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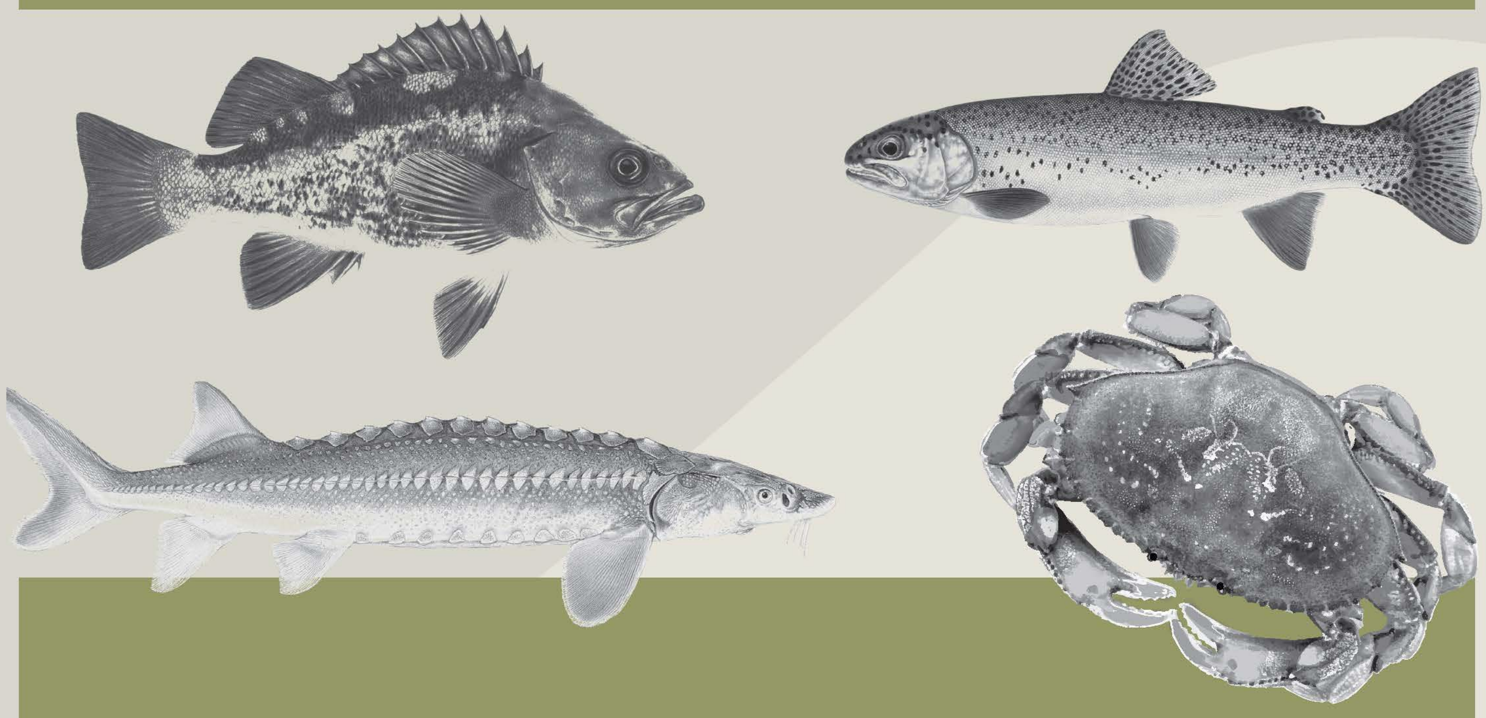

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Summary of Double-crested Cormorant Colony Monitoring in the Columbia River Estuary, 2020 and 2021

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Cover: Aerial photo of a portion of the double-crested cormorant colony on the Longview Bridge near Longview, Washington, taken on June 25, 2020. Photograph courtesy U.S. Army Corps of Engineers.

Introduction

Predation of juvenile fish by double-crested cormorants (*Nannopterum auritum*) is a possible limiting factor for various runs of imperiled salmonids in the Columbia River basin (Roby et al. 2021). To reduce predation, the U.S. Army Corps of Engineers (Corps) implemented a management plan during 2015–2020 to reduce double-crested cormorant abundance on East Sand Island, a human-modified island near the mouth of the Columbia River estuary (ESI management plan; USACE 2015). Prior to management, during 2004–2014, East Sand Island supported an average 12,982 nesting pairs, about 97% of all nesting pairs within the estuary (Lawonn 2023). Although management substantially reduced double-crested cormorant abundance at the East Sand Island colony, thousands of individuals dispersed to breeding locations farther upriver within the Columbia River estuary, where their per capita predation impact on salmonids is greater (Lawes et al. 2021, Evans et al. 2022, Lawonn 2023). As a result, the impact of double-crested cormorant predation on imperiled salmonids in the Columbia River estuary may be equivalent or greater today than the period prior to management.

Monitoring double-crested cormorant colonies within the Columbia River estuary is important to assess the effectiveness of management at reducing predation on salmonids (Roby et al. 2021) and to ensure the regional population of double-crested cormorants remains sustainable (Pacific Flyway Council 2013). Here I present results of recent colony surveys within the Columbia River estuary, which add to a dataset that extends to 1979, when the first survey of double-crested cormorants was conducted in the estuary (Carter et al. 1995). The purpose of this report is to summarize survey information from the 2020 and 2021 field seasons and provide a brief discussion of findings. For a more detailed treatment of double-crested cormorant status and predation impacts within the Columbia River estuary, the reader is referred to Lawes et al. (2021) and Lawonn (2023).

