Independent Multidisciplinary Science Team (IMST)

State of Oregon

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July 25, 2011

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Dear Dave,

In your May 4, 2011 letter you requested the Independent Multidisciplinary Science Team (IMST) to review and assess the scientific and technical underpinnings of ODFW's document titled *Lower Columbia River White Sturgeon Conservation Plan* (April 2011 draft; hereafter the Plan). The IMST has completed its review. In your letter you listed 7 topic areas with questions. Answers to those questions are in the review along with general and specific observations made by the IMST. As we mentioned at the IMST's June 22, 2011 public meeting, this review does not include any formal recommendations.

As has been the case with salmonid recovery plans reviewed by IMST, this Plan clearly reflects the high level of professional effort expended by ODFW employees to address the difficult and complex environmental and management conditions in the Columbia River basin. The Plan contains several significant improvements over past conservation and recovery plans that the IMST has reviewed, particularly with respect to the identification and discussion of areas of uncertainty. The authors of the Plan should be commended for their approach and frankness related to known uncertainties.

Please contact us, if you or the Plan authors have any questions regarding the IMST's review.

Sincerely,

Carl Schreck
IMST Co-Chair

Nancy Molina
IMST Co-Chair

Cc: Bruce McIntosh, ODFW
Tony Nigro, ODFW
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IMST Review of Oregon Department of Fish and Wildlife's *Lower Columbia River White Sturgeon Conservation Plan* (*April 2011 draft*)

Released on July 25, 2011

Independent Multidisciplinary Science Team
Oregon Plan for Salmon and Watersheds
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Review Preparation – This review was prepared by the IMST based on an initial draft by an IMST subcommittee (Bob Hughes, Carl Schreck, and Vic Kaczynski with Kathy Maas-Hebner providing administrative support). Tony Nigro (ODFW), Tucker Jones (ODFW), Tom Rein (ODFW), Chris Kearns (ODFW), Christine Mallete (ODFW), and Dave Jepsen (ODFW) were present at the IMST's June 22, 2011 public meeting to discuss the IMST's draft comments and to provide clarification of ODFW's process. The IMST discussed initial review comments at its June 22, 2011 meeting and unanimously adopted (V. Kaczynski was absent) the review at its July 25, 2011 meeting.

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ACRONYMS AND ABBREVIATIONS

cm	centimeter
IMST	Independent Multidisciplinary Science Team
K	thousands
m	meter
M	millions
ODFW	Oregon Department of Fish and Wildlife
OSY	Optimum Sustainable Yield
PVA	Population Viability Analysis
y	year
USACE	US Army Corps of Engineers

INTRODUCTION

The Independent Multidisciplinary Science Team (IMST) reviewed the document titled *Lower Columbia River White Sturgeon Conservation Plan* (April 2011 draft) at the request of the Oregon Department of Fish and Wildlife (ODFW; letter from Dave Jepsen dated May 4, 2011). In particular, ODFW asked the IMST to review the draft Conservation Plan (here after the Plan) respect to the following seven sets of questions:

1. **Conservation and desired status thresholds for the primary biological attributes of abundance, productivity, diversity, distribution and habitat (Section 6; Table 17).** Are the measurable criteria and evaluation thresholds appropriate to assess the target population relative to desired and conservation status? Is the basis for deriving desired and conservation status thresholds for adult and sub-adult abundance clear?
2. **Current population status for primary biological attributes (Section 7).** Is the current population status for biological attributes adequately described using appropriate assessment procedures and best available information?
3. **Limiting factors and threats that may prevent us from achieving desired status (Section 9).** Is the suite of limiting factors comprehensive and balanced in presentation? Are the magnitude and effect of limiting factors described appropriately? Of particular interest are marine mammal predation, flow and flow variation, and fishery effects.
4. **Data gaps that limit our ability to make informed and appropriate management decisions (Section 10; Table 18).** Is the suite of data gaps comprehensive and balanced in presentation? Are priorities to address data gaps sound and described appropriately?
5. **Recommended research, monitoring, and evaluation needed to address identified data gaps (Section 11; Table 19).** Does the recommended RM&E appropriately address the highest priority information needs in a logical sequence?
6. **An implementation and adaptive management process for the conservation plan (Section 12).** Does the adaptive management section describe a logical sequence to implement actions, report the effect of those actions, and respond to new findings that will assure progress toward desired status?
7. **Population viability modeling (Appendix B).** Our intent is to use the best available population dynamics information (empirical and theoretical) to ascertain the likely magnitude and timing of responses to changes in abundance and productivity, as well as responses to changes in those vital rates we can influence. We are particularly interested in your review of treatments of predation, egg to age-1 survival, stock recruitment, extinction thresholds, and habitat carrying capacity.

