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Expedition Austral Islands: Photo-identification, song recording, and biopsy sampling of humpback whales (Megaptera novaeangliae) in southern French Polynesia

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ABSTRACT

The Austral Islands in southern French Polynesia are known to harbor humpback whales during the southern hemisphere winter, but the genetic structure, song similarities, and migratory connections of these whales to the better known Society Islands farther north have been only cursorily addressed. To acquire data germane to these issues, on 22 days from 24 August to 21 September 2013 we conducted boat-based photo-ID, song recording, and biopsy sampling surveys at four of the Austral Islands: Raivavae, Tubuai, Rurutu, and Rimatara. Our biopsy sampling was the first ever accomplished at any of these islands; our photo-ID sampling was the first at Raivavae and Rimatara; and our acoustic recordings were the first at Rimatara. In total, 55 groups of humpback whales were encountered, photographed, acoustically recorded, and/or biopsy sampled. No other cetaceans of any species were observed anywhere during our surveys. Photo-ID fluke images yielded 22 different individuals, and a singing male at Rurutu was discovered to be a previously known individual (Mo9946) from 1999, 2005, and 2010 at Mo'orea in the Society Islands. 28 biopsies and 6 sloughed skin samples were obtained from 34 different individuals, and a total of 14 hours of song was obtained for later analyses. There were no differences in habitat use or behavior between the Austral and Society Islands. This fieldwork was the third and final stage of our larger surveying effort that previously included two other archipelagos, the Tuamotu and Gambier Islands in eastern French Polynesia (2010), and the Marquesas Islands (2012) in northern French Polynesia.

KEYWORDS: HUMPBACK WHALES; AUSTRAL ISLANDS; FRENCH POLYNESIA; PHOTO-ID; SONG; BIOPSIES

INTRODUCTION

French Polynesia's Fii stock of breeding humpback whales is the most recently discovered of all humpback populations, first described by Poole (1993) and Poole and Darling (1999). French Polynesia's southernmost archipelago is the Austral Islands (Figure 1), and based on reports submitted to his sighting/stranding network from 1988-1993, Poole (1993) mentioned three Austral islands at which humpbacks had been observed: Raivavae, Tubuai, and Rurutu. With these and other data he suggested that French Polynesia's Society, Austral, and Tuamotu/Gambier Islands comprised a previously unknown humpback whale breeding ground. Poole and Darling (1999) added Rimatara as a fourth Austral Island to harbor humpbacks. Based on dedicated and opportunistic acoustic and visual surveys, Gannier (2004) observed humpback whale at these same four islands. Poole (2002, 2006) summarized the presence of humpbacks throughout all of French Polynesia.

Our photo-identification studies have identified over 500 individual whales in French Polynesia's Society Islands (primarily at Mo'orea) and at Rurutu in the Austral Islands (Poole 2002, 2006) as well as in the Tuamotu and Gambier Islands (Poole et al., 2013a). Low-level (~ 4%) inter-annual movements have been found between Mo'orea/Rurutu and other South Pacific winter grounds, including the Cook Islands, American Samoa, Tonga, and New Caledonia (Poole 2006; Garrigue et al. 2011). DNA studies primarily at Mo'orea and Rurutu have

shown these whales to be genetically differentiated from other areas of the South Pacific (Olavarria et al. 2007). Based on photo-ID sampling from the years 2003-2007 and using CAPTURE in Program Mark, a closed population estimate for this Fii stock of N=853 (CV 0.24) was produced by Albertson-Gibb et al. (2009). Based on photo-ID and DNA analyses, Constantine et al. (2012) produced additional Fii population estimates of N=440 (CV=0.23) and N=934 (male-based x 2), respectively. The small size of this stock, along with similarly low numbers for New Caledonia's and Tonga's whales, resulted in the IUCN's decision to reclassify South Pacific (Oceania) whales as endangered (Childerhouse et al. 2008).

