# Diversity, habitat associations and stock structure of odontocete cetaceans in the waters of American Samoa, 2003-06

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ABSTRACT

Little is known about the species composition, distribution, abundance or stock structure of odontocetes in the central and western tropical Pacific Ocean, including those inhabiting the US Exclusive Economic Zone (EEZ) waters of American Samoa. While some information on species presence in this region has been gleaned from anecdotal sightings and whaling and stranding records, odontocete diversity in the waters of American Samoa has never been formally investigated. This lack of information precludes efforts to determine the sustainability of cetacean populations within US EEZ waters. This paper reports on the first dedicated surveys to document the presence and distribution of odontocete cetaceans in the waters of American Samoa. A series of small-boat photo-identification and biopsy surveys for cetaceans were conducted in the nearshore waters of Tutuila during 2003-06. In addition, ship-based visual surveys were conducted in the waters surrounding the Manu'a Islands, Rose Atoll and Swains Island in summer 2006. A total of 58 groups of odontocete cetaceans were encountered during both small-boat and ship-based surveys: spinner dolphins (*Stenella longirostris, n*=34), rough-toothed dolphins (*Steno bredanensis, n*=10), sperm whales (*Physeter macrocephalus, n*=3), false killer whales (*Pseudorca crassidens, n*=5), bottlenose dolphins (*Tursiops truncatus*., *n*=1), dwarf sperm whales (*Kogia sima*, *n*=1), short-finned pilot whales (*Globicephala macrorhynchus, n*=1), and three groups of unidentified odontocetes. Photographs were analysed for quality and individuals with distinctive markings were selected for entry into a photo-identification catalogue. The resultant catalogue included 46 spinner dolphins, 41 rough-toothed dolphins, 2 bottlenose dolphins, 5 false killer whales, 4 pilot whales, 1 dwarf sperm whale and 4 sperm whales. Thirteen spinner dolphins and 14 rough-toothed dolphins were sighted in multiple years. To investigate stock structure, spinner dolphin genetic data were used to compare mitochondrial control region genetic diversity and allele frequencies between American Samoa and the Hawaiian Islands. American Samoa had a higher genetic diversity, and populations at the two locations were genetically distinct ($\Phi_{ST}$ = 0.21). The high diversity at American Samoa indicates that spinner dolphins at this location are not reproductively isolated, but the data do not rule out the possibility that these dolphins may be demographically isolated on ecological timescales.

KEYWORDS: PACIFIC OCEAN; ODONTOCETES; SURVEY – VESSEL; BIOPSY SAMPLING; PHOTO-ID; MOVEMENTS; GENETICS; SPINNER DOLPHINS; ROUGH-TOOTHED DOLPHIN; SPERM WHALE; FALSE KILLER WHALE; BOTTLENOSE DOLPHIN; DWARF SPERM WHALE; SHORT-FINNED PILOT WHALE

## INTRODUCTION

The species composition, distribution, abundance and stock structure of odontocete cetaceans in Oceania (the region encompassing the tropical and subtropical waters of the central and western Pacific) are poorly understood, and in many regions, dedicated survey efforts to address these gaps in knowledge have been few. The available information regarding species presence and distribution within this expansive region has recently been compiled and reviewed (see Reeves *et al*., 1999), and much of the available information has been gleaned from anecdotal reports and opportunistic sightings (e.g. Paton and Gibbs, 2002), historic and recent whaling records (Kasamatsu *et al*., 1995; Townsend, 1935) and documentation of stranded animals (Trianni and Kessler, 2002). For many portions of this region however, the diversity of cetaceans has never been formally investigated nor have predictions of species presence in certain areas been confirmed.

In particular, very little is known about the odontocetes inhabiting the waters of American Samoa. American Samoa, the only US territory in the Southern Hemisphere, is primarily made up of four eroded volcanic islands (Tutuila, Ofu, Olosega and Ta'u) and two coral atolls/islands (Rose Atoll and Swains Island). Historic whaling records document the catches of sperm whales (*Physeter macrocephalus*) in the waters of American Samoa (Townsend, 1935), and a recent study of humpback whales (*Megaptera novaeangliae*) in this region indicates their presence during the winter (breeding) period (Robbins and Mattila, 2006). Surveys for cetaceans conducted in nearby Independent Samoa (approximately 95km west of American Samoa) have also confirmed the presence of humpback whales and at least three species of odontocetes thought to inhabit those waters (Noad *et al*., 2006). However, complementary surveys for odontocetes in the waters of American Samoa are lacking. A recent review of cetacean information for American Samoa (Dolar, 2005) synthesised anecdotal sighting information presented in Reeves *et al*. (1999) and Craig (2005), species recorded included spotted dolphins (*S. attenuata*), spinner dolphins (*Stenella longirostris*), bottlenose dolphins (*Tursiops truncatus*), rough-toothed dolphins (*Steno bredanensis*), killer whales (*Orcinus orca*) and false killer whales (*Pseudorca crassidens*). In addition, Dolar (2005) noted sightings and strandings of short-finned pilot whales (*Globicephala macrorhynchus*), a stranded Cuvier's beaked whale (*Ziphius cavirostris*) and photo-documented spinner dolphins within the coastal waters of Tutuila.

