

2015 Annual Report to the PCCRC

Investigating the foraging and diving behavior of transient killer whales in the central and western Aleutians to determine predation on Steller sea lions

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1. PROJECT INTRODUCTION

Killer whales have been implicated in the decline of the western stock of Steller sea lions. Transient-type killer whales (also known as Bigg's killer whales) are known to prey on Steller sea lions in other parts of the North Pacific but few observations have been made of predation on Steller sea lions in the western and central Aleutians, though observation effort has been relatively sparse. Two dramatically different foraging strategies have been observed in transient killer whales in the central and western Aleutians through the use of location-only satellite tags. Some whales have moved ~1000nm south of the Aleutians to the North Pacific transition zone, and other whales have been seen to remain in a single location over deep-water at the head of a submarine canyon for an entire month, behavior not previously seen in transient killer whales. Additionally, stable isotope analysis suggests the hypothesis that transient killer whales in the western and central Aleutians could be foraging substantially on squid in addition to marine mammals. Predation on Baird's beaked whales, Dall's porpoise, and sea otters has also been documented in the western and central Aleutian Islands.

This project is designed to describe transient killer whale foraging in the western and central Aleutian Islands, and test the hypothesis that they forage on squid in addition to marine mammals. The project will do this by attempting to deploy Mk10-A satellite-linked depth tags on transient killer whales in the western and central Aleutians to track their movements and record their diving behavior. The costs of the project are being kept low by piggy-backing on existing AFSC/NMML Steller sea lion research cruises. The majority of the cost of the project is to purchase 8 tags, pay for ARGOS time for the tags, and pay for travel costs of personnel going into the field.

2. 2015 SUMMARY/ACCOMPLISHMENTS/UPDATE

Planning and budget

We continued to receive excellent support for the project from Dr. Tom Gelatt, Program Leader of the Alaska Ecosystem Program at NMML, who is accommodating us on his Steller sea lion research cruises. For the 2015 field season we planned to piggyback on a Steller sea lion cruise to the western and central Aleutians in late June/early July.

The eight Mk10-A satellite-linked depth tags were purchased from Wildlife Computers in spring 2013. Field equipment and expendable supplies (e.g., batteries, sterilizing chemicals) were also purchased prior to the survey.

NMML 2015 Steller sea lion research cruise (June 18-July 3)

Research Plan

Wade and Durban planned to participate in the primary leg of this cruise on the U.S. Fish and Wildlife Service vessel *Tiglax*, starting in Adak, going as far west as Attu Island, and ending in Dutch Harbor. Counts of Steller sea lion pups and non-pups by multiple observers were made at rookeries and haul-outs from the vessel wheelhouse, small-skiff, or on land depending on site access and size. Pup branding and sampling were conducted at several Steller sea lion rookeries.

For killer whale studies, preparations were made to observe, photo-id, and satellite tag killer whales encountered throughout the study area. Wade and Durban planned, when possible, to stand killer whale watches from the flying bridge of the *Tiglax*, scanning for killer whales and other cetaceans using 7x handheld Fujinon binoculars. This search effort was planned to occur primarily during transits between Steller sea lion rookeries and/or haul-outs. On some occasions, it was hoped that additional search effort could be accomplished in the vicinity of rookeries while sea lion research was being carried out ashore. From previous killer whale surveys, we have identified two transient killer whale hotspots in the western and central Aleutians: (1) Kiska Island and the Rat Islands and (2) the Delarof Islands. Therefore, our initial plan was to particularly focus dedicated killer whale searching in these two areas on both the westward trip to Attu Island and on the return trip back to Adak. The total amount of time available on these 4 days would be dependent upon the logistics of the trip, and the amount of delays due to poor weather encountered. When killer whales would be encountered it would be at the discretion of the Chief Scientist (Gelatt) as to whether there was sufficient time available to attempt to tag the whales.

