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By Bill Bakke

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Native Fish Society

Conservationists Sue PGE Over Water Quality Standards At Round Butte Dam

<http://www.opb.org/news/article/oregon-round-butte-dam-deq-pge-lower-deschutes-water-quality/>

by [Amanda Peacher](#), Updated: Aug. 17, 2016 (Amanda Peacher - OPB photos)



Round Butte Dam holds back the waters of the Deschutes River to form Lake Billy Chinook near Madras, Ore., Tuesday, July 13, 2004.

Update: *The Deschutes River Alliance formally filed suit Friday, Aug. 12, 2016 against Portland General Electric over alleged water quality violations.*

“The Deschutes River Alliance alleges that since the installation of the device, PGE has violated water quality standards more than 1,200 times without serious consequence.” That finding is based on PGE’s own water quality tests. The conservation group also believes that Oregon’s Department of Environmental Quality, which regulates water quality, has developed an overly cozy relationship with PGE and that regulators are lax in enforcing standards.

Prior to the building of the water mixing tower above the dam to regulate the temperature of the water in the river below the dam, the water was cooler in the spring and warmer in the fall. Now the tower mixes the water so that it is warmer in the spring and cooler in the summer and fall.

According to Rod French, Rod French, fisheries biologist with Oregon Department of Fish and Wildlife: “We feel that that’s the natural regime that these fish evolved with over time.”



Conservationists Greg McMillan believes that Oregon's Department of Environmental Quality is being too lax with regulating Portland General Electric for water quality standards on the lower Deschutes.

“The Deschutes River Alliance alleges that since the installation of the device, PGE has violated water quality standards more than 1,200 times without serious consequence. That finding is based on PGE’s own water quality tests. The conservation group also believes that Oregon’s Department of Environmental Quality, which regulates water quality, has developed an overly cozy relationship with PGE and that regulators are lax in enforcing standards.

“But since the mixing device was installed in 2009, PGE has struggled to meet all of those standards. Water temperature wasn’t a problem, but the utility found it wasn’t always able to get the levels of pH and dissolved oxygen right.

“The Deschutes River Alliance activists are fed up with flexibility. They say PGE has violated water quality standards more than 1,200 times since the mixing device went in seven years ago.

“And PGE leaders note that they’re doing everything DEQ has asked. “We work really closely with our water quality regulators,” said Steve Corson, a utility spokesman. “We believe that we are in compliance.”

“On top of the known water quality challenges with dissolved oxygen and pH, conservationists are also frustrated with other, more mysterious changes they’ve seen since the mixing device went in. The [insect] hatches don’t seem to be as robust. There’s algae in the river that didn’t used to be there. That algae can suffocate the bugs.

“PGE has a monitoring program in place that Nigg hopes will provide some clarity about nutrients in the river in coming years. But the Deschutes River Alliance sees an obvious link between the algae blooms and the water mixing device. The reservoir’s surface water comes from the nutrient-laden Crooked River, which sees heavy agricultural use. The cold bottom water comes from the Metolius.

“If you look at the water quality in the Crooked River and the Deschutes too, there’s a big difference,” Hafele said. “Crooked River is poor. Metolius is excellent. Now you’re releasing that [Crooked River] water downstream with higher nutrient levels.”

“Conservationists believe the new downstream mix — an intended consequence of the mixing tower — is why algae blooms are on the rise.

Last month, the alliance announced its intent to sue PGE over water quality violations. The utility plans to challenge the suit.

“Our ask of people is to remember that this is a long-term effort,” said Corson, the PGE spokesman. “The bottom line is we’re trying to improve conditions for salmon and steelhead, while at the same time maintaining this valuable, emissions-free, carbon-free energy source for our customers.”

“McMillan said he’s hoping the lawsuit will force PGE to consistently meet water quality standards in the short-term, and in the long term, make the utility go back to releasing water from the bottom of a reservoir.

