Black Oystercatcher population estimate and reproductive success on Oregon's Coast and in the Marine Reserve and Marine Protected Areas – 2016

Joe Liebezeit[1], Amelia O'Connor[1], Jim Lyons[2], Courtney Shannon[1], Shawn Stephensen[3], Elise Elliott-Smith[4], Paul Engelmeyer[1]

[1] Audubon Society of Portland, 5151 NW Cornell Rd, Portland, OR 97210
[2] USGS Patuxent Wildlife Research Center, 12100 Beech Forest Road, Laurel, MD 20708
[3] U.S. Fish and Wildlife Service, Oregon Coast National Wildlife Refuge Complex, 2127 SE Marine Science Drive, Newport, Oregon 97365
[4]USGS Forest and Rangeland Ecosystem Science Center, 3200 SW Jefferson Way, Corvallis, OR 97331

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Introduction and Background

Black Oystercatchers are a conspicuous bird found along the west coast of North America ranging from the Aleutian chain down to Baja California. They are largely dependent on marine shorelines for food and nesting. Habitat types most commonly used by nesting oystercatchers in Oregon include near-shore rocks and islands, rocky shoreline, and headlands. Oystercatchers forage exclusively on intertidal macroinvertebrates (e.g., limpets and mussels).

Because of their small global population size (estimated at approximately 10,000) (Andres and Flaxa 1995; Tessler et al. 2014), low overall reproductive rate, and near complete dependence on rocky intertidal habitats, Black Oystercatchers are considered a "species of high concern" by the U.S. and Canadian National Shorebird Conservation Plans (Brown et al. 2000) and a "focal species for priority conservation action" by the U.S. Fish and Wildlife Service (Tessler et al. 2007). They are also on National Audubon's Watch List (National Audubon Society 2002) and are a target species in the Pacific Americas Shorebird Conservation Strategy (Senner et al. 2016). Here in Oregon they were recently listed by the Department of Fish and Wildlife as a "strategy species"[1] in their Oregon Nearshore Strategy[2]. Because of their dependence on intertidal areas, they are particularly vulnerable to habitat degradation, oil spills, as well as sea level rise and ocean acidification associated with a changing climate (Hollenbeck et al. 2014). They are also susceptible to human disturbance particularly during the nesting season (Andres and Flaxa 1995).

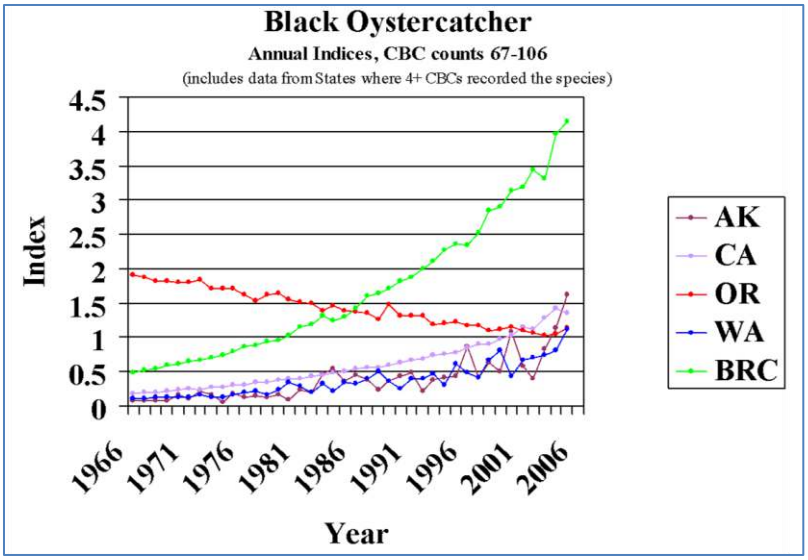

Figure 1. Trends in annual indices of abundance of Black Oystercatchers from 1966 through 2006 in Alaska (AK), California (CA), Oregon (OR), Washington (WA) and British Columbia (BRC) based on Audubon Christmas Bird Count (CBC) data (from Niven 2011). For methods used to calculate the CBC indices see Link et al (2006).