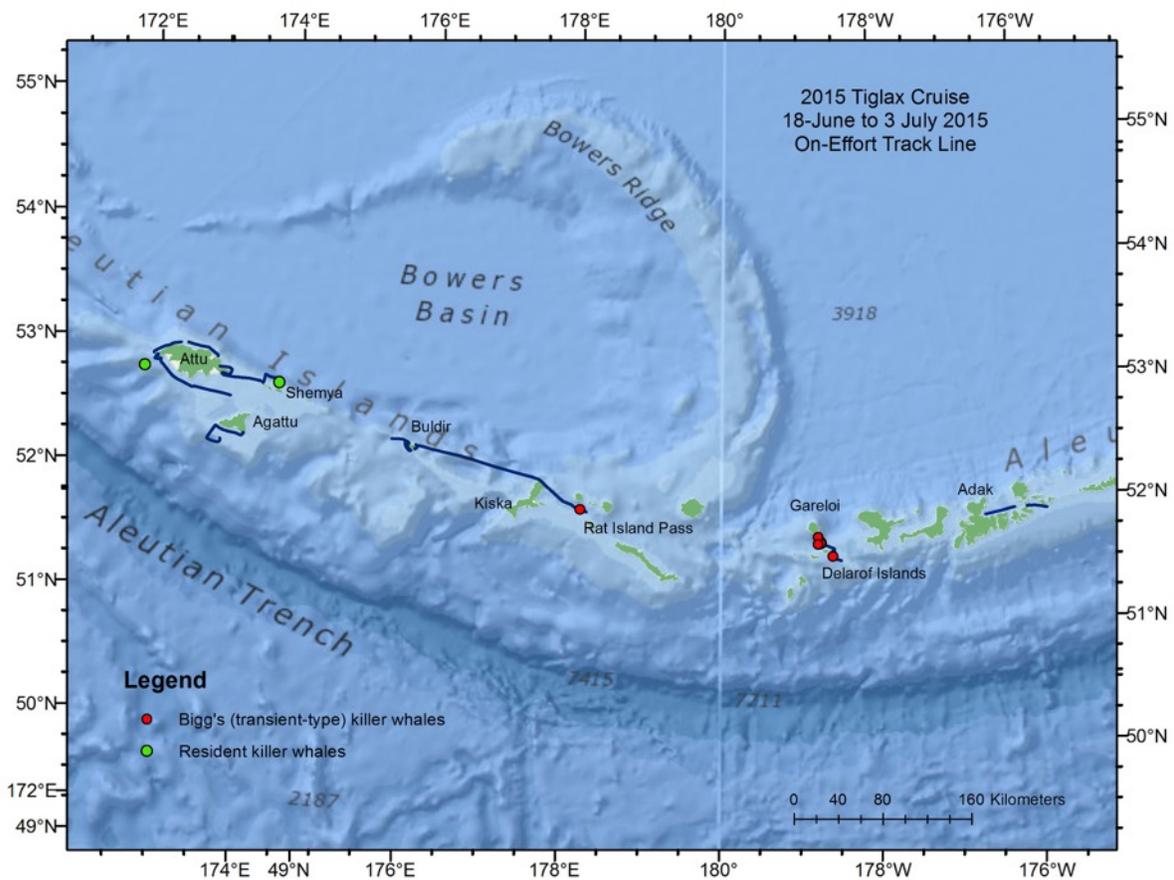
Results

During the 16 full days at sea, Durban and Wade went ashore to assist with sea lion research at rookeries on 6 different days, including Cape Wrangel, Attu, Gillon Pt. and Cape Sabak, Agattu, Cape St. Stevens, Kiska, Ulak Island, Delarofs, and Bogoslof Island. When not ashore assisting with sea lion research, Durban and Wade were able to spend a total of ~45 hours on killer whale watch, covering ~600 km of trackline (Fig. 1). This continued the success seen in 2014. Some killer whale watch occurred the majority of the 16 sea-days. The amount of killer whale watch

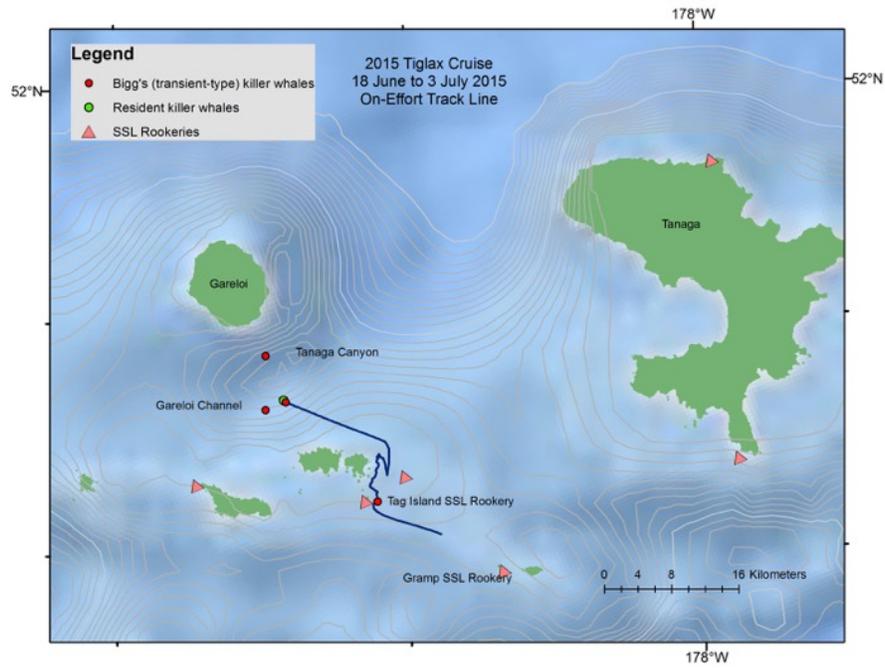
varied depending upon the scheduled sea lion work and weather, with fog being a problem on at least 4 days. Given the piggyback nature of the research, the killer whale watch was not systematic throughout the region. However, killer whale watch effort was distributed throughout most of the cruise area, but with concentrations of effort around the Near Islands (Attu, Agattu, Shemya), between Buldir and around Kiska, in the Delarofs and Adak, and Bogoslof and Unalaska in the eastern Aleutians. Fortunately, for the first time in 3 field seasons, weather and logistics cooperated and allowed for search effort in the two previously identified transient killer whale hot spots in the Rat Islands and in the Delarofs in the pass between Gareloi and Kavalga Islands. As anticipated, this led to several encounters with Bigg's killer whales.

