Yaquina Head Seabird Colony Monitoring
2016 Season Summary

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Project Overview

Yaquina Head Outstanding Natural Area (YHONA) is home to some of Oregons'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. Additionally, this had been one of the most rapidly growing and productive murre colonies on the Oregon coast. In the past 6 years, however, the reproductive success has been greatly reduced and colony size has fluctuated markedly. Summer 2016 was the 10th consecutive year of collaboration between Oregon State University, U.S. Fish and Wildlife Service, and the Bureau of Land Management. Combined with similar studies conducted by Julia Parrish (University of Washington) at YHONA from 1998 to 2002, our investigation for the Oregon Coast is now a 15-year time series. Basin scale ocean conditions in 2016 were widely considered anomalous, with warm water persisting offshore in the northeast Pacific (the "warm blob"), positive and strengthening of El Niño conditions, and a positive Pacific Decadal Oscillation index throughout the spring and summer. The conditions in 2016 started with a slightly earlier than average spring transition with strong upwelling winds during June and July. Looking ahead, the warm water "blob" was evident in early fall, but then temperatures began to decrease with winter storm activity and a shift back toward a forecast for La Niña conditions to develop and persist through the winter and spring of 2017. 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. Due to changing colony and predator-prey dynamics, we added three new reproductive study plots in 2016. In addition to our original 12 plots on Colony Rock and Flat Top Rock (Fig. 1), we added new plots on Lower Colony Rock (below Colony Rock; see cover photo), Satellite Rock (next to Colony Rock), and the south end of Flat Top Rock. 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. We also conducted observations to estimate the time elapsed between chick feeding events, which can be used as a proxy for prey availability near the colony.

In 2016 was also continued our second year of tracking individual murres during the breeding season and our first year of year-round tracking.

Results

In 2015 we logged 243 hours during 74 days of observations between 16 May and 27 July for murre reproductive success and predators (Table 1), and through 22 August for cormorant nesting observations and murre diets. **As in 2015, Common Murres had a total reproductive failure (reproductive success = 0.00 ± 0.00 SE) on both Colony Rock and Flat Top.** This was the second time in 15 years of data collection that both sub-colonies failed, maintaining a 6-year run (2011-2016) of low reproductive success that is less than half the success for the first four years of study (2007-2010, Table 1). The only chicks that survived to fledging were in a new plot on Lower Colony Rock, which is not disturbed by predators. However, even reproductive success on Lower Colony Rock was only 0.21 fledglings/nest, considerably lower than years prior to increased disturbance.

During 243 hours of observation, we witnessed 132 disturbance events where a minimum of 1023 eggs, 7 chicks, and 67 adult murres were taken (Table 1). Like the previous seasons, much of the reproductive loss in 2016 was due to egg predators. **2016 had the highest rate of murre egg and adult loss with 4.21 eggs destroyed and 0.28 adult murre fatalities per hour (Table 1).** Disturbance rates first began to increase in 2010, and then greatly escalated in 2011 and 2012. Some disturbance events were already in progress when observers arrived early in the morning and not all egg removals can be observed, therefore, the rate of egg and adult murre loss should be considered conservative estimates. **Bald Eagles were again the dominant disturbance source (Fig. 5, 94%, 111 of 118 disturbances), with only a small number of disturbances for which the primary cause remained unknown (11%, 14 of 132). In many cases, these disturbance events were initiated prior to observers arriving for the day, and were likely also caused by eagles.** 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 rearing provided an added challenge for diet data collection in 2016. 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 2016 were again dominated by smelt (82%), a trend that has continued since 2010 (with minor exception of 2011; Fig. 6). 2016 was the highest proportion of smelt recorded in a single year, with sand lance a distant second (16%).**

For the seventh year, we also conducted chick provisioning rate watches. We generally conduct four watches per year throughout chick rearing, but in 2016 we found chicks only on Lower Colony Rock allowing us to perform only one chick provisioning rate watch, as in 2015. Observers recorded the frequency that adult murres were delivering food to chicks at selected nests. Chick feeding rates (also foraging trip duration) are a good overall measure of food availability and are a valuable metric to compare among years. Due to the reproductive failure, we were not able to collect feathers of beach-cast 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.