In Oregon, the most recent estimate of the oystercatcher population indicates a relatively small number of birds, approximately 300 individuals, based on research conducted by the U.S. Geological Survey nearly a decade ago (Lyons et al. 2012[3]). Since this time, there has been some annual monitoring but no range-wide analyses on the population status of this bird in Oregon. Christmas Bird Count Data (CBC) from Oregon from 1966-2006 suggests a moderate decline over that period of time (Fig. 1). However, the CBC trend must be viewed cautiously as it relies on relatively few sites along the coast and observer effort has been variable through the years.

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[1] Species in need of greatest management attention

[2] http://www.dfw.state.or.us/mrp/nearshore/document.asp

[3] Estimate based on shore-based surveys, off-shore islands were not sampled

In 2012 five marine reserves (MRs)/marine protected areas (MPAs) were designated in Oregon's nearshore waters (Fig. 2). These areas prohibit extractive uses, such as commercial fishing, in order to support stable populations of marine life and protect key nearshore habitats including rocky intertidal habitats that oystercatchers depend on. In MRs all extractive uses are prohibited while MPAs are areas protected for a specific conservation purpose, allowing for some, but not all, uses. Oystercatchers, being top trophic level predators, may act as an indicator of overall health in the intertidal ecosystem. Therefore monitoring oystercatcher use of rocky intertidal habitat adjacent to MRs/MPAs may lend some perspective into how effectively reserves support intertidally dependent species like the Black Oystercatcher.

Project Goals and Objectives

The main objectives of this project are to 1) Estimate the current population of breeding Black Oystercatchers in Oregon and to compare that to previous estimates to better understand the population trend of this vulnerable species; 2) Describe spatial distribution of oystercatchers along the coast; 3) Document oystercatchers abundance in rocky intertidal habitat adjacent to the MR/MPAs; 4) Document nest locations and reproductive success of Oregon's oystercatchers; 5) Better understand human disturbance patterns to nesting oystercatchers, and 6) Promote community engagement and raise awareness about marine reserves and oystercatcher conservation through community science participation.

Results of this effort will be available to relevant agencies (i.e. USFWS's Oregon Coast National Wildlife Refuge complex and ODFW Marine Resources Program) to help make informed management decisions with respect to this species. The data collected as part of this project is being incorporated into the USFWS Oregon seabird colony database. The updated population estimate and trend findings will help refine the range-wide population estimate which is critical for effective conservation planning (Tessler et al. 2014). Information on human disturbance will help target signage placement along the coast to minimize such disturbances.

Study site and Methodology

Abundance surveys

We targeted rocky shoreline habitat along Oregon's coastline to perform both abundance surveys and reproductive success monitoring. We used a slightly modified version of existing

protocols developed by USGS researchers to monitor Black Oystercatchers (Elliott-Smith and Haig 2006). Attempts were made to conduct two abundance (population) surveys between 6-30 May in 2015 and 6-29 May in 2016. This timing corresponds to peak mating pair establishment and courting behavior when oystercatchers are most conspicuous. Observers were assigned one or more survey routes along the rocky intertidal coastline to conduct the abundance surveys. A total of 75 survey routes were established in 2016 (Figs. 2, 3) based on those previously used by Elliott-Smith and Haig (2006). These routes included most available mainland rocky intertidal habitat and near-shore islands but did not include a small number of distant offshore islands that could only be surveyed by boat. In 2016 we monitored the same 60 sites as in 2015 but also included 8 additional sites that were not monitored in 2015. For logistical purposes, we also split three of the routes into two routes.

Figure 2. Location of both sampled and unsampled survey routes along the North and Central Oregon coast in 2016.

During a typical survey, trained volunteers/observers used binoculars and/or spotting scopes, and stopped at one or more observation points along the survey route to find and count oystercatchers. Oystercatchers were typically detected visually but we also counted birds detected by ear. Surveys in each route were conducted for a minimum of 30 minutes and all detected birds were plotted on a map and recorded on a data form. Volunteers recorded behaviors to help determine whether birds were likely breeding pairs or unpaired sub-adults. Surveys were typically conducted in the morning to maximize best possible light for viewing and periods of inclement weather were avoided. Attempts were made to avoid double counting. Consult the protocol[4] for more information on sampling procedures.

