Idaho Fish Consumption Rate and Human Health Water Quality Criteria—Discussion Paper #5

Anadromous Fish

State of Idaho
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Introduction

Anadromous fish are born and reared in freshwater habitats, then migrate to the ocean where they spend a majority of their lifecycle before returning to freshwater to spawn. Salmon (Coho, Sockeye, and Chinook), steelhead, and lamprey are Idaho's anadromous fish species. Stream-type species of anadromous fish (i.e., salmon and steelhead) remain in freshwater streams or rivers to rear for approximately 1–3 years before migrating toward marine habitats.

The decline of the Columbia River's once numerous salmon and steelhead runs is well documented (USFWS 2005). Columbia River basin anadromous fish runs ranged from 10 to 16 million fish returning annually at the turn of the 20th century (NPPC 1986). By comparison, current return numbers rarely top 2 million per year (Harrison 2008). Despite these declines, salmon and steelhead fishing are popular recreational activities in the state as current fisheries of these species in Idaho are supported by hatchery production.

Whether to include or exclude anadromous species from the calculation of a state-specific fish consumption rate, used to derive toxics criteria, is a risk management decision. The question is not whether anadromous fish are caught and consumed—they are. The issue is where anadromous fish acquire their burden of contaminants and how that should be handled in developing water quality criteria that are applied in Idaho. This is the policy decision that the Idaho Department of Environmental Quality (DEQ) is addressing during this meeting.

Anadromous Fish Consumption

According to the National Marine Fisheries Service (NMFS 2014), the third most commonly consumed fish in the United States is salmon. However, 91% of seafood consumed in the United States is imported, and only about half of that is wild-caught (NOAA 2014). Still, most of the Chinook in the US market comes from US fisheries (mainly off Alaska, Washington, and Oregon, with a small amount from California) and Canadian fisheries (NOAA 2014). In the Pacific Northwest, salmon is the most frequently consumed finfish (more than 90%) for all adult respondents from all of the regional-specific fish dietary surveys that were reviewed, though not all of this fish was locally sourced (Ecology 2013). In designing a robust fish consumption survey for the state, wherein the type and source of the fish will be reported, DEQ aims to quantify the proportion of anadromous fish Idaho residents eat, compared to other types of finfish and shellfish, and identify its source.

Life History and Contamination Levels in Anadromous Fish

Contamination levels in fish vary in relation to many factors including not only where they live, but also what they eat, the duration of their exposure to contaminants in the environment, and their reproductive life history. Species, gender, fat content, and how many times a fish reproduces are also factors influencing contaminant levels. The complexity of the life history of these species may explain why the few available studies that do exist seem to contradict each other.

O'Neill et al. (2006) state that because anadromous fish typically spend the majority of their life at sea, where food is abundant, the majority of the bioaccumulative toxins present in their tissue can be attributed to their growth at sea. By comparing the contaminant levels in returning adult Chinook Salmon to out-migrating smolts and juveniles, the study found that 97–99% of the body burden of persistent organic pollutants was acquired at sea. Thus, the majority of the toxins present in the tissue of anadromous fish species are likely attributed to the quality of ocean waters, which is outside of Idaho’s regulatory control.

In the US Environmental Protection Agency’s (EPA’s) Columbia River Basin Fish Contaminant Survey, fish tissue samples collected from various locations throughout the Pacific Northwest (including Idaho) were analyzed for 132 different chemicals. The study found that concentrations of organic chemicals in the salmonids (Chinook and Coho Salmon, Rainbow Trout and steelhead) were lower than any other species sampled. Pacific Lamprey, White Sturgeon, and Mountain Whitefish, on the other hand, had some of the highest concentrations. The concentrations of metals did not show a distinct difference between anadromous and resident fish species (EPA 2002a).

Contaminant body burdens in farm-raised salmon have been well documented compared to wild salmon, with European farm-raised salmon containing significantly higher levels of dioxins, polychlorinated biphenyls (PCBs), and pesticides than North American farm-raised salmon (Hites et al. 2004).

Because Chinook Salmon and steelhead are the main anadromous fisheries in the state, they are discussed in more detail below.

Chinook Salmon

Chinook Salmon are native to Idaho and are loosely classified into three groups: spring, summer, and fall-run, based on their size and ocean life history (IDFG 2014a). According to the Idaho Department of Fish and Game, Idaho’s Chinook Salmon can spend 0–2 years in freshwater before migrating to the ocean; fall-run Chinook normally migrate after less than 1 year in freshwater, while the majority (approximately 99%) of spring/summer-run Chinook (the most recreationally fished run in Idaho) out-migrate after 1 year in freshwater. The fish scale and fin ray samples collected and analyzed by state fisheries biologists indicate Chinook spend anywhere from 1 to 4 years in the ocean before returning to Idaho to spawn, although 4 years at sea is rare (Wright, personal communication).

