U.S. Navy Marine Species Density Database Phase III

for the

Gulf of Alaska Temporary Maritime Activities Area

Final Technical Report

Amended November 2021

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Elizabeth Becker, Mike Zickel, Conrad Erkelens,
ManTech International

Graphics: Ryan Hoopes, Kristina McCowin
ManTech International

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ACRONYMS AND ABBREVIATIONS

C	Celsius
°	degrees
AFSC	Alaska Fisheries Science Center
AOR	Area of Responsibility
CV	Coefficient of Variation
DPS	Distinct Population Segment
EEZ	Exclusive Economic Zone
EO	Executive Order
ESA	Endangered Species Act
GOA	Gulf of Alaska
GOALS	Gulf of Alaska Line Transect Survey
HARPs	High-frequency Acoustic Recording Packages
IWC	International Whaling Commission
km	kilometer(s)
km^2	square kilometer(s)
LME	Large Marine Ecosystem
m	meter(s)
MMPA	Marine Mammal Protection Act
N	North
NA	Not Applicable
Navy	U.S. Department of the Navy
NEPA	National Environmental Policy Act
NM	nautical mile(s)
NMFS	National Marine Fisheries Service
NMSDD	Navy Marine Species Density Database
NOAA	National Ocean and Atmospheric Administration
OPAREA	Operating Area
PCFG	Pacific Coast Feeding Group
RES	Relative Environmental Suitability
S	South
SAR	Stock Assessment Report
SMRU Ltd.	Sea Mammal Research Unit, Limited (at University of St. Andrews)
SWFSC	Southwest Fisheries Science Center
SYSCOMS	System Commands
TAP	Tactical Training Theater Assessment and Planning Program
TMAA	Temporary Maritime Activities Area
U.S.	United States

EXECUTIVE SUMMARY

The purpose of the United States (U.S.) Department of the Navy'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 Navy's Gulf of Alaska Temporary Maritime Activities Area (TMAA), and to provide a summary of species-specific and area-specific density estimates incorporated into the NMSDD. The following discussion summarizes improvements that have been made in the density estimation process for Phase III of the Gulf of Alaska Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement and associated regulatory documentation and analyses. Generally, the availability of systematic survey data and associated analyses, and published abundance and occurrence data have resulted in improvements to previous estimates of species' densities.

Cetaceans. Several new analyses were completed subsequent to the Phase II effort that provided improvements to the Phase III cetacean density estimates. For example, acoustic data collected during the 2013 Navy-funded Gulf of Alaska survey were used to estimate the density of Cuvier's beaked whale for four strata within the TMAA (Yack et al., 2015). Survey data collected from 2010 to 2012 as part of the International Whaling Commission-Pacific Ocean Whale and Ecosystem Research Project allowed for the derivation of a sei whale abundance estimate for the Gulf of Alaska (Hakamada et al., 2017). Further, the analysis of three systematic surveys conducted within the Study Area provided updated estimates of density and/or uncertainty for many cetacean species (Rone et al., 2017). Given the additional data and analyses, these estimates are considered more robust than estimates used for Phase II (Rone et al., 2014).

Pinnipeds. All pinniped density estimates were updated for the Phase III analysis based primarily on the latest published abundance and distribution data. In addition, a meeting was held at the Alaska Fisheries Science Center in Seattle, Washington on October 31, 2019, with scientists who have extensive experience and knowledge of pinniped behavior, distribution, and occurrence in the Gulf of Alaska and North Pacific. As a result of the meeting, recommendations on the best available published and unpublished data were used from multiple sources to derive the best possible density estimates for modeling Navy acoustic impacts. For example, tagging data for Steller sea lions showed that female sea lions traveled no farther than the continental shelf break, remaining over the shelf, during foraging trips. As a result, while density values increased compared with Phase II densities, sea lion distribution was limited to the inshore portion of the TMAA that overlaps with the continental shelf. Similar refinements to the other pinniped density estimates were made for Phase III.

Sea Turtles. Insufficient data exist to estimate a density for leatherback sea turtles at this time. Only leatherback sea turtles possess the physiological adaptations to sustain normal behavior in the cold waters of the Gulf of Alaska. Tagged leatherbacks have been not tracked into the Gulf of Alaska; however, several have migrated into the central North Pacific between 40 and 50° North latitude before their tags stopped recording (Bailey et al., 2012; Benson et al., 2011). Approximately 20[1] sightings of leatherbacks have been recorded in Alaskan waters over the past six decades, with most of these sightings occurring prior to 1983 (Hodge and Wing, 2000; MacDonald, 2003; Cushing et al., 2021), and largely occurring in coastal, shelf-associated waters. The most recent sightings occurred in 2013 (Cushing et al 2021). Prior to 2013, the last confirmed sighting of a leatherback in Alaskan waters was in 1993 (Hodge and Wing, 2000).

Elimination of Data Sources Low in the Data Quality Hierarchy. Given recently derived density estimates, the Navy was able to eliminate the use of all Level 4–5 data sources (i.e., the least preferred sources of density data). Given the uncertainty associated with predictions from relative environmental suitability models, and the sometimes orders-of-magnitude difference in relative environmental suitability estimates as compared to validated estimates derived from years of survey data (U.S. Department of the Navy, 2015), this represents a substantial improvement to the Phase III NMSDD.

[1] 19 reported in (Hodge & Wing, 2000), plus one additional sighting in 2013 reported in (Cushing et al., 2021). Sightings recorded in 1963, 1978, 1979, 1983, 1984, 1990, 1993, and 2013. Navy confirmed that there have been no sightings of leatherbacks since the 2013 report through email correspondence with multiple NMFS biologists: Kate Savage, Barbra Mahoney, and Mandy Keogh, dated March 8, 2021.

1 BACKGROUND

To ensure compliance with United States (U.S.) regulations, including the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), the National Environmental Policy Act (NEPA), and Executive Order (EO) 12114 (Environmental Effects Abroad of Major Federal Actions), the U.S. Department of the Navy (Navy) takes responsibility for reviewing and evaluating the potential environmental impacts of conducting at-sea training and testing. All marine mammals in the United States are protected under the MMPA, and some species receive additional protection under the ESA. As stipulated by the MMPA and ESA, information on the species and numbers of protected marine species is required in order to estimate the number of animals that might be affected by a specific activity. The Navy performs quantitative analyses to estimate the number of marine mammals and sea turtles that could be affected by at-sea training and testing activities. A key element of this quantitative impact analysis is knowledge of the abundance and concentration (density) of the species in specific areas where those activities may occur. The most appropriate metric for this type of analysis is density, which is the number of animals present per unit area. This report includes a description of the currently available density data used in the “Phase III” quantitative impact analysis for each marine mammal and sea turtle species present in the Navy’s Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA) Study Area (GOA TMAA Study Area). Phase III is the third implementation of the Navy’s Tactical Training Theater Assessment and Planning Program (TAP). TAP is a comprehensive, integrated process to preserve access to and use of Navy training ranges, testing ranges, and operating areas (OPAREAs) by addressing encroachment and environmental compliance issues. In addition to preserving access and use of ranges, TAP’s purpose is to comply thoroughly with environmental laws.

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

A significant amount of effort is required to collect and analyze survey data in order to produce a marine species density estimate. Unlike surveys for terrestrial wildlife, many marine species spend much of their time submerged, making visual observation difficult or impossible. Therefore, the computed density of marine species must also take into account an estimate of the number of animals likely to be present but not observed, as compared to the animals that are actually spotted on these surveys. The uncertainty of such estimates decreases with an increasing number of observations. In order to collect enough sighting data to make reasonable density estimates, multiple observations are required, often in areas that are not easily accessible (e.g., far offshore). National Marine Fisheries Service (NMFS) is the primary agency responsible for estimating marine mammal and sea turtle density within the U.S. Exclusive Economic Zone (EEZ). Other independent researchers, however, often publish density data or data that can be used to calculate densities for key species in specific areas of interest.

For most cetacean species, abundance is estimated using line-transect surveys or mark-recapture studies (e.g., Barlow, 2010; Barlow & Forney, 2007; Calambokidis et al., 2008). These methods usually produce a single value for density that is an averaged estimate across very large geographical areas, such as waters within the U.S. EEZ off California, Oregon, and Washington (referred to as a "uniform" density estimate). This is the general approach applied in estimating cetacean abundance in the NMFS stock assessment reports. The disadvantage of these methods is that they do not provide information on varied concentrations of species in sub-regions of very large areas, and do not estimate density for other seasons or timeframes that were not surveyed. More recently, a newer method called spatial habitat modeling has been used to estimate cetacean densities that address some of these shortcomings (e.g., Barlow et al., 2009; Becker et al., 2020; 2012; Becker et al., 2010; Becker et al., 2016; 2014; Ferguson et al., 2006; 2015; Forney et al., 2012; Redfern et al., 2006). (Note that spatial habitat models are also referred to as "species distribution models" or "habitat-based density models.") These models estimate density as a continuous function of habitat variables (e.g., sea surface temperature, seafloor depth) and thus, within the study area that was modeled, densities can be predicted at all locations where these habitat variables can be measured or estimated. Spatial habitat models therefore allow estimates of cetacean densities on finer scales than traditional line-transect or mark-recapture analyses. Regardless of the approach used to estimate density, there is a continual need for systematic sampling in order to improve existing density estimates and to account for changes in abundance due to both true changes in population size and distribution shifts resulting from variability in habitat conditions.

Uncertainty in published density estimates is typically large because of the low number of sightings available for their derivation. Uncertainty is typically expressed by the coefficient of variation (CV) of the estimate, which is derived using standard statistical methods and describes the amount of variation with respect to the population mean. It is expressed as a fraction, or sometimes a percentage, and can range upward from zero, indicating no uncertainty, to high values. When the CV exceeds 1.0, the estimate is very uncertain. For example, a CV of 0.85 would indicate high uncertainty in the population estimate. The CV does not capture the full extent of uncertainty in an estimate. For example, since cetacean distributions often shift in response to oceanic variability (Becker et al., 2018), the uncertainty associated with movements of animals into or out of an area due to changing environmental conditions is much larger than is indicated by the CV.

The methods used to estimate pinniped at-sea densities are typically different than those used for cetaceans, because pinnipeds are not limited to the water and spend a significant amount of time on land (e.g., at rookeries). Pinniped abundance is generally estimated via shore counts of animals on land at known haulout sites or by counting number of pups weaned at rookeries and applying a correction factor to estimate the abundance of the population (for example Harvey et al., 1990; Jeffries et al., 2003; Lowry, 2002; Sepulveda et al., 2009). Estimating in-water densities from land-based counts is difficult given the variability in foraging ranges, migration, and haulout behavior between species and within each species, and is driven by factors such as age class, sex class, breeding cycles, and seasonal variation. Data such as age class, sex class, and seasonal variation are often used in conjunction with abundance estimates from known haulout sites to assign an in-water abundance estimate for a given area. The total abundance divided by the area of the region provides a representative in-water density estimate for each species in a different location, which enables analyses of in-water stressors resulting from at-sea

Navy testing or training activities. In addition to using shore counts to estimate pinniped density, traditional line-transect derived estimates are also used, particularly in open ocean areas.

Ideally, density data would be available for all species throughout the study area year round in order to best estimate the impacts of Navy activities on marine species. However, in many places, inclement weather conditions and high sea states prevent the completion of comprehensive year-round surveys. Even with surveys that are completed, poor conditions may result in lower sighting rates for species that would typically be sighted with greater frequency under favorable conditions. Lower sighting rates preclude having an acceptably low uncertainty in the density estimates. A high level of uncertainty, indicating a low level of confidence in the density estimate, is typical for species that are rare or difficult to sight. In areas where survey data are limited or non-existent, known, or inferred associations between marine habitat features and (the likelihood of) the presence of specific species are sometimes used to predict densities in the absence of actual animal sightings. Consequently, there is no single source of density data for every area, species, and season because of the fiscal costs, resources, and effort involved in providing enough survey coverage. The amount of effort required to collect and analyze data to estimate the densities for all protected marine species for the Navy's study areas is beyond the scope of any single organization or beyond any feasible means for the Navy. Therefore, to characterize marine species density for large oceanic regions, the Navy needed to review, critically assess, and prioritize existing density estimates from multiple sources, requiring the development of a systematic method for selecting the most appropriate density estimate for each combination of species, area, and season. The resulting compilation and structure of the selected marine species density data resulted in the Navy Marine Species Density Database (NMSDD).

Uncertainty, as used in this report, is an indication of variation in an estimate that is unique to each data source and is dependent on how the values were derived. Each source of data may use different methods to estimate density, of which uncertainty in the estimate can be directly related to the method applied. As noted above, uncertainty in published density estimates is typically large because of the low number of sightings collected during large survey efforts. Uncertainty characterization is an important consideration in marine mammal density estimation, and some methods inherently result in greater uncertainty than others. Therefore, in selecting the best density estimate for a species, area, and time, it is important to select the data source that used a method that provides the most certainty for the geographic area. Uncertainty is incorporated into the density estimates for most species; for those estimates that do not incorporate uncertainty, an appropriate measure of uncertainty was not available.

Chapter 2 (Navy Marine Species Density Database Protocol) of this report provides a summary of the protocol that the Navy developed to describe how the data sources compare to each other and to provide guidance on the most appropriate source to use for the specific area. These data are compiled by the Fleets and Systems Commands and are incorporated into Navy environmental compliance documents. The Navy completed the first NMSDD and published a final report describing the density data used in the "Phase II" quantitative impact analysis for each marine mammal and sea turtle species present in the Navy's Pacific 3rd and 7th Fleet's Area of Responsibility (AOR) (U.S. Department of the Navy, 2015). The Pacific Fleet Study Areas addressed in the 2015 report included the Hawaii-Southern California Training and Testing Study Area, the Mariana Islands Training and Testing Study Area, the

Northwest Training and Testing Study Area, and the GOA TMAA Study Area. For the "Phase III" analyses, each of these four study areas is addressed in a separate technical report. This technical report provides further details on Navy protocol and how it was implemented for each marine mammal and sea turtle species present in the Navy's GOA TMAA Study Area. A glossary of frequently used terms is provided in Appendix B (GLOSSARY OF TERMS) to assist the reader with understanding the density derivation process described in this report.

2 NAVY MARINE SPECIES DENSITY DATABASE PROTOCOL

2.1 *Density Estimation Methods and Relative Uncertainty*

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

Marine species density is the number of individuals that are present per unit area, typically per square kilometer (km^2). Density estimation of marine species, in particular marine mammals and sea turtles, is very difficult because of the large amount of survey effort required, often spanning multiple years, and the resulting low number of observed sightings. "Distance sampling" describes methods that are used to estimate the density or abundance of biological populations given the assumption that many of the target species are not detected during surveys (Buckland et al., 2001). The most common type of distance sampling is line-transect sampling, which characterizes the probability of visually detecting an animal or group of animals from a survey transect line to quantify and estimate the number of individuals missed. The result generally provides one single average density estimate for each species for the entire survey coverage extent, and usually is constrained to a specific timeframe or season. The estimate does not provide information on the species distribution or concentrations within that area, and does not estimate density for other timeframes/seasons that were not surveyed.

To quantify how species density varies geographically requires stratifying survey effort into smaller sub-regions during the density estimation process. Several methods can be applied to accomplish this, and each will affect the uncertainty in the estimate differently. Three commonly used methods of density estimation using direct survey sighting data and distance sampling theory are considered here: (1) designed-based, (2) stratified-designed based, and (3) spatial models. Another suite of models, Relative Environmental Suitability (RES) models (also known as Environmental Envelope or Habitat Suitability Index models), uses known or inferred habitat associations to predict densities, typically in areas where direct survey sighting data are limited or non-existent. In some cases, extrapolation from neighboring regional density estimates or population/stock assessments into areas with no density estimates is appropriate based on expert opinion. In many cases, this may be preferred over using RES models because of discrepancies identified by local expert knowledge, and result in more certainty in the extrapolated estimates. This includes an extrapolation of no occurrence based on other sources of data, such as the NMFS stock assessment reports or expert judgment. Following is a short summary of each of the density estimation methods.

2.1.1 Designed-Based Density Estimate

Designed-based density estimation uses line-transect survey data and usually involves distance sampling theory (Buckland et al., 2001) to estimate density for the entire survey extent. Systematic line-transect surveys can be conducted from both ships and aircraft; however, the time period available for sighting an animal is much shorter for aerial surveys as compared to ship surveys, and therefore more aerial survey effort may be required in order to obtain enough sightings to estimate densities. Conversely, aerial surveys can cover a much larger area in a shorter period of time than ship surveys. Line-transect methods can also rely on passive acoustic detections of animals typically obtained from a towed hydrophone during a concurrent visual survey (e.g., Barlow & Taylor, 2005). Line-transect surveys are typically designed from the ground up with intent to survey and estimate density for a specific geographic area, hence the term "designed-based." This is the method of abundance estimation typically used for the NMFS marine mammal stock assessment reports. Values in the literature may be reported as abundance for the survey area, for which a density estimate can be inferred if the area is specified.

2.1.2 Stratified Designed-Based Density Estimate

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

2.1.3 Spatial Models

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

2.1.4 Density Based on Relative Environmental Suitability Models

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

Two recognized methods and sources of density estimation for marine mammals were considered here: the Kastner et al. (2006) global density estimates and the Sea Mammal Research Unit, Limited at University of St. Andrews (SMRU Ltd.) global density estimates (Sea Mammal Research Unit [SMRU] Ltd., 2012). Predictions from the SMRU Ltd. model are preferred over the Kaschner et al. model because the SMRU Ltd. version used separately derived population abundance estimates to constrain the global density estimates from the RES model. Given that uncertainty is very high, and results can substantially diverge from adjacent empirically based results (or don't correspond to densities measured from surveyed areas), this method of density estimation is the least preferred type of data source.

2.2 Overarching Data Source Selection and Implementation Guidelines

Ideally, marine species sighting data would be collected for the specific area and time period of interest and density estimates derived accordingly. However, as mentioned above, density data are not available for every species and season necessary for Navy impact analyses because of the fiscal costs, resources, and effort involved providing enough survey coverage to sufficiently estimate density. Therefore, depending on the region, species, and season of interest, there may be little to no density data available or multiple estimates derived from different methods. For example, relative to many other areas of the world's oceans, waters off the U.S. West Coast have been surveyed extensively for the purpose of estimating cetacean abundance; both stratified designed-based (e.g., Barlow & Forney, 2007) and density spatial models (e.g. Forney et al., 2012) are available for many of these species. Some of these surveyed areas overlap with Navy OPAREAs; however, very little survey data are available for other regions that encompass the Navy's AOR, and for these cases, density estimates from adjoining areas need to be used, thus inherently including a high degree of uncertainty.

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

All density estimates are subject to a level of uncertainty. Further, many of the sources of uncertainty and the data themselves are not independent, which complicates standard analytical methods for estimating variance. Density estimates and predictions from ecological models should always be considered an approximation to truth (Burnham & Anderson, 1998). Each model is limited to the variables and assumptions considered by the original data source provider. No mathematical model representation of any biological population is perfect, and with regards to marine mammal biodiversity, any single model will not completely explain the results.

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

2.2.1 Hierarchal Approach for Ranking Density Estimates

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

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

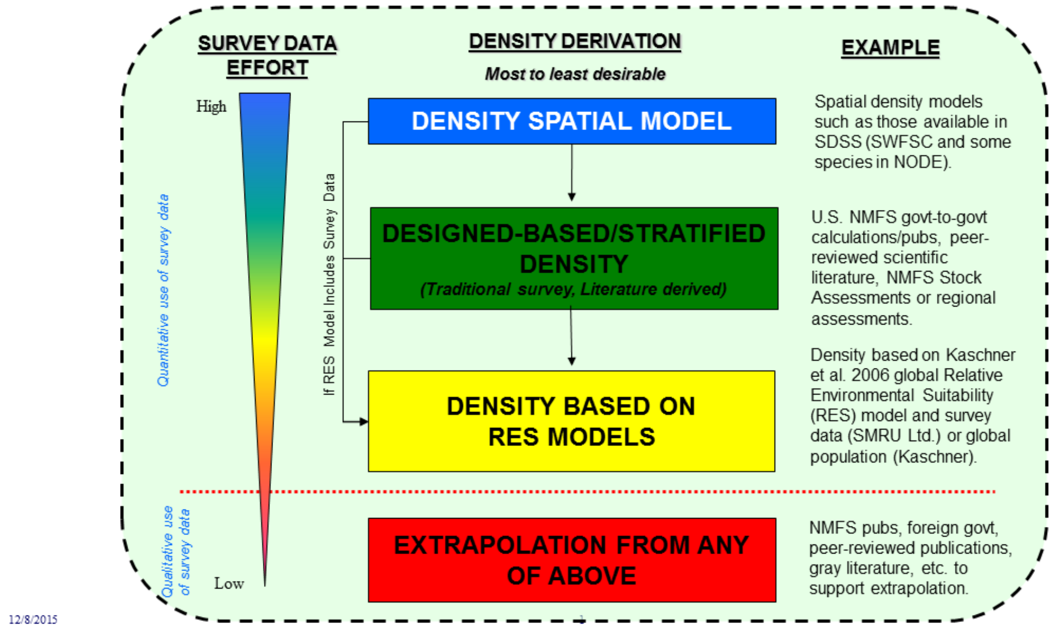
B. If no density spatial model-based estimates were available, the following were used in order of preference:

    1. Density estimates using designed-based methods incorporating line-transect survey data and involving spatial stratification (i.e., estimates split by depth strata or arbitrary survey sub-regions). Although stratified designed-based estimates typically have higher uncertainty due to fewer sightings available for the smaller strata, geographically stratified density estimates provide a better indication of a species' distribution within the study area.

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

    3. Density estimates derived using a RES model from SMRU Ltd. (2012) or Kaschner et al. (2006). These are the least preferred sources of density data given their very coarse spatial resolution (global estimates) and high uncertainty. Based on the Navy's hierarchical approach, these data should be used only when other sources of density data are not available.

C. As mentioned in Section 2.1 (Density Estimation Methods and Relative Uncertainty), in some cases extrapolation from neighboring regional density estimates or population/stock assessments into areas with no density estimates is appropriate based on expert opinion.



2.2.2 Navy Marine Species Density Database Density Data Compilation and Integration

In an effort to coordinate across the Navy's OPAREAs and establish a consistent approach to select the best available density estimates, data for each species are compiled for each specific area by season using the hierarchical approach outlined in Section 2.2.1 (Hierarchal Approach for Ranking Density Estimates) as a guideline for selection.

If species-specific density data are not available, the density value of a surrogate species or season can be used as a proxy value. A surrogate species is a species with similar morphology, behavior, and habitat preferences. A surrogate season is a season that best represents the expected distribution and density for that species.

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

2.2.3 Methods for Seasonal Designation

Seasons are defined by the available data and the minimum number of timeframes that characterize the species distribution over one year. The number of timeframe designations could vary based on the detail of the available data. For example, timeframes could be designated by the traditional four seasons (spring, summer, winter, and fall), warm and cold seasons (exact timeframes are regionally dependent; also referred to as a "Mediterranean climate"), breeding and feeding seasons (species dependent), or monthly or smaller increments.

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

The ultimate result is a series of data files that contain spatially and temporally explicit density estimates that span the species' expected distribution for the entire year. The number of density data files for a given species is defined by the data region of greatest detail (i.e., the greatest number of seasonal timeframe designations) and may result in geographic partitioning and multiple density data files for a single species if seasonal definitions differ for oceanic areas. Since Navy activities in the GOA TMAA Study Area are limited to the April–October time frame, density estimates incorporated into the NMSDD are representative only of this period.

2.2.4 File Format and Management

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

The file format and structure standards are managed by the Naval Undersea Warfare Center (Newport, Rhode Island) modeling team in collaboration with Naval Facilities Engineering Command, Atlantic. By keeping the data in the same file format, new data can easily be added to future iterations of the species density data files.

Uncertainty is characterized in different ways by the original density data provider, and these estimates are preserved in the file format for use in the Navy's effects modeling (Appendix C, METADATA DICTIONARY, provides a list of the metadata fields currently in use for uncertainty values; additional fields other than the ones listed can be used to incorporate uncertainty values).

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

The following sections describe the GOA TMAA Study Area and sources of density data that have been compiled and incorporated into the NMSDD Phase III. A summary of the improvements that have been made to the NMSDD from Phase II to Phase III is provided in the Executive Summary, and changes in species' densities from Phase II to Phase III are shown in Appendix A (Changes in Marine Species Density Estimates Between Phase II and Phase III).

3.1 GULF OF ALASKA TEMPORARY MARITIME ACTIVITIES AREA STUDY AREA

The GOA TMAA Study Area is composed of surface and subsurface ocean training areas and overlying airspace that includes the majority of Warning Area 612 (W-612) (Figure 3-1). The TMAA is situated south of Prince William Sound and east of Kodiak Island. The northern boundary of the TMAA is located approximately 24 nautical miles (NM) south of the shoreline of the Kenai Peninsula, which is the largest proximate landmass. The Seamount Habitat Protection Areas shown on Figure 3-1 were established under various Fisheries Management Plans developed by North Pacific Fishery Management Council and implemented by NMFS for the protection of fisheries. Seamounts are isolated underwater mountains rising 900–3,000 meters (m) above the surrounding ocean bottom and thus provide a unique habitat for both deep-sea and shallow-water organisms. Upwelling often occurs around seamounts because currents push cold water from the depths up the slopes of the seamounts, bringing fresh nutrients to the surface.

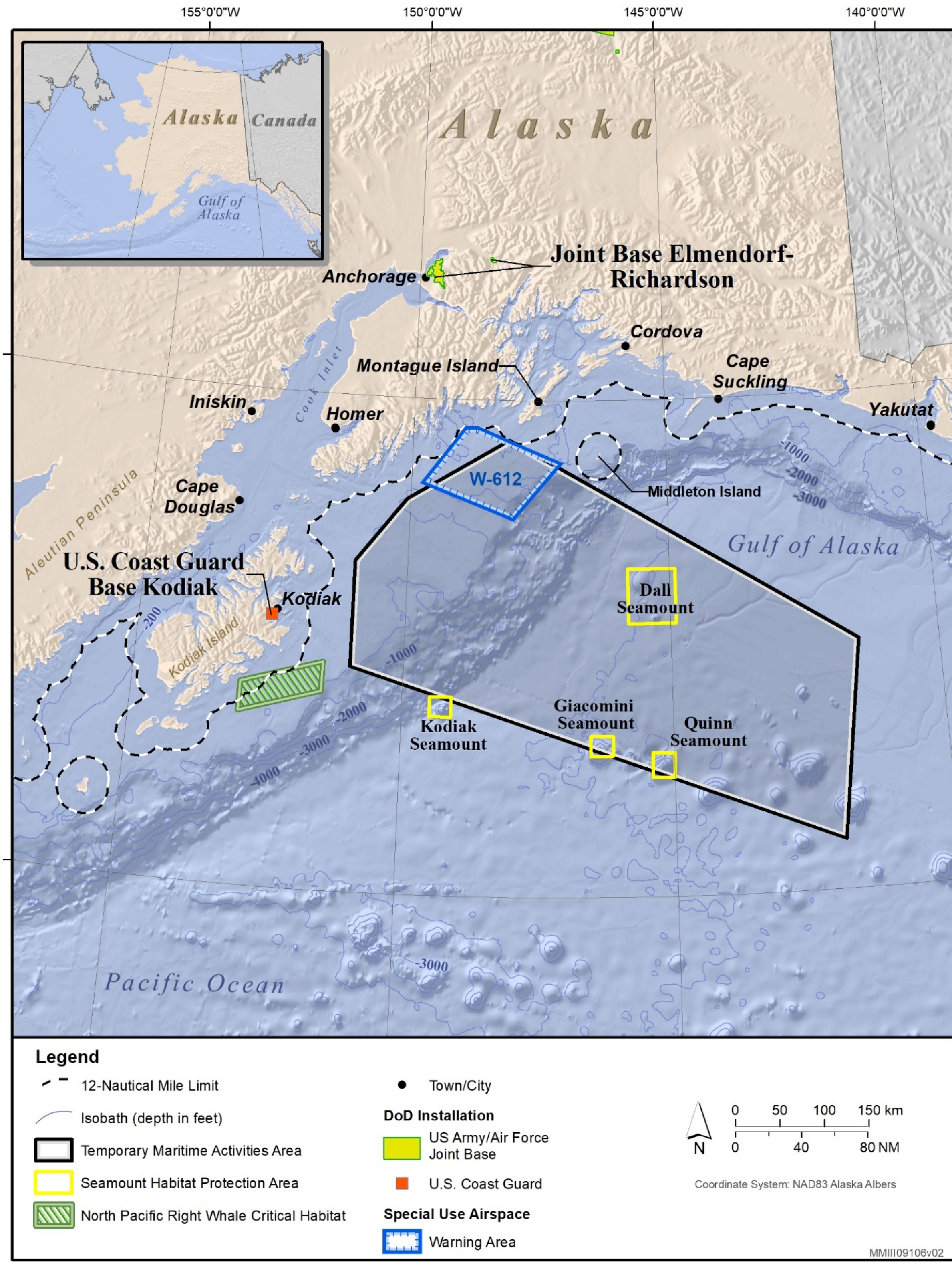


Figure 3-1: Gulf of Alaska Temporary Maritime Activities Area

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

NMSDD shapefiles for the GOA TMAA Study Area are representative of the April–October time period as mentioned above. If density data were available for finer temporal resolutions within this period, they were used on a species-specific basis. However, density data for this Study Area were rarely available at a finer temporal resolution.

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

Table 3-1: Hierarchy of Density Data Sources

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

Marine mammal survey data in the offshore waters of the GOA TMAA Study Area are limited, as most survey efforts have been localized and nearshore. The Navy conducted the first comprehensive marine mammal survey of waters in the Study Area from April 10 to 20, 2009 (Rone et al., 2009). The Navy funded a second systematic survey of the Study Area that occurred from June 23 to July 18, 2013 (Rone et al., 2014). In addition to these Navy-funded surveys, the National Oceanic and Atmospheric Administration (NOAA) and other scientists have published abundance estimates for smaller regions within the GOA TMAA Study Area that provide Level 2 and Level 3 sources of density data. For all species, the NMSDD protocol was applied when selecting the best available marine species density for the GOA TMAA Study Area. The different data sources are described in more detail in the following sections.

3.3 INFORMATION ON DENSITY DATA SOURCES CONSIDERED AND INCLUDED

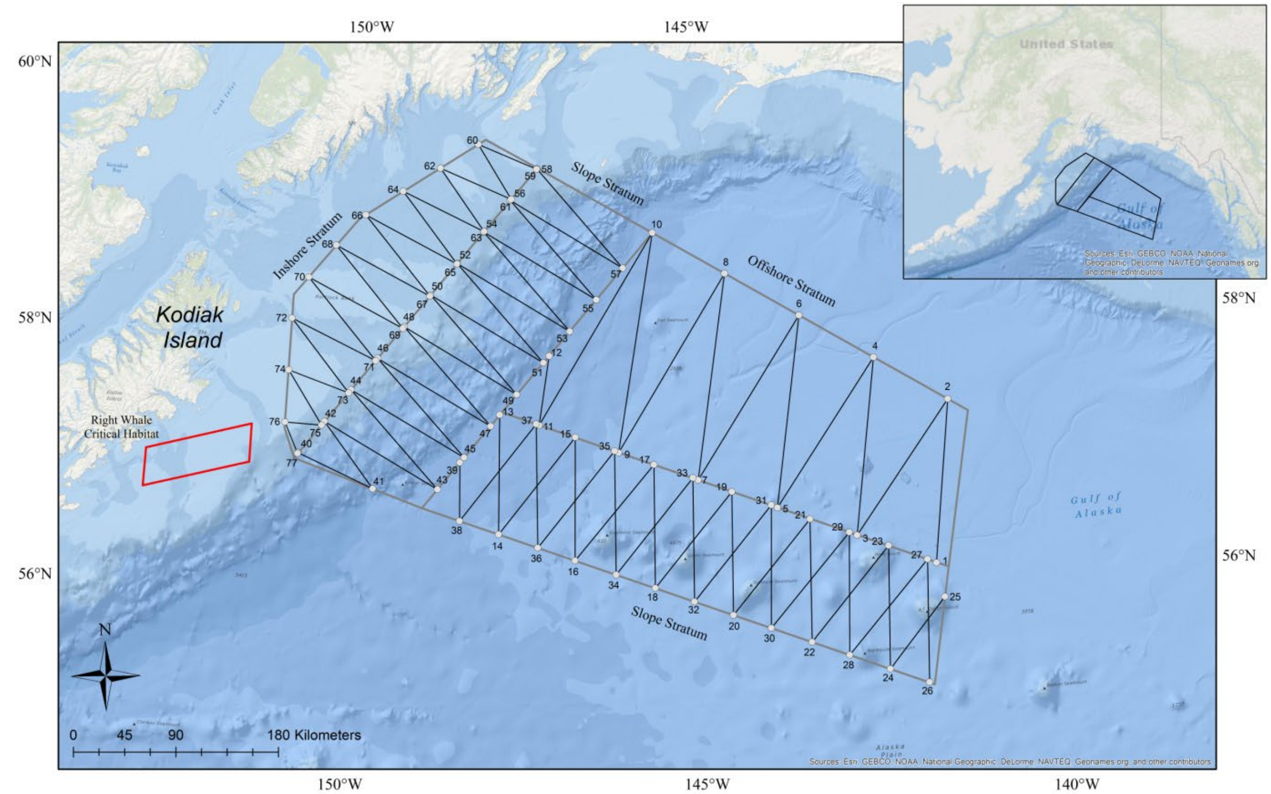
3.3.1 LEVEL 1–LEVEL 3 DATA SOURCES

The hierarchical approach for ranking density estimates as described in Section 2.2.1 (Hierarchal Approach for Ranking Density Estimates) and the established levels summarized in Table 3-1 were used to select the best available density estimates for Phase III. Given the limited systematic sighting data available for the GOA TMAA Study Area, no Level 1 (spatially explicit density estimates from spatial models) were available. The majority of data used to describe cetacean densities within the GOA TMAA Study Area were estimated from Level 2 and Level 3 sources (e.g., systematic line-transect surveys) as described below. The majority of data used to describe pinniped densities within the GOA TMAA Study Area were estimated or extrapolated from Level 3 data sources.

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

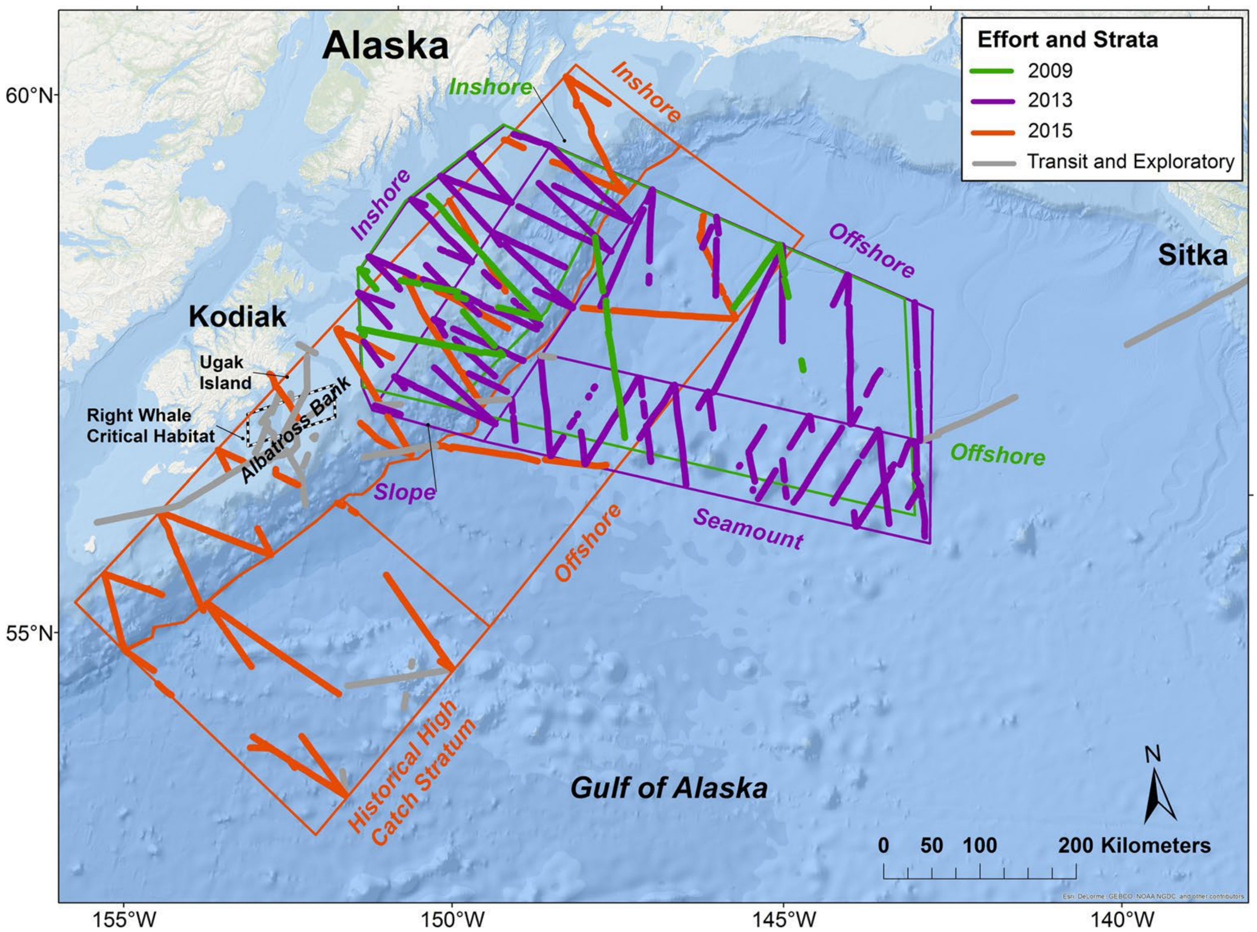
This data source is one of the preferred (Level 2) sources of density data in the established hierarchy.

The Navy has conducted two comprehensive marine mammal surveys of waters in the GOA TMAA Study Area. The first Gulf of Alaska Line-Transect Survey (GOALS) was conducted from April 10 to 20, 2009, using systematic line-transect survey protocol, and both visual and acoustic detection methods were employed (Rone et al., 2009). Sighting data were sufficient to derive line-transect density estimates (Level 3) for fin and humpback whales (Rone et al., 2009). During the second Gulf of Alaska Line-Transect Survey (GOALS II) that occurred from June 23 to July 18, 2013, both visual and acoustic data were collected in four strata that were designed to encompass the four distinct habitats within the TMAA (Figure 3-2). Rone et al. (2014) provided stratified line-transect abundance estimates (Level 2) for fin, humpback, blue, sperm, and killer whales, as well as Dall’s porpoise and northern fur seals. These density estimates were updated based on additional data collected in August 2015 on a survey that was designed to cover historical North Pacific right whale habitat (Figure 3-3) (Rone et al., 2015; Rone et al., 2017). Given the additional data and analyses, these updated estimates of density and uncertainty for many of the cetacean species are considered more robust than the previous estimates used for Phase II (Rone et al., 2014). The updated densities incorporated increased sample sizes that allowed for more precise estimates of detection functions and geographically stratified density estimates.



Source: Rone et al. (2014)

Figure 3-2: Survey Strata and Planned Tracklines for the 2013 GOALS II Survey



Source: Rone et al. (2017)

Figure 3-3: Completed Tracklines and Strata from the 2009, 2013, and 2015 Surveys

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

In addition to the NOAA and Navy line-transect density estimates described above, additional peer-reviewed published studies of designed-based estimates (Level 2; see Table 3-1) were used for the GOA TMAA Study Area. These included 1998 line-transect aerial surveys designed to estimate harbor porpoise abundance in Alaskan coastal areas (Hobbs & Waite, 2010), line-transect ship surveys conducted in coastal areas of the Aleutian Islands and Alaska Peninsula in 2001–2003 (Zerbini et al., 2006), and 2010–2012 line-transect data collected in the central and eastern North Pacific during the International Whaling Commission-Pacific Ocean Whale and Ecosystem Research cruises (Hakamada et al., 2017).

NMFS Stock Assessment Reports

This data source is one of the preferred (Level 3) sources of density data in the established hierarchy. Abundance estimates for marine mammals are available from NMFS Stock Assessment Reports for Alaska and the Pacific (Carretta et al., 2020; Muto et al., 2020). The NOAA Stock Assessment Reports provide uniform abundance estimates for recognized stocks of marine mammals within broad geographic strata, from which density estimates can be derived.

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

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

In the absence of existing density data, the Navy and other entities often need to develop unique methods for deriving study-area specific density estimates in order to assess potential impacts in compliance with the ESA, MMPA, NEPA, and EO 12114. Depending on the study area, the time period(s), and the assumptions used to generate the estimates, these data can provide representative density estimates when other data do not exist, and they are typically developed in coordination with NMFS scientists. These estimates are included within this section as they rely primarily on Level 2 or Level 3 density data sources. Densities for most pinnipeds and the leatherback sea turtle were derived using this method in consultation with scientists from NMFS.

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

3.3.2 Level 4–Level 5 Data Sources

The Level 4–5 data sources are the least preferred sources of density data. As described in Section 2.1.4 Density Based on Relative Environmental Suitability Models, these data sources are based on environmental suitability models developed by Kaschner et al. (2006) and later improved by SMRU Ltd. (2012). Density estimates from RES models had to be used for the Navy's Phase II analyses, because no other data sources were available. RES data are not based on survey data specific to the GOA TMAA Study Area but rather on inferred associations between marine habitat features and (the likelihood of) the presence of specific species, giving rise to a high degree of uncertainty in densities specific to the GOA TMAA Study Area. With the availability of new sources of density data specific to the GOA TMAA Study Area, the Navy was able to eliminate the need for RES data, thereby improving the density estimates used for Phase III acoustic modeling.

4 INDIVIDUAL SPECIES' DENSITY PROFILES

The remainder of this document provides the density profiles that are being used by the Navy for modelling the potential exposure of each species to Navy sound sources in the GOA TMAA Study Area based on the data sources and selection methods described in Sections 2 (NAVY MARINE SPECIES DENSITY DATABASE PROTOCOL) and 3 (NAVY MARINE SPECIES DENSITY DATABASE PHASE III – OVERALL METHODS AND SOURCES IMPLEMENTED). Species found in the GOA TMAA Study Area are presented in Table 4-1 and organized in the table by taxa: baleen whales, sperm whales, delphinids, porpoises, beaked whales, pinnipeds, and sea turtles. Within each family, species are presented in alphabetical order by their scientific name; hence, the scientific names are presented in the table before the common names. This organization scheme keeps closely related species together. Table 4-1 also includes references to species-specific sections in this report.

Table 4-1: Species with GOA TMAA Study Area Density Estimates Included in the NMSDD

Taxonomic Name[1]	Common Name	Section Number
Cetaceans (Order Cetacea)		
Baleen Whales (Suborder Mysticeti)		
Right Whales (Family Balaenidae)		
Eubalaena japonica	North Pacific right whale	Section 5.1.6
Rorquals (Family Balaenopteridae)		
Balaenoptera acutorostrata	Minke whale	Section 5.1.1
Balaenoptera borealis	Sei whale	Section 5.1.2
Balaenoptera musculus	Blue whale	Section 5.1.3
Balaenoptera physalus	Fin whale	Section 5.1.4
Megaptera novaeangliae	Humpback whale	Section 5.1.7
Gray Whales (Family Eschrichtiidae)		
Eschrichtius robustus	Gray whale	Section 5.1.5
Toothed Whales (Suborder Odontoceti)		
Sperm Whales (Family Physeteridae)		
Physeter macrocephalus	Sperm whale	Section 6.1.1
Dolphins (Family Delphinidae)		
Lagenorhynchus obliquidens	Pacific white-sided dolphin	Section 7.1.1
Orcinus orca	Killer whale	Section 7.1.2
Porpoises (Family Phocoenida)		
Phocoena phocoena	Harbor porpoise	Section 8.1.1
Phocoenoides dalli	Dall's porpoise	Section 8.1.2

Table 4-1: Species with GOA TMAA Study Area Density Estimates Included in the NMSDD (continued)

Taxonomic Name[1]	Common Name	Section Number
Beaked Whales (Family Ziphiidae)		
Berardius bairdii	Baird's beaked whale	Section 9.1.1
Mesoplodon stejnegeri	Stejneger's beaked whale	Section 9.1.2
Ziphius cavirostris	Cuvier's beaked whale	Section 9.1.3
Pinnipeds (Order Carnivora, Suborder Pinnipedia)		
Fur Seals and Sea Lions (Family Otariidae)		
Callorhinus ursinus	Northern fur seal	Section 10.1.1
Eumetopias jubatus	Steller sea lion	Section 10.1.2
Zalophus californianus	California sea lion	Section 10.1.6
True Seals (Family Phocidae)		
Histriophoca fasciata	Ribbon seal	Section 10.1.3
Mirounga angustirostris	Northern elephant seal	Section 10.1.4
Phoca vitulina	Harbor seal	Section 10.1.5
Otters (Family Mustelidae)		
Enhydra lutris kenyoni	Northern sea otter	Section 11.1.1
Sea Turtles (Order Testudines, Family Dermochelyidae)		
Dermochelys coriacea	Leatherback sea turtle	Section 12.1.1

[1]Taxonomy follows the Committee on Taxonomy (2018)

There are three elements in each species profile: (1) species-specific information related to stock structure and detection in the field, (2) information on the density data used for the GOA TMAA Study Area, and (3) maps of the estimated species density in the Study Area. Each of these elements is described in more detail below. In a few cases, one of the elements may be expanded or removed based on special circumstances for that species.

4.1 SPECIES DESCRIPTIONS

For each species, a brief description of the general appearance and notable identifying characteristics is provided. The description is not meant to be a detailed profile of the species but instead conveys the ease or challenges of detecting and identifying the species in the field. This information provides a context for the information on species presence. Species that have a low likelihood of being seen or a high likelihood of being confused with other species lead to higher levels of uncertainty in estimates of their density. Scientists are often conservative in classifying a marine mammal or sea turtle seen in the field, unless there is a high level of certainty. This conservative approach leads to observations that cannot be positively classified to species and thus fall into general groups such as "unidentified large whale" (e.g., Rone et al., 2017). Those species that are more difficult to sight or identify are more likely than others to have large number of observations fall into the general groups. Challenges to identifying animals in the field can thus be an impediment to obtaining enough sighting data to enable the estimation of species-specific density or abundance; in these cases, density is sometimes estimated for broader taxa (e.g., "small beaked whales," *Mesoplodon* spp.).

Within each species description, information on stocks recognized by NMFS and the International Whaling Commission (IWC) (for large whales) is also presented. Stocks are the management unit used by NMFS (Carretta et al., 2020; Muto et al., 2020) for most species; however, NMFS has recently identified distinct population segments (DPSs) for a few species to refine management and listing under the ESA (e.g., humpback whales). For those stocks and DPSs that are Threatened or Endangered, the Navy needs to be aware of stock structure and the likelihood of interacting with a particular stock or DPS. When an individual marine mammal is observed, it may be quite difficult to define which stock or DPS it belongs to if the geographic ranges of two or more stocks overlap, as it does for species such as killer whales. When possible, densities are provided for specific stocks, but for the majority of cases, densities are reported for the species as a whole.

