

## **Cetacean Surveys of Guam and CNMI Waters: August – September, 2011**

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## Mission

The Pacific Islands Fisheries Science Center's (PIFSC) Cetacean Research Program (CRP) conducted surveys for cetaceans in the waters surrounding Guam and the Commonwealth of the Northern Mariana Islands (CNMI) (Figure 1) in an effort to further develop a record of cetacean occurrence in the region and to gather photos and biopsy samples for population studies. This project was carried out in partnership with the U.S. Navy Commander, Pacific Fleet by a team of six primary personnel (Table 1).

## Methods

Small boat surveys (PIFSC Mission Number SB-11-05) were conducted off of Guam between 26 August and 05 September, 2011 (Tables 2-3, Figure 2). All Guam surveys, except one, were conducted aboard a 9.4 m Bertram Sport Fisherman with flying bridge and twin-diesel inboard engines (*Lucky Strike*). One survey utilized a 7.0 m GlassPro with twin 4-stroke outboard engines (*Anna Marie*). Surveys were conducted off of the southernmost islands of the CNMI (Saipan, Tinian, Aguijan, and Rota) 7- 29 September, 2011 (Table 4, Figures 3-4). During 7-13 and 19-30 September the observer team's research base was located on Saipan. All surveys were conducted aboard a 12.2 m sport-fisher with flying bridge and twin-diesel inboard engines (*Sea Hunter*) and included the waters surrounding Saipan, Tinian, and Aguijan (Figure 3). During 14-19 September surveys were based off of Rota and were conducted aboard a 12.2 m Ocean Alexander Sport-fisher with flying bridge and twin-diesel inboard engines (*Sr. Dung*) in the waters surrounding Rota (Figure 4).

Survey effort was designed to cover representative habitat within the study area and did not conform to systematic (i.e. line-transect) design. Vessel tracks were spread out from day to day to ensure representative survey coverage of the study area, particularly over a wide range of depths, and were also dictated by weather and sea conditions. The survey vessels traveled at a speed of 8-12 knots, depending on the size of the vessel and sea conditions. Between three and seven observers scanned for marine mammals with unaided eye or occasional use of 10x binoculars, collectively searching 360-degrees around the vessel. The primary research team (Tables 1-2) was accompanied by one to four additional individuals. The vessels were operated by locally experienced captains, with knowledge of cetacean sighting locations. In CNMI, both sets of captains allowed primary research team to operate vessel during primary search effort and when approaching cetaceans. On occasion, individuals from Guam and Saipan local field offices of the Pacific Islands Fisheries Science Center, Pacific Islands Regional Office, CNMI Department of Fish and Wildlife, CNMI Coastal Resource Management, and CNMI Division of Environmental Quality assisted the observer team with survey efforts.

All cetacean groups encountered were approached for species confirmation, group size estimates, photo-identification, and biopsy sampling (for assessment of genetic population structure) when possible. Digital SLR cameras with telephoto zoom lenses were used for taking photographs. Photographic efforts were focused on dorsal fin images (for individual identification purposes) and images of the body and head (for assessments of health and

scarring). Additional data collected during each sighting included the location, behavior, estimate of calf numbers (when possible), Beaufort sea state, and swell height. Environmental data (e.g., Beaufort sea state, swell height) and effort status were recorded regularly as conditions changed. Global Positioning System (GPS) readings of the vessel's track were automatically recorded once per minute.

Although not requested by the Navy, PIFSC conducted biopsy sampling during the project in order to support their goals of evaluating stock structure. Biopsy sampling was conducted using a Barnett RX-150 crossbow and Ceta-Dart bolts with sterilized, stainless steel biopsy tips (25 mm long x 8 mm diameter). Tissue samples were preserved in a cooler on ice while on the boat. Samples were split in half longitudinally at the end of each field day (with each subsample stored in a different vial) and transferred to a standard refrigerator freezer until the end of the project. Samples were transported, in a cooler with dry ice, on board a commercial airline to Honolulu, HI, USA<sup>1</sup>. One vial of each sample is stored in an -80°C freezer at the Pacific Islands Fisheries Science Center (Honolulu, HI, USA), and the other was submitted (via PIFSC) to the Southwest Fisheries Science Center (SWFSC, La Jolla, CA, USA) for tissue archiving. Samples are archived until adequate numbers are available to assess stock structure or until funding is provided to address other specific questions. Biopsy samples were collected under MMPA permit 14097 issued to SWFSC and CNMI-DFW permit, license no. 02260-11.

Bathymetric datasets, used in displaying and analyzing the depth profiles of our survey effort and sightings, were obtained from two different sources. First, the Pacific Islands Benthic Habitat Mapping Center (PIBHMC) has available high-resolution multibeam color-shaded bathymetry datasets for nearshore waters. There are 5 m grids available for waters inside the 400 m isobath surrounding Guam, Rota, Saipan, Tinian, Aguijan and Marpi Reef. In addition, 60 m grids are available for portions of the waters out to the 3,500 m isobath surrounding Guam; the 2,700 m isobath surrounding Saipan, Tinian, and Aguijan; and the 1,900 m isobath surrounding Rota. The datasets were downloaded as binary ASCII files (.asc) from the School of Ocean and Earth Science and Technology's (University of Hawaii at Manoa) website ([http://www.soest.hawaii.edu/pibhmc/pibhmc\\_cnmi.htm](http://www.soest.hawaii.edu/pibhmc/pibhmc_cnmi.htm)). The second source of bathymetric data was the General Bathymetric Chart of the Oceans (GEBCO) ([http://www.gebco.net/data\\_and\\_products/gridded\\_bathymetry\\_data](http://www.gebco.net/data_and_products/gridded_bathymetry_data)). A binary ASCII file of the one arc-minute grid was downloaded using the GEBCO Grid Demonstrator software. This dataset was used for displaying the bathymetry beyond the 500 m isobath around all of the islands.

All bathymetry datasets were processed using ArcCatalog 9.3 (ESRI, Redlands, CA). The ASCII files were first converted into raster grids and were then projected in the WGS 1984 UTM Zone 55N coordinate system. Contours were also extracted from the high-resolution PIBHMC grids as shape-files (.shp) and projected. Contour shape files and raster grid datasets were imported into ArcMap 9.3 (ESRI, Redlands, CA). Vessel GPS tracks and sighting locations were also

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<sup>1</sup> Samples collected in the waters of CNMI were inspected by the U.S. Fish and Wildlife Officer on Guam and imported to the US under CITES permit # US774223/9 issued to SWFSC.

projected in the WGS 1984 UTM Zone 55N coordinate system and then overlaid onto the bathymetric datasets. Depths of sighting locations were determined by joining the sighting locations and the bathymetric raster datasets within ArcMap. If the high-resolution PIBHMC multibeam data were not available for a particular sighting location, then the depth value was either interpolated using the two nearest nautical chart depth soundings (for locations near islands or submerged reefs) or obtained from the GEBCO 1 arc-minute raster dataset (for offshore locations). To analyze the amount of search effort by depth, on-effort times were calculated for depth bins from 0 to 2,200 m in 100 m intervals. In ArcMap, on-effort tracklines were joined to the bathymetric raster datasets and depths were assigned to the trackline points (each representing 1 minute).

