Yaquina Head Seabird Colony Monitoring
2017 Season Summary

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December 2017

Project Overview

Yaquina Head Outstanding Natural Area (YHONA) is home to some of Oregon's largest and most publically visible seabird colonies, including over 60,000 Common Murres (*Uria aalge*). The seabird colonies surrounding Yaquina Head present a unique opportunity for research and monitoring given their close proximity to viewing platforms and intensive oceanographic studies of surrounding waters. During a nearly 30-year period since 1980, this was one of the most rapidly growing and productive murre colonies on the Oregon coast. In the past 7 years, however, reproductive success was greatly reduced with the colony experiencing reproductive failure during several years.

Summer 2017 was the 11th consecutive year of collaboration between Oregon State University, U.S. Fish and Wildlife Service, and the Bureau of Land Management, extending the full time series to 16-years when combined with similar data collected by Julia Parrish (University of Washington) at Yaquina Head from 1998 to 2002. Even though some basin-scale physical ocean indicators like the Pacific Decadal Oscillation (PDO) and the El Niño Southern Oscillation Index (ENSO) were trending back toward long-term averages by summer 2017 (PDO slightly positive, ENSO slightly negative), the residual biological impacts of the recent marine heat wave were prominent in the Northern California Current System off Oregon and Washington. The recent marine heat wave in the northeast Pacific identified initially as "the blob" in late 2013 then persisting through 2016 as a strong ENSO is proving to be a major disruption to the ecosystem in the Pacific Northwest. The significance of this heat wave is not only the multi-year duration, but also the greater depth at which water temperatures were affected. Looking ahead, projections for 2018 are to maintain the La Niña ocean cooling trend, however the extent to which biological responses will lag these physical changes after such a prolonged perturbation is uncertain. Continuing the time series of seabird studies at Yaquina Head is an important contribution to understanding local biological impacts of these large-scale climate fluctuations. Recent years have certainly been interesting to capture seabird responses to environmental variability on the central Oregon coast.

In general, we are interested in how seabird breeding chronology, reproductive success, diet, and foraging activities are affected by changing ocean conditions. However, there is another important dynamic occurring with seabird predators, mainly increasing numbers of Bald Eagles (*Haliaeetus leucocephalus*) and other predators impacting the seabird colonies on the Oregon Coast. Our objectives include quantifying the effects of Bald Eagles and other sources of predation on or disturbance to seabirds during the breeding season. Last year we added additional reproductive monitoring plots to account for changing colony and predator-prey dynamics. This year, we had to conduct all observations from the public viewing deck at the base of the lighthouse, which prevented monitoring of one of our long-term monitoring plots (see footnote of Table 1). We also added two new plots on Lion's Head and one plot on West Whaleback Rock (a location not used by nesting murres in previous years). All plots were monitored throughout the breeding season (May-August). Within these plots, we closely observed breeding birds (Fig. 2), watching and recording when eggs were laid and then following the success of each breeding pair through egg incubation and chick rearing. Simultaneously, we watched for disturbances to the breeding colony and recorded the frequency, duration, and consequences (e.g., loss of eggs or chicks) of these events. For prey identification, we used a digital camera and spotting scope (digiscoping; Fig. 3) to photograph fish in the bills of murres returning to the colony. This information allows us to analyze the birds' diet and provide information about foraging conditions and link to oceanographic investigations adjacent to these seabird colonies. No chicks survived long enough for us to conduct feeding rate observation in 2017. In 2017, we also completed our third year of using satellite tags to track the spatial movements of individual murres during and after the breeding season.

Results

In 2017, we logged 203 hours during 99 days of observations between 16 May and 15 August for murre reproductive success and predators (Table 1), and through 22 August for cormorant nesting observations and murre diets. In 2017, **Common Murres experienced complete reproductive failure (reproductive success = 0.00 $\pm$ 0.00 SE) in all plots**. There were no visible signs of successful breeders throughout the entire Yaquina Head colony**.** This was the third time in 16 years of data collection that the main sub-colonies failed, maintaining a 7-year run (2011-2017) of low reproductive success that is less than half the success for the first four years of study (2007-2010, Table 1). During widespread colony failures in 2015 and 2016, a few chicks ($\leq$ 12 chicks) survived on Lower Colony Rock, which received little or no predator disturbance. Even Lower Colony Rock, however, did not have chicks survive to fledging in 2017. Murres on Lower Colony Rock were able to incubate their eggs the longest (max of 17 days) compared to any other plot (max of 4 days) in 2017. Overall, average incubation time was less than 3 days before an egg was lost, well under the approximately 30 or more days that are needed for successful incubation.

