



Independent Scientific Review Panel

for the Northwest Power & Conservation Council

851 SW 6th Avenue, Suite 1100

Portland, Oregon 97204

www.nwcouncil.org/fw/isrp

Memorandum (2018-1)

January 17, 2018

To: James Yost, Chair, Northwest Power and Conservation Council

From: Steve Schroder, ISRP Chair

Subject: Response Request for Northern Pike Suppression and Monitoring Proposal (#2017-004-00)

Background

In response to the Northwest Power and Conservation Council's December 7, 2017 request, the ISRP reviewed a [proposal](#) titled *Northern Pike Suppression and Monitoring* (#2017-004-00) from the Colville Confederated Tribes (CCT), Spokane Tribe of Indians' (STOI), and Washington Department of Fish and Wildlife (WDFW). The goal of this proposal is to suppress northern pike in the Lake Roosevelt watershed and prevent the species from spreading and expanding into other water bodies, especially those that support anadromous salmon. The proposed approach to achieve this goal is multi-tiered and includes mechanical removal techniques, angler incentives, and targeted monitoring and research.

The proposal was requested as part of the Council's conditional recommendation in June 2017 associated with the STOI's funding [request](#) of May 31, 2017 to the Council and Bonneville Power Administration's Budget Oversight Group (BOG) for Project #1994-043-00, *Lake Roosevelt Data Collection*. The requested action was to increase gill-netting efforts to remove northern pike. The Council approved the request (\$123,017) with the condition that "*all further activities in Lake Roosevelt addressing the control of Northern Pike funded through the F&W Program be addressed through a new project proposal narrative.*"

The Council's condition specified that the fish co-managers in Lake Roosevelt—the CCT, STOI, and WDFW—develop a new proposal that describes "*a comprehensive strategy to assess and remove Northern Pike in Lake Roosevelt, with time deliverable objectives.*" The proposal also would need to respond to previous ISRP reviews and describe an integrated strategy by the co-managers to ensure the Program funds and contracts are efficiently used.

The ISRP's June 2017 review ([ISRP 2017-6](#)) of the STOI's request included the following recommendation and qualifications:

Thus, the following concerns, along with our original qualifications (see Part B ... [[ISRP 2017-6](#)]), must be addressed. The responses to the qualifications and concerns should be described in the next annual report and also in the Three-year Northern Pike Relative Abundance Survey and Suppression Plan. The ISRP should review the annual report and the Suppression Plan before long-term commitments are made for this project.

- 1. Provide quantitative objectives and timelines, as discussed ... in [ISRP 2016-6](#). Clearly articulate quantitative catch limits for non-target species.*
- 2. Provide justification for terminating the suppression of northern pike if catch limits are exceeded for non-native walleye and smallmouth bass and hatchery trout.*
- 3. Describe in more detail the methodology and level of effort associated with the proposed expansion of the removal effort, and demonstrate how the methodology will be adequate to track the status of northern pike in Lake Roosevelt over time.*
- 4. Assess whether the benefits of longer nighttime set times outweigh the harm to other species by comparing catch rates of northern pike and mortality rates of other species in daylight versus nighttime sets, and using gillnets versus electrofishing.*

In summary, the ISRP recommends that the current proposal sufficiently meets scientific criteria to begin expansion of efforts to suppress the spread of northern pike in Lake Roosevelt, provided the proponents can at the same time meet the urgent qualifications listed above, with emphasis on developing and implementing a monitoring program. However, the ISRP cautions that much more analysis and policy development is needed to justify a long-term program to suppress northern pike in Lake Roosevelt. Indeed, the overall strategy for controlling northern pike and other non-native predators requires broader discussion within the Fish and Wildlife Program.

The ISRP's review of the CCT, STOI, and WDFW multi-year proposal follows below.

ISRP Recommendation

Response Requested

The proposal includes a review of the northern pike problem and suppression efforts in Lake Roosevelt, the upper Columbia Basin, and in regions beyond the Columbia Basin. The expansion of piscivorous, non-native northern pike is a concern for the conservation of native resident fishes in the upper Columbia Basin and for anadromous salmon in downstream areas. The proponents provide a reasonable argument for the need to control northern pike abundance, which is consistent with the vision of the Fish and Wildlife Program and its strategy to control invasive species. *"The goal of the project is to suppress Northern Pike in Lake Roosevelt watershed and to prevent them from spreading further downstream in the Columbia River system."*

The proposal partially addresses the planning needed for an expanded effort to suppress northern pike in Lake Roosevelt in spring 2018. However, substantially more detailed information is needed for a full assessment of the proposal by the ISRP, particularly in regard to the monitoring program and adaptive management.

