Osoyoos Lake Water Science Forum

A Watershed beyond Boundaries: Stewardship of our Shared Waters

October 7-9, 2015

SUMMARY REPORT

Prepared for:

Osoyoos Lake Water Science Forum Organizing Committee
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AUTHOR'S NOTE

This Summary Report is an outcome of the third bi-national Osoyoos Lake Water Science Forum, held in Osoyoos, BC from October 7th-9th, 2015. I was present at the forum, and took extensive written notes and audio recordings of all of the presentations, panel discussions and audience questions and feedback throughout the forum. I used these materials, copies of presenters' PowerPoint presentations and notes to synthesize the proceedings of the forum. In some cases, I consulted the web pages of presenters' organizations to verify I had accurately represented the information within this report.

As I synthesized the discussions and information presented at the forum, I noted various gaps and areas for improvement that were identified by panelists and audience members alike. This provided the basis for the recommendations that I included in this report. I took care to include all questions and comments made participants, and, where these were actionable and pragmatic, included them in the list of recommendations.

About the Author

Christine Mettler is a passionate water and environmental protection professional with a background in policy, research, technical writing, project management and community outreach. She holds a Master's degree in Environmental Studies and a graduate certificate in Integrated Watershed Management, and is a dedicated interdisciplinary thinker who is interested in bridging the physical sciences with social sciences and humanities. Christine launched her firm, WaterCycles Consulting, in 2014 with a view to help facilitate collaboration and community engagement in watershed and environmental protection.

EXECUTIVE SUMMARY

From October 7th – 9th, 2015, the third binational Osoyoos Lake Water Science Forum was held at the Sonora Centre in Osoyoos, BC. The forum included presentations and panel discussions by scientists, environmental professionals, advocates, and officials from all levels of government on both sides of the border, First Nations and Tribal organizations. Ninety participants, including panelists, local community members and students registered for the 2015 forum. Forty local high school students also joined for an afternoon session on October 9th.

The 2015 forum, called "A Watershed beyond Boundaries: Stewardship of our Shared Waters," built upon the knowledge and relationships formed in the 2007 and 2011 Osoyoos forums. As in 2007 and 2011, the goal of the 2015 forum was: *To provide a communication bridge for all levels of government and the public aimed at learning, sharing and developing strategies to work together to improve Osoyoos Lake and promote its future sustainability.* Osoyoos Lake straddles the Canada-US border. An oasis in the desert, the lake is an important refuge and passage to fish, supports diverse ecosystems, and is a source of much needed (and enjoyed) water to the people living on its shores. However, the sustainability of Osoyoos Lake is threatened by a variety of pressures. Restoring and protecting the ecological health of the lake requires the concerted and deliberate action of a variety of individuals and organizations.

Over two and a half days, presenters and participants discussed the implications of science and management updates, commended successes and offered recommendations for ways we can better work together to protect our shared waters. Some of the topics that were discussed focused specifically on Osoyoos Lake and the Okanagan River system, while others had a broader focus, pertaining to the Okanagan basin, the Columbia River basin, or the Pacific Northwest more generally. This report summarizes the key points made by panelists and audience members at the forum. For conceptual clarity and continuity of the Summary Reports of past years, the report is organized according to seven topic areas:

1) Bi-lateral and collaborative governance
2) Fisheries recovery and restoration
3) Climate change and variation
4) Water quantity
5) Land-use planning
6) Water quality
7) Aquatic invasive species

The section on ***bi-lateral and collaborative governance*** includes a presentation from the International Joint Commission (IJC) on its International Watershed Initiative and presentations by the International Osoyoos Lake Board of Control, which discussed the IJC Orders and conditions of operation for Zosel Dam and related water-level effects on Osoyoos Lake, in addition to other updates.

Fisheries recovery and restoration features information related to cross-border collaborative salmon restoration initiatives in the Okanagan River system, an overview of the Okanagan

Community Salmon Initiative, and presentations from two non-traditional commercial fisheries in the Okanagan—a Mysis shrimp fishery and an enclosed Arctic char facility.

Climate change and variation summarizes projected climate and hydrological shifts in the Pacific Northwest under expected climate change scenarios and provides an update on findings from the Okanagan Water Supply and Demand project and research on supply and demand in the Similkameen basin.

Water quantity discusses various actions of Washington State, British Columbia and the Okanagan Valley in responding to the 2015 drought, as well as considerations for future planning. It also summarizes presentations on Washington's approach to water (re)allocation, and water management considerations related to the Okanagan Lake Regulation System.

Land-use planning features presentations from representatives from the Town of Osoyoos and the City of Oroville regarding efforts to better integrate land-use planning with water management in those municipalities. The section also includes a presentation on the Washington-British Columbia Transboundary Climate-Connectivity Project, an undertaking to harmonize land-use planning on both sides of the border to safeguard wildlife corridors.

Water quality provides an overview of presentations on a variety of water quality concerns, including the impact of wildfires on water quality, blue-green algae management in Washington State, and the role of wetlands restoration in the Okanagan as a means to preserve water quality.

Aquatic invasive species is a category that was added in the 2015 report. This section compares the milfoil removal approaches of the Okanagan Basin Water Board to the north and Okanogan County to the south, with the former using harvesters and the latter using chemicals to remove milfoil. This section also summarizes a presentation on BC's Invasive Mussel Defense Program.

The report also summarizes a talk, "Ascending the Okanagan: 1811-1860", given by historian and author Jack Nisbet on the historical relationship between people, environment, and fish.

In synthesizing deliberations of the 2015 Osoyoos Lake Water Science Forum, some themes began to emerge. Those themes were identified as:

- **THEME 1: Partnerships are fundamental to protecting and enhancing health of our shared waters.**
- **THEME 2: Intentional, strategic and proactive action needs to be taken.**
- **THEME 3: Integrate the social, cultural and political with the scientific.**
- **THEME 4: Adaptive management requires flexibility and compromise.**

These themes should guide the ethos of future action.

The report then goes on to assess progress made from the 2007 and 2011 forums, and provides recommendations for future actions. In total, 32 actions in the seven categories named above were recommended. The report concludes with the reminder that sustainability is something that we continually strive for—a process rather than a destination.

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1.0 Introduction

Osoyoos Lake is the southernmost and warmest lake in the Canadian Okanagan basin. With a national border that transects its waters, Osoyoos Lake is shared by the residents of the United States and Canada, as well as First Nations and Tribes people who have lived along its shores for thousands of years. It is a portal to the Okanagan basin to the north and the Columbia River basin to the south, connected to these watersheds by the Okanagan/Okanogan River.[1] The health of the lake is instrumental to the passage and survival of salmon that come through the Columbia River to the waters of the Okanagan/Okanogan River to spawn, and back again on their journey out to sea. The lake not only holds important ecosystem values, but also considerable value for the many people who live close to its shores, providing water for drinking, agriculture, food fisheries, recreation, and spiritual and aesthetic connection.

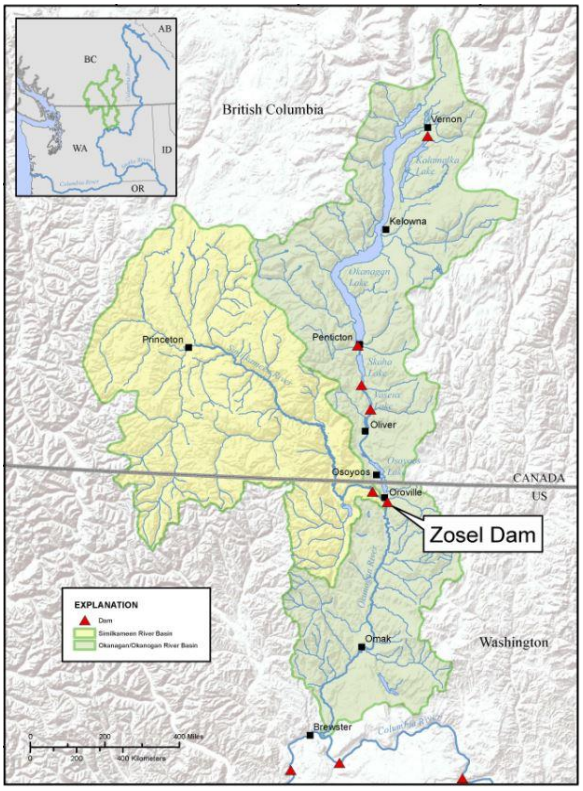

Figure 1: Map of the Okanagan/Okanogan River basin (green) and Similkameen River basin (yellow) on both sides of the Canada-U.S. border

Despite the value of Osoyoos Lake, it is threatened. Climate change, urban development, invasive species, recreation, demand for irrigation and drinking water all put pressure on the lake. In order to ensure its continued ability to support ecosystem and human health, professionals and local citizens from both sides of the border are working together to manage and mitigate threats to the lake. The Osoyoos Lake Water Science Forum is a space to forge connections, share knowledge and stimulate action to do this.

1.1 The 2015 Osoyoos Lake Water Science Forum

The 2015 Osoyoos Lake Water Science Forum (OLWSF) was the third bi-national forum of its kind. The forum, called "A Watershed beyond Boundaries: Stewardship of our Shared Waters," was held in Osoyoos, BC from October 7th-9th, 2015. As with the 2007 and 2011 forums, the goal of the 2015 forum was: *To provide a communication bridge for all levels of government and the*

[1] Okanagan River is the name used to refer to the river on the Canadian side, while Okanogan River refers to the river on the U.S. side. In this report, "Okanagan River" is used to refer to the portion of the river between the south end of Okanagan Lake and Osoyoos Lake in Canada, and Okanogan River is used to refer to the portion of the river between Osoyoos Lake and the Columbia River in the U.S..

public aimed at learning, sharing and developing strategies to work together to improve Osoyoos Lake and promote its future sustainability.

The forum featured presentations and panel discussions from a variety of officials, water managers, researchers, scientists and advocates from First Nations organizations and different levels of government from both sides of the border. Some of the topics that were discussed focused specifically on Osoyoos Lake and the Okanagan/Okanogan River system, while others had a broader focus, pertaining to the Okanagan basin, the Columbia River basin, or the Pacific Northwest more generally. Presenters' contact information is included in Appendix B.

After each panel, forum participants were able to come to the microphone to ask questions or make comments. There were also question boxes made available. In total, 90 people from Canada and the US participated in the forum, and 40 local high school students also joined the discussion on the afternoon of October 9th. Powerpoint presentations delivered at the forum and an agenda are available online on the Okanagan Basin Water Board's website (www.obwb.ca/olwsf/).

1.2 Background of the Osoyoos Lake Water Science Forum

The 2015 OLWSF continued to build on the knowledge and relationships formed at the 2007 and 2011 forums. Summary Reports were produced after both of these forums, which summarized themes, synthesized information and dialogue, and documented recommendations for future actions to address concerns.

The 2007 forum was organized in response to a growing public concern about the sustainability of Osoyoos Lake, and anticipating the need to renew the operating Orders for Zosel Dam, which controls the levels the lake, under the Boundary Waters Treaty. The forum recognized the need for concerted actions from public officials to develop concrete programs, policies and funding streams to address issues and concerns in Osoyoos Lake. The 2007 Summary Report synthesized proceedings of the forum and identified 26 actions and steps for further scientific investigation to help achieve this goal.

The 2011 forum continued the conversation, provided science updates, followed up on action items that arose from the 2007 forum, and was an opportunity for public consultation as the International Osoyoos Lake Board of Control gathered information to update the Zosel Dam operating Orders. The 2011 Summary Report conducted a thorough review of the status of recommendations from the 2007 report, and found that 77% of recommendations either had good or excellent progress. It also generated 41 more recommendations for future action.

1.3 Considerations of this Report

This Summary Report of the 2015 OLWSF highlights themes that arose in the forum, synthesizes discussions and presentations, provides some analysis on progress made from past forums, and makes recommendations for future actions.

Where possible, the author included hyperlinks to documents and programs mentioned in the forum. A list of all the hyperlinks provided is available in Appendix C. For continuity, this report uses the same categories as the 2011 report to thematically organize the proceedings of the forum, with some minor changes to the titles of categories, and the addition of an "aquatic invasive species" category. These categories, in order of appearance, are:

1) Bilateral and collaborative governance
2) Fisheries recovery and restoration
3) Climate change and variation
4) Water quantity
5) Land-use planning
6) Water quality
7) Aquatic invasive species

Presentations, discussions and dialogue that took place in the forum are organized according to these topics, and not necessarily in the chronological order in which they took place at the forum.

The report is organized as follows:

- Section 2 provides an overview of the presentations, discussions and dialogue of the forum, organized according to theme;
- Section 3 reflects on some overarching themes that emerged from the forum;
- Section 4 discusses progress from past forums and gives suggestion for future actions; and
- Section 5 offers concluding remarks.

Appendix A contains a list and description of the "key players" of the forum. Appendix B is a list of the names and contact information of forum panelists. Appendix C contains a list of all the hyperlinks embedded throughout this document.

2.0 Overview of Presentations, Panel Discussions and Audience Feedback

2.1 Transboundary and Collaborative Governance

Introduction

Concerted, collaborative governance between organizations and agencies on both sides of the border and with First Nations organizations and communities is instrumental to build capacity and resources to effectively address complex, cross-boundary environmental issues. This section summarizes presentations, discussions and dialogue from two bi-national organizations: the International Joint Commission and the International Osoyoos Lake Board of Control, which held its first annual public meeting at the 2015 OLWSF since adding four new board members.

The International Joint Commission and the International Watershed Initiative

***Rich Moy**, Commissioner, U.S. Section, International Joint Commission*

The International Joint Commission (IJC) is composed of three board members on either side of the border (six in total) and an international staff based in Washington, DC and Ottawa, ON. Although board members are appointed by the President in the United States and the Prime Minister in Canada, the IJC is a non-political, independent and impartial organization that makes recommendations to government based on the best available science. The Commission's vision is to promote "healthy shared waters for present and future generations" by preventing and resolving water disputes along the Canada-US border.

In 1997, the IJC published a report that set out the foundations of the International Watershed Initiative (IWI), a program designed to help establish international watershed boards that adopt an integrated, ecosystem approach to transboundary environmental issues. Watershed boards are comprised of local actors on either side of the border. The IWI provides technical and financial support to:

- Help local watershed boards develop watershed models
- Harmonize data sets and collection on either side of the border
- Develop strategies to manage nutrient loads, heavy metals and other water quality concerns
- Manage and plan for impacts of climate change in transboundary watersheds.

"It is so important [to the IWI] that local people [and] local institutions are critically involved in making decisions at the local level."
- Rich Moy, IJC

The first watershed board, St. Croix River Watershed Board, was founded in 2007, and since then one more has been formed, two are in pilot stages, and several transboundary projects and programs have been funded. Osoyoos Lake has a board of control, rather than a watershed board, but IWI is a major funder of the Osoyoos Lake Water Science Forum and has also funded other initiatives related to Osoyoos Lake, such as the participation of the Osoyoos Lake Board of

Control members at IWI workshops and a documentary in development about cross-boundary watershed management issues of the Okanagan/Okanogan River.