“Ultimately, it’s the river and it’s the fish populations that are suffering because of poor regulation and perceived ‘flexibility’ with the utility,” McMillan said. “The tower was a great engineering idea, but sometimes great engineering ideas don’t work.” (OPB Earth Fix, August 17, 2016)

<http://www.opb.org/news/article/oregon-round-butte-dam-deq-pge-lower-deschutes-water-quality/>

Salmon Reintroduction Upstream of the Dams

Salmon and steelhead were blocked at the dams in the 1960s when the world’s longest fish way got too hot and the fish get would not go through it. There was the additional problem that smolts, juvenile salmonids making their way to the sea, would not pass down Round Butte reservoir. The mixing tower was built to create a current in the surface water of the reservoir and guide the smolts to the passage system at the dam.

“PGE spends more than \$2 million annually on the salmon reintroduction program, including more than 20 fisheries-related jobs.”

The plan was to collect 75 percent of the spring chinook smolts but collection has “never been above 50 percent since the tower has been in place.”

PGE and biologists claim it will take years to work out the “kinks.”

Wychus Creek Redband Rainbow are Disappearing

In an effort to reintroduce summer steelhead above the dams on the Deschutes, the Oregon Department of Fish and Wildlife has been introducing juvenile steelhead into Wychus Creek, a tributary to the Deschutes River that use to have a wild steelhead spawning population prior to dam construction. Wychus Creek also has a resident form of rainbow trout.

A recent genetic study by U. S. Fish and Wildlife Service and the U.S. Forest Service (2015) found that the 2005 and 2013 collections of Wychus Creek were “significantly different from each other.”

Rainbow trout and steelhead belong to the same species *Oncorhynchus Mykiss*. The 2013 genetic study found that 75% of the trout surveyed were steelhead from Round Butte Hatchery, the source for reintroduction of steelhead. Only 15% of the fish surveyed were associated with the 2005 reference study that included redband trout. Wild steelhead were blocked by Pelton Dam 56 years ago, leaving only native wild rainbow trout in Wychus Creek. The genetic study is able to differentiate Round Butte Hatchery steelhead from native redband trout.

The researchers conclude that Round Butte Hatchery *O.mykiss* “have predominately displaced natural-origin *O.mykiss* from Wychus Creek over the last two generations.”

Adams et al. 2015 Genetic Determination of Stock of Origin for O.mykiss Collected in the upper Deschutes River Basin. U.S. Fish and Wildlife Service and U.S. Forest Service.

Could Spring Warm Water Releases from Deschutes Dams Establish Ecological Conditions for Resident Breeding Smallmouth Bass in the Lower Deschutes River?

Steelhead anglers are frequently catching smallmouth bass (a nonnative species) in the lower Deschutes River as far upstream as Buckhollow Creek, just below Sherars Falls, 44 miles upstream from the Columbia River. Smallmouth bass

of 12 inches long and 7 years old (Simpson and Wallace 1982) feed more on juvenile salmonids more than larger bass. Small mouth bass smaller less than 300 mm (11.7 inches) consumed the vast majority of juvenile salmonids (83.6%). Small bass were much more abundant than larger bass. Salmonids that were 100 mm (3.9 inches) or larger were rarely consumed by smallmouth bass (Fritts and Pearsons 2006). Therefore, salmonid fry such as rainbow trout, fall chinook, spring chinook, and steelhead are vulnerable to predation by smallmouth bass.

Smallmouth bass spawn in April when water temperature approaches 60 degrees F. (Simpson and Wallace 1982). Warmer water releases in spring from PGE dams on the Deschutes has warmed the river earlier than when cold water releases were the norm. According to the U.S. Geological Survey temperature gage at Moody (the mouth of the Deschutes) the river water temperature approaches 60 degrees in April. This ecological condition would support the development of resident breeding smallmouth bass in the lower Deschutes River. Biologists with ODFW are evaluating the bass population in the lower Deschutes. At this time they assume the bass are migrating up from the Columbia River to Buckhollow Creek 44 miles upstream. However, if smallmouth bass are now a resident population and breeding in the Deschutes River, then wild salmonids would be at greater risk. This year anglers are reporting more bass in the lower Deschutes and some have had good success targeting them rather than fishing for steelhead and trout.

