Columbia River Basin White Sturgeon Planning & Passage Workshop

Proceedings

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Edited by

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ABBREVIATIONS AND ACRONYMS

BiOp	2000 Federal Columbia River System Biological Opinion
BPA	Bonneville Power Administration
CCT	Colville Tribes
CRFMP	Columbia River Fishery Management Plan
CRITFC	Columbia River Inter-Tribal Fish Commission
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CTWSRO	Confederated Tribes of the Warm Springs Reservation of Oregon
ESA	U. S. Endangered Species Act
FERC	Federal Energy Relicensing Commission
FCRPS	Federal Columbia River Power System
IDFG	Idaho Fish and Game
IPC	Idaho Power Company
ISRP	Independent Scientific Review Panel
M&E	Monitoring and Evaluation
NPCC	Northwest Power and Conservation Council
NPT	Nez Perce Tribe
ODFW	Oregon Department of Fish and Wildlife
ORNL	Oak Ridge National Laboratory
PUD	Public Utility District
PVA	Population Viability Analysis
RPA	Reasonable and Prudent Alternative
SARA	Canadian Species At Risk Act
UCWSRI	Upper Columbia White Sturgeon Recovery Initiative
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WDFW	Washington Department of Fish and Wildlife
YN	Yakama Indian Nation

This workshop was supported by the Columbia River Inter-Tribal Fish Commission, Northwest Power and Conservation Council and Bonneville Power Administration. Workshop planning committee members included Blaine Parker (CRITFC), Mike Parsley (USGS), Tom Rien (ODFW), Christine Mallette (ODFW), and Brad James (WDFW). Shadia Duery of Cramer Fish Sciences and Karl Weist of NPCC assisted with note taking. Kay Holzweissig of Cramer Fish Sciences assisted with workshop logistics and planning.

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EXECUTIVE SUMMARY

This was the third in a series of technical workshops organized to foster discussion and coordination among governmental, Tribal and other organizations in support of regional sturgeon management and mitigation efforts related to the Northwest Power and Conservation Council's (NPCC, Council) Fish and Wildlife Program. The facilitated workshop, held over two days in January 2012, brought together 87 participants with a broad range of scientific, technical, and management expertise.

This workshop focused on questions identified by the Independent Scientific Review Panel (ISRP) in a review of sturgeon projects currently being implemented in the lower-mid Columbia region (NPCC 2010). Workshop subjects included: 1) regional sturgeon status and planning updates, 2) the development of a basinwide white sturgeon management framework for the Columbia River Basin, and 3) sturgeon passage at the mainstem Columbia River hydroelectric dams. These efforts will inform 1) the development of a unifying umbrella framework addressing sturgeon-related programs, plans and activities throughout the region, and 2) recommendations to the NPCC and ISRP on sturgeon passage.

What's new?: Innovations & Revelations, Challenges & Constraints

Workshop organizers invited a series of brief presentations or informal updates which collectively were intended to provide a snapshot of the current programs and plans for white sturgeon populations throughout the Columbia River Basin. This session emphasized innovations, revelations, challenges, and constraints. Tucker Jones of the Oregon Department of Fish and Wildlife (ODFW) presented on the stock status and management of lower and mid-Columbia sturgeon populations (from the mouth to McNary Dam). Chad Jackson with Washington Department of Fish and Wildlife (WDFW) discussed sturgeon mitigation progress in upper mid-Columbia. Jason McLellan with the Colville Tribes (CCT) described an innovative larval collection alternative to hatchery propagation in the transboundary Columbia (US) region. Jim Powell with Freshwater Fisheries Society of British Columbia (FFSBC) spoke about the transboundary Columbia (Canada) region's Upper Columbia White Sturgeon Recovery Initiative. Information on the Kootenai River sturgeon conservation and recovery program was presented by the Fish and Wildlife Service's (USFWS) Jason Flory. Jeff Dillon of Idaho Fish and Game (IDFG) and Ken Lepla of Idaho Power Company (IPC) reviewed Snake River population status and management spotlighting IPC's entrainment studies at C.J. Strike Dam.

Comprehensive Framework Plan for Columbia River White Sturgeon

The Northwest Power and Conservation Council and Independent Scientific Review Panel have identified the need for the development of a comprehensive basin-wide planning framework to ensure that sturgeon projects are being implemented in a complementary and cost effective manner. The lower-mid Columbia sturgeon planning group has expanded their effort to organize development of this framework through a collaborative process with sturgeon interests in other parts of the basin. A draft/template sturgeon framework document is being developed by review and synthesis of the available published and unpublished material from throughout the basin. This workshop provided an overview of this effort and the opportunity for other regional sturgeon interests to participate in the framework development process, particularly regarding critical uncertainties and needs for integration of efforts within and among different areas.

Participants generally acknowledged that 1) there is some value in an effort such as this to highlight needs and acknowledge gaps, 2) the process is useful for facilitating communication, and 3) ancillary tools developed as part of this document can be useful. However, there were questions about the utility of the actual document. Sturgeon projects and activities within any given management unit are already undertaken within the responsibilities and authorities of the appropriate jurisdictions. Objectives and strategies are tailored to the specific circumstances within each management unit and participating entities already support significant consultation and coordination among themselves as part of their normal processes. Thus, while a framework document might serve as a useful descriptive document to provide a comprehensive overview of sturgeon-related activities throughout the basin, it was much less clear whether this effort would result in substantive new information or useful guidance to local projects and programs. In the final analysis, people were generally supportive of proceeding with this effort and amenable to providing supporting information and review of a sturgeon framework development effort led by the lower Columbia sturgeon planning team.

Sturgeon Passage

White sturgeon historically ranged freely through hundreds of miles of the Columbia and Snake Rivers until construction of mainstem dams blocked upstream movements and isolated fish in reservoirs and river segments which may no longer provide favorable conditions for all stages of the life cycle. As a result, sturgeon, abundance, productivity and fishery opportunities have been reduced throughout the basin. High rates of sea lion predation also suggest that sturgeon productivity below Bonneville Dam has been limited by the inability to migrate farther upstream in the system to spawn.

While fish ladders have proven effective for passing adult salmon and steelhead upstream, these methods are generally not effective for sturgeon. Upstream passage of sturgeon with elevators was explored after Bonneville Dam was constructed but elevator use was discontinued when ladders proved much more effective for salmonids. Fishway counts show little use by sturgeon although some structures are marginally more effective than others. The greatest use occurs in the east fishway at The Dalles Dam and appears to be related to the greater width and larger submerged orifices in this ladder. Most movements appear to be by juvenile or subadult fish rather than adult spawners.

Downstream passage of juvenile salmonids occurs through dam spillways and various bypass systems, but downstream passage of juvenile sturgeon is relatively low. Telemetry and conventional marking studies show a small level of downstream movement by sub-adult and adult sturgeon through spillways, and smaller fish may also pass downstream through turbines. Sturgeon use of navigation locks has not been demonstrated. Downstream movements of sturgeon generally exceed upstream movements although net movements in either direction are very low.

Sturgeon also regularly enter dam structures for reasons other than passage. Large increases in fishway entry have been observed at Bonneville Dam since 2007 and this pattern is correlated with a large influx of Steller Sea lions into the lower Columbia River. Large numbers of sturgeon may also be trapped in the turbine draft tubes at many dams when stop logs are placed during dewatering for maintenance. Removal of sturgeon from dewatered fishways and draft tubes is labor-intensive and injury or mortality has been reported on multiple occasions, but protocols now in place have substantially reduced numbers of sturgeon trapped during maintenance activities.

Sturgeon transplants were explored in the 1990s as an alternative to traditional dam passage. Juveniles were collected downstream of Bonneville Dam and transported into upstream impoundments where limited natural recruitment has underseeded the available habitat. This experiment demonstrated the feasibility of capturing significant numbers of juveniles and high survival of these fish following release. However, current levels of natural production downstream from Bonneville Dam limit the availability of juvenile sturgeon for transplant. Small-scale transplants are being employed in the upper Snake River to move fish entrained downstream from productive to unproductive river segments back upstream.

Work on sturgeon passage in other parts of the country has met with variable success. Passage of lake sturgeon has been achieved in some areas at low head structures but fishway passage in larger systems such as Canada's Richelieu River has been relatively ineffective. Field and laboratory studies are beginning to provide information on sturgeon behavior in the vicinity of dams, passage mortality, and upstream and downstream fish guidance requirements for other sturgeon species but results have not yet translated into effective usage. However, work at The Dalles Dam and flume studies at UC Davis indicate that fishways can be effectively designed for upstream passage of subadult and adult white sturgeon.

Passage benefits that increase connectivity can, in some cases, increase gene flow, productivity, and fishery opportunity. However, unintended consequences must be given consideration as they can reduce benefits or prove detrimental. Modeling of upper Snake River populations demonstrated that passage benefits depend on the relative rates of upstream and downstream movements and population productivity in upstream and downstream areas. Many impounded river sections contain habitat that is underutilized by sturgeon due to poor natural recruitment. Net productivity might be improved by providing passage of juvenile and subadult sturgeon into underutilized areas. However, increased upstream passage could be detrimental to net production if adults move from favorable into unfavorable areas.

Attempts to improve upstream or downstream passage of sturgeon at dams also risks confounding salmon and steelhead passage. Passage requirements of salmonids and sturgeon

are different but not mutually exclusive. We learned from work at The Dalles Dam that sturgeon and salmon passage can co-exist. Sturgeon can ascend the same water velocities that salmon can, but differ in swimming abilities or ability to locate or enter passage entrances. However, salmon passage systems have been optimized through decades of engineering, testing, and refinement. Any changes in passage systems to benefit sturgeon will require careful analysis of salmonid tradeoffs. Changes in existing passage systems intended to benefit sturgeon will require costly construction and testing. Federal funding for sturgeon passage research is currently limited due to declining federal budgets and increasing demands on budgets from failing and old infrastructure and a suite of requirements for salmon in ESA Biological Opinions.

Workshop participants generally concluded that too little is yet known regarding passage requirements, benefits, and risks to support the need for large-scale sturgeon passage improvements at Columbia River dams at this time. A number of passage-related issues or activities were identified that warrant further development:

1. Clarify specific goals and objectives for subpopulations based on current natural recruitment potential, habitat productivity, and limiting factors to provide guidance on potential benefits and risks of increased upstream or downstream passage on a case-by-case basis.
2. Consider additional analysis or research of larval and juvenile downstream passage and mortality to better understand tradeoffs between upstream and downstream subpopulations.
3. Include detailed evaluations of costs, benefits and risks of passage improvements relative to other potential strategies including habitat improvement, flow management, fishery regulation and hatchery supplementation in sturgeon mitigation, conservation and restoration plans.
4. Consider opportunities for incorporating sturgeon-friendly features in existing fish ladders during future ladder designs and planned modification where consistent with sturgeon population goals and objectives.
5. Consider opportunities for non-volitional passage by taking advantage of fish trapped in dewater draft tubes or fish ladders during maintenance. These fish can be released back downstream from dams or transplanted upstream. Fish could also be tagged as a means to gain information on sturgeon behavior and movement in and around dams. This would be cost effective since it occurs with planned maintenance. There is also a need for better communication/coordination with maintenance operations so we can take advantage of these instances as they occur.
6. Review current protocols used to prevent fish stranding/mortality during planned maintenance activities (such as dewatering draft tubes) to determine if the level of protection/prevention is adequate and whether improvements could be made. Where appropriate and feasible, improve prevention/control of existing sources of mortality caused by the projects either from dewatering mishaps or blade strikes associated with turbine starts. For instance, powerhouse upgrades to digital controls would allow “slow roll” starts to be used for all turbine starts throughout the year.

INTRODUCTION

The Columbia River basin historically supported a very large and productive population of white sturgeon that ranged from the ocean upstream for hundreds of miles into Idaho and Canada. The unimpounded lower Columbia downstream from Bonneville Dam continues to support a substantial population, providing one of the most valuable fisheries in the region and one of the healthiest sturgeon populations in the world. Impounded populations upstream from Bonneville Dam have not fared as well.

What was once a single population or a series or broadly overlapping meta populations has now been fragmented by dam construction into a series of subpopulations. Status varies among impounded subpopulations from marginally productive to functionally extirpated. Impounded subpopulations are unable to support significant fisheries anywhere near the scale of that seen downstream from Bonneville Dam. Natural recruitment has failed in most upper Columbia and Snake river subpopulations which now consist solely of aging cohorts of mature fish that are gradually declining as fish die and are not replaced.

Population attributes that have proven adaptive for millions of years are often now a liability (Beamesderfer and Farr 1997). Large size and high fecundity makes sturgeon a valuable fishery commodity, but longevity and delayed maturation make them extremely vulnerable to overfishing. Critical habitats have been altered. Dam construction has blocked movements and restricted sturgeon to river fragments that may no longer provide the full spectrum of habitats necessary to complete the life cycle. Flow regulation has limited seasonal and annual fluctuations that provide behavior cues and suitable spawning or rearing conditions. All of these changes favor a much different aquatic community of prey, predators, and competitors. Long life span and benthic feeding increase susceptibility to bioaccumulation of industrial and community pollutants with potentially detrimental effects on health, growth, maturation, and recruitment.

Over the last 25 years, impounded Columbia River sturgeon populations have been the subject of extensive research and management efforts. These efforts have provided a fundamental understanding of the biology, population dynamics and habitat requirements of this unique species, determined the status of subpopulations throughout the region, and identified key life stages and factors limiting most subpopulations. Additionally, they have provided a firm scientific basis for regulating fisheries to optimize use consistent with current status. The feasibility and effectiveness of protection, mitigation, and restoration alternatives are now being explored.

White Sturgeon projects currently being implemented through the Northwest Power and Conservation Council's (NPCC) Fish and Wildlife Program in the lower mid-Columbia were recently reviewed by the Independent Scientific Review Panel (ISRP; NPCC 2010). This review identified the need for a comprehensive basinwide planning framework to ensure that sturgeon projects are being implemented in a complementary and cost effective manner. The ISRP also recommended convening a regional workshop to evaluate mainstem passage. The workshop was designed to address these two data gaps identified by the ISRP.

Workshop Goals and Objectives

The purpose of this workshop was to foster collaboration among resource managers, scientists, planners, and industry representatives with the background, expertise, and tools necessary to identify critical uncertainties and needs for integration of sturgeon conservation, restoration, management, and mitigation efforts within and among different areas.

Specific objectives included:

1. Discuss and seek regional input on the development of a Sturgeon Management Framework for the Columbia River Basin intended to provide a unifying umbrella to inform sturgeon-related programs, plans and activities throughout the region; and
2. Review risks, benefits, opportunities, constraints, and critical unknowns regarding white sturgeon passage of mainstem Columbia and Snake river dams.

Workshop Organization and Participation

The workshop was organized by a lower mid-Columbia River sturgeon planning group led by Blaine Parker (CRITFC), Christine Mallette (ODFW), Brad James (WDFW), Mike Parsley (USGS), and Ray Beamesderfer (Cramer Fish Sciences). Dani Evenson (Cramer Fish Sciences) acted as the workshop coordinator and Alison Squier (Ziji Creative Resources) helped design the workshop sessions and facilitated the workshop. The workshop was structured to promote participation and interaction among participants and to generate a broad range of ideas for further discussion and development. The agenda from the workshop is presented in Appendix A.

Workshop participants were invited from state and federal agencies, Indian tribes, and other organizations with management or mitigation authority or responsibility and specific knowledge and expertise on sturgeon in the region. Workshop announcements were broadly distributed among agencies and parties with a potential interest and no limit was placed on attendance. Participants included a mixture of policy and technical representatives with broad-spectrum experience. Public participation was not sought in this incipient stage of the planning process – public processes of the participating parties are expected to provide ample opportunity for public involvement prior in the consideration of any plans that may arise from this workshop.

Participants included representatives from federal (USFWS, USACE, USGS, NOAA, BPA), state (NPCC, ODFW, WDFW and WDEC, IDFG, California DWR), and provincial (BCMOE) natural resource agencies, Tribes (CRITFC, YN, CTUIR, NPT, KTOI, CCT), public utility districts (Chelan County PUD, Douglas County PUD, Grant County PUD, Idaho Power Company, Manitoba Hydro), federal research laboratories (Oak Ridge), universities (University of California, Carleton University) and contractors (Cramer Fish Sciences, Alden Research Laboratories Inc., Longview Associates, Blue Leaf Environmental, LGL, and R2 Resource Consultants). A complete list of the 87 participants is presented in Appendix B.

DAY 1 – BASINWIDE FRAMEWORK

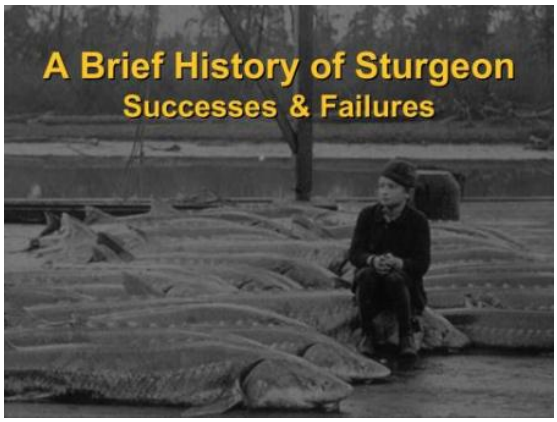
Ray Beamesderfer welcomed participants and provided an overview of the workshop purpose and context. This first day of the workshop was designed to gather input on critical uncertainties and needs for integration of efforts within and among different areas for the comprehensive basinwide plan. The objectives were to provide clear feedback to the ISRP and to stimulate discussion thereby taking advantage of all the brainpower we have in the room.

White Sturgeon projects currently being implemented under through the Northwest Power and Conservation Council's (NPCC) Fish and Wildlife Program in the lower mid-Columbia were recently reviewed by the ISRP (NPCC 2010). This review identified the need for the development of a comprehensive basinwide planning framework to ensure that sturgeon projects are being implemented in a complementary and cost effective manner. The lower-mid Columbia sturgeon planning group has expanded their effort to organize development of this framework through a collaborative process with sturgeon interests in other parts of the basin. A draft/template sturgeon framework document is being developed by review and synthesis of the available published and unpublished material from throughout the basin, and an outline of the document is included with the workshop materials. The goal of this session was to provide an overview of this effort and provide the opportunity for other regional sturgeon interests to participate in the framework development process.

The workshop was intended to be an active working session and everyone was expected to participate. Workshop organizers hoped to extract as many ideas as possible from the participants regarding the elements of a comprehensive Management Framework Plan for Columbia Basin white sturgeon. Specifically, workshop organizers were seeking information for the Framework on the data gaps in each area, unique opportunities and constraints, and how can we maximize the value of this effort.

Conservation, restoration, mitigation and management of Columbia River white sturgeon is complicated by their widespread distribution, fragmented population structure, and population differences throughout their range. Specifics of characteristics, status, and limiting factors for each subpopulation require different treatments and remedies. The broad distribution over hundreds of miles of river results in an overlapping patchwork of involvement and jurisdiction by a wide spectrum of interests, agencies, and authorities. Too provide context for the afternoon discussion on a basinwide management plan, we will first hear a brief history of sturgeon in the Columbia River Basin followed by a series of short presentations or informal updates given by representatives from each geographic management/planning on their respective sturgeon plans, programs, and projects.

A Brief History of Sturgeon: Successes & Failures



Ray Beamesderfer provided a historical perspective on Columbia River white sturgeon (Appendix C, Presentation 1). Overfishing during the late 1800's collapsed the once robust white sturgeon population and recovery required almost 100 years. In just six years (1889–1895), a commercial fishery removed 200,000 fish averaging 100 pounds for a total harvest of 20 million pounds. Sturgeon did not recover until after 1950 when a 72" maximum size limit was adopted to protect the large adult spawners. Work leading to effective fishery regulations for sturgeon was led by Alexander Bajkov, an expatriate Russian who had a long career in fish research working first for Environment Canada and then for the Oregon Fish Commission in the late 1940s.

Subsequent population trends in the lower Columbia River downstream from Bonneville Dam showed periods of spawner recovery (1950–1970's), fishery recovery (1970's–1990), and fishery optimization (1990–2008). By the late 1970s, the unimpounded sturgeon population supported an annual harvest of over 40,000 fish in combined sport and commercial fisheries. However, sturgeon populations and fisheries in impounded areas upstream from Bonneville Dam never recovered to historical levels. Generally speaking, the further upriver you go, the fewer sturgeon there are. Several reservoirs including Bonneville and The Dalles support modest populations and limited fisheries. However, most reservoirs and river segments currently support very low fish numbers and no meaningful fisheries. Populations in headwater areas are severely depleted and a unique population in the Kootenai River was listed as endangered under the ESA in 1994.

The root of the problem is that sturgeon are unable to pass the dams readily. Where sturgeon historically ranged widely throughout the basin to take advantage of broadly distributed and seasonally available resources, a series of subpopulations are now trapped in reservoirs. Many reservoirs lack conditions suitable for an entire life cycle, particularly for natural recruitment which has been shown to be related to local habitat conditions and river discharge.

The modern era of sturgeon research and management began during the 1980s following the adoption of the Northwest Power Act which, amongst other things, established a directed funding source for fish protection and enhancement under the direction of the NPCC and the BPA. Subsequent plans developed in 1982–1985 led to a progression of sturgeon research, monitoring and evaluations throughout the basin. This work documented sturgeon status and limiting factors and led to the implementation of a series of conservation and fishery optimization measures. At the same time, effective sturgeon aquaculture methods were developed based on pioneering work by Dr. Serge Doroshov at the University of California at Davis. Conservation hatchery programs have now been implemented in the upper Columbia and Kootenai rivers.

We have now reached the next crossroads in sturgeon history and this series of workshops has been developed to guide where we go from here.

What's new?: Innovations & Revelations, Challenges & Constraints

To provide a foundation for the planned work sessions, the workshop organizers asked participants from each geographic management/planning area (Figure 1) to give brief presentations or informal updates. Collectively, these updates were intended to provide a snapshot of current programs and plans for white sturgeon populations throughout the Columbia River Basin with emphasis on innovations, revelations, challenges, and constraints. Tucker Jones, ODFW Columbia River Sturgeon Project Leader, presented on stock status and management in the lower and mid-Columbia (from the mouth to McNary Dam). Chad Jackson, WDFW Region II District Fish Biologist, summarized recent research and plans for the upper mid-Columbia. Jason McLellan, a Fish Biologist with the Confederated Tribes of the Colville Reservation (CCT), presented information on the transboundary Columbia (US) region with special emphasis on their cooperative larval collection project. Dr. Jim Powell, Head of the Fish Culture Department at Freshwater Fisheries Society of British Columbia (FFSBC), spoke about the Upper Columbia White Sturgeon Recovery Initiative. Jason Flory, a biologist with USFWS Northern Idaho Field Office, provided information on the sturgeon recovery program in the Kootenai River. Jeff Dillon, Regional Fishery Manager with IDFG, and Ken Lepla, fisheries scientist with Idaho Power Company (IPC), co-presented information on Snake River population status and management, spotlighting IPC's entrainment studies at C.J. Strike Dam.

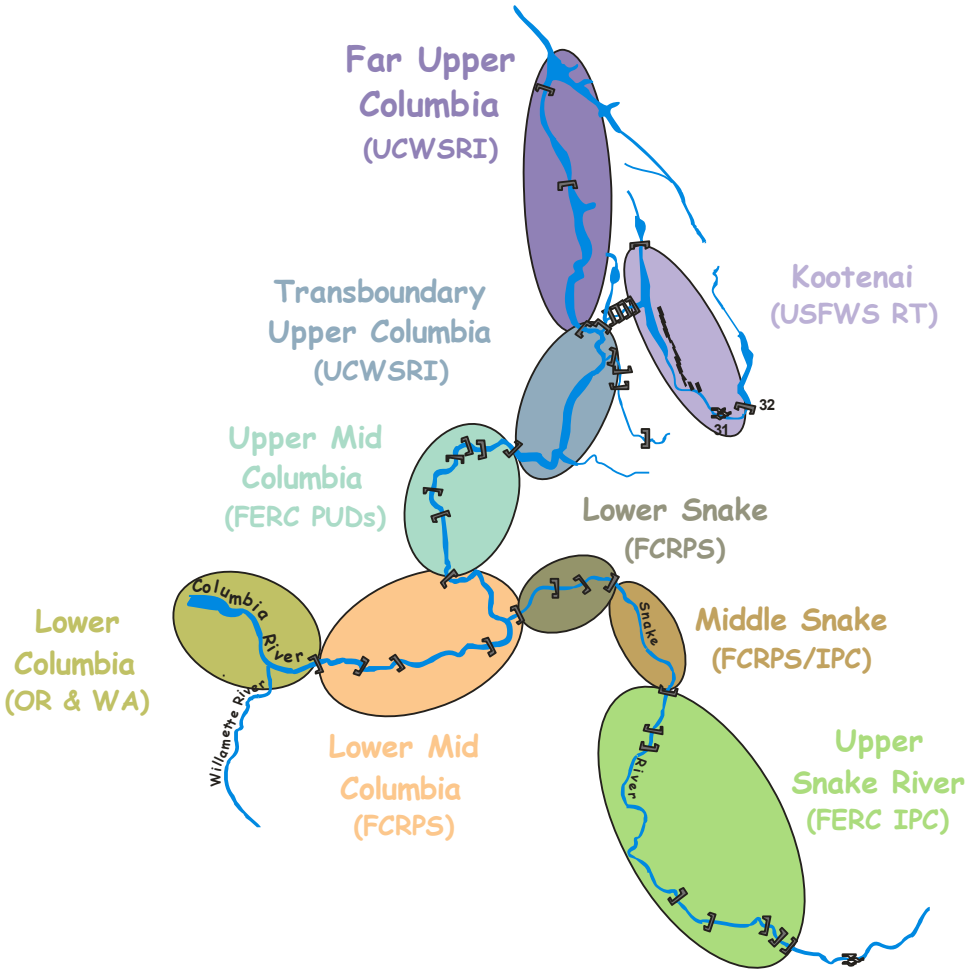


Figure 1. Depiction of planning areas for white sturgeon recovery efforts currently underway throughout the Columbia and Snake river basins.

Lower Columbia (mouth to McNary Dam)

Tucker Jones began his presentation by highlighting the research ODFW is currently conducting in the Columbia River from the river mouth to McNary Reservoir, and in the Willamette River downstream of Willamette Falls. This work consists largely of assessments of stock status and of age-0 recruitment. ODFW has also recently completed a Lower Columbia River and Oregon Coast White Sturgeon Conservation Plan, conducted a temporal genetic evaluation of white sturgeon downstream of Bonneville Dam in cooperation with UC Davis, and investigated spawning activities in the lower Willamette River.

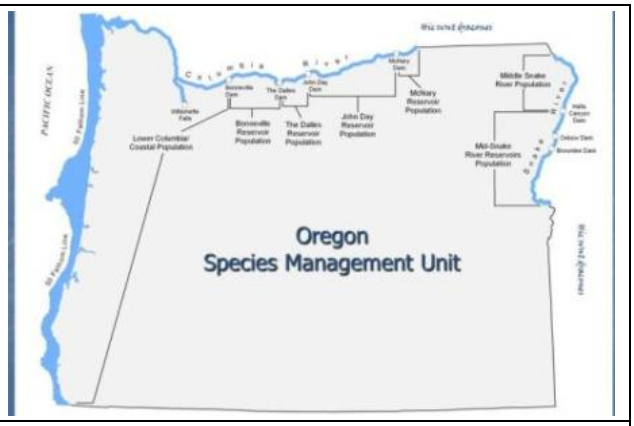
Annual stock assessments downstream of Bonneville Dam involved 224 mainstem set line sets in 2010 resulting in a catch of 1,683 sturgeon and 230 sets in 2011 yielding a catch of 1,472. Results from the lower Willamette River were included in the overall population estimate, because of the demonstrated connectedness to the adjacent Columbia River. Approximately 85,000 legal-sized white sturgeon were estimated downstream of Bonneville Dam in 2010 and 70,000 in 2011. This represents a decline from past estimates; however, while there is concern with associated fisheries, ODFW does not believe the population segment on the whole is at risk. Populations in Bonneville, The Dalles, and John Day reservoirs are each assessed once every three years; the most recent assessments indicate that there are approximately 334,000, 133,000, and 41,000 white sturgeon in Bonneville, The Dalles, and John Day reservoirs, respectively. In 2012, ODFW will also update assessments of McNary Reservoir and the 3 lowest Snake River reservoirs.

Annual recruitment is strongly correlated with spring flow level and becomes more variable and less consistent as you move upstream in the lower mid-Columbia reservoirs. ODFW has just started to build the time series of age-0 indexing data downstream of Bonneville Dam where the relationship between discharge and recruitment is less well understood.

Other sturgeon-related research by ODFW includes a genetic evaluation of the lower Columbia River population and investigations of white sturgeon spawning in the lower Willamette River. The genetic evaluation identified no substantive change in the lower Columbia population since the 1940's. No fish were identified as originating from the Sacramento or Fraser rivers. Spawning was documented for the first time in the Willamette River; prior to this work the only known spawning habitat in the lower Basin was was in the vicinity of Bonneville Dam.

In August of 2011, the Oregon Fish and Wildlife Commission formally adopted the Lower Columbia River and Oregon Coast White Sturgeon Conservation Plan. The plan established conservation and desired status thresholds for a suite of biological attributes, recommended a sustainable harvest rate, established population checkpoints, and identified limiting factors, threats and critical data gaps in order to prioritize management actions and research, monitoring, and evaluation activities.

While knowledge of sturgeon has greatly increased over the last couple decades, even in the best cases, we've only been working for about one white generation. In many cases, we've just gotten started. Given the complexity and the longevity of the fish, it is not surprising that the number of white sturgeon unknowns is still large.



Todays Topics

- Stock Assessments
  - Downstream of Bonneville Dam, Lower Willamette, Upstream of Bonneville Dam
- Age-0 Indexing
  - Downstream of Bonneville Dam, Lower Willamette, Upstream of Bonneville Dam
- Other White Sturgeon Activities
  - Lower Columbia River Conservation Plan; Lower Columbia River Genetics; Lower Willamette River spawning investigations

Stock Assessments

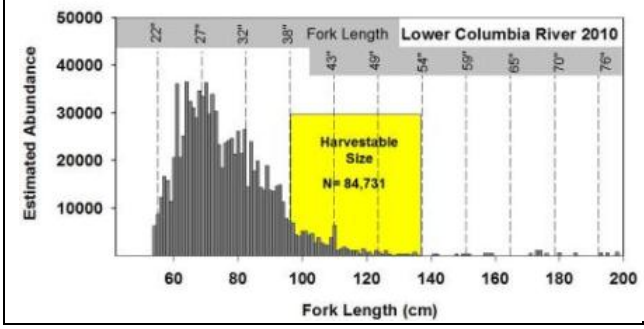
Stock Assessments

- Length frequency distributions
- Population estimates
- Annual growth information
- Survival estimates

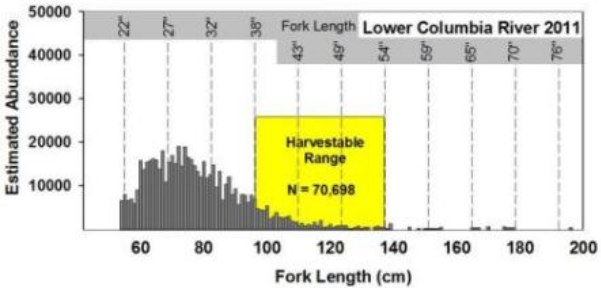
Stock Assessment Results – Downstream

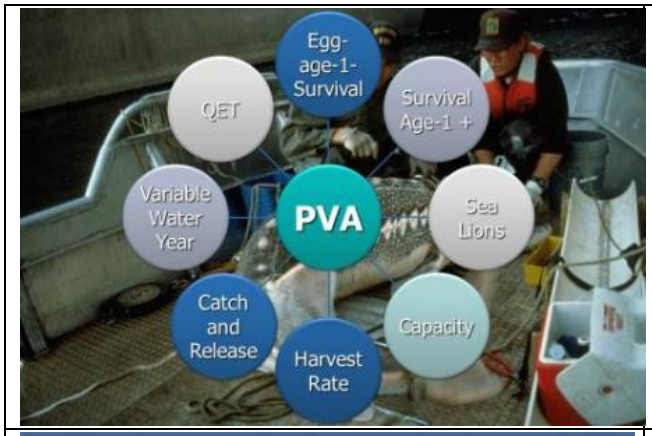
- We started annual assessments in 2010 (a pilot effort was conducted in 2009)
- We made 224 mainstem sets in 2010 and 230 in 2011
- Not enough recaptures for growth or survival yet
- This resulted in catches of 1,683 and 1,472 white sturgeon in 2010 and 2011 respectively
- We estimated that, post fisheries, 85,000 legal sized white sturgeon in 2010 and 70,000 in 2011
- This represents an apparent decline from past estimates of the legal population
- We are concerned with associated fisheries, but do not believe the population is at risk

Stock Assessment Results – Downstream



Stock Assessment Results – Downstream





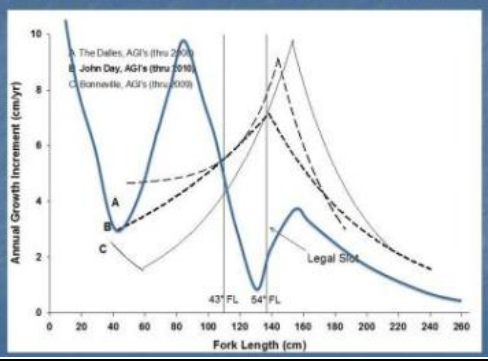
Stock Assessment Results – Lower W.

