Foraging Behavior and Reproductive Success of Ospreys along the Yellowstone River, MT

An Osprey bringing in a fish to a nest in Paradise Valley.

Renee Seacor[1]
Rocky Mountain College
Yellowstone River Research Center
1511 Poly Drive
Billings, MT 59102
renee.seacor@rocky.edu

Kayhan Ostovar
Associate Professor Environmental Science
Rocky Mountain College
Yellowstone River Research Center
1511 Poly Drive
Billings, MT 59102
Kayhan.ostovar@rocky.edu

Collaborators:
Marco Restani, St. Cloud University
Yellowstone Valley Audubon Society
The Peregrine Fund
The Cinnabar Foundation

Statistical Analysis:
Ulrich Hoensch, YRRC, RMC

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Introduction

Osprey (*Pandion haliaetus*) populations saw worldwide declines from the 1940s to the 1970s due to environmental contaminants (Poole 1982, Grove et al. 2009, Langner et al. 2011). In 1981, a study assessing the status of osprey in southeastern Montana found no osprey nesting along the Yellowstone River (Swenson 1981). Since then osprey populations have continued to increase on the Yellowstone River from Yellowstone National Park to Miles City, Montana (974 km). The increase in this osprey population coincides with more intense human settlement and development along the river and raises questions about osprey settlement patterns and factors influencing productivity. This study focuses on osprey foraging behavior, and success rates on the Yellowstone River and the influence this could potentially have on fledgling success.

Previous Research: In 2010 the Yellowstone Valley Audubon Society (YVAS) began monitoring the osprey nesting along the Yellowstone River. Members of YVAS each conducted observations at least once every two weeks at active nest sites along the river. In 2012, monitoring continued with the help of citizen scientists and the Yellowstone River Research Center (YRRC). The YRRC also initiated an additional study focused on evaluating mercury exposure to nestlings in this population. This collaborative research project determined a difference in fledgling success upstream versus downstream on the Yellowstone River (Sapp 2012).

In 2012, three ospreys were found entangled in polypropylene baling twine resulting in a 10% mortality rate in the population. The use of baling twine as a nesting

material has been documented as a mortality factor in two other osprey populations as well (Blem et al. 2002, Houston and Scott 2006). Other limiting factors for this population have yet to be determined and differences in fledgling success upstream versus downstream in 2012 prompted further research aimed at identifying factors influencing the productivity of this population.

Limiting Factors on the Population: We assumed that nesting sites were not a limiting factor in this population because of the large abundance of artificial utility pole structures containing unoccupied nests all along the study area and ospreys willingness to nest on these structures in the past (Poole 1982, Ewins 1996, Henny and Kaiser 2008). Prey abundance in previous studies has been shown to influence raptor foraging rates (Bechard 1982 Bretagnolle et al. 2008). Foraging success has also been shown to differ based on water clarity and aquatic vegetation density (Toschik et al. 2006, Johnson et al. 2009). Since water clarity and, other habitat conditions and the length of the study area (974 km) the opportunity to examine the difference in foraging success in areas with different habitat conditions (upstream vs. downstream). Foraging success influences fledgling survival and success rates (Poole 1982). By examining differences in foraging success rates upstream versus downstream we can begin to determine factors affecting the productivity of this population of breeding osprey.

Methods

Study Area: The Yellowstone River ecosystem in which this study took place is a highly dynamic, unregulated system, which is comprised of wide multi-channel reaches, forested

islands, gravel bars, and straight channels with cliffs. The study area extended approximately 974 km along the Yellowstone River from the WY-MT border (47°45'28"N, 104°02'42"W) to the MT-ND border (44°59'29"N, 110°30'58"W). The river was divided into upstream section and downstream reaches for comparison of fledgling and foraging differences. The dividing line was drawn at river kilometer 390 near the confluence of the Clarks Fork River. The upstream section of the river is generally a low volume, high gradient, clear, cold mountain system with primarily *Salmonidae* prey species. While the downstream section is a high volume, low gradient, turbid, warm-water system with a more diverse prey base. Vegetation change along the riparian corridor reflects the drop in elevation, from higher elevation (1750 m) forests dominated by conifers (e.g., *Juniperus*, *Pinus*, *Picea* spp.) to river bottoms (615 m) composed mostly of shrubs (e.g., *Salix* spp.) deciduous trees (e.g., *Populus* spp.). Upstream anthropogenic land uses along the river included small grain farming, livestock grazing while downstream involved more recreation, and urban-centered industries, such as oil refining and coal-fired power generation. Billings (pop. 106,000) is the largest city, and is situated approximately in the middle of the study area (405 km). Climate was semi-arid.