Brandt's (*Phalacrocorax peniscillatus*) and Pelagic (*P. pelagicus*) Cormorant nests were monitored for the ninth consecutive year (Tables 2 and 3). **In 2016 both species were successful rearing young. Brandt's Cormorants reproductive success (0.87 fledglings/nest) was lower than 2015 (1.70 fledglings/nest),** but greater than 2014 (0.72 fledglings/nest) and overall slightly above the long term mean (Table 2). Median hatch date (June 27th) was among the earliest recorded in our time series. Average brood size (1.65 chicks) was close to the long-term average (Table 2).

Pelagic Cormorants had their second highest reproductive success (1.37 fledglings/nest), only surpassed by 2013 (2.13 fledglings/nest; Table 3). There were 30 nests visible from observation platforms, also second only to 2013 (34 nests) and more than double 2015 (11 nests). Pelagic Cormorant reproductive success has been highly variable during our time series (Table 3).

Summary and Future Directions

The second 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. The disturbance activity during the past 7 years has remained elevated compared to the early years of our study (2007-2009). The predation rates in 2010-2016 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. For example, during 1999-2006 this had been one of the most rapidly growing and productive murre colonies on the Oregon coast. Since 2010, however, the population has fluctuated markedly with no identifiable trend during a period when reproductive success has been greatly reduced.

Murre diets in recent years have reflected more warm water associated smelt vs. cooler water associated sand lance, for example a switch from El Niño in 2010 to La Nina in 2011. With the exception of 2011, however, murre diets have been dominated by smelt. During this time, with the exception of 2011 again, conditions were either El Niño neutral or slightly positive or impacted by the warm water blob. It is intriguing that increased predator activity co-occurred with this rather prominent change in diet since 2010.

We will continue studies in 2017 with the goal of maintaining 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 began the second of a three-year, 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.

Publications

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

[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.

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

[a]Rate of hatchlings that fledged (≥25 days old)
[b]Chicks fledged (≥25 days old); mean among 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

[a]Rate of hatchlings that fledged (>25 days old)
[b]Chicks fledged (≥25 days old); mean among nests

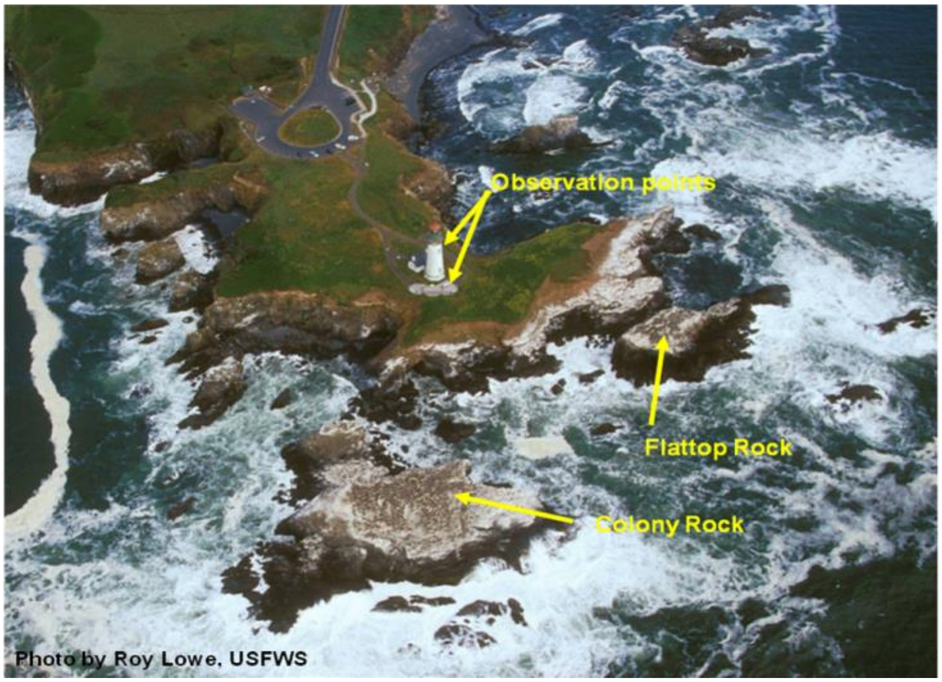

Figure 1. Study plots on Colony and Flat Top Rocks.

