Final Report on the Survey of Whales and Dolphins in Samoa

September 2003

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South Pacific Island Whale & Dolphin Program

South Pacific Whale Research Consortium

Natural Heritage Trust

Helping Communities Helping Australia

A Commonwealth Government Initiative

Southern Cross University Whale Research Centre

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1 Executive Summary

This report presents the findings from the whale and dolphin survey conducted in Samoa from the 15th to the 27th September 2003 and additional sightings during the survey reconnaissance trip conducted 4th – 10th August 2003. The project completed a total of 61 hours and 57 minutes of visual searching from a number of vessel-based observation platforms in Samoa.

During a total of 7 hours and 18 minutes spent with cetaceans, twenty pod sightings were made of six species including Humpback whales, Long-snouted Spinner dolphins, Short-finned Pilot whales, an unidentified species of Beaked Whale, Bottlenose dolphin and Rough-toothed dolphins. These last three species are documented for the first time in Samoan waters.

The survey confirmed the finding from the initial cetacean survey in 2001 that humpback whales have not recovered from commercial whaling and appear to be in very low numbers in Samoan waters. A seminar held at the National University of Samoa concluded the survey and highlighted preliminary results.

2 Project Objectives

- Following the survey undertaken in 2001, to conduct further investigation of the current status of cetacean species in areas identified as having higher concentrations of cetaceans in the waters of Samoa, subject to the approval from the relative government authorities;

- To work in partnership with local government authorities, organisations, commercial operators and educational institutions to introduce techniques used in cetacean identification, behaviour monitoring and marine mammal research;

- To undertake further meetings with Samoan Government authorities in relation to the proposed survey in 2003, the results of the survey undertaken in 2001, the proposed Whale, Dolphin, Turtle and Shark Sanctuary within Samoan waters and to raise awareness of marine mammals within the region;

- To assist the Samoan Government with the supply of current information on whales and dolphins within their waters.

3 Background

NB: Much of the background information in this report is sourced from the initial Samoan cetacean survey carried out in September 2001 and presented in Paton et al., (2002).

Populations of the great whales were severely depleted following commercial whaling in the South Pacific by countries outside the region during the nineteenth and twentieth centuries. The extent to which these populations have since recovered, in addition to addressing continuing threats to the region's cetaceans are poorly understood and require further study.

The current status, migration routes and breeding grounds of the whale and dolphin species utilising many areas of the proposed South Pacific Whale Sanctuary is unclear. Research programs are being conducted in a number of areas of the Oceania region including Fiji, Tonga, New Caledonia, the Cook Islands and French Polynesia.

During 2001, Environment Australia (now the Department of Environment and Heritage) funded the Southern Cross University Whale Research Centre (SCUWRC) to conduct a collaborative project with the Samoan Division of Fisheries, Samoan Department of Lands, Surveys and Environment, Samoan Marine Protected Area Project and South Pacific Regional Environment Program in undertaking the first formal cetacean survey in Samoan waters.

This preliminary survey confirmed the presence of humpback whales, sperm whales, spinner dolphins and false killer whales within Samoan waters. The survey report (Paton *et al.* 2002) recommended that further research be conducted to monitor the abundance and movement patterns of cetaceans within Samoan waters.

Since the survey conducted by SCUWRC in 2001, the Samoan Government has declared its intent to establish a Whale, Dolphin, Turtle and Shark Sanctuary within Samoan waters.

Following the 2001 preliminary survey, it was determined to follow up with a targeted research program focussing on key areas identified as having higher densities of cetaceans for further surveys in 2003. This report details all the aspects of the second phase, undertaken as part of the SPIWDP, particularly the results of the combined visual and acoustic survey of cetaceans in Samoan waters during September 2003.

3.1 Geography

Samoa is located in the SW Pacific Ocean between $13^0$25'S and $14^0$45'S, and $171^0$23'W and $172^0$48'W. Figure 1 shows the geography and bathometry of Samoa. It is part of an archipelago of small oceanic volcanic islands, which includes American Samoa. Samoa possesses two main islands (Upolu and Savaii), in addition to seven smaller islands with numerous islets and rocks. The total area of land is approximately 2,820 sq km, with over 95% of the total land area consisting of the two islands of Upolu and Savaii.

3.2 Bathymetry and Oceanography

Recent and historical volcanic activity on Upolu and Savaii has smothered much of the islands inshore coral reefs. As a consequence, there is limited reef production around the group. Samoa has a total area of 277 sq km of coral reef, with Savaii having only a quarter (57 sq km) of the total found off Upolu (220 sq km), despite being the larger of the two islands (Zann, 1991 a and b). Deeper water bathymetry (>200 m isobath) of Western Samoa has been charted by the Royal Australian Navy. However, the bathymetry of inshore lagoons, reef and reef slopes is far less complete. Navigation charts show the coastal bathymetry of only a few harbours and bays, and do not extend far into the unnavigable reef and lagoon waters. Figure 1 shows the geography and bathymetry of Samoa.

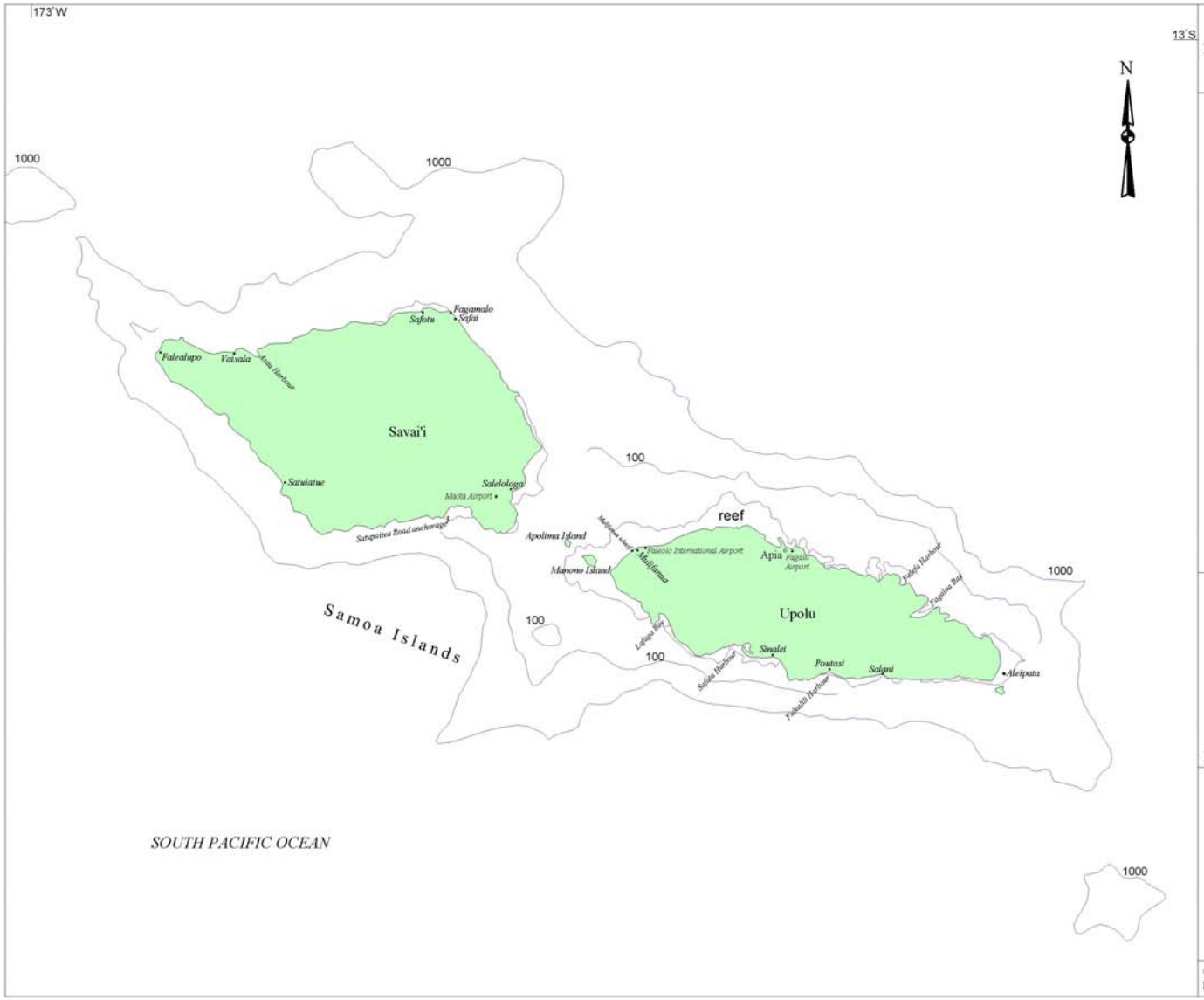
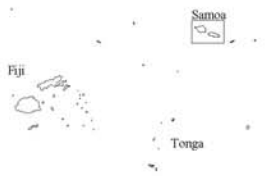


Figure 1 - Samoa study area and location map



Regional location

Southern Cross Centre for Whale Research
A Project of Southern Cross University

Map produced by Greg Luker, GIS Lab, SCU, 13 August 2002.

3.3 Winds

The prevailing 'winter' winds in Samoa are from the southeast for most of the year, whereas in summer the wind predominantly blows from the northwest. The Samoan archipelago lies near the northerly edge of the cyclone belt and hence is occasionally influenced by generating cyclones. Samoa is occasionally affected by low-pressure systems from the southwest, which may occasionally develop into severe tropical cyclones. The most severe cyclone in recorded and oral history was cyclone Ofa in February 1990. This particular cyclone caused catastrophic damage to land, the fishing fleet and reef environments.

3.4 Climate

Samoa's equatorial location results in a tropical, oceanic climate, with hot and humid conditions for the greater part of the year. The wet season occurs from November to April, and the dry season from May to October. The average annual temperature is 26.5^0C in coastal areas, with a decrease in temperature as the altitude rises inland. Overall cloud cover and humidity is generally greater inland than on the coast. The average rainfall is around 3,000 mm with approximately 75% of the precipitation occurring from November to January (Zann, 1991a and b).

