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Jessica L. Freeman
Western Oregon University

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The Distribution and Abundance of Aquatic of Macrophytes Between Nearshore and Farshore Transects at the Harriman State Park of Idaho Trumpeter Swan Wintering Ground, 1988-2015

By
Jessica L. Freeman

An Honors Thesis Submitted in Partial Fulfillment of the
Requirements for Graduation from the
Western Oregon University Honors Program

Dr. Jeffrey W. Snyder,
Thesis Advisor

Dr. Gavin Keulks,
Honors Program Director

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ABSTRACT

Trumpeter Swans, *Cygnus buccinator*, are native to North America and the largest waterfowl species in the world. This study was designed to determine the abundance and distribution of aquatic macrophytes in one of the most important wintering grounds that serve as a winter food resource of Trumpeter Swans: Harriman State Park of Idaho.

Within five sampled river sections, I sampled 20 transects, and approximately 320 point intercept frames. Total percent cover for nearshore transects among all four years was 72.57%, whereas total percent cover for farshore transects among all four years was 74.58 %. The top three species composing this coverage remains the same between both nearshore and farshore transects; *Zannichellia palustris, Elodea canadensis,* and *Potamogeton pectinatus* (*stuckenia* spp.). I found significant differences in species composition and total vegetative cover between nearshore and farshore transects. Species composition differences included bare ground, *Potamogeton pectinatus (stuckenia spp.)*, *Rannunculus aquatilis*, and *Zannichellia palustris*. Bare ground was significantly higher within nearshore transects, as was *Zannichellia palustris*. Contradictorily, I found significantly greater cover in the farshore transects for *Potamogeton pectinatus (stuckenia spp.)* and *Rannunculus aquatilis*.

Species composition between sections and years differed over time. In 2012, I found greater bare ground coverage in section D compared to 1988, 2011, and 2015. This may be due to increased spring river discharges carrying and depositing greater sediment loads into the section.

These results allow for important implications to be made regarding food availability for swans during the winter months when the top layer of the river freezes from the shore to the thalweg. Favored swan foods like *Zannichellia palustris* may be unavailable when ice-covered, whereas *Elodea canadensis, Rannunculus aquatilis* and *Potamogeton pectinatus* (*stuckenia* spp.) may be available during the early winter, even as reduced river discharges increase river icing across the entire river channel.

INTRODUCTION

As the largest native North American waterfowl, the Trumpeter Swan (*Cygnus buccinator*) is a long-lived (> 20 years in the wild) species easily identified through its large size, all white plumage, and trumpet-like call (Mitchell and Eichholz 2010). Trumpeter Swans were once abundant across North America; however, by 1900 they were almost extinct due to habitat loss and overhunting through both commercial hunting and subsistence hunting (Coale 1915). According to Mitchell and Eichholz (2010), there were only 69 Trumpeter Swans that were known to exist by 1935. Through conservation efforts (protection from shooting, habitat conservation and management, and range expansion programs) scientists and natural resource agencies have been able to restore this species to a portion of its former distribution. In 2005, a continent-wide survey was conducted and found 34,803 Trumpeter Swans (Mitchell and Eichholz 2010). Today, Trumpeter Swan population numbers have grown to 63,016; roughly 11,721 of which make up the Rocky Mountain Population (Groves, 2017). As populations increase, Trumpeter Swans have become an indicator species for healthy freshwater aquatic ecosystems due to their ability to thrive in clean waters and high-quality habitats (Creative et al. 2009).

Behaviorally, Trumpeter Swans build a foundation of strong family bonds to pass on knowledge of habitat occupancy from generation to generation. With the decline of the species during the 18th and 19th Centuries, crucial knowledge of traditional migration routes was lost in the population, as was knowledge to important winter food sources (Creative et al. 2009). Despite the recent increase in population abundance and distribution, many populations are still at risk from poor quality breeding habitats, continued loss of wintering habitats, and the concentration of wintering flocks at relatively few sites (Mitchell and Eichholz 2010). Winter habitats that provide open water, access to food, and security from distance can be difficult to locate (Mitchell and Eichholz, 2010).

The Rocky Mountain Population of Trumpeter Swans winters along the Henry's Fork of the Snake River through Harriman State Park of Idaho due to the shallowness, warmth, and ice-free river sections. During the winter, these birds feed on aquatic macrophytes to sustain their physiological health. Trumpeter Swans need the water they reside in to be warm enough to keep at least a portion of the river unfrozen, and warm enough for them to be in the water when their environment is cold. These birds also need a long area with no obstacles to be able to take off and land (Travsky and Beauvais, 2004). The ice-free sections of the Snake River of Idaho provide this open runway.

