Standardized piscivorous bird monitoring protocol and results at U.S. Army Corps of Engineers' dams on the lower Columbia and Snake Rivers, 2013.

By

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EXECUTIVE SUMMARY

The US Army Corps of Engineers (USACE) has been tasked with monitoring piscivorous birds at its dams on the Columbia and Snake rivers (Reasonable and Prudent Alternative 48 of the 2008 Federal Columbia River Power System Biological Opinion). To address this task, a standardized monitoring program was developed and initiated with the following objectives: 1) Provide site-specific training at each dam, 2) Develop and implement standard avian observation protocols in order to provide comparable bird counts between eight Army Corps dams on the Columbia and Snake rivers, and 3) Provide data collection devices or data sheets and a centralized database to standardize data collection. This report summarizes the results of the second season of monitoring after standardized counting protocols were introduced.

Pre-season trainings, a written protocol, and datasheets were delivered during site visits to each of the eight dams by Portland District's Fish Field Unit staff. Monitoring was carried out by Project Fishery Biologists or Biological Science Technicians stationed at each dam. Data was collected using either paper data sheets or hand held tablet PC. The Project Fisheries staffs were asked to count and categorize the behaviors of nine species of piscivorous birds at least once a day as part of their daily duties.

Similar to monitoring in 2012 (Zorich et al. 2014) and historical monitoring efforts, bird abundance and species diversity varied both through time and between dams. Bird abundance was highest in May coinciding with the typical salmonid smolt and juvenile lamprey outmigration and hatching of gull chicks. Seasonal mean daily abundance of foraging birds was generally higher at dams closer to colonies of nesting birds, such as The Dalles 48.0 foraging birds per day, McNary 40.1, and Ice Harbor 26.0, than that of the remaining dams. Although species varied from dam to dam the most abundant piscivores were gulls (*Larus spp*.) with a seasonal mean daily count ranging from 7.4 birds per day at Lower Granite Dam to 98.6 at The Dalles Dam, followed by double-crested cormorants (*Phalacrocorax auritus*) with a seasonal mean daily count ranging from 0.1 at Lower Granite Dam to 23.3 at Ice Harbor Dam.

As part of the effort to ameliorate passage survival of ESA listed fish stock's at USACE dams on the Columbia and Snake rivers, system wide monitoring of piscivorous birds should continue and deterrent efforts should be maintained. The continued monitoring of piscivorous birds within defined zone boundaries highlights bird movement and foraging "hotspots" throughout the fish passage season. This presents managers with the information to better utilize abatement methods at their projects. With continued participation and effort over time, this program will have the ability to detect long term trends in bird abundance and movement both through time and among dams.

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INTRODUCTION

The Columbia River basin drains approximately 250,000 square miles from the states of Washington, Oregon, Idaho, Montana, Wyoming, and Nevada as well as the Canadian provinces of British Columbia and Alberta. While hydropower development in the basin has been substantial, this study focuses on eight large United States Army Corps of Engineers (USACE) hydroelectric dams on the Columbia and Snake rivers built from 1938 – 1975. Increasing successful fish passage at USACE dams is an important part of the effort to protect fish stocks which include Endangered Species Act listed evolutionarily significant units (ESU) passing through the hydropower system (NOAA 2008). Dams may be a source of bottlenecking and disorientation of juvenile salmonids as they pass through turbine units or spillways. Gulls (*Larus spp.*) and double-crested cormorants (*Phalacrocorax auritus*) along with several other piscivorous water birds are commonly observed foraging at or near dams on the lower Columbia and Snake rivers (Merrel, 1959, Ruggerone 1986, Jonas et al. 2008, Wiese et al. 2008). Many of these birds are part of colonies that nest and rear offspring on nearby islands during the months of April through July (BRNW 2010), a time period that coincides with the salmonid smolt outmigration as well as outmigration of juvenile Pacific lamprey from the Columbia River basin to the Pacific Ocean.

The USACE implements avian deterrent programs (Reasonable and Prudent Alternative 48 of the 2008 Federal Columbia River Power System Biological Opinion) in an effort to protect juvenile salmonids from avian predators at its lower Columbia and Snake River dams, where these fish may be more vulnerable to predation (Raymond 1979, Ruggerone 1986). A variety of avian predation deterrent methods are currently in use including installation of passive deterrent devices (e.g., avian lines or wires, spikes) and non-lethal active hazing methods (pyrotechnics or propane cannons). Determining the effectiveness of avian deterrent programs can be difficult as the abundance of birds varies in a given year both spatially and temporally. Abundance may be influenced by a variety of factors including distance from nesting colonies, most abundant food source, and avian deterrent actions used at the dams (Zorich et al. 2010, 2011, 2012). To help determine effectiveness of avian predation deterrent methods, the Zorich studies utilized multiple observers, at multiple sites, to collect and upload data to a centralized database. Results were comparable among years and between dams (John Day Dam 2009-11 and The Dalles Dam 2010-11) and could be accessed, managed, and analyzed real-time via a web-based portal. The success of this effort has lead to a request to standardize techniques to monitor long-term bird abundance trends at the eight dams on the lower Columbia and Snake rivers and to report the in-season abundance so “hot spots” could be addressed as warranted.

OBJECTIVES

Our goal was to monitor short and long term trends in piscivorous bird abundance and behavior using a standardized protocol at eight USACE dams on the lower Columbia and Snake rivers. Data was to be collected by a project biologist or biological technician during their daily duties. This data will be used to determine the number and spatial distribution of birds at each dam and to document the change in

abundance over time. Using standardized methods ensures that data collected at multiple sites, by multiple observers, will be comparable between years and sites. We accomplished this goal by completing three objectives:

1) Provide site-specific training and coordination at each dam.

We met with project biologists to evaluate the prior season of bird survey and avian predation issues that are unique to each project. This included reviewing zone boundaries and training on how to better utilize the data collection methods used in 2012.

2) Implement standard avian observation protocols in order to provide comparable bird counts between eight USACE dams on the Columbia and Snake rivers.

Input from project personnel after the conclusion of the first season of standardized bird monitoring was incorporated in the written protocol (APPENDIX A. Avian Observer Protocol). This included site-specific information provided by the project biologists during the field season such as, zone modifications, special situations, or other pertinent information.

3) Provide data collection devices with custom application or data sheets and a centralized database for use by project fisheries staff.

As part of developing a standardized protocol, standardized methods to collect the data were also developed including data sheets and an online data portal (APPENDIX B. Avian Observer Data Sheet). Project fisheries biologists were offered the ability to either collect data via a handheld tablet PC that would allow for direct upload to the portal or handwritten data sheets that would require the additional step of manually inputting the data into the portal. Project fisheries staffs have the ability to manage the data from a centralized source. In addition, biologists and managers from other agencies have access to real-time summary reports via the on-line Avian Data Portal that allow comparisons of bird distribution and activity

Here we report on seasonal trends at all eight dams individually and the system as a whole.

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METHODS

SITE DESCRIPTION

This study focuses on eight USACE hydroelectric dams on both the Columbia and Snake rivers. These dams are Bonneville, The Dalles, John Day, and McNary on the lower Columbia River; and Ice Harbor, Lower Monumental, Little Goose, and Lower Granite on the lower Snake River (Figure 1). They are part of the Federal Columbia River Power System that is a primary source of electricity in the region while also providing navigation, flood reduction, and recreation, and they are operated to facilitate successful passage of juvenile and adult anadromous fish. Further detail and aerial photographs are presented in the results sections for each dam.

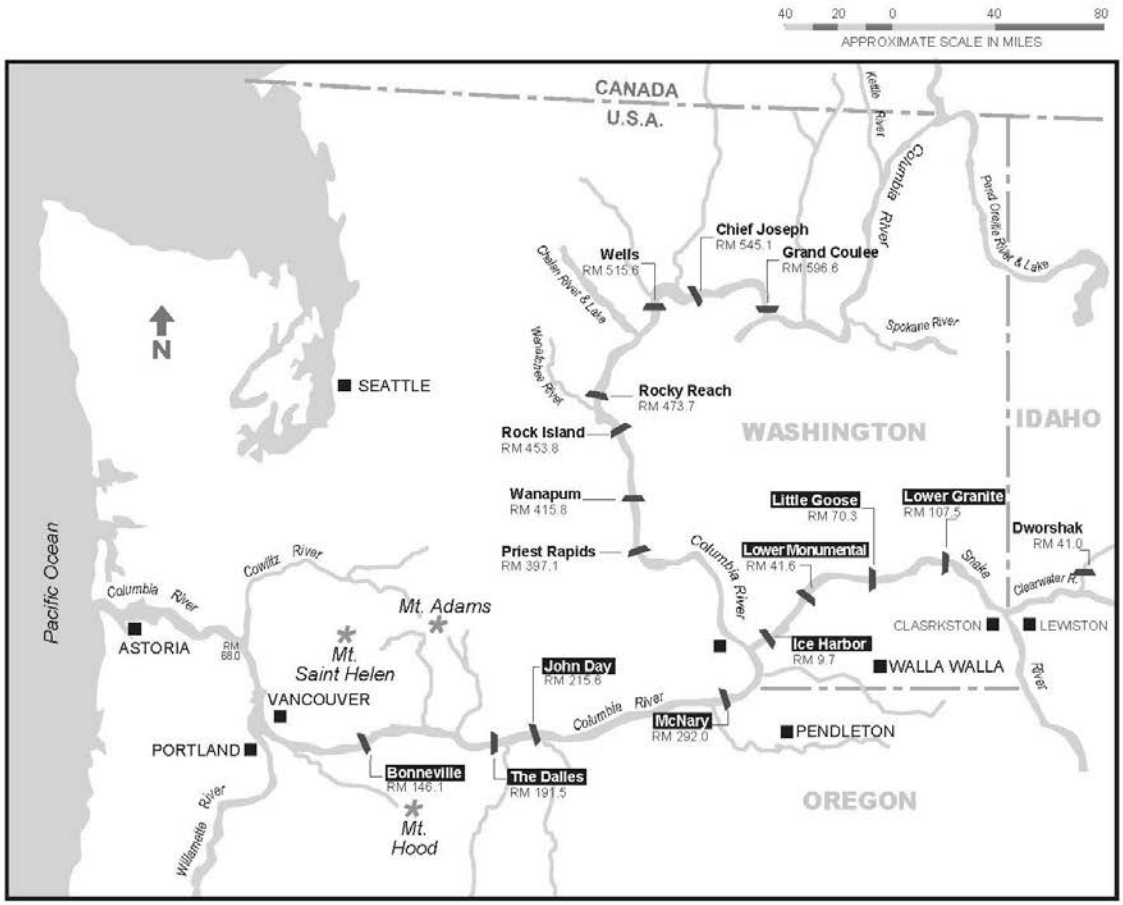

Figure 1. Map of Columbia Basin dams including the eight USACE dams, highlighted in black, which participated in the standardized monitoring program for piscivorous birds in 2013.

COORDINATION WITH PROJECTS AND TRAINING

In 2013, the Fisheries Field Unit and USACE project staff continued the development of a standardized protocol originated in 2012 (Zorich et al 2014). Preseason training, a written protocol, and datasheets were delivered by the FFU to fisheries biologists and their staff during site visits at all eight dams. Observers from each dam collected and uploaded data on the nine most common piscivorous bird species: American white pelican (*Pelecanus erythrorhynchos*), bald eagle (*Haliaeetus leucocephalus*), Caspian tern (*Sterna caspia*), common mergansers (*Mergus merganser*), double-crested cormorant (*Phalacrocorax auritus*), great blue heron (*Ardea Herodias*), grebes (*Podicipedidae spp.*), gulls (*Laridae spp.*), and osprey (*Pandion haliaetus*). The abbreviation for common bird names used in graphs and tables in this report follows that of Klimkiewicz and Robbins (1978):

AWPE = American White Pelican
BAEA = Bald Eagle
CATE = Caspian Tern
COME = Common Merganser
DCCO = Double-crested Cormorant
GBHE = Great Blue Heron
GULL = any gull species*
GREBE = Clark's or Western Grebe
OSPR = Osprey

**Gulls are typically not identified to species for reporting purposes due to the difficulty in identifying individual species of active birds at a distance.*

Most near dam areas are too large to be seen by one observer from one location. Therefore sites were divided into zones which together covered, at a minimum, from the upstream to the downstream boat restricted zones of each dam. After the first season of monitoring several biologists requested changes to existing zones to expedite data collection and entry. Changes were made to add a downstream zone at The Dalles Dam and combine zones at John Day Dam. The entire observed area at each site was measured with Google Earth Pro[1] using the polygon measuring tool and reported in square kilometers and square miles.

DATA COLLECTION

Bird count data collection was accomplished by one of two methods. Data was collected on traditional paper datasheets then manually entered into an on-line data portal at Bonneville, McNary, Lower

[1] Use of brand name does not imply endorsement from the USACE.

Monumental, Little Goose, and Lower Granite dams (see APPENDIX B. Avian Observer Data Sheet). Data was collected electronically on tablet PC's (xTablet T7200 by MobileDemand1) then wirelessly synced to the data portal at The Dalles, John Day, and Ice Harbor dams. An instantaneous scan, performed with 8 x 42 binoculars, was used to count the number of birds of each species or genus in each zone (forebay, spillway tailrace, powerhouse tailrace, juvenile outfall pipe, etc), time of scan, and classifying behavior (foraging, resting, fly by, and scavenging). One round of collecting bird counts from all predetermined zones defines a session (Appendix A). The goal is for projects to complete at least one session of bird counts per day within an hour (to reduce double counting of moving birds). Typically bird counts were recorded during daily fishway inspection duties.

To streamline and standardize the data collection process, a mobile application was developed for use with the rugged tablet PC's. The application (developed by RealTime Research) allowed users to consistently and accurately record data on bird abundance and behavior, while minimizing personnel time and costs. A Microsoft Windows-based application was loaded on tablet PC's enabled with wireless communications that allow users to synchronize (transfer) their data from the field to a centralized database - a secure (i.e., password protected) web-based data portal and analysis hub for all project data. Authorized project personnel had access to the data via the web portal in order to add, edit, graph, and manage project data. In addition, regional resource managers such as US Fish and Wildlife Service, NOAA Fisheries, and regional partners from the States of Washington, Oregon, and Idaho had access to near real-time summary graphics that allow comparisons of bird distribution and predation activity both within and among the different hydroelectric dams.

DATA ANALYSIS

Graphs and tables presented here are based on daily, weekly, or seasonal mean bird counts. We estimated daily bird abundance by calculating the mean daily count for each observation zone and then taking the sum of these means to yield a mean daily count for the site. If only one count was taken during a day it is reported as the mean, (see results for each project). Seasonal mean counts refer to April 1 – July 31. To estimate the seasonal mean number of birds per day we summed the counts for each observation zone, divided by the number of days observed, and then summed these values for all zones. Confidence intervals (95% CI's) for non-normal count data were estimated using the percentile boot strap process, re-sampling 10,000 times with replacement to develop a normal distribution, then selecting the 2.5 percentile and the 97.5 percentile (McDonald and Robinson 2010, Efron 1979)

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RESULTS

ALL PROJECTS

Piscivorous bird abundance was similar to 2012, highly variable from dam to dam but commonly peaked in May, which typically coincides with salmonid smolt and juvenile lamprey outmigration (Zorich et al. 2011, 2012, and 2014). The Dalles and McNary dams consistently had more foraging birds than the other dams (Figure 2). Foraging bird numbers generally began increasing in April, reached their highest levels in May, decreased until early June, and for some dams increased again in late June or early July (Figure 3).

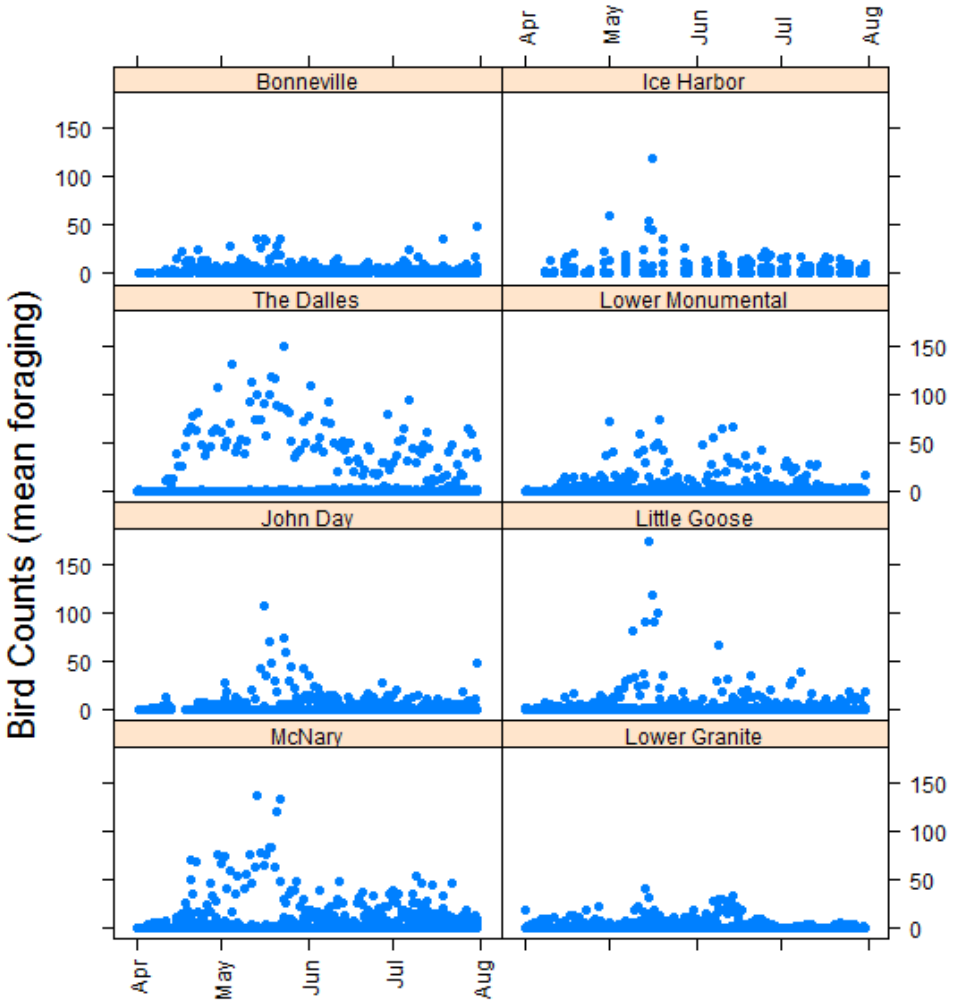

Figure 2. Timing and abundance of foraging birds at eight USACE dams in 2013. Project means have been calculated for each day from one to three counting sessions depending on the dam.