3.5 Current status of whales and dolphins in Independent Samoa

There is a paucity of information regarding the distribution and abundance of cetaceans in the South Pacific region in general, and within Samoan waters in particular. "*Marine Mammals in the Area served by the South Pacific Regional Environment Programme (SPREP)*" was co-authored by Randall Reeves, Stephen Leatherwood, Gregory Stone and Lucius Eldredge in early 1999. This report compiled baseline information on a range of topics relevant to marine mammals in the region up until1996.

The Reeves *et al.* (1999) review of cetaceans in the region did not include any recent reports of cetaceans found in Samoa. However, records from American Samoa in the report suggest there are several species of cetaceans common to the region.

Table 1 summarises the little that is known about the status of cetaceans in Samoa. This table was initially presented in Paton *et al.* (2002) which in turn, was derived from a variety of sources including:

- The report on Marine Mammals in the areas served by the South Pacific Regional Environment Programme, by Reeves *et al.* (1999);

- The report by Paton & Gibbs (2002) on the documented and anecdotal sightings of cetaceans within Samoa, Fiji, Vanuatu and the Solomon Islands; and

- Interviews and discussions with locals e.g. tour operators, fisherman and government officials.

Table 1. Cetaceans likely to be present in Samoan waters to 2001.

Common Name	Species	Documented	Anecdotal	Likely to be present
Humpback whale	*Megaptera novaeangliae*	✓	✓	
Bryde's whale	*Balaenoptera edeni*			✓
Minke whale	*Balaenoptera bonaerensis*	✓		
Sperm whale	*Physeter macrocephalus*	✓		
Killer whale	*Orcinus orca*			✓
False killer whale	*Pseudorca crassidens*	✓		
Short-finned pilot whale	*Globicephala macrorhynchus*		✓	
Bottlenose dolphin	*Tursiops truncatus*			✓
Spinner dolphin	*Stenella longirostris*	✓	✓	
Pantropical spotted dolphin	*Stenella attenuata*			✓
Striped dolphin	*Stenella coeruleoalba*			✓
Melon-headed whale	*Peponocephala electra*			✓
Risso's dolphin	*Grampus griseus*			✓
Fraser's dolphin	*Lagenodelphis hosei*			✓
Cuvier's beaked whale	*Ziphius cavirostris*			✓
Rough-toothed dolphin	*Steno bredanensis*			✓

3.6 Cetacean / Longline Interactions

Following the initial cetacean survey in 2001, the Fisheries Division highlighted the on-going issue of cetacean interactions with the longline fishery in Samoa. The main issues appear to be twofold; firstly that 'dolphins' take the bait from the longline hooks, and secondly, that 'whales' depredate or remove the catch itself.

The interactions are characterised by a lack of documented information regarding the species involved in depredation events, the scale of depredation and temporal and spatial variation. Impacts for the fishery include increased expenditure on bait, fuel and time, while impacts on cetaceans remain unquantified although anecdotal evidence indicates few occasions of cetacean by-catch or entanglements.

A workshop was held in November, 2002 on *"Cetacean Interactions with Commercial Longline Fisheries in the South Pacific Region: Approaches to Mitigation" which* met at the headquarters of the South Pacific Environment Programme (SPREP) in Apia, SPREP (2002).

This workshop had the aims:

- to begin an assessment of depredation on longlines by cetaceans in the South Pacific;

- to identify and provide best current information on possible mitigation measures; and

- to agree actions and research priorities to address this global problem.

A number of researchers, fishery / environmental organizations, fishermen and NGO's attended from local, regional and international backgrounds. The outcomes of the workshop were developed into the Plan of Action and Priorities for Research to reduce Depredation on Longlines by Cetaceans.

One of the authors of this report (SW) is currently developing a project in collaboration with the Samoan Fisheries Division and the Southern Cross University Whale Research Centre to research the interactions more closely and ultimately, trial and evaluate mitigation alternatives. This project plans to utilise the above Plan of Action as a 'springboard' to direct research activities.

3.7 South Pacific Whale Sanctuary

(Extracted from Paton (2001) in Appendix 1: South Pacific Island Whale & Dolphin Program – Project Proposal)

There has been a long-term proposal for a South Pacific Whale Sanctuary, which will complement the existing Southern Ocean and Indian Ocean Whale Sanctuaries. It will ensure that Southern Hemisphere whales are protected in their South Pacific breeding grounds as well as their Southern Ocean feeding grounds.

The Sanctuary will protect all species of great whales found in the region: the Blue, Fin, Sei, Southern right, Humpback, Bryde's, Minke, Pygmy right and Sperm whales. This includes all Southern Hemisphere species whose populations were significantly depleted through commercial whaling.

A SPREP Members Regional Workshop was held in Apia, Samoa in April 2001. This workshop developed a proposal (referred to as the Apia Statement) for a South Pacific Whale Sanctuary for consideration by the Pacific Island Forum Leaders.

In this statement it is noted that:

"The critical significance of the South Pacific as breeding grounds for nine species of great whales…"

"The serious depletion of great whale stocks in the South Pacific region…"

"That the gathering of great whales on their South Pacific breeding grounds is one of the great wildlife spectacles of the world"

The statement also

“Agrees that SPREP’s Regional Marine Mammal Conservation Programme (RMMCP) is currently assisting whale conservation in the region and could usefully assist the effective implementation of a South Pacific Whale Sanctuary;”

“Urges donors to favourably consider providing financial resources to support SPREP’s RMMCP in work connected with the proposed South Pacific Whale Sanctuary.”

“Calls on SPREP to consider including in its RMMCP the activities listed in Attachment 3;”

Attachment 3 of the Apia Statement proposes:

“Support national measures for a South Pacific Whale Sanctuary (SPWS) by providing technical advice and helping to access necessary resources and expertise;”

“Coordinate the development of research programs and maximising the opportunities for Pacific Island involvement;”

Ensure an efficient flow of relevant information between SPREP members taking advantages of opportunities to build awareness and understanding of the purpose of work undertaken in a SPWS;”

“Provide technical advice and feasibility assessments on request for SPREP members interested in the development of whale watching, based on the successful development of whale watching, in the Kingdom of Tonga including guidelines for the conduct of tourism operations and the behaviour of vessels around whales;”

“Maintain and exchange of information, including monitoring information, with the relevant agencies, Particularly the International Whaling Commission and the South Pacific Tourism Organisation”

“Assist and advise, where requested, to provide technical assistance with the development of legislation and technical protocols for the conservation of whales.”

In May 2002, the Samoan Cabinet, approved a proposal for the establishment of a National Marine Sanctuary (120,000sq km EEZ), which includes turtle, shark and marine mammal conservation. A follow-up workshop was held in August 2002 and community consultations conducted in early 2003.

4 Methods

4.1 Direct Observations / Photo-identification

Vessel based observations were conducted as visual line-transect surveys. Straight line transects of around one hour duration were undertaken with hydrophone drops at the end of each transect. After the acoustic sample had been completed, the hydrophone would be retrieved and the vessel would start a new transect.

All persons on board observed for cetaceans while underway. Usually at least one spotter was stationed either side of the vessel to observe abeam and astern, while the driver and at least one other spotter would both scan ahead of the vessel to approximately 45° to either side of the bow.

When a cetacean was spotted, the transect would be broken and the vessel would approach the animal in an attempt for identification of species, and for the collection of genetic, acoustic, and photographic samples. Conclusive species identification was not always possible due to elusive behaviour or to inclement sea conditions. The transect was resumed following the collection of as much data as was feasible.

Photographs of cetaceans encountered were taken using a Canon EOS 5 with a Canon 70 - 300 mm lens. When delphinids were encountered, photographs were attempted of the whole animal and of the lateral aspect of the dorsal fin. When humpback whales were encountered, photographs were attempted of the underside of the flukes and of lateral body pigmentation for individual identification purposes.

The observers included the following people:

- **Simon Walsh** (Conservation Management Officer, NSW Fisheries & MSc candidate, Southern Cross University, Australia);

- **Juney Ward** (Department of Natural Resources & Environment, Samoa);
- **Carlos Olavarría** (PhD candidate, University of Auckland NZ);
- **Solomona Tufuga** (Division of Fisheries, Samoa);
- **Malaki Iakopo** (Department of Natural Resources & Environment, Samoa);
- **Yvette Kerslake** (Department of Natural Resources & Environment, Samoa);
- **Inspector Mulinuu Mulinuu** and the **17 crew of the *Nafanua*** (Police Maritime Services, Samoa);
- **Willie and Tauvela Vao'tuua** and the **3 crew of the Manono alia** (Vao'tuua Beach Fales, Manono Island, Samoa);
- the **2 crew of the Asau alia # 51;**
- **Foua Toloa & crew of the Moana Divers** boat.

David Paton also undertook preliminary surveys and recorded sightings during the initial reconnaissance trip from 4th – 10th August 2003.

4.2 Survey effort

Due to the difficulties in performing a structured, patterned survey, some coastal regions were subject to more or less effort than others. Following on from the findings of the 2001, survey effort was concentrated in two main areas – south western Upolu and north western Savaii. This is where the bulk of cetaceans were observed during 2001.

4.3 Vessel platforms

Five different vessels were used to conduct a combined visual and acoustic survey of the coastal waters of Independent Samoa.

