APPENDIX A

(INCLUDED AS APPENDIX A WITHIN: FINAL 2013 COMPREHENSIVE EXERCISE AND MARINE SPECIES MONITORING REPORT FOR THE U.S. NAVY'S HAWAII RANGE COMPLEX)

SUMMARY REPORT:

COMPILATION OF VISUAL SURVEY EFFORT AND SIGHTINGS FOR MARINE SPECIES MONITORING IN THE HAWAII RANGE COMPLEX, 2005–2012

Hawaii Range Complex, 2010; NOAA permit #14451

November 2012

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Cover Photo: Short-finned pilot whale (*Globicephala macrorhynchus*) photographed during the RIMPAC 2010 vessel survey by A. Milette.

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Acronyms and Abbreviations

ASW	Anti-submarine Warfare
BARSTUR	Barking Sands Tactical Underwater Range
BSS	Beaufort Sea State
BSURE	Barking Sands Underwater Range Expansion
COMPACFLT	Commander, U.S. Pacific Fleet
ESA	Endangered Species Act
GIS	geographic information system
ft	foot/feet
HFAS	high-frequency active sonar
HRC	Hawaii Range Complex
ICMP	Integrated Comprehensive Monitoring Program
ITS	Incidental Take Statement
km	kilometer(s)
LOA	Letter of Authorization
LOE	Lookout Effectiveness
m	meter(s)
M3R	Marine Mammal Monitoring on Navy Ranges
MFAS	mid-frequency active sonar
MHI	Main Hawaiian Islands
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
MTE	major training event
NM	nautical mile
NMFS	National Marine Fisheries Service
PAM	passive acoustic monitoring
PMRF	Pacific Missile Range Facility
RHIB	rigid-hulled inflatable boat
RIMPAC	Rim of the Pacific
SCC	Submarine Commanders Course
SD	standard deviation
SINKEX	Sinking Exercise
SWTR	Shallow Water Training Range
U.S.	United States
ULT	Unit Level Training
UNDET	underwater detonation
USWEX	Undersea Warfare Exercise

Section 1 Introduction

The United States (U.S.) Navy is responsible for compliance with a suite of Federal environmental laws and regulations that apply to marine mammals and other marine protected species, including the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA). There are training activities in the Hawaii Range Complex (HRC) that the U.S. Navy predicts would result in the generation of sound levels in the water that the National Marine Fisheries Service (NMFS) has indicated are likely to result in the harassment of marine mammals. These activities involve the use of sonar (mid-frequency active sonar [MFAS] or high-frequency active sonar [HFAS]) or the use of live ordnance, including the underwater detonation (UNDET) of explosives. In order to train in realistic conditions (i.e., with sonar and explosives), the U.S. Navy obtains Incidental Take Statements (ITS) and Letters of Authorization (LOAs) from NMFS under the ESA and MMPA, respectively. Marine species monitoring efforts partially fulfill requirements of the *Hawaii Range Complex Monitoring Plan* as specified in the LOA, and meet a variety of program objectives outlined in the Integrated Comprehensive Monitoring Program (ICMP). Monitoring of marine mammals and sea turtles includes visual surveys from aircraft (e.g., fixed-wing and helicopter) and vessels, marine mammal tagging, and passive acoustic monitoring (PAM).

The ICMP provides the overarching framework for coordination of the U.S. Navy Monitoring Program and coordination to compile data from range-specific monitoring plans. The *Hawaii Range Complex Monitoring Plan* is one component of the ICMP. The overall objective of the ICMP is to assimilate relevant data collected across U.S. Navy range complexes in order to answer questions pertaining to the impact of sonar and explosives on marine mammals and sea turtles.

The first phase to integrate the historical sum of these U.S. Navy-sponsored visual survey efforts for marine species monitoring in the HRC was prepared by Uyeyama (2011). This report represents the second phase of that effort and presents an overview of monitoring survey effort to date in the HRC. Available data from visual surveys performed by both contractor-led efforts and U.S. Navy in-house surveys was compiled and processed in order to:

1. Create a geographic information system (GIS)-based summation of all survey tracks that can be easily visualized.
2. Construct a geo-referenced database of sightings that can be queried by species, observer platform, Beaufort Sea State (BSS), season, or other sighting/survey variables.
3. Conduct an enhanced analysis of sighting success with respect to survey platform, field protocol, and environmental conditions.
4. Inform and adjust data collection procedures on future surveys as needed to reflect lessons learned from sighting data compilation efforts presented here.
5. Provide information to enhance informed management of marine protected species in the HRC and support the adaptive management process that is part of the ICMP.

Section 2 Methods

The U.S. Navy has supported marine protected species monitoring in the HRC since 2005. These efforts include collection of baseline data and monitoring in conjunction with U.S. Navy training events. Monitoring methods include visual surveys using vessel and aircraft platforms. This report summarizes results from a total of 58 monitoring surveys conducted in the HRC since 2005 (**Table 1** and **Appendix A**). Detailed sighting and effort data from all 58 surveys were entered into a comprehensive HRC monitoring survey database, which was used to generate the tables, figures, and survey effort and sightings maps found in Section 3 and in the appendices to this report.

2.1 Compiled Monitoring Effort

This report presents sightings (see **Section 3**) made during both vessel and aerial surveys, conducted either as baseline or pilot monitoring surveys, monitoring during major training events (MTEs), and as monitoring during non-MTEs.

2.1.1 Pilot/Baseline Monitoring

Pilot and baseline monitoring efforts supported by the U.S. Navy have been conducted in the HRC since 2005. Pilot surveys (preliminary survey efforts to determine feasibility of data collection methods) and baseline monitoring surveys were designed to collect marine species data without association with a particular U.S. Navy training event. A brief summary of each of those efforts is presented below.

Deepwater Cetacean Survey. During February 2005, a pilot study was conducted that consisted of a combined visual (vessel-based)-acoustic cetacean survey, which included waters offshore of Oahu and Kauai, with focused effort in the Kaulakahi Channel (between Kauai and Niihau) (Cetos 2005, **Table 1**). This survey was designed to address a gap in information about deep-water species of cetaceans around the Main Hawaiian Islands (MHI). Visual and PAM detections of minke whales (*Balaenoptera acutorostrata*) were a highlight during this effort and were detailed in Rankin et al. (2007). This survey was conducted by the non-governmental organization Cetos, with funding from the Commander, U.S. Pacific Fleet (COMPACFLT) for report preparation.

Vessel Survey at Alenuihaha Channel and the Island of Hawaii. Vessel-based monitoring was scheduled to take place from January to February 2007, during a planned Anti-submarine Warfare (ASW) training event (Cetos 2007, **Table 1**). Ultimately, the event was cancelled due to deteriorating weather conditions. The survey continued in areas that typically are not surveyable due to prevailing weather conditions (Cetos 2007). Surveys were conducted in the Alenuihaha Channel (between the islands of Hawaii and Maui) and along the northeastern and eastern portions of waters off the Island of Hawaii. Prior to this survey, no vessel-based transects had been conducted along the eastern and northeastern coast of the Island of Hawaii.

Table 1. Summary of HRC monitoring survey sighting data with associated sea state data.

Survey Type	Survey Title	Survey Timeframe	Monitoring Platform	Dedicated Platform?	BSS[1]		
					Mean (SD)	Max	Min
Pilot/Baseline Monitoring							
Deepwater Cetacean Survey	Deepwater Cetacean Survey	February 2005	Vessel	Yes	N/A	N/A	N/A
Vessel Survey	Vessel Survey at Alenuihaha Channel and the Island of Hawaii	January/February 2007	Vessel	Yes	N/A	N/A	N/A
Kaula Island Aerial and Vessel Surveys	Kaula Island Vessel Surveys	June 2010	Vessel	Yes	3.1 (0.63)	5	2
	Kaula Island Vessel Surveys	February 2011#1[2]	Vessel	Yes	2.8 (0.90)	5	1
	Kaula Island Vessel Surveys	February 2011#2[2]	Vessel	Yes	3.1 (1.38)	6	1
	Kaula Island Aerial Surveys	February 2011	Aerial	Yes	2.3 (0.61)	3	1
	Kaula Island Aerial Surveys	June 2011	Vessel	Yes	N/A	N/A	N/A
	Kaula Island Vessel Surveys	July 2012	Vessel	Yes	6.2 (0.39)	7	6
Marine Mammal Monitoring on Navy Ranges (M3R) Tagging Survey	Tagging Survey in the Western Main Hawaiian Islands	July/August 2011	Vessel	Yes	2.5 (0.99)	6	0
January Large Vessel Survey	PMRF Vessel and Tagging Survey	January 2012	Vessel	Yes	3.9 (1.33)	6	1
Pearl Harbor Entrance Channel and Kaneohe Bay Sea Turtle Surveys	Pearl Harbor Entrance Channel and Kaneohe Bay Sea Turtle Survey	April/May 2011	Vessel/Diver	Yes	2.8 (1.05)	4	1
	Pearl Harbor Entrance Channel Sea Turtle Survey	May 2012	Vessel/Diver	Yes	1.0 (0.00)	1	1
Small-Vessel Tag/Biopsy/Photo-ID Surveys	Small-Vessel Tag/Biopsy/Photo-ID (Mar/Apr 2006)	March/April 2006	Vessel	Yes	1.8 (0.90)	6	0
	Small-Vessel Tag/Biopsy/Photo-ID (Jul 2006)	July 2006	Vessel	Yes	2.0 (0.90)	5	0
	Small-Vessel Tag/Biopsy/Photo-ID (Nov/Dec 2006)	November/December 2006	Vessel	Yes	1.7 (0.82)	5	0
	Small-Vessel Tag/Biopsy/Photo-ID (Aug 2007)	August 2007	Vessel	Yes	1.9 (0.93)	5	0
	Small-Vessel Tag/Biopsy/Photo-ID (Apr/May 2008)	April/May 2008	Vessel	Yes	2.0 (1.07)	5	0
	Small-Vessel Tag/Biopsy/Photo-ID (Jun/Jul 2008)	June/July 2008	Vessel	Yes	2.1 (1.07)	6	0
	Small-Vessel Tag/Biopsy/Photo-ID (Dec 2008)	December 2008	Vessel	Yes	1.8 (0.86)	5	0
	Small-Vessel Tag/Biopsy/Photo-ID (Apr/May 2009)	April/May 2009	Vessel	Yes	2.1(1.03)	5	0
	Small-Vessel Tag/Biopsy/Photo-ID (Oct 2009)	October 2009	Vessel	Yes	2.0 (1.03)	5	0
	Small-Vessel Tag/Biopsy/Photo-ID (Dec 2009)	December 2009	Vessel	Yes	1.9 (0.89)	5	0
	Small-Vessel Tag/Biopsy/Photo-ID (Apr 2010)	April 2010	Vessel	Yes	2.2 (0.90)	5	0
	Small-Vessel Tag/Biopsy/Photo-ID (Jul/Aug 2010)	July/August 2010	Vessel	Yes	2.2 (0.70)	4	1
	Small-Vessel Tag/Biopsy/Photo-ID (Oct 2010)	October 2010	Vessel	Yes	2.5 (1.02)	5	0
	Small-Vessel Tag/Biopsy/Photo-ID (Dec 2010)	December 2010	Vessel	Yes	1.9(0.92)	5	0
	Small-Vessel Tag/Biopsy/Photo-ID (May 2011)	May 2011	Vessel	Yes	2.0 (0.94)	5	0
	Small-Vessel Tag/Biopsy/Photo-ID (Aug/Sep 2011)	August/September 2011	Vessel	Yes	2.1 (0.62)	4	0
	Small-Vessel Tag/Biopsy/Photo-ID (Oct/Nov 2011)	October/November 2011	Vessel	Yes	1.8 (0.95)	6	0
	Small-Vessel Tag/Biopsy/Photo-ID (Jan 2012)	January 2012	Vessel	Yes	2.8 (1.13)	5	0
	Small-Vessel Tag/Biopsy/Photo-ID (May 2012)	May 2012	Vessel	Yes	2.0 (0.93)	5	0
	Small-Vessel Tag/Biopsy/Photo-ID (Jun/Jul 2012)	June/July 2012	Vessel	Yes	2.5 (0.84)	4	0
Major Training Events (MTEs)							
Koa Kai	Monitoring during Koa Kai	November 2010	Vessel	No	3.2 (1.44)	7	1

Survey Type	Survey Title	Survey Timeframe	Monitoring Platform	Dedicated Platform?	BSS[1]		
					Mean (SD)	Max	Min
	Monitoring during Koa Kai	November 2010	Aerial	Yes	3.0 (0.87)	5	1
RIMPAC Aerial and Vessel Surveys	Monitoring during RIMPAC 2006	July 2006	Aerial	Yes	3.8 (1.58)	6	0
	Monitoring during RIMPAC 2008	July 2008	Vessel	No	4.1 (1.43)	7	1
	Monitoring during RIMPAC 2008	July 2008	Aerial	Yes	3.9 (1.49)	7	1
	Monitoring during RIMPAC 2010	July 2010	Vessel	No	N/A	N/A	N/A
USWEX Surveys[3]	Monitoring during USWEX	November 2007	Aerial	Yes	3.8 (1.22)	6	1
	Monitoring during USWEX	November 2007	Vessel	Yes	N/A	N/A	N/A
	Monitoring during USWEX	May/June 2008	Vessel	No	4.3 (1.18)	6	2
	Lookout Effectiveness Study SCC & USWEX	February 2011	Vessel	No	4.1 (1.26)	6	1
	Monitoring during USWEX	February/March 2011	Aerial	Yes	2.8 (0.86)	5	2
Non-Major Training Events							
LOE Study Surveys	Lookout Effectiveness Study	February 2009	Vessel	No	5.2 (0.67)	6	4
	Lookout Effectiveness Study - SCC	February 2010	Vessel	No	3.0 (1.63)	7	0
	Lookout Effectiveness Study - Koa Kai	November 2010	Vessel	No	N/A	N/A	N/A
	Lookout Effectiveness Study - Koa Kai	November 2011	Vessel	No	3.7 (1.61)	6	1
	Lookout Effectiveness Study - SCC	February 2012	Vessel	No	4.2 (1.47)	6	1
SCC Surveys[3]	Monitoring during SCC	August 2008	Aerial	Yes	5.0 (1.36)	7	0
	Monitoring during SCC	February 2009	Aerial	Yes	N/A	N/A	N/A
	Monitoring during SCC	August 2009	Aerial	Yes	4.9 (1.32)	6	1
	Monitoring during SCC	February 2010	Aerial	Yes	4.6 (1.41)	6	1
	Monitoring during SCC & USWEX	February 2011	Aerial	Yes	4.5 (1.20)	6	2
	Monitoring during SCC	February 2012	Aerial	Yes	4.7 (1.60)	7	2
SINKEX 2010 Survey	Monitoring during SINKEX	July 2010	Vessel	Yes	N/A	N/A	N/A
ULT Surveys	Monitoring during ULT at Puuloa Underwater Range	June 2009	Aerial	Yes	5.1(1.55)	7	2
UNDET Surveys	Monitoring during UNDET at Puuloa Underwater Range	June 2009	Aerial	Yes	5.1(0.89)	6	3
	Monitoring during UNDET at Puuloa Underwater Range	October 2011	Vessel	Yes	2.4 (1.18)	4	1

Notes:
[1] N/A=BSS data was unavailable for some surveys
[2] Two types of vessels were used on the same survey
[3] Includes one joint USWEX/SCC Survey
Key:
LOE = Lookout Effectiveness
M3R = Marine Mammal Monitoring
MTE = Major Training Event
RIMPAC = Rim of the Pacific
SCC Submarine Commander's Course
SINKEX = Sinking Exercise
ULT = Unit Level Training
UNDET = Underwater Detonation
USWEX = Undersea Warfare Exercise

Kaula Island Aerial and Vessel Surveys. There were five vessel-based surveys and one aerial survey conducted by the U.S. Navy for marine mammals, sea turtles, and seabirds at Kaula Island, with additional effort at Kauai and Niihau. Kaula Island survey efforts occurred in June 2010, February 2011, June 2011 and July 2012 (**Table 1**). As noted by Uyeyama (2011), the July 2009 vessel survey had no Global Positioning System positions of the ship tracks or sightings, and therefore was not included in the HRC monitoring survey database.

Marine Mammal Monitoring on Navy Ranges (M3R) Tagging Survey. A small-vessel rigid-hulled inflatable boat (RHIB) survey was conducted during July and August 2011 on and near the Pacific Missile Range Facility (PMRF) offshore of Kauai in conjunction with an SCC (**Table 1**). The primary goals were to: (1) validate species identifications by the Marine Mammal Monitoring on Navy Ranges (M3R) hydrophone array, and (2) deploy satellite tags in order to provide more data on residency patterns, habitat use, and movement patterns by toothed whales in the western half of the HRC, where naval activities are concentrated and little information is available for marine mammal usage of the area (Baird et al. 2012a). Sightings data (but no tagging data) are presented in this report.

PMRF Vessel and Tagging Survey. Vessel-based effort was conducted during January 2012 in waters west of Kauai off the PMRF (HDR 2012). Effort was conducted from the U.S. Ship *Sioux*. The goals of the survey were to: (1) validate species identifications by the M3R hydrophone array, (2) deploy satellite tags from a second vessel, a RHIB, in order to provide more data on residency patterns, habitat use, and movement patterns by toothed whales in the western half of the HRC, where naval activities are concentrated and little information is available for marine mammal usage of the area (Baird et al. 2012b), and (3) conduct a pilot acoustic study via deployment of sonobuoys. Sightings data (but no tagging data) are included in this report.

Pearl Harbor Entrance Channel and Kaneohe Bay Sea Turtle Surveys. The U.S. Navy conducts natural resources assessments as part of the Integrated Natural Resources Management Plan for Pearl Harbor. As a result, the U.S. Navy has a data set of in-water surveys for marine resources, including sea turtles. The Pacific Navy Marine Species Density Database contains data for sea turtles from 2000 to 2011 (Hanser et al. 2012). Included in this report are data from 12 April 2011, 10 and 16 May 2011, and May 2012 (**Table 1**).

Small-Vessel Tag/Biopsy/Photo-Identification Surveys. RHIBs were used to conduct vessel surveys in the western MHI to examine spatial use and residency patterns of odontocetes (toothed whales) in the HRC using satellite tags, as well as obtain individual identification photographs and biopsy samples for assessment of population identity and structure (Baird et al. 2012a,b). Sightings data from surveys conducted from 2006 to 2012 are included in this report (**Table 1**). All monitoring was conducted from a separate, dedicated survey-vessel.

2.1.2 Monitoring During Major Training Events (MTEs)

MTEs typically involve numerous participants, last multiple days, and are conducted over large areas. In general, these exercises include ASW training (when MFAS is deployed).

Koa Kai. Koa Kai is a semi-annual exercise held in HRC waters, and is designed to prepare independent deployers in multiple warfare areas and provide training in a multi-ship environment. Both aerial and vessel survey data from a Koa Kai event (November 2010) are included in this report.

Rim of the Pacific (RIMPAC). RIMPAC is held biennially during June and July of even-numbered years. In 2006, surveys for marine mammals were performed on dates corresponding with scheduled dates for "choke point" (i.e., narrow passage) maneuvers of the RIMPAC exercises. Surveys were conducted in the vicinity of the Kaulakahi Channel (between Kauai and Niihau) and the Alenuihaha Channel (between the islands of Hawaii and Maui) (Rivers 2006). RIMPAC 2006 was the first U.S. Navy training activity utilizing MFAS to receive an LOA and an ITS. Sighting data from surveys conducted in association with RIMPAC 2006, 2008 and 2010 are summarized in this report (**Table 1**).

Undersea Warfare Exercise (USWEX). USWEX is an advanced ASW exercise conducted by U.S. Navy Carrier Strike Groups and Expeditionary Strike Groups. There are four USWEX events included in this report: November 2007 (aerial and vessel), May/June 2008 (vessel), February 2011 (aerial), and one vessel survey during a joint SCC-USWEX event in February/March 2011 (**Table 1**).

2.1.3 Monitoring During Non-MTEs

Lookout Effectiveness (LOE). Studies of the effectiveness of U.S. Navy lookouts were conducted using U.S. Navy Marine Mammal Observers (MMOs) to collect data that characterize the likelihood of detecting marine species from a U.S. Navy warship. Data from five cruises using U.S. Navy MMOs are included in this report: February 2009, February 2010 (SCC), November 2010 (Koa Kai), November 2011 (Koa Kai), and February 2012 (SCC and an unspecified training exercise).

Submarine Commanders Course (SCC). SCCs are multi-unit events that are required to provide the necessary training to prospective submarine commanders in rigorous and realistic scenarios involving ASW. The SCC area includes the PMRF off Kauai and Niihau. Aerial monitoring effort and sightings from six SCC events are included in this report: SCC August 2008, SCC February 2009, SCC August 2009, SCC February 2010, SCC February 2011, and SCC February 2012.

Sinking Exercise (SINKEX). In a SINKEX event, a vessel that is no longer sea-worthy (vessel "hulk") is used as a target and intentionally sunk during the course of the exercise. The hulk ship is towed to a designated location where various platforms use multiple types of weapons to fire shots at the hulk. Platforms may include air, surface, and subsurface elements, and weapons may include missiles, precision and non-precision bombs, gunfire, and torpedoes. If none of these test shots succeed in sinking the hulk, either a submarine shot or placed explosive charges are used to sink the ship. Data included in this report was collected by MMOs for two SINKEX events during RIMPAC 2010. A total of three SINKEXs were performed during RIMPAC 2010. However, marine mammal and sea turtle monitoring surveys were conducted during only the first and the third events.

Unit Level Training (ULT). ULT typically involves a single platform (e.g., surface ship), is of short duration (e.g., 1 to 5 hours), is conducted in a relatively small area, and focuses on a specific issue. One ULT is included in this report; during June 2009, aerial monitoring was conducted for a ULT Assessment Certification event that assessed a ship's ability to conduct drills, which include firefighting, anchoring, and defending the ship in simulated combat situations.

Underwater Detonations (UNDET). Underwater detonation exercises are designed to provide training in identifying and destroying or neutralizing inert ground mines, floating/moored mines, and possibly excess ship hulks. In the HRC, these events take place at various locations. Monitoring efforts for UNDET in this report were all performed on the Puuloa Underwater Range outside Pearl Harbor (Oahu). These include aerial monitoring during June 2009 and U.S. Navy MMO monitoring from vessels during October 2011.

Section 2.2 Survey Data Processing and Map Creation

Survey data, including sightings, vessel position, and environmental conditions for visual (aerial and vessel) surveys, were provided by multiple researchers and organizations. Survey data were collected using a variety of data logging software, including WinCruz (developed by Robert Holland at the NMFS Southwest Fisheries Science Center; *http://swfsc.noaa.gov/textblock.aspx?Division=PRD&Parent MenuId=147&id=1446*) and Whale Identification Logging and Display (WILD) geospatial mapping software (developed by the Space and Naval Warfare Systems Command; *http://sea-inc.net/2011/09/27/socal-brs-tools-wild-geospatial-mapping-software/*). Survey data files were imported into a web-based database created with Microsoft SharePoint collaboration software (2010 version) (**Figure 1**).

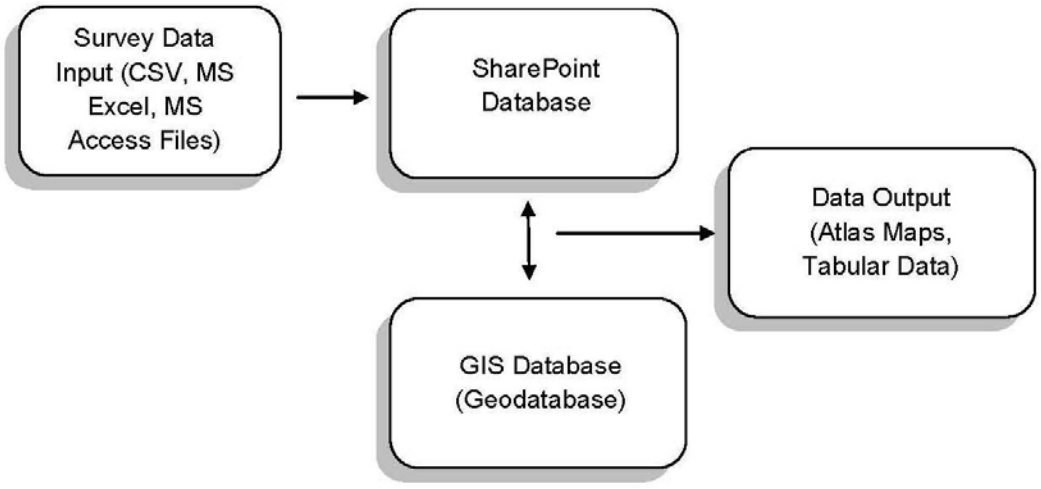

Figure 1. Data processing steps.

A collaborative SharePoint site was created to house all data in both unedited and modified forms. Each time new data files were received, they were uploaded to the SharePoint site in their raw format for archival purposes, as well as in formats that were more conducive to editing. The raw files were not edited during the data development process. In order to undergo editing, data files were "checked out" of the SharePoint site so that only one person at a time could edit a file. Once editing was complete, the file was "checked-in" to the SharePoint site, and people with appropriate privileges could then access the edited file. This procedure ensured file version control and effectively tracked edits as new data were received.

Data were compiled into a series of "key" files and cross-referenced against a standardized set of fields in a comprehensive database that incorporated all fields from all datasets. Where appropriate, fields were added that further standardized the data. To provide a link between sightings data and trackline data, a field called "SurveyLink" was created in the comprehensive sightings database that combined a unique Survey ID for each survey and the date of each

sighting. A four-letter species code was created for all sightings, which was made up of the first letter of the genus and the first three letters of the species (e.g., *Tursiops truncatus* = TTRU).

GIS data layers for species sightings and survey tracklines were created as part of the Atlas data development and mapping process. Survey data included surveys conducted by the U.S. Navy, HDR, and other U.S. Navy contractors and subcontractors. Once the data were consolidated from the original formats into a common format and table structure, a combination of processes was used to convert them to a GIS format. The species sightings locations were manipulated and stored in a tabular data format with all relevant attribute fields populated where the information was available. This table was imported into ArcGIS Desktop and the points were plotted using the Add XY function. The latitudes and longitudes were used as the location information for each point and a shapefile was created from the resulting plotted locations. The shapefile data layer was then loaded into a geodatabase and maps were created for specific species using the four-letter species codes. A high-resolution bathymetry shapefile was used to create all effort and sightings maps, and to provide maximum, minimum and mean depth data for all sightings and survey effort. This GIS data layer was created for use in the U.S. Navy's *Marine Resources Assessment for the Hawaiian Islands Operating Area* (DoN 2005), which summarizing marine resources data and information relevant to the HRC.

The survey trackline data were received in multiple data formats including *.csv, *xls/xlsx or *.mdb tabular format. The raw data included point locations along a survey track that marked where certain environmental elements of the survey changed. Each point location contained related environmental elements including BSS, cloud cover, and glare, among others. Sightings and trackline data were converted to GIS point and line layers, respectively, with all available attributes included.

The Points-to-Lines tool was used to create a single line that connected all of the points generated from the raw survey track data. The final output layer for each survey track contained all linear features and associated attributes for an individual day of a survey. This process was repeated for all survey days, the individual layers were combined, and the final data layer was stored in a personal geodatabase. Attribute fields were added to the final survey trackline data layer to store the SurveyLink and a unique Segment ID. A relationship class was built in the geodatabase using the SurveyLink field. This created a relationship between the species sightings points and the associated survey tracklines for use in a GIS desktop environment that allows users to use the Identify tool on a species sightings point and see the associated survey tracklines, and vice versa.

Once the GIS database was completed, two types of maps were created: (1) survey effort maps displaying comprehensive tracklines for all surveys (with available data) grouped by survey type, survey effort relative to BSS, and the bathymetry of the survey area; and (2) sighting maps with animal locations layered on top of the plotted survey effort. Sighting maps depict sightings of a particular species seen during multiple surveys. Tracklines were color-coded for BSS 0-7, except in those cases where BSS information was not available for a particular survey or survey segment; in these cases, the trackline was colored in gray. No survey data were available for BSS greater than 7, and sighting conditions in fact deteriorate quickly in conditions with BSS above 4 (see **Appendix B**). Sighting events are denoted by open circles, and larger circles represent larger group sizes, as indicated in each map legend. The survey tracks for the LOE Studies conducted on U.S. Navy vessels during ASW training events (see **Figure C-11**) are represented as lines drawn between ship positions filtered to approximately once every several hours so that

survey effort is generally represented, but the exact ship track is not. Frequently sighted species and sightings that occurred close together may not be clearly distinguishable because of overlapping circles. There is inevitably a tradeoff between clarity of map symbols and spatial resolution of sightings, and symbols indicating sighting locations may in some cases obscure other sightings, and cetacean sightings may appear to be on land (none were).

Section 2.3 Sighting Rate Analyses

Sighting rates, calculated as sightings of all species per kilometer (sightings/km) of survey effort, were compared by platform type as well as for dedicated *vs.* non-dedicated survey protocols. Dedicated platforms prioritize marine species data collection, whereas non-dedicated U.S. Navy platforms, [e.g. frigates, destroyers and cruisers] execute training missions, and marine species data are collected opportunistically. This approach allowed for comparisons among survey types and platforms, since each involve travel at different speeds for varying lengths of time per survey day.

In a separate analysis, sighting rates of humpback whales (*Megaptera novaeangliae*) were examined in relation to survey platform and sea state. HRC monitoring data collected over a 7-year period (2005 to 2012) representing 93 survey days (shipboard and aerial platforms combined) were considered for suitability to investigate the relationship amongst BSS, survey platform type, and sighting rate (individuals/km surveyed). The following questions were posed: (1) "Does sighting rate vary by survey platform?" and (2) "Is there a relationship between BSS and sighting rate?" An independent samples t-test was performed to examine differences in sighting rate relative to survey platform, and a bivariate correlation was run using International Business Machines Statistical Package for the Social Sciences (Version 19) to examine the relationship between BSS and sighting rate. Only humpback whale sightings were included in the analysis for the following reasons: (1) no other taxon provided sufficient sample sizes to conduct the analysis; (2) the selection of a single species reduces the confounding influence of body size on sighting probabilities, and (3) the relatively large body size and salient characteristics of this species might reasonably serve as a proxy when estimating sightability of other baleen whale species. Other frequently sighted species, such as short-finned pilot whales (*Globicephala macrorynchus*) and pantropical spotted dolphins (*Stenella attenuata*), could conceivably be pooled in a sighting rate analysis in order to increase sample size. However, this option was ruled out because inclusion of these species would introduce issues of body size heterogeneity and differences in sighting cues, and possibly confound results. Effort and sightings from November through April were included in the analysis, which corresponds to the period of seasonal residency of humpback whales in the HRC. The dataset was reduced to 44 survey days (19 aerial, 25 vessel) after eliminating days where one or more of the three variables in question was missing from the dataset. Certain surveys prioritized tagging and biopsy of toothed whales, and therefore, humpback whale presence was not recorded. These surveys were excluded from the analysis. For each of the 44 survey days, sighting rate was calculated based on total individuals seen per km surveyed. See **Section 3.3** for results of sighting rate analyses.

Since observers' ability to make accurate marine species sightings from aircraft decreases with increasing altitude, all effort above 3,000 feet (ft) (914 meters [m]) was excluded from survey effort maps, sighting maps, and related sighting rate analyses (J. Mobley, University of Hawaii, pers. comm.). In any case, no marine species sightings were made from above this altitude for

any survey. Likewise, only effort from November through April was included in the humpback whale sighting map and related sighting rate analyses (J. Mobley, University of Hawaii, pers. comm.). Not all monitoring effort involved dedicated survey platforms (**Table 1, Figure 2**). For example, U.S. Navy MMOs collected marine species sighting data, but these vessels did not follow typical survey protocols and traveled at speeds >10 knots (Watwood et al. 2012a,b). U.S. Navy vessels used for training exercises prioritize the training mission, and MMOs do not have control over the speed or direction of the vessel. Since the data on non-dedicated surveys is collected in a substantially different manner than that on dedicated survey platforms, sighting rates were calculated separately for each type of survey protocol.

Section 3 Results

3.1 Survey Effort

A total of 58 U.S. Navy monitoring surveys performed in the HRC from 2005 to 2012 are described in this report (**Table 1, Appendix A**) Maps displaying these monitoring efforts are organized by survey type (**Table 1**) and are found in **Appendix C**. Sea state conditions during all surveys, when recorded, ranged from 0 to 7, with an overall mean ($\bar{X}$) BSS of 3.6 (SD = 1.65) (**Table 1**). Survey effort is presented by sea state in four classes (BSS 0-2, 3-4, 5-7, and not recorded). Monitoring surveys that occurred during MTEs or non-MTE training events were, in some cases, performed from both aerial and vessel platforms. Four of the 15 survey types employed line-transect methodology: USWEX, RIMPAC, SCC, and ULT. Data from the same area and season in multiple years are available from the Pearl Harbor Sea Turtle, Kaula Island Vessel, RIMPAC, Small-Vessel Tag/Biopsy/photo-identification (Photo-ID) Surveys, and SCC surveys.

3.1.1 Pilot/Baseline Monitoring

Deepwater Cetacean Survey. In February 2005, a vessel survey was conducted offshore of Oahu and Kauai, with focused effort in the Kaulakahi Channel between Kauai and Niihau (Cetos 2005; **Figure C-1**). Bottom depths during the survey ranged from <100 to 3,200 m. BSS data were not available for this survey.

Vessel Survey at Alenuihaha Channel and the Island of Hawaii. In January and February 2007, a vessel survey was conducted in the Alenuihaha Channel and along the northeastern and eastern portions of waters off the Island of Hawaii (see **Figure C-2**). As described in **Section 2.1**, the surveys were to be performed in conjunction with an ASW exercise, which was cancelled. However, marine species surveys continued. Bottom depths during the survey ranged from <100 to 2,800 m. BSS data were not available for this survey.