Methods

I analyzed aerial images of double-crested cormorant colonies taken in the Columbia River estuary during the presumed peak of colony abundance during 2020 and 2021. I followed Simenstad (2011) and considered the estuary to extend from the mouth of the river to the uppermost extent of tidal influence at Bonneville Dam (river km [RKM] 234). Based on previous work by Simenstad et al. (1990) and Anderson et al. (2004), I categorized colonies as occurring within one of three estuary salinity zones: marine, mixing, and freshwater zones. Images were provided by USACE staff and were taken by Civil Air Patrol (CAP) as part of a Corps monitoring effort for piscivorous birds. Photographs were taken by CAP personnel using a handheld digital camera (Nikon D7200) and telephoto lens from a small propeller-driven airplane. I used the computer program GIMP to analyze photographs of cormorant colonies. I manually marked each active nest on digital images, then tallied the marks using an automated procedure (i.e. code script). For the Astoria-Megler Bridge colony in 2020, ODFW staff counted most nests from a boat, but supplemented this survey with nests counted from aerial images. Survey information for some colonies was provided by staff from the Corps, Oregon State University, and Real Time Research (Bend, Oregon). Based on expansive survey coverage of known survey flights and discussions with various regional biologists, I assumed my results constituted a census of breeding double-crested cormorants within the Columbia River estuary during each of the two study years. To estimate predation impacts associated with estuary colonies, I followed the methods described in Lawonn (2023).

Results and Discussion

I identified 29 historical colony or sub-colony sites in the Columbia River estuary and one previously unreported site adjacent to The Dalles Dam, which lies upstream of the estuary (Figs. 1a, 1b; Tables 1, 2). Active double-crested cormorant nests were detected at 20 of these sites within the Columbia River estuary and the site adjacent to The Dalles Dam during 2020 and 2021. In 2020, 5,924 pairs nested in the estuary at 19 sites (Table 3). Most nested on the Astoria-Megler Bridge, which supported 5,081 breeding pairs, the largest size this colony has attained to date, while other estuary sites supported 843 breeding pairs. East Sand Island did not support sustained nesting by double-crested cormorants in 2020 (USACE unpubl. data). During 2020, double-crested cormorant abundance within marine, mixing, and freshwater zones was 81, 5,081, and 762 breeding pairs, respectively. In addition to breeding activity in the estuary, an estimated 35 pairs nested on The Dalles Dam transmission towers in 2020 (J. Day, USACE, pers. comm). During 2021, 5,599 double-crested cormorant pairs nested at 19 estuary sites (Table 3). Similar to 2020, most nesting within the Columbia River estuary in 2021 occurred at the Astoria-Megler Bridge colony, which supported 4,151 breeding pairs (Evans et al. 2022). East Sand Island supported an estimated 425 breeding pairs in 2021, but nesting activity did not appear to be continuously sustained for a sufficient period for chicks to hatch (T. Lawes, Oregon State University, pers. comm.). Other estuary sites supported 1,023 breeding pairs in 2021. During 2021, double-crested cormorant abundance within marine, mixing, and freshwater zones was 503, 4,151, and 945 breeding pairs, respectively. Besides breeding activity in the estuary, The Dalles Dam transmission towers supported an estimated 65 breeding pairs in 2021 (J. Day, USACE, pers. comm). In addition to documented nesting in 2020 and 2021, The Dalles Dam colony was reportedly active during 2018 and 2019, when the colony supported an estimated 20 and 25 breeding pairs, respectively (J. Day, USACE, pers. comm).

Double-crested cormorant abundance at estuary colonies besides East Sand Island increased from 747 breeding pairs in 2014, the year prior to management on East Sand Island, to 5,174 pairs in 2021 (Fig. 2). Most of this increase occurred within the mixing and freshwater zones (Fig. 3), which lie upriver of East Sand Island, located in the marine zone (Fig. 1a). Double-crested cormorant colonies within the mixing and freshwater salinity zones can have disproportionately high predation impacts because individuals associated with them tend to consume more salmonids on a per capita basis compared with those on East Sand Island (Cramer et al. 2021, Evans et al. 2022). The reason for the difference in the double-crested cormorant diet among salinity zones appears to be associated with higher availability of alternative, non-salmonid fish species as salinity increases closer to the mouth of the river (Collis et al. 2002).

The number of double-crested cormorants nesting at the Astoria-Megler Bridge colony continued to increase compared to the period prior to 2020 (Fig. 2); however, this colony declined by about 18% in 2021 compared to its all-time high in 2020. Nevertheless, the Astoria-Megler Bridge colony supported 74% of all double-crested cormorant breeding pairs in the Columbia River estuary in 2021 and was likely the largest colony in the Pacific Flyway during both 2020 and 2021. Estimated predation impacts on steelhead (*Oncorhynchus mykiss*) for the Astoria-Megler Bridge colony in 2021 were equivalent to predation by 17,849 breeding pairs on East Sand Island (predation equivalents), higher than at the East Sand Island colony prior to its decline (Fig. 4). In 2021, estimated double-crested cormorant predation on steelhead within the marine, mixing, and freshwater zones reflected 503, 17,849, and 8,127 predation equivalents, respectively. Estimated estuary-wide double-crested cormorant predation on steelhead in 2021 was 26,479 predation equivalents, about 169% of predation during the 2004–2014 peak abundance period, which averaged 15,670 predation equivalents (Fig. 4).

