The use of Dtags to assess the risk of entanglement for humpback and fin whales in Maine coastal fishing waters

Project Manager:

Erin Summers
Maine Department of Marine Resources
PO Box 8
West Boothbay Harbor, ME. 04575
(207) 633-9556 office
(207) 633-9579 fax
erin.l.summers@maine.gov

Co-investigators:

Alex Loer
Ocean Works Group, Inc.
Mattapoisett, Ma. 02739
(617) 721-5437 phone
(508)758-9436 fax
info@pier8pictures.com

Peter Tyack
Woods Hole Oceanographic Institution
Woods Hole, Ma. 02543
(508) 289-2818 phone
(508) 457-2041 fax
ptyack@whoi.edu

Mark Johnson
Woods Hole Oceanographic Institute
Woods Hole, Ma. 02543
(508) 289-2605 phone
(508) 457-2195 fax
majohnson@whoi.edu

Reporting period: June 1, 2008 – November 30, 2009

Final Report

Project summary and background

The Maine Department of Marine Resources (DMR) has been working with the Atlantic Large Whale Take Reduction Team since its inception to quantify and reduce the risk of entanglements of large whales in Maine's coastal fishing habitats. There has been a stated consensus among scientists that information regarding the foraging habits of large whales, including humpback (*Megaptera novaeangliae*) and fin (*Balaenoptera physalus*) whales, are unknown in rocky bottom habitats that make up the majority of Maine's coast. Until recently, efforts to modify inshore fishing gear have been hindered not only by our ignorance of the entanglement process but also how the risk of entanglement could vary with feeding behaviors, depth and bottom type in different areas. Given these data gaps it was of the utmost importance to the take reduction process to assess the risk of entanglement as a function of depth in the critical inshore fishing grounds of the Gulf of Maine. The data in the following report provides information critical for understanding which parts of fixed gear potentially pose the most risk of entanglement and how risk changes by area with related gear density and configurations. Dtags, developed by Tyack and Johnson at the Woods Hole Oceanographic Institute (WHOI), were used to non-invasively record sounds, depth and behavior of two tagged humpback whales. No fin whales were tagged in the study. Tags were deployed with priority being given to coastal down-east areas. Relative depth, gear density in the immediate area and other environmental variables were collected during tracking procedures. Based on recorded depths and the occurrence of mud on one tagged whale's head, it was concluded that whales were diving at or near the bottom, but were not exhibiting extensive rolling behavior. The majority of time was spent in the top 20 meters of the water column for both whales, with up to 13 deep dives occurring during the near 4 hour recording period. Based on these conclusions, the structure of the gear at the surface system and at the bottom were determined to be the parts of the gear that pose the most risk of entanglement. Since the ban on floating groundline went into effect in April of 2009, much of the risk at the bottom has been eliminated. After the tagging field work was completed, some funds were directed to determining the density of vertical lines in the immediate and adjacent areas of the whale sightings.

Project accomplishments:

Field Survey

The tagging effort was mounted July 20 through August 4, 2008. Only six of these days were used for survey effort due to poor weather conditions and low visibility. Surveys were carried out aboard the R/V Stellwagen with sighting support from the Bar Harbor Whale Watch vessels and local researchers from Allied Whale/College of the Atlantic (COA). Observers were stationed port and starboard on the fly bridge at a height of eye of 25' in a two hour rotation. All sightings of marine mammals were recorded on a laptop on the fly bridge as well as environmental conditions, visibility, Beaufort sea state, cloud cover, wind speed and direction, fishing gear densities, and the presence of active fishing boats (Figure 1). GPS survey effort was recorded in real time automatically on the laptop. Tagging procedures were conducted by a tagging team from WHOI on a 23' hard bottom inflatable. Photo-identification specialists from NMFS and the Whale Center of New England were also stationed on the inflatable to document individuals and tag placement. Five tagging efforts were made during the survey. During those efforts the team was able to tag two humpback whales. "Himalaya" was tagged on July 22 for about three and a half hours and "Breakers" was tagged on July 29 for about four hours. No fin whales were tagged during the cruise. Tags were programmed to come off prior to sunset to ensure retrieval.

Gear Methods

While relative gear densities within the immediate area of the tagged whale were judged and recorded by observers during the survey effort, a larger comprehensive look at gear in the area was done during the summer of 2009. While it was not done simultaneous to the tagging, the data are still relevant as gear placement and seasonality are fairly stable in the lobster industry from year to year. Lobstermen fish territories that may have been fished in their families for generations during different seasons of the year. Funds from this grant, along with several other sources were pooled to do a pilot program of targeted surveys to determine vertical line density in the area as well as assess potential overlap with whale habitat. This work is on-going through other funding sources and remains important for putting whale habitat use and behavior in context with the potential entanglement risk in areas with different gear density and configuration characteristics.

DMR partnered with COA to design and implement the pilot project aimed at determining methods that could be used for on-the-water buoy density counts. Transects off the coast of Bar Harbor were done throughout the peak fishing season in 2009 (July through October). Randomized transect lines were set up in the area and sampled twice a month, weather permitting. An inter-sampling period of two weeks was chosen, as lobster gear is usually not moved in a time span shorter than that. Data was compiled after the close of season and displayed in a geodatabase in ArcGIS. The number of vertical lines per unit effort was calculated and will be compared to results gathered through other methods such as the on-going fishery dependent gear surveys and reporting logs. To avoid double counting of gear, and to ensure the most efficient and accurate survey technique, data collection while aboard the vessel was standardized by only noting gear distribution to the starboard side of the vessel, since attempting to observe both sides would result in patchy data and an inability to count every buoy. All buoys sighted within 0.5 nm from the starboard beam of the vessel, were recorded in an HP Ipaq handheld PDA connected to a GPS, which also collect a latitude and longitude position along the transect line.

In addition to the standardized trackline, opportunistic data were collected on various vessels as they become available; for example, the Bar Harbor Whale Watch Company fleet. While not systematic or unbiased in their data collection methods, the whale watch vessels added important and complementary data for this study, especially in recording the simultaneous presence of whales and gear. Because the buoy positions were recorded up to a half nautical mile away from the starboard beam of the boat, these data were organized by half nautical mile increments along the transect line. This shows how many buoys per half nautical mile were within a half nautical mile of the research vessel.