## Results

### *Guam Surveys*

During eight days, between 26 August and 5 September, nine surveys were completed within the waters surrounding Guam (< 20 km from shore). A total of 968 km were covered with over 66 on-effort hours of survey (Table 3, Figure 2). Most of the surveys (8 out of 9) originated from the Hagatna Boat Basin (13.4781° N, 144.7496° E). One survey, on the final day, originated from Agat Marina (13.3690° N, 144.6507° E). Seventeen (26%) on-effort survey hours were spent inside of the 200 m isobath (Figure 5). The average daily Beaufort sea state ranged from 2.7 to 4.8 (Table 3). More than half (57%, 549 km) of the total on-effort trackline distance was surveyed in Beaufort 1 - 3 conditions, while the remaining 43% (419 km) was surveyed in Beaufort 4 - 5 (Figures 6-7). Preliminary local climatological data from the Guam National Weather Service Office (Station: Guam International Airport) indicate that winds predominated from the WSW with average daily wind speeds ranging from 3 to 11 knots, and maximum wind speeds ranging from 14 to 23 knots (Table 5). During the study period, the swell conditions off the west side of Guam were affected by Typhoon Nanmadol and Severe Tropical Storm Talas. Estimated maximum swell heights reached 5 – 12 ft (Table 3). More than a third (36%, 348 km) of the total on-effort trackline distance was surveyed in swell heights of 6 - 12 ft (Figures 8-9). Four field days (25 August; 2-4 September) were lost due to inclement weather (*i.e.*, high winds and rain).

There were eight cetacean sightings (Figure 2) during the nine surveys off of Guam. The overall sighting rate was 0.83 sightings/100 km of effort. The species included bottlenose dolphins (*Tursiops truncatus*), spinner dolphins (*Stenella longirostris*), pantropical spotted dolphins (*Stenella attenuata*), and short-finned pilot whales (*Globicephala macrorhynchus*). Spinner dolphins were the most frequently encountered species with 4 sightings (50%). An opportunistic off-effort sighting of spinner dolphins was also observed from shore by the research team off Sirena Beach along the northern coast between Ritidian and Pati Points. All sightings of spinner dolphins were in water depths less than 100 m (Table 8). All cetacean sightings were in depths less than 1,000 m (Table 8). A total of 2,185 photos and 21 biopsy samples were collected from the eight cetacean groups (Tables 7-8).

## CNMI Surveys

Between 7 and 29 September, a total of 21 cetacean surveys were conducted in the waters surrounding Saipan, Tinian, Aguijan, and Rota. The surveys covered 2,165 km of trackline with 139 on-effort hours (Table 4, Figures 3-4). Fifteen of the surveys originated from the Smiling Cove Marina (15.2173° N, 145.7224° E) on Saipan and covered the waters surrounding Saipan, Tinian, and Aguijan (Figure 3). The remaining six surveys covered the waters surrounding Rota and originated from the Rota West Harbor (14.1349° N, 145.1332° E) (Figure 4). A total of 62 (45%) on-effort survey hours were inside of the 200 m isobath (Figure 5). The average daily Beaufort sea state ranged from 1.5 to 4.7 (Table 4). More than half (52%, 1,126 km) of the total on-effort trackline distance was surveyed in Beaufort 0 – 3 conditions, while 48% (1,040 km) of the trackline was surveyed in Beaufort 4 – 6 conditions (Figures 6-7). Preliminary local climatological data from the National Weather Service Office (Station: Saipan/Isley) indicates that wind direction shifted from the WSW at the beginning of the study period to the ESE at the end (Table 6). Average daily wind speeds ranged from 4 to 13 knots, and maximum wind speeds ranged from 13 to 23 knots (Table 6). The estimated maximum swell heights reached 3 – 6 ft (Table 4). Most (95%, 2,066 km) of the total on-effort trackline was surveyed in swell heights 0 – 4 ft (Figures 8-9).

During the 21 surveys within the CNMI waters (< 35 km from shore) there were 30 on-effort sightings of cetaceans (Tables 7, 9; Figures 3-4). The overall sighting rate was 1.39 sightings/100 km of effort. The species included bottlenose dolphins, spinner dolphins, pantropical spotted, short-finned pilot whales, pygmy killer whales (*Feresa attenuata*), a dwarf sperm whale (*Kogia sima*), and unidentified medium and small delphinids (Tables 7, 9; Figures 3-4). An opportunistic off-effort sighting of short-finned pilot whales was also observed from shore by the research team about 2 km offshore of the Rota West Harbor. Spinner dolphins were the most frequently encountered species with 18 sightings (60%). All spinner dolphin sightings were in waters depths less than 100 m (Table 9). All cetacean sightings were in depths less than 1,000 m except for a single sighting of unidentified small dolphins in 1,500 m deep water off of Rota (Table 9). A total of 8,597 photos and 68 biopsy samples were collected during the study period (Table 7).

## Discussion

These surveys represent the second collaborative effort of the PIFSC's CRP and the U.S. Navy Pacific Fleet toward a better understanding of the occurrence and distribution of cetaceans in waters off of Guam and the southernmost islands of CNMI (Saipan, Tinian, Aguijan, and Rota). The U.S. National Marine Fisheries Service (NMFS) and the PIFSC are responsible for the assessment of marine mammal stocks in the Exclusive Economic Zone (EEZ) waters of Guam and CNMI. The U.S. Navy is mandated by the Marine Mammal Protection Act (MMPA) of 1972 and the Endangered Species Act (ESA) of 1973 to monitor cetacean and turtle presence within the Mariana Island Range Complex (MIRC). The first collaborative effort was carried out in February-March, 2010 and included 10 survey days off Guam and 6 off Saipan and Tinian (Oleson and Hill 2010, Ligon *et al.* 2011). These initial surveys are an effort toward creating

species inventories and collecting both photo and genetic data to aid in stock structure evaluation. Long-term goals include the evaluation of the population status of each stock. This includes producing population abundance estimates of the island-associated species using mark-recapture techniques.

### *Guam Surveys*

The surveys off Guam were largely confined to the northwestern and northern portions of the island. Both the sea conditions and the harbor location (Hagatna) of the main survey vessel (*Lucky Strike*) played a role in this outcome. Weather patterns far offshore of Guam produced large swells along the western coast during most of the study period. In addition, winds predominated from the southwest and west-southwest (Table 5). Those factors combined to reduce the survey efforts off the southwestern coast of Guam. Effort was made on several days to survey within the lee (on the northeastern side) of the island, however, it was not possible to do so daily because of the transit time to and from the Hagatna Boat Basin. Surveys on these days lasted between 9 and 10 hours, reaching the maximum for the vessel charter agreement and the project budget. One survey track circumnavigated the island close to shore and focused on species typically found in shallow waters < 100 m (*e.g.*, spinner dolphins and bottlenose dolphins). The survey took 9.5 hours with one spinner dolphin encounter off of Inarajan Bay on the southeastern shore (Tables 3, 8; Figure 2). Another survey went up to Rota Bank, approximately 19 km northwest of the island. The captain of the *Lucky Strike* indicated that pantropical spotted dolphins were seen there regularly by fishermen.

Compared to the surveys of 2010, conditions in 2011 were more amenable to working farther offshore. The winter in the Marianas is characterized by strong northeast (trade) winds, which were evident during the 2010 surveys (Ligon *et al.* 2011). Most of the 2010 surveys (7 out of 10) were within Agat Bay and along the southwestern shore of the Island. Only one of the current surveys targeted that area because of the wind and sea conditions out of the southwest. Use of the larger vessel (*Lucky Strike*; 9.4 m) in 2011, for all but one survey, facilitated our ability to operate farther offshore and farther from the harbor. The same vessel was used for one of three surveys off the northwest side of the island in 2010. Conditions during those surveys were mostly Beaufort 5+ with swell heights > 3 ft and up to 10 ft (Ligon *et al.* 2011). The summer months are described as typically the calmest in the Marianas, except for periods punctuated by typhoons and tropical storms. During the current surveys, swells produced by a typhoon and tropical storm west of the island affected visibility. The large swells may have contributed to the relatively low sighting rate (0.83 sightings/100 km of effort), which was lower than the adjusted sighting rate of 2010 (0.96 sightings/100 km of effort; Ligon *et al.* 2011). At times, the swell blocked the horizon line even from the observers standing on the flying bridge. The higher sighting rate in 2010 may also have related to the greater effort spent close to shore (< 100 m depth: 16.8 hrs (29.5%) in 2010 vs 13 hrs (19.6%) in 2011 where spinner dolphins regularly occur (Ligon *et al.* 2011).

