

Double-crested Cormorant Western Population Status Evaluation

Final Annual 2015 Report



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by

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to

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Executive Summary

The U.S. Army Corps of Engineers (Corps) developed the Double-crested Cormorant Management Plan and Final Environmental Impact Statement (FEIS)(Corps 2015) to comply with reasonable and prudent alternative action (RPA) 46 in the 2008 FCRPS Biological Opinion (BiOp), and its 2010 and 2014 Supplements, issued by National Marine Fisheries Services (NOAA Fisheries), which identified a management objective of no more than 5,380-5,939 breeding pairs of Double-crested Cormorants on East Sand Island (2014 Supplemental FCRPS BiOp). The Corps selected Alternative C-1 from the FEIS to meet RPA 46 based on feasibility, minimizing impacts to the Western Population of Double-crested Cormorants and other species, and minimizing the potential for Double-crested Cormorant dispersal. Alternative C-1 includes coordination with the U.S. Fish and Wildlife Service (USFWS) and States to implement the Pacific Flyway Council (PFC) Monitoring Strategy (PFC 2013) annually, which is the subject of this report.

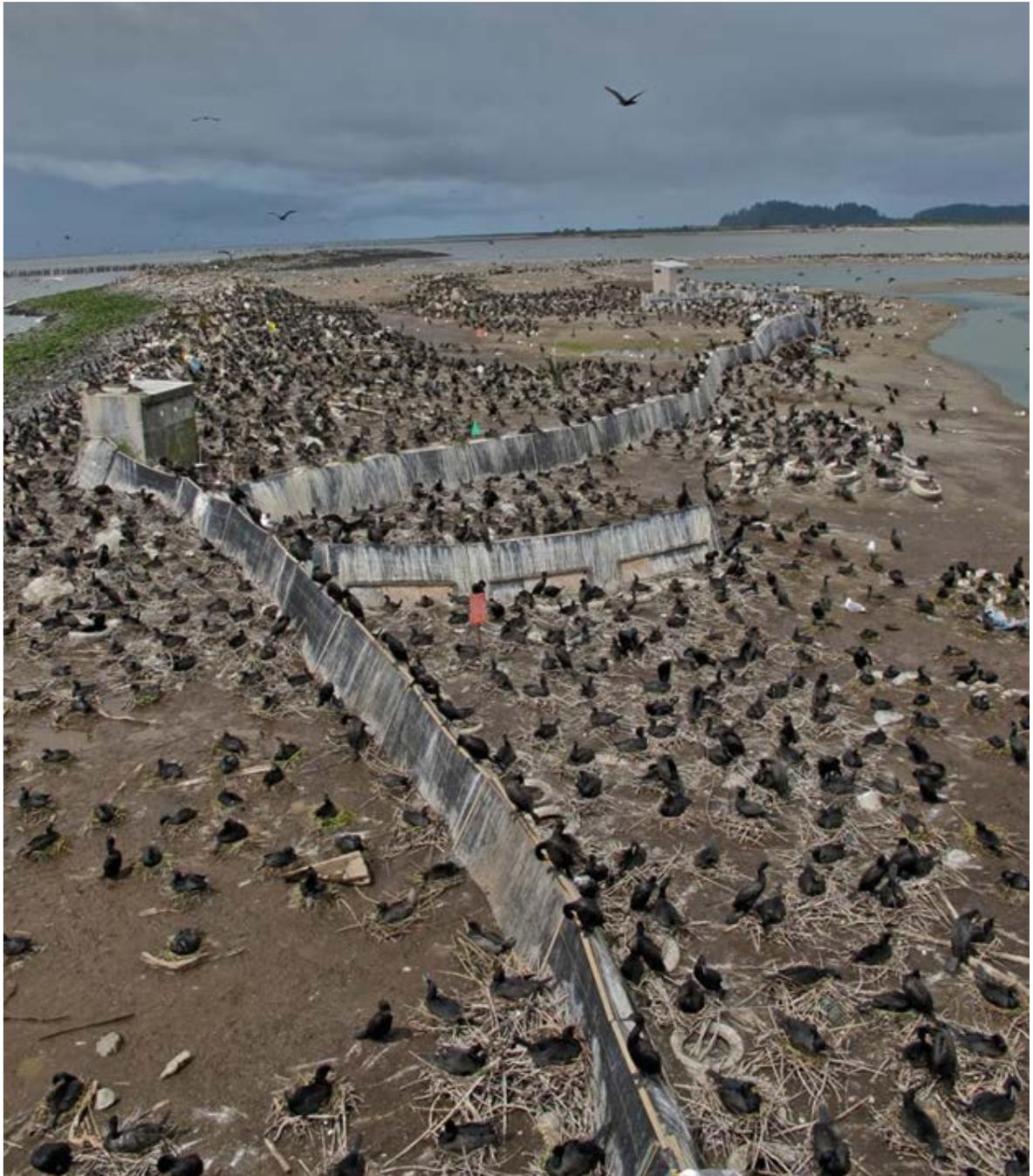
The PFC Monitoring Strategy is a coordinated monitoring effort to estimate the breeding population size, trend, and distribution of the Western Population of Double-crested Cormorants, and was implemented for the first time in 2014. Corps funding was used to survey sites where other PFC Partners would not have otherwise collected data in 2015. Survey methods included ground, boat, and/or aerial (plane or helicopter) direct counting or photo enumeration. Surveys were completed, at minimum once per site, to estimate peak number of breeding Double-crested Cormorants,