Although perhaps less conspicuous than the recent growth of the Astoria-Megler Bridge colony, aggregate double-crested cormorant abundance at other colonies has increased about 3.8-fold since implementation of the ESI management plan (Figs. 5, 6), from a pre-management average 270 breeding pairs during 2004–2014 to 1,023 breeding pairs in 2021. Most of these colonies lie within the freshwater zone of the estuary, where sampled per-cormorant predation rates on salmonids are about 3 to 18 times higher compared with East Sand Island, depending on sample period and salmonid species/run (Collis et al. 2002, Cramer et al. 2021). While aggregate abundance at these colonies is considerably lower than previous abundance at East Sand Island or current abundance at the Astoria-Megler Bridge, they could nevertheless contribute to considerable predation mortality on juvenile salmonids. For example, available data suggest per-cormorant predation rates on steelhead may be 8.6 times higher at colonies in the freshwater zone compared with East Sand Island (Cramer et al. 2021). Thus, the 945 double-crested cormorant pairs that nested at freshwater zone colonies in 2021 may have had the same predation impact on steelhead as 8,127 pairs on East Sand Island (Fig. 4). If this estimate is correct, the level of predation from these freshwater colonies alone would far exceed the predation goal under the original management plan: impacts equivalent to 5,380–5,939 breeding pairs on East Sand Island (USACE 2015).

Overall, the abundance of double-crested cormorants in the Columbia River estuary declined from an average 13,337 pairs during 2004–2014, to 5,599 pairs in 2021. However, double-crested cormorant predation rates on juvenile salmonids may currently be the same or higher than prior to management because of the unintended redistribution of cormorants to colonies within the estuary's mixing and freshwater zones. The available data strongly suggest additional work is needed to meet the objective of improved fish survival reflected in the ESI management plan.

In light of recent changes to double-crested cormorant status within the Columbia River estuary, monitoring double-crested cormorant abundance and predation rates at estuary colony sites will be necessary to make informed decisions regarding potential future management. Further, although double-crested cormorant abundance in the Columbia River estuary has declined in recent years, it still composes a substantial fraction of the regional population across western North America. Based on the most recent published point estimate for the regional population (22,889 breeding pairs; USFWS 2020), colonies in the Columbia River estuary composed about 24% of regional double-crested cormorant abundance in 2021. Therefore, future changes in double-crested cormorant status within the Columbia River estuary could have a considerable influence on the regional population, further highlighting the importance of the Columbia River estuary in regional monitoring efforts.

Funding for future abundance and predation monitoring appears uncertain for colonies that have recently supported the vast majority of double-crested cormorant breeding activity in the estuary. These colonies include the Astoria-Megler Bridge, most or all navigation markers, and other colonies besides those administered by the Corps. Given the potentially considerable impact of current levels of double-crested cormorant predation on outmigrating salmonids, fish managers should carefully evaluate the need for continued double-crested cormorant monitoring, and possibly future management, within the context of other conservation priorities for ESA-listed salmonids.

Acknowledgements

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Figures and Tables

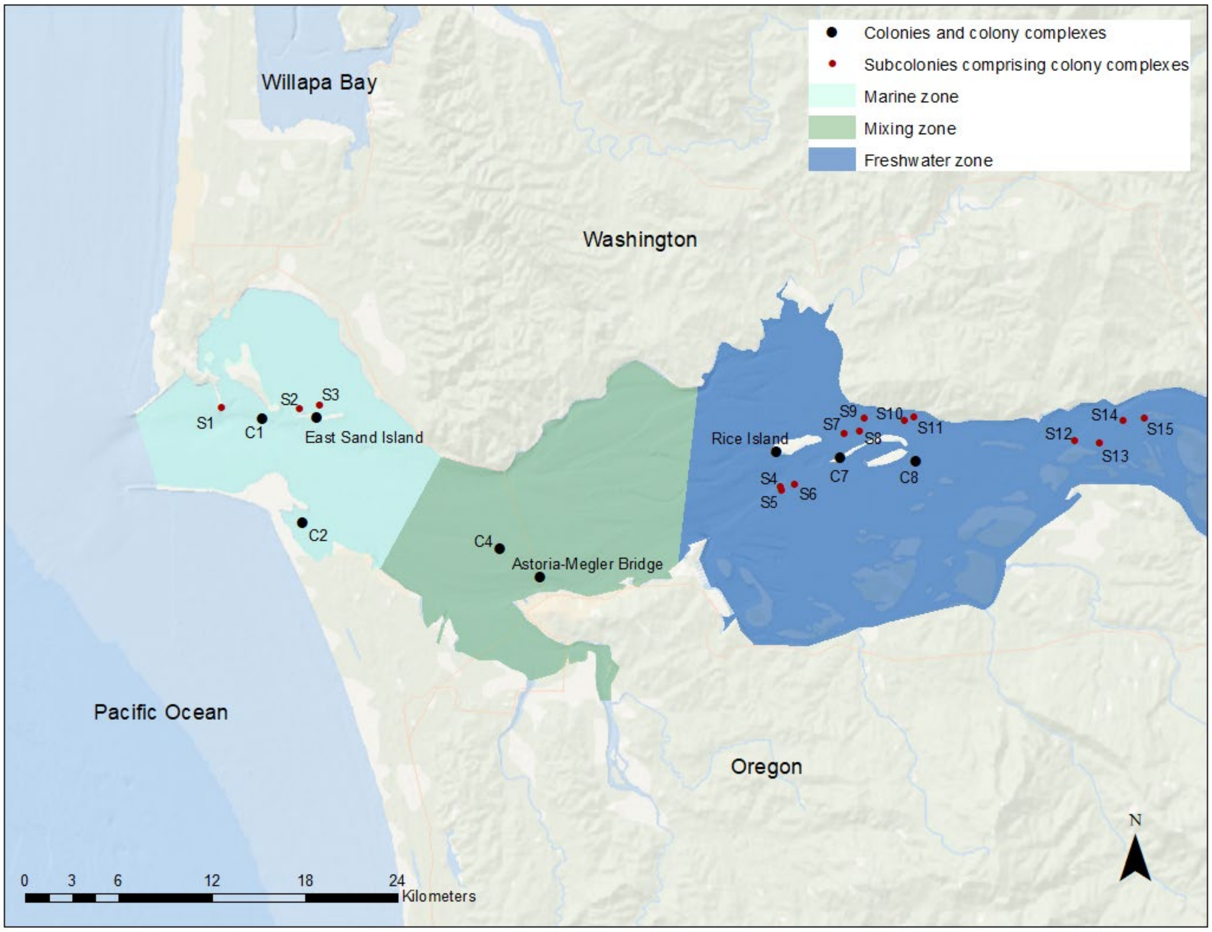

Figure 1a. Location of double-crested cormorant colonies and sub-colonies along the lower 55 km of the Columbia River estuary relative to salinity zones based on Simenstad et al. (1990) as modified by Anderson et al. (2004). Colony and sub-colony labels refer to colony names or ID codes in Tables 1 and 2.