[4] http://audubonportland.org/files/research/2016-black-oystercatcher-abundance-survey-1

Nest monitoring

A subset of volunteers monitored nests that were discovered opportunistically while conducting the abundance surveys. A few volunteers were particularly ambitious nest-searchers and went out of their way to find nests. Volunteers attempted to monitor nests weekly to estimate hatching success (at least 1 chick in a nest hatches) and fledgling success (at least 1 chick reared to age when it is capable of flight). Black Oystercatcher incubation period ranges from 26-32 days and fledging typically occurs 38-40 days after hatch. In order to assess nest activity and stage of development volunteers would watch a nest (from a far enough distance to not disturb birds) until they could clearly see nest contents or nesting activity (e.g. incubating adult, incubation exchange eggs, chicks). Nest monitoring occurred from early May through early September in both 2015 and 2016. Consult the protocol[5] for more information on sampling procedures.

Figure 3. Location of survey routes along the Southern Oregon coast in 2016.

[5] http://audubonportland.org/files/research/2016-black-oystercatcher-monitoring-protocol

Volunteer conducting an abundance survey at Cape Arago (Photo: Bev Minn)

<u>Analysis</u>

Abundance

We used N-Mixture model statistical methods to estimate both oystercatcher abundance and probability of detection (Royle 2004). This method provides a flexible framework for modeling count data since it allows incorporation of additional explanatory variables (covariates) to refine the estimate. This same statistical procedure was previously used to provide the most recent (2006) Oregon oystercatcher population estimate (Lyons et al. 2012) and was appropriate for using with the 2015 and 2016 datasets since it was collected using the same methodology. We included route length and observation points per route (proxies for survey route size), and section of coast (north vs. south coast[6]; and north, central, south[7]) as covariates in the population estimate. We also considered including rain, wind speed, and number of observers as covariates in the analysis. However, in the 2006 population estimate (Lyons et al. 2012), only rain was important in affecting detection probability (among all three covariates). None of the 2015 or 2016 surveys were conducted in the rain so we did not include rain, wind speed or number of observers. We followed procedures for extrapolating the population estimate to the unsampled sites as described in Lyons et al. (2012).

To quantify oystercatcher spatial distribution across the coast we used ArcGIS (ESRI 2016) to plot abundance categories based on average birds detected across survey replicates. We compared oystercatcher density in the North, Central, and Southern sections of the coast by

[6] Oregon Dunes was breakoff point

[7] North coast=Columbia R. to Neskowin; Central coast= Neskowin to Florence; South coast=Florence to CA border

dividing the average number of oystercatchers per route by the average survey route length (in each of the three sections of coast).

Reproductive success

In order to qualitatively compare reproductive success with previous estimates, we report hatch success as the percent of nests that hatched at least one egg and fledging success as the percent of nests that fledged at least one chick. We also calculate the average number of chicks fledged per nest and the average number of chicks fledged per pair (divided number of chicks/fledglings per nest by total number of monitored nests).

Human disturbance

We asked volunteers that were monitoring the 52 oystercatcher nests to assess human disturbance to the nesting birds by answering the following two questions during each monitor visit: 1) "During your time monitoring did you see other people or people with dogs within ~100 meter of the nest?" and 2) "Did you see any disturbance resulting in both parents leaving the nest?"

Results

Population estimate and abundance patterns

Seventy-four of the 75 survey routes were surveyed for oystercatcher abundance (Figs. 2 and 3). We were not able to conduct surveys at one site (South Cascade Head). The number of abundance surveys conducted per site ranged from 1 to 6 with the average being 2.5 which was an improvement over 2015 (Table 1). Among all sites, the sum maximum number of oystercatchers observed was 367, down from 374 in 2015 (Table 1).

Table 1. A comparison of Oregon oystercatcher surveys in 2006 and 2015–2016.

Year	2006	2015	2016
Number of routes	56	60	74
Mean number of visits per route	1.8	1.6	2.5
Population index (sum of max # birds detected per route)	252	374	367
Estimated population size – Coast-wide (*N*-mixture model ± CRI[8])	311 (276-382)*	627 (547-739)	506 (463-560)
Estimated population size – MR/MPAs (*N*-mixture model ± CRI[6])	n/a	78 (50-122)	67 (52-91)
Earliest survey date	7-May	6-May	6-May
Latest survey date	3-Jun	30-May	29-May
Probability of detection (N-mixture model)	0.68*	0.53	0.51

*Poisson lognormal mixture model in 2006 to account for over-dispersion; negative binomial model in 2015-2016.

