

**AN EXAMINATION OF MOVEMENTS OF BOTTLENOSE DOLPHINS BETWEEN
ISLANDS IN THE HAWAIIAN ISLAND CHAIN**

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Abstract

Information on population size, residency and movements of bottlenose dolphins (*Tursiops truncatus*) around oceanic islands is extremely limited. We photo-identified bottlenose dolphins around the islands of O'ahu, Maui/Lana'i, and Hawai'i, in April and May 2002, and compared photographic identities with dolphins identified off Maui/Lana'i in 2000 and 2001. Seventeen bottlenose dolphin groups (mean group size of 8.5 individuals) were encountered during 28 days of field effort, and 58 individuals with long-term markings were documented in the three areas. Of the 18 individuals identified off Maui/Lana'i, 11 of these had been documented in that area in 2000/2001, indicating that individuals show some residency to the area. Of the 40 individuals identified off the islands of O'ahu (29) and Hawai'i (11), none had been previously documented. Combined with an apparent preference for shallow (<200 m deep) areas, these data suggest that movements between islands are limited. Concurrent biopsy sampling for collection of genetic samples may provide evidence of differentiation between islands, however sample sizes off the islands of O'ahu (6) and Hawai'i (4) are currently insufficient for such testing.

Introduction

While bottlenose dolphins are found in coastal areas, in the open ocean, and around oceanic islands, information on population characteristics (e.g., population size or individual residency) of bottlenose dolphins around oceanic islands are limited. Work by Acevedo-Gutierrez (1999) at Cocos Island, off the Pacific coast of Costa Rica, suggests that some oceanic island bottlenose dolphin populations are both large and transitory in nature. A recent study of bottlenose dolphins in Hawai'i, in an area of approximately 3,000 km² between the islands of Maui, Lana'i and Kaho'olawe, found a relatively small population size and individuals that appeared to show some residency to the area (Baird et al. 2001). This area, colloquially termed the "four islands" (also including the island of Moloka'i), is unique within the main Hawaiian Island chain, with a broad shallow (<200 m) plateau between the four islands, rather than single pinnacles surrounded by deep (>2000 m) waters, as is characteristic of the islands of Hawai'i, O'ahu, and Kaua'i.

Baird et al. (2001) estimated that only approximately 134 individuals (95% CI = 107-179) used the Maui/Lana'i/Kaho'olawe area between 1999 and the spring of 2001, from a between-year mark-recapture study of photo-identified individuals. They found evidence that individuals in the periphery of the study area were seen less frequently than individuals in the core part of the study area. This suggests that individual dolphins may show preferences for particular areas within the Hawaiian Island chain, potentially limiting movements between islands. The boundaries of the Baird et al. (2001) study area were set largely by travel distance from a central port (Lahaina, Maui) and worsening sea conditions away from the lee created by the west Maui mountains, rather than by known limits to the movements of the dolphins. Both coastal and offshore forms of bottlenose dolphins are known to make long-distance movements (Wells et al. 1990, 1999), and the distance from the four island area to the next closest islands (O'ahu to the northwest and the island of Hawai'i to the southeast) is relatively small (less than 25 nm), a distance that is probably trivial in terms of the movements of individual bottlenose dolphins. Bottlenose dolphins are known to occur off other islands in the Hawaiian Island chain (Mobley et al. 2001), but no photo-identification effort has been extended around other islands to document individual use of these areas.

During the spring of 2002 we conducted field work off the islands of Hawai'i, Maui and Lana'i, and O'ahu, to: 1) confirm that bottlenose dolphins in the Maui/Lana'i population previously studied by Baird et al. (2001) were continuing to show residence to the area; 2) assess whether individuals from this population were moving to other adjacent islands; and 3) to collect skin samples from bottlenose dolphins for genetic stock identification studies.

