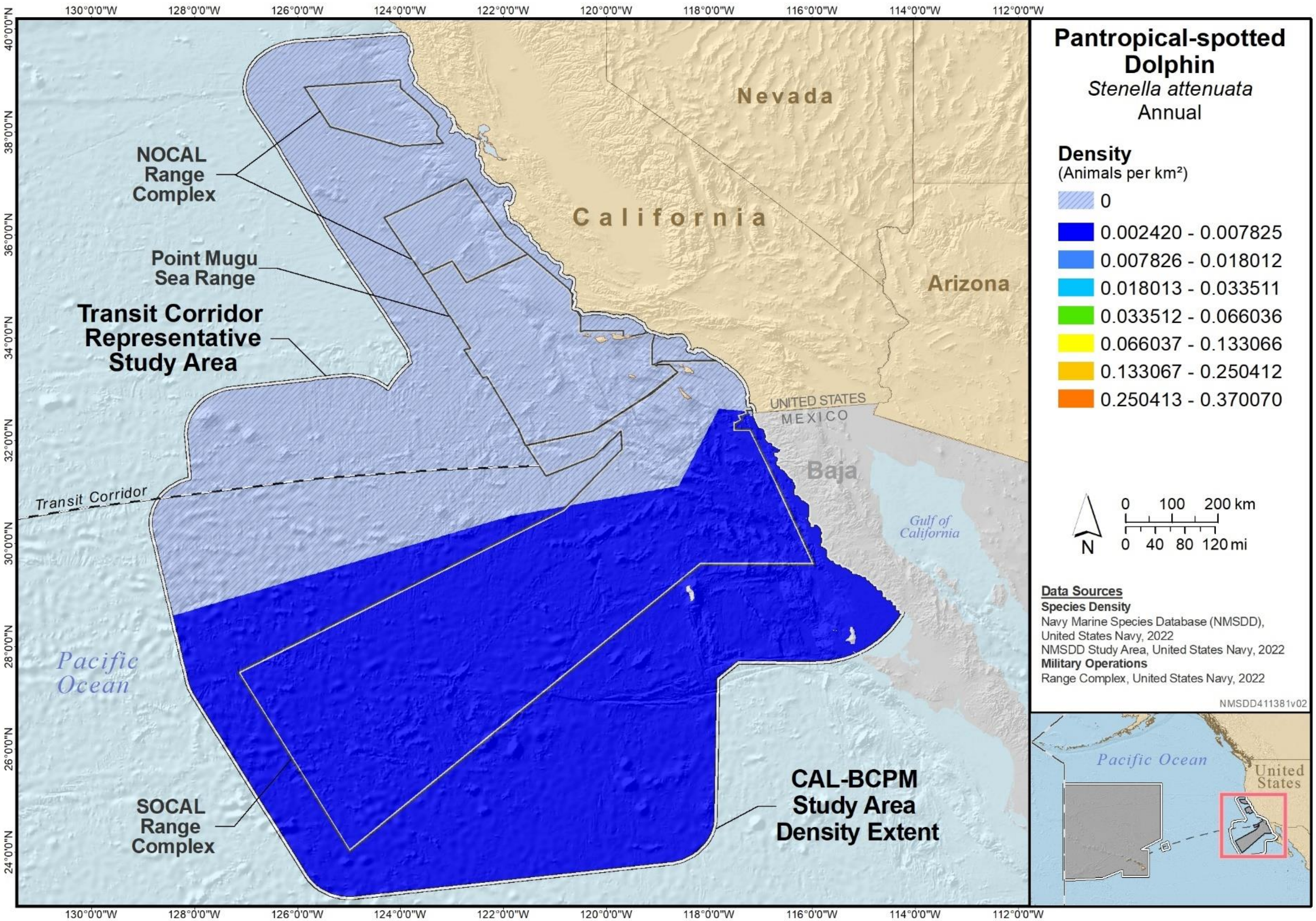

Figure 6-35: Annual Distribution of Pantropical Spotted Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

6.13 *STENELLA COERULEOALBA*, STRIPED DOLPHIN

NMFS recognizes two stocks of striped dolphin within the Pacific EEZ, a Hawaiian stock and a California/Oregon/Washington stock (Carretta et al., 2022). Animals in HRC or CAL-BCPM are assumed to belong to their respective stock.

HRC. New survey data collected by NMFS within the Exclusive Economic Zone of the Hawaiian Islands supported the derivation of updated striped dolphin density estimates from model-based analyses (Becker et al., 2022b). The new habitat-based density model for striped dolphin represents an improvement to the model available for Phase III (Forney et al., 2015) because it more accurately accounted for bias in group size estimates and variation in detection probabilities, and provided finer-scale density predictions (~9 km x 9 km resolution vs. the previous ~25 km x 25 km resolution) that better accounted for uncertainty. The updated striped dolphin spatial model was applied to all seasons for the acoustic modeling areas associated with HRC and the western portion of the transit corridor.

CAL-BCPM. The Phase III NMSDD included data from a CCE habitat-based density model for striped dolphins based on systematic survey data collected from 1991 to 2009 (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 models were updated to include additional systematic survey data collected in summer and fall of 2014 and 2018 (Becker et al., 2020a). Model improvements were recognized from additional sighting data collected off the continental shelf and slope, and the inclusion of a broader range of habitat conditions. In addition, recently developed techniques for deriving estimates of uncertainty (Miller et al., 2022) were used to provide more comprehensive variance estimates for the model-based predictions. Density estimates from the updated striped dolphin model were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area north of Point Conception (34.45 degrees N), as well as the eastern portion of the transit corridor for summer and fall.

Given that many cetacean species exhibit substantial seasonal variability in abundance and distribution in the CCE (e.g., Becker et al., 2017; Forney & Barlow, 1998), and the limited systematic survey data available for winter/spring, the CCE striped dolphin model for summer/fall was used to derive separate winter and spring estimates for waters off the U.S. West Coast using techniques designed to avoid spatial and temporal extrapolation (Becker et al., In Prep.). These estimates represent an improvement from Phase III, when the summer/fall estimates were used for all seasons. The new model-based analyses provide spatially explicit estimates which better capture species distribution patterns in the cool seasons (Becker et al., In Prep.). Density estimates from the striped dolphin model predictions were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for winter and spring.

In order to improve density estimates for Phase IV, the Navy funded an analysis to develop habitat-based density models for the Southern California Current, an ecologically meaningful study area that extends from Point Conception to the tip of the Baja California Peninsula. Resulting models provide the first spatially explicit estimates of striped dolphin density for waters off the Baja California Peninsula (Becker et al., 2022a), and were applied to the HCTT study area south of Point Conception. These density estimates represent a major improvement over density estimates previously used for Phase III (Ferguson & Barlow, 2003), because they are based on more recent survey data, they provide finer-scale density predictions (9 km x 9 km grid resolution vs. the 5° x 5° grid resolution available for density estimates used in Phase III), and improved, spatially explicit estimates of uncertainty. Model-derived density estimates were applied to the BCPM region year-round since seasonally specific values are not currently available.

Table 6-13: Summary of Density Values for Striped Dolphin in the Hawaii-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
CAL	S	S	S	S
BCPM	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.

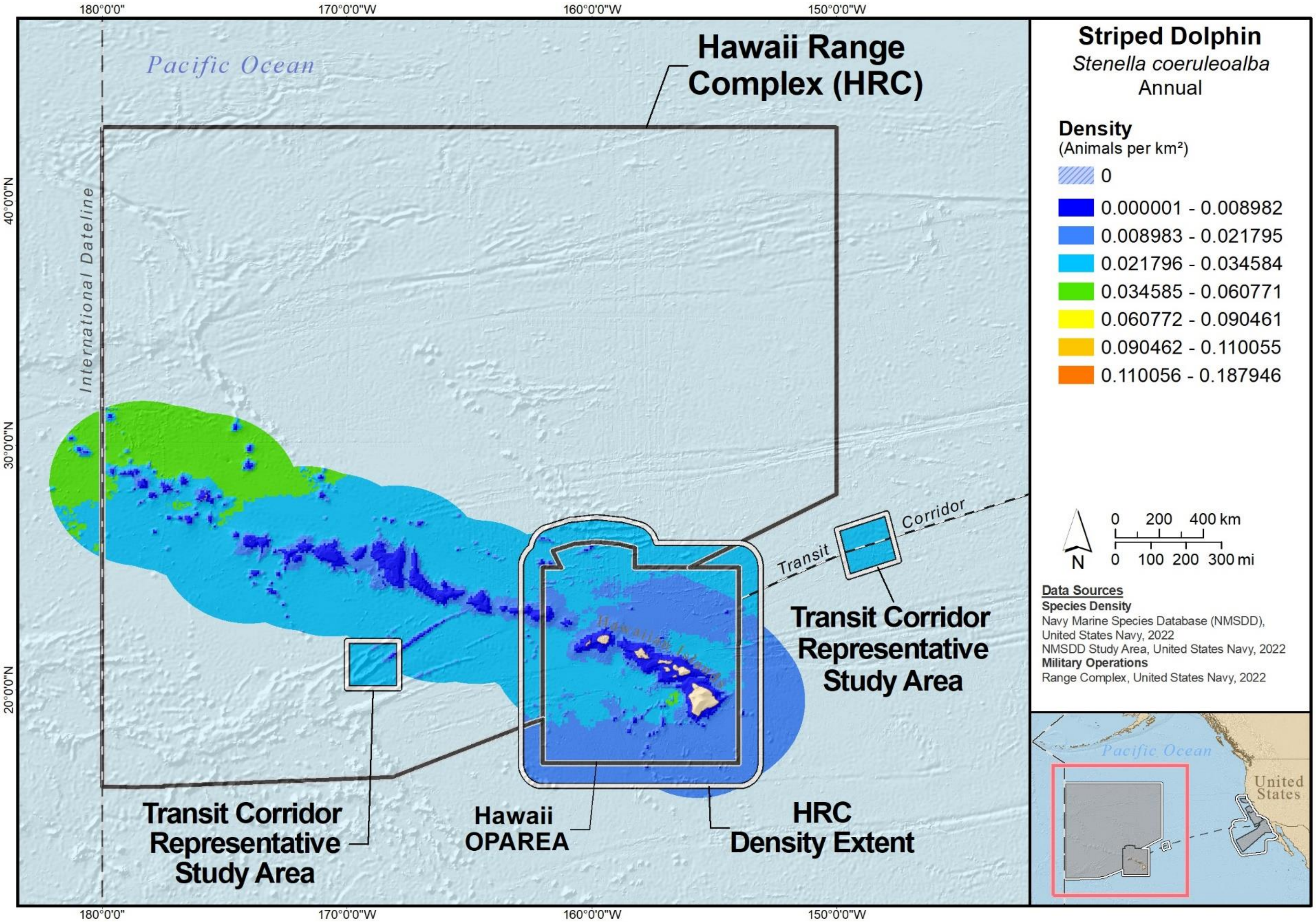

Figure 6-36: Annual Distribution of Striped Dolphin in HRC and the Western Portion of the Transit Corridor

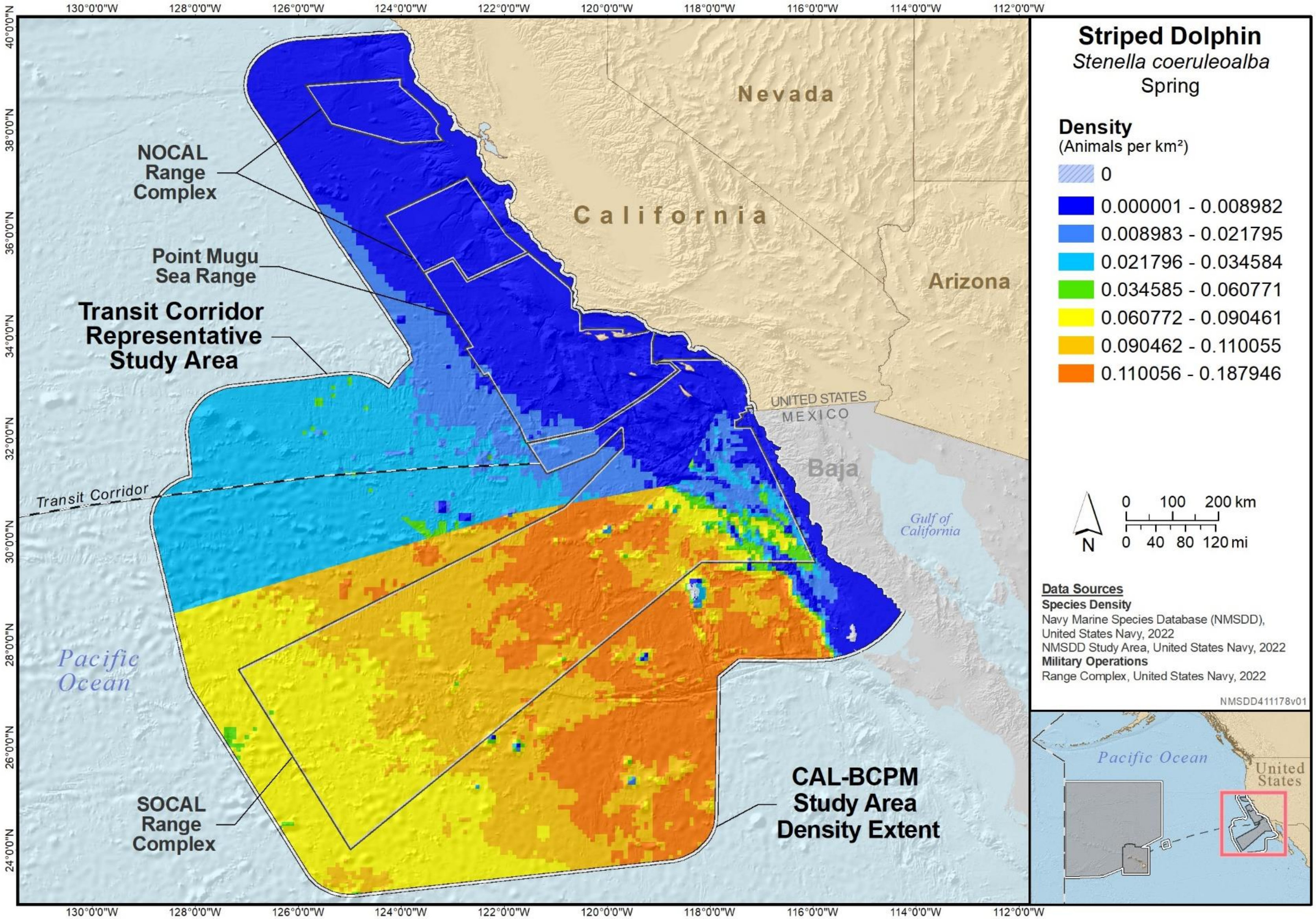

Figure 6-37: Spring Distribution of Striped Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

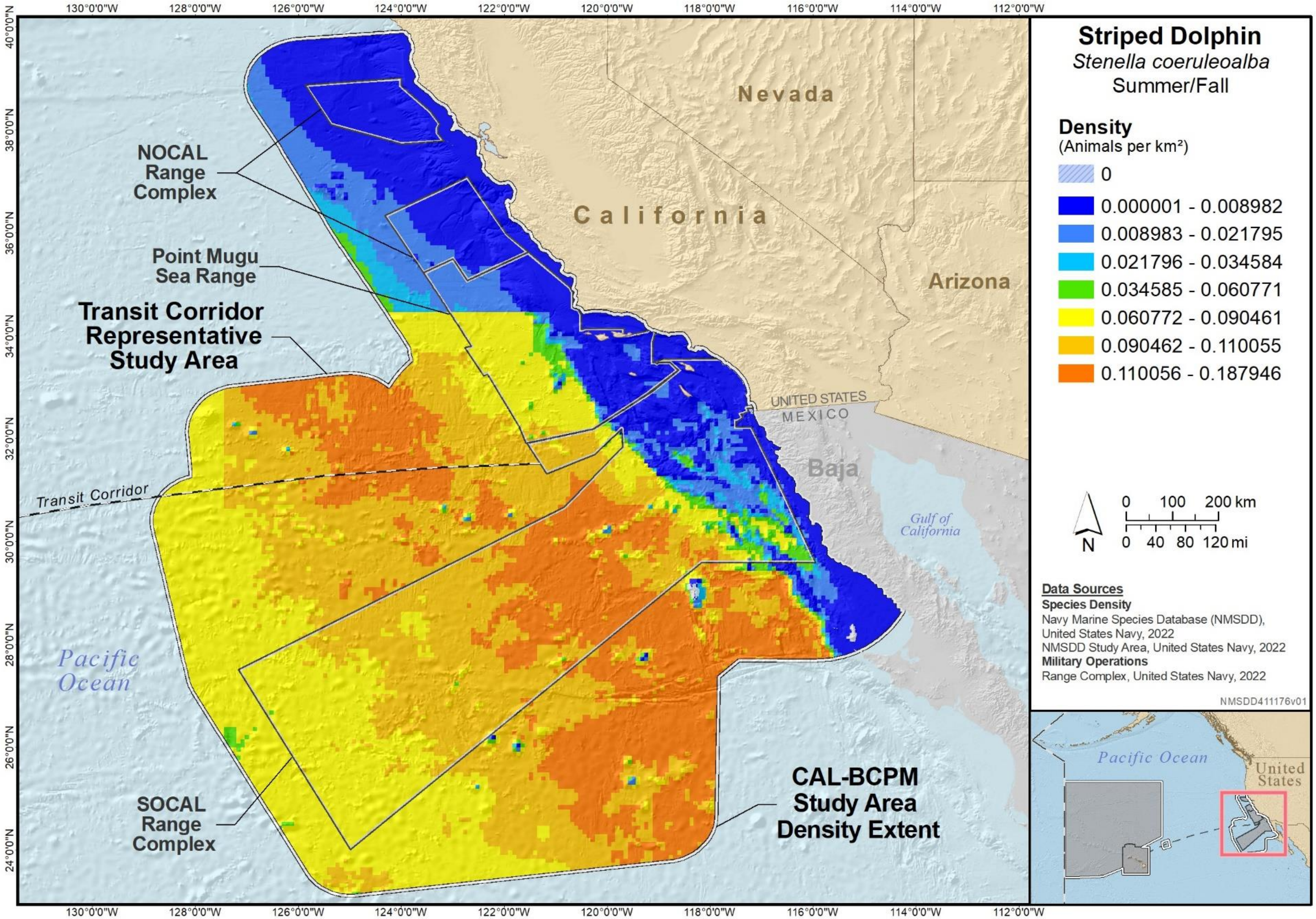

Figure 6-38: Summer/Fall Distribution of Striped Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

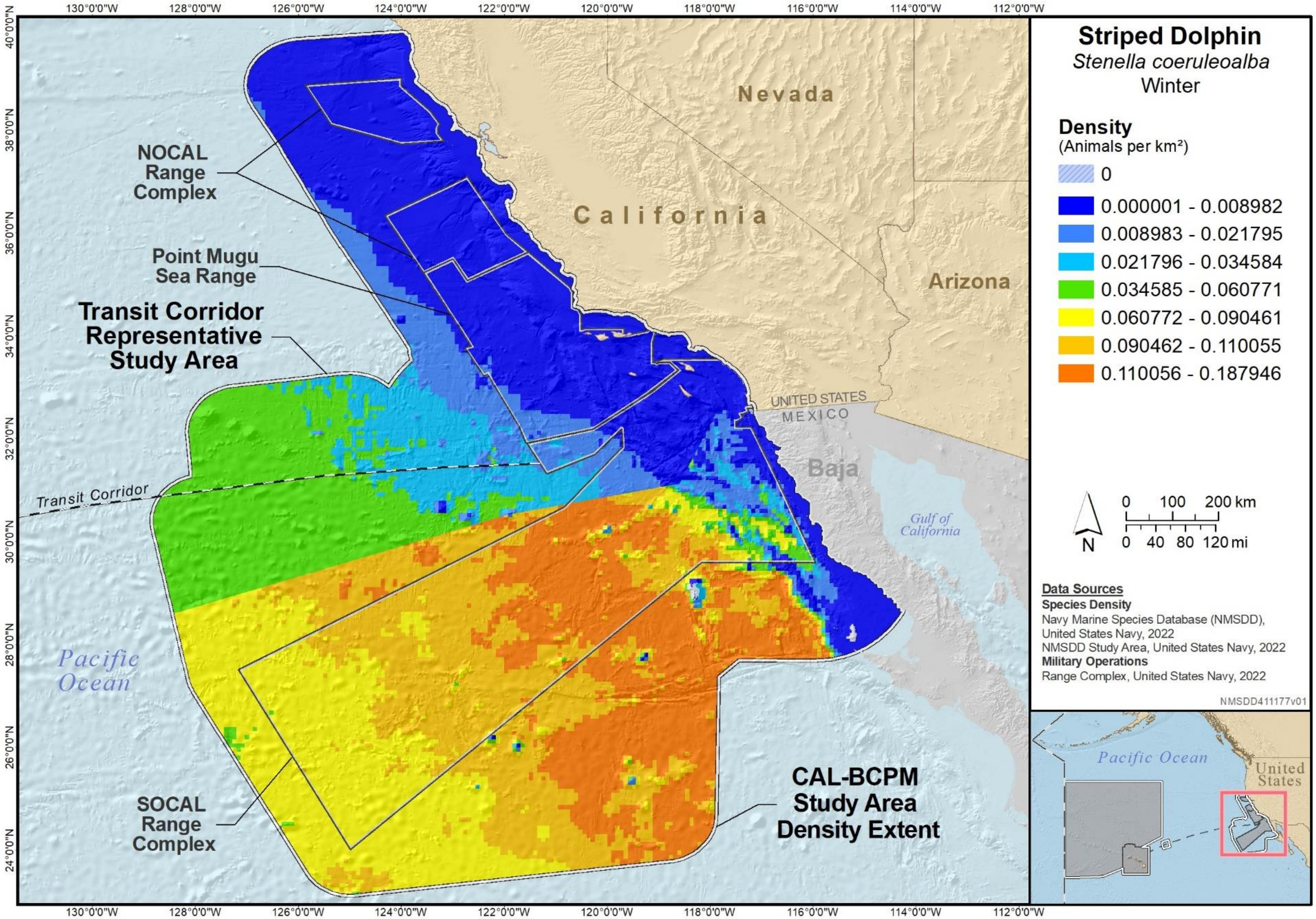

Figure 6-39: Winter Distribution of Striped Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

6.14 *STENELLA LONGIROSTRIS*, SPINNER DOLPHIN

NMFS recognizes six stocks of spinner dolphins within the Hawaiian Islands EEZ (Carretta et al., 2022), including 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., 2022). 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 year-round photo-identification surveys conducted from 2010 to 2012 (Tyne et al., 2016), the most recent (2012) abundance estimate for the Hawaii Island stock of spinner dolphins is 665 (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 0.070 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. This is updated from the 2011 estimate previously used for Phase III (Tyne et al., 2014).

HRC: Oahu/4-islands Stock. The most recent abundance available for this stock of spinner dolphins is that used for Phase III, which was based on analyses by (Hill et al., 2011). The Hill et al. (2011) 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.

HRC: Kauai/Niihau Stock. The most recent abundance available for this stock of spinner dolphins is that used for Phase III, which was based on analyses by (Hill et al., 2011). The Hill et al. (2011) 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.

HRC: Hawaii Pelagic Stock. The limited number of on-effort sightings of spinner dolphins during ship surveys conducted by NMFS within the Exclusive Economic Zone of the Hawaiian Islands (12 total for the 2002–2017 surveys) did not support the development of an updated habitat-based density model for this species (Becker et al., 2021). Forney et al. (2015) developed a habitat-based model for spinner dolphins using survey data collected within the central North Pacific from 1997 to 2012, and density predictions from this model were incorporated into the NMSDD for Phase III. Model predictions were available on a 25 km × 25 km spatial grid that covered the entire HRC and provided representative density values for the two western transit corridor study areas. The model was developed using all spinner dolphin sightings (i.e., not identified to stock), but given the transect coverage on the surveys that contributed data to the habitat model, most of the spinner dolphin sightings were from the Hawaii Pelagic stock. Since the model provides spatially explicit density estimates that better represent the distribution of this species in the study area, the Navy applied the modeled estimates to all seasons for HRC and the western portion of the transit corridor.

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

Table 6-14: Summary of Density Values for Spinner Dolphin in the Hawaii-California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC: Hawaii Island Stock (range specific)	0.070	0.070	0.070	0.070
HRC: Oahu/4-Islands Stock (range specific)	0.023	0.023	0.023	0.023
HRC: Kauai/Niihau Stock (range specific)	0.097	0.097	0.097	0.097
HRC: Hawaii Pelagic Stock	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	0	0	0	0
CAL	0	0	0	0
BCPM	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.

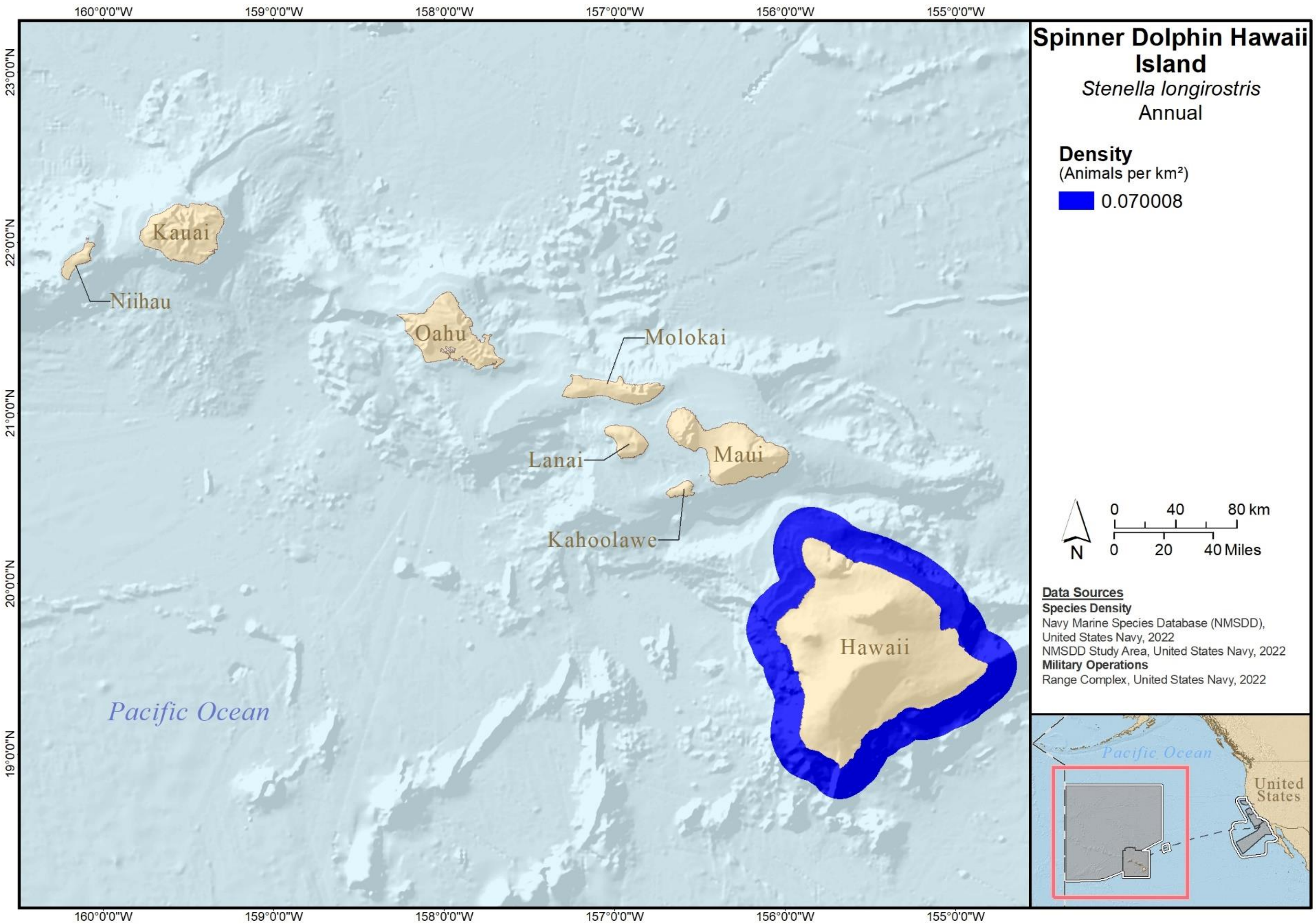

Figure 6-40: Annual Distribution of Spinner Dolphin Hawaii Island Stock in HRC and the Western Portion of the Transit Corridor

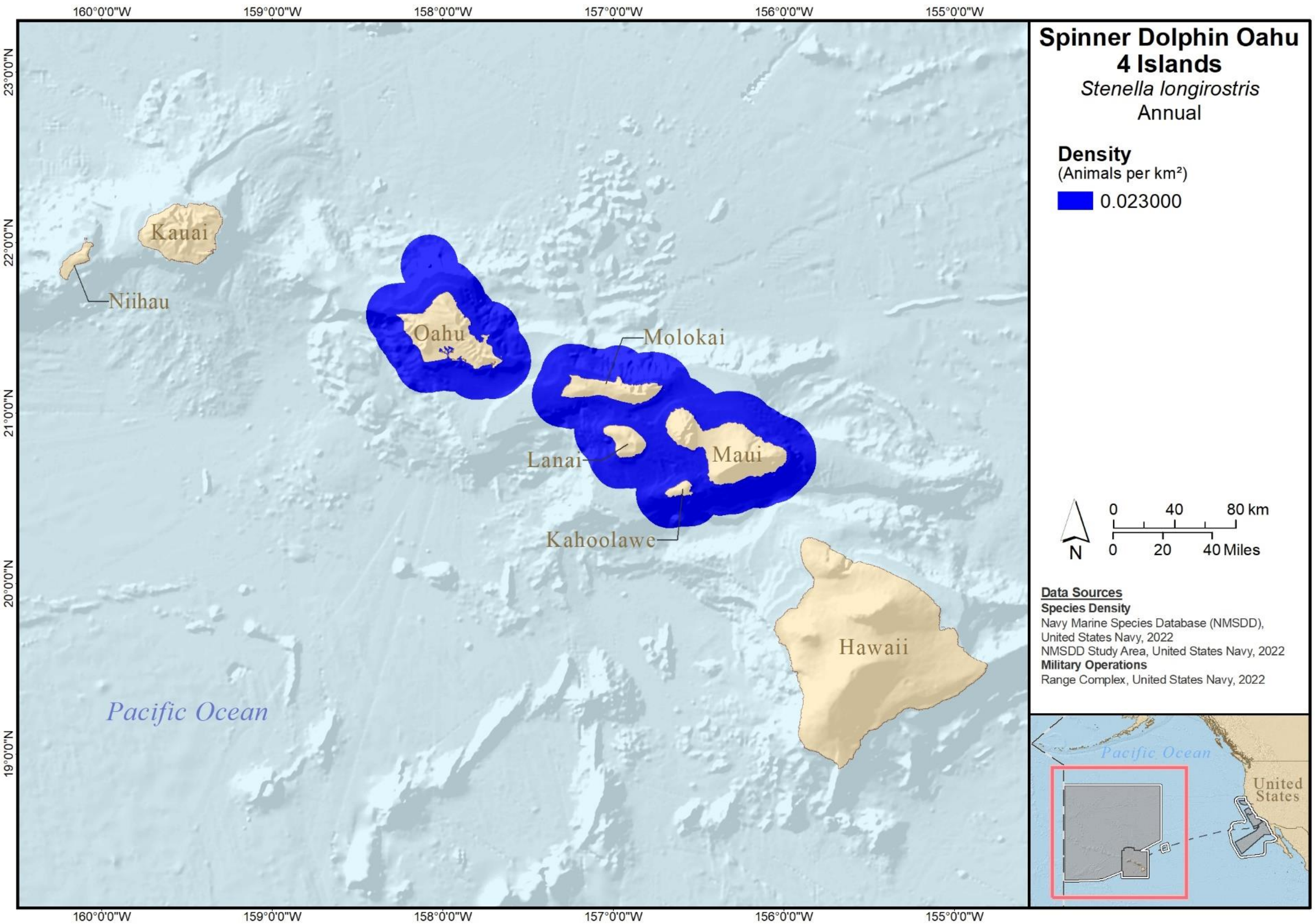

Figure 6-41: Annual Distribution of Spinner Dolphin Oahu/4-Islands Stock in HRC and the Western Portion of the Transit Corridor

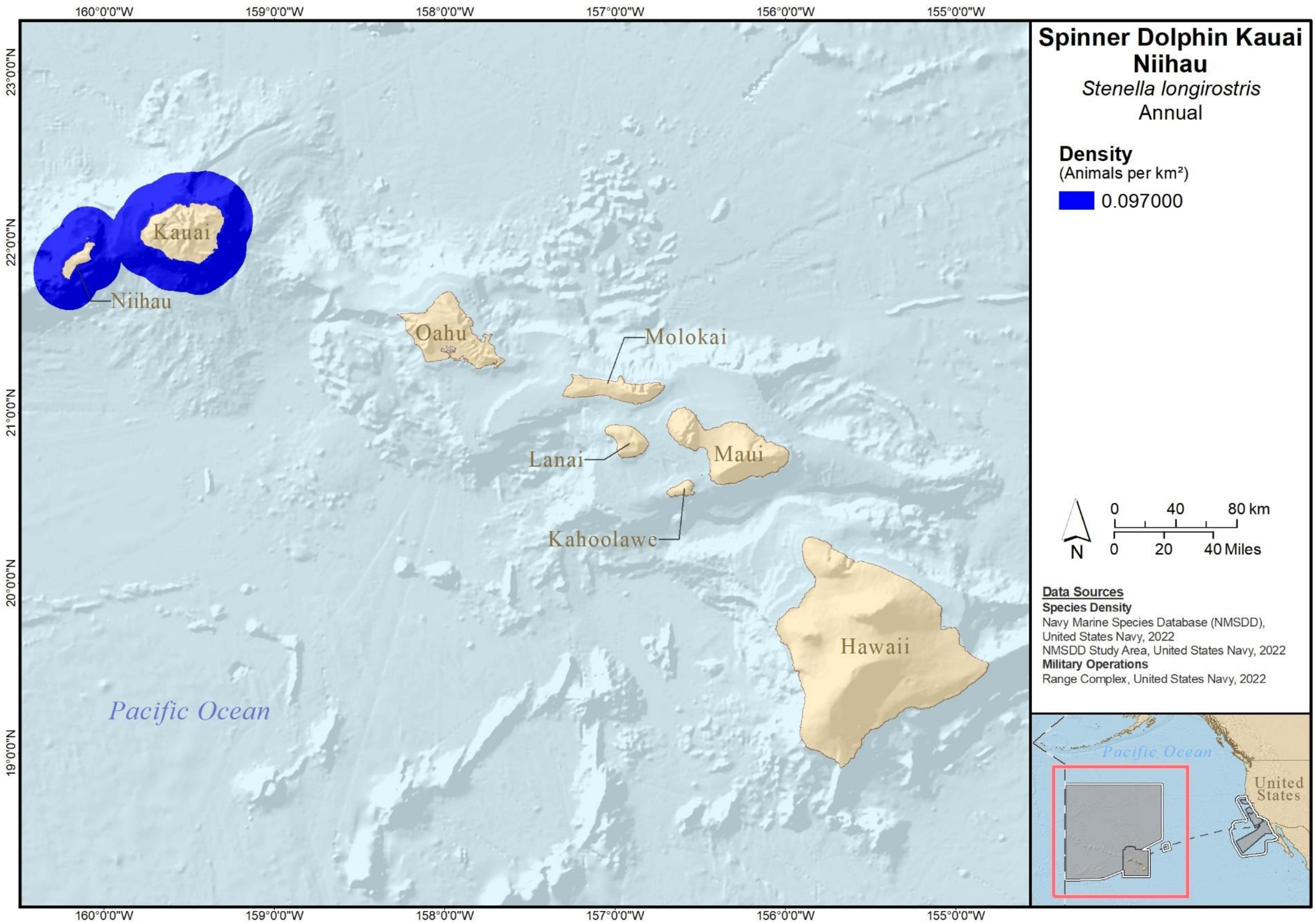

Figure 6-42: Annual Distribution of Spinner Dolphin Kauai/Niihau Stock in HRC and the Western Portion of the Transit Corridor

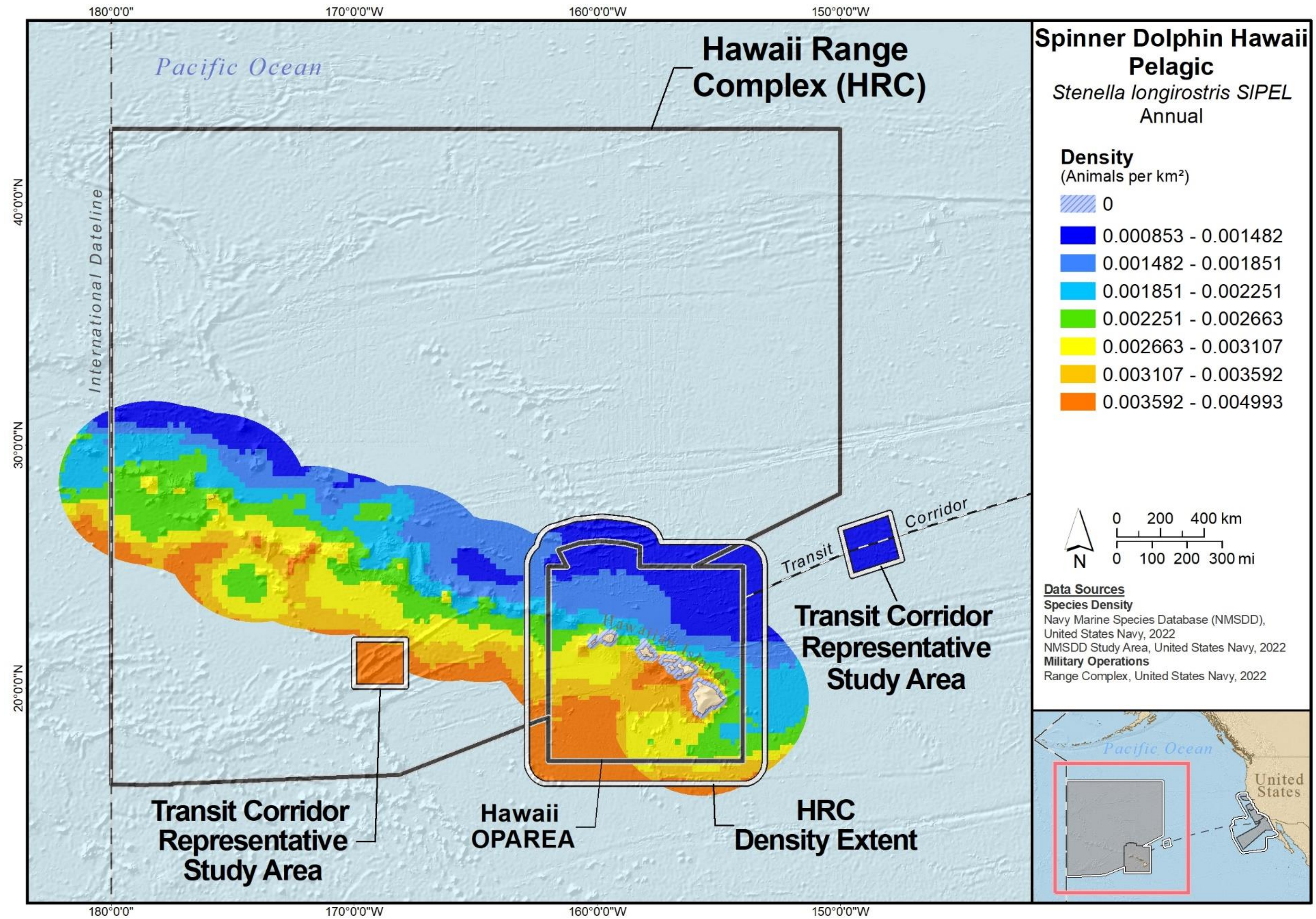

Figure 6-43: Annual Distribution of Spinner Dolphin Hawaii Pelagic Stock in HRC and the Western Portion of the Transit Corridor

6.15 *Steno bredanensis*, Rough-Toothed Dolphin

NMFS recognizes two Pacific management stocks of rough-toothed dolphin: the Hawaiian stock and the American Samoa stock (Carretta et al., 2022).

HRC. New survey data collected by NMFS within the Exclusive Economic Zone of the Hawaiian Islands supported the derivation of updated rough-toothed dolphin density estimates from model-based analyses (Becker et al., 2022b). The new habitat-based density model for rough-toothed dolphin represents an improvement to the model available for Phase III (Forney et al., 2015) because it more accurately accounted for bias in group size estimates and variation in detection probabilities, and provided finer-scale density predictions (~9 km x 9 km resolution vs. the previous ~25 km x 25 km resolution) that better accounted for uncertainty. The updated rough-toothed dolphin spatial model was applied to all seasons for the acoustic modeling areas associated with HRC and the western portion of the transit corridor.

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

Table 6-15: Summary of Density Values for Rough-Toothed Dolphin in the Hawaii-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
CAL	0	0	0	0
BCPM	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.

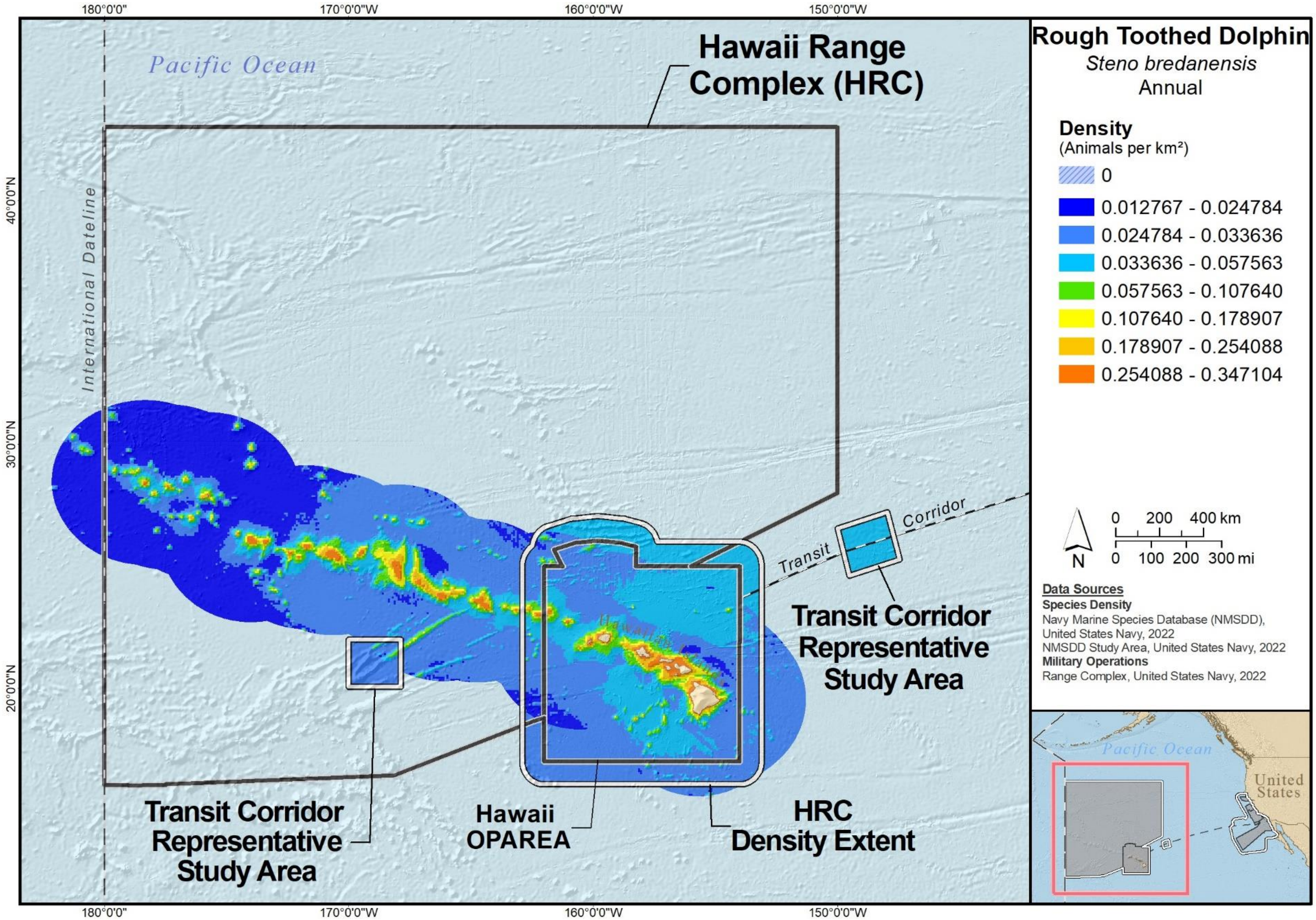

Figure 6-44: Annual Distribution of Rough Toothed Dolphin in HRC and the Western Portion of the Transit Corridor

6.16 *Tursiops truncatus*, Common Bottlenose Dolphin

NMFS recognizes two stocks and one stock complex of bottlenose dolphins in U.S. Pacific waters: a Hawaiian Island Stock Complex, a California/Oregon/Washington Offshore stock, and a California Coastal stock (Carretta et al., 2022). The Hawaiian Islands Stock Complex includes an Oahu stock, a 4-islands stock (Molokai, Lanai, Maui, Kahoolawe), a Kauai/Niihau stock, a Hawaii Island stock, and a Hawaii Pelagic stock.

HRC: Oahu Stock. The most recent abundance estimate available for the Oahu stock of common bottlenose dolphins is based on analyses by Van Cise et al. (2021), who estimated annual abundance of the four insular stocks between 2000 and 2018 using photo identification techniques. The most recent (2018) abundance estimate for the Oahu stock of common bottlenose dolphins is 112 animals (CV = 0.17). 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 0.0282 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.

HRC: 4-Islands Stock. The most recent abundance estimate available for the 4-Islands stock of common bottlenose dolphins is based on analyses by Van Cise et al. (2021), who estimated annual abundance of the four insular stocks between 2000 and 2018 using photo identification techniques. The most recent (2018) abundance estimate for the 4-islands stock of common bottlenose dolphins is 64 animals (CV = 0.15). 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 0.0058 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).

HRC: Kauai/Niihau Stock. The most recent abundance estimate available for the Kauai/Niihau stock of common bottlenose dolphins is based on analyses by Van Cise et al. (2021), who estimated annual abundance of the four insular stocks between 2000 and 2018 using photo identification techniques. The most recent (2018) abundance estimate for the Kauai/Niihau stock of common bottlenose dolphins is 112 animals (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 2,820.28 km^2, resulting in a density estimate of 0.0397 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.

HRC: Hawaii Island Stock. The most recent abundance estimate available for the Hawaii Island stock of common bottlenose dolphins is based on analyses by Van Cise et al. (2021), who estimated annual abundance of the four insular stocks between 2000 and 2018 using photo identification techniques. The most recent (2018) abundance estimate for the Hawaii Island stock of common bottlenose dolphins is 136 animals (CV = 0.43). 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 0.0292 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.

HRC: Hawaii Pelagic Stock. New survey data collected by NMFS within the Exclusive Economic Zone of the Hawaiian Islands supported the derivation of updated common bottlenose dolphin density estimates from model-based analyses (Becker et al., 2022b). The new habitat-based density model for common bottlenose dolphin represents an improvement to the model available for Phase III (Forney et al., 2015) because it more accurately accounted for bias in group size estimates and variation in detection probabilities, and provided finer-scale density predictions (~9 km x 9 km resolution vs. the previous ~25 km x 25 km resolution) that better accounted for uncertainty. In addition, the new common bottlenose dolphin model is specific to the pelagic stock (i.e., it was developed using only those sightings of animals identified as belonging to the pelagic stock), while the previous models were not stock-specific, but based on all common bottlenose dolphin sightings. The updated common bottlenose dolphin spatial model was applied to all seasons for the acoustic modeling areas associated with HRC and the western portion of the transit corridor.

CAL-BCPM: **California/Oregon/Washington Offshore Stock.** The Phase III NMSDD included data from a CCE habitat-based density model for common bottlenose dolphins based on systematic survey data collected from 1991 to 2009 (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 models were updated to include additional systematic survey data collected in summer and fall of 2014 and 2018 (Becker et al., 2020a). Model improvements were recognized from additional sighting data collected off the continental shelf and slope, and the inclusion of a broader range of habitat conditions. In addition, recently developed techniques for deriving estimates of uncertainty (Miller et al., 2022) were used to provide more comprehensive variance estimates for the model-based predictions. Density estimates from the updated common bottlenose dolphin model were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area north of Point Conception (34.45 degrees N), as well as the eastern portion of the transit corridor for summer and fall.

Given that many cetacean species exhibit substantial seasonal variability in abundance and distribution in the CCE (e.g., Becker et al., 2017; Forney & Barlow, 1998), and the limited systematic survey data available for winter/spring, the CCE common bottlenose dolphin model for summer/fall was used to derive separate winter and spring estimates for waters off the U.S. West Coast using techniques designed to avoid spatial and temporal extrapolation (Becker et al., In Prep.). These estimates represent an improvement from Phase III, when stratified uniform density estimates based on aerial line-transect data collected in winter and spring of 1991 and 1992 were used (Forney et al., 1995). The new model-based analyses provide spatially explicit estimates which better capture species distribution patterns, they are based on more recent survey data, and they better account for trackline detection probabilities (Becker et al., In Prep.). Density estimates from the common bottlenose dolphin model predictions were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for winter and spring.

In order to improve density estimates for Phase IV, the Navy funded an analysis to develop habitat-based density models for the Southern California Current, an ecologically meaningful study area that extends from Point Conception to the tip of the Baja California Peninsula. Resulting models provide the first spatially explicit estimates of common bottlenose dolphin density for waters off the Baja California Peninsula (Becker et al., 2022a), and were applied to the HCTT study area south of Point Conception. These density estimates represent a major improvement over density estimates previously used for Phase III (Ferguson & Barlow, 2003), because they are based on more recent survey data, they provide finer-scale density predictions (9 km x 9 km grid resolution vs. the 5° x 5° grid resolution available for density estimates used in Phase III), and improved, spatially-explicit estimates of uncertainty. Model-derived density estimates were applied to the BCPM region year-round since seasonally specific values are not currently available.

CAL-BCPM: **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), although recent photo-identification studies suggest the range of this stock has expanded along the Northern California coast at least as far as Sonoma County (38.7 degrees N) (Keener et al., 2023). 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). 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 this spatially explicit density layer to all seasons.

Dudzik et al. (2006) provide a uniform density of 0.3612 common bottlenose dolphins/km^2 within 1 km of the coast and this value was applied to the BCPM portion of the HCTT Study Area for all seasons.

