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ABUNDANCE, DISTRIBUTION, AND DISSUASION EFFORTS OF COLONIAL PISCIVOROUS WATERBIRDS ON RICE ISLAND, MILLER SANDS, AND PILLAR ROCK ISLAND OF THE COLUMBIA RIVER: 2023 SEASON SUMMARY REPORT.

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SUMMARY

This report documents compliance with Term and Condition 1.k. of the 11 July 2012 Biological Opinion issued by National Marine Fisheries Service (NMFS) for the Columbia River Navigation Channel Operations and Maintenance, mouth of the Columbia River to Bonneville Dam, Oregon, and Washington. Term and Condition 1.k. requires the U.S. Army Corps of Engineers to monitor upland dredge material placement sites during the nesting season and discourage any avian predators that are found nesting at upland dredged material placement sites, consistent with the Migratory Bird Treaty Act (MBTA). The upland placement sites of concern are located at Rice Island, Miller Sands, and Pillar Rock Islands. During the period of 11 May to 1 August there was a persistent and sustained effort by Caspian Terns (*Hydroprogne caspia*) to establish a breeding colony on Rice Island. A colony of Ring-billed Gulls (*Larus delawarensis*) formed within the interior of Rice Island, the site of which saw an elevated level of interest from the terns. There was an outbreak of Highly Pathogenic Avian Influenza (HPAI) which resulted in numerous mortalities among Lower-Columbia River (LCR) Estuary waterbirds. No Caspian Terns or Double-crested Cormorants (*Nannopterum auritum*) successfully nested on these placement sites in 2023.

While not associated with the 2012 NMFS Biological Opinion activities, this report also includes results from additional surveyed locations and additional avian species observed, to provide a broader context within the LCR region and at these sites.

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BACKGROUND

Long-term evaluation of Caspian Terns (CATE; *Hydroprogne caspia*, formerly *Sterna caspia*) and Double-crested Cormorants (DCCO; *Nannopterum auritum,* formerly *Phalacrocorax auritus*) in the Columbia River Estuary has revealed that aggregations of these birds can negatively impact some salmonid stocks (Evans et al., 2012, Adkins et al., 2014). In response to the increased presence and abundance of these bird species in the Columbia River Estuary, National Oceanic and Atmospheric Administration (NOAA) fisheries issued a Biological Opinion (BiOp) in 1999 requiring the U.S. Army Corps of Engineers (USACE) to dissuade colonial water birds from nesting on USACE owned and managed lands in the estuary. The avian directives present in the 1999 BiOp were reissued in subsequent BiOps in 2005 and 2012. This has led to complex management efforts to balance the impacts of avian predators on Endangered Species Act (ESA) listed salmonids while preserving the integrity of the avian populations in the Pacific Flyway (NOAA 1999, 2005, 2012; BPA, 2020).

In 1984, CATE began breeding colonially on East Sand Island (ESI), a 62-acre natural island at the mouth of the Columbia River. By 1986, CATE also began to breed further upriver, colonizing sites on the roughly 200-acre Rice Island, which would eventually host the world's largest CATE colony (approximately 16000 individual birds) (Roby at al., 2003). In 2000, the Rice Island colony was successfully relocated to ESI as part of an ongoing joint federal and state directive to protect ESA-listed salmonid stocks including: Chinook (*Oncorhynchus tshawytscha*), Coho (*O. kisutch*), Sockeye (*O. nerka*), and Steelhead (*O. mykiss spp.*) from avian predation. In 1998 -1999, prior to relocating the 8000-pair CATE colony to ESI, an estimated 5.4 – 14.2 million smolts were consumed per annum by CATE on Rice Island. This represented 5 – 15% of the migrating smolts that reached the estuary (Roby et al., 2003). ESA- listed salmonids were estimated to have comprised 77-90% of the CATE diet on Rice Island whereas CATE on ESI were found to consume a substantially fewer listed salmonids (33-47% of diet), supporting the decision to relocate the colony to achieve BiOp directives pertaining to conservation of ESA-listed stocks (Roby et al., 2002, 2021). The dissuasion methods developed to move the colony from Rice to ESI have since been employed to continually deter re-colonization of Rice Island, Miller Sands, and Pillar Rock Island (collectively "RMP", and hence abbreviated as such) (NOAA 2005, Figure 1) by piscivorous waterbirds. Continued monitoring and dissuasion is required to ensure that CATE and DCCO do not successfully recolonize these dredge material placement sites.

Specifically in reference to Term and Condition 1.k. of the 11 July 2012 BiOp issued by NMFS for the Columbia River Navigation Channel Operations and Maintenance, mouth of the Columbia River to Bonneville Dam, Oregon and Washington requires USACE to monitor upland dredged material placement sites during the nesting season and discourage any avian predators found nesting at an upland dredged material placement site. To comply with this condition in 2023, the USACE Portland District Fisheries Field Unit (FFU) office operationalized a monitoring and dissuasion effort on RMP, funded by the Columbia and Lower Willamette Rivers federal navigation channel project. The objective of the effort was to deter colonial piscivorous waterbird interest in these sites and ensure none of these avian predators successfully reproduced on these islands. Using the methods developed by Real Time Research™ (RTR), Oregon State University (OSU), and United States Geological Survey (USGS) Avian Research Cooperative Unit, the FFU deployed hazing operations and multiple dissuasion techniques on Rice Island and recorded abundance data for CATE, DCCO, and American White Pelicans (AWPE; *Pelecanus erythrorhynchos*) on RMP in 2023.

The Streaked Horned Lark (SHLA; *Eremophila alpestris strigata*), a state and federally listed subspecies of Horned Lark, is known to reside and breed on dredge material-fill islands within the LCR, including RMP. USACE is required to monitor SHLA abundance on these islands, a condition of the 2014 O&M Columbia River Federal Navigation Channel BiOp issued by United States Fish and Wildlife Service (USFWS). USACE operations may not reduce (Columbia River) network-wide SHLA abundance below 52 detectable pairs on a three-year average or perform actions that result in a take exceeding two SHLA nests. These operations include dredge material deposition from maintenance of the Columbia River shipping channel and deterrence of piscivorous avian predators to protect ocean-bound ESA-listed salmonid smolts. Additionally, per the 2014 BiOp, USACE must meet annual reporting and submittal requirements of SHLA monitoring to the USFWS. In 2023, USACE contracted Turnstone Environmental Consulting to perform SHLA surveys and draft a report on the status of SHLA within the LCR. USACE biologists also performed facultative SHLA monitoring while engaged in dissuasion of piscivorous colonial waterbirds during the 2023 field season. SHLA monitoring is detailed in Strong and Tidwell (2024).

This report details the actions taken by the FFU to ensure the USACE meets the conditions set forth by the 2012 NMFS Biological Opinion for Rice Island, Miller Sands, and Pillar Rock Island in 2023.

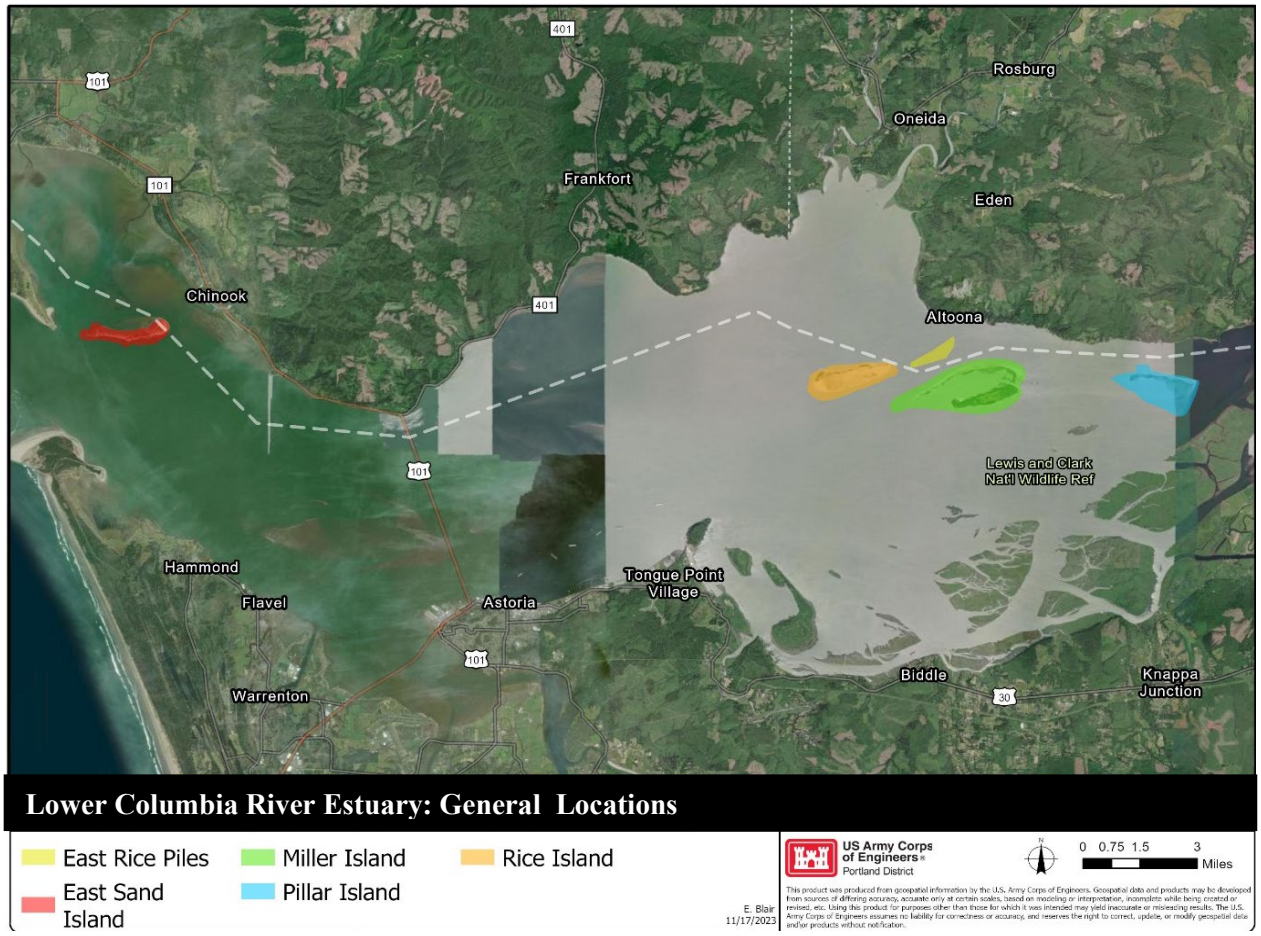

Figure 1. Map of Lower Columbia River (LCR) Estuary. Upland dredged material placement sites: Rice (orange), Miller Sands (green), and Pillar Rock Islands (blue) (collectively RMP) are depicted in reference to Term and Condition 1.k. of the 11 July 2012 BiOp issued by the National Marine Fisheries Service (NMFS) for the Columbia River Navigation Channel Operations and Maintenance, mouth of the Columbia River to Bonneville Dam, Oregon, and Washington. East Sand Island (ESI; red) is included for visualizing broader trends in colonial piscivorous waterbird activity within the estuary. U.S Army Corps of Engineers (USACE) management of avian colonies on ESI in accordance with 2020 Bonneville Power Administration (BPA) BiOp. Additional information pertaining to USACE management of avian activity on ESI may be found in Blair et al (2024). *Map by Erin Blair.*