Data Collection: Behavioral observations were conducted on nesting osprey starting on 20 June 2013 and lasting until 14 July 2013. These dates were chosen based on known hatch dates from the previous two years of observation. Eight nests were chosen for observation, four nests on the upstream reach and four nests on the downstream reach. In order to distribute the location of nests selected, the river was divided into four equal river reaches with two nests chosen within each. Nests within the river reaches were selected based on

access and good observation locations. Nest sites selected for observation were located at river kilometers 143, 187, 356, 387, 409, 458, 621, and 639.

Foraging activity was determined by conducting four, four-hour behavioral observations at each nest. Start times were randomly selected for each four-hour observation period (0500 to 0900, 1000 to 1300, and 1500 to 1900). All nests were observed during each time block, with the fourth observation randomly selected from the three time blocks. This provided a suitable representation of foraging activity across all daylight hours at each nest site.

A spotting scope was used to observe prey deliveries from a distance of 25 to 90 meters from the nest. Time of prey delivery, size estimate of the fish being delivered, as well as the scientific families of fish delivered were recorded. Deliveries were photographed so fish species could be confirmed. Specific species were difficult to identify so fish were grouped into the following scientific families: Cyprindae, *Castomidae*, *Salmonidae*, *Centrarchidae*, *Castomidae*, and *Ictaluridae.* Sizes of fish were estimated in reference to an average male osprey body length (22").

This data was then used to run a linear regression model for each family of fish, and based off of the size estimate (cm) we calculated the biomass (g) of each delivery (Murphy et al. 1996). From nest observation data we calculated the total number of deliveries to each nest. We did not standardize the number of deliveries to nests by brood size because male ospreys do not adjust foraging rates by brood size (Spitzer et al. 1983). We then calculated the total biomass delivered to each nest per nestling (g), which then was standardized to brood size.

We pooled our data with nest observations conducted by YVAS and other citizen scientists to calculate the fledgling success for all active nests in 2013. Using Google Earth we measured the distance of the nest from the Yellowstone River to analyze if the, distance of the nest from the river was a factor in foraging activity (e.g. delivery rate).

Data Analysis: Data analysis was run with the assistance of biostatistician Dr. Ulrich Hoench. All statistical analysis were run on Microsoft Excel 2008. A chi-squared test was conducted on fledgling success upstream versus downstream. Foraging success data was quantified as 1) total number of deliveries, and 2) total prey biomass per chick (grams). A chi-squared test was run on both variables upstream versus downstream. A one-way ANOVA was run to evaluate distance of the nest from the river and foraging success.

Results

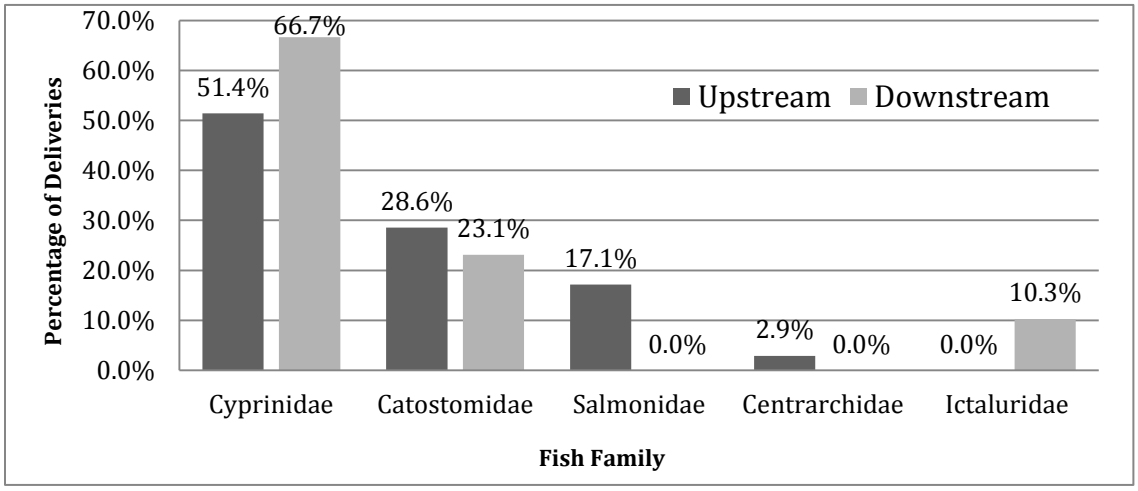
Behavioral observations were conducted on eight osprey nests during the 2013 breeding season totaling 128 hours of observation. Foraging success was quantified in two ways: total number of deliveries, and total prey biomass (g). For upstream nests (n=4) a total of 32 deliveries, downstream (n=4) a total of 37 deliveries (Table 1). Osprey nesting on the upstream river reach delivered twice as much total biomass per chick to their nests (2787 g) than the osprey nesting downstream (1320 g) (Table 1).