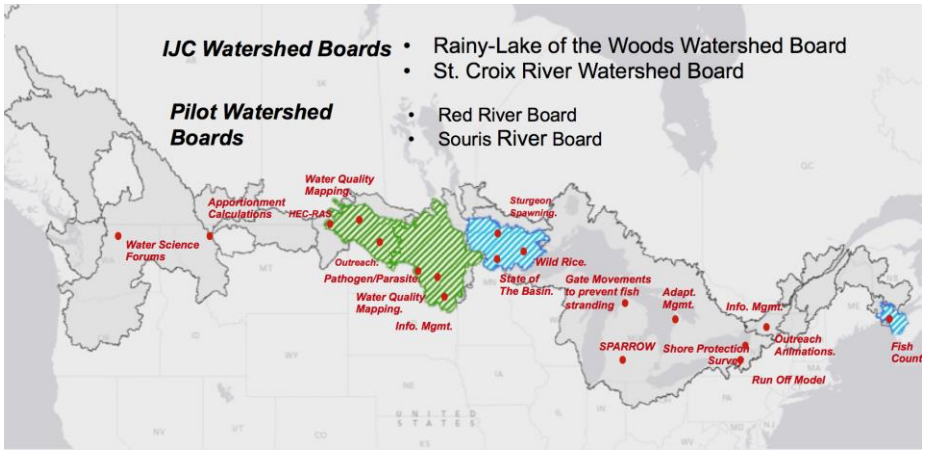

Figure 2: A map denoting watershed boards and projects funded by the IWI.

Osoyoos Lake Board of Control Annual Public Meeting

The Osoyoos Lake Board of Control held its annual public meeting concurrently with the 2015 Osoyoos Lake Water Science Forum. The membership of the Board was recently expanded to include greater local representation. Board members are:

U.S. Members

Cynthia Barton (US Chair) US Geological Survey
***John Arterburn**, Confederated Tribes of the Colville Reservation
Col. John Buck, US Army Corps of Engineers
Kris Kauffman, Water Rights, Inc.
***Ford Waterstrat**, Lake Osoyoos Association

Canadian Members

Bruno Tassone (Canadian Chair), Environment Canada (retired)
Glen Davidson, B.C. Ministry of Forests, Lands and Natural Resource Operations
***Sue McKortoff**, Mayor of the Town of Osoyoos
Brian Symonds, B.C. Ministry of Forests, Lands and Natural Resource Operations (retired)
***Anna Warwick Sears**, Okanagan Basin Water Board

* newly appointed board members

The meeting included an overview of Zosel Dam's 2013 operating Orders, a summary of the unusual hydrological conditions in the Okanagan in 2015 and how the Board of Control responded to those conditions, and an assessment of fisheries in light of the dam and other projects.

2013 Zosel Dam Operating Orders

***Bruno Tassone**, Canadian Chair, Osoyoos Lake Board of Control*

The operating Orders of Zosel Dam were updated in 2013, for the first time since 1985. Although the dam is in the state of Washington, it controls Osoyoos Lake levels upstream in Canadian waters for part of the year, and is therefore subject to IJC regulations. Much of the proceedings of the 2011 Osoyoos Lake Water Science Forum were focused on the renewal of the Orders, and the Summary Report of the 2011 forum included 20 recommendations directed at the IJC for consideration during the renewal process . Effectively, the updated Orders took input from the 2011 forum into consideration. In particular, a revised Rule Curve for dam operations was put into place with the new Orders.

The Rule Curve helps dam operators to manage water levels in Osoyoos Lake:

- In normal years, the dam operates to keep water levels in Osoyoos Lake within the solid black lines shown in fig. 3;
- In years of drought, the dam operator has increased flexibility to control Osoyoos Lake water levels. For example, the operator may begin storing water earlier in the year. The dashed red lines indicate allowable water levels for drought years;
- Certain exceptional hydrological conditions may cause deviation from this Rule Curve, for example extreme freshet inflows into Osoyoos Lake and high flows in the Similkameen River (the latter can cause a natural backwater effect in Osoyoos Lake).

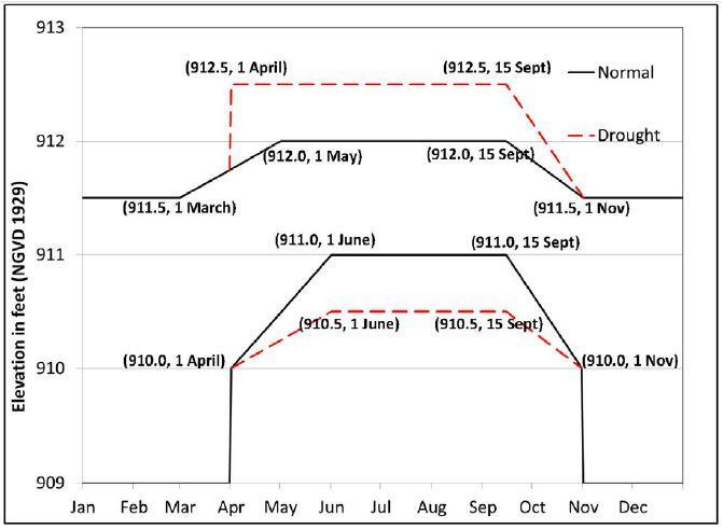

Figure 3: Updated Rule Curve of the updated Zosel Dam operating Orders

The Operator of Zosel Dam (Washington State Department of Ecology) is required to stay within the upper and lower bounds of the IJC rule curve while considering multiple purposes and needs when operating the dam, including recreation, agriculture, water supply, fish and wildlife.

Hydrological conditions in the Okanagan/Okanogan in 2015

***Marijke van Heeswijk**, U.S. Geological Survey, Washington Water Science Center*

The year 2015 was the year of the "double whammy" in the Okanagan/Okanogan: a below average snowpack followed by a warm and dry spring and summer. These conditions made for lower than average water levels in Okanagan Lake, putting strain on water users. Since Okanagan Lake has much greater storage capacity than Osoyoos Lake, low water levels in Okanagan Lake affects the whole downstream system. Operators at Zosel Dam and Okanagan Lake Regulation System must communicate to ensure operations are coordinated and keep the system functioning smoothly.

Even though precipitation amounts were about average, snowpack accumulation was below normal in the Okanagan/Okanogan in the winter of 2014-2015 because of higher than average air temperatures. In addition, in many areas the snowpack also melted much earlier than normal in the spring. Notable hydrologic conditions in 2015 included:

- Very early freshet, causing Okanagan Lake to fill up approximately 3 weeks ahead of normal
- A warm and dry spring, causing water users to use more water earlier in the year
- The volume of water stored in Okanagan Lake started decreasing a month earlier than normal (July instead of August) (see Figure 4)
- Very low flows in the Similkameen River[2] (68% of normal flows from April-July; record low flows occurred in the summer)

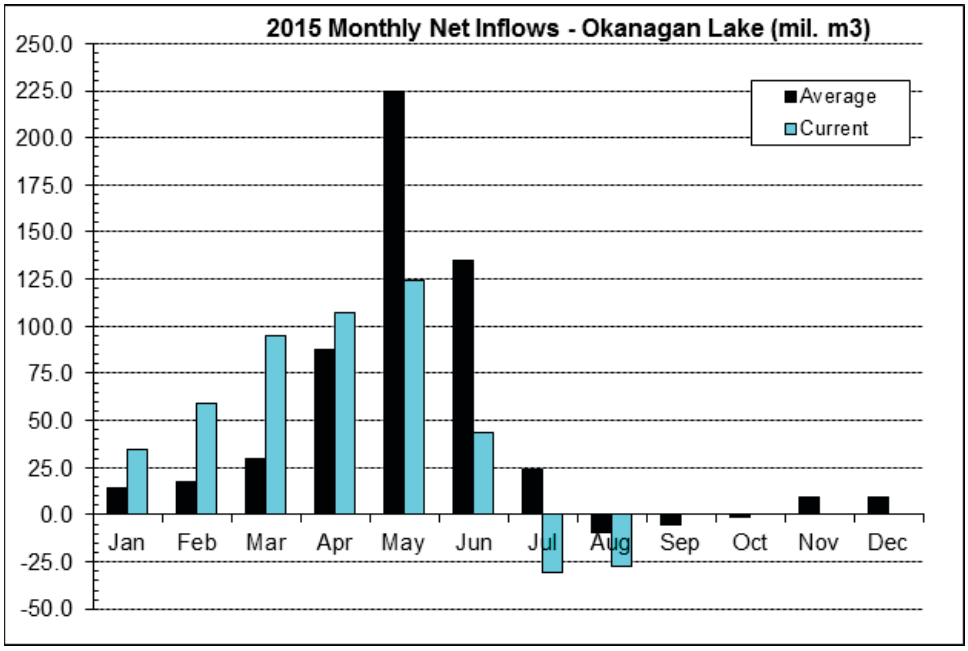

Figure 4: Net monthly inflows to Okanagan Lake (2015)

Both Washington State and the Province of British Columbia declared drought in the Okanagan/Okanogan Basin in the summer of 2015 (see pp. 21-23). However, despite the unusual hydrologic conditions, the International Osoyoos Lake Board of Control did not issue a drought declaration, as criteria for drought specified in the IJC Orders (see Table 1) were not met. The IJC gave the dam operator special permission under a variance to operate as though it was a drought year. Because there was insufficient water available by late summer, however, the dam operator kept Osoyoos Lake Levels within the confines of the 2013 Rule Curve for a normal year. The inconsistency of drought declarations between the International Osoyoos Lake Board of Control and different governments was a source of confusion for many water users.

[2] Although the Similkameen River merges with the Okanogan River downstream from Zosel Dam, it is still very hydrologically important. In a normal year, the Similkameen River has about 4 times the amount of flow as that coming out of Okanogan River. Flows from the Similkameen are particularly important to US users, as this is a large determinant of how much water there will be downstream of Osoyoos Lake.

Criteria for Declaring a Drought	♣Forecasted Early April ♦Forecasted Early May ♠Actual Value	Drought Criterion Met?	Significance
a) April-July flow volume in the Similkameen River is less than 1 million ac-ft	♣1.039 million ac-ft ♦0.831 million ac-ft ♠0.820 million ac-ft	No Yes Yes	Required for drought declaration
b) i) April-July net inflow to Okanagan Lake is less than 195,000 ac-ft	♣396,000 ac-ft ♦316,200 ac-ft ♠199,100 ac-ft	No No No	One of these two required for drought declaration
ii) June or July maximum level of Okanagan Lake is less than 1,122.6 feet	♣>1,122.6 ft by mid-April ♦1,123.3 ft ♠1,123.3 ft	No No No	

Table 1: Criteria for declaration of drought by the International Osoyoos Lake Board of Control

Okanagan River Fisheries Update

***John Arteburn**, Fish Biologist, Confederated Tribes of the Colville Reservation*

The Fish Advisory Group is a joint initiative of the Confederated Tribes of the Colville Reservation and government departments on either side of the border to track fish populations.

2014 was a record year for sockeye return in the Columbia River—over 614,000 fish. Some 80%, or 490,000, sockeye made it past Bonneville Dam to Wells Dam. Lake levels themselves have a fairly benign effect on fisheries. However, Zosel Dam can impact fish passage as a structure and in its regulation of downstream flows. There was a concern that fish might be constrained when passing Zosel Dam, but underwater photography revealed that there was a one-day instantaneous fish passage of 80,000 fish. Based on that information, the Fish Advisory Group reported to the International Osoyoos Lake Board of Control that they estimated that 1.1 million sockeye in any given seasonal run could pass through the dam without constraint.

2015 was a very different year. 510,000 sockeye returned to the Columbia, but only 187,000 returned to Wells Dam—a 36% passage rate. There were major die offs due to very warm water temperatures and disease outbreaks. The conditions that so drastically affected sockeye in 2015 were beyond the control of the International Osoyoos Lake Board of Control.

Low streamflow conditions can impact spawning habitat. The 2013 dam Orders reduce incidences of low flows from Zosel Dam. Even so, the dam operator cannot always compensate for hydrological conditions that may induce low flows (e.g., heat and drought conditions). In order to take some stress off salmon and steelhead during spawning, the Confederated Tribes of the Colville Reservation and the Washington State Department of Ecology constructed a fish passage channel between the Similkameen and Okanogan Rivers. More information on the project, and other projects of the Colville Tribe's Okanogan Basin Monitoring and Evaluation Project (OBMEP) can be found on their website at http://www.colvilletribes.com/obmep.php.

Focus of Audience Questions and Feedback

Audience members showed concern about lake levels, and were curious about what kind of hydrological conditions impact them. One member of the audience expressed concern about how **high lake levels** (which are allowed during drought years to store more water for fish flows, irrigation and other uses) cause damage to her dwelling. Some panelists noted that as the Okanagan transitions from a mostly snow-fed watershed to more of a rain-fed watershed, we will need to find **more ways of storing water** for the demand-intensive summer months. One panelist commented that since 80% of the Okanogan River's flows in the U.S. are provided by the Similkameen River, perhaps we need to revisit the construction of a dam on the Similkameen River at Shanker's Bend.[3] Audience members were also interested in the **hydrological and ecological impacts** of the channel connecting the Okanogan and Similkameen Rivers. The presenter noted that there were not significant hydrological impacts of this project. The ecological impacts were that fish had more spawning ground and hence greater chance of survival.

Dr. Sears noted that although the International Osoyoos Lake Board of Control is not a watershed board per the IWI program, it has recently been expanded to include a greater membership. Perhaps the board can work with the IJC to increase its scope and become a cross-national watershed board.

Chris Branch from the city of Oroville noted that he used to be part of a formal organization that did cross-boundary work, but that travelling across the border could be very complicated due to visa requirements for "work," and eventually the Federal government pulled the plug on the organization. Sometimes informal structures can allow greater flexibility in performing similar substantive work.

2.2 Fisheries Restoration and Recovery

Introduction

Topics related to fisheries in the Okanagan were varied. Despite 2015 yielding much lower salmon runs than expected, extensive monitoring indicates that riparian restoration projects and hatcheries have been quite successful in bringing salmon back to the Okanagan River system. 2014 was a record year for salmon run in recent history. This section features summaries of presentations and discussions related to collaborative restoration projects, the Okanagan Community Salmon Initiative, and the operation of two non-salmon commercial fisheries.

[3] After a three-year feasibility study conducted by the Okanogan Public Utility District (PUD) between 2008 and 2011, the PUD surrendered its preliminary permit to build a dam at Shanker's Bend on September 26th, 2011.

