CHALLENGES OF INVASIVE NORTHERN PIKE IN THE WEST: THREATS AND MANAGEMENT OPTIONS

Northern Pike Management Idaho’s Perspective

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Northern Pike *Esox lucius* were illegally introduced into Idaho’s Coeur d’Alene Lake system in the early 1970’s. From there, they’ve been illegally transferred to other northern Idaho waters, but to date their distribution in Idaho is restricted to the five northern counties. For better or worse, northern pike have created some of the region’s most popular fisheries. Although classified as a game fish in Idaho, management policy prohibits the intentional introduction of pike into new waters and discourages illegal introductions into other waters by removing bag limits and prohibiting catch and release tournament events. Under existing regulatory strategies angler exploitation, where estimated, is high and relative densities are low. Observations in most pike waters suggest regulatory strategies combined with environmental conditions minimize the potential impact to native and other game fish. Where predation by northern pike on other fish species has been estimated, direct impacts appear to be localized. Due to the challenges of northern pike suppression in large and connected systems and observed conditions in north Idaho waters, continued unregulated management of pike is likely.

Control and management of Northern Pike: experiences from Colorado, USA

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Non-native Northern Pike *Esox lucius* were first introduced into the State of Colorado in the 1950s. This species was initially stocked by fishery managers into salmonid reservoirs to provide sport fishing opportunities for anglers, and to control various prey populations of catostomids. Populations of Northern Pike eventually became established in these popular, recreational waters that were historically managed as trout fisheries. Escapement of Northern Pike from lentic habitats into lotic systems, and illicit stocking of these piscivores into western Colorado water bodies have created concern amongst anglers, recreational fishing communities, conservationists, and fishery managers alike. Multiple introductions of a top-level predator into the Upper Colorado River Basin threaten recreational cold and warm water fisheries, as well as conservation waters managed for Federal- and State-listed and non-listed native fishes. As fishery management biologists, we explore the unique challenges created by these situations, provide a summary of projects targeting control of Northern Pike, and discuss various management options that Colorado has implemented for this non-native fish species.

Northern pike expansion into Wyoming portions of the Yampa River drainage, south central Wyoming

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The Little Snake River in south central Wyoming is a tributary to the Yampa River in the Upper Colorado River drainage and a stronghold for native game, and nongame fishes including roundtail chub (*Gila robusta*), and Colorado River cutthroat trout (*Oncorhynchus clarkii pleuriticus*). This is, in part, due to the exclusion of downstream invasive fish species, such as northern pike (*Esox lucius*). State and Federal managers of Colorado waters throughout the Yampa River drainage have been grappling with management of northern pike following intentional stockings in headwater reservoirs in the 1950’s. Until recently, colonization of Wyoming waters seemed highly unlikely. However, increased passage opportunities coupled with two sequential, unseasonably high spring run-off events enabled downstream pike to access Wyoming portions of the Little Snake River. To date only adult pike have been detected and it is unknown whether Wyoming offers ample suitable habitat to provide for a resident pike
population. Establishment of pike in drainage, however, would be extremely detrimental to the management of native fish in both Wyoming and Colorado. Moving forward, the Little Snake River case study may offer valuable insights into the abilities of northern pike to expand into drainages offering “sub-optimal” habitat.

**Maintaining trout fishing opportunity in the face of northern pike predation**

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Colorado has traditionally managed its high profile, recreational trout fisheries through spring stocking of “sub-catchable” 12-16 cm rainbow trout to take advantage of favorable growing conditions in these extremely productive reservoirs. Following years of complete recruitment failure brought about by intense northern pike predation, we explored an alternative stocking strategy that considers consumption demand as a function of water temperature. By shifting the stocking of rainbow trout to late fall, we acknowledge that northern pike consume about a tenth as many calories in winter when these lakes freeze over, yet take advantage of a trout’s ability to grow under these conditions. Stocking large trout (30 cm average), yields 35 cm fish by spring when predation demand increases, at which point they are only vulnerable to a much smaller portion of the northern pike population. We discuss our successes over the last decade in maintaining recreational trout fisheries using this strategy, as well as the associated opportunity costs.