Results

Humpback Dive Summaries

Figure 2 depicts the cruise effort with track lines from both tagged whales; “Himalaya” is in red (left) and “Breakers” is in blue (right). Both whales stay close to the 50 fathom contour line depicted in orange. This is a feature that many fishermen say marks the change in bottom type from hard rock and ledge to more gravel and mud. Himalaya recorded 13 deep dives shown in Figure 3. The majority of the remaining recorded time was spent in shallow dives in the top 20 meters of the water column. Table 1 shows dive

and bottom time durations as well as maximum dive depths and approximate water depths taken from the vessel during focal follows. Mean dive depths ranged from 77-91 meters with an average dive time of 4.4 minutes (2 minute average bottom time). Breakers logged 8 deep dives (Figure 4). Shallow dives also stayed around 10-20 meters but had longer durations than Himalaya, potentially showing some kind of foraging behavior. Table 2 shows dive and bottom time durations as well as maximum dive depths and approximate water depths for Breakers. Dives were longer and deeper with an average of 7.3 minutes (2.4 minute average bottom time) duration to depths ranging from 81-105 meters.

While we were not able to get a precise track of the tagged whales during the tracking effort, the depths recorded by the Stellwagen seem to indicate that both whales were using the entire water column. Additionally, prior to tagging, a photograph was taken of Breakers with mud on the top of the head. This indicates some rolling behavior on the bottom, although this was not seen in the tag data. Unfortunately, both whales were tagged far enough offshore that the bottom type was not the hard, rocky bottom we were hoping to capture. In the future, more sea days will be needed to ensure that at least some of the whales tagged can be found inside of the rocky bottom zone. The density of whales in these areas is low enough to make a lot of effort there with limited days at sea not efficient.

No vocalizations were recorded for either whale. Both traveled alone and exhibited no rolling or other behavior at the bottom. While Breakers traveled offshore beyond the 12 nautical mile line, Himalaya was first sighted within state waters (3 miles from shore) and very near the Maine exemption area. Himalaya's track occurs completely within federal waters, however, the proximity of the higher densities of gear within the state water limit should be noted.

Gear

Figure 5 shows all of the effort that was done during the 2009 fishing season to document gear density on both standardized and opportunistic platforms. A 2km buffer was placed around all concurrent sightings of whales (noted during the gear surveys) to determine the extent of overlap between whales and gear in the area. A green buffer indicates that there is no overlap, yellow indicates an overlap with 1 piece of gear, orange depicts an

overlap with 2-3 pieces of gear and red indicates an overlap of 4-8 pieces of gear. Figure 6 shows an example of the standardized survey effort that was done in the area where Breakers was tagged. Figure 7 shows an opportunistic track aboard the Bar Harbor Whale Watch. As the sightings of whales get closer the state waters boundary, the more overlap with gear is reported. This is also indicated in Figure 7 that breaks down the number of vertical lines recorded compared to whale sightings in the different reporting areas (exemption area, within 12 miles and beyond the 12 nautical mile boundary).

Figure 8 and 9 are taken from vertical line survey data done by DMR in 2008. This survey documented the configuration and density of gear fished in different areas by month. This data was used to extrapolate how many vertical lines are present per square kilometer in different areas by month. Figure 8 shows those calculations for the same month in which the whales were tagged. While densities are low in federal waters where the tracks occurred, they reach 69 and 186 vertical lines per square kilometer in the areas just adjacent to where Himalaya was tagged. Additionally, this data can be used to assess changes that can be made to reduce the risk of entanglement in vertical lines. Figure 9 shows the configurations of gear that were documented in the survey. An area such as Zone B, which is where both Breakers and Himalaya were tagged, may be able to simply change configurations to longer trawls to achieve a reduction in vertical lines. However, areas such as Zone A, to the east of where Breakers was tagged, already fish longer trawls and may have to resort to a trap cut to achieve the same reduction in risk.

Entanglement Context

It was concluded based on the dive data that the biggest risk for entanglement in the areas that the humpbacks were tagged is in the surface system. While, both whales appeared to be utilizing the water column just above the bottom, both whales were tagged in areas under current regulations through the Atlantic Large Whale Take Reduction Plan that requires the use of sinking groundline between traps. This nearly eliminates the risk of entanglement in groundline in these areas. However, caution should be used due to the close proximity of Himalaya to waters that are exempted from Take Reduction Plan and floating groundlines are not prohibited.

The majority of time was spent in the top 20 meters for both humpback whales. While inshore lobster gear generally only uses a single buoy to mark the location, offshore gear

can have additional flotation devices such as toggles and a second line marker such as a highflyer. The current regulations require no floating line to be found at the surface. While this may be less of an entanglement risk for surface feeders, there is concern that line sinking down through the water column could pose an entanglement risk to whales doing shallow dives such as those in this study. More research on the risk of surface systems and viable alternatives is warranted.

Both whales were tagged outside of the three mile limit, while most of the lobster fishery in Maine is conducted inside of this line. As seen in Figure 8, the density of vertical lines as extrapolated from previous gear surveys is different as you move across areas. The majority of the Maine lobster fishery holds state licenses but not federal, restricting them to waters inside of the three mile limit. This division of fishing areas changes the number of lines spanning the water column that large whales might encounter. For instance, Himalaya was first sighted inside of the three mile limit where the density of gear is much higher than the federal waters through which it was tracked.

Dissemination

This work has been presented as a poster at the Maine Fishermen's Forum in March of 2009 as well as at the Biennial Conference for the Society of Marine Mammalogy in Quebec City in October of 2009. In addition to formal presentations, this work has been discussed with fishermen at different industry meetings. Future plans for this work have included securing additional funding to expand the sample size and include more species, right and fin whales, as well as conduct simultaneous measurements of prey characteristics. This has not been accomplished to date. However, the Program Manager is interested in pursuing a publication for this data even if the sample size can not be expanded.

