

5. Biologically Important Areas for Cetaceans Within U.S. Waters – Hawai‘i Region

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Abstract

Of the 18 species of odontocetes known to be present in Hawaiian waters, small resident populations of 11 species—dwarf sperm whales, Blainville’s beaked whales, Cuvier’s beaked whales, pygmy killer whales, short-finned pilot whales, melon-headed whales, false killer whales, pantropical spotted dolphins, spinner dolphins, rough-toothed dolphins, and common bottlenose dolphins—have been identified, based on two or more lines of evidence, including results from small-boat sightings and survey effort, photo-identification, genetic analyses, and satellite tagging. In this review, we merge existing published and unpublished information along with expert judgment for the Hawai‘i region of the U.S. Exclusive Economic Zone and territorial waters in order to identify and support the delineation of 20 Biologically Important Areas (BIAs) for these small and resident populations, and one reproductive area for humpback whales. The geographic extent of the BIAs in Hawaiian waters ranged from approximately 700 to 23,500 km². BIA designation enhances existing information already available to scientists, managers, policymakers, and the public. They are intended to provide synthesized information in a transparent format that can be readily used toward analyses and planning under U.S. statutes that require the characterization and minimization of impacts of anthropogenic activities on marine mammals. Odontocete BIAs in Hawai‘i are biased toward the main Hawaiian Islands and populations off the island of Hawai‘i, reflecting a much greater level of research effort and thus certainty regarding the existence and range of small resident populations off that island. Emerging evidence of similar small resident populations off other island areas in Hawaiian waters suggest that further BIA designations may be necessary as more detailed information becomes available.

Key Words: Hawai‘i, reproductive area, resident population, anthropogenic sound, species distribution

Introduction

This review document coalesces existing published and unpublished information in Hawaiian waters (shoreward of the Exclusive Economic Zone [EEZ] boundary) to define Biologically Important Areas (BIAs) for specific cetacean species that meet the criteria for reproductive areas or small and resident populations defined in Table 1.2 of Ferguson et al. (2015b) within this issue. A comprehensive overview of the BIA delineation process; its caveats (Table 1.4), strengths, and limitations; and its relationship to international assessments also can be found in Ferguson et al. Table 1.3 provides a summary of all BIAs identified, including region, species, BIA type, and total area (in km²). A summary also can be found at <http://cetsound.noaa.gov/important>. Table 1.1 defines all abbreviations used in this special issue. Metadata tables that concisely detail the type and quantity of information used to define each BIA are available as an online supplement.

In Hawai‘i, the low density of most species of cetaceans, combined with high species diversity, the presence of many cryptic or difficult-to-identify species, and a limited amount of large vessel or aerial survey effort to estimate density, results in a limited ability to determine high-use areas for most species. Additional areas of biological importance to cetaceans likely exist within the Hawai‘i region (e.g., for most species within the northwestern Hawaiian Islands and for some species within the western half of the main Hawaiian Islands and on the windward sides of the islands) but are not included due to insufficient information or because data collection and analyses to identify such areas are ongoing.

The quantity and type of data used to define BIAs within U.S. waters in general, and in Hawaiian waters in particular, were spatially and temporally heterogeneous and included data derived from visual sightings and effort data from small-boat surveys (see Baird et al., 2013a), photo-identification, satellite-tagging data, and genetic analyses. Although sighting and effort data are available for Hawaiian waters from both aerial surveys (e.g., Mobley et al., 2000) and large-vessel surveys (e.g., Barlow, 2006), and help inform species distributions, among other things, these datasets were generally not informative for delineating small and resident populations of odontocetes.

Within the Hawai'i region, 11 of the 18 species of odontocetes are known to have populations resident to either the main Hawaiian Islands or the northwestern Hawaiian Islands. Populations of all 11 species—dwarf sperm whale (*Kogia sima*), Blainville's beaked whale (*Mesoplodon densirostris*), Cuvier's beaked whale (*Ziphius cavirostris*), pygmy killer whale (*Feresa attenuata*), short-finned pilot whale (*Globicephala macrorhynchus*), melon-headed whale (*Peponocephala electra*), false killer whale (*Pseudorca crassidens*), pantropical spotted dolphin (*Stenella attenuata*), spinner dolphin (*Stenella longirostris*), rough-toothed dolphin (*Steno bredanensis*), and common bottlenose dolphin (*Tursiops truncatus*)—met the criteria for small and resident populations, and BIAs were created accordingly for these. A reproductive BIA was created for one migratory species—humpback whales (*Megaptera novaeangliae*).

Biologically Important Areas in the Hawai'i Region

Dwarf Sperm Whales (Kogia sima) Small and Resident Population

Dwarf sperm whales are found throughout tropical, subtropical, and warm temperate waters worldwide. They were one of the most abundant cetaceans documented in a 2002 survey of Hawaiian waters (Barlow, 2006). Currently, only a single EEZ wide stock is recognized within Hawaiian waters (Carretta et al., 2014).

Results from analyses of depths at sightings in relation to effort and photo-identification data both suggest there is a small resident population of dwarf sperm whales off the island of Hawai'i (Mahaffy et al., 2009; Baird et al., 2013a). Analyses of sighting rates (sightings/100 survey hours) by depth, corrected for effort, indicate the highest sighting rates of dwarf sperm whales off the island of Hawai'i are between 500 and 1,000 m in depth (Baird et al., 2013a). Sighting rates drop by more than two-thirds in waters > 1,000 m, suggesting a strongly island-associated population that uses relatively nearshore slope habitats. Despite the

infrequent encounters with this species (Baird, 2005; Baird et al., 2013a), a number of individuals documented off the island of Hawai'i have been seen in more than 1 y, with one individual documented in seven different years over a 9-y span (Cascadia Research Collective [CRC], unpub. data, 2004-2013). Neonates and small calves are regularly documented, suggesting it is an area used for calving as well as feeding. No individuals of this species have been satellite tagged, so knowledge of the range of the population is limited to sighting locations from boat-based visual surveys off the west side of the island of Hawai'i. The area identified as the BIA (Figure 5.1; Table S5.1) is a minimum convex polygon around 55 sightings of dwarf sperm whales from small-boat surveys (CRC, unpub. data, 2002-2012). Whether there are one or more resident populations of this species elsewhere in the main Hawaiian Islands is not known, primarily due to the relatively small amount of survey and photo-identification effort in areas of suitable habitat (Baird et al., 2013a), and the difficulty in detecting and identifying this species in anything other than ideal sea conditions. Assessment of potential genetic differentiation of dwarf sperm whales off the island of Hawai'i from other areas has not been undertaken due to insufficient genetic sample sizes. Oleson et al. (2013) proposed recognition of "a prospective island-associated stock of dwarf sperm whales around" (p. 28) the island of Hawai'i, although this proposal was not incorporated into the 2013 stock

