BASINS AND BEYOND:
WATER QUALITY IN THE COLUMBIA RIVER BASIN

Image Courtesy of Wikipedia Commons[14]

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INTRODUCTION

The Colombia River Basin provides vital resources including precious metals, fertile soils, and abundant fish and wildlife that support the livelihoods of many stakeholders across the Western frontier. Human-related stresses on the landscape, most notably agriculture production and hydropower generation, have contributed to pressing water concerns. Water quantity is a major concern for the West given future projections for changes in climate and population. However, we also need to consider water quality issues as poor water quality can have detrimental effects on human health, ecosystem services, and the economy. There are many water quality concerns in the CRB such as temperature and sediment loading; however, we will focus our analysis on chemical contaminants present in the CRB. The food-energy-water nexus helps us evaluate water quality concerns by considering:

- Various drivers and feedback loops from contaminants emitted in the water supply;
- The scale at which food production is linked to consumer demand and water and energy inputs;
- The range of stakeholders and their values in developing water quality management plans.

THREE THINGS TO KNOW

1. The EPA's *State of the River Report* released in 2009 identifies four major toxic contaminants of concern in the Columbia River Basin with high levels resulting in fish consumption advisories in many watersheds within the CRB[1]. These contaminants include:
    - **Mercury**: a toxic metal that bioaccumulates in fish;
    - **DDT**: a pesticide banned in the 1970s that still exhibits harmful levels in much of the basin;
    - **PCBs**: a class of chemicals formerly used in several industrial applications; and
    - **PBDEs:** flame retardants.

2. Farming communities in the CRB have been impacted by a growing demand for water-intensive and nutrient-intensive crops and dairy products. This has contributed to high nitrogen levels in both surface and groundwater, which can have negative human health impacts, particularly for infants and young children[2].

3. The Framework for Water Quality Valuation designed by Keeler et al. (2012) is a streamlined conceptual model that links changes in contaminant concentrations with changes in the value of water quality-related services[3].

OVERVIEW OF WATER QUALITY STANDARDS

Water quality standards are created by states, territories, and tribal groups and must be submitted to the EPA for federal review. States and tribal groups can adopt water quality criteria that meet their unique needs, such as determining their own fish consumption rates, or they can use the EPA's recommended criteria. They must create water quality standards that protect the designated use of the water body and meet the minimum legal requirement set by the EPA[4,5].

The four major toxic contaminants described in the EPA's *State of the River Report* are examples of contaminants that need to have strong water quality standards because of their potential impact on human health. Exposure to these contaminants is largely through fish consumption. However, we have a limited understanding of the levels of these contaminants and their patterns of change across the Basin because of a lack of comprehensive data. The EPA reports that DDT and PCB concentrations are generally decreasing in the Basin, as they have been banned since the 1970s. Mercury and PBDE concentrations are generally increasing, along with other emerging contaminants of concern, such as pharmaceuticals. Mercury, in particular, can be difficult to track, as 84% of mercury in the Basin comes from global sources[1]. The lack of data and the challenge to control sources of toxics from outside of the CRB can make it difficult to determine proper standards and effective means of achieving them.

Water quality standards and procedures can vary by state and tribal jurisdiction[4], but water flows freely between states, tribal lands, and Canada within the CRB. The movement of toxics and other potentially harmful chemicals from one territory to the next may result in conflicts. Watersheds that span across borders are more apt to exploit water resources and pass some of the costs, in the form of toxic contaminants, imposed by food and energy production onto downstream users[a]. This is evidenced from our examination of toxics and agricultural chemical use in the Colombia River Basin.

WATER QUALITY AT THE FOOD-ENERGY-WATER NEXUS

Both energy and food production impact water quality in the CRB. An example of the relationship between energy and water quality is the atmospheric deposition of mercury in surface water from coal-fired power plants outside of the Basin. Mercury bioaccumulates in fish species and consumption of these fish species can result in human health hazards[1].

Food production also impacts water quality. For example, DDT, now banned from use as an agricultural insecticide, was used heavily in the CRB until the 70s. It is still present in the soils and can enter the surface water supply through soil erosion. Changes in agricultural practices that reduce soil erosion have reduced the levels of DDT found in the water system[1].