Figure 2b. Location of double-crested cormorant colonies and sub-colonies from river km 55 upstream to the forebay of The Dalles Dam. Salinity zones based on Simenstad et al. (1990) as modified by Anderson et al. (2004). Colony and sub-colony labels refer to colony names or ID codes in Tables 1 and 2.

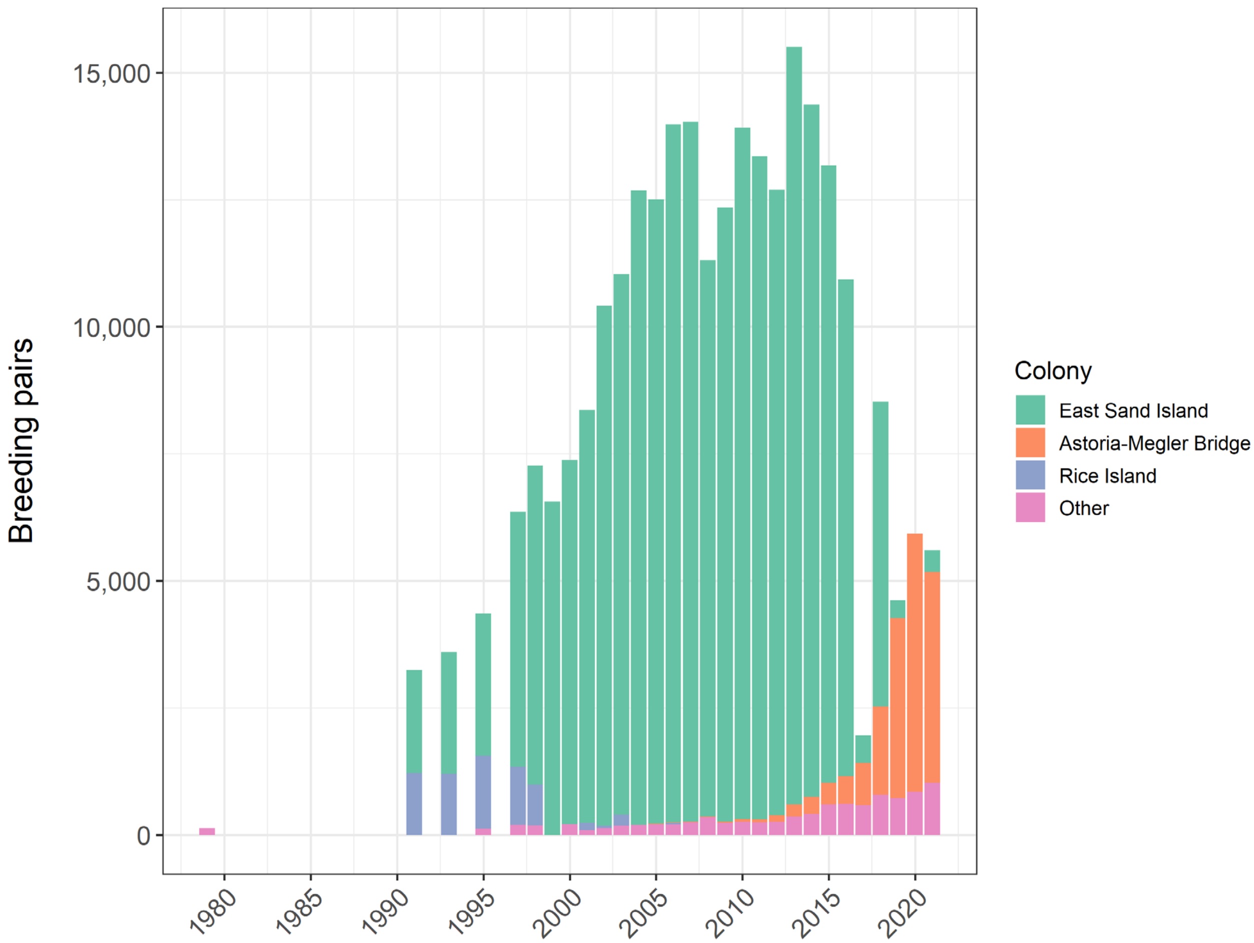

Figure 3. Number double-crested cormorant breeding pairs nesting within the Columbia River estuary, 1979–2021. Graph only includes years when survey effort was presumed to reflect estuary-wide double-crested cormorant abundance. Data summarized in this report and Lawonn (2023).