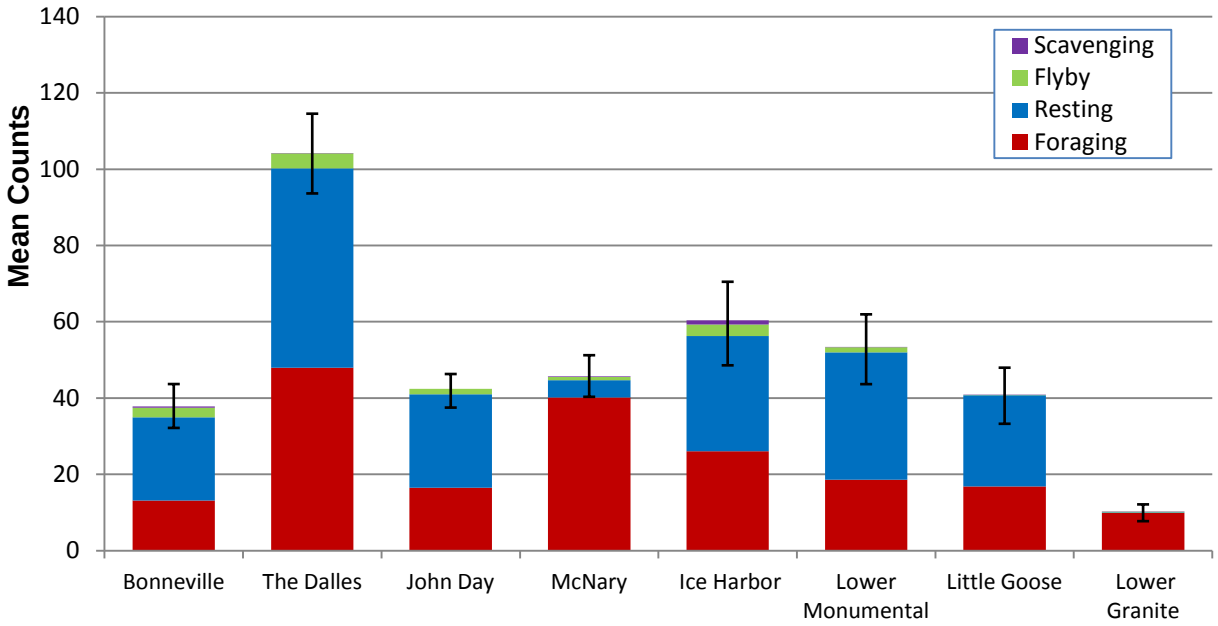

Figure 3. Seasonal mean daily bird counts by behavior at eight USACE dams April 1 through July 31, 2013 (with 95% CI bars). Project means have been calculated for each day from one to three counting sessions depending on the project.

Species diversity varied from dam to dam with gulls being the most common piscivore followed by double-crested cormorants. Seasonal mean daily gull counts (i.e., average number of gulls observed per day from 1 April to 31 July) ranged from a low of 7.4 at Lower Granite to a high of 98.6 at The Dalles (Table 1). Double-crested cormorants were the second most prevalent species and were commonly counted at Ice Harbor, Bonneville, and The Dalles dams. Double-crested cormorant seasonal mean daily counts ranged from 0.1 at Lower Granite to 23.3 at Ice Harbor. At Ice Harbor Dam large numbers of American white pelicans were observed resting at Eagle Island and occasionally foraging in the tailrace. While at John Day Dam the most abundant piscivores are grebes which are found exclusively in the forebay zones of the dam. Osprey, great blue heron, and common mergansers were occasionally present at some projects, but there were typically only a few individuals of each at any given time.

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Table 1. Seasonal mean daily bird counts (all behaviors) for each species at each dam from April 1 to July 31, 2013. All behaviors combined. Maximum counts are included in parenthesis.

Species	Bonneville	The Dalles	John Day	McNary	Ice Harbor	Lower Monumental	Little Goose	Lower Granite
AWPE	0 *(0)*	<0.1 *(3)*	2.2 *(78)*	**5.5** *(25)*	**14.9** *(42)*	**1.9** *(13)*	0.7 *(17)*	**2.7** *(21)*
BAEA	0.1 *(2)*	<0.1 *(1)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0)*	<0.1 *(1)*	0 *(0)*
CATE	0 *(0)*	<0.1 *(1)*	<0.1 *(2)*	8 *(75)*	3.2 *(16)*	0.2 *(4)*	<0.1 *(1)*	0 *(0)*
COME	0.2 *(4)*	<0.1 *(12)*	0 *(0)*	0.2 *(12)*	4.6 *(25)*	0 *(0)*	<0.1 *(1)*	<0.1 *(1)*
DCCO	**15.6** *(80)*	**15.4** *(71)*	0.5 *(10)*	1.4 *(42)*	**23.3** *(57)*	**5.1** *(25)*	**7.4** *(140)*	0.1 *(4)*
GBHE	0.8 *(13)*	0.1 *(9)*	0 *(0)*	<0.1 *(1)*	0.1 *(2)*	<0.1 *(2)*	<0.1 *(1)*	0 *(0)*
GREBE	1.8 *(25)*	1.2 *(14)*	**24.0** *(66)*	**6.3** *(70)*	<0.1 *(1)*	0.1 *(2)*	<0.1 *(2)*	<0.1 *(1)*
GULL	**17.7** *(70)*	**98.6** *(282)*	**15.9** *(106)*	**24.3** *(125)*	**15.0** *(47)*	**46.0** *(187)*	**32.6** *(160)*	**7.4** *(27)*
OSPR	3.7 *(9)*	1.1 *(5)*	<0.1 *(1)*	0.1 *(3)*	0.2 *(2)*	0.1 *(2)*	0.1 *(3)*	<0.1 *(1)*

AWPE = American White Pelican, BAEA = Bald Eagle, CATE = Caspian Tern, GULL = any gull species, DCCO = Double-crested Cormorant, GBHE = Great Blue Heron, OSPR = Osprey, COME = Common Merganser, GREBE = Clark's or Western Grebe. *Means in bold highlight dominant predators*

It should be noted that piscivorous birds are present at the dams throughout the year, but the species composition, including species of gull, changes seasonally. Project biologist's from Lower Granite, Little Goose, Ice Harbor, John Day, Bonneville, and The Dalles dams, who continued to monitor piscivorous birds through the 2012/13 winter reported an increase in the number of resting birds, primarily gulls, but also double-crested cormorants, common mergansers, and bald eagles (The Dalles Dam). The largest winter gathering of birds occurred in the John Day forebay and on the forebay's navigation lock wing wall which were visited by thousands of resting gulls during early November (Figure 4).

Figure 4. Gulls on the navigation lock wing wall in John Day Dams forebay during November, 2013.

BIRD COUNTS BY PROJECT

BONNEVILLE

Bonneville Dam is located on the Columbia River at river kilometer 234 (rm 146.1). The dam is surrounded by steep forested mountains on both banks and receives the most precipitation of the eight projects. The majority of juvenile fish migrating out from the Columbia River basin must pass through Bonneville Dam, including several salmonid evolutionarily significant units (ESU's) listed as threatened or endangered under the Endangered Species Act (NOAA 2008). The second of two powerhouses at Bonneville Dam, has screened turbine intakes that are designed to guide fish into a bypass system away from the turbines and deposit them back into the river at the juvenile fish outfall (JFOF) 3.2 km (2 miles) downstream (Figure 5) on the Washington shore. The monitored area consists of twelve zones that cover 0.82 square km (0.32 square miles) (Figure 5). Methods to deter piscivorous birds include United Stated Department of Agriculture (USDA) land-based hazers using pyrotechnics, deterrent line arrays in the tailrace areas of the spillway, powerhouses I and II, and the corner collector, hydro-cannons on the juvenile fish facility outfall pipe terminus, and perch deterrents such as spike strips.

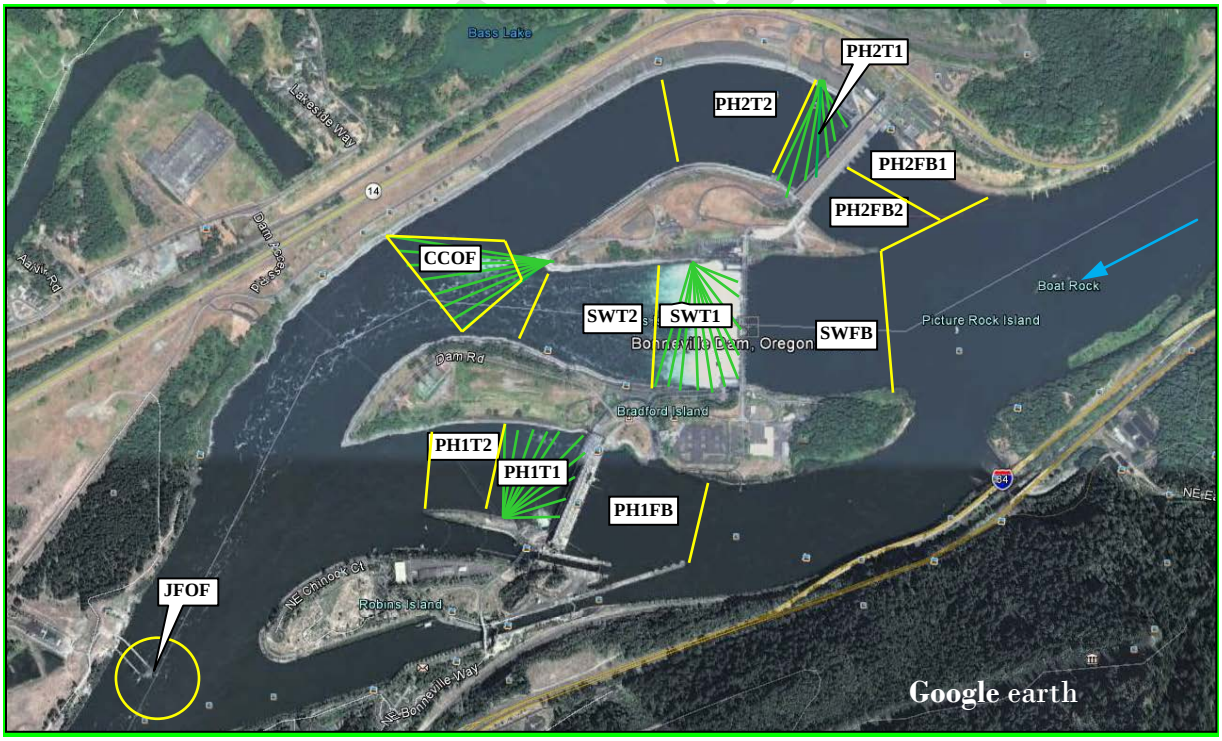

Figure 5. Zone map of Bonneville Dam used in 2013. Yellow lines delineate the zones, green lines represent the avian deterrent lines (not exact number), and the blue arrow indicates flow direction. PH1T1-2 = powerhouse I tailrace zones, PH1FB = powerhouse I forebay, SWT1-2 = spillway tailrace zones, SWFB = spillway forebay, PH2T1-2 = powerhouse II tailrace zones, PH2FB1-2 = powerhouse II forebay zones, JFOF = juvenile fish outfall, CCOF = corner collector outfall.

Project fisheries biologists at Bonneville performed bird counts for 103 of the 122 day season, April 1 through July 31, typically once a day. Bonneville Dam was next to last (seventh of the eight dams) in foraging bird counts for the season and all behaviors combined (Table 1). Bird abundance at the dam increased to a maximum count of 142 on May 16 (Figure 6).

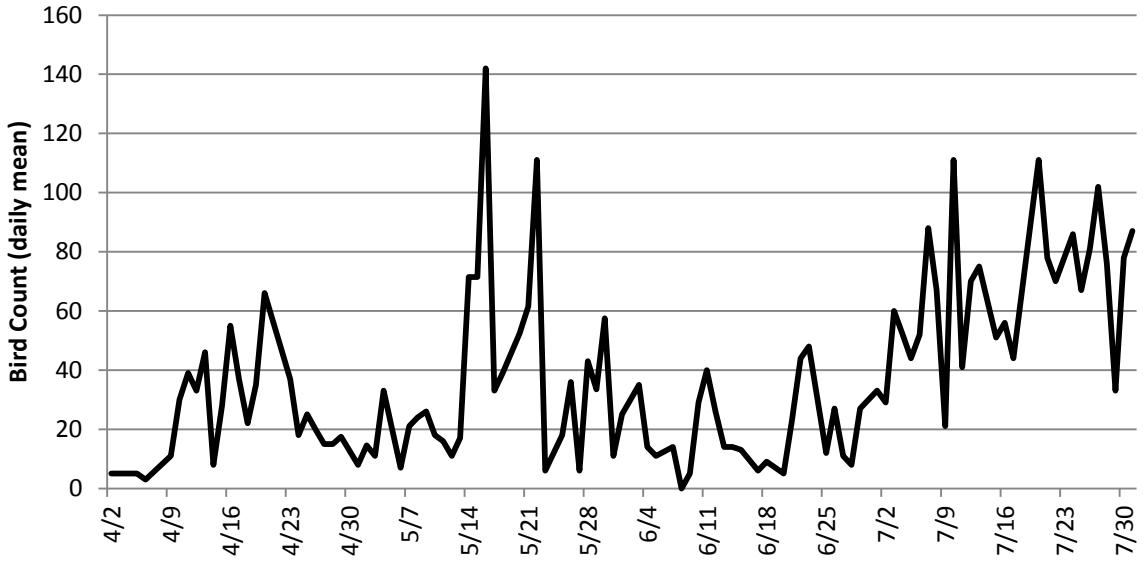

Figure 6. Mean daily bird counts (all behaviors) at Bonneville Dam during the primary smolt outmigration. Counts reported here are for April 1 through July 31, 2013.

All four bird behaviors were catalogued at Bonneville Dam. Foraging accounted for 41.1% of observed bird behaviors, resting 50%, flyby 7.8%, and scavenging (mostly from sea lions eating adult salmonids or sturgeon) 1.1%. Foraging behavior was predominant in April and May. Birds were observed resting more often in the month of July (Figure 7).

Gulls and cormorants comprised the majority of the bird species in the survey. Similar to 2012, gulls were the most abundant piscivore with a seasonal mean daily count of 17.7, fifth highest of the eight dams (Table 1). Gull abundance was greatest in April and May (Figure 7). Gulls were observed foraging in the area of the spillway tailrace (SWT2) zone, not protected by avian deterrent lines, and the JFOF zone (Figure 8). Resting gulls were often seen in the powerhouse 1 forebay (PH1FB) zone and on the JFOF and corner collector outfall (CCOF) zone outfall structures (Figure 8). Gull abundance declined as the abundance of double-crested cormorants increased in June and July. Unlike 2012, when double-crested cormorants had a seasonal mean daily count of 1.1, this year they increased to a seasonal mean daily count of 15.6, the second highest of the eight dams (Table 1). Double-crested cormorants were most often seen resting in the powerhouse II forebay (PH2FB) zone (Figure 8) with a smaller amount foraging and/or resting in other zones across the project (Table 2). Other birds present in small numbers in various zones were osprey, grebe, great blue heron, bald eagle, and common merganser (Table 2). There were no sightings of Caspian terns or American white pelicans.

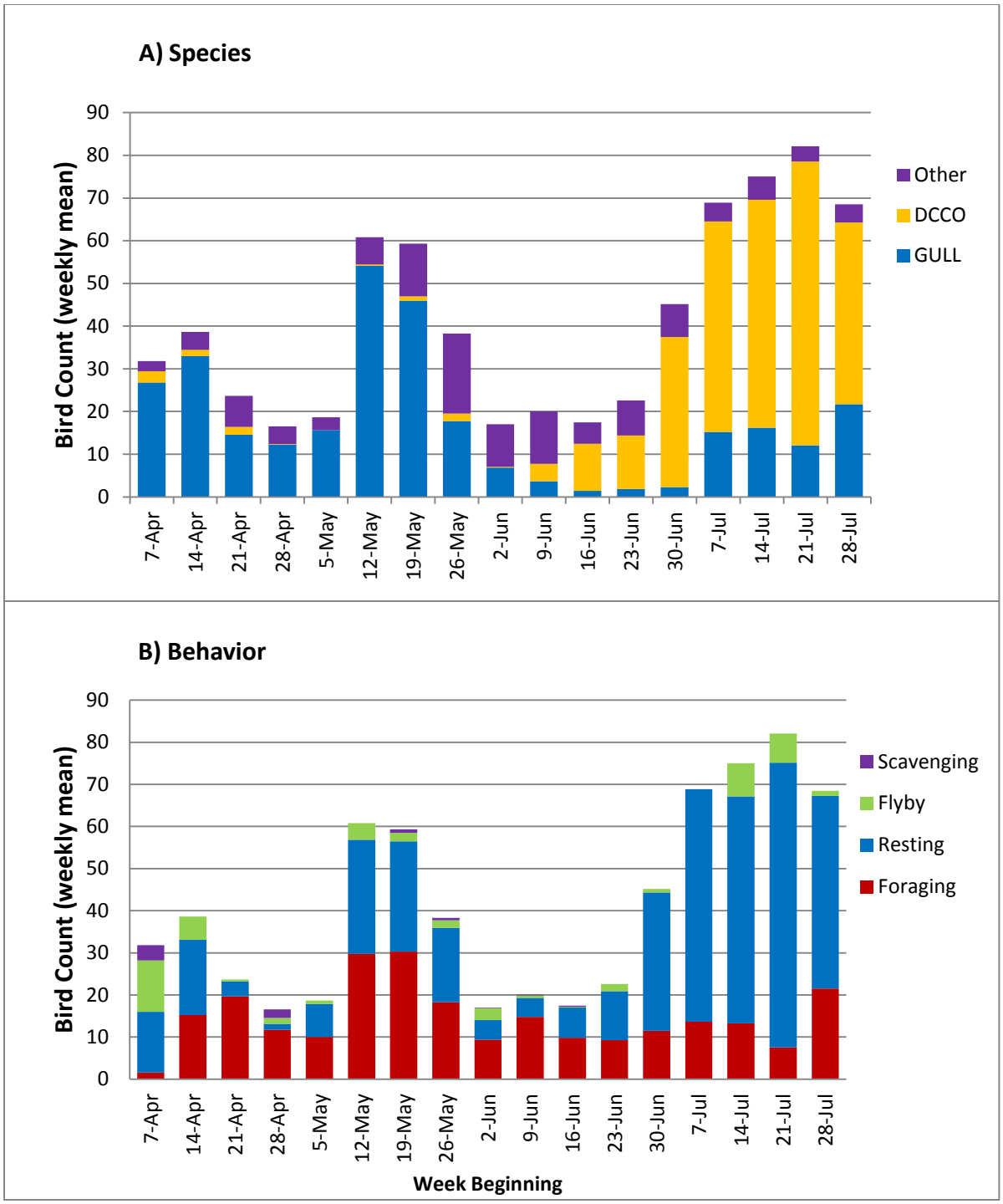

Figure 7. Timing, abundance, diversity, and behavior of nine piscivorous birds at Bonneville Dam April 1 through July 31, 2013. A) The most numerous species; GULL = any gull species, DCCO = double-crested cormorant, Other = remaining monitored species. B) Behavior of the birds in graph A.