4.1.1 SPECIES CONSIDERED BUT NOT INCLUDED

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

To the Navy's knowledge, the data needed to create spatially explicit, absolute at-sea density estimates for the ESA-listed fish species occurring within the GOA TMAA Study Area do not exist, nor could they be readily created. As such, density estimates for fishes are not included in this technical report.

Little or no telemetry data are available for the ESA-listed sea birds expected to be in offshore areas of the GOA TMAA Study Area. Although population estimates do exist for some seabird species, without robust information on distribution patterns, too many assumptions would need to be made to produce reasonable in-water density estimates for these species and, as such, they are excluded from this report. U.S. Fish and Wildlife Service has produced relative density models for guilds of sea birds, but these relative abundance models cannot be used for quantitative take estimation.

4.2 DENSITY DATA FOR THE GULF OF ALASKA STUDY AREA

4.2.1 TABLES

Information on the sources of density data are summarized in the text. The density values used in the NMSDD Phase III are reported in a table that appears in each species description. Due to the different sources of density data and their inherent limitations, the precision of the density estimates is variable. Specific uniform density values are provided for designed-based estimates.

The majority of density estimates used in the NMSDD Phase III come from the sources and methods described in Sections 2 (NAVY MARINE SPECIES DENSITY DATABASE PROTOCOL and 3 (NAVY MARINE SPECIES DENSITY DATABASE PHASE III – OVERALL METHODS AND SOURCES IMPLEMENTED) of this document. In some cases, density for a particular species could not be characterized by the data available from these sources. In those cases, information from scientific literature was used to derive a density estimate. This method relied mainly on information provided in peer-reviewed publications. In all cases the data sources were prioritized based on the descriptions in Sections 2.2.1 (Hierarchal Approach for Ranking Density Estimates) and 3.2 (Application of the Navy Marine Species Density

Database Protocol to Pacific Fleet Density Database) to ensure consistency with the hierarchical approach established to select density values.

Maps

Maps from the Geographic Information System database used in NMSDD Phase III are provided for each species. As noted in Section 2.2.3 (Methods for Seasonal Designation), shapefiles for the GOA TMAA Study Area are representative of the April–October time period. If there is a difference in density values between these months in the study area, then a map will be provided for the time periods that differ.

The maps of species density should be interpreted with caution. Designed-based estimates may differ by orders of magnitude at the borders of their predictive areas, because of differences in assumptions, detection parameters used, and other factors. These differences between data sources can cause incongruities in density values within a study area. Ultimately, the Navy is most concerned with having the highest quality data in the areas where Navy exercises take place and where animals may be exposed to sound generated from Navy activities. For many of these areas, marine mammal and sea turtle densities are currently characterized in a satisfactory manner by the data available; however, there are ongoing efforts to improve density datasets, and the Navy will incorporate improved estimates into the NMSDD as they become available.

To ensure consistent representation throughout the report, a density classification scheme was developed that includes seven density classes with colors representing low (light blue) to higher (dark orange) values relative to each species. The same color does not represent the same density value across all species due to the widely varying densities among species. The only exception is that the lightest blue color represents a density of zero for all species.

5 BALEEN WHALES

5.1 BALEEN WHALES SPECIES PROFILES

5.1.1 *BALAENOPTERA ACUTOROSTRATA*, MINKE WHALE

Minke whales are a species whose presence can be challenging to quantify, because they are difficult to observe on visual surveys. They can move quickly over sustained distances (Ford et al., 2005), their blow is cryptic and relatively small, and they do not raise their flukes when diving (Jefferson et al., 2015; Leatherwood et al., 1988). In some cases, they do approach ships, affording good identification (Leatherwood et al., 1988; Perrin et al., 2009). Common minke whales are the smallest baleen whale in the North Pacific (Leatherwood et al., 1988). Their body shape is distinctive for a rorqual whale, because they have a sleek body and a pointed head. Their dorsal fin is tall and falcate for a baleen whale. The coloration is distinctive with a dark back, white belly, swathes and streaks of intermediate color on the sides, and a white band on the pectoral fins (Jefferson et al., 2015; Leatherwood et al., 1988). At a distance, the species could be mistaken for other baleen whales, such as a fin whale, sei whale (*Balaenoptera borealis*), or Bryde's whale (Jefferson et al., 2015; Leatherwood et al., 1988). If only the back is seen, the species could also be mistaken for a beaked whale (Jefferson et al., 2015; Leatherwood et al., 1988).

The IWC recognizes three stocks of minke whales in the North Pacific: (1) the Sea of Japan/East China Sea, (2) the rest of the western Pacific west of 180°N, and (3) the "remainder of the Pacific" (Donovan, 1991). These broad designations basically reflect a lack of knowledge about the population structure of minke whales in the North Pacific (Carretta et al., 2020). NMFS has designated three stocks of minke whale in the North Pacific: (1) the Hawaii stock, (2) the California/Oregon/Washington stock, and (3) the Alaska stock (Carretta et al., 2020; Muto et al., 2020). The three NMFS stocks primarily fall into the IWC's "remainder of the Pacific" stock. Minke whales in the GOA TMAA Study Area are members of the Alaska stock.

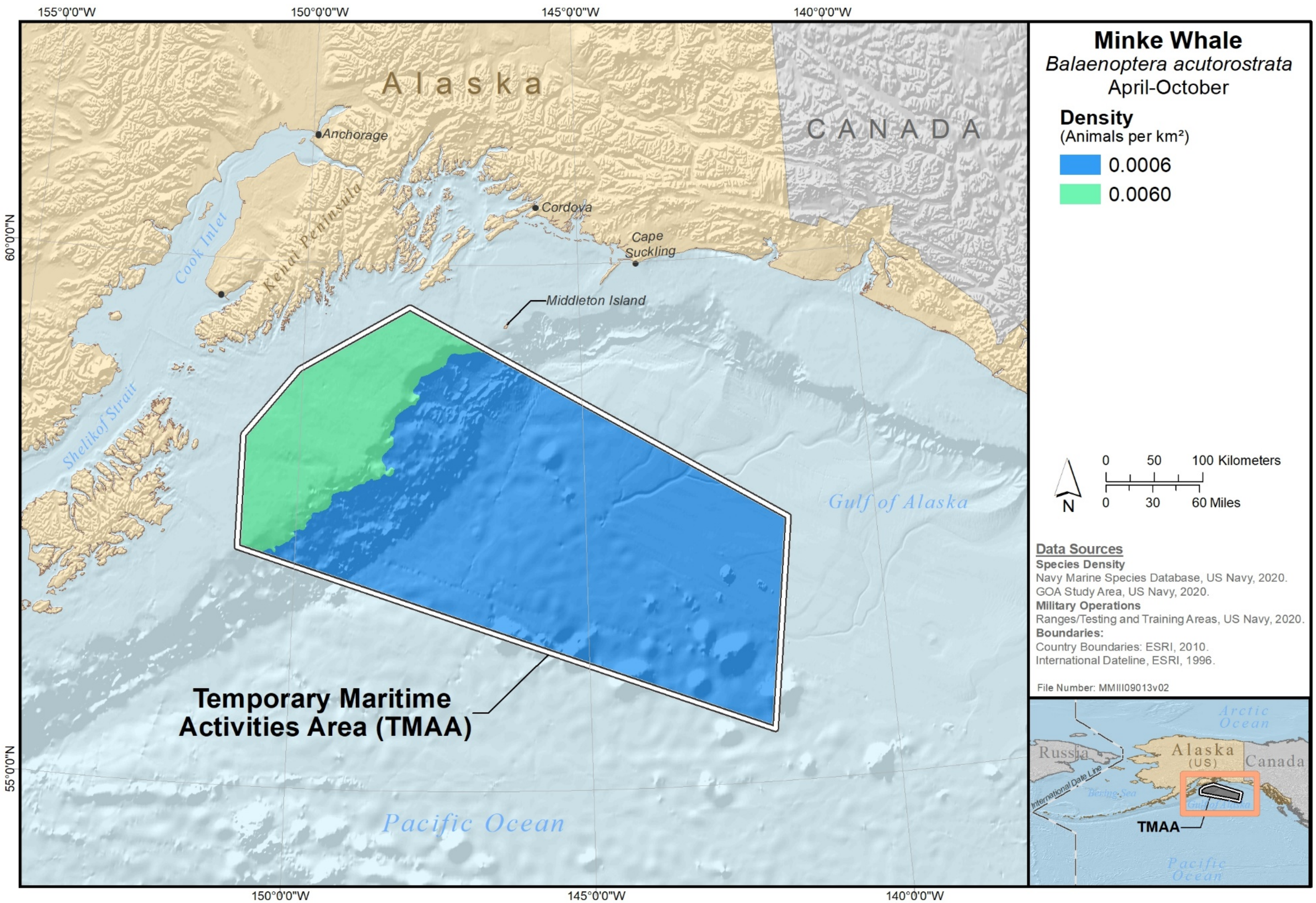
Density Data. The limited number of minke whale sightings (five) during the Navy's 2009 and 2013 surveys of the Study Area precluded the derivation of a line-transect density estimate (Rone et al., 2017). There were 72 on-effort minke whale sightings during line-transect surveys conducted in the summer of 2001, 2002, and 2003 in shelf and nearshore waters from the Kenai Fjords in the Gulf of Alaska to the central Aleutian Islands (Zerbini et al., 2006). These records are consistent with observations that minke whales generally occupy inshore waters in the GOA (Moore & Allen, 2000). However, sighting records indicate that minke whales are distributed offshore as well. For example, Matsuoka et al. (2013) reported a minke whale sighting on the slope within the eastern Gulf of Alaska and another offshore in the western Gulf of Alaska during a line-transect survey in summer and early fall of 2012. The five minke whale sightings from the Navy's TMAA surveys were distributed in both inshore and offshore waters, with two sightings in the inshore stratum in 2009, one sighting in the slope stratum, one sighting in the seamount stratum, and a third sighting offshore and outside the TMAA in 2013 (Rone et al., 2017).

Given their predominantly inshore distribution, a density estimate of 0.006 animals/km^2 was assigned to waters within the 1,000 m isobath based on estimates from Zerbini et al. (2006). A density estimate of 0.0006 animals/km^2 was assigned to the remainder of the TMAA based largely on sighting data from Waite (2003) (U.S. Department of the Navy, 2009). Given the lack of more recent estimates, this density estimate (shown in Table 5-1 and Figure 5-1) is considered the best available metric for this species in this area.

Table 5-1: Summary of Density and Uncertainty Values for Minke Whale

Location	April–October
TMAA – within the 1,000 m isobath	0.006 (CV = 0.34)
TMAA – region deeper than the 1,000 m isobath	0.0006 (CV = NA)

Notes: (1) The units for numerical values are animals/km^2. (2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation, NA = not applicable.



Minke Whale
Balaenoptera acutorostrata
April-October
Density
(Animals per km²)
0.0006
0.0060
Alaska
CANADA
Anchorage
Cordova
Cape Suckling
Middleton Island
Cook Inlet
Kenai Peninsula
Shelikof Strait
Gulf of Alaska
Pacific Ocean
Temporary Maritime Activities Area (TMAA)
155°0'0"W
150°0'0"W
145°0'0"W
140°0'0"W
60°0'0"N
55°0'0"N
0 50 100 Kilometers
0 30 60 Miles
N
Data Sources
Species Density
Navy Marine Species Database, US Navy, 2020.
GOA Study Area, US Navy, 2020.
Military Operations
Ranges/Testing and Training Areas, US Navy, 2020.
Boundaries:
Country Boundaries: ESRI, 2010.
International Dateline, ESRI, 1996.
File Number: MMIII09013v02
Arctic Ocean
Russia
Alaska (US)
Canada
TMAA
Pacific Ocean

5.1.2 *BALAENOPTERA BOREALIS*, SEI WHALE

Sei whales are relatively large, dark-colored baleen whales. Sei whales are more common in colder waters and are nearly absent from tropical zones, particularly in the summer (Jefferson et al., 2015; Perrin et al., 2009). They are a species that can be difficult to identify positively from a distance, because of their superficial similarity to fin and Bryde's whales (Jefferson et al., 2015; Leatherwood et al., 1988). For this reason, sei whales may often be underrepresented in data from visual surveys; with their identity unresolved, they are relegated to the "unidentified rorqual" or "unidentified large whale" categories. NMFS recognizes two stocks of sei whales in the U.S. Pacific, the Eastern North Pacific stock and the Hawaii stock (Carretta et al., 2020; Muto et al., 2020). The IWC only recognizes one stock of sei whales in the North Pacific. Sei whales in the GOA TMAA Study Area are members of the Eastern North Pacific stock.

Density Data. Sei whales were acoustically detected during the 2013 GOALS II survey, but there were no confirmed visual sightings, and the limited acoustic data prohibited the derivation of line-transect density estimates (Rone et al., 2014). There were two sei whale sightings during a 2015 survey that was designed to cover historical North Pacific right whale habitat, but both were outside the TMAA and data were too limited to produce a density estimate (Rone et al., 2017). The first sei whale abundance estimates for the central and eastern North Pacific were derived based on 2010–2012 line-transect data collected during the International Whaling Commission-Pacific Ocean Whale and Ecosystem Research cruises (Hakamada et al., 2017). Over the three-year period, the summer (July and August) surveys covered a broad area north of 40°N, south of the Aleutian Islands, and between 170°E and 135°W. Data from all three years were pooled to estimate the probability of detection, and density estimates were made for six geographic strata defined by separate northern and southern regions for each year. The 2012 northern stratum, with an approximate area of 488,511 km^2, encompassed the majority of the TMAA. Hakamada et al. (2017) derived an abundance estimate of 195 sei whales for this stratum, and the corresponding density estimate of 0.00040 animals/km^2 (Table 5-2 and Figure 5-2) was assigned to the TMAA.

Table 5-2: Summary of Density and Uncertainty Values for Sei Whale

Location	April–October
TMAA	0.00040 (CV=0.745)

Note: (1) The units for numerical values are animals/km^2. (2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation

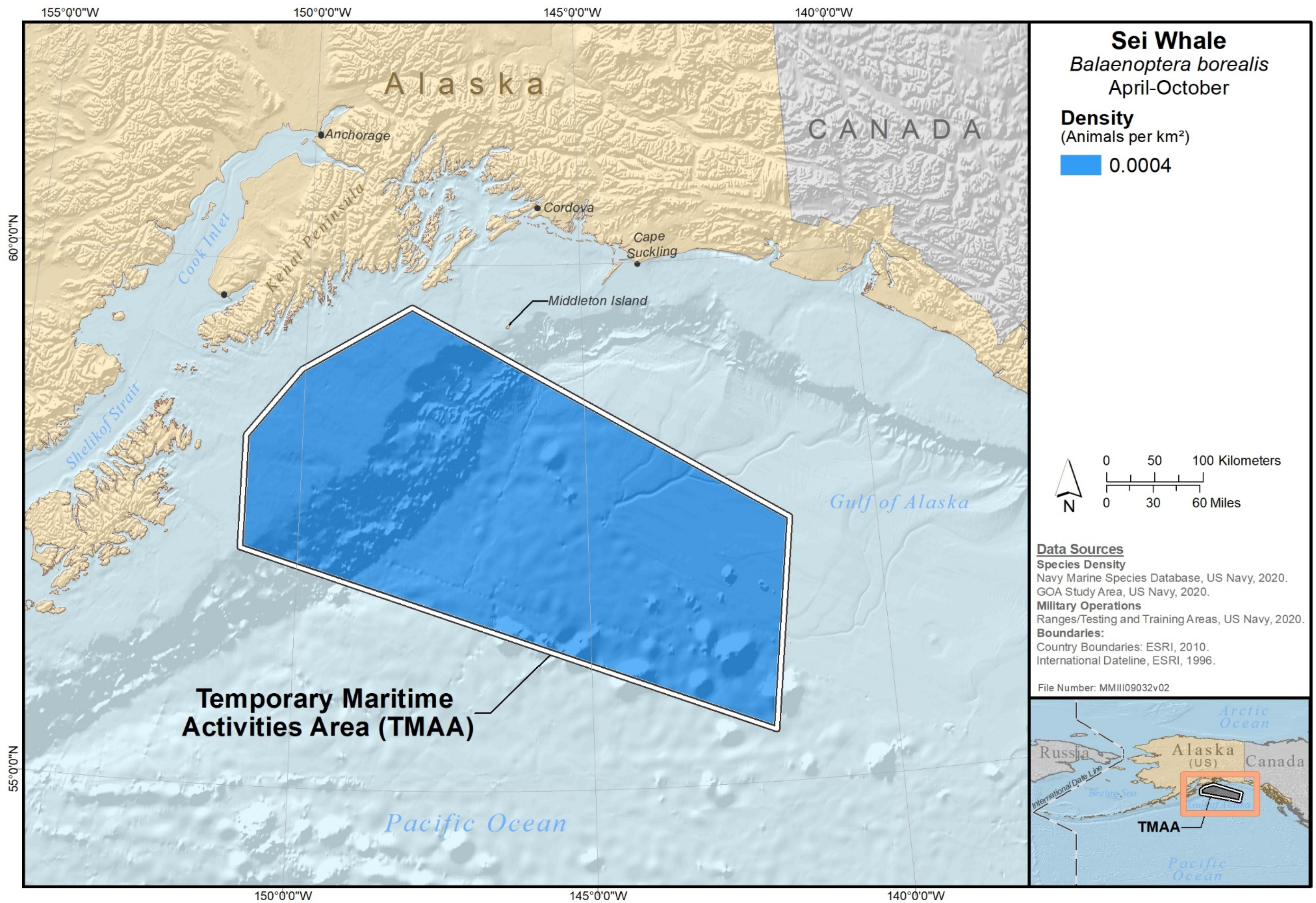


Figure 5-2: Estimated Density of Sei Whale in the TMAA from April Through October

5.1.3 *BALAENOPTERA MUSCULUS*, BLUE WHALE

Blue whales are relatively easy to observe and identify in the field. They are the largest baleen whale, their blow is tall and distinctive, and their color is a mottled, light gray-blue compared to the dark gray to black of the other large baleen whales (Jefferson et al., 2015). The dorsal fin is set far back on the body and is reduced in size—it may be present only as a small bump (Jefferson et al., 2015; Leatherwood et al., 1988). From a distance or in backlight, blue whales could be mistaken for fin whales, but a close view will dispel misidentification (Jefferson et al., 2015; Leatherwood et al., 1988). There are four subspecies of blue whale, but only *Balaenoptera musculus* is found in the North Pacific (Muto et al., 2017; Muto et al., 2020). Because they are readily identifiable, density values for blue whales are available in the literature and NMFS reports for areas that have been surveyed.

The IWC recognizes a single stock of blue whales in the North Pacific, while NMFS recognizes two stocks: an Eastern North Pacific stock and a Central North Pacific stock (Carretta et al., 2020; Carretta et al., 2017). The Eastern North Pacific stock includes animals found in the eastern North Pacific from the northern Gulf of Alaska to the eastern tropical Pacific (Carretta et al., 2020). Blue whales from either stock could occur in the GOA TMAA Study Area.

Density Data. Blue whale calls have been acoustically detected in the Gulf of Alaska during every month of the year, although peak occurrence is generally from July through November, and call rates drop substantially after early December (Baumann-Pickering et al., 2012a; Debich et al., 2014; Moore et al., 2006; Rice et al., 2015; Rice et al., 2018). Navy-funded High-frequency Acoustic Recording Packages (HARPs) have been deployed in various locations within the TMAA during the last nine years, including shelf, slope, seamount, and deep-water sites; and blue whale calls have been recorded at all locations (Baumann-Pickering et al., 2012a; Debich et al., 2013; Debich et al., 2014; Rice et al., 2015; Rice et al., 2018). Calls from both the Central North Pacific and Eastern North Pacific stocks have been detected (Rice et al., 2018).

Although there were no blue whale sightings during the Navy-funded survey of the Study Area in April 2009 (Rone et al., 2009), there were five blue whale sightings during the 2013 GOALS II survey in June and July, and an additional 10 sightings in August 2015 on a survey that was designed to cover historical North Pacific right whale habitat (Rone et al., 2017). Based on an updated analysis of the 2013 and 2015 survey data, Rone et al. (2017) derived density estimates specific to the inshore and seamount strata of 0.0001 animals/km^2 and 00014 animals/km^2, respectively (Table 5-3 and Figure 5-3). Based on pooled sightings from all strata and incorporation of prorated estimates for unidentified large whale species sighted during the 2013 GOALS II survey, an overall blue whale density estimate for the Study Area was calculated as 0.0005 animals/km^2 (Rone et al., 2014). In lieu of stratum-specific density estimates for the offshore and slope strata, this study area estimate was applied to these strata.

Table 5-3: Summary of Density and Uncertainty Values for Blue Whale

Location	April–October
TMAA – Inshore Stratum	0.0001 (CV=1.06)
TMAA – Offshore Stratum	0.0005 (CV=1.22)
TMAA – Seamount Stratum	0.0014 (CV=0.76)
TMAA– Slope Stratum	0.0005 (CV=1.22)

Notes: (1) The units for numerical values are animals/km^2.
(2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation

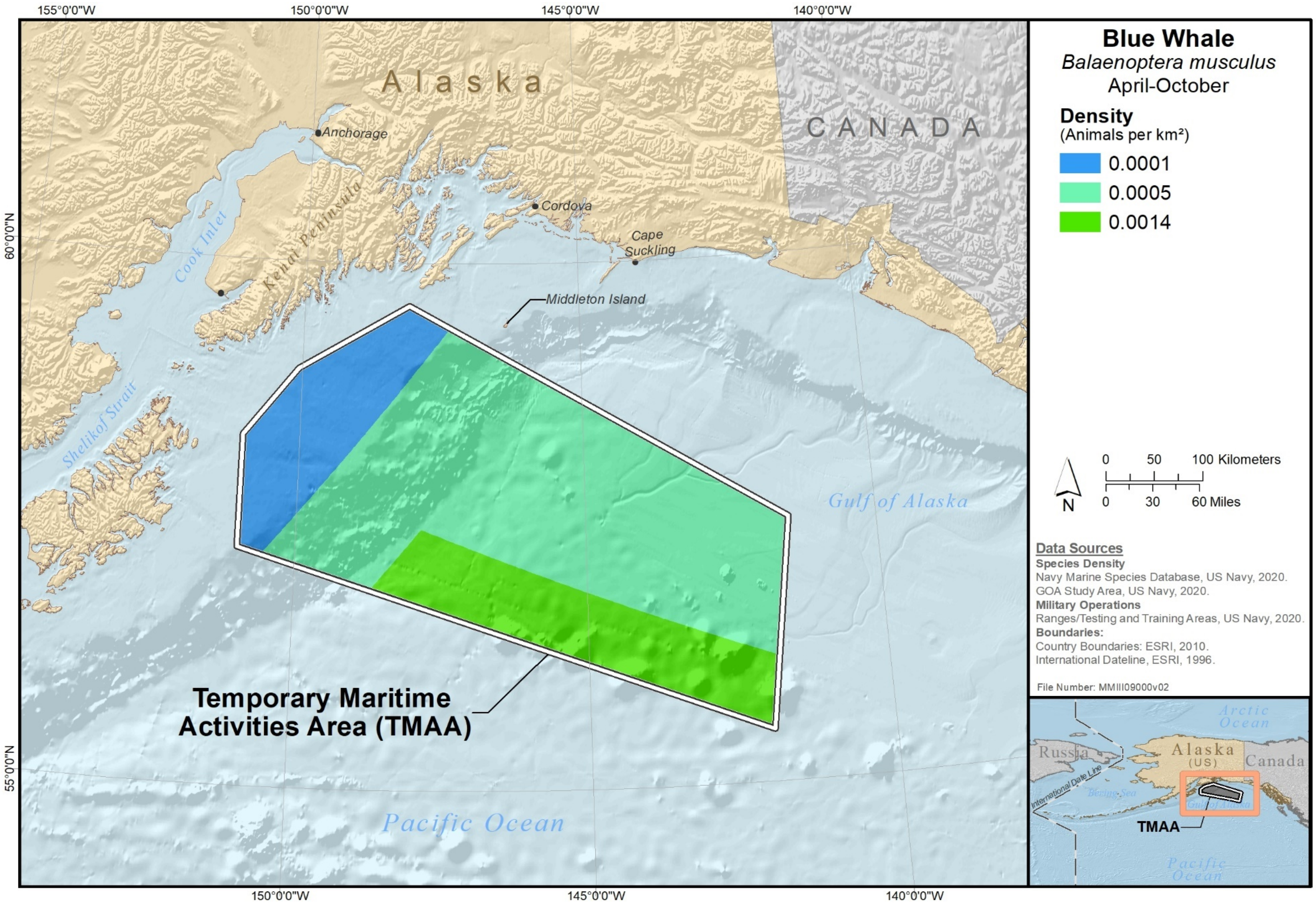


Figure 5-3: Estimated Density of Blue Whale in the TMAA from April Through October

5.1.4 *BALAENOPTERA PHYSALUS*, FIN WHALE

Fin whales are the second-largest baleen whale species and are almost black in color, except for a bright white right lip, whitish belly, and light chevron and streaks on the back (Jefferson et al., 2015). They are sometimes observed with blue whales (Aguilar, 2009), but the difference in color makes the species relatively distinguishable. Fin whales can be difficult to identify positively from a distance, because of their superficial similarity to sei and Bryde's whales (Jefferson et al., 2015; Leatherwood et al., 1988). For these reasons, fin whales may often be underrepresented in data from visual surveys, because they may fall into the "unidentified rorqual" or "unidentified large whale" categories. Three stocks of fin whales (the Northeast Pacific stock, the California/Oregon/Washington stock, and the Hawaii stock (Carretta et al., 2020; Muto et al., 2020)) are recognized by NMFS in U.S. Pacific waters. Fin whales in the GOA TMAA Study Area belong to the Northeast Pacific (Alaska) stock (Muto et al., 2020).

Density Data. Fin whales have been acoustically detected in the Gulf of Alaska year round (Baumann-Pickering et al., 2012a; Debich et al., 2013; Debich et al., 2014; Moore et al., 2006; Rice et al., 2015; Rice et al., 2018; Stafford, 2007), although in the eastern North Pacific, fin whale calls are generally detected from October through April (Watkins et al., 2000). Navy-funded HARPs have been deployed in various locations within the TMAA during the last nine years, including shelf, slope, seamount, and deep-water sites; fin whale calls have been recorded at all locations (Baumann-Pickering et al., 2012a; Debich et al., 2013; Debich et al., 2014; Rice et al., 2015; Rice et al., 2018). Fin whales were the most commonly detected baleen whale based on HARP recordings from June 2013 to May 2014 at five locations within the TMAA (Debich et al., 2014). These acoustic data are consistent with sighting data, as fin whales were the most frequently sighted large whale during the Navy-funded 2009 and 2013 line-transect surveys, and sightings were made throughout the entire study area (Rone et al., 2017).

There were 20 fin whale sightings during the April 2009 survey (Rone et al., 2009), 172 fin whale sightings during the June and July 2013 GOALS II survey, and an additional 42 sightings in August 2015 on a survey that was designed to cover historical North Pacific right whale habitat (Rone et al., 2017). Based on an updated analysis of the 2013 survey data, Rone et al. (2017) derived density estimates specific to the four TMAA strata: 0.068 animals/km^2 (inshore stratum), 0.016 animals/km^2 (offshore stratum), 0.003 animals/km^2 (seamount stratum), and 0.013 animals/km^2 (slope stratum) (Table 5-4 and Figure 5-4).

Table 5-4: Summary of Density and Uncertainty Values for Fin Whale

Location	April–October
TMAA – Inshore Stratum	0.068 (CV=0.48)
TMAA – Offshore Stratum	0.016 (CV=0.23)
TMAA – Seamount Stratum	0.003 (CV=0.37)
TMAA – Slope Stratum	0.013 (CV=0.20)

Notes: (1) The units for numerical values are animals/km^2.
(2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation

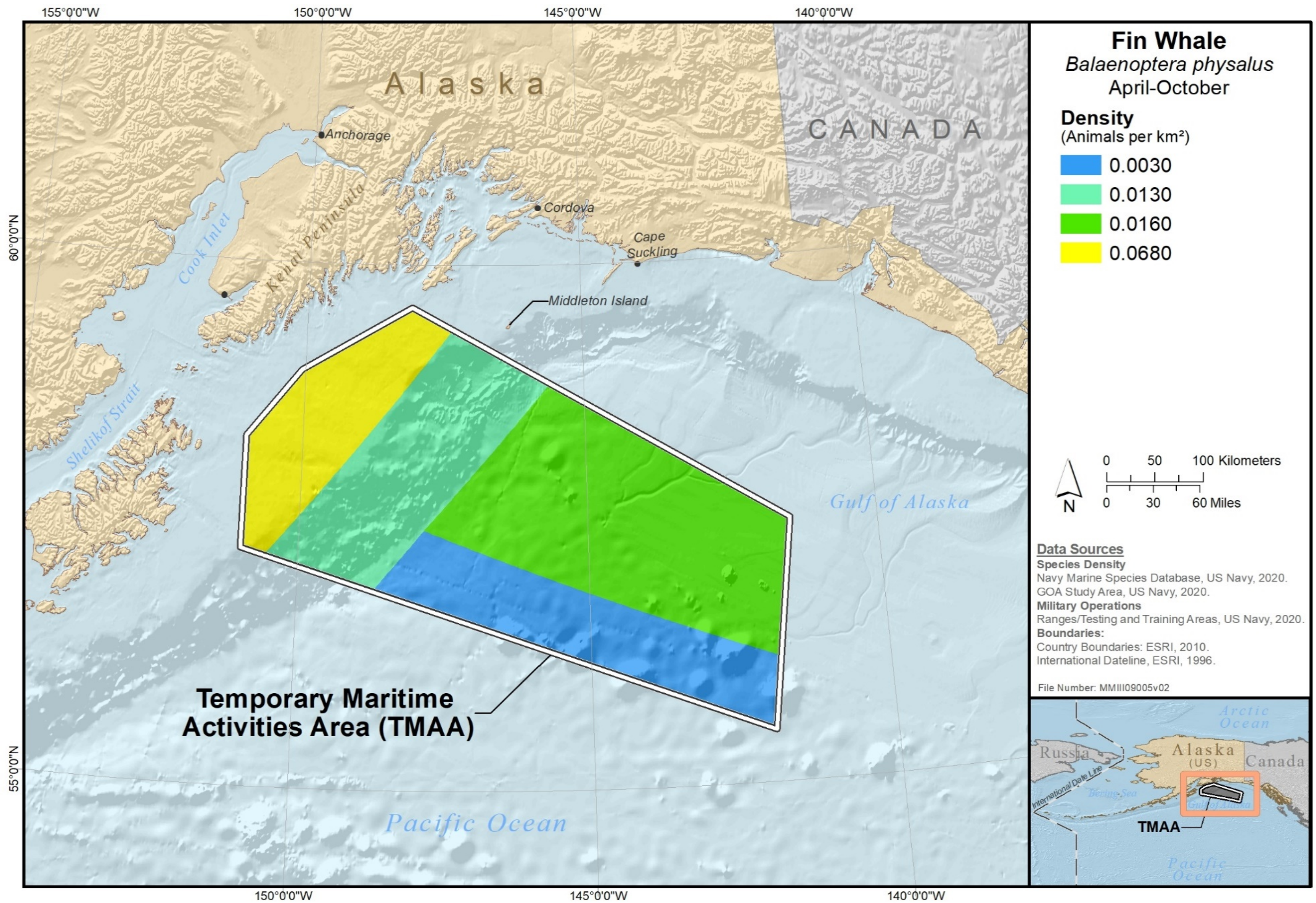


Figure 5-4: Estimated Density of Fin Whale in the TMAA from April Through October

5.1.5 *Eschrichtius robustus*, Gray Whale

The gray whale is distinctive in appearance, with a small dorsal hump and many barnacles and irregularities on their skin, which is a uniform light gray (Jones et al., 1984). NMFS recognizes two stocks of gray whales in the North Pacific: the larger Eastern North Pacific stock and the highly endangered Western North Pacific stock (Carretta et al., 2020; Carretta et al., 2017); the IWC also recognizes the same two stocks. Until recently, these two stocks were considered exclusive from each other, but recent satellite tagging and photo mark-recapture data have suggested that there is some exchange of individuals (Mate et al., 2013; Mate et al., 2015). Further, photo-catalog comparisons of eastern and western North Pacific gray whale populations suggest that there is more exchange between the western and eastern populations than previously thought, since “Sakhalin” whales were sighted off Santa Barbara, California; British Columbia, Canada; and Baja California, Mexico (Weller et al., 2013). While it is possible that sightings of western population animals might be included in the data used to estimate gray whale density in the Eastern North Pacific, given the current paucity of data regarding the western population, as well as the very low population numbers, separate density estimates for the western population were not included in the NMSDD Phase III. Density values in the NMSDD Phase III are thus presumed to apply to the Eastern North Pacific stock of gray whales.

A group of a few hundred gray whales known as the Pacific Coast Feeding Group (PCFG) feeds along the Pacific coast between Southeast Alaska and Southern California throughout the summer and fall (Calambokidis et al., 2002). Ship surveys conducted off Ugak Bay in August and September of 2002, 2003, and 2005 confirmed that large aggregations of gray whales feed in this area in the summer, and photo-identification suggest that some of these whales are members of the PCFG, indicating that their range may extend as far north as Kodiak Island (Gosho et al., 2011). The discovery of the PCFG has generated uncertainty regarding the stock structure of the Eastern North Pacific population (Carretta et al., 2020; Carretta et al., 2017). Photo-identification, telemetry, and genetic studies suggest that the PCFG is demographically distinct (Calambokidis et al., 2010; Frasier et al., 2011; Mate et al., 2010). Currently, the PCFG 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., 2020; Carretta et al., 2017).

Density Data. 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). Gray whales are found along the shore in the northern Gulf of Alaska during their migrations between the breeding and feeding grounds. The southbound migration begins in early October, when gray whales move from the Bering Sea through the Unimak Pass and along the coast of the Gulf of Alaska (Braham, 1984). The southbound migration continues into the winter season between October and January. Migration of gray whales past Kodiak Island peaks in mid-December (Rugh et al., 2001). During the northbound migration, the peak of migration in the Gulf of Alaska is in mid-April (Braham, 1984). As noted above, although most gray whales migrate to the Bering Sea to feed, some whales do not complete the migration, but instead remain to feed in coastal waters in the Gulf of Alaska (Gosho et al., 2011).

Navy-funded HARPs have been deployed in various locations within the TMAA during the last nine years, and gray whale calls have been recorded from July through October, most commonly from recorders on the continental shelf (Debich et al., 2014; Rice et al., 2015; Rice et al., 2018). Sighting data recorded on the Cetacean Density and Distribution Mapping Working Group website (www.st.nmfs.noaa.gov/cetsound) indicate that gray whales have been sighted in the Gulf of Alaska in April, June, July, and August, and are expected to occur there year round. There were three gray whale sightings during the April 2009 GOALS survey, two off Kodiak Island and one sighting of two individuals within the inshore stratum of the TMAA (Rone et al., 2009). One group of an estimated 25 gray whales was sighted off Kodiak Island in July 2013 (outside the TMAA) during the off-effort portion of the 2013 GOALS II survey (Rone et al., 2014). An additional six gray whale sightings were made during the August 2015 survey designed to cover historical North Pacific right whale habitat, all outside the TMAA and the majority near Kodiak Island (Rone et al., 2017).

Abundance estimates for the Eastern North Pacific gray whale population have fluctuated over the years, ranging from approximately 17,000 to 21,000 animals between 2006 and 2016 (Carretta et al., 2020; Rugh et al., 2008; Swartz et al., 2006). For stock assessment purposes, NMFS currently uses an abundance estimate of 26,960 animals (CV = 0.05), which is the highest estimate recorded over the 1967 to 2015 time series (Carretta et al., 2020). While abundance estimates are typically updated yearly based on shore counts, density estimates are more difficult to derive given the mobile nature of this migratory species. Carretta et al. (2000) calculated an overall gray whale density of 0.051 animals/km^2, which was used in concert with two zones based on data from Shelden and Laake (2002) to represent gray whale density in the GOA TMAA Study Area (Table 5-5 and Figure 5-5): (1) a zone from 0 to 2.25 NM from the coast with a density of 0.0485724 animals/km^2, and (2) a zone from 2.25 to 20 NM with a density of 0.0024276 animals/km^2. In the absence of density data specific to the TMAA, these estimates were considered to represent the best available.

Table 5-5: Summary of Density and Uncertainty Values for Gray Whale

Location	April–October
TMAA: 0–2.25 NM from shore*	0.04857 (CV=NA)
TMAA: 2.25–20 NM from shore	0.00243 (CV=NA)

Notes: (1) The units for numerical values are animals/km^2.
(2) NM = nautical miles, CV = coefficient of variation, NA = not applicable
*Not shown, because the area is too shallow to occur in the TMAA.

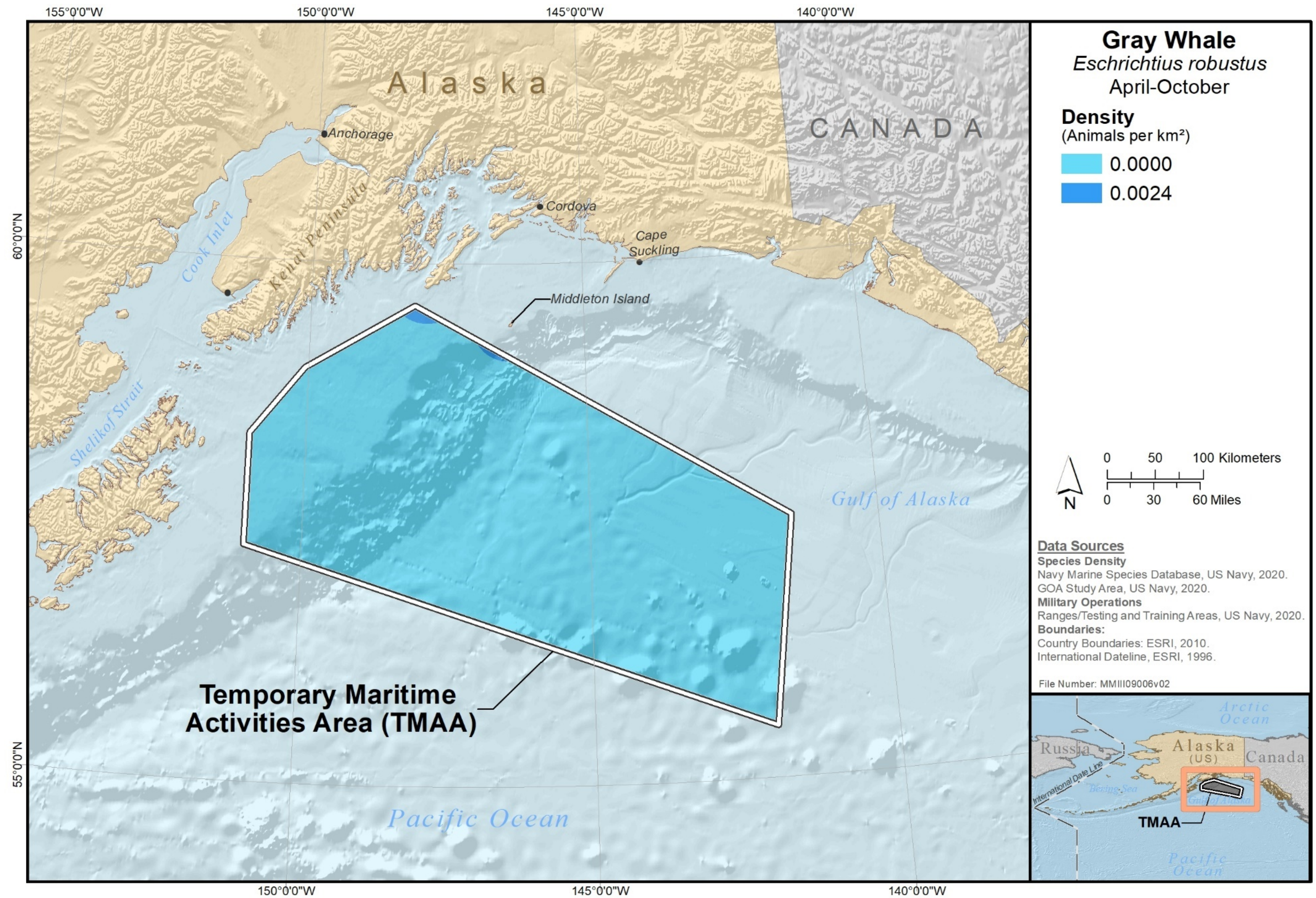


Figure 5-5: Estimated Density of Gray Whale in the TMAA from April Through October

5.1.6 *EUBALAENA JAPONICA*, NORTH PACIFIC RIGHT WHALE

Once abundant enough to support a whaling industry, the North Pacific right whale (*Eubalaena japonica*) is now apparently the most endangered whale species in the world (Wade et al., 2011b). The most recent population estimate for the North Pacific right whale is between 28 and 31 individuals and although this estimate may be reflective of a Bering Sea subpopulation, the total eastern North Pacific population is unlikely to be much larger (Wade et al., 2011a; Wade et al., 2011b). Because of the low population numbers in the North Pacific, few individuals have been observed, and until recently sightings have occurred primarily in the Okhotsk Sea and the eastern Bering Sea (Brownell et al., 2001; Wade et al., 2006; Wade et al., 2011b; Zerbini et al., 2010). NMFS currently recognizes two stocks of North Pacific right whale: (1) an Eastern North Pacific stock; and (2) a Western North Pacific stock, thought to feed primarily in the Sea of Okhotsk (Allen & Angliss, 2014). It is assumed that any North Pacific right whale in the Study Area would be from the Eastern North Pacific stock.

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

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

North Pacific right whales were not observed during the 2009 or 2013 GOALS surveys, nor were they seen during the 2015 survey designed to cover known historical right whale habitat (Rone et al., 2017). However, limited right whale calls were recorded during both the 2013 and 2015 surveys in the western Gulf of Alaska. In July 2013, during the GOALS II survey, three North Pacific right whales were acoustically detected in the Barnabus Trough region on Albatross Bank, southeast of Kodiak Island (Rone et al., 2014). This is the same area where there were four sightings as noted above. During the 2015 survey, North Pacific right whales were acoustically detected on August 10 and August 16, both documented again in the Barnabus Trough region on Albatross Bank (Rone et al., 2015).

North Pacific right whales were not detected on any of the passive acoustic monitoring devices deployed in the shelf and slope regions of the Study Area between July 2011 and May 2013 (Baumann-Pickering et al., 2012b; Debich et al., 2013; Debich et al., 2014). Between June and September 2013, North Pacific right whale calls were detected on a Navy-funded passive acoustic device located at the southeast edge of the TMAA on Quinn Seamount (Debich et al., 2014; Sirovic et al., 2014). These acoustic detections are the only known potential occurrence records of this species within the TMAA in recent years. Navy-funded HARPs deployed in various locations within the TMAA during numerous periods between April 2014 and September 2017 had no acoustic detections of right whales at any of the monitoring sites (Rice et al., 2015; Rice et al., 2018).

Given the available sighting and acoustic data, the total number of right whales still using the GOA feeding ground is likely to be on the order of 10 or fewer animals. The minimum estimate based on visual sightings is four whales in the northern GOA (Wade et al., 2011a). Given their current extremely low population numbers, but in order to acknowledge their potential presence in the GOA TMAA Study Area and based on the data summarized above, it is assumed that five North Pacific right whales could be present within the TMAA at any one time, and thus a density estimate of 0.00003 animals/km^2 was assigned to this area (Table 5-6 and Figure 5-6).

Table 5-6: Summary of Density and Uncertainty Values for North Pacific Right Whale

Location	April–October
TMAA	0.00003 (CV=NA)

Notes: (1) The units for numerical values are animals/km^2.
(2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation, NA = not applicable

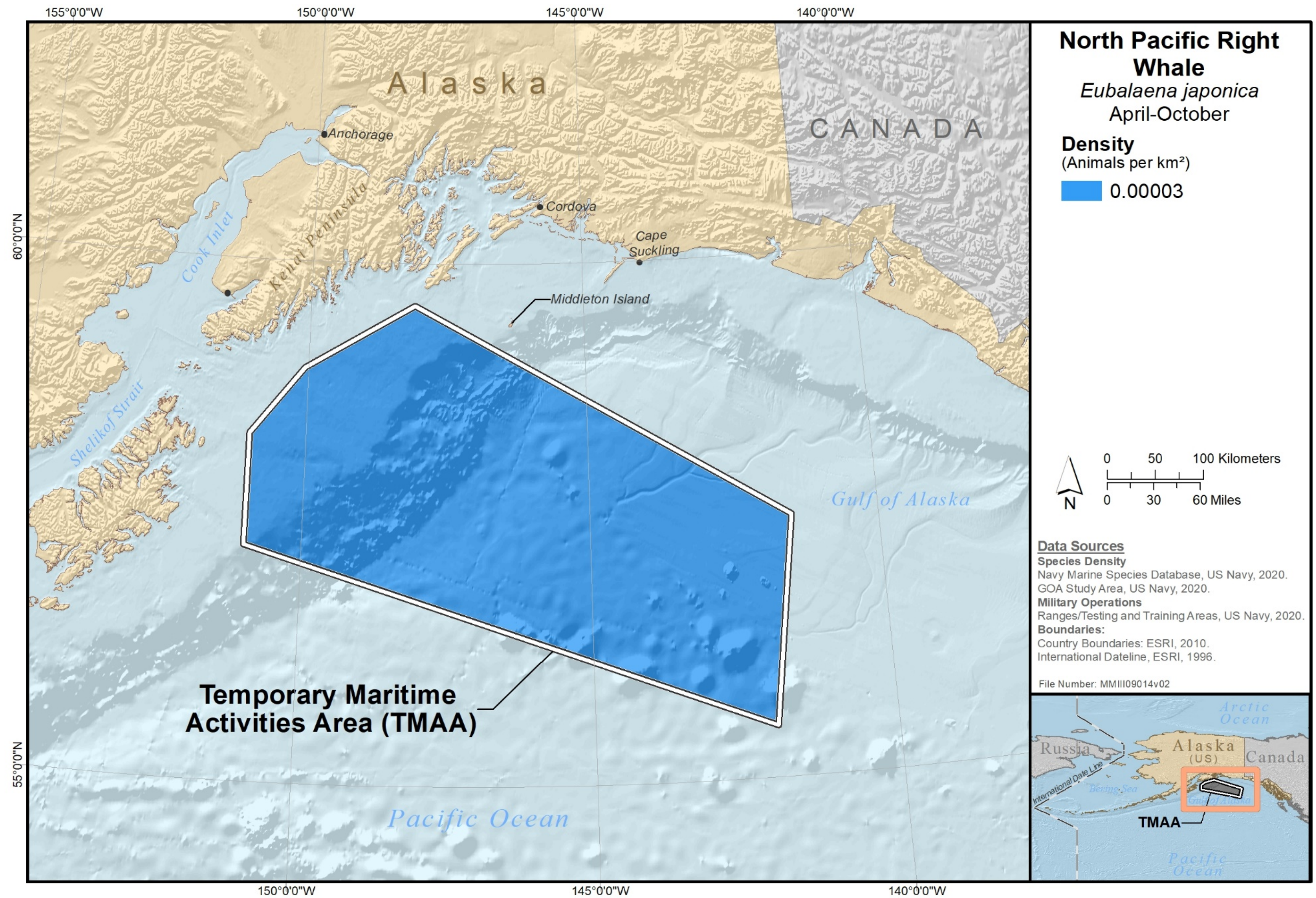


Figure 5-6: Estimated Density of North Pacific Right Whale in the TMAA from April Through October

5.1.7 *Megaptera novaeangliae*, Humpback Whale

Humpback whales are a relatively easily identified species of baleen whale, because of notable morphological features and behaviors they exhibit. They have long pectoral flippers that are white underneath, have a fairly distinctive dorsal fin that they arch high out of the water when they dive, often raise their flukes in the air when they dive, and exhibit surface-active behaviors such as breaching or slapping their tail or fins on the water (Clapham, 2000). In the Pacific, NMFS divides humpback whales into four stocks (Carretta et al., 2020; Muto et al., 2020): (1) Central North Pacific stock, consisting of winter and spring populations of the Hawaiian Islands that migrate to northern British Columbia and Alaska, the Gulf of Alaska, the Bering Sea, and Aleutian Islands; (2) Western North Pacific stock, consisting of winter and spring populations off Asia that migrate to Russia and the Bering Sea and Aleutian Islands; (3) California, Oregon, Washington, and Mexico stock, consisting of winter and spring populations in coastal Central America and coastal Mexico that migrate to coastal California and to British Columbia in summer and fall; and (4) American Samoa stock, with largely undocumented feeding areas as far south as the Antarctic Peninsula. On October 11, 2016, NMFS's Final Rule was published (81 Federal Register 62259) to designate 14 DPSs worldwide, four of which occur in the North Pacific: (1) Western North Pacific, (2) Hawaii, (3) Mexico, and (4) Central America. Whales from both the Central North Pacific and Western North Pacific stocks occur in the GOA TMAA Study Area. The IWC recognizes one large stock of humpback whales in the North Pacific.