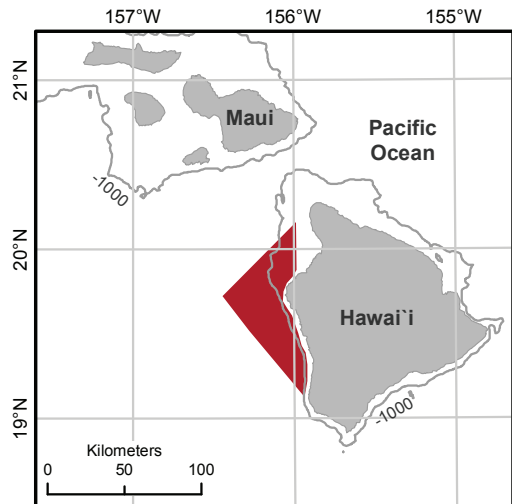


Figure 5.1. The year-round Biologically Important Area (BIA) for dwarf sperm whales (*Kogia sima*) residing within the Hawai'i region, substantiated through photo-identification data, extensive vessel-based survey data, and expert judgment; note dwarf sperm whales are also found in other areas among the main Hawaiian Islands.

assessment report for this population (Carretta et al., 2014).

Blainville's Beaked Whales (Mesoplodon densirostris) Small and Resident Population

Blainville's beaked whales are distributed in deep oceanic waters throughout the tropics and subtropics worldwide, and they typically only approach nearshore around oceanic islands. They have been documented in deep waters off most of the main Hawaiian Islands (Mobley et al., 2000; Baird et al., 2013a). Currently, only a single EEZ wide stock is recognized within Hawaiian waters (Carretta et al., 2014), although off the island of Hawai'i a small resident population of Blainville's beaked whales has been identified (McSweeney et al., 2007; Schorr et al., 2009a). Analyses of sightings in relation to effort by depth show the highest density of groups in water between 500 and 1,500 m in depth, with density decreasing further offshore, then peaking again in depths of 4,000 to 4,500 m, which may reflect sampling of an offshore population (Baird et al., 2011b, 2013a). Long-term photo-identification has indicated high site fidelity, with individuals using the area over periods of at least 15 y, although there is evidence that adult females may exhibit a greater degree of site fidelity than adult males (McSweeney et al., 2007). Mark-recapture analyses of photo-identification data suggest the population is relatively small (Baird et al., 2009c). Baird et al. (2009c) estimated 125 individual Blainville's beaked whales (CV = 0.30) used the area off the west side of the island of Hawai'i from 2003 to 2006, although this estimate included individuals from both the resident population and from an offshore population (Baird et al., 2011b), suggesting the resident population is smaller. Ten individuals from this population (including four adult males) were satellite tagged in four different years from 2006 to 2011, with over 1,800 satellite-derived locations available to assess range and habitat use. Location information from satellite tags was available for periods of 15 to 71 d (median = 44 d, $n = 10$). All 10 individuals remained associated with the island of Hawai'i for the duration of tag attachments, with locations generally restricted to the west side of the island (Schorr et al., 2009a). The delineation of the known range of the population (Figure 5.2; Table S5.2) is based on a minimum convex polygon (with smoothed edges and excluding land) around 1,809 locations from 10 individuals satellite tagged through 2011 (CRC, unpub. data, 2009-2011; Schorr et al., 2009a; Baird et al., 2010a). Whether there are one or more resident populations of this species elsewhere in the main Hawaiian Islands is not known, primarily due to the relatively small amount of

survey, photo-identification, and tagging effort in areas of suitable habitat elsewhere among the islands (Baird et al., 2013a). Assessment of potential genetic differentiation of Blainville's beaked whales off the island of Hawai'i from other areas has not been undertaken due to insufficient genetic sample sizes. Oleson et al. (2013) proposed recognition of a "prospective stock of Blainville's beaked whales within the main Hawaiian Islands with a range of 50 km from the islands" (p. 21), but this proposal was not incorporated into the 2013 stock assessment report for this population (Carretta et al., 2014).

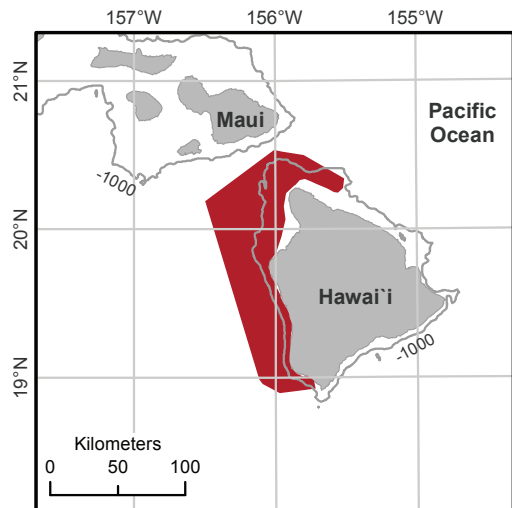


Figure 5.2. The year-round BIA for Blainville's beaked whales (*Mesoplodon densirostris*) residing within the Hawai'i region, substantiated through satellite-tag data, photo-identification data, extensive vessel-based survey data, and expert judgment; note Blainville's beaked whales are also found elsewhere among the Hawaiian Islands, but this area represents the known range for individuals thought to be resident to Hawai'i Island.

Cuvier's Beaked Whales (Ziphius cavirostris) Small and Resident Population

Cuvier's beaked whales are distributed worldwide in deep oceanic waters except for high-latitude polar regions. They were one of the most abundant cetaceans in a 2002 survey of Hawaiian waters, with sightings throughout the EEZ (Barlow, 2006). Currently, only a single EEZ wide stock is recognized within Hawaiian waters (Carretta et al., 2014). Around the main Hawaiian Islands, there have been occasional sightings off Kaua'i and Ni'ihau (Mobley et al., 2000), but the majority of sightings of this species have been off the island of Hawai'i. Off that island, a small resident population of Cuvier's

beaked whales has been identified based on a combination of photo-identification data, satellite-tagging data, and analyses of sightings and survey effort. Analyses of sightings in relation to effort by depth show the highest density of groups in water between 1,500 and 4,000 m in depth along the slope of the island, with density decreasing in deeper waters further offshore (Baird et al., 2013a). Long-term photo-identification has indicated high site-fidelity, with individuals using the area over periods of at least 21 y, although there is evidence that adult females may exhibit a greater degree of site fidelity than adult males (CRC, unpub. data, 2006-2014; McSweeney et al., 2007). Mark-recapture analyses of photo-identification data suggest the population is relatively small; Baird et al. (2009c) estimated that 55 individual Cuvier's beaked whales ($CV = 0.26$) used the area off the west side of the island of Hawai'i from 2003 to 2006.