Deviations in the work plan

We were not able to record precise tracks as was planned in the original proposal. Pinger buoys that were supposed to triangulate the locations of the diving whales were supposed to give researchers exact locations of deep dives and therefore the depth and bathymetry of the bottom. However, due to poor weather conditions (fog and rough seas) during the field portion of the survey, the pinger buoys were not able to be deployed during the

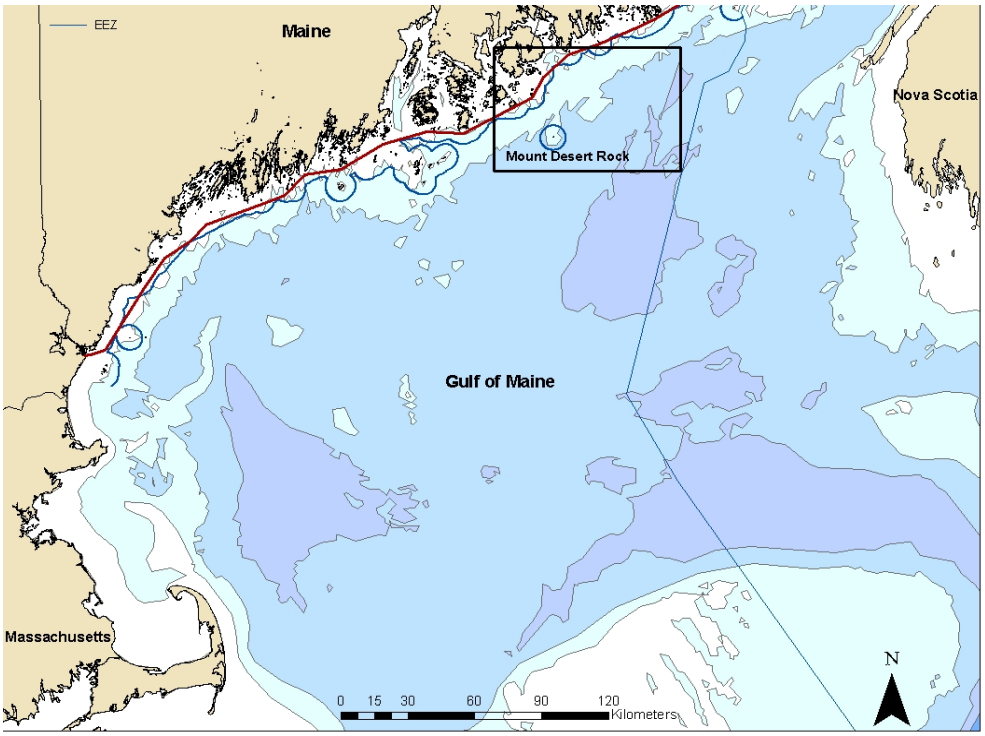
tagging and tracking process. The tracking vessel tried to take depths as often as possible but these could not be synced exactly with diving locations. We do have confidence that both whales were utilizing the entire water column based on maximum dive depths, recorded bottom depths and the mud on Breakers' head after a dive.

We were also not able to get any tags out on fin whales. It was determined that the tagging operations would be concentrated first on humpback whales and then move to other species. Fin whales are faster and more elusive than humpback whales and with reduced visibility and rough seas it was decided that putting tags on fin whales would risk losing the equipment.

The pilot project to record gear density in the area of tagging operations was an amendment made to the scope of the grant in 2009. Funds left over after the tagging portion of this project were used to support this piece and added good context to the question of entanglement risk in relation to the location of the active fishery.

Figures and Tables:

A.



B.

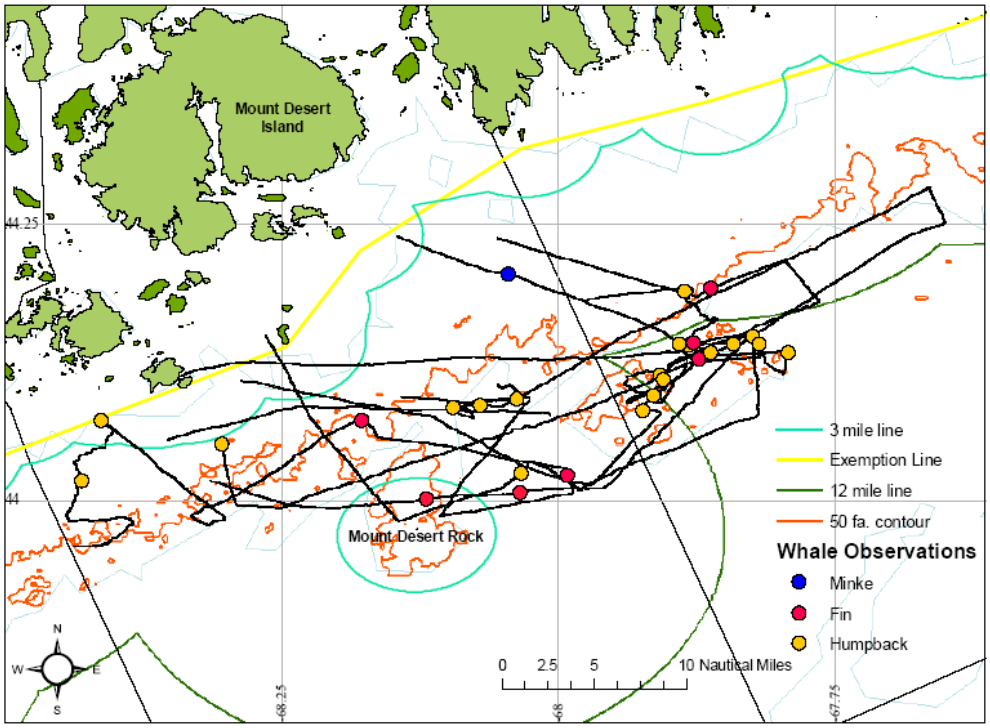


Figure 1. Study area around Mount Desert Rock and Island and the Schoodic Ridges in Downeast Maine. A) Indicates the study area in the regional context. B) Shows all tracklines recorded during the survey as well as all sightings of large whales seen while on effort.