All organisms on Earth require basic concepts: food, water, cover, and space (Leopold, 1987). To determine how important these factors truly are, we must ask ourselves, how do these factors affect the survival and subsequent reproduction of Trumpeter Swans? To sustain optimal reproductive output, Trumpeter Swans must be in good physiological health (USFWS, 2008). If one of the four factors is unavailable for swans during the months, they will be unable to sustain physiological health for the subsequent spring reproduction, which leads to a poor reproductive output. This is critical to Trumpeter Swans due to the species ability to survive in the Rocky Mountain Population (Tamisier and Grillas, 1994).

During the wintering months, favorable habitat is an important factor in their survival. This crucial time is one of the most stressful times for Trumpeter Swans due to the fact that the wintering months are a limiting factor of survival for this species. When the Trumpeter Swans have access to food resources, they are able to survive, and sustain their physiological health for successful reproduction (Tamisier and Grillas, 1994). On the shore, these birds are subject to land predators without a way to escape them. Within the channel thalweg, Trumpeters are safe from land predators, and have access to aquatic macrophytes. Limitations occur for both locations, with the biggest limitations being shores covered in snow, and the channel thalweg covered in ice.

Food habits of Trumpeter Swans greatly reflect the time of year they are trying to feed during. When they winter at Harriman State Park of Idaho, their diets tend to consist mainly of *Elodea canadensis* according to Squires and Anderson (1995) and augment this diet by also feeding on agricultural crops. However, Snyder (1991) showed Trumpeter Swans' preference for river sections containing *Potamogeton pectinatus (stuckenia spp.)* and *Zannichellia palustris.* According to Squires and Anderson (1995), depending on the time of year and age of Trumpeter Swan, the typical diet ranges from agricultural crops on land, to macrophytes within the rivers. Cygnets and nesting swans tend to only feed in the river, while mature Trumpeter Swans will feed on land and in water. However, during the winter, when snow and ice limit available food sources, Trumpeter Swans will feed primarily on aquatic macrophytes available in the river (Squires and Anderson, 1995).

My research objective was to learn about the abundance and distribution of aquatic macrophytes at Harriman State Park of Idaho. Specifically, I was interested in determining if swans might be limited in their food availability based on the flow gradient in the river, and the macrophytes that are found relative to their location across the river channel.

My null hypothesis is as follows: there is no significant difference in aquatic macrophyte abundance and distribution between nearshore and farshore random transects at selected river sections in the wintering and feed grounds. My alternate hypothesis is as follows: there is a significant difference in aquatic macrophyte abundance and distribution between random nearshore and farshore transects at selected river sections in the wintering and feed grounds.

STUDY AREA

The area of study for this research project took place in Southeast Idaho, specifically in Harriman State Park of Idaho. Within this location, there is a 12-mile length of Henry's Fork of the Snake River (Snyder, 1991). This area was chosen due to it being the preferred wintering location of the Rocky Mountain Population of Trumpeter Swans (USFWS 2008). All of data for this study were collected in 1988, 2011, 2012, and 2015.