METHODS

Surveys

Bird Count Surveys: USACE biologists utilized a combination of on-foot, ATV, and boat-based surveys to enumerate colonial piscivorous waterbirds within the LCR (Figure 1). We report mean and standard deviation (SD) estimates derived from direct observation in this report for CATE, DCCO, and AWPE. On-foot surveys consisted of USACE biologists searching the island (on foot) and using 8 x 42 field glasses to enumerate the maximum numbers of each colonial waterbird species observed for each day. These data were recorded, and later transcribed into a Microsoft Excel database. On Rice Island specifically, two Yamaha ATVs were used in circumnavigations of the island in search of CATE, DCCO, and AWPE. During boat-based surveys, at least two USACE biologists were present: one operating the boat and the other as observer. The operator piloted the vessel upriver past RMP while the observer scanned for colonial piscivorous waterbirds on the islands, counting only birds seen on solid ground or associated pilings. USACE biologists used avian enumeration methods per Bowman (2015).

Incidental observations of SHLA were recorded throughout the season and abundance data was collected in the form of incidental observations (see below) during avian dissuasion operations. Special attention was given to the laser-covered zone on the west end of Rice Island (Figure 1, Figure 5). This region, referred to hereafter as "The Bowl" is an open, un-vegetated, sandy depression with elevated berms along the periphery and is approximately 15.4-acres in size. SHLA observations that occurred while engaged in avian dissuasion activities (i.e incidental observations) were recorded, as well as any sightings of that occurred while completing circumferential ATV tours of the island. A lack of SHLA data for any given day should not be equated with the absence of SHLA on that day, but rather that USACE biologists made no dedicated survey efforts or incidental observations. Established routes of transit through sensitive SHLA habitat were abided by and USACE biologists did not set foot off-trail in locations outside of CATE congregations to minimize impacts to SHLA. Three dedicated SHLA surveys were performed by Turnstone Environmental Consultants between 18 May and 14 June on each of the RMP sites. The survey methods employed by Turnstone are as detailed in (Turnstone Environmental Consultants, 2023). The contractor data and incidental observations by USACE biologists are used to infer the potential impacts from avian enumeration and dissuasion operations on SHLA.

CAP Flight Photography: USACE contracted the Civil Air Patrol (CAP) to fly four missions over the LCR region in 2023. An onboard photographer would canvas each island, photographing all birds on/around the islands and accompanying pilings and channel markers. These photos were used to estimate the total number of each target species present on each island at the time of the flight (Figure 2). Analysis of CAP flight photography was secondary to observational CATE, DCCO, and AWPE data collected during USACE field surveys, but was the sole tool for enumeration of the Ring-billed Gull (RBGU; *Larus delawarensis*) colony that formed within the interior of Rice Island. Range for maximum recorded counts of each species includes CAP data (Tables 1, 2, 3; Supplementary Tables 1, 2, 3).

Figure 2. Example of Civil Air Patrol (CAP) Flight Photography, from 12 July 2023. Photo shows 93 Caspian Terns (CATE), 3456 Double-crested Cormorants (DCCO), 130 American White Pelican (AWPE), and at least 480 adult Ring-billed Gull (RBGU) (chicks not counted) on the northwestern beach of Rice Island.

Dissuasion Techniques

Autonomous Laser: On 4 April preparation for hazing on Rice Island began with the deployment of the AVIX Autonomic Laser (Figure 3). The AVIX Autonomic Laser (Mark II AVIX laser®, Bird Control Group, Wilsonville, OR. 97070) (henceforth abbreviated to "laser") was installed on Rice Island at an elevated position overlooking The Bowl; a site historically used by CATE as nesting habitat (Figure 3, Figure 5). The unit is powered by auxiliary solar batteries and produces a green laser of intermediate power, rated class 3B, that operates in the 495mW- 499mW range. This range maximizes visual disturbance for the target species (primarily CATE). The device was programmed such that the laser's beam moves across area of operation following a preprogrammed path and operating on a 15-minute interval (three minutes active/12 minutes inactive), turning on one hour before sunrise and one hour after sunset to coincide with heightened periods of avian activity. In low light conditions, the laser would flush roosting birds near the beam's point of contact. This provided effective dissuasion within The Bowl, without requiring constant USACE biologist presence on-island. Use of the laser was approved by the USFWS in 2021. After field testing during the 2021 season, the laser was deployed in 2022 and again in 2023. Installation and programming of the autonomous laser was performed by Class 3B Laser certified operators.

Use of the laser reduced field time and use of field materials and reduced potential impacts on other species. In reducing USACE reliance on the use of dissuasion flagging, which requires a substantial amount of material and can become degraded through time and must be replaced. The Bowl is regularly used for dredge material placement, and SHLA observations have been scarce and sporadic at the site since 2019 (2022 Annual Report: Strong and Tidwell, 2023). USACE biologists regularly communicated with contacts at the USFWS by sending weekly reports on hazing activity, use of the laser/s, and observations of SHLA that occurred throughout the week every Friday.

Precautions were taken to protect the visiting public and passing vessels from exposure to the laser beam. Warning signs were installed on the island to warn potential visitors of the laser's operation. The laser's path was programmed with a six-meter buffer formed by the berm of The Bowl to protect marine traffic from a direct or reflected beam.

Figure 3. USACE Biologist observing the Avix Mark II Autonomous Laser® in operation. The sand berm around the 15.4-acre zone of coverage prevents overshooting by the beam. *Photography by Erin Blair*.

Active Dissuasion: The primary deterrence technique utilized by USACE biologists on Rice Island, patrols of the shoreline and upland areas were performed to dissuade any CATE attempting to land on the island. Two ATVs were used for transportation of personnel and equipment, circumnavigation of the beaches for avian surveys, and to rush loafing and nest-prospecting avian piscivores to flush them. ATV operation was restricted to the beaches (below wrack-line) and designated ATV trails within the interior of Rice (Figure 5) to avoid infringing upon designated SHLA habitat. When CATE were seen landing, loafing, or showing evidence of scraping behavior within the upland, a USACE biologist would approach the site and force the CATE to flush. A flashlight was used to startle approaching CATE in the evenings, and handheld strobe lights were placed on the ground to dissuade additional roosting attempts throughout the night. If scrapes were found, the location was recorded on ESRI ArcGIS FieldMaps® mobile application and the scrapes were filled in with sand. If eggs were found, biologists would remain close by to prevent CATE from returning to the immediate location and to observe the egg/s, observing if the egg fell prey to other wildlife or lost to the elements. If CATE continued to remain at the site, dissuasion flagging (as described in Harper & Collis, 2018) was erected to both mark the site and act as a passive form of dissuasion. Adjacently nested RBGU and foraging Western (WEGU; *Larus occidentalis*), Glaucous-winged (GWGU; *Larus glaucescens),* and hybrid "Olympic" (WGWH; *Larus occidentalis* x *glaucescens*) Gulls were habituated to opportunistically depredating any CATE eggs while the adult CATE were away from the nest. If the eggs were not consumed by gulls or otherwise destroyed by natural events, they were destroyed by USACE biologists in accordance with egg take permits (Permit #209988) from USFWS covering take of up to 200 (later updated to 250) CATE eggs.

Handheld Laser: In addition to the autonomous laser, USACE biologists used a Bird Control Group Agrilaser Handheld 500 (Agrilaser Handheld 500®, Bird Control Group, Wilsonville, OR. 97070) to dissuade CATE attempting to land on Rice. The tool was primarily used in hazing efforts directed towards CATE in inaccessible to foot-traffic/ATV locations on Rice, specifically locations outside the designated trail network which were designated as SHLA habitat. The handheld laser was particularly useful in rousting CATE attempting to form evenings roosts in the interior of Rice, east of the RBGU colony and deep in SHLA habitat. Laser operators made sure to follow all safety instructions in the equipment manual and were certified in the use of AVIX bird control lasers prior to beginning work. Care was taken to operate the laser only at low angles to avoid overshooting of targets or causing reflection from nearby water.

Passive Dissuasion: Extensive passive dissuasion efforts were required to combat colonization of Rice Island's interior by CATE, complicated by the formation of a RBGU colony in the same region. Passive dissuasion efforts included flagging and human/predatory bird effigies. Materials and methods of flagging and passive dissuasion are adapted from the same system previously employed by contractors on the island, and consisted of metal u-posts (facultative substitution with t-posts), placed upright in the ground in a 3 m^2 grid pattern, strung up with braided oyster-line, and used to suspend yellow caution tape such that it flutters in the wind, presenting a visual deterrent to landing birds (Harper & Collis, 2018) (Figure 4). This flagging was intended to render otherwise desirable nesting habitat unattractive to prospecting CATE by blocking sightlines introducing visual disturbance. The team targeted locations characterized by the greatest density of observed congregating CATE, as well as sites containing nesting scrapes and eggs. Additional flagging was placed at a site further east from the primary RBGU colony where CATE were observed scraping. Flagging was also installed on the north beach near an ancillary RBGU colony where CATE were observed loafing and scraping.

