Independent Scientific Review Panel
for the Northwest Power & Conservation Council
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Memorandum (ISRP 2014-8) **July 31, 2014**

To: Bill Bradbury, Chair, Northwest Power and Conservation Council

From: Greg Ruggerone, ISRP Chair

Subject: Review of a Revised Proposal for the Lake Roosevelt Burbot Population Assessment Project (#200811500)

Background

In response to the Northwest Power and Conservation Council's June 3, 2014 request, the ISRP reviewed a revised proposal for the Colville Confederated Tribes' (CCT) project *Lake Roosevelt Burbot Population Assessment* (#2008-115-00). As described in the revised proposal, "*the goal of the project is to achieve a stable, harvestable Burbot population in Lake Roosevelt. The primary objective of this project is to provide technical advice to the Lake Roosevelt Co-Managers [CCT, Washington Department of Fish and Wildlife, and Spokane Tribe of Indians] regarding management alternatives so that they can develop realistic fishery targets and appropriate implementation strategies. Stock assessment data will be used to estimate current population harvest potential, evaluate alternative management scenarios, and assess recruitment variability.*"

This is a follow-up to the ISRP's review and Council's recommendation in the Resident Fish, Data Management, and Regional Coordination Category Review (ISRP 2012-6, pages 79 - 81). In that review, the ISRP recommended that the project met scientific review criteria in part: "*The full proposal is not yet justified. Deliverable 1 should proceed. Previous and ongoing burbot data collection in Lake Roosevelt from WDFW Fall Walleye Index Netting (FWIN) should be fully examined and analyzed to determine if it is adequate for evaluating the status of burbot before exerting significant additional sampling effort in the lake. Evaluation based on Deliverable 1 should be used to design field sampling efforts, if needed, beyond existing efforts as a means to meet project goals. The ISRP should review a subsequent revised proposal that builds on results from Deliverable 1. The design should consider other ISRP comments noted below.*" See the ISRP's full comments from the Category review attached below.

The Council subsequently recommended "*Implement Objective 1, deliverable 1 only through completion and not beyond FY2017 (Analysis of Fall Walleye Index Netting Bycatch Data).*

Sponsor to submit revised proposal based on this analysis for ISRP/Council for review and recommendation prior to additional assessment efforts in Lake Roosevelt."

ISRP Recommendation

Meets scientific review criteria in part (qualified)

The proposal meets scientific review criteria in part; Deliverable 2 is not recommended until the feasibility of that deliverable can be demonstrated in a pilot project and until scenarios are developed to demonstrate how the proposed collection of new information could change the management of the fishery.

The recent analysis of FWIN data by Bennett and Steinhorst (2014) demonstrates that the existing FWIN program data can be used to detect year-to-year changes in relative abundance of burbot and to identify strong and weak year classes in a general way. It also provides estimates of age composition and length-at-age, although changes in these metrics over time may not be readily detectable unless the change is large. Thus, the sponsors should be able to detect trends in recruitment and provide basic data needed to monitor the population for the current modest fishery (typically <500 fish per year) for this large reservoir. Now that a comprehensive analysis of the FWIN data has been completed, it appears that relatively little additional effort would be needed to use these data to inform harvest management. Monitoring and full utilization of burbot bycatch in the FWIN program should continue; any burbot accidentally killed in the process of FWIN sampling should be sampled for age determination to aid in assessing year class strengths.

The basis for instituting more intensive field collections and stock assessment of this fishery, as outlined in the proposal, is less clear. The stated goal of this project is to liberalize fishing regulations for burbot if it is determined that the population can support greater harvest. Current regulations limit the daily harvest to five burbot, and setlines (multiple hooks) are not allowed. The fishery is open year round. These regulations already seem quite liberal compared with regulations elsewhere, including Alaska, especially given the health warning for potential consumers by the Washington Department of Health. Acquiring more data may not be particularly useful, necessary, or cost effective given the apparent limited interest in the fishery. Population estimates may not be needed to manage this fishery as trend data currently provided by the FWIN may be adequate. Not all fisheries can or need to be monitored intensively (e.g., Johannes 1998), especially if the fishery is small and of limited interest.