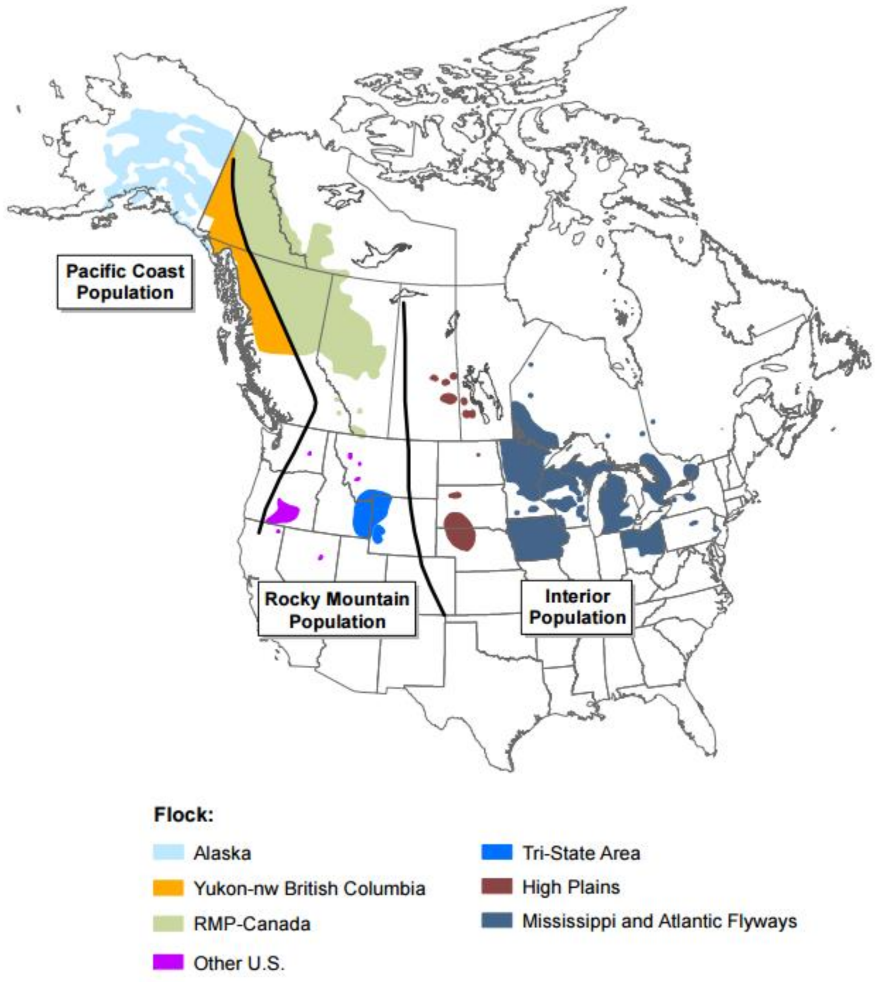


Figure 1. Map of the United States of America showing wintering and breeding grounds of different populations of Trumpeter Swans. (Groves, 2017).

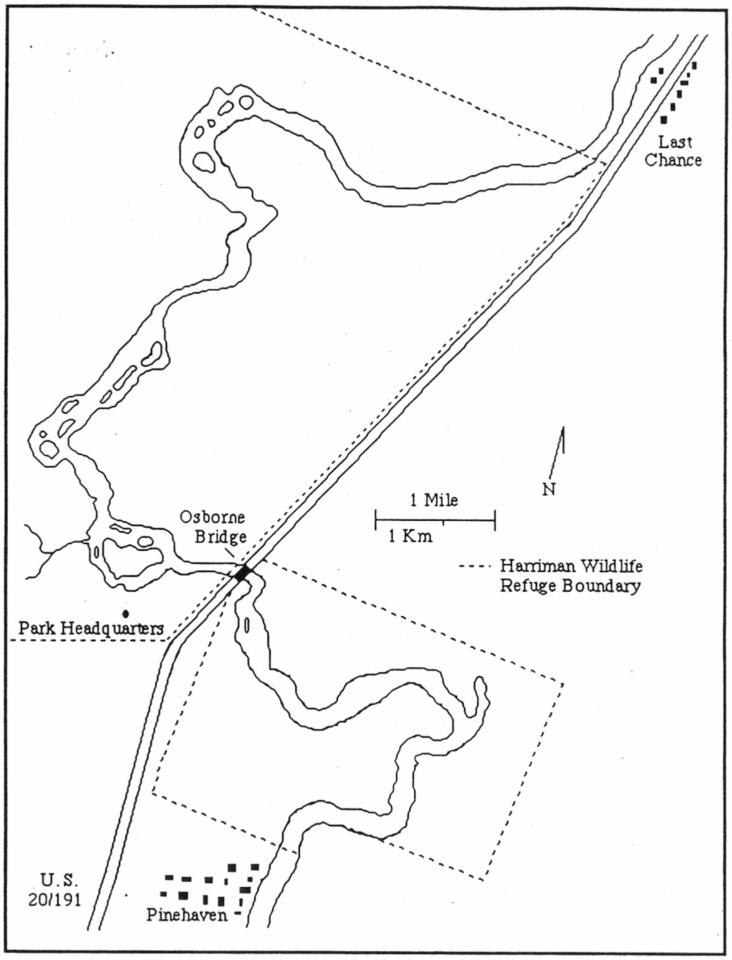


Figure 2. Harriman State Park of Idaho Trumpeter Swan wintering grounds along Henry's Fork of the Snake River.