As they mature, Chinook Salmon also tend to eat more fish than other salmon. More than any other salmonid, the Chinook Salmon is the most piscivorous, with its diet consisting of a considerable amount of various fish species (Ecology 2013). Their feeding habits probably account for the higher contamination levels in their tissues. Lipid content is an important factor, as lipophilic (“lipid-loving”) contaminants can occur at higher numbers, and in greater concentrations, in these fish. A 100 gram (g) serving size of salmon contains approximately 11 g of fat (NOAA 2014). Seasonal abundance of food in the ocean contributes to overall size and fat content of the fish (Ecology 2013). Fat content between salmonid stocks within a given system can also vary substantially between years, seasons, sexes, and runs.

Male and female Chinook generally have the same fat content upon returning from the ocean, but the females typically have a much lower fat content by the time spawning occurs. Both males and females stop eating once they return to freshwater to spawn, using their fat reserves to survive the journey. The difference in fat content is primarily attributed to females using their fat reserves for gonadal development of the eggs. As the female converts fat energy during gonadal development, the eggs receive maternal-transferred contaminants at elevated levels due to their high lipid content (Hearsey 2011). When Chinook Salmon return to spawn (and die) in Idaho waters, they also return vital nutrients to the environment along with any contaminants they have acquired at sea, which are then taken up by other organisms and returned once again to the food web.

Although the study took place in Washington and may not be comparable to Idaho's waters, Johnson et al. (2007) investigated exposure to several persistent pollutants including PCBs and dichloro-diphenyl-trichloroethane (DDT) in out-migrant juvenile fall Chinook Salmon in the lower Columbia River (estuarine habitat) and found that body concentrations of these pollutants were high to extremely high, suggesting that salmon can, in fact, acquire some of their body burden in freshwater habitats prior to migrating to the ocean.

Steelhead Trout

Steelhead are native Rainbow Trout that migrate to the ocean as juvenile fish and return to freshwater as adults to spawn (IDFG 2014b). In Idaho, juvenile steelhead can remain in freshwater habitats from 1 to 5 years, but they typically begin migrating downstream toward the ocean in the spring of their second or third years (Wright, personal communication). Idaho steelhead are often classified into two groups, A-run and B-run, based on their size and ocean life history (IDFG 2014). A-run steelhead are usually found in the Snake and Salmon rivers; they typically only spend 1 year in the ocean and return earlier in the year. B-run steelhead most often return to the Clearwater River, but some return to tributaries in the Salmon River basin; these fish usually spend 2–3 years in the ocean and start their migration back to Idaho later in the summer and fall. Both classes of steelhead grow rapidly in the ocean, but because of the extra year(s) spent out to sea, B-run steelhead are typically larger than A-run.

Unlike Chinook Salmon, returning adult steelhead sometimes continue to eat (but grow little, if at all) once entering freshwater to spawn and do not always die after spawning. Steelhead can spawn up to four times, although two to three times is more common (Pauley et al. 1986). As a result, post-spawn adult steelhead migrate back toward marine habitats within a relatively short period of time after spawning (Ecology 2013).

There have been very few investigations into the origin of steelhead body burden and contaminants compared to other salmonids. But given that steelhead can live many more seasons in marine environments than other co-occurring salmonids, with multiple freshwater re-entries for spawning, it is reasonable to assume that steelhead may potentially have a higher body burden accumulation than other species (Ecology 2013).

Including Anadromous Fish and Effect on Criteria

Comparable to the issues explored on the topic of market versus locally caught fish, DEQ must consider the impacts of including anadromous species in the fish consumption rate. The task is to derive a rate that is protective of fish consumers. The importance of the resource, the level of protection necessary to support the resource, and the health of the people utilizing the resource all need to be carefully considered. Since an inverse relationship exists between fish consumption rates and criteria values, including anadromous fish in the overall fish consumption rate may drive the criteria down. On the other hand, if anadromous species data are omitted from the data set, it is possible that the resulting criteria may not be adequately protective of Idahoans who eat salmon, steelhead, or other anadromous fish.

EPA's Position

The main driver for EPA disapproving the state's toxics criteria was that Idaho had not considered the available local and regional fish consumption information, of which anadromous fish are a component. Recall that Idaho selected to use EPA's national default recommended fish consumption rate (17.5 g/day) due to a lack of Idaho specific information. This local and regional information (primarily Washington and Oregon studies) suggested to EPA that fish consumption in Idaho may be greater than 17.5 g/day. Therefore, EPA could not find that Idaho's criteria, based on 17.5 g/day, were based on a sound scientific rationale and would protect human health in Idaho. EPA (2000) recommends that "States and Tribes should ensure that when selecting local or regionally-specific studies, both finfish and shellfish are included when the populations exposed are consumers of both types." However, in its 2002 national fish consumption report, EPA determined salmon to be largely (96%) of marine origin and excluded consumption of marine fish from its calculations of a nationally recommended consumption rate to be used in criteria (EPA 2002b).

