20 Year Management Plan of Snake River Finespotted Cutthroat Trout (*Oncorhynchus clarkii behnkei*) in Southeastern Idaho

Dinah DiMeolo

Spring 2022

Paul Smith's College

Submitted: April 26th 2022

A paper submitted in partial fulfillment of the requirements for the degree of Bachelor of Science in Fisheries and Wildlife Sciences, Wildlife Concentration, at Paul Smith's College.

Executive Summary

Snake River Finespotted Cutthroat Trout *(Oncorhynchus clarkii behnkei)* is a freshwater trout species native to the upper Snake River and its tributaries between the states of Wyoming, Idaho, and Montana. This species is recognizable by its fine hair-like spots delicately speckling its entire body, and often have distinctively rosy colored gill plates which characterize its name, “cutthroat”. Similar to many salmonid species, cutthroat face many challenges with reproducing due to predatory competition within spawning season. Larger, more dominant fish such as Brown Trout *(Salmo trutta)*, and Rainbow Trout *(Oncorhynchus mykiss)* are known to often prey on active Cutthroat redds for an easy opportunity for a meal. With 0.03% of Cutthroat Trout eggs having the chance to survive to become parr, the risk of predatory species eliminating a large portion of these eggs is becoming increasingly more and more important to manage. These predators continue to be introduced and stocked into more native Cutthroat Trout waters, which is not allowing this species of concern to thrive or reproduce in greater numbers on their own. Aside from predators in the water, all trout species are currently facing the detrimental effects of climate change, which are impacting waterways worldwide and most especially cold-water fisheries. With rising risks of drought, forest fires, low water levels and high water temperatures, Cutthroat Trout are in urgent need of proper management. To increase the opportunity for Snake River Finespotted Cutthroat Trout to abundantly reproduce, a 20-year management plan studying best fit practices for conserving Cutthroat Trout eggs within redds will be introduced. This study will assess how to protect the redds safely and effectively without harming the amount of oxygen the eggs will be receiving and keeping predators away from the redds without causing damage to other microhabitats within the streams. Education will also be a large component of this management plan, aiming to increase public knowledge and awareness of ethical catch and release practices of anglers, and maintaining ethical decisions while fishing highly trafficked fishing locations during summer months. For a species already suffering from lack of reproduction and struggling with the outcome on streams from climate change, pressure from fishing tourism is a large variable that is crucial to properly manage. With the implementation of extended research on protecting redds, increased public education events on trout conservation, and improved knowledge to fishermen on ethical fishing practices in order to keep this trophy species healthy, the future for Snake River Finespotted Cutthroat Trout has potential to improve significantly.

Contents

Introduction

Snake River Finespotted Cutthroat Trout (*Oncorhynchus clarkii behnki*) are recognized as one of the most concerned subspecies of Cutthroat Trout in modern time (Homel and Kershner 2014). Many trout species within the last decade have seen major population declines all due to similar issues, mainly relative to the declination of aquatic ecosystems. With degradation of streams, habitat fragmentation, and nonnative species competition standing in the way of allowing this species to flourish, management implications are necessary to enforce. Conservation strategies for other Cutthroat Trout subspecies have been implemented in several states throughout the United States, but Snake River Finespotted Cutthroat Trout specifically have not had sufficient support in managing for their conservation (CRCT Coordination Team 2006).

Snake River Finespotted Cutthroat reside in their historical range between the Snake River headquarters to below the Jackson Lake Dam within Grand Teton National Park in the United States (Homel and Kershner 2014). Historically, this species was known to travel great distances through spring-fed creeks to reach optimal spawning habitats to build redds in. Throughout the scenic range of river within and outside of Grand Teton National Park, over 600 kilometers of streams and tributaries contribute to the watershed in which these fish reside (CRCT Coordination Team 2006).

A proper management plan for Snake River Finespotted Cutthroat Trout would allow the species to not only thrive in its historical range but survive and reproduce effectively in the distribution they have acquired throughout evolution. Without proper management, they will continue to be outcompeted by other nonnative species such as Brook Trout *(Salvelinus fontinalis),* Rainbow Trout *(Oncorhynchus mykiss)* and Brown Trout *(Salmo trutta)* (Peterson

and Fausch 2003). Long term efforts to increase population sizes by protecting spawning fish, as well as implementing necessary regulations within angling tourism to reduce mortality in several different ways can boost the success of potentially increasing Snake River Finespotted Cutthroat Trout populations and conserving this historical species. The model below shows the increase in Snake River Finespotted Cutthroat Trout by properly managing for greater juvenile survival rate from egg to fry, and implantation of protection on redds to increase egg survivability from predators. (Figure 1).