The IMST finds the conservation plan for lower Columbia white sturgeon an impressive effort and an improvement over previous ODFW conservation plans—indicating considerable thought and analyses. IMST has several suggestions for consideration that are offered to further strengthen the plan. Those suggestions are organized below in sections organized by Answers to ODFW's Questions, General Comments, and Specific Comments.

ANSWERS TO ODFW'S QUESTIONS

1. ***Conservation and desired status thresholds for the primary biological attributes of abundance, productivity, diversity, distribution and habitat (Section 6; Table 17).*** *Are the measurable criteria and evaluation thresholds appropriate to assess the target population relative to desired and conservation status? Is the basis for deriving desired and conservation status thresholds for adult and sub-adult abundance clear?*

Given the unsustainable status and trends of most Columbia and Snake populations of white sturgeon and their listing as endangered by the American Fisheries Society, the lower Columbia population may be the only one with a reasonable probability of persisting (Jelks *et al.* 2008; Jager *et al.* 2010). Consequently, the species eventually may be listed federally as threatened and harvest further curtailed. It would be advantageous for ODFW to discuss these issues explicitly in the Plan and to consider this probability in advance of setting conservation and exploitation targets. Additionally, if ODFW were to view the lower Columbia population in the context of the entire species management unit and what once may have been a single Columbia-Snake-coastal population, the agency might be able to more fully address the multiple needs for passage of young, sub-adult and adult sturgeon as well as the need for ecological flows and river and estuarine habitat rehabilitation for rearing and refuge.

The status thresholds and discussions were not always clear. Some conservation status thresholds appeared arbitrary (or rationales were insufficiently developed or explained; see specific comments below). Some conservation thresholds appeared to be too optimistic. Further explanation and support are needed for a population comprised of 91% juveniles, 8% sub-adults, and 1% adults. Because of the much greater reproductive potential of very large adult fish (whether sturgeon or rockfish), would it not be more important, biologically, to manage for a higher abundance of the most productive fish?

The Plan could be strengthened by providing more scientific and social rationale for the conservation and desired status numbers. Similarly, the Plan could be strengthened by providing more scientific rationale for the population delineations. They appear to be based simply on barriers to effective migration of adults and young. It also would be useful if there were more consideration of the strength of the taxonomic characters used to describe the gene conservation group. Given that sturgeon are polyploids, it would be informative to discuss the confidence that stability in the frequency of the 14 monitored alleles over time would truly indicate a preservation of the extant life history plasticity.

2. ***Current population status for primary biological attributes (Section 7).*** *Is the current population status for biological attributes adequately described using appropriate assessment procedures and best available information?*

ODFW used the best available information; but the available information was seriously incomplete, requiring several important assumptions and data fitting. The assessment procedures appeared appropriate given those constraints. The Plan concentrates on the Columbia River and essentially ignores coastal sturgeon. It would be helpful to provide either more discussion concerning coastal sturgeon or a rationale as to why they do not deserve additional consideration.

3. ***Limiting factors and threats that may prevent us from achieving desired status (Section 9).*** *Is the suite of limiting factors comprehensive and balanced in presentation? Are the magnitude and effect of limiting factors described appropriately? Of particular interest are marine mammal predation, flow and flow variation, and fishery effects.*

The suite of limiting factors appears comprehensive and balanced. Marine mammal and human predation may be more important than presented because it affects the older animals critical to reproduction, productivity and persistence. With the cooperation of the US Army Corps of Engineers (USACE), river flow and flow variation are probably being addressed reasonably well. Historical fishery effects seem underestimated, hence over-fishing may have resulted in fewer than desired adults and sub-adults at present. Current fishery impacts, legal and illegal, may also be underestimated given the concerns about poaching presented in the document. The potential effects of the repeated catch and release of oversized fish by the sport fishery could use more consideration. Stress can be maladaptive to reproduction in teleosts in a variety of ways (Schreck 2010). A review of the rationales for past fishery regulations might reveal limiting factors that have not been recognized or well understood. The fact that marine mammals appear to be preying on smaller sturgeon through time could be treated in more depth, considering the ramifications of potential explanations (immigration or altered population age structure and hence fecundity).

4. ***Data gaps that limit our ability to make informed and appropriate management decisions (Section 10; Table 18).*** *Is the suite of data gaps comprehensive and balanced in presentation? Are priorities to address data gaps sound and described appropriately?*

The Plan includes a good accounting and discussion of uncertainty. Table 18 is not organized to specifically address data gaps. Tables 17 and 18 in combination do this, but not directly. Perhaps another table could be developed to directly address data gaps.