## CNMI Surveys

The survey effort within the CNMI waters was separated into two regions in order to maximize the time spent in the nearshore waters of each island. The proximity of Tinian and Aguijan to Saipan enabled the research team to work from Saipan for an extended period (Tables 2, 4; Figure 3). The distance, by boat, between Saipan and Rota is over 130 km. A daytime (8-10 hour) trip from Saipan to Rota was not logistically viable. Instead, the observer team flew down to Rota from Saipan and worked out of the Rota West Harbor for six days (Tables 2, 4; Figure 4).

During the first two days of surveys off Saipan, Tinian, and Aguijan conditions were ideal for cetacean observations. The Beaufort sea state was low, and the swell was much smaller than the previous period off of Guam (Table 4, Figures 6-9). The first survey was a circumnavigation of the three islands (Saipan, Tinian, and Aguijan), which took 9.5 hours with one spinner dolphin encounter off of Aguijan (Table 4, Figure 3). This was a very similar scenario to the Guam circumnavigation, but the *Sea Hunter* off Saipan was able to cover more ground during the same period of time and was farther offshore (Figure 3). At the end of the first five days of surveys the conditions deteriorated slightly due to localized weather systems that produced wind and rain. Most of the survey effort around the three islands was located off of the west-northwest sides of Saipan and Tinian (Figure 3). The bulk of the surveys (10 out of 16) took place after the team's return from Rota (September 19). Beginning on 16 September winds predominated from the southeast and east at maximum speeds of 15-23 knots (Table 6). During 20-29 September, surveys off the eastern shores of Saipan and Tinian were tight along the coast (Figure 3). Over the entire period working off the three islands spinner dolphins were the most frequently encountered species (10 out of 20 sightings). This was also the case in 2010 when all but one sighting (6 out of 7) were of spinner dolphins (Oleson and Hill 2010, Ligon *et al.* 2011).

The observer team flew to Rota on 13 September and completed a series of six surveys around the island (Table 4, Figure 4) before returning to Saipan on the 19th. All but one of the surveys included a circumnavigation of the island. The circumnavigations took seven to eight hours and each included two cetacean sightings (Table 4, Figure 4). Spinner dolphins were again the most frequently encountered species representing eight out of ten on-effort sightings (80%). These surveys around Rota are the first completed by the PIFSC CRP as no surveys were attempted in 2010.

Some re-sightings of distinctive individuals were noted in the field during the surveys within the CNMI waters. On 9 September, a group of bottlenose dolphins was observed off the southeast side of Saipan. Individuals from that group were observed the following day off the northwest side of Tinian (Table 4, Figure 4). During the surveys off of Rota, individual spinner dolphins with distinctive fins were recognized by observers between sightings. In addition, the off-effort sighting of pilot whales on 16 September, observed from shore, included an adult male with a particularly distinctive fin that was recognized by the team from the on-effort pilot whale sighting of the previous day.



Five submerged, offshore reefs were visited during the study period off Saipan, Tinian, and Rota (Figures 3-4). Two groups of spinner dolphins and a single dwarf sperm whale were encountered at Marpi Reef, 15 km north of Saipan (Figure 3). Two groups of spinner dolphins were also seen at Marpi Reef in 2010 (Oleson and Hill 2010, Ligon *et al.* 2011). Analysis has not yet been done to determine whether any of these are the same individuals. Archiving and development of Guam and CNMI photo-ID catalogs will begin in summer 2012 and will allow for evaluation of animal movements and abundance for commonly seen species.

## Acknowledgements

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## Tables

Table 1: Personnel, roles and organizations.

<b>Name</b>	<b>Role</b>	<b>Organization</b>
Erin Oleson	Chief Scientist/Marine Mammal Observer	Pacific Islands Fisheries Science Center
Marie Hill	Marine Mammal Observer	Joint Institute for Marine and Atmospheric Research
Allan Ligon	Survey Leader/Marine Mammal Observer	Hawai'i Association for Marine Education and Research
Mark Deakos	Marine Mammal Observer	Hawai'i Association for Marine Education and Research
Adam Ü	Marine Mammal Observer	HDR under contract to NAVFAC Pacific
Erik Norris	Marine Mammal Observer/VOC	NOAA Corps

Table 2: Mission schedule, locations, and personnel.

<b>Dates (2011)</b>	<b>Location</b>	<b>Personnel</b>
24 August – 06 September	Guam	Deakos, Hill, Ligon, Norris, Ü
06 – 13 September	Saipan	Deakos, Hill, Ligon, Norris, Ü
13 – 19 September	Rota	Deakos, Ligon, Norris, Ü
19 – 30 September	Saipan	Deakos, Ligon, Oleson, Ü

Table 3: Guam surveys summary.

Date (2011)	Vessel	# Crew	Harbor	Survey Location Description	Begin On-Effort Time	End On-Effort Time	Total On-Effort Time	On-Effort Distance (km)	Average Beaufort	Maximum Swell Height (ft)
08/26	<i>Lucky Strike</i>	6	Hagatna Boat Basin	Hagatna north and east to Katalina Pt.	6:10	14:46	8:36	135	2.7	6
08/27	<i>Lucky Strike</i>	7	Hagatna Boat Basin	Guam west side	6:11	14:36	8:25	113	2.9	12
08/28	<i>Lucky Strike</i>	6	Hagatna Boat Basin	Hagatna north and east to Hawaii Rock Quarry	6:13	15:36	8:56	123	3.1	8
08/29	<i>Lucky Strike</i>	7	Hagatna Boat Basin	Hagatna north to Rota Bank	6:11	15:19	9:08	124	2.9	10
08/30	<i>Lucky Strike</i>	7	Hagatna Boat Basin	Guam circumnavigation (counter clockwise)	6:05	15:22	9:13	140	2.7	8
08/31	<i>Lucky Strike</i>	6	Hagatna Boat Basin	Guam west side	6:05	11:00	4:54	73	2.6	10
09/01	<i>Lucky Strike</i>	6	Hagatna Boat Basin	Hagatna around north to northeast	6:04	14:21	8:11	116	4.6	8
09/05	<i>Lucky Strike</i>	6	Hagatna Boat Basin	Hagatna south to Facpi Pt.	6:13	11:47	5:23	88	4.8	7
09/05	<i>Anna Marie</i>	3	Agat Marina	Agat south to Cocos	6:38	10:07	3:27	55	4.3	5
<b>Total:</b>							<b>66:13</b>	<b>968</b>		

Table 4: CNMI surveys summary.