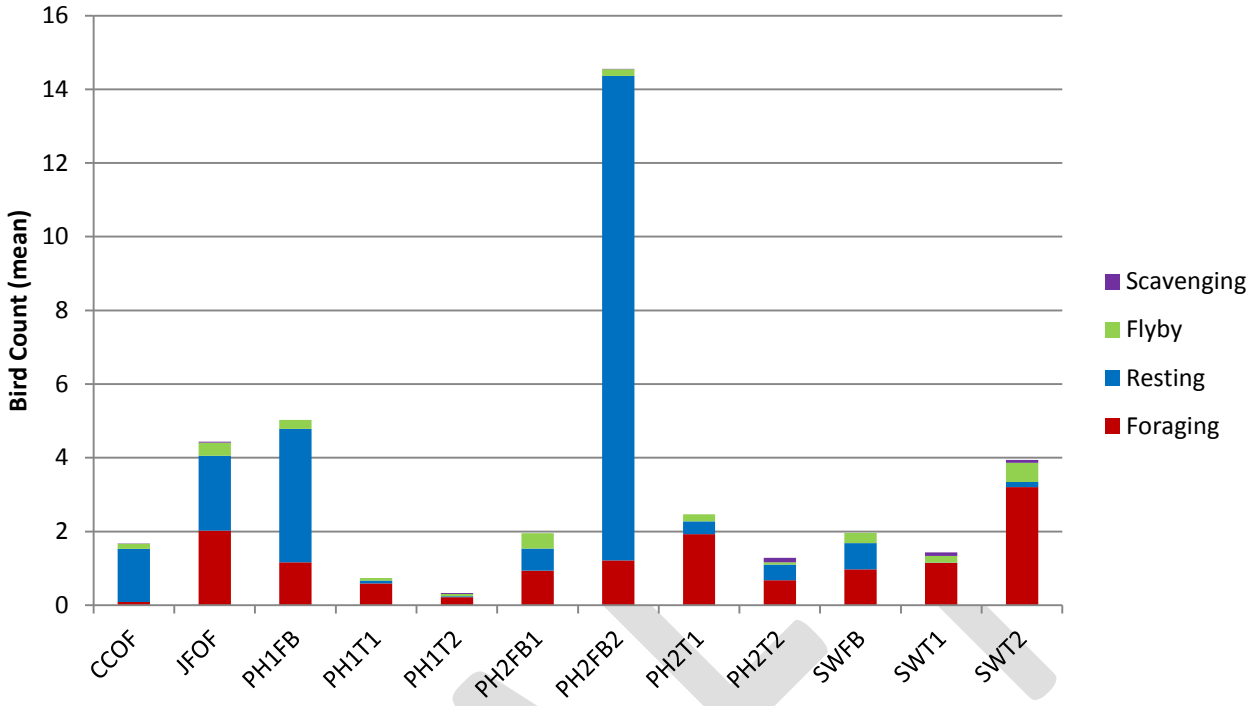

Figure 8. Spatial distribution of birds by zone and behavior at Bonneville Dam, seasonal mean daily bird counts for April 1 through July 31, 2013.

Table 2. Seasonal mean daily bird counts (all behaviors) by zone and species at Bonneville Dam, April 1 through July 31, 2013.

Common Name	CCOF	JFOF	PH1FB	PH1T1	PH1T2	PH2FB1	PH2FB2	PH2T1	PH2T2	SWFB	SWT1	SWT2
American White Pelican	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bald Eagle	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	0.0	<0.1	0.0	<0.1	<0.1
Caspian Tern	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Common Merganser	0.0	0.0	0.1	0.0	0.0	0.1	<0.1	0.0	0.0	0.0	0.0	0.0
Double-crested Cormorant	<0.1	0.1	0.1	0.2	0.1	0.6	13.6	0.6	0.2	<0.1	<0.1	<0.1
Great Blue Heron	0.0	<0.1	<0.1	0.2	0.1	0.0	0.4	<0.1	<0.1	<0.1	<0.1	<0.1
Grebe	0.0	0.0	0.9	<0.1	0.0	0.0	<0.1	0.0	0.0	0.9	0.0	0.0
Gull	1.7	4.3	3.3	<0.1	0.1	1.0	0.1	0.5	0.7	0.7	1.3	3.9
Osprey	0.0	0.1	0.5	0.2	0.1	0.2	0.4	1.4	0.4	0.3	0.1	0.1

DRAFT

THE DALLES

The Dalles Dam is located on the Columbia River at river kilometer 308 (rm 191.5). The dam is situated on a large bend in the river next to The Dalles, OR, and is near agricultural lands, a county landfill, and a regional landfill. It is also about 21.5 rkm (13.4 miles) downstream from the gull colony at Miller Island's rocks which has an estimated population of ca. 4,760 California gulls and ca. 50 ring-billed gulls (BRNW 2014). There are nine monitored zones covering approximately 2.05 square km (0.80 square miles) (Figure 9). The monitored area was expanded from that of 2012 to include islands downstream of the SWT4 zone. Piscivorous bird deterrent methods at the dam include USDA land-based hazers using pyrotechnics, 74 avian deterrent lines covering the powerhouse and spillway tailrace areas, and perch deterrents such as bird spikes.

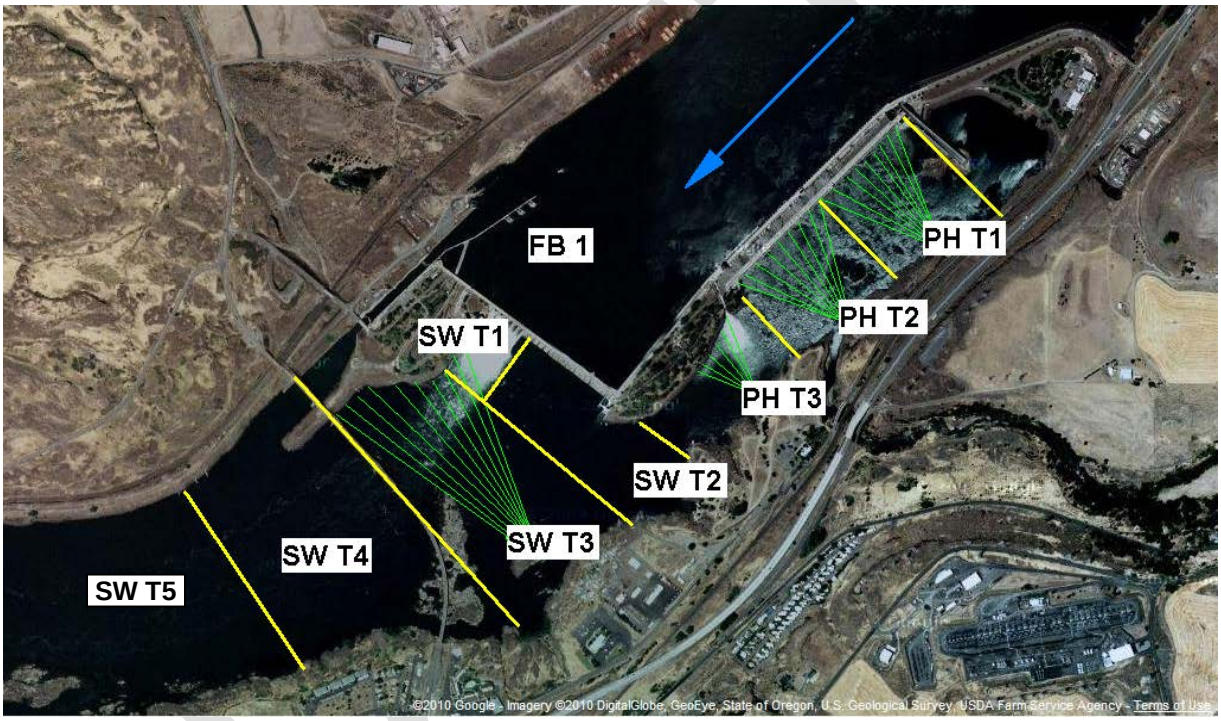

Figure 9. Zone map for The Dalles Dam in 2013. Yellow lines delineate the zones, green lines represent the avian deterrent lines (not exact number), and the blue arrow indicates flow direction.

Project fisheries biologists conducted bird counts twice a day from April 1 through July 31. The Dalles Dam had a seasonal mean daily foraging bird count of 48, largest of all eight dams and an increase from the seasonal mean daily foraging bird count of 39.7 in 2012 (Figure 2). Bird abundance at The Dalles rose in early May dropped toward the end of the month and then rose again the first week of June. The highest daily bird count of 331 (all behaviors) was recorded on June 5. Bird counts decreased through most of July although the number of birds remained over 100 (Figure 10).

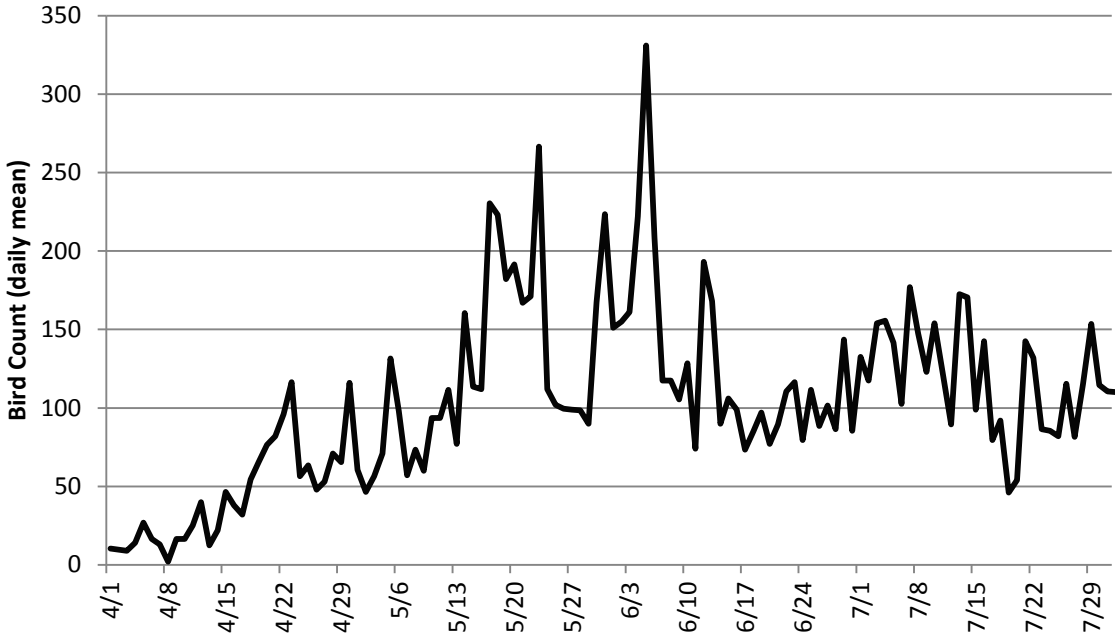

Figure 10. Mean daily bird counts (all behaviors) at The Dalles Dam during primary smolt outmigration, April 1 through July 31, 2013.

All four bird behaviors were observed at The Dalles Dam. Foraging comprised 46.1% of the bird behaviors observed, while resting was observed 50.1% and fly by 3.7%. Scavenging (mainly from tribal fisherman's discarded fish entrails) was seldom seen, accounting for only 0.04% of bird behaviors. Foraging was predominant in April and May, while resting birds were seen most often from mid May through July (Figure 11).

Gulls and double-crested cormorants comprised the majority of bird species in the survey. These birds were spatially concentrated in four of the nine count zones. Gulls foraged in spillway zones SWT3 and SWT4 (Figure 12). Resting gulls were mainly seen on the rock islands in zones SWT3 and SWT5. The Dalles Dam had the highest seasonal mean daily gull count (98.6) of all eight dams. This was a noticeable increase from the seasonal mean daily gull count of 55.9 in 2012. The increase was mainly due to the addition of the SWT5 zone which includes rock islands where many birds rest during the day (Figure 12). When comparing the two seasons without including zone SWT5 counts, the mean daily gull count of 64.2 for 2013 was still higher than the previous season. Double-crested cormorants began increasing in numbers by late May but their greatest abundance occurred in July. They comprised the majority of resting birds in the forebay (FB1) and as in previous years, were often seen perched on the electrical transmission towers near the Washington shore (Table 3). The seasonal mean daily count for double-crested cormorants was 15.4, the third highest of the eight dams. As for the other species; grebes, osprey, great blue heron, common merganser, American white pelican, Caspian tern, and bald eagle, these birds were seen infrequently throughout the juvenile fish passage season (Table 3). Bald eagles and common mergansers increase in abundance in the winter months of December through March when maximum daily counts reached 85 and 81 respectively.

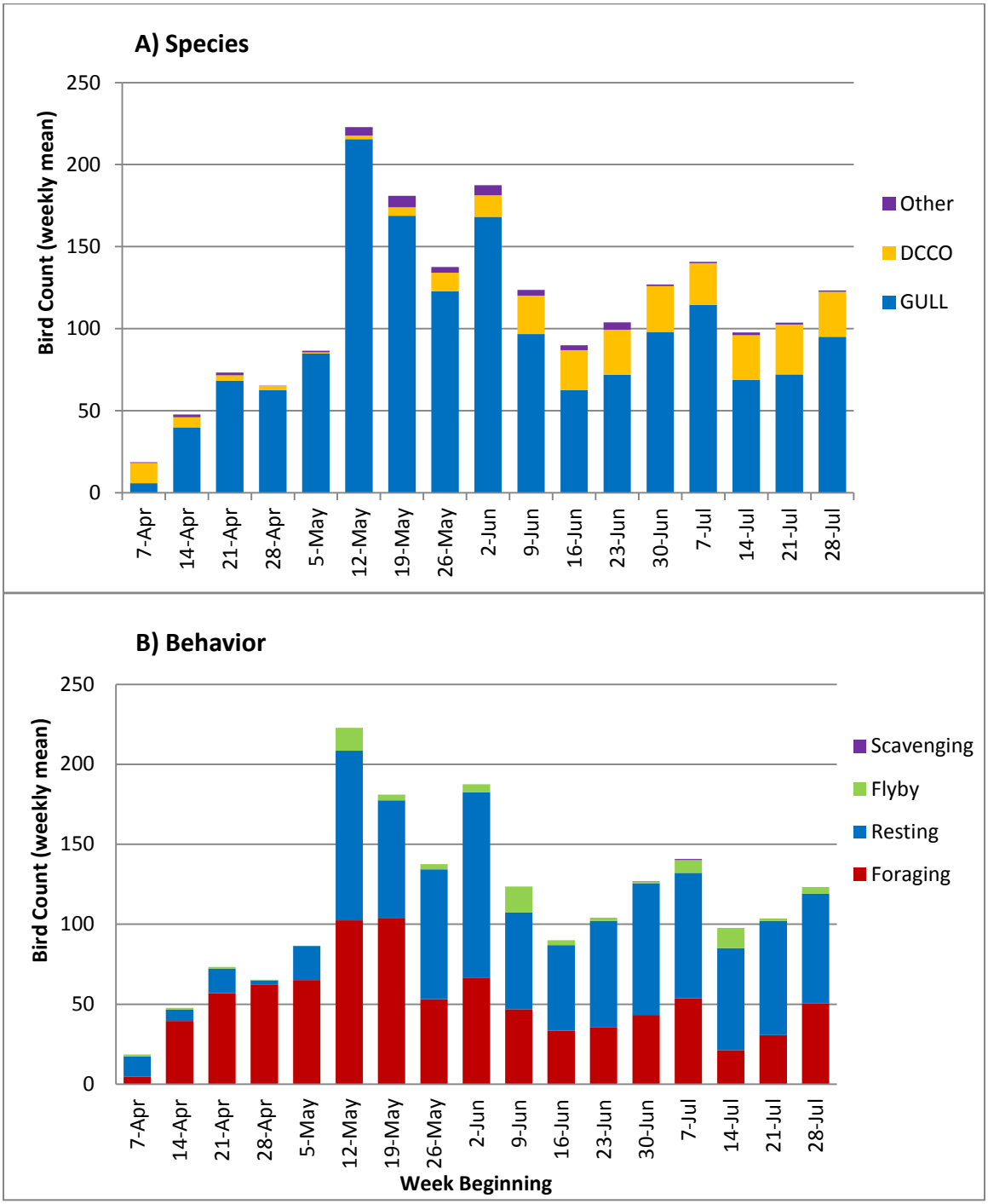

Figure 11. Timing, abundance, diversity, and behavior of nine piscivorous birds at The Dalles Dam April 1 through July 31, 2013. A) The most numerous species; GULL = any gull species, DCCO = double-crested cormorant, and Other = remaining monitored species. B) Behavior of the birds in graph A.

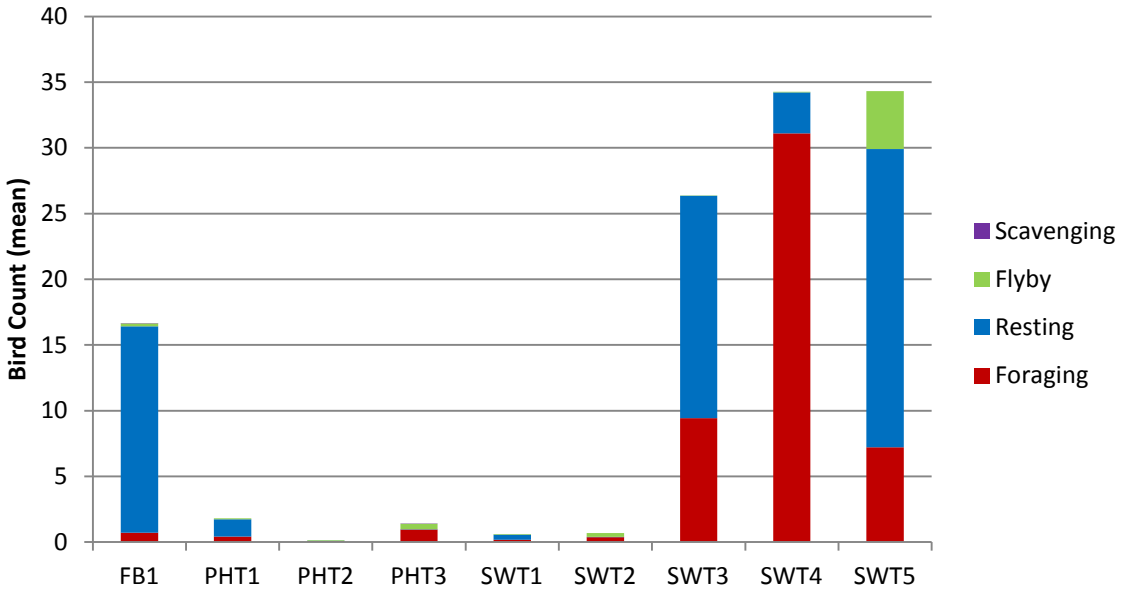

Figure 12. Spatial distribution of birds by zone and behavior at The Dalles Dam, seasonal mean daily bird count for April 1 through July 31, 2013. FB1 = forebay, PHT1 to 3 = powerhouse tailrace zones, SWT1 to 5 = spillway tailrace zones. PHT1, PHT2, SWT1, and SWT2, are adjacent to dam.

Table 3. Seasonal mean daily bird counts (all behaviors) by zone and species at The Dalles Dam, April 1 through July 31, 2013.

Common Name	FB1	PHT1	PHT2	PHT3	SWT1	SWT2	SWT3	SWT4	SWT5
American White Pelican	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1
Bald Eagle	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0
Caspian Tern	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0
Common Merganser	<0.1	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Double-crested Cormorant	13.5	1.5	<0.1	<0.1	<0.1	0.2	0.1	<0.1	<0.1
Great Blue Heron	0.1	<0.1	0.0	<0.1	0.0	0.0	0.0	0.0	<0.1
Grebe	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gull	1.4	0.1	<0.1	1.3	0.2	0.4	26.4	34.4	34.5
Osprey	0.4	0.2	<0.1	<0.1	0.4	0.1	<0.1	<0.1	<0.1

DRAFT

JOHN DAY

John Day Dam is located on the Columbia River at river kilometer 348 (rm 216). The powerhouse at John Day is equipped with screens that divert juvenile fish away from the turbines and through the juvenile bypass system on the south shore (zone PH T2 in figure 13). John Day Dam is 15.3 km (9.5 miles) upstream from Miller Island's rocks where a colony of California and ring-billed gulls nest. Here the monitored area was divided into eight zones, a reduction from the ten zones of the previous year however the area of coverage remained the same 1.94 square km (0.75 sq mi). The change from 2012 monitoring zone definitions involved combining the middle two zones for the powerhouse into a single zone resulting in three powerhouse tailrace zones. This change was made on the spillway side of the tailrace as well (Figure 13). Piscivorous bird deterrent methods at the dam include USDA boat-based hazers using pyrotechnics, 125 avian deterrent lines covering the spillway and powerhouse tailrace area, and perch deterrents such as bird spikes.