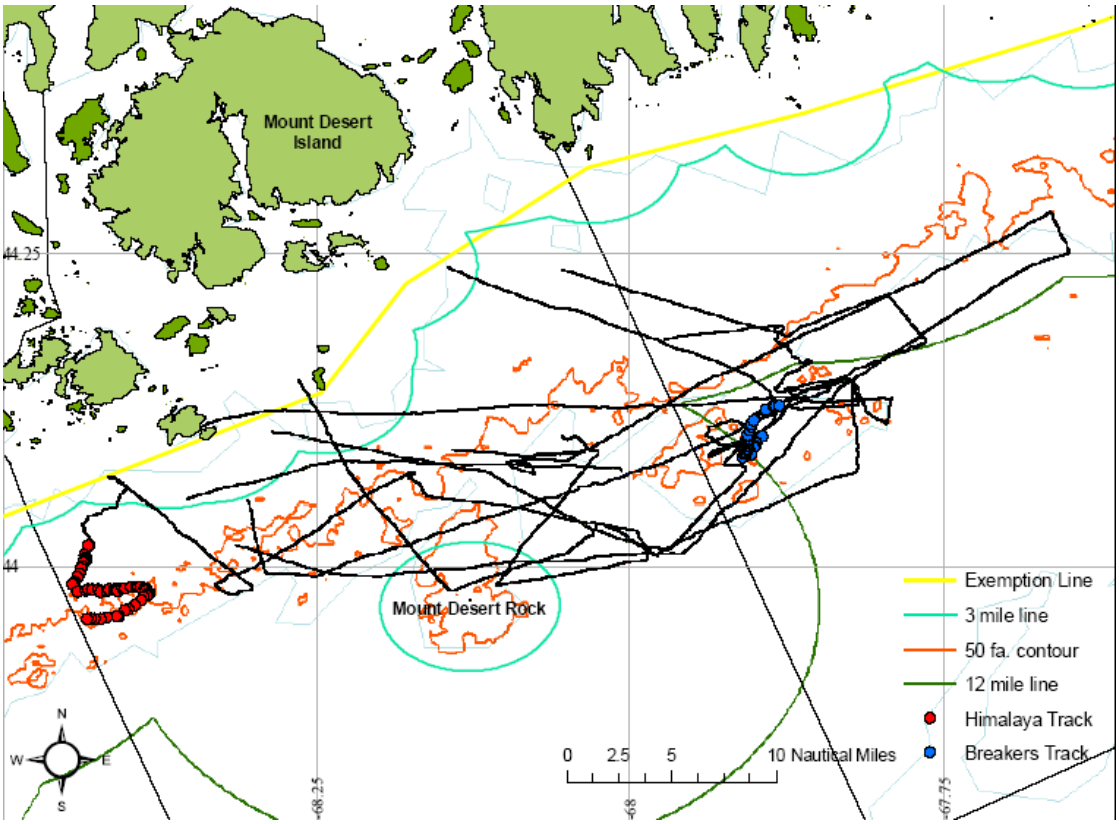


Figure 2. Indicates the position of the tracks of Himalaya (in red) and Breakers (in blue) in context with all of the effort done on the survey and the 50 fa. contour line in orange. Breakers was tagged offshore, just past the 12 nautical mile line. Himalaya was tagged just outside of the three mile state waters limit, although it was first sighted within this zone.

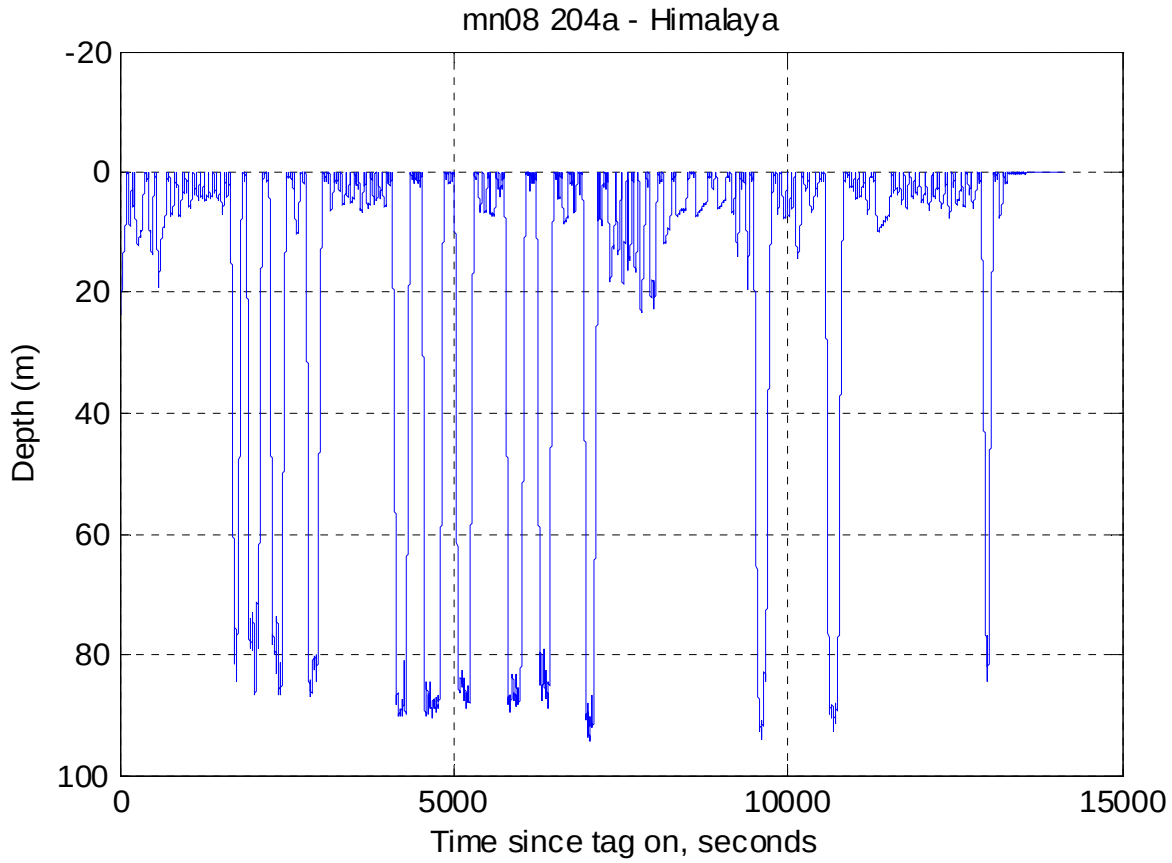


Figure 3. The dive profiles of Himalaya. Thirteen deep dives were logged in around 4 hours, although the majority of time is spent in the top 20 meters of the water column.