Date (2011)	Vessel	# Crew	Harbor	Survey Location Description	Begin On-Effort Time	End On-Effort Time	Total On-Effort Time	On-Effort Distance (km)	Average Beaufort	Maximum Swell Height (ft)
09/07	<i>Sea Hunter</i>	7	Smiling Cove Marina	Saipan-Tinian-Aguijan circumnavigation	6:00	15:23	9:23	159	2.1	4
09/08	<i>Sea Hunter</i>	7	Smiling Cove Marina	Saipan-west & north to Marpi Reef	5:59	15:40	9:41	117	1.5	3
09/09	<i>Sea Hunter</i>	7	Smiling Cove Marina	Saipan circumnavigation	6:08	12:47	6:31	90	3.4	5
09/10	<i>Sea Hunter</i>	7	Smiling Cove Marina	Tinian circumnavigation	5:57	12:53	6:51	99	4.0	6
09/12	<i>Sea Hunter</i>	7	Smiling Cove Marina	Saipan-Tinian west side, Coke Reef & 300 Reef	6:11	13:54	7:44	131	3.0	4
09/14	<i>Sr. Dung</i>	6	Rota West	Rota circumnavigation	6:56	13:44	6:47	108	3.3	4
09/15	<i>Sr. Dung</i>	6	Rota West	Rota circumnavigation	6:58	14:38	7:40	98	3.5	4
09/16	<i>Sr. Dung</i>	6	Rota West	Rota west side	13:34	16:56	3:22	80	3.4	3
09/17	<i>Sr. Dung</i>	6	Rota West	"Ice Box" Reef & Rota circumnavigation	6:54	15:12	8:18	153	3.7	3
09/18	<i>Sr. Dung</i>	6	Rota West	Rota circumnavigation	7:58	15:47	7:49	123	3.9	4
09/19	<i>Sr. Dung</i>	5	Rota West	Rota circumnavigation	7:15	11:20	4:05	61	3.3	3
09/20	<i>Sea Hunter</i>	7	Smiling Cove Marina	Saipan-Tinian west side	8:07	14:08	6:01	104	3.0	5
09/21	<i>Sea Hunter</i>	7	Smiling Cove Marina	Saipan west side	7:00	12:33	5:33	94	4.5	5
09/22	<i>Sea Hunter</i>	6	Smiling Cove Marina	Saipan north-west	11:56	16:10	4:14	60	4.4	3
09/23	<i>Sea Hunter</i>	7	Smiling Cove Marina	Saipan-Tinian west side	6:57	12:31	5:33	96	3.3	4
09/24	<i>Sea Hunter</i>	5	Smiling Cove Marina	Marpi Reef & Saipan west side	7:00	16:07	9:07	143	3.7	5
09/25	<i>Sea Hunter</i>	7	Smiling Cove Marina	Saipan circumnavigation - nearshore	7:01	13:15	6:14	85	3.0	4
09/26	<i>Sea Hunter</i>	6	Smiling Cove Marina	Saipan-Tinian west side	7:24	11:25	4:01	66	4.7	6
09/27	<i>Sea Hunter</i>	8	Smiling Cove Marina	Saipan west side	9:59	13:36	3:38	59	4.6	5
09/28	<i>Sea Hunter</i>	6	Smiling Cove Marina	Saipan north-west	7:08	14:06	6:59	118	4.3	4
09/29	<i>Sea Hunter</i>	5	Smiling Cove Marina	Tinian circumnavigation	7:01	16:49	9:47	122	3.9	4
<b>Total:</b>							<b>139:17</b>	<b>2,165</b>		

Table 5: Wind speed and direction on Guam during the 2011 cetacean survey study period. Preliminary local climatological data from the National Weather Service, Guam office (Station: Guam International Airport). Note: Data have not undergone final quality control by the National Climatic Data Center (NCDC).

<b>Month</b>	<b>Day</b>	<b>Average (24 hr) Speed</b>	<b>Max Speed</b>	<b>Direction (2 min deg)</b>
August	26	4.3	14	170
	27	4.5	17	250
	28	4.8	14	280
	29	4.3	16	310
	30	2.9	15	230
	31	4.3	21	260
September	1	11.3	18	280
	2	7.6	23	270
	3	9	21	280
	4	6.8	17	210
	5	5.8	14	240

Table 6: Wind speed and direction on Saipan during the 2011 cetacean survey study period. Preliminary local climatological data from the National Weather Service, Guam office (Station: Saipan/Isley). Note: Data have not undergone final quality control by the National Climatic Data Center (NCDC).

Month	Day	Average (24 hr) Speed	Max Speed	Direction (2 min deg)
September	7	4.8	13	70
	8	3.6	13	70
	9	8.6	17	230
	10	7.3	16	200
	11	6.7	14	170
	12	4.7	8	240
	13	5.9	15	240
	14	6.8	15	290
	15	7.6	15	290
	16	6.9	23	110
	17	6.1	16	150
	18	9.7	18	80
	19	12.8	21	80
	20	8.3	22	110
	21	8.6	22	70
	22	9.2	21	140
	23	8.3	17	130
	24	6.2	15	70
	25	4.7	15	110
	26	10.8	21	120
27	12.7	23	130	
28	10.2	12	60	
29	8.5	15	100	

Table 7: Summary of on-effort cetacean sightings by region and species.

<b>GUAM</b>				
<b>Species Common</b>	<b>Species Scientific</b>	<b># Sightings</b>	<b># Photos</b>	<b># Biopsy Samples</b>
Bottlenose dolphin	<i>Tursiops truncatus</i>	1	158	1
Pantropical spotted dolphin	<i>Stenella attenuata</i>	2	185	1
Short-finned pilot whale	<i>Globicephala macrorhynchus</i>	1	389	7
Spinner dolphin	<i>Stenella longirostris</i>	4	732	12
Total:		8	2,185	21
<b>CNMI</b>				
<b>Species Common</b>	<b>Species Scientific</b>	<b># Sightings</b>	<b># Photos</b>	<b># Biopsy Samples</b>
Bottlenose dolphin	<i>Tursiops truncatus</i>	2	516	3
Dwarf sperm whale	<i>Kogia sima</i>	1	63	0
Pantropical spotted dolphin	<i>Stenella attenuata</i>	1	306	6
Pygmy killer whale	<i>Feresa attenuata</i>	1	256	0
Short-finned pilot whale	<i>Globicephala macrorhynchus</i>	3	2225	22
Spinner dolphin	<i>Stenella longirostris</i>	18	5211	37
Unid. medium delphinid		3	20	0
Unid. small delphinid		1	0	0
Total:		30	8,597	68
<b>COMBINED</b>				
<b>Species Common</b>	<b>Species Scientific</b>	<b># Sightings</b>	<b># Photos</b>	<b># Biopsy Samples</b>
Bottlenose dolphin	<i>Tursiops truncatus</i>	3	674	4
Dwarf sperm whale	<i>Kogia sima</i>	1	63	0
Pantropical spotted dolphin	<i>Stenella attenuata</i>	3	491	7
Pygmy killer whale	<i>Feresa attenuata</i>	1	256	0
Short-finned pilot whale	<i>Globicephala macrorhynchus</i>	4	2614	29
Spinner dolphin	<i>Stenella longirostris</i>	22	5943	49
Unid. medium delphinid		3	20	0
Unid. small delphinid		1	0	0
Total:		38	10,782	89

Table 8: Guam cetacean sightings details.