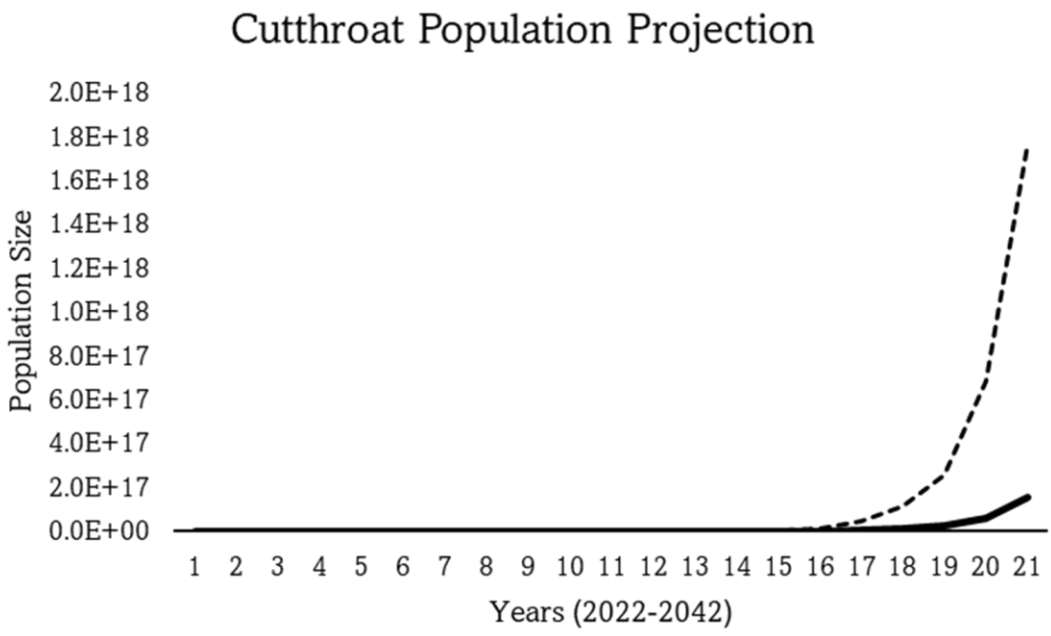

Figure 1. Population projection of Snake River Finespotted Cutthroat Trout over the next 20 years with proper management implementations (dashed) versus current management.

Natural History

Taxonomy

The classification of Cutthroat Trout (*Oncorhynchus clarkii*) is separated into 14 unique subspecies categorized by their different geographical locations among the Western United States (Trotter et al. 2015). Costal, Westslope, Boneville, and Snake River Cutthroat are just a few of the many subcategories of Cutthroat Trout that have developed over the years. Originating known as *Oncorhynchus clarkii,* other subspecies of Cutthroat have gained their own classifications, the three most commonly being *O. c. lewisi, 0. c. henshawi*, and *O. c. bouvieri* (Trotter et al. 2015).

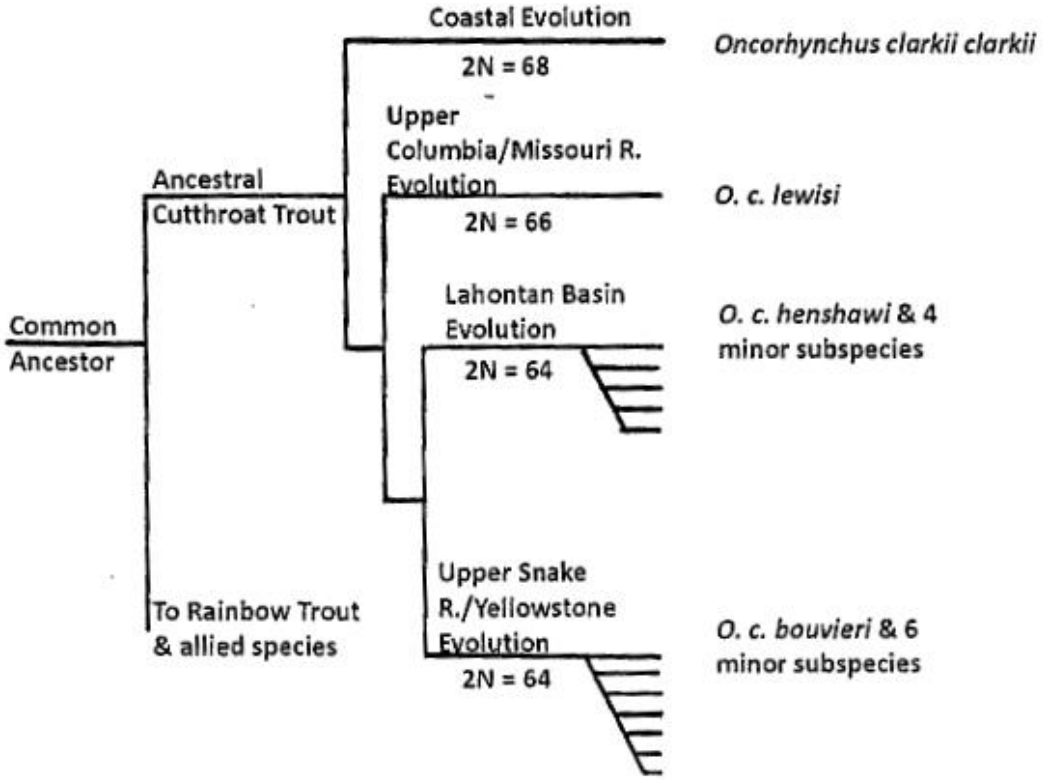

Figure 2. Assumed phylogenic classification of Cutthroat Trout into four major subspecies and 10 minor subspecies (redrawn from Trotter et al. 1988).

Species Identification

This species is easily recognizable by their bright reddish-orange patch near the gills, where the name "cutthroat" originates. (Trotter et al. 2015). Identifiable by irregular defined spots along their dorsal fins, and their bright colored throat, their body color is variable from silverish yellow, to brighter orange-reddish colorations. (Trotter et al. 2015). These dots are often described as "pepper-like", exemplifying the delicate dappling that these fish are observed to have (Trotter et al. 2015). They have the smallest spots of any other Cutthroat subspecies, which reflects their name. The distinctions between Yellowstone Cutthroat and Snake River Finespotted Cutthroat are minimal, and besides the size of the spots and slightly different coloration, the two species are often have misidentified.

Figure 3. Distinct markings of Snake River Finespotted Cutthroat Trout, exhibiting bright red gills, finely speckled tail and fins (Carl 2011).

Spatial Distribution

The classification of Cutthroat Trout (*Oncorhynchus clarkii*) is separated into 14 unique subspecies categorized by their different geographical locations among the western United States (Trotter et al. 2015). Dating back in history, it is claimed that Cutthroat likely originated in Asia, reaching parts of North America where they integrated into the Columbia River Basin. Today

they range from as far west as the Yellowstone and Missouri Rivers to as far east as the Arkansas River (Trotter et al. 2015). Snake River Finespotted Cutthroat are the species with the smallest historical distribution of any other Cutthroat subspecies, while their range in modern time extends out between several different states (Trotter et al. 2015). Robert Behnke, long-time researcher of Cutthroat Trout claims that due to the resilience of this subspecies, Snake River Finespotted Cutthroat Trout are the only subspecies to continue to dominate their historically native range (Carl 2011).