through nest and adult counts, April through August.

USFWS and its contractors, PFC Partners, and Corps contractors monitored a total of 95 sites in 2015. The USFWS assembled and processed all 2015 colony information and derived a 2015 estimate of the Western Population as described in the PFC Monitoring Strategy. This annual estimate was compared to the Double-crested Cormorant Western Population Model prediction.

The 2015 estimate for the Western Population is 77,432 (63,593-91,271; $\pm 95\%$ confidence limit) breeding individuals. This is approximately 2.9% below the 2014 estimate [79,901 (66,520-93,282; $\pm 95\%$ confidence limit) breeding individuals], and is larger than the predicted abundance after culling for Year 1 of the Management Plan provided in Table 5-4 of the FEIS (Corps 2015).

The results of this survey will help determine the 2016 take levels using the adaptive management framework. Through adaptive management provided in Alternative C-1 from the FEIS, take levels can change based upon the observed abundance as compared to the predicted abundance for both the East Sand Island colony and the Western Population. Year-to-year adjustments to proposed take levels will occur in coordination with the Adaptive Management Team (the cooperating agencies to the FEIS, NOAA Fisheries, and tribal entities).



Double-crested and Brandt's Cormorant Colony on East Sand Island. Photo credit USFWS 2012.

Introduction

The Pacific Flyway Council published *A Framework for the Management of Double-crested Cormorant Depredation on Fish Resources in the Pacific Flyway* in 2012 (PFC 2012). The PFC recognized Double-crested Cormorant depredation at localized areas within the Pacific Flyway was creating conflicts with federal Endangered Species Act (ESA)-listed and special status fish and supplemental fisheries. This plan was developed to address these localized conflicts while managing Double-crested Cormorant numbers and distributions at the Flyway scale (Figure 1). The goal of the flyway plan was to maintain Double-crested Cormorants as a natural part of the waterbird biodiversity of the Pacific Flyway while minimizing substantial negative ecological, economic, and social impacts of Double-crested Cormorants. The purpose of the plan was to provide agencies with information and guidance to facilitate management of Double-crested Cormorants in the Pacific Flyway. The plan provides a framework for agencies and states to follow when addressing fish depredation issues. Strategies were provided to aid in developing and coordinating research, monitoring, and management of Double-crested Cormorants across the Pacific Flyway (PFC 2012).