The warmer water releases by PGE at the dams 100 miles upstream may be having an unintended impact on native wild salmonids in the lower Deschutes River. Changing water temperatures and timing can have ecological effects on the river and the recent abundance of smallmouth bass expanding from the area near the mouth of the river to 44 miles upstream represent a change that may be favoring smallmouth bass. The ODFW biologists have yet to find smallmouth bass in the fish trap at Sherars Falls, but are very concerned if they do, for it means that bass can colonize the whole lower Deschutes, introducing a new predator and limiting factor on salmonid production in the river. However, biologists say small mouth bass are frequently passing downstream from the PGE reservoirs, but river conditions do not support breeding.

Some will say that smallmouth bass are in the Columbia so what is the problem with them colonizing the Deschutes? They are in the John Day River. Biologists have found smallmouth bass in the wilderness portion of the North Fork John Day River, so these predators are extending their range in the John Day as water temperatures increase due to climate change. They are now found in areas of the river where steelhead and spring chinook spawn and rear. In most years salmonid smolts migrate to the Columbia when the John Day is high and turbid which may favor salmonid survival. The Deschutes is a clear water river in the spring so juvenile salmonids would be more vulnerable to bass predation. In the Yakima River small mouth bass primarily feed on fall chinook fry (Fritts and Pearsons 2006). The lower Deschutes is the only river above The Dalles Dam on the Columbia River that is managed for wild fall chinook, that is, there are no hatchery fish released. Expanding smallmouth bass into spawning and rearing habitat for salmonids can only increase the risk to wild salmonids. Since larger bass (more than 12 inches) feed less on large salmonids such as smolts, suggests that predation on smolts may be less. However, of the salmonids in the 200-248 mm (7.8 to 9.7 inches) size were 26.7% of the smolt size salmonids consumed by larger smallmouth bass (Fritts and Pearsons 2006). This would increase the risk to endangered summer steelhead and wild spring chinook in the Deschutes River.

According to Deschutes biologists a recent trip down the lower Deschutes to the mouth turned up no bass fry, indicating that the smallmouth bass are, at this time, not breeding in the river.

With regard to the Columbia River basin “The results indicate that the effect of nonindigenous species on salmon could equal or exceed that of four commonly addressed causes of adverse impacts—habitat alteration, harvest, hatcheries, and the hydrosystem; we suggest that managing nonindigenous species may be imperative for salmon recovery. Nonindigenous species pose one of the dominant environmental threats to biological diversity (Vitousek et al. 1996, Simberloff et al. 2005) and are cited as a cause of endangerment for 48% of the species listed under the US Endangered Species Act (ESA)” (Sanderson et al. 2009). BMB



Rearing strategies alter patterns of size-selective mortality and heritable size variation in steelhead trout

Berejikian, Barry A., Jeffrey J Hard, Christopher P Tatara, Donald M Van Doornik, Penny Swanson, Donald A Larsen. 2016. Rearing strategies alter patterns of size-selective mortality and heritable size variation in steelhead trout (*Oncorhynchus mykiss*). Canadian Journal of Fisheries and Aquatic Sciences, 10.1139/2016-0175

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<http://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2016-0175#.V6F1xLgrIVA>

ABSTRACT

Steelhead trout (*Oncorhynchus mykiss*) reared under two different regimes: high food ration for one year (S1; typical strategy) or low ration for two years (S2) were subjected to a seawater challenge during the corresponding the spring outmigration period. The S1 smolts were smaller, suffered greater seawater challenge mortality (23.9% compared to 0.7% for the S2 smolts) that was significantly and negatively related to body size. Heritability for body size was similar for the two treatments during the parr stage (fork length: S1 = 0.181, S2 = 0.245; mass: S1 = 0.372; S2 = 0.447), but higher for the S1 treatment during the smolt stage for length (S1 = 0.212, S2 = 0.002) and body mass (S1 = 0.145, S2 = 0.015). Strong family effects for both traits and significant family by environment interactions for parr mass and smolt length indicated significant phenotypic plasticity. A genetic response to size-selective mortality caused by insufficient growth opportunity in the S1 treatment is plausible and may affect fitness in the natural environment through effects on correlated traits.