- *Nafanua* – Police Patrol Boat – 31 metres with crew of 18 + 2 observers (SW, JW); (See Plate 1)

- *Manono alia* – local fishing vessel – 8 metres with crew of 2-3 + 3 observers (SW, JW, CO);

- *Asau alia # 51* – local fishing vessel – 8 metres with crew of 2 + 4 observers (SW, JW, CO, ST);

- *Savaii / Upolu Ferry* – trans-island ferry – approx. 70 metres with 3 observers (SW, JW, CO). DP also utilised this vessel during the reconnaissance trip;

- *Moana Divers* – dive operators boat - 9 metres with crew of 2 + 5 observers (SW, JW, CO, MI, YK). (See Plate 2)

4.4 Photographs

Plate 1: Nafanua Patrol Boat

Plate 2: Moana Divers boat

Plate 3: Bottlenose Dolphin

Plate 4: Rough-toothed Dolphin

Plate 5: Short-finned pilot whale - Spy-hopping

Plate 6: Short-finned pilot whales

Plate 7: Spinner dolphin biopsy

Plate 8: Successful biopsy sample

Plate 9: Recording data

Photographer: Simon Walsh

4.5 Acoustic survey and samples

The model of hydrophone used was a High Tech HI-96-MIN, which was connected to the line-in of a Sony TCD-D7 DAT recorder and included a 40-dB preamplifier at the hydrophone. Used on 'short-play', the system response was flat (± 3dB) from 20 Hz to 22 kHz. The hydrophone cable was wrapped in string (fixed to the cable by electrical tape) in an attempt to reduce low-frequency noise produced by poor water flow over the cable.

During the line-transect visual survey, hourly periodic breaks were made for acoustic sampling as detailed above. The hydrophone was lowered and listening commenced for acoustic signals from cetacean activities. If cetaceans were detected then recordings were made for a minimum period of five minutes. These 'sample recordings' were made approximately hourly and were usually of approximately five minutes duration.

4.6 Genetic sampling

Genetic samples were obtained using a PAXARM biopsy system, which is a modified .22 rifle designed to propel floating darts with a tip modified to retain a small sample of skin and blubber (see Plates 7 & 8). The biopsy system itself was exclusively operated by Carlos Olavarría, although Juney Ward also assisted with processing of samples collected. The dart would be aimed posterior to the dorsal fin and anterior to the flukes of targeted animals. Following sampling, the dart would be retrieved from the water and preserved in alcohol for subsequent laboratory analysis.

4.7 Permits

The survey conducted in 2003 within Samoan waters was undertaken under the following authorities, licences, consents and endorsements:

- Samoan Prime Ministers Department;

- Samoan Ministry of Natural Resources and Environment;
- Samoan Police Department;
- Samoan Customs Department;
- South Pacific Regional Environment Program (SPREP);
- Australian Department of Environment and Heritage (formally Environment Australia);
- South Pacific Whale Research Consortium;
- Southern Cross University Animal Ethics Committee.

5 Results

5.1 Survey effort

A total of 10 days were spent surveying, during which 61 hours and 57 minutes of searching for whales and dolphins were undertaken. A total of 20 pods of whales or dolphins were seen during the survey with a total of over 210 individual animals. In total, 7 hours and 18 minutes were spent with cetaceans.

The survey period was characterised by inclement weather conditions. On average, each survey day consisted of 4.6 hours on the water as strong winds in the afternoon generally prevented effective observations. In addition, high winds and / or the limited availability of a suitable research vessel for the prevailing off shore conditions prevented surveys on some days.

5.2 Sightings / photo-identification

Six different species of whale and dolphin were observed including:

Table 2: Cetacean species observed during the 2003 Survey

• Humpback whale	*Megaptera novaeangliae*
• Beaked whale sp.*	*Mesoplodon sp.*
• Short-finned pilot whale	*Globicephala macrorhynchus*
• Rough-toothed Dolphin *	*Steno bredanensis*
• Long-snouted spinner dolphins	*Stenella longirostris*
• Bottlenose Dolphin *	*Tursiops truncatus*

*** NB. Indicates species previously unrecorded for Samoan waters.**

In addition, there were further pods of whales or dolphins that could not be identified due to poor visibility or distance from the observers.

Between 4th and 10th August 2003, David Paton undertook a reconnaissance trip to Samoa to co-ordinate permits, logistics and meet with relevant Government agencies. During this period a 2.5 hour opportunistic survey on board the inter-island ferry between Savaii and Upolu was undertaken. In addition opportunistic land based observations were also undertaken. During this period, a humpback whale was observed opportunistically off the south east coast of Savaii.

Photo-identification samples were collected from Humpback whales (dorsal and lateral body only), Short-finned pilot whales, Bottlenose dolphin, Long-snouted spinner dolphins and Rough-toothed dolphins. These will be further analysed and compiled into a catalogue to compare with individuals from other areas of the South Pacific. Full copies of all photos have been provided to the Ministry of Natural Resources & Environment, Samoa and the Division of Fisheries to facilitate matching with whales and dolphins seen in the future.

The humpback fluke identification shots taken in 2001 have been compared with the humpback fluke catalogues available from the South Pacific Whale Research Consortium. These include the areas of Cook Islands, Tahiti, Tonga, Fiji, Vanuatu and New Caledonia; no matches were made with the Samoan photos from 2001. Further matching is proposed with the Eastern Australia catalogues managed by Southern Cross University Whale Research Centre and the Oceania Project.

5.2.1 Bottlenose dolphin

Bottlenose dolphins, while relatively common in other parts of the world are documented here in Samoan waters for the first time (see Plate 3).

Bottlenose dolphins are predominantly grey with a lighter ventral surface, a short but definite beak and pointed flippers. The dorsal fin is curved back and

prominent. There is a large degree of variation between adult sizes in different parts of their distribution (from 2.3 to 3.8 metres) and between inshore and offshore populations.

Females and calves tend to stay together in a defined home range, whereas males form long term bonds with each other and tend to range further afield.

Feeding habits of Bottlenose dolphins are diverse and cosmopolitan.

5.2.2 Rough-toothed dolphin

Although superficially resembling the Bottlenose Dolphin from a distance, at closer quarters the differences become more apparent (see Plate 4). While both species display a similar prominent dorsal fin, the rough-toothed dolphin has a smooth beak without a characteristic crease where it joins the forehead. It has been described as having a slightly reptilian appearance. White-ish lips are also visible on close inspection.

5.2.3 Beaked Whale species

Unfortunately, the single occasion on which Beaked whales were observed was too brief to allow conclusive identification or to enable successful photo-identification to be undertaken. However, the encounter was of sufficient duration for the research team to identify three individuals of the same Beaked whale species.

Beaked whales are the least known of all cetacean species. Generally living in deep water, they are shy and spend long periods underwater with brief surfacings. Diet is thought to be typically squid and some deep-water fish species.

5.3 Pod sizes

Table 3: Summary number of pods and individual cetaceans.

Species	Number of pods	Number of individuals	Average per pod
Humpback whale	3	4	1.33
Beaked whale sp.	1	3	3
Short-finned pilot whale	1	11	11
Rough-toothed dolphin	7	49	7
Long-snouted spinner dolphins	7	150	21.4
Bottlenose dolphin	1	1	1
TOTALS	**20**	**218**	**10.9**

5.4 Acoustic sampling

No hydrophone drops were attempted until day 6 of the survey due to a combination of poor weather conditions, lack of a suitable research vessel and the hydrophone cable being part of a lost luggage consignment in transit from New Zealand.

Following this, a total of eighteen acoustic sampling attempts were made. Humpback whales were heard clearly on six occasions, with up to three animals recorded singing concurrently; rough-toothed dolphins were recorded once echo-locating immediately adjacent to the hydrophone and an unidentified whale (possibly also Humpback) was recorded on a single occasion.

Ongoing technical difficulties with the hydrophone resulted in heavy static causing signal disruption, making acoustic signatures undetectable if present,

on seven further samples. Due to hydrophone malfunction, no further acoustic samples were collected on the last day of survey.

In summary, of 18 (100%) acoustic drops; 7 were successful (38.9%) in detecting cetaceans, 4 were unsuccessful (22.2%) and on a further 7 occasions (38.9%) heavy static prevented recognition of cetacean acoustic signals if present.

This positive detection rate compare favourably to the results from 2001 where cetaceans were heard clearly in 36 % of the recordings. It may be that the static problems encountered may have prevented further cetacean detections and highlight the usefulness of this particular research tool for further work.

5.5 Genetics

NB: See Appendix 1 (Olavarría et al. 2003) for the full report on the genetic sampling and detailed results from the 2003 survey.

The PAXARM system operator commenced field involvement with the survey on day 6. A total of 14 biopsy samples were attempted. Five genetic samples of skin and blubber were collected from 4 pods of Rough-toothed dolphins; three samples from three pods of Spinner dolphins; three samples from a single pod of Short-finned pilot whales; and a single sample from a solitary Bottlenose dolphin. With a total of 12 collected samples, a further two sampling shots were unsuccessful.

Subsequent laboratory analysis was performed on these 12 samples, in addition to the two humpback samples collected in 2001.

The two humpback samples were confirmed as having come from the same animal, as was noted in the field at the time. This whale was observed to be singing and the genetic analysis has confirmed its sex to be male. The animal

has shared genetic characteristics with other animals sampled from the South Pacific region ie. Cook islands, New Caledonia, Tonga and Western Australia.

The three Short-finned pilot whale samples (1 female, 2 males) were all genetically similar. Analysis showed that these Samoan animals were more closely related to populations sampled in French Polynesia and New Zealand; rather than other sub-sets from Japan, Portugal, California, North Atlantic and the Eastern Tropical Pacific.

The four Rough-toothed dolphin samples (1 female, 3 males) showed a close relationship to each other but differed from samples collected in French Polynesia.

The three spinner dolphin samples (1 male, 2 female) each had a different mtDNA haplotype. Each haplotype differed significantly from samples collected in French Polynesia, Tonga and the Cook Islands.

The Samoan bottlenose dolphin sequence (single male) differed with samples from Kiribati, Marlborough Sound (New Zealand South Island), the Bay of Islands (New Zealand North Island), the North Atlantic, China and South Eastern Australia.

5.6 Cetacean / longline interactions

On one occasion, (24th September) a soaking longline was encountered off Asau. Upon the vessels approach, two pods of rough-toothed dolphins appeared and circled the boat. The Fisheries Division representative retrieved the longline to examine the state of a number of hooks, which were found to be clean and without bait or catch attached. It was suggested that the dolphins had taken the baits and would often approach vessels near longlines seeking additional food.