Table 1: *Overview of Foraging and Reproductive Success*

Study area section	Total no. of active nests	Mean no. of young per occupied nests	Percent of chicks fledged	Observed deliveries	Biomass per chick (g)
Upstream	32	1.3	59.4%	32	2787
Downstream	15	1.6	73.3%	37	1320

We determined variations in diet composition by totaling the number of each family of fish brought to the nest. The *Cyprindae* family was the most consumed fish (small minnows including carp) upstream (51%), as well as downstream (67%). In the upstream reach, three other families of fish were consumed: *Castomidae* (Sucker) (29%), *Salmonidae* (Trout) (17%) and, *Centrarchidae* (Sunfish) (3%). Downstream only two other families of fish were consumed *Castomidae* (Sucker) (23%), and *Ictaluridae* (Catfish) (10%)(Fig. 1).

Figure 1: *Composition of Fish Families in Osprey Nest Deliveries*



Osprey nesting further from the river delivered on average less frequently to their nests but on average more total prey biomass per chick (Fig. 2 & 3). There was a strong correlation (P= .0009) with the average biomass brought to the nest relative to the distance

of the nest from the river. A weaker, not significant, correlation existed between the total numbers of deliveries relative to the distance of the nest from the river (P= .015).

Figure 2: *Average prey biomass delivered per chick in relation to the distance of the nest from the river.*

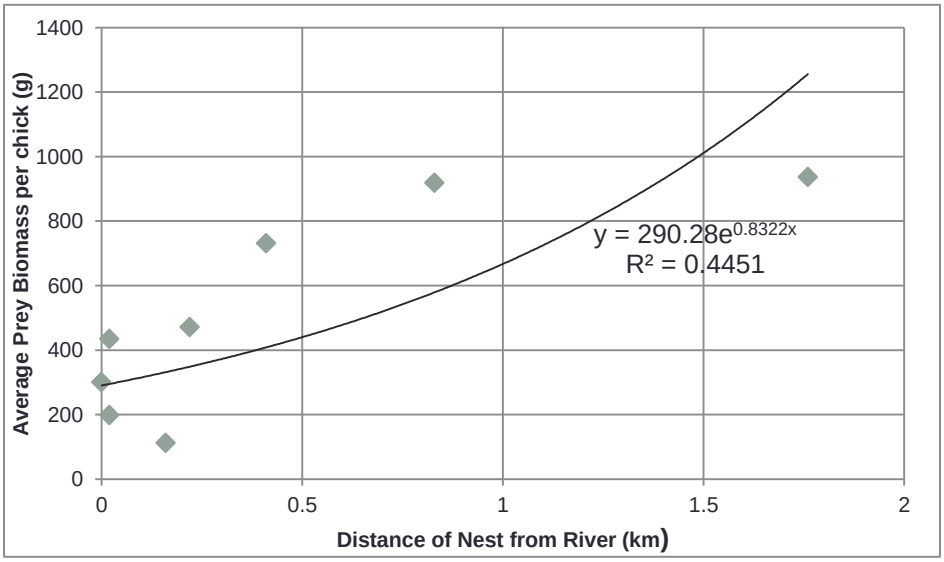
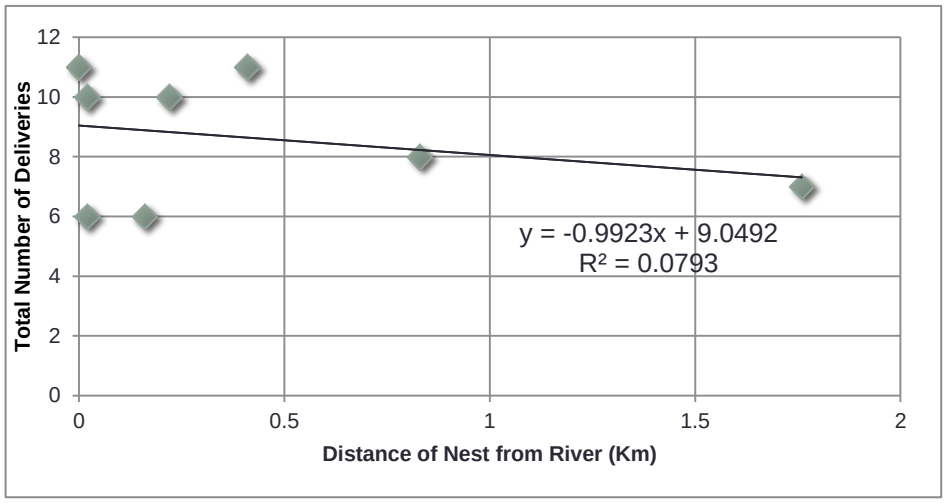