French Polynesia's Austral Islands are the southernmost extension of the same geological archipelago that, in its northern range, contains the southern Cook Islands. One could expect that northward migrating whales might pass from Antarctica to the Austral Islands, and then from the Australs to the Cooks by following the line of sea mounts and islands from southeast to northwest. Likewise, at the end of the winter season they might pass from the southern Cooks to French Polynesia's Austral Islands. However, more than 10 years of fluke photo-ID comparisons between Mo'orea/Rurutu (n ~ 400) and the southern Cook Islands (n ~ 150 IDs) have produced only one match (between Moorea and Palmerston Atoll) and DNA studies show that French Polynesia's and the Cook Islands whales are not part of the same genetic stock (Garrigue et al, 2002, 2011; Olavarria et al, 2007).

For this present study, our primary objective was to conduct an inventory of all cetaceans, but with particular effort towards humpback whales. We intended to photographically identify each individual; obtain biopsy samples from as many individuals as possible; and to record humpback whale song. Comparisons could then be made to the datasets from Moorea in the Society Islands, as well as to those from the Cook Islands and other areas.

METHODS and RESULTS

On 22 days from 24 August to 21 September 2013 we conducted boat-based photo-ID, song recording, and biopsy sampling surveys at four of the Austral Islands: Raivavae, Tubuai, Rurutu, and Rimatara. (Table 1, Figure 1). Logistical constraints (lack of an airport and only twice monthly sea freighters) precluded our working at Rapa in the far southeast Austral Islands. Our surveys were primarily coastal around the islands, but when possible we also conducted a few pelagic surveys. We also conducted oral interviews with local inhabitants.

We conducted dedicated boat surveys onboard locally based 5-8m motorboats with their captains. Effort was biased for one or two sides of each island because of meteorological and ocean swell conditions. Every 30-45 minutes or whenever conditions changed we noted the meteorological and sighting conditions. Stopping the boat to submerge a hydrophone and record for a minimum of 5 minutes on a MicroTrack 24/96 digital recorder, if humpback song of fair to good quality was detected, we recorded the song for a minimum of 20-30 minutes, and then rejoined our survey track line. When we visually detected animals, we noted their position with a GPS, as well as the number of individuals, the presence of calves, and their behavior. Dorsal fins and flukes were targeted for photo-identification with digital still cameras. Biopsy sampling was conducted with a modified 22-caliber veterinary rifle equipped with a variable pressure valve that fired a small dart (Krützen *et al.* 2002). Obtained skin samples were stored in 70% ethanol for later laboratory analyses.

Raivavae 26, 27, 28, 29 August (Table 1; Figure 2a)
Situated 730 km south-southeast of Mo'orea, local residents at Raivavae informed us of their observations of humpback whales each winter. We conducted two days of shore-based surveys from an east facing mountain peak that permitted a 180-degree view from south to north. During four days of boat surveys in an 8m motorboat, we circumnavigated the island three times, but additional effort was concentrated on Raivavae's north shore and east coast. We encountered the same single whale on two of our four days on the water, although additional whales were observed during shore surveys. From this whale we obtained one biopsy and one fluke ID. We recorded 74 minutes of good quality song on the NW corner of the island. Unexpectedly, the song at Raivavae comprised one single theme.

Tubuai 31 August, 01, 02, 03, 04, 05, 06 September (Table 1; Figure 2b)
Situated 630 kilometers south of Mo'orea, at Tubuai local inhabitants stated that humpback whales are present every winter just outside the barrier reef, and more rarely inside the lagoon. During seven days of boat surveys in a 5m motorboat, we circumnavigated the island once, but most of our effort was concentrated on the island's north shore and east coast, with one afternoon in pelagic waters off the east coast. We had 20 encounters with humpbacks resulting in 9 fluke IDs, 12 biopsies and 4 sloughed skin samples, and 4.5 hours of good quality song. The song was bi-thematic, and neither theme was similar to that which we had recorded at Raivavae.

Rurutu 09, 10, 11, 13, 14, 15 September (Table 1; Figure 2c)
Situated 560 kilometers south-southwest of Mo'orea, during six days in a 7m motorboat at Rurutu we circumnavigated the island once, while most of our effort was concentrated on the island's west coast. During 22 encounters with humpback whales we obtained 10 biopsies and 2 sloughed skin samples, 1.5 hours of quality song, and 7 fluke IDs. On 09 September we resighted a whale that was at Tubuai on 04 September. On 11 September the mono-thematic song from Raivavae arrived and was incorporated into the other themes already present at Rurutu. One male singer was discovered to be a previously known individual (Mo9946) from 1999, 2005, and 2010 at Mo'orea. In a surface active/competitive group that included a female/calf pair, the larger of the two escorts was very aggressive to the calf. He pushed, submerged, lifted, and hit the calf, in spite of the female's efforts to place herself between her calf and the escort. The next day the same escort continued his aggression against the same calf, including hurling it out of the water. On the third day, however, subsequent observations of the female and calf (with no escorts) revealed no visible injuries to the calf.

