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Assessment of the Extent of Potential Salmonid Predation by American White Pelicans in the Pool and Tailrace of McNary Dam 2002

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Under a Related Services Agreement With the
U.S. Department of Energy
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Summary

Piscivorous birds prey upon millions of juvenile salmonids annually as they emigrate from the Columbia River Basin. American white pelicans (*Pelecanus erythrorhynchos*) are thought to prey primarily upon larger fish. However, the pelicans' persistence and use patterns below the McNary Dam complex implicates them as contributors to juvenile salmonid mortality there. In 2002, observations of pelican use and foraging patterns around the McNary Dam tailrace were systematically collected from March 29 to August 30, 2002, to assess potential salmonid predation through associating the pelican use and behavior with the presence of salmonids. A test-of-techniques for tagging pelicans in the tailrace area was successfully conducted in August 2002. In addition, a small-scale captive study was conducted between November 2002 and February 2003 to verify the utility of radiofrequency (RF) tags to measure time-sensitive use and foraging efforts by wild pelicans at prescribed "hot spots" (areas with the highest pelican use and foraging) in the McNary tailrace.

Observational datasets in 2002 indicated a bi-modal distribution of pelican use and foraging efforts below the tailrace that generally corresponded to the juvenile salmonid out-migration index over time and passage routes. Over 95% of all pelican foraging documented in the tailrace study areas occurred between June and July 2002. However, pelicans were first consistently observed in the tailrace in small numbers during the week of April 21. A maximum instantaneous count of 24 pelicans using the tailrace immediately below the dam was recorded during the last week in May. The peak in pelican foraging and success rates coincided with the peak in salmonid passage through the bypass facility during the 2002 out-migration season. Foraging rates throughout the 2002 out-migration season were highest in the observation zone immediately below the juvenile bypass outfall alongside the Oregon shore. The diel foraging patterns of pelicans generally coincided with the diel pattern of salmonid passage through the bypass system. Foraging and passage peaked at dawn and rose again in early afternoon.

Results suggested bird deterrent measures at McNary Dam for non-listed piscivorous birds (primarily water cannon and firearms for gulls) initially altered the foraging behavior of pelicans. However, the pelicans rapidly acclimated.

Observations of pelican flight departure directions and age classes of birds found using the tailrace study areas suggested little intermixing with the local breeding population at Badger Island, until mid- to late August, when some young-of-year birds were documented in the tailrace study areas.

Pelicans were successfully captured, tagged, and released immediately below the McNary tailrace during a test-of-techniques effort conducted in late July. Three captive pelicans were fitted with RF tags to address tag safety, retention, and foraging behavior detection questions before using the RF tags on wild pelicans in the McNary tailrace.

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1.0 Introduction

1.1 Background

Piscivorous birds, such as gulls and terns, prey upon millions of juvenile salmonids annually as they emigrate from the Columbia River Basin (Roby et al. 1998). Hydroelectric dams are known to attract piscivorous birds, as the dams concentrate salmonids through diversion systems and are also known to cause smolt-disorientation immediately below the dam complexes. Studies conducted in the mid- and upper-Columbia River Basin have documented avian predation rates up to 2% and 3% of the juvenile salmonids that migrated past the known "hot spot" (Ruggerone 1986; Phinney et al. 1998).

Although American white pelicans (*Pelecanus erythrorhynchos*) are not thought to prey primarily upon small smolt-sized fish, persistence and use patterns below the McNary Dam complex implicates them as contributors to the juvenile salmonid predation problem. At McNary, up to six dozen American white pelicans have been observed along the Oregon shore a short distance below the McNary Dam juvenile facility during the spring migration period (NMFS 2000). The ISO-PIT tag recovery program, supported by the National Marine Fisheries Service (NMFS), found a limited number of salmonid pit tags on the only nesting pelican colony in Washington State, approximately 20 km upstream of McNary Dam. It is unknown how many, if any, active breeding pelicans use the McNary tailrace area during the spring out-migration period (April-August). In the past 2 years, pelican numbers have dramatically increased on the Yakima River system, particularly near the smolt-rearing and acclimation sites (personal comm., Doug Florh, Washington Department of Fish and Wildlife).

The utility of ISO-PIT tag to quantify juvenile salmonid consumption rates by American white pelicans at McNary is limited because of inherent biological and behavioral traits (e.g., pelicans eliminate ingested pit tags via defecation, and this occurs at loafing sites, foraging sites, and potential nesting sites).

Some pelican foraging efforts (group herding of fishes, kleptoparasitism, etc.) occur in the daylight hours; however, research near Lake Winnipeg has shown that two to three times as many pelicans fed at night as compared to day and that foraging flocks were larger at night as well (McMahon and Evans 1992a). The daytime loafing sites used by the pelicans were also used during the night hours for foraging.

American white pelicans require an estimated 1.8 kg of fish in a 24-hour period (Terres 1980), which roughly equals 31 to 45 juvenile salmonids per 24 hours per bird assuming that 40.0 to 60.0 g juvenile salmonids were the pelican's entire daily diet. Using a simple conceptual energetic demand calculation, 60 birds that consumed their daily-required mass of fish per day below the McNary Dam for 30 days during the spring salmonid out-migration could consume 81,000 juvenile salmonids. This gross approximation exceeds the minimum estimated numbers of juvenile salmon consumed by gulls at Bonneville Dam (11,114) in 1997 and (35,966) in 1998 (Jones et al. 1999). Ruggerone (1986) estimated a minimum of 111,750 salmonids (or 2% of the estimated run) was consumed by gulls and terns at Wanapum Dam in 1982.

Breeding pelicans in Washington State have been absent since the early 1900s, until a single colony (approximately 30 pair) was discovered on one island along the Columbia River in 1994 (Ackerman 1994). The birds in this single colony moved from Crescent Island, to nearby Badger Island; both are dredge-spill islands made by the U.S. Army Corps of Engineers (COE) in 1985 and managed by the U.S. Fish and Wildlife Service (USFWS). The State of Washington Department of Fish and Wildlife lists the American white pelican as "endangered." Currently, large numbers (exceeding 100) of pelicans nest at this single Badger Island colony, located approximately 20 km upstream of McNary Dam. Neither state nor federal agencies have monitored the trends of this population since the discovery in 1994. In addition, non-breeding and migrant populations of pelicans may also use the McNary area during the salmonid out-migration. The size of the nesting pelican population has increased over the past decade, and pelicans have become common sightings, year-round, throughout the Columbia Basin.

Empirical data are needed to quantify pelican numbers and diel foraging efforts that occur in the McNary tailrace area during the juvenile salmonid out-migration. Observational datasets can be used to describe pelican foraging patterns near the McNary tailrace. This same approach may be applied to other outfall systems and other predators. This study complements ongoing projects (funded by NMFS, Bonneville Power Administration [BPA], and COE) directed at monitoring avian predation upon juvenile salmonids (Collis et al. 1999; Jones et al. 1999; Phinney et al. 2000).

1.2 Objectives

At the request of the COE, Pacific Northwest National Laboratory (PNNL) conducted a study to address the 2001 Biological Opinion, reasonable and prudent alternative action 102 and 103, which states "quantify the extent of predation by white pelicans on juvenile salmonids in the McNary pool and tail-race." This information is also needed to determine and improve fish passage conditions at McNary Dam.

This study had the following objectives:

1. Estimate the relative abundance of white pelicans that used the McNary Dam tailrace for roosting and feeding during the juvenile salmonid out-migration (April-August).

2. Quantify diel foraging efforts and locations (area-use patterns) of white pelicans in the McNary Dam tailrace, including proximity to the juvenile fish facility and outfall pipe, turbine units, spill bays, and spill/lock wing-wall.

3. Examine the contribution of white pelicans from the nearby Badger Island breeding colony to foraging near McNary Dam.

4. Examine white pelican behavior, for example, relationships of white pelican foraging and use patterns to measured operational conditions (e.g., spill rates, total project discharge, bird deterrents).

5. Examine the efficacy of capture and marking techniques of white pelicans at loafing areas below McNary Dam tailrace.

1.3 Study Area

The primary study site for pelican foraging was the McNary Dam tailrace. McNary Dam is located on the Columbia River approximately 470 km from ocean (river mile 292). Approximately 20 km upriver of the dam is Badger Island (Figure 1.1), where the only active breeding colony of American white pelicans exists in Washington State.