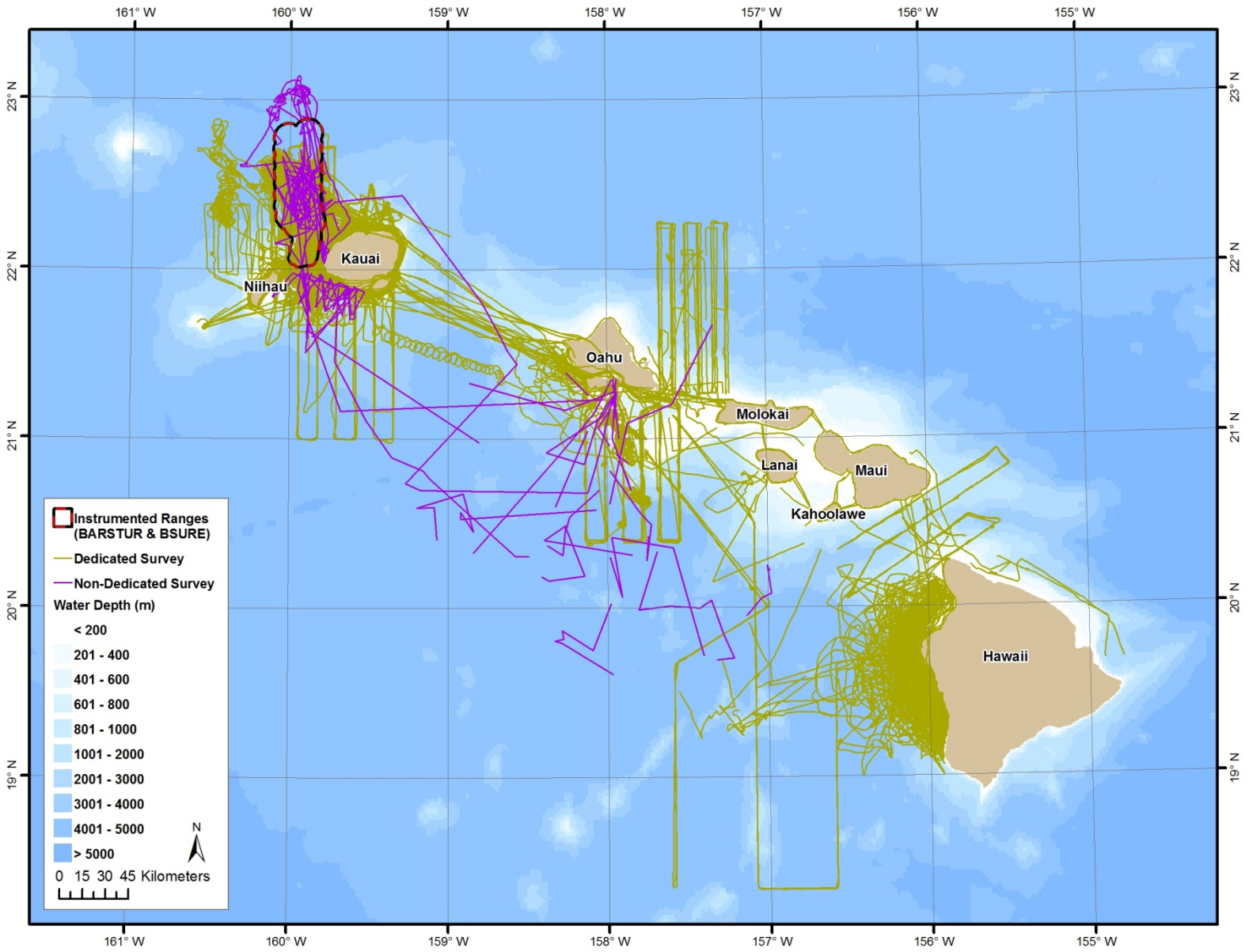

Figure 2. Dedicated *vs.* non-dedicated monitoring efforts.

Kaula Island Vessel Surveys. Aerial and vessel surveys were conducted off Kaula Island in June 2010, February 2011, June 2011 and July 2012 (see **Figure C-3**). Surveys employed a combination of line-transect and opportunistic methods, and were conducted in/over waters with bottom depths <100 to 3,200 m. Survey platforms transited past Kauai and Niihau and made circumnavigations of Kaula. In February 2011, the waters north of Kauai were also surveyed. BSS ranged from 1 to 7 for these surveys ($\bar{X}$ = 3.2, standard deviation [SD] = 1.20, **Table 1**).

Marine Mammal Monitoring on Navy Ranges (M3R) Tagging Survey. Satellite-tagging and photo-identification surveys were conducted using a small vessel off Kauai in July and August 2011 (see **Figure C-4**). Tagging surveys were opportunistic in nature and did not follow standardized tracklines. Surveys were conducted in waters with bottom depths <100 to 2,500 m. Effort was concentrated to the west of Kauai. Survey effort was conducted in BSS 0-6 ($\bar{X}$ = 2.5, SD = 0.99, **Table 1**).

PMRF Vessel and Tagging Survey. In January 2012, a vessel survey was conducted off Kauai (**Figure C-5**), with surveys primarily focused on the PMRF. Bottom depths for the survey ranged from 250 to 3,000 m. BSS was 1-6 for these surveys ($\bar{X}$ = 4.02, SD = 1.33, **Table 1**)

Pearl Harbor Entrance Channel and Kaneohe Bay Sea Turtle Surveys. Diver surveys were conducted in coastal waters off Oahu in April and May 2011 and in May 2012 (see **Figure C-6**). Surveys were conducted within 10 km of shore in waters over bottom depths <100 m. Dives were conducted to the south of Oahu off Pearl Harbor, and at U.S. Marine Corps Base Kaneohe on the eastern shore of Oahu. Surveys were opportunistic in nature and did not follow standardized tracklines. Surveys were conducted in BSS 1-4 ($\bar{X}$ = 2.7, SD = 1.10); on one day, BSS was not recorded (**Table 1**). BSS is also of interest for underwater surveys, because sea conditions can affect visibility (and therefore, turtle sightability) *via* turbidity (i.e., light penetration of the water surface and the amount of particulates in the water column).

Small-Vessel Tag/Biopsy/Photo-Identification Surveys. Small-vessel tag/biopsy/photo-ID surveys were conducted in March and April 2006, July 2006, November and December 2006, August 2007, April and May 2008, June and July 2008, December 2008, April and May 2009, October 2009, December 2009, April 2010, July and August 2010, October 2010, December 2010, May 2011, August and September 2011, October and November 2011, January 2012, May 2012, and June and July 2012 off the western MHI (see **Figure C-7**). Surveys were conducted in waters with bottom depths <100 to 4,800 m. The majority of the survey efforts were conducted off Oahu and Kauai, and concentrated in the HRC. Sea state conditions for these surveys ranged from BSS 0 to 6 ($\bar{X}$ = 2.0, SD = 0.95, **Table 1**).

3.1.2 Monitoring During MTEs

Koa Kai Surveys. Aerial and vessel surveys were conducted in November 2010 (see **Figure** C-8). Surveys were conducted in waters with bottom depths <100 to 4,800 m. A portion of survey effort concentrated on scanning island shorelines for stranded animals, and surveys did not follow standardized tracklines. Effort was concentrated along the shorelines of Maui, Kahoolawe, Lanai, and Molokai; the northwestern shoreline of the Island of Hawaii; the southeastern shoreline of Oahu; and deep water areas south of Oahu and west of the Island of Hawaii. LOEs were also conducted on U.S. Navy platforms during these exercises. Sea state conditions for these surveys ranged from BSS 1 to 7 ($\bar{X}$ = 3.0, SD = 0.93, **Table 1**).

Rim of the Pacific (RIMPAC) Aerial and Vessel Surveys. Vessel and aerial surveys were conducted off Oahu, Niihau, and Kauai in July 2006, July 2008, and July 2010, and followed standardized tracklines (see **Figure C-9**). Surveys were conducted in waters with bottom depths <100 to 4,800 m. Effort was concentrated to the northwest of Oahu, south of Kauai, and in waters surrounding Niihau and Kauai. Sea state conditions for RIMPAC surveys ranged from 0 to 7 ($\bar{X}$ = 4.0, SD = 1.50, **Table 1**).

Undersea Warfare Exercise (USWEX) Surveys. Aerial and vessel line-transect surveys were conducted off the islands of Hawaii, Kahoolawe, Lanai, Oahu, and Kauai in November 2007, May and June 2008, and February and March 2011 (see **Figure C-10**). LOE studies were also conducted from U.S. Navy vessels during some of these exercises. Effort was concentrated to the west of the islands of Hawaii, Kahoolawe, and Lanai; to the east and southwest of Oahu; and to the south of Kauai. Surveys were conducted in BSS 1-6 ($\bar{X}$ = 3.0, SD = 1.09, **Table 1**) and over waters with bottom depths <100 to 5,000 m.

3.1.3 Monitoring During Non-MTEs

Lookout Effectiveness (LOE) Study Surveys. LOE studies were conducted using naval vessels off Kauai and Oahu in conjunction with U.S. Navy training exercises in the months of February 2009, February and November 2010 November 2011, and February 2012 (see **Figure C-11**). U.S. Navy MMOs were stationed aboard naval vessels that deployed MFAS during the course of these exercises. Data was recorded opportunistically while the vessel was underway, and surveys therefore, did not follow standardized tracklines. Surveys were conducted in waters with bottom depths <1,000 to 4,900 m. Effort was concentrated to the northwest of Kauai and to the south of Oahu. Conditions for LOE Study surveys ranged from BSS 0 to 7 ($\bar{X}$ = 3.6, SD = 1.66, **Table 1**).

Submarine Commander Course (SCC) Surveys. Aerial surveys were conducted in August 2008, February and August 2009, February 2010, February 2011, and February 2012 off Oahu, Niihau, and Kauai (see **Figure C-12**). Aerial monitoring involved two methods: (1) line-transects, and (2) circling in front of the naval vessel as it transited using MFAS. This results in the "corkscrew" appearance of some aerial tracklines. Surveys were conducted in and over waters with bottom depths <100 to 5,000 m. The majority of survey efforts were conducted northwest and southwest of Kauai, and concentrated on the PMRF. LOE studies were also conducted from U.S. Navy platforms during SCCs. BSS conditions ranged from 0 to 7 for these surveys ($\bar{X}$ = 4.7, SD = 1.44, **Table 1**).

Sinking Exercise (SINKEX) 2010 Surveys. Aerial surveys were conducted during two SINKEX events on 10 and 17 July 2010 off northwest Kauai (see **Figure C-13**) and were considered opportunistic, because they did not use a dedicated survey platform. Aerial surveys were conducted from a helicopter at altitudes of 90 to 3,048 m[1] and in waters with bottom depths <100 to 5,000 m. BSS data was not available for these surveys, and no sightings occurred.

Unit Level Training (ULT) Surveys. Aerial surveys were performed in conjunction with a ULT event off Oahu in June 2009 (see **Figure C-14**). The ULT involved a naval vessel that was utilizing MFAS. A fixed-wing survey aircraft tracked the vessel while it was underway. Post-ULT line transect surveys were performed in both inshore and offshore areas after the

[1] Note: Only survey effort at or below 3,000 ft [914 m] is included in relevant maps and analyses for this survey.

vessel had returned to port. Monitoring techniques involved a combination of line-transect methods (post-ULT) and circling of transiting naval vessels (during ULT). Surveys were conducted over waters with bottoms depths ranging from <100 to 4,800 m. Sea state conditions for the ULT survey ranged from BSS 2 to 7 ($\bar{X}$ = 5.1, SD = 1.55, **Table 1**)

Underwater Detonation (UNDET) Surveys. Monitoring during UNDET events was conducted from a helicopter in June 2009 and from a small vessel in October 2011, south of Oahu. All surveys followed line-transect methodology (see **Figure C-15**). Surveys were conducted at the mouth of Pearl Harbor and off the south shore of Oahu, in and over waters with bottom depths <100 m. Sea state conditions for UNDET surveys ranged from BSS 1 to 6 ($\bar{X}$ = 3.1, SD = 1.61, **Table 1**).

3.2 Marine Mammal and Sea Turtle Species

Twenty-seven marine mammal and five sea turtle species have documented occurrence in the Hawaiian Islands (DoN 2005). From the compiled U.S. Navy monitoring data sets covering the period from 2005 to 2012, 88 percent (*n* = 2,560) of a total of 2,898 sightings were identified to species (23 marine mammal and one sea turtle species, see **Table 2**)**.** Sightings for each of these 24 species are presented in **Appendix D**. Of the 2,560 sightings identified to species-group and associated with BSS, 85 percent (*n* = 2,182) were made in BSS ≤4, and 75 percent (*n*=1,917) were made in BSS ≤3 (**Table 2**). **Table 2** includes two beaked whale classifications that were not identified to the species level (unidentified beaked whale, and unidentified *Mesoplodon* sp. [*n*=9 sightings]).

Each species map in **Appendix D** displays survey tracklines and sighting locations, and therefore, shows surveyed areas where no sightings were recorded. Species' sightings trends portrayed in **Appendix D** may be due to survey design and implementation, and do not necessarily indicate biologically significant patterns in habitat use. It should also be noted that sightings information, including BSS, bottom depth, and group size, reflect surveys currently available in the HRC monitoring survey database, and may not accurately reflect a species' occurrence, habitat preferences, etc.

Thirty-seven percent (*n* = 947) of the 2,560 confirmed species sightings were of the humpback whale, while the green turtle (*Chelonia mydas*) accounted for 5 percent (*n* = 133). The short-finned pilot whale (*n* = 390; 15 percent), pantropical spotted dolphin (*n* = 246; 10 percent), rough-toothed dolphin (*Steno bredanensis*) (*n* = 201; 8 percent), spinner dolphin (*Stenella longirostris*) (*n* = 156; 6 percent), and bottlenose dolphin (*Tursiops truncatus*) (*n* = 123; 5 percent) were also frequently recorded. There was a total of 93 beaked whale sightings, with 5 sightings (63 percent) identified as the Blainville's beaked whale (*Mesoplodon densirostris*). The Bryde's whale (*Balaenoptera edeni*), pygmy sperm whale (*Kogia breviceps*), killer whale (*Orcinus orca*), and Cuvier's beaked whale (*Ziphius cavirostris*) were each identified only once.

Table 2. Summary of sea state conditions during HRC monitoring surveys.

Scientific Name	Common Name	BSS			Number of Sightings per BSS Level									# of Animals [2]	# of Sightings (# of sightings group size based on)	Group Size [3]			Depth Range (m)
		Mean (SD)	Min	Max	0	1	2	3	4	5	6	7	N/A [1]			Mean (SD)	Max	Min	
Balaenoptera acutorostrata	minke whale	2.8 (0.50)	2	3	0	0	1	3	0	0	0	0	1	6	5 (5)	1.2 (0.45)	2	1	300-3,400
Balaenoptera borealis	sei whale	3.0 (1.00)	2	4	0	0	1	1	1	0	0	0	0	5	3 (3)	1.7 (1.15)	3	1	3,100 - 4,500
Balaenoptera edeni	Bryde's whale	3.0	3	3	0	0	0	1	0	0	0	0	0	1	1 (1)	1.0	1	1	3,400
Chelonia mydas	Green turtle	3.3 (1.46)	1	6	0	8	44	28	18	18	13	0	4	206	133 (133)	1.5 (1.58)	14	1	<100-350
Feresa attenuata	pygmy killer whale	1.9 (0.98)	1	5	0	13	10	7	0	1	0	0	0	101	31 (6)	16.8 (6.62)	25	5	100-2,900
Globicephala macrorhynchus	short-finned pilot whale	1.8 (0.95)	0	5	12	149	144	60	17	4	0	0	4	665	390 (38)	17.2 (15.00)	64	1	<100-4,500
Grampus griseus	Risso's dolphin	3.0 (1.60)	1	6	0	1	3	1	2	0	1	0	0	54	8 (3)	18.0 (19.16)	40	5	<100-4,700
Kogia breviceps	pygmy sperm whale	1.0 (0.82)	0	2	1	2	1	0	0	0	0	0	0	1	4 (1)	1.0	1	1	1,100 - 3,900
Kogia sima	dwarf sperm whale	1.4 (0.75)	0	4	3	32	19	3	1	0	0	0	0	1	58 (1)	1.0	1	1	100-4,700
Lagenodelphis hosei	Fraser's dolphin	1.5 (0.71)	1	2	0	1	1	0	0	0	0	0	0	N/A	2 (0)	N/A	N/A	N/A	1,300 - 2,300
Megaptera novaeangliae	humpback whale	3.4 (1.33)	0	7	5	22	230	210	176	168	48	3	85	1594	947 (947)	1.7 (0.93)	9	1	<100-4,800
Monachus schauinslandi	Hawaiian monk seal	2.7 (1.03)	1	6	0	1	20	13	4	2	1	0	0	58	41 (41)	1.4 (0.89)	5	1	<100-800

Scientific Name	Common Name	BSS			Number of Sightings per BSS Level									# of [2] Animals	# of Sightings (# of sightings group size based on)	Group Size[3]			Depth Range (m)
		Mean (SD)	Min	Max	0	1	2	3	4	5	6	7	N/A[1]			Mean (SD)	Max	Min	
Orcinus orca	killer whale	3.0	3	3	0	0	0	1	0	0	0	0	0	4	1 (1)	4.0	4	4	1,600
Peponocephala electra	melon-headed whale	1.8 (0.69)	0	3	1	8	19	4	0	0	0	0	0	1	32 (1)	1.0	1	1	200-4,000
Physeter macrocephalus	sperm whale	2.5 (1.58)	0	6	2	5	9	4	2	3	1	0	0	5	26 (5)	1.0	1	1	800-4,600
Pseudorca crassidens	false killer whale	2.2 (0.85)	1	4	0	7	18	10	3	0	0	0	0	81	38 (9)	9.0 (9.19)	28	1	<100-4,800
Stenella attenuata	pantropical spotted dolphin	1.8 (0.80)	0	5	5	88	116	30	5	1	0	0	1	1045	246 (20)	52.3 (45.59)	170	1	<100-4,800
Steno bredanensis	rough-toothed dolphin	1.8 (0.81)	0	6	2	51	93	41	7	4	1	0	2	611	201 (63)	9.4 (13.19)	85	1	250-4,700
Stenella coeruleoalba	striped dolphin	2.3 (1.17)	0	4	1	9	16	3	1	0	0	0	0	199	30 (6)	33.2 (27.49)	75	9	1,000 - 4,800
Stenella longirostris	spinner dolphin	2.1 (0.95)	0	6	1	40	60	31	13	3	4	0	4	2688	156 (71)	38.1 (29.3)	122	1	<100-3,000
Tursiops truncatus	bottlenose dolphin	2.4 (1.25)	0	6	1	25	56	21	12	4	4	0	0	489	123 (39)	11.8 (31.02)	200	1	<100-4,300
<u>All beaked whales</u>		1.6 (0.95)	0	6	4	45	32	7	3	0	1	0	1	35	93 (15)	2.3 (1.65)	6	1	350-4,600
Unidentified beaked whale species		2.3 (1.21)	1	4	0	2	1	2	1	0	0	0	1	8	7 (4)	2.0 (2.00)	5	1	1,000 - 4,600
Unidentified *Mesoplodon* sp.		2.5 (0.71)	2	3	0	0	1	1	0	0	0	0	0	4	2 (2)	2.0 (1.41)	3	1	1,500 - 3,700

Scientific Name	Common Name	BSS			Number of Sightings per BSS Level									# of [2] Animals	# of Sightings (# of sightings group size based on)	Group Size[3]			Depth Range (m)
		Mean (SD)	Min	Max	0	1	2	3	4	5	6	7	N/A[1]			Mean (SD)	Max	Min	
Mesoplodon densirostris	Blainville's beaked whale	1.6 (1.14)	0	6	3	16	13	2	1	0	1	0	0	19	36 (7)	2.5 (1.85)	6	1	350-3,900
Indopacetus pacificus	Longman's beaked whale	1.0	1	1	0	1	0	0	0	0	0	0	0	N/A	1 (0)	N/A	N/A	N/A	3,000
Ziphius cavirostris	Cuvier's beaked whale	1.5 (0.72)	0	4	1	26	17	2	1	0	0	0	0	4	47 (2)	2.0 (1.41)	3	1	600-3,400

Notes:

[1] N/A = Beaufort sea state (BSS) data was unavailable for some sightings

[2] Number of animals summed only for sightings for which group size was available

[3] Averages computed only over sightings for which group size was available. N/A = Group size data was unavailable for some sightings

In terms of numbers of individuals, 7,842 animals were confirmed to species (or in the case of the beaked whales, to Generic level, or as unidentified beaked whale); 97 percent (n = 7,644) of animals identified to species were marine mammals; while 3 percent (n = 206) were green turtles. The spinner dolphin was the most frequently sighted marine mammal species (34 percent; n = 2,688). The total number of individuals above does not account for the surveys where the group size information was not included as part of the dataset. Of the 2,560 sightings included in this analysis, 1,160 (15 percent) did not include group size information. The total number of sightings with missing group size information per species is accounted for in the individual species sections below. Because group size information was not included for some sightings, the total number of individuals in **Table 2** may be less than the total number of sightings.

3.2.1 Marine Mammal Species

***Balaenoptera acutorostrata* (minke whale).** There were five confirmed sightings for a total of six minke whales; all sightings were during vessel-based surveys including the February 2005 Deepwater Cetacean Survey, February 2010 SCC LOE Survey, November 2010 Koa Kai, and the January 2012 PMRF Vessel and Tagging Survey (see **Figure D-1** and **Appendix A** Survey IDs: 1, 25, 33 and 52). Bottom depths for the sightings were 300 to 3,400 m, and sightings occurred at BSS 2 and BSS 3, respectively. There were three sightings of "unidentified small whales," each with one individual per sighting. These occurred during the 2007 USWEX, 2010 Koa Kai, and 2011 USWEX LOE surveys (see **Appendix A** Survey IDs: 8, 33, and 37). The notes for the sighting during the 2011 USWEX LOE survey indicate that this individual was a "possible minke" (Farak et al. 2011b). Rankin et al. (2007) noted that the lack of sightings of minke whales in the Hawaiian Islands may be due to misidentification (i.e., confusion with other balaenopterid species) and/or poor sighting conditions. Minke whale vocalizations have been detected at several locations near Kauai and Oahu during U.S. Navy monitoring efforts during winter months (Rankin et al. 2007, Martin et al. in press).

***Balaenoptera borealis* (sei whale).** There were three confirmed sighting of sei whales for a total of five individuals—all made from vessels (see **Figure D-2**). Two sightings were documented northeast of Oahu during the November 2007 USWEX survey effort, while the third was west of the Island of Hawaii during the November 2010 Koa Kai survey effort (see **Appendix A** Survey IDs: 9, 33 and 35). The 2007 sightings were also detailed by Smultea et al. (2010). Bottom depths for the sei whale sightings were from 3,100 to 4,500 m. Sightings were made during BSS 2-4. Smultea et al. (2010) noted that the lack of sightings of sei whales in the Hawaiian Islands may be due to misidentification (i.e., confusion with other balaenopterid species) and/or poor sighting conditions. Groups ranged in size from one to three individuals.

***Balaenoptera edeni* (Bryde's whale).** There was only one confirmed sighting of a Bryde's whale, which was recorded northeast of Oahu during a baseline vessel survey in November 2007 (see **Figure D-3** and **Appendix A** Survey ID: 6). This sighting was also detailed by Smultea et al. (2010). The solitary individual was observed for 50 minutes (Cetos 2007, Smultea et al. 2010). Bottom depth was approximately 3,400 m, and the sighting was made during BSS 3 (Cetos 2007, Smultea et al. 2010). Smultea et al. (2010) noted that the lack of sightings of Bryde's whale in the Hawaiian Islands may be due to misidentification (i.e., confusion with other balaenopterid species) and/or poor sighting conditions. There were five unidentified balaenopterid sightings on the February 2009 SCC Aerial Monitoring Survey, and two on the 2012 February LOE Study (Mobley et al. 2009, Watwood et al. 2012b).

Beaked whales. There were 93 beaked whale sightings for a total of 35 individuals, identified to species or genus (see **Figure D-4**). Of the 93 sightings, group size information was not available for this analysis for 78 sightings (84 percent), and are not included in the total of individuals. Two sightings were of *Mesoplodon* sp., 47 of the Cuvier's beaked whale (*Ziphius cavirostris*), 7 unidentified beaked whales, one of Longman's beaked whale (*Indopacetus pacificus*), and 36 of Blainville's beaked whale (*Mesoplodon densirostris*). Sightings were recorded during the February 2005 Deepwater Cetacean Survey, the August 2007 small-vessel surveys, July 2006 and 2008 RIMPAC aerial surveys, the 2007 USWEX aerial surveys, the November 2010 Koa Kai vessel survey, and January 2012 PMRF Vessel and Tagging Survey (see **Appendix A** Survey IDs: 1, 2, 4, 5, 6, 7, 9, 10, 12, 16, 14, 19, 23, 24, 27, 30, 32, 33, 36, 47, 44, 48, 52, 51, and 55). Sightings were made off Kauai, Niihau, and within the Kaulakahi Channel; northeast of Oahu; and west of Hawaii in waters over bottom depths 350 to 4,600 m. Group size ranged from one to six individuals during BSS 0-6. See write-ups for the *Ziphius cavirostris* (Cuvier's beaked whale), *Indopacetus pacificus* (Longman's beaked whale), and *Mesoplodon densirostris* (Blainville's beaked whale) for sightings identified to species, as well as unidentified *Mesoplodon* species.

***Globicephala macrorhynchus* (short-finned pilot whale).** There were 390 short-finned pilot whale sightings for a total of 665 individuals (see **Figure D-5**). Of the 390 sightings, group size information was not available for this analysis for 352 sightings (90 percent), and are not included in the total of individuals. These sightings were made off Kauai, Niihau, Oahu, and Lanai during the February 2005 Deepwater Cetacean Survey, 2007 vessel surveys, November 2007 and February 2011 USWEX aerial surveys, July 2008 RIMPAC aerial survey, February 2010 SCC aerial survey, July 2010 RIMPAC vessel survey, 2010 Koa Kai vessel survey, February 2011 vessel and aerial surveys, November 2011 and February 2012 LOE Study surveys, and January 2012 PMRF Vessel and Tagging Survey (see **Appendix A** Survey IDs: 1, 6, 8, 14, 26, 31, 33, 37, 39, 41, 42, 50, 52, and 53). The remaining sightings occurred during small-vessel tag, biopsy and photo-ID surveys from 2006 to 2012 (see **Appendix A** Survey IDs: 2, 3, 5, 7, 10, 12, 16, 19, 23, 24, 27, 30, 32, 36, 44, 47, 48, 51, 55, and 57) and included sightings throughout the HRC. Sightings were made in waters over bottom depths <100 to 4,500 m in BSS 0-5. Groups ranged in size from one to 64 individuals.

***Grampus griseus* (Risso's dolphin).** There were eight sightings of Risso's dolphins for a total of 54 individuals (see **Figure D-6**). Of the eight sightings, group size information was not available for this analysis for five sightings (63 percent), and are not included in the total of individuals. These sightings were centered generally around Oahu during the November 2007 USWEX vessel survey, June 2009 ULT aerial survey, and February 2011 LOE Study conducted during SCC and USWEX (see **Appendix A** Survey IDs: 9, 20 and 37). The remaining sightings occurred during small-vessel tag, biopsy and photo-ID surveys during 2008 and 2009 (see **Appendix A** Survey IDs: 10, 12, and 19) primarily off the west coast of Hawaii. Sightings were made in waters over bottom depths of <100 to 4,700 m in BSS 1-6. Groups ranged in size from 5 to 40 individuals.

***Megaptera novaeangliae* (humpback whale).** There were 947 humpback whale sightings for a total of 1,594 individuals (see **Figure D-7**). Humpbacks were recorded throughout the islands (with the exception of the island of Hawaii) with clustering around Kauai and Nihau, including within the Kaulakahi Channel; south of Oahu; and in the Kaiwi Channel (Molokai Channel between Oahu and Molokai) (see **Figure D-7**). Sightings occurred during the February 2005

Deepwater Cetacean Survey, the 2007 vessel surveys, 2007 vessel and 2011 aerial and vessel USWEX surveys, 2009 and 2010 SCC aerial surveys, the 2009, 2010, and 2012 LOE surveys, the 2010 Koa Kai aerial and vessel surveys, the 2011 Kaula aerial and vessel surveys, the February 2011 and 2012 SCC surveys, and the January 2012 PMRF Vessel and Tagging Survey (see **Appendix A** Survey IDs: 1, 6, 9, 17, 18, 25, 26, 33, 35, 37, 38, 39, 41, 52, 53, and 54) Group sizes ranged from one to nine individuals. Humpback whales were sighted in waters with bottom depths <100 to 4,800 m. Sixty-four humpback whale sightings (11 percent of total, *n*=107) were observed within the boundaries of the Hawaiian Islands Humpback Whale National Marine Sanctuary (see **Figure D-7**), defined by the 100 fathom (183 m) isobaths off portions of the MHI. This species was sighted during BSS 0-7 with 79 percent (*n*=450) of observations recorded in BSS 2-5 (**Table 2**). Mobley (2011) remarked on the doubling of this species' sighting rate during a 2011 aerial survey (0.04 sightings/km) when compared to the 2006 North Pacific Acoustic Laboratory aerial survey (0.02 sightings/km, Mobley 2011). This sighting rate further increased to 0.065 sightings/km during the February 2012 SCC aerial survey (Mobley and Pacini 2012). Of the 58 individual surveys identified in **Table 1**, humpback whales were sighted during 16 surveys (27.6 percent). These 16 surveys were included in the humpback whale sightings rate analysis (**Section 3.3**[2]) and in the humpback whale map (**Figure D-7**).

***Feresa attenuata* (pygmy killer whale).** There were 31 confirmed sightings of pygmy killer whales for a total of 101 individuals. Of the 31 sightings, group size information was not available for this analysis for 25 sightings (81 percent), and are not included in the total of individuals. A sighting was recorded during the 2007 vessel surveys as well as off the southwestern coast of Kauai during the August 2009 SCC event, while the other was of 20 individuals in deep waters off the western coast of the Island of Hawaii during the November 2010 Koa Kai event (see **Figure D-8**, and **Appendix A** Survey IDs: 6, 22, and 33). The remaining sightings occurred during small-vessel tag, biopsy and photo-ID surveys from 2006 to 2012 (see **Appendix A** Survey IDs: 2, 3, 5, 7, 10, 16, 19, 23, 27, 30, 32, 47, 48, and 55) off the west coasts of Hawaii and Oahu. Pygmy killer whales were sighted in waters with bottom depths from approximately 100 to 2,900 m. This species was sighted during BSS 1-5. Pygmy killer whales are often confused with melon-headed whales (*Peponocephala electra*) and false killer whales (*Pseudorca crassidens*) (Jefferson et al. 2008). Therefore, identification to species might account for the low number of confirmed sightings.

***Indopacetus pacificus* (Longman's beaked whale).** There was one confirmed sighting of Longman's beaked whale made during a small-vessel survey in August 2007 (see **Figure D-4** and **Appendix A** Survey ID: 7). However, the group size information for this sighting was not available for this analysis. This sighting was made off the Island of Hawaii in waters with a bottom depth of 3,000 m during BSS 1. The reader is referred to the "Beaked whales" section for a summary of all beaked whale sightings.

[2] Surveys not included in the analysis include: Kaula Island Surveys (June 2010, February and June 2011, and July 2012); LOE Study Surveys (November 2010, and 2011); M3R Tagging Survey (July/August 2011); RIMPAC Aerial and Vessel Surveys (July 2006, 2008, and 2010); SCC Surveys (August 2008, and 2009); Sea Turtle Survey (April/May 2011, and May 2012); Small Vessel Tag/Biopsy/Photo-ID surveys (March/April, July, and November/December 2006, August 2007, April/May, June/July, and December 2008, April/May, October, and December 2009, April, July/August, October, and December 2010, May, August/September, and October/November 2011, January, May, and June/July 2012); ULT Surveys (June 2009); UNDET Surveys (June 2009, October 2011); USWEX Surveys (November 2007, February/March 2011).

***Kogia breviceps* (pygmy sperm whale).** There were four confirmed sightings of pygmy sperm whales for a total of one individual (see **Figure D-9**). Of the four sightings, group size information was not available for this analysis for three sightings (75 percent), and are not included in the total of individuals. The one sighting that did include group size information was of a single individual. Sightings were made during the small-vessel surveys in August 2007, August 2011, May 2012, and during the November 2010 Koa Kai vessel survey (see **Appendix A** Survey IDs: 2, 3, 5, 7, 10, 12, 16, 19, 23, 24, 27, 30, 32, 36, 44, 47, 48, and 55). Pygmy sperm whales were sighted during BSS 0-2 in waters with bottom depths of 1,100 to 3,900 m off the west coast of Hawaii.

***Kogia sima* (dwarf sperm whale).** There were 58 confirmed sightings of dwarf sperm whales. Of the 58 sightings, group size information was not available for this analysis for 57 sightings (98 percent), and are not included in the total of individuals. The one sighting that did include group size information was of a single individual. The sightings occurred during small-vessel tag, biopsy and photo-ID surveys from 2006 to 2012 (see **Appendix A** Survey IDs: 2, 3, 5, 7, 10, 16, 19, 23, 27, 30, 32, 47, 48, and 55) (Baird 2005, 2012) (see **Figure D-10**). Dwarf sperm whales were sighted in waters with a bottom depth of 100 to 4,700 m during BSS 0-4 off the west coast of Hawaii with one sighting off the west coast of Oahu. ***Lagenodelphis hosei* (Fraser's dolphin).** There were two confirmed sightings of Fraser's dolphins during small-vessel tag/biopsy/photo-ID surveys in April 2008, and May 2012 (Baird unpublished data) (see **Figure D-11**). The group size information for these two sightings was not available. The sightings occurred during small-vessel tag, biopsy and photo-ID surveys during 2008 and 2012 (see **Appendix A** Survey IDs: 10 and 55). Fraser's dolphins were sighted in waters with a bottom depth of 1,300 to 2,300 m during BSS 1-2 off the west coast of Hawaii.