During 203 hours of observation, we witnessed 107 disturbance events where a minimum of 483 eggs, 0 chicks, and 15 adult murres were taken (Table 1). Like previous seasons, much of the reproductive loss in 2017 was due to egg predators. **Rates of murre egg depredation (2.38 eggs/hr) was average** for the 2011-2017 period of elevated disturbance rates (Table 1). The **adult murre depredation rate (0.07 adult murres/hr), however, was much less**, and more comparable to the low disturbance period of 2007-2010. Occasionally disturbance events are already in progress when observers arrived at the colony and not all predation events were observed, therefore, the rate of egg and adult murre loss should be considered conservative estimates. **Bald Eagles were again the dominant disturbance source (80%, Fig. 5)**. There were no disturbances caused by Brown Pelicans, and pelicans were not observed landing on the colony.

Murre diets vary annually and are generally dominated by either clupeids (herring or sardines), Pacific sand lance (*Ammodytes hexapterus*), or smelt (Osmeridae), but occasionally occur in relatively equal proportions in a given year. The failure of most of the colony prior to chick hatch provided an added challenge for diet data collection. We were able to collect diet data, however, very few of these samples were likely fed to chicks, but instead simply adults flying into the colony with fish. **Diets in 2017 were again dominated by smelt (53%), but with an increase in Pacific sand lance (35%) from previous years (Fig. 6)**. **Sand lance are generally associated with cold water years (e.g., 2008)**.

Since 2010, we have generally conducted four chick provisioning rate watches per year (1-2 in years of high chick mortality). In 2017, however, no chicks survived long enough to permit provisioning rate watches. Chick feeding rates (also foraging trip duration) are a good overall measure of food availability and are a valuable metric to compare among years. Also, due to the reproductive failure, we were not able to collect feathers of beachcast murre chick carcasses from Yaquina Head for stable isotope analyses of diet composition and nutrient sources. With the help of collaborators in southern Oregon, however, we did obtain feather samples from murre chicks fledged from colonies off Bandon Oregon, 125 miles south of Yaquina Head. Beach walkers found relatively few chick carcasses, likely indicating low reproductive success for murres on the southern Oregon coast too.

Brandt's (*Phalacrocorax peniscillatus*) and Pelagic (*P. pelagicus*) Cormorant nests were monitored for the 10th consecutive year (Tables 2 and 3). **In contrast to murres in 2017, both species were successful rearing young. Brandt's Cormorants reproductive success (0.79 fledglings/nest) a bit less than 2016** and overall close to the long term mean (Table 2). Median hatch date (July 6th) and average brood size (1.73 chicks) were close to the long-term averages (Table 2).

Pelagic Cormorants had a new second highest reproductive success (1.65 fledglings/nest), only surpassed by 2013 (2.13 fledglings/nest; Table 3). 2017 had the most nests visible to observers. The number of nests and reproductive success of Pelagic Cormorant has been highly variable during our time series (Table 3).

Summary and Future Directions

The third year of reproductive failure at the Yaquina Head colony raises questions and concerns about the shifting dynamics between murres and eagles on the central Oregon coast. Although disturbance rates were lower in 2017, they still remained within the range of the high disturbance rate period at the colony. That said, evidence of reduced prey availability and lack of parental investment were also evident in explaining the reproductive failure this year. The disturbance activity during the past 8 years has remained elevated compared to the early years of our study (2007-2009). The predation rates in 2010-2017 ranged from 4 to over 10 times the average disturbance rate (disturbances/hour of observation) during 2007-2009. These elevated disturbance rates have taken a toll on reproductive output of the colony and could begin affecting overall size of the colony.