Nine individuals from this population (including two adult males) have been satellite tagged in five different years, with movement data for periods of from 2 to 45 d (median = 22 d). Satellite tag data show the population is generally restricted to the slope of the island of Hawai'i (Schorr et al., 2008; Baird et al., 2009a, 2010), with the majority of individuals spending most of their time off the west and southeast side of the island. The BIA is based on the delineation of the known range of the population (Figure 5.3; Table S5.3), generated as a minimum convex polygon (excluding land and locations in shallow water with steep bathymetry, thus likely due to Argos error) around 581 locations from nine satellite-tagged individuals (Schorr et al., 2008; Baird et al., 2009a, 2010). Although the number of individuals tagged is relatively large, the shorter attachment durations yet greater range documented than Blainville's beaked whales suggest that the range of individuals from this population is likely to increase as additional satellite-tag data become available.

Whether there are one or more resident populations of this species elsewhere in the main Hawaiian Islands is not known due to the relatively small amount of survey effort in deep-water habitats elsewhere among the islands (Baird et al., 2013a). Assessment of potential genetic differentiation of Cuvier's beaked whales off the island of Hawai'i from other areas has not been undertaken due to insufficient genetic sample sizes. Oleson et al. (2013) proposed recognition of a "prospective island-associated stock of Cuvier's beaked whales within the Hawaiian Archipelago out to 70 km from shore" (p. 24), but this proposal was not incorporated into the 2013 stock assessment report for this population (Carretta et al., 2014).

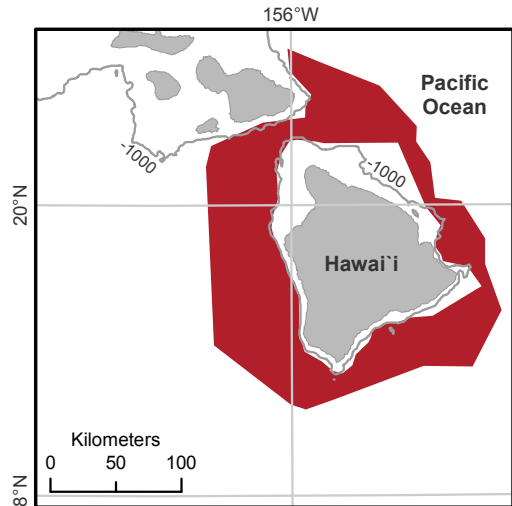


Figure 5.3. The year-round BIA for Cuvier's beaked whales (*Ziphius cavirostris*) residing within the Hawai'i region, substantiated through satellite-tag data, photo-identification data, extensive vessel-based survey data, and expert judgment; this species is found elsewhere among the Hawaiian Islands, but this represents the known range of individuals that appear to be resident to Hawai'i Island.

Pygmy Killer Whales (Feresa attenuata) Small and Resident Population

Pygmy killer whales are distributed throughout tropical oceanic waters worldwide and generally do not approach close to shore except around oceanic islands. This species is naturally rare and one of the least known of the small cetaceans. There are sightings of this species from throughout Hawaiian waters, and currently, only a single EEZ wide stock is recognized (Carretta et al., 2014).

There are high resighting rates of photo-identified pygmy killer whales off both O'ahu and Hawai'i Island, suggesting small resident populations off each island (McSweeney et al., 2009; Mahaffy et al., 2013). Individuals have been documented over spans of up to 27 y off the island of Hawai'i (CRC, unpub. data, 2008-2014; McSweeney et al., 2009), suggesting they are long-term residents. Two individuals that were satellite tagged off Hawai'i Island (in two different years) remained strongly associated with the island slope during the periods of tag attachment (10 and 22 d; Baird et al., 2011a). One group of five individuals known to be resident to O'ahu were documented off Hawai'i Island but were not observed with any of the known resident individuals there (Mahaffy et al., 2013). Only one other individual documented off the island of Hawai'i also has been documented off another island (O'ahu) and that individual had only been seen on a single occasion off the island of Hawai'i (Mahaffy et al., 2013).

We identify a BIA for the Hawai'i Island resident population, although we recognize that as additional information is obtained on the range of the O'ahu resident population, a BIA for that population will likely be warranted. The known range of the Hawai'i Island resident population includes the west side of the island of Hawai'i, from northwest of Kawaihae south to the south point of the island, and along the southeast coast of the island, as determined by locations from two satellite-tagged individuals (Baird et al., 2011a; Figure 5.4; Table S5.4). Given the small sample size, this range is likely to increase if additional satellite-tag data become available. Assessment of potential genetic differentiation of pygmy killer whales off the island of Hawai'i from other areas has not been undertaken due to insufficient genetic sample sizes. Oleson et al. (2013) proposed recognition of a "prospective island-associated stock of pygmy killer whales within the main Hawaiian Islands with a range of up to 20 km from shore" (p. 26), but this proposal was not incorporated into the 2013 stock assessment report for this population (Carretta et al., 2014).

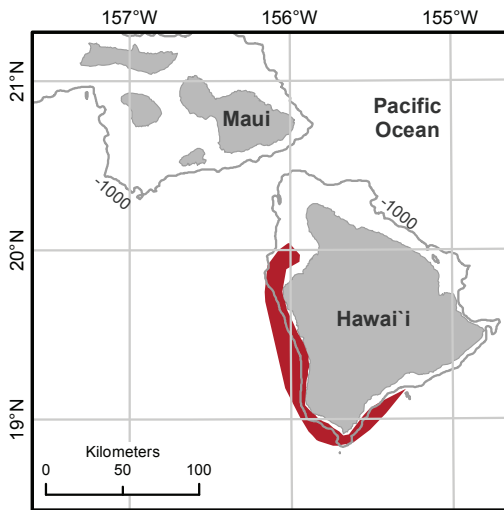


Figure 5.4. The year-round BIA for pygmy killer whales (*Feresa attenuata*) residing within the Hawai'i region, substantiated through photo-identification data, satellite-tag data, extensive vessel-based survey data, and expert judgment; note pygmy killer whales are found elsewhere among the Hawaiian Islands, but this represents the known range for individuals that appear to be resident to Hawai'i Island.