5. ***Recommended research, monitoring, and evaluation needed to address identified data gaps (Section 11; Table 19).*** *Does the recommended RM&E appropriately address the highest priority information needs in a logical sequence?*

Table 19 addresses the information needs. There is much to do in 1 to 5 years. Can ODFW do all of this? Can those needs be prioritized?

Given the many unknowns concerning abundance, distribution, growth rates, and predation rates, the absence of an outline for a monitoring plan in this conservation plan is a substantial omission. An ideal monitoring plan would include probability and targeted sampling designs, multiple sturgeon indicators, site-scale designs involving the use of alternative gear (including benthic trawls and epibenthic sled hauls for young fish and trawls for older fish, and hydroacoustic surveys for large adults) in addition to set lines, physical habitat assessments, and basic biological studies designed to fill monitoring and knowledge gaps. Both population status and trends need to be assessed, along with estimates of confidence in the mean conditions. The assistance of a survey statistician in designing the monitoring program is essential. See Stevens and Urquhart (2000), Hughes & Peck (2008), Bonar *et al.* (2009) and IMST (2009) for

suggestions concerning survey design, site-scale design, standard sampling methods and data aggregation, respectively.

6. ***<u>An implementation and adaptive management process for the conservation plan (Section 12)</u>.*** *Does the adaptive management section describe a logical sequence to implement actions, report the effect of those actions, and respond to new findings that will assure progress toward desired status?*

This is a good start, but the conservation threshold appears to be set at too late of a stage to initiate effective adaptive management. Effective adaptive management should be initiated long before conservation thresholds are met. There are many unknowns in the dynamics of the sturgeon population, particularly its relationship to the physical system and to predation by marine mammals and humans. Many assumptions were made and several important variables were derived by modeling run trials to see if they fit the assumed model. The baseline information clearly has some serious gaps, and the model does not inspire high confidence. Thus the conservation plan that results would be more robust scientifically if it followed the precautionary principle. In particular, it appears unnecessarily risky to wait until conservation thresholds are met before taking corrective actions.

As with monitoring, an explicit adaptive management plan is lacking. Although ODFW outlines an adaptive management plan, IMST finds that outline insufficient for adaptive management. A formal plan would give more confidence in the approach proposed by ODFW. Goodman *et al.* (2011) provides a concise description of adaptive management, that could be used as a model for a sturgeon adaptive management plan. Based on Goodman *et al.* (2011; pp 23–24), an effective adaptive management plan should include *(1) a series of explicit expectations, models and indicators to evaluate status and trends and (2) explicit loops from monitoring results back to key trigger points. This approach forces managers to consider how they will measure and report results and how and when they will determine whether actions are successful or not. Key adaptive management elements include the following:*

- *Explicit statements of problems, objectives and goals, with trigger points and possible alternatives at those points described in advance.*
- *Clear conceptual models of processes of concern, and simulation models supported by data.*
- *Clear results of predictions and performance indicators from the proposed actions, along with potential alternatives if expectations are not met within explicit confidence bounds.*
- *A rigorous monitoring and assessment program with periodic analyses for evaluating progress and selecting alternative actions.*
- *A research and management team to evaluate results and, when needed, to revise goals, objectives, or actions. The team should be led by a Chief Scientist responsible and accountable for leading the program.*
- *An adequately funded lead agency willing to implement the recommended changes.*

Program duties include stimulating public discussion of scientific issues; facilitating rigorous peer review of important documents; supplying public and scientific reports; managing open retrievable databases; and revising models for continuous analysis and assessment.

7. ***Population viability modeling (Appendix B).*** *Our* [ODFW] *intent is to use the best available population dynamics information (empirical and theoretical) to ascertain the likely magnitude and timing of responses to changes in abundance and productivity, as well as responses to changes in those vital rates we can influence. We are particularly interested in your* [IMST] *review of treatments of predation, egg to age-1 survival, stock recruitment, extinction thresholds, and habitat carrying capacity.*

It seems too early for IMST to fully assess and make specific recommendations on the population modeling. Some general suggestions are offered about modeling that might be wise to discuss in the plan for those unfamiliar with modeling (based on Goodman *et al*. 2011). Model predictions of fish numbers are best viewed relative to a baseline, alternative actions, etc. versus an actual number of fish and for identifying critical information gaps because relatively little is known about lower Columbia white sturgeon with absolute certainty. The process of developing a model, reproducing historical conditions, simulating multiple habitat conditions, running the model multiple times to assess variation, and running the model under various constraints helps assess various bottlenecks and major data needs. A model helps focus the monitoring design and indicators and to choose effective alternative actions, i.e. to think about the system and how it is responding to current environmental and anthropogenic changes, and might do so in the future.