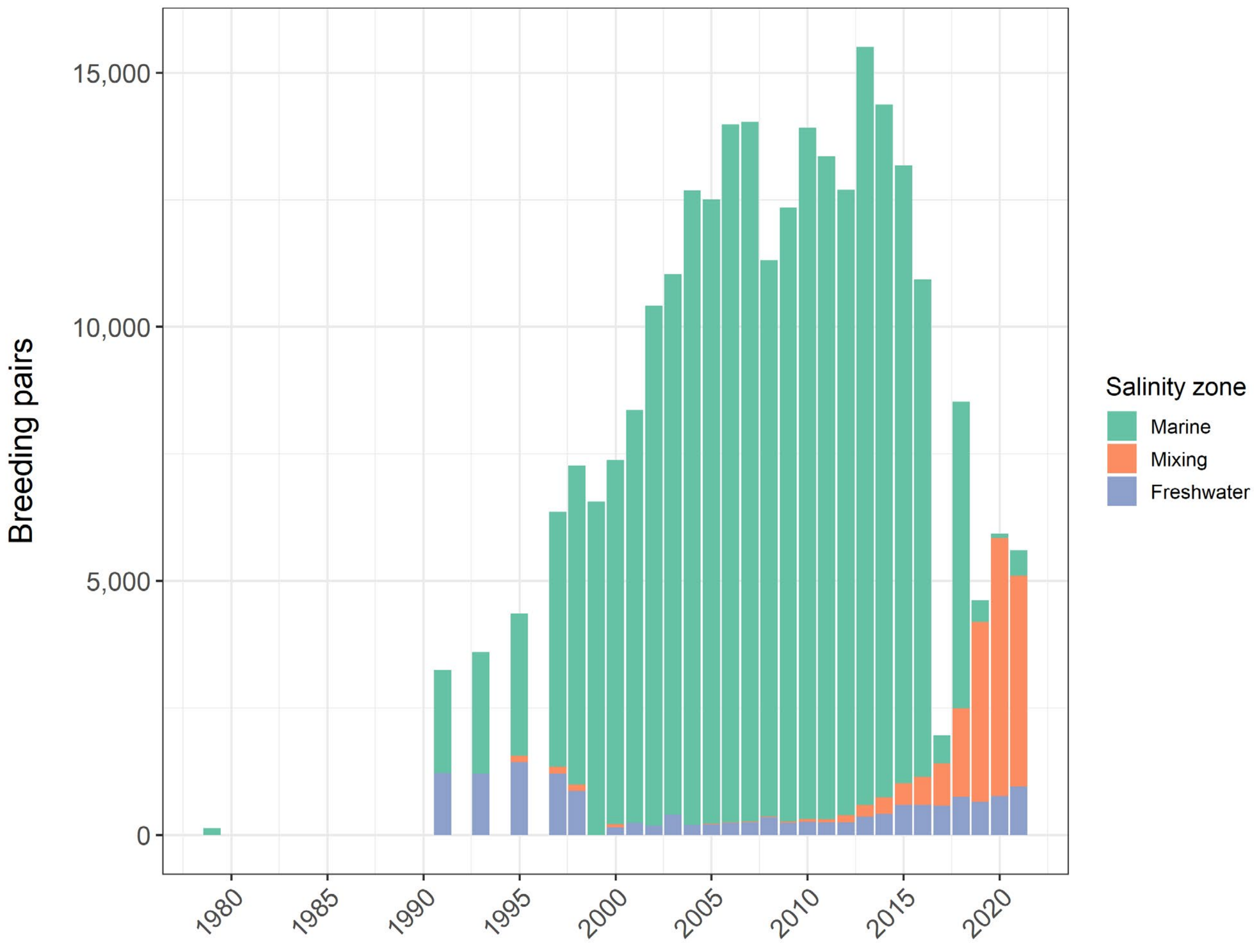

Figure 3. Number of double-crested cormorant breeding pairs nesting within three salinity zones of the Columbia River estuary, 1979–2021 Graph only includes years when survey effort was presumed to reflect estuary-wide double-crested cormorant abundance. Data summarized in this report and Lawonn (2023).