This lack of information on cetaceans in American Samoa has conservation implications. To ensure populations have an acceptable conservation status, resource managers

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require reliable information on the stock structure and abundance, along with knowledge of any threats they face. Reliable baseline information is also essential to assess and address potential future, and as yet unexpected management issues that may arise. Currently, little information about threats to cetaceans in the waters of American Samoa exists. There is limited coastal development and ecotourism within American Samoa, suggesting that threats from these sources to cetaceans and their habitats are currently minimal. However, there is ample evidence of interactions between cetaceans and commercial fisheries elsewhere in Oceania (see Donoghue *et al*., 2002) which may represent threats to small, isolated populations if significant bycatch occurs (see Carretta *et al*., 2005). There is a commercial long-line fishery based in the American Samoa region and only recently has a fisheries observer programme been implemented in this industry. At present, there have been no observed interactions between cetaceans and long-line fishing operations in the waters of American Samoa. Cetaceans are known to interact with longline fisheries operating out of nearby Independent Samoa (Simon Walsh, pers. comm.). An initial review of catch logs for this fishery indicated that approximately 3-6% of sets were affected by depredation, and that false killer whales are associated with damaged catches. Furthermore, rough-toothed dolphins have been seen removing baits from hooks in this fishery.

The purpose of the present study was to conduct the first dedicated surveys for odontocetes in the waters of American Samoa to document the diversity, habitat associations, and stock structure of odontocete cetaceans in this region. For the most abundant species, spinner dolphins, genetic diversity, and allele frequencies of the mitochondrial DNA (mtDNA) control region were compared between American Samoa and the Big Island of Hawaii for a preliminary evaluation of stock structure. Data generated from these surveys will provide a baseline for future efforts to quantify the abundance and structure of management units of cetaceans and assess the sustainability of their populations in the waters of American Samoa.

## METHODS

### Study site

American Samoa is located approximately halfway between the main Hawaiian Islands and New Zealand in the central Pacific Ocean. The main islands of Tutuila and the Manu‘a Islands (Ofu, Olosega and Ta‘u) lie at approximately 14°15’S and between 169°24’W and 170°51’W. Maps illustrating the location of American Samoa and its islands are presented in Fig. 1.

### Small boat surveys

Between 2003 and 2006, small-boat surveys for cetaceans were conducted in the coastal waters of Tutuila, the main island in American Samoa. Winter/Spring effort (2003-06) was focused on September and early October, coincident with efforts to maximise encounters with humpback whales. Summer surveys (2006) were conducted in February and March. Unsystematic coastal surveys were conducted from 7m to 10m vessels launched from either the north or south side of the island, depending on sea conditions. Two experienced observers, on watch whenever sighting conditions allowed, scanned for cetaceans around the vessel using naked eye and 8× binoculars. Vessel position was logged by a global positioning system (GPS) at 1-minute or shorter intervals.

### Ship surveys

During summer 2006, ship-based surveys were conducted in the coastal waters of the Manu‘a Group, Rose Atoll and Swains Island, as well as portions of the offshore regions among these coastal areas. Surveys were conducted from the flying bridge of a 68m oceanographic vessel (NOAA RV *Oscar Elton Sette*) outfitted with 25×150 ‘big eye’ binoculars. Two observers (port and starboard) scanned constantly from straight ahead to 90 degrees abeam during daylight hours along preset tracklines. Observations were conducted following standard distance sampling/line transect methods for cetaceans, similar to those employed in Barlow (2006). During both small-boat and ship-based surveys, the location, species present, general behavior, and group size estimates for each cetacean encounter were recorded. These sightings were incorporated into a Geographic Information system (GIS) using *ArcGIS 9.1* (ESRI, Redlands, CA) for comparison with co-incident depth data. For the small boat survey sightings, gridded (5m cell size) bathymetry of the shelf and slope environments were used (see PIBHMC, 2007). For sightings generated during large ship surveys, a sub-sample of the General Bathymetric Chart of the Oceans (GEBCO) 1-minute worldwide bathymetry dataset was employed to assess habitat associations.