Figure 13. Zone map used at John Day Dam in 2013. Yellow lines demarcate zones and green lines represent the avian deterrent lines (not exact number), and the blue arrow indicates flow direction.

Project fisheries biologists conducted bird counts one or two times a day for 111 of the 122 day season from April 1 through July 31. The seasonal mean daily foraging bird count at John Day was 16.5, sixth highest of the eight dams. Bird abundance peaked May 24th, when the maximum daily count of 157 was reached (Figure 14).

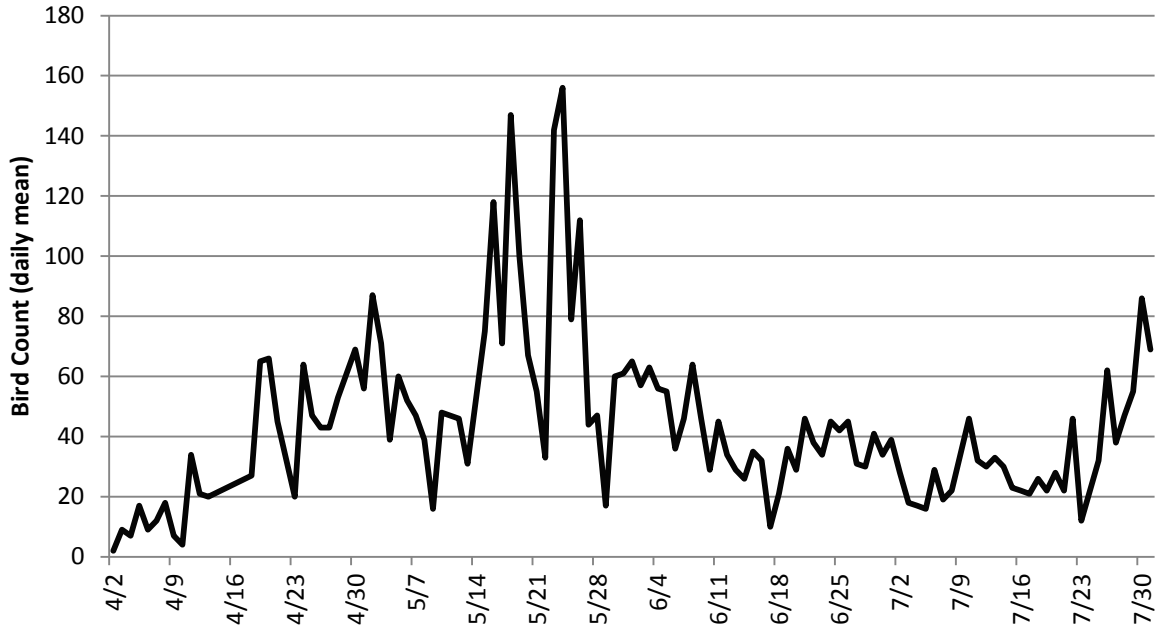

Figure 14. Mean daily bird count (all behaviors) at John Day Dam during primary smolt outmigration, April 1 through July 31, 2013.

Three of the four bird behaviors were observed at John Day. Foraging birds comprised 39% of the counts while resting birds comprised 57.7% and flyby 3.3%. Foraging behavior was predominant in May while resting behavior was seen most often in April, June, and July (Figure 15).

Gulls and grebes comprised the majority of the bird species in the survey. These birds were concentrated in the powerhouse forebay zone PHFB, and to a lesser degree in the furthest downstream spillway tailrace zone SWT3. The seasonal mean daily gull count at John Day decreased from 22.2 in 2012 to 15.9 in 2013, sixth highest of the eight dams. Gulls were observed foraging mostly in SWT3 and PHT3 just downstream of the avian deterrent array (Figure 16), but could also be seen in various zones around the project (Table 4). Grebes on the other hand were observed exclusively in the forebay zones, mainly PHFB. The seasonal mean daily grebe count was 24, an increase from the mean of 14.8 in 2012. Other birds observed less often during the season were Caspian terns, double-crested cormorants, and osprey. Great blue heron and bald eagles were not observed during the 2013 monitoring season (Table 4). Bald eagles were observed on a few occasions during the winter months.

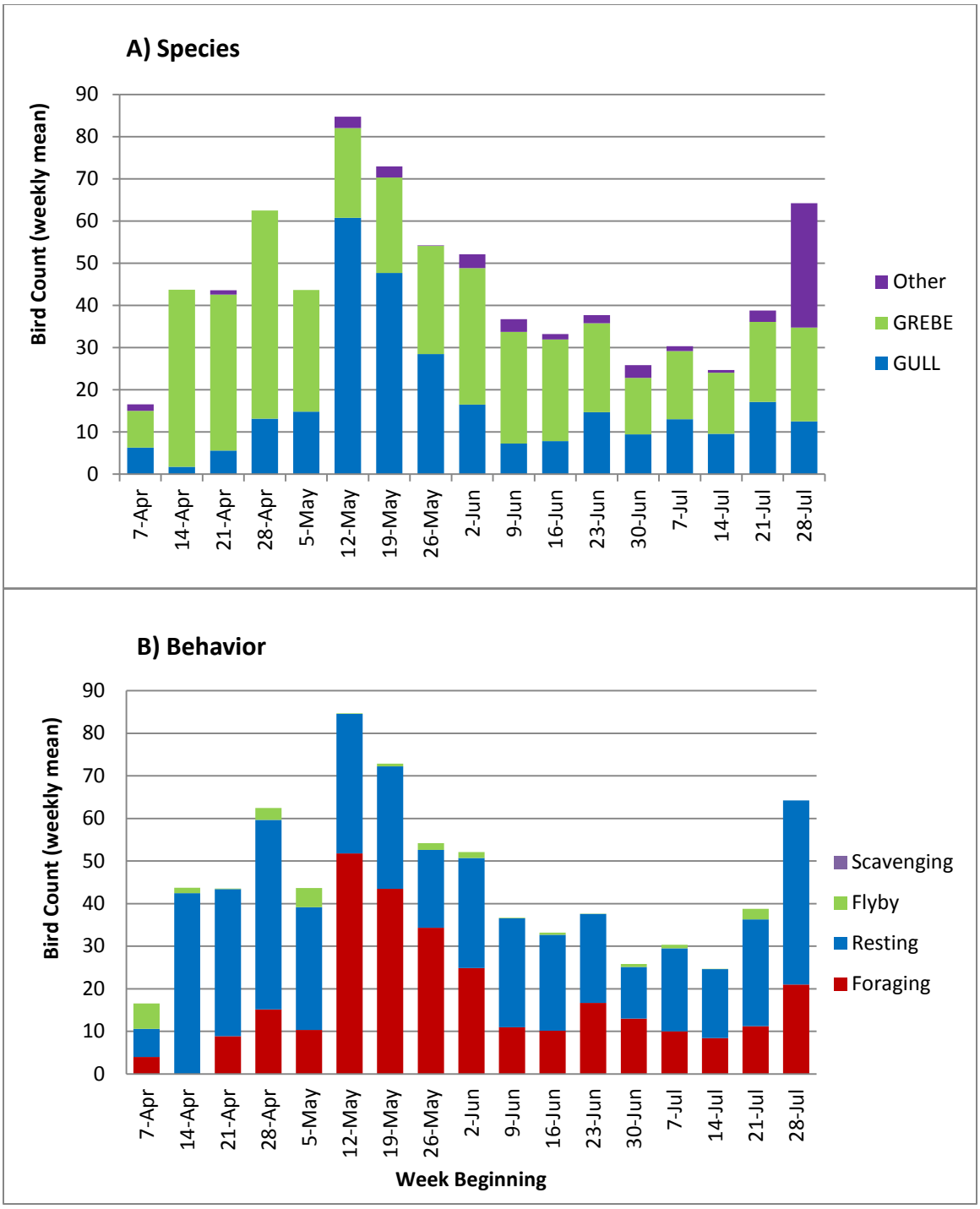

Figure 15. Timing, abundance, diversity, and behavior of nine piscivorous birds at John Day Dam April 1 through July 31, 2013. A) The most numerous species: GULL = any gull species, GREBE = Western or Clark's Grebes, Other = remaining monitored species. B) Behavior of the birds in graph A.

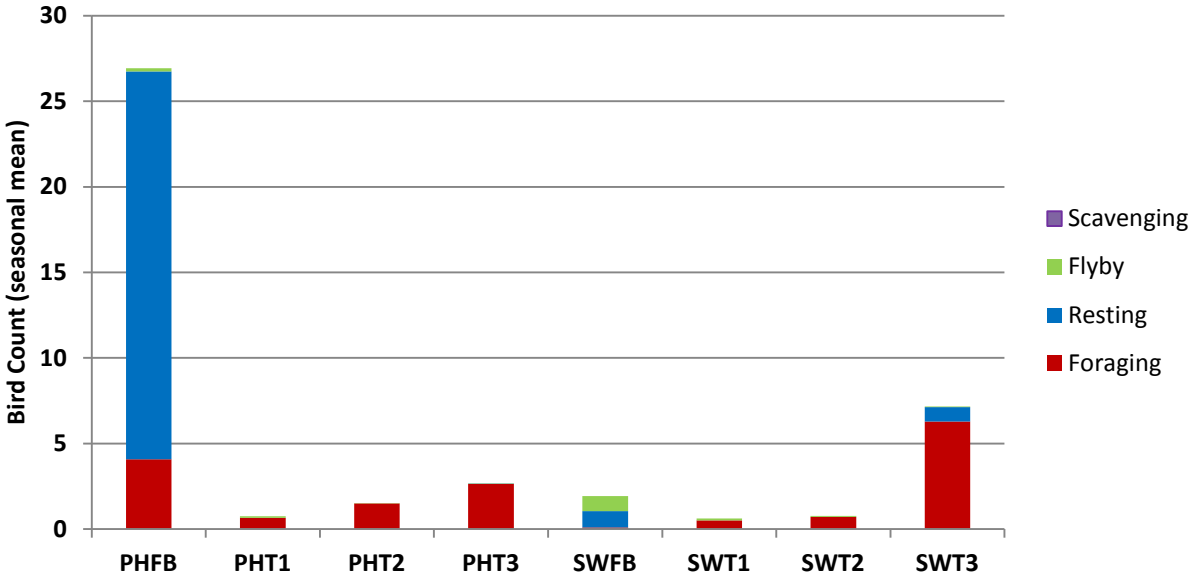

Figure 16. Spatial distribution of birds by zone and behavior at John Day Dam, seasonal mean daily bird counts for April 1 through July 31, 2013. SWFB = spillway forebay, PHFB = powerhouse forebay, SWT1 to SWT3 = spillway tailrace zones, PHT1 to PHT3 = powerhouse tailrace zones.

Table 4. Seasonal mean daily bird counts (all behaviors) by zone and species at John Day Dam, April 1 through July 31, 2013.

Common Name	PHFB	PHT1	PHT2	PHT3	SWFB	SWT1	SWT2	SWT3
American White Pelican	0.1	0.0	0.0	0.1	<0.1	<0.1	0.1	1.8
Bald Eagle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Caspian Tern	<0.1	0.0	0.0	0.0	<0.1	0.0	0.0	0.0
Common Merganser	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Double-crested Cormorant	0.4	<0.1	0.0	0.0	0.0	0.0	0.0	<0.1
Great Blue Heron	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grebe	23.7	<0.1	0.0	0.0	0.3	0.0	0.0	0.0
Gull	2.7	0.7	1.5	2.5	1.6	0.6	0.7	5.5
Osprey	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DRAFT

McNARY

McNary Dam is located on the Columbia River at river kilometer 470 (rm 292). The powerhouse at McNary Dam is equipped with screens that divert juvenile fish away from the turbines and through a juvenile bypass system on the south shore. The outfall pipe is located 0.6 km downstream of the tailrace deck. The dam is surrounded by agricultural and wetland areas, it is also close to populated areas such as the cities of Umatilla and Hermiston, Oregon both of which can be potential food sources for gulls. Downstream of the dam there are nesting gulls on islands such as Anvil Island/Blalock Islands (ca. 3,980 California gulls and ca. 1,710 ring-billed gulls) and Straight Six Island/Blalock Islands (ca. 100 California gulls and ca. 1,110 ring-billed gulls (BRNW 2014). Using aerial photography 2,083 adult American white pelicans were counted on Badger Island upstream of the dam (BRNW 2014). The monitored area at McNary Dam was divided into four zones which covered 1.42 square km (0.55 sq mi) (Figure 17). Methods to deter piscivorous birds from the dam include active USDA land-based hazers using pyrotechnics, avian deterrent lines across the powerhouse tailrace, bird spikes to deter perching, and hydro-cannons on the juvenile fish facility outfall pipe terminus.

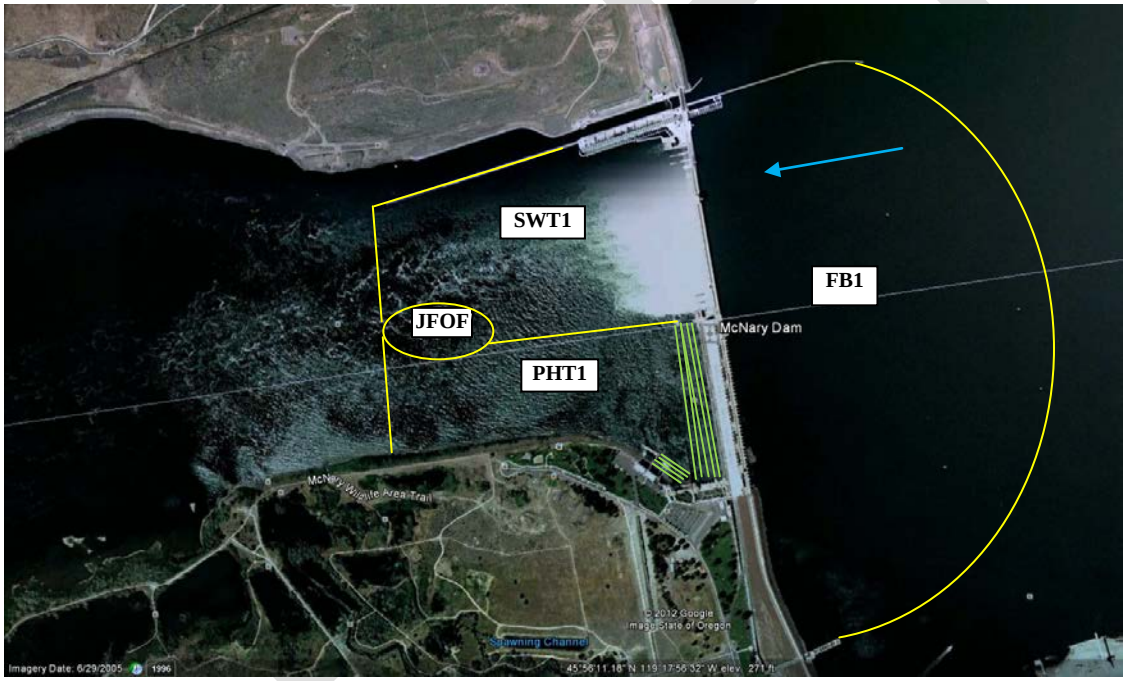

Figure 17. Zone map used at McNary Dam in 2013. Yellow lines demarcate zones, green lines represent the avian deterrent lines downstream of the powerhouse (not exact number), and the blue arrow indicates flow direction.

Project fisheries biologists monitored bird numbers and behavior once a day for 122 days of the 122 day season from April 1 through July 31. McNary Dam had the second highest seasonal mean daily foraging bird count (40.1) among the eight dams (Table 1). Bird abundance rose in April and May with

the highest count of 236 recorded on May 22 (Figure 18) and then decreased in June before picking up again in July.

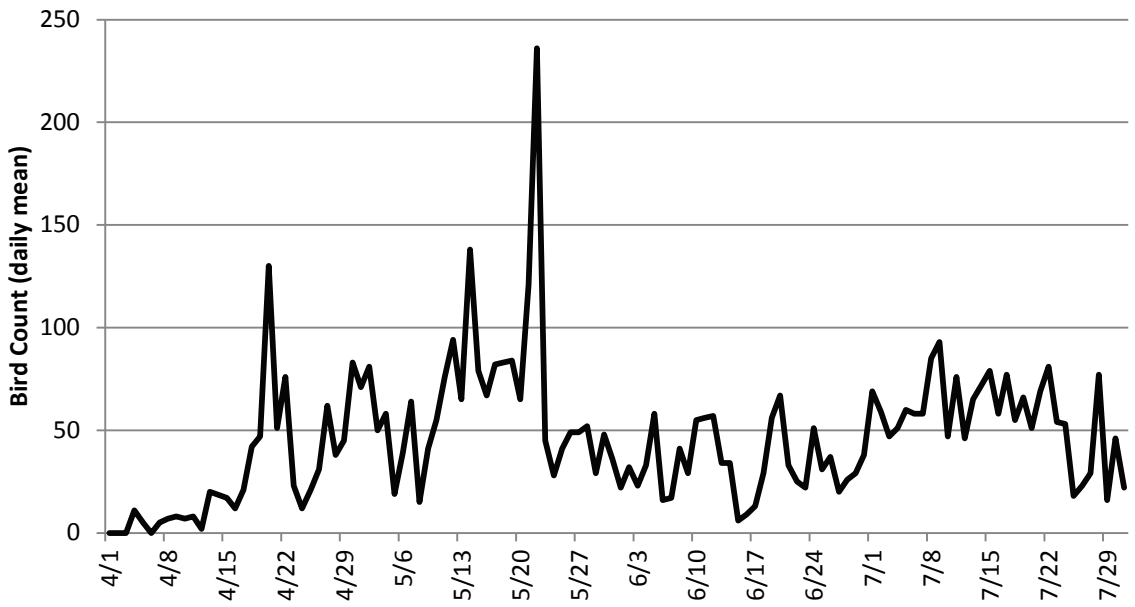

Figure 18. Mean daily bird count (all behaviors) at McNary Dam during primary smolt outmigration, April 1 through July 31, 2013.

All four bird behaviors were observed at McNary Dam. Foraging activity comprised 87.7% of the counts, resting 10.1%, flyby 1.7%, and scavenging 0.5%. Foraging behavior was observed almost exclusively from April through June while both foraging and resting behaviors were observed in July (Figure 19).

Gulls, grebes, Caspian terns, and American white pelicans comprised the majority of bird species in the survey. Similar to 2012, gulls were the most abundant piscivore with a seasonal mean daily count of 24.3, fourth highest of the eight dams (Table 1). However, gull abundance was lower than in 2012 when the seasonal mean daily count was 40.6. Gull abundance was at the maximum in May (Figure 19). They were primarily seen foraging in the spillway tailrace SWT1 zone and the JFOF zone (Figure 20). Gull abundance declined as the presence of other piscivores increased. Caspian terns and American white pelicans were observed foraging in the SWT1 and JFOF zones in July. Caspian terns had a seasonal mean daily count of 8.0 compared to 3.7 in 2012, and American white pelicans had a seasonal mean daily count of 5.5 compared to 8.3 in 2012 (Table 1). Grebes were seen mainly in the forebay zone accounting for most of the foraging activity there (Table 5). Although they were present throughout the season, grebes were observed in greater abundance in July (Figure 19). The seasonal mean daily count for grebes was 6.3 (Table 1). Other birds seen less often throughout the season were double-crested cormorants, great blue heron, osprey, and common mergansers. There were no sightings of bald eagles.