The PVA model is only as good as the assumptions that go into it. Clearly there are important information gaps that need to be filled. Because of the data limitations and many assumptions, ODFW needs to be cautious. The estimates of pinniped predation do not appear realistic and need further review. Survival of age-0 sturgeon is unknown as stated. If the estimated value is seriously wrong it will have large consequences in the PVA model. The estimation of egg production is logical but the derivation of S-1 was unclear. Other than that the model was fitted and unique to various survival curves. The use of a survival curve is more realistic than using a fixed overall survival value. The extinction threshold discussion was clear and the use of 250 adults as seen in the Bonneville Pool appears reasonable but the choice of 25 years is unclear (other than it is the first age of reproduction). Habitat carrying capacity is a substantial question because many factors may limit the population. Carrying capacity is higher than at present and the number of spawning adults appears to be an obvious limiting factor; therefore, measures to protect adults and increase their longevity should be a high priority.

It is advisable to include error bands or confidence intervals in all abundance and growth rate estimates, and to include those in subsequent modeling. It is unclear whether or not this was done in the preliminary modeling efforts.

The Plan clearly considers the importance of predation on sturgeon. IMST suggests that potential future shifts in the sturgeon food web could be equally important. It would be extremely valuable in terms of strengthening the scientific rigor of the Plan if some analyses were provided that considered the stability of the sturgeon's food web and if it were to shift through time, what the consequences might be. This could be important from a bioenergetic perspective and in other ways. For example, if populations of alien invertivores (shad) and

piscivores (smallmouth bass, walleye, yellow perch, channel catfish, flathead catfish) continue to become more dominant in the system with warming and flow regulation and if alternative prey become less plentiful, it is likely that sturgeon growth and reproduction would be impaired. The piscivores also are likely to increase the mortality rate of age-1 sturgeon. Shad are particularly high in thyminase (Tillitt *et al.* 2008); their increased consumption by sturgeon could lead to a vitamin B deficiency and hence inhibited reproduction (Honeyfield *et al.* 2005; Wolgamood *et al.* 2005). The Plan also would be more robust scientifically if the role of micro- and macro-parasites and disease were considered. As stressors in the system change and perhaps become more severe, the role of parasites and disease as a population regulatory factor likely will become more prominent.

GENERAL COMMENTS

Strategy vs. Plan

The plan is actually much more of an analysis and discussion directed at a *strategy* for conserving sturgeon rather than a *plan* for doing so. There are no detailed on-the-ground actions proposed. It would elevate confidence in success considerably if something comparable to a business plan could be developed by specifying clear actions related to conservation and harvest goals, and major research needs. As IMST suggested in other ODFW conservation and recovery plan reviews, it is important to consider the probability of meeting the implementation timeline for each action and the consequences resulting if things do not happen as planned or do not lead to results in the timeframe expected. This leads directly into the following comment about the 500 year time frame identified for sturgeon.

500 Year Time Frame

Five-hundred years does not seem to be a reasonable time frame for evaluating success of the Plan. It is rational for ODFW to have used the same reasoning used in the agency's salmon recovery plans of a 20-generation time frame. However, because of the exceptionally long time line, this leads to a whole new, extremely complex set of uncertainties. It would greatly increase the scientific confidence in the Plan if this topic were discussed more, and perhaps reconsidered.

There are many unknowns regarding the future that far out. Because of those uncertainties, it seems unreasonable to assume a linear relationship between actions and fish population dynamics, as the Plan appears to do. Considering the difficulty of forecasting conditions 20-30 years in the future, it seems questionable to develop a Plan that runs for 500 years. Even excluding catastrophic events, like Mount Hood erupting and the effects of global climate change, there could be many unforeseen changes, including political and social needs, that might derail the Plan well beyond any options suggested by an adaptive management strategy. Consider that ancient Rome is now buried under 10 m of sand and dust—demonstrating the very gradual, pervasive changes that geologic processes can have on the landscape that are almost imperceptible over any short time. Within 150 years, the Willamette River main stem was changed from a braided network of channels and sloughs with a 10 km wide floodplain to a single, entrenched main channel. The United States has only existed for 235 years. Will it still exist as we know it in the year 2500? The changing social and political needs

of the United States as it expanded from the east coast to the west coast led to a multitude of species being extirpated or driven to extinction or near extinction. What will the next 100 years bring and how will human, climate, and geological impacts alter the Columbia River system? To judge the scientific merit of the plan, it would be very useful if ODFW could provide some insight into how confident it was in judging what the lower Columbia basin and its biotic systems would look like after 500 years.