Methods

Research was undertaken along the lee shores of the islands of Hawai'i, Maui, and O'ahu, during April and May 2002 (Figure 1). Research vessels in the three areas were similar. Off the island of Hawai'i two vessels were used, a 20' and a 27' Whaler; off Maui/Lana'i a 19' rigid-hulled inflatable was used; and off O'ahu a 20' Whaler was used. During all times on the water between 3 and 5 observers would visually scan 360 degrees around the vessel as it moved through the area at speeds of between 15 and 30 kph. At intervals of 5 to 10 minutes the vessel

was stopped for approximately one minute for 360 degree scanning of the horizon with 7-10 power binoculars. Distribution of search effort was limited primarily by sea conditions, with the vessel attempting to remain in areas with sea conditions less than Beaufort 4. Within these constraints, efforts were made to cover as wide an area as possible in each study area, extending as far alongshore and offshore as possible, given sea and fuel constraints.

When bottlenose dolphins were encountered we attempted to obtain multiple photographs of every individual present in the group, using 100 ASA color slide film and a Canon SLR with a 100-300 autofocus lens. Minimum, maximum and “best” estimates of group size were noted in the field. We remained with each group until one of the following: 1) we were confident that all individuals in the group were photo-identified; 2) groups were lost; 3) photographic efforts had to be discontinued due to sea conditions; or 4) individuals in the group were showing clear avoidance of the research vessel which was preventing any additional good-quality photos being obtained.

Only good quality photographs (in focus, un-obscured, with the dorsal fin relatively perpendicular to the plane of the photograph, and with the dorsal fin large enough to identify small notches, if present) were used. Individual dolphins were identified from photographs based primarily on the size, location and pattern of notches on the trailing edge of the dorsal fin and on the back directly behind the dorsal fin (cf. Wells and Scott 1990; Wursig and Jefferson 1990). Those individuals with dorsal fin or back notches are hereafter referred to as “marked” animals. Individuals without dorsal fin or back notches could often be identified within and between encounters based on other features (e.g., pigmentation patterns, dorsal fin shape, skin scrapes or scars). However, because the longevity of many of these features is known to be shorter than dorsal fin notches (Wilson 1995), those dolphins identified only from such characteristics were not used for inter-year comparisons. Inter-year comparisons of all marked individuals were made with a catalog of 68 individual bottlenose dolphins photo-identified off the islands of Maui, Lana'i and Kaho'olawe from February 2000 through March 2001 (Baird et al. 2001). Calculations of average group size used the “best” estimates from the field, unless the number of individuals photo-identified from a particular encounter was greater. In these cases the larger value was used; when fewer individuals were photo-identified than estimated in the field this

lower value was not used, as other conditions (see above) may have resulted in incomplete photo-identification of all individuals present.

Results and Discussion

Between April 3 and May 1, 2002, a total of 196.3 hours on 28 different days (average of 7 h/day) were spent searching for odontocetes in the nearshore waters of Hawai'i. A total of 2,730 km of trackline was covered spread between the three study areas, with 10 days spent off the west coast of the island of Hawai'i, nine days working between the islands of Maui and Lana'i, and nine days working off the west and south coasts of the island of O'ahu (Figure 2). Bottlenose dolphins were encountered on 17 occasions on 12 days, with four encounters each off the islands of Hawai'i and O'ahu, and nine encounters off Maui/Lana'i (Table 1).

Associations between bottlenose dolphins and other species were noted. Associations with humpback whales (*Megaptera novaeangliae*) were common (7 encounters, 41%). One additional encounter involved an association with false killer whales (*Pseudorca crassidens*). Encounter rates with bottlenose dolphins off the islands of Maui and Lana'i were greater than three times higher than encounter rates off the other islands, though this difference was not significant (Kruskal-Wallis one-way ANOVA, $p = 0.26$).

A total of 679 photographic frames were taken of bottlenose dolphins during the study. From these, we obtained 103 identifications, including both "marked" (notched) and unmarked dolphins (Table 2). Seventy-nine of these identifications were of marked individuals, however there were a number of re-sightings within the study period, resulting in a total of 58 individual marked bottlenose dolphins being identified in 2002. During the winter of 2000/2001 (November 2000 through March 2001) a total of 59 marked individuals were documented in 323 hours on 49 field days (Baird et al. 2001). The greater number of individuals identified per unit field time during 2002 results primarily from two large groups encountered (and photo-documented) off O'ahu. Average group size was about three times larger off O'ahu than the other islands or during the 2000/2001 study reported by Baird et al. (2001), though this difference was not significant (Kruskal-Wallis one-way ANOVA, $p = 0.164$).