METHODS

In order to determine an ecological measure for abundance and distribution I decided to quantify percent macrophyte cover. According to Snyder (1991), there are three possible methods of determining the coverage of aquatic macrophytes: the Daubenmire frame, line interception, and the point interception frame. The Daubenmire frame (Anderson and Floyd, 1982) is a qualitative method, which relies on subjective assessment from the researcher to determine the percent coverage seen in the frame. Although it is the fastest process of the three, it does not capture the accuracy of aquatic macrophyte cover. The line intersection method uses a line transect laid down over the vegetation. The researcher would report the vegetative species every centimeter down the line. This is very tedious and time consuming, and over estimates the cover of rare species (Anderson and Floyd, 1982). The point interception frame was deemed the most accurate method of collection to use. With the point interception frame, a frame is built with a certain number of points on two superimposed grids, and those points would be used to locate and identify aquatic macrophyte species. This process was almost as fast as the Daubenmire frame, but with a higher rate an accuracy (Anderson and Floyd, 1982).

The point interception frame constructed by Anderson and Floyd (1982) uses wood, three adjustable aluminum camera tripod legs, and black fly-fishing line as the primary construction materials. Applying the point interception method in a flowing river necessitated the size of the frame to be reduced to allow for safe transport in the water. Steel was used instead of wood and aluminum to withstand river forces (i.e., [Snyder, 1991] felt that wood would rot in water, aluminum tripod legs would bend, and would have been awkward and dangerous to carry in deep water because of its large size). The modified point interception frame was constructed of 0.64 cm diameter (0.25 in.) cold-rolled steel (approx. price $11) welded into two superimposed 61 x38 cm frames, spaced 10 cm apart, and four 30 cm support legs (Figure 3). Yellow fly-fishing line was used to construct thirty 7.5 x 10 cm grids on each frame.

This pattern produced 20 superimposed grid points. Anderson and Floyd (1982) constructed their frame with 36 grid points per frame, recommending a minimum number of 17 grid points per frame. This new frame was smaller, yet the number of grid points still exceeds Anderson and Floyd's recommended minimum number.

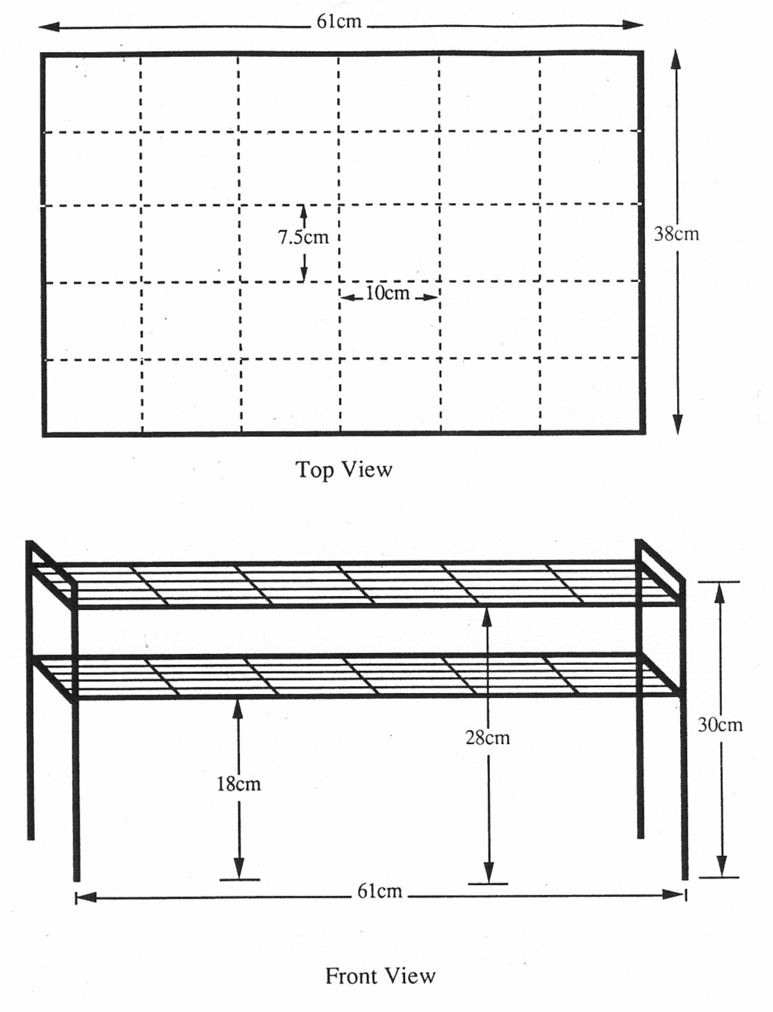


Figure 3. Point Interception Frame created based on Anderson and Floyd's (1982) methods.