**Management of invasive northern pike in Southcentral Alaska**

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Northern pike are not native to Southcentral Alaska. Illegal introductions of northern pike began in the Upper Susitna drainage in the late 1950s. Subsequent expansion coupled with continued illegal introductions over the decades have resulted in the widespread distribution of northern pike from the Matanuska-Susitna Valley to the Kenai Peninsula. Northern pike are highly piscivorous and reduce ecologically and economically valuable salmonid populations throughout Southcentral Alaska.

**Monitoring the northern pike population in Box Canyon Reservoir, Pend Oreille River, Washington**

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The Kalispel Tribe and Washington Department of Fish and Wildlife have been annually monitoring the abundance, distribution, and demographic characteristics of northern pike in Box Canyon Reservoir, Pend Oreille River, WA since 2005. Standardizing a sampling program for the large (90 Km), complex, run-of-river reservoir with a patchy and expanding pike distribution has been a challenge for biologists. The Spring Pike Index Netting (SPIN) survey was developed in 2010 after considerable literature review and consultation with experts from US and Canada. Since management decisions on future suppression efforts are based on SPIN survey results and clearly defined population targets, accuracy and precision of mean CPUE estimates are paramount. An analysis of 2010-2012 data indicated that 3 times the netting effort than had been previously applied was required to achieve our goal of 95% confidence intervals with a bound of 0.5 fish. A spatially-balanced, stratified sampling design with two-stage cluster sampling of sloughs was implemented in 2013. Although we improved precision of CPUE estimates in all three strata to within ± 0.22-0.66, those improvements came with considerable implementation costs. We present 2010-2013 monitoring data with implications for other researchers and managers in the West faced with ever-expanding pike populations.
Population abundance and dynamics of introduced Northern Pike, Yampa River, Colorado

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We modeled demographic parameters of invasive Northern Pike (Esox lucius) in the Yampa River, Colorado, 2004–2010, using tag-recapture data. Sampling occurred in three regions: “Hayden to Craig”, a buffer zone upstream of endangered species habitat in the next two regions; “South Beach, Little Yampa Canyon, Juniper”; and most-downstream “Maybell, Sunbeam”. Analyses in Program MARK showed important region, interval, and pike length effects on survival rate estimates and interacting region, year, and pass effects with additive length effects on capture probability estimates. Annual survival was lowest for pike upstream (mean: 0.25, range: 0.12–0.38), but abundance estimates were highest. Pike downstream had highest survival and lowest abundance estimates. Capture probabilities ranged from 0.03 to 0.51 for average-length Northern Pike, but over 70% of estimates were <0.20. Removal rates were variable and relatively low, while total mortality rates remained consistent across years. Average mortality rates in the two upstream regions were high (70–75%), but population increases due to recruitment and/or immigration (67–74%) nearly offset those effects. Present removal rates may not be adequate to reduce populations of Northern Pike in the Yampa River if immigration and recruitment are not reduced.

Population structure, seasonal habitat use and assessment of monitoring data of the northern pike population of Cabinet Gorge Reservoir, Montana

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The potential impact of northern pike (Esox lucius) to native salmonids in Cabinet Gorge Reservoir provided the impetus for this study. Active and passive capture techniques were used to characterize the northern pike population and provide fish for radio-tagging for the first phase of this study from 2003 through 2005. Fifty-one northern pike were tracked to ascertain habitat use and possible overlap with salmonids. Other aspects of this first phase included describing population characteristics, estimating local abundance, and performing an opportunistic angler survey. Efforts to document reproduction suggested that water level fluctuations negated successful spawning. Earlier sampling and population indices were revisited in 2010 to update the status of northern pike and assess whether current reservoir monitoring, that employs standardized gill nets, was sufficient to determine changes in northern pike abundance. During both phases, northern pike of high relative weight between four and six years of age comprised a majority of captures. Population estimates of spawning aggregations during both phases resembled trends of reservoir monitoring catch rates. Although no trout were found in 79 stomachs sampled, the preponderance of northern pike detections in Bull River Bay represented a potential opportunity for predation of native salmonids from this important nursery tributary.