Date (2011)	Sighting #	Species - Common	Species -Scientific	Time	Latitude	Longitude	Depth (m)	Bathymetry Source	Beaufort	Swell Height (ft)	Group Size	# Calves	Behavior	# Photos	# Biopsy Samples
08/27	1	Pantropical spotted dolphin	<i>Stenella attenuata</i>	7:14	13.5986	144.7695	740	PIBHMC 5m	3	4-8	4	0	leap/spin; boat approach	0	0
08/27	2	Short-finned pilot whale	<i>Globicephala macrorhynchus</i>	7:51	13.5791	144.7501	824	PIBHMC 5m	3	4-8	14	0	slow travel	389	7
08/28	1	Spinner dolphin	<i>Stenella longirostris</i>	14:56	13.5159	144.7951	36	PIBHMC 5m	4	4-8	30	1	social; leap/spin	266	2
08/29	1	Spinner dolphin	<i>Stenella longirostris</i>	10:10	13.7955	144.9532	74	nautical chart	3	6-10	45	3	mill	428	3
08/29	2	Bottlenose dolphin	<i>Tursiops truncatus</i>	11:18	13.7996	144.9539	71	nautical chart	3	6-10	14	2	mill	158	1
08/30	1	Spinner dolphin	<i>Stenella longirostris</i>	9:30	13.2720	144.7571	33	nautical chart	3	1-2	40	2	rest	320	3
08/31	1	Pantropical spotted dolphin	<i>Stenella attenuata</i>	8:38	13.6099	144.7002	964	GEBCO 1 arc-minute	3	6-8	21	2	feed; fast travel	185	1
09/01	1	Spinner dolphin	<i>Stenella longirostris</i>	10:42	13.5630	144.9430	20	PIBHMC 5m	3	1-2	55	2	mill	439	4
09/03	1	Spinner dolphin *	<i>Stenella longirostris</i>	13:46	13.6073 *	144.9079 *	~10 *	Estimated *	2	1-3	50	n/a	rest	0	0

\* Opportunistic, shore-based spinner dolphin group observed by research team on 09 Sept, 2011. Lat/Long & depth were estimated from sighting location.



Table 9: CNMI cetacean sightings details.

Date (2011)	Sighting #	Species - Common	Species - Scientific	Time	Latitude	Longitude	Depth (m)	Bathymetry Source	Beaufort	Swell Height (ft)	Group Size	# Calves	Behavior	# Photos	# Biopsy Samples
09/07	2	Spinner dolphin	<i>Stenella longirostris</i>	11:05	14.8557	145.5823	48	nautical chart	2	3	55	4	mill	619	6
09/08	1	Unid. Medium delphinid	n/a	6:25	15.2682	145.6886	464	PIBHMC ** SMAR 60m	2	2-3	1	0	slow travel	0	0
09/08	2	Short-finned pilot whale	<i>Globicephala macrorhynchus</i>	7:07	15.3039	145.7113	570	PIBHMC ** SMAR 60m	1	2-3	34	5	slow travel	437	7
09/08	3	Pygmy killer whale	<i>Feresa attenuata</i>	10:58	15.3799	145.8184	563	PIBHMC ** SMAR 60m	1	2-3	6	1	slow travel	256	0
09/08	4	Spinner dolphin	<i>Stenella longirostris</i>	11:55	15.4110	145.8704	61	PIBHMC Marpi 5m	0	2-3	42	3	mill	349	2
09/08	5	Dwarf sperm whale	<i>Kogia sima</i>	13:23	15.4373	145.8432	673	PIBHMC ** SMAR 60m	0	2-3	1	0	log	63	0
09/09	1	Spinner dolphin	<i>Stenella longirostris</i>	6:59	15.2680	145.7790	64	PIBHMC Saipan 5m	3	1	65	2	fast travel	704	7
09/09	2	Bottlenose dolphin	<i>Tursiops truncatus</i>	10:05	15.1351	145.7456	34	PIBHMC Saipan 5m	2	2-3	10	0	mill	294	2
09/10	1	Spinner dolphin	<i>Stenella longirostris</i>	8:02	14.9790	145.6681	29	PIBHMC Tinian 5m	4	1-2	40	5	leap/spin; boat approach	483	2
09/10	2	Spinner dolphin	<i>Stenella longirostris</i>	9:10	14.9202	145.6415	44	PIBHMC Tinian 5m	5	2-3	30	1	boat approach; bow ride	31	0
09/10	3	Bottlenose dolphin	<i>Tursiops truncatus</i>	11:14	15.0990	145.6365	61	PIBHMC Tinian 5m	5	2-3	10	0	boat approach; bow ride	222	1
09/12	1	Unid. small delphinid	n/a	10:35	15.2218	145.4556	1,502	GEBCO 1 arc-minute	4	2-4	2	n/a	wag tail leap	0	0
09/14	1	Spinner dolphin	<i>Stenella longirostris</i>	6:57	14.1401	145.1307	34	PIBHMC Rota 5m	2	2	8	n/a	n/a	0	0
09/14	2	Spinner dolphin	<i>Stenella longirostris</i>	9:51	14.1095	145.1775	46	nautical chart	3	1-2	18	0	slow travel	320	1
09/15	1	Short-finned pilot whale	<i>Globicephala macrorhynchus</i>	10:36	14.1136	145.1259	216	PIBHMC Rota 5m	4	2-3	38	1	slow travel	996	9
09/15	2	Spinner dolphin	<i>Stenella longirostris</i>	13:31	14.1156	145.1243	97	PIBHMC Rota 5m	4	2-3	13	0	mill	145	3

Date (2011)	Sighting #	Species - Common	Species - Scientific	Time	Latitude	Longitude	Depth (m)	Bathymetry Source	Beaufort	Swell Height (ft)	Group Size	# Calves	Behavior	# Photos	# Biopsy Samples
09/16	1	Short-finned pilot whale *	<i>Globicephala macrorhynchus</i>	13:00	14.1510*	145.1240*	188 *	Estimated *	n/a	n/a	30	n/a	slow travel	0	0
09/17	1	Unid. medium delphinid	n/a	7:24	14.0397	145.0372	969	GEBCO 1 arc-minute	3	2	5	n/a	evasive	20	0
09/17	2	Spinner dolphin	<i>Stenella longirostris</i>	12:29	14.1953	145.2935	91	PIBHMC Rota 5m	4	2	18	n/a	mill	470	0
09/18	1	Spinner dolphin	<i>Stenella longirostris</i>	11:34	14.1839	145.2938	59	nautical chart	5	2-3	24	n/a	mill	343	1
09/18	2	Spinner dolphin	<i>Stenella longirostris</i>	13:46	14.1279	145.2310	90	PIBHMC Rota 5m	4	2-3	18	n/a	slow travel	214	2
09/19	1	Spinner dolphin	<i>Stenella longirostris</i>	7:34	14.1306	145.1409	71	PIBHMC Rota 5m	2	1-2	28	n/a	rest	263	0
09/19	2	Spinner dolphin	<i>Stenella longirostris</i>	9:35	14.1832	145.2947	59	nautical chart	4	2-3	40	n/a	mill	207	1
09/22	1	Pantropical spotted dolphin	<i>Stenella attenuata</i>	13:58	15.3052	145.7457	561	PIBHMC** SMAR 60m	4	2-3	40	n/a	slow travel	306	6
09/24	1	Spinner dolphin	<i>Stenella longirostris</i>	9:48	15.4328	145.8862	72	PIBHMC Marpi 5m	4	3-4	55	n/a	mill	393	3
09/25	1	Spinner dolphin	<i>Stenella longirostris</i>	9:06	15.1926	145.7849	62	PIBHMC Saipan 5m	3	2-3	55	n/a	slow travel	377	6
09/25	2	Spinner dolphin	<i>Stenella longirostris</i>	11:29	15.0922	145.7532	91	PIBHMC Saipan 5m	5	2-3	28	n/a	mill	72	3
09/25	3	Spinner dolphin	<i>Stenella longirostris</i>	12:18	15.1200	145.6864	66	PIBHMC Saipan 5m	4	2	18	n/a	slow travel	28	0
09/29	1	Unid. small delphinid	n/a	7:25	15.1909	145.6911	26	PIBHMC Saipan 5m	2	1-2	1	n/a	n/a	0	0
09/29	2	Spinner dolphin	<i>Stenella longirostris</i>	9:22	14.9878	145.6725	55	PIBHMC Tinian 5m	5	2-3	6	n/a	moderate travel	193	0
09/29	3	Short-finned pilot whale	<i>Globicephala macrorhynchus</i>	11:51	15.0219	145.5413	723	PIBHMC ** SMAR 60m	4	1-3	33	n/a	moderate travel	792	6

\* Opportunistic, shore-based short-finned pilot whale group observed by research team on 16 Sept, 2011. Lat/Long & depth were estimated from approximated sighting location.