***Mesoplodon densirostris* (Blainville's beaked whale).** There were 36 confirmed sightings for a total of 19 Blainville's beaked whales during the July 2008 RIMPAC aerial survey and January 2012 PMRF Vessel and Tagging Survey (see **Figure D-4**). Of the 36 sightings, group size information was not available for this analysis for 29 sightings (81 percent), and are not included in the total of individuals. Sightings were made off the west side of Hawaii, Oahu, Kauai and Niihau in waters with bottom depths of 350 to 3,900 m. Group sizes ranged from one to six individuals sighted during BSS 0-6. There were two sightings for a total of four individuals identified to the genus *Mesoplodon*. One sighting of six animals was seen during the 2008 RIMPAC aerial survey, and four sighting of seven individuals was seen during the January 2012 PMRF Vessel and Tagging Survey (see **Appendix A** Survey IDs: 14 and 52). The remaining sightings occurred during small-vessel tag, biopsy and photo-ID surveys from 2006 to 2012 (see **Appendix A** Survey IDs: 2, 5, 7, 12, 19, 23, 24, 30, 32, 44, 47, 48, 51, and 55). Sightings were made in waters west and northwest of Kauai and west of Hawaii in waters with a bottom depth of 2,000 to 4,000 m during BSS 0-6. See also "Beaked whales" summary above.

***Monachus schauinslandi* (Hawaiian monk seal).** There were 41 sightings of Hawaiian monk seals for a total of 58 individuals on (or near) Kauai, Kaula, Niihau, Oahu, and Molokai (**Table 3** and see **Figure D-12**). Forty-seven (81 percent) individuals were seen during aerial surveys, and eleven (19 percent) during vessel surveys. Monk seals were most frequently observed at Niihau, possibly because of the relatively low level of disturbance at this location (NMFS 2007). Fifty-two (88 percent) individual seals were observed hauled out, and six (10 percent) were in the water. Sightings were reported during the 2007 USWEX aerial surveys, July 2008 and 2010 RIMPAC vessel surveys, August 2009 and February 2012 SCC aerial surveys, February and

June 2011, and July 2012 Kaula vessel surveys, October 2011 UNDET monitoring from vessels (see **Appendix A** Survey IDs; 8, 14, 22, 31, 39, 45, 49, 54, and 58). Sighted individuals were hauled-out, or in waters as deep as 800 m. Sightings were made during BSS 1-6. Group sizes ranged from one to five individuals.

Table 3. Hawaiian monk seal sightings among islands (2007-2012).

Location	Total # of Animals Observed	Total # of Groups	$\bar{X}$ Group Size (SD)
Kauai	11	10	1.1 (0.32)
Kaula	8	2	4.0 (1.41)
Molokai	2	1	2.0
Niihau	31	23	1.4 (0.78)
In-water	6	5	1.2 (0.45)
Total	**58**	**41**	**1.41**

***Orcinus orca* (killer whale).** There was one confirmed killer whale sighting, which was made off the west coast of Kauai during a July-August 2011 tagging and photo-ID effort (see **Figure D-13**, see **Appendix A** Survey ID: 46). The sighting was made in waters over a bottom depth of 1,600 m and during BSS 3. Group size was four individuals.

***Peponocephala electra* (melon-headed whale).** There were 32 confirmed melon-headed whale sightings (Aschettino et al. 2011; Baird et al. 2006; R. Baird, Cascadia Research Collective, pers. comm.). Of the 32 sightings, group size information was not available for this analysis for 31 sightings (97 percent). The one sighting that did include group size information was of a single individual. Sightings were made during small-vessel tag, biopsy and photo-ID surveys in March and April 2006, July 2006, April and May 2008, June and July 2008, December 2008, April and May 2009, October 2009, December 2009, April 2010, July and August 2010, October 2010, December 2010, August and September 2011, October and November 2011, and May 2012 (**Figure D-14** and see **Appendix A** Survey IDs: 2, 3, 10, 12, 16, 19, 23, 24, 27, 30, 32, 36, 47, 48, and 55). Melon-headed whales were sighted in waters with a bottom depth of 200 to 4,000 m during BSS 0-3 off the west coasts of Hawaii, Oahu and Kauai.

***Physeter macrocephalus* (sperm whale).** There were 26 confirmed sperm whale sightings for a total of five individuals during surveys from 2006 to 2012. Of the 26 sightings, group size information was not available for this analysis for 21 sightings (81 percent), and are not included in the total of individuals. Five confirmed sightings were noted off the west coast of Kauai during the January 2012 PMRF Vessel and Tagging Survey and another confirmed sperm whale sighting occurred during an LOE study in 2010 (see **Appendix A** Survey IDs: 25, and 52). The remaining sperm whale sightings occurred during small-vessel tag, biopsy and photo-ID surveys

during 2006, and from 2008 to 2011 (see **Figure D-**15, and see **Appendix A** Survey IDs: 2, 5, 10, 12, 16, 23, 24, 27, 30, 36, and 48). Farak et al. (2011b) noted a possible sperm whale sighting during the February 2011 LOE Study (SCC and USWEX) survey. Bottom depth for this sighting was between 800 and 4,600 m. BSS during this survey was often 3-5; the remaining sperm whale sightings were made during BSS 0-6 off the west coast of Hawaii. Cetos (2005) reported on an acoustic detection of this species in the same general area as the sightings mapped in **Figure D-15**. An additional sighting of a probable sperm whale was reported for the Alenuihaha Channel area by Cetos (2007).

***Pseudorca crassidens* (false killer whale).** There were 38 confirmed false killer whale sightings for a total of 81 false killer whales (see **Figure D-16**). Of the 38 sightings, group size information was not available for this analysis for 29 sightings (76 percent), and are not included in the total of individuals. Sightings occurred during the 2006 RIMPAC surveys, the 2007 vessel surveys, the August 2009 and February 2010 SCC surveys, June 2010 Kaula survey, and November 2010 Koa Kai aerial and vessel surveys (see **Appendix A** Survey IDs: 4, 6, 22, 26, 28, 33, and 35). The remaining sightings occurred during small-vessel tag, biopsy and photo-ID surveys from 2006 to 2012 (see **Appendix A** Survey IDs: 2, 5, 7, 10, 12, 16, 24, 30, 32, 36, 47, 48, and 57).This species was sighted during BSS 1-4 in waters with bottom depths of <100 to 4,800 m throughout the HRC. Group size ranged from 1 to 28 individuals.

***Stenella attenuata* (pantropical spotted dolphin).** There were 246 sightings for a total of 1,045 pantropical spotted dolphins. Of the 246 sightings, group size information was not available for this analysis for 226 sightings (92 percent), and are not included in the total of individuals. Sightings occurred throughout the HRC (see **Figure D-17**). Sightings were made during the July 2006 RIMPAC, June 2009 ULT aerial monitoring, August 2009 and February 2010 SCC surveys, November 2010 Koa Kai survey, November LOE Survey, and a July-August 2011 tagging and photo-ID survey (see **Appendix A** Survey IDs: 4, 20, 22, 26, 33, 34, and 46). The remaining sightings occurred during small-vessel tag, biopsy and photo-ID surveys from 2006 to 2012 (see **Appendix A** Survey IDs: 2, 3, 5, 7, 10, 12, 16, 19, 23, 24, 27, 30, 32, 36, 44, 47, 48, 55, and 57). Sightings were made during BSS 0-5 in waters with bottom depths <100 to 4,800 m. Group sizes ranged from 1 to 170 individuals.

***Stenella coeruleoalba* (striped dolphin).** There were 30 sightings of striped dolphins for a total of 199 individuals. Of the 30 sightings, group size information was not available for this analysis for 24 sightings (80 percent), and are not included in the total of individuals. Sightings were made off Kauai and Niihau, including within the Kaulakahi Channel; in the Kaieie Waho Channel (between Kauai and Oahu); west of Hawaii; and south of Oahu (see **Figure D-18**). Striped dolphins were recorded during the May-June 2008 and February 2011 USWEX vessel surveys, July 2008 RIMPAC aerial survey, June 2009 ULT aerial monitoring, February 2010 LOE Study survey, and February 2011 SCC aerial survey (see **Appendix A** Survey IDs: 11, 14, 20, 25, 26, and 37). The remaining sightings occurred during small-vessel tag, biopsy and photo-ID surveys from 2006 to 2012 (see **Appendix A** Survey IDs: 2, 3, 7, 10, 12, 16, 19, 27, 36, 44, 48, and 55). Sightings were made in BSS 0-4 in waters over bottom depths of 1,000 to 4,800 m. Group size ranged from 9 to 75 individuals.

***Stenella longirostris* (spinner dolphin).** There were 156 sightings of spinner dolphins for a total of 2688 individuals around all the islands in the HRC(see **Figure D-19**). Of the 156 sightings, group size information was not available for this analysis for 85 sightings (54 percent), and are

not included in the total of individuals. Sightings were made during the February 2005 Deepwater Cetacean Survey, November 2007, May-June 2008, and February 2011 USWEX vessel surveys, the November 2007, and February-March 2011 USWEX aerial surveys, the July 2008 Vessel surveys, the July 2008 and 2010 RIMPAC aerial surveys, August 2008 and 2009, and February 2010 and 2012 SCC aerial surveys, June 2010 ands 2011, and July 2012 Kaula surveys, November 2010 Koa Kai aerial survey, November 2010 LOE survey, April-May 2011 turtle surveys, the July-August 2011 tagging and photo-ID effort, and the January 2012 PMRF Vessel and Tagging Survey (see **Appendix A** Survey IDs: 1, 8, 9, 11, 13, 14, 15, 22, 26, 28, 31, 34, 35, 37, 41, 42, 43, 45, 46, 52, 54, and 58). The remaining sightings occurred during small-vessel tag, biopsy and photo-ID surveys from 2006 to 2012 (see **Appendix A** Survey IDs: 2, 3, 5, 7, 10, 12, 16, 19, 23, 24, 27, 30, 32, 36, 44, 47, 48, 51, 55, and 57). Sightings were made in waters with a bottom depth of <100 to 3,000 m in BSS 0-6. Sixty-seven percent of sightings (*n*=40) were made in BSS 2-3 (**Table 2**). Group size ranged from 1 to 122 individuals.

***Steno bredanensis* (rough-toothed dolphin).** There were 201 sightings for a total of 611 rough-toothed dolphins (see **Figure D-20**). Of the 201 sightings, group size information was not available for this analysis for 138 sightings (69 percent), and are not included in the total of individuals. Sightings primarily occurred to the west of Hawaii and in-between Kauai and Niihau, including within the Kaulakahi Channel, as well as sightings to the west and southwest of Oahu. Sightings occurred during the 2008 RIMPAC vessel and aerial surveys, and the 2010 RIMPAC vessel surveys, the August 2009 SCC aerial surveys, the June 2010, February 2011, and June 2011 Kaula surveys, the February 2010 and November 2011 LOE Study surveys, the November 2010 Koa Kai survey, the July-August 2011 satellite-tagging and photo-ID survey, and the January 2012 PMRF Vessel and Tagging Survey (see **Appendix A** Survey IDs: 13, 14, 22, 25, 28, 31, 33, 39, 40, 45, 46, 50, and 52). The remaining sightings occurred during small-vessel tag, biopsy and photo-ID surveys from 2006 to 2012 (see **Appendix A** Survey IDs: 2, 3, 5, 7, 10, 12, 16, 19, 23, 24, 27, 30, 32, 44, 47, 48, 51, 55, and 57). Sightings were made in waters over bottom depths of 250 to 4,700 m in BSS 0-6. Seventy-eight percent of sightings (*n*=45) were made in BSS 2-3 (**Table 2**). Groups ranged in size from one to 85 individuals.

***Tursiops truncatus* (bottlenose dolphin).** There were 123 sightings of bottlenose dolphins for a total of 489 individuals. Of the 123 sightings, group size information was not available for this analysis for 84 sightings (68 percent), and are not included in the total of individuals. The majority of sightings were off Hawaii, Kauai and Niihau, including within the Kaulakahi Channel; Oahu; and Molokai (see **Figure D-21**). Sightings were made during the 2006 and 2008 RIMPAC aerial surveys and the 2008 RIMPAC vessel Surveys, the 2007 vessel surveys, the 2007 and 2011 USWEX aerial surveys, the 2010 SCC aerial surveys, the June 2010, February 2011, and the July 2012 Kaula vessel surveys, 2010 Koa Kai aerial and vessel surveys, the July-August 2011 tagging and photo-ID effort, and the January 2012 PMRF Vessel and Tagging Survey (see **Appendix A** Survey IDs: 4, 6, 8, 13, 14, 26, 28, 33, 35, 39, 40, 42, 45, 46, 52, and 58). The remaining sightings occurred during small vessel tag, biopsy and photo-id surveys from 2006 to 2012 (see **Appendix A** Survey IDs: 2, 5, 7, 10, 12, 16, 19, 23, 24, 27, 30, 32, 36, 48, 51, 55, and 57). This species was sighted in waters with bottom depths <100 to 4,300 m. Sightings were made in BSS 0-6, with over 50 percent of sightings (*n*=19) made in BSS 2-3 (**Table 2**). Group sizes ranged from 1 to 200 individuals.

***Ziphius cavirostris* (Cuvier's beaked whale).** There were 47 confirmed sightings of Cuvier's beaked whales for a total of four individuals east of Kauai during the July 2008 RIMPAC aerial

survey (Mobley 2008c) (see **Figure D-4**). Of the 47 sightings, group size information was not available for this analysis for 45 sightings (96 percent), and are not included in the total of individuals. Sightings were made during the 2006 and 2008 RIMPAC aerial surveys (see **Appendix** A Survey IDs: 4 and 14). The remaining sightings occurred during small-vessel tag, biopsy and photo-ID surveys during 2006, and from 2008 to 2012 (see **Appendix A** Survey IDs: 2, 5, 10, 12, 16, 19, 23, 24, 27, 30, 36, 47, 48, and 55). The sightings were in waters over a bottom depth of 600 to 3,400 m during BSS 0-4 (see "Beaked whales" section for a summary of all beaked whale sightings) primarily around the islands of Hawaii, Kauai and Niihau, as well as the Alenuihaha channel. Group size ranged from one to three individuals.

3.2.2 Sea Turtle Species

***Chelonia mydas* (green turtle).** There were 133 sightings of 206 individual green turtles recorded during vessel, aerial, and in-water (diver) monitoring efforts. Sixty-eight sightings (n = 97 individuals) were made during aerial surveys, and 39 sightings (n = 52 individuals) were made during vessel surveys. Sightings were made during the 2007 and 2011 USWEX aerial surveys and the 2011 USWEX vessel survey, the June 2009 and October 2011 UNDET surveys, the November 2010 Koa Kai survey, the November 2010 LOE survey, the April-May 20ll and May 2012 Turtle surveys, and the February 2012 SCC aerial surveys (see **Appendix A** Survey IDs: 8, 21, 34, 37, 42, 43, 49, 54, and 56). Sightings occurred predominantly around Kauai, Oahu and Molokai, with a clustering at Pearl Harbor (see **Figure D-22**), reflecting the U.S. Navy's in-water monitoring effort in this area. Green turtles were seen during BSS 1-6, with a fairly even distribution of animals seen in all sea states (**Table 2**). Group sizes ranged from 1 to 14 individuals, and all sightings were made in waters with bottom depths between <100 and 350 m. No tea turtles of any species were observed in waters deeper than 350 m, from either aerial or vessel platforms.

3.3 Sighting Rates

Overall, sighting rates for all species on dedicated survey platforms were higher than on non-dedicated platforms (0.029 and 0.016 sightings/km, respectively). Sighting rates were also slightly higher on vessel platforms (0.033 sightings/km) than on aerial platforms (0.017 sightings/km). Sighting rates of humpback whales were examined in relation to platform and sea state. **Table 4** shows a summary of results by platform, and **Figure 3** shows the relationship of sighting rates and BSS.

Table 4. Descriptive summary of sighting rate by platform (aerial *vs.* vessel).

Platform Type	Total linear km surveyed	# Days	$\bar{X}$ BSS (SD)	Total # Individuals	Total # Sightings	Sighting Rate (Individuals/km) (SD)
Aerial	22,149	19	4.11 (1.35)	1016	610	0.0459 (0.0807)
Vessel	2,859	25	3.62 (1.37)	356	215	0.1245 (0.2388)

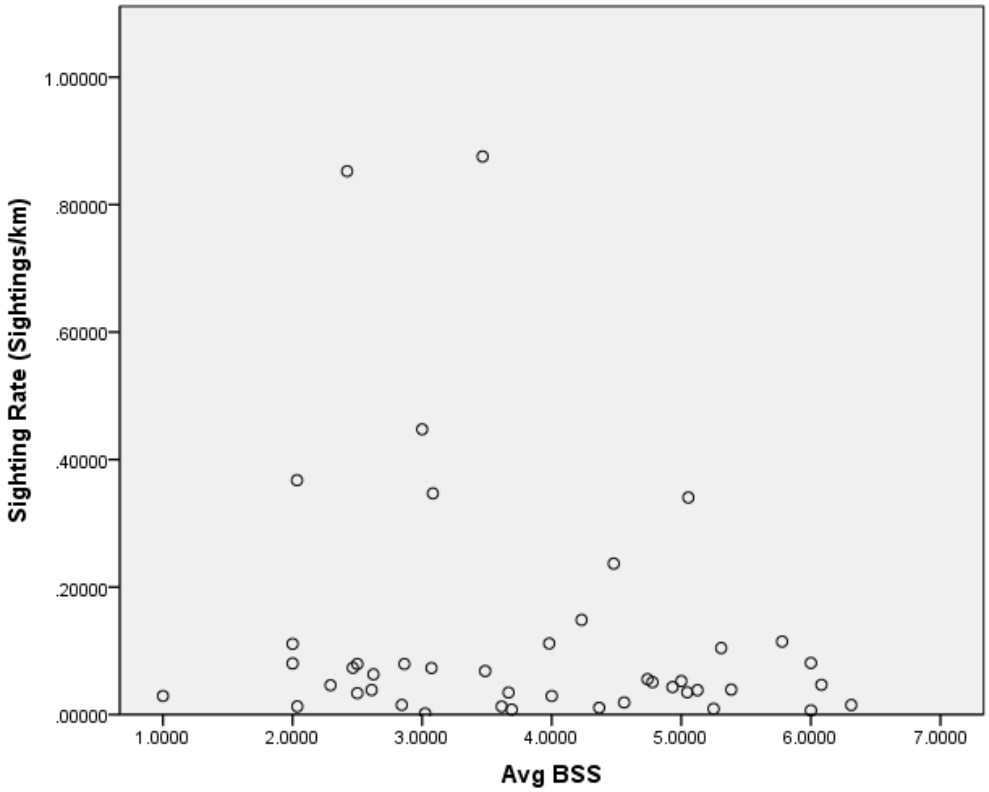

Figure 3. Relationship of sighting rate and BSS.

Question 1: "Does sighting rate vary by platform?" Mean sighting rates were significantly higher for shipboard relative to aerial surveys (**Table 4**) t (30.83) = 2.14, $p < 0.05$ (Note: since the result of Levene's test was significant, F = 9.08, $p < .05$, these results were adjusted for violation of the equal variances assumption). These results represent a moderate effect size (r_{pb} = 0.36). Since other variables that potentially affect sighting rates were not considered here (e.g., bottom depths surveyed, distance offshore, etc.), it is not clear whether this difference is due to the platform used or other sources.

Question #2: "Is there a relationship between Beaufort Sea State and sighting rate?" When sighting rate was plotted relative to sea state, there appeared to be a general trend for higher sighting rates to occur at lower BSS (**Figure 3**). However, correlation results indicated this relationship to be non-significant, r (42) = -0.19, $p > 0.05$. The lack of significance is likely due to the small sample size used here (n = 44), despite the focus on an abundant species. It is interesting to note from **Figure 3**, that sightings continued to occur even at the higher BSS (i.e., BSS 6). In general, calmer conditions were encountered close to shore and in the lee (west side) of the Island of Hawaii, since the prevailing winds in the Hawaiian Islands are generally northeasterly (**Figures 4a, 4b, and 4c**). However, during the 2007 Cetos survey, shifting wind conditions allowed the north and east sides of the Island of Hawaii to be surveyed (Cetos 2008). Likewise, unusual wind patterns during a tagging survey off Kaula in February 2011 allowed tagging effort to occur off the north side of Kauai, and the field team utilized the North shore

port of Hanalei rather than the more commonly used port to the southeast (Kikiaola) (Baird et al. 2012).

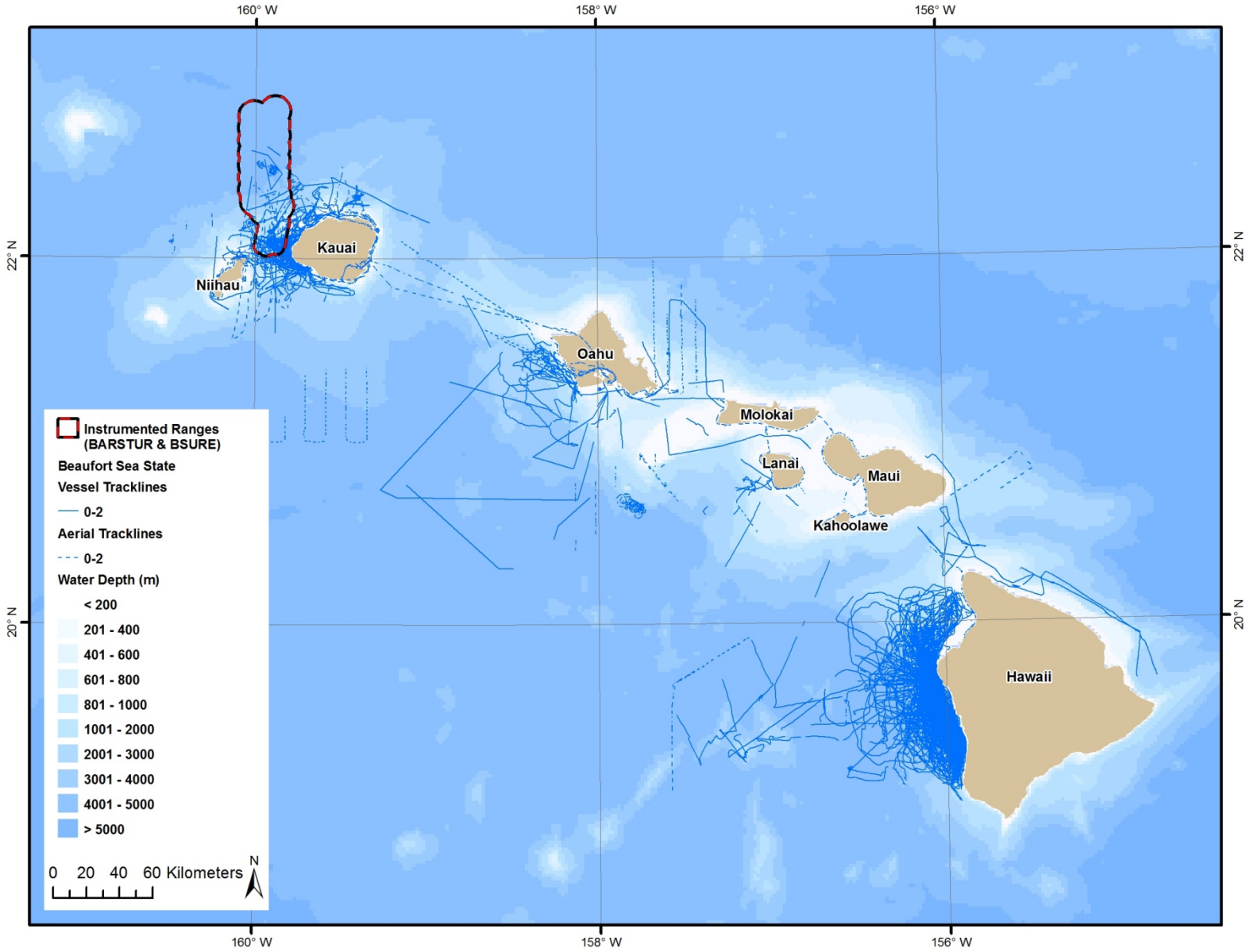

Figure 4a. All monitoring survey effort, BSS 0-2.

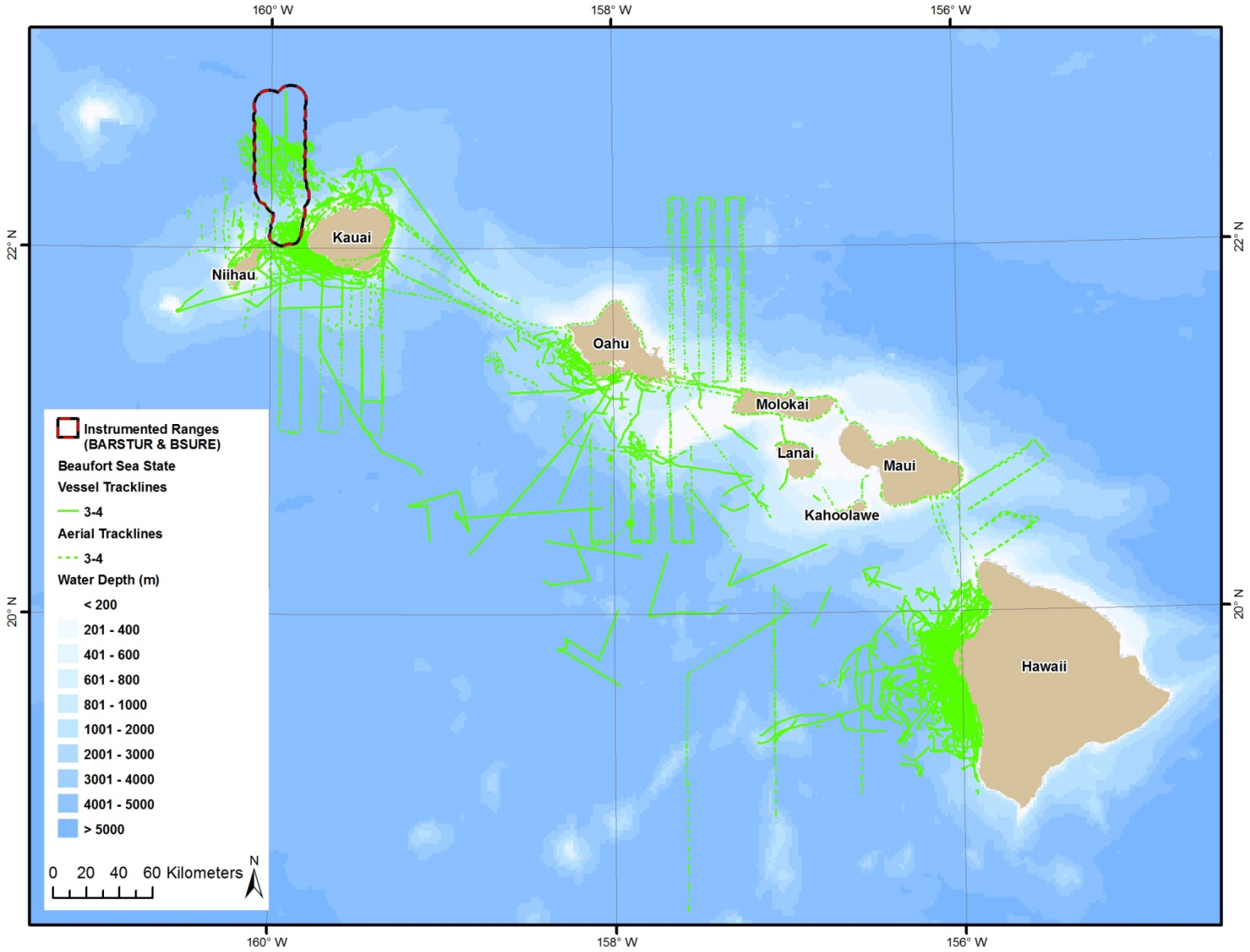

Figure 4b. All monitoring survey effort, BSS 3-4.

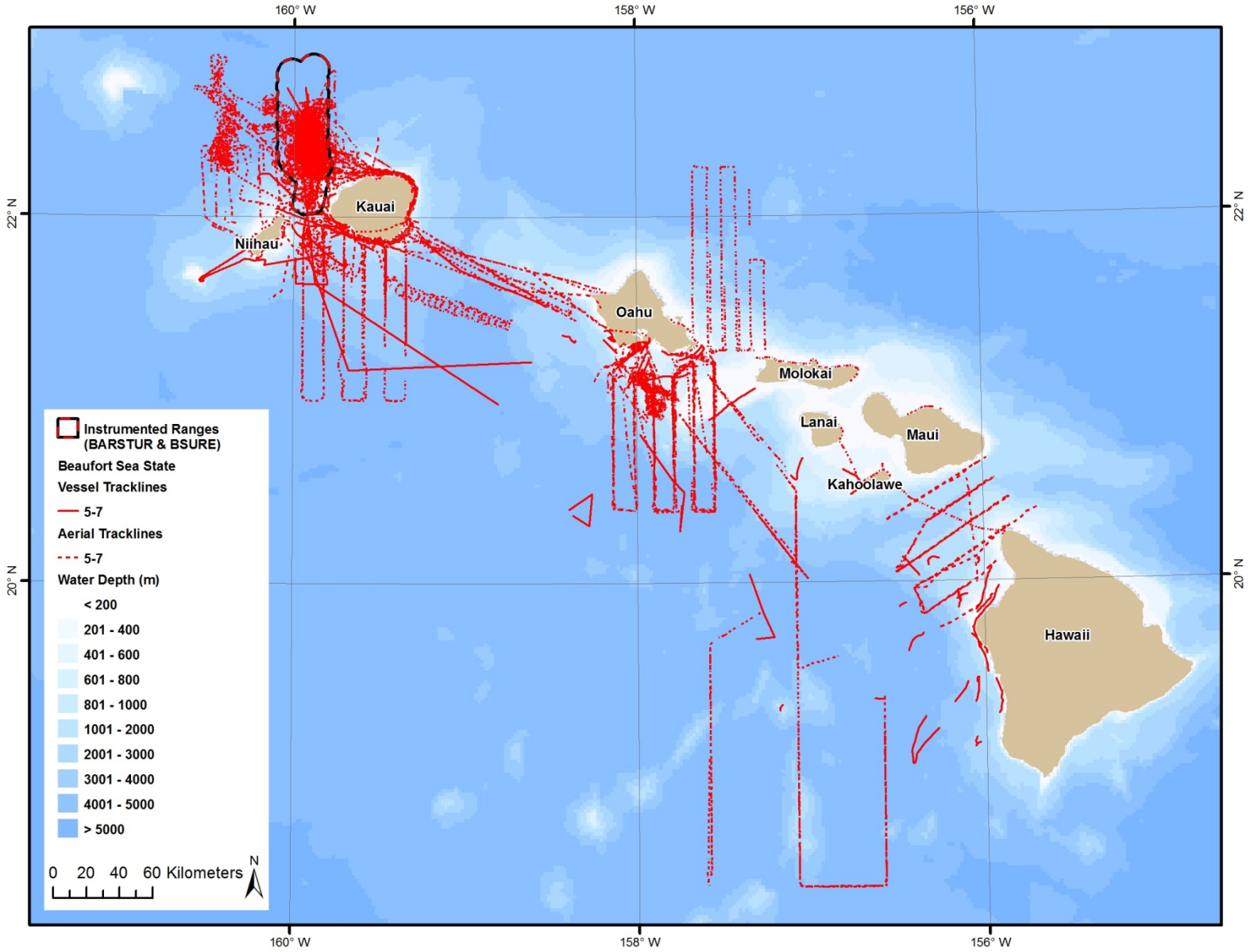

Figure 4c. All monitoring survey effort, BSS 5-7.

There were also several instances where sea state was unusually calm in far offshore areas. For example, an USWEX aerial survey encountered BSS conditions of 0-2 approximately 150 km south of the eastern tip of Oahu, and an USWEX vessel survey encountered similar conditions approximately 100 km southwest of Oahu (see **Figure C-10**). Likewise, an USWEX LOE cruise encountered consistent BSS conditions of <2 south and southwest of the Kaieie Waho Channel that separates Oahu and Kauai (see **Figure C-11**).

3.4 Marine Species Sightings on Instrumented Ranges

Three instrumented (hydrophone) ranges lie in the waters north of the Kaulakahi Channel, which separates Kauai and Niihau: (1) Barking Sands Tactical Underwater Range (BARSTUR) Hydrophones, (2) Barking Sands Underwater Range Expansion (BSURE) Hydrophones, and the (3) Shallow Water Training Range (SWTR). These ranges are known collectively as the PMRF. A portion of U.S. Navy training exercises involving MFAS in the HRC are frequently performed on these instrumented ranges, and therefore, animals present on these ranges may be exposed to MFAS and other U.S. Navy noise-generating activities on a regular basis. Typical usage of MFAS is highest on the BARSTUR range, and progressively less on the BSURE and SWTR ranges (S. Martin, Space and Naval Warfare Systems Center Pacific, pers. comm.).

From 2005 to 2012, a total of 367 sightings were made on the BARSTUR, BSURE and SWTR instrumented ranges (see **Appendix D**; note that although the SWTR range is not depicted on maps, species detected on SWTR are included in this data summary). In 2005, 55 percent of sightings (11 sightings) were of the humpback whale, followed by unidentified cetaceans (45 percent; nine sightings) (**Figure 5**). In 2006, the only marine species sighting on the PMRF was of a group of 14 pantropical spotted dolphins. There were no marine species sightings on the PMRF in 2007, and in 2008, there were two sightings of rough-toothed dolphins (**Figure 5**).