Density Data. Based on both sighting data and acoustic detections, humpback whales are known to occur year round in the Gulf of Alaska (Baumann-Pickering et al., 2012a; Calambokidis et al., 2008; Debich et al., 2013; Debich et al., 2014; Rice et al., 2015; Rice et al., 2018; Stafford, 2007). Humpback whales were observed during both the 2009 and 2013 GOALS surveys, and were the most commonly sighted cetacean during the 2015 survey designed to cover known historical right whale habitat (Rone et al., 2017). The majority of all sightings were on the continental shelf within the Inshore Stratum. Based on an updated analysis of the 2013 survey data, Rone et al. (2017) derived density estimates specific to the four TMAA strata (Table 5-7 and Figure 5-7): 0.093 animals/km^2 (inshore stratum), 0.001 animals/km^2 (offshore stratum), 0.001 animals/km^2 (seamount stratum), and 0.0002 animals/km^2 (slope stratum).

Table 5-7: Summary of Density and Uncertainty Values for Humpback Whale

Location	April–October
TMAA – Inshore Stratum	0.093 (CV=0.74)
TMAA – Offshore Stratum	0.001 (CV=0.85)
TMAA – Seamount Stratum	0.001 (CV=0.59)
TMAA – Slope Stratum	0.0002 (CV=1.01)

Notes: (1) The units for numerical values are animals/km^2.
(2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation

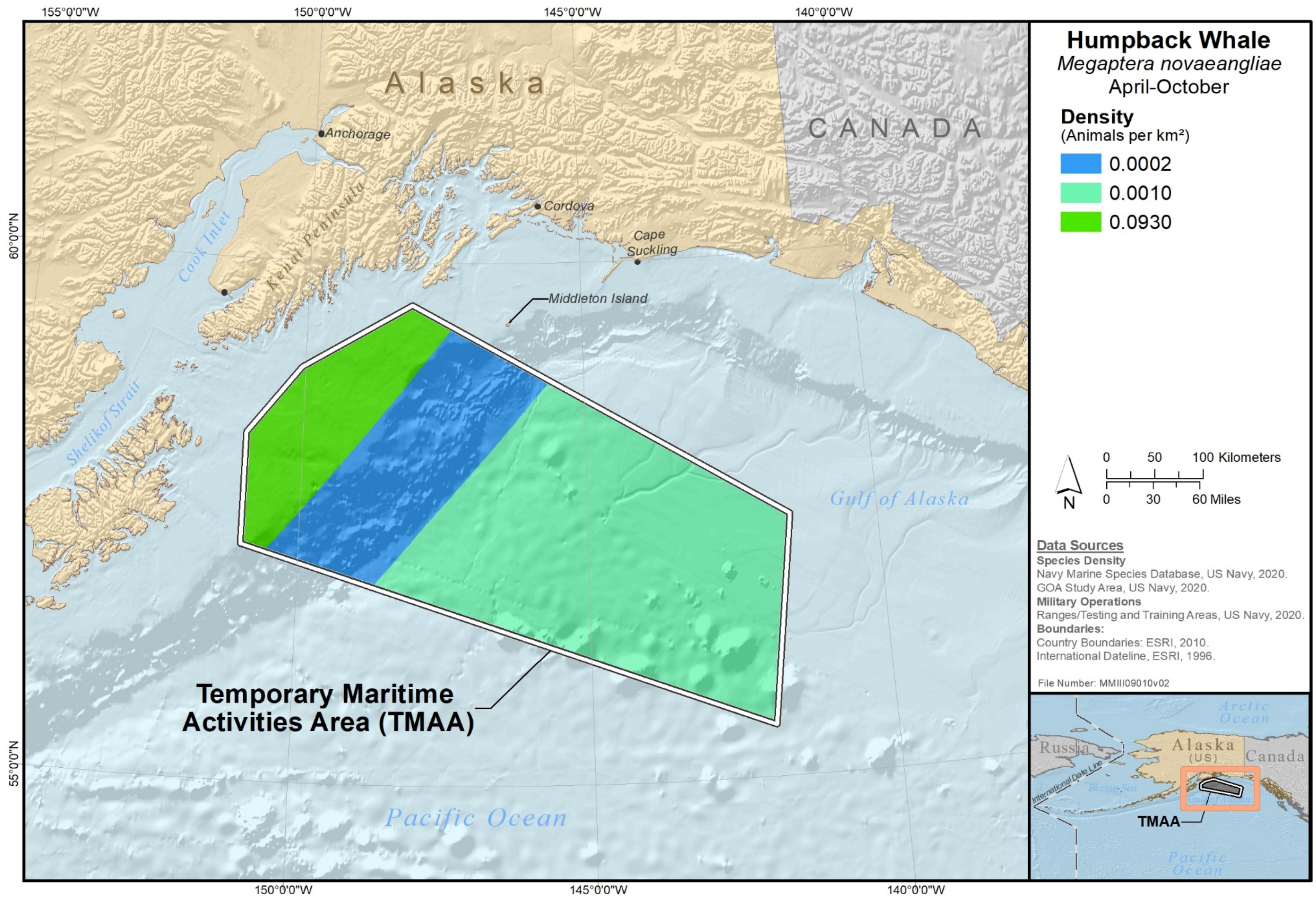


Figure 5-7: Estimated Density of Humpback Whale in the TMAA from April Through October

6 SPERM WHALES

6.1 SPERM WHALES SPECIES PROFILES

6.1.1 *PHYSETER MACROCEPHALUS*, SPERM WHALE

Sperm whales are the largest of the extant toothed whales and are one of the best studied species of whale in the world (Whitehead, 2003). Their size, distinctive form, and angled “bushy” blow makes them one of the easiest species of whale to identify in the field (Leatherwood et al., 1988; Whitehead & Weilgart, 2000). Sperm whales are one of the most-widely distributed species of marine mammal (Whitehead, 2009). NMFS has divided sperm whales in the North Pacific into three stocks: the California/Oregon/Washington stock, the Hawaii stock, and the Alaska/North Pacific stock (Carretta et al., 2020; Muto et al., 2020). The Alaska/North Pacific stock primarily uses the Gulf of Alaska and the Bering Sea. NMFS acknowledges the stocks are not entirely discrete, but they are thought to reflect population centers (Carretta et al., 2020; Carretta et al., 2017) and are based on a phylogeographic approach to defining stock structure (Dizon et al., 1992). The IWC recognizes eastern North Pacific and western North Pacific management units of sperm whales (Carretta et al., 2020; Carretta et al., 2017). Animals from the Alaska/North Pacific stock are those that are expected to occur in the GOA TMAA Study Area.

Density Data. Acoustic surveys have detected the presence of sperm whales year round in the Gulf of Alaska, (Baumann-Pickering et al., 2012a; Debich et al., 2013; Debich et al., 2014; Mellinger et al., 2004; Moore et al., 2006; Rice et al., 2015; Rice et al., 2018). Sperm whales were not observed during the 2009 GOALS survey, but there were 19 on-effort sightings during the 2013 GOALS II survey, and 25 on-effort sighting during the 2015 survey designed to cover known historical right whale habitat (Rone et al., 2017). During the 2013 GOALS II survey there were also 241 sperm whale acoustic detections from the towed hydrophone array, 174 of which were localized. Based on the localized acoustic detections, the following density estimates were derived for sperm whales: 0.0013 animals/km^2 (offshore stratum), 0.00036 (seamount stratum), and 0.0033 (slope stratum) (Rone et al., 2014) (Table 6-1). Based on an analysis of the 2015 visual survey data, Rone et al. (2017) was able to derive a density estimate for the inshore stratum of 0.002 animals/km^2 (Table 6-1 and Figure 6-1). Rone et al. (2017) also provided density estimates derived from the visual sighting data for the other three strata; however, these were less precise than those derived from the acoustic detections so the latter were included in the NMSDD.

Table 6-1: Summary of Density and Uncertainty Values for Sperm Whale

Location	April–October
TMAA – Inshore Stratum	0.002 (CV=0.58)
TMAA – Offshore Stratum	0.0013 (CV=0.36)
TMAA – Seamount Stratum	0.00036 (CV=0.55)
TMAA – Slope Stratum	0.0033 (CV=0.18)

Notes: (1) The units for numerical values are animals/km^2.

(2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation

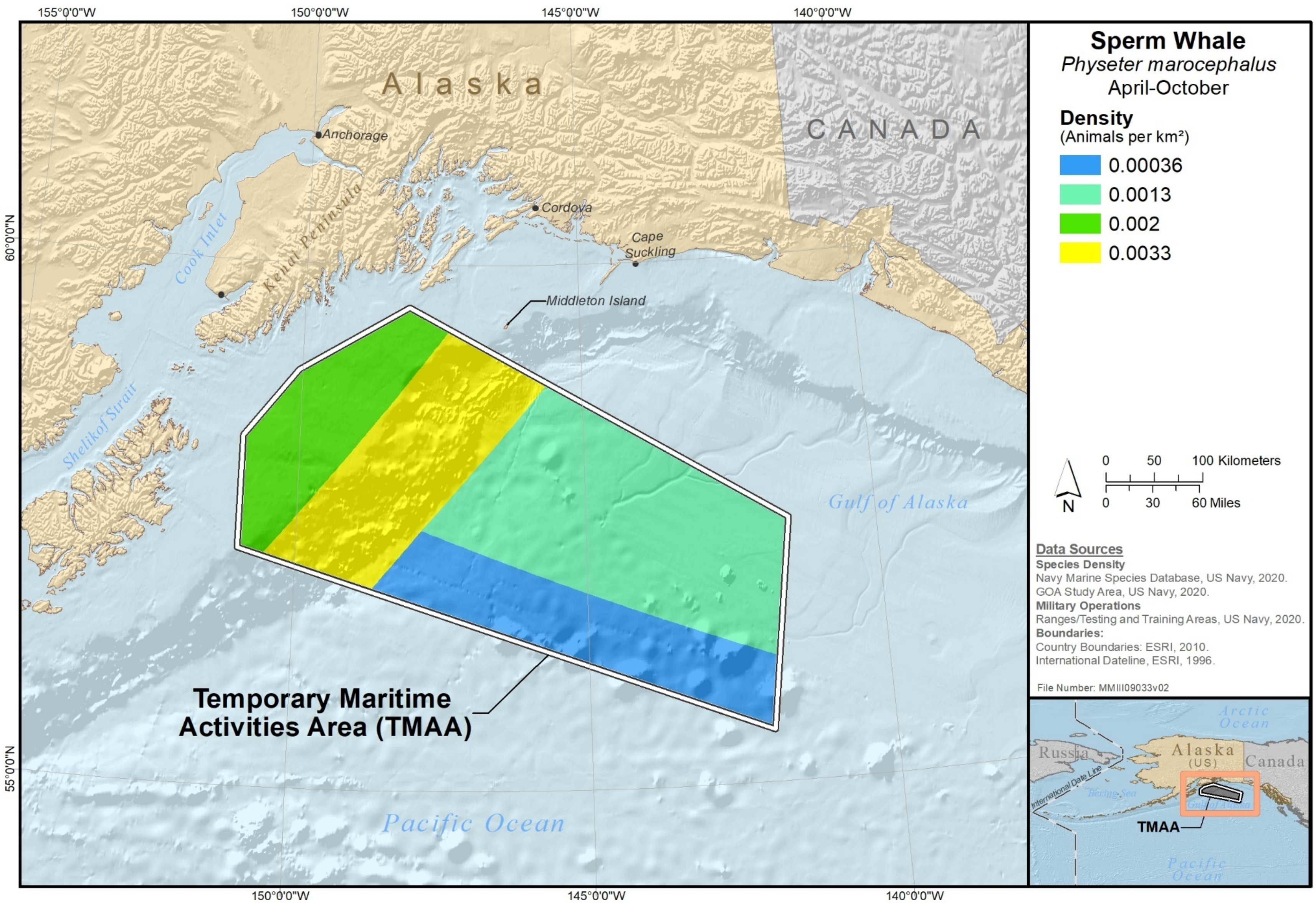


Figure 6-1: Estimated Density of Sperm Whale in the TMAA from April Through October

7 DELPHINIDS (DOLPHINS)

7.1 DELPHINID SPECIES PROFILES

7.1.1 *LAGENORHYNCHUS OBLIQUIDENS*, PACIFIC WHITE-SIDED DOLPHIN

This small-bodied dolphin with a small but distinctive beak is found in the temperate waters of the North Pacific (Jefferson et al., 2015). It is primarily seen off the slope and shelf along the west coast of North America (Hamilton et al., 2009). The coloration of Pacific white-sided dolphins is distinctive, bold, and complex. The white belly is separated from the gray patch on the side by a thin black line and the dorsal side has a "suspenders" pattern that flows from the rostrum over the shoulder to the flank (Black, 2009; Brownell et al., 1999). The dorsal fin is distinctive because it is strongly curved or hooked, particularly in older individuals, in which the fin takes on a lobate shape (Allen et al., 2011; Jefferson et al., 2015). Although the diagnostic coloration and the shape of the fin should make this species relatively easy to identify, they could be mistaken for common dolphins (*Delphinus* sp.) and Dall's porpoise (Leatherwood et al., 1988). At a distance, a rapidly moving group of Pacific white-sided dolphins could be mistaken for a large group of either long- or short-beaked common dolphin. The "rooster-tail" splashes made by the dorsal fins of Pacific white-sided dolphins are similar to the splashes typically made by Dall's porpoises (Leatherwood et al., 1988). What often gives away the identity of Pacific white-sided dolphins is their acrobatic behavior (Black, 2009; Brownell et al., 1999). They are often seen in groups with a wide variety of marine mammals, including California sea lions (*Zalophus californianus*) (Baird & Stacey, 1991; Black, 2009; Brownell et al., 1999; Leatherwood et al., 1988).

Two stocks of Pacific white-sided dolphin are recognized by NMFS (Carretta et al., 2020; Muto et al., 2020). 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 second stock recognized by NMFS is the Alaska/North Pacific stock that covers the west coast of Canada, the Gulf of Alaska, and the area around the Aleutian Islands (Carretta et al., 2020; Muto et al., 2020). Animals from the Alaska/North Pacific stock are those that are expected to occur in the Study Area.

Density Data. There is currently no reliable population estimate for the Alaska/North Pacific stock of Pacific white-sided dolphins (Muto et al., 2020). Based on sighting data collected from surveys north of 45 degrees (°) North (N) from 1987 to 1990 (Buckland et al., 1993), Pacific white-sided dolphin abundance specific to the Gulf of Alaska was estimated at 26,880 animals (Muto et al., 2020). Sighting data recorded on the Cetacean Density and Distribution Mapping Working Group website (www.st.nmfs.noaa.gov/cetsound) indicate that Pacific white-sided dolphins have been sighted in the Gulf of Alaska in April, May, June, and July, and are expected to occur there year round. During the April 2009 GOALS survey, Pacific white-sided dolphins were sighted only once (a group of 60 individuals), although the location of the sighting was outside the TMAA and inside the shelf break to the southeast of Kodiak Island (Rone et al., 2009). Pacific white-sided dolphins were not sighted during the Navy's 2013 survey of the Study Area (Rone et al., 2014), but there were six on-effort sightings during the August 2015 survey designed to cover known historical right whale habitat (Rone et al., 2017). However, density estimates were not derived from these data. Based on sighting data from Waite (2003), the U.S. Department of the Navy (2009) derived a year-round density estimate of Pacific white-sided dolphins of

0.0208 animals/km^2. This estimate is consistent with an overall study area density estimate of 0.02 used in the NMSDD (Table 7-1 and Figure 7-1), calculated by taking the Gulf of Alaska population estimate from the NMFS Stock Assessment Report (26,000; (Muto et al., 2020) divided by the TMAA study area (1,533,000 km^2).

Table 7-1: Summary of Density and Uncertainty Values for Pacific White-Sided Dolphin

Location	April–October
TMAA	0.02 (CV=NA)

Notes: (1) The units for numerical values are animals/km^2.
(2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation, NA = not applicable

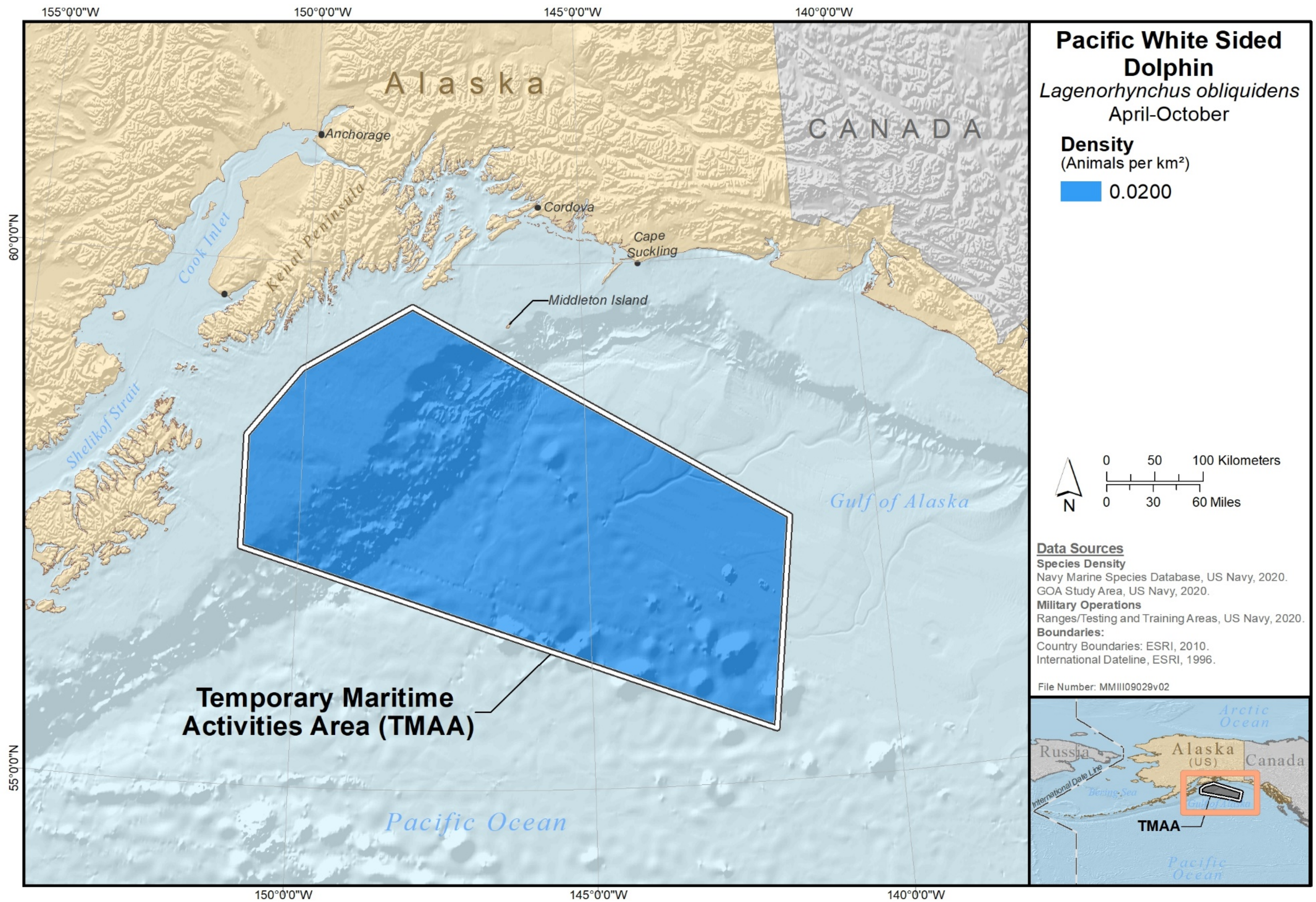


Figure 7-1: Estimated Density of Pacific White-Sided Dolphin in the TMAA from April Through October

7.1.2 *ORCINUS ORCA*, KILLER WHALE

Killer whales are top predators that are found throughout the world's oceans (Dahlheim & Heyning, 1999; Jefferson et al., 2015). The structure of the division of groups within the species is complex and has a strong bearing on the range, behavior, foraging strategy, and physiology of each type of killer whale (Baird, 2000; Foote et al., 2011; Foote et al., 2009; Kasamatsu et al., 2000; Pitman & Durban, 2012). A single species of killer whale is currently recognized, but strong and increasing evidence indicates the possibility of several different species of killer whales worldwide, many of which are currently called "ecotypes" (Ford, 2008; Morin et al., 2010). The different geographic forms of killer whale are distinguished by distinct social and foraging behaviors and other ecological traits. In the North Pacific, these recognizable geographic forms are variously known as "residents," "transients," and "offshores" (Baird, 2000; Barrett Lennard et al., 1996). Killer whales' physical profile is unmistakable. They have a tall dark dorsal fin, a robust black body with a striking patch of white behind the eye, a white lower jaw, and lighter-colored "saddle patch" behind the dorsal fin (Jefferson et al., 2015). They are unlikely to be mistaken for any other species, except possibly Risso's dolphins if only the dorsal fins are seen from a distance or false killer whales if only females (which are smaller than males) and juveniles are encountered (Leatherwood et al., 1988).

Eight killer whale stocks are recognized within the Pacific U.S. EEZ, including the (1) Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock (Prince William Sound through the Aleutian Islands and Bering Sea); (2) AT1 Transient stock (Alaska from Prince William Sound through the Kenai Fjords); (3) Alaska resident stock (Southeast Alaska to the Aleutian Islands and Bering Sea); (4) Northern Resident stock (British Columbia through part of Southeast Alaska); (5) West Coast Transient stock (Alaska through California); (6) Offshore stock (Southeast Alaska through California); (7) Southern Resident stock (within the inland waters of Washington State and southern British Columbia, and also in coastal waters from British Columbia through California); and (8) Hawaii stock (Carretta et al., 2020; Muto et al., 2020). Killer whales most likely to occur in the GOA TMAA Study Area based on dominant distribution patterns include the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock and the Alaska Resident stock; while whales from the AT1 Transient stock and the Offshore stock could also occur in the GOA TMAA Study Area, occurrence is considered rare and infrequent, respectively.

Density Data. Sighting data recorded on the Cetacean Density and Distribution Mapping Working Group website (www.st.nmfs.noaa.gov/cetsound) indicate that killer whales have been sighted in the Gulf of Alaska year-round. Killer whales were detected at HARPs deployed in the shelf and slope region of north-central Gulf of Alaska from July 2011 through early January 2012, with peak presence during mid-July and mid-August (Baumann-Pickering et al., 2012b). Killer whales were detected from five HARPs deployed in various locations within the TMAA from June 2013 to May 2014, with peaks in click and whistle detections varying both temporally and spatially (Debich et al., 2014). During the April 2009 GOALS survey, six groups of killer whales totaling 119 animals were sighted, and there were an additional 16 acoustic detections (Rone et al., 2009). During the June and July 2013 GOALS II survey there were 21 killer whale sightings of 138 total animals (Rone et al., 2014). During the August 2015 survey designed to cover known historical right whale habitat, there were nine on-effort killer whale sightings of 66 total animals (Rone et al., 2017). Killer whales were sighted in all four of the Study Area strata, although in 2013 the majority were observed in the slope stratum. Based on an updated analysis of the 2013 and 2015 survey data, Rone et al. (2017) derived density estimates specific to three of the four TMAA strata: 0.005 animals/km^2 (inshore stratum), 0.002 animals/km^2 (seamount stratum), and 0.019 animals/km^2 (slope stratum) (Table 7-2 and Figure 7-2). Based on pooled sightings from all strata, an overall killer whale density estimate for the Study Area was calculated as 0.002 animals/km^2 (Rone et al., 2017). In lieu of a density estimate specific to the offshore stratum, and given the multiple acoustic detections in the offshore area (Rone et al., 2014), the overall study area density estimate was applied to this stratum. The density estimates were not stratified by ecotype although the presence of transient and resident ecotypes was confirmed through photo-identification and the presence of the offshore ecotype was confirmed through acoustic detections (Rone et al., 2017).

Table 7-2: Summary of Density and Uncertainty Values for Killer Whale

Location	April–October
TMAA – Inshore Stratum	0.005 (CV=0.59)
TMAA – Offshore Stratum	0.002 (CV=0.72)
TMAA – Seamount Stratum	0.002 (CV=0.77)
TMAA – Slope Stratum	0.019 (CV=0.92)

Notes: (1) The units for numerical values are animals/km^2. (2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation

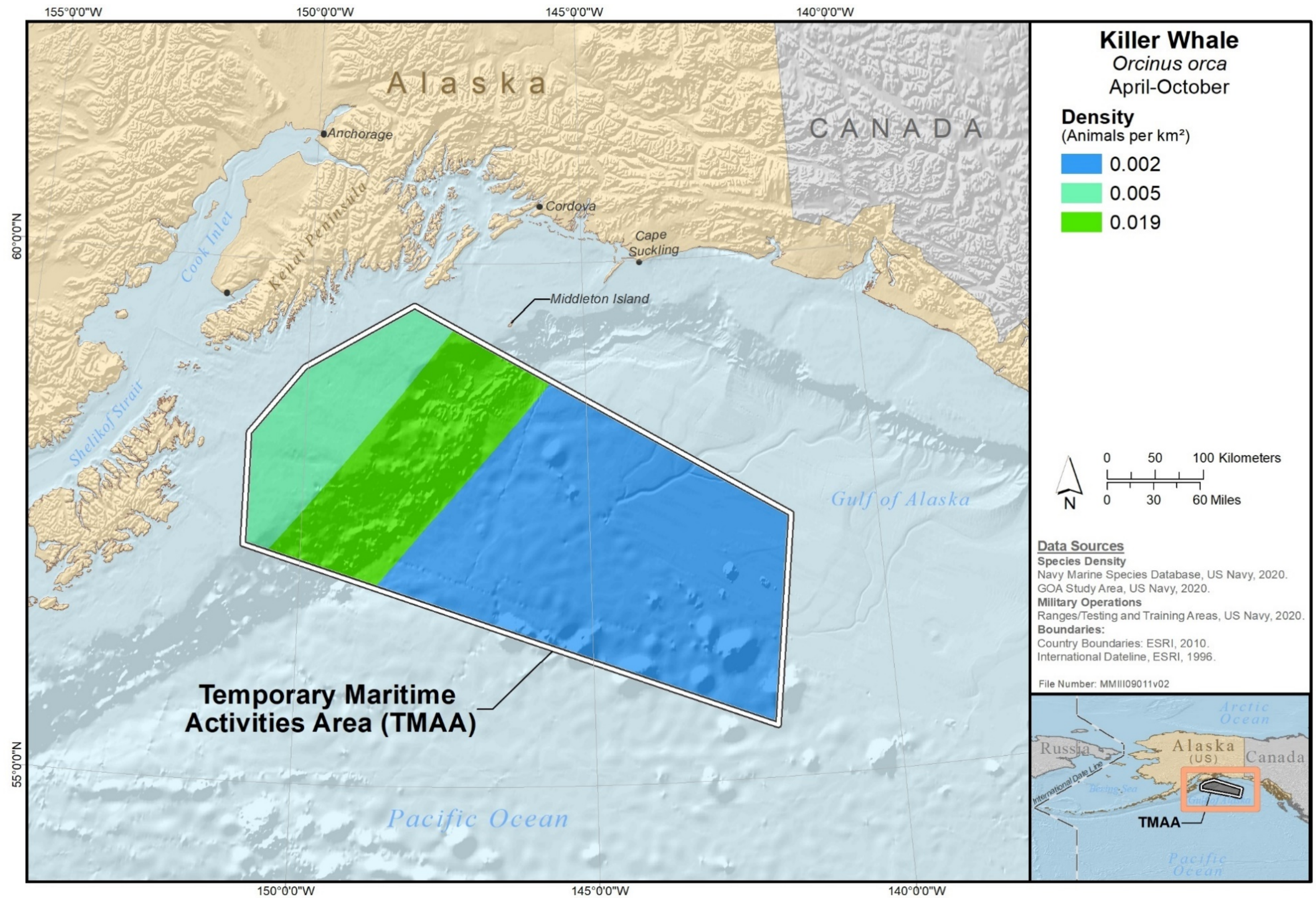


Figure 7-2: Estimated Density of Killer Whale in the TMAA from April Through October

8 PORPOISES

8.1 *PORPOISE SPECIES PROFILES*

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

8.1.1 *PHOCOENA PHOCOENA*, HARBOR PORPOISE

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

Stocks of harbor porpoises are finely divided on the Pacific coast of the United States. Nine separate stocks are defined by NMFS: the Bering Sea stock, the Gulf of Alaska stock, the Southeast Alaska stock, the Washington Inland Waters stock, the Northern Oregon/Washington Coastal stock, the Northern California/Southern Oregon stock, the San Francisco-Russian River stock, the Monterey Bay stock, and the Morro Bay stock (Carretta et al., 2020; Muto et al., 2020). Harbor porpoise from both the Gulf of Alaska and Southeast Alaska stocks may occur in the GOA TMAA Study Area.

Density Data. Harbor porpoises are often found in coastal waters in the Gulf of Alaska and occur most frequently in waters less than 100 m deep (Hobbs & Waite, 2010). The majority of the Study Area is offshore and beyond the normal habitat range for harbor porpoise. During the April 2009 GOALS survey, there was only one harbor porpoise sighting within the Study Area, which occurred in one of the shallowest regions (Rone et al., 2009). There were an additional 29 sightings made in-transit to the Study Area, and these were in shallow waters south of Kodiak Island and the Alaska Peninsula. During the June and July 2013 survey of the Study Area, there were a total of eight harbor porpoise sightings in the inshore stratum and on the shelf in the slope stratum (Rone et al., 2014), and one sighting during the August 2015 survey designed to cover known historical right whale habitat (Rone et al., 2017). Density estimates were not derived from these data.

Abundance estimates for the two harbor porpoise stocks that may occur in the GOA TMAA Study Area (Gulf of Alaska and Southeast Alaska stocks) were derived from survey data collected in summer 1997 in Southeast Alaska and 1998 in the Gulf of Alaska and included correction factors for both perception and availability bias (Hobbs & Waite, 2010). Data derived from Hobbs and Waite (2010) were used to characterize harbor porpoise density in the Gulf of Alaska, based on their published depth distributions as characterized by the strata listed in Table 8-1 and shown in Figure 8-1.

Table 8-1: Summary of Density and Uncertainty Values for Harbor Porpoise

Location	April–October
GOA inside 100 m isobath*	0.4547 (CV=NA)
GOA from 100 to 200 m isobaths	0.0473 (CV=NA)
GOA > 200 m isobath	0

Notes: (1) The units for numerical values are animals/km^2. 0 = species is not expected to be present. (2) GOA = Gulf of Alaska, m = meters, CV = coefficient of variation, NA = not applicable

*Not shown, because the area is too shallow to occur in the TMAA.

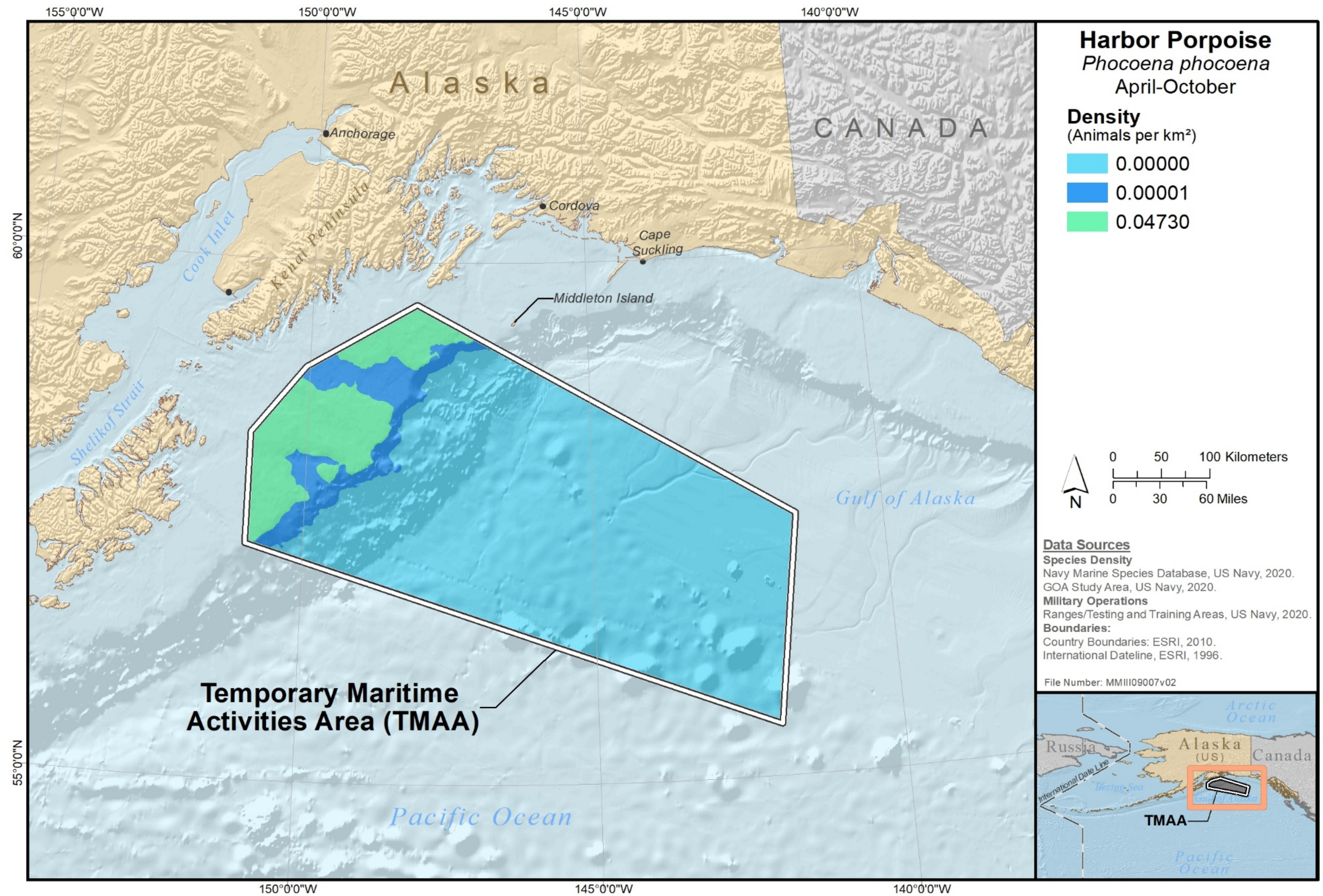


Figure 8-1: Estimated Density of Harbor Porpoise in the TMAA from April Through October

8.1.2 *Phocoenoides dalli*, Dall's Porpoise

Dall's porpoise is a robust cetacean that is somewhat larger than the harbor porpoise (Jefferson et al., 2015). They have an extremely stocky build, with the body particularly humped in the middle of the back and tapering quickly toward the head and at the peduncle (Allen et al., 2011; Leatherwood et al., 1988). Dall's porpoises are black with large lateral white patches, as well as white on the upper portion of the dorsal fin and the trailing edge of the flukes (Jefferson et al., 2015). The tail fluke is unusual in that it will either have a flat trailing edge or even a forward canted trailing edge (Jefferson et al., 2015). The dorsal fin is farther forward than on the harbor porpoise, and it forms an upright triangle with the front side curving or leaning forward, more so in adult males (Jefferson et al., 2015; Leatherwood et al., 1988). Dall's porpoise could be mistaken for harbor porpoise or Pacific white-sided dolphin in the field, until observed at closer range (Allen et al., 2011; Leatherwood et al., 1988). The coloration and body shape will dispel any misidentification. Dall's porpoise often move quickly and cause a spray when they break the surface of the water (Houck & Jefferson, 1999); this splash is similar to the spray at times caused by Pacific white-sided dolphins. When moving more slowly, the roll of the back of Dall's porpoise can look like a harbor porpoise if the white of the dorsal fin is not visible due to inadequate lighting.

The behavior of the Dall's porpoise and the harbor porpoise are very different in most circumstances. Dall's porpoise approach boats readily (Houck & Jefferson, 1999) and are not shy. They are one of the fastest cetaceans and they like to keep pace with vessels and weave back and forth in front of the bow (Allen et al., 2011; Houck & Jefferson, 1999). Moving in front of a pressure wave from humpback, gray, blue, and fin whales has also been reported for Dall's porpoise (Allen et al., 2011; Houck & Jefferson, 1999). Two stocks of Dall's porpoise (an Alaska stock and a California/Oregon/Washington stock (Carretta et al., 2020; Muto et al., 2020)) are defined by NMFS. Animals occurring in the GOA TMAA Study Area belong to the Alaska stock.

Density Data. Sighting data recorded on the Cetacean Density and Distribution Mapping Working Group website (www.st.nmfs.noaa.gov/cetsound) indicate that Dall's porpoises have been sighted in the Gulf of Alaska from April to October and are expected to occur there year round. During the April 2009 GOALS survey, there were 10 Dall's porpoise sightings of 59 animals (Rone et al., 2009). During the June and July 2013 survey of the Study Area, there were a total of 320 Dall's porpoise on-effort sightings of 859 animals (Rone et al., 2014). There were an additional 93 on-effort sightings of 364 individuals during the August 2015 survey designed to cover known historical right whale habitat (Rone et al., 2017). Sightings were made within all four of the Study Area strata; however, during the 2013 survey there were substantial concentrations of Dall's porpoise in both the inshore and slope strata. Based on an updated analysis of the 2013 survey data, Rone et al. (2017) derived density estimates specific to the four TMAA strata (Table 8-2 and Figure 8-2): 0.218 animals/km^2 (inshore stratum), 0.037 animals/km^2 (offshore stratum), 0.024 animals/km^2 (seamount stratum), and 0.196 animals/km^2 (slope stratum).

Table 8-2: Summary of Density and Uncertainty Values for Dall's Porpoise

Location	April–October
TMAA – Inshore Stratum	0.218 (CV=0.39)
TMAA – Offshore Stratum	0.037 (CV=0.42)
TMAA – Seamount Stratum	0.024 (CV=0.45)
TMAA – Slope Stratum	0.196 (CV=0.48)

Notes: (1) The units for numerical values are animals/km^2.
(2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation

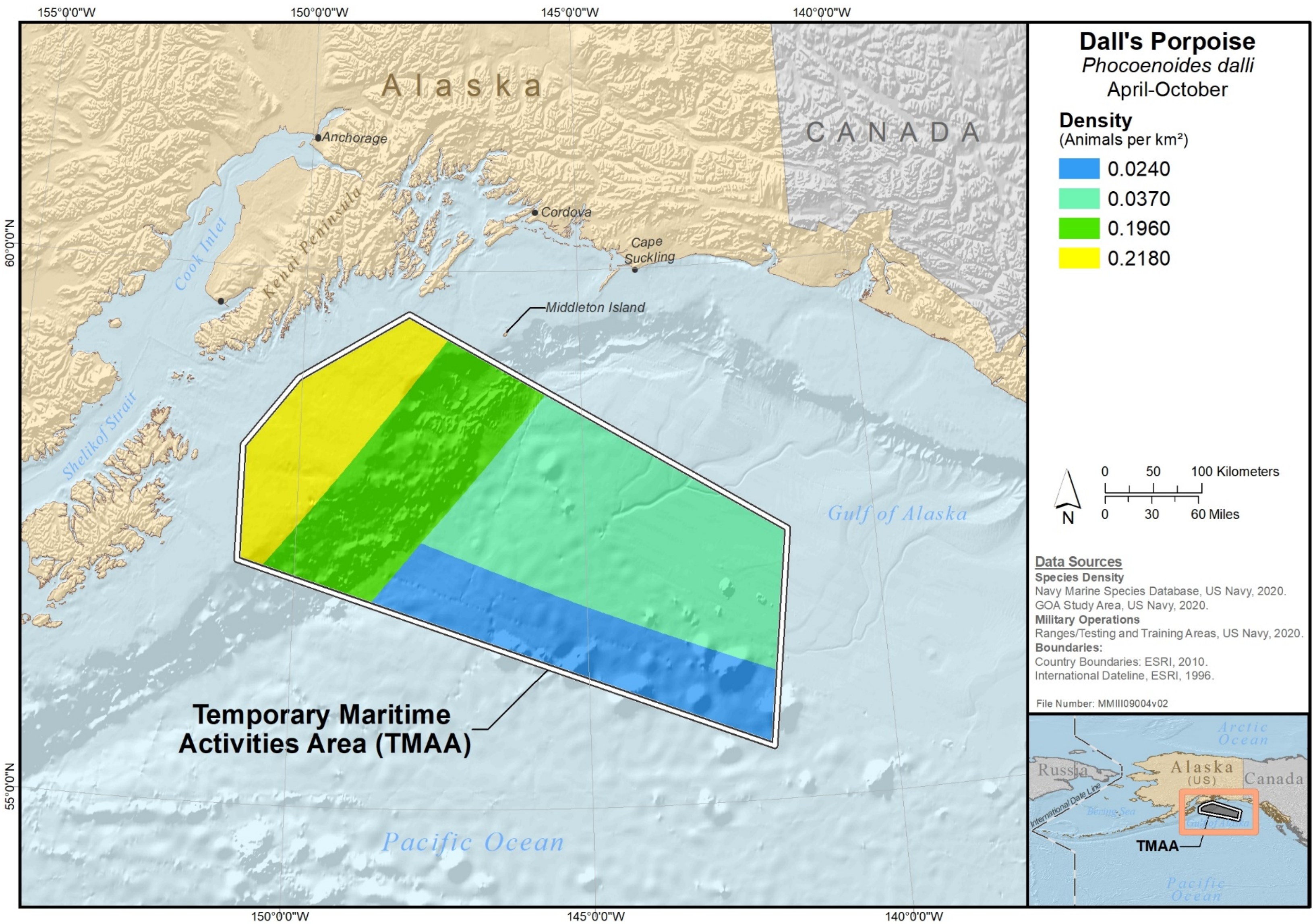


Figure 8-2: Estimated Density of Dall's Porpoise in the TMAA from April Through October

9 BEAKED WHALES

9.1 BEAKED WHALE SPECIES PROFILES

This group of species is problematic in terms of establishing values for the marine mammal density database. Beaked whales are notoriously difficult to detect and identify at sea because of their short surfacing series relative to long dive times (Baird et al., 2006; Barlow, 1999), low profile (Barlow et al., 2006), and likely avoidance of vessels (Heyning, 1989; Pitman, 2009). These difficulties result in having few sightings for a number of species and questionable identification in many cases for the beaked whales that are seen. Researchers have addressed these problems primarily by pooling the data into groups either by family or at least size. Although this dilutes the actual knowledge for a particular species, it allows for a more robust sense of the presence of beaked whales in general. This is a better solution than not estimating the degree of presence until sufficient data exist, because the Navy needs to be able to quantify to some degree its interactions with all species of concern in its OPAREAS.

There have been limited sightings of beaked whales within the GOA TMAA Study Area, but information on beaked whale occurrence has been augmented with acoustic recordings. There are currently three beaked whale species confirmed to occur in the GOA TMAA Study Area for which the Navy entered values into the density database: Baird's, Cuvier's, and Stejneger's (*Mesoplodon stejnegeri*) beaked whales.

9.1.1 BERARDIUS BAIRDII, BAIRD'S BEAKED WHALE

This large, dark-colored beaked whale is the largest whale in the family *Ziphiidae* (Jefferson et al., 2015). They are found only in North Pacific temperate waters up to the vicinity of drift ice in the Bering Sea (Jefferson et al., 2015; Leatherwood et al., 1988). Baird's beaked whale may prefer continental shelf and sea mount habitat (Jefferson et al., 2015). The species can be elusive and difficult to approach (Minamikawa et al., 2007). They have a long rostrum and a slender body, giving them a relatively unique profile for a large beaked whale. Their small but obvious dorsal fin is two-thirds of the way along the body and is typically rounded at the tip (Jefferson et al., 2015; Leatherwood et al., 1988). They often have scars all over their body, like Risso's dolphin, which are thought to come from the pair of protruding teeth at the front of the lower jaw of conspecifics; both sexes have the tusks (Balcomb, 1989).

In the field, Baird's beaked whale is less likely to be confused with other beaked whales that occur in their range than they are of being confused with minke whales from a distance (Jefferson et al., 2015; Leatherwood et al., 1988). Fortunately, the surfacing behavior of Baird's beaked whale allows the unique shape of their head to be seen, as they often lift it out of the water as they surface (Jefferson et al., 2015). In contrast to minke whales and many other beaked whale species, Baird's beaked whales often occur in large groups (Baird et al., 2008; Leatherwood et al., 1988). The groups are often tight knit with the animals aligned like a "log jam" (Jefferson et al., 2015). This group behavior may sometimes make a group of Baird's beaked whales mistaken for a group of sperm whales logging at the surface (Leatherwood et al., 1988).