It was not clear to the ISRP how new information, beyond that obtained from FWIN, would be used to change burbot management in Lake Roosevelt. How much would the management of the burbot fishery improve if the sponsors gained the additional data? Would the additional data actually make a difference given the limited nature of the fishery? For example, the major field sampling effort proposed to examine selectivity (bias) of the FWIN gillnets has not been adequately justified in terms of how it would contribute to achieving the overarching management goal. The sponsors should also show how the additional data and FAMS analysis

would better inform different harvest scenarios. The proposal does not describe any alternative harvest strategies for burbot. Broader social and ecological aspects of the harvest are not well described. Is it realistic to increase this fishery given that it is primarily a winter fishery? Is it prudent to increase this fishery given that burbot are generally a species of concern in the lower 48 states? Is it even desirable to expand this fishery given the health warning released by the Washington Department of Health for children and pregnant women that may consume burbot? In short, the goal of this project to potentially liberalize harvest regulations (e.g., increase daily bag limit beyond five fish) may not be warranted.

The sponsor's concern over non-representative sampling of the small, young fish comes from the Bennett and Steinhorst (2014) analysis. The shortage of age two and younger fish in samples is hypothesized to be a result of limitations of the FWIN survey. To better assess the relative abundance of young fish, the sponsors would need to develop or test monitoring methods different than FWIN, specifically a bottom trawl capable of catching burbot representatively at ages 2, 3, and 4. These representative catch data could then be used to develop a scaling factor to correct any size bias in the FWIN data. Other factors may be clouding the current sampling results. For example, what if age 3 fish are migrants? The bottom trawl may help clarify these issues *if* it can representatively sample the key age groups. Are the sponsors also planning to use data for other non-target species captured with their proposed methods to better understand species composition in Lake Roosevelt?

Since it is not clear to the ISRP that more information is justified at the current level of the fishery, the proposed expansion of field monitoring requires additional justification. Is obtaining the identified information on younger-aged fish feasible and cost effective? Several sampling methods are identified including trawls, cod pots, and trammel nets, but no information is provided regarding the likely effectiveness of these methods, especially in Lake Roosevelt. The proposal does not describe efforts and successes using these and other methods elsewhere, in and beyond the Columbia River Basin. For example, mark-recapture experiments of burbot have not been effective in Canada (Neufeld 2008). Under these circumstances, it would be prudent to start by testing the effectiveness of new methods at a pilot level, one that is considerably less intensive than proposed. A full-blown sampling program should not be undertaken until some significant and potentially useful insights and catch rates as well as a feasible path forward have been demonstrated in a pilot study.

The ISRP also questions the feasibility of obtaining adequate data for the FAMS model, especially a measure of total recruitment in the reservoir.

Given the limited nature of the fishery and the unproven methods for effective sampling of younger burbot, Deliverable No. 2 (FWIN data that are corrected for size and age selectivity) is not recommended at this time. The ISRP suggests a focused, scaled-back field investigation until sampling methods are proven to be effective and the prospects for obtaining the needed data for FAMS modeling are much clearer.

ISRP Comments

1. Clarification on goals and objectives

The goals and objectives of the project are clearly stated: *"The goal of the project is to achieve a stable, harvestable Burbot population in Lake Roosevelt. The primary objective of this project is to provide technical advice to the Lake Roosevelt Co-Managers regarding management alternatives so that they can develop realistic fishery targets and appropriate implementation strategies. Stock assessment data will be used to estimate current population harvest potential, evaluate alternative management scenarios, and assess recruitment variability."* The goal of achieving a stable level of *abundance* seems inconsistent with the conclusion that recruitment of the dominant age 2 (or 3) year class varies widely from year to year (Bennett and Steinhorst 2014), especially given that annual regulations cannot be set based on in-season estimates of recruitment due to "procedural bottlenecks." See the following statements on page 6/19: "*Recruitment variability can complicate the management of a fishery (Maceina and Pereira 2007). Without the ability to manage the Lake Roosevelt Burbot fishery with annual regulation changes (due to procedural bottlenecks), variable recruitment will likely result in more conservative management strategies as a relatively small number of year classes will support the fishery over multiple years."* Under these conditions, a more reasonable goal might be to achieve a modest but stable *catch*, or a stable *effort*, or maintain catch rates *above some target level some proportion of years*.