The Henry's Fork Trumpeter Swan wintering ground is divided into seventeen sections (Snyder, 1991) for the purposes of quantifying Trumpeter Swan distribution and abundance and river icing. Aquatic macrophyte abundance and distribution, as measured by the point interception method, were quantified for these previously identified river sections and placed randomly (Snyder, 1991). First, a random baseline transect point was selected at each river section along a line drawn from the beginning to the end of each river section. The flip of a coin determined which shore to place the transect, and its position was marked on a topographic map (scale 1:24,000). Once the baseline transect "beginning" was located at the study area, a 50 m tape was laid in the downstream direction parallel to the river flow (Figure 4). Along this 50 m baseline transect, 4 sampling points were randomly selected. Four 50 m sampling lines, perpendicular to the river flow, were then established in the river. If two or more sampling lines were 1 m apart or less, then a new sampling line was chosen to avoid inadvertent trampling of aquatic macrophyte beds yet to be sampled. A random 20 m section of each sampling line was then selected for sampling. At each sample line, a set of three steel reinforcing rods was driven into the river bottom along the sampling line. A nylon rope marked with 1 m intervals was tightly stretched just above the river surface. At this time, I determined if the entire length of the sample line could be walked with the frame. If it could not be walked, then a new sample line location was selected. This may bias estimates of abundance by selectively eliminating plants existing in deep water. The point frame was read at 1 m intervals by placing its long axis parallel to the tape at the

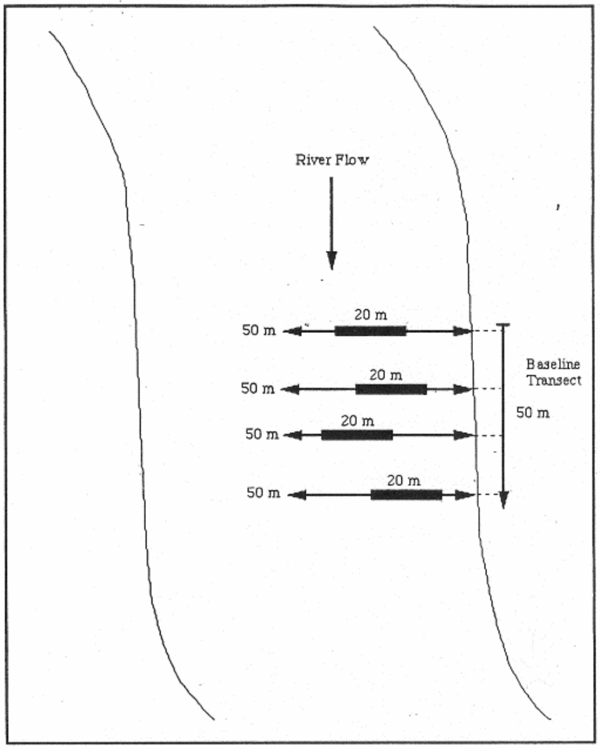


Figure 4. Map of the river showing the baseline and river transects with regard to river flow.

predetermined distance along the upstream side of the sampling line and adjusting it to an optically level position to insure vertical projection of the grid points. A 0.32 cm thick, 35 x 25 cm plexiglass case was floated over the frame to clearly identify aquatic macrophytes that lay directly underneath the two superimposed grid points without bias due to light diffraction. A species was recorded when it lay under the two superimposed grid points. The first two letters of the plants' scientific name served as a species code. When aquatic macrophytes were moving underneath the frame from the force of water, I counted to the number "five" and recorded the macrophyte species directly underneath the proper grid points. This eliminated any bias associated with selectively choosing a slow-moving plant. When a large rock prevented me from properly positioning the frame, I moved it to the next adjacent sampling point and read an additional frame at the end of the sampling line. These were *a priori* decisions. The number of points falling on a species divided by the total number of points sampled then equaled the percent cover for that species. No assumptions were made about plant canopies or their possible effect on covering a species; either a species fell on a grid point or it did not (Anderson and Floyd, 1982). The steel fence post, marking the "beginning" of the baseline transect, remained at the study site to allow subsequent investigators to sample the lines (Snyder, 1991). Nomenclature followed Hotchkiss (1972). I hypothesized that there were no significant differences in aquatic macrophyte cover among species and river sections.