Two stocks of Baird's beaked whale are recognized by NMFS: an Alaska stock, which covers a large part of the North Pacific, and a California/Oregon/Washington stock that is found primarily in the California Current Ecosystem (Carretta et al., 2020; Muto et al., 2020). The Alaska stock is the population likely to be found in the GOA TMAA Study Area.

Density Data. Baird's beaked whales were detected regularly from September through February during passive acoustic monitoring from a HARP deployed in the slope region of north-central Gulf of Alaska from July 2011 to February 2012 (Baumann-Pickering et al., 2012b). Acoustic detections were not made at the passive acoustic recording site deployed in the shelf region, consistent with this species apparent preference for deep waters (Baumann-Pickering et al., 2012b). Recordings from five HARPs placed in various locations within the Study Area from June 2013 to May 2014 confirmed this species apparent preference for deep water as Baird's beaked whales were detected only from HARPs at the three deepest sites (i.e., > 850 m deep) (Debich et al., 2014). Detections were made throughout most of the recording period, but peak detections varied seasonally by site.

There were no beaked whale sightings during the April 2009 survey of the Study Area (Rone et al., 2009). During the Navy-funded June and July 2013 GOALS II survey, there were six on-effort sightings of Baird's beaked whales in the offshore, seamount, and slope strata (Rone et al., 2014). There were no Baird's beaked whale sightings during the August 2015 survey designed to cover known historical right whale habitat (Rone et al., 2015). Although there were 32 acoustic encounters of Baird's beaked whales during the 2013 survey, these data did not provide a sufficient sample size to reliably estimate density using line-transect distance sampling methods. The acoustic encounters occurred mainly in the slope stratum (56 percent), followed by the seamount stratum (33 percent), and offshore stratum (11 percent). Sighting data from Waite (2003) were used by the U.S. Department of the Navy (2009) to derive a density estimate for Baird's beaked whale of 0.0005 animals/km^2, and this estimate was incorporated into the NMSDD in the absence of more recent data for all but the inshore stratum (Table 9-1 and Figure 9-1). Based on the estimate of 0 density for Cuvier's beaked whale in the inshore stratum (Yack et al., 2015), and given sighting and acoustic data that suggest that Baird's beaked whale also prefer deep-water habitat, 0 density was assigned to the inshore stratum for Baird's beaked whale.

Table 9-1: Summary of Density and Uncertainty Values for Baird's Beaked Whale

Location	April–October
TMAA – Inshore Stratum	0
TMAA – Offshore Stratum	0.0005 (CV=NA)
TMAA – Seamount Stratum	0.0005 (CV=NA)
TMAA – Slope Stratum	0.0005 (CV=NA)

Notes: (1) The units for numerical values are animals/km^2. 0 = species is not expected to be present. (2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation, NA = not applicable

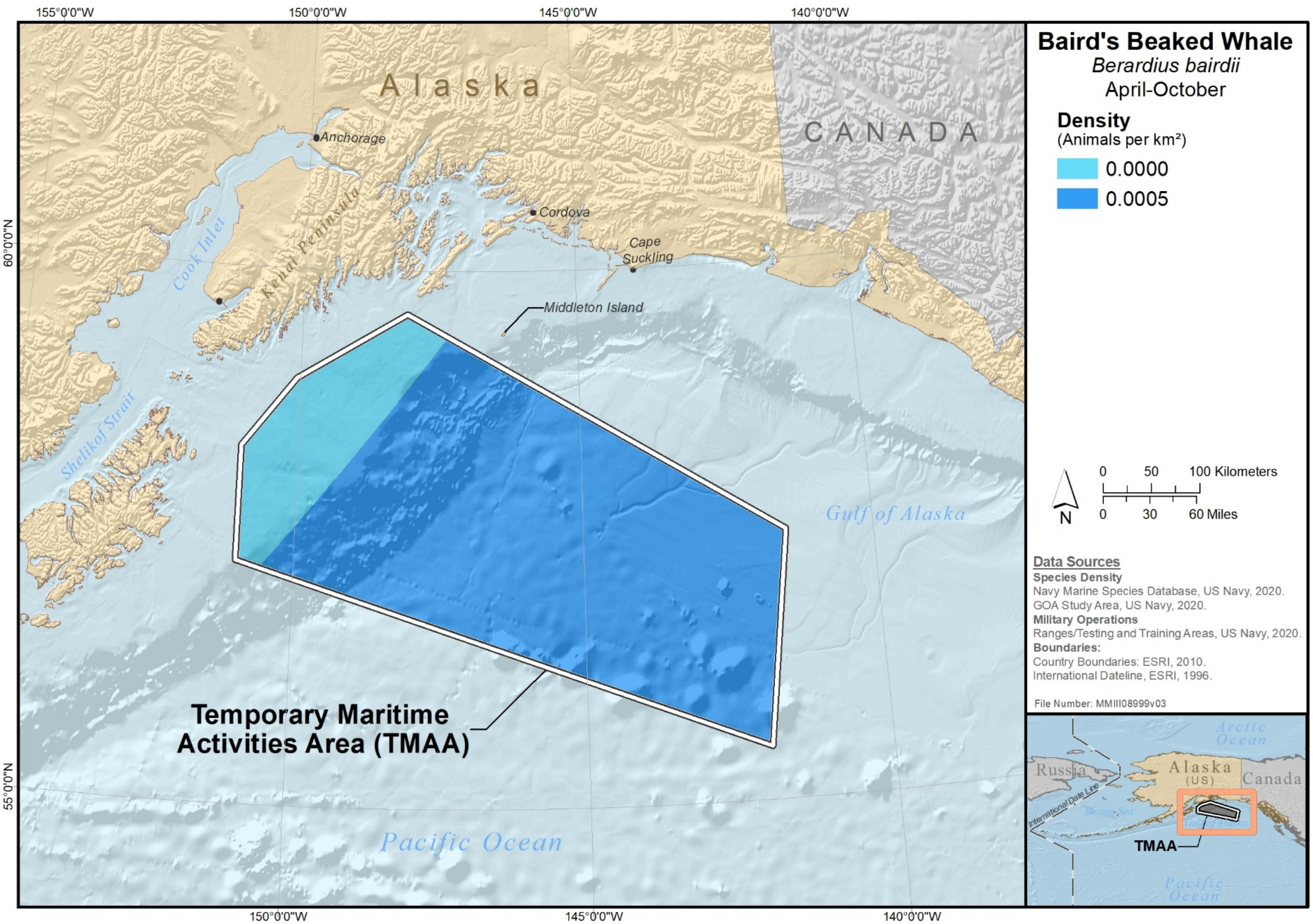


Figure 9-1: Estimated Density of Baird's Beaked Whale in the TMAA from April Through October

9.1.2 *MESOPLODON STEJNEGERI*, STEJNEGER'S BEAKED WHALE

Stejneger's beaked whale is rarely seen at sea and stranded specimens provide the majority of information on their distribution. Stejneger's beaked whale appears to prefer cold temperate and subpolar waters, and is by far the most common species of mesoplodont that occurs in Alaskan waters (Loughlin & Perez, 1985; MacLeod & D'Amico, 2006). This species has been observed in waters ranging in depth from 730 to 1,560 m on the steep slope of the continental shelf (Loughlin & Perez, 1985). The farthest south this species has been recorded in the eastern Pacific is Cardiff, California (33°N), but this is considered an extralimital occurrence (Loughlin & Perez, 1985; MacLeod & D'Amico, 2006; Mead, 1989).

Two of the three *Mesoplodon* stocks that NMFS recognizes include Stejneger's beaked whale (1) all *Mesoplodon* species off California, Oregon, and Washington; and (2) an Alaska stock of Stejneger's beaked whale (Carretta et al., 2020; Muto et al., 2020). Stejneger's beaked whales that occur in the GOA TMAA Study Area belong to the Alaska stock.

Density Data. Stejneger's beaked whales were detected almost continually during passive acoustic monitoring from a HARP deployed in the slope region of north-central Gulf of Alaska from July 2011 to February 2012 (Baumann-Pickering et al., 2012b). Acoustic detections were not made at the passive acoustic recording site deployed in the shelf region, consistent with this species apparent preference for deep waters (Baumann-Pickering et al., 2012b). Subsequent acoustic monitoring analyses revealed similar patterns, with Stejneger's beaked whales detected regularly on all HARPs located off the shelf region (Debich et al., 2013; Debich et al., 2014; Rice et al., 2015; Rice et al., 2018).

There were no beaked whale sightings during the April 2009 survey of the Study Area (Rone et al., 2009). No Stejneger's beaked whales were visually identified during the June and July 2013 GOALS II survey of the Study Area, although five unidentified beaked whale sightings were reported, and there were six acoustic detections of Stejneger's beaked whales (Rone et al., 2014). These data did not provide a sufficient sample size to reliably estimate density using line-transect distance sampling methods. Of the three beaked whale species known to occur in the Study Area, only Cuvier's and Stejneger's beaked whale signals were detected during passive acoustic monitoring in the Study Area from April 2014 to September 2015 and April to September of 2017 (Rice et al., 2015; Rice et al., 2018). Both species were regularly detected throughout the monitoring periods, but their detection rates varied spatially and temporally. In the absence of density data specific to Stejneger's beaked whale, the pooled strata density estimate for Cuvier's beaked whale (see Section 9.1.3, *Ziphius cavirostris*, Cuvier's Beaked Whale) of 0.0021 animals/km^2 (Yack et al., 2015) was used to represent Stejneger's beaked whale density in the three deep water strata (Table 9-2 and Figure 9-2). Based on the estimate of 0 density for Cuvier's beaked whale in the inshore stratum (Yack et al., 2015), and given acoustic data that suggest that Stejneger's beaked whales also prefer deep-water habitat, 0 density was assigned to the inshore stratum for Stejneger's beaked whale.

Table 9-2: Summary of Density and Uncertainty Values for Stejneger's Beaked Whale

Location	April–October
TMAA – Inshore Stratum	0
TMAA – Offshore Stratum	0.0021 (CV = NA)
TMAA – Seamount Stratum	0.0021 (CV = NA)
TMAA – Slope Stratum	0.0021 (CV = NA)

Notes: (1) The units for numerical values are animals/km^2. 0 = species is not expected to be present. (2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation, NA = not applicable

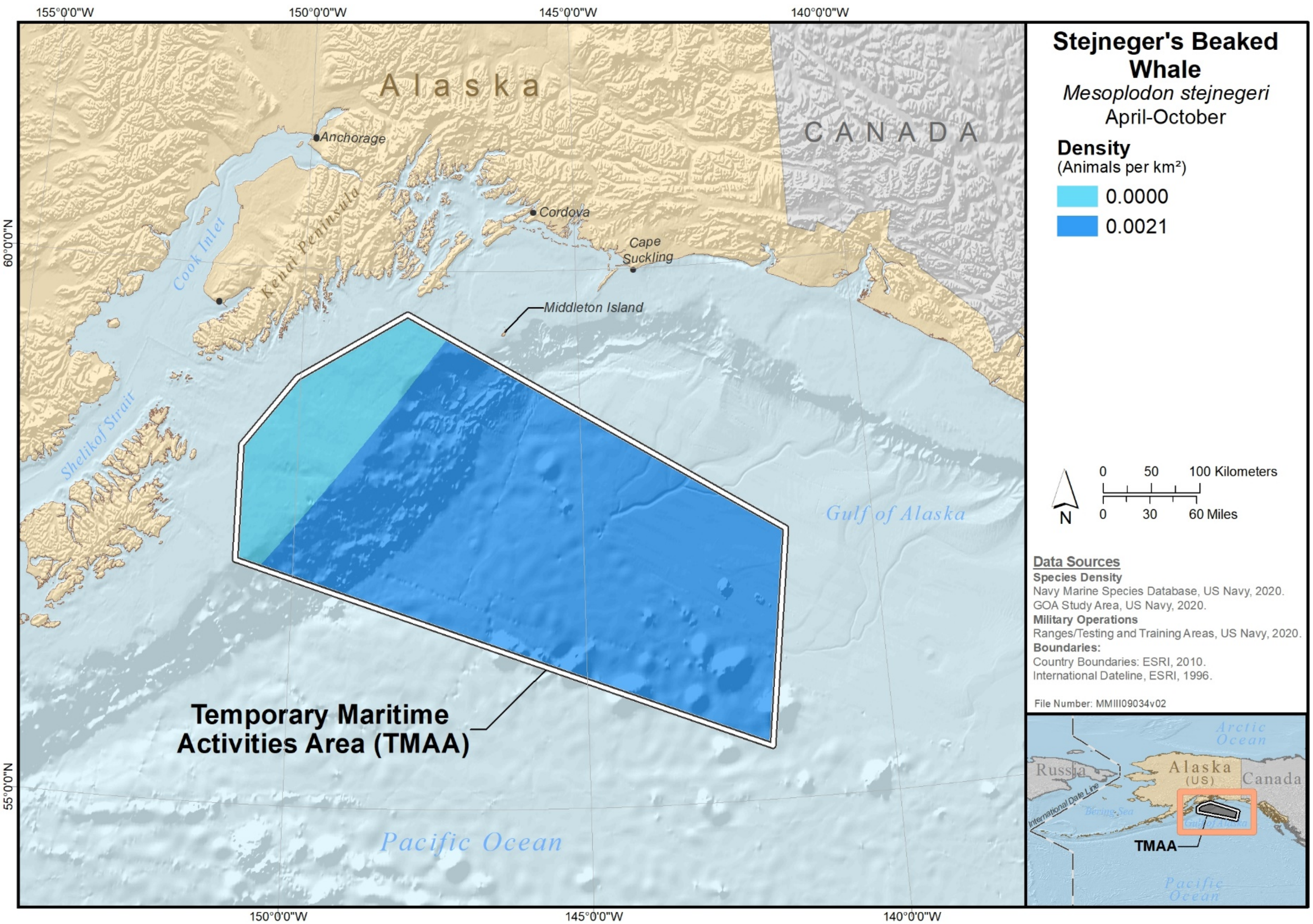


Figure 9-2: Estimated Density of Stejneger's Beaked Whale in the TMAA from April Through October

9.1.3 *ZIPHIUS CAVIROSTRIS*, CUVIER'S BEAKED WHALE

This beaked whale is the most cosmopolitan of the beaked whales, with a presence in all oceans except the polar seas (Heyning, 1989). Cuvier's beaked whale is a "robust" version of the typical beaked whale form (Jefferson et al., 2008; Leatherwood et al., 1988). Like other beaked whales the dorsal fin is small, falcate, and sits two-thirds of the way back on the length of the body. They have a stubby beak and a gently sloped to bulbous head which is pronounced in adult males (Jefferson et al., 2008; Leatherwood et al., 1988). Their jaw line only curves gently and is upturned at the gape (Jefferson et al., 2008). The color can be slate gray to brown and is lighter or white around the head and on the back anterior to the blowhole, especially so in adult males, which may appear completely white around the head and anterior body. Their blow is diffuse and angled forward and they actively avoid boats, so they can be quite difficult to observe at sea, except in calm sea states (Heyning & Mead, 2009; Jefferson et al., 2008). When observed they can be mistaken for other beaked whales, but the robustness of the body and fact that they have one of the shortest beaks of any beaked whale makes them reasonably distinguishable (Jefferson et al., 2008; Leatherwood et al., 1988). Their body color, particularly their head, is lighter than most other cetaceans, making them easier to identify than other beaked whales (Leatherwood et al., 1988). Cuvier's beaked whale is also one of the most active of the beaked whales when at the surface (Leatherwood et al., 1988).

There are three stocks of Cuvier's beaked whale recognized by NMFS: an Alaska stock, a California/Oregon/Washington stock, and a Hawaii stock (Carretta et al., 2020; Muto et al., 2020). Cuvier's beaked whales occurring in the GOA TMAA Study Area belong to the Alaska stock.

Density Data. Passive acoustic monitoring analyses have regularly detected Cuvier's beaked whales on HARPS deployed in the Study Area since 2011, typically on instruments located off the shelf region, consistent with this species apparent preference for deep waters (Baumann-Pickering et al., 2012b; Debich et al., 2013; Debich et al., 2014; Rice et al., 2015; Rice et al., 2018). There were no beaked whale sightings during the April 2009 survey of the Study Area (Rone et al., 2009). During the June and July 2013 GOALS II survey, one individual Cuvier's beaked whale was identified in the offshore stratum, although there were five additional unidentified sightings of beaked whales (Rone et al., 2014). There were 47 acoustic encounters of Cuvier's beaked whales during the 2013 survey and the Navy-funded analysis of these data provided the first acoustic-based line-transect density estimate for Cuvier's beaked whale within the Gulf of Alaska (Yack et al., 2015). Based on the 40 localized acoustic detections, estimated density was 0 in the inshore stratum, 0.002 animals/km^2 in the offshore stratum, 0.003 animals/km^2 in the seamount stratum, and 0.0008 animals/km^2 in the slope stratum (Table 9-3 and Figure 9-3).

Table 9-3: Summary of Density and Uncertainty Values for Cuvier's Beaked Whale

Location	April–October
TMAA – Inshore Stratum	0
TMAA – Offshore Stratum	0.002 (CV=0.48)
TMAA– Seamount Stratum	0.003 (CV=0.30)
TMAA – Slope Stratum	0.0008 (CV=0.74)

Notes: (1) The units for numerical values are animals/km^2. 0 = species is not expected to be present. (2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation, NA = not applicable

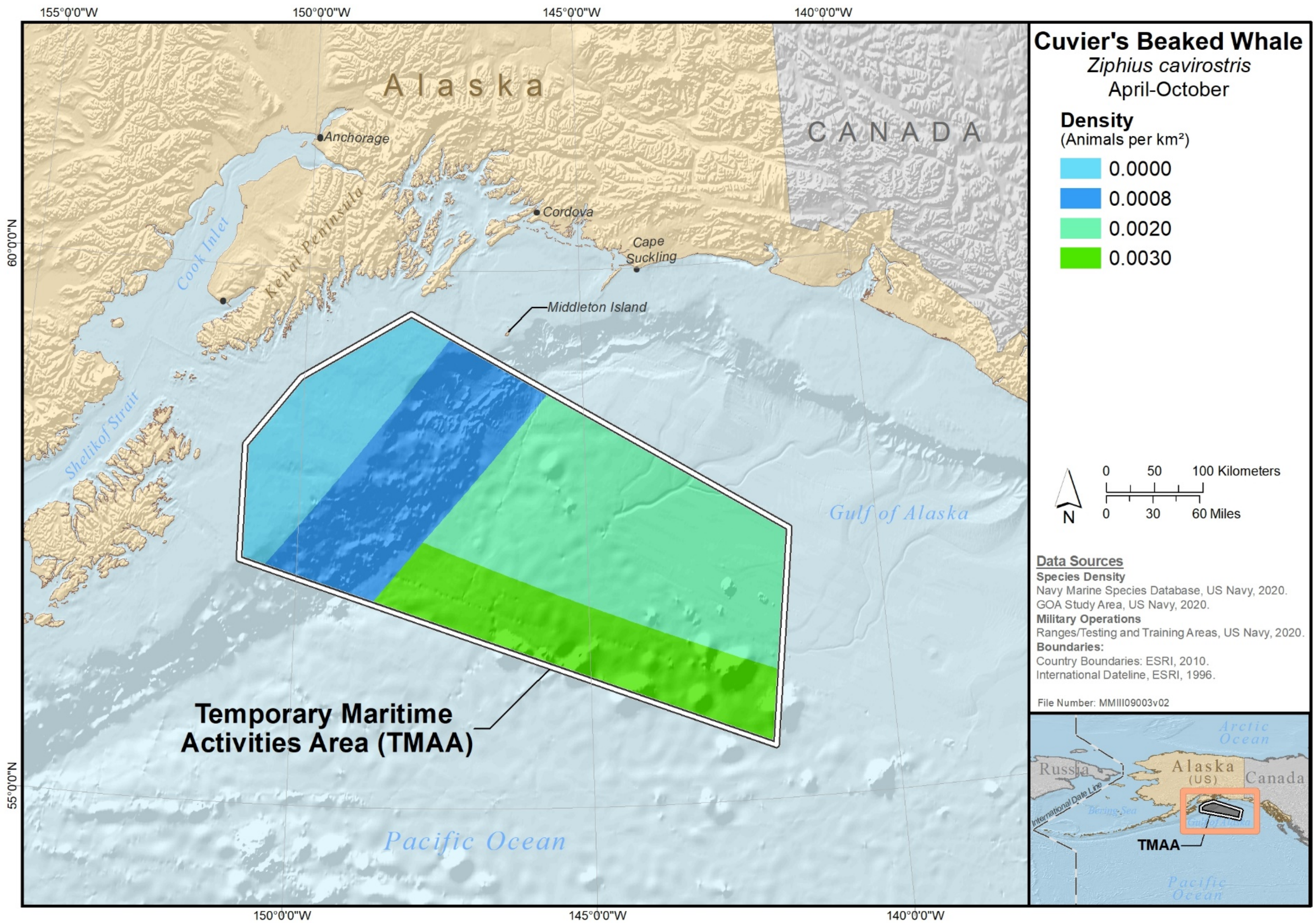


Figure 9-3: Estimated Density of Cuvier's Beaked Whale in the TMAA from April Through October

10 PINNIPEDS (SEALS AND SEA LIONS)

10.1 PINNIPED SPECIES PROFILES

As many as six pinniped species occur within the GOA TMAA Study Area: northern fur seal (*Callorhinus ursinus*), northern elephant seal (*Mirounga angustirostris*), harbor seal (*Phoca vitulina*), California sea lion (*Zalophus californianus*), Steller sea lion (*Eumetopias jubatus*), and ribbon seal (*Histriophoca fasciata*). Occurrence varies among species, with northern fur seal and northern elephant seal having the highest likelihood of occurrence in the offshore portions of the TMAA and Steller sea lion and harbor seal more likely to occur over the continental shelf in the inshore portion of the TMAA (Figure 3-3). California sea lion and ribbon seal are expected to occur only rarely in the TMAA.

Many studies assess pinniped numbers by counting individuals at haulouts or the number of pups weaned at rookeries (for example Harvey et al., 1990; Jeffries, 2014; Jeffries et al., 2003; Lowry, 2002; Lowry et al., 2014; Sepulveda et al., 2009). Translating these numbers to in-water densities presents challenges unique to pinnipeds. No in-water line transect survey data were available for harbor seal, Steller sea lion, ribbon seal, or California sea lion in the Gulf of Alaska. Surveys conducted by Rone et al. (2014) recorded sightings of northern elephant seal and northern fur seal in the TMAA; however, the data were insufficient to estimate a density for northern elephant seal, and the density for northern fur seal that was estimated by Rone et al. (2014) was ultimately not used in the Navy's analysis in light of the availability of more recent data (see Section 10.1.1, Northern Fur Seal, for details). To account for the lack of in-water survey data for pinnipeds, published abundance estimates used in the density calculations were adjusted using a species-specific haulout factor to estimate an in-water abundance for each species based on haulout behavior. The calculated in-water abundance and an area of distribution specific to each species was used to estimate a density.

The Navy continues to seek appropriate means of incorporating uncertainty into density estimates for pinnipeds. Of the six pinniped species for which densities were calculated, only northern fur seal incorporated a CV as a measure of uncertainty in the density estimate. The density calculations for the other pinnipeds did not allow for a statistically robust uncertainty estimate.

10.1.1 *CALLORHINUS URSINUS*, NORTHERN FUR SEAL

The population of northern fur seals occurring in U.S. waters is comprised of two main stocks recognized by NMFS: The Eastern Pacific Stock and the California Stock. There are approximately 620,660 northern fur seals in the Eastern Pacific Stock, most of which breed in the Pribilof Islands located in the southern Bering Sea (Muto et al., 2020). In addition there are approximately 14,050 northern fur seals in the California Stock that breed on San Miguel Island and the Farallon Islands off of California (Carretta et al., 2020).

During the breeding season, roughly half of the world's population of northern fur seals is found in the Bering Sea, on the Pribilof Islands (St. Paul, St. George), and on Bogoslof Island (Call et al., 2008; Muto et al., 2020; Towell et al., 2006; Zeppelin & Ream, 2006). The vast majority of northern fur seal occurrence in the Gulf of Alaska and TMAA occurs during migration to and from breeding sites by the Eastern Pacific Stock (Ream et al., 2005; Sterling et al., 2014; Zeppelin et al., 2019). Adult males in the Eastern Pacific

Stock arrive on shore in the Pribilof Islands between May and August, with some remaining on land through October or November. Following the breeding season, adult males are at sea from approximately mid-November through mid-May, migrating into the Gulf of Alaska (Melin et al., 2012; National Marine Fisheries Service, 2007; Sterling et al., 2014).

The understanding of the movements of females, pups, and juvenile males has been evolving in recent years. Over the past two decades, satellite tags have been attached to northern fur seals both in the Pribilof Islands and on San Miguel Island to study fur seal post-breeding migrations (Melin et al., 2012; Sterling et al., 2014). Some of the more recent data have yet to be published, but the data indicate that not all females, sub-adult males, and pups from the Eastern Pacific Stock migrate eastward, as had been the conventional wisdom. A portion of that population moves west into the western North Pacific as far as the nearshore waters off Japan, and a substantial number move farther south into the open waters of the central North (DeLong, 2018; Sterling et al., 2014; Zeppelin et al., 2019).

The pattern that has emerged from the recorded movements of satellite-tagged animals has shown that pups, juveniles, and adult females have varying migratory behaviors (Sterling et al., 2014). Some leave the Bering Sea and move east through the Gulf of Alaska and into continental shelf waters and continue south into the California Current along the U.S. West Coast, as has been the conventional wisdom based upon the pelagic collections (Bigg, 1990; Lander, 1980; Olesiuk, 2012). Pups appear to move as far south as southern British Columbia; although there is no evidence from satellite tracking of entry into the California Current, pups may travel farther south than British Columbia during the first five months (through April) of their initial migration, which occupies three-fourths of their first year of life. Some females and pups make a very different migration, moving out of the Bering Sea and then spreading out over deep waters of the North Pacific from the Aleutian Islands south to the Transition Zone associated with the southern boundary of the Alaska Gyre and within the North Pacific Current at approximately 45˚ N latitude (Polovina et al., 2001). They remain there for the duration of winter (Lea et al., 2009; Ream et al., 2005; Sterling et al., 2014). On their return migration, coastal females transit through the Gulf of Alaska to the Bering Sea in June (Pelland et al., 2014). Some yearlings remain in the open ocean with a pelagic existence during the first summer following their initial migration, but older juveniles do return to the Bering Sea rookeries before maturing at approximately four years of age, at which time females are recruited into the breeding population (Bigg, 1986; Kenyon & Wilke, 1953). Based on available satellite telemetry data, adult northern fur seals from the California Stock are not expected to migrate into the Gulf of Alaska, traveling only as far north as northern California after the breeding season (Melin et al., 2012). However, there is some indication that pups from the California Stock may be present in the Gulf of Alaska (Lea et al., 2009).

Interannual variability in habitat use may factor into occurrence in the Gulf of Alaska, especially in pups (Baker, 2007; Lea et al., 2009; Zeppelin et al., 2019). In addition, mesoscale eddies known to occur in the Gulf of Alaska can exert a dominant influence on the upper-ocean and lower trophic levels in the TMAA and surrounding Gulf of Alaska (Crawford et al., 2007; Ladd, 2007; Okkonen et al., 2003). These eddies can persist for very long periods (e.g., months), and are another potential source of interannual variability affecting all lifestages of northern fur seal (Melin et al., 2012; Pelland et al., 2014; Ream et al., 2005).

Density Data. The density for northern fur seal in the Gulf of Alaska varies throughout the year and by age and sex classes. To calculate a density for modeling purposes, the abundance of northern fur seals was estimated by month and based on the percentage of each class occurring in the Gulf of Alaska Large Marine Ecosystem (LME) (Large Marine Ecosystem Hub, 2020). The Gulf of Alaska LME was used as the distribution area for the density calculation even through it extends south to the U.S.–Canada border, because telemetry evidence supports the idea that LME delineations do capture large-scale physical and ecological patterns that drive behavior (Pelland et al., 2014; Sterling et al., 2014; Zeppelin et al., 2019). Averaging over a larger area (LME vs. TMAA) therefore increases sample size while still providing densities that can be considered representative.

Lifestage ratios for age and sex classes for northern fur seals were based on Table 4 in Loughlin et al. (1994). The percentage of the Eastern Pacific stock represented by each class was determined based on the population at that time. Those percentages were then applied to the current abundance estimate for the stock breakdown the abundance by age and sex classes (Table 10-1).

Table 10-1: Age and Sex Class Percentages for Northern Fur Seal in the Eastern Pacific Stock

Class	Percentage of Stock (%)[1]	Abundance Estimate
Pups	22	138,705
Yearlings	11	69,353
2-year-old (males and females)[2]	9	55,482
3-year-old females	4	23,857
3-year-old males	4	22,193
Adult females	37	231,175
Adult Males	13	79,894
Total	**100**	**620,660**
Pups from the California stock[3]	N/A	3,346

[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. (2020)

Zeppelin et al. (2019) reported on the proportional use of LMEs in the North Pacific by tagged northern fur seals from October 1 through May 1. The classes with tagged fur seals included male and female adults, juveniles, and pups, which does not exactly match the classes identified by Loughlin et al. (1994). To reconcile the differences, the following assumptions on occurrence in the Gulf of Alaska LME were made: (1) Juveniles are represented by the combined abundance of 2-year-olds and 3-year-olds; and (2) yearlings, which are not represented in the tagging data, have the same monthly percentages as pups through June. Furthermore, the tagging data do not capture the entire migration due to tag retention issues; therefore, the following reasonable, conservative assumptions were made for the remainder of the year:

1. Adult males: The highest percentage (25 percent) was extrapolated through May, and no occurrence was assumed until the start of the next migration.
2. Adult Females: The highest percentage (25 percent) was extrapolated through May. Assumed two-thirds returned from migratory habitat transiting through the Gulf of Alaska in June and July (33 percent each month). Assumed no occurrence from August until the start of the next migration.
3. Juveniles (2- and 3-year-olds): The average percentage from January through April (29 percent for males and 16 percent for females) was extrapolated through June. Fifty percent of the June percentage was extrapolated through August. No occurrence was assumed through November.
4. Yearlings: The percentage for April was extrapolated through June. From July through November, assume 50 percent are in the Bering Sea, and, of the 50 percent outside of the Bering Sea, assume 25 percent (or one-eighth of the total abundance) are in the Gulf of Alaska.
5. Pups: The percentage for April was extrapolated through June. No occurrence was assumed through November.
6. California Stock: There is evidence that pups from the California stock (San Miguel Island) utilize the Gulf of Alaska; pups from San Miguel Island were tagged in two migrations (Lea et al., 2009). The date of the first entry to the Gulf of Alaska was recorded on December 21. Between January 1 and March 1, the proportion in the Gulf of Alaska varied from 33 percent (4 out of 12) to 57 percent (8 out of 14) in a similar composite analysis to that performed by Zeppelin et al. (2019). As a conservative approach, 50 percent of pups from the California stock are assumed to be in the Gulf of Alaska year-round.

Based on these assumptions, the percentages used to determine the monthly abundances of northern fur seals in the Gulf of Alaska LME by age and sex classes are shown in Table 10-2, and the resulting abundance estimates are shown in Table 10-3. The total abundance estimates shown in the last column of Table 10-3 were used to calculate densities, as described below.

Table 10-2: **Monthly Percentages of Age and Sex Classes of Northern Fur Seal in the Gulf of Alaska LME from April to October**

Month	Eastern Pacific Stock						California Stock
	Adult females	Adult Males	Juvenile Females (2 & 3-year-olds)	Juvenile Males (2 & 3-year-olds)	Yearlings*	Pups	Pups
April	15	15	35	10	15	15	50
May	25	25	29	16	15	15	50
June	33	0	29	16	15	15	50
July	33	0	14	8	13	0	50
August	0	0	14	8	13	0	50
September	0	0	0	0	13	0	50
October	0	0	0	0	13	0	50

*Assumes yearlings, which are not included in Zeppelin et al. (2019) and pups in the Eastern Pacific stock have the same monthly percentages through June.

Table 10-3: **Monthly Abundance Estimate of Northern Fur Seal in the Gulf of Alaska LME by Age and Sex Classes from April to October**

Month	**Eastern Pacific Stock**							**California Stock**	**Total Abundance**
	Adult females	Adult Males	Juvenile Females (2 &3-year-olds)	Juvenile Males (2 & 3-year-olds)	Yearlings	Pups	**Total**	Pups	
April	34,676	11,984	18,465	5,276	10,403	20,806	101,609	1,673	103,282
May	57,794	19,974	15,167	8,573	10,403	20,806	132,716	1,673	134,389
June	76,288	0	15,167	8,573	10,403	20,806	131,237	1,673	132,910
July	76,288	0	7,584	4,286	8,669	0	96,827	1,673	98,500
August	0	0	7,584	4,286	8,669	0	20,539	1,673	22,212
September	0	0	0	0	8,669	0	8,669	1,673	10,342
October	0	0	0	0	8,669	0	8,669	1,673	10,342

Monthly density estimates (Table 10-4) were calculated by dividing the abundance estimates in Table 10-3 by the area of the Gulf of Alaska LME (Large Marine Ecosystem Hub, 2020). A sample calculation is shown below for July:

Density = 98,500 fur seals/1,491,252 km^2 = 0.0661 fur seals per km^2

Monthly densities from April through October for northern fur seal in the TMAA are depicted in Figure 10-1 through Figure 10-6.

A sufficient number of northern fur seals were detected during the GOALS II survey conducted in 2013 to derive a density estimate for the four strata defining the survey area (Rone et al., 2014). The densities for northern fur seal reported in Table 10-4 are higher than the densities estimated by Rone et al. (2014), which ranged from 0.0042 to 0.0169 fur seals/km^2; however, the densities are within an order of magnitude and, as reported in this section, newer data and information have become available since the GOALS II surveys in 2013.

Table 10-4: Summary of Density and Uncertainty Values for Northern Fur Seal in the TMAA

Location	**April**	**May**	**June**	**July**	**August**	**September**	**October**
TMAA	0.0693 (CV=0.2)	0.0901 (CV=0.2)	0.0891 (CV=0.2)	0.0661 (CV=0.2)	0.0149 (CV=0.2)	0.0069 (CV=0.2)	0.0069 (CV=0.2)

Notes: (1) The units for numerical values are animals/km^2. 0 = species is not expected to be present.
(2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation

