

NOAA Technical Memorandum NMFS



APRIL 2009

ATLAS OF CETACEAN SIGHTINGS FOR SOUTHWEST FISHERIES SCIENCE CENTER CETACEAN AND ECOSYSTEM SURVEYS: 1986 - 2005



Photograph by Michael Richlen courtesy of NOAA Southwest Fisheries Science Center

Tiffanie A. Hamilton, Jessica V. Redfern, Jay Barlow, Lisa T. Ballance,
Tim Gerrodette, Rennie S. Holt, Karin A. Forney and Barbara L. Taylor

NOAA-TM-NMFS-SWFSC-440

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

The National Oceanic and Atmospheric Administration (NOAA), organized in 1970, has evolved into an agency that establishes national policies and manages and conserves our oceanic, coastal, and atmospheric resources. An organizational element within NOAA, the Office of Fisheries is responsible for fisheries policy and the direction of the National Marine Fisheries Service (NMFS).

In addition to its formal publications, the NMFS uses the NOAA Technical Memorandum series to issue informal scientific and technical publications when complete formal review and editorial processing are not appropriate or feasible. Documents within this series, however, reflect sound professional work and maybe referenced in the formal scientific and technical literature.



NOAA Technical Memorandum NMFS

This TM series is used for documentation and timely communication of preliminary results, interim reports, or special purpose information. The TMs have not received complete formal review, editorial control, or detailed editing.

APRIL 2009

ATLAS OF CETACEAN SIGHTINGS FOR SOUTHWEST FISHERIES SCIENCE CENTER CETACEAN AND ECOSYSTEM SURVEYS: 1986 - 2005

Tiffanie A. Hamilton

Jessica V. Redfern

Jay Barlow

Lisa T. Ballance

Tim Gerrodette

Rennie S. Holt

Karin A. Forney

Barbara L. Taylor

NOAA-TM-NMFS-SWFSC-440

U.S. DEPARTMENT OF COMMERCE

Gary F. Locke, Secretary

National Oceanic and Atmospheric Administration

Jane Lubchenco, Undersecretary for Oceans and Atmosphere

National Marine Fisheries Service

James W. Balsiger, Acting Assistant Administrator for Fisheries

CONTENTS

INTRODUCTION	1
CRUISE SUMMARIES.....	1
<i>Eastern Tropical Pacific (ETP) Cetacean and Ecosystem Assessment Cruises</i>	1
<i>Northern Gulf of California Vaquita Cruise</i>	2
<i>West Coast Marine Mammal and Ecosystem Assessment Surveys</i>	3
<i>Central Pacific Cetacean Surveys</i>	3
<i>Alaska Cetacean Surveys</i>	4
METHODS	5
RESULTS.....	6
REFERENCES	7
TABLES	8
FIGURES	10
APPENDIX I - <i>ETP Cetacean and Ecosystem Assessment Survey Reports</i>	63
APPENDIX II – <i>Northern Gulf of California Vaquita Survey Reports</i>	67
APPENDIX III - <i>West Coast Marine Mammal and Ecosystem Survey Reports</i>	67
APPENDIX IV - <i>Central Pacific Cetacean Survey Reports</i>	68
APPENDIX V - <i>Aerial Survey Reports</i>	69

Atlas of Cetacean Sightings from Southwest Fisheries Science Center Cetacean and Ecosystem Surveys: 1986 – 2005

Tiffanie A. Hamilton, Jessica V. Redfern, Jay Barlow, Lisa T. Ballance, Tim Gerrodette, Rennie S. Holt, Karin A. Forney and Barbara L. Taylor

INTRODUCTION

The Southwest Fisheries Science Center (SWFSC) has surveyed the eastern Pacific Ocean to determine marine mammal abundance and distribution since the mid 1970s. Surveys covered areas from the Bering Sea in the north to Peru in the south and as far west as the Northwest Hawaiian Islands. These efforts have yielded one of the largest collections of marine mammal sightings in the world. These data represent an invaluable resource for understanding how cetaceans are distributed and for addressing marine mammal management and conservation questions.

SWFSC cetacean distribution data have not been mapped in their entirety. Lee (1993) mapped the distribution of cetaceans frequently detected on surveys conducted by the SWFSC from 1974 and 1985. In this report, we plot cruise tracklines and sighting locations for cetacean species that were seen on SWFSC surveys in the eastern Pacific Ocean from 1986 to 2005.

CRUISE SUMMARIES

SWFSC surveys were conducted every year from 1986 to 2005 and collectively covered a wide range of geographic areas. Summaries of survey details are grouped below by five geographic areas. Cruise numbers were assigned to each survey; if two vessels were used on the same survey, each was assigned a distinct cruise number. Cruise numbers, survey dates, and cruise acronyms are given in Table 1 for the 41 distinct cruises conducted by the SWFSC from 1986 to 2005. This report does not plot sightings made on aerial surveys, but information on sightings made on SWFSC aerial surveys is listed in Appendix V.

Eastern Tropical Pacific (ETP) Cetacean and Ecosystem Assessment Cruises

The primary objective of these cruises was to assess the status of dolphin stocks that have been incidentally affected by the yellowfin tuna (*Thunnus albacares*) purse-seine fishery. Dolphin abundance was estimated with data collected using line-transect methods. Studies of dolphin school composition, behavior, acoustics, molecular ecology, and morphological variation were conducted to complement the abundance research. To provide a context for the abundance estimates, ecosystem studies were conducted, including studies of physical and biological oceanography, prey fishes and squids, and other apex predators.

Since 1986, cetacean and ecosystem assessment surveys have been conducted in the eastern

tropical Pacific in eleven different years: a) a five-year series (1986 – 1990) known as Monitoring of Porpoise Stocks (MOPS), b) a two-year series (1992 and 1993) known as Population of *Delphinus* Stocks (PODS), c) a three-year series (1998 – 2000) known as *Stenella* Population Abundance Monitoring (SPAM – 1998) and *Stenella* Abundance Research (STAR – 1999, 2000), and d) a STAR survey in 2003. Cruise tracklines and associated Beaufort sea states are depicted in Figures 2a-c. The study area extends from the US-Mexico border to the territorial waters of Peru (30° north to 18° south); it is bounded on the east by the continental shores of the Americas and to the west by Hawaii (153° west). Each survey differed somewhat in its study area boundaries, but all cruises followed the same general protocols. Three National Oceanic and Atmospheric Administration (NOAA) research ships (R/V *David Starr Jordan*, R/V *McArthur*, and R/V *McArthur II*) and one UNOLS ship (R/V *Endeavor*) were used; in most years, two NOAA ships worked simultaneously in different parts of the study area for approximately 4 months.

Details on the cetacean and ecosystem research conducted between 1986 and 2003 can be found in the list of NOAA Technical Memoranda in Appendix I. Additional information is available at <http://swfsc.noaa.gov/PRD-star.aspx>.

Northern Gulf of California Vaquita Cruise

The vaquita (*Phocoena sinus*) is an endangered porpoise endemic to a small area in the northern Gulf of California. The immediate threat to vaquita is bycatch in gillnet fisheries in the upper Gulf. The overall objective of this joint project conducted between the US National Marine Fisheries Service (NMFS) and the Mexican Instituto Nacional de Pesca (INP) in 1997 was to collect data to estimate the abundance of the vaquita. The secondary objective was to collect biological and oceanographic data to characterize vaquita habitat.

The study area for the cruise was the northern end of the Gulf of California, where the Colorado River flows into the Gulf. The southern boundary points for the study area were Punta Final (29° 46' N) on the west side of the Gulf, and Punta Jaghey (30° 48' N) on the east side, in waters less than 100 meters. A grid of tracklines was designed to cover this entire area, with the highest coverage in the area with the most historical sightings. Cruise tracklines and associated Beaufort sea states are depicted in Figure 2c.

Three vessels collected line-transect data. The R/V *David Starr Jordan*, a NOAA research ship, was the main vessel and surveyed the deep portions of the study area. The Buque de Investigacion Pesquera (BIP) XI, an INP research vessel that was converted from a 74 foot shrimp trawler, worked in conjunction with the DSJ to complete the survey. The BIP XI surveyed shallow water areas (i.e., less than 20 meters deep) around the coastline of the Gulf. A small open boat, called a panga, was used to survey in very shallow waters at the extreme north of the Gulf. Marine mammal surveys were also conducted on the R/V *David Starr Jordan* during the transit between the study area and San Diego.

Selected vaquita publications are in Appendix II. Specific results from the 1997 cruise can be found in Jaramillo-Legorreta et al. (1999). General information about the vaquita is available at

http://www.vaquitarina.org/english/info_gral.php.

West Coast Marine Mammal and Ecosystem Assessment Surveys

The primary objective of the West Coast marine mammal surveys was to estimate the abundance of all cetacean species within this area using line-transect methods. To increase our understanding of cetacean abundance trends and distribution patterns, the pelagic ecosystem was characterized through the collection of underway and station-based biological and oceanographic data, seabird studies, and acoustic sampling. Biopsy sampling and photo-identification studies were also conducted for species of special interest.

Ship surveys of marine mammal abundance were conducted within 300 nautical miles of the US West Coast in 1991, 1993, 1996, 2001, and 2005. Cruise tracklines and associated Beaufort sea states are shown in Figure 2d. Each survey differed somewhat in the goals and study area boundaries, and different names and acronyms were used, but all followed the same survey protocols. Three NOAA research ships were used on these surveys (R/V *David Starr Jordan*, R/V *McArthur*, and R/V *McArthur II*), often with two ships being used in the same year for different parts of the survey.

The California Marine Mammal Survey (CAMMS) in 1991 surveyed only those waters offshore of California. The CAMMS survey followed a uniform grid of tracklines between the coast and approximately 300 nmi offshore and also included circumnavigations of most of the Channel Islands in Southern California. The Populations of *Delphinus* Stocks (PODS) survey in 1993 covered the CAMMS study area using a sparser sampling grid, but also covered the range of *Delphinus* species (*D. delphis* and *D. capensis*) along the west coast of Baja California, Mexico, and in the Gulf of California. Although the PODS survey emphasized abundance estimation for these two species, data for all species were collected using the same protocols as other West Coast surveys. The Oregon, California, Washington Line-transect Experiment (ORCAWALE) surveys in 1996 and 2001 expanded the study area to include waters off Oregon and Washington. The Collaborative Survey of Cetacean Abundance and the Pelagic Ecosystem (CSCAPE) in 2005 covered the study area (CA, OR and WA) with a uniform survey grid, but also included more intensive survey efforts within several of the NOAA National Marine Sanctuaries on the US West Coast. Additional references to West Coast Surveys are given in Appendix III.

Central Pacific Cetacean Surveys

Ship surveys of cetacean abundance in the central Pacific have been conducted by the SWFSC in 1997, 2002, and 2005. Cruise tracklines and associated Beaufort sea states are shown in Figure 2e. Each survey differed somewhat in the goals and areas surveyed, and different names and acronyms were used, but all followed the same line-transect survey protocols. Three NOAA research ships were used on these surveys (R/V *David Starr Jordan*, R/V *McArthur*, and R/V *McArthur II*).

The Sperm Whale Abundance and Population Structure (SWAPS) survey in 1997 was designed to estimate the abundance of sperm whales (*Physeter macrocephalus*) in the eastern temperate

Pacific and to study sperm whale genetic population structure by collecting biopsy samples. This survey was conducted in the spring to coincide with the presumed breeding season of sperm whales. This survey was preceded and followed by two shorter cruises in the same year (TTOP – Tagging and Tracking of *Physeter*), which also studied sperm whales and collected sighting data for other species off the California coastline. A summary of the three cruises (SWAPS and two TTOPs cruises) can be found in a joint cruise report (NMFS-SWFSC, unpublished). Sperm whale data from SWAPS were used to estimate the abundance of sperm whales in the study area (Barlow and Taylor 2005).

The Hawaiian Island Cetacean and Ecosystem Assessment Survey (HICEAS) in 2002 was designed to estimate the abundance of all cetacean species within the U.S. Exclusive Economic Zone (EEZ) around the Hawaiian Islands (Barlow 2006). The Pacific Island Cetacean and Ecosystem Assessment Survey (PICEAS) in 2005 was designed to estimate the abundance of all cetacean species within the EEZ around Palmyra Atoll, Kingman Reef, and Johnston Atoll, and in the waters between those islands and the Hawaiian Islands. A summary of the PICEAS survey results can be found in the cruise report (NMFS-SWFSC, unpublished). Both the HICEAS and PICEAS surveys included transits to and from the U.S. West Coast during which standard survey methods were used. Survey reports are listed in Appendix IV.

Alaska Cetacean Surveys

The Aleutian Island Marine Mammal Survey (AIMMS) was a two-part survey, conducted during July 1994 off the coasts of Oregon and Washington, and during August 1994 along the Aleutian Islands in Alaska using the NOAA R/V Surveyor. The study was a collaborative effort between the NMFS, the U.S. Navy, the Pacific Marine Environmental Laboratory, Scripps Institution of Oceanography, Oregon State University, and the University of Washington. The first part of the cruise was designed to test the U.S. Navy's Integrated Underseas Surveillance Systems as a tool for investigating the movements and abundance of large whales. The primary objective of Leg 1 was to collect underwater acoustic recordings in the presence of large whales off Oregon and Washington to verify species identification. On Leg 2, a line transect survey was conducted south of the Aleutian Islands, Alaska, with the objective of obtaining information on the present abundance and distribution of large whales in the region of historical whaling activity south of the Aleutian Islands. Line transect methods were applied along a set of 11 transects located south of the Aleutian Islands between Kodiak Island and Tanaga Island and extending approximately 200 nmi (370 km) southward and offshore. Blue whales (*Balaenoptera musculus*) and humpback whales (*Megaptera novaeangliae*) were of particular interest, but sighting information was recorded for all encountered cetacean species. In addition, acoustic recordings, tissue samples, and photographs of individual whales were opportunistically collected.

The North Pacific Right Whale Study (NORTH PAC) in 2002 was a dedicated study of the highly endangered right whale (*Eubalaena japonica*) population in the eastern Bering Sea using the NOAA R/V *McArthur*. The first leg of survey effort included a transit from Seattle through the Gulf of Alaska to Kodiak Island. The subsequent legs primarily included survey effort within a defined area in the southeastern Bering Sea where right whales had been previously seen. Sightings of all species were recorded on this survey, although the emphasis was on finding,

photographing and obtaining biopsy samplings from right whales.

The Structure of Populations Levels of Abundance and Status of Humpbacks (SPLASH) survey in 2004 was part of a Pacific basin-wide collaborative project to study humpback whales. The NOAA R/V *McArthur II* was used to survey waters from British Columbia through Southeast Alaska, the Gulf of Alaska, Kodiak Island, the Alaska Peninsula, the Aleutian Island Chain, and the southeastern Bering Sea. The primary focus of the cruise was to obtain individual identification photographs of humpback whale flukes and to obtain biopsy samples of humpback whales for genetic and pollutant studies. During this survey, however, cetacean sightings were recorded for all species.

Cruise tracklines and associated Beaufort sea states for all Alaskan surveys are shown in Figure 2f.

METHODS

On all surveys, effort was comprised of three observers searching for cetaceans. Two observers used high power (25 x 150) “bigeye” binoculars mounted on the port and starboard sides of the ships’ flying decks to scan from 10° on the opposite the trackline (i.e., just across the bow of the vessel) to 90° perpendicular. The third observer, the designated data recorder, used handheld 7 x 50 binoculars and naked eye to scan the entire 180° in front of the ship.

Cetaceans were identified to the lowest possible taxonomic level based on morphological characteristics. It is difficult to differentiate species of the genus *Globicephala* in the field, but *G. melas* is not known to occur north of the Equator in the Pacific Ocean. All *Globicephala* sightings north of the Equator were classified as *G. macrorhynchus* and sightings south of the equator were classified as unidentified *Globicephala* spp. unless they could be unambiguously classified to species. Kinzey et al. (2000) provide a thorough description of the SWFSC marine mammal data collection procedures on research ship line-transect surveys.

During each survey, line-transect data were recorded in ASCII files as a series of spatially referenced events, such as a sighting or change in effort, observers, and conditions. For example, Beaufort sea state was recorded because it affects the probability of detecting cetaceans (Barlow et al. 2001). When a sighting occurred, observers independently recorded three group size estimates: low, best, and high. If a sighting contained multiple species, observers estimated the percentage of each species in the group.

We used Perl programs to extract transect and sighting data from the ASCII files. It was assumed that the ship traveled in a straight line between events; consequently, transects were composed of a series of straight-line segments connecting on-effort events. We differentiated between effort on planned transects and effort during transit to planned transects. Typically, the Beaufort sea state was entered immediately following the start of a segment. In those cases where it was not entered immediately, the Beaufort sea state recorded closest in time to the start of the segment was assigned to the segment. A new segment was created when Beaufort sea state changed.

Sighting data extracted from the ASCII files for each species included Beaufort sea state, effort (both off- and on-effort sightings were output; on-effort sightings were differentiated into the effort categories described for the transects), whether it was a mixed species sighting, and group size. The best estimate from each observer was averaged to obtain a single group size estimate for each sighting. For sightings containing multiple species, we averaged the percentage of each species estimated by the observers. If none of the observers provided a best estimate for group size, the average of low estimates for group size was used. If both best estimates and low estimates for group size or an estimate for the percentage of species in mixed groups were missing, the sighting was excluded from the map.

Cruise tracklines, Beaufort sea states, and sighting data were mapped in ArcGIS (ARCGIS version 9.2, ESRI, Inc.). Maps are presented in a Lambert azimuthal equal-area projection. This projection is suited for mapping large regions such as ocean basins; it also preserves direction and the area of individual polygons. Consequently, shapes are minimally distorted and distance is accurate at the center of the map (Kennedy and Kopp 2000).

Each map depicts a species' distribution as well as cruise tracklines (1986-2005) to show the areas that were surveyed but in which no sightings occurred. A three color gradient differentiates between both group sizes and Beaufort sea states. Breaks in group size were chosen such that a near even distribution was depicted. In the case of sperm whales, the smallest group size was set to one animal. These are often solitary males, which exhibit different behaviors than males found in female groups (Whitehead 2003). Breaks in Beaufort sea state were chosen by the severity of the sea state.

RESULTS

Cruise tracklines are presented in Figure 1. Beaufort sea states are shown by geographical location in Figures 2a-f. Details of the cruises are listed in Table 1. Distributional maps of cetaceans occurring in the eastern Pacific Ocean and cruise tracklines from 1986 to 2005 are shown in Figures 3 to 51. Distributions were not mapped for species that were encountered infrequently (Table 2).

The maps are presented in alphabetical order by genus and species. Those species with few sightings are excluded from the atlas (Table 2). For example, gray whales (*Eschrichtius robustus*), although relatively abundant, are not included in the atlas because their migration pattern does not coincide with the survey areas during the August – December cruises.

Four species of Mesoplodonts (*Mesoplodon carlhubbsi*, *Mesoplodon densirostris*, *Mesoplodon pacificus*, and *Mesoplodon stejnegeri*) were rarely encountered; these species are presented on one map (Figure 26). Pitman and Lynn (2001) found unidentified *Mesoplodon* sp. (species code 083) to be males of *Mesoplodon peruvianus*. Therefore, sightings for these two species are compiled in a single map entitled, *Mesoplodon peruvianus* (Figure 27).

REFERENCES

- Barlow J., T. Gerrodette, and J. Forcada. 2001. Factors affecting perpendicular sighting distances on shipboard line-transect surveys for cetaceans. *J Cetacean Res Manage* 3:201-212
- Barlow, J. and B. L. Taylor. 2005. Estimates of sperm whale abundance in the northeastern temperate Pacific from a combined acoustic and visual survey. *Marine Mammal Science* 21:429-445.
- Barlow, J. 2006. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. *Marine Mammal Science* 22(2):446-464.
- Jaramillo-Legorreta, A. M., L. Rojas-Bracho, and T. Gerrodette. 1999. A new abundance estimate for vaquitas: first step for recovery. *Marine Mammal Science* 15:957-973.
- Kennedy, M. and S. Kopp. 2000. *Understanding Map Projections: GIS by ESRI*. ArcGIS 8 concept guides. Redlands, CA: ESRI, Inc. 116pp.
- Kinzey, D., T. Gerrodette, J. Barlow, A. Dizon, W. Perryman, and P. Olson. 2000. Marine mammal data collected during a survey in the eastern tropical Pacific Ocean aboard the NOAA ships McArthur and David Starr Jordan, July 28 - December 9, 1999. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-293. 89pp.
- Lee, T. 1993. Summary of cetacean survey data collected between the years of 1974 and 1985. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-181. 184pp.
- Pitman, R.L. and M. S. Lynn. 2001. Biological observations of an unidentified mesoplodont whale in the eastern tropical Pacific and probable identity: *Mesoplodon peruvianus*. *Marine Mammal Science* 17(3):648-657.
- Whitehead, H. 2003. Sperm whales: Social evolution in the ocean. University of Chicago Press, Chicago, IL.

Table 1. Summary of cetacean and ecosystem cruises, 1986-2005.

Cruise Number	Date	Research		Survey Region	Cruise Acronym and Definition	
		Vessel			MOPS	Monitoring of Porpoise Stocks
0989	Jul-Dec 1986	Jordan		Eastern Tropical Pacific (ETP)		
0990	Jul-Dec 1986	McArthur		ETP	MOPS	
1080	Jul-Dec 1987	McArthur		ETP	MOPS	
1081	Aug-Dec-1987	Jordan		ETP	MOPS	
1164	Jul-Dec 1988	Jordan		ETP	MOPS	
1165	Jul-Dec 1988	McArthur		ETP	MOPS	
1267	Jul-Dec 1989	Jordan		ETP	MOPS	
1268	Jul-Dec 1989	McArthur		ETP	MOPS	
1369	Jul-Dec 1990	Jordan		ETP	MOPS	
1370	Jul-Dec 1990	McArthur		ETP	MOPS	
1426	Jul-Nov 1991	McArthur		California	CAMMS	California Marine Mammal Survey
1467	Jul-Nov 1992	McArthur		ETP	PODS	Population of <i>Delphinus</i> Stocks
1468	Jul-Nov 1992	Jordan		ETP	PODS	
1508	Jul-Nov 1993	McArthur		U.S. West Coast/ Mexico	PODS	
1509	Jul-Nov 1993	Jordan		U.S. West Coast/ Mexico	PODS	
1546	Jul-Aug 1994	Surveyor		Alaska	AIMMS	Aleutian Islands Marine Mammal Survey
1601	Sep-Nov 1995	McArthur		ETP	CADDIS	Cetacean Acoustic Detection and Dive Interval Studies
1604	Jul-Nov 1996	McArthur		U.S. West Coast	ORCAWALE	Oregon, California, and Washington Marine Mammal Survey
1605	Sep-Nov 1996	Jordan		U.S. West Coast	ORCAWALE	
1606	Feb-Mar 1997	McArthur		U.S. West Coast	T-Top	
1607	Mar-Jun 1997	McArthur		Central Pacific	SWAPS	Sperm Whale Abundance and Population Structure Survey
1608	Aug-Sep 1997	Jordan		ETP	VAQT	Vaquita Survey
1609	Oct 1997	Jordan		U.S. West Coast	T-TOP2	
1610	Jul-Dec 1998	McArthur		ETP	SPAM	<i>Stenella</i> Population Abundance Monitoring survey

Table 1. Summary of cetacean and ecosystem cruises, 1986-2005.

Cruise Number	Research		Cruise Acronym and Definition		
	Date	Vessel	Survey Region		
1611	Jul-Dec 1998	Endeavor	ETP	SPAM	Stenella Abundance Research project
1612	Jul-Dec 1998	Jordan	ETP	SPAM	
1613	Jul-Dec 1999	Jordan	ETP	STAR	
1614	Jul-Dec 1999	McArthur	ETP	STAR	
1615	Jul-Dec 2000	Jordan	ETP	STAR	
1616	Jul-Dec 2000	McArthur	ETP	STAR	
1617	Jul-Nov 2001	Jordan	U.S. West Coast	ORCAWALE	
1619	Nov-Dec 2001	McArthur	U.S. West Coast	ORCAWALE	North Pacific Right Whale Study
1620	Jul-Sep 2002	McArthur	Alaska	NORTH PAC	
1621	Jul-Dec 2002	Jordan	Central Pacific	HICEAS	
1622	Oct-Dec 2002	McArthur	Central Pacific	HICEAS	Structure of Populations, Levels of Abundance and Status of Humpbacks
1623	Jul-Dec 2003	McArthur II	ETP	STAR	
1624	Jul-Dec 2003	Jordan	ETP	STAR	
1625	Jun-Nov 2004	McArthur II	Alaska	SPLASH	
1627	Jun-Jul 2005	McArthur II	U.S. West Coast	CSCAPE	Collaborative Survey of Cetacean Abundance and the Pelagic Ecosystem
1628	Aug-Dec 2005	Jordan	U.S. West Coast	CSCAPE	Pacific Islands Cetacean Ecosystem Assessment Survey
1629	Jul-Nov 2005	McArthur II	Central Pacific	PICEAS	

Table 2. Species excluded from the atlas due to few or no sightings.

Species Code	Species	Standard Common Name
035	<i>Globicephala melas</i>	Long-finned pilot whale
042	<i>Phocoena spinipinnis</i>	Burmeister's porpoise
045	<i>Delphinapterus leucas</i>	White whale
050	<i>Hyperoodon planifrons</i>	Southern bottlenose whale
053	<i>Mesoplodon hectori</i>	Hector's beaked whale
056	<i>Mesoplodon bidens</i>	Sowerby's beaked whale
057	<i>Mesoplodon ginkgodens</i>	Ginkgo-toothed beaked whale
060	<i>Mesoplodon layardii</i>	Strap-toothed beaked whale
069	<i>Eschrichtius robustus</i>	Gray whale

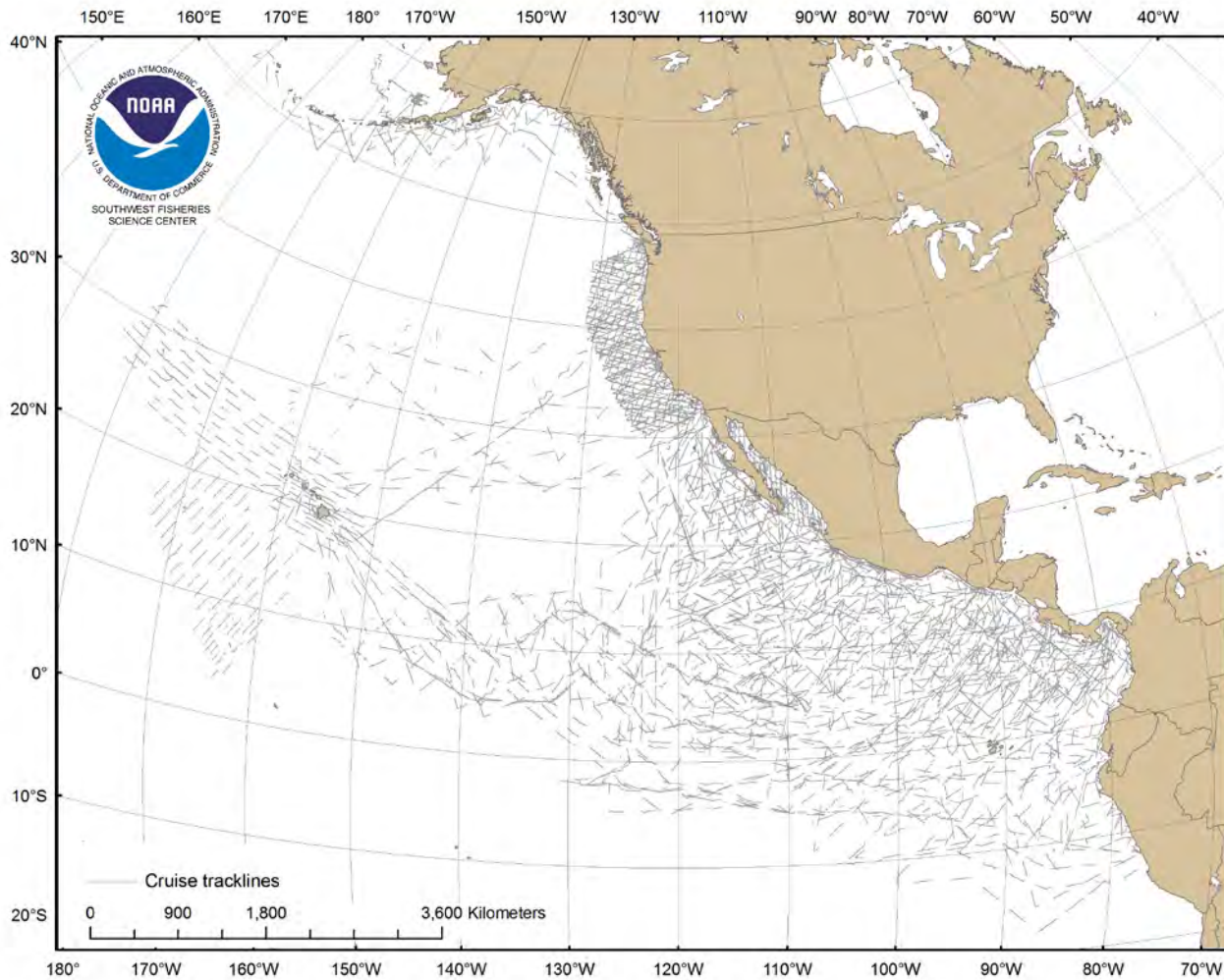
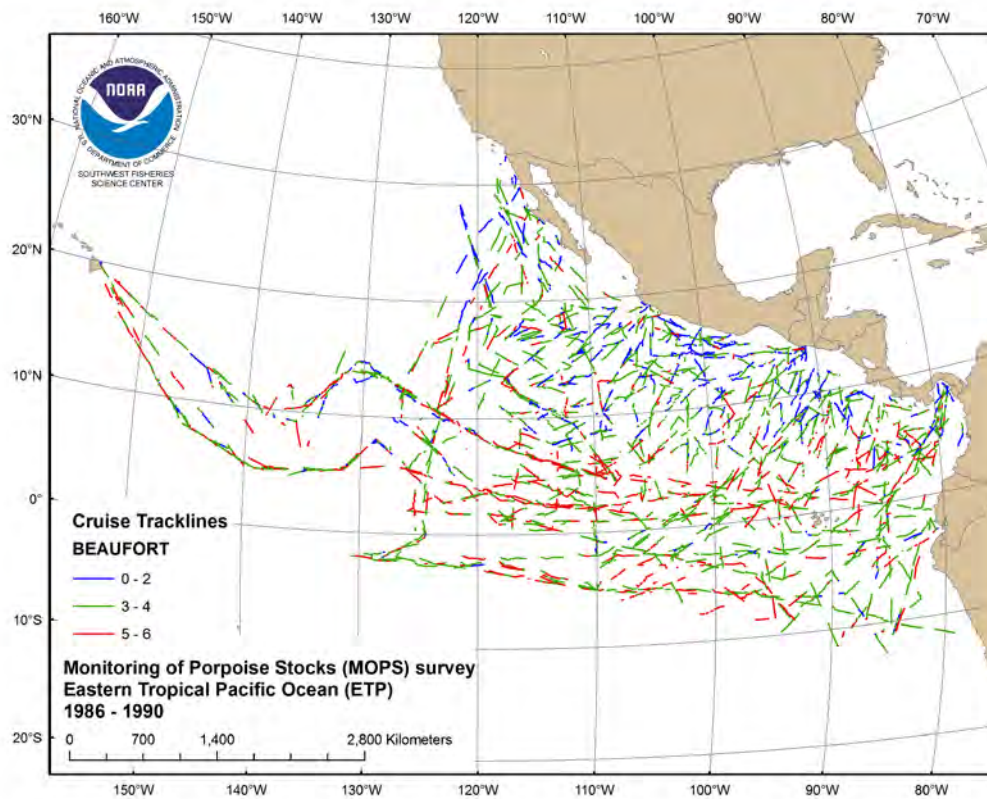
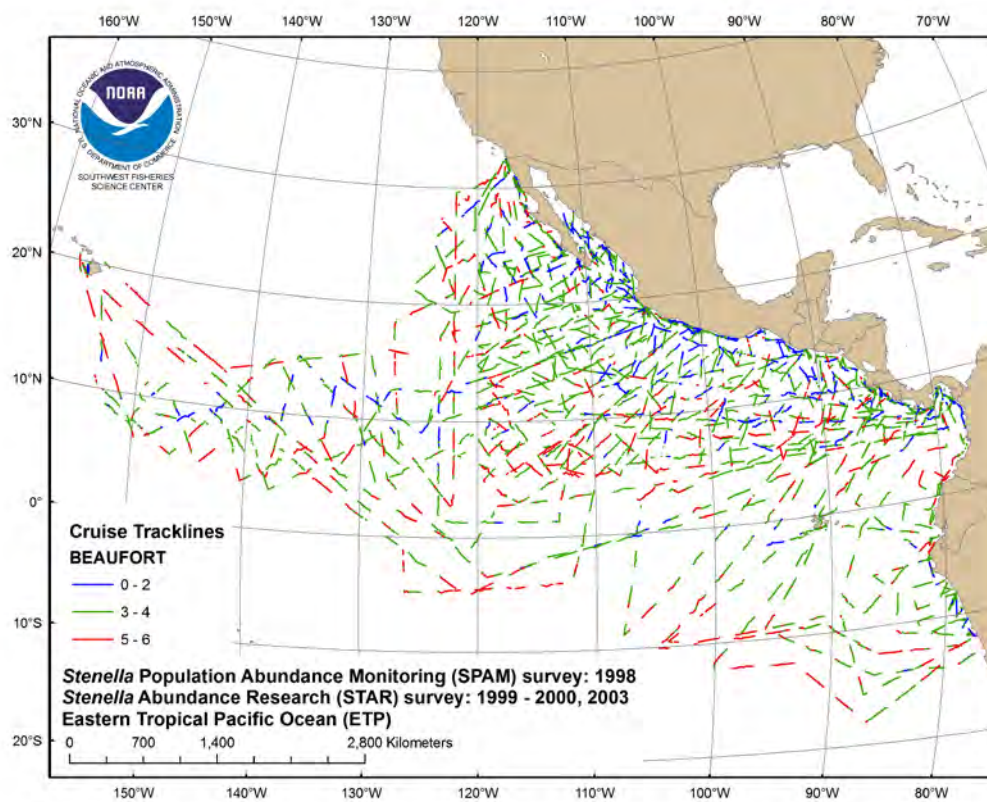


Figure 1. Cruise tracklines surveyed by the Southwest Fisheries Science Center, 1986-2005.

a.