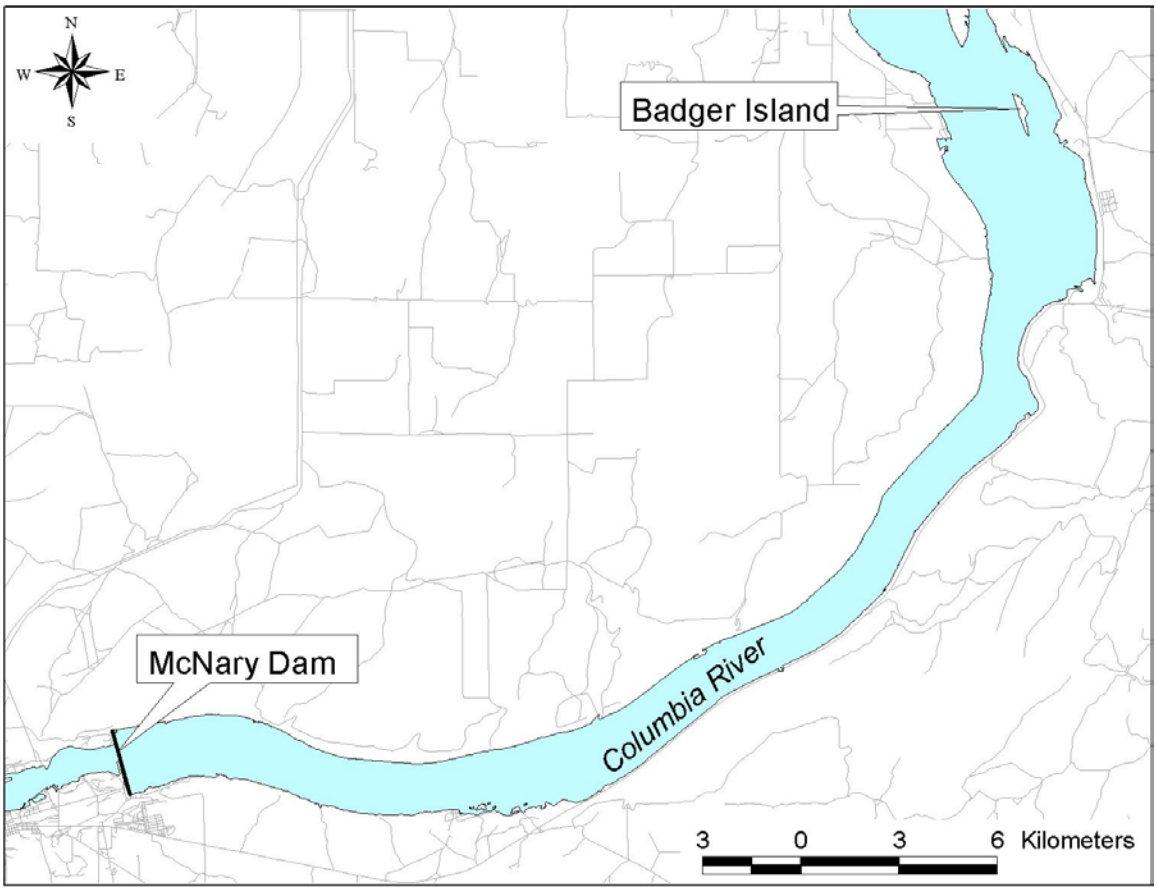

Figure 1.1. Map of McNary Dam and Pool Area Showing Location of Badger Island

2.0 Methods

2.1 Visual Observations

Observations were made using 15 x 35 mm or 10 x 70 mm binoculars and a 12-36 x 50 mm spotting scope. Nighttime observations were made using ITT Night Quest G3 night vision binoculars. Each day was divided up into four segments, called "day-periods." Day-period 1 refers to the time between 1 hour before and 1 hour after sunrise. Day-period 2 consisted of the time between 1 hour after sunrise and 1 hour before sunset. This day-period was subdivided into two parts: 2AM (before noon) and 2PM (after noon). This was done because there were differences in pelican activity between the morning and afternoon, which would not be captured by encompassing them into a single day-period. Day-period 3 consisted of the time between 1 hour before and 1 hour after sunset. Day-period 4 is the time between 1 hour after sunset and 1 hour before sunrise. Because of the change in the sunrise and sunset times throughout the study, the length of day-periods 2 and 4 were variable, whereas day-periods 1 and 3 were always 2 hours in length.

Observations of the pelican activity in the McNary Dam tailrace were made from the Oregon shore immediately below the dam beginning on March 26. Most observations were done from the picnic area on the Oregon shore just below the juvenile bypass facility. These observations consisted of a count of all pelicans visible within each of the observation zones of the tailrace (Figure 2.1) conducted every

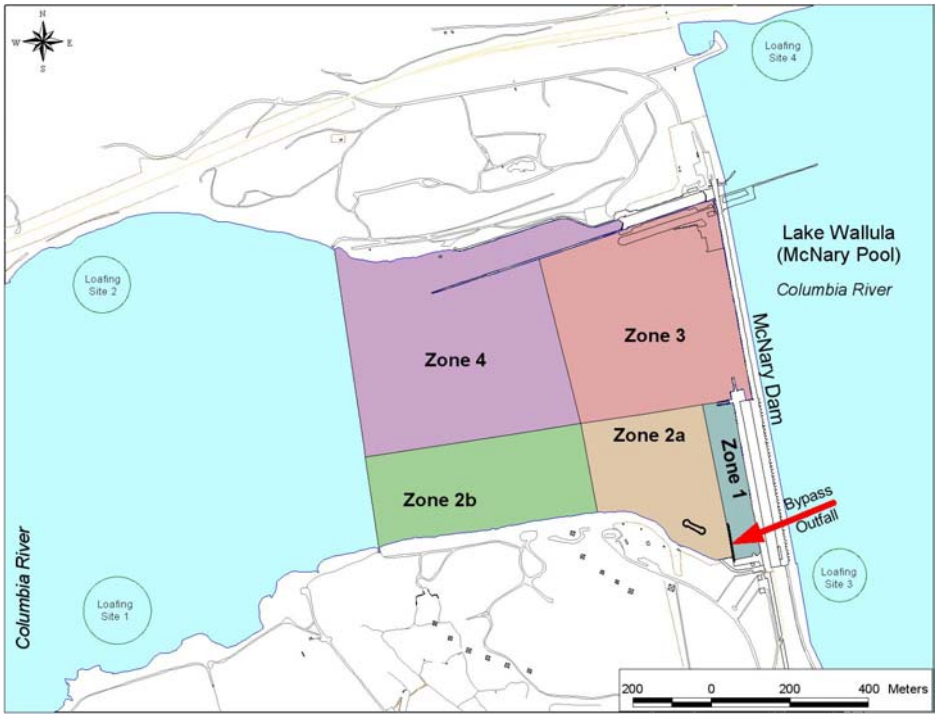

Figure 2.1. Map of the Tailrace Observation Zones and Loafing Sites Monitored During the 2002 Study

30 minutes. This was done over the length of each day-period. The four day-periods, when combined total 24 hours, were not covered consecutively on the same day but were covered systematically within each week. Thus, the sampling units were the four day-periods representing pelican activity in the tailrace for the week.

The area immediately below the dam was divided into observation zones 1, 2a, 2b, 3, and 4 to determine specific high-use areas within the tailrace (Figure 2.1). Zone 1 is the area immediately below the powerhouse down to the juvenile bypass outfall. Zone 2a and 2b consist of the area between the Oregon shore and the spillway channel and immediately below the juvenile bypass outfall to about 1 km downstream of the dam. The dividing line between 2a and 2b is just below the picnic area on the Oregon shore where the majority of the observations were made from. Zone 3 is immediately below the spillway, and zone 4 is mid-channel and the nav-lock entrance (Figure 2.1).

Limited monitoring also occurred near Badger Island, situated approximately 20 km upriver of McNary Dam (Figure 1.1). Observations were made from the east shore of the river directly opposite the colony area on the island. The shore was about 800 m from the island, so counts were done using a spotting scope. As in the tailrace, snapshot counts were done every 30 minutes within day-periods 1 through 3. A few nighttime observations (day-period 4) were conducted from a small boat 200 to 300 m offshore from the island using night vision binoculars to evaluate foraging at night there. This was done because the island was beyond the range of the night vision binoculars from the east shore of the river.

The number of gulls in the tailrace as well as the number in close proximity to the juvenile bypass outfall were also noted in each of the 30 minute scans. Pelicans arriving or departing upstream or downstream from the tailrace observation area were noted whenever observed.

This report also presents a comparison of counts of pelicans made by COE staff during the 2001 out-migration season near the juvenile bypass outfall structure. The observation areas were divided into three general regions: 1) wing wall/lock, 2) spill, 3) turbine, and 4) forebay. Observations were generally made during daylight hours by one observer. The time of day was not identified in the survey notes.