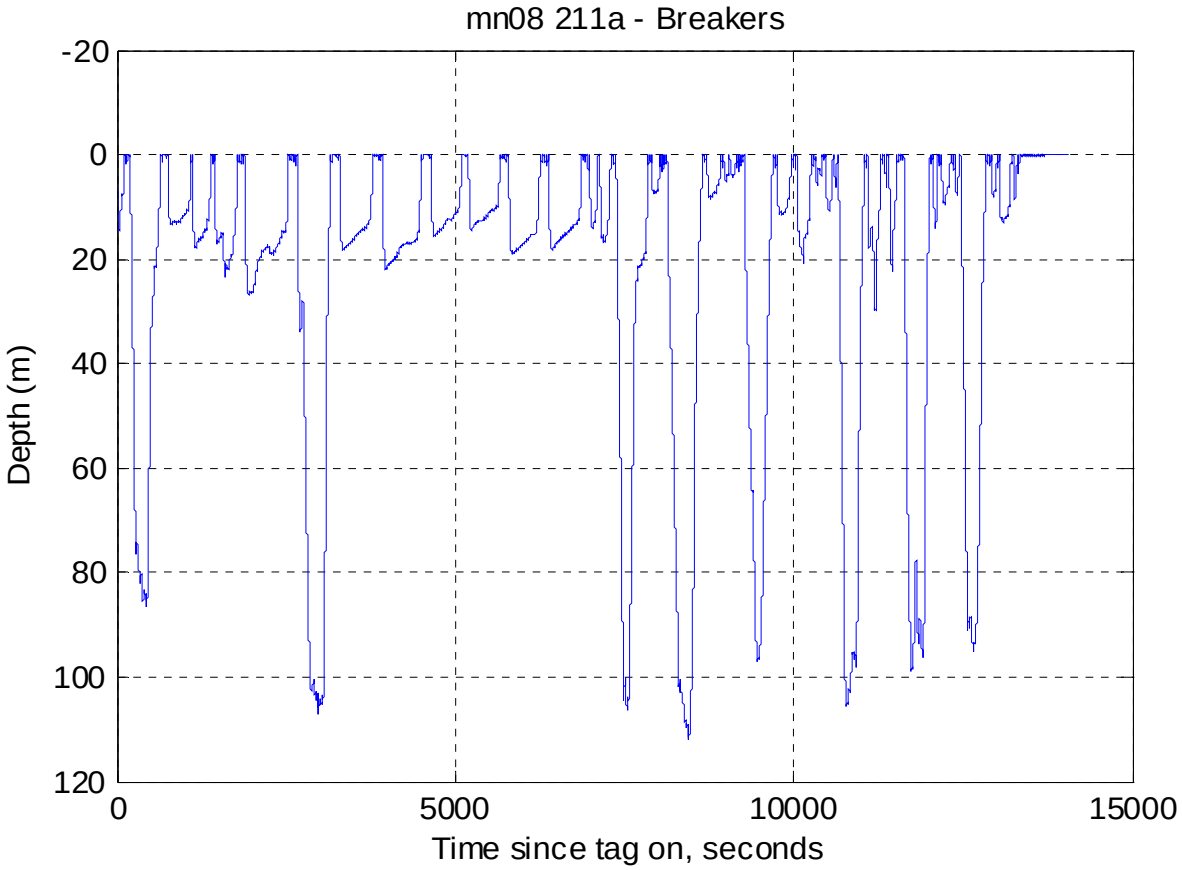


Figure 4. The dive profiles of Breakers. Eight deep dives were recorded during the tag duration. Breakers' dives were longer and deeper than Himalaya as the track was further offshore. There is some indication that foraging could be occurring in the top 20 meters with the extended shallow dives recorded here.

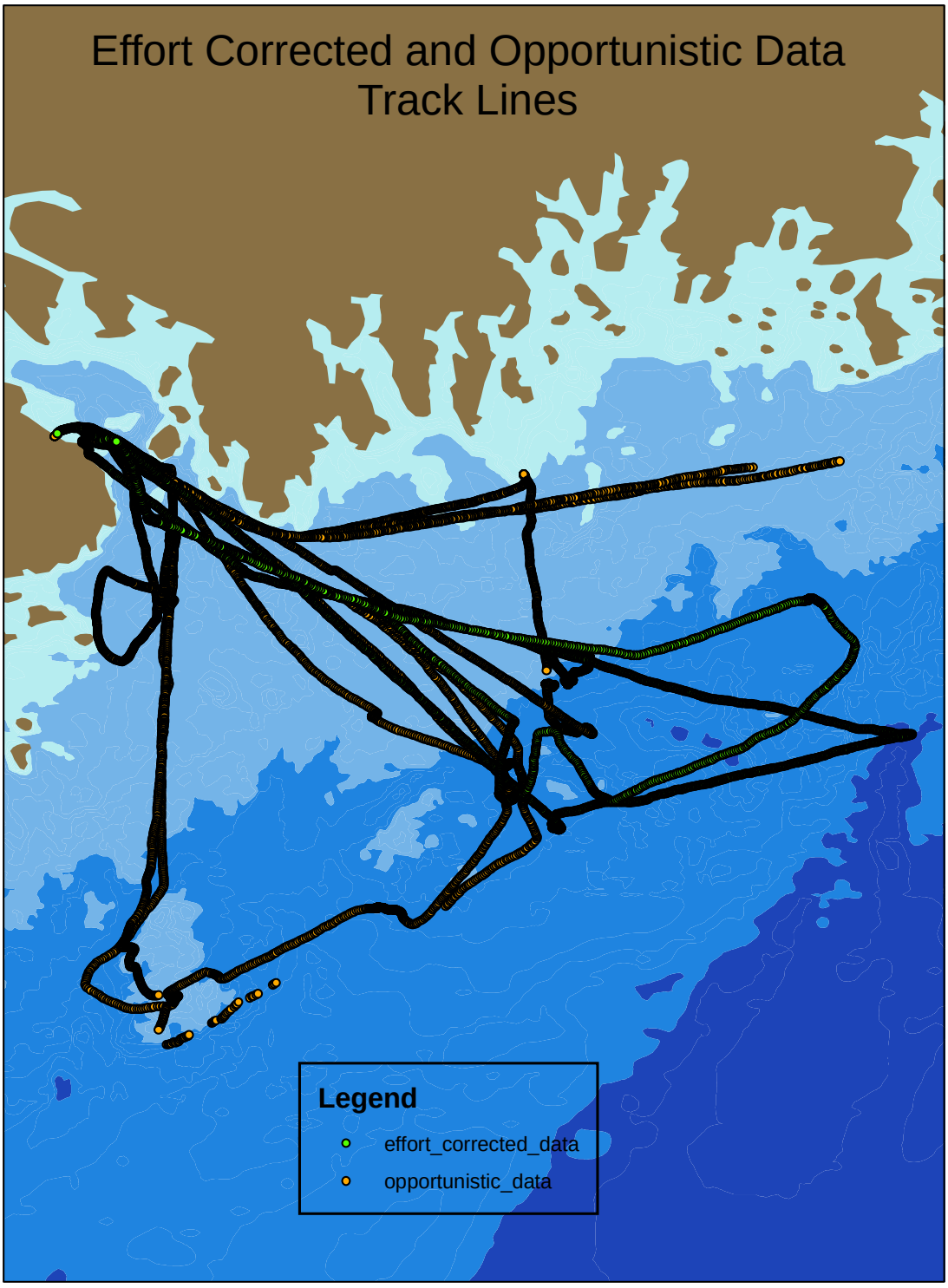


Figure 5. All effort that was conducted for the gear density pilot project on both standardized surveys and opportunistic platforms.