Murre diets in six of the seven previous years have reflected more warm water associated smelt vs. cooler water associated sand lance, consistent with recent warm ocean conditions. Smelt continued to dominate murre diets in 2017, but there was a considerable increase in sand lance. Pacific herring were noticeably minimal in murre diets in 2016 and 2017. The change to smelt dominant diets co-occurred with the period of increased predator activity and it will be very interesting to see if this pattern begins to change with potential La Niña cooling trends in 2018.

Although we were not able to collect chick feeding rate data, none of the four murres tracked during the breeding season conducted central-place foraging trips, in contrast to previous years. Instead, most birds tagged in June and August moved north into Washington and British Columbia, and a couple all of the way into the Gulf of Alaska (Fig. 7). This was the furthest north we have tracked murres from Yaquina Head. Sample sizes of tracked birds are small, but for our birds to disperse north of Oregon is consistent with the generally low prey available reported for Oregon waters and the lack of investment in reproduction that the murres appeared to have.

We will continue studies in 2018 to maintain long-term monitoring and research at this site. Long-term research and monitoring efforts at YHONA are becoming increasingly valuable to oceanographic research and monitoring off Oregon, such as the Newport Hydrographic Line and a wide array of other research conducted by NOAA Fisheries, Oregon State University, and others, including the cabled ocean observing system offshore of Yaquina Head (Endurance Array http://ceoas.oregonstate.edu/ooi/ & http://oceanobservatories.org/array/coastal-endurance/).

We are continuing our efforts to explore the use of remote cameras for data collection and outreach at this site and others along the Oregon coast. In 2017, we concluded the third and final year of our multi-species, at-sea tracking and habitat use study funded by the U.S. Bureau of Ocean Energy Management. This project included common murres among other focal species to assess potential impacts of offshore wind energy development.

An important change in operations for Yaquina Head seabird studies is that Drs. Don Lyons and Rachael Orben, both also with the Department of Fisheries and Wildlife at OSU, will be taking over as leads for this study. This is part of Dr. Rob Suryan's transition to work with NOAA's Alaska Fisheries Science Center in Juneau. It makes departure much easier for Rob to see support from colleagues, the Bureau of Land Management, and the U.S. Fish and Wildlife Service to continue long-term research at this site. Thank you!!

Publications

No new publications at this time, however, 1998-2016 data were included in the 2017 State of the California Current publication (Wells et al., in review) and the 2009-2016 North Pacific Ecosystems Status Report (North Pacific Marine Science Organization, in progress).

Acknowledgements

Data collection during the 2017 field season would not have been possible without the support of the Bureau of Land Management (Janet Johnson, Katherine Fuller, Jay Moeller, Meredith Matherly, and staff at the Yaquina Head Outstanding Natural Area) and the U.S. Fish and Wildlife Service (Kelly Moroney, Shawn Stephensen, Dawn Harris, and Rebecca Chuck of the Oregon Coast National Wildlife Refuge Complex). We thank our volunteers, Rachel Kaplan (OSU) for collecting disturbance and reproductive success data. We also owe a special thanks to Diane and Dave Bilderback and Kent Hall and Beverly Minn for collecting murre chick feathers from beach cast carcasses in Bandon, Oregon. Funding for these studies was provided in part by the Bureau of Land Management and our summer intern was supported by Environment for the Americas.

Table 1. Preliminary summary metrics from studies of Common Murres at the Yaquina Head colony, 2007-2016.