Table 6-16: Summary of Density Values for Common Bottlenose Dolphin in the Hawaii-California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC: Oahu Stock (range specific)	0.0282	0.0282	0.0282	0.0282
HRC: 4-Islands Stock (range specific)	0.0058	0.0058	0.0058	0.0058
HRC: Kauai/Niihau Stock (range specific)	0.0397	0.0397	0.0397	0.0397
HRC: Hawaii Island Stock (range specific)	0.0292	0.0292	0.0292	0.0292
HRC: Hawaii Pelagic Stock	S	S	S	S
W. Transit Corridor	S	S	S	S
E. Transit Corridor	S	S	S	S
CAL	S	S	S	S
BCPM	S	S	S	S
California Coastal Stock: CAL	S	S	S	S
California Coastal Stock: BCPM	0.3612	0.3612	0.3612	0.3612

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

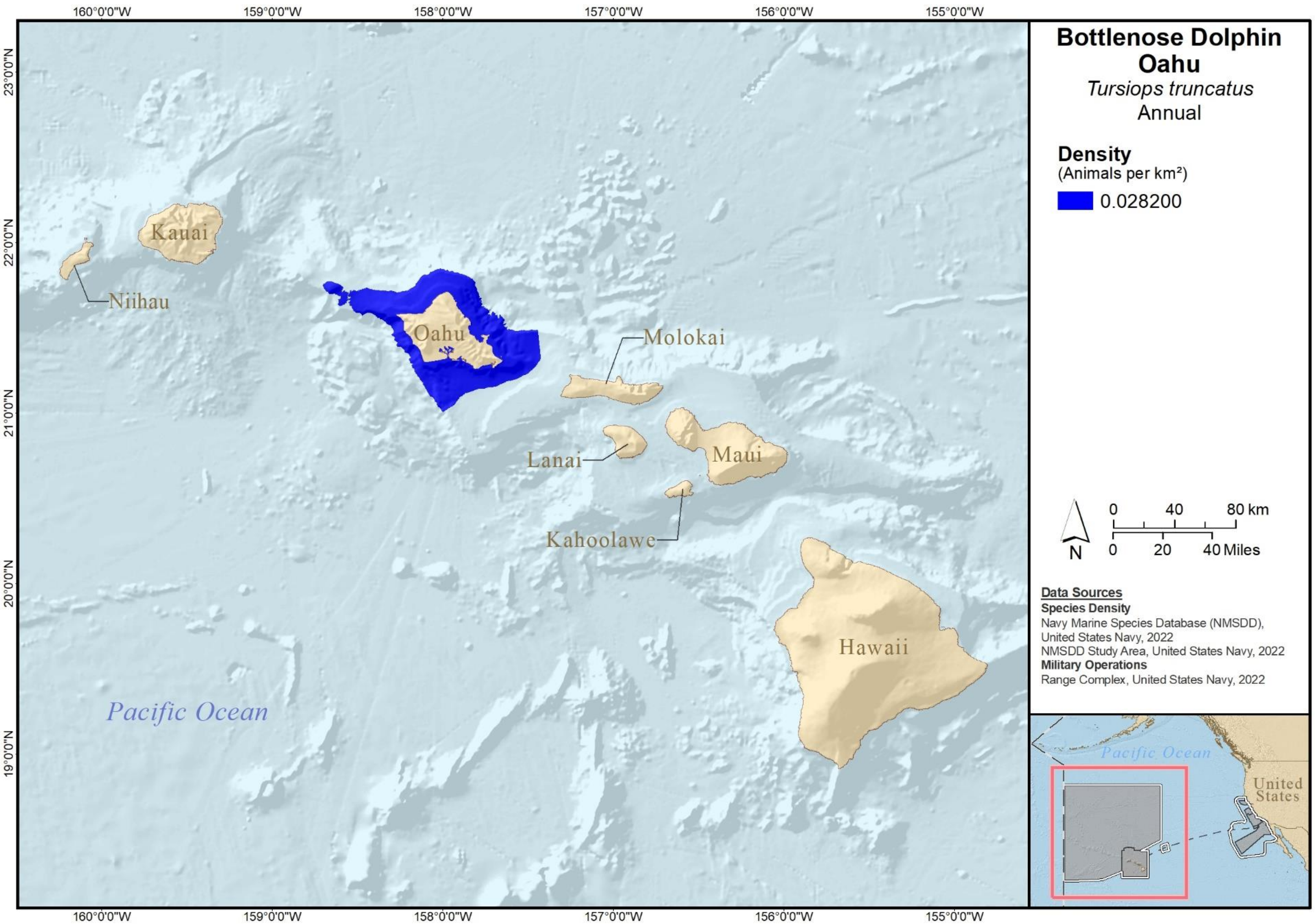

Figure 6-45: Annual Distribution of Bottlenose Dolphin Oahu Stock in HRC and the Western Portion of the Transit Corridor

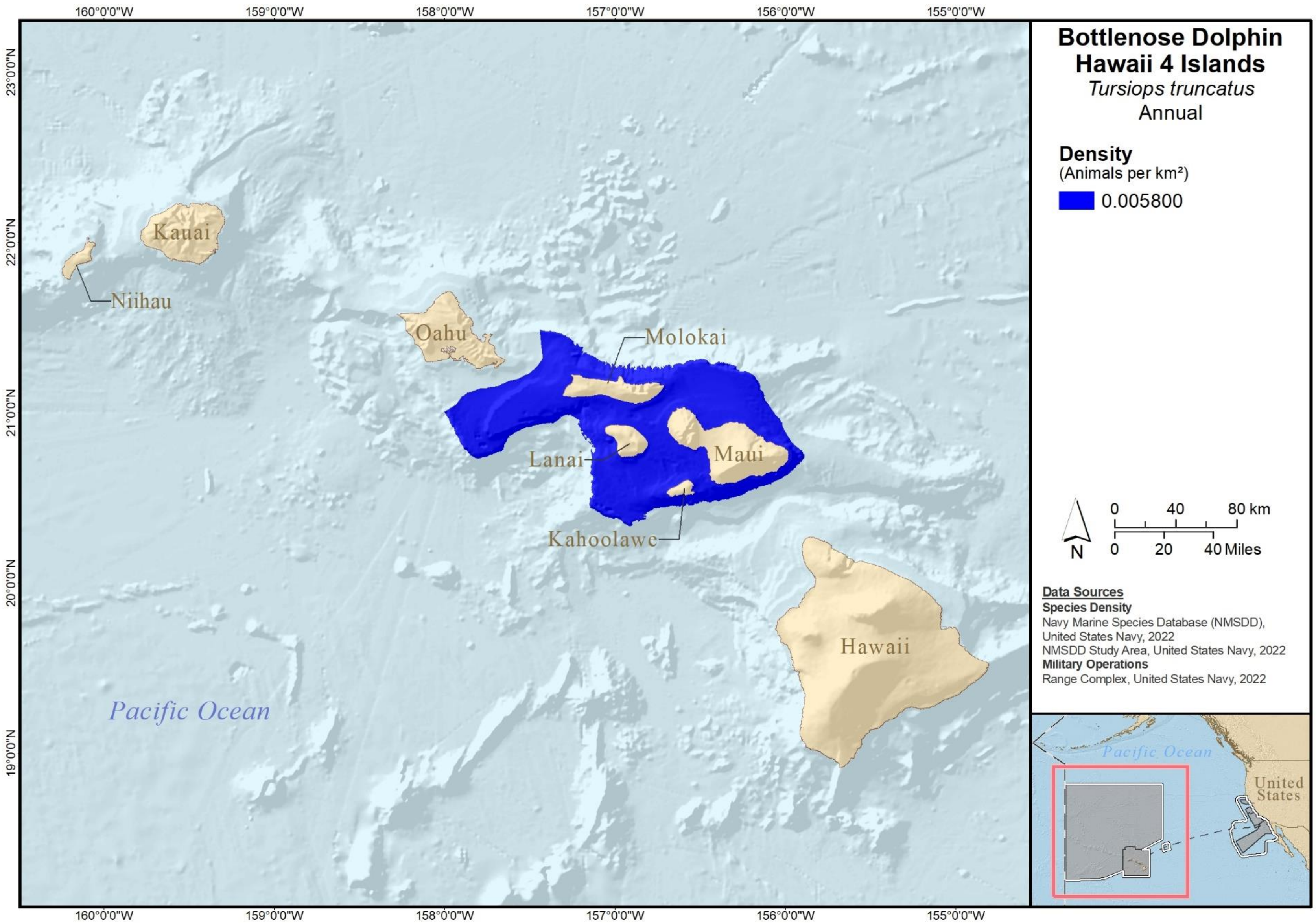

Figure 6-46: Annual Distribution of Bottlenose Dolphin 4-Islands Stock in HRC and the Western Portion of the Transit Corridor

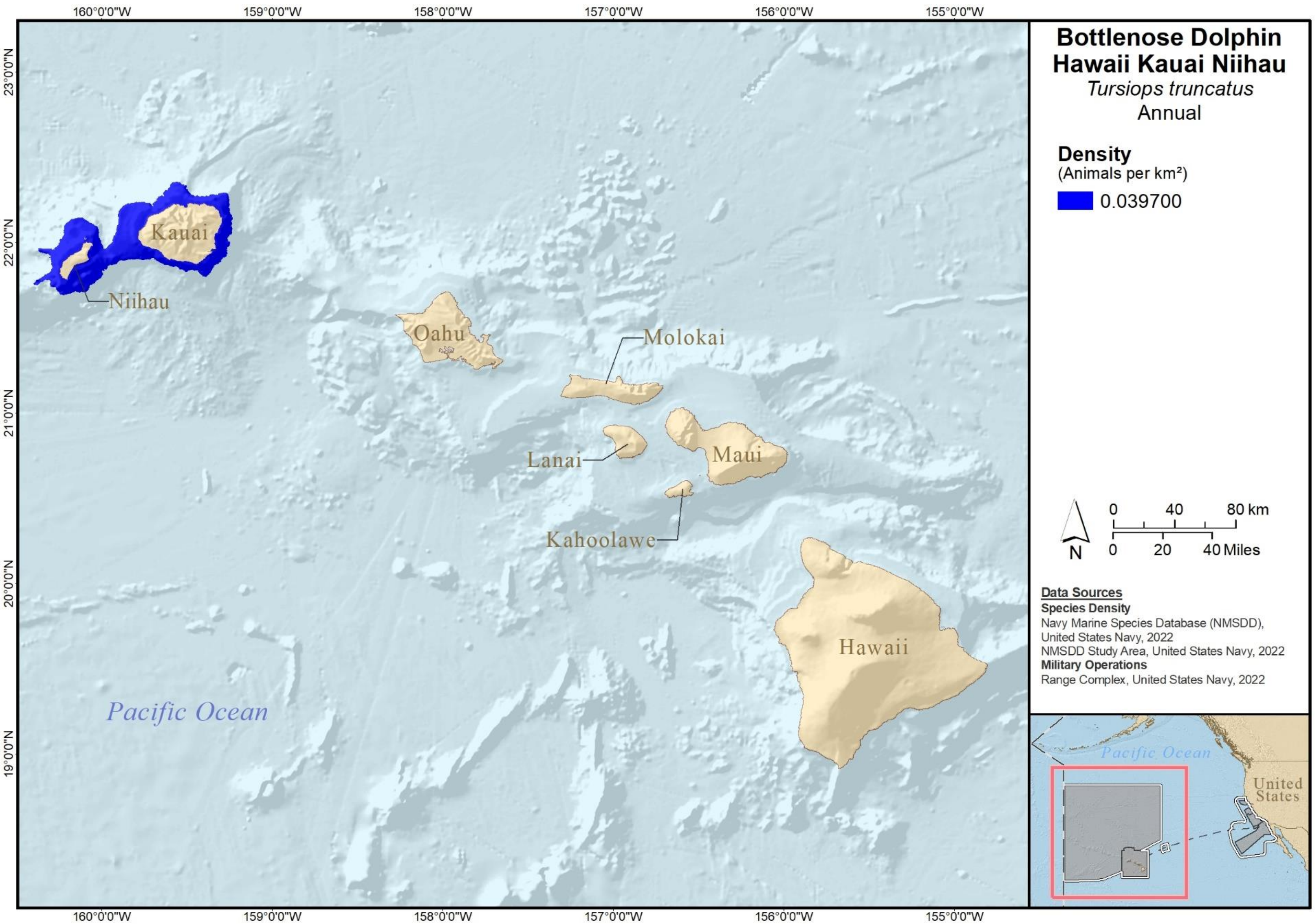

Figure 6-47: Annual Distribution of Bottlenose Dolphin Kauai/Niihau Stock in HRC and the Western Portion of the Transit Corridor

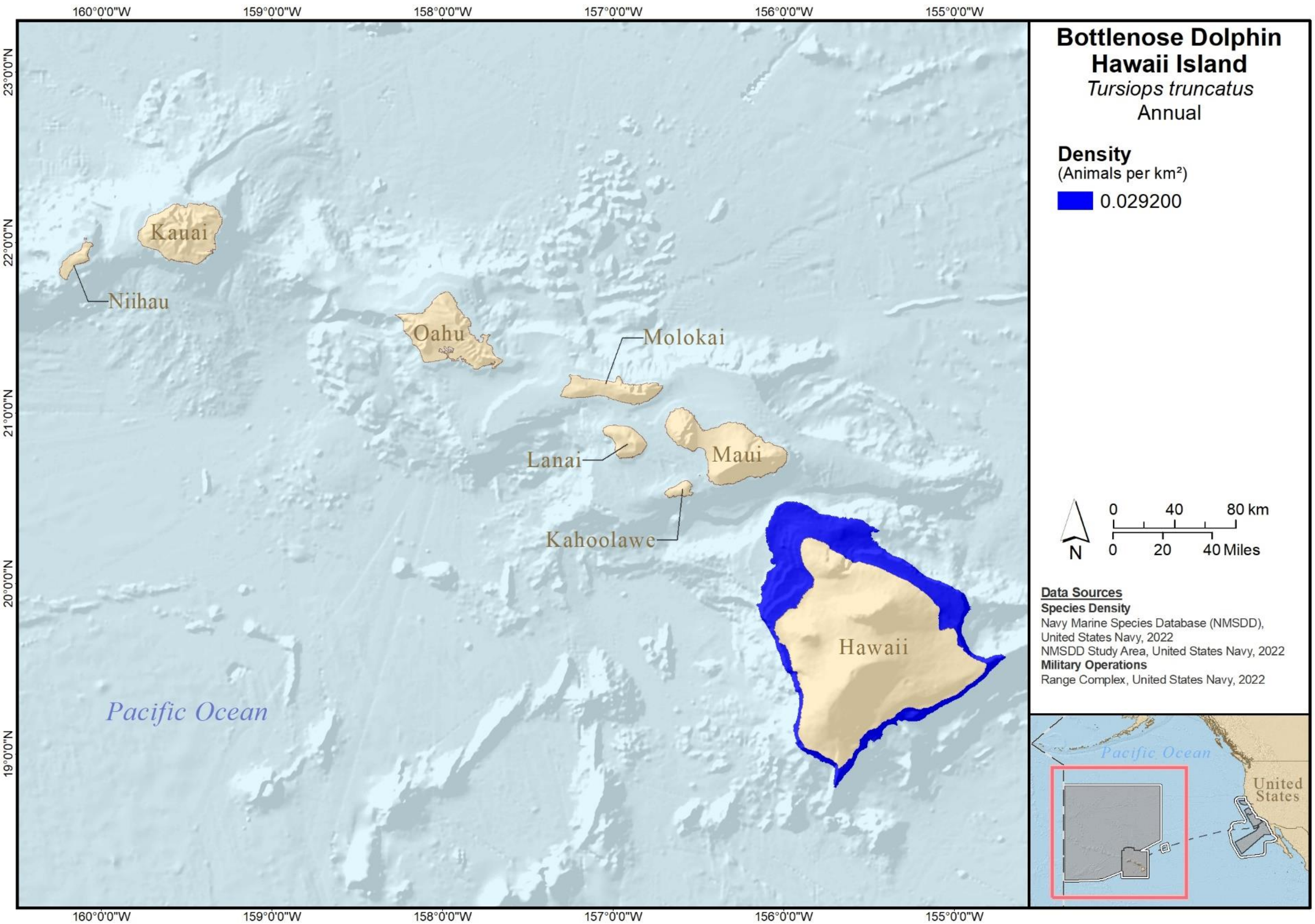

Figure 6-48: Annual Distribution of Bottlenose Dolphin Hawaii Island Stock in HRC and the Western Portion of the Transit Corridor

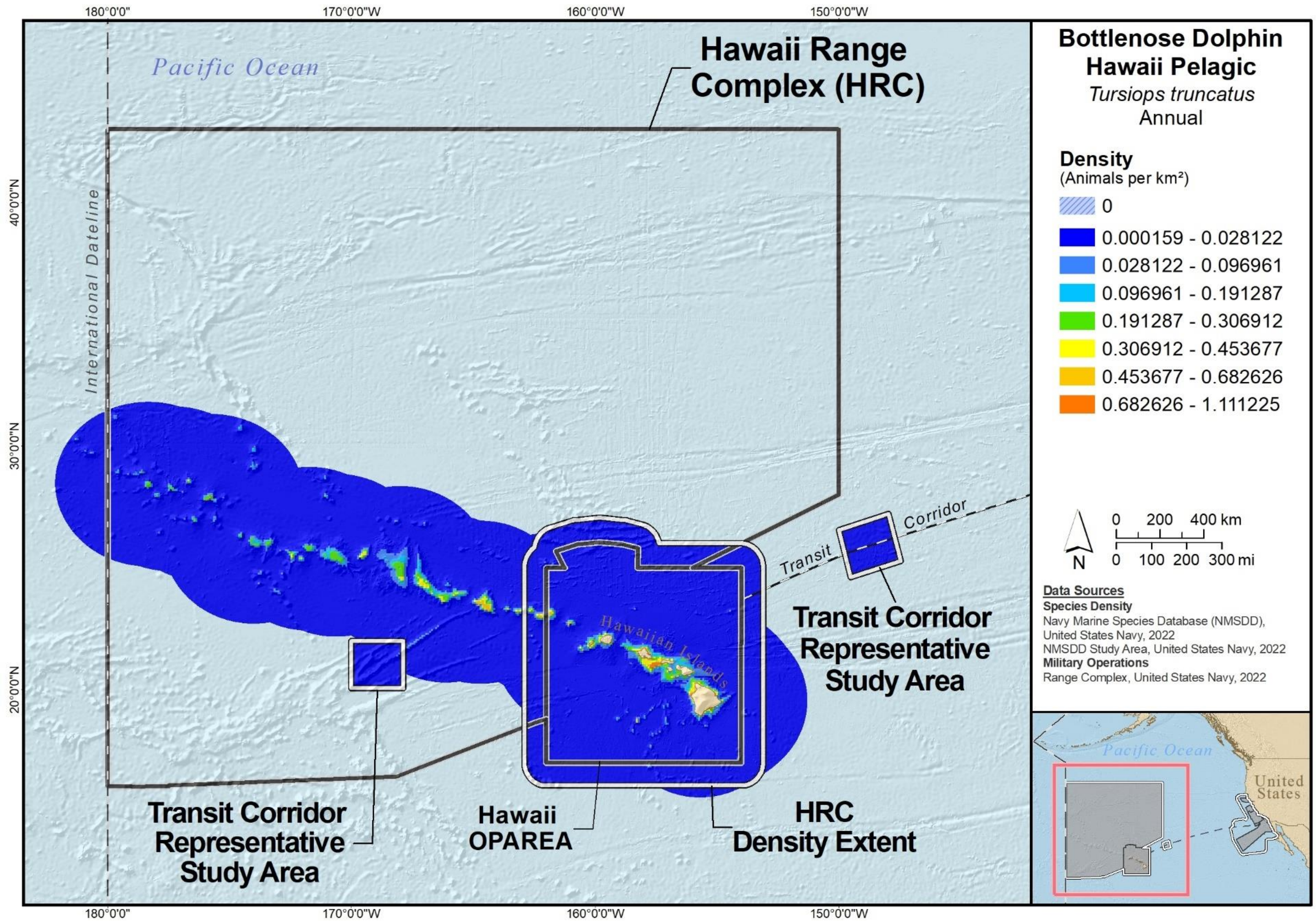

Figure 6-49: Annual Distribution of Bottlenose Dolphin Hawaii Pelagic Stock in HRC and the Western Portion of the Transit Corridor

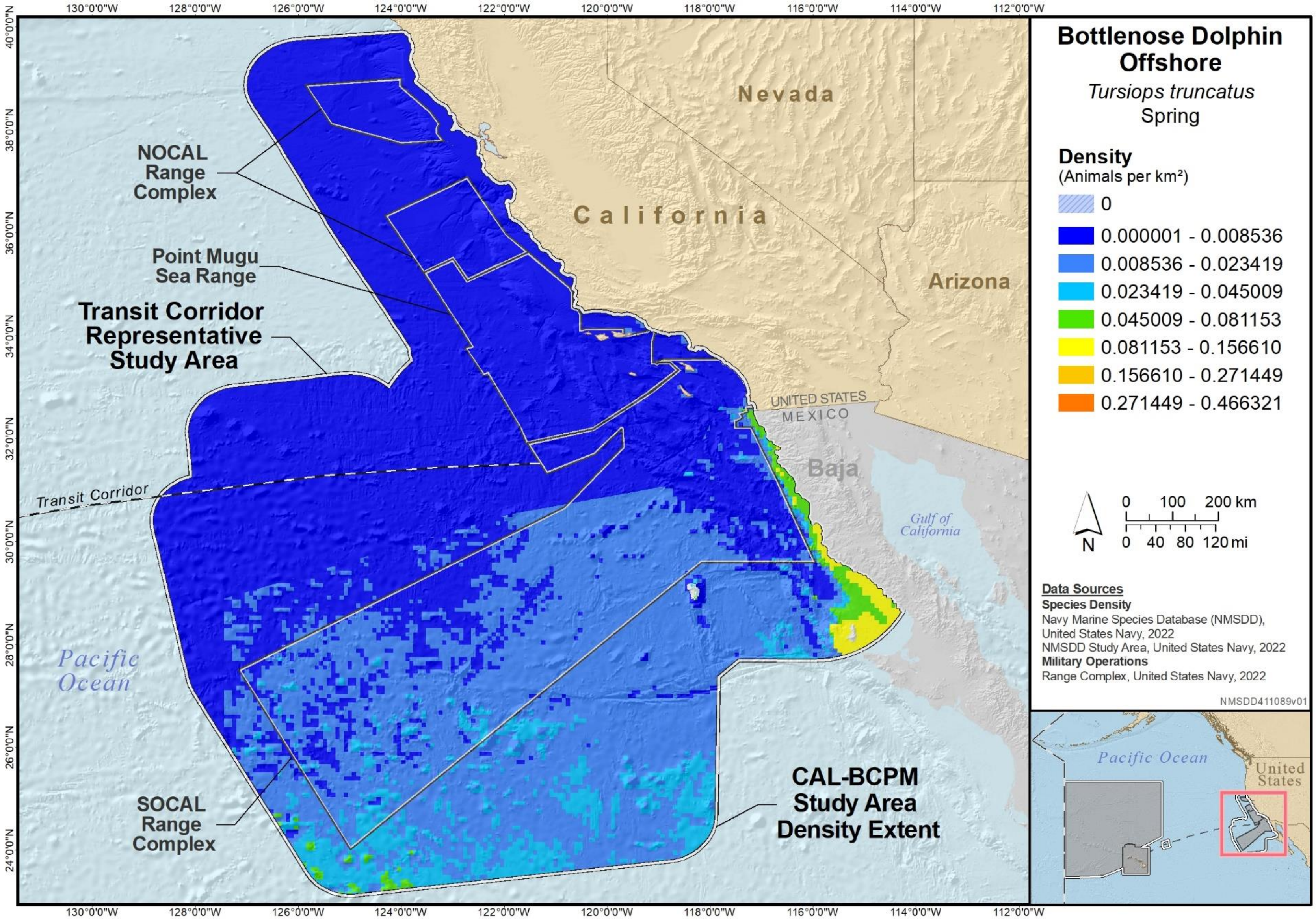

Figure 6-50: Spring Distribution of Offshore Bottlenose Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

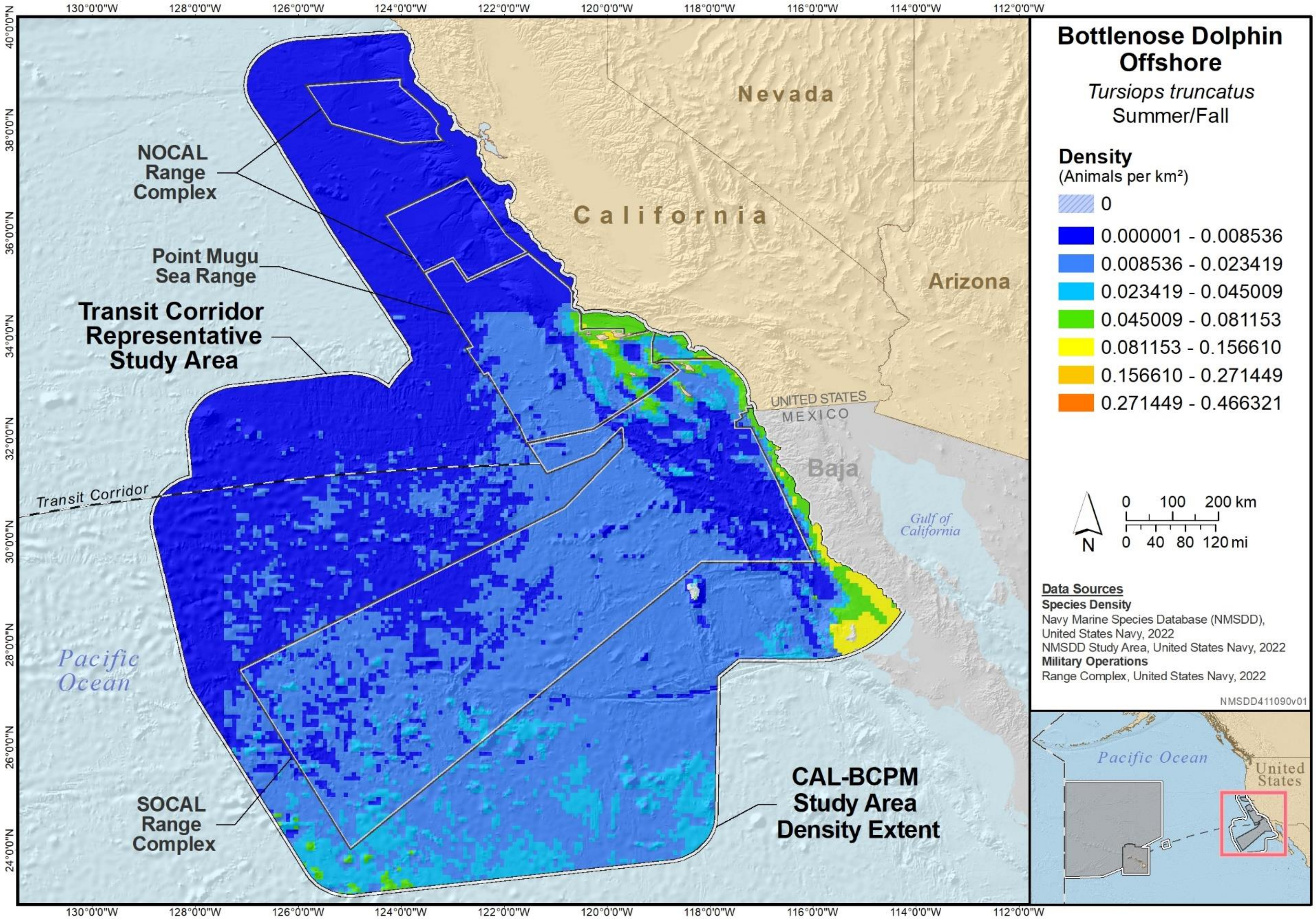

Figure 6-51: Summer/Fall Distribution of Offshore Bottlenose Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

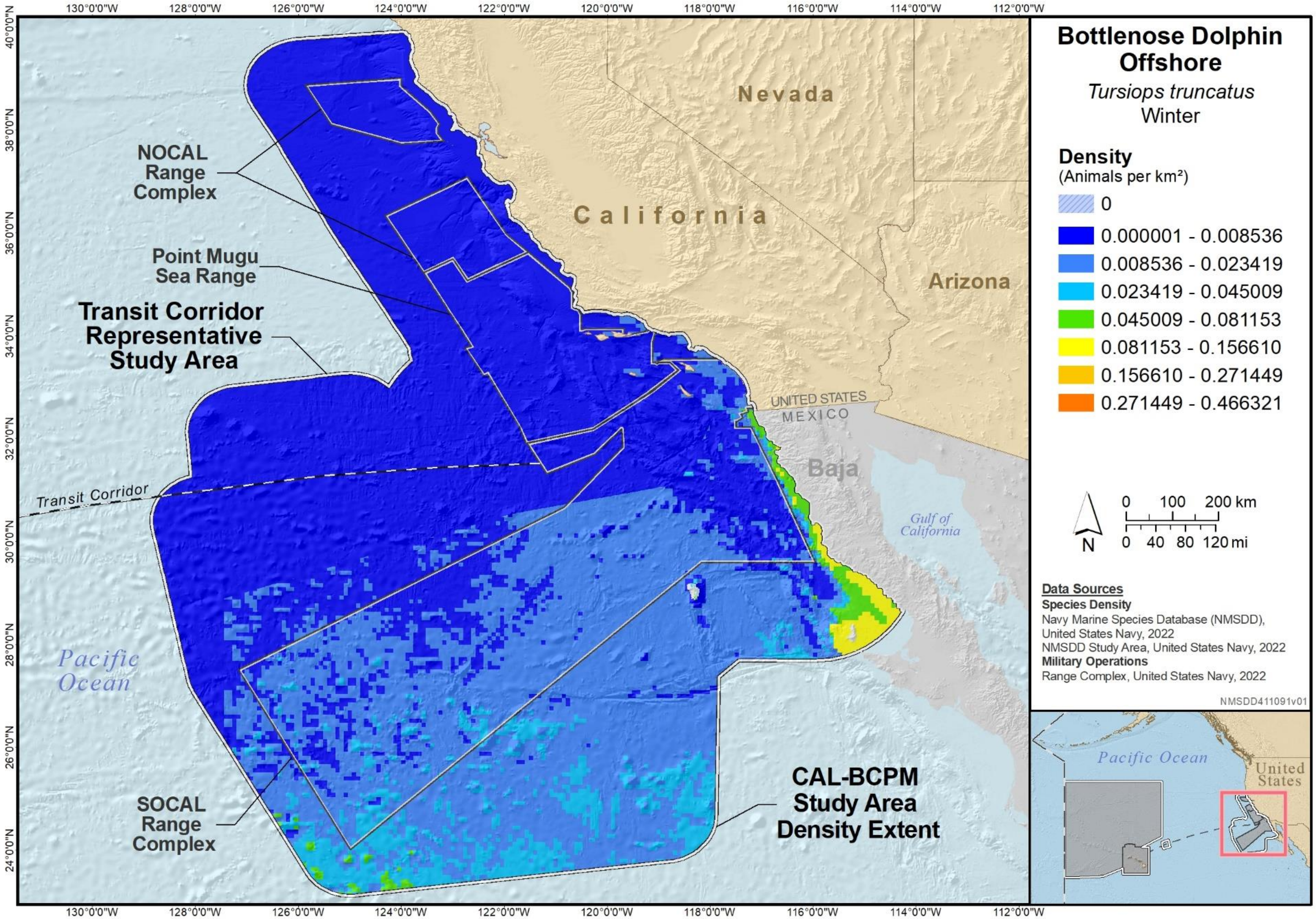

Figure 6-52: Winter Distribution of Offshore Bottlenose Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

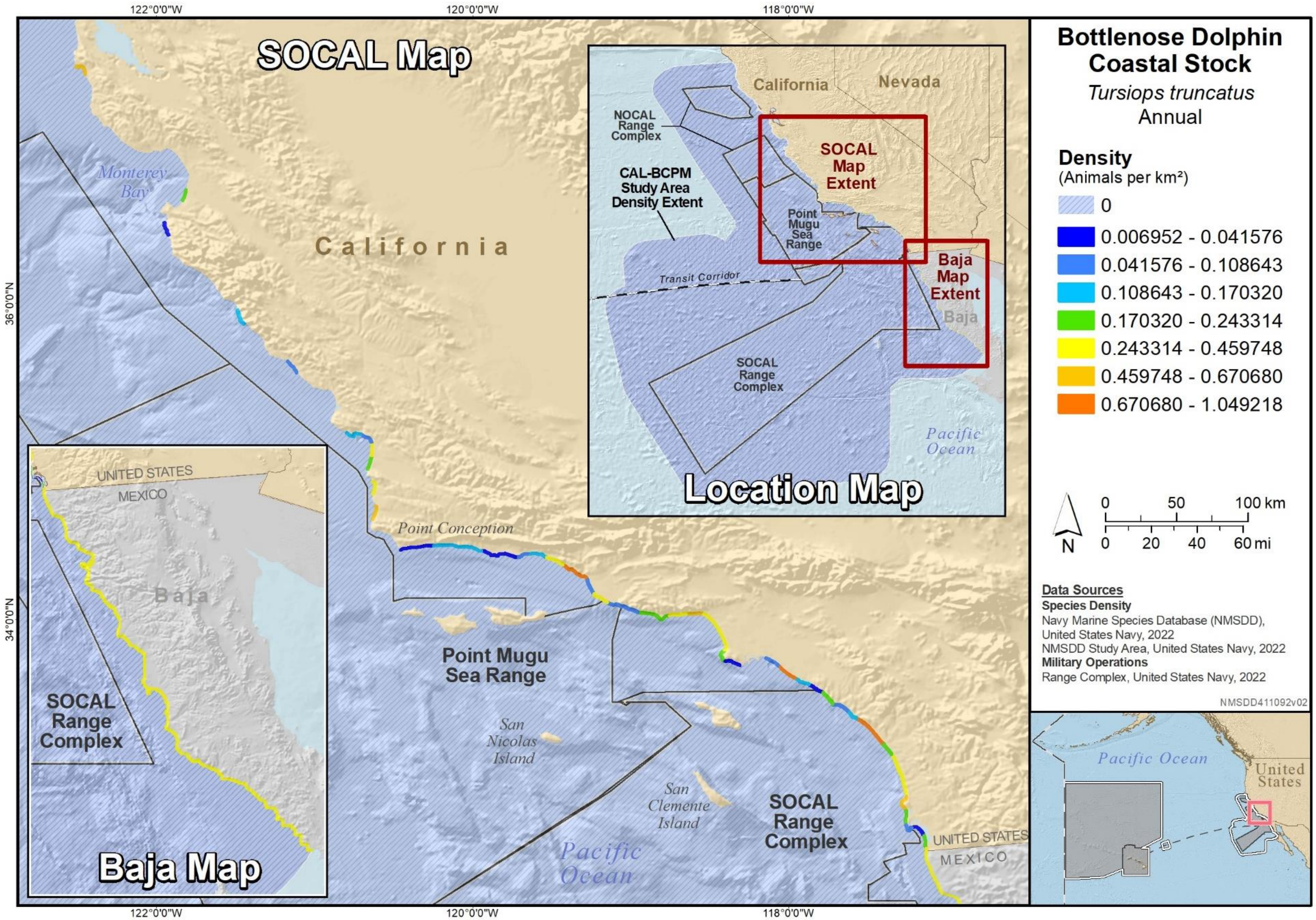

Figure 6-53: Annual Distribution of Coastal Bottlenose Dolphin in CAL-BCPM and the Eastern Portion of the Transit Corridor

7 PORPOISES

7.1 *PHOCOENOIDES DALLI*, DALL'S PORPOISE

NMFS recognizes two stocks of Dall's porpoise in U.S. Pacific waters, an Alaska stock and a California/Oregon/Washington stock (Carretta et al., 2022). The California/Oregon/Washington stock is the stock expected to occur within the CAL-BCPM portion of the HCTT Study Area.

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

CAL-BCPM. The Phase III NMSDD included data from a CCE habitat-based density model for Dall's porpoise based on systematic survey data collected from 1991 to 2009 (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 was updated to include additional systematic survey data collected in summer and fall of 2014 and 2018 (Becker et al., 2020a). Model improvements were recognized from additional sighting data collected off the continental shelf and slope, and the inclusion of a broader range of habitat conditions. In addition, recently developed techniques for deriving estimates of uncertainty (Miller et al., 2022) were used to provide more comprehensive variance estimates for the model-based predictions. Density estimates from the updated Dall's porpoise model were applied to the portion of the Navy's CAL-BCPM 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.

Given that many cetacean species exhibit substantial seasonal variability in abundance and distribution in the CCE (e.g., Becker et al., 2017; Forney & Barlow, 1998), and the limited systematic survey data available for winter/spring, the CCE Dall's porpoise model for summer/fall was used to derive separate winter and spring estimates for waters off the U.S. West Coast using techniques designed to avoid spatial and temporal extrapolation (Becker et al., In Prep.). For Phase III, the first winter/spring habitat-based density models for Dall's porpoise in southern California waters (Becker et al., 2017) were used, but model predictions did not cover the northern portion of the expanded HCTT Study Area. The new model-based analyses provide spatially explicit estimates which capture species distribution patterns throughout the SWFSC CCE study area, they are based on more recent survey data, and they better account for trackline detection probabilities (Becker et al., In Prep.). The Dall's porpoise model predictions were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor for winter and spring.

Ferguson and Barlow (2003) provide density values for areas off BCPM. For the Navy's Phase IV analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the HCTT acoustic modeling footprint and resulted in a Dall's porpoise density estimate of 0.0047 animals/km^2 (CV = 0.41). In the BCPM waters, the same value is used for all seasons since no seasonally specific values are currently available.

Table 7-1: Summary of Density Values for Dall's Porpoise in the Hawaii-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
CAL	S	S	S	S
BCPM	0.0047	0.0047	0.0047	0.0047

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.

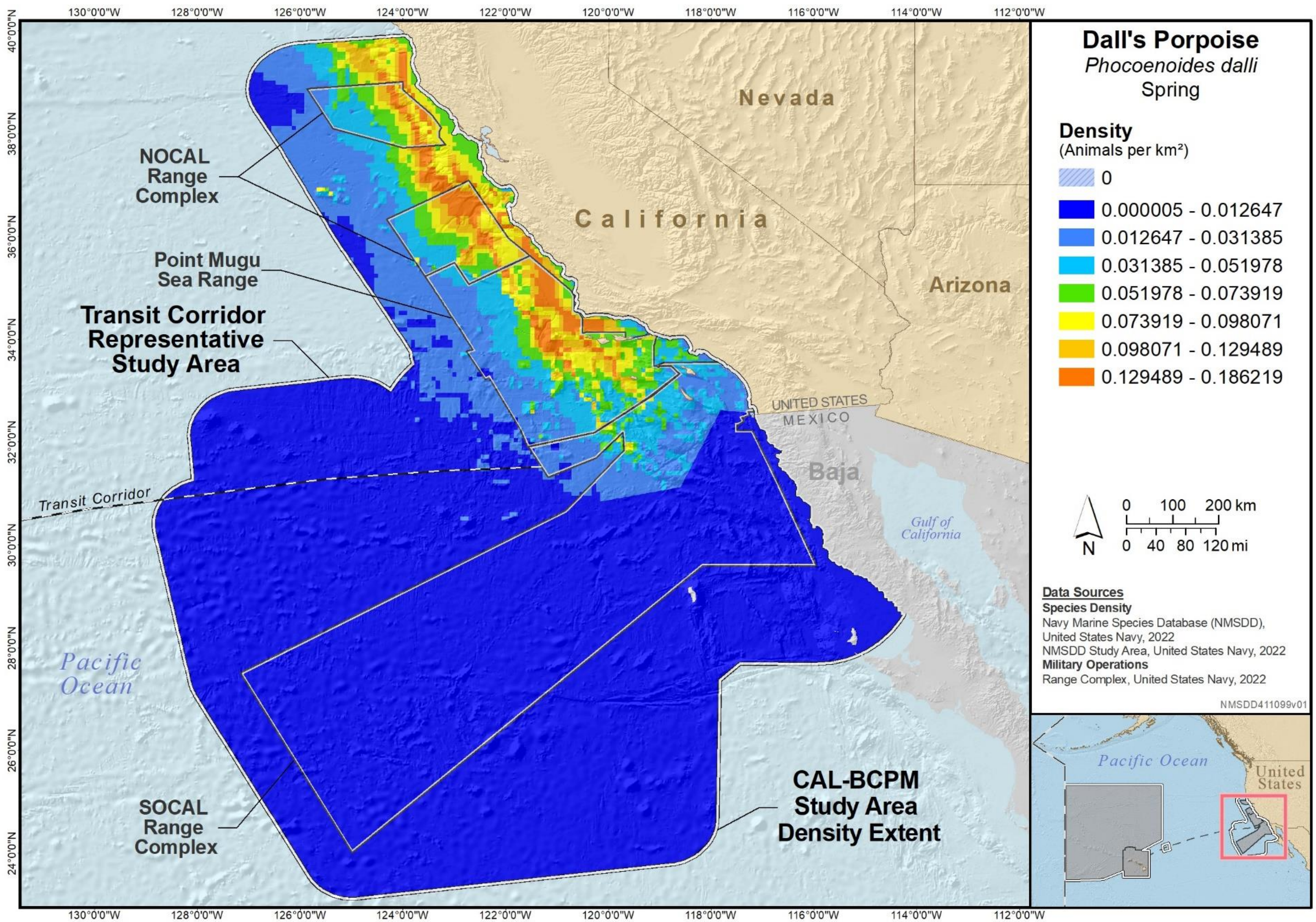

Figure 7-1: Spring Distribution of Dall's Porpoise in CAL-BCPM and the Eastern Portion of the Transit Corridor

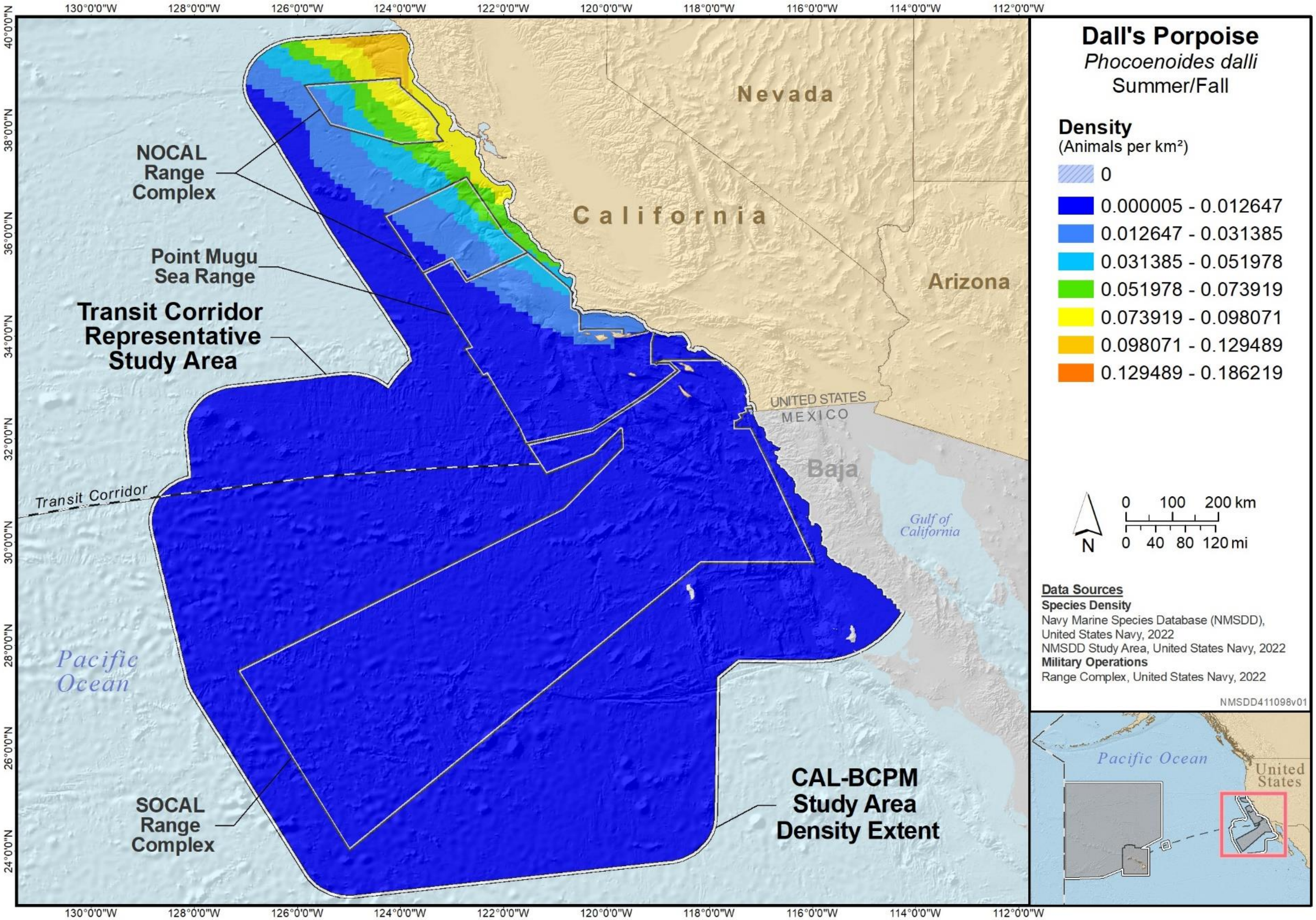

Figure 7-2: Summer/Fall Distribution of Dall's Porpoise in CAL-BCPM and the Eastern Portion of the Transit Corridor

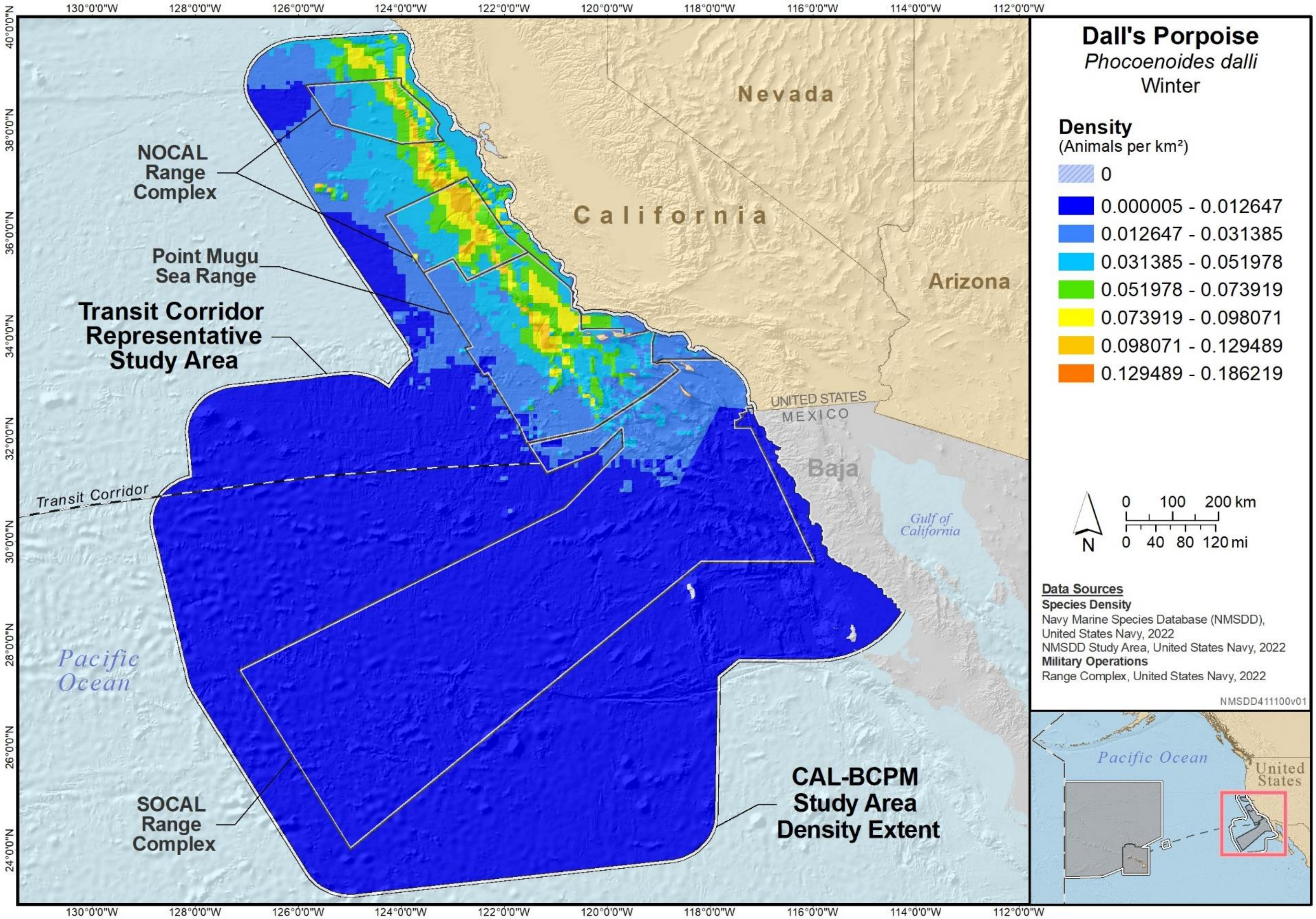

Figure 7-3: Winter Distribution of Dall's Porpoise in CAL-BCPM and the Eastern Portion of the Transit Corridor

7.2 *PHOCOENA PHOCOENA*, HARBOR PORPOISE

NMFS recognizes six stocks of harbor porpoise in waters off the U.S. West Coast: the Inland Washington stock, the Northern Oregon/Washington Coastal stock, the Northern California/Southern Oregon stock, the San Francisco-Russian River stock, the Monterey Bay stock, and the Morro Bay stock (Carretta et al., 2022). The southern range limit for this species is considered Point Conception. Based on published range boundaries (Carretta et al., 2022), the stocks expected to occur within the California portion of the HCTT Study Area include the Northern California/Southern Oregon stock, the San Francisco-Russian River stock, the Monterey Bay stock, and the Morro Bay stock. Harbor porpoises are primarily found in shallow waters (i.e., less than 92 m deep) off the California coast (Forney et al., 2014).

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

CAL-BCPM. Forney et al. (2020) recently used stratified distance sampling analysis within a Bayesian hierarchical model to examine trends in harbor porpoise abundance off the California coast. Based on this analysis, spatially stratified density estimates were derived for the primary nearshore habitat of harbor porpoise off the California coast (Forney, unpublished data). Density estimates from Forney et al. (2014) were used to capture the lower occurrence of this species in deeper waters out to the 200 m-isobath. These estimates were applied year-round.

Table 7-2: Summary of Density Values for Harbor Porpoise in the Hawaii-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
CAL	S	S	S	S
BCPM	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.

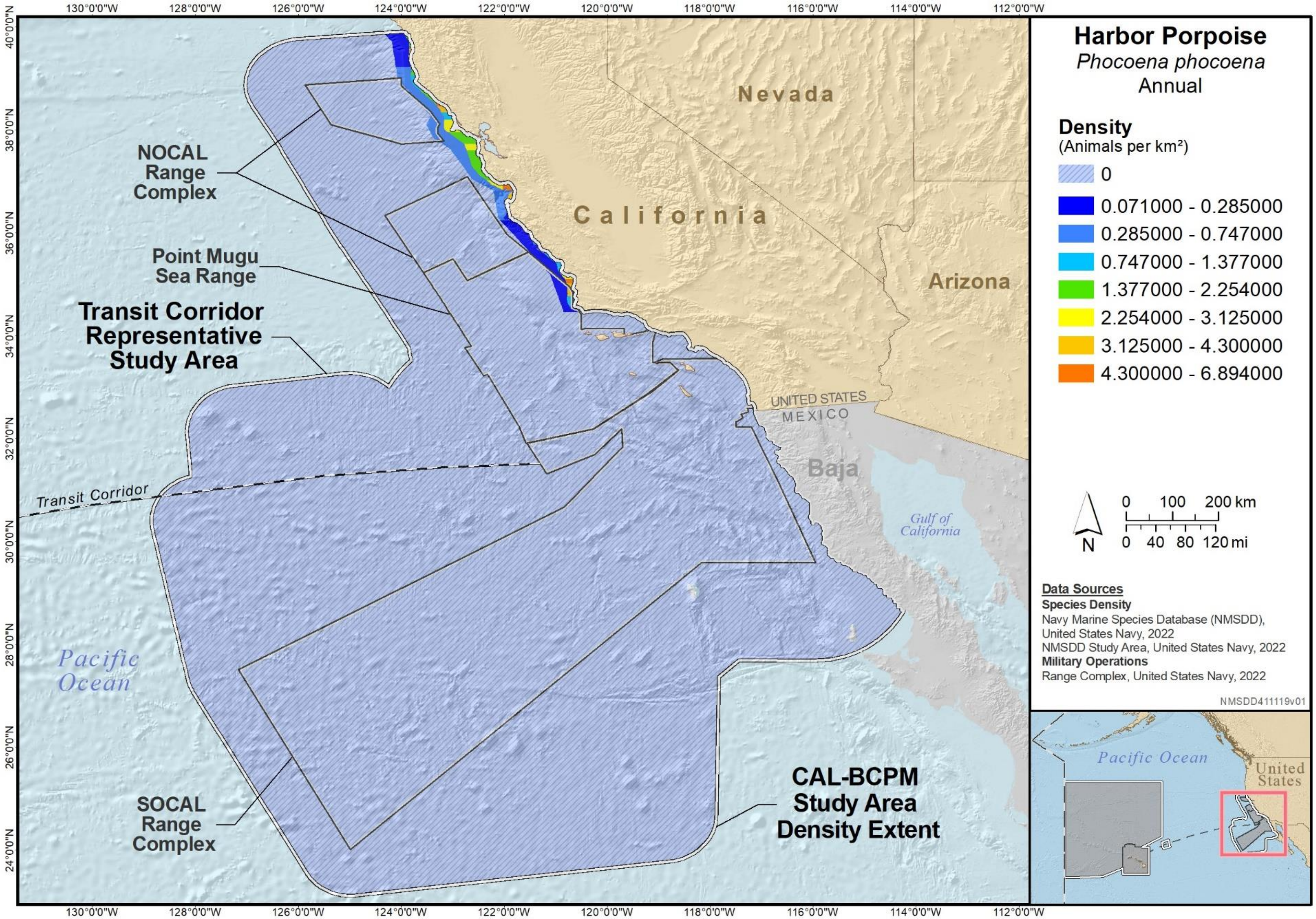

Figure 7-4: Annual Distribution of Harbor Porpoise in CAL-BCPM and the Eastern Portion of the Transit Corridor

8 BEAKED WHALES

8.1 *BERARDIUS BAIRDII*, BAIRD'S BEAKED WHALE

Two stocks of Baird's beaked whale are recognized by NMFS, an Alaska stock and a California/Oregon/Washington stock (Carretta et al., 2022). The latter stock occurs within CAL-BCPM.

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

CAL-BCPM. The Phase III NMSDD included data from a CCE habitat-based density model for Baird's beaked whale based on systematic survey data collected from 1991 to 2009 (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 models were updated to include additional systematic survey data collected in summer and fall of 2014 and 2018 (Becker et al., 2020a). Model improvements were recognized from additional sighting data collected off the continental shelf and slope, and the inclusion of a broader range of habitat conditions. In addition, recently developed techniques for deriving estimates of uncertainty (Miller et al., 2022) were used to provide more comprehensive variance estimates for the model-based predictions. Density estimates from the updated Baird's beaked whale model were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor. Given the lack of quantitative seasonal information on this species, these estimates were applied year-round.

Ferguson and Barlow (2003) provide density values for areas off BCPM. For the Navy's Phase IV analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the HCTT acoustic modeling footprint and resulted in a Baird's beaked whale density estimate of 0.00003 animals/km^2 (CV = 1.00). In the BCPM waters, the same value is used for all seasons since seasonally specific values are not currently available.

Table 8-1: Summary of Density Values for Baird's Beaked Whale in the Hawaii-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
CAL	S	S	S	S
BCPM	0.00003	0.00003	0.00003	0.00003

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

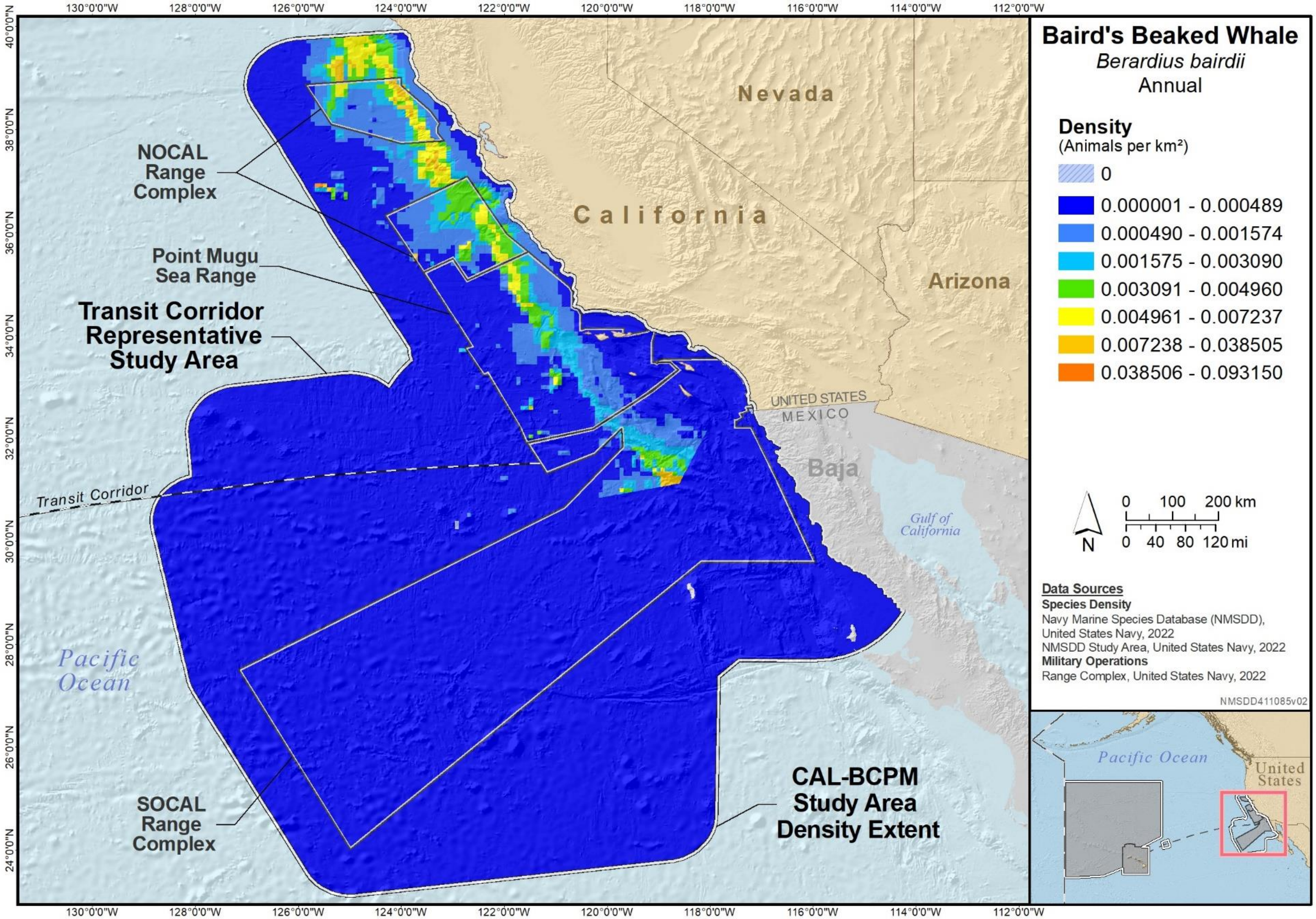

Figure 8-1: Annual Distribution of Baird's Beaked Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

8.2 *INDOPACETUS PACIFICUS*, LONGMAN'S BEAKED WHALE

There is only one stock of Longman's beaked whale recognized by NMFS in the Pacific, the Hawaii Stock (Carretta et al., 2022). This stock includes animals found within the Hawaiian Islands EEZ and adjacent high sea waters.