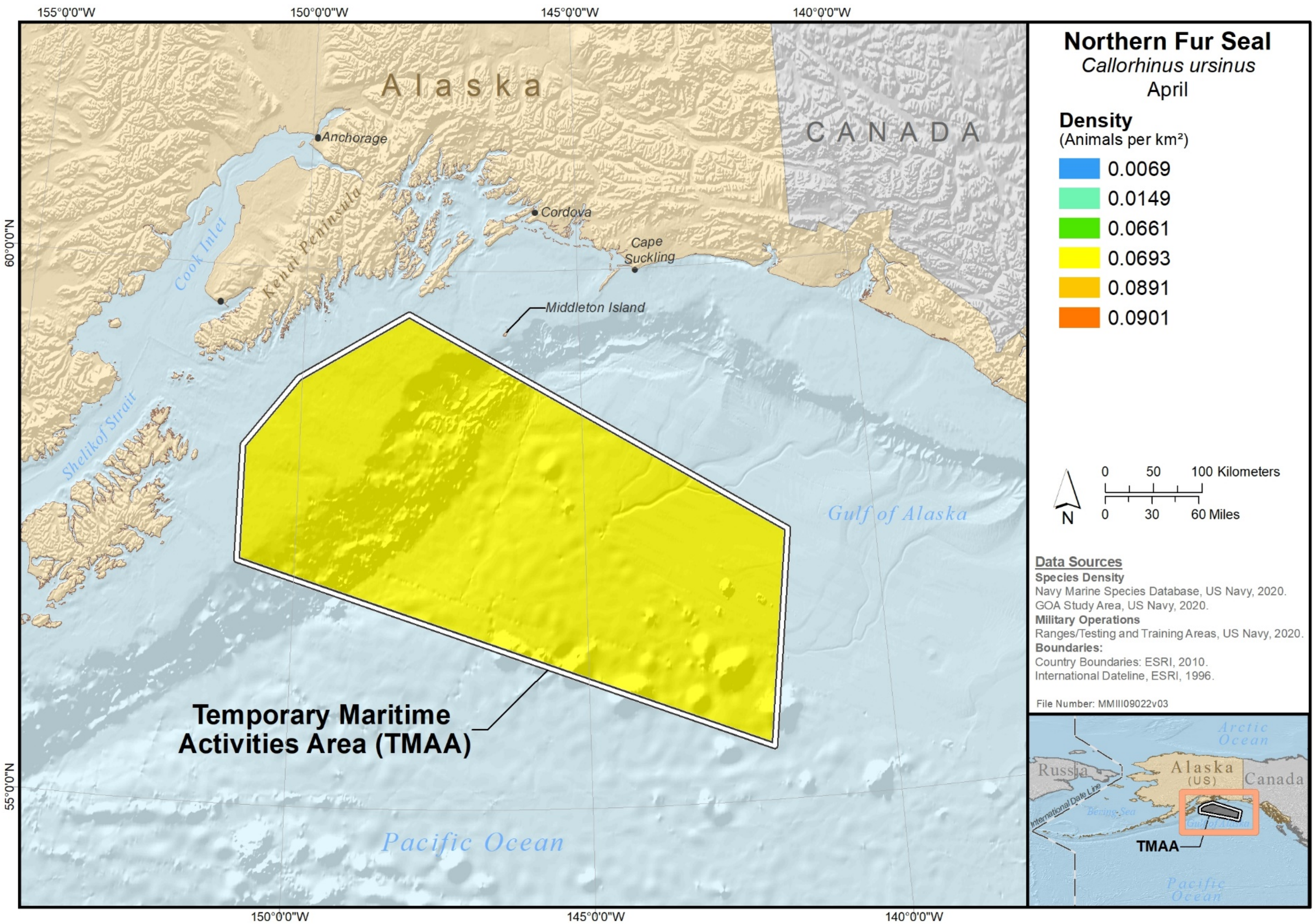


Figure 10-1: Estimated Density of Northern Fur Seal in the TMAA in April

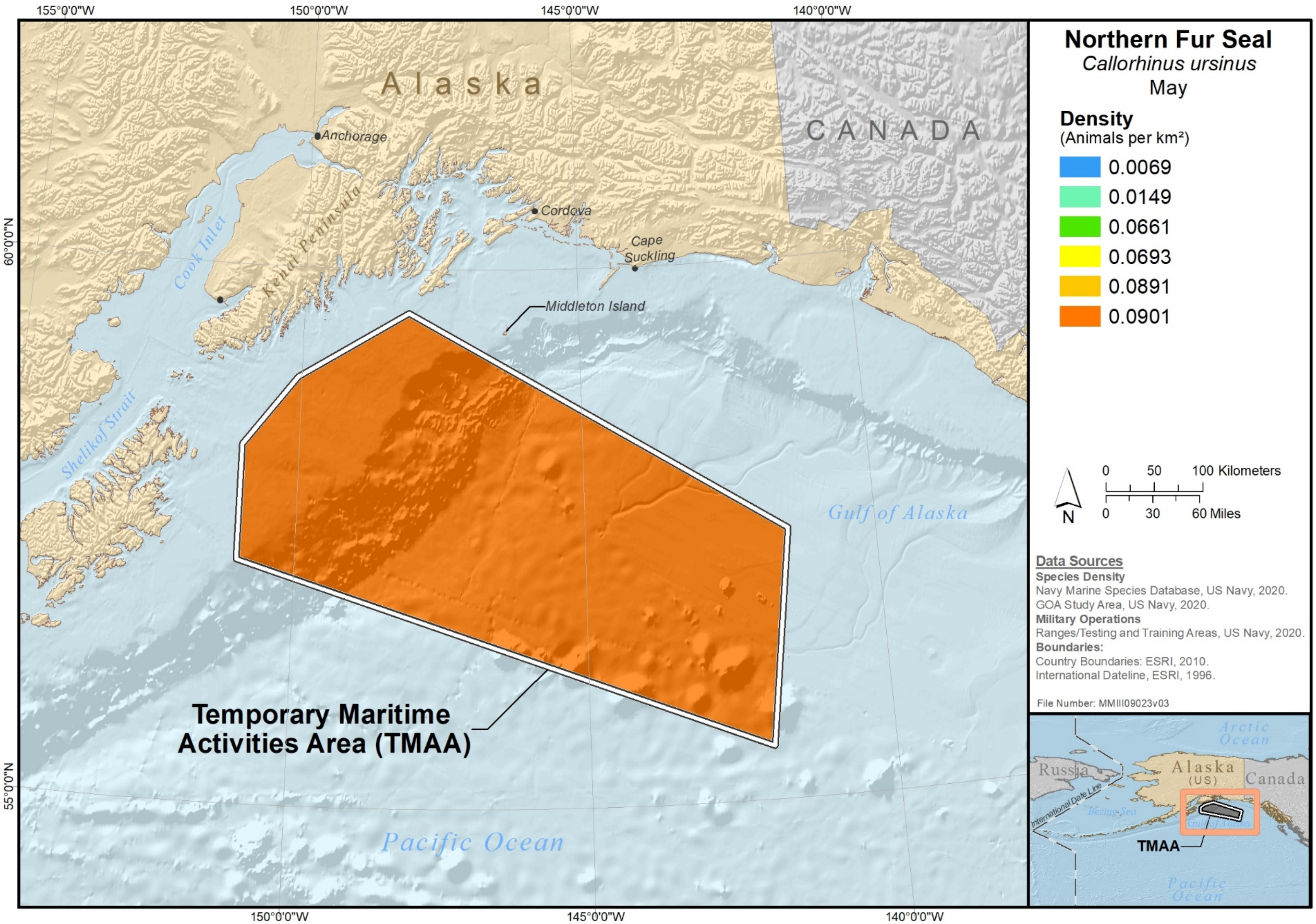


Figure 10-2: Estimated Density of Northern Fur Seal in the TMAA in May

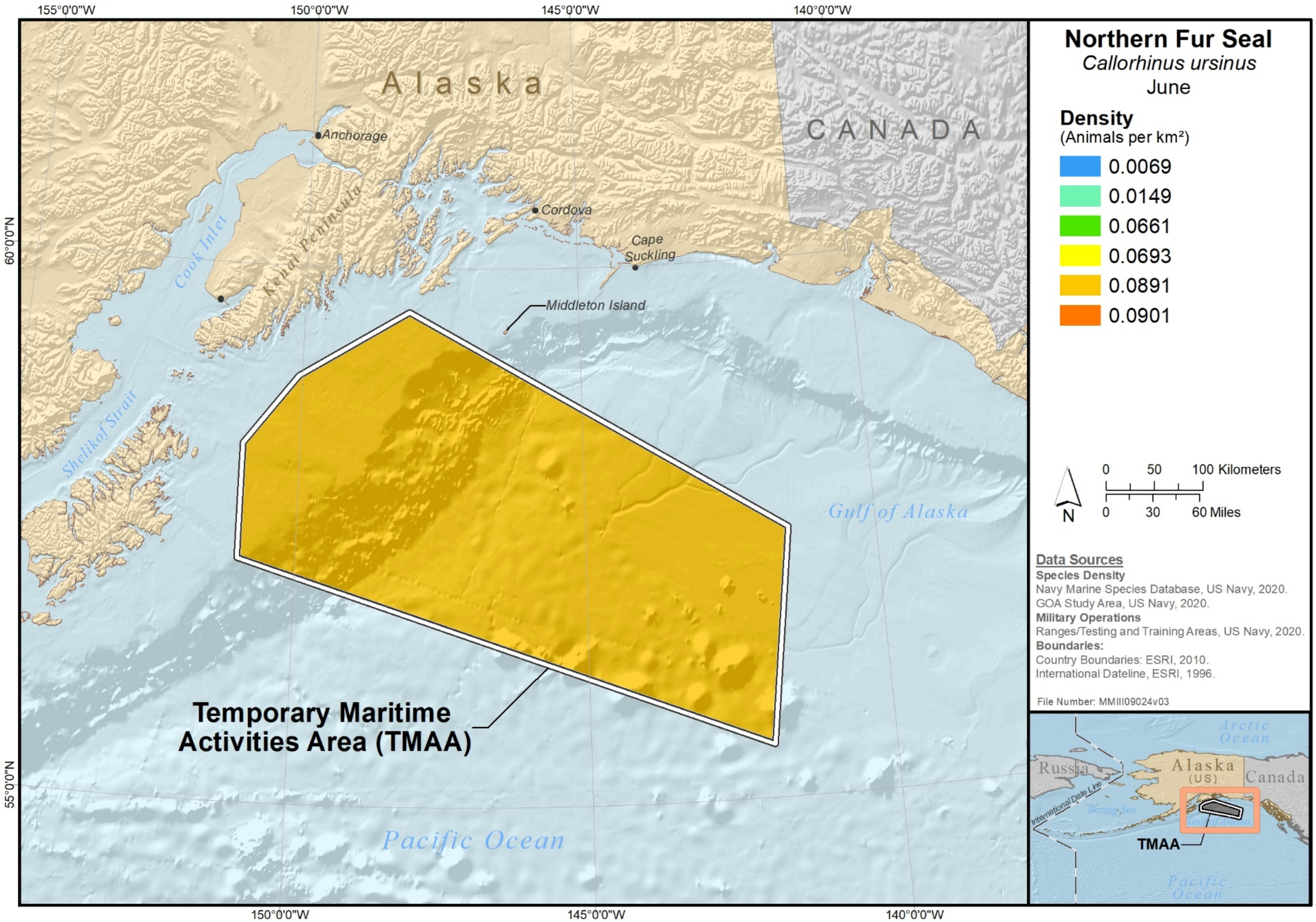


Figure 10-3: Estimated Density of Northern Fur Seal in the TMAA in June

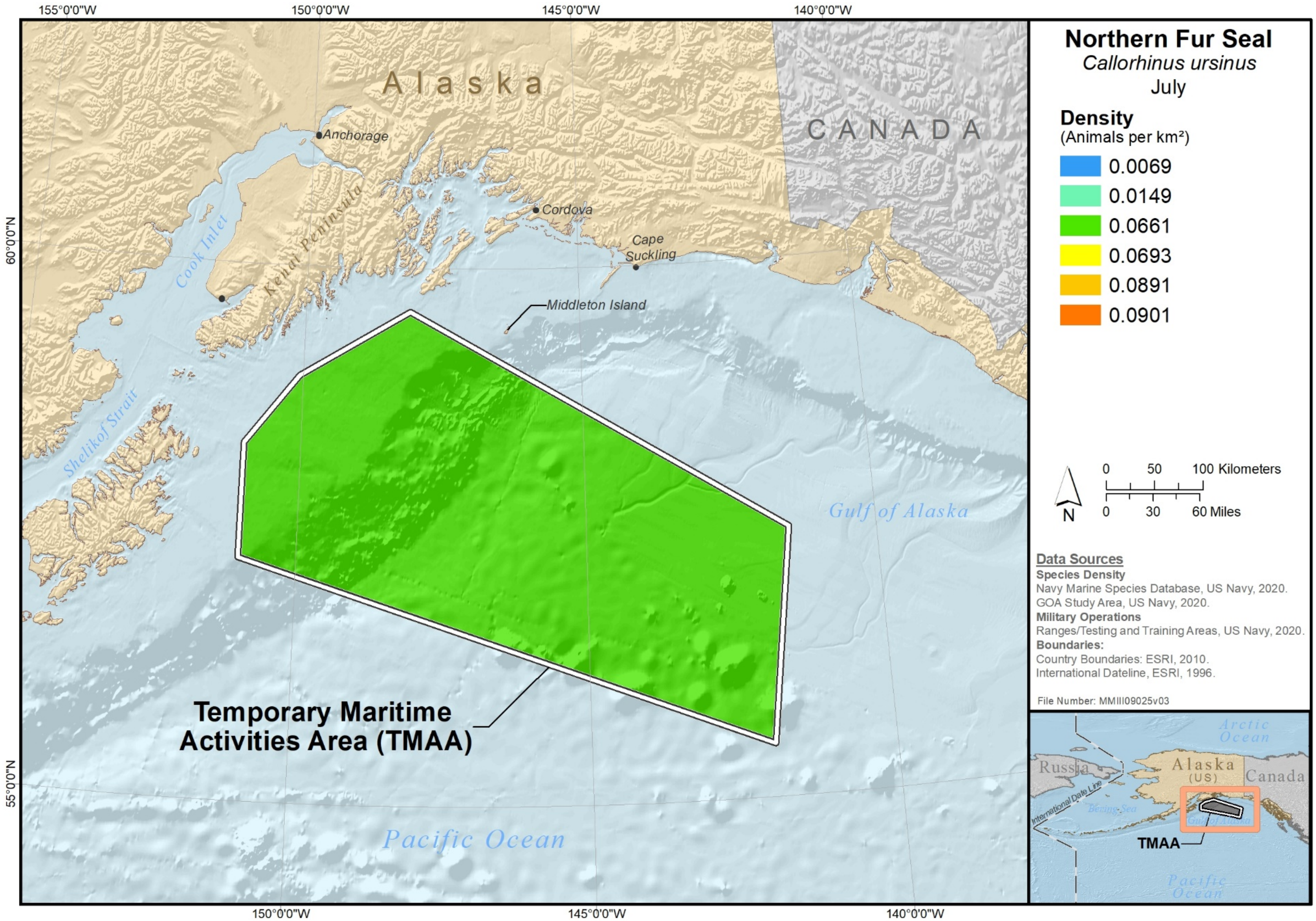


Figure 10-4: Estimated Density of Northern Fur Seal in the TMAA in July

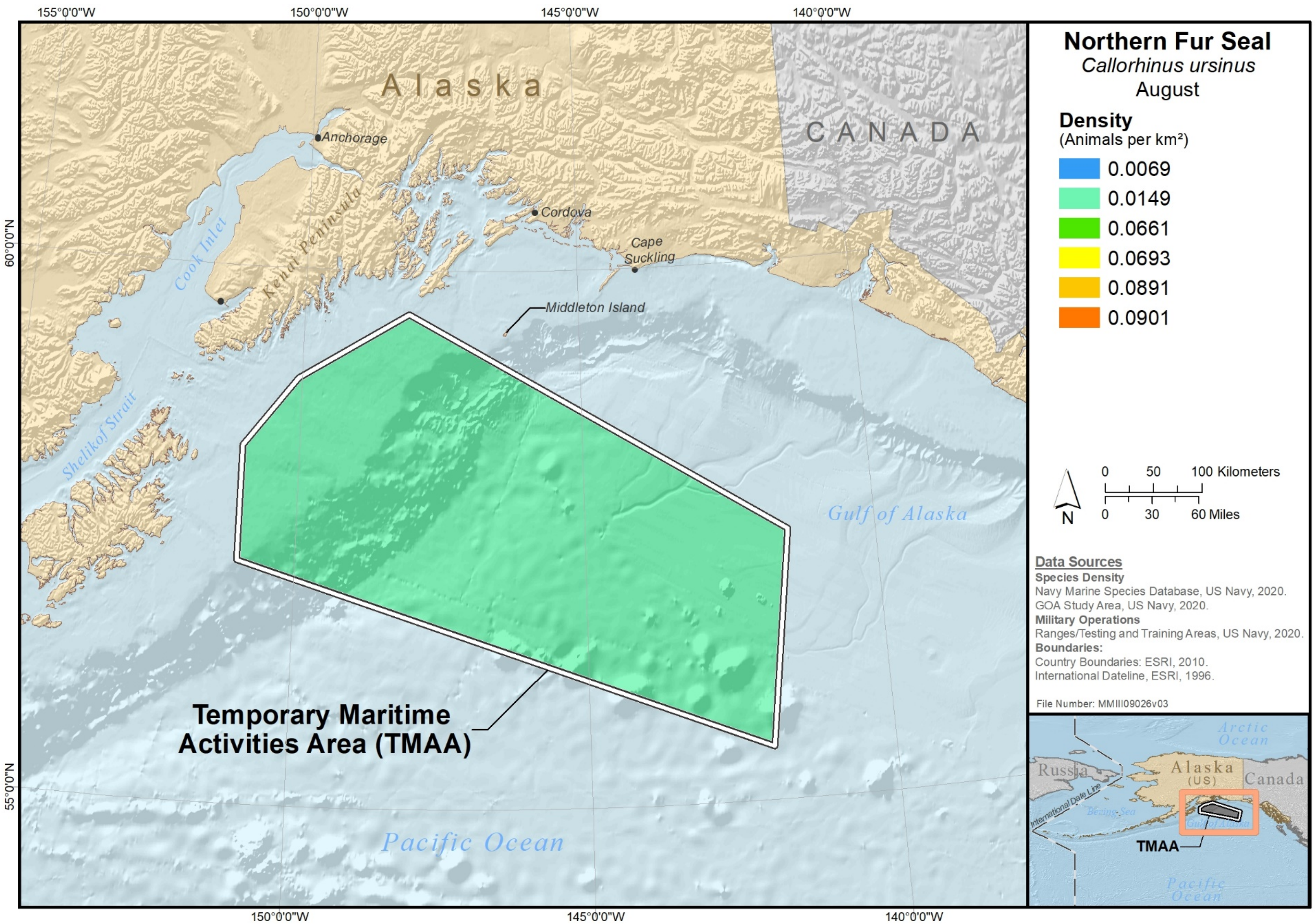


Figure 10-5: Estimated Density of Northern Fur Seal in the TMAA in August

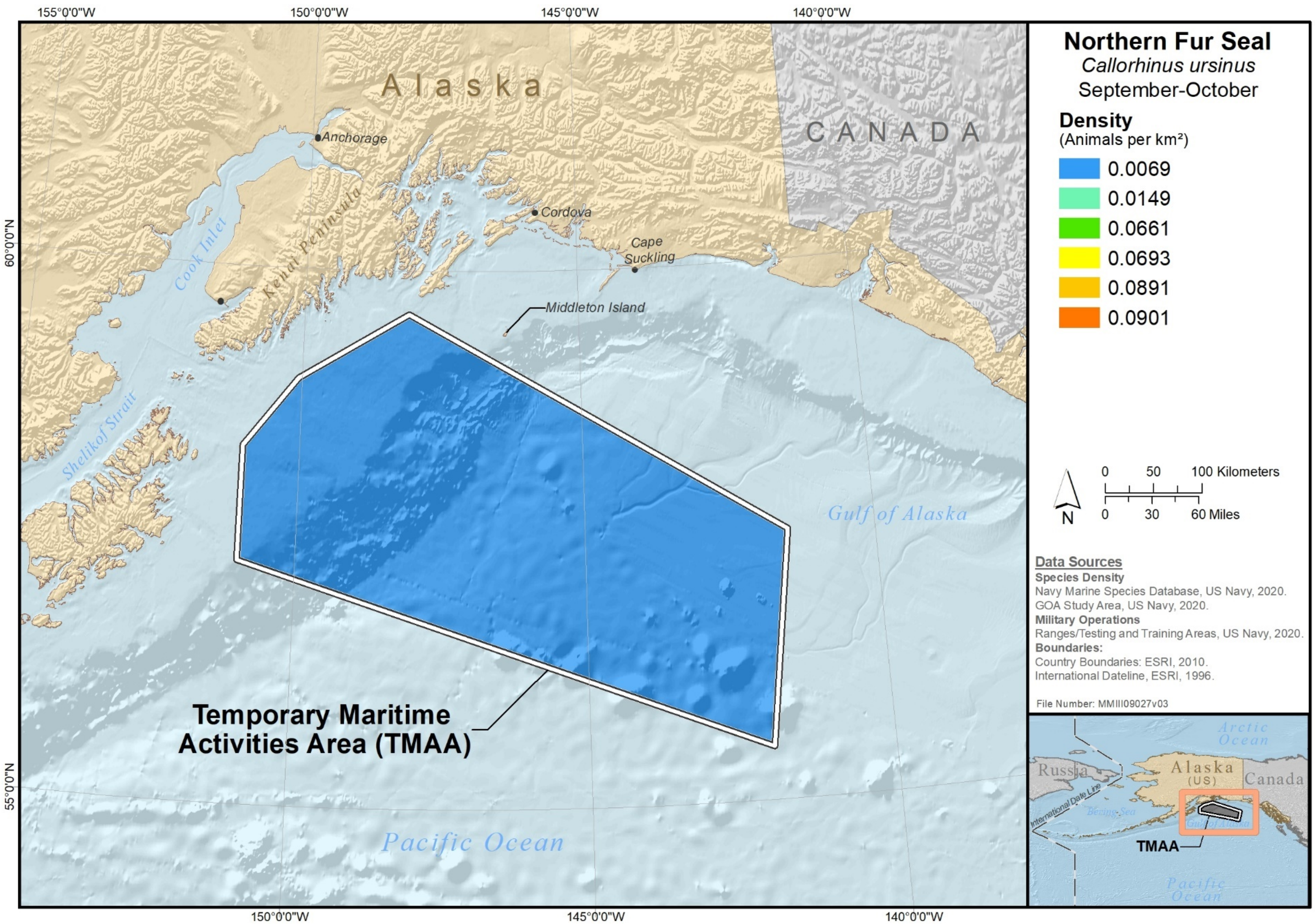


Figure 10-6: Estimated Density of Northern Fur Seal in the TMAA from September Through October

10.1.2 *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., 2020). 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., 2018b; Muto et al., 2020; National Marine Fisheries Service, 2013b; 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 Western DPS are expected to occur in the TMAA. The Western DPS is listed as depleted under the MMPA and endangered under the ESA. Critical habitat for the Western DPS was designated by NMFS in 1993 (58 Federal Register 45269) and includes a 20 NM buffer around all major haulouts and rookeries, as well as associated terrestrial, air, and aquatic zones, and three large offshore foraging areas that are all in Alaska waters. In recent years, the abundance of Steller sea lions in the Western DPS has been increasing by about 2 percent annually due to increases in the abundance of sea lions in the eastern half of their range, including in the Gulf of Alaska. By contrast, the abundance Steller sea lions occurring west of Samalga Pass and in the western and central Aleutians have continued to decline at rates between 0.5 and 6.47 percent annually (Muto et al., 2020; Sweeney et al., 2018).

Despite the wide-ranging movements of juveniles and adult males in particular, until recently (the past 15–30 years) there has been little evidence that breeding adults emigrated from one DPS to the other (except at adjacent rookeries at the DPS boundary) (Fritz et al., 2016; Hoffman et al., 2009; Jemison et al., 2013; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2020; Raum-Suryan et al., 2004; Trujillo et al., 2004). An analysis of over 4,000 Steller sea lions branded as pups between 2000 and 2010 from both the western and eastern DPSs revealed that juvenile males regularly crossed the DPS boundary and that there is "strong evidence" that some breeding females from the western DPS have permanently emigrated to and are reproducing as part of the eastern DPS (Fritz et al., 2016; Jemison et al., 2013; Raum-Suryan et al., 2004). The study also showed that females from the eastern DPS had a very low probability of migrating into and breeding in the western DPS (Fritz et al., 2016; Jemison et al., 2013; National Marine Fisheries Service, 2013b). Poor or declining environmental conditions in the west and more favorable environmental conditions in the east are thought to have facilitated the migration of male and female Steller sea lions from the Western DPS across the DPS boundary, resulting in higher survivability and reproductive success in the east (Jemison et al., 2013).

During the breeding season, sea lions, especially adult females, typically return to their natal rookery or a nearby breeding rookery to breed and pup (Hastings et al., 2017). In one study, foraging females typically returned to breeding sites within 24 hours and traveled a maximum of 5.5–21 km from the breeding site, with variability the distance traveled depending on the individual (Rehberg et al., 2009). The movements of juveniles tagged between the years 2000 and 2014 in Prince William Sound revealed a primarily coastal range with core areas located in nearshore waters adjacent to the coastline (Bishop et al., 2018). Broader home ranges extended from Kayak Island in the east to Kodiak Island in the west with excursions over the continental shelf and into the inshore stratum of the TMAA but only as far as the shelf break (Bishop et al., 2018). An analysis of over two decades of platform-of-opportunity data from southeast Alaska through the Aleutian Islands revealed similar spatial use patterns in the Gulf of Alaska with the highest encounter rates near the shelf break and in Prince William Sound (Himes Boor & Small, 2012).

Density Data. Three sub-groups of Steller sea lions within the Western DPS overlap with the Gulf of Alaska: the Western Gulf of Alaska, Central Gulf of Alaska, and Eastern Gulf of Alaska (Jemison et al., 2018; Sweeney et al., 2018). Of these three groups, only Steller sea lions from the Eastern Gulf of Alaska and Central Gulf of Alaska are expected to occur within the TMAA, based on proximity of haulout and breeding sites located along the coastline. Steller sea lions from these two groups are likely to occur year-round in the inshore stratum of the TMAA. Unpublished data from the Alaska Department of Fish and Game show tagged female Steller sea lions repeatedly traveling from haulouts to the shelf break (approximated as the 500 m isobath) to forage but not venturing off the shelf. Very little data exist on the offshore movements of male Steller sea lions, and a similar foraging strategy (i.e., remaining over the shelf) is assumed for modeling purposes.

Within the Western DPS, there is evidence that a substantial number of sea lions from the Eastern Gulf of Alaska and Central Gulf of Alaska groups interact and frequently cross the boundary between the two regions outside of the breeding season. This suggests that it may be inappropriate to treat the eastern and central Gulf of Alaska groups as “closed” populations (Jemison et al., 2018). Accordingly, the Navy’s acoustic impacts analysis used a single density estimate to represent both groups.

Using data collected from 1978 through 2017, there is strong evidence for positive trends in pup and non-pup counts of western DPS Steller sea lions in the GOA (Fritz et al., 2015; Muto et al., 2020; Sweeney et al., 2017; Sweeney et al., 2018). In the areas occupied by the groups (i.e., the Eastern Gulf of Alaska and Central Gulf of Alaska groups), the pup count increased by 3.10 percent per year from 2002 through 2017, and the non-pup count increased by 4.03 percent per year over the same time period (Sweeney et al., 2017). The combined abundance estimate for the Eastern Gulf of Alaska and Central Gulf of Alaska groups is 17,555 sea lions, with 5,373 sea lions in the Eastern Gulf of Alaska group and 12,182 in the Central Gulf of Alaska group (Fritz et al., 2016). As noted above, there is substantial crossover between the two groups outside of the breeding season; therefore, the analysis of acoustic impacts used the combined abundance rather than analyzing the two groups independently (Fritz et al., 2016).

To calculate an in-water density, the combined abundance (17,555 sea lions) was adjusted to factor in sea lions hauled out on land. The percentage of time sea lions are hauled out varies widely with season, location, and age and sex classes (Call et al., 2007; Holmes et al., 2007; Trites & Porter, 2002). During the breeding season (May through August; Hastings et al., 2019), when pups, adult females nursing pups, and adult males spend more time on land, it was assumed that 63 percent of sea lions were in the water at any given time. Outside of the breeding season (April, September–October), sea lions were assumed to haul out less frequently or for shorter time periods, and the analysis estimated that 75 percent of sea lions are in the water.

The in-water abundance from May through August is calculated as:

Abundance = 17,555 sea lions x 0.63 = 11,060 sea lions

The in-water abundance for April, September, and October is calculated as:

Abundance = 17,555 sea lions x 0.75 = 13,166 sea lions

The spatial area used to calculate densities was defined by the area of critical habitat designated in the Eastern Gulf of Alaska and Central Gulf of Alaska areas (Jemison et al., 2018; Sweeney et al., 2018) and the area of the continental shelf extending beyond the critical habitat to the 500 m isobath (defined as the shelf break). The spatial area was truncated to remain within the boundaries of the Eastern Gulf of Alaska and Central Gulf of Alaska areas (Jemison et al., 2018). The total spatial area summed to 194,138 km^2.

To calculate a density for each season, the seasonal abundance was divided by the distribution area.

For May through August the in-water density is calculated as:

Density = 11,060 sea lions/194,138 km^2 = 0.0570 sea lions/km^2

For April, September, and October the in-water density is calculated as:

Density = 13,166 sea lions/194,138 km^2 = 0.0678 sea lions/km^2

Density estimates for the Western DPS of Steller sea lion are shown in Table 10-5, Figure 10-8, and Figure 10-9.

As noted above, Steller sea lions in the Eastern DPS are not expected to occur in the TMAA. However, a density was derived for a small portion of their range located over the continental shelf at 144°W longitude so that any potential impact from acoustic propagation from inside the TMAA could be quantitatively determined.

A similar process to the one used for Western DPS Steller sea lions was used to estimate a density for Steller sea lions in the Eastern DPS. An abundance of 34,196 Steller sea lions in the Eastern DPS area was estimated based on pup counts from 2015 (Fritz et al., 2016) and was divided by an area of 90,796 km^2 representing the Eastern DPS to calculate a density. However, this density is limited to a small area near

Cape Suckling at 144°W longitude and extending only to the 500 m isobath, which is approximately 100 km north of the TMAA. The density is provided in Table 10-6 but is not shown in Figure 10-7, because it does not overlap with the TMAA.

Table 10-5: Summary of Density Values for the Western DPS of Steller Sea Lion in the TMAA

Location	May–August	April, September–October
TMAA – Continental Shelf to 500 m Isobath	0.0570	0.0678
TMAA – Beyond the 500 m isobath	0	0

Notes: (1) The units for numerical values are animals/km^2. 0 = species is not expected to be present.
(2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation, m = meters

Table 10-6: Summary of Density Values for the Eastern DPS of Steller Sea Lion in the TMAA

Location	May–August	April, September–October
TMAA – Continental Shelf to 500 m Isobath	0	0
TMAA – Beyond the 500 m isobath	0	0
Outside of the TMAA at 144°W longitude – Continental Shelf to 500 m Isobath	0.2373	0.2825

Notes: (1) The units for numerical values are animals/km^2. 0 = species is not expected to be present.
(2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation, m = meters

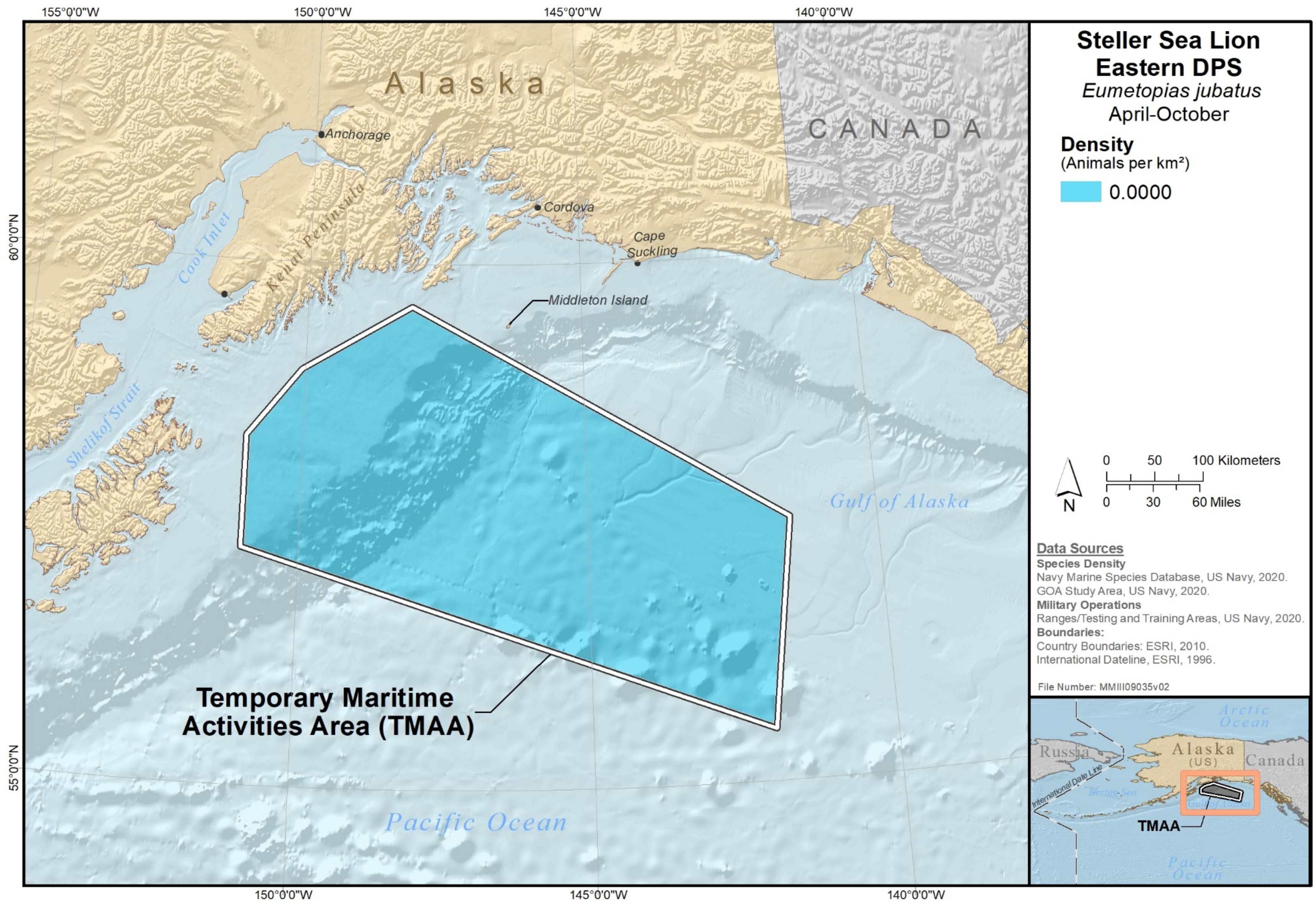


Figure 10-7: Estimated Density of Eastern Distinct Population Segment of Steller Sea Lion in the TMAA from April Through October

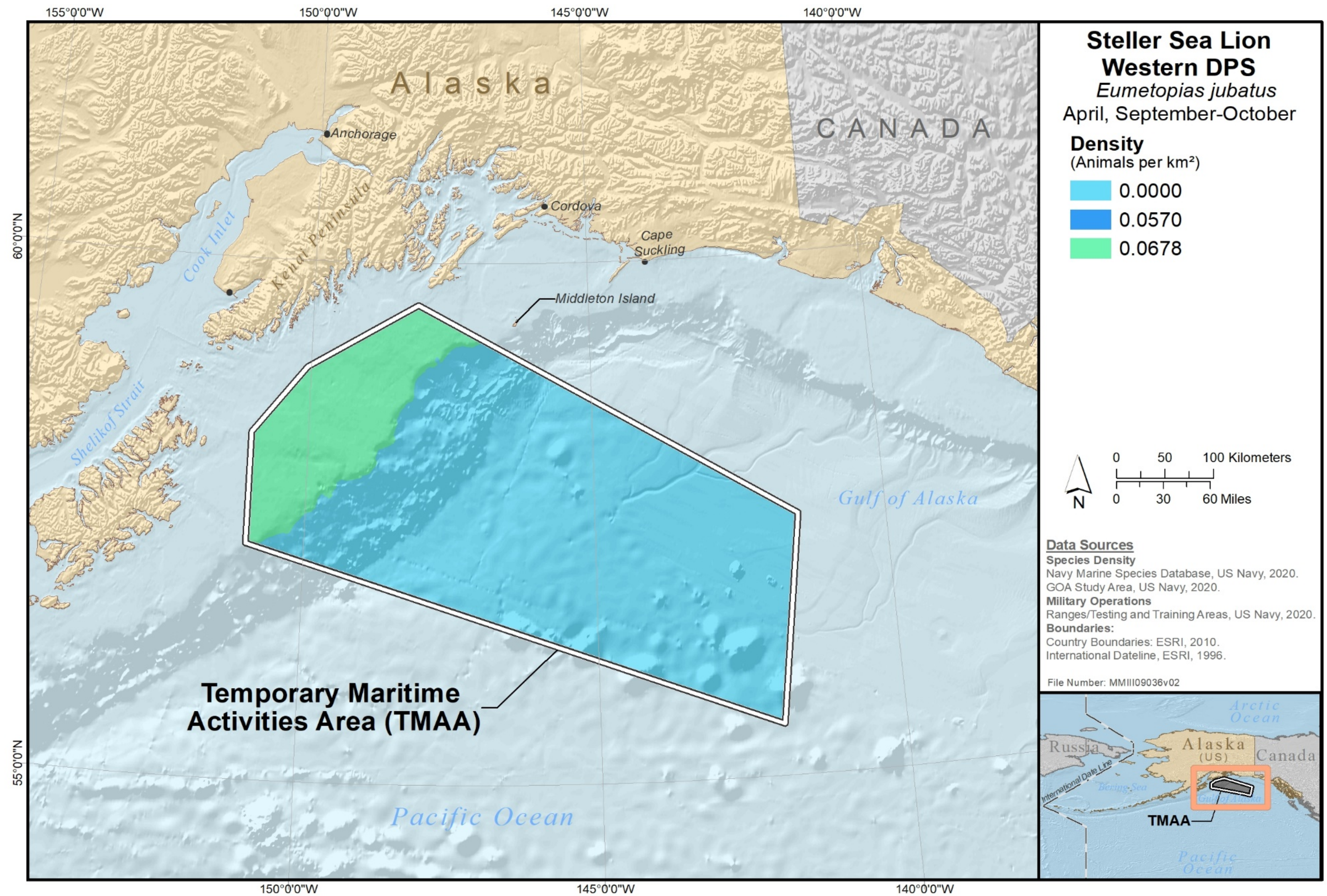


Figure 10-8: Estimated Density of Western Distinct Population Segment of Steller Sea Lion in the TMAA in April and from September Through October

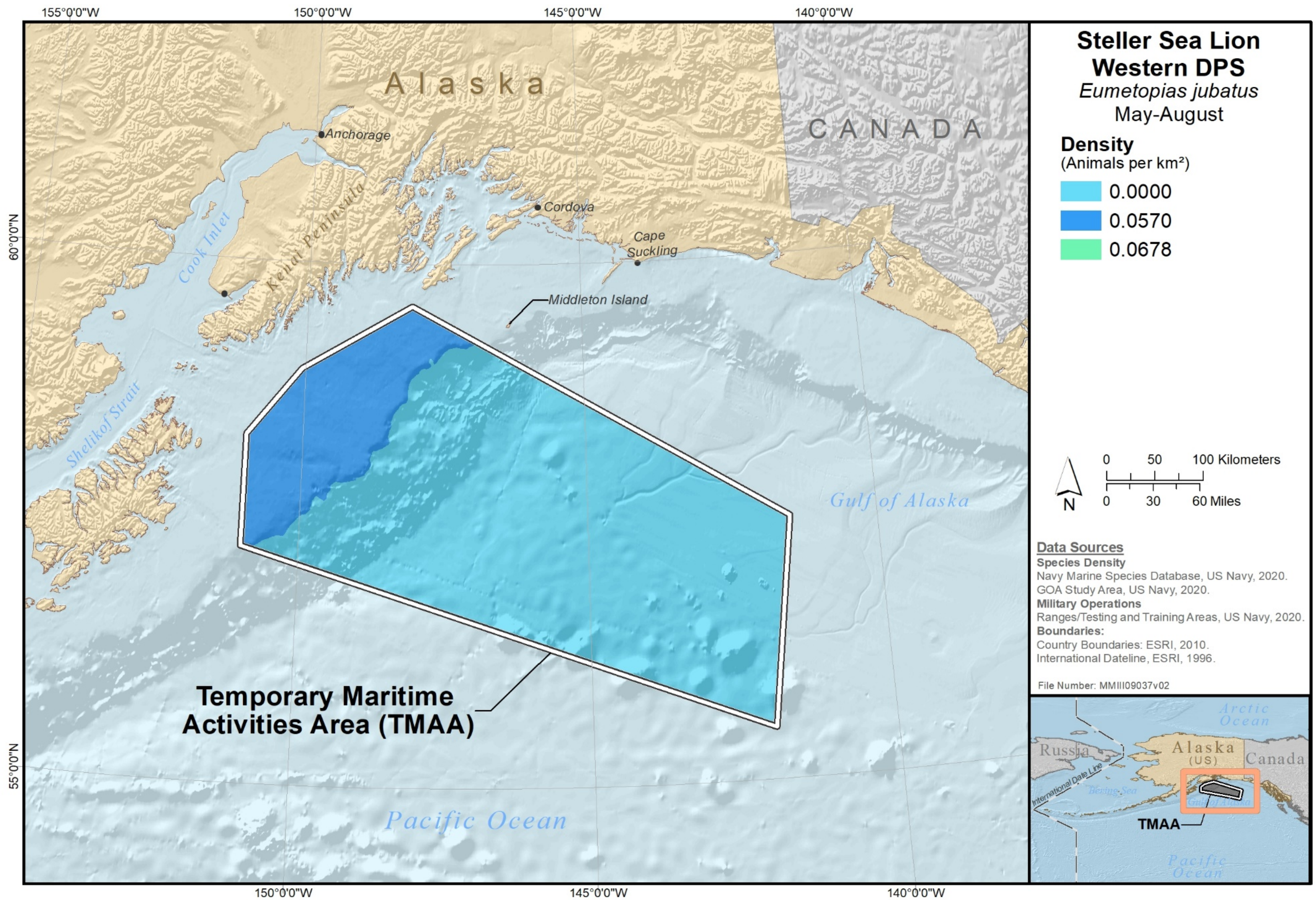


Figure 10-9: Estimated Density of Western Distinct Population Segment of Steller Sea Lion in the TMAA from May Through August

10.1.3 *Histriophoca fasciata*, Ribbon Seal

There is no defined range for ribbon seals in Alaska waters (Muto et al., 2020); however, ribbon seals inhabit the North Pacific and adjacent parts of the Arctic Ocean and disperse into the open ocean when sea ice in the Bering Sea recedes (Alaska Department of Fish and Game, 2008; Boveng & Lowry, 2018; Boveng et al., 2013). In Alaska waters, ribbon seals occur primarily west of the Gulf of Alaska in the western Beaufort sea, Chukchi sea, and Bering Sea as well as around the Aleutian Islands (Muto et al., 2018a). Although individuals have occurred in Gulf of Alaska, Canadian waters, and along the U.S. West Coast as far south as California (Alaska Department of Fish and Game, 2008), these areas are not considered part of their normal range (Boveng & Lowry, 2018). Ribbon seals are rarely found on shore-fast ice or land and are most often observed on sea ice during spring and early summer when breeding behaviors and molting occur. They are abundant in the northern part of the ice front in the central and western parts of the Bering Sea. From mid-summer, when sea ice recedes, through fall they are pelagic and rarely haul out, returning to the sea ice in the Bering Sea in November (Boveng et al., 2013; Muto et al., 2020).

NMFS currently recognizes a single stock of ribbon seal, the Alaska stock, in the North Pacific and Bering Sea. The Alaska stock of ribbon seal is not designated as depleted under the MMPA and is not listed as endangered or threatened under the ESA. The Alaska stock of ribbon seal is not considered a strategic stock (Muto et al., 2020).

Density Data. Insufficient data are available to estimate a density for ribbon seal in the GOA. Information regarding ribbon seals use of the GOA is extremely limited. In 2009, a tagged ribbon seal traveled from the northern Bering Sea into the Gulf of Alaska (National Marine Fisheries service, unpublished data), indicating that their summer distribution may include the Gulf of Alaska; however, the number of ribbon seals that could occur in the Gulf of Alaska or TMAA and their seasonal distribution is largely unknown (Boveng et al., 2013). Ribbon seal occurrence in the TMAA should be considered rare year round.

10.1.4MIROUNGA ANGUSTIROSTRIS, NORTHERN ELEPHANT SEAL

The northern elephant seal (*Mirounga angustirostris*) 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., 2020; Hoelzel, 1999; Stewart et al., 1994). There are two distinct populations of northern elephant seal: one that breeds in Baja California, Mexico; and a second that breeds in U.S. waters in California (Garcia-Aguilar et al., 2018). NMFS recognizes the one stock in U.S. waters as the California Breeding Stock (Carretta et al., 2020). The separate breeding population in Baja California, Mexico, is considered to be demographically isolated from the California Breeding Stock (Carretta et al., 2020; Mesnick et al., 1998). Density values calculated in this report are based only on the California Breeding Stock abundance of 179,000 northern elephant seals (Carretta et al., 2020).

Although elephant seals that breed in Baja California, Mexico, may migrate north as far as the TMAA, for the purposes of calculating a density and analyzing acoustic impacts, northern elephant seals in the TMAA are all considered to be exclusively from the California Breeding Stock. There is some evidence to support this assumption; females from the population in Mexico are known to forage approximately 8° of latitude farther south than females from the California Breeding stock (Aurioles-Gamboa & Camacho-Rios, 2007; Aurioles et al., 2006; Carretta et al., 2020). In addition, elephant seals from both stocks make two annual migrations into the North Pacific, both originating from natal rookeries either off California or in Baja California, Mexico. The post-breeding migration, extending approximately from February to May, is shorter, and many seals from either may not reach Alaska waters, particularly seals originating farther south in Baja California, Mexico, before beginning the migration back to natal rookeries to molt. The longer post-molting migration, which extends from mid-June through December for females and September through December for males, allows elephant seals to extend their distribution northward and into Alaska waters (Le Boeuf et al., 2000; Peterson et al., 2015; Robinson et al., 2012). Despite the longer time period, seals from the Mexico population are less likely to reach the Gulf of Alaska. Migrations of elephant seals into the Gulf of Alaska are not unexpected as shown by tagging data and relative densities of females (Robinson et al., 2012); however, highest the densities of seals were farther south at the confluence of the sub-Arctic and sub-tropical gyres and the variable location of the Transition Zone Chlorophyll Front (Robinson et al., 2012).

Density Data. The two annual migrations of northern elephant seals result in significant variability in the seasonal occurrence in the Gulf of Alaska. To capture that variability, monthly densities were estimated from April through October based on tagging data for adult elephant seals (Le Boeuf et al., 2000; Peterson et al., 2015; Robinson et al., 2012). Males and females both migrate north from rookeries; however, males generally remain over the continental slope and females disperse more widely into the North Pacific although considerable overlap in distribution occurs (Le Boeuf et al., 2000; 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 TMAA 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 migration is different, the ratio of males to females in the California Breeding stock was determined to estimate monthly occurrence in the Gulf of Alaska. Based on the 2010 pup count of 40,684 elephant seals and pup multipliers for males (3.88) and females (4.91), the total population of 179,000 elephant seals is approximately 44 percent male and 56 percent female (Lowry et al., 2014) (Table 10-7). A lifestage table report by Condit et al. (2014) supports the same male to female ratio.

Table 10-7: Sex Class Abundance of Northern Elephant Seal

Group	Pup Multiplier	Class Abundance	Percent in Class
Population	4.39	178,603	100
Males	3.88	78,927	44
Females	4.91	99,879	56

Based on Condit et al. (2014); Lowry et al. (2014).

The percentage of females occurring in the Gulf of Alaska from April through October was based on analysis by Peterson et al. (2015) showing 30 out of 77 (about 40 percent) tagged elephant seals followed a more northerly route that took several into the Gulf of Alaska, and analysis by Robinson et al. (2012) reporting monthly relative densities of females in the North Pacific, including in the Gulf of Alaska, from satellite-tagged elephant seals. In the study by Peterson et al. (2015) the remaining 60 percent of tagged elephant seals stayed farther south, migrated farther offshore into the North Pacific, or bypassed the Gulf of Alaska en route to the Aleutian Islands. Most of the shorter-duration post-breeding migrations did not reach the Gulf of Alaska. Monthly female elephant seal occurrence in the Gulf of Alaska was also determined by interpreting the relative density estimates of elephant seals reported by Robinson et al. (2012) that indicated a higher probability of occurrence in the Gulf of Alaska from July through September. The percentage of males in the Gulf of Alaska from April through October was also based on the seasonal migrations of satellite-tagged elephant seals (Le Boeuf et al., 2000). The majority of transits terminated in Alaska waters, ranging along the entire coastline from the Aleutian Islands in the west to eastern Alaska and including several entering the Gulf of Alaska. The resulting estimates of monthly occurrence in the Gulf of Alaska for males and females are shown in Table 10-8.

The area used to represent the Gulf of Alaska for the purposes of calculating a density for northern elephant seal was adopted from a U.S. Geological Survey definition of the Gulf as the area bounded by the shoreline to the north and a straight line extending between the south tip of Kodiak Island in the west to Dixon Strait in the east (U.S. Geological Survey, 1981). Based on that definition, the area of the Gulf of Alaska used to estimate a density for northern elephant seal is 513,158 km^2.

Table 10-8: Monthly Abundance of Northern Elephant Seal in the Gulf of Alaska

Month	Abundance in GOA				
	Females (%)	Adult females (Number)	Males (%)	Adult Males (Number)	Total
April	5%	4,994	20%	15,785	20,780
May	5%	4,994	15%	11,839	16,833
June	5%	4,994	5%	3,946	8,940
July	30%	29,964	0%	0	29,964
August	40%	39,952	0%	0	39,952
September	40%	39,952	20%	15,785	55,737
October	10%	9,988	0%	0	9,988

To calculate a density, the total abundance for each month was divided by the area of the Gulf of Alaska. A sample calculation for the month of April is shown below:

Density = 20,780 elephant seals/513,158 km^2 = 0.0405 elephants seals/km^2

Density estimates for northern elephant seal are shown in Table 10-9 and Figure 10-10 through Figure 10-16.

Table 10-9: Summary of Density Values for Northern Elephant Seal in the TMAA

Location	April	May	June	July	August	September	October
TMAA	0.0405	0.0328	0.0174	0.0584	0.0779	0.1086	0.0195

Notes: (1) The units for numerical values are animals/km^2. 0 = species is not expected to be present.
(2) TMAA = Temporary Maritime Activities Area