Whenever possible, digital photographs of encountered cetaceans were obtained for species identification confirmations and individual photo-identification. Photographs were obtained with *Canon* digital SLR cameras equipped with 100-300mm zoom lenses. Photographs were shot in 24-bit colour at a resolution of 3072×2048 pixels and saved in jpeg format. All photographs were analysed for quality and were graded based on clarity (1-5), contrast (1-5), and angle of the fin to the photographer (1-5). An overall grade was then assigned to each photograph: 3-8=excellent quality, 9-11=average quality, and ≥12=poor quality (Friday *et al*., 2000; Urian *et al*., 1999). Photographs were then analysed for individual distinctiveness based on the patterns of nicks and notches in the dorsal fins and flukes and, to a lesser extent, by scar or colour patterns on the bodies. Overall distinctiveness was based on a scale of 1 (very distinctive; features evident even in distant or poor quality photograph) to 3 (not distinctive following Friday *et al*. (2000) and Urian *et al*. (1999). Those individuals with a distinctiveness rating of 1 or 2 were considered for integration into the photo-identification (ID) catalogue. Photographs of animals were compared between encounters and between years to look for matches. Individuals were entered into the catalogue under one of two conditions; the individual was sighted in more than one encounter and the overall quality of the photograph was at least average, or the individual was sighted once and the overall quality of the photograph was excellent. Where possible, skin/blubber biopsies from animals were obtained from individuals using a *Barnett* RX-150 crossbow and *Ceta-Dart* darts with 25mm tips. Biopsy samples were kept on ice and frozen at the end of each day in liquid nitrogen.

### Population genetic analyses

Genomic DNA was extracted from 16 tissue samples collected from spinner dolphins in American Samoa using Qiagen *DNEasy* extraction kits. A portion of the mtDNA control region was amplified using the polymerase chain reaction (PCR) and sequenced according to previously described protocols (Andrews *et al*., 2006). Control region sequences for spinner dolphins sampled at the Big Island of Hawaii ($n$=18) were obtained from *GenBank* (Accession