Management to Sustain Salmon Bearing Ecosystems and Human Systems in the Okanagan Valley

Kim D. Hyatt *Head, Salmon in Regional Ecosystems Program and Ecosystem Research Scientist, Department of Fisheries and Oceans Canada*

"Management to Sustain Salmon Bearing Ecosystems and Human Systems in the Okanagan Valley" is the working name of the *ad hoc* collaboration between individuals working for the Department of Fisheries and Oceans Canada (DFO), the Okanagan Nation Alliance (ONA), the Confederated Tribes of the Colville Reservation, Douglas County Public Utility District, and Washington State's Department of Fisheries and Wildlife.

The Okanagan River system formed as the result of a glacial dam breach at McIntyre Bluff some 10-12,000 years ago. Okanagan aquatic ecosystems formed in a rich complex of lakes, streams, wetlands and riparian corridors. Human and natural systems developed gradually over millennia, until the mid-1800s when agricultural and industrial development accelerated rapidly with a wave of human population immigration and settlement from eastern North America.

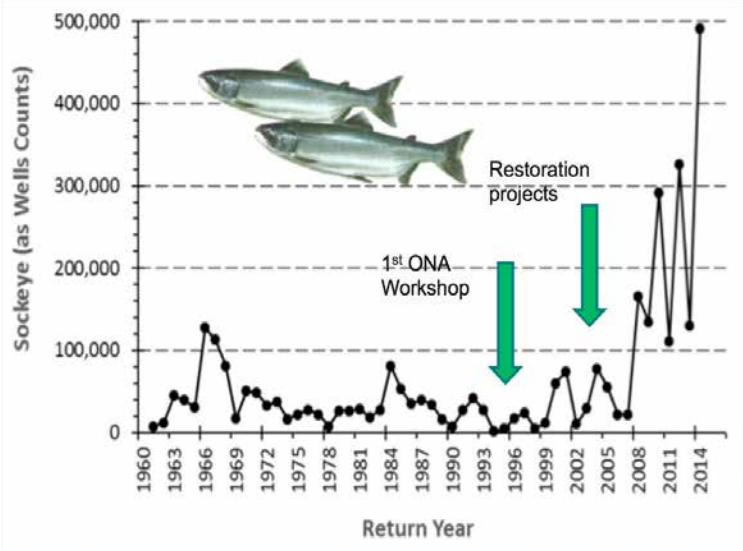

Figure 5: Sockeye returns in the Columbia River system, measured at Wells Dam

As these settlers inhabited the Okanagan basin, natural flooding proved to be an inconvenience. The Okanagan River was channelized, and dams were built throughout the basin to control flooding. Channelization reduced the Okanagan River by about half of its original length as meanders were straightened. 84% of the river was channelized, and approximately 90% of riparian vegetation was lost. Salmon populations—and the First Peoples who depended on them as a food source—were deeply affected, as spawning grounds were all but destroyed. Intensification of human activities and land-use change has further degraded aquatic ecosystems. By the late 1990s, mere dozens of salmon were coming back via the Columbia River to spawn in the Okanagan River.

The organizations above have worked on several programs since the late 1990s to make the Okanagan River a major salmon-bearing river once again. Projects include:

- Ecological restoration of oxbows and riparian zones to create more and better spawning habitat on both sides of the border
- Dam passage improvement at Antoine Creek in Washington
- Skaha Salmon Hatchery (opened in 2014, operated by the ONA), which has added between 10-20,000 salmon to runs in the Okanagan River in recent years

- Chief Joseph Hatchery (opened in 2013, operated by CCT) to restore Chinook Salmon to upper and mid reaches of the Columbia River
- Retrofitting dams in the Columbia River (mostly with bypasses to help ease the passage of smolts
- The Fish Water Management Tool, a decision support system to help dam operators make decisions about controlling flows to maximize benefits to human and natural systems

Many of these programs are separate initiatives, not well integrated or part of a specific program, though many of them include the same people as collaborators. However, since these programs have been put into place there have been unprecedented returns of sockeye to the Okanagan River System in the post-dam era. It became apparent that Osoyoos Lake and the Okanagan River had much larger capacity to sustain sockeye than scientists had previously realized, and that fish and their ecosystems are quite resilient.

Factors to salmon restoration success include:

- Strong leadership; inspired view of what needed to be done and energy to drive it through
- Identification of common cause between First Nations, State, Federal and Provincial agencies
- Systemic, science-based analysis to identify worthy projects
- Fostering strong interpersonal relationships and trust between partners
- Adaptive management

Fisheries Recovery Panel

Individuals and organizations that are playing significant roles in the Okanagan/Okanogan River transboundary fisheries collaborative include:

- **Kim D. Hyatt**, Head of Salmon and Regional Ecosystems Programs at the Department of Fisheries and Oceans Canada (DFO). DFO, in collaboration with the Okanagan Nation Alliance, provides technical advice and support to this program.
- **Jeremy Cram**, Research Scientist with the Department of Fish and Wildlife in Washington. The Department of Fish and Wildlife fund various salmon recovery projects and provide technical support.
- **Casey Baldwin**, Research Scientist with the Confederated Tribes of the Colville Reservation in Washington. In addition to the Sockeye recovery, the Confederated Tribes of the Colville Reservation have a robust fisheries program that includes recovery of other species such as Steelhead and Chinook salmon. They have completed a hatchery genetic management plan for Steelhead conservation (awaiting approval from the Federal government), and have an experimental Chinook salmon hatchery at Chief Joseph Dam on the Columbia River.
- **Tom Kahler**, Fisheries Biologist with the Douglas County Public Utility District (DCPUD). DCPUD is a primary funder of the Fish Water Management Tool, which is being modernizing to reflect the newest science. DCPUD's habitat mitigation program also funded projects to re-meander sections of the Okanagan River.
- **Richard Bussanich**, Fisheries Biologist with the Okanagan Nation Alliance (ONA). ONA is contributing scientific and technical advice as well as Traditional Ecological Knowledge

to fisheries recovery projects. Traditional knowledge of First Peoples in the Okanagan/Okanogan dates back over 7,000 years. First Nations people manipulated the environment too, but they learned from negative environmental responses and adapted their practices. Modern society needs to learn from the environment and adapt their practices as well.

Okanagan Salmon Community Initiative (OSCI)

***Richard Bussanich**, Fisheries Co-management Coordinator, Okanagan Nation Alliance (ONA)*
***Rick Simpson**, Co-Chair, Okanagan Region Fisheries Committee, BC Wildlife Federation (BCWF)*

The Okanagan Salmon Community Initiative (OSCI) is an *ad hoc* initiative between ONA, BCWF and the Department of Fisheries and Oceans Canada to build a resilient, responsible and sustainable community-based recreational fishery in the Okanagan. There is no overarching program or formal mechanisms, but rather the initiative developed out of long-standing collaborative efforts between various players to restore salmon in the Okanagan.

OSCI includes a network of fishers, environmentalists, consumers, naturalists, and conservationists that collaborate to integrate local knowledge, traditional knowledge and ecological principles to manage the fishery. The initiative provides training to local anglers to engage in artisanal trolling in Lake Osoyoos and the Okanagan River for sockeye salmon. The fishers use their own gear and vessels to troll, and at the end give their catch to ONA who arrange for the fish to be sold at local retailers. A portion of the proceeds of sales goes back to the OSCI for program cost recovery. Depending on the abundance of the run, fishers may be able to pack fish for themselves. Fishers also have the option to trade their services for fish. As more fish make it past Wells Dam, the recreational fishery will become more active.[4]

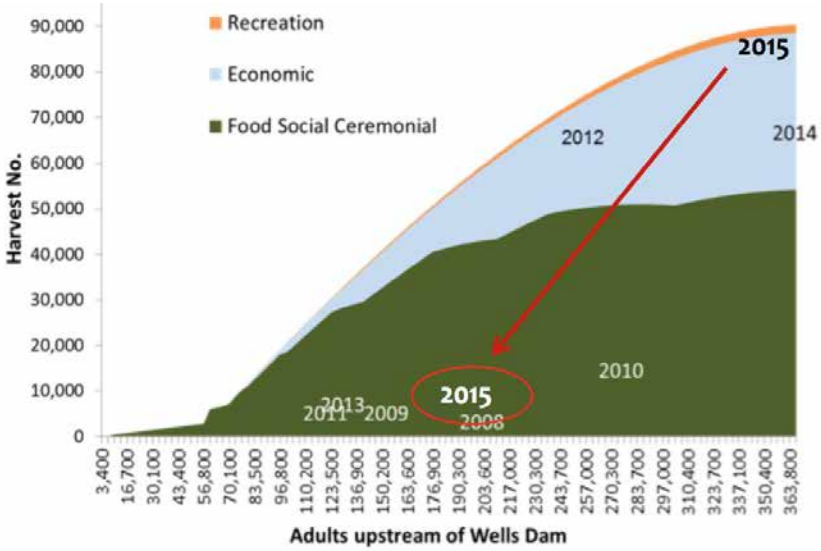

Figure 6: Salmon returns and use by type in the Okanagan

The ONA is seeking more fishers from the South Okanagan and to engage more young fishers in the initiative.

[4] As more sockeye run upstream of Wells Dam, more fish are available for recreational purposes. 2015 was expected to be a large run, but due to warm temperatures and disease outbreaks, the run was much smaller than expected.

Mysis Shrimp Fishery on Okanagan Lake

***Nuri Fisher**, President, Piscine Energetics Inc.*

Mysis shrimp were deliberately introduced to Okanagan Lake by fisheries biologists to increase food sources for Kokanee salmon and Rainbow trout. However, both Mysis and Kokanee feed on zooplankton, and as Mysis began to multiply (by the early 2000s, there was an estimated six metric tonnes of Mysis Shrimp biomass in Okanagan Lake), they began to impinge on the food source of Kokanee, threatening their viability. Further, Kokanee have little opportunity to eat mysids as they rarely share the same waters in deep lakes. Mysis shrimp tend to stay at the bottom of the lake during the day when Kokanee are feeding near the surface, migrating to the surface at night to eat.

In 1995, the British Columbia Ministry of the Environment completed its Okanagan Lake Action Plan, which called for the introduction of an experimental Mysis shrimp fishery on Okanagan Lake to reduce mysid biomass. *Piscine Energetics* developed a harvesting system to eliminate bycatch of other fish species. The system involves towing nets only at night when the mysids rise to the surface and at less than one naught allowing more mature Kokanee to easily swim away. For junior kokanee who might get caught in the net, there is a hole in the pipe that ejects them but carries the Mysis shrimp up to the boats.

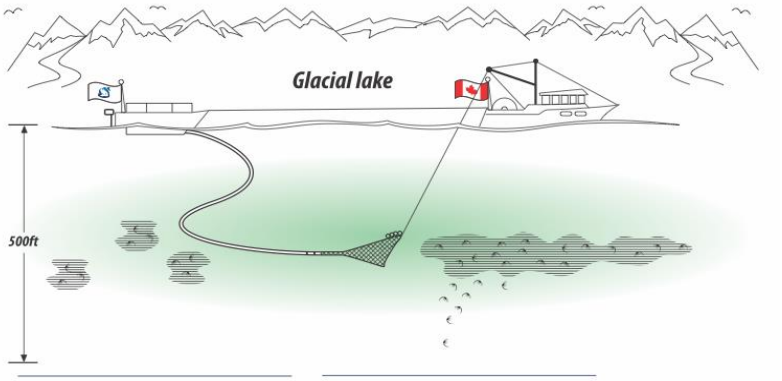

Figure 7: Piscine Energetic's Mysis Shrimp harvesting system on Okanagan Lake

Piscine Energetics sells the Mysis shrimp harvest to aquaria around the world as fish food. Currently, the company is only operating on Okanagan Lake, but they are exploring the possibility of bringing operations to other lakes where Mysis shrimp have migrated, including Skaha and Kalamalka Lakes.

Arctic Char Aquaculture in the Okanagan

***Gary Klassen**, President, DelicaSea Fish Co. Ltd*

Road 17 Arctic Char is an enclosed facility that farms Arctic char in Oliver, BC. After much controversy among community members and fisheries biologists, the facility attained approval from the Department of Fisheries and Oceans Canada to launch operations. Water for the facility comes from underground wells, which yields water at temperatures around 12°C (54°F),

an ideal temperature for char.[5] Staff at the facility soak the char eggs, which are shipped from the Northwest Territories, in an iodine solution to prevent against disease. An onsite oxygen injection vessel oxidizes water, eliminating the need for pharmaceuticals. Tanks are cleaned often with a system that settles out suspended solids in the water. Water is then filtered through a 50-micron drum filter, and discharged into the environment. The char is sold as a high-end product to restaurants and grocers.

Focus of Audience Interest and Feedback

Topics related to fisheries elicited a fair amount of interest and curiosity from the audience. With regard to the **commercial fisheries**, one audience member brought up that in the case of *Piscine Energetic's* Mysis shrimp fishery, environmental sustainability may be at odds with business sustainability since if they are successful, they would "fish themselves out of business." The representative from *Piscine Energetics* concurred, but stated that there are still quite a lot of shrimp to be fished because current technology only allows access to limited areas. Another audience member expressed concern that the iodine waste, after disinfecting eggs at the Road 17 facility, would be introduced to the environment. Gary Klassen affirmed that the waste is introduced into ground waste storage in the environment, but that it takes very little iodine to disinfect eggs—about 1L for 30,000 eggs—so the net volume introduced into the environment is quite small.

The audience's attention then turned to **salmon recovery**. One audience member asked that although the "miracle in the desert" of sockeye salmon returning to the Okanagan River system is impressive, the numbers are still dramatically lower than in the preindustrial era. In 2015, there was only 7,000-7,500 returning, whereas in previous years since restoration projects have taken place, there were 200,000 to 300,000. Given this, is it accurate to call the Okanagan a "healthy ecosystem" or are we back to square one in terms of salmon returns? Dr. Hyatt responded that certainly in 2015, sockeye runs were not good. . Climate change and land-use change are a "new normal" that have altered the system. However, mitigation efforts have been quite successful: when restoration initiatives first started 15 years ago, there were only about 5000 sockeye returning to the Okanagan River system on average. We will likely not see runs as low as 7,500 as restoration efforts continue, but runs of 15,000-20,000 are very possible as lower thresholds. In the winter of 2014, exceptional runoff created excellent incubation conditions, making it one of the best incubation years on record. Osoyoos Lake received some 60,000,000 fry in the spring of 2015. It is expected that when these salmon return, runs will once again be very high. Richard Bussanich of the Okanagan Nation Alliance added that we do not know how fish will respond to restoration efforts, but that if we give the fish a chance, they will teach us.

"If we give the fish a chance, they will teach us."