In 2009 and 2010, the majority of sightings were of humpback whales (73 percent in 2009, 11 sightings; 80 percent in 2010, 47 sightings). In 2011, 51 percent of sightings (32 sightings) were of rough-toothed dolphins. Only 14 percent of sightings (9 sightings) were of humpback whales. In 2012, the majority of sightings were of humpback whales (56 percent; 116 sightings), and 18 percent of sightings (37 sightings) were of rough-toothed dolphins (**Figure 5**). It should be noted that survey effort was not evenly distributed among years, and the increase in the number of sightings, individuals and number of species sighted over time is likely a function of increased survey effort in these years, rather than an underlying change in animal abundance or species richness.

Section 4 Discussion

Sighting distributions presented in this report are generated by survey efforts that may be unevenly distributed due to variation in survey goals and design. As such, only limited assessments can be made about animal abundance and habitat use from this information. Monitoring surveys in the HRC are conducted using a variety of platforms, designed for different objectives, and are employed using various data collection methods. Interpretation of compiled data is therefore challenging, since results cannot be easily compared across different surveys.

Figure 5. Percentage of species sightings by year on the PMRF.

It should also be noted that some sighting data may be biased by poor sea state conditions, and mismatches between species' seasonal occurrences and spatial and temporal patterns of naval monitoring efforts (for example, humpback whales are only seen November through April in the HRC [J. Mobley, University of Hawaii, pers. comm.]), when the species seasonally uses Hawaiian waters as a major breeding ground). Monitoring surveys that repeat similar effort in the same season and region across years, and follow standard line-transect methodology, will most likely yield the most reliable data for marine species abundance and density estimation (Kaschner et al. 2012).

Although fewer humpback whales were seen in higher sea states, this relationship was no statistically significant. It is possible that the high salience of the sighting cue of the humpback's blow may contribute to sightings at higher BSS, and therefore that the relationship between BSS and sighting rate of this species may be subtle. Sightability of smaller species with different sighting cues may decay more markedly with deteriorating sea conditions.

Figure 6 shows all monitoring survey effort currently in the HRC monitoring survey database. Although coverage is substantial around Kauai and off the west coast of the Island of Hawaii, there has been little offshore monitoring effort north of Oahu, off Molokai, Maui or Lanai, or north, east or south of the Island of Hawaii. The most heavily surveyed areas are the waters northwest and west of Kauai; the area of the PMRF; the waters south of Oahu; and those off the western coast of the Island of Hawaii.

Although the PMRF itself is well-sampled visually, other surrounding areas have never been surveyed or are rarely surveyed. These include the areas east of the range and north of Kauai; the areas west and southwest of the PMRF around Niihau; the area south of the Kaulakahi Channel (Kauai/Niihau channel); the deep waters around Kaula, southwest of the range; and waters around Middle Bank, northwest of the PMRF (**Figure 6**). As a consequence, it is difficult to draw conclusions about animal movements on and off the instrumented range in response to training exercises given existing visual survey monitoring data. For example, recent studies conducted in the Bahamas and off Southern California have shown that some beaked whales leave U.S. Navy training ranges during exercises involving MFAS, and that these animals return to the range when sonar activity ceased (McCarthy et al. 2011, Melcon et al. 2011, Tyack 2011, Southall et al. 2012, Tyack et al. 2011).

The majority of marine species sightings were made within 50 km from shore, in waters less than 1,000 m in depth and were clustered around Kauai, south of Oahu, and off the leeward side of the Island of Hawaii (**Figure 7**). Humpback whale and sea turtle sightings are called out in the figure, since sightings of these taxa were quite frequent. Distinguishing these species helps to highlight frequently sighted species, as well as the relative number of sightings of all other species. Note that the absence of humpback whale sightings on the leeward side of the Island of Hawaii is indicative of a lack of survey effort in this area, and does not necessarily mean that humpbacks are not present in this area. After spinner dolphins, the most commonly observed species was the humpback whale, followed by the pantropical spotted dolphin and short-finned pilot whale.

Confirmed sightings of rorquals (besides the humpback whale) during U.S. Navy monitoring efforts were the minke whale, sei whale, and Bryde's whale. No blue whales (*Balaenoptera musculus*) or fin whales (*Balaenoptera physalus*) were visually detected and confirmed to species. However, PAM data supports the use of this area (and central North Pacific) by fin whales at all times of the year and by blue whales in all seasons except summer, as modeled from acoustic detections (Hanser et al. 2012). Additionally, there are published sighting records for fin whales in Hawaiian waters: one north of Oahu during May 1976, one in the Kaieie Waho Channel (between Kauai and Oahu) during February 1979, one north of Kauai from February 1994 (DoN 2005), one stranded on Maui (Shallenberger 1981), one sighted north of Kauai during an aerial survey in 1996 (Mobley 1996), several offshore sightings during the 2002 Hawaiian Islands Cetacean Assessment Survey (Barlow 2006), and a single juvenile reported off Kauai in 2011 (DoN 2011).

Section 5 Acknowledgements

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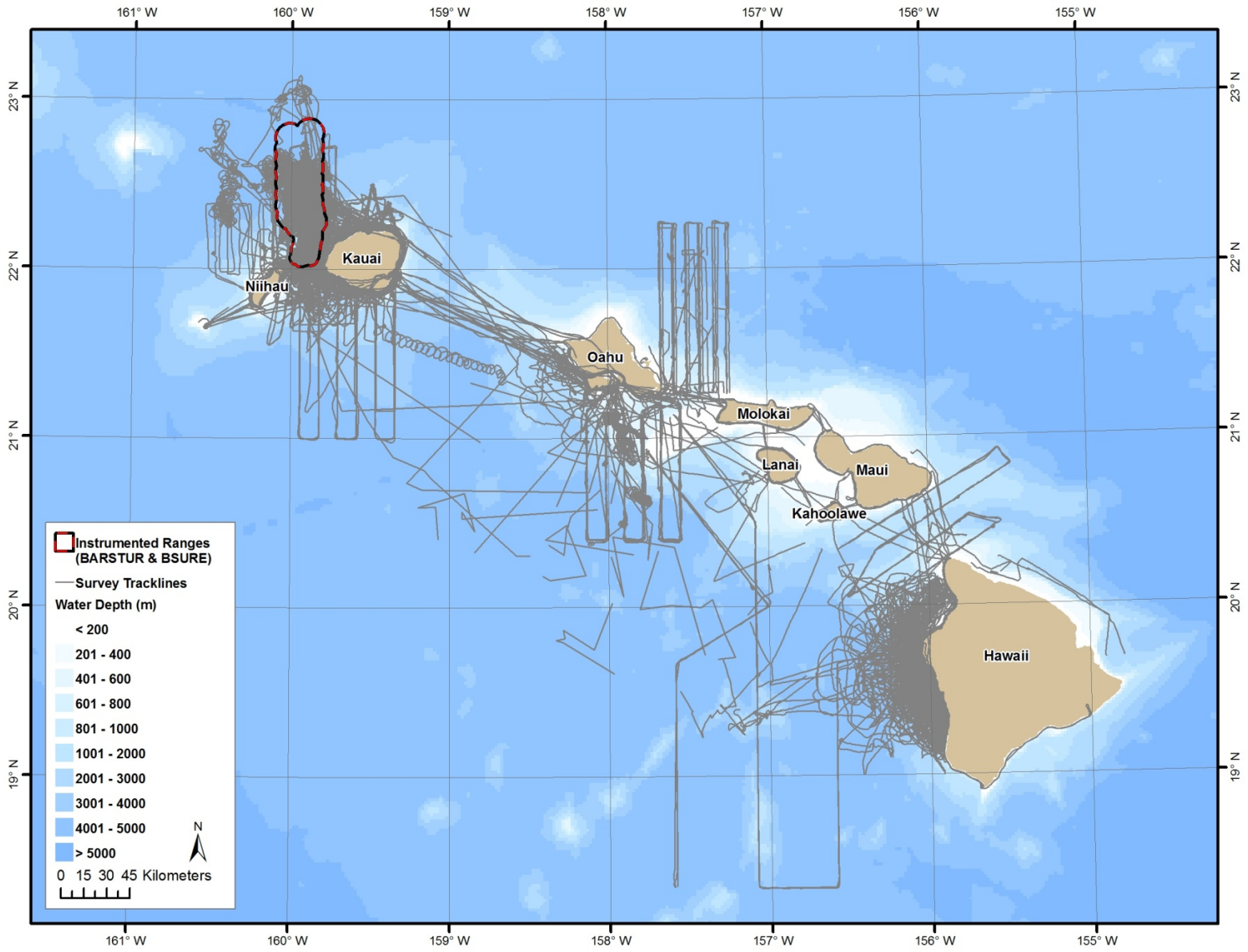

Figure 6. Total effort for vessel and aerial monitoring surveys in the HRC, 2005-2012.

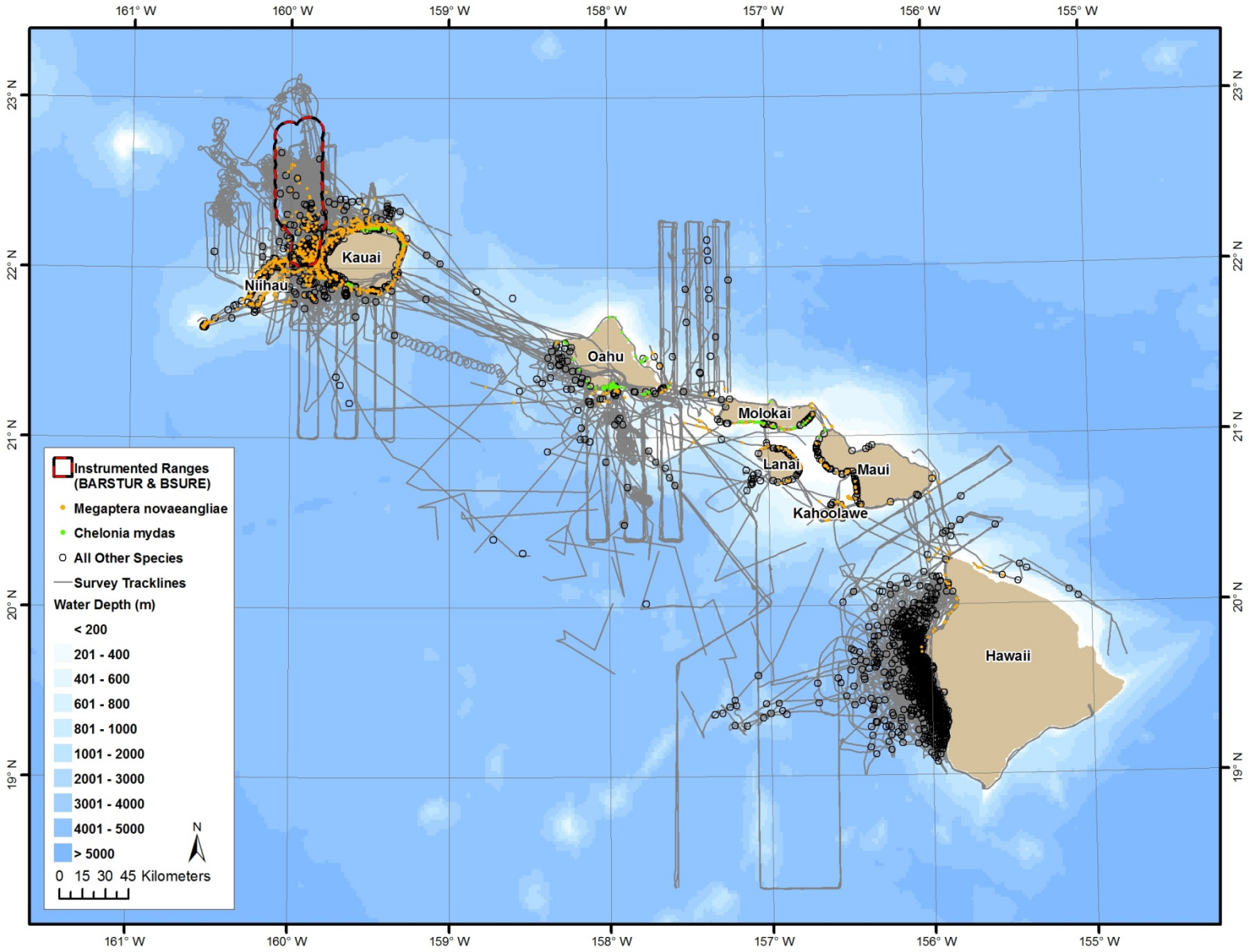

Figure 7. All sightings and effort from monitoring efforts in the HRC, 2005-2012.

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APPENDIX A

List of HRC Monitoring Efforts, 2005-2012

Note: see Literature cited section in the main body of this report for citations

Survey ID	Year	Survey Dates	Survey Title	Survey Platform	Survey Effort			Contract No.	Source	Survey Category
					Days	Hours[1]	NM of Trackline (km)			
1	2005	Feb 17-24	Deepwater Cetacean Survey	Vessel	8	30	316 (585.32)	Cetos/Geo-Marine, Contract #2057sa05-F	Cetos 2005†	Deepwater Cetacean Survey
2	2006	Mar 20-31; Apr 01-07, 09-10, 12-17, 19-23	Small-Vessel Tag/Biopsy/ Photo-ID (Mar-Apr 2006)[3]	Vessel	28	n/a	2192.75 (4,060.95	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
3	2006	Jul 16-25	Small-Vessel Tag/Biopsy/ Photo-ID (Jul 2006)[3]	Vessel	9	n/a	581.6 (1,077.23)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
4	2006	Jul 17, 20, 24-16	Monitoring during RIMPAC 2006	Aerial	6	18	1,728 (3,200.26)	MMRC, Contract #N62742-06-P-1887	Mobley 2006†	RIMPAC
5	2006	Nov 16-27, 29-30; Dec 03-11	Small-Vessel Tag/Biopsy/ Photo-ID (Nov & Dec 2006)[3]	Vessel	20	n/a	1,360.3 (2,519.08)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
6	2007	Jan 27-31; Feb 01-02	Vessel Survey at Alenuihaha Channel and the Island of Hawaii	Vessel	7	60.8	240 (444.48)	Cetos, Contract #N62742s-07-P-1895	Cetos. 2007†	Vessel Survey
7	2007	Aug 9-13, 15-23, 25-27	Small-Vessel Tag/Biopsy/ Photo-ID (Aug 2007)[3]	Vessel	14	n/a	1,140.43 (2,112.78)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
8	2007	Nov 11-12, 15-17	Monitoring during USWEX	Aerial	5	17.3	1,701 (3,150.25)	MMRC, Contract #N62742-07-P-1914	Mobley 2008a	USWEX
9	2007	Nov 11-17	Monitoring during USWEX	Vessel	7	66	492 (911.18)	Cetos, N62742-07-P-1915	Cetos 2008	USWEX
10	2008	Apr 18-22, 24-30; May 1-15	Small-Vessel Tag/Biopsy/ Photo-ID (Apr-May, 2008)[3]	Vessel	15	n/a	1,864.27 (3,452.63)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID

Survey ID	Year	Survey Dates	Survey Title	Survey Platform	Survey Effort			Contract No.	Source	Survey Category
					Days	Hours[1]	NM of Trackline (km)			
11	2008	May 26-27; Jun 02-04	Monitoring during USWEX	Aerial	5	20.4	n/a	MMRC, Contract #N62742-08-P-1933	Mobley 2008b	USWEX
12	2008	Jun 25-30; Jul 01-13, 15-22, 24-27	Small-Vessel Tag/Biopsy/ Photo-ID (Jun-Jul 2008)[3]	Vessel	28	n/a	1,818.91 (3,368.62)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
13	2008	Jul 12-17	Monitoring during RIMPAC 2008	Vessel	5	65	474 (877.84)	MMRC, Contract No. N62742-08-P-1934	Smultea 2008	RIMPAC
14	2008	Jul 13-17	Monitoring during RIMPAC 2008	Aerial	5	15.4	n/a	MMRC, Contract No. N62742-08-P-1935	Mobley 2008c	RIMPAC
15	2008	Aug 18-21	Monitoring during SCC	Aerial	4	28.5	n/a	MMRC, Contract No. N62742-09-P-1942	Smultea and Mobley 2009	SCC
16	2008	Dec 01-10, 13-15	Small-Vessel Tag/Biopsy/ Photo-ID (Dec 2008)[3]	Vessel	13	n/a	862.35 (1,597.07)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
17	2009	Feb 16-21	Monitoring during SCC	Aerial	5	27.3	n/a	SES & MMRC, Contract #N62742-09-P-1956	Smultea et al. 2009a	SCC
18	2009	Feb 19	Lookout Effectiveness Study	Vessel	1	n/a	226.8 (420.03)	n/a	Robert Uyeyama, pers. comm.	LOE
19	2009	Apr 19-30; May 01-07	Small-Vessel Tag/Biopsy/ Photo-ID (Apr-May, 2009)[3]	Vessel	18	n/a	1,208.78 (2,238.67)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
20	2009	Jun 17-18, 20-21, 23-25	Monitoring during ULT at Puuloa Underwater Range	Aerial	9	45	n/a	MMRC, Contract #28H-1087365	Mobley et al. 2009a	ULT
21	2009	Jun 19	Monitoring during UNDET at Puuloa Underwater Range	Aerial	9	45	n/a	MMRC, Contract #28H-1087365	Mobley et al. 2009a	UNDET

Survey ID	Year	Survey Dates	Survey Title	Survey Platform	Survey Effort			Contract No.	Source	Survey Category
					Days	Hours[1]	NM of Trackline (km)			
22	2009	Aug 26-30	Monitoring during SCC	Aerial	5	31.4	3,806 (7,048.71)	MMRC & SES, Contract #N62742-09-P-1966	Smultea et al. 2009b	SCC
23	2009	Oct 19-31	Small-Vessel Tag/Biopsy/ Photo-ID (Oct 2009)[3]	Vessel	12	n/a	888.31 (1,645.15)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
24	2009	Dec 08-21	Small-Vessel Tag/Biopsy/ Photo-ID (Dec 2009)[3]	Vessel	13	n/a	857.26 (1,587.51)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
25	2010	Feb 16-22	Lookout Effectiveness Study – SCC	Vessel	7	49.4	n/a	n/a	Farak et al, 2010	LOE
26	2010	Feb 16-21	Monitoring during SCC	Aerial	6	33	n/a	MMRC, Contract #N62742-08-P-1803	Mobley and Milette 2010	SCC
27	2010	Apr 8-22	Small-Vessel Tag/Biopsy/ Photo-ID (Apr 2010)[3]	Vessel	14	n/a	948.75 (1,756.94)	n/a	Robin Baird, pers. comm.	Small- Vessel Tag/Biopsy/Photo-ID
28	2010	Jun 26-28	Kaula Island Vessel Surveys	Vessel	3	n/a	n/a	n/a	Uyeyama and Hanser 2010a	Kaula Island
29	2010	Jul 10, 17	Monitoring during SINKEX	Aerial	2	27.5	n/a	n/a	Hanser and Uyeyama 2010	SINKEX
30	2010	Jul 17-24, 26-30; Aug 01-03, 05-14, 16-19, 21, 24	Small-Vessel Tag/Biopsy/ Photo-ID (Jul-Aug 2010)[3]	Vessel	28	n/a	1,649.03 (3,053.76)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
31	2010	Jul 18-25	Monitoring during RIMPAC 2010	Vessel	8	66	329 (609.31)	HDR, Contract #N62470-10-D-3011 CTO KB01	HDR 2010	RIMPAC
32	2010	Oct 10-11, 13-24	Small-Vessel Tag/Biopsy/ Photo-ID (Oct 2010)[3]	Vessel	9	n/a	825.18 (1,528.12)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
33	2010	Nov 11-23	Monitoring during Koa Kai	Vessel	12	95	607 (1,124.16)	HDR, Contract #N62470-10-D-3011 CTO KB05	HDR 2011	Koa Kai

Survey ID	Year	Survey Dates	Survey Title	Survey Platform	Survey Effort			Contract No.	Source	Survey Category
					Days	Hours[1]	NM of Trackline (km)			
34	2010	Nov 12-16	Lookout Effectiveness Study - Koa Kai	Vessel	5	35	n/a	n/a	Farak et al. 2011a	LOE
35	2010	Nov 18, 22	Monitoring during Koa Kai	Aerial	2	14	1,254 (2,322.41)	HDR, Contract #N62470-10-D-3011 CTO KB05	HDR 2011	Koa Kai
36	2010	Dec 05-09, 11-17	Small-Vessel Tag/Biopsy/ Photo-ID (Dec 2010)[3]	Vessel	10	n/a	911.38 (1,687.73)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
37	2011	Feb 15-22	Lookout Effectiveness Study SCC & USWEX	Vessel	8	60.5	n/a	n/a	Farak et al. 2011b	USWEX/SCC
38	2011	Feb 16-18	Monitoring during SCC & USWEX	Aerial	3	18.1	n/a	HDR, Contract # N62470-10-D-3011, CTO KB07	Mobley 2011	SCC
39	2011	Feb 16-20	Kaula Island Vessel Surveys *(M/V Searcher*)	Vessel	6	34.7	275 (509.3)	n/a	Richie and Fujimoto 2011	Kaula Island
40	2011	Feb 17-20	Kaula Island Vessel Surveys (RHIB)	Vessel (RHIB)	4	25.50	197 (364.84)	n/a	Richie and Fujimoto 2011	Kaula Island
41	2011	Feb 19	Kaula Island Aerial Surveys	Aerial	1	6.60	717 (1327.84)	n/a	Richie and Fujimoto 2011 (aerial also in Mobley 2011)	Kaula Island
42	2011	Feb 28; Mar 05	Monitoring during USWEX	Aerial	8	46	n/a	HDR, Contract #N62470-10-D-3011 CTO KB05	Mobley 2011	USWEX
43	2011	Apr 12, May 10, 16	Pearl Harbor Entrance Channel and Kaneohe Bay Sea Turtle Survey	Vessel/ Diver	3	n/a	50 (92.6)	n/a	R. Uyeyama, pers. comm.	PH & K-Bay Sea Turtle Follow
44	2011	May 06-15	Small-Vessel Tag/Biopsy/ Photo-ID (May 2011)[3]	Vessel	9	n/a	668.43 (1,237.83)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
45	2011	Jun 30	Kaula Island Vessel Surveys	Vessel	1	11.5	n/a	n/a	Uyeyama et al. 2011	Kaula Island

Survey ID	Year	Survey Dates	Survey Title	Survey Platform	Survey Effort			Contract No.	Source	Survey Category
					Days	Hours[1]	NM of Trackline (km)			
46	2011	Jul 21-31; Aug 01-08	Tagging Survey in the Western Main Hawaiian Islands	Vessel	18	118.8	1,065 (1,972.38)	CRC, Grant No. N00244-10-1-0048	Baird et al. 2012a	M3R Tagging Survey
47	2011	Aug 11-29; Sep 05	Small-Vessel Tag/Biopsy/ Photo-ID (Aug & Sep 2011)[3]	Vessel	19	n/a	959.39 (1,776.65)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
48	2011	Oct 18-31; Nov 01-13	Small-Vessel Tag/Biopsy/ Photo-ID (Oct-Nov 2011)	Vessel	26	n/a	2,064.48 (3,823.11)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
49	2011	Oct 19, 26	Monitoring during UNDET at Puuloa Underwater Range	Vessel	3	8.5	n/a	n/a	Uyeyama et al. 2012	UNDET
50	2011	Nov 10-17	Lookout Effectiveness Study - Koa Kai	Vessel	8	48	n/a	n/a	Watwood et al. 2012a	LOE
51	2012	Jan 10-11, 13-14, 18-19	Small-Vessel Tag/Biopsy/ Photo-ID (Jan, 2012)[3]	Vessel	9	96	718 (1,329.74)	HDR, ContractN62470-10-D-3011, CTO KB14	HDR 2012	Small-Vessel Tag/Biopsy/Photo-ID
52	2012	Jan 11-19	PMRF Vessel and Tagging Survey	Vessel	9	42.2	354 (655.61)	HDR, ContractN62470-10-D-3011, CTO KB14	Baird et al. 2012b†	January Large Vessel Survey
53	2012	Feb 13-17	Lookout Effectiveness Study – SCC	Vessel	5	28.4	n/a	n/a	Watwood et al. 2012b	LOE
54	2012	Feb 15-25	Monitoring during SCC	Aerial	6	29	n/a	HDR, Contract N62470-10-D-3011, CTO KB14	Mobley and Pacini 2012†	SCC
55	2012	May 05-24	Small-Vessel Tag/Biopsy/ Photo-ID (May 2012)[3]	Vessel	19	n/a	1,200.71 (2,223.53)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
56	2012	May 14	Pearl Harbor Entrance Channel Sea Turtle Survey	Vessel/ Diver	1	n/a	7.71 (14.29)	n/a	Robert Uyeyama, pers. comm.	PH & K-Bay Sea Turtle Follow
57	2012	Jun 6, 12-30; Jul 01-02	Small-Vessel Tag/Biopsy/ Photo-ID (Jun-Jul 2012)[3]	Vessel	19	n/a	1,032.37 (1,911.80)	n/a	Robin Baird, pers. comm.	Small-Vessel Tag/Biopsy/Photo-ID
58	2012	Jul 06	Kaula Island Vessel Surveys	Vessel	1	10.3	61.5 (113.89)	n/a	Richie et al. 2012	Kaula Island

Survey ID	Year	Survey Dates	Survey Title	Survey Platform	Survey Effort			Contract No.	Source	Survey Category
					Days	Hours[1]	NM of Trackline (km)			

Notes:
[†]Anti-submarine warfare (ASW) exercise had been planned, but did not take place during survey effort
[1] Some data was not available in cited reports
[2] Two types of vessels were used on the same survey
[3] Group size was not available for these surveys
Key:
CRC = Cascadia Research Collective
CTO = Contract Task Order
LOE = Lookout Effectiveness
MMRC = Marine Mammal Research Consultants
n/a = not available
Photo-ID = photo-identification
RHIB = rigi-hulled inflatable boat
RIMPAC = Rim of the Pacific
SCC = Submarine Commanders Course
SES = Smultea Environmental Sciences, LLC
SINKEX = Sinking Exercise
ULT = unit level training (ASW exercise)
UNDET = underwater detonation
USWEX = Undersea Warfare Exercise

APPENDIX B

Beaufort Sea State Scale

Beaufort Scale	Wind Speed		Descriptive Term	Effects Observed at Sea
	Km/hr	Knots		
0	Less than 1	Less than 1	Calm	Sea surface like a mirror, but not necessarily flat.
1	1 - 5	1 - 3	Light air	Ripples with the appearance of scales are formed, but without foam crests.
2	6 - 11	4 - 6	Light breeze	Small wavelets, still short but more pronounced. Crests do not break. When visibility good, horizon line always very clear.
3	12 - 19	7 - 10	Gentle breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered whitecaps.
4	20 - 28	11 - 16	Moderate breeze	Small waves, becoming longer. Fairly frequent whitecaps.
5	29 - 38	17 - 21	Fresh breeze	Moderate waves, taking a more pronounced long form. Many whitecaps are formed. Chance of some spray.
6	39 - 49	22 - 27	Strong breeze	Large waves begin to form. The white foam crests are more extensive everywhere. Probably some spray.
7	50 - 61	28 - 33	Near gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.
8	62 - 74	34 - 40	Gale	Moderately high waves of greater length. Edges of crests begin to break into the spindrift. The foam is blown in well-marked streaks along the direction of the wind.
9	75 - 88	41 - 47	Strong gale	High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility.
10	89 - 102	48 - 55	Storm	Very high waves with long overhanging crests. Dense white streaks of foam. Surface of the sea takes a white appearance. The tumbling of the sea becomes heavy and shock-like. Visibility affected.
11	103 - 117	56 - 63	Violent storm	Exceptionally high waves. Sea completely covered with long white patches of foam. Visibility affected.
12	118 - 133	64 - 71	Hurricane	Air filled with foam and spray. Sea entirely white with foam. Visibility seriously impaired.

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APPENDIX C
Survey Trackline Maps

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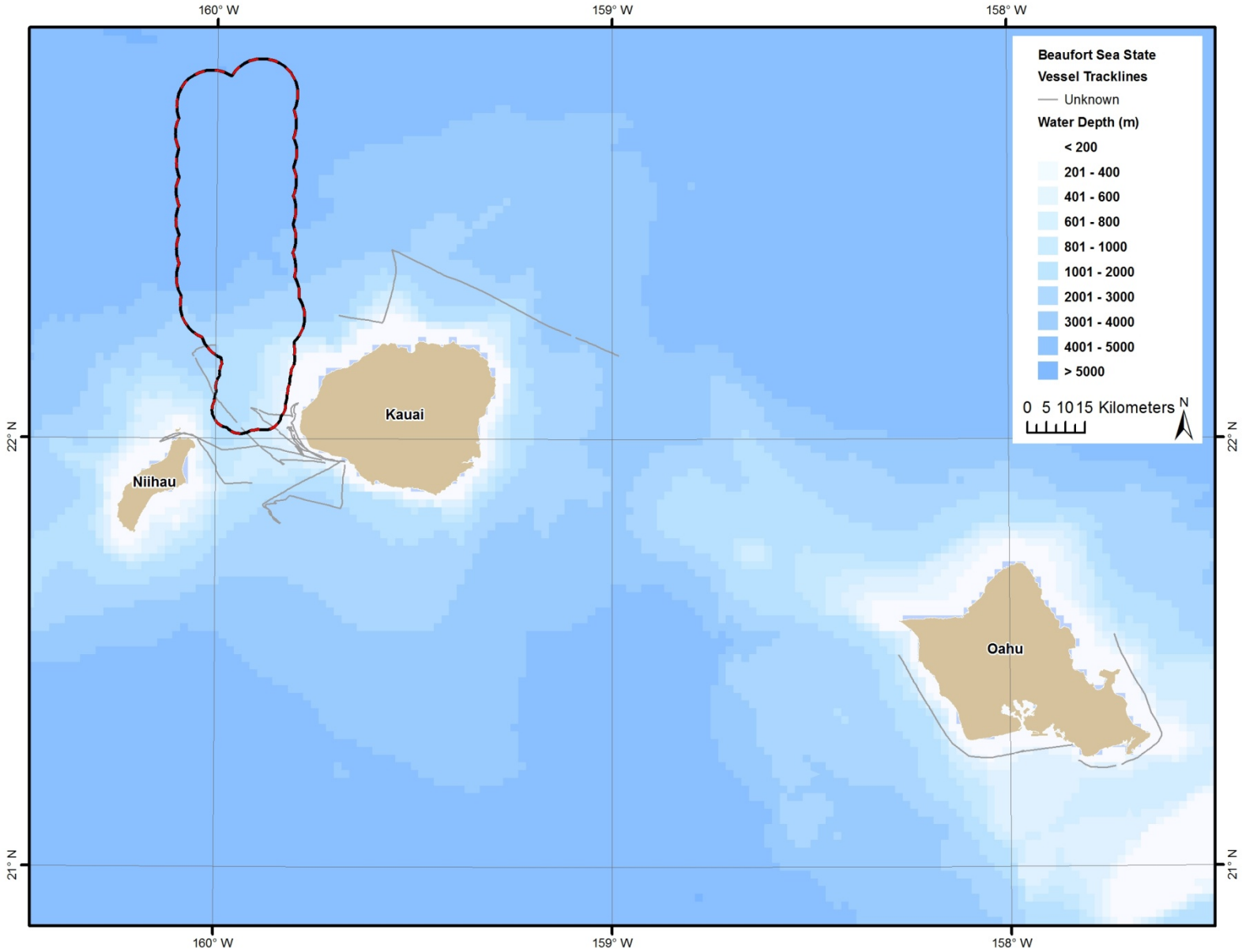

Figure C-1. Vessel tracklines for a deepwater cetacean vessel survey during February 2005.

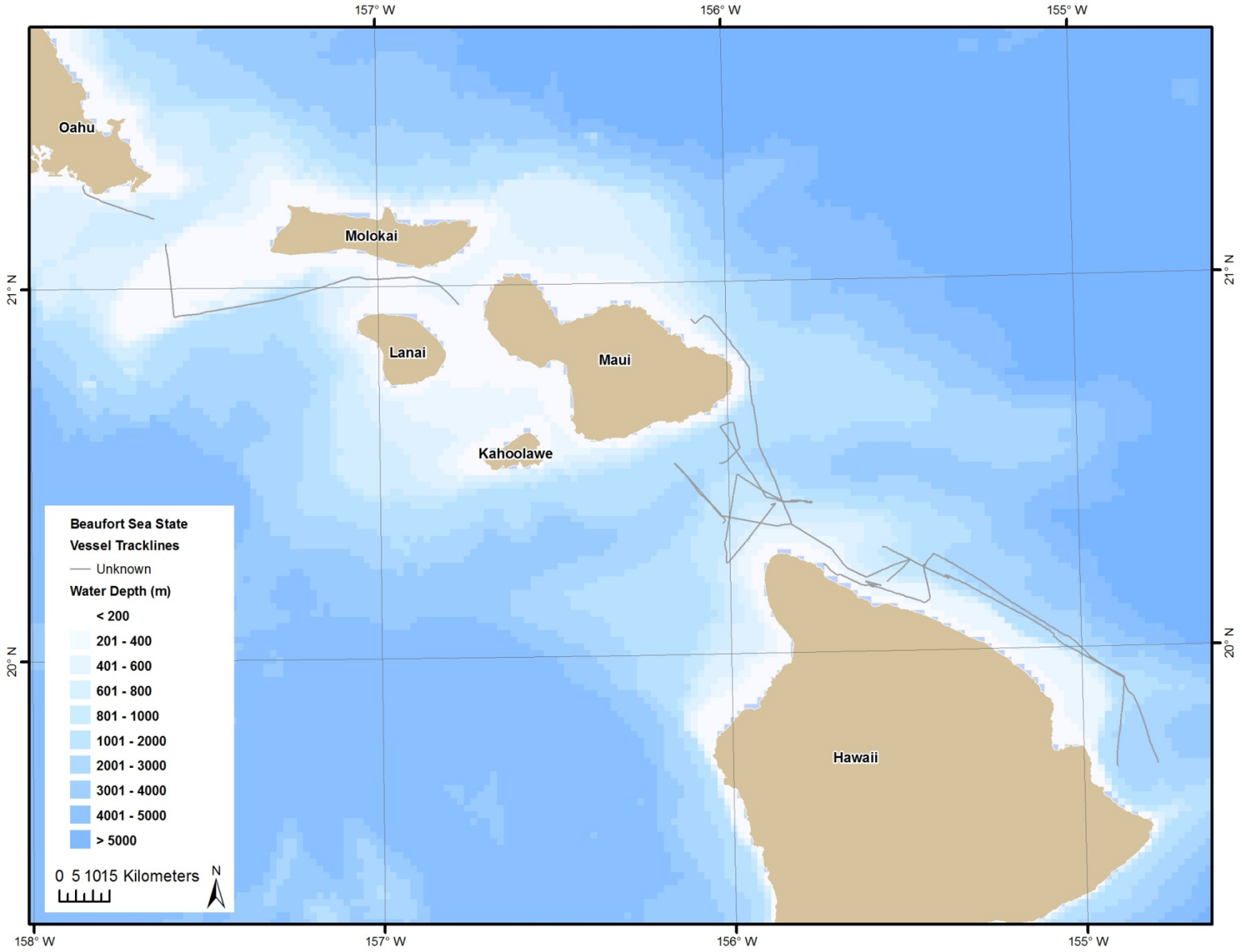

Figure C-2. Vessel survey tracklines at Alenuihaha Channel and the Island of Hawaii in January and February 2007.

