The Ecological Significance of Mountain Whitefish (*Prosopium williamsoni*) in a Central Idaho Wilderness Stream

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Abstract

Organisms that may be ecologically important are often overlooked if they have not been perceived as being beneficial to humans or esthetically appealing. Mountain whitefish (*Prosopium williamsoni*) are among the most abundant native fishes in western North America, yet their ecological role is largely unknown because they have not been considered a valuable game fish. Here I propose to investigate the ecological significance of mountain whitefish in Big Creek, a wilderness watershed in central Idaho. In this study I will use underwater counts and hook and line surveys to determine whitefish distribution and abundance and estimate their biomass, nutrient, and energy contributions within the aquatic ecosystem. This study will determine the significance of an overlooked organism in an ecosystem that has not experienced major human landscape modification.

1. Objectives

1. Determine the summertime distribution of mountain whitefish in the Big Creek watershed.
2. Estimate population abundance, size structure, and biomass of mountain whitefish in the Big Creek watershed.
3. Analyze mountain whitefish tissues to estimate energy and nutrient composition per unit of fish mass, and compare to published values for other species.
4. Estimate the ecological contribution of mountain whitefish in the Big Creek watershed by estimating total whitefish biomass, nutrient, and energy composition in units of mass and energy.

By addressing these four objectives, I will begin to determine the ecological significance of mountain whitefish in the Big Creek watershed, and my analysis will help characterize the role mountain whitefish play in overall nutrient and energy flows within aquatic ecosystems.

2. Importance

As ecological awareness has grown, an important realization has been that any organism may play an important, multifaceted role in its surrounding ecosystem. Thus it is important to study the role of key organisms as valuable parts of an ecosystem, even if their direct human benefit has not yet been realized.

Mountain whitefish (*Prosopium williamsoni*) are among the most abundant fish in western North American rivers and lakes from northern British Columbia south to the Lahontan Basin of northern Nevada (Scott, 1973). Mountain whitefish are members of the family Salmonidae, the same family as trout, salmon, and char. In many relatively unimpacted rivers, mountain whitefish may make up a large component of fish biomass and production (Goodnight and Bjornn, 1971; Baxter, 2002).

Figure 1: Mountain whitefish (*Prosopium williamsoni*) constitute a large portion of fish biomass in many rivers of western North America, and may also serve as important transport vectors of nutrients and energy within aquatic ecosystems.

Despite their significance, mountain whitefish have received little research or conservation attention. Historically mountain whitefish were viewed by the public and fisheries managers as no more than a nuisance and an inhibitor to trout abundance. Attempts have often been made to locally extirpate mountain whitefish (Erickson, 1966). At present, mountain whitefish are regarded as a lower class, non-target game fish, and in most of Idaho they receive little to no conservation consideration, with legal harvest limits higher than any other salmonid (the daily, legal harvest limit of mountain whitefish is 25 fish per day; IDFG, 2001).

As a major component of fish biomass and production, mountain whitefish may serve as important reservoirs and transport vectors for aquatic nutrients and energy. Based on the oily texture of their tissues, they may possess greater per mass energy and nutrients than other fishes in Big Creek, but no tissue analysis has been performed on this species. In part, the importance of mountain whitefish may be due to their migratory life cycle which connects small streams with larger, more productive river habitats. In streams where there are no or reduced numbers of other migratory salmonids (e.g. pacific salmon and steelhead) these movements may be especially valuable constituents of ecosystem nutrient and energy cycles. This may be particularly important in central Idaho streams where natural salmon returns have been severely diminished since the completion of hydroelectric dams on the lower Snake River in the mid 1970s.

Mountain whitefish movements are often closely tied to feeding and spawning habits (Davies and Thompson, 1976). Many migrate in the spring and early summer from large rivers into small tributaries to feed, and presumably to evade higher summertime water temperatures. As water temperatures cool and days shorten in late summer and early fall, mountain whitefish migrate out of smaller tributary streams back to deeper areas in large rivers for spawning and over-wintering (Brown, 1952). Mountain whitefish often exhibit migratory homing, returning to the same streams during each migration movement (Liebelt, 1970; Davies and Thompson, 1976;

Behnke, 2002).