- Richard Bussanich, ONA

[5] Local river and lake water would be too warm for Arctic char to survive if they were to somehow escape due to infrastructural or human error.

Some audience members were interested in the **Fish Water Management Tool**. One asked whether the tool could be used to mitigate the oxygen squeeze[6] in Osoyoos Lake. Panelists answered that in normal years, releasing pulse flows from Okanagan Lake (which has much more storage) can help to mitigate oxygen squeezes. However, this takes quite a bit of water, and this year there was not enough water to be able to do this. Another forum participant asked whether the Fish Water Management Tool could be adapted for two different spawning times. Panelists answered that currently the tool is calibrated for dominant runs, but that it could be recalibrated to include more than one.

The discussion then turned to **fisheries recovery and restoration initiatives under climate change**. An audience member asked whether fisheries biologists planned on using genetic research to amplify the natural selection process and encourage the introduction of more heat tolerant salmon to the Okanagan River. The Panelists agreed that this could be a possibility, although fish are already adapting, for example by spawning later in the season. Genetic diversity is important to the survival of the species, so ensuring this is a priority going forward.

At a panel at the end of Day 1 of the forum, an audience member questioned why there is so much attention paid to salmon in the Okanagan instead of other Species at Risk. The panelists noted that there are several reasons for the scientific and political attention that salmon receive:

- Salmon are a major food source for the Okanagan people, and carry a great deal of cultural significance
- Salmon are an indicator (sentinel) species: if salmon are doing poorly, it is very likely that other species are also doing poorly; when we restore ecosystems for salmon, we also restore them for other species
- Salmon are very tied to the history of European settlement in the West, and have been a major consideration throughout the history of North American environmental management and flow regulation
- Salmon are an excellent metaphor for ecological connectedness: they connect the local to the far away, and also provide many nutrients that sustain the biodiversity of ecosystems hundreds of kilometers away
- Salmon are a “charismatic megafauna” and therefore carry more traction in these discussions—it is easier for people to feel compelled to care about salmon than other species at risk that may be very small and hard to perceive

Finally, an audience member asked for clarification regarding **what kind of fishing equipment** fishers from the ONA use compared to OSCI fishers use. The panelists responded that OSCI fishers use rods. ONA fishers who catch sockeye for food may use nets.

2.3 Climate Variation and Change

Introduction

[6] Low oxygen levels in the water caused by higher-than-normal temperatures that can threaten the survival of fish and other aquatic organisms.

Climate change is expected to have significant impacts on hydrology, and consequently the human systems and ecosystems that water supports. 2015 was a particularly dramatic year, in terms of weather and hydrology, in the Pacific Northwest. Some panelists characterized 2015 as a "test run" for expected conditions under climate change. This section summarizes projected hydrological and ecological consequences of climate change in the Pacific Northwest in general and in the Okanagan basin.

Climate Change and its Impacts in the Pacific Northwest

***Meade Krosby**, Research Scientist, Climate Impacts Group, University of Washington*

Analysis of ice core data shows conclusively that the current concentrations of CO2, CH4 and N2O in the atmosphere are known to exceed any level measured for at least the past 800,000 years. Further, the average rate of change of the introduction of these greenhouse gases (GHG) into the atmosphere exceeds any rate observed over the past 20,000 years. Since 1880, global surface temperatures have increased by 0.85°C (1.5°F). Most of this warming has occurred since 1970. Ten of the hottest years on record have occurred since 1998. It is projected that the climate could warm by 4°C by 2100; if we make large-scale changes to reduce GHG emissions, it is still projected that temperatures will rise by at least 1°C.

In the Pacific Northwest, temperatures have changed by 0.75°C (1.3°F) between 1885-2011, slightly less than the global average. There has been an observed lengthening of the frost-free season by approximately 35 days in this time period as well. Various climate change models have been elaborated for the Pacific Northwest. They project the following trends:

- Warming is projected through the 21st century in all scenarios
- Warming is expected in all seasons
- Extreme heat events will become more frequent
- Fall, winter and springs will be wetter; summers will be drier
- Heavy rainfall events will become more frequent
- Decreased snowpack in winter and spring; snowmelt earlier in the season

These climate changes are expected to impact hydrological cycles. In particular, because streams will be increasingly rain-fed instead of snow-fed, it is projected that the Pacific Northwest will experience increased winter flows, earlier spring peak flows, and lower summer flows.[7]

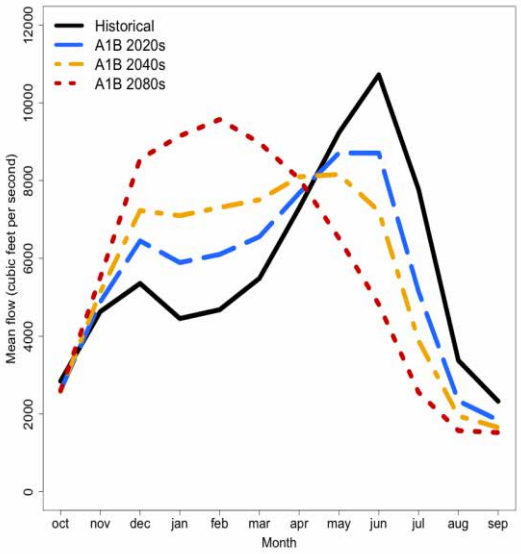

Figure 8: Projected changes in the hydrograph in the Pacific Northwest interior due to climate change

These changes in stream flow and precipitation patterns could precipitate:

[7] Figure 7 shows historical trends for streamflow (black line) and projected streamflow patterns in 2020 (blue line), 2040 (yellow line) and 2080 (red line) under projected climate change scenarios.

- Greater risk of landslides and flooding in the winter and early spring months
- Greater pressures on water demand (e.g. for irrigation, fish flows) in the summer and autumn months
- Increased stream temperatures, which would compromise salmon survival and impact other wildlife[8]
- Greater likelihood and intensity of wildfires in summer months—climate projections estimate twice as many forest fires by 2020 and three times as many by 2050

Ecosystem and hydrological consequences of climate change are likely to impact First Nations and Tribes more profoundly, as traditional food sources, and important plant and animal species are threatened. In order to reduce the risks of climate change on natural and human ecosystems, both mitigative and adaptive measures are necessary.

Water Supply and Demand in the Okanagan and Similkameen River Basins

***Brian Guy**, National Practice Leader and Senior Geoscientist, Summit Environmental Inc.*

Several reports on water demand and supply in the Okanagan and Similkameen Basins have been published over the past years. The *Okanagan Water Supply and Demand Project* was a comprehensive study that was a major update to a study of a similar nature conducted in 1974. The study modeled and assessed current water supply and demand (phase 2), and conducted modeling of future supply and demand under climate change scenarios (phase 3)[9]. Significant findings include:

Supply

- 80% of incoming precipitation evaporates before reaching streams, lakes or percolating into the ground;
- Of all the inflow to Okanagan Lake, about half evaporates off the lake;
- Inflow is highly variable throughout the year—85% of inflow to Okanagan Lake comes between March-July;
- Inflow is also highly variable between years ;
- Climate change will cause streamflow to peak earlier in the season and low flows will last longer in the summer months;
- Evaporation will be more significant as temperatures continue to rise.

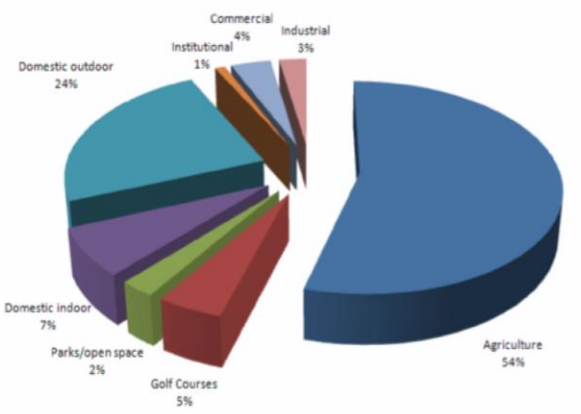

Figure 9: Water demand by type in the Okanagan basin (Canadian side)

Demand

- 443,000 megalitres (ML)[10] of water in the Okanagan is licensed for offstream use and 351,000 ML is licensed to remain in the streams for aquatic ecosystem purposes;
- About one-third of water licensed for diversion is supported by storage;

[8] On a global scale, species have moved approximately 17km poleward per decade and 11m up the alpine/decade.

[9] Phase 1 of the study identified what data and information was already available.

[10] 1 ML = 1,000,000L

- Only about one-third of the water licensed for withdrawal is actually withdrawn, but the demand varies from year to year, and is highest in dry years;[11]
- 86% of water used in basin is used outdoors; of this 54% is for agriculture and 24% domestic outdoor purposes;
- Projected population growth of 36% between 2012-2035 will put more demand pressures on water supply, especially if new development continues as usual.

Technical studies conducted on water supply and demand in the Similkameen River showed that:

Supply

- Like the Okanagan, streamflow is highly variable between seasons and from year to year;
- Although the Similkameen and Okanagan basins are quite similar in size, streamflow in the Similkameen is about 2.5 times that of the Okanagan;[12]
- Peak flows in the Similkameen are approximately 8 times greater than the Okanagan;
- Climate projections are similar in the Similkameen as in the Okanagan.

Demand

- Demand in the Similkameen is about one quarter the demand in the Okanagan;
- Less than a quarter of the water that is licensed for withdrawal is actually withdrawn.

These studies have highlighted the need for more monitoring (e.g. streamflow, groundwater levels), research (e.g. instream flow requirements for fish passage) modeling and mapping (e.g. aquifers, floodplain mapping) planning and mitigation measures (e.g. source protection, stormwater, invasive species) and greater coordination of science with traditional knowledge of First Nations peoples.

2016 Columbia River Basin Long-Term Water Supply and Demand Forecast

***Dan Haller**, Director, Aspect Consulting*

The Department of Ecology in Washington State updates its *Columbia River Basin Long-Term Water Supply and Demand Forecast* every five years, and submits the document to the State Legislature. The last report was issued in 2011, and the next report is scheduled to be released in November 2016. The report helps to determine what changes in policy and law need to be implemented to keep up with the latest science.

The 2011 report:

- Forecasted surface water supply and demand through 2030, but did not include groundwater;
- Included minimum required instream flow measures, but these are regularly unmet in practice;

[11] Currently, licenses exist only for surface water withdrawals until the groundwater regulations for the Water Sustainability Act 2014 come into effect in 2016.

[12] The Similkameen is fed by the wet Cascade Mountain Range.

- Projected zero new hydropower flow requirements by 2030, but that will likely change in the updated version.

The 2016 report will:

- Forecast through 2035, and will include both surface and groundwater;
- Improve hydrological models and integrate climate change projections;
- Integrate economic, policy, other considerations such as projected changes in irrigation demand into forecasting;
- Assess how water banking and prices affect demand in Washington;
- Include more robust watershed planning considerations.

Focus of Audience Interest and Feedback

Only a few forum participants explicitly asked questions or gave comments related to climate change, however, the implications of climate change were very much woven into other questions and comments throughout the forum. One participant asked about the **linkages that exist between climate change, El Niño and extreme meteorological events**. Ms. Krosby replied that extreme events are an example of the peak end of variability based on historical data. However, we only have about three examples of El Niño events in past century, so we do not have a good historical data to be able to project variability and extreme events with a level of certainty.

Some other audience members expressed frustration at progress on mitigating climate change, despite a great deal of science that point to the causes and effects of climate change. One participant chastised politicians for not having enough political will, and another lambasted "hope," saying what we really need is action.

2.4 Water Quantity

Introduction

Presentations related to water quantity at the 2015 OLWSF included the regulation of water flows throughout the Okanagan, Washington's water allocation program, and a variety of presentations that discussed the impacts of drought on water supply on both sides of the border. Indeed, drought was a notable theme for 2015, when both British Columbia and Washington felt the strain of low water supplies. Low snowpack, early snowmelt, low spring precipitation, and high temperatures in the spring and summer months were major contributing factors for the drought. Impacts varied by region on both sides of the border, but included fish stress and mortality; low to critically low levels in some drinking water reservoirs; agricultural impacts; hydropower generation impacts[13]; and industrial impacts.

[13] For example, 95% of power generation in BC comes from hydroelectric means and hydro generates some $400M in revenue for the province, so there was a notable financial impact as well.

Water Management of the Okanagan Lake Regulation System

***Shaun Reimer**, Section Head for Public Safety and Protection, BC Ministry of Forests, Lands and Natural Resources Operations*

All of the mainstem lakes in the Okanagan system are regulated. Every lake has either a hydraulic, electrical lift, or hand crank dam at its outflow. There are four dams that comprise the Okanagan Lake Regulation System: Kalamalka Lake Dam, Okanagan Lake Dam, Skaha Lake Dam, and McIntyre Dam (at Vaseaux Lake). Constructed between 1950-1958, this flood control system includes 17 vertical drop structures that allow fish passage, 38km of engineered channels, 68km of dikes, and 4 basins to trap sediment.

Lake level decisions for dam operations are made using the Fish Water Management Tool (FWMT), a computer model that helps with decision-making processed regarding lake and rivers levels. It is based on:

- Inflow forecasts, put together by River Forecast Centre in Victoria;[14]
- Release schedule from Okanagan Lake Dam;[15]
- Peak spawning dates, temperature data, and field observations to inform the water manager of fish hatching and emergence.

The FWMT gives dam operators a better understanding of when they can increase flows in the spring, with the constraint that Okanagan River cannot exceed certain flows at different times of the year or fish smolts and eggs may be washed away. These constraints are overridden during times of intense freshet, as Okanagan Lake dam does not have much storage and cannot control large inflows.

Washington's Trust Water Rights Program

***Kelsey Collins**, Statewide Trust Water Coordinator/Water Acquisitions, Washington State Department of Ecology*

Issues arising from the tensions between a strained water supply and user demand in Washington State have been salient for a long time. In the Yakima basin, a surface water rights lawsuit that began in 1977 is still undergoing adjudication. In order to address these tensions, the Washington State legislature has put into effect various programs. In particular, they have instituted:

- A statewide Trust Water Rights Program (established 1991)
- The Watershed Planning Act (1997)
- The Irrigation Efficiencies Grant Program (established 2001), and
- The Water Acquisition Program (established 2003).

The Watershed Planning Act enables citizens in a watershed to develop watershed plans that balance minimum instream flow requirements with local water demand interests. The Trust

[14] Forecasts are made by estimating snow water equivalents from snow pillows, flows from Water Survey Canada, and temperature data

[15] The range of flows through Okanagan Lake Dam is not very variable. It allows lake levels to fluctuate by 1.15m (3.77ft) between 341.34m (1119.2ft) and 342.48m (1123.65ft).