HRC. Bradford et al. (2021) report a uniform density value for the Hawaiian Islands stock of Longman's beaked whale of 0.00104 animals/km^2 (CV = 0.67) that is applicable to the HRC study area and western portion of the transit corridor. This represents an improvement to the density estimate used previously in the Navy's Phase III analyses as it is based on multiple-covariate line-transect analyses of sighting data collected on three surveys of waters within the Hawaiian Islands EEZ in 2002, 2010, and 2017. The Bradford et al. (2021) estimate for the most recent year (2017) is considered a year-round estimate since available data are insufficient to identify any seasonal patterns in the distribution of this species.

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

Table 8-2: Summary of Density Values for Longman's Beaked Whale in the Hawaii-California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.00104	0.00104	0.00104	0.00104
W. Transit Corridor	0.00104	0.00104	0.00104	0.00104
E. Transit Corridor	0	0	0	0
CAL	0	0	0	0
BCPM	0	0	0	0

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

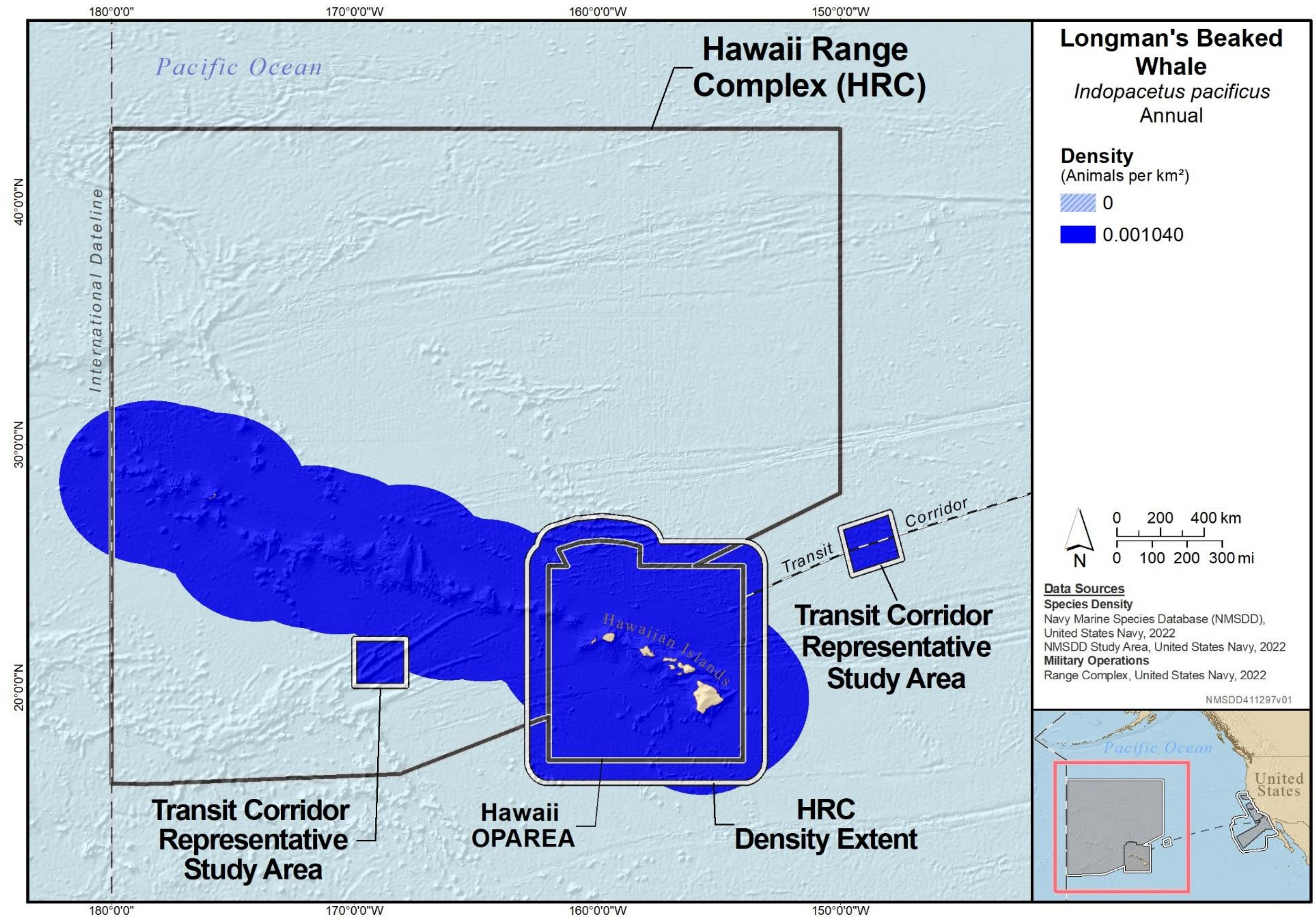

Figure 8-2: Annual Distribution of Longman's Beaked Whale in HRC and the Western Portion of the Transit Corridor

8.3 *MESOPLODON DENSIROSTRIS*, BLAINVILLE'S BEAKED WHALE

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., 2022).

HRC. Bradford et al. (2021) report a uniform density value for the Hawaiian Islands stock of Blainville's beaked whale of 0.00046 animals/km^2 (CV = 0.99) that is applicable to the HRC study area and western portion of the transit corridor. This represents an improvement to the density estimate used previously in the Navy's Phase III analyses as it is based on multiple-covariate line-transect analyses of sighting data collected on three surveys of waters within the Hawaiian Islands EEZ in 2002, 2010, and 2017. The Bradford et al. (2021) estimate for the most recent year (2017) is considered a year-round estimate since available data are insufficient to identify any seasonal patterns in the distribution of this species.

CAL-BCPM. This species is addressed in the small beaked whale guild for CAL-BCPM and the eastern portion of the transit corridor (Section 8.7).

Table 8-3: Summary of Density Values for Blainville's Beaked Whale in the Hawaii-California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.00046	0.00046	0.00046	0.00046
W. Transit Corridor	0.00046	0.00046	0.00046	0.00046
E. Transit Corridor	G	G	G	G
CAL	G	G	G	G
BCPM	G	G	G	G

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range. G = this species is part of the small beaked whale guild in CAL-BCPM.

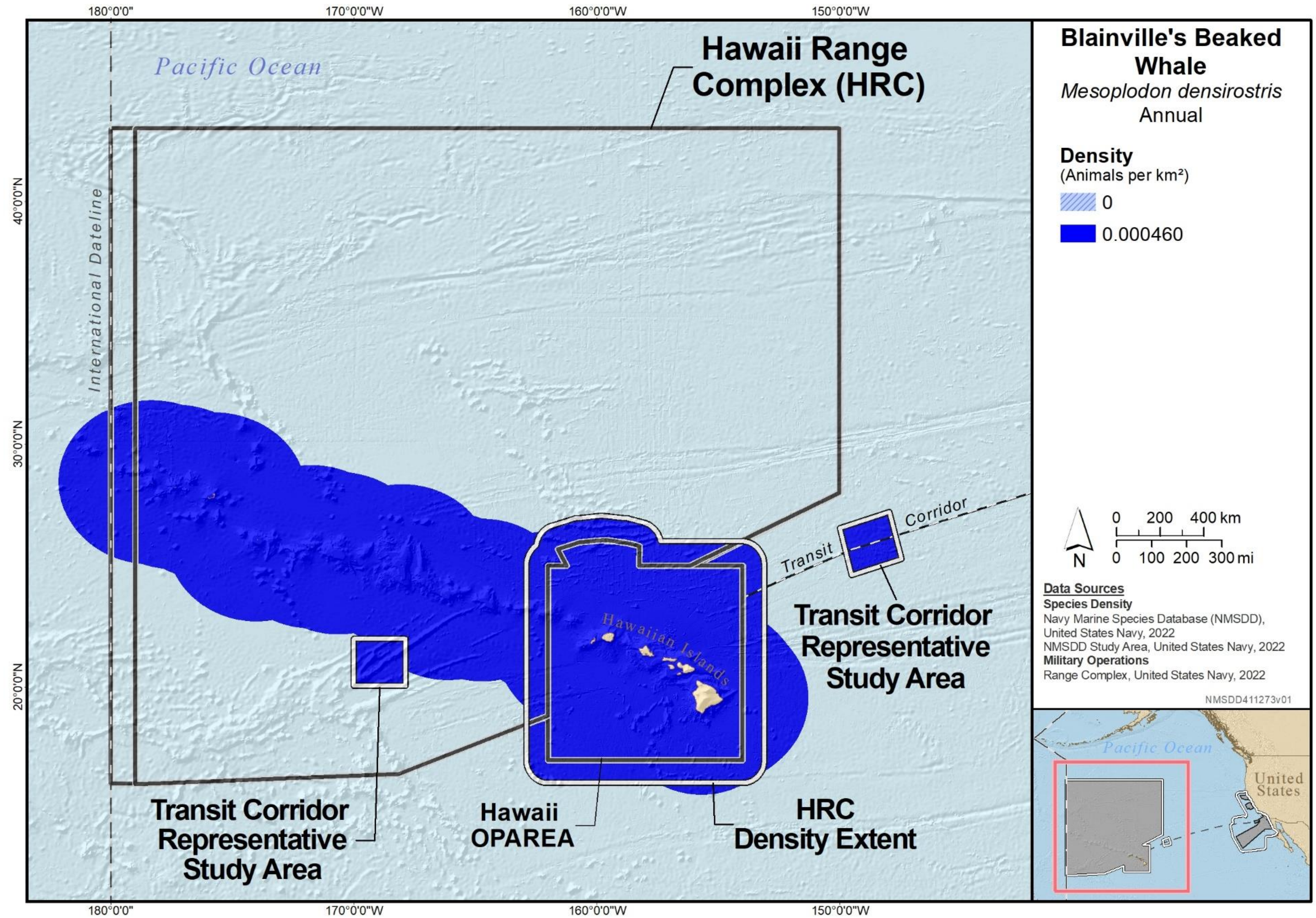

Figure 8-3: Annual Distribution of Blainville's Beaked Whale in HRC and the Western Portion of the Transit Corridor

8.4 *MESOPLODON GINKGODENS*, GINKGO-TOOTHED BEAKED WHALE

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 of Mesoplodont beaked whales (Carretta et al., 2022).

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).

CAL-BCPM. This species is addressed in the small beaked whale guild for CAL-BCPM and the eastern portion of the transit corridor (Section 8.7).

Table 8-4: Summary of Density Values for Ginkgo-Toothed Beaked Whale in the Hawaii-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
CAL	G	G	G	G
BCPM	G	G	G	G

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range. G = this species is part of the small beaked whale guild in CAL-BCPM.

8.5 *MESOPLODON STEJNEGERI*, STEJNEGER'S BEAKED WHALE

Stejneger's beaked whale is included in two stocks recognized by NMFS: (1) all *Mesoplodon* species off California, Oregon, and Washington, and (2) an Alaska stock of Stejneger's beaked whale (Carretta et al., 2022; Muto et al., 2017). In CAL-BCPM, Stejneger's beaked whales are part of the California, Oregon, and Washington stock of Mesoplodont beaked whales.

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

CAL-BCPM. This species is addressed in the small beaked whale guild for CAL-BCPM and the eastern portion of the transit corridor (Section 8.7).

Table 8-5: Summary of Density Values for Stejneger's Beaked Whale in the Hawaii-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
CAL	G	G	G	G
BCPM	G	G	G	G

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range. G = this species is part of the small beaked whale guild in CAL-BCPM.

8.6 *ZIPHIUS CAVIROSTRIS*, CUVIER'S BEAKED WHALE

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., 2022). Animals in CAL-BCPM or HRC are assigned to their respective stock.

HRC. Bradford et al. (2021) report a uniform density value for the Hawaiian Islands stock of Cuvier's beaked whale of 0.00181 animals/km^2 (CV = 0.41) that is applicable to the HRC study area and western portion of the transit corridor. This represents an improvement to the density estimate used previously in the Navy's Phase III analyses as it is based on multiple-covariate line-transect analyses of sighting data collected on three surveys of waters within the Hawaiian Islands EEZ in 2002, 2010, and 2017. The Bradford et al. (2021) estimate for the most recent year (2017) is considered a year-round estimate since available data are insufficient to identify any seasonal patterns in the distribution of this species.

CAL-BCPM. Fiedler et al. (In Press) developed a habitat-based density model for Cuvier's beaked whale that provided density predictions at 25 km x 25 km spatial resolution for the SWFSC CCE Study Area. Methods followed those of Becker et al. (2020a) but included biologically relevant predictor variables to try to improve models for deep-diving species such as Cuvier's beaked whale. Based on recent acoustic-based abundance estimates for this species that are more precise than those from visual line-transect analyses (Barlow et al., 2022), correction factors were applied to the Fiedler et al. (In Press) model-based estimates to match the point estimate from Barlow et al. (2021) of 5,454 animals. Density estimates from the new Cuvier's beaked whale model were applied year-round to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor.

Ferguson and Barlow (2003) provide density values for areas off BCPM. For the Navy's Phase IV analyses, the Ferguson and Barlow (2003) density estimates and CVs were recalculated based on the extent of the HCTT acoustic modeling footprint and resulted in a Cuvier's beaked whale density estimate of 0.00703 animals/km^2 (CV = 0.39). In the BCPM waters, the same value is used for all seasons since seasonally specific values are not currently available.

Table 8-6: Summary of Density Values for Cuvier's Beaked Whale in the Hawaii-California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	0.00181	0.00181	0.00181	0.00181
W. Transit Corridor	0.00181	0.00181	0.00181	0.00181
E. Transit Corridor	S	S	S	S
CAL	S	S	S	S
BCPM	0.00703	0.00703	0.00703	0.00703

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range. G = this species is part of the small beaked whale guild in CAL-BCPM.

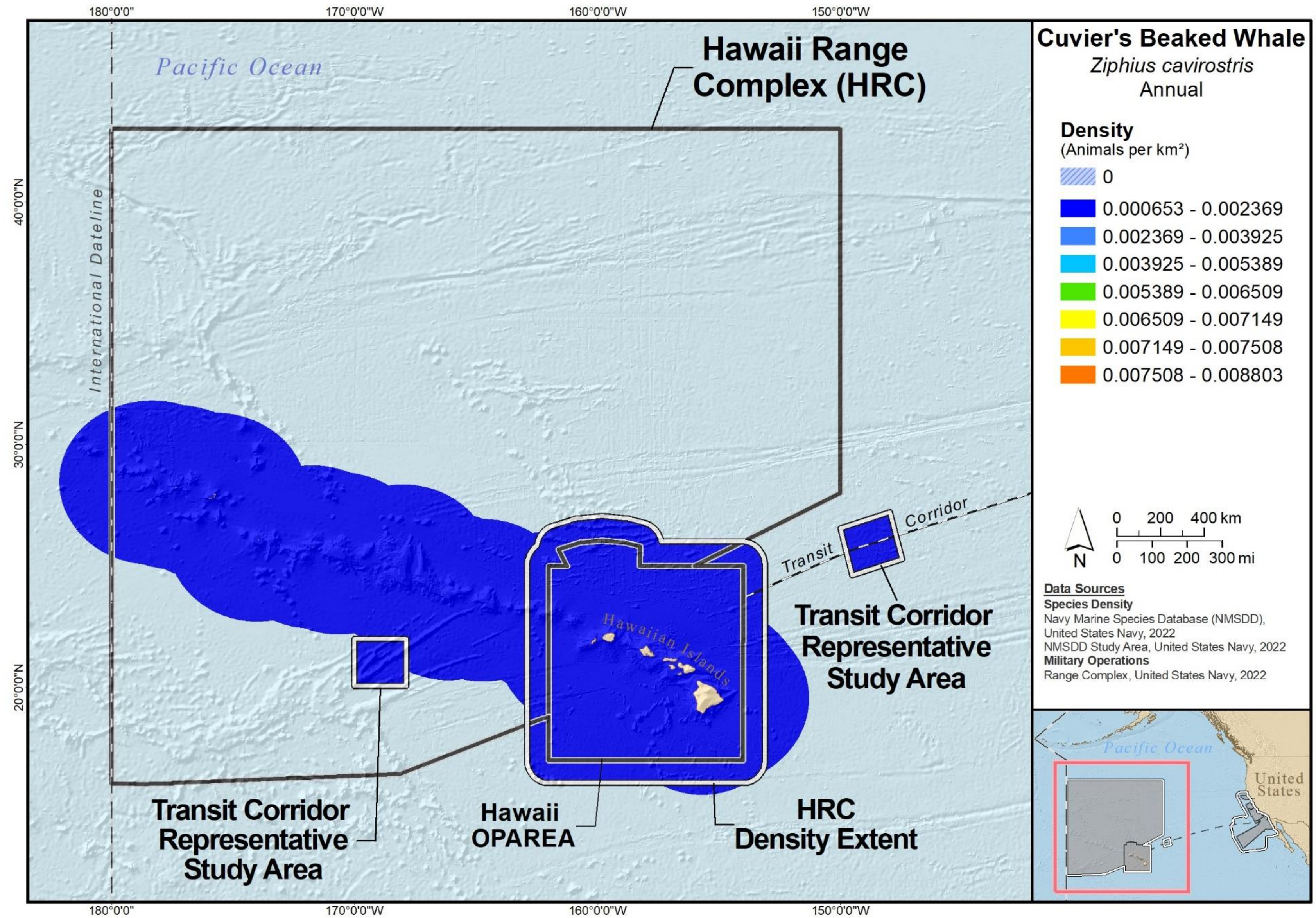

Figure 8-4: Annual Distribution of Cuvier's Beaked Whale in HRC and the Western Portion of the Transit Corridor

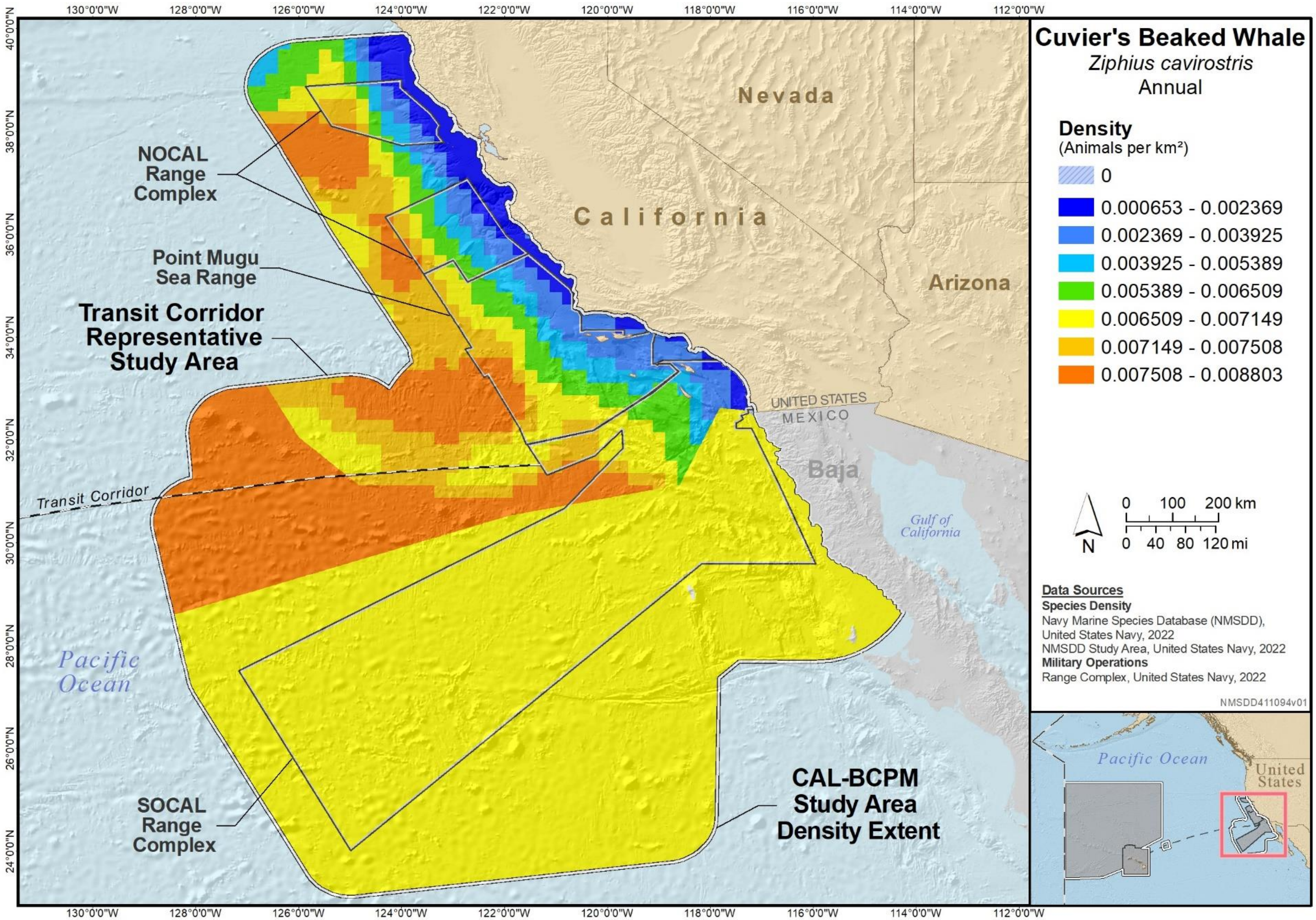

Figure 8-5: Annual Distribution of Cuvier's Beaked Whale in CAL-BCPM and the Eastern Portion of the Transit Corridor

8.7 Small Beaked Whale Guild

Due to the difficulty in distinguishing the different *Mesoplodon* species from one another, NMFS has combined six *Mesoplodon* species to make up the California, Oregon, and Washington stock of Mesoplodont beaked whales (Carretta et al., 2022). Due to limited sample sizes, NMFS combined all *Mesoplodon* spp. sightings with sightings of Cuvier's beaked whale and unidentified small beaked whales to develop habitat-based density models for a small beaked whale guild in the CCE (Becker et al., 2012b; Forney et al., 2012). 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 whales 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).

CAL-BCPM. The Phase III NMSDD included data from a CCE habitat-based density model for the small beaked whale guild based on systematic survey data collected from 1991 to 2009 (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 models were updated to include additional systematic survey data collected in summer and fall of 2014 and 2018 (Becker et al., 2020a). Model improvements were recognized from additional sighting data collected off the continental shelf and slope, and the inclusion of a broader range of habitat conditions. In addition, recently developed techniques for deriving estimates of uncertainty (Miller et al., 2022) were used to provide more comprehensive variance estimates for the model-based predictions. Density estimates from the updated small beaked whale guild model were applied to the portion of the Navy's CAL-BCPM acoustic modeling study area that overlaps the SWFSC's CCE study area, as well as the eastern portion of the transit corridor. Given the lack of quantitative seasonal information on this group of species, these estimates were applied year-round.

In the summer and fall, density for *Mesoplodon* spp. has been 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 estimates of trackline detection probability derived by Barlow (2015). Since this estimate is based on line-transect survey data that includes sightings of all Mesoplodont species within the Navy's acoustic modeling study area, it was applied to the BCPM portion of the HCTT Study Area for all seasons.

Table 8-7: Summary of Density Values for the Small Beaked Whale Guild in the Hawaii-California Training and Testing Study Area

Location	Spring	Summer	Fall	Winter
HRC	***	***	***	***
W. Transit Corridor	***	***	***	***
E. Transit Corridor	S	S	S	S
CAL	S	S	S	S
BCPM	0.00217	0.00217	0.00217	0.00217

The units for numerical values are animals/km^2. 0 = species is not expected to be present; S = spatial model with various density values throughout the range. *** = a small beaked whale guild is not used to define densities for this area/season.

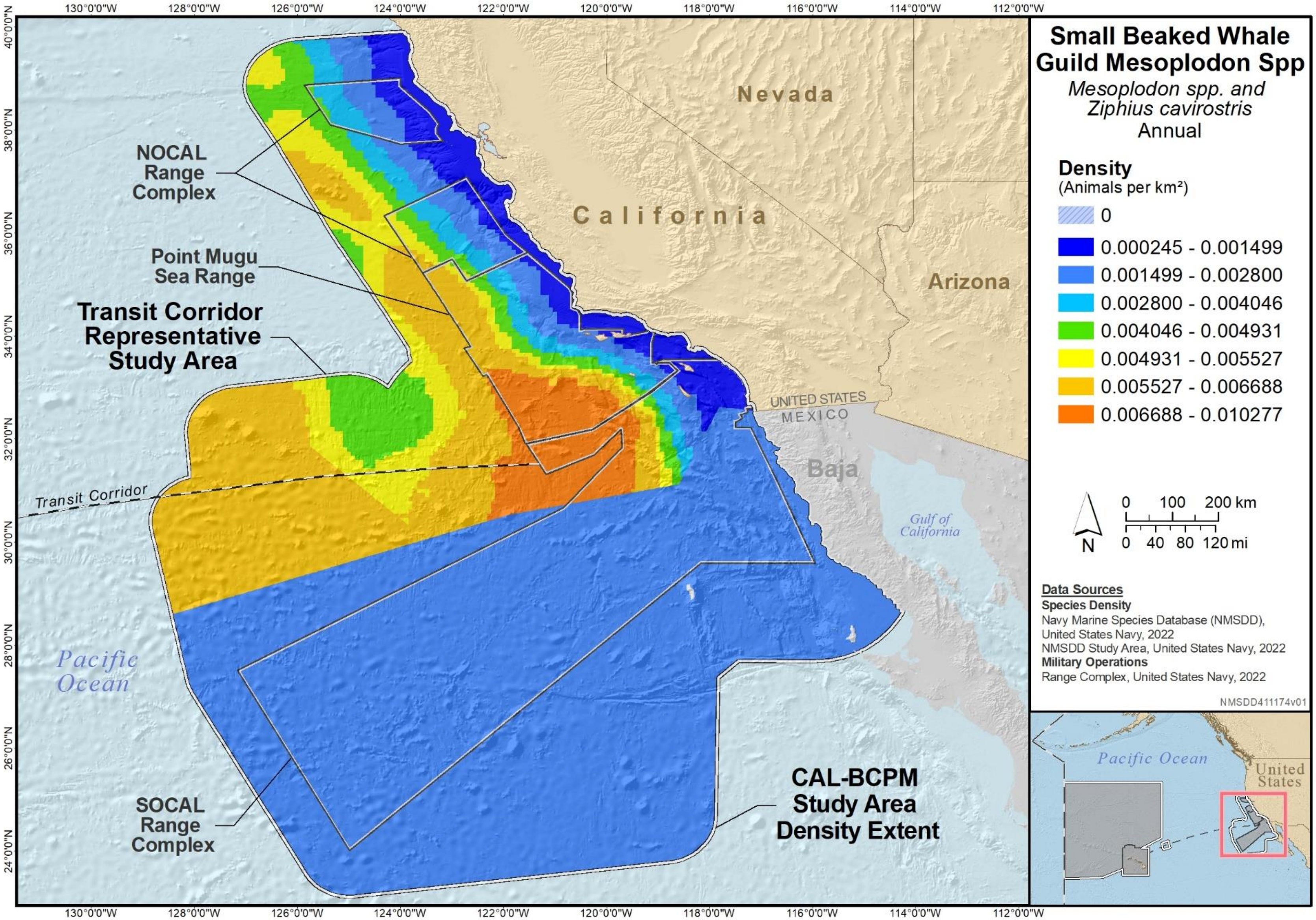

Figure 8-6: Annual Distribution of Small Beaked Whale Guild in CAL-BCPM and the Eastern Portion of the Transit Corridor

9 PINNIPEDS (SEALS AND SEA LIONS)

The Navy's acoustic effects model requires in-water density estimates to support its analyses; however, population or abundance estimates for pinniped species typically rely on counts of individuals on land at haul-out sites and breeding rookeries or estimates of the number of pups born and surviving at rookeries (for example Harvey et al., 1990; Jeffries et al., 2003; Lowry, 2002; Lowry et al., 2014; Lowry et al., 2021; Sepulveda et al., 2009). Translating these abundance estimates into in-water densities adds a degree of uncertainty that is dependent on species' haul-out and migration behaviors and how accurately those behaviors can be represented in the calculation of in-water densities. Since systematic offshore marine species surveys are primarily focused on cetaceans, observations of pinnipeds during surveys are recorded less frequently and usually only for selected species. Density distributions in open-ocean areas far from shore and haul-out locations are therefore based on limited data, adding a higher degree of uncertainty to density estimates in much of the Study Area, like the transit corridors and western offshore areas of HCTT, far from haulouts and breeding sites, but where several species are known to occur during migrations and overwintering periods.

Only one pinniped species, the Hawaiian monk seal (*Neomonachus schauinslandi*), occurs in Hawaii. As many as six pinniped species occur within the CAL-BCPM portion of the Study Area: Guadalupe fur seal (*Arctocephalus townsendi*), northern fur seal (*Callorhinus ursinus*), northern elephant seal (*Mirounga angustirostris*), Pacific harbor seal (*Phoca vitulina*), California sea lion (*Zalophus californianus*), and Steller sea lion (*Eumetopias jubatus*). Species' distributions in the Study Area vary; however, in general, pinniped densities are highest closer to shore and near haul-out sites and decrease with distance from shore. For several species, densities in areas far from typical habitat and where occurrence is considered extralimital are estimated to be zero.

9.1 *ARCTOCEPHALUS TOWNSENDI*, GUADALUPE FUR SEAL

Guadalupe fur seals were once plentiful off the coasts of California and Mexico, ranging from the Gulf of the Farallones near San Francisco, to the Revillagigedo Islands, Mexico (Aurioles-Gamboa et al., 1999). However, over-harvesting in the 19th century led them to the brink of extinction. With implementation of protective measures in the 20th century by both the United States and Mexico, the population began to slowly recover and expand into its historical range extending from central Mexico to waters off Washington State (Aurioles-Gamboa et al., 2010; D'Agnese et al., 2020; Melin & DeLong, 1999; Norris & Elorriaga-Verplancken, 2020; Stewart, 1981; Stewart et al., 1993). Since all the individuals are descendants from a breeding colony at Isla Guadalupe, Mexico, the Guadalupe fur seal population is treated as a single stock by NMFS (Carretta et al., 2022).

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

CAL-BCPM. Off North America, Guadalupe fur seals are pelagic and rarely come to shore along the mainland coast (Norris & Elorriaga-Verplancken, 2020). The primary breeding colony is on Guadalupe Island, located off the BCPM and south of the SOCAL OPAREA. Breeding also occurs on a smaller scale on islands in the San Benito Archipelago, which has only recently been recolonized by the fur seals and is also located south of the SOCAL OPAREA (Aurioles-Gamboa et al., 2010). Occasional sightings of Guadalupe fur seal pups have also been reported on the Channel Islands, including San Miguel, San Nicolos, and the Farallon Islands (Gallo-Reynoso, 1994; Juárez-Ruiz et al., 2018; Melin & DeLong, 1999).

During a 2019 pinniped survey of the Channel Islands, Lowry et al. (2021) reported seeing only one Guadalupe fur seal, which was on San Nicolos Island. With rare exceptions, Guadalupe fur seals are expected to be in the water and not hauled out when in the Study Area.

Navy-funded tagging studies tracking Guadalupe fur seal movements from Guadalupe Island north along the U.S. West Coast show that non-pups (adults and juveniles of both sexes) occur in highest concentrations in offshore waters near the Patten Escarpment or at approximately the 2,000 m depth contour in the SOCAL OPAREA and PMSR (Norris, 2019; Norris & Elorriaga-Verplancken, 2020). Pups, however, migrate closer to shore than non-pups and are known to migrate farther north into waters off Oregon, Washington, and British Columbia. Based on the tracking results and unpublished data, a “core range” and a broader “geographic range” representing Guadalupe fur seal distribution was defined (Norris, 2022). The Navy used these ranges as the distribution areas for the density estimates.

An unpublished abundance estimate of 43,360 Guadalupe fur seals based on pup counts was provided by Norris (2022) as the mean of two separately derived abundance estimates of 37,940 and 48,780 fur seals. As a conservative approach, the Navy chose to use the greater of the two abundance estimates instead of the mean to calculate densities, which also accounts for any pups missed during counts. The pup count has not yet been published by the researchers and at their request is not provided in this technical report.

An estimated 50 to 100 percent of Guadalupe fur seals occur in the core range and 10 to 50 percent of Guadalupe fur seals occur in the geographic range, depending on seasonal fluctuations in distribution. For the purposes of calculating a density, the mid-point of each percentage was used to estimate the abundance of Guadalupe fur seals in each range. Therefore, 75 percent of Guadalupe fur seals are estimated to occur in the core range and 30 percent are estimated to occur in the geographic range at any given time. Using the mid-points of each range effectively increases the abundance used in the calculations by 5 percent (i.e., 75 + 30 percent = 105 percent). Since most pups are born in summer on Guadalupe Island south of the Study Area and remain on land through March, few if any pups would occur in the Study Area from July through March.

From April through June, the entire population of 48,780 Guadalupe fur seals is assumed to be in the water, with 75 percent distributed in the core range and 30 percent distributed in the geographic range. From July through March, a lower in-water abundance estimate of 43,360 Guadalupe fur seals is used to account for pups remaining on land or outside of the Study Area. The size, seasonal abundances, and densities for each range are shown in Table 9-1, and densities within the Study Area are shown in Figure 9-1 and Figure 9-2.

Table 9-1: Summary of Density Estimates for Guadalupe Fur Seal in CAL-BCPM

Range	Area (km^2)	In-Water Abundance (July – March)	In-Water Abundance (April – June)	Density (July – March)	Density (April – June)
Core	582,319	32,520	36,585	0.05585	0.06283
Geographic	4,553,909	13,008	14,634	0.00286	0.00321

Abundance is the number of animals; density is the number of animals per km^2.

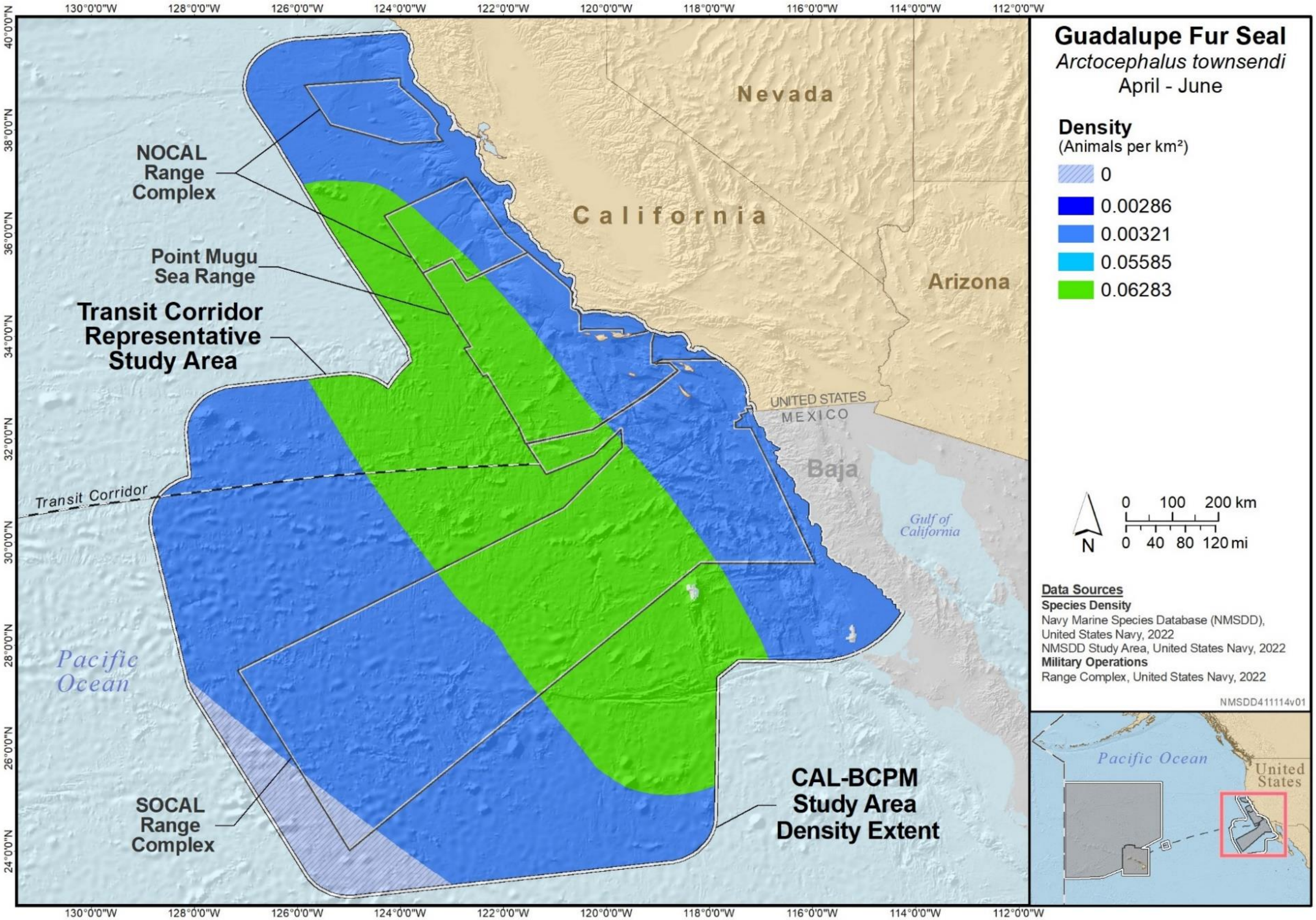

Figure 9-1: April-June Distribution of Guadalupe Fur Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

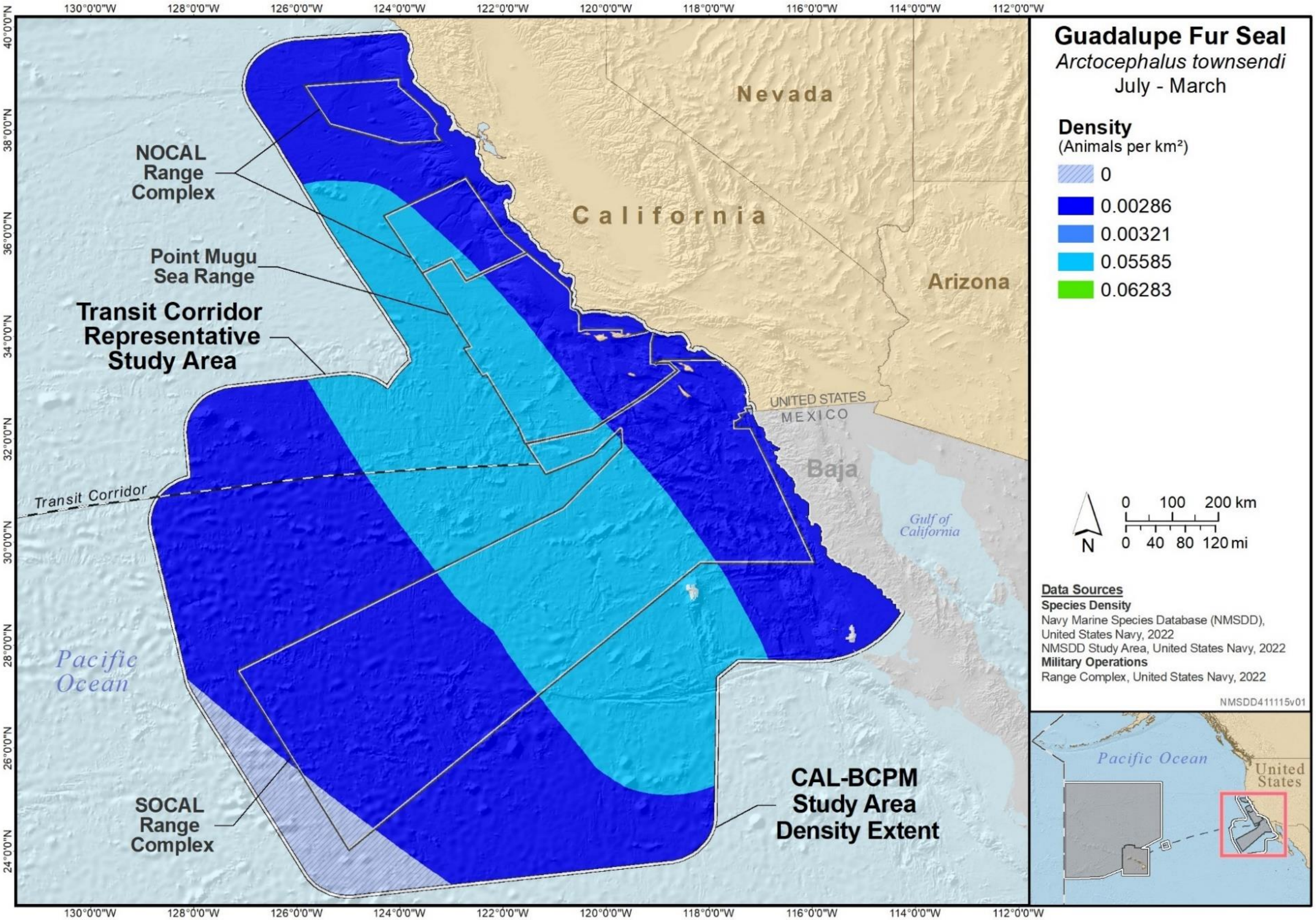

Figure 9-2: July-March Distribution of Guadalupe Fur Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

9.2 *Callorhinus ursinus*, Northern Fur Seal

Northern fur seals occur from the northern Channel Islands off California north along the coast of North America to the Bering Sea and west to Japan (Carretta et al., 2022). 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 fur seals breeding on San Miguel Island and the Farallon Islands, and the significantly larger Eastern Pacific Stock, which includes fur seals that breed primarily on islands in the Bering Sea (Carretta et al., 2022). The abundance of the Eastern Pacific Stock is estimated to be 626,618 (CV = 0.2) fur seals and the abundance of the California Stock is estimated at 14,050 fur seals (Carretta et al., 2020; Muto et al., 2020b; Muto et al., 2021). Northern fur seals from both stocks occur in the Study Area; however, only some juvenile and adult females and yearlings of both sexes from the Eastern Pacific Stock would migrate as far as the northern portion of the CAL-BCPM, and an even smaller portion would migrate as far south as the Channel Islands and southern California.

During the breeding season, adult males from both stocks are on shore between June and August, with some remaining ashore through November. Adult females come to shore in June and remain 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 natal rookery.

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

CAL-BCPM. The density for northern fur seals off California (northern fur seals are not expected off the BCPM) is based on an estimate of each stock's monthly abundance off California. Monthly abundance estimates for both stocks are combined to calculate a density for the species off California. From the Eastern Pacific Stock, a portion of adult and juvenile females and yearlings of both sexes migrate from the Bering Sea, across the Gulf of Alaska, to the west coast of North America following the breeding season (Bigg, 1990; Pelland & Zickel, 2020; Pelland et al., 2014; Ream et al., 2005; Sterling et al., 2014). With the exception of some adult males, northern fur seals from the California Stock remain in waters offshore of California and are concentrated near haulouts and breeding sites on San Miguel Island and the Farallon Islands (Antonelis & Fiscus, 1980).

Three strata were defined to represent the combined distribution of northern fur seals from both stocks along the California coast: 1) San Miguel, 3) Northern Coastal, and 3) Northern Offshore. A brief description of the strata, including estimates of their size used below in density calculations is provided in Table 9-2.

Abundance estimates needed for the density calculations were derived by estimating the percentage of the two stocks occurring in the three strata. The percentages were evaluated by month to capture the migratory behavior and variable occurrence of northern fur seals from the larger Eastern Pacific Stock, which dominates the population in the northern part of the Study Area during the first half of the year, but makes up only about 20 percent to less than half of the population during the second part of the year (Pelland, 2022; Pelland et al., 2014; Zeppelin et al., 2019).

Table 9-2: Strata for Northern Fur Seal Density Calculations

Stratum	Area (km^2)	Description
San Miguel	14,915	Area centered around San Miguel Island and extending 140 km northwest, based on the distribution of lactating females (Antonelis et al., 1990); bounded on the west by the 3,000 m depth contour, and on the east by the 200 m depth contour (Pelland et al., 2014). Extends 40 km southeast from San Miguel Island.
Northern Coastal (200 m depth contour to 250 km from 200 m depth contour)	281,128	Area extending north from the San Miguel stratum to the California-Oregon border, bounded by the 200 m depth contour to the east and a distance of 250 km from the 200 m depth contour to the west (Pelland et al., 2014).
Northern Offshore (250 km to 450 km offshore)	251,100	Area extending north from the San Miguel stratum to the California-Oregon border, bounded by the 250 km boundary to the east and a distance of 450 km from shore to the west (Pelland et al., 2014).

km = kilometer; m = meter; % = percent.

Since only certain age and sex classes of northern fur seals from the Eastern Pacific Stock migrate along the U.S. West Coast, it was necessary to estimate abundance by class. Lifestage ratios for age and sex classes for northern fur seals were approximated from Table 4 in Loughlin et al. (1994). While the stock abundance has decreased since the study was completed, the Navy assumes the class breakdown remains representative of the stock. The class percentages from Loughlin et al. (1994) were used to estimate class abundances using the latest stock abundance estimate (Table 9-3). Northern fur seals from the California Stock are expected to remain off the California coast and largely within the defined strata; however, to capture some of the variability in class distribution, the same age and sex class ratios shown in Table 9-3 were applied to the California Stock as well.

Northern fur seals occurring in the San Miguel stratum are almost exclusively from the California Stock with only a token number of adult females from the Eastern Pacific Stock expected to migrate as far south as the Channel Islands (Pelland, 2022; Pelland et al., 2014). To estimate an abundance of northern fur seals in the San Miguel stratum, the Navy estimated 0.1 percent of adult females from the Eastern Pacific Stock would reach the San Miguel Stratum in February before beginning their return trip to the Bering Sea in April. No other fur seals from the Eastern Pacific Stock are expected to occur in the San Miguel Stratum, and adult females are not expected that far south at any other time of year.

In general, northern fur seals in the California Stock are concentrated in the San Miguel stratum near breeding sites on San Miguel Island and the Farallon Islands in summer and then disperse northward following breeding and pupping (Antonelis & Fiscus, 1980; Kajimura, 1984). The Navy estimated a percentage of each age and sex class occurring in the San Miguel stratum based on research summarized below by class.

Table 9-3: Age and Sex Class Percentages for the Eastern Pacific Stock of Northern Fur Seal

Class	Percentage of Stock (%)[1]	Abundance Estimate
Pups	22.35	140,037
Yearlings	11.17	70,018
2-year-old (males and females)[2]	8.94	56,015
3-year-old females	3.84	24,086
3-year-old males	3.58	22,406
Adult females	37.25	233,394
Adult Males	12.87	80,661
Total[3]	**100**	**626,618[4]**

[1]Based on Table 4 in Loughlin et al. (1994)
[2]Assumed half of 2-year-olds are male and half are female
[3]Based on Muto et al. (2020a); Muto et al. (2021)
[4] The sum of class abundance estimates is 626,617; however, the stock abundance is 626,618 based on Muto et al. (2020a)
% = percent

Adult Males: Little is known about where adult males from San Miguel Island and the Farallon Islands migrate following the breeding season. Kajimura (1984) reports historical data on captured seals indicating males and females (adults and younger seals) move north from San Miguel Island. More males were captured at higher latitudes than farther south following the breeding season. While there was no differentiation between the two stocks, males from the Eastern Pacific Stock are not known to migrate to the West Coast, so it was assumed that captured males were from the California Stock. For the non-breeding season, the Navy estimated 50 percent of adult males remain in the San Miguel stratum, and 50 percent migrate into the two Northern strata extending to the California-Oregon border. During the June - August breeding season, adult males are almost exclusively on land defending territory on San Miguel Island with a few on the Farallon Islands (Carretta et al., 2020). To account for some foraging, the Navy estimated 5 percent of adult males would be in the water during the breeding season. Some males remain on land after giving up territory, so only 80 percent are estimated to be in the water in September. The non-breeding season distribution of 50 percent in the San Miguel stratum and 50 percent in the two Northern strata extends from October through April. Adult males return to the San Miguel stratum in May, enroute to breeding colonies, with an estimated 80 percent in the water in May (Table 9-4).

Pups: Most northern fur seal pups are born in July and remain on land through summer (Zeppelin et al., 2019). To account for the possibility that a small number of pups might venture into the water for a brief period of time in summer, the Navy estimated 10 percent of pups would be in the San Miguel stratum from July through October and then 90 percent in November when pups leave with adult females and migrate north (Lea et al., 2009; Pelland & Zickel, 2020). Many pups may remain at sea for 22 months north of the Study Area before returning to their natal rookery as juveniles (Bigg, 1990; Kenyon & Wilke, 1953; Zeppelin et al., 2019). Lea et al. (2009) tagged pups born on San Miguel Island and tracked their migration north, with a large portion entering the Gulf of Alaska. In the study, the first pup entered the Gulf of Alaska on December 21, and from January 1 to March 1, between 33 and 57 percent of tagged pups were in the Gulf of Alaska.

Adult Females: Post-partum females remain on shore for about 7 days after giving birth but then begin foraging trips that last for an average of 6.9 days, mostly traveling northwest of San Miguel Island before returning to land to feed their pups (Antonelis et al., 1990). On average, post-partum females spent 180 hours in the water for every 40 hours on land, equating to 78 percent of time in the water. Based on these results, the Navy estimated 78 percent of adult females would be in the water from June through November. Adult females migrate north and northwest of San Miguel Island in November (Carretta et al., 2020; Lea et al., 2009) but for modeling purposes are assumed to remain within the San Miguel stratum for the remainder of the year. The results of the telemetry study reported by Antonelis et al. (1990) showed that 92 percent of lactating females foraged northwest of San Miguel Island with only 8 percent foraging south or southeast of the island, and the females traveled up to 140 km northwest and 40 km southeast of the island.

Juveniles: Pups and juvenile northern fur seals (up to three years old) are primarily pelagic, returning to shore for the first time when in their third year, although some juveniles return to breeding sites earlier (Carretta et al., 2022; Zeppelin et al., 2019). The Navy estimates that 50 percent of juveniles remain in the San Miguel stratum in summer, and then most disperse into the two Northern strata in fall, with only 20 percent remaining in the San Miguel stratum through April.

San Miguel Stratum Abundance: Based on this temporal distribution, the Navy estimated the percentage of each age and sex class occurring in the San Miguel stratum by month (Table 9-4).

Table 9-4: Monthly Percentage of Northern Fur Seals Occurring in the San Miguel Stratum by Class

Month	California Stock				Eastern Pacific Stock
	Adult females (%)	Adult Males (%)	Juveniles[1] (%)	Pups (%)	Adult Females (%)
January	100	50	20	0	0
February	100	50	20	0	0.1
March	100	50	20	0	0.1
April	100	50	20	0	0.1
May	100	80	30	0	0
June	78	5	50	0	0
July	78	5	50	0	0
August	78	5	50	10	0
September	78	80	40	10	0
October	78	50	30	10	0
November	78	50	20	90	0
December	100	50	20	10	0

[1]Juveniles include yearlings and two- and three-year old fur seals estimated as about 28 percent of the stock.
% = percent

Multiplying the stock abundance by the class percentages from Table 9-3 and the occurrence percentage of each class from Table 9-4 results in monthly class in-water abundance estimates in the

San Miguel stratum (Table 9-5). Summing abundance estimates over all classes and both stocks results in a total monthly in-water abundance of northern fur seals in the San Miguel stratum (Table 9-5).

Table 9-5: Monthly In-Water Abundance Estimates of Northern Fur Seals in the San Miguel Stratum

Month	Eastern Pacific Stock	California Stock					Total Abundance
	Adult females	Pups	Juveniles	Adult females	Adult Males	Total	
January	0	0	787	5,233	904	6,924	6,924
February	233	0	787	5,233	904	6,924	7,158
March	233	0	787	5,233	904	6,924	7,158
April	233	0	787	5,233	904	6,924	7,158
May	0	0	1,180	5,233	1,447	7,860	7,860
June	0	0	1,967	4,082	90	6,139	6,139
July	0	0	1,967	4,082	90	6,139	6,139
August	0	314	1,967	4,082	90	6,453	6,453
September	0	314	1,574	4,082	1,447	7,416	7,416
October	0	314	1,180	4,082	904	6,480	6,480
November	0	2,826	787	4,082	904	8,599	8,599
December	0	314	787	5,233	904	7,238	7,238

For example, to calculate the in-water abundance of adult females from the California Stock in the San Miguel stratum in January, the following equation is used:

Abundance = $14{,}050_{\text{(stock abundance)}}$ x $0.3725_{\text{(class proportion)}}$ x $1.00_{\text{(proportion in the stratum)}}$ = 5,233 adult female northern fur seals

The same calculation was made for each class using the corresponding values in Table 9-3 and Table 9-4, and then all class abundances were summed resulting in an overall in-water abundance for January of 6,924 northern fur seals. Note that for calculations incorporating the Eastern Pacific Stock, the stock abundance is 626,618 fur seals.

<u>Northern Strata Abundance</u>: The same process was followed to estimate the abundance of fur seals in the two Northern strata (Offshore and Coastal). Fur seals in the Eastern Pacific Stock dominate abundance in the Northern strata from January through May, after which adult and juvenile females and most yearlings from the stock begin their return trip to Alaska waters and the Bering Sea. Only a portion of yearlings from the stock are likely to occur in California waters from July through December (Pelland, 2022). Northern fur seals from the Eastern Pacific Stock (i.e., adult and juvenile females and yearlings of both sexes) that migrate to the West Coast have been described as coastal migrators (Pelland, 2019; Pelland et al., 2014). The abundance of coastal migrators occurring in the Northern strata was estimated based on telemetry studies by Zeppelin et al. (2019) and Pelland et al. (2014), and correspondence with researchers at the Alaska Fisheries Science Center Marine Mammal Lab (Pelland, 2022). Figure 5 in Pelland et al. (2014) shows the monthly progression of the alongshore distribution of adult female northern fur seals as they migrate into California waters in January and depart before June. Figure 4 in (Zeppelin et al., 2019) tracks the occurrence of coastal migrators in the Gulf of Alaska and California

Current large marine ecosystems from October to May by age and sex classes. The proportions of each class in the Northern strata were estimated using the two figures and supporting analysis in Pelland et al. (2014) and Zeppelin et al. (2019), and through collaboration with researchers at the Marine Mammal Lab to fill gaps in the data (Pelland, 2022).

The following formula was used to calculate the abundance of adult female coastal migrators from the Eastern Pacific Stock:

Abundance = $626{,}618_{\text{(stock abundance)}}$ x $0.3725_{\text{(percent adult females)}}$ x (0.24 + 015) = 91,024 adult female coastal migrators;

where 24 percent of adult females were in the California Current Large Marine Ecosystem and 15 percent were in the Gulf of Alaska Large Marine Ecosystem in January (Zeppelin et al., 2019). Similar calculations were made for juvenile females and yearlings using estimates of the proportion of each class occurring in the two large marine ecosystems (Table 9-6).