Evaluating harvest potential seems to be a reasonable goal. However, the burbot is an embattled, declining fish in many locations, especially in regulated rivers and in the southern portion of its range. It can also be fished nearly to extirpation in some cases, and very few agencies have effectively managed, or even tried to manage, the species. It is an unusual freshwater fish with an unusual life history (winter-early spring spawning under ice). It would be very useful, and probably necessary, to survey other burbot fisheries, assessing how many of them are sustainable and well-monitored, and what factors account for that sustainability, either harvest management approaches or ecological factors that may affect stock productivity. Do non-native species or habitat changes affect recruitment? Who is managing burbot effectively and exactly how are they doing it? What is their approach? Much of this material could have been presented and would have resulted in an improved proposal.

The re-analysis of the FWIN data confirms that the burbot by-catch data has value for detecting large fluctuations in recruitment and for monitoring current management, but it does not convincingly demonstrate that the by-catch data will be sufficiently accurate and precise for directing changes in management. The power analyses were not conducted with reference to specific appropriate goals for monitoring. For example, would the FWIN program have sufficient power to detect a change in abundance in x years after a regulation change? Although the FWIN data have provided some indication of relative year class strength, more detailed data will be needed for managing for optimum yield. A key practical question then, is whether the more extensive field effort and analysis being proposed can be justified to direct a substantial fishery toward this species, given the lack of evidence that it is feasible or prudent. The

proposal states that *"Burbot have generally been neglected by Lake Roosevelt anglers, with less than 1% targeting Burbot in any year between 2001 and 2009 and harvest likely never exceeding 500 fish except in 2002 when an estimated 950 Burbot were harvested."* The former use of setlines (multiple baited hooks) has been banned by the state, and this seems to be a reasonable gear restriction for a recreational fishery because non-target species may also be captured on setlines. The sponsors state that this project is necessary to estimate the population status of burbot in Lake Roosevelt so that fishing regulations might be liberalized and to encourage more fishermen to participate in the burbot fishery. Currently, the fishery is open all year, but most effort likely occurs in winter when catch rates are likely higher. Key recreational angling management issues to be addressed by the project are 1) whether or not there should be a change in daily bag limit and 2) whether or not size restrictions (currently none) should be implemented. It is unclear how these possible changes in management could be used to entice more people to fish for burbot. Given the current low effort and limited total catch for burbot in Lake Roosevelt, it is not clear that field studies are justified in order to refine gillnet selectivity of the ongoing FWIN survey, which was shown to provide a coarse but perhaps adequate and inexpensive index of burbot abundance.

Is it wise to encourage people to eat more of these fish? More discussion is needed whether the Program should be encouraging the public to eat more burbot than are currently consumed, given the health warning for children and pregnant women. The current daily bag limit is 5 fish, which is high for a fish that has received a health warning for potential consumers by the Washington Department of Health. Despite the high bag limit, fishing effort and harvest are low. Would it not be more prudent to direct efforts for increased harvest to other species in the reservoir with recent histories of higher abundance and sustainable harvest potential? Has this idea been considered?

2. FWIN survey results, application as a burbot Index, and revised sampling design

The analysis of the FWIN burbot data, as recommended by ISRP, provided important information for this proposed project. The new analysis was used to show that the initially proposed mark-recapture approach, for estimating gear selectivity, would not work without unrealistic effort. The analysis also showed that the existing FWIN data provides 1) a reasonable estimate of relative annual abundance of burbot, 2) annual survival values that exceeded 60%, and 3) relative abundance by age and size, including sizes related to recruitment to the sport fishery. Numbers-at-age data provided in Table 1 (based on the FWIN catch data and age-length keys) are consistent in suggesting that unusually strong recruitment of age-2 burbot accounted for the high catch rates of the 2001, 2004, 2008, and 2009 year classes (defined by year of age-2 recruitment as in Figure 1). This consistency suggests that the FWIN survey data and age determinations are able to detect year class differences that would be important to managing a burbot fishery. The FWIN survey is an important step toward quantitative stock assessment for burbot.

Since the overarching conclusion of the study was that the FWIN program is adequate for monitoring year-to-year differences in burbot population indices, given the availability of the FWIN data each year, managers could examine population trends over time to see if there were significant declines in catch per effort or declines in large fish for example, then restrict the fishery if effort was thought to be contributing to this decline (based on creel survey). The cost to do this would be low.