The ISRP requests the following responses:

1. A detailed description of the suppression efforts planned to begin in 2018. For each type of gear mentioned in the proposal (i.e., gillnets, boat electrofishers, fyke nets, and seines), describe: (a) the gear to be used, (b) how the gear will be deployed, (c) the locations where the gear will be used, (d) when the gear will be used and how long it will be in use at each location, (e) the field data that will be obtained with each gear (i.e., total length, weight, sex, maturity, etc.), (f) database management, and (g) the descriptive statistics (i.e., metrics, e.g. CPUE) that will be computed from the data. Also, explain the timing and spatial distributions of suppression efforts with each gear relative to changing water temperature and reservoir elevations. The data and process used to determine the proposed lengths of gillnet sets also need to be described.

Specific questions include:

- (1) Will standardized gillnets be used by all co-managers throughout the suppression effort?
 - (2) What time of the day will gillnets be set and what is the duration of gillnet sets? What were the data and process used to determine the proposed timing and duration of gillnet sets?
 - (3) Will similar boat electrofishing gear be used throughout the suppression effort?
 - (4) What standardized methods will be used for recording field data?
 - (5) How will field data be pooled into a common database for analysis?
 - (6) What techniques will be used to maximize viability of native bycatch species (i.e., redband trout, wild kokanee, and wild sturgeon) that will be released?
2. A science-based justification for bycatch limits for native and non-native fishes is requested. The bycatch limits described in the proposal appear to give a priority to fishes valued by anglers, but the proposal does not provide science-based reasoning for limiting their bycatch. The inclusion of bycatch limits for non-native fishes is inconsistent with project goals and Fish and Wildlife Program goals.
 3. A detailed description of northern pike population monitoring and assessment protocols as part of an adaptive management process is requested. Please include a full description of the design of the population monitoring plan, the sampling gear to be used, sampling locations, data to be obtained, and analyses of the data. The ISRP emphasizes the need to develop quantitative objectives for each task described in the proposal and incorporate these objectives into an adaptive management process. Description of a process that uses monitoring and suppression data to assess the level of suppression effort being applied and progress toward quantitative objectives is a critical part of an adaptive management plan.

We ask the proponents to: (1) provide quantitative objectives with timelines for each task in the proposal, (2) explain how metrics developed from monitoring and(or) suppression data will be used to assess progress toward the stated objectives, and (3) describe the process to be used for making decisions regarding modification of the suppression program. As described in the proposal, the proposed suppression effort will occur regardless of northern pike catch rates or response of the population during the next 5 years. However, the suppression plan should consider the possibility of changes in effort based on catch rates, monitoring data, and quantitative objectives that are part of an adaptive management process.

4. A detailed study plan is requested for three research elements described as Monitoring Actions in the proposal: (a) northern pike natal origin, (b) early detection (eDNA), and (c) reservoir operations. For each of these studies, the study plan should describe the research objectives, research hypotheses, experimental design, methods, data analysis, and how this information will inform the adaptive management framework.
 - a) Specific questions regarding the northern pike natal origin study include:
 - (1) Why is the otolith microchemistry approach better than active sampling of habitat types preferred for spawning?
 - (2) Which tributaries to Lake Roosevelt have been sampled for water chemistry?
 - (3) Is water chemistry at sampling sites sufficiently unique to allow delineation of northern pike origins using otoliths?
 - (4) Are otoliths from only 50 northern pike per year a sufficient sample size?
 - (5) What sizes and ages of northern pike are to be targeted for otolith sampling?
 - (6) How will data on northern pike natal origin be used to assess suppression efforts?
 - b) Specific questions regarding early detection monitoring (eDNA) include:
 - (1) How can eDNA be used to detect northern pike dispersal into new downstream areas?
 - (2) What is the likelihood of not detecting northern pike in new areas when in fact they are present?
 - (3) To what extent might northern pike eDNA from the upper mainstem areas (where they currently occur) contaminate or confound interpretation of eDNA samples from lower mainstem areas?
 - (4) Can more than one reference area be included to assure that false positives are not occurring in the dataset?
 - c) Specific questions regarding the reservoir operations data gap studies include:
 - (1) Will egg counts be associated with species and size of plants?
 - (2) Will there be controls that involve egg counts in adjacent un-vegetated substrate?
 - (3) When and for how long do northern pike eggs need to be dewatered at varying temperatures to effectively kill them?
 - (4) When and for how long do northern pike larvae require vegetative cover to survive?