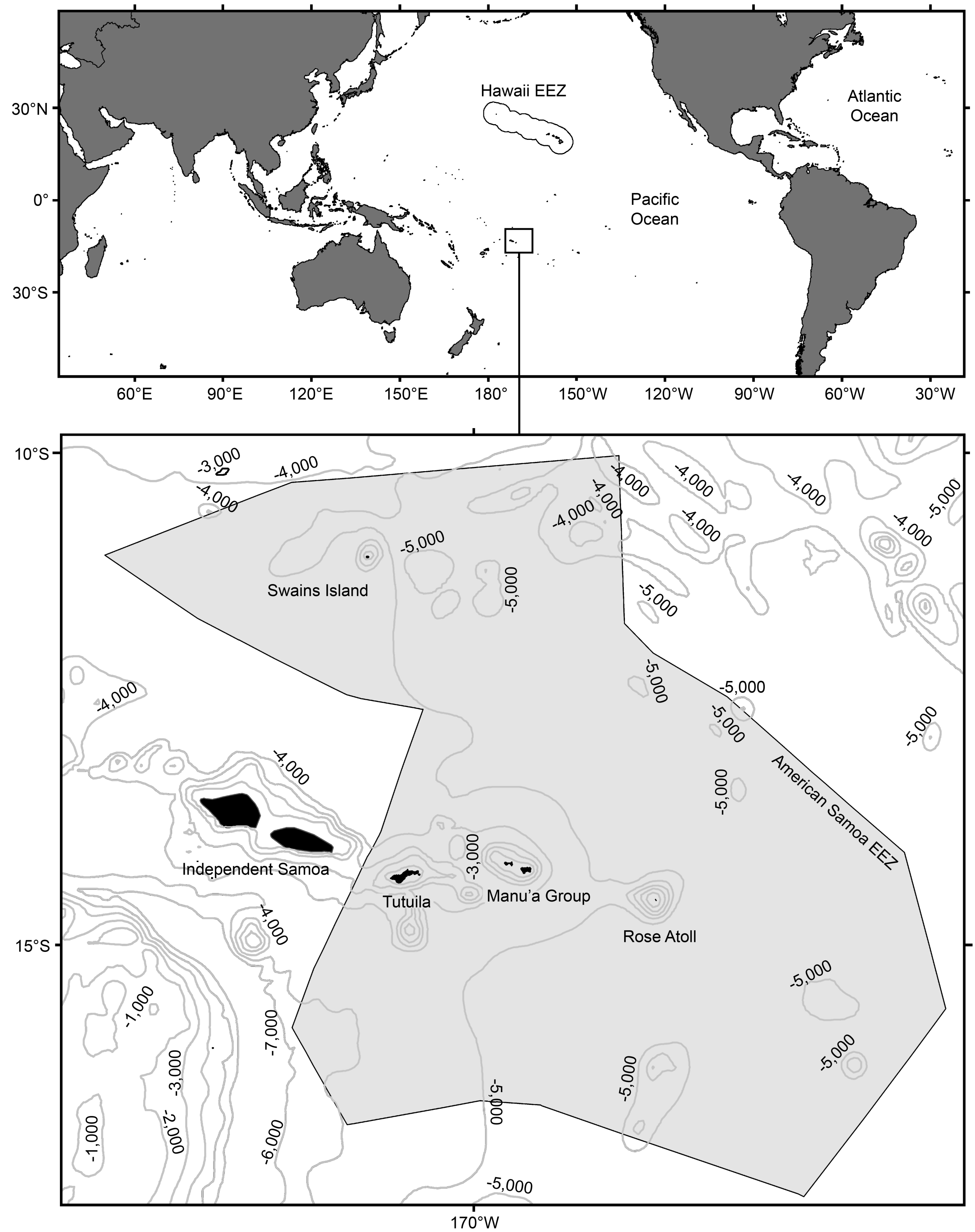


Fig. 1. The location of American Samoa, its Exclusive Economic Zone (EEZ) and its islands in the Central Pacific Ocean.

numbers AY989745-AY989762). All sequences were aligned using SEQUENCHER v.4.2 (Genecodes Corporation), resulting in the comparison of a 390 base pair fragment for all samples.

Nucleotide and haplotype diversities were calculated, and genetic population structure between locations was tested using exact tests of population subdivision (Raymond and Rousset, 1995) and Analysis of Molecular Variance (AMOVA) pairwise $\Phi_{ST}$ comparisons. Pairwise $\Phi_{ST}$ values can range from 0 to 1, with values of 0 indicating genetic panmixia between locations, and increasing values indicating increasing levels of genetic isolation between locations (Wright, 1951). Significance of pairwise $\Phi_{ST}$ comparisons was tested using 100,000 random permutations. All genetic analyses were conducted using ARLEQUIN v.3.11 (Excoffier *et al*., 2005).

## RESULTS

### Small boat surveys

During the austral winters of 2003-06, 35 days of surveys were conducted. An average of 87km of trackline per day was covered and a total of 2,900km of trackline was surveyed. Sea state conditions ranged between Beaufort 1 and 4, with most survey effort conducted in Beaufort 2. Thirty groups of cetaceans were encountered during these surveys, producing a daily encounter rate of 1.2 groups of odontocetes per day. During the 2006 austral summer, 11 days of surveys were conducted covering an average of 93km of trackline per day; a total of 1,021.5km of trackline was surveyed. Sea state conditions were optimal in 7 of the 11 surveys days with light winds and Beaufort 0 or 1 conditions throughout the day. The three remaining days had sea states ranging from Beaufort 2 to Beaufort 4. Twenty-two groups of odontocetes were encountered producing a daily encounter rate of 2.2 groups per day. Of the total 3,925km surveyed, approximately 2,200km (56%) were conducted in waters of less than 250m depth.

A total of 52 groups of odontocete cetaceans were encountered during small boat surveys, representing 34 groups of spinner dolphins, 10 groups of rough-toothed dolphins, 1 group of bottlenose dolphins, 2 groups of sperm whales, 3 groups of false killer whales, 1 group of dwarf sperm whales (*Kogia sima*), and 1 group of unidentified odontocetes. Descriptive statistics for odontocete sightings for all small boat surveys are presented in Table 1. Fig. 2 illustrates the tracklines covered during these surveys as well as the locations of cetacean encounters during the austral summer and winter seasons.

Photographs of cetaceans were obtained from each encounter, producing a total of 1,190 frames useful for identifying individual animals within and between survey years. Data on the number of distinct individuals sighted, the number entered into the photo-ID catalogue, and the numbers of resighted individuals are presented in Table 2. The catalogue included 46 spinner dolphins, 41 rough-toothed dolphins, 2 bottlenose dolphins, 5 false killer whales, 1 dwarf sperm whale, and 3 sperm whales. Thirteen (13) spinner dolphins and 14 rough-toothed dolphins were sighted in multiple years. The other catalogued individuals were seen only once or were resighted within the same year. The number of biopsies obtained per species is presented in Table 1.

### Ship surveys

During March 2006, six days of surveys were conducted around the Manu‘a Islands, Rose Atoll, and Swains Island. Circuit surveys were conducted around each island group. Two circuits were conducted around Rose Atoll and Swains Island; a single circuit and one transect south of the Manu‘a Islands were surveyed. Transect lines covered during ship surveys, along with the locations of cetacean sightings are presented in Fig. 3. Approximately 160km of trackline were covered per day, with a total of 960km surveyed. A total of six groups of odontocetes were detected during ship surveys. Two groups of false killer whales and one group of pilot whales were detected in the nearshore waters of the Manu‘a Islands; one spinner dolphin was sighted proximate to one of the groups of false killer whales in this region. One group of sperm whales and two groups of unidentified odontocetes were also encountered during ship surveys. Photographs of cetaceans were taken in some of the encounters during the ship surveys, producing 52 frames useful for identifying individuals. As a result, 4 pilot whales and 1 sperm whale were entered into the catalogue.