Quotes from text:

“Fitness loss in salmonid fish populations is currently considered an unavoidable consequence of captive breeding.”

“There are massive differences between environments experienced by hatchery- and natural-origin fish during egg incubation, emergence from gravel nests, and juvenile development, which cannot be mimicked in hatchery environments.

“The predominant management response has been to limit the productivity drag on natural populations by quantitatively controlling gene flow between hatchery and natural populations (Baskett and Waples 2013). However, the ability to effectively manage gene flow in the natural environment to minimize interbreeding between hatchery and natural populations is largely uncertain (Lorenzen et al. 2012), and population viability models suggest that even a low level of fitness loss (e.g., 15%) can reduce productivity over the long term (Bowlby and Gibson 2011). Far less attention has been paid to changes in culture strategies (separate from breeding practices) that might reduce genetic changes in key phenotypic traits contributing to fitness variation between hatchery and natural populations.”

“One way to minimize the impact of culture environments may be to minimize time in captivity (Christie et al. 2014), but this partially offsets the primary benefit of supportive breeding (high survival), because fish released at a younger age and smaller body size suffer lower post-release survival (Berejikian et al. 2004, Leber et al. 2005).

“Because survival during captivity is typically very high and post release survival is very low, selection on phenotypic variation may be much stronger in the post-release environment, but likely acts on traits that fish develop in the culture environment (Waples 1999, Quinn 2005).

“The modal age-at-smoltification is age-2 throughout much of the species’ southern range where hatchery production is greatest. Nevertheless, hatchery-reared steelhead are almost ubiquitously reared on accelerated growth regimes and released at age-1, primarily to increase production and minimize costs. Steelhead populations reared under this approach have diverged from wild progenitors for a number of juvenile traits related to fitness including competitive and predator avoidance abilities (Berejikian 1995, Berejikian et al. 1996). Atlantic salmon (*Salmo salar*), which share a similar life history trajectory (typically age-2 smolts), show divergence in juvenile growth rate with just one generation of captive rearing (Wilke et al. 2015).

“Thus, understanding how changes to conventional hatchery culture environments influence the viability of released fish is an important step in minimizing domestication selection.

“Phenotypic plasticity refers to the ability of a single genotype, or sometimes a group of closely related individuals, to produce different phenotypes under different environmental conditions; it represents an adaptive response to the environment that sometimes involves genetic change (Roff 1997, Schlichting and Pigliucci 1998).

“The two approaches to producing hatchery-reared steelhead smolts (S1: high ration for one year; S2: low ration for two years) resulted in significant differences in seawater challenge mortality that were strongly dependent on body size. Nearly all fish (99%) in the S2 treatment, which averaged 209 mm fork length, survived the 21 d seawater challenge ... suggesting no evidence for size-selective mortality within this treatment. Survival in the S1 treatment (76%; average fork length = 154 mm) was significantly lower overall and strongly influenced by size. The positive correlation between body size and endurance in the challenge indicated that larger fish took longer to succumb to osmoregulatory stress.

“Christie et al. (2012) found an inverse relationship between the reproductive success of hatchery-spawned steelhead broodstock and reproductive success of their offspring spawning in nature, providing evidence of domestication selection.

“The results of the present study together with evidence of size-biased downstream migration (Reisenbichler 2004, Tatara et al. in review) suggests that hatchery programs can alter evolutionary trajectories of size at smolting and subsequent marine survival for steelhead trout. Because this species harbors some plasticity in size at smolting as well, this source of diversity could help facilitate rapid adaptation of these traits to hatchery rearing regimes.

“The results of the present study are most relevant to S1 programs that use broodstock with natural spawn timing and rear juveniles on cold water sources. In those cases, or in similar situations for other species, growth rate selected hatchery populations may be partially mismatched for the natural environment, and may explain a portion of the fitness loss in hatchery populations.