It would be very useful for the Plan to consider if it were feasible to meet the goals of the Plan in a much shorter time that is more reasonable from a human perspective. The 25 or 50-year time lines of the salmon plans are somewhat more palatable since they cover about 1-2 human generations. IMST suggests developing a sturgeon conservation plan for 100 years (2-4 human generations) by using more rigorous measures. If that is impossible, that would be useful to know as well.

Interagency Cooperation

Given that the lower Columbia River borders both Washington and Oregon and sturgeon harvest is jointly governed by the two states, it seems wise to explicitly incorporate a Washington and federal agency and Tribal representation in this Plan at some point. While the current plan is designed to meet the requirements of Oregon's Native Fish Conservation Policy, white sturgeon management and monitoring is done by multiple agencies and ODFW relies on those agencies for information and cooperation. Without clearly including other pertinent agencies and stakeholders in this plan, it is less likely to be implemented effectively and cooperatively.

Overall Document

IMST feels that the document would benefit from a careful editing to correct grammatical, spelling, and logical errors. The IMST did not have sufficient time to list specific editorial comments in this review. Redundancy could be reduced by merging Sections 9, 10, and 11. Merging these sections could also improve connectiveness and clarity of the information.

All figures and tables could be inserted in to the body of the document to better aid the reader and to help clarify points of discussion made in the text. The glossary is a very good addition to the overall readability of the document.

SPECIFIC COMMENTS

Page 5, Lines 34-35 & and Page 6, Line 14 – Sub-adult lengths are listed as 38-54" on page 5 but on page 6 they are listed as 38-65". It would be useful to also list the length at which females mature (65") versus when males typically mature (54"). In addition, it seems prudent to implement an exploitation window that allows reproduction before harvest (e.g., 75") if a sustainable population is a goal.

Page 9, Line 27 – Explain why the adult population is expected to decrease within the next 15 years. Is this a result of sub-adult overexploitation and various other mortality factors?

Page 9, Lines 28-29 – This assumes the model is correct.

Page 10, Lines 36-40 – This is very appropriate.

Page 13, Line 3 – Incorrect statement about salmon being diploid, they are tetraploid, .

Page 13, Line 17 – How many years of data are there for a fish that lives nearly 100 years?

Page 14, Lines 9-21 – Do they smolt?

Page 15, Lines 1-2 – Explain why this is relevant to sturgeon.

Page 15, Line 14 – This is logical, but provide evidence if possible.

Page 15, Line 26 – These are rather meaningless statistics without mention of depths available.

Page 17, Line 36 – What evidence exists to suggest that the sturgeon in the Willamette River are from discontinued hatchery practices?

Page 17, Lines 42-44 – Good point.

Page 22, Lines 8-13 – Provide the errors associated with these estimates. Explain how the errors are used in the models.

Page 22, Lines 20-21 – Indicate the confidence limits of the estimate and whether it is conservative or not.

Page, 22, Lines 34-39 – Explain how the effect of stress is accounted for in oversize fish. Even in light of adjustments on p. 25, this sort of modeling has the same issues the IMST has discovered for the State's salmon plans. In addition, it is ever more problematic for sturgeon as there are far fewer data upon which to base the modeling and to estimate the appropriateness of the assumptions.

Page 23, Lines16-25 – "250 fish" seems to be an arbitrary number and perhaps inaccurately estimated initially. Would ODFW use 100 or 1000 fish if one of those had been the estimate?

Page 23, Lines 26-35 – A fully random selection of years seems irrational and under-protective. IMST suggests allowing the incorporation of multiple bad years and multiple good years in series.

Page 23, Line 42 – Management actions are apparently not triggered until the conservation status level is reached. This appears late and not sufficiently conservative. The plan appears tilted toward harvest.

Page 24, Line 17 – Explain why this is "desired".

Page 24, Line 31 – Explain why this is "desired". Explain the drop between first and second year abundances.

Page 25, Line 4 – Explain why 5% is acceptable.

Page 25, Lines 22-24 – It is unclear whether the maximum projected pinniped predation rate is the maximum observed or set at a higher rate than observed. The predation rate has been steadily increasing and has high uncertainty.