\*\* The bathymetry source SMAR refers to the Southern Marianas 60 m grid and includes the waters surrounding Saipan, Tinian, and Aguijan out to 2,700 m depth in some locations.

## Figures

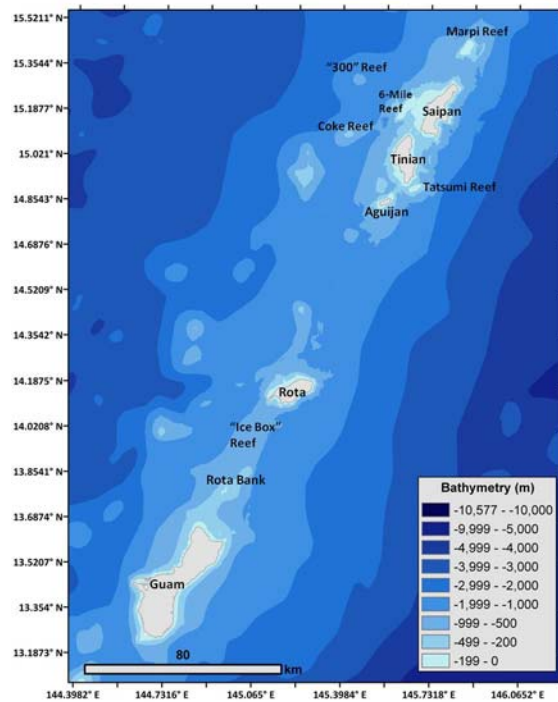


Figure 1: Survey locations of Guam and the Commonwealth of the Northern Mariana Islands displaying bathymetry from all datasets combined in depth bins between 0 and 10,500 m.

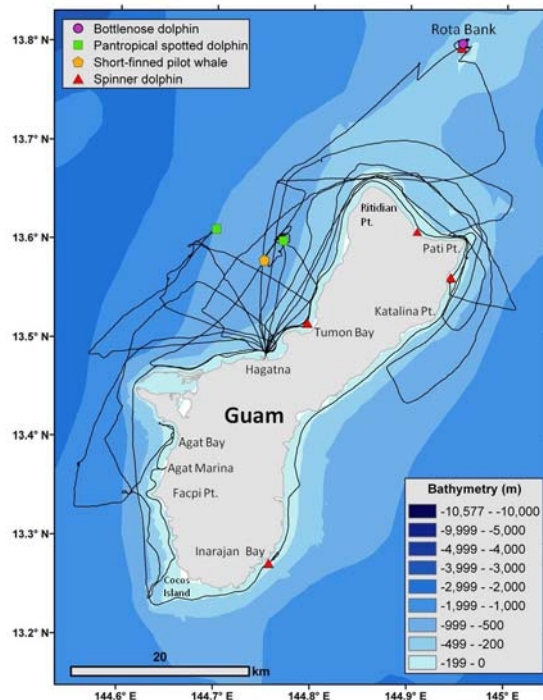


Figure 2: Guam survey tracklines (black lines) and cetacean sightings (26 August – 05 September, 2011). The spinner dolphin sighting shown on the north coast of Guam is a shore-based opportunistic sighting made by the research team.

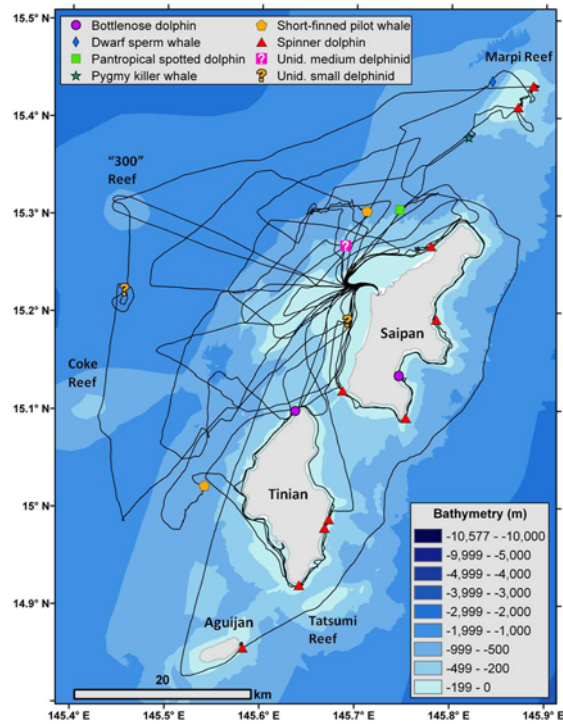


Figure 3: CNMI survey tracklines (black lines) and cetacean sightings around Saipan, Tinian, and Aguijan (7-12 and 20-29 September, 2011).

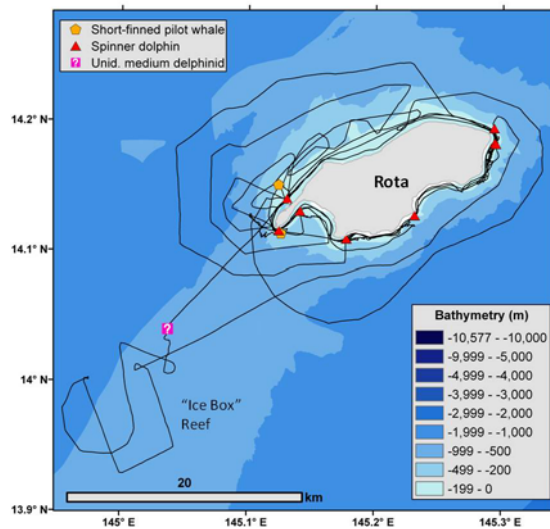


Figure 4: CNMI survey tracklines (black lines) and cetacean sightings around Rota (14-19 September, 2011). The pilot whale sighting shown on the west side of Rota is a shore-based opportunistic sighting made by the research team.