Figure 3: *Total number of deliveries relative to the distance of the nest from the river.*



Data from all nests with behavioral observations in this study were pooled together with all other nest observations by citizen scientists and observations during banding (n=47) to determine total fledgling success along the Yellowstone River in 2013. Ospreys nesting on the upstream reaches of the river were less successful then osprey nesting on the downstream reaches of the river (Table 1). Upstream the percent of chicks fledged from active nests was 59.4% while downstream, the percent of chicks fledged from active nests was 73.3% (Table. 1).

Discussion

While there was no significant difference in total prey deliveries in the upstream reach versus the downstream reach there was significantly more biomass delivered per nestling. In 2013 upstream of the river kilometer 390 there were a total of 32 active nests, while downstream there were a total of 15 active nests. Nesting site availability was not assumed to be a limiting factor in this population because of the numerous utility poles, and artificial nest structures located along the river in both the upstream and downstream reaches (Pulliam & Danielson 1991, Martell et al. 2002). The average brood size downstream was larger than upstream in 2013. Based on water clarity on the upstream section of the Yellowstone River we assumed greater foraging and fledgling success rates on that section of the river. What we found was the opposite, although there was more biomass per chick delivered to the upstream nests fledgling success was greater on the downstream nests.

Foraging Activity: On the upper Missouri River in Montana, prey abundance was found to shape the settlement of breeding ospreys (Harmata et al. 2007). Foraging success in

osprey has been shown to differ based on water clarity and aquatic vegetation density (Toschik et al. 2006, Johnson et al. 2008, Poole 2002). Greater foraging success (biomass per chick) upstream is a potential factor influencing reproductive success. Habitat conditions such as turbidity increase downstream on the Yellowstone River potentially decreasing foraging success rates and changing prey species composition. In our study the ospreys nesting on the upstream reach of the river had greater foraging success in terms of biomass per chick (g) brought into the nest than the osprey nesting on the downstream reach. While behavioral observations were only conducted at eight nests, this gave us a representative sample of how foraging varied on the river. To more accurately determine the correlation between foraging success and fledgling success future research on this population should consist of a larger sample size.

Fledgling Success: Greater fledgling success was recorded for the downstream nests when compared to the upstream nests for all 47 active nests monitored in 2013 (Tab. 1). The average brood size upstream was smaller (1.3) than the average brood size downstream (1.6) (Tab. 1). Since greater prey biomass per chick was documented upstream we would have expected a correlation with fledgling success rates. This correlation was not found, raising the question of what other factors are influencing fledgling success?

Fledgling success does vary based on numerous factors. A few factors specific to this study that had an effect on fledgling success were electrocutions, baling twine, and weather. In 2012, a 10% mortality rate was documented in this osprey population due to entanglement in baling twine. In 2013, there were no observed mortalities due to baling twine but one nestling was entangled upon a visit to the nest and was successfully freed. In

2013, we had three birds (two adults, and one nestling) die of electrocutions. Also in 2013, we had four nest monitors report that nests had blown down due to harsh storms that came through the area and we found five nonviable eggs in five separate nests during sampling all in the upstream section of the river. Harsh weather conditions; severe hailstorms and wind may have been a factor in egg failure. Another factor affecting fledgling success could be predators. Great horned owls *(Bubo virginianus)* have been observed and are prevalent over most of this study area and are also a known predator of osprey nestlings. While no Great horned owls were observed preying on nestlings, one nest monitor did observe and photograph common ravens *(Corvus corax)* taking osprey eggs from one nest in the upstream section.

Central Place Foraging Theory: We found osprey foraging behavior consistent with the central place foraging theory. This theory states that animals forage and return back to a central place with their food. When the animal has to travel a further distance to forage they bring back a larger quantity of food. This has been documented in numerous other species of birds including European starlings (*Sturnus vulgaris*), house martins (*Delichon urbicum*), sand martins (*Riparia riparia*), and swallows (*Hirundinidae*) (Bryant and Turner 1982 Kacelnik 1984). Our results support this theory since we found ospreys nesting further from the food source (Yellowstone River) bring a larger quantity of food back to the nest presumably because they have to travel a greater distance to fish (Fig. 2). Central place foraging theory has never been studied in osprey before and requires future research.

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