	Observation			**Hatch Date**					**Predation Rate # per hour[c] (total #)**		
Year	**Hours**	**Days**	**# plots**	**1st**	**Med**	**Hatching Success[a]**	**Reproductive Success[b]**	**# disturbances**	**Egg**	**Chick**	**Adult**
2007	149	30	11[d]	6/20	6/27	0.70	0.54	23	0.21	0.00	0.06
						(± 0.05 SE)	(± 0.07 SE)		(32)	(0)	(9)
2008	117	35	11[d]	6/10	6/23	0.86	0.77	20	0.21	0.00	0.04
						(± 0.04 SE)	(± 0.05 SE)		(25)	(0)	(5)
2009	140	53[f]	10[e]	6/17	6/24	0.86	0.77	27	0.36	0.00	0.04
						(± 0.03 SE)	(± 0.04 SE)		(50)	(0)	(6)
2010	223	56	11 [d]	6/24	7/8	0.87	0.68	20	1.07	0.04	0.00
						(± 0.04 SE)	(± 0.04 SE)		(239)	(10)	(0)
2011	372	79	11[d]	6/28	7/8	0.36	0. 22	186	2.78	0.38	0.19
						(± 0.07 SE)	(± 0.05 SE)		(1034)	(142)	(70)
2012	264	53	12	6/25	6/28	0.46	0.27	220	2.69	1.16	0.17
						(± 0.09 SE)	(± 0.06 SE)		(710)	(305)	(46)
2013	200[g]	62	12	6/24	7/4	0.41	0.24	80	1.47	0.22	0.18
						(± 0.09 SE)	(± 0.09 SE)		(275)	(40)	(33)
2014	156	51	12	6/29	7/3	0.23	0.17	75	1.37	0	0.16
						(+ 0.13 SE)	(+ 0.11 SE)		(215)	(0)	(25)
2015	110	46	12	NA	NA	0.0	0.0	65	3.27	0	0.22
						(± 0.0 SE)	(± 0.0 SE)		(360)	(0)	(24)
2016	243	74	13[h]	6/28	7/5	0.03	0.02	132	4.21	0.03	0.28
						(± 0.02 SE)	(± 0.02 SE)		(1023)	(7)	(67)
2017	203	99	10[i]	NA	NA	0.00	0.0	107	2.38	0	0.07
						(± 0.00 SE)	(± 0.0 SE)		(483)	(0)	(15)

[a]Chicks hatched per eggs laid (mean among plots)
[b]Chicks fledged (≥15 days old) per eggs laid (mean among plots)
[c]Total # observed taken/total # observation hours
[d]Two adjacent plots (CR5 & CR6) were combined because of a low number of visible eggs to follow
[e]Two sets of adjacent plots (CR2 & CR3, CR5 & CR6) were combined because of a low number of visible eggs to follow
[f]Thick fog limited observations to very short time periods or prevented observations altogether during some days in July – much more so than in previous years.
[g]Observation hours for disturbance were lower (186 hours, 58 days) because a data book was lost in the field and could not be recovered.
[h]Of the original 12 plots, two adjacent plots (CR2 & CR3) were combined, CR5 was excluded because no eggs within view survived long enough to be mapped within the plot, CR6 was excluded because only one egg was laid within view of observers, and 3 new plots were added on Lower Colony Rock, Satellite Rock, and the south end of Flat Top Rock.
[i] Viewing was restricted to ground level at Yaquina Head. We were not able to use the lighthouse gallery deck as an observation point to look down on the colony. This new viewpoint did not permit observations of FT2 nor the south end of Flat Top Rock. All or a portion of plots from previous years were viewed, however, pairs from some were combined because there were too few pairs (< 10) followed in some plots (FT3,4,5,&6). Additionally, two new plots were added, one each on Whale Rock and Lion's Head Rock, although with < 10 pairs in each, these plots were combined in final analyses.

Table 2. Reproductive metrics of Brant's cormorants at the Yaquina Head colony.

Year	# Nests	Median Hatch Date	Average Brood Size	Fledge Success[a]	Reproductive Success[b]
2008	71	7/8	2.38	0.23	0.55
2009	4	7/11	1.60	0.50	1.00
2010	47	6/30	1.51	0.17	0.25
2011	93	7/11	1.54	0.27	0.42
2012	33	7/20	1.15	0.16	0.18
2013	123	7/9	1.05	0.54	0.57
2014	60	7/3	1.87	0.45	0.72
2015	84	7/21	2.33	0.73	1.70
2016	46	6/27	1.65	0.53	0.87
2017	86	7/6	1.73	0.51	0.79

[a](# of chicks that survive to $\geq$25 days old)/(# of chicks hatched)
[b](# of chicks that survive to $\geq$25 days old)/(# of nests)

Table 3. Reproductive metrics of pelagic cormorants at the Yaquina Head colony.