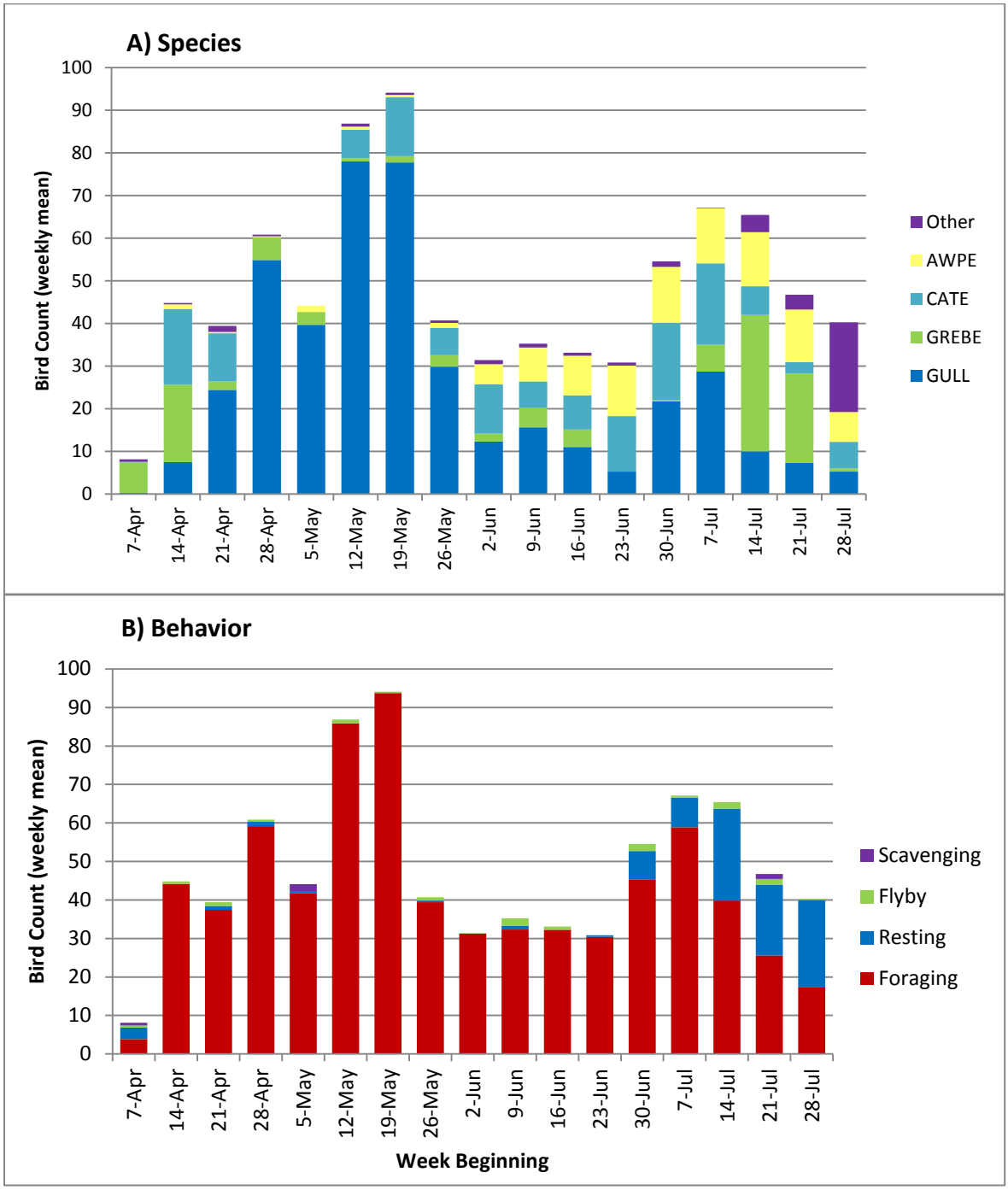

Figure 19. Timing, abundance, diversity, and behavior of nine piscivorous birds at McNary Dam April 1 through July 31, 2013. A) The most numerous species: GULL = any gull species, GREBE = western or Clark's grebes, CATE = Caspian tern, AWPE = American white pelican, and Other = remaining monitored species. B) Behavior of the birds in graph A.

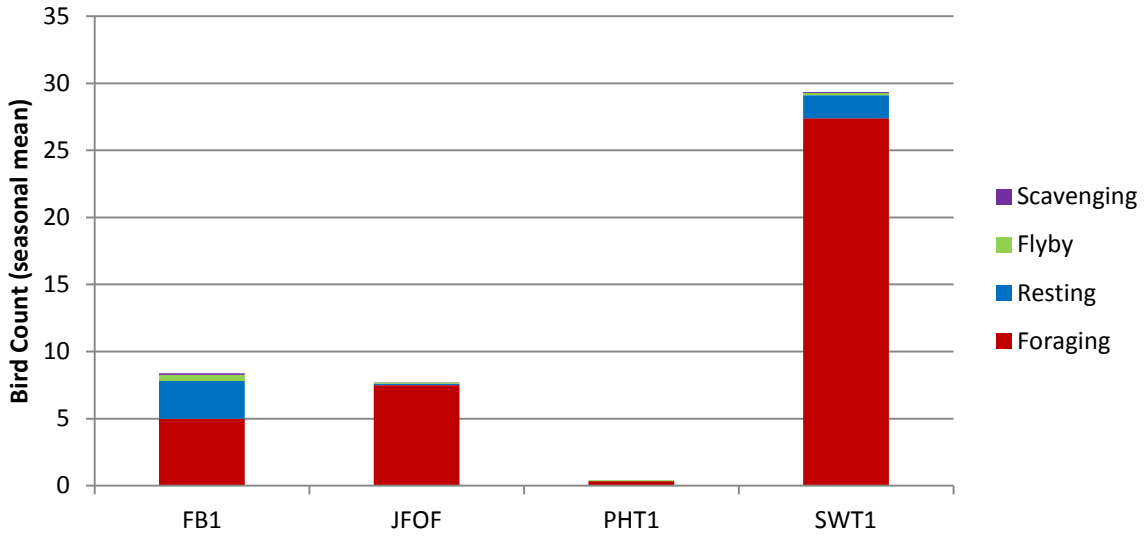

Figure 20. Spatial distribution of birds by zone and behavior at McNary Dam, seasonal mean daily bird counts for April 1 through July 31, 2013. FB1 = forebay, JFOF = juvenile fish outfall, PHT1 = powerhouse tailrace, SWT1 = spillway tailrace.

Table 5. Seasonal mean daily bird counts (all behaviors) by zone and species at McNary Dam, April 1 through July 31, 2013.

Common Name	FB1	JFOF	PHT1	SWT1
American White Pelican	0.3	1.4	0.1	3.7
Bald Eagle	0.0	0.0	0.0	0.0
Caspian Tern	0.1	1.1	0.1	6.6
Common Merganser	0.0	0.0	0.0	0.2
Double-crested Cormorant	0.1	0.1	<0.1	1.1
Great Blue Heron	0.0	0.0	0.0	<0.1
Grebe	6.2	0.1	0.0	0.0
Gull	1.6	4.9	0.1	17.7
Osprey	0.1	0.0	<0.1	0.0

DRAFT

ICE HARBOR

Ice Harbor Dam is located on the Snake River at river kilometer 15.6 (rm 9.7). Looking upstream, it is the first of several dams on the Snake River, a tributary of the Columbia River. The powerhouse is equipped with screens that divert juvenile fish away from turbine units to a juvenile bypass on the south shore (Figure 21). The dam is close to Burbank, Washington and the larger urban area of the Tri Cities (Richland, Pasco, and Kennewick, Washington). It is surrounded by agricultural lands made up of mainly orchards. The dam is in close proximity to nesting colonies of piscivorous birds on islands downstream of the dam such as Island 20 (ca. 8,980 California gulls and ca. 5,060 ring-billed gulls) and Badger Island (BRNW 2014). The monitored area was divided into eight zones and encompassed 0.74 sq kilometers (0.29 sq mi). Piscivorous bird deterrent methods at the dam include active USDA land-based and periodic boat-based hazer using pyrotechnics, avian deterrent line array across the spillway and powerhouse tailraces, remotely operated bird distress calls, hand held lasers, hydro-cannon placed on the terminus of the juvenile fish outfall pipe, and perching deterrents such as spike strips.

Figure 21. Zone map used at Ice Harbor Dam in 2013. Yellow lines demarcate zones, green lines represent the avian deterrent lines (not exact number), and the blue arrow indicates flow direction. Eagle Island Zone is approx 1.1 km downstream of the dam.

Project fisheries biologists monitored bird abundance and behavior once a day for 49 of the 122 day season from April 1 through July 31. This was not improved from last year's effort of 41% (50/122). Ice Harbor Dam had a seasonal mean daily foraging bird count of 26.0 the third highest of the eight

dams. Bird abundance rose in mid May with the highest count of 222 recorded on May 16, sharply declined by the end of May before increasing again in July (Figure 22).

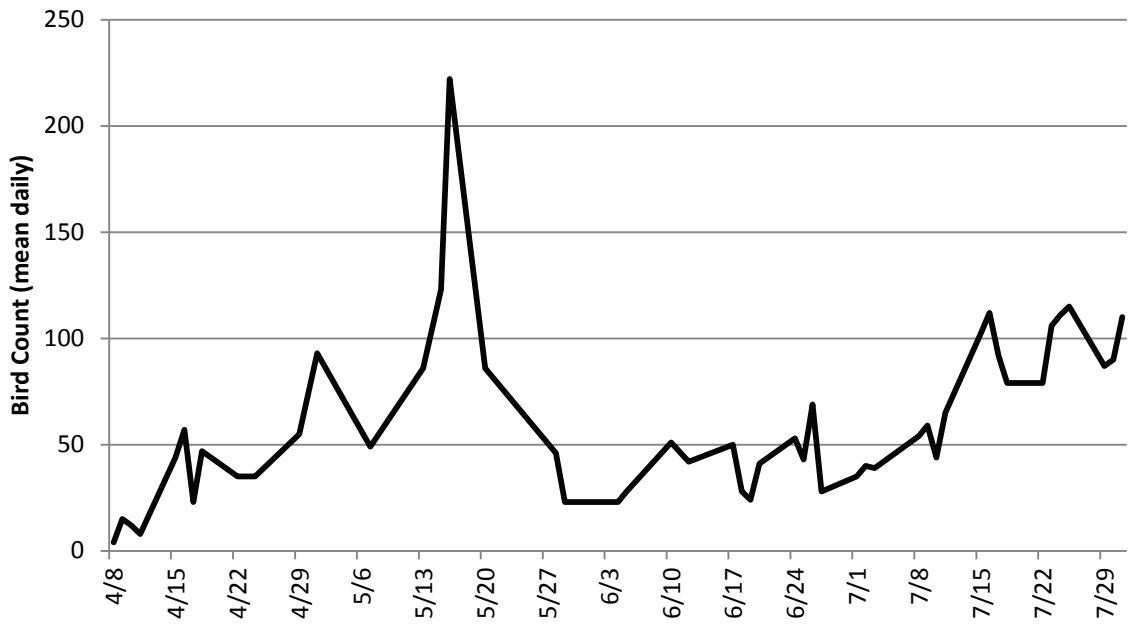

Figure 22. Mean daily bird counts (all behaviors) at Ice Harbor Dam during primary smolt outmigration, April 1 through July 31, 2013.

All four bird behaviors were observed at Ice Harbor. Foraging accounted for 43.2% of observed behaviors while resting birds comprised 50.0% of the counts, flyby 4.9%, and scavenging 1.9%. Foraging behavior was predominant in May and June while resting birds were most often seen in July (Figure 23).

Gulls, double-crested cormorants, and American white pelicans comprised the majority of the bird species in the survey. These birds were spatially concentrated in four of the eight zones. Gulls foraged in spillway tailrace zones SWT2 and SWT3 (Figure 24). Resting gulls were mainly seen on the rocks at Eagle Island (EAIS) and in the forebay zone (FB1). The seasonal mean daily gull count was 15.0 a decrease from the seasonal mean daily gull count of 24.2 in 2012. Double-crested cormorants were present throughout the season and were most often seen resting in the FB1and EAIS zones. They were also observed foraging and resting in the spillway tailrace. The seasonal mean daily count for double-crested cormorants was 23.3, the highest of all eight dams. American white pelicans were present in May, June, and July. They were frequently seen in the EAIS, SWT2 and SWT3 zones. Their seasonal mean daily count was 14.9 the highest of all eight dams. Caspian terns, common merganser, great blue heron, grebes, and osprey were observed in small numbers in various zones at the dam. There were no sightings of bald eagles during the season.

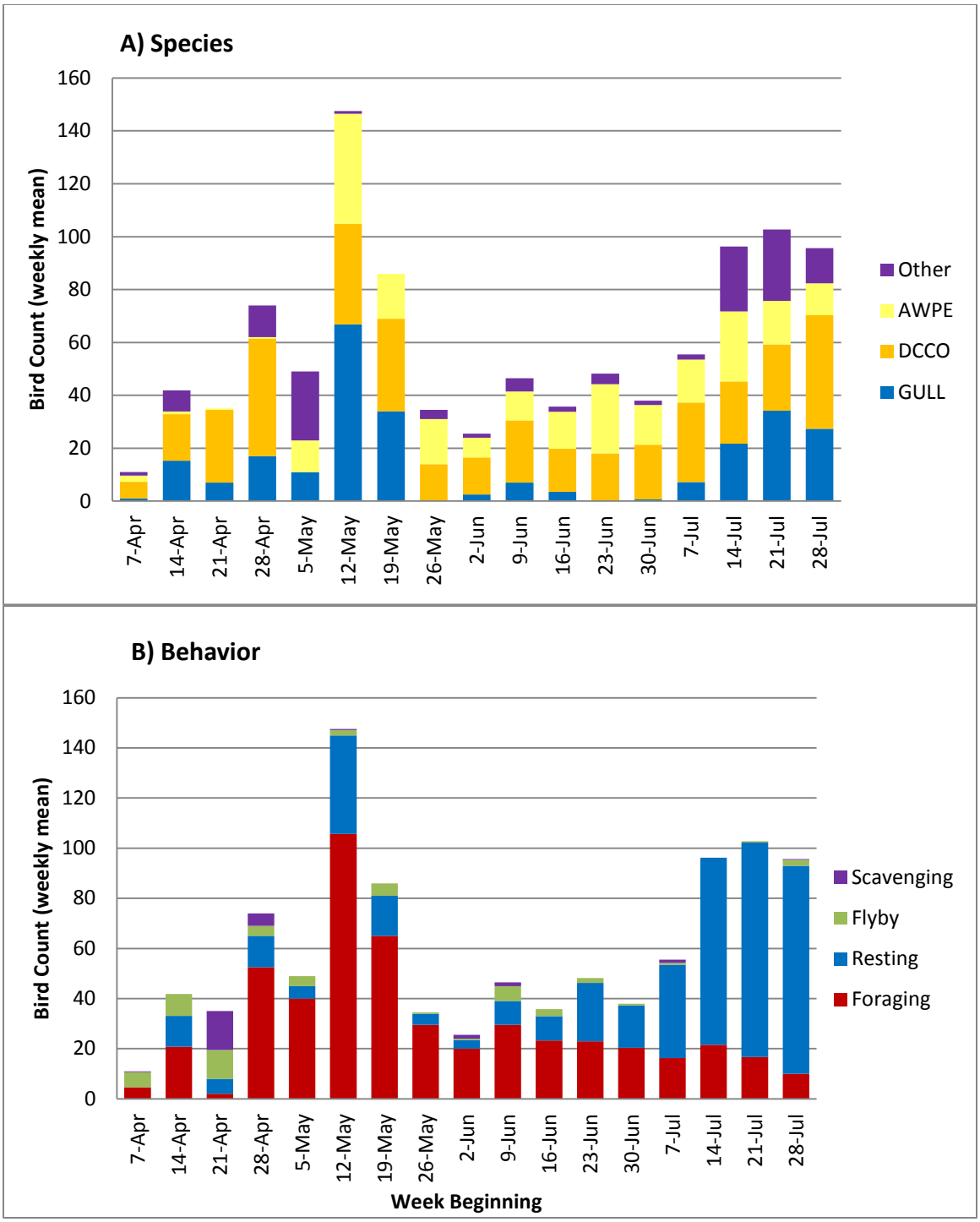

Figure 23. Timing, abundance, diversity, and behavior of nine piscivorous birds at Ice Harbor Dam April 1 through July 31, 2013. A) The most numerous species: GULL = any gull species, DCCO = double-crested cormorant, AWPE = American white pelican, Other = remaining monitored species. B) Behavior of the birds in graph A.

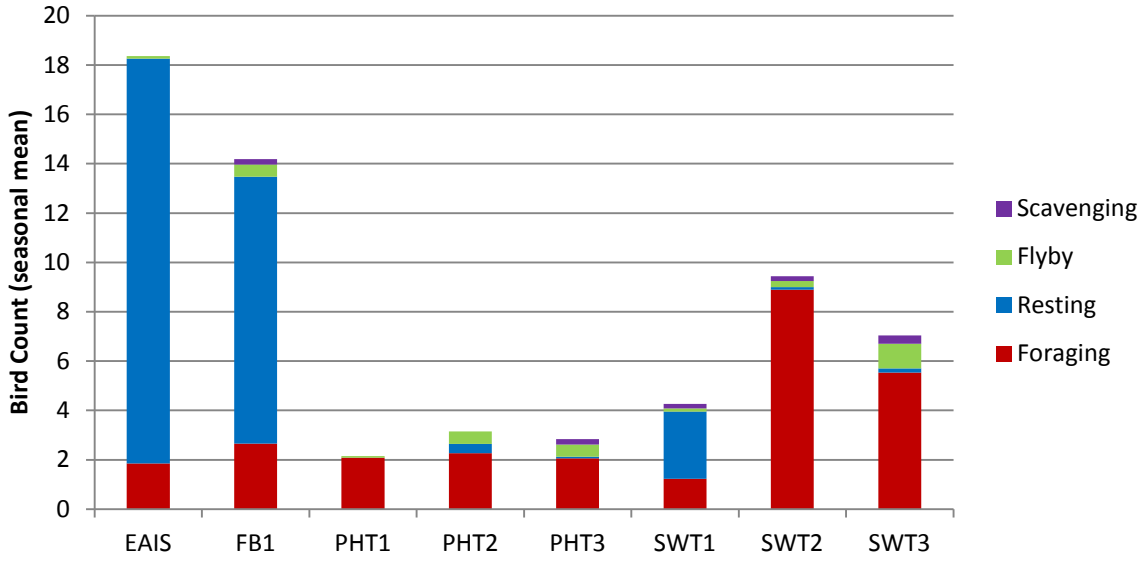

Figure 24. Spatial distribution of birds by zone and behavior at Ice Harbor Dam, seasonal mean daily bird counts for April 1 through July 31, 2013. EAIS = Eagle Island downstream of the dam, FB1 = forebay, PHT 1-3 = powerhouse tailrace zones, SWT 1-3 = spillway tailrace zones.

Table 6. Seasonal mean daily bird counts (all behaviors) by zone and species at Ice Harbor Dam, April 1 through July 31, 2013.