Rimatara *16, 17, 18, 19, 21 September (Table 1; Figure 2d)*
Located 540km southwest of Mo'orea, local inhabitants at Rimatara stated that humpback whales are present every winter. During five days in a 7m motorboat we circumnavigated the island five times, with additional effort on the north shore and west coast. We had 11 encounters with humpback whales, and obtained 5 biopsies and 3 fluke IDs. We heard no song whatsoever at any time anywhere around the island. Interestingly, the six whales we observed the first day were the only whales at Rimatara while we were there, and they progressively left the island until no whales were present during our last day on the water.

DISCUSSION

We observed, biopsied and/or acoustically recorded humpback whales at all four islands. All age and sex classes were observed, but the numbers of whales encountered were lower than at Mo'orea in the Society Islands (unpublished data). Habitat use was similar to that seen at Mo'orea. Specifically, whales were observed very close to shore, just tens to hundreds of meters off reefs or shorelines. Other than one pod travelling due east 15km offshore of the east coast of Tubuai, we saw no offshore humpbacks. Surprisingly, we found no other cetacean species anywhere. During aerial surveys conducted in 2011 around Raivavae, Tubuai, and Rurutu, several species of cetaceans, including sperm whales, beaked whales, and blackfish (Globicephala/Pseudorca) were observed; no humpbacks were found because those surveys were not conducted during the winter/spring season (Laran et al. 2012). While most of our surveys were conducted just hundreds of meters from the islands' reefs and shorelines because whales were present there, we also conducted surveys out to 2-5 kilometers offshore at all the islands, and at Tubuai we followed one pod of humpbacks out to 15 km. But we saw no other cetaceans anywhere. It is possible that, due to the majority of our boat surveys being coastal, and due to the winter weather conditions (Beaufort Force 4 – 5; rain; 4m – 6m swells), we missed cetaceans such as beaked whales, which can be rather discrete. However, we are confident that had pilot whales or sperm whales been present, we would have seen them.

Gannier (2004) conducted acoustic surveys at Raivavae, Tubuai, and Rurutu, but our acoustic surveys at Rimatara were the first at that island. Our biopsy sampling was the first at all four of the islands, although in past years sloughed skin had been collected from whales at Rurutu. Our photo-ID work was the first ever at Raivavae, Tubuai, and Rimatara. Using photo-ID data, we previously confirmed low-level movements of whales between archipelagoes within French Polynesia, as well as to other countries' archipelagoes to the west (Poole 2002, 2006, 2013a). From 1998-2007, 51 whales were photographically identified at Rurutu, of which three (Ru0001, Ru0102, Ru0309) were resighted in later years at Mo'orea; three whales from Moorea (Mo9405, Mo 9717, Mo0222) were later resighted at Rurutu. (Poole, unpublished data). In this present study around the four Austral Islands we took 3500 ID photos from which we photographically identified 20 different humpback whales' flukes. One whale we observed at Rurutu was previously known at Mo'orea (Mo9946), becoming the seventh whale observed at both Mo'orea and Rurutu. Of 80 whales identified at Rurutu over the years, seven individuals (9%) have also been observed at Mo'orea. In the Tuamotu/Gambier Islands in 2010 we identified seven whales; one at Raraka was first identified (MOZ 0601) at Mo'orea in 2006 (Poole et al. 2013a). Raraka is 550km east of Mo'orea (the same distance that Rurutu is to the south of Mo'orea) and this one match represents 14% of all whales identified in that 2010 study.

