

SCIENCE  
*in the service of*

WASHINGTON STATE

WASHINGTON STATE  
» Academy of Sciences



# Columbia River Treaty: Issues for the 21st Century



Summary of the Proceedings of the Ninth Annual Symposium  
*Held as Part of the 2016 Annual Meeting of the*  
Washington State Academy of Sciences  
September 15, 2016, Museum of Flight, Seattle, WA

February 2017

© 2017 Washington State Academy of Sciences

# Columbia River Treaty: Issues for the 21st Century

Summary of the Proceedings  
of the Ninth Annual Symposium  
held as part of the 2016 Annual  
Meeting of the  
Washington State Academy of Sciences

September 15, 2016  
Museum of Flight, Seattle, WA

Proceedings Released  
February 2017

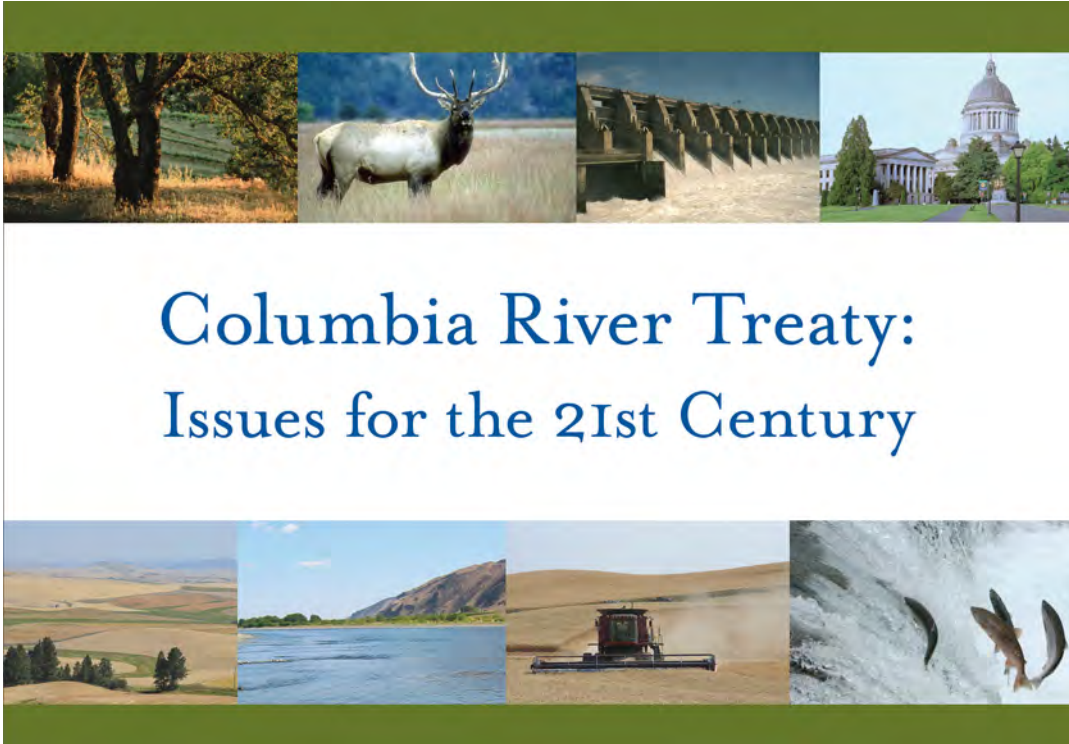
The Washington State Academy of Sciences (WSAS) is an organization of Washington state's leading scientists and engineers dedicated to serving the state with scientific counsel. Formed as a working academy, not an honorary society, the academy is modeled on the National Research Council. Its mission is two-fold: to provide expert scientific and engineering analysis to inform public policymaking in Washington state; and to increase the role and visibility of science in the state.

Governor Christine Gregoire authorized legislation establishing WSAS in 2005. Its 12-member Founding Board of Directors was recommended by the presidents of Washington State University and the University of Washington, and was duly appointed by the governor. In April 2007, WSAS was constituted by the Secretary of State as a private, independent 501(c)(3).

Source material for the Ninth Annual Symposium may be found on the WSAS website, including:

- Speakers' slides
- Video of the invited speakers' presentations
- Symposium handouts
- Symposium photographs

Washington State Academy of Sciences  
410 11th Avenue SE, Suite 205  
Olympia, WA 98501  
email: [wsas.programs@washacad.org](mailto:wsas.programs@washacad.org)  
[www.washacad.org](http://www.washacad.org)  
(360) 534-2338



## Columbia River Treaty: Issues for the 21st Century

Welcome to the proceedings of our ninth annual symposium, Columbia River Treaty: Issues for the 21st Century. Most people are not even aware that there is a unique transboundary river Treaty between the United States and Canada. It was signed in 1964 with a 60-year term, and is currently being renegotiated. The Northwest's hydropower costs ratepayers one-half to one-third of other U.S. utilities, and is free of greenhouse gases, so we have thought this was a good thing. Only later, after the dams were built, did we realize that when you make big changes in nature, there are side effects—environmental impacts on fish and other wildlife, on Native American tribes and First Nations, and on entire ecosystems. The speakers are all stakeholders who dig deep into what has been learned, and the many challenges and opportunities of a modernized Columbia River Treaty.

*Anjan Bose, President*

## The Columbia River Treaty—A Primer

<p><b>What is the Columbia River Treaty?</b></p> <p>A transboundary water management agreement between Canada and the U.S., it was ratified in 1964, and focused on power production and flood control. The guiding principle was to create and share benefits equitably.</p>	<p><b>What are the key provisions?</b></p> <p>Canada constructed three dams to provide 15.5 million acre-feet of water storage, the U.S. built a dam in Montana, and the Treaty continues indefinitely but could be terminated in 2024 with a 10-year notice.</p>	<p><b>What entities implement the Treaty?</b></p> <p>The Treaty is implemented in the U.S. by the U.S. Army Corps of Engineers and Bonneville Power Administration, and in Canada by B.C. Hydro and the British Columbia government.</p>
<p><b>What are the main benefits to Canada?</b></p> <ul style="list-style-type: none"> <li>▶ Water storage capacity</li> <li>▶ Power production</li> <li>▶ Canadian Entitlement (approximately \$130 million annually)</li> </ul>		<p><b>What are the main benefits to the U.S.?</b></p> <ul style="list-style-type: none"> <li>▶ Flood control</li> <li>▶ Increased power production potential</li> <li>▶ Seasonal availability of water supply for irrigation, municipalities, navigation and recreation</li> </ul>
<p><b>Who/what was excluded?</b></p> <ul style="list-style-type: none"> <li>▶ U.S. Native American tribes</li> <li>▶ Canada's First Nations</li> <li>▶ Affected Canadian communities</li> <li>▶ Fish passage was overlooked</li> </ul>	<p><b>What has changed?</b></p> <ul style="list-style-type: none"> <li>▶ Energy markets</li> <li>▶ Societal values</li> <li>▶ Climate change</li> <li>▶ Environmental science</li> <li>▶ Unanticipated value of benefits</li> </ul>	<p><b>What is the Treaty review status today?</b></p> <p>In 2014, B.C. released a decision to continue the Treaty and seek improvements. In the U.S., the Treaty has been in a federal review process in the Department of State since 2013.</p>



Figure 1. The Columbia River Basin



Source: U.S. Army Corps of Engineers

## Executive Summary

The Columbia River Treaty is a good opportunity to look at myriad aspects of our transboundary river and examine why and how science should be used in developing this kind of policy. Now that the time is approaching for the Treaty to be renegotiated, sovereigns and stakeholders from British Columbia and the U.S. Pacific Northwest have been analyzing the costs, benefits, and impacts of the river's dams. Their recommendations seek a better balance as river planning moves into the 21st century.

### **In B.C., the Treaty brought benefits and hardships**

The Columbia River Treaty is unique in the world because it was founded on the principle of creating benefits and sharing them equitably. Kathy Eichenberger explored British Columbia's experience with the Treaty, including the building of the Canadian dams, and the Canadian Entitlement of energy and capacity, which is worth about \$130 million per year. But when the Treaty was developed, First Nations and communities were not consulted and suffered hardships, environmental impacts, and acrimony that continue. People from the First Nations and communities told her, "If you're going to review the Treaty, just do it right this time." For the B.C. treaty review, public consultation included three rounds of more than 20 community events. B.C. has released a provincial decision to continue the Treaty and seek improvements within its existing framework.

### **Forecasts were fundamentally wrong**

The United States agreed to split the benefits of increasing power production at U.S. facilities based on forecasts of how the power system would develop. Compared to what was expected, Steve Wright pointed out that currently the downstream power benefits cost the U.S. about a million dollars every three days. The Treaty's terms are outdated because the massive electricity production and storage capacity as a result of the dams have extraordinary value in today's power markets, which are changing fast with wind and solar. Environmental protection and laws were not part of the picture when the Treaty was negotiated. Today, ecosystem functions are among the benefits being discussed along with the underlying issue of climate change that will impact temperature and stream flow, which are important to both power and fish.

### **Significant scientific and technical support is necessary for making decisions**

Ultimately politicians, not scientists, developed the Framework of the Treaty. Tom Karier explained what a contemporary, broader look would include: marketable hydropower connections with California; fish passage, which had been overlooked; investments in energy efficiency; and integration of renewables. The U.S. Pacific Northwest delegation presented recommendations for a modernized Treaty to the U.S. Department of State in 2013 that await action. Changing flows to help salmon, and potentially reintroducing anadromous fish, are topics proposed. A new plan should assess potential alternatives for flood risk management. Water supply was not included in the original Treaty, and spring/summer storage and release should be considered. The importance of navigation as well as recreational and cultural resources should be recognized.