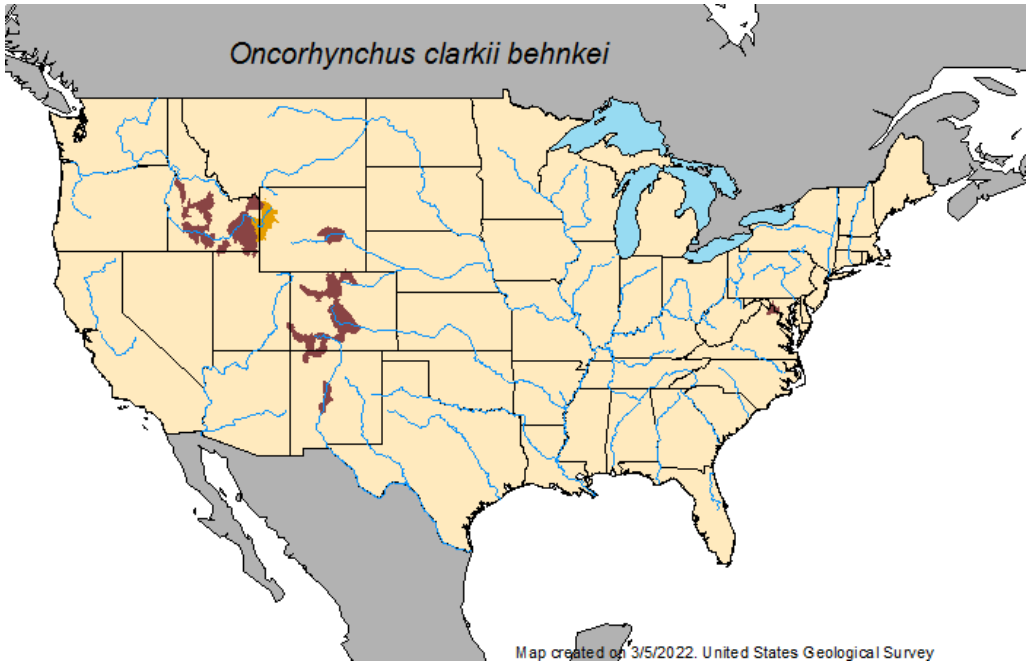

Figure 4. Native and non-native hydrologic unit codes of Snake River Finespotted Cutthroat Trout (Neilson and Fuller 2022).

Habitat

Cutthroat Trout require deep, cold bodies of water, mainly large rivers, lakes, and tributary streams, in which contain a high amount of dissolved oxygen and plenty of gravel substrate to create redds (Peterson and Fausch 2003). They also favor structure in the water such

as large woody debris, boulders, and other similar places that allow them to seek cover. Cutthroat Trout use cover for both feeding and hiding from predators. Snake River Finespotted Cutthroat specifically tend to seek areas with coarser gravel substate on the stream or river bottom, rather than small sandy sediments. Small deep pools and behind shallow riffles are common areas to find Cutthroat sitting by and waiting to find food sources.

Spawning requires cooler temperatures, which are often found in shaded areas of streams near banks and downed trees (Peterson and Fausch 2003). Here, they preferably look fir looser gravel which they can easily access with their fins in order to create redds to deposit eggs. While predation on eggs is one of the greatest threats to these fish, it is necessary for a female to find a specifically safe location to lay these eggs redds (Peterson and Fausch 2003). Additionally, population decline has been observed in areas near construction and mining, which impacts the water quality and therefore the survival rates of the fish (USDA Forest Service, 2007).

Diet

Aquatic macroinvertebrates are a large portion of the diet of Snake River Finespotted Cutthroat Trout (Hilderbrand et al. 2004). Cutthroat trout are opportunistic omnivores, and will primarily consume macroinvertebrates such as stoneflies, caddisflies and mayflies, as well as small fish, fish eggs, and occasionally terrestrial insects. Hilderbrand et al. (2004) studied Cutthroat Trout diet in comparison to Brook Trout and analyzed the diet overlap showing that Cutthroat consume a significantly more invertebrates compared to brook trout in individual trials. Both diets consisted mainly of representatives from the Diptera and Trichoperta families (Hilderbrand et al. 2004).

Reproduction

Reproduction varies among different subspecies of Cutthroat, as elevation and temperature impact the timing at which these trout will reproduce. Typically, late spring and early summer will be the range for Snake River Finespotted Cutthroat to begin spawning, as the water temperatures rise slightly after the winter, before the harsh summer temperatures begin to occur (USDA Forest Service 2007). Adult Cutthroat do not reach sexual maturity until they are approximately three years old and can lay clutches of eggs ranging from several hundred to several thousand depending on their age and past success of spawning.

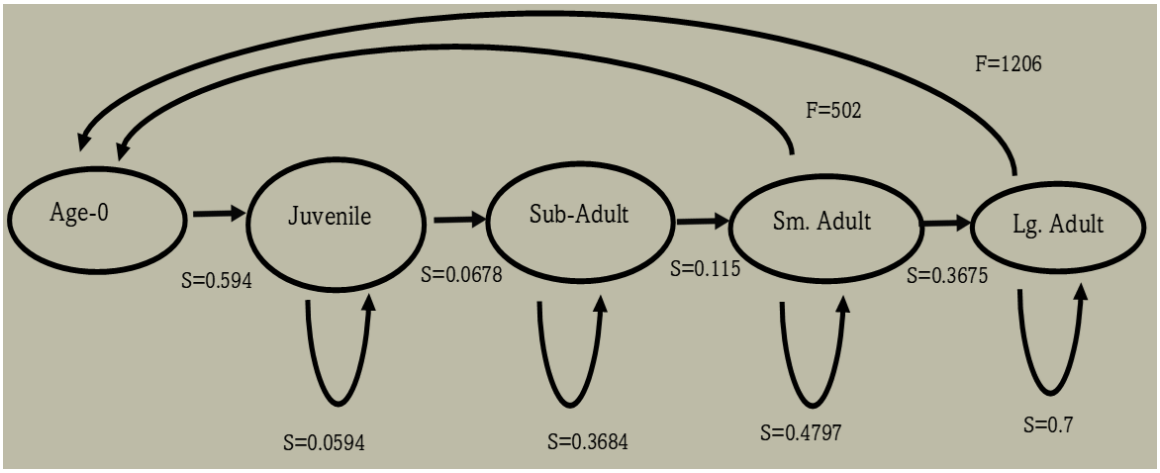

Figure 5. Population life diagram of Snake River Finespotted Cutthroat Trout based off population indices from surrogate subspecies.