Short-Finned Pilot Whales (Globicephala macrorhynchus) Small and Resident Population

Short-finned pilot whales are distributed worldwide throughout the tropics, subtropics, and warm-temperate areas. They are typically found in the open-ocean except around oceanic islands, where

they are often found relatively close to shore. They are found throughout Hawaiian waters with higher density around the main Hawaiian Islands (Barlow, 2006), although currently only a single EEZ wide stock is recognized within Hawaiian waters (Carretta et al., 2014).

Evidence from analyses of sighting and effort data, long-term photo-identification data, and satellite-tag deployments all indicate the existence of a resident population of short-finned pilot whales off the island of Hawai'i (Baird et al., 2011c, 2013a; Mahaffy, 2012). Analyses of 13 y of survey effort show this species is primarily associated with slope habitats off the islands, with the highest sighting density between 1,000 and 2,500 m in depth, with density dropping off substantially after 2,500 m in depth (Baird et al., 2013a). Long-term resightings of individuals indicate high site fidelity and suggest that at least some proportion of the population is resident to the island (Mahaffy, 2012). Between 2006 and 2011, satellite tags were deployed on 44 occasions on 41 different individual short-finned pilot whales off Hawai'i Island for periods ranging from 3 to 110 d (median = 31 d), with individuals remaining strongly associated with the island slope in all but one case (CRC, unpub. data, 2006-2011). A contiguous, high-use area has been identified through the analysis of tag data from 35 tag deployments (through 2010), with the highest density of satellite-tag locations along the west side of the island of Hawai'i, extending somewhat off the north tip of the island and along the southeast slope of the island (Figure 5.5; Table S5.5). This high-use area was defined following the methods of Baird et al. (2012), with the study area broken into 5 km × 5 km grid cells, and the total time of satellite tracks within each cell allocated to the cell. Cells with total time greater than 1 standard deviation (SD) above the mean were classified for this analysis as high-use areas, and the largest contiguous block of high-use cells is identified. There is accumulating information suggesting that there are one or more additional small resident populations off the western and central main Hawaiian Islands (Ni'ihau to Lāna'i; CRC, unpub. data, 2008-2014), and, thus, assessment of one more BIA off those islands may be warranted as additional information becomes available. Assessment of potential genetic differentiation of short-finned pilot whales off the island of Hawai'i from other areas in Hawaiian waters has not yet been undertaken; however, a preliminary genetic analysis using mitochondrial DNA showed that short-finned pilot whales around the main Hawaiian Islands were differentiated from those elsewhere in the Pacific (Van Cise et al., 2013).

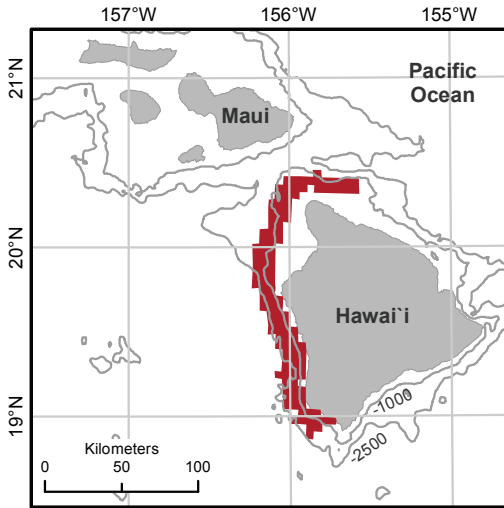


Figure 5.5. The year-round BIA for short-finned pilot whales (*Globicephala macrorhynchus*) residing within the Hawai'i region, substantiated through photo-identification data, extensive vessel-based survey data, satellite-tag data, and expert judgment. Note short-finned pilot whales are found around the other Hawaiian Islands; this represents a high-use area for a subset of individuals that appear to be resident to Hawai'i Island.

Melon-Headed Whales (*Peponocephala electra*) *Small and Resident Population*

Melon-headed whales are distributed throughout tropical and subtropical oceanic waters around the world. The only areas they typically approach close to shore are oceanic islands. Although melon-headed whales are broadly distributed within Hawaiian waters (Barlow, 2006; Woodworth et al., 2011), off the island of Hawai'i, a resident population has been identified that primarily uses the Kohala area (Figure 5.6; Table S5.6). This population was recently recognized as the Kohala Resident Stock (Carretta et al., 2014). Dispersal analyses based on photo-identification data (Baird et al., 2010b; Aschettino et al., 2011a), and preliminary genetic analyses of biopsy samples (Aschettino et al., 2011b) both suggest this population is demographically isolated from a population of melon-headed whales that extends throughout the main Hawaiian Islands and into offshore waters (Schorr et al., 2009b; Aschettino et al., 2011b; Woodworth et al., 2011). This latter population is recognized as the Hawaiian Islands Stock (Carretta et al., 2014). Abundance estimated for the Kohala Resident Stock using mark-recapture analyses of photo-identification data was 447 individuals (CV = 0.12; Aschettino, 2010). Based on photo-identification throughout the main Hawaiian Islands and satellite tagging of six individuals (tagged in four different years, with tag data available for periods of

from 5 to 26 d; median = 10 d), the Kohala Resident Stock appears to have a range restricted to the northwest coast of the island of Hawai'i (CRC, unpub. data, 2008-2012; Aschettino et al., 2011a, 2011b) in significantly shallower water than the main Hawaiian Islands population. The delineation of the range of this population is based on a minimum convex polygon (with smoothed edges and excluding land) around locations obtained from four satellite-tagged individuals ($n = 545$ locations; CRC, unpub. data, 2008-2012), which also encompasses the range based on sightings presented by Aschettino et al. (2011a).

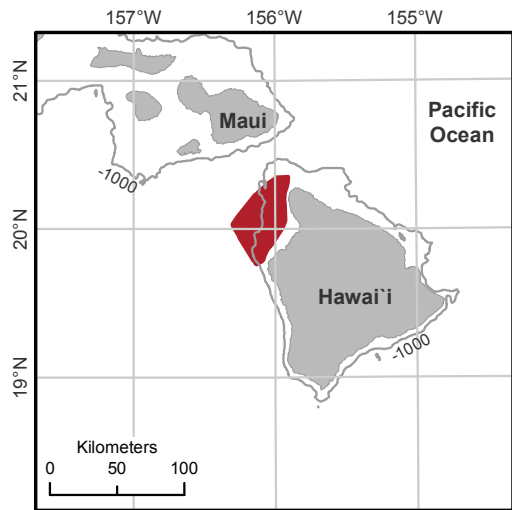


Figure 5.6. The year-round BIA for melon-headed whales (*Peponocephala electra*) residing within the Hawai'i region, substantiated through photo-identification data, satellite-tag data, extensive vessel-based survey data, and expert judgment; this area represents most of the known home range of the Kohala Resident Stock of melon-headed whales.