In order to understand the ecological significance of mountain whitefish in a natural setting, the study will be conducted in Big Creek, a tributary to the Middle Fork of the Salmon River located within the Frank Church-River of No Return Wilderness in central Idaho (Figure 2). The wilderness nature of the Big Creek drainage allows for the study of natural watershed ecosystem processes in the absence of large-scale human landscape alterations. Mountain whitefish in Big Creek likely display a migratory life-cycle similar to that described elsewhere in the Snake River Basin, with fish moving into Big Creek from the Middle Fork of the Salmon River in early spring and summer and returning to the Middle Fork of the Salmon River in the fall. This study will be conducted during the summer, when their abundance should be greatest, and they can be easily surveyed and sampled.

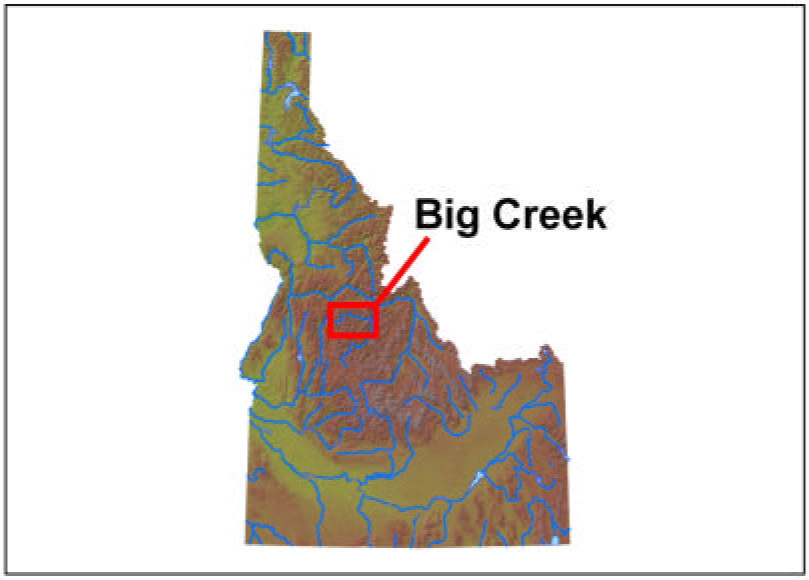
During watershed ecology studies being conducted by Dr. Baxter and colleagues, abundant mountain whitefish were observed in Big Creek. I had the opportunity to participate in an extensive underwater fish survey of Big Creek as part of that study. From that experience I gained a desire to study the ecology of this potentially important fish species in a wilderness watershed. I plan to evaluate the ecological significance of mountain whitefish in Big Creek by addressing three working hypotheses.

Hypothesis 1: Mountain whitefish constitute the dominant fish biomass in Big Creek.

Hypothesis 2: Mountain whitefish possess more energy and nutrients per mass than other fish species found in the Big Creek watershed.

Hypothesis 3: Mountain whitefish are the largest fish-based reservoir of nutrients and energy now present in the Big Creek watershed.

It is my hope that this research will foster a public and scientific appreciation for mountain whitefish as a critical part of western aquatic ecosystems. A greater appreciation for this species will not only lead to more research, but a shift in conservation strategies that will encourage its preservation.