2.2 Foraging

Tagged birds were not available during this study to independently select focal birds to represent overall foraging rates near the tailrace. Focal birds observed in this study were selected based upon their presence in the key study regions (1-4) when focal monitoring was scheduled (between the 30-minute instantaneous bird counts). If more than one bird was found in the study region during the foraging evaluations, a bird was arbitrarily selected by the observer. The focal bird was observed until it left the observer's field of view (e.g., flew off, drifted away, was lost in the troughs of large waves, lost among a group of other pelicans) or another count was performed. The start and end times of the focal bird observations and the zones in which the bird was observed were recorded. The time and number of bill-dips were recorded separately for each of the zones where the focal birds were observed. The number of swallows was also recorded during the observation period. A successful feeding attempt was denoted by either a rapid jerk of the head (referred to as a "pop") or if the bill was raised past horizontal to swallow the prey. Sometimes the tail of a fish or a bulge in the bill pouch was also visible, which confirmed a successful prey capture. The number of these successes was recorded over the same observed time frame

as the bill-dips. This was then used to calculate foraging rates as the number of bill-dips per hour per bird. The success rate was determined by the percentage of the observed bill-dips that resulted in a successful prey capture. Kleptoparasitism from gulls or terns was also recorded if observed. Differences between observation datasets were depicted using means, and variability was estimated using standard errors (SE) generated about these means. Observational data points were assumed to be independent (no autocorrelations) because the time between observations (30-minute intervals) was generally sufficient for the animals to move across the entire study area.

Flight departure directions and the total number of birds departing were recorded by observers at the McNary pool pelican colony and the McNary tailrace. This provided limited insight on the use of the tailrace area by actively breeding adult pelicans from the nearby colony.

2.3 Additional Use Areas

During the McNary tailrace observations, four main areas where pelicans would consistently loaf or float in groups were observed outside of our prescribed observation zones. These areas were designated as loafing sites 1 through 4 (Figure 2.1). These areas were consequently observed periodically consistent with methods prescribed for the snapshot counts conducted in the tailrace observation zones. The numbers of pelicans using the loafing areas were recorded, but foraging observations (i.e., bill-dip rates) were not conducted. The pelican counts were combined to form an area use estimate to provide an indication of the pelicans' total use of the area. These results were also used to represent instantaneous maximum, mean, and minimum numbers of pelicans found using the tailrace area.

As well, boat surveys were conducted from the mouth of the Snake River down through to the McNary Pool on May 24, July 16, and August 15 to search and estimate pelican numbers throughout the entire pool region.

2.4 Capture and Tagging

Pelicans were captured using soft leg-hold traps anchored to stakes in the substrate and spread out in the tailrace areas where pelicans were observed loafing. Trapping efforts were consistent with PNNL's State and federal scientific collecting permits 02-129 and 07781, respectively. This primary trap site existed as a "land bar" located about 60 m off the Oregon shoreline halfway between the end of the McNary tailrace survey zone and the highway bridge. There were two gravel/cobble piles surrounded by several isolated basalt boulders. These rock formations are submerged at river flows over about 250 kcfs, thus restricting our capture efforts to times when flows were below this discharge rate.

The traps were set as quickly as possible, and the researchers then boated away from the island to wait for the pelicans to return. The trap area was continuously observed from the time the traps were set so that captured birds would be immediately subdued, tagged, and released.

The captured pelicans were approached with a large blanket that was quickly draped over the bird to block its vision and wing flapping. The bird was then secured in a comfortable position and its foot removed from the trap. The bird, still subdued in the blanket, was then transferred to the boat. The

blanket was wetted either at the time of covering the bird or later on the boat to prevent the bird from overheating. The left leg was banded with a USFWS migratory bird leg band. Each wing was then successively extended, and a yellow wing (patagial) tag attached to each through the space between the radius and ulna. Captured birds were then placed inside a large duffle bag and suspended from a scale to obtain a weight. The bird was then carefully released over the side of the boat.

3.0 Results

3.1 Visual Observations

A total of 1440 hours of pelican foraging-effort observations were documented at the McNary Dam tailrace in 2002. These observations covered approximately 6% of the time available for foraging throughout the 23-week study period. Out of the 23-week period, 25 days were monitored to provide estimates of the relative abundance of pelicans in each region and each day-period.

3.1.1 Abundance

Only 1 pelican was observed in the McNary tailrace during day-period 2 (2AM and 2PM) on March 25. A single pelican was again observed the following week during day-period 1 (April 5). No pelicans were observed again until the week of April 21.

Mean pelican numbers, observed during all four day-periods within a week, increased from the week of April 28 to the week of May 26 (Figure 3.1). The numbers then declined slightly then dramatically increased again in late June and early July. Maximum instantaneous counts never exceeded 16 birds through August.

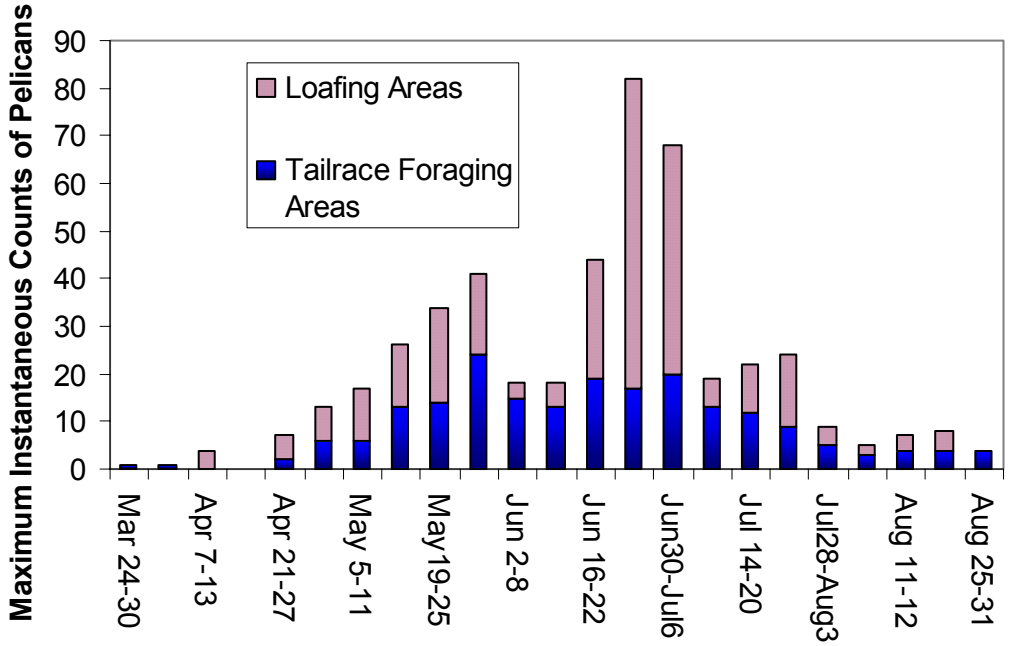

Figure 3.1. Maximum Instantaneous Counts of Pelicans in the McNary Dam Tailrace Observation Zones Across All Day-Periods Throughout the 2002 Study

In 2001, observations made by McNary Dam workers showed the peak number of pelicans in the tailrace occurred around June 10 (Figure 3.2). These numbers were compared with PNNL's numbers

from day-period 2 (2AM and 2PM) combined because the observations made last year occurred during the day. Figure 3.2 shows the single peak recorded in June 2001, as opposed to the slightly bi-modal distribution of the pelican numbers recorded in this study in 2002. The highest daytime use for 2002 was during late May, with a second, smaller rise in numbers in early July.

When the pelican counts from the four main loafing areas were included, the use of the McNary tail-race area appeared to coincide directly with the juvenile salmonid out-migration. The out-migration was based on the 2002 salmonid out-migration index provided from the McNary Dam juvenile fish bypass facility (Figure 3.3).

Using relative abundance counts as an estimate of the minimum number of individual birds present (pelican relative abundance index), it was apparent that birds foraging at the tailrace would generally switch back and forth between the nearby loafing areas and the foraging areas closer to the dam. Figure 3.3 shows the mean relative use of the loafing sites and the tailrace observation zones during the salmonid out-migration period. Although relative numbers of pelicans observed using the tailrace zones (foraging areas) declined slightly during the peak of salmonid out-migration, the mean instantaneous counts of pelicans found at the loafing areas increased. In other words, as catch-per-unit effort went up, the total number of pelicans foraging in the tailrace at any single point in time dropped. Most notably, Figure 3.3 illustrates the strong direct relationship between pelican abundance at the McNary Dam and the relative abundance of juvenile salmonids passing through the McNary Dam complex.