In 2013, the Pacific Flyway Council followed up with *A Monitoring Strategy for the Western Population of Double-crested Cormorants within the Pacific Flyway* (PFC 2013). The goal of the monitoring strategy is to establish a coordinated, long-term monitoring effort to estimate the breeding population size, trend, and distribution of the Western Population of cormorants. This information is fundamental for

developing effective management recommendations, and for guiding and assessing management actions pertaining to cormorant depredation on fish resources.

The U.S. Army Corps of Engineers (Corps) developed the Double-crested Cormorant Management Plan and Final Environmental Impact Statement (FEIS) (Corps 2015) to comply with reasonable and prudent alternative action (RPA) 46 in the 2008 FCRPS Biological Opinion (BiOp), and its 2010 and 2014 Supplements, issued by National Marine Fisheries Services (NOAA Fisheries); the BiOp identified a management objective of no more than 5,380-5,939 breeding pairs of Double-crested Cormorants on East Sand Island (2014 Supplemental FCRPS BiOp). The Corps selected Alternative C-1 from the FEIS to meet RPA 46 based on feasibility, minimizing impacts to the Western Population of Double-crested Cormorants and other species, and minimizing the potential for Double-crested Cormorant dispersal. Alternative C-1 includes coordination with the U.S. Fish and Wildlife Service (USFWS) and States to implement the Pacific Flyway Council (PFC) Monitoring Strategy (PFC 2013) annually. The PFC Monitoring Strategy is a coordinated monitoring effort to estimate the breeding population size, trend, and distribution of the Western Population of Double-crested Cormorants.

Methods

The dual-frame methodology of sampling and analysis employed in the PFC's monitoring strategy is modified from Haines and Pollock's 1998 study with bald-eagles, 'dual-frame' referring to the designation of colonies as belonging to either a 'list' or an 'area frame'. The number of active nests counted at these locations provides an index to estimate the total number of breeding adults. The dual-frame sampling approach concentrates sampling effort on the largest, active colonies and ensures that the majority of the population is sampled. The approach also includes sampling outside of known active colonies, which provides a more robust population estimate and can provide additional information on population distribution and dynamics. Double-crested Cormorant colonies on the list frame are active sites (≥ 5 nests). Area frame sites are historic or sites with < 5 nests. Sites were stratified by size, and then randomly selected for monitoring beginning in 2014 according to the PFC Monitoring Strategy (PFC 2013). For 2014 and 2015 the population estimates were derived from the sum of the total size class (strata) estimates. The number of colonies in each size class (strata) and mean colony size were multiplied to determine each total strata estimate. Since the mean colony sizes for each size class are used in creating the population estimate, precision is gained in the population estimate as the number of colonies surveyed increases,

The Pacific Flyway Monitoring Strategy has the objective to detect a 5% change/year in the Western Population of cormorants with 80% power ($\beta = 0.20$) and a 10% Type I error rate ($\alpha = 0.10$). A power analyses was conducted to identify the most cost-effective sampling scheme that achieved the monitoring objective. In total, a minimum of 44 locations will be

monitored per monitoring year. It is recognized that more locations will likely be monitored under various monitoring efforts and programs. When possible, these data will be included in the database and analyses. This will ensure a more precise population and trend estimate.

Monitoring began in 2014 and will occur every third year thereafter for at least 10 years (i.e., 2014, 2017, 2020, 2023) (PFC 2013). However, the Corps has needs for an annual assessment to fulfill monitoring objectives in the FEIS (Corps 2015). The Corps has adopted the methods, and the partnership used by the PFC, for this annual assessment of the Western Population.

The Monitoring Strategy was implemented for the first time in 2014, and selected 44 colonies for monitoring across nine states and British Columbia using the monitoring strategy sampling protocol. In 2015, using the same protocol, 46 sites were selected. In both years, additional sites were monitored and are used to derive the population estimate. In addition, we treat the Great Salt Lake 'colony' as individual sites rather than one, conforming generally to our treatment of colonies elsewhere across the range of the Western Population of Double-crested Cormorants.