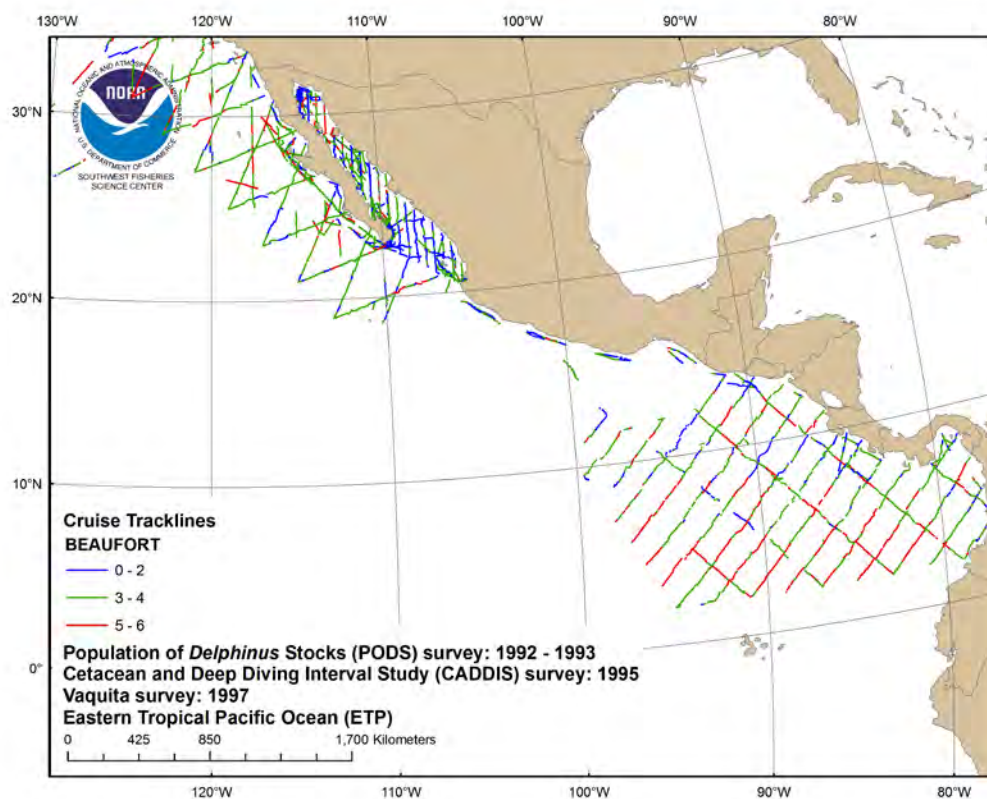


b.

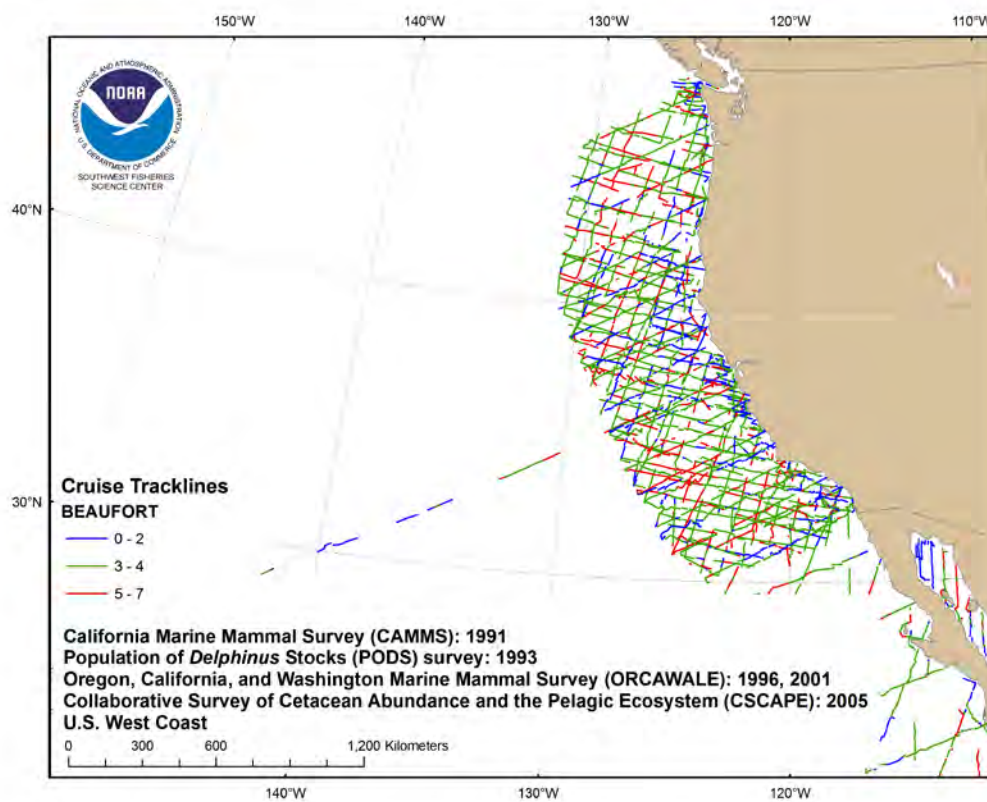


Figures 2a-b. Cruise tracklines showing Beaufort sea state by geographical region, 1986-2005.

c.

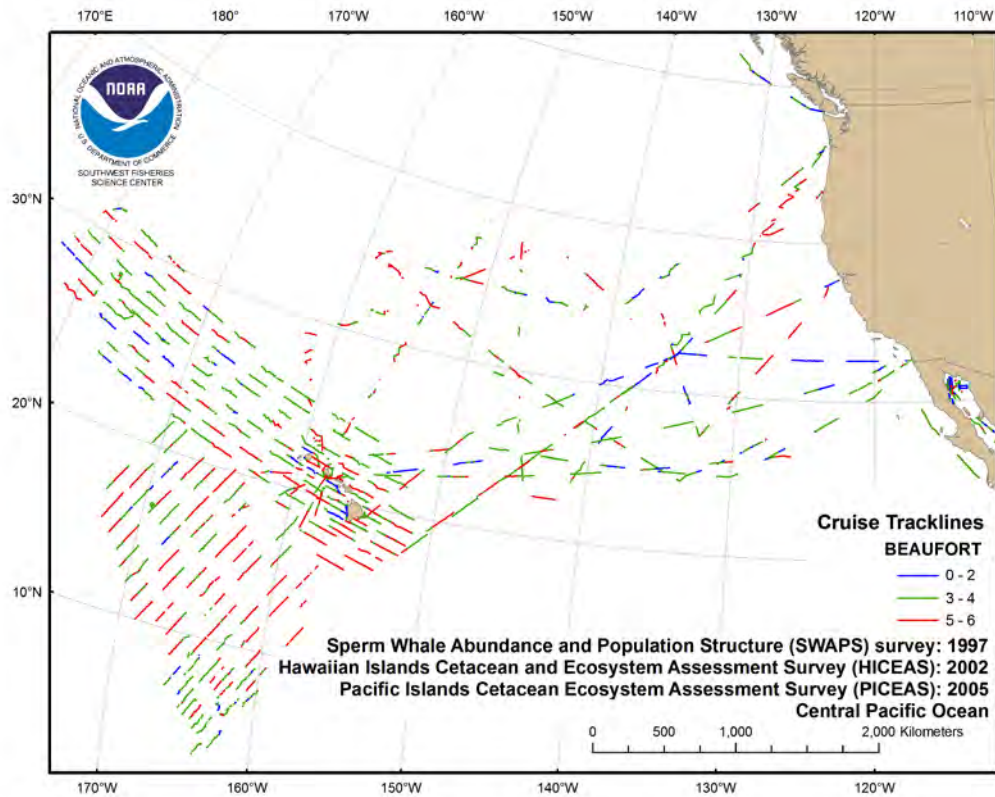


d.

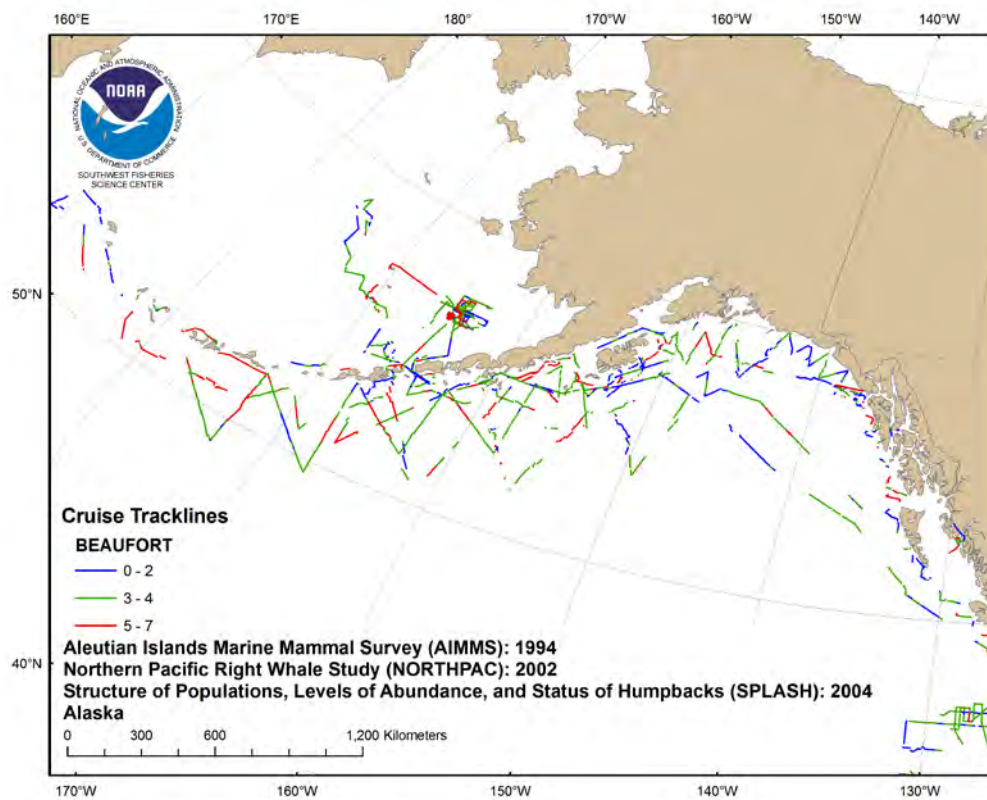


Figures 2b-c. Cruise tracklines showing Beaufort sea state by geographical region, 1986-2005.

e.



f.



Figures 2e-f. Cruise tracklines showing Beaufort sea state by geographical region, 1986-2005.

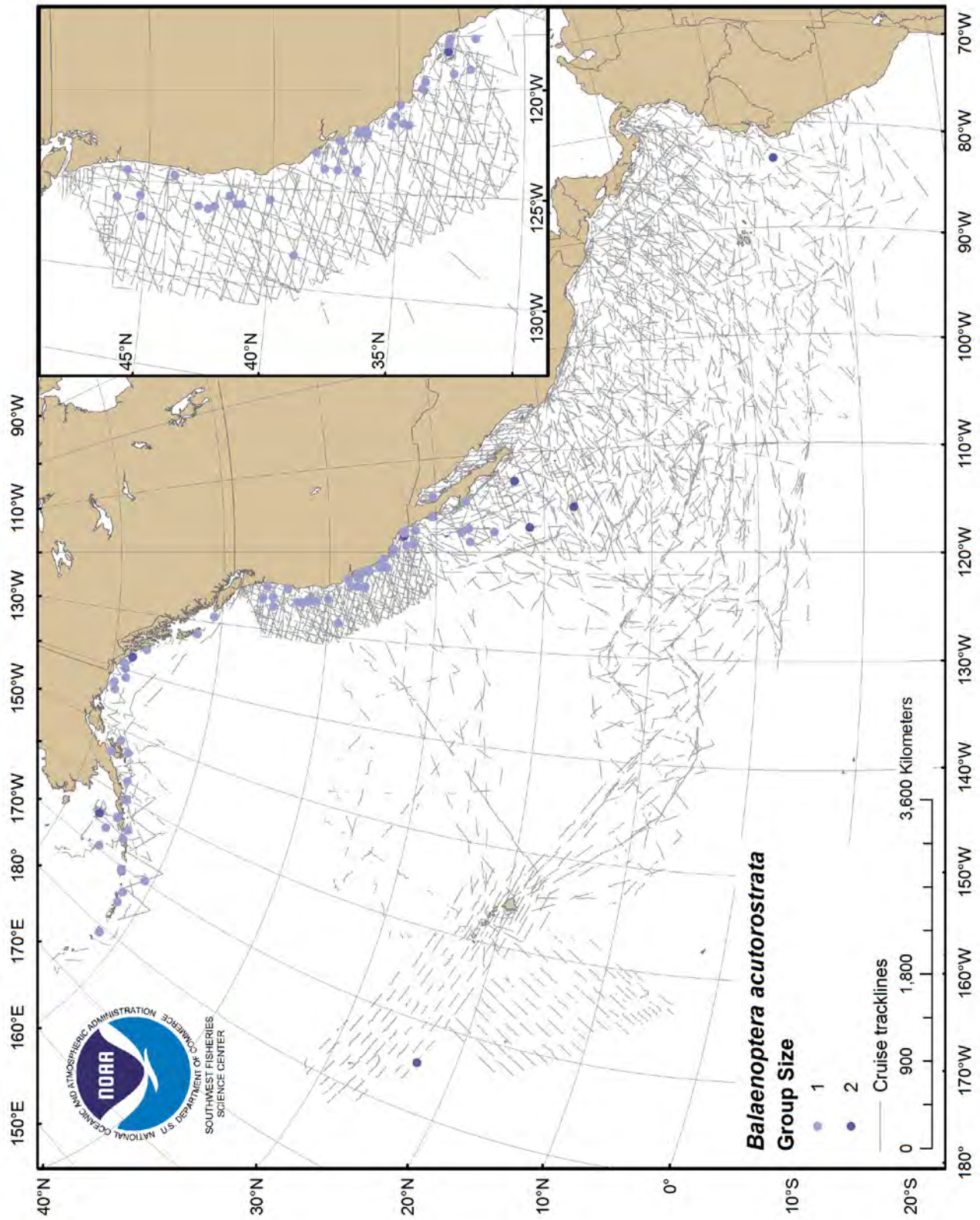


Figure 3. Distribution of common minke whale, *Balaenoptera acutorostrata*, species code 071.

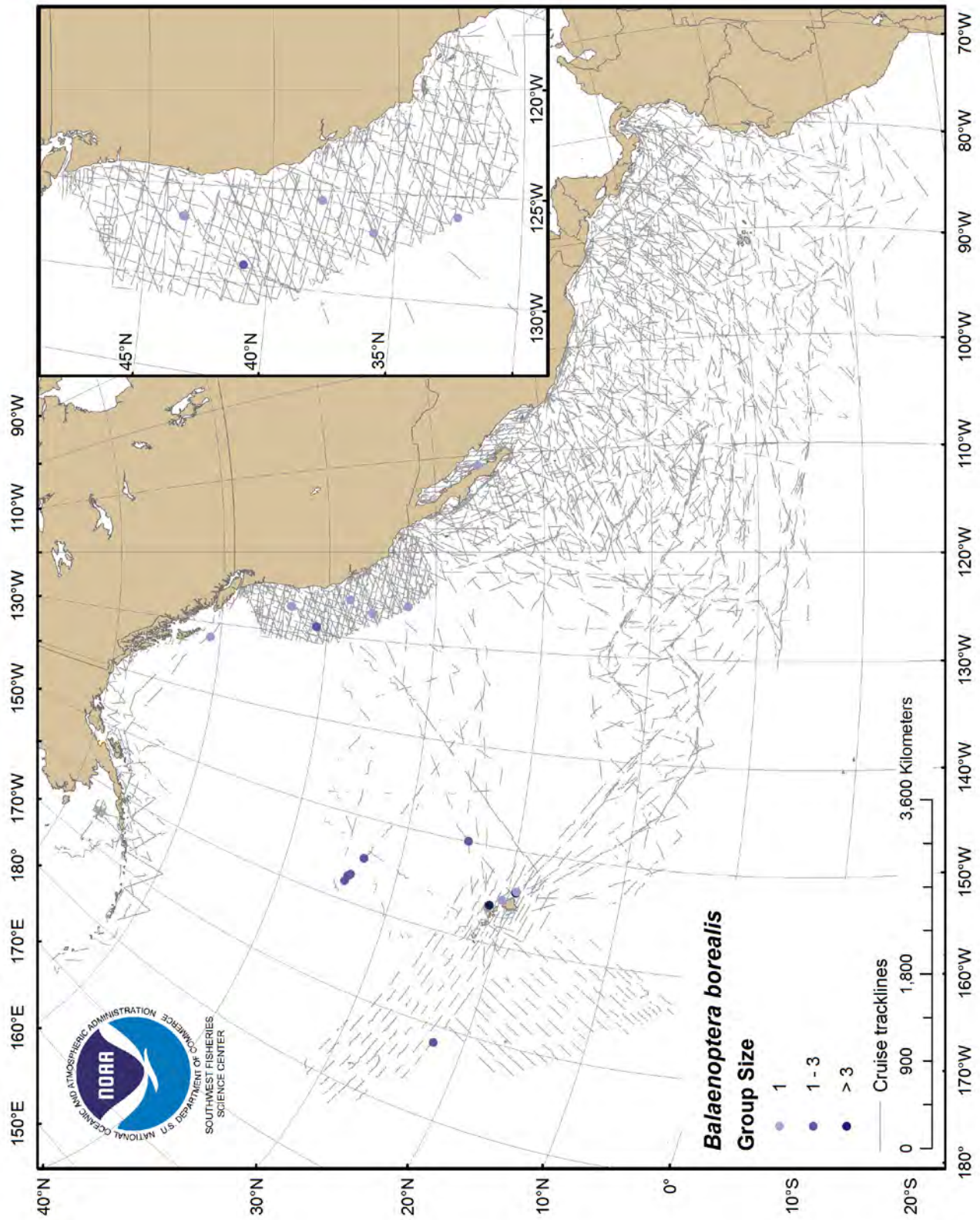


Figure 4. Distribution of sei whale, *Balaenoptera borealis*, species code 073.

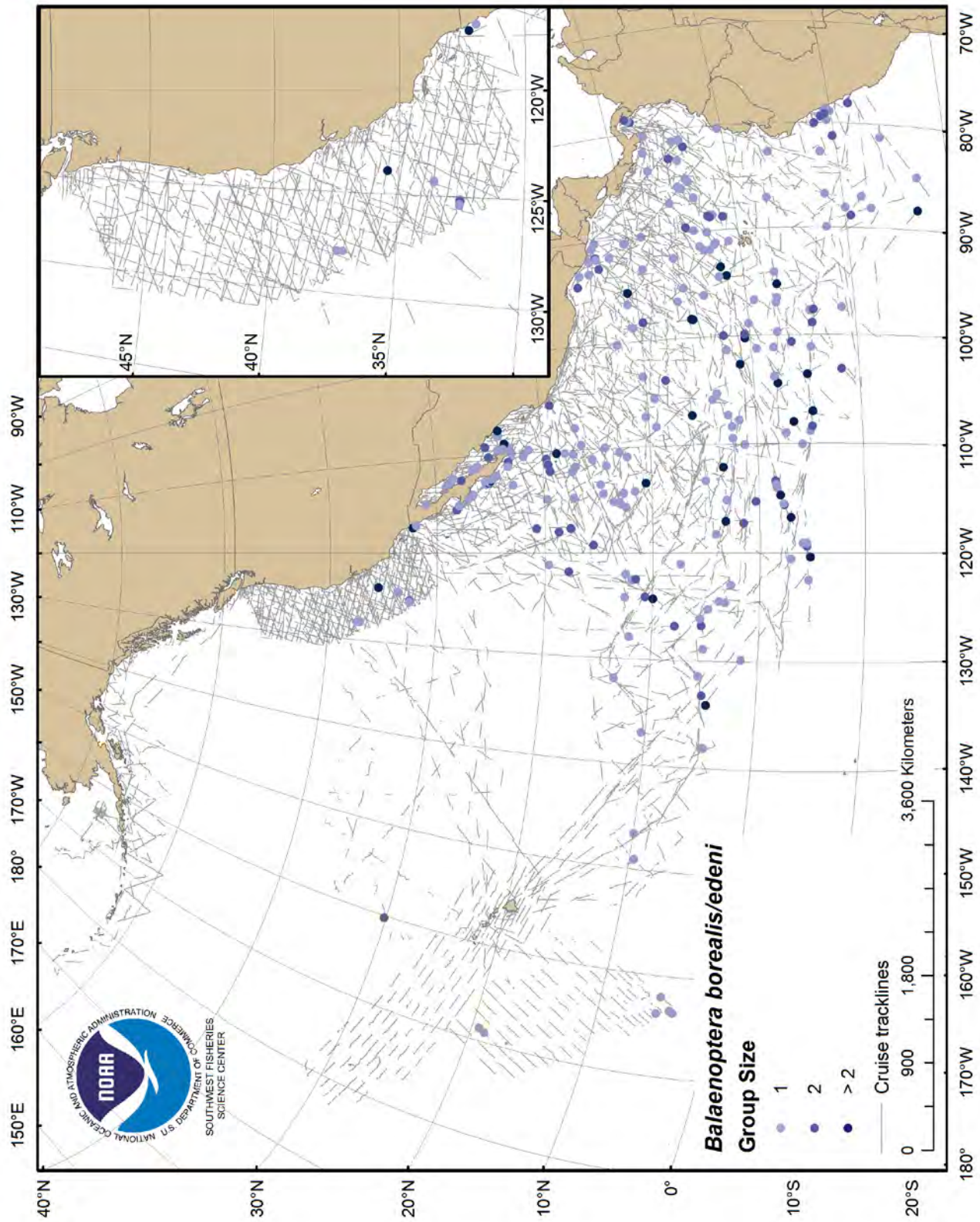


Figure 5. Distribution of rorqual identified as a sei or Bryde's whale, *Balaenoptera borealis/edeni*, species code 099.

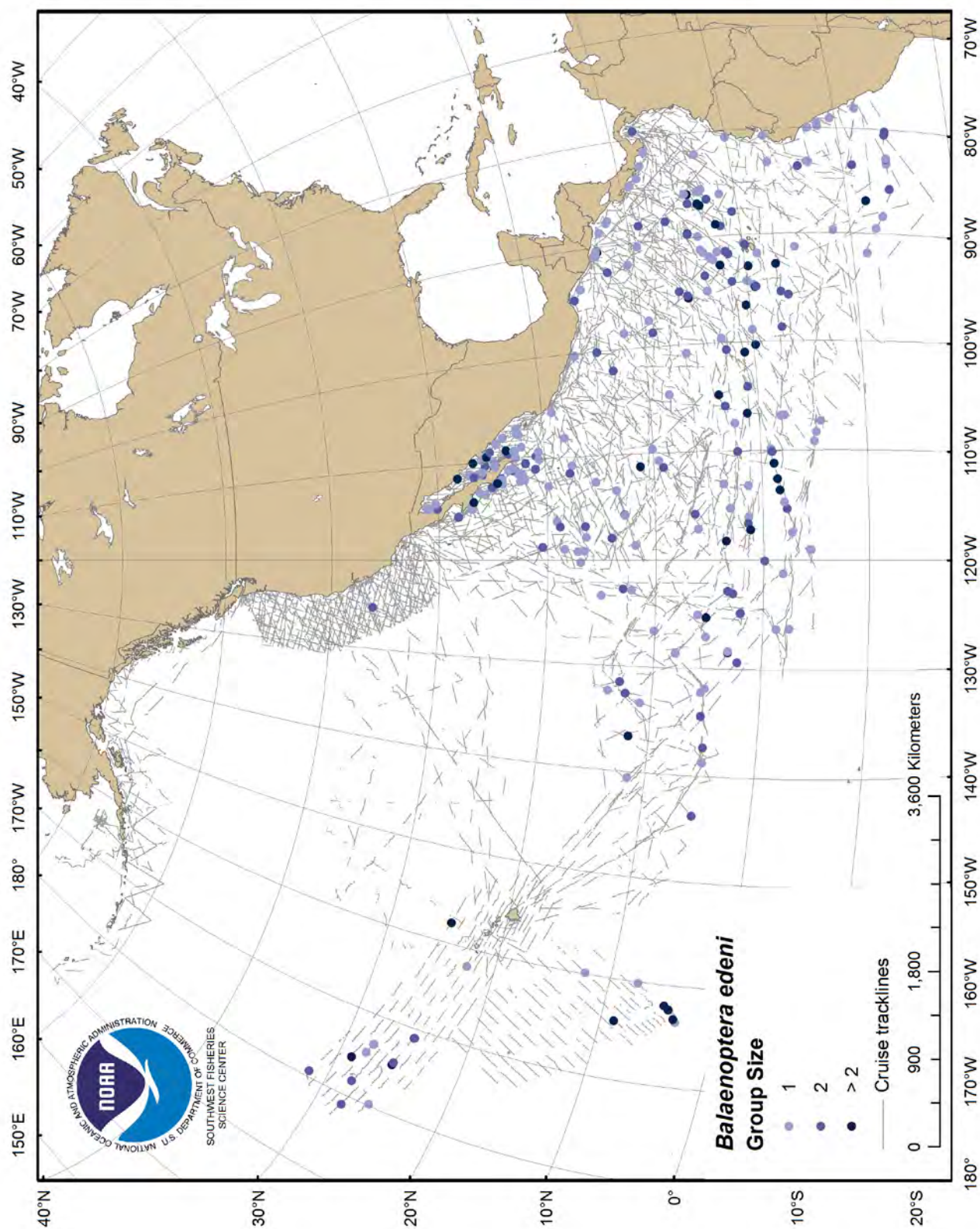


Figure 6. Distribution of Bryde's whale, *Balaenoptera edeni*, species code 072.

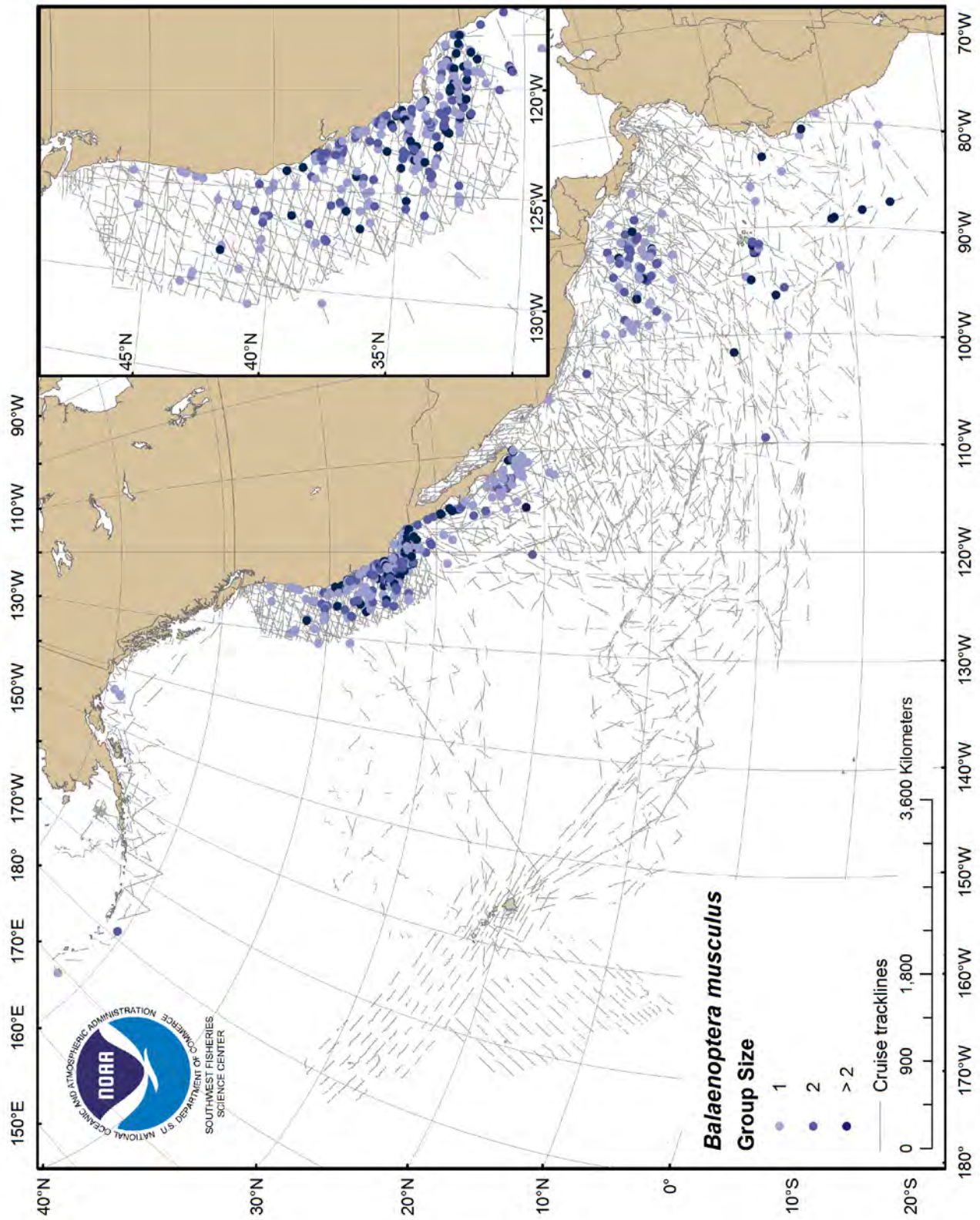


Figure 7. Distribution of blue whale, *Balaenoptera musculus*, species code 075.