3.1.2 Diel Use and Movement Patterns

The number of pelicans observed during each of the four day-periods differed most drastically between day and night. Pelican abundance in the morning hours of day-period 2 was consistently less than the afternoon within the same day-period. The mean pelican count for the afternoon

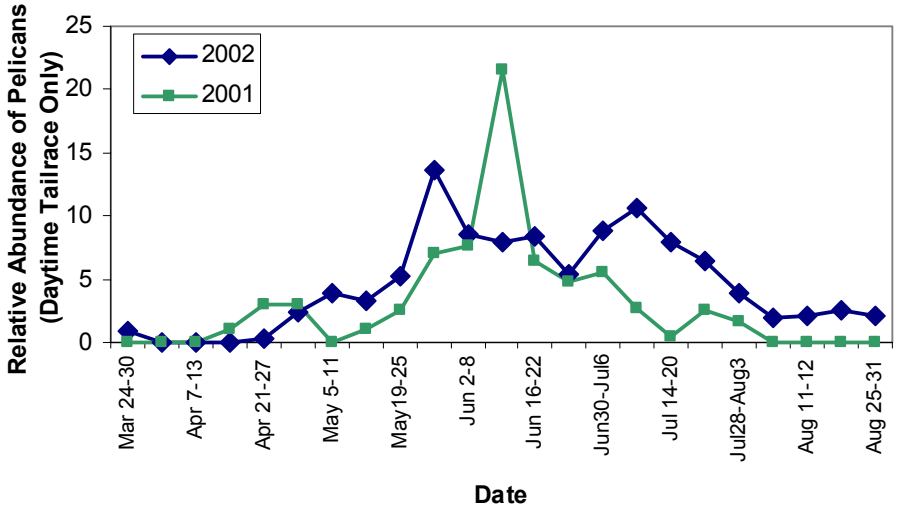

Figure 3.2. Mean Relative Abundance of Pelicans from Daytime Observations Made in 2001 Compared to Observations From the 2002 Study

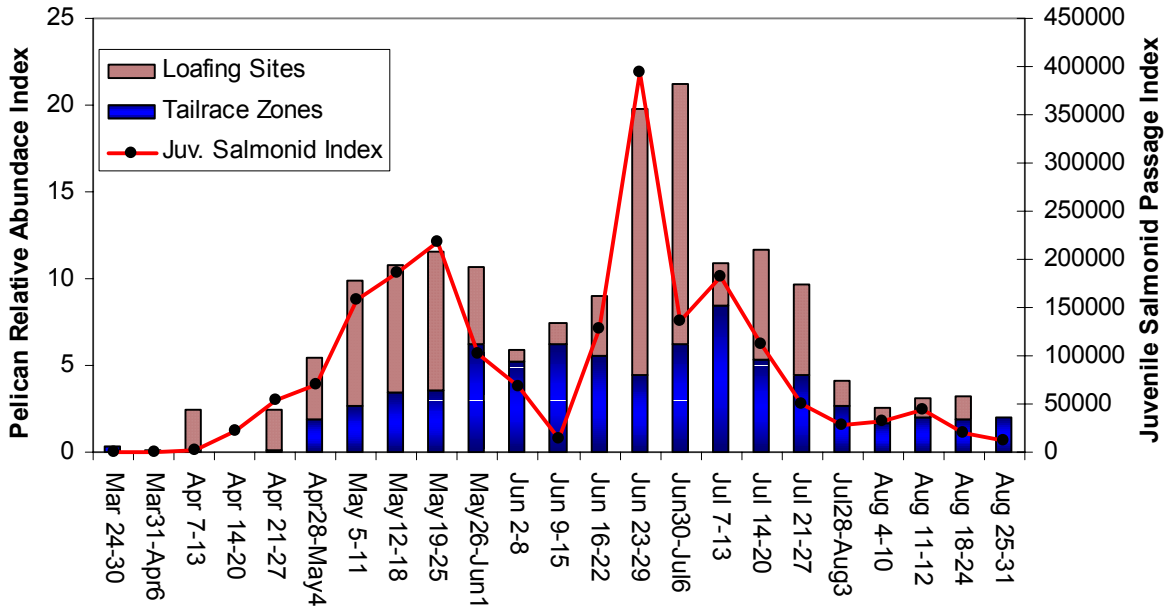

Figure 3.3. Weekly Relative Abundance of Pelicans in the Tailrace Observation Zones and the Loafing Sites Across All Day-Periods Throughout the 2002 Study

(2PM, day-period 2) tended to be higher (mean= 6.17 +/- SE 0.29) than the counts from the morning (2AM, day-period 2) (mean= 4.24 +/- SE 0.36). The maximum instantaneous counts tended to follow the same pattern with the exception of day-period 4 (Figure 3.4), where a single maximum instantaneous count of 16 pelicans occurred on June 21, when typically pelican numbers in the tailrace were very low to near zero during the night (mean = 1.67 +/- SE 0.18) for the duration of the study.

Use of loafing areas tended to increase at night coinciding with a decrease in birds using the tailrace zones (Figure 3.5). Increases in both the tailrace and loafing area use during the afternoon indicated an influx of birds. This use pattern was consistent with foraging and loafing trends described in Section 3.1.1, where the number of birds found using the tailrace study sites was inversely related to the number of birds found using the loafing sites.

Diel counts of pelicans conducted around the McNary Dam complex suggest a number of the birds at the McNary tailrace are not active breeding adults. Animal tagging events were not conducted during 2002 to estimate the relative contribution of nearby breeding colony pelicans foraging at the McNary tailrace. However, movement, abundance, and foraging observations of untagged birds were conducted near the breeding colony to help shed light on this question. From April 23 to May 16, weekly observations were made of the pelican colony on Badger Island during daylight hours (day-periods 1 through 3). During these snapshot counts (conducted at 30-minute intervals), pelicans were consistently seen foraging near the colony or in areas within 1 km upstream of Badger Island. Overall, 9.3% of the pelicans observed near the colony area were found foraging. Foraging activity was frequently noted in areas within 1 km upstream of Badger Island and often close to shore along the east side of Badger Island near the colony.

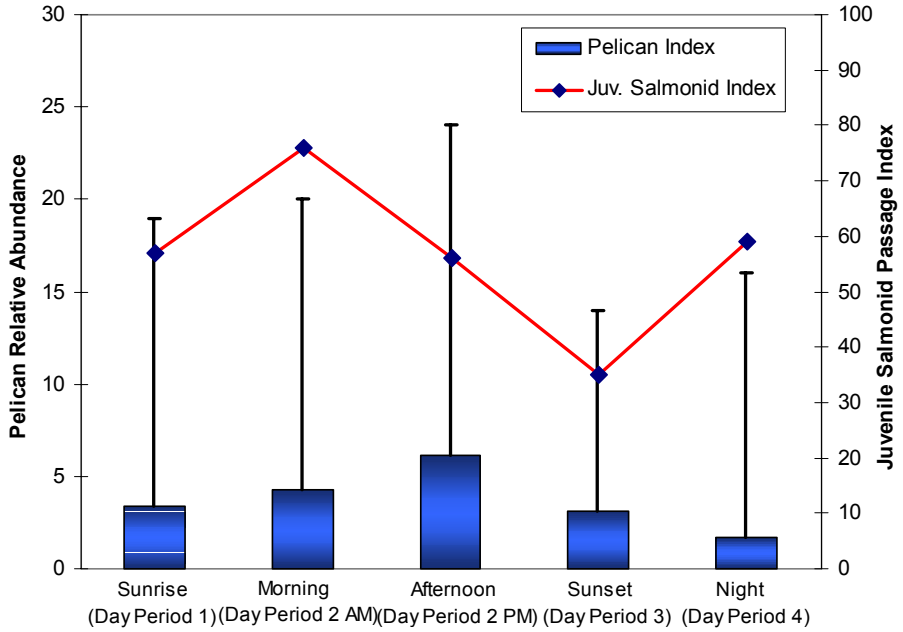

Figure 3.4. Mean and Maximum Instantaneous Pelican Counts Using the McNary Tailrace and the Relative Juvenile Salmonid Passage From Each Day-Period (March-August 2002)