### Tribes reserved “the right of taking fish ...”

In the 1800s, when Columbia Basin tribes entered into peace treaties with the U.S. government, as sovereign nations they reserved for themselves “the right of taking fish at all usual and accustomed places.” Jim Heffernan noted that the tribes were not consulted during the Columbia River Treaty negotiations, but they were forced to make substantial sacrifices to cultural, health, social, religious, and ecosystem resources on behalf of the hydropower system. The 15 tribes of the Columbia Basin Tribes Coalition have come together to develop common goals and objectives for a modern Treaty, which include restoring spring and early summer freshets, reconnecting floodplains, restoring fish passage, and reintroducing salmon and other species back to the Canadian spawning grounds.

### Ecosystem function needs to be the third leg of the stool

When the Columbia River Treaty was negotiated, it was based on flood control and power. Rich Zabel said the Treaty needs to add ecosystem function as the third leg and take into account impacts on fish populations and other ecosystem components. Two populations of salmon that migrate through the Columbia are listed as endangered species. A team of scientists has been tagging fish to study downstream migration and survival of juvenile salmonids through the hydropower system. They found a strong correlation of flow with survival—when fish get to the estuary sooner, they come back at a greater rate. The data also show a fairly strong response to water temperature in terms of survival. A hydraulic simulation model looked at releasing more water in low-flow years and showed a modest benefit for in-river survival for steelhead and chinook.

*“The Columbia River Treaty is unique in the world because instead of being based on shared costs, it was founded on the principle of creating benefits and sharing them equitably.”*

Kathy Eichenberger

### Estimating a theoretical world of future hydropower

Scott Corwin described the Treaty’s power provisions as creating “a fictional world, seen through the lens of 1960s economics and assumptions of what the energy system would look like over 50 years.” There are many reasons for changing the Treaty. The hydropower system’s interconnection with the entire West, which didn’t exist back then, is becoming increasingly important. The Treaty is based on an array of outdated assumptions. Think of the state of computers, or weather forecasting, in the 1960s. Today’s considerations include

environmental laws, energy efficiency, new sources of generation, and energy markets. The Treaty needs to be rebalanced, reducing U.S. power cost, and ensuring costs and benefits are appropriately aligned. The renegotiation offers the opportunity to optimize the arrangements and create a more modern and flexible agreement.

### The tremendous value of a healthy river

A truly modernized Treaty would recognize, preserve, and help to restore the valuable natural resource contributions the Columbia River makes to our lives. We need to build on its strength as we also right historic wrongs, and prioritize the protection of its health. Joseph Bogaard proposed adding a treaty representative for the interests of the ecosystem, besides dam and power managers. Thirteen salmon and steelhead populations today are at risk on the U.S. side of the Columbia-Snake river basin. Often overlooked are boating, hunting, food, and commercial, recreational and tribal fishing that sustain jobs,



businesses, communities, and cultures. A new Treaty cannot remain narrowly focused on megawatts, power bills, and flood management. Ecosystem function must be added as a new co-equal purpose. Healthy, functioning ecosystems can deliver low-cost, high-value services to society. A modernized Treaty must integrate a more holistic approach to better managing and co-optimizing the many valuable and at times competing resources of the Columbia Basin.



## Why is it Time to Revisit a Successful Treaty?

### A Canadian Perspective

**Kathy Eichenberger**

Executive Director, Columbia River Treaty Review,  
British Columbia Ministry of Energy and Mines

---

### Synopsis

The Columbia has been described as North America's most powerful river, falling 2,600 feet from its headwaters to the mouth. Although British Columbia's portion of the Columbia Basin accounts for only 15 percent of the total geographic area, in a high water year it accounts for 50 percent of the runoff. Over time, destructive flooding throughout the Basin led to discussions about a transboundary water management treaty. Planning grew serious in 1948, when a flood destroyed Vanport, Oregon's second-largest city. There were deaths and 35,000 people were displaced. The two countries got serious, especially since after the Second World War, industrialization in both the U.S. and Canada demanded on more power to develop the economy. It wasn't until 1964 that a Treaty was ratified. It was focused on flood control and optimization of power production.

### Key provisions and estimated power production

The Treaty determined that Canada would construct three dams in British Columbia—Duncan, Keenleyside and Mica—to provide 15.5 million acre-feet of water storage. The U.S. had the option to construct Libby Dam in Montana, which it did. Canada made 67 kilometers of land available for the reservoir.

Canada's water storage would optimize power generation downstream in the United States, and Canada committed to managing water flows for certain times and seasons, so that there could be incremental power production in the U.S. In return, the U.S. would deliver half of the incremental, estimated (estimated is an important word) increase in power production in the form of energy and capacity.

### The Canadian Entitlement

At the time of the Treaty, British Columbia did not have the funds to build the dams. Instead, it pre-sold the share of the Canadian Entitlement—the estimated incremental benefits—to a consortium of U.S. utilities for 30 years, for an up-front price of \$254.4 million (less than \$10 million a year). At the end of that 30 years, in 1994, the Canadian Entitlement returned to B.C. again as electricity to be sold or used. Thus, the current benefit of the Treaty to B.C. is the Canadian Entitlement of about 1,320 megawatts of capacity, 4,540 gigawatt hours of energy, and \$130 million per year.

The Treaty's benefits to the U.S. include flood control, increased power production potential, seasonal availability of water supply for irrigation and other uses, meeting fisheries objectives, maintenance of commercial navigation conditions, and an extended recreation season.

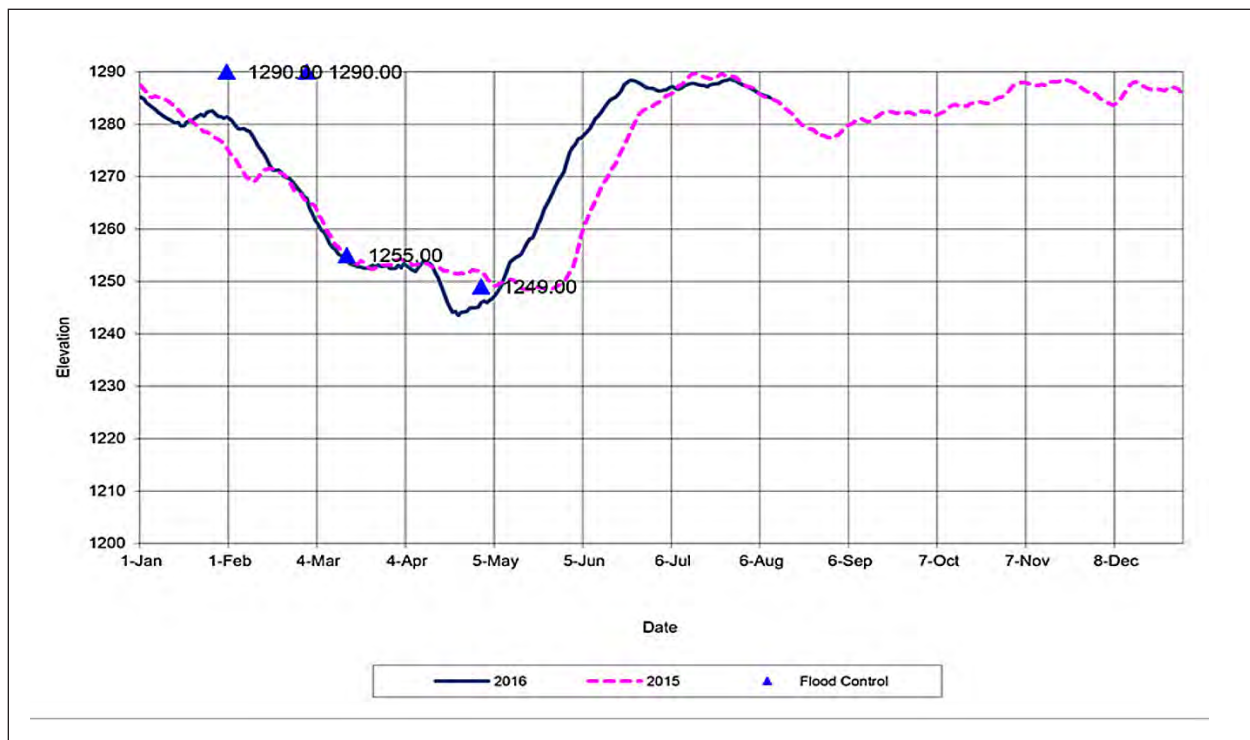
The Treaty continues indefinitely, but can be terminated at the earliest in 2024; 2014 was the first opportunity to use a 10-year notice. Both countries decided to review the Treaty. But should it continue as is? Should it be modified?

### Much has changed since 1964

The energy market has changed tremendously since 1964, as have environmental science and societal values. First Nations and communities were not consulted when the Treaty was developed, yet they were directly affected. Whole communities were moved, citizens were displaced, rich farmland was flooded, and houses and even churches that could not be moved in time were burned. Many people felt they were not well compensated.

For the Treaty review, tribes and First Nations were consulted directly by the provincial and federal governments, and public engagement included three rounds of 23 community events, social media, local political involvement, and the presentation of a draft report. A permanent Columbia Basin Regional Advisory Committee was formed. What was learned through the process is that the Treaty has been successful, still has value, and can change and grow, but it needs improvements.

**Figure 2. Lake Roosevelt water levels, 2015-2016**



Source: British Columbia Ministry of Energy and Mines

The Treaty has also brought negative impacts that touch a broader range of values beyond power and flood control. Lake Roosevelt and Arrow Lakes Reservoir are regularly drafted below full pool, although the timing of the drafting is more favorable to the U.S. reservoir and less so to the Canadian one. The communities around Arrow Lakes Reservoir are tourist-dependent and are key recreation destinations, but a swimming dock at a major beach that normally would be fully afloat was dry in August, high vacation season. The low reservoir elevations are the result of B.C. meeting its Treaty commitments.

---

**Figure 3. Arrow Lakes Reservoir, August 2016**



Source: British Columbia Ministry of Energy and Mines

### Provincial decision to continue the Treaty

In March 2014, British Columbia released a provincial decision to continue the Treaty and seek improvements within its existing framework. Fourteen principles will guide the discussion going

forward, including assessing the value of benefits in today's terms, changing flood-control provisions, and giving additional consideration to upstream regulation in light of climate change impacts of extreme rainfall and droughts.