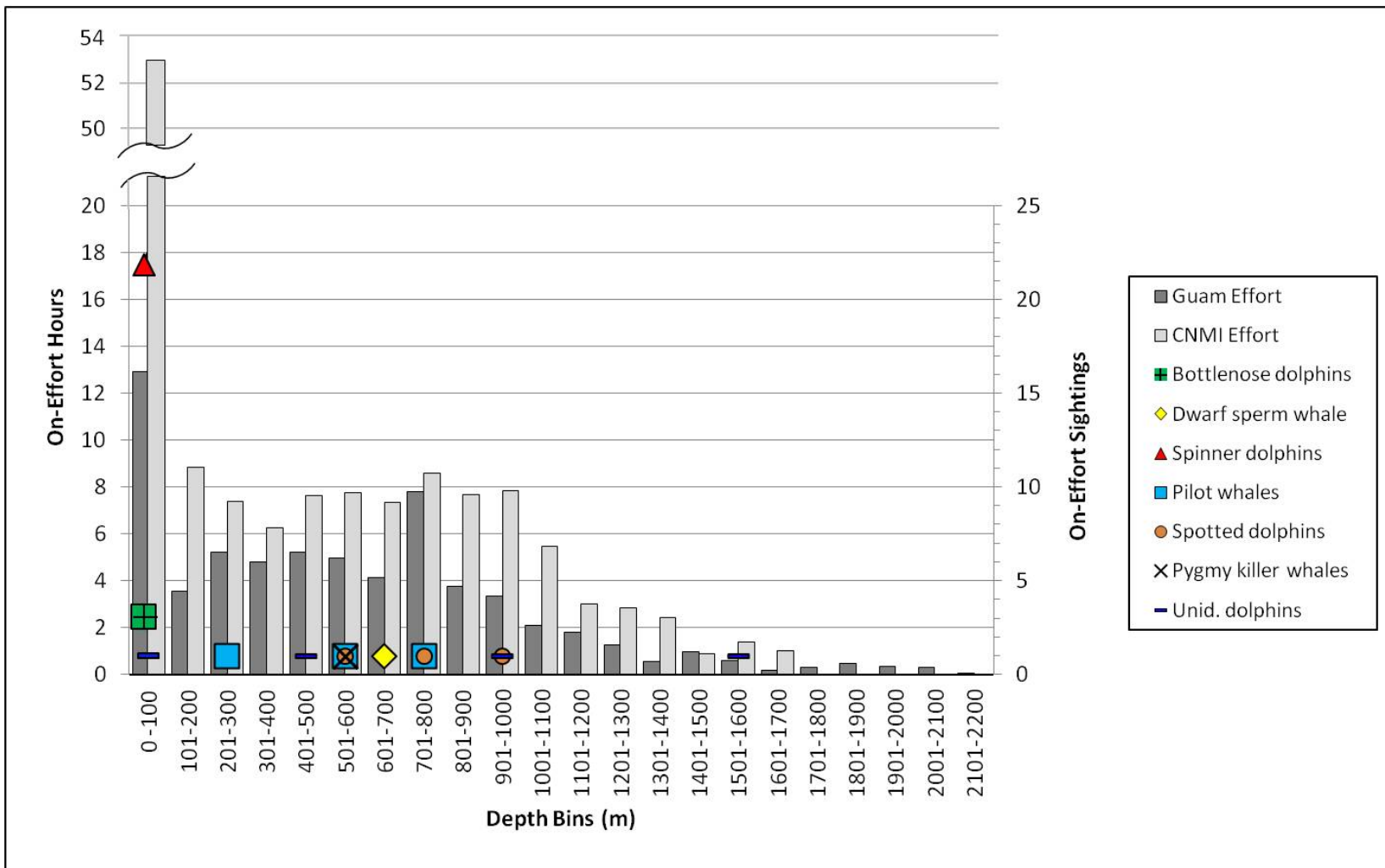


Figure 5: Distribution of sightings and search effort across depth profiles divided into 100 m interval depth bins. Guam total on-effort hours = 66. CNMI total on-effort hours = 139.

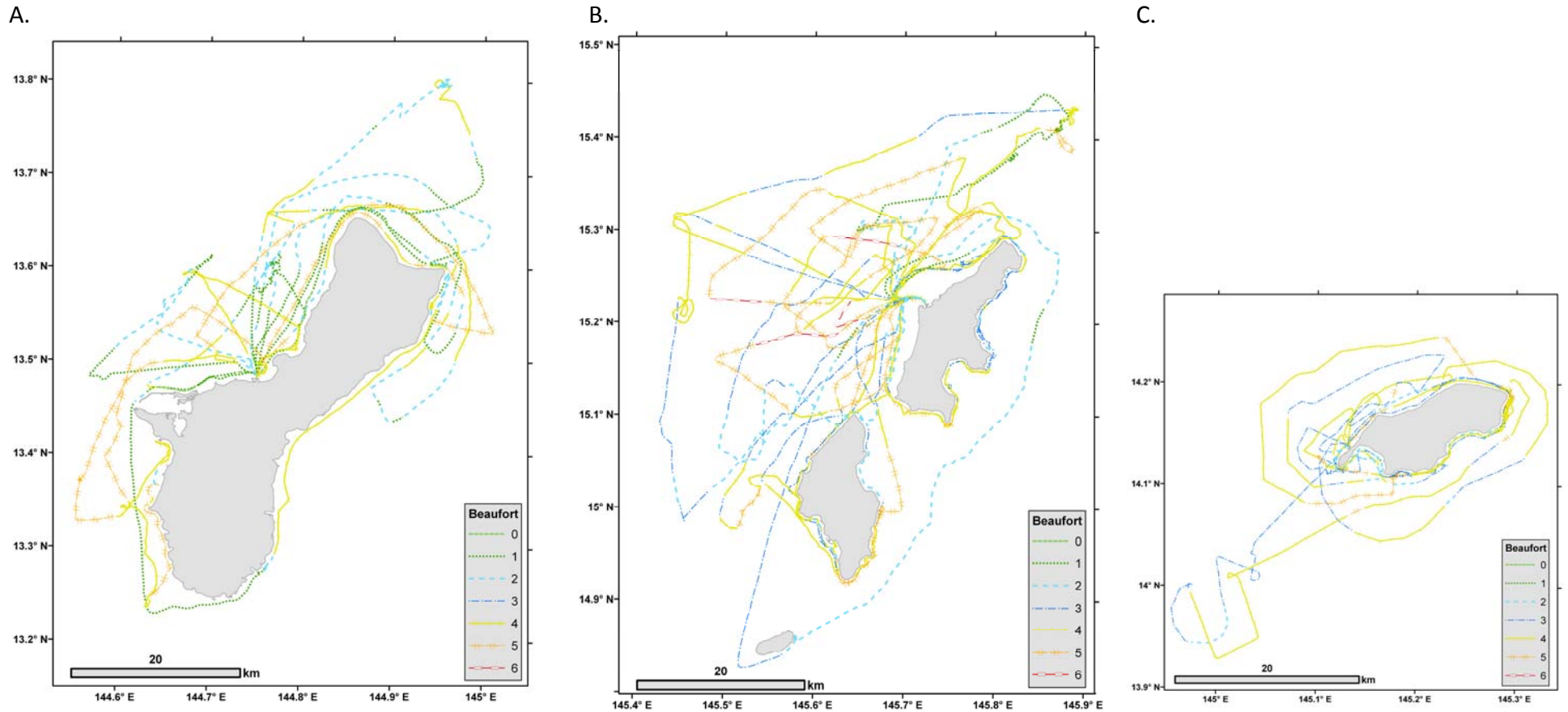
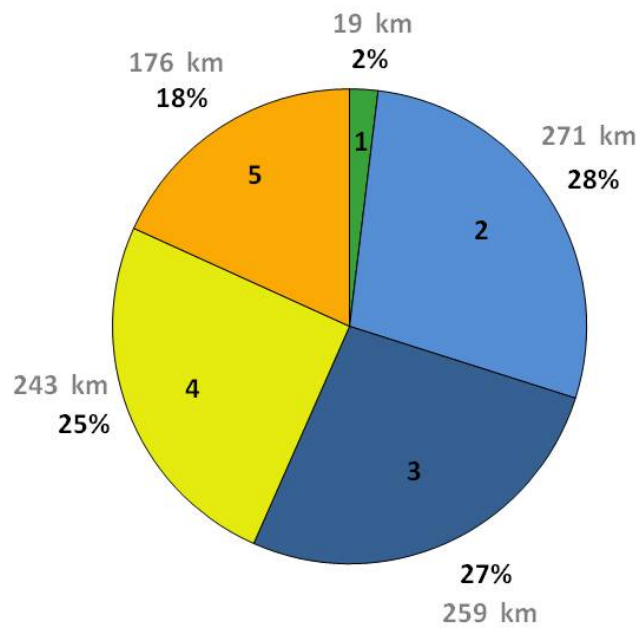


Figure 6: On-effort tracklines by Beaufort sea state in the waters surrounding Guam (A); Saipan, Tinian, and Aguijan (B); and Rota (C).

A.



B.