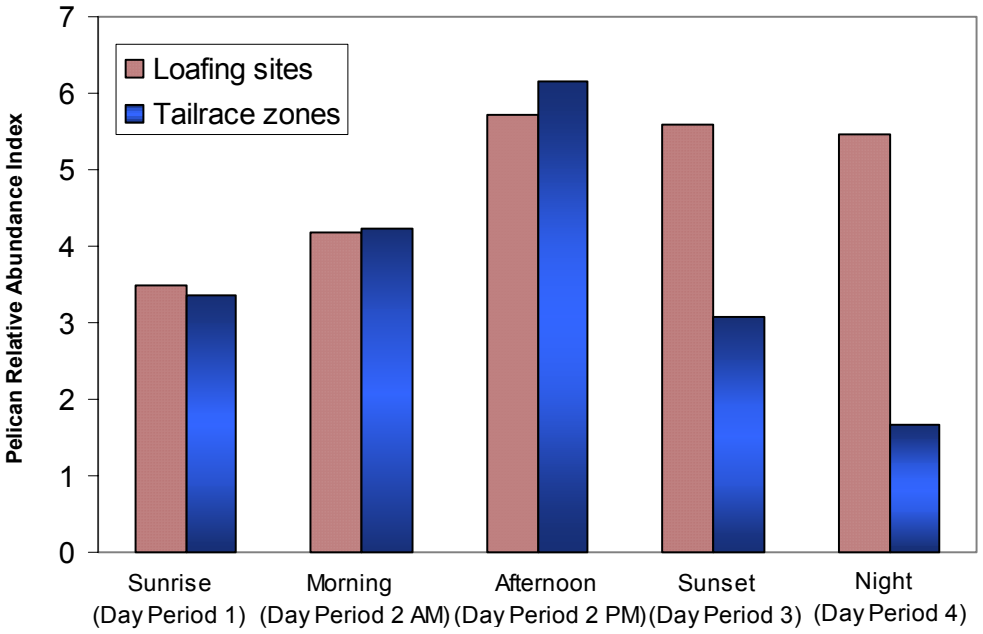

Figure 3.5. Relative Abundance of Pelicans Observed at the Loafing Sites and in the Tailrace Zones in Each Day-Period Throughout the 2002 Study

Arrivals and departures to and from the colony occurred mostly in the early morning and late afternoon. The arriving or departing birds were observed in "flocks" ranging from 1 to 8 (mean 2.7; n =35), which accounted for only 3.7% of the average number of pelicans observed around the colony in total. Out of the 49 departures observed during May and June 2002, 14.3% headed downstream, usually towards the Walla Walla River delta. The rest (85.7%) were seen heading upstream past the inlet at McNary Wildlife Area, 3 km upstream of Badger Island. Also, out of the 46 observed arrivals to the colony, only 8.7% came from downstream. No birds were observed flying up- or downstream between the mouth of the Walla Walla River and McNary Dam. On several occasions, pelicans were observed flying up the Walla Walla River.

At the tailrace, 67% of the observed arrivals and departures were from and to areas downstream. Because of the researchers vantage point below the dam, the departures upstream were not evident as to their destination. Loafing site 4 (located in the forebay; Figure 2.1) was a frequently used area, but birds flying from below the dam to that site were simply recorded as upstream departures.

3.1.3 Use Patterns by Study Zones

Use of the observation zone 2b below the juvenile bypass outfall was consistently highest throughout the study period (Table 3.1). The relative abundance of pelicans at the four major loafing sites also appeared to differ. Loafing site 1 (Figure 2.1) had the highest consistent use. However, a single record of 65 pelicans in loafing site 2 on the night of June 27 inflated the relative abundance in loafing site 2 (Table 3.1). Loafing site 3 (Figure 2.1) was only observed in use a few times and by small numbers of birds each time.

3.1.4 Foraging

Kleptoparasitism (scavenging fish from another predator) against gulls was only observed 31 times, and these attempts resulted in 5 successful captures of prey.

Table 3.1. Overall Mean, Max, and Standard Error (SE) Instantaneous Pelican Counts

Zone	Surveys (N)	Mean	Standard (SE)	Max
1	816	0.07	0.01	4
2a	515	0.26	0.03	4
2b	827	**2.62**	0.11	18
3	821	0.41	0.04	12
4	770	0.58	0.04	9
L.site1	139	4.17	0.39	20
L.site2	49	6.92	1.97	65
L.site3	37	0.57	0.17	4
L.site4	46	10.76	1.98	45

Foraging rates, defined as the number of bill-dips per bird per hour, did not closely correlate with the relative abundance of pelicans observed in the tailrace ($R^2 = 0.15$). The week that had the highest relative

abundance of pelicans using the tailrace (July 7-13; Figure 3.3) had one of the lowest foraging rates (Figure 3.6). However, foraging rates closely mimicked the patterns of pelican abundance at the tailrace and nearby loafing areas combined.

The peak in juvenile salmonid passage through the bypass facility occurred during the week of June 23-29; this coincided with the second highest mean pelican foraging rate of 34.6 bill-dips per hour (Figure 3.6). The highest mean bill-dip rate of 39.27 bill-dips per hour was observed during the week of July 21-27, 4 weeks after the peak in juvenile salmonid out-migration. However, success rates (indicated by observed swallows) were highest by far during the week of peak juvenile salmonid out-migration (Figure 3.6). This peak in juvenile salmonid passage was composed almost exclusively of fall chinook salmon. An earlier peak in juvenile salmonid passage occurred in late May (Figure 3.6), which consisted of spring chinook salmon. Pelican foraging and success rates were very low at that time.

Bill-dip rates were typically highest in the afternoon (day-period 2 PM) and at dawn (day-period 1). This roughly coincides with increased juvenile salmonid numbers through the juvenile bypass facility that peaked in the early morning and early afternoon. There was also typically a daily surge in juvenile salmonid passage between 22:00 and 23:00 hours when pelican activities were at a minimum. The time of day did not seem to influence the success rate of the foraging pelicans. No significant difference was found in the rate of successful prey capture, indicated by observed swallows, among day-periods ($p = 0.681$), although rates were almost zero at night (Figure 3.7). The highest mean success rates occurred during day-period 2.2, followed closely by day-period 1 (Figure 3.7), and no successes were observed at night (day-period 4). Success rates did not correspond to bill-dip rates very well.

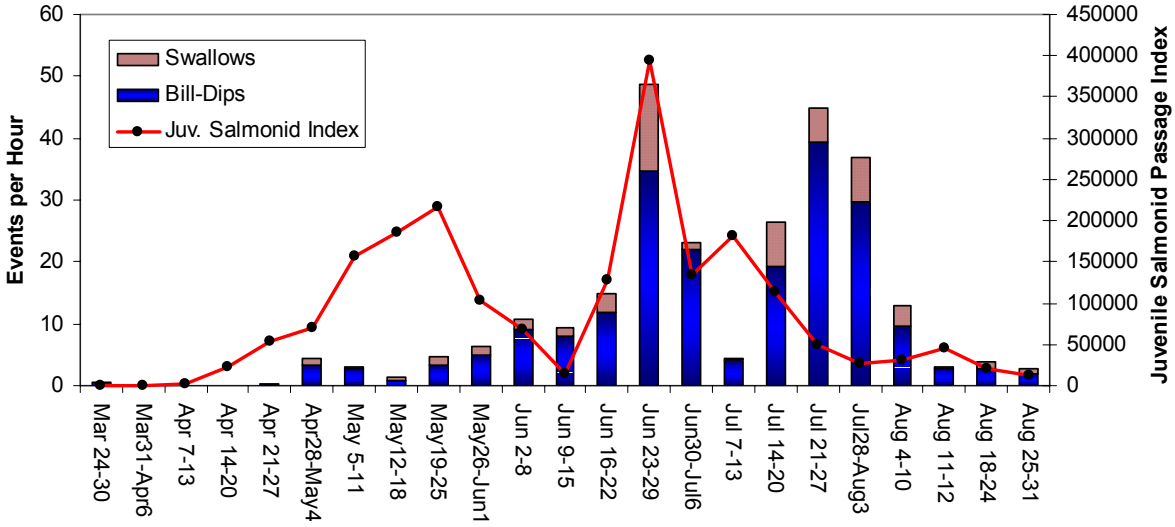

Figure 3.6. Weekly Foraging Effort Observed in the McNary Dam Tailrace Observation Zones Throughout the 2002 Study