Current agricultural chemical use, particularly fertilizer, can also impact water quality. Richard Manning's journalistic piece featured in High Country News brings to light the array of water quality concerns due to expansive crop production, dairy cattle grazing, and largescale food processing. The combination of cattle biproducts and intensive crop production requiring more nitrogen-based fertilizers results in high levels of nitrates in surface and groundwater sources. Manning reports that drinking wells in the 'Magic Valley' area had ten times the natural background level of nitrogen[6]. According to a report by the U.S. Geological Services in 2012, if all nitrogen pollution from feedlots and farm fertilizer ceased immediately, excess nitrogen would remain in drinking water wells for about forty years[7].

Social and ethical dilemmas underlie water quality concerns in Idaho as largescale producers have lobbying power to skirt around regulations targeted at reducing pollution. For example, feedlots are not currently designated as a point source of pollution; therefore, they are not subject to total maximum daily load regulations[6]. These water quality concerns may impact the health of residents and fish species throughout the rest of the Columbia River Basin.

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[a] For more information on negative externalities and 'free riding' refer to Olmstead and Sigman (2015)'s empirical analysis on dam intensity as a function of sharing of rivers[13].

WATER QUALITY VALUATION FRAMEWORK AT THE FOOD-ENERGY-WATER NEXUS

Keeler et al. (2012) propose an integrative framework for Water Quality Valuation. The main challenge with utilizing conventional ecosystem service valuation and cost benefit analysis is that biophysical and economic models are typically developed in isolation, which makes it difficult to integrate the outputs of one model into the inputs of another model[3].

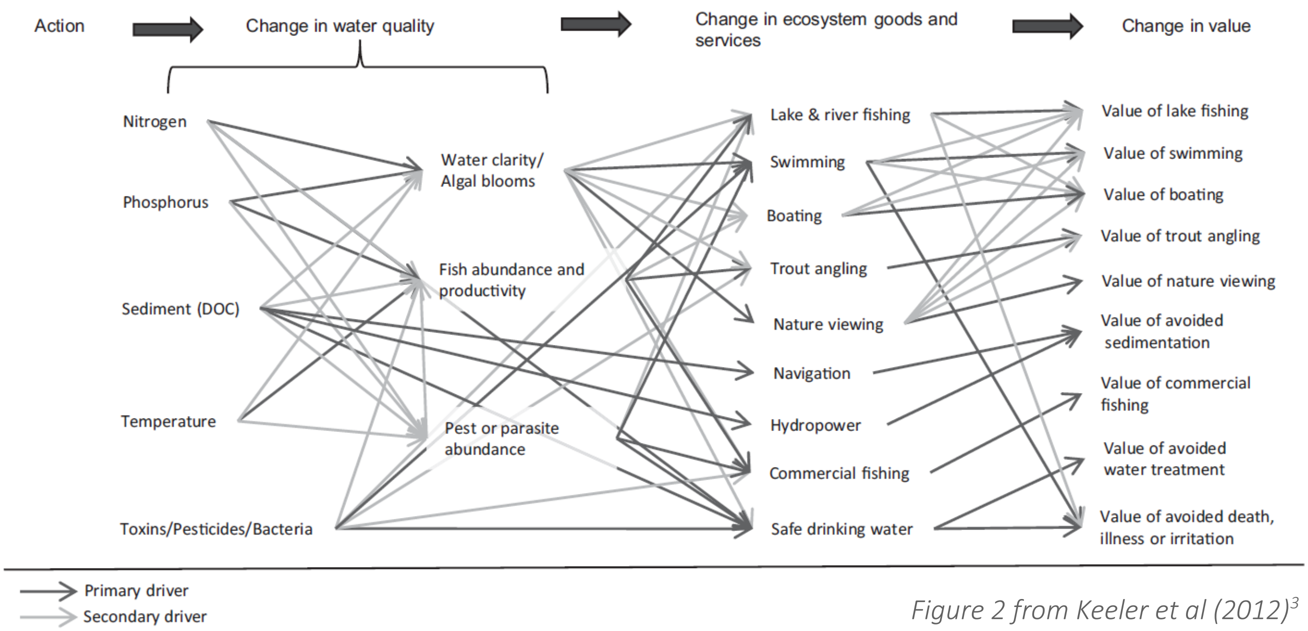

Figure 2 from Keeler et al (2012)[3]