Mortality

Mortality of eggs is caused significantly by predation on eggs from nonnative trout species or other predators (Roberts et al. 2017). Already being such an isolated species, Snake River Finespotted Cutthroat Trout face many challenges form predatory species outcompeting and overpopulating streams where they cannot lay enough eggs to account for their eggs that are

being predated on. Nonnative competition combined with the negative effects from the global climate crisis cause this species to have a very difficult time being able to account for their losses in trying to produce for a better population (Roberts et al. 2017).

Aside from direct predation, Snake River Finespotted Cutthroat and many other trout species face significant mortality from the effects of climate change, and other water related issues caused by climate change (Roberts et al. 2017). Based on Trout Unlimited's *Conservation Success Index of Snake River Finespotted Cutthroat Trout*, nearly 80% of the watersheds which this species occupies are considered highly threatened, with a conservation success index score greater than 81/100 (Williams 2006). Findings showed high climate success index (CSI) of a significant portion of the watersheds that this species lives in, and that while climate effects are a large threat to their wellbeing as a species, the introduction of nonnative species still remains the greatest threat of all. Figures 5 and 6 exemplify the drought risk among the distribution of the species, and the integrity of the populations among different locations. It is observed that southeastern Idaho, the lower left corner of each figure shows significant drought risk, and low integrity for both restoring population and habitat. Additionally, stream near Idaho Falls is visibly different in the conservation strategy map (Fig. 6) where the population integrity is near extirpated for reintroduction (Williams 2006).

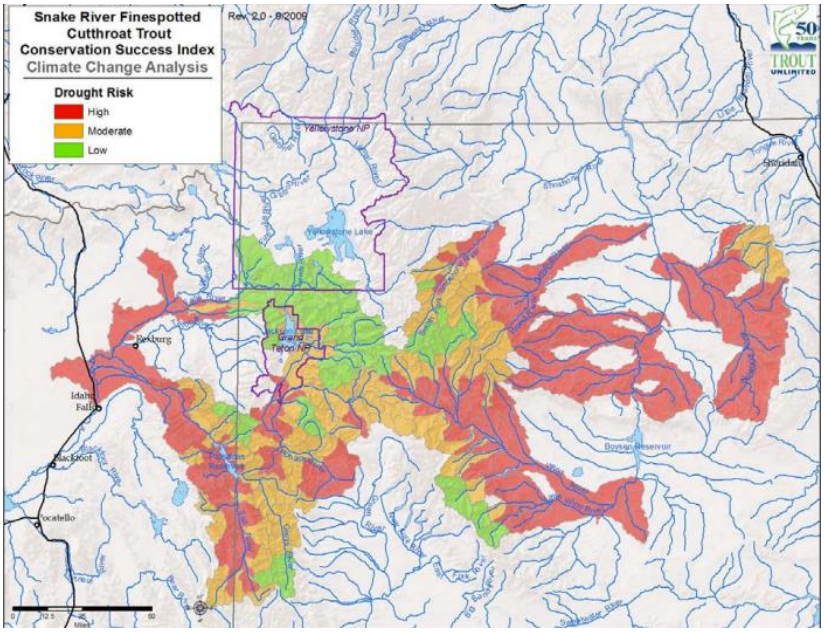

Figure 5. Climate change analysis of Snake River Finespotted Cutthroat Trout habitat, visualizing the drought risk among the distribution of the species (Williams 2006).

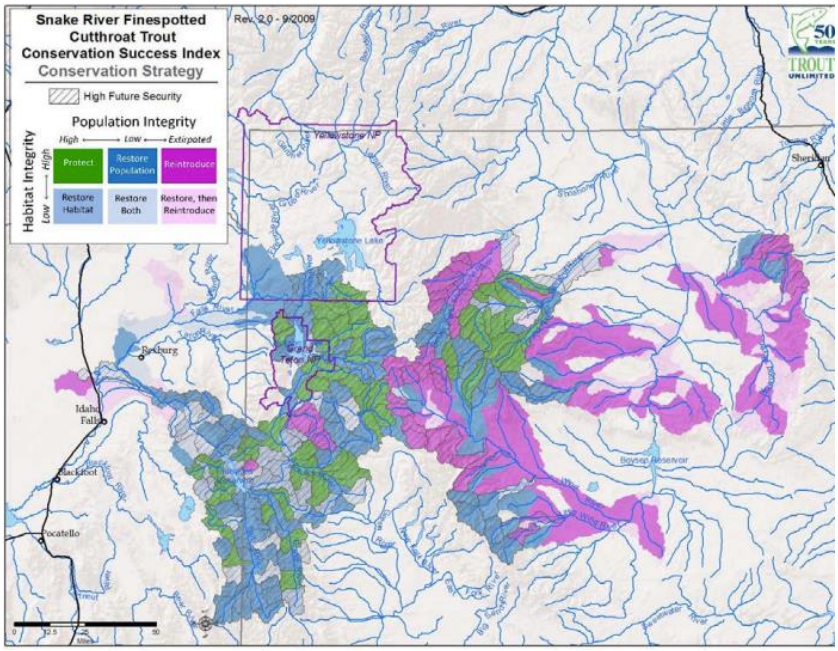

Figure 6.. Conservation strategy comparison of Snake River Finespotted Cutthroat Trout habitat, visualizing the population integrity and habitat integrity among the distribution of the species (Williams 2006).