Figure 1. On-effort cruise tracks during killer whale watch during the NMML 2015 Steller sea lion research cruise. The blue lines represent times when two researchers were standing watch on the flying bridge searching for killer whales and other cetaceans using 7x handheld binoculars. Circles represent encounters with Bigg's killer whales (red) and resident-type killer whales (green).

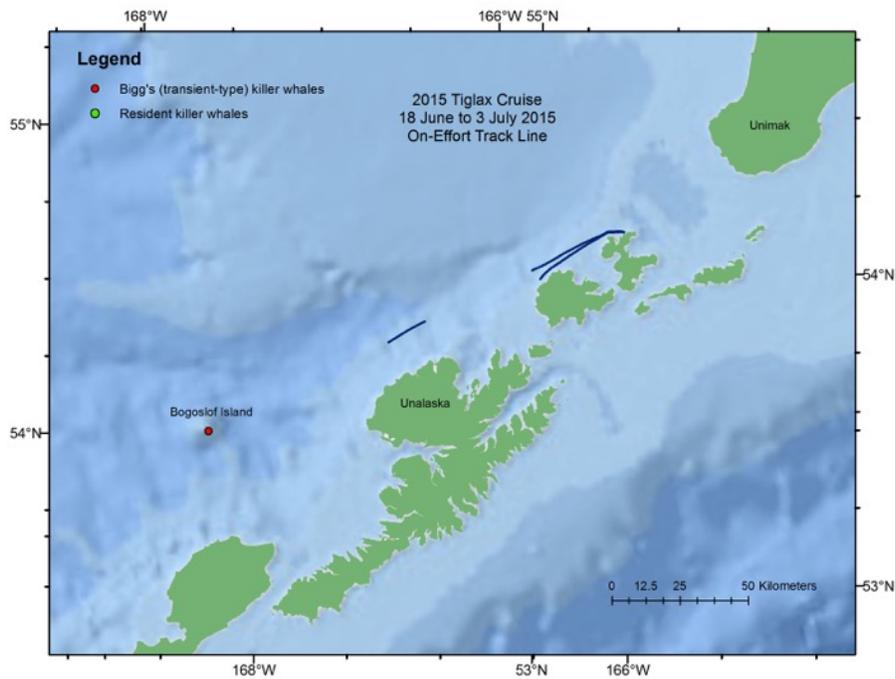
(a) Western and central Aleutians – Adak to Attu.



(b) Detail of effort and encounters in the Delarof Islands. Note there were encounters with 3 groups of Bigg's killer whales and one group of resident killer whales in Gareloi Channel, as well as the Bigg's killer whale encounter at Tag Island.



(c) Eastern Aleutians – Bogoslof to Unimak. Note there was a small amount of search effort at Bogoslof but a group of Bigg's killer whales were immediately detected, so no line is visible.



Over 100 sightings of cetaceans were made during dedicated killer whale watch, including 9 sightings of groups of killer whales (details to follow below). Other cetaceans seen included Dall's porpoise, harbor porpoise, sperm whales, minke whales, and humpback whales.

As previously mentioned, a total of 9 groups of killer whales were seen from throughout the region. A total of six groups of Bigg's killer whales were found, including one group in Rat Island Pass east of Kiska Island, four groups in the Delarof Islands, and one group at Bogoslof Island. A total of three groups of resident type killer whales were seen, including two groups in the Near Islands (Attu and Shemya), and one group in the Delarof Islands.

Three Bigg's killer whales were tagged with Wildlife Computers SPLASH10-292A tags, configured as Limited Impact Minimally Percutaneous External Electronic Transmitters (LIMPET; Andrews et al. 2008). Two were tagged in Rat Island Pass, and one was tagged in the Delarof Islands (Fig. 2). Other groups of Bigg's killer whales were in Gareloi Channel and at Bogoslof Island, but it was not possible to get close enough to those whales to make a tagging attempt.

Figure 2. Small satellite LIMPET-SPLASH tag deployed on the dorsal fin of a sub-adult male Bigg's killer whales at Tag Island in the Delarof Islands (arrow indicates tag attachment sites). This is the moment of impact; the crossbow bolt detached a second later.



Rat Island Pass Whales

A group of 12 Bigg's killer whales were detected on June 25 in Rat Island Pass (just east of Kiska Island). The whales were in two clear sub-groups, and were on the site of a presumed kill of an unidentified marine mammal (there was a small oil slick, many birds feeding on visible prey remains in the water, and the whales appeared to be feeding – a prey sample was collected which will be submitted for genetic analysis to identify the species). Tags were deployed on one whale from each sub-group. The first whale tagged (PTT 102223) was identified as WT318 (an adult female); this whale has been previously seen in 2006 in Rat Island Pass. The second whale tagged (PTT 102224) was identified as WT313 (another adult female). This whale has been previously seen twice in 2006 in Rat Island Pass (one time with WT318). Given the two whales were in different subgroups, they were expected to travel separately, and this was the case.