Rights Water Program (TWRP) allows the Department of Ecology to hold water rights[16] in trust when they are not being used. If water rights holders do not use their allocations for five years, they lose the water right (as dictated in the "use it or lose it" relinquishment law). The Department of Ecology (Ecology) can then hold these water rights for other instream or out-of-stream purposes. TWRP allows water rights holders who are not currently using their allocations to either:

- Sell back all or part of their water right to Ecology;
- Lease all or part of their water right to Ecology;
- Temporarily donate all or part of their water right to Ecology. Rights holders can get their water right back when they want it, but it is effectively "parked" for the time it is donated;
- Sell their water rights to water banks, which can re-sell them to other users or hold them for mitigation (i.e. instream flows);
- Privately exchange water rights with other rights holders.

Both the Irrigation Efficiencies Grant Program and the Water Acquisition Program were established after three species of Columbia River salmon were added to the Endangered Species list. The State Governor commented that "extinction is not an option," and these programs to conserve supply and reduce demand were put into place. The Irrigation Efficiencies Grant Program provides up to $8M biannually for farmers to invest in more efficient irrigation technology. The Acquisition Program is quite similar to the TWRP in that rights holders can sell or lease their water right back to Ecology, however it is aimed at water rights located in streams with critically low flows where fish survival may be threatened. Federal and State funds are allocated for Ecology to buy back water rights exclusively for instream needs. All water obtained through this program is returned to the creeks, streams and rivers where it was originally withdrawn.

Washington State Drought Response

***Jeff Marti**, Drought Coordinator, Washington State Department of Ecology*

2015 was the first year since 2005 when drought was declared in Washington State. There are two criteria for declaring drought in Washington:

- There is 75% or less of normal water supply in a watershed;
- The strain on water supply is declared as causing "hardship."[17]

For 18 months straight between February 2014 and September 2015, the State of Washington experienced warmer-than-average temperatures. Snowpack was unusually low in the Olympic Mountains: In normal years, about

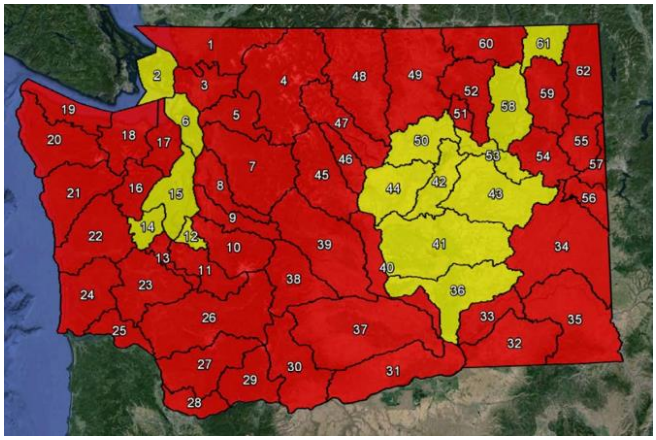

Figure 10: Washington State watersheds projected to have 75% of normal water supply or less (in red) in May 2015

[16] A "water right" is akin to a water allocation or license. In Washington and British Columbia, there is a "First in Time, First in Right" (FITFIR) system where water users that have had their water allocation for the longest period of time have priority over junior users.

[17] I.e. severe impacts to the economy, the environment, and/or public health

45% of precipitation falls as snow. In 2015, that number was about 11-12%[18]. By May 2015, 85% of the state's watersheds were projected to have 75% less water supply than normal, and a statewide drought declaration was made.
A drought declaration in the State of Washington's gives the Department of Ecology authority to take actions to mitigate impacts. Drought response included:

- Leasing water rights[19] in the Yakima and Dungeness Basins[20] to boost stream flows;
- Funding emergency fish passage and hatchery projects;
- Authorizing emergency wells for groundwater pumping in the Yakima Basin;
- Issuing curtailment orders to protect senior water rights users and instream flows.

The drought had notable impacts on streamflow and fish (some smaller streams went completely dry or ceased to reach the ocean). The impacts to agriculture are still being calculated; senior water rights holders may not have been impacted very much but junior rights holders may have had their supply reduced or shut off entirely. Impacts to drinking water varied by basin; in the Yakima basin, reservoirs were about 200,000 acre feet less full than in a normal year. Many water utilities implemented conservation measures. There were also reports of groundwater wells running dry throughout the state. It is projected that higher temperatures in 2016 due to El Niño activity could trigger another drought year in Washington State.

Drought 2015: BC's Planning and Response

***Glen Davidson**, Director, Water Management Branch, BC Ministry of Forests Lands and Natural Resource Operations*

At the Ministry of Forests, Lands and Natural Resource Operations (FLNRO), staff thought they were prepared for a drought, but discovered that the ministry will need to consider how to act more effectively in the future. In the summer of 2015, the province put into effect its Drought Response Plan, which it had not used since 2008. The plan establishes technical working committees, sets out the framework for collaborative and local government actions for each drought level.

Province (FLNRO is lead agency)	Local Government
• Coordinating interagency action • Determining drought levels[21] • Monitoring conditions and issuing stream advisories • Implementing statutory regulations (e.g. curtailing water rights, closing streams) • Communicating to the public and stakeholders • Supporting local emergency preparedness	• Monitoring local conditions • Managing community water supplies • Implementing water conservation measures • Communicating with the local public, stakeholders and media • Leading emergency preparedness actions

Table 2: Roles and responsibilities of provincial and local governments for drought response in BC

[18] This is the lowest amount of precipitation in Washington that has come as snow in 65 years.
[19] \ Ecology makes an offer to buy water rights, and leases users back a portion of that for the summer.
[20] These are fully allocated basins, i.e. all water for out of stream purposes has been allocated.
[21] The province recognizes four levels of drought, with Level 4 being the most severe.

In the Okanagan, a Level 3 drought was declared in July 2015 (this was elevated to a Level 4 drought in early August). The province responded by revising operations of the Okanagan Lake Regulation System to let pulse flows through. No water rights were curtailed in the Okanagan, but this was very nearly in the case in the Similkameen. The province also suggested voluntary reduction of water use, which was quite effective.

While the Drought Response Plan helped to coordinate actions to respond to the province-wide drought, it was clear that more work needs to be done to more effectively respond and mitigate impacts. 2015 was something of a "test run" for the future hydrological conditions approximated by climate change projections. Important lessons learned for future drought planning should include:

- Clarifying roles and responsibilities;
- Planning for multi-year drought;
- Increasing capacity and resources;
- Increasing water conservation efforts in both drought and non-drought years.

Okanagan Drought Planning and Response

***Kelly Garcia**, Environmental Planner, Associated Engineering Consultants Inc.*

The drought of 2015 revealed that there are some major gaps in drought response planning. When the Province of BC first declared a drought in Okanagan, there was a level of confusion among local water purveyors regarding what it meant for them. The Okanagan Basin Water Board (OBWB) largely filled the gap to coordinate local response in the Okanagan.[22]

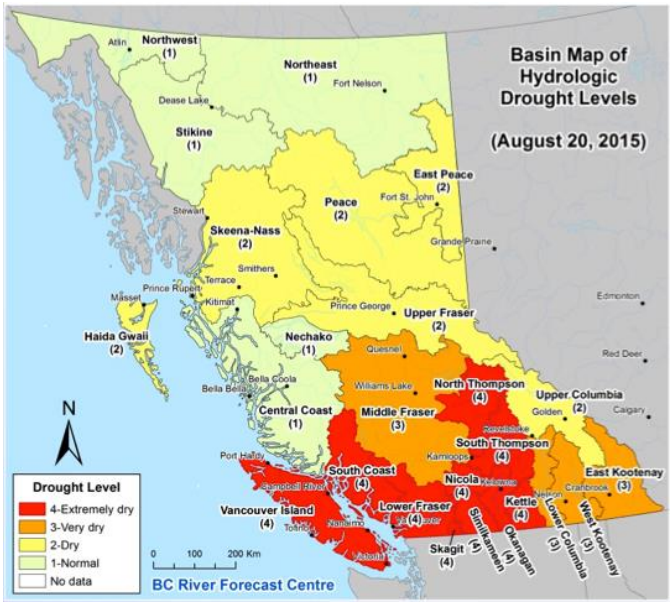

Figure 11: Hydrologic drought in regions of BC (August 2015)

Impacts of the drought in the Okanagan were comparable to impacts in Washington and BC. Several streams were put on the "watch list" for water rights curtailments and other regulatory actions. However, unlike in other jurisdictions throughout BC and Washington, drinking water reservoirs in the Okanagan generally fared quite well. The vast majority of reservoirs are either on the mainstem lakes or at high elevations and filled quickly in the spring due to high spring runoff (although became somewhat more strained in the summer and fall[23]). The relatively high reservoirs levels actually created issues in coordinating drought response actions, because some drinking water purveyors were not as affected by low water supplies and consequently were less inclined to implement drought response measures.

[22] Actions included: frequent e-mail updates to water purveyors and stakeholders, public messaging and media relations, commissioning studies to gauge how drought was affecting water supply in the Okanagan and the effectiveness of drought response actions, and holding a public webinar and workshop.

[23] There is concern that reservoirs could face shortages next year if there is not enough precipitation in the winter and spring of 2016.

Water utilities throughout the Okanagan had varied responses: some initiated voluntary water reduction measures,[24] others required reduction in water allocations, and some engaged in public communication.

Specific challenges to drought response in the Okanagan included:

- Reactionary instead of proactive response ("too little, too late");
- Poor framework for establishing roles, responsibilities and coordination between different players;
- Different criteria for drought at the provincial and local levels (confusing);
- Poor communication of what actions are required at the local level when province declares drought ;
- Poor integration of responses by water suppliers throughout the watershed.[25]

To address these issues, OBWB has commissioned an Okanagan drought response gap analysis to evaluate preparedness and strengthen drought resiliency.[26] It was determined that all water purveyors but one in the Okanagan have water restriction bylaws, but only 5/18 have formal drought response plans. The analysis is still underway, but initial recommendations include:

- Gathering better information and data to help support drought planning;
- Developing drought plans for water suppliers and for the basin as a whole that take into account projected hydrological changes under climate change;
- Adopting consistent definitions of drought at the local and provincial levels;
- Initiating year-round water conservation planning;
- Developing a framework for clear and consistent communication and messaging.

Drought Planning in Osoyoos

Sue McKortoff, *Mayor, Town of Osoyoos*

Osoyoos has been examining drought response measures. Ms. McKortoff noted that, as the only desert in Canada, Osoyoos should be leading the way in conserving water. Some restrictions were put into place in the summer of 2015:

- In June, the town restricted outdoor watering to two days a week;
- In July, the town worked with the region to also restrict water districts to watering to two days a week;
- Public remarks from the mayor about conserving water (awareness raising).

There was a fair amount of push-back from local residents who did not see the need for water conservation when the lake appeared full.

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[24] It was suggested that water purveyors and users implement voluntary water use reduction measures of 30%. It was determined that a 30% reduction would have meaningful impacts on the viability of juvenile sockeye.

[25] The north and south basins of the Okanagan are highly interconnected and actions at one end can affect the other, but it is difficult to demonstrate the importance of hydrologic connectivity to water managers.

[26] Factors that influence water resiliency include: a good understanding of water supply and demand (current and future), monitoring, record-keeping and reporting; continued and heightened conservation; formal communication strategies; and consistent, deliberate and proactive cooperation.

The Town is concerned about water supply to its six groundwater wells, and has asked town staff to conduct a study on water supply to the well to determine how water levels respond to drought. The Mayor noted that she was quite confident that Osoyoos would start out next year with some kind of water restrictions to conserve water, and that they would work on making their communication and public messaging more clear and consistent.

Focus of Audience Interest and Feedback

Given the severity of the drought that impacted British Columbia and Washington in the summer of 2015, forum participants were quite interested in this topic and a variety of questions and feedback arose. A couple of participants were interested in **how political decisions at the provincial level affect drought response** on the ground. One audience member asked whether the newly passed Water Sustainability Act would affect drought response planning. Mr. Davidson responded that the province is still in the process of developing regulations for the act, so as of now it is unclear. Regulations will start to come into place in January 2016 and will continue to roll out through next few years. Another participant remarked that they were quite impressed with the proactive nature of drought response actions in Washington, and asked why the response in BC was less extensive and was not triggered until the drought was already underway. Mr. Davidson noted in that in Washington, a drought declaration triggers funding and other operational measures, but that in BC there is no additional funding associated with drought declarations.

Another question was related to **water curtailment orders**. An audience member from the Washington State Department of Ecology asked how BC decides which water allocations will be curtained during times of drought and how they enforce curtailment orders. Mr. Davidson noted that BC uses a *First in Time, First in Right* system for water allocations but may deviate from that model slightly in times of drought through the Fish Protection Act, that will be brought into the Water Sustainability Act. For example, regional offices of FLNRO have discretion to change conditions of water licenses when they judge that very low flows may compromise fish survival. The ministry also has the authority to curtail water allocations entirely, without compensation, if deemed necessary. In 2015, approximately 50 licensees had their water shut off in the Nicola Valley under Fish Protection orders because flows were extremely low. The audience member responded that in Washington State, it is *First in Time, First in Right* and that water allocations are curtailed based on that—there is not discretion to curtail based on priority of need.

A participant asked how Washington State's handles **demand for bottled water**. Kelsey Collins of the Department of Ecology replied that it is considered a water right like any other water use, but that all new water rights must also have mitigate their use, i.e. purchase an old water right. No "new" water is allocated in Washington.

An other audience member commented that in the Okanagan, there is about 6 times more **golf courses** per capita than in the rest of Canada (about 24 golf courses/100,000 people) and reminded forum participants that land-use planning measures cannot be separated from water management.

2.5 Land Use Planning

Introduction

There were three presentations that discussed the relationship between land-use planning and water management at the 2015 OLWSF. Two presentations discussed local level initiatives in Osoyoos and Oroville to plan for more water-friendly cities on the shores of Lake Osoyoos. The third discussed an initiative to bring greater harmony in land-use planning and natural resource management on both sides of the border.

Land Use Planning in Oroville, WA

***Chris Branch**, Community Development Director, City of Oroville*

Passed in 1971 by the Washington legislature and adopted by the public in a referendum in 1972, the *Shoreline Management Act* is a major tool to preserve shorelines in the State of Washington. The act requires that every country and city with shorelines adopt a Shoreline Master's Program (SMP). Osoyoos Lake has approximately 48km (30mi) of shoreline on the Washington side, but only 5% of that is managed by the city. Another 30% is managed by Okanogan County, and the remaining shoreline is privately owned and used for residential or recreational purposes. Okanogan County did not initially adopt a SMP, so the department of Ecology enacted one on behalf of the county. In 1990, the City of Oroville adopted an SMP of its own. The SMP included measures such as setbacks of development from the shoreline and vegetation retention measures.