Page 26, Line 21 – This estimate assumes linearity to surface area effect over space, which seems questionable given spatial differences in habitat quality.

Page 27, Lines 33-40 – Provide the rationale for examining only 14 loci and explain why those are the correct alleles (not only providing a citation) and for setting triggers of 235 and 140 alleles for desired and conservation status, respectively. IMST is also concerned about maintaining or increasing phenotypic diversity. The number of alleles depends on the methods used to find them. This section is very implicit; it needs to be much more explicit.

Page 29, Lines 1-2 – Explain what an "age-0 indexing activity" is. This could be added in the glossary.

Page 29, Lines 3-4 – If no age-0 juveniles are captured for 5 consecutive years (the conservation status that would trigger action), this appears too late for effective population conservation. Although this may be a function of the method used to back-calculate egg to year-one survival or the life history of the sturgeon, it seems to be a risky management strategy based on a single Dalles Reservoir study that did not receive peer review.

Page 29, Lines 13-14 & 17 – Explain the choice of ~95%, 4.5% and 60% versus some other percentages.

Page 29, Lines 30-32 – Provide the rationale for this statement.

Page 29, Lines 42-43 – The uncertainty surrounding the relationship of age-0 indexing to future abundances of older year classes means lower confidence in the subsequent estimates. Reducing that uncertainty is a critically important area for additional research.

Page 31, Lines 12-15 & 23-26 – Conservation status for rearing habitat area is simply ½ the desired status estimated in 1994, which seems arbitrary. Something dramatic would have to happen to decrease the area that much, which appears to be risky.

Page 31, Line 39 – Provide the uncertainty of the weighted usable area (WUA).

Page 33, Lines 8, 10 – What are these probabilities based on?

Page 34 – It seems risky to assume that present conditions are good and to use the median growth as the desired status and the minimum growth observed as the conservation status.

Page 36, Line 13 – It is important to include delayed effects on mortality and on reproduction (i.e., stress is anti-reproductive).

Page 39, Lines 30-31 – It is unclear how ODFW determined the sub-adult conservation status (31,000).

Page 39 – The adult conservation status goal (3,900) is not revealed until page 71 and it is unclear how it was derived.

Page 42 – Age-0 productivity lower than desired, length frequency lower than desired, and declining catch per unit effort trend in the recreational fishery all indicate trouble in the population and suggest caution.

Pages 43 and 44 – The actual spawning habitats have not exceeded the desired performance, and 4 out of the last 10 years have been below the conservation status. These suggest caution.

Page 44, Lines 23-26 – Fish population growth is a highly variable parameter. It seems highly unlikely that growth rate would be significantly related to any single environmental variable at any single time, let alone over long times. IMST suggests using a multivariate model.

Page 45 – Figure 8 is interesting and short term trends in growth appear to be present. If these are trends, determining their causes could be revealing.

Page 46, Line 35 – Consider using the simpler 1 minus fishing mortality rate or at least using it as a reality check.

Page 47 – Previous fishing mortality rates were high and higher than the projected advisable 16% from the PVA model. Fishing mortality is forecasted to drop to 16.5% and then 13.5% by 2012 and 2013 respectively. Are the reductions forecasted a result of more restrictive fishing regulations or an increasing population?

Page 47, Lines 12-13 – Provide support for this statement.

Page 48 – If the population is not at its desired status, it seems that ODFW should be more conservative until it reaches that desired status.

Page 49 – Index site sampling can produce reasonable (but not representative) trend estimates if there is density independent growth and survival—but not if growth and survival are density dependent. Also index results cannot be used to estimate total population size or effective female population size. Given the very serious population overestimate that ODFW produced for coastal natural coho salmon based on ad hoc sites (Jacobs & Cooney 1995), IMST is concerned that ODFW continues to produce abundance estimates through use of ad hoc index sites. Such estimates produce erroneous and statistically biased estimates of population abundance and untrustworthy estimates of trend (Paulsen *et al.* 1998).

Page 51, Line 32-45 – Historical harvest rates were continually set lower, but sub-adults continued to decline. Apparently something was wrong with the harvest goals, the inputs used in estimating an appropriate harvest level, or both. It would be useful to learn from those historical errors.

Page 52, Line 2 – Explain better how the 17K or 22.5% harvest was determined, and provide evidence that this harvest rate is appropriate. The preceding paragraph is an honest description of the dangers of using OSY to estimate harvest rate--chiefly the tendency of OSY to overestimate population size and to assume optimum conditions in natural populations that rarely achieve optima and rarely are in equilibrium. The population over-estimate also indicates the substantial error in ODFWs methods of estimating abundance and exploitation, possibly related to using the optimistic mean versus a pessimistic lower bound based on the error of the estimate. Optimism is common to fishery management and common to fishery over-exploitation. After over 100 years of fishery over-exploitation, it seems advisable to exercise greater caution.