Corps funding was used to survey sites where other PFC Partners were not acquiring colony survey data in 2015. Survey methods included ground, boat, and/or direct counting from either plane or helicopter, or later enumeration of aerial photographs. Surveys were completed, at minimum once per site, to estimate peak number of breeding Double-crested Cormorants, through nest and adult counts, April through August.

The USFWS assembled and processed all 2015 colony information obtained from the Western Population sites and derived a 2015 estimate of the Western Population as described in the PFC Monitoring Strategy. This annual estimate was

compared to the Double-crested Cormorant Western Population Model prediction in Table 5-4 of the FEIS (Corps 2015). Additionally, changes in population indices between the current and previous year were calculated and assessed with a two-tailed z-test using the sum of variances for the two estimates and an alpha level of 0.05.

We incorporated two changes to the methods from the published monitoring strategy. First,

we assumed the number of colonies in the Area Frame did not change. This accounts for the scenario that a “new” colony was previously established, but not monitored. In addition, this reduces the probability of overestimating the population. Second, sites on the List Frame with < 5 pairs recorded were analyzed with the Area Frame sites for 2015, but will be sampled in future years under the List Frame sampling schedule.

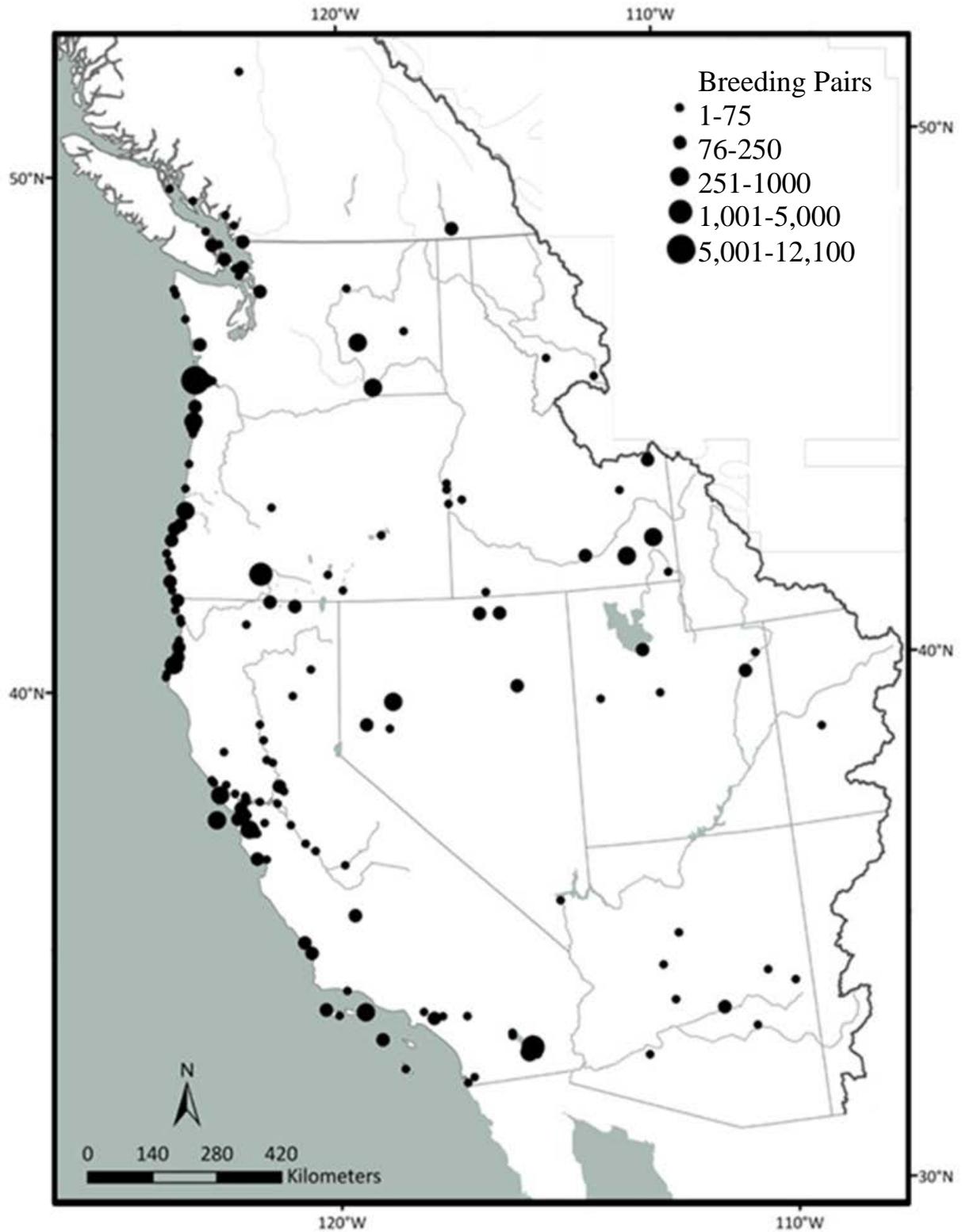


Figure 1. Distribution and relative size of Double-crested Cormorant breeding colonies in the Western Population at the time of last status assessment (1998-2009), (Adkins et al. 2010).

Results