Competition

Cutthroats are often found to survive in the presence of other non-native fish such as Brook Trout, Brown Trout, and Rainbow Trout (Roberts et al. 2017). While management of other Cutthroat species have been effective in isolating subspecies from other invasives, Snake River Fine Spotted Cutthroat have not had efficient management in keeping these other outside species away from impacting their own populations (Roberts et al. 2017). Competition for food resources and spawning habitat are the greatest variables in reference to competition, and Snake River Finespotted Cutthroat are at constant battle with these other species for these resources. Given that they still live in their native geographical distribution, they have resiliently continued to hold their native range, but continue to compete for resources to maintain their populations.

Disease

Trout in general are susceptible to various diseases living in abundant populations with many other individuals (CRCT Coordination Team 2006). The most prevalent disease Cutthroat Trout specifically suffer from is *Myoxoblus cerebralis* (MC), better known as whirling disease. MC was found to effect highly sensitive trout species more than any other fish in these streams, as they are well known as an indicator species of poor water quality and therefore diseased water. This highly transmissible disease is can raid through hatchery populations of Brown Trout, Rainbows, and Cutthroat. Stocked trout are well recognized as a high threat to native trout populations in healthy streams prior to stocking (CRCT Coordination Team 2006).

While whirling disease impacts other trout species besides Cutthroat, it is a significant threat to populations of native Cutthroat among the west. Introducing new nonnative species to native Cutthroat streams has been a highly debated topic in recent years as it is threatening to these fish.

Roberts et. al 2016 shared that translocation have decreased significantly and almost came to a complete halt in the last 15 years, due to finding the source of where this disease was stemming from. Isolation simply was not enough to slow the spread of this water-borne disease.

A study comparing the five main Cutthroat Trout subspecies identified Snake River Finespotted Cutthroat to be moderately affected by this disease in comparison to the four other subspecies. It was found that in a comparison of frequency distribution percentages of 5- and 10-week-old eggs, approximately 94% of Snake River Cutthroat eggs were infected with *Myoxoblus cerebralis* (Wagner et. al 2002).

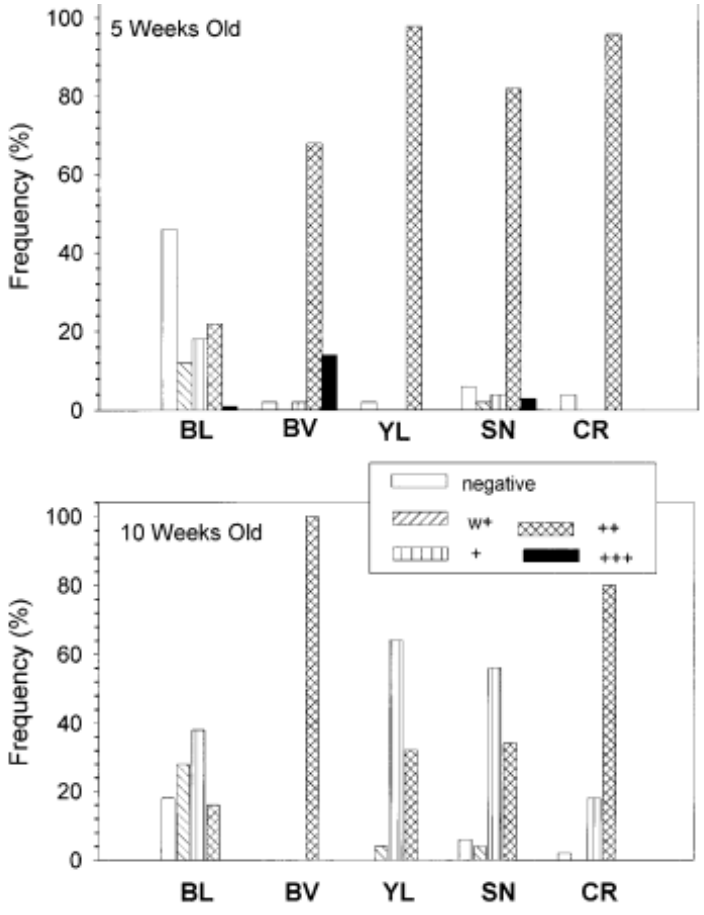

Figure 1. Frequency distribution comparison of Cutthroat Trout subspecies (Wagner et al. 2002)

Additionally, mortality is also often caused by parasitic diseases that infect the fish, most commonly pancreatic necrosis (USDA Forest Service 2007). This viral disease has also been observed to cause infectious kidney problems as well as pancreatic issues. Pancreatic necrosis causes significant inflammation to the pancreas causing atrophy of the muscle and can ultimately lead to death in this fish. At this time, there is no effective treatment for trout of any species to recover or be treated for pancreatic necrosis (Okamoto et al. 1993).

Conservation Needs

Economic

Similar to the sociocultural impacts ecotourism has on maintaining trout populations worldwide, ecotourism is also a large contributor to the economic impact this industry possesses. Anglers play a large role in supporting fisheries monetarily by fishing licenses and gear. Worldwide, over 34 million individuals participate in recreational angling and almost 30 million licenses alone are purchased within any given year (Zwirn et al. 2005). In the state of Idaho, an adult resident 1 year fishing license is $30.50. In 2020, the Idaho Department of Fish and Game sold 376,464 fishing licenses, a 15% increase of resident and nonresident tag sales (Boise State Public Radio 2020). This is a significant economic impact, and the money used to purchase tags goes back into many research and management projects. On the contrary, poor angling practices are also responsible for a large portion of fish mortalities, such as harming species of concern and using the wrong type of tackle or bait which will harm fish (Zwirn et al. 2005).