Table 9-6: Percentages Used to Approximate the Abundance Coastal Migrators from the Eastern Pacific Stock of Northern Fur Seals

Month	Adult females (%)		Juvenile Females (%)[3]		Yearlings (%)[4]	
	CC LME	GOA LME	CC LME	GOA LME	CC LME	GOA LME
January[1]	24	15	10	30	10	30
February[1]	40	10	37.5	12.5	37.5	12.5
March[1]	40	20	40	20	40	20
April[1]	50	15	40	30	40	30
May[2]	50		31.88	23.13	31.88	23.13
June[2]	16.77		31.88	23.13	31.88	23.13
July[2]	0		15.9	11.6	25	
August[2]	0		15.9	11.6	25	
September[2]	0		0		25	
October[1]	0		0		25	
November[1]	1		0		25	
December[1]	2		5		25	

[1]Percentages estimated from Zeppelin et al. (2019)
[2]Percentages estimated from Pelland (2022) and Pelland et al. (2014)
[3]Juvenile percentages in May and June are averages of January – April, and percentages for July and August as half of the May and June estimates
[4]Yearling percentages in May and June area averages of January – April
Notes: GOA = Gulf of Alaska, CC = California Current, LME = Large Marine Ecosystem

Only a portion of the coastal migrators from the Eastern Pacific Stock would occur in the two Northern strata. Percentages used to estimate in-water abundance for both stocks in the Northern strata are shown in Table 9-7.

Table 9-7: Monthly Percentage of Northern Fur Seals Occurring in the Northern Strata by Class

Month	California Stock				Eastern Pacific Stock		
	Adult females[2] (%)	Adult Males (%)	Juveniles[1] (%)	Pups (%)	Adult Females (%)	Juvenile Females (%)	Yearlings (%)
January	0	50	80	100	40	25	25
February	0	50	80	100	50	50	50
March	0	50	80	100	40	40	40
April	0	50	80	100	25	25	25
May	0	20	70	100	10	10	10
June	0	0	50	100	5	5	10
July	0	0	50	100	0	0	10
August	0	0	50	0	0	0	10
September	0	20	60	0	0	0	10
October	0	50	70	0	0	0	10
November	0	50	80	10	0	0	10
December	0	50	80	90	0	0	10

[1]Juveniles includes yearlings and two- and three-year old fur seals estimated as 28 percent of the stock.
[2]Adult females from the California Stock are assumed to remain within the San Miguel stratum
% = percent

The following example illustrates how abundances in the Northern strata were calculated. The Navy estimated that 40 percent of adult female coastal migrators occurred in the Northern strata based on Figure 5 in Pelland et al. (2014) and supplemental information (Pelland, 2022).

Abundance = 91,024$_{\text{(adult female coastal migrators)}}$ x 0.40 = 36,410 adult females in the Northern strata.

The same formula was used to calculate the abundance of adult females, juvenile females, and yearlings from the Eastern Pacific Stock occurring in the Northern strata by month throughout the year.

Table 9-8: Monthly In-Water Abundance Estimates of Northern Fur Seals from the Eastern Pacific Stock in the Northern Strata

Month	Eastern Pacific Stock			
	Adult Females	Juvenile Females	Yearlings	Total
January	36,410	5,209	7,002	48,621
February	58,349	13,023	17,505	88,877
March	56,015	12,502	16,804	85,322
April	37,927	9,116	12,253	59,296
May	11,670	2,865	3,851	18,386
June	1,957	1,433	3,851	7,241
July	0	0	1,750	1,750
August	0	0	1,750	1,750
September	0	0	1,750	1,750

Month	Eastern Pacific Stock			
	Adult Females	Juvenile Females	Yearlings	Total
October	0	0	1,750	1,750
November	0	0	1,750	1,750
December	0	0	1,750	1,750

The Navy assumed that all northern fur seals in the California Stock remain in either the San Miguel or the Northern strata, such that if, for example, 20 percent of juveniles were distributed in the San Miguel stratum in January, then 80 percent would be in the Northern strata. There are a few exceptions when the sum of percentages does not equal 100; these occur when a class is on land and spends little or no time in the water. For example, 95 percent of adult males from the California Stock are estimated to be on San Miguel Island (or the Farallon Islands) during the breeding season from June – August. The remaining 5 percent are distributed in the San Miguel stratum, and 0 percent occur in the Northern strata. Monthly percentages for the California Stock in the Northern strata are shown in Table 9-7. In-water abundance estimates of northern fur seals from the California Stock in the Northern strata are shown in Table 9-9.

Table 9-9: Monthly In-Water Abundance Estimates of Northern Fur Seals from the California Stock in the Northern Strata

Month	California Stock				
	Adult females[2]	Adult Males	Juveniles[1]	Pups	Total
January	0	904	3,147	3,140	7,191
February	0	904	3,147	3,140	7,191
March	0	904	3,147	3,140	7,191
April	0	904	3,147	3,140	7,191
May	0	362	2,754	3,140	6,255
June	0	0	1,967	3,140	5,107
July	0	0	1,967	3,140	5,107
August	0	0	1,967	0	1,967
September	0	362	2,360	0	2,722
October	0	904	2,754	0	3,658
November	0	904	3,147	314	4,365
December	0	904	3,147	3,140	6,877

[1]Juveniles includes yearlings and two- and three-year old fur seals estimated as 28 percent of the stock.
[2]Adult females from the California Stock are assumed to remain within the San Miguel stratum

<u>San Miguel Stratum Density</u>: To calculate monthly densities for northern fur seal in the San Miguel stratum, the total abundance estimates from Table 9-5 were divided by the area of the San Miguel stratum (Table 9-2). For January, the calculation is:

$$\text{Density} = 6{,}924_{\text{(abundance in January)}} / 14{,}915\ \text{km}^2 = 0.4642\ \text{northern fur seals/km}^2$$

Monthly density estimates of northern fur seals in the San Miguel stratum are shown in Table 9-10.

Northern Strata Density: To calculate monthly densities for northern fur seal in the Northern strata, the total abundance estimates from Table 9-8 (Eastern Pacific Stock) and Table 9-9 (California Stock) for the Northern strata were summed, and the combined total was distributed over the two strata, with 70 percent occurring in the Coastal stratum and 28 percent occurring in the Offshore stratum. The proportions are based on results reported by Pelland et al. (2014) on the cross-shore distribution of adult female northern fur seals that indicated approximately 70 percent remained within 250 km seaward of the 200 m depth contour and that approximately 98 percent occurred within 450 km of the 200 m depth contour (refer to Figure 6 and Figure S2 in Pelland et al. (2014)). The small number (about 2 percent) of northern fur seals that may occur more than 450 km from the 200 m depth contour are well outside of the Navy's HCTT Study Area. The density calculation for the Northern Coastal stratum in March is:

Density = [85,322$_{\text{(Eastern Pacific Stock)}}$ + 7,191$_{\text{(California Stock)}}$] x 0.70$_{\text{(Coastal Stratum)}}$ / 281,128 km^2 = 0.2304 animals / km^2 northern fur seals

Table 9-10: Northern Fur Seal Densities in the San Miguel Stratum

Month	San Miguel Stratum Density (animals/km^2)
January	0.4642
February	0.4799
March	0.4799
April	0.4799
May	0.5270
June	0.4116
July	0.4116
August	0.4327
September	0.4972
October	0.4345
November	0.5765
December	0.4853

Note: km = kilometer

The same formula was followed to calculate monthly densities in the Northern strata for the entire year (Table 9-11). Northern fur seal densities within the HCTT Study Area are shown in Figure 9-3 through Figure 9-14. The figures show densities as a range of values instead of a single value to standardize the legend across all figures for the species. However, each stratum on a map has only one density value (Table 9-10 and Table 9-11).

Table 9-11: Northern Fur Seal Abundance and Density in the Northern Coastal and Northern Offshore Strata

Month	Northern Strata			
	Coastal Abundance	Offshore Abundance	Coastal Density (animals/km^2)	Offshore Density (animals/km^2)
January	39,068	15,627	0.1390	0.0622
February	67,248	26,899	0.2392	0.1071
March	64,759	25,904	0.2304	0.1032
April	46,541	18,617	0.1656	0.0741
May	17,249	6,900	0.0614	0.0275
June	8,643	3,457	0.0307	0.0138
July	4,800	1,920	0.0171	0.0076
August	2,602	1,041	0.0093	0.0041
September	3,131	1,252	0.0111	0.0050
October	3,786	1,514	0.0135	0.0060
November	4,281	1,712	0.0152	0.0068
December	6,040	2,416	0.0215	0.0096

Note: km = kilometer

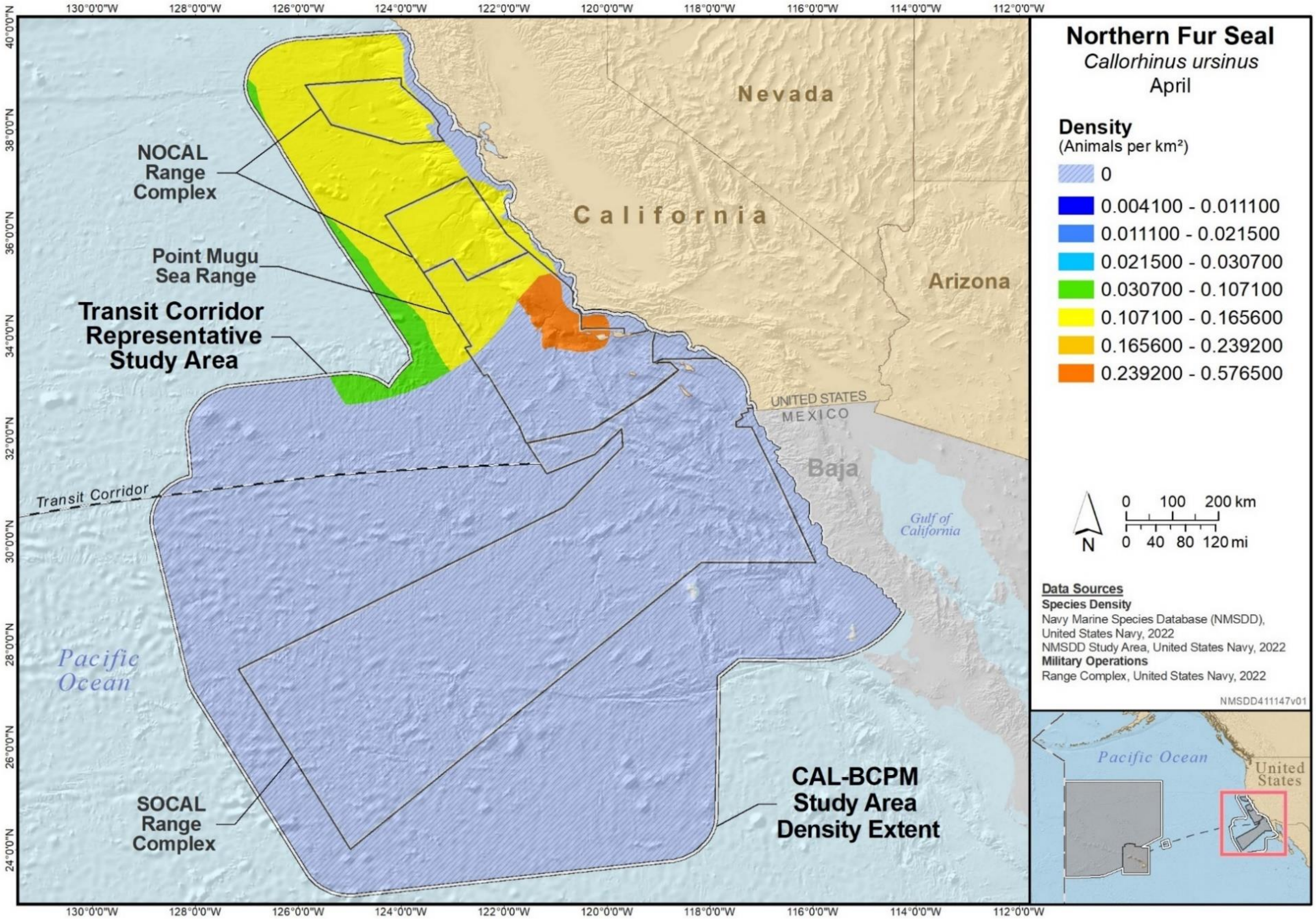

Figure 9-3: April Distribution of Northern Fur Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

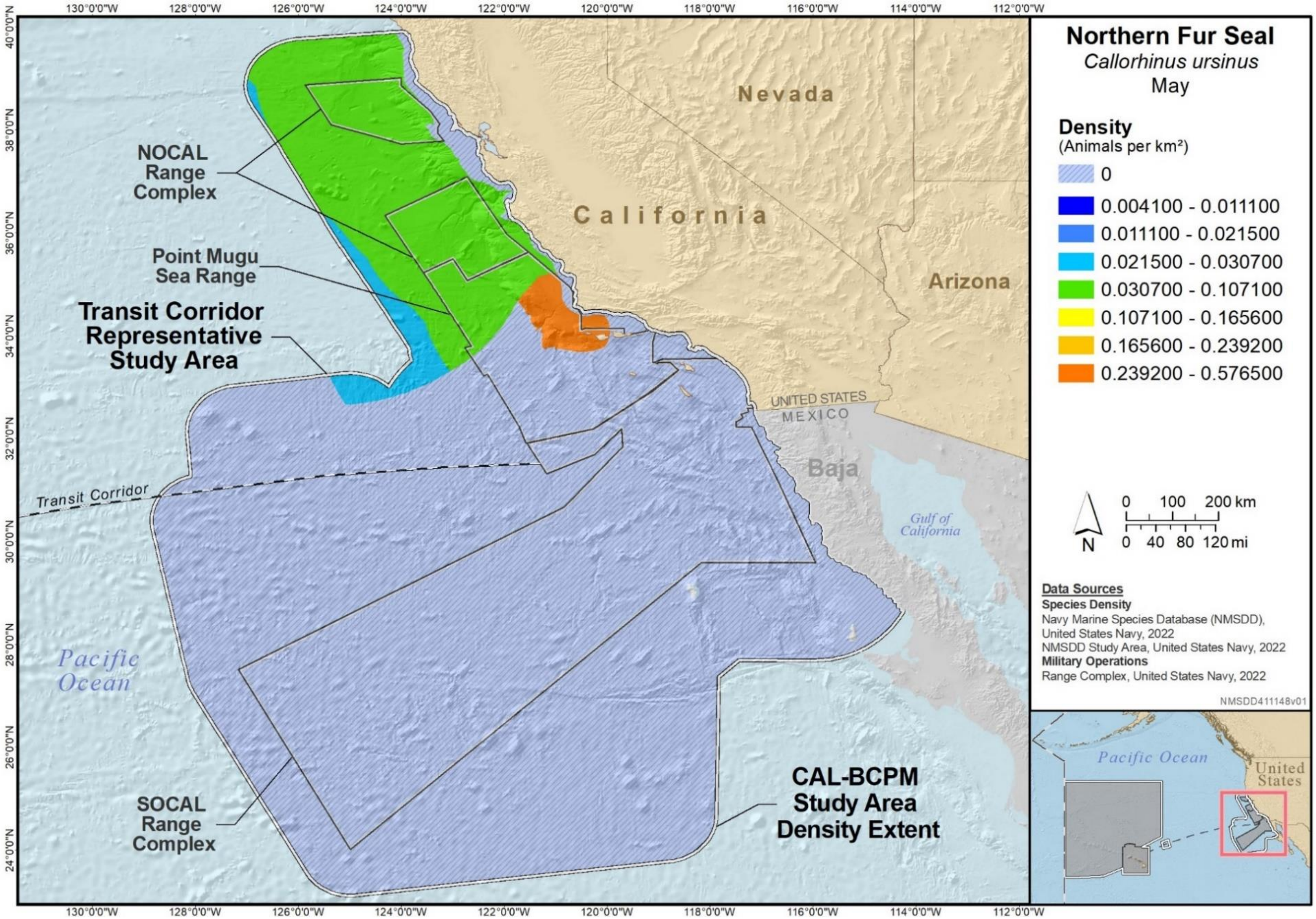

Figure 9-4: May Distribution of Northern Fur Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

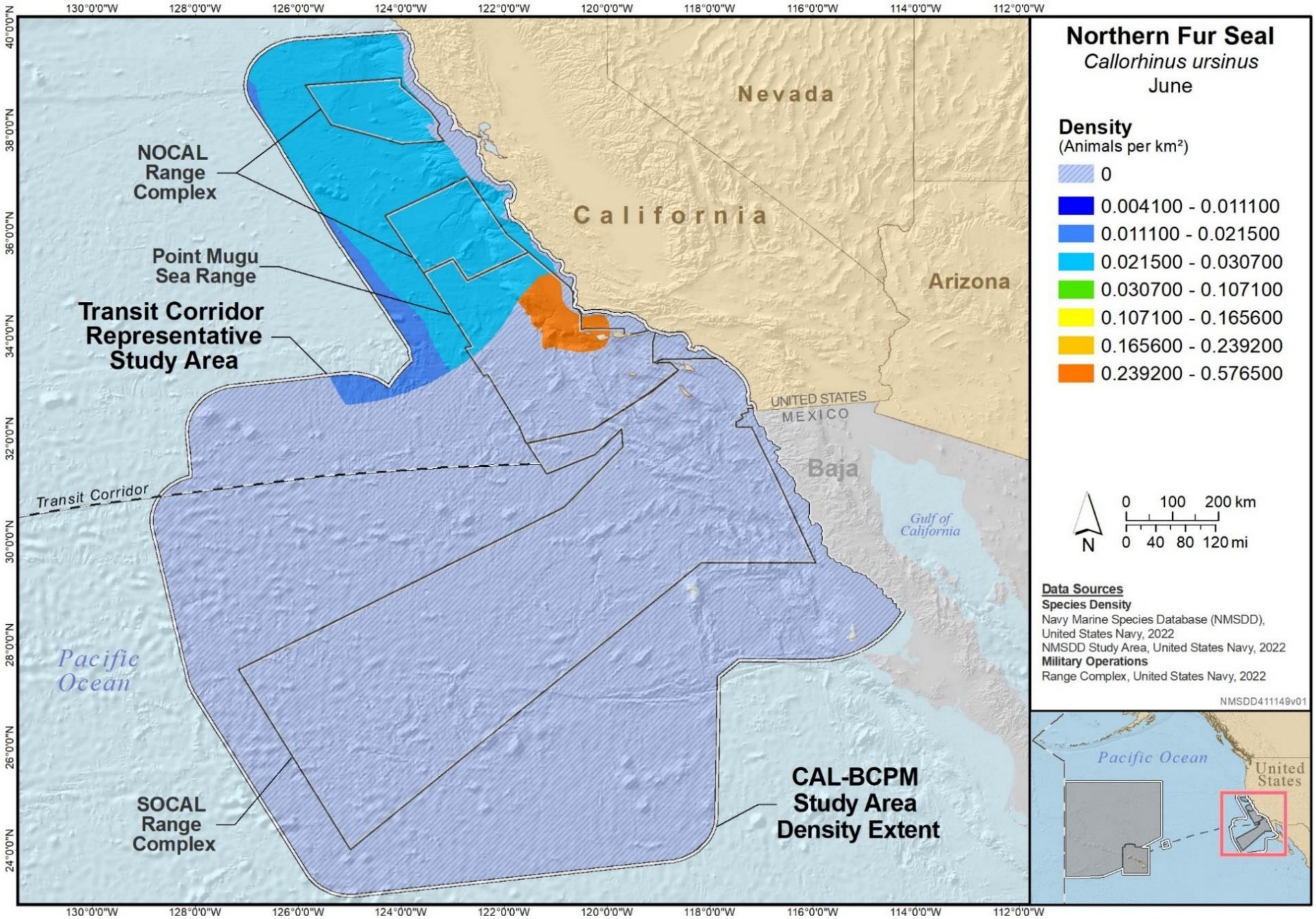

Figure 9-5: June Distribution of Northern Fur Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

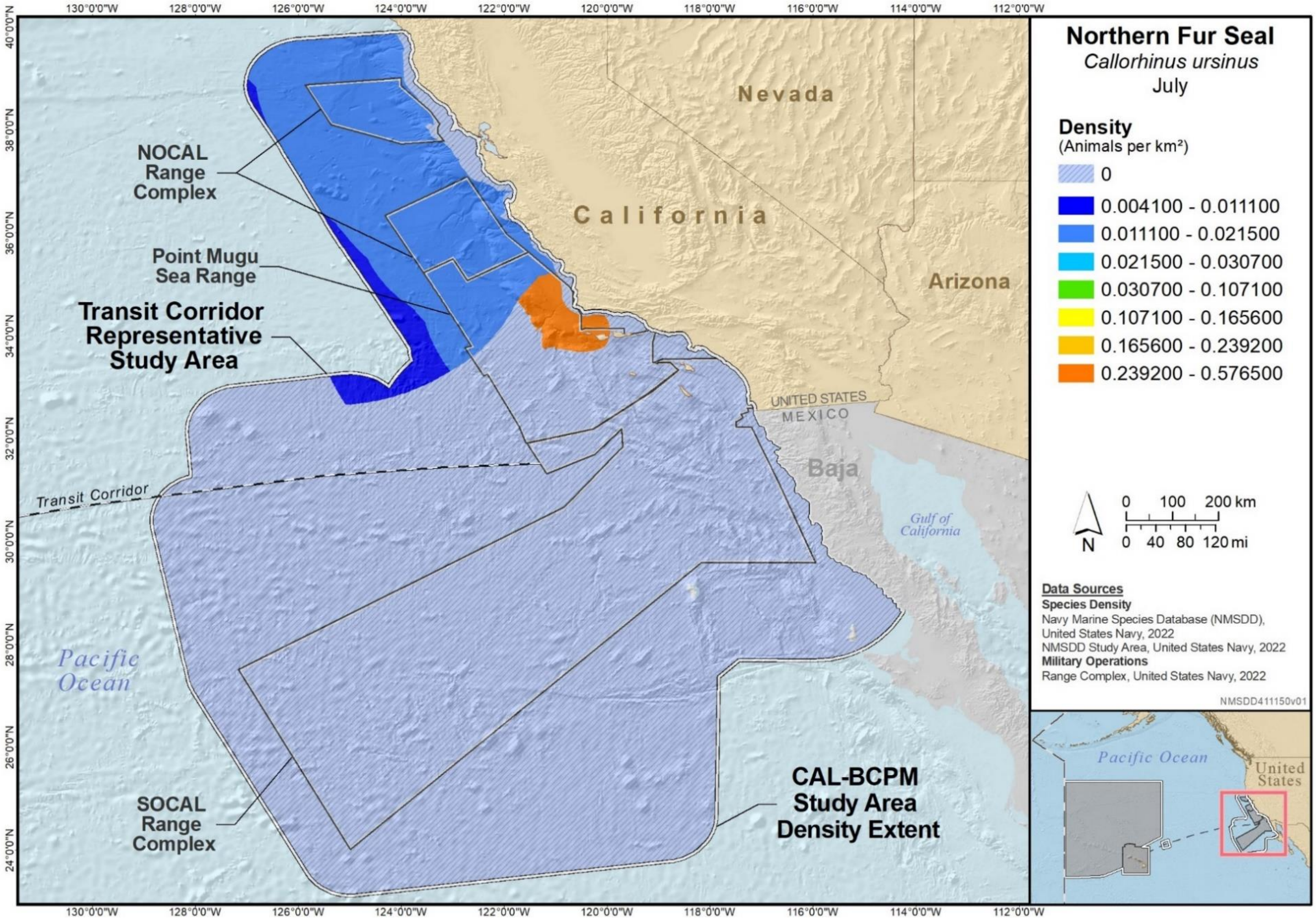

Figure 9-6: July Distribution of Northern Fur Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

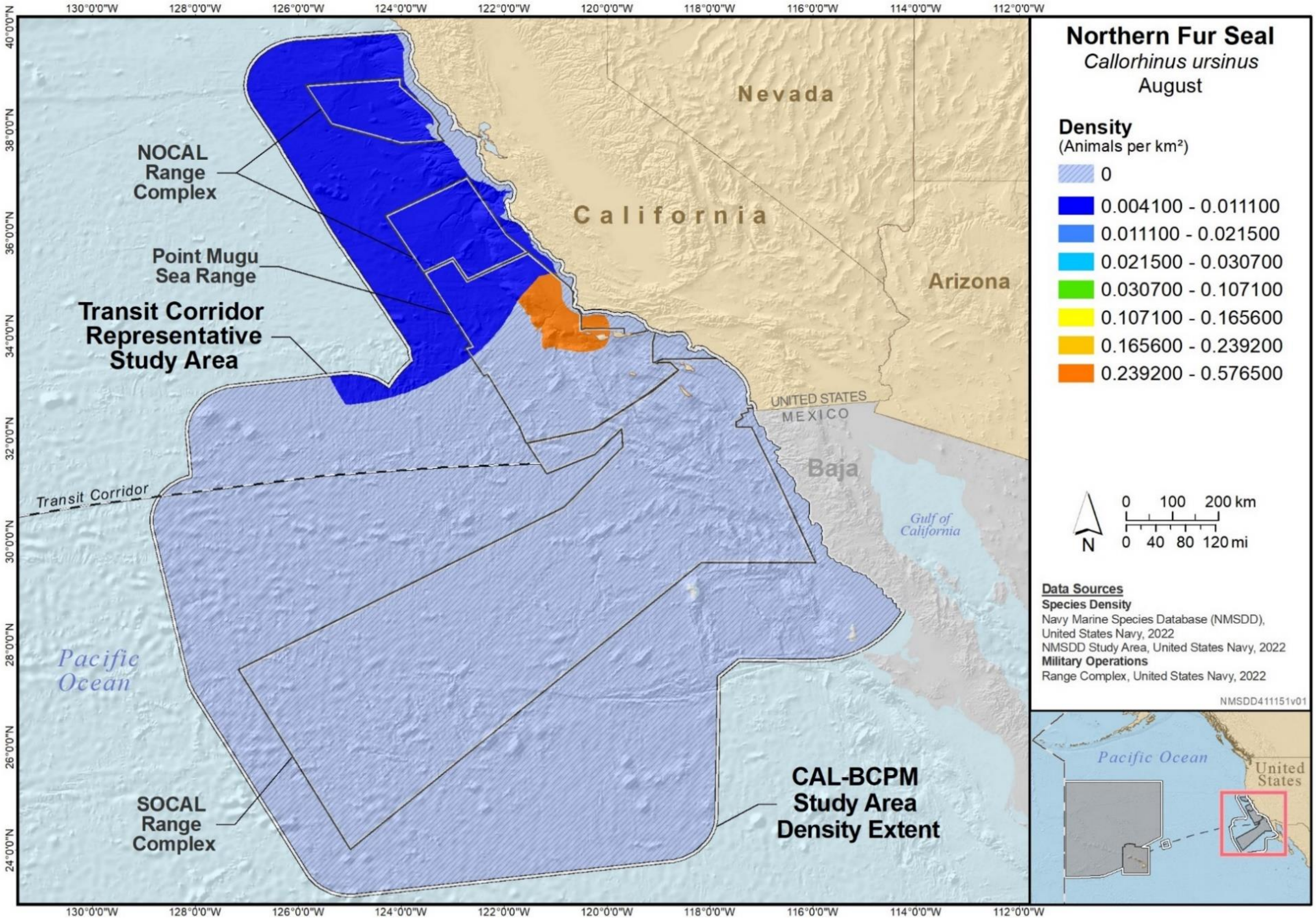

Figure 9-7: August Distribution of Northern Fur Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

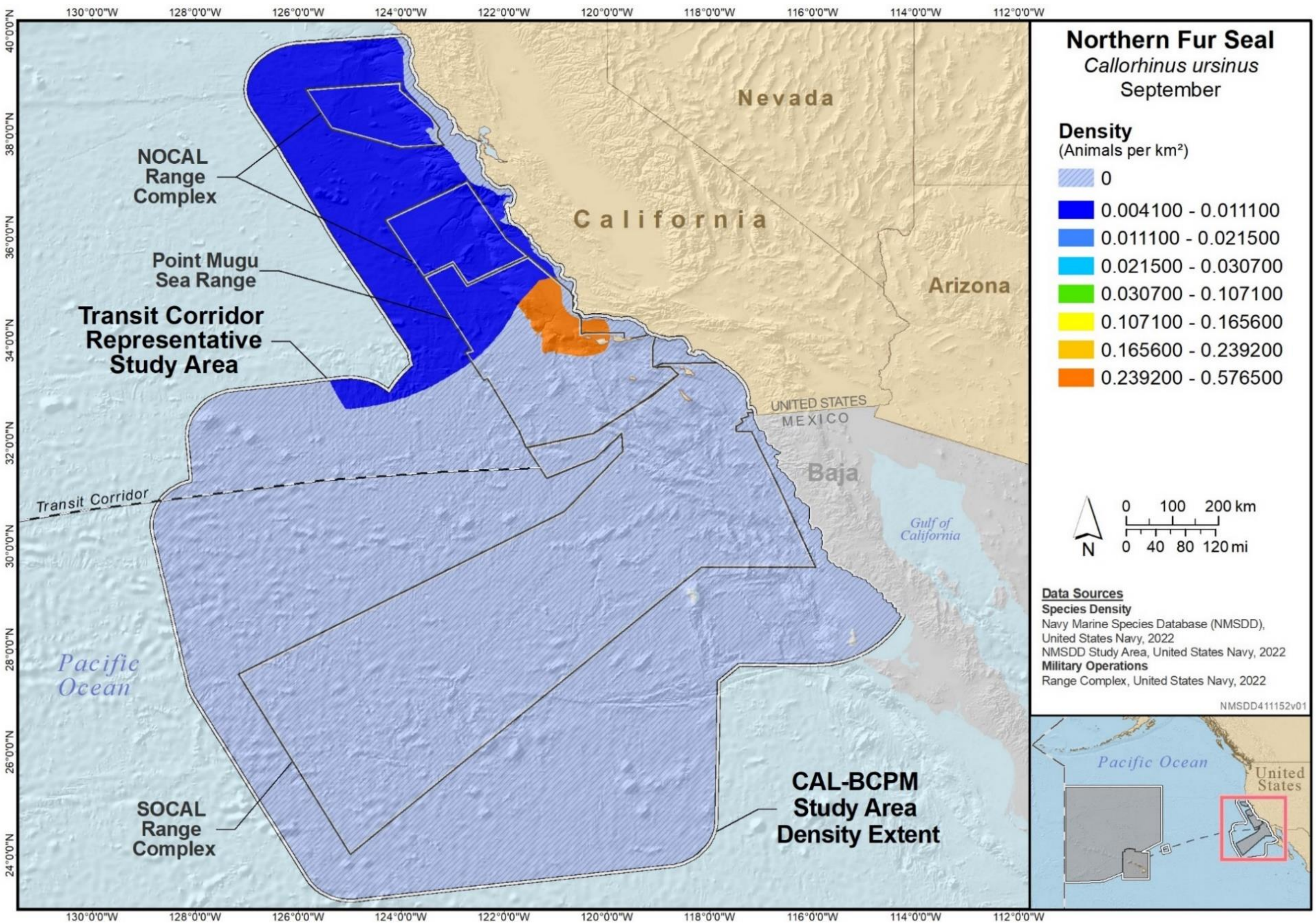

Figure 9-8: September Distribution of Northern Fur Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

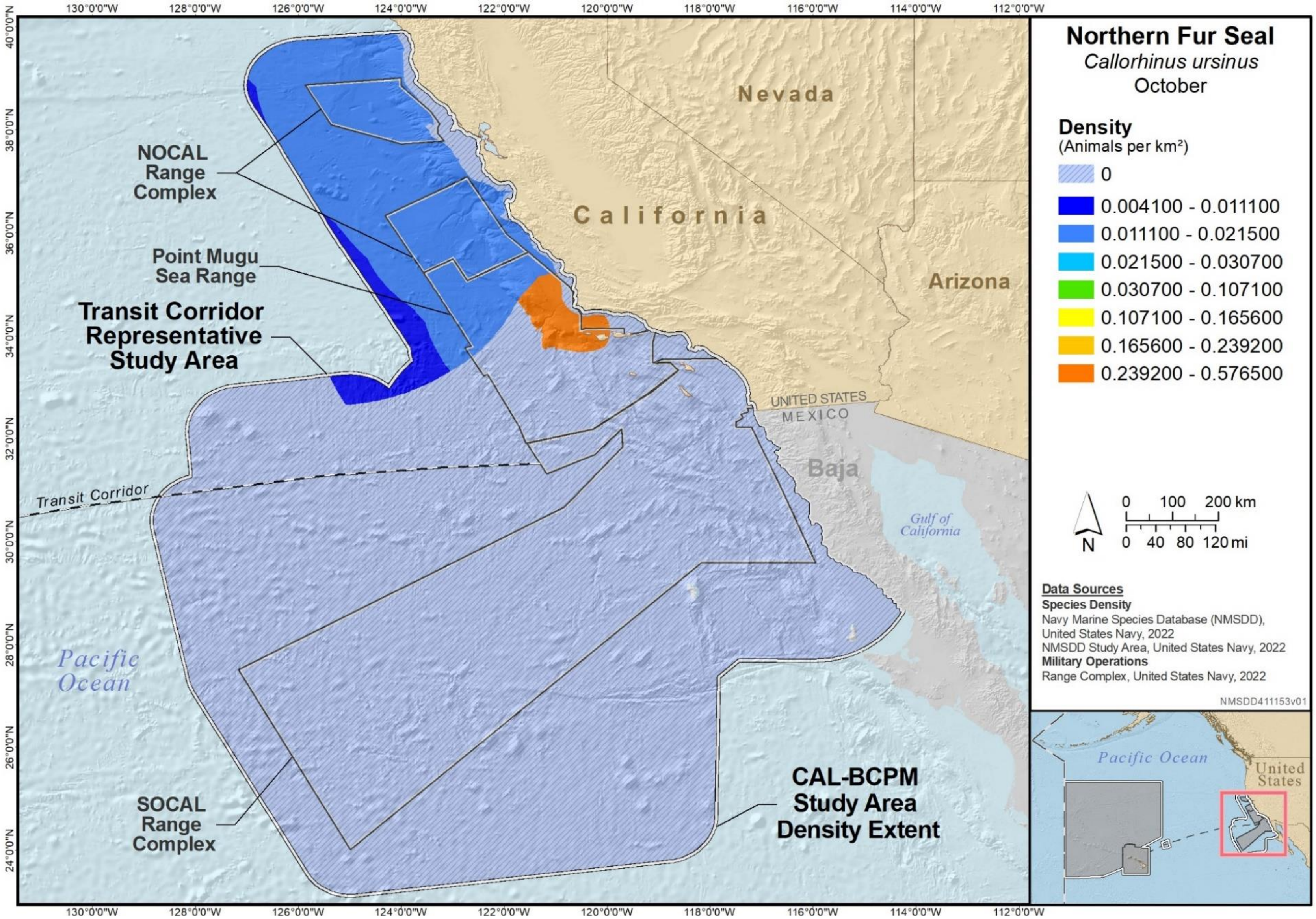

Figure 9-9: October Distribution of Northern Fur Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

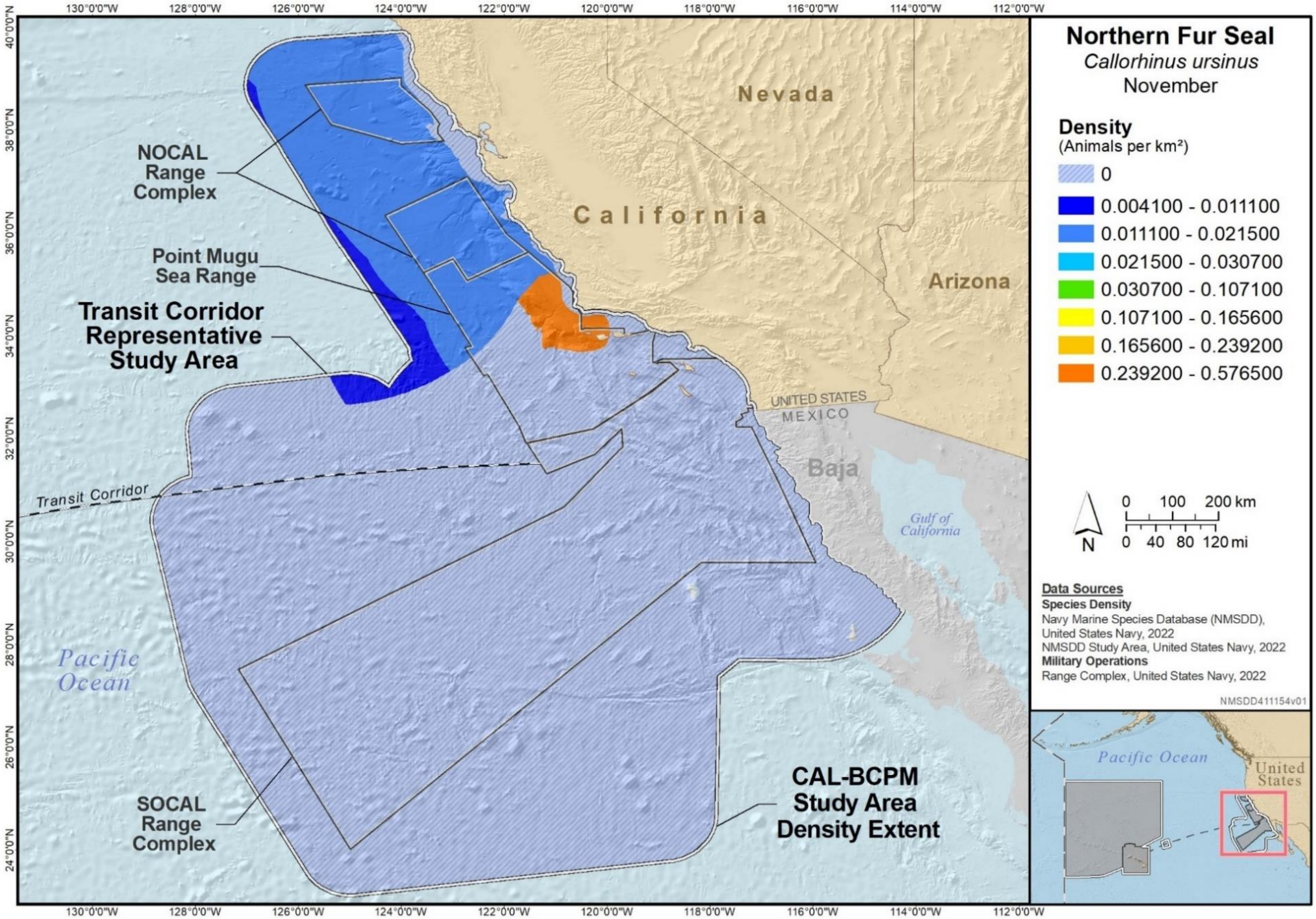

Figure 9-10: November Distribution of Northern Fur Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

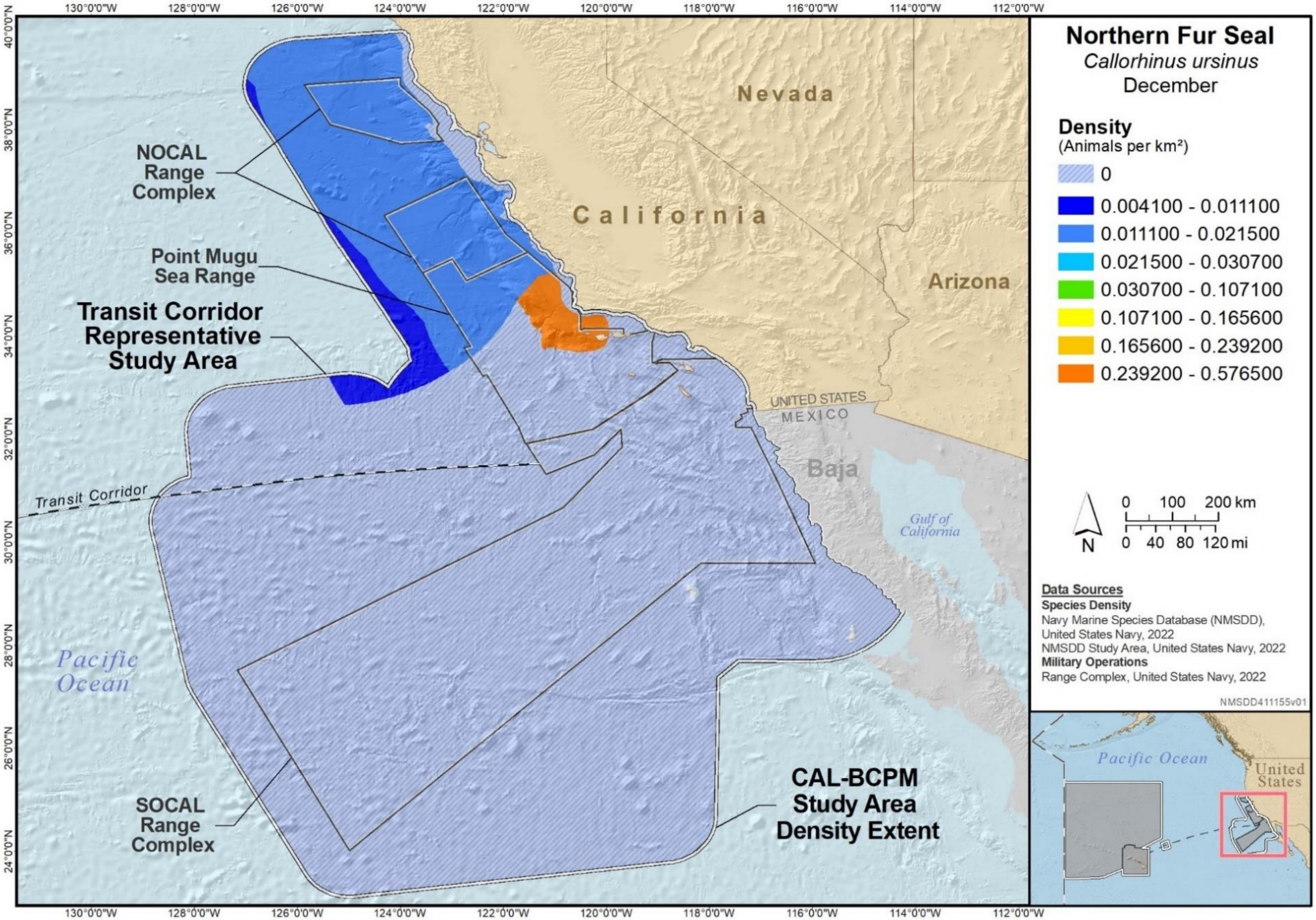

Figure 9-11: December Distribution of Northern Fur Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

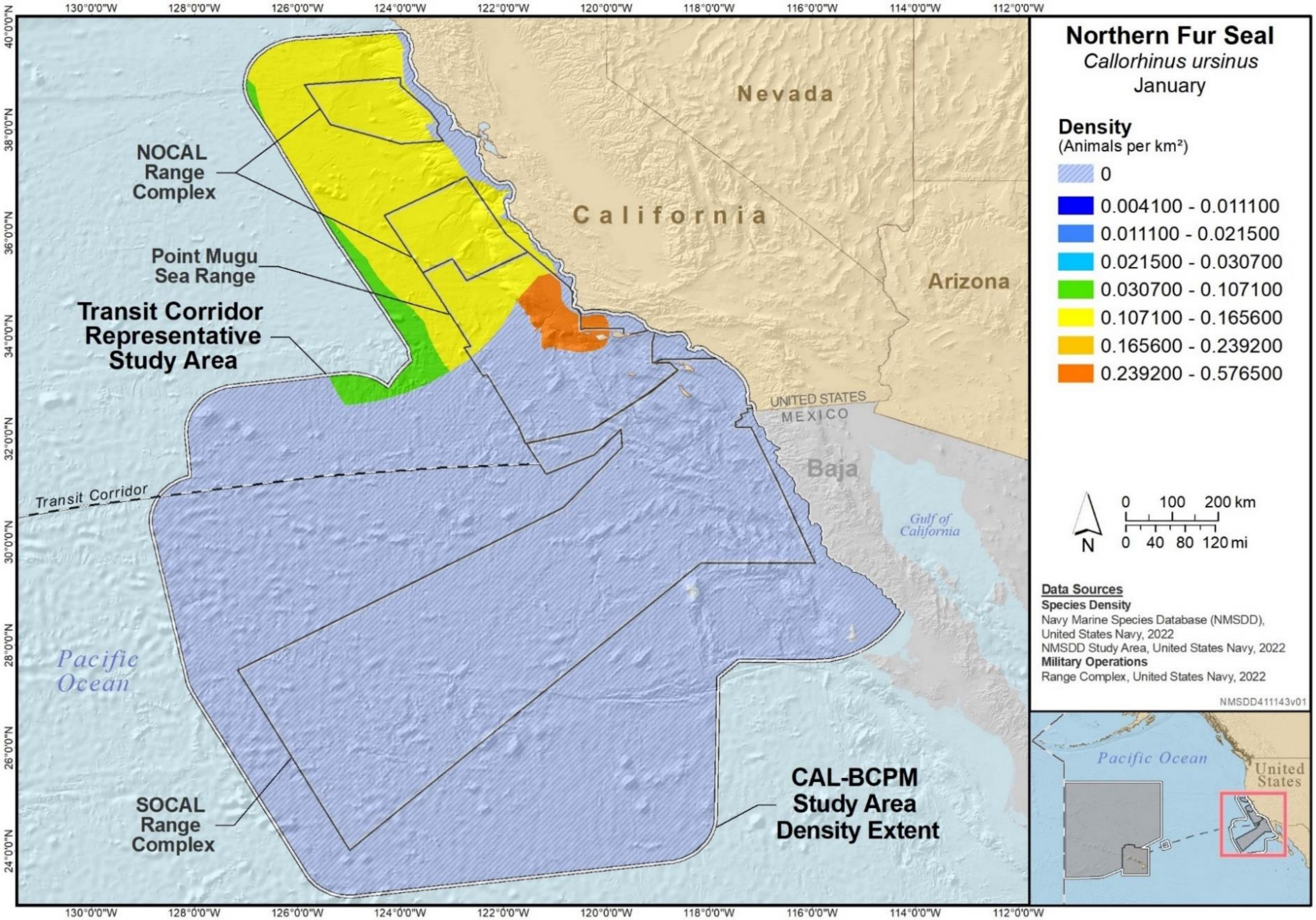

Figure 9-12: January Distribution of Northern Fur Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

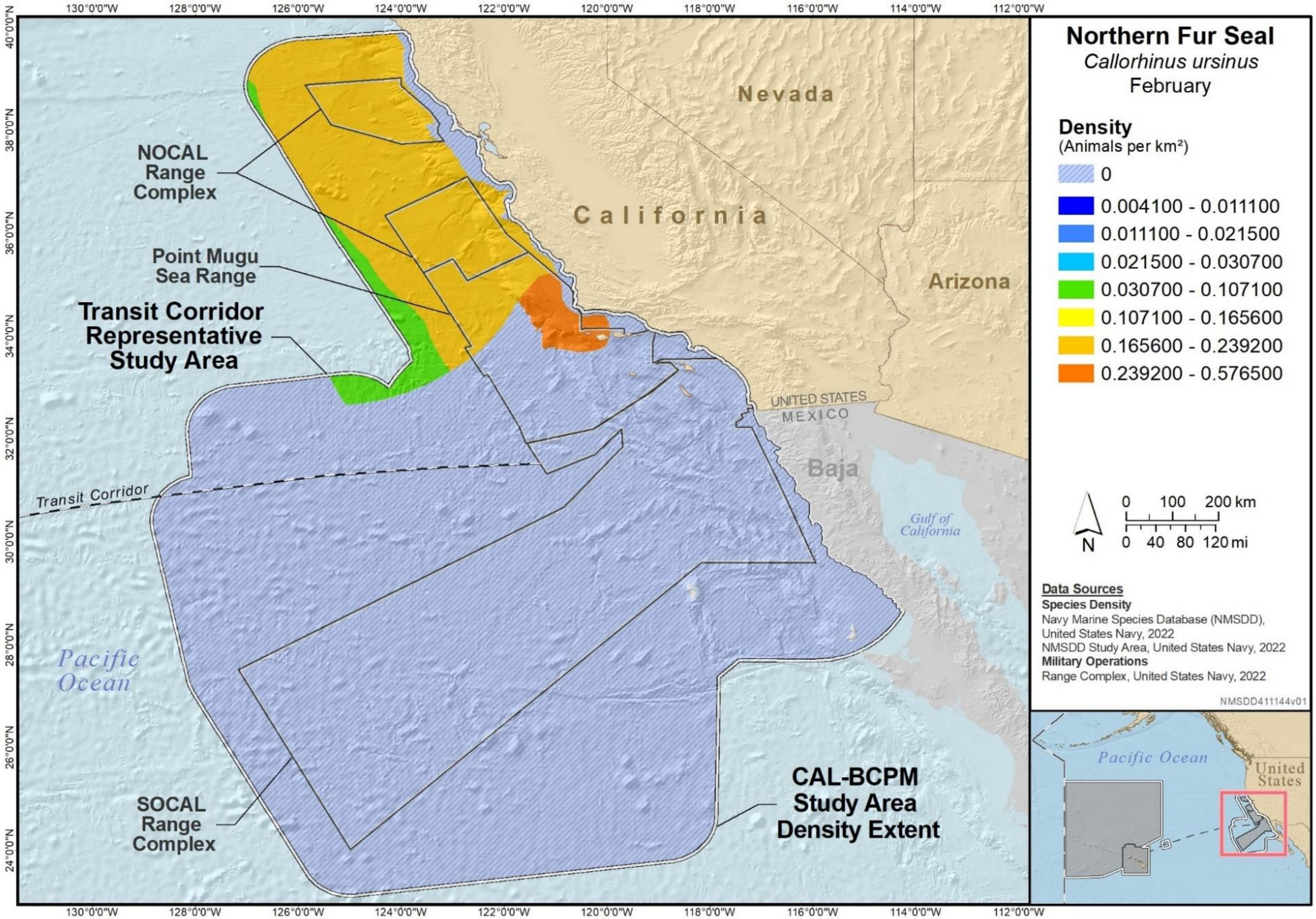

Figure 9-13: February Distribution of Northern Fur Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

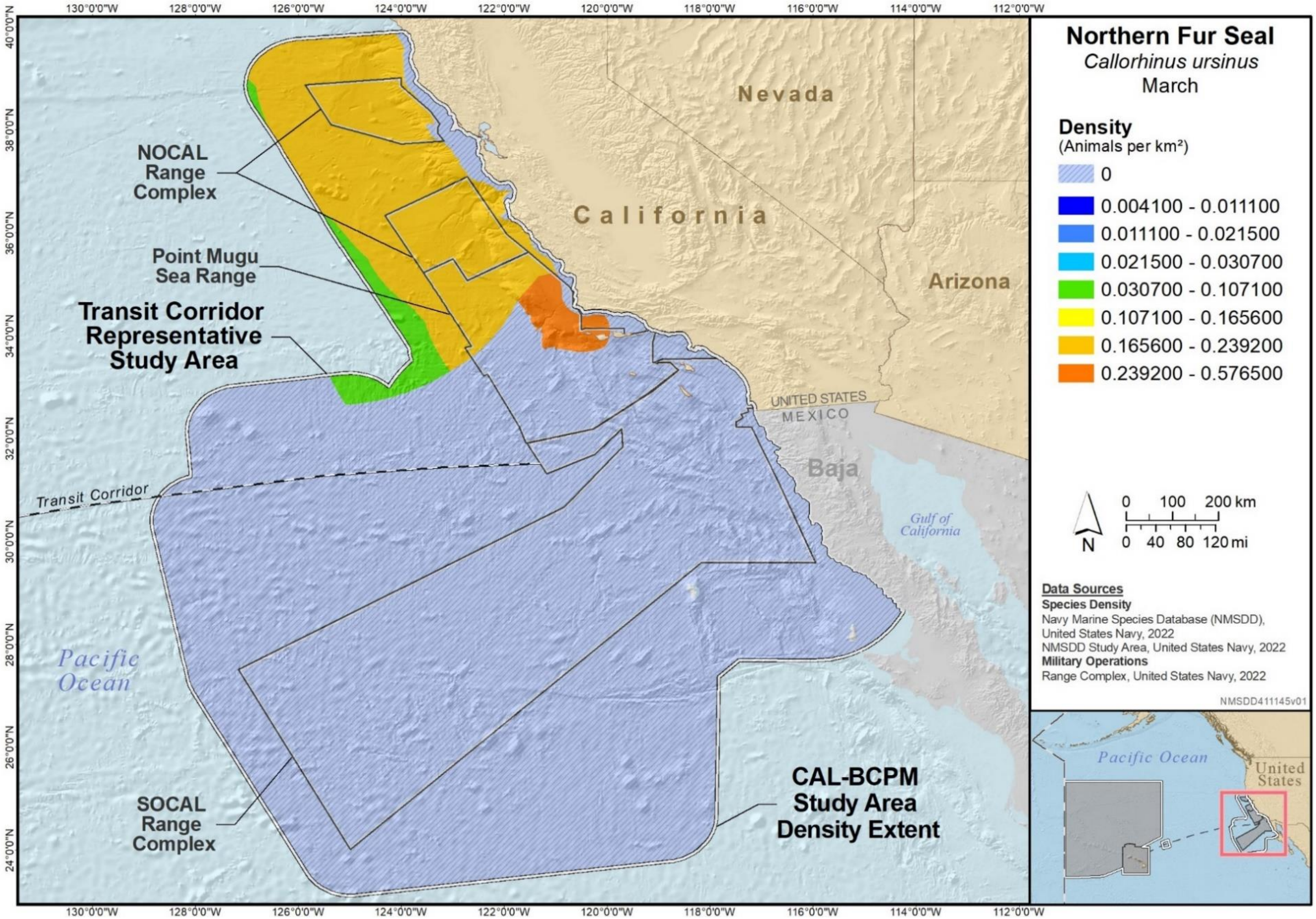

Figure 9-14: March Distribution of Northern Fur Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

9.3 *MIROUNGA ANGUSTIROSTRIS*, NORTHERN ELEPHANT SEAL

The northern elephant seal has made a remarkable recovery from overharvesting in the 1800s. The population was reduced to perhaps no more than 10–100 animals surviving in Mexico in the 1890s (Carretta et al., 2022; Hoelzel, 1999; Stewart et al., 1994). There are two distinct breeding populations of northern elephant seal: one that breeds along the BCPM and a second that breeds in the Central California Channel Islands (Garcia-Aguilar et al., 2018). NMFS recognizes the stock in U.S. waters as the California Breeding Stock (Carretta et al., 2022). The separate BCPM breeding population is considered to be demographically isolated from the California Breeding Stock (Carretta et al., 2022; Mesnick et al., 1998), although there is overlap in the distribution of the populations during post-molting and post-breeding foraging trips (Garcia-Aguilar et al., 2018; Robinson et al., 2012). Density values calculated in this report consider both the California Breeding Stock, with an abundance of 187,386 elephant seals (Carretta et al., 2022), and the BCPM breeding population with an estimated abundance of 22,000 elephant seals (Garcia-Aguilar et al., 2018).

HRC. Northern elephant seals are not expected to occur in the HRC or the western portion of the transit corridor (other than occasional extralimital sightings).