Questions pertinent to the logistic-regression modeling phase of the reservoir operation study are:

- (1) What sampling strategy and data (metrics) will be used to describe year class strength of northern pike?
 - (2) Given the types and quantity of data collected will there be enough statistical power to detect changes in year class strength?
 - (3) Will year class strength be based on mainstem spawners, tributary spawners, or both?
 - (4) To what extent might drawdown in the mainstem affect northern pike spawning in tributaries?
 - (5) How are low, moderate, and high drawdown years defined?
5. Justification for exclusion of northern pike diet monitoring or a plan for monitoring northern pike diet is requested. The ISRP previously recommended continued diet monitoring to evaluate the extent to which northern pike consume salmon and trout compared to other non-native predators (i.e., walleye and smallmouth bass), but monitoring of northern pike diet was not included in the current proposal.
6. A detailed description of the northern pike reward program with assessment of both biological effects and social consequences of the program is requested. The potential for the reward program to contribute to suppression of the northern pike population needs to be addressed in a quantitative manner. The social consequences and potential for illegal activities associated with the reward program need to be evaluated and included in the description.

Specific questions regarding the rewards program include:

- (1) Is the existing reward program cost-effective compared with other efforts proposed for the suppression of northern pike in Lake Roosevelt?
 - (2) What sizes of northern pike are turned in for rewards by anglers?
 - (3) Is it possible that the rewards program could encourage anglers to illegally stock northern pike?
 - (4) Why does the Colville Tribe reserve the right to suspend this program at any time?
 - (5) What are the issues that could lead to the program's suspension?
7. A more detailed description of the public outreach plan including of quantitative objectives and monitoring and assessment protocols is requested.

ISRP Comments

A. Clearly defined objectives and outcomes

2017 Q1. *Provide quantitative objectives and timelines, as discussed ... in [ISRP 2016-6](#). Clearly articulate quantitative catch limits for non-target species.*

[2016 Q1-3 related to objectives:

- 1. Include quantitative objectives for the northern pike suppression effort as a means to evaluate program success (e.g., reduce northern pike CPUE by __% and reduce the relative abundance of large northern pike [$>$ __ mm total length] by __% by the year 20__). Quantitative objectives should be developed for each metric used to evaluate northern pike suppression, and a time frame should also be included in each objective.*
- 2. Include explicit hypotheses to be tested by the proposed activities and provide quantitative objectives for what is to be achieved.*
- 3. Include quantitative objectives regarding the protection of native fishes captured as bycatch.*

Neither the 2016 nor the 2017 qualifications regarding project objectives have been addressed. The proposal lists two objectives: (1) Reduce or eliminate Northern Pike in the Lake Roosevelt watershed and (2) Conduct Public Outreach. These statements are consistent with the project goal, but they are not quantitative objectives that can be assessed using monitoring and suppression data. Additionally, they do not include a time frame for the expected accomplishments.

The ISRP asked for inclusion of quantitative objectives and timelines to facilitate an adaptive management process, but as yet, no process for adaptive management has been proposed. The proponents state, "This is a new project and no Adaptive Management actions have been taken." This statement misses the need to describe the process for adaptive management. Thus, we are repeating our request to include quantitative objectives, timelines, and assessment protocols. We ask the proponents to: (1) provide quantitative objectives with timelines for each task, (2) explain how metrics developed from monitoring and(or) suppression data will be used to assess progress toward the stated objectives, and (3) describe the process for making decisions regarding modification of the suppression program. The ISRP suggests that a flow diagram that uses the metrics obtained from monitoring or suppression efforts be developed to illustrate the adaptive management process. Numerous examples of adaptive management processes can be found online, for example, [Using Adaptive Management to Meet Conservation Goals](#).