Two Bald Eagle (BAEA; *Haliaetus leucocephalus*) decoys, constructed of plywood, painted with appropriate colors, and mounted on 2 x 4 stakes were placed east of the RBGU colony to dissuade CATE from landing at the site. On 28 June USACE biologists also created a seated human effigy (Figure 4) from cardboard, old field clothes, and flotsam and other detritus sourced from Rice Island. This "scarecrow" was initially placed east of the RBGU colony (in addition to the BAEA decoys) to dissuade CATE from landing and scraping in the open interior of the island. The effigy, along with the two BAEA decoys, were later relocated to various points throughout the interior of the island as needed to cover zones of higher CATE activity during the remainder of the season and to reduce the probability of habituation.

Figure 4. Examples of passive dissuasion tools. Effigy (Rice Island) and dissuasion flagging (East Sand Island).

RESULTS

Rice Island Incipient CATE Colony - Monitoring was conducted from 4 April and 14 September. USACE biologists first identified heightened CATE abundance on Rice Island on 24 April when at least 1000 CATE were observed resting on the north shore during the early evening. A USACE biologist remained on Rice overnight to dissuade CATE from roosting and to document CATE presence during low and no light conditions. They reported that the birds appeared to have vacated Rice by 21:30. On 25 April, 650 CATE were dissuaded from roosting on the island and USACE biologists staying overnight counted and filled-in 21 CATE scrapes in the island's interior. On 2 May USACE biologists began installing dissuasion flagging on Rice (Figure 5) at sites of CATE activity. Figure 8 displays the chronology of CATE nesting activity.

In early May, RBGU formed an approximately 0.78-acre colony (Figure 5, Figure 11) within the interior region of Rice Island and USACE biologists observed numerous RBGU nests and eggs by 11 May (all efforts were focused on CATE surveying and dissuasion; RBGU nests and eggs were not counted). Based on CAP flight photos from 1 June, 15 June, the interior RBGU colony on Rice grew from 1057 to a seasonal maximum of 3174 adults (Supplementary Table 1), plus an uncounted number of juveniles. To avoid violation of the Migratory Bird Treaty Act, USACE biologists did not haze the RBGU colony as eggs

had already been laid at the time of detection. CATE were observed digging scrapes in and near the RBGU colony on 16 May, necessitating that USACE biologists entered the RBGU colony to dissuade the CATE therein. Dissuasion flagging installation surrounding the RBGU colony began on 23 May. A total of 0.95 acres of dissuasion flagging was installed on Rice Island (Figure 5). The flagging-covered area proximal to the RBGU colony was .89 acres (93.4% of total). The total CATE and RBGU occupied area on Rice Island covered approximately 1.67-acres (Figure 5). The first CATE egg was recorded on 17 May. USACE biologists kept the egg under observation to determine if take was necessary (only if the egg was not destroyed by natural phenomena). During the observation period the egg remained undisturbed, at the conclusion of which USACE biologists destroyed it according to USFWS egg take protocol and USACE 2022 Columbia Estuary avian management protocol (Tidwell and Brandtner, 2022).

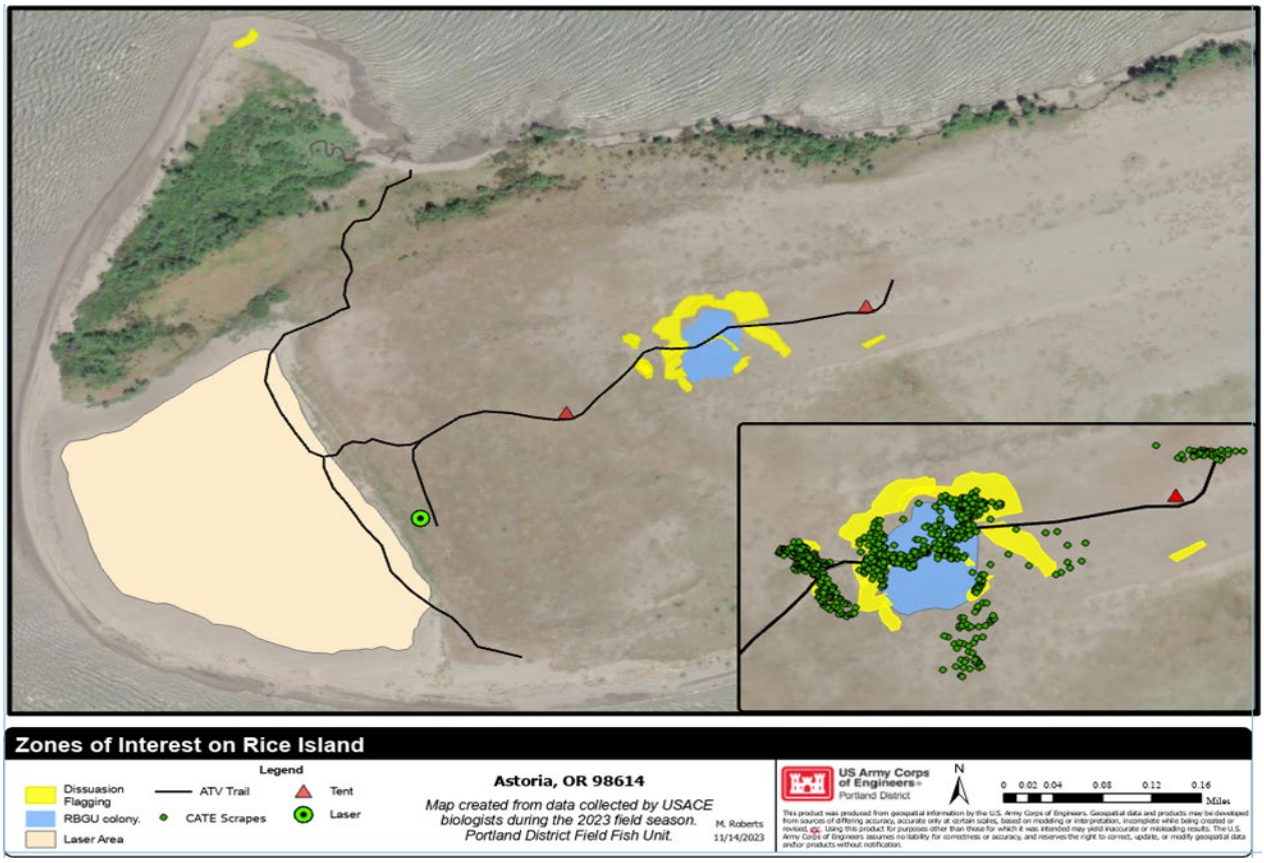

Figure 5. A 2023 map of zones of interest, Caspian Tern (CATE) activity, and USACE monitoring and dissuasion operations for colonial piscivorous waterbirds on Rice Island in the Lower Columbia River (LCR) Estuary.

The sequence of events described above was repeated in multiple iterations throughout the season (i.e: scout for and then observe zone of heightened CATE activity, haze on foot or ATV, install dissuasion flagging; locate, fill, and record locations of scrapes; locate, observe, and record data for CATE eggs, then perform egg take if necessary) with the expected variation in specific action being dependent upon the attempted nesting activities of the CATE at the time. An ancillary RBGU colony formed above the rack line on the north beach of Rice Island, and evidence of heightened CATE interest in the site (landing, scrapes, and at least nine eggs) was observed. The site was appropriately canvased with dissuasion flagging.

Figure 6. Tent used by USACE biologists for overnighting on Rice Island. *Photography by Erin Blair.*

Due to continued observations of heightened CATE presence in both the morning and evening hours, USACE biologists determined the course-of-action was to spend nights on the island (Figure 6) to accommodate hazing activities that coincided with observed instances of elevated of CATE activity, those being roosting attempts and subsequent attempts to return the following dawn. A similar course of action

was employed on Rice Island over a three-day period in 2022 (Strong & Tidwell, 2023). A total of 24 overnight hazing operations were conducted on Rice Island from 24 April to 15 June (Supplementary Table 4). After the morning of 16 June, USACE biologists continued to haze into the late evening hours, but no longer remained on island overnight, instead opting return to dock between 2200 – 2400 hours, and then return to Rice early the following morning (no later than 0800, weather permitting). These late-night hazing and reconnaissance ventures encompassed seven days (nine total surveys, two days included AM and PM hours) of the total 65 spent on Rice.

Throughout the season USACE biologists documented and subsequently filled 3464 CATE scrapes between 25 April and 26 July. The peak period for attempted nesting (defined in-context as scraping and egg-laying) was between 17 May and 21 June, with the highest recorded scrapes and eggs being found during the week of 31 May. USACE requested additional egg take authority as the level of CATE activity on Rice lead to the egg take threshold of 200 being rapidly approached (480 eggs recorded and 181 eggs taken by week of 12 June). This request was made to ensure USACE's ability to effectively prevent CATE nesting on Rice in the event of the egg-take threshold being met. USFWS provided a revision to the permit, effective 5 July, authorizing the take of an additional 50 CATE eggs (up to 250 total), by USACE biologists throughout the remainder of the season. After the week of 12 June, only 18 eggs were taken. Of the total 800 CATE eggs recorded, 199 were taken by USACE biologists. The 601 eggs recorded but not taken by USACE biologists (75.1% of total), were consumed or otherwise destroyed by opportunistic gulls including both adjacently nested RBGU and foraging WEGU, GWGU, and WGWH. In one noteworthy display of gluttony, an individual GWGU was observed to consume 8 CATE eggs in a single siting, swallowing several whole in rapid succession. Throughout the season, observations of gull behavior suggested that many individuals became habituated to foraging for CATE eggs in locations cordoned-off with dissuasion flagging. On 27 June gulls were observed moving into a newly erected patch of dissuasion flagging and consumed the exposed eggs. On 10 July, 18 new CATE eggs were discovered and almost as soon as USACE biologists had begun installation of dissuasion-flagging (and well before installation was completed) gulls moved in and consumed the CATE eggs. Given the sheer volume of scraping activity that occurred throughout the season, and the fact that many scrapes were intermixed with nests of breeding RBGU, recording the location of each individual occurrence was not possible as many scrapes were superimposed upon previously filled in ones. Whenever possible, location data for scrapes and eggs were recorded on FieldMaps.