CAL-BCPM. NMFS updated the stock assessment for northern elephant seal in 2022 and increased the abundance estimate for the California Breeding Stock from 179,000 to 187,386 elephant seals (Carretta et al., 2022). Garcia-Aguilar et al. (2018) noted that abundance for the BCPM breeding population of 22,000 elephant seals was made in 2009 and is likely an overestimate due to a declining trend in abundance at major breeding sites that began in the 2000's. The authors hypothesized that the elephant seals may be responding to warming trends off the BCPM associated with climate change and moving into cooler waters farther north off California and contributing to the growth of the California Breeding Stock.

Northern elephant seals from both breeding populations make two annual foraging migrations, a post-breeding and a post-molting migration, into the North Pacific. Both migrations originate from natal rookeries either off California or the BCPM and extend north or northwest from breeding sites. The post-breeding migration takes place from February to May, and the longer post-molting migration is from mid-June through December for females and September through December for males (Peterson et al., 2015). During the post-molting migration in particular, elephant seals are widely distributed in the eastern and central North Pacific, beyond the extent of the Study Area (Le Boeuf et al., 2000a; Peterson et al., 2015; Robinson et al., 2012), with highest densities typically north and offshore of the Study Area at the confluence of the sub-Arctic and sub-tropical gyres and the location of the Transition Zone Chlorophyll Front (Robinson et al., 2012).

Males and females both migrate north from rookeries; however, males generally remain over the continental shelf and slope to forage at or near the seafloor and females disperse more widely into the North Pacific and forage in the water column, although there is substantial overlap in the distributions (Kienle et al., 2022; Le Boeuf et al., 2000a; Peterson et al., 2015). Juveniles of both sexes are thought to follow a migratory pattern similar to that of adult females but with less time on land during the breeding season (Costa et al., 2003; Le Boeuf et al., 1996). Acknowledging these differences, densities for northern elephant seal in the Study Area were based primarily on tagging data from adult female elephant seals, which make up the majority of the available data.

Because the timing of the male and female post-molting migrations differs, the ratio of males to females in the California Breeding Stock was needed to estimate monthly abundance more accurately in the Study Area. The latest population abundance of 187,386 elephant seals was based on a state-wide estimate of 42,685 pups born in California in 2013 (Lowry et al., 2020). Using multipliers for males (3.88) and females (4.91) derived by Lowry et al. (2014), the ratio of males to females is approximately 44 percent male to 56 percent female (Table 9-12). A lifestage table reported by Condit et al. (2014) supports the same male to female ratio.

Table 9-12: Sex Class Abundance and Ratio for Northern Elephant Seal

Group	Pup Multiplier	Class Abundance	Percent in Class
Population[1]	4.39	187,386	100
Males	3.88	82,809	44
Females	4.91	104,792	56

[1]The sum of male and female abundance is 187,601, which is larger than the population abundance. The difference does not affect the ratio of males to females and is likely due to rounding of multipliers.
Sources: Condit et al. (2014); Lowry et al. (2014).

Strata: Three strata were defined within the Study Area to represent the monthly distribution of elephant seals (Table 9-13). The Nearshore and Offshore strata extend northward from rookeries on the Northern Channel Islands and are separated by the dramatic change in the slope of the seafloor defining the western boundary of the Continental Borderland in the Southern California Bight. The boundary separating the two strata approximately follows the 3,000 m depth contour from the Channels Islands north to the Study Area boundary. The Offshore stratum is bounded to the west by the Study Area and to the south by approximating the spatial extent of kernel density distributions derived by Robinson et al. (2012) from satellite-tagged female elephant seals. The Nearshore stratum meets the Offshore stratum to the west, has the shoreline as its eastern boundary, and extends just south of the Northern Channel Islands so that it includes that major breeding sites. The Baja stratum meets the Nearshore stratum at its northern boundary and is defined as the continental shelf extending approximately 500 km north from the San Benito Archipelago at the southern end of the BCPM. The Baja Stratum is based on telemetry data reported by Robinson et al. (2012) showing that approximately 20 percent of adult female elephant seals remained over the shelf and within 500 km to the north of the San Benito Archipelago year round.

Table 9-13: Strata for Northern Elephant Seal Density Calculations

Stratum	Area (Km^2)
Offshore	209,876
Nearshore	90,208
Baja	129,088

Le Boeuf et al. (2000b) tagged 27 male elephant seals on Año Neuvo Island off central California, obtaining 23 migratory tracks long enough for analysis. Males migrated to foraging destinations off the Aleutian Islands, mostly remaining along the continental shelf; however, 9 of the 23 took a direct route transiting through open ocean waters instead of following the continental margin. Based on these results, the Navy estimated that 9 out of 23 (or 39 percent) of males would use the Offshore stratum, and the remaining 61 percent would use the Nearshore stratum enroute to Alaska waters.

In-Water and Occurrence Percentages: Monthly in-water percentages were estimated for females and males separately and were based on their asynchronous migrations from breeding and molting sites into the northern part of the Study Area and beyond. Kernel density distributions presented by Robinson et al. (2012) representing the distribution of female elephant seals were used to estimate in water occurrence in the Study Area. For example, during the breeding season, estimated as January and February for females and December to February for males, most elephant seals are expected to be in waters off central California near breeding sites, and adults of both sexes are expected to be primarily on land. The Navy estimated that 80 percent of females would be off California and 25 percent of those seals would be in the water at any time during January and February. Similarly, for males, the Navy estimated that all males would be off California from December through February, and 25 percent would be in the water at any time (Table 9-14). Estimates of occurrence off California and in-water percentages were made by month for the remainder of the year using the distributions presented by Robinson et al. (2012) and supplemented with descriptions of migration timing and duration (Condit et al., 2021; Le Boeuf et al., 2000b; Peterson et al., 2015).

Table 9-14: Monthly In-Water Percentage and Percentage Occurrence off California of Northern Elephant Seals

Month	In-Water Percentage- (Females)	Percentage Off California-- (Females)	In-Water Percentage (Males)	Percentage Off California- (Males)
January	25	80	25	100
February	25	80	25	100
March	100	10	100	10
April	100	25	100	0
May	0	80	100	0
June	0	60	100	0
July	100	5	50	50
August	100	5	0	100
September	100	5	100	10
October	100	5	100	0
November	100	10	100	25
December	100	20	25	100

Abundance: To calculate the abundance of female elephant seals in the Offshore stratum in January, the percentages from Table 9-14 were multiplied by the population class abundance (Table 9-12).

Abundance = $0.80_{\text{(percentage off California)}} \times 0.25_{\text{(percentage in-water)}} \times 104{,}792_{\text{(number of females in the California Breeding Stock)}}$ = 20,958 female elephant seals in the Offshore stratum from the California Breeding Stock.

In addition, elephant seals from the Mexico breeding population migrate north into the Study Area and overlap with the distribution of the California Breeding Stock (Garcia-Aguilar et al., 2018). Robinson et al.

(2012) estimated that 80 percent of the Mexico breeding population migrate into the Study Area (and beyond) and 20 percent remain off the BCPM year-round and do not migrate into California waters.

To calculate the abundance of female northern elephant seals from the Mexico breeding population that migrate into the Study Area, the percentages from Table 9-14 were applied to the females from the Mexico breeding population migrating into California waters.

Abundance = 22,000 (Mexico breeding population) x 0.56 (proportion female) x 0.80 (percentage of Mexico population that migrate north) x 0.80 (percentage off California) x 0.25 (percentage in-water in January) = 1,968 female elephant seals in the Offshore stratum from the Mexico breeding population.

The total abundance of females in the Offshore stratum in January would be:

Abundance = 20,958 + 1,968 = 22,927 females in the Offshore stratum in January.

The number of male elephant seals in the Offshore stratum in March, following the breeding season, was calculated as:

Abundance = 82,809 (number of males in the California Breeding Stock) x 0.10 (percentage off California) x 1.00 (percentage in-water) x 0.39 (percentage of males in the Offshore stratum) = 3,230 male elephant seals in the Offshore stratum from the California Breeding Stock. Males from the Mexico breeding population that migrate into the Study Area were assumed to remain in the Nearshore stratum.

To calculate the abundance of male northern elephant seals from the California Breeding Stock that migrate into the Nearshore stratum in March, the percentages from Table 9-14 were applied to the population class abundance.

Abundance = 82,809 (number of males in the California Breeding Stock) x 0.10 (percentage off California) x 1.00 (percentage in-water) x 0.61 (percentage of males in the Nearshore stratum) = 5,051 male elephant seals from the California Breeding Stock in the Nearshore stratum.

Males from the Mexico breeding population would also migrate into the Nearshore stratum and contribute to the total abundance of elephant seals off California.

Abundance = 22,000 (Mexico breeding population) x 0.44 (proportion male) x 0.80 (percentage of Mexico population that migrate north) x 0.10 (percentage off California) x 1.00 (percentage in-water in March) = 778 male elephant seals in the Nearshore stratum from the Mexico breeding population in March.

The total abundance of males in the Nearshore stratum in March would be:

Abundance = 5,051 + 778 = 5,829 males in the Nearshore stratum in March.

The abundance of elephant seals remaining off the BCPM is estimated to be 20 percent of the breeding population abundance, or 4,400 elephant seals. Monthly in-water abundance estimates for males and females are shown in Table 9-15.

Table 9-15: Monthly In-Water Abundance of Northern Elephant Seals in the Nearshore, Offshore, and BCPM Strata

Month	Offshore			Nearshore		BCPM
	California Females	California Males	Mexico Females	California Males	Mexico Males	Mexico (Male and Female
January	20,958	8,074	1,968	12,628	1,944	4,400
February	20,958	8,074	1,968	12,628	1,944	4,400
March	10,479	3,230	984	5,051	778	4,400
April	26,198	0	2,461	0	0	4,400
May	0	0	0	0	0	4,400
June	0	0	0	0	0	4,400
July	5,240	8,074	492	12,628	1,944	4,400
August	5,240	0	492	0	0	4,400
September	5,240	3,230	492	5,051	778	4,400
October	5,240	0	492	0	0	4,400
November	10,479	8,074	984	12,628	1,944	4,400
December	20,958	8,074	1,968	12,628	1,944	4,400

<u>Density</u>: To calculate monthly densities in the Offshore, Nearshore, and BCPM strata, the abundance estimates from Table 9-15 were summed by stratum and divided by the area of each stratum. For example, the density for January in the Offshore stratum was calculated as:

Density = $20{,}958_{\text{(California females)}} + 8{,}074_{\text{(California Males)}} + 1{,}968_{\text{(Mexico Females)}} = 31{,}000 / 209{,}876 =$ 0.1477 elephant seals / km^2

Similar calculations were made for each stratum by month resulting in the density estimates shown in Table 9-16. Northern elephant seal densities within the HCTT Study Area are shown in Figure 9-15 through Figure 9-24. The figures show densities as a range of values instead of a single value to standardize the legend across all figures for the species. However, the strata on each map represent only one density value (Table 9-16).

Table 9-16: Monthly Density Estimates for Northern Elephant Seal in CAL-BCPM

Month	Offshore Density (seals/km^2)	Nearshore Density (seals/km^2)	Baja Density (seals/km^2)
January	0.1477	0.1615	0.0341
February	0.1477	0.1615	0.0341
March	0.0700	0.0646	0.0341
April	0.1365	0.0000	0.0341
May	0.0000	0.0000	0.0341
June	0.0000	0.0000	0.0341
July	0.0658	0.1615	0.0341
August	0.0273	0.0000	0.0341

Month	Offshore Density (seals/km^2)	Nearshore Density (seals/km^2)	Baja Density (seals/km^2)
September	0.0427	0.0646	0.0341
October	0.0273	0.0000	0.0341
November	0.0931	0.1615	0.0341
December	0.1477	0.1615	0.0341

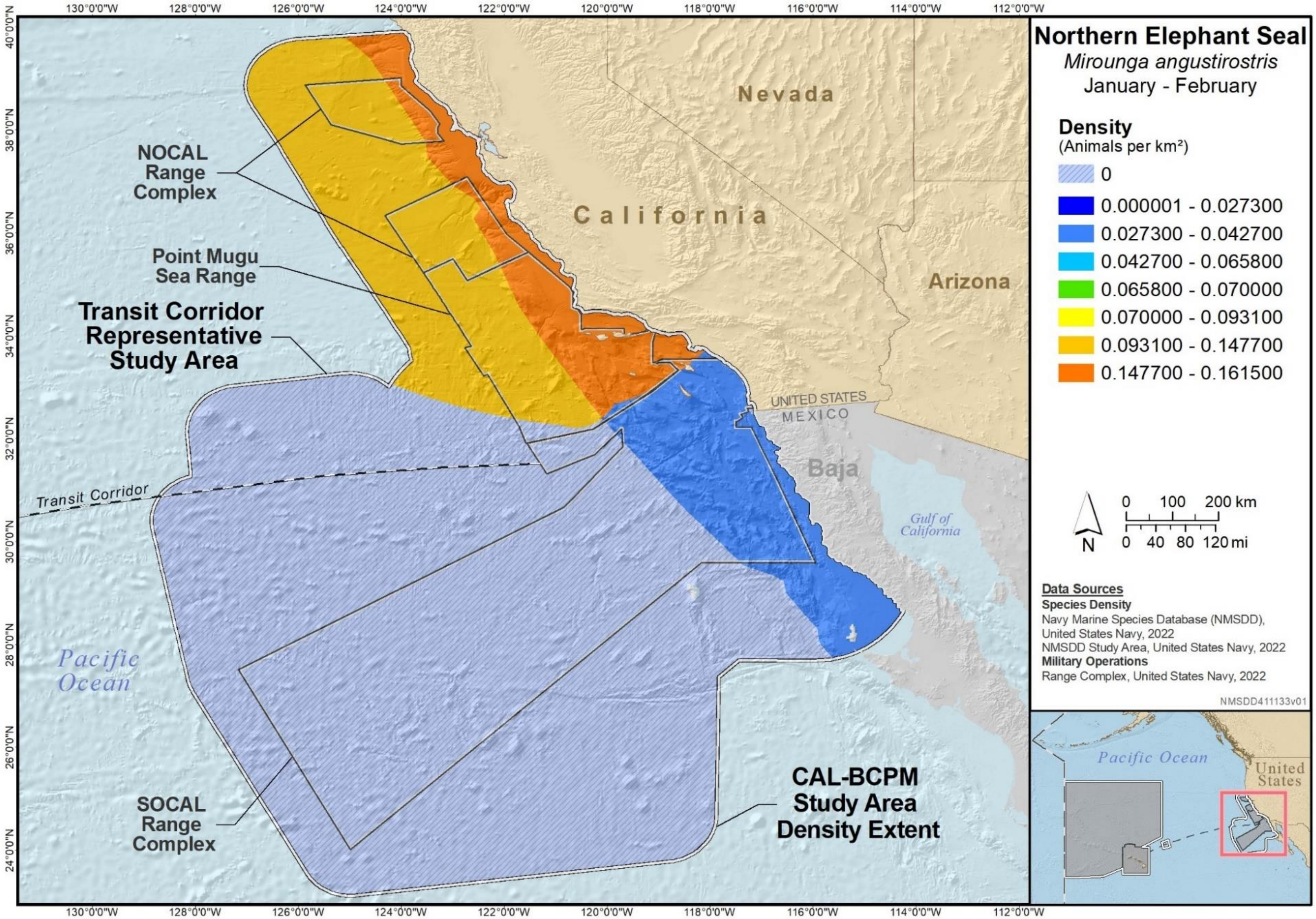

Figure 9-15: January-February Distribution of Northern Elephant Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

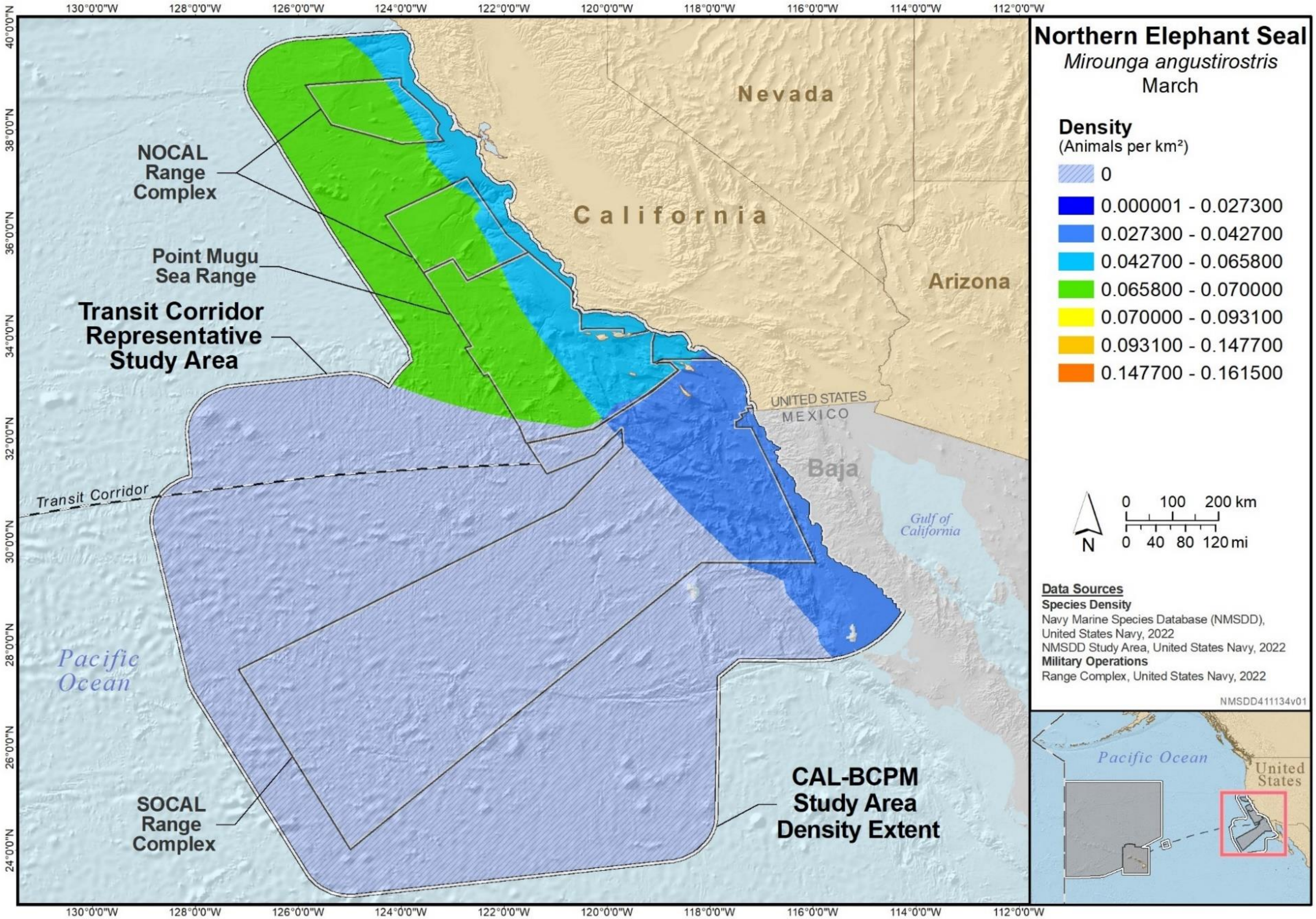

Figure 9-16: March Distribution of Northern Elephant Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

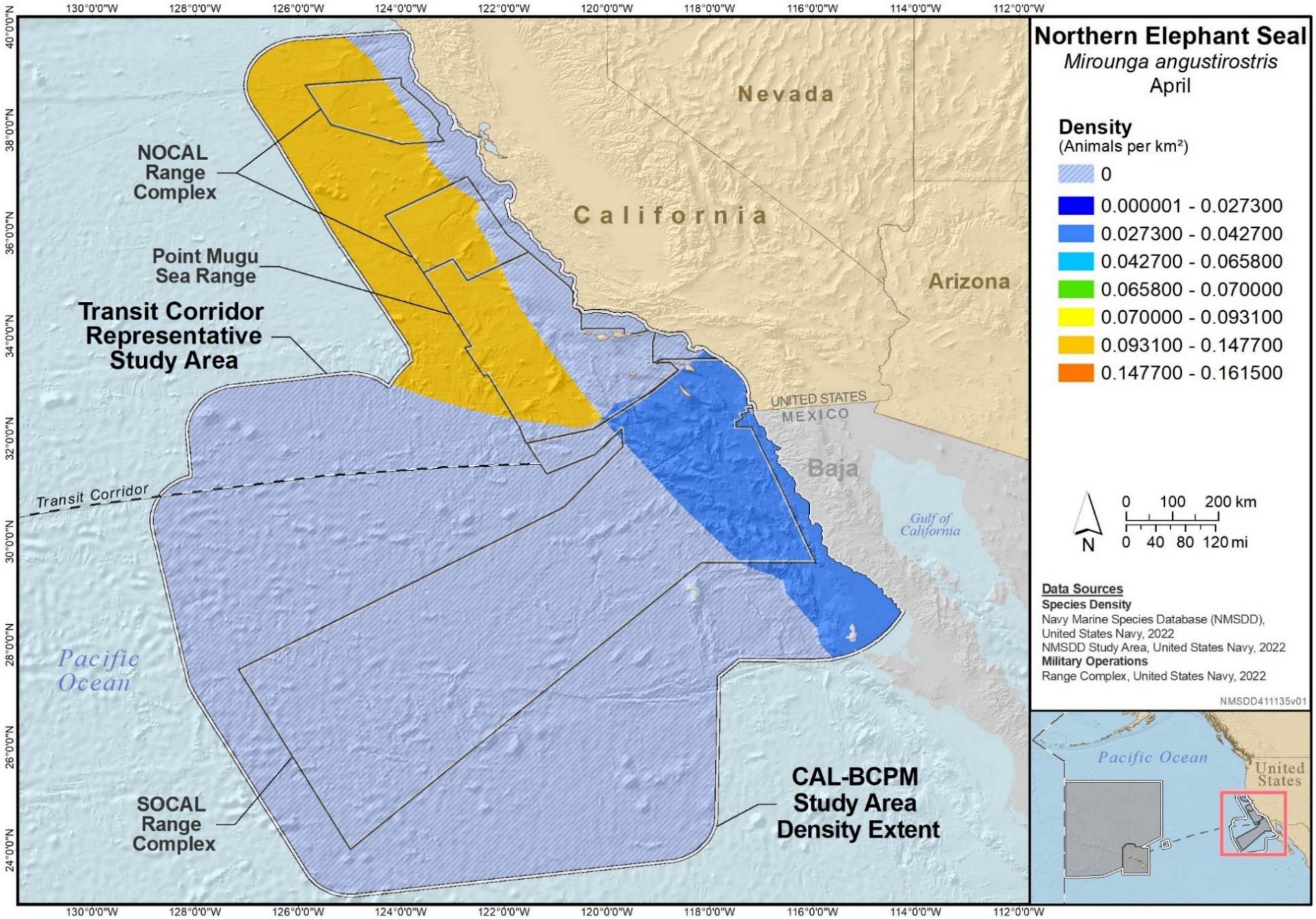

Figure 9-17: April Distribution of Northern Elephant Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

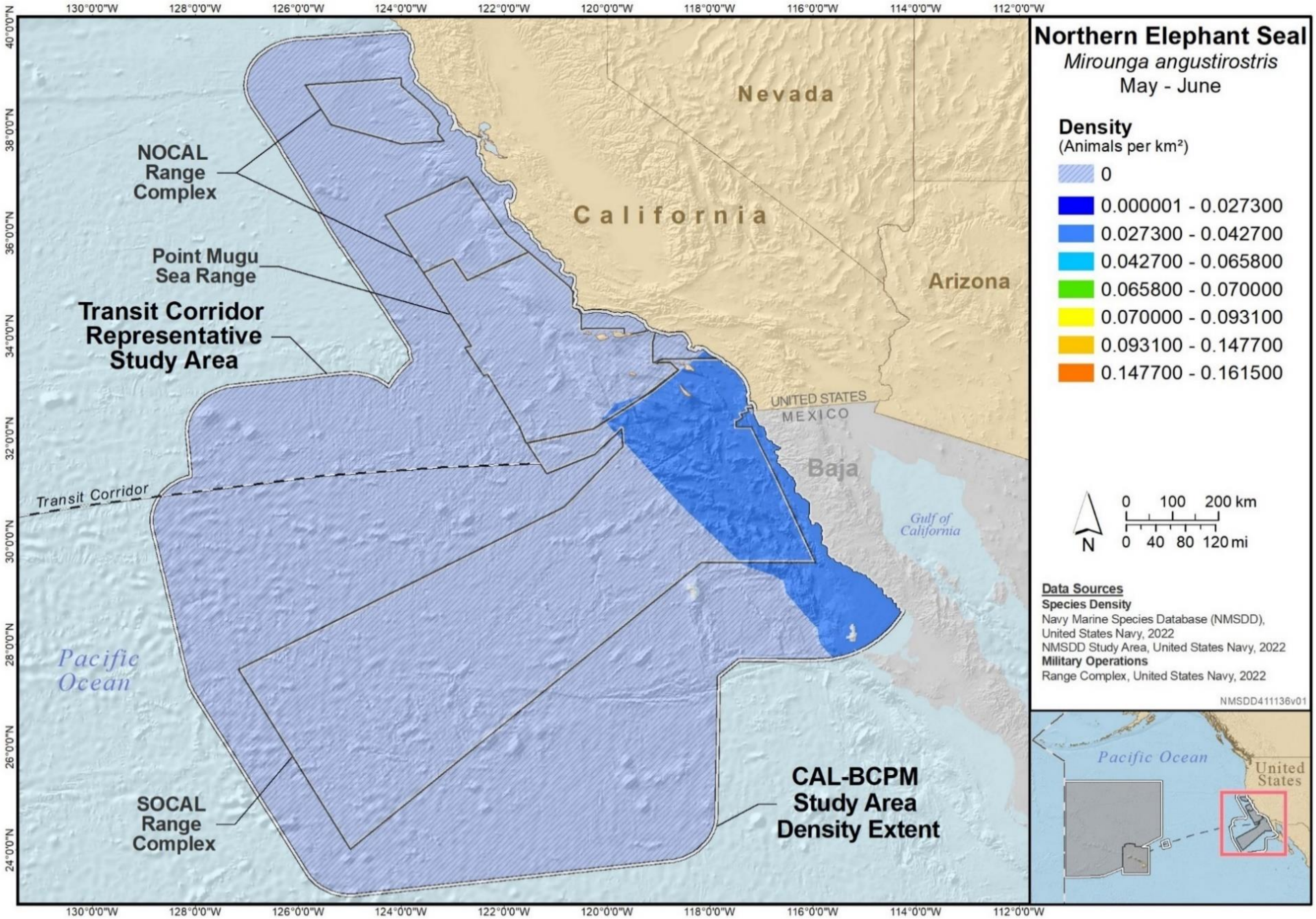

Figure 9-18: May-June Distribution of Northern Elephant Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

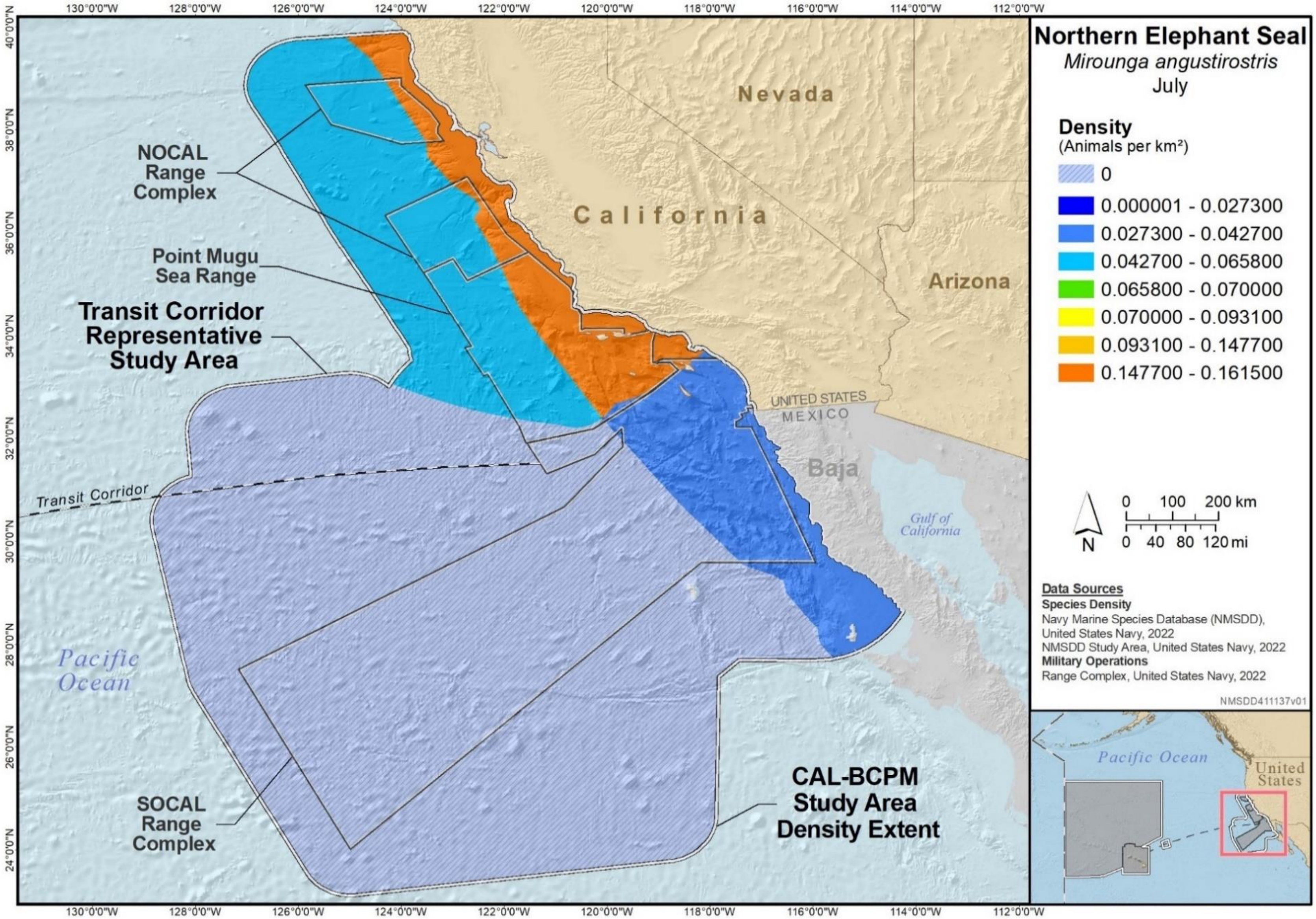

Figure 9-19: July Distribution of Northern Elephant Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

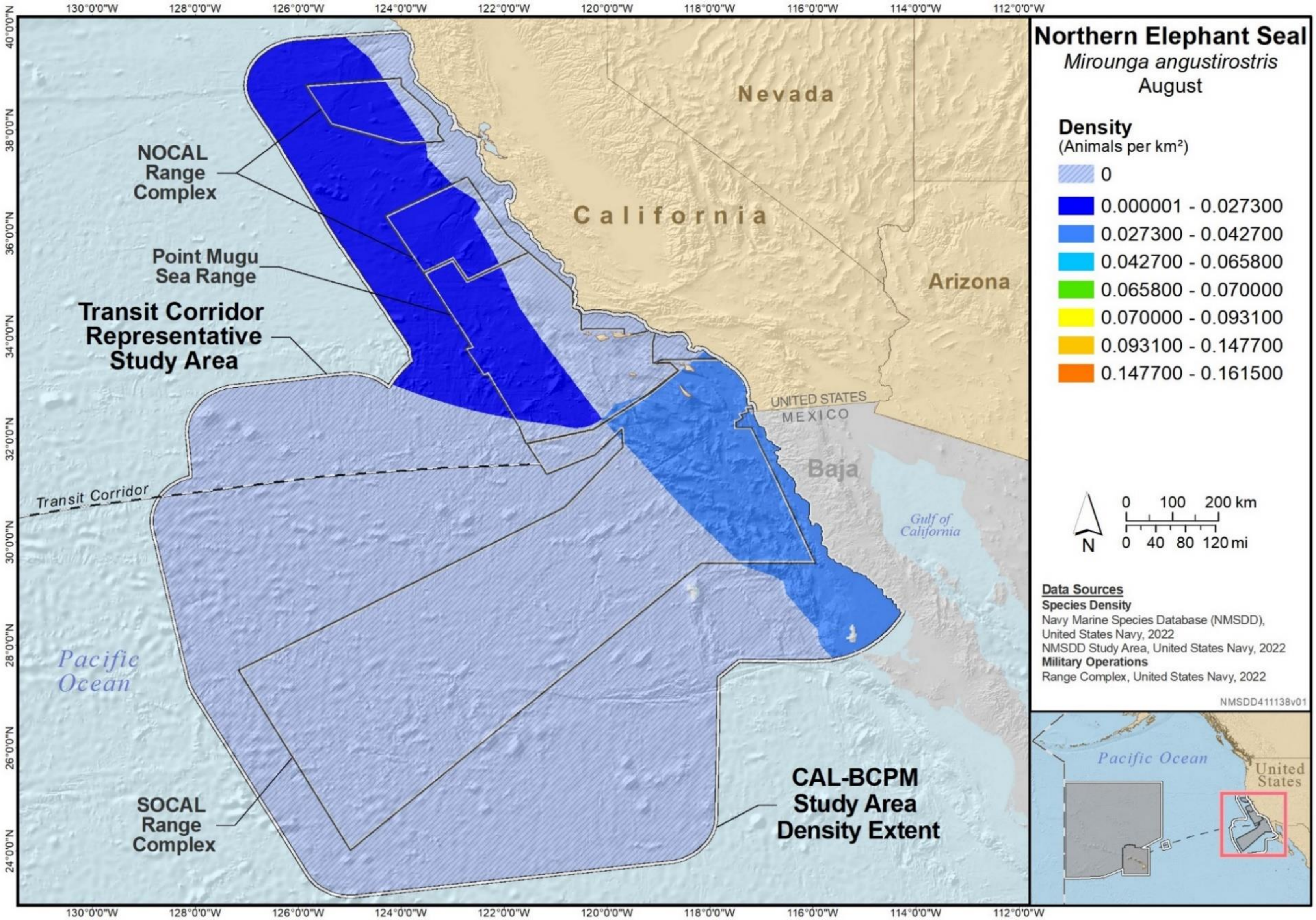

Figure 9-20: August Distribution of Northern Elephant Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

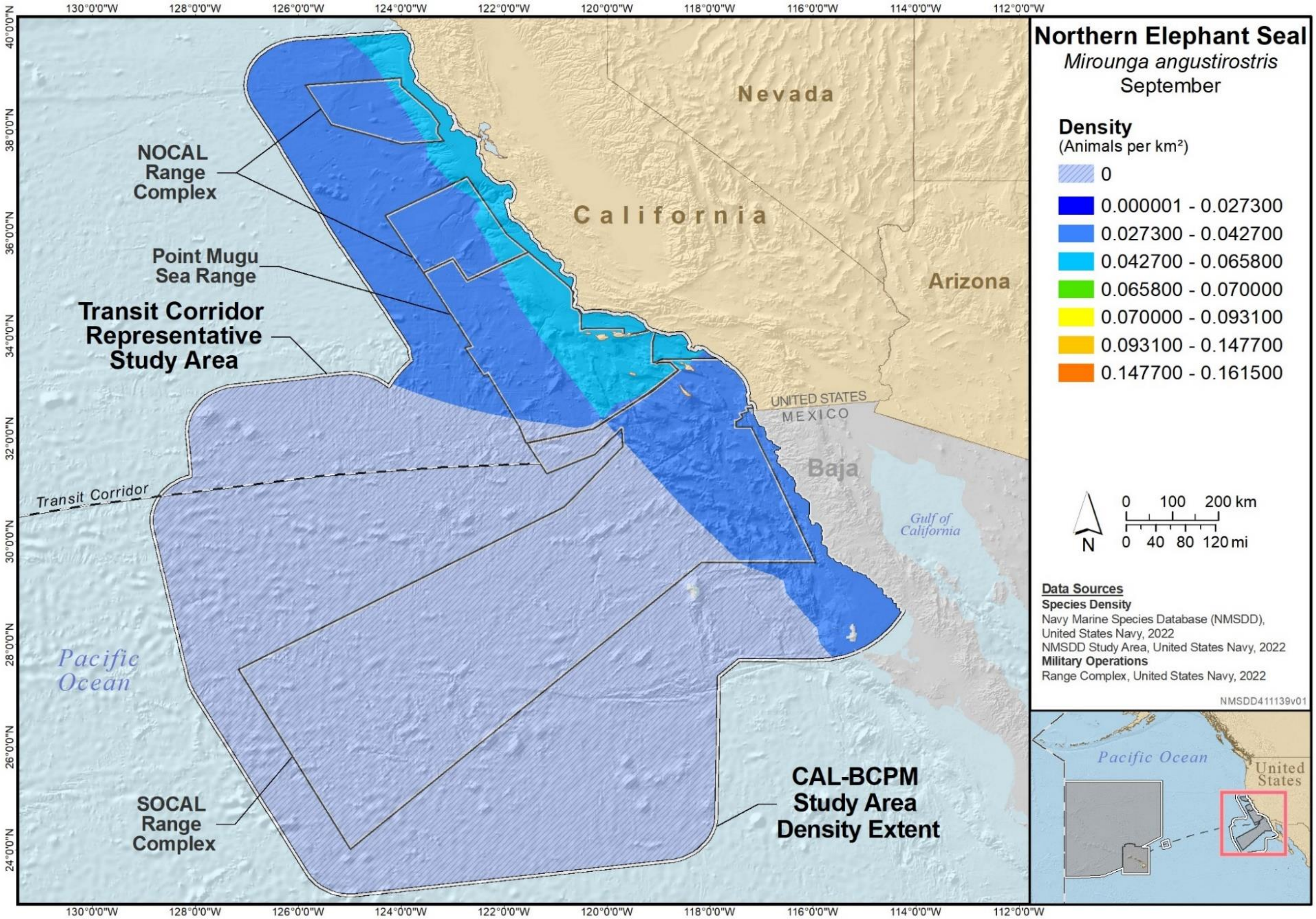

Figure 9-21: September Distribution of Northern Elephant Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

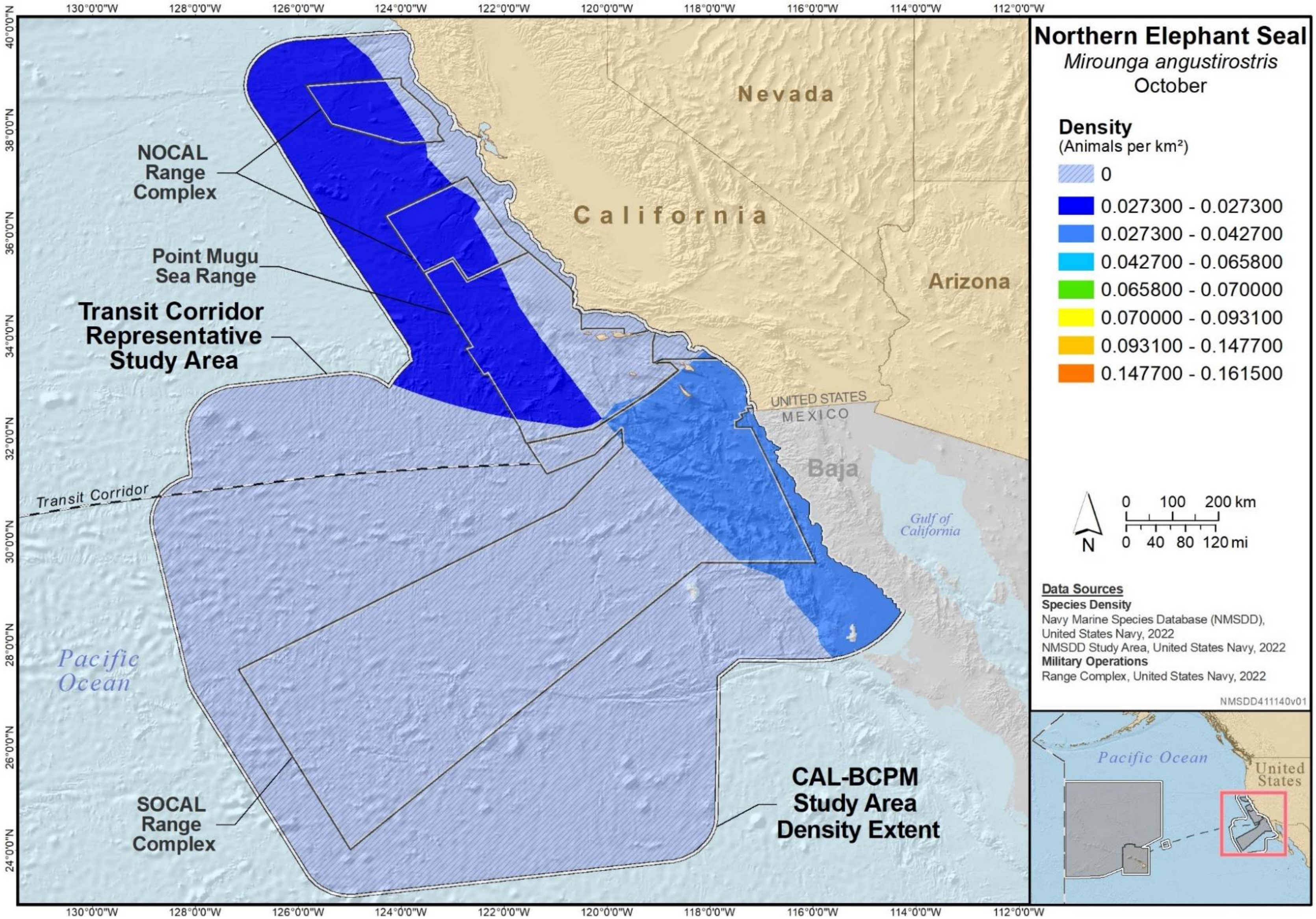

Figure 9-22: October Distribution of Northern Elephant Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

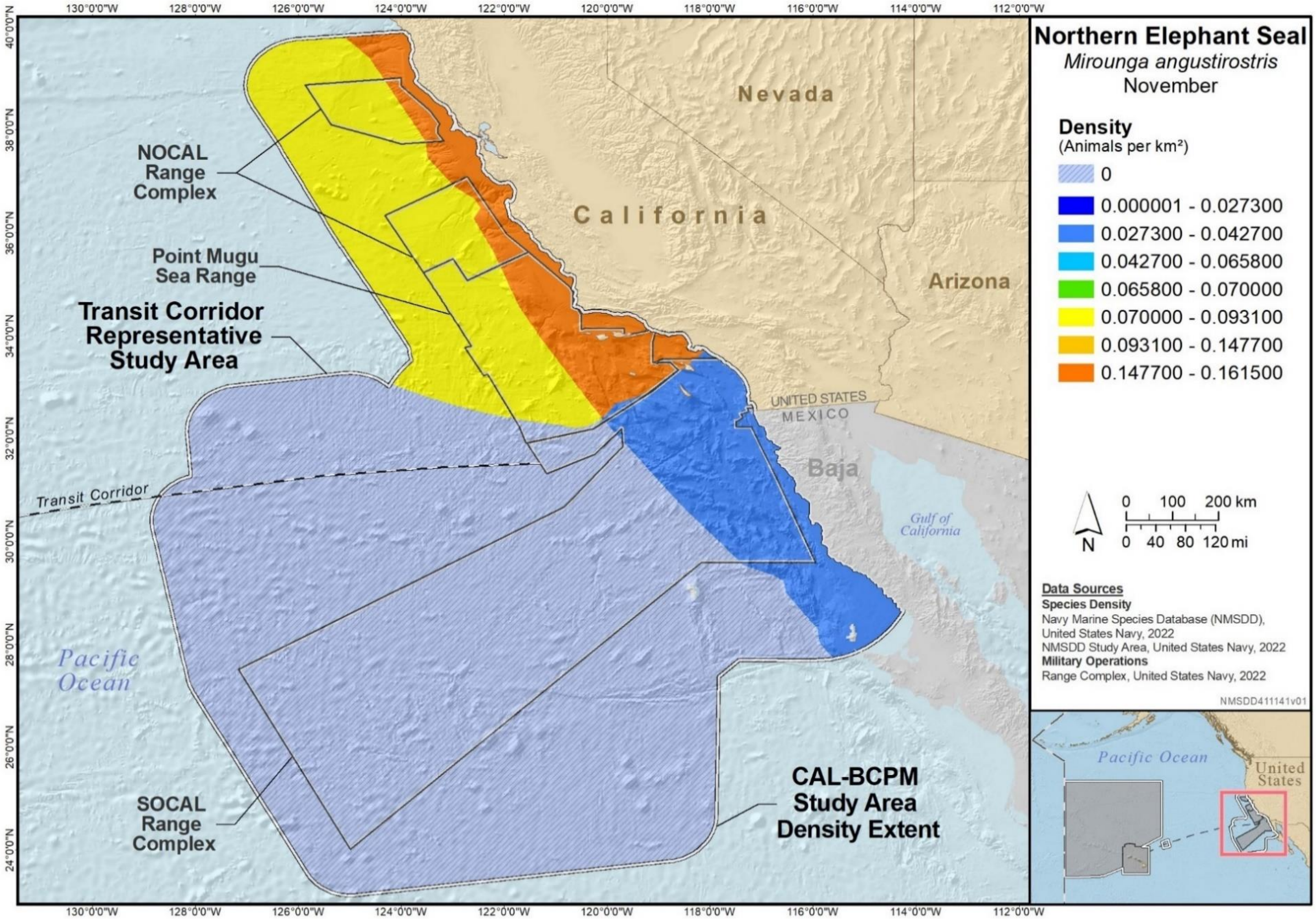

Figure 9-23: November Distribution of Northern Elephant Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

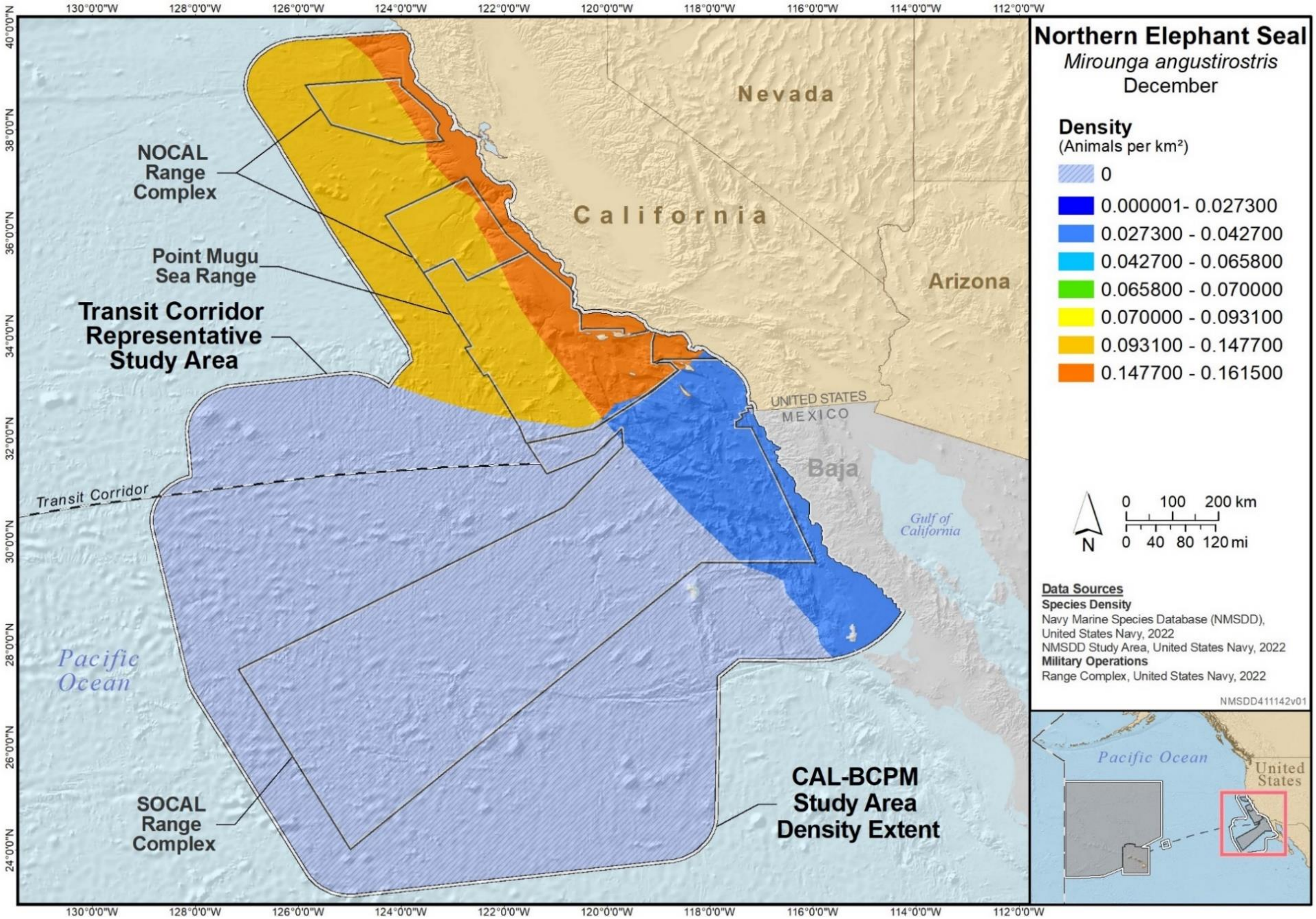

Figure 9-24: December Distribution of Northern Elephant Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

9.4 *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 Hawaiian Islands (Carretta et al., 2022). The majority of the population is distributed in the Northwestern Hawaiian Islands with subpopulations on French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Atoll, Kure Atoll, and Necker and Nihoa Islands (Baker et al., 2016; Carretta et al., 2022). A smaller subpopulation in the Main Hawaiian Islands has been increasing in recent years; whereas the larger population in the Northwestern Hawaiian Island was thought to have been in a long-term decline (Antonelis et al., 2006; Baker et al., 2016; Baker et al., 2011; Baker & Johanos, 2004) until a new approach was developed to estimate the abundance range-wide and for individual island-specific subpopulations (Baker et al., 2016). The new approach incorporates multiple methods of estimating site-specific abundances (e.g., direct counts, counts corrected for seals at sea, capture-recapture) and combines the results into a model (Harting et al., 2017). The Monte Carlo-style model is employed to overcome inconsistent field survey data, which, due to the difficulty of surveying numerous remote islands simultaneously, are collected years apart and often using differing, non-standardized methods. Based on the most recent count data and modeling results, the range-wide abundance is estimated at 1,437 monk seals (Carretta et al., 2022). Island-specific subpopulations used to derive the range-wide abundance are provided in Table 9-17. The model also indicted that the monk seal population increased at a rate of 2 percent per year from 2013-2019, countering previous trend analysis indicating the population was in decline (Carretta et al., 2022; Robinson et al., 2022).

Table 9-17: Island-Specific Abundance Estimates of Hawaiian Monk Seal

Location	Non-pups	Pups	Total[1]
French Frigate Shoals	188	35	223
Laysan	194	40	234
Lisianski	139	19	158
Pearl and Hermes Reef	120	21	141
Midway	70	10	80
Kure	81	13	94
Necker	62	8	70
Nihoa	72	4	76
MHI (without Ni'ihau/ Lehua)	161	25	186
Ni'ihau/Lehua	138	23	161
Total NWHI	926	150	1076
Total MHI	299	48	347

[1]The sum of island-specific subpopulation abundances does not equal the median range-wide abundance of 1,437 monk seals due to the process of summing median values (Carretta et al., 2021).

Robinson et al. (2022) provided a comprehensive review of Hawaiian monk seal behavior and social interactions, including habitat use and foraging behavior. The authors note that occurrence is concentrated within the 200 m depth contour with foraging dives typically less than 50 m. Monk seals forage at or near the seafloor and tend to concentrate where bathymetry supports foraging activity, such as at reefs, seamounts, and shallow banks. While this generally means that monk seals are concentrated in shallow waters surrounding natal islands, they are known to travel hundreds of kilometers over deeper waters to reliable foraging sites (Robinson et al., 2022). For example, in the Northwestern Hawaiian Islands, monk seals residing on Kure Atoll and Midway Atoll both transit through deeper waters to forage at the Nero Seamount located between the two atolls. In the Main Hawaiian Islands, over two thirds of monk seals move between islands, but most prefer to forage close to the island on which they commonly haul out (Robinson et al., 2022; Wilson et al., 2017).

Hawaii. For the purpose of calculating a density in the Study Area, the Navy assumed all monk seals remain within the Hawaiian Islands EEZ, which extends 200 NM from shore, but are primarily distributed within the 200 m depth contour around the islands. In-water abundance estimates were calculated using the island-specific abundances reported by Carretta et al. (2021) (Table 9-17), a regional haul-out factor, and the proportion of monk seals within the 200 m depth contour.

Wilson et al. (2017) used data from tagged monk seals to estimate the ratio of time spent in the water and on land. In the Northwestern Hawaiian Islands, monk seals are in the water approximately 69 percent of the time (on land 31 percent), and in the Main Hawaiian Islands they are in the water 58 percent of the time (ashore 42 percent). As noted above, monk seals are concentrated within the 200 m depth contour, but they do transit through deeper waters between islands and to foraging locations. To capture these movements the Navy estimated that monk seals are within the 200 m depth contour 90 percent of the time and in deeper waters, extending seaward to a distance of 200 NM from shore, 10 percent of the time.

For example, the in-water abundance for French Frigate Shoals was calculated as:

$$\text{In-Water Abundance} = 223_{\text{(island abundance)}} \times 0.69_{\text{(haul-out factor)}} \times 0.90_{\text{(proportion within 200 m depth contour)}} = 138$$
monk seals.

Densities for Hawaiian monk seals are calculated as the in-water abundance divided by an estimate of a distribution area. For example, the density for French Frigate Shoals is calculated as:

$$\text{Density} = 138_{\text{(in-water abundance)}} \,/\, 949\ \text{km}^2_{\text{(area < 200 m depth around the island)}} = 0.1459\ \text{monk seals/km}^2$$

Island-specific distribution areas within the 200 m depth contour and deeper, offshore areas around the Northwestern Hawaiian Islands and Main Hawaiian Islands extending to 200 NM from shore are shown in Table 9-18.

Table 9-18: Area Estimates for Nearshore (Less than 200 m Depth Contour) and Offshore (Greater than 200 m Depth Contour) Strata Used in Hawaiian Monk Seal Density Calculations

Location	Area (< 200 m Depth) (km^2)
French Frigate Shoals	949
Laysan	559
Lisianski	1,199
Pearl and Hermes Reef	650
Midway	336
Kure	298
Necker	1,540

Location	Area (< 200 m Depth) (km^2)
Nihoa	556
MHI (without Ni’ihau and Lehua)	6,283
Ni’ihau and Lehua	298
Total NWHI > 200 m depth contour	1,661,647
Total MHI > 200 m depth contour	800,414

Notes: km = kilometer, > = greater than, < = less than

For an example from the Main Hawaiian Islands, density around the islands of Ni’ihau and Lehua was calculated as:

$$\text{Density} = 161_{\text{(in-water abundance)}} \times 0.58_{\text{(haul-out factor)}} \times 0.90_{\text{(proportion within 200 m depth contour)}} / 298\ km^2_{\text{(area < 200 m depth around the islands)}} = 0.2825 \text{ monk seals/km}^2$$

Similar calculations were made for each island and the two deep-water regions to estimate densities within the Study Area (Table 9-19).