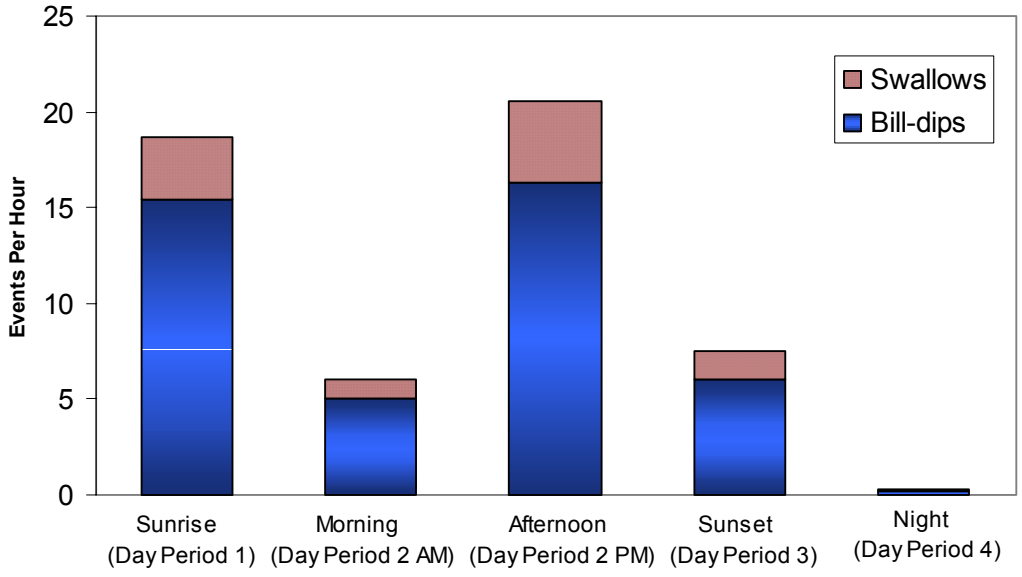

Figure 3.7. Mean Bill-Dip and Success Rates in Each of the Day-Periods Throughout the 2002 Study

Day-period 3 had the highest success rate, but the lowest bill-dip rate of the 4 daylight periods. However, the late afternoon had the second highest success rate and the highest bill-dip rate.

Foraging activity was only observed 3 times in the tailrace at night and occurred during the first 3 hours of day-period 4. Observations at the Badger Island colony on May 16 and 22 also recorded no foraging activity by the pelicans throughout the night, and the resumption of flying and foraging at dawn.

Pelican foraging and success rates were highest in observation zones 1 and 2b (Figure 3.8), which are located proximate to the juvenile bypass outfall and between the Oregon shore and the turbulent section of water below the spillway (Figure 2.1). Foraging and success rates appeared to differ among the 5 observation zones in the tailrace. Zone 2a had the highest mean success rate at 7.17%, while zone 1 had the highest mean bill-dip rates at 28.2 bill-dips per hour (Figure 3.8).

3.1.5 Relationships to Operations

Operational conditions (spill vs. total discharge) generally change by the hour. As such, the observational data collected during this study were not sufficient to provide a clear interpretation of the effect(s) of these rapid changes on either pelican abundance or foraging effort. A simple correlation analysis failed to show a distinct relationship between the mean number of pelicans observed in the tailrace area and the outflow from the dam on the same dates as the pelican observations ($R^2 = 0.116$; Figure 3.9).

There was also no distinct relationship between the amount of spill and the number of pelicans observed in the tailrace observation zones ($R^2 = 0.068$; Figure 3.10). Even use of zone 3, the area immediately below the spillway, did not change appreciably during times of spill versus no spill (Figure 3.10).

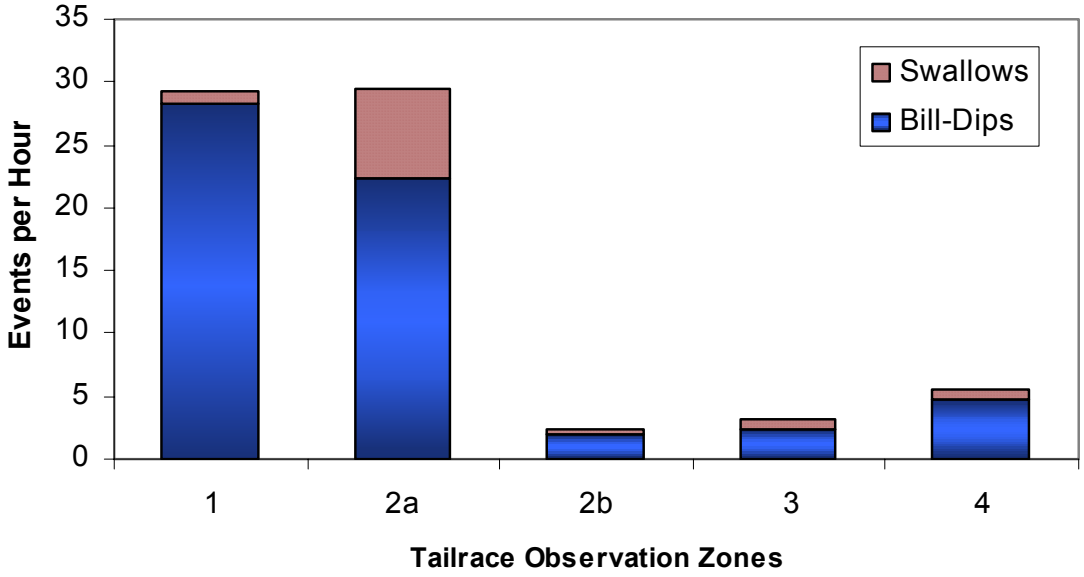

Figure 3.8. Mean Bill-Dip and Success Rates in Each of the Tailrace Observation Zones Throughout the 2002 Study

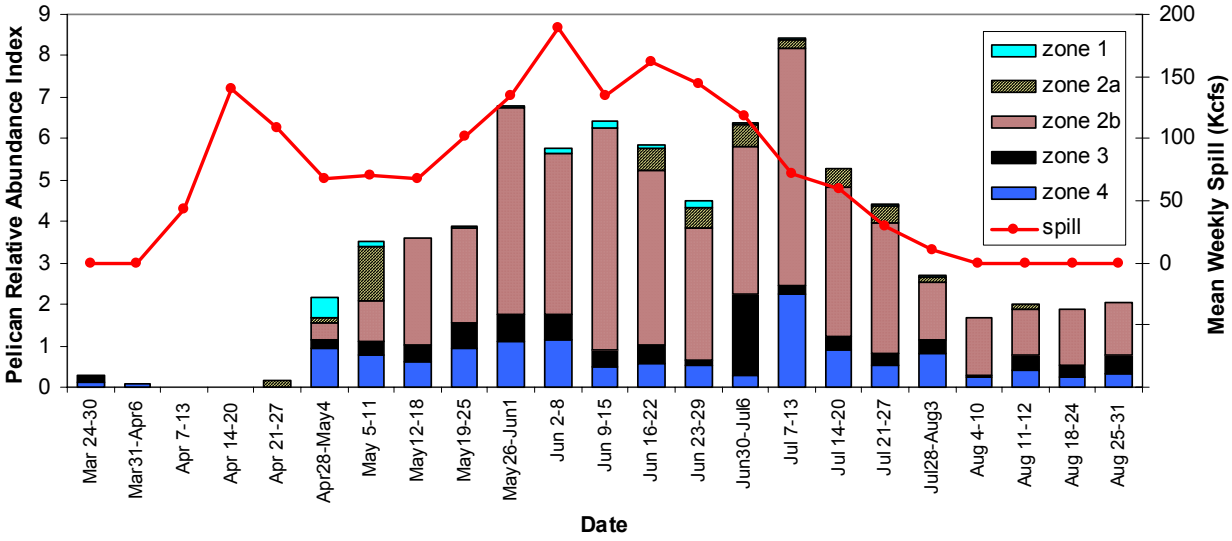

Figure 3.9. Relative Abundance of Pelicans in the Observation Zones Compared to the Outflow at McNary Dam

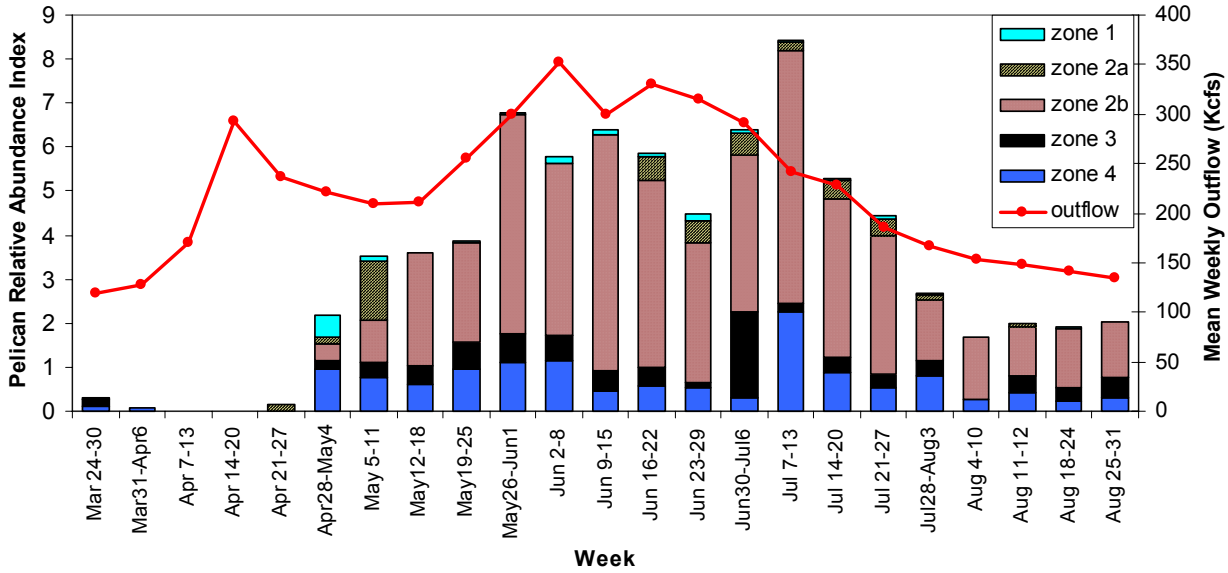

Figure 3.10. Relative Abundance of Pelicans in the Observation Zones Compared to the Amount of Spill at McNary Dam