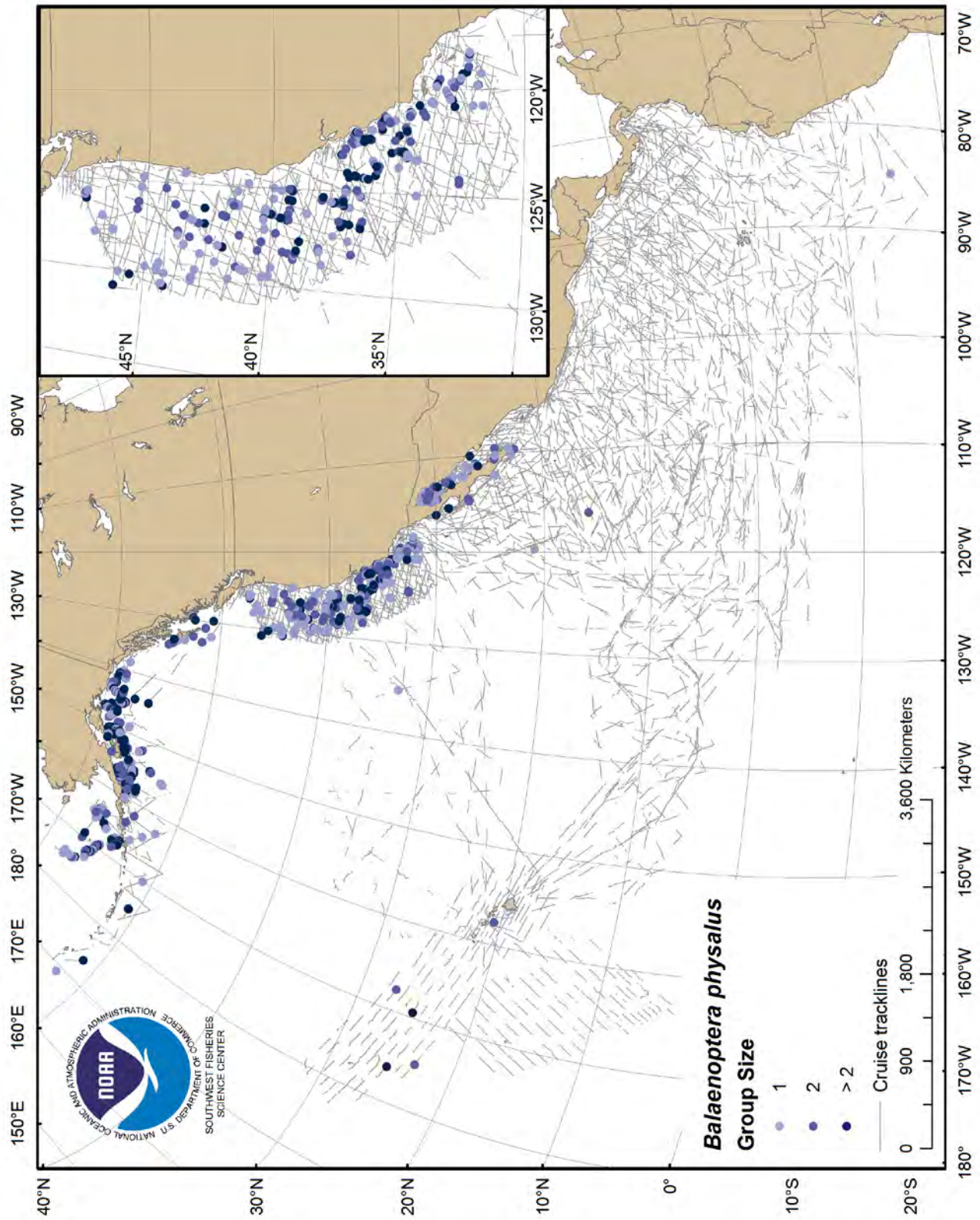


Figure 8. Distribution of fin whale, *Balaenoptera physalus*, species code 074.

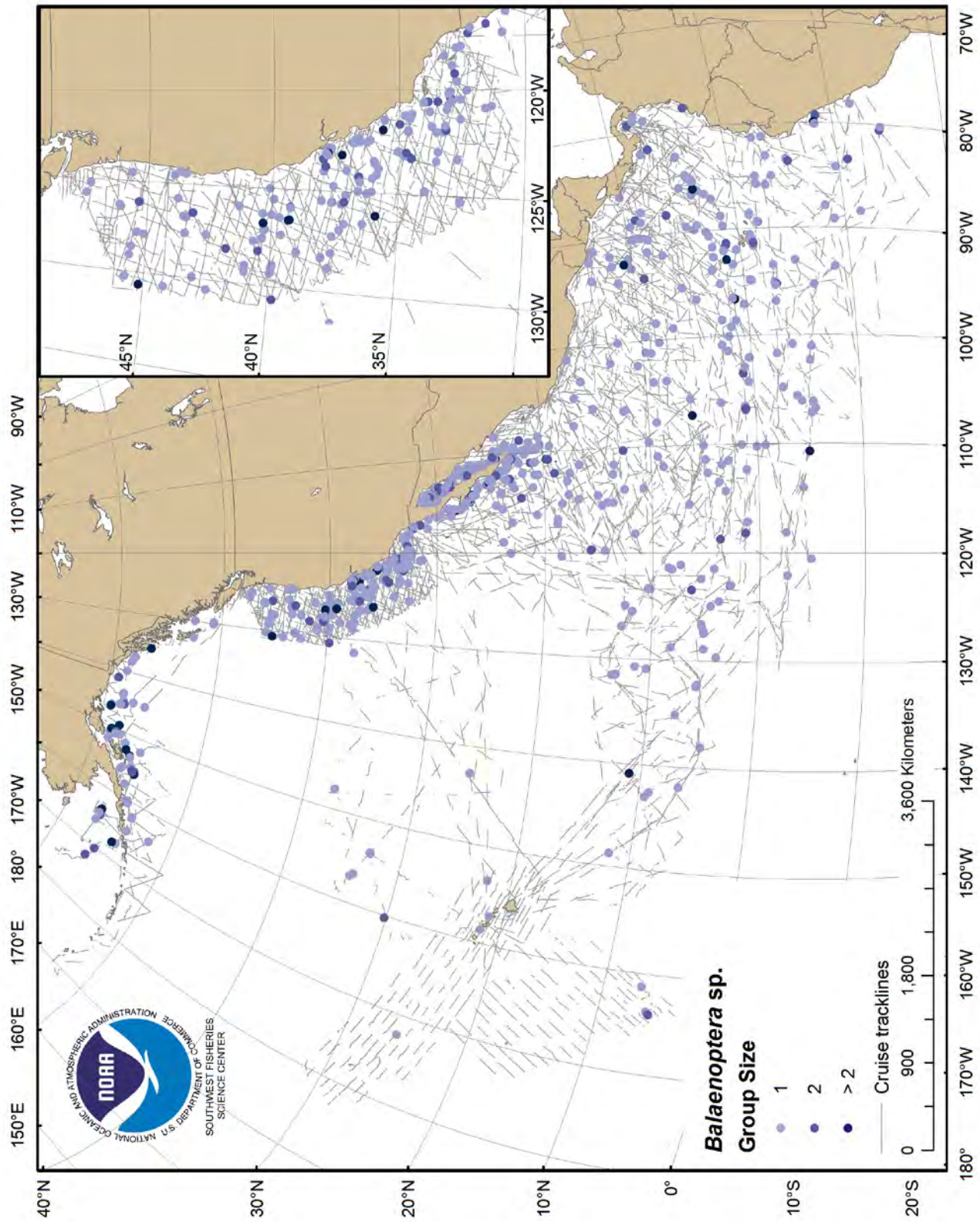


Figure 9. Distribution of unidentified rorqual, *Balaenoptera* sp., species code 070.

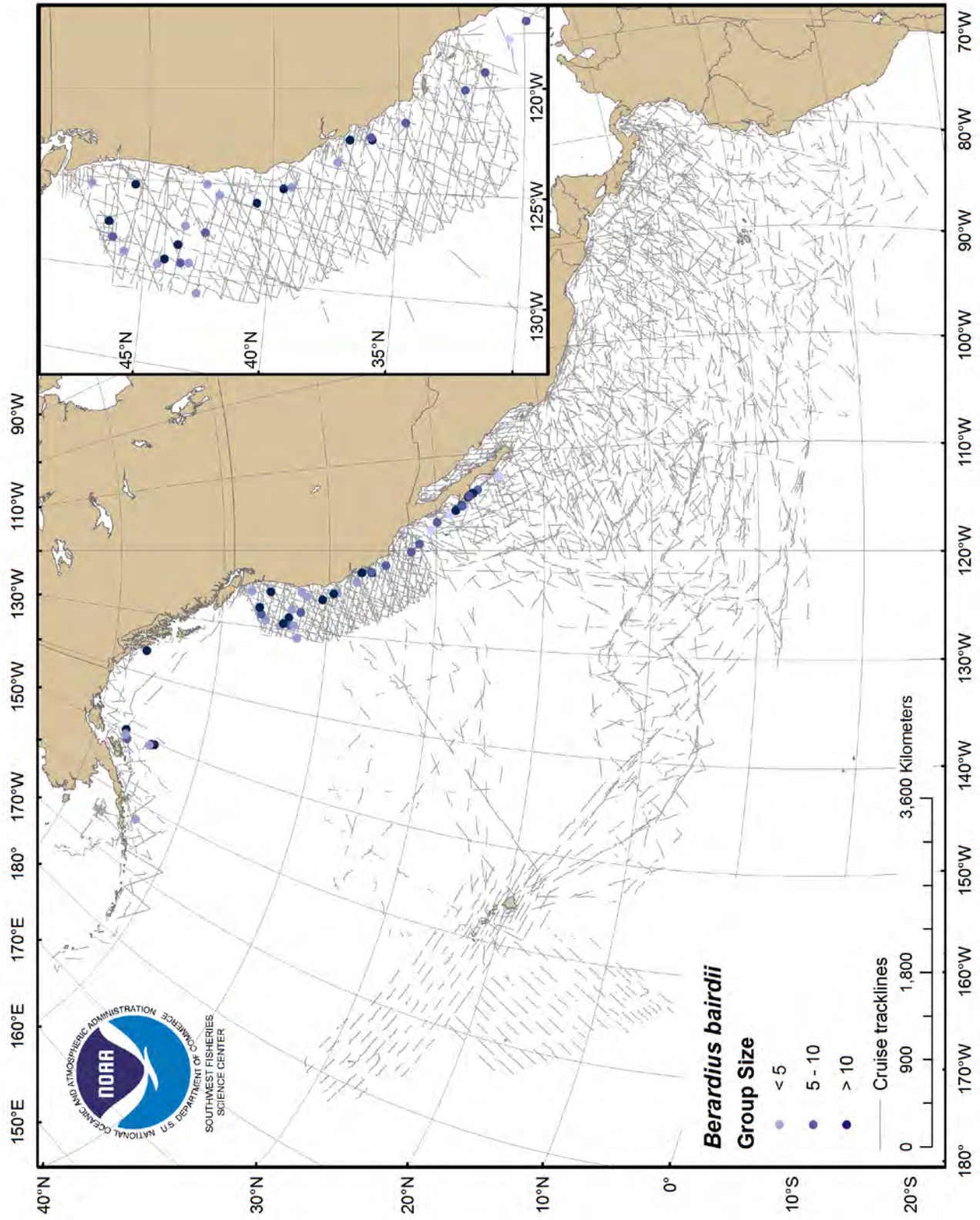


Figure 10. Distribution of Baird's beaked whale, *Berardius bairdii*, species code 063.

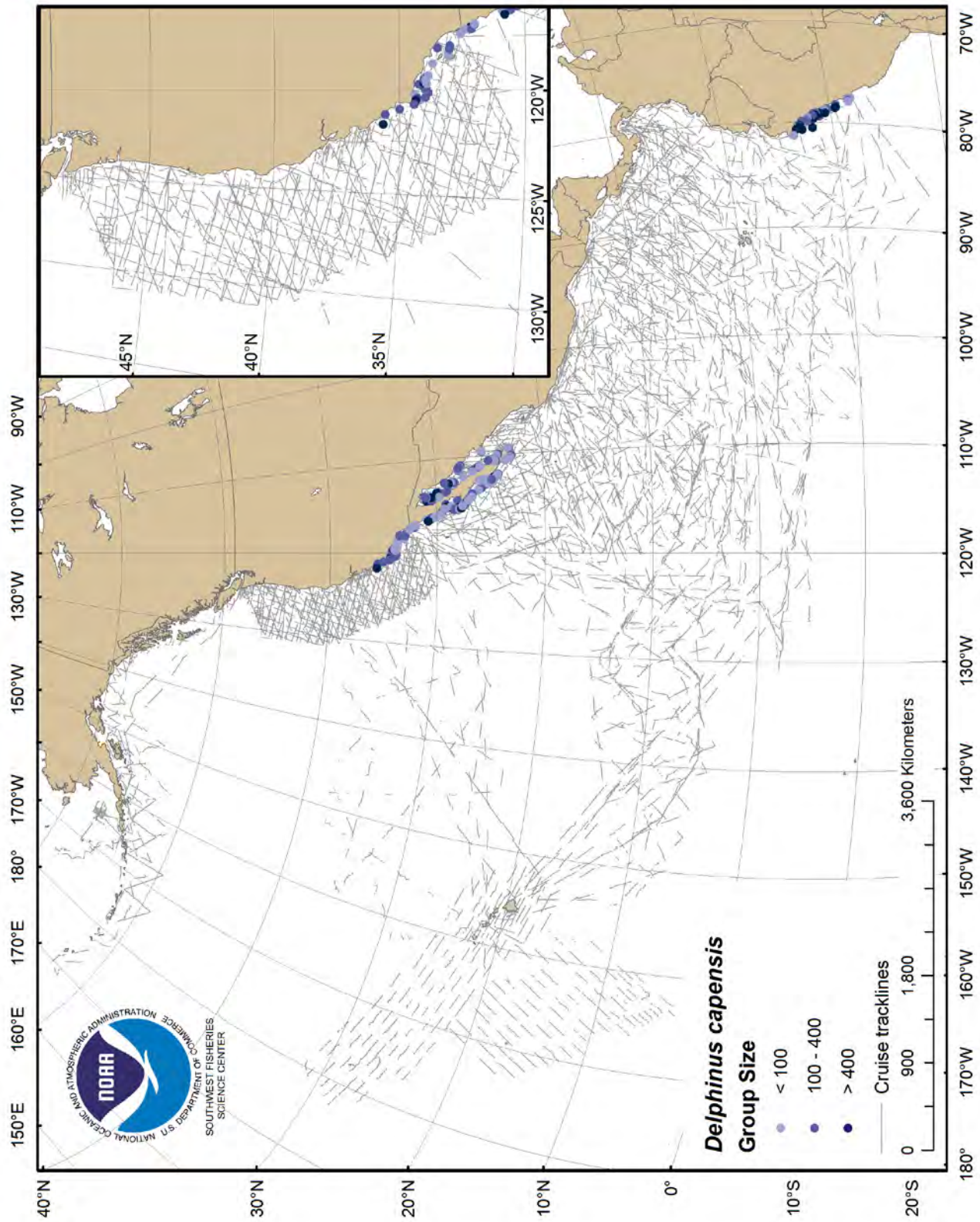


Figure 11. Distribution of Baja neritic common dolphin, *Delphinus capensis*, species code 016.

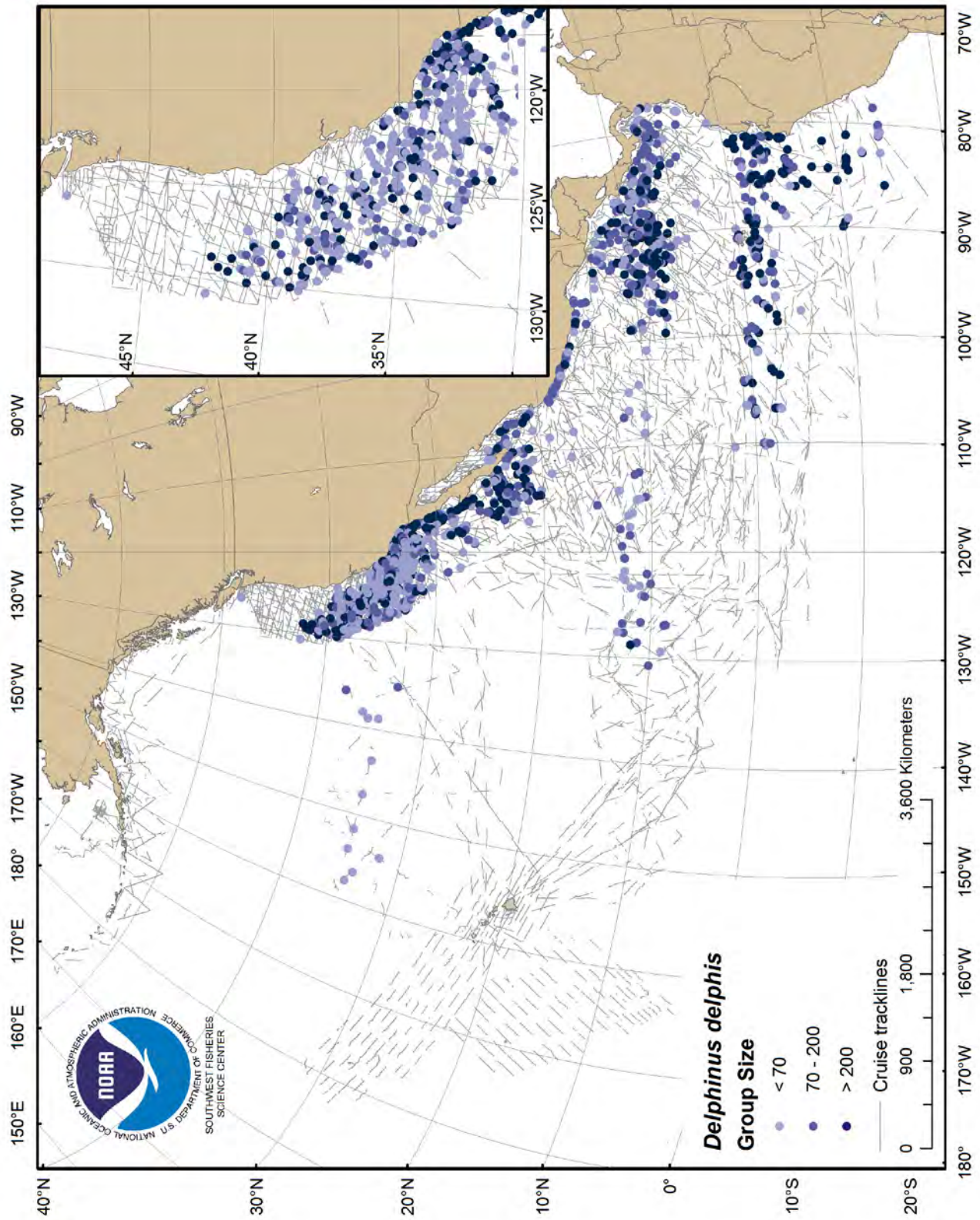


Figure 12. Distribution of offshore common dolphin, *Delphinus delphis*, species code 017.

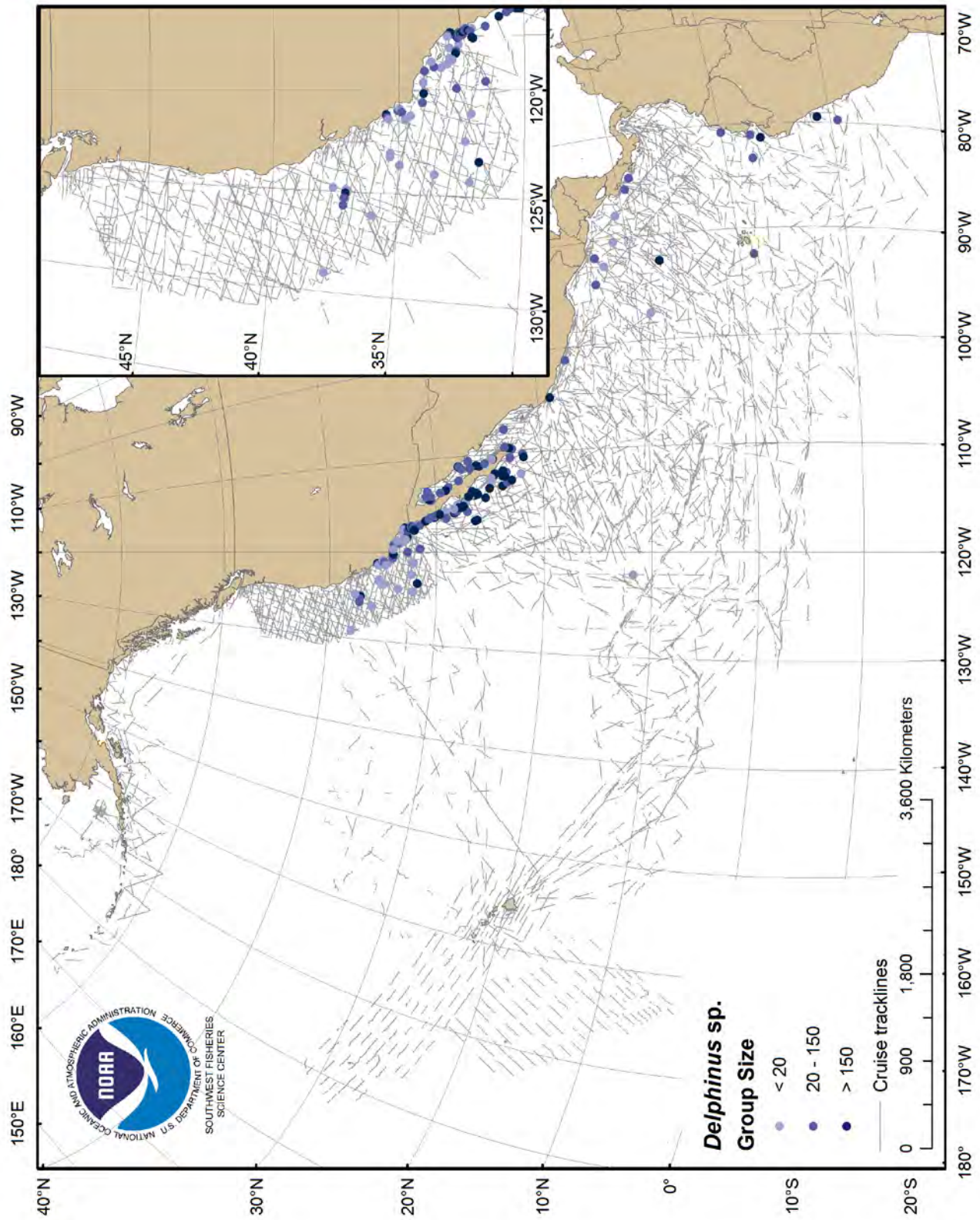


Figure 13. Distribution of unidentified common dolphin, *Delphinus* sp., species code 005.

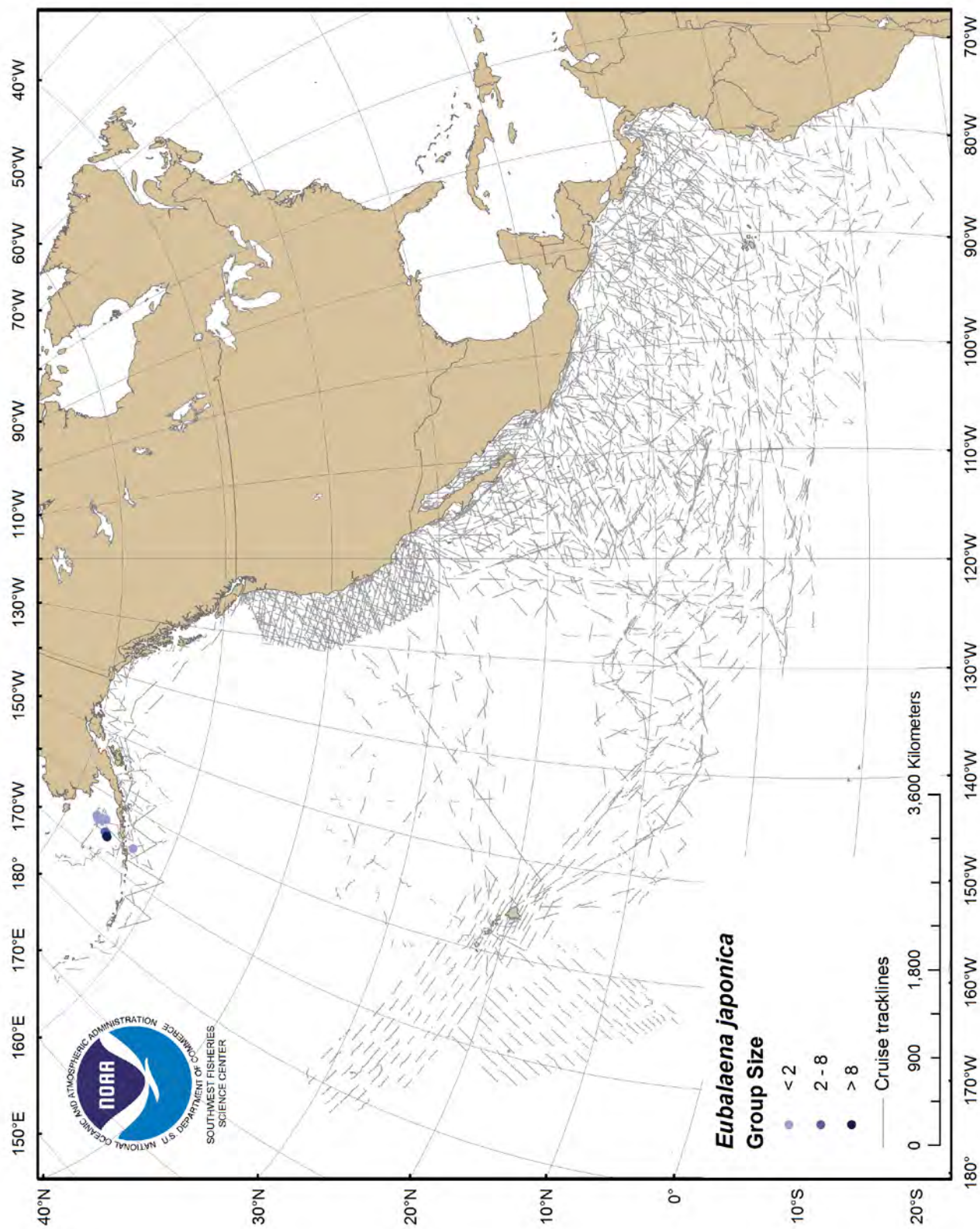


Figure 14. Distribution of North Pacific right whale, *Eubalaena japonica*, species code 066.

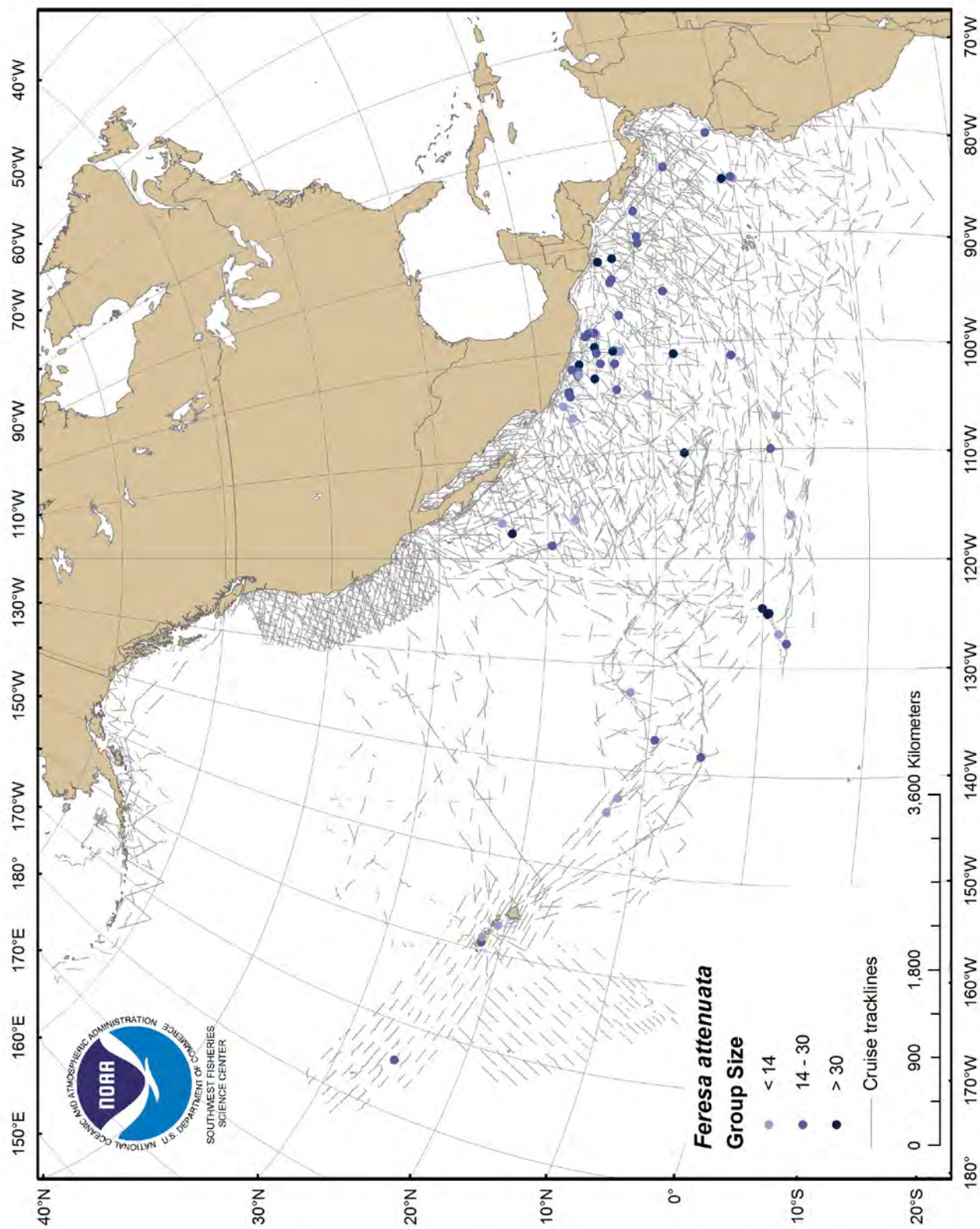


Figure 15. Distribution of pygmy killer whale, *Feresa attenuata*, species code 032.