Recently, the City began work to update the SMP to include a cumulative impacts assessment into shoreline planning. The City of Oroville is proposing 50' setbacks (15m) with half of that area as vegetated buffer in the updated plan. Currently, the county's required setback is 25' (7.5m). Given the small amount of shoreline that Oroville manages, they are trying to work with the county to have them adopt the larger 50' setback and buffer. Oroville city council will likely adopt this this year, but Okanogan County has not been amenable to the update. Mr. Branch noted the necessity of strong leadership and communication to ensure sustainability of Lake Osoyoos. He suggested that if we do not know the impacts of a development we should employ the precautionary principle.

Land Use Planning in Osoyoos, BC

***Stu Wells**, Former Mayor, Town of Osoyoos; Chair, Osoyoos Lake Water Quality Society*

The Town of Osoyoos integrates various water issues into its planning process, and has invested in extensive infrastructure to support water management. Investments include:

- Infrastructure to allow treated effluent from the wastewater facilities to be used for irrigation at the Osoyoos Golf and Country Club and school fields;[27]

[27] This in contrast to most other communities in the Okanagan that discharge effluent into the lakes.

- Collaborating with the regional district to extend sewer services to rural properties so that residents can switch from septic systems;
- Constructing a twin pipe system to rural areas to deliver water for agricultural purposes and drinking water purposes in separate pipes (project underway) ;
- Stormwater projects to collect and filter runoff from impervious areas before it reaches the lake, e.g. town staff worked with the Watermark Hotel to install a 13 acre stormwater system to filter lake-bound contaminants from the town's principal roadway.

The town also has various bylaws that are intended to help preserve water quality, such as a requirement that all new lakefront developments have a setback of at least 15m. In 2012 they introduced a foreshore development zoning bylaw that established zoning of public, private, commercial and recreational areas in the foreshore area that is inclusive of docks, wharfs and boatlifts. The bylaw also regulates the length and setbacks of docks and boatlifts.

The Washington-British Columbia Transboundary Climate-Connectivity Project

***Meade Krosby**, Research Scientist, Climate Impacts Group, University of Washington*

Figure 12: An air photo showing incongruous land-use development on either side of the Canada-U.S. border

Habitat connectivity refers to the extent to which wildlife can move throughout a landscape or water body. This is especially important in an era of climate change when species have to migrate quickly to get to cooler areas. However, political barriers can be an impediment to the movement of species.

There is relatively good coordination on either side of the Canada-USA border to promote fish movement, but not so much for terrestrial species. Different levels of development on either side of the border make it difficult for species to migrate. For example, in the Okanagan there is high development on Canadian side, but not on the American side, so species migrating from the US might find themselves suddenly in a developed area.

In addition to landscape discrepancies on either side of the border, collaboration can be further complicated by inconsistencies in scientific data. In order to address barriers to transboundary connectivity in the Pacific Northwest, the *Washington – British Columbia Transboundary Climate-Connectivity Project* was initiated. Spearheaded by the Climate Impacts Group in the US and the Pacific Climate Impacts Consortium in Canada, the project brings scientists and

environmental managers on both sides of the border[28] into dialogue in order to promote a connected, resilient, transboundary region. Deliverables of the project include:

- Gathering, interpreting, and applying existing datasets to identify climate impacts to ecological connectivity in the transboundary region;
- Developing and disseminating management strategies and tactics for conserving climate-connectivity in the transboundary region;
- Identifying information gaps and institutional barriers, and the additional research and policy needed to address them;
- Increasing climate adaptation and connectivity conservation capacity of participant agencies, tribes, and organizations;
- Increasing transboundary and inter-agency/tribe/NGO collaboration.

A great deal of cooperation, flexibility, and persistence has been necessary to push this initiative forward. Particularly challenging has been getting partners from both sides of the border to the table.

Focus of Audience Interest and Feedback

The audience was quite interested in the land-use planning discussion, and a few questions arose in the short question and answer period. The first participant asked whether Osoyoos and Oroville have measures in place to **regulate boat density and access** to the lake, as the concentration of boats has been an issue on many of the mainstem lakes throughout the Okanagan. The presenter from Oroville responded that the county's planning designations allow for large resort development and docks, so accessing the lake is quite easy. An issue of concern for Oroville is how to limit new development but ensure a level of fair access (i.e. is it fair to restrict new residents from accessing the lake while allowing longer term residents access?) The panelist from Osoyoos affirmed that there are no bylaws to regulate boat density currently and that it could be quite messy to implement, since regulation of boats would take enforcement, and residents and tourists tend to be adverse to enforcement. Enforcement would also be a financial burden on a small community. Further, the town shares shoreline with the Okanagan Nation Alliance, so if they started to develop and allow boats, it would further complicate the issue of fairness.

Another audience member noted that while planning measures were important, we need to do a better job at looking at underlying causes of environmental degradation, such as economic development, and that federal, state and provincial governments ought to take more responsibility in addressing these causes. Finally, a participant noted that, although British Columba has a riparian law that recognizes full public access to the shoreline below the high water mark, that several small lakefront communities (including Osoyoos) have allowed private developments that impede public access.

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[28] In Canada, project partners include the Pacific Climate Impacts Consortium, BC Parks, the BC Ministry of Forests, Lands and Natural Resource Operations, the Okanagan Nation Alliance, the South Similkameen Conservation Program, the Okanagan Collaborative Conservation Program; in the US, partners are the Climate Impacts Group, the National Park Service, the US Forest Service, the Confederated Tribes of the Colville Reservation, and the Washington Wildlife Habitat Connectivity Working Group.

2.6 Water Quality

Fire and Water

***Don Dobson**, Senior Engineer, Urban Systems Ltd.*

Although some forest fires are provoked by naturally occurring causes, they can have notable effects on water quality and hydrology, which can threaten aquatic organisms and compromise drinking water. Impacts include:

- Increased turbidity and sediment transport;[29]
- Earlier snow melt and increased runoff into streams;
- Increased nitrates and possibly heavy metals;
- Increased microbial pathogens (e.g. bacteria, viruses, parasites);
- Changes in pH;
- Increased stream temperatures;
- Decreased dissolved oxygen.

Fires can impact streamflow by changing the physical and chemical composition of soils. Burnt soils can become hydrophobic (water repellant), such that water does not infiltrate and is instead converted into runoff.[30] When organic matter burns, soil can become powdery. If a fire is hot enough, organic matter can be completely incinerated, causing nutrients in streams and lakes to be reduced.

How a watershed reacts to a fire depends on the intensity of the fire and burn severity. A severe fire may permanently change the hydrology of streams. For example, a fire in the Kootenays caused a stream to be washed out entirely. Low and medium intensity fires can have beneficial impacts to an ecosystem by helping to rejuvenate plant communities. Smaller, less intense fires also help to prevent larger, more intense fires. Catastrophic forest fires can be prevented and mitigated by taking measures such as reducing fuels (especially in areas around communities), and the impacts minimized by using post-fire risk assessment procedures.

Blue-Green Algae: The Basics and Washington's Monitoring Program

***Jennifer Parsons**, Aquatic Plants Specialist, Washington State Department of Ecology*

Blue-green algae are a kind of cyanobacteria[31] that occur in fresh and marine water. They can produce toxins that can cause skin irritations or damage to internal organs if ingested. They may also be lethal to pets, fish, wildlife and even humans. Not all blue-green algae contain toxins,

[29] Tests of a stream impacted by forest fire in the Okanagan registered turbidity of 70 NTU. NTU stands for "nephelometric turbidity units", and is a measure of water's ability to scatter and absorb light rather than transmit it in straight lines. The City of Kelowna rates water quality "poor" and inappropriate for drinking water any stream that registers over 5NTU.

[30] The presenter described a small watershed in Kelowna, BC where as experiencing streamflows at about ten times the amount as expected in a 100-year flow event after a forest fire had occurred.

[31] Bacteria that are blue-green (cyano) in colour.

Figure 13: A thick blue-green algae bloom on a Washington Lake

and it cannot be determined whether algae contain toxins until they are tested. They have a "pea soup" like appearance, but cannot be picked up like other kinds of algae mats.

Although blue-green algae occur naturally in waters, they tend to be unnoticeable until they build up into a bloom. Blooms are precipitated by the introduction of phosphorous and nitrates (from fertilizers and other sources) into surface waters, which is more likely after rainfall events that produce runoff. Because these algae get their energy from photosynthesis, conditions such as warm temperatures and sunshine can trigger large blooms.

In 2005, Washington State's Department of Ecology initiated a blue-green algae monitoring program. Funds from boat registration fees ($1/boat) fund the program. The program consists of testing water and identifying whether the blooms are toxic. It is a reactionary program that requires the public or municipal authorities to notify Ecology about blooms and send in samples to be tested. In addition to testing, the State of Washington also:

- Establishes guidance levels for closing sources for drinking water when certain amounts of toxins exist (micrograms/L); guidelines vary by toxin type;[32]
- Tracks geographical location and details of blooms with a publicly accessible map-based program;
- Undertakes various mitigation measures, such as lake management plans, nutrient reduction plans and experimental techniques like floating wetlands to filter water.

Okanagan Wetland Strategy Phase I and II

***Nelson Jatel**, Water Stewardship Director, Okanagan Basin Water Board*

Preserving and restoring wetlands is instrumental to mitigating flooding, safeguarding biodiversity and maintaining water quality. The valley bottoms of the Okanagan used to be largely wetlands, and high elevation wetlands were prevalent. However, urbanization and agriculture caused major land-use changes that resulted in a drastic loss of these ecosystems. Some 84% of original low elevation wetlands have been lost; 38% of wetlands have been lost between the 1980s until 2010. 93% of wetlands along the Okanagan River have been lost due to land-use change and development.

The Okanagan Wetland Strategy is a three-phase project to re-establish wetlands in the Okanagan. Wetlands have incredible emotional, spiritual and recreational value. Recently, economists have attempted to put an economic valuation on wetlands to approximate the

[32] Types of toxins that blue-green algae produce include Microcystin, Anatoxin-a, Cylindrospermopsin, and Saxitoxin

realm of ecological services they offer. This value is projected at $22,000/ha/year, a value that considers wetlands' capacity to:

- Ease freshwater shortages and drought;
- Mitigate flooding and erosion;
- Maintain and improve water quality;
- Mitigate the effects of climate change by acting as a carbon sink;
- Provide a diversity of aesthetic, educational, recreational, cultural, and spiritual values;
- Improve interaction with groundwater (infiltration).

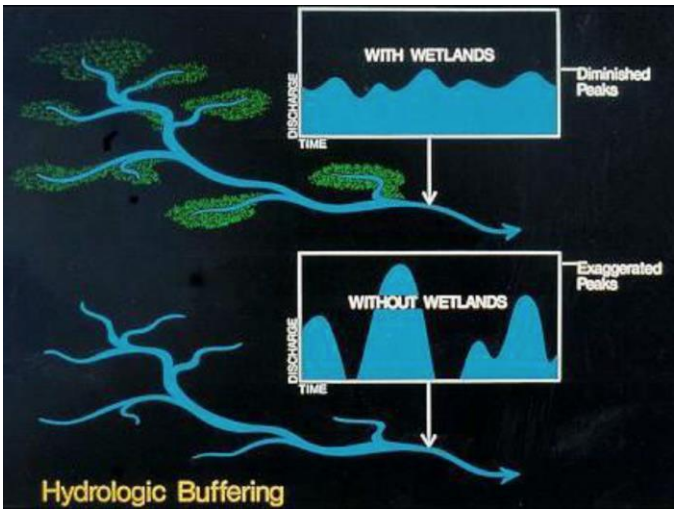

Figure 14: A picture showing how wetlands help to regulate streamflow by smoothing peak flow and low flows

When wetlands are lost, there are many costs borne by society, such as dealing with the impacts of flooding. The Manitoba floods could have largely been mitigated if riverine wetlands had not been converted.

The Okanagan Wetlands Strategy has three phases:

- Phase 1 (complete): Data collection and mapping to determine where remaining wetlands are located; outreach to stakeholders and community;[33]
- Phase 2 (underway): Strategic approach to prioritize wetland restoration and conservation with high habitat, recreational value; working with partners to establish long-term data management strategy;
- Phase 3 (starting in 2016): Focus on writing an Okanagan Wetlands Strategy document.

A number of wetlands in Kelowna, Vernon, Penticton and surrounding areas have already been restored, and work is ongoing.

Focus of Audience Interest and Feedback

Presentations in the water quality panel were pertinent to water quality in general and not specific to concerns in Osoyoos Lake. Notwithstanding, forest fires, blue-green algae and wetlands are topics that are all relevant to Osoyoos Lake and other water bodies in the Okanagan. There was a range of questions that were directed to all three topics. Regarding **forest fires**, one audience member asked the panel whether fire suppression could lead to larger, more catastrophic fires. Mr. Dobson confirmed that it could, and that one strategy is not

[33] A publicly facing website that maps existing wetlands and provides information about them can be found at http://okanaganwetlands.ca/.

to suppress fires but to reduce fuels and keep fires in controllable areas. One way to do this is to link cut blocks of forest together to create fire breaks.

One participant asked what kind of **health risks blue-green algae** present to fish and other wildlife. Ms. Parsons responded that the science is still "out" with regard to the impacts on fish, but that toxins found in blue-green algae could biomagnify up the food chain when consumed by wildlife. Another participant expressed concerned that there is not currently a **protocol for reporting blue-green algae** in the Okanagan, or alerting the public and closing beaches during outbreaks, and asked Ms. Parsons about the process for reporting and taking action in Washington State. The panelist responded that there is no hotline, and that if someone suspects blue-green algae in Washington, they should get in touch with their local health department. The health department is responsible for closing beaches, and Ecology does the testing of water.

Some audience members were interested in **wetlands**. One asked what specifically qualifies as a wetland? Mr. Jatel noted that in the Okanagan Wetlands Strategy, there are six different categories in the Okanagan region. Another participant asked whether the Okanagan has ever considered floating wetlands to control milfoil, to which Mr. Jatel responded that has not been on the table in the Okanagan.

2.7 Aquatic Invasive Species

Introduction

The Okanagan has been afflicted with some aquatic invasive species, such as Eurasian milfoil, but has been able to avoid infestations that have burdened other watersheds throughout North America, such as quagga and zebra mussels. Much like milfoil, once invasive mussels are introduced into water bodies they are nearly impossible to eradicate. Ensuring that these species do not enter into Okanagan waters will take the concerted efforts of government, water managers, scientists and the public. The presentations in this section discuss different jurisdictions' approaches to dealing with milfoil and efforts to prevent the introduction of invasive mussels.