PTT-102224 (WT313)

The deployment of the tag on WT313 was low (at the base of the dorsal fin), so as expected, it did not provide a lot of transmissions and dive data, but what it provided was still interesting. Over 6 days (25 June to 1 July) the whale started in Rat Island Pass (where tagged), moved towards the southern end of Kiska Island, and then spent the next 5 days around Kiska (Fig. 3). The whale spent a lot of time close to shore, apparently foraging near the Sobaka, Lief, or Cape St. Stevens Steller sea lion (SSL) rookeries on at least 2 occasions over the 5 days. The dive data indicated the whale was staying near the surface most of this time, but on one occasion the whale made a few repeated dives to ~350m when it was about 20km west of Kiska in deeper water (Fig. 4).

Figure 3. Movement data for whale WT313 (PTT 102224). Higher quality locations are plotted as circles, and the full track including poorer quality positions is shown as a line.

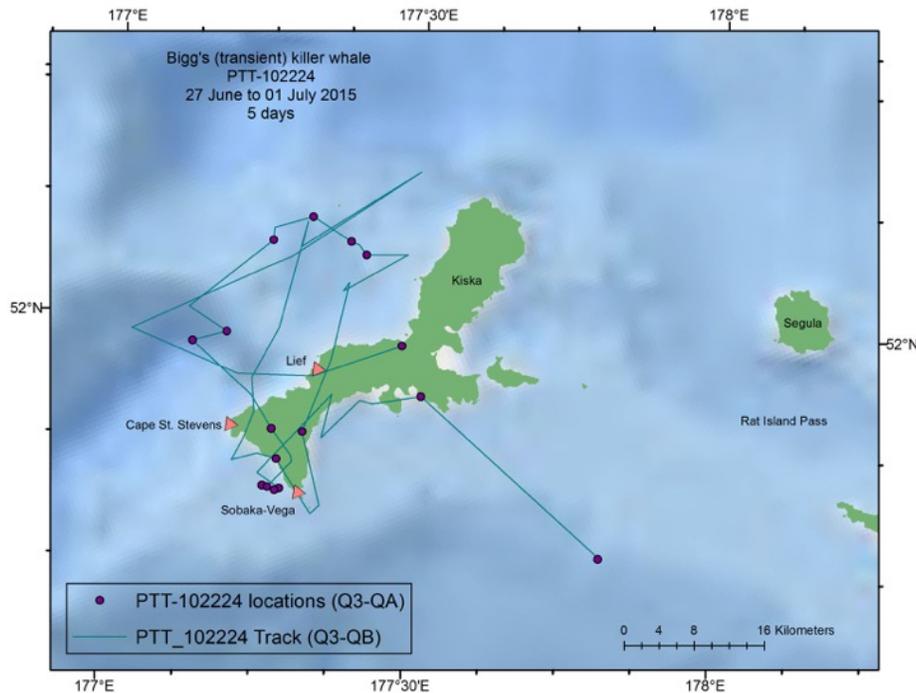
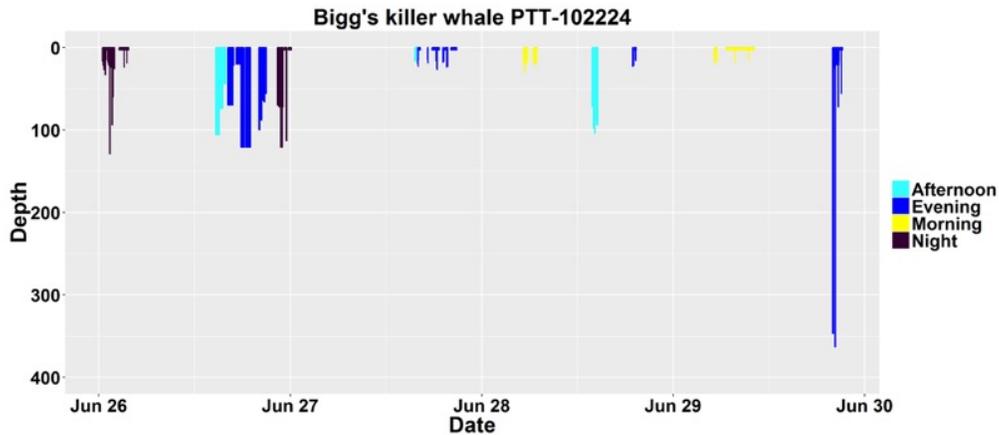


Figure 4. Dive time-series for WT313 (PTT 102224). Gaps in the dive series were due to lack of transmissions to the satellite due to the low position of the tag on the dorsal fin.