Year	# Nests	Median Hatch Date	Average Brood Size	Fledge Success[a]	Reproductive Success[b]
2008	20	7/08	1.80	0.44	0.84
2009	12	7/23	1.83	0.09	0.14
2010	26	7/21	1.52	0.28	0.35
2011	6	7/18	0.33	0.00	0.00
2012	16	7/20	2.63	0.40	1.06
2013	16	7/09	2.69	0.79	2.13
2014	34	7/3	2.29	0.53	1.21
2015	11	7/24	0.09	0.00	0.00
2016	30	7/13	2.17	0.63	1.37
2017	46	7/18	2.00	0.75	1.65

[a](# of chicks that survive to $\geq$25 days old)/(# of chicks hatched)
[b](# of chicks that survive to $\geq$25 days old)/(# of nests)

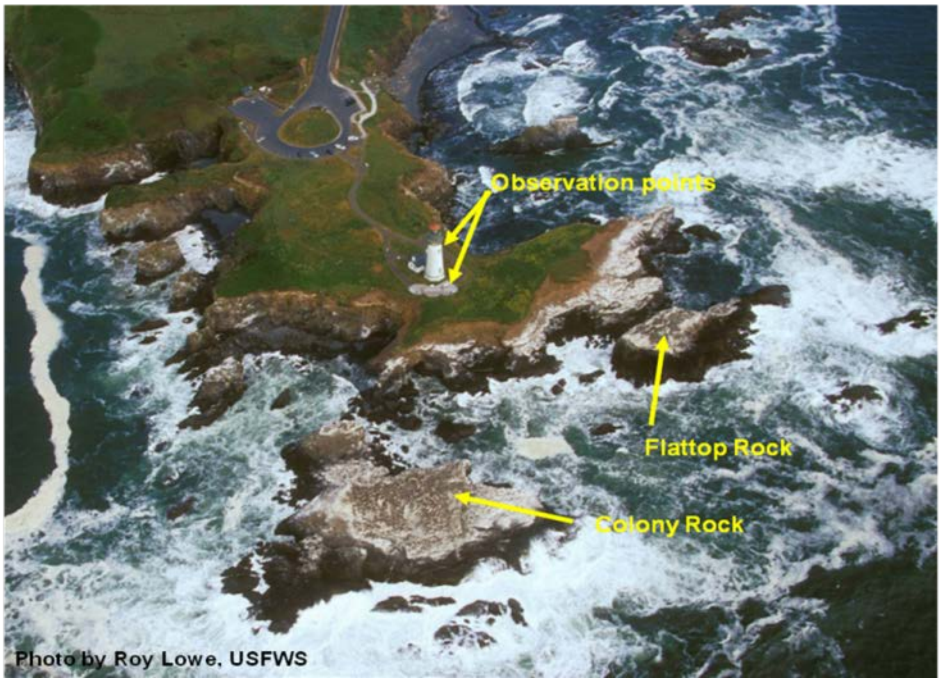

Figure 1. Study plots on Colony and Flat Top Rocks.