Responses to bird deterrent efforts were noted if observed during regular scans at the McNary tailrace. The efficacy of bird deterrent measures, including water cannons and cracker-shells, were monitored at the McNary juvenile bypass outfall. On several occasions, pelicans foraging at the base of the juvenile bypass outfall did not flush when the bird deterrents were fired. On other occasions, they would simply drift away from the outfall after a sounding deterrent was fired. When the pelicans were flushed by sounding-device deterrents, the first pelican would return within an average of 1.5 minutes; others would follow, arriving at the outfall after an average of 1.6 minutes after the deterrent was fired. Initially, the pelicans were hesitant to approach the water cannon located at the end of the juvenile bypass outfall. However, within a few days of the water cannon installation, the pelicans did not appear reluctant to go into range of the water cannon.

3.2 Capture and Tagging

On July 9 and 10, 3 pelicans were successfully captured at the main loafing area (loafing site 1, Figure 2.1) below McNary Dam. Six to eight soft leg-hold traps were deployed in the area. The average handling time was 33 minutes, from the time they were caught in the trap to their release after tagging. Yellow patagial tags with black lettering (numbered A00, A01, and A02, respectively) were successfully attached to each wing of each of the 3 birds. The loafing area used for trapping was subsequently re-inhabited by pelicans within a few hours of the disturbance. Two pelicans were captured from the same loafing site 1 hour and 46 minutes apart. This illustrates the feasibility of repeated captures of pelicans from the same site.

On July 22 and 24, pelican A00 was re-sighted in the tailrace area. None of the 3 tagged pelicans were seen during the subsequent boat surveys conducted from the mouth of the Snake River to the McNary Dam forebay on July 16 and August 15.

3.3 Radiofrequency (RF) Tag Technology to Measure Foraging Rates

In 2002, two complete RF tag monitoring stations were constructed to monitor tagged pelicans foraging in hot-spot regions of the McNary tailrace. Prototype RF tags (45 g, total wt.) were built so that they could be mounted to the upper bill of pelicans, using a medical-grade cyano-acrylate adhesive. The tags were built to record and log bill-dipping events and successful swallowing events within specific regions of the tailrace. In May 2002, the U.S. Geological Service's National Banding Lab formally requested that a captive study be conducted in 2002 to verify that tags attached in this fashion did not adversely affect birds' safety or health.

In response to this request, a small-scale captive study was initiated in coordination with the Tracy Aviary (Salt Lake City, Utah) to examine safety and health aspects of tagging pelicans on the bill using this technology. Three non-releasable captive American white pelicans that reside at the Tracy Aviary were fitted with RF tags on December 4, 2002 (Figure 3.11). The captive study included monitoring 1) physical condition of the bird and bill, 2) foraging efficiency, and 3) social order of 3 individual pelicans. The study also allowed for some validation of the activity switches (i.e., controlled testing of bill-dip and swallows). The study duration included 2 weeks of baseline measurements (without tags), 1 to 2 months (with tags), and another 2 weeks after the tags were removed (without tags).

Three non-releasable captive American white pelicans that reside at the Tracy Aviary were fitted with RF tags on December 4, 2002, and January 4, 2003 (Figure 3.11). Two of the birds were relatively small, had short bills (less than 30 cm long) with a relatively smooth bill surface, and were less than 3 years of age. One of the three birds was an adult male with a 36.3-cm bill and a developing breeding sail with a relatively rough textured surface. Encapsulated RF tags (45 grams) were built with a concave base to coarsely mimic the curvature of a pelican's bill. The tag adhesive was a medical-grade cyano-acrylate developed by Master Bond Inc. (MB-297-1). Each bird was captured from the pond and subdued for approximately 30 minutes. A thin coat of cyano-acrylate was placed on the bill tissue and on the surface of the tag and held in place for 20 minutes. Birds were immediately released back into the aviary pond where they intermixed with three additional non-releasable pelicans.

Condition of the birds and foraging efficiency (successful foraging attempts and fish catch rates) were monitored over several weeks (before the tags were placed on birds and during the period tags were affixed to the birds). Birds were monitored during the daily feeding events, where they were typically tossed individual fish ranging in size between 30.0 grams and approximately 160.0 grams. At least one feeding event per week was monitored for 6 weeks before the tagging event. At least 10 feeding events were monitored for each bird while the tags were attached to their bills. Typically 10 foraging attempts (10 fish tosses) for each tagged bird were recorded during the daily feeding events.

A detailed research report was submitted to the U.S. Geological Survey National Banding Laboratory in March 2003 for consideration of approval to use RF tags on wild American white pelicans near the McNary tailrace in 2003. A summary of the findings included:

1. There were no attempts of scratching or picking at the tags by the individual birds or by con-specifics.

2. The tags remained adhered to the bill of the birds from 3 to 5 days on the younger birds to 16 days on the adult male.

3. No tissue damage or irritations were observed for any of the birds immediately after the tags sloughed off.

4. Successful foraging attempts and fish catch rates were not reduced when tags were on the birds.

5. Placement of the tag on the bill of breeding males did not interfere with breeding sail development.

(a)

(b)

Figure 3.11. RF Tag on Captive Pelican at the Tracy Aviary, Salt Lake City, Utah (a: the tag was positioned between the nares and the breeding sail; b: captive pelicans swimming in the aviary pond. The first, second, and fourth birds from right to left are tagged [December 2002])

4.0 Discussion

4.1 Abundance and Foraging

This study was initially designed to examine the abundance and foraging behavior of the endangered American white pelicans using the areas immediately below the dam (see observation zones in Figure 2.1). However, very early in the study it was evident that pelicans foraging at the dam were loafing in nearby areas (see loafing sites in Figure 2.1). It was obvious that most of the birds observed using the tailrace for foraging would fly or float back and forth between the loafing sites and the areas below the dam, in particular the juvenile bypass outfall. Typically the birds became active at first light and would forage in zone 2a below the juvenile bypass outfall. Activity would subside in late morning, and the birds would loaf approximately 0.75 km downstream of the dam (loafing sites, Figure 2.1). A loafing site near the north shore of the forebay was consistently used throughout the study period (loafing site 4, Figure 2.1). Tailrace use and foraging activity would then typically increase in the evening and dusk hours. Once darkness occurred, the pelicans would retreat to one of the loafing sites. It thus appeared that the pelicans using the tailrace typically remained in the area, but this could not be concisely determined or quantified without the use of marked birds. The data on relative abundance of birds using the tailrace and those using the loafing areas (Figure 3.5) also indicated there was some influx of birds to the area during the day. Maximum instantaneous counts combined (Figure 3.5) at loafing areas and the tailrace study zones may slightly inflate estimates of the actual number of birds found there, as observations taken at these sites were not simultaneously recorded. Again, this becomes difficult to quantify without monitoring marked birds

During the spring and summer, pelican use of the McNary Dam tailrace generally followed the juvenile salmonid out-migration season. The first pulse of juvenile salmonid passage was the spring chinook salmon, during which time the pelicans began to forage and remain in the tailrace area in increasing numbers. However, the foraging effort at this time was relatively low, and thus overall predation pressure by pelicans on the spring chinook salmon out-migration appears to be relatively low. Foraging efforts greatly increased concurrent with the next pulse of juvenile salmonid passage, which was composed largely of fall Chinook salmon.