False Killer Whales (*Pseudorca crassidens*) *Small and Resident Population*

False killer whales are distributed throughout tropical oceanic waters worldwide. Three populations of false killer whales have been recognized from Hawaiian waters—an open-ocean (pelagic) population and two insular populations (Carretta et al., 2014). One of the insular populations is found around the main Hawaiian Islands, and one is found in the northwestern Hawaiian Islands, with overlap of the two insular populations around Kaua'i and Ni'ihau (Chivers et al., 2007; Baird et al., 2008b, 2012, 2013b; Oleson et al., 2010). More information is available on the main Hawaiian Islands population than either of the other populations. The most recent estimate of abundance for the main Hawaiian Islands insular

Stock of false killer whales is 151 individuals (CV = 0.20; model average of four mark-recapture models from 2006-2009; Oleson et al., 2010), and this population was listed as Endangered under the U.S. Endangered Species Act (ESA) in 2012 (77 FR 70915). The known range of this population based on satellite-tagging data extends from west of Ni‘ihau to east of Hawai‘i, with the furthest extent at 122 km offshore (Baird et al., 2012). Within this range, it is possible to delineate high-use areas based on density of location data obtained from satellite tags. To aid in identifying Critical Habitat for this population, Baird et al. (2012) identified several high-use areas based on grid cells that were greater than 2 SD above the mean for density of locations. Baird et al. note a variety of limitations of their sample, including a seasonal bias in tag data and having telemetry data from only two of the three large social groupings within the population when spatial use is known to vary between social groups. For this assessment, grid cells with density of locations greater than 1 SD above the mean are considered high-use areas and mapped accordingly to identify the BIA (Figure 5.7). While we have not identified a BIA for the northwestern Hawaiian Islands population, consideration of one or more BIAs would be warranted as more information becomes available.

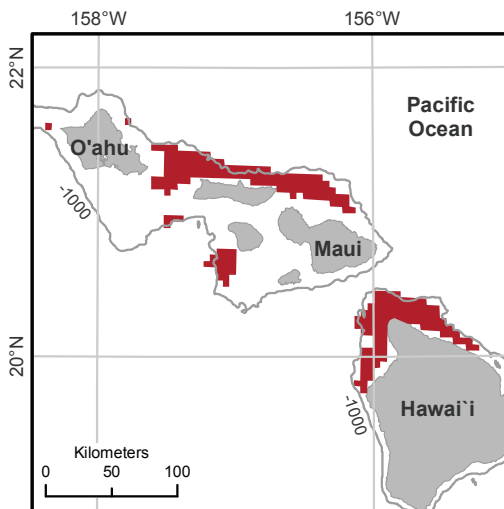


Figure 5.7. The year-round BIA for false killer whales (*Pseudorca crassidens*) residing within the Hawai‘i region, substantiated through satellite-tag data and expert judgment; this represents the high-use areas for the main Hawaiian Islands insular population of false killer whales, although this population ranges from east of Hawai‘i Island to west of Ni‘ihau, and two other populations of false killer whales have ranges that partially overlap.

Pantropical Spotted Dolphins (Stenella attenuata)

Small and Resident Population

Pantropical spotted dolphins are found worldwide throughout tropical waters. Genetic evidence suggests that there are three demographically isolated populations of this species around the main Hawaiian Islands (Figure 5.8; Table S5.8), with significant genetic differentiation between populations off O‘ahu, in the four-island area (i.e., Maui, Lāna‘i, Moloka‘i, and Kaho‘olawe), and off Hawai‘i Island (Courbis et al., 2014). The levels of genetic differentiation are similar to those found among stocks of spinner dolphins and common bottlenose dolphins within the Hawaiian archipelago (Andrews et al., 2010; Martien et al., 2011; Carretta et al., 2014; Courbis et al., 2014). Three insular stocks were recognized in 2014 corresponding to these island areas (Carretta et al., 2014). The boundaries of these populations are not known due to biased survey effort off the leeward sides of the islands (Baird et al., 2013a) and lack of satellite-tag data. The known ranges of pantropical spotted dolphins off each island based on sighting data from small-boat surveys (Baird et al., 2013a) was used to delineate three BIAs—one off each of the three island areas (Figure 5.8), corresponding to one BIA for each of the three recognized insular stocks. There are sightings of spotted dolphins elsewhere among the main

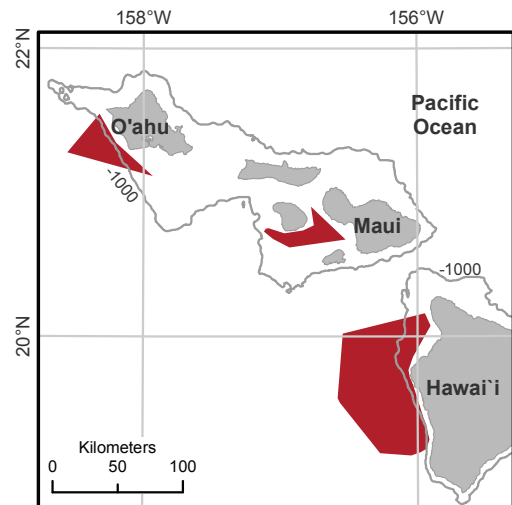


Figure 5.8. The year-round BIAs for pantropical spotted dolphins (*Stenella attenuata*) residing within the Hawai‘i region, substantiated through extensive vessel-based survey data, genetic analyses, and expert judgment; each of these BIAs corresponds to part of the stock range for the three recognized insular stocks of pantropical spotted dolphins in Hawaiian waters. Note pantropical spotted dolphins are also found elsewhere among the islands.

Hawaiian Islands (e.g., Mobley et al., 2000), however, and boundaries for these BIAs should be reassessed as more information becomes available.