In 2015, 45 sites were monitored of the 46 selected; one of those 45 sites, the Great Salt Lake, now is considered seven separate sites. Creston Valley Wildlife Management Area in BC was not monitored (Tables 1 and 3). An additional 45 sites were also surveyed for a total of 96 sites were monitored and analyzed (Table 1). In 2014, data were reported for 38 of the 44 selected sites, and 74 additional sites were monitored, for a total of 113 monitored sites (Table 2).

The 2015 breeding population estimate for the Western Population of Double-crested Cormorants is 38,716 pairs (95% CI 31,797-45,636 pairs) (Table 4).

The 2014 data yielded an estimate of 39,950 (33,260-46,641; $\pm 95\%$ confidence limit) breeding pairs (Table 4).

In comparison, the population estimate for 2015 is approximately 2.9% lower, but there is no evidence of a change (Table 4). The estimates are not statistically different ($p = 0.80$). We noted several shifts in class size and nine new colonies were identified in 2015 (along the Oregon Coast, in Arizona, British Columbia, Idaho and Utah). Additional data from Oregon coastal colonies have recently been contributed and the data for the East Sand Island colony used in this analysis were preliminary. New and updated data will be added to future analyses. This will change the population estimate, but since the main calculations are on mean colony size/class, the change will likely be small.



Double-crested Cormorant Colony in the Great Salt Lake. Photo credit : Utah Division of Wildlife Resources

Table 1. 2015 Sites Monitored

	Sites Selected (Submitted)	Additional Sites Monitored	Total (Monitored)
AZ	0	6	6
BC	2	7	9 (8)
CA	14	4	18
ID	4	2	6
MT	1	0	1
NV	1	0	1
OR	15	19	34
UT	1	1	8 ^a
WA	7	6	13
WY	1	0	1
Sum	46 (45)	45	97(96) ^b

^aThe Great Salt Lake was analyzed as seven sites.

Table 2. 2014 Sites Monitored

	Sites Selected (Submitted)	Additional Sites Monitored	Total (Monitored)
AZ	0	8	8
BC	2	0	2
CA	16	4	20
ID	4	3	7
MT	1	0	1
NV	2	0	2
OR	14	41	55
UT	1	5	6 ^a
WA	4	13	17
WY	0	1	1
Sum	44 (38)	74	119 (113)

^aSeparation of Utah sites for analysis accounts for any sum discrepancies.