### Population genetic analyses

Nucleotide and haplotype diversities were higher for American Samoa ($h$ =0.975, $\pi$= 0.02) than for the Big Island of Hawaii ($h$=0.6993, $\pi$= 0.007). Genetic comparisons between Hawaii and American Samoa were significant for both the exact test of population differentiation ($p$<0.001) and AMOVA ($\Phi_{ST}$ = 0.21, $p$<0.001).

## DISCUSSION

### Species diversity

The surveys described here provide baseline data on the diversity of odontocete cetaceans in the waters of American Samoa. Previous reviews of the diversity of cetaceans in the waters of Pacific island nations (Reeves *et al*., 1999) suggested that at least 15 species were present (some seasonally) in the waters of American Samoa, although at least seven had never been confirmed. Most of these were believed to inhabit the waters of American Samoa based on sightings from other locations in the region with similar habitat envelopes. Several of these species (e.g. bottlenose dolphins and pantropical spotted dolphins) were considered ‘common’ in American Samoa by Reeves *et al*. (1999), however, this classification was based on a single reference and may not have accurately represented the most common species found in American Samoa. The results of the surveys described in this paper confirmed the presence of at least seven species of cetaceans in the waters of American Samoa and provided the first confirmed sightings of four species in this region: bottlenose dolphins; false killer whales; rough-toothed dolphins; and dwarf sperm whales.

The results suggest that the cetacean fauna found in American Samoa is indeed similar to that found in the waters of other Pacific island nations. For example,

Table 1

List of odontocete cetaceans encountered during surveys in the coastal waters of Tutuila, American Samoa including biopsies taken, group size estimates and depth of water.

| | | | Group size estimate | | | Depth (m) | |
|---|---|---|---|---|---|---|---|
| Species | Encounters | Biopsies | Mean min. | Mean max. | Range | Mean | SD |
| Spinner dolphin | 34 | 20 | 16.7 | 26.3 | 2-75 | 44 | 21 |
| Rough-toothed dolphin | 10 | 6 | 13.3 | 21.1 | 10-30 | 123 | 104 |
| False killer whale | 3 | 5 | 5 | 8.3 | 1-20 | 229 | 236 |
| Bottlenose dolphin | 1 | 0 | 5 | 10 | 5-10 | 90 | n/a |
| Dwarf sperm whale | 1 | 0 | 4 | 4 | n/a | 707 | n/a |
| Sperm whale | 2 | 0 | 2 | 2 | n/a | 907 | 11 |
| Unidentified odontocete | 1 | 0 | 4 | 10 | 4-10 | 224 | n/a |