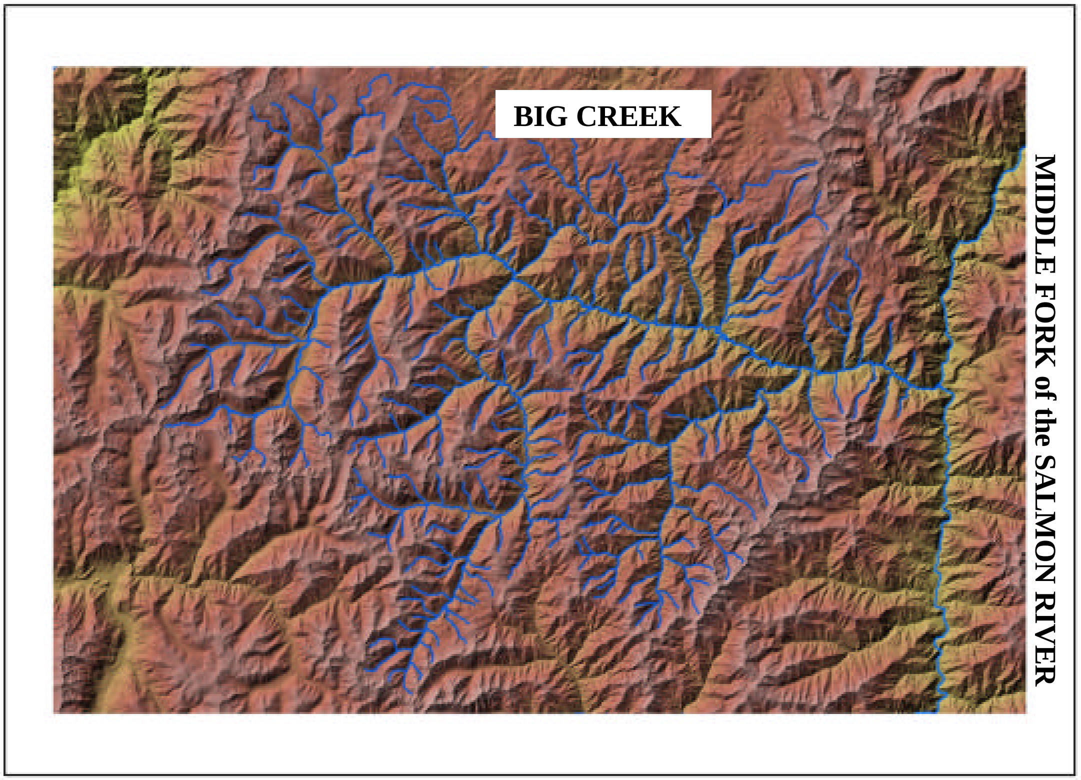


Figure 2: Big Creek shown in reference to the state of Idaho, and a map showing the Big Creek watershed which flows east into the Middle Fork of the Salmon River. Most of the Big Creek watershed is included within the Frank Church River of No Return Wilderness Area, the largest wilderness area in the contiguous United States. This area also constitutes the largest area in the Snake River Basin that is largely unaltered by humans (IDWR, 2005).

3. Fulfilling educational and career goals

As an ecology student at Idaho State University, it is my goal to better understand natural ecosystem processes. The opportunity to participate in a wilderness stream research project was a major catalyst driving my desire to conduct my own undergraduate research. This project will not only be an opportunity to apply some of the ideas and concepts I have learned, but it will also help me to fine tune skills necessary for future graduate level research. Once I have completed my program of study at Idaho State University, I am going to continue with graduate studies emphasizing fisheries ecology and watershed management. I then plan to apply my education in natural resource and ecosystem management techniques working with an agency such as the U. S. Forest Service. I will be able to use my education and experiences to help better manage and protect the ecosystems on which we and all organisms are dependent.

This research project will be an essential experience in the progression of my career. Not only will I be able to gain a better perspective of natural ecosystem and scientific processes, but I will be able to learn, practice, and use research methods that I will use repeatedly in future graduate and natural resources studies.

4. Methods

Abundance of mountain whitefish within the Big Creek watershed will be estimated through repeated visual counts at locations along the length of Big Creek. Sites will be delineated between the upstream limit of mountain whitefish distribution (to be determined) and the Middle Fork of the Salmon River. Exact sites will be chosen upon arrival and examination of each reach. The area of Big Creek that will be surveyed will be somewhat dependent upon the densities of whitefish found and the amount of time available. Some surveys may be conducted in the lower reaches of two large tributaries, Rush and Monumental creeks.

Visual counts will be conducted using snorkeling survey methods similar to those used in other recent studies of fish assemblages in Pacific North West rivers (Baxter, 2002; Torgersen et al., in press; Figure 3). For snorkel surveys, Big Creek will be divided into stream segments and reaches[1]. Within each segment, survey reach units approximately 300 m in length will be delineated. Each unit will consist of a stream reach containing habitat that is representative of the entire segment. Underwater surveys will commence once spring flows drop enough to render Big Creek safe and clear enough to achieve accurate visual counts. Each unit will be snorkeled multiple times throughout the summer to count fish abundance. Units will be snorkeled in two passes, the first to gather mountain whitefish counts and approximate sizes, and the second to count all fish species present. The multiple passes will allow for estimates of mountain whitefish abundance and snorkeling efficiency (how accurately fish numbers are estimated with a snorkel survey) at each site. Counts will then be compared and referenced to spatially continuous surveys of fish assemblage structure by Dr. Baxter and colleagues during the summers of 2005 and 2006. This will allow extrapolation to estimate total mountain whitefish abundance.

Figure 1: Snorkel surveys will be conducted to determine the abundance and approximate size of mountain whitefish in the Big Creek watershed.