Sociocultural

Ecotourism is one of the largest contributors to the impact of sociocultural influences with Cutthroat Trout. Within ecotourism, fishing is the largest platform of these impacts. Many people look at ecotourism as being a positive influence on the tourism industry,

but only to a certain extent (Macdonald nd.). It is important to encourage a balance between supporting sustainable ecotourism and continuing to maintain and improve fisheries habitat.

With fishing being such a large contributor to poorly managed ecotourism, an influx of anglers with little knowledge on properly handling and catching fish can ruin trout populations (Hoogendoorn 2017). A case study in South Africa found that by implementing proper fishing interpretation and education, ecotourism can have a more positive impact on fisheries and produce more responsible anglers (Hoogendoorn 2017). With angling being some of the primary sources of income for people in these fishing towns, proper education is crucial for keeping these businesses going.

Regulatory/ Policy

Several different subspecies of Cutthroat Trout have come near the brink of extinction, but only the Lahontan Cutthroat Trout (*Oncorhynchus clarkii henshawi*) are currently still protected under the Endangered Species Act (California Department of Fish and Wildlife Nd.). While Snake River Finespotted Cutthroat Trout are not listed under the Endangered Species Act, they have formerly been a candidate for review of listing endangered and listed as a threatened species due to threatened habitat (US Fish and Wildlife Service Nd.). Asside from endangered species concerns, there is a law with Idaho Fish and Wildlife that implements specific fish species bag limits per day, depending on specific locations within Idaho (Idaho Fish and Game, Nd.). Additionally, implemented in 2021 due to extremely high-water temperatures and drought, Montana and Idaho addressed these trying times for trout by restricting fishing certain waters when water temperatures exceeded 70 degrees Fahrenheit, in order to decrease fish stress and therefore mortality (Mcnally 2021).

Statement of Need

There is a plethora of legal, sociocultural, ecological, and economic impacts that Snake River Finespotted Cutthroat Trout face not only in their native habitats that are a call to action and proper management. With a large emphasis on continuing to allow this species to thrive in their native range, this management plan proposal will certainly strike legal and sociocultural issues. The ecological impact this plan would have on the environment would be to implement research opportunities to find best fit management strategies for increasing egg survival rates, and aid in keeping adult survival rates on the incline. Aside from predators in the water, all trout species are currently facing the detrimental effects of climate change, which are impacting waterways worldwide and most especially cold-water fisheries. With rising risks of drought, forest fires, low water levels and high-water temperatures, Cutthroat trout are in urgent need of proper management.

Snake River Finespotted Cutthroat Trout Management Goals, Objectives, and Actions:

Goal 1: Increase Snake River Finespotted Cutthroat Trout (*Oncorhynchus clarkii)* populations within the Snake River in the state of Idaho.

Objective 1.1: Increase egg and juvenile survival rate by 25% within 20-year span to increase egg survival rate by 0.1% per year.

Action 1.1A: Design a study within the Snake River section of Idaho to assess best fit management practice. With a large portion of egg mortality being caused by predation, protecting each spawning bed from predatory fish such as brown trout (*Salmo trutta*) is a significant goal. In order to keep these predators from refraining to consume Cutthroat eggs, the decrease in mortality of eggs can be used as a tool to measure progress, and aid in increasing population sizes in the future (Yoon et al. 2014).

Action 1.2A: Introduce a portion of hatchery raised fry to streams after assessing the juvenile mortality each year. By introducing fry into a residing Cutthroat stream, population density can be traced by practicing mark-recaptures to future analyze the percentage of released trout survived, and therefore were able to reproduce and successfully aid in supporting increased populations (Bohlin et al. 2002). Through adipose fin clipping, stocked trout can be easily identifiable among natives (Nater et al. 2020), and then first-generation hatchery fish can measure either successful or unsuccessful in improving population sizes.

No Action: No effort towards increasing Snake River Finespotted Cutthroat Trout populations would lead to eventual decrease in population size of the species. (Bohlin et al. 2002). As per the population model protection, with first year adults possessing a 0.7% survival rate, this would be the greatest survival rate of all the Cutthroat age classes to continue growing

the population. With only approximately 0.06% of eggs surviving, an increase to this percentage would have potential to increase overall populations significantly.

Final Action for Objective 1.1: Begin studying the Cutthroat populations within the Snake River immediately by implementing Action 1.1, and also implement action 1.2 after completing the study and marking hatchery fish. These actions will be measured by identifying whether or not hatchery raised Cutthroats will improve overall populations after several years.

Assessment: Determine the likelihood of reaching the optimal egg and juvenile survival rate (20% increase) within a 5-year timeframe. Each year success will be noted, and after 5 years it will be necessary to compare yearly success. Based off of the population model, success will be measured in terms of the following: moderately successful= 11-20% success of increased survival rate reached. Low success= 5-10% of increased survival rate reached. No success= 0-4% of increased survival rate reached.

Objective 1.2: Increase trout conservation awareness to public communities within the next 5 years through education efforts.

Action 1.1B: Offer youth educational programs through conservation organizations. Trout in the Classroom (TIC) is a well-known conservation-minded educational program for young children to learn about cold-water fisheries and conservation needs (Heath, 2014). By teaching young individuals about trout habitat through this program, and others similar, younger generations can become better educated on the necessity of protecting stream ecosystems and the fish populations within them. Success of improved education will be measured by recording pre- and post- evaluation surveys, to analyze how many individuals gained a deeper understanding of fisheries after participating in educational programs.

Action 1.2B: Hold public seminars to engage locals in this dilemma and encourage them to donate to research efforts in order to maintain and increase Cutthroat populations. By encouraging the public to interact with wildlife professionals such as those with organizations like Trout Unlimited, public teaching events about trout conservation can spread knowledge amongst a wide variety of people (Penn's, n.d.). While encouraging missions to protect streams and rivers of trout habitats, Trout Unlimited strives to educate the public on addressing conservation issues (Penn's, n.d.) Similar to youth educational program success measurement, a pre- and/or post- survey can aid in supporting whether or not educational efforts are worthwhile

No Action: Failing to increase public knowledge on conservation needs would result in the continuation of mediocre public knowledge of fisheries overall (Penn's, n.d.) As fish can be argued to be a public resource, general interest from the public is important to have on any given open resource (Mikalsen and Jentoft, 2001). By having no further increase in public education on fisheries management, this public resource is not being well represented (Mikalsen and Jentoft, 2001).