(This study continues the peer reviewed research that confirms hatchery steelhead and other species are maladapted to nature. This was first established by research on wild and hatchery steelhead in Oregon’s Deschutes River (Reisenbichler and McInyre 1978. Based on this and other scientific information we know that hatchery fish have genetic and ecological impact on wild salmonids, reducing their reproductive success. We also know that hatchery fish are expensive, and can cost thousands of dollars per harvested fish. Yet the fishery agencies stubbornly continue to pour money into hatchery programs rather than fund actions to recover endangered wild salmonids across the landscape. Government agencies will continue down this road because there is no down side. Therefore they will continue to serve the commercial fisheries (sport and commercial fisheries and preserve federal funding for hatcheries.) BMB



Elder, Timothy, Christa M. Woodley, Mark A. Weiland, Angela L. Strecker. 2016. Factors influencing the survival of outmigrating juvenile salmonids through multiple dam passages: an individual-based approach. Ecology and Evolution.

<http://onlinelibrary.wiley.com/doi/10.1002/ece3.2326/epdf>

Summary

Substantial declines of Pacific salmon populations have occurred over the past several decades related to large-scale anthropogenic and climatic changes in freshwater and marine environments. In the Columbia River Basin, migrating juvenile salmonids may pass as many as eight large-scale hydropower projects before reaching the ocean; however, the cumulative effects of multiple dam passages are largely unknown. Using acoustic transmitters and an extensive system of hydrophone arrays in the Lower Columbia River, we calculated the survival of yearling Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*) passing one, two, or three dams. We applied a unique index of biological characteristics and environmental exposures, experienced by each fish individually as it migrated downstream, in order to examine which factors most influence salmonid survival. High outflow volumes led to involuntary spill in 2011 and created an environment of supersaturated dissolved gas concentrations. In this environment, migrating smolt survival was strongly influenced by barometric pressure, fish velocity, and water temperature. The effect of these variables on survival was compounded by multiple dam passages compared to fish passing a single dam. Despite spatial isolation between dams in the Lower Columbia River hydrosystem, migrating smolt appear to experience cumulative effects akin to a press disturbance. In general, Chinook salmon and steelhead respond similarly in terms of survival rates and responses to altered environmental conditions. Management actions that limit dissolved gas concentrations in years of high flow will benefit migrating salmonids at this life stage.

Quotes

“Survival of Chinook and steelhead passing one dam decreased as dissolved gas concentrations increased above 113%. For both species passing two dams, there is a sharp decrease in survival at 113% and then again at concentrations >120%. There was a nonlinear relationship with dissolved gas for both species passing three dams, with low concentrations having a similar negative effect on survival as high concentrations. Although a similar pattern exists between these species, steelhead appear more tolerant of elevated dissolved gas concentrations between 113% and 120%.

“Chinook passing one and two dams showed increased survival with increasing outflow discharge. For steelhead passing one dam, outflow discharge between 7000 and 10,000 m³·sec⁻¹ showed the highest survival. For both species passing three dams, there is a large increase in survival at outflow discharges between 6000 and 7000 m³·sec⁻¹ and then virtually no effect above 7000 m³·sec⁻¹.

“There was slight decrease in survival with increasing spill discharge for both species passing a single dam. Fish passing three dams showed a sharp increase in survival at spill discharges ~3000 m³·sec⁻¹. Interestingly, after averaging out the effects of other variables, survival probabilities based on spill volume alone were asymptotic around 70% and did not increase as spill discharges increased above 3000 m³·sec⁻¹.

“In general, for both species and all dam passages, survival increased as water temperatures increased up to 12°C (53.6°F); however, for temperatures above 12°C, survival drops quickly. Steelhead survival, in general, appeared more resilient to the effects of water temperatures than Chinook salmon survival.