However, extending conclusions far beyond that of identifying years of unusually large or small recruitment has limitations and presents challenges. In relatively long-lived species such as burbot, annual fluctuations in abundance (or growth) of fully-recruited cohorts (age 3 and older) typically reflect measurement error rather than real changes in abundance (or growth). Much of the smaller scale annual variability in abundance indices (detected as statistically significant in the contracted assessment) seems to lack a coherent biological explanation, suggesting it is an artifact caused by non-representative sampling, or simply sampling too few fish, rather than indicating biologically meaningful processes relevant to management. It may imply instead that the survey data are not precise enough to detect anything but very large differences in abundance among strata. This interpretation does not argue against using the survey data for management but does imply limitations on the potential resolution of population processes.

The ISRP has some concerns about the analysis of the FWIN data by Bennett and Steinhorst (2014). They used standard ANOVA methods either treating each FWIN net as the sampling unit (e.g., for CPUE) or the entire set of nets within a stratum as a sampling unit (e.g., analysis of observed proportions of burbot). In some cases, analyses were performed on transformed data (e.g., arcsin sqrt -p) but such transformations are no longer recommended for many analyses (Warton and Hui 2011).

In many cases, the “year” effects were treated as fixed effects, but a more appropriate analysis would treat years as random effects. Presumably interest lies in extrapolating the results of the FWIN surveys outside the actual 10-year window. By treating year effects as fixed effects, estimates of multi-year averages have reported standard errors that are too small and reported power values tend to overestimate the actual power. For example, Figure 9 shows substantial variation in the CPUE among years when presumably the population is in a pre-harvest mode. Presumably these fluctuations result from random year effects rather than being tied to specific years.

The FWIN analysis includes several crucial assumptions. For instance, it is assumed that gear selectivity of the FWIN net is not changing over time or among the strata so that changes seen among years and/or strata reflect changes in the population rather than simple artifacts of sampling. The report needs to include justification of all of the assumptions made.

Power analyses examined if the FWIN program could detect changes in various outcomes over the period for which FWIN data are available, but the relevance of the power computations in using FWIN as a monitoring tool is unclear. Many of the analyses examine power to detect

strata effects or general year effects within the current sampling window. But interest lies in monitoring going forward. For example, suppose that an increased harvest of burbot was promoted and occurred. One could imagine that the observed proportion of burbot in the FWIN samples may then decline either as a gradual trend or as a step function. How many years of sampling would be needed to detect? How big of an effect could be detected in the next five years? It is unclear how the current power analysis would answer this. Similarly, many of the power analyses to detect "year effects" look for any changes over time (because year was treated as a fixed effect) rather than targeting the power analysis for trend or step changes.

Changes in average weight or average length may not be useful for forward monitoring purposes because of the large inertia in the population. Figure 13 appears to show very high serial correlation over time and so this will reduce forward-looking power to detect trends or step changes as well. A better chart would depict annual age composition and size at age.

Although the Bennett and Steinhorst (2014) report is a thorough evaluation of the internal consistency of the burbot data collected in the FWIN index, it is strictly associated with the internal aspects of the data set and not with external factors that may affect the results. It is primarily a statistical study rather than a biological/ecological assessment. For example, it was reasonably concluded from the analysis and from the observation of the data that the years 2001, 2004, 2008, and 2010 were good recruitment years for age-2 fish. The strength of those cohorts in subsequent years clearly implied that the FWIN index was saying something about burbot recruitment. If the number of age-2 fish recruited is the key factor in establishing a large year class, how did that relate to the number and CPUE of predator-sized walleyes caught in the nets or in the reservoir? That sort of interspecies or community-level analysis remains to be done. However, it could provide insight into ecological factors creating strong versus weak year classes.

3. Fish age and size selectivity due to gear bias

The statistically significant annual variability, without trend, in length-at-age and proportional size distribution (PSD) of fully recruited burbot warrants further explanation as it suggests non-representative sampling or ageing determination error. Further, Bennett and Steinhorst (2014) note in their Discussion that "variability in length was a huge factor." If the variability arises from non-representative sampling or age determination errors, then additional samples to improve age indexing of small and large fish may not help to correct for size selectivity.

Gillnets are always selective for certain sizes and body shapes of fish. The FWIN gillnets are certainly selective too, with regard to burbot size and age. The most important issue for this burbot project is to ensure that the FWIN gillnets are used consistently each year so that the data can be compared and evaluated over time.