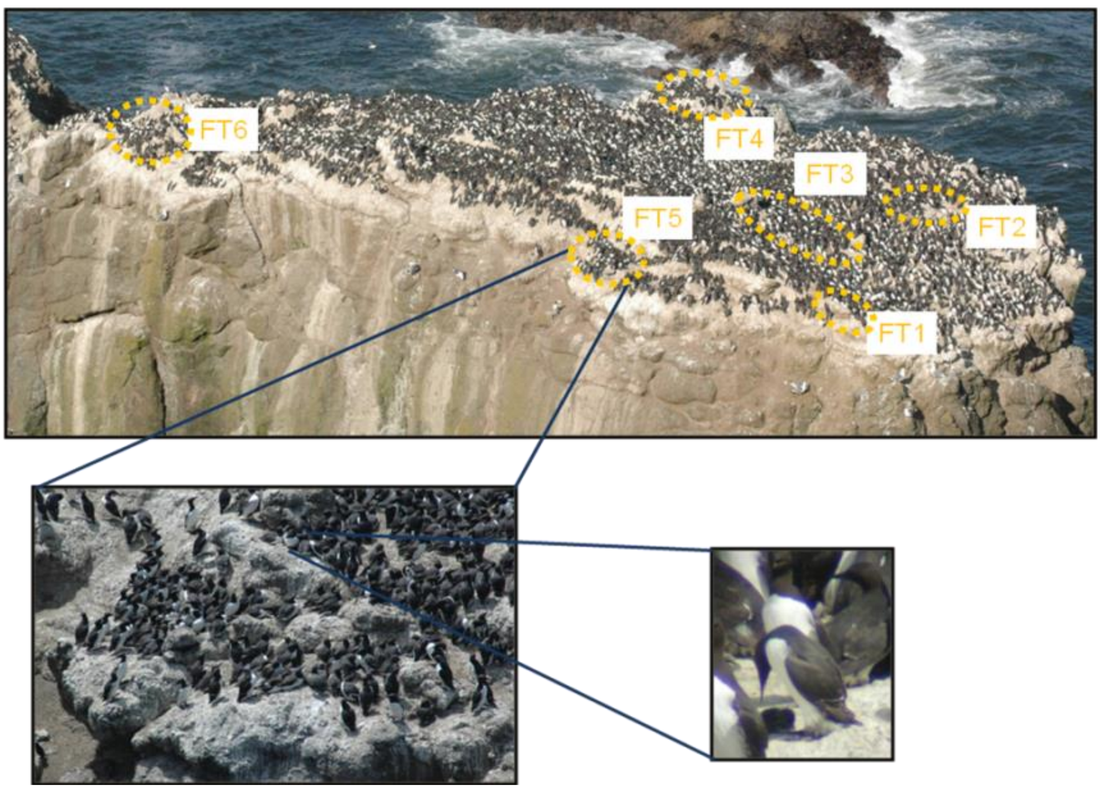

Figure 2. Close-up of Flat Top Rock, plot #5, and an adult with a young chick

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

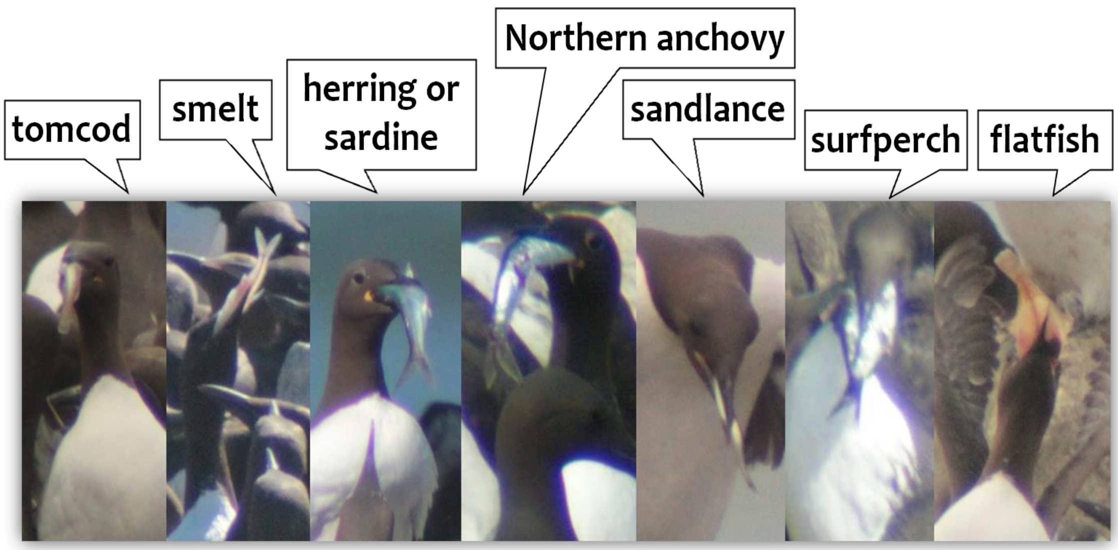

Figure 4. Prey photos taken from the observation deck at the base of the lighthouse.