- We made 24 sets in 2010 and 30 in 2011
- This resulted in catches of 246 and 196 white sturgeon in 2010 and 2011 respectively
- Similar to Lower Columbia in CPUE and in size
- Because of connectedness and demonstrated interchange, with Lower Columbia this information is included in the Lower Columbia River population estimate

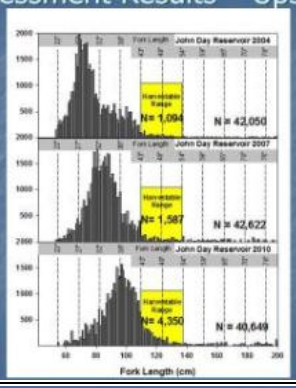
Stock Assessment Results – Upstream

- Bonneville, The Dalles, John Day reservoirs assessed once every 3 years
- We do have annual growth information for these 3 pools
- In 2011 we began a 3 year rotation to sample McNary, Ice Harbor, Lower Monumental, and Little Goose reservoirs – even though they are outside my acknowledged universe

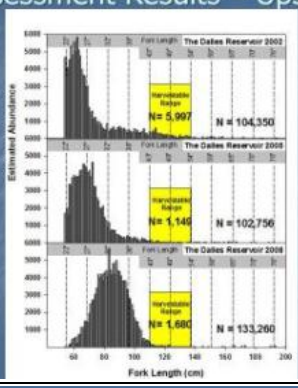
Stock Assessment Results – Upstream



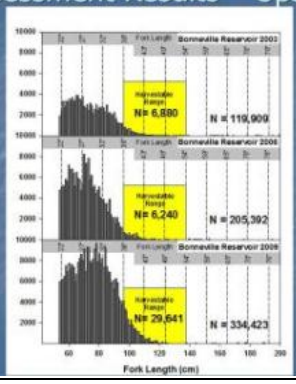
Stock Assessment Results – Upstream



Stock Assessment Results – Upstream



Stock Assessment Results – Upstream



Todays Topics?

- Stock Assessments
  - Downstream of Bonneville Dam, Lower Willamette, Upstream of Bonneville Dam
- Age-0 Indexing
  - Downstream of Bonneville Dam, Lower Willamette, Upstream of Bonneville Dam
- Other White Sturgeon Activities
  - Lower Columbia River Conservation Plan; Lower Columbia River Genetics; Lower Willamette River spawning investigations

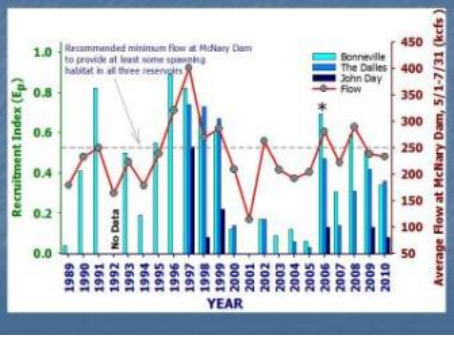
Age-0 Indexing

Age-0 Indexing

Age-0 Indexing

Year	LCR	Will. R.	BON	TDA	JDA	MCN	IHA	LGO
1997				0.74	0.53		0.00	
1998				0.73	0.08			0.32
1999				0.67	0.22	0.08	0.03	0.08
2000				0.14	0.00	0.00	0.00	0.00
2001				0.00	0.00	0.00	0.00	0.00
2002				0.17	0.00	0.06	0.00	0.00
2003				0.00	0.00	0.00	0.00	0.00
2004	0.44			0.06	0.00	0.00	0.00	0.00
2005	0.49			0.03	0.00	0.03	0.00	0.00
2006	0.52		0.69	0.47	0.13	0.06		
2007			0.31	0.14	0.00	0.06		
2008	0.45		0.59	0.31	0.00	0.06		
2009	0.78		0.51	0.42	0.13	0.06		
2010	0.18	0.28	0.34	0.36	0.08	0.00		

Age-0 Indexing



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- Stock Assessments
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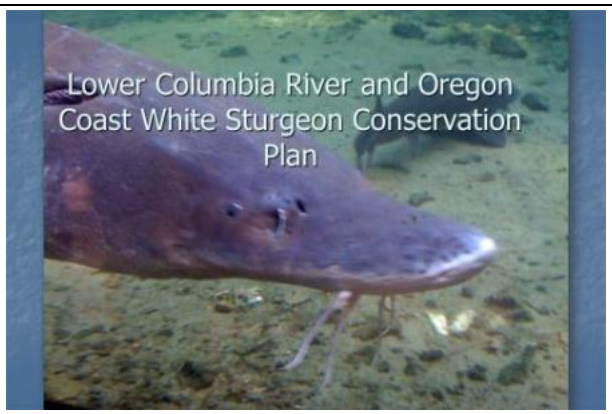
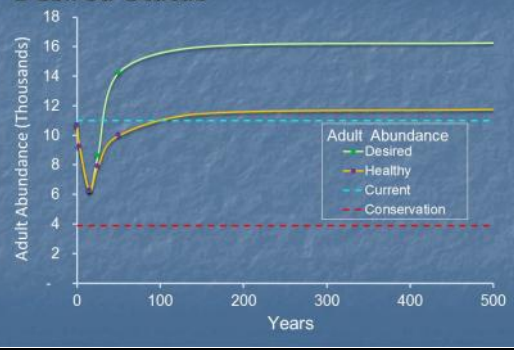


Conservation and Desired Status

- Biological Attributes
  - Abundance
  - Distribution
  - Diversity
  - Productivity
  - Habitat
  - Persistence
  - Growth and condition
  - Natural mortality and survival
  - Fishing mortality

Conservation Status

Desired Status

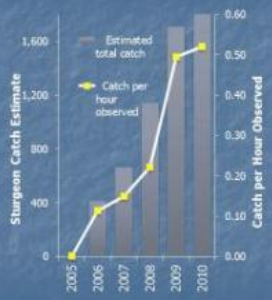


Key Limiting Factors

- Sea Lion Predation
- Hydropower System Operation and River Conditions
- Over Utilization

Sea Lion Predation

- Why is this important?
  - Substantial increase in past 5 years
  - Threat to broodstock abundance
  - Total losses unknown
- What do we intend to do about it?
  - Continue proposed harassment and removals of problem animals
  - Assess extent of predation river-wide

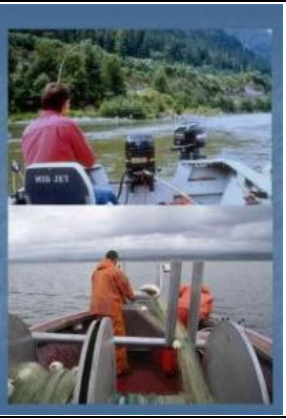


Hydropower System Operation and River Conditions

- Why is this important?
  - Sturgeon spawn and rear in the mainstem
  - River conditions affect amount and quality of spawning and rearing habitat
  - Strong relationship between water velocity and recruitment
- What do we intend to do about it?
  - Continue to advocate for hydropower operations that best mimic a natural hydrograph and normative river conditions

Over Utilization

- Why is this important?
  - Sea lion predation has reduced sustainable harvest rate
  - Recent recruitment has been lower than historic
  - Fisheries management must account for increased predation and lower recruitment
- What do we intend to do about it?
  - Reduce harvest rate
  - Continue to monitor populations and fisheries
  - Increase law enforcement

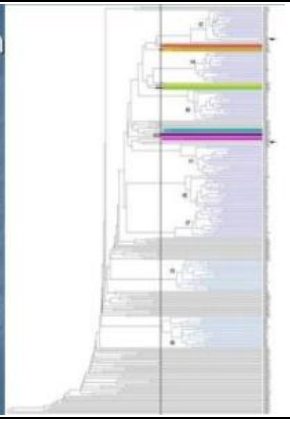


Conservation Plan

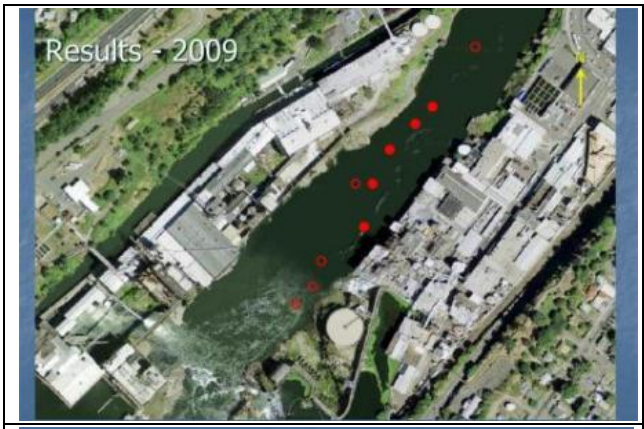
- Obviously there's much MUCH more
- Available on CD upon request
- Visit our website (http://www.dfw.state.or.us/fish/CRP/lower_columbia_white_sturgeon_plan.asp)
- We are now moving efforts to the impounded Columbia River

Genetics – Downstream

- Examined in 2007 – UC Davis
- Temporal samples from 1940s, 1980s, and 2000s
- Difficulties amplifying 1940s samples
- Could amplify enough to see no apparent change in genetic diversity between 1940s and 2000s
- Only 1 population detected in lower Columbia Samples (i.e, no Sacramento or Fraser)



White Sturgeon Spawning in the Lower Willamette River, Oregon



Achievements

- ✓Lower Columbia River White Sturgeon Conservation Plan adopted by OFWC
- ✓Documentation of Willamette River white sturgeon spawning
- ✓The building of impounded populations through careful management and effective

Challenges

- ! Information demands are large, resources are not
- ! Despite the body of work, there are still lots of white sturgeon unknowns
- ! Just getting started downstream of Bonneville Dam

Upper Mid-Columbia

Chad Jackson presented information on the Upper mid-Columbia, a geographic area defined as Priest Rapids Dam to Grand Coulee Dam. Chad began his talk by recognizing the Yakama Nation (YN), the Colville Confederated Tribes (CCT), the WA Department of Ecology (Ecology), Grant County PUD, Douglas County PUD, and Chelan County PUD and their respective stake holders for their conservation and restoration efforts in the mid-Columbia.

White sturgeon in the upper middle Columbia River exist as isolated subpopulations in the pools of hydroelectric projects with abundances around 50-500 individuals per pool. Some pools may have slightly less and some slightly more. Spawning and/or recruitment success is minimal to nonexistent. The effects of the hydroelectric projects on white sturgeon might include river regulation, inundation of historical spawning and rearing habitats, impaired water quality, fish community changes, and population fragmentation. In 2008 and 2009, GCPUD and CPUD received new FERC licenses, respectively, to operate the Priest Rapids and Rocky Reach hydroelectric projects. As a requirement of the FERC licenses, both PUDs are required to develop white sturgeon management plans that call for hatchery supplementation and monitoring/evaluation programs. DCPUD's new FERC license is pending and is expected to have similar requirements for sturgeon.

Hatchery supplementation is entering its third year in 2012 in the Priest Rapids and Rocky Reach project areas. To date, approximately 15,500 hatchery-origin juvenile sturgeon have been stocked in these two project areas. Hatchery fish from brood year 2011 are currently being held at the YN Marion Drain White Sturgeon Hatchery (GPUD's fish) and WDFW Chelan Hatchery (CPUD's fish). Reduced stocking levels are planned for 2012 (500-1,000 fish range) due to the low number of brood stock collected in 2011. The 2012 brood stocking plans for GPUD and CPUD are essentially the same as 2011, with hopes of increasing effort and collecting brood stock from the John Day Pool. GCPUD is entering into its third year of white sturgeon M&E in the Priest Rapids project area and is currently evaluating proposals to continue this work through 2015. CPUD recently selected a contractor (Blue Leaf Environmental/LGL/Columbia River Research Team) to initiate white sturgeon M&E in 2012 in the Rocky Reach project area. DCPUD is evaluating proposals to initiate their hatchery supplementation program in 2012.

There were two recent innovations and revelations: a new hatchery facility and a mobile tracking study. The Yakima Nation has transformed an old cornfield into the Marion Drain White Sturgeon Hatchery. Fish being planted today are spawned and reared at that facility. A mobile tracking study with acoustic tags is underway. The goal is to see how fish move or act and gage general stock performance to inform future stock decisions or actions. Fish were stocked in May 2011 in Priest Rapids Project Area (stocking of tagged fish included both Priest and Wanapum Reservoirs) from three separate stocks: Upper Columbia, Middle Columbia, and Lower Columbia. Preliminary results indicate that juveniles produced from Lower Columbia captive brood fish seem to move a bit more and actually leave project area, Wanapum Pool had more downstream movement, Priest Rapids all had some downstream movement. However, most of the fish stayed in the reservoir.

Chad concluded his talk by highlighting challenges and constraints. Firstly, all three mid Columbia River PUDs have staggered supplementation and M&E implementation schedules with different stakeholders; regionally coordinating these efforts from the Co-Managers'

standpoint has, at times, been challenging. Secondly, it is challenging to incorporate the new science into white sturgeon supplementation and M&E programs. Adaptive management with new science is sometimes slow to implement. Thirdly, there have been brood stock collection difficulties and concerns during the first two years of implementation. Excessive high flows during the first two years has been problematic for being able to fish in preferred areas and collect ripe fish. Running out of brood stock in certain areas is a long-term concern. Lastly, coordinating mid-Columbia activities with downstream managers is of growing importance; however, incorporating their concerns into mid-Columbia River sturgeon activities could potentially be challenging.

UPPER-MIDDLE COLUMBIA RIVER WHITE STURGEON CONSERVATION & MANAGEMENT UPDATE

Chad Jackson, District Fish Biologist
Washington Department of Fish and Wildlife
Region 2 Fish Program-Ephrata, WA

BACKGROUND

- White sturgeon in the upper middle Columbia River exist as isolated stocks in between the pools of hydroelectric projects
- Abundances around 50-500 individuals per pool
- Spawning and/or recruitment success is minimal to nonexistent depending upon pool
- Effects of hydroelectric projects on white sturgeon might include: river regulation, inundation of historical spawning and rearing habitats, impaired water quality, fish community changes, population fragmentation etc.

BACKGROUND

- In 2008 and 2009, GPUD and CPUD received new licenses, respectively, from FERC to operate the Priest Rapids and Rocky Reach hydroelectric projects
- As a requirement of the FERC licenses, both PUDs required to develop a white sturgeon management plan that calls for hatchery supplementation and monitoring/evaluation programs
- DPUD's new FERC license is expected in the spring 2012 and will have similar requirements for white sturgeon supplementation and M/E

WHAT'S NEW? OR RELATIVELY NEW

- Entering into a third year of hatchery supplementation in 2012 in the Priest Rapids and Rocky Reach project areas
- To date, ~15,500 hatchery-origin juvenile sturgeon have been stocked in the Priest Rapids and Rocky Reach project areas
- BY 2011 currently held at YN Marion Drain White Sturgeon Hatchery (GPUD's fish) and WDFW Chelan Hatchery (CPUD's fish)
- Reduced stocking levels in 2012 (500-1,000 fish range)
- 2012 brood stocking plans are essentially same as 2011, with hopes of increasing effort and collecting fish from John Day Pool

WHAT'S NEW? OR RELATIVELY NEW

- GPUD entering into its third year of white sturgeon M/E in the Priest Rapids project area and currently evaluating proposals to continue this work through 2015
- CPUD recently selected a contractor (Blue Leaf Environmental/LGL/Columbia River Research Team) to initiate white sturgeon M/E in 2012 in the Rocky Reach project area
- DPUD evaluating proposals to initiate their hatchery supplementation program in 2012

INNOVATIONS &/OR REVELATIONS

- Just really getting started with supplementation M/E in the middle Columbia River, however…..
- YN Marion Drain White Sturgeon Hatchery Improvements:
  - Brood stock holding facility (8-10' and 4-20' holding tanks)
  - Two 30hp pumps to heat and chill water
  - New 600gph well with another 600gph well on the way to accompany existing 500gph well
  - 20,000 juvenile (1-year old) white sturgeon capacity

INNOVATIONS &/OR REVELATIONS

- GPUD Mobile Acoustic Tracking & Stock Performance:
  - Research performed by Golder Associates for GPUD
  - Acoustic tracking of juvenile white sturgeon originating from three different stocks (TB-W/MC-W/LC-CB) within the Columbia River stocked into the Priest Rapids project area during 2011
  - Questions amongst managers and researchers regarding migratory behaviors of white sturgeon originating from different areas of Columbia River
  - Help inform future stocking events

INNOVATIONS &/OR REVELATIONS

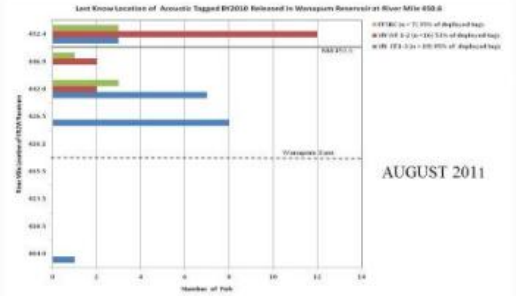
Actual YN & FFSBC Juvenile White Sturgeon 2010BY Release Numbers

YN Release	Project Area	Priest Pool Release	Wanapum Pool Release
PIT Only			
Aberrathy (CP)	2574	594	1880
Wild-cross (WF)	3857	891	2966
Total PIT	6431	1485	4846
PIT/Acoustic Tagged Fish			
Aberrathy (CP)	20	6	20
Wild-cross (WF)	39	9	30
Total PIT/Acoustic Tagged Fish	59	15	50
Total Release	6490	1500	4896

FFSBC Release	Project Area	Priest Pool Release	Wanapum Pool Release
Total PIT tagged Only	2801	598	2003
Total PIT/Acoustic Tagged Fish	26	6	20
Total Release	2827	604	2023

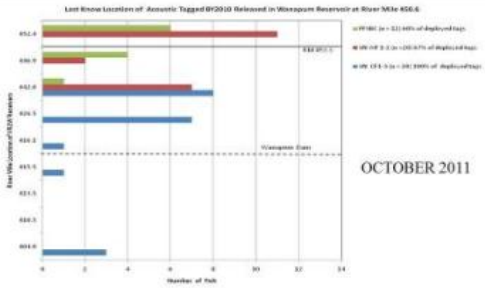
Total 2010BY Release	Project Area	Priest Pool Release	Wanapum Pool Release
Total PIT tagged Only	9032	2083	6949
Total PIT/Acoustic Tagged Fish	91	21	70
Total Release	9123	2104	7019

INNOVATIONS &/OR REVELATIONS



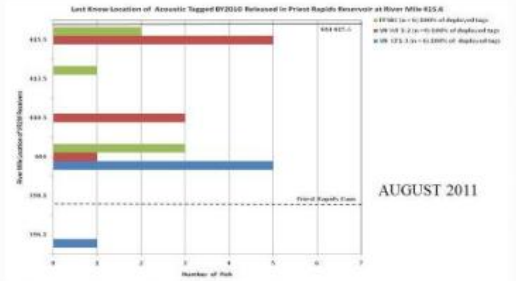
AUGUST 2011

INNOVATIONS &/OR REVELATIONS



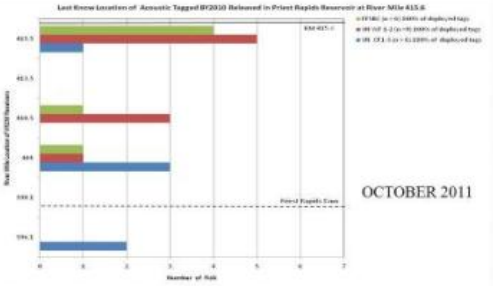
OCTOBER 2011

INNOVATIONS &/OR REVELATION



AUGUST 2011

INNOVATIONS &/OR REVELATIONS



OCTOBER 2011

INNOVATIONS &/OR REVELATIONS

- Preliminary Results:
  - Wanapum Pool-higher downstream movement of LC-CB fish with four fish leaving the reservoir
  - Priest Rapids Pool- Pool-all three stocks exhibited downstream movement with two LC-CB fish leaving the project area
  - By in large though, the three juvenile white sturgeon stocks planted into Priest and Wanapum are residing within project area
  - Mobile acoustic tracking will continue in 2012

CHALLENGES & CONSTRAINTS

- Regional coordination between Co-Managers and PUDs with staggered supplementation and M/E implementation schedules and stake holders
- Incorporating the "new" science into the white sturgeon supplementation and M/E programs
- Brood stocking difficulties and concerns
- Coordination with downstream managers

Transboundary Columbia River (US)

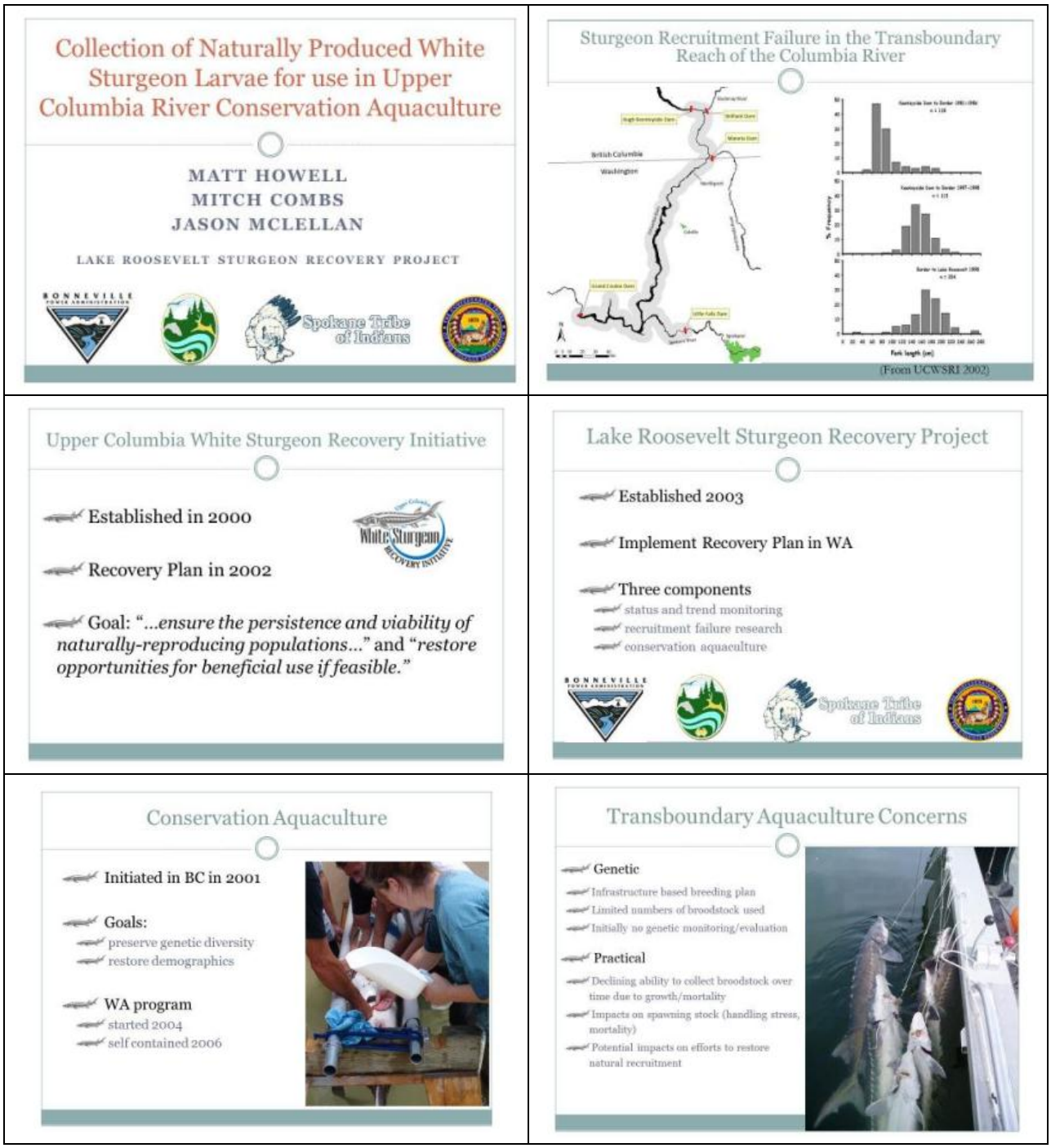
Jason McLellan gave a talk focused on a new fish culture innovation - using wild spawned larvae rather than artificially spawning wild-caught broodstock. Recruitment in the transboundary population has declined to very low levels in the last 30 years. In 2000, the Upper Columbia White Sturgeon Recovery Initiative (UCWSRI) was established and a recovery plan was completed in 2002 with the goal to "*…ensure the persistence and viability of naturally-reproducing populations*…" and "*restore opportunities for beneficial use if feasible."*

The Lake Roosevelt Sturgeon Recovery Project began in 2003 as a cooperative effort between the Spokane Tribe of Indians, Washington Department of Fish and Wildlife, and Colville Confederated Tribes with funding by BPA. The project has three components: 1) status and trend monitoring, 2) recruitment failure research, and 3) conservation aquaculture. However, there were both genetic and practical concerns with using transboundary wild-caught broodstock in conservation aquaculture. These included limited numbers of broodstock used, no initial monitoring and evaluation, declining ability to collect broodstock over time due to growth/mortality, impacts on natural spawning stock, and potential effects on efforts to restore natural recruitment. An alternative approach, collecting naturally produced larvae, emerged from the success of early life history studies. Large catches of larvae indicated that sturgeon were spawning and incubating successfully, but not surviving beyond the stage when they began exogenous feeding. The benefits of using larval collection rather than adult broodstock include increased effective population size, decreased relatedness, reduction in artificial selection pressures, imprinting, and decreased stress/mortality effects on the broodstock population. Potential drawbacks to larval collection include hatchery infrastructure modifications (for the Lake Roosevelt project specifically), disease concerns, increased labor required for field collection and husbandry, and size at release.

Larvae are collected with D-ring plankton nets fished on the bottom with frames fitted with modified collection buckets to keep larvae from getting crushed by debris. Each system is moored so that it can be deployed and left. At each location, 12 nets (6 pairs) were fished. In 2010, a pilot program collected larvae downstream of two known spawning sites - Waneta and Northport. In 2011, sampling was repeated using D-rings and a stationary trawl. The catch included small numbers of early free embryos, short-dispersal egg sac larvae, and early larvae that disperse after hiding phase as they begin exogenous feeding. Catches ranged from >3,000 larvae in 2010 to >10,000 in 2011. Catch rates were much higher at night and day sampling was not productive. The survival at capture was 97-98% using the modified collection bucket.

Larvae were reared at Sherman Creek Hatchery using pumped reservoir water that was treated with UV and degassed. Fish were fed Otohime marine larvae feed and also treated prophylactically with salt to reduce stress and control pathogens. The initial feedings were challenging. Survival of 2,700 larvae brought into the hatchery in 2010 was 19% to produce 522 fish. Fish were released in December at an average of 30 grams which was smaller than desired. In 2011, the 10,000 larvae transferred to the hatchery resulted in 3,590 for release, or 35% survival. A propane heater was installed late in 2011 to increase water temperatures and growth rates. The release objective is 4,000 per year in the US portion of the transboundary reach. Based on these results, collection of naturally produced larvae is a viable way to supplement white sturgeon. Currently, presumed genetic benefits (increased numbers of

spawners and decreased relatedness) are under study. The wild broodstock collection effort has now been suspended.



Alternative approach - larval collection

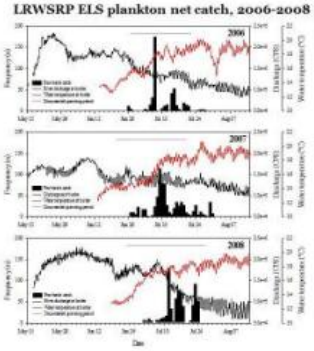
Presumed benefits

- Increased number of spawners represented (N_b) (Crossman et al. 2011)
- Decreased relatedness (Crossman et al. 2011)
- Reduction in artificial selection pressures
- Imprinting
- Decreased stress/mortality effects on broodstock population
- Secondary monitoring benefits

Potential drawbacks

- Hatchery infrastructure modifications
- Disease concerns
- More labor intensive from both field collection AND husbandry perspectives
- Size at release

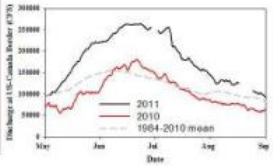
Alternative approach - larval collection



- ELS collection identified as option in Recovery Plan
- Potential demonstrated by LRWSRP ELS research efforts

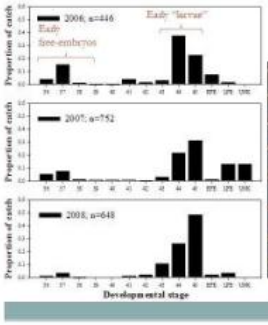
Larval Collection Efforts in 2010 and 2011

- 2010 (pilot)
  - D-ring gear only
  - Mostly long duration (overnight) sets
  - "average" water year
- 2011
  - D-ring and stationary trawl
  - Short duration night sets only
  - "wet" water year

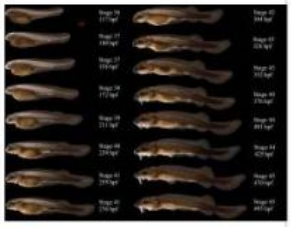


Experimental Gear

Typical catch composition (D-ring gear)



Catch dominated by fish around the first-feeding stage of development



Figures from: Howell and McLellan *in review*

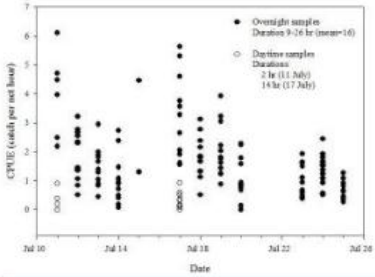
Collection Summary

	2010 (pilot)	2011*
Sampling period	10-25 Jul	25 Jul-1 Aug
Sampling depth range (m)	23-25	12-29
Mean (range; n) sample duration (hr)	16.1 (2.2-25.5; 73)	2.4 (1.1-11.1; 155)**
Total sampling effort (frame hrs)	1,173	373
Bottom water velocity range (m/s)	0.13-0.37	0.27-0.55
No. free embryos captured (% alive)	405 (28%)	56 (not recorded)
No. early larvae captured (% alive)	3,235 (97%)	10,355 (98%)

* Numbers reflect the primary collection effort only. Additional fish were collected during spot sampling prior to 25 July

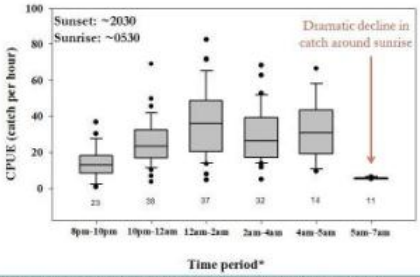
** Includes sampling with experimental stationary trawl gear (n=16)

Diel differences in catch rates (2010)



- Comparatively low catch rates during daylight sets

2011 night sampling



* Data were assigned to bins based on the mid-point time value for each sample

Husbandry

- WDFW Sherman Creek Hatchery
- Water source - Columbia River water
  - UV filtration
  - degassing tower
  - heating in 2011
- Otohime Marine Larval Feed
  - 2011 – 30% freeze dried arctic copepods (1 mo.)
- Prophylactic treatments (1% salt)

Rearing Summary

	2010	2011
No. transported to hatchery	2,744	10,295
No. released	522	3,590
Survival to release	19%	35%
Release date	01 Dec	30 Nov
Mean (range) fork length (mm)	166 (93-246)	151 (97-215)
Mean (range) weight (g)	31 (6-90)	23 (6-64)

Conclusions

- Larval collection is a viable alternative to traditional broodstock capture for white sturgeon supplementation efforts
- Genetic evaluations are currently underway
- LRWSRP aquaculture program
  - Suspension of broodstock collection in favor of larval collection pending results of genetic analyses

Acknowledgements

- Charlee Capaul, Jennifer Ratfield, Rex Gearhart, Tammy Thueringer, Brian Lyon, Steve Roberts, Chris Donley, Bill Baker, Jeff Wilson, Chuck Lee, Leslie King, Marc Divens – WDFW
- Hank Etue, Deanne Pavlik-Kunkel, Andy Miller – STOI
- Eric Simonsen, William Dick – CCT

Transboundary Columbia River (Canada)

Dr. Powell began his talk with a quote from the Upper Columbia White Sturgeon Recovery Initiative (UCWSRI) web site: *"In the last 125 years, human development, construction of hydroelectric dams, water quality changes, contaminants, changes in flow patterns, as well as the introduction of exotic species and harvesting may have led to the sturgeon's decline."* The Transboundary Columbia includes the area from Grand Coulee Dam to Mica Dam on the mainstem Columbia River and part of the Kootenay River. This area still supports many big fish, but natural recruitment is very low. A primary goal of the UCWSRI is to identify causes and address recruitment failure. In 2006, all white sturgeon in Canada, except the mid- and lower-Fraser River stocks, were listed as threatened under the Species At Risk Act (SARA). These listings mean that we cannot do harm to sturgeon or their 'critical habitat'.