I collected data from farshore transects (established 15m - 30 m from shore), and from nearshore transects (0m - 14m) in selected river sections that were identified as primary feeding sites (C, D, F, P, and Q [Snyder, 1991]). To determine significance, I used a general linear model (GLM) multi-way analysis of variance test (ANOVA) with a logit transformation of percent data (Warton and Hui 2011). For overall plant cover between transects, I used a Kruskal-Wallis test (Zar, 1984) to compare differences in total plant cover between transects.

RESULTS

Based on these results, I reject my null hypothesis of there being no significant difference in species composition between nearshore and farshore transects. I found significant differences in species composition and vegetative cover between nearshore and farshore transects.

I sampled five sections within the river. Within these sections, I sampled 20 transects, and 1,316 frames. Total percent cover for nearshore transects for all four years was 72.57% while total percent cover for farshore transects for all four years was 74.58 %. The top three species composing this coverage remains the same in both nearshore and farshore transects; *Zannichellia palustris, Elodea canadensis,* and *Potamogeton pectinatus* (*stuckenia* spp.), respectively. I found a significant difference between nearshore and farshore transects regarding species composition (Figure 5). Species composition significant differences included bare ground, *Potamogeton pectinatus (stuckenia spp.)*, *Rannunculus aquatilis*, and *Zannichellia palustris* (species one, six, eight, and nine [Figure 6]).

Bare ground was significantly higher within nearshore transects, as was *Zannichellia palustris*. Contradictorily, *Potamogeton pectinatus (stuckenia spp.)* and *Rannunculus aquatilis* were found in significantly higher levels in farshore transects.

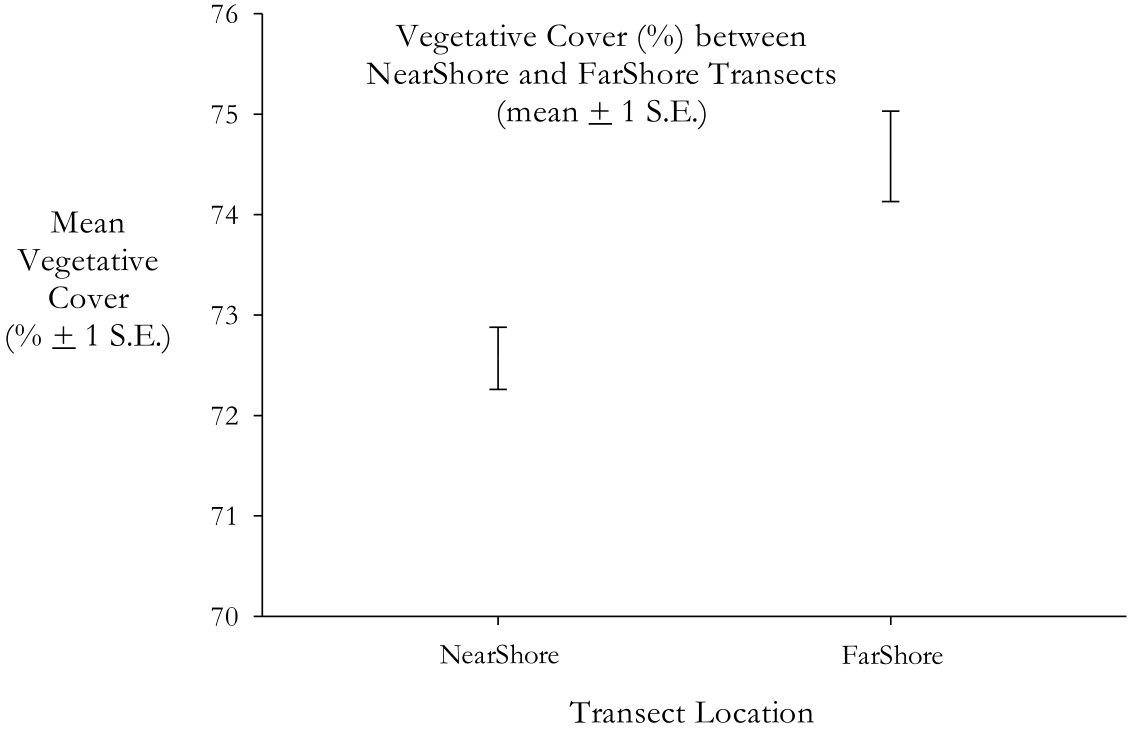
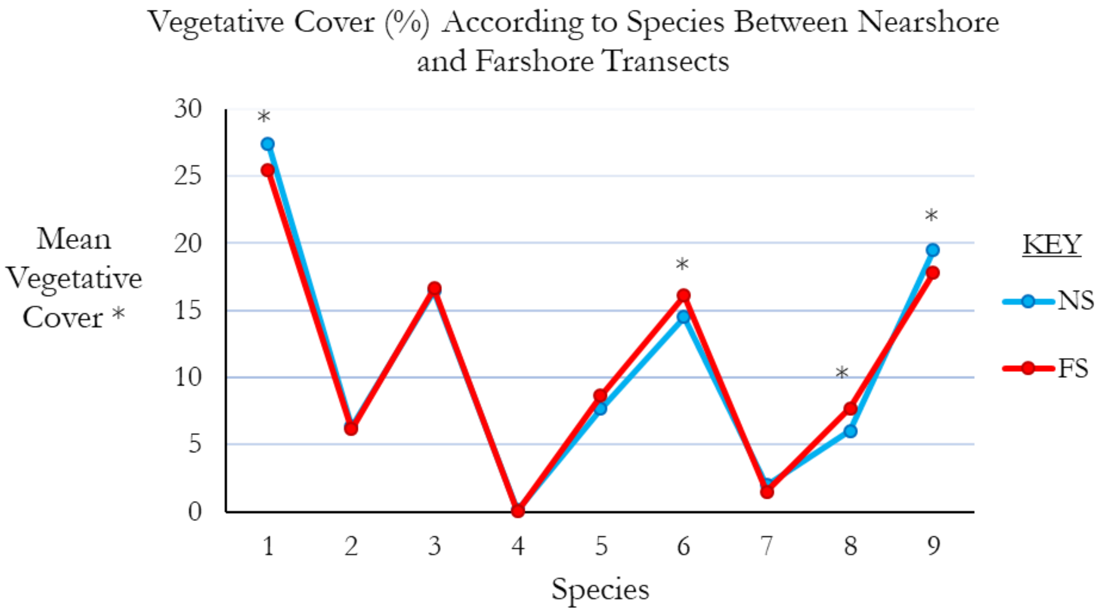