Other principles include balancing certainty with flexibility, exploring ecosystem improvement, and in general, improving on what remains of the Treaty in 2024. Given all the challenges, the Treaty needs to take into account—not just the next provincial electoral cycle, and not just the next 10 years—but the next generations. Decisions made now will transcend generations into the future.

*“A lot of hardship and acrimony still exist today. Promises weren’t lived up to. People from First Nations and communities told me, ‘If you’re going to review the Treaty, just do it right this time.’ ”*

Kathy Eichenberger

Slides and a video for this talk are available at [www.washacad.org](http://www.washacad.org)



## Why is it Time to Revisit a Successful Treaty?

### A U.S. Perspective

Steve Wright

General Manager, Chelan County Public Utility District (PUD)

---

#### Synopsis

Sharing a river that crosses an international border is not easy, and has been a source of conflict throughout the world. The Columbia River Treaty is a collaborative model for the rest of the world. It came about after nearly two decades of conversation and negotiation. The Treaty is fundamentally about the economics of building and operating three dams in Canada while allowing the United States to build a dam in the U.S. that backs up into Canada and then releases water into Canada. The Treaty produced invaluable downstream flood protection and power as a result of the four dams. It also created dams with massive electricity production and storage capacity that have extraordinary value in today's power markets.

#### The weakness of relying on formulas

As part of the Treaty, the United States agreed to split the benefits of increasing power production at U.S. facilities for a minimum of 60 years, based on forecasts of how the power system would develop—forecasts that turned out to be fundamentally wrong. The U.S. paid up front to purchase the Canadian share for the first 30 years. At the time, energy production was the highest-value product. In today's world, the flexible capacity product produced by the dams is highly valuable. This is a big change from when the Treaty was put in place, without wind and solar power.

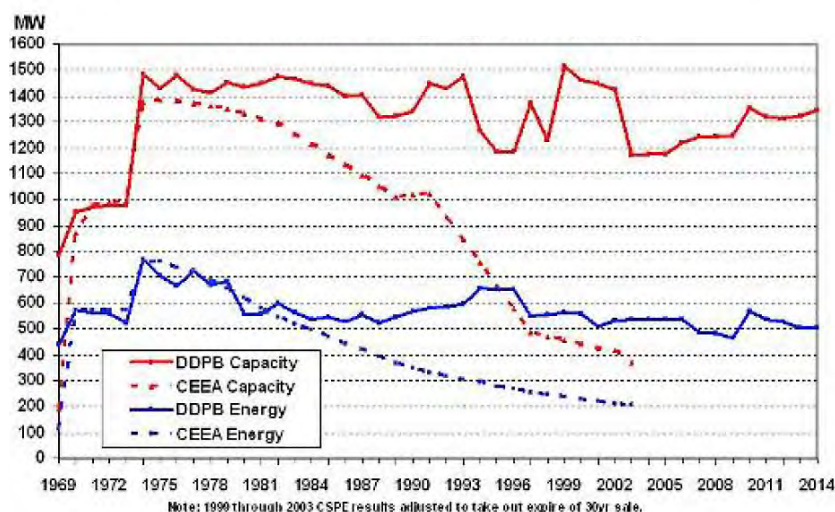
Canada wanted enough money to fund all the costs of dam construction and the U.S. wanted a fair share in dam benefits during negotiations. Many adjustments were made to the formula that is the basis for benefit allocation. What Canada bargained for and got was up-front money that paid for more than 20 million acre-feet of storage at no cost to Canada, and even a surplus that helped for half the cost of generation. The original economic assumptions were based on a declining downstream power benefit, but that is not how the future has played out.

*“We have an opportunity now to figure out how we will operate this hydropower system in a world in which the markets have changed so dramatically.”*

Steve Wright



**Figure 4. Canadian Entitlement from annual determination of downstream power benefits (DDPB) vs. 1964 Canadian Entitlement Exchange Agreement (CEEAA)**



Source: Hyde, John M. 2010. *Columbia River Treaty Past and Future*

The dotted lines on the graph show what was expected in terms of megawatts (MW) of downstream benefits at the time the Treaty was entered into. The solid lines are the actual MW, which are substantially higher. Currently, the downstream power benefits cost the U.S. about \$1 million dollars every one to three days.

### Termination of power provisions was intentional

The Treaty created a unilateral right for each country to terminate the electrical power provisions with a 10-year notice, an option that is incredibly important. The Treaty framers picked a date, September 2024, to allow modification of the flood control and power terms.

It is not happenstance that these two provisions were handled differently post-2024. Flood control has an automatic default feature that assures a minimum amount of flood control will be maintained even if disputes prevent an amicable renegotiation. Power provisions are maintained post-2024 unless either country exercises a unilateral right to terminate the Treaty. The expectation was that each country would compare the continued operation of the Treaty against its alternatives and make a decision in its best interests. For the U.S., termination of the commercial power provisions of the Treaty is a predictable and anticipated consequence of the Treaty framers' understanding of the human inability to forecast the future.

### The Treaty's terms have become outdated

Today's power markets are changing, and changing fast. Now there are solar power and wind power options that cannot be controlled and dispatched reliably like hydropower. In a world increasingly dominated by concern about greenhouse gas emissions, the economic and environmental value of hydropower has yet to be truly realized. British Columbia and the U.S. Pacific Northwest are natural allies in managing large hydropower generation that can reduce greenhouse gases emitted from fossil fuels in the western part of North America.

### Three reasons why treaty should be modernized

#### Treaty opportunities:

- ▶ Power generation
- ▶ Flood control
- ▶ Environmental protection

When the Treaty was negotiated in the 1950s and '60s, environmental protection was not well understood. There was no U.S. National Environmental Policy Act, no Endangered Species Act. But today, they are part of the collective value system, and the Treaty negotiation is an opportunity to gain future protections for fish. Ecosystem protection is among the benefits being discussed as part of a newly negotiated Treaty. There are also new flood-control opportunities that could replace the default ad hoc process post-2024 under the existing Treaty, which requires federal appropriations necessary to support the payments that would be made to Canada. Underlying all this is the issue of climate change, which will impact temperature and stream flow in the river, both important to power and fish.

### The path forward

The Canadians have indicated they are ready to sit down and talk when the U.S. is ready. Currently, the U.S. is amid a federal review process that has been going on for nearly three years. A regional recommendation was put in place in December 2013. The Northwest delegation wrote to the State Department in 2014 and 2015 seeking swift review, and again in September 2016 urging prompt action.

The process can seem overwhelmingly difficult, but there is a set of core issues that absolutely can be resolved and would create a better world. It is just like 1964 in that regard. We have the ability to do that again. We can forge an agreement that will produce the lasting collaboration and camaraderie that have taken place for the past 50 years.

*“A new agreement that does not address ecosystems will be untenable in today’s political environment.”*

Steve Wright

Slides and a video for this talk are available at [www.washacad.org](http://www.washacad.org)



## Modernizing the Columbia River Treaty

### Views from a Northwestern State

Tom Karier

Council Member, Northwest Power & Conservation Council

---

#### Synopsis

In 2013, when the U.S. State Department was given the Northwest delegation's eight-page recommendation regarding continuation of the Columbia River Treaty, they said, "We don't do anything fast." They were exactly right. But it is in the interest of the Northwest states, the state of Washington, and the tribes to get this moving, to get a modernized Treaty sooner rather than later.

#### Washington state interests in the Treaty

Washington state has a stake in all the issues related to the Treaty. We benefit from the power generation. We value salmon and resident fish. Parts of our state are at flood risk because of the Columbia River, so flood control is important. Water supply has gotten more scarce over the decades of the Treaty, and we are interested in how a modernized Treaty can help with issues of agricultural, commercial, and municipal water supplies. The barge transportation system brings billions of dollars of value. Water quality, recreation, navigation, and tribal cultural resources are all issues that have an impact or cost or benefit to the state of Washington.

*"We want to see this Treaty modernized, and we want to see it balanced. Canada is deriving substantially greater value than the United States. By 2024, the U.S. will have funded about three times the construction costs of the dams."*

Tom Karier

#### Unanticipated benefits of the Canadian Entitlement

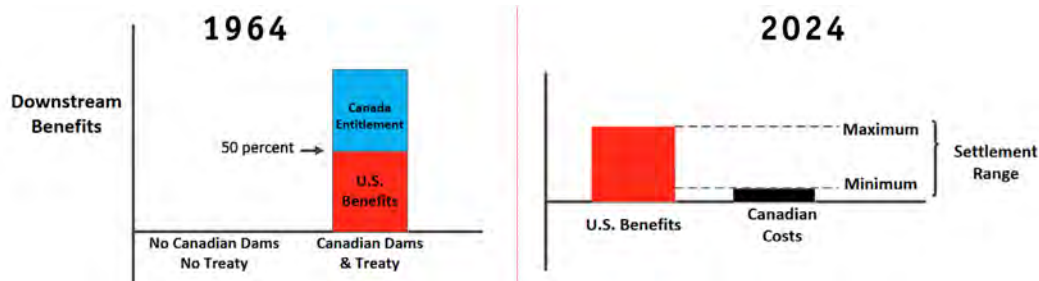
The U.S. benefits are a fraction of what was expected from initial forecasts in the 1960s. Since 1998, the U.S. has been paying about a hundred million dollars a year and Washington state pays about 75 percent of the Entitlement. The recommendations point out that in recent years the United States has been overpaying, and that needs to be corrected.

In 1964, the question was whether to build dams or not. Building the Canadian dams would offer great advantages to the United States. Spring runoff that would normally run

through the river system in a matter of weeks could be held for power generation when needed—later in the summer or even in winter.