EPA's current water quality recommended values are based on a national fish consumption rate of 17.5 g/day. This rate represents the 90th percentile of fish consumers based on national food survey data (USDA 2000). To derive a fish consumption rate to protect high consumers of fish, EPA used the 99th percentile from the same general population data. The resulting national recommendation for a fish consumption rate for subsistence fishers is 142.5 g/day (EPA 2002b). Recently, EPA (2014) has proposed revising its national default from 17.5 g/day to 22 g/day. It has not proposed a revision to the subsistence fisher's rate of 142.5 g/day.

With respect to choosing a state-specific consumption rate, EPA has developed a hierarchal list of preferred options: (1) use local data, (2) use data reflecting similar geography/population groups, (3) use data from national surveys, and (4) use EPA's default intake rates.

Available Options

Several options are available for dealing with anadromous fish in the fish consumption rate: (1) treat anadromous fish the same as all other fish, (2) include anadromous fish in the consumption rate calculation at a discounted rate, or (3) do not include anadromous fish in the calculation of a fish consumption rate. The argument for not including anadromous fish at the full rate of consumption is that the full body burden of contaminants in anadromous fish does not come from Idaho waters. Therefore, it is arguably not appropriate to include a full consumption rate for these fish if the overall purpose of the criteria is to regulate only Idaho waters and the impacts from Idaho waters.

The first option includes anadromous fish in the calculation of a fish consumption rate at the full rate of consumption identified in the survey. Oregon's fish consumption rate included salmon. This option would likely increase the overall fish consumption rate used in calculating the human health criteria. Similar to including all sources of fish, the impact to the human health criteria would likely be a reduction in the overall values, although the exact impact would be specific to the chemical. Including anadromous fish consumption would mean that the water quality criteria are set at levels that ensure the overall fish consumption rate would be the most protective of human health.

The second option includes anadromous fish in the calculation of a fish consumption rate but at a discounted rate. This approach may take the form of identifying anadromous fish consumed by participants in the survey and then multiplying that consumption by a predetermined discount rate prior to incorporating it into the calculation of the full consumption rate, thereby reducing the overall impact of anadromous fish on consumption rate. This option incorporates anadromous fish but recognizes that some portion of the contamination they acquire is not regulated by Idaho water quality standards. Setting the discount rate would likely be a policy decision as well, although it would be rational to set the discount rate equivalent to the overall percentage of time the average fish of that species spends in Idaho waters.

The final option excludes anadromous fish from the calculation of the fish consumption rate. This option would be analogous to EPA's national guidance that excluded marine fish from the calculation of a fish consumption rate. This approach recognizes that anadromous fish present a unique situation that is not completely governed by laws of the individual states or the United States in general. While anadromous fish do spend the first year or so of their lives in state waters, the majority of the contamination they accumulate occurs while they are reaching full growth in international ocean waters. Although EPA used this approach in its calculation of a national fish consumption rate, the complexity of Pacific Northwest fish consumption and its high inclusion of these fish species in the diets of all means that ignoring anadromous fish would be less protective of those within Idaho who enjoy consuming these types of fish.

Neighboring Pacific Northwest states and other states in EPA Region 10 have approached these recommendations in several ways.

Oregon—After EPA disapproved Oregon's 2004 proposed human health criteria for toxic pollutants in June 2010, the state started revising and adopting water quality criteria based on a fish consumption rate of 175 g/day. This rate was based on fish consumption studies relevant to Oregon, including tribal surveys. Although the State of Oregon received comments on the proposed rule that it should not include salmon in the fish consumption rate, the agency decided that inclusion of anadromous species was appropriate. EPA agreed that the 175 g/day rate more accurately depicted actual fish consumption by all Oregonians—including tribal members, who eat more fish than the typical Oregonian—and the proposed criteria were approved by EPA in 2011. In a letter to the Oregon Department of Environmental Quality, EPA stated that "the revised standards would serve as a national and regional model." As a result of this approval, Oregon now has the highest estimated fish consumption rate in the nation and is facing implementation challenges related to having much more stringent criteria to meet. Two and a half years later, none of the new criteria have been put into action. Implementation issues are discussed in more detail below.