The proponents provide some quantitative information about the amount of suppression effort that may be applied annually by each of the co-managers using gill nets and boat electrofishing from 2018-2022. However, there are no quantitative objectives (i.e., targets, desired outcomes) provided for the 2018-2022 interval. Focusing on the suppression effort, there are no targets for the number of northern pike to be removed annually with specific gears or the CPUE of

northern pike to be achieved annually with particular gear. Focusing on expected population responses that may be observed through monitoring, there are no quantitative objectives for future abundance or distribution of northern pike. The 2016 review ([ISRP 2016-6](#)) provided an example for how quantitative objectives may be applied to the monitoring program, but there is no evidence of such objectives within the proposal.

Repeating 2016 ISRP concerns, no hypotheses regarding population responses to suppression efforts are found in the proposal. Metrics based on total length, weight, sex, and maturity data, as well as catch-per-unit-effort data, captured with different gear (i.e., gill nets or boat electrofishing) can be used in the development of hypotheses regarding population responses. These hypotheses can be used to understand the relationships between sampling and population size and demographics. For example, it could be hypothesized that the length frequency distribution of northern pike captured among all mesh sizes will shift to shorter lengths by X% after two years of suppression efforts. Or, it could be hypothesized that CPUE among all mesh sizes of gill nets will decline by X% by 20xx.

Public outreach is an important goal and quantitative objectives are needed to assess both outcomes and progress. Objectives for determining successful public outreach are not included in the proposal. For example, simple targets might include the number of signs, meetings, or news articles to be produced annually. Other ways to evaluate success of public outreach, such as surveys to assess changes in public attitude toward northern pike, could be included in the project. Metrics are needed to evaluate the success of public outreach. We recommend that a social scientist be consulted to guide the development of quantitative objectives and protocols for assessment of outcomes of public outreach.

The proposal should have described quantitative objectives for each of the following tasks:

1.0 Monitoring Actions

- 1.1 Northern Pike Population Monitoring 2018-22
- 1.2 Northern Pike Natal Origin Monitoring
- 1.3 Northern Pike Early Detection Monitoring - eDNA
- 1.4 Reservoir Operations Study

2.0 Suppression Strategies

- 2.1 Mechanical Removal
- 2.2 Northern Pike Reward Program

3.0 Public Outreach Plan

B. Sound scientific principles and methods

2017 Q.2. Provide justification for terminating the suppression of northern pike if catch limits are exceeded for non-native walleye and smallmouth bass and hatchery trout.

The proposal states that bycatch limits for various species are to be established. These limits will be weekly and area-specific. If exceeded, northern pike suppression efforts would be

terminated for that week and specific area of the reservoir. However, no science-based justification is provided for inclusion of bycatch limits.

Weekly bycatch limits include non-native smallmouth bass and walleye in addition to hatchery rainbow trout. Such bycatch limits could reduce northern pike suppression efforts in some key northern pike areas and would be inconsistent with the project goals and Fish and Wildlife Program goals. The proposal appears to give a higher priority to protecting non-native, invasive smallmouth bass and walleye than to suppressing non-native, invasive northern pike, the target of the suppression effort.

All live bycatch would be released back into the reservoir. The proposal does not describe techniques to maximize viability of native bycatch species (i.e., redband trout, wild kokanee, and wild sturgeon) that will be released.

2017 Q.3. Describe in more detail the methodology and level of effort associated with the proposed expansion of the removal effort, and demonstrate how the methodology will be adequate to track the status of northern pike in Lake Roosevelt over time.

1.0 Monitoring Actions

1.1 Northern Pike Population Monitoring 2018-2022

It appears from the proposal that a specific northern pike population monitoring plan for 2018 and later years has not been fully developed. General concepts describing both spring and fall monitoring are provided, but details are insufficient to enable a science-based assessment of the proposed northern pike population monitoring plan.

The proponents provide summary statistics from the 2015 to 2017 northern pike population monitoring during both spring and fall. They point out that the result of the spring monitoring was a very low CPUE for northern pike, which was not consistent with an indication of increasing abundance of northern pike from other data sources (i.e., creel, fall monitoring, and suppression efforts). They also point out that the level of effort during fall monitoring was insufficient to detect a significant change in CPUE of northern pike and recommended that more sites in shallow water be added. It appears that both spring and fall monitoring designs need to be altered to achieve effective monitoring. Plans for 2018 are not stated in the proposal.