5.7 Anecdotal sightings

During the project, anecdotal sightings were collated from dive operators, fishermen and other observers, these are shown in Table 4 below. A whale and dolphin sighting form for Samoa has been developed by the Ministry of Natural Resources & Environment (MNRE), Samoa (see Appendix 2) and circulated to people likely to see whales or dolphins in Samoa.

Negotiations have also taken place with a range of dive operators, fishermen, airline pilots, commercial shipping firms, inter-island ferry services and agency staff in Samoa to complete the forms upon any opportunistic sightings and return to the MNRE. These forms will be collated and data gained then added to the Cetacean Sighting Database that is currently under development by MNRE.

Table 4: Anecdotal sightings documented from 2003

Species	**Number**	**Date**	**Behaviour**	**Location**	**Reporter**
Humpback	2	5th September	Heading NE	Fanutapu Island	Steve Brown (Green Turtle Tours)
Humpback	1	6th September	Heading NE	Fanutapu Island	Steve Brown
Humpback	5 - 6	10th September	Heading NE	Fagamalo (American Samoa)	Polynesian Air pilots via Steve Brown
Humpback	3	August		Apolima Strait	Nafanua crew
Sperm	Many	Year round		Southern Savaii	Nafanua crew

5.8 Preliminary survey of American Samoa

During September 2003, David Mattila, Science and Rescue Coordinator, Hawaiian Islands Humpback Whale National Marine Sanctuary, coordinated a cetacean survey in American Samoa (D. Mattila, pers. comm.)

Preliminary results supplied by Mattila indicate that densities of humpback whales in American Samoa are potentially higher that those reported within Independent Samoa. These results are consistent with anecdotal reports and the reports by Malaga,1985; Paton & Gibbs 2001; Paton et al. 2002).

David Paton and Mattila have entered into discussion in relation to collaboration for data collected within the Samoan Region.

5.9 Updated table of cetaceans present in Samoa

Following the results presented above, Table 5 below shows an updated list of cetaceans recorded present in Samoan waters up to September 2003.

Table 5. Updated table of cetaceans present in Samoan waters.

Common Name	**Species**	**Documented**	**Anecdotal**	**Likely to be present**
Humpback whale	*Megaptera novaeangliae*	✓	✓	
Bryde's whale	*Balaenoptera edeni*			✓
Minke whale	*Balaenoptera bonaerensis*	✓		
Sperm whale	*Physeter macrocephalus*	✓		
Killer whale	*Orcinus orca*			✓
False killer whale	*Pseudorca crassidens*	✓		
Short-finned pilot whale	*Globicephala macrorhynchus*	✓		
Bottlenose dolphin	*Tursiops truncatus*	✓		
Spinner dolphin	*Stenella longirostris*	✓	✓	
Pantropical spotted dolphin	*Stenella attenuata*			✓
Striped dolphin	*Stenella coeruleoalba*			✓
Melon-headed whale	*Peponocephala electra*			✓
Risso's dolphin	*Grampus griseus*			✓
Fraser's dolphin	*Lagenodelphis hosei*			✓
Cuvier's beaked whale	*Ziphius cavirostris*			✓
Beaked whale sp.		✓		
Rough-toothed dolphin	*Steno bredanensis*	✓		

6 Communication activities

6.1 Seminar

A seminar was held at the National University of Samoa on 26th September 2003 to discuss the preliminary findings of the 2003 cetacean survey. Lui Bell, Ministry of Natural Resources and Environment, acted as Master of Ceremonies throughout the presentations.

25 attendees hailed from a number of agencies and organisations including the Ministry of Foreign Affairs & Trade, Ministry of Natural Resources & Environment, Division of Fisheries, National University of Samoa, Marine Protected Area Program – IUCN, South Pacific Whale Research Consortium, University of Auckland, Southern Cross University, Pacific Quest Divers, Samoa Observer newspaper and numerous NGO's.

Appendix 3 contains a copy of the invitation letter sent to prospective participants by the CEO of the Ministry of Natural Resources and Environment, Taulealeausumai Laavasa Malua.

Research findings were highlighted and discussed following presentations from:

- Mike Donoghue (NZ Department of Conservation, SPWRC) - *Historical exploitation of whales in the South Pacific and Conservation Research including the South Pacific Whale Research Consortium (SPWRC)*;

- Simon Walsh (SCUWRC, NSW Fisheries) - *Project Aims and Objectives - preliminary results;*

- Carlos Olavarría (Auckland University) - *Genetics overview – SPWRC and other programs undertaken in the South Pacific*;

- Juney Ward (Ministry of Natural Resources and Environment) - *Marine Mammals programme in Samoa including sightings records and database;*

- Pouvave Fainuulelei (Samoan Division of Fisheries) - *History of Whales in Samoa.*

6.2 Media

An article was printed in the Samoa Observer newspaper (see Appendix 4 for a copy) outlining the findings of the 2003 survey.

6.3 Additional presentations

Project results were also presented to the South Pacific Whale Research Consortium held in Byron Bay, Australia from 2 – 6th April 2004. Regional cetacean researchers and staff from Environmental Management Agencies and NGO's were also present at this meeting.

A further opportunity to present the survey findings was undertaken to the Rotary Club of Apia on 16th May 2004. Numerous local business leaders, bankers, community heads and university staff were present on this occasion.

During the survey itself, a number of organisations and individuals were contacted and encouraged to participate in the cetacean research program. These included:

- Ministry of Natural Resources & Environment, Samoa (MNRE);

- Division of Fisheries, Samoa (FD);

- National University of Samoa (NUS);

- Police Maritime Services, Samoa;
- Department of Foreign Affairs & Trade (DFAT);
- Marine Protected Area project (MNRE);
- South Pacific Regional Environment Program (SPREP);
- Samoa Observer newspaper;
- Vao'tuua Beach Fales, Manono Island, Samoa ;
- Ecotour Samoa / Green Turtle Eco-tours;
- Moana Divers;
- Pacific Quest Divers;
- Savaii Surfaris.

7 Key outcomes

7.1 Provision of scientific data to assist cetacean conservation in those South Pacific countries in whose waters surveys have been conducted.

The South Pacific Island Whale and Dolphin Program has been developed in consultation with the Samoan Ministry of Natural Resources and Environment and the Division of Fisheries. Consultation was also held with a number of Non-Government Organisations (NGO's) and commercial operators in Samoa. In addition the South Pacific Regional Environment Program (SPREP) and the South Pacific Whale Research Consortium (SPWRC) were involved in the development of the program.

The program has been developed with an aim to provide scientific data to assist the Samoan Government in making well informed decisions in relation to the management of marine mammals within their Exclusive Economic Zone (EEZ).

The Ministry of Natural Resources and Environment, as well as the Division of Fisheries; have been provided with copies of the field data sheets and also a full set of all photographs taken during the survey period.

Copies of both the preliminary and final reports will also be provided upon completion to those agencies. The Ministry of Natural Resources and Environment is keen to display a copy of this document on its website.

Copies of the genetics report detailing the sampling protocol, methodology and analyses of the results have also been supplied to those agencies.

In addition to the program being developed with input from the above Samoan organisations, a wide range of personnel from a broad cross-section of the Samoan community were involved in the implementation of the surveys. See

section 6.3 above for a full list of the individuals / organisations involved in participating in the 2003 survey.

A copy of the final report will be provided to each of the above organisations. It is further proposed a paper will be presented to the Scientific Committee of International Whaling Commission Meeting outlining the results of the survey. It is also proposed that a manuscript will be prepared for publication in relation to the survey results.

As the Samoan Government has recently declared their intent to establish a Whale Sanctuary within their EEZ, this survey in conjunction with the 2001 survey and the report by Paton & Gibbs (2001) on the Anecdotal and Reported Sightings of Cetaceans within the region, will substantially add to the current base line knowledge in relation to cetaceans within Samoan waters.

7.2 Capacity building in the South Pacific in relation to cetacean biology, ecology and identification.

Since the reconnaissance trip and the cetacean survey in 2001 in conjunction with the survey in 2003, general awareness and skill base in relation to cetaceans in Samoa has markedly increased. Previously awareness of cetaceans was fairly limited with many people unaware of the presence of these animals in Samoan waters. On completion of the 2003 survey, a great deal of interest had been generated and reports of cetacean sightings have been more forthcoming to Ministry of Natural Resources and Environment (MNRE). The Ministry has now commenced a program to collect anecdotal sightings from throughout Samoa.

MNRE in particular were extremely keen and interested to develop a cetacean focus within their organisation. Following the project's latest visit, MNRE have developed a Cetacean Sightings form with input from the research team (copy attached, see Appendix 2) which has been supplied to Samoan fishers, eco-

tour operators, inter-island ferry companies, airlines etc. The information collected is then entered into a Cetacean Sightings Database developed and held at MNRE. In addition to this, posters have been developed to aid in cetacean species identification and web pages are under development as well.

In addition the close working relationship with a range of organisations (both Government, NGO and commercial tourist operators) has resulted in an increase in skills and general knowledge in relation to cetacean biology, ecology and identification in the region (see Plate 9).

Complementing these outcomes, the Southern Cross University Whale Research Centre (SCUWRC) is currently investigating a proposal to develop a unit at the University of the South Pacific (USP) based in Suva. Discussions are currently underway with Professor Leon Zann, the Director of Marine Science at USP in relation to this proposal. USP has a campus located in Apia and there may be potential for further capacity building in Samoa through the establishment of this node of the centre at USP.

The WWF South Pacific office is currently developing a proposal with input from the SPWRC in relation to further activities associated with the conservation of marine mammals within the South Pacific region. An aspect of this proposal is the further development of capacity building within the South Pacific region. It is proposed that projects such as this one will be the catalyst for the development of skills in relation to cetacean biology, ecology and identification in the region.

In addition, the Ministry of Natural Resources and Environment has developed a comprehensive proposal to build upon the surveys that have already been undertaken within Samoan waters - the National Marine Biodiversity Conservation Programme. We understand that this proposal to the United Nations Development Programme includes building upon the good working relations already established between the SPIWDP, SCUWRC, SPWRC and USP over a five year period.