### Figure 5. Downstream benefits

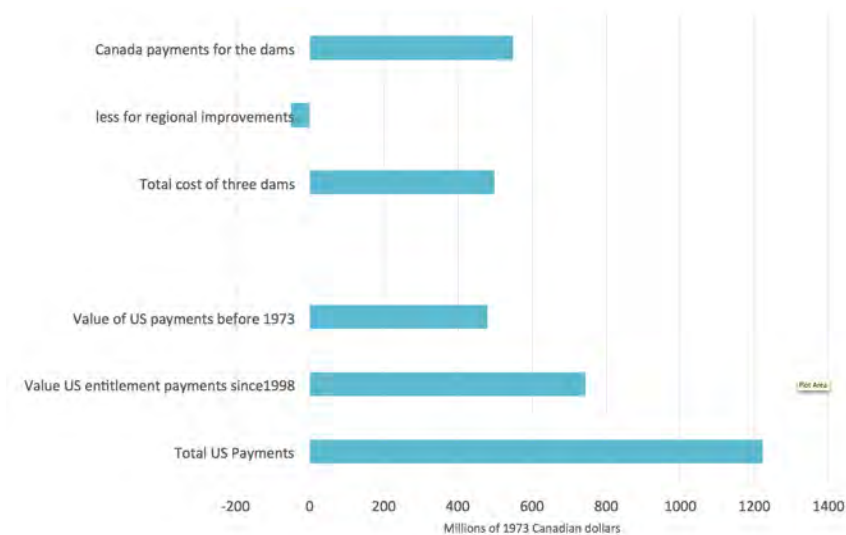
Somewhere in the range of U.S. benefits and Canadian costs is an optimum negotiated settlement between the two countries.



Source: Northwest Power & Conservation Council

Ultimately politicians developed a methodology. Canada did not want to build the dams and pay for them if the U.S. was going to reap the benefit. If the United States was getting the benefits, the U.S. should pay the cost of dam construction. It was decided to resolve the externality by splitting the downstream benefits. The formula came from that and the framers' best guess and forecast of what the downstream benefits would be in the future.

### Figure 6. Cost of the Canadian Treaty Dams and U.S. Payments



Data sources: Hugh Keenleyside (1974), British Columbia Ministry of Finance Budget and Fiscal Plans, Statistics Canada.

Since 1964, the United States has paid about two and a half times the construction costs of the dams. In addition, it is recognized that the dams also bring benefits to the Canadians. They benefit from flood control, and Mica and Keenleyside dams produce valuable hydropower. The economists in 1964 might have encouraged both countries to look at the broader transboundary benefits and costs, but that did not happen.

## Today's energy landscape

In 1964, there was no large transmission connection between the Northwest and California. The Treaty presumed that only 40 percent of the hydropower in excess of Northwest loads was usable or marketable. Fish passage was overlooked. The Treaty reduced the Entitlement only when the U.S. built new thermal generation—not when energy efficiency or renewables were developed. This penalized the Northwest, which has invested in energy efficiency. We currently use the same amount of electricity as 10 years ago, even with a bigger population and larger economic base. We also know that the Canadian dams could be better operated to optimize capacity generation and integrate renewables to reduce carbon.

## Pacific Northwest recommendations to the Treaty

*“It is in the interest of the Northwest states, the state of Washington, and the tribes to get a modernized Treaty sooner rather than later.”*

Tom Karier

**Salmon.** The original Treaty did not include operations to benefit salmon. Changing flows would help fish move through the system faster. Talks should include the potential of the reintroduction of anadromous fish above Grand Coulee Dam to Canadian spawning grounds.

**Flood risk management.** The 8.95 million acre feet of assured flood control storage purchased from Canada in 1968 and 1995 expires in 2024. A new plan should assess potential alternatives, including planned Canadian storage.

**Water supply.** The original Treaty did not include water supply. Recommendations include allowing the storage and release of water from Canada in the spring and summer for additional in-stream and out-of-stream uses.

**Navigation, recreation, climate change.** The importance of navigation, and recreational and cultural resources, should be recognized, and impacts from climate change should be considered.

**Economic and reliable power.** Post-2024, power will require consideration of many elements, including lost revenue, carbon emissions, renewable resource integration, and shifts in streamflow quantity and timing.

## The next steps

Significant scientific and technical support is necessary for making decisions regarding the Columbia River Treaty. The United States and Canada can work out something that's balanced and predictable, while also flexible. A long period would lock in the agreement; the more detail that is added, the less flexible it is. We are going to have to find the right balance for the time period and the level of detail.

Slides and a video for this talk are available at [www.washacad.org](http://www.washacad.org)





## Modernizing the Columbia River Treaty

### Views from the Columbia Basin Tribes

Jim Heffernan

Policy Analyst, Columbia River Inter-Tribal Fish Commission

---

### Synopsis

In 1855, the Yakima Nation, the Nez Perce Tribe, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes of the Umatilla Nation entered into peace treaties with the United States government. The tribes ceded territory that included more than 25 percent of the entire Columbia Basin, but as sovereign nations, they reserved for themselves “the right of taking fish at all usual and accustomed places” from time immemorial to time going forward for future generations.

---

**Figure 7. Columbia Basin Tribes Coalition**



Source: Columbia River Inter-Tribal Fish Commission

The Columbia Basin Tribes Coalition was formed in 2009 and includes 15 tribes whose reserved lands and ceded territories cover the majority of the Columbia River Basin. Its formation was a rather historic event because previously the battle over flows and reservoir operations often pitted lower river tribes against

upriver tribes. Since then, the Coalition has developed common goals and objectives for what they want to see in a modernized Columbia River Treaty. Some tribes have gained experience with international treaties through their participation in the negotiation and implementation of the U.S.-Canada Pacific Salmon Treaty.

Even before the Columbia River Treaty was contemplated, Grand Coulee Dam was built without fish passage, blocking the historic run of June hogs (50- to 60-pound summer chinook) to Canadian spawning grounds. When Canada was consulted by the United States during the construction of Grand Coulee Dam, the Canadians responded that they did not have any commercial fisheries that would be affected by the project, ignoring the fact that First Nation fisheries were occurring in those areas. With the implementation of the Treaty, tribes were forced to make additional substantial

sacrifices to cultural, health, social, religious, and ecosystem resources for the development and continued operation of the hydropower system.

*“The tribes were not consulted the entire time the Columbia River Treaty was being discussed or negotiated. Yet their sacrifices were huge and immense. Downriver folks had absolutely no idea of the sacrifices the people in the upper basin had made.”*

Jim Heffernan

### What happens when the flow of a river is changed?

The three Treaty dams constructed by Canada in the upper Columbia River resulted in peak flows of the spring and early summer freshet being moved—flows that salmon, sturgeon and the other fish and wildlife in the basin evolved with and around. Twenty and a half (20.5) million acre-feet is a lot of water moved for the benefit of optimized power generation and coordinated flood risk management. In addition, the Treaty created permanent flooding upriver for the benefit of people living downriver.

### Recommendations for a modern Treaty

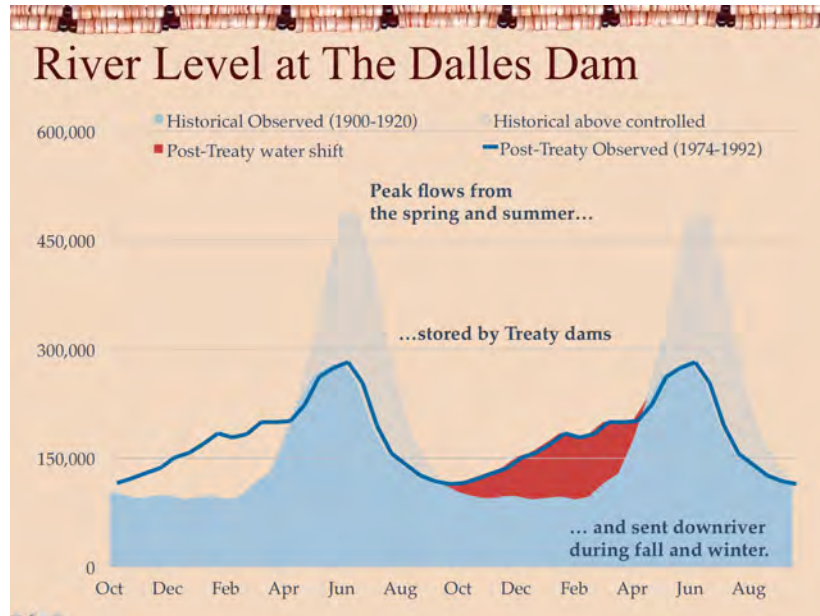
The Coalition worked with the U.S. Entity, four states, and 11 federal agencies on the development of a regional recommendation with three purposes: (1) maintain coordinated flood risk management and a reliable, economically sustainable hydropower system; (2) rebalance the downstream benefits formula, and what the Canadian Entitlement should be going forward; and (3) incorporate ecosystem-based function as a third primary purpose. Ecosystem-based function arises from the obligation the tribes and First Nations have for the gifts from the Creator going forward for their people and everyone else who populates the basin—the gifts of water, the salmon, the roots, and the berries.

The Coalition wants to see the spring and early summer freshets partially restored, moving 3 to 5 million acre-feet of water back to support juvenile migration. The tribes want to reconnect floodplains to the river, restore fish passage and reintroduce salmon and other species back to the Canadian spawning grounds, and stabilize reservoir operations through new draft and refill rules. That means a need to change current operations and move some water back to the spring and early summer

freshet. The tribes want to incorporate a dry-year strategy that provides additional water for salmon flows in the driest of water years, and investigate leaving cooler water in reservoirs for river flows and diverting warmer waters from reservoirs for irrigation.

---

**Figure 8. River level at the Dalles Dam**



Source: Columbia River Inter-Tribal Fish Commission

Fish passage and reintroduction are an essential part of integrating ecosystem-based function into a modernized Treaty, and critical issues for the tribes. Last year, the Columbia Basin tribes and First Nations co-hosted a Future of Our Salmon Conference focused on fish passage. The conference produced several recommendations, including the need to modify all fish ladders to avoid passage blockages, and suggested using new technologies—juvenile- and adult-moving tools—to provide fish access to historical habitats throughout the upper Columbia River Basin.