Continued monitoring of northern pike diet was not included. The ISRP recommends continued diet monitoring to evaluate the extent to which northern pike consume salmon and trout compared to other non-native predators (i.e., walleye and smallmouth bass).

1.2 Northern Pike Natal Origin Monitoring

Continued use of otolith microchemistry to monitor natal origin is proposed. The goal of the

natal origin monitoring program is to use otolith microchemistry techniques to determine general spawning locations and movement patterns to assist with increasing the efficiency of the suppression efforts. According to the proponents, this information will help determine if the downstream distribution of northern pike is from the primary known spawning location (i.e., Kettle River) or from other locations.

However, the proposed otolith monitoring is not described in sufficient detail to determine if this approach will provide meaningful data on natal origin. Research objectives, hypotheses, sampling designs, sampling methods, and data analysis techniques need to be described. Specific questions regarding the northern pike natal origin study are listed in the ISRP's response requested recommendation above.

1.3 Northern Pike Early Detection Monitoring – eDNA

The goal is to use eDNA as an early detection tool for monitoring the distribution and expansion of northern pike in the Upper Columbia River watershed. The proposal is to add five additional monitoring sites to increase the probability of detecting pike in new waters: four in the lower sections of Lake Roosevelt and one at the outlet of Banks Lake. A total of 28 sites will be sampled annually in September through 2022.

The eDNA monitoring is not described in sufficient detail to enable a science-based assessment by the ISRP. There is a need for clearly defined research objectives, research hypotheses, sampling designs, sampling methods, and data analysis techniques. Additionally, the map shows only one reference site which is an insufficient number. Additional reference sites are needed to provide assurance that false positives do not bias the outcome of early detection monitoring. A statistician should be consulted to determine an appropriate number of reference sites and in the monitoring design and analysis. Specific questions regarding early detection monitoring (eDNA) are listed in the ISRP's response requested recommendation above.

1.4 Reservoir Operations Study

Insufficient detail is provided to enable a science-based assessment of the reservoir operations study.

The goal is to examine the potential use of reservoir operations to dewater key spawning locations and reduce northern pike spawning success. Northern pike eggs are deposited where they can stick to vegetation, which suspends them above the sediment until they hatch. It is hypothesized that when the reservoir begins to refill, terrestrial vegetation becomes inundated and northern pike will use this habitat to spawn. Refill typically begins in early May with the spawning period occurring in mid-late May when water temperatures range between 8-12°C.

Three data gaps are listed for investigation: (1) the duration of the spawning period, (2) the extent of use of submerged vegetation for spawning, and (3) the physical characteristics of submerged vegetation. No information was presented about the planned sampling designs for

2018-2020 to address these data gaps. Studies to address the three data gaps are research endeavors. Clearly defined research objectives, research hypotheses, sampling designs, sampling methods, and data analysis techniques are needed for each data gap. Specific questions regarding the data gap studies are listed in the ISRP's response requested recommendation above.

The preliminary plan is to use logistic-regression modeling to determine if certain reservoir operations (low, average, high drawdown years; water temperatures; inflow; or drawdown timing) affect year class strength. It is unclear how or if the range of operational conditions to be examined (e.g., low to high drawdowns, water temperatures, inflows, and drawdown timing) will be produced, raising questions about the ability to evaluate these factors. If this modeling effort can be conducted, it is recommended that a statistician, as well as individuals with expertise in reservoir operations, hydrology and GIS monitoring, be involved. Questions pertinent to this phase of the study are listed in the ISRP's response requested recommendation above.

Although reservoir operations might be useful for controlling the reproductive success of northern pike spawning in the reservoir, the proponents must also evaluate the extent to which existing reservoir operations may constrain manipulation of reservoir elevations. Reservoir operation schedules are set far in advance by the operating agency. Much of the operations of the reservoir are legally mandated. An analysis of the operational and legal feasibility of modifying reservoir operation is needed to assess the potential for application of manipulation of reservoir elevations as a means of suppressing northern pike.