7.3 Establishment and maintenance of existing links to stakeholders in cetacean conservation including government, educational institutions, industry and NGOs.

Building on the existing extensive links with stakeholders from a broad section of the community established during 2001 by the research team, the 2003 survey not only maintained the established links but also allowed the development of new links within Samoa. During the 2003 survey a number of representatives from a range of organisations including the Samoan Ministry of Natural Resources & Environment, Samoan Division of Fisheries, Samoan Police Maritime Services, Moana Divers, plus a number of personnel from resorts and from the general community throughout Samoa participated in aspects of the survey.

The 2003 survey, along with meetings in Apia with Government, SPREP, NGO's and commercial tourist operators; media coverage (Appendix 4) and the public presentation held at the National University of Samoa were successful in raising the awareness of cetaceans within the Samoan region.

7.4 Identification of gaps in knowledge concerning cetacean distribution, abundance and movements in the South Pacific.

The South Pacific Island Whale and Dolphin survey undertaken in Samoa during 2003, was able to confirm the presence of two new species for Samoan waters, the Bottlenose dolphin (*Tursiops truncatus*) and the Rough-toothed dolphin (*Steno bredanensis*). The presence of Beaked whales was also confirmed although the exact species identification remains uncertain.

One outcome of the South Pacific Whale Research Consortium meeting held in Byron Bay, April 2004; was to compile a table of the current status of cetacean knowledge in the areas being surveyed across the region. The

Samoan component was able to be updated with these new species sightings and hence reduce the knowledge gaps previously present.

Further surveys are required to continue to improve the understanding of the cetacean biodiversity in Samoan waters. Cetacean sightings in other areas of Samoa and at other times of year need to be further investigated.

Preliminary discussions with David Mattila of the US National Marine and Fisheries Service (NMFS) in relation to collaborations of data collected within the Samoan island group (including both Independent Samoa and American Samoa) have commenced. In conjunction with this possible collaboration, existing collaborations through the SPWRC on the resights of cetacean from the Samoan region will substantially add to the current knowledge of the diversity, distribution and movement patterns of cetacean throughout the South Pacific. This collaborative approach will allow a better assessment of the importance of this region to cetaceans, not only within the Samoan region but the South Pacific as a whole.

7.5 Collation of opportunistic behavioural data on cetacean species observed during the surveys.

Opportunistic behavioural data of cetaceans was recorded during the survey. This information is important in relation to determining the critical habitats (e.g., feeding, resting or nursery areas) for cetaceans in Samoa. It is also important to understand the habitat requirements to allow the assessment of any potential impacts from development and or commercial activities, including fishing activities or commercial whale and dolphin watching.

7.6 A comment on preliminary findings of any changes in cetacean distribution, abundance, timing of migrations etc observed or noted from historical records.

As identified by Paton and Gibbs (2001) and Paton *et al.* (2002) there is very limited information, either historical or recent, available on the diversity, distribution, abundance and timing of migration of cetacean within the Samoan region.

The 2001 survey was able to confirm the presence of four (4) cetacean species within the Samoan EEZ. The 2003 survey was able to add three new records for cetacean species observed in Samoa.

Further surveys are required to determine the distribution, abundance and timing of migration of a range of species observed in the region.

7.7 Collaboration with other cetacean researchers, in particular those from southern hemisphere countries who may benefit from training opportunities and interaction with other researchers.

David Paton is an executive member of the SPWRC and was the founding Director of the SCUWRC. Both Simon Walsh and Carlos Olavarría are affiliated with the SPWRC and have attended a number of Consortium meetings. Complementing these affiliations, and collaborations, the project team collectively has in excess of 30 years experience conducting marine mammal research through out the South Pacific and other regions.

This collective experience and wealth of knowledge in relation to cetacean research techniques, behaviour, identification etc was made available to a range of individuals and organisations within Samoa.

Currently within Samoa, the Ministry of Natural Resources and Environment have developed a proposal to undertake further cetacean training and research within the region. Staff from the Ministry were involved in a range of aspects of the 2003 survey. A strong emphasis was placed on training in research techniques, use of specialised research equipment and marine mammal identification.

With the increased awareness and interest of cetaceans in the region, the declaration of the intended Samoan Whale, Dolphin, Shark and Turtle Sanctuary, and the prospect of the establishment of a unit of the SCUWRC at USP, there is already a strong collaborative relationships developing with both Samoan Government Departments and institutes in relation to cetacean research / conservation.

7.8 Participation in relevant domestic and international forums through presentation of research findings.

Preliminary research findings were made available to the relevant Samoan Government agencies, NGO's, ecotourism operators and members of the community at the public meeting held in Apia at the end of the 2003 survey.

At the Fifth Annual Meeting of the SPWRC at Byron Bay in April 2004 the results of the 2003 Samoan survey were presented and discussed with other cetacean researchers from through out the South Pacific. In addition a summary of the results is incorporated into the SPWRC annual report, which is presented to the IWC Scientific Committee at its annual meeting. It is proposed a more detailed paper will also be presented to the IWC Scientific Committee meeting in 2005 outlining the results of the survey. It is also proposed that a manuscript will be prepared for publication in relation to the survey results.

7.9 Liaison and collaboration on projects with IWC, CMS and other similar international organisations where opportunity arises.

A document detailing the current knowledge of cetacean within the Samoan EEZ and other regions of the South Pacific where SPWRC members were either working or had knowledge of, was prepared at the SPWRC meeting in 2003. This information was collated into a reference document and presented

to participants reviewing the SPREP Regional Marine Mammal Management Plan.

Documentation on the current knowledge of cetaceans within the region was supplied to SPWRC members and Australian Government representatives attending the 2004 Convention of Migratory Species (CMS) meeting in Apia, Samoa.

During the meeting, the Government of Samoa announced its intention to join the CMS, in the process becoming the first Pacific nation to do so.

As previously stated it is proposed a paper will be presented to the IWC Scientific Committee meeting in 2005 outlining the results of the survey. It is also proposed that a manuscript will be prepared for publication in relation to the survey results.

8 Recommendations

- Further surveys are essential to obtain the base line information required to assist the Samoan Government in making effective management decisions for the conservation and management of cetaceans within Samoan waters.

- Continue to support the rapidly developing capacity of local researchers to undertake surveys through provision of additional training and resources. This could allow for year round surveys including on platforms of opportunity;

- Any further cetacean surveys within Samoan waters should be of a collaborative nature, such as the 2001 & 2003 surveys, involving the Samoan organisations which took part in the SPIWDP, to ensure the transfer of information to local organisations and in country capacity building;

- The waters off north-western Savaii be further investigated as a priority (the three new odontocete species were observed in this region and additional species may also be present in this region). Asau harbour is recommended as a suitable all weather anchorage in close proximity to this region.

- Due to the average prevailing weather conditions it is recommended that larger vessels be utilised as research platforms. This enables more ground to be covered quickly under a greater range of inclement sea conditions. The *Nafanua* Police Patrol boat was a good example of this;

- Use of smaller *alia* type vessels are not recommended as research platforms as they can be hazardous to the research team members due to a lack of handholds and associated safety features. *Alia*

skippers are hampered by a lack of visibility from the low seating arrangement and are unfamiliar with working closely around marine mammals. In addition while local navigational knowledge and awareness of local conditions are invaluable, the difficulties in securing rapid and effective communications between boat operators and researchers can also be an issue;

- Timing of future research surveys could be important in coinciding with peak numbers of species such as Humpbacks. Anecdotal evidence suggested that mid August / early September may be worthy of further study;

- Aerial surveys, although not undertaken during 2003, are identified as an effective tool for covering large areas in a relatively short period of time. Dedicated aerial reconnaissance could assist in identifying further key areas for vessel based surveys;

- The use of advanced acoustic techniques such as autonomous acoustic detection devices that can be deployed and retrieved after days, week or months, or radio-linked hydrophones buoys anchored off section of the coast that can be monitored form the shore continuously and in real time should be further investigated;

- Poor weather conditions can reduce research time significantly. Extending the time available in-country could assist in providing insurance to cover such reduced research opportunities.

- Any further surveys should include the collection of genetic samples to assist in the determination of population structures, distribution and movement patterns.

- Facilitate and support further research into the issue highlighted by the Fisheries Division of cetacean / longline interactions.

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11 Appendices

11.1 Appendix 1 – Olavarría et al. *(2003)*

GENETIC ANALYSIS OF CETACEAN SKIN SAMPLES COLLECTED IN SAMOA

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Summary

Surveys have been conducted around the islands of Samoa in recent years to establish the current cetacean diversity. To date seven species have been recorded: sperm whale (*Physeter macrocephalus*), humpback whale (*Megaptera novaeangliae*), false killer whale (*Pseudorca crassidens*), spinner dolphin (*Stenella longirostris*), short-finned pilot whale (*Globicephala macrorhynchus*), bottlenose dolphin (*Tursiops truncatus*) and rough-toothed dolphin (*Steno bredanensis*).

In 2001 and 2003 skin samples were collected from five cetacean species during surveys around the two main islands of Samoa (Savai'i and Upolu): humpback whales (2), spinner dolphins (3), short-finned pilot whales (3), rough-toothed dolphins (4) and a bottlenose dolphin (1). The sex of all samples collected was identified through molecular methods. Sequencing of the mitochondrial DNA control region and a comparison to reference sequences confirmed the field species identification.

A comparison between Samoan and other South Pacific populations suggested a similar pattern of genetic isolation in the three dolphin species (spinner, bottlenose and rough-toothed dolphins). The single humpback whale sequence matched with those of other South Pacific wintering grounds, suggesting a certain degree of genetic interchange, but could also be explained by a historical high genetic diversity observed in the South Hemisphere. The short-finned pilot whale sequence matched with those from New Zealand and French Polynesia suggests a large pelagic range or a low mitochondrial DNA diversity. However, the small sample size to date do not allow further conclusions.