### Acceptable flood risk management

We need to look at a different way of managing flood risk, something that makes sense integrated with ecosystem-based function. We need reservoir management and storage that allow us to protect some areas—critical economic impact areas in the lower river—while also recognizing the burden on both resources and people upriver by maintaining these permanent floods created by the Treaty dams.

*“Ecosystem services are things that man derives from a river. The tribes and First Nations don’t talk about taking things. They talk about gifts from the Creator given so that the people can survive into the future. They distinguish between ecosystem services and ecosystem-based function.”*

Jim Heffernan

### **Tribes and First Nations must be involved**

The tribes are sovereigns, the First Nations are sovereigns. They need to be involved in both the negotiations and the implementation of the new Treaty because it includes and impacts their sovereign rights and their resources. The rights they reserved go back to time immemorial for accessing water of sufficient quality and volume to support those resources. The preservation and enhancement of those resources provides and supports a diversified economy and benefits everybody. The tribes, states, and federal agencies are developing a common database of information to support negotiations and a collaborative process going forward.

Slides and a video for this talk are available at [www.washacad.org](http://www.washacad.org)

For further information:

<http://www.critfc.org/tribal-treaty-fishing-rights-policy-support/columbia-river-treaty>



## A Deeper Look at the 21st Century Issues

# Ecosystems and the Columbia River Treaty

Rich Zabel

Director, Fish Ecology, NOAA Fisheries

---

### Synopsis

When the Columbia River Treaty was negotiated, it was based on flood control and hydropower. In renegotiating the treaty, we need to add ecosystem function as the third leg of the stool and take into account impacts on fish populations and other ecosystem components.

Two populations of salmon that migrate in the Columbia are listed as endangered species—the Upper Columbia spring chinook salmon and the Upper Columbia steelhead. To study the downstream migration and survival of juvenile salmonids through a hydropower system, our team of scientists developed a model for comprehensive passage we called COMPASS.

### Comprehensive passage (COMPASS) model

The physical aspects of the model begin with headwater flows and cover the whole basin. They include geography, flow and velocity, temperature, and the dam configurations and operations. The biological side of the model covers dam passage, reservoir survival, and migration behavior, such as the fish spreading out as they move downstream. A post-hydrosystem model looks at the adult return rate related to estuary arrival timing, showing the impact of the hydrosystem experience on survival through the ocean and back to adulthood.

Types of data that go into the model include Passive Integrated Responder (PIT) tags, which are inserted in individuals and remain for a lifetime. PIT tags can automatically detect fish as they pass dams and provide information about survival and migration. For more detailed data about dam passage survival, we use acoustic tags with telemetry that tracks individuals. These are larger tags with batteries and that have a shorter life span.

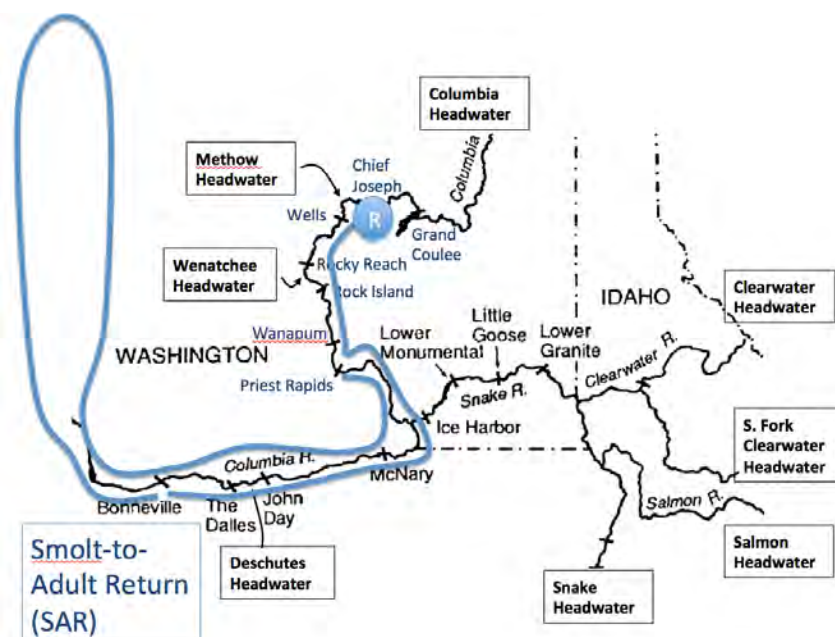
*“There is a strong and consistent relationship between flow and fish survival. Fishes that arrive earlier in the Columbia River estuary return at a higher rate.”*

Rich Zabel



### Figure 9. In-river survival study of salmon

Fish released below Chief Joseph Dam down to Bonneville Dam.



Source: NOAA Fisheries

### Survival and spill, temperature, travel time, and flow

The study looked at different levels of spill. There is not a lot of spill in the upper Columbia dams for a variety of reasons, and the model did not show a strong correspondence between spill and upriver survival. The data showed a fairly strong response to water temperature in terms of survival. Unfortunately, water temperature is not protected by flow releases from the Canadian provinces.

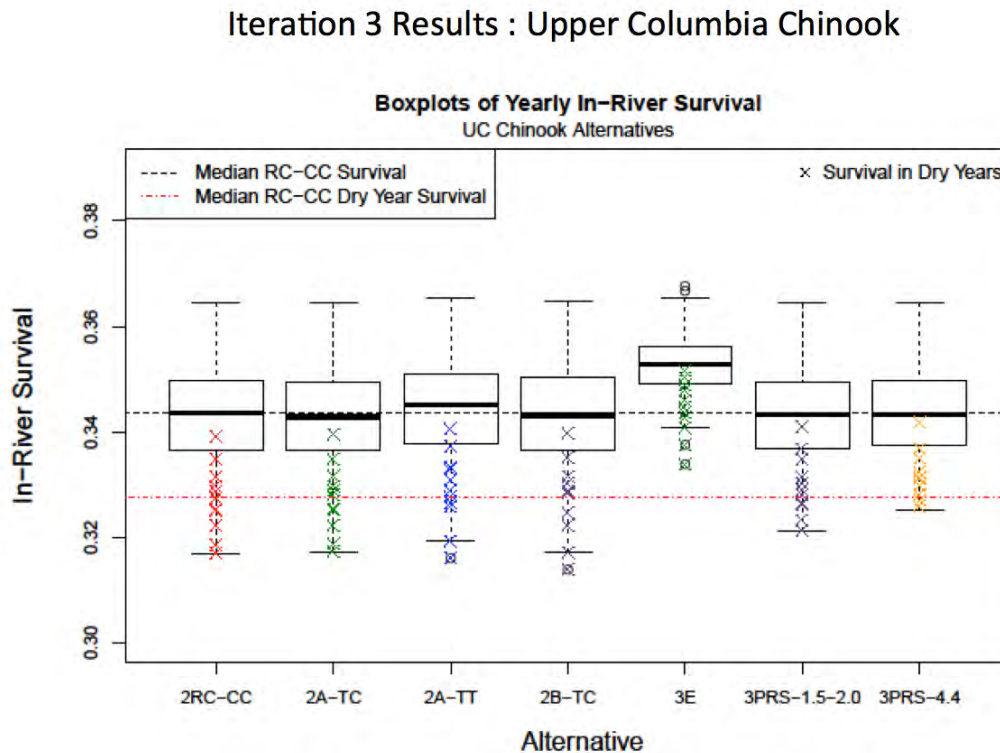
Travel time—the time it takes an individual fish to go from the release point down to Bonneville dam—is faster with more flow in the river, which moves fish down more quickly and has a potential benefit. Analyzing the return rate showed a much stronger effect of flow. When fish get to the estuary sooner, they come back at a greater rate, presenting a strong correlation of flow with survival when calculated through adulthood. Lamprey and eulachon, a federally listed species, also benefit from faster water velocity getting to the ocean.

A hydraulic simulation model, Bonneville Power Administration's HYDSIM, was used to test specifically for the Treaty, simulating a 70-year water record beginning in the early 1900s. It looked at precipitation patterns for individual years, storage rate, daily temperature, and reservoir hold, and then imposed release schedules and calculated the release of water through the system. HYDSIM provided data based on different release schedules and scenarios, allowing scientists to calculate the impacts on fish populations from the different iterations.

Iteration 3 released more water in low-flow years, and showed a modest benefit for in-river survival for steelhead and chinook. Low-flow years are critical times for these fish, so Iteration 3 is the one that most

people look at and see as a viable alternative going forward—releasing more water in low-flow years. Of course, everyone wants the water in low-flow years, so that is one of the problems.

**Figure 10. HYDSIM Iteration 3. Red crosses are current conditions.**



Source: NOAA Fisheries

### Other ecosystem considerations

One of the challenges is going to be how to shape the flows to best benefit the ecosystem. Under the Treaty, the spring freshets are stored and released later for the benefit of hydropower. Salmon evolved under the regime of natural-flowing spring freshets.

High water temperatures during summer are very detrimental to sockeye populations. In 2015, approximately 80 percent of sockeye salmon in the upper Columbia were lost. The Treaty might have some capability to mitigate for that; some gains might be achieved by releasing water from Canada.

The rising and falling of the water elevation can be harmful to fish populations that are spawning. For fall chinook, if the water goes below where their redds, or nests, are laid, there can be desiccation events. For salmon spawning at Bonneville Dam,

*“It’s not surprising that moving water back to a more natural system would help the migratory fish.”*

Rich Zabel

maintaining the right elevation is important. Sturgeon chum seem to benefit from more water flows. They are a long-lived species, so they are susceptible to die-offs.

Other considerations are the condition of the estuary and the extensive plume that forms off the coast of the Columbia. Juvenile salmon reside in the plume, which is a mixture of freshwater and saltwater that enables them to transition toward the saltwater environment. The amount of flow coming from the Columbia River affects the size of the plume, and consequently can affect the salmon populations. The estuary connects the floodplain ecosystems to become beneficial habitat for rearing salmon and other species.