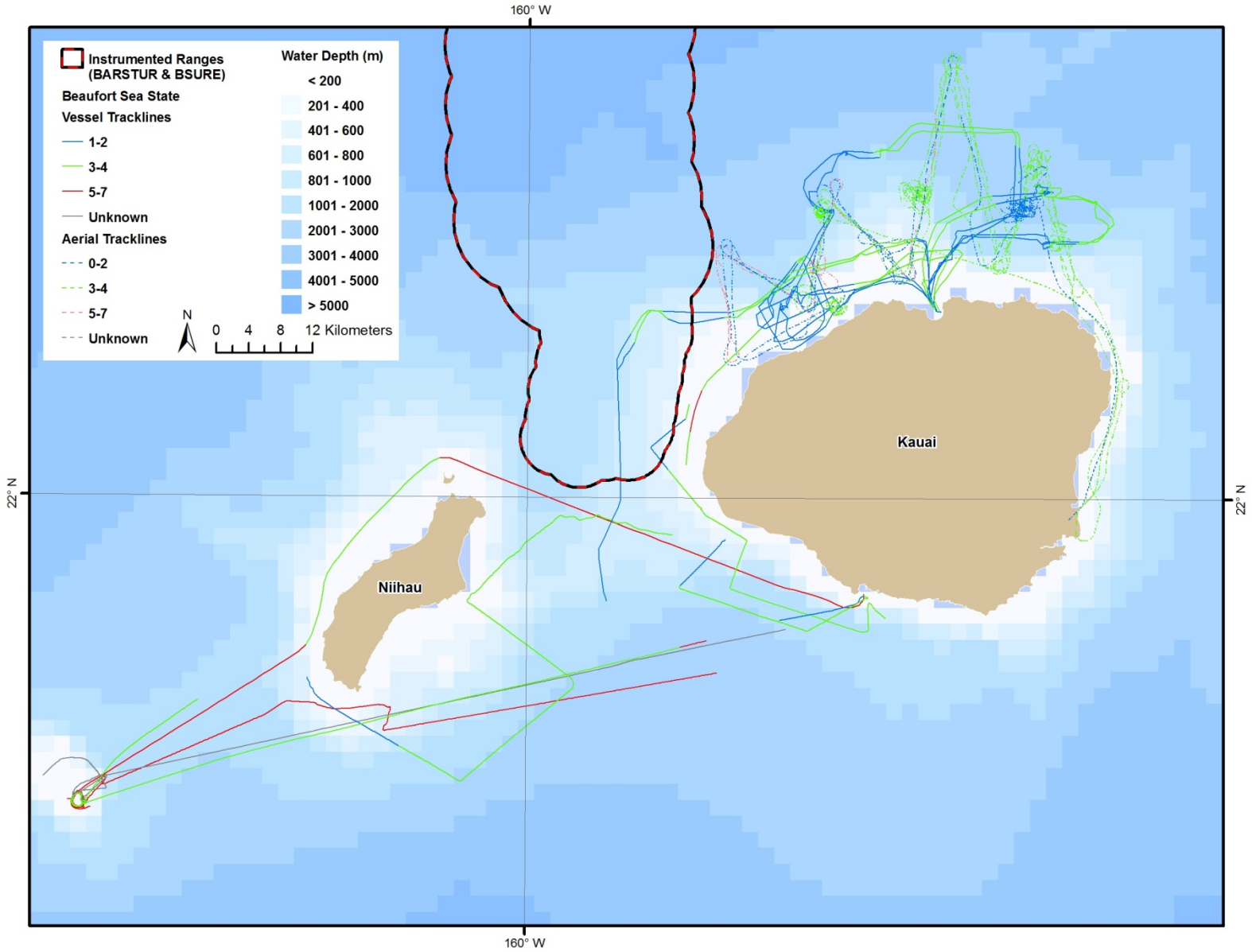

Figure C-3. Aerial and vessel tracklines for Kaula monitoring effort and February 2011 Kauai tagging effort.

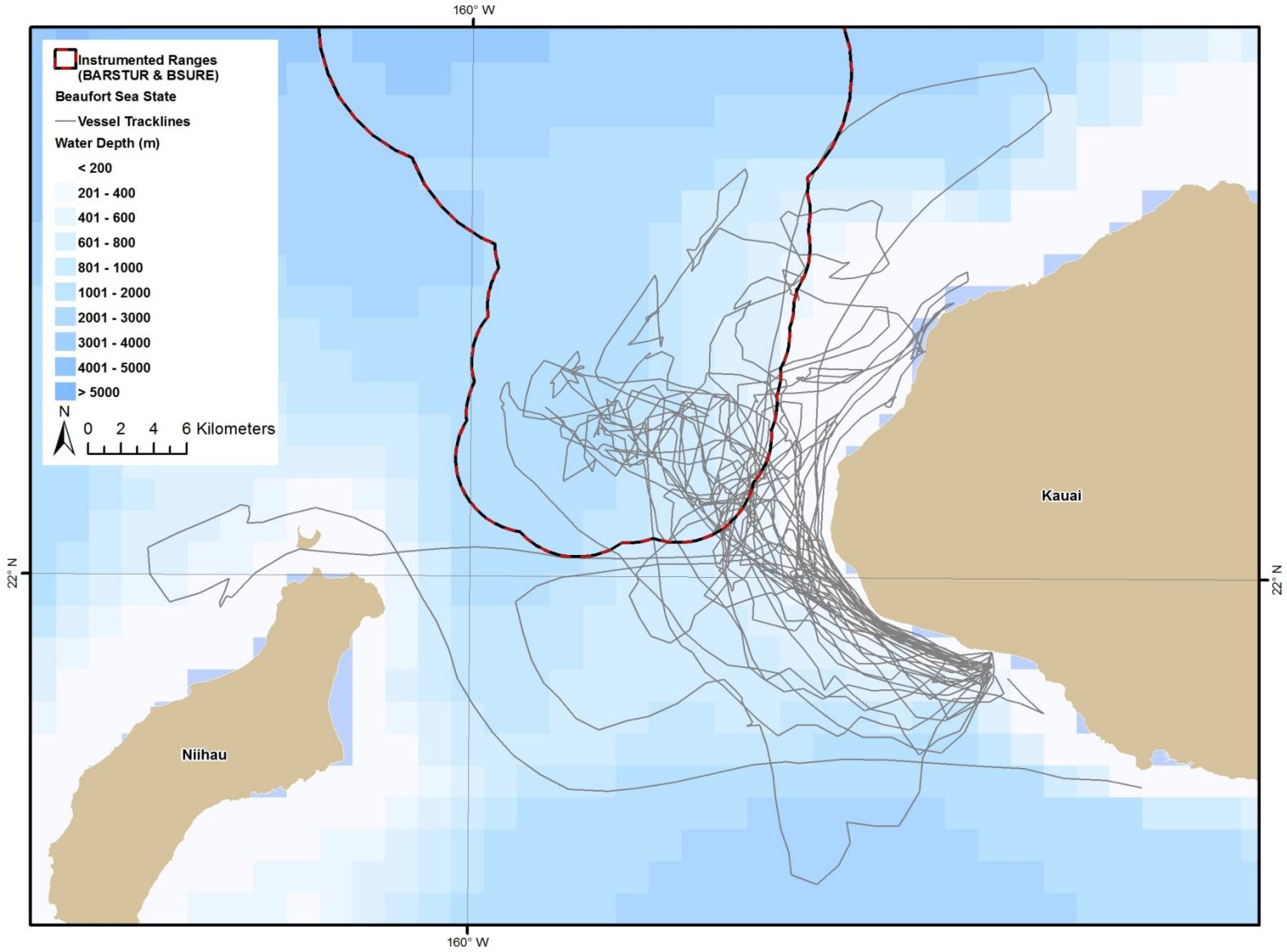

Figure C-4. Vessel tracklines for tagging and photo-identification survey (Baird et al. 2012a).

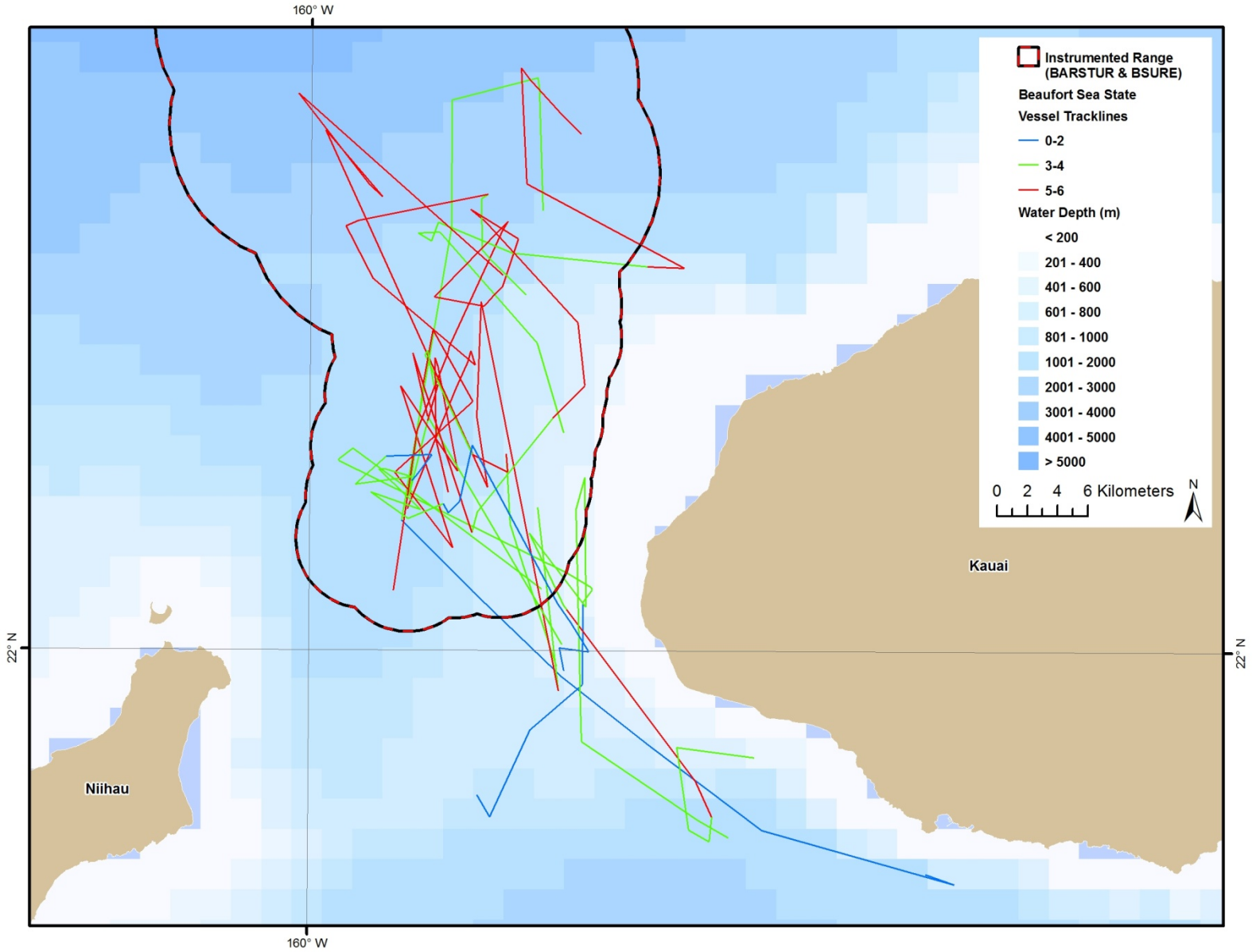

Figure C-5. PMRF vessel and tagging survey tracklines during January 2012.

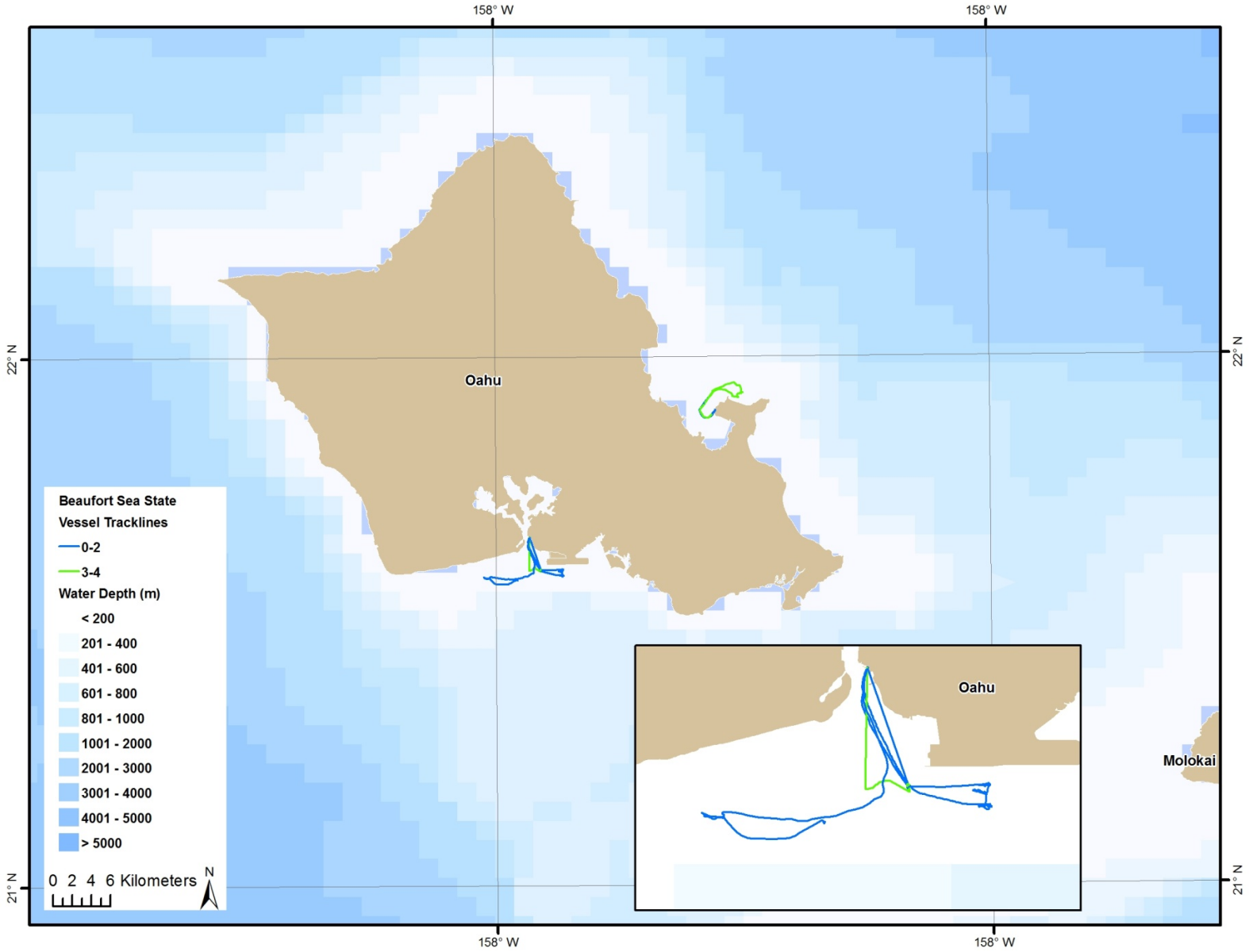

Figure C-6. Vessel tracklines for U.S. Navy-conducted diver-turtle surveys at Pearl Harbor and Kaneohe Bay.

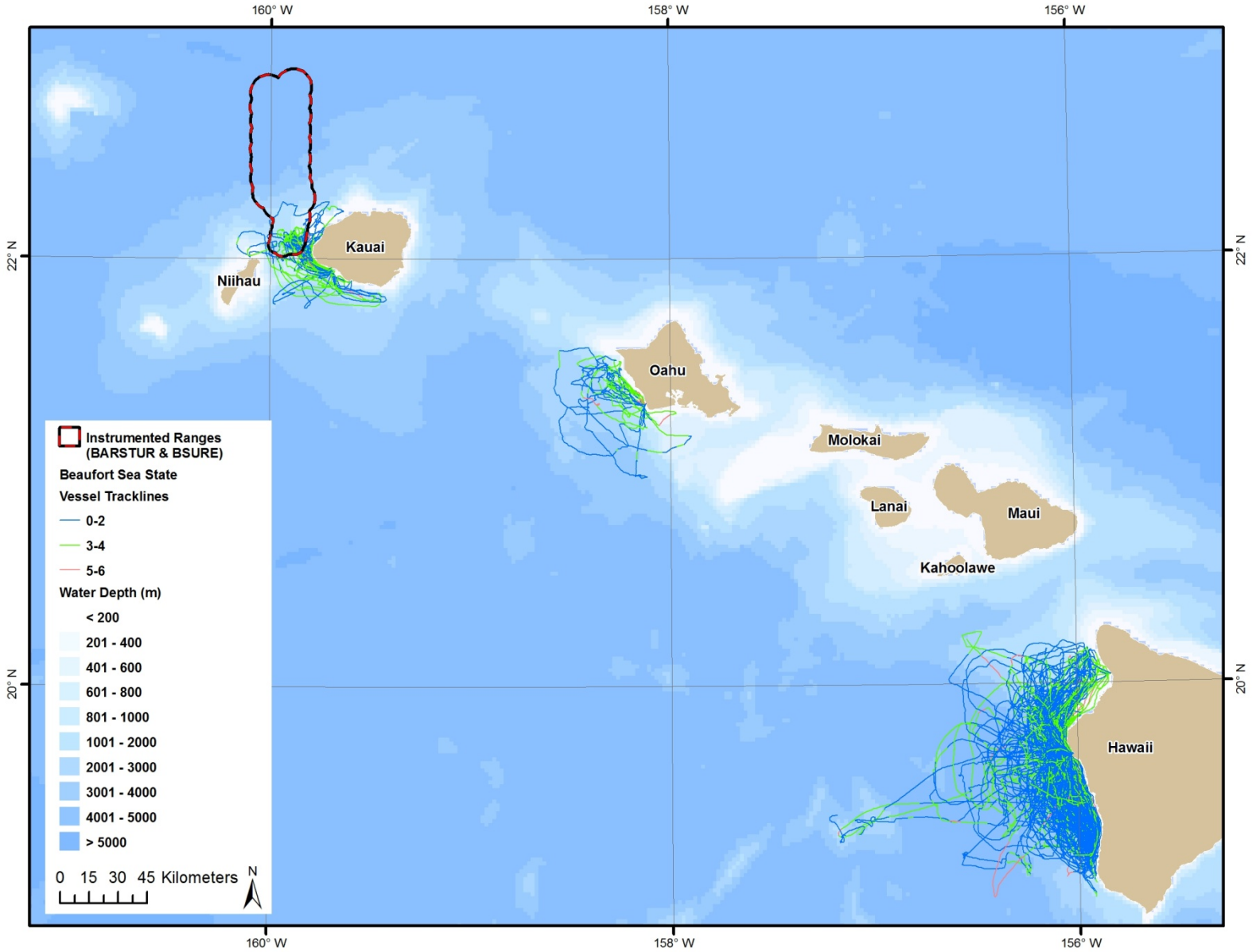

Figure C-7. Vessel tracklines for small-vessel tag/biopsy/photo-ID surveys (Baird et al. 2012a).

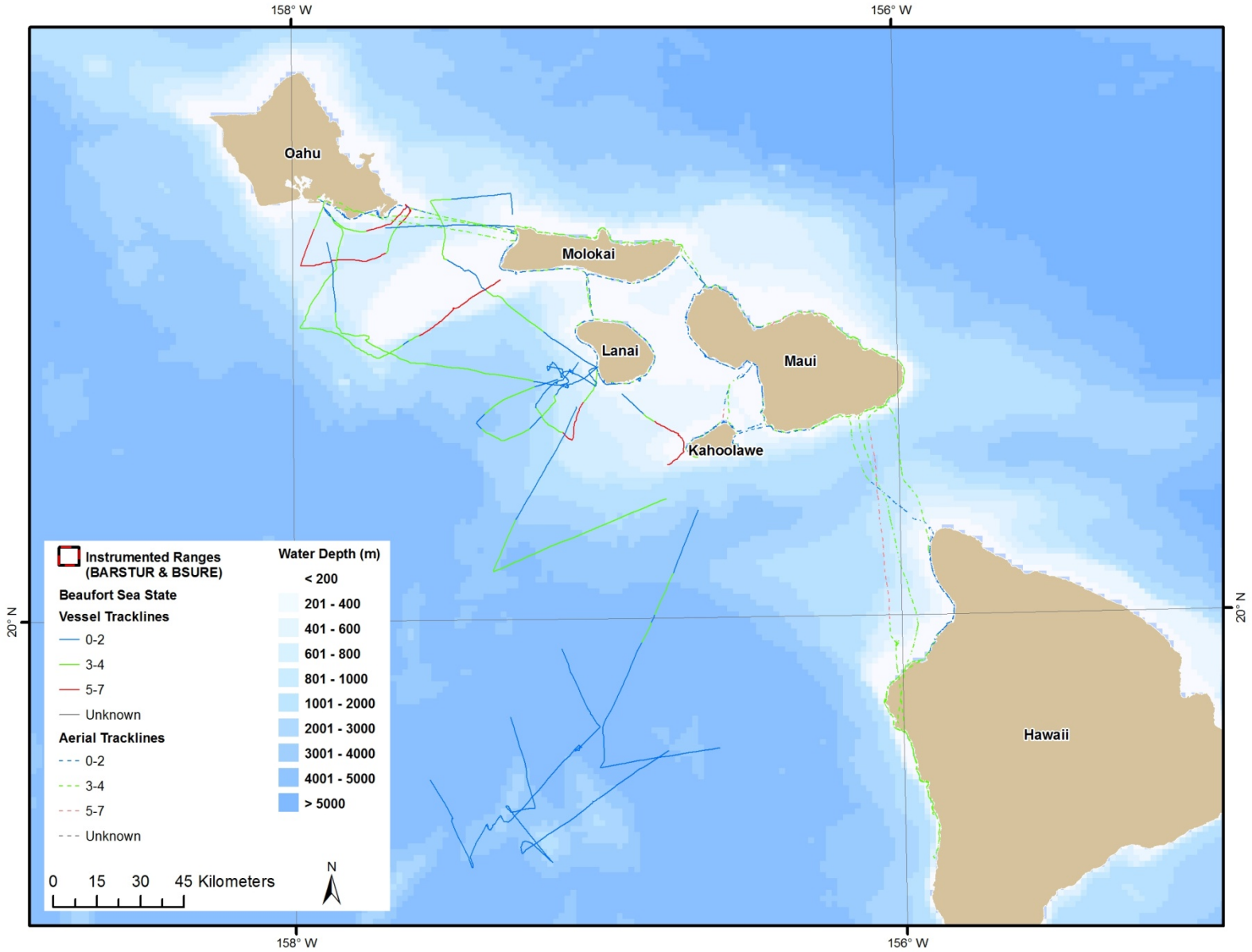

Figure C-8. Aerial and vessel tracklines for Koa Kai monitoring effort.

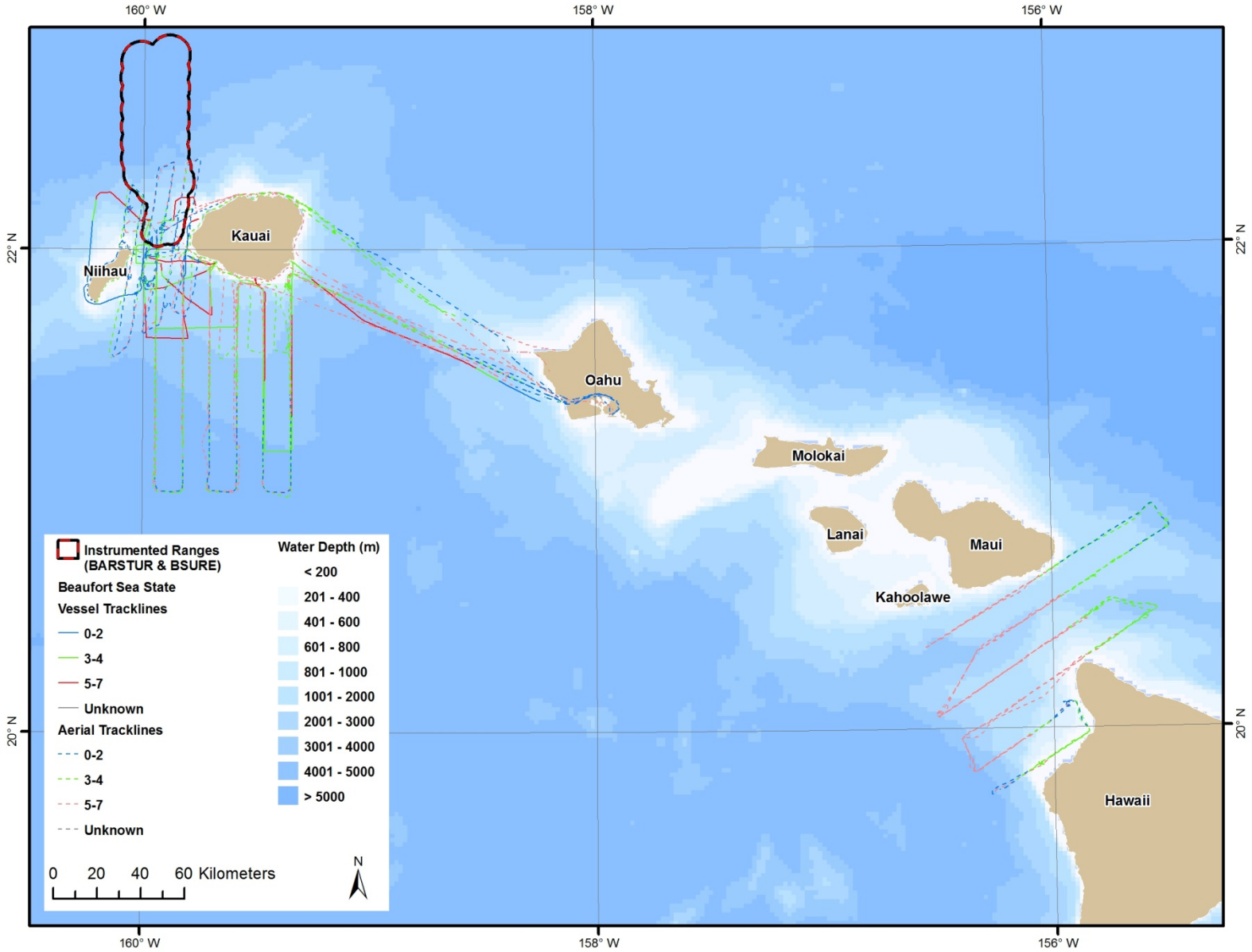

Figure C-9. Aerial and vessel tracklines for RIMPAC surveys conducted during 2006, 2008 and 2010.

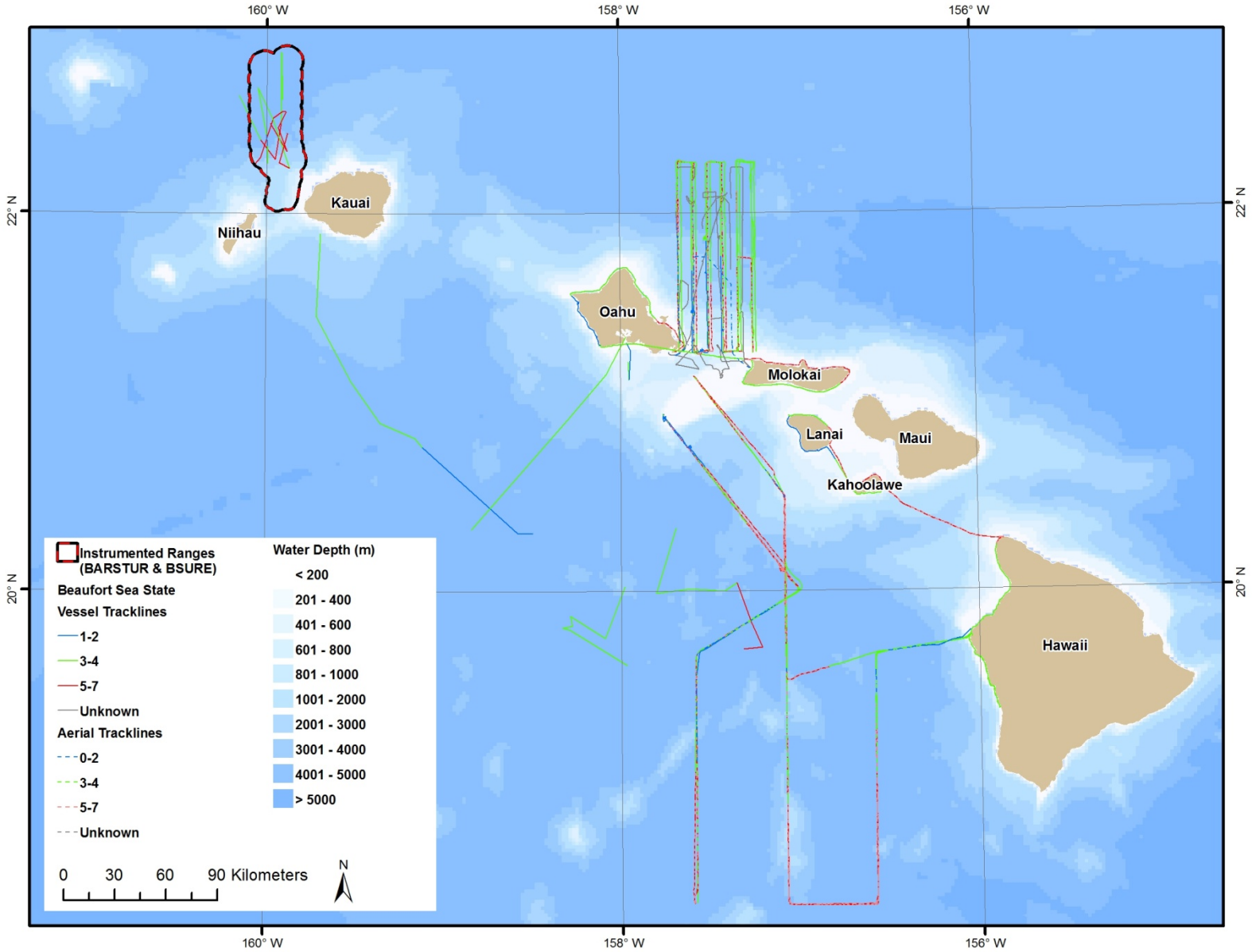

Figure C-10. Aerial and vessel tracklines for USWEX surveys.

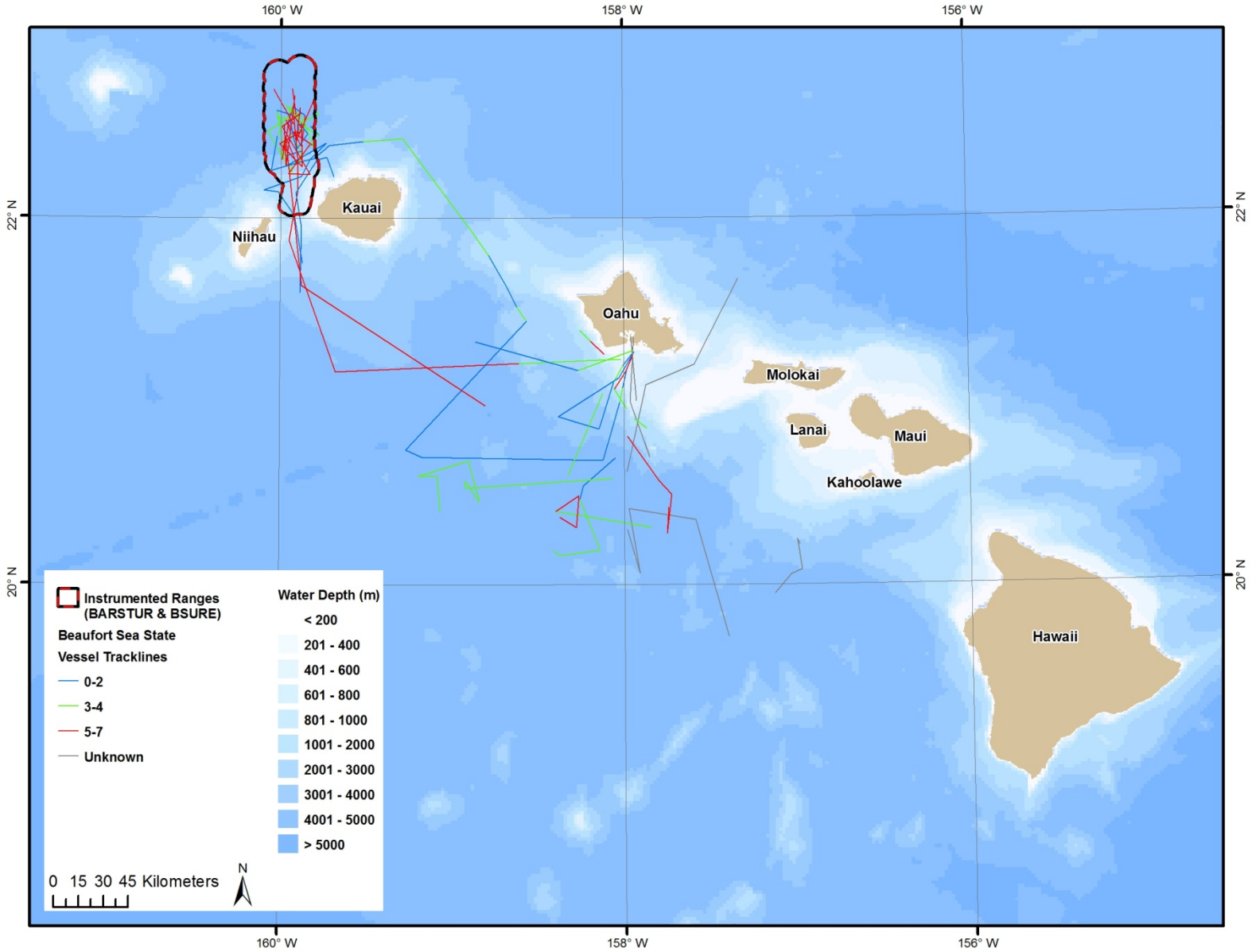

Figure C-11. Vessel tracklines for LOE Study surveys.