Page 53, Line 32 & Page 54, Line 6 – In addition to water quality, it is equally important to establish ecological flows and naturalize the Columbia River flow regime.

Page 54, Line 17 – Explain the meaning that “biotic factors are likely to be either density-dependent or independent”.

Page 55, Lines 9-15 – Explain how productivity can be adequate given such a decrease in size.

Page 56, Line 16 & Page 57, Line 12 – It would be useful to map the historical Columbia River floodplain, active channel, and estuary and compare it to current conditions. On an area-wide basis, it is likely that habitat extent and quality for sub-adults and larvae have been

markedly reduced. Presumably opportunities exist for rehabilitating parts of the channel and estuary into something more resembling a natural floodplain river and estuarine system.

Page 60, Lines 6-8 – IMST suspects that larvae, unlike older fish, lack the capacity of adapting to poor respiratory flow and gas supersaturation.

Page 60, Lines 34-38 – "May" is too weak a word to use here. The desire to appear neutral suggests ignorance of likely multiple stressors resulting from catch-and-release fishing. There is good evidence that handling stress has immediate and latent effects that are detrimental to fish.

Page 61, Lines 3-4 – A portion of a sentence and key material is missing here: “Additionally, recent research” ????

Page 62, Line 42 & Page 63, Line 2 – “May” is too weak a word to use here. Dredging is likely to increase sturgeon susceptibility to dredging entrainment, as well as entrainment of prey—especially when dredging attracts foraging fish.

Page 63, Lines 25-31 – “May” is too weak a word to use here. The openness of the Columbia system, 71% tag loss over 4 years, and the non-random application and recovery of tags violate 3 key assumptions of mark-recapture models and lead to inaccurate abundance and mortality estimates.

Page 63, Line 71 – The many unknowns and assumptions in this section inspire low confidence.

Page 64, Line 28 – Quantify the error in the PVA.

Page 65, Lines 13-14 – A portion of one sentence and key material is missing here: “Investigations of pectoral fin-spine micro-chemistry and acoustic telemetry studies could inform some” ???

Page 65, Line 27 – Explain how climate change may affect sturgeon prey, competitors, and predators.

Page 66, Section 10.7 – Additional information about native forage species may be available from Portland General Electric preoperational base line and monitoring studies for benthos and zooplankton in the vicinity of the Trojan Nuclear Plant. There should be about 30 years of data. Also Hiram Li (Oregon Cooperative Fishery Research Unit) conducted a fish assemblage survey of a portion of the lower Columbia about 30 y ago.

Page 69, Line 22 – There also is no direct evidence that there is no handling stress related to angling. The lack of evidence either way is another data gap that increases uncertainty.

Page 72, Line 33 – Explain why there are no coastal fish in the sample.

Page 76, Line 15 – Indicate the percent of pinnipeds intended for redistribution.

Page 76, Lines 20-23 – What is the actual “standard”?

Page 77, Lines 1-3 – Provide evidence whether hazing has or has not reduced sea lion predation on salmon.

Page 77, Lines 10-14 – What is the specific action to be done?

Page 77, Lines 16-18 – What is the actual “standard”?

Page 78, Line 4 – It is unclear how commenting on permits will help and what will be accomplished.

Page 78, Lines 14-22 – What is the actual "standard"?

Page 79, Lines 8-13 – This is a vague statement.

Page 79, Line 11 – Provide the intended action for "could be accomplished".

Page 79, Line 16 – What are the actual "standards"?

Page 79, Lines 17-20 – A 5-year average for passage seems like a very weak expectation and reduces the potential to evaluate trends over fewer years.

Page 80, Line 24 – "Flat-load" is jargon; be more explicit or add to glossary.

Page 81, Lines 23-29 – This is a vague statement.

Page 81, Line 30 – What are the actual "standards"?

Page 82, Lines 25-44 – Good.

Page 90, Line 15 – Annual meetings of a Technical Team are likely too infrequent to be effective.

Page 92, Lines 33-41 – Although the effect of habitat improvements may be less predictable than reduced exploitation, IMST suggests that ODFW include such variables in its modeling to reduce the probability that reduced exploitation will remain the only feasible tool for protecting and rehabilitating white sturgeon.