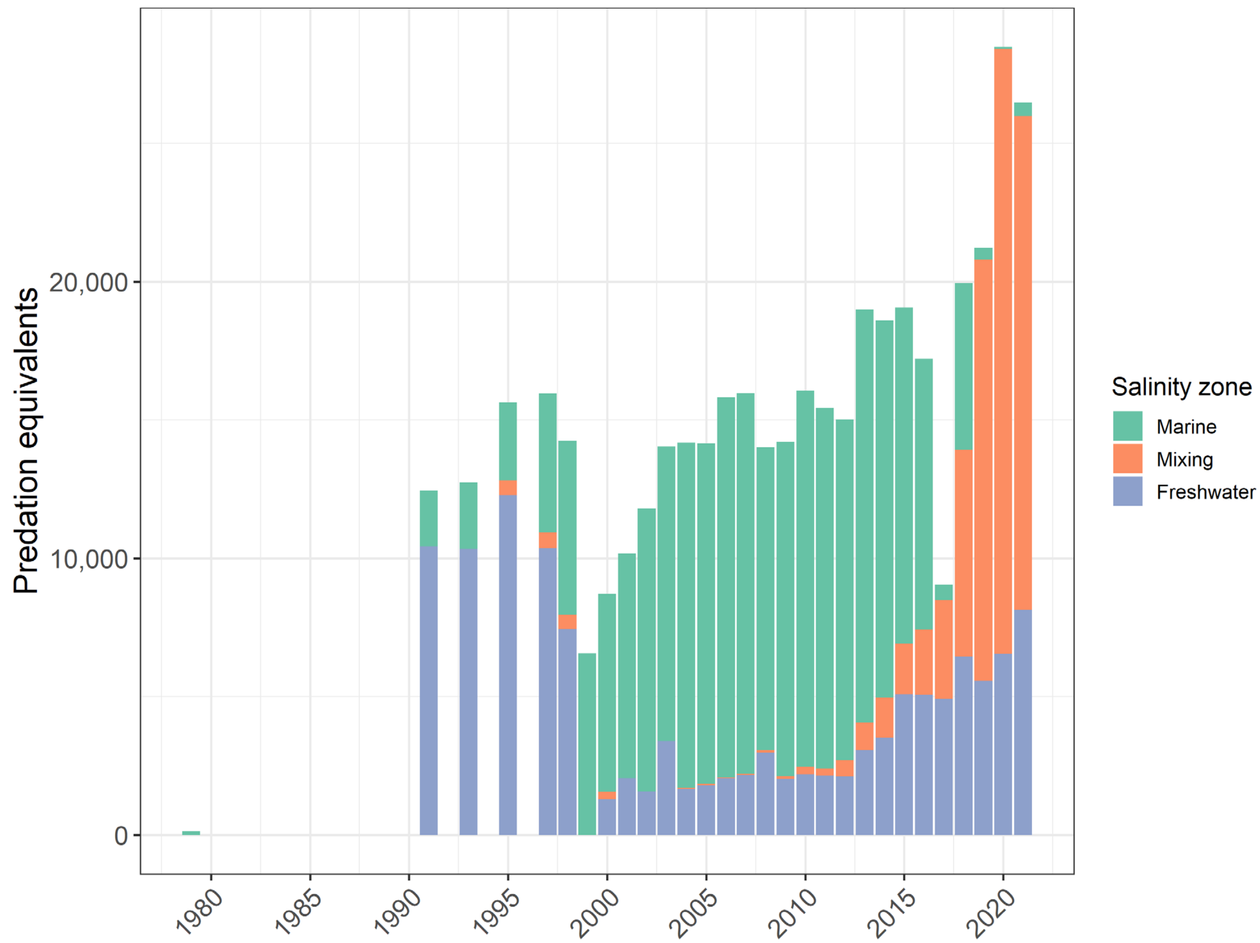

Figure 4. Estimated predation impact on juvenile steelhead for double-crested cormorants breeding in three salinity zones within the Columbia River estuary. Predation expressed as the number of breeding pairs on East Sand Island that would cause equivalent predation impacts (predation equivalents). Graph only includes years when survey effort was presumed to reflect estuary-wide double-crested cormorant abundance. Data summarized in this report and Lawonn (2023). Method to calculate predation equivalents described in Lawonn (2023).

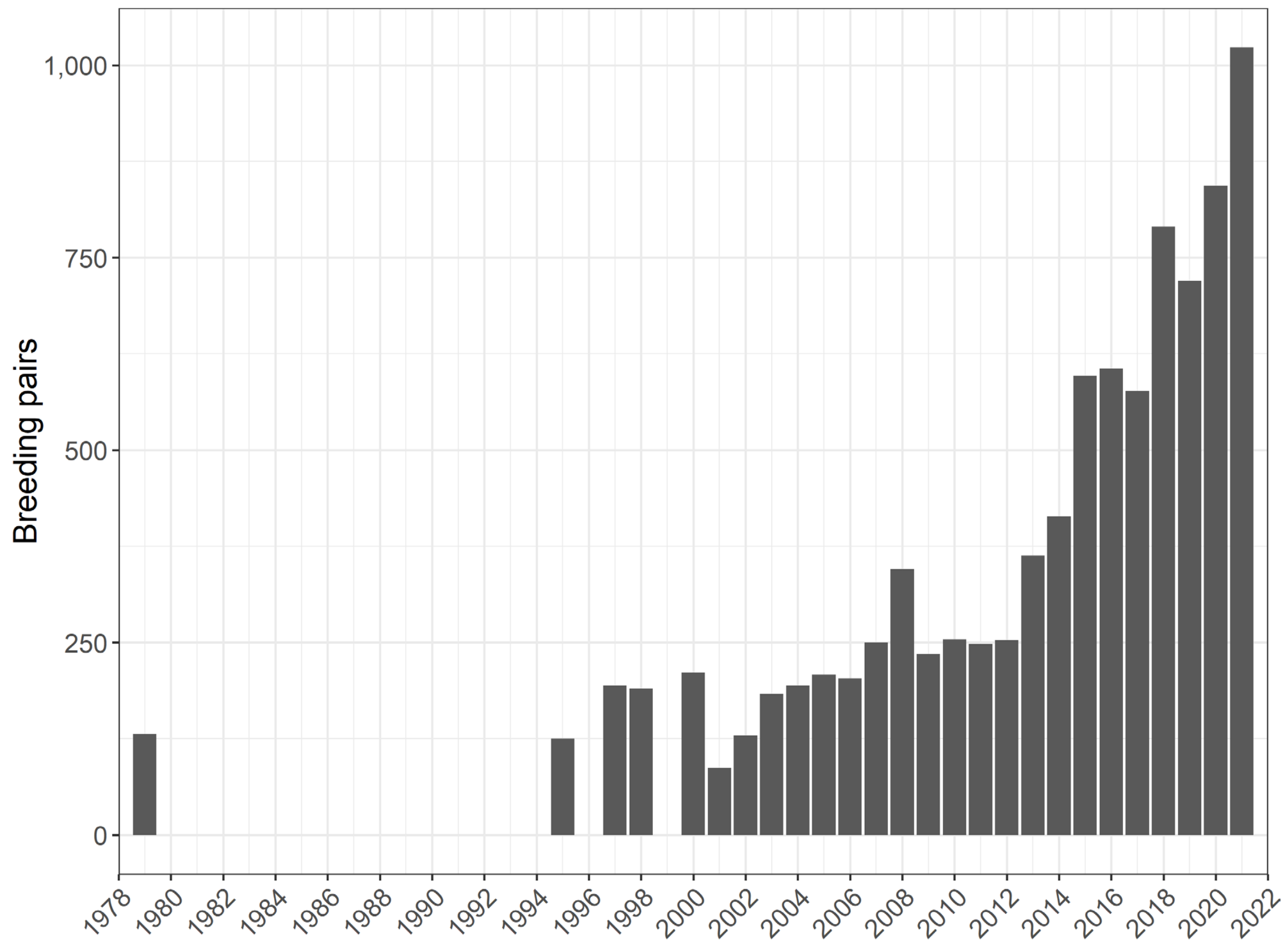

Figure 5. Aggregate number double-crested cormorant breeding pairs nesting in the Columbia River estuary during 1979–2021 at sites besides large historical colonies at Rice and East Sand islands and the contemporary colony at the Astoria-Megler Bridge. Data summarized in this report and Lawonn (2023).