In the future we recommend continuation of the genetic sampling, concentrating the effort on the area off Asau, Savai'i island, as this area is suitable both logistically and in terms of cetacean presence.

Introduction

Cetacean diversity and abundance around Samoa is poorly described. Although it is known from historical records that some species were abundant, particularly sperm whale (*Physeter macrocephalus*), there is little information about other species present around Samoan islands (Paton et al., 2002).

In 2001 a one-month survey around Samoa recorded four species of cetaceans: sperm whale, humpback whale (*Megaptera novaeangliae*), false killer whale (*Pseudorca crassidens*) and spinner dolphin (*Stenella longirostris*). Additionally, a stranding was reported in the island of Savai'i in 2000 involving what was most likely a short-finned pilot whale (*Globicephala macrorhynchus*) (Paton et al., 2002). With the aim of extending the knowledge of cetacean diversity in Samoan waters, a two-week field survey was undertaken during September 2003. Five species were recorded: humpback whale, short-finned whale, spinner dolphin, rough-toothed dolphin (*Steno bredanensis*) and bottlenose dolphin (*Tursiops truncatus*) (Walsh and Paton, 2003).

In this report we present the results of the genetic analysis of the cetacean skin samples collected during the 2001 and 2003 surveys. We also suggest collaborative research that may be undertaken in the near future.

Materials and Methods

Collection of skin samples

Two methods were used for the collection of samples for genetic analysis: *sloughed skin* sampling during the 2001 survey and *biopsy* sampling during the 2003 survey.

Sloughed skin is collected as it occurs naturally in the wake of whales. Sampling involved the collection of skin from the surface of the water using a sieve (Amos et al., 1992). Using sterilised forceps the pieces of skin were removed and deposited in a labelled tube filled with 70% ethanol.

Biopsy sampling involved the use of a PAXARM biopsy system (Krützen et al., 2002) which uses a modified veterinary capture rifle powered by a .22 blank as propellant. The pressure in the barrel can be varied, according to the size of animal and the distance that the dart is to travel. A dart is fired, bounces off the animal's body with a small piece of skin attached. The dart floats and can be retrieved by hand from

the surface of the sea. The biopsy samples were removed from the dart with sterilised forceps and stored in a labelled tube filled with 70% ethanol.

Genetic analysis

DNA was extracted from a small portion of the skin sample using a standard phenol/chloroform protocol (Davis et al. (1986) as modified by Baker et al. (1993)).

The sex of all sampled animals was identified by amplification of sex specific markers following Gilson et al. (1998). This protocol amplifies a fragment of 224 base pairs (bp) long from the *Sry* gene located on the Y chromosome via the Polymerase Chain Reaction (PCR, Saiki et al., 1988). As an internal positive control against amplification failure, the homologous ZFY/ZFX region of 445 bp is amplified to show that the lack of the amplified segment is not due to an amplification failure. Thus, in males two bands of 224 and 445 bp are observed and in females just one of 445 bp.

The mitochondrial DNA (mtDNA) is a circular, non-recombining genome that is maternally inherited (Wilson et al., 1985). Because of its small effective population size and its rapid rate of evolution compared to nuclear DNA (Brown et al., 1986) this molecular marker has been widely used in phylogenetic and population genetic analysis. Within the mtDNA, the control region or D-loop is the most rapidly evolving in most vertebrates and as such is the most commonly used segment for population analysis (Moritz et al., 1987).

Symmetrical amplification of the mtDNA control region, proximal to the tPro RNA gene, was performed via PCR. An 800 bp portion of the mtDNA control region was amplified using the primers, light-strand tPro-whale Dlp-1.5 (Dalebout et al., 1998) and heavy strand Dlp-8G (Pichler et al., 2001). Amplification and subsequent cycle sequencing were improved by the addition of an M13 sequence to the 5' end of the tPro-whale Dlp-1.5. Amplicons were electrophoresed on a 1.6% agarose gel, stained with ethidium bromide and visualized under UV light.

PCR products were then sequenced with BigDye™ terminator chemistry (ABI vs 3.1) on an ABI3100 DNA sequencer (Applied Biosystem). Sequences were aligned and edited using the program Sequencher TM (version 4.1.2, Genes Codes Co.).

Species confirmation of the field identification of each animal sampled was performed before further analysis. Each sequence was compared to the DNA

Surveillance data set, developed for molecular taxonomy of cetaceans (www.dna-surveillance.auckland.ac.nz, Baker et al., 2003; Ross et al., 2003).

Population comparison of sequences were performed in MacClade vs. 4.0 (Maddison and Maddison, 2000). Sequences from Samoan species were downloaded together with sequences obtained from a centralized genetic data base, GenBank (www.ncbi.nlm.nih.gov), and from samples collected in other regions of the South Pacific as part of doctoral research by C. Olavarría, M. Oremus and G. de Tezanos Pinto (Population Genetics and Evolution group in the University of Auckland, under the supervision of Ass. Prof. C. S. Baker). This comparison allowed the identification of unique sequences or haplotypes and the polymorphic sites that defined them.

Results and Discussion

Thirteen skin samples were collected from five cetacean species in Samoan waters during the 2001 and 2003 surveys: humpback whale (n=2), short-finned pilot whale (n=3), spinner dolphin (n=3), rough-toothed dolphin (n=4) and bottlenose dolphin (n=1). Most of the samples were collected off the northwest of Savai'i island using the biopsy sampling protocol. The two humpback whale samples were collected off the south western part of Upolu. The field data related to those samples is summarized in Table 1 with locations shown in Figure 1.

The sex was identified in all the samples collected, as detailed in Table 1 and shown in Figure 2. The amplification and sequencing of the mtDNA control region was successful for all the thirteen samples.

The comparison of the sequences with the web-based program DNA Surveillance confirmed the field identification of all the individuals sampled (Figure 3). An example of the output of this program is shown for the rough-toothed dolphin (Figure 4). This analysis is based on phylogenetic methods using a validated set of reference sequences, displaying the affinity of the user sequence with the reference sequences as a phylogenetic tree (Ross et al., 2003).

Comparison of both the D-loop sequences and the sex of the two humpback whale samples confirmed that these corresponded to a single individual whale, as was noted in the field. This sequence was compared to an extensive data base of South Pacific humpback whales sequences (n= 1069 sequences, Olavarría et al. (2003)) revealing

that this haplotype is relatively common in Tonga and New Caledonia, but also is found in Cook islands and Western Australia.

Comparison of the three Samoan short-finned pilot whale samples revealed that all three samples shared the same haplotype. A comparison of these with sequences from eight samples from French Polynesia, six from New Zealand (M. Oremus unpublished data), one each from Japan, Portugal, California, North Atlantic and the Eastern Tropical Pacific (from Genbank), showed that the Samoan haplotype was shared with French Polynesia (n = 6) and New Zealand (n = 2).

The four Samoan rough-toothed dolphin sequences shared a single haplotype. This Samoan haplotype differed from six other samples collected in French Polynesia (M. Oremus unpublished data).

The three spinner dolphin samples each had a different mtDNA haplotype. A comparison with 64 samples from French Polynesia, one from Tonga and one from the Cook Islands (M. Oremus unpublished data) showed the three Samoan haplotypes were not shared with any of the two regions.

The Samoan bottlenose dolphin sequence differed with 23 samples from Kiribati (courtesy of A. Hutt and G. Stone), 20 from Marlborough Sound (New Zealand South Island), 19 from the Bay of Island (New Zealand North Island) (G. de Tezanos Pinto unpublished data), 15 from the North Atlantic, 12 from China and seven from South East Australia (Genbank).

Table 1. Field data of cetaceans skin samples collected in Samoa. SS: slough skin sampling. B: biopsy sampling.

Species	Sample Code	Location	Date	Type	Sex*	Comments	Collector
Humpback whale	Mno01Sa01	14°02'S; 171°51'W	21/10/2001	SS	Male	Same individual as Mno01Sa02. Singer (assumed male)	N Gibbs & D. Paton
Humpback whale	Mno01Sa02	14°02'S; 171°51'W	21/10/2001	SS	Male	Same individual as Mno01Sa01. Singer (assumed male)	N Gibbs & D. Paton
Spinner dolphin	Slo03Sa01	13°30'S; 172°48'W	23/09/2003	B	Male	This sample and Slo03Sa02 from same pod	C. Olavarría
Spinner dolphin	Slo03Sa02	13°30'S; 172°48'W	23/09/2003	B	Female	This sample and Slo03Sa01 from same pod	C. Olavarría
Spinner dolphin	Slo03Sa03	13°30'S; 172°48'W	24/09/2003	B	Female		C. Olavarría
Rough-toothed dolphin	Sbr03Sa01	13°24'S; 172°40'W	24/09/2003	B	Female		C. Olavarría
Rough-toothed dolphin	Sbr03Sa02	13°25'S; 172°39'W	25/09/2003	B	Male	This sample and Sbr03Sa03 are from same pod	C. Olavarría
Rough-toothed dolphin	Sbr03Sa03	13°25'S; 172°39'W	25/09/2003	B	Male	This sample and Sbr03Sa02 are from same pod	C. Olavarría
Rough-toothed dolphin	Sbr03Sa04	13°25'S; 172°39'W	25/09/2003	B	Male	From different pod than Sbr03Sa02 and Sbr03Sa03	C. Olavarría
Bottlenose dolphin	Ttr03Sa01	13°25'S; 172°36'W	24/09/2003	B	Male		C. Olavarría
Short-finned pilot whale	Gma03Sa01	13°29'S; 172°45'W	24/09/2003	B	Male	This sample and Gma03Sa02/03 are from same pod	C. Olavarría
Short-finned pilot whale	Gma03Sa02	13°29'S; 172°45'W	24/09/2003	B	Female	This sample and Gma03Sa01/03 are from same pod	C. Olavarría
Short-finned pilot whale	Gma03Sa03	13°29'S; 172°45'W	24/09/2003	B	Male	This sample and Gma03Sa01/02 are from same pod	C. Olavarría