Final Action for Objective 1.2: Begin actively increasing education efforts by putting Action 1.2A and 1.2B into motion. By increasing education to both a younger and older demographic in separate settings, there is opportunity to showcase the importance of proper fisheries management to people of all ages (Mikalsen and Jentoft, 2001).

Assessment: Determine an education goal of teaching as many individuals as possible about the importance of Snake River Finespotted Cutthroat management. Moderate success will be obtained by hosting several events and having 200+ active participants over the course of one

year (youth to adult ratio to be further determined). Low success will be considered teaching 50-199 individuals. Low success will be less than 50 participating individuals.

Goal 2: Determine which tributaries of the Snake River are most highly trafficked by anglers to assess where to manage fishing restrictions during summer months.

Objective 2.1: Minimize Cutthroat stress during high drought/ temperature risk during summer season by implementing fishing regulations, measured by percentage of abiding anglers.

Action 2.1A: Implement a temporary ban fishing these given streams between 2pm and 5pm each day until water levels rise and/or water temperature returns to below 67°F (Lamborn, 2019). By altering the fishing opportunities, angling pressure and poor practices of catch & release will decrease, allowing trout to recover on days of high temperature. (Lamborn, 2019). Several states have implemented "Hoot Owl" water watchlists, which is a request that fisherman avoid fishing between the hours of 2pm and midnight, voluntarily (CDFW, 2021).

Action 2.2A: Enforce disciplinary action to any fishermen disobeying this ban implementation and offer educational resources on why to follow regulations. By further encouraging anglers that disobey these bans, there is opportunity to teach individuals that may not be aware of the dangers of fishing warm waters. This will improve the likelihood of adult trout survival rates in order to grow to spawn and eventually reproduce.

No Action: The continuation of uninformed fishermen on the dangers of fishing in high temperatures would eventually lead to greater fish mortality due to extreme stress from fishing pressure during drought season.

Final Action for Objective 2.1: Action 2.1A and 2.2A would greatly benefit survival rates of trout by reducing fishing pressure during these harsh times.

Assessment: Manage fishing regulations and determine success of upholding these regulations by implementing temporary fishing bans on 100% of days where water temperatures exceed 70 degrees Fahrenheit. Moderately successful= 75-100% of fishermen follow these restrictions. Low success= 50-74% of fishermen follow these restrictions. No success= >49% of fishermen follow these restrictions. This would be measured by observing highly trafficked river sections on a daily basis and keep surveillance of whether or not fishermen are following these bans.

Objective 2.2: Increase trout conservation awareness over the next 5 years to fishermen specifically by implementing educational programs through angling organizations.

Action 2.1B: Connect with local Trout Unlimited chapters to raise awareness to Cutthroat habitat loss and predation. Trout Unlimited is currently working on a "demand management" program, where recreational businesses such as fishing outfits could receive compensation for temporarily following these closed-water bans (Armano 2021).

Action 2.2B: Connect local angling companies along the Snake River to teach clients proper fishing etiquette to decrease fish fatalities in peak tourism season/ dangerous water temperature times throughout the summer. Along with Trout Unlimited's "demand management program", opportunity for local angling companies to teach clients about the importance to follow these rules for the future of healthy fisheries could be extremely beneficial. Companies are much more likely to follow these rules themselves if being compensated for abiding (Armano 2021), while people's livelihoods are at stake with losing money from temporarily halting fishing trips.

No Action: Failing to increase anglers' knowledge on conservation needs would result in the continuation of mediocre knowledge given to outdoorsmen on trout conservation.

Final Action for Objective 2.2: Action 2.2A and 2.2B would both benefit the protection of Snake River Finespotted Cutthroat populations, as decreased fishing pressure and increased public knowledge seamlessly form improvement of future populations.

Assessment: Weekly surveys could potentially be a valuable resource for analyzing the number of active participants in following these regulations. Asking local fishing shops and Trout Unlimited chapters to both send out knowledge-based questionnaires to measure the number of people who agree and actively follow these rules would be helpful in supporting these regulations. The percentage of surveys received would determine the measure of success with this objective.

Conclusion

The Snake River Finespotted Cutthroat Trout management plan for Idaho has potential to increase survival rates significantly over time and improve the abundance of mature trout residing in streams all across the state. The improved management of this species has the opportunity to inhibit increased economic and cultural influence with regards to angling (Zwirn et al. 2005) and therefore increase further management studies. With little or no further management on this species, the Snake River Finespotted Cutthroat Trout will continue to face difficulties with invasive species holding them to unnecessary competition for their native ranges. Further recommendations to improving this plan will come from having time to see what additional changes will need to be made, and where the species is at in the future without the implementation of these new ideas. By beginning with the changes suggested in this plan, the longevity of this species will be maintained, while continuing to research and study what can help in possibly attempting to make other species not compete with Snake River Fine Spotted Cutthroat Trout in the future. As for now, it is crucial to aid in protecting their residing

distribution. While there is great action that will need to be set in motion to develop solutions to this issue of low age class within Cutthroat populations, there are opportunities to improve this problem and find solutions. This management plan is a starting point in developing these essential changes in the care and administration of properly governing one of Idaho's most coveted aquatic species.

Acknowledgements

I would like to express my gratitude to my professors and peers here at Paul Smith's for the guidance and support in constructing this management plan. I would also like to thank my family and friends who have stood in unwavering faith supporting me to pursue an education and career centered around what I love.

Literature Cited

Armano, K. 2021. Drought and fishing in the Colorado River Basin. Trout Unlimited. Western Water 101 Series.

Bohlin, T., Sundström, L.F., Johnsson, J.I., Höjesjö, J. and Pettersson, J. 2002. Density-dependent growth in brown trout: effects of introducing wild and hatchery fish. Journal of Animal Ecology 71: 683-692.