[8] CRI="credible interval" captures the potential range in population estimate size with 95% confidence.

The best fitting N-mixture model for total population size in 2016 was 506 birds (95% CRI [463-560]) with 67 (95% CRI [52-91]) in the MR/MPAs (Table 1). This estimate is lower than the population estimate for 2015 but still higher than the 2006 estimate (Table 1). The 2016 estimate is more precise compared to the 2015 estimate (narrower CRI) and is likely due to the increase in survey replicates per route in 2016. The 2015 and 2016 population estimates are not directly comparable to the 2006 population estimate because different model assumptions were used for both the abundance and detection components of the model[9]. In 2016, the model with most support included # observation points and geographic region (North/South split) as predictors of abundance (Table 2). The effect of geographic region corresponded with greater bird density in the southern region; on average there were about two more birds per route in the South. Also, each additional observation point added about 1 bird, but there was not a strong relationship between abundance and # of observation points. Population size (and probability of detection) was very similar for all three models that were fit to the 2016 data (Table 2).

Table 2. Model selection results, estimated population size (*N*), and estimated probability of detection (*p*) for the 2016 Oregon oystercatcher survey (*N*-mixture model with negative binomial assumptions for abundance and binomial for detection). DIC is Deviance Information Criterion and pD is a measure of model complexity.

				95% Confidence Interval			95% Confidence interval	
Description	**pD**	**DIC**	***N***	**Lower (*N*)**	**Upper (*N*)**	***p***	**Lower (*p*)**	**Upper (*p*)**
***N*(# obs. points + North/South zones), *p*(i,t)**	223	689	506	463	560	0.51	0.48	0.55
***N*(# obs. points), *p*(i,t)**	225	692	508	465	563	0.51	0.48	0.55
Null *N*(.), *p*(i,t)	227	694	508	466	563	0.51	0.48	0.55

Overall, the coast-wide population estimates for both 2015 and 2016 are larger than the 2006 estimate (Table 1) indicating that the oystercatcher population on the Oregon coast does not appear to be declining and may have increased in recent years. According to the models, Black Oystercatcher abundance adjacent to marine reserve/MPAs accounted for ~12.4% of the total population estimate in 2015 and 13.2 % in 2016 (Table 1). Abundance and density was higher on the south coast in both 2015 and 2016 (Fig. 4) compared to the north and south coasts (2015 - south, north, central: 3.7, 1.3, and 1.5 birds/km; 2016 - south, north, central: 1.4, 0.9, 0.8 birds/km).

Reproductive success

A total of 68 nests were discovered by volunteers during the 2016 field season (see Appendix for nest location maps). Of those 52 were monitored for hatching and fledging

[9] In 2015 and 2016 a negative binomial distribution provided a better model fit while in 2006 a Poisson log-normal & quasi-binomial distribution was used (Lyons et al. 2012).

success including seven nests on islands or rocky shorelines adjacent to the marine reserves / protected areas (MR/MPA) (Table 3). Of the 52 monitored nests, we were unable to determine hatching success on four nests and fledgling success on nine nests due to difficulty in determining whether or not nests were active or if chicks were present. Nests were discovered or monitored in 4 of the 5 marine reserve complexes (Cape Falcon [n=2], Cascade Head [n=2], Otter Rock [n=2], and Cape Perpetua [n=1]). Overall hatching success was similar when comparing coast-wide and MR/MPA estimates (Table 3). However fledging success was markedly higher adjacent to MR/MPAs compared to the overall estimate. It is important to emphasize the very small sample size for the MR/MPAs so these results must be interpreted cautiously. Across the coast, monitored nests fledged approximately one chick per every two nests (0.59 ± 0.14; Table 3) which is similar to 2015 (0.54 ± 0.10 SE; see Liebezeit et al 2016).