If the burbot sport fishery was a highly prized fishery with considerable angler effort and value, then it might be worthwhile to evaluate selectivity of the FWIN gillnets beyond what is already

known. For example, Table 1 (proposal) demonstrates that age-0 and age-1 burbot are not vulnerable to the FWIN nets. Partial recruitment to the nets begins at age 2. This recruitment to the FWIN nets is likely due to the size of fish relative to the net mesh size, but habitat preferences by life stage can also play an important role in gear selectivity. It seems that this latter factor was not considered by the investigators when looking at gear selectivity.

It is not clear from the proposal how the supplemental fishing effort, using a variety of gears and each with their own potential burbot selectivity (bias) issues, will be used to modify the FWIN data for input into the FAMS model for estimating potential yield of burbot. If this effort-intensive approach is taken, will supplemental sampling be required every year? It does not seem that the low effort shown in this burbot fishery demands this intensity of sampling to inform management decisions.

The sponsors propose to examine fish captured in each of the individual panels (with different mesh sizes) and then use the method in Millar and Holst (1997) to estimate the *relative* selectivity of the different gears to give a corrected (relative) population length distribution. A length-age key will then be applied to translate the corrected relative length class distribution into a corrected relative age-class distribution in the population. It was not clear how many years of data will need to be collected in order to do the correction. Table 1 (proposal) shows that about 200 burbot/year are captured in FWIN with the majority of the fish in the younger age classes. This implies that the number of burbot in each of the 8 panels of the FWIN nets (with different mesh sizes) will also be fairly small. When this is further subdivided by length classes the data will be very sparse in any one year. A preliminary power analysis/simulation study is needed to see how well the proposed method will work and if the size selectivity can actually be differentiated and corrected given the number of fish that are likely to be sampled.

The investigators provide some evidence that a different method for aging burbot from otoliths may provide more accurate results (e.g., thin-sectioned otoliths versus whole otoliths). Therefore, as suggested by the sponsors, it may be worthwhile to inform WDFW of the possible current bias so that they might change their approach. No data on the degree of bias (e.g., under-estimating burbot age) were presented.

Overall, although gear bias may be an issue, its importance seems overemphasized in the proposal in relation to other more serious potential problems. It may be less of an issue than the current low interest in the fishery and the need for an improved understanding of recruitment and factors affecting recruitment. Another potential problem is the effort in other fisheries projects to enhance potential predators of young, pre-recruited burbot.

4. Estimating burbot harvest potential under current and alternative scenarios

The general outline of intended analyses with FAMS seems reasonable, but more description would be needed to support a thorough ISRP review at this stage. One concern would be whether the input data (as listed in DELV-3) have been estimated reliably enough to allow meaningful conclusions about productivity, carrying capacity, and sustainable harvest strategies.

One evaluation centered on assessing the potential for harvest under conditions of stable recruitment. The evaluation of the FWIN and observations of the year class table strongly indicate irregular recruitment. It would seem more appropriate to evaluate harvest under that sort of scenario, especially until the causes of the variable recruitment are better understood.

The proposed model for evaluating burbot harvest management strategies is a standard, cookbook method to assess and manage burbot. Most of the fisheries of this type are managed with liberal, open seasons (sometimes open all year) with specific length restrictions or individual bag limits to target middle and older-age fish, often with a poor understanding of total population numbers and actual harvest. The ISRP wonders if a harvest cap is a better approach. And, how many spawners are needed for effective reproductive success and recruitment? The stock-recruitment relationship is often a mystery, and it remains so. Before relying on the FAMS model, more information than that presented in the report is needed on life history. For instance, do males mature a year or two earlier than females, as is often the case in such fishes? In Bennett and Steinhorst (2014) the percentage of mature burbot was well less than 100%, even for older age classes. Does this indicate that fish, especially females, do not spawn every year? Skipped spawning is found in other populations, according to a review by McPhail and Paragamian (2000). Figure 31 of Bennett and Steinhorst (2014) suggests that possibility for females, though not necessarily for males. Are males and females equally vulnerable to recreational harvest? Do we have an idea of the total population size? What type of fishery would be best given the life history of the fish and the recruitment variability? The FAMS model and ones like it unfortunately do not fully consider some of these factors and lead to the usual size limit recommendations without fully dealing with the actual stock status. This native species can be affected by climate change and recruitment issues common to southerly stocks. Burbot management is minimal or non-existent in most regions (Stapanian et al. 2010). Even in places such as Alaska, harvest management has had to become more and more restrictive (Bonar et al. 2000). For this species, whose requirements are not well understood, a sustainable harvest management approach will be different and should be more specifically defined than approaches for non-native largemouth bass or walleyes. None of these considerations are presented in the proposal, and they should be.