Common Name	EAIS	FB1	PHT1	PHT2	PHT3	SWT1	SWT2	SWT3
American White Pelican	6.3	0.2	0.2	1.5	0.5	0.4	3.4	2.4
Bald Eagle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Caspian Tern	1.0	0.4	0.3	0.2	0.3	0.1	0.8	0.1
Common Merganser	1.2	1.6	0.1	0.5	0.4	0.6	0.1	0.3
Double-crested Cormorant	4.5	9.2	1.6	1.0	1.0	3.2	0.9	1.9
Great Blue Heron	0.0	0.1	0.0	0.0	<0.1	0.0	0.0	0.0
Grebe	0.0	<0.1	0.0	<0.1	0.0	0.0	0.0	0.0
Gull	5.3	2.4	0.0	0.0	0.6	0.1	4.3	2.3
Osprey	0.0	0.1	<0.1	0.0	0.0	0.0	0.0	<0.1

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LOWER MONUMENTAL

Lower Monumental Dam is located on the Snake River at river kilometer 67 (rm 41.6). The monitored area was divided into five count zones covering 0.46 sq kilometers (0.18 sq mi) (Figure 25). The powerhouse is equipped with screens that divert juvenile fish away from turbine units to the juvenile bypass system located on the north shore with an outfall 0.95 km downstream of the dam. The dam is surrounded by farmlands and is fairly isolated from populated areas. Methods to deter piscivorous birds include active USDA land-based hazers using pyrotechnics, avian deterrent lines in the powerhouse tailrace, hydro-cannons on the juvenile outfall pipe terminus, and perch deterrents such as spike strips.

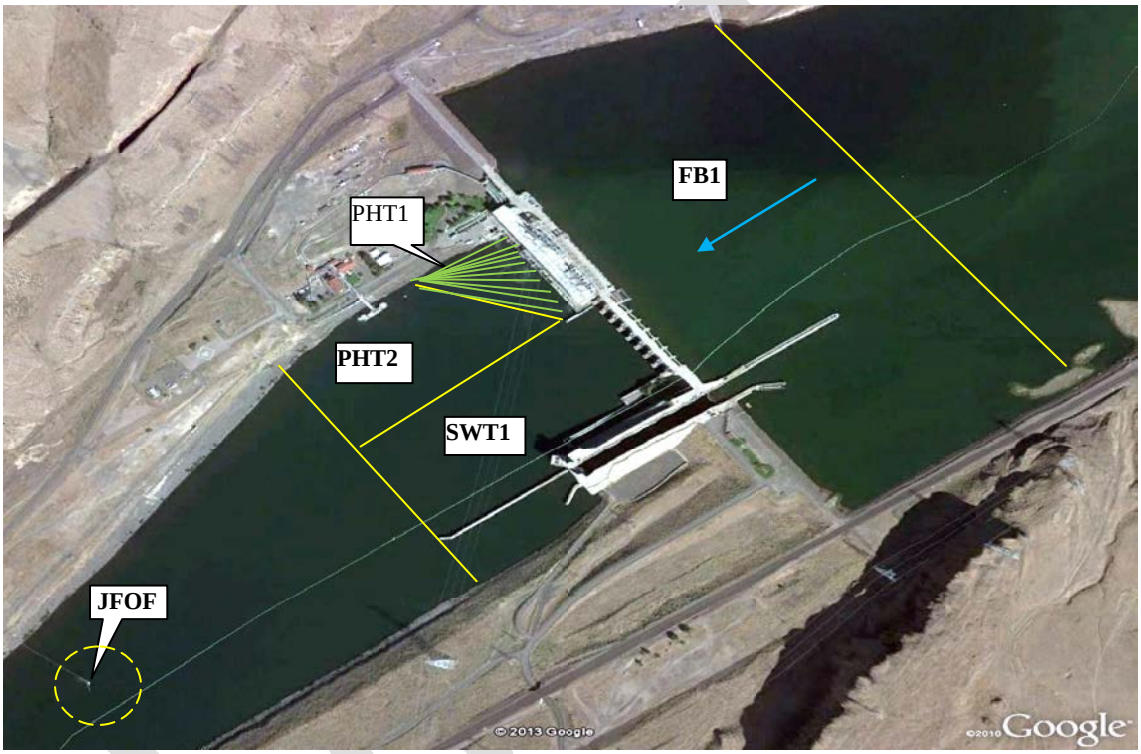

Figure 25. Zone map used at Lower Monumental Dam in 2013. Yellow lines demarcate zones, green lines represent the avian deterrent lines (not exact number), and the blue arrow indicates flow direction.

Project fisheries biologists monitored bird numbers and behavior once a day all 122 days from April 1 to July 31, 2013. Lower Monumental Dam had a seasonal mean daily foraging bird count of 18.6, fourth highest of the eight dams. Bird abundance increased through May before reaching the maximum count of 258 on May 19th. A second, smaller increase occurred in June before the presence of birds decreased through July (Figure 26).

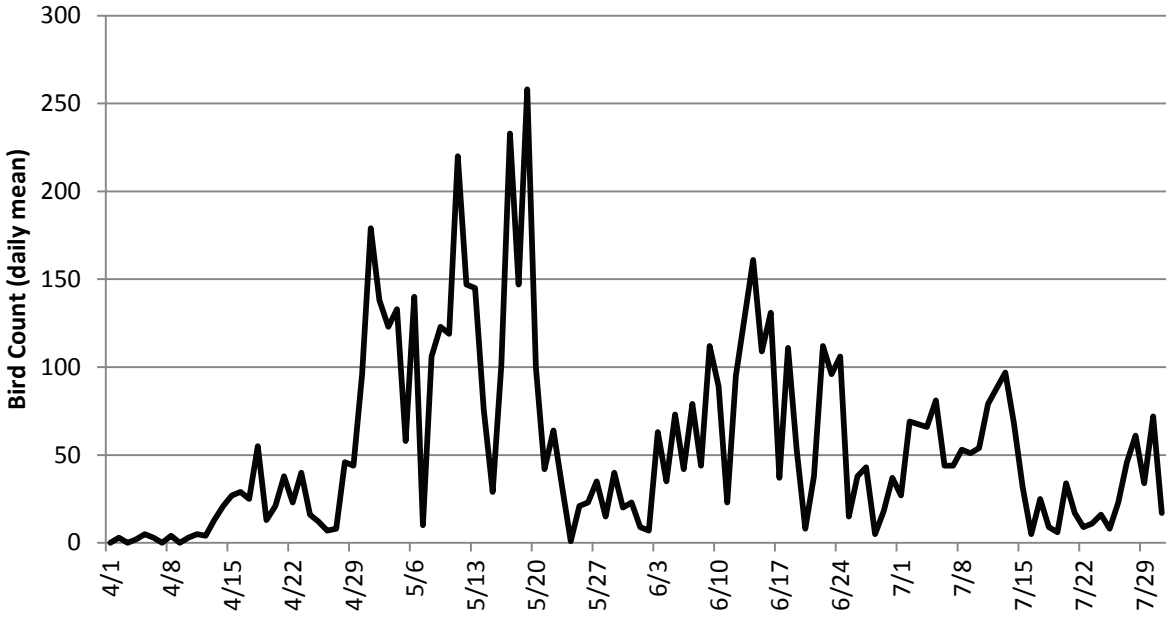

Figure 26. Mean daily bird counts (all behaviors) for Lower Monumental Dam during peak smolt outmigration, April 1 through July 31, 2013.

Three of the four bird behaviors were observed at Lower Monumental. Foraging accounted for 34.6% of the observed behaviors, resting 62.8%, and flyby 2.6%. Although foraging behavior increased in the months of May and June, a large percentage of birds were observed resting (Figure 27).

Gulls, double-crested cormorants, and American white pelicans comprised the majority of the bird species in the survey. Similar to 2012, gulls were the most numerous piscivore with a seasonal mean daily count of 46.0, second highest of all eight dams (Table 1) and an increase from the 2012 seasonal mean daily count of 12.8. Gull abundance was at its highest in the month of May (Figure 27). They were primarily seen foraging in the spillway tailrace zone SWT1 and resting in the forebay FB1 zone (Figure 28). Double-crested cormorants and American white pelicans were observed in the FB1, PHT2, and SWT1 zones (Table 7). Double-crested cormorants had a seasonal mean daily count of 5.1 compared to 10.9 in 2012. They were most often observed in the SWT1 zone. American white pelicans had a seasonal mean daily count of 2.0 compared to 3.3 in 2012 (Table 1). Other birds seen less often during the season were Caspian terns, grebes, and osprey. There were no sightings of bald eagles, common mergansers, or great blue heron during the season.

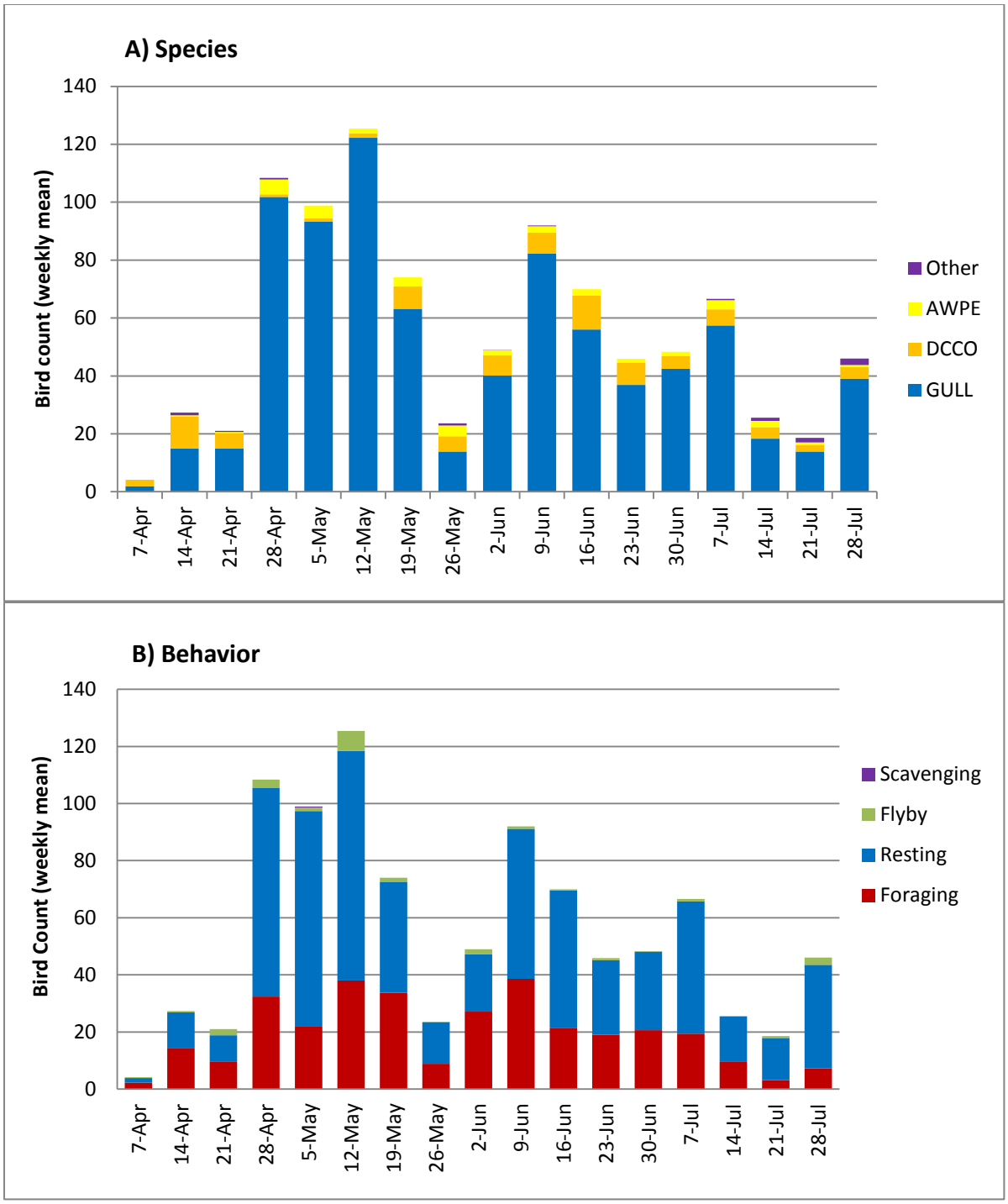

Figure 27. Timing, abundance, diversity, and behavior of nine piscivorous birds at Lower Monumental Dam April 1 through July 31, 2013. Graph A) The most numerous species: GULL = any gull species, DCCO = double-crested cormorant, AWPE = American white pelican, and Other = remaining monitored species. Graph B) Behavior of the birds in graph A.

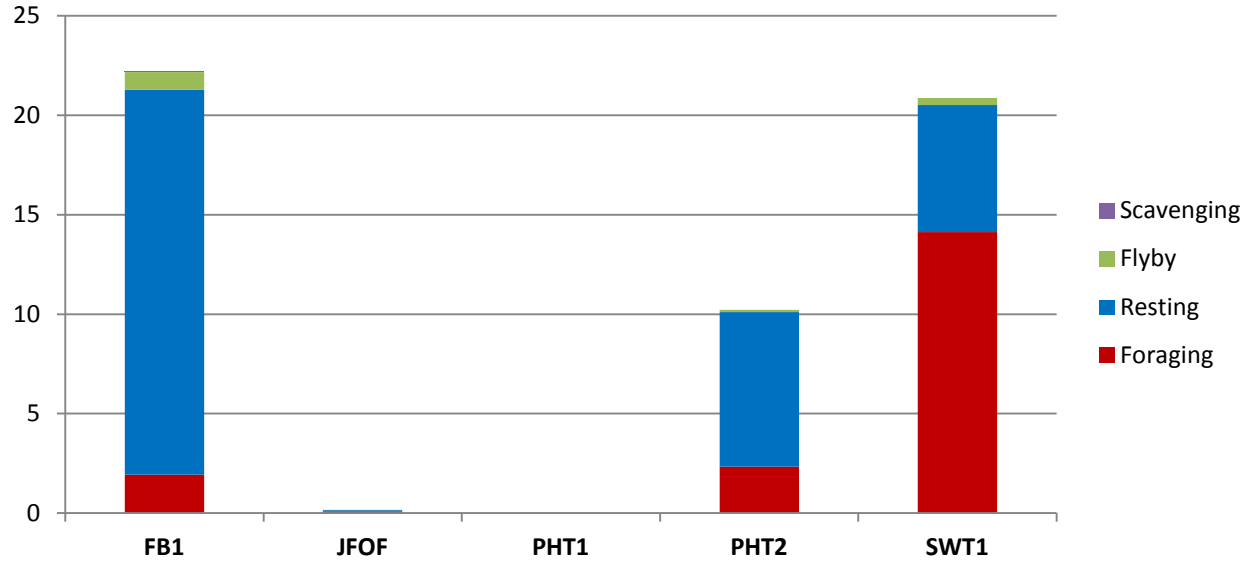

Figure 28. Spatial distribution of birds by zone and behavior at Lower Monumental Dam, seasonal mean daily bird counts for April 1 through July 31, 2013. FB1 = forebay, JFOF = juvenile fish outfall, PHT1 - 2 = powerhouse tailrace, SWT1 = spillway tailrace.

Table 7. Seasonal mean daily bird counts (all behaviors) by zone and species at Lower Monumental Dam, April 1 through July 31, 2013.

Common Name	FB1	JFOF	PHT1	PHT2	SWT1
American White Pelican	0.7	0.0	0.0	0.7	0.6
Bald Eagle	0.0	0.0	0.0	0.0	0.0
Caspian Tern	0.0	0.0	0.0	0.0	0.1
Common Merganser	0.0	0.0	0.0	0.0	0.0
Double-crested Cormorant	1.3	0.0	0.0	0.4	3.4
Great Blue Heron	0.0	0.0	0.0	0.0	0.0
Grebe	0.1	0.0	0.0	0.0	0.0
Gull	20.0	0.2	0.0	9.1	16.7
Osprey	0.1	0.0	0.0	0.0	0.0

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LITTLE GOOSE

Little Goose Dam is located on the Snake River at river kilometer 113 (rm 70.3). The powerhouse is equipped with screens to divert juvenile fish away from turbine units and down to a juvenile bypass facility on the south shore with an outfall 0.42 km downstream of the dam. The dam is surrounded by farmlands and fairly isolated from populated areas. The monitored area was divided into five zones that cover approximately 0.52 sq km (0.21 sq mi) (Figure 29). Piscivorous bird deterrent methods at Little Goose Dam include active USDA land-based hazer using pyrotechnics, remote activated propane cannons, twelve avian deterrent lines in the powerhouse tailrace, and hydro-cannons on the juvenile outfall pipe terminus, visual scare tactics, and perch deterrents such as spike strips.

Figure 29. Zone map used at Little Goose Dam in 2013. Yellow lines demarcate zones, green lines represent the deterrent lines downstream of the powerhouse (not exact number), and the blue arrow indicates flow direction.

Project fisheries biologists monitored bird numbers and behavior two to three times a day all 122 days from April 1 to July 31. Little Goose had a seasonal mean daily foraging bird count of 16.83, which was the fifth highest mean of all eight dams. Bird abundance increased in May rising to a maximum count of 245 on May 16 before the abundance of birds decreased. Except for a short term increase in the middle of June, bird numbers remained around 50 through the rest of the season (Figure 30).

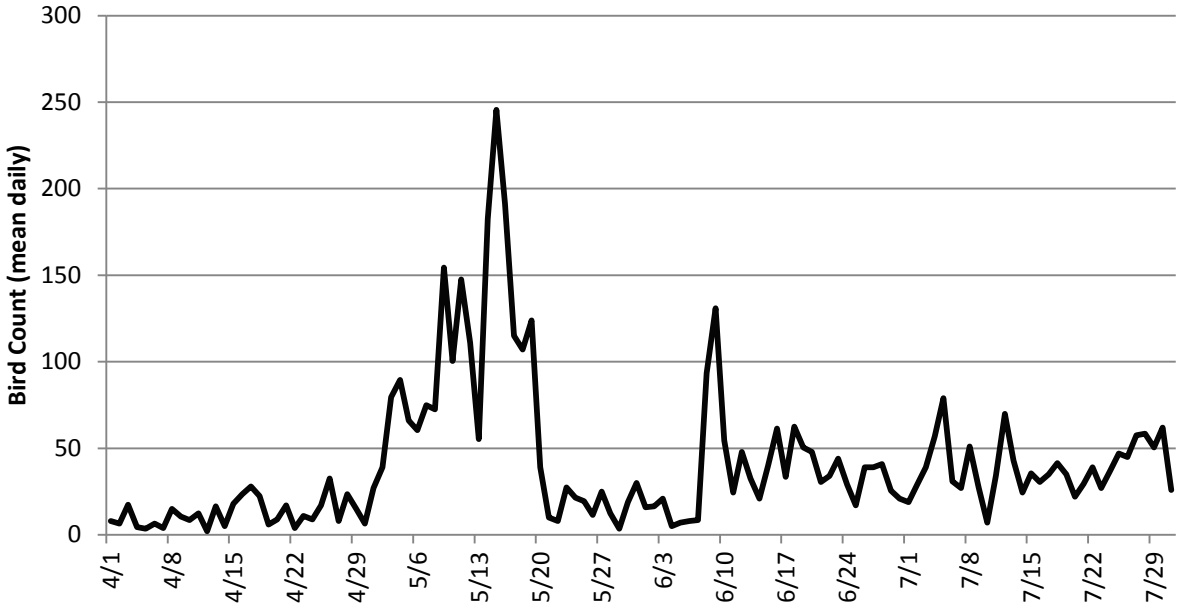

Figure 30. Mean daily bird counts (all behaviors) for Little Goose Dam during primary smolt outmigration, April 1 through July 31, 2013.

All four bird behaviors were observed at Little Goose. Foraging comprised 41.2% of observed behaviors, resting 58.6%, flyby 0.2%, and scavenging 0.1%. Foraging and resting bird counts were both highest during the first two weeks of May (Figure 31).