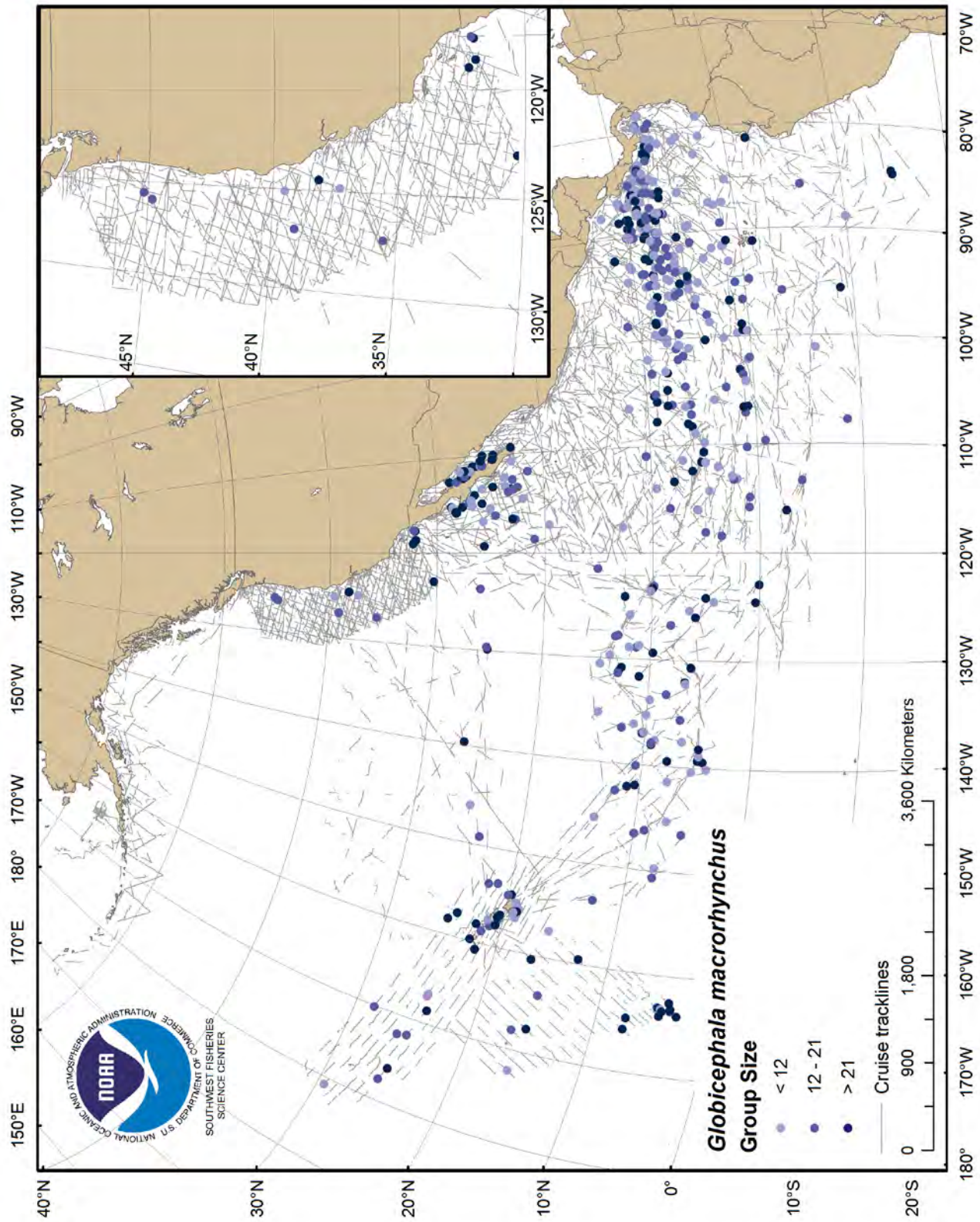


Figure 16. Distribution of short-finned pilot whale, *Globicephala macrorhynchus*, species code 036.

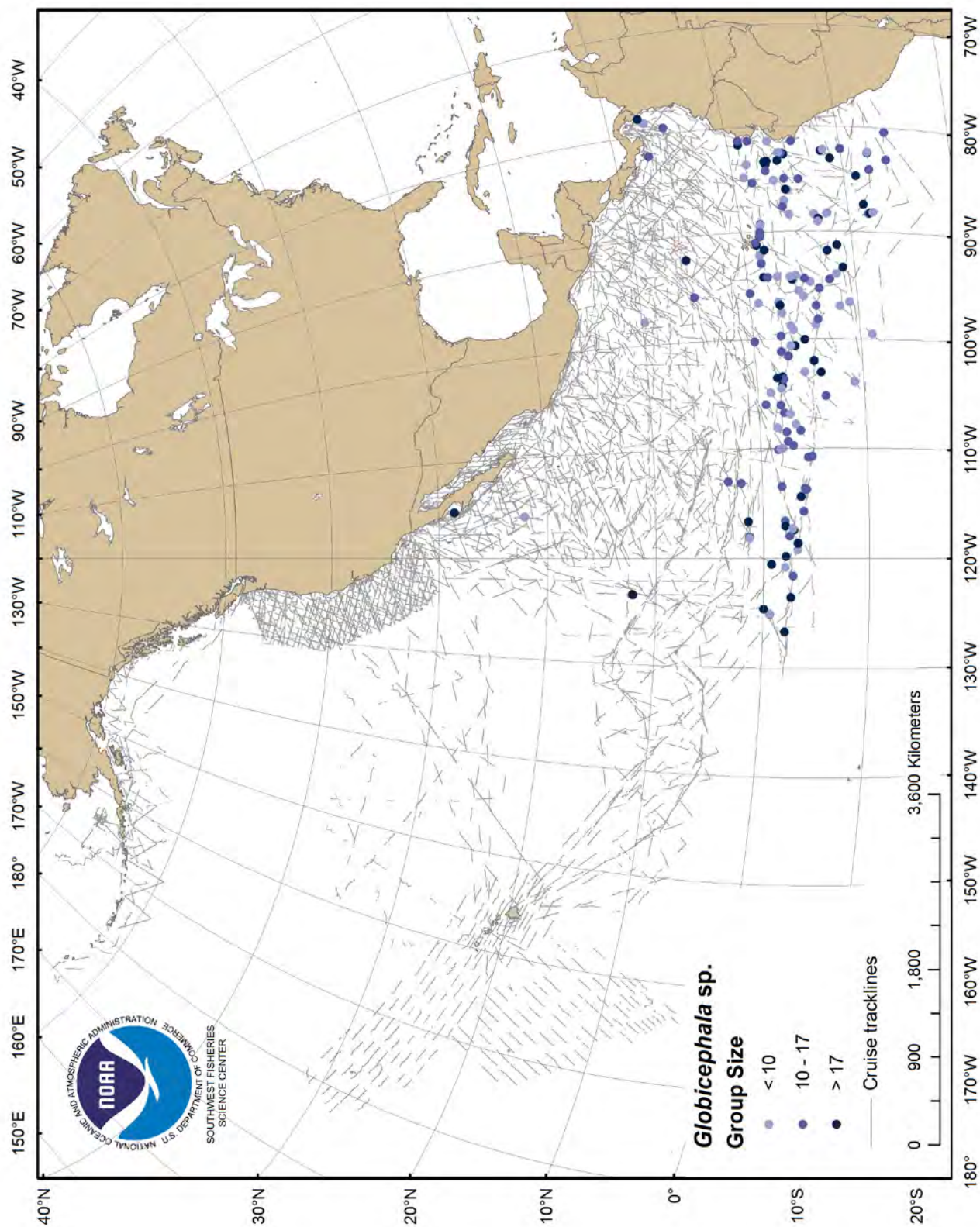


Figure 17. Distribution of unidentified pilot whale, *Globicephala* sp., species code 034.

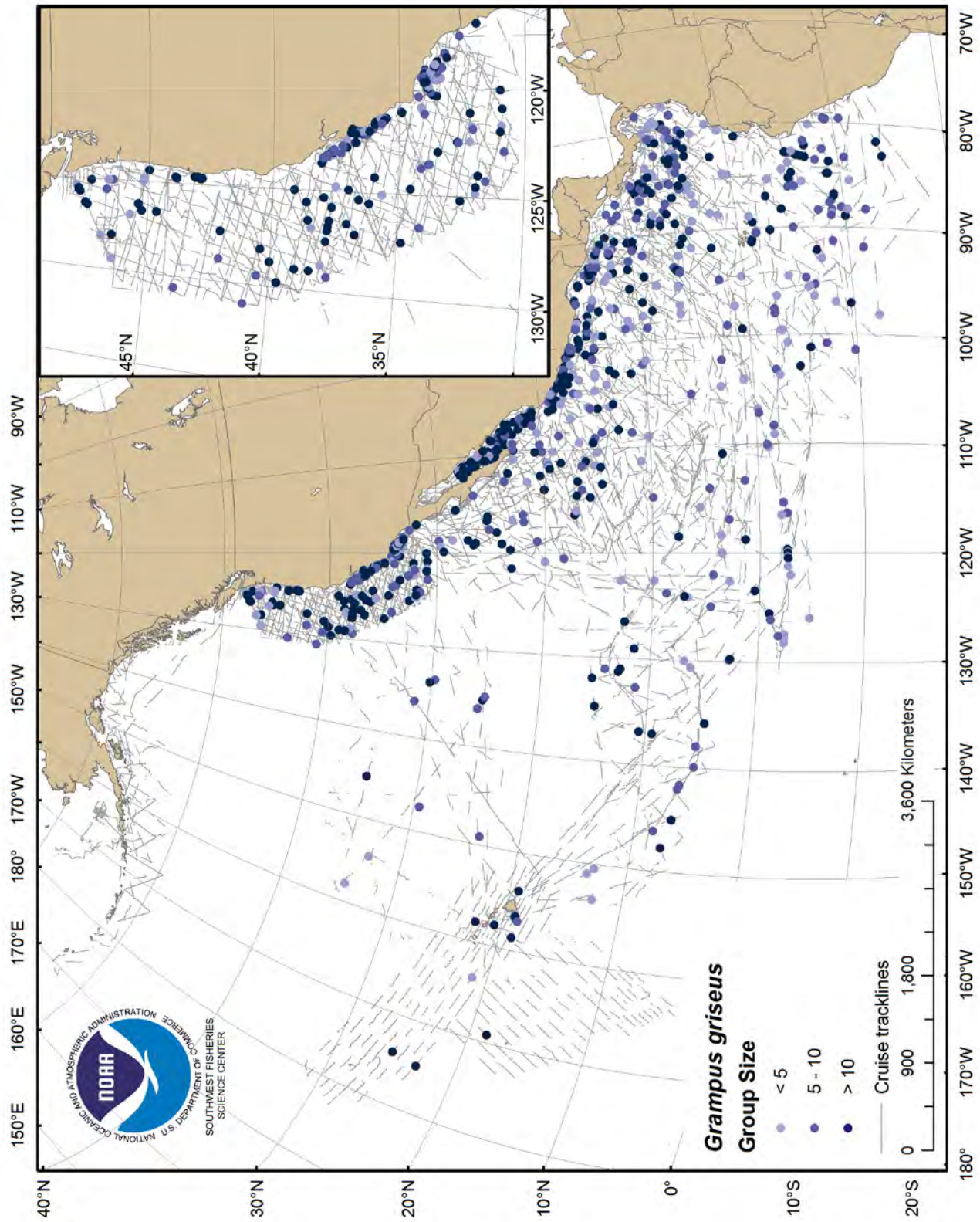


Figure 18. Distribution of Risso's dolphin, *Grampus griseus*, species code 021.

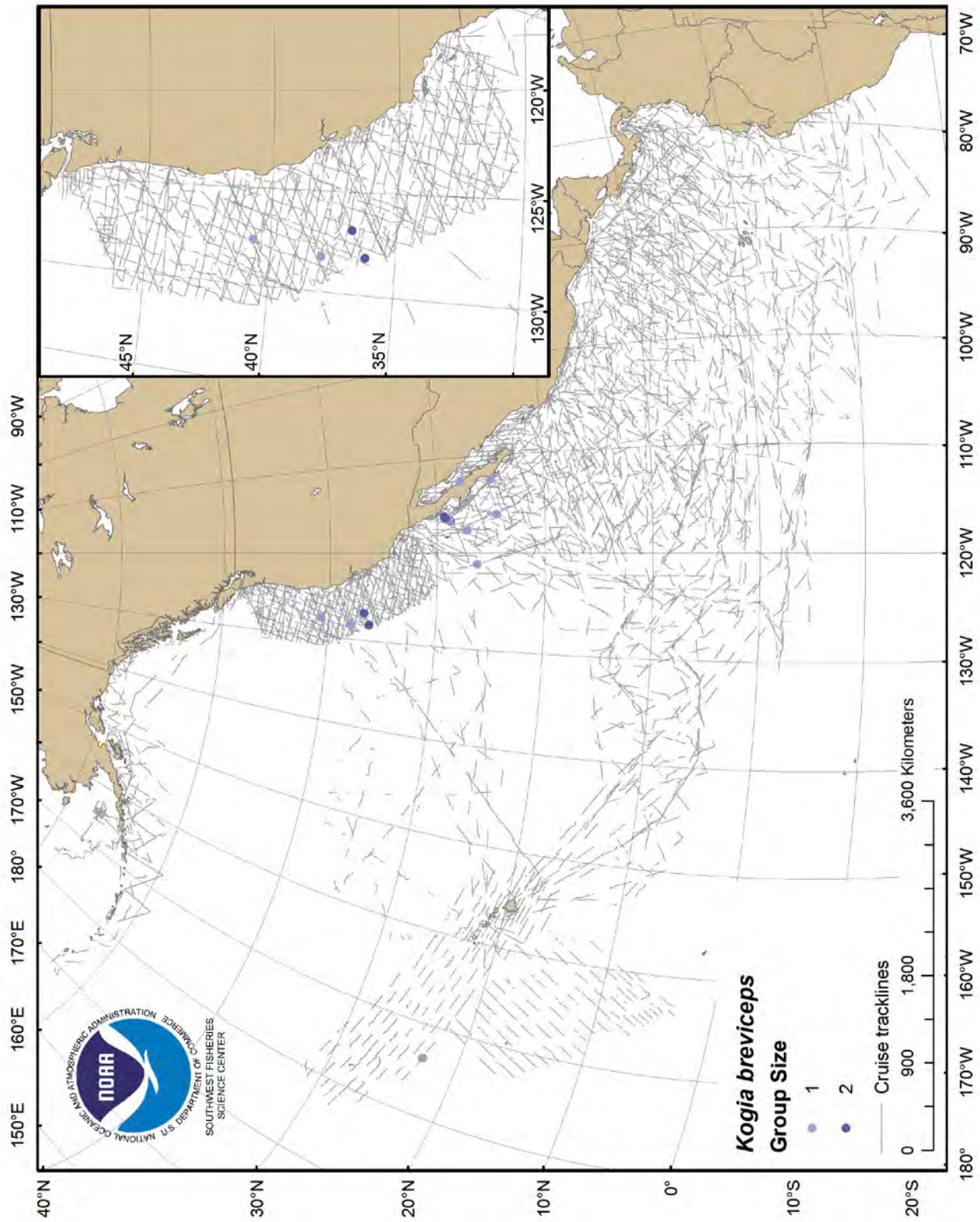


Figure 19. Distribution of pygmy sperm whale, *Kogia breviceps*, species code 047.

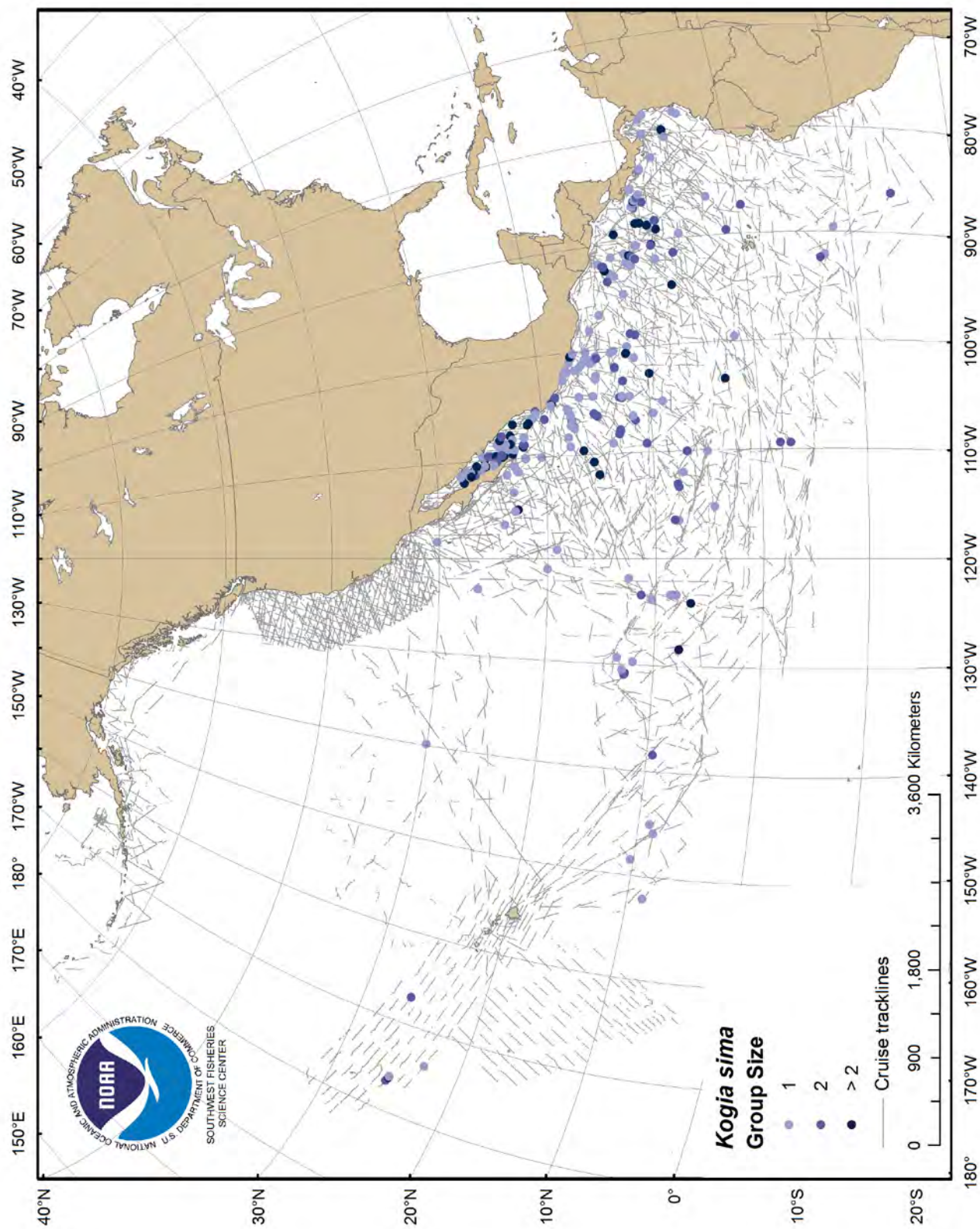


Figure 20. Distribution of dwarf sperm whale, *Kogia sima*, species code 048.

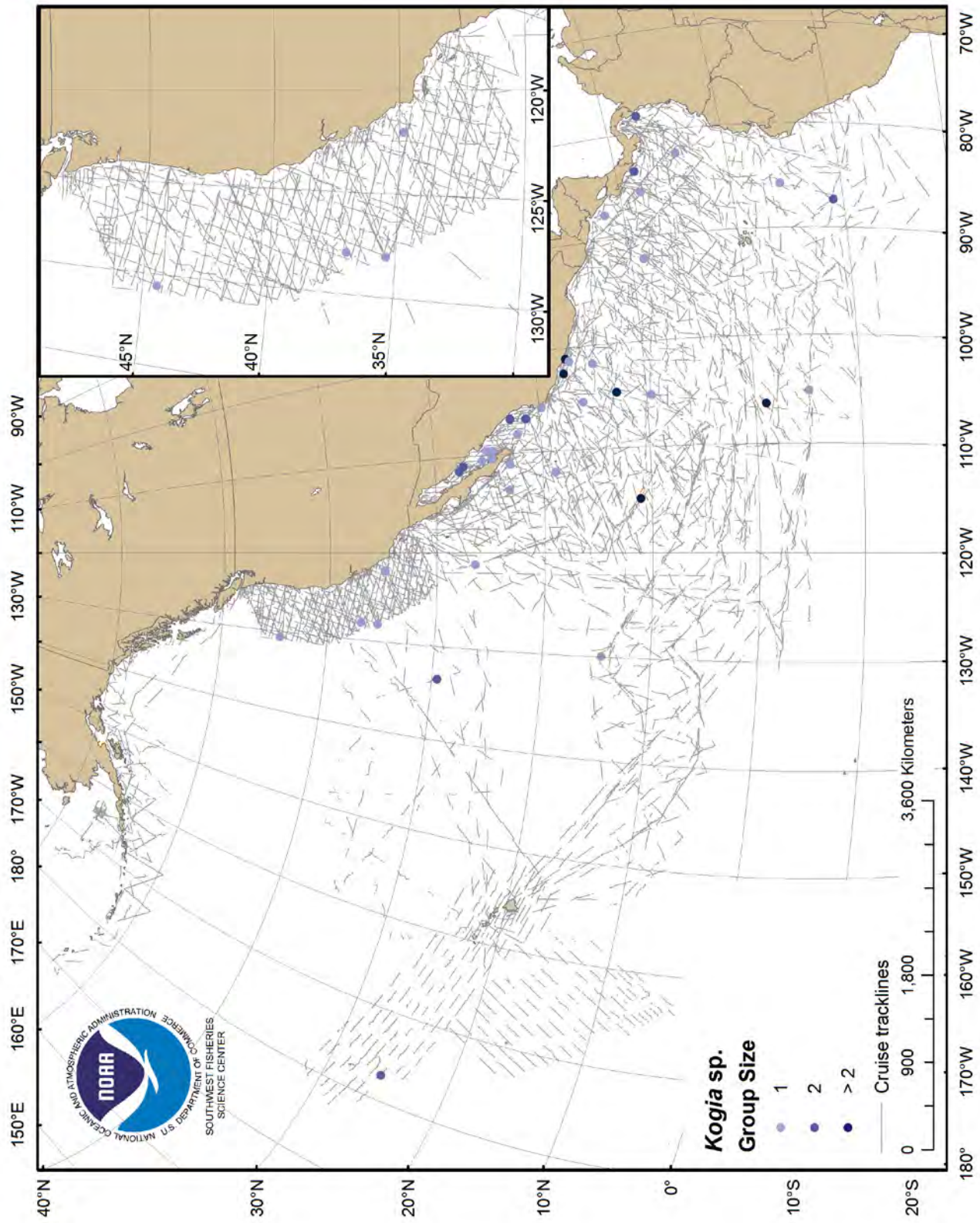


Figure 21. Distribution of unidentified dwarf or pygmy sperm whale, *Kogia* sp., species code 080.

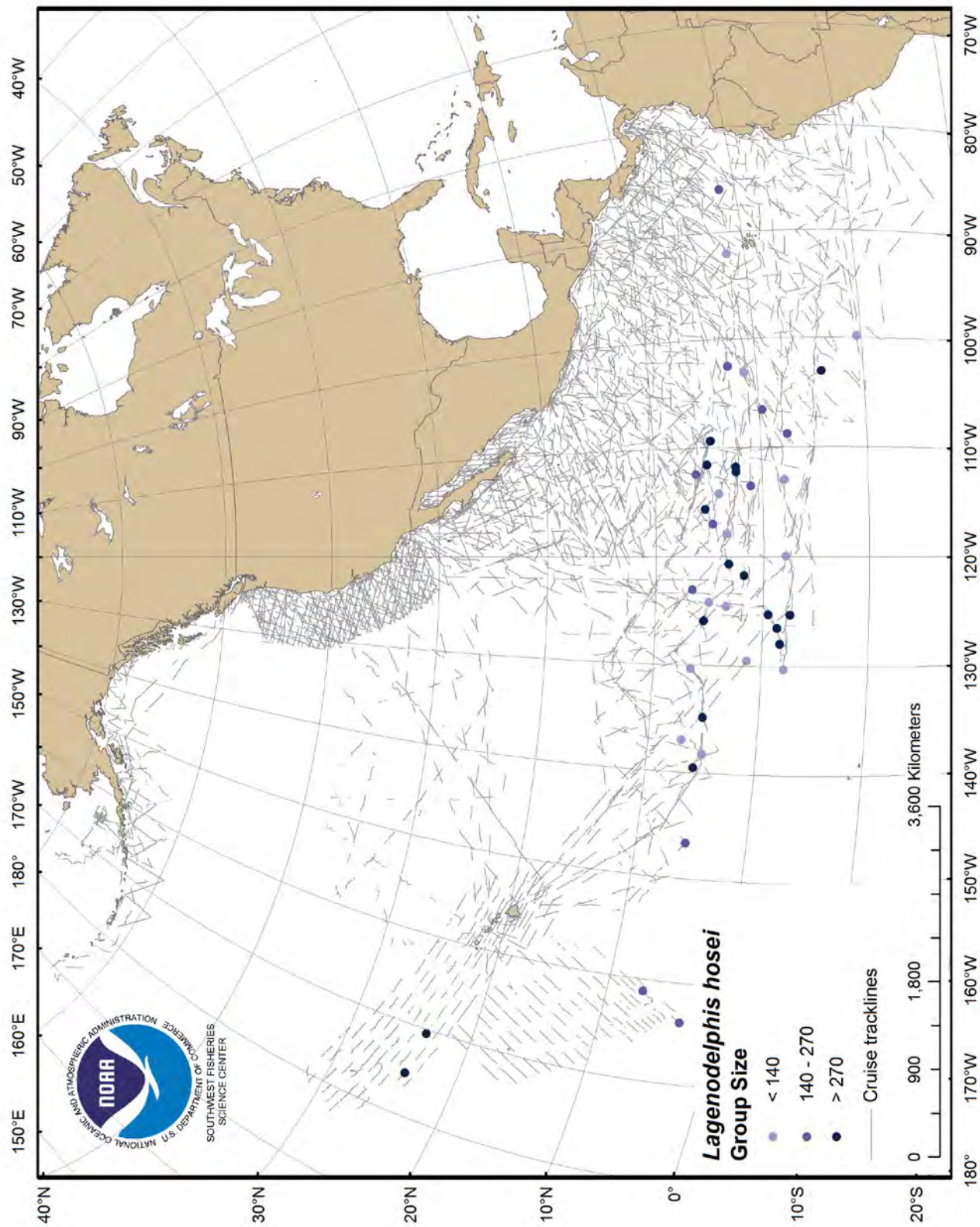


Figure 22. Distribution of Fraser's dolphin, *Lagenodelphis hosei*, species code 026.

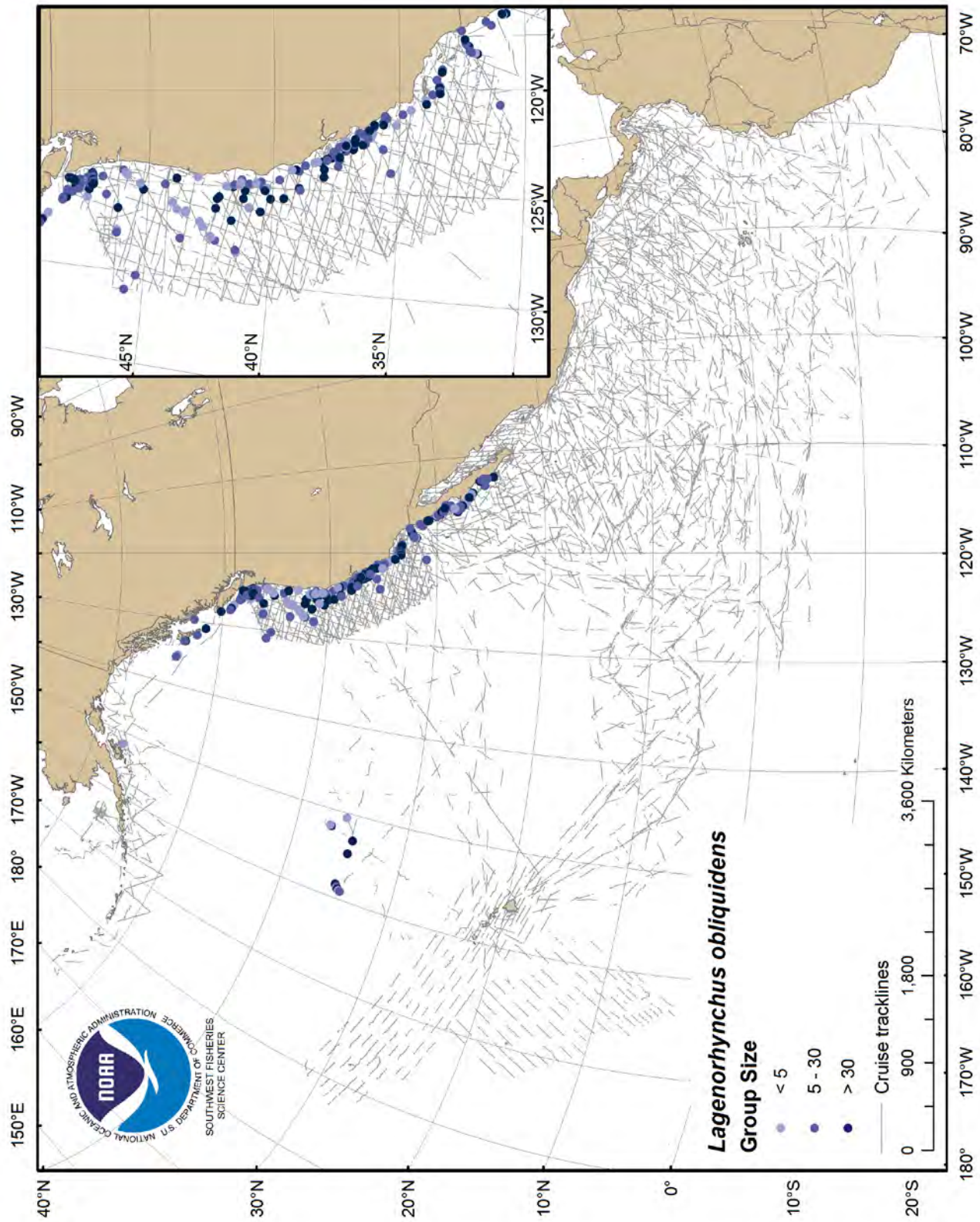


Figure 23. Distribution of Pacific white-sided dolphin, *Lagenorhynchus obliquidens*, species code 022.