2.0 Suppression Strategies

2.1 Mechanical Removal

Very little detail about the proposed suppression efforts was provided in the proposal, so it is not possible to evaluate the adequacy of the suppression efforts.

Information was provided regarding how much effort may be spent gillnetting (i.e., 24 weeks by the CCT and STOI between February and November and 6 weeks by the WDFW) and electrofishing (i.e., 20 days) by the co-managers. However, it remains unclear from the proposal as to where and when suppression efforts will be applied with these two gear types (i.e., gillnets and boat electrofishing), the specific type of gillnets and boat electrofishing gear to be used, how the gears will be deployed, how much effort will be expended with each gear, and the spatial and temporal distributions of effort with each gear. Clear descriptions of the effort to be expended with each type of gear are needed.

Within the section on Project Deliverables, there is mention of use of 20 fyke nets and 20 seine surveys as part of the suppression effort. No detail is provided regarding the design of suppression efforts with these two gear types. Explanation of the plan for inclusion of these two gear types in the northern pike suppression effort is needed.

The suppression effort as described in the proposal will occur regardless of northern pike catch rates (high or low) or response of the population during the next 5 years. The suppression plan should consider the possibility of changes in effort based on catch rates, monitoring data, and quantitative objectives that are part of an adaptive management process.

Biological data (total length, weight, sex, and maturity) will be recorded from a sample of northern pike captured during the suppression effort each month. The proposal should identify the number of fish that need to be sampled each month in order to document trends or to test hypotheses. A statistician should be consulted to determine sample sizes needed to assess possible changes in various metrics. Given the variable age and size of northern pike and the use of variable-mesh, size-selective gillnets, it may be prudent to collect biological data on all northern pike and for each mesh size.

2.2 Northern Pike Reward Program

The northern pike reward program is identified as another tool for suppressing northern pike. The proposal notes that the reward strategy was *"developed with the eight key points listed by Pasko and Goldberg (2014); 1) define management plans and objectives, 2) manage costs, 3) understand the target species population dynamics, 4) evaluate potential ecological outcomes, 5) monitor for unintended outcomes, 6) prevent re-introduction, 7) incorporate adaptive management, and 8) conduct public outreach."* However, little or no information was provided on these eight key points in relation to the design of the reward program.

The potential effectiveness of the northern pike reward program in controlling the northern pike population in Lake Roosevelt is unknown. The \$10 per fish bounty seems to provide sufficient incentive to anglers to target northern pike and return heads to one of two drop off stations. By October 31, 2017, a total of 1,090 heads had been turned in for rewards. This was a substantial proportion of the total number of northern pike removed in 2017. It remains unclear how effective this program may be in contributing to northern pike population suppression, however, because uncertainty exists about the number of northern pike presently in Lake Roosevelt. Thus, it is not possible to determine the proportion of northern pike being removed from the lake via the reward program. More information on the harvested northern pike would be beneficial, such as location of captures, sizes, and effort (hours) expended by an individual to catch a fish. A northern pike total-length versus eye-to-tip-of-snout length (or a similar metric) regression model could be developed to estimate total lengths from heads that are returned for rewards. This would help assign caught fish into year classes. For a reason that is unclear (i.e., taxes?), a maximum number of 59 heads can be turned in by any one person. If motivated anglers are contributing to suppression efforts, it seems that there should be no limit on the maximum number of heads they may turn in for reward. Both the biological effects and the social consequences of the reward program need to be assessed.

3.0 Public Outreach Plan

There are no quantitative objectives for this task. At a minimum, the proposal should state the number of signs, newspaper articles, or public meetings that the plan includes. In addition, the proponents should consider an approach for determining if public outreach is effective. For example, a survey could be conducted to determine the level of awareness about northern pike and other invasive species and why it is important to control the spread of these species. We recommend that a social scientist or extension specialist be consulted to guide the evaluation of the public outreach plan.

2017 Q.4. Assess whether the benefits of longer nighttime set times outweigh the harm to other species by comparing catch rates of northern pike and mortality rates of other species in daylight versus nighttime sets, and using gillnets versus electrofishing.

These issues were not addressed in the proposal.