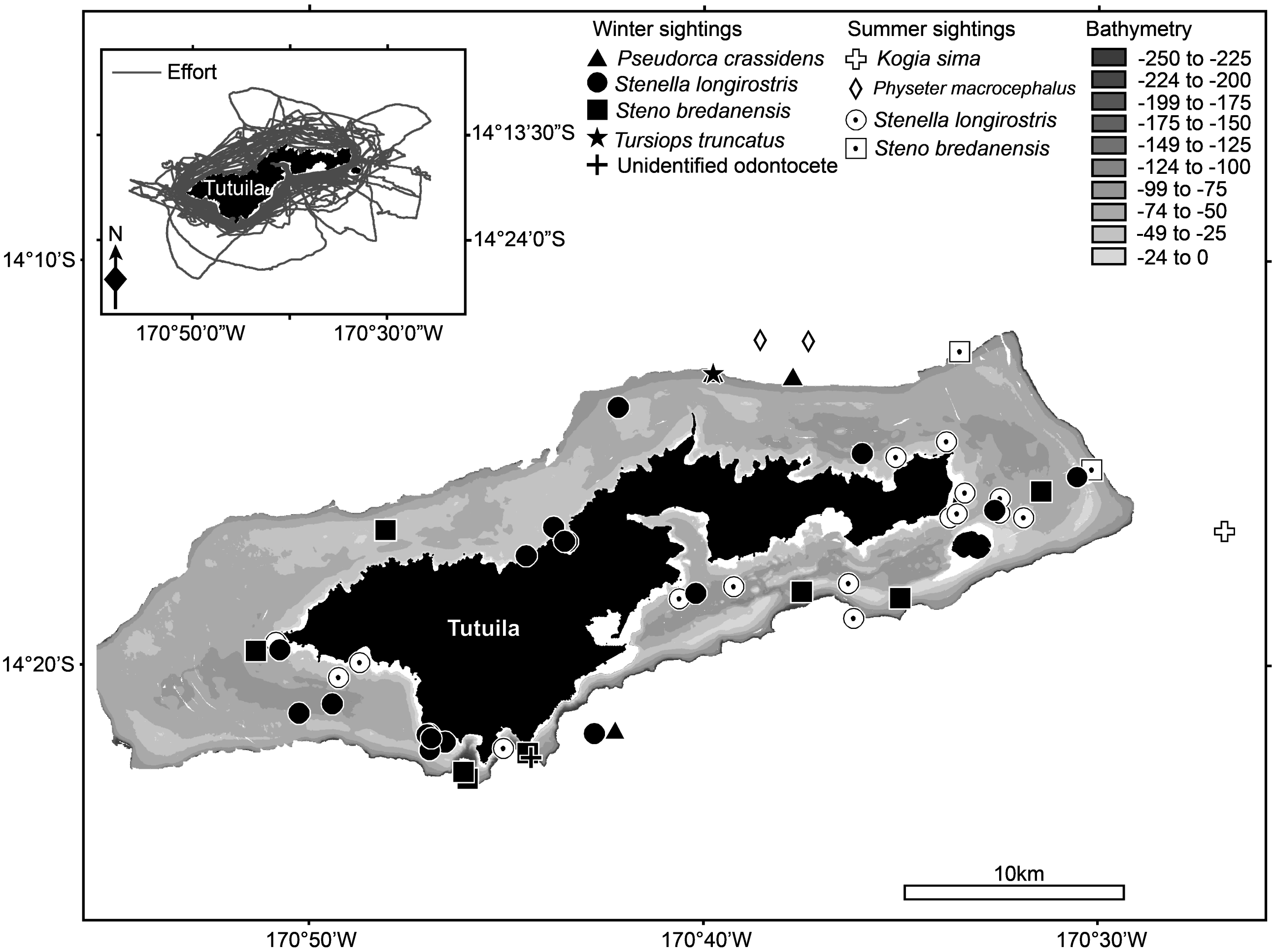


Fig. 2. Survey effort and sighting locations for odontocete cetaceans observed during small boat surveys in the coastal waters of Tutuila, American Samoa during the austral winter (2003-06) and austral summer (2006).

Table 2

Distinct individuals determined from photographs taken during surveys in the coastal waters of Tutuila, American Samoa.

| Species | Total no. distinct individuals | No. entered into catalogue | No. resighted between years | No. resighted within 2006 |
|---|---|---|---|---|
| Spinner dolphin | 131 | 46 | 13 | 8 |
| Rough-toothed dolphin | 81 | 41 | 14 | 4 |
| False killer whale | 7 | 5 | 0 | 0 |
| Bottlenose dolphin | 2 | 2 | 0 | 0 |
| Dwarf sperm whale | 3 | 1 | 0 | 0 |
| Sperm whale | 3 | 3 | 0 | 0 |

Noad *et al*. (2006) found spinner dolphins, false killer whales, and sperm whales during 24 days of joint visual/acoustic surveys in the waters of nearby Independent Samoa (see Fig. 1). Recent joint visual/acoustic surveys in the Solomon Islands (Kahn, 2006) found direct evidence of twelve species of cetaceans. Multiple groups of spinner dolphins, pantropical spotted dolphins, and common bottlenose dolphins were sighted during their surveys, as were single encounters with Indo-Pacific bottlenose dolphins (*T. aduncus*), killer whales, Risso's dolphins (*Grampus griseus*), rough-toothed dolphins and short-finned pilot whales. These surveys also generated single sightings of Mesoplodon beaked whales (*Mesoplodon* sp.). Sperm whales were detected acoustically on these surveys but were not seen. Unrelated to their directed survey effort, Kahn (2006) also reported on a single stranded false killer whale whose skeleton was found on a remote beach within the Arnavon Islands Marine Protected Area. False killer whales had been previously sighted near the Solomon Islands (Shimada and Pastene, 1995).

## Habitat use

During the small-boat surveys around Tutuila, three out of the six confirmed species (false killer whales, dwarf sperm whales and sperm whales) were encountered in waters deeper, on average, than 200m (Table 1). Both sperm whale species are deep diving odontocetes and are commonly found in abyssal waters (Baird, 2005; Watkins *et al*., 2002). While false killer whales are not known to be deep divers (e.g. Ligon and Baird, 2001) they are frequently sighted in waters deeper than 200m in other portions of their range. Ship-based surveys around the Manu'a Islands, Rose Atoll