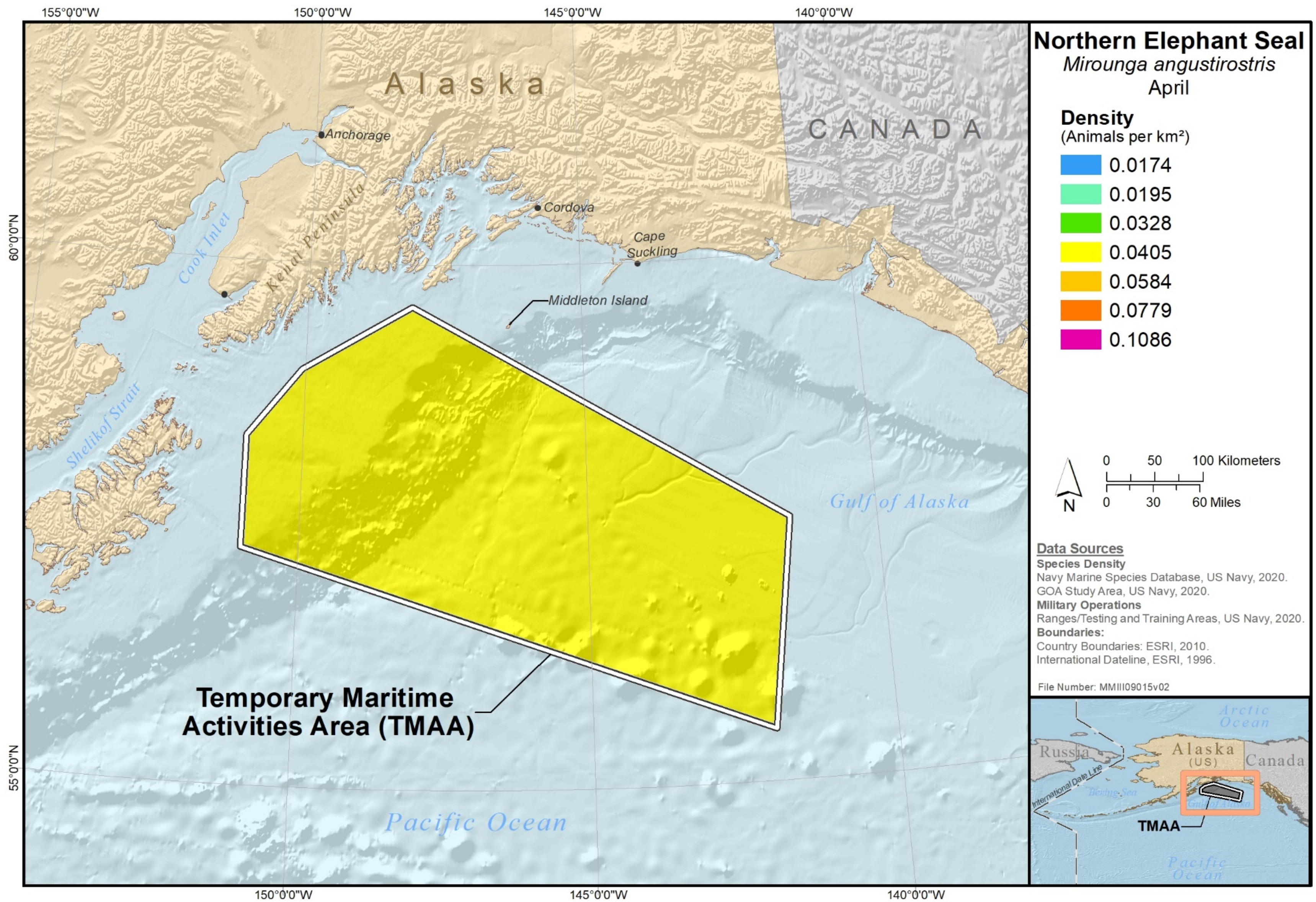


Figure 10-10: Estimated Density of Northern Elephant Seal in the TMAA in April

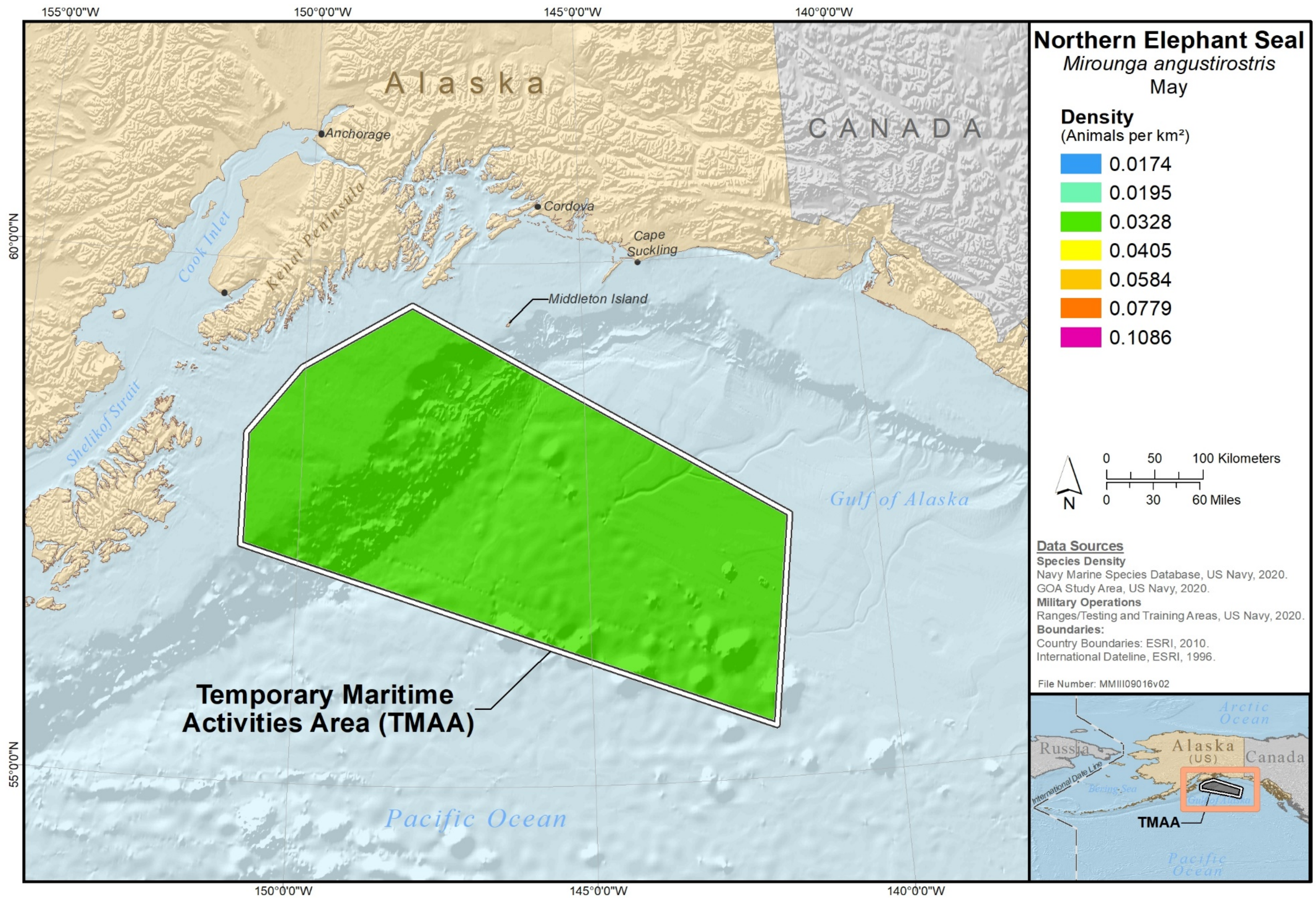


Figure 10-11: Estimated Density of Northern Elephant Seal in the TMAA in May

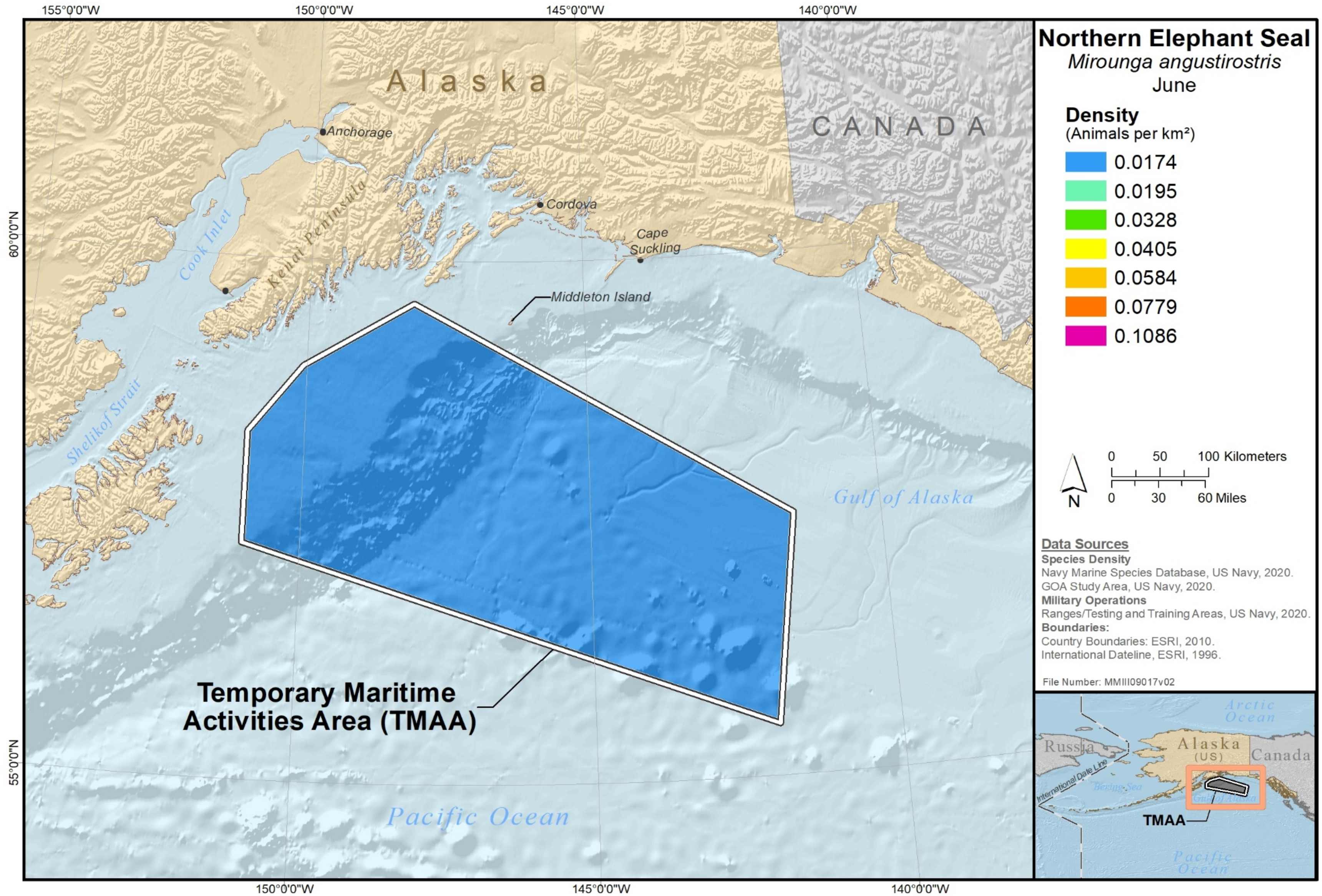


Figure 10-12: Estimated Density of Northern Elephant Seal in the TMAA in June

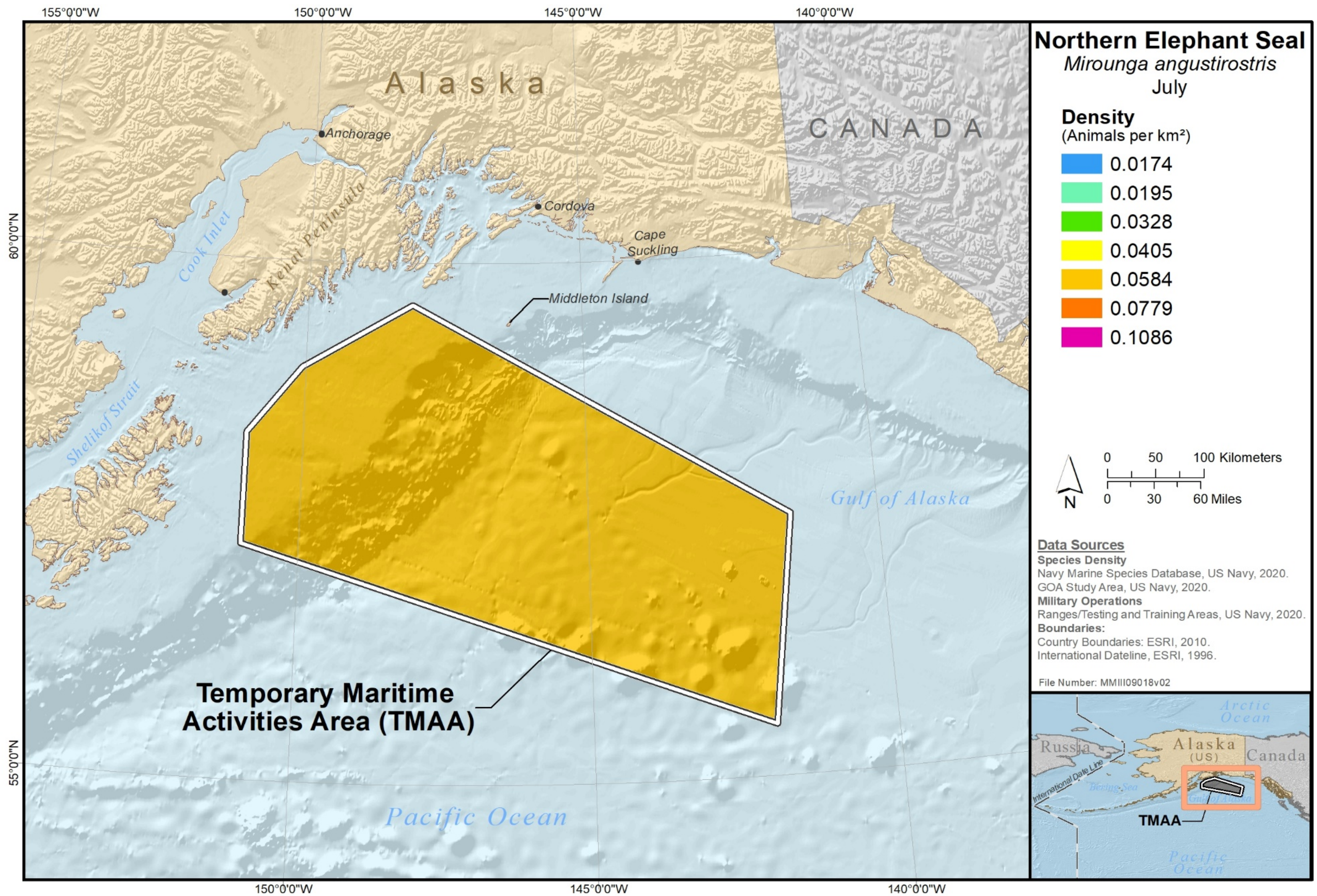


Figure 10-13: Estimated Density of Northern Elephant Seal in the TMAA in July

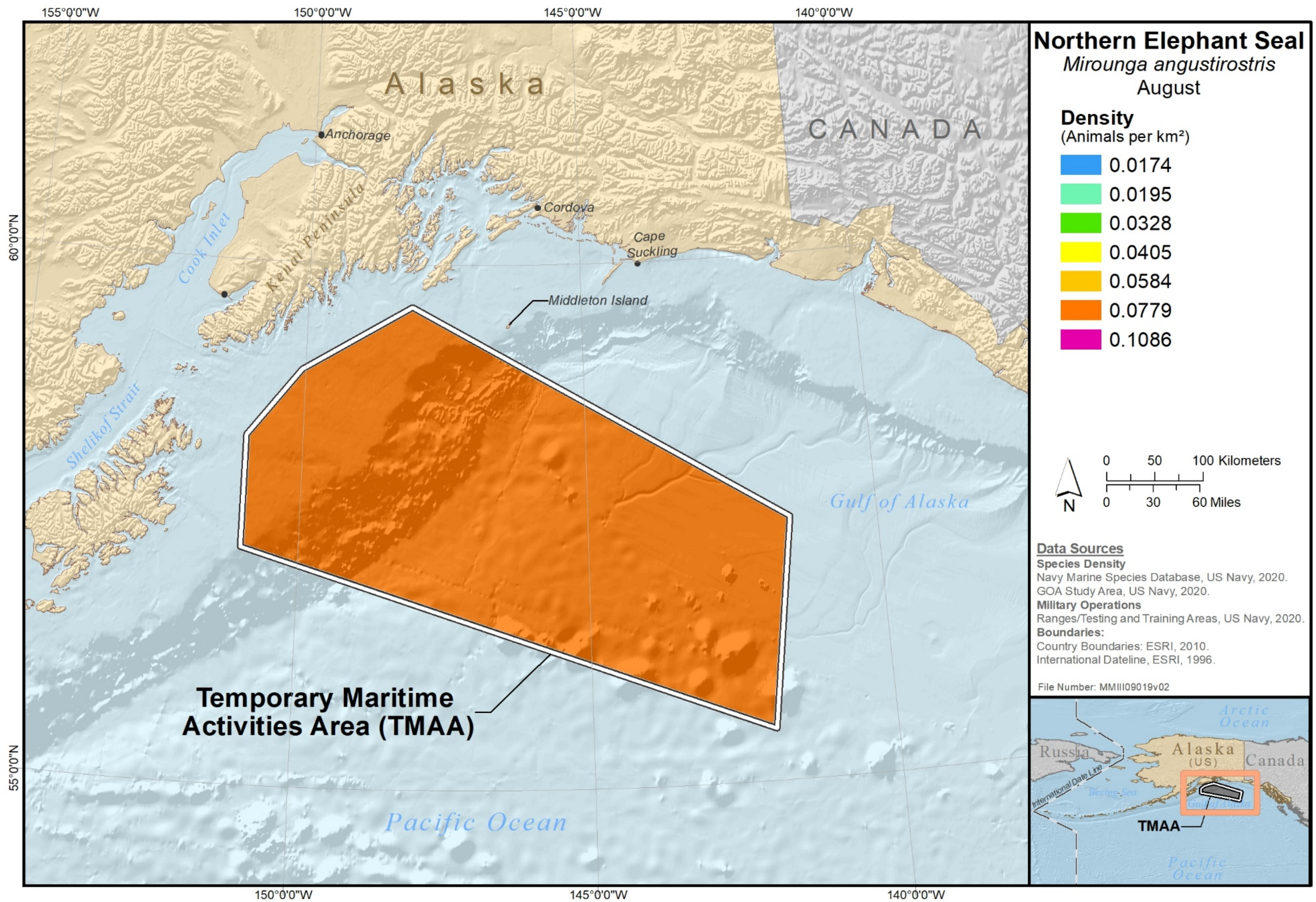


Figure 10-14: Estimated Density of Northern Elephant Seal in the TMAA in August

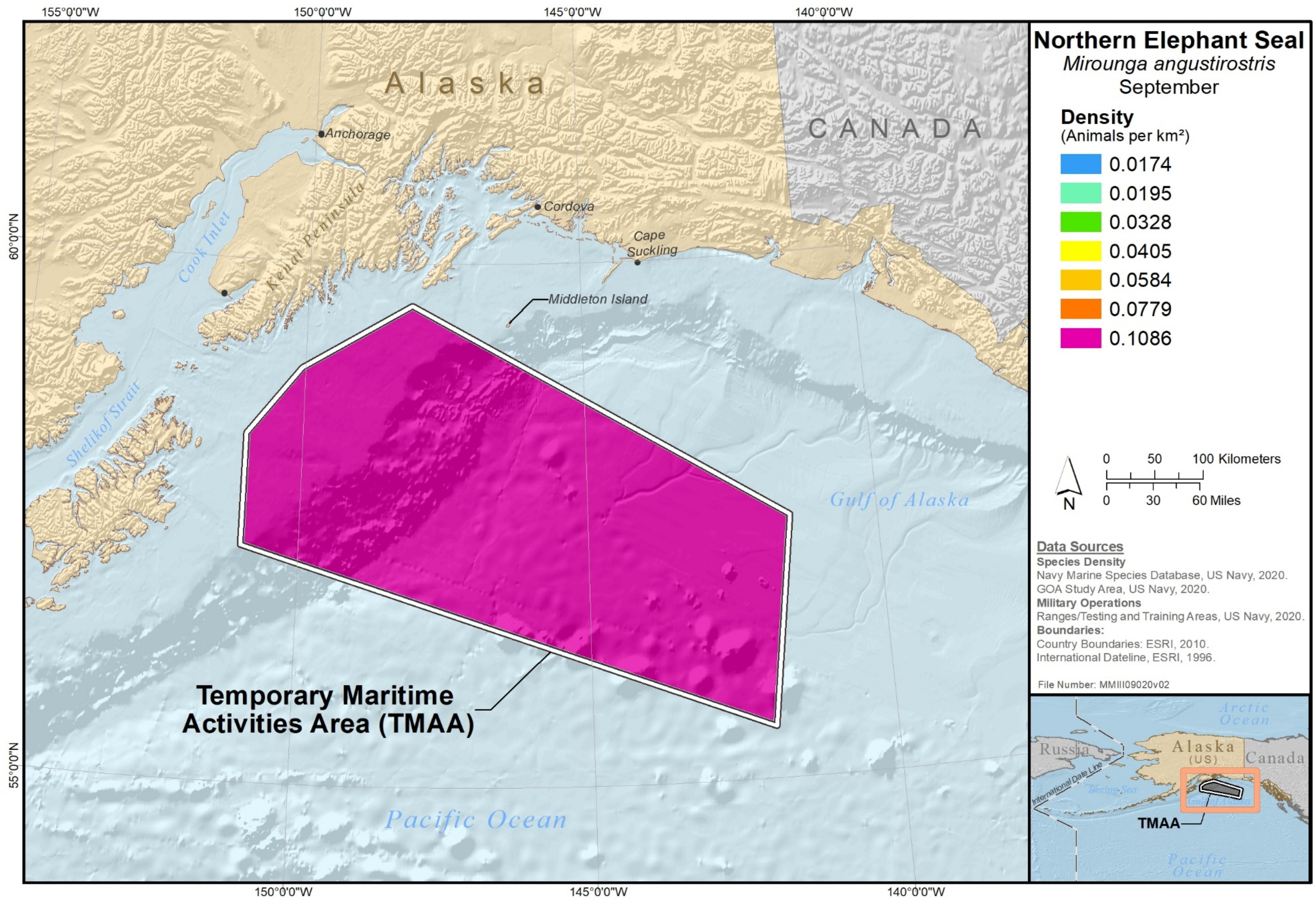


Figure 10-15: Estimated Density of Northern Elephant Seal in the TMAA in September

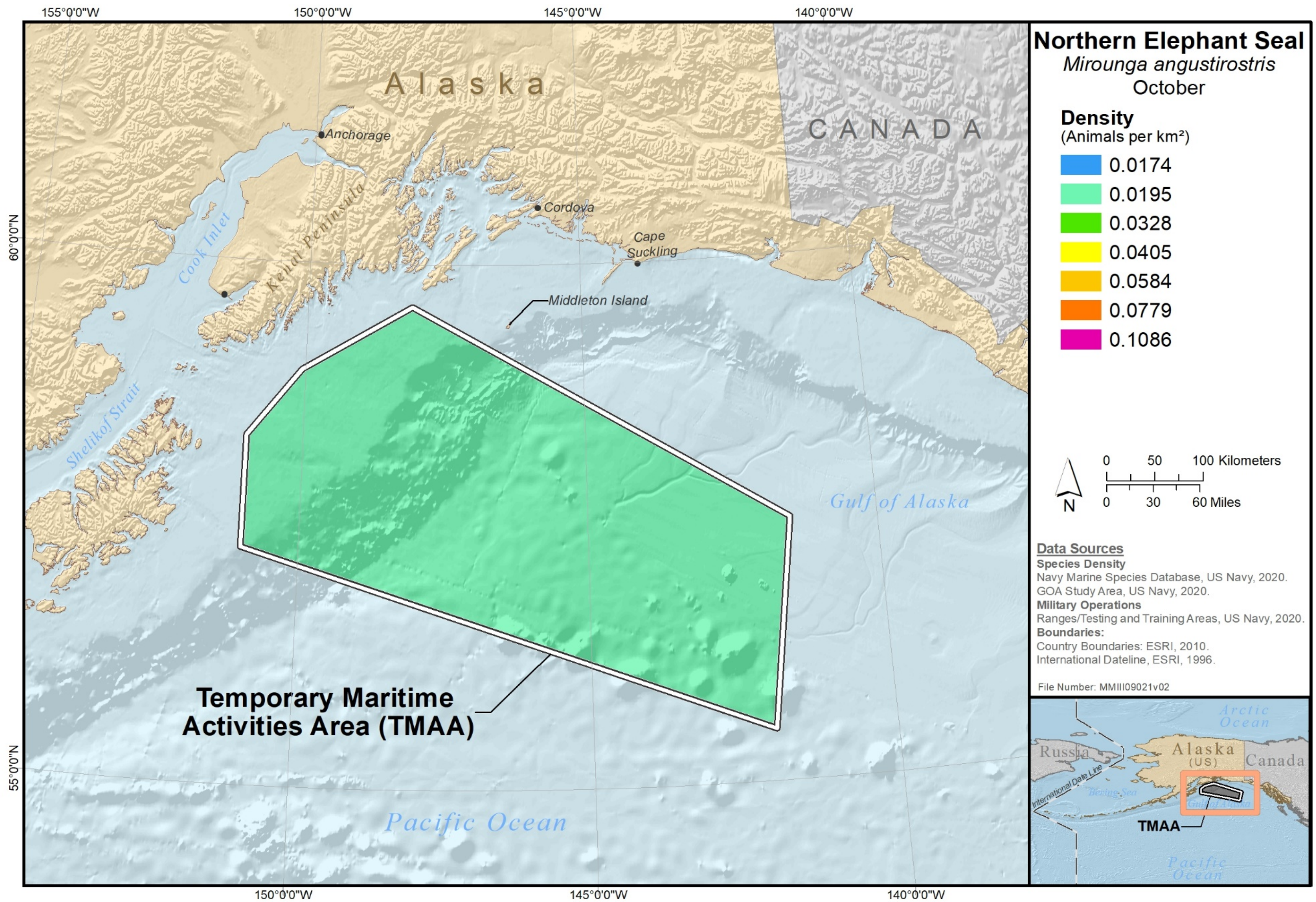


Figure 10-16: Estimated Density of Northern Elephant Seal in the TMAA in October

10.1.5 PHOCA VITULINA, HARBOR SEAL

The harbor seal is a small seal found in nearshore environments of much of the Northern Hemisphere (Jefferson et al., 2015). It is one of the most adaptable seals and can haul out in a variety of terrestrial environments (Riedman & Estes, 1990); in some locations, such as Alaska, it can even occupy freshwater lakes. The NMFS recognizes 12 stocks in Alaska waters (Carretta et al., 2020; Muto et al., 2020). The harbor seals from just 4 of the 12 stocks in Alaska would be expected in to occur in the Study Area based on proximity to the TMAA: North Kodiak, South Kodiak, Prince William Sound, and Cook Inlet/Shelikof Strait. Most harbor seals do not migrate and are expected to occur in approximately the same numbers in the Study Area year-round.

The distribution of harbor seals is largely tied to suitable haulout sites and breeding habitat for pupping and molting, and areas offering easy access to productive foraging as well as protection from predators, such as killer whales. Satellite-tracking studies recording the movements of adults and pups near Kodiak Island and elsewhere in the GOA indicate that the mean distance between haulouts and at-sea foraging was 10–25 km for juveniles and 5–10 km for adults (e.g., Lowry et al., 2001; Rehberg & Small, 2001). Nearly all locations foraging locations were in waters < 200 m deep, with an apparent preference for depths of 20–100 m (Frost et al., 2001).

Density Data. The coastal distribution and preference for shallower depths make it unlikely that harbor seals would regularly occur in the offshore portions of the TMAA. However, habitat over the continental shelf (defined as extending to the 500 m isobath) is likely used by a portion of harbor seals from the four stocks identified above (National Marine Fisheries Service, 2020; unpublished data). The approximate distribution of harbor seals from each of the four stocks does not overlap with the TMAA (with the exception of a small area representing habitat of the Prince William Sound stock) (Figure 10-17) (Muto et al., 2020); however, juveniles and adults of both sexes are expected to spend some time over the continental shelf, which includes the inshore stratum of the TMAA.

To calculate a density for harbor seal in the TMAA, an estimate of the number of harbor seals in each age and sex class that spend time over the continental shelf was needed. The percentage of juvenile and adult male and female seals occurring in the Gulf of Alaska was estimated based on data presented by Lowry et al. (2001) and adapted in Table 10-10. The number of harbor seals in each age and sex class was estimated based on a lifestage table created by Hastings et al. (2012) for the South Kodiak stock. Extrapolating the survival rates reported by Hastings et al. (2012) over 35 years and assuming an annual increase of 1,234 seals (Muto et al., 2020) allowed for a calculation estimating the proportion of seals in each age and sex class in the stock (Table 10-10). The age and sex class proportions were extrapolated to all four stocks as a reasonable approximation for estimating a combined abundance over the continental shelf. Seals between the ages of 1 and 3 were considered to be juveniles (in both sexes), and seals age 4 and older were counted as adults. Pups (seals in their first year) were not expected to be present over the continental shelf and were not considered in the density estimates.

The abundance of each stock over the continental shelf is calculated by multiplying the stock abundance (Muto et al., 2020) by the proportion of each age and sex class entering the Gulf of Alaska and then summing the classes to estimate the number of seals from each of the four stocks occurring over the continental shelf.

Table 10-10: Proportion of Age and Sex Classes of Harbor Seal in the Four Stocks and the Proportion that Entered the Gulf of Alaska

Age/Sex Class	Entered Gulf of Alaska (%)[1]	Proportion of Total Population[2] (%)
Juvenile Female	55	13
Juvenile Male	36	10
Adult Female	20	45
Adult Male	33	17

[1]Adapted from Table 2 in Lowry et al. (2001).

[2]Adapted from Table 2, model A in Hastings et al. (2012)

For example, for the North Kodiak stock the abundance of juvenile females in the stock occurring over the continental shelf is calculated as:

$\text{Abundance}_{\text{(Continental Shelf)}} = 8{,}677_{\text{(Stock Abundance)}} \times 0.55_{\text{(Percent in GOA)}} \times 0.13_{\text{(Percent in Class)}} = 630$ juvenile females

Abundances for each age and sex class are calculated in a similar way. The totals are then summed, resulting in a total abundance for the North Kodiak stock occurring over the continental shelf (Table 10-11). The same process was used to calculate abundances for the other three stocks.

Table 10-11: Stock Abundances of Harbor Seal by Age and Sex Classes

Age/Sex Class	Abundance in Gulf of Alaska			
	North Kodiak	South Kodiak	Prince William Sound	Cook Inlet/Shelikof Strait
Juvenile Female	630	1,922	3,252	2,064
Juvenile Male	310	944	1,597	1,014
Adult Female	778	2,370	4,011	2,546
Adult Male	496	1,511	2,557	1,623
Total	**2,213**	**6,746**	**11,416**	**7,247**

The total abundance of harbor seals occurring over the continental shelf is the sum of the stock abundances.

$$\text{Abundance}_{\text{(Total)}} = 2{,}213 + 6{,}746 + 11{,}416 + 7{,}247 = 27{,}623 \text{ harbor seals}$$

The in-water abundance was calculated by applying seasonal haulout factors. The haulout factors were based on studies by Withrow and Loughlin (1995), who estimated that harbor seals were hauled out 58 percent of the time (42 percent in water) during molting season (August–September) on Grand Island in southeast Alaska; Pitcher and McAllister (1981), who estimated seals were in the water 50 percent of the time during pupping season and 59 percent of the time during molting season on Kodiak Island; and Withrow et al. (1999), who reported seals were hauled out 52 percent of the time (48 percent in water) at Pedersen and Aialik glaciers on the Kenai Peninsula. These references report haulout data from the Gulf of Alaska region and are consistent in their estimates.

To calculate a density for June through September, harbor seals were estimated to be in the water 50 percent of the time and hauled out 50 percent of the time, and for April, May, and October, the in-water percentage was estimated as 60 percent. June is peak pupping time in the Gulf of Alaska, and molting season is from June through September; therefore, the harbor seals are expected to spend less time in the water and remain closer to shore (and perhaps venturing onto the shelf less frequently) than at other times of the year.

The seasonal in-water density for harbor seal in the TMAA was calculated by dividing the total in-water abundance during each season by the area of the continental shelf stratum shown in Figure 10-17.

$$\text{In-Water Density}_{(\text{Shelf})} = 27{,}623 \text{ harbor seals x } 0.60_{(\text{April-May, October})}/98{,}155 \text{ km}^2 = 0.1689 \text{ harbor seal /km}^2$$

$$\text{In-Water Density}_{(\text{Shelf})} = 27{,}623 \text{ harbor seals x } 0.50_{(\text{Jun-September})}/98{,}155 \text{ km}^2 = 0.1407 \text{ harbor seal /km}^2$$

The resulting densities are shown in Table 10-13 and depicted in Figure 10-20 and Figure 10-21. Harbor seals are not expected to occur beyond the 500 m isobath in the Gulf of Alaska.

Table 10-12: Summary of Density Values for Harbor Seal in the TMAA

Location	June–September	April–May, October
TMAA – Continental Shelf to 500 m isobath	0.1407	0.1689
TMAA – Beyond the 500 m isobath	0	0

Notes: (1) The units for numerical values are animals/km^2. 0 = species is not expected to be present.
(2) TMAA = Temporary Maritime Activities Area, m = meters

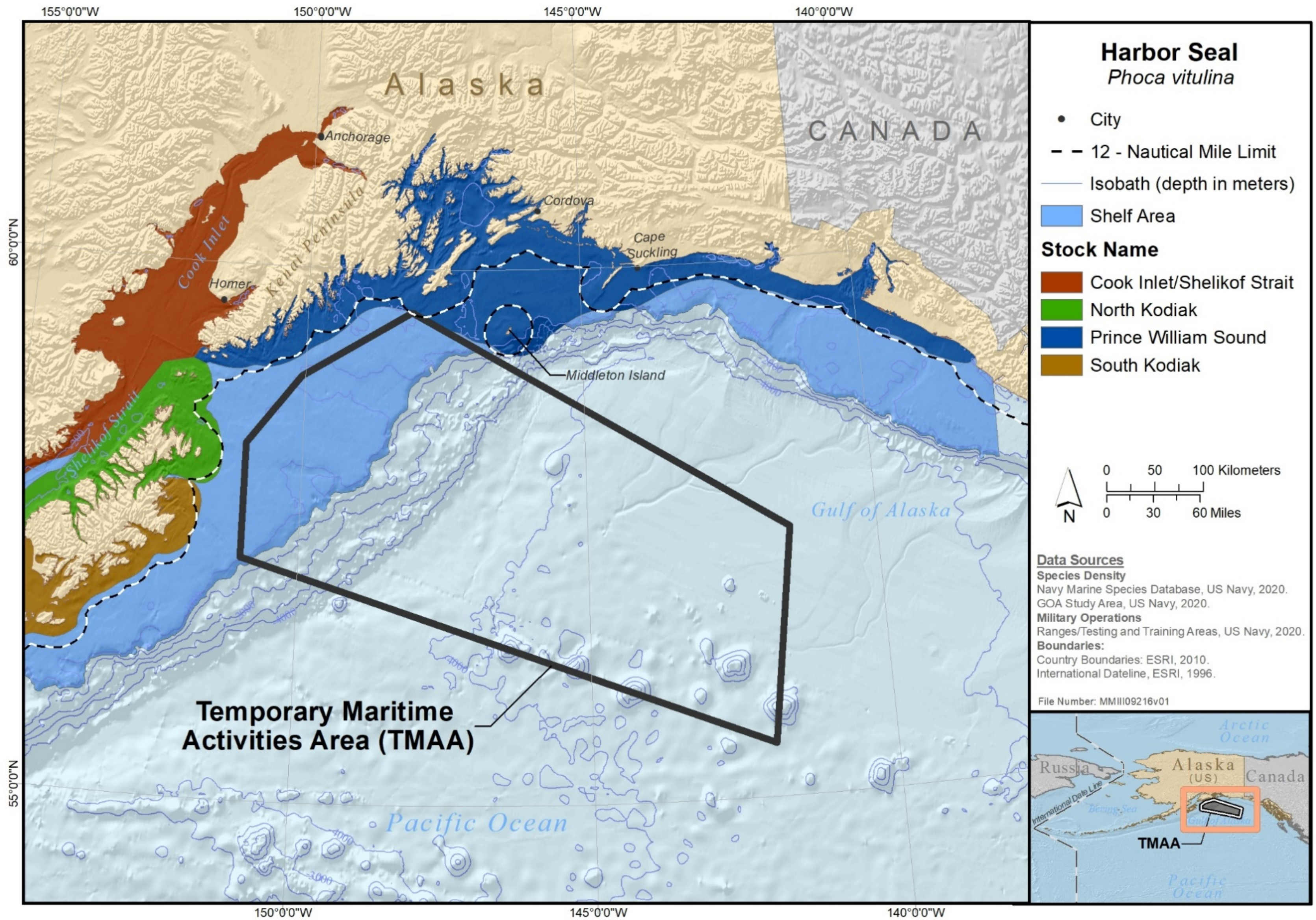


Figure 10-17: Approximate Harbor Seal Stock Extents in Proximity to the TMAA

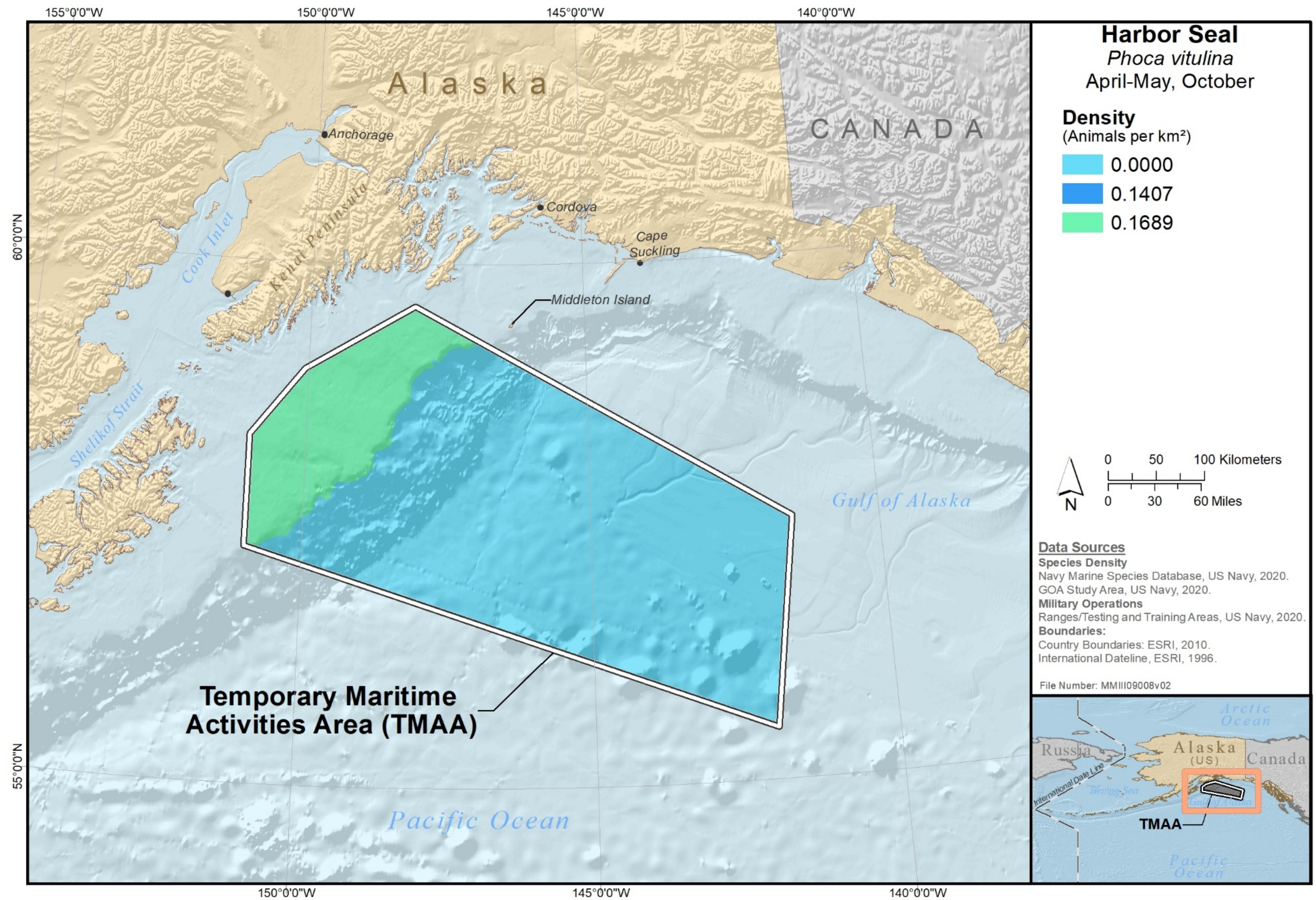


Figure 10-18: Estimated Density of Harbor Seal in the TMAA from April Through May and in October

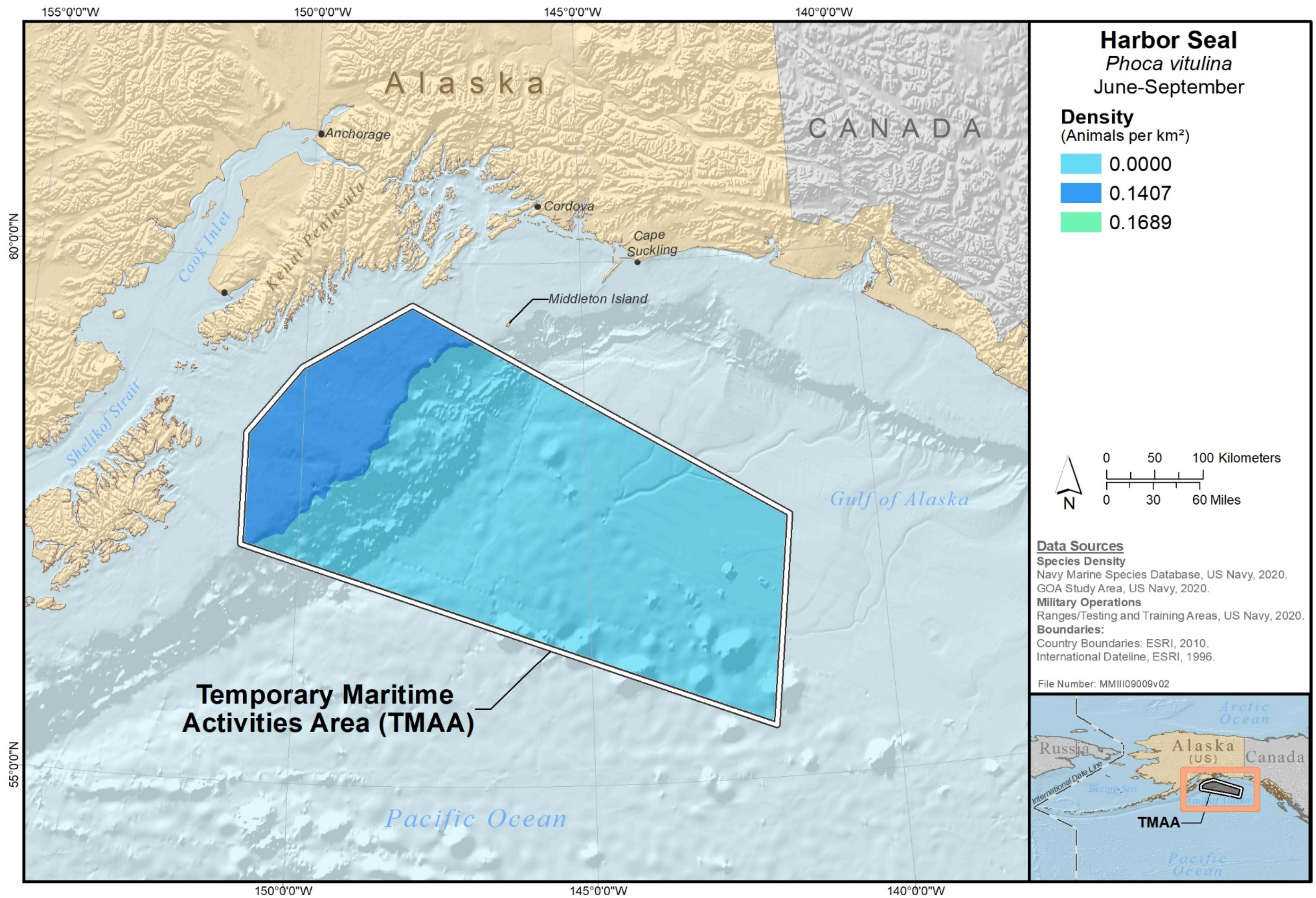


Figure 10-19: Estimated Density of Harbor Seal in the TMAA from June Through September

10.1.6 *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). 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 lion are expected to be from May through October far to the south of the TMAA and Gulf of Alaska (Carretta et al., 2000; Le Boeuf & Bonnell, 1980; Lowry et al., 1992; Lowry & Forney, 2005; Lowry et al., 2017). However, California sea lions appear to be extending their foraging range farther north, and increasing numbers of sightings have been recorded in Alaska waters (Maniscalco et al., 2004) and at haulouts (Alaska Department of Fish and Game, 2020, unpublished data), which are positively correlated with the growth of the California sea lion population.

NMFS recognizes one stock of California sea lions (the U.S. Stock) and estimated the stock abundance to be 257,606 animals in 2014 (Carretta et al., 2020). California sea lions breed in the Channel Islands in the Southern California Bight and south into Baja California, Mexico, from May through July. Males migrate north after the breeding season to nearshore 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 immature males will remain in northern feeding areas year round; although it’s unclear if that includes the Gulf of Alaska (Jeffries, 2017; Jeffries & Sleeman, 2018). Only adult and sub-adult males would be expected to migrate into the Gulf of Alaska following the breeding season (Jeffries et al., 2000; Lowry & Forney, 2005). Females generally do not migrate as far north as males and are not expected to occur in the Gulf of Alaska.

Density Data. There is currently insufficient data on the occurrence of California sea lions in the GOA to estimate a density. California sea lions have been sighted throughout Alaska from Forrester Island in southeast Alaska to St. Matthews Bay, Prince William Sound, and St. Paul Island in the Bering Sea, although few travel that far north. California sea lions are often observed hauled out with Steller sea lions, including on Middleton Island in the Gulf of Alaska. Warmer water temperatures and changes in the ocean environment may be factors that have favored California sea lions over Steller sea lions in the southern part of the Steller sea lion range in Alaska (Muto et al., 2020). Counts in the hundreds of California sea lions have been reported at Dry Bay, Alaska, which is located north of Glacier Bay National Park on the eastern shore of the Gulf of Alaska (Alaska Department of Fish and Game, 2020, unpublished data). California sea lion occurrence in the TMAA would be seasonal and limited to April and May, at which time sea lions depart from haulouts along the Alaska coastline to breeding sites in California. The offshore waters of the Gulf of Alaska are not considered part of the typical habitat for California sea lions, and their occurrence in the TMAA should be considered rare due to their limited abundance in the northern North Pacific and the species’ preference for nearshore habitat and accessible haulouts.

11 OTTERS

11.1 OTTER SPECIES PROFILES

11.1.1 *ENHYDRA LUTRIS KENYONI*, NORTHERN SEA OTTER

Sea otters forage in shallow, nearshore coastal habitats and are most commonly found in less than 40 m of water or within 400 m of the shore (Bodkin, 2015; Bodkin et al., 2004; Coletti et al., 2011; Coletti et al., 2016; Fisheries and Oceans Canada, 2015; Garlich-Miller et al., 2018; Schneider, 1977; Tinker et al., 2019). In general, sea otters are limited by their inability to forage at depths greater than 100 m (Bodkin, 2015; Bodkin et al., 2004; Coletti et al., 2011; Thometz et al., 2014; Tinker et al., 2019). Bodkin (2015) notes that sea otters can be found many kilometers from shore in locations where there are shoals far from land, however, there are no known offshore populations near the TMAA. It is possible that vagrant individuals from the Southcentral Alaska stock or the Southeast Alaska stock of sea otters could potentially occur in the nearshore margins of the TMAA.

Density Data. Sea otter densities were defined based on water depth and distances from shore for a section of the Kenai Peninsula (Alaska) coastline located inshore of the TMAA (Coletti et al., 2011; Coletti et al., 2016). These densities were based on surveys conducted in the Kenai Fjords National Park in 2002, 2007, and 2010 as reported in Coletti et al. (2011). There has been no subsequent published sea otter survey data for the Kenai Fjords area (Muto et al., 2019, 2020).

The extent of the density strata used in the Navy's analysis is consistent with the range parameters provided in Coletti et al. (2011) and Tinker et al. (2019). Those references indicate a high-density stratum extends from shore to 400 m offshore or to the 40 m depth contour, whichever is greater, and a low-density stratum extends from the high-density stratum line to 2 km offshore or to the 100 m depth contour, whichever is greater. Bays and inlets along the coastline are considered to be part of the high-density stratum, regardless of water depth.

Sea otter densities are available for the Katmai National Park and Preserve (on the Alaska Peninsula) and for western Prince William Sound (Coletti et al., 2016), and Simpson Bay inside Prince William Sound to the east (Wolt et al., 2012). While the high density strata estimates are similar between the nearby western Prince William Sound and Kenai Fjords (within the standard errors), Prince William Sound provides a different habitat than the Gulf of Alaska margins along the Kenai Peninsula (Coletti et al., 2016), and is therefore not relevant to the Navy's analysis of impacts from activities in the TMAA (the differences in habitats are also applicable to the Simpson Bay area). The locations in the Katmai National Park where the surveys occurred are on the opposite side of Kodiak Island and over 100 NM from the nearest boundary of the TMAA. The Navy therefore used the densities provided for the Kenai Fjords National Park as representative of sea otter densities along the coastline shoreward of the TMAA[2] that are close enough to the TMAA to be considered in the modeling.

[2] The ocean coastlines facing the TMAA are at Kodiak Island, Barrens Islands, Kenai Peninsula, Montague Island, Hinchinbrook Island, and the coast south southwest of Cordova to Kayak Island.

The remainder of the Gulf of Alaska coastline habitat is too far from the TMAA to be exposed to acoustic or other stressors from activities in the TMAA. The densities provided for the NMSDD are consistent with other similar sea otter habitat along ocean facing coastal margins at the Alaska Peninsula, Kodiak Island, and Southeast Alaska (Newsome et al., 2015; Tinker et al., 2019).

Densities for sea otters in the Study Area were adopted from Coletti et al. (2011) (Table 2) and are shown in Table 11-1 below. Coletti et al. (2011) reported both high and low densities for the years 2002, 2007, and 2010. To estimate a density in the Study Area shoreward of the TMAA, the Navy averaged the density estimates for each stratum in each of those years. Sea otters are not expected to occur within the boundaries of the TMAA, resulting in a 0 density, as shown in Figure 11-1.

Table 11-1: Summary of Density and Uncertainty Values for Northern Sea Otter in the TMAA

Location	Spring	Summer	Fall	Winter
Shoreward of TMAA – High Density Area	1.30 (CV=0.26)	1.30 (CV=0.26)	1.30 (CV=0.26)	1.30 (CV=0.26)
Shoreward of TMAA – Low Density Area	0.33 (CV=0.77)	0.33 (CV=0.77)	0.33 (CV=0.77)	0.33 (CV=0.77)
TMAA	0	0	0	0

Notes: (1) The units for numerical values are animals/km^2. 0 = species is not expected to be present.
(2) TMAA = Temporary Maritime Activities Area, CV = coefficient of variation

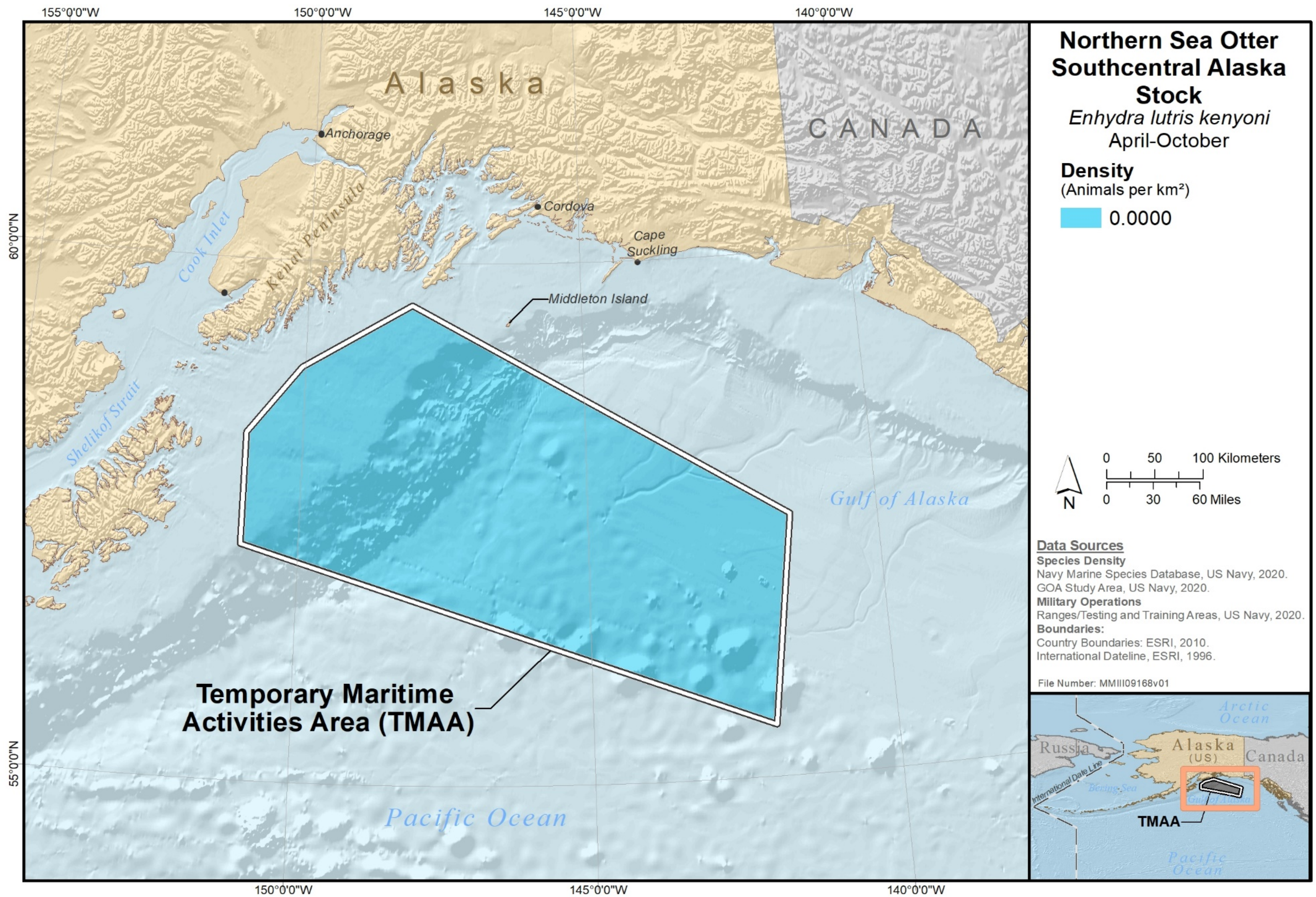


Figure 11-1: Estimated Density of Southcentral Alaska Stock of Northern Sea Otter in the TMAA from April Through October

12 SEA TURTLES

12.1 SEA TURTLE SPECIES PROFILES

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., 2011; Coles & Musick, 2000; Crear, 2015; Crear et al., 2016; Etnoyer et al., 2006; James & Mrosovsky, 2004; Storch et al., 2005).