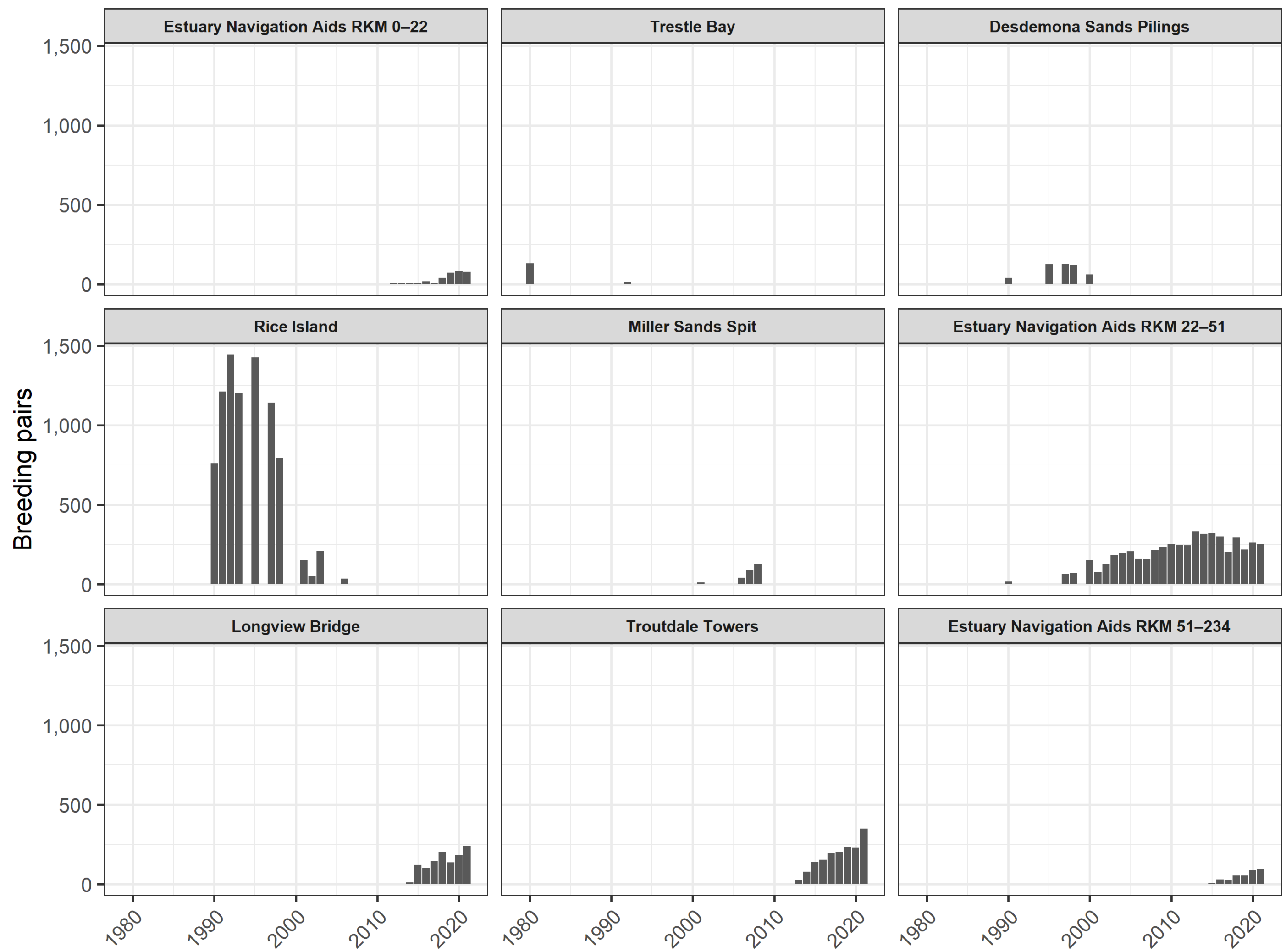

Figure 6. Number double-crested cormorant breeding pairs nesting in the Columbia River estuary during 1979–2021 at colony sites besides East Sand Island and the Astoria-Megler Bridge. Data summarized in this report and Lawonn (2023).

Table 1. Location of double-crested cormorant colonies and colony complexes in the Columbia River estuary and adjacent to The Dalles Dam during 1979–2021. Information from Roby et al. 2021, Lawonn 2023, and personal communication with USACE staff.

ID	Colony name	Latitude	Longitude	Notes
C1	Estuary Navigation Aids RKM 0–22	46.261940	-124.013859	Colony complex comprising 3 navigation aids along the stretch of river from the Columbia River mouth to the Astoria-Megler Bridge (ca. river km [RKM] 21.6). Each sub-colony is located on an individual navigation aid.
C2	Trestle Bay	46.220000	-123.990833	Historic colony site located on abandoned trestle used for construction of South Jetty (CREST 1984).
C3	East Sand Island	46.262190	-123.982252	Colony site has varied across years, but generally located near center to west end of island.
C4	Desdemona Sands Pilings	46.209722	-123.876389	Colony site located on pilings from historical Desdemona Sands Lighthouse. Probably unsuitable for nesting since at least early 2010s (Adam Peck-Richardson, Oregon State University, pers. comm.).
C5	Astoria-Megler Bridge	46.198015	-123.853266	Breeding concentrated within 1.5 km of south terminus but occurs on all portions of the bridge’s approx. 6 km extent.
C6	Rice Island	46.248694	-123.716442	Historical colony site at west tip of island.
C7	Miller Sands Spit	46.246084	-123.679441	Historical colony site at west tip of island.
C8	Estuary Navigation Aids RKM 22–51	46.244692	-123.635143	Colony complex comprising 12 navigation aids along the stretch of river from Astoria-Megler Bridge upstream through river km 51. Each sub-colony is located on an individual navigation aid. This complex comprises all navigation aids from “Miller Sands Navigational Aids” and “Upper Estuary Navigational Aids” in Adkins and Roby (2010).
C9	Longview Bridge	46.104545	-122.961960	Colony located on two main piers of bridge.
C10	Troutdale Towers	45.567872	-122.412055	Colony located on cluster of five power transmission towers.
C11	Estuary Navigation Aids RKM 51–234	45.565447	-122.182918	Colony complex comprising 6 navigation aids along stretch of river from river km 51 to Bonneville Dam (ca. river km 234). Each sub-colony is located on an individual navigation aid.