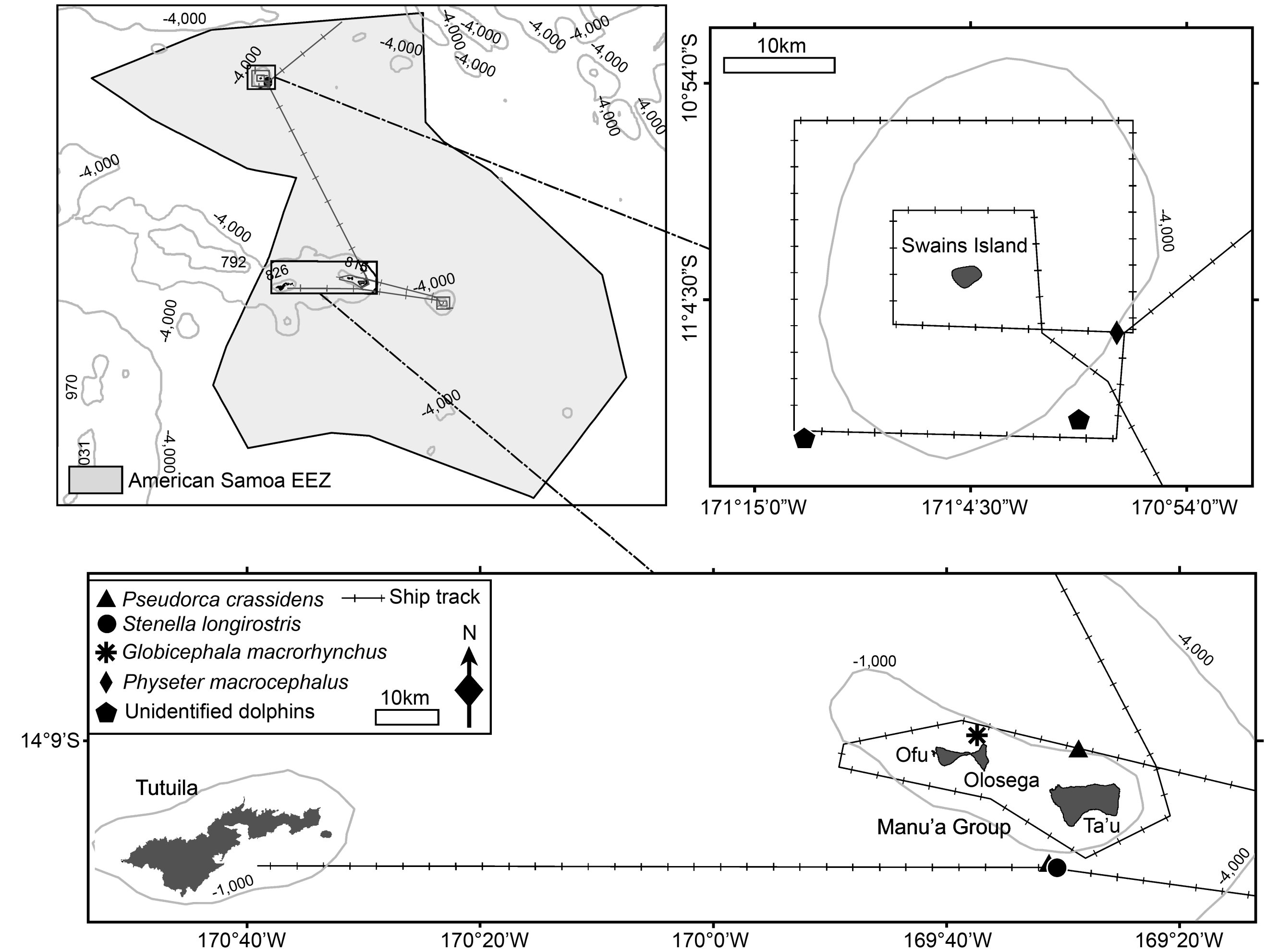


Fig. 3. Survey tracklines and sighting locations for odontocete cetaceans observed during ship-based surveys in the waters of American Samoa during the austral summer 2006.

and Swains Island were biased toward deeper water habitats. For example, sperm whales were encountered in 4,055m deep water, false killer whales were encountered in 1,040±374m deep water and pilot whales were encountered in 375m deep water.

Spinner dolphin encounters were generally inshore (often in or near bays and over regions of sandy bottom less than 60m deep), despite substantial survey effort in waters deeper than 120m. These daytime, inshore sighting patterns are indicative of behaviors exhibited by island-associated spinner dolphins elsewhere in the Pacific. For example, in Hawaii (Karczmarski *et al*., 2005; Norris *et al*., 1994), French Polynesia (Poole, 1995) and the Solomon Islands (Kahn, 2006), spinner dolphins use sheltered inshore regions during the day for resting and predator avoidance. The inshore daytime habits of these animals often make them the focus of tourism operations (Norris *et al*., 1994) and there is growing concern in some areas that intensive tourism may present a threat by impinging on their resting behavior or excluding them from primary resting habitats. There are currently no dedicated dolphin-watching operations in American Samoa.