Sea turtles are highly migratory, long-lived reptiles that occur throughout the open-ocean and coastal regions of the Study Area. Generally, sea turtles are distributed throughout tropical to subtropical latitudes (i.e., in warmer waters closer to the equator), with some species extending poleward into temperate seasonal foraging areas. In general, sea turtles spend most of their time at sea, with the notable exception of mature females returning to land, primarily beaches, to nest. The habitat preferred by sea turtles and their distribution at sea varies by species and life stage (e.g., hatchling, juvenile, adult).

There is insufficient data to estimate sea turtle densities in the Gulf of Alaska. Although tagging studies of individual turtles have been conducted that provide an indication of migratory patterns and seasonal occurrence (for example Benson et al., 2011; Benson et al., 2007; Blumenthal et al., 2009; Gaos et al., 2011; Shillinger et al., 2008; Whiting & Miller, 1998; Witt et al., 2010), there are limited data on the general presence of turtles in an area beyond their use of nesting beaches. Many studies estimate sea turtle abundance and population status by counting nesting individuals or the number of eggs (Cheng et al., 2008; Hitipeuw et al., 2007; Honarvar et al., 2008; Lopez-Castro et al., 2004; Patino-Martinez et al., 2008) or by recording bycatch (Donoso & Dutton, 2010; Koch et al., 2006). In-water densities cannot be estimated from data collected on the beach at breeding sites and incidental sighting report data.

Only the leatherback sea turtle has the potential to occur in Alaska, but no sightings have been documented in the TMAA. The hard-shell turtles of the Cheloniidae family (loggerhead, olive ridley, and green) are considered tropical, subtropical, and warm temperate species that rarely stray into colder waters (Eckert, 1993; Hodge & Wing, 2000). Hard-shell turtles encountered in the Study Area are usually stranded dead or cold stunned (National Marine Fisheries Service, 2017). In contrast to leatherback sea turtles, most hard-shell turtles seek warmer waters and become cold-stressed and inactive when temperatures are too low. Green sea turtles prefer waters where the sea surface temperature exceeds 22° Celsius (C) (Van Houtan et al., 2015) and become inactive when temperatures fall below 15°C (Crear, 2015). Olive ridley sea turtles primarily occupy areas where the sea surface temperature is between 23 and 28°C (Polovina et al., 2004) and most frequently around 27°C (Eguchi et al., 2007). Between 10 and 13.5°C, olive ridleys become cold stunned (Mrosovsky, 1980). Based on multiple studies conducted in the North Pacific, loggerhead sea turtles are known to occur in areas where sea surface temperature ranges between 10 and 28.7°C; however, mean sea surface temperatures, which are 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). Water temperature in the Gulf of Alaska has historically (based on data from 1950 to 1997) ranged between 6 and 10°C, fluctuating on both seasonal and interannual cycles (Bograd et al., 2005). Anomalously warm waters in the Gulf of Alaska were observed from 2014 to 2019, with average annual sea surface temperature up to 2°C higher compared with pre-industrial estimates (Litzow et al., 2020). Even considering the apparent warming trend, waters in the Gulf of Alaska would remain inhospitable to hard-shell sea turtles.

12.1.1 *Dermochelys coriacea*, Leatherback Sea Turtle

The leatherback turtle is the most widely distributed of all sea turtles, found from tropical to subpolar oceans, and nests on tropical and occasionally subtropical beaches (Gilman, 2008; Myers & Hays, 2006; National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1992). Found from 71°N to 47°S, it has the most extensive adult range of any turtle (Eckert, 1995). Leatherbacks are also the most migratory sea turtles and are able to tolerate colder water. Thermoregulatory adaptations such as a counter-current heat exchange system, high oil content, and large body size allow them to maintain a core body temperature higher than that of the surrounding water (Hughes et al., 1998; James & Mrosovsky, 2004). Adult leatherback turtles forage in temperate and subpolar regions in all oceans and migrate to tropical nesting beaches between 30°N and 20°S.

Density Data. Leatherback sea turtles are known to sporadically occur within Alaskan waters, but there is currently not enough known about their occurrence to provide a reasonable density estimate. 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. Benson et al. (2011) includes 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 tropical western North Pacific to waters off California, the Pacific Northwest, and British Columbia, Canada. While no tagged leatherbacks have been tracked into the Gulf of Alaska, several have migrated into the central Pacific between 40 and 50°N latitude (located south of the Gulf of Alaska and aligning with the latitudes off California, Oregon, and Washington), before their tags stopped recording (Bailey et al., 2012; Benson et al., 2011). Approximately 20[3] sightings of leatherbacks have been recorded in Alaskan waters over the past six decades, with most of these sightings occurring prior to 1983 (Hodge and Wing, 2000; MacDonald, 2003; Wing, 2004; Cushing et al., 2021), and all occurring in coastal, shelf-associated waters. The most recent sighting occurred in 2013, over the continental shelf at approximately 58° latitude and 140° longitude, west of Yakobi Island and Glacier Bay National Park in

[3] 19 reported in (Hodge & Wing, 2000), plus one additional sighting in 2013 reported in (Cushing et al., 2021). Sightings recorded in 1963, 1978, 1979, 1983, 1984, 1990, 1993, and 2013. Navy confirmed that there have been no sightings of leatherbacks since the 2013 report through email correspondence with multiple NMFS biologists: Kate Savage, Barbra Mahoney, and Mandy Keogh, dated March 8, 2021.

southeast Alaska (Cushing et al 2021). Prior to 2013, the last confirmed sighting of leatherback in Alaskan waters was in 1993 (Hodge and Wing, 2000).

A recent paper by Benson et al. (2020) concludes that there are even fewer leatherbacks foraging off the U.S. West Coast than previously thought. The study looked at decades' worth of data on leatherbacks occurring along the U.S. West Coast and concluded that the number of leatherbacks foraging off the west coast declined by 5.6 percent annually between 1990 and 2017, representing an 80 percent decline in the foraging population over that time period. From 1990 to 2003, the authors estimated that an average of 128 leatherbacks foraged in Central California waters, whereas from 2004 to 2017, the estimate declined to an average of 55 leatherbacks. Tagging of leatherback in the CCE seems to indicate a preference for turtles to use waters over the coastal shelf (<200 m) (Benson et al. 2011, Benson et al. 2007). Off Oregon and Washington, feeding behavior was identified in the continental shelf and slope habitat (200-2,000 m). This is consistent with the sighting records since 1960 reported in Hodge and Wing 2000, which show leatherback sightings occurring in the nearshore and inland waters of Alaska. Based on sighting data, leatherbacks in the Gulf of Alaska are rare, but if present are much more likely to occur over the shelf and slope habitats in Southeast Alaska, well outside of the TMAA.

13 CONCLUSION

The density estimates provided in this report represent the best available values that were used in modeling the effects from Navy Phase III sound sources to marine species. These data have been updated since the Navy's Phase II analyses (U.S. Department of the Navy, 2015) but still represent a snapshot in time, so that as science progresses and better estimates become available, the NMSDD will be updated for use in future Navy modeling efforts. Scientists from NMFS and the Navy have already identified many new methods and projects that will improve and expand the data in the NMSDD for the next time it is called upon as a data source. The ultimate goal is to arrive at accurate density estimates for every species. As suggested in the species descriptions, this may be very difficult to achieve for some species, and techniques other than line-transect sampling may be required. Even when estimates are achieved, they will need to be maintained through regular monitoring, because the size of marine species populations changes over time and their distributions change with the large-scale dynamics in the world's oceans. It is an ambitious endeavor to maintain accurate information on all of the marine species in the Navy's OPAREAs, but the partnership and pooling of resources and expertise amongst NMFS, scientific experts, and the Navy is more likely to achieve this than any other partnership that has come before.

14 LITERATURE CITED

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

Alaska Department of Fish and Game. (2008). *Ribbon Seal*. Retrieved September 28, 2020, from https://www.adfg.alaska.gov/static/education/wns/ribbon_seal.pdf.

Allen, B. M. and R. P. Angliss. (2014). *Alaska Marine Mammal Stock Assessments, 2014* (NOAA Technical Memorandum NMFS-AFSC-301). Seattle, WA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.

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

Aurioles-Gamboa, D. and F. J. Camacho-Rios. (2007). Diet and feeding overlap of two otariids, *Zalophus californianus* and *Arctocephalus townsendi*: Implications to survive environmental uncertaintly. *Aquatic Mammals, 33*(3), 315–326. DOI:doi: 10.1578/AM.33.3.2007.315

Aurioles, D., P. L. Koch, and B. J. Le Boeuf. (2006). Differences in Foraging Location of Mexican and California Elephant Seals: Evidence from Stable Isotopes in Pups. *Marine Mammal Science, 22*(2), 326–338.

Bailey, H., S. R. Benson, G. L. Shillinger, S. J. Bograd, P. H. Dutton, S. A. Eckert, S. J. Morreale, F. V. Paladino, T. Eguchi, D. G. Foley, B. A. Block, R. Piedra, C. Hitipeuw, R. F. Tapilatu, and J. R. Spotila. (2012). Identification of distinct movement patterns in Pacific leatherback turtle populations influenced by ocean conditions. *Ecological Applications, 22*(3), 735–747. DOI:10.1890/11-0633

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

Baird, R. W., G. S. Schorr, D. L. Webster, D. J. McSweeney, and S. D. Mahaffy. (2006). *Studies of Beaked Whale Diving Behavior and Odontocete Stock Structure in Hawaii in March/April 2006*. Olympia, WA: Cascadia Research Collective.

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

Baird, R. W., D. L. Webster, G. S. Schorr, D. J. McSweeney, and J. Barlow. (2008). Diel variation in beaked whale diving behavior. *Marine Mammal Science, 24*(3), 630–642. DOI:doi: 10.1111/j.1748-7692.2008.00211.x

Baker, J. D. (2007). Post-weaning migration of northern fur seal *Callorhinus ursinus* pups from the Pribilof Islands, Alaska. *Marine Ecology Progress Series, 341*, 243–255.

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

Barlow, J. (1999). Trackline Detection Pobability for Long-Diving Whales. In G. W. Garner (Ed.), *Marine Mammal Survey and Assesment Methods* (pp. 209–221). Rotterdam, Netherlands: Balkema.

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

Barlow, J., M. Ferguson, E. Becker, J. Redfern, K. Forney, I. Vilchis, P. Fiedler, T. Gerrodette, and L. Ballance. (2009). *Predictive Modeling of Cetacean Densities in the Eastern Pacific Ocean* (NOAA

Technical Memorandum NMFS-SWFSC-444). La Jolla, CA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

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

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

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

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

Baumann-Pickering, S., A. E. Simonis, M. A. Roch, M. A. McDonald, A. Solsona-Berga, E. M. Oleson, S. M. Wiggins, R. L. Brownell, Jr., and J. A. Hildebrand. (2012a). *Spatio-temporal patterns of beaked whale echolocation signals in the North Pacific* (2012 Marine Mammal & Biology Program Review). Arlington, VA: Office of Naval Research.

Baumann-Pickering, S., A. Širović, J. A. Hildebrand, A. J. Debich, R. S. Gottlieb, S. C. Johnson, S. M. Kerosky, L. K. Roche, A. Solsona Berga, L. Wakefield, and S. M. Wiggins. (2012b). *Passive Acoustic Monitoring for Marine Mammals in the Gulf of Alaska Temporary Maritime Activities Area 2011-2012*. La Jolla, CA: Marine Physical Laboratory, Scripps Institution of Oceanography.

Becker, E. A., J. V. Carretta, K. A. Forney, J. Barlow, S. Brodie, R. Hoopes, M. G. Jacox, S. M. Maxwell, J. V. Redfern, N. B. Sisson, H. Welch, and E. L. Hazen. (2020). Performance evaluation of cetacean species distribution models developed using generalized additive models and boosted regression trees. *Ecology and Evolution, 10*, 5759–5784.

Becker, E. A., D. G. Foley, K. A. Forney, J. Barlow, J. V. Redfern, and C. L. Gentemann. (2012). Forecasting cetacean abundance patterns to enhance management decisions. *Endangered Species Research, 16*, 97–112. DOI:10.3354/esr00390

Becker, E. A., K. A. Forney, M. C. Ferguson, D. G. Foley, R. C. Smith, J. Barlow, and J. V. Redfern. (2010). Comparing California Current cetacean–habitat models developed using in situ and remotely sensed sea surface temperature data. *Marine Ecology Progress Series, 413*, 163–183. DOI:10.3354/meps08696

Becker, E. A., K. A. Forney, P. C. Fiedler, J. Barlow, S. J. Chivers, C. A. Edwards, A. M. Moore, and J. V. Redfern. (2016). Moving Towards Dynamic Ocean Management: How Well Do Modeled Ocean Products Predict Species Distributions? *Remote Sensing, 8*(2), 149. DOI:10.3390/rs8020149

Becker, E. A., K. A. Forney, D. G. Foley, R. C. Smith, T. J. Moore, and J. Barlow. (2014). Predicting seasonal density patterns of California cetaceans based on habitat models. *Endangered Species Research, 23*(1), 1–22. DOI:10.3354/esr00548

Becker, E. A., K. A. Forney, J. V. Redfern, J. Barlow, M. G. Jacox, J. J. Roberts, and D. M. Palacios. (2018). Predicting cetacean abundance and distribution in a changing climate. *Biodiversity Research, 2018*, 1–18. DOI:10.1111/ddi.12867

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

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

Benson, S. R., K. A. Forney, J. E. Moore, E. L. LaCasella, J. T. Harvey, and J. V. Carretta. (2020). A long-term decline in the abundance of endangered leatherback turtles, *Dermochelys coriacea*, at a foraging ground in the California Current Ecosystem. *Global Ecology and Conservation, 24*. Retrieved from https://doi.org/10.1016/j.gecco.2020.e01371.

Bigg, M. A. (1986). Arrival of northern fur seals, *Callorhinus ursinus*, on St. Paul Island, Alaska. *Fishery Bulletin, 84*(2), 383–394.

Bigg, M. A. (1990). *Migration of Northern Fur Seals (Callorhinus ursinus) off Western North America* (Canadian Technical Report of Fisheries and Aquatic Sciences No. 1764). British Columbia, Canada: Department of Fisheries and Oceans Biological Sciences Branch Pacific Biological Station Nanaimo.

Bishop, A., C. Brown, M. Rehberg, L. Torres, and M. Horning. (2018). Juvenile Steller sea lion (*Eumetopias jubatus*) utilization distributions in the Gulf of Alaska. *Movement Ecology, 6*(6), 1–15.

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

Blumenthal, J. M., T. J. Austin, J. B. Bothwell, A. C. Broderick, G. Ebanks-Petrie, J. R. Olynik, M. F. Orr, J. L. Solomon, M. J. Witt, and B. J. Godley. (2009). Diving behavior and movements of juvenile hawksbill turtles, *Eretmochelys imbricata,* on a Caribbean coral reef. *Coral Reefs, 28*(1), 55–65. DOI:10.1007/s00338-008-0416-1

Bodkin, J. L. (2015). Chapter 3: Historic and Contemporary Status of Sea Otters in the North Pacific *Sea Otter Conservation*. Anchorage, AK: U.S. Geological Survey, Alaska Science Center.

Bodkin, J. L., G. G. Esslinger, and D. H. Monson. (2004). Foraging depths of sea otters and implications to coastal marine communities. *Marine Mammal Science, 20*(2), 305–321.

Bograd, S. J., R. Mendelssohn, F. B. Schwing, and A. J. Miller. (2005). Spatial heterogeneity of sea surface temperature trends in the Gulf of Alaska. *Atmosphere-Ocean, 43*(3), 241–247.

Boveng, P. and L. Lowry. (2018). Ribbon Seal: Histriophoca fasciata. In *Encyclopedia of Marine Mammals* (pp. 811–813). Cambridge, MA: Academic Press.

Boveng, P. L., J. L. Bengtson, M. F. Cameron, S. P. Dahle, E. A. Logerwell, J. M. London, J. E. Overland, J. T. Sterling, D. E. Stevenson, B. L. Taylor, and H. L. Ziel. (2013). *Status Review of the Ribbon Seal (Histriophoca fasciata)*. Silver Spring, MD: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.

Braham, H. W. (1984). Distribution and Migration of Gray Whales in Alaska. In M. L. Jones, S. L. Swartz, & S. Leatherwood (Eds.), *The Gray Whale, Eschrichtius robustus* (pp. 249–266). Orlando, FL: Academic Press, Inc.

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

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

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

Buckland, S. T., D. Bloch, K. L. Cattanach, T. Gunnlaugsson, K. Hoydal, S. Lens, and J. Sigurjonsson. (1993). Distribution and abundance of long-finned pilot whales in the North Atlantic, estimated from NASS-87 and NASS-89 data. *Reports of the International Whaling Commission, Special Issue 14*, 33–49.

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

Calambokidis, J., J. D. Darling, V. Deecke, P. Gearin, M. Gosho, W. Megill, C. M. Tombach, D. Goley, C. Toropova, and B. Gisborne. (2002). Abundance, range and movements of a feeding aggregation of gray whales (*Eschrichtius robustus*) from California to southeastern Alaska in 1998. *Journal of Cetacean Research and Management, 4*(3), 267–276.

Calambokidis, J., E. A. Falcone, T. J. Quinn, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, R. LeDuc, D. Mattila, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán R., D. Weller, B. H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, and N. Maloney. (2008). *SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific*. Olympia, WA: Cascadia Research.

Calambokidis, J., J. L. Laake, and A. Klimek. (2010). *Abundance and Population Structure of Seasonal Gray Whales in the Pacific Northwest, 1998–2008*. Washington, DC: International Whaling Commission Scientific Committee.

Call, K. A., B. S. Fadely, A. Greig, and M. J. Rehberg. (2007). At-sea and on-shore cycles of juvenile Steller sea lions (*Eumetopias jubatus*) derived from satellite dive recorders: A comparison between declining and increasing populations. *Deep-Sea Research II, 54*, 298–310. DOI:10.1016/j.dsr2.2006.11.016

Call, K. A., R. R. Ream, D. Johnson, J. T. Sterling, and R. G. Towell. (2008). Foraging route tactics and site fidelity of adult female northern fur seal (*Callorhinus ursinus*) around the Pribilof Islands. *Deep-Sea Research Part II-Topical Studies in Oceanography, 55*(16–17), 1883–1896.

Carretta, J. V., K. A. Forney, E. M. Oleson, D. W. Weller, A. R. Lang, J. Baker, M. M. Muto, B. Hanson, A. J. Orr, H. Huber, M. S. Lowry, J. Barlow, J. E. Moore, D. Lynch, L. Carswell, and R. L. Brownell Jr. (2020). *U.S. Pacific Marine Mammal Stock Assessments: 2019* (NOAA-TM-NMFS-SWFSC-629). La Jolla, CA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Carretta, J. V., M. S. Lowry, C. E. Stinchcomb, M. S. Lynn, and R. E. Cosgrove. (2000). *Distribution and abundance of marine mammals at San Clemente Island and surrounding offshore waters: Results from aerial and ground surveys in 1998 and 1999*. La Jolla, CA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

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

Cheng, I.-J., P. H. Dutton, C. L. Chen, H. C. Chen, and J. W. Shea. (2008). Comparison of the genetics and nesting ecology of two green turtle rookeries. *Journal of Zoology, 276*(4), 375–384. DOI:10.1111/j.1469-7998.2008.00501.x

Clapham, P. J. (2000). The humpback whale: Seasonal feeding and breeding in a baleen whale. In J. Mann, R. C. Connor, P. L. Tyack, & H. Whitehead (Eds.), *Cetacean Societies: Field Studies of Dolphins and Whales* (pp. 173–196). Chicago, IL: University of Chicago Press.

Coles, W. C. and J. A. Musick. (2000). Satellite sea surface temperature analysis and correlation with sea turtle distribution off North Carolina. *Copeia, 2000*(2), 551–554.

Coletti, H. A., J. L. Bodkin, and G. G. Esslinger. (2011). *Sea Otter Abundance in Kenai Fjords National Park: Results from the 2010 Aerial Survey*. Anchorage, AK: National Park Service.

Coletti, H. A., J. L. Bodkin, D. H. Monson, B. E. Ballachey, and T. A. Dean. (2016). Detecting and inferring cause of change in an Alaska nearshore marine ecosystem. *Ecosphere, 7*(10).

Committee on Taxonomy. (2018). *List of Marine Mammal Species and Subspecies*. Retrieved November 2, 2018, from https://www.marinemammalscience.org/species-information/list-marine-mammal-species-subspecies/.

Condit, R., J. Reiter, P. A. Morris, R. Berger, S. G. Allen, and B. J. Le Boeuf. (2014). Lifetime survival rates and senescence in northern elephant seals. *Marine Mammal Science, 30*(1), 122–138.

Costa, D. P., D. E. Crocker, J. Gedamke, P. M. Webb, D. S. Houser, S. B. Blackwell, D. Waples, S. A. Hayes, and B. J. Le Boeuf. (2003). The effect of a low-frequency sound source (acoustic thermometry of the ocean climate) on the diving behavior of juvenile northern elephant seals, *Mirounga angustirostris*. *The Journal of the Acoustical Society of America, 113*(2), 1155–1165.

Crawford, W. R., P. J. Briskley, and A. C. Thomas. (2007). Mesoscale eddies dominate surface phytoplankton in northern Gulf of Alaska. *Progress in Oceanography, 75*, 287–303.

Crear, D. (2015). *The effects of temperature and habitat on the movement patterns of green sea turtles (Chelonia mydas) within an urbanized river and local estuary.* (Master's thesis). Retrieved from https://pqdtopen.proquest.com/doc/1707671197.html?FMT=ABS.

Crear, D. P., D. D. Lawson, J. A. Seminoff, T. Eguchi, R. A. LeRoux, and C. G. Lowe. (2016). Seasonal shifts in the movement and distribution of green sea turtles *Chelonia mydas* in response to anthropogenically altered water temperatures. *Marine Ecology Progess Series, 548*, 219–232. DOI:10.3354/meps11696

Cushing, D., E. Labunski, and K. J. Kuletz. (2021). *Summer tourists: The rare, amazing, and out-of-their-range visitors observed during seabird surveys in the Gulf of Alaska and Aleutian Islands* [Poster]. Presented at the Alaska Marine Science Symposium. Virtual conference online.

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

Debich, A., S. Baumann-Pickering, A. Sirovic, J. Hildebrand, J. S. Buccowich, R. S. Gottlieb, A. N. Jackson, S. C. Johnson, L. Roche, J. T. Trickey, B. Thayre, L. Wakefield, and S. M. Wiggins. (2013). *Passive Acoustic Monitoring for Marine Mammals in the Gulf of Alaska Temporary Maritime Activities Area 2012-2013*. La Jolla, CA: Marine Physical Laboratory of the Scripps Institution of Oceanography University of California, San Diego.

Debich, A. J., S. Bauman-Pickering, A. Sirovic, J. A. Hildebrand, A. L. Alldredge, R. S. Gottlieb, S. T. Herbert, S. C. Johnson, A. C. Rice, L. K. Roche, B. J. Thayre, J. S. Trickey, L. M. Varga, and S. M. Wiggins. (2014). *Passive Acoustic Monitoring for Marine Mammals in the Gulf of Alaska Temporary Maritime Activities Area 2013-2014*. La Jolla, CA: University of San Diego.

DeLong, R. (2018). *Draft Pinniped Write-Ups for the Navy's Marine Species Density Database Technical Report-Multiple Species*. Washington, DC: U.S. Department of the Navy.

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

Donoso, M. and P. H. Dutton. (2010). Sea turtle bycatch in the Chilean pelagic longline fishery in the southeastern Pacific: Opportunities for conservation. *Biological Conservation, 143*(11), 2672–2684. DOI:10.1016/j.biocon.2010.07.011

Donovan, G. P. (1991). A Review of International Whaling Commission Stock Boundaries. *Reports of the International Whaling Commission, 13*, 39–68.

Eckert, K. L. (1993). *The Biology and Population Status of Marine Turtles in the North Pacific Ocean*. Silver Spring, MD: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

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

Eguchi, T., T. Gerrodette, R. L. Pitman, J. A. Seminoff, and P. H. Dutton. (2007). At-sea density and abundance estimates of the olive ridley turtle, *Lepidochelys olivacea,* in the eastern tropical Pacific. *Endangered Species Research, 3*(2), 191–203. DOI:10.3354/esr003191

Eguchi, T., S. McClatchie, C. Wilson, S. R. Benson, R. A. LeRoux, and J. A. Seminoff. (2018). Loggerhead turtles (*Caretta caretta*) in the California current: Abundance, distribution, and anomalous warming of the North Pacific. *Frontiers in Marine Science, 5*(452), 1–15.

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

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

Fisheries and Oceans Canada. (2015). *Trends in the abundance and distribution of sea otters (Enhydra lutris) in British Columbia updated with 2013 survey results*. Nanaimo, British Columbia: Center for Science Advice, Pacific Region.

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

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

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

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

Forney, K. A., E. A. Becker, D. G. Foley, J. Barlow, and E. M. Oleson. (2015). Habitat-based models of cetacean density and distribution in the central North Pacific. *Endangered Species Research, 27*, 1–20. DOI:10.3354/esr00632

Forney, K. A., M. C. Ferguson, E. A. Becker, P. C. Fiedler, J. V. Redfern, J. Barlow, I. L. Vilchis, and L. T. Ballance. (2012). Habitat-based spatial models of cetacean density in the eastern Pacific Ocean. *Endangered Species Research, 16*(2), 113–133. DOI:10.3354/esr00393

Frasier, T. R., S. M. Koroscil, B. N. White, and J. D. Darling. (2011). Assessment of population substructure in relation to summer feeding ground use in the eastern North Pacific gray whale. *Endangered Species Research, 14*(1), 39–48. DOI:10.3354/esr00340

Fritz, L., K. Sweeney, R. Towell, and T. Gelatt. (2015). *Results of Steller Sea Lion Surveys in Alaska, June–July 2015*. Seattle, WA: National Marine Fisheries Service, Alaska Fisheries Science Center.

Fritz, L., K. Sweeney, R. Towell, and T. Gelatt. (2016). *Aerial and Ship-Based Surveys of Stellar Sea Lions (Eumetopias jubatus) Conducted in Alaska in June–July 2013 through 2015, and an Update on the Status and Trend of the Western Distinct Population Segment in Alaska* (National Oceanic and Atmospheric Administration Technical Memorandum NMFS-AFSC-321). Seattle, WA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.

Frost, K. J., M. A. Simpkins, and L. F. Lowry. (2001). Diving behavior of subadult and adult harbor seals in Prince William Sound, Alaska. *Marine Mammal Science, 17*, 813–834.

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

Garlich-Miller, J. L., G. G. Esslinger, and B. P. Weitzman. (2018). *Aerial Surveys of Sea Otters (Enhydra lutris) in Lower Cook Inlet, Alaska* (USFWS Technical Report MMM 2018-01). Anchorage, AK: U.S. Fish and Wildlife Service, Marine Mammals Management.

Gilman, E. (2008). *Pacific Leatherback Conservation and Research Activities* (Financing and Priorities). Honolulu, HI: The World Conservation Union and Western Pacific Fishery Management Council and IUCN.

Gosho, M., P. Gearin, R. Jenkinson, J. Laake, L. Mazzuca, D. Kubiak, J. Calambokidis, W. Megill, B. Gisborne, D. Goley, C. Tombach, J. Darling, and V. Deecke. (2011). *Movements and diet of gray whales (Eschrichtius robustus) off Kodiak Island, Alaska, 2002–2005*. Presented at the International Whaling Commission AWMP workshop 28 March–1 April 2011. Washington, DC.

Gregr, E. J. (2011). Insights into North Pacific right whale *Eubalaena japonica* habitat from historic whaling records. *Endangered Species Research, 15*, 223–239. DOI:10.3354/esr00381

Hakamada, T., K. Matsuoka, H. Murase, and T. Kitakado. (2017). Estimation of the abundance of the sei whale *Balaenoptera borealis* in the central and eastern North Pacific in summer using sighting data from 2010 to 2012. *Fisheries Science, 83*, 887–895.

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

Harvey, J. T., R. F. Brown, and B. R. Mate. (1990). Abundance and Distribution of Harbor Seals (*Phoca vitulina*) in Oregon, 1975–1983. *Northwestern Naturalist, 71*(3), 65–71. DOI:10.2307/3536774

Hastings, K. K., L. A. Jemison, G. W. Pendleton, K. L. Raum-Suryan, and K. W. Pitcher. (2017). Natal and breeding philopatry of female Steller sea lions in southeastern Alaska. *PLoS ONE, 12*(6), e0176840.

Hastings, K. K., M. J. Rehberg, G. M. O’corry-Crowe, G. W. Pendleton, L. A. Jemison, T. S. Gelatt, and A. Hohn. (2019). Demographic consequences and characteristics of recent population mixing and colonization in Steller sea lions, *Eumetopias jubatus*. *Journal of Mammalogy*. DOI:10.1093/jmammal/gyz192

Hastings, K. K., R. J. Small, and G. W. Pendleton. (2012). Sex- and age-specific survival of harbor seals (*Phoca vitulina*) from Tugidak Island, Alaska. *Journal of Mammalogy, 93*(5), 1368–1379.

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

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

Himes Boor, G. K. and R. J. Small. (2012). Steller sea lion spatial-use patterns derived from a Bayesian model of opportunistic observations. *Marine Mammal Science*, 1–28. DOI:10.1111/j.1748-7692.2011.00541.x

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

Hobbs, R. C. and J. M. Waite. (2010). Abundance of harbor porpoise (*Phocoena phocoena*) in three Alaskan regions, corrected for observer errors due to perception bias and species misidentification, and corrected for animals submerged from view. *Fishery Bulletin, 108*(3), 251–267.

Hodge, R. P. and B. L. Wing. (2000). Occurrences of marine turtles in Alaska waters: 1960—1998. *Herpetological Review, 31*(3), 148–151.

Hoelzel, A. R. (1999). Impact of population bottlenecks on genetic variation and the importance of life-history; a case study of the northern elephant seal. *Biological Journal of the Linnean Society, 68*, 23–29.

Hoffman, J. I., K. K. Dasmahapatra, W. Amos, C. D. Phillips, and T. S. Gelatt. (2009). Contrasting patterns of genetic diversity at three different genetic markers in a marine mammal metapopulation. *Molecular Ecology, 18*, 2961–2978.

Holmes, E. E., L. W. Fritz, A. E. York, and K. Sweeney. (2007). Age-structured modeling reveals long-term declines in the natality of western Steller sea lions. *Ecological Applications, 17*(8), 2214–2232.

Honarvar, S., M. P. O'Connor, and J. R. Spotila. (2008). Density-dependent effects on hatching success of the olive ridley turtle, *Lepidochelys olivacea*. *Oecologia, 157*(2), 221–230. DOI:10.1007/s00442-008-1065-3

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

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

James, M. C. and N. Mrosovsky. (2004). Body temperatures of leatherback turtles (*Dermochelys coriacea*) in temperate waters off Nova Scotia, Canada. *Canadian Journal of Zoology, 82*, 1302–1306. DOI:10.1139/Z04-110

Jefferson, T. A., M. A. Webber, and R. L. Pitman. (2008). *Marine Mammals of the World: A Comprehensive Guide to Their Identification*. London, United Kingdom: Elsevier.

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

Jeffries, S. (2014). *Aerial Surveys of Pinniped Haulout Sites in Pacific Northwest Inland Waters. Final Report* (Prepared for Commander, U.S. Pacific Fleet, Pearl Harbor, Hawaii). Silverdale, WA: Naval Facilities Engineering Command (NAVFAC) Northwest.

Jeffries, S. (2017). Personnal communication between Steve Jeffries and Stephanie Sleeman regarding counts at multiple haul-out sites.

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

Jeffries, S. and S. Sleeman (2018, April 13). Personal communication via email between Steve Jeffries (Washington Department of Fish and Wildlife) and Stephanie Sleeman (U.S. Department of the Navy) regarding California sea lion abundance in the Puget Sound.

Jeffries, S. J., P. J. Gearin, H. R. Huber, D. L. Saul, and D. A. Pruett. (2000). *Atlas of Seal and Sea Lion Haulout Sites in Washington*. Olympia, WA: Washington Department of Fish and Wildlife, Wildlife Science Division.

Jemison, L. A., G. W. Pendleton, L. W. Fritz, K. K. Hastings, J. M. Maniscalco, A. W. Trites, and T. S. Gelatt. (2013). Inter-population movements of Steller sea lions in Alaska with implications for population separation. *PLoS ONE, 8*(8), e70167.

Jemison, L. A., G. W. Pendleton, K. K. Hastings, J. M. Maniscalco, and L. W. Fritz. (2018). Spatial distribution, movements, and geographic range of Steller sea lions (*Eumetopias jubatus*) in Alaska. *PLoS ONE, 13*(12).

Jones, M. L., S. L. Swartz, and S. Leatherwood. (1984). *The Gray Whale, Eschrichtius robustus*. Orlando, FL: Academic Press.

Kasamatsu, F., K. Matsuoka, and T. Hakamada. (2000). Interspecific relationships in density among the whale community in the Antarctic. *Polar Biology, 23*(7), 466–473. DOI:10.1007/s003009900107

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

Kenyon, K. W. and F. Wilke. (1953). Migration of the Northern Fur Seal, *Callorhinus ursinus*. *Journal of Mammalogy, 34*(1), 86–98.

Koch, V., W. J. Nichols, H. Peckham, and V. de la Toba. (2006). Estimates of sea turtle mortality from poaching and bycatch in Bahia Magdalena, Baja California Sur, Mexico. *Biological Conservation, 128*(3), 327–334.

Ladd, C. (2007). Interannual variability of the Gulf of Alaska eddy field. *Geophysical Research Letters, 34*.

Lander, R. H. (1980). *Summary of Northern Fur Seal Data and Collection Procedures. Vol. 2: Eastern Pacific Pelagic Data of the United States and Canada (excluding fur seals sighted)* (NOAA Technical Memorandum NMFS-F/NWC-4). Springfield, VA: National Technical Information Service, U.S. Department of Commerce.

Large Marine Ecosystem Hub. (2020). *Large Marine Ecosystem Hub: A Regional Perspective on the World's Ocean*. Retrieved September 17, 2020, from https://www.lmehub.net/.

Le Boeuf, B. J. and M. L. Bonnell. (1980). Pinnipeds of the California Islands: Abundance and distribution. In D. M. Power (Ed.), *The California Islands: Proceedings of a Multidisciplinary Symposium* (pp. 475–493). Santa Barbara, CA: Santa Barbara Museum of Natural History.

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

Le Boeuf, B. J., P. A. Morris, S. B. Blackwell, D. E. Crocker, and D. P. Costa. (1996). Diving behavior of juvenile northern elephant seals. *Canadian Journal of Zoology, 74*, 1632–1644.

Lea, M.-A., D. Johnson, R. Ream, J. Sterling, S. Melin, and T. Gelatt. (2009). Extreme weather events influence dispersal of naive northern fur seals. *Biology Letters, 5*, 252–257. DOI:10.1098/rsbl.2008.0643

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

Litzow, M. A., M. Hunsicker, E. J. Ward, S. C. Andersen, J. Gao, S. G. Zador, S. Batten, S. C. Dressel, J. T. Duffy-Anderson, E. Fergusson, R. R. Hopcroft, B. J. Laurel, and R. O'Malley. (2020). Evaluating ecosystem change as Gulf of Alaska temperature exceeds the limits of preindustrial variability. *Progress in Oceanography, 186*.

Lopez-Castro, M. C., R. Carmona, and W. J. Nichols. (2004). Nesting characteristics of the olive ridley turtle (*Lepidochelys olivacea*) in Cabo Pulmo, southern Baja California. *Marine Biology, 145*(4), 811–820. DOI:10.1007/s00227-004-1359-x

Loughlin, T. R., G. A. Antonelis, J. D. Baker, A. E. York, C. W. Fowler, R. L. DeLong, and H. W. Braham. (1994). Status of the northern fur seal population in the United States during 1992. In E. H. Sinclair (Ed.), *Fur Seal Investigations, 1992*. Seattle, WA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.

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

Lowry, L. F., K. J. Frost, J. M. Ver Hoef, and R. A. DeLong. (2001). Movements of satellite-tagged subadult and adult harbor seals in Prince William Sound, Alaska. *Marine Mammal Science, 17*(4), 835–861.

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

Lowry, M. S., P. Boveng, R. J. DeLong, C. W. Oliver, B. S. Stewart, H. DeAnda, and J. Barlow. (1992). *Status of the California sea lion (Zalophus californianus californianus) population in 1992*. Silver Spring, MD: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Lowry, M. S., R. Condit, B. Hatfield, S. G. Allen, R. Berger, P. A. Morris, B. J. Le Boeuf, and J. Reiter. (2014). Abundance, distribution, and population growth of the northern elephant seal (*Mirounga angustirostris*) in the United States from 1991 to 2010. *Aquatic Mammals, 40*(1), 20–31. DOI:10.1578/am.40.1.2014.20

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

Lowry, M. S., S. E. Nehasil, and E. M. Jaime. (2017). *Distribution of California Sea Lions, Northern Elephant Seals, Pacific Harbor Seals, and Steller Sea Lions at the Channel Islands During July 2011–2015* (National Oceanic and Atmospheric Administration Technical Memorandum NMFS-SWFSC-578). Springfield, VA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

MacLeod, C. D. and A. D'Amico. (2006). A review of beaked whale behaviour and ecology in relation to assessing and mitigating impacts of anthropogenic noise. *Journal of Cetacean Research and Management, 7*(3), 211–221.

Maniscalco, J. M., K. Wynne, K. W. Pitcher, M. B. Hanson, S. R. Melin, and S. Atkinson. (2004). The occurrence of California sea lions (*Zalophus californianus*) in Alaska. *Aquatic Mammals, 30*(3), 427–433. DOI:10.1578/AM.30.3.2004.427

Mate, B., B. Lagerquist, and L. Irvine. (2010). *Feeding habitats, migration, and winter reproductive range movements derived from satellite-monitored radio tags on eastern North Pacific gray whales*. Washington, DC: International Whaling Commission.

Mate, B. R., A. Bradford, G. A. Tsidulko, V. Vertankin, and V. Ilyashenko. (2013). *Late feeding season movements of a western North Pacific gray whale off Sakhalin Island, Russia and subsequent migration into the eastern North Pacific* (Paper SC/63/BRG23). Washington, DC: International Whaling Commission.

Mate, B. R., V. Y. Ilyashenko, A. L. Bradford, V. V. Vertyankin, G. A. Tsidulko, V. V. Rozhnov, and L. M. Irvine. (2015). Critically endangered western gray whales migrate to the eastern North Pacific. *Biology Letters, 11*(4), 1–4. DOI:10.1098/rsbl.2015.0071

Matsuoka, K., S. Mizroch, Y. R. An, S. Kumagai, and K. Hirose. (2013). *Cruise report of the 2012 IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER)*. Tokyo, Japan: The Institute of Cetacean Research.

Mead, J. G. (1989). Beaked whales of the genus *Mesoplodon*. In S. H. Ridgway & R. Harrison (Eds.), *Handbook of Marine Mammals* (Vol. 4, pp. 349–430). San Diego, CA: Academic Press.

Melin, S. R., J. T. Sterling, R. R. Ream, R. G. Towell, T. Zeppelin, A. J. Orr, B. Dickerson, N. Pelland, and C. E. Kuhn. (2012). *A Tale of Two Stocks: Studies of Northern Fur Seals Breeding at the Northern and Southern Extent of the Range*. Seattle, WA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.

Mellinger, D. K., K. M. Stafford, and C. G. Fox. (2004). Seasonal occurrence of sperm whale (*Physter marcrocephalus*) sounds in the Gulf of Alaska, 1999–2001. *Marine Mammal Science, 20*, 48–62.

Mesnick, S. L., M. D. G. Rivas, and B. J. Le Boeuf. (1998). Northern elephant seals in the Gulf of California, Mexico. *Marine Mammal Science, 14*(1), 171–178.

Minamikawa, S., T. Iwasaki, and T. Kishiro. (2007). Diving behaviour of a Baird's beaked whale, *Berardius bairdii*, in the slope water region of the western North Pacific: First dive records using a data logger. *Fisheries Oceanography, 16*, 573–577.

Moore, S. E., S. K. M., M. D. K., and H. J. A. (2006). Listening for large whales in the offshore waters of Alaska. *BioScience, 56*, 49–55.

Moore, S. L. and M. J. Allen. (2000). Distribution of Anthropogenic and Natural Debris on the Mainland Shelf of the Southern California Bight. *Marine Pollution Bulletin, 40*(1), 83–88.

Morin, P. A., F. I. Archer, A. D. Foote, J. Vilstrup, E. E. Allen, P. Wade, J. Durban, K. Parsons, R. Pitman, L. Li, P. Bouffard, S. C. Abel Nielsen, M. Rasmussen, E. Willerslev, M. T. Gilbert, and T. Harkins. (2010). Complete mitochondrial genome phylogeographic analysis of killer whales (*Orcinus orca*) indicates multiple species. *Genome Research, 20*(7), 908–916. DOI:10.1101/gr.102954.109

Mrosovsky, N. (1980). Thermal Biology of Sea Turtles. *American Zoologist, 20*, 531–547.

Muto, M. M., V. T. Helker, R. P. Angliss, B. A. Allen, P. L. Boveng, J. M. Breiwick, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, R. G. Towell, P. R. Wade, J. M. Waite, and A. R. Zerbini. (2017). *Alaska Marine Mammal Stock Assessments, 2016* (NOAA Technical Memorandum NMFS-AFSC-323). Seattle, WA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.

Muto, M. M., V. T. Helker, R. P. Angliss, B. A. Allen, P. L. Boveng, J. M. Breiwick, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. (2018a). *Alaska Marine Mammal Stock Assessments, 2017* (NOAA Technical Memorandum NMFS-AFSC-378). Seattle, WA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.

Muto, M. M., V. T. Helker, R. P. Angliss, P. L. Boveng, J. M. Breiwick, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. (2018b). *Alaska Marine Mammal Stock Assessments, 2018. Draft*. Seattle, WA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.

Muto, M. M., V. T. Helker, B. J. Delean, R. P. Angliss, P. L. Boveng, J. M. Breiwick, B. M. Brost, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. (2019). *Alaska Marine Mammal Stock Assessments, 2019*. Seattle, WA: Marine Mammal Laboratory, Alaska Fisheries Science Center.

Muto, M. M., V. T. Helker, B. J. Delean, R. P. Angliss, P. L. Boveng, J. M. Breiwick, B. M. Brost, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. (2020). *Alaska Marine Mammal Stock Assessments, 2019* (NOAA Technical Memorandum NMFS-AFSC-404). Juneau, AK: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.

Myers, A. E. and G. C. Hays. (2006). Do leatherback turtles, *Dermochelys coriacea,* forage during the breeding season? A combination of data-logging devices provide new insights. *Marine Ecology Progress Series, 322*, 259–267.

National Marine Fisheries Service. (2007). *Conservation Plan for the Eastern Pacific Stock of Northern Fur Seal (Callorhinus ursinus)*. Juneau, AK: National Oceanic and Atmospheric Administration, National Marine Fisheries, Service Protected Resources Division, Alaska Region.

National Marine Fisheries Service. (2013a). *Final Recovery Plan for the North Pacific Right Whale (Eubalaena japonica)*. Silver Spring, MD: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources.

National Marine Fisheries Service. (2013b). *Occurrence of Western Distinct Population Segment Steller Sea Lions East of 144° W. Longitude*. Silver Spring, MD: National Oceanic and Atmospheric Administration.

National Marine Fisheries Service. (2017). *Sea Turtles in Washington and Oregon (Dataset)*. Silver Spring, MD: National Oceanic and Atmospheric Administration, West Coast Region.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. (1992). *Recovery Plan for Leatherback Turtles (Dermochelys coriacea) in the U.S. Caribbean, Atlantic and Gulf of Mexico*. Silver Spring, MD: National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Newsome, S. D., M. T. Tinker, V. A. Gill, Z. N. Hoyt, A. Doroff, L. Nichol, and J. L. Bodkin. (2015). The interaction of intraspecific competition and habitat on individual diet specialization: A near range-wide examination of sea otters. *Oecologia, 178*(1), 45–59. DOI:10.1007/s00442-015-3223-8

Okkonen, S. R., T. J. Weingartner, S. L. Danielson, and D. L. Musgrave. (2003). Satellite and hydrographic observations of eddy-induced shelf-slope exchange in the northwestern Gulf of Alaska. *Journal of Geophysical Research, 108*, 15-11 to 15-10.

Olesiuk, P. F. (2012). *Habitat utilization by northern fur seals (Callorhinus ursinus) in the Northeastern Pacific Ocean and Canada* (Research Document 2012/040). Nanaimo, Canada: Canadian Science Advisory Secretariat.

Palka, D. (1996). *Effects of Beaufort sea state on the sightability of harbor porpoises in the Gulf of Maine*. Washington, DC: International Whaling Commission.

Patino-Martinez, J., A. Marco, L. Quinones, and B. Godley. (2008). Globally significant nesting of the leatherback turtle (*Dermochelys coriacea*) on the Caribbean coast of Colombia and Panama. *Biological Conservation, 141*(8), 1982–1988. DOI:10.1016/j.biocon.2008.05.012.

Pelland, N. A., J. T. Sterling, M.-A. Lea, N. A. Bond, R. R. Ream, C. M. Lee, and C. C. Eriksen. (2014). Fortuitous Encounters between Seagliders and Adult Female Northern Fur Seals (*Callorhinus ursinus*) off the Washington (USA) Coast: Upper Ocean Variability and Links to Top Predator Behavior. *PLoS ONE, 9*(8), e101268.

Perrin, W. F., C. S. Baker, A. Berta, D. J. Boness, R. L. Brownell, Jr., M. L. Dalebout, D. P. Domning, R. M. Hamner, T. A. Jefferson, J. G. Mead, D. W. Rice, P. E. Rosel, J. Y. Wang, and T. Yamada. (2009). *Marine Mammal Species and Subspecies*. Retrieved 2010, from http://www.marinemammalscience.org/index.php?option=com_content&view=article&id=420&Itemid=280.