Figure 5. Comparison of vegetative percent cover between nearshore and farshore transects. 1989, 2011, 2012, and 2015 data included.

Species composition between sections and years differed over time. In 2012, I found greater bare ground coverage in section D compared to 1988, 2011, and 2015. This may be due to increased spring river discharges carrying and depositing greater sediment loads into the section.



SPECIES KEY:

Species 1: Bareground
Species 2: *Callitriche hermaproditica*
Species 3: *Elodea canadensis*
Species 4: *Lemna trisulca*
Species 5: *Myriophyllum spicatum*
Species 6: *Potamogeton pectinatus (stuckenia spp.)*
Species 7: *Potamogeton richardsonii*
Species 8: *Rannunculus aquatilis*
Species 9: *Zannichellia palustris*

*: Astrisk indicates standard errors did not overlap; therefore there is a significant difference

Figure 5. Comparison of vegetative percent cover between species in regard to nearshore and farshore transects. 1989, 2011, 2012, and 2015 data included.

Figure 5 shows there is a significant difference in percent coverage between nearshore and farshore transects. However, nearshore transects retained more bare ground than farshore transect areas by about 2%. Additionally, there is a significant difference with the statistical model for bare ground, *Potamogeton pectinatus (stuckenia spp.)*, *Rannunculus aquatili*, and *Zannichellia palustris*.

Based on the data collected, there is a specific trend shown that both transect locations exhibit. Although the general trend remains similar between nearshore and farshore transects, there are distinct differences that are significant between certain species. These species include *Potamogeton pectinatus (stuckenia spp.)*, *Rannunculus aquatili*, and *Zannichellia palustris*, as well as the amount of bare ground.