Washington—The State of Washington followed suit and began developing criteria a few months later. Unlike Oregon and Idaho, the Washington Department of Ecology (Ecology) did not previously have its own criteria; thus, the effort is not aimed at revising state criteria but adopting state criteria for the first time. Washington currently uses the National Toxics Rule human health criteria for regulatory purposes; the exposure assumptions include a 6.5 g/day fish consumption rate. Ecology held public meetings to address the preliminary fish consumption rate alternatives under consideration, all of which are based on consumer-only data: (1) use the mean of the “highest highly exposed” fish consumption study and recreation fish consumption (225 g/day); (2) use the same value as Oregon (175 g/day) since the geographical regions are so similar and access to the same resources apply; or (3) use 125 g/day, which is the mean result of fish consumption rates based on three Puget Sound tribe surveys. All three of the alternative fish consumption rates include the use of anadromous fish. Because all of the rates are well above tenfold the current rate, Ecology has recognized and is anticipating implementation issues and is developing tools to address these issues. A new rate has not yet been adopted.

Alaska—The State of Alaska Department of Environmental Conservation (DEC) currently uses a fish consumption rate of 6.5 g/day but has identified this subject as being high priority for the current triennial review cycle, recognizing the need for updating the rate to be more protective of its population, including Alaska natives (DEC 2014). Alaska is home to 256 tribes, and native heritage diets include anadromous fish. The DEC is following Washington and Idaho’s efforts closely to determine the best path forward for Alaska. DEC is in the process of finalizing a literature review, not unlike the ones conducted by Washington Ecology and Idaho DEQ. In the interim, DEC is holding internal conversations regarding data acquisition and relevance, stakeholder participation, and use of existing implementation tools to address and protect areas where people may have higher consumption rates (Tabor, personal communication).

Implementation Issues

It is difficult to say what effect more stringent water quality criteria will have on lowering contaminant levels in fish. This section addresses two of the more prominent contaminants of concern in Idaho and the Pacific Northwest: mercury and PCBs. Mercury is the top contaminant in fish consumption advisories issued by the Idaho Fish Consumption Advisory Program (IFCAP) and the region (MacCoy 2014). PCBs are also a common cause for fish consumption advisories in Washington, particularly the Puget Sound region (WADHW 2013). In EPA’s 2009 *State of the River Report for Toxics* for the Columbia River basin, mercury, PCBs, DDT, and polybrominated diphenyl ethers (PBDEs) were identified as the four contaminants of concern (EPA 2009).

Mercury is naturally occurring but has experienced global increases in environmental concentrations, mainly due to deposition of mercury emitted to the air from burning fossil fuels (UNEP 2013). Water quality criteria cannot be applied to these air sources. More stringent water quality criteria will lead to tighter control of permitted wastewater discharges but with little if any effect on concentrations of mercury in water and the resulting levels of contamination in fish. Because mercury is naturally occurring, some is always present in fish. Criteria an order of magnitude lower than those currently used and approved by EPA in Idaho (0.3 milligrams/kilogram) will mean that the state could be striving for a level of mercury in fish so low it will hardly be met even in the best waters (USGS 2014) and quite possibly lower than what occurs naturally in many waters.

PCBs are a banned substance and are no longer produced or used in manufacturing, but because of their great persistence, they are still present in the environment (Grossman 2013). No waters are currently listed for PCBs in Idaho; thus, no total maximum daily loads will target lower PCB loadings to waterways. There are also no National Pollutant Discharge Elimination System (NPDES) permitted discharges in Idaho with effluent limits for PCBs. A lowering of the criterion for PCBs could, conceivably, cause future listings for PCB contamination and permits with PCB effluent limits in Idaho. However, another issue with PCBs is that the criterion at a fish consumption rate of 17.5 g/day is 0.000064 parts per billion (ppb), while the most sensitive analytical method (USGS-NWQL method O-3104) has a detection limit of 0.01 ppb (NEMI 2014). When detection limits are greater than criteria, routine monitoring and assessment resulting in a measurement below the detection limit indicates compliance with the criteria.

Techniques are available to concentrate PCBs in water. For example, semi-permeable membrane devices—sometimes called “fat bags” (Huckins et al. 1993)—have been used, but these methods are still experimental and have not yet been approved by EPA for monitoring NPDES permit compliance, nor are they used in routine monitoring practices. The ability to truly measure compliance if criteria are lowered will only be more difficult. Furthermore, tangible gains in PCB reduction can be achieved by going directly after the known remaining sources of PCBs (e.g., residues allowed in inks, dyes, and caulks), completely independent of water quality criteria and wastewater treatment.

Even when water quality criteria do enter into permits, they only limit sources within Idaho’s jurisdiction. If lower criteria become common across the region, they will certainly have some effect on the quality of local fish; they will have much less effect on the quality of anadromous fish returning to Idaho waters and likely no effect on the quality of fish most commonly eaten—the 91% imported from outside the United States.

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