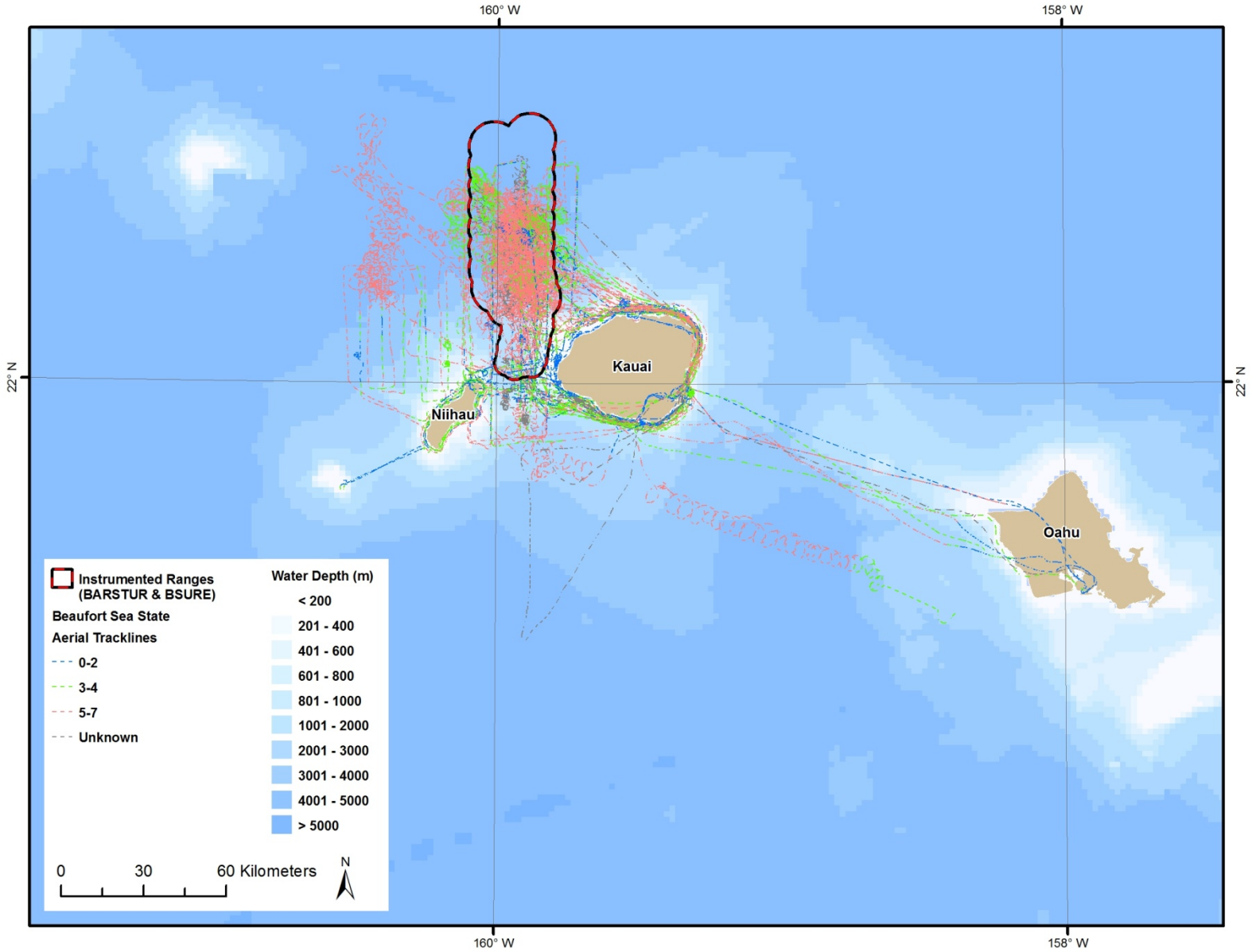

Figure C-12. Aerial tracklines for SCC surveys.

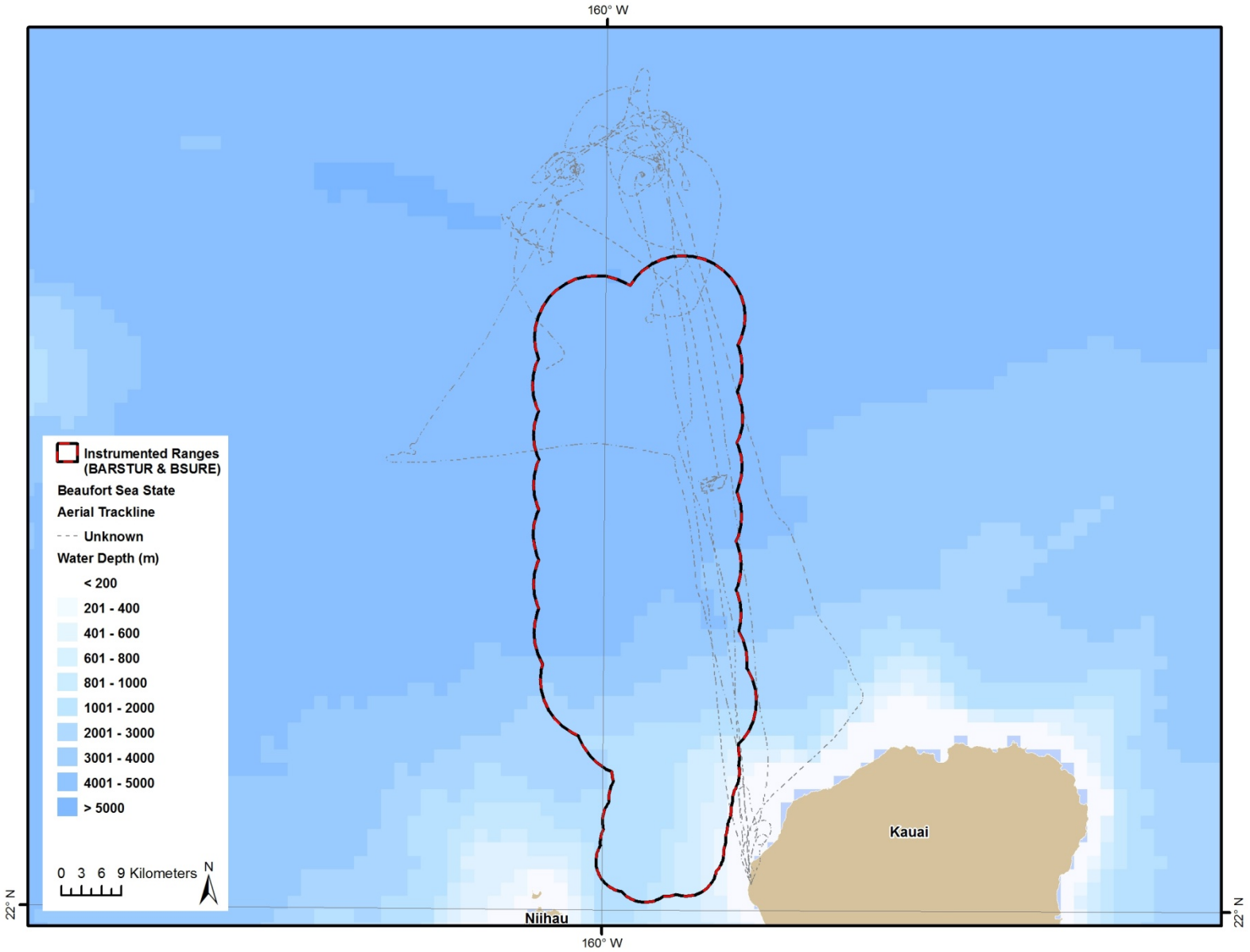

Figure C-13. Aerial tracklines for SINKEX surveys.

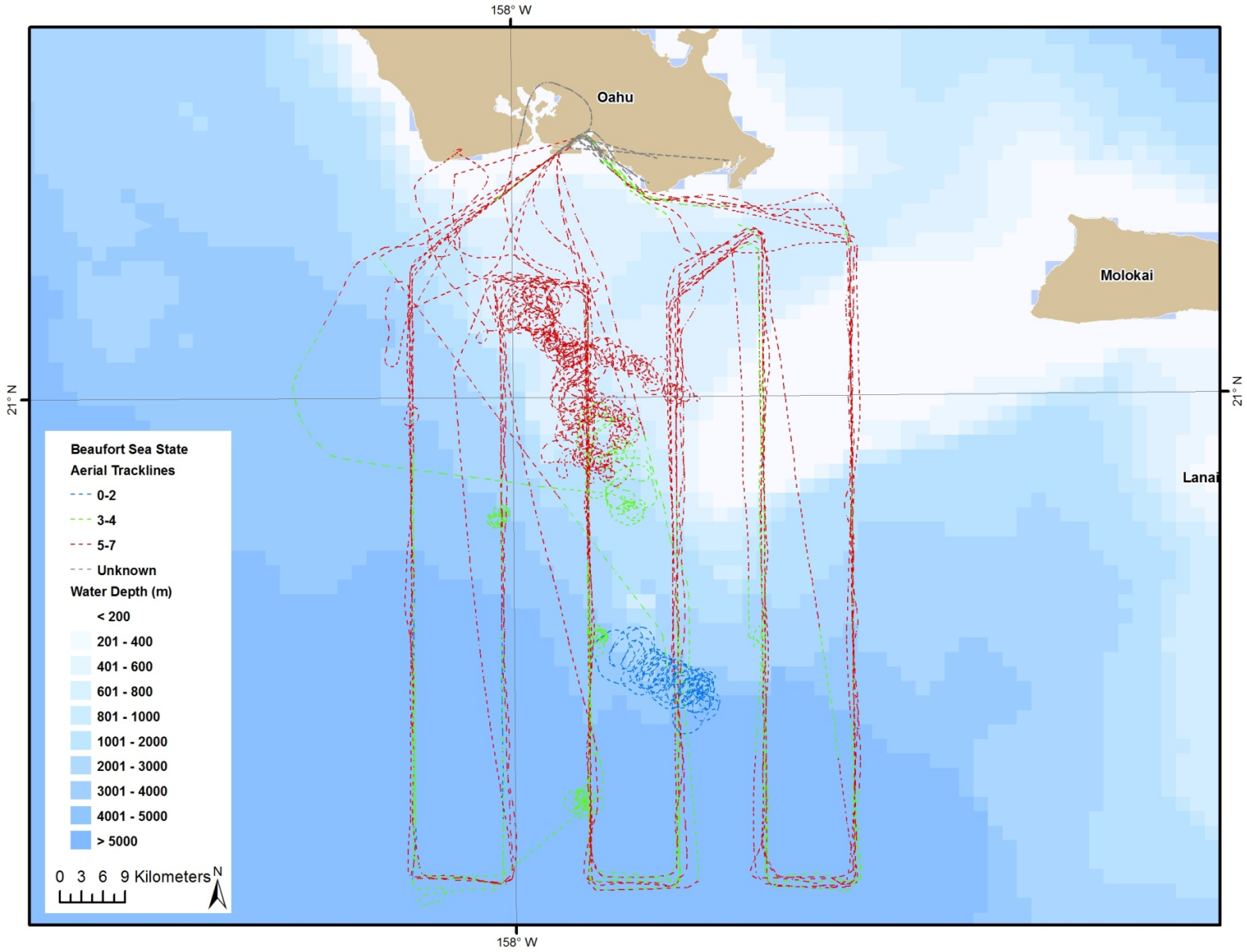

Figure C-14. Aerial tracklines for ULT surveys.

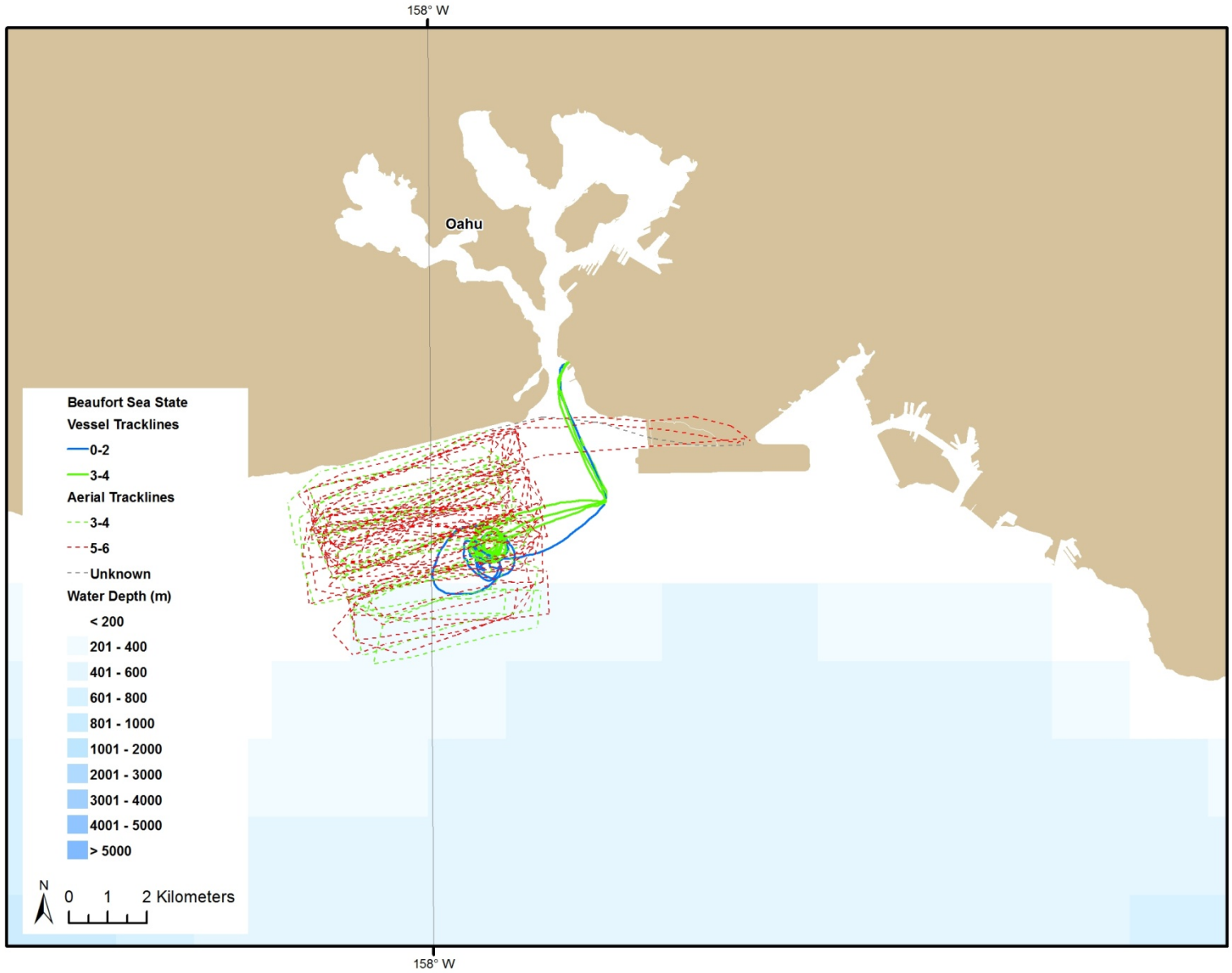

Figure C-15. Aerial and vessel tracklines for UNDET surveys.

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APPENDIX D

Species Sightings Maps

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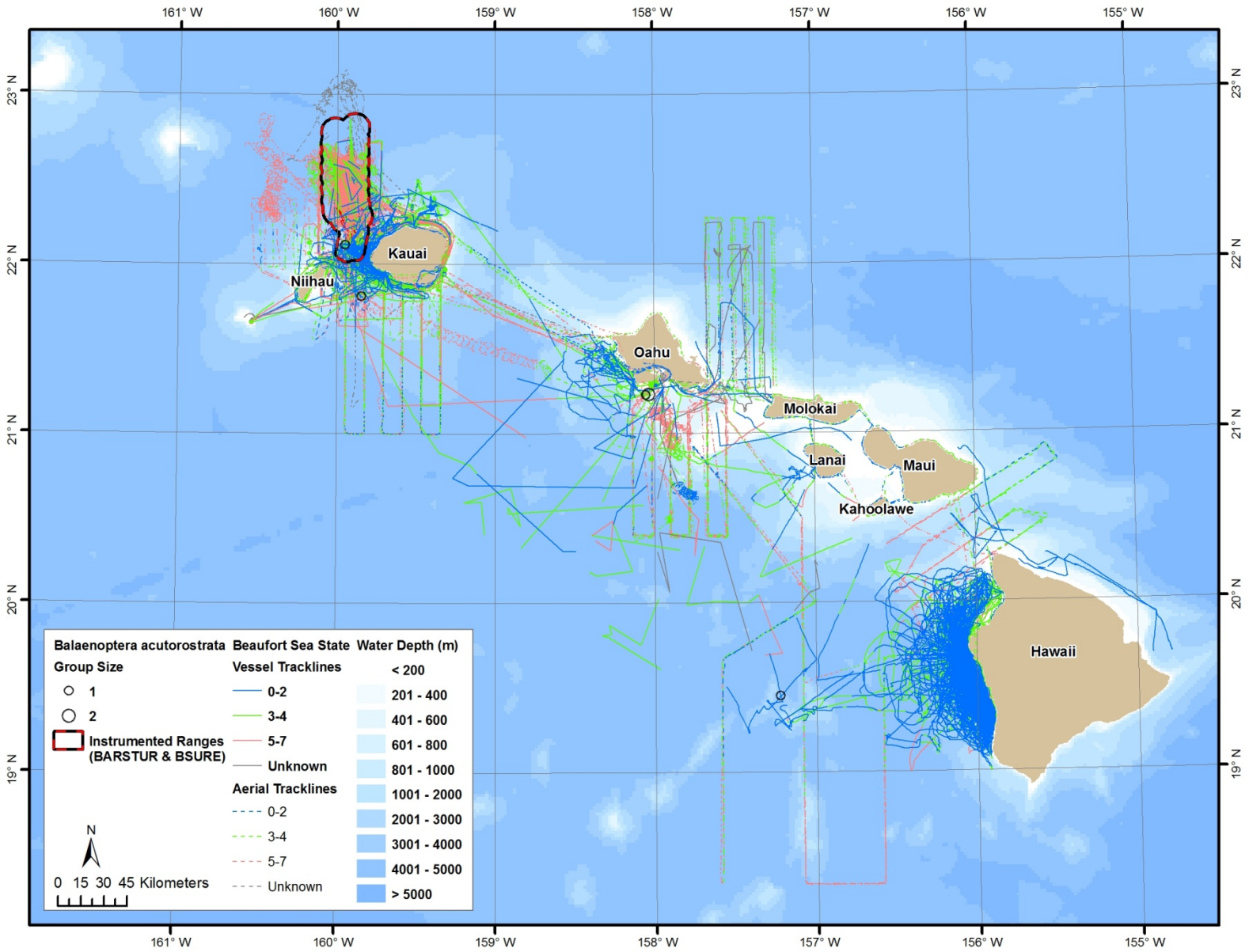

Figure D-1. Minke whale (*Balaenoptera acutorostrata*) sightings.

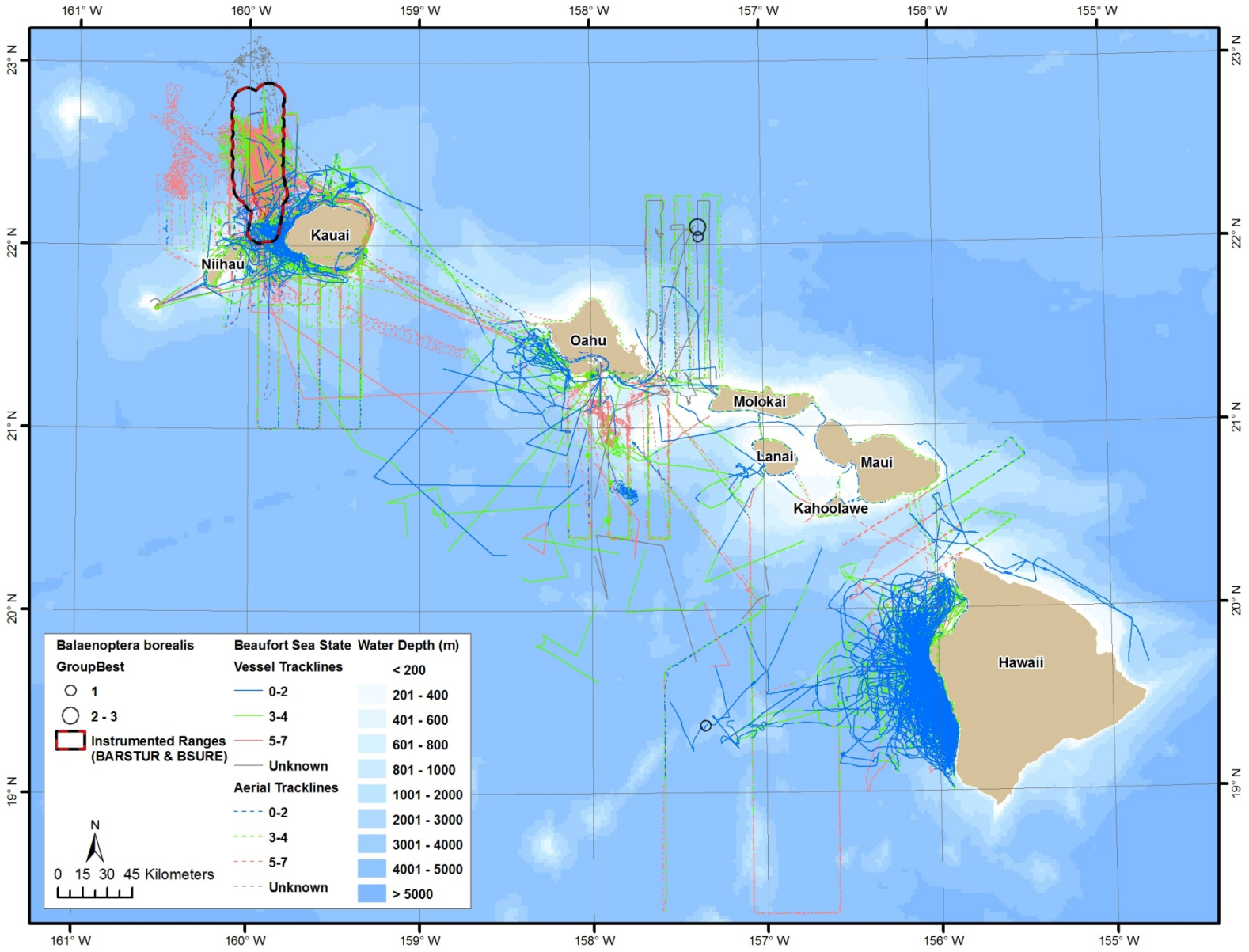

Figure D-2. Sei whale (*Balaenoptera borealis*) sightings.

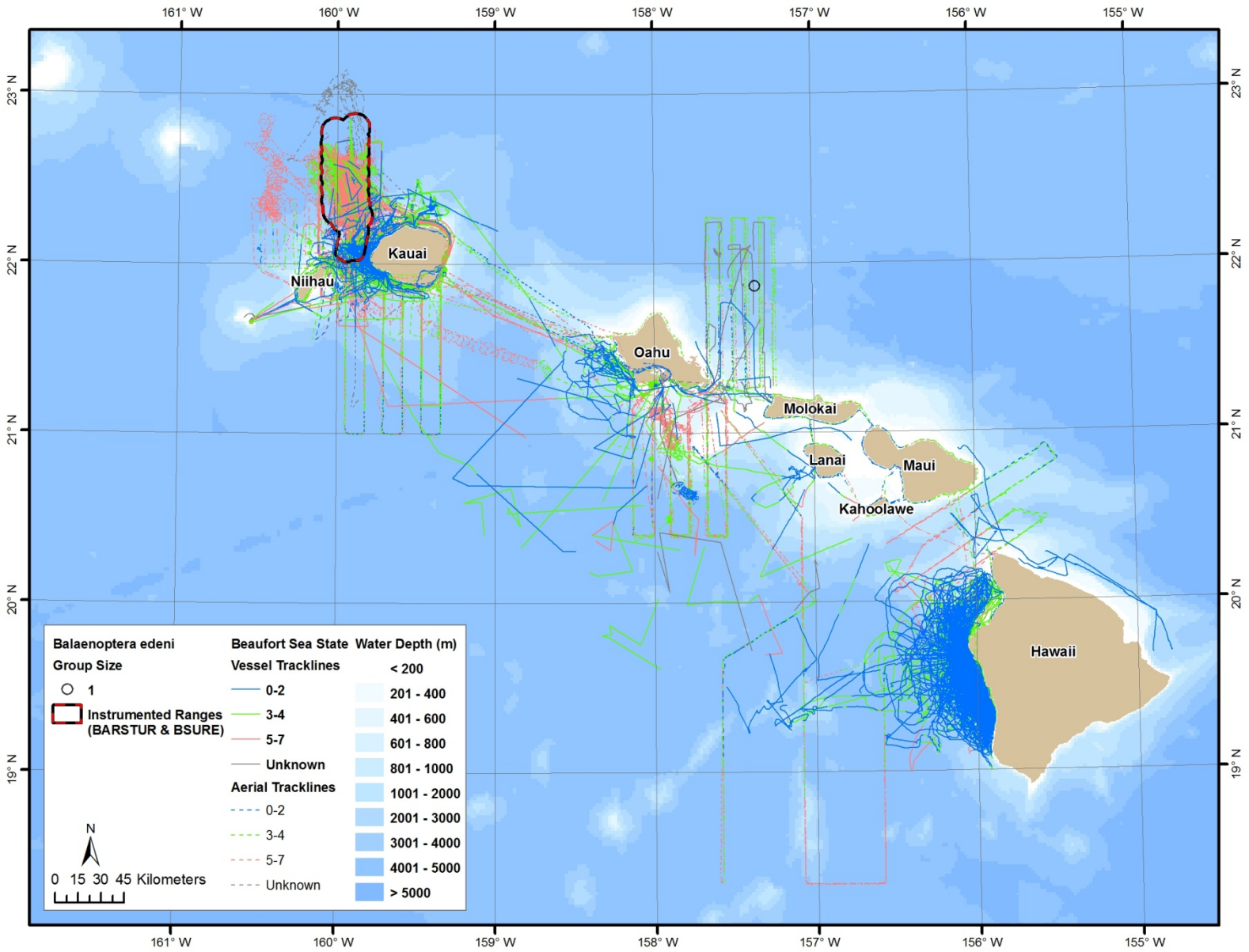

Figure D-3. Bryde's whale (*Balaenoptera edeni*) sightings.

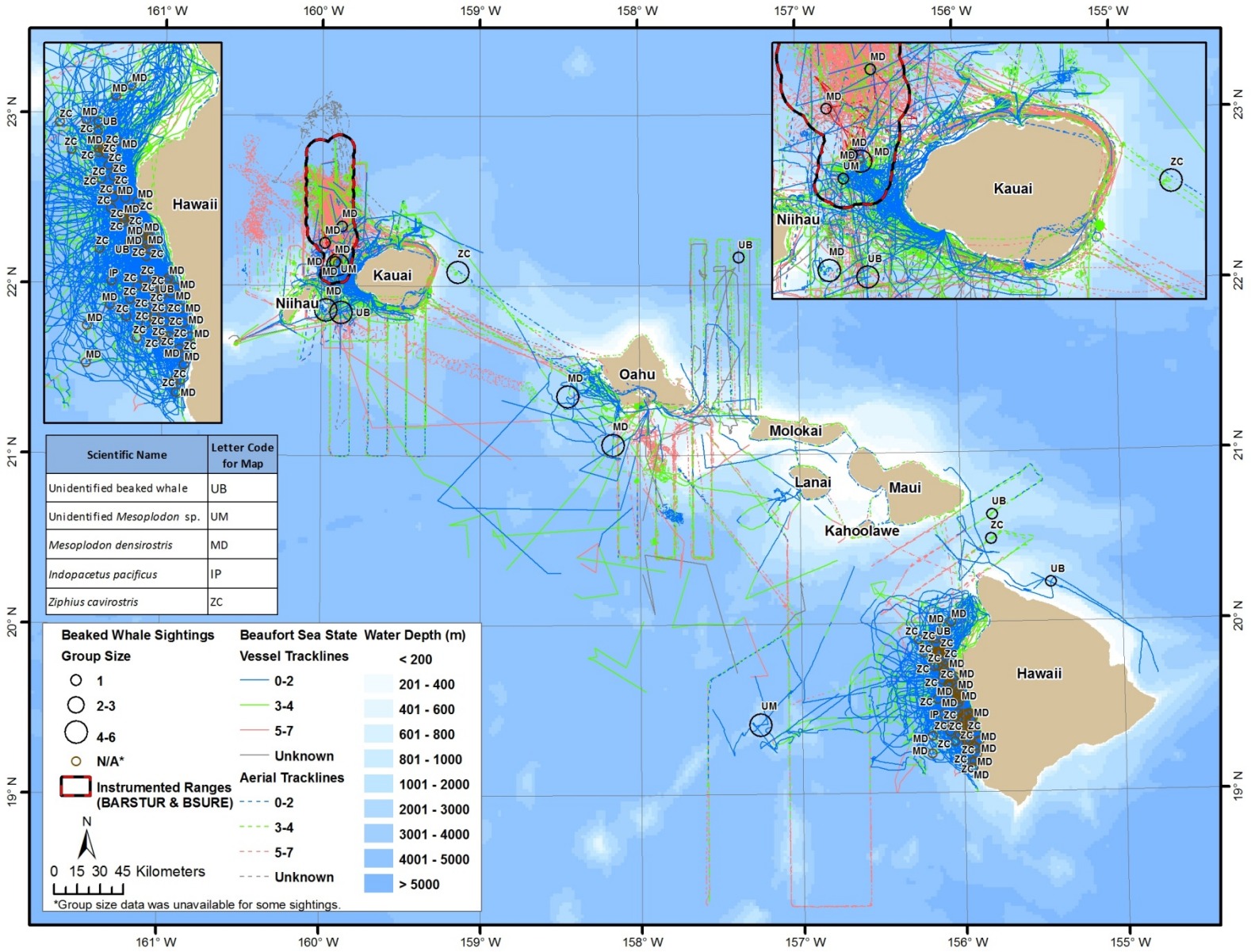

Figure D-4. Beaked whale sightings.