Comparisons of photographically-identified dolphins between the islands, and with the 2000/2001 catalog of Baird et al. (2001), revealed no matches of individuals between islands. Of the 18 individual “marked” dolphins that were identified off Maui and Lana‘i, 11 of these individuals (61%) had been documented in 2000/2001, suggesting that no large-scale movement of dolphins out of the area had occurred between the 2000/2001 and 2002 field seasons. Baird et al. (2001) reported a similar (57.6%) proportion of resighted individuals between years off Maui and Lana‘i. In terms of assessing the potential for movements of dolphins between islands, sufficient time between field seasons is needed to allow re-distribution of dolphins, thus between-year comparisons have a greater potential in revealing such movements, if they in fact exist. Given a 61% between-year resighting rate, if bottlenose dolphins in the Maui/Lana‘i area were freely mixing between islands we would have expected six or seven of the 11 dolphins off the island of Hawai‘i and 17 or 18 of the 29 dolphins off O‘ahu to have been previously documented off Maui/Lana‘i. A chi-square test comparing the number of dolphins matched previously from each island (Hawai‘i – 0; Maui/Lana‘i – 11; O‘ahu – 0) and the number not matched (Hawai‘i – 11; Maui/Lana‘i – 7; O‘ahu – 29) was significant ($p < 0.001$), illustrating that this result did not occur by chance alone. With no matches between Maui/Lana‘i and the other two islands, it is clear that bottlenose dolphins are not mixing freely between the islands.

Examining the distribution of sightings in relation to effort both in 2000/2001 (see maps in Baird et al. 2001) and in the current study (Figure 2), suggests that bottlenose dolphins found in near-shore waters around the main Hawaiian Islands are island-associated, that is, they are not members of a pelagic population that occasionally passes by the islands. Two lines of evidence support this. Firstly, while considerable effort was spent in offshore (deep, > 200 m) waters around O‘ahu and the island of Hawai‘i in 2002, and off the island of Lana‘i in 2000/2001 (Baird et al. 2001), virtually all of the sightings occurred in relatively near-shore and shallow (< 200 m) waters. Secondly, the lack of documented movements between islands all relatively close to each other, suggest that the rate of movements between islands, over relatively deep channels, is, at most, very low. This lack of movements between islands and apparent preference for near-shore shallow-waters suggests that genetic differentiation may exist between bottlenose dolphins within the main Hawaiian Island chain. Concurrent with the 2000-2002 field efforts, 28 skin biopsy samples of bottlenose dolphins from these islands have been obtained, though only four

samples have been obtained off the island of Hawai'i and six samples off O'ahu. Given the level of genetic variability found within this species (Hoelzel et al. 1998), existing samples sizes at each island area are likely insufficient to assess whether genetic differentiation exists.

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Table 1. Summary of effort and bottlenose dolphin encounters.

Island	# hours effort	# km effort	# encounters	Group size average (SD)
Hawai'i	75.5	1089	4	7.0 (3.6)
Maui/Lana'i	63.8	785	9	5.3 (2.9)
O'ahu	57	860	4	17.3 (17.9)
Total	196.3	2,730	16	8.5 (9.6)

Table 2. Summary of photo-identification results and inter-island comparisons.

Island	# identifications ("marked" and unmarked)¹	# identifications "marked" only¹	# marked individuals identified²	# Individuals previously documented³
Hawai'i	16	13	11	0
Maui/Lana'i	38	27	18	11
O'ahu	49	39	29	0
Total	103	79	58	11

¹Includes within-season re-sightings. ²Does not include within-season resightings - individuals seen more than once at each study site counted only once. ³Comparisons made with a catalog of 68 individual "marked" dolphins documented off the islands of Maui, Lana'i and Kaho'olawe between February 2000 and March 2001.