PTT-102223 (WT318)

The tag on WT318 provided a lot of high quality dive data (Fig. 5) and locations (Fig. 6) for about one month (June 25 to July 23). At first, WT318 spent several days around Rat Island Pass, including near the Ayugadak SSL rookery, and moved briefly down to the NE tip of Amchitka (Fig. 2). WT318 then made a loop around Semisopochnoi Island, came back to Rat Island Pass, but then headed west past the north end of Kiska. The whale continued west to Buldir Island, and then on to near Shemya in the Near Islands. She then returned on a more southerly route, spending time on some shallower banks, until returning all the way to Rat Island Pass. WT318 spent part of nearly every day doing bouts of deeper dives (to ~200-450m, on 9 out of the first 13 days). The days with no deep diving occurred several of the days when she moved relatively rapidly all the way out to Shemya and back. The tag started duty cycling after July 7 (as scheduled to save battery life), and then only turned on every fifth day. On July 13 WT318 was back in Rat Island Pass, on July 18 she had moved back west to northwest of Attu Island and was half way to the Commander Islands in Russia (approximately 600km from it's tagging location), and on July 23 (the last transmission day), she was moving east again between Buldir and Kiska.

Figure 5. Dive time-series for WT318 (PTT 102223). The gaps after July 7 were due to the tag duty cycling off for 4 days to save battery life.

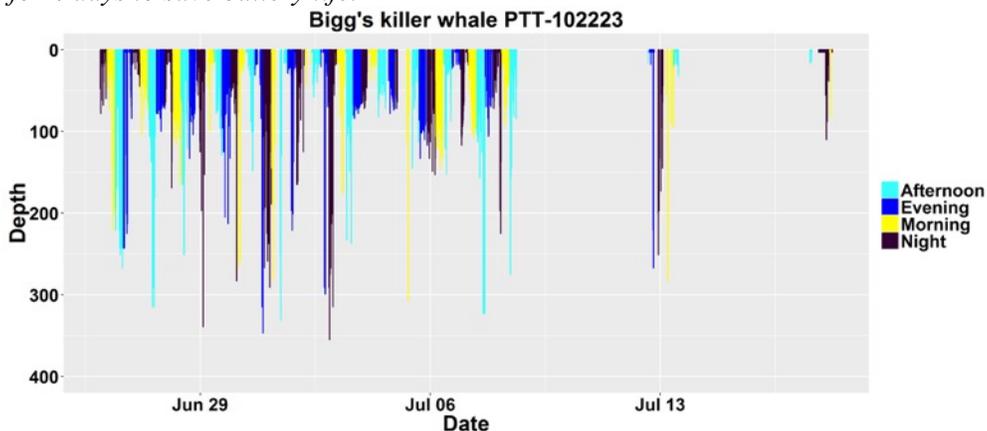
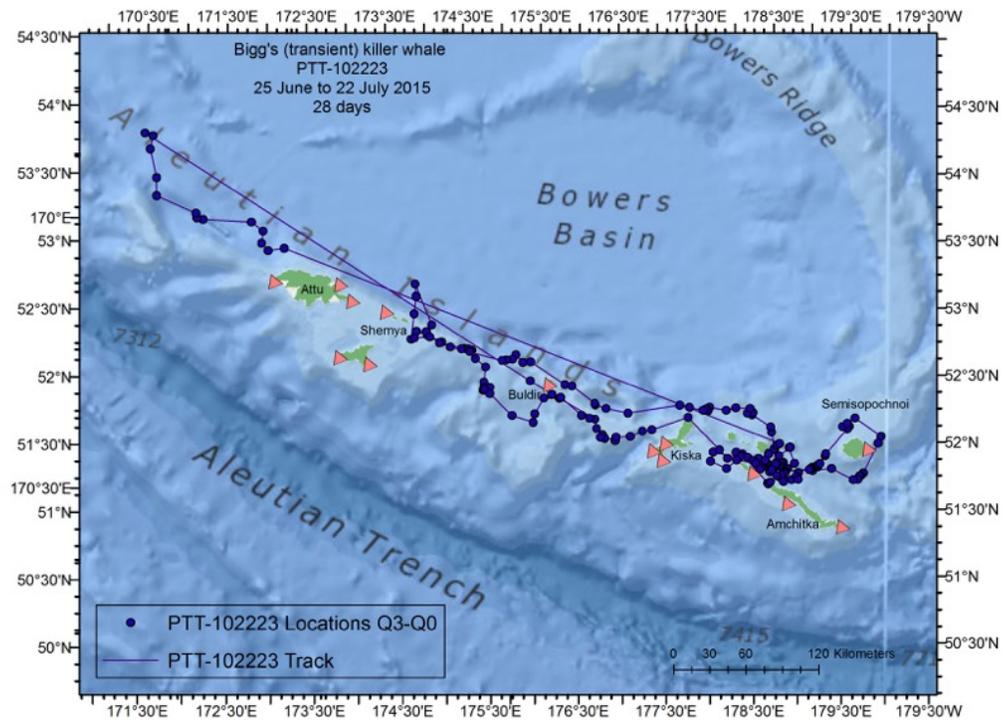
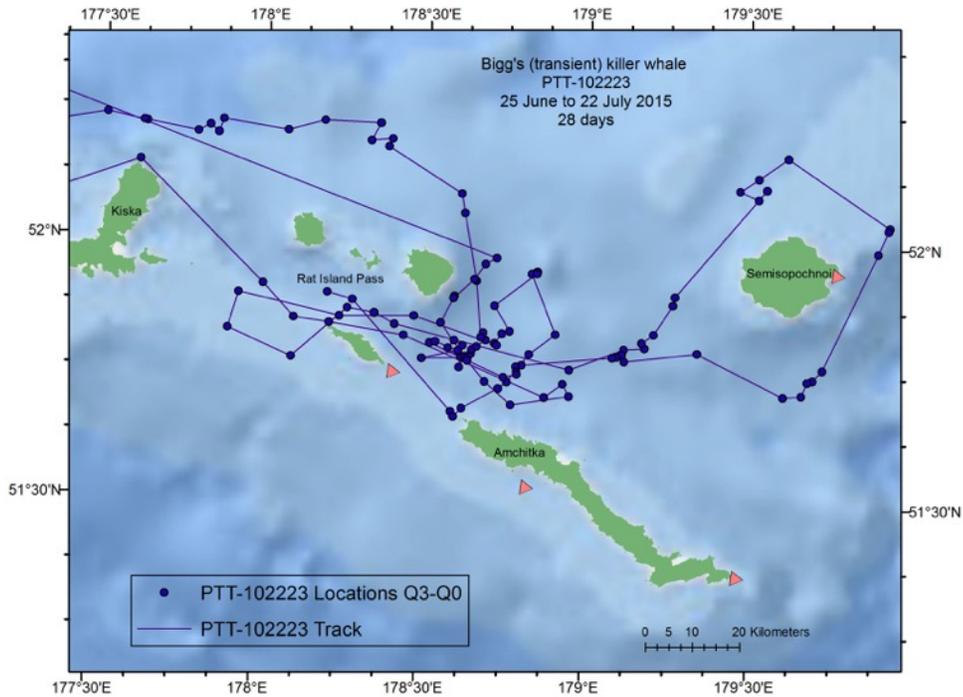