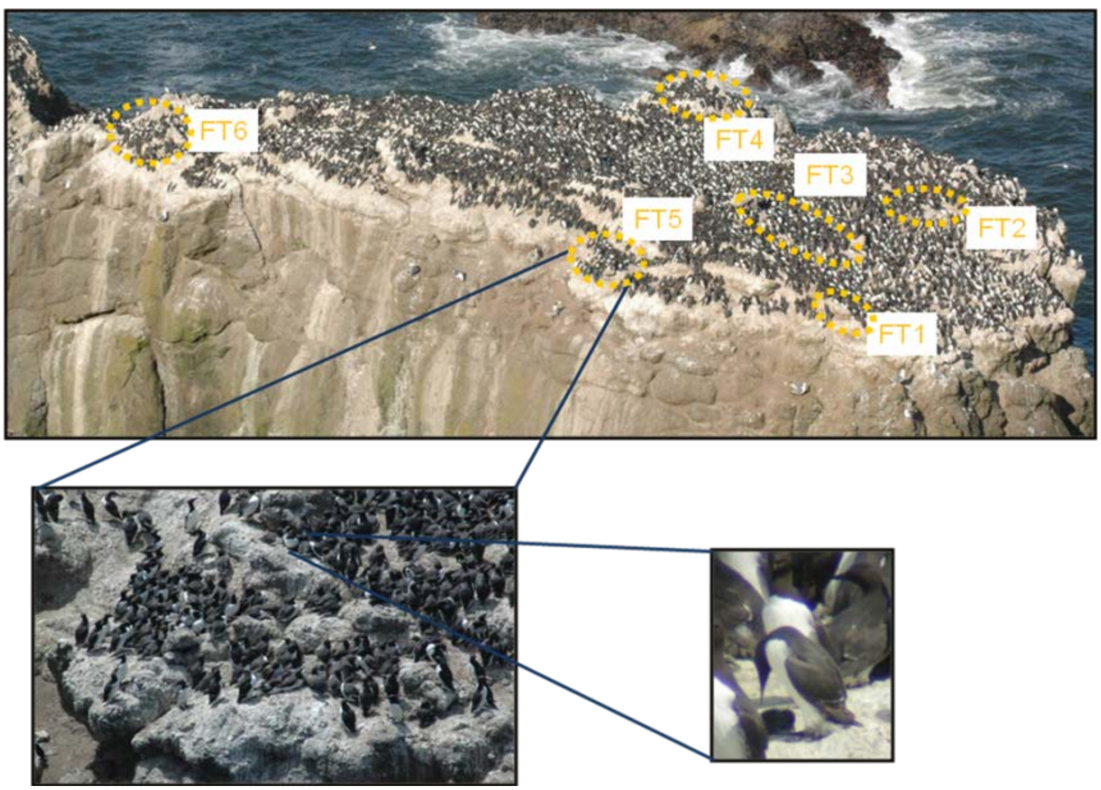

Figure 2. Close-up of Flat Top Rock, plot #5, and an adult with a young chick

Figure 3. Digiscoping techniques for photographing and identifying forage fish delivered by adult murres to feed their chicks on the colony.

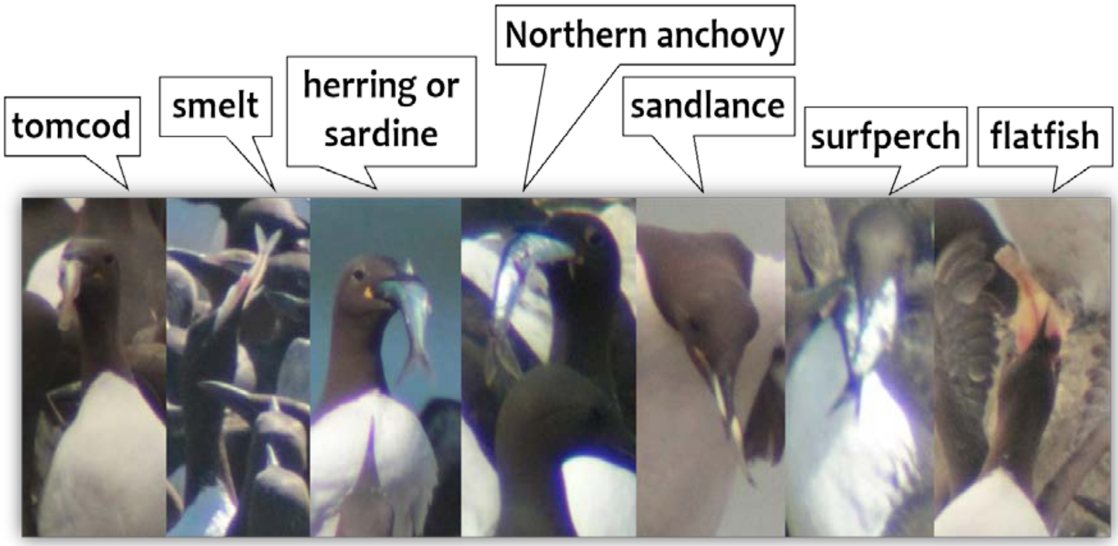

Figure 4. Prey photos taken from the observation deck at the base of the lighthouse.