DISCUSSION

The habitat of the Snake River is crucial when examining the species composition of nearshore and farshore transects; including the river hydraulics, river flow, and the ability of the aquatic macrophytes to survive and reproduce in such conditions. If the flow of the river is too extreme, it is difficult for new species to establish and maintain their existence. Therefore, only strong and established species would be able to survive. Aquatic macrophytes and Trumpeter Swans show a very distinct form of interaction, this interaction is seen through species composition of the plants and the winter-feeding grounds of Trumpeter Swans. I found plants occupy a large percentage of both nearshore and farshore transects.

A complication arises during the winter when the river begins to freeze, beginning from the shoreline and freezing towards the middle of the river (Snyder, 1991). Wintering Trumpeter Swans can only access aquatic macrophytes in the ice free portions in the river. Nearshore plants are not available when the ice freezes over the river edges, which leads Trumpeter Swans to the middle of the river where they are able to take advantage of the farshore aquatic macrophyte population.

To survive, organisms must be able to survive and reproduce (Leopold, 1987). Organisms must ensure their habitat is favorable for both survival and reproduction. Aquatic macrophytes require nutrients, which they receive from the water they are in and the sunlight they absorb. Based on the preliminary analysis, differences in river flow may affect the location of aquatic macrophyte species across the riverbed channel. The average percent cover of aquatic macrophytes shows there is significantly more average coverage in farshore transects than nearshore transects in these preferred river sections.

When comparing this to the original question of the study, it is reasonable to conclude that the placement of the aquatic macrophytes seem to respond to a gradient of ever-increasing flow of the river. Aquatic macrophyte species in the thalweg may be resistant to higher flows possibly due to the plants being able to remain established in a certain area, reproduce successfully, and continue to survive with an ice influence. These concerns may not be relative to species within nearshore transects.

Trumpeter Swans are physiologically stressed during the winter months due to limited food resources, attempting to retain physiological health for subsequent spring reproduction, and occupying safe wintering grounds that allow the escape from predators. Trumpeter Swans occupy the river sections that have open, ice-free water for the most part of the winter months. These sections (C, D, F, P, and Q [Snyder, 1991]) are favored due to their available food resources (aquatic macrophytes), and the escape open, ice free water provides. Open water tends to be a beneficial safe zone for waterfowl when confronted by land predators, such as a coyote (Kempthorne and Collignon, 2002). After examining aquatic macrophytes and Trumpeter Swans as separate entities, it is imperative to merge them together to truly grasp the implications of this study.

During the winter months, the level of water in the Henry's Fork decreases, thus significantly reducing the thalweg area. The level of water is planned by regulated discharge releases from the upstream Island Park Dam. This action decreases the river water depth. As air temperatures and discharges decrease, ice begins to form on the shore and eventually stretches to the middle of the river. This means nearshore transects are the first transects to be covered by ice, and unavailable to serve as food sources for Trumpeter Swans. Most of the sections near the thalweg tend to be the only sections of Henry's Fork to remain uncovered and available for use (Snyder, 1991). Any remaining availability of ice-free water is due to the thermal influence of warm springs in the wintering ground. These springs feed into the river and are able to keep the overall temperature of the river warm enough to not completely freeze over (Snyder, 1991). When Trumpeter Swans feed during these months, they are most likely feeding in the areas of the thalwegs, and on specific types of plants. Aquatic macrophytes that are preferred by Trumpeter Swans, if they are available, are *Potamogeton pectinatus (stuckenia spp.)*, *Rannunculus aquatili*, and

Zannichellia palustris (Snyder, 1991). This diet directly correlates to the findings of my research. However, Squires and Anderson (1995) found *Elodea canadensis* to be the most preferred aquatic macrophyte for consumption in the greater Yellowstone area (intersection of Idaho, Montana and Wyoming).

According to the data, there is a significant difference in the species *Potamogeton pectinatus (stuckenia spp.)*, *Rannunculus aquatili*, and *Zannichellia palustris* at the 5% level in the General Linear Model between nearshore transects and farshore transects. This significant difference also adheres to the amount of bare ground in nearshore and farshore transects. The data show greater bare ground in the nearshore transects than the farshore transects. This could be due to the nearshore transects being the river sections where water is limited due to the regulation of local dam discharges and that these sections are easily covered by ice in the winter, both of which lessen the ability of aquatic macrophytes to establish themselves and successfully survive.

As the population of Trumpeter Swans continues to struggle, research regarding aquatic macrophyte availability and food resources at their major wintering grounds should continue. With further investigation and more data collection, researchers, and scientists will begin to truly understand how this population of Trumpeter Swans are able to survive during wintering months.

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