Hook and line sampling will be conducted using traditional angling techniques to obtain measurements of whitefish length, age, and weight, and to collect fish for analyses of tissue protein, lipid, and energy composition. The standard method for physical capture of fish is the

[1] A stream segment consists of a portion of stream with in which similar hydrologic and sediment transport processes are present. A stream reach is a smaller unit within a stream segment where similar pool and riffle configurations are found.

use of an electric current to stun fish (electrofishing), but this will not be used in order to prevent possible adverse affects to fish species in Big Creek that are listed as threatened species under the Endangered Species Act (Chinook salmon *Oncorhynchus tshawytscha*, steelhead trout, *Oncorhynchus mykiss*, and bull trout *Salvelinus confluentus*). Angling provides a good means for analyzing physical characteristics of fish populations without being intensely harmful. A total of 150 fish will be measured for total length (from the tip of the snout to the tip of the caudal fin), weighed, and will have two scales removed from just below the dorsal fin for use in determining approximate age. Fish will be immediately released following proper recovery. For tissue analyses, a random sample of 45 fish will be euthanized via blunt force.

Tissue analyses will consist of removal of otoliths (analogous to mammalian ear bone structures) and analysis of tissue protein, lipid, and energy composition. Otoliths will be used to determine exact ages and give an otolith/scale age relationship (otolith age calculations are exact where as scale aging can be skewed due to environmental conditions). Under the guidance of Dr. Ken Rodnick, analysis of tissue protein, lipid, and energy composition will be conducted at University of Idaho’s aquaculture facility in Hagerman, Idaho using methods similar to those described by J. A. Green and colleagues (2002). For this type of analysis, fish will be pureed so that a uniform tissue sample can be retrieved. Pureed samples will be centrifuged to separate and analyze lipid and nitrogen content, and another sample of 1 ml of pureed fish will be inserted into a bomb calorimeter to estimate per unit mass energy content.

Once all data has been collected it will be compiled and entered into a database. Then population estimates and confidence intervals will be calculated using CAPTURE, a software program for population estimation (Otis et al., 1978; White et al., 1982). Whitefish total biomass by age class will be estimated by multiplying the population estimate by the mean mass of individual fish, which will be estimated using length-weight regressions. Tissue composition of mountain whitefish will be analyzed by fish size, age, and sex, and will be compared to published values for other Pacific Northwest fishes. Total watershed nutrient and energy composition will analyzed by multiplying per mass estimates of lipids, nitrogen, and energy by total whitefish biomass estimates. Finally, data will be entered into a Geographic Information System (GIS) where fish distribution, density, biomass, and energy can be displayed and analyzed.

5. Time Line

Preparatory GIS analysis to aid in the selection of survey sites will be performed in the fall of 2005, and field research will begin in May 2006 after the end of the spring semester at Idaho State University. Once on Big Creek, work will commence delineating sites for repeated surveys. With the opening of the general fishing season on May 27, hook and line sampling will be conducted until water levels recede enough to conduct snorkel surveys. Once water levels are safe and clear enough, snorkel surveys will begin and continue until August 20. During the fall semester at Idaho State, work will continue processing otoliths and tissue samples. Finally, analyses, calculation, and interpretation of tissue composition, age, distribution, and abundance will be synthesized into a final report to be submitted for dissemination.

7. Cooperation

My faculty sponsor on this work is Dr. Colden V. Baxter. Dr. Baxter's research specialty has been the study of aquatic food webs and aquatic-terrestrial interactions between food webs influencing nutrient and energy flows. He will assist with some field work, in addition to providing guidance in study design, methods, analysis, and write-up. This project will be integrated with Dr. Baxter's study of land-water linkages within the Big Creek watershed.

Further cooperation will come from Dr. Ken Rodnick. Dr. Rodnick will help with fish tissue analysis to be conducted at University of Idaho's Hagerman facility.

8. Dissemination

This work will be disseminated in several different ways. Results of the study will be presented at the 2007 state and western meetings of the American Fisheries Society. Present at the meeting will be fisheries, watershed, and aquatic ecology professionals from resource management, administration, education, and research. Also, the final report will be presented at the spring 2007 Idaho State University undergraduate research symposium. Ultimately, with Dr. Baxter's assistance, I intend to publish the key findings in a peer reviewed journal such as: *Freshwater Biology, Transactions of the American Fisheries Society*, or *Western North American Naturalist*.

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