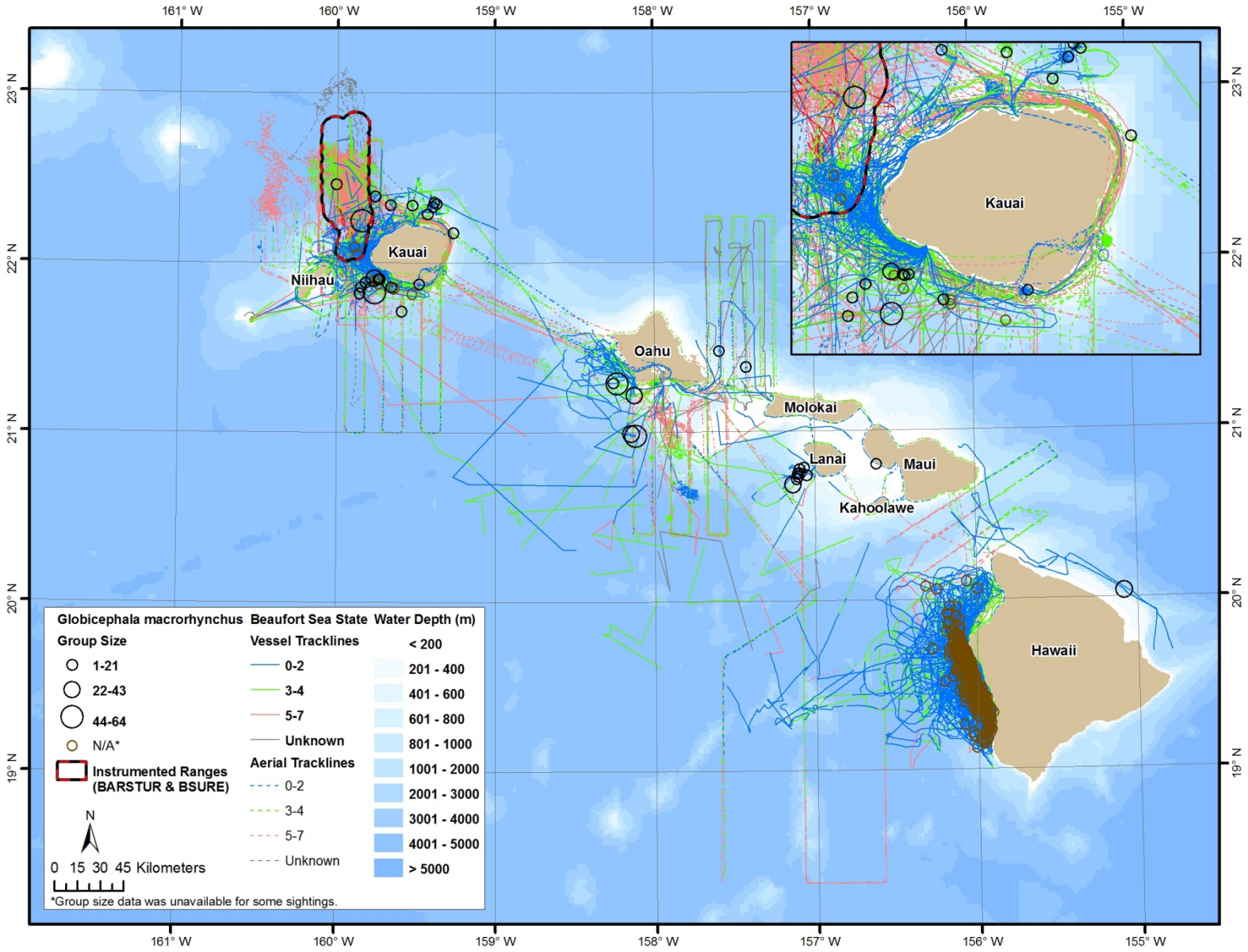

Figure D-5. Short-finned pilot whale (*Globicephala macrorhynchus*) sightings.

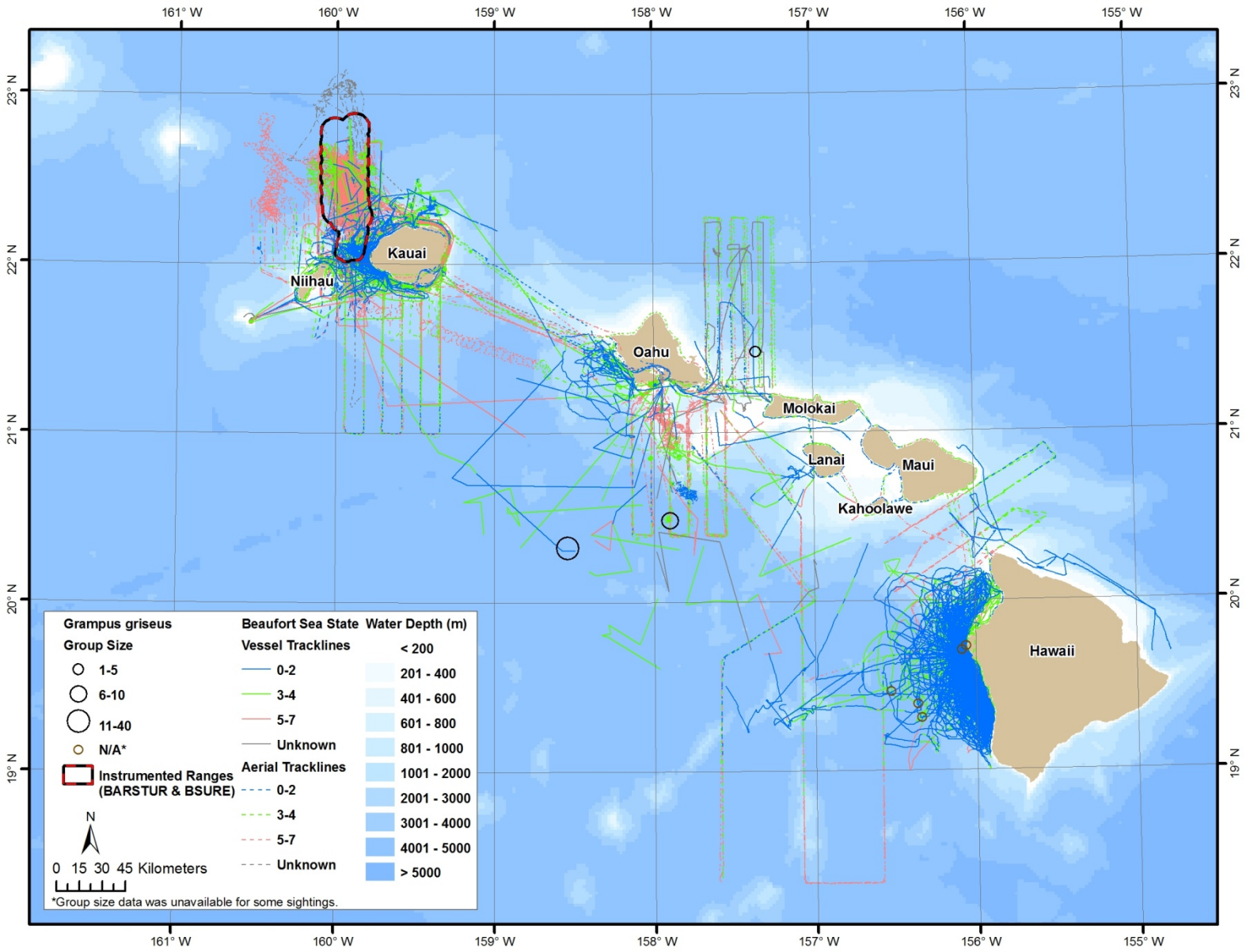

Figure D-6. Risso's dolphin (*Grampus griseus*) sightings.

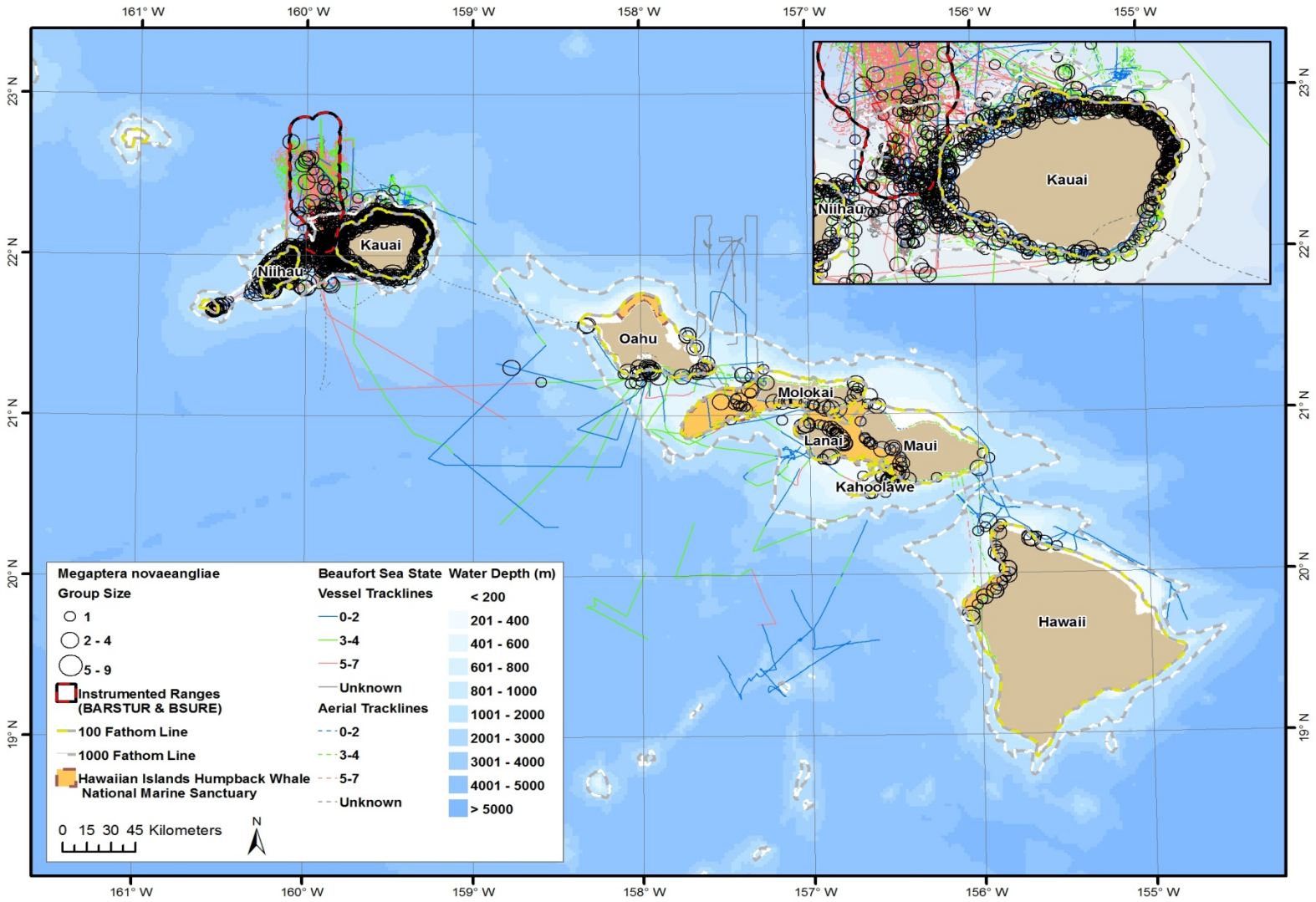

Figure D-7. Humpback whale (*Megaptera novaeangliae*) sightings.[3]

[3] Surveys included in the above map: Large vessel survey (January 2012); Kaula Island surveys (February 2011); Koa Kai surveys (November 2010); Lookout Effectiveness surveys (February 2009 to 2012); SCC surveys (February 2009 to 2012); USWEX survey (November 2007) and a Vessel survey (January/February 2007).

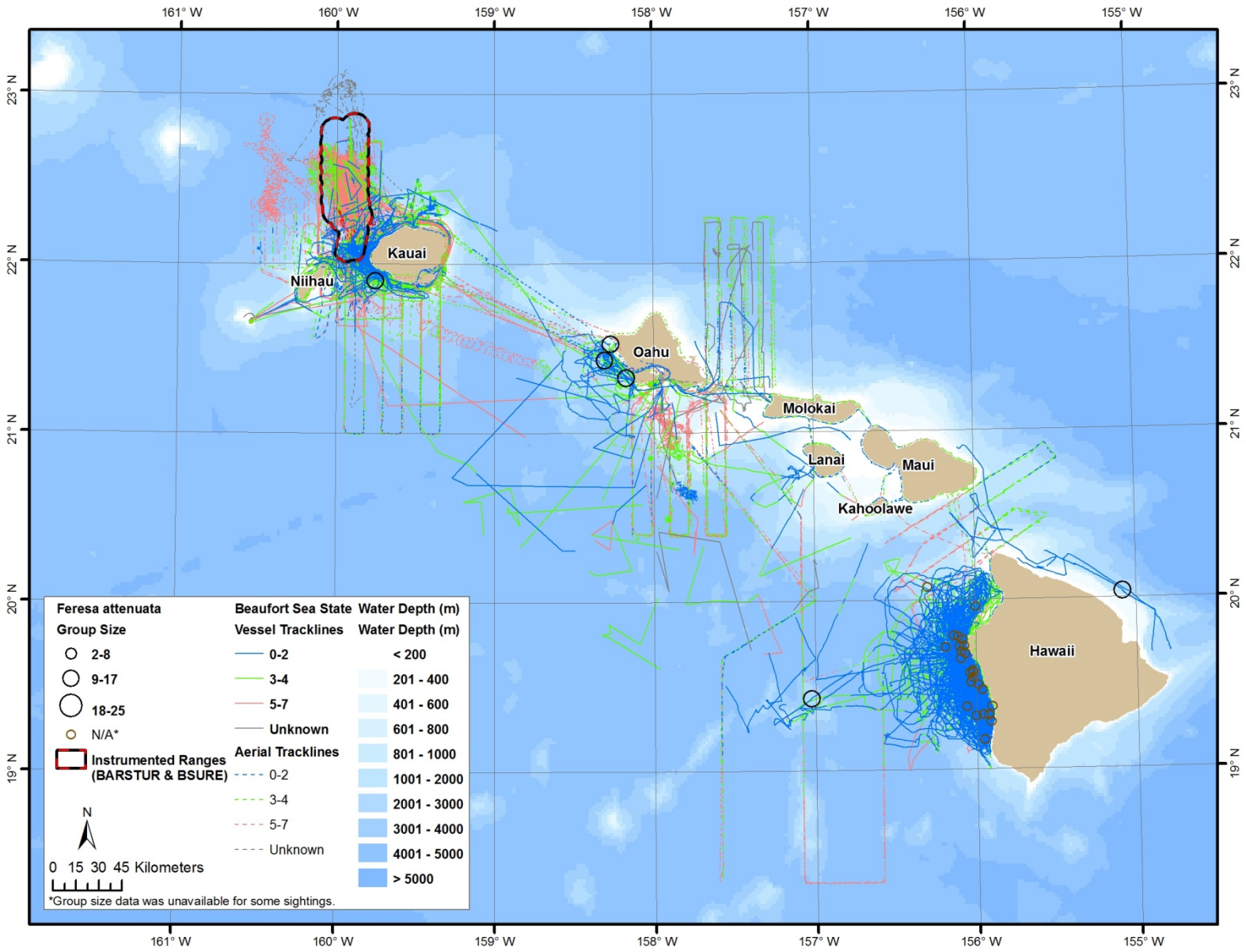

Figure D-8. Pygmy killer whale (*Feresa attenuata*) sightings.

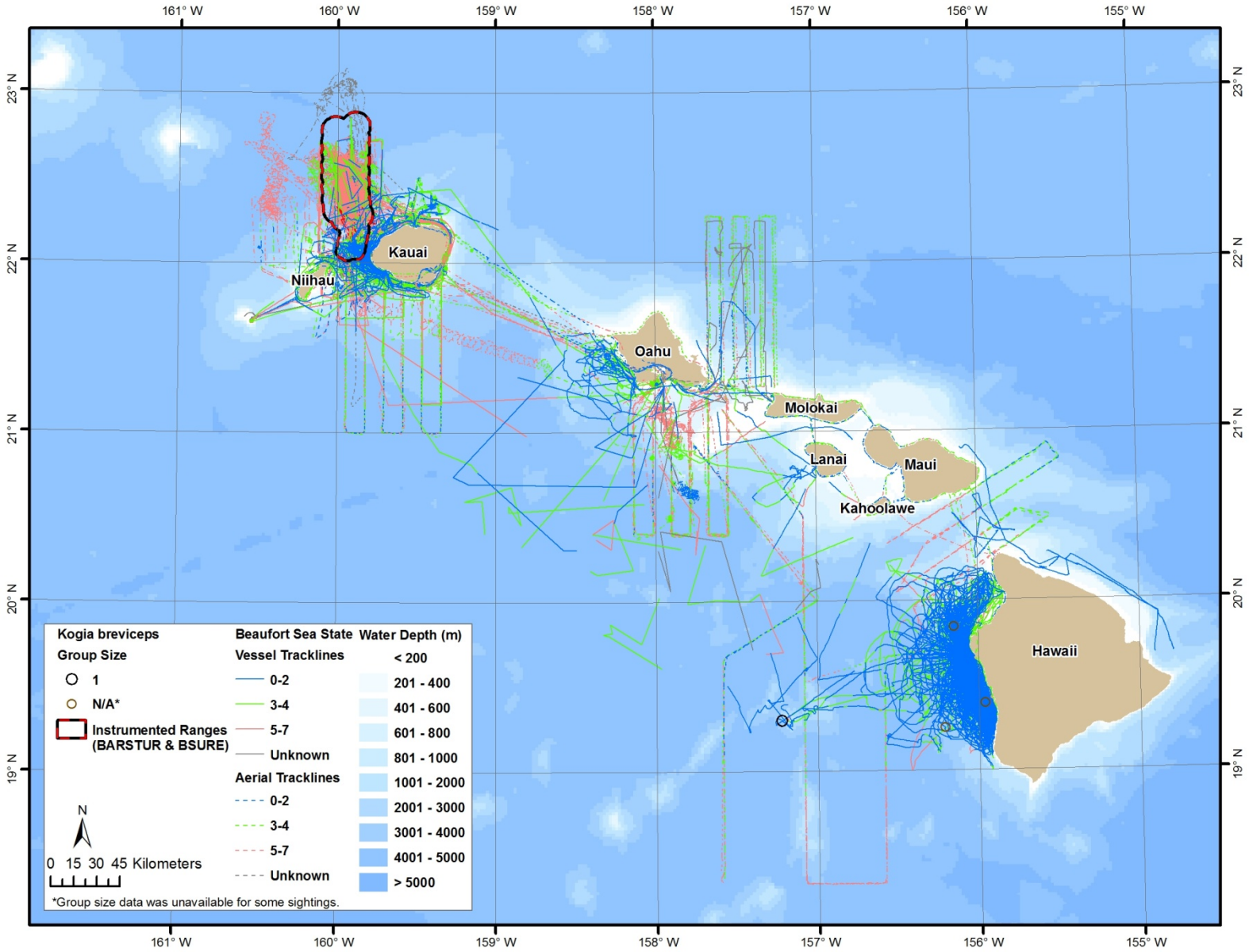

Figure D-9. Pygmy sperm whale (*Kogia breviceps*) sightings.

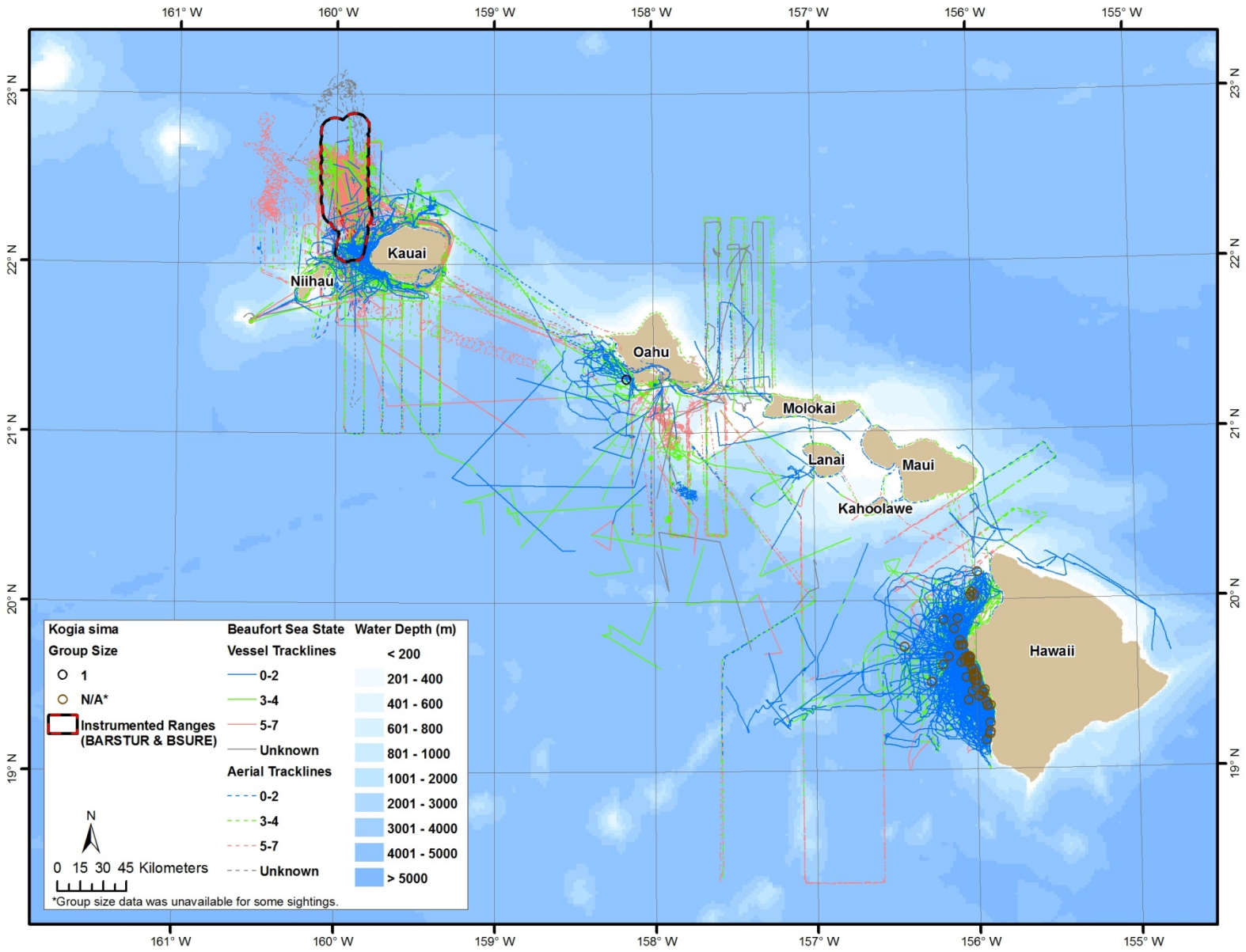

Figure D-10. Dwarf sperm whale (*Kogia sima*) sightings.

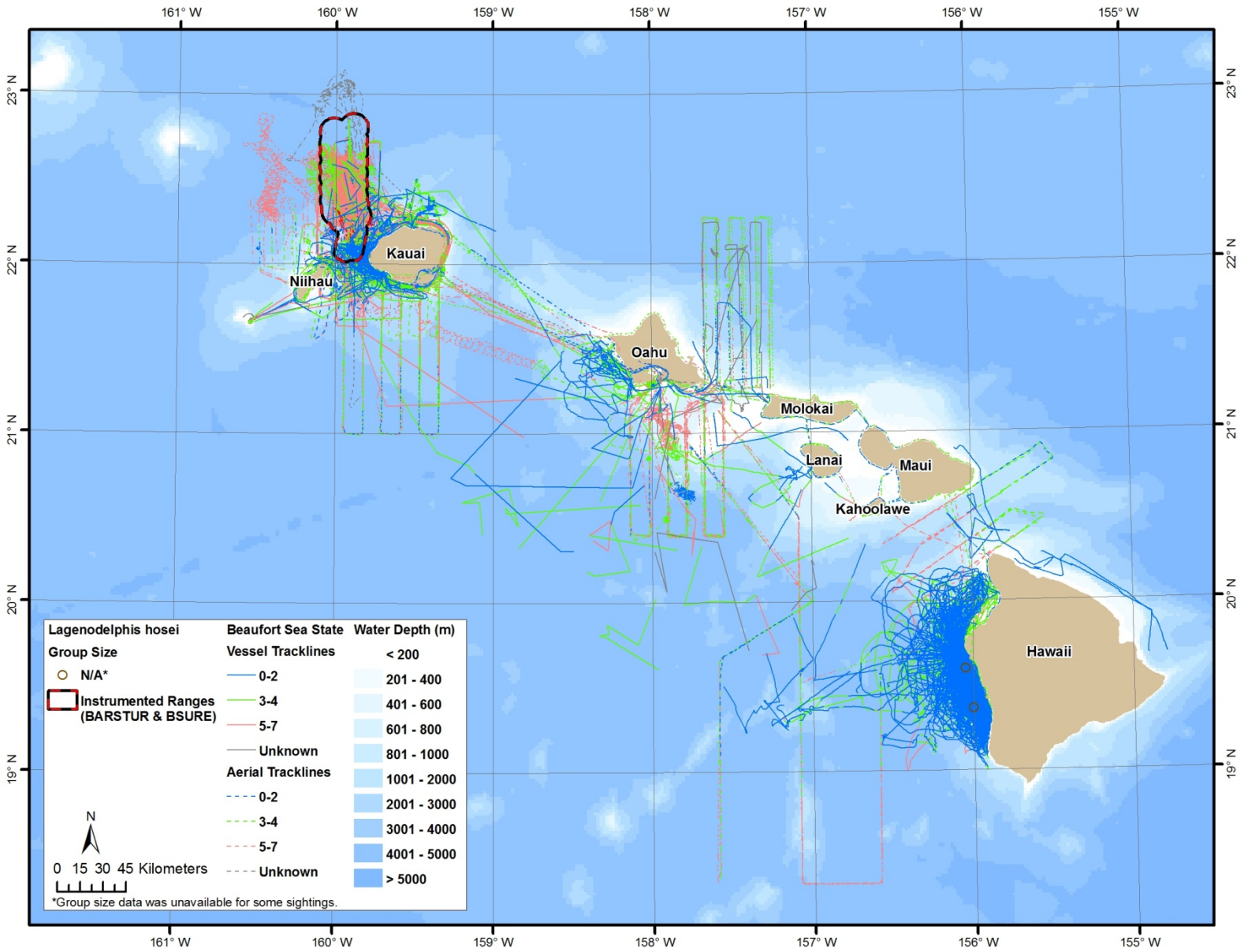

Figure D-11. Fraser's dolphin (*Lagenodelphis hosei*) sightings.

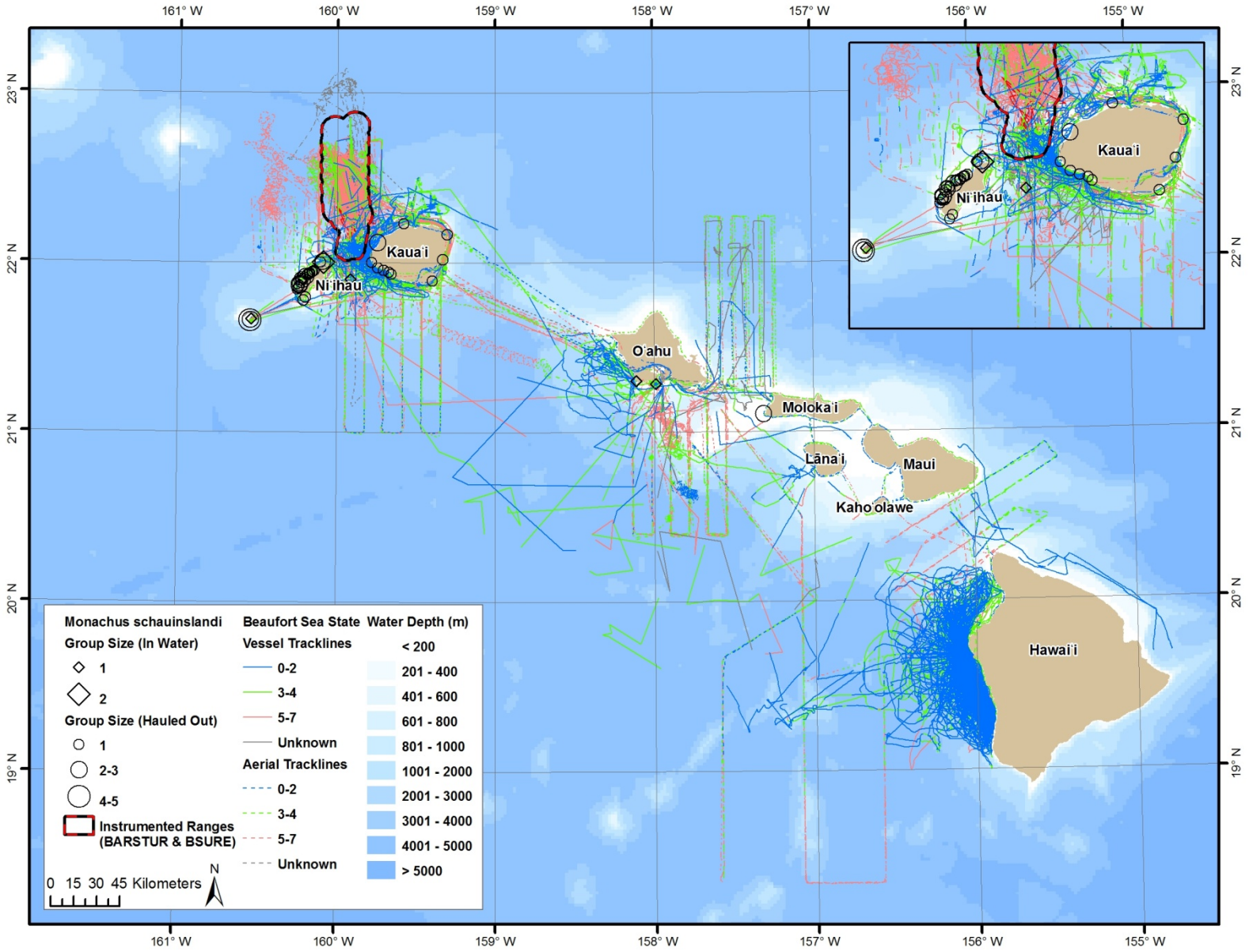

Figure D-12. Hawaiian monk seal (*Monachus schauinslandi*) sightings.

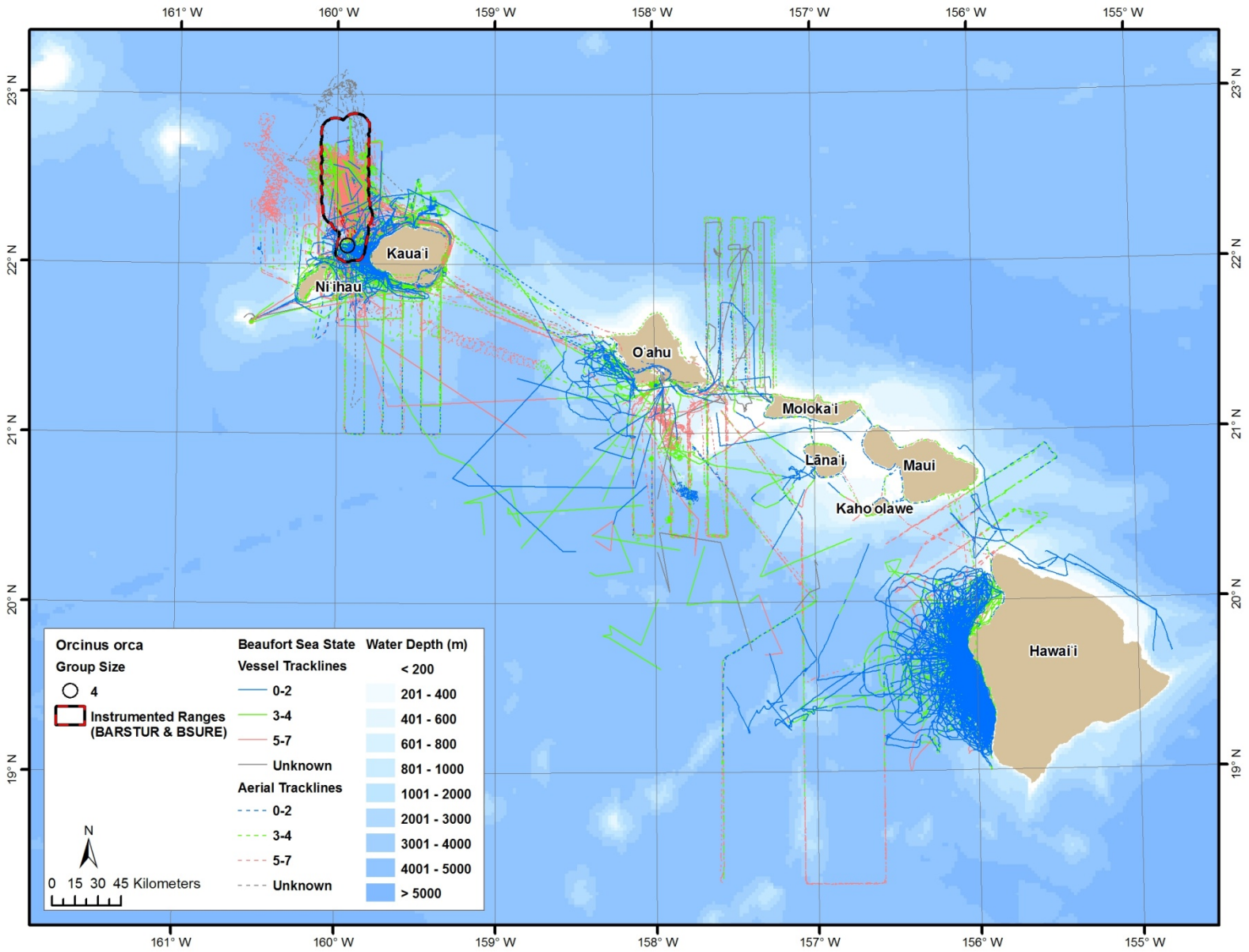

Figure D-13. Killer whale (*Orcinus orca*) sightings.