The UCWSRI was initiated in 2000, and subsequently expanded to include US transboundary partners in 2002. The UCSWRI has both technical (scientists) and community working groups, but is distinguished from other recovery efforts by its broad community stakeholder support. Funding comes from water use permits (licensing fees for using the water) – similar to FERC in the US, and from grants, the government, and stakeholders.

The recovery plan includes habitat mitigation and conservation aquaculture components. A habitat mapping effort is underway to characterize substrate, flow, diel and seasonal patterns, and fish use by life stage. For habitat mitigation, UCWSRI's approach includes gravel placement and restoration of spawning and larval rearing beds complemented with an effectiveness monitoring strategy. Initial habitat mitigation work has yielded encouraging results. The conservation aquaculture component includes spawning and rearing of fish from artificially-spawned wild broodstock. Current projections anticipate a "Death Valley" as eventually no wild spawners are expected to remain and before supplemental fish become mature. Additionally, there is a big outreach effort organized by the community working group that involves local communities on issues of sturgeon conservation.

Current research includes spawning distribution and timing, larval and juvenile survival, fish movement and passage, contaminants, and predation. Success in broodstock capture has been excellent downstream of the Waneta dam during the spawning period. All fish caught are sampled for tissue (genetic analysis), marked and tagged. In the hatchery, maturity and spawning time is managed with thermal regime. A factorial mating design is employed where each available female is spawned with each available male to maximize genetic diversity in the offspring. Each male/female cross is incubated separately. Egg numbers are balanced at neurulation then pooled for each female following hatch. To evaluate the potential for larval seeding, fed and unfed larvae are being released on enhanced and existing substrate, along with substrate lab studies, and feeding and temperature studies. Movement and growth of hatchery juveniles has been monitored following release for over 10 years via netting/trapping and insertion of sonic tags. Fish movement and passage is mainly evaluated with telemetry.

Jim identified several challenges and constraints. Firstly, they are collecting a lot of data, but lack the staff resources to analyze it. This makes it difficult to evaluate the success of the various approaches. Many of the samples collected for genetic analysis have not been analyzed. Secondly, cryopreservation of milt has not worked yet, but there is a Norwegian company looking into it. Thirdly, there are increasing regulatory demands with SARA. Finally, funding is limited.

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Intro

- The issue
- UCWSRI and Governance
- Recovery Plan
- Results
- Challenges and Constraints

At Issue

In the last 125 years, human development, construction of hydro electric dams, water quality changes, contaminants, changes in flow patterns, as well as the introduction of exotic species and harvesting may have led to the sturgeon's decline.

- UCWSRI website

Recruitment Failure Hypothesis

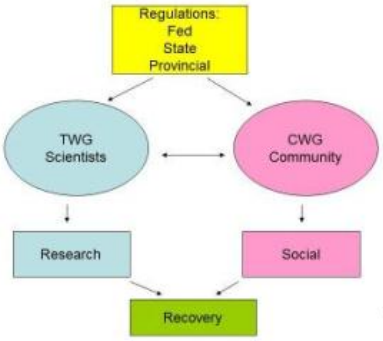
- Environmental changes
  - Impacts lifecycle
- Failure to recruit
  - No juveniles produced
- Identify causes
  - Specific, not general
- Remediation
  - ID what can be done

Key Stage Recruitment

Addressing the Need: UCWSRI

- Formed in 2000
- Funded for 2 years (BCH-MoE-DFO)
- Expanded to encompass US portion
- Formed TWG and CWG
- WS listed in 2006
- 23 participating members

UCWSRI Governance



Regs: SARA and ESA

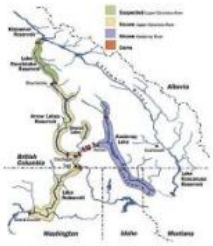
- Species At Risk Act
  - All populations in BC are covered
  - Except middle and lower third of the Fraser
- Endangered Species Act
  - Listed in Kootenai
  - Species of interest in many areas of the Columbia Basin & Sacremento

Funding

Canada
- WUP licensing fees
- Grants
- Gov support
- Stakeholder support

USA
- Gov support
- Tribes
- Power facilities

Upper Columbia



- Grand Coulee to Mica
- Includes part of the Kootenay River
- Mostly mainstem
  - GC to Rev

Recovery Plan

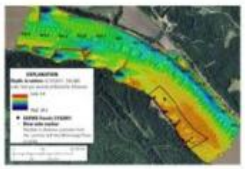
1. Predation
2. Substrate
3. Hydrograph
4. Food supply
5. Contaminants
6. Genetics
7. Fish culture
8. Communications

General Plan

1. Habitat mitigation
   - Monitor
   - Repair
2. Conservation aquaculture
   - Stock
   - Preserve
   - Research

1) Habitat: Mapping

- USGS/WDFW
- BC Hydro
- Looks at substrate, utilization, flows
- Hydrography
- Spawning capability
- Larval rearing
- Juvenile rearing



1) Habitat: Mitigation

- Gravel placement
- Spawning and larval rearing beds
- Monitor tagged adult
- Look for offspring
- Outplant eggs and larvae - monitor

2) Conservation Fish Culture

- Restoring fish numbers
- Genetic conservation
- Research: Larvae and Juveniles
- Outreach

Brood Capture

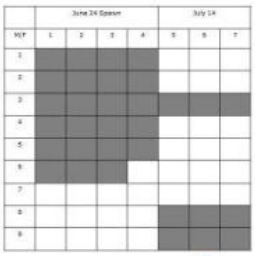
WDFW Method

a) Outreach

- Over 10,000 school children so far
- FN involvement
- Linked to community events
- CWG/TWG coordination

b) Genetic Preservation

- Fin clips of every capture
- UCD msat work
- Breeding programme
  - Factorial mating
  - Maternal families
  - Equalization
  - Single use
  - Cryopreservation

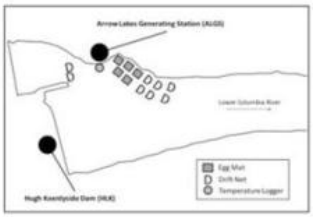


c) Research

- Spawn monitoring and larval survival
- Contaminant research
- Predation research
- Larval survival
- Juvenile survival
- Fish movement and passage

BCH Spawn/Larvae Monitoring

Spawning – HLK/ALH



Predation Studies

Larval Studies

- Unfed and fed releases
- Enhanced and existing substrate
- Substrate lab studies
- Feeding and temperature studies

Juvenile Indexing

- Netting/trapping
- Sonic tags
- Angling
- Data is tracked for movement and growth
- 10+ years of indexing

Fish Movement & Passage

- Adult and juvenile telemetry
- No clear pattern
- Food is an incentive
- Movement during spawning season

Challenges & Constraints

- Victims of success
  - Good survival
- Too much data
  - Not enough information
- Genetics
  - Catalogue backlog
  - Loading decrease
  - Death Valley approaches

Challenges & Constraints

- Cryopreservation
  - Proving difficult
- Regulations
  - Harder to supply
- GED
  - Chasing the $

Summary

- 10+ years & counting
- Great success
- Still some challenges
- Outreach is the future
- Are we doing all we can?

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Kootenai River

Jason Flory discussed the Kootenai River population which was listed as endangered under the ESA in 1994 and under SARA in 2006. The wild population consists of a dwindling number of adult sturgeon. An estimated 500-1,000 wild adults remain. There has been no significant natural recruitment since 1974, corresponding with closure of Libby Dam, though natural recruitment was depressed and/or absent prior to 1974. The apparent causes of this decline are unsuitable spawning habitats and loss of ecosystem function (riparian, diking, floodplain connection, food web). The lower Kootenai River includes canyon, braided, straight, and meander reaches. Spawning occurs over low quality sand-silt substrates in the upper meander reach. Recent historical data suggest there might have been spawning upstream near Kootenai falls where habitat conditions appear to be more favorable. However, telemetry information shows that adult spawners do not move upstream from Bonners Ferry at the head of the meander reach.

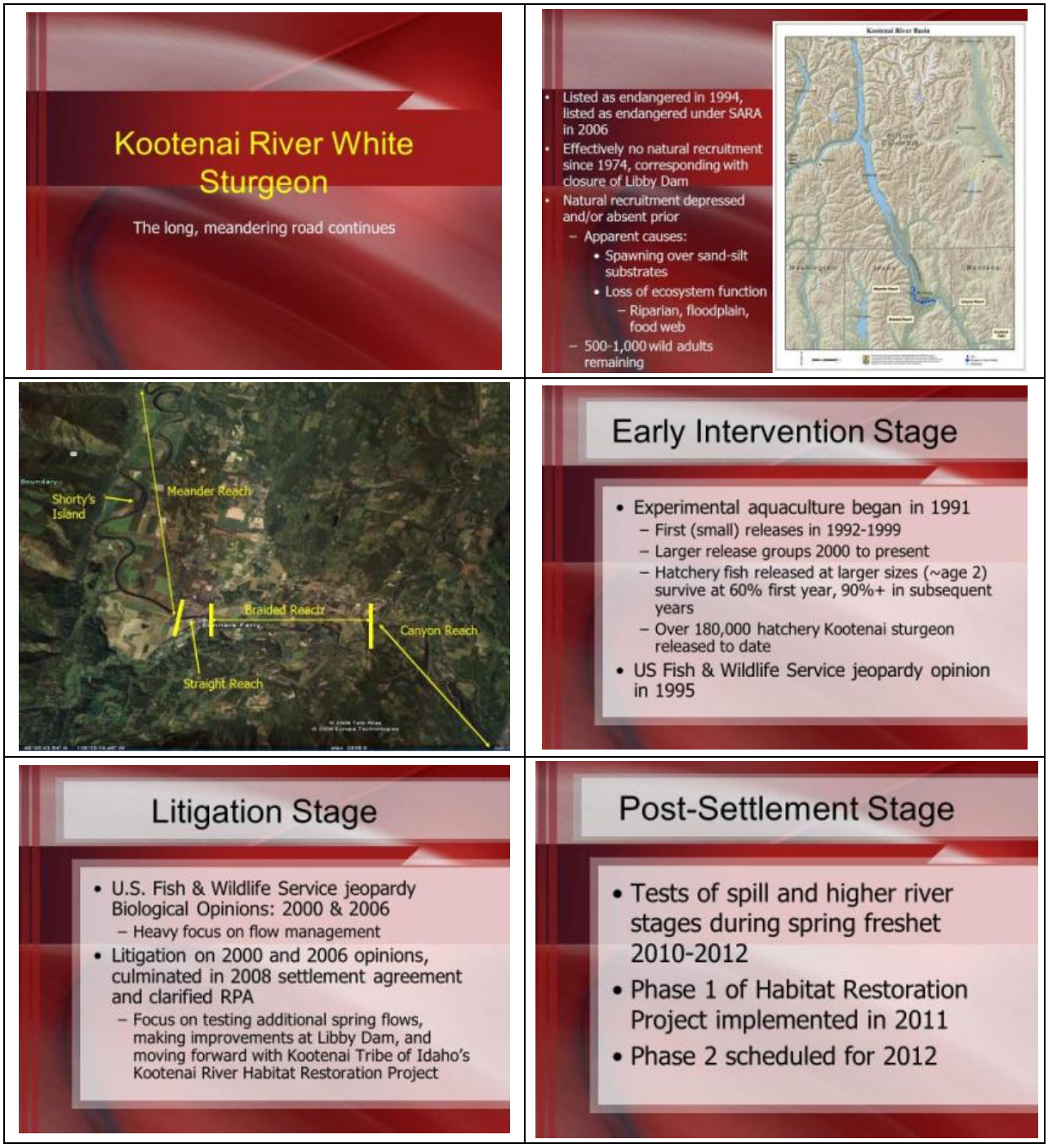
A conservation aquaculture program has successfully forestalled extinction of Kootenai sturgeon, at least in the near term. A substantial population of hatchery-produced juvenile sturgeon has been established in the river. Survival was high for initial hatchery releases of large two-year-old fish but declined in subsequent releases of smaller fish.

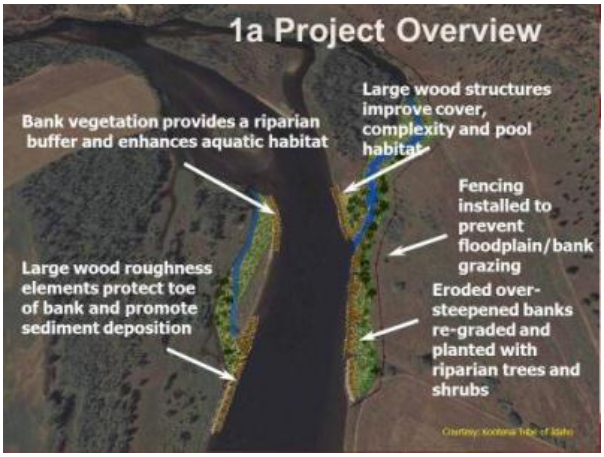
Flow measures are also being employed in an attempt to restore natural recruitment. The first jeopardy biological opinion in 1995 on Libby Dam included a very specific flow prescription. The FCRPS BiOp (2000) included the effects of Libby Dam on Kootenai sturgeon. That Opinion and the subsequent 2006 opinion contained RPAs that focused primarily on flow management. Both Opinions were litigated, culminating in a settlement agreement in 2008 that called for testing of higher flows as well as habitat restoration. Current efforts are focused on testing flow management, improving Libby temperature controls, and implementing habitat restoration projects. Most recently, there is a post settlement stage which includes tests of spill and higher river stages during spring freshets 2010-2012. However, 2010 was a low water year with gas constraints, 2011 had high flows due to reservoir drafting for flood control but no spill. In 2011, river flows were high but no distinct freshet occurred as flows gradually ramped up and down. No population response to these high flows was observed which suggests that it will be difficult to get conditions believed necessary for successful natural recruitment.

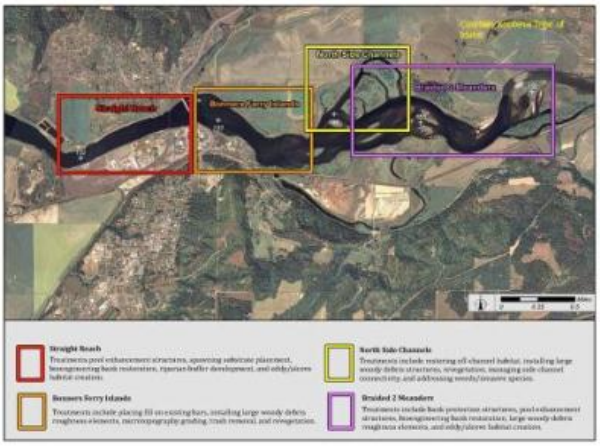
An ambitious habitat restoration project has been initiated with the goal of large-scale ecosystem restoration. Concurrent efforts are underway to improve habitat where sturgeon are spawning and to coax fish into moving into more favorable habitat upstream. Phase 1A, bank stabilization to reduce sediment, has been completed. The first part of Phase 2, involving north channel restoration, is scheduled for implementation in 2012. Other Phase 2 actions include riparian restoration, flow deflectors to create some scour pools, and increased channel complexity. Additional habitat actions may include placing rocky substrates at current spawning areas and increasing channel depth in straight and lower braided reaches. Phase 3: (restore some ecosystem functions) is anticipated to include larger scale floodplain reconnections, side channel restoration and reconnection, and riparian restoration, but will depend on identified opportunities given the agricultural uses in that area.

This endangered population continues to face daunting challenges. Chief among these are the pending demise of the few remaining wild adults, continuing failure to restore or identify effective measures for restoring natural recruitment, the long term viability of a hatchery-

supported population, and the effectiveness of habitat and ecosystem restoration efforts. Other concerns include adaptive management; flow management; future litigation potential driven by environmental groups; and demands from increasing human population growth in the region. Lastly, the Columbia River Treaty has implications for future dam operations and implications of flood control priorities.







Additional Habitat Actions

- Improving/placing suitable rocky substrate in current spawning areas
- Additional depth in straight and lower braided reaches
- Phase III
  - Floodplain reconnections
  - Side channel restoration and reconnection
  - Riparian restoration

Challenges Moving Forward

- Adaptive management
- Flow management
- Staying "litigation free"
- Aquaculture program long-term
- Demographic pressures
  - Increasing local population and demand on resources
- Columbia River Treaty

Special Thanks to Kootenai Tribe of Idaho

Snake River

Jeff Dillon with IDFG co-presented information on the Snake River along with Ken Lepla of IPC. There are three separate plans for the conservation and management of white sturgeon (IPC 2005; NPT 2005; IDFG 2008). The Snake River is divided into eight reaches for management purposes. There are two "core" or self-sustaining populations of white sturgeon in the Snake River (Hells Canyon and the Bliss Reach). The remaining populations consist of small numbers of adults which are not self-sustaining. Associated areas are designated as "conservation reaches." In addition, two sturgeon populations introduced for fishing outside the native distribution.

IDFG's management goals are to protect core populations, actively manage conservation reaches, and provide fishing opportunity where feasible. The sturgeon population in the Bliss reach has gradually been increasing since catch and release sportfishing regulations were adopted statewide over 30 years ago. However, for conservation reaches where recruitment is absent, some active management is needed to maintain populations and angling opportunity. Proactive management steps were taken with the recognition that populations could not be maintained with wild stocks only.

Key sturgeon management activities include conservation, enforcement, translocation, hatchery supplementation, catch and release angling evaluations, and technical guidance. Enforcement action plans have focused on core populations, key locations and individuals, and may involve covert surveillance, education, and compliance monitoring. Since there is periodically successful recruitment in the Bliss reach, the State has felt comfortable transplanting adult spawners from below C.J. Strike Dam where no natural recruitment occurs into the Bliss reach. Experimental hatchery supplementation has occurred recently on a limited scale so as not to overwhelm the system. The effect of catch and release angling is being evaluated, as the fishery is very intensive and there are concerns for the impacts to the population. A 2007-2008 study below C.J. Strike Dam found that each fish had been hooked an average of 7.7 times and landed an average of 3.5 times. Mortalities directly related to fishing are rare but long term effects of repeated capture are unclear. In a second study on gear ingestion, 32% of the sturgeon in Hells Canyon had metal (tackle) in them, and the rate was 50% for fish over 190 cm. In a controlled hatchery experiment, hatchery-reared sturgeon with ingested hooks are being monitored to evaluate stress response and growth effects.

Ken Lepla discussed current IPC monitoring of entrainment at the penstock and spillway of C.J. Strike Dam. The white sturgeon population in the Bliss reach above C.J. Strike Dam is one of the larger and more successful populations in the Snake basin (3,500-4,000 fish). Population assessments have shown some downstream movement through the dam and IPC is investigating routes of passage. A DIDSON mounted in front of the penstock intakes looked at sturgeon entrainment during low and average water years in 2007-2009. There were some limitations of the camera when shooting distances up to 38 m, which required use of low resolution mode. While this worked for identifying large targets, smaller fish less than 100 cm could not be distinguished as sturgeon. Over the 3 years of monitoring, fish mostly show up in the spring and fall, with sizes ranging from 100–282 cm. The current trash bar spacing of 22 cm excludes sturgeon larger than 203 cm. Sturgeon have increasing blade strike probabilities as length increases up to 90 cm and fish between 90 and 203 cm in length have 100% blade strike probability. Although 43% of fish approaching the dam were not restricted by the trash screen,

only one fish (151 cm) entrained into the penstock. Most sturgeon appeared to sense the screen and turned to avoided it, but behavior was variable with some fish first bumping into the bars before returning upstream. No obvious water year effects were apparent but IPC does not feel they understand the behavior enough to draw conclusions and will continue monitoring to include additional high-flow years.

A spillway camera was installed in 2011 as earlier population surveys showed some fairly big fish had migrated downstream that could not have come through the penstocks. From April 10 to June 28, there were 299 observations of sturgeon with lengths ranging from 94 to 313 cm. Most of the sturgeon showed up at the peak spill in June, and most sturgeon were 120–150 cm in length. As sturgeon approached the spill bays, some fish went head first but most individuals attempted to turn and re-orient upstream upon sensing the flow transition zone, with several observed going downstream backwards. It's unclear whether this response was intentional or perhaps fish wanted to return upstream, but had entered the point of no-return. IPC counted 32 sturgeon passing over the spillway in two open gates. A preliminary extrapolation to account for additional open gates suggests up to 80 fish may have spilled over, which represents about 1-2% of the Bliss population. IPC plans to continue monitoring at C.J. Strike Dam to better quantify entrainment during spill events.

Partners
Idaho Power Company
College of Southern Idaho
Nez Perce Tribe
Annual Sturgeon "Summit"

Goals
Protect self-sustaining "Core" populations
Actively manage other "Conservation" reaches
Provide fishing opportunity

Key Activities
Conservation enforcement
Translocation
Hatchery supplementation
Effects of C&R angling
Technical guidance

Enforcement Action Plans
Focus on Core Populations
Key Locations/individuals
Covert surveillance
Education, compliance

Translocation
(wild fish)
Adult spawners from below Strike to above
Total of 26 fish since 2007
Juvenile fish from Bliss reach to below Strike
50 fish fall 2010

Hatchery Supplementation - 2010
Within historic range
50 fish to Bell Rapids, Lower Salmon Dam
100 large fish below Swan Falls Dam
Outside historic range
400 fish to Idaho Falls
200 fish below American Falls

Effects of C&R angling
-Hooking injury, gear ingestion, and mortality?
- Catch frequency?
Below CJ Strike 2007-2008
Population = 560 fish
4,360 hooked (7.7 times/fish)
1,996 landed (3.5 times/fish)

Tackle in WS
Hells Canyon
32% overall
50% of fish >190 cm
Effects????

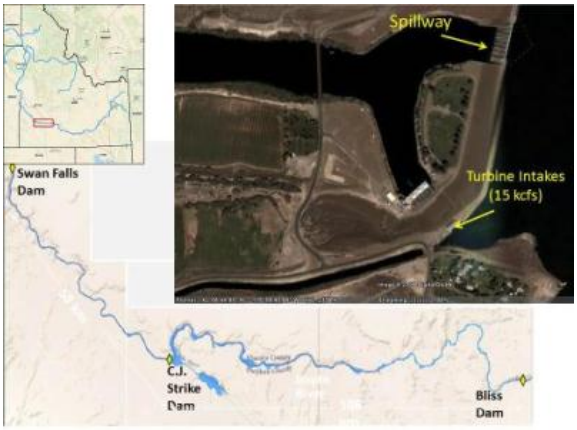
Entrainment Monitoring at C.J. Strike Dam

Penstock

- DIDSON Camera at trash screen
- Continuous recording
- Data collected from 2007 to 2009

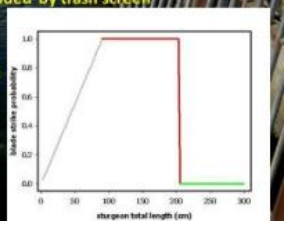
Spillway

- Initiated in 2011
- Data collected during spill events



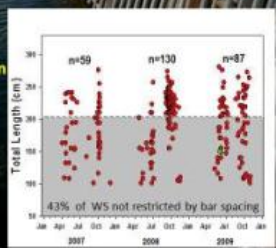
Penstock Monitoring

- Bar spacing = ~22 cm; limits only large-size WS (>203 cm)
- WS have increasing blade strike probabilities up to 90 cm
- WS between 90 and 203 cm have 100% blade strike probability; >203 cm fish excluded by trash screen
- Velocity in front of the trash screen ranges from 0.3 m/s to 1.1 m/s (1-3 turbines)
- Camera Limitations
  - Fish < 100 cm not counted
  - Coverage ~47%



Penstock Monitoring

- 276 obs. of WS; mostly spring-fall months; night obs. common
- Lengths ranged from 100 -282 cm TL
- 43% of WS not restricted by bar spacing
- Sonar shadows indicate most WS approached the forebay near bottom
- Most sturgeon appear to sense the screen - *but behavior was variable*
- No impingement of WS occurred; 1 WS entrained (151 cm TL); ~4200 cfs;

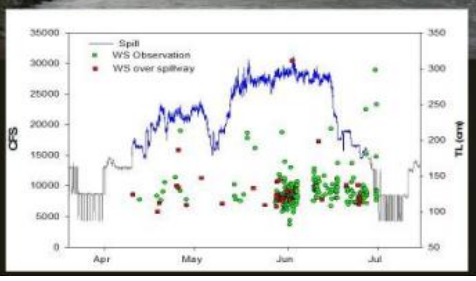


Spillway Monitoring

- Open spill bays from Apr 10 to Jun 28, 2011
- Spill flows reached ~ 14,000 cfs (up to 5,000 cfs per gate)
- Two spill gates nearest the camera were opened first to limit viewing distances (<35 m), however 3 additional gates were eventually opened
- Data for gates 4 & 5 & 7 not analyzed

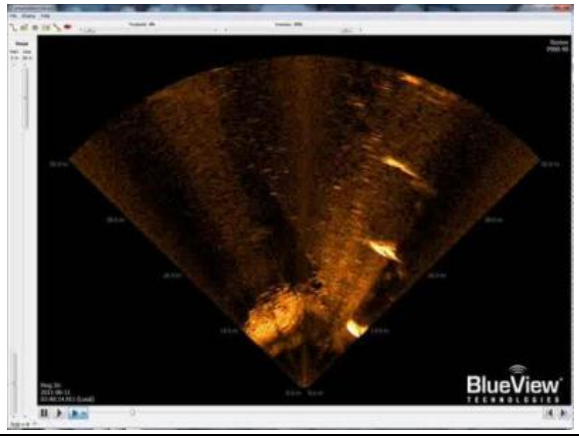
Spillway Monitoring

- 299 obs. (repeats?); majority obs. end of May-Jun
- Lengths ranged from 94 to 313 cm TL
- Point of no return
- Preliminary estimate of 32 WS > 100 cm were entrained



Future Tasks

- At C.J. Strike:
  - Continue monitoring spill events to quantify entrainment loss during spill events
  - Monitor penstock entrainment at scheduled intervals
- Incorporate software (Echoview) to assist data processing
- Lessens learned/deploy cameras to additional mid-Snake dams



Facilitated Work Session – Basin-wide Sturgeon Framework

Ray Beamesderfer introduced the first facilitated work session. He explained that the Council and ISRP have expressed concern regarding whether all the various sturgeon programs throughout the basin are effectively complementary and coordinated. In their review of lower river programs, the ISRP concluded that "an effective basinwide management plan for white sturgeon is lacking and is the most important need for planning future research and restoration." The specific ISRP comments were as follows:

> *We suggest that a clear, unambiguous basinwide plan be developed that addresses data gaps, and a better understanding of the factors limiting recruitment be developed before instituting widespread, uncoordinated expansion of hatchery programs in the Basin. A review of the projects indicates that some agencies and tribes are proposing and implementing major hatchery recovery efforts (e.g., 2007-155-00, 2008-455-00) without understanding the causes of recruitment failure; they have essentially given up on natural recruitment of wild fish to rebuild populations in pools above Bonneville Dam. This may be the appropriate conclusion, but that conclusion should be an outcome of basinwide plan discussions and some scientific evidence of the factors clearly preventing natural recruitment in various localities. The potential impacts of greatly increased hatchery production on wild fish are not known, and the long generation time for sturgeon makes an assessment much more difficult than for fish such as salmon with short generation times. Without overstating the issues, sturgeon management, research, and restoration in the Basin are at an important crossroad.*

The ISRP was proscriptive in their direction stating that the basinwide management plan should include the following elements:

- *A description of what we know and do not know about sturgeon life history, status, limiting factors, and current and past programs and activities. This plan should describe a comprehensive and integrated vision, goals, critical uncertainties, research, etc. for sturgeon encompassing all areas throughout the basin. This will include information common to all areas of the basin.*
- *Area-specific sections or chapters that identify conservation, mitigation, management and research objectives, strategies, actions and schedules for different portions of the basin (See Figure 2 below). This hierarchical organization will balance the need for comprehensive treatment with area-specific issues and actions. Different combinations of agencies and stakeholders will also be involved in the development of specific plans and programs in different areas.*
- *There are seven dedicated sturgeon planning areas. The areas affected by the programmatic issue include planning efforts for the lower Columbia, the lower mid-Columbia and the lower Snake. At the same time, conclusions about limiting factors, research and restoration needs and future work plans should be made with all dedicated sturgeon planning areas in mind. The guidance for subsequent implementation work plans, schedules and agreements in these areas must be incorporated into the basinwide plan.*

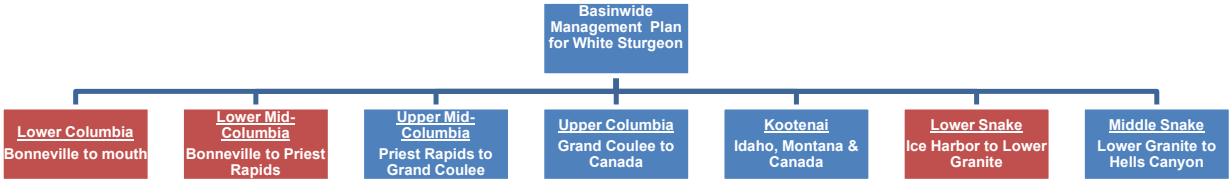


Figure 2. Schematic of the seven sturgeon planning areas identified by the ISRP. The red boxes represent areas covered by the recent ISRP review that resulted in the call for a basinwide management plan.

Since this issue was raised in a review of lower river sturgeon projects, the lower Columbia planning team has volunteered to lead the development of this basinwide plan (which we are calling a Framework to distinguish it from the lower mid-Columbia Strategic Plan being completed concurrent with a hatchery master planning project). Our idea was to take the lead and put together all the available material from the various areas into a comprehensive document and then run it by people in each area for their additions, revisions, and hopefully endorsement. The intent is to keep it from turning into yet another huge planning effort for everybody, while also providing a clear and comprehensive overview of the state of the sturgeon. The framework document should not be viewed as directing or limiting what anyone's sturgeon programs are about, but a documentation of everyone's good work. We are looking to use this work session to introduce the idea of the Framework plan and to elicit information and input to help guide its development. We are also seeking to identify regional gaps or common information needs that might warrant attention. A draft outline of the Framework plan is given in Appendix C.