In particular, the (FAMS) estimates harvest potential or yield (Y) by:

$$Y = \frac{F * N_t * e^{(Z*r)} * W_\infty}{K} [\beta(X,P,Q)] - [\beta(X_1,P,Q)]$$

where:

F = instantaneous rate of fishing mortality (Chapter 4);

N_t = the number of recruits entering the fishery at some minimum length at time (t);

Z = instantaneous rate of total mortality (Chapter 4);

r = time in years to recruit to the fishery ($t_r - t_o$);

W_∞ = maximum theoretical weight derived from predicting this weight using L_∞ and the weight-to-length regression equation (Chapter 3);

K = is the growth coefficient in the von Bertalanffy growth equation (Chapter 3);

β = incomplete Beta function;

$X = e^{-Kr}$;

$X_1 = e^{-k(Maxage - to)}$ and Maxage is the maximum age of the population;

P = Z/K; and

Q = slope of the weight-length relation + 1.

It is not clear how some metrics will be obtained, such as the number of recruits (burbot population size) entering the fishery (N_i). In particular, the current FWIN data does not provide an absolute estimate of the size of recruitment that is needed to "anchor" projections with the actual population sizes of burbot in the lake. Without such anchoring, how will a "10% harvest of fish bigger than x inches" be translated into a measure of total catch to see if this is feasible given the current fishing effort?

Key management issues to be addressed by the proposed project are changes in daily bag limits (currently five burbot) and implementation of size restrictions (currently none). It is not clear that the Fishery Analysis and Modeling Simulator (FAMS) model is needed to inform these decisions given the low fishing effort in the large reservoir. Implementation of size restrictions or a reduction in daily catch would likely reduce fishing effort rather than increase interest in the burbot fishery.

Lastly, the FAMS software is deterministic and does not provide for stochastic variability in the output which may give a misleading picture of the impact of a fishery. Additionally, the output from the FAMS models needs to be combined with the FWIN sampling to see if changes in the fishery can properly be managed. For example, Bennett and Steinhorst (2014) (page 5) indicated that only a very large shift in age distribution could be detected using the FWIN program. The FAMS software should be used to estimate the potential change in the age distribution given a proposed management regime.

5. Evaluation of factors influencing burbot recruitment

Although this assessment does provide evidence that the FWIN survey can detect large variations in recruitment of age-2 burbot, these changes might be caused by variable immigration downstream from Arrow Lake, rather than variability in factors affecting survival (i.e., reproductive success). Without reliable estimates of actual recruitment (reproductive success), it is questionable whether abiotic factors affecting recruitment could be identified from correlations with age-2 abundance data. The most that could be argued is that finding correlations would help to identify future studies that could demonstrate causation.

The proposal to evaluate factors affecting burbot recruitment is a relatively low effort approach. Obviously, there might be many factors, some controllable, at least in theory (e.g., operational decisions) and some not. However, there was no information provided as to hypotheses about what those factors might be, and how the hypotheses would be evaluated, or the overall approach used (e.g., a large set of possible variables and AIC, and so forth). It would seem appropriate for the sponsors to more carefully and fully develop this portion of the proposal. The sponsors plan a standard regression approach to try and tease out the impacts of various factors on the recruitment index from FWIN. The modeling should consider autocorrelation and collinearity issues. However, the sponsors may be too optimistic; there are only 10 data points for recruitment, and so the number of variables that could be used to "explain" recruitment must be very small, otherwise over-fitting will occur. It is not clear how data from other populations (e.g., Arrow Lakes) will be useful as many of the proposed variables are specific to Lake Roosevelt.