Spinner Dolphins (Stenella longirostris) Small and Resident Population

Spinner dolphins are distributed worldwide throughout the tropics, with populations often found near-shore around oceanic islands. Genetic evidence suggests that there are five demographically isolated populations of spinner dolphins throughout the Hawaiian archipelago (Andrews et al., 2010; Figure 5.9; Table S5.9). These five populations have recently been recognized as distinct stocks by NOAA Fisheries (Carretta et al., 2014). The boundaries of these stocks as currently recognized are from shore out to 10 nmi from shore around Kure and Midway Atolls, Pearl and Hermes Reef, Kaua'i and Ni'ihau, O'ahu and the four-island area, and Hawai'i Island (Carretta et al., 2014); these boundaries were used as boundaries for the BIAs.

Rough-Toothed Dolphins (Steno bredanensis) Small and Resident Population

Rough-toothed dolphins are distributed throughout tropical and subtropical oceanic waters worldwide.

In the Pacific, this species typically is found close to shore only around oceanic islands. Currently, only a single EEZ wide stock is recognized within Hawaiian waters (Carretta et al., 2014), and a small demographically isolated resident population of rough-toothed dolphins has been identified off the island of Hawai'i (Baird et al., 2008a; Albertson, 2015). A mark-recapture estimate of distinctive photo-identified individuals from 2003 to 2006 off the island of Hawai'i was 198 individuals (CV = 0.12; Baird et al., 2008a). Two individuals were documented moving from Kaua'i to Hawai'i but were not seen with any of the dolphins known to be part of the resident social network off Hawai'i (Baird et al., 2008a). Both individuals have been subsequently documented back off of Kaua'i (Baird et al., 2013c), and, thus, these movements do not appear to represent dispersal between the populations. An analysis of dispersal rates between these populations indicated that observed movements were consistent with, at most, a 2%/y dispersal rate between the two areas (Baird et al., 2008a). Genetic analyses of samples collected from Kaua'i and Hawai'i indicated strong genetic differentiation between the two areas (Albertson, 2015), further supporting that the Hawai'i Island

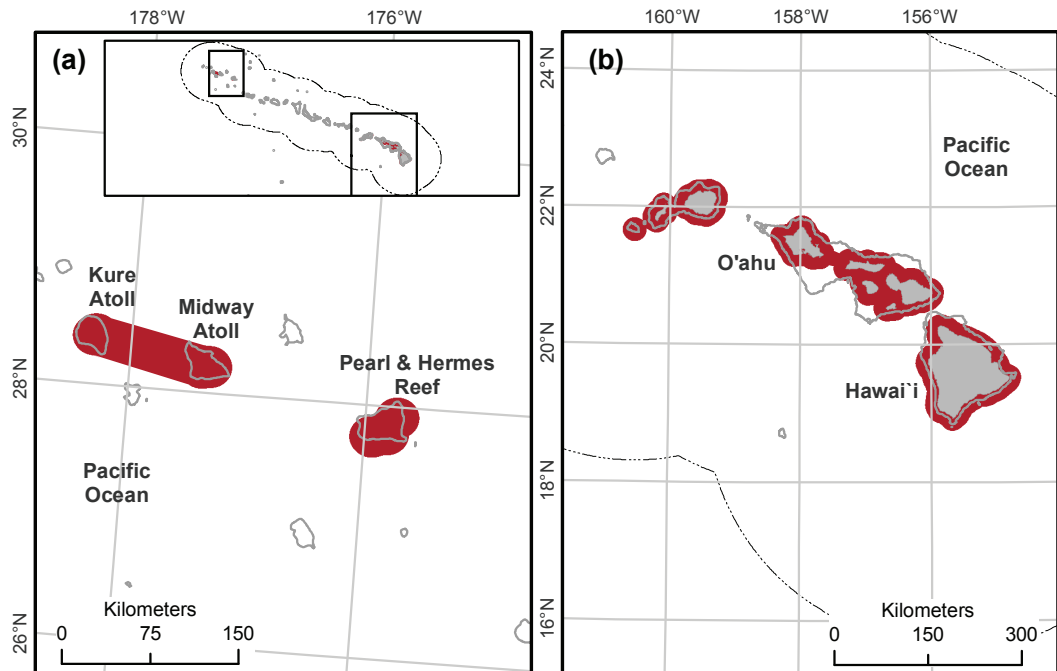


Figure 5.9. The year-round BIAs for spinner dolphins (*Stenella longirostris*) residing within the Hawai'i region in (a) the northwestern Hawaiian Islands and (b) the main Hawaiian Islands; these BIAs were substantiated through extensive vessel-based survey data, genetic analyses, and expert judgment. Areas outlined represent the stock boundaries for the five recognized insular stocks of spinner dolphins in Hawaiian waters. Also shown is the 1,000-m depth contour. Inset shows extent of U.S. EEZ around the Hawaiian Archipelago, with frames around extent for boxes (a) and (b).

resident population is demographically isolated. No individuals off the island of Hawai'i have been satellite tagged, so information on range is restricted to sighting locations from long-term small-boat survey effort restricted to the west side of the island (CRC, unpub. data, 2002-2014). The BIA represents a minimum convex polygon around all sighting locations of this species off the island of Hawai'i (Figure 5.10; Table S5.10).

Resighting rates of rough-toothed dolphins off Kaua'i and Ni'ihau also indicate a resident population off those islands (Baird et al., 2008a), although there was no significant genetic differentiation between Kaua'i/Ni'ihau and animals sampled in the northwestern Hawaiian Islands or off O'ahu (Albertson, 2015). Ongoing research utilizing satellite tags is beginning to identify high-use areas off Kaua'i and Ni'ihau (Baird et al., 2014), and recognition of a BIA there may be warranted as more information becomes available. Furthermore, sightings of rough-toothed dolphins have been documented elsewhere among the islands (e.g., Mobley et al., 2000), and boundaries for these BIAs should be re-assessed as more information becomes available.