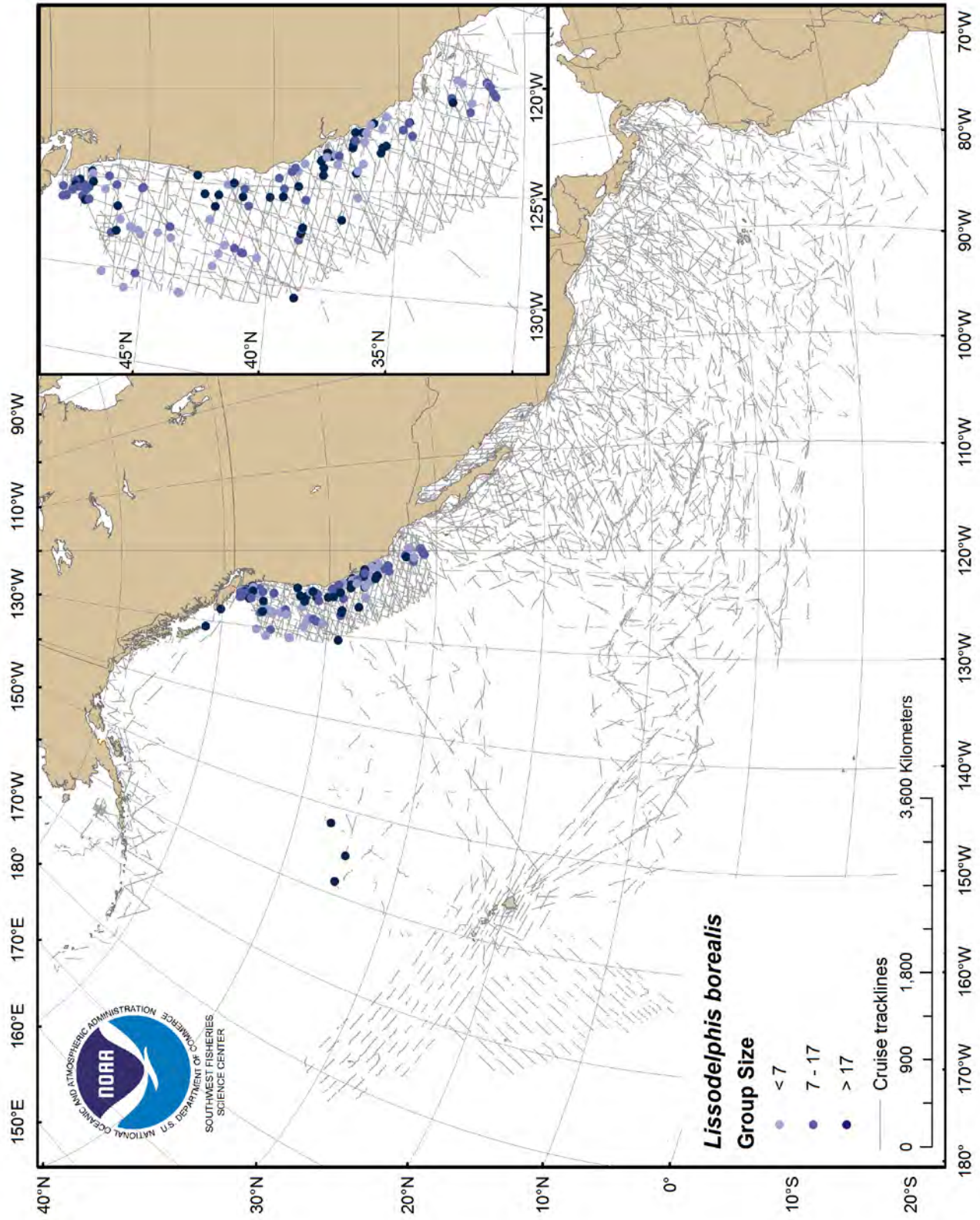


Figure 24. Distribution of northern right whale dolphin, *Lissodelphis borealis*, species code 027.

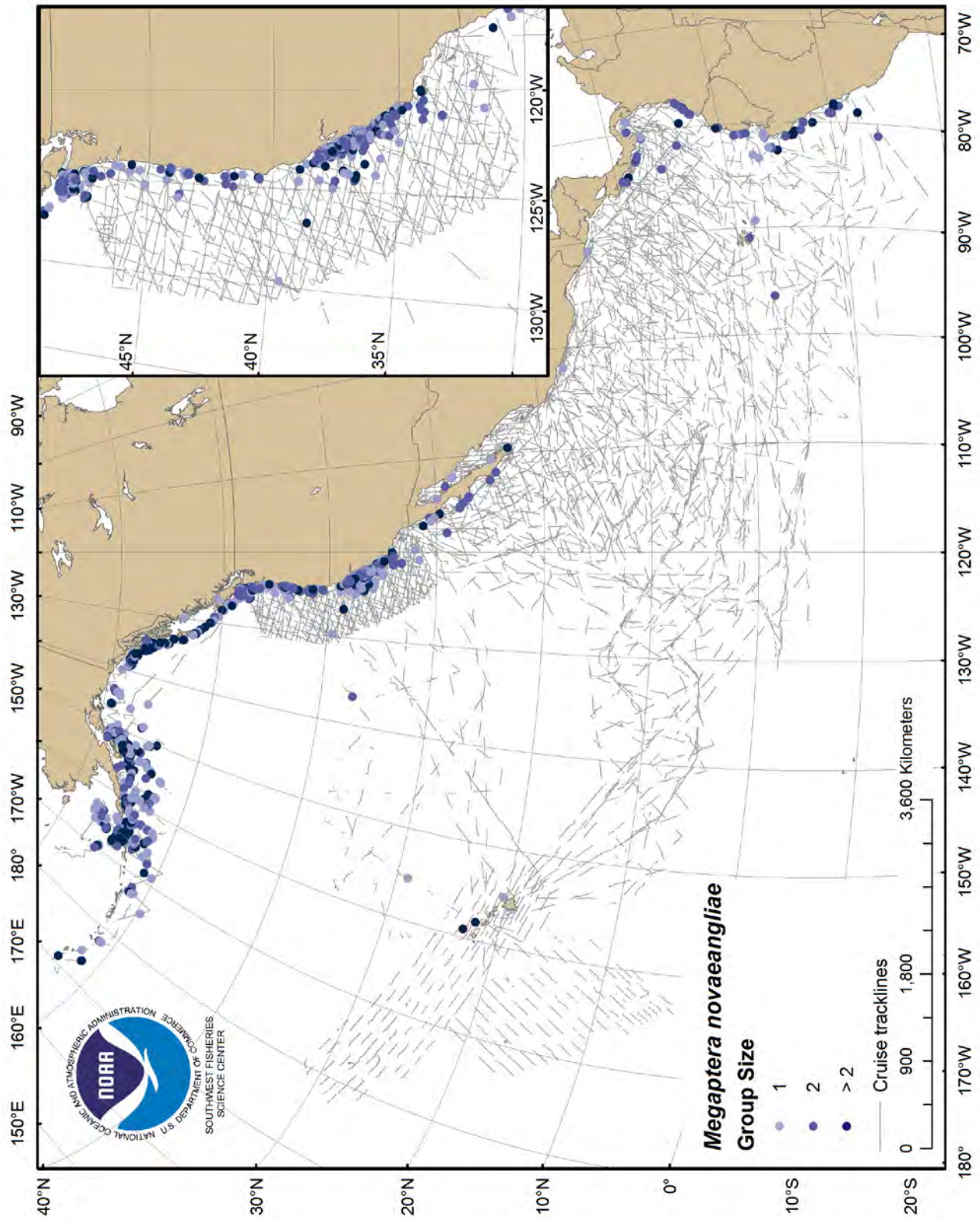


Figure 25. Distribution of humpback whale, *Megaptera novaeangliae*, species code 076.

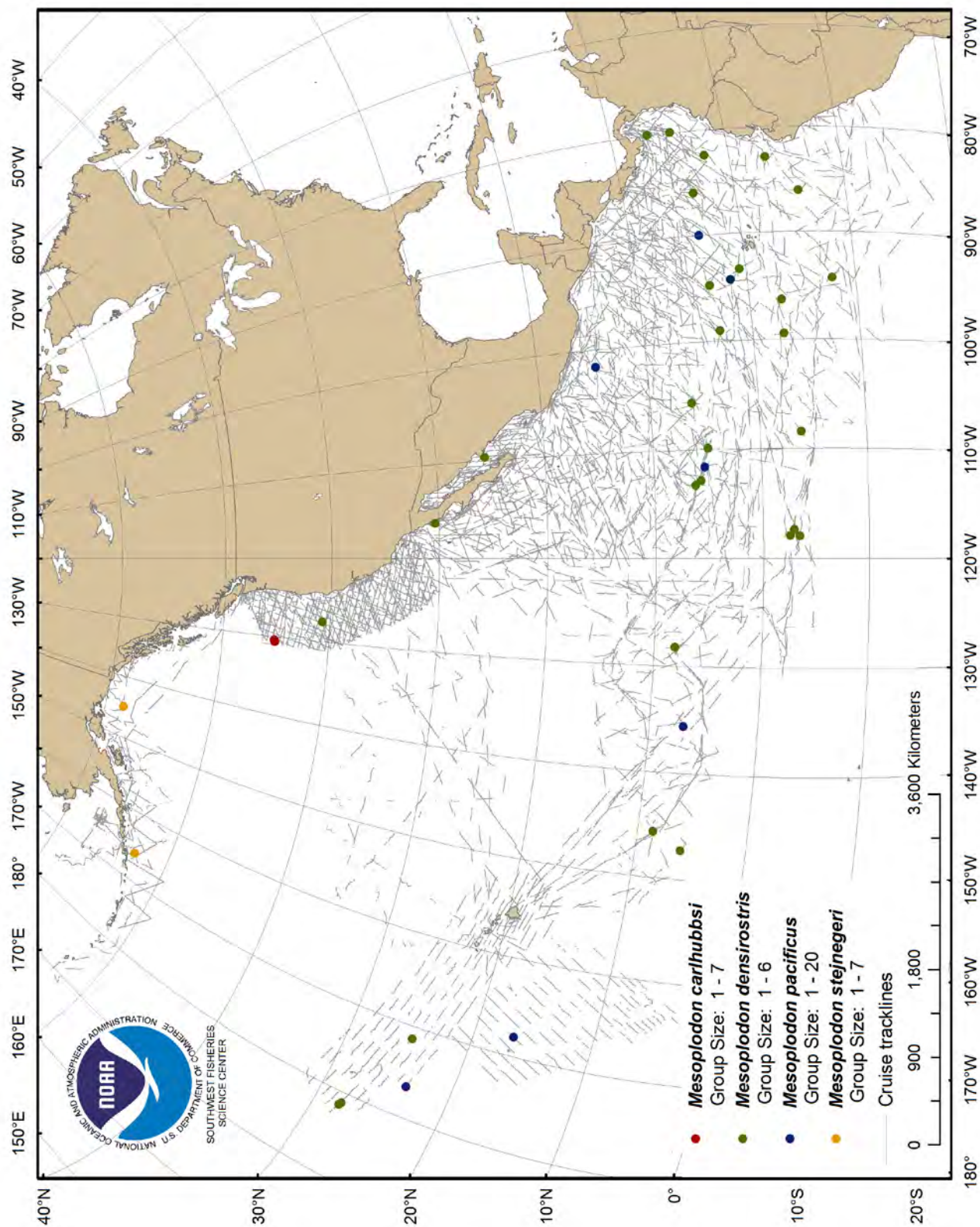


Figure 26. Distribution of four *Mesoplodon* beaked whales: Hubb's (*M. carlhubbsi*), Blaineville's (*M. densirostris*), Longman's (*M. pacificus*), Steinger's (*M. steinegeri*), species codes 052, 059, 065, 081, respectively.

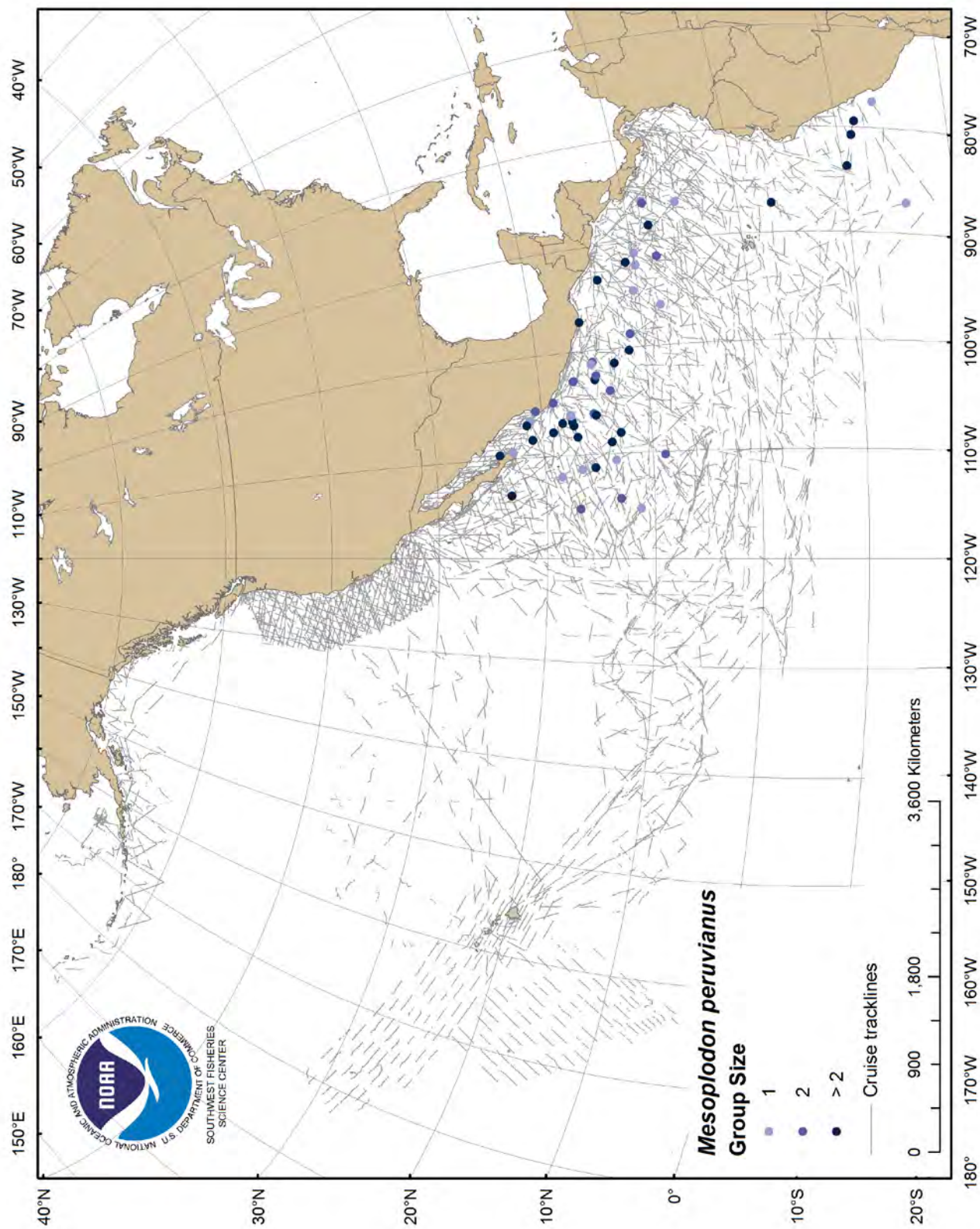


Figure 27. Distribution of pygmy beaked whale, *Mesoplodon peruvianus*, species code 001, 083.

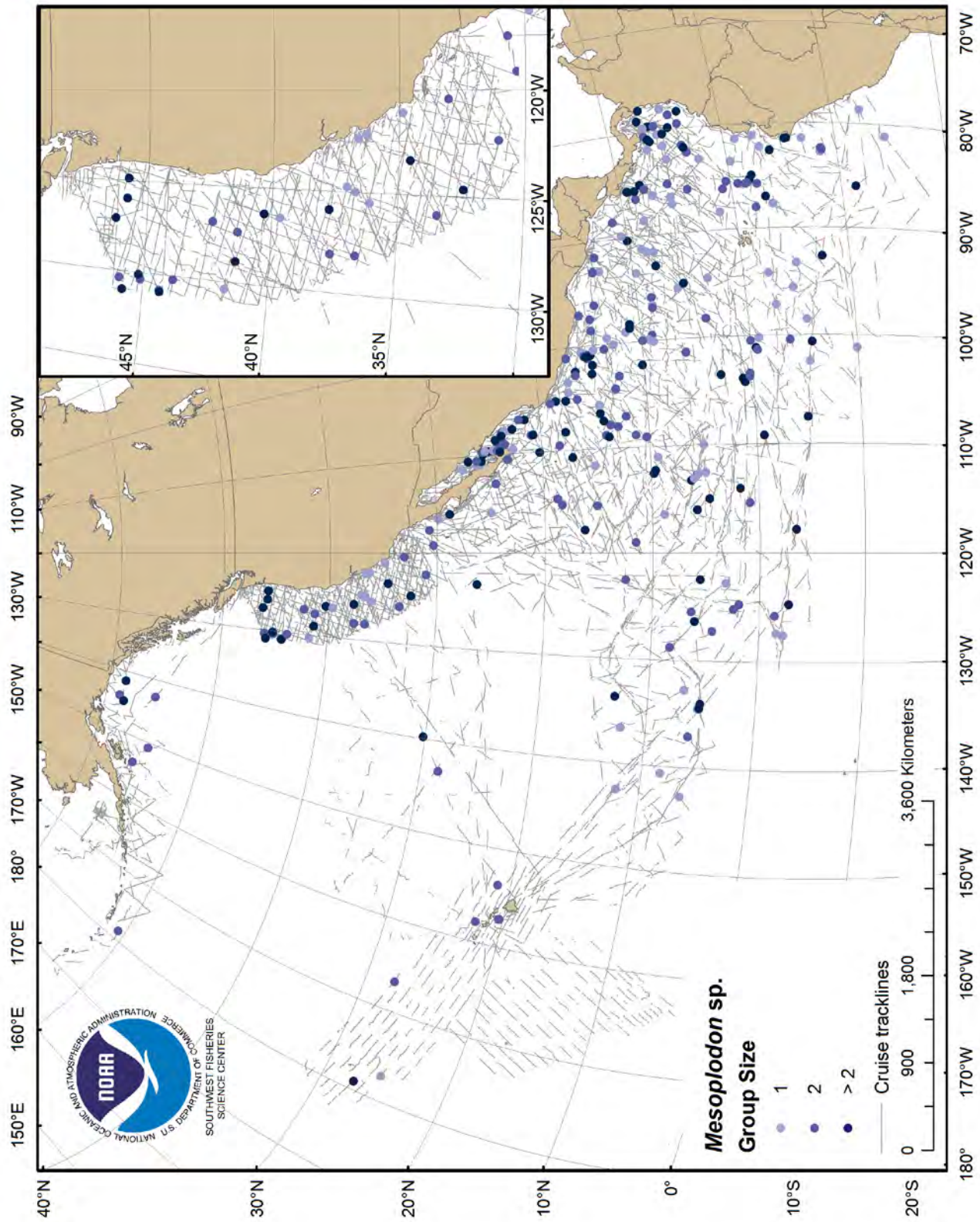


Figure 28. Distribution of unidentified *Mesoplodon* sp., species code 051.

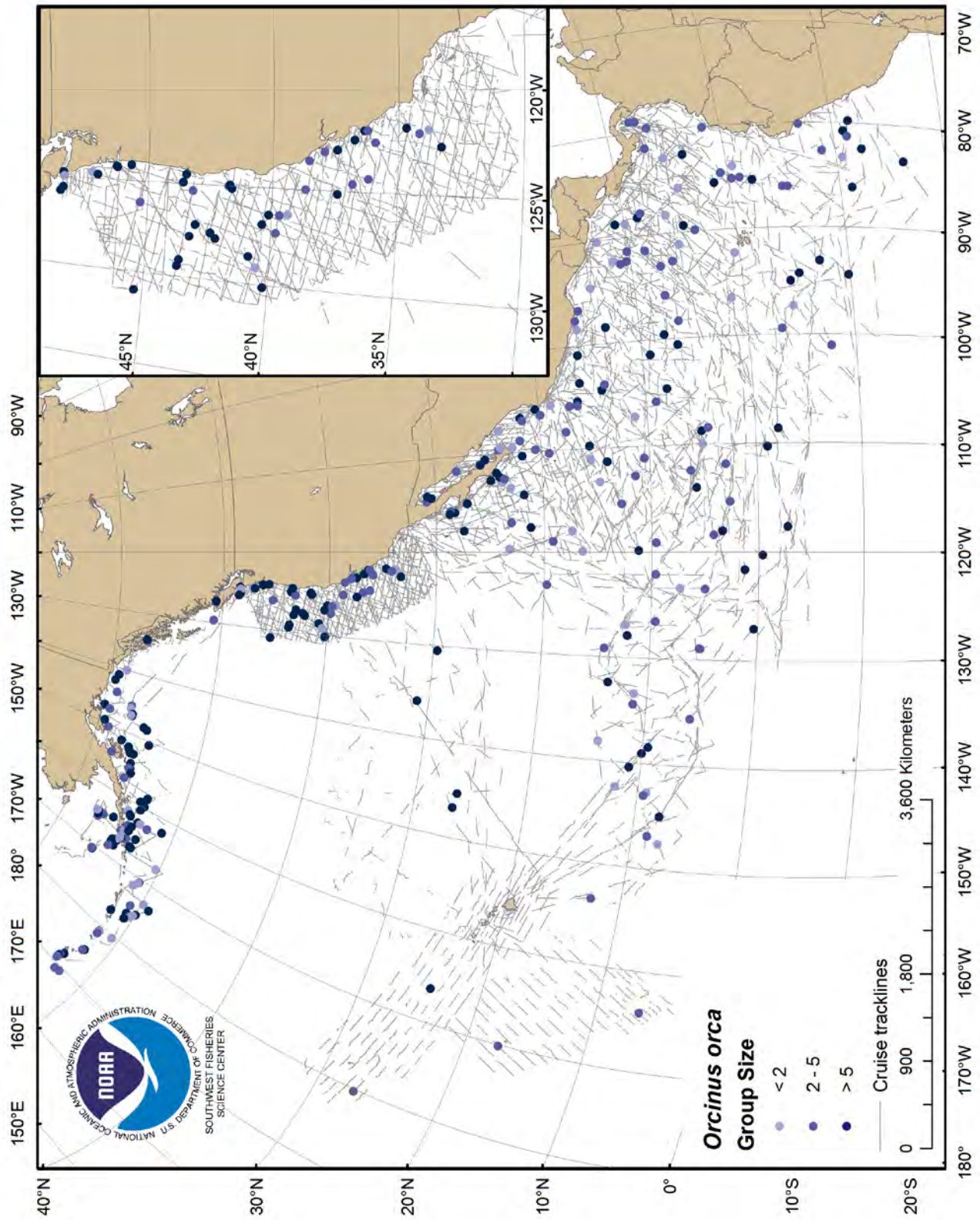


Figure 29. Distribution of killer whale, *Orcinus orca*, species code 037.

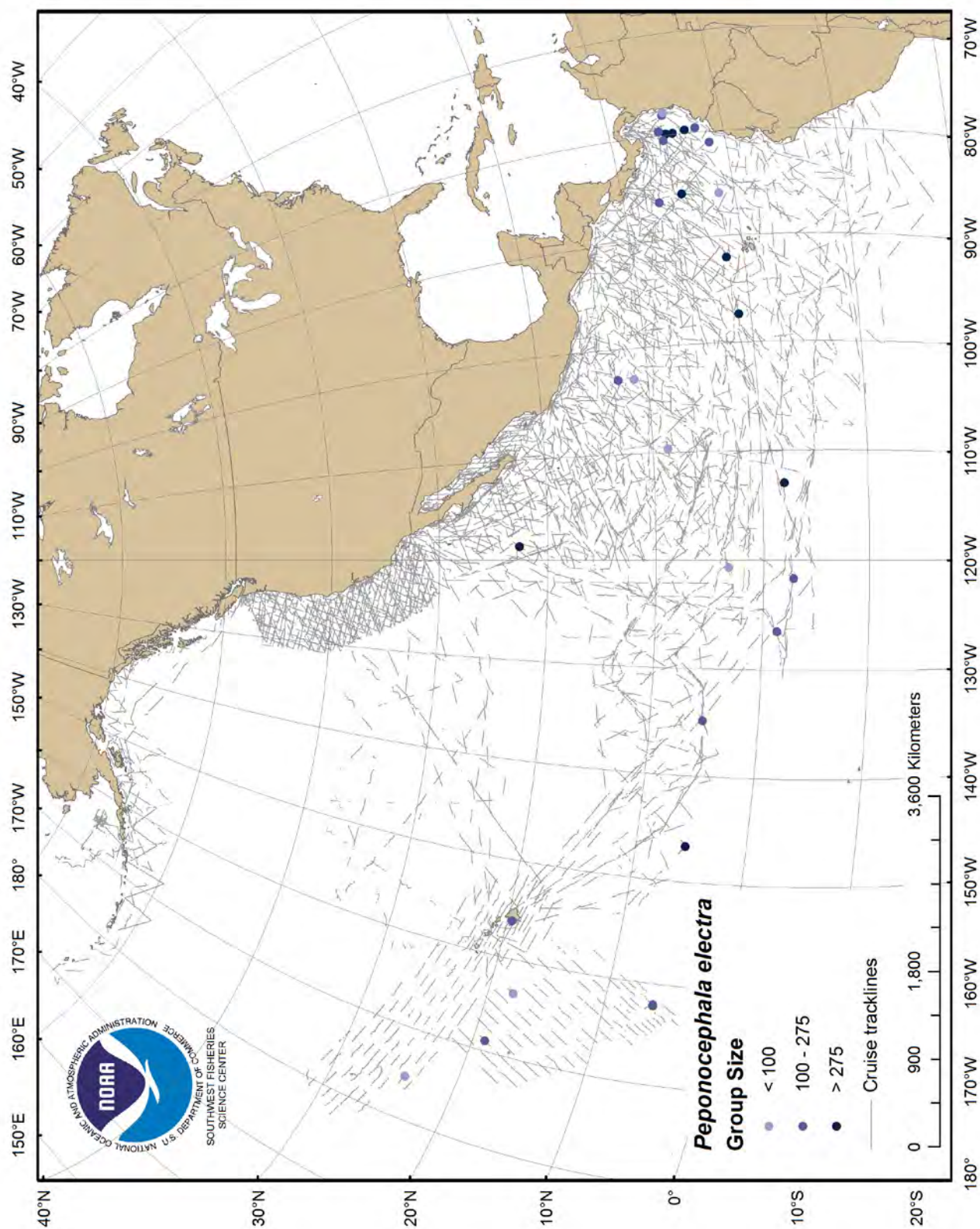


Figure 30. Distribution of melon-headed whale, *Peponocephala electra*, species code 031.

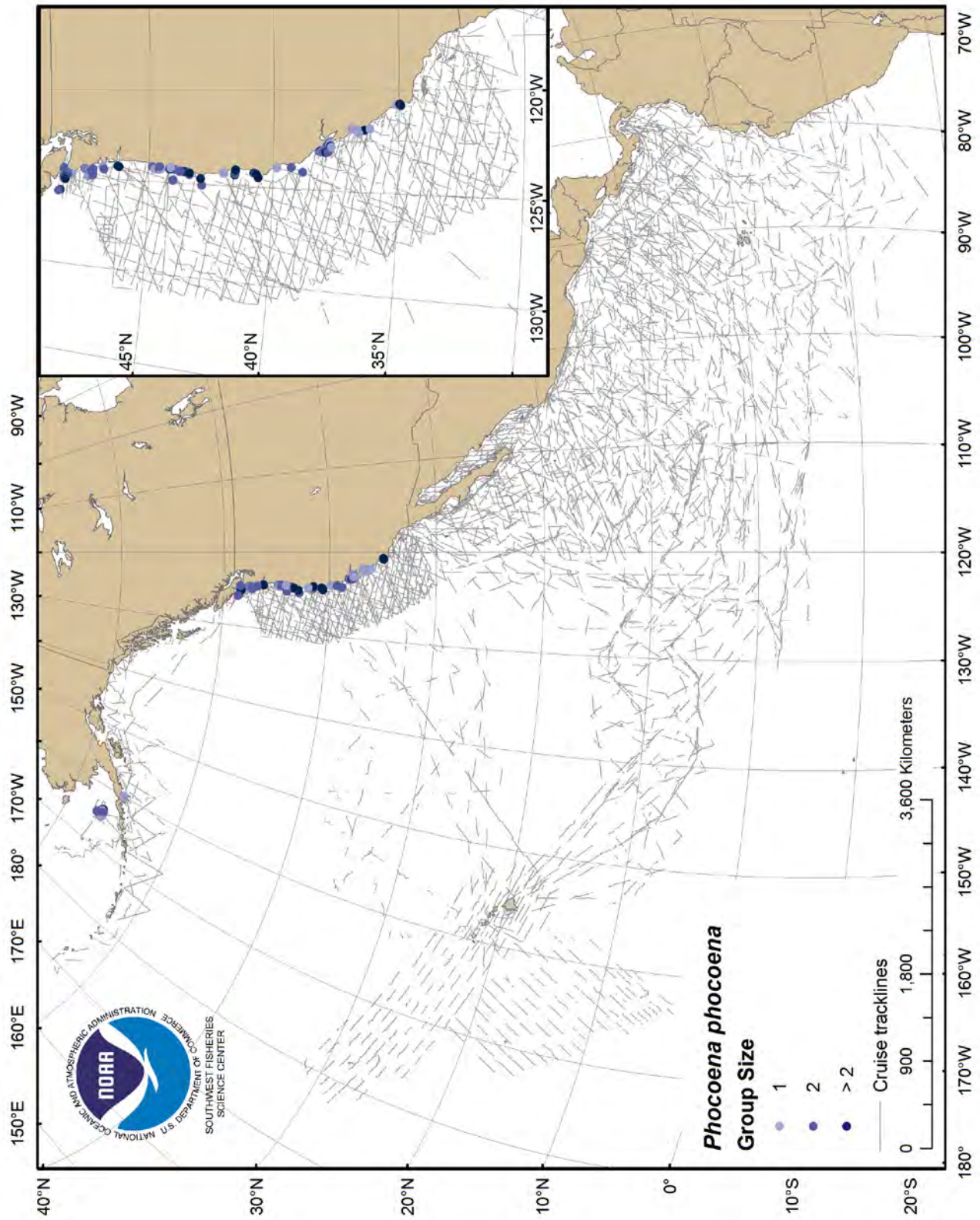


Figure 31. Distribution of harbor porpoise, *Phocoena phocoena*, species code 040.