To provide metrics tracking the potential impact that CATE on Rice had on out-migrating salmonid smolts in the LCR, USACE biologists sowed 100 Passive Integrated Transponder (PIT) tags in proximity to the RBGU colony and CATE hotspots on Rice Island on 2 May (Figure 5). Funding for this effort was provided by the The Columbia River Fish Mitigation (CRFM) Fund pursuant to the system-wide evaluation of Avian Predation work conducted by RTR. The recovery rate of these sown tags is used to estimate recapture efficiency for the total number of recovered tags deposited by avian piscivores. PIT-tags were later recovered and analyzed by RTR per contract through Bonneville Power Administration (BPA) and the Grant County Public Utility District. PIT-Tag analysis by RTR showed that, at minimum, 1215 PIT-tagged smolts were consumed by avian predators on Rice Island in 2023 (Banet, pers. comm., 2023). Of the 1215 recovered tags, 819 (67.4%) were attributed to Steelhead (*Oncorhynchus mykiss*), 292 (24.0%) to Chinook Salmon (*O. tshawytscha*), 57 (4.7%) to Coho (*O. kisutch*), 37 (3.1%) to Sockeye (*O. nerka*), and 10 (0.8%) to Coastal Cutthroat Trout (*O. clarkii*). For information on species run consumption percentages please consult the 2023 Final Annual Report (Evans et al., 2024). A visual representation of the species composition of depredated salmonids may be seen in Figure 7. It is not possible to attribute specific instances of predation to either CATE or RBGU due proximal activity and intermixing observed in 2023.

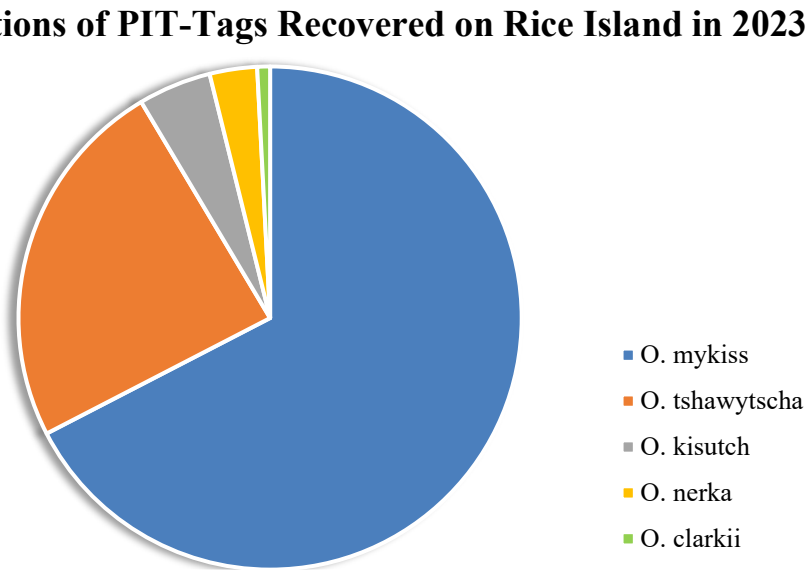

Figure 7. Representation of the 1215 PIT-Tags recovered and analyzed by Real Time Research (RTR) from the interior (RBGU colony and attempted CATE incipient site) of Rice Island in 2023. Each tag represents a migrating salmonid smolt consumed by avian predators in the Lower Columbia River (LCR) Estuary and deposited on Rice Island.

Beginning 26 May, USACE biologists observed multiple moribund and deceased CATE on Rice Island. Afflicted birds appeared lethargic, slow to respond to approach, and hesitant to take flight. Specimens were collected for testing for suspected Highly Pathogenic Avian Influenza (HPAI). Four diseased CATE were transferred to ODFW on 15 June. Laboratory tests by ODFW of the specimens were able to isolate a strain (H5N1) of HPAI, suggesting this to be the pathogen responsible for the observed CATE mortality. A total of 201 deceased CATE were observed on Rice Island at locations ranging fron the RBGU colony within the island interior to the beaches, including multiple instances below the wrack-line. It is possible that deceased CATE below the wrack-line were washed away by tidal action and were therefore never counted. When enumerating dead and/or diseased CATE, USACE biologists approached only to mark the birds with fluorescent green spray-paint for enumeration. Otherwise, personnel limited close contact with obviously sick birds and wore protected equipment. Suspected sick birds were counted daily, but due to an indefinite timeline of succession from sickness to death or recovery and an inability to track sick birds, estimated totals were difficult to determine. Gulls (RBGU, WEGU, GWGU, and WGWH) seemed less susceptible to infection. At least four instances of deceased juvenile gulls were observed, although other causes of death could not be ruled out. An unknown number of lethargic adults were also observed. The final observation of deceased CATE on Rice Island was on 12 July; on that day 13 fresh mortalities were counted on the north beach.

East Sand Island CATE Colony – Concurrent to the monitoring and dissuasion efforts at RMP, USACE biologists also maintained a monitoring regimen for ESI in 2023. The 1-acre CATE colony on ESI is not the focus of this report, yet this section has been included within the results section to provide a broader view of CATE population and activity levels within the LCR region and for RMP in 2023. The ESI colony failed to produce any young during both the 2022 (Strong and Tidwell, 2023) and 2023 breeding seasons (Blair et al, 2024). There were two instances in 2023 where CATE abundance on the ESI colony dropped substantially: these being on dates between 25 May – 1 June and 28 June – 6 July (Figure 9). Despite circumstantial and situational evidence of a suite of predation and disease pressures, it is not possible to determine the proximate cause of the ESI drop-off event. However, there appears to be an association between declining ESI CATE colony numbers and increasing CATE presence on Rice (Figure 9). For a more in-depth analysis of the colonial piscivorous waterbird breeding, abundance, and predator-prey dynamics on ESI in 2023, please review Blair et al (2024).

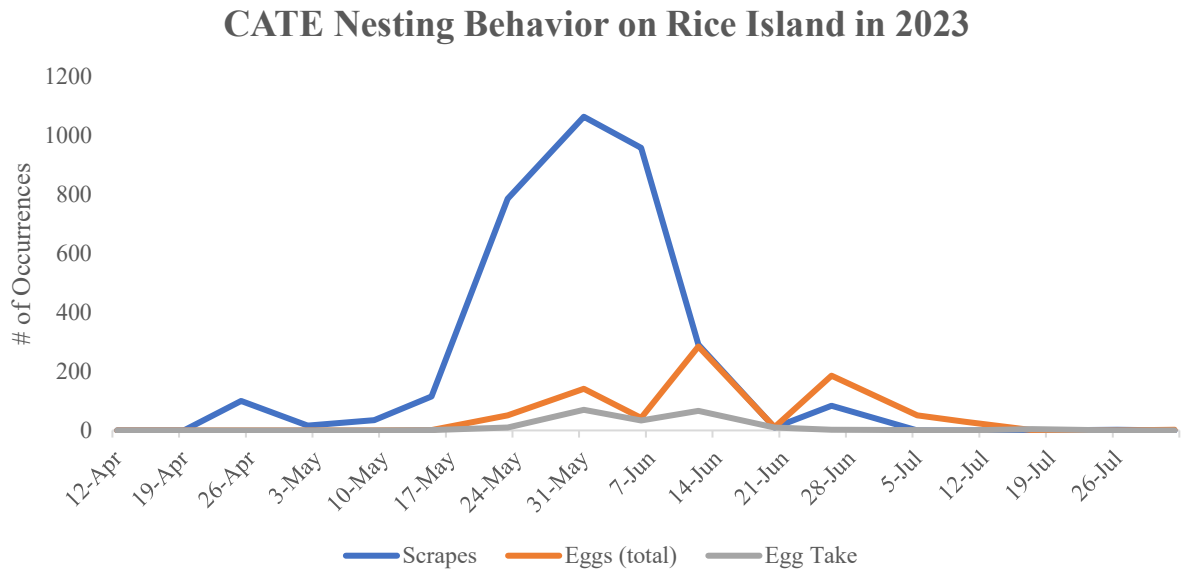

Figure 8. Caspian Tern (CATE) scrapes, eggs, and egg-take by USACE biologists during in 2023.