The Okanagan Basin Water Board's (OBWB) Eurasian Milfoil Removal Program

James Littley, *Operation and Grants Manager, Okanagan Basin Water Board*

Eurasian milfoil was introduced into the Okanagan in the early 1970s, and by 1974 the plant was well established in all of the mainstem lakes. Milfoil grows in thick mats and can multiply very quickly: up to 5cm/day in good light conditions. It spreads by fragmentation (for example, breaking off from boats and regenerating elsewhere). Adverse impacts of milfoil include:

- Reducing oxygen in waters and lowering water quality;
- Restricting native fish habitat;
- Promoting algae blooms;
- Contributing to unattractive and odorous mats on beaches;

- Lowering property values by up to 19%.

OBWB's removal program has been ongoing for nearly four decades. The plant cannot be eradicated, only controlled. Technicians use a large rototiller to take out the roots when the plant is dormant in the fall and winter months. The plant then dies, and floats to the surface. When it regrows from any remaining roots in the spring and summer, the plant is harvested underwater, much like mowing a lawn.

Milfoil removal is not permitted in all areas. There are some areas where sensitive species habitat precludes the introduction of heavy machinery. There are also parts of the lake that the rototiller cannot get to because there are no access points. GPS is helping OBWB to be more strategic about milfoil removal, as it allows them to track precisely where they have already removed and what areas to prioritize in the future. Public areas are prioritized over private areas for milfoil removal.

Milfoil Removal in Okanogan County, Washington

***Anna Lyon**, Office Manager, Okanogan County Noxious Weed Control Board*

Okanogan County first started controlling for milfoil on Palmer Lake. The Osoyoos Lake Association put pressure on the county to initiative milfoil control on Osoyoos Lake, and pushed for the establishment of an Okanogan Noxious Weed Control Board. In 2011, the county obtained a permit from the Department of Ecology to use chemical means to control milfoil on Lake Osoyoos. There was a lot of public concern about the use of chemicals. Notwithstanding, treatment began in 2012, when the country treated 4 acres on the east side of Lake Osoyoos using an EPA-approved aquatic herbicide called triclopyr-TEA. The county also developed an integrated aquatic vegetation management plan[34] for the US side of Lake Osoyoos, which discusses vegetation issues on the lake and various methods to control them. Chemical treatment of milfoil has been ongoing. The county has worked largely with lake-dwelling landowners to control milfoil around their property.

The county, in conjunction with the Department of Ecology, also experimented with using biological measures to control milfoil by deploying weevils. Notwithstanding the relative success of this method, the effort to find and deploy weevils was very time intensive and the county is not currently continuing this. They have also explored using rototillers to harvest milfoil in the US side of Lake Osoyoos, however there has been a lot of pushback from the Department of Fish and Wildlife and the Department of Natural Resources.

The presenter recognized the need for greater public education and outreach, as the county often gets notifications from landowners who think that native aquatic plants are milfoil.

[34] See page 106-137 of document.

BC Invasive Mussel Defense Program

***Barb Leslie**, Conservation Officer (Okanagan Region), BC Conservation Office Service*
***Martina Beck**, Aquatic Invasive Species Research Analyst, BC Ministry of the Environment*

Figure 15: A picture of a zebra (left) and quagga (right) mussel (Source: www.redberrylake.ca)

Zebra and quagga mussels can survive out of water for up to 30 days and their larvae may survive in standing water. They can easily attach to boats and be introduced into new ecosystems when watercrafts are transported between waterways. They can multiply very quickly (females lay up to 1 million eggs per year) and infestations may occur with the introduction of only a few specimens. In addition to compromising local ecosystem health and water quality, invasive mussels can cause significant damage to infrastructure (e.g. blocking pipes in hydroelectric dams, compromising bridge stability). Mitigating the impacts of invasive species can be extremely time consuming and costly.

In British Columbia, the Ministry of the Environment is responsible for regulation related to invasive species, and the Conservation Officer Service is in charge of enforcement. This is mandated under the Controlled Alien Species Regulations (developed in 2009), a part of BC's *Wildlife Act*. In 2012, the regulations were updated to stipulate that it is illegal to transport, introduce or breed zebra and quagga mussels. Failure to clean mussels off boats or equipment could result in a fine of up to $100,000.

BC also introduced its *Invasive Mussel Defense Program* in 2015. The program, which ran from May-October 2015, trained six crews in BC to conduct inspections on watercraft entering the province, perform decontaminations and deliver education and outreach about the dangers of introducing mussels into BC. Statistics for the first year of the program include:

- 9,400 – the number of people crews conducted outreach and education to clean, drain and dry their boats;
- 4,000 – the number of boats inspected over the summer;
- 33 – the number of boats requiring decontamination;
- 15 – the number of boats containing mussels or standing water;
- 6 – the number of boats that were issued a 30-day quarantine order.

BC also collaborates with regional invasive species committees and other jurisdiction including Alberta, and states south of the border (Washington, Idaho, Montana) to increase intelligence regarding mussel detection and mitigation.

Focus of Audience Interest and Feedback

This panel discussion generated a great deal of interest, and many questions were posed to the panelists. Most questions were about invasive mussels, although one audience member asked **why Washington does not use a harvester to control milfoil.** Ms. Lyon responded that the Federal Department of Wildlife was opposed to it because they may inadvertently hurt fish, turtles, or other aquatic wildlife, so they use targeted herbicide application to control milfoil.

Many questions and comments pertained to invasive mussels. One audience member reminded participants that there are over 138 invasive species in the Great Lakes, which have taken quite a toll on the ecosystem, and that mussels have caused near ecosystem collapse in Lake Winnipeg, so we ought to be **proactive in keeping invasives out**. Another audience member asked whether there are measures being taken to **control the spread of mussels at the source**. The panelists responded that this is a key message in some jurisdictions in the US, but local marina staff often lack training to properly clean boats. One audience member was surprised that mussels could be transported through kayaks and canoes as well, and asked if efforts were being taken to **educate the public about invasive mussels** at places such as outdoor outfitters or where float planes may be located. The panelists from the government of BC answered that currently, outreach is not being conducted at airports but that it was on their radar for future outreach initiatives. Lisa Scott answered that the Okanagan and Similkameen Invasive Species Society conducts outreach at Canadian Tire and at community events. Someone asked the panel **what kind of partnerships should** be developed and strengthened to give invasive species defense programs more teeth. Mr. Littley responded that he would like to see senior politicians get on board and increase funding and on-the-ground capacity. Another participant asked what **the public can do** to help raise the profile of mussel defense programs. Panelists answered that putting public pressure on elected officials is important. So is getting youth involved. Mr. Littley noted that in the USA, there are several good examples of programs that use stickers to show which boats have successfully passed mussel inspections and that BC should look into having a similar program. A way stakeholder groups could help is to do an assessment of these programs and their successes.

Finally, one participant asked **what lessons we have learned** from milfoil infestation in our waters and how we can we apply that to keep mussels out? Panelist responses varied. One panelist noted how expensive milfoil control is, and that an economic argument might help to conjure greater political will. Another noted how education is instrumental to prevention. The panelists from the province of BC noted how public education and on-the-ground efforts are raising the profile of mussel defense programs, which is key to growing public acceptance and compliance.

2.8 Special Presentation: "Ascending the Okanagan 1811-1860"

Jack Nisbet, *Author*

Mr. Nisbet presented a compelling presentation on the relationship between salmon and people in the Columbia River basin, and how that relationship is mediated by the landscape. Using maps developed by European explorers and cartographers, the presenter highlighted the struggles of the early explorers to capture the complexity of the landscape of the Pacific Northwest, with its abundance of mountain ranges and network of rivers. For example, explorer David Thompson

made a crude map of the Okanagan basin without actually ever visiting the area, but approximated the landscape through conversations with tribes people and First Nations with intimate local knowledge of the landscape. Explorers and cartographers attempted to make maps of the Columbia River basin to help guide fur traders avoid the Fraser River on their way to the coast.

The presentation described the sheer abundance of salmon that existed in the Columbia basin in the early days of settlement. Despite the complexity of these watersheds, fish were always able to navigate the system. The fish are incredibly adaptable. Indeed, there is evidence that a genetic variation of salmon were living here between 2-5 million years ago (in the Mio-Pliocene era). The abundance of salmon was instrumental to human settlement and survival in this region, and the relationship between humans and salmon is ancient. Researchers have discovered salmon vertebrae from at least 9,300 years ago that show signs of human contact. The fish themselves and the relationship of people to fish has evolved throughout the years.

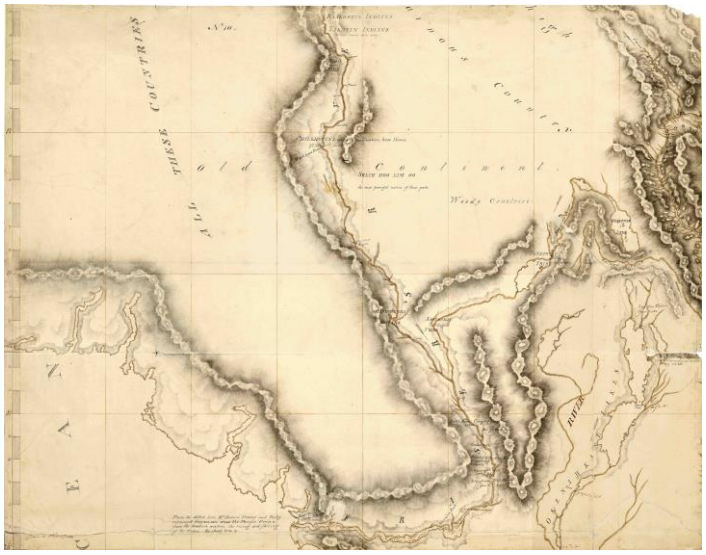

Figure 16: A map of the relationship of river systems between the Rockies and Cascade by David Thompson (1826)

First peoples had a good understanding of salmon, but the explorers did not. They were often hungry, and did not understand spawning cycles. Some explorers began herding cattle instead of relying on the natural abundance of fish for protein and fat.

Focus of Audience Interest and Feedback

The audience was very interested in the history of the relationship between people and fish in the Columbia basin. Quite a few audience members were interested in **how fish were able to bypass some key areas** to rich upper parts of the watershed. One audience member asked how fish were able to get up Kettle falls and another asked whether fish made it to the top of the Similkameen River. Mr. Nisbet did not know the answer to either of those questions. An audience member from the Confederated Tribes of the Colville Reservation replied fish never went above Enloe Falls on the Similkameen River, and that there are Okanagan creation stories about this.

Another audience member asked whether early canneries affected spawning. Mr. Nisbet was unsure, but postulated that fish wheels may have taken out some genetic strains of salmon, but that history shows that salmon are incredibly adaptable.

3.0 Emergent Themes

At the end of days 1 and 2, panelists were invited to reflect upon what they had learned during the day and what we should take into consideration when planning for a sustainable Osoyoos Lake and Okanagan watersheds into the future. The discussions from the synthesis panels and the author's own observations in drafting this report have informed the identification of key themes of the 2015 OLWSF. These themes are:

THEME 1: Partnerships are fundamental to protecting and enhancing health of our shared waters. The environment connects us, and what happens downstream/downwind affects what happens upstream/ upwind and *vice versa*. It does not follow jurisdictional boundaries; therefore we have to work effectively across political jurisdictions, cultures and organizational boundaries to collaborate on a watershed scale. Partnerships do not only increase our capacity but also our resiliency in responding to crisis. Important to forming healthy partnerships is forming shared visions and goals.

THEME 2: Intentional, strategic and proactive action needs to be taken. Although forming relationships is a necessary step to improve the health of our watersheds, it is not sufficient. Relationship building should be done with a will to take action to address specific threats and concerns. Actions should be proactive and future-oriented, and seek to mitigate and adapt to the anticipated impacts of climate change. Local leaders should be at the forefront of these actions, but state, provincial and federal governments should lend strong support. The current moment is rife with political opportunities that we should seize when planning for the future.

THEME 3: Integrate the social, cultural and political with the scientific. Evidence-based policy is very important in ensuring that our actions have real and lasting impact. However, humans are complex, multi-dimensional beings that place great value on what we deem to have social and cultural significance. Rational contemplation is often not enough to compel us to act; we will protect what we care about, and care is socially, culturally and politically mediated. Environmental managers should be mindful of this when taking action.

THEME 4: Adaptive management requires flexibility and compromise. Ecosystems are dynamic systems that cannot be predicted with certainty. In order to respond to the unexpected or unknown, environmental managers have to be adaptive and flexible. This also means being able to compromise. Environmental outcomes are not necessarily consistent with other outcomes (e.g. some economic development, resource extraction, irrigation needs, recreation, etc.), so we have to be willing to accept trade-offs.

These themes should guide the ethos of future action.

4.0 Assessing Progress and Planning for the Future

4.1 Assessing Progress: 2007-2015

The 2007 and 2011 Osoyoos Lake Water Science Forums were important opportunities to assess where we are and where we would like to go with regard to ecosystem health in Osoyoos Lake and the wider Okanagan Basin. Since the 2007 forum, significant progress has been in some areas. Of particular note is progress in the areas of:

- Collaborative efforts to restore salmon fisheries in the Okanagan; since 2008, there has been a major spike in salmon returns to the Okanagan River
- Integration of many of the recommendations made in the 2011 forum and Summary Report into the renewed Zosel Dam operating Orders
- Expansion of the International Osoyoos Lake Board of Control to include more local participation on both sides of the borders
- Increased flexibility and collaboration in managing flows of the Okanagan watershed system, especially with continued improvements to the Fish Water Management Tool
- Improved data and information about water supply and demand in the Okanagan, due in large part to the ongoing work of the Okanagan Water Supply and Demand Project
- Drought response planning, particularly through the ongoing elaboration of an Okanagan Drought Plan
- Strengthened government response to protecting watersheds of the Pacific Northwest from invasive mussels
- Ecological restoration and protection measures, especially related to the restoration and protection of wetlands and riparian zones supported by the Okanagan Wetlands Strategy
- Increased integration of land-use planning initiatives with sustainable water management objectives in Osoyoos and Oroville
- Increased regulatory tools in British Columbia to protect and manage watersheds through the passing of the *Water Sustainability Act 2014*

Despite these successes, some areas of action as recommended in the 2007 and 2011 Summary Reports have had little progress, or have progressed in piecemeal and *ad hoc* rather than systematic ways. In particular, the following are areas where concerted efforts could be made:

- Collaborative water quality monitoring and planning
- Improving knowledge of instream flow requirements for fish passage
- Mapping and monitoring groundwater aquifers
- Increasing the number of weather and hydrometric stations in the Okanagan
- Improving endangered species legislation in British Columbia

Actions that address these areas are once again recommended in the 2015 report.

4.2 Recommendations for Future Action

The following 32 recommendations have been devised based on named challenges and areas for improvement by panelists and participants alike at the 2015 Osoyoos Lake Water Science Forum. They are organized according to the topic area, and suggest organizations and agencies that could take lead and support roles to implement the actions.