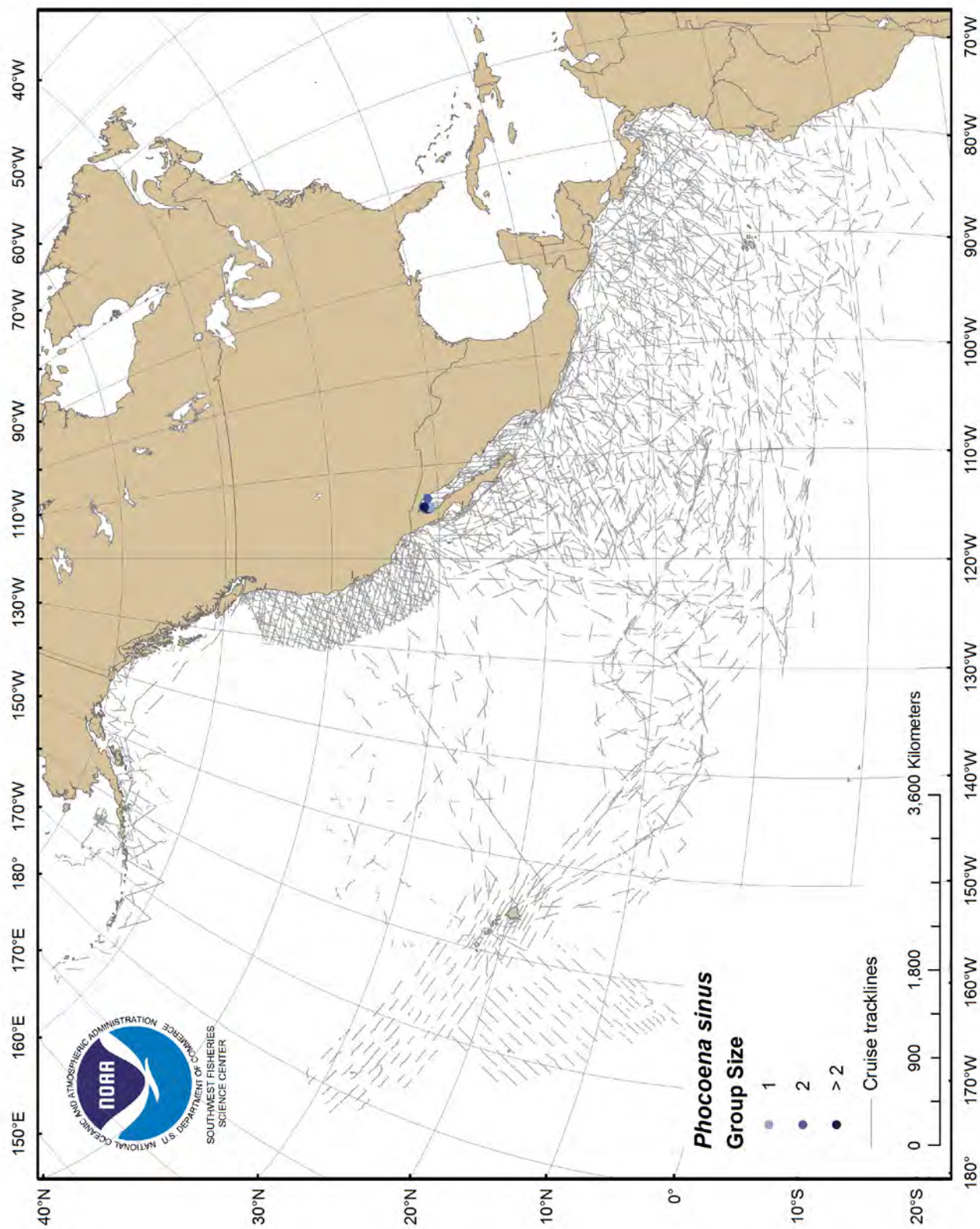


Figure 32. Distribution of vaquita, *Phocoena sinus*, species code 041.

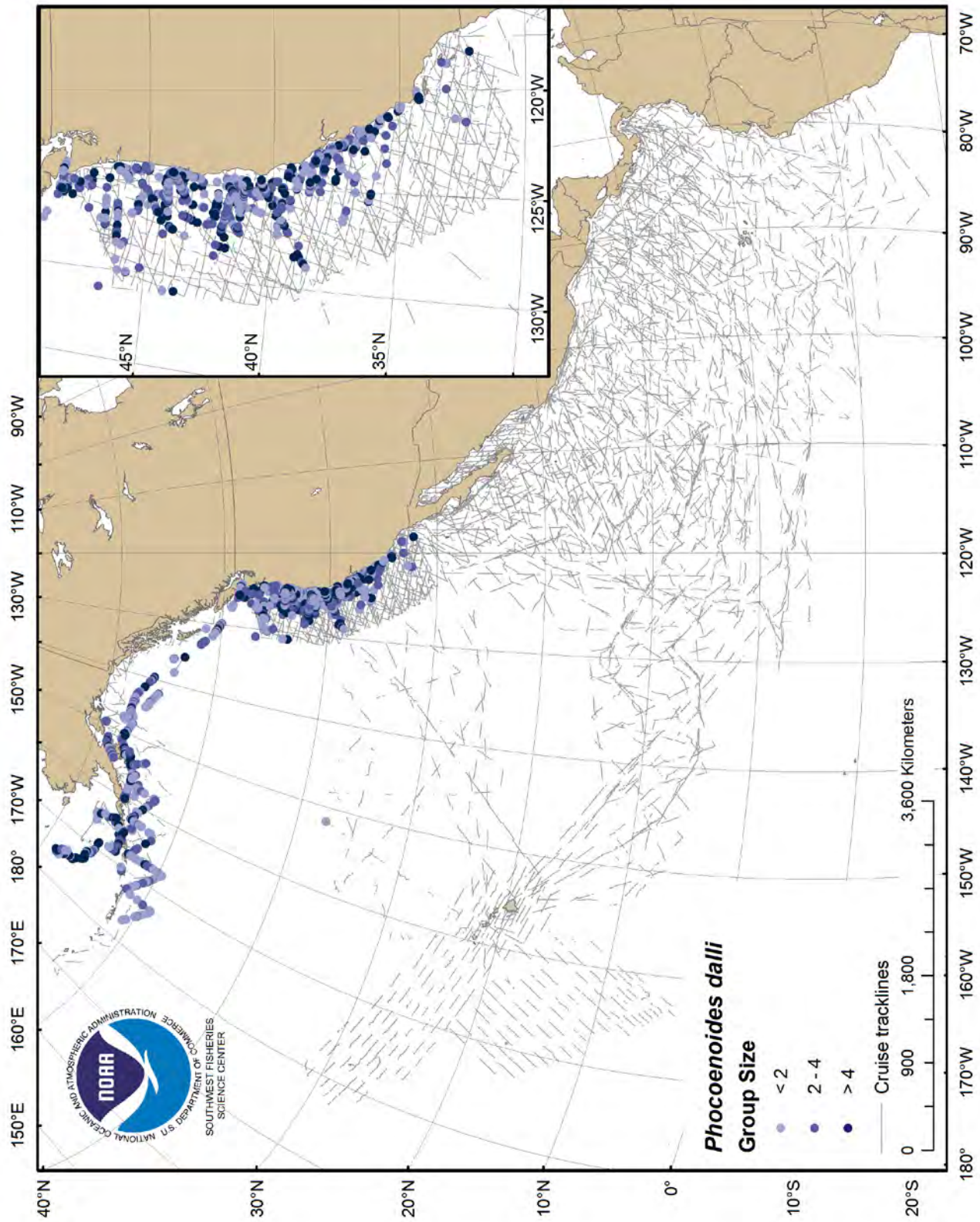


Figure 33. Distribution of Dall's porpoise, *Phocoenoides dalli*, species code 044.

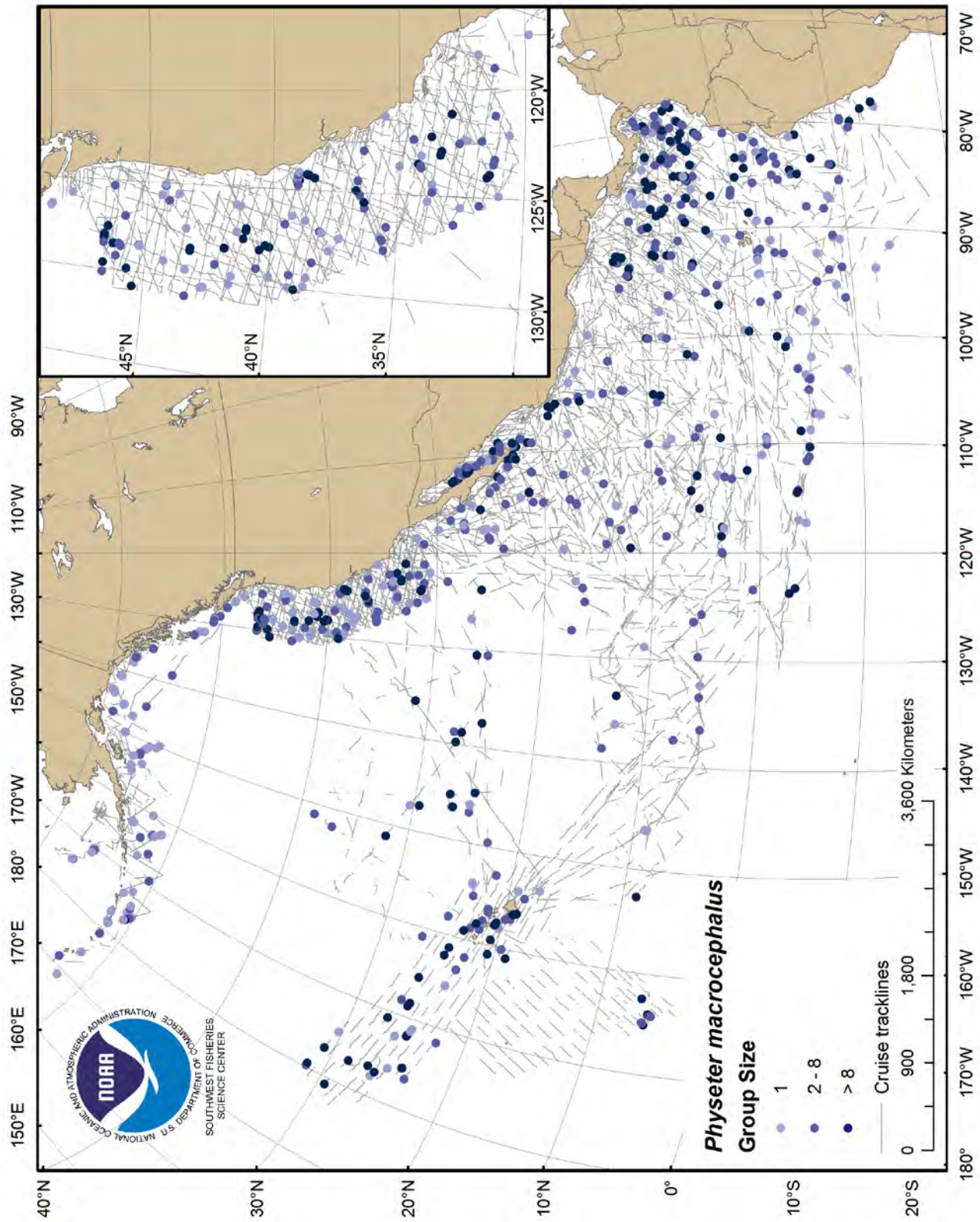


Figure 34. Distribution of sperm whale, *Physeter macrocephalus*, species code 046.

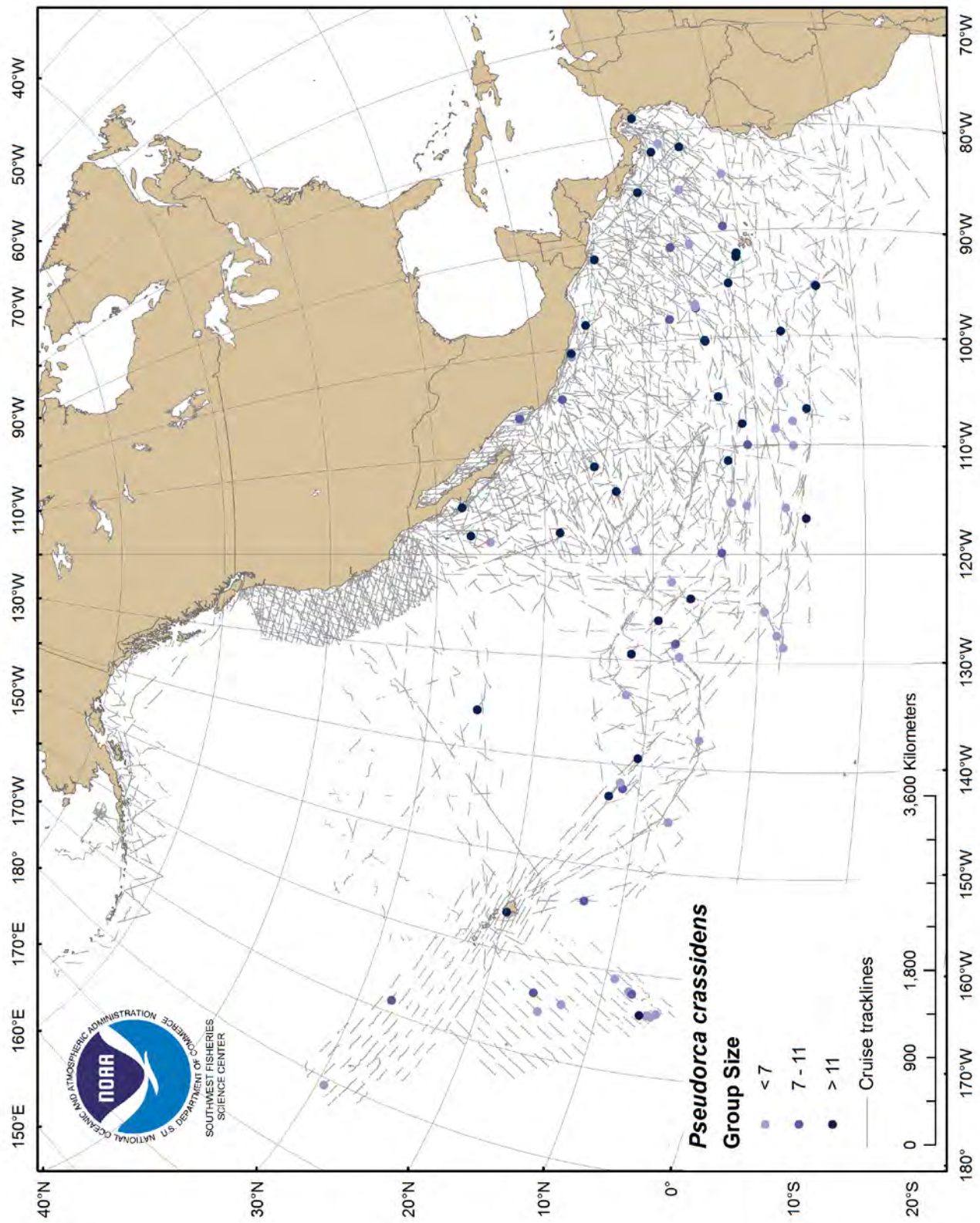


Figure 35. Distribution of false killer whale, *Pseudorca crassidens*, species code 033.

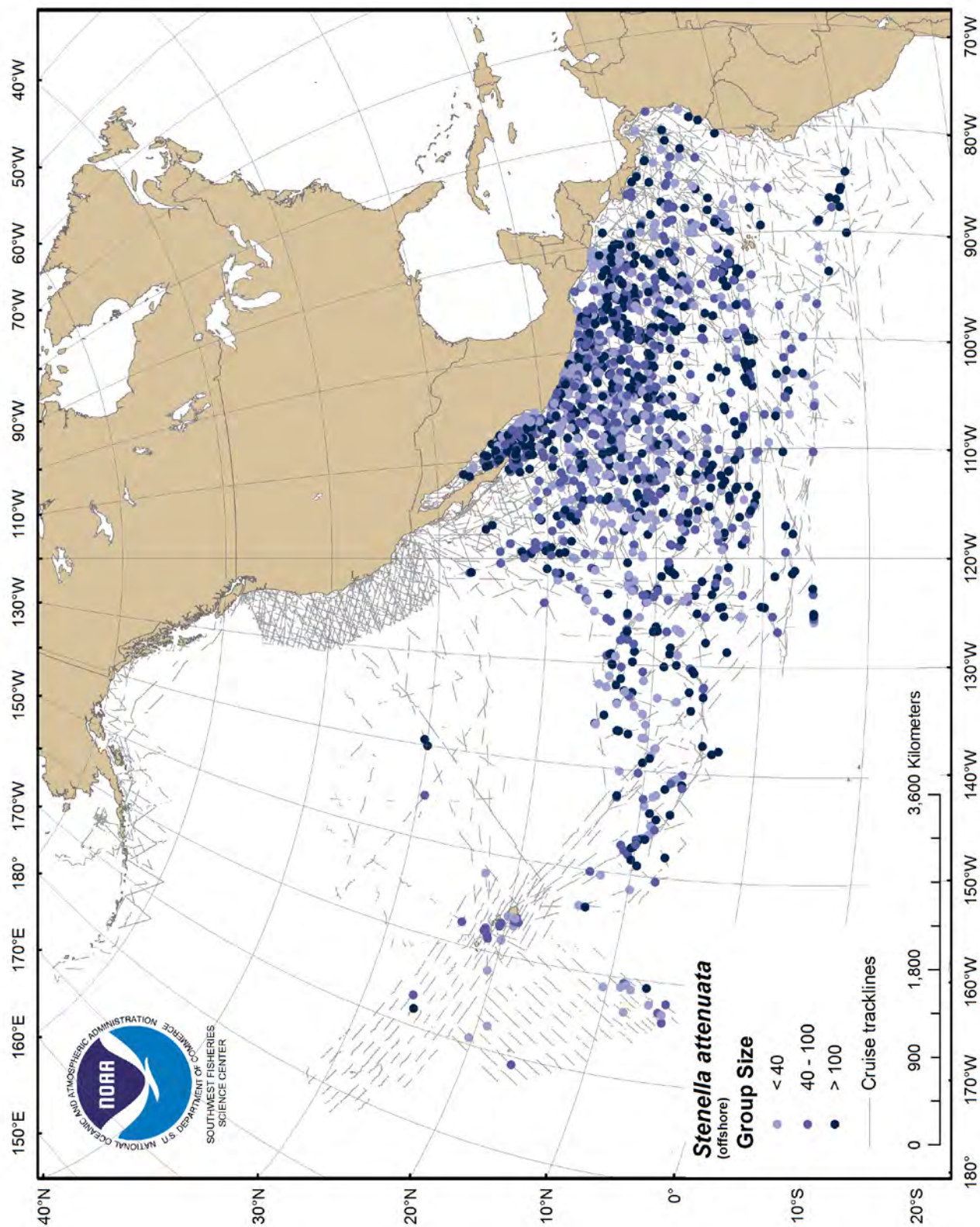


Figure 36. Distribution of offshore pantropical spotted dolphin, *Stenella attenuata* (offshore), species code 002.

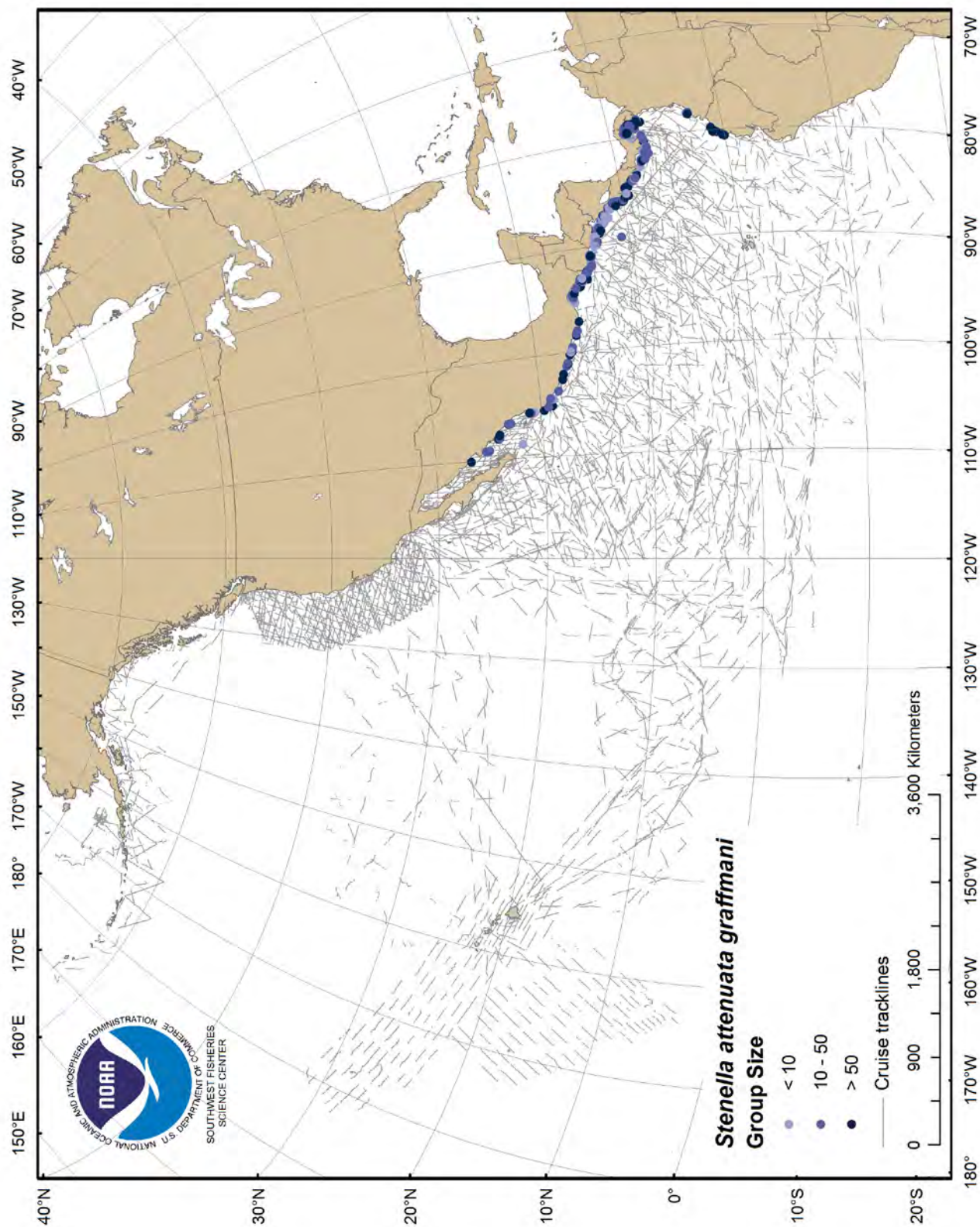


Figure 37. Distribution of coastal spotted dolphin, *Stenella attenuata graffmani*, species code 006.

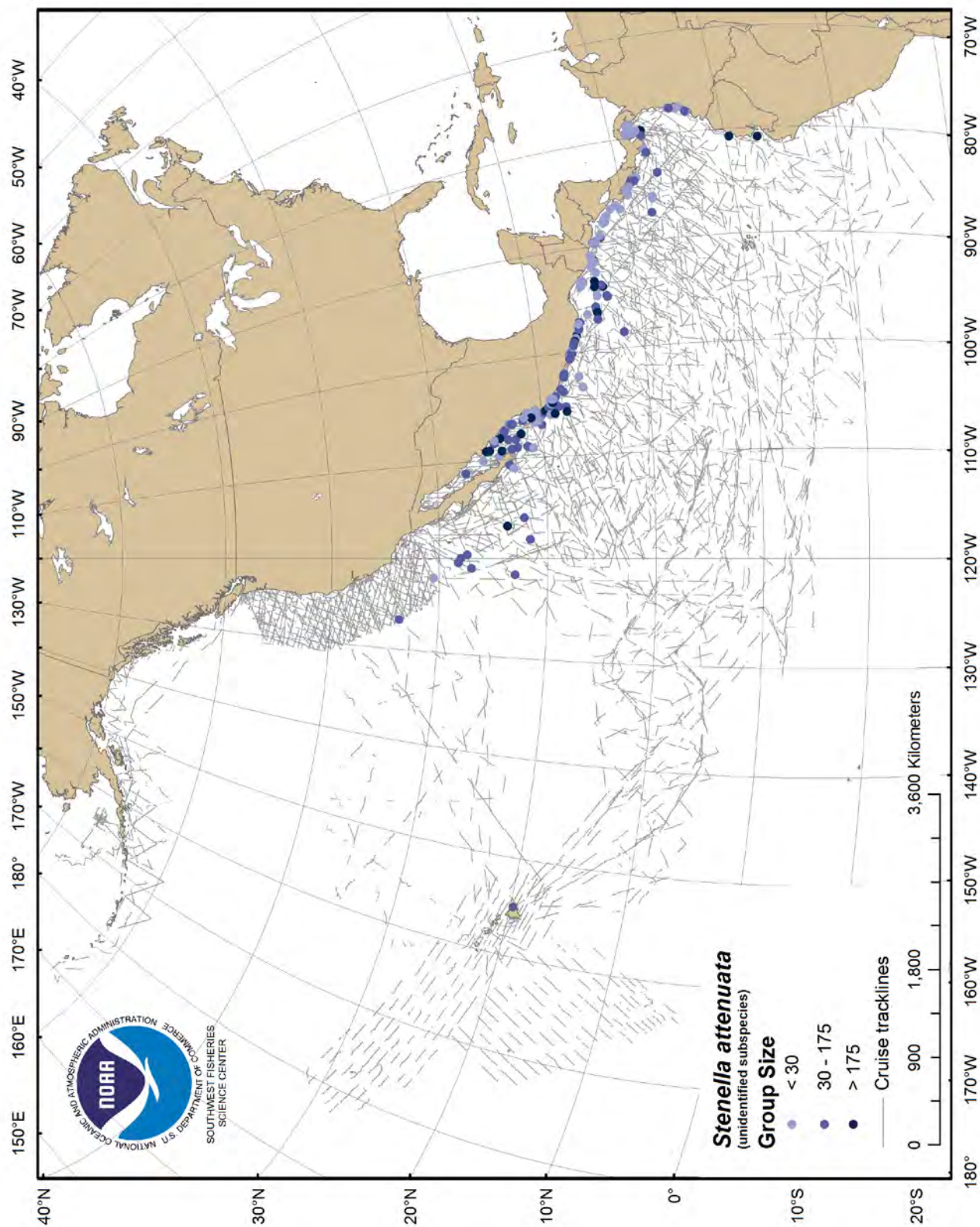


Figure 38. Distribution of unidentified pantropical spotted dolphin, *Stenella attenuata* (unid. subsp.), species code 090.

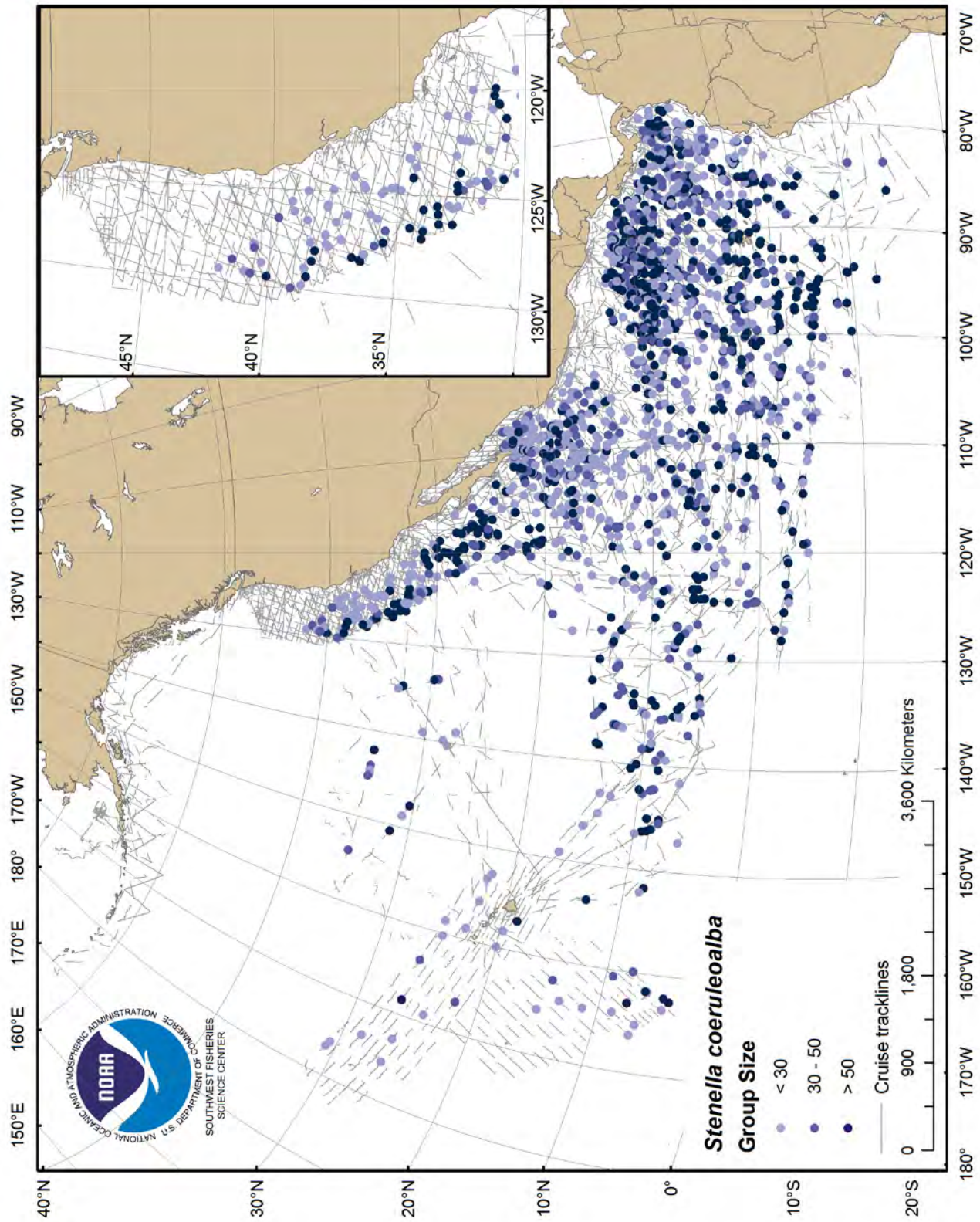


Figure 39. Distribution of striped dolphin, *Stenella coeruleoalba*, species code 013.

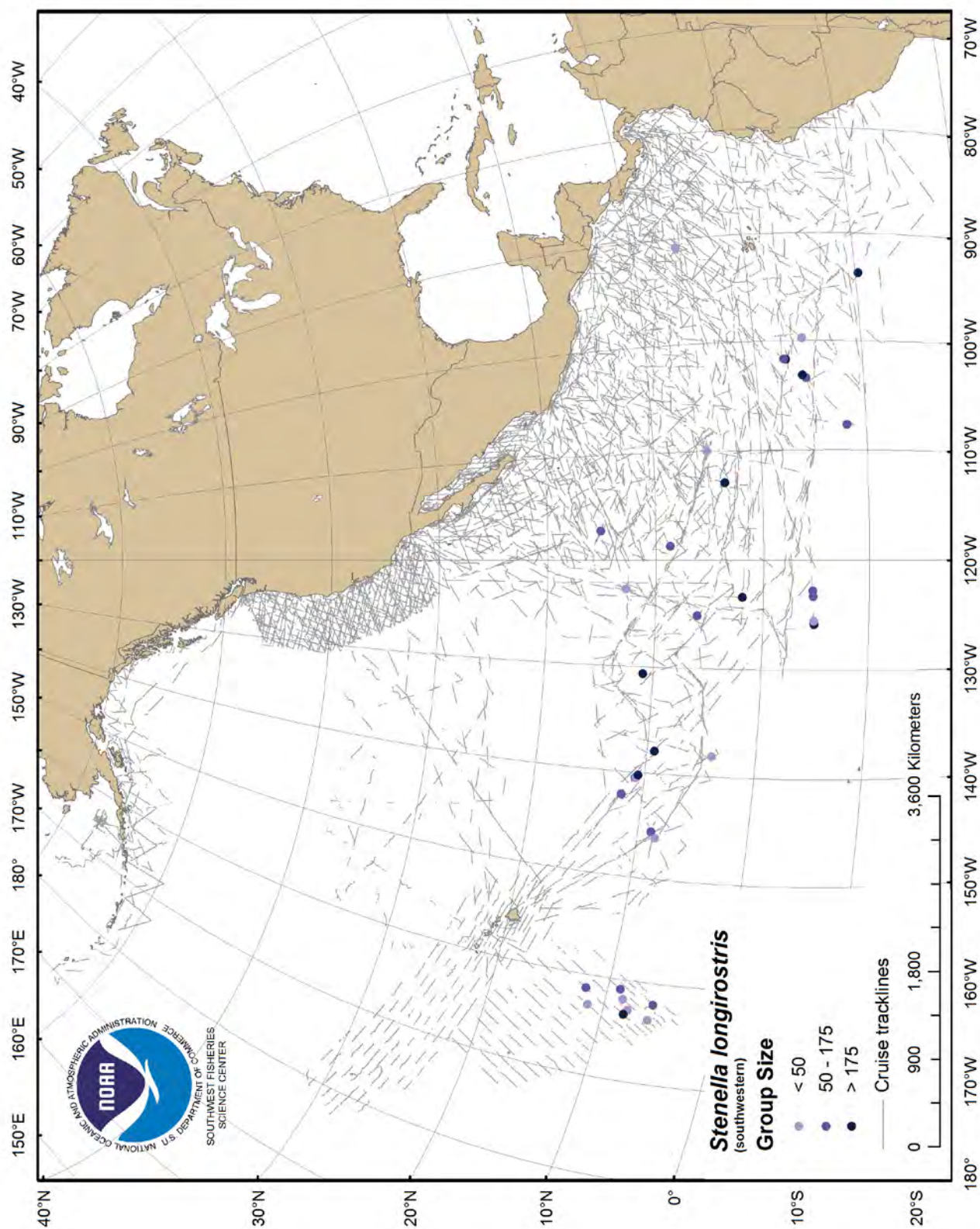


Figure 40. Distribution of southwestern spinner dolphin, *Stenella longirostris* (southwestern), species code 101.