Figure 6. Movement data for whale WT318 (PTT 102223).

(a) All positions over the 28-day life of the tag.



(b) Details of movements around Rat Island Pass.



Delarof Islands Whale (PTT-87624)

On June 27 a group of four Bigg's killer whales were detected within a few hundred meters of the Steller sea lion rookery at Tag Island in the Delarof Islands, and a tag was deployed on a sub-adult male in the group (none of the four whales had been previously identified). The tag worked until July 13 (17 days) and provided extensive location and diving data. This whale stayed within a 60 by 80 km area in the Delarof Islands, extending east to the western side of Tanaga Island (Fig. 7). This whale showed an interesting daily pattern. Nearly every morning the whale was close to shore near either the Tag Island SSL rookery (where it was tagged) or near the Gramp Island SSL rookery (about 20km southeast of Tag Island). On the majority of the days the whale would then move to deeper water in the afternoon, evening and night time, usually in the wide channel between Gareloi and Ogliuga Islands over the head of a submarine canyon (an extension of Tanaga Canyon, the same area previously mentioned where two whales tagged in 2010 stayed for a month). This suggests a pattern of hunting for sea lions in the morning, and perhaps hunting for squid in the evening. The whale's dive pattern was to show mostly shallow surface behavior in the morning (when hunting sea lions), and then switch to a behavior of repeated dives to ~350m in the afternoon and evening (Fig 8). As the night progressed, the dives shoaled to ~250m, suggesting their prey were coming up to shallower depths during the night. This whale also made two trips during this period to the west coast of Tanaga Island where it spent time close to shore in the vicinity of several harbor seal haulouts.

Figure 7. Movement data for the whale tagged in the Delarof Islands (PTT 87624). The track (blue line) connects all positions, but only morning (yellow) and evening (blue) positions are plotted to highlight the daily movement pattern of the whale.