The structure and process for the work session was as follows. To divide the participants into groups while ensuring a diversity of interests and regional representation in each group, the participants were asked to count off numbers 1 to 8 sequentially around the room and then sit at the corresponding table number. In this manner, the eight groups were randomly formed. Each group was assigned a note taker, who was responsible for facilitating the discussion and for capturing the salient discussion points.

Participants were asked to respond to the following four questions:

1. **What are the opportunities and limiting factors?**
2. **What are the data gaps at a global scale?**
3. **How can we maximize value of this effort?**
4. **What will you do?**

During the 'report back' session, a designated representative from each group presented the key discussion points to the larger group. Each of the first three questions were addressed individually, getting input from each of the eight breakout groups before proceeding onto the next question. After all groups had presented their information, all participants were asked whether they had additional input to provide. The following is a summary of the notes from the 'report back' discussion.

Question 1. What are the opportunities and limiting factors?

Participants expressed a measured view of what a framework document can and cannot do. Participants generally acknowledged that 1) there is some value in an effort such as this to highlight needs and acknowledge gaps, 2) the process is useful for facilitating communication, and 3) ancillary tools developed as part of this document could also be potentially useful.

However, there was skepticism about the utility of the actual document. Sturgeon projects and activities within any given management unit are already undertaken within the responsibilities and authorities of the appropriate jurisdictions. Objectives and strategies are tailored to the specific circumstances within each management unit and participating entities already support significant consultation and coordination among themselves as part of their normal processes. Thus, while a framework document might serve as a useful descriptive document to provide a comprehensive overview of sturgeon-related activities throughout the basin, it was much less clear whether this effort would result in substantive new information or guidance of utility to local projects and programs.

Moreover, given the potentially limited value of a regional planning effort, many people were reticent to take on significant extra workload associated with yet another planning effort, which would be additive to already busy schedules and likely unfunded. In the final analysis, people were generally supportive of proceeding with this effort and amenable to providing supporting information and review of a sturgeon framework development effort led by the lower Columbia sturgeon planning team.

Table 1. Opportunities and limiting factors for developing a basinwide sturgeon framework plan.

Opportunities
• **Regional coordination & collaboration**
• **Information sharing/collective intelligence**
• **Consistency/standardization in methods and approaches**
• **Centralized information repository**
• **Eliminate redundancy in efforts; opportunity for foresight in planning efforts**
• **Understanding of diverse interests**
• **Encourage more research in areas that are lacking**
• **Build a regional database**
• **Identification of commonalities**
• **Potential to direct funding, priorities, and schedules**
• **Ensure a scientific approach basin-wide**
• **More value as a living document**
Limiting Factors
• **Many entities; difficult to coordinate efforts**
• **Large geographical area**
• **Differing plans, mandates, goals, and priorities**
• **Funding**
• **Credibility of the document, especially given that many areas have their own plan**
• **Competing for resources breeds “turf wars” or sometimes secrecy in data/ results**
• **Prioritization of goals varies among regions and entities**
• **Not binding; NPCC has no regulatory authority**
• **Might not get much voluntary support/contributions**

Question 2. What are the data gaps at a global scale for the comprehensive plan or to integrate at the larger level?

Each group was asked to rank the top three priority data gaps. Responses in the table below are organized by level of priority with the number of votes (out of 8) received in the right hand column. Groups were almost unanimous in highlighting needs for a better understanding of recruitment failure and sturgeon genetics. A better understanding of carrying/capacity and habitat or flow limitations and effects was also highlighted.

Table 2. Overarching data gaps and priorities for Columbia River white sturgeon.

Statement	# of Votes
Mechanisms of recruitment failure • **Why are we observing age-0 to age-1 survival failures?** • **Why is there spawning but few age-0?**	7
Genetic information- both basin-wide and range-wide • **Basin-wide and range-wide** • **Genetic effects of captive broodstock programs**	7
Carrying capacity/Bioenergetics	3
Critical habitat identification & improvements including flows • **Spawning** • **Rearing** • **Feeding**	3
Fish passage/ population connectivity	2
Role of predation	1
Consistent hatchery guidelines	1
Fishing effects on individual survival • **Lost gear effects** • **Catch & release mortality**	
Sources and rates of mortality by life history stage	
Accurate estimates of population sizes & harvests	
Ocean component of life history • **Geographic distribution** • **Ocean/freshwater interaction** • **Migratory timing for entering/exiting the river** • **How much of the population resides in salt water?**	
Contaminants, especially in Snake River	
Diet • **Interspecific interactions** • **Feeding behavior**	

Question 3. How can we maximize the value of this effort?

Participants strongly advised that a useful framework document would need to be current, comprehensive, and credible to be of value. Several participants expressed concerns that it would be challenging to 1) get enough voluntary support to achieve these goals, and 2) to sustain it as a living document. It is important to note that participants seemed to be looking to the process, rather than the document itself, to develop basinwide protocols and standards for maintaining genetic integrity (i.e., hatchery supplementation), sampling methods, and data reporting in a single, publicly available database.

Table 3. Suggestions to maximize the value of a basinwide planning effort.

Statement
Basinwide protocol to maintain genetic integrity
Standardizing methods for comparison of sampling efforts
Coordination of information and efforts
Common framework including: • **A recognition of regional goals** • **Priorities** • **Database** • **Project descriptions** • **Project results**
Needs to be high level and comprehensive
Recommendations, guidance, some goals, and priorities
Maximizing the resources to collect information
Public outreach
Make it relevant to local managers
Yearly proceedings of Columbia Basin white sturgeon research, monitoring, and evaluation

Day 1 Closing Comments

To wrap up Day 1 of the workshop, participants were asked to provide closing thoughts, comments or takeaway messages. The following is a selected list of participant responses:

- I've been here about 2 hours, and am beginning the immersion process. I am struck by power of this group and the frequency at which certain themes come up. Communicating, cooperating, collaboratively. Clearly, we can achieve more if we can leverage collective efforts. The charge of the council is to Preserve, mitigate & enhance. However, most of the work by the Council has been focused on salmon with lessor efforts for resident fish and wildlife. Groups like this communicate the message that the importance of sturgeon. We can avoid drifting into jeopardy. We can help decide what to do – we need to give due attention to sturgeon. Phil Rockefeller (NPCC – WA Council Member).
- I find value in understanding big research needs even though outside BPA funding. This is also a great opportunity to collaborate with others. Jim Chandler (IPC)
- I recognize that trying to manage to everybody's expectations and compiling data is difficult; we must understand the population first. Yetta Jager (ORNL)
- I will be happy to review and ensure relevance. Karl Weist (NPCC)
- I really appreciate this process. Jason McLellan (CCT)
- I'm really impressed by quality of information and how much we've learned. Mike Parsley (USGS)
- Manitoba is going through a similar process. Suggestions and discussion of usefulness of a comprehensive document; I want to highlight the value of having the document useful to the public (outreach). Marilynn Kullman (Manitoba Hydro)
- We look to the Pacific Northwest for templates. Alicia Seesholtz (CDWR)
- The passion and great concern is amazing to see. Lance Beckman (USGS rtd.)
- Getting all the agency strategies and goals to line up is daunting. Scott Everett (NPT)
- One of bottom lines will be global gaps. This will be one of the more useful pieces but can't be so specific as to stifle creativity. Many issues are the same across the basin. We need to get a list and order them. Jeff Korth (WDFW)
- I never cease to be amazed at the value of information exchanged. Tucker Jones (ODFW)
- The relevance of the document is key. It is a huge and daunting task, and we need to assess risks of going forward with putting on record strategies that may not be beneficial to the species. This is my 3rd workshop; thanks for providing me with inspiration. Christine Mallette (ODFW)
- These workshops are a great learning process. I always enjoy them. Donella Miller (YN)
- Look at complexity of salmon and how it's being managed under the Accords. We can use this opportunity to create a vision with implications for all the projects, synergy for leveraging limited funds, and prioritization for critical gaps. I see value in the continuation

of this effort. I have seen the energy at 3 workshops and I commend Blaine Parker & CRITFC for their dedication and effort. Mark Fritsch (NPCC)

- Going through the process and communicating may be more important than the final product. Corey Wright (Blue Leaf Environmental)
- I arrived with a blank page of sturgeon knowledge. I'm impressed. I can now share sturgeon knowledge. It's amazing what a group working together can accomplish. Shadia Duery (Cramer Fish Sciences)
- Any time we get together to talk about technical stuff is good. Remember to shape document for public. Jeff Dillon (IDFG)
- I'm impressed about everything going on that I didn't know about. Terry Hurd (USACE)
- Collaboration is the key. Ron Rhew (USFWS)
- I'm willing to support future work. Miroslaw Zyndol (USACE)
- I'm optimistic that we can meet challenges; we are in good shape compared to California. Zac Jackson (USFWS – CA)
- I share your passion, and take your message to the public (outreach is super important). Steal shamelessly from Wisconsin's sturgeon program. Harry Barber (LCFEG)
- We have an obligation to future generations to maintain resource and we have to try to improve the environment. Blaine Parker (CRITFC)
- I've been gleaning planning ideas from what you do in the Northwest; it's very encouraging to see. Julie Day (NOAA - CA)
- I'm learning more from the process than from the final products. Shawn Young (KTOI)
- I'm part of the core group. I appreciate everybody coming here. One of the challenges will be to identify key participants – key points of contact. The need is apparent to identify the decisions and purposes of the document. How will it be used in agency decisions? Tom Rien (ODFW)

DAY 2 – STURGEON PASSAGE

Background

Ray Beamesderfer introduced the topic of the day, sturgeon passage, and provided a contextual background. Sturgeon are "big river" fish. They live a long time and can navigate through big river currents. These traits are highly adaptive for sturgeon dealing with the variable and scattered productivity that is characteristic of dynamic river systems such as the Columbia.

Sturgeon historically migrated widely throughout the Columbia River Basin and ranged freely between freshwater and ocean environments to take advantage of seasonally available prey species and a variety of habitats. They are a highly mobile species and move, as needed, to take advantage of ever-changing river conditions. Since the construction of the mainstem dams, movements have been blocked and they have been left to rely upon the resources in the location where they have been trapped (Figure 3). Further, what was once a single population or a series or broadly overlapping metapopulations has now been fragmented into a series of subpopulations trapped in reservoirs. Most impounded populations are recruitment-limited due to unsuitable habitat or flow conditions.

The lower Columbia downstream from Bonneville Dam continues to support a large and productive population; these populations still have access to the ocean. Populations in impounded reservoir/river sections upstream from Bonneville Dam have not fared as well. Status varies among impounded subpopulations from marginally productive to functionally extirpated. Several reservoirs including Bonneville and The Dalles support modest populations and limited fisheries. However, most reservoirs and river segments currently support very low fish numbers and no meaningful fisheries. Populations in headwater areas are severely depleted and a unique population in the Kootenai River is threatened with extinction.

The root of the problem is that sturgeon are unable to readily pass the dams. Fish passage facilities for migrating fish were designed primarily for adult salmon and steelhead.

In programmatic comments on the lower river white sturgeon projects, the ISRP called for an evaluation of mainstem passage (NPCC 2011). In response, the Council committed to work with BPA, the USACE, and the fish and wildlife managers to conduct a sturgeon passage workshop. The ISRP and NPCC recommended that the workshop objectives include:

- *Review sturgeon passage projects in other areas -- regionally, nationally and internationally;*
- *Define and characterize or quantify anticipated risks and benefits of passage among reservoirs;*
- *Identify opportunities and constraints to implementing white sturgeon passage improvements among lower mainstem dams;*
- *Identify critical unknowns and potential assessments to address them;*
- *Consider experimental and adaptive approaches for implementing changes; and*
- *Identify monitoring needed to assess passage effectiveness.*

To address these objectives, the workshop was organized around three parts: a review of current knowledge of sturgeon passage in the Columbia River, information from experts on

sturgeon passage in other areas, and a discussion of the potential benefits and risks of improving sturgeon passage at mainstem Columbia basin dams. The outcome of the workshop will provide feedback to the Council on passage. These workshop proceedings serve as a report back to the NPCC and ISRP.

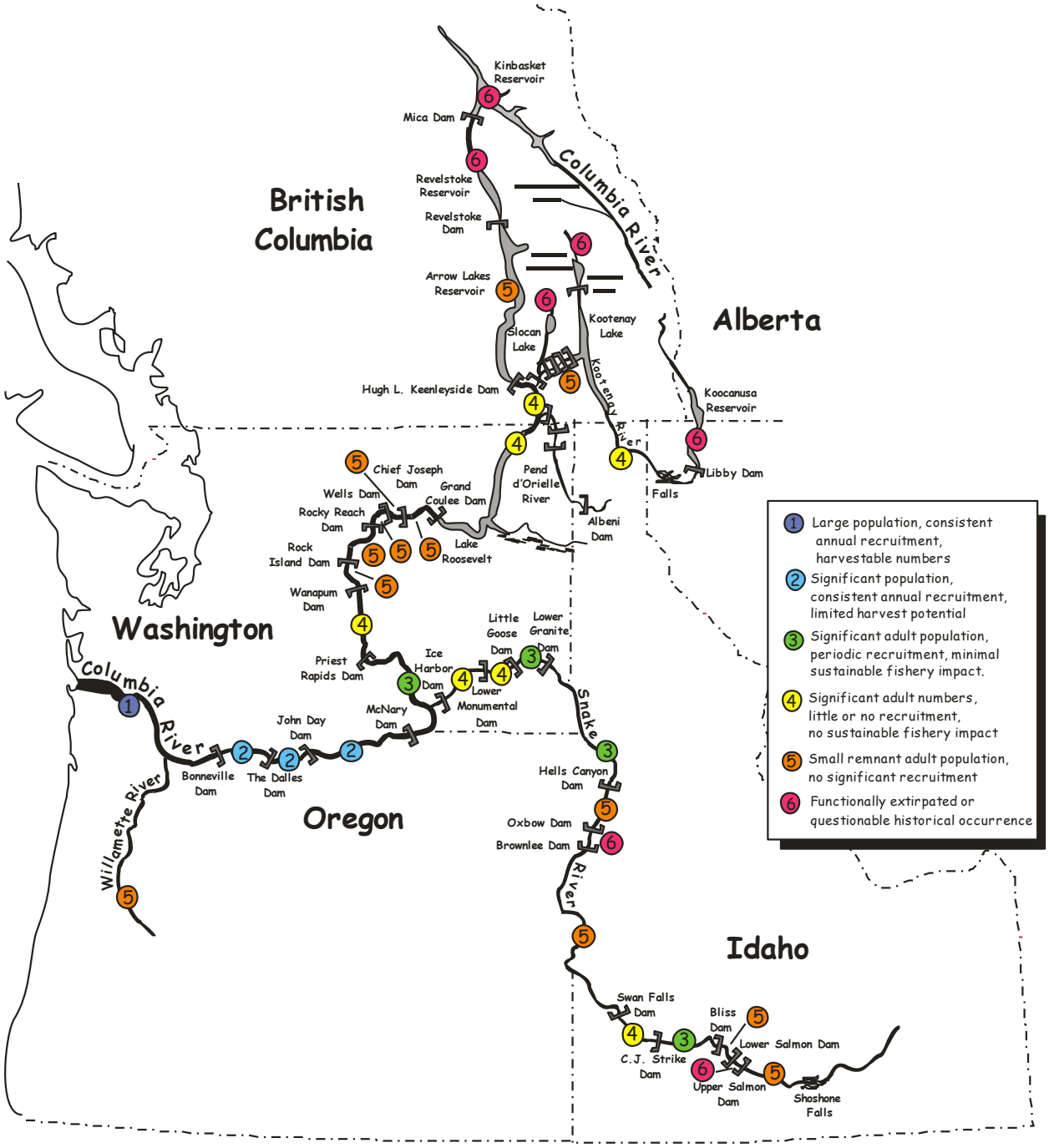


Figure 3. Map of the Columbia River Basin showing dams and current sturgeon population status.

Columbia Basin Sturgeon Passage: What Do We Know About It?

This session was intended to describe the current state of knowledge for passage of sturgeon. Mike Parsley, a fishery research biologist and project lead at the USGS's Western Fisheries Research Center, Columbia River Research Laboratory, presented an historic overview of fish passage activities and research on the Columbia River. Bjorn van der Leuuw with the U.S. Army Corps of Engineers Fisheries Field Unit, Portland District, gave a description of sturgeon observations at the Federal hydropower facilities (FCRPS). Colin Chapman, a fisheries biologist with ODFW's Ocean Salmon and Columbia River Program, presented results of an experimental evaluation of the "trawl and haul" transportation program. This session concluded with a facilitated discussion on sturgeon observations at the Columbia River Dams.

Overview and historical passage efforts

Mike Parsley began with a reminder that sturgeon passage is not a new idea in the Columbia Basin. In 1942, USACE Bonneville Dam biologist Ivan Donaldson wrote a series of recommendations to the Area Engineer including several regarding sturgeon passage. Donaldson was successful at passing sturgeon upstream at Bonneville Dam using fish elevators and he recommended that future dams include elevators for this purpose. In 1940, Donaldson passed about 100 sturgeon and in 1951, he passed about 1,600. There were also elevators at The Dalles and McNary dams, but they fell out of favor in the 1950's, mainly because ladders were superior for passing salmon. Elevator use for sturgeon passage was subsequently discontinued. It is important to note that elevators aren't necessarily volitional passage.

In 1993, USGS published a document titled *Fishway Use by White Sturgeon on the Columbia River* that summarized Donaldson's passage of white sturgeon and presented information on numbers of white sturgeon counted in fish ladders. This information was being recorded by fish counters at the dams, but was not being publicly reported as are the counts for many other species. The current limits of upstream passage via fishways extends to Chief Joseph Dam in the Columbia River and Hells Canyon Dam in the Snake River. Counts of sturgeon at non-FCRPS dams were not included in Mike's presentation.

In 1998, the Army Corps of Engineers began posting a report of miscellaneous fish counts, including sturgeon, at USACE operated mainstem dams. These data show high variability in numbers among dams and within years at individual dams. The east fishway at The Dalles Dam always has the highest counts of sturgeon. Since 1998, the cumulative sturgeon count at The Dalles Dam of >2,500 has been higher than at all of the other FCRPS dams combined; Bonneville Dam had a cumulative count of approximately 700. Most of the fish counted are in the 2-4 feet length range, but fish as large as 8 to 10 feet have been observed. Length-frequency analysis and timing suggests that fish moving upstream through the ladders are not on a spawning migration; most are too small to be reproductively mature and most of the counts occur after the known spawning period.

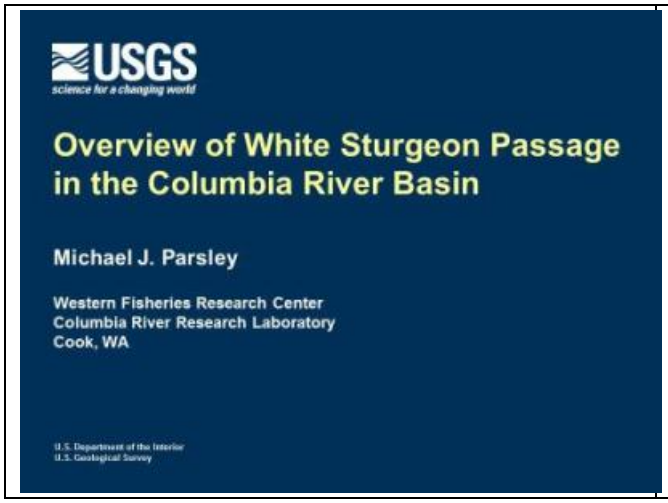
A collaborative study by the USGS, National Marine Fisheries Service (NMFS), University of Idaho, and USACE used acoustic and radio telemetry at The Dalles Dam evaluate juvenile and adult white sturgeon distribution and movements in the immediate vicinity of the dam and to determine timing and routes of upstream and downstream passage. Some tagged white sturgeon entered and resided in both fish ladders, but upstream occurred only at the east

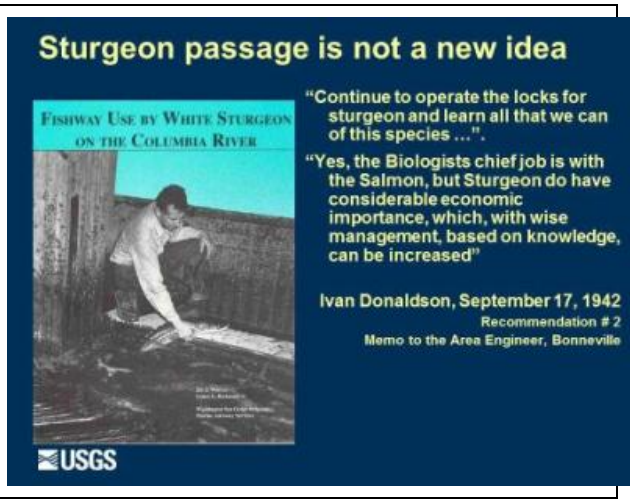
ladder. Differences in passage success were related to differences in ladder design. Both ladders have overflow weirs with submerged orifices so fish can pass either near the surface or along the bottom of the ladder. However, the east ladder is wider and the submerged orifices are twice the size of the orifices in the north ladder.

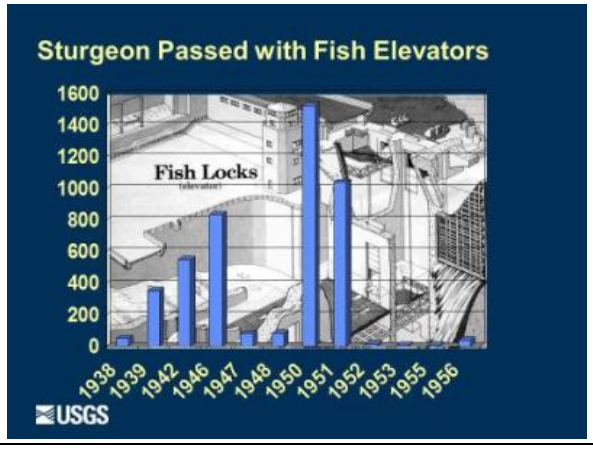
USGS also found that white sturgeon passed downstream through open spillway gates and that some fish that passed downstream through the spillway gates quickly returned back upstream by passing through the east ladder. Some tagged fish also passed downstream through the Bonneville Reservoir and Bonneville Dam and were subsequently located in the Columbia River estuary. Other findings included:

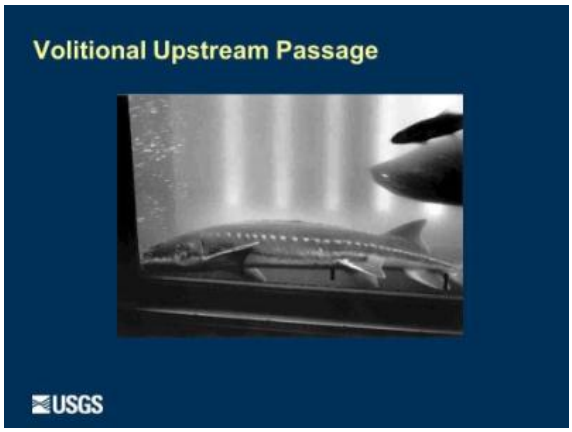
- White sturgeon resided within the ladders for periods ranging from 1 minute to nearly 6 months.
- Upstream and downstream passage primarily occurred between April and September.
- 17% of the sturgeon tagged in the forebay moved downstream indicating that lower river fisheries benefit from fish produced in upstream areas.
- During winter months, white sturgeon aggregated downstream of the dam as well as in the forebay. They dispersed as water temperatures rose during the spring.

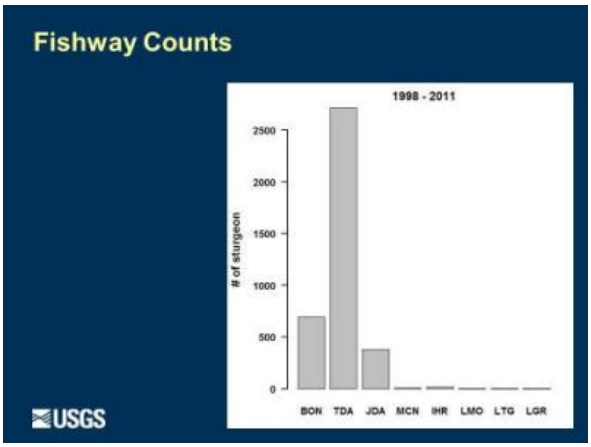
Construction of passage improvements for juvenile and adult salmon, such as spillway retaining walls or the installation of removable spillway weirs, would likely alter upstream and downstream passage dynamics of white sturgeon. The trash rack spacing on turbines precludes subadults and adults from passing through turbines, but younger fish probably pass through turbines. Other tagging studies have shown that there is a net downstream movement of white sturgeon with little upstream passage. This slowly depletes the upstream populations. Downstream populations may benefit from the influx, but the demographic benefit to the metapopulation decreases if upstream production is inadequate.

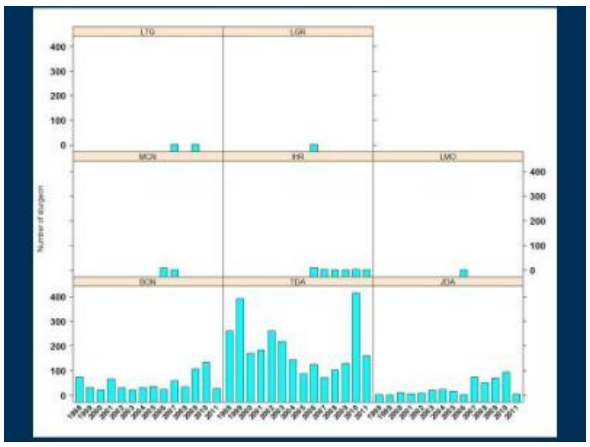


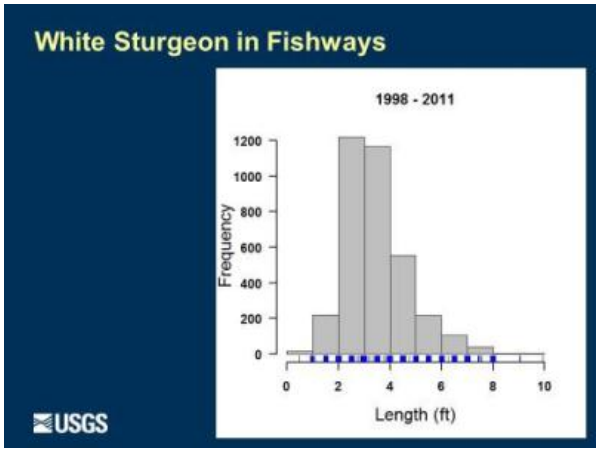


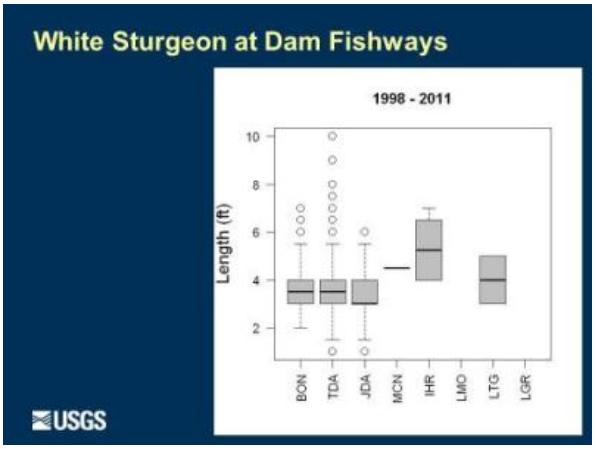

Sturgeon Passed with Fish Elevators
1600
1400
1200
1000
800
600
400
200
0
Fish Locks
1938
1939
1942
1946
1947
1948
1950
1951
1952
1953
1955
1956
USGS

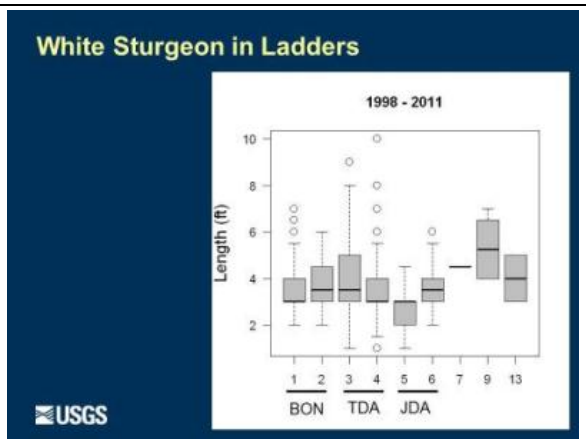

Volitional Upstream Passage
USGS


Fishway Counts
1998 - 2011
# of sturgeon
2500
2000
1500
1000
500
0
BON
TDA
JDA
MCN
IHR
LMO
LTG
LGR
USGS


LTG
LGR
MCN
IHR
LMO
BON
TDA
JDA


White Sturgeon in Fishways
1998 - 2011
Frequency
1200
1000
800
600
400
200
0
0
2
4
6
8
10
Length (ft)
USGS


White Sturgeon at Dam Fishways
1998 - 2011
Length (ft)
10
8
6
4
2
BON
TDA
JDA
MCN
IHR
LMO
LTG
LGR
USGS


White Sturgeon in Ladders
1998 - 2011
Length (ft)
10
8
6
4
2
1
2
3
4
5
6
7
9
13
BON
TDA
JDA
USGS

Extent of Upstream Passage
Columbia River Basin
Canada
U.S.
N
WA
MT
ID
OR
CA
NV
USGS

Current Understanding of White Sturgeon Passage

- Current upstream passage is not a spawning migration
- Downstream passage is mostly through open spillways
  - Trash rack spacing precludes subadults and adults from passing through turbines
  - Younger fish probably pass through turbines

USGS

Current Understanding of White Sturgeon Passage

- There is a net downstream movement of white sturgeon with little upstream passage
- This slowly depletes the upstream populations. Downstream population may benefit but the demographic benefit to the metapopulation decreases.

USGS

USGS science for a changing world

University of Idaho

Behavior of Sturgeon Around The Dalles Dam Hydroproject And Fishways

Michael J. Parsley, Corey D. Wright, Christopher A. Peery[1], Mary L. Moser[2]

Columbia River Research Laboratory
Cook, WA

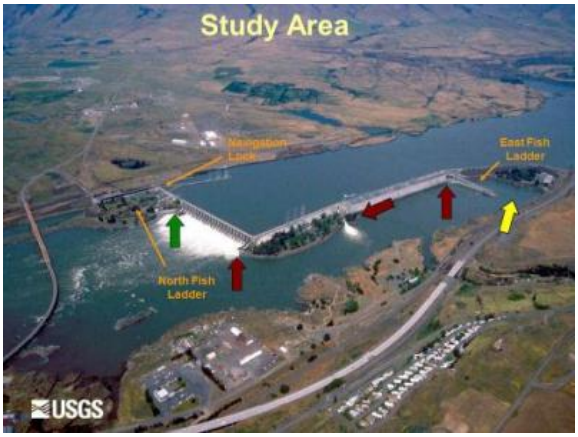
[1] Idaho Cooperative Fish and Wildlife Research Unit
Moscow, Idaho

[2] National Marine Fisheries Service
Northwest Fisheries Science Center
Seattle, WA

U.S. Department of the Interior
U.S. Geological Survey

US Army Corps of Engineers

Study Area



USGS

Objectives

- To describe the distribution, movements, and behavior of white sturgeon *Acipenser transmontanus* near dams, fishways, navigation locks, and the immediate forebay and tailrace areas.
- To determine routes of passage taken by fish moving between reservoirs and fate of fish that ascend fishways.