Gulls and double-crested cormorants comprised the majority of the bird species in the survey (Figure 31). These birds were spatially concentrated in two of the five zones. The seasonal mean daily count for gulls was 32.6 (Table 1), an increase from the seasonal mean daily count of 10.5 in 2012. Gulls were observed foraging mainly in spillway tailrace zone SWT1, while resting gulls were observed in the forebay FB1 zone (Figure 32). Double-crested cormorants were present throughout the season and were also often seen resting in the FB1 zone. The seasonal mean daily count for double-crested cormorants was 7.4 (Table 1), an increase from the seasonal mean daily count of 2.6 in 2012. American white pelicans, bald eagles, Caspian terns, common mergansers, great blue heron, grebes, and osprey were all observed in small numbers during the season (Table 8).

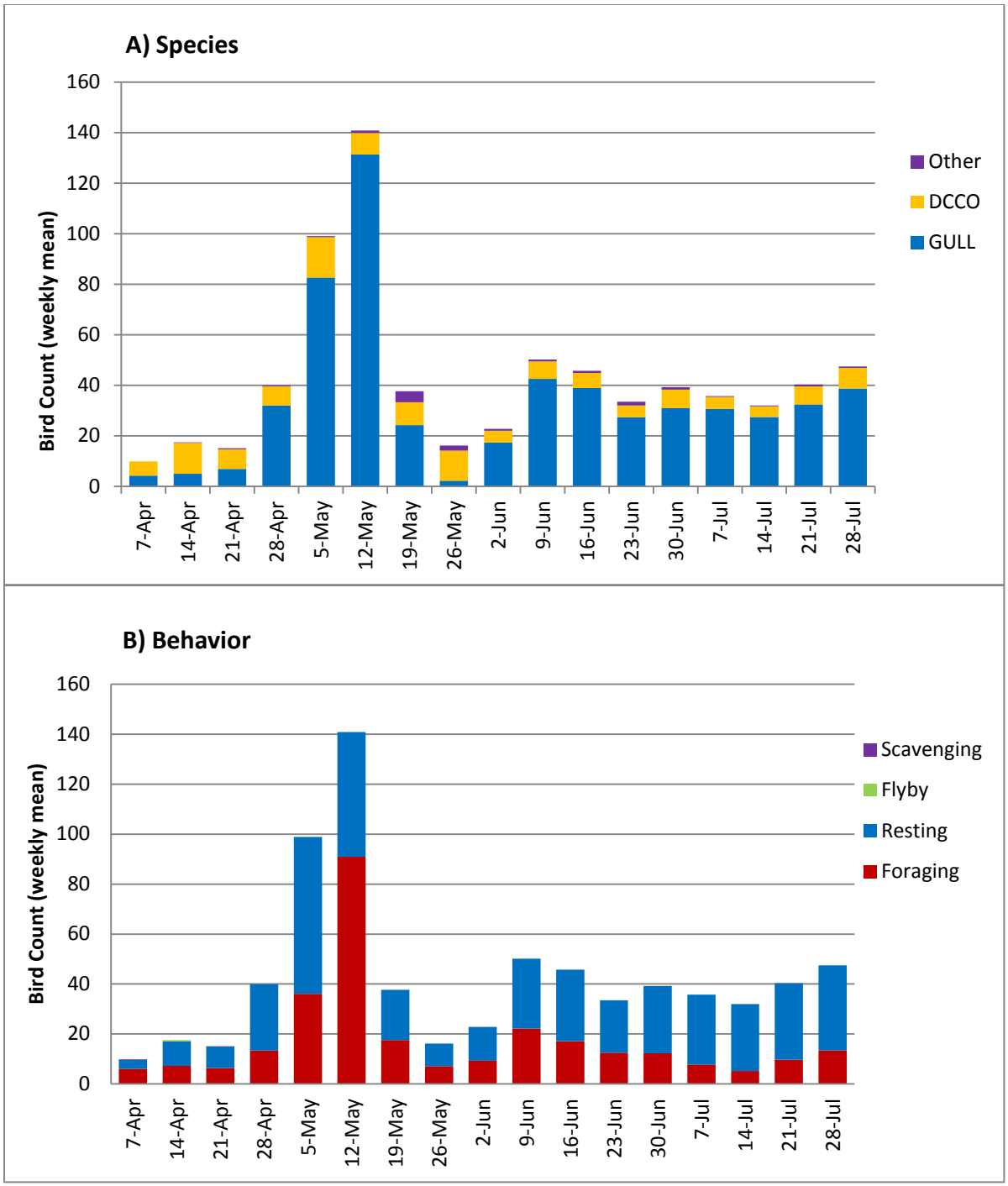

Figure 31. Timing, abundance, diversity, and behavior of nine piscivorous birds at Little Goose Dam April 1 through July 31 2013. A) The most numerous species; GULL = any gull species, DCCO = double-crested cormorant, Other = remaining monitored species. B) Behavior of the birds in graph A.

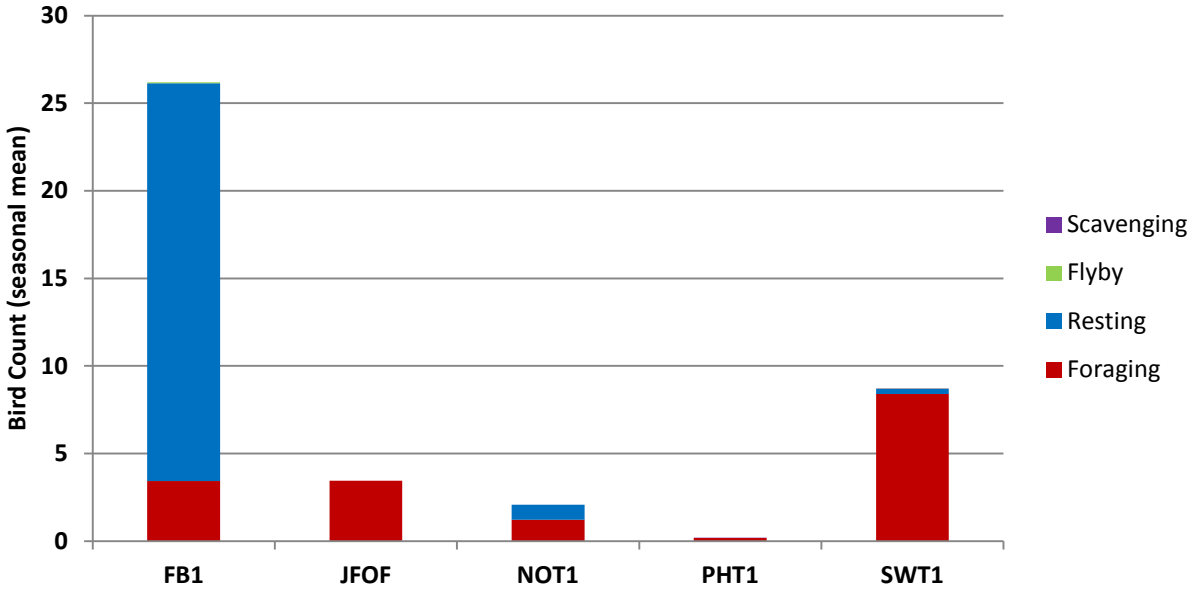

Figure 32. Spatial distribution of birds by zone and behavior at Little Goose Dam, seasonal mean daily bird counts for April 1 through July 31, 2013. FB1 = forebay, JFOF = juvenile fish outfall, NOT1 = North tailrace of earthen dam, PHT1 = powerhouse tailrace, SWT1 = spillway tailrace.

Table 8. Seasonal mean daily bird counts (all behaviors) by zone and species at Little Goose Dam, April 1 through July 31, 2013.

Common Name	FB1	JFOF	NOT1	PHT1	SWT1
American White Pelican	0.1	<0.1	0.4	0.0	0.2
Bald Eagle	<0.1	0.0	0.0	0.0	0.0
Caspian Tern	<0.1	0.0	0.0	0.0	0.0
Common Merganser	<0.1	0.0	0.0	0.0	0.0
Double-crested Cormorant	7.2	0.1	0.1	<0.1	0.1
Great Blue Heron	<0.1	0.0	0.0	0.0	0.0
Grebe	<0.1	0.0	0.0	0.0	0.0
Gull	19.0	3.4	1.6	0.2	8.4
Osprey	0.1	<0.1	0.0	<0.1	<0.1

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LOWER GRANITE

Lower Granite Dam is located on the Snake River at river kilometer 173 (rm 107.5). The powerhouse at Lower Granite is equipped with screens that divert juvenile fish away from the turbines and through a juvenile bypass system on the south shore tailrace. The dam is surrounded by farmlands and fairly isolated from populated areas. The area observed at Lower Granite Dam was divided into six count zones covering 0.31 sq km (0.12 sq miles) (Figure 33). Active and passive methods to deter piscivorous birds include USDA land-based hazer using pyrotechnics, 26 avian deterrent lines across the powerhouse tailrace, perch deterrents such as spike strips, and hydro-cannons on the juvenile fish outfall pipe terminus.

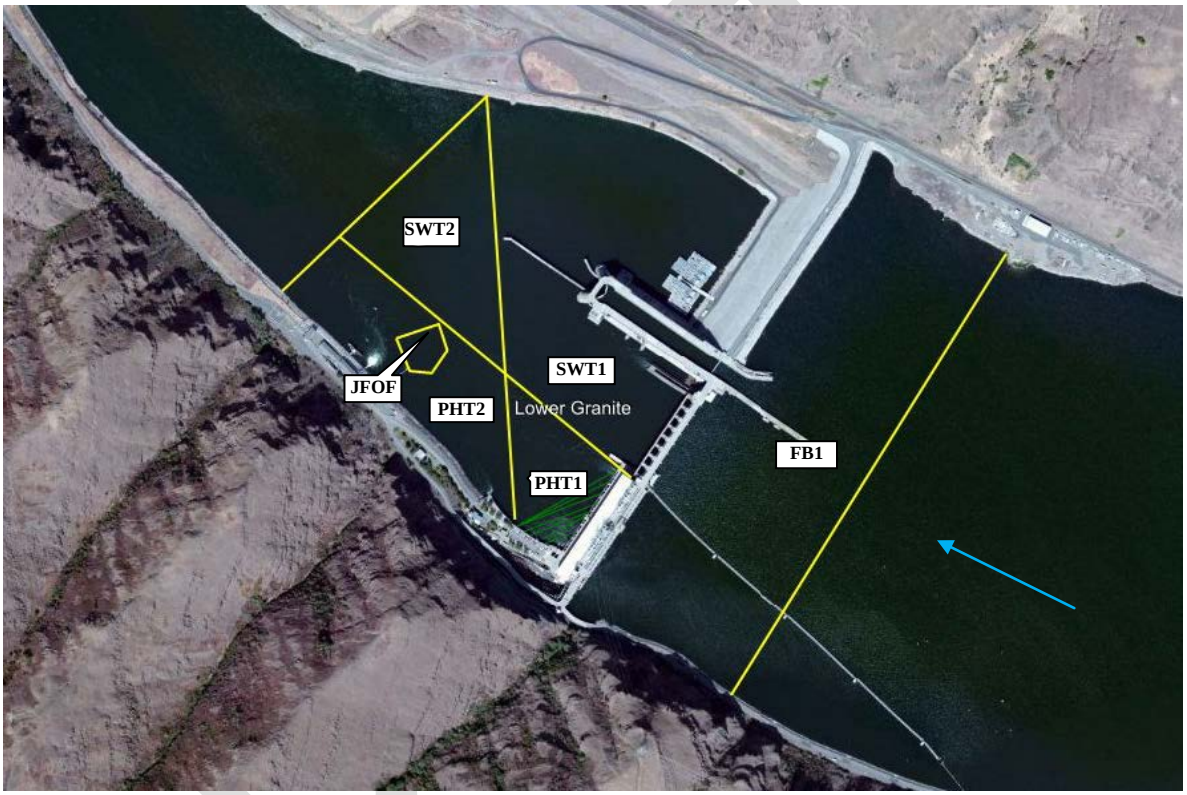

Figure 33. Zone map of Lower Granite Dam used in the 2013 season. Yellow lines delineate the zones, green lines represent avian deterrent lines (not exact number), and the blue arrow indicates flow direction.

Project fisheries biologists monitored bird numbers and behavior one to three times a day all 122 days from April 1 to July 31. Lower Granite Dam had a seasonal mean daily foraging bird count of 9.9 the lowest of all eight dams. Bird abundance spiked briefly in May and again in June. The maximum bird count of 58 was recorded on June 14 before bird numbers quickly dropped and remained low through the rest of the season.

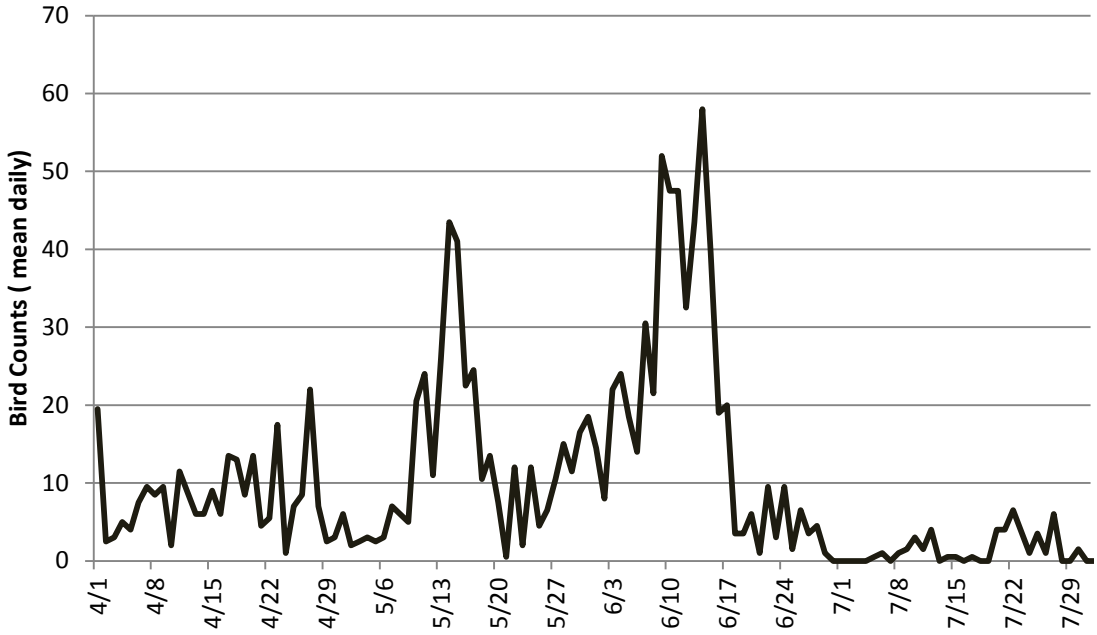

Figure 34. Mean daily bird counts (all behaviors) at Lower Granite Dam during primary smolt outmigration, April 1 through July 31, 2013.

All four of the bird behaviors were observed at Lower Granite. Foraging birds comprised 96.9% of the observed behaviors, resting was seen 1.0%, flybys 1.6%, and scavenging 0.5%. Foraging birds were observed almost exclusively from April through July.

Gulls and American white pelicans comprised the majority of the bird species in the survey. Similar to 2012, gulls were the most numerous piscivore with a seasonal mean daily count of 7.4, the lowest of the eight dams (Table 1). Gull abundance was highest in May and June (Figure 35). Foraging gulls were seen most often in the spillway tailrace SWT2 zone (Figure 36). However, they were also found in all the zones that were monitored. While gulls were present throughout the season, American white pelicans were present in May and June. Unlike 2012, when their seasonal mean daily count was 6.9, American white pelicans decreased to a seasonal mean daily count of 2.7 (Table 1). They were most often seen in the spillway tailrace SWT2 zone (Figure 36). A few American white pelicans were also observed foraging and/or resting in other zones across the project (Table 9). Other piscivorous birds seen less often in various zones were common merganser, double-crested cormorant, grebe, and osprey, (Table 9). There were no sightings of bald eagle, Caspian tern, or great blue heron.

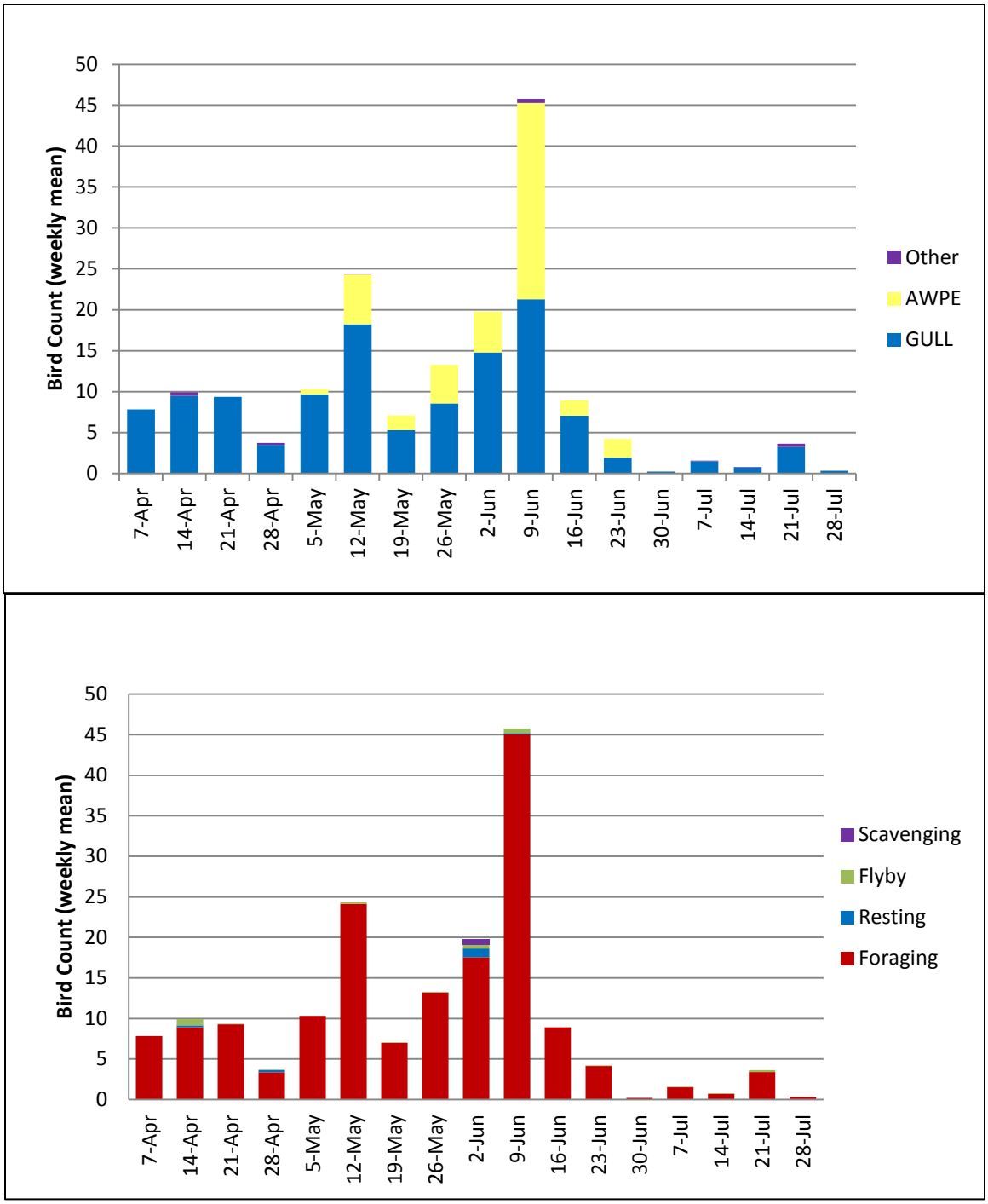

Figure 35. Timing, abundance, diversity, and behavior of nine piscivorous birds at Lower Granite Dam April 11 through July 31, 2013. A) The most numerous species; GULL = any gull species, AWPE = American white pelican, and Other = remaining monitored species. B) Behavior of the birds in graph A.