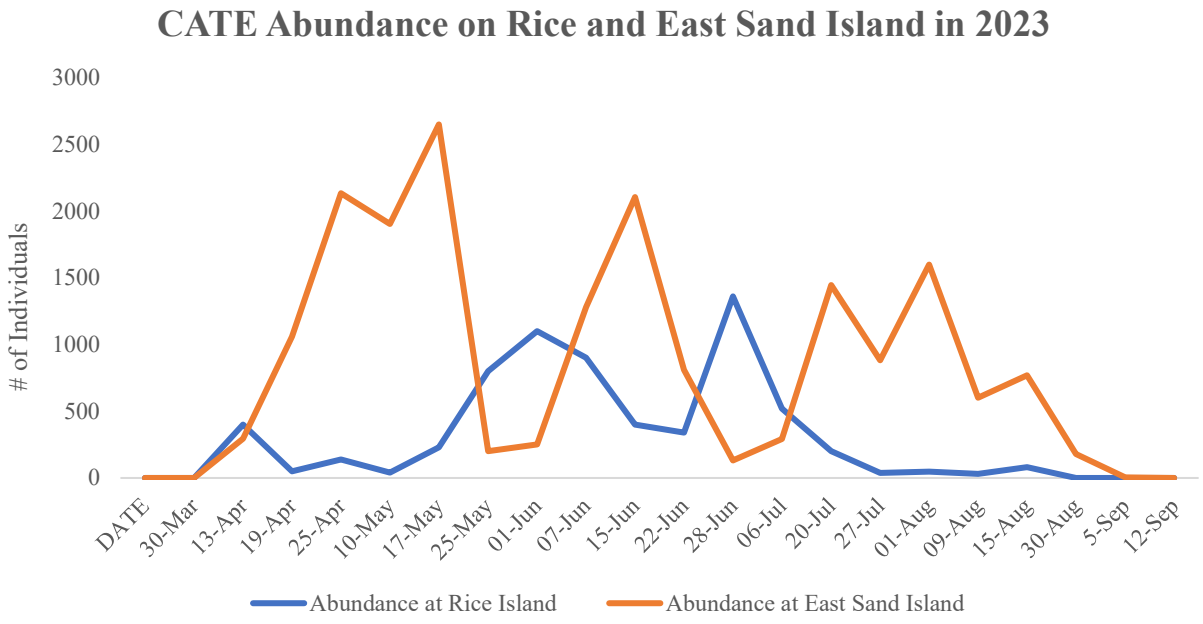

Figure 9. Individual Caspian Tern (CATE) counts (weekly maxima) on Rice and East Sand Islands in 2023, note the abundance drop-offs on ESI and upticks in CATE activity on Rice Island around 25 May and 22 June, respectively.

Abundance and Distribution: CATE – Avian enumeration surveys for Rice Island occurred on 65 days, beginning on 4 April and continuing through to 14 September. CATE were first observed from Rice Island in 2023 on 4 April when 3 were seen flying over the island while USACE biologists visited the island to deploy the anchor & buoys and to install the autonomous laser. However, as these CATE were not seen landing, they were not included in daily counts. CATE were first enumerated on Rice the following week on 10 April when 15 were seen loafing on the north beach. The mean number of CATE observed daily on Rice throughout the season was 322.0 ± 341.4 SD birds (Table 1). The seasonal maximum of 1360 CATE was observed on 26 June. Of the 65 days Rice Island was surveyed, instances of no CATE being observed on-island occurred only thrice, those being on the first and last two survey days of the 2023 season, respectively). CATE were observed on Rice during each of the four CAP flight surveys (1 June, 15 June, 12 July, and 1 August). The maximum count of CATE from CAP photo analysis was for 1 June; 148 CATE were enumerated on Rice Island. Throughout the season, USACE biologists recorded a total of 3464 CATE nesting scrapes and 800 CATE eggs (Figure 8, Supplementary Table 1), mostly concentrated within the island's interior near the RBGU colony. No young CATE were hatched or fledged on Rice Island in 2023.

Avian enumeration surveys for Miller Sands began occurred on 22 days, beginning on 4 April, and continuing through to 14 September (Table 1). CATE were counted on Miller Sands on a total of seven instances (five surveys including boat surveys by USACE biologists, and during CAP flights on 1 June and 1 August). The first observation occurred on 12 April when 30 CATE were counted during a boat survey. The mean number of CATE observed on Miller Sands was 4.5 ± 10.2 SD birds. The greatest number of CATE occurred on 29 August when 35 birds were counted by USACE biologists while completing a boat survey. This was also the final instance of CATE observation during the 2023 season (Supplementary Table 2). No CATE are known to have nested or produced young on Miller Sands in 2023.

Avian enumeration surveys for Pillar Rock Island occurred on 20 days, beginning on 4 April and continuing through to 14 September (Table 1). During this time no CATE were observed to have landed or attempted nesting on Pillar Rock Island, nor were any young produced in 2023 (Supplementary Table 3).

Table 1. Abundance monitoring data for Caspian Terns (CATE) on Rice Island, Miller Sands, and Pillar Rock Island in the Columbia River Estuary between 4 April and 14 September 2023.

		CATE Abundance, 4 April – 14 September.		
Site	*n* days monitored	$\bar{X}$ ± SD	Range	*n* days = 0
Rice Island	65	322.0 ± 341.4	0-1360	3
Miller Sands	22	4.5 ± 10.2	0-35	17
Pillar Rock Island	20	0	0	20

Abundance and Distribution: DCCO - The first observation of DCCO on Rice Island in 2023 occurred on 2 May, when five birds were observed loafing on the northwestern beach. The mean number of DCCO spotted on Rice Island was 193.0 ± 476.4 SD birds (Table 2). The greatest number of DCCO observed by USACE biologists was an estimated 2800 birds, also on the north beach below the wrack-line, on 22 June. The overall maximum number of DCCO counted on Rice was 4898 birds, which were captured in two images from a CAP flight on 1 August. The final observation of DCCO on Rice took place on 14 September when two individuals were seen loafing on the north beach (Supplementary Table 1). DCCO were never observed above the wrack-line anywhere on Rice. No DCCO were observed to have nested or produced young on Rice Island in 2023.

The first observation of DCCO on Miller Sands occurred on 1 June when 53 birds were spotted during a CAP flight. The seasonal mean for DCCO numbers on Miller Sands was 8.9 ± 19.9 SD birds (Table 2). A maximum of 85 DCCO were known to have been present on Miller Sands during the 2023 season. This was also the final observation of DCCO on Miller Sands and took place on 14 September. DCCO were captured in photos from three CAP flights in 2023 (Supplementary Table 2). USACE biologists did not observe any breeding/nesting behavior from DCCO at Miller Sands placement site and no young are known to have been produced in 2023.

For Pillar Rock Island, the first observation of DCCO in 2023 occurred on 4 April when four birds were observed roosting on the associated pilings on 4 April. The mean number of DCCO observed on Pillar Rock was 19.8 ± 32.2 SD birds (Table 2). The seasonal maximum of DCCO observed was 142 individuals on 11 May by USACE biologists conducting a boat survey. The final date upon which DCCO were observed on Pillar Rock Island was also the final day of observations (14 September); 20 birds were counted (Supplementary Table 3).

While not associated with the 2012 NMFS Biological Opinion activities, the East Rice pilings (Figure 1) were surveyed in 2023 and included within the results to provide a broader view of DCCO activity and abundance within the LCR. These pilings are used for roosting by foraging DCCO and were surveyed 20 times between 4 April and 14 September by boat as part of surveying the other RMP sites. The first observation of DCCO in 2023 was on 4 April and 101 DCCO were observed. The mean number of DCCO observed on these pilings was 160.4 ± 170.3 SD birds (Table 2). The seasonal maximum of 648 birds were observed resting on the pilings on 16 May. Only two instances of zero DCCO being observed occurred; those being on 31 May during a boat survey and again on 26 July when USACE contractor Dredge Crews were actively working nearby on Rice. Shortly thereafter, on 4 August, 168 DCCO were observed on the pilings, while the Dredge Crew was still operating. The final DCCO observation occurred on 14 September; 60 birds were enumerated during a boat-survey (Supplementary Table 4).

Table 2. Abundance monitoring data for Double-Crested Cormorant (DCCO) on Rice Island, Miller Sands, and Pillar Rock Island in the Columbia River Estuary between 4 April and 14 September 2023.

		DCCO Abundance, 4 April – 14 September.		
Site	*n* days monitored	$\bar{X}$ ± SD	Range	*n* days = 0
Rice Island	65	193.0 ± 476.4	0-4898	29
Miller Sands	22	8.9 ± 19.9	0-85	16
Pillar Rock Island	20	19.8 ± 32.2	0-142	2
East Rice pilings	20	160.4 ± 170.3	0-648	2

Abundance and Distribution: AWPE - AWPE were first enumerated on Rice Island on 13 April, when four birds were observed loafing on the north beach. The mean number of AWPE observed on Rice was 36.0 ± 107.1 SD birds (Table 3). The maximum number of AWPE observed on Rice occurred on 17 July, when 802 individuals were counted below the wrack-line, again on the north beach. 14 September was the final day on which AWPE were recorded on Rice (75 birds recorded on the north beach). No AWPE breeding was observed on Rice Island in 2023, although between 26 July and 2 August three juveniles were observed, one living but in poor health, and two deceased. The origin of these young could not be determined.

AWPE were first spotted on Miller Sands on 13 April when an estimated minimum of 225 birds were seen within the interior bay of Miller Sands by USACE biologists during a boat survey. There was evidence of more individuals hiding within the woody vegetation, but visibility was poor and an accurate count of obscured AWPE could not be obtained. USACE biologists estimated that there were roughly 1000 AWPE present on Miller Sands at the time, but the actual number could not be ascertained. The mean number of AWPE observed in 2023 was 52.2 ± 97.3 SD birds (Table 3). A seasonal maximum of 995 AWPE was observed on 15 June during a CAP Flight. CAP flights provided the most precise counts of visible AWPE activity on Miller Sands in 2023 (Supplementary Table 2), but it should be noted that an uncounted number of AWPE may have been present yet were obscured by vegetation during the CAP flights, rendering the above counts conservative estimates. AWPE breeding activity is known to have occurred on Miller Sands in 2023, although it is not known how many young were successfully fledged from the site.

The first instance of AWPE being observed on Pillar Rock Island was on 16 May, when 14 birds were spotted during a boat survey (Table 3, Supplementary Table 3). The only other time AWPE were recorded on Pillar Rock was on 1 June, when six AWPE were captured in a CAP flight photo (Supplementary Table 3). No AWPE breeding activity is known to have occurred on Pillar Rock Island in 2023 and all observations were of birds at or below the wrack-line (no observed inland presence).

Table 3. Abundance monitoring data for American White Pelicans (AWPE) on Rice Island, Miller Sands, and Pillar Rock Island in the Columbia River Estuary between 4 April and 14 September 2023.