Slides and a video for this talk are available at [www.washacad.org](http://www.washacad.org)



## A Deeper Look at the 21st Century Issues

# Electricity and the Columbia River Treaty

Scott Corwin

Executive Director, Public Power Council

---

### Synopsis

The Public Power Council includes the not-for-profit consumer utilities all around the Northwest, which historically have the first right to purchase power off the federal Columbia River power system. It also includes the mid-Columbia utilities that have their own hydro power projects.

### Time for change

There are many reasons for changing the Columbia River Treaty, not just because the Treaty is old. The hydropower system is a marvel of engineering, but some projects go back a hundred years. The Treaty framers had no way to envision the kinds of things we are seeing in policy right now.

Columbia Basin hydro power provides about 44 percent of total hydro power generation in the U.S. It is a key resource that does not emit carbon. California is moving toward a 50 percent renewable portfolio.

Hydropower and the interconnection between the entire

West—which didn't exist back then—are becoming increasingly important. Grand Coulee Dam and Chief Joseph Dam are significant because they are at the head of the system, are critical for balancing the whole system, and their size dwarfs the other projects, but they are not part of the Treaty right now.

### Challenges of controlling the flow

The total average flow at The Dalles Dam is about 260,000 cubic feet per second. That is a lot of water. If you stood and stared across the river and counted off one second, you would have seen 2 million gallons of water go past in that second. At the extreme, it would be 9 million gallons. There is only so much that can be done to control it.

A major provision in the Treaty states that the U.S. and Canada will share equally the downstream power benefits produced in the U.S. from the operation of Canadian Treaty storage. There is some generation that is significant that does not enter the Canadian Entitlement calculation at all—Mica Dam's 2,800 megawatts, Libby's 600, and Keenleyside's 185.

*“The Treaty creates a fictional world, seen through the lens of 1960s economics and assumptions of what the energy system itself would look like over the next 50 years.”*

Scott Corwin

### Figure 11. Power provisions and Canadian Entitlement

- Canada must operate 15.5 maf of their Treaty storage for optimum power generation downstream in Canada AND the United States.
- U.S. to deliver electric power to Canada equal to one-half the **estimated** U.S. power benefits (Canadian Entitlement) from the operation of Canadian Treaty storage
- Value varies widely depending on market assumptions over time: \$100M-\$300M/yr.
- B.C. Government owns Canadian Entitlement. BPA (on behalf of the U.S. Entity) delivers the power based on daily schedules set by B.C.
- Owners of five Mid-Columbia non-federal hydro projects deliver 27.5% of Canadian Entitlement to BPA for delivery to B.C.



Source: Public Power Council

### Estimating a theoretical world of future hydropower

It was important that the Treaty requires BPA to deliver power on daily schedules set by B.C. because it reinforces the flexibility of hydropower for stability, reliability, and integration of renewables. The Treaty focused on energy, with a longer-term look over time about what is being created in the system, not the minute-by-minute variability that we are trying to tackle today.

The Treaty's organizational chart looks like a structure from the 1950s and '60s and does look arcane by today's standards. But think about the state of computers, or the state of weather forecasting, in the 1960s. The U.S. and the Canada entities are mirrored. There is a permanent Engineering Board, and committees for engineering and operations, and for determining the hydrological and meteorological conditions—trying to guess what is happening with the water in the system. For the power benefits, the framers were trying to estimate a theoretical world of what the power system would look like with or without the Treaty in place, over a period of 50 years.

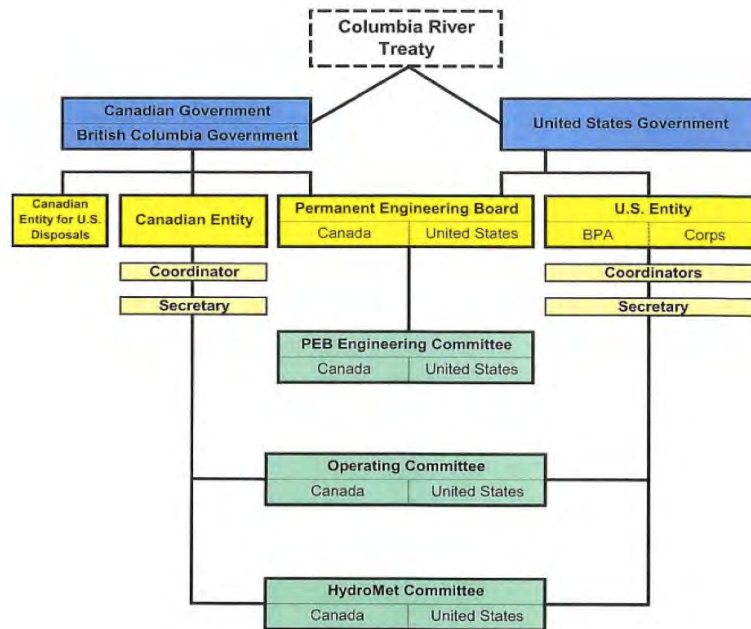
### Past and the future

Despite being detailed, the Treaty is based on an array of outdated assumptions. It was a hydro power-based system, and that was the driver. Energy efficiency had not even been conceived much at the time. The United States changed our own use of the hydro power projects when environmental laws came on. That, and the evolving markets and portfolio of generation sources, changed what the baseline is, so that the calculated downstream power benefits no longer reflect reality.

Looking into the next few decades, it becomes a different discussion. In 1964, we did not have energy markets the way they exist today. We are no longer isolated; electrically, we have a lot of connectivity across the entire West. California is creating more market opportunities. There are also a lot of new resources on the generation side that would not have been expected at the time.



Figure 12. Organization chart for the Columbia River Treaty



Notes:

- 1) The Entities and the PEB are creations of the Treaty, and all report directly to their respective governments.
- 2) The Operating Committee and HydroMet Committee report to the Entities; the PEBCOM reports to the PEB.
- 3) CRT XIV2(f): The Entities are tasked with "assisting and cooperating with the PEB".
- 4) CRT XV2(c): Similarly, the PEB is directed to "assist in reconciling differences concerning technical or operational matters that may arise between the entities".

Source: Public Power Council

## The Treaty needs to be rebalanced

There are 6.5 million consumers (and twice as many citizens) affected by the Treaty. An updated Treaty needs to reduce U.S. power cost, insuring that the costs and benefits are appropriately aligned. We need to make sure to avoid negotiating anything that would reduce flexibility and reliability. Flood control and ecosystem considerations need to be made priorities.

The process through the State Department, continuing since 2013, has been arduous. We hear that they are close, and hopefully we can finally get this moving. From a ratepayer perspective, we know the U.S. is over-paying \$100 to 300 million a year. Every year that goes by is lost value that does not make sense. Time does matter.

A new Columbia River Treaty provides the opportunity for getting creative, for optimizing and modernizing the arrangements between the two countries on the power provisions. We can move outside of the current version and get a more modern and flexible agreement. Historically there has been a lot of value in the Treaty. But the future looks a lot different from the past in the energy world, and we really need to get moving forward.

*"The Treaty offers challenges but also unique opportunities for the Northwest."*

Scott Corwin

Video for this talk is available at [www.washacad.org](http://www.washacad.org)



## A Deeper Look at the 21st Century Issues

# Fish and the Columbia River Treaty

Joseph Bogaard

Executive Director, Save Our wild Salmon

---

### Synopsis

For both nations, a truly modernized Treaty will build on its strength to right historic wrongs, properly recognize the valuable and priceless contributions the Columbia River makes to our lives, and prioritize the protection and restoration of its health. It should better meet the needs of basin communities who have borne the brunt of the Treaty and who rely on the river and its gifts for their culture and way of life.

Save Our wild Salmon has been working for the past quarter-century on legal policies and public means to protect and restore healthy, self-sustaining, harvestable populations of salmon and steelhead in the Columbia-Snake river system. Four years ago, we helped form a caucus to advocate for what we thought

*“Modernization represents a chance to look ahead, think long-term, and craft a Treaty that we and the generations to follow us will need to sustain a big part of what makes our corner of the planet so exceptional.”*

Joseph Bogaard

a modern Treaty must include. The caucus includes conservation organizations, fishing business associations, and faith-based and other groups including American Rivers, the Center for Environmental Law and Policy, Earth Ministry, League of Women Voters, Pacific Rivers, and the Sierra Club.

### Adding a third purpose and representative

We maintain regular communications with the Columbia River tribes and First Nations in Canada, with a goal of sharing interest and expertise to build a new vision of ecosystem-based function. In addition to adding a third purpose to the Treaty, our focus is also on the addition of

a third member of the United States Entity, now composed only of dam and power managers. The Treaty needs a representative for the interests of the ecosystem.

### Salmon at risk

Today on the U.S. side of the Columbia-Snake river basin there are 13 salmon and steelhead stocks at risk of extinction. Many have been lost already, including the Upper Columbia June hogs that used to spawn in Canada. In the summer of 2015, both of our nations lost hundreds of thousands of salmon in the mainstem Columbia due to hot water made hotter by its series of reservoirs. That same summer, the Snake River lost 99 percent of returning adult sockeye salmon.

This once-complex, diverse, vast ecosystem has been simplified. Spawning habitats have been reduced. Cultures and livelihoods of many communities have been harmed. Scientists recently announced a link between the steep decline of salmon in the Columbia and Snake river basin and the decline of southern resident killer whales, endangered in large part by the lack of sufficient prey—chinook salmon.

---

**Figure 13. Columbia River Basin: Accessibility to salmon**



Source: *Save Our Wild Salmon*

We have five species of salmon in the Pacific Northwest. Salmon are masters of adaptation and survival. For millions of years they have bounced back from volcanic eruptions, catastrophic fires, landslides, floods, and ice ages. But we have clearly put them to the test in the past hundred or so years. Salmon rely on living rivers and connectivity. The basin's dams and their excessive, sustained disruption of ecosystems have harmed not only salmon but the more than 130 other species that depend on them.