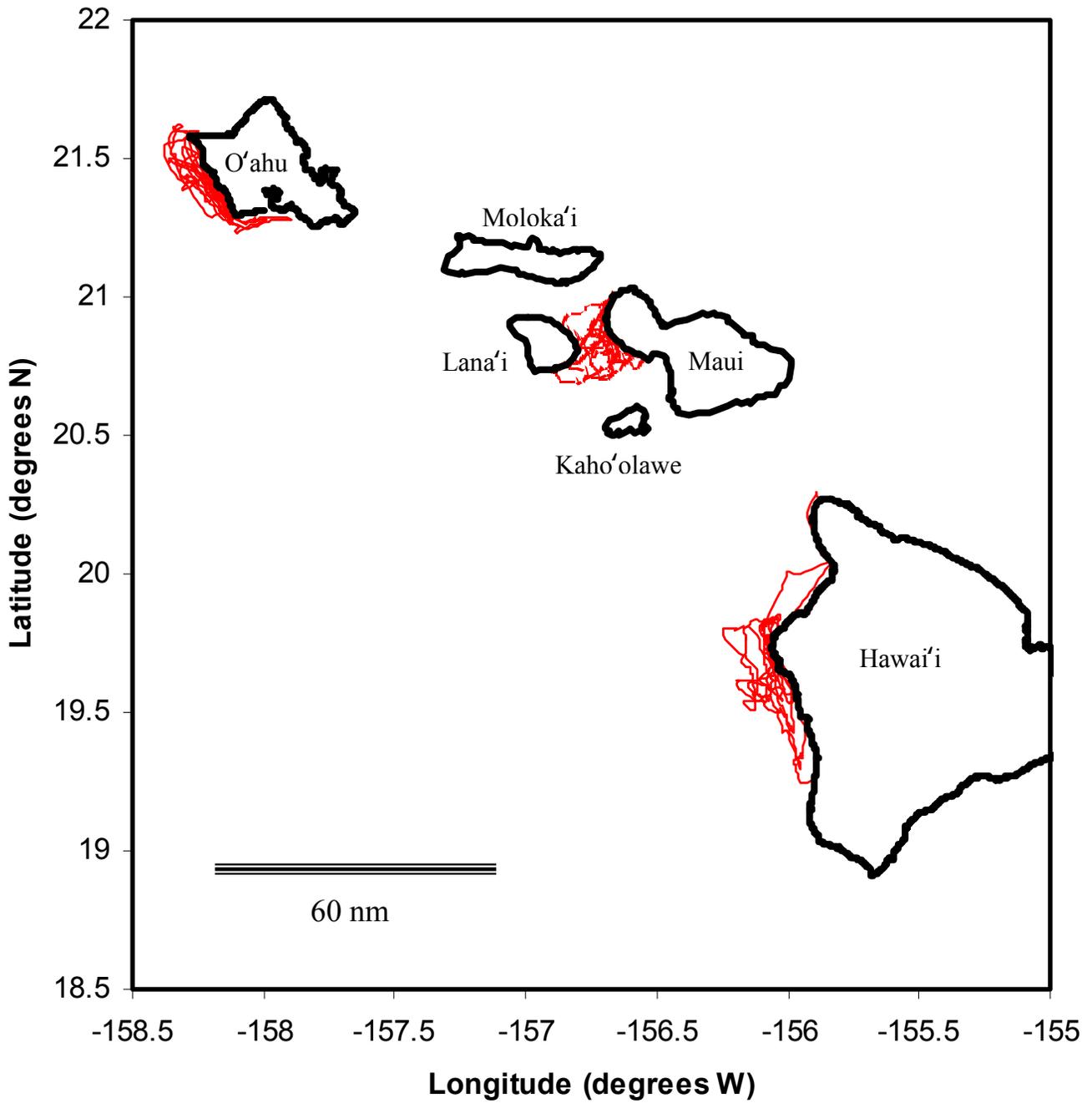


Figure 1. Distribution of search effort in Hawai'i, April – May 2002.