The proponents appear to have selected overnight sets of gillnets for the northern pike suppression effort and 4-hour sets for monitoring of the response of the northern pike population to suppression efforts. Uncertainty exists on whether these times will be consistently applied during 2018 and beyond. Instead of fixing set times, we recommend that decisions regarding the duration of gillnet sets should be driven by data from the literature or obtained by the proponents. Currently, there does not appear to be any assessments that compare the catch rates of northern pike and non-target species in nighttime and daytime gill net sets. Similarly, there are no assessments that compare the mortality rates of various species that may be captured as bycatch with gill nets. Such assessments should be added to the proposal.

The ISRP ([2017-6](#)) has noted that *"overnight gillnet sets have proven more effective at catching northern pike than 4-hour daytime sets, but no data are presented to demonstrate that the increased catch rate of northern pike in overnight sets outweighs the possible harm to other species through increased bycatch mortality. A particular concern of longer nighttime sets in the targeted areas is the possibility of increased mortality to burbot."* This concern is insufficiently addressed with the proposed bycatch limit for burbot of 50 fish per week per area.

Overall impression of the soundness of methods:

The need for an adaptive management process seems to be unrecognized by the proponents. Under the heading of Adaptive Management, the proponents state, "This is a new project and no Adaptive Management actions have been taken." An adaptive management plan is needed to guide the effort over the next five years and into the future.

Only limited details about proposed methods are present in the proposal, which limits the amount of constructive feedback that the ISRP can provide. For example, the proponents acknowledge the need to track northern pike abundance, and the challenges in doing so, but

they have not proposed specific population monitoring methods that can be reviewed and evaluated by the ISRP.

The proponents have minimally considered evidence from other regions and from other invasive species suppression efforts to identify the amount of effort that may be needed in Lake Roosevelt to suppress the northern pike population. For example, the proponents note the success achieved in suppression of northern pike in Box Canyon Reservoir and propose a level of suppression effort slightly greater for Lake Roosevelt than was expended in Box Canyon Reservoir, but they fail to acknowledge that Lake Roosevelt is an order of magnitude larger than Box Canyon Reservoir. A full assessment of suppression efforts for northern pike that have been successful (or not) is not evidenced in the proposal.

C. Provisions for monitoring and evaluation of results

2016 Q.6. Include a study design and description of the otolith microchemistry methods the project will use to determine the natal origins of northern pike sampled in Lake Roosevelt. Discuss how knowledge of natal origins will inform adaptive management decisions regarding northern pike suppression in Lake Roosevelt.

2017 comments: Qualification 6 is not addressed in the 2017 proposal. Lee and King (2016) state that they have archived otoliths for future analysis, pending a demonstration that the samples can be used to identify and target specific spawning areas. However, the capture of age-0 northern pike in Lake Roosevelt in 2017 suggests that northern pike may be reproducing in the lake, in addition to migrating from upstream spawning areas. Successful reproduction of northern pike in Lake Roosevelt is not particularly surprising, but this recent confirmation means it will be important to re-evaluate whether the otolith microchemistry study proposed previously will still be cost effective and useful for adaptive management decisions.

As described in ISRP ([2016-6](#)), it is important that the STOI develop a statistically rigorous approach for assessing changes in the northern pike population over time. Suppression is likely to be an annual requirement in perpetuity, so development of consistent metrics and methodology will be critical for monitoring trends and evaluating progress. Metrics should involve indices of northern pike abundance, sex ratio, and size or age distributions. Furthermore, diet analyses should be conducted to estimate the percentages of species consumed by northern pike. Lee and King (2016) reported that yellow perch and walleye were the primary species eaten by northern pike in 2016 and that salmonids represented only 6.8% of the diet (by numbers of fish). This observation suggests that northern pike, as a top fish predator, might compensate to some extent for their own depredation on salmonids by reducing predation by other non-native fish predators (see [ISAB 2016-1](#) for a recent review of the complexity of estimating the impacts of predation).

The adaptive management portion of the northern pike suppression proposal is not yet complete. There is no indication in the proposal as to how data obtained by monitoring may be used to assess and modify the design of the suppression efforts into the future. Similarly, it is unclear how either the natal origin (otolith microchemistry) data or the eDNA data will be used. Overall, the lack of detail connecting monitoring to actions reflects the lack of a clearly described adaptive management process. Not enough thought appears to have been given as to how data from various elements of the monitoring program will be assessed by the Lake Roosevelt Northern Pike Technical Team or how decisions will be made regarding continuation or modification of various suppression activities.