The figure above links changes in contaminant concentrations with changes in people's value of water quality-related services. Biophysical researchers concentrate on understanding actions on the left side of the figure including primary drivers of water quality and land use change. Social scientists then apply these estimates to people's wellbeing before and after a change in water quality. Comprehensive integration hinges on a translation zone whereby these changes at specific endpoints are linked to indicators of human-wellbeing[3]. This approach can be applied to evaluate land management policies and predict future scenarios, which is vital for addressing human and ecosystem health in the CRB.

STAKEHOLDERS

The *Columbia River Toxics Reduction Working Group*, a multi-stakeholder group consisting of state agencies from Washington, Oregon, and Idaho along with federal and tribal agencies, compiled the 2009 *State of the River Report*. Unfortunately, their work has been limited by a lack of resources to collect and monitor information about toxics in the CRB[1].

State agencies: The Columbia River Basin drains water from seven states – Washington, Oregon, Idaho, Montana, Wyoming, Nevada, and Utah. Each state may set different water quality criteria and standards, which reflect the different needs of the states[4]. Improving water quality will involve each state to work together on solutions.

Federal agencies: The Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the U.S. Geological Services are involved in water quality issues in the CRB. The EPA is responsible for reviewing water quality standards set by the states. The USFWS has an interest in protecting vulnerable wildlife, such as birds of prey. The USGS collects valuable water quality data through their monitoring stations.

Tribal communities: Toxic contaminants in fish can have a negative impact on tribal communities. Tribal communities were instrumental in raising the fish consumption rate for water quality standards for Washington State from 6.5 to 175 grams per day[8,9]. This is still likely much lower than tribal heritage fish consumption rates, which have been estimated to be 600-700 grams per day. The heritage rate and traditional lifestyles are technically protected in treaties[10].

Environmental groups: Several environmental groups are heavily involved in water quality issues in the Basin, such as Columbia Riverkeeper[11]. They advocate for stricter water quality standards and strong regulations to protect water quality, which may be at odds with the needs of other stakeholders in the Basin.

Farmers, dairy farmers, ranchers: Agricultural producers, often faced with thin profit margins, need to maintain high levels of production and may use nitrogen fertilizers and other agricultural chemicals to do so. These chemicals can enter the surface and groundwater supply. Stakeholders must work together to ensure farmers' livelihoods while protecting water quality.

Fishermen/women: Within the CRB, non-tribal commercial fisheries are valued at $5.4 million based on the average annual sales they receive from catches[12]. Toxic contaminants can negatively impact fish health, which can reduce fish populations.

Residents of the CRB: Water quality impacts residents of the Basin who live, work, and play near these waters. Exposure to contaminants can occur through drinking water, recreation, or consuming fish.

Tourists: Recreation plays a large role in the CRB's economy and is valued at nearly $5 billion[12]. Through activities such as swimming, fishing, and boating, visitors may be exposed to contaminants. Additionally, if water quality concerns become visible (algae blooms), this can have negative impacts on the tourism industry, which is a major employer in the region.

QUESTIONS

- Do you have any personal connections related to water quality in the CRB?
  - Is water quality linked to your job or hobbies?
- Do you have any concerns about the quality of water in the CRB? If so, what are they?
- Can you think of any local drivers of water quality change in the area?
  - Do you think these changes have been improving or worsening in recent years?
- What are some of the practices you use or steps you take to protect water quality?
- Have the fish consumption advisories impacted you, your friends, or your family? If so, how?
- In your opinion, what is the main use of the water in your area?
  - Does this water use align with the way you value the water in the Basin?

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14. Cover image available at https://commons.wikimedia.org/wiki/File:Barge_in_the_Columbia_River_Gorge.jpg.