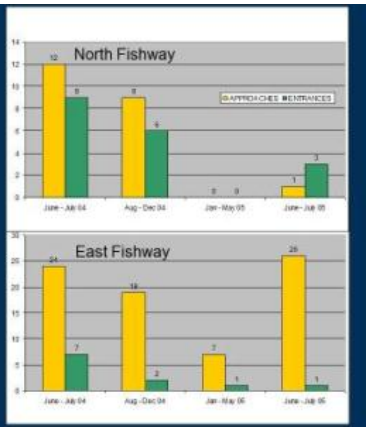
USGS

Findings

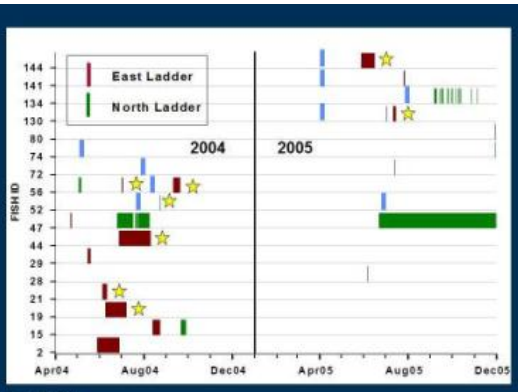
- Volitional passage occurs at TDA
- High ladder counts in east fishway due in part from repeat ascents by individuals
- Upstream passage not related to spawning activity
- Evidence of learned behavior?

USGS

Are white sturgeon trying to get upstream?



USGS



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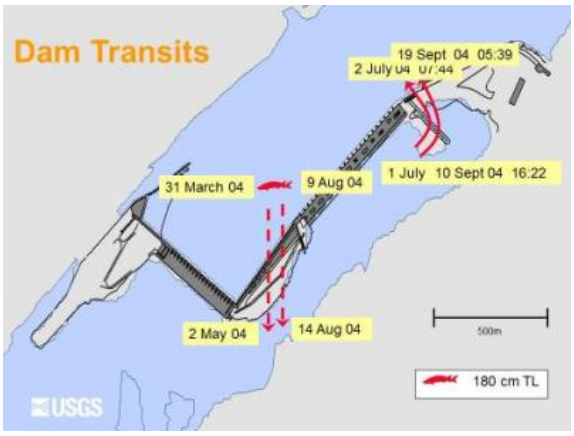


Passage Routes

	2004		2005	
	Downstream	Upstream	Downstream	Upstream
Spill			10	
Unknown	6	1	2	
East Ladder		5		2

USGS

Current Understanding of White Sturgeon Passage

- Variable residence time in fishways

USGS

Current Understanding of White Sturgeon Passage

- Variable residence time in fishways
- Fishway counts may suggest higher upstream movement than actually occurs
- Effects of salmon passage improvements likely to alter upstream and downstream passage of white sturgeon
  - Flow guidance walls
  - RSWs

USGS

"… We may find in the future that sturgeon must migrate to some extent. Yes, I'm aware that almost all the engineers and Biologists laugh at me for my concern about this fish, but I can point to their value now and the vast poundage handled in the commercial fishery before their depletion which took place in the late 1800's – I'm a zealot too."

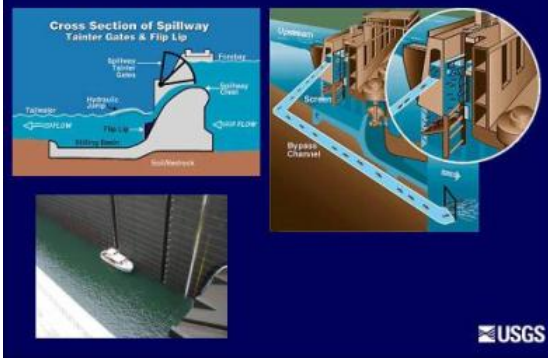
Ivan Donaldson, September 17, 1942
Recommendation # 19 (in part)
Memo to the Area Engineer, Bonneville

USGS

Upstream Passage – All Fishways are Similar, but not the Same

USGS

Routes of downstream passage



USGS

What's next?

Decisions – Mitigate or not?

- Current carrying capacity
- Consequences to metapopulation

Understand passage opportunities

- Structural engineering design criteria
- Dam operations criteria
- System operations criteria

Fishery management options

USGS

Sturgeon observations at FCRPS facilities

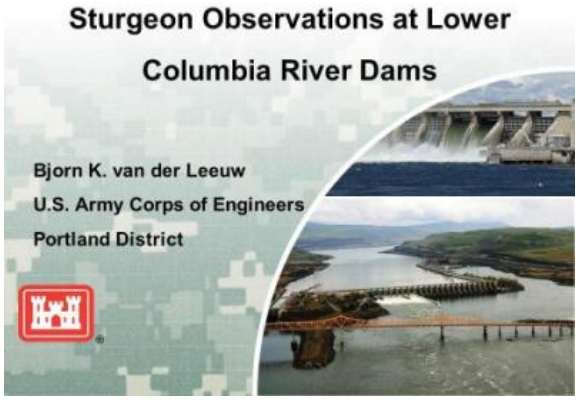
Bjorn van der Leeuw of the USACE described anecdotal observations of sturgeon at FCRPS facilities. This talk mainly focused on Bonneville Dam where sturgeon are encountered in higher numbers compared to the dams farther upriver. Sturgeon are frequently observed during fishway dewaterings, turbine unit dewaterings, turbine unit start-ups, and sea lion predation surveys.

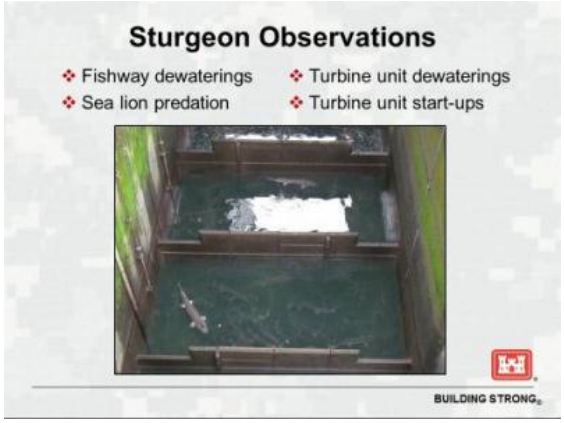
The USACE has been seeing large increases of sturgeon in the fishways at Bonneville Dam since 2007. One hypothesis is that this increase is due to Steller sea lion predation avoidance. Sturgeon are a primarily prey species in winter of Steller sea lions whose numbers have increased sharply in the vicinity of the dam. Surveys enumerated 89 individuals in 2011 and documented 2,100 sturgeon predation events just in the limited survey areas near the dam. The average size class of sturgeon being consumed by sea lions was estimated at 2-4 feet in length. The USACE has recently expanded the period of sea lion surveys to include fall in addition to late winter and spring.

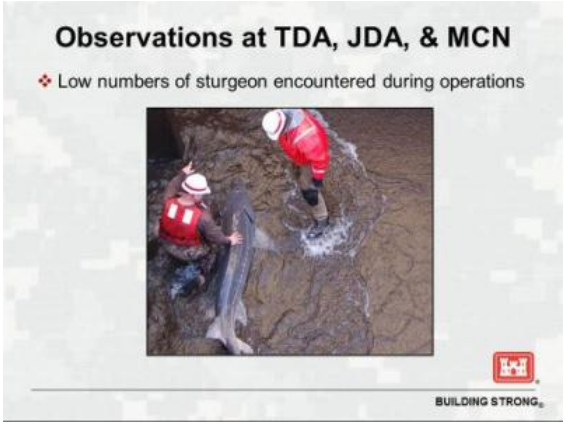
During annual fishway maintenance, the USACE has to manually remove sturgeon when they dewater. At Bonneville Dam, there has been an increase of sturgeon being handled during fishway dewaterings. These fish are of various sizes and have to be manually removed out of the fishways, which is a very labor-intensive process. Data are not currently being collected from dewatered fish and the numbers encountered are highly variable. Nonetheless, this could be a potential opportunity to tag fish for future studies.

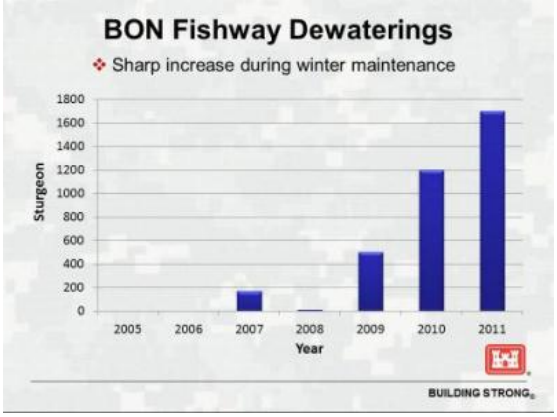
The USACE also encounters sturgeon during turbine dewaterings. The fish swim into the draft tubes and get caught above stop logs. The number of sturgeon increases during the winter months (in the hundreds). The USACE has been discussing ways to minimize sturgeon entering the turbines. During turbine unit start-ups, sturgeon can get struck by turbine blades. A slow row start-up procedure gives sturgeon an opportunity to get out of the way; it's intent is to reduce injury or mortality. From Dec 1 through the end of June each year, a slow roll procedure in place.

Bjorn concluded his presentation with an outline of a path forward. This included: 1) a review of dewatering plans to evaluate the potential to shift maintenance schedules to avoid sturgeon, 2) establishing a Sturgeon Task Group to provide recommendations to Fish Passage Operations and Maintenance Coordination Team (FPOM), and 3) continuing to identify research needs through the Anadromous Fish Evaluation Program (AFEP).

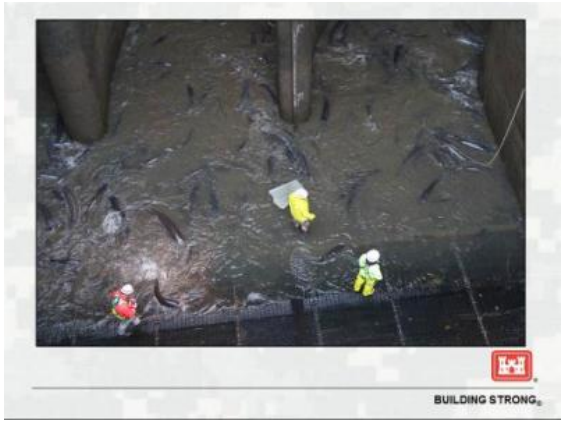

Sturgeon Observations at Lower Columbia River Dams
Bjorn K. van der Leeuw
U.S. Army Corps of Engineers
Portland District


Sturgeon Observations
Fishway dewaterings
Sea lion predation
Turbine unit dewaterings
Turbine unit start-ups
BUILDING STRONG


Observations at TDA, JDA, & MCN
Low numbers of sturgeon encountered during operations
BUILDING STRONG


BON Fishway Dewaterings
Sharp increase during winter maintenance
Sturgeon
1800
1600
1400
1200
1000
800
600
400
200
0
2005
2006
2007
2008
2009
2010
2011
Year
BUILDING STRONG

Sturgeon in BON Fishway
BUILDING STRONG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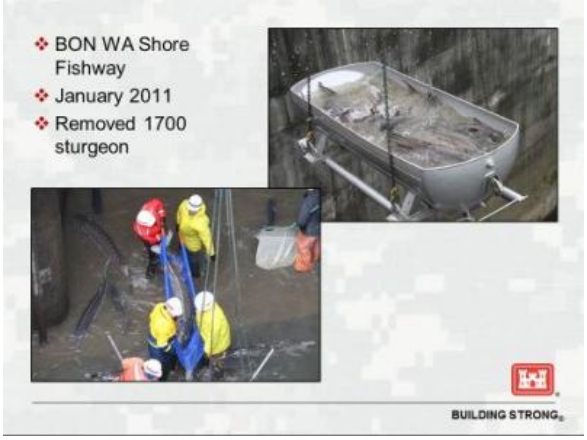
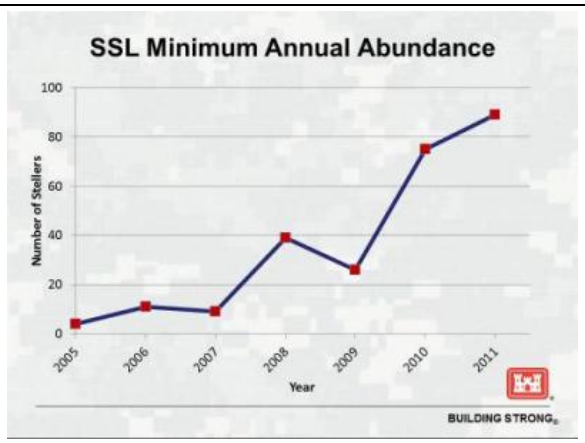
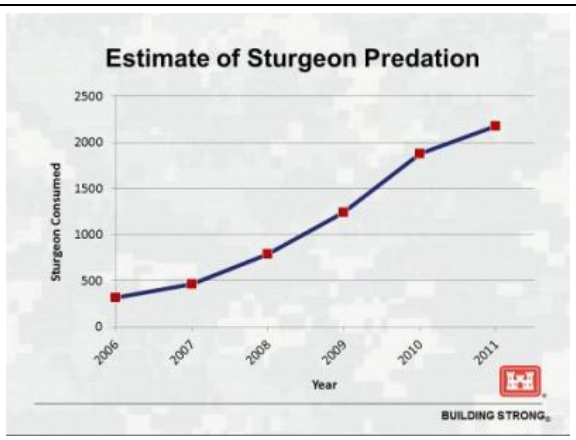

BON WA Shore Fishway
January 2011
Removed 1700 sturgeon
BUILDING STRONG

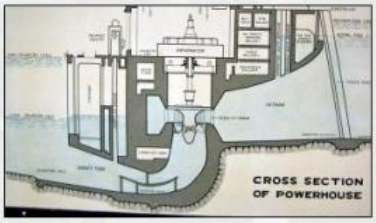
Steller Sea Lion Predation
BUILDING STRONG





Turbine Unit Dewaterings

- Number of sturgeon highly variable
  - Dependant on season
  - Procedures in place to minimize sturgeon entry



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Turbine Unit Start-ups

- Known cause of sturgeon injury/mortality
- Slow Roll Procedure
  - Unit ramps up over 5 min period
  - Reduces injury/mortality
  - December – June

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Path Forward

- Review dewatering plans
  - Shift maintenance schedules to avoid sturgeon?
- Sturgeon Task Group established to provide recommendations to Fish Passage Operations and Maintenance Coordination Team (FPOM)
  - Still in the early stages
- Continue to identify research needs through the Anadromous Fish Evaluation Program (AFEP)

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Questions?

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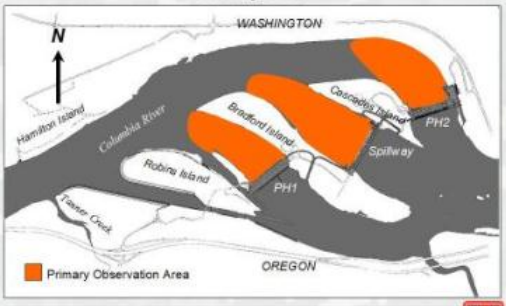
Study Site



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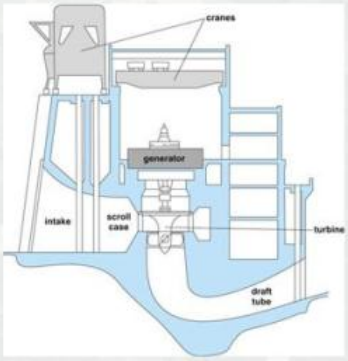

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Trawl & haul program

Colin Chapman of ODFW spoke about the growth, survival, and contribution to fisheries of transplanted white sturgeon in the lower Columbia River. Research from the mid 1980's to the early 1990's showed substantial differences in population density and productivity between the impounded reaches and the free-flowing reach below Bonneville Dam. The difference in productivity between the areas was attributed to lower natural recruitment levels and increased recruitment variability in the impounded reaches. This decline in natural recruitment prompted the co-managers to ask the question, what can we do immediately to supplement natural recruitment in impounded sturgeon populations?

Since the benefits of typical mitigation actions would likely be realized several years down the line, the co-managers came up with the idea of transplant supplementation, where fish would be captured live from an area of higher density and productivity and relocated to areas with reduced density and productivity. In 1994, they began what came to be known as the "Trawl & Haul" program. The objective was to determine the feasibility of using transplanted fish to: 1) mitigate for lost recruitment and passage by directly increasing white sturgeon biomass in the impounded reach, 2) provide Treaty Indian harvest opportunities, and 3) improve the status of impounded white sturgeon populations by contributing individuals that would eventually recruit to the spawning population.

In 1994 and 1995, sturgeon were captured from the free-flowing section below Bonneville Dam using trawl gear, measured and marked with PIT-tags, and then transported to The Dalles Reservoir for release. The Dalles Reservoir was selected to receive the transplanted fish for two reasons: 1) lower productivity in the reservoir was being attributed to recruitment variability, and 2) the relatively small size of the reservoir (with the idea that in a smaller reservoir you would get enough recaptures to accurately assess the program). A total of 2,838 and 5,611 white sturgeon were transplanted In 1994 and 1995, respectively.

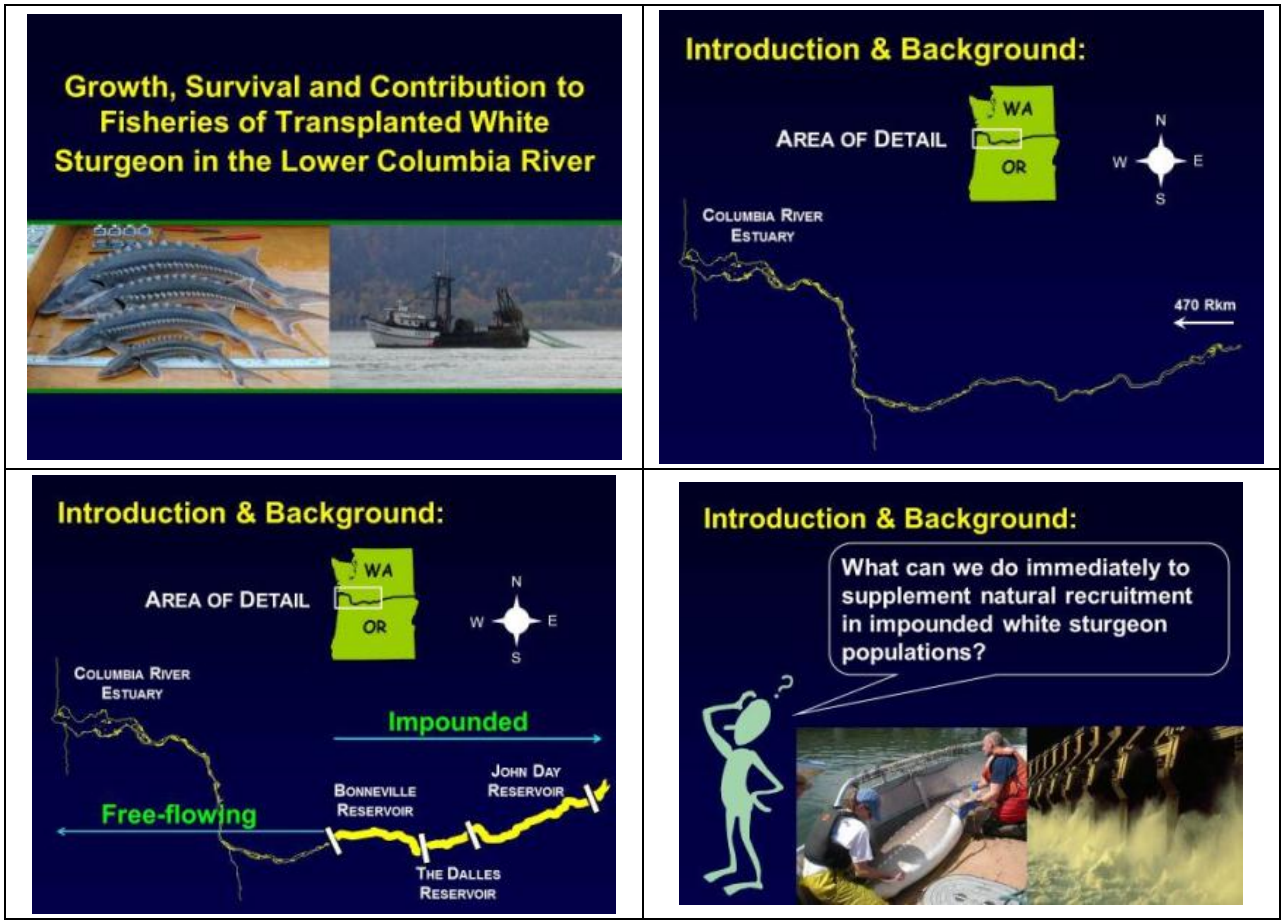
Size and age distribution, survival, abundance, growth and condition of transplanted fish were based on mark-recapture surveys (i.e. stock assessments) conducted every three years and from retention fisheries every year. Results showed that in the short-term (2-3 years after release) transplanted fish were growing extremely fast, with median growth rates of 11-14 cm/year. Interestingly, this rate of growth was much faster than comparable-sized resident sturgeon from either The Dalles Reservoir or below Bonneville Dam. The reasons for the rapid growth following transplantation are unknown. Eventually, growth rates slowed, and by 2002-2005 growth assumed a more reservoir-like rate.

Survival rates were estimated using multiple mark-recapture analysis (Program Mark). Survival was estimated from release to 1997, from 1997 to 2002, and from 2002 to 2005. Average annual survival was approximately 85% for each release group. This survival rate is similar to other published rates for resident fish of similar size in the lower Columbia River reservoirs.

Recapture data from stock assessments in all three reservoirs, as well as recovery data from fisheries, were used to assess the distribution (or emigration) of transplanted sturgeon. Approximately 5% of all recaptures occurred downstream of The Dalles Dam in Bonneville Reservoir, 94% remained in The Dalles Reservoir, and 1% occurred upstream in John Day Reservoir. These estimates of movement among reservoirs are similar to other published estimates of movement by resident sturgeon.

Fish transplanted into The Dalles Reservoir in 1994 and 1995 contributed to both the Treaty Indian commercial fishery and the non-Indian recreational fishery. A contribution to commercial harvest occurred in each year from 1998-2011, with estimates ranging from a low of 0.6% in 1998 to a high of 9.1% in 2006. Over the same period, annual contribution of transplants to recreational harvest in The Dalles Reservoir ranged from a low of 0% to a high of 7.2% in 2008.

Study results demonstrate that the transplant supplementation program was successful in meeting its stated goals, and that transplanted sturgeon can: 1) survive, grow and distribute similar to resident counterparts, 2) contribute to both commercial and recreational fisheries, and 3) eventually recruit to the spawning population. Advantages for this type of transplant supplementation program include instant augmentation of multiple year classes simultaneously, increase in upstream gene flow, immediacy and flexibility of actions, and maintenance of genetic diversity (by avoiding potential selective pressures of hatchery augmentation). The primary downside (or constraint) to this program is that it requires a robust donor population. In conclusion, the capture and relocation of white sturgeon could be considered among available options to mitigate for lost white sturgeon production in areas impacted by hydropower development in the Columbia River.



Introduction & Background:

What can we do immediately to supplement natural recruitment in impounded white sturgeon populations?

Transplant Supplementation

Introduction & Background:

'Trawl & Haul' Program

Introduction & Background:

'Trawl & Haul' Program

Long-term goals:

Determine the feasibility of using transplanted fish to:

1) mitigate for lost recruitment and passage by directly increasing white sturgeon biomass in the impounded reach

Introduction & Background:

'Trawl & Haul' Program

Long-term goals:

Determine the feasibility of using transplanted fish to:

1) mitigate for lost recruitment and passage by directly increasing white sturgeon biomass in the impounded reach
2) provide Treaty Indian harvest opportunities

Introduction & Background:

'Trawl & Haul' Program

Long-term goals:

Determine the feasibility of using transplanted fish to:

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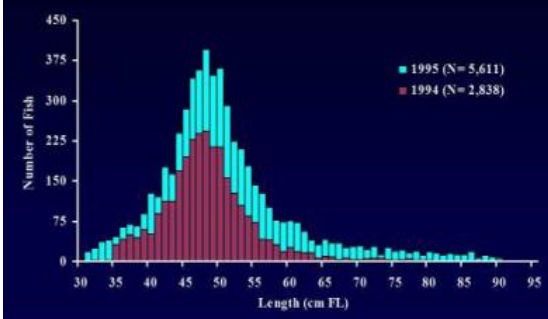
Methods: Capture/Transport/Release

Methods: Capture/transport/release



Methods: Recaptures

1) Stock Assessments

- large-scale mark-recapture studies
- 3 year rotation

2) Retention Fisheries

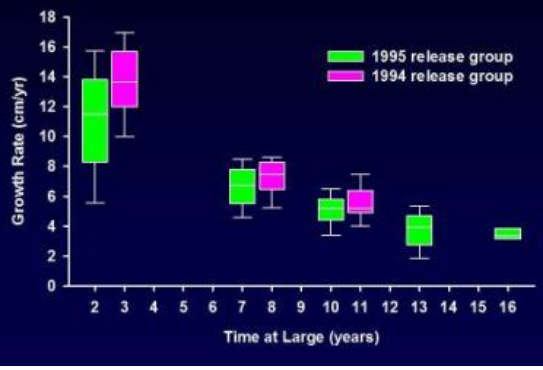
- annual sampling of both sport and commercial fisheries

Methods: Data analysis

Data from recaptured transplants were used to evaluate:

1. Growth
2. Survival
3. Distribution
4. Contribution to fisheries

Results: Growth



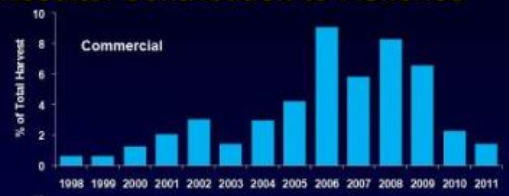
Results: Survival

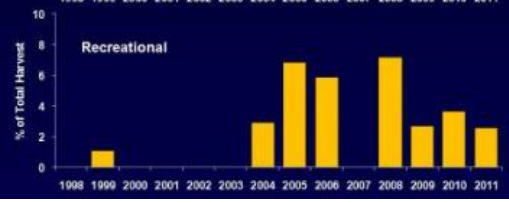
1994 Release Group		
Year	n	Avg Annual Survival
1994	2,838	--
1997	1,948	0.882
2002	874	0.863
2005	367	0.830
1995 Release Group		
Year	n	Avg Annual Survival
1995	5,611	--
1997	3,815	0.825
2002	2,088	0.868
2005	1,012	0.843

Results: Distribution

Recapture Reservoir	% of Recaps
Bonneville	5 %
The Dalles	94 %
John Day	1 %

Results: Contribution to Fisheries





Conclusions: Long-term Program Assessment

... So, was the program a success?

Did the program achieve its stated goals?

Conclusions: Long-term Program Assessment

Results demonstrate that transplanted white sturgeon can:

1) Survive, grow and distribute similar to resident counterparts
2) Contribute to both commercial and recreational fisheries
3) Eventually recruit to the spawning population

Conclusions: Long-term Program Assessment

Pros:

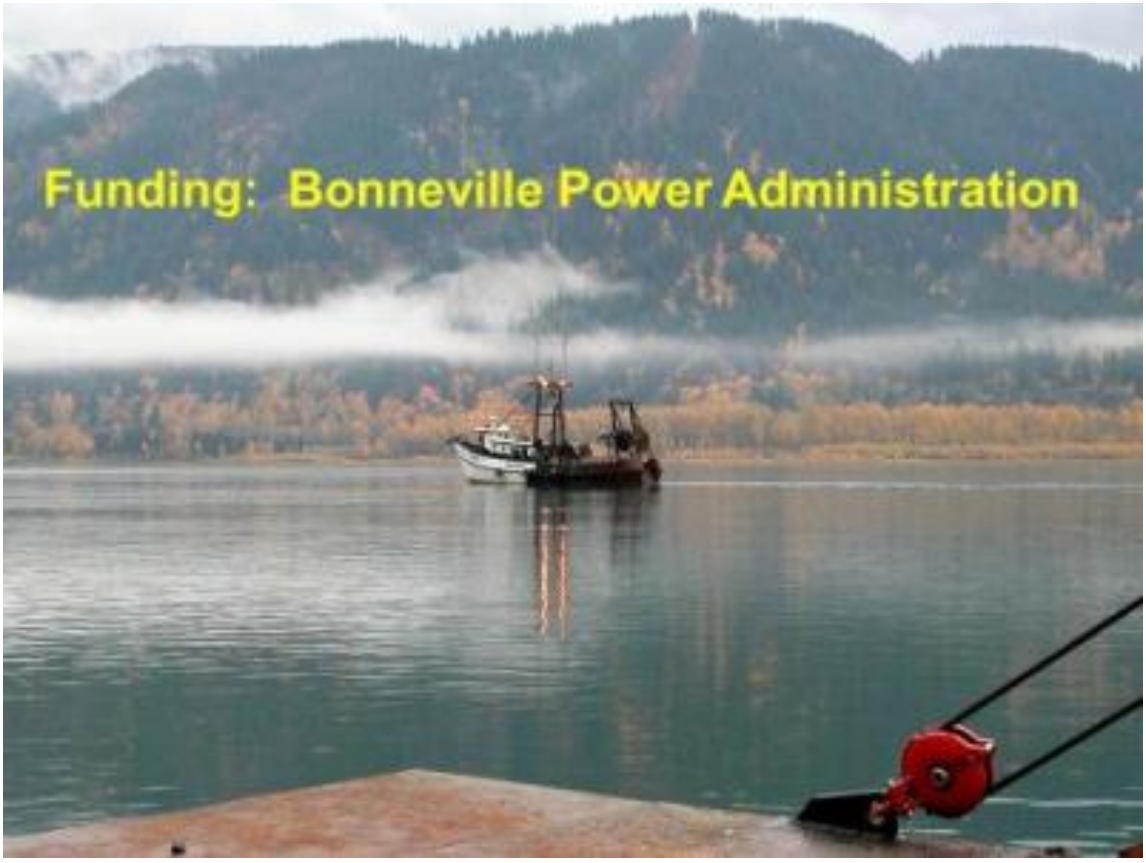
- Instantly augments several poor year classes
- Increases upstream gene flow
- Immediacy and flexibility of the action
- Maintains genetic diversity

Cons:

- Requires a robust donor population

Conclusions: Long-term Program Assessment

The capture and relocation of white sturgeon could be considered among available options to mitigate for lost white sturgeon production in areas impacted by hydropower development in the Columbia River



Other sturgeon passage observations

Recognizing that many of the participants in the room may have morsels of information on this subject from personal observations or second-hand knowledge, this discussion was an effort to capitalize on the collective expertise to draw out more pieces of the sturgeon passage puzzle. The following table represents a laundry list of feedback.

Table 4. White Sturgeon Observations associated with Columbia River hydro-electric facilities.

Statement
• Passage can occur with proper conditions
• 5,500 hatchery fish released in the mid-Columbia, only one seen downstream
• The PUDs have rarely seen sturgeon passing their dams

• Sturgeon info is being uploaded into PITagis.
  ○ ODFW uploaded 80,000 records; 200 detected by counters at dams
  ○ IDFG has loaded data from below Hells Canyon Dam
  ○ UCR is starting to load data
  ○ Data include both releases and recaptures
  ○ PITagis recapture data are designed for salmon

• NMFS is planning on putting a PIT tag detector at the mouth of the Snake River.
• One source of information might be old fyke net studies done at the dams. If there were sturgeon going through the turbines, they should have recorded it.
• NMFS did some suspended array tests downstream from Bonneville Dam and saw one sturgeon repeatedly
• Two (of 148 fish) of Mike Parsley's fish from The Dalles passed through 2 dams into the estuary; this provides an opportunity to get more info from movements
• Also looking to put detectors on spillway weir in Lower Granite Dam
• Maybe we can get better resolution cameras to determine what is going on downstream of turbines, i.e. whether really small sturgeon are going through turbines
• Sturgeon use fish ladders when shad are around
• Adult sturgeon have been observed in Priest Rapids when shad are around
• Some juveniles observed in Rocky Reach juvenile bypass system
• Some juveniles observed in dewatered navigation locks
• Sturgeon have been observed at Arrow lakes generating station, when it is turned off for maintenance
• How do we capitalize on behavior like draft tubes to figure out how to get more effective projects?
• 11 years of information on downstream passage through juvenile bypass facilities in the Snake River recently recovered
• No age-0 observed at John Day Dam

Sturgeon Passage Research: What can the experts tell us?