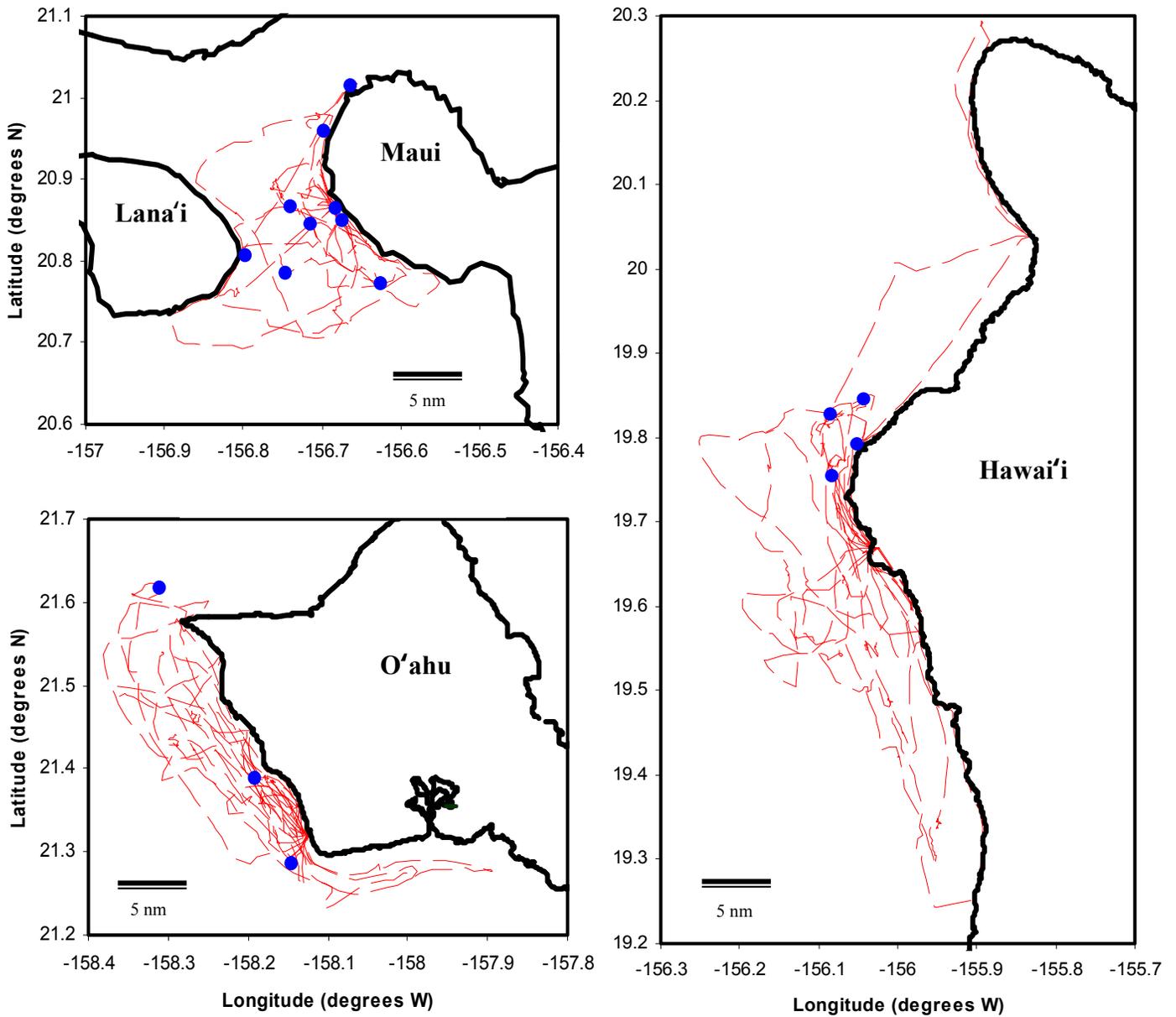


Figure 2. Details of effort tracklines (dashed lines) and sightings of bottlenose dolphins (circles) in Hawai'i, April-May 2002.