The difference in pelican foraging effort between the spring run and fall run observed at McNary Dam may have to do with the age and swimming ability or other characteristics of the fall juvenile salmonid compared to the spring run. It may also be a product of the migration patterns of the pelicans whose arrival coincides with the beginning of the fall chinook salmon passage. The daytime observations from 2001, showing a peak in pelican numbers in late June, are consistent with this theory. Another possibility is that the foraging effort increased at that time because of hatching at the colony and subsequently increased energetic demands for the adult pelicans. However, the observational evidence obtained in 2002 suggests that the pelicans from the Badger Island colony contribute very little to the foraging at the tailrace. The arrival and departure observations from both the colony and the tailrace suggest that the birds tended to loaf and forage within their respective areas and did not appear to travel between the colony and the dam. The pelicans observed heading to and from the colony in the downstream direction usually were seen landing near the Walla Walla River delta or flying inland near

the Walla Walla River. Further evidence is that large numbers of the birds at the colony at any given time were observed foraging within about 1 km of the colony; hence, these birds were not likely to be foraging much at the tailrace as well. Note, this cannot be quantified without the use of individually tagged birds.

The diel foraging pattern also tended to coincide with the diel juvenile salmonid passage numbers through the bypass system, which often surged in the early morning and afternoon. The area in which pelicans had the highest observed bill-dip rates and the highest success rates (swallows) were the observation zones encompassing the juvenile bypass outfall.

In this study, almost no foraging activity was observed at night. Other studies on pelican foraging have demonstrated significant foraging at night (Anderson 1991; McMahon and Evans 1992a), but this likely relates to the lack of available prey during daylight. Because the pelicans lack visual references at night, this foraging is presumably accomplished by trolling their bills through the water until they come into contact with a potential prey item (McMahon and Evans 1992a). Because of the depth of the tailrace, perhaps pelicans foraging there simply cannot hunt efficiently by trolling because prey would be too deep for them to contact with their bills. The abundance of foodstuff in the tailrace and successful foraging during the day may also play a role in the lack of nighttime foraging by pelicans there.

Studies have also documented foraging in flocks where groups of pelicans will work cooperatively to herd fish into shallow areas for easier capture (O'Malley and Evans 1984; Anderson 1991; McMahon and Evans 1992b). This group foraging behavior was not observed in the pelicans in the McNary tailrace. The pelicans in the tailrace tended to forage as individuals. They would fly up near the bypass outfall and forage briefly, then drift away on the current, then fly back up to the outfall again. This behavior was repeated many times by some individuals and only a few times by others. However, the pelicans in the tailrace did cue off the successes of each other. Quite often when a pelican captured a fish, other pelicans in the vicinity would fly over to it and try to steal the fish or would bill-dip in the immediate area where the fish was caught. These small groups of birds would stay in proximity for a short time and then disperse. Kleptoparasitism was observed but was clearly not the primary foraging strategy either (O'Malley et al. 1983).

The physical constraints of the tailrace may play a role in the lack of group foraging. The strong current and relatively deep water likely prevent the birds from being able to successfully herd fish into an area where they would be easier to catch. It is likely that it is more efficient for them to hunt opportunistically. Therefore, foraging near and below the juvenile bypass outfall affords the pelicans a better chance of catching any fish that are near the surface, perhaps those that become disoriented after emerging from the outfall pipe. A study of pelicans in Wyoming suggested that diet composition was primarily determined by prey vulnerability (Findholt and Anderson 1995). As mentioned, this may be a factor in the concentration of foraging activity on the juvenile fall chinook salmon, if they are more susceptible to disorientation and remaining near the surface after emerging from the bypass.

None of the deterrents appeared to affect pelican use or foraging at the McNary tailrace, except a very short-term avoidance response to the water cannon placed at the juvenile bypass outfall at the beginning of the out-migration. Spill and total discharge will require more time-sensitive pelican use or foraging datasets to examine to what degree they affect pelican patterns there.

4.2 Capture and Tagging Feasibility

The original 2002 plan called for tagging adult birds at the nearby colony site for a more complete analysis of colony-related contributions at the McNary tailrace. However, colony access restrictions imposed by the State of Washington Department of Fish and Wildlife and USFWS refuge land managers prevented the examination of pelicans from the nearby colony.

Tagging efforts with wing (patagial) tags and leg bands were authorized by State of Washington Department of Fish and Wildlife and U.S. Geological Survey in mid-June 2002 for pelicans near the McNary tailrace. However, timing prevented these monitoring efforts from occurring during the early and peak out-migration periods.

The successful captures of the three pelicans in July illustrate the feasibility of capturing and tagging pelicans in the tailrace to accomplish a more detailed study of the site fidelity and movements of the pelicans using the McNary tailrace. The fact that 2 pelicans were caught less than 2 hours apart from the same site reduces the concern over spooking the birds after capturing one, causing the loafing site to be abandoned and preventing subsequent captures. However, this possibility is still a concern, and the captures should be spread out to as great a degree as possible to minimize this risk. Also, the use of pelican decoys at the capture site should help facilitate their return to the area.

More thorough and detailed consumption data are needed to confirm the general use and feeding trends observed in 2002. As well, more time-sensitive activity data are needed to assess any impact that changes in operations such as spill and total discharge at the dam may produce. To this end, a tagging and monitoring study at the juvenile bypass outfall may provide greater detail of foraging and use patterns by pelicans. Visual tagging will provide information about the size of pelican population there and the extent of in- and out-migration of pelicans at McNary Dam.

4.3 RF Tag Study

The small-scale captive pelican study was completed in mid-February 2003. Captive study results indicated the RF tags did not appear to adversely affect the birds when mounted to the upper bill. No tissue damage was observed from the cyano-acrylate adhesive, and the tag did not interfere with breeding sail (bill nob) development. Foraging efficiencies of birds used in this study (successful foraging attempts and catch rates) did not appear to be reduced.

RF tags consistently failed to adhere to the bills of the smaller and younger birds for a period of time sufficient to consider for field applications. However, tag retention time was substantial on the one adult male, whose bill had a relatively rough texture and was larger than the two other test birds.

Based upon these findings, approval by the U.S. Geological Survey and the Washington Department of Fish and Wildlife to attach RF tags to adult male birds at the McNary tailrace is anticipated.

These preliminary results indicate that RF tags might be useful in future capture and tagging events of mature male pelicans, for which the tags may be retained for up to 3 weeks.

4.4 Summary

This study has demonstrated that the use of the McNary Dam tailrace by the endangered American white pelicans coincides with the juvenile salmonid out-migration season. The juvenile bypass outfall area tended to be a focal point for pelican use and foraging activities throughout the juvenile salmonid out-migration season. A noticeable increase in use of this outfall area was observed during and following the peak in juvenile salmonid passage. Most of the intensive foraging efforts by pelicans appeared to be focused on the fall chinook juvenile salmonid that migrated past the dam in late June.

The diel foraging patterns of the pelicans also roughly coincided with the diel changes in the numbers of juvenile salmonid passing through the juvenile bypass facility (highest in the morning and afternoon). As well, the study showed that the pelicans using the McNary tailrace area do not forage substantially at night or in large co-operative flocks. However, group foraging near the shorelines was observed on rare occasion in areas greater than 1 km downstream of the tailrace. Although nighttime foraging was minimal within the tailrace study regions, limited nighttime foraging datasets were collected at the major loafing areas.

This study also suggests that the pelicans foraging at the McNary Dam tailrace tend to remain in that area. The nearby breeding colony on Badger Island, upstream of the dam, appears to make little contribution to the pelican population in the tailrace area. Pelicans from the colony were observed foraging in shallow backwater areas of the Columbia River within a short distance of the colony island.

The coarse operations at McNary Dam (i.e., spill and outflow) did not seem to influence the distribution or intensity of pelican foraging efforts. During periods of no spill, the pelicans did not change the areas in which they foraged from times when there was spill. As well, bird deterrent efforts at the juvenile bypass outfall did not seem to hinder the pelicans foraging below the outfall very much.

This study also demonstrated a suitable capture and tagging technique to use on pelicans in the McNary tailrace for future studies using telemetry and visually marked birds to better quantify the use and foraging patterns examined in this study. A small study that attached RF tags to 3 captive birds in 2002 suggested no serious threats are likely to be imposed on wild birds captured and fitted with RF tags used to measure foraging and use patterns.

Focal monitoring of the highest pelican use and foraging zones, “hot spots,” and tagging of several birds foraging in the tailrace area would allow more accurate estimates of the number of fish consumed by pelicans. Tagging birds will also allow for two estimator techniques: 1) catch per unit effort (bird-hour x fish consumed per hour), and 2) energetic-based estimates (number of birds x number of fish consumed per day x number of days). Data in 2002 clearly indicated that bird deterrent measures were not related to pelican use and foraging patterns near the juvenile bypass outfall. However, operational conditions such as spill and total discharge are so variable that the collection of foraging data using radio-telemetry may be needed to accurately demonstrate “cause-effect” on pelican foraging patterns.

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