**Stock structure**

For management purposes, cetaceans inhabiting the waters of American Samoa are considered *protected species* under the US Marine Mammal Protection Act (MMPA). The MMPA requires that assessments for each stock of marine mammals be conducted. These assessments include details on population discreteness and abundance estimates. In several locations in the Pacific Islands, cetaceans often exhibit island-associated population discreteness, with restricted gene flow at meso-spatial scales. For example, spinner dolphins exhibit restricted gene flow between islands separated by as little as 17km in the Society Islands (Oremus *et al*., 2007) and as little as 50km in the Hawaiian Archipelago (Andrews *et al*., 2006). Bottlenose dolphins also exhibit restricted gene flow between islands in the Hawaiian Archipelago (Martien *et al*., In review). On a larger geographic scale, island-associated false killer whales in Hawaii appear genetically distinct from those found in the Eastern Tropical Pacific and around Palmyra Atoll (Chivers *et al*., 2007).

Consistent with observations at other locations in the Pacific, the photographic identification data provide preliminary evidence for population discreteness for some cetacean species at the islands of American Samoa. The relatively high resighting rates of both rough-toothed and spinner dolphins in the waters of Tutuila, and the spatial proximity of between-year sightings for some individuals (e.g. one individual rough-toothed dolphin sighted in 2004 was resighted in 2006 approximately 2km away from the initial sighting), suggest some level of site fidelity for these two species. However, if cetacean populations were completely isolated at American Samoa, small population sizes and low genetic diversity could be predicted based on the small size of this geographic region. Contrary to this prediction, spinner dolphin genetic diversity at American Samoa is higher compared to the Big Island of Hawaii, despite the fact that the Big Island has more available resting habitat than American Samoa. Therefore, the high genetic diversity is likely not the result of a larger population size at American Samoa but rather the result of gene flow between American Samoa and other locations. However, the level of gene flow may be low enough that spinner dolphins at American Samoa remain demographically isolated on ecological time scales that are relevant to conservation. For example, in the Society Archipelago, spinner dolphins at different islands have high genetic diversity despite demographic closure, as revealed by photo-ID data (Oremus *et al*., 2007). The high diversity is hypothesised to be due to metapopulation dynamics, with occasional inter-island movement by 'visitors' and long-term migrants between islands across a geographic area larger than the Society Archipelago. The genetic and photo-ID data presented, while preliminary, follow a pattern similar to that in the Society Archipelago, indicating that metapopulation dynamics may be occurring similarly in American Samoa.

The genetic population structure analyses provide further support for the hypothesis of metapopulation dynamics for spinner dolphins at American Samoa. The exact test and pairwise $\Phi_{ST}$ test comparing American Samoa and the Big Island of Hawaii ($\Phi_{ST} = 0.21$) indicate that these locations are genetically distinct. This result is not surprising given that genetic distinctions were found between spinner dolphins at different islands within Hawaii separated by as little as 50km (Andrews *et al*., 2006). However, the pairwise $\Phi_{ST}$ value between American Samoa and the Big Island is similar to $\Phi_{ST}$ values for the same genetic locus between spinner dolphins at Pacific islands separated by much less geographic distance. For example, pairwise $\Phi_{ST}$ values within the Hawaiian Archipelago were as high as 0.16 (K. Andrews, unpublished data), and pairwise $\Phi_{ST}$ values between islands within the Society Archipelago were as high as 0.32 (Oremus *et al*., 2007). The fact that American Samoa and the Big Island of Hawaii have a comparable pairwise $\Phi_{ST}$ despite the large geographic distance separating these islands indicates that some gene flow may occasionally occur between islands within a larger region of the Pacific Islands, including these two locations. However, consistent with the predictions of metapopulation dynamics, this gene flow appears to be low enough that spinner dolphins at these islands are demographically discrete on an ecological timescale and could be considered separate management units for conservation. Collection of more genetic and photographic identification data is needed at American Samoa and other locations in the Pacific to determine the extent of genetic and demographic connectivity between American Samoa and other locations. Similar data are needed for each cetacean species occurring at American Samoa before effective management decisions can be made concerning stock structure.

## CONCLUSIONS

These surveys provide data on the cetacean species diversity in American Samoa, information that is critical for marine mammal management purposes in the US. Further surveys are required to fully assess the diversity of cetaceans and to develop abundance estimates for odontocetes in American Samoa waters. Further genetic and photo-ID studies will help establish the relationships between cetaceans sampled in this region and those found in the waters of other nearby Pacific Island Region nations. In particular, coordinated surveys with researchers in Independent Samoa would be extremely useful for stock assessments of several of the island-associated species such as spinner dolphins and bottlenose dolphins. Similarly, further research is required to assess the potential threats to cetaceans in waters of American Samoa.

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