In contrast, Palmerston Atoll and Rarotonga in the southern Cook Islands are 1110 and 1400km west and west-southwest of Mo'orea, and only one photo-ID match has been made in more than 10 years. Specifically, comparison of 359 humpback whales identified at Mo'orea with 96 whales identified at Rarotonga and Palmerston found this one match, representing 1% of Rarotonga's IDs (Garrigue et al, 2002; South Pacific Whale Research Consortium, 2004). Additional comparisons since then have found no other matches between

Mo'orea (n ~ 400 IDs) and the Cooks (n ~ 150 IDs). The Austral Islands are the southernmost extension of the same geological archipelago that contains Rarotonga in the southern Cook Islands, and it could be expected that northward migrating whales might pass from Antarctica to the Austral Islands, and then from the Australs to the Cooks by following the line of sea mounts and islands from southeast to northwest. Likewise, at the end of the winter season they might pass from the southern Cooks to French Polynesia's Austral Islands and then on to the Antarctic. However photo-ID and genetic data do not support this, as there are no matches between the Australs and the Cook Islands.

Only 4% of Mo'orea's and Rurutu's whales have been observed at some other winter ground to the west of French Polynesia, specifically at the Cook Islands, American Samoa, Tonga, and New Caledonia, representing low-level movements between breeding grounds F and E (Poole 2006; Garrigue et al. 2011). However, genotype comparisons of whales sampled across the South Pacific from East Australia to western South America found that one whale sampled at Mo'orea was also sampled in Columbia, South America (Steel et al., 2008). This animal represents the first and only documented movement between breeding grounds F and G. Only one match (by photo-ID) has been made from French Polynesia to summer feeding grounds, and it was to the Antarctic Peninsula in the southeast (unpublished data).

At Rurutu on 09 September we observed a whale that we had seen at Tubuai on 04 September. Over a five-day period this whale had traveled 215km, for an average of 43km/day. On 11 September the mono-thematic song from Raivavae arrived at Rurutu and was incorporated into the other themes that were already present. We had not heard this theme during the previous two days at Rurutu nor at Tubuai. The 13 days and 535km between Raivavae and Rurutu yield an average movement of 41km/day, nearly identical to that of the whale observed at Tubuai and Rurutu. However, these movements are significantly less than those documented for other whales in the South Pacific (Noad and Cato 2007; Hauser et al. 2010), the North Pacific (Mate et al. 1998), and the southwestern Atlantic oceans (Zerbini et al. 2006).

We obtained 28 biopsies, the first ever at any of these islands, as well as 14 hours of song, of which over 7 hours were of good quality. These data will be analyzed later for comparison with data from Mo'orea and from other breeding grounds across the South Pacific, including the Cook Islands. Previous studies suggest that, in spite of substantial longitudinal and latitudinal separation, whales in French Polynesia's Society Islands, Austral Islands, and Tuamotu and Gambier Islands, comprise a single breeding stock (Fii). Therefore, the same song would be expected for all of these whales. However, in this present study we found significant differences in song among three of the four Austral Islands, and between the Australs and the Society Islands (Mo'orea). The mono-thematic song at Raivavae and the bi-thematic song at Tubuai were completely unexpected, as was the theme from Raivavae arriving and being incorporated into the song at Rurutu. Recent studies of humpback whale song show a cultural transmission of song from east Australia to New Caledonia, then to Tonga, and finally to French Polynesia's Society and Austral Islands over a period of a few years (Garland et al., 2011). We are curious to know if themes similar to those in the Austral Islands in 2013 have occurred elsewhere. In addition, the phenology of the introduction of new song elements is of interest, and not just longitudinally from west to east, but also across latitudes from south to north. To address this issue, we have spoken with Dr. Michael Noad of the University of Queensland about undertaking a comparison of song evolution during a single season's northward migration at several different points, from south to north, along Australia's east coast.

This fieldwork was the third stage of our large surveying effort that previously included two other archipelagos. In 2010 we conducted boat-based surveys in the Tuamotu and Gambier Islands in eastern French Polynesia (Poole et al. 2013a), and in 2012 we conducted surveys in the Marquesas Islands in northern French Polynesia (Poole et al. 2013b). These three field seasons of data, combined with our data from the Society Islands where we are based, contribute to a more complete understanding of the presence of cetaceans in all of French Polynesia's archipelagoes, and can be useful for conservation and management decisions.

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Table 1. Effort and results at four Austral Islands.
Skin samples are biopsies (b) and sloughed skin (s).