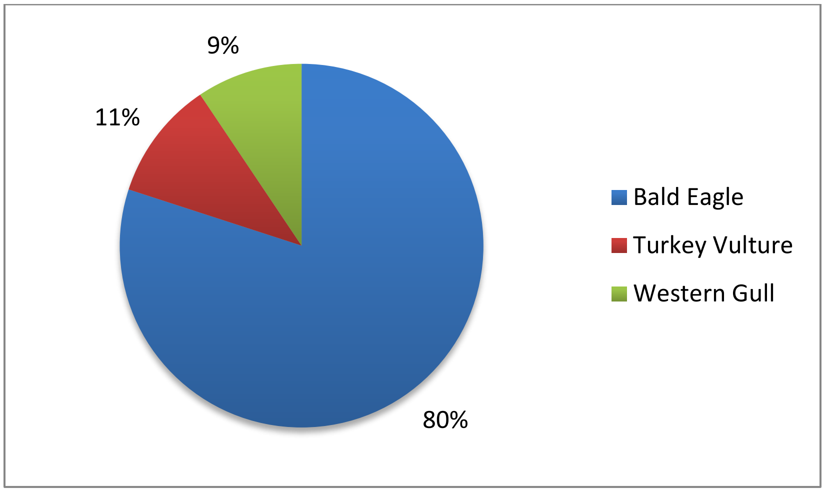

Figure 5. Identifiable sources of disturbance to Common Murres at Yaquina Head in 2017. A total of 107 disturbances were recorded, and the source of the disturbance was identified in 85 instances**.** Many of the disturbances in which the cause could not be determined were initiated before observers arrived in the morning, and were likely caused by eagles.

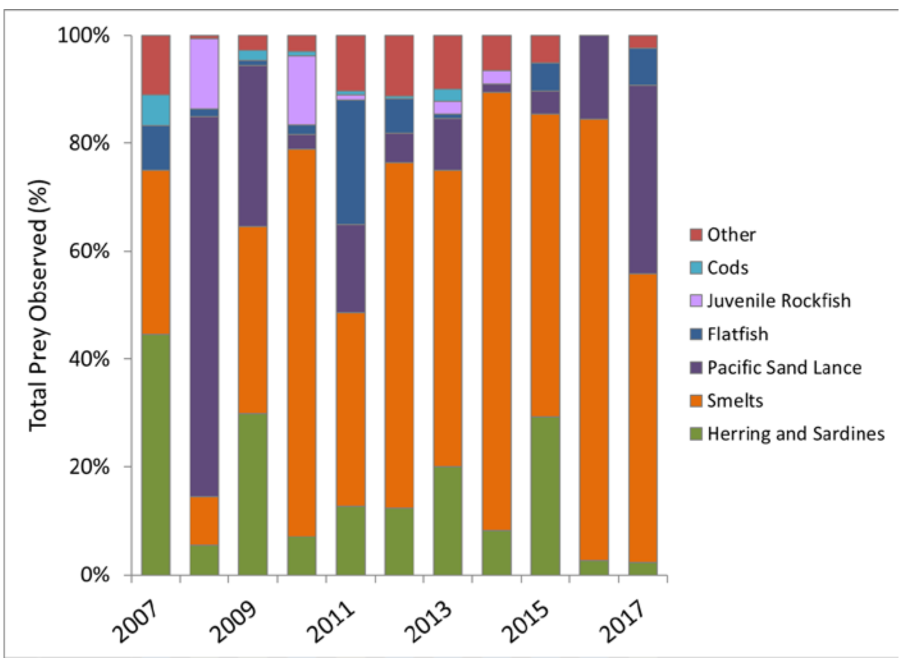

Figure 6. Diets of Common Murre chicks (% occurrence) during 2007-2016. Diet in 2008, a particularly cold water year, stands out with a high proportion of sand lance, 2010 diets had a pulse of juvenile rockfish and began a period of mostly smelt dominated diets that continued through 2016, with the exception of 2011. 2011 was also notable for increased consumption of flatfish during an upwelling relaxation period. Diets in 2016 had the highest percentages of smelt in the time series.