Table 3. 2015 Sites Selected

Province/State	Area	Site Name
BC	Interior	Creston Valley Wildlife Management Area
BC	Vancouver Area	Second Narrows Bridge Power Tower
CA	Central Coast – Outer Coast North	South Farallon Islands
CA	Central Coast – San Francisco Bay	Bair Island Power Towers (incl. Steinberger Slough)
CA	Central Coast – San Francisco Bay	Alviso Plant, Pond Nos. A9 & A10
CA	Interior	Laguna de Santa Rosa
CA	Interior	Mullet Is., Salton Sea (So.)
CA	Interior	Anaheim Lakes
CA	Northern Coast – North Section	Pilot Rock
CA	Northern Coast – North Section	Arcata Bay Sand Islands
CA	Northern Coast – North Section	Big Lagoon
CA	Northern Coast – South Section	Dillon Beach Rocks
CA	Northern Coast – South Section	Hog Island
CA	Southern Coast	Prince Island
CA	Southern Coast	Santa Barbara Island
CA	Southern Coast	Seal Cove Area
ID	All	Coeur d' Alene River
ID	All	American Falls Reservoir
ID	All	Blackfoot Reservoir
ID	All	Bear Lake NWR
MT	East of Cont Div	Arod Lake
NV	All	S-Line Reservoir
OR	Central Coast	Yaquina Bay Bridge
OR	Central Coast	Parrot Rock
OR	Columbia River Mouth	East Sand Island
OR	Columbia River Mouth	Miller Sands Navigational Aids
OR	Interior	Spring Lake
OR	Interior	Prineville
OR	Interior	Historic Lower Klamath Lake
OR	Interior	Willamette River - W Coburg
OR	Interior	Rivers End (Lake Abert)

Table 3. 2015 Sites Selected cont.

Province/State	Area	Site Name
OR	Interior	Malheur NWR - Frenchglen Area - Baca Lake
OR	Northern Coast	Unnamed Colony (Cape Lookout)
OR	Southern Coast	Bolon Island
OR	Southern Coast	Hunters Island
OR	Southern Coast	Unnamed Colony (N of Ferry Road Park)
OR	Southern Coast	Unnamed Colony (Mack Reef)
UT	All	Great Salt Lake
WA	Grays Harbor	Grays Harbor Channel Markers
WA	Interior	Rock Island Dam Power Towers
WA	Interior	North Potholes Reservoir
WA	Interior	Pend Oreille River - Kelly Island
WA	Interior	Kent Creek
WA	San Juan Islands	Bird Rocks
WA	San Juan Islands	Drayton Harbor
WY	All	Molly Islands, Yellowstone NP



Double-crested Cormorant Colony in the Great Salt Lake. Photo credit : Utah Division of Wildlife Resources

Table 4. Estimated Number of Colonies and Double-crested Cormorant Western Population Estimates, 2015 and 2014

2015					2014			
Colony Size (Breeding Pairs)	# of Colonies Sampled	Colonies per size class estimate	Mean Colony Size	Population Estimate	# of Colonies Sampled	Colonies per size class estimate	Mean Colony Size	Population Estimate
>10,000	1	1	12,150	12,150	1	1	13,626	13,626
10,000-500	7	8	584	4,506	5	6	667	4,003
499-100	17	40	237	9,410	19	45	238	10,705
99-5	39	152	38	5,828	37	145	27	3,939
List Frame	64	201		31,894	62	197		32,273
Area Frame	33	224	30	6,822	51	224	34	7,677
Sum of Frames				38,716				39,950
Total Individuals				77,432				79,901
Variance Around Population Estimates								
			Population Estimate	Standard Error	CV %	Estimated LCL	Estimated UCL	
	2015	Pairs	38,716	3,530	9.1%	31,797	45,636	
		Individuals	77,432	7,061	9.1%	63,593	91,271	
	2014	Pairs	39,950	3,413	8.5%	33,260	46,641	
		Individuals	79,901	6,827	8.5%	66,520	93,282	