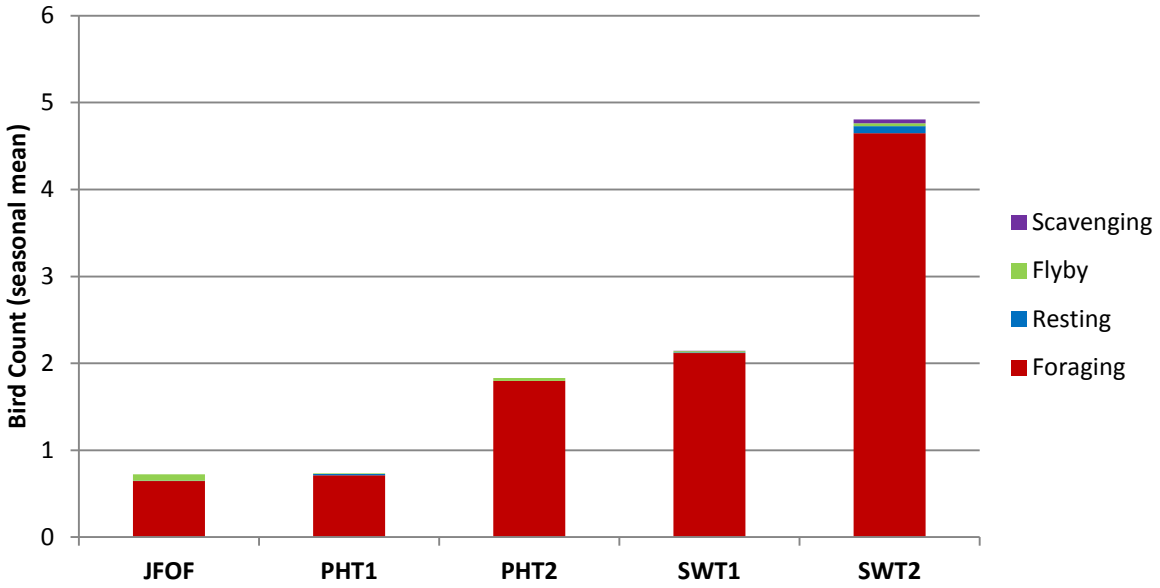

Figure 36. Spatial distribution of birds by zone and behavior at Lower Granite Dam, seasonal mean daily bird counts for April 1 through July 31, 2013. FB1 = forebay, JFOF = juvenile fish outfall, PHT1 & 2 = powerhouse tailrace zones, SWT1 & 2 = spillway tailrace zones.

Table 9. Seasonal mean daily bird counts (all behaviors) by zone and species at Lower Granite Dam, April 1 through July 31, 2013.

Common Name	FB1*	JFOF	PHT1	PHT2	SWT1	SWT2
American White Pelican		0.2	0.2	0.6	0.2	1.5
Bald Eagle		0.0	0.0	0.0	0.0	0.0
Caspian Tern		0.0	0.0	0.0	0.0	0.0
Common Merganser		<0.1	0.0	0.0	0.0	0.0
Double-crested Cormorant		<0.1	0.0	<0.1	<0.1	<0.1
Great Blue Heron		0.0	0.0	0.0	0.0	0.0
Grebe		0.0	0.0	<0.1	0.0	0.0
Gull		0.5	0.5	1.2	1.9	3.2
Osprey		0.0	0.0	<0.1	0.0	<0.1

***NOTE:** FOREBAY FB1 ZONE WAS NOT COUNTED.

DISCUSSION

The implementation of the standard avian observation protocols has provided comparable bird counts that have highlighted a common trend in bird abundance and behavior at all eight dams. Foraging birds increased and reached a maximum abundance during May, declined in June, and rebounded in July. The maximum abundance of observed foraging birds at the dams coincides with the duration of juvenile fish outmigration (Zorich et al. 2014) as well as when gulls rear their chicks (Thompson and Tabor, 1981). The ability to compare uniformly collected data temporally and spatially confirms that quantifying piscivorous birds at these dams and monitoring their behaviors is beneficial to understanding the impacts they are having on migrating smolt and juvenile lamprey survival during dam passage.

Of the nine piscivorous bird species that were monitored during the juvenile fish out-migration, gulls were the most abundant at the majority of these dams. The greater abundance of foraging birds at projects such as The Dalles, McNary and Ice Harbor dams (Figure 37) is likely influenced by their proximity to various colonies of nesting birds such as gulls and American white pelicans (Miller Island Rocks, Blalock Complex, Badger Island, etc) as well as their proximity to urban areas. Miller Island Rocks gull colony, upstream of The Dalles Dam, has been identified through recovered PIT tags as a nesting colony consuming relatively high numbers of juvenile salmonids compared to other gull colonies in the Columbia Plateau region (Collis et al 2001). Recent studies of on-colony PIT tag deposition rates for gulls have uncovered differences between deposition rates of gulls, Caspian terns, and double-crested cormorants (BRNW 2014). PIT tags ingested by gulls may become unreadable when broken down by thick muscles of the gizzard and small stones that are consumed to aid the digestive process (Zorich et al. 2010, 2011). Previous estimates of predation rates for gulls have used models based on PIT tag deposition rates of terns or cormorants. Adjusting for these differences, PIT tag recovery on gull colonies has increased minimum predation estimates by a factor of 6.2 compared to previously published data (BRNW, 2014). This indicates that gulls from colonies such as Miller Island Rocks may have a larger impact on smolt survival than previous data has described. With this in mind, monitoring the presence and behaviors of these piscivores enables the USACE to better understand bird impacts at these dams.

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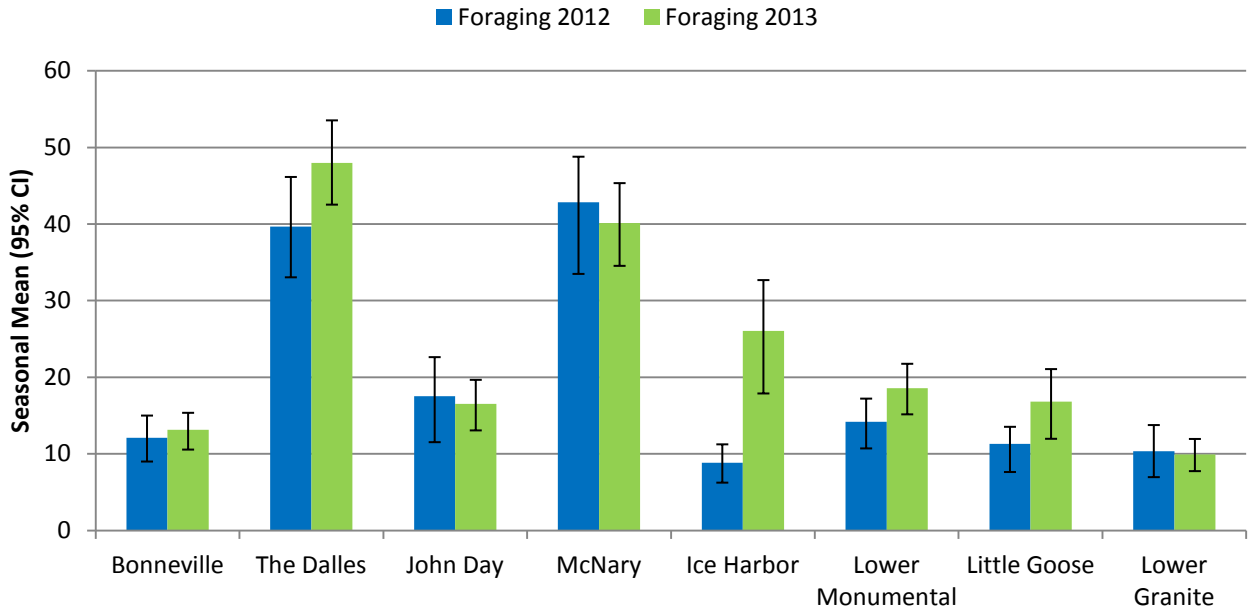

Figure 37. Seasonal mean (1 April – 31 July) of foraging birds at eight USACE dams in 2012-13 (with 95% CI bars). Project means have been calculated for each day from one to three counting sessions depending on the project.

Caspian terns were observed most often at McNary and Ice Harbor dams. The proximity of these two dams to sites utilized by Caspian terns for nesting and resting areas may explain the amount of foraging activity observed here. Caspian terns are rarely observed at the remaining USACE dams along the Columbia and Snake rivers. However, these birds are a monitoring priority as efforts to manage double-crested cormorant and Caspian tern nesting colonies in the Columbia River basin, and in particular the colonies in the estuary, are ongoing. The progress of these management efforts needs to be monitored to determine whether birds are moving inland toward other areas, such as the dams, that are sensitive to the predation of ESA-listed juvenile salmonids.

The pelican colony in Washington, located on Badger Island, is close to McNary, Ice Harbor, and Lower Monumental dams where these birds are often seen in the tailrace areas. The abundance of American white pelicans has increased over the last few years on rocky outcroppings downstream of John Day and The Dalles dams as well. Although the abundance of American white pelicans on these islands has been noted by Zorich et al (2010, 2011), they are infrequently observed in monitored zones closer to these dams.

Comparable bird counts collected using the standardized bird observation protocols enables managers to identify dams that have potentially greater impacts on smolt survival from bird predation. Similar to 2012, The Dalles Dam has had the largest abundance of piscivorous birds, particularly gulls, of all eight dams (Figure 3). In addition to the nearby gull colony at Miller Island Rocks, gulls frequently use the exposed rock beds downstream of The Dalles Dam as resting areas. In 2013, these rocky outcroppings were included within zone SWT5 and helped to illustrate the number of resting birds within the vicinity

of the dam. Bird abundance from this zone did not grossly affect the seasonal mean of foraging birds. Foraging birds (mainly gulls) were spatially focused downstream of the US-197 bridge in spillway zone SWT4 (Figure 9). In this zone it is difficult for land-based hazers to effectively disperse piscivorous foragers. During 2010 and 2011 boat-based hazing, coupled with an expanded avian deterrent line array in zone SWT3, successfully reduced bird abundance in primary foraging areas above and below the US-197 bridge (Zorich et al. 2011, 2012). The Dalles Dam switched back to land-based hazing efforts in 2012 and foraging bird abundance has since increased (Figure 37).

At John Day Dam, just upriver from the Miller Island Rocks gull colony, the number of birds is less than half that observed at The Dalles Dam. John Day Dam has a more isolated location from urban areas, it also benefitted from the installation of an avian deterrent line array prior to the 2010 fish passage season that covers its tailrace. Previous monitoring showed that prior to 2010, John Day Dam had as many or more foraging birds than The Dalles Dam (Zorich et al. 2012). The present deterrent line array coupled with boat-based hazing has successfully reduced the abundance of piscivores such as gulls and American white pelicans foraging at the dam (Figure 37). Some of these displaced predators may be seeking foraging opportunities at other dams in close proximity (The Dalles or McNary dams).

The 2013 seasonal mean of foraging birds at McNary Dam (40.1) was slightly lower than last year (42.8), although it is the second highest of the eight dams (Figure 37). Nesting islands for gulls, Caspian terns, and American white pelicans are located close enough to potentially make it an attractive spot to forage for juvenile salmonids that are out-migrating from the upper Columbia River and the Snake River drainages as they pass McNary Dam. Increasing deterrent methods to help reduce piscivores at the dam could include actions such as boat-based hazing downstream of the spillway during peak fish outmigration. The addition of avian lines in the spillway tailrace may help to protect salmonids during the absence of hazers.

Ice Harbor Dam is also located in close proximity to piscivorous bird colonies and resting areas which increases the potential for these birds to forage at the dam. While a large number of resting birds aggregate at Eagle Island, foraging birds were deterred by boat-based and land-based hazing efforts and the avian deterrent line array in the tailrace in 2012. The following season, in 2013, shows a threefold jump in the seasonal mean daily number of foraging birds (Figure 37). The reasons for this substantial increase are uncertain. However, monitoring effort at the dam has been sporadic at best with only 40-45% of the days observed during both 2012 and 2013. This lack of consistent effort could explain some of the differences seen between years.

Piscivorous bird monitoring effort at Bonneville Dam was started earlier than the previous year's and still seasonal bird abundance remained similarly low (Figure 37). It was unexpected to find seasonal bird abundance comparable between years even with a month and a half shorter in the 2012 monitoring season. The lack of foraging birds at Bonneville Dam could be explained by its relative distance from nesting colonies of piscivorous birds. The closest nesting colonies are located downriver in the estuary

(Roby & Collis et al. 2011). Zorich et al. 2014 suggested that the configuration of the dam lends itself to more efficient land-based hazing. The forebay and tailrace areas at Bonneville Dam are divided by islands that separate the spillway from each powerhouse. The hazers are closer to the smaller foraging areas of each tailrace, especially when compared to the broad tailraces at The Dalles and McNary Dams or the boat-based hazers working in the tailrace of John Day Dam. Lower Monumental, Little Goose, and Lower Granite dams also have lower bird abundance and are relatively distant from any large nesting colonies of piscivorous birds. However, many of the piscivorous bird species utilize locations within the lower Snake River as resting areas.

This program of standardized piscivorous bird monitoring at all eight USACE dams affords the flexibility to adjust protocols and collect pertinent comparable information. The tablet PC's provided an efficient means to collect data and reduce human error involved with manual data entry. The synchronization process was not without difficulties as sometimes the synchronization process did not function. The tablet PC's were able to store data until synchronization was achieved so this did not cause data loss. The manual entry into the database portal from paper data sheets was more time consuming and data entry error was occasionally a problem. Although there has been resistance to using binoculars at some projects, the choice to combine small zones into large zones makes the use of binoculars by all observers a necessity to complete an accurate and reliable bird survey. Even in smaller zones, resting and foraging birds can be missed without the assistance of binoculars. The continued monitoring of piscivorous birds within defined zone boundaries highlights bird movement and foraging hotspots throughout the fish passage season. This presents managers with the information to better utilize abatement methods at their projects. Protocols are flexible enough to be adjusted to fit informational needs at the request of regional managers. With continued project participation and effort over time, this program will have the ability to detect long term trends in bird abundance and movement both through time and among dams.

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APPENDICES

APPENDIX A. AVIAN OBSERVER PROTOCOL

Bird counts were collected in accordance with the following protocol:

1. Perform counts at least once a day and in every zone if possible. Record counts by behavior category: foraging, resting, flyby, or scavenging. Every zone should have a data point so in the **Species** field record "No Birds" if no piscivorous birds are in that zone. Once the survey is complete enter the data into the database that day.

2. For each survey be sure to enter the following header information:
   Project: Name without Dam suffix.
   Observer: first and last name (for example "Nathan Zorich")
   Date: the date of the scan.
   Hazer: record "Y" if present on project or "N" if not. We might refine this later, such as "Hazer in Zone? Y/N". Depends on how important people feel that is. If a hazer is on project they are likely impacting all zones. Boat or shore hazing can be reported in the Notes.
   Spill: record "Y" if spilling or "N" if not
   Surface Passage: If your project has an RSW, TSW, corner collector, ice/trash sluice way etc. that pulls water from the surface (compared to deeper tainter gate releases), "Y" if it is open, "N" if it is closed, "NA" if this is Not Applicable to your project.
   Juvenile System: (On/Off) Is your juvenile bypass system or other juvenile collection system *diverting fish from the river*?
   Juveniles to outfall? (Y/N) Are smolt going back to the river near the project? This may act to attract birds. Includes both SbC operations and primary/secondary return to river operations.
   Juveniles to transport? (Y/N) Are smolt collected by the JBS routed to a raceway, barge, or truck? These smolt not available for birds.

3. For each zone be sure to enter the following information:
   Time: time the count was made in that zone.
   Zone: the zone code (see code list on project maps)

4. We are monitoring specifically for nine piscivorous birds (see species codes below or datasheet). If they are not present then, "No Birds" should be recorded as species along with zeros under behavior counts– zeros are data too! It is just as important to know when there are no birds at our projects as it is to know when there are.

   Species: species of bird observed, focusing on the nine most common fish eaters (see species list at end). If not on the list you can use "Other" and then give the species or common name in the **Notes** field. "No Birds" also accepted here when no piscivorous birds are seen and counts should be zero.

5. **Behaviors** fall into four general categories: Foraging, Resting, Scavenging, or just Flying by. Animals display an amazing variety of behavior. Below are some general guidelines to help you decide.

BEHAVIORS COMMON TO ALL BIRD SPECIES:

Flyby: number in transit through the project area. Not stopping to forage. The bird is flying from point 'A' to point 'Z' not searching for food. Typically but not exclusively, these birds are flying at a higher elevation than foraging birds.

Scavenging: opportunistic feeding (e.g. carcasses, sea lion or fisherman scraps).
Will be the same for all species, the key is that the bird is feeding on something that is dead. We've seen this below fishing platforms.

SPECIES SPECIFIC BEHAVIOR:

American White Pelican **(AWPE)**
Foraging: They feed using a subtle dip of their large bill. So if they are floating on water, it is assumed they are foraging.
Resting: Sitting on an island, land, or structure.

Bald Eagle **(BAEA)**
Foraging: Flying in circular searching pattern and/or striking water surface with talons for fish.
Resting: Perched on tree, transmission tower, or shore.

Caspian Tern **(CATE)**
Foraging: Flying in circular searching pattern and/or diving head first for fish.
Resting: Floating or perched on shore or structure.

Common Merganser **(COME)**
Foraging: Diving underwater from surface.
Resting: Floating, head on back, not diving.

Double-crested Cormorant **(DCCO)**
Foraging: Diving underwater from surface.
Resting: Perched on shore or structure.

Great Blue Heron **(GBHE)**
Foraging: Standing within striking distance of water.
Resting: Standing on shore or structure away from water.

Grebe – Western or Clark's **(GREBE)**
Foraging: Diving underwater from surface.
Resting: Floating, especially floating with head on back. Not diving.

Gull – all species **(GULL)**
Foraging: Flying in circular searching pattern often close to water surface and/or diving head first for fish.
Resting: Floating or perched on shore or structure.

Osprey **(OSPR)**
Foraging: Flying in circular searching pattern and/or striking water surface with talons for fish. Carrying a fish in talons
Resting: Perched on tree, transmission tower, or nest box.

Notes: Use as needed. Specific info on location (i.e. log boom, tower) or to describe "OTHER" species such as "Common Loon", "Red-breasted Merganser". These abbreviations are from Institute for Bird Populations: http://www.birdpop.org/alphacodes.htm

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APPENDIX B. AVIAN OBSERVER DATA SHEET

FCRPS Piscivorous Bird Count Data Sheet - USACE

Project:_____ **Observer :** _____ **Date:**_____

(First & Last name) **Sheet** __ **of** ___

Circle One

Spill:	ON	OFF	Juvenile System:	ON	OFF
Surface Passage:	ON	OFF			
Hazer on Project:	YES	NO	If on:	To Outfall	Transport

Zone	Time (24hr)	Species	Counts by Behavior				Notes
			Foraging	Resting	Fly By	Scavenging	

Zones: See Zone map for each project's codes or print on backside of this sheet

In general PH = Powerhouse, SW=Spillway, T = tailrace, FB = forebay

Abbreviations from birdpop.org/alphacodes.htm

No piscivorous birds	NB	Caspian Tern	CATE	Great Blue Heron	GBHE
Any Gulls	GULL	Double-crested Cormorant	DCCO	Bald Eagle	BAEA
Western and/or		Common Merganser	COME	Osprey	OSPR
Clark's Grebes	GREBE	Am. White Pelican	AWPE	Other	OTHER

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