* molecular sex identification

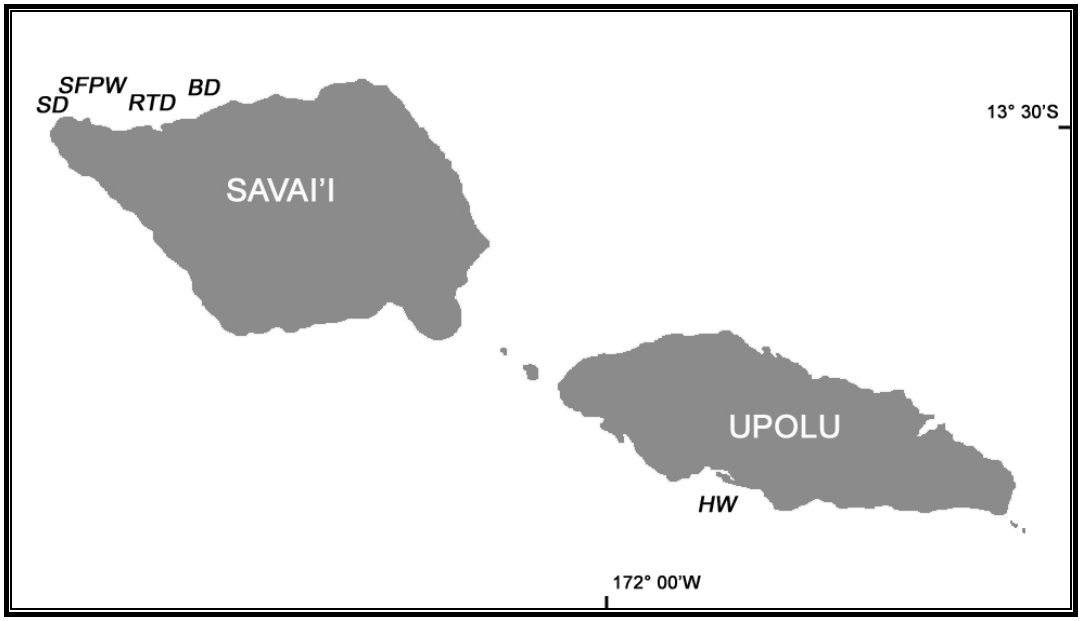

Figure 1. Map showing the approximate location of sampled species. SD: spinner dolphin, SFPW: short-finned pilot whale, RTD: rough-toothed dolphin, BD: bottlenose dolphin and HW: humpback whale. See Table 1 for exact GPS locations

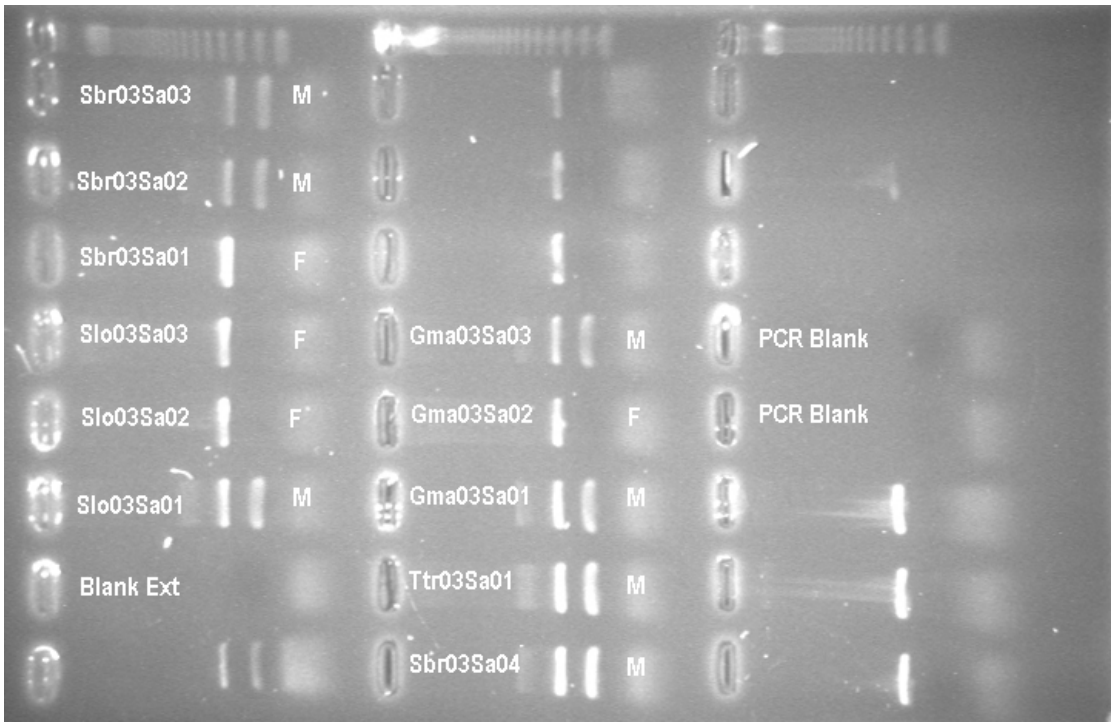

Figure 2. Sex identification of cetacean skin samples collected in Samoa during the 2003 survey. M: male, F: female.

A

B

C

D

Figure 3. Species of cetacean visually identified in the field as (A) bottlenose dolphin, (B) rough-toothed dolphin, (C) spinner dolphin and (D) short finned pilot whale. Individuals showed in (A) and (D) were sampled (Tr03Sa01 and Gma03Sa01). Photos: Simon Walsh

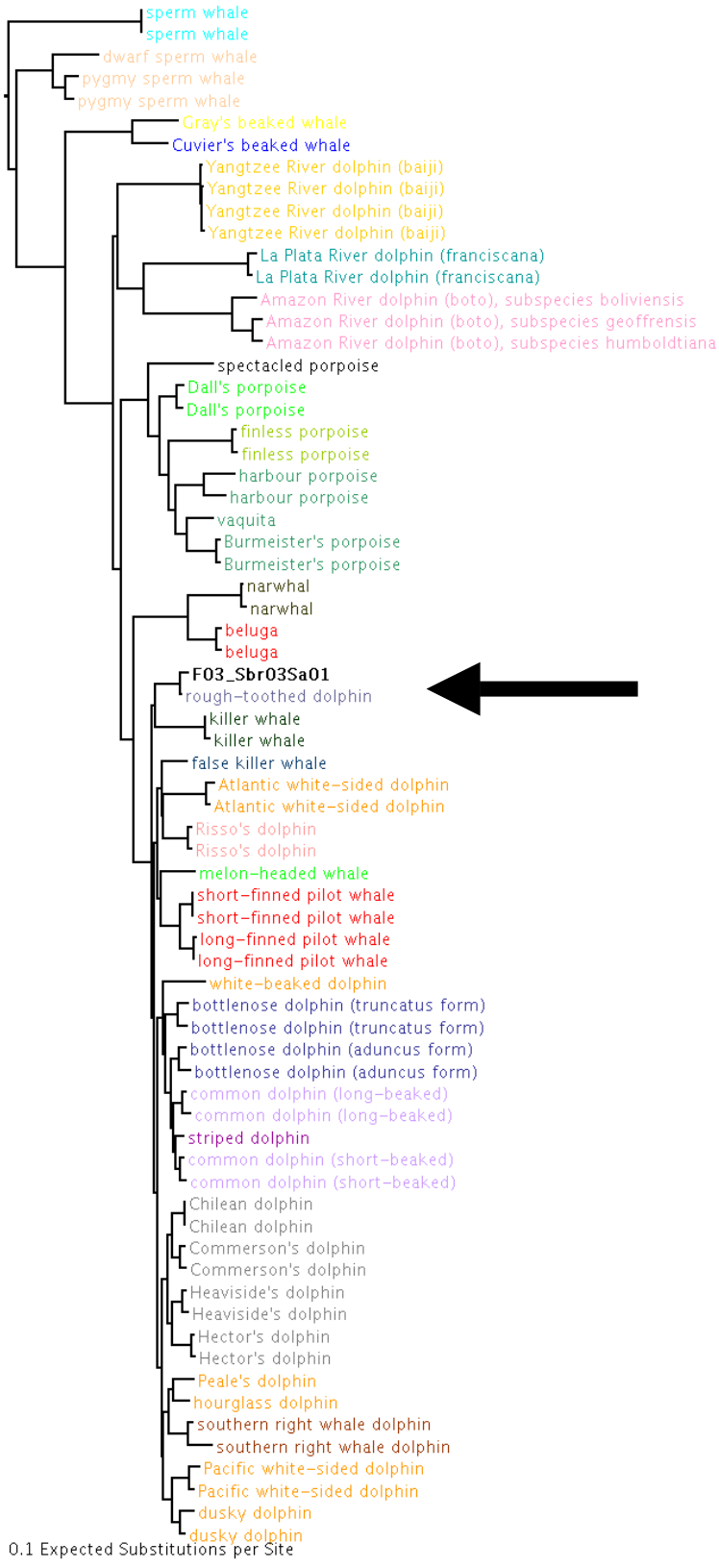

Figure 4. Phylogenetic identification of rough-toothed dolphin *Steno bredanensis* Sbr03Sa01 sampled in Samoa.

Conclusions

The small sample size of Samoan cetacean species collected to date is insufficient for further conclusions on the genetic structure of these species in the region, however it is possible to suggest interesting preliminary patterns.

The shared haplotype of Samoan humpback whale with other populations suggests a high degree of genetic interchange between the mentioned areas. Alternatively, this could be explained by the historical high genetic diversity observed in this species across the South Pacific (Baker et al., 1998).

The similar pattern of shared haplotypes with distant regions in the South Pacific (New Zealand and French Polynesia) observed in the short-finned pilot whales suggests a degree of genetic flow occurring between the South Pacific populations by a large pelagic range in this species. Alternatively, this species may have a very low diversity across its range.