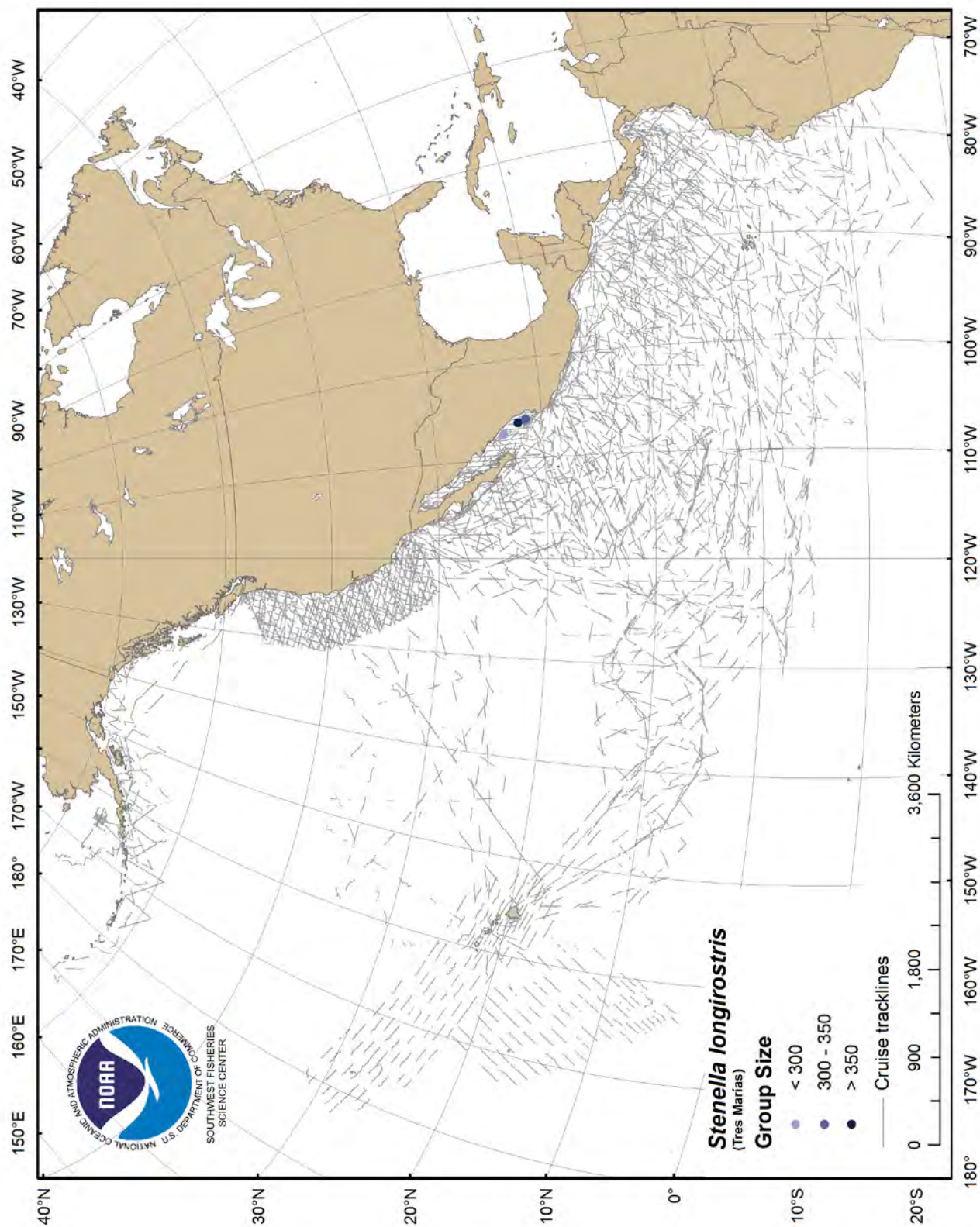


Figure 41. Distribution of Tres Marias spinner dolphin, *Stenella longirostris* (Tres Marias), species code 100.

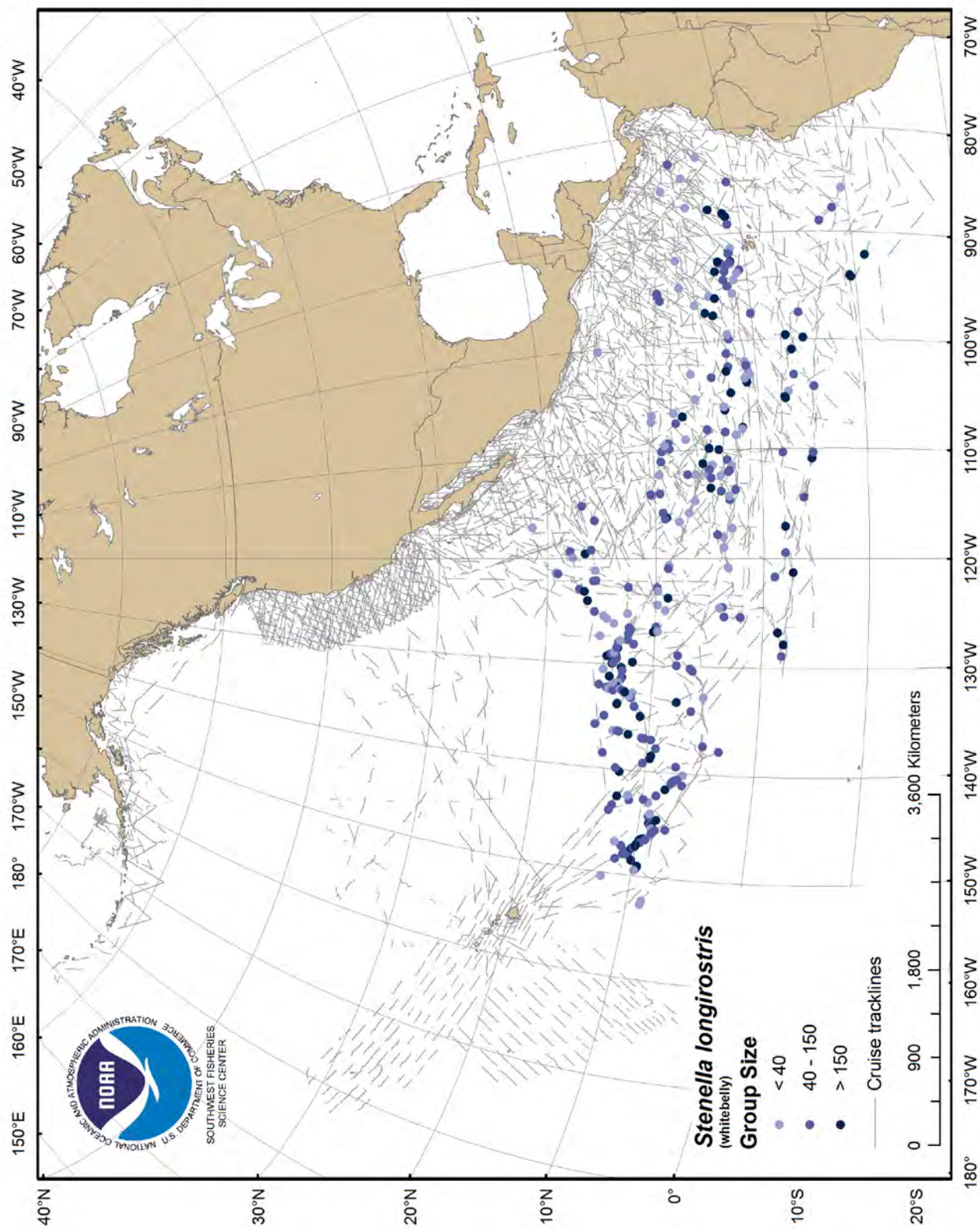


Figure 42. Distribution of whitebelly spinner dolphin, *Stenella longirostris* (whitebelly), species code 011.

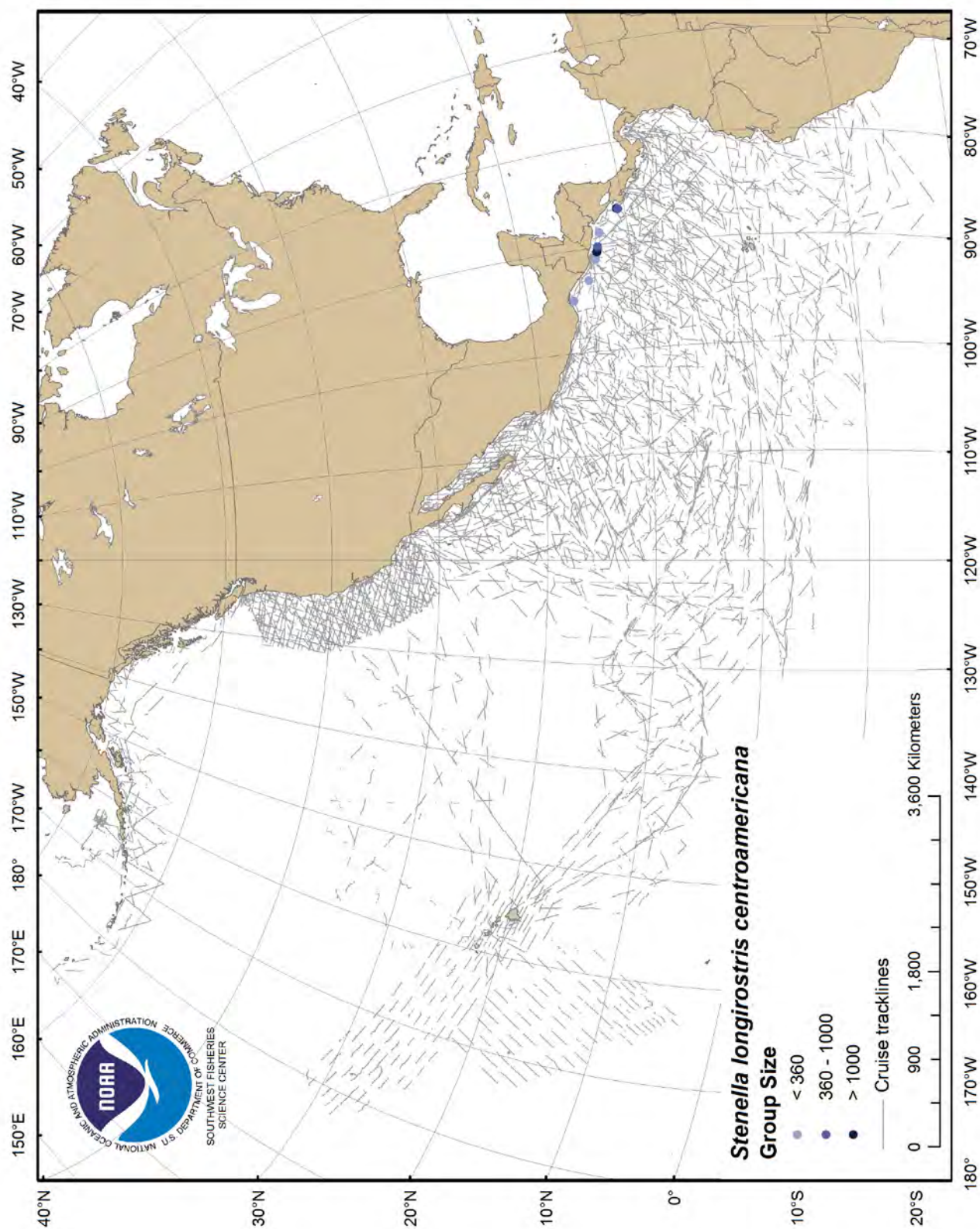


Figure 43. Distribution of Central American spinner dolphin, *Stenella longirostris centroamericana*, species code 088.

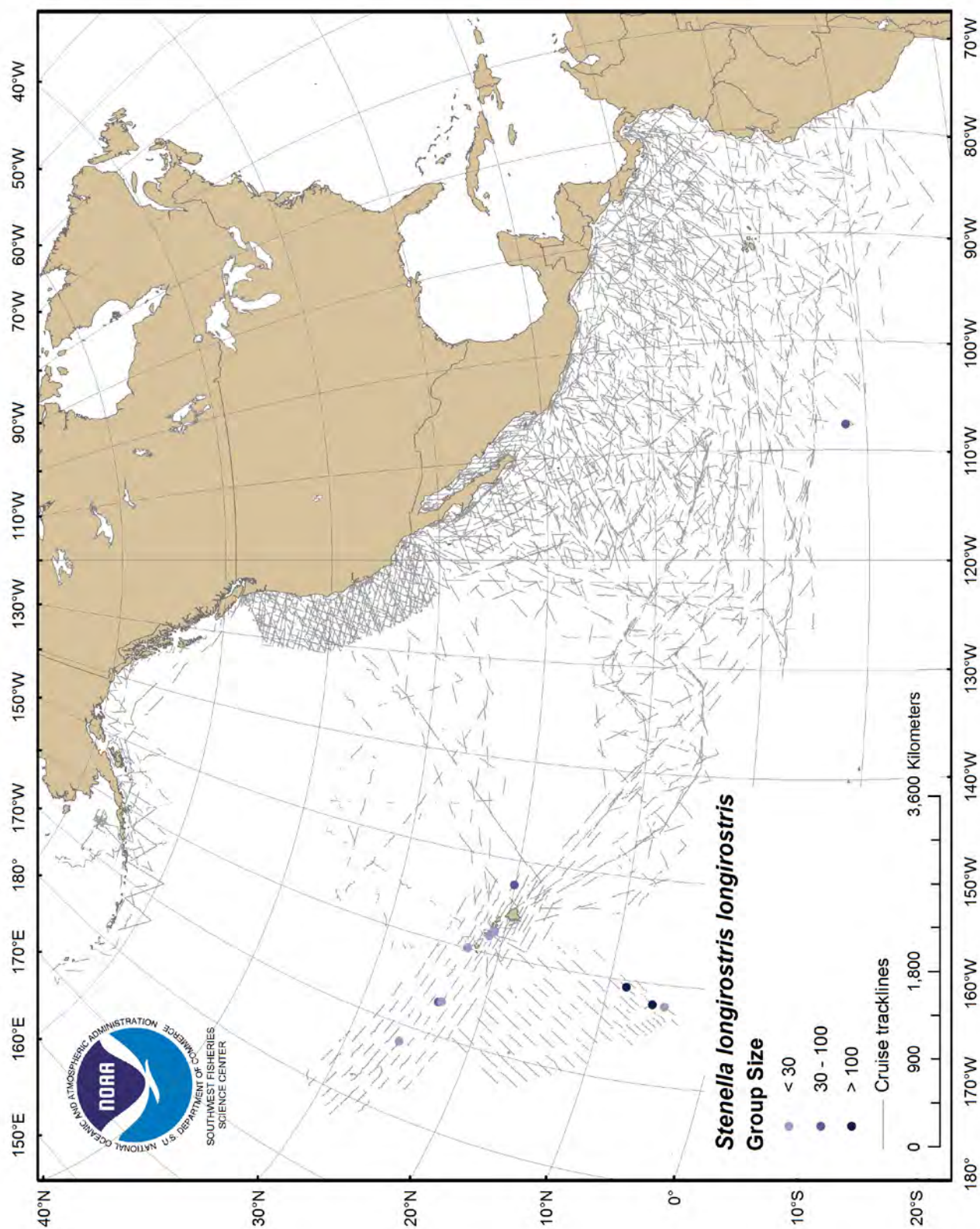


Figure 44. Distribution of Gray's spinner dolphin, *Stenella longirostris longirostris*, species code 102.

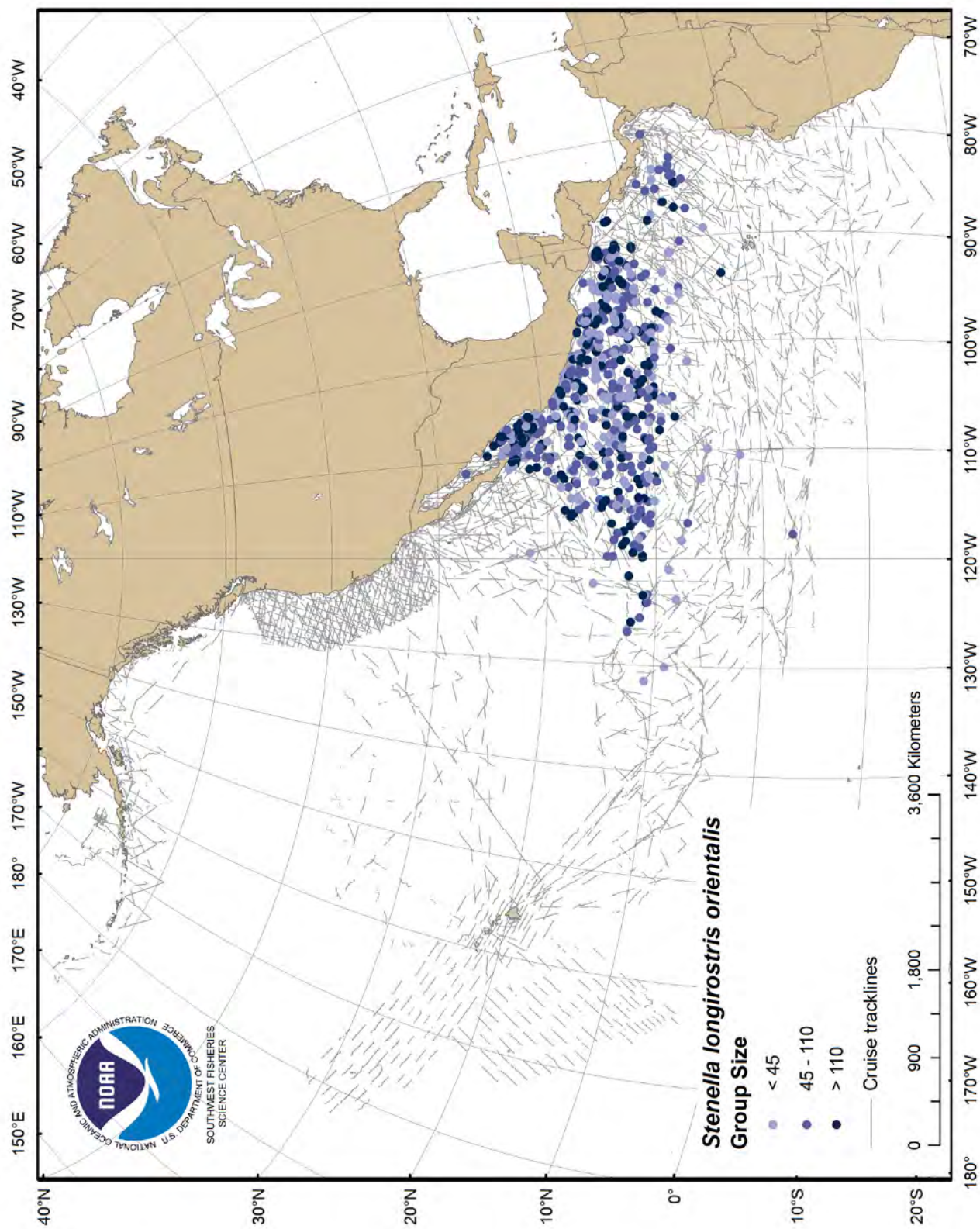


Figure 45. Distribution of eastern spinner dolphin, *Stenella longirostris orientalis*, species code 010.

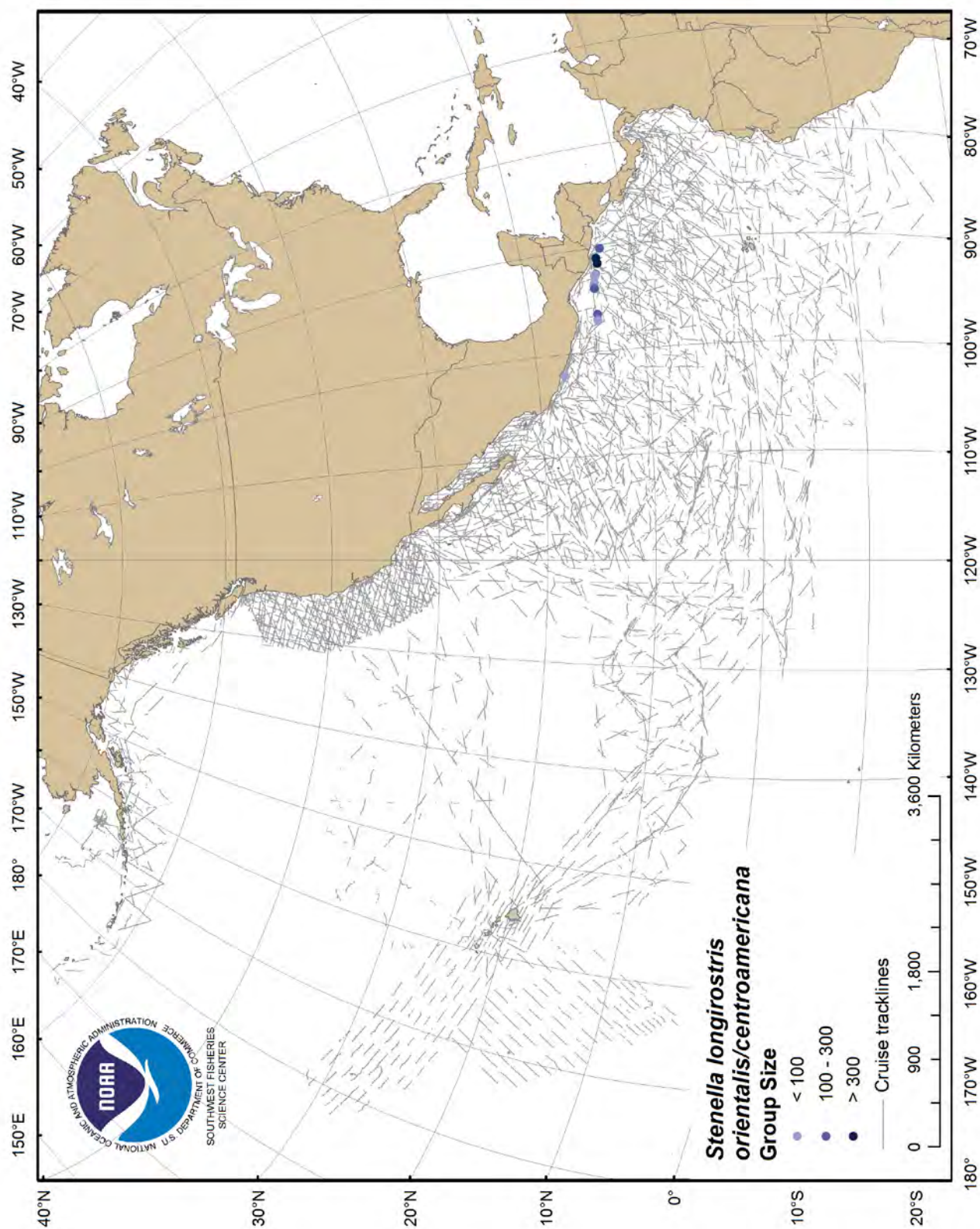


Figure 46. Distribution of undetermined eastern or Central American spinner dolphin, *Stenella longirostris orientalis centroamericana*, species code 103.

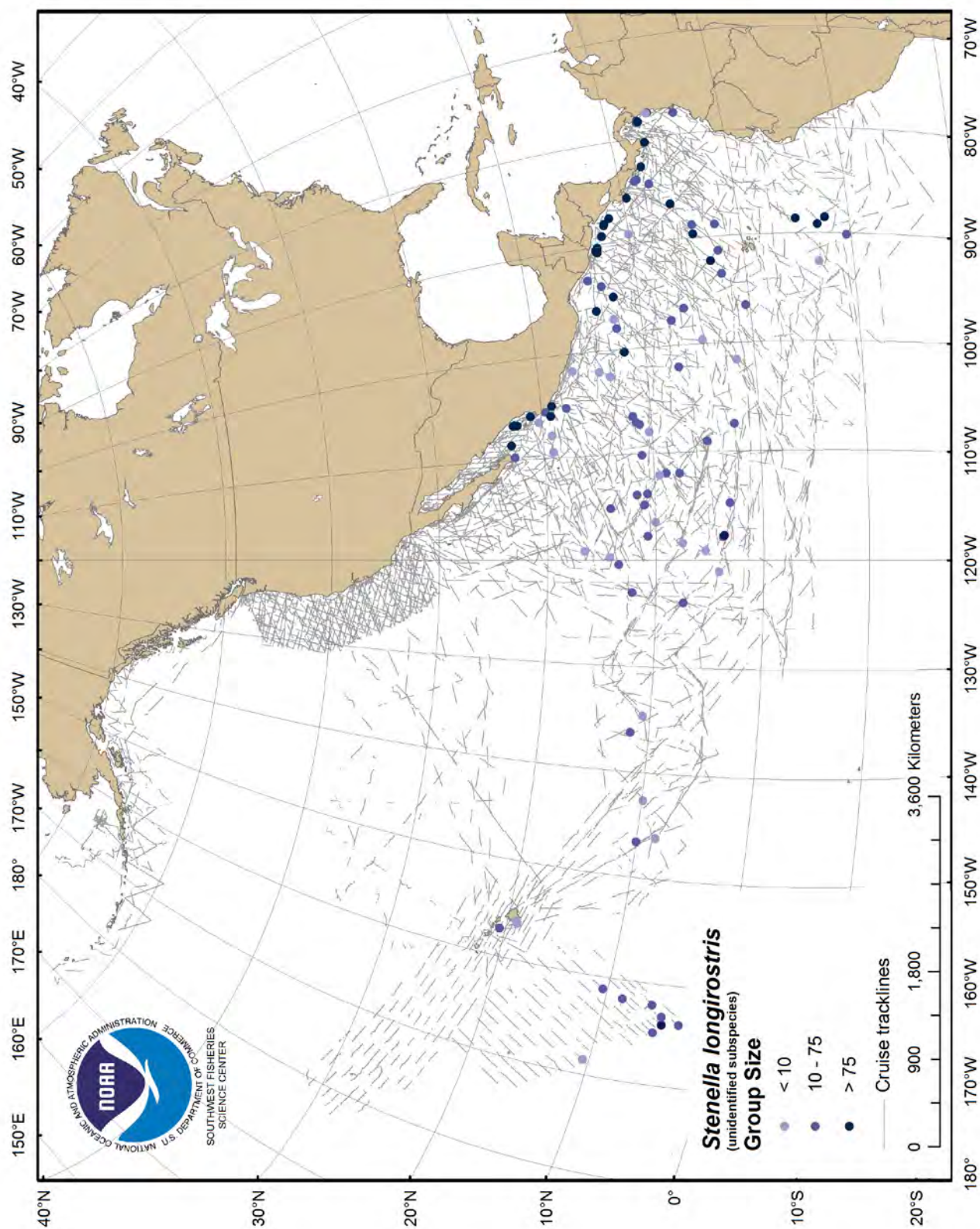


Figure 47. Distribution of unidentified spinner dolphin, *Stenella longirostris* (unid. subsp.), species code 003.

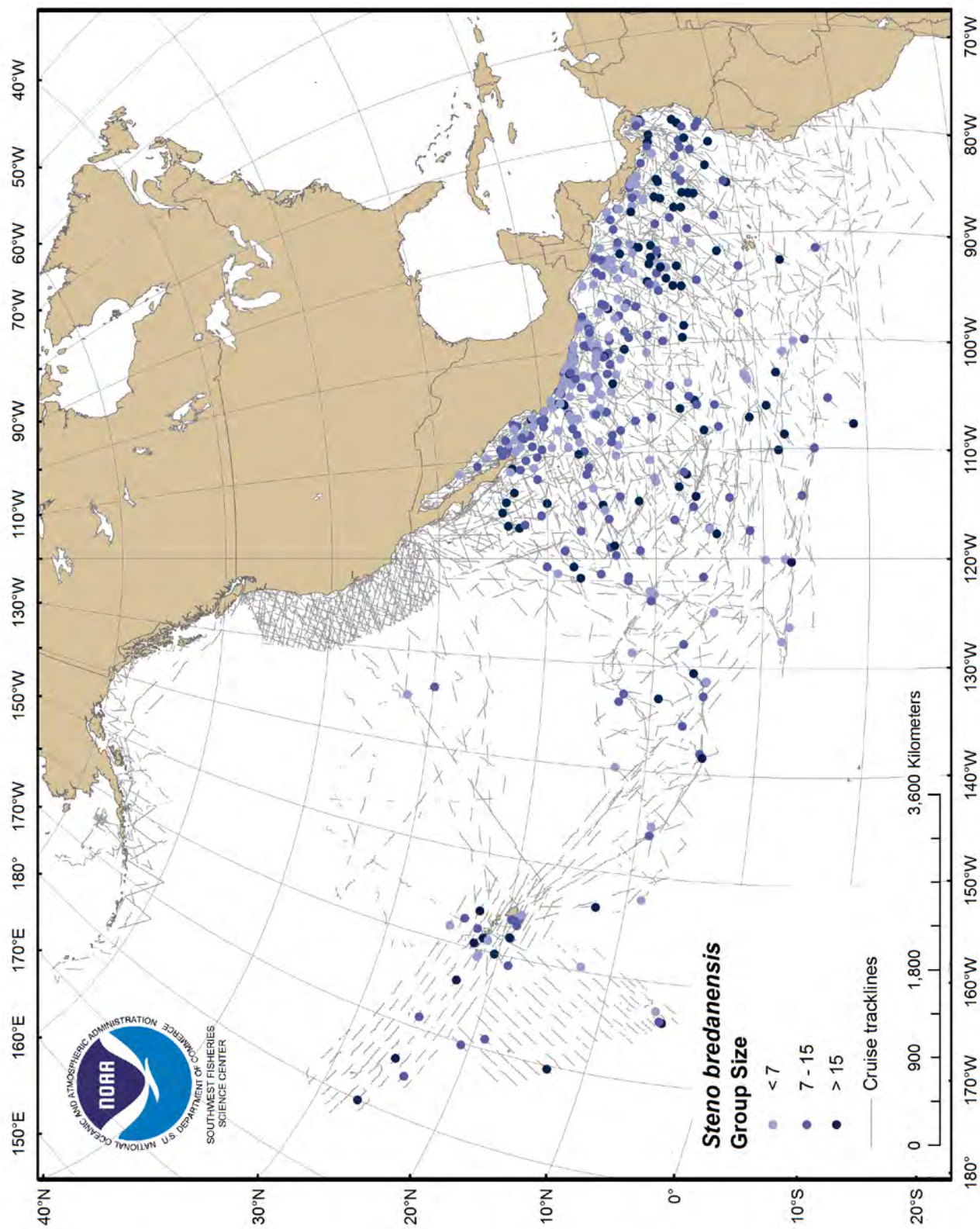


Figure 48. Distribution of rough-toothed dolphin, *Steno bredanensis*, species code 015.