Table 5. Comparison of 2015, 2014 and ca. 2009 List Frame Population Estimates

	2015			Pacific Flyway Monitoring 2014			Adkins et al. 2014	
Colony Size (Breeding Pairs)	Estimate of the # of colonies in each size class	Mean Colony Size	POP EST (2015)	Estimate of the # of colonies in each size class	Mean Colony Size	POP EST (2014)	Mean Colony Size	POP EST (~2009)
>10,000	1	12,150	12,150	1	13,626	13,626	12,087	12,087
10,000-500	8	584	4,506	6	667	4,003	1,199	7,193
499-100	40	237	9,410	45	238	10,705	155	6,991
99-5	152	38	5,828	145	27	3,939	44	6,428
List Frame	201		31,894	197		32,273		32,700

Discussion

The strength in using the PFC Monitoring Strategy is the ability to detect change from 2014 forward. Monitoring methods are standardized for the first time, and a sampling approach is used that does not require monitoring all colonies. This monitoring approach derives an index and trend information on the majority of active colonies (approx. 70% of the known population), coordinated with multiple partners across the Western Population. Additionally, information is collected on the status of historical and small colonies and on the transition rates of colonies between size classes. Furthermore, this monitoring uses a randomized sampling design that allows for a total population estimate, with confidence intervals.

Caution should be used, however, when comparing the 2015 and 2014 results to previous assessments and population estimates since different methodologies were used in the past. It is inadvisable to directly compare the 2015 estimate of 38,716 (31,797-45,636; $\pm 95\%$ CI) breeding pairs and the 2014 estimate of 39,950 (33,260-46,641; $\pm 95\%$ CI) breeding pairs, both of which used the list and area frame method, with previous estimates. The circa 2009 (2008-2010), estimate was 31,200 breeding pairs (Adkins et al. 2014) and was derived using a whole census method, across multiple years, and which omitted colonies of fewer than 5 breeding pairs. Up to 1992, the estimate was 17,691 breeding pairs (Carter et al. 1995), and this was derived from a whole census method, across multiple years, and only included coastal states and BC. The 1975–1992, estimate was 20,830 breeding pairs (Tyson et al. 1997) and was derived from a whole census method across multiple years. Table 5 compares the population estimates from 2014 and 2015 with the circa 2009 data (Adkins et al.

2014), using only the list frame sites from 2014 and 2015; these are the most directly comparable with the earlier data. There is no evidence of a change in population size comparing the 2015, 2014 and ca. 2009 list frame analyses (Table 5).

There are additional opportunities for analysis within these data sets, including analyses of transition rates between size classes, and between list and area frame classifications. These data might also be used to better define the spatial resolution of colonies, and better define what constitutes a ‘new’ colony. Distribution changes may be looked at on a broad scale. Since the monitoring is currently taking place on an annual (versus every 3 year) basis and more colonies surveyed than the minimum, the power analysis could be updated.

The results of this survey will help determine the 2016 take levels using the adaptive management framework. Through adaptive management provided in Alternative C-1 from the FEIS, take levels can change based upon the observed abundance as compared to the predicted abundance for both the East Sand Island colony and the Western Population. Year-to-year adjustments to proposed take levels will occur in coordination with the Adaptive Management Team (the cooperating agencies to the FEIS, NOAA Fisheries, and tribal entities).



Double-crested Cormorant Colony in the Great Salt Lake. Photo credit : Utah Division of Wildlife Resources

Conclusion

The 2015 preliminary estimate for the Western Population of Double-crested Cormorants is 77,432 (63,593-91,271; $\pm 95\%$ confidence limit) breeding individuals. This is approximately 2.9% lower than the 2014 estimate, using similar methods to estimate the population, but well within 95% confidence levels and not statistically different ($p = 0.80$).

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Appendices

Please see the accompanying external hard drive for an index of hyperlinked reference documents, photos, and video.