A number of researchers with experience in sturgeon passage in other areas were invited to share their expertise. Jason Thiem, a Ph.D. candidate at Carleton University in Ottawa presented his thesis research on upstream passage of adult lake sturgeon passage through a vertical slot fishway located in Quebec, Canada. Dr. Steve Amaral, a Senior Fisheries Research Biologist with Alden Research Laboratories Inc., discussed the development and status of downstream passage technologies for sturgeon. Dr. Joe Cech, Professor Emeritus at the University of California at Davis (UC Davis), presented information on success and stress response of adult white sturgeon to a "sturgeon compatible" fish ladder.

Lake Sturgeon Passage Evaluations in Quebec's Richelieu River

Jason Thiem presented on his research on passage success, passage rates and inter-individual differences in fishway use of adult lake sturgeon (*Acipenser fulvescens*) during passage through a vertical slot fishway located on the Richelieu River in Quebec, Canada. Spawning migrations of lake sturgeon have been impacted by dams which create barriers to migration; however, fishways installed to facilitate upstream passage past these barriers have generally been unsuccessful.

Migratory lake sturgeon (n=107, 939–1625 mm TL) were captured immediately downstream of the fishway, tagged with PIT tags and released into the fishway entrance. Volitional entry into the fishway occurred for most individuals (82%), however, only 30% successfully ascended the entire fishway and overall passage efficiency was just 36%. Sturgeon exhibited an ability to traverse the fishway quickly (minimum passage rate of 1.2 hrs), however successful passage rates were variable (6.2–75.4 hours from release).

Jason concluded that neither passage rate nor maximum distance of ascent was correlated with fish length or water temperature (11–20°C). Passage behavior was variable, in some cases resulting in cumulative upstream movements three times in excess of fishway length. Passage rates through the two turning basins were disproportionately longer compared with other basins; however, the activity of individuals within these and other locations remain unknown and represent an important knowledge gap. Collectively, data from this study contribute to understanding how fishways can be used to facilitate the upstream passage of imperiled sturgeon at dams.

Funding and support

Ressources naturelles et Faune Québec

Fédération canadienne de la faune / Canadian Wildlife Federation

Natural Resources Canada / Ressources naturelles Canada

Canada Fisheries and Oceans / Pêches et Océans

Carleton University – Canada's Capital University

NSERC CRSNG

NSERC HydroNet CRSNG

Canada Foundation for Innovation / Fondation canadienne pour l'innovation

Outline

- Lake sturgeon background
- Current knowledge on lake sturgeon passage
- My research (*so far*)

} Upstream passage focus

Lake sturgeon background

- 27 recognised sturgeon species spanning temperate Asia, Europe and North America
  - Spawn in freshwater
  - Migrate upstream to spawn
  - Most populations under threat from over exploitation and habitat degradation
- Global decline - 16 species listed as critically endangered and 2 species as endangered (IUCN 2010)
- Barriers to movement globally regarded as a key threatening process and limit recovery (Rochard et al. 1990)
  - >45,000 large dams worldwide (>15 m high)
  - Numerous small dams (96,000 in US, ~800,000 worldwide – Rosenberg et al. 2000)

Bemis & Kynard (1997)

Lake sturgeon background

- Lake sturgeon (*Acipenser fulvescens*)
  - Most widely distributed Nth Am sturgeon
  - Complete life cycle solely in freshwater
  - Migrate short (<200 km) distances to spawn
  - Suffered from overharvest and habitat modification
- Listed as 'least concern' (i.e. abundant and widely distributed by IUCN)
  - Many localised populations have severely declined
    - In Canada, SARA lists 8 populations as special concern, threatened or endangered

Lake sturgeon background

- Dams prevent access to upstream spawning grounds
- Potential for increased hydropower
  - Currently in Ontario >100 licence renewals or proposals
- Fishways are increasingly being viewed as THE solution
- Lake sturgeon also respond to artificial enhancement of spawning grounds (Dumont et al. 2011), and will spawn immediately below dams (Auer 1996)

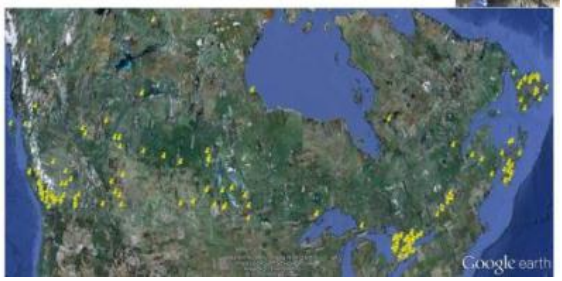
Aecom (2009)

Outline

- Lake sturgeon background
- Current knowledge on lake sturgeon passage
- My research (*so far*)

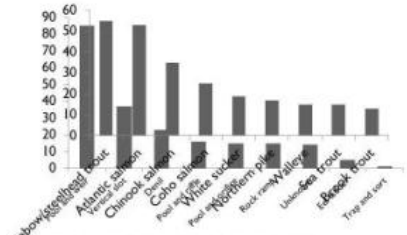
Location of fishways in Canada

- Hatry, C., *et al.* 2011. Development of a national fish passage database for Canada (CanFishPass): rationale, approach, utility, and potential applicability to other regions. *Canadian Water Resources Journal* 36:219-228



Fishways in Canada

- 211 fishways identified to date



- >70 species of fish have been observed using fishways in Canada

OMNR

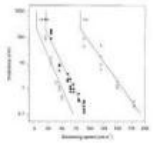
Sturgeon and fishways

- The problem: **sturgeon rarely use fishways** (CanFishPass n=1)
- What has been done to answer the '*why*'?

1. Laboratory swimming performance
2. Simulated fishways
3. Field studies

Laboratory swimming performance

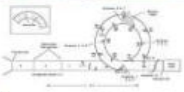
- Peake et al. 1997

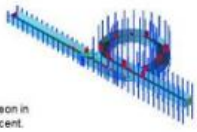


Peake, S., et al. (1997). Relating swimming performance of lake sturgeon, *Acipenser fulvescens*, to fishway design. CJFAS, 54:1361-1366

Simulated fishways

- Prototype side-baffle ladder inside a spiral flume
  - 38.3 m long, 1 m wide, 1 m high, 6% slope with a 1.92-m rise in elevation
  - Max. velocity1.8 m s^{-1}
  - 22 cultured lake sturgeon
  - Greater passage in spring than fall
  - Passage possible in <1 min
  - Swim speed 1.8-2.2 bl s^{-1}
  - Swim-Pause-Swim





Kynard et al. (2011) Passage and behaviour of cultured Lake Sturgeon in a prototype side-baffle fish ladder: I. Ladder hydraulics and fish ascent. JAI, 27 (Suppl. 2), 77–88

Field studies?

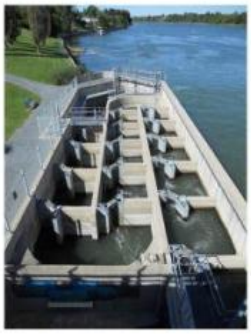
- Few reports of successful fishway passage by lake sturgeon
  - Bruch (2008) Lake sturgeon use of the Eureka dam fishway, upper Fox River, Wisconsin, USA *In* Rosenthal, Bronzi, Spezia, Poggioli (eds) Proceedings from the workshop: *Fish elevators: a tool for overcoming barriers for large migratory fish.* World Sturgeon Conservation Society, pp 88-94
- No evaluations

Outline

- Lake sturgeon background
- Current knowledge on lake sturgeon passage
- My research (*so far*)

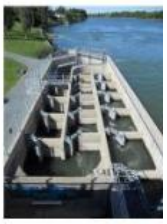
A successful sturgeon fishway?

A successful sturgeon fishway?



A successful sturgeon fishway?

- How do you measure success?
  - Attraction and passage efficiency
    - 90-100% (Lucas & Baras 2001)
  - 'Transparent' passage
    - No delays (Castro-Santos & Haro 2009)
- Electronic tagging
  - Calculate efficiency and passage delay
- Is the Vianney-Legendre fishway successful?



A successful sturgeon fishway?

- ~85 m long concrete structure and rises 2.65 m
- 0.6 m wide vertical slots (n=15)
- Large entrance and exit basins, 12 uniform rectangular basins (3.5 × 3 m) connected by two resting/turning basins with horizontal floors and curved walls (2.75 m radius)
- Uniform basins have a slope of 4.3%
- Passes ~1 $m^3 s^{-1}$ of water, with a capacity for an additional ~6.5 $m^3 s^{-1}$ attraction flow
  - Average annual discharge is 362 $m^3 s^{-1}$
- Vertical slot velocity 1.72 $m s^{-1}$

Objectives

Using lake sturgeon (*Acipenser fulvescens*) as a model, to determine:

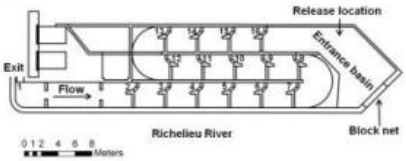
- Whether passage success is influenced by fish size or water temperature
- How sturgeon behave during fishway passage, and whether this behaviour is indicative of success or failure
- Whether passage duration is uniform throughout the fishway

Behaviour and passage success of upriver-migrating lake sturgeon *Acipenser fulvescens* in a vertical slot fishway on the Richelieu River, Quebec, Canada

Methods

Methods

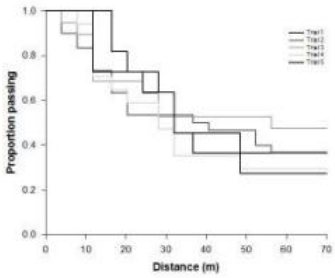
- Spatial location within the fishway
  - Date
  - Time
  - Fish ID
- Passage duration
- Passage success or failure
- Distance moved



Results

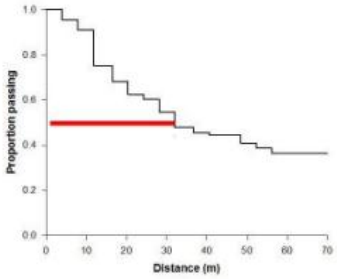
Trial	n	TL (mm)	Water temperature (°C)	Number successfully passed	Passage efficiency (%)
1	22	1033–1505	11.9 ± 0.3	4	36.4
2	34	984–1558	12.2 ± 0.1	11	36.7
3	21	990–1625	14.5 ± 0.1	9	47.4
4	19	939–1375	17.1 ± 0.1	5	29.4
5	11	982–1445	19.8 ± 0.0	3	27.3

Results

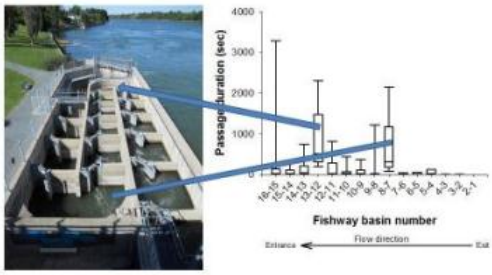


Results

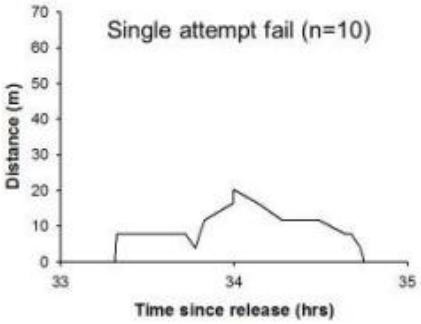
- Passage failure was most common in the downstream half of the fishway (52.3%)
- 14 sturgeon (15.9%) failed at the first turning basin



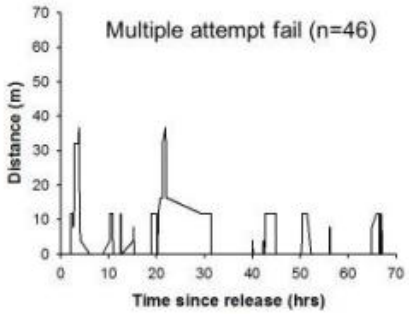
Results



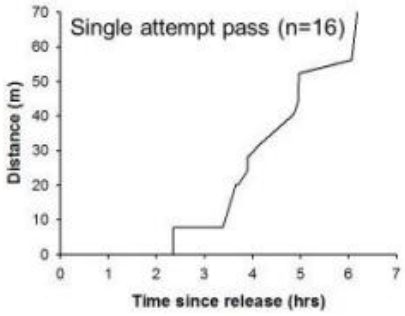
Results



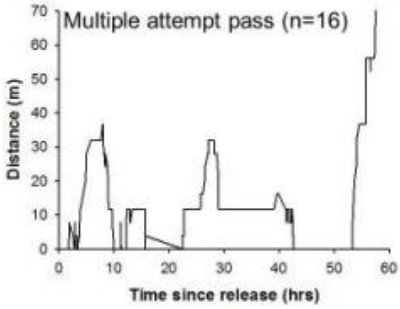
Results



Results



Results



Do all fish behave the same during passage?

Cumulative upstream distance moved (m)	Behaviour					
	No attempt	Probe	Unsuccessful passage		Successful passage	
			Single attempt	Multiple attempts	Single attempt	Multiple attempts
Mean			14.3	70.1	87.0	136.1
SE			4.3	7.4	4.8	12.9
Range			3.9–43.7	**11.7–194.3**	**70.5–139.2**	**74.4–222.7**
n	3	16	10	46	16	16

Discussion

- 41% passage efficiency for white sturgeon at Dalles Dam (Parsley et al. 2007)
- Failure at turns has been reported for other species (e.g., walleye, Bunt et al. 2000)
  - No comparable information for sturgeon
- The reasons for slow passage through turns remain unknown
  - Fatigue and subsequent rest (supported by Peake et al. 1997, Webber et al. 2007)
  - Confusing hydraulic conditions (lack of cues)

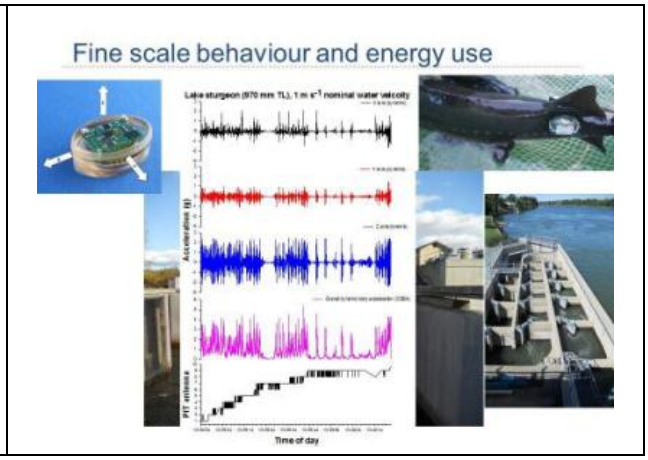
Balancing multi-species fishway use

Species	n	Number attempting	Number passed	Passage efficiency (%)	Passage duration (hrs)
white sucker	40	33	25	75.8	0.8–240.3
smallmouth bass	14	11	7	63.6	1.0–452.9
Atlantic salmon	13	8	8	100	0.4–25.1

Thiem *et al.* (In press) River Research and Applications

Synthesis

- Is the Vianney-Legendre fishway successful as a sturgeon and multispecies fishway?
  - Optimist
    - Some is better than none
  - Pessimist
    - Not even close to 90-100% (Lucas & Baras 2001) for most species
- Very little information with which to compare
- More questions than answers……..where to next?



Development and Status of Downstream Passage Technologies for Sturgeon

Dr. Steve Amaral began his presentation by stating that if he had given this talk 12 years ago, he would only have the title slide for his presentation and not much else, as no downstream passage research was conducted previously. Few fishways have been designed specifically for sturgeon and those installed for other species (e.g., salmonids) are often ineffective. Consequently, fish passage for sturgeon has been receiving more attention, with recent studies focusing on the development of design criteria for effectively and safely passing various sturgeon species up and downstream at hydro dams. In particular, several laboratory studies have investigated various guidance structure and bypass designs for reducing turbine entrainment. Additionally, some studies have examined the survival of sturgeon passing through turbines, including factors that affect mortality from blade strike.

Laboratory studies that have evaluated downstream passage technologies for sturgeons have generally focused on physical structures that prevent turbine entrainment and guide fish to a bypass. Flume tests conducted with bar racks and louvers angled at 15 and 45 degrees to approach flow and with 1 or 2-inch clear bar spacing demonstrated poor guidance for young-of-the-year lake sturgeon (mean lengths of about 130 to 150 mm), with bypass efficiencies of about 10 to 37% at approach flow velocities of 1 to 3 ft/s (EPRI 2001; Amaral et al. 2002). Larger lake and shortnose sturgeon (mean lengths of 345 and 319, respectively) also were tested with the 15 degree structures and exhibited much higher guidance rates (85 to 100%) compared to the smaller fish.

In a similar study, Kynard and Horgan (2001) reported guidance efficiencies of 58 to 80% for shortnose (275 mm mean length) and pallid sturgeon (216 mm mean length) exposed to a bar rack angled at 45 degrees to the flow with 1.5-inch clear bar spacing and an approach velocity of 1 ft/s. The lowest efficiencies for both species were observed during night testing. Guidance efficiencies were 96 to 100% for nighttime tests with a 20-degree louver array and 1.5 and 3.5-inch clear bar spacing. In general, the results of these laboratory studies suggest that guidance efficiencies of angled structures will be higher at lower velocities (1 to 2 ft/s) and that guidance

of sturgeon greater than 200 mm in length will be higher than it is for smaller (younger) fish. Also, structures angled at 20 degrees and less to the flow will provide better guidance than structures angled at 45 degrees. The results from a field study conducted with shortnose sturgeon and a 400-ft louver array angled 15 degrees to the flow with 2-inch clear spacing verified the laboratory results, demonstrating guidance efficiencies of 100% at approach velocities of about 1 to 2 ft/s (EPRI 2006).

More recently, a series of laboratory studies was conducted specifically for developing downstream passage design criteria for shortnose sturgeon at the Hadley Falls Hydroelectric Project on the Connecticut River in Massachusetts. These studies were conducted in large flume test facilities at the USGS Conte Anadromous Fish Research Center (Kynard et al. 2005, 2006) and Alden Research Laboratory, Inc. (Alden 2007, 2008, 2009; Hogan et al. 2008). The Conte Center studies evaluated exclusion for three age groups of shortnose sturgeon (yearlings less than 500 mm in length and juveniles and adults greater than 500 mm) exposed to a 20-ft wide bar rack structure with 2-inch clear spacing and approach velocities of 1 to 3 ft/s. Entrainment was 0% for all three life stages at a velocity of 1 ft/s and for the two older life stages at 2 and 3 ft/s. Combined entrainment and impingement rates increased with velocity for yearlings to about 16% at 2 ft/s and 74% at 3 ft/s. Tests conducted at Alden evaluated a similar bar rack structure (10 ft wide, 2.0 to 2.3 ft/s approach velocity, 2-inch clear spacing) to determine exclusion rates and bypass efficiencies associated with various bypass entrance sizes, locations, and entrance velocities. Bypass efficiencies ranged from 0 to 74% and increased with fish length (range tested: about 200 to 425 mm) and entrance velocity (range tested: 1 to 6.2 ft/s). The results of these studies indicate that a bar rack with 2-inch clear spacing and approach velocities of about 2 ft/s and less should effectively exclude most shortnose sturgeon from entrainment at Hadley Falls, and that a bypass with an entrance velocity of about 5 ft/s would be the most effective at attracting and passing fish downstream.

Extensive research examining injury and mortality of fish passing through hydro turbines has been conducted over the past 50 years. However, most studies have focused on anadromous salmonids and more typical riverine species, with very little information being collected for sturgeons. The only turbine passage survival study that has investigated injury and mortality to sturgeon was a pilot-scale laboratory evaluation conducted with the Alden fish-friendly turbine (Cook et al. 2003; Amaral et al. 2003). The results of this study demonstrated that white sturgeon (about 103 mm mean length) had immediate (1-hr) and total (96-hr) survival rates of 98.3 and 97.0%, respectively. These survival rates were statistically greater than those of teleost (boney) species that were also tested (alewife, smallmouth bass, rainbow trout, and coho salmon). It is likely that the cartilaginous skeleton and tough integument (with no scales) of white sturgeon contributed to less blade strike injury and mortality compared the other species, which all have true bones and are prone to scale loss when struck by turbine blades. These results were confirmed by a follow-up study that examined the primary parameters influencing blade strike mortality (i.e., fish length, leading edge thickness, and strike velocity) (EPRI 2008, 2011; Amaral et al. 2008, 2011). The results of blade strike testing demonstrated that white sturgeon struck with thinner leading edges at higher strike velocities suffered less mortality than trout tested with thicker blades and lower velocities.

Downstream passage is an important issue for fisheries managers attempting to protect and restore sturgeon populations throughout North America, however, information on effective

designs is limited. Angled bar racks and louvers have potential to effectively guide sturgeon away from turbines and to bypasses at hydro projects if slat spacing and approach velocities are selected based life stages targeted for protection (e.g., clear bar spacing of 2 inches or less and approach velocities no greater than 2 ft/s for young-of-year fish). Also, bypass entrance velocities should be about 5 ft/s or higher to ensure fish are attracted and retained if they approach and enter a bypass. Although angled structures typically provide better guidance to bypasses, existing intake racks perpendicular to approach flows may be sufficient for preventing turbine entrainment and allowing sturgeon to find a downstream bypass if the bar spacing and approach velocities are appropriate for the smallest fish expected to encounter the structure. However, because sturgeon are less susceptible to blade strike injury and mortality during turbine passage, total passage survival may be high (greater than 90%) even when large numbers of smaller fish may be susceptible to entrainment.

Adult White Sturgeon Passage & Associated Stress Responses in a Laboratory Flume

Dr. Joe Cech presented results of laboratory flume evaluations of passage success and stress response of adult white sturgeon in a "sturgeon compatible" fish ladder. Upstream passage (including spawning migrations) of anadromous fishes, particularly non-salmonid species such as sturgeon, is blocked or impeded by a variety of dams and weirs in the Sacramento-San Joaquin Watershed, California. Many existing passage structures are designed for salmonid species and are known to be ineffective for adult sturgeon passage due to these species' size, physiology, and primarily benthic cruising, "non-jumping" locomotion. The inaccessibility to suitable spawning grounds is likely a leading factor in the decline of many sturgeon populations. To assist in the design of a sturgeon-compatible fish ladder, the passage performance of wild-caught, adult white sturgeon (n = 121, 123-225 cm TL) was tested in a laboratory fishway section.

A system of vertical baffles was designed to dissipate flowing water kinetic energy as well as to provide guidance (i.e., via a straight, 0.61-m-wide slot between the baffle pairs) for upstream migration of sturgeon in a 24.4-m-long flume with a 4% increasing slope. Fish passage performance was examined in this flume under low and high tailwater treatments. The water velocity through the slots, between the baffles, ranged from 1.7 to 2.1 m/s. Successful attraction flows were >0.45 m/s, and peak, adult sturgeon swimming velocity when quickly ascending the flume was 2.57 m/s, through the slot, at the first of five baffle pairs. Percentages of uninjured fish reaching the upstream end of the flume in both the low (54%) and high (63%) tailwater treatments exceeded that of injured fish (13%) when tested in the low-tailwater treatment. The highest percentage of successful passage (63%) occurred with aligned passage slots, deeper tail pool depths, and with individuals in greater health.

Blood samples from cannulated fish (n = 4, mean TL: 172 cm) showed post-swimming peaks in mean hematocrit and plasma cortisol concentrations, compared with pre-swimming and (24-h) post-experiment levels. Hence, stress responses were generally not detectable 24 hours after the passage experiment had concluded. In addition, plasma pH and lactate concentration showed mean post-swimming decreases and increases respectively, indicating white muscle recruitment. Finally, mean plasma osmolality showed a transient increase associated with swimming in the flume, which was attributed to plasma water osmotically moving into the white muscle compartment with its presumed increase in lactate concentration. Importantly,

plasma osmolality did not decrease with swimming in the freshwater flume, which would have indicated an increased gill permeability to water, from severe stress.

Overall results from Dr. Cech's study showed that adult white sturgeon successfully ascended the sturgeon-compatible fishway and displayed burst-swimming-associated stress responses typical of many teleostean fishes, followed by complete recovery after 24 h.

Adult White Sturgeon Passage, and Associated Stress Responses, in a Laboratory Flume

Joe Cech,
Professor Emeritus of Fish Biology
Department of Wildlife, Fish, and Conservation Biology
University of California, Davis

White Sturgeon Distribution

Spawning Populations:

- Fraser River, BC
- Columbia River, WA
- Sacramento, Feather, San Joaquin rivers, CA

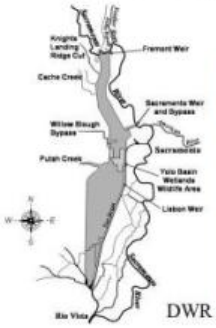
Land-locked populations

- Columbia River
- Shasta Reservoir

Life-History

- Late-maturing, long-lived
- Multiple spawners
  - females: 2 to 4 year intervals
  - males: 1 to 2 year intervals
- High fecundity (200,000 eggs/ 'average' female)
- Spawning migrations to freshwater rivers
- High river flows may stimulate increased number of spawners

Dams and weirs can block or divert fish from spawning habitat



Can sturgeon pass barriers, using ladders intended for salmonids?

Objectives

- Design and test a "sturgeon-compatible" fish ladder.
- Concentrate studies on a "random mid-section" of such a ladder.
- Measure hydraulic characteristics, adult white sturgeon passage success, and stress responses associated with passage.

Acipenser transmontanus

- 121 adult white sturgeon, over 3 y
- Means and ranges:
  - Mass: 23.2 kg (11.6 - 54.9)
  - FL: 1.36 m (1.22 - 2.25)
  - Est. age range: 12.6 - 29.1 y *
- Iteroparous:
  - Mature at 10 - 12 y
  - Spawning interval:
    - Females : 2 – 4 y
    - Males: 1 – 2 y
- High flows may stimulate spawning migrations up the Sacramento River.

*(Kohlhorst 1980, linear growth equation)

Sturgeon Collection

- Winter - Spring 2003 – 05
- San Francisco Bay Estuary (hook-and-line)
- Yolo Bypass toe drain (fyke trap)

Adult White Sturgeon Transport and Holding

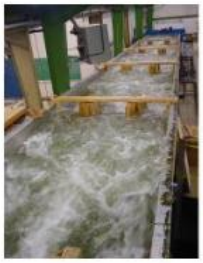
- Captured fish transported in specially designed fish transport trailer with water from capture site

- Fish held in 3.05-m and 3.66-m diameter tanks for 10 d (mean)

Five-baffle CSE Sturgeon Passage Structure (Flume) of Aluminum

- CSE = Contraction, Straightening, and Expansion
- 31-35 cfs (0.88-0.99 m^3/s) flow through
- 4% bed slope over 24.4-m length
- 81.3 cm & 91.4 cm tail-pool depth treatments

Five-baffle CSE Sturgeon Passage Structure



High tail-pool depth treatment ←

Low tail-pool depth treatment →

Sturgeon Experiments

- Sturgeon held for 3 d after capture before 1st experiment, and held 2 d between experiments.
- Examined for pre-test injury
- Given 30-min acclimation before 1-h experiment
- Fish only allowed two, prolonged (30 s) impingements, shortening experiment to <1 h duration.
- Two standard treatments, with low (S1) and high (S2) tail-pool water heights.

Passage/flume behavior

- Showed burst swimming (mean: < 1.6% of experiment time between the 1st and 5th baffle).
- Passage swimming depth related to tail-pool water depth:
  - Low depth: pass near/touching flume floor
  - High depth: pass near bottom to mid-water (pilot)
- Sturgeon can "anchor" position in velocities < 1.07m/s (straight flume), and they often searched for low-velocity refuges in tail pool.

Passage/flume behavior

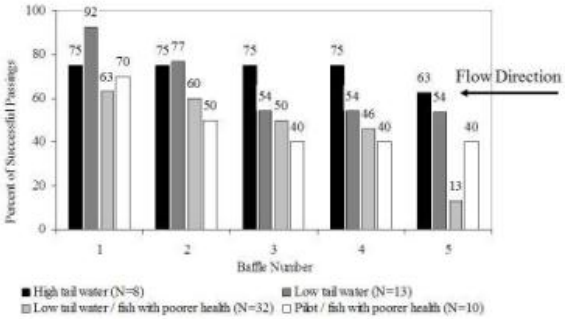
- Second passage, after failed 1st attempt, occurred in only 18% of fish.
- Incomplete experiments due to 2nd impingements:
  - Low tail-pool depth: 52%
  - High tail-pool depth: 10%
- Downstream movement after failed passage:
  - Low tail-pool depth: pass using + rheotaxis
  - High tail-pool depth: pass using – rheotaxis

1st Baffle Passage Video

Swimming Performance

- Attraction flows: ≥ 0.45 m/s (2003)
- Mean swimming velocity: 2.57 m/s (8.55 ft/s) at 1st baffle (Peak™ motion tracking software).
- Passage improved when baffle slots were aligned.
- Time to pass five baffles:
  - Low: 11-45 s
  - High: 45-131 s

Passage Efficiency

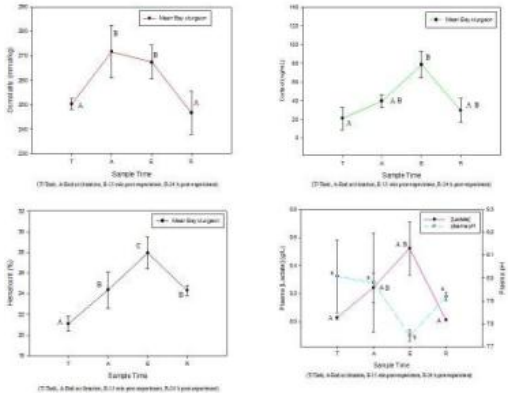


Passage Efficiency

- Pre-test health (HAI) condition and holding time significantly affected passage rates.
  (-) HAI p = 0.0002, GLM
  (+) holding time p = 0.01, GLM
- Fish with 13% passage rate (low tailpool depth); success increased to 40% when tested in a high tail pool depth treatment.
- Hydraulic conditions seem to have a greater effect on passage than the sturgeon's pre-test health.

Stress Response

- Physiological stress responses to passage were assessed by measuring blood hematocrit, and plasma pH, cortisol, osmolality, and lactate concentrations.
- Sampled via in-dwelling cannula in the caudal vein

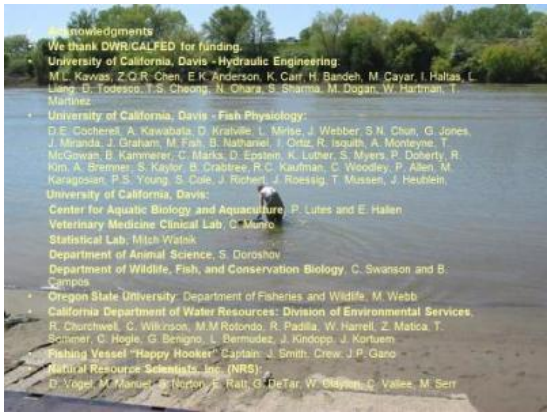


Stress Response Conclusions

- Sturgeon showed significant, and typical, physiological responses to handling and passage.
- Sturgeon apparently recruited (anaerobic) white muscle fibers to ascend the flume. These powerful bursts required the fish to rest, to clear accumulated H^+ and lactate$^-$ and to restore muscle glycogen stores.
- 24-h post-swimming exercise data often were not significantly different than pre-exercise levels.

Overall Conclusions

- Adult white sturgeon can negotiate a random mid-section of an CSE-type passage structure with peak water velocities up to 2.57 m/s, over 24.4 m at a 4% bed-slope.
- Sturgeon passage is improved with aligned passage slots and deeper tail pool depths (independent of water velocity), as is control of swimming direction.
- Future Research Questions:
  - How do sturgeon negotiate passage entrances and exits?
  - What role does substrate play in passage success?
  - How is reproduction influenced by "successful" passage?