One issue that might receive more attention is identifying when the recruitment bottlenecks occur, although this level of understanding may not be necessary for managing this small fishery. From the gillnet data it is not possible to assess reproductive success since the age-0 fish are not captured. It would be useful to know if the issue is reproductive success (i.e., irregular reproductive success) because of some abiotic issues such as water temperature or other reservoir factors, or whether the limitation is from age-0 to age-1, where the issue might be predation from fishes such as walleye. That hypothesis is consistent with the finding in Bennett and Steinhorst (2014) that the growth increment was greatest between age-1 and age-2. It was noted in the brief summary of possible variables that nothing was said about indices of piscivorous predators. One possibility would be that age-0 fish grow slowly in some years because of abiotic factors affecting food supply and remain vulnerable to predation for a longer time. Do the fish need to achieve some particular size to be largely free of potential predation? It is noted that burbot are long, thin fish and may therefore be able to appear as large after a year or two, thereby lessening predation pressure. They are obviously not strong swimmers. How does habitat use change as the fish age from 0 to 1 to 2? The suite of factors that could result in the observed recruitment, as indicated by age-2 fish in the nets, is large and not well understood. It would have been helpful to have a flowchart and a table of potential factors and some plausible hypotheses, showing that the sponsors have given the issue considerable thought.

6. Other comments and specific editorial suggestions

It would have been very beneficial if the sponsors had provided more details of burbot and its associated species in Lake Roosevelt and their approaches for addressing the management questions. The reference list is fairly long, but the use of the references in formulating hypotheses or arguments is very minimal.

Analysis of relative abundance (page 12). Refer to Warton and Hui (2011) as an alternative to the analysis of the arcsine-square root-transformation.

Table 4 (page 17). We are not sure of the relevance of these tables. Yes, there are differences among years in the attribute measured, but why is this important to know?

Analysis of catch/net (page 19). The authors analyzed the standardized (to 24 hours) data, but a generalized linear model using a Poisson or Negative Binomial distribution with a log-link and an offset equal to the length of the sampling period may be more appropriate.

Figure 5 (page 21) and similar figures. These figures need to be redrawn as the bars total more than 100%.

Mortality rate estimation (page 26). This analysis assumes that gear selectivity is flat after fish are recruited. Otherwise, changes in observed age composition are confounded with changes in gear selectivity. This assumption needs to be discussed. Something odd is reported – all of the strata survival rates are 69% or higher, yet the pooled data has only an estimated 62% survival rate. Is this correct?

Length-at-age (page 27). This again makes a key assumption that all lengths are equally selected after recruitment to the FWIN. This is likely untrue for the younger age groups where there may be some truncation at lower lengths (see Figure 16 showing on the left tail the effect of gear selectivity).

Age structure (page 28). These results are only for the observed age distribution in the FWIN rather than the absolute age distribution.

Figure 17 (page 33). What are “data scores”?

Figure 21 (page 36). What does “lower fish are 10% older” mean?

Analysis of age distributions (page 27). The data were pooled over years before being compared across strata. This ignores the correlations in the age distributions due to “inertia”; i.e., this year’s 3-year olds are next year’s 4-year olds, and so forth.

Table 10 (page 39). Why are the intermediate bootstrap values presented? They usually don't have any value and only the final results would be useful.

Body condition (page 40). The analysis of the 75th percentile should be replaced by quantile-regression methods.

Figure 32 (page 53). Something odd with 12-year old males – sample size is 1, but 30% were mature?

References

Bonar, S. A., L. G. Brown, P. E. Mongillo, and K. Williams. 2000. Biology, distribution, and management of Burbot (*Lota lota*) in Washington State. Northwest Science 74:87-96.

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Warton, D. I., and F. K. C. Hui. 2011. The arcsine is asinine: the analysis of proportions in ecology. Ecology 3. http://dx.doi.org/10.1890/10-0340.1

Attachment: ISRP Review from the Resident Fish, Data Management, and Regional Coordination Category Review (ISRP 2012-6, pages 79 - 81)

200811500 - Lake Roosevelt Burbot Population Assessment

Sponsor: Colville Confederated Tribes
ISRP recommendation: Meets Scientific Review Criteria - In Part

Qualifications:

In Part - The full proposal is not yet justified. Deliverable 1 should proceed. Previous and ongoing burbot data collection in Lake Roosevelt from WDFW Fall Walleye Index Netting (FWIN) should be fully examined and analyzed to determine if it is adequate for evaluating the status of burbot before exerting significant additional sampling effort in the lake. Evaluation based on Deliverable 1 should be used to design field sampling efforts, if needed, beyond existing efforts as a means to meet project goals. The ISRP should review a subsequent revised proposal that builds on results from Deliverable 1. The design should consider other ISRP comments noted below.