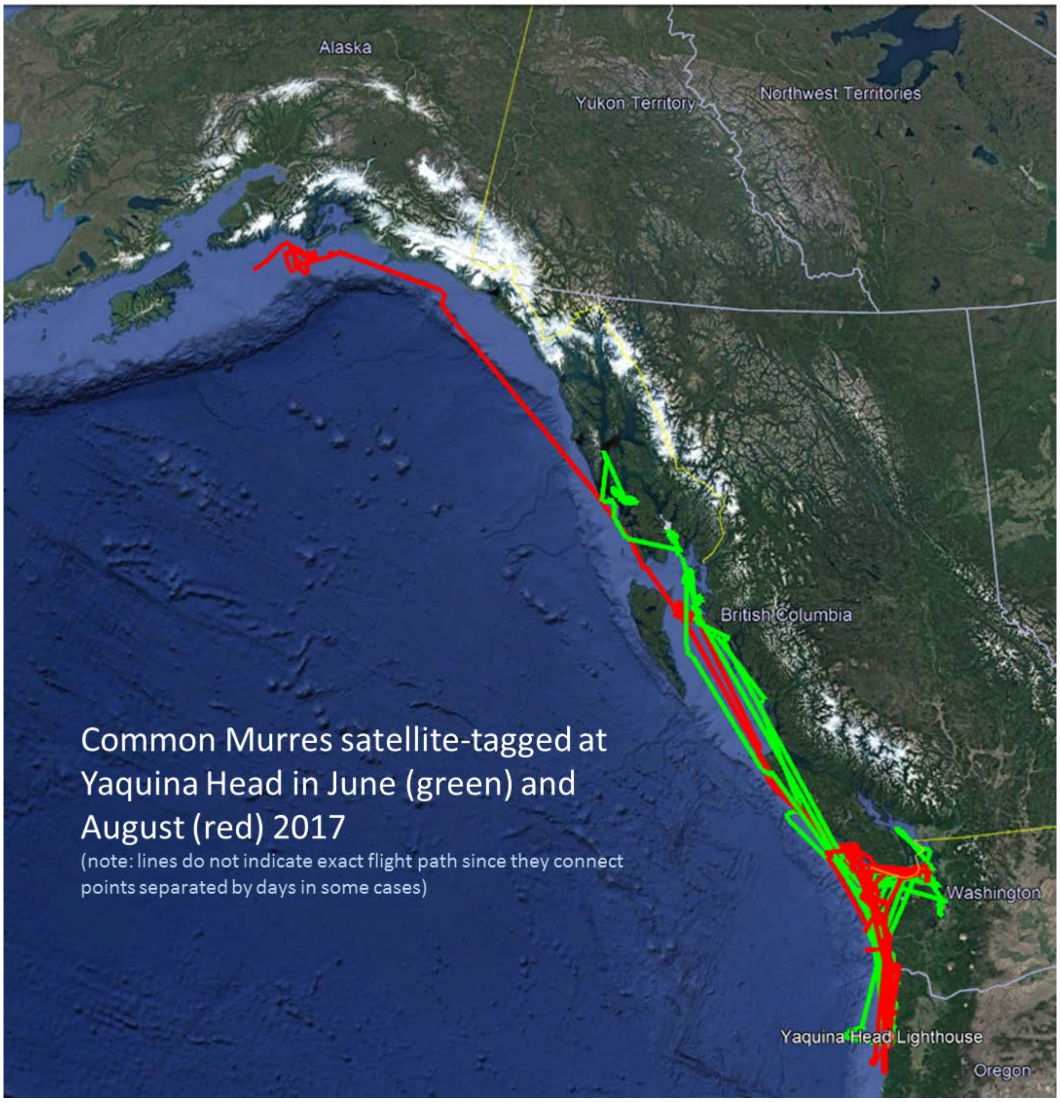

Figure 7. Tracks of Common Murres satellite-tagged at sea off Yaquina Head in June (green lines; n = 3) and August (red lines; n = 6). Some birds tagged in June were tracked through September and some tagged in August were tracked through December. Murres tagged this year traveled further north than birds from previous years, and spent little time off the coast of Oregon.