Publications

- Webber, J.D., S.N. Chun, T.R. MacColl, L.T. Mirise, A. Kawabata, E.K. Anderson, T.S. Cheong, L. Kavvas, M.M. Rotondo, K.L. Hochgraf, R. Churchwell, and J.J. Cech, Jr. 2007. Upstream swimming performance of adult white sturgeon: effects of partial baffles and a ramp. Trans. Amer. Fish. Soc. 136:402-408.
- Cocherell, D.E., A. Kawabata, D.W. Kratville, S.A. Cocherell, R.C. Kaufman, E.K. Anderson, Z.Q. Chen, H. Bandeh, M.M. Rotondo, R. Padilla, R. Churchwell, M.L. Kavvas, and J.J. Cech, Jr. 2011. Passage performance and physiological stress response of adult white sturgeon ascending a laboratory fishway. J. Appl. Ichthyol. 27:327-334.

Evaluating Passage Risks and Benefits

The final round of presentations and discussions was designed to address the risks or unintended consequences of providing sturgeon passage. Dr. Henriette (Yetta) Jager, Oak Ridge National Laboratory, presented results of a theoretical modeling evaluation of effects of habitat fragmentation by dams on population persistence. Bernard Klatte, Chief of the Fisheries Section of the Operations Division of the U.S. Army Corps of Engineers (USACE, Corps), discussed the logistical and practical challenges to providing sturgeon passage at Columbia River dams. Mike Parsley (USGS) briefly spoke about the potential for unintended consequences of providing sturgeon passage.

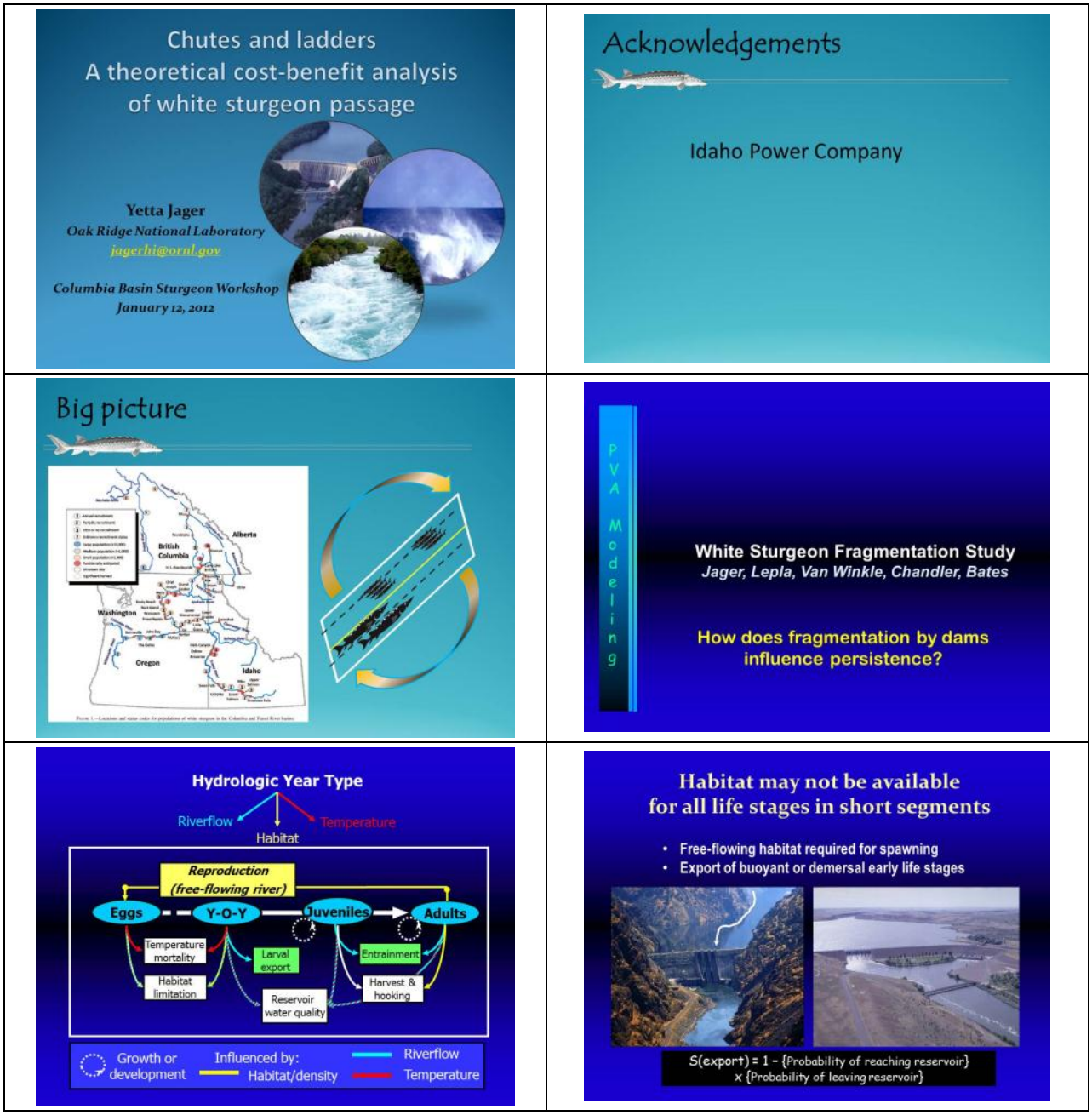
Chutes and Ladders: Modeling Snake River Passage Alternatives

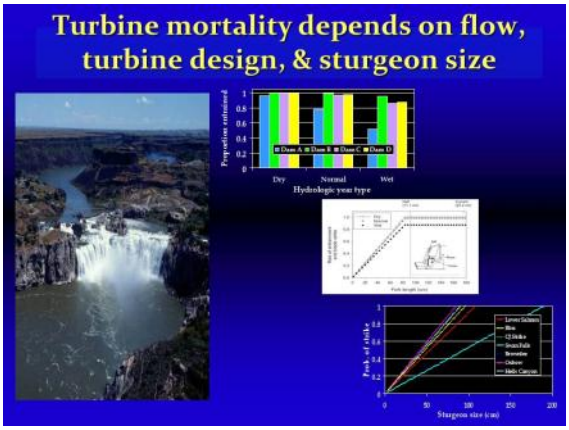
Dr. Yetta Jager of the ORNL presented on the results of her study looking at passage alternatives in the Snake River (funded by Idaho Power Company). They used an individual-based model to understand how habitat fragmentation by dams and alternative reconnection options might influence population persistence of white sturgeon. In addition to simulations specific to river segments and dams in the Snake River, theoretical scenarios were simulated to understand general patterns and improve the ability to generalize results.

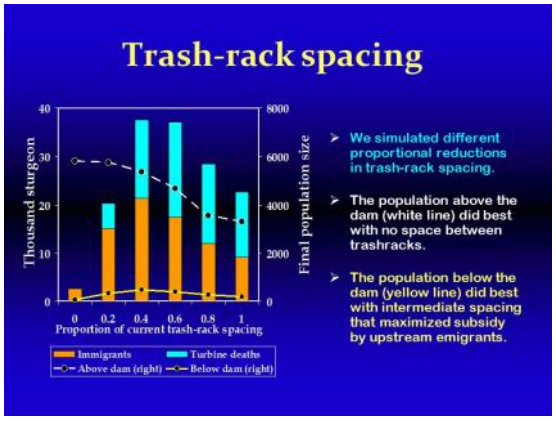
Experiments that varied the spacing between dams were simulated. These showed that closely spacing dams can turn a healthy source population into a metapopulation of sinks with significantly lower long-term viability. Export of larva in reaches lacking free-flowing habitat was the main mechanism for this. Reconnection scenarios were examined, including upstream passage and translocation, using realistic settings for trash rack spacing, which influences entrainment risk and risk of strike given entrainment. Both quantities are functions of fish length, with the highest risk for intermediate-sized fish that are still small enough to pass through trash racks but large enough to have a high risk of blade strike.

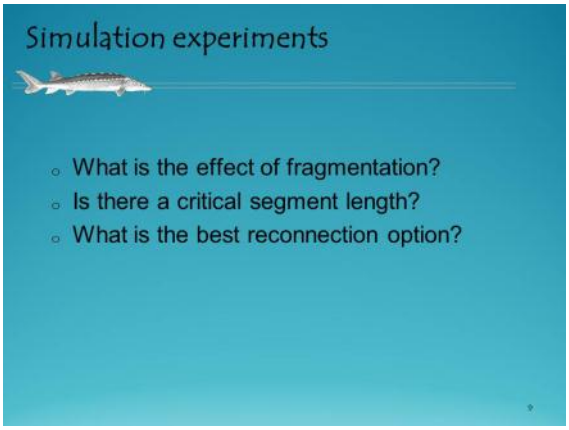
Results showed that the best reconnection option depended on the status of downstream and upstream segments. In general, upstream passage was not beneficial to the metapopulation alone. However, upstream passage combined with downstream passage or screening (narrower trash rack spacing) was beneficial. In the case of a long, source population upstream, screening was sometimes the best option to help maintain shorter downstream sink populations. Recommendations from the study include: 1) conduct translocation first to see if the overall metapopulation benefits, 2) monitor downstream population to assess overall

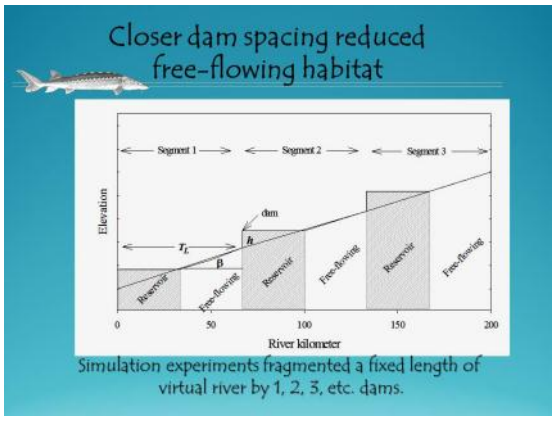
benefit, 3) use effort-based removals to conduct translocation. More recently, the Department of Energy (DOE) is funding efforts to optimize hydropower operations. Dr. Jager's work is currently focused on optimizing flows for salmon. However, we envision the sturgeon PVA model above could be used to conduct a basin-scale assessment of where, and what kind, of passage mitigation would lead to the best overall solution for the Columbia River basin.

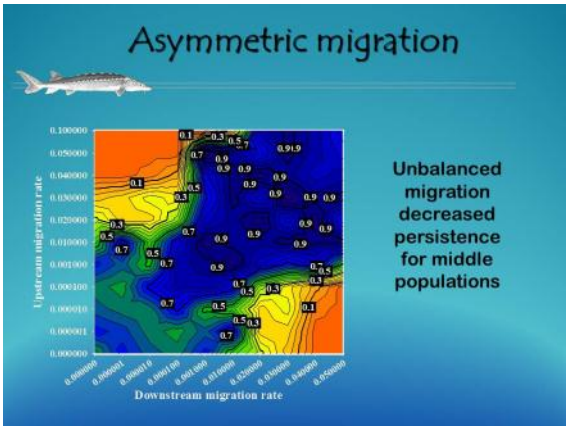


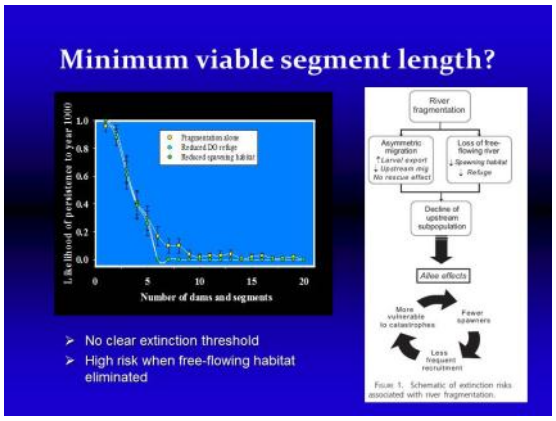

Turbine mortality depends on flow, turbine design, & sturgeon size
Proportion entrained
Dam A
Dam B
Dam C
Dam D
Dry
Normal
Wet
Hydrologic year type
Fork length (cm)
Fork of sturgeon
Sturgeon size (cm)

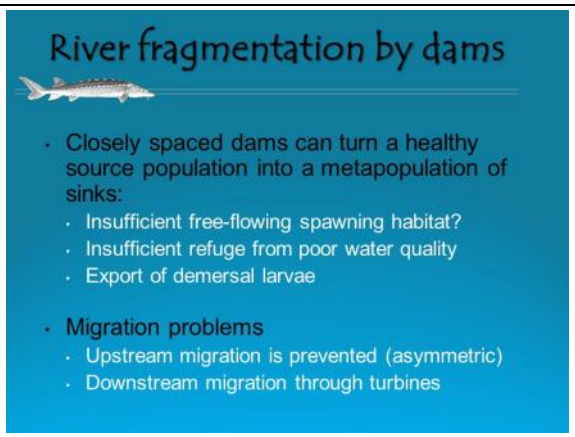

Trash-rack spacing
Thousand sturgeon
Final population size
Proportion of current trash-rack spacing
Immigrants
Turbine deaths
Above dam (right)
Below dam (right)
We simulated different proportional reductions in trash-rack spacing.
The population above the dam (white line) did best with no space between trashracks.
The population below the dam (yellow line) did best with intermediate spacing that maximized subsidy by upstream emigrants.

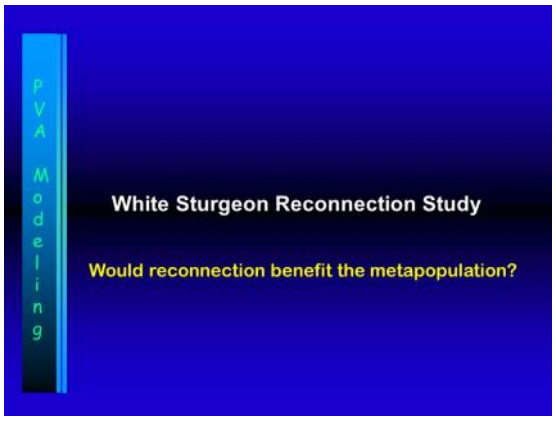

Simulation experiments
What is the effect of fragmentation?
Is there a critical segment length?
What is the best reconnection option?


Closer dam spacing reduced free-flowing habitat
Segment 1
Segment 2
Segment 3
Elevation
dam
Reservoir
Free-flowing
River kilometer
Simulation experiments fragmented a fixed length of virtual river by 1, 2, 3, etc. dams.


Asymmetric migration
Upstream migration rate
Downstream migration rate
Unbalanced migration decreased persistence for middle populations

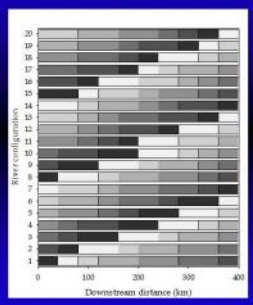

Minimum viable segment length?
Number of dams and segments
No clear extinction threshold
High risk when free-flowing habitat eliminated
River fragmentation
Decline of upstream subpopulation
Allee effects


River fragmentation by dams
Closely spaced dams can turn a healthy source population into a metapopulation of sinks:
Insufficient free-flowing spawning habitat?
Insufficient refuge from poor water quality
Export of demersal larvae
Migration problems
Upstream migration is prevented (asymmetric)
Downstream migration through turbines


PVA Modeling
White Sturgeon Reconnection Study
Would reconnection benefit the metapopulation?

Hypothetical river configurations

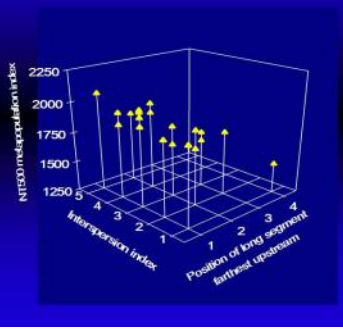
- Distinguish effects of
  - longitudinal position
  - river segment length
- Each configuration has 3 short and 3 long segments.
- Long segments have free-flowing habitat
- Extra segment removes boundary effects



Metapopulation status

- NT500 is an index of demographic status.
  - Sum of final population sizes, each truncated at 500.
  - NT500-7 includes the extra, 7th, segment.
- Genetic indices:
  - Gst is Nei's index of genetic subdivision – low values=more homogenous
  - Nall, a measure of introgression, is the average number of alien alleles (initially private to another population) in the final metapopulation.

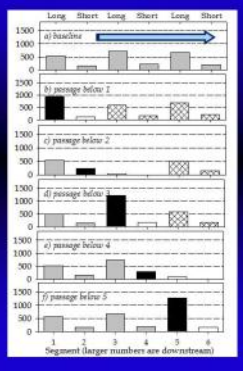
Best configurations: upstream long & high interspersion



Reconnection options

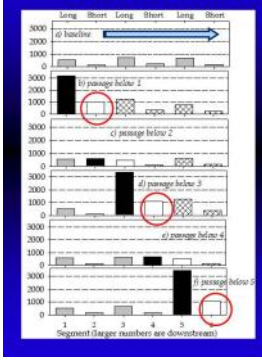
- Translocation
- Upstream passage with
  - Current trashrack spacing (wide)
  - Halved trashrack spacing (narrow)
  - Downstream passage

Upstream passage alone



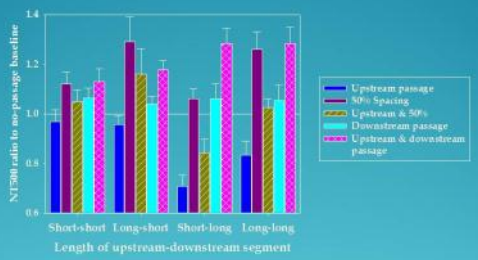
- Simulated the effects of providing upstream passage for river configuration #15.
- Donor populations below the dam with passage (open bars) decreased.
- Recipient populations above the dam (black) increased.
- No "trickle-down" benefits

Up & downstream passage combined



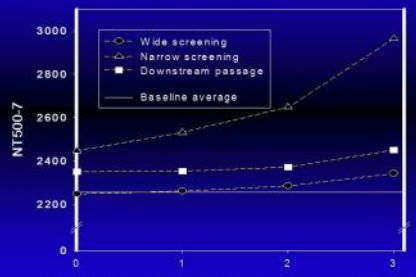
- How does providing downstream passage affect things?
- Donor populations below the dam with passage (open bars) decreased.
- Recipient populations above the dam (black) increased, especially if the segment was long.
- Now, we see trickle-down benefits when recipient segment is long.

Minimize risk in both directions



Translocation with narrow screening

Upstream recipient supports downstream sink



Conclusions

- Upstream passage provided a net demographic benefit:
  - When combined with reduced entrainment mortality
  - When upstream segment was long, downstream short
- Combining two segments (up and downstream passage) was best when the downstream segment was long.
- Screening was very effective alone or combined with upstream passage, especially for long river segments above short segments.

Take-home messages

- Best option depends on configuration
- Low risk of entrainment mortality is key
- Use translocation to evaluate effectiveness
- Evaluate effectiveness by monitoring downstream donor population
- Remove translocees by setting effort, not quota

DOE Waterpower

DOE-funded Research
Fish Passage (Cada)
Environmental Basinwide Optimization

HI Jager, Brennan Smith, Glenn Cada (ORNL)
John Hayse (ANL), Ken Ham (PNNL)

Glenn Cada

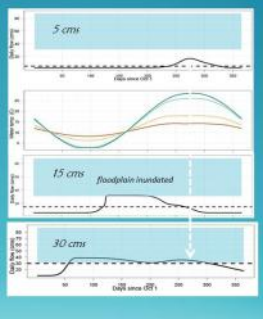
- Cada, G.F., J.M. Loar, L. Garrison, R.K. Fisher, and D. Neitzel. 2006. Efforts to reduce mortality to hydroelectric turbine-passed fish: Locating and quantifying damaging shear stresses. Environmental Management 37(6):898-906.
- Cada, G.F. 2001. The development of advanced hydroelectric turbines to improve fish passage survival. Fisheries 26(9):14-23.
- Cada, G.F. 1997. Shaken, not stirred: The recipe for a fish-friendly turbine. p. 374-382 IN Waterpower '97. Proceedings of an Intern'l Conference & Exposition on Hydropower. American Society of Civil Engineers, New York, NY. 2267 p.
- Cada, G.F. 1998. Fish passage mitigation at hydroelectric power projects in the US. p. 208-219 IN Fish Migration and Fish Bypasses. M. Jungwirth, S. Schmutz, and S. Weiss (eds.). Fishing News Books, Blackwell Science, Inc. Malden, MA. 438 p.
- Cada, G.F. 1998. Better science supports fish-friendly turbine designs. Hydro Review XVII (6): 52-61.

Francfort *et al.* 1994. Environmental Mitigation at Hydroelectric Projects. Volume II. Benefits and Costs of Fish Passage and Protection. DOE/ID-10360.

- Nationally, 9.5% of 1825 FERC-regulated hydropower projects had upstream passage mitigation measures
- Fish ladders were the most common methods (62%)
- Of 12 case studies of upstream passage:
  - 20-year total costs ranged from $75,000 to $46.1 million
  - Costs per kilowatt-hour ranged from 0.05 to 10.6 mills
  - Six were successful at meeting stated goals for fish passage (the others were not monitored or extenuating factors reduced effectiveness or monitoring)
- Recent NEPA guidance from the CEQ requires monitoring:
  - *"Agencies should not commit to mitigation unless they have sufficient legal authorities and expect there will be necessary resources available to perform or ensure the performance of the mitigation"*

Environmental optimization

- Add fish objectives
- Maximize salmon & energy production
- Seasonal flow releases (floodplain inundation)



Basin-scale decision making

Kuby et al. 2005

- Where are the most effective and beneficial places to provide passage and screening?

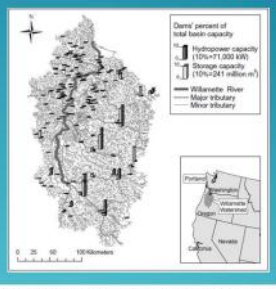
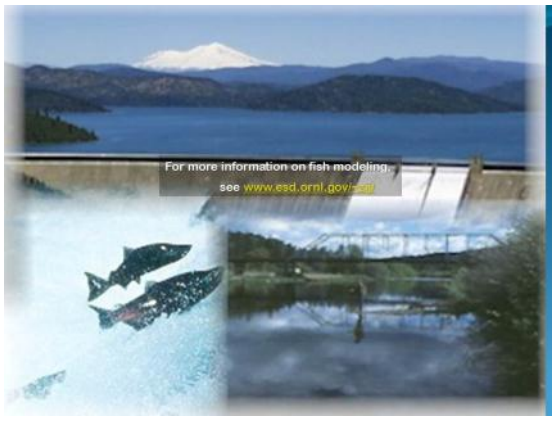
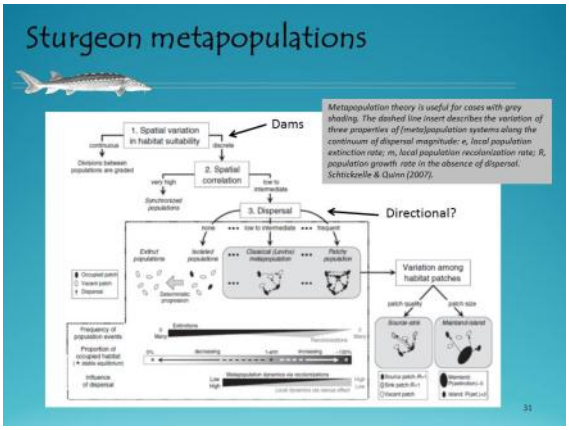
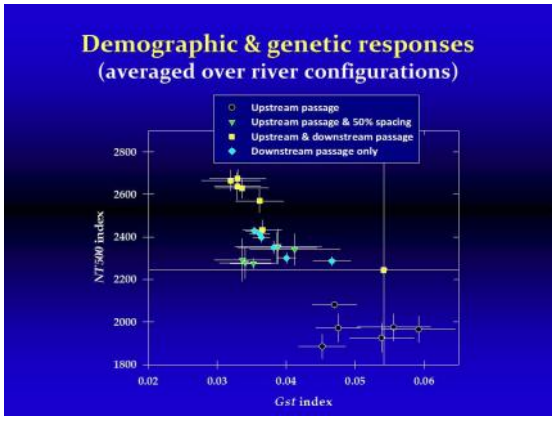


Fig. 1. Hydropower and water-storage capacities of dams in the Willamette River basin, as a percent of the basin's total capacity. Note that the largest dams tend to be located far upstream, without large drainage areas or many other dams further upstream. The stream network has a fairly uniform drainage density, which justifies the use of drainage area as a reasonably proportional proxy for total stream-reach length. The inset map shows location of Willamette watershed study area.







Challenges in Considering Sturgeon Passage in the Columbia River Basin

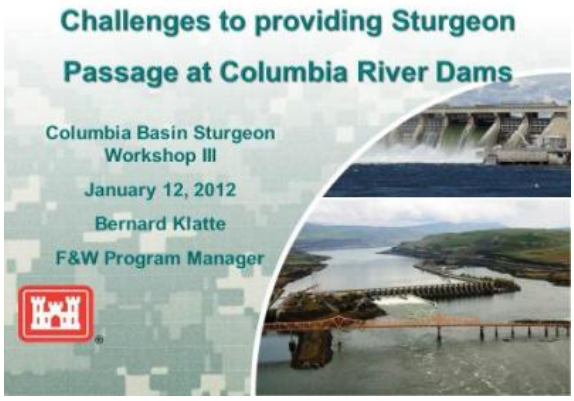
Bernard Klatte of the USACE gave a presentation on the challenges to providing sturgeon passage at Columbia River dams. The primary challenge to implementing any sturgeon passage actions is funding. All sturgeon related work competes with ESA-mandated species (salmon) as well as Tribal Fish Accords lamprey passage operations and maintenance, and the budget has been declining. Currently, the lion's share of the funding is appropriated to species listed under the ESA as well as the Corps hatchery mitigation program.

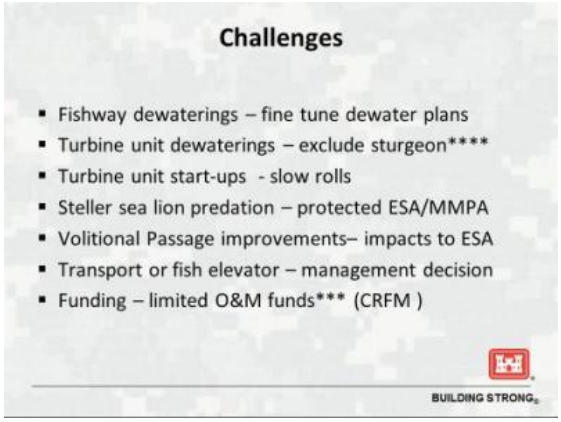
Other challenges and potential impacts to sturgeon include fishway dewaterings, turbine unit maintenance and dewatering, turbine unit start-ups, Steller sea lion predation, and poor volitional passage. Fishway dewaterings are coincident with the increasing presence of Steller sea lions in the Bonneville Dam tailrace. Recently, higher numbers of sturgeon have been documented in the fishways presumably due to predator avoidance. The regional forum team for fish passage operations and maintenance has established protocols to try to minimize impacts to sturgeon when performing routine maintenance such as fishway dewaterings. There isn't much that can be done about ESA-protected Steller sea lion predation at this point except non-lethal hazing. Sturgeon encounters have increased during turbine unit dewaterings as well, with one recent case of several hundred fish. There are stoplogs to exclude sturgeon, but it takes hours to install them using a crane. The USACE is looking at different options to reduce impacts to sturgeon like exclusion grating.

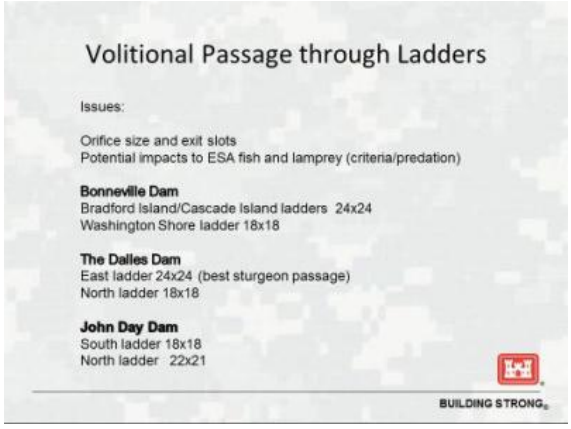
Regarding turbine unit start-ups, Bonneville powerhouse I has digital governors that automatically do slow roll turbine start-ups, but powerhouse II does not. Without digital governors, it is a manual process to implement a slow roll start procedure that is labor intensive and has a high potential for error. The long-term plan is to add digital governors, which is one passage-related measure that might reasonably be pursued. The slow roll start-up procedure is currently done manually at The Dalles Dam, which hasn't experienced the same problems. The USACE is planning on installing digital governors at The Dalles Dam over the next 2 years. Any future volitional passage improvements would have to consider potential impacts to ESA listed salmon and lamprey (criteria/predation). For consideration, Bernard presented the current orifice sizes for the existing fish ladders.

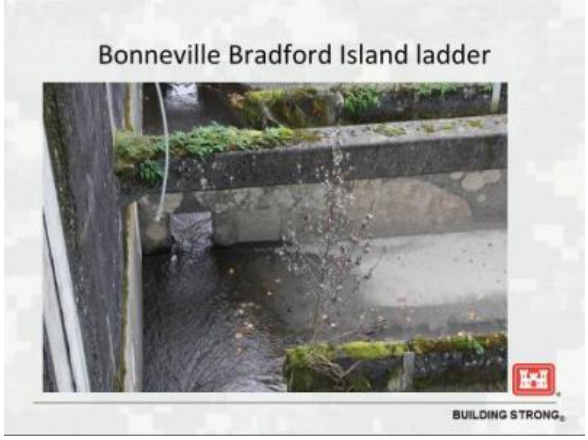
Mr. Klatte also highlighted a few potential sturgeon passage opportunities. Firstly, there are non-volitional options including fish ladders, trap and transport – a good opportunity to move fish if deemed to be appropriate. Secondly, there are fish elevators present at Bonneville and

The Dalles Dams that could be rehabilitated and resurrected if deemed appropriate. Thirdly, there is potential to consider sturgeon passage in future ladder designs and planned modifications. The Bradford Island fish ladder at Bonneville Dam is almost 75 years old and in need of major rehabilitation, which might provide an opportunity for re-engineering at some point. Additionally, the ladder at John Day Dam is currently being improved for salmon and lamprey passage. Any future redesigns would need to consider slope, velocities, exit configurations and minimize any impacts to other fish species. Lastly, funding is an issue but one possibility may be available through a future Water Resources Development Act of Congress.