		AWPE ABUNDANCE, 4 April – 14 September.		
Site	*n* days monitored	$\bar{X}$ ± SD	Range	*n* days = 0
Rice	65	36.0 ± 107.1	0-802	28
Miller Sands	22	52.2 ± 97.3	0-995	14
Pillar Rock	20	0.7 ± 3.1	0-14	19

Abundance and Distribution: SHLA - While not associated with the 2012 NMFS Biological Opinion activities, SHLA were regularly observed by USACE biologists during the 65 days surveying Rice Island and included within the results to provide a broader view of avian presence at these placement sites. SHLA abundance surveys were performed by contractors as required by the 2014 USFWS Biological Opinion (Turnstone Environmental Consultants, 2024). Most USACE observations recorded throughout the 2023 season were incidental and occurred during monitoring and dissuasion of colonial piscivorous waterbirds The first observation of SHLA on Rice Island occurred on 4 April, the season's first trip to Rice, wherein three were seen (one male near the boat landing site and a pair along an old dredge road). The most incidental observations of SHLA occurred on 3 May, when 18 SHLA were observed over the course of the day by one USACE biologists during CATE hazing and ATV circumferential surveys. The expanded temporal window of these sightings makes it possible that some individual SHLA were observed on multiple occasions and thus increased the count. The highest definitive count obtained by USACE biologists occurred on 17 July; 16 total SHLA were observed between the east and west ends of Rice Island.

Seven SHLA-specific surveys were conducted on Rice Island in 2023, four site-focused efforts by USACE biologists and three abundance counts of the island done by Turnstone Environmental Consulting. The first survey by Turnstone was on May 18 and USACE biologists were on site to provide quality-assurance for this survey. May 18's survey resulted in detection of 46 SHLA on Rice Island, at least 34 of

which were male. Two additional surveys by Turnstone occurred on 1 June and 14 June with the former effort detecting 38 SHLA (23 males) and the latter finding 41 (27 males). The surveys performed by USACE biologists took place on the eastern tip of Rice on 11 July, 13 July, 17 July, and 18 July. USACE contractor Dredge Operations were beginning fill deposition on Rice, and USACE biologists performed these SHLA surveys to inform this planned action. On the initial eastern-tip survey five SHLA were observed at the proposed deposition site. On 13 July, eight SHLA were observed (five male, three female, and one fledged juvenile). A total of nine SHLA were seen at the same site on 17 July; consisting of six adults and three flighted juveniles. The following day on 18 July, three SHLA were observed at the deposition site. No evidence of nests, eggs, or chicks (aside from the previously seen volant young) was found at the deposition site during the surveys. Between 11 – 18 July, SHLA were also observed incidentally near the ATV trails (Figure 5) and during CATE dissuasion. The final SHLA observation occurred on 16 August; two were seen when USACE biologists landed on Rice to begin de-mobilization for the season (Supplementary Table 1). The total number of SHLA young produced on Rice Island is unknown. At minimum three fledglings were observed in one instance, but as the birds were already flighted it was not possible to determine if Rice Island was their natal origin point.

SHLA were observed on several occasions by USACE biologists on Miller Sands in 2023. On 12 April biologists landed on Miller Sands but no SHLA were seen, although calls were heard. The first sighting occurred on 6 June when a pair of SHLA were seen carrying possible nesting material. USACE biologists were on-island surveying for SHLA due to upcoming dredge fill deposition operations on Miller Sands. No nest was found but the sighting location was recorded on FieldMaps. This occasion was also the highest single count of SHLA recorded on Miller Sands by USACE biologists. The final observation occurred on 2 August when a single SHLA was observed on the beach (Supplementary Table 2). Turnstone performed three SHLA abundance surveys on Miller Sands in 2023. On 18 May a single SHLA was detected, and 1 June's survey found six SHLA, three of which were male. The survey on June 13 located four SHLA, three of which were confirmed male.

Pillar Rock Island was not surveyed by USACE for SHLA in 2023, and none were spotted during any of the 20 RMP boat surveys (Supplementary Table 3). Turnstone abundance surveys for Pillar Rock on 18 May and 1 June both located three SHLA (two of which were male). On 14 June two SHLA were spotted.

DISCUSSION

The monitoring and dissuasion efforts by the USACE maintained compliance with the 2012 Navigation BiOp requirements by deterring CATE and DCCO nesting attempts on dredge material placement sites in the lower Columbia River. CATE were dissuaded from nesting on RMP, despite their persistent and sustained efforts to nest on Rice Island. No DCCO were documented attempting to nest on any of these three sites for the duration of the 2023 season.

In comparing abundance data for CATE in the LCR for recent years, there appears to be an overall upward trend. In 2019 an average of 52.2 ± 63.3 SD and a maximum daily count of 275 terns was recorded (Tidwell, 2020). In 2020, an average of 49.6 ± 55 SD CATE with a maximum of daily count of 200 were recorded during the season, although monitoring efforts were sporadic due to travel complications arising from the COVID-19 pandemic (Tidwell, 2021). In 2021 an incipient CATE colony attempted to form, and the daily average rose to 294.9 ± 408.2 SD birds (maximum of 1355) (Brandtner and Tidwell, 2022). In 2022, the average rose again to 446.7 ± 862.3 SD with a maximum of 3500 CATE (Strong and Tidwell, 2023). The average and maximum daily abundance values for CATE in 2023 generally exceed values from the previous years, albeit less than values calculated for 2022. The reduction in CATE abundance is likely tied to the increased monitoring and dissuasion effort of 2023 (Supplementary Table 4).

The persistency of nesting efforts by CATE utilizing the LCR is consistent with recent years data collected by the USACE. In 2019, 808 scrapes were recorded on Rice Island. In 2020, only 622 CATE scrapes were recorded, in 2021 1,280 scrapes were recorded, and in 2022 1761 scrapes were recorded (Tidwell 2020; Tidwell 2021; Brandtner and Tidwell 2022; Strong and Tidwell 2023). At the end of 2023 USACE biologists had enumerated 3464 distinct CATE scrapes (Table 1), a figure that most likely represents a substantial under-reporting of the true number, particularly when considering that an unknown number of CATE scrapes likely went uncounted as a symptom of their proximity to, and presence within, the RBGU colony (Figure 5). This represents an increase from the totals of previous years, suggesting that CATE interest in re-establishing a breeding colony on Rice Island has recently increased, and that CATE will likely continue to attempt to colonize Rice Island. CATE ousted by USACE hazing were seen to fly back and forth between the beaches and the upland interior of the island by USACE biologists when hazing operations were being conducted in both locations, necessitating simultaneous and bi-locational USACE

presence. Motivation to utilize Rice Island as a breeding colony may extend past the suitability of the site and may be entrenched in remnant nesting site fidelity. USACE Biologists observed CATE digging scrapes on sloped terrain adjacent to the RBGU colony, a nesting behavior notable as being atypical for a species that normally prefers to nest on flat sites (Strong et al., 2004). During the 2023 season, USACE biologists recovered bands from seven deceased CATE on Rice Island, two of which were banded as chicks 21 years ago (USGS Bird Banding laboratory, pers. comm., 2023) suggesting that they may have been among the first CATE cohort to have been hatched on ESI but had parents with strong site fidelity to Rice Island. The endurance and duration of colonization attempts by CATE in 2023 shows that the birds would likely succeed without the concerted efforts of USACE biologists The extended intensive dissuasion period in 2023, and the 24 overnighting operations conducted on Rice, were necessary in preventing colonization of the island. The result was a total halt of all CATE activity on Rice by season's end.

Deployment of passive dissuasion techniques against colonial avian piscivores by USACE on RMP has changed over time in terms of scale of application, with a noticeable reduction in use as alternate technologies have been incorporated (i.e., the laser) (Supplementary Table 4). In 2019, 4.58 acres of dissuasion flagging was installed on Rice, also concentrated in The Bowl (Tidwell, 2020). In 2020, prior to field testing or deployment of the laser, 4.1 acres of dissuasion flagging were erected on Rice Island in The Bowl (Tidwell, 2021). During the 2021 season autonomous laser was deployed and less than 0.5 acres of dissuasion flagging was placed on Rice Island (Brandtner and Tidwell, 2022). In 2022, the laser was again used to cover the 15.4-acres of The Bowl, but 0.60 acres of dissuasion flagging was deployed within the interior of Rice Island. These unmanned dissuasion techniques, along with 3 overnighting operations (23 to 25 May) performed by USACE biologists were sufficient to deter CATE from roosting and nesting on Rice in 2022 (Strong and Tidwell, 2023).

Pertaining to avian response to passive dissuasion measures, flagging deployed by USACE biologists in 2023 was observed to prevent CATE from landing in covered locations under certain conditions. CATE did not land while dissuasion flagging was being installed, although this may have been due to active dissuasion from USACE activity as opposed to the flagging itself. Un-nested CATE would not land within areas covered with flagging. However, dissuasion flagging did not always prevent CATE from eventually attempting to return to a scrape with eggs (especially if multiple eggs were present), nor did it prevent CATE from landing adjacent to the flagging at uncovered sites. Installation of additional

flagging was eventually curtailed as observations showed that flagging installation was neither time-effective nor successful in repelling CATE from the island (birds were simply redirected further inland towards SHLA habitat, not the desired result). The upland habitat type used by RBGU and CATE in 2023 covers some 118 acres of Rice Island's interior, rendering total coverage of potential nesting habitat with flagging a non-option due to time and labor constraints and disturbance of optimal SHLA habitat (Strong and Tidwell, 2024). The flagging was not observed to have an impact on the loafing, nesting, or foraging activities of gulls, including nesting RBGU (Figure 5, Figure 10). Observations by USACE biologists suggest that gulls developed an association between the presence of flagging and the opportunity to depredate CATE eggs. Juvenile RBGU were observed to seek cover within flagging when attempting to evade territorial aggression from adults. The situational variation in effectiveness of the flagging observed in 2023 may have been a function of timing. The bulk of flagging installation was reactionary to the detection of CATE activity and nest site fidelity by the CATE may have exceeded the repellant effect of post-hoc flagging installation, attenuating its capacity for deterrence. Initially, the BAEA decoys and effigy elicited agonistic responses from CATE (vocalizations and diving) and successfully deterred CATE from returning to scrapes northeast of the RBGU colony (Figure 5). However, long term effectiveness was reduced, likely a result of habituation. Hence, we infer that the laser reduced the amount of materials and labor needed to effectively dissuade CATE from The Bowl area, but a regimen consisting of both passive techniques (Figure 4) and active hazing by USACE biologists was critical to dissuading CATE from other sites (Figure 5). The nuances of intra and interspecific interaction, as well as interplay between dissuasion techniques, need to be noted to effectively implement dissuasion.