The proposed monitoring methods appear to be in early stages of development and require further research and calibration. Similarly, the plan to investigate the feasibility of reducing northern pike reproduction by drawing down the reservoir during a critical period may have merit, but it requires research that is described in insufficient detail to enable a science-based review. For example, evaluation of the reservoir drawdown hypothesis must also consider potential constraints imposed by reservoir operation protocols.

The proponents state that there was no adaptive management plan proposed because this is a "new project" (page 15). Detailed northern pike suppression and monitoring plans within an active adaptive management framework are needed at the initiation of the project. Adaptive management is needed to guide future actions based on observations (i.e., data from both suppression and monitoring efforts) and thoughtful assessment of outcomes.

D. Results: benefits to fish and wildlife

Does the proponent's summary describe to what extent the project has met its objectives? Does the summary describe the lessons learned and how the project has changed (objectives, actions, etc.) based on biological responses or information gained from project actions.

Within the proposal, there are varying statements of project goals and objectives. Initially, the purpose statement is that the "goal is to suppress Northern Pike in the Lake Roosevelt watershed and prevent the species from spreading and expanding into other water bodies." The problem statement differs slightly, "The goal of the North Pike Suppression and Monitoring Project is to suppress and eradicate Northern Pike in the Lake Roosevelt watershed." Further, the objectives of the project are stated to be to (1) reduce or eliminate Northern Pike in the Lake Roosevelt watershed and (2) conduct public outreach. A focused goal on suppression of the northern pike population in Lake Roosevelt would facilitate development of specific quantitative objectives for northern pike suppression in the reservoir.

The proponents provide information regarding the numbers of northern pike that have been removed through suppression efforts in 2016 and 2017. However, these numbers are not related to specific objectives for suppression.

The proponents have provided a discussion of lessons learned from their 2015-2017 suppression work. In some cases, they have indicated how lessons learned have contributed to additions or modification to the suppression effort. However, they do not refer to an adaptive management process through which data and insights are assessed and decisions are made.

The proponents note the need to fine-tune northern pike population monitoring, particularly the spring monitoring that is affected by severe drawdown of lake levels. However, the description as to how the monitoring plan for 2018 has been altered to address this problem is unclear. They state that spring monitoring will not begin until water temperature is $\geq 5^{\circ}$ C. It is unclear how this addresses the problem of drawdown during spring monitoring.

Another lesson learned is that the existing FWIN monitoring protocol is insufficient for northern pike, based on a specific review by a contractor. A new monitoring approach is under consideration, but details of this approach were not described. The proposal noted that the Technical Team finalized the "Lake Roosevelt Northern Pike Suppression and Monitoring Strategy" in 2017, but a reference to this strategy or report was not provided.

Examples of additional lessons learned by the proponents include:

1. The proponents discuss the need for longer gillnets for suppression efforts over large expanses of flats in the reservoir and the need for shorter gillnets in the Kettle River and tributaries. However, it is unclear if this lesson has led to a modification of suppression plans for 2018.
2. The proponents state that it has been learned that boat electrofishing works relatively well for capturing juvenile northern pike during fall in Lake Roosevelt. However, they have not fully described a fall monitoring protocol that emanates from this lesson learned.
3. The proponents indicate that they have learned that there is a need to experiment with a variety of methods for northern pike suppression. Mention is made of inclusion of fyke nets and seines as suppression tools, but specific plans for testing these gears are not included in the proposal.

The issue of northern pike suppression in Columbia River Basin reservoirs would benefit from the use of ecosystem modeling to explore the complicated effects of northern pike predation on salmonids, other salmon predators, food web structure, and overall ecological conditions. The classic studies of Lake Mendota (Wisconsin) and other lakes where fish predators have been manipulated to influence lake conditions need to be considered. These and other studies provide valuable information on what happens to system characteristics and processes when a new apex predator arrives or when the abundances are modified. The proponents of northern pike suppression need to consider inclusion of ecosystem modeling and a full assessment of the array of literature on manipulation of apex predators when establishing goals and management objectives for the Columbia River Basin.