Mechanical suppression of northern pike in Box Canyon Reservoir, Pend Oreille River, WA

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Invasive northern pike (Esox lucius) recently became established in Box Canyon Reservoir, Pend Oreille River, WA. Northern pike threaten many species, including ESA listed bull trout (Salvelinus confluentus) and salmon and steelhead populations downstream in the Columbia River. Methods to reduce the impact of these invasive predators on native fish recovery were developed by the Kalispel Tribe and Washington Department of Fish and Wildlife including angler education and outreach, fishing contests promoting harvest, and an intensive 3-year mechanical suppression project using gillnets. Our objective is to reduce relative abundance of adult (>350 mm) pike from 2011 baseline 13.2 NP/net night to <1.7 NP/net night in the southern half of the reservoir and <0.5 NP/net night in the northern half of the reservoir by 2014, measured in Spring Pike Index Netting survey (SPIN). In the first two years of implementation a total of 12,260 northern pike were removed in 2,246 overnight gill net sets. Based on 2013 SPIN results, the adult population in the core area (southern half) was reduced by 91% from the 2011 baseline to 1.2
Managing pike-invaded lakes for trout angling in Arizona

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Rainbow Lake and Fool’s Hollow Lake provide popular put-and-take Rainbow Trout (Oncorhynchus mykiss) fisheries in Arizona’s White Mountains. Since the illegal introduction of Northern Pike (Esox lucius) in the late 1990’s, the Arizona Game and Fish Department has conducted mechanical suppression of pike with trap nets, electrofishing boats, and gill nets. A study conducted in 2006 estimated the pike population in Rainbow Lake at 462 fish and during annual removals conducted in 2008 through 2013, an average of 178 pike were removed annually. The Arizona Game and Fish Department will continue to identify and adopt strategies to meet fishery management objectives including continued predator removals, alternative stocking practices, and nuisance weed control.

Invasive Northern Pike control and research on the Alaska Kenai Peninsula

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Invasive Northern Pike Esox lucius on the Kenai Peninsula of Alaska have decimated some wild and stocked fish populations and have caused the loss of fishing opportunity. Northern Pike are likely to invade new areas and cause further fishery losses, particularly to areas where potential Northern Pike habitat is plentiful. The Alaska Department of Fish and Game has conducted northern pike control and research activities on the Kenai Peninsula for over a decade. Of the nineteen waterbodies on the Kenai Peninsula where self-sustaining populations of northern pike have been identified, only twelve still contain northern pike. Control and eradication efforts have included liberalization of sport harvests, mechanical removal, fish barriers and pesticide treatments. The most recent pesticide treatment was a 7,000 acre-foot open lake that supports a wild anadromous fish population. A new multi-year project to remove northern pike from a 42mi² drainage is currently underway. Recent invasive Northern Pike research has included studying the effects of intensive gillnetting on Northern Pike populations and tracking northern pike movements using radio-telemetry methods. A new research project is underway to evaluate the effectiveness of using environmental DNA (eDNA) techniques for detecting Northern Pike presence.

Intensive northern pike suppression in a tributary of the Susitna River, Alaska

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Northern pike pose a threat to salmon habitats in Southcentral Alaska where they are an invasive species. One of the most affected areas includes Alexander Lake and Alexander Creek, a tributary of the Susitna River that was once highly productive for Chinook salmon. Today, northern pike are widespread throughout that system which is shallow and densely vegetated, making it ideal northern pike habitat. Predation by northern pike has led to drastically low Chinook salmon abundance in Alexander Creek. Other salmonid species have similarly declined, and currently, all fisheries are closed.