“For both species passing a single dam, fish velocities around 2 km·h⁻¹ showed the highest survival. For Chinook passing two dams, survival was highest around 4.5 km·h⁻¹, while for steelhead, there was sharp increase in survival between 0.5 and 2 km·h⁻¹ and little effect of increasing velocity past 2 km·h⁻¹. For both species passing three dams survival increased substantially as fish velocity increased, though interestingly, survival declined slightly for Chinook salmon at velocities >3 km·h⁻¹, while steelhead survival remained high for all velocities.

Discussion

“The influence of biological and environmental variables on smolt survival changed depending on dam passage experience, and we observed cumulative, negative effects for fish passing multiple dams. Our analysis indicates that the ecological effects of hydropower facilities are not confined to isolated areas of deleterious environment conditions (i.e., pulse disturbance), but rather, exert a cumulative influence on migrating smolt, affecting survival throughout our study system (i.e., press disturbance). For both Chinook salmon and steelhead, atmospheric barometric pressure, dissolved gas concentrations, outflow discharge, spillway discharge, water temperature, and fish velocity were identified as most influential in terms of survival; however, the importance of these variables changed based on how many dams were experienced. For example, fish velocity had little effect on the survival of Chinook salmon passing a single dam, while survival of Chinook passing three dams was strongly negatively affected when fish travelled at low velocities.

“In general, Chinook salmon and steelhead responded similarly to altered ecological conditions. We believe that the strength and influence of the altered river conditions acting on salmonids during this life stage overcomes physiological and biological differences between these species. Both species had statistically similar survival rates for each dam passage and had similar overall responses to environmental conditions. Steelhead appeared to handle the effects of dissolved gas slightly better than Chinook salmon, but this trend was not reflected in overall survival rates. These findings suggest that strategies that create more favorable ecological conditions, that improve survival for one species, will benefit other salmonid species as well. The influence of environmental variables and their implications are discussed below.

“Outflow discharge has been shown to affect survival indirectly, by slowing migration and leading to increased predation and longer exposures to deleterious environmental variables (Raymond 1979; Weitkamp and Katz 1980, Giorgi et al. 1997). In our study, increasing outflow discharge did not increase survival of smolt passing one or two dams but there was a substantial benefit to smolt passing three dams. The effect of flow volume on smolt survival is likely more important during low flow years when delayed migration and predation risks are higher (Connor et al. 2003; Smith et al. 2003), compared to years of high flow volumes where secondary processes such as involuntary spill dominate survival patterns (this study, Raymond 1979).

“Beginning in 1991, the US Army Corps of Engineers began implementing measures at Snake and Columbia River dams to increase the survival of fish populations listed under the Endangered Species Act (USACE 2011). One successful management strategy is a program of voluntary water release through spillways during juvenile outmigration periods. Smolt passage through spillways has been repeatedly shown to have the highest survival rates of any in-river passage route (Muir et al. 2001; Budy et al. 2002). During years of high spring runoff when water flows exceed hydroelectric capacity, dams are forced into periods of involuntary spill, which result in dissolved gas concentrations that exceed the State of Oregon's water quality standard for concentrations <110% saturation (USACE 2011; Appendix S4). In our study, migrating Chinook salmon and steelhead were strongly influenced by high flow volumes and cascading effects resulting from involuntary spill through the Lower Columbia River hydrosystem.

“As seen over the course of our study period, high flow volumes and involuntary spill elevate dissolved gas concentrations resulting from entrained atmospheric gasses held in solution (Johnson et al. 2005; Appendix S3). Gas concentrations >100% saturation have been shown to have both acute and chronic effects on salmonids that manifests as gas bubble trauma, which is most affected by the concentration of dissolved gas and the length of exposure (Mesa et al. 2000). While acute exposure to gas concentrations <120% are unlikely to cause direct mortality, chronic exposure, and behavioral changes to compensate for high levels of gas may indirectly increase both species' susceptibility to predation and disease (e.g., Ebel and Raymond 1976; Mesa and Warren 1997). Over the course of our study, the median dissolved gas concentrations were 116.6, 113.3, and 112.7% at the forebay of BON, TDA, and JDA, respectively, with maximum concentrations of 124.7%, 126.2%, and 131% (Appendix S3). These concentrations are well within the ranges found to cause gas bubble trauma in salmonids (Colt 1986, Mesa and Warren 1997; Mesa et al. 2000).