**Figure 14. Pacific Northwest salmon**



Source: John Gussman

### **Tremendous economic value in a healthy river**

Often overlooked are all the forms of outdoor work and recreation that have real economic value, sustain jobs and businesses, and are important to many people, families and communities—boating, hunting, food, and commercial and recreational fishing. The Treaty should not be so narrowly focused on megawatts and power bills.

Healthy, functioning ecosystems can deliver low-cost, high-value services to society, such as water quantity, water quality, pollution abatement, and flood management, while also sustaining fish and

wildlife, fishing, hunting, and outdoor recreation. The tribes and our caucus have teamed up to fund an independent analysis of the value of a healthy Columbia basin.

*“There needs to be a third member of the U.S. Entity—to represent the interests of the ecosystem in the decision-making processes that will flow from the next version of the Treaty.”*

Joseph Bogaard

### **Innovative floodplain management and climate change**

Restoring floodplain connectivity can enhance flood management options and capabilities, and improve salmon survival and fish populations. The caucus and the basin tribes have asked the federal government to undertake a flood risk management review to better understand costs, needs, benefits, and trade-offs.

The floods of 1948 may have helped trigger the first Treaty, but I would argue we now have our own flood of this century—not

from water, but from heat. The seriousness and scale of the response it requires threaten to overshadow all else. It is critical that a successfully modernized Treaty incorporate today’s climate science, anticipate what’s ahead, and engage and embrace a strategy of both care and prevention.

### **A Treaty to honor the river and communities**

A modernized Treaty must better honor the river and the communities that have been impacted by it, and be more equitable. The energy landscape today is incredibly dynamic. The challenge is to create a far more holistic approach to managing the many valuable resources of the Columbia Basin. Our children and grandchildren will undoubtedly be very grateful.

Video for this talk is available at [www.washacad.org](http://www.washacad.org)



## Q & A Highlights

**Academy member question:** *You're standing in front of a roomful of scientists who have an interest in how science informs policy. Is anyone putting together a list of topics in which better science or additional science could inform the policies that would make this Treaty more effective?*

"The power area and the fish and wildlife area are the two where we can benefit the most by informed and objective science. The energy that we can get out of the system is important. There are probably some more creative ways to use this big system to support and integrate renewables. We also want to provide an environment that's better for fish. As an economist, I can think about the best way to spend money: on increasing flows every year—or in the lowest-water years. Where can we make the biggest difference?"

**Tom Karier**

"We do need a lot more research. As a result of collaboration under the Biological Opinion, the region instituted 24-hour spill at the Snake River dams and we started to see better survivals a result. It's an area we need to look at more. We've talked about the Treaty having the flexibility to do more for salmon. In the current Treaty, the Permanent Engineering Board follows the obligation for optimizing power. That board should take into account a third purpose—ecosystem-based function—and not overrule it for power purposes. "

**Jim Heffernan**

**Academy member question:** *Resilience was mentioned. What is the trade-off of resilience as an important ecosystem function in tension with the energy and water requirements that we expect from the Columbia?*

"The Columbia basin is unhealthy. We have got to make some concessions, to make some room, for the wildlife that are important and legally protected and economically valued to provide jobs and so forth. We've got to deploy new strategies that favor and provide opportunities for salmon and steelhead. There are things we ought to be doing to improve their genetic diversity. We've been pushing them to the brink. We've got to take action to reduce water temperatures that are killing the river and its life. Hot water is a mortal threat to the survival of a bunch of resources we value, and we're going to need to take steps to address that."

**Joseph Bogaard**

**Academy member question:** *Why is the State Department dragging its feet? Why is Canada ready and we are not?*

"The problem is that fundamentally, this issue doesn't rise to the top in terms of level of importance. North American leaders are dealing with huge issues like climate change and

global terrorism. Also, a lot of the expertise is in the Pacific Northwest. We need to find ways to take the people who really understand this and allow them to be able to be unleashed and go to work.”

**Steve Wright**

“For Canada, it’s less complicated, frankly. The way our constitution is set up, Canada is the signatory on international treaties. However, for resource management issues, where the interests are provincial, the province is really the functional lead. On our side of the border in the Columbia Basin, we have 160,000 people. We don’t have drought or water supply issues.”

**Kathy Eichenberger**

**Academy member question:** *There is a model of a natural flow regime—the Fraser River, where there are no mainstem dams. What’s happening with the chinook salmon in the Fraser compared to the Columbia?*

“People have looked at the Fraser River as a control. Interestingly enough, survival of the juveniles through the Columbia is higher than it is in the Fraser. The Fraser has some of its own problems. So for a variety of reasons, we don’t know all of them, to me it just says that there is no control—when you have a different system, there are different problems.”

**Rich Zabel**

**Academy member question:** *There was some talk about whether the Treaty would have to be approved by Congress. What triggers that?*

“The Senate will determine what they wish to take up. Clearly if you’re adding new dynamics—big enough substantive changes—and they’re in Treaty form, the Senate is going to have a strong interest in that. The Senate Foreign Relations Committee has followed the regional recommendation developments. There’s a hope that a lot can be consistent with the current Treaty, even though that may be difficult. There is no presumption of one path or another right now.”

**Scott Corwin**

**Academy member question:** *What is the lifetime of the dams, and how does that relate to these treaties that last a long time?*

“No dam lasts forever. However, it depends on how much effort you put into maintaining it. We have some dams that are over 100 years old. We keep upgrading and reinforcing dams. We don’t have sedimentation issues behind the dams. So it’s indefinite as long as you continue to fund and maintain those facilities.”

**Kathy Eichenberger**

“The dams themselves, the concrete structures, are fantastically engineered. The inner workings do require some capital upgrades and maintenance. We have plenty of life left for the dams. My guess is I don’t think we’ll do another 50-year agreement because we have too much uncertainty about flood control, environmental protection, and all the power markets.”

Steve Wright

**Academy member question:** *Can you put some number on the impact of temperature rise due to climate change on the survival of the fish?*

“We have started to look at climate change scenarios in our COMPASS model, and there can be some very significant impacts projected. There is some ability to do temperature regulation in these systems, but I don’t think enough to counter climate change effects. I think it will be a big problem into the future, and when you add that on top of impacts on other life stages it’s a serious concern for these populations.”

Rich Zabel

**Academy member question:** *The lower river and estuary are a system in a highly altered state. Should periodic pulsed flows be considered as part of the management of the flows?*

“Given the configuration of the hydrosystem today, I think those opportunities are limited. We aren’t going to return to a time when we have big disruptive flows that were actually quite helpful overall in terms of ecosystem health and replenishing resources. But I do think that increased flows in the spring and early summer that would help move fish out through the system could also provide some marginal benefit to that plume.”

Joseph Bogaard

“The tribes are trying to get higher flows to recharge the estuary as much as possible in the low and moderate flow years. The reality is right now over the long-term average, I think we’re managing for about 250,000 cubic feet per second at The Dalles Dam, which is really, really low. Maybe it’s up to 350 in higher flow years. Generally, the Corps of Engineers gets nervous when it gets above 450, so they’re trying to keep it lower. Higher pulse events and higher flow years like 2012 are good for the estuary.”

Jim Heffernan

“We’ve done lots of experiments with spill, and we’re trying to figure out the optimum amount. Although it’s intuitive that fish have evolved to migrate during high spring flows with undammed rivers, if we were trying to replicate that in the current system with the hydro dams in place, we’d come up with a high level of dissolved gas that’s a pollutant and is harmful to species in the water.”

Tom Karier

Video for this talk is available at [www.washacad.org](http://www.washacad.org)

## K-12 Special Guests

### American Junior Academy of Sciences Award Winners

The Washington State Academy of Sciences continues to support high school science students with our sponsorship of American Junior Academy of Sciences award winners. This is the sixth year for the WSAS award program, and two students were selected to travel with a mentor to represent Washington at the 2017 AJAS convention in Boston, Massachusetts. The students were chosen based on their academic record, with strong scientific merit and a strong interest in science or engineering and research. The winners and six of the eight finalists set up project boards and reviewed them with Academy members. Parents and teachers were also present to witness their students receiving WSAS certificates and awards.

While inviting members to review the student posters, WSAS past president Allan Konopka commented, “This is an opportunity to engage these young scientists. It’s always a humbling experience to see what they are doing and it’s great to encourage them to move forward. These sorts of opportunities can really change people’s careers, and it gives the Academy the chance to impact young people’s lives in a significant way.” K-12 Committee member Gary Foss presented the awards. He noted that “It’s well known that understanding science and engineering increases greatly through the application of concepts and projects represented in high school science and engineering fairs and competitions. The challenge and fun of planning, executing, and reporting on projects is an excellent way to engage students, introduce them to the structure of research and problem-solving, and give them deep immersion into a topic of their choice.” He encouraged WSAS members to volunteer as judges for the science and engineering fairs around the state.

Winner Adeline Hillier’s project, *Communication by Ultrasound Using Radio Modulation Techniques: An Alternative to Wi-fi*, involved the design, creation and testing of a communication system that can send and receive an information-bearing ultrasound signal using modulation-demodulation techniques commonly used in radio. A member of the West Seattle Amateur Radio Club with a ham radio license, she has been entering science fairs since the second grade and continues to work on mechanical and electrical engineering projects. She sees a lot of potential with this project because it avoids many issues normally encountered with wi-fi, such as crowding and interference in the ISM band, and anticipates taking the work further. She is looking forward to the AJAS convention and added, “I’m thrilled by the opportunity to meet so many people who are at the cutting edge of their fields and to be able to talk to them about my project and share my research with them, and to meet other students who are really excited about research.”