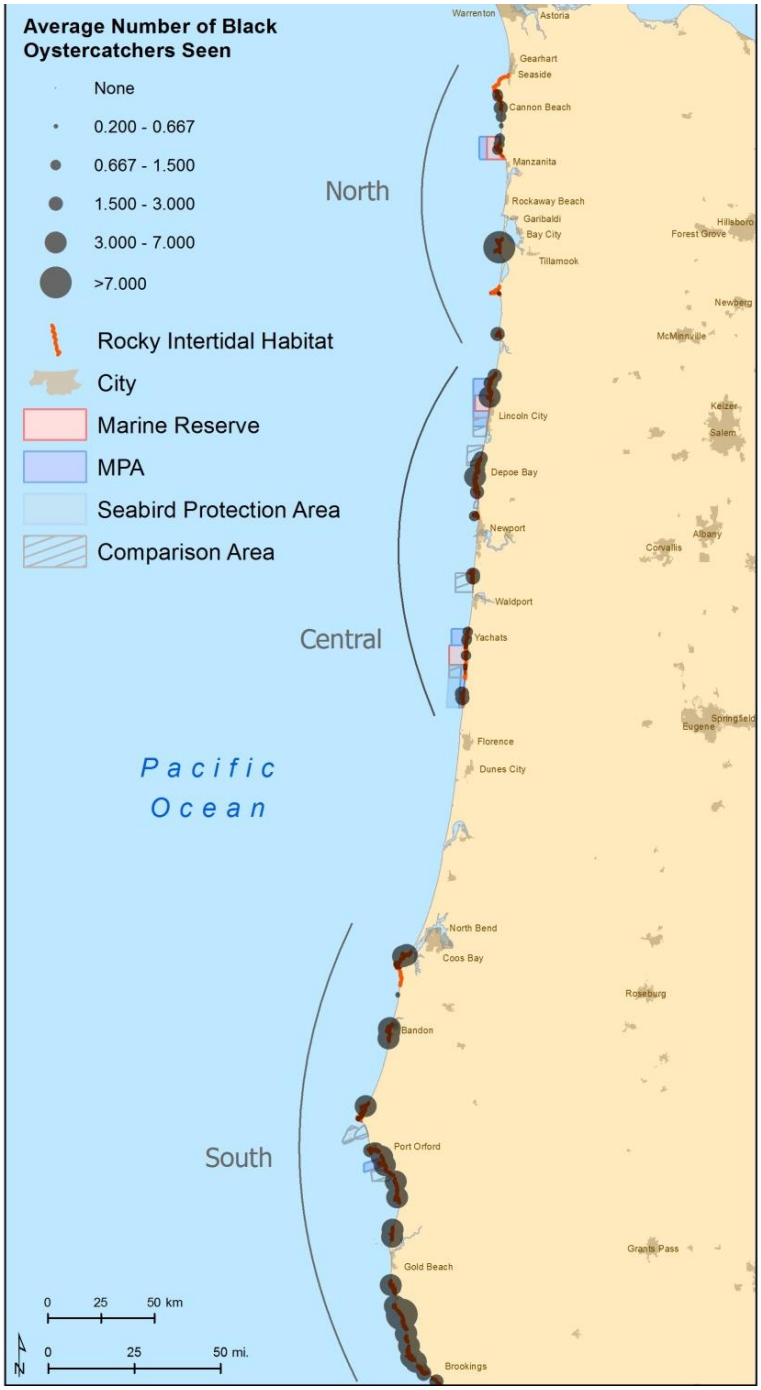

Figure 4. Abundance distribution of Black Oystercatchers along the Oregon Coast in May 2016.

Similar to 2015, hatching success was higher on the south coast compared to the north and central coasts. Fledging success was highest on the central coast but this is based on a low sample size (n=8; Table 3). In 2015, fledging success was highest on the south coast. In 2016 mainland nests had higher hatching success compared to island nests but the reverse was true for fledging success (Table 3). In 2015 both hatching and fledging success were higher at island nests compared to mainland nests. However, we need to perform quantitative analyses to conclusively confirm these apparent annual differences.

Human disturbance

Overall, we found that approximately half the monitored nests (48.1%) at some point had people and/or people with dogs within 100m of the nest site. When comparing this between the three coastal sections, we found that just under half of the nests in both the central and south coasts (45.5% and 44.1% respectively) experienced dogs/humans in close proximity during the time volunteers were monitoring. However, on the north coast the rate was much higher (71.4%). Incidence of both oystercatcher adults leaving their nests due to human-related disturbance occurred at 23% of all monitored nests. Among the three sections of the coast, the south coast had the lowest incidence of temporary nest abandonment due to disturbance (11.8%). The central and north coasts had higher levels (54.5% and 28.6% respectively). It is important to point out that sample sizes for this analysis were low on the north and central coasts (n=7, n=11 respectively). Sample size on the south coast was 34 nests.