“Multiple factors acting in concert may influence how dissolved gas concentrations will affect migrating smolt, including barometric pressure, water temperature, and fish velocity (Colt 1986, Mesa et al. 2000). The influence of atmospheric

“barometric pressure on dissolved gas concentrations has received little attention in recent years. The difference between atmospheric barometric pressure and total gas pressure of water is called the differential pressure (ΔP), where ΔP values <0 inhibit bubble formation and values >0 can lead to gas bubble formation in aquatic organisms (Colt 1986). Salmonids experience chronic gas bubble trauma when ΔP is between 38–76 mmHg and acute gas bubble trauma at levels >76 mmHg (Colt 1986). Salmonids can behaviorally adjust swimming depths to avoid $\Delta P >38$ mmHg.

Although ΔP changes throughout the season, with changing spillway discharge and barometric pressure, migration depths >2 m would compensate for all ΔP values calculated over our study period (Appendix S5). Swim bladder over inflation caused by sudden changes in pressure in supersaturated water may prevent smolt from reaching compensation depths (Shrimpton et al. 1988). Despite no difference in survival estimates, our partial dependence plots indicate that steelhead are slightly better adapted to an environment of elevated barometric pressures and dissolved gas concentrations compared to Chinook salmon.

“In addition to depth compensation, migrating smolt can reduce the effect of gas bubble trauma by increasing swimming velocity, which reduces exposure times to elevated gas levels. For both species passing a single dam, all measured velocities maintained survival probabilities above 80%. For fish passing two and three dams, fish velocities $<2.5 \text{ km} \cdot \text{h}^{-1}$ resulted in survival well below 80% (Figs 3Q–R and 4Q–R). This finding suggests that faster fish limit exposure time to sublethal levels of dissolved gas or other sources of mortality and supports our cumulative effect hypothesis.

Conclusions

“For both species, we observed a positive relationship between survival and water temperatures between 9 (48.2 F) and 12°C (53.6 F). At temperatures $>12^\circ\text{C}$, survival decreased for both species, but this effect was stronger for Chinook salmon. Water temperatures observed between April and June were well below acute lethal levels for both species ($<24^\circ\text{C}$; Sullivan et al. 2000); thus, we hypothesize that the pattern of increasing survival with increasing temperature is related to the inverse relationship between water temperature and dissolved gas concentrations. Weitkamp and Katz (1980) report that as water temperatures raise its capacity to hold dissolved gas in solution decreases, thus reducing the risk of gas bubble trauma for fish.

“Fish passing one, two, and three dams experience varying environmental conditions that differentially affect survival rates. The majority of Chinook salmon and steelhead smolt in the Lower Columbia River are outmigrating from upriver sites and therefore likely pass through multiple dams. While salmonids are physiologically and behaviorally adapted to wide ranges of environmental conditions, the altered state of the Lower Columbia River hydrosystem represents novel conditions for which smolts have little evolutionary context (Hicks et al. 1991). Despite being spatially isolated in the system, the temporal frequency that smolts encounter these dams equates to a press disturbance, limiting smolts' ability to recover from one set of deleterious conditions before experiencing another significant disturbance. We find tempered encouragement in the convergent responses of Chinook salmon and steelhead survival to the altered environmental conditions in the Lower Columbia River. We believe this finding indicates that management actions intended to improve smolt survival for one species will be beneficial to other salmonids.”