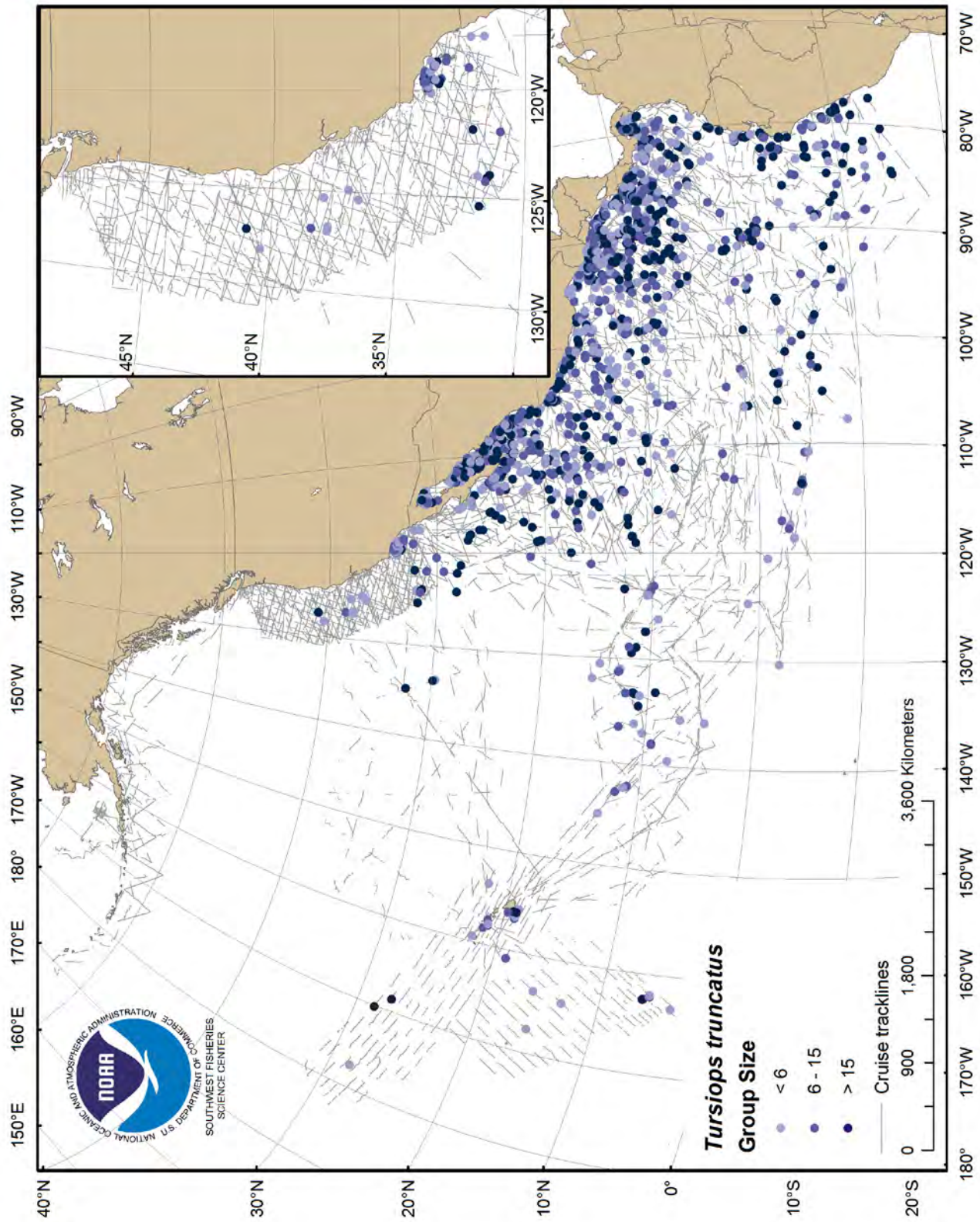


Figure 49. Distribution of bottlenose dolphin, *Tursiops truncatus*, species code 018.

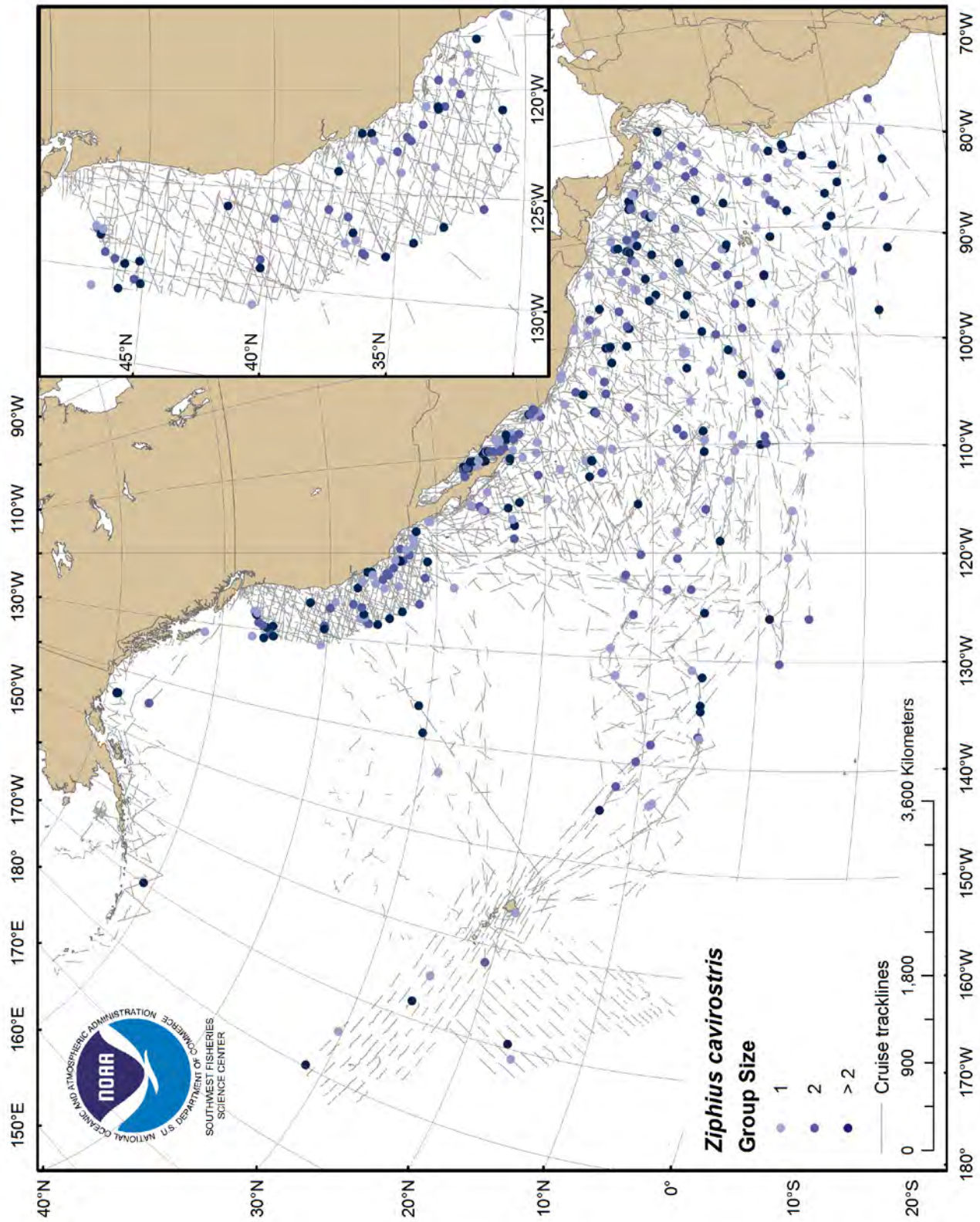


Figure 50. Distribution of Cuvier's beaked whale, *Ziphius cavirostris*, species code 061.

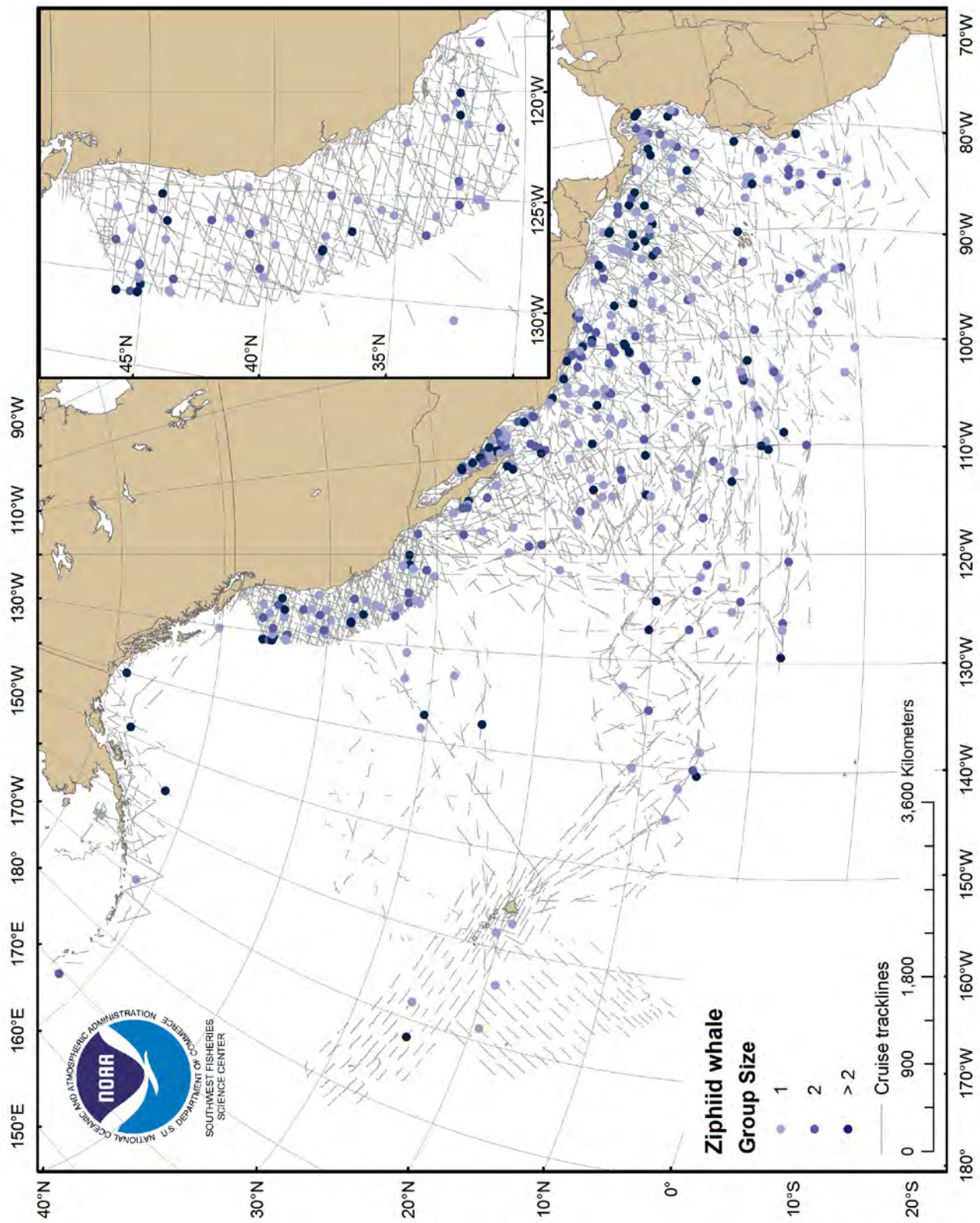


Figure 51. Distribution of unidentified beaked whale, Ziphiid whale, species code 049.

APPENDIX I - *Eastern Tropical Pacific Cetacean and Ecosystem Assessment Survey Reports*

- Allen, A. C., S. Mesnick, and T. Gerrodette. 2000. Evasive behavior of eastern tropical Pacific dolphins relative to research vessels, 1986-90 and 1998. NOAA/NMFS/SWFSC, Administrative Report LJ-00-09.
- Ambrose, D. A., R. L. Charter, H. G. Moser, and S. B. Reilly. 2000. Ichthyoplankton and station data for surface tows taken during the 1988 eastern tropical Pacific dolphin survey on the research vessels David Starr Jordan and McArthur. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-288.
- Ambrose, D.A., R.L. Charter, H.G. Moser, S.R. Charter, and W. Watson. 2002a. Ichthyoplankton and station data for surface (Manta) and oblique (Bongo) plankton tows taken during a survey in the eastern tropical Pacific Ocean July 30 - December 9, 1998. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-337.
- Ambrose, D.A., R.L. Charter, H.G. Moser, B.S. MacCall, and W. Watson. 2002b. Ichthyoplankton and station data for surface (manta) and oblique (bongo) plankton tows taken during a survey in the eastern tropical Pacific Ocean July 28 - December 9, 2000. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-342.
- Charter, S. R., R. L. Charter, H. G. Moser, and S. B. Reilly. 2000. Ichthyoplankton and station data for surface tows taken during the 1989 eastern tropical Pacific dolphin survey on the research vessels David Starr Jordan and McArthur. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-289.
- Hill, P.S., A. Jackson, and T. Gerrodette. 1990a. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel McArthur July 29 - December 7, 1989. U.S. Department of Commerce. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFC-143.
- Hill, P.S., A. Jackson, and T. Gerrodette. 1990b. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel David Starr Jordan July 29 - December 7, 1989. U.S. Department of Commerce. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFC-142.
- Hill, P.S., A. Jackson, and T. Gerrodette. 1991a. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel McArthur July 28 - December 6, 1990. U.S. Department of Commerce. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFSC-159.
- Hill, P.S., R.C. Rasmussen, and T. Gerrodette. 1991b. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel David Starr Jordan July 28 - December 6, 1990. U.S. Department of Commerce. NOAA Technical Memorandum, NOAA-TM-

- Holt, R.S. and A. Jackson. 1987a. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel McArthur July 29 - December 6, 1986. U.S. Department of Commerce. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFC-77.
- Holt, R.S. and S.N. Sexton. 1987b. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel David Starr Jordan, July 29 - December 5, 1986. U.S. Department of Commerce. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFC-76.
- Holt, R.S. and A. Jackson. 1988a. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel McArthur July 30 - December 10, 1987. U.S. Department of Commerce. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFC-116.
- Holt, R.S. and S.N. Sexton. 1988b. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel David Starr Jordan, August 8 - December 10, 1987. U.S. Department of Commerce. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFC-117.
- Holt, R.S. and S.N. Sexton. 1989. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel David Starr Jordan July 28 - December 6, 1988. U.S. Department of Commerce. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFC-129.
- Kinzey, D., T. Gerrodette, J. Barlow, A. Dizon, W. Perryman, P. Olson, and A. Von Saunder. 1999. Marine mammal data collected during a survey in the eastern tropical Pacific Ocean aboard the NOAA ships McArthur and David Starr Jordan and the UNOLS ship Endeavor July 31 - December 9, 1998. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-283. 113pp.
- Kinzey, D., T. Gerrodette, A. Dizon, W. Perryman, P. Olson, and S. Rankin. 2001. Marine mammal data collected during a survey in the eastern tropical Pacific Ocean aboard the NOAA ships McArthur and David Starr Jordan, July 28 - December 9, 2000. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-303. 107pp.
- Lierhiemer, L.J., P.C. Fiedler, S.B. Reilly, R.L. Pitman, L.T. Balance, and D.W. Behringer. 1989a. Report of ecosystem studies conducted during the 1988 eastern tropical Pacific dolphin survey on the research vessel McArthur. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-132.
- Lierhiemer, L.J., P.C. Fiedler, S.B. Reilly, R.L. Pitman, L.T. Ballance, G.G. Thomas, and D.W. Behringer. 1989b. Report of ecosystem studies conducted during the 1988 eastern tropical

- Pacific dolphin survey on the research vessel David Starr Jordan. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-131.
- Lierhiemer, L.J., P.C. Fiedler, S.B. Reilly, R.L. Pitman, L.T. Ballance, S.C. Beavers, and D.W. Behringer. 1990a. Report of ecosystem studies conducted during the 1989 eastern tropical Pacific dolphin survey on the research vessel McArthur. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-140.
- Lierhiemer, L.J., P.C. Fiedler, S.B. Reilly, R.L. Pitman, L.T. Ballance, S.C. Beavers, G.G. Thomas, and D.W. Behringer. 1990b. Report of ecosystem studies conducted during the 1989 eastern tropical Pacific dolphin survey on the research vessel David Starr Jordan. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-139.
- Moser, H. G., R. L. Charter, S. B. Reilly, D. A. Ambrose, S. R. Charter, E. M. Sandknop, and W. Watson. 2000. Ichthyoplankton and station data for surface tows taken during the 1987 eastern tropical Pacific dolphin survey on the research vessels David Starr Jordan and McArthur. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-287.
- Olson, P.A., R.L. Pitman, L.T. Ballance, and S.B. Reilly. 2000. Summary of seabird, marine turtle, and surface fauna data collected during a survey in the eastern tropical Pacific ocean, July 30 - December 9, 1998. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-298.
- Olson, P.A., Pitman, R.L., Ballance, L.T., Hough, K.R., Dutton, P., and S.B. Reilly. 2001a. Summary of seabird, marine turtle, and surface fauna data collected during a survey in the eastern tropical Pacific Ocean, July 28-December 9, 1999. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-301.
- Olson, P.A., Pitman, R.L., Ballance, L.T., Hough, K.R., Dutton, P.H., and S.B. Reilly. 2001b. Summary of seabird, marine turtle, and surface fauna data collected during a survey in the eastern tropical Pacific Ocean, July 28-December 9, 2000. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-304.
- Philbrick, V.A., P.C. Fiedler, S.B. Reilly, R.L. Pitman, L.T. Ballance, and D.W. Behringer. 1991a. Report of ecosystem studies conducted during the 1990 eastern tropical Pacific dolphin survey on the research vessel McArthur. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-161.
- Philbrick, V.A., P.C. Fiedler, S.B. Reilly, R.L. Pitman, L.T. Ballance, G.G. Thomas, and D.W. Behringer. 1991b. Report of ecosystem studies conducted during the 1990 eastern tropical Pacific dolphin survey on the research vessel David Starr Jordan. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-160.
- Philbrick, V.A., P.C. Fiedler, S.B. Reilly, R.L. Pitman, and L.T. Ballance. 1993. Report of

- ecosystem studies conducted during the 1992 eastern tropical Pacific common dolphin survey on the research vessels David Starr Jordan and McArthur. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-180.
- Philbrick, V. A., P. C. Fiedler, J. T. Fluty, and S. B. Reilly. 2001a. Report of oceanographic studies conducted during the 1998 eastern tropical Pacific Ocean survey on the research vessels David Starr Jordan, McArthur, and Endeavor. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-NMFS-SWFSC-307.
- Philbrick, V. A., P. C. Fiedler, J. T. Fluty, and S. B. Reilly. 2001b. Report of oceanographic studies conducted during the 1999 eastern tropical Pacific Ocean survey on the research vessels David Starr Jordan and McArthur. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-NMFS-SWFSC-308.
- Philbrick, V. A., P. C. Fiedler, J. T. Fluty, and S. B. Reilly. 2001c. Report of oceanographic studies conducted during the 2000 eastern tropical Pacific Ocean survey on the research vessels David Starr Jordan and McArthur. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-NMFS-SWFSC-309.
- Sandknop, E. M., R. L. Charter, H. G. Moser, and S. B. Reilly. 2000. Ichthyoplankton and station data for surface tows taken during the 1990 eastern tropical Pacific dolphin survey on the research vessels David Starr Jordan and McArthur. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-290.
- Sexton, S.N., R.S. Holt, and A. Jackson. 1989. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel McArthur July 28 - December 6, 1988. U.S. Department of Commerce. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFC-128.
- Thayer, V.G., B.G. McDonald, J.M. Ellingson, C.W. Oliver, D.W. Behringer, and S.B. Reilly. 1988a. Report of ecosystem studies conducted during the 1986 eastern tropical Pacific dolphin survey on the research vessel McArthur. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-104.
- Thayer, V.G., S.B. Reilly, P.C. Fiedler, R.L. Pitman, G.G. Thomas, and D.W. Behringer. 1988b. Report of ecosystem studies during the 1986 eastern tropical Pacific dolphin survey on the research vessel David Starr Jordan. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-105.
- Thayer, V.G., S.B. Reilly, P.C. Fiedler, C.W. Oliver, and D.W. Behringer. 1988c. Report of ecosystem studies conducted during the 1987 eastern tropical Pacific dolphin survey on the research vessel McArthur. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-114.
- Thayer, V.G., S.B. Reilly, P.C. Fiedler, R.L. Pitman, G.G. Thomas, and D.W. Behringer. 1988d. Report of ecosystem studies during the 1987 eastern tropical Pacific dolphin survey on

the research vessel David Starr Jordan. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-115.

Watson, W., R. L. Charter, H. G. Moser, and S. B. Reilly. 2000. Ichthyoplankton and station data for surface tows taken during the 1992 eastern tropical Pacific common dolphin survey on the research vessels David Starr Jordan and McArthur. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-291.

Watson, W., E.M. Sandknop, S.R. Charter, D.A. Ambrose, R.L. Charter, and H.G. Moser. 2002. Ichthyoplankton and station data for surface (Manta) and oblique (Bongo) plankton tows taken during a survey in the eastern tropical Pacific Ocean July 28 - December 9, 1999. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-338.

APPENDIX II – *Northern Gulf of California Vaquita Survey Reports*

Barlow, J., T. Gerrodette, and G. Silber. 1997. First estimates of vaquita abundance. *Mar. Mamm. Sci.* 13:44-58.

D'Agrosa, C., C. E. Lennert-Cody, and O. Vidal. 2000. Vaquita bycatch in Mexico's artisanal gillnet fisheries: driving a small population to extinction. *Conserv. Biol.* 14:1110-1119.

Rojas-Bracho, L., and B. L. Taylor. 1999. Risk factors affecting the vaquita (*Phocoena sinus*). *Mar. Mamm. Sci.* 15:974-989.

Taylor, B. L., and L. Rojas-Bracho. 1999. Examining the risk of inbreeding depression in a naturally rare cetacean, the vaquita (*Phocoena sinus*). *Mar. Mamm. Sci.* 15:1004-1028.

APPENDIX III - *West Coast Marine Mammal and Ecosystem Survey Reports*

Appler, J., J. Barlow, and S. Rankin. 2004. Marine mammal data collected during the Oregon, California and Washington line-transect expeditions (ORCAWALE) conducted aboard the NOAA ships McArthur and David Starr Jordan, July-Dec 2001. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-359. 28pp.

Barlow, J. 1994. Abundance of large whales in California coastal waters: a comparison of ship surveys in 1979/80 and in 1991. *Rept. Int. Whal. Commn.* 44:399-406.

Barlow, J. 1995. The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall of 1991. *Fish. Bull.* 93:1-14.

Barlow, J. and T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-233. 15pp.

- Barlow, J. 1997. Preliminary estimates of cetacean abundance off California, Oregon, and Washington based on a 1996 ship survey and comparisons of passing and closing modes. NOAA National Marine Fisheries Service, Southwest Fisheries Science Center Administrative Report LJ-97-11. 25pp.
- Barlow, J. and B. L. Taylor. 2001. Estimates of large whale abundance off California, Oregon, Washington, and Baja California based on 1993 and 1996 ship surveys. NOAA National Marine Fisheries Service, Southwest Fisheries Science Center Administrative Report LJ-01-03.
- Barlow, J. 2003. Preliminary Estimates of the Abundance of Cetaceans along the U.S. West Coast: 1991-2001. NOAA National Marine Fisheries Service, Administrative Report LJ-03-03, available from Southwest Fisheries Science Center, 8604 La Jolla Shores Dr., La Jolla CA 92037. 31pp.
- Hill, P.S. and J. Barlow. 1992. Report of a marine mammal survey of the California coast aboard the research vessel *McArthur* July 28 – November 5, 1991. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-169. 112pp.
- Mangels, K.F. and T. Gerrodette. 1994. Report of cetacean sightings during a marine mammal survey in the eastern Pacific Ocean and the Gulf of California aboard the NOAA ships *McArthur* and *David Starr Jordan* July 28 – November 6, 1993. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-211. 96pp.
- Philbrick, V. A., P. C. Fiedler, L. T. Ballance, and D. A. Demer. 2003. Report of ecosystem studies conducted during the 2001 Oregon, California, and Washington (ORCAWALE) marine mammal survey on the research vessels *David Starr Jordan* and *McArthur*. U.S. Department of Commerce. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-349.
- VonSaunders, A. and J. Barlow. 1999. A report of the Oregon, California and Washington Line-Transsect Experiment (ORCAWALE) conducted in West Coast waters during summer/fall 1996. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-264. 49pp.
- Two reports, one for each ship, for the CSCAPE-05 survey are available as SWFSC Cruise Reports at: http://swfsc.noaa.gov/uploadedFiles/Divisions/PRD/Projects/Research_Cruises/US_West_Coast/CSCAPE/CSCAPEDSJ.pdf and http://swfsc.noaa.gov/uploadedFiles/Divisions/PRD/Projects/Research_Cruises/US_West_Coast/CSCAPE/CSCAPEMAC.pdf.

APPENDIX IV - Central Pacific Cetacean Survey Reports

- Barlow, J., S. Rankin, E. Zele, and J. Applier. 2004. Marine mammal data collected during

the Hawaiian Islands cetacean and ecosystem assessment survey (HICEAS) conducted aboard the NOAA ships McARTHUR and DAVID STARR JORDAN, July-December 2002. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-362. Available from Southwest Fisheries Science Center, 8604 La Jolla Shores Dr., La Jolla CA 92037. 32pp.

Barlow, J. and B. L. Taylor. 2005. Estimates of sperm whale abundance in the northeastern temperate Pacific from a combined acoustic and visual survey. *Mar. Mamm. Sci.* 21(3):429-445.

APPENDIX V - *Aerial Survey Reports*

Barlow, J., C. Oliver, T. D. Jackson, and B. L. Taylor. 1988. Harbor porpoise (*Phocoena phocoena*) abundance estimation in California, Oregon and Washington: II. Aerial surveys. *Fish. Bull.* 86:433-444.

Carretta, J. V. and K. A. Forney. 1993. Report on two aerial surveys for marine mammals in California coastal waters utilizing a NOAA DeHavilland Twin Otter Aircraft: March 9-April 7, 1991 and February 8-April 6, 1992. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-185. 77pp.

Carretta, J. V., K. A. Forney, and J. Barlow. 1995. Report of 1993-94 marine mammal aerial surveys conducted within the U.S. Navy Outer Sea Test Range off southern California. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-217. 90pp.

Carretta, J. V., K. A. Forney, and J. L. Laake. 1998. Abundance of southern California coastal bottlenose dolphins estimated from tandem aerial surveys. *Mar. Mamm. Sci.* 14(4):655-675.

Carretta, J.V. and K.A. Forney. 2004. Preliminary estimates of harbor porpoise abundance in California from 1999 and 2002 aerial surveys. NOAA National Marine Fisheries Service, Southwest Fisheries Science Center Administrative Report. LJ-04-01. 13pp.

Forney, K. A., D. A. Hanan, and J. Barlow. 1989. Detecting trends in harbor porpoise abundance using aerial surveys: a preliminary report based on three years. NOAA National Marine Fisheries Service, Southwest Fisheries Center Administrative Report LJ 89 20. 17pp.

Forney, K. A., D. A. Hanan, and J. Barlow. 1991. Detecting trends in harbor porpoise abundance from aerial surveys using analysis of covariance. *Fish. Bull.* 89(3):367-377.

Forney, K. A. and J. Barlow. 1992. Preliminary winter abundance estimates for cetaceans along the California coast based on a 1991 aerial survey. *Int. Whal. Commn. Working Paper* SC/44/SM13. 26pp.

- Forney, K. A. and J. Barlow. 1993. Preliminary winter abundance estimates for cetaceans along the California coast based on a 1991 aerial survey. Rept. Int. Whal. Commn. 43:407-415.
- Forney, K. A., Barlow, J., and J. V. Carretta. 1995. The abundance of cetaceans in California waters. Part II: Aerial surveys in winter and spring of 1991 and 1992. Fish. Bull. 93:15-26.
- Forney, K.A. and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991-1992. Mar. Mamm. Sci. 14(3):460-489.
- Lee, T. 1994. Report on cetacean aerial survey data collected between the years of 1974 and 1982. U.S. Department of Commerce. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-195. 62pp.

RECENT TECHNICAL MEMORANDUMS

SWFSC Technical Memorandums are accessible online at the SWFSC web site (<http://swfsc.noaa.gov>). Copies are also available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161 (<http://www.ntis.gov>). Recent issues of NOAA Technical Memorandums from the NMFS Southwest Fisheries Science Center are listed below:

- NOAA-TM-NMFS-SWFSC-430 Spawning biomass of Pacific sardine (*Sardinops sagax*) off U.S. in 2008. N.C.H. LO, B.J. MACEWICZ, D.A. GRIFFITH, and R.L. CHARTER (November 2008)
- 431 Reliability of California's groundfish landing estimates from 1969-2006. D.E. PEARSON, B. ERWIN, and M. KEY (November 2008)
- 432 Framework for assessing viability of threatened Coho salmon in the southern Oregon/Northern California coast evolutionarily significant unit. T.H. WILLIAMS, B.C. SPENCE, W. DUFFY, D. HILLEMEIER, G. KAUTSKY, T. LISLE, M. MCAIN, T. NICKELSON, E. MORA, and T. PEARSON (December 2008)
- 433 Stenella abundance research line transect and ecosystem (STAR-LITE) 2007 cruise report. F.I. ARCHER, A.E. HENRY, and L.T. BALLANCE (December 2008)
- 434 U.S. Pacific marine mammal stock assessments: 2008 J.V. CARRETTA, K.A. FORNEY, M.S. LOWRY, J. BARLOW, J. BAKER, D. JOHNSTON, B. HANSON, M.M. MUTO, D. LYNCH, and L. CARSWELL (January 2009)
- 435 Preliminary estimates of harbor porpoise abundance in California waters from 2002 to 2007. J.V. CARRETTA, K.A. FORNEY, and S.R. BENSON (February 2009)
- 436 Creation of a captive broodstock program for southern Coho Salmon (*Oncorhynchus kisutch*): Results from the initial rearing and spawning of the first brood year. E.A. STURM, E.A. GILBERT-HORVATH, J.C. GARZA, and R.B. MacFARLANE (March 2009)
- 437 Developing a structure for quantitative listing criteria for the U.S. endangered species act using performance testing. Phase 1 report. T. REGAN, B. TAYLOR, G. THOMPSON, J. COCHRANE, R. MERRICK, M. NAMMACK, S. RUMSEY, K. RALLS, and M. RUNGE (March 2009)
- 438 Report on the NMFS California Current Ecosystem Survey (CCES) (April and July-August 2008)
Edited by S. McCLATCHIE (March 2009)
- 439 Vaquita expedition 2008: Preliminary results from a towed hydrophone survey of the Vaquita from the *Vaquita Express* in the upper Gulf of California. S. RANKIN, R. SWIFT, D. RISCH, B. TAYLOR, L. ROJAS-BRACHO, A. JARAMILLO-LEGORRETA, J. GORDON, T. AKAMATSU, and S. KIMURA (April 2009)