**Figure 15. K-12 Committee Member Representative Gary Foss, AJAS winners Sriharshita Musunuri and Adeline Hillier, Past President Allan Konopka.**



Sriharshita (Harshu) Musunuri's winning project, *Computational and Experimental Design of MIP Nanoparticles: A Novel Theranostic Solution to Detect and Neutralize Endotoxins*, offers a solution that allows for a quantifiable approach to identifying abnormal endotoxin concentrations, a proven indicator of gram-negative sepsis. Currently, sepsis is difficult to diagnose, due to the variability of physicians' practices and standards. Inspired by an article on the topic, she developed a methodology, then approached a professor in the Chemistry Department of the University of Washington and received permission to perform her experimental procedures in their lab. She commented, "I'd love to go into chemical engineering. It's a major that allows me to push through with the energy aspect that I've been interested in for a long time, as well as the biotechnology that I'm doing here." Gary Foss also announced that Harshu Musunuri recently was awarded a \$50,000 Davidson Fellowship, "one of the 10 biggest scholarships in the world." The fellowship was based on her WSAS 2015 finalist project, *Application of Tetrahedrite and Magnesium Silicide on a Novel Thermoelectric Unicouple to Generate Electricity from Industrial Waste Heat*.



**Figure 16. 2016 AJAS Winners and Finalists**



*Back Row: Finalist Gabi Crippen, Finalist Dhruvik Parikh, Finalist Afeef Sheikh, Finalist Christopher Kang  
Front Row: Finalist Eshika Saxena, Winner Adeline Hillier, Finalist Dyuti Nandy, and Winner Sriharshita Musunur.*

### **AJAS finalists**

- Naveena A. Bontha, Hanford High School
- Gabi Crippen, Spokane Valley Tech
- Christopher Kang, Hanford High School
- Nitya Kumar, Olympia High School
- Dyuti Nandy, Newport High School
- Dhruvik Parikh, Henry M. Jackson High School
- Eshika Saxena, Interlake High School
- Afeef Sheikh, Nikola Tesla STEM High School

# Washington State Folk Song

## *Roll On, Columbia*

*Words by Woody Guthrie, Music based on "Goodnight, Irene" (Huddie Ledbetter and John Lomax)*

Green Douglas firs where the waters cut through.  
Down her wild mountains and canyons she flew.  
Canadian Northwest to the ocean so blue,  
Roll on, Columbia, roll on!

CHORUS: Roll on, Columbia, roll on.  
Roll on, Columbia, roll on.  
Your power is turning our darkness to dawn,  
Roll on, Columbia, roll on.

Other great rivers add power to you,  
Yakima, Snake and the Klickitat, too,  
Sandy Willamette and Hood River, too;  
Roll on, Columbia, roll on.

CHORUS

Tom Jefferson's vision would not let him rest,  
An empire he saw in the Pacific Northwest.  
Sent Lewis and Clark and they did the rest;  
Roll on, Columbia, roll on.

CHORUS

It's there on your bank that we fought many a fight,  
Sheridan's boys in the blockhouse that night,  
They saw us in death but never in flight,  
Roll on, Columbia, roll on.

CHORUS

At Bonneville now there are ships in the locks,  
The waters have risen and cleared all the rocks,  
Shiploads of plenty will steam past the docks,  
Roll on, Columbia, roll on.

CHORUS

And on up the river is Grand Coulee Dam,  
The mightiest thing ever built by a man,  
To run these great factories and water the land,  
It's roll on, Columbia, roll on.

CHORUS

These mighty men labored by day and by night,  
Matching their strength 'gainst the river's wild flight,  
Through rapids and falls they won the hard fight,  
Roll on, Columbia, roll on.

*© Copyright 1936 (renewed), 1957 (renewed) and 1963 (renewed) by Woody Guthrie Publications, Inc. & TRO-Ludlow Music, Inc. (BMI).<sup>1</sup>*

---

1 [https://www.sos.wa.gov/seal/symbols\\_songs.aspx](https://www.sos.wa.gov/seal/symbols_songs.aspx)

## Speaker bios

**Joseph Bogaard** is the Executive Director of Save Our wild Salmon, a diverse, 25-year-old coalition working to protect and restore abundant populations of wild salmon in the Columbia and Snake rivers. Before joining the SOWS team in 1996, he spent many years teaching and working in the forests and mountains of the West. He got hooked on Northwest salmon restoration efforts while in graduate school, where he authored a paper in the early 1990s exploring the then-relatively recent Snake River salmon listings under the Endangered Species Act, and how it might affect the region and its federal lands and dams. His expertise includes environmental policy, community outreach and development, strategic planning, sustainability policy, and policy analysis. He holds a B.S. in Zoology and Environmental Studies from the University of California at Davis, and an M.S. in Natural Resource Policy from the University of Michigan.

**Scott Corwin** is the Executive Director of the Public Power Council, which represents the common interests of consumer-owned electric utilities with respect to the Federal Columbia River Power System, including issues around BPA power and transmission. Previously, he worked for Portland General Electric, the Speaker's Office of the Oregon House of Representatives, and in various positions with the U.S. Senate in Washington, D.C., including Legal Counsel to Senator Mark O. Hatfield and staff to the U.S. Senate Appropriations Committee. He also worked for a law firm specializing in tax and pension legislation. He serves on national advisory committees to the American Public Power Association and the National Rural Electric Cooperative Association. He graduated from Dartmouth College and has a law degree from the University of Washington School of Law. He is a member of the Oregon Bar Association and the District of Columbia Bar Association.

**Kathy Eichenberger** is the Executive Director of the Columbia River Treaty Review, Electricity and Alternative Energy Division of the British Columbia Ministry of Energy and Mines, Canada. Since October 2011, she has been responsible for leading all aspects of the Columbia River Treaty review, including technical, legal, environmental, and economic studies, as well as First Nations and public consultation. Previously, she worked as Executive Project Assessment Director for the B.C. Environmental Assessment Office and Regional Manager, Environmental Protection for the Ministry of Environment. She is a hydraulic engineer by profession and is certified by the P. Eng. Association of Professional Engineers and Geoscientists of B.C..

**Jim Heffernan**, Policy Analyst with the Columbia River Inter-Tribal Fish Commission, focuses on regional efforts to modernize the Columbia River Treaty. Under direction from tribal governments, he worked with federal and state representatives on the Sovereign Review and Technical Teams to collaborate on the U.S. Entity Recommendation on the Future of the CRT after 2024, submitted to the U.S. State Department in 2013. He continues to work with the 15 tribes in the Columbia Basin Tribes Coalition to ensure that ecosystem-based function, which includes fish passage and reintroduction, is integrated as a key element of a modern CRT, equal to flood control and hydropower production. He received a B.S. in Wildlife Biology from Colorado State University. He worked seasonally for the U.S. Forest Service in timber sale layout and preparation for several years. He earned a J.D. and Certificate in Environmental Law from the Northwestern School of Law at Lewis and Clark College (now Lewis and Clark Law School).

**Dr. Thomas Karier** is a member of the Northwest Power & Conservation Council. He was appointed in 1998 and has served as Council Chair, and Chair of the Power Committee. He has been a board member for the Northwest Energy Efficiency Alliance, and co-chair of the Northwest Energy Efficiency Leadership and the Northwest Wind Integration Forum. Previously, he was an associate dean at Eastern Washington University (1995-1998) and professor of economics (before 1995). He also served as a Research Associate for the Jerome Levy Economics Institute in Annandale, New York. He is the author of three books, *Intellectual Capital* (Cambridge University Press), *Great Experiments in American Economic Policy* (Praeger), *Beyond Competition* (M. E. Sharpe), a dozen journal articles, and many reports and Op/Ed articles. He earned a Ph.D. from the University of California, Berkeley, with a major in energy and natural resource economics. His B.S. from the University of Illinois is in both physics and economics.

**Steve Wright** is General Manager of the Chelan County PUD. Since he was named to that post in September 2013, he has led the development of a community-based Strategic Plan, finalized in 2015. From 2000 to 2013, he was chairman of the U.S. Entity responsible for implementing the Columbia River Treaty and initiated the regional discussions that ultimately led to the regional recommendations to the U.S. State Department. Chelan owns and operates Rocky Reach and Rock Island hydropower projects on the Columbia River, which are affected by and have contractual commitments supporting the implementation of the CRT. He began his professional career at the Bonneville Power Administration in 1981 in the energy conservation division. He held a number of positions within BPA, the last 12 years as Administrator/CEO. BPA provides roughly one-third of the electricity and 70 percent of the high voltage transmission in the Pacific Northwest. He received a graduate degree from the University of Oregon in public administration.

**Dr. Rich Zabel** is the Director of the Fish Ecology Division at NOAA's Northwest Fisheries Science Center in Seattle. The division conducts research on ocean and estuary ecology of salmon and other fish species, watershed processes, ecosystem analyses, and survival and migration of salmon through rivers. His own research focuses on developing models of population viability, survival, and behavioral ecology of salmon populations. He led a team that assessed the affects on migrating salmon of proposed alternatives under the Columbia River Treaty. He also leads a multi-agency team that is developing life cycle models to assess the effectiveness of suites of mitigation actions to recover salmon populations in the Columbia and Willamette river basins. He received a B.S. and M.S. from the University of Michigan, and a Ph.D. in Quantitative Ecology and Resource Management from the University of Washington.



## Acknowledgments

The Washington State Academy of Sciences acknowledges with grateful thanks the financial support and sponsorship by The Boeing Company.

The success of the symposium reflects the work of the scientific organizing committee members: Ron Thom, and Anjan Bose, Chair. Special thanks also go to Jody Opheim of the Washington State University Energy Innovations Center for her invaluable event planning support, organizational and technical skills so critical to the success of the annual meeting and symposium.

Symposium Proceedings

prepared by

Donna Matrazzo, The Writing Works

Portland, Oregon

Edited by John Hagemann

Layout and design by Laurel le Noble

WASHINGTON STATE  
*Academy of Sciences*

Washington State Academy of Sciences  
410 11th Avenue SE, Suite 205  
Olympia, WA 98501  
[wsas.programs@washacad.org](mailto:wsas.programs@washacad.org)  
[www.washacad.org](http://www.washacad.org)  
(360) 534-2338