Common Bottlenose Dolphins (Tursiops truncatus) Small and Resident Population

Common bottlenose dolphins (hereafter bottlenose dolphins) are distributed in coastal and oceanic

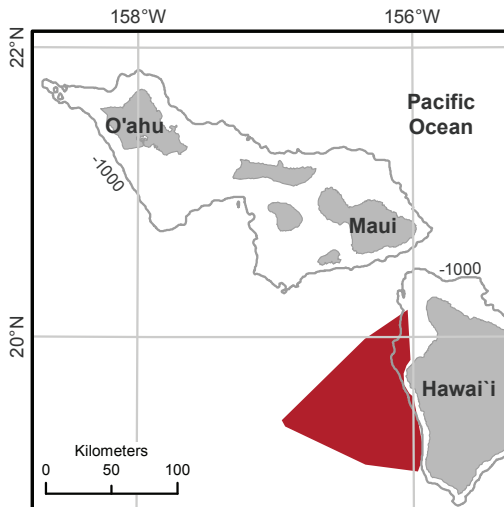


Figure 5.10. The year-round BIA for rough-toothed dolphins (*Stenella bredanensis*) residing within the Hawai'i region, substantiated through photo-identification data, extensive vessel-based survey data, genetic analyses, and expert judgment; this species is found elsewhere around the Hawaiian Islands, but this area represents the known range of individuals from an apparently resident population off Hawai'i Island.

waters throughout the tropics, subtropics, and in some warm temperate areas. In Hawaiian waters, they are found both in offshore and nearshore areas (Barlow, 2006), but around the main Hawaiian Islands they are primarily found in depths of less than 1,000 m (Baird et al., 2013a). Photo-identification data from the main Hawaiian Islands revealed high resighting rates around each island area, and analysis of movement rates suggested that dispersal among island areas is less than 2%/y (Baird et al., 2009b). Genetic analyses of biopsy samples indicate there are four demographically isolated insular populations in the main Hawaiian Islands (Martien et al., 2011) as well as an offshore (pelagic) population. These populations have been recognized as stocks (Carretta et al., 2014), with boundaries delineated by the 1,000 m depth contour around Ni'ihau and Kaua'i, Hawai'i Island, and O'ahu and the four-island area, with the latter two separated by a line in the deepest water approximately equidistant between O'ahu and Penguin Bank/Moloka'i (Figure 5.11; Table S5.11). These stock boundaries were used as boundaries for the BIAs. Satellite-tag data from nine individuals, representing three of the four insular stocks, support the recognition of these four insular stocks (Gorgone et al., 2013). Estimates of the abundance of the marked individuals for each island area are available from mark-recapture analysis of photo-identification data and indicate that populations off Hawai'i Island, in the four-island area, and off Kaua'i and Ni'ihau are all relatively small—that is, likely < 250 marked individuals in each area (Baird et al., 2009b).

Humpback Whales (Megaptera novaeangliae)

General—Humpback whales are a migratory species with a worldwide distribution. Within the North Pacific, three main breeding populations have been recognized based on photo-identification and genetic data, including Asia, Hawai'i, and Mexico/Central America (Calambokidis et al., 1997; Baker et al., 1998). While the overall pattern of movements between breeding and feeding areas is complex, a high degree of population structure exists, and the combination of these breeding populations with their respective feeding grounds has led to the designation of three main stocks of humpback whales in the North Pacific (Baker et al., 2008; Calambokidis et al., 2008a; Allen & Angliss, 2012). The Central North Pacific Stock is comprised of animals that winter primarily in the Hawaiian Islands and feed in British Columbia/Southeast Alaska, the Gulf of Alaska, and the Aleutian Islands/Bering Sea. Recent work, however, has suggested that a greater degree of population structure exists in the North Pacific than has previously been recognized (Baker et al., 2013), suggesting that there are five *distinct population*

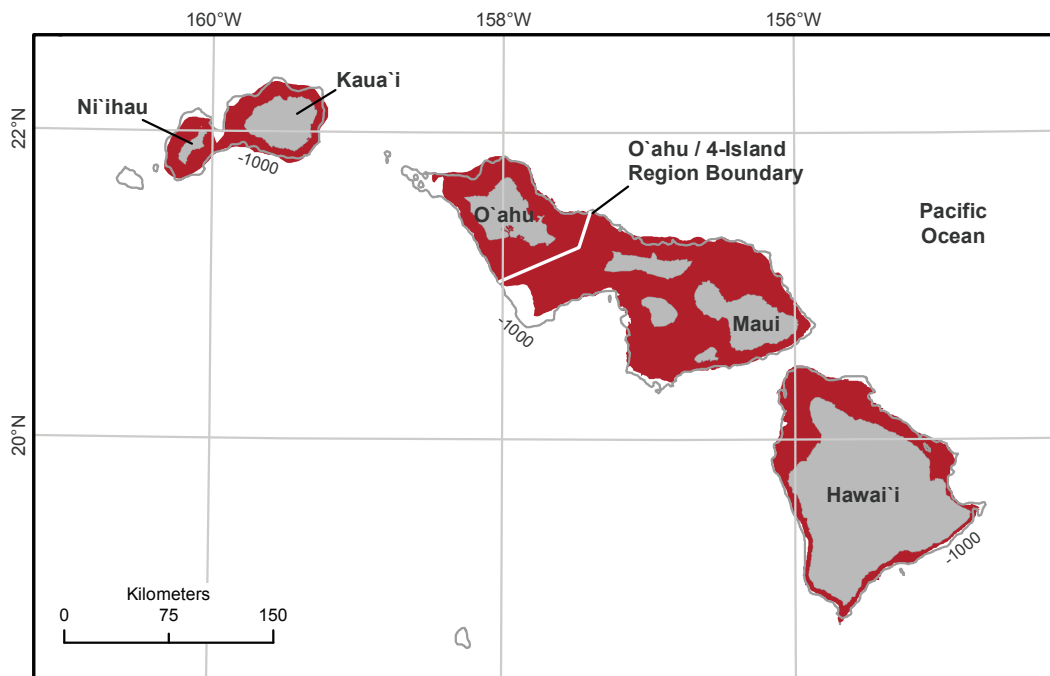


Figure 5.11. The year-round BIAs for bottlenose dolphins (*Tursiops truncatus*) residing within the Hawai'i region, substantiated through satellite-tag data, photo-identification data, extensive vessel-based survey data, genetic analyses, and expert judgment; areas outlined represent the stock boundaries for the four insular stocks of bottlenose dolphins in Hawaiian waters. This species is also found elsewhere among the Hawaiian Islands.

segments (DPSs) among the breeding grounds in the North Pacific. This changes the traditional view of stock structure. Within this framework, the Hawaiian Islands population comprises one DPS.

Reproduction—The Hawaiian archipelago comprises the largest breeding area for humpback whales in the North Pacific, with over 50% of the population migrating to this region during winter months. Current population estimates for this region range from approximately 7,000 to 10,000 animals, with an estimated annual growth rate between 5.5 to 6.0% (Calambokidis et al., 2008a). Migratory timing varies, with peak abundance generally from February through March (Mobley et al., 1999). Animals are highly concentrated on Penguin Bank and in the waters between Maui, Moloka'i, Lāna'i, and Kaho'olawe (Mobley et al., 2001; Office of National Marine Sanctuaries, 2010) (Figure 5.12; Table S5.12). However, densities have also increased substantially around other islands, particularly in the Kaua'i/Ni'ihau region (Mobley et al., 1999; Figure 5.12). Most animals are found in higher densities in areas with water depths less than 200 m (Herman et al., 1980; Frankel et al., 1995; Mobley et al., 2001).