Table 9-19: Annual Hawaiian Monk Seal In-Water Densities in the Hawaiian Islands

Location	In-Water Density (monk seals/km^2)
French Frigate Shoals	0.1459
Laysan	0.2599
Lisianski	0.0818
Pearl and Hermes Reef	0.1348
Midway	0.1478
Kure	0.1958
Necker	0.0282
Nihoa	0.0848
Main Hawaiian Islands (without Ni’ihau and Lehua)	0.0155
Ni’ihau and Lehua	0.2825
Northwestern Hawaiian Islands (> 200 m depth to 200 NM)	0.00004
Main Hawaiian Islands (> 200 m depth to 200 NM)	0.00003
Pearl Harbor	0.00159

Notes: km = kilometer, NM = nautical miles, > = greater than, < = less than

A separate monk seal density estimate was calculated for Pearl Harbor. The Navy recorded 835 sightings of monk seals from 2012 to March 2021 in five locations on Oahu: Nimitz Beach, White Plains Beach, Reef Runway, Hickam Air Force Base, and Pearl Harbor. Only 14 of the sightings occurred in Pearl Harbor, and of those, 4 sightings were of the same identified female weaned pup in 2013, and 2 were of an unidentified adult in 2016 (Unpublished Navy data). Considering the rare occurrence of monk seals in the harbor and the three-to-four-year period between sightings, it’s possible the adult monk seal sighted in 2016 could have been the same seal sighted multiple times in 2013 as a pup. The eight other sightings in Pearl Harbor were of monk seals of unknown lifestage and sex.

To calculate a density, the Navy conservatively assumed each of the 14 sightings was of a different individual seal (a very conservative assumption considering 4 sightings were of the one individual in 2013, and 2 sightings in 2016 were of another seal). On average, there were 14 sightings over seven years (2013-2019) in Pearl Harbor, which is 2 sightings per year. Monk seal sightings are a rare event in Pearl Harbor, but the presence of some seals could go undetected or unreported. Given that, the Navy chose to estimate that one monk seal is in the harbor every month. Pearl Harbor is approximately 21 km^2 in area; therefore, the density of monk seals is calculated as:

$$\text{Density} = 1 \text{ monk seal} / 21\ km^2_{\text{(area of Pearl Harbor)}} / 30_{\text{(average days per month)}} = 0.00159 \text{ seals}/km^2/\text{day}.$$

This is a static annual uniform density for all of Pearl Harbor. The density outside of Pearl Harbor for the Main Hawaiian Islands including Oahu is 0.0155 monk seals/km^2 (Table 9-19).

Hawaiian monk seal densities within the Hawaiian Islands are shown in Figure 9-25 and Figure 9-26. The figures show densities as a range of values instead of a single value to standardize the legend across all figures for the species. However, the strata on each map represent only one density value (Table 9-19).

CAL-BCPM. Hawaiian monk seals are not expected to occur in CAL-BCPM or the eastern portion of the transit corridor.

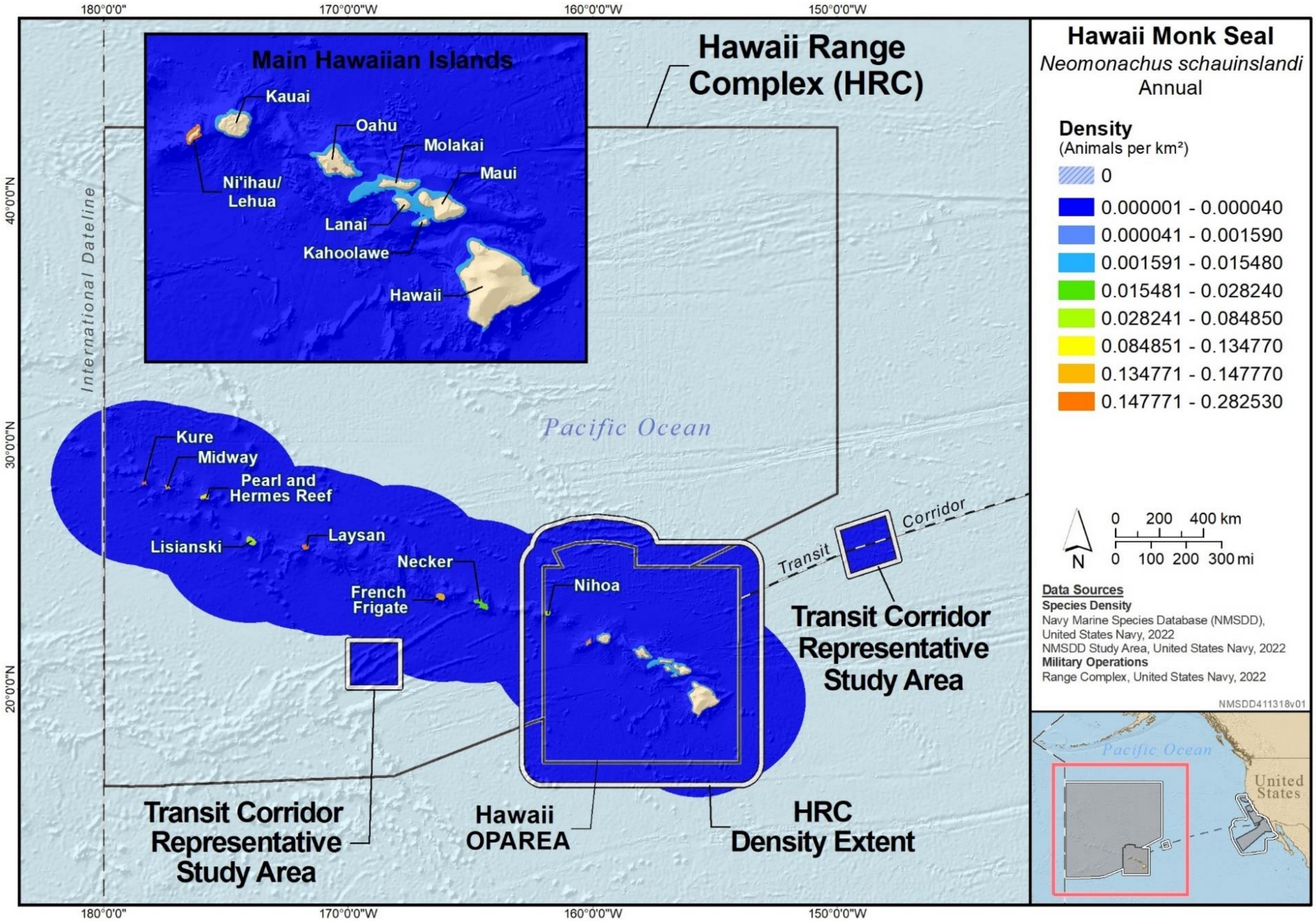

Figure 9-25: Annual Distribution of Hawaiian Monk Seal in HRC and the Western Portion of the Transit Corridor

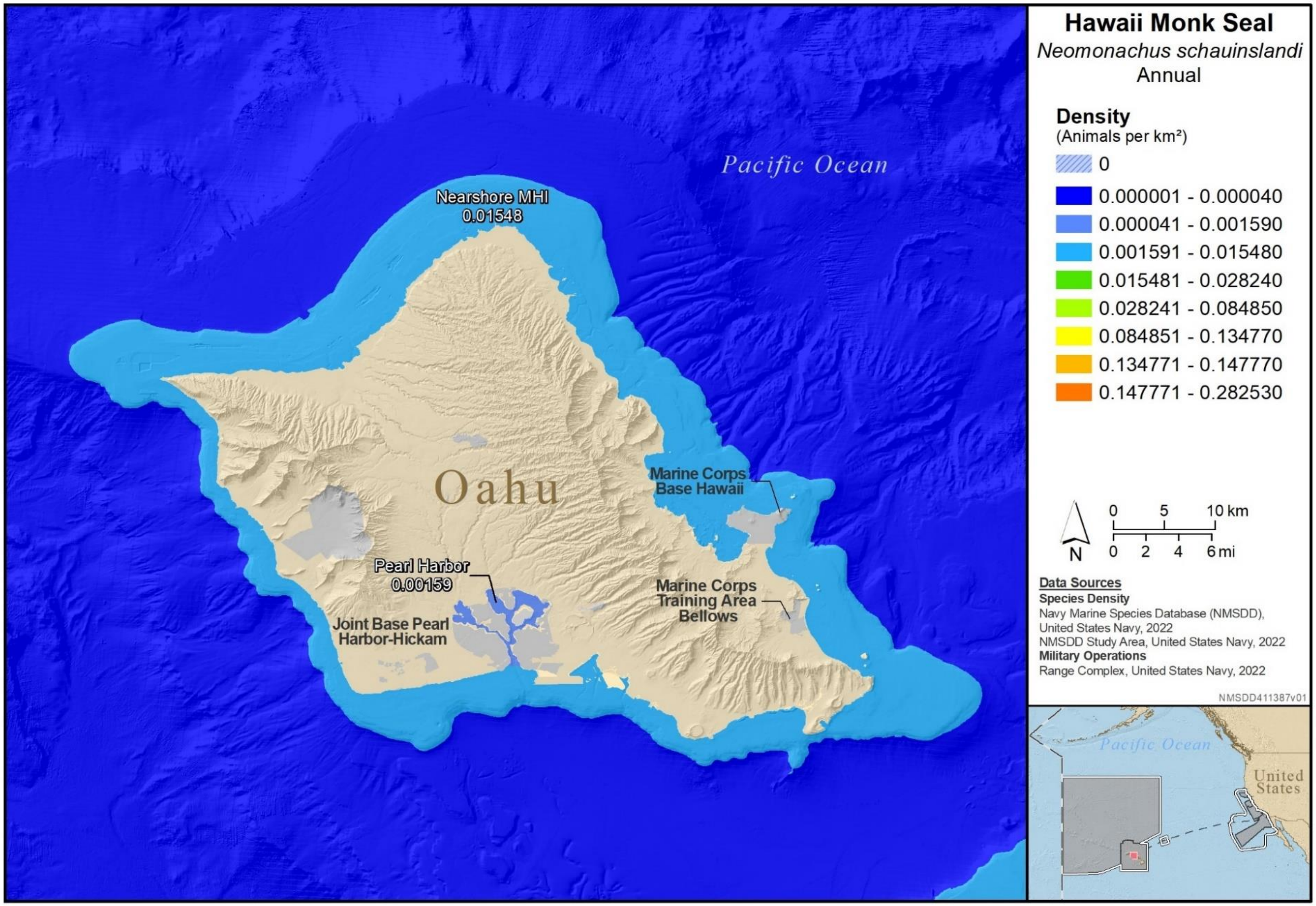

Figure 9-26: Annual Distribution of Hawaiian Monk Seal in Pearl Harbor and off the Island of Oahu

9.5 *PHOCA VITULINA*, HARBOR SEAL

The harbor seal is found in temperate and Arctic nearshore marine environments throughout much of the Northern Hemisphere (Jefferson et al., 2015). Harbor seals are one of the most adaptable pinnipeds and can haul out in a variety of terrestrial environments (Riedman & Estes, 1990). The Pacific harbor seal (*Phoca vitulina richardsi*) is the eastern North Pacific subspecies that would be encountered in the Study Area (Riedman & Estes, 1990). NMFS recognizes 17 harbor seal stocks along the U.S. Pacific coast, including Alaska (Carretta et al., 2022), but just one, the California Stock, occurs in the Study Area.

Harbor seals do not make long seasonal or annual migrations like other pinnipeds. The distribution of harbor seals is largely tied to suitable haul-out sites and habitat for breeding, pupping, and molting, and areas offering easy access to productive foraging as well as protection from predators. The range of pupping dates varies by location, with more northerly locations having later pupping dates; however, along the California coast, pupping is generally from May to August. The molting period, when juveniles and adults spend more time ashore, is from March through June; molting in Southern California may begin later, in April or May. Harbor seals spend more time in the water in fall (September through November) and winter (December through February) than they do during the spring and summer molting and breeding seasons (Boness et al., 1994; Manugian et al., 2016; Stewart & Yochem, 1984; Yochem et al., 1987).

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

CAL-BCPM. The abundance of harbor seal stocks is estimated by counting the number of seals ashore at haul-out sites during the peak haul-out period from May through July and applying a haul-out correction factor to the counts total (Carretta et al., 2022). Using this method and an average correction factor of 1.54 derived by Harvey and Goley (2011), the abundance of the California Stock was estimated at 30,968 seals in 2013 (Carretta et al., 2022). Since haulout behavior among harbor seals varies widely across haul-out sites, with latitude, and seasonally (Harvey & Goley, 2011; Huber et al., 2001; Yochem et al., 1987), site-specific haul-out correction factors were used where available to estimate in-water abundance in the Study Area. Regional or statewide correction factors were used if no other data were available or where an average correction factor was most appropriate, such as along the mainland coast of central and northern California.

With several site-specific haul-out correction factors available for multiple sites in the Channel Islands and mainland California (Harvey & Goley, 2011; Huber et al., 2001; Lowry et al., 2008; Stewart & Yochem, 1983), more recent counts data from Lowry et al. (2021) were used to estimate in-water abundance in the Study Area instead of using the stock abundance, which relied on counts from 2012, to calculate densities. In-water percentages shown in Table 9-20 were derived from published haul-out correction factors to calculate in-water abundance estimates.

Table 9-20: Seasonal In-Water Percentages for Harbor Seals Used to Calculate In-Water Abundance

Location	March – August (% in-water)	September – February (% in-water)	Source
San Miguel Island	23	81 - 86	(Lowry et al., 2008; Yochem et al., 1987)
San Nicolas Island	59		(Huber et al., 2001; Stewart & Yochem, 1983)
Southern California	17	65	(Harvey & Goley, 2011; Huber et al., 2001)
California (statewide average)	40	35	(Harvey & Goley, 2011; Lowry et al., 2008)
BCPM	37	65	(Harvey & Goley, 2011; Lubinsky-Jinich, 2019)

Note: BCPM = Baja California Peninsula, Mexico

Abundance: Counts of harbor seals ashore on the Channel Islands reported by Lowry et al. (2021) were adjusted to estimate island-specific abundance by using a correction factor of 0.41, based on an estimate that 41 percent of seals are ashore on San Nicolas Island in July (Huber et al., 2001). The estimate of 41 percent was used to represent all Channel Island due to a lack of other data and because it also coincided with the timing of counts by Lowry et al. (2021), which were also conducted primarily in July. For example, a count of 76 harbor seals on Anacapa Island in 2016 is estimated to be 41 percent of the island abundance, which equates to 185 seals.

$$\text{Abundance} = 76_{\text{(count)}} \;/\; 0.41_{\text{(proportion ashore)}} = 185_{\text{(abundance)}}$$

At Point Mugu and La Jolla in Southern California, 87 percent (instead of 41 percent) of harbor seals were estimated to be ashore in summer, and the abundance for the central and northern California mainland was not based on a direct count, but was estimated as 78 percent of the stock abundance of 30,968 harbor seals (Harvey & Goley, 2011). Counts, total abundance, and seasonal in-water abundance for harbor seal haul-out locations in California are shown in Table 9-21.

Table 9-21: Counts from 2016 to 2019, Corrected Abundance Estimates, and Calculated Seasonal In-Water Abundance at Haul-out Sites in California

Location	Year	July/August Count at Haulouts	Total Abundance	In-Water Abundance (Mar-Aug)[1]	In-Water Abundance (Sep-Feb)[1]
Anacapa Island	2016	76	185	109	159
Richardson Rock		1	2	1	2
San Clemente Island		26	63	37	55
San Miguel Island		702	1712	394	1472
San Nicolas Island		437	1066	629	917
Santa Barbara Island		36	88	52	76
Santa Cruz Island		316	771	455	663
Santa Rosa Island		386	941	555	810
Anacapa Island	2017	25	61	36	52
Richardson Rock		4	10	6	8

Location	Year	July/August Count at Haulouts	Total Abundance	In-Water Abundance (Mar-Aug)[1]	In-Water Abundance (Sep-Feb)[1]
San Clemente Island		71	173	102	149
San Miguel Island		230	561	129	482
San Nicolas Island		290	707	417	608
Santa Barbara Island		13	32	19	27
Santa Cruz Island		173	422	249	363
Santa Rosa Island		266	649	383	558
Richardson Rock	2018	2	5	3	4
San Clemente Island		44	107	63	92
San Miguel Island		208	507	117	436
San Nicolas Island		52	127	75	109
Santa Barbara Island		10	24	14	21
Santa Cruz Island		86	210	124	180
Santa Rosa Island		41	100	59	86
Anacapa Island	2019	10	24	14	21
Richardson Rock		13	32	19	27
San Clemente Island		254	620	366	533
San Miguel Island		190	463	107	399
San Nicolas Island		20	49	29	42
Santa Barbara Island		8	20	12	17
Santa Cruz Island		107	261	154	224
Santa Rosa Island		148	361	213	310
Southern California					
Point Mugu	2003	287	330	56	214
La Jolla	2003	155	178	30	116
Central and Northern California Mainland Coast					
Central and Northern CA	2004	N/A	24,155	9,662	8,454

[1]Shaded cells identify the highest abundance for each island based on the maximum count from 2016-2019.
Sources: 2016 -2019 counts are from Lowry et al. (2021), 2003 counts are from Lowry and Carretta (2003), and data from 2004 are from Harvey and Goley (2011)

Seasonal in-water abundance was estimated using the total abundance (derived from counts) and an estimate of the percentage of seals in the water (Table 9-20). With the exception of San Miguel Island, all island-specific in-water abundance estimates for March through August are 59 percent of the total island abundance. Haul-out data from radio-tagged seals on San Miguel Island resulted in a correction factor of 1.3 or 23 percent of seals in the water in spring and summer (Lowry et al., 2008). For the September through February time period, the in-water abundance was estimated as 86 percent of the total abundance, based on data from San Miguel Island reported by Yochem et al. (1987) and included in a summary by Huber et al. (2001).

With the exception of haulouts on Richardson Rock and San Clemente Island, the highest abundance estimates were from 2016 (Table 9-21). As a conservative measure, the Navy used the highest abundance estimates from 2016-2019 instead of a multi-year average or data from the most recent year counts were conducted (2019). The abundance calculations for San Miguel Island follow:

In-Water Abundance$_{\text{(March – August)}}$ = 1,712$_{\text{(Total Abundance)}}$ x 0.59$_{\text{(Percentage in-water)}}$ = 394 harbor seals

In-Water Abundance$_{\text{(September - February)}}$ = 1,712$_{\text{(Total Abundance)}}$ x 0.86$_{\text{(Percentage in-water)}}$ = 1,472 harbor seals

Strata: The strata for distributing densities were derived from sources that tracked harbor seal movements from haul-out locations and characterized their movements in terms of distance from shore, distance traveled, and water depth. Bailey et al. (2014) applied multiple tracking systems to model harbor seal movements off Scotland. The results showed that harbor seals remained within 30 km from haulouts and in waters less than 50 m deep. Manugian et al. (2016) reported that seals in central California remained within 50 km from main haul-out sites and that their results were consistent with the results from earlier studies. Lowry et al. (2001) described the movements of radio-tagged harbor seals in Prince William Sound, Alaska, where the mean distance from haul-out sites to at-sea foraging locations was 5 to 10 km for adults and 10 to 25 km for juveniles. Nearly all seals remained over the continental shelf in waters less than 200 m deep; however, several made excursions into deeper waters in the Gulf of Alaska. Boness et al. (1994) recorded dive depths of lactating females off eastern Canada where the mean depth was 18 m and the averages for individual seals ranged from 7 to 31 m. The maximum dive depth for all seals was nearly 60 m. Pacheco-Sandoval et al. (2019) described harbor seals off the BCPM foraging at depths up to 50 m and within 25 to 30 km of haulouts. Oleson et al. (2009) reported the results of marine mammal surveys offshore of the Washington coast, including distance from shore, distance from the shelf break (estimated as the 200 m depth contour), and water depth to define typical habitat. Harbor seals were sighted an average of 11 km from shore and in waters with a mean depth of 56 m. Sightings of harbor seals were an average of 42 km inshore of the shelf break. However, the authors did note that a few harbor seals were sighted farther from shore (out to 64 km) and in deeper waters, with multiple sightings near the 1,000 m depth contour. Stewart and Yochem (1994) documented movement patterns of harbor seals in the southern Channel Islands, including foraging behavior using time-depth recorders, from 1978 through 1993. Seals foraged on average at depths ranging from 80 to 100 m and within 20 km of shore.

Based on a review of these studies, the Navy defined strata for calculating densities using a combination of the 120 m depth contour and a distance of 20 km from shore. The 120 m depth contour was used to define strata around all islands and along the mainland coast from Pt. Conception to the California – Oregon border, approximating the surveyed areas reported by Lowry et al. (2008) and Harvey and Goley (2011), and the offshore foraging ranges described above. Survey effort south of the Channel Islands is limited, but harbors seals are known to occur off Pt. Mugu at Naval Base Ventura County, and off La Jolla Beach north of San Diego (Lowry & Carretta, 2003). To account for harbor seal occurrence in these two areas, the Navy estimated two strata, defined by a radius of 20 km seaward from each location and the 120 m depth contour, whichever was closer to shore. The same combination of the 120 m depth contour and a distance of 20 km from shore was used to define strata surrounding islands and along the coastline off the BCPM.

The size of the strata used in the density calculations and the resulting seasonal in-water densities are provided in Table 9-22. Densities were calculated by dividing the in-water abundance (Table 9-21) by the strata area (Table 9-22) for each location. For example, the calculation for Anacapa Island in the March through August time period is:

$$\text{Density}_{(\text{Anacapa Island})} = 109_{(\text{In-Water Abundance})} \ / \ 120 \text{ km}^2{}_{(\text{Stratum Area})} = 0.9114 \text{ seals / km}^2 \ _{(\text{March – August})}$$

Table 9-22: Strata Size and Seasonal In-Water Density Estimates for Harbor Seal in CAL-BCPM

Location	Strata Area (km^2)	In-Water Density (March - August)	In-Water Density (September - February)
Channel Islands			
Anacapa Island	120	0.9114	1.3285
Richardson Rock	151	0.1239	0.1806
San Clemente Island	206	1.7743	2.5863
San Miguel Island	357	1.1031	4.1246
San Nicolas Island	761	0.8264	1.2045
Santa Barbara Island	73	0.7097	1.0344
Santa Cruz Island	446	1.0196	1.4862
Santa Rosa Island	709	0.7834	1.1420
California Mainland			
Pt. Mugu	175	0.2085	0.7973
La Jolla	253	0.0777	0.2971
Central and Northern California	16,351	0.0879	0.3361
BCPM			
Coronado Islands	474	0.4656	0.8180
Todos Santos Island	377	0.6509	1.1435
San Martín Island	658	0.3429	0.6024
San Jerónimo Island	629	1.1630	2.0431
Cedros Island	1,937	0.2403	0.4221
San Benito Islands	89	0.5646	0.9919
Natividad Island	1,018	0.7540	1.3246
San Roque Island	476	2.0044	3.5212
Asunción Island	177	1.9600	3.4433
Baja Coast	17,854	0.0235	0.0414

Note: km = kilometer

Harbor seal densities in CAL-BCPM are shown in Figure 9-27 and Figure 9-28. The figures show densities as a range of values instead of a single value to standardize the legend across all figures for the species. However, the strata on each map represent only one density value (Table 9-22).

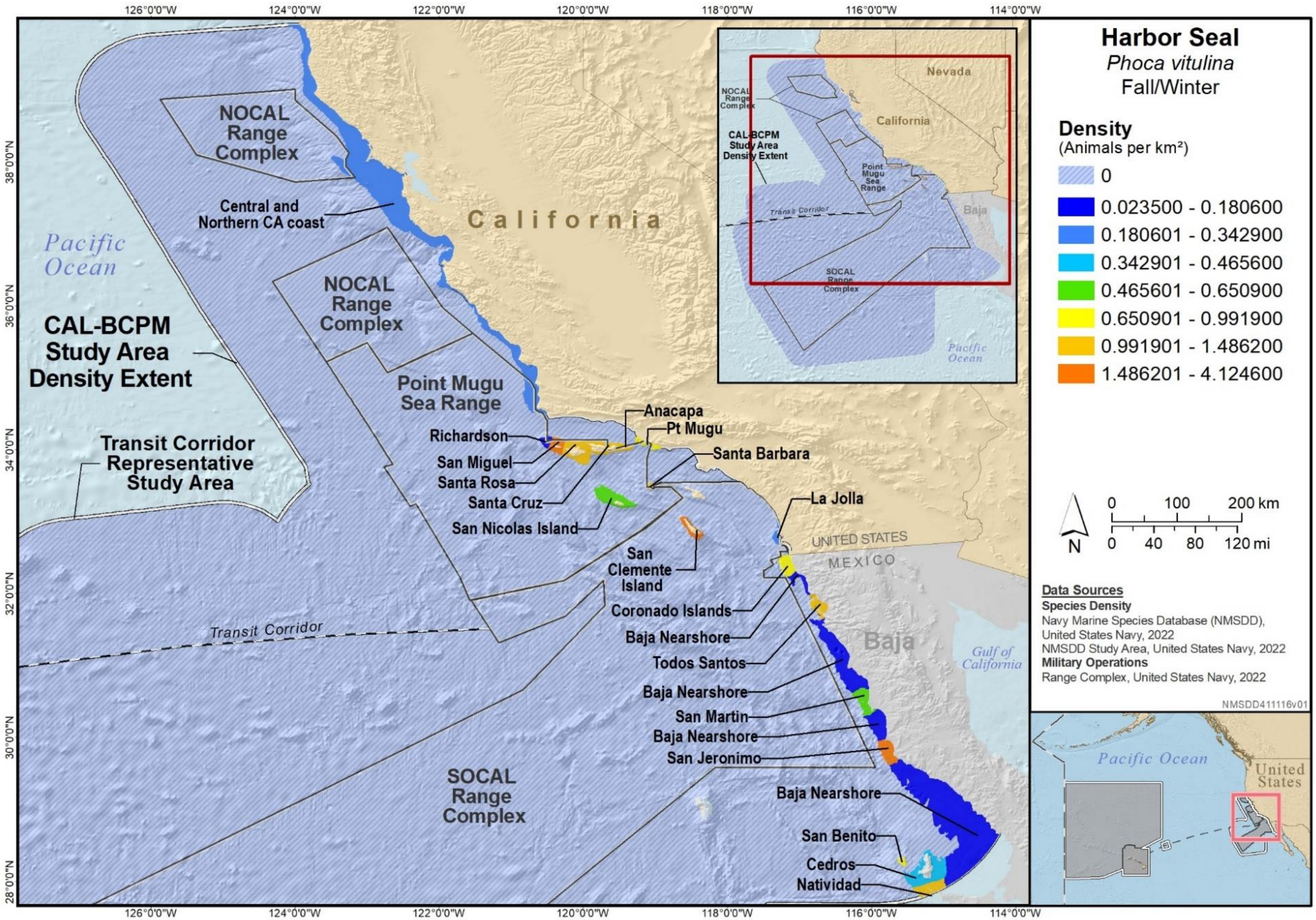

Figure 9-27: Fall/Winter Distribution of Harbor Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

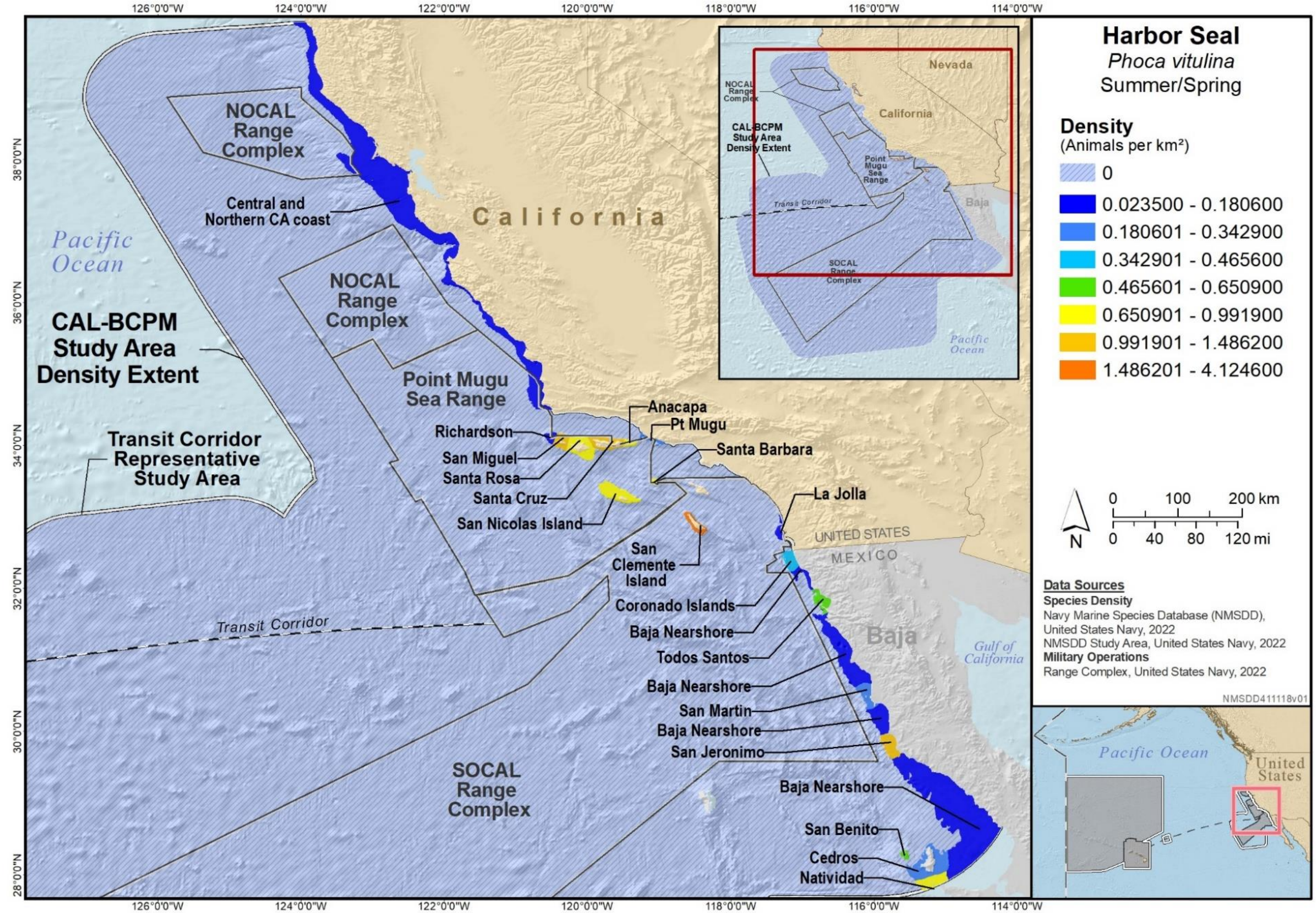

Figure 9-28: Summer/Spring Distribution of Harbor Seal in CAL-BCPM and the Eastern Portion of the Transit Corridor

9.6 *ZALOPHUS CALIFORNIANUS*, CALIFORNIA SEA LION

The California sea lion is an abundant pinniped found along the Pacific coast of North America from the Gulf of Alaska to Southern Mexico (Jefferson et al., 2015). California sea lions breed in the Channel Islands and off the BCPM from May through July or August. Males migrate north after the breeding season primarily in nearshore waters over the continental shelf to waters off Washington, Oregon, and British Columbia, with some males traveling as far as the Gulf of Alaska (Lowry & Forney, 2005; Maniscalco et al., 2004). Some males also migrate into Puget Sound where they forage through spring (Jeffries, 2014). Some immature males will remain in northern feeding areas year-round (Jeffries, 2017; Jeffries & Sleeman, 2018). Females generally do not migrate as far north as males and are expected to remain in nearshore waters around the Channel Islands and off the mainland coast of southern and central California (Laake et al., 2018).

The U.S. Stock of California sea lions has an abundance of 257,606 (Carretta et al., 2022; Laake et al., 2018). The abundance estimate is based on a pup count from 2014; however, the mean pup count from 2016 through 2019 by Lowry et al. (2021) was nearly the same, and applying the same multiplier to estimate stock abundance results in a similar estimate and indicates that the population growth may be leveling off. Furthermore, Laake et al. (2018) analyzed data from 1987 through 2015 and concluded that the population in 2014 was approaching carrying capacity. In a comprehensive review of the status of the California sea lion, Hernández-Camacho et al. (2021) estimated the population abundance, including both the U.S. Stock and Mexico breeding population, to be between 327,157 – 334,205 individuals with 80 percent in the U.S. Stock, 14 percent in the BCPM, and 6 percent in the Gulf of California. The average of the range in abundance is 330,681 sea lions, and 80 percent of the average is 264,545, which is only 3 percent greater than the abundance estimated by Laake et al. (2018) and reported in the NMFS 2021 stock assessment report (Carretta et al., 2022).

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

CAL-BCPM. The primary rookeries off the coast of the United States are on San Nicolas, San Miguel, Santa Barbara, and San Clemente islands, where the majority of sea lions are expected to be from May through October (Briscoe et al., 2018; Hernández-Camacho et al., 2021; Laake et al., 2018; Lowry et al., 1992; Lowry & Forney, 2005; Lowry et al., 2017). 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 the Channel Islands to forage following the breeding season (May – July) (Briscoe et al., 2018; Kuhn, 2006; Kuhn & Costa, 2014; Laake et al., 2018; Melin et al., 2008; Melin et al., 2012; National Oceanic and Atmospheric Administration, 2016; Testa, 2012). The Channel Islands accounted for 95 to 97 percent of all pups and 72 to 78 percent of all non-pups counted during surveys from 2016 through 2019 (Lowry et al., 2021). The two largest rookeries in the Channel Islands are on San Nicolas Island and San Miguel Island and comprised approximately 69 to 90 percent of all California sea lions counted in the U.S. Stock from 2016 through 2019. The islands of Anacapa, Santa Rosa, Santa Cruz, and Santa Catalina and Richardson Rock are sparsely populated (Lowry et al., 2021).

Strata: The Navy defined four strata to represent the different distributions during the breeding and non-breeding seasons as presented by Laake et al. (2018) for both male and female sea lions (see Figure 1 in Laake et al. (2018)). Two strata were defined to represent the distribution of sea lions during the breeding season (May – July). Together, they extend from central California to the southern tip of the BCPM and are separated by the U.S. – Mexico border. During the non-breeding season (August – April), California sea lions from both populations move north along the coast as far as Alaska. To capture this wider distribution, the strata used for the non-breeding season extend from southeast Alaska in the north to south of the Gulf of California, Mexico in the south. The southernmost portion of the BCPM non-breeding stratum is south of the Study Area and is not shown on density distribution maps in this report, but data from the stratum were incorporated into the density calculations to accurately represent the distribution. The sizes of the four strata are provided in Table 9-23.

Table 9-23: Strata for California Sea Lion Density Calculations

Strata	Area (km^2)
California Breeding	106,062
California Non-Breeding	342,957
BCPM Breeding	396,259
BCPM Non-Breeding	502,858

Note: BCPM = Baja California Peninsula, Mexico

Abundance: In-water abundance estimates were calculated for each of the four strata by determining the seasonally varying ratios of males and females in each stratum and incorporating haul-out correction factors representative of each age and sex class. In estimating the abundance of the U.S. Stock, Laake et al. (2018) determined from a population reconstruction model that 57.6 percent of the stock were female and 42.4 percent were male. Applying those same ratios to the combined population abundance estimated by Hernández-Camacho et al. (2021) results in 190,624 females and 140,057 males in the population comprised of the U.S. Stock and Mexico breeding population. Using the proportions from Hernández-Camacho et al. (2021) of 80 percent for the U.S. Stock, 14 percent for the BCPM subpopulation, and 6 percent for the Gulf of California subpopulation to estimate abundance by region results in the totals shown in Table 9-24.

Table 9-24: Abundance of California Sea Lion by Population and Sex Class

Stock or Population	Female Abundance	Male Abundance	Proportion (%)
U.S Stock	152,499	112,046	80
BCPM Breeding	26,687	19,608	14
Gulf of California, Mexico Breeding	11,437	8,403	6
Total	190,624	140,057	100

BCPM = Baja California Peninsula, Mexico, % = precent

Haul-out Behavior: California sea lion haul-out behavior varies with season (breeding and non-breeding) and age and sex classes. DeLong et al. (2017) tagged male California sea lions in Puget Sound in the Pacific Northwest to assess haul-out and foraging behavior during the non-breeding season. An average of 43 percent of males of varying ages were on land from December through April/May; monthly ratios ranged from 37 to 48 percent. Weise et al. (2006) followed the offshore movements of male sea lions tagged in Monterey Bay, California and observed that an average of 50 percent were hauled out from October through January during normal climate conditions. Weise et al. (2010) used data from the same tagged sea lions to show that larger sea lions spent more time hauled out, at least in part, because they adopted more efficient foraging strategies, requiring less time in the water. The mean percentage of time sea lions in each of three groups identified by Weise et al. (2010) were on land was 42, 49, and 54 percent, depending on the foraging strategy.

During the breeding season, adult males 7 years and older are hauled out approximately 25 percent of the time, and juvenile and subadult males younger than 7 years are hauled out 40 percent of the time (Melin, 2022). The ratio of adult to subadult and juvenile males in the population was approximated as 35 percent to 65 percent based on an analysis of annual age-specific abundance estimates derived by Laake et al. (2018) from a population reconstruction model.

For the purposes of calculating in-water abundance estimates, the Navy assumed 57 percent of male California sea lions would be in the water during the non-breeding season (August – April) and 75 percent of adult males and 60 percent of subadult and juvenile males would be in the water during the breeding season (May – July).

Melin et al. (2000) measured attendance times of lactating females at San Miguel Island from 1990 – 1994 in winter and spring, the non-breeding season. Females foraged at sea an average of 72 to 76 percent of the time throughout the winter and spring over the four year study (excluding limited data from 1993). Kuhn and Costa (2014) reported similar haul-out behavior with females spending an average of 68 percent of time at sea. For the purpose of calculating in-water abundance estimates, the Navy assumed 75 percent of female California sea lions would be in the water during the non-breeding season (August – April) and 70 percent of adult females would be in the water during the breeding season (May – July).

McHuron et al. (2018) reported that juveniles of both sexes are in the water an average of 70 percent of the time during the non-breeding season. The Navy anticipated that pups would be on land 100 percent of the time during the breeding season and 66 percent of the time during the non-breeding season (Melin et al., 2000), which translates to 0 and 34 percent in-water abundance during the breeding and non-breeding seasons, respectively. The percentages used to calculate in-water abundance estimates by season and class are shown in Table 9-25.

Table 9-25: Haul-out Correction Factors Used to Calculate In-Water Abundance for California Sea Lion

Area of Study	Breeding Season (May-July)				Non-Breeding Season (August-April)			
	Pups (%)	Females (%)	Adult Males (%)	Juvenile Males (%)	Pups (%)	Adult Females (%)	Adult Males (%)	Juveniles (%)
San Miguel Island		70	75	60	34	75		
Puget Sound							57	
Central California	0							70

<u>In-Water Abundance</u>: The abundance estimates shown in Table 9-24 were adjusted using the haul-out correction factors from Table 9-25 and, for males, the ratio between adults and juvenile males in the

population. For example, the calculation for the in-water abundance of all sea lions off California during the breeding season is:

$\text{Abundance}_{\text{(in-water)}} = (152{,}499_{\text{(females)}} \times 0.70_{\text{(haul-out factor)}}) + (112{,}046_{\text{(males)}} \times 0.35_{\text{(percent adult)}} \times 0.75_{\text{(haul-out factor)}}) + (112{,}046_{\text{(males)}} \times 0.65_{\text{(percent juvenile)}} \times 0.60_{\text{(haul-out factor)}} = 179{,}859$ sea lions off California during the breeding season.

The distribution of California sea lions expands north following the breeding season when males migrate along the coast as far as north as Alaska. The in-water abundances for females and males off California during the non-breeding season is calculated as:

$\text{Abundance}_{\text{(in-water)}} = (152{,}499_{\text{(females)}} \times 0.75_{\text{(haul-out factor)}}) + (112{,}046_{\text{(males)}} \times 0.57_{\text{(haul-out factor)}}) = 114{,}374_{\text{(females)}} + 63{,}866_{\text{(males)}}$.

Since in-water abundance estimates for males and females are distributed over different strata for the density calculations, there is no need to combine the totals.

<u>Density</u>: Density estimates were calculated by dividing the in-water abundance by the area of the appropriate stratum. For example, the density off California during the breeding season is calculated as:

$\text{Density} = 179{,}859_{\text{(in-water abundance)}} / 106{,}062\ \text{km}^2{}_{\text{(California breeding area)}} = 1.6958$ sea lions per km^2

The density during the non-breeding season is calculated as:

$\text{Density} = (114{,}374_{\text{(females)}} / 106{,}062\ \text{km}^2{}_{\text{(California breeding area)}}) + 63{,}866_{\text{(males)}}./ 342{,}957\ \text{km}^2{}_{\text{(California non-Breeding Area)}} = 1.2646$ sea lions per km^2

All California sea lions were assumed to be within the California and Mexico breeding strata during the breeding season, therefore, the density is zero for the two non-breeding strata during the breeding season.

San Diego Bay. The California sea lion is the only pinniped species that occurs regularly in San Diego Bay, so a separate density estimate was derived for San Diego Bay and the adjacent Silver Strand Training Complex located on the oceanside of the Silver Strand Isthmus. Between February 2007 and June 2011, the Navy conducted five cold season surveys and six warm season surveys of San Diego Bay and waters off 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, defined as May through October in the study, California sea lions are engaged in breeding, nursing, and molting, which require more haul-out time than during the cool season (November through April). For both the warm and cool seasons, the in-water density estimate for North San Diego Bay is 13 sea lions/km^2 (Graham & Saunders, 2015).

$\text{Density}_{\text{(North San Diego Bay)}} = 169_{\text{(sea lions)}} / 13\ \text{km}^2{}_{\text{(area)}} = 13$ sea lions per km^2

Differences in nearshore and offshore sea lion abundance were observed in waters off the Silver Strand Training Complex. The in-water offshore density was estimated to be 2.17 sea lions/km^2 and the nearshore density was 3.45 individuals/km^2.

$\text{Density}_{\text{(Offshore Silver Strand Training Complex)}} = 76_{\text{(sea lions)}} / 35\ \text{km}^2{}_{\text{(area)}} = 2.17$ sea lions per km^2

$\text{Density}_{\text{(Nearshore Silver Strand Training Complex)}} = 147_{\text{(sea lions)}} / 42.6\ \text{km}^2{}_{\text{(area)}} = 3.45$ sea lions per km^2

California sea lion densities in CAL-BCPM are shown in Figure 9-29 and Figure 9-30. The figures show densities as a range of values instead of a single value to standardize the legend across all figures for the species. However, the strata on each map represent only one density value (Table 9-26).

Table 9-26: Seasonal In-Water Density Estimates for California Sea Lion in CAL-BCPM

Location	Density (Sea Lions/km^2)	
	Breeding May – July	**Non-Breeding August - April**
California Breeding	1.6958	1.2646
California Non-Breeding	0	0.1862
BCPM Breeding	0.0794	0.0727
BCPM Non-Breeding	0	0.0222
North San Diego Bay	13.0	13.0
Offshore Silver Strand Training Complex	2.17	2.17
Nearshore Silver Strand Training Complex	3.45	3.45

Notes: BCPM = Baja California Peninsula, Mexico, km = kilometer

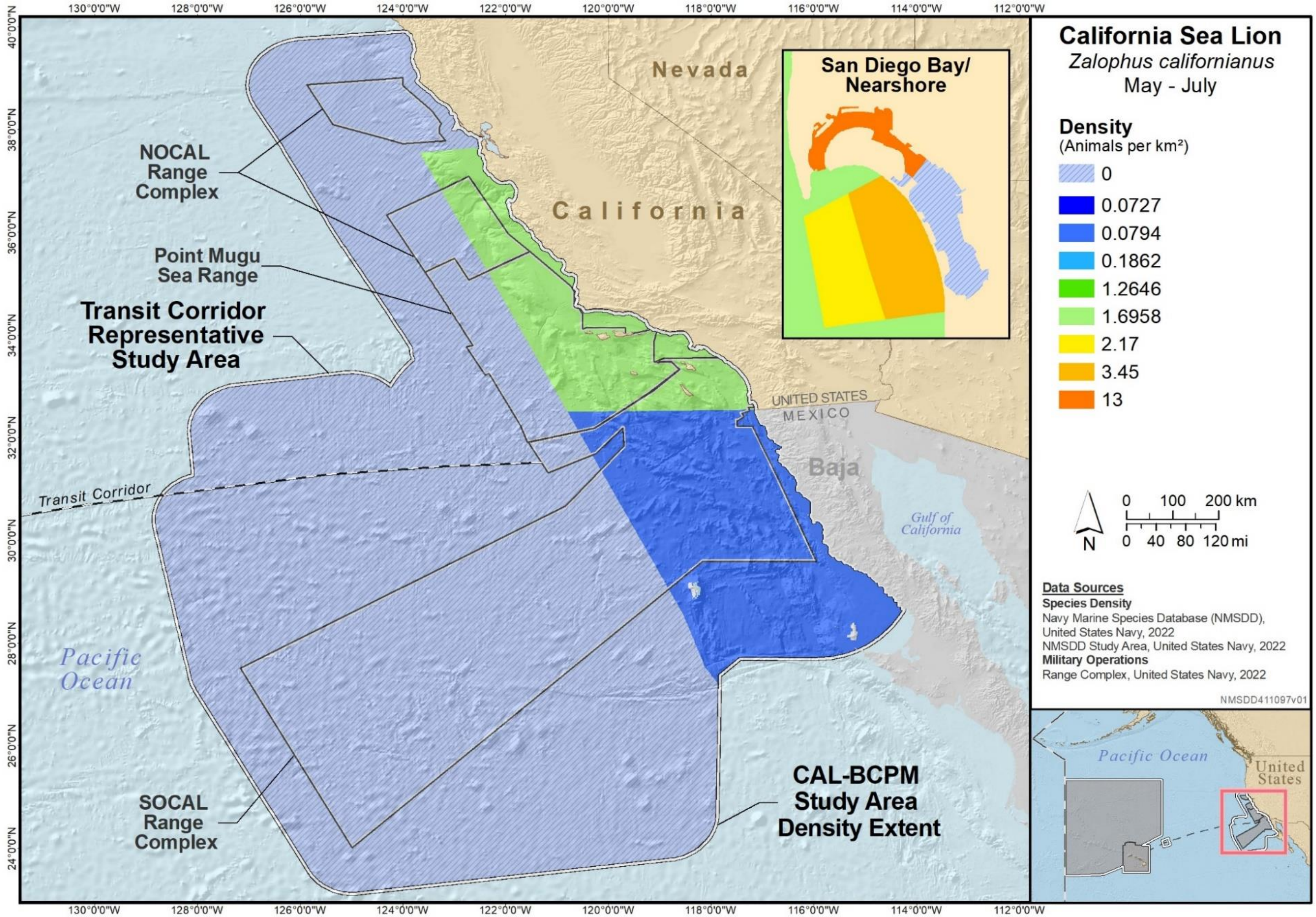

Figure 9-29: May-July Distribution of California Sea Lion in CAL-BCPM and the Eastern Portion of the Transit Corridor

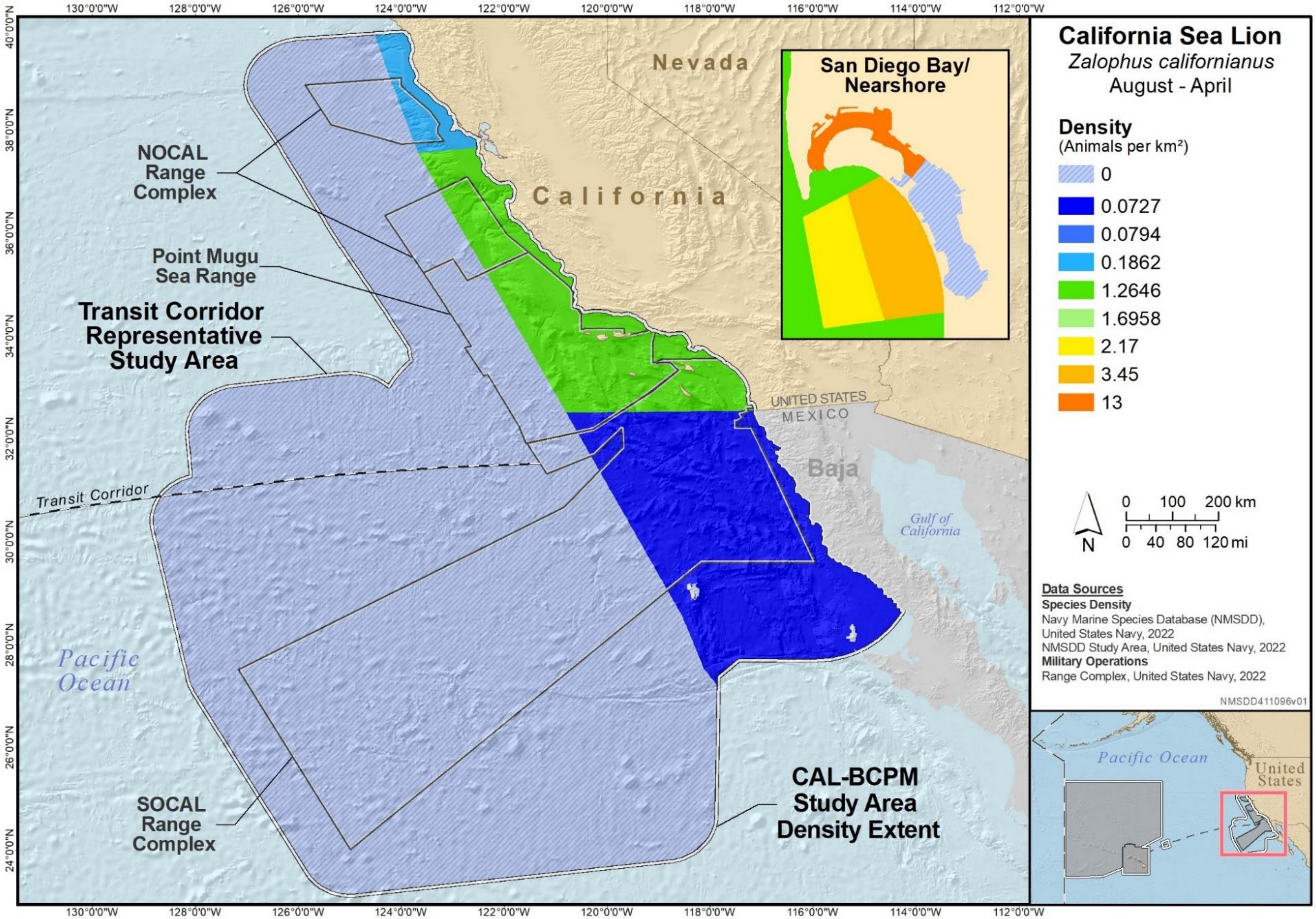

Figure 9-30: August-April Distribution of California Sea Lion in CAL-BCPM and the Eastern Portion of the Transit Corridor

9.7 *Eumetopias jubatus*, Steller Sea Lion

Steller sea lions range along the North Pacific Rim from northern Japan to California, with centers of abundance and distribution in the Gulf of Alaska and Aleutian Islands. The species is not known to migrate, but individuals disperse widely outside of the breeding season. NMFS has designated two Steller sea lion stocks in the North Pacific corresponding to two DPSs (Muto et al., 2020a). The Eastern U.S. Stock (or DPS) is defined as the population occurring east of 144°W longitude, and the Western U.S. Stock (or DPS) consists of sea lions occurring west of 144°W longitude. Although the distribution of individuals from the two stocks overlaps outside of the breeding season (May–July), Steller sea lions typically return to their natal rookeries and haulouts in each DPS area prior to the breeding season (Fritz et al., 2016; Jemison et al., 2013; Muto et al., 2017; Muto et al., 2018; Muto et al., 2020a; National Marine Fisheries Service, 2013; Raum-Suryan et al., 2004; Sigler et al., 2017). Males arrive at breeding sites in May, with females following shortly afterwards. Pups are born from late May to early July and begin traveling with their mothers to other haulouts at two to three months of age. Adults depart rookeries in August. Females with pups remain within 500 km of their rookery during the non-breeding season, but juveniles of both sexes and adult males disperse more widely while remaining primarily over the continental shelf (Jemison et al., 2013; Jemison et al., 2018; Wiles, 2015).

Only Steller sea lions from the Eastern U.S. Stock are expected to occur in waters off California, with highest levels of occurrence in the northern part of the Study Area and fewer occurring in the Channel Islands and Southern California waters. Important haulouts along the California coastline include Año Nuevo Island and the Farallon Islands in Central California and the Saint George Reef rookery and the Sugarloaf Island rookery at Cape Mendocino in northern California (Lowry et al., 2021).

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

CAL-BCPM. In-water abundance and density estimates for central and northern California were based on summer counts from 2016 – 2019 by Lowry et al. (2021). Abundance and density estimates for Southern California, including the Channel Islands, were based on winter counts from 2013 reported by Lowry et al. (2020). Steller sea lion breeding rookeries are located north of the Channel Islands, limiting the number of sea lions that would occur in Southern California during the summer breeding season when Lowry et al. (2021) conducted counts in northern and central California; the authors observed only three juvenile Steller sea lions during the July 2019 survey. Following the breeding season, Steller sea lions disperse and are more widely distributed in California waters, including in the Channel Islands, where occurrence at haulouts is higher than in summer (Lowry et al., 2021). A few male Steller sea lions may transit through Southern California waters in winter to waters and islands as far south as the BCPM (Gallo-Reynoso et al., 2020). However, these occurrences are considered beyond the normal distribution for the species, and the available data only support reasonable density estimates as far south as the U.S. – Mexico border.

<u>Strata</u>: The strata defining the density distribution areas were adopted from Figure 1 in Lowry et al. (2021). The authors segmented the California coastline into three regions: Northern California, Central California, and Southern California, and then subdivided the northern and central California regions into seven zones labeled A – G. The Southern California region extends from Point Conception to the U.S. – Mexico border and was not subdivided (Figure 9-31).