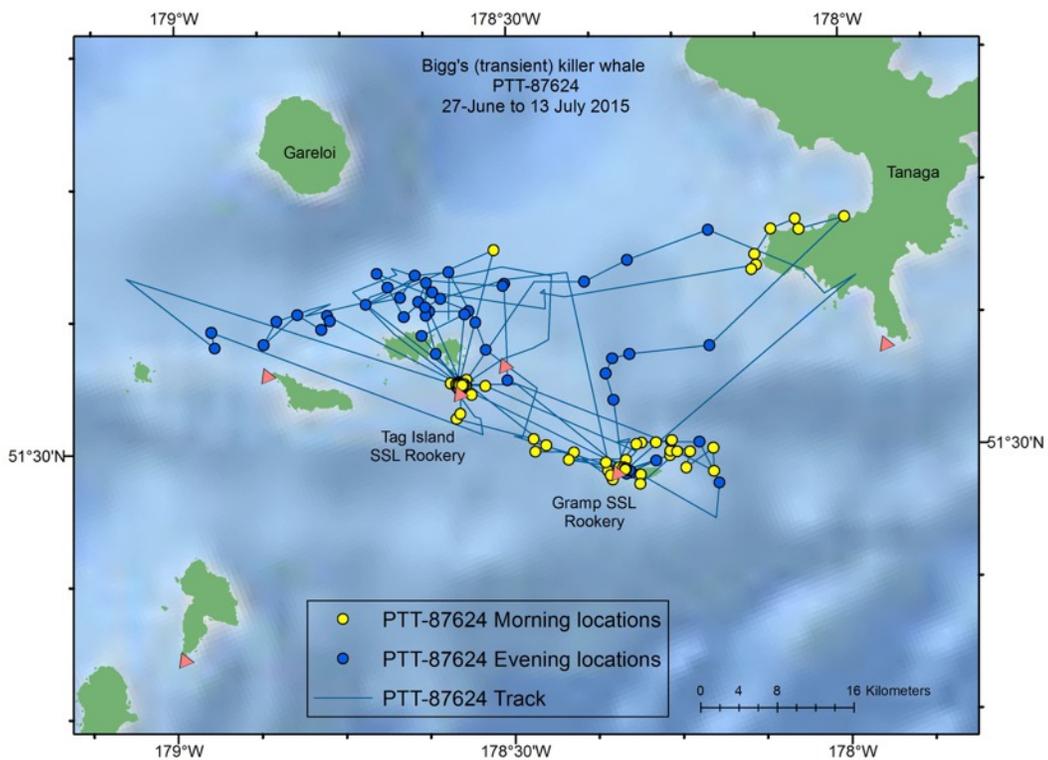
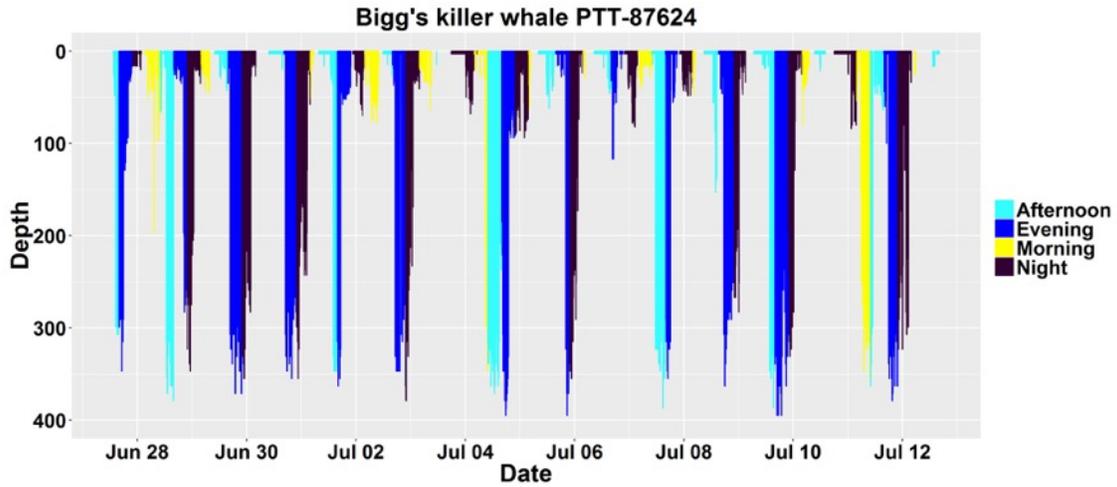


Figure 8. Dive time-series for the whale tagged in the Delarof Islands (PTT 87624).



From the plot in Fig. 9, it can be seen the whale was staying at the surface from 3-10am when it was close to SSL rookeries. It then started deeper diving in the afternoon, and then did extensive repeated deep diving in the evening from 8-11pm, with the diving getting shallower as the night progressed.

Figure 9. Depth distribution of dives plotted as a boxplot by hour of the day for PTT 87624. Note the period of shallow diving in the morning, the beginning of deep diving in the afternoon, and the period of extensive deep diving in the evening.