	Raivavae	Tubuai	Rurutu	Rimatara	TOTAL
Survey Dates	26 - 29 Sept	31 Aug 01 - 06 Sept	09 – 11 Sept 13 - 15 Sept	16 – 19 Sept 21 Sept	
# Survey Days	4	7	6	5	**22**
Survey Distances	294km	431km	238km	147km	**1110km**
# Encounters	2	20	22	11	**55**
# Fluke Photo-IDs	1	9	7	3	**20**
# Skin Samples	1b	12b, 4s	10b, 2s	5b	**28b, 6s**
Good song (mins)	74	273	96	0	**443**

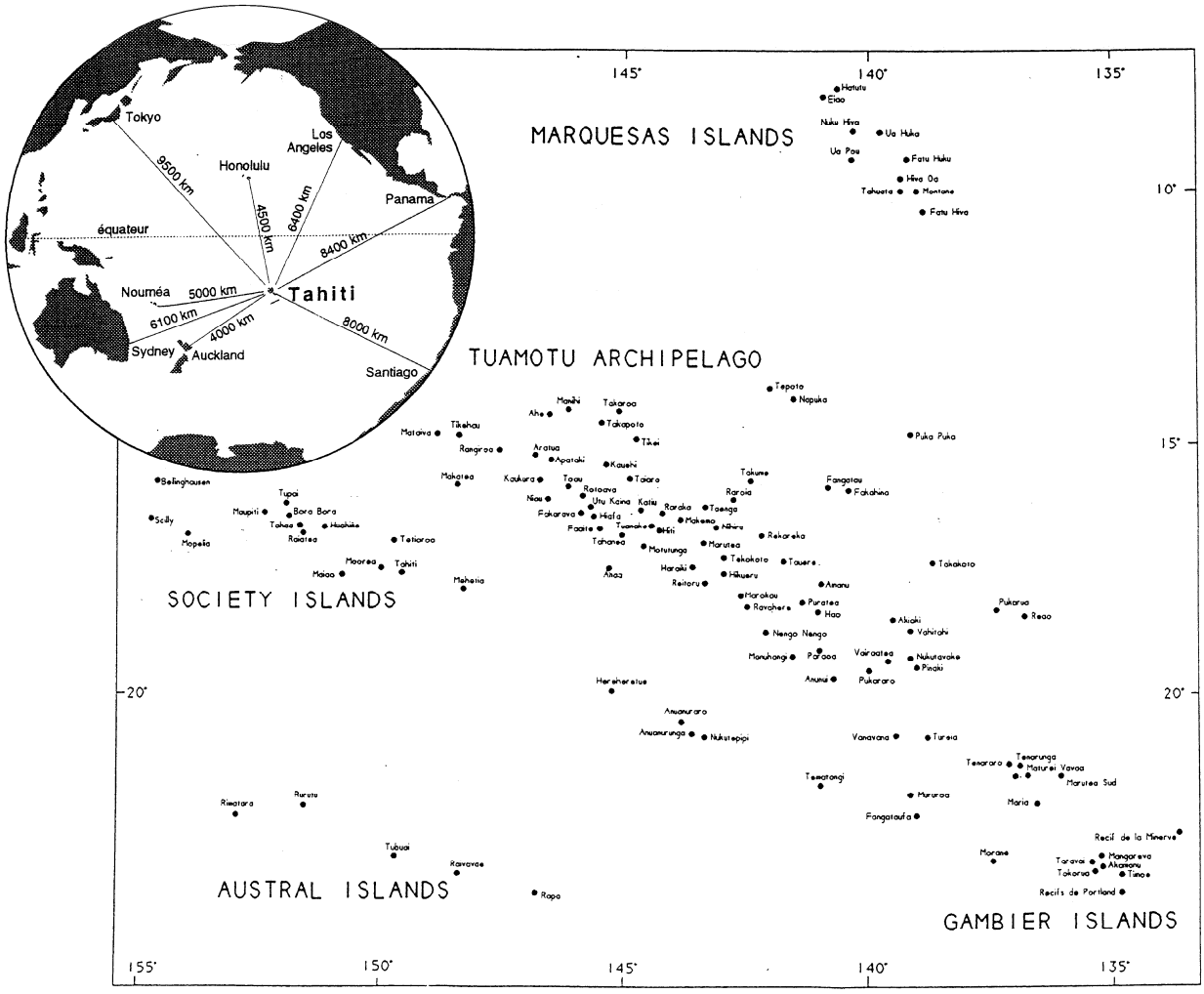

Figure 1. French Polynesia

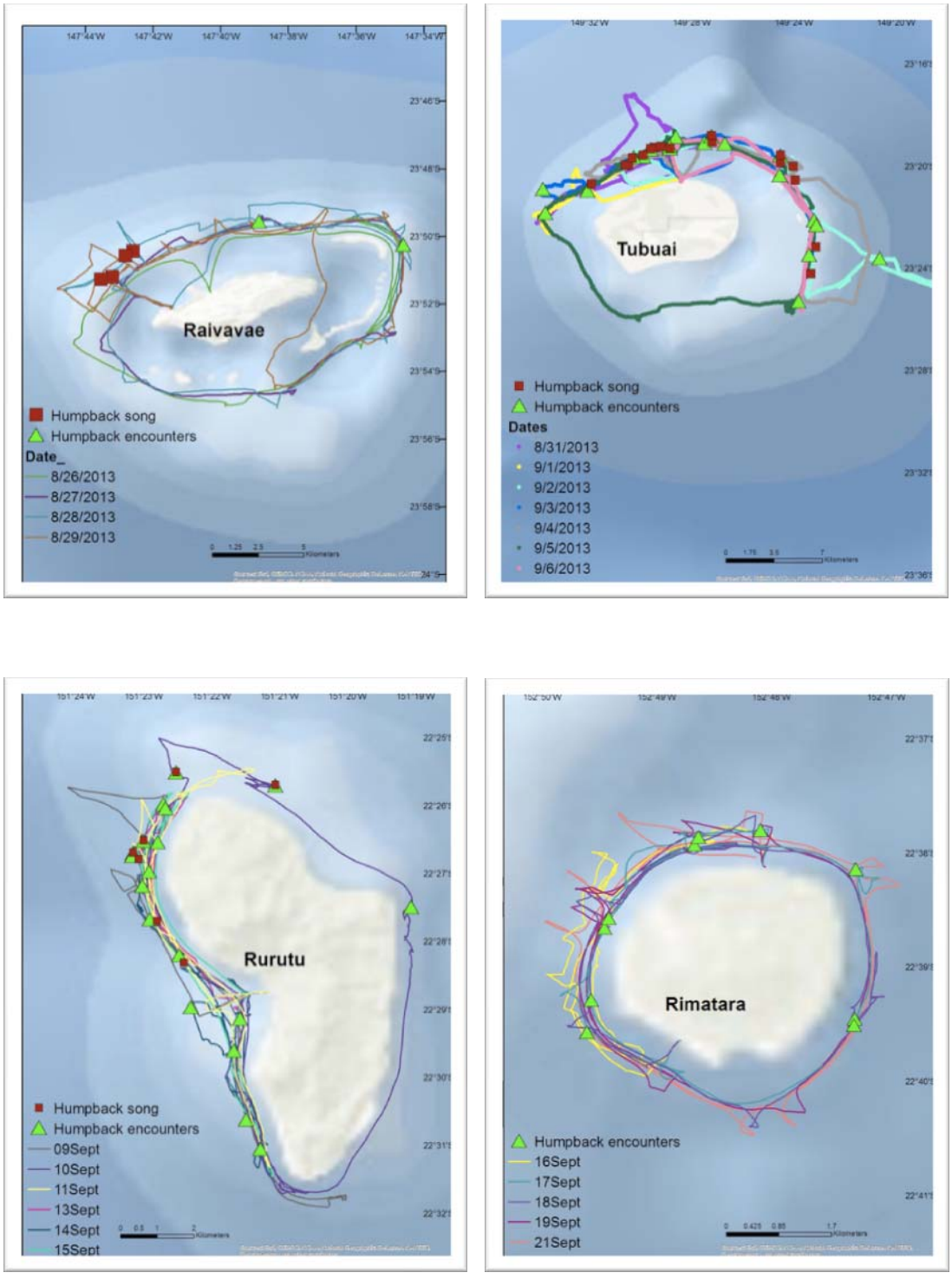

Figure 2. Boat survey dates, track lines, encounters with humpback whales, and locations of recorded song at each island.