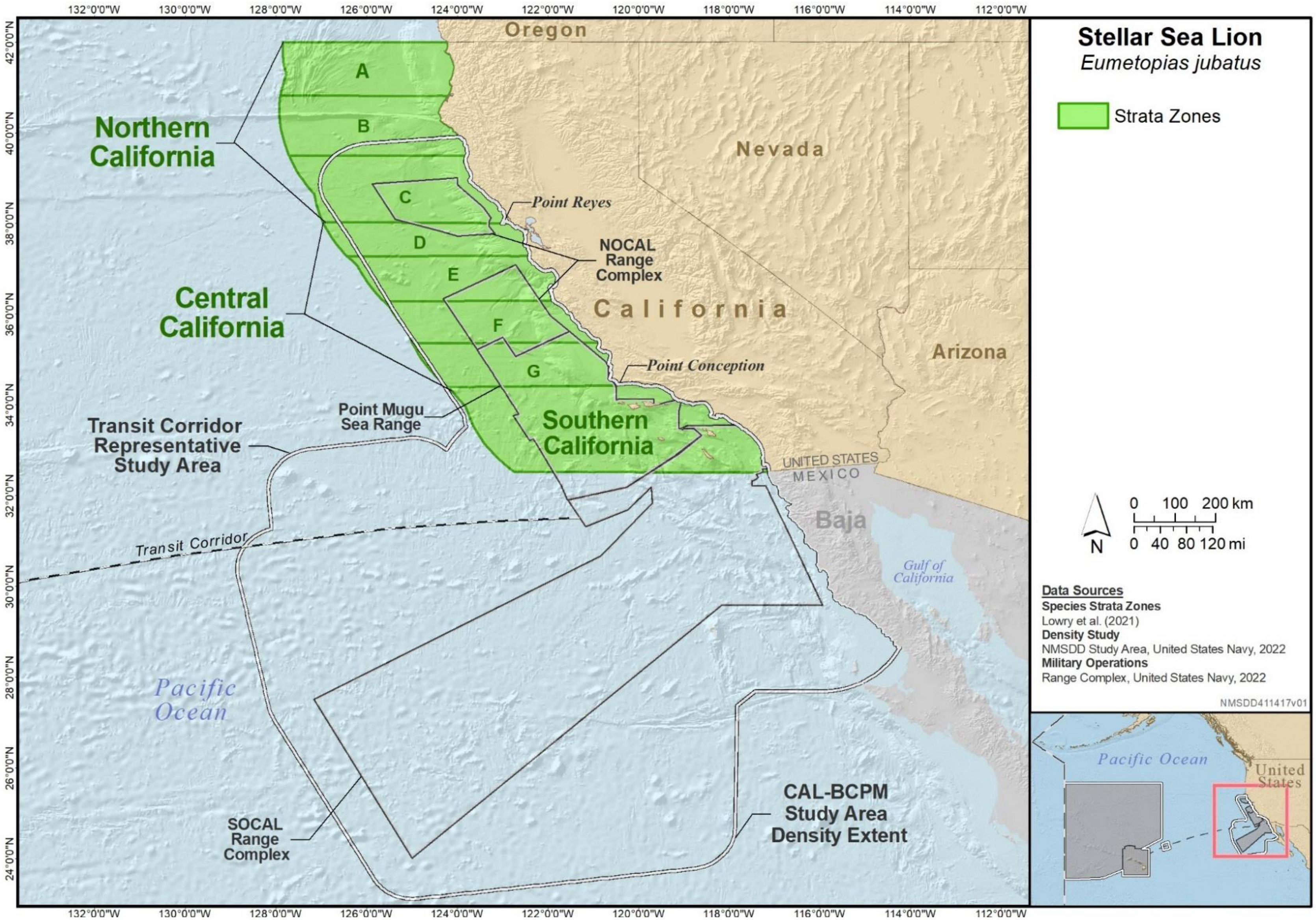

Figure 9-31: Strata Used for Steller Sea Lion Density Distribution

The Navy used the 200 m depth contour to approximate the shelf break and define the western boundary for the majority of Steller sea lion occurrence off California. Based on sightings of Steller sea lions in offshore waters beyond the continental shelf (Wiles, 2015), an offshore stratum was defined extending from the 200 m depth contour to a distance of 300 km from shore. The depth and distance parameters are consistent with the parameters the Navy defined to calculate densities in the Northwest Training and Testing Study Area located north of (and partially overlapping) the HCTT Study Area (U.S. Department of the Navy, 2020). The areas of the strata are shown in Table 9-27.

Table 9-27: Strata Areas Used in Steller Sea Lion Density Calculations

California Region	Zone	Shore to 200 m Depth Contour (km²)	200 m Depth Contour to 300 km From Shore (km²)
Northern California	A	3,418	37,595
	B	2,355	45,207
	C	4,428	51,475
Central California	D	4,257	26,264
	E	2,306	37,472
	F	967	35,565
	G	2,049	36,965
Southern California	Channel Islands	8,726	99,411

Note: km = kilometer

Abundance: Counts of Steller sea lions in northern and central California by region, zone, and age and sex classes are taken from Table 6 in Lowry et al. (2021) and reported below showing the total live count (excludes dead pups at rookeries) and the calculated multiyear average count used in the density calculations (Table 9-28).

Table 9-28: Steller Sea Lion Counts at California Haulouts in 2013 (winter) and 2016-2019 (summer)

California Region	Zone	Survey Date	Total Count	Multiyear Average Count[1]
Northern	A	2016 July 14	2,271	2,118
		2017 July 14	1,965	
	B	2016 July 15	816	737
		2017 July 15	657	
	C	2016 July 17 & 25	75	122
		2017 July 15	168	
Central	D	2016 July 18	472	436
		2017 July 16	294	
		2018 July 26	543	
	E	2016 July 17 & 20	356	405
		2017 July 16	403	
		2018 July 26	457	
	F	No counts 2016-2019	0	0
		No counts 2016-2019	0	
		No counts 2016-2019	0	
	G	No counts 2016-2019	0	0

<table>
<tr><th>California Region</th><th>Zone</th><th>Survey Date</th><th>Total Count</th><th>Multiyear Average Count[1]</th></tr>
<tr><td rowspan="2"></td><td rowspan="2"></td><td>No counts 2016-2019</td><td>0</td><td rowspan="2"></td></tr>
<tr><td>No counts 2016-2019</td><td>0</td></tr>
<tr><td rowspan="9">Southern</td><td>Anacapa Island</td><td>2013 February 13</td><td>1</td><td rowspan="9">17</td></tr>
<tr><td>San Clemente Island</td><td>2013 February 15</td><td>1</td></tr>
<tr><td rowspan="4">San Miguel Island</td><td>2013 February 9</td><td>3</td></tr>
<tr><td>2013 January 30</td><td>4</td></tr>
<tr><td>2013 February 13</td><td>2</td></tr>
<tr><td>2013 March 7</td><td>4</td></tr>
<tr><td>San Nicolas island</td><td>2013 February 15</td><td>1</td></tr>
<tr><td>Santa Rosa Island</td><td>2013 February -13</td><td>1</td></tr>
</table>

[1]Multiyear counts are averaged by zone for northern and central California regions; however, for Southern California, because counts are low, the multiyear count is a sum across all locations.
Source: (Lowry et al., 2021; Lowry et al., 2020)

Haul-out correction factors for Steller sea lion were summarized by Holmes et al. (2007) (see Appendix E of the paper). The Navy selected separate correction factors for the breeding and non-breeding seasons to estimate total abundance and in-water abundance with preference given to studies from California, and, if data from California were not available, to studies from southeast Alaska, over studies from the Gulf of Alaska and the Aleutian Islands. To estimate total abundance from the total average counts, the Navy conservatively assumed that 30 percent of sea lions were on shore to be counted during the breeding season. This estimate is based on a study by Higgins et al. (1988) on the haul-out and foraging behavior of lactating females. The study showed that females increased their time in the water from 40 to 70 percent as their pups aged from 9 to 47 days. By applying a correction factor of 30 percent, the Navy assumes that 70 percent of sea lions are in the water during the breeding season.

The Navy used a correction factor of 24 percent for the non-breeding season based on attendance patterns of nursing females in southeast Alaska (Trites & Porter, 2002). Correction factors measured for pups, yearlings, and juveniles in southeast Alaska were all greater than 24 percent (Call et al., 2007; Trites & Porter, 2002).

Since counts of sea lions in Southern California were made in winter, a correction factor of 36 percent on shore, instead of 30 percent, was used and was based on an average of correction factors reported by Call et al. (2007) and Trites and Porter (2002) to estimate total abundance in both seasons. As noted above, very few Steller sea lions are expected to occur in Southern California during the breeding season (Lowry et al., 2021). Therefore, both abundance estimates and haul-out behavior relied on data from the non-breeding season to calculate densities.

The following equation calculates the total abundance in Zone A during the breeding season.

Total Abundance$_{\text{(Zone A)}}$ = 2,118$_{\text{(Average Count)}}$ / 0.30$_{\text{(Correction Factor)}}$ = 7,060 Steller sea lions in Zone A during the breeding season

To estimate the in-water abundance of Steller sea lions during the breeding and non-breeding seasons, the Navy used the average of multiple correction factors from California and Southeast Alaska to account for variability in haul-out behavior. Three studies from California estimated females were in the water 55, 60, and 70 percent of the time, for an average of 62 percent during the breeding season (Higgins et al., 1988; Hood & Ono, 1997). During the non-breeding season, the average of the percentages that pups (56 percent), yearlings (61 percent), juveniles (63 percent), and adult females (76 percent) were in the water (i.e., 64 percent) was used to calculate in-water abundance estimates (Call et al., 2007; Trites & Porter, 2002).

For example, the in-water abundance from Zone A is,

In-Water Abundance$_{\text{(Zone A)}}$ = 7,060$_{\text{(Total Abundance)}}$ x 0.62$_{\text{(Correction Factor)}}$ = 4,354 Steller sea lions in-water in Zone A during the breeding season

Similar calculations for each zone and season resulted in the in-water abundance estimates shown in Table 9-29.

Table 9-29: In-Water Abundances of Steller Sea Lion Off California

<table>
<tr><th>California Region</th><th>Zone</th><th>Average In-Water Abundance (May-August)</th><th>Average In-Water Abundance (September - April)</th></tr>
<tr><td rowspan="3">Northern</td><td>A</td><td>4,354</td><td>5,637</td></tr>
<tr><td>B</td><td>1,514</td><td>1,960</td></tr>
<tr><td>C</td><td>250</td><td>323</td></tr>
<tr><td rowspan="4">Central</td><td>D</td><td>897</td><td>1,161</td></tr>
<tr><td>E</td><td>833</td><td>1,079</td></tr>
<tr><td>F</td><td>0</td><td>0</td></tr>
<tr><td>G</td><td>0</td><td>0</td></tr>
<tr><td rowspan="5">Southern</td><td>Anacapa Island</td><td rowspan="5">29</td><td rowspan="5">30</td></tr>
<tr><td>San Clemente Island</td></tr>
<tr><td>San Miguel Island</td></tr>
<tr><td>San Nicolas island</td></tr>
<tr><td>Santa Rosa Island</td></tr>
</table>

In-water densities were calculated by dividing the seasonal in-water abundance estimates for each zone from Table 9-29 by the area of the corresponding stratum (Table 9-27). One additional factor was incorporated in the density calculations. To account for sea lion occurrence in deep, offshore waters beyond the continental shelf, the Navy assumed 5 percent of sea lions would occur between the 200 m depth contour and a distance of 300 km from shore, and 95 percent of sea lions would occur from shore to the 200 m depth contour. These proportions account for the possibility that a small number of Steller sea lions would occasionally occur farther offshore but the majority would remain concentrated over the continental shelf in preferred foraging habitat.

The density of Steller sea lions in Zone A from shore to the 200 m depth contour during the breeding season is calculated as:

$$\text{Density}_{(\text{Zone A Nearshore})} = 4{,}354_{(\text{In-water abundance})} \times 0.95_{(\text{Nearshore proportion})} / 3{,}418 \text{ km}^2 = 1.2101 \text{ Steller sea lions per km}^2$$

Similar calculations were made to estimate the density for each zone and season (Table 9-30).

Table 9-30: Seasonal In-Water Density Estimates for Steller Sea Lion in CAL-BCPM

California Region	Zone	Density May-August (Sea lions/km^2)		Density September – April (Sea lions/km^2)	
		< 200 m Depth	200 m to 300 km From Shore	< 200 m Depth	200 m to 300 km From Shore
Northern	A	1.2101	0.0058	1.5668	0.0075
	B	0.6107	0.0017	0.7908	0.0022
	C	0.0536	0.0002	0.0694	0.0003
Central	D	0.2002	0.0017	0.2592	0.0022
	E	0.3433	0.0011	0.4445	0.0014
	F	0.0032	0.00001	0.0033	0.00002
	G	0.0032	0.00001	0.0033	0.00002
Southern	Anacapa Island	0.0032	0.00001	0.0033	0.00002
	San Clemente Island				
	San Miguel Island				
	San Nicolas island				
	Santa Rosa Island				

Notes: m = meter, km = kilometer, < = less than

Steller sea lion densities in CAL-BCPM are shown in Figure 9-32 and Figure 9-33. The figures show densities as a range of values instead of a single value to standardize the legend across all figures for the species. However, the strata on each map represent only one density value (Table 9-30).

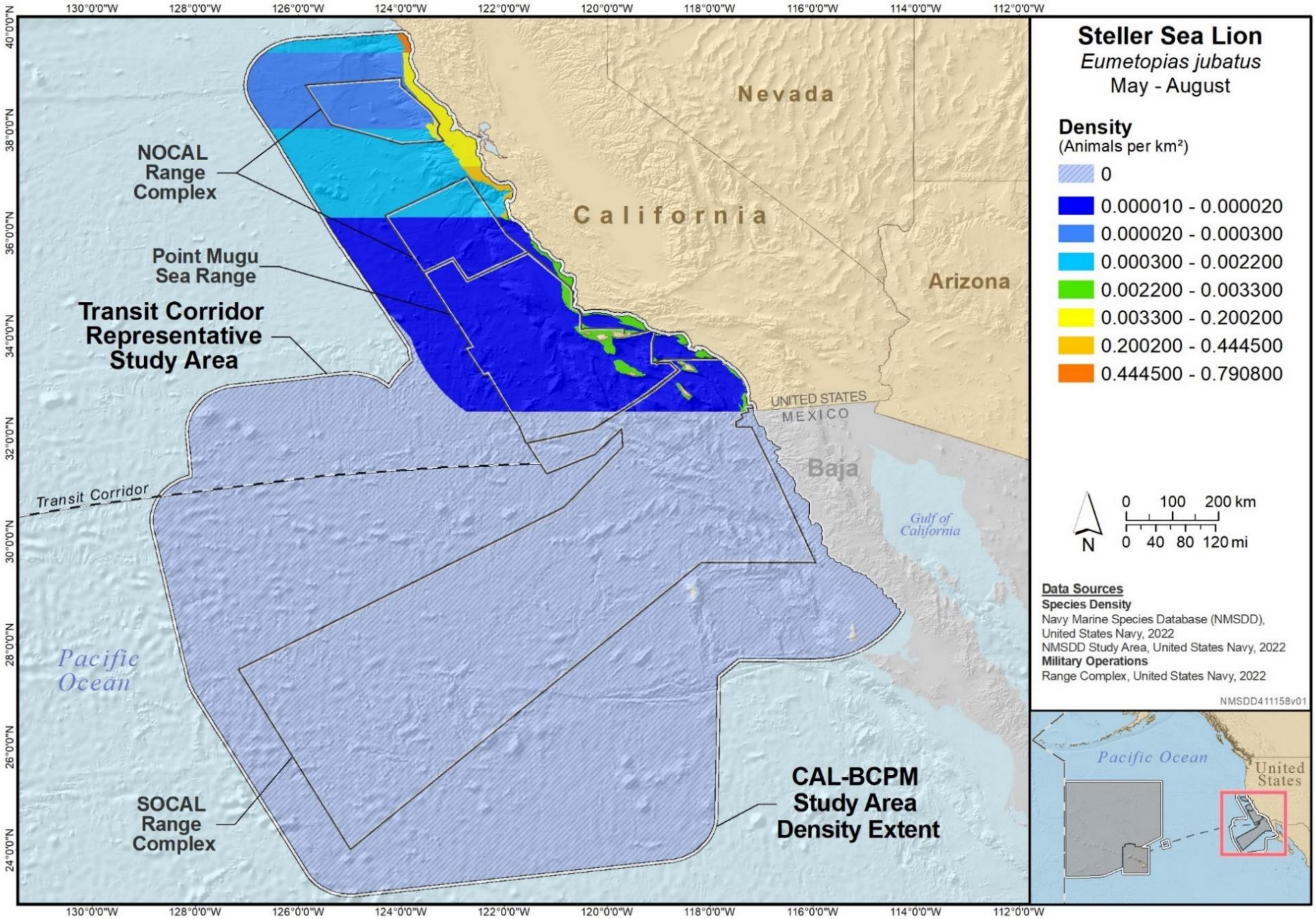

Figure 9-32: May-August Distribution of Stellar Sea Lion in CAL-BCPM and the Eastern Portion of the Transit Corridor

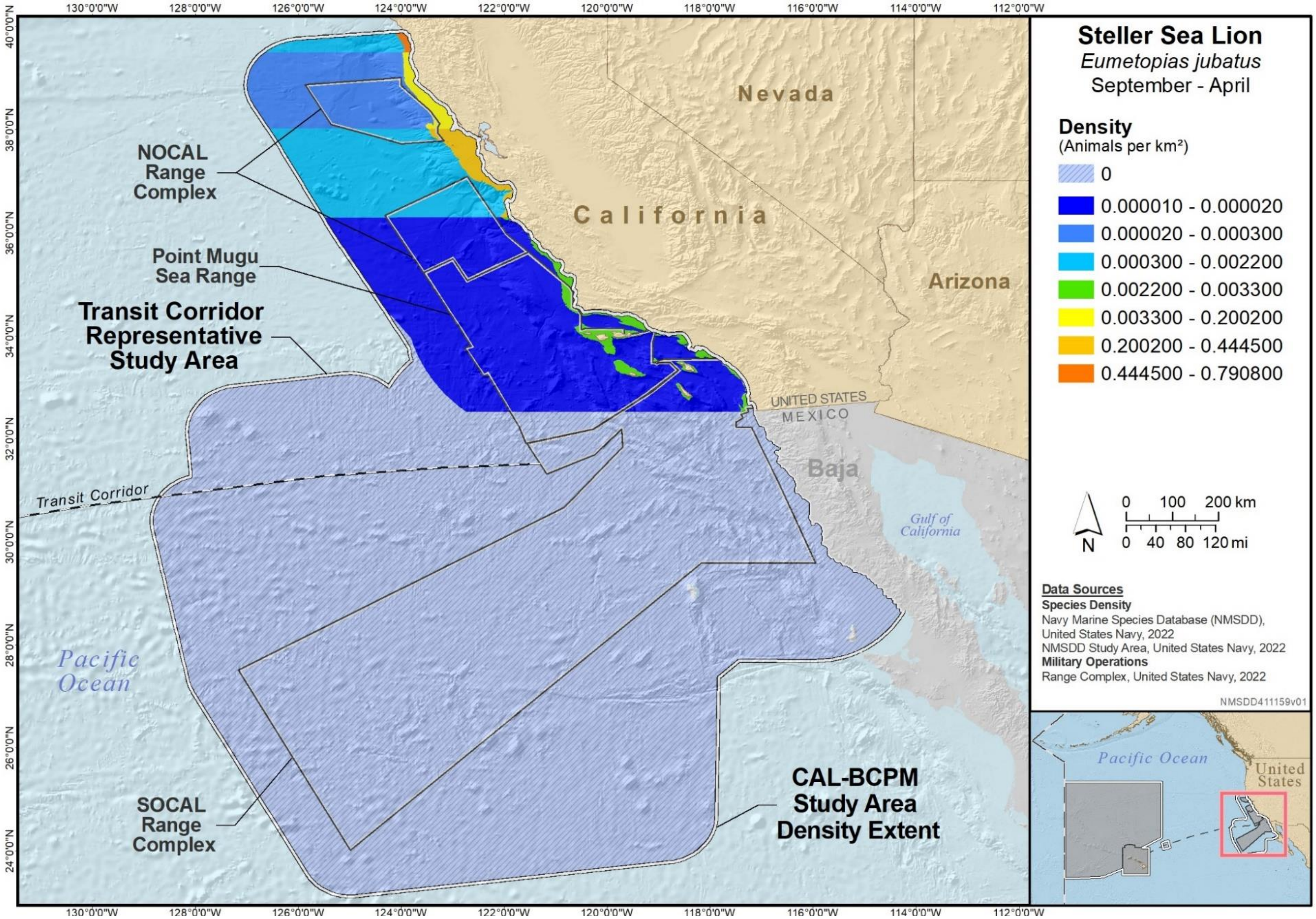

Figure 9-33: September-April Distribution of Stellar Sea Lion in CAL-BCPM and the Eastern Portion of the Transit Corridor

10 MUSTELIDS

10.1 *ENHYDRA LUTRIS NERIS*, SOUTHERN SEA OTTER

The southern sea otter currently occupies just a fraction of its historical range, which once included portions of coastal Oregon, all coastal waters off California, and the BCPM (Tinker et al., 2021; U.S. Fish and Wildlife Service, 2015, 2019). The distribution of the southern sea otter is currently limited to nearshore waters off the coast of central California, ranging from Pigeon Point in the north to south of Point Conception, and around San Nicolas Island (Hatfield et al., 2016; Hatfield et al., 2019; Tinker et al., 2017). Southern sea otters at San Nicolas Island were translocation by the USFWS between 1987 and 1990 (U.S. Fish and Wildlife Service, 2012), specifically to reestablish a population on an island where they historically occurred (Bodkin, 2015). The USFWS declared the attempt to reestablish the population a failure in 2012 and ended the program, but despite that, the population has continued to grow.

Southern sea otters rarely come ashore and spend most of their life in nearshore waters, where they swim, forage, reproduce, and rest. Sea otter distribution is typically defined by habitat features, frequently water depth and distance from shore, which are linked to the otter's dive depth limitations or preferences (Bodkin et al., 2004; Thometz et al., 2016; Tinker et al., 2017; Tinker et al., 2021). Kelp canopy has also been shown to be a strong indicator of sea otter occurrence in California waters (Lafferty & Tinker, 2014; Yee et al., 2020).

Surveys conducted in 2019 along the central California mainland extended from shore to the 60 m depth contour (Hatfield et al., 2019) and surveys off San Nicolas Island from 2017 through 2020 extended out to the 30 m depth contour (Yee et al., 2020). Sea otters may occasionally be present in deeper waters when moving between areas or in attempts to establish new habitat (Burn & Doroff, 2005). Although uncommon, southern sea otters have been known to transit between San Nicolas Island and the mainland coast, likely in search of new habitat (Hatfield, 2005).

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

CAL-BCPM. The highest densities of southern sea otters along the mainland coast occur off central California from the Monterey Peninsula to Estero Bay (Hatfield et al., 2019), which is north of the SOCAL OPAREA and inshore of the PMSR and NOCAL OPAREA. Sea otter densities for mainland California were derived from data presented by Hatfield et al. (2018) and made available by the authors for download as GIS data files. The data were plotted within the Study Area and represent uniform density strata in units of animals/km^2 (Figure 10-1). The surveys to count southern sea otters were conducted from May through July. However, sea otters are not known to make seasonal migrations, so for the purposes of calculating densities, the data are assumed to be representative of year-round occurrence and distribution along the mainland coast.

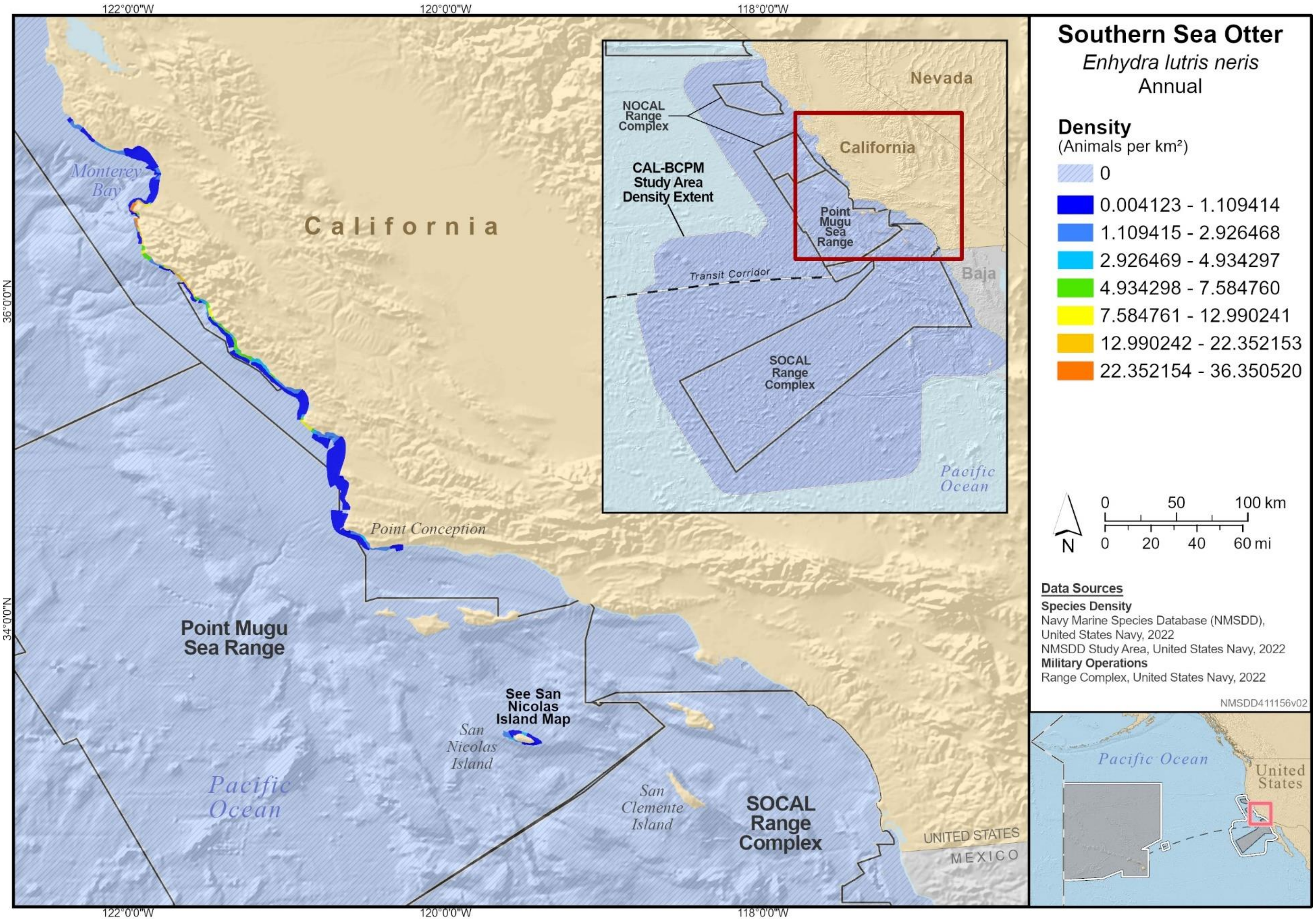

Figure 10-1: Annual Distribution of Southern Sea Otter in CAL-BCPM and the Eastern Portion of the Transit Corridor

Sea otter densities at San Nicolas Island were derived from surveys conducted by Yee et al. (2020). The authors reported counts of otters off San Nicolas Island from 2017 – 2020. Densities around the island were stratified seasonally by using counts from the most recent surveys in each season, which were specifically from April, July, and October of 2019 and February 2020. Yee et al. (2020) partitioned the nearshore habitat around San Nicolas Island from shore to the 30 m depth contour into nine distinct and contiguous survey areas (see Figure 1 in Yee et al. (2020)).

The Navy calculated density values using the seasonal counts reported by Yee et al. (2020) and shown in Table 10-1.

Table 10-1: Seasonal Counts of Sea Otters in Survey Areas Around San Nicolas Island

Season	Year	Month	Counts of Sea Otters by Survey Area									Total
			1	2	3	4	5	6	7	8	9	
Spring	2019	April	24	18	0	24	29	0	10	5	11	121
Summer	2019	July	35	4	50	9	34	2	7	6	7	154
Fall	2019	October	36	0	26	4	30	4	7	2	0	109
Winter	2020	February	2	3	7	42	14	7	11	24	4	114

Source: Yee et al. (2020)

The counts were used to estimate the percentage of the population found in each of the nine survey areas during each season (Table 10-2). For example, the percentage of counts in Survey Area 1 during spring is calculated as

Percentage of Counts = 24 counts / 121 total counts = 0.1983 or 19.83 percent.

For the purpose of calculating a density estimate, the Navy assumed that 19.83 percent of the sea otter population on San Nicolas Island are located in Survey Area 1 in spring. The same formula was used to populate the remainder of Table 10-2.

Table 10-2: Percentage of Total Seasonal Counts in Survey Areas Around San Nicolas Island

Season	Percentage of Counts by Survey Area								
	1	2	3	4	5	6	7	8	9
Spring	19.83	14.88	0.00	19.83	23.97	0.00	8.26	4.13	9.09
Summer	22.73	2.60	32.47	5.84	22.08	1.30	4.55	3.90	4.55
Fall	33.03	0.00	23.85	3.67	27.52	3.67	6.42	1.83	0.00
Winter	1.75	2.63	6.14	36.84	12.28	6.14	9.65	21.05	3.51

U.S. Fish and Wildlife Service (2021) reported an abundance of 99 sea otters in waters around San Nicolas Island. Distributing the 99 otters across all nine survey areas for each season according to the percentages in Table 10-2 resulted in the seasonal abundance estimates for each survey area shown in Table 10-3. For example, the abundance in Survey Area 1 during spring is calculated as:

Abundance = $19.83_{\text{(percent in Survey Area 1)}}$ x $99_{\text{(SNI population)}}$ = 19.64 sea otters in Survey Area 1 in spring.

Table 10-3: Seasonal Abundance Estimates in Survey Areas Around San Nicolas Island

Season	Seasonal Abundance by Survey Area[1]								
	1	2	3	4	5	6	7	8	9
Spring	19.64	14.73	0.00	19.64	23.73	0.00	8.18	4.09	9.00
Summer	22.50	2.57	32.14	5.79	21.86	1.29	4.50	3.86	4.50
Fall	32.70	0.00	23.61	3.63	27.25	3.63	6.36	1.82	0.00
Winter	1.74	2.61	6.08	36.47	12.16	6.08	9.55	20.84	3.47

[1]Assumes an abundance of 99 southern sea otters (U.S. Fish and Wildlife Service, 2021)

Yee et al. (2020) presents seasonal distributions of relative densities around SNI (see Figure 9 in Yee et al. (2020)). The authors provided their georeferenced relative density data, and the Navy plotted the data and measured the spatial extent (in km^2) of the distribution areas. Only the portions of the nine survey areas with non-zero relative density values in the data provided by Yee et al. (2020) were used to calculate the size of the Navy's distribution areas. In other words, the portions of the nine survey areas where the relative density reported by Yee et al. (2020) was zero were not used to calculate the spatial extent of the Navy's distribution areas. The sizes of the Navy's density distribution areas are shown in Table 10-4.

Table 10-4: Size of the Density Distribution Areas Around San Nicolas Island

Season	Distribution Area (km^2)[1]								
	1	2	3	4	5	6	7	8	9
Spring	5.36	4.90	11.96	12.28	7.04	5.40	7.47	3.66	3.41
Summer	5.36	4.90	15.16	12.28	7.04	5.43	5.81	3.66	3.41
Fall	5.36	4.90	14.94	12.25	7.04	7.44	8.44	2.82	2.88
Winter	5.36	4.90	14.13	12.28	7.04	2.71	7.31	3.66	3.41

[1]The density distribution area (km^2) within each of the nine survey areas can vary by season depending on the number of non-zero relative density values in the survey area.

Seasonal density estimates around San Nicolas Island were calculated by dividing the abundance in each area (Table 10-3) by the corresponding density distribution area (Table 10-4). For example, the density in Survey Area 1 in spring is calculated as:

$$\text{Density} = 19.64 \text{ sea otters} / 5.36 \text{ km}^2 = 3.66 \text{ sea otters per km}^2$$

The calculated densities were applied as uniform density strata within the nine survey areas. Seasonal densities within each survey area are shown in Table 10-5 and depicted in Figure 10-2. The figure shows densities as a range of values instead of a single value to standardize the legend across all figures for the species. However, the strata on each map represent only one density value (Table 10-5Table 9-30)

Table 10-5: Seasonal Sea Otter Density Estimates by Survey Area Around San Nicolas Island

Season	Year	Month	Seasonal Densities by Survey Area[1] (sea otters / km^2)								
			1	2	3	4	5	6	7	8	9
Spring	2019	April	3.66	3.01	0.00	1.60	3.37	0.00	1.10	1.12	2.64
Summer	2019	July	4.20	0.52	2.12	0.47	3.10	0.24	0.77	1.05	1.32
Fall	2019	October	6.10	0.00	1.58	0.30	3.87	0.49	0.75	0.64	0.00
Winter	2020	February	0.32	0.53	0.43	2.97	1.73	2.24	1.31	5.69	1.02

[1]Assumes an abundance of 99 southern sea otters (U.S. Fish and Wildlife Service, 2021)

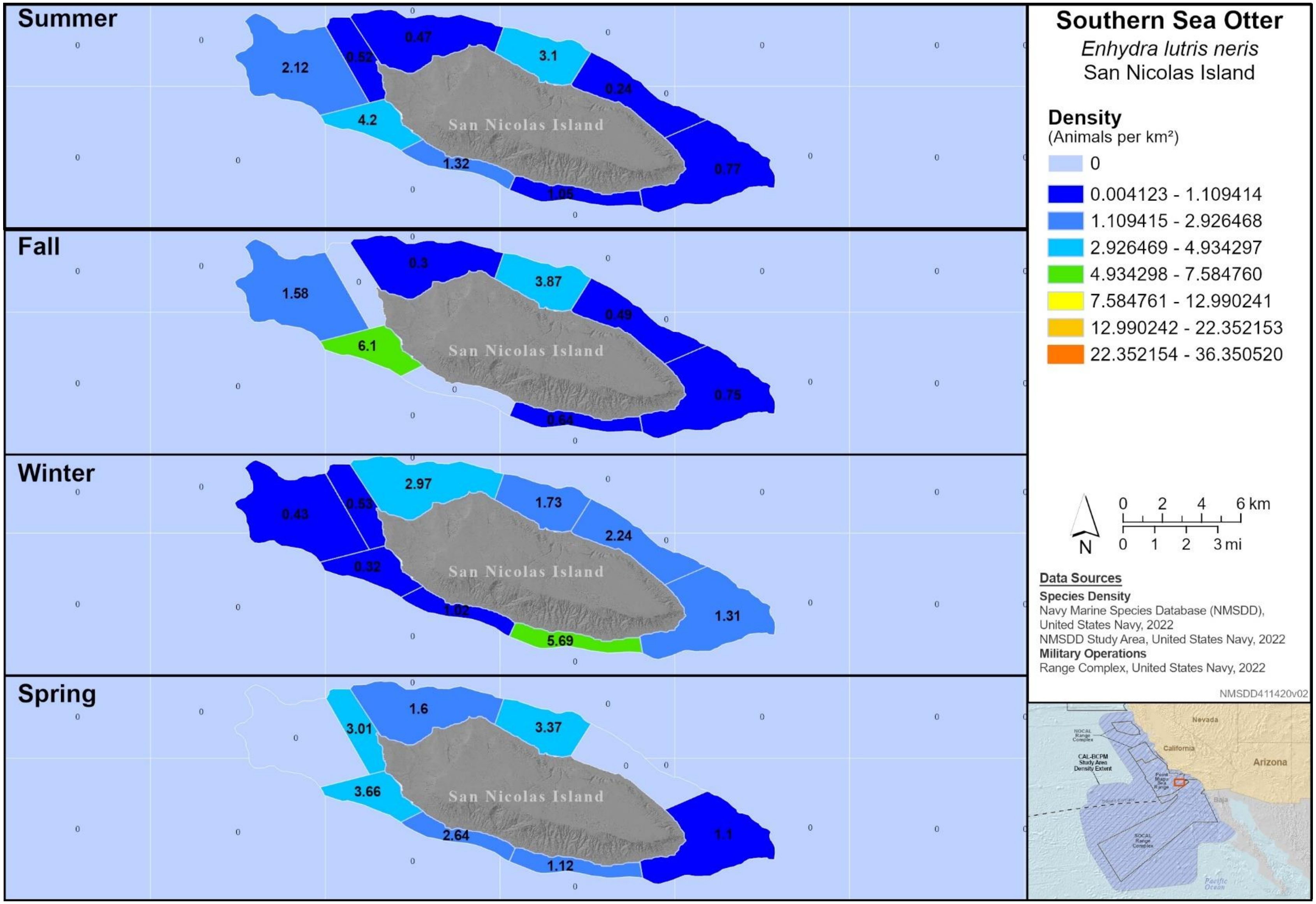

Figure 10-2: Seasonal Distribution of Southern Sea Otter Off San Nicolas Island

11 SEA TURTLES

Sea turtles are highly migratory, long-lived reptiles that occur throughout the open-ocean and coastal regions of Hawaii and the CAL-BCPM. Generally, sea turtles are distributed throughout tropical to subtropical latitudes with some species expanding their ranges poleward into temperate seasonal foraging habitat. After hatching, sea turtles immediately enter the ocean environment and remain at sea for the remainder of their lives, with the notable exception of mature females returning to natal nesting beaches to lay eggs. Habitat preferences and species distribution at sea varies by species and lifestage (e.g., hatchling, juvenile, adult), with little known about the distribution of hatchlings and juveniles (Spotila, 2004).

All sea turtles are ectotherms, commonly referred to as “cold-blooded” animals. Ectotherms have adopted different strategies for regulating body temperature through external sources of heat (e.g., basking in the sun) to compensate for their limited ability to regulate body temperature internally. As a result, sea surface temperature is a key factor in determining the distribution of sea turtle species (Benson et al., 2011b; Coles & Musick, 2000; Crear, 2015; Crear et al., 2016; Etnoyer et al., 2006; James & Mrosovsky, 2004; Storch et al., 2005). In an analysis of sea turtle densities in coral reef ecosystems across the Pacific, including in the Hawaiian Islands, Becker et al. (2019) found that sea surface temperature was the most influential driver of density, with warmer waters correlating with higher densities.

Five sea turtle species are known to occur in the Study Area: Loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), and olive ridley (*Lepidochelys olivacea*). All five species occur in the Hawaiian Islands, but only leatherback and green sea turtles are likely to occur regularly in California waters. Loggerhead sea turtles may occur as far north as the PMSR during anomalously warm water conditions (e.g., during a strong El Niño) (Eguchi et al., 2018); however, under normal conditions they would not be expected in waters off California. Hawksbill and olive ridley sea turtles prefer warmer waters south of the Study Area in the eastern Pacific (Eckert, 1993; Eguchi et al., 2007; Mrosovsky, 1980; Polovina et al., 2004).

11.1 *CARETTA CARETTA*, LOGGERHEAD SEA TURTLE

The loggerhead sea 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 sea turtles have adapted to a wide variety of habitats and can be found hundreds of miles offshore, as well as inshore in areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers (Dodd, 1988).

Loggerheads observed in the eastern North Pacific Ocean 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). During their transoceanic migration across the Pacific, from nesting beaches in Japan through the North Pacific Transition Zone to foraging habitats off the BCPM, their distribution is largely unknown; however, loggerheads may occur in offshore waters and the transit corridor between Hawaii and the CAL-BCPM (Bowen et al., 1995; Briscoe et al., 2016a; Briscoe et al., 2016b; Briscoe et al., 2021; Kobayashi et al., 2008). The highest densities of loggerheads are likely coincident with the North Pacific Transition Zone north of the Hawaiian Islands (Briscoe et al., 2021; Polovina et al., 2004; Polovina et al., 2000).

Loggerhead sea turtles have been reported to occur in waters where sea surface temperature ranged between 10 and 28.7°C; however, mean sea surface temperature, which is more indicative of preferred habitat, ranged between 16.3 and 24°C (Eguchi et al., 2018). Below 15°C, loggerheads become lethargic and inactive, and when temperatures fall to 10°C, they become cold-stunned (Mrosovsky, 1980).

HRC. Densities for this species in Hawaii are provided in Section 11.6 (All Sea Turtles Species in the Hawaiian Islands).

CAL-BCPM. Loggerheads are known to forage off the coast of the BCPM and may occur offshore of Southern California during anomalously warm water temperatures. To account for the potential occurrence of loggerhead sea turtles off Southern California, the Navy used density estimates derived by Eguchi et al. (2018) from counts of loggerheads off Southern California during the strong 2015 El Niño event (Table 11-1). The density is only applied during the warmest time of the year, approximated as September – October for modeling purposes. During the remainder of the year, water temperatures are expected to be lower than temperatures preferred by loggerheads, and occurrence is expected to be low, which is consistent with prior surveys of the same area during which no loggerheads were sighted (Eguchi et al., 2018).

Loggerheads nesting south of the Study Area on beaches along the coasts of Mexico and Central and South America are from the South Pacific DPS and are not expected to occur in the Study Area (Rguez-Baron et al., 2020). Seminoff et al. (2014) estimated 43,226 (CV=0.51) loggerheads occurred off the BCPM south of the Study Area and derived a density of 0.650 loggerheads per km^2 for a highly productive feeding area in the Gulf of Ulloa. The surveys, conducted from 2005-2007, took place almost exclusively in September; however, the loggerheads are juveniles and are expected to remain in Gulf of Ulloa for years to decades before returning to nesting beaches in Japan as mature adults (Seminoff et al., 2014). Therefore, the density is considered annual and applies uniformly over the survey area.

Loggerhead sea turtle densities in CAL-BCPM are provided in Table 11-1 and shown in Figure 11-1. Densities in the Gulf of Ulloa are south of the Study Area and are not shown.

Table 11-1: Density Estimates for Loggerhead Sea Turtle Off the CAL-BCPM

Strata	Density (turtles/km^2)			
	September - October	CV	November - August	CV
Southern CA Inshore	0.08	0.35	0	0
Southern CA Offshore	0.24	0.26	0	0
BCPM (South of Study Area)	0.650	0.51	0.650	0.51

Source: Eguchi et al. (2018) and Seminoff et al. (2014)

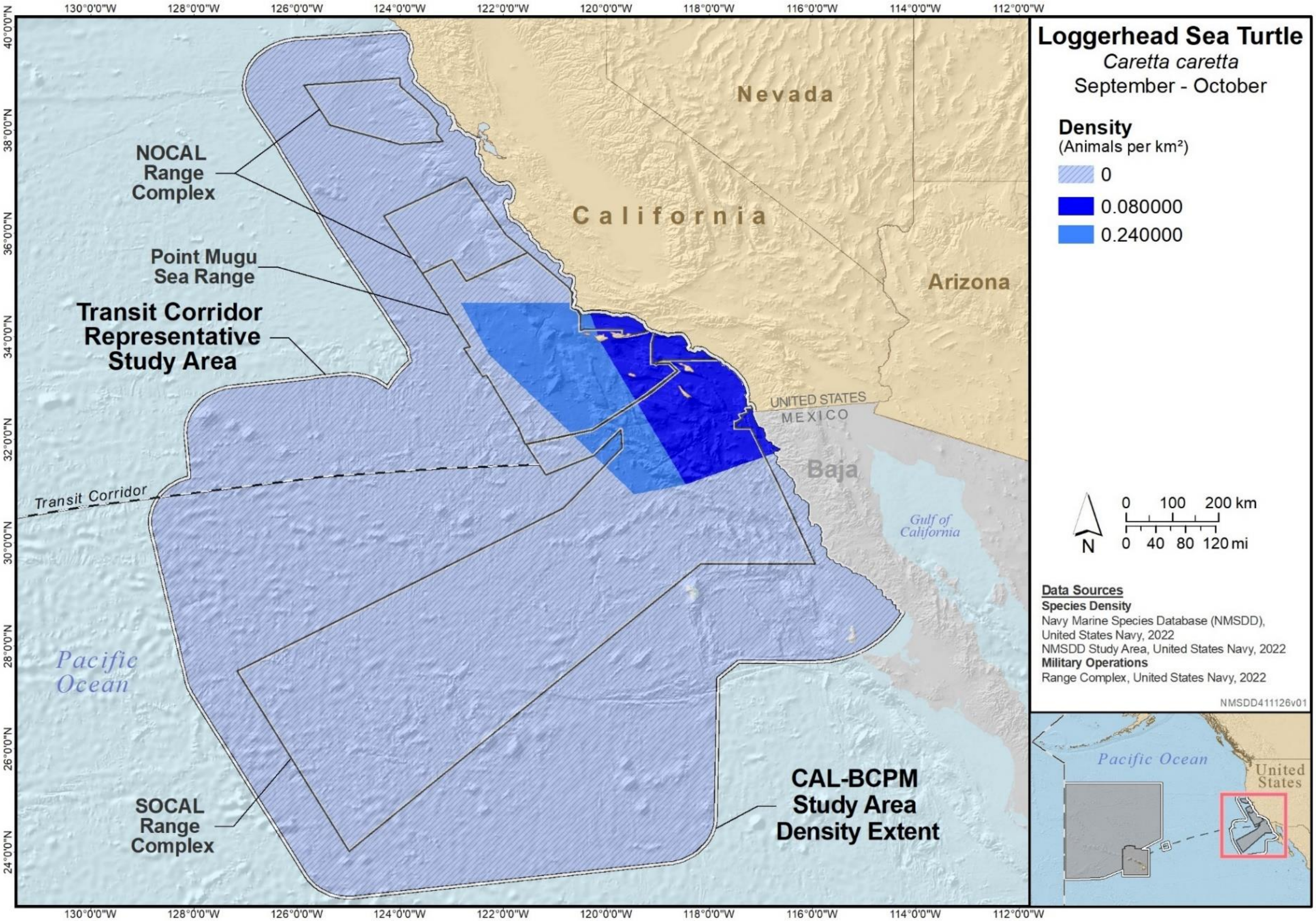

Figure 11-1: Distribution for Loggerhead Sea Turtle During Anomalously Warm Water Conditions (Approximated as September – October for Modeling Purposes)

11.2 *CHELONIA MYDAS*, GREEN SEA TURTLE

Green sea turtles are found in all of the world's oceans, preferring waters in the tropics and subtropics (Ernst et al., 1994; Spotila, 2004). The NMFS and the USFWS have 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. Only green sea turtles from two DPSs, the Central North Pacific DPS or the East Pacific DPS, occur in the Study Area, and both DPSs are listed as threatened under the ESA.

A "resident" group of green sea turtles occurs in San Diego Bay, and smaller groups occur at the mouth of the San Gabriel River and in the Seal Beach National Wildlife Refuge, considered the northernmost distribution off California (Crear et al., 2017; Eguchi et al., 2020; Hanna, 2021). Grean sea turtles primarily feed on sea grasses, which grow in nearshore and inshore coastal habitat (Spotila, 2004).

Green sea turtles are often seen in nearshore waters in the Hawaiian Islands and basking on some beaches (Van Houtan et al., 2015; Whittow & Balazs, 1982). Juvenile and adult 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 sea turtles has been improving, with larger numbers of turtles recorded near the Main Hawaiian Islands and some areas possibly approaching carrying capacity (Chaloupka & Balazs, 2007; Chaloupka et al., 2009).

HRC. Densities for this species in Hawaii are provided in Section 11.6 (All Sea Turtles Species in the Hawaiian Islands).

CAL-BCPM. Green sea turtles are expected to occur mainly in inland coastal estuaries where sea grass beds provide foraging habitat and water temperatures are sufficiently warm to maintain activity (Banerjee et al., 2019; Barraza et al., 2020; Crear et al., 2017; Eguchi et al., 2020; Hanna et al., 2020). Green sea turtles have been tracked using satellite telemetry from the Seal Beach National Wildlife Refuge into nearshore waters of the Southern California Bight (Hanna 2021; Hanna et al. 2021; Hanna et al, 2020) and a resident population separate from the population in San Diego Bay is suspected to be present at Santa Catalina Island (Eguchi & Zickel, 2020). However, available data are insufficient to estimate a density in the Southern California Bight, including in waters around Santa Catalina Island (Eguchi & Zickel, 2020). The northernmost extent of occurrence is the Seal Beach NWR and San Gabriel River where small, isolated populations occur (Banerjee et al., 2019; Crear et al., 2017).

The population of green sea turtles in San Diego Bay is approximately 60 individuals. For the purpose of calculating a density, the Navy assumed that in summer and fall 95 percent of the population occurs in South San Diego Bay and 5 percent occurs in North San Diego Bay. In winter and spring, 100 percent of green sea turtles occur in South San Diego Bay (0 percent in North San Diego Bay). The delineation of South and North San Diego Bay followed Bredvik et al. (2015) and MacDonald et al. (2012).

Eguchi et al. (2020) defined 50 percent and 95 percent utilization distribution areas within South San Diego Bay. To calculate a density for green sea turtles in South San Diego Bay, the Navy, assumed 95 percent of the turtles occurred within the 95 percent utilization distribution area and 5 percent occurred outside of the area but remained within South San Diego Bay. The size of the area used in the density calculation is defined by the 95 percent distribution area from Figure 4 in Eguchi et al. (2020).

In summer and fall, the calculation is:

Density = 60$_{(abundance)}$ x 0.95$_{(percent\ in\ South\ San\ Diego\ Bay)}$ x 0.95$_{(percent\ in\ area)}$ / 5 km^2$_{(size\ of\ area)}$ = 10.830 sea turtles per km^2

Outside of the 95 percent utilization distribution area the calculation is:

Density = 60$_{(abundance)}$ x 0.95$_{(percent\ in\ South\ San\ Diego\ Bay)}$ x 0.05$_{(percent\ in\ area)}$ / 1.37 km^2$_{(size\ of\ area)}$ = 2.0803 sea turtles per km^2

For North San Diego Bay in summer the fall the calculation is:

Density = 60$_{(abundance)}$ x 0.05$_{(percent\ in\ North\ San\ Diego\ Bay)}$ / 35.72 km^2$_{(size\ of\ area)}$ = 0.0840 sea turtles per km^2

In winter and spring, when all 60 green sea turtles are expected to be in South San Diego Bay, the density is calculated as:

Density = 60$_{(abundance)}$ x 1.0$_{(percent\ in\ South\ San\ Diego\ Bay)}$ x 0.95$_{(percent\ in\ area)}$ / 5 km^2$_{(size\ of\ area)}$ = 11.400 sea turtles per km^2

Outside of the 95 percent utilization distribution area the calculation is:

Density = 60$_{(abundance)}$ x 1.0$_{(percent\ in\ South\ San\ Diego\ Bay)}$ x 0.05$_{(percent\ in\ area)}$ / 1.37 km^2$_{(size\ of\ area)}$ = 2.1898 sea turtles per km^2

Seminoff et al. (2014) observed green sea turtles in Ulloa Bay along the BCPM during surveys for loggerhead sea turtles. The authors estimated an abundance and density for loggerheads but not for other species; however, sightings of green sea turtles were estimated to be between 1 and 11 percent of loggerhead sightings. Assuming sightability (i.e., g(0)) is similar (i.e., similar availability bias and dive intervals), then a density for green sea turtles can be approximated as 11% (to be conservative) of the loggerhead density of 0.650 sea turtles per km^2.

Density = 0.650$_{loggerhead\ density}$ x 0.11 = 0.0715 green sea turtles per km^2

Ulloa Bay is located south of the Study Area; however, Tomaszewicz et al. (2018) identified foraging areas north of the bay along the BCPM, and small populations of green sea turtles occur in isolated foraging locations along the California coast from San Diego Bay to the Seal Beach National Wildlife Refuge. Unpublished data from NMFS reported a green sea turtle tagged at the Seal Beach National Wildlife Refuge in California traveled south to Ulloa Bay before returning north and apparently approaching a beach off the BCPM (Seminoff, 2022). Based on the documented occurrence north of Ulloa Bay, the Navy extended the density from Ulloa Bay north to the U.S. – Mexico border using the western extent of the route taken by the tagged sea turtle as the seaward extent of the distribution area (Seminoff, 2022; Seminoff et al., 2014).

Primary nesting beaches used by green sea turtles are located south of the BCPM in Central America where offshore densities would be higher (Rguez-Baron et al., 2020). Density estimates for green sea turtles in CAL-BCPM area provided in Table 11-2 and shown in Figure 11-2. Densities in the Gulf of Ulloa are south of the Study Area and are not shown in Figure 11-2.

Table 11-2: Density Estimates for Green Sea Turtles in CAL-BCPM

Location	Density (Animals/km^2)	
	Winter/Spring	Summer/Fall
Southern California Bight	ID	ID
Santa Catalina Island	ID	ID
San Diego Bay North	0.0000	0.0840
San Diego Bay South (95% Core Range)	11.4000	10.8300
San Diego Bay South (Outside 95% Core Range)	2.1898	2.0803
Baja California Peninsula, Mexico	0.0715	0.0715

ID = Species are known to occur in the area, but data are insufficient to estimate density.

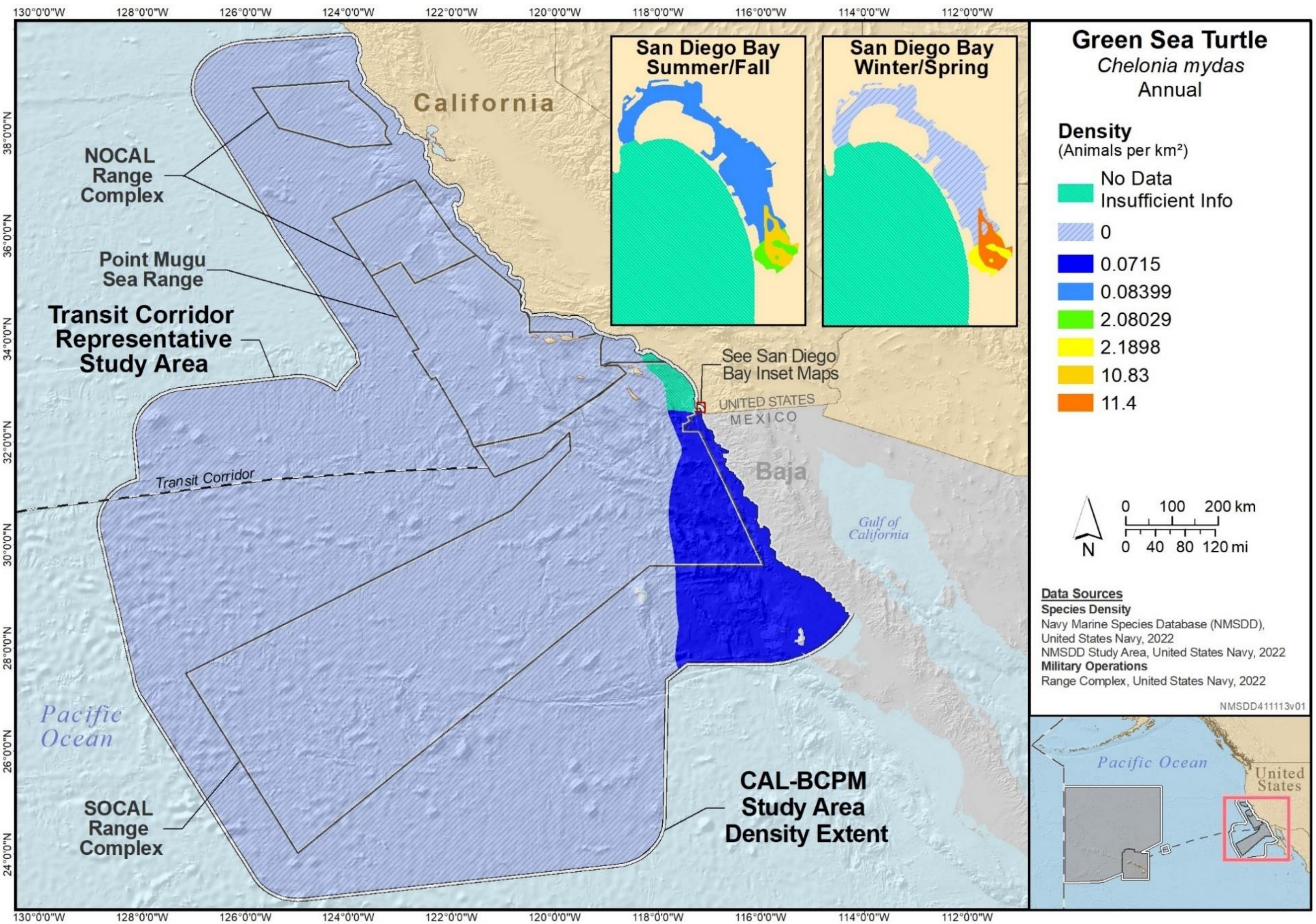

Figure 11-2: Annual Distribution of Green Sea Turtle in CAL-BCPM and the Eastern Portion of the Transit Corridor

11.3 *DERMOCHELYS CORIACEA*, LEATHERBACK SEA TURTLE

The leatherback sea turtle has the most expansive distribution of any adult sea turtle species; it is found from tropical to subpolar oceans ranging from 71° N to 47° south (Eckert, 1995; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2020). The geographic distribution of leatherback nesting locations is limited primarily to tropical and occasionally subtropical beaches, with the majority of major nesting sites located in southeastern Asia (Hebshi et al., 2008; Myers & Hays, 2006; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1992). Leatherback sea turtles do not nest in the Study Area. Leatherbacks are also the most migratory sea turtles, with populations traversing the Pacific, Atlantic, and Indian oceans between nesting and foraging grounds and migratory routes extending into subpolar regions (Bailey et al., 2012; Gaspar & Lalire, 2017; Spotila, 2004). Thermoregulatory adaptations such as a counter-current heat exchange system, high oil content, metabolic rate, and large body size allow leatherbacks to maintain a core body temperature higher than that of the surrounding water, enabling them to tolerate colder water temperatures than other sea turtle species. (Casey et al., 2014; Hughes et al., 1998; James & Mrosovsky, 2004).