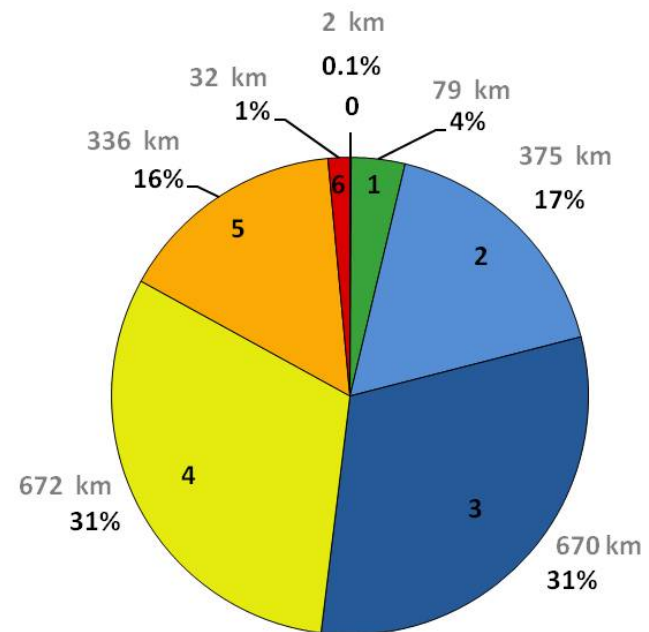


Figure 7: Beaufort sea state as a percentage of the total on-effort trackline distance off (A) Guam (Total trackline distance = 968 km) and (B) Saipan, Tinian, Aguijan, and Rota (Total trackline distance = 2165km).



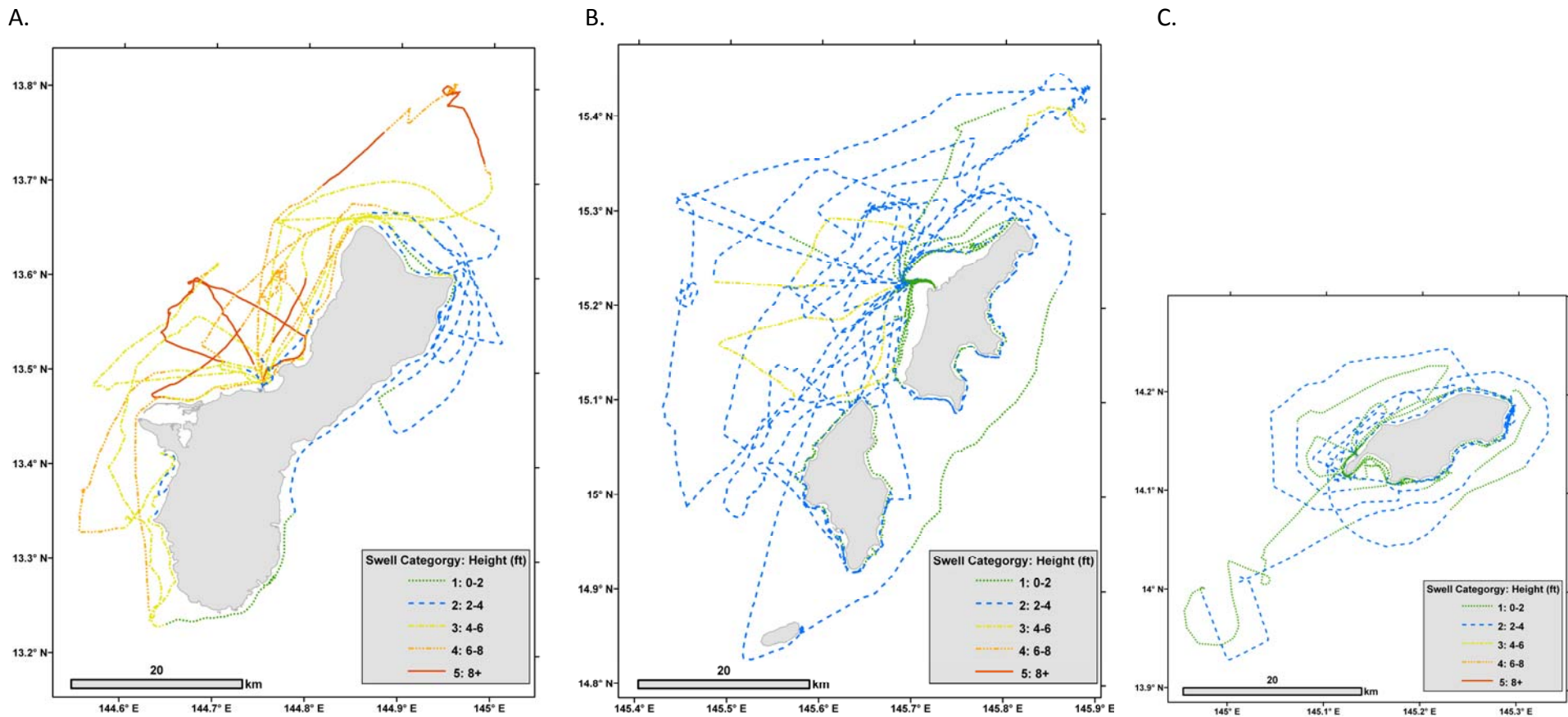
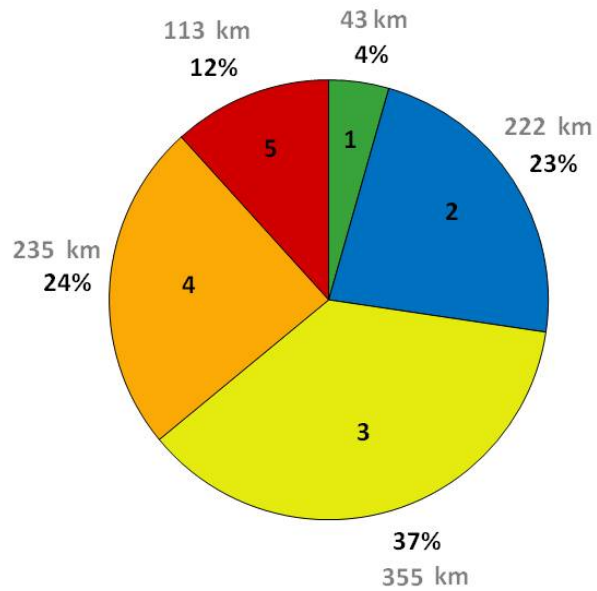


Figure 8: On-effort survey tracklines by swell height in the waters surrounding Guam (A); Saipan, Tinian, and Aguijan (B); and Rota (C).



A.



B.

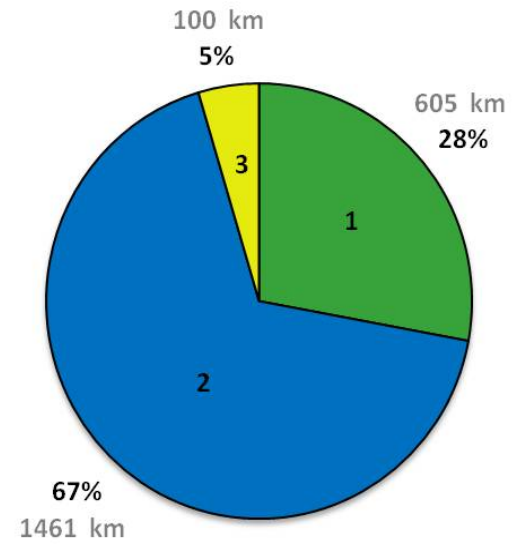


Figure 9: Swell height as a percentage of the total on-effort trackline distance off (A) Guam (Total trackline distance = 968 km) and (B) Saipan, Tinian, Aguijan, and Rota (Total trackline distance = 2165 km). Swell categories- 1: 0-2 ft; 2: 2-4 ft; 3: 4-6 ft; 4: 6-8 ft; 5: 8+ ft.