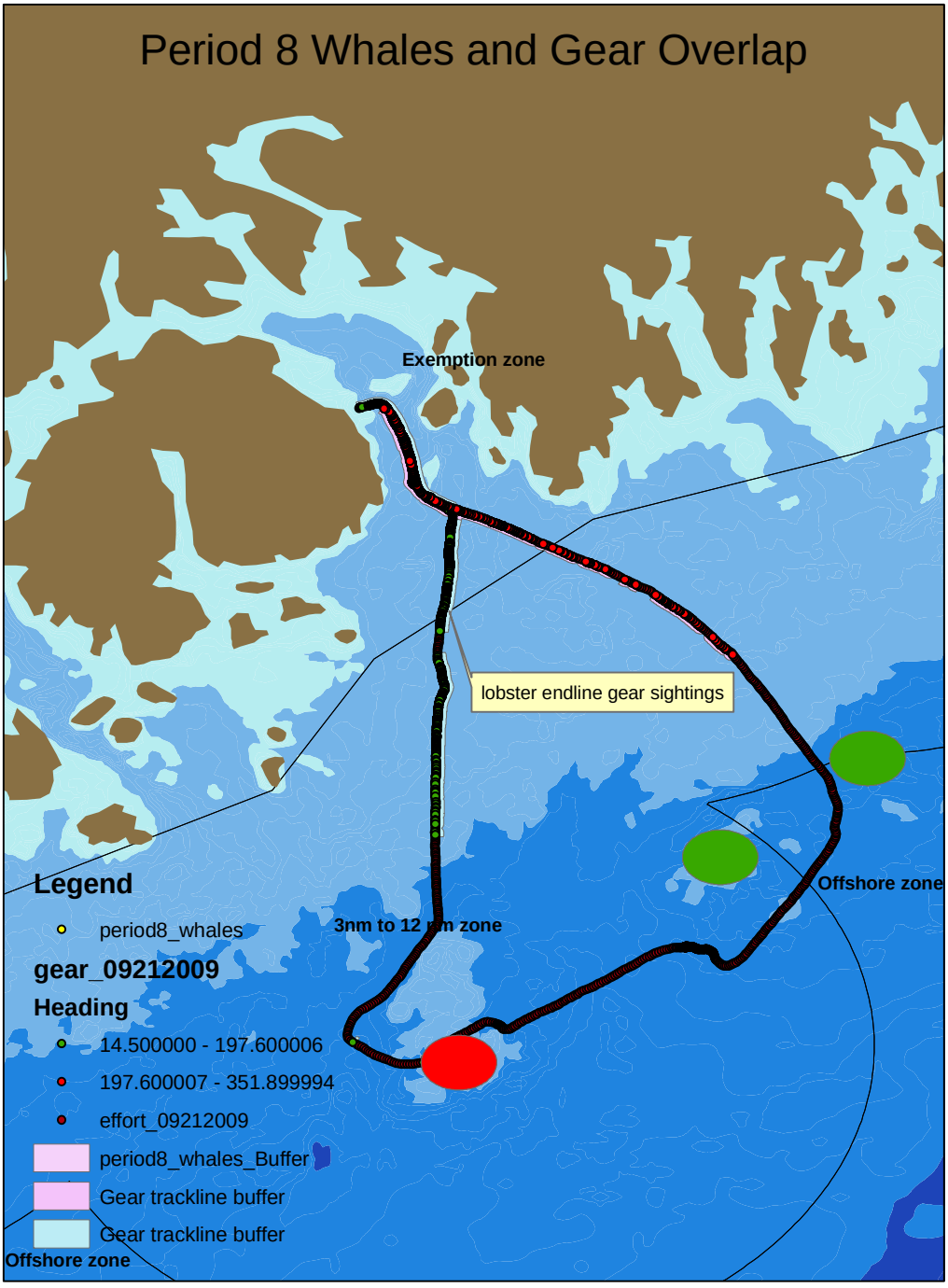


Figure 6. An example of whale/gear overlap using the 2km buffer. The area with the high overlap is within the three mile area around Mount Desert Rock. This is an offshore area that is considered state waters because it surrounds an island so state waters fishermen can fish here.