Comment:

1. Purpose: Significance to Regional Programs, Technical Background, and Objectives

Significance to Regional Programs: The sponsor refers to several regional programs, including the Spokane Subbasin plan, the Columbia River Basin Research Plan, the Lake Roosevelt Guiding Document, MERR, and the NPPC Fish and Wildlife Program 2009. The declining status of burbot in many southerly portions of their range is a valid concern to resident fish managers.

Technical Background: The proposal provides decent technical background information on sampling and status of burbot, although additional gray literature might be available on burbot sampling.

Key information involving the ultimate goal of the proposal was missing until the presentation by the sponsor. During the presentation, the sponsor noted that current harvest levels of burbot are low because fishing gear is now limited to hook and line since set lines were banned in 2006. No sport or subsistence catch data was provided. According to WDFW regulations, the daily bag limit for burbot is currently five fish, but the state also recommends that women of child bearing years and children not consume more than one meal of burbot per week because the fish are contaminated. The sponsor cited a 10-year old WDFW report suggesting the Lake Roosevelt burbot population was “healthy” based on stable electrofishing and catch per effort sampling. Given the reportedly low catch rates of burbot by fishermen and the apparent healthy status of the population, the ultimate goal of this project seems to be whether the population of burbot could withstand a higher harvest rate, possibly through changes in gear regulation. If so, this would be a potential benefit to subsistence and recreational anglers. If

changing harvest and gear regulations is an ultimate goal of this effort, then metrics and benchmarks for making this decision should be developed.

Objectives: The goal is reasonable: a healthy and harvestable burbot population. The objective is reasonable: to monitor and facilitate management to achieve the goal. Specific target levels to define "healthy population" and harvest levels are needed.

2. History: Accomplishments, Results, and Adaptive Management (ISRP Review of Results)

This is a new project so no accomplishments, adaptive management, or results.

However, the ISRP thought the sponsor should have analyzed the existing Fall Walleye Index Netting data (FWIN) prior to developing this proposal to conduct extensive field effort. Analysis of the existing FWIN data may be sufficient to evaluate status of burbot relative to previous sampling efforts (e.g., Bonar study), and this analysis could be used to inform the sampling design if it was determined that an extensive field effort was needed in addition to ongoing FWIN sampling and creel survey efforts.

3. Project Relationships, Emerging Limiting Factors, and Tailored Questions for Type of Work (hatchery, RME, tagging)

Project Relationships: The proposal described how this project was related to four other projects: Lake Roosevelt Data Collection Project, Kootenai River Resident Fish Mitigation, CCT Chief Joseph Kokanee, and CCT White Sturgeon Enhancement Project. Four BPA projects are listed that this project will coordinate with and share data.

Emerging limiting factors: Climate change, chemical contamination, and potential impacts by non-native predators are discussed.

Tailored questions: The sponsor addressed the PIT tag study to develop population estimates. They plan to tag and release all viable burbot, approximately 2200 fish per year based on assumptions. The sponsor notes that they do not know if the proposed sample size is adequate for estimating burbot population size, but they suggest this is not needed since the project is a pilot study. The ISRP notes that prior to the proposed field effort, the sponsor should examine "what if" scenarios to determine whether tagging of 1100 fish twice per year might be sufficient to detect population trends over time in this very large reservoir. Also, the sponsor should develop criteria for determining whether captured burbot are suitable for tag and release even though previous studies suggested mortality in trammel nets was low. Tagging of burbot that die from capture and tagging operations would significantly bias population estimates if not properly accounted for. The sponsor did describe how they would classify the health of burbot captured in traps. The sponsor notes that a biometrician would be consulted.

4. Deliverables, Work Elements, Metrics, and Methods

Deliverables are adequate.

The sponsor did a good job describing methods in MonitoringMethods.org. However, presenting methods on separate web pages makes it difficult to evaluate how the overall sampling program fits together.

Additional information on metrics should have been provided. Age and year class strength are key metrics when assessing population status of fishes, yet it was not clear how age of burbot captured in traps, trammel nets, or gillnets (FWIN) will be assessed and incorporated into the analysis. burbot are relatively long-lived (up to ~15 years) and could be susceptible to high harvest rates. Each gear type will have its own selectivity for size and age of burbot; how will selectivity be evaluated?

4a. Specific comments on protocols and methods described in MonitoringMethods.org

The sponsor did a good job describing methods in MonitoringMethods.org. Estimates of growth will be based on recaptured burbot, but growth estimates may be few. Were other approaches considered and excluded for estimating growth?