Boise State Public Radio 2020. Idaho fish and game sees surge in license sales as people opt outside.

Carl, M. 2011. The ecological angler.

California Department of Fish and Wildlife. Nd. Lahontan Cutthroat Trout.

California Department of Fish and Wildlife. 2021. "Hoot Owl" water watchlist.

CRCT Coordination Team. 2006. Conservation strategy for Colorado River Cutthroat Trout (*Oncorhynchus clarkii pleuriticus*) in the states of Colorado, Utah, and Wyoming. Colorado Division of Wildlife, Fort Collins, CO., USA.

Heath, T. 2014. Trout in the Classroom. EGU General Assembly Conference Abstracts 13258.

Hilderbrand, R. H., & Kershner, J. L. 2004. Influence of habitat type on food supply, selectivity, and diet overlap of Bonneville cutthroat trout and nonnative brook trout in Beaver Creek, Idaho. North American Journal of Fisheries Management, 24: 33-40.

Homel, K. M., Gresswell, R. E., & Kershner, J. L. 2014. Life history diversity of Snake River Finespotted Cutthroat Trout: Managing for persistence in a rapidly changing environment. North American Journal of Fisheries Management 35: 789-801.

Hoogendoorn, G. 2017. Fly-fishing as ecotourism in South Africa: a case study. Journal of Ecotourism 16: 152-168.

Idaho Fish and Game. Nd. Fishing seasons and rules.

Idaho Fish and Game. Nd. Lisceneses, tags, and permits- residents.

Macdonald, M. nd. Enhancing and sustaining ecotourism in Waterton Biosphere Reserve.

Mcnally, B. 2021. Montana and Idaho address low water, high temps for trout with different regs. Outdoor Life.

Mikalsen, K. H., & Jentoft, S. 2001. From user-groups to stakeholders? The public interest in fisheries management. Marine Policy 25: 281-292.

Nater, C. R., Vindenes, Y., Aass, P., Cole, D., Langangen, Ø., Moe, S. J., Rustadbakken, A., Turek, D., Vollestad, L. A., and Ergon, T. 2020. Size-and stage-dependence in cause-specific mortality of migratory brown trout. Journal of Animal Ecology 89: 2122-2133.

Neilson, M., and Fuller, P. 2022. *Oncorhynchus clarkii behnkei* Montgomery, 1995: U.S. Geological survey, nonindigenous aquatic species database.

Okamoto, N., Tayama, T., Kawanobe, M., Fujiki, N., Yasuda, Y., & Sano, T. 1993. Resistance of a rainbow trout strain to infectious pancreatic necrosis. Aquaculture 117: 71-76.

Penn's W. W. C. Trout Unlimited policy and procedure manual. Policy, 21, 02.

Peterson, D. P., & Fausch, K. D. 2003. Upstream movement by nonnative brook trout (*Salvelinus fontinalis)* promotes invasion of native Cutthroat Trout (*Oncorhynchus clarkii*) habitat. Canadian Journal of Fisheries and Aquatic Sciences 60: 1502-1516.

Roberts, J. J., K. D. Fausch, M. B. Hooten, and D. P. Peterson. 2017. Nonnative trout invasions combined with climate change threaten persistence of isolated Cutthroat Trout populations in the southern Rocky Mountains. North American Journal of Fisheries Management 37: 314–325.

Trotter, P. J. Stolz and J. Schnell. 1991. Cutthroat Trout. The Wildlife Series.

US Fish and Wildlife Service. Nd. Environmental Conservation Online System-Snake River fine spotted Cutthroat Trout (*Oncorhynchus clarkii*).

Wagner, E., Arndt, R., Brough, M., & Roberts, D. W. 2002. Comparison of susceptibility of five Cutthroat Trout strains to Myxobolus cerebralis infection. Journal of Aquatic Animal Health 14: 84-91.

Williams, J. E. 2006. Conservation success index: Snake River Finespotted cutthroat trout. Trout Unlimited.

Yoon, J.T., Sun, S.M. & Chung, G. 2014. Sargassum bed restoration by transplantation of germlings grown under protective mesh cage. J Appl Phycol 26: 505–509.

Young, M. K. 1995. Conservation assessment for inland Cutthroat Trout. USDA Forest Service general technician report.

Zwirn, M., Pinsky, M., & Rahr, G. 2005. Angling ecotourism: issues, guidelines and experience from Kamchatka. Journal of Ecotourism, 4: 16-31.

Appendix 1

Snake River Finespotted Cutthroat Trout Survey

The questions below will be used to analyze public knowledge on the current conservation status of Snake River Finespotted Cutthroat Trout, utilized for Paul Smith's College FWS 470- Wildlife Management Capstone.

1. What is your age? *
   - 18 or under
   - 19-25
   - 26-35
   - 36-45
   - 46+

2. Please list the state you live in: _____

3. Please select-Which of the following descriptions best fits where you live? *
   - In a large city
   - In a rural area
   - In the suburbs
   - Other

Do you care about the future of aquatic environments and cold-water fisheries? *
- No
- Neutral
- Yes

Do you enjoy fishing? *
- No
- Sometimes
- Yes

How far do you often travel to fish?
- Less than a mile
- 1-20 miles
- 21-50 miles
- 51-100 miles
- +100 miles

Do you find any of these species becoming increasingly more scarce? *
- No
- Somewhat
- Yes

Please select the level in which you believe native cutthroat streams are currently being managed

- Insufficiently
- Sufficiently
- Excessively sufficient

If willing to share, please state which species and a prediction to why?

_____
_____
_____

How willing would you be to learn more about conservation through local educational events explaining the need for more action on protecting Snake River Finespotted Cutthroat Trout?*

- Not willing
- Neutral
- Very willing

If you would like to learn more about the conservation of Snake River Finespotted Cutthroat Trout, please add an email below and more information on this management project will be shared.

_____