Females with calves appear to exhibit preferential habitat selection, historically favoring the

protected waters of the Au'au Channel (Craig & Herman, 2000; Cartwright et al., 2012), though they are found throughout the island chain (Mobley et al., 1999). Movement of individuals between the main Hawaiian Islands is considered to be extensive, based both on photo-identification and satellite-tag studies, with high rates of interchange between Kaua'i and Hawai'i Island (Cerchio et al., 1998), as well as between these two islands and Maui (Calambokidis et al., 2008a) and Penguin Bank (Mate et al., 1998). The BIA boundaries represent the highest density areas within the main Hawaiian Islands. While peak densities are from February through March, the breeding season typically spans December through April, during which time humpbacks may be found in lower densities throughout the region. The occurrence of humpback whales in the northwestern Hawaiian Islands, now part of the Papahānaumokuākea Marine National Monument, has been documented in recent years (Johnston et al., 2007; Lammers et al., 2011), and habitat modeling suggests that there may be over 14,000 km² of suitable wintering habitat in that region (Johnston et al., 2007). These studies suggest that the northwestern Hawaiian Islands may now represent an extension of humpback whale wintering habitat beyond the main

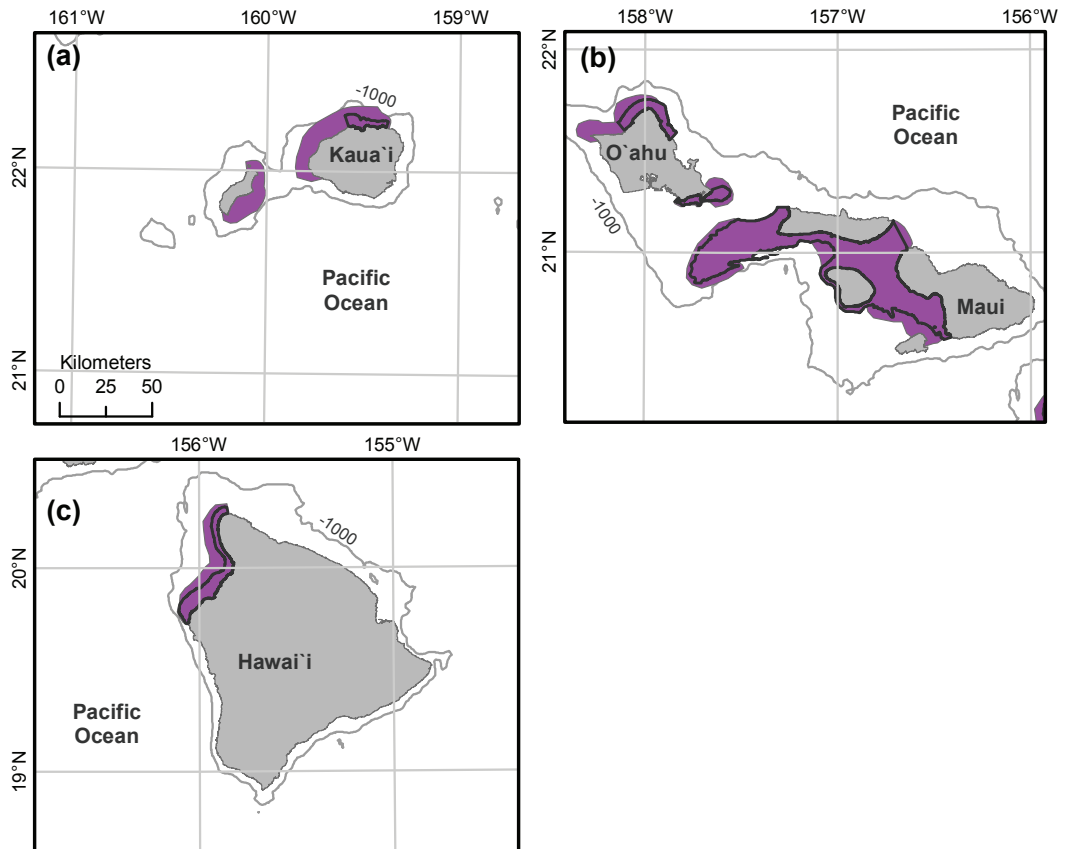


Figure 5.12. The BIA for breeding humpback whales (*Megaptera novaeangliae*) within the Hawai'i region around (a) Kaua'i and Ni'ihau, (b) O'ahu, Moloka'i, Lāna'i, and Maui, and (c) Hawai'i; the breeding season typically spans December through April, with highest densities of animals in February through March. This BIA was substantiated through extensive survey data, satellite-tag data, and expert judgment. Also shown is the boundary for the Hawaiian Island Humpback Whale National Marine Sanctuary (solid black line) and the 1,000-m depth contour (light gray line).

island chain, though there are not yet enough data to delineate a BIA in that region.

Summary

We designate 20 BIAs for small and resident populations of all 11 species of odontocetes known to be resident around the Hawaiian islands, and one BIA representing a reproductive area for one species of baleen whale. With the exception of spinner dolphins, all of our BIAs are located among the main Hawaiian Islands. This reflects research efforts for most species, which have been concentrated in the main Hawaiian Islands. Among the main Hawaiian Islands, for three species that have had extensive photo-identification and/or genetic studies (i.e., common bottlenose dolphin, spinner dolphin, and pantropical spotted dolphin), for humpback whales, and for one species of odontocete with a large sample size of satellite tag data

showing extensive movements among the islands (i.e., false killer whales), BIAs have been identified throughout the islands. For other species of odontocetes, however, the BIAs are further biased toward areas near the island of Hawai'i. This reflects the much greater level of research effort in deep waters off the leeward side of that island (Baird et al., 2013a) and, thus, certainty about the existence of small resident populations and their approximate ranges for some of the rarer and more difficult-to-study species around that island (e.g., dwarf sperm whales, and Blainville's and Cuvier's beaked whales). It is clear, however, that there are small resident populations of some of the deeper-water species off other islands (e.g., rough-toothed dolphins off Kaua'i and Ni'ihau, pygmy killer whales off O'ahu, and short-finned pilot whales from Lāna'i to Ni'ihau), and BIA designations for those populations should be considered as additional information becomes available.