Transboundary and Collaborative Governance

#	Recommendation	Lead and Support Organization(s)
1	Examine the feasibility of increasing the scope of the International Osoyoos Lake Board of Control to apply for funding for projects or to gain watershed board status from the International Watershed Initiative	IJC, International Osoyoos Lake Board of Control
2	Establish a working group to increase coordination and consistency in criteria for drought declarations among governments, water utilities and municipalities	IJC, FLNRO, OBWB, International Osoyoos Lake Board of Control, Washington State Department of Ecology, water suppliers
3	Develop a protocol to deepen working relationships with First Nations and Tribes in watershed management in the Okanagan; integrate Traditional Ecological Knowledge and First Nations perspectives on water with science in watershed management and decision-making	ONA, Confederated Tribes of the Colville Reservation, OBWB, DFO, FLNRO, Washington Department of Fish and Wildlife

Fisheries Restoration and Recovery

#	Recommendation	Lead and Support Organization(s)
4	Capitalize on the Department of Fisheries and Ocean's stated priorities to restore annual funding for freshwater research and funding to protect the health of fish stocks	DFO, ONA, Confederated Tribes of the Colville Reservation, FLNRO
5	Participate in the renegotiation of the Columbia River Treaty and Pacific Salmon Treaty to advocate for the consideration of Okanagan salmon runs in the renewed treaties	MOE, ONA, Confederated Tribes of the Colville Reservation, FLNRO, Washington State Department of Ecology, Washington Department of Fish and Wildlife
6	Update the Fish Water Management Tool to reflect newest water science, and consider calibrating to include multiple spawning times	FLNRO, DFO, ONA, International Osoyoos Lake Board of Control

7	Fund research to improve knowledge of instream flow requirements for fish passage through the Okanagan River system	IJC, International Osoyoos Lake Board of Control, DFO

Climate Change and Variation

#	Recommendation	Lead and Support Organization(s)
8	Undertake a climate change risk assessment in the Okanagan to evaluate key areas of vulnerability to climate change impacts and propose mitigation and adaptation measures	OBWB, MOE
9	Map floodplain areas in the Okanagan, including floodplain areas under projected hydrological changes due to climate change	OBWB, municipalities, MOE, water suppliers
10	Update drinking water storage measurements and guidelines to account for projected hydrological changes due to climate change; consider options for additional storage needs	OBWB, municipalities, water suppliers

Water Quantity

#	Recommendation	Lead and Support Organization(s)
11	Conduct a review of different water allocation programs in water-strained basins and examine their strengths, weaknesses and potential applicability to British Columbia	MOE, OBWB
12	Consider revising state regulations to incorporate more flexibility and discretion in curtailing water rights in times of drought (e.g. integrating ecosystem considerations instead of solely *First in Time, First in Right*)	Washington State Department of Ecology
13	Review the strengths and weaknesses of Washington's Irrigation Efficiencies Grant Program (and similar programs) in other jurisdictions and consider initiating such a program in British Columbia	MOE, BC, Ministry of Agriculture, Agriculture Canada, Environment and Climate Change Canada
14	Improve drought planning and response in BC by: i) clarifying roles and responsibilities between actors, ii) planning for multi-year droughts, iii) increasing capacity and resources to deal with drought, iv) increasing water conservation efforts in both drought and non-drought years, v) allowing for proactive drought response measures	FLNRO, MOE
15	Continue work on the Okanagan Drought Plan and implement recommendations of the plan once completed	OBWB, FLNRO, MOE
16	Host workshops and information sessions with officials and	OBWB

	administrators in the Okanagan Valley to demonstrate the importance of hydrological connectivity in the basin	
17	Increase the number of hydrometric and weather stations in the Okanagan and reintroduce deactivated stations	Environment and Climate Change Canada
18	Develop and implement water conservation plans at the local level	Municipalities, regional districts, OBWB
19	Map and monitor groundwater aquifers in the Okanagan	MOE, OBWB

Land-Use Planning

#	Recommendation	Lead and Support Organization(s)
20	Undertake a review and cost-benefit analysis of preserving vs. developing ecosystem services in urban regions; integrate climate change lens into analysis	OBWB, not-for-profit groups
21	Engage Okanogan County in land-use planning decisions regarding buffer zones for development along the shores of Lake Osoyoos	City of Oroville, Department of Ecology, Osoyoos Lake Board of Control
22	Conduct a review of mechanisms that jurisdictions with small lakes use to regulate boat density and access; examine the suitability of mechanisms to the Okanagan context	Town of Osoyoos, municipalities, OBWB
23	Develop more incentives for development that integrates green stormwater management into design	Regional districts, Town of Osoyoos, City of Oroville, Okanogan County
24	Continue to support the *Washington – British Columbia Transboundary Climate-Connectivity Project* to promote habitat connectivity between the Canada-US border; work with federal partners to make cross-border participation easier	Climate Impacts Group, Pacific Climate Impacts Consortium, project partners

Water Quality

#	Recommendation	Lead and Support Organization(s)
25	Develop a wildfire management strategy for watersheds in the Okanagan that examines sustainable forestry practices that could help to mitigate the impacts of wildfire on watersheds	FLNRO, OBWB, MOE
26	Undertake a review and gap analysis of existing water quality data, monitoring and mitigation actions in the Okanagan; make recommendations to better coordinate water quality management	MOE, OBWB, municipalities, water suppliers

27	Establish a protocol for public reporting of suspected blue-green algae outbreaks and procedures for alerting the public and closing beaches in the Okanagan	MOE
28	Better integrate source protection planning in the Okanagan by funding and developing a basin-wide source protection plan with dedicated resources to implement plan	MOE, OBWB municipalities, water suppliers
29	Continue to implement and roll out Phase 3 of the Okanagan Wetlands Strategy; ensure appropriate funding for implementation	OBWB, not-for-profit partners, municipalities

Aquatic Invasive Species

#	Recommendation	Lead and Support Organization(s)
30	Develop a best management practices document for milfoil removal comparing methods and potential risks (e.g. cumulative effects concerns of chemical use, risks to wildlife from rototillers, etc.) of different removal methods; arrange meeting to discuss implications of findings	OBWB, Okanagan Noxious Weed Board
31	Conduct a review and assessment of invasive mussel defense programs in North America and make recommendations for actions in BC	Not-for-profit groups, OBWB, MOE
32	Develop Species at Risk legislation that includes measures to protect BC's waters from aquatic invasive species	FLNRO, MOE

5.0 Concluding Remarks

The 2015 Osoyoos Lake Water Science Forum provided a space to continue conversations, relationship-building, and idea generation leading to action to protect and restore the health of Lake Osoyoos and the waters of the Okanagan Basin as a whole. The 2007 and 2011 forums and Summary Reports proved to be helpful tools to promote public accountability of collaborative watershed governance on both sides of the border.

Notable progress has been made in some areas, but there remain many actions that can be undertaken to promote the health and sustainability of our watersheds. This Summary Report recommended 32 actions that can improve management of our shared waters. Sustainability is not an end, but something to be continually strived for. As our knowledge of watershed science and management grows, and new opportunities to strengthen our commitment to a healthy environment arise, we should continue to take action to ensure that the health of our watersheds is sustained into the future.

APPENDIX A: Key Players at the OLWSF

Below is a list and description of public organizations and institutions that play significant roles in the management of Osoyoos Lake and the watersheds of the Okanagan basin as a whole. This is not a comprehensive list, but covers the major players.

The International Joint Commission (IJC) – Borne of the 1909 *Boundary Waters Treaty* between Canada the United States, the IJC is a bi-national organization that helps to coordinate the management of transboundary waters. The IJC has three major levers to do this: 1) Regulation (including the issuance of Orders of Operation for dams in transboundary waters), 2) Technical Advice, and 3) Funding.

The International Osoyoos Lake Board of Control – The International Osoyoos Lake Board of Control is a bi-national organization with members from the USA and Canada. It was established by the IJC in the 1940s to give oversight to the operation of Zosel Dam, a dam located in Washington at the outflow of Lake Osoyoos, and ensure it is operating in accordance with its operating Orders. The dam's Operation Orders were most recently updated in 2013.

The Okanagan Basin Water Board (OBWB) – OBWB is a public agency based in the Canadian side of the Okanagan basin dedicated to improving water management in the Okanagan Valley. The OBWB undertakes a variety of initiatives to achieve its aim, including its milfoil control program, providing science-based information to water managers, communicating and coordinating between governments and the public, and funding water projects throughout the valley.

The Okanagan Nation Alliance (ONA) – The ONA is the administrative body representing eight First Nations member communities in Syilx (Okanagan) territory on both sides of the border. The ONA works to advance Okanagan's Rights and Title in their territory. Among other programs, they have a rigorous fisheries program, which is the largest inland fishery in Canada.

The Confederated Tribes of the Colville Reservation – The Confederated Tribes of the Colville Reservation is a sovereign nation with over 5,000 residents from 12 aboriginal tribes (including the Okanagan) living in its territory. The Confederated Tribes of the Colville Reservation have a dynamic governance system with a variety of social and environmental programs, including its Okanagan Basin Monitoring and Evaluation Program.

The Town of Osoyoos – Osoyoos is a town of just under 5,000 residents situated on the shores of Lake Osoyoos in British Columbia, Canada. The town has been host to the Osoyoos Lake Water Science Forum in 2007, 2011 and 2015.

The City of Oroville – Oroville is a city of approximately 1,600 residents situated on the south shore of Lake Osoyoos in Washington, USA.

Department of Fisheries and Oceans Canada (DFO) - DFO is a department of the Government of Canada that is responsible for developing policies, funding programs and advancing ecological and scientific interests related to Canada's marine and freshwater environments. DFO lends scientific and technical support to aid fisheries restoration in the Okanagan basin.

BC Ministry of Forests, Lands, Natural Resource Operations (FLNRO) – FLNRO is a ministry of the Government of British Columbia that is responsible for a variety of programs, policies and enforcement strategies related to management of natural resources and wildlife in British Columbia. Management of the Okanagan Lake Regulation System falls under the purview of this ministry.

BC Ministry of the Environment (MOE) – The MOE is the provincial ministry responsible for regulation and programs that promote a healthy natural environment in British Columbia. In 2014, the MOE passed its Water Sustainability Act, which updated the 100-year old Water Act. The ministry is in the process of developing regulations for the act, which will be rolled out beginning in January 2014.

Washington State Department of Ecology ("Ecology") – Ecology is a department of the Government of Washington that is responsible for upholding the integrity of natural ecosystems. Ecology also oversees programs related to water rights and allocations in the state of Washington.

APPENDIX B: Contact Information of Presenters and Panelists

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APPENDIX C: List of Hyperlinks Included in Summary Report

Description	Web address
BC Ministry of Forests, Lands, Natural resources Operations (FLNRO)	http://www.env.gov.bc.ca/fw/
BC Ministry of the Environment (MOE)	http://www.env.gov.bc.ca/
The City of Oroville	http://oroville-wa.com/
Columbia River Basin Long-Term Water Supply and Demand Forecast	http://www.ecy.wa.gov/programs/wr/cwp/2016Forecast.html
The Confederated Tribes of the Colville Reservation ("Confederated Tribes of the Colville Reservation")	http://www.colvilletribes.com/about_us.php
Department of Fisheries and Ocean Canada's stated priorities for newly Liberal government	http://pm.gc.ca/eng/minister-fisheries-oceans-and-canadian-coast-guard-mandate-letter
Department of Fisheries and Oceans Canada (DFO)	http://www.dfo-mpo.gc.ca/index-eng.htm
The International Joint Commission (IJC)	http://www.ijc.org/en_/
The International Osoyoos Lake Board of Control	http://ijc.org/en_/iolbc/Mandate
International Osoyoos Lake Board of Control – Member List	http://ijc.org/en_/iolbc/Members
Okanagan Basin Monitoring and Evaluation Program	http://www.colvilletribes.com/obmep.php
Okanagan Basin Water Board (OBWB)	http://www.obwb.ca/
Okanagan Basin Water Board – Milfoil removal program	http://www.obwb.ca/milfoil/
The Okanagan Nation Alliance (ONA)	http://www.syilx.org/
Okanagan Water Supply and Demand Project	http://www.obwb.ca/wsd/
Okanagan Wetland Strategy	http://www.obwb.ca/wetlands/
Okanogan County's Integrated Aquatic Vegetation Management Plan	http://www.okanogancounty.org/nw/docs/Okanogan_county_iavmp_final3.pdf
Okanogan Noxious Weed Control Board	http://www.okanogancounty.org/nw/
Osoyoos Lake Water Science Forum – 2007 forum	http://www.obwb.ca/workshops/osoyoos-lake-water-science-forum-2007/
Osoyoos Lake Water Science Forum – 2011 forum	http://www.obwb.ca/workshops/osoyoos-lake-water-science-forum-2011/
Osoyoos Lake Water Science Forum – 2011 forum Summary Report	http://www.obwb.ca/olwsf/wp-content/uploads/2012/06/OLWSF_2011_Report_Final_May_17_2012_email.pdf
Osoyoos Lake Water Science Forum online resources	http://www.obwb.ca/olwsf/
Province of BC's Water Sustainability Act	http://engage.gov.bc.ca/watersustainabilityact/the-proposal/

Province of British Columbia – Drought Response Plan	http://www.livingwatersmart.ca/drought/docs/2015/Drought-Response-Plan-Update-June-2015.pdf
The Town of Osoyoos	http://www.osoyoos.ca/
Washington State Department of Ecology – Trust Water Rights Program	http://www.ecy.wa.gov/programs/wr/market/trust.html
Washington State Department of Ecology – Irrigation Efficiencies Grant Program	http://scc.wa.gov/irrigation-efficiences/
Washington State Department of Ecology – Water Acquisition Program	http://www.ecy.wa.gov/programs/wr/instream-flows/wacq.html
Washington State Department of Ecology – Blue-green algae monitoring program	http://www.nwtoxicalgae.org
Washington State Department of Ecology – Map-based program for documenting blue-green algae outbreaks	https://fortress.wa.gov/ecy/coastalatlas/tools/LakeDetail.aspx
Washington State Department of Ecology ("Ecology")	http://www.ecy.wa.gov/
Washington State's Shoreline Management Act	http://www.ecy.wa.gov/programs/sea/sma/st_guide/intro.html
Washington State's Shoreline Master's Program (SMP)	http://www.ecy.wa.gov/programs/sea/shorelines/SMP/index.html
Washington State's Watershed Planning Act	http://www.ecy.wa.gov/watershed/misc/background.html
Yakima Basin surface water rights lawsuit	http://www.ecy.wa.gov/programs/wr/rights/adjhome.html
Zosel Dam operating Orders – Renewed in 2013	http://www.ijc.org/files/dockets/Docket 108/Docket 108 Supplemental Order 2013-01-29.pdf