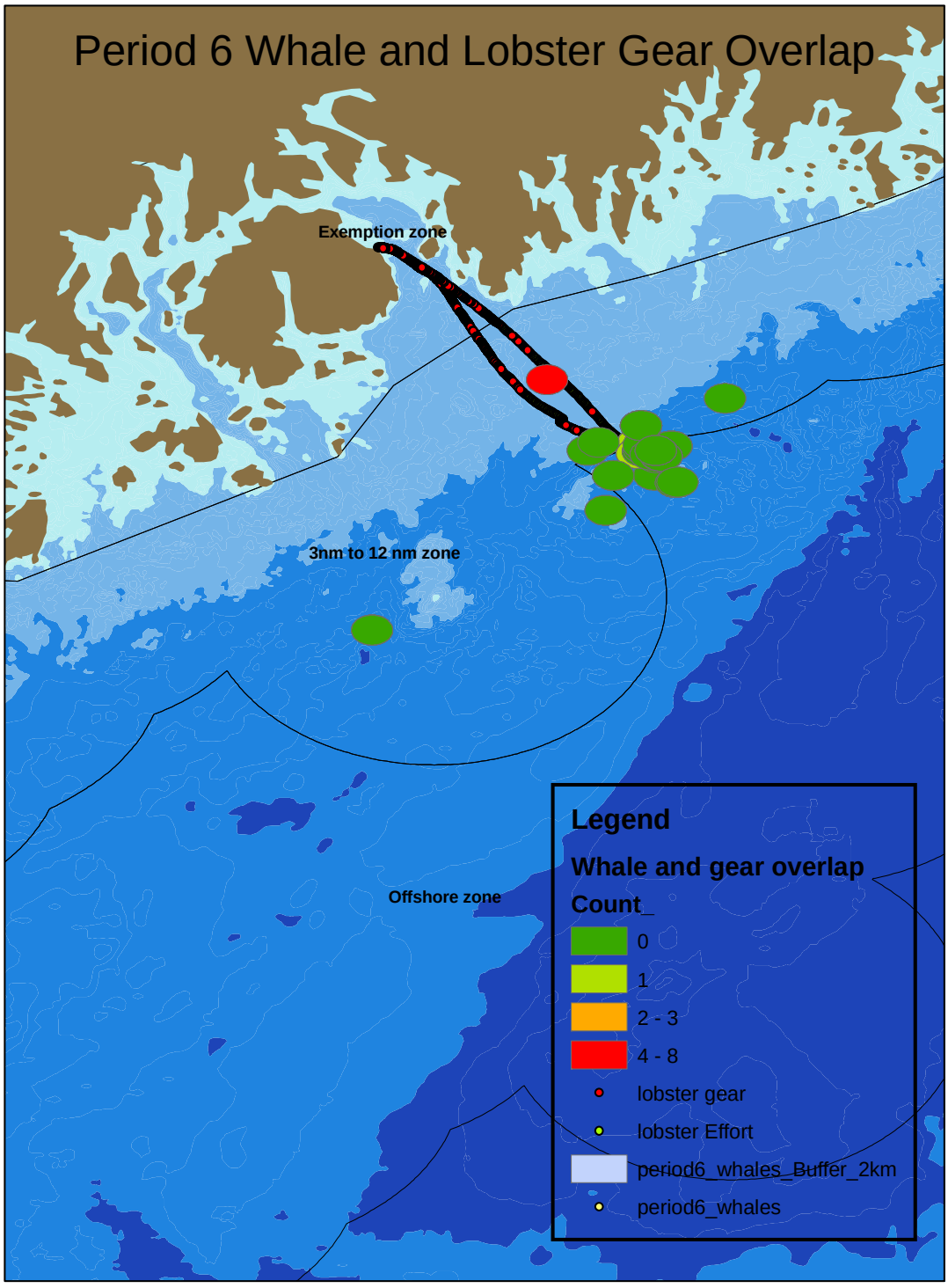


Figure 7. An example of an opportunistic track that documented both whales and gear. This area overlaps directly with the track recorded for Breakers.

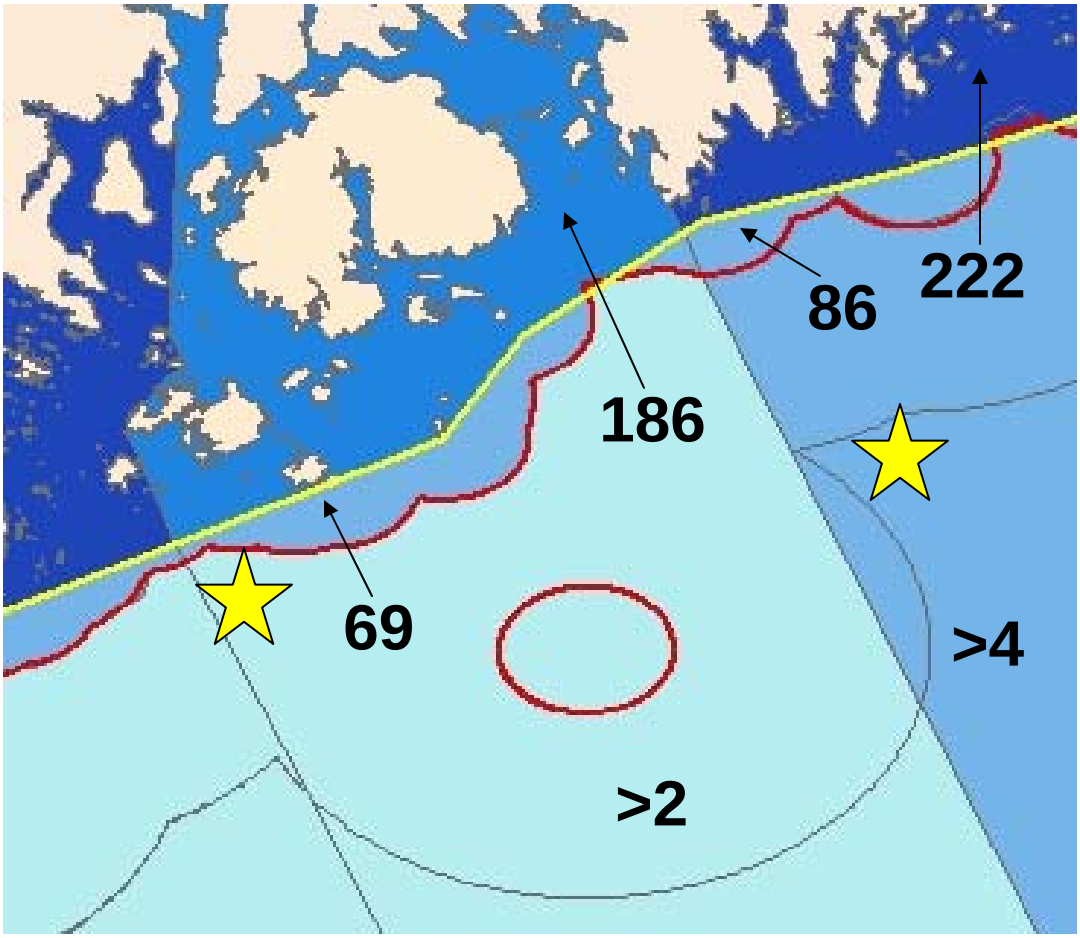
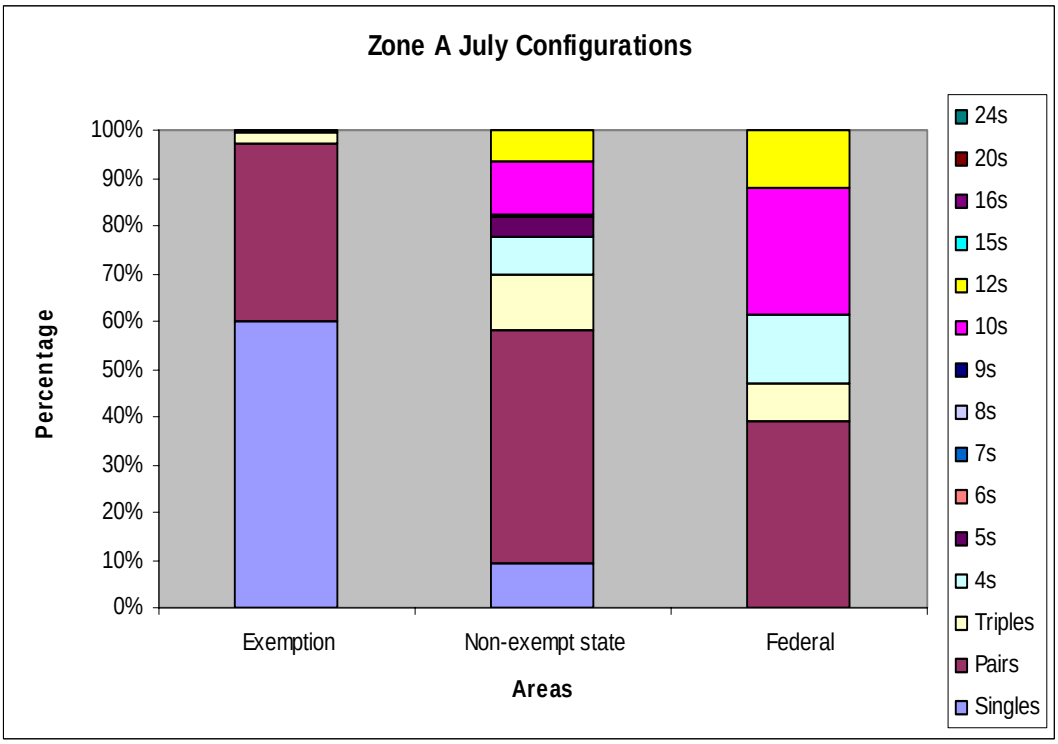