The formation of an RBGU breeding colony complicated CATE dissuasion efforts throughout the season after its formation in May. The origin of the RBGU that formed the colony are not known, but a noticeable reduction in RBGU abundance on nearby ESI (observed by USACE biologists) by 28 June may account for at least some of the gulls present on Rice. There was a notable association between CATE nesting attempts and the RBGU colony, wherein CATE were attracted to and dug scrapes adjacent to the RBGU (Figure 5, Figure 10). Empirical studies have found CATE and RBGU to breed in proximity under certain conditions, with CATE noted as preferring elevated sites adjacent to nesting RBGU (Fetterolf and Blokpoel, 1983 and Morris et al., 2009). The impetus for this attraction of CATE to nesting RBGU is not known, although the possibility of a commensal relationship cannot be ruled out. RBGU may present less of a threat to CATE eggs and young, especially compared to larger WEGU, GWGU, and WGWH, which

have been implicated in CATE colony failures due to nest predation (Roby et al., 1998). Despite several diagnostic features allowing for the differentiation of RBGU and CATE nests (CATE scrapes are bare while RBGU line their nests with vegetation and shells, and the apex of CATE eggs tend towards a strongly-prolate shape compared to the overall rounder eggs of RBGU), doing so in the field was impossible at times for USACE biologists due to the proximity of the CATE and RBGU and the high level of activity within the colony. Some RBGU scrapes may have been usurped or superimposed upon by CATE or vice versa due to colony density. In one noteworthy instance USACE biologists observed a pair of CATE brooding young RBGU chicks (Figure 10). The factors leading up to this brood adoption are not known, but it is possible that the contents of a nearby CATE nest were taken by USACE biologists or destroyed by gull activity. The CATE pair, displaying fidelity to their nest site, may have re-directed brooding behavior towards a proximal RBGU nest that had either been usurped by the CATE or previously abandoned by the parent gulls. The observation was cut short when adult RBGU cannibalized the adopted chicks shortly thereafter. A similar interaction was recorded in Ontario, CN circa 2011; where CATE foster parents successfully fledged at least one RBGU chick (Oswald et al., 2013).

Observations of attempted proximal nesting behavior by the CATE towards the RBGU on Rice Island was not limited to 2023. USACE biologists observed a similar phenomenon in 2022 (Strong and Tidwell, 2022). It is not known if the RBGU that colonized Rice Island in 2023 included individuals that had been observed doing so the previous year. In addition to acting as a potential beacon for CATE and muddling PIT tag deposition data, the presence of the RBGU colony made it more difficult for USACE biologists to enumerate and haze CATE in the vicinity of the colony (Figure 5, Figure 11). The gulls also presented a direct threat to USACE biologists under certain circumstances. USACE biologists were required to wear hearing protection within and around the colony, as RBGU colonial vocalizations exceed the allowed workplace decibel threshold for requiring PPE and may cause hearing damage (Blokpoel and Neuman, 1997). Adult RBGU were observed to become dramatically more aggressive after the eggs started to hatch, repeatedly dive-bombing and defecating on USACE biologists. Because of this, raingear and face-coverings were worn to protect personal clothing and skin from soiling by gulls. On multiple occasions attacking gulls made contact with USACE biologists, striking about the head with open bills and feet.

Figure 10. Caspian Tern and Ring-billed Gulls among dissuasion flagging on Rice Island. The tern is guarding a Ring-Billed Gull chick in the nest. July 12, 2023. *Photography by Erin Blair*.

The impact on salmonids by the increasing incipient CATE colonization efforts at Rice have been assessed with PIT-tag recovery efforts by Real Time Research in contract with BPA in 2020 and during the past two years. In comparing 2023 salmonid predation estimates (Figure 7) to 2020 and 2022; Rice Island CATE consumed substantially more overall tagged fish in 2023 than in 2020, and far fewer than in the 2022. Predation by Rice Island CATE was implicated in the deposition of 293 PIT-tags in 2020 (Collis et al., 2021), and 2385 PIT-tags recovered by RTR in 2022 (Evans et al., 2023). PIT-tag recovery data for Rice Island CATE was not published in 2021. Piscivorous birds (CATE and RBGU) at the recovery site on Rice consumed more than four times as many tagged smolts in 2023 as in 2020, but only half as many as were depredated in 2022. In 2020, the 293 recovered tags coincided with a mean CATE abundance of 49.6 ± 55 SD birds (Tidwell, 2021). Based on this abundance data, each bird consumed an estimated 5.9 tagged salmonids (total tags divided by mean seasonal CATE abundance). In 2022 a mean CATE abundance of 446.7 ± 862.3 SD birds was reported (Strong and Tidwell, 2023). When compared to the 2385 recovered tags, this equates to an estimated 5.3 PIT-tagged smolts consumed per bird in 2022. The ratio of recovered tags (1215) to CATE abundance in 2023 was 6.3 smolts per bird, more than either of the estimated per capita smolt consumptions for the two previously reported years, although this does not consider additive depredations by RBGU. Steelhead smolts were disproportionally impacted by the 2023 CATE incursion on Rice and accounted for 67.4% of all recovered PIT-tags (Figure 7). This is a probable result of timing; peak Steelhead downriver migration (recorded at Bonneville Dam) occurred between 1-16 May (Fish Passage Center, 2023), likely placing the out-migrating smolts within the LCR estuary during times of elevated CATE (and RBGU) activity on Rice (24 April – 26 July) (Figure 8, Figure 9) and thusly subjecting them to elevated predation risk. A similar trend was reported in 2022 when incipient CATE activity on Rice aligned with the peak period of Steelhead migration, resulting in an estimated 2.3 - 2.9% of all 2022-run Steelhead smolts being consumed by the Rice Island CATE, a greater proportion than for the other co-occurring salmonid species (Evans et al., 2023). In 2023, the next most impacted species (as assessed via PIT-tag recovery) was Chinook, which accounted for 24% of recovered tags (Figure 7). For a more detailed analysis of, and for making 2020-2022-2023 comparisons between, species-specific run consumption percentages by Rice Island avian predators, please consult Collis et al. (2021), Evans et al. (2023), and Evans et al. (2024) respectively. The additive salmonid predation impacts from the associated RBGU colony on Rice in 2023 are difficult to disentangle and may have played a role in the apparent higher per capita tagged-smolt consumption for the year. The observed tendency of CATE to congregate in and around

the RBGU colony would render it virtually impossible to attribute deposition of recovered PIT tags to either species with any degree of certainty. One study concluded that the probability of deposition and recovery of operable PIT-tags from fish depredated by gulls may be as low as 15% compared to 71% for Caspian Terns (Hostetter et al., 2015). The lower detection efficiency for gull-depredated fish suggests that the recovery of 1215 PIT-tags from Rice Island in 2023 may constitute an undercounting of total depredated PIT-tagged smolts. The impacts from avian predation on migrating smolts may have been far greater had USACE not successfully deterred CATE from colonizing Rice Island and rearing young. Although the numerical impacts to migrating smolts were not as severe in 2023 as in 2022, the possibility for greater impacts in the future exists and warrants the continued efforts of USACE to dissuade colonial avian predators from colonizing Rice Island.

The extent of any potential SHLA impact from the formation of the RBGU/CATE colony could not be directly ascertained during the 2023 season. SHLA were observed in proximity to CATE and gulls (of all species), but never within the dissuasion flagging or RBGU colony proper. Whether this was due to the detection efficiency reduction from activity level and density of the colonial waterbirds, or displacement by the raucous and aggressive RBGU/CATE cannot be determined. The gulls may have also posed a predatory threat to SHLA, their eggs, and young and thus displaced the SHLA. Alternatively, the gulls may have simply monopolized available space within the confines of the colony and made detection of SHLA difficult. The presence of the large RBGU/CATE colony likely attracted avian predators to Rice Island. On 21 June a Peregrine Falcon (*Falco peregrinus anatum*) was observed strafing the RBGU colony and flying off with a depredated RBGU chick. Around this time several deceased RBGU and CATE were observed, showing evidence of raptor predation (feathers plucked and breast muscles/viscera consumed). Falcons attracted to the island by nesting waterbirds may have represented a predatory threat to SHLA and Horned Larks have been recorded as falling prey to Peregrine Falcons (Ellis et al., 2004; Baril et al., 2015). No evidence of predation on SHLA was observed in 2023. Also of note is the potential RBGU colony impacts to SHLA habitat on Rice. The scraping behavior in nest construction by the gulls (and attempts by the CATE) resulted in at least .78 acres of mossy turf being converted back into bare sand (Figure 5). The importance of mossy groundcover to SHLA is debatable, but SHLA have been observed to forage in areas with mossy turf coverage (sometimes consuming the moss directly) (Pearson and Knapp, 2016). Many SHLA observations made during in 2023 by USACE biologists occurred in mossy turf areas, suggesting it may be an important feature or possible foraging substrate within SHLA territories on dredge-fill islands.

Figure 11. Ring-billed Gull colony at sunset, interior of Rice Island, May 25, 2023. *Photography by Noah Strong*.