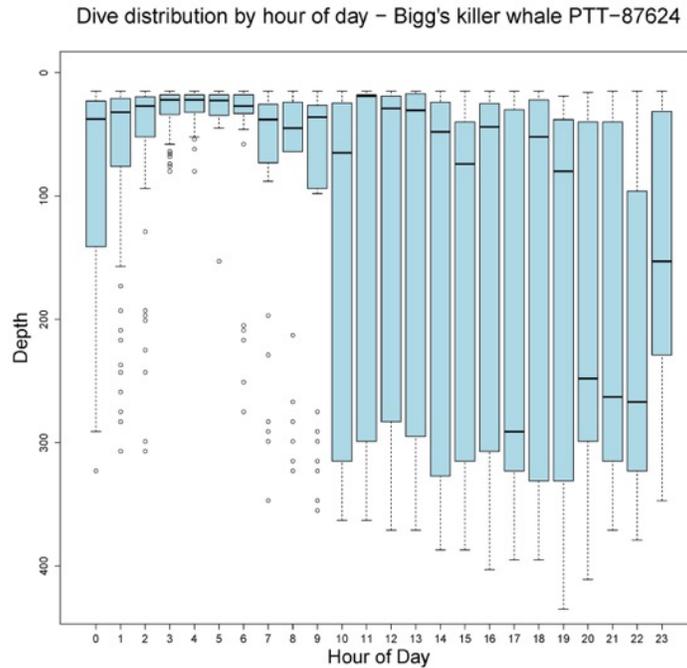
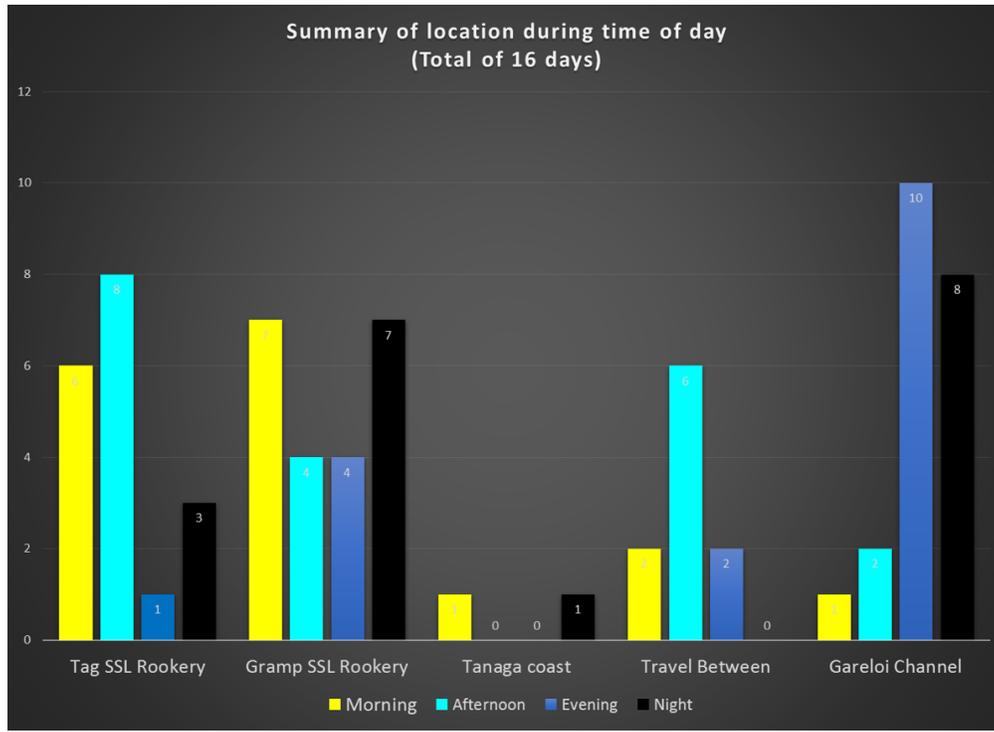


Figure 10. Geographic location by time of day for the sub-adult male (PTT 87624) tagged at the Tag Island SSL rookery (the whale could be at more than one location during a single time period).



The geographic location of the whale during different time periods of the day is summarized in Fig. 10. On 13 of 14 mornings that the tag reported a location, the whale was at either the Tag or Gramp SSL rookery; the 14th morning it was along the coast of Tanaga Is. near harbor seal haulouts. During 12 of the afternoons the whale was still at the same rookery as the morning or had moved to the other rookery (3 occasions). During 10 of the evenings and 8 of the nights the whale was in deeper water in Gareloi Channel. On 10 of the nights the whale also returned to one of the SSL rookeries (meaning he arrived prior to 4am).

Summary

Two of the whales showed repetitive diving to depths of 250-400m, consistent with foraging on squid. The third whale did not provide much dive data, but also showed one bout of repeated dives to 350m, so all three whales showed some evidence of deep diving behavior. Additionally, two of the whales also spent considerable time foraging around Steller sea lion rookeries; in particular one of those whales regularly foraged nearly every morning around one of two Steller sea lion rookeries in the Delarof Islands. The third whale did not show as much clear foraging close to sea lion rookeries, though it did swim near to sea lion rookeries at Semisopchnoi, Ayugada, and Buldir (twice) over a period of approximately one month.

In conclusion, it appears that both foraging hypotheses may be correct – at least some Bigg’s killer whales appear to forage extensively on both Steller sea lions and on squid in the central and western Aleutian Islands. What was most intriguing was to see one individual whale apparently switch between these two foraging strategies on a daily basis, hunting Steller sea lions in the morning, and hunting squid in the evening and first part of the night. This raises the possibility that Steller sea lions in the western and central Aleutians have fallen into a “predator pit”, meaning there is possibly enough predation from killer whales to prevent the sea lion population from recovering to higher levels, as the predator population may be sustained at relatively high levels due to the availability of squid.

3. PUBLICATIONS/PRESENTATIONS

- Wade, P. R., Durban, J. W., Gelatt, T., Pitman, R. L., Andrews, R. D. 2015. Take me to the spa – North Pacific killer whales make rapid long-range movements to subtropical waters: more evidence for physiological maintenance migrations? Talk presented at the Biennial Conference of the Society for Marine Mammalogy, December 2015, San Francisco.
- Wade, P. R., Durban, J. W., Andrews, R. D., and Gelatt, T. 2016. Steak for breakfast and calamari for dinner – does a balanced diet for killer whales mean a predator pit for Steller sea lions? Poster presented at the Alaska Marine Science Symposium, January, 2016, Anchorage.
- Wade, P. R. 2015. Steller Sea Lions for Breakfast and Calamari for Dinner–A Balanced Diet for Killer Whales? Alaska Fisheries Science Center Quarterly Research Reports & Activities, Spring 2015. <http://www.afsc.noaa.gov/Quarterly/AMJ2015/tocNMML.htm>