Table 3. Reproductive success of Black Oystercatchers on the Oregon coast and adjacent to the marine reserves/MPAs in 2016. Number in parenthesis = number of nests.

	total nests	monitored nests	Hatch Success	Fledge Success	Chicks per Nest (M±SE)	Fledglings per Nest* (M±SE)
Coast-wide	68	52	77.1% (48)	37.2% (43)	1.26 ± 0.13	0.59 ± 0.14
MR/MPA only	7	6	83.3% (6)	42.9% (6)	2.00 ± 0.43	1.00 ± 0.49
North coast	7	7	85.7% (7)	50.0% (4)	1.14 ± 0.26	0.50 ± 0.29
Central coast	13	11	75% (8)	37.5% (8)	1.13 ± 0.35	0.88 ± 0.44
South coast	48	34	75.76% (33)	34.4% (32)	1.35 ± 0.17	0.53± 0.15
Mainland nests	19*	18†	88.2% (17)	40.0% (15)	1.35 ± 0.17	0.47 ± 0.17
Island nests	30*	30†	67.9% (28)	52.9% (27)	1.29 ± 0.21	0.67 ± 0.20

* 19 nests were unrecorded or undetermined if on mainland or off-shore island

† Four nests were undetermined if on mainland or off-shore island

Surveyor Effort & Outreach

Surveys were conducted by 52 volunteers, eight agency biologists, and two Portland Audubon employees. One volunteer also spent some time conducting GIS analysis and map making. Total volunteer time contributed to this project was approximately 1,200 hours.

Through presentations, trainings and outreach in the field we connected with over 340 people about Black Oystercatcher and seabird conservation as well as on Oregon's system of Marine Reserves/MPAs. We also contributed an article to Oregon Coast magazine in the Jan/Feb issue that has a circulation of 40,000 subscribers. Through social media posts highlighting this project we reached approximately 17,000 people with more than 400 likes on Facebook posts and >50 shares.

Conclusions and next steps

Over the past two years we have provided the first population estimate of oystercatchers in Oregon in a decade (since 2006). Our findings suggest that the population is small but stable or possibly increased. The raw data from the past two years, alone, also support a population increase since at most comparable survey routes (between 2006 and 2015-16) maximum counts were higher in 2015-16. There were inevitable differences in observer ability to access routes depending on the terrain. For some routes, observers were able to walk around and traverse habitat while in other areas, surveys could only be performed from observation points where habitat was scanned from a distance and the view was incomplete (e.g., back-sides of nearshore islands). This issue was ameliorated to some degree by extending survey time in such areas and by conducting multiple rounds of surveys providing time for active birds to come into view. The percentage of "missed birds" is factored into the detection probability estimate.

We assumed oystercatchers were not using sandy beach habitats during the breeding season. This assumption is likely not a significant source of bias in the population estimate because this species' life history is so closely tied to rocky intertidal habitats. However, it is possible that we missed some birds by not sampling sandy beach habitats.

Variability in observer experience conducting surveys may also have affected the population estimate. However we provided two trainings in 2015 and three in 2016 attended by many of the volunteers prior to surveys and approximately half of the surveyors had previously conducted oystercatcher surveys including some volunteers that helped with the surveys back in 2006 that USGS led. In addition, oystercatchers are an ideal community science species because they are easy to identify, even for inexperienced volunteers, and they are quite conspicuous in May during the early breeding period. Other researchers have relied on community scientists for oystercatcher population monitoring (e.g. Weinstein et al. 2014).

Since 2006, there have been no other rigorous population estimates of this species in Oregon. The U.S. Fish and Wildlife Service have opportunistically monitored Black Oystercatchers during their annual aerial seabird colony estimates. While these estimates are quite rough, their most recently published estimate of breeding individuals from 2007 is similar to our recent population estimates (470 birds; Naughton et al. 2007). The Christmas Bird Count data from 1966-2006 indicates a decline in Black Oystercatcher numbers in Oregon (Fig. 1) however this estimate is based on only 11 CBC circles and during the 40 year period covered by the analysis, oystercatchers were reported on an average of 5.38 circles per year (D. Niven, pers. comm.). Although breeding oystercatchers are not believed to move too far from

breeding areas, in winter they often gather in communal groups (Andres and Flaxa 1995). Consequently a more clumped distribution in winter could lead to greater error in estimates if survey coverage is not comprehensive.