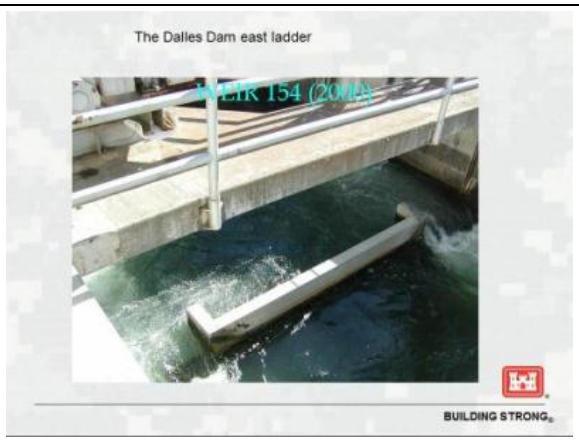


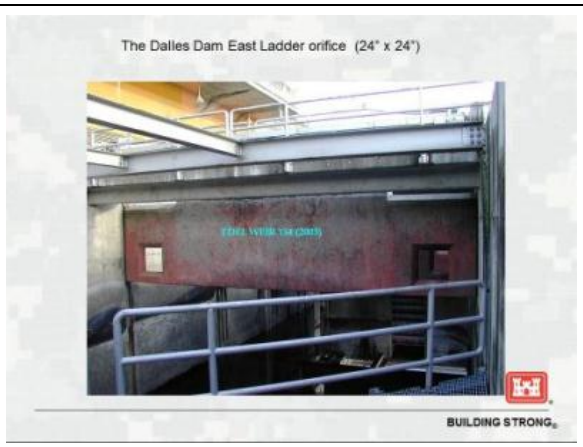


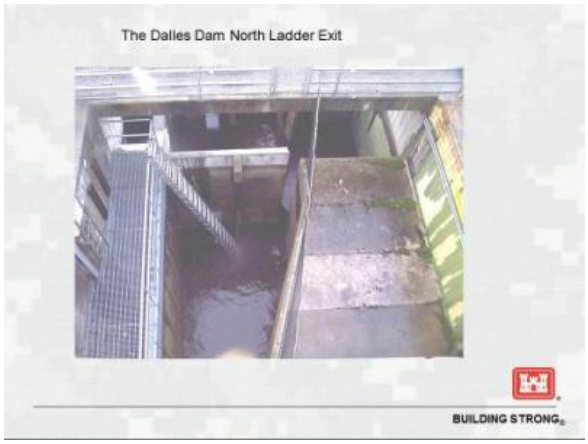


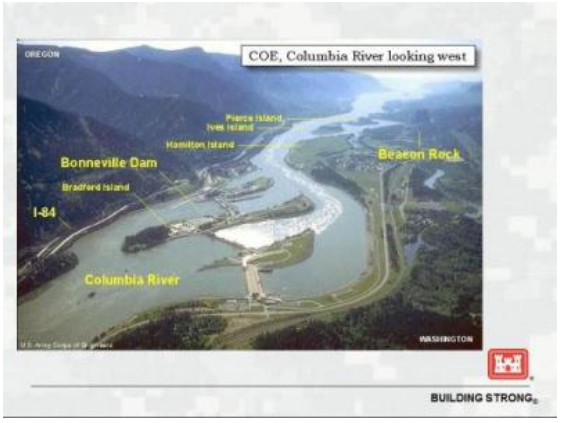


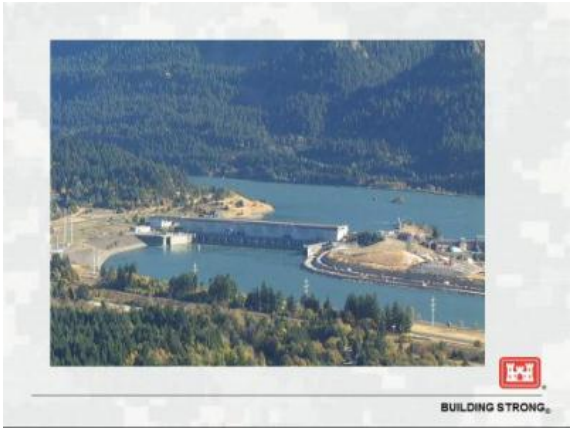
Upper BI ladder
BUILDING STRONG

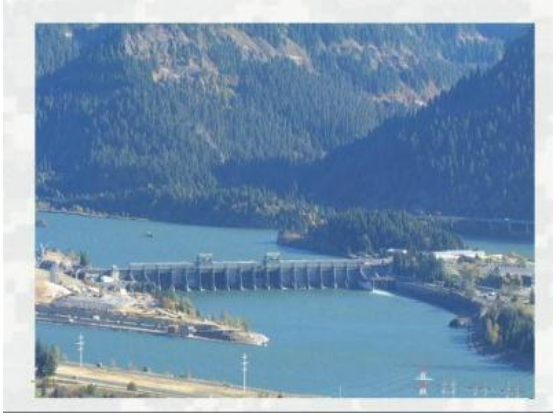

The Dalles Dam east ladder
BUILDING STRONG

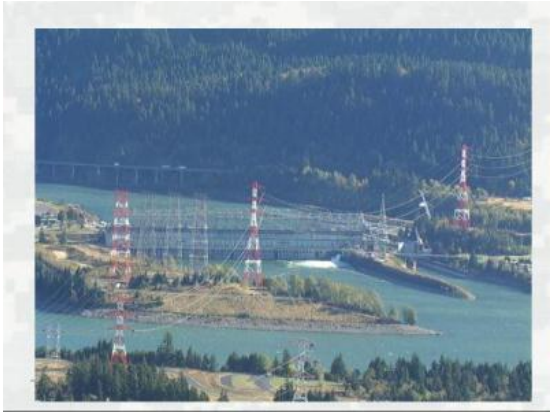

The Dalles Dam East Ladder orifice (24" x 24")
BUILDING STRONG

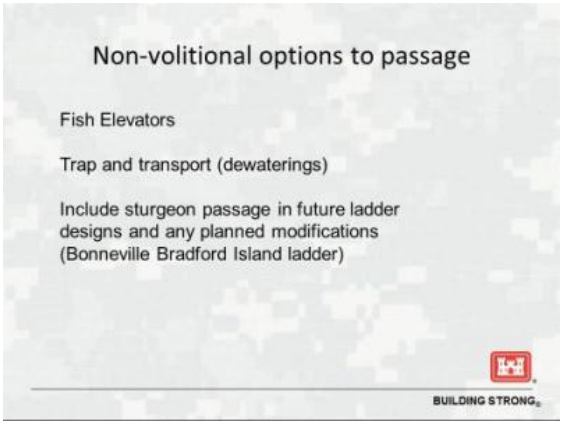

The Dalles Dam North Ladder Exit
BUILDING STRONG

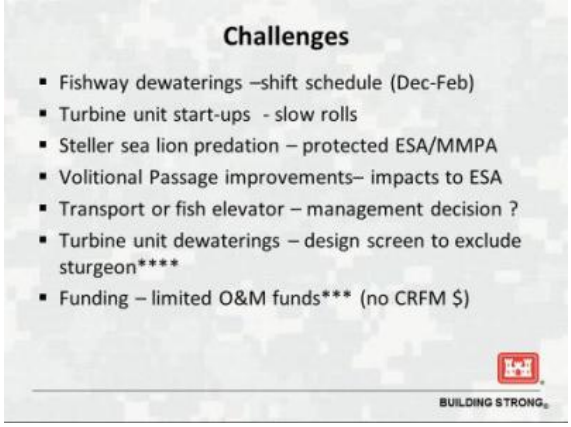

OREGON
COE, Columbia River looking west
Pierce Island
Ives Island
Hamilton Island
Bonneville Dam
Beacon Rock
Bradford Island
I-84
Columbia River
WASHINGTON
BUILDING STRONG


BUILDING STRONG





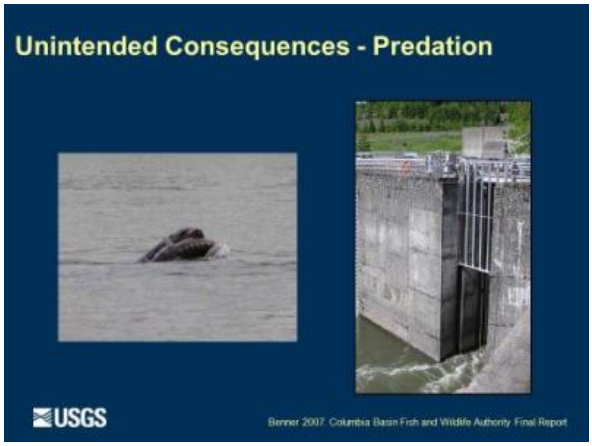


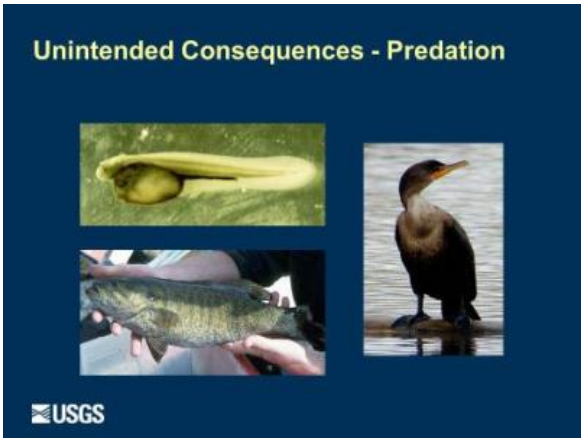


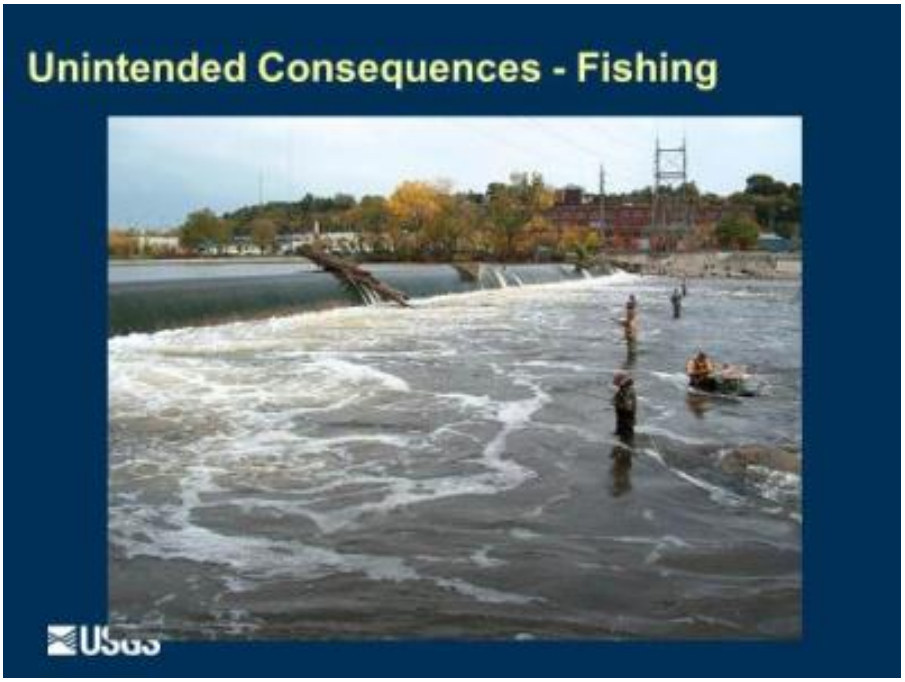
Unintended consequences of providing passage

Mike Parsley began his brief presentation by highlighting several unintended consequences of improving upstream and downstream passage that he and Dr. Rob McLoughlin discussed at a recent Great Lakes lake sturgeon passage workshop. The topics included increased potential for expansion of the range of invasive species, increased spread of diseases, increased predation, and the potential for elevated mortality due to fishing or poaching, though Mike admitted that some of these consequences may be more applicable to the Great Lakes than to the Columbia River. However, he remarked that his role here was to remind participants to be cognizant of unintended consequences.

The potential for increased predation is a concern for both juveniles and adults; enhancement upstream or downstream passage may allow sturgeon to move to areas with greater risk of predation from native and non-native predators. Mortality associated with increased fishing or poaching can be an unintended consequence of moving sturgeon to a location where the fishing regulations or enforcement are less strict. Bycatch of sturgeon by non-sturgeon anglers or increased catches of juvenile and over-legal sized fish may also result in hooking mortality. The goals of increasing passage opportunities include increasing overall population productivity and not just achieving a redistribution of fish. Thus, fishery managers considering opportunities to increase sturgeon movements among river reaches should assess the risk of unintended consequences to the greater population of sturgeon and other riverine biota.


Unintended Consequences - Predation
USGS
Benner 2007. Columbia Basin Fish and Wildlife Authority Final Report


Unintended Consequences - Predation
USGS


Unintended Consequences - Fishing
USGS

Facilitated Work Session – Sturgeon Passage

This session was intended to facilitate synthesis of what we currently know about sturgeon passage, opportunities and constraints to implementing sturgeon passage improvements among lower mainstem dams, critical unknowns and potential assessments, experimental and adaptive approaches for implementation and monitoring, and potential action items and next steps. The desired outcome of this work session was to provide direction to the Council and the ISRP on how best to address sturgeon passage issues.

For this final work session, the participants were divided into groups that were intended to include expertise from a broad geographic distribution and management diversity (to the extent possible). Each group was provided with a note taker who was responsible for facilitating the breakout group discussion as well as capturing the salient discussion points.

Participants were asked to respond to the following questions:

1. **What else do you know about sturgeon passage?**
2. **What are the pros, cons, and tradeoffs?**
3. **What do we do next?**

At the end of an allotted time, a representative from each group was asked to present their responses and supporting rationale for each question. The key points from the breakout group discussions and additional approaches that were identified by the larger group are summarized in the following pages. Participants then engaged in a facilitated discussion of what they thought the next steps should be. In an effort to reach consensus, facilitator Alison Squier asked several follow up questions, which included: 1) Are there so many unknowns right now that we are reluctant to pursue passage right now? 2) Might there be unique cases where passage might make sense? 3) How many would support moving fish but not employing a permanent passage structure? 4) How many are ready to advocate for passage based on what we know now? Although the available time was not sufficient establish a consensus, participants provided reasonably clear direction on the next steps they would like to see occur.

Question 1. What else do you know about sturgeon passage?

This topic was designed to draw out any additional information and ideas from the expertise in the room. The responses were divided into three categories for organizational purposes: observations, ideas, and unknowns (Table 5). While this session generated a laundry list of items, a lot of the ensuing discussion was centered on the unknowns. One of the common themes was the uncertainty associated with sturgeon behavior. There are still many aspects to learn surrounding movement and behavior of white sturgeon that could have implications for passage. For instance, why do we see movements up to dams? Would sturgeon continue pass this point or perhaps they are there for other reasons? Do we know everything that we need to know about migratory behaviors before embarking on passage efforts? One example of our lack of understanding of sturgeon behavior was the “sturgeon ball” at the base of Bonneville Dam.

Table 5. Observations, ideas, and questions about sturgeon passage.

Observations
• We know there are no protocols for sturgeon passage in the Columbia basin.
• Volitional vs. artificial passage: the objective is important. We can pass artificially.
• Swim performance is greater than previously thought
• Predators might be changing sturgeon-dam interaction dynamics.
• Passage is important for genetic integrity
• In the winter during the dewatering season there were many sturgeon
• In the fall, sturgeon move upstream to the base of Bonneville Dam as they feed on migratory species. Although sturgeon cannot follow migratory runs further upsteam, they can wait and use habitats around the dam and then take advantage of the returning runs to feed on out-migrants
• There are still many aspects to learn surrounding movement and behavior of white sturgeon that could have implications for passage.
• Pallids and shovelnose sturgeon like eddies and velocity refuges.
• 24" orifice in the lab study is same as The Dalles fishway
• Idaho Power does slow roll turbine start up at 1 project
• At least above Bonneville, there is no evidence of directed migration upstream for spawning
• Within a reservoir spawning migrating behavior occurs in tail races
Ideas
• Sometimes movement is cued by flow. We might consider using varying flows in ladders to keep sturgeon moving through them.
• Potential to catch fish in juvenile bypass facilities; an opportunity to PIT tag.
• Have attraction flows at locks and lifts to increase efficiency.
• The bottom line is we need a better understanding of movement and behavior (perhaps telemetry studies) to obtain a better sense of what sturgeon are using, why they're using it, when they're using it, which then determines whether or not passage would meet that need.
• Building passage around dams might have larger success.
Unknowns
• Sturgeon migratory behaviors
• Is the Fish Passage Center tracking sturgeon?
• Do we know about natural sturgeon staging areas?
• Is passage that critical of an issue?
• Why do we see movements up to dams?
• Would sturgeon continue pass this point or perhaps they are there for other reasons?
• Winter aggregations – new or forever? Related or aggravated for predation?

Question 2. What are the pros, cons, and tradeoffs?

Unlike question 1 which generated a broad suite of information, most of the break out groups identified similar benefits, risks, and tradeoffs to providing sturgeon passage. The most commonly cited benefits included gene flow, habitat connectivity, maximizing productivity, and increased harvest opportunity. However, the list of risks contained some strong counterpoints mostly related to funding, unknowns and uncertainties, and to increased management complexity. Overall, the group had more cons for passage than pros, not so much about passage in of itself, but more along the lines of uncertainty and poor understanding of sturgeon movement and behavior. The group recognized that funding would be the biggest trade off to implementing sturgeon passage projects with the added concern that funding would only be available at the expense of another program.

Table 6. Pros, cons, and tradeoffs to providing sturgeon passage.

Pros
• **Gene flow/ genetic integrity/ maintaining genetic diversity**
• **Increased harvest opportunity**
• **Maximizing overall productivity of the river**
• **Increased production**

• **Habitat connectivity**
  ○ **Seeding underutilized habitat**
  ○ **Allow fish to migrate to better habitat**

• **Access to the ocean**
• **Economic benefits**
• **Aiding resilience and diversity for overcoming some potential catastrophe**
• **Escape from predators**
Cons
• **Costs and funding availability**
• **Many unknowns**
• **Uncertainty- probably won't get it right the first time**
• **Genetic concerns from hatchery fish interaction if passage is provided**
• **Dashed expectations; it doesn't pay to move fish up to areas where recruitment is broken**
• **Management complexity**
• **Disease**
• **Access/exposure to predators**
• **The limiting factors are in certain areas may be unknown; i.e., need to have suitable habitat in reservoirs before restoring access**
• **Unrestricted passage could impact downstream populations**
• **Unintended consequences for other species, listed and non**
• **Injury during passage**
• **Given that we will always have dams and partial passage, actions may not be effective**
Trade offs
• **Limited money – tradeoffs with other program areas in completion**

• **Passage versus habitat enhancement or stock supplementation**
• **Risk to donor stock**
• **May not be the most cost-effective alternative**
• **Cumulative risk of passage itself, particularly for those fish moving multiple times**
• **Unintended consequences of free-ranging fish**
• **Translocation instead of building a structure**
• **It may not be a value-added action without habitat and other corrective actions**

Question 3. What do we do next?

This question was designed to draw out what the next two or three things that we should do next are, given what we currently know about sturgeon passage. There was general agreement among participants that before any passage measures are pursued, the overall objectives need to be clearly defined. There are currently so many unknowns that many of the participants are reluctant to pursue passage in earnest right now. This underscores the need for further research particularly in the areas of sturgeon behavior. Many of the prepared presentations from today's technical sessions elucidated opportunistic areas of potential value that have been previously overlooked or that participants were unaware of. Participants requested that a list of these opportunities (i.e., opportunities to tag fish during routine dam-related O&M procedures, developing sturgeon criteria for consideration in refurbishing existing fish passage structures, reviewing protocols used to prevent fish stranding and mortality at dams) be compiled for consideration, as most of these ideas were new information that needed to be processed and considered before implementing any new actions.

Table 7. Ideas on how best to approach sturgeon passage.

Ideas
• **Establish clear goals and objectives**
• **Identify improvements that can be made in existing fish structures & operations**
• **Analyze whether passage should be provided volitionally or artificially**

• **Gain a better understanding of:**
  ○ **Dam mortality**
  ○ **Behavior at dams**
  ○ **Immigration/emigration rates**
  ○ **Scale of potential home ranges**
  ○ **Downstream avenues and survival rates**

• **Compile a list of opportunities to get our hands on fish; i.e., fish ladder maintenance**
• **Identify reaches where volitional and non-volitional passage could be implemented**
• **Evaluate features of best ladder passage**
• **Consider sturgeon criteria when refurbishing existing ladders**
• **Develop up a modeling approach to evaluate more fully**.
• **Identify areas of potential value – cost-benefit**
• **Since recruitment is the main issue, it is more important to gain a better understanding of the mechanism of recruitment failure before addressing passage**
• **Do nothing – choose alternate strategy**

Summary

White sturgeon historically ranged freely through hundreds of miles of the Columbia and Snake Rivers until construction of mainstem dams blocked upstream movements and isolated fish in reservoirs and river segments which may no longer provide favorable conditions for all stages of the life cycle. As a result, sturgeon, abundance, productivity and fishery opportunities have been reduced throughout the basin. High rates of sea lion predation also suggest that sturgeon productivity below Bonneville Dam has been limited by the inability to migrate farther upstream in the system to spawn.

While fish ladders have proven effective for passing adult salmon and steelhead upstream, these methods are generally not effective for sturgeon. Upstream passage of sturgeon with elevators was explored after Bonneville Dam was constructed but elevator use was discontinued when ladders proved much more effective for salmonids. Fishway counts show little use by sturgeon although some structures are marginally more effective than others. The greatest use occurs in the east fishway at The Dalles Dam and appears to be related to the greater width and larger submerged orifices in this ladder. Most movements appear to be by juvenile or subadult fish rather than adult spawners.

Downstream passage of juvenile salmonids occurs through dam spillways and various bypass systems, but downstream passage of juvenile sturgeon is relatively low. Telemetry and conventional marking studies show a small level of downstream movement by sub-adult and adult sturgeon through spillways, and smaller fish may also pass downstream through turbines. Sturgeon use of navigation locks has not been demonstrated. Downstream movements of sturgeon generally exceed upstream movements although net movements in either direction are very low.

Sturgeon also regularly enter dam structures for reasons other than passage. Large increases in fishway entry have been observed at Bonneville Dam since 2007 and this pattern is correlated with a large influx of Steller Sea lions into the lower Columbia River. Large numbers of sturgeon may also be trapped in the turbine draft tubes at many dams when stop logs are placed during dewatering for maintenance. Removal of sturgeon from dewatered fishways and draft tubes is labor-intensive and injury or mortality has been reported on multiple occasions, but protocols now in place have substantially reduced numbers of sturgeon trapped during maintenance activities.

Sturgeon transplants were explored in the 1990s as an alternative to traditional dam passage. Juveniles were collected downstream of Bonneville Dam and transported into upstream impoundments where limited natural recruitment has underseeded the available habitat. This experiment demonstrated the feasibility of capturing significant numbers of juveniles and high survival of these fish following release. However, current levels of natural production downstream from Bonneville Dam limit the availability of juvenile sturgeon for transplant. Small-scale transplants are being employed in the upper Snake River to move fish entrained downstream from productive to unproductive river segments back upstream.

Work on sturgeon passage in other parts of the country has met with variable success. Passage of lake sturgeon has been achieved in some areas at low head structures but fishway passage in larger systems such as Canada's Richelieu River has been relatively ineffective. Field and

laboratory studies are beginning to provide information on sturgeon behavior in the vicinity of dams, passage mortality, and upstream and downstream fish guidance requirements for other sturgeon species but results have not yet translated into effective usage. However, work at The Dalles Dam and flume studies at UC Davis indicate that fishways can be effectively designed for upstream passage of subadult and adult white sturgeon.

Passage benefits that increase connectivity can, in some cases, increase gene flow, productivity, and fishery opportunity. However, unintended consequences must be given consideration as they can reduce benefits or prove detrimental. Modeling of upper Snake River populations demonstrated that passage benefits depend on the relative rates of upstream and downstream movements and population productivity in upstream and downstream areas. Many impounded river sections contain habitat that is underutilized by sturgeon due to poor natural recruitment. Net productivity might be improved by providing passage of juvenile and subadult sturgeon into underutilized areas. However, increased upstream passage could be detrimental to net production if adults move from favorable into unfavorable areas.

Attempts to improve upstream or downstream passage of sturgeon at dams also risks confounding salmon and steelhead passage. Passage requirements of salmonids and sturgeon are different but not mutually exclusive. We learned from work at The Dalles Dam that sturgeon and salmon passage can co-exist. Sturgeon can ascend the same water velocities that salmon can, but differ in swimming abilities or ability to locate or enter passage entrances. However, salmon passage systems have been optimized through decades of engineering, testing, and refinement. Any changes in passage systems to benefit sturgeon will require careful analysis of salmonid tradeoffs. Changes in existing passage systems intended to benefit sturgeon will require costly construction and testing. Federal funding for sturgeon passage research is currently limited due to declining federal budgets and increasing demands on budgets from failing and old infrastructure and a suite of requirements for salmon in ESA Biological Opinions.

Workshop participants generally concluded that too little is yet known regarding passage requirements, benefits, and risks to support the need for large-scale sturgeon passage improvements at Columbia River dams at this time. A number of passage-related issues or activities were identified that warrant further development:

7. Clarify specific goals and objectives for subpopulations based on current natural recruitment potential, habitat productivity, and limiting factors to provide guidance on potential benefits and risks of increased upstream or downstream passage on a case-by-case basis.

8. Consider additional analysis or research of larval and juvenile downstream passage and mortality to better understand tradeoffs between upstream and downstream subpopulations.

9. Include detailed evaluations of costs, benefits and risks of passage improvements relative to other potential strategies including habitat improvement, flow management, fishery regulation and hatchery supplementation in sturgeon mitigation, conservation and restoration plans.

10. Consider opportunities for incorporating sturgeon-friendly features in existing fish ladders during future ladder designs and planned modification where consistent with sturgeon population goals and objectives.

11. Consider opportunities for non-volitional passage by taking advantage of fish trapped in dewater draft tubes or fish ladders during maintenance. These fish can be released back downstream from dams or transplanted upstream. Fish could also be tagged as a means to gain information on sturgeon behavior and movement in and around dams. This would be cost effective since it occurs with planned maintenance. There is also a need for better communication/coordination with maintenance operations so we can take advantage of these instances as they occur.

12. Review current protocols used to prevent fish stranding/mortality during planned maintenance activities (such as dewatering draft tubes) to determine if the level of protection/prevention is adequate and whether improvements could be made. Where appropriate and feasible, improve prevention/control of existing sources of mortality caused by the projects either from dewatering mishaps or blade strikes associated with turbine starts. For instance, powerhouse upgrades to digital controls would allow "slow roll" starts to be used for all turbine starts throughout the year.

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APPENDIX A – WORKSHOP AGENDA

Columbia Basin Sturgeon Workshop III

Day 1: Basin-wide Sturgeon Management Framework

January 11, 2012

8:30 a.m. **Welcome and Introductions**

9:00 a.m. **A Brief History of Sturgeon: Successes & Failures** – *Ray Beamesderfer (CFS)*

- Session Objective & Approach
- Status, Trends & Limitations
- Workshops, Plans & Programs

9:45 a.m. **What's new?: Innovations & Revelations, Challenges & Constraints**

- Lower Columbia River (mouth to McNary Dam) – *Tucker Jones (ODFW)*

10:25 a.m. **Break** (20 min)

10:45 a.m. **What's new?** (continued)

- Upper mid-Columbia – *Chad Jackson (WDFW)*
- Transboundary Columbia River (US) – *Jason McLellan (CCT)*
- Transboundary Columbia River (CAN) – *Jim Powell (FFSBC)*

12:15 p.m. **Lunch**

1:15 p.m. **What's new?** (continued)

- Kootenai River – *Jason Flory (FWS)*
- Snake River – *Ken Lepla (IPC) & Jeff Dillon (IDFG)*

2:00 p.m. **Work Session: Developing a comprehensive Strategic Plan in the Columbia River Basin**

4:30 p.m. **Wrap up and next steps**

5:00 p.m. **Adjourn**

Day 2: Sturgeon Passage

January 12, 2012

8:00 a.m. Welcome and Introductions

- ISRP/Council direction
- Basis for interest: summary of programs, plans, and policies calling for passage & mortality studies
- The role of passage in achieving sturgeon management objectives

9:00 a.m. Columbia Basin Sturgeon Passage: What Do We Know About It?

- Overview and historical passage efforts – *Mike Parsley (USGS)*
- Sturgeon observations at FCRPS facilities – *Bjorn van der Leeuw (USACE)*
- Trawl & haul program – *Colin Chapman* (ODFW)

10:10 a.m. Break (20 min)

10:30 a.m. Sturgeon Passage Research: What can the experts tell us?

- Behaviour and passage success of Lake Sturgeon in a Quebec River fishway – *Jason Thiem (Carleton University)*
- Development and status of downstream passage technologies for sturgeon – *Steve Amaral (Alden Labs)*
- Flume studies of adult white sturgeon passage and stress responses – *Joe Cech (UC Davis)*

12:00 p.m. Lunch

1:00 p.m. Evaluating Passage Risks and Benefits

- Chutes and Ladders: Modeling Snake River Passage Alternatives – *Yetta Jager (ORNL)*
- Challenges in considering sturgeon passage in the Columbia River Basin – *Bernard Klatt (USACE)*
- Unintended consequences of providing passage – *Mike Parsley (USGS)*

2:00 p.m. Break

2:20 p.m. Work Session on Sturgeon Passage: When Does It and Doesn't It Make Sense?

- What else do we know about sturgeon passage?
- What are the pros, cons, and tradeoffs of providing sturgeon passage?
- What now?

4:00 p.m. Wrap up and next steps

4:30 p.m. Adjourn

APPENDIX B – WORKSHOP PARTICIPANTS

Workshop participants were invited from State and Federal Agencies, Indian Tribes, and other organizations with management or mitigation authority or responsibility and specific knowledge and expertise on sturgeon in the region. Participants include a mixture of policy and technical representatives. Workshop announcements were broadly distributed among agencies and parties with a potential interest and no limit was placed on attendance.

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APPENDIX C – COLUMBIA BASIN WHITE STURGEON FRAMEWORK

Working Outline

1. EXECUTIVE SUMMARY

2. INTRODUCTION
   - 2.1. Planning Area & Management Units
   - 2.2. Planning & Policy Framework
     - 2.2.1. Northwest Power and Conservation Council
     - 2.2.2. States of Washington, Oregon, Idaho, Montana
     - 2.2.3. Columbia River Treaty Tribes
     - 2.2.4. Non-Treaty Tribes
     - 2.2.5. US v. Oregon / Columbia River Fishery Management Plan
     - 2.2.6. Canada
     - 2.2.7. ESA & SARA
     - 2.2.8. FERC Licensing
   - 2.3. Planning Process
   - 2.4. Plan Organization

3. BIOLOGY & LIFE HISTORY
   - 3.1. Species Description
   - 3.2. Range
   - 3.3. Reproductive Strategy & Maturation
   - 3.4. Spawning
   - 3.5. Incubation & Early Life History
   - 3.6. Food & Feeding
   - 3.7. Age & Growth
   - 3.8. Survival
   - 3.9. Movements & Habitat Use

4. OVERVIEW OF DISTRIBUTION & STATUS
   - 4.1. Distribution
   - 4.2. Genetic Stock Structure
   - 4.3. Abundance
   - 4.4. Population Productivity
   - 4.5. Individual Productivity

5. OVERVIEW OF FISHERIES
   - 5.1. History
   - 5.2. Current Fishery Types & Areas
   - 5.3. Regulation
   - 5.4. Harvest, Yield, Exploitation & Effort

6. OVERVIEW OF LIMITING FACTORS & THREATS
   - 6.1. Habitat Condition & Connectivity
   - 6.2. Flow & Flow Variation
   - 6.3. Water Quality
   - 6.4. Exploitation & Illegal Harvest

6.5. Incidental Hydro-system Mortality
6.6. In-water Work Activities
6.7. Contaminants
6.8. Ecological Factors
6.9. Climate Patterns & Trends

7. MANAGEMENT UNIT SUMMARIES
7.1. Lower Columbia (below Bonneville)
7.1.1.Status
7.1.2.Limiting Factors & Threats
7.1.3.Plans, Objectives & Strategies
7.1.4.Programs, Projects, Actions & Schedules
7.1.5.Needs & Uncertainties
7.2. Lower Mid-Columbia (Bonneville Dam to Priest Rapids Dam)
7.3. Upper Mid-Columbia (Priest Rapids Dam to Grand Coulee Dam)
7.4. Transboundary Upper Columbia (Grand Coulee Dam to Keenleyside Dam)
7.5. Far Upper Columbia (Keenleyside Dam to Kinbasket Reservoir)
7.6. Kootenay Lake & Kootenai River
7.7. Lower Snake (Ice Harbor Dam to Lower Granite Dam)
7.8. Middle Snake (Lower Granite Dam to Hells Canyon Dam)
7.9. Upper Snake (Hells Canyon Dam to Shoshone Falls)

8. REGIONAL FRAMEWORK FOR CONSERVATION, MANAGEMENT, RESTORATION & MITIGATION
8.1. Vision
8.2. Goals
8.3. Objectives
8.4. Strategies
8.4.1.Habitat
8.4.2.Passage/Connectivity
8.4.3.Water management
8.4.4.Harvest
8.4.5.Hatcheries
8.4.6.Contaminants
8.4.7.Ecological factors
8.5. Monitoring & Research
8.6. Implementation

9. GAP ANALYSIS – CRITICAL UNCERTAINTIES & NEEDS
9.1. Strategies
9.2. Monitoring
9.3. Research
9.4. Programmatic

10. GUIDANCE & RECOMMENDATIONS

11. LITERATURE CITED

12. GLOSSARY