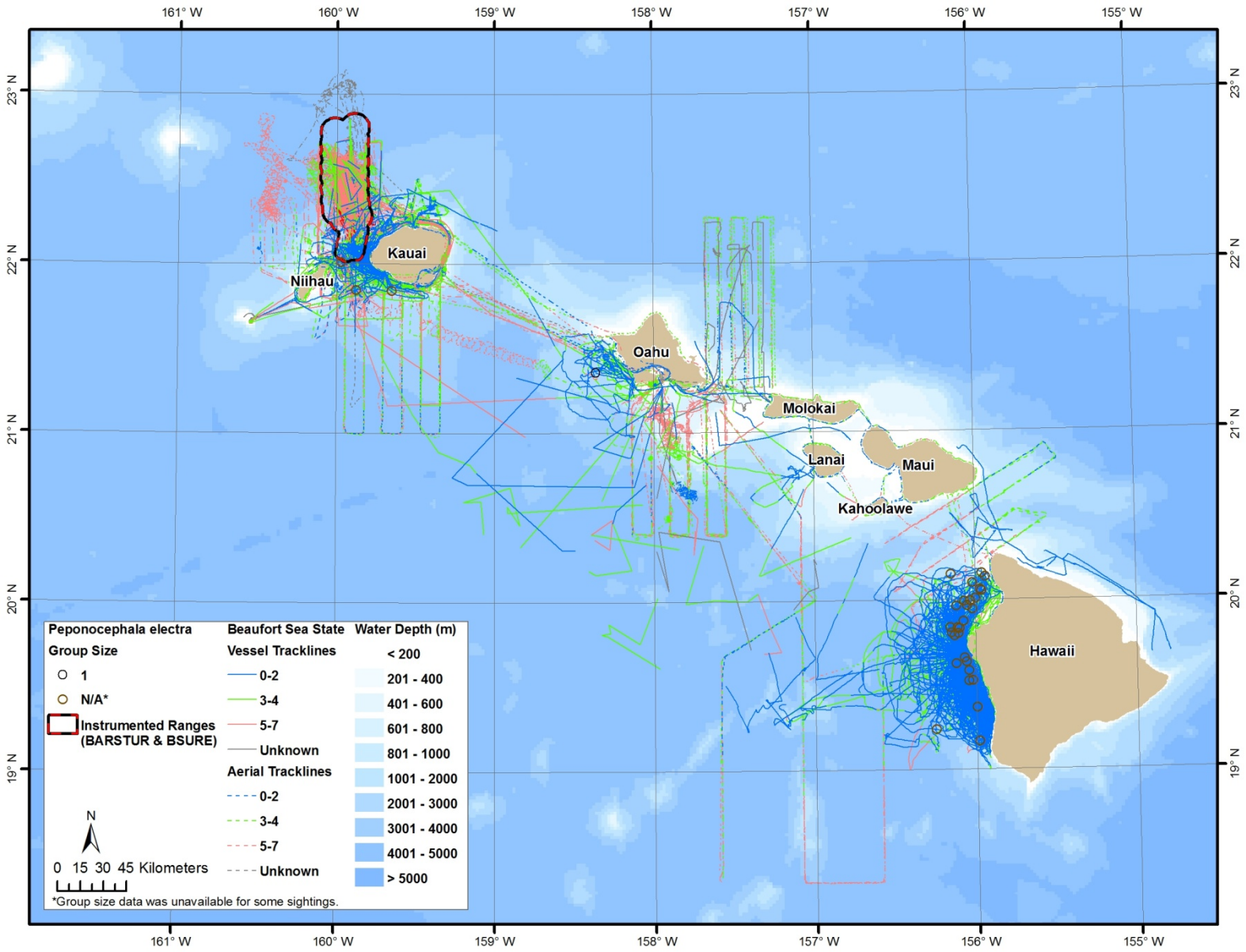

Figure D-14. Melon-headed whale (*Peponocephala electra*) sightings.

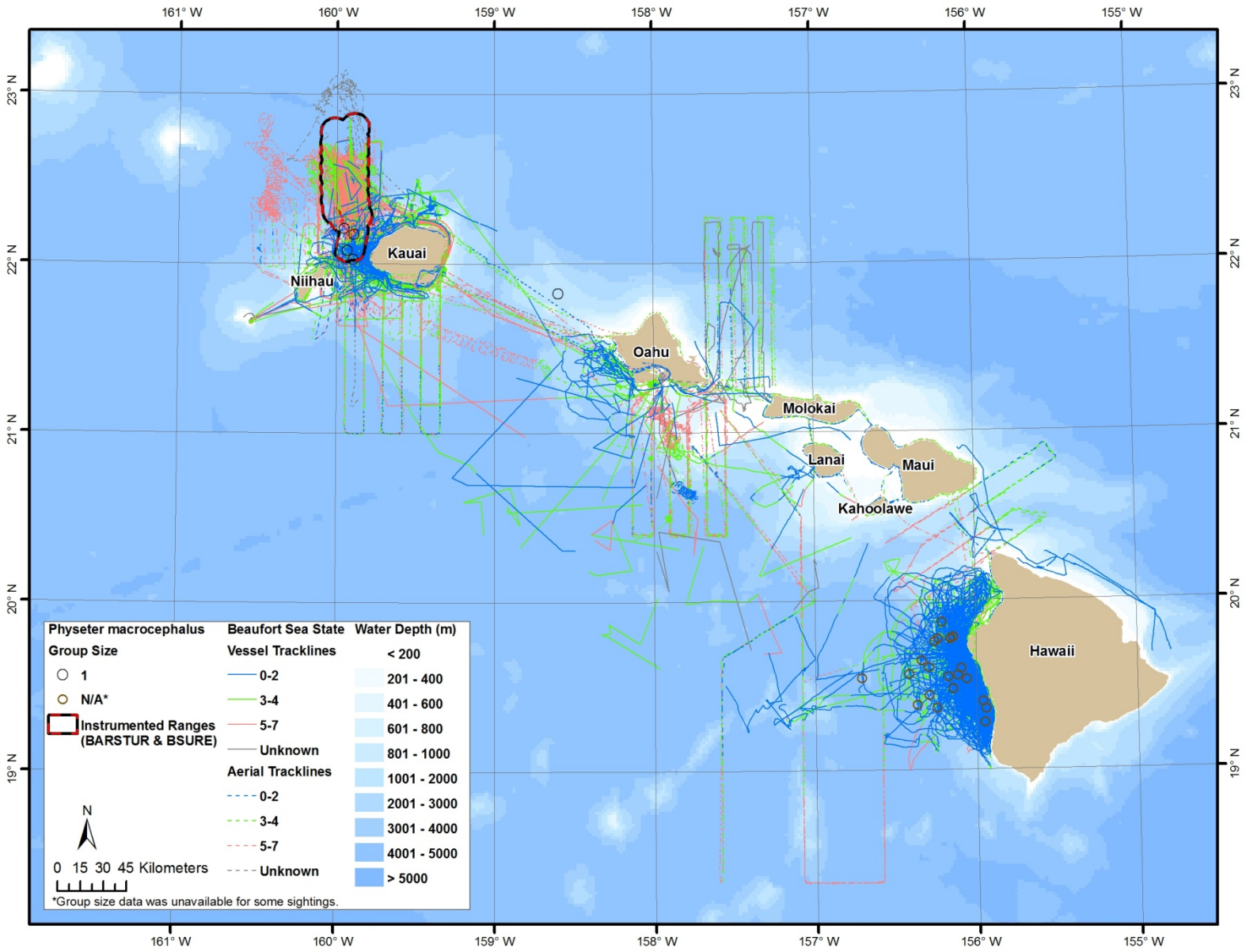

Figure D-15. Sperm whale (*Physeter macrocephalus*) sightings.

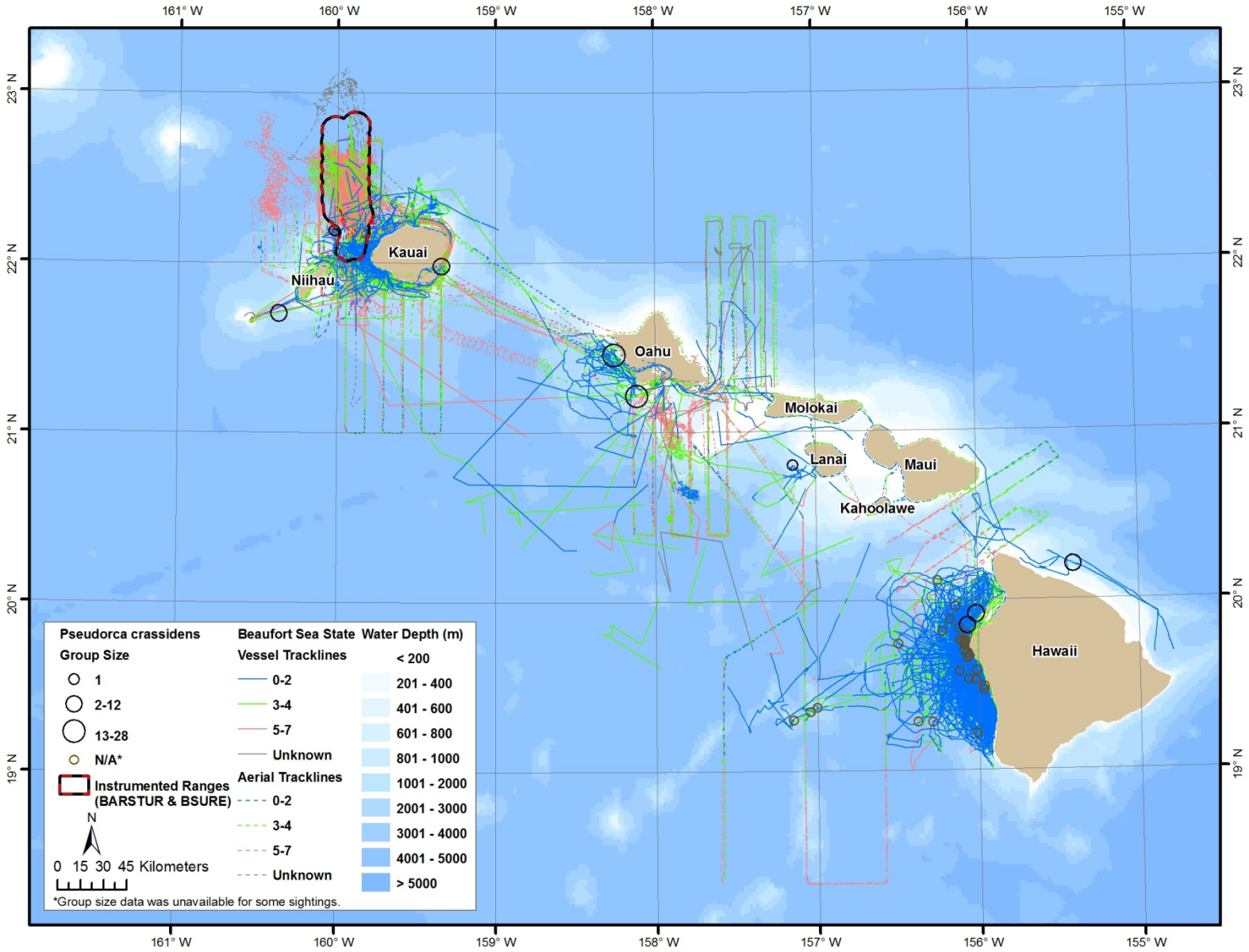

Figure D-16. False killer whale (*Pseudorca crassidens*) sightings.

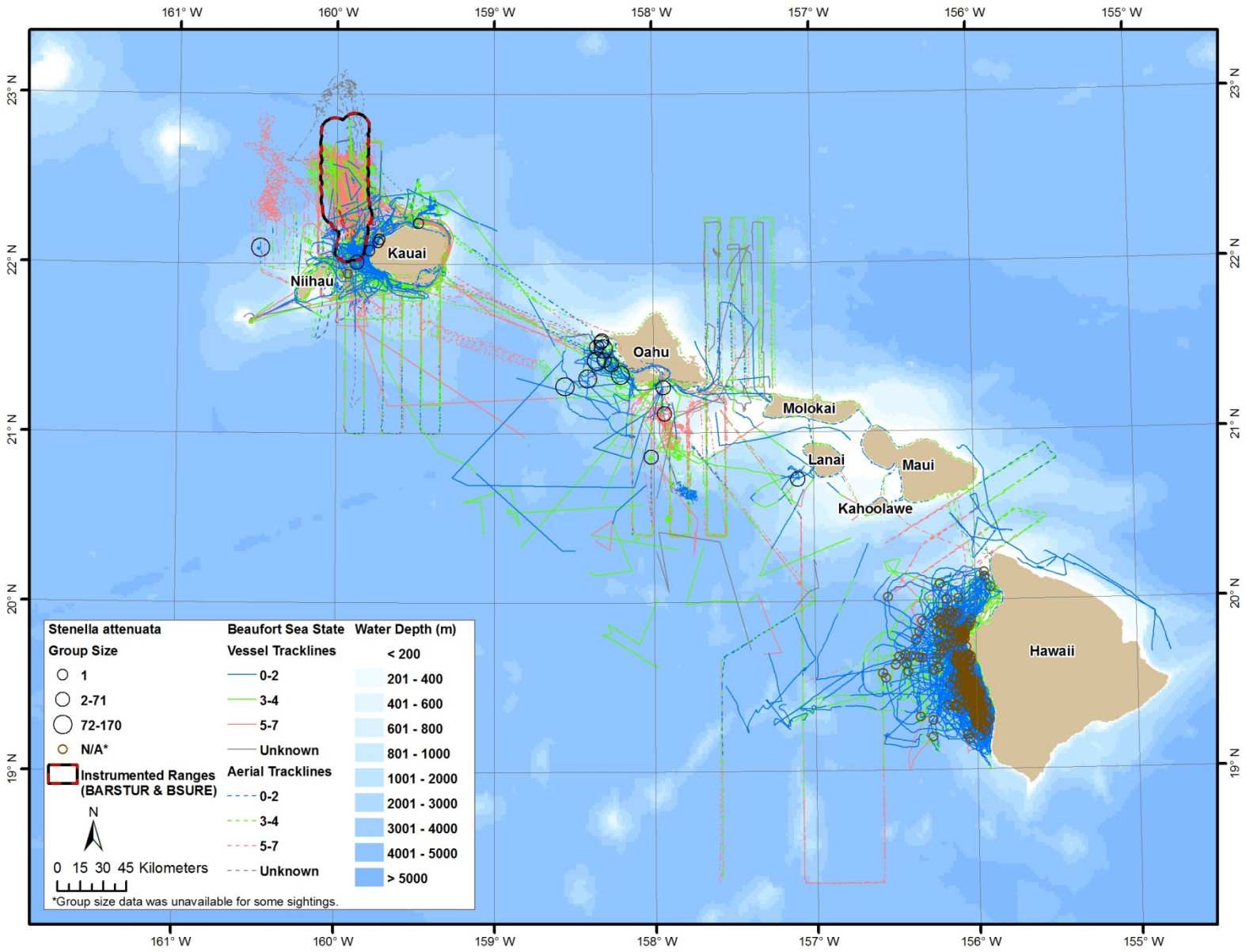

Figure D-17. Pantropical spotted dolphin (*Stenella attenuata*) sightings.

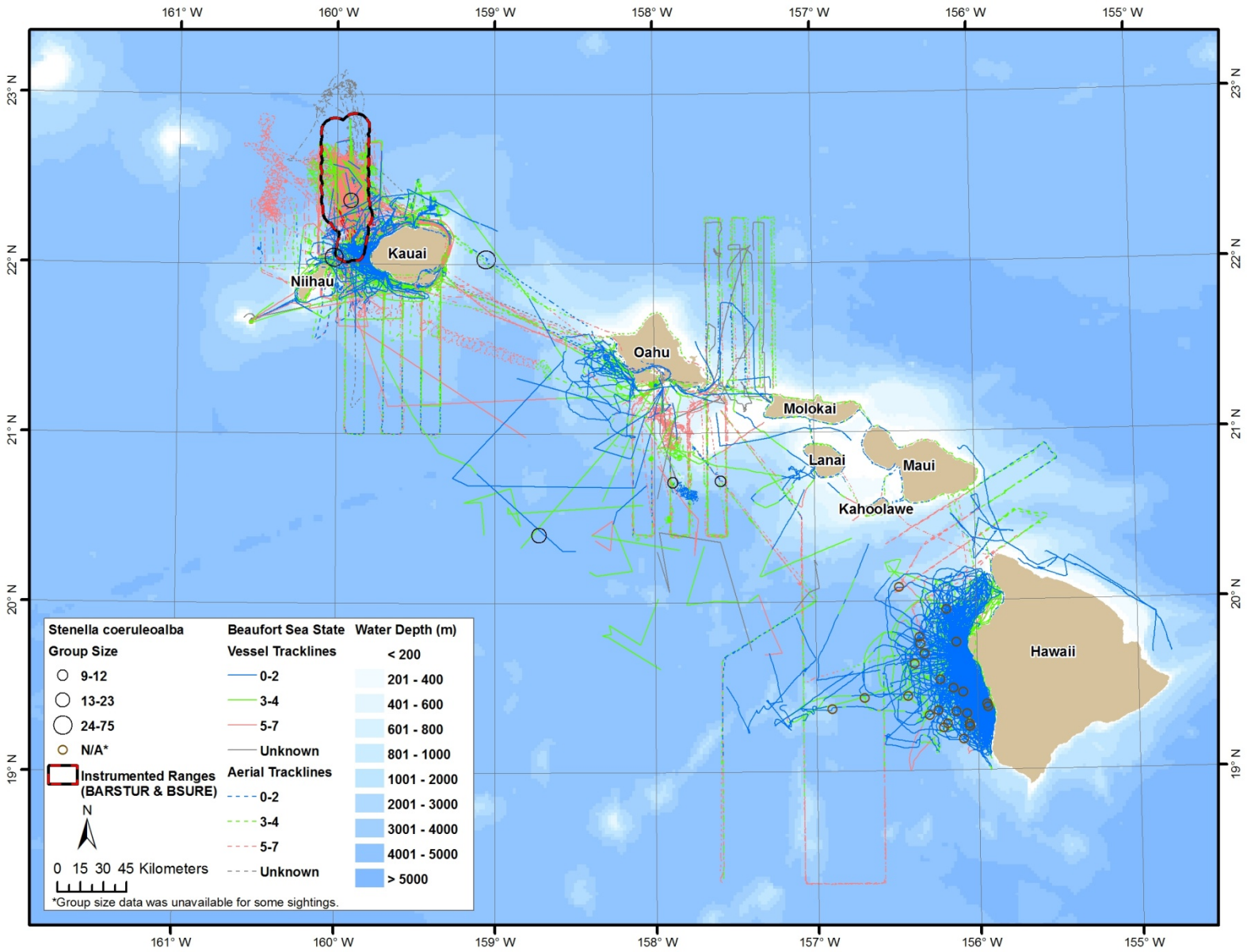

Figure D-18. Striped dolphin (*Stenella coeruleoalba*) sightings.

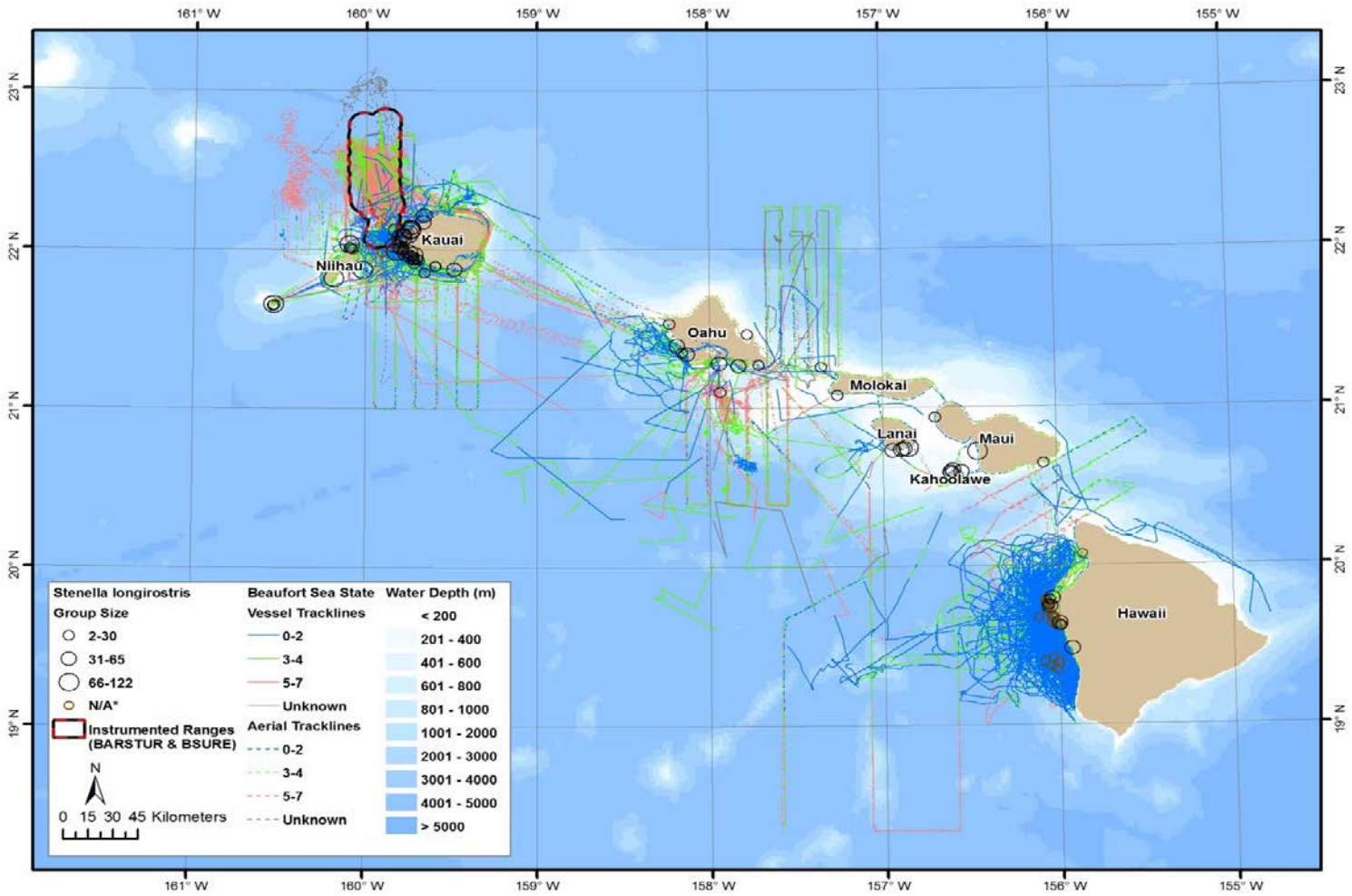

Figure D-19. Spinner dolphin (*Stenella longirostris*) sightings.[4]

[4] Surveys included in the above map: Deepwater Cetacean survey (February 2005); Large Vessel survey (January, 2012); Kaula Island surveys (June 2010 and 2011, February 2011, July 2012); Koa Kai survey (November 2010); LOE surveys (November, 2010); M3R Tagging survey (July/August 2011); Sea Turtle survey (April/May 2011); RIMPAC surveys (July 2008 and 2010); SCC surveys (August 2009, February 2010, February 2012); Small Vessel Tag/Biopsy/Photo-ID surveys (March/April, July, and November/December 2006, August 2007, April/May, June/July, and December 2008, April/May, October, and December 2009, April, July/August, October, and December, 2010, May, August/September, and October/November, 2011, January, May, and June/July, 2012); USWEX surveys (November 2007, May/June 2008, February and February/March 2011).

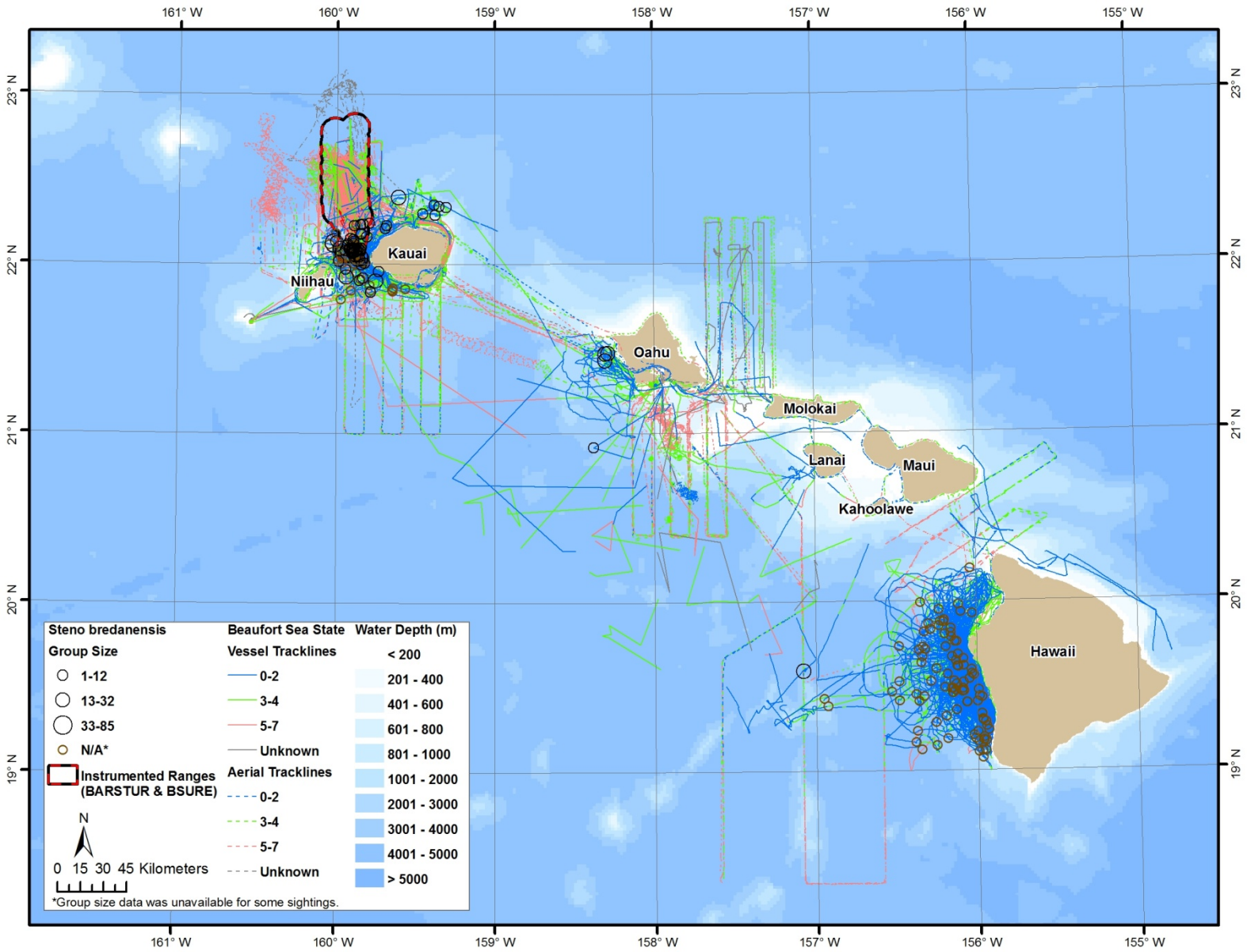

Figure D-20. Rough-toothed dolphin (*Steno bredanensis*) sightings.

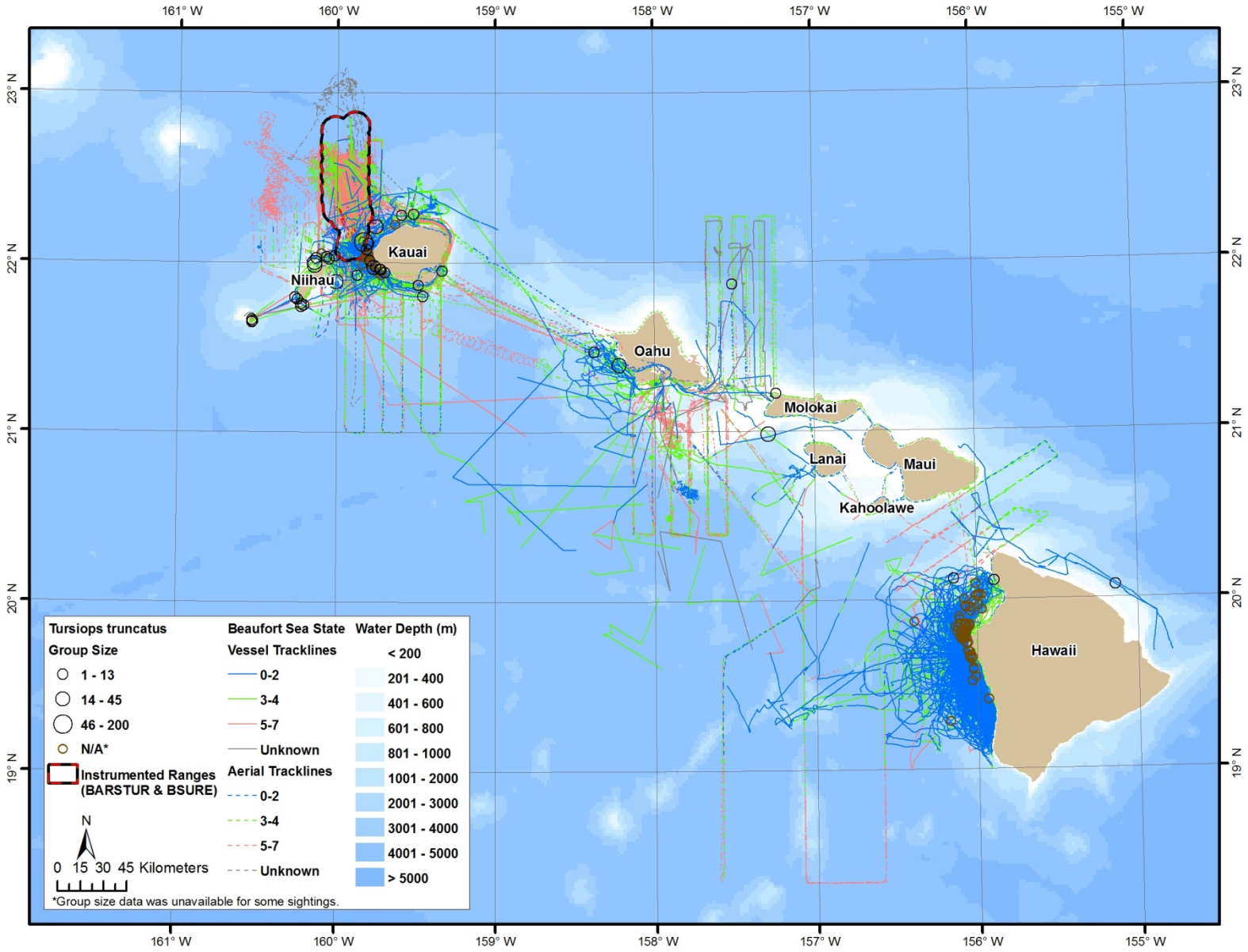

Figure D-21. Bottlenose dolphin (*Tursiops truncatus*) sightings.

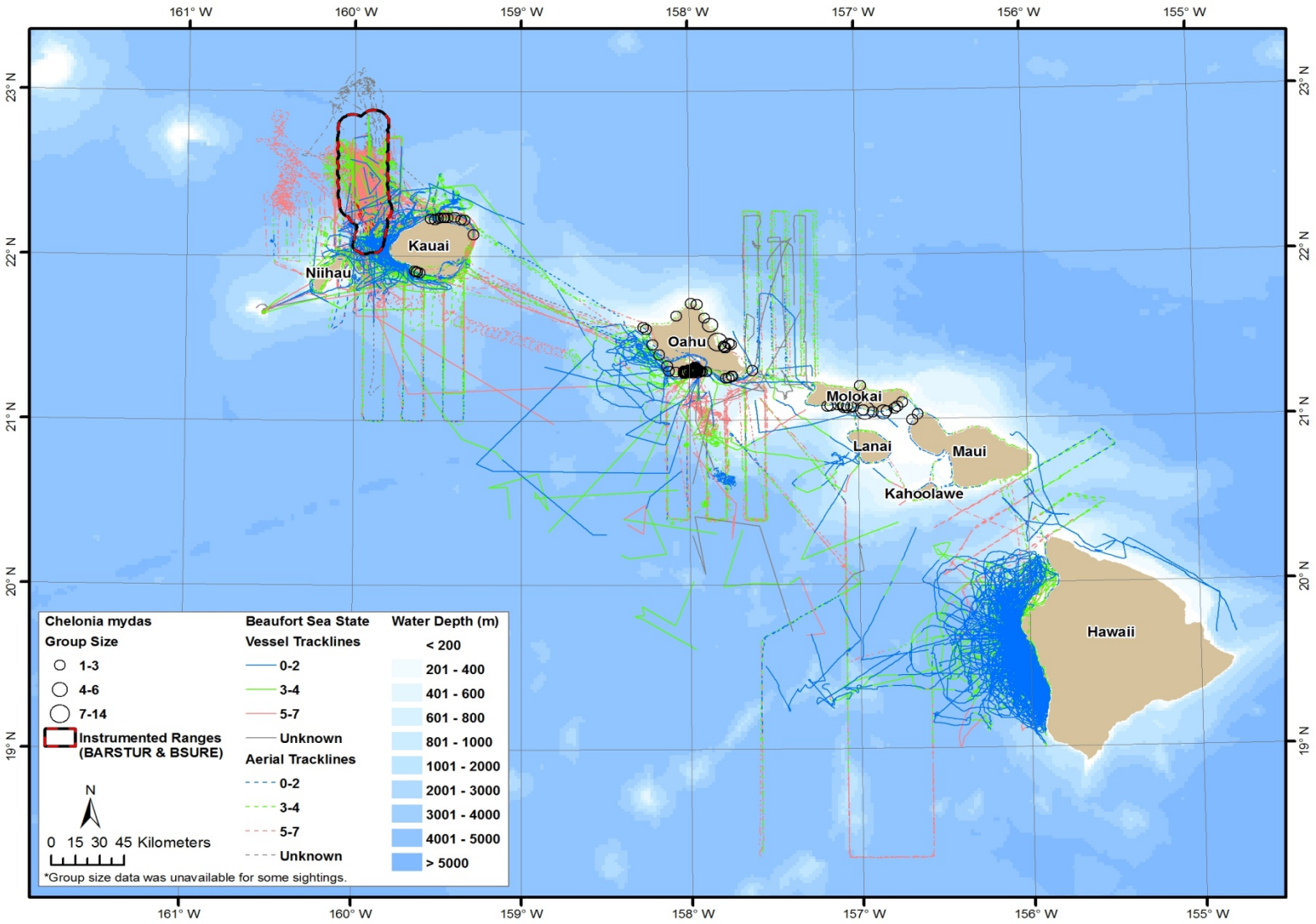

Figure D-22. Green turtle (*Chelonia mydas*) sightings.[5]

[5] Surveys included in the above map: LOE survey (November 2010); SCC survey (February 2012); Sea Turtle surveys (April/May 2011, May 2012); UNDET surveys (June 2009, October 2011); USWEX surveys (November 2007, February 2011).