While we believe the 2006 and 2015/2016 population estimates are comparable because of standardization of survey routes and sampling methods, we do know some survey routes had particularly low coverage because the areas were difficult to access. This includes a few shoreline based sites (e.g. north of Short Sands in Oswald West State Park) and a small number of off-shore islands that can only be reliably sampled by boat. We do know that oystercatchers breed on some of these islands. In 2016, we were able to get better coverage and more surveys per site. This enabled us to provide a more precise population estimate in 2016. In 2016 we attempted to work with ODFW Marine Reserve Program to have a volunteer ride with them on a research during their hook and line surveys to conduct oystercatcher surveys on off-shore islands off of Cascade Head and Redfish Rocks. We were unable to make that happen for logistical reasons but we will attempt that again in 2017.

We found that the south coast of Oregon (Fig. 4) seems to support a higher average density of oystercatchers compared to central and north coast sites. This finding may indicate this region has higher habitat quality than both the central and north coasts. This is supported by hatching and fledging success which may also be higher on the south and central coasts compared to the north coast (Table 3, Liebezeit et al. 2016). Subsequent conservation efforts directed on this species may want to target the south coast since this region appears to supports the core of the Oregon population.

We would have expected more oystercatchers in/adjacent to MR/MPAs based on availability of suitable habitat. MR/MPAs contain ~25% of the available rocky intertidal habitat in Oregon, yet our population estimate indicates they supported only 10-13% of the oystercatcher population. However, although we were able to sample all MR/MPAs, coverage was incomplete on some of them. In particular, the northern portion of the Cape Falcon MR/MPA was difficult to access sites and two survey routes went unsampled at Cape Perpetua in 2015 and one site at Cascade Head in 2016. The dominant rocky area at Redfish rocks are the prominent offshore islands, most of which were too far away to sample from shore.

The results of our reproductive success estimate should be interpreted cautiously since nests were found and monitored opportunistically and we did not correct for nest exposure time so we cannot assume our findings reflect reproductive success for the entire Oregon population. That said, our estimates of hatching and fledging success are comparable to what

was found in 2006 and 2007 (Elliott-Smith et al. 2008). Elliott-Smith et al. (2008) documented 74% apparent hatching success in 2006 and 49% in 2007 and fledging success of 38% and 34.9% in 2006 and 2007 respectively. Elliott-Smith et al. (2008) found reproductive success appeared higher on island nests compared to mainland nests, likely because island sites are less accessible to mammalian predators and because they are less likely to be disturbed by humans (Elliott-Smith et al. 2008). We similarly observed both higher apparent hatching and fledgling success on island nests in 2015 but this only appeared true for fledging success in 2016. We did not estimate reproductive success using a daily survival rate estimator (e.g. using Program MARK; White and Burnham 1999) although we will consider doing so for future estimates as this technique is more versatile and meets assumptions not met by estimating apparent reproductive success.

Our results of human disturbance indicate higher disturbance rates on the north coast. This is not surprising because the north coast location is much closer to Portland and Willamette Valley cities and therefore used by visitors and tourists in the summer more frequently than other sections of the coast. Audubon Portland recently performed a more comprehensive survey of human related disturbance to oystercatchers on the coast. This information will be summarized in a separate report and will be shared with USFWS and other collaborators with the intention of minimizing disturbance at key sites through signage or possibly direct outreach.

The 2016 Black Oystercatcher monitoring effort was highly successful. We will continue this effort in 2017 and continue to expand our volunteer base outreach and awareness of this project and of Oregon's MR/MPA system.

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Appendix. Nest locations and nest success maps for north, central, and south coast.

North / Central Coast

South Coast


Map Key
Hatch Success
Success
Failed
Not Monitored
Unknown
Rocky Shoreline
Major Highways
Marine Reserve
MPA
Seabird Protection Area
Comparison Area
City
North Bend
Coos Bay
Coquille
Bandon
Myrtle Point
Powers
Port Orford
Gold Beach
Brookings
Pacific
Ocean
0
5
10 Miles
N