C12	The Dalles Dam Towers	45.617148	-121.134697	Colony located on power transmission towers adjacent to The Dalles Dam. First observed in 2018 (J. Day, USACE, pers. comm.).

Table 2. Location of constituent navigation markers for double-crested colony complexes in the Columbia River estuary, 1979–2021. Information from Roby et al. 2021 and Lawonn 2023.

Colony complex	ID	Navigation marker	Name in Roby et al. (2021)	Latitude	Longitude
Estuary Navigation Aids RKM 0–22	S1	Jetty A Tower	Jetty A Channel Marker	46.265954	-124.037809
	S2	Sand Island Range Front Light	Sand Island Channel Marker #1	46.265832	-123.992948
	S3	Sand Island Range Rear Light	Sand Island Channel Marker #2	46.267293	-123.981073
Estuary Navigation Aids RKM 22–51	S4	Harrington Point Channel 52 Light	Estuary Channel Marker #1	46.234162	-123.714198
	S5	Tongue Point Channel Range Front Light	Estuary Channel Marker #2	46.232948	-123.713511
	S6	Tongue Point Channel Range Rear Light	Estuary Channel Marker #3	46.235152	-123.705794
	S7	Harrington Point Range Front Light	Estuary Channel Marker #4	46.255911	-123.677035
	S8	Harrington Point Range Rear Light	Estuary Channel Marker #5	46.256534	-123.668582
	S9	Miller Sands Dike Light 5	Estuary Channel Marker #6	46.261769	-123.665627
	S10	Miller Sands Dike Light 11	Estuary Channel Marker #7	46.261145	-123.641955
	S11	Miller Sands Range Front Light	Estuary Channel Marker #8	46.262415	-123.636661
	S12	Pillar Rock Lower Range Front Light	Estuary Channel Marker #9	46.252761	-123.543447
	S13	Pillar Rock Lower Range Rear Light	Estuary Channel Marker #10	46.251728	-123.529404
	S14	Pillar Rock Upper Range Front Light	Estuary Channel Marker #11	46.260721	-123.515554
	S15	Pillar Rock Upper Range Rear Light	Estuary Channel Marker #12	46.261706	-123.502956
Estuary Navigation Aids RKM 51–234	S16	Martin Island Lower Range Front Light	Not reported	45.957934	-122.808994
	S17	Martin Island Lower Range Rear Light	Not reported	45.955872	-122.806304
	S18	Washougal Upper Range Rear Light	Not reported	45.551788	-122.339813
	S19	Fashion Reef Lower Range Front Light	Not reported	45.585095	-122.127023
	S20	Fashion Reef Lower Range Rear Light	Not reported	45.586233	-122.119301
	S21	Warrendale Lower Range Rear Light	Not reported	45.613594	-122.037611

Table 3. Number double-crested cormorant nesting pairs at known colonies from the mouth of the Columbia River to The Dalles Dam forebay during the presumed period of peak nest abundance during 2020 and 2021. Survey data from ODFW analysis of aerial photos taken on June 25, 2020, and June 8, 2021, except for footnoted data.

Colony name	2020	2021
Jetty A Tower	23	30
Sand Island Range Front Light	34	23
Sand Island Range Rear Light	24	25
Trestle Bay	--[a]	0[b]
East Sand Island	0[c]	425[b]
Desdemona Sands Pilings	0[a]	0[a]
Astoria-Megler Bridge	5,081	4,151[d]
Rice Island	0	0
Harrington Point Channel 52 Light	--[a]	--[a]
Tongue Point Channel Range Front Light	--[a]	--[a]
Tongue Point Channel Range Rear Light	--[a]	5
Miller Sands Spit	0	0
Harrington Point Range Front Light	43	44
Miller Sands Dike Light 5	5	--[a]
Harrington Point Range Rear Light	50	50
Miller Sands Dike Light 11	0	--[a]
Miller Sands Range Front Light	12	10
Pillar Rock Lower Range Front Light	--[a]	0
Pillar Rock Lower Range Rear Light	27	22
Pillar Rock Upper Range Front Light	55	47
Pillar Rock Upper Range Rear Light	68	75
Longview Bridge	184	242
Martin Island Lower Range Front Light	14	13
Martin Island Lower Range Rear Light	45	51
Troutdale Towers	229	351
Washougal Upper Range Rear Light	--[a]	--[a]
Fashion Reef Lower Range Front Light	10	13
Fashion Reef Lower Range Rear Light	15	22
Warrendale Lower Range Rear Light	5	0
The Dalles Dam Towers	35[e]	65[e]

[a]Aerial photos not taken during CAP survey, presumed inactive
[b]T. Lawes, Oregon State University
[c]USACE, unpubl. data
[d]Evans et al. 2022
[e]Estimated by J. Day, USACE