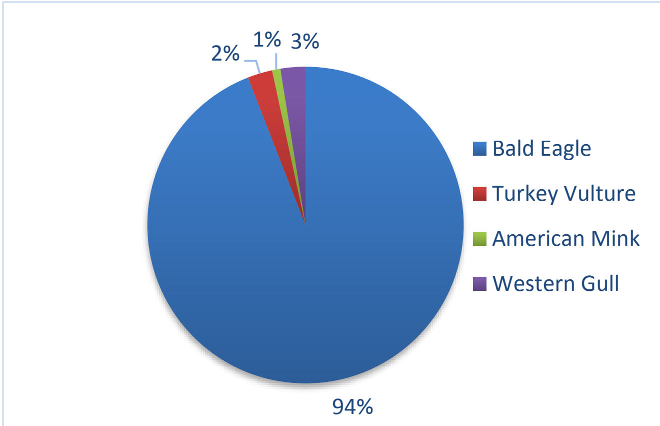

Figure 5. Identifiable sources of disturbance to Common Murres at Yaquina Head in 2016. A total of 132 disturbances were recorded, and the source of the disturbance was identified in 118 instances**.** Many of the disturbances in which the cause could not be determined were initiated before observers arrived in the morning, and were likely caused by eagles.

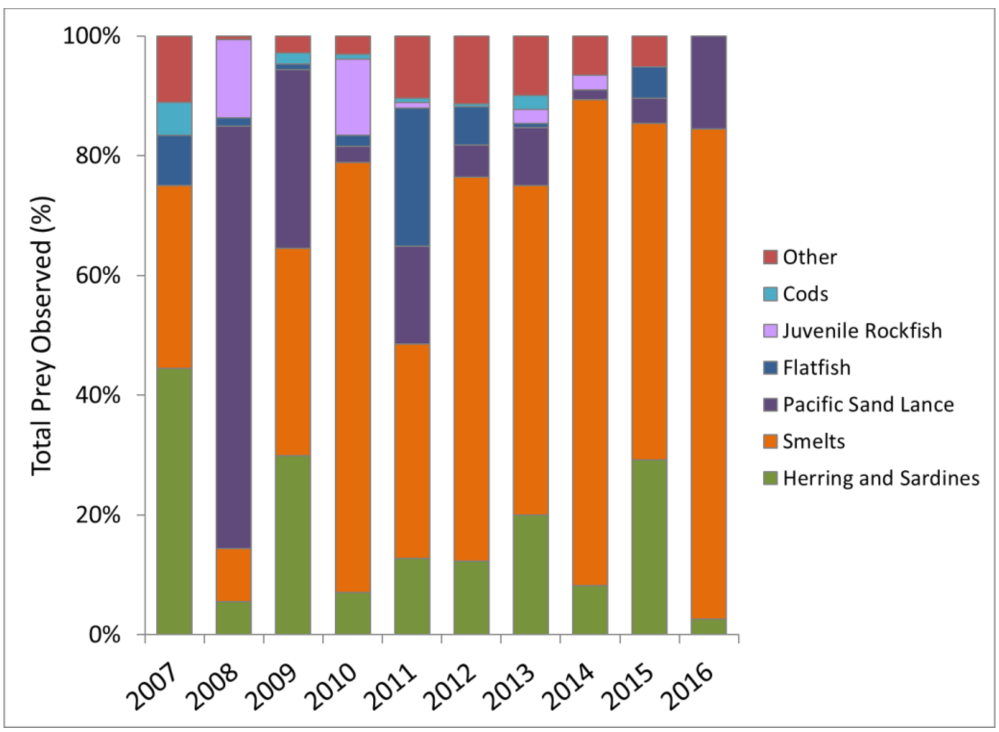

Figure 6. Diets of common murre chicks (% occurrence) during 2007-2016. Diet in 2008, a particularly cold water year, stands out with a high proportion of sand lance, 2010 diets had a pulse of juvenile rockfish and began a period of mostly smelt dominated diets that continued through 2016, with the exception 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.