Figure 8. Vertical line densities in square kilometers by area for the month of July as calculated from the 2008 DMR gear survey. The stars indicate the locations of the tagged whales. Both occur in federal waters where vertical line densities are low. However, Himalaya was sighted in the area with 69 vertical lines per square kilometer and is near the area with 186 lines/km^2.

A.



B.

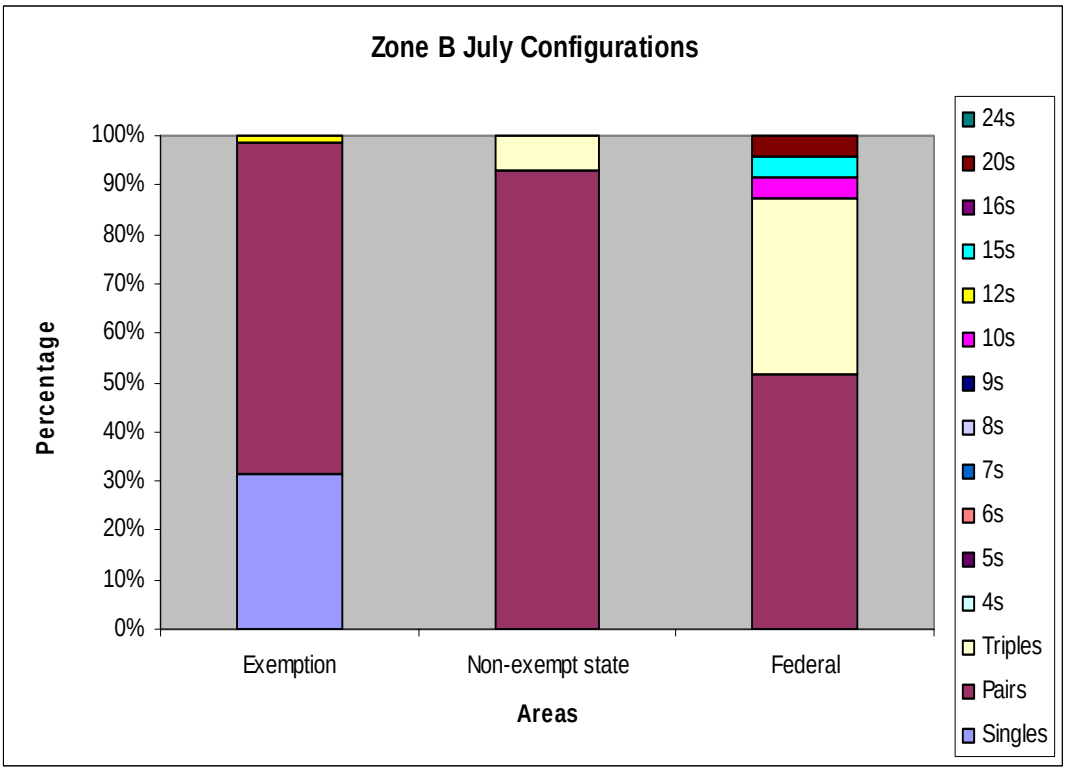


Figure 9. Depicts the gear configurations for the two zones in the area in which the whales were tagged (both are inside of Zone B and Zone A is to the east of Breakers). A). Zone A fishermen fish longer gear in longer trawls outside of the exemption area than Zone B. B). Zone B fishes short sets of gear and could potentially trawl up their gear to achieve entanglement risk reduction through fewer lines in the water column.

Dive #	Duration (seconds)	Max dive depth (m)	Total Bottom Time (sec)	Approx. Water depth (m)
1	177	84.54	58	86.97
2	244	86.77	133	86.67
3	264	86.79	129	84.85
4	266	86.92	111	87.27
5	282	90.21	136	91.52
6	340	90.59	208	91.52
7	301	88.88	159	90.91
8	322	89.51	180	88.79
9	263	88.94	135	86.97
10	231	94.36	102	N/A
11	275	94.02	124	84.55
12	290	92.67	119	91.52
13	187	84.35	28	84.85

Table 1. The dive statistics for Himalaya's 13 deep dives.

Dive #	Duration (seconds)	Max dive depth (m)	Total Bottom Time (sec)	Approx. Water depth (m)
1	439	86.67	85.67	95.76
2	497	107.13	105.13	100.30
3	470	106.34	103.34	98.18
4	521	111.97	107.97	104.24
5	423	97.2	92.2	100.90
6	383	105.77	99.77	N/A
7	390	98.85	91.85	N/A
8	380	95.21	87.21	N/A

Table 2. The dive statistics for Breakers' 8 deep dives

	GEAR	WHALES
Exemption Area	5699	10
exempt-12 Miles	3707	144
12 plus miles	0	146

Table 3. The amount of gear/vertical lines and whale sightings logged in the different areas during the gear density pilot project. Note that most sightings of whales take place in offshore waters while most of the gear recorded is found inside of three miles where the majority of the fishery is permitted to fish.