Peterson, S. H., J. T. Ackerman, and D. P. Costa. (2015). Marine foraging ecology influences mercury bioaccumulation in deep-diving northern elephant seals. *Proceedings of the Royal Society B: Biological Sciences, 282*(20150710), 10. DOI:10.1098/rspb.2015.0710

Pitcher, K. W. and D. C. McAllister. (1981). Movements and haulout behavior of radio-tagged harbor seals, *Phoca vitulina*. *Canadian Field-Naturalist, 95*(3), 292–297.

Pitman, R. (2009). Indo-Pacific beaked whale *Indopacetus pacificus*. In W. F. Perrin, B. Wursig, & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 600–602). Cambridge, MA: Academic Press.

Pitman, R. L. and J. W. Durban. (2012). Cooperative hunting behavior, prey selectivity and prey handling by pack ice killer whales (*Orcinus orca*), type B, in Antarctic Peninsula waters. *Marine Mammal Science, 28*(1), 16–36.

Polovina, J. J., G. H. Balazs, E. A. Howell, D. M. Parker, M. P. Seki, and P. H. Dutton. (2004). Forage and migration habitat of loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) sea turtles in the central North Pacific Ocean. *Fisheries Oceanography, 13*(1), 36–51.

Polovina, J. J., E. Howell, D. R. Kobayashi, and M. P. Seki. (2001). The transition zone chlorophyll front, a dynamic global feature defining migration and forage habitat for marine resources. *Progress in Oceanography, 49*, 469–483.

Raum-Suryan, K. L., M. J. Rehberg, G. W. Pendleton, K. W. Pitcher, and T. S. Gelatt. (2004). Development of Dispersal, Movement Patterns, and Haul-Out Use by Pup and Juvenile Steller Sea Lions (*Eumetopias jubatus*) in Alaska. *Marine Mammal Science, 20*(4), 823–850.

Read, A. J. (1999). Harbor porpoise, *Phocoena phocoena* (Linnaeus, 1758). In S. H. Ridgway & R. Harrison (Eds.), *Handbook of Marine Mammals* (Vol. 6, pp. 323–355). San Diego, CA: Academic Press.

Ream, R. R., J. T. Sterling, and T. R. Loughlin. (2005). Oceanographic features related to northern fur seal migratory movements. *Deep-Sea Research II, 52*, 823–843.

Redfern, J. V., M. C. Ferguson, E. A. Becker, K. D. Hyrenbach, C. Good, J. Barlow, K. Kaschner, M. F. Baumgartner, K. A. Forney, L. T. Ballance, P. Fauchald, P. Halpin, T. Hamazaki, A. J. Pershing, S. S. Qian, A. Read, S. B. Reilly, L. G. Torres, and F. Werner. (2006). Techniques for cetacean-habitat modeling. *Marine Ecology Progress Series, 310*, 271–295.

Rehberg, M. and R. J. Small. (2001). *Dive behavior, haulout patterns, and movements of harbor seal pups in the Kodiak Archipelago, 1997-2000* (Harbor Seal Investigations in Alaska, Annual Report, NOAA Grant NA87FX0300). Anchorage, AK: Alaska Department of Fish and Game, Division of Wildlife Conservation.

Rehberg, M. J., R. D. Andrews, U. G. Swain, and D. G. Calkins. (2009). Foraging behavior of adult female Steller sea lions during the breeding season in Southeast Alaska. *Marine Mammal Science, 25*(3), 588–604.

Rice, A. C., S. Baumann-Pickering, A. Širović, J. A. Hildebrand, A. M. Brewer, A. J. Debich, S. T. Herbert, B. J. Thayre, J. S. Trickey, and S. M. Wiggins. (2015). *Passive Acoustic Monitoring for Marine Mammals in the Gulf of Alaska Temporary Maritime Activities Area 2014-2015*. La Jolla, CA: Whale Acoustics Laboratory, Marine Physical Laboratory, Scripps Institution of Oceanography.

Rice, A. C., A. S. Berga, N. Posdaljian, M. Rafter, B. J. Thayre, J. S. Trickey, S. M. Wiggins, S. Baumann-Pickering, A. Sirovic, and J. A. Hildebrand. (2018). *Passive Acoustic Monitoring for Marine Mammals in the Gulf of Alaska Temporary Maritime Activities Area May to September 2015 and April to September 2017*. La Jolla, CA: Marine Physical Laboratory Scripps Institute of Oceanography, University of California San Diego.

Rice, D. W. and A. A. Wolman. (1971). *The Life History and Ecology of the Gray Whale* (Vol. 3). Lawrence, KS: The American Society of Mammalogists.

Riedman, M. L. and J. A. Estes. (1990). *The Sea Otter (Enhydra lutris): Behavior, Ecology, and Natural History*. Washington, DC: U.S. Fish and Wildlife Service.

Robinson, P. W., D. P. Costa, D. E. Crocker, J. P. Gallo-Reynoso, C. D. Champagne, M. A. Fowler, C. Goetsch, K. T. Goetz, J. L. Hassrick, L. A. Huckstadt, C. E. Kuhn, J. L. Maresh, S. M. Maxwell, B. I. McDonald, S. H. Peterson, S. E. Simmons, N. M. Teutschel, S. Villegas-Amtmann, and K. Yoda. (2012). Foraging behavior and success of a mesopelagic predator in the northeast Pacific Ocean: Insights from a data-rich species, the northern elephant seal. *PLoS ONE, 7*(5), e36728. DOI:10.1371/journal.pone.0036728

Rone, B. K., P. J. Clapham, D. W. Weller, J. L. Crance, and A. R. Lang. (2015). *North Pacific right whale visual and acoustic survey in the northwestern Gulf of Alaska. Final Report*. Bethesda, MD: Marine Mammal Commission.

Rone, B. K., A. B. Douglas, P. Clapham, A. Martinez, L. J. Morse, and J. Calambokidis. (2009). *Cruise Report for the April 2009 Gulf of Alaska Line-Transect Survey (GOALS) in the Navy Training Exercise Area*. Monterey, CA: Naval Post Graduate School.

Rone, B. K., A. B. Douglas, T. M. Yack, A. N. Zerbini, T. N. Norris, E. Ferguson, and J. Calambokidis. (2014). *Report for the Gulf of Alaska Line-Transect Survey (GOALS) II: Marine Mammal Occurrence in the Temporary Maritime Activities Area (TMAA)*. Olympia, WA: Cascadia Research Collective.

Rone, B. K., A. N. Zerbini, A. B. Douglas, D. W. Weller, and P. J. Clapham. (2017). Abundance and distribution of cetaceans in the Gulf of Alaska. *Marine Biology, 164*(23), 1–23. DOI:10.1007/s00227-016-3052-2

Rugh, D. J., M. M. Muto, R. C. Hobbs, and J. A. Lerczak. (2008). An assessment of shore-based counts of gray whales. *Marine Mammal Science, 24*(4), 864–880.

Rugh, D. J., K. E. W. Shelden, and A. Schulman-Janiger. (2001). Timing of the gray whale southbound migration. *Journal of Cetacean Research and Management, 3*(1), 31–39.

Schneider, K. B. (1977). *Assessment of the Distribution and Abundance of Sea Otters Along the Kenai Peninsula, Kamishak Bay and the Kodiak Archipelago*. Juneau, AK: Alaska Department of Fish and Game.

Sea Mammal Research Unit [SMRU] Ltd. (2012). *Supporting Documentation for Global Predicted Density Data. Unpublished Sea Mammal Research Unit (SMRU) Ltd. report*. St. Andrews, United Kingdom: Scottish Oceans Institute, University of St. Andrews, Scotland.

Sepulveda, M., P. Inosrtoza, M. J. Perez-Alvarez, D. Oliva, and R. Moraga. (2009). Seasonal variation in the abundance of South American sea lions *Otaria flavescens* (Shaw, 1800) in Chanaral Island, Reserva Nacional Pinguino de Humboldt, Chile. *Revista de Biologia Marina y Oceanografia, 44*(3), 685–689.

Shelden, K. E. W. and J. L. Laake. (2002). Comparison of the offshore distribution of southbound migrating gray whales from aerial survey data collected off Granite Canyon, California, 1976–96. *Journal of Cetacean Research and Management, 4*(1), 53–56.

Shelden, K. E. W., S. E. Moore, J. M. Waite, P. R. Wade, and D. J. Rugh. (2005). Historic and current habitat use by North Pacific right whales *Eubalaena japonica* in the Bering Sea and Gulf of Alaska. *Mammal Review, 35*(2), 129–155.

Shillinger, G. L., D. M. Palacios, H. Bailey, S. J. Bograd, A. M. Swithenbank, P. Gaspar, B. P. Wallace, J. R. Spotila, F. V. Paladino, R. Piedra, S. A. Eckert, and B. A. Block. (2008). Persistent leatherback turtle migrations present opportunities for conservation. *PLoS Biology, 6*(7), 1408–1416.

Sigler, M. F., S. M. Gende, and D. J. Csepp. (2017). Association of foraging Steller sea lions with persistent prey hot spots in southeast Alaska. *Marine Ecological Progress Series, 571*, 233–243. DOI:10.3354/meps12145

Sirovic, A., S. C. Johnson, L. K. Roche, L. M. Varga, S. M. Wiggins, and J. A. Hildebrand. (2014). North Pacific right whales (*Eubalaena japonica*) recorded in the northeastern Pacific Ocean in 2013. *Marine Mammal Science, 31*(2), 800–807. DOI:10.1111/mms.12189

Stafford, K. M. (2007). *Baleen Whale Acoustic Activity in the North Pacific: Historical analysis and current occurence*. Monterey, CA: University of Washington.

Sterling, J. T., A. M. Springer, S. J. Iverson, S. P. Johnson, N. A. Pelland, D. S. Johnson, M. A. Lea, and N. A. Bond. (2014). The sun, moon, wind, and biological imperative-shaping contrasting wintertime migration and foraging strategies of adult male and female northern fur seals (*Callorhinus ursinus*). *PLoS ONE, 9*(4), e93068. DOI:10.1371/journal.pone.0093068

Stewart, B. S., P. K. Yochem, H. R. Huber, R. L. DeLong, R. J. Jameson, W. J. Sydeman, S. G. Allen, and B. J. Le Boeuf. (1994). History and present status of the northern elephant seal population. In B. J. Le Boeuf & R. M. Laws (Eds.), *Elephant Seals: Population Ecology, Behavior, and Physiology* (pp. 29–48). Berkeley, CA: University of California Press.

Storch, S., R. P. Wilson, Z. M. Hillis-Starr, and D. Adelung. (2005). Cold-blooded divers: Temperature-dependent dive performance in the wild hawksbill turtle, *Eretmochelys imbricata*. *Marine Ecology Progress Series, 293*, 263–271.

Swartz, S. L., B. L. Taylor, and D. J. Rugh. (2006). Gray whale, *Eschrichtius robustus,* population and stock identity. *Mammal Review, 36*(1), 66–84.

Sweeney, K., L. Fritz, R. Towell, and T. Gelatt. (2017). *Results of Steller Sea Lion Surveys in Alaska, June-July 2017*. Seattle, WA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Marine Mammal Laboratory.

Sweeney, K., R. Towell, and T. Gelatt. (2018). *Results of Steller Sea Lion Surveys in Alaska, June–July 2018*. Seattle, WA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Marine Mammal Laboratory.

Thometz, N. M., M. T. Tinker, M. M. Staedler, K. A. Mayer, and T. M. Williams. (2014). Energetic demands of immature sea otters from birth to weaning: implications for maternal costs, reproductive behavior and population-level trends. *Journal of Experimental Biology, 217*(12), 2053–2061. DOI:10.1242/jeb.099739

Tinker, M., V. Gill, G. G. Esslinger, J. Bodkin, M. Monk, M. Mangel, D. H. Monson, W. Raymond, and M. Kissling. (2019). Trends and carrying capacity of sea otters in Southeast Alaska. *The Journal of Wildlife Management, 83*(5), 1073–1089.

Towell, R. G., R. R. Ream, and A. E. York. (2006). Decline in northern fur seal (*Callorhinus ursinus*) pup production on the Pribilof Islands. *Marine Mammal Science, 22*(2), 486–491.

Trites, A. W. and B. T. Porter. (2002). Attendance patterns of Steller sea lions (*Eumetopias jubatus*) and their young during winter. *Journal of Zoology, London, 256*(4), 547–556. DOI:10.1017/S0952836902000596

Trujillo, R. G., T. R. Loughlin, N. J. Gemmell, J. C. Patton, and J. W. Bickham. (2004). Variation in Microsatellites and mtDNA Across the Range of the Steller Sea Lion, *Eumetopias jubatus*. *Journal of Mammalogy, 85*(2), 338–346.

U.S. Department of the Navy. (2009). *Appendix E, Marine Mammal Density Report* (In Gulf of Alaska Navy Training Activities Draft Environmental Impact Statement/Overseas Environmental Impact Statement). Solana Beach, CA: ManTech SRS Technologies, Inc.

U.S. Department of the Navy. (2015). *U.S. Navy Marine Species Density Database for the Pacific Ocean* (NAVFAC Pacific Technical Report). Pearl Harbor, HI: Naval Facilities Engineering Command Pacific.

U.S. Geological Survey. (1981). *Feature Detail Report for: Gulf of Alaska*. Retrieved October 6, 2020, from https://geonames.usgs.gov/apex/f?p=138:3:::NO:3:P3_FID,P3_TITLE:1413097,Gulf%20of%20Alaska.

Van Houtan, K. S., J. M. Halley, and W. Marks. (2015). Terrestrial basking sea turtles are responding to spatio-temporal sea surface temperature patterns. *Biology Letters, 11*(1), 20140744. DOI:10.1098/rsbl.2014.0744

Wade, P. R., A. De Robertis, K. R. Hough, R. Booth, A. Kennedy, R. G. LeDuc, L. Munger, J. Napp, K. E. W. Shelden, S. Rankin, O. Vasquez, and C. Wilson. (2011a). Rare detections of North Pacific right whales in the Gulf of Alaska, with observations of their potential prey. *Endangered Species Research, 13*, 99–109.

Wade, P. R., M. P. Heide-Jorgensen, K. E. W. Shelden, J. Barlow, J. Carretta, J. W. Durban, R. G. LeDuc, L. Munger, S. Rankin, A. Sauter, and C. Stinchcomb. (2006). Acoustic detection and satellite-tracking leads to discovery of rare concentration of endangered North Pacific right whales. *Biology Letters, 2*, 417–419.

Wade, P. R., A. Kennedy, R. G. LeDuc, J. Barlow, J. C. Carretta, K. Shelden, W. Perryman, R. Pitman, K. Robertson, B. Rone, J. C. Salinas, A. Zerbini, R. L. J. Brownell, and P. J. Clapham. (2011b). The world's smallest whale population? *Biology Letters, 7*(1), 83–85.

Waite, J. M. (2003). *Cetacean Assessment and Ecology Program: Cetacean Survey*. Seattle, WA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.

Waite, J. M., K. Wynne, and D. K. Mellinger. (2003). Documented sighting of a North Pacific right whale in the Gulf of Alaska and post-sighting acoustic monitoring. *Northwestern Naturalist, 84*(1), 38–43.

Watkins, W. A., M. A. Daher, G. M. Reppucci, J. E. George, D. L. Martin, N. A. DiMarzio, and D. P. Gannon. (2000). Seasonality and distribution of whale calls in the North Pacific. *Oceanography, 13*(1), 62–67.

Weller, D. W., S. Bettridge, R. L. Brownell, J. L. Laake, M. J. Moore, P. E. Rosel, B. L. Taylor, and P. R. Wade. (2013). *Report of the National Marine Fisheries Service Gray Whale Stock Identification Workshop* (NOAA Technical Memorandum NMFS-SWFSC-507). La Jolla, CA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Whitehead, H. (2003). *Sperm Whales Social Evolution in the Ocean*. Chicago, IL: University of Chicago Press.

Whitehead, H. (2009). Sperm whale, *Physeter macrocephalus*. In W. F. Perrin, B. Wursig, & J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 1091–1097). Cambridge, MA: Academic Press.

Whitehead, H. and L. Weilgart. (2000). The sperm whale; Social females and roving males. In J. Mann, R. C. Connor, P. L. Tyack, & H. Whitehead (Eds.), *Cetacean Societies; Field Studies of Dolphins and Whales* (pp. 154–172). Chicago, IL: University of Chicago Press.

Whiting, S. D. and J. D. Miller. (1998). Short term foraging ranges of adult green turtles (*Chelonia mydas*). *Journal of Herpetology, 32*(3), 330–337.

Wiles, G. J. (2015). *Periodic Status Review for the Steller Sea Lion*. Olympia, WA: Washington Department of Fish and Wildlife.

Withrow, D. E., J. C. Cesarone, and J. L. Bengtson. (1999). Abundance and distribution of harbor seals (*Phoca vitulina richardsi*) for southern Southeast Alaska from Frederick Sound to the US/Canada border in 1998. In A. L. Lopez & D. P. DeMaster (Eds.), *Marine Mammal Protection Act and Endangered Species Act Implementation Program 1998*. Silver Spring, MD: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.

Withrow, D. E. and T. R. Loughlin. (1995). *Haulout Behavior and Method to Estimate the Proportion of Harbor Seals Missed During Molt Census Surveys in Alaska*. Seattle, WA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.

Witt, M. J., L. A. Hawkes, M. H. Godfrey, B. J. Godley, and A. C. Broderick. (2010). Predicting the impacts of climate change on a globally distributed species: The case of the loggerhead turtle. *The Journal of Experimental Biology, 213*(6), 901–911. DOI:10.1242/jeb.038133

Wolt, R. C., F. P. Gelwick, F. Weltz, and R. W. Davis. (2012). Foraging behavior and prey of sea otters in a soft- and mixed-sediment benthos in Alaska. *Mammalian Biology, 77*, 271–280.

Yack, T. M., T. Norris, E. Ferguson, S. Coates, and B. K. Rone. (2015). *From Clicks to Counts: Using Passive Acoustic Monitoring to Estimate the Density and Abundance of Cuvier's Beaked Whales in the Gulf of Alaska (GoA)*. Pearl Harbor, HI: U.S. Department of the Navy, Naval Facilities Engineering Command Pacific.

Zeppelin, T., N. Pelland, J. Sterling, B. Brost, S. Melin, D. Johnson, M. A. Lea, and R. Ream. (2019). Migratory strategies of juvenile northern fur seals (*Callorhinus ursinus*): Bridging the gap between pups and adults. *Scientific Reports, 9*. DOI:10.1038/s41598-019-50230-z

Zeppelin, T. K. and R. R. Ream. (2006). Foraging habitats based on the diet of female northern fur seals (*Callorhinus ursinus*) on the Pribilof Islands, Alaska. *Journal of Zoology, 270*(4), 565–576.

Zerbini, A. N., P. J. Clapham, and M. P. Heide-Jørgensen. (2010). *Migration, wintering destinations and habitat use of North Pacific right whales (Eubalaena japonica)* (North Pacific Research Board: Project 720-Final Report). Seattle, WA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, National Marine Mammal Laboratory.

Zerbini, A. N., J. M. Waite, J. L. Laake, and P. R. Wade. (2006). Abundance, trends and distribution of baleen whales off Western Alaska and the central Aleutian Islands. *Deep-Sea Research Part I, 53*, 1772–1790.

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APPENDIX A CHANGES IN MARINE SPECIES DENSITY ESTIMATES BETWEEN PHASE II AND PHASE III

The following tables present the changes from Phase II to Phase III in marine species density estimates used in the Navy Acoustic Effects Model for estimating impacts on marine species from acoustic sources. The Phase II analysis supported conclusions in the 2016 Gulf of Alaska Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement, and the Phase III (current) density estimates were used for the analysis in the 2020 Gulf of Alaska Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement.

Table A-1 presents the Phase II and Phase III cetacean density estimates and shows the changes in species' densities. Changes in density estimates are calculated by subtracting the Phase II density from the Phase III density (i.e., Change = Phase III density – Phase II density). If a species' density increased from Phase II to Phase III, the difference is highlighted green, and if the density decreased the difference is highlighted blue. No highlighting indicates the density did not change. A brief explanation for any change is presented in the Notes column.

Table A-1: Changes in Cetacean Density Estimates Between Phase II and Phase II

Species	Location or Stratum	Density		Density Change	Notes
		Phase II	Phase III		
North Pacific right whale	TMAA	0.00001	0.00003	0.00002	Derived in coordination with SMEs from SWFSC and AFSC.
Humpback whale	Inshore	0.12900	0.09300	-0.03600	Rone et al. (2017): Density and CVs were updated from the Rone et al. (2014) values used in Phase II.
	Slope	0.00020	0.00020	0.00000	
	Offshore	0.00100	0.00100	0.00000	
	Seamount	0.00100	0.00100	0.00000	
Blue whale	Inshore	0.00050	0.0001	-0.00040	Rone et al. (2017): Density and CVs were updated from the Rone et al. (2014) values used in Phase II.
	Slope	0.00050	0.00050	0.00000	
	Offshore	0.00050	0.00050	0.00000	
	Seamount	0.00200	0.00140	-0.00060	

Table A-1: Changes in Cetacean Density Estimates Between Phase II and Phase II (continued)

Species	Location or Stratum	Density		Density Change	Notes
		Phase II	Phase III		
Fin whale	Inshore	0.071	0.068	-0.00300	Rone et al. (2017): Density and CVs were updated from the Rone et al. (2014) values used in Phase II.
	Slope	0.014	0.013	-0.00100	
	Offshore	0.021	0.016	-0.00500	
	Seamount	0.005	0.003	-0.00200	
Sei whale	TMAA	RES	0. 00040	NA	Hakamada et al. (2017): Provides new density estimate for GOA that was not available for Phase II.
Minke whale	Within 1,000 m Isobath	0.00060	0.00600	0.00540	Zerbini et al. (2006): Applied to small portion of TMAA given additional data that show minke whales distributed in more nearshore waters.
	TMAA	0.00060	0.00060	0.00000	Derived in U.S. Department of the Navy (2009) based on Waite (2003). Note that the 2012 POWER cruise had minke whales sighted in deep offshore waters of GOA.
Gray whale	Coastline to 2.5 NM	0.04857	0.04857	0.00000	S. Hanser 2011, Based on a total density of 0.051 animals/km^2 and split between the two substrata (based on sources listed in S. Hanser 2011: internal memo, "Arriving at Density of Gray Whales")
	2.5–20 NM	0.00243	0.00243	0.00000	
Sperm whale	Inshore	0	0.0020	0.00200	Rone et al. (2017): Provided new estimate for inshore stratum that was not available for Phase II.
	Slope	0.0033	0.0033	0.00000	Rone et al. (2014) based on acoustic detections (For sperm whales, density estimates derived from acoustic detections are more robust due to larger sample size: Rone et al. (2017)).
	Offshore	0.0013	0.0013	0.00000	
	Seamount	0.00036	0.00036	0.00000	
Killer whale (not stock specific)	Inshore	0.005	0.005	0.00000	Rone et al. (2017): Density and CVs were updated from the Rone et al. (2014) values used in Phase II.
	Offshore	0.002	0.002	0.00000	
	Seamount	0.002	0.002	0.00000	
	Slope	0.02	0.019	-0.00100	

Table A-1: Changes in Cetacean Density Estimates Between Phase II and Phase II (continued)

Species	Location or Stratum	Density		Density Change	Notes
		Phase II	Phase III		
Pacific while-sided dolphin	TMAA	0.02080	0.02000	-0.00080	GOA population estimate from SAR (26,000) divided by GOA area (1,533,000 km^2). Consistent with previous estimate derived in U.S. Department of the Navy (2009) based on Waite (2003).
Harbor porpoise	0–100m	0.4547	0.4547	0.00000	Derived from Hobbs and Waite (2010)
	100–200m	0.0473	0.0473	0.00000	
	200–1000m	0.00001	ID	NA	
	>1000m	0	0	0.00000	
Dall's porpoise	Inshore	0.214	0.218	0.004	Rone et al. (2017): Density and CVs were updated from the Rone et al. (2014) values used in Phase II.
	Offshore	0.028	0.037	0.009	
	Seamount	0.011	0.024	0.013	
	Slope	0.133	0.196	0.063	
Cuvier's beaked whale	Inshore	0.0022	0	-0.0022	Yack et al. (2015): These acoustic-based line-transect density estimates were not available in time to support the NUWC modeling process for Phase II.
	Offshore	0.0022	0.0020	-0.0002	
	Seamount	0.0022	0.0030	0.0008	
	Slope	0.0022	0.0008	-0.0014	
Baird's beaked whale	Inshore	0.00050	0	-0.00050	Based on estimate of zero density for Cuvier's beaked whale in the inshore stratum (Yack et al. 2015).
	Offshore	0.00050	0.00050	0.00000	Derived inU.S. Department of the Navy (2009) based on Waite (2003)
	Seamount	0.00050	0.00050	0.00000	
	Slope	0.00050	0.00050	0.00000	
Stejneger's beaked whale	Inshore	RES	0	NA	In the absence of density data, use pooled strata density estimate for Cuvier's from Yack et al. (2015) since, based on acoustic detections in the GOA, Stejneger's beaked whale had the highest relative daily occurrence in the Gulf of Alaska compared to both Baird's and Cuvier's beaked whales.
	Offshore	RES	0.0021	NA	
	Seamount	RES	0.0021	NA	
	Slope	RES	0.0021	NA	

Species	Location or Stratum	Density		Density Change	Notes
		Phase II	Phase III		

Notes: RES = Relative Environmental Suitability, TMAA = Temporary Maritime Activities Area, GOA = Gulf of Alaska, CV = Coefficient of Variation, km^2 = square kilometers, ID = Insufficient Data to Derive a Density, SAR = Stock Assessment Report, NUWC = Naval Underwater Warfare Center, NA = Not Applicable, m = meters, NM = nautical miles, SME = Subject Matter Expert, SWFSC = Southwest Fisheries Science Center

Table A-2 through Table A-13 present the Phase II and Phase III pinniped density estimates and show the changes in species' densities. Changes in density estimates are calculated by subtracting the Phase II density from the Phase III density (i.e., Change = Phase III density – Phase II density). If a species' density increased from Phase II to Phase III, the difference is highlighted green, and if the density decreased the difference is highlighted blue. No highlighting indicates the density did not change. A brief explanation for a change is presented in the notes column of the table showing density changes for each species.

Northern Fur Seal

Table A-2: Phase II Density Estimates for Northern Fur Seal

Species	Location or Stratum	Spring	Summer	Fall	Winter
Northern fur seal	Inshore	0.01520	0.01520	0.01520	0.01520
	Slope	0.00420	0.00420	0.00420	0.00420
	Offshore-North	0.01690	0.01690	0.01690	0.01690
	Seamount	0.00560	0.00560	0.00560	0.00560
	Offshore-South	0.01130	0.01130	0.01130	0.01130

Notes: Density estimates have units of animals/km^2. Spring = March–May, Summer = June–August, Fall = September–November, Winter = December–February.

Table A-3: Phase III Density Estimates for Northern Fur Seal

Location or Stratum	January	February	March	April	May	June	July	August	September	October	November	December
GOA LME	0.0807	0.0709	0.0866	0.0693	0.0901	0.0891	0.0661	0.0149	0.0069	0.0069	0.0080	0.0379

Notes: (1) Density estimates have units of animals/km^2. (2) GOA LME = Gulf of Alaska Large Marine Ecosystem.

The Phase III densities were not estimated by stratum as they were in Phase II, so changes in species' densities were calculated by subtracting the Phase II density for each stratum in a given season from the highest monthly density estimate in that season. For example, to calculate the change in the density for the inshore stratum in spring, the Phase II density of 0.01520 fur seals/square kilometers (km^2) was subtracted from the Phase III density for May of 0.0901 fur seals/km^2, because the May density is the highest density in Spring. The result is an increase of 0.07492 fur seals/km^2. This approach results in the largest of the possible density changes in a particular season.

Table A-4: Changes in Densities for Northern Fur Seal from Phase II to Phase III

Species	Location or Stratum	Spring	Summer	Fall	Winter	Notes
Northern fur seal	Inshore	0.07492	0.07393	-0.00826	0.06550	New data and input provided by NMFS Alaska Fisheries Science Center, Marine Mammal Lab
	Slope	0.08592	0.08493	0.00274	0.07650	
	Offshore-North	0.07322	0.07223	-0.00996	0.06380	
	Seamount	0.08452	0.08353	0.00134	0.07510	
	Offshore-South	0.07882	0.07783	-0.00436	0.06940	

Notes: Density estimates have units of animals/km^2. Spring = March–May, Summer = June–August, Fall = September–November, Winter = December–February. Increases in densities are highlighted green and decreases are highlighted blue. Change = Phase III density - Phase II density.

Northern Elephant Seal

Table A-5: Phase II Density Estimates for Northern Elephant Seal

Species	Location or Stratum	Spring	Summer	Fall	Winter
Northern elephant seal	Inshore	0.00240	0.00220	0.00220	0.00240
	Slope	0.00240	0.00220	0.00220	0.00240
	Offshore-North	0.00240	0.00220	0.00220	0.00240
	Seamount	0.00240	0.00220	0.00220	0.00240
	Offshore-South	0.00240	0.00220	0.00220	0.00240

Notes: Density estimates have units of animals/km^2. Spring = March–May, Summer = June–August, Fall = September–November, Winter = December–February.

Table A-6: Phase III Density Estimates for Northern Elephant Seal

Location or Stratum	January	February	March	April	May	June	July	August	September	October	November	December
GOA (USGS Definition)	0.0000	0.0000	0.0405	0.0405	0.0328	0.0174	0.0584	0.0779	0.1086	0.0195	0.0000	0.0308

Notes: (1) Density estimates have units of animals/km^2. (2) GOA LME = Gulf of Alaska, USGS = United States Geological Survey.

Changes in species' densities were calculated by subtracting the Phase II density for each stratum in a given season from the highest monthly density estimate in that season. For example, to calculate the change in the density for the inshore stratum in spring, the Phase II density of 0.00240 elephant seals/km^2 was subtracted from the Phase III density for April of 0.0405 elephant seals/km^2, because the April (and March) density is the highest density in Spring. The result is an increase of 0.03809 elephant seals/km^2. This approach results in the largest of the possible density changes in a particular season.

Table A-7: Changes in Densities for Northern Elephant Seal from Phase II to Phase III

Species	Location or Stratum	Spring	Summer	Fall	Winter	Notes
Northern elephant seal	Inshore	0.03809	0.07565	0.10642	0.02836	More in-depth analysis of existing publications and input from scientists at the University of California Santa Cruz
	Slope	0.03809	0.07565	0.10642	0.02836	
	Offshore-North	0.03809	0.07565	0.10642	0.02836	
	Seamount	0.03809	0.07565	0.10642	0.02836	
	Offshore-South	0.03809	0.07565	0.10642	0.02836	

Notes: Density estimates have units of animals/km^2. Spring = March–May, Summer = June–August, Fall = September–November, Winter = December–February. Increases in densities are highlighted green and decreases are highlighted blue. Change = Phase III density - Phase II density.

Harbor Seal

Table A-8: Phase II Density Estimates for Harbor Seal

Species	Location or Stratum	Spring	Summer	Fall	Winter
Harbor seal	Inshore	0.00001	0.00001	0.00001	0.00001
	Slope	0.00001	0.00001	0.00001	0.00001
	Offshore-North	0.00001	0.00001	0.00001	0.00001
	Seamount	0.00001	0.00001	0.00001	0.00001
	Offshore-South	0.00001	0.00001	0.00001	0.00001

Notes: Density estimates have units of animals/km^2. Spring = March–May, Summer = June–August, Fall = September–November, Winter = December–February.

Phase III densities for harbor seal were estimated based on differences in in-water abundance in the breeding and non-breeding seasons and approximate stock extents as reported in Muto et al. (2020). Only densities for April–October were needed for modeling purposes.

Table A-9: Phase III Density Estimates for Harbor Seal

Species	Location or Stratum	April - May	June - September	October	Winter
Harbor seal	Continental Shelf	0.1689	0.1407	0.1689	NE

Notes: (1) Density estimates have units of animals/km^2. Spring = March–May, Summer = June–August, Fall = September–November, Winter = December–February. (2) NE = Not estimated.

Changes in species' densities were calculated by subtracting the Phase II density for each stratum in a given season from the corresponding seasonal density estimate. For example, to calculate the change in the density for the inshore stratum in Spring, the Phase II density of 0.00001 harbor seals/km^2 was subtracted from the Phase III density for April–May of 0.16886 harbor seals/km^2. The result is an increase of 0.16885 harbor seals/km^2. This approach results in the largest of the possible density changes in a particular season.

Table A-10: Changes in Densities for Harbor Seal from Phase II to Phase III

Species	Location or Stratum	Spring	Summer	Fall	Winter	Notes
Harbor seal	Continental shelf	0.1689	0.1407	0.1689	NE	New data and input provided by NMFS Alaska Fisheries Science Center, Marine Mammal Lab

Notes: (1) Density estimates have units of animals/km^2. Spring = March–May, Summer = June–August, Fall = September–November, Winter = December–February. Increases in densities are highlighted green and decreases are highlighted blue. Change = Phase III density - Phase II density. (2) NE = Not estimated.

1

Steller Sea Lion

Table A-11: Phase II Density Estimates for Steller Sea Lion

Species	Location or Stratum	Spring	Summer	Fall	Winter
Steller sea lion	Inshore	0.00980	0.00980	0.00980	0.00980
	Slope	0.00980	0.00980	0.00980	0.00980
	Offshore-North	0.00980	0.00980	0.00980	0.00980
	Seamount	0.00980	0.00980	0.00980	0.00980
	Offshore-South	0.00980	0.00980	0.00980	0.00980

Notes: Density estimates have units of animals/km^2. Spring = March–May, Summer = June–August, Fall = September–November, Winter = December–February.

Phase III densities for Steller sea lion were estimated based on differences in in-water abundance in the breeding and non-breeding seasons and tagged sea lions foraging over the continental shelf, but not beyond. Only densities for April–October were needed for modeling purposes.

Table A-12: Phase III Density Estimates for Steller Sea Lion

Species	Location or Stratum	April	May– August	September –October	Winter
Steller sea lion	Continental Shelf and Critical Habitat	0.0678	0.0570	0.0678	NE

Notes: (1) Density estimates have units of animals/km^2. Spring = March–May, Summer = June–August, Fall = September–November, Winter = December–February. (2) NE = Not estimated.

Changes in species' densities were calculated by subtracting the Phase II density for each stratum in a given season from the corresponding seasonal density estimate. For example, to calculate the change in the density for the inshore stratum in Spring, the Phase II density of 0.00980 Steller sea lions/km^2 was subtracted from the Phase III density for April of 0.0678 Steller sea lions/km^2. The result is an increase of 0.0580 Steller sea lions/km^2.

Table A-13: Changes in Densities for Steller Sea Lion from Phase II to Phase III

Species	Location or Stratum	April	May – August	September - October	Winter	Notes
Steller sea lion	Continental Shelf and Critical Habitat	0.0580	0.0472	0.0580	NE	New data and input provided by NMFS Alaska Fisheries Science Center, Marine Mammal Lab and Alaska Department of Fish and Game

Notes: (1) Density estimates have units of animals/km^2. Spring = March–May, Summer = June–August, Fall = September–November, Winter = December–February. Increases in densities are highlighted green and decreases are highlighted blue. Change = Phase III density - Phase II density. (2) NE = Not estimated.

APPENDIX B GLOSSARY OF TERMS

Abundance: Total number of individuals in a given area.

Alaska Fisheries Science Center: One of the six science centers under the purview of National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS).

Cetacean: A marine mammal included in the taxonomic order Cetacea that includes whales, dolphins, and porpoises.

Coefficient of variation (CV): The CV is a measure used to express uncertainty in published density estimates and is calculated by dividing the standard error of the estimate by the best available density point estimate (i.e., the ratio of the standard error to the mean). A CV can be expressed as a fraction or a percentage and ranges upward from zero, indicating no uncertainty, to high values. For example, a CV of 0.85 would indicate high uncertainty in the population estimate.

Density: The number of animals present per unit area, typically expressed as number of animals per square kilometer.

Designed-based density estimates: A type of estimation that uses line-transect survey data and usually involves distance sampling theory to estimate density for the entire survey extent.

Distance sampling: A widely used technique for estimating the size of a population. Observers travel the length of line transects (or use points) to collect sighting data, with the objective of estimating the average density of objects within a region. In addition to counting occurrences, observers estimate the distance of the object from the path. This results in an estimate of the way in which detectability increases from probability 0 (far from the path) and approaches 1 (near the path). Using the raw count and this probability function, one can arrive at an estimate of the population size (distance sampling theory is described in detail in (Buckland et al., 2001).

Exclusive Economic Zone (EEZ): The EEZ is a sea zone prescribed by the United Nations Convention on the Law of the Sea over which a state has special rights regarding the exploration and use of marine resources. The United States EEZ extends no more than 200 nautical miles (NM) from the territorial sea baseline and is adjacent to the 12 NM territorial sea of the United States, including the Commonwealth of Puerto Rico, Guam, American Samoa, the U.S. Virgin Islands, the Commonwealth of the Northern Mariana Islands, and any other territory or possession over which the United States exercises sovereignty.

Fundamental niche: All of the environments in which a species can theoretically survive, absent competition from other species.

Habitat suitability models: Models that use information on species occurrence and known or inferred habitat associations to predict densities. These models are used typically when survey data are unavailable. (Also known as relative environmental suitability models or habitat suitability index models).

Haulout site: Areas on land or ice used regularly by seals or sea lions between periods of foraging activity. Haulout sites are used for mating, giving birth (termed "rookeries"), and rest. Other benefits of hauling out may include predator avoidance, thermal regulation, social activity, and parasite reduction.

Hierarchy of Density Data Sources for the Gulf of Alaska Temporary Maritime Activities Area Study Area:

The Navy ranked density data sources from most to least preferable, as follows:

- Level 1 (Most Preferred): Peer-reviewed published studies of density spatial models that provide spatially explicit density estimates (i.e., habitat-based density models)
- Level 2: Peer-reviewed published studies of stratified designed-based density estimates (i.e., stratified line-transect density estimates)
- Level 3: Peer-reviewed published studies of designed-based density estimates
- Level 4: St. Andrew's Relative Environmental Stability (RES) Model (Sea Mammal Research Unit [SMRU] Ltd., 2012), used for species for which density data are completely lacking
- Level 5 (Least Preferred): Kaschner et al. RES Model (Kaschner et al., 2006)

Level 4 and 5 data sources are based on environmental suitability models.

Kaschner et al. (2006) Marine Mammal Density Models: Kaschner et al. (2006) developed relative environmental suitability models to predict the average annual range of a marine mammal species on a global level. Habitat preferences based on sea surface temperature, bathymetry, and distance to nearest land or ice edge were used to characterize species distribution and relative concentration on a global oceanic scale at 0.5° grid cell resolution. Published estimates of global population were then used to transform the relative concentrations to density estimates. One of the disadvantages of these models is that validating the results is difficult because much of the area covered by the models has never been surveyed. This is the least preferred (Level 5) source of density data.

Line-transect: A path along which one counts and records occurrences of a target species. In a line-transect survey, the observers count occurrences as well as estimate the distance of the object from the path. (See distance sampling.)

Marine mammal stock: The Marine Mammal Protection Act defines a marine mammal "stock" as "a group of marine mammals of the same species or smaller taxon in a common spatial arrangement that interbreed when mature." For management purposes under the Marine Mammal Protection Act, a stock is considered an isolated population or group of individuals within a whole species that is found in the same area.

Mark-recapture: A method commonly used to estimate the size of a population. Typically, a portion of the population is captured, marked, and released. Later, another portion is captured and the number of marked individuals within the sample is counted. Since the number of marked individuals within the second sample should be proportional to the number of marked individuals in the whole population, an estimate of the total population size can be obtained. Mark-recapture techniques for cetaceans use photographs to “capture” a proportion of the population, and distinctive physical features (e.g., humpback flukes) are used as the “marks” for comparison to subsequent photographs.

Mysticete: A whale of the suborder Mysticeti (“baleen whales”), characterized by a symmetrical skull, paired blowholes, and rows of baleen plates for feeding on zooplankton.

NMFS Southwest Fisheries Science Center Habitat-Based Density Models: Spatially explicit models that estimate cetacean density as a continuous function of habitat variables (e.g., sea surface temperature, seafloor depth) and thus allow predictions of cetacean densities on finer spatial scales than traditional line-transect or mark-recapture analyses.

Odontocete: A whale or dolphin in the suborder Odontoceti (“toothed whales”), characterized by an asymmetrical skull, a single blowhole, and rows of teeth, feeding primarily on fish, squid, and crustaceans.

Pacific Coast Feeding Group: A group of a few hundred gray whales that feed along the Pacific coast between southeast Alaska and Southern California during the summer and fall. At present, these animals are not treated as distinct from the Eastern North Pacific population.

Pinniped: A marine mammal included in the taxonomic order Carnivora that includes the extant families Odobenidae (whose only living member is the walrus), Otariidae (the eared seals: sea lions and fur seals), and Phocidae (the earless, or true seals).

Realized niche: The portion of the fundamental niche in which species live. Due to factors such as interspecific and intraspecific dynamics, and lack of resources, the realized niche is typically smaller than the fundamental niche.

Relative Environmental Suitability models: Also known as Environmental Envelope or Habitat Suitability Index models, RES models can be used to understand the possible extent and relative expected concentration of a marine species distribution. (See Kaschner et al. (2006) Marine Mammal Density Models.)

Seasons: While most people are familiar with the traditional four calendar seasons, the Navy Marine Species Density Database shapefiles for the Study Area were separated into four seasonal periods as follows:

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

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

Shapefiles: This is a simple, nontopological ESRI (Environmental Systems Research Institute) format used to store geometric location and attribute information of geographic features.

Sea Mammal Research Unit, Limited (SMRU Ltd.), global habitat-based models: This is one of the least preferred (Level 4) source of density data. Data for 45 species of marine mammals were determined by developing a relationship between the Kaschner RES values (see Kaschner et al. (2006) Marine Mammal Density Models) and empirical density data. That relationship is then used to generate density predictions for locations where no surveys have been conducted.

Southwest Fisheries Science Center: One of the six science centers under the purview of National Oceanic and Atmospheric Administration, NMFS.

Spatial Models: Spatial models are those for which density predictions are spatially defined (i.e., density varies based on a species geographic distribution and concentration), and are typically based on a species relationship with habitat features (see NMFS Southwest Fisheries Science Center Habitat-Based Density Models).

Stratified designed-based density estimates: Stratified designed-based density estimates use the same survey data and methods as the designed-based method, but the study area is stratified into sub-regions, and densities are estimated specific to each sub-region.

Stock Assessment Reports (SARs): NMFS prepares annual stock assessment reports for marine mammals that occur in waters under U.S. jurisdiction. The U.S. Fish and Wildlife Service prepares SARs for marine mammals under their jurisdiction (manatees, polar bears, sea otters, and walruses). Each SAR includes a description of the stock's geographic range, a minimum population estimate, current population trends, current and maximum productivity rates, "Potential Biological Removal" levels, status of the stock, estimates of annual human-caused mortality and serious injury by source, and descriptions of other factors that may be causing a decline or impeding the recovery of strategic stocks.

Surrogate species: Species with similar morphology, behavior, and habitat preferences to the species whose density is being determined. The density values of a surrogate species are used when species-specific density data are unavailable.

Systematic line-transect surveys: Line-transect surveys in which the lines are systematically spaced (versus randomly placed). Systematic survey designs are often preferred over random placement because they provide better spatial coverage and can be designed to ensure that the lines do not coincide with a regular spatial feature (e.g., sampling along an isobath where bias can be introduced into the sampling).

APPENDIX C METADATA DICTIONARY

Field name	Type	Description
UID	Long	Unique ID Field for species per study area. This field is created prior to coming to NUWC but populated by NUWC as it is specific to modeling.
SPECIES	Text254	Species common name (no apostrophes or special characters)
SPECIES_2	Text254	Species scientific name (no apostrophes or special characters)
MONTH_NUMB	Long	Month number 01–12 if you are going to use, if not make 'null'
MONTH_NAME	Text50	Month name January-December if you are going to use, if not make 'null'
STUDY	Text254	Source/study information
STRATUM	Text50	Stratum name
MODEL_TYPE	Text50	Identifies what type of model was used to calculate density (e.g., habitat-based density model)
DENSITY	Double	Density value
UNCERTAINTY	Double	Numerical uncertainty value (CV)
UNCER_QUAL	Text254	Qualitative uncertainty value (description of uncertainty when numerical value is not present or to describe additional qualitative information)
MODEL_VERS	Text50	Not needed for NAEMO modeling but may be used for density creators/publishers for their own internal model tracking. If not used calculate as 'null'
NAEMO_VERS	Long	Identifies version of data - NAEMO specific. Populate as '01' or 'null'
SEASON	Text50	To be populated to capture season information, i.e., Spring, Summer, Fall, Winter. if you are not going to use make 'null'
AREA_SQKM	Float	Area in square kilometers; area must be calculated in features prior to delivery and projection must be documented in metadata
ABUNDANCE	Double	Calculated as 'AREA_SQKM'*'DENSITY' per cell and used as a metric in the QAQC process and to aid in understanding the density values

*ArcGIS built in attributes table fields not included in data dictionary but will be auto generated (Shape_Leng, Shape_Area, ObjectID, and Shape)

Feature/layer naming convention

- Feature/layer names must include the species common name and season or month when determined necessary by Navy. If multiple stocks of the same species are to be modeled then an additional method of identification will need to be developed.

Seasonal feature/layer creation and additional attribute table information:

- Species with seasonal distributions: <u>Create 4 layers</u>, one for each season, Spring, Summer, Fall, or Winter
    - Populate the SEASON field as Spring, Summer, Fall, or Winter
    - Duplicate seasonal density data were necessary to accommodate the Cold and Warm classification
    - Duplicate seasonal density data were necessary to accommodate multiple seasons (i.e., Spring, Summer, Fall, and not Winter)
- Species with annual distribution: <u>Create 4 layers</u>, one for each season, Spring, Summer, Fall, or Winter

  - Duplicate the annual layer for each of the four seasons so there are four separate seasonal layers for each species that hold identical annual density information across all four seasons (e.g., Blue_whale_spring, Blue_whale_summer, Blue_whale_fall, Blue_whale_winter)

- Species with monthly distribution: Create 12 layers, one for each month, (e.g., Blue_whale_01, Blue_whale_02, Blue_whale_03)

Other Notes
Restrict All Special Characters from text fields:
Commas ,
Apostrophes ‘
Dashes -
Periods .

MONTH_NAME and MONTH_NUMB Fields
Should be NULL unless needed to do temporal resolution

Projection:
Features should be delivered in WGS84.

Coastline:
Minimum coastline resolution of 250k should be used (e.g., for Phase III Southern California the NGA 75k coastline was used with manual removal of bays and inlets by the Naval Undersea Warfare Center).

Grid:
Grid size should reflect resolution of the model; however, efforts should be made to align grid cells with existing Navy Marine Species Density Database data if possible.