The genetic distinctiveness of the three Samoan dolphin species (spinner, rough-toothed and bottlenose dolphins) may be reflecting a common degree of genetic isolation. To our knowledge there has not been a study addressing this issue in the Pacific islands.

Future collection of samples from the Samoan region as well as from other areas in the South Pacific are needed to explore these questions.

Future genetic research

This preliminary analysis on the genetic diversity of Samoan cetacean species indicates that it is important to continue this work to understand the potential uniqueness of some Samoan cetacean species. In a broader scale, the comparison with other Pacific populations will help to understand the degree of genetic isolation, gene flow and population structure that may be occurring in these cetacean species.

It is strongly recommended that any further research on cetaceans within Samoan waters incorporates the collection of genetic material as a core part of the survey design.

Based on the 2003 survey experience, we suggest that future genetic sampling be focused on dolphin species in the area off Asau, where better sampling conditions and the majority of the encounters occurred.

It is strongly recommended that field work be continued in 2004 with emphasis on biopsy sampling. Additionally, photo-identification sampling should be undertaken to establish interchange and re-sights at a local level. Photo-identification and biopsy collection should have high priority, as the data obtained from them could be comparable to current PhD researches (M. Oremus and G. de Tezanos Pinto) which involve some of the same species from French Polynesia and New Zealand.

This information would contribute to build the basic cetacean biodiversity knowledge in Samoa, that is currently undertaken by the Ministry of Natural Resources and Environment of Samoa. This basic information will help to management issues, such as the assessment of cetacean interactions with long-lines in the area (Donoghue et al., 2003).

Acknowledgements

For collection of samples in the 2001 survey we thank Simon Childerhouse, Nadine Gibbs, Michael Noad and Simon Walsh. For field assistance in the 2003 survey we thank Simon Walsh, Juney Ward and Solomona Tufuga. For assistance in the coordination of 2003 survey thanks to Lui Bell, Juney Ward and Malake Iakopo. The collection of samples was funded by the Department of the Environment and Heritage of the Australian Government, with partial support of the International Fund for Animal Welfare and with permits from the Ministry of the Prime Minister and Cabinet, Ministry of Natural Resources and Environment, the Police and Prisons Department of the Samoan Government and the Department of Environment and Heritage of Australia.

Field work in other locations in the South Pacific, from which samples have been used for comparison in this report have been collected thanks to many collaborators, especially from the South Pacific Whale Research Consortium. We thanks Greg Stone and Alistar Hutt for providing access to bottlenose samples from Kiribati Islands. Financial support has been obtained from the James Watson Conservation Trust, Whale and Dolphin Adoption Project and the International Fund for Animal Welfare.

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MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT

WHALE AND DOLPHIN SIGHTING REPORT

Observer's Name: _____ **Vessel:** _____ **Contact:** _____ **Date:** _____ **Time:** _____

Species Observation [refer to *Identification Sheet* for key]:

Species:_____ Very sure/Sure/Not Sure

Total #:_____; # of Adult_____; # of Calves:_____

Animal Length:_____

Direction of travel when 1st sighted:_____

Did direction of travel change?:_____

Photos taken: Y/N

Interaction with vessel: Y/N

Location: Village where sighted: _____

Latitude: _____ **Longitude**: _____

Behaviour State: **Behaviour Events:**
[refer to *Identification Sheet* for Behaviour Definition]

Travelling	☐	Leaping	☐	Spy hop	☐
Milling	☐	Tail slapping	☐	Vocalizing	☐
Feeding	☐	Chasing	☐	Fin Slapping	☐
Socializing	☐	Belly to belly	☐	Frequent change	☐
Resting	☐	Bow Riding	☐	travel direction	

Weather Conditions: Scale (Please Circle):

0 ----------1 ----------2----------3---------- 4 --------- 5

flat	moderate	very
calm	white caps	rough

Cloud Cover: (Please Circle)

Clear/Patchy cloud/Overcast/Rain

Wind direction:_____ Wind speed:_____Water current direction:_____

Other Comments [for whales & dolphins]:

Other Marine Species of Interest [please Refer to back of Whale/Dolphin Identification Sheet for examples]

Other species [e.g. turtle, whale shark]: _____ Comments:

Number observed: _____ Any juveniles observed [#]: _____ Comments:

Please return completed sheet to: **Marine Conservation Section, Division of Environment and Conservation, Ministry of Natural Resources and Environment**
P.O. Private Bag, Apia. Old New Zealand High Commission Building, Tamaligi
Fax: 25856, Phone: 30965 or 26957 and 23092 Ext 26

11.3 Seminar invitation letter

Ministry of Natural Resources & Environment
P.O. Box Private Bag, Apia, Samoa
Savalalo: (685)22481-22485, Tamaligi: (685)23092/23800/26957 Vaiala: (685)25869/30100/31198
Malo o Samoa *Fax: (685) 23176 / 25856* *Address all correspondents to CEO*

23 September 2003

Chief Executive Officer
Ministry of Education

Marine Mammals Research Project in Samoa: Public Seminar

A 2-week assessment survey of Marine Mammals [including whales and dolphins] is currently being undertaken in Samoan waters. This survey is led by the Southern Cross University, in collaboration with other overseas agencies and the Samoa Ministry of Natural Resources and Environment and the Fisheries Division of the Ministry of Agriculture. The survey will be completed at the end of this week and will conclude with a public seminar to present objectives and preliminary results of the survey. The purpose of this letter then is to invite a participant from your Ministry to the seminar, which will be held on Friday, 26 September 2003 at the NUS Conference Room from 09:00 am to 12 noon. The seminar will cover the following topics:

- Historical exploitation of whales in the South Pacific and Conservation Research including the South Pacific Whale Research Consortium [SPWRC]: *Mr. Michael Donoghue, Department of Conservation, NZ*
- Project Aims and objectives– preliminary results: *Mr. Simon Walsh, Southern Cross University;*
- Genetics overview – SPWRC and other programs undertaken by consortium in South Pacific: *Mr. Carlos Olavarria, University of Auckland*
- History of whales in Samoa: *Samoa Fisheries Division*
- Marine mammals programme in Samoa including sighting records and database: *Samoa Division of Environment & Conservation*

Please confirm participation of your Ministry by Thursday, 25 September, to the Division of Environment and Conservation [phone: 30965] so that proper arrangement can be made. Should you also require any additional information, please use this same contact.

Looking forward to your participation.

Faafetai tele lava

Taulealeausumai Laavasa Malua
Acting Chief Executive Officer

11.4 Appendix 4 – Samoa Observer article

NEW SPECIES OF WHALE, DOLPHINS FOUND IN SAMOA

By Malia Sio

APIA, Samoa (Samoa Observer, Sept. 28) - Two species of dolphin and what is believed to be a beaked whale have been officially sighted for the first time in Samoan waters.

Sightings of Rough Tooth dolphins and Bottlenose dolphins have been recorded by a team of marine biologists who are conducting a survey of marine mammal species in Samoa.

Rough Tooth dolphins are distinguished from other dolphin species by their head, snout and color pattern. They feed on small fish, squid and pelagic octopus.

The Bottlenose dolphin has a long spout like a beak, which protrudes from twelve to twenty four inches. This dolphin is fast in speed and has a long diving range compared to other dolphins. They normally feed on Cuttlefish, Mollusks and small fry.

Though many have reported sighting these two mammal types in recent years, this is the first time an official sighting has been made.

The other new sighting is an unidentified whale believed to be a Beaked whale, which is very uncommon here.

Beaked whales are the least known family of whales, which inhibit oceanic waters of greater than 200 hundred meters in depth and are thought to be the deepest and longest diving of all marine mammals. They feed primarily on deep-water squid and fish and as such are an integral part of the deep-water ecosystem.

The marine mammal team of Simon Walsh, of Southern Cross University; Carlos Olavarria, of Auckland University; and Juney Ward, of the Ministry of Natural Resources and Environment; held a public seminar on their findings. This was held at the National University of Samoa conference room.

They located the new types of mammal while undergoing a two-week assessment survey of marine mammals in Samoan waters.

The Southern Cross University in collaboration with other overseas agencies and the Samoa Ministry of Natural Resources and Environment along with the Fisheries Division of the Ministry of Agriculture led the survey.

The funds came from the South Pacific Regional Environment Program, Australian Environment Ministry, and Ministry of Natural Resources and Environment.

Pouvave Fainuulelei, of the Fisheries Division, said:" The information is important on the status of dolphins and whales in Samoa, especially because of the current problem of Cetacean Long line Interaction."

He added that their office will now have information on the type and number of whales, to establish solutions on this problem of larger fish (whales) feeding on smaller fish (catch).

He also said that at the moment the marine mammals are protected in Samoa and are not facing any major threats.

The main areas of Samoa in which the whale and dolphin sighting occurred were along the coastal Falealupo Peninsula area of Savai'i, Asau, and the areas between the two main islands.

The most common marine mammals found within these areas are the Humpback whales, Short Fin pilot whales, Beaked whales (new), Spinner dolphins, and Rough Tooth dolphins (new).

Another species believed to be found in local waters is the Sperm whale. However, the last sighting of this kind in Samoa was in 2001.

To help assist future research the Ministry of Natural Resources and Environment is set to give out sheets of different types of marine mammals.

Ms Ward said that would be called a sighting report sheet given to pilots and fishermen.

"They will take these sheets out on their voyages and mark any sighting of any of the different mammals, the date, time and other information which will be useful for us" she said.

Other initiatives will also be set up based on the outcomes of this research, especially beneficial for education and research purposes.

One is to set up a display board in the Public Library showing different types of marine mammals and information will also be provided.

Another initiative is to soon have Samoan names for all the marine mammals and a task force is to be set up for stranded marine mammals.

Participants in the public seminar also added some future initiatives for the ministry in the area of setting up a marine Aquatic Center in the future.

"There really is a need for this because Samoan children do not even know the different types of mammals found in the sea or much about sea life," one participant said.

September 30, 2003

Samoa Observer: www.samoaobserver.ws/

SOURCE: Pacific Islands Report