An outbreak of HPAI also impacted the breeding activities of CATE within the LCR estuary. USACE biologists observed at minimum 201 CATE mortalities on Rice between 26 May and 12 July. Many of the observed carcasses lay below the wrack-line where they would be subject to washing away via tidal action. It is very likely that many deceased CATE escaped enumeration in this manner, so the total death-toll on Rice could very well have exceeded the current estimate of 201. In collecting CATE specimens for ODFW, USACE biologists observed that any individual seen handling dead or dying birds is apparently recognized by other birds (including different species) that witness the interaction. The carcass-collecting biologist responsible for specimen collection noted that, while doing so within the RBGU colony, the surrounding healthy birds took flight, alarm called incessantly, and refused to land while he was still in the area. Afterwards, fellow USACE biologists witnessed apparent retention of memory for this event among the birds on Rice Island, which thereafter displayed an elevated level of antipathy towards the specimen-collecting individual. The carcass-collecting biologist was observed to be mobbed more severely when

entering the RBGU colony, alarm calls seemed louder and more frequent, and the clothing worn by the biologist showed evidence of increased defecation attempts. USACE biologists later co-opted old/soiled clothing from the individual and used these items to construct an effigy, to be placed in areas of heightened CATE activity. While the evidence provided by these observations is largely anecdotal it isn't outside the realm of possibility to infer that *Laridae* can form lasting memories pertaining to unpleasant stimuli, such as apparent colony predators. Similar memory-formation has been documented in corvids (Marzluff et al., 2010). It remains to be seen as to whether USACE can leverage avian persistence of memory as a tool within their dissuasion and hazing operations.

The resultant success of the USACE efforts to monitor and dissuade piscivorous colonial water birds at RMP show that despite increasing efforts by RBGU and CATE, the colonies can be dissuaded, and hatching CATE can be avoided. However, the last two years suggest that CATE interest in Rice Island's ideal nesting habitat is increasing, and more effort will be required in the coming years. The USACE FFU is committed to fulfilling the statutory requirements of the 2012 NMFS Navigation BiOp and maintaining no nesting success of CATE or DCCO on dredge material sites in the LCR. To that end, management tools and dissuasion tactics to deter CATE, DCCO, and RBGU colony formation must continue to be explored and perhaps augmented moving forward.

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APPENDICES

Supplementary Table 1. Raw data for Rice Island Caspian Tern (CATE), Double Crested Cormorant (DCCO), American White Pelican (AWPE), and Streaked Horned Lark (SHLA) monitoring during the 2023 season. Repeat dates equate to AM/PM observations.

Dates not present were not sampled, Blanks and (-) denote no surveys being made that day.

Date	CATE	DCCO	AWPE	SHLA	CATE Egg	Egg Take	CATE Scrape	CAP - CATE	CAP - DCCO	CAP - AWPE	CAP - RBGU
4/04	0	0	0	3	-		-				
4/10	15	0	0	3	-		-				
4/12	39	0	0	2	-		-				
4/13	67	0	4	0	-		-				
4/19	700	0	4	0	-		0				
4/21	250	0	0	0	-		-				
4/24	1000	0	0	0	-		-				
4/25	650	0	0	0	-		21				
4/26	650	0	6	0	-		0				
4/26	650	0	0	0	-		0				
4/27	350	0	0	0	-		0				
5/01	700	0	0	0	0		79				
5/02	150	0	0	0	0		4				
5/02	600	5	0	0	0		12				
5/03	150	0	0	18	0		0				
5/03	400	0	0	2	0		0				
5/04	50	0	0	0	0		0				
5/08	193	0	0	3	0		25				
5/09	30	0	0	0	0		0				
5/09	138	0	0	4	0		6				
5/10	78	0	2	7	0		0				
5/10	129	0	0	3	0		2				
5/11	65	0	0	0	0		2				
5/11	103	0	0	0	0		0				
5/12	29	0	0	0	0		0				
5/15	215	0	0	0	0		31				
5/16	26	0	0	0	0		0				

5/16	220	0	0	0	0		17				
5/17	40	0	13	5	0		0				
5/17	152	2	4	0	1	1	65				
5/18	54	-	-	-	-	-	2				
5/23	522	0	0	-	41	0	378				
5/23	800	0	0	-	6	5	116				
5/24	230	0	0	-	0	5	0				
Date	CATE	DCCO	AWPE	SHLA	CATE Egg	Egg Take	CATE Scrape	CAP - CATE	CAP - DCCO	CAP - AWPE	CAP - RBGU
5/24	300	3	1	4	4	0	189				
5/25	115	0	0	-	0	-	8				
5/25	217	0	0	4	0	-	92				
5/26	126	0	0	6	0	-	4				
5/31	1100	275	0	4	70	-	605				
5/31	820	0	0	2	52	52	387				
6/01	600	0	0	0	18	18	38				
6/01	-	-	-	4	1	0	35	148	176	3	1057
6/02	27	0	0	1	0	-	0				
6/06	293	0	6	0	30	30	125				
6/06	900	50	50	2	3	3	399				
6/07		0	0	1	0	0					
6/07	510	0	0	2	1	1	137				
6/08	400	3	6	2	0	0	208				
6/08	374	6	0	1	2	0	30				
6/09	300	0	22	0	6	0	60				
6/12	1300	14	11	0	50	0	-				
6/13	600	0	0	0	70	13	172				
6/14	1188	6	19	0	70	28	47				
6/15	400	0	0	0	70	0	32				
6/15	110	9	15	3	25	0	40	136	34	1	3174
6/16	30	0	0	0	0	25	0				
6/20	340	200	63	2	10	10	0				
6/21	100	-	70	3	0	0	0				
6/22	50	200	20	-	1	0	10				
6/26	1360	180	95	2	84	2	84				
6/27	419	147	10	2	23	0	-				
6/27	1135	125	95	0	15	0					
6/28	770	50	200	1	27	0	-				
6/29	545	300	180	0	23	0					
6/30	177	140	7	0	14	0					
7/05	520	200	300	0	-	0	-				
7/06	286	41	0	9	51	1	-				
7/10	590	250	400	1	21	0	-				
7/11	82	1400	7	10	0	0	-				
7/12	120	500	60	3	2	0	-	136	3479	171	2210
7/13	61	1000	91	9	6	0	-				

7/17	200	250	802	16	1	5	-				
7/18	65	540	0	11	0	0	-				
7/19	78	130	25	3	0	0	-				
7/26	37	2800	48	1	0	0	2				
8/01	-	-	-	-	-	-		116	4898	585	-
8/02	47	1250	16	0	2	0	-				
8/04	18	615	33	0	0	0	-				
Date	CATE	DCCO	AWPE	SHLA	CATE Egg	Egg Take	CATE Scrape	CAP - CATE	CAP - DCCO	CAP - AWPE	CAP - RBGU
8/08	30	1500	81	1	0	0	0				
8/09	20	1800	3	0	0	0	-				
8/16	80	1350	3	2	0	0	-				
8/29	5	59	8	0	0	0	0				
9/07	0	225	100	14	0	0	-				
9/14	0	2	75	6	0	0	-				
				Total:	**800**	**199**	**3464**				

Supplementary Table 2. Raw data for Miller Sands Caspian Tern (CATE), Double Crested Cormorant (DCCO), American White Pelican (AWPE), and Streaked Horned Lark (SHLA) monitoring during the 2023 season. Dates not presented were not sampled, blanks and (-) denote no surveys being made that day.

* Denotes SHLA detection through auditory means, but no confirmed visual

Date	**CATE**	**DCCO**	**AWPE**	**SHLA**	**CATE - CAP**	**DCCO - CAP**	**AWPE - CAP**
04-Apr	0	0	0	0			
12-Apr	30	0	225	*			
19-Apr	0	0	300	0			
24-Apr	0	0	0	0			
04-May	0	0	0	-			
11-May	0	0	0	-			
16-May	0	0	0	0			
23-May	0	0	12	-			
31-May	0	0	0	-			
01-Jun	-	-	-	-	2	53	905
06-Jun	3	35	95	2			
7-Jun	0	0	0	0			
15-Jun	0	0	0	-	0	2	995
22-Jun	0	0	0	0			
30-Jun	0	0	0	-			
05-Jul	0	0	0	0			
12-Jul	0	0	0	0	0	0	747
26-Jul	0	0	90	0			
01-Aug	-	-	-	-	12	52	446

02-Aug	20	15	100	1			
09-Aug	10	10	300	-			
16-Aug	0	0	0	-			
29-Aug	35	25	0	-			
14-Sep	0	85	0	-			

Supplementary Table 3. Raw data for Pillar Rock Island Caspian Tern (CATE), Double Crested Cormorant (DCCO), American White Pelican (AWPE), and Streaked Horned Lark (SHLA) monitoring during the 2023 season. Observational data for East Rice Pilings DCCO are also included.

Dates not presented were not sampled, blanks and (-) denote no surveys being made that day.

Date:	**CATE**	**DCCO**	**AWPE**	**SHLA**	**CATE - CAP**	**DCCO - CAP**	**AWPE - CAP**	**DCCO – East Rice Pilings**
04-Apr	0	14	0	0				101
12-Apr	0	4	0	-				60
19-Apr	0	0	0	-				22
24-Apr	0	30	0	-				88
04-May	0	25	0	-				480
11-May	0	142	0	-				251
16-May	0	36	14	0				648
23-May	0	21	0	-				418
31-May	0	12	0	-				0
1-Jun				-	0	0	6	-
07-Jun	0	55	0	-				87
15-Jun				-	0	0	0	-
22-Jun	0	2	0	0				126
30-Jun	0	0	0	0				145
05-Jul	0	2	0	0				69
12-Jul	0	2	0	0	0	0	0	42
26-Jul	0	3	0	0				0
1-Aug				-	0	0	0	-
04-Aug	0	3	0	-				168
09-Aug	0	5	0	-				205
16-Aug	0	3	0	-				151
29-Aug	0	20	0	-				87
14-Sep	0	0	0	-				60

Supplementary Table 4. Summary of time spent (in days and overnight stays) by USACE biologists performing piscivorous waterbird surveys/dissuasion and surface acres covered by dissuasion flagging for Rice Island over the past five years. The single overnighting event in 2021 was a QA trip to ensure the Avix Mark II Autonomous Laser's® range did not overlap with known SHLA habitat. *Denotes years in which the laser was operated on island.

Field Season *Laser used	**Observation Days**	**Nights on Island**	**Dissuasion Flagging (acres)**
2019	47	0	4.58
2020	20	0	4.1
2021*	24	1	< 0.50
2022*	44	3	0.60
2023*	65	24	0.95