Page 126 – Although potential longevity is high (75 y), it is unlikely attained. Because size and fecundity increase with age (e.g., 250K eggs at 25 y, and 1M eggs at 70 y), IMST suggests aiming management more at increasing adult survival, especially older adults. Also, conservatism is justified because adults are difficult to age, errors in aging increase with age, and cohort analysis is difficult; thereby reducing confidence in modeling results, and justifying increased conservatism.

Page 127 – Juveniles less than 54 cm fork length are difficult to collect and representative sampling is difficult. In sampling small benthic fishes in warm water rivers, Guy *et al.* (2009) recommended using small and large mesh benthic trawls depending on the target species and their sizes. Others have used a 1 m^2 (net mouth opening) epibenthic sled. Heavy duty gear requires a fairly large vessel with a boom and considerable care in towing (Guy *et al.* 2009).

Survival by age or size is unknown, especially age-0. Small changes in age-specific mortality have large effects on mortality estimates in modeling. Thus confidence in model estimates is lower and conservatism is necessary until research produces much more accurate survival estimates.

Page 128, 1st Paragraph – Good description of uncertainty.

Page 128 – Age specific stock recruitment survivals are not known but were estimated by fitting values to the model. Presumably, if the fitted results looked reasonable to the assumed model, those survival values were selected. The estimated survival values were unique to each survival curve used in the modeling. This results in considerable model uncertainty and calls for management conservatism.

Also model high and low *S1* values to estimate likely ranges.

Page 129 – Pinniped predation is extensive but the total number of pinnipeds and their predation rates are unknown, and pinniped numbers appear to be increasing. It is unclear how the estimate was obtained that half of the pinnipeds from Phoca Rock (44) to the dam would be observed in the USACE observation area. It is also unclear how the estimated population growth rate of Stellar sea lions of 10 per year was obtained. It is unclear how the consumption rate of 0.44 sturgeon per day per sea lion was obtained. Many assumptions were made in estimating pinniped predation in the lower river. The resultant overall estimated predation rate appears low. It seems more reasonable to estimate high and low sea lion numbers and predation rates and employ highest and lowest cases in the modeling to estimate confidence limits around the mean estimates. The estimated number of sturgeon killed per year in 2009 is appreciable. Because these are primarily adults and sub-adults, their deaths have substantial effects on sturgeon production and persistence.

Page 130 – The maximum number of Stellar sea lions at Phoca Rock was assumed to be 102 in the future, but the derivation of this number is unclear and lacks certainty. It is unclear how the estimates of 0.01 sturgeon consumed per day by Stellar sea lions below Phoca Rock and of 0.005 for California sea lions were obtained.

It is unrealistic to cap predation at 10,600. As numbers of sturgeon increase, predation is likely to increase as well; if number of salmon or other alternative prey increase, predation on sturgeon will likely decrease depending on the foraging strategies of sea lions and the timing of their prey migrations.

Page 131 – Assuming that future sturgeon biomass can attain 1880s biomasses assumes that the dams and reservoirs do not affect carrying capacity in the river and estuary for spawning, rearing, and refuge. IMST doubts that this is the case and suggests that those biomasses are unrealistic even for modeling purposes.

Might the paucity of small sturgeon in the 1880s indicate a higher proportion of large (and more productive) fish in the population, and higher proportions of old growth adults than current Agency goals?

Page 132 – It is unclear if 0.8% mortality is annual mortality, if so, it could be a substantial loss of large fish. What is the basis of the assumed mortality?

Given that there is no guarantee that the past sequence of years is a prediction of future sequences, it might be wise for the modeling to allow any sequence of years (more of a Monte Carlo approach, and range).

Page 135 – The proposed approach for evaluating stochasticity precludes covarying variables, which are likely to co-occur. Again, this tends to create more optimal vs. suboptimal conditions in the modeling and, consequently, more optimistic abundance and growth estimates.

Page 136 – Estimate the lifetime effects on sturgeon prey and the errors in those estimates.

Given that mortality was the key driver in persistence and productivity of the sturgeon population, it seems advisable to exercise options to reduce that mortality.

Page 137 – In Table B2, “Egg to Age-1 Survival” values for female spawner abundance appear to be reversed.

Page 171 – The points in Figure 8 indicate some periodicity in growth rates. Can ODFW suggest variables associated with the lows and highs? IMST suggests using both high and low percentiles to estimate model error and variability, especially if those growth rates can be associated with measured abiotic or biotic variables.

Page 177 – ODFW and USACE appear to be working together to address major flow/temperature concerns which can be measured quite accurately. Uncertainty needs to be reduced concerning predation on sub-adults and adults by sea lions and humans.

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