Leatherback sea turtles are regularly seen off the west coast of the United States, with the greatest densities found in waters off central California during summer and fall when sea surface temperatures are warmer. 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 (e.g., jellyfish). 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 California Current Ecosystem where leatherbacks come to forage (Benson et al., 2007; Hebshi et al., 2008; Kobayashi et al., 2008). The high energetic cost of transiting the Pacific Ocean to forage off the U.S. West Coast may require leatherbacks to remain on foraging grounds for multiple years before returning to natal nesting beaches to mate and nest (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2020).

Leatherback sea 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 and are not expected to occur in CAL-BCPM (Benson et al., 2011a; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013b).

An aerial survey for leatherback sea turtles conducted in October 2015 in the Southern California Bight did not record any leatherback sightings (Eguchi, 2015); however, the survey occurred during anomalously warm water conditions and did result in an unexpectedly high number of loggerhead sea turtles sightings (Eguchi et al., 2018), suggesting that water temperatures may have been warmer than leatherbacks prefer.

Bailey et al. (2012) combined the tracking data for 135 leatherbacks with data on longline fishing effort to predict “hot spots,” where leatherback sea turtles in the Pacific Ocean are most likely to be at risk of bycatch. The study identified areas of relative high use by leatherback sea turtles that varied seasonally and correlated with likely migratory 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 bycatch is documented off Hawaii, leatherback-stranding events on Hawaiian beaches are rare. From 1982 to 2003, only 5 leatherback strandings were reported in the Hawaiian Islands out of a total of over 3,700 reported for all sea turtle species (Chaloupka et al., 2008). The data presented by Bailey et al. (2012) also support the potential occurrence of leatherback sea 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. Densities for this species in Hawaii are provided in Section 11.6 (All Sea Turtles Species in the Hawaiian Islands).

CAL-BCPM. Density estimates for leatherback sea turtle were derived from data reported by Benson et al. (2020) and in collaboration with NMFS including sharing unpublished data on leatherback density multipliers in neritic waters off California (Benson, 2022). Densities in nearshore waters off California were based on a six-year average of leatherback abundance in the California Current Ecosystem and strata-specific multipliers (Table 11-3). The average abundance from 2013 – 2017 was 65.6, and the survey area used to derive that abundance was 6,842 km^2, resulting in an average density for Central California of 0.00959 turtles per km^2. Using these values, the density for the Big Sur stratum is calculated as:

$$\text{Density} = 0.00959_{(\text{average density})} \times 0.224_{(\text{multiplier})} = 0.002 \text{ leatherback sea turtles / km}^2$$

While research indicates there is seasonal variability in leatherback distribution and occurrence off California (Bailey et al., 2012; Benson, 2022; Benson et al., 2020), the data available for calculating a density along the California coast only allowed for annual density estimates.

Table 11-3: Density Estimates for Leatherback Sea Turtles in CAL-BCPM

Stratum Number	Stratum Name	Average Central California Density (animals/km^2)	Stratum-Specific Multiplier	Stratum-Specific Density (animals/km^2)
14	Big Sur	0.00959	0.224	0.002
15	S. Monterey Bay	0.00959	0.356	0.003
16	N. Monterey Bay	0.00959	0.617	0.006
17	Davenport	0.00959	0.290	0.003
18	Ano Nuevo	0.00959	0.752	0.007
19	Pescadero	0.00959	1.618	0.016
20	Half Moon Bay	0.00959	1.397	0.013
21	Montara	0.00959	1.989	0.019
22	Double Point	0.00959	1.039	0.010
23	Drakes Bay	0.00959	0.586	0.006
24	Pt. Reyes	0.00959	1.621	0.016
25	Bodega Bay	0.00959	0.719	0.007
26	Russian River	0.00959	0.115	0.001
41	Timber Cove	0.00959	0.609	0.006
42	Sea Ranch	0.00959	0.551	0.005
43	Gualala	0.00959	0.284	0.003
44	Pt. Arena	0.00959	0.250	0.002
NA	CA Offshore	0.00959	1.000	0.0096
NA	Baja Offshore	NA	NA	0.001

Source: Densities for numbered strata were derived from Benson et al. (2020). Densities for CA Offshore and Baja Offshore were derived in collaboration with NMFS (Benson, 2022).

Leatherback sea turtle densities in CAL-BCPM are shown in Figure 11-3. The figure shows densities as a range of values instead of a single value to present a wide range of individual densities. However, the strata on each map represent only one density value as presented in Table 11-3.

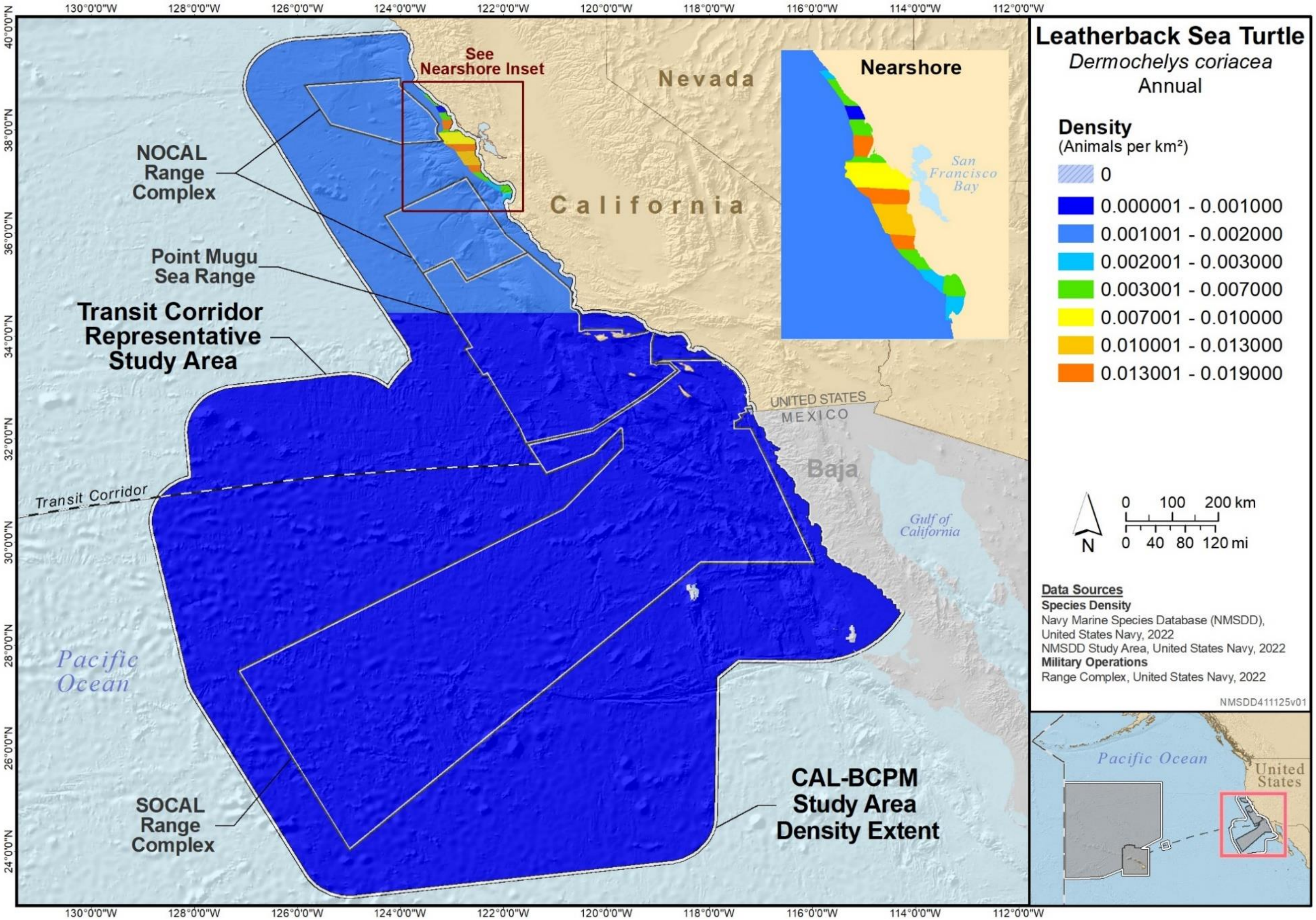

Figure 11-3: Annual Distribution of Leatherback Sea Turtle in CAL-BCPM and the Eastern Portion of the Transit Corridor

11.4 *ERETMOCHELYS IMBRICATA*, HAWKSBILL SEA TURTLE

The hawksbill is the most tropical of the world's sea turtles, rarely occurring above 35° N or below 30° S (Witzell, 1983). While hawksbills are known to occasionally migrate long distances in the open ocean, they are primarily found in coastal habitats and use nearshore areas more exclusively than other sea turtles. Of all sea turtle species, hawksbills are the most dependent on coral reef habitat for prey (Becker et al., 2019).

Hawksbill sea turtles primarily occupy areas where the sea surface temperature is between 23 and 30°C (Gaos, 2011; Storch et al., 2005). Thirteen adult female hawksbills, fitted with satellite tags, spent 91 percent of the time in waters within that temperature range. Three of the tagged hawksbills spent between 6 and 16 percent of their time in cooler waters ranging from 19 to 24°C, and only one hawksbill spent time in colder waters, between 16 and 18°C (Gaos, 2011). Water temperatures in the Study Area, particularly north of Point Conception, are typically much cooler than temperatures preferred or even tolerated by hawksbills. Hawksbills also do not typically range far from nesting sites, which are located mainly off Central and South America (Gaos, 2011).

Fewer than 10 females make up the nesting population on Baja California, Mexico, and no nests have been documented off the U.S. West Coast (Van Houtan et al., 2016). Juveniles and adults primarily inhabit nearshore neritic habitat and occur south of Mexico with limited expansion into marine habitat (Rguez-Baron et al., 2020). In the eastern North Pacific, counts of adult females at nesting sites in Mexico, Costa Rica, Guatemala, El Salvador, Nicaragua, and Ecuador were used to estimate an abundance of about 285 nesters, with declines predicted for all nesting sites (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013a).

Worldwide, hawksbill sea turtles have not shown the same upward population trend seen with green sea 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. Observations of hawksbills have been documented in the Northwestern Hawaiian Islands (Van Houtan et al., 2012), but little survey effort has occurred and data are insufficient to estimate a nearshore density. Strandings and observations of hawksbill sea turtles in Hawaii are uncommon (Chaloupka et al., 2008).

HRC. Densities for this species in Hawaii are provided in Section 11.6 (All Sea Turtles Species in the Hawaiian Islands).

CAL-BCPM. This species is not expected to occur in CAL-BCPM.

11.5 *LEPIDOCHELYS OLIVACEA*, OLIVE RIDLEY SEA TURTLE

The olive ridley sea turtle is known as an open-ocean species, but can be found in coastal areas. Olive ridley sea turtles occur 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). The olive ridley is the most abundant sea turtle in the world, with an at-sea abundance estimate ranging from 1.15 to 1.62 million (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2014). Major arribada beaches on the eastern Pacific Ocean include Nancite and Ostinal in Costa Rica and the Santuario Playa Escobilla in Mexico. The term “arribada” is derived from Spanish and refers to the synchronized large-scale nesting activity demonstrated by olive ridley (and Kemp’s ridley) sea turtles. As many as 500,000 female olive ridley sea turtles arrive at the nesting beaches on La Escobilla and Ostinal over a few days to lay their eggs.

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). 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 sea turtles are not likely to occur in the cooler waters off 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, Oahu in 2009 (Marine Corps Base Hawaii, 2011). The latest olive ridley nest was discovered at Kailua Beach Park on Oahu in 2019 (National Marine Fisheries Service, 2019).

HRC. Densities for this species in Hawaii are provided in Section 11.6 (All Sea Turtles Species in the Hawaiian Islands).

CAL-BCPM. 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), as this species prefers sea surface temperatures warmer than commonly occur off California. Seminoff et al. (2014) sighted olive ridleys in Ulloa Bay, Mexico during surveys for loggerhead sea turtles. The authors estimated an abundance and density for loggerheads but not for other species; however, sightings of olive ridleys were estimated to be between 10 and 34 percent of loggerhead sightings (Note: the paper reports 24 percent in the text, but Table 1 in the paper reports a maximum of 34 percent). Assuming sightability (i.e., g(0)) is similar (i.e., similar availability bias and dive intervals), then a density for olive ridley sea turtles in BCPM but south of the Study Area can be approximated as 34 percent (to be conservative) of the loggerhead density of 0.650 sea turtles per km^2.

$$\text{Density} = 0.650_{\text{loggerhead density}} \times 0.34 = 0.2210 \text{ olive ridleys per km}^2$$

Nesting beaches used by olive ridleys are located south of the BCPM in Central America where offshore densities would be higher (Rguez-Baron et al., 2020). Densities in the Gulf of Ulloa are south of the Study Area and are not shown in a figure in this report.

Table 11-4: Density Estimates for Olive Ridley Sea Turtle Off the CAL-BCPM

Strata	Density (turtles/km^2)	
	September - October	November - August
California	0	0
BCPM (South of Study Area)	0.2210	0.2210

Source: Eguchi et al. (2018) and Seminoff et al. (2014)

11.6 All Sea Turtle Species in the Hawaiian Islands

The Navy conducted aerial marine mammal stranding surveys from 2009–2013 in the Hawaiian Islands as part of a monitoring program and documented incidental sightings of sea turtles (Department of the Navy, Unpublished Data). Because the surveys were intended to identify stranded animals, only nearshore areas were surveyed. The Navy treated the aerial surveys as strip transects (Buckland et al., 2001) with an effective strip width of 2 km. 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 was applied to account for the number of turtles that were present but not observed, due to the turtles being either camouflaged or too deep below the surface to be seen (Buckland et al., 2001). The Navy made a conservative estimate of g(0) = 0.1, 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 with sea turtle sightings are available only for the Islands of Kauai, Lanai, Molokai, and Oahu. Island-specific densities were derived for those four islands, and for the remaining Hawaiian Islands, the mean density of the four islands was used to approximate sea turtle densities in nearshore waters, defined as extending from shore to the 100 m depth contour. This is considered a conservative estimate of the shallow habitat preferred by green sea turtles, because diving data suggest they remain well within the 100 m depth contour (Blumenthal et al., 2010; Brill et al., 1995; Hays et al., 2007). Green sea turtles are the species with highest occurrence in nearshore waters off Hawaii (Becker et al., 2019), so the treatment of the data is biased toward that species. Tag data have shown that green sea turtles move through deep water between islands, but this is considered relatively uncommon and associated with migration to other nearshore foraging sites (Rice & Balazs, 2008). Nevertheless, to address sea turtle occurrence in areas of the Hawaiian Islands beyond the 100 m depth contour, the Navy reduced the mean nearshore density by two orders of magnitude.

The Navy's acoustic impacts analysis requires species-specific density estimates; however, species identification during the aerial surveys was not possible. To derive density estimates for the five sea turtle species, the Navy made assumptions on the likelihood of occurrence based on habitat preferences and observations for the nearshore stratum (extending from shore to the 100 m depth contour) and using bycatch data from the longline fishery beyond the 100 m isobath. The percentages used to calculate species-specific densities from the Navy's general sea turtle densities are shown in Table 11-5 for the nearshore stratum and Table 11-6 for the offshore stratum.

Table 11-5: Percentage of Sea Turtle Species' Occurrence in Nearshore Waters of the Hawaiian Islands

Location	Green	Hawksbill	Loggerhead	Olive Ridley	Leatherback
Nearshore (< 100 m depth contour)	99	0.9.	0	0.10	0
Pearl Harbor	99	1	0	0	0

Table 11-6: Counts of Interactions with the Longline Fishery by Species and Percentages of Sea Turtle Species' Occurrence in Offshore (> 100 m Depth Contour) Waters of the Hawaiian Islands

Sea Turtle Species	Number of Interactions			Estimated Percentage of Density (%)
	Shallow-Set Longline Fishery	Deep-Set Longline Fishery	Total	
Green	8	18	26	**5.36**
Hawksbill[1]	0	0	0	**1.00**
Loggerhead	163	14	177	**36.49**
Olive Ridley	9	162	171	**35.26**
Leatherback	80	31	111	**22.89**

[1]No reported interactions, but estimated 1 percent to include hawksbills in the analysis
% = percent

Applying these ratios to the general sea turtle densities enabled the calculation of species-specific density estimates for nearshore (< 100 m depth contour) and offshore (> 100 m depth contour) waters of the Hawaiian Islands (Table 11-7).

Table 11-7: Species-Specific Sea Turtle Density Estimates in Nearshore and Offshore Waters of the Hawaiian Islands

General Density (sea turtles/km^2)	Location	Species-Specific Density (sea turtles/km^2)				
		Green	Hawksbill	Loggerhead	Olive Ridley	Leatherback
0.27860	Nearshore Kauai	0.27581	0.00251	0.00000	0.00028	0.00000
0.44910	Nearshore Lanai	0.44461	0.00404	0.00000	0.00045	0.00000
0.16240	Nearshore Molokai	0.16078	0.00146	0.00000	0.00016	0.00000
1.12520	Nearshore Oahu	1.11395	0.01013	0.00000	0.00113	0.00000
0.50383	Nearshore Other Islands	0.49879	0.00453	0.00000	0.00050	0.00000
0.00504	Offshore Hawaiian Islands	0.00027	0.00005	0.00184	0.00178	0.00115

km = kilometer

Pearl Harbor. The Navy conducted sea turtle surveys and monitoring in Pearl Harbor, the entrance channel, and portions of the Naval Defensive Sea Area from approximately 2000 – 2011. The resulting data were used to derive density estimates for green and hawksbill sea turtles, the only species observed in the harbor (Department of the Navy, Unpublished Data, previously cited as Hanser et al. (In Prep.).

Sea turtles were not evenly distributed in Pearl Harbor. They tended to congregate along the margins of the channel leading into Pearl Harbor more so than in 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 (June – October). Within Pearl Harbor, the turtles were encountered more frequently in the western loch than in either the eastern or middle lochs.

Species-specific annual sea turtle density distributions in the Main Hawaiian Islands are shown in Figure 11-4 through Figure 11-8. Note that the range of density values shown in the legend of each figure is unique to that figure and that colors on the maps should not be compared across figures. Density distributions for green and hawksbill sea turtles in Pearl Harbor are shown in Figure 11-9 through Figure 11-12 for both the warm and cool seasons.

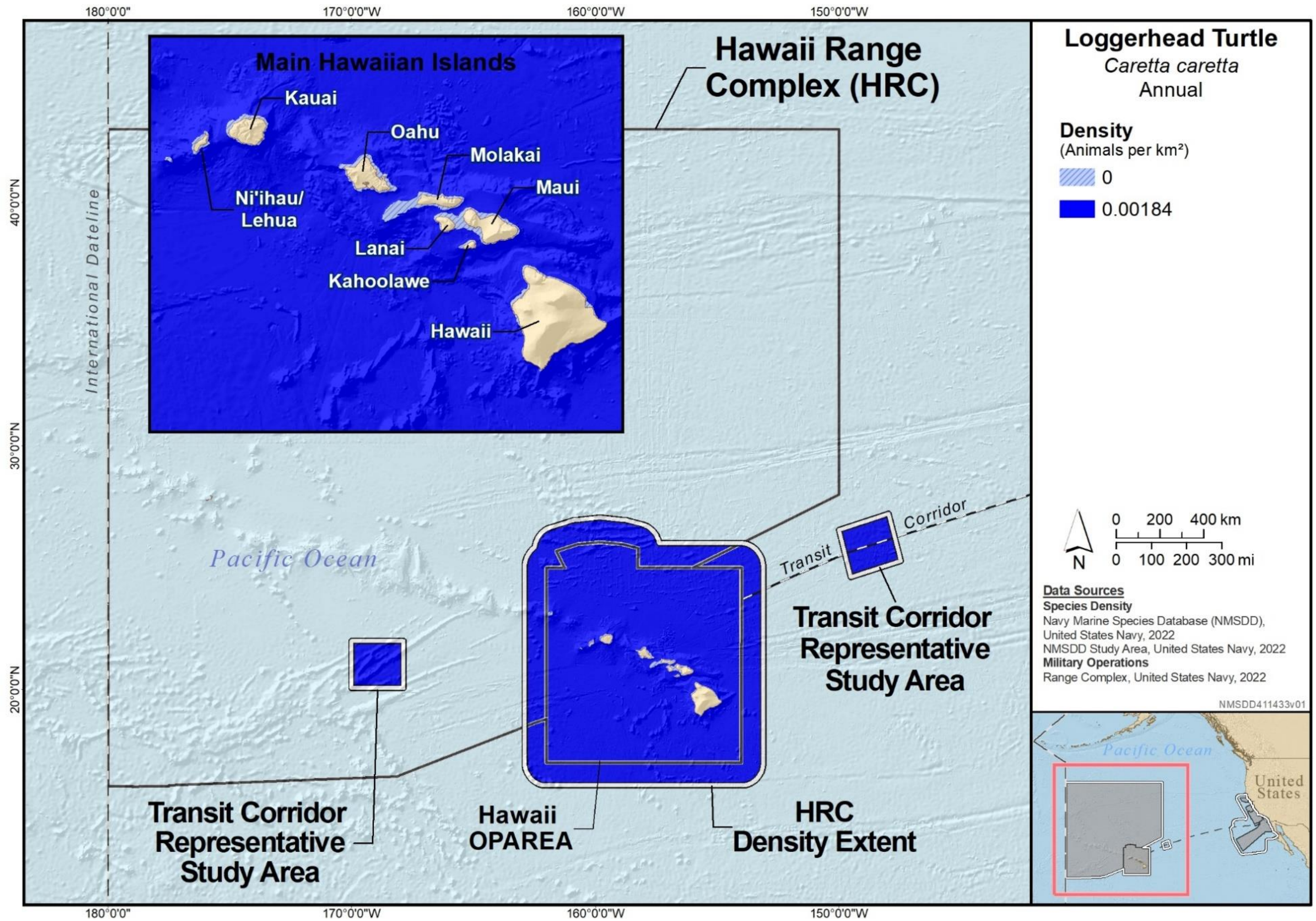

Figure 11-4: Annual Distribution of Loggerhead Sea Turtle in the Main Hawaiian Islands and the Western Portion of the Transit Corridor

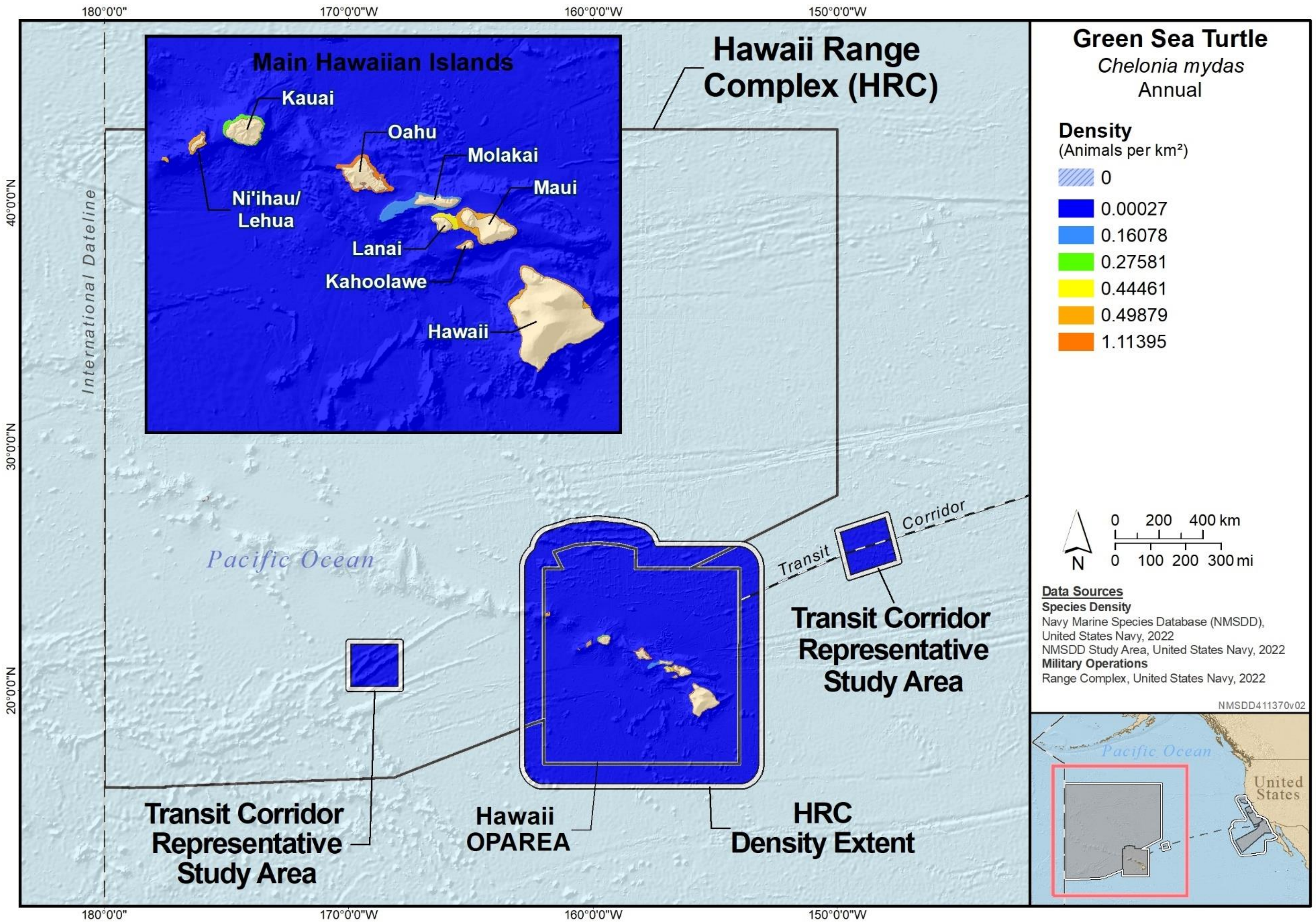

Figure 11-5: Annual Distribution of Green Sea Turtle in the Main Hawaiian Islands and the Western Portion of the Transit Corridor

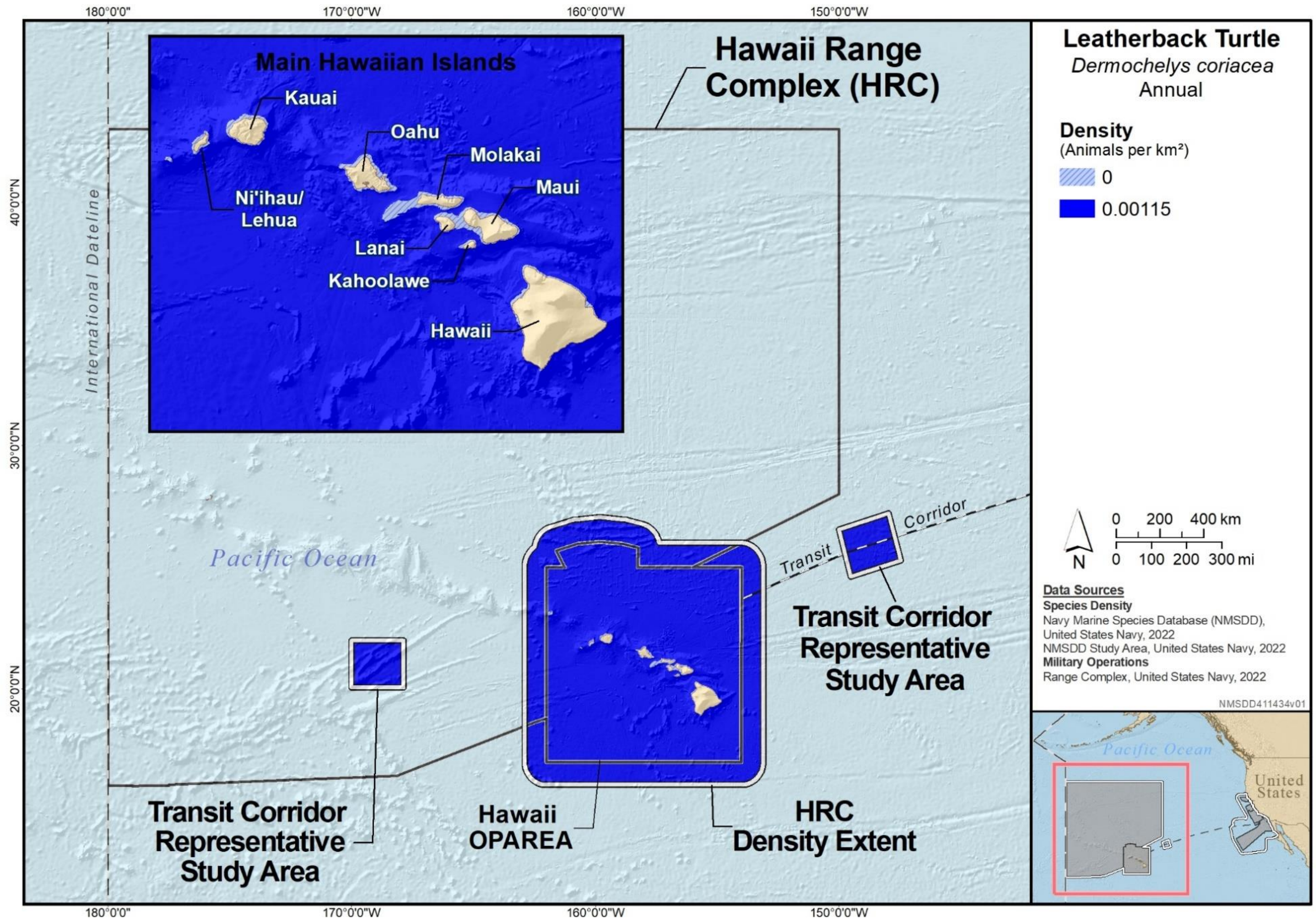

Figure 11-6: Annual Density Distribution of Leatherback Sea Turtle in the Main Hawaiian Islands and the Western Portion of the Transit Corridor

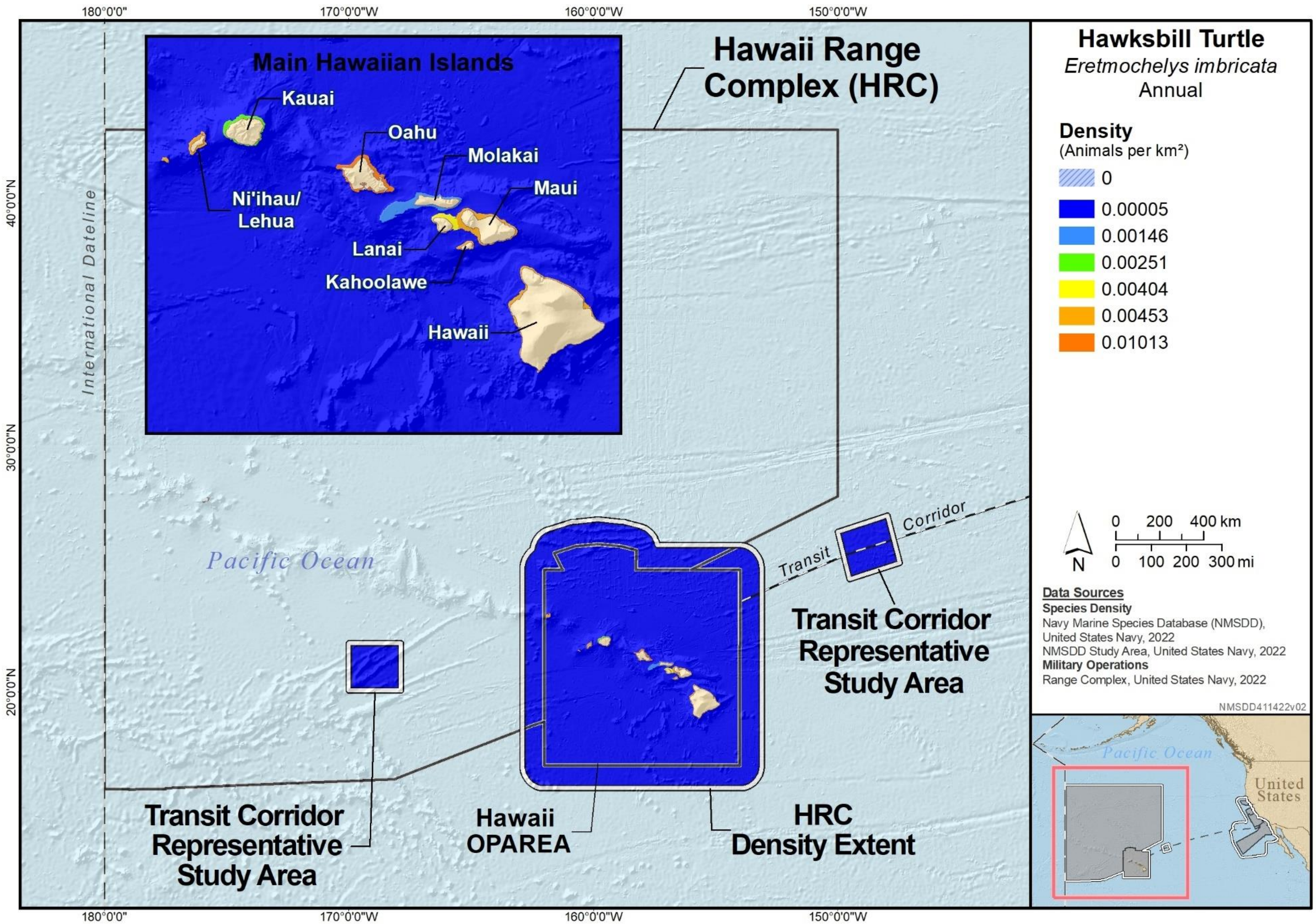

Figure 11-7: Annual Density Distribution of Hawksbill Sea Turtle in the Main Hawaiian Islands and the Western Portion of the Transit Corridor

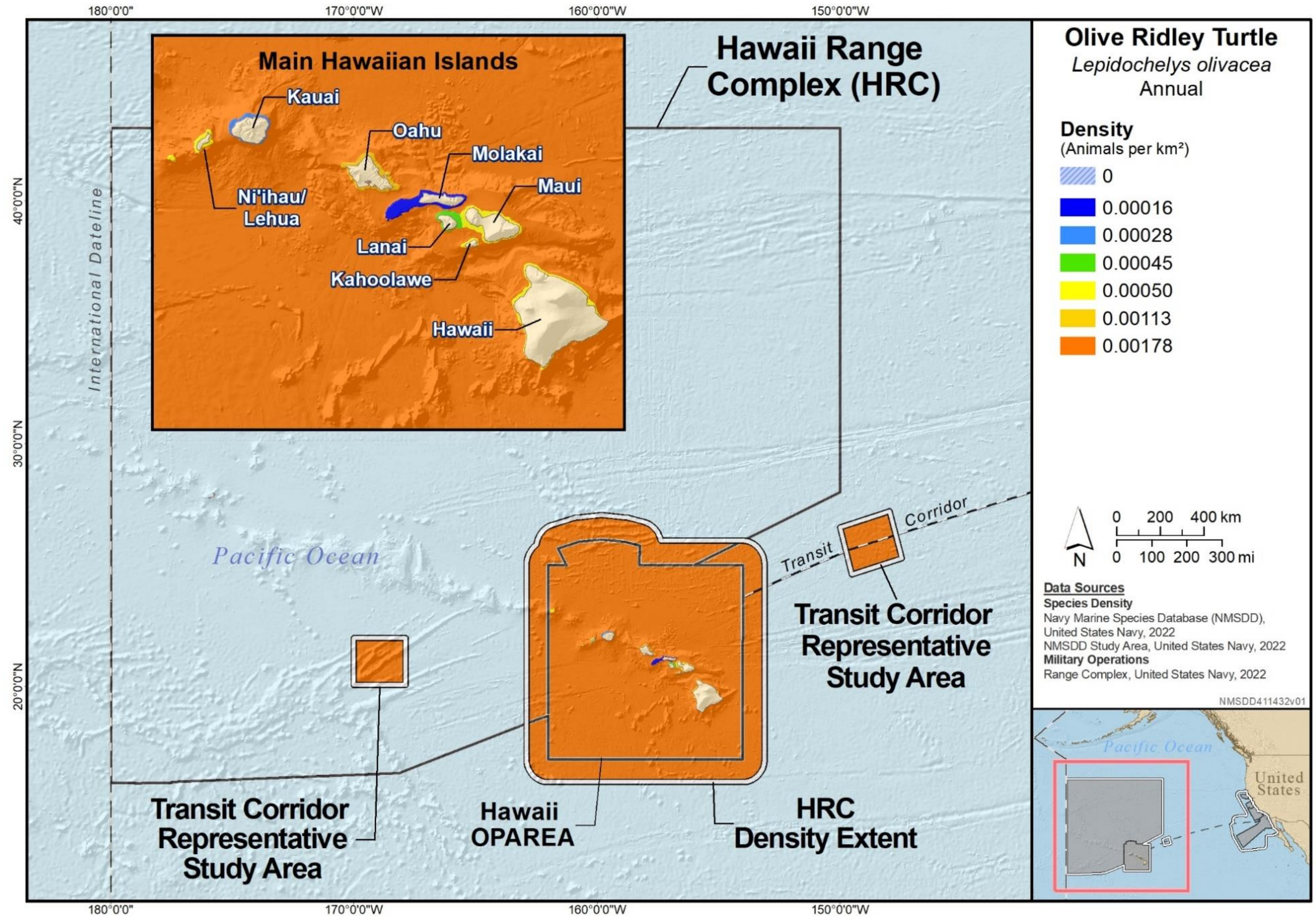

Figure 11-8: Annual Density Distribution of Olive Ridley Sea Turtle in the Main Hawaiian Islands and the Western Portion of the Transit Corridor

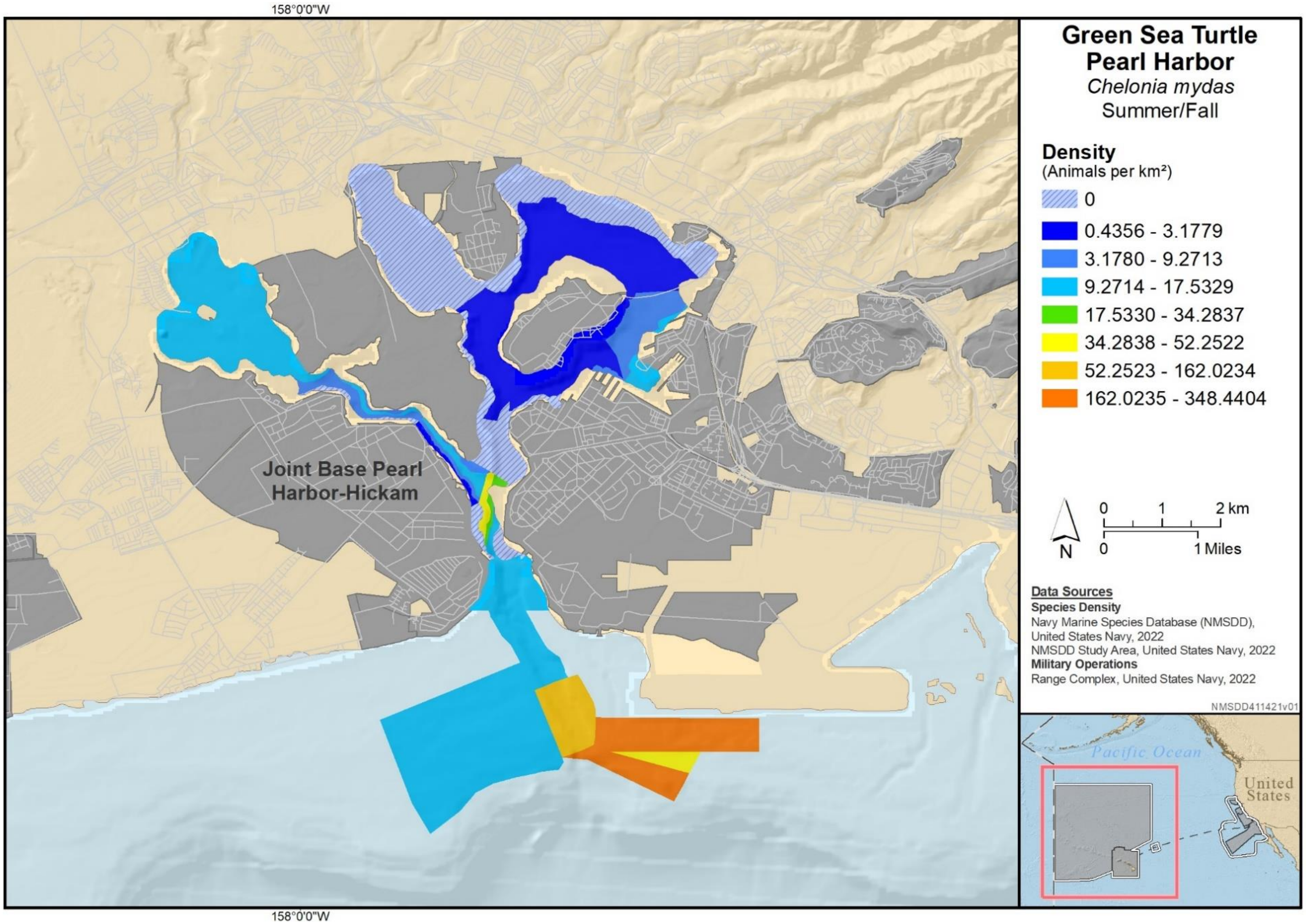

Figure 11-9: Warm Season Distribution of Green Sea Turtle in Pearl Harbor

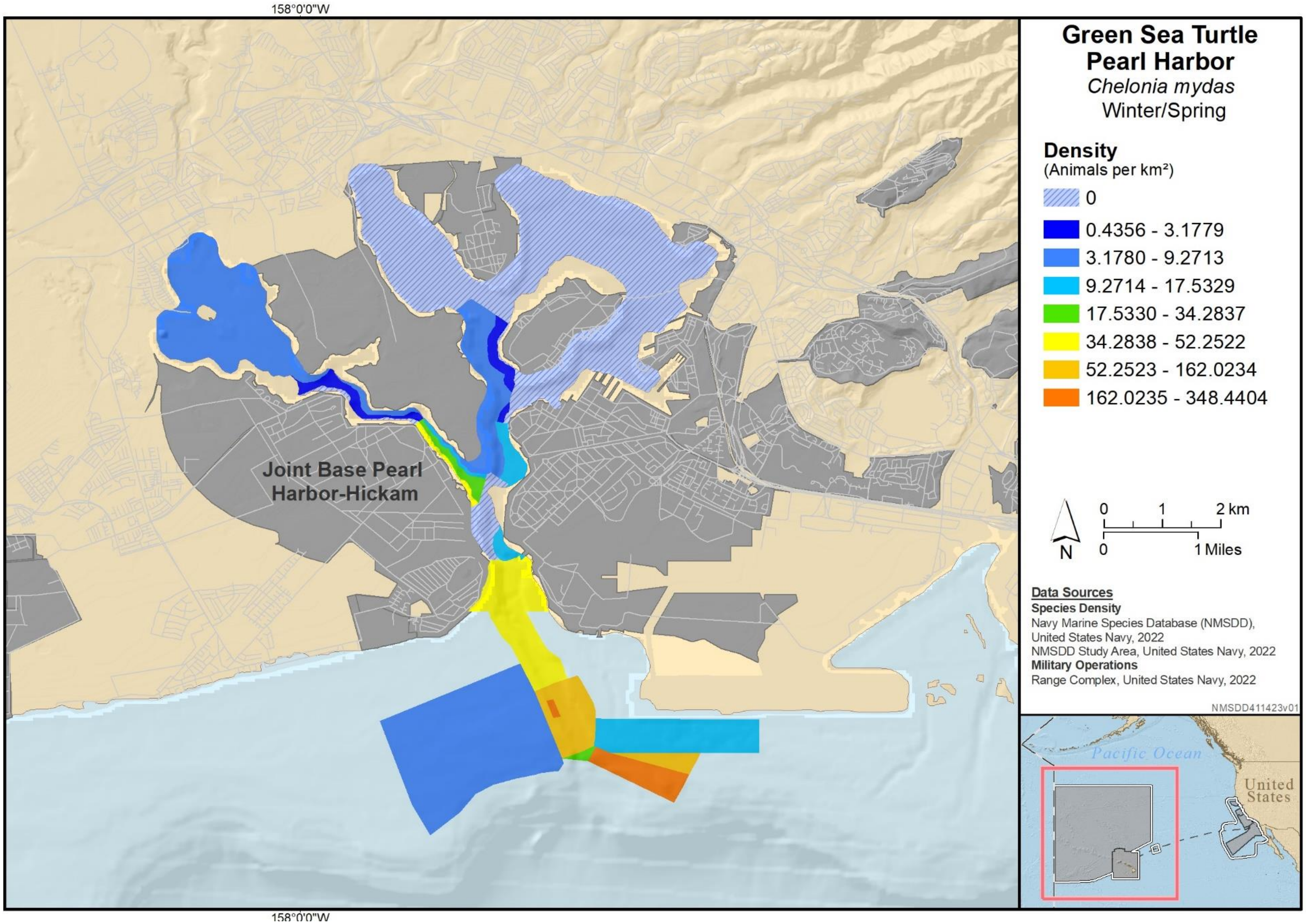

Figure 11-10: Cool Season Distribution of Green Sea Turtle in Pearl Harbor

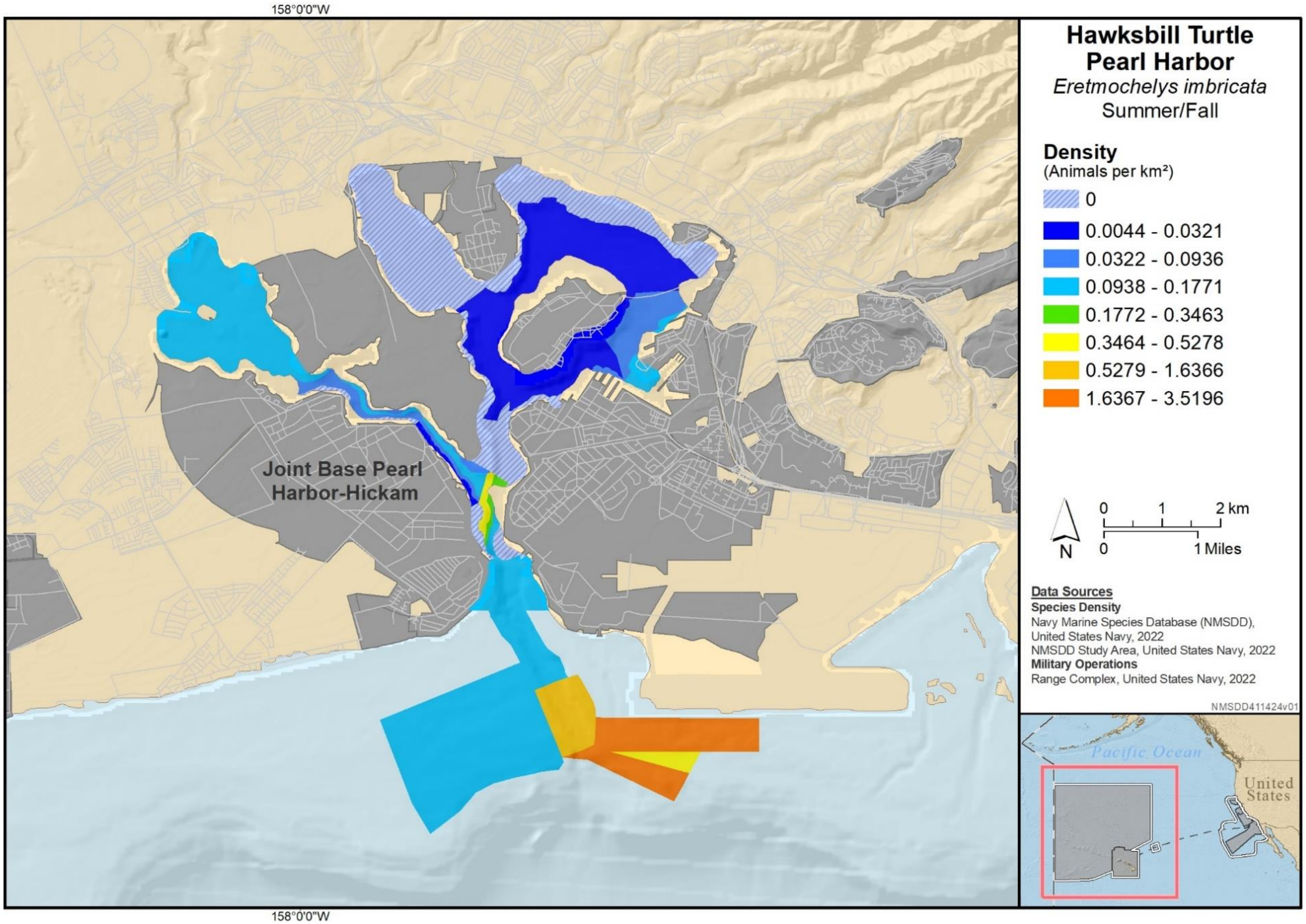

Figure 11-11: Warm Season Distribution of Hawksbill Sea Turtle in Pearl Harbor

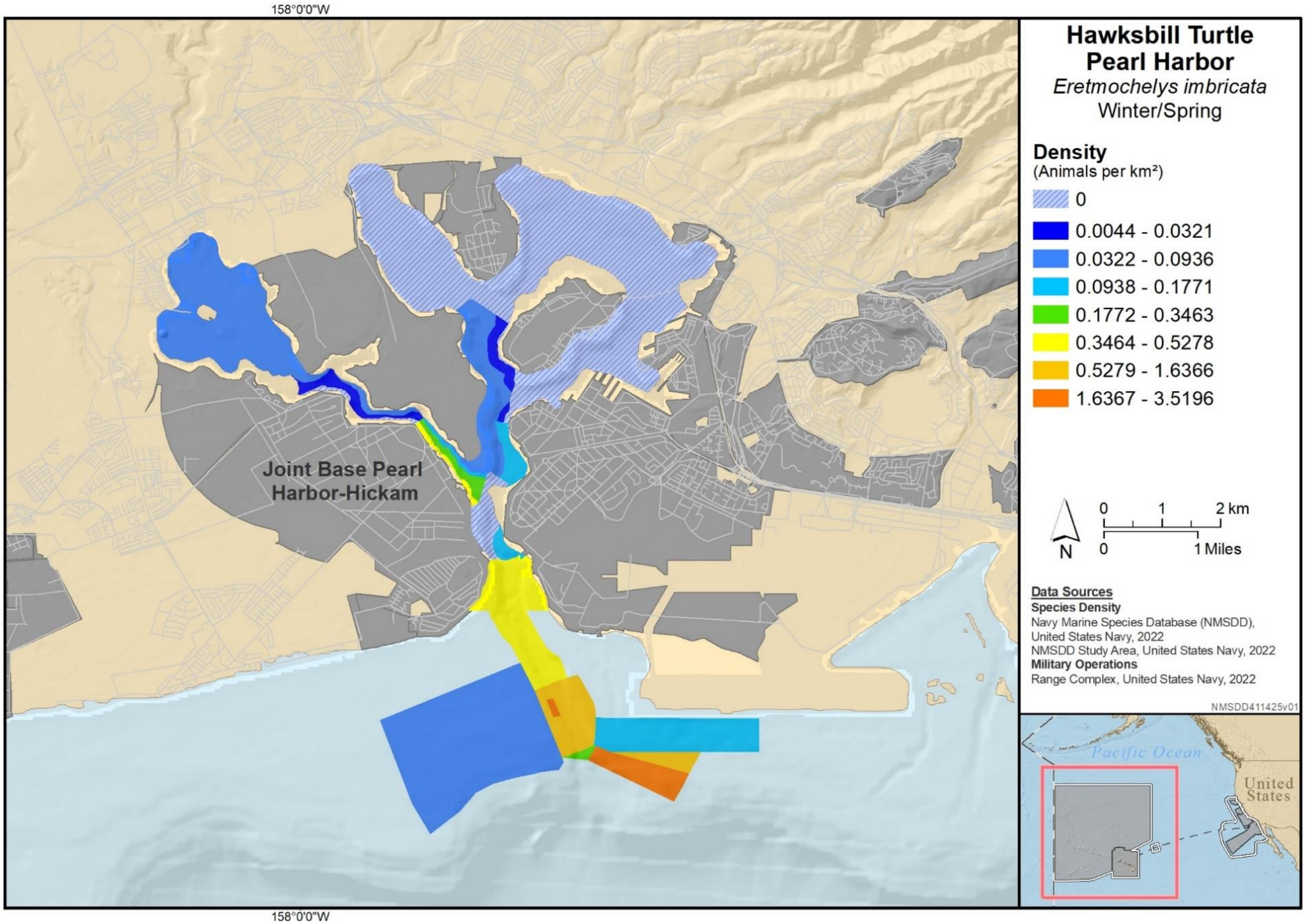

Figure 11-12: Cool Season Distribution of Hawksbill Sea Turtle in Pearl Harbor

12 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 IV sound sources to marine species. These data have been updated since the Navy's Phase III analyses (U.S. Department of the Navy, 2017), 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 goal is to arrive at the most accurate density estimates for every species from the data available at that time. This may be very difficult to achieve for some species, and techniques other than the preferred line-transect sampling to acquire supporting data are necessary. Even when accurate and representative density estimates are achieved, they need to be maintained and updated through regular species 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 the marine species in the Navy's OPAREAs, and to achieve this goal, the Navy has partnered with marine species scientists at NMFS, universities, and other institutions to pool resources, data, and expertise. The main goal of this collaborative effort is to ensure the Navy uses the most robust marine species density estimates to support their environmental planning efforts.

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