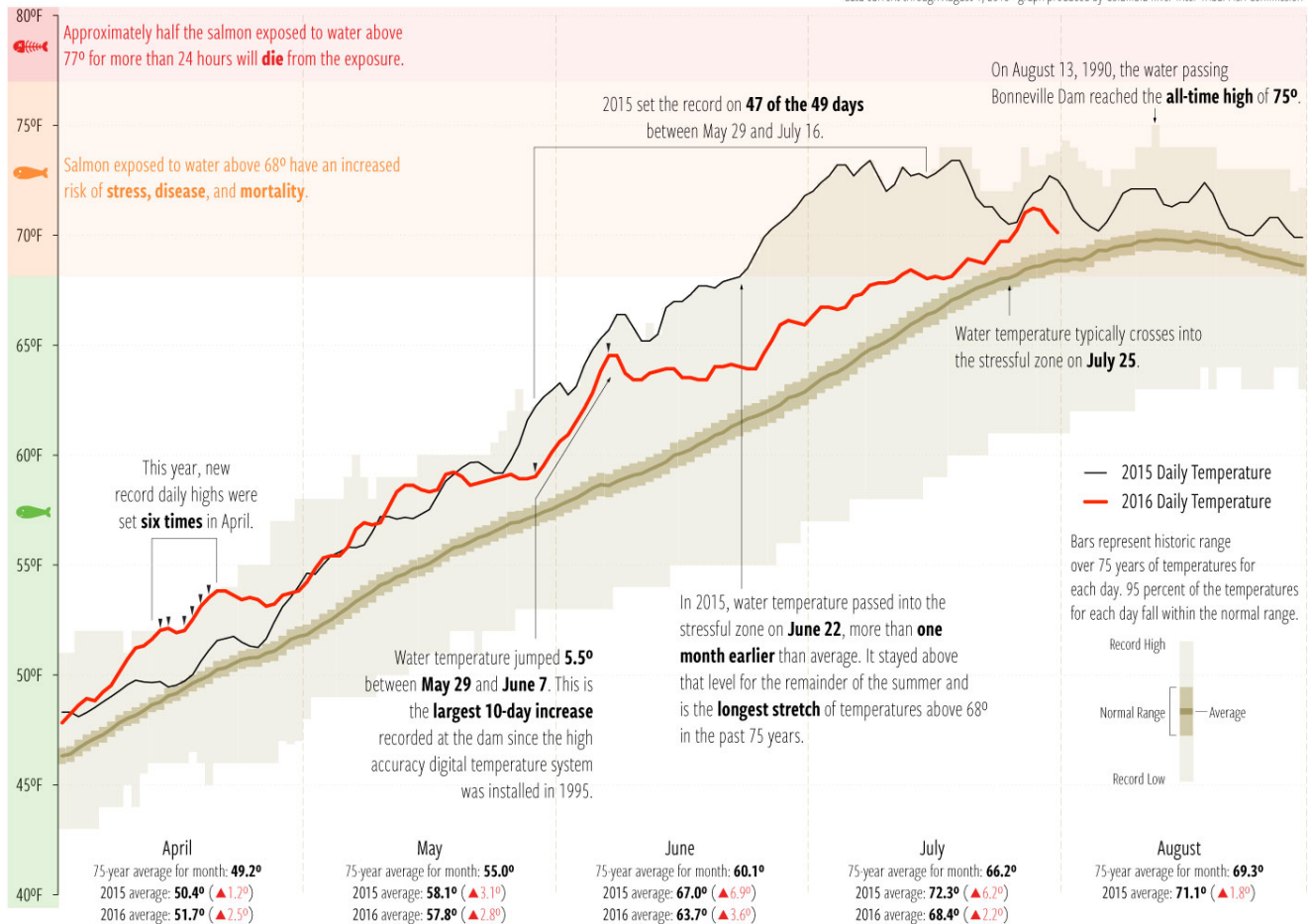
Anthropogenic alterations within freshwater ecosystems have caused substantial impacts to aquatic organisms throughout the world. Continued monitoring and evaluation of the ecological impacts of hydroelectric development are needed to conserve current threatened and endangered species and to prevent further species loss globally.



Water Temperature Passing Bonneville Dam from April through August

uses data from 1940 through 2016

data current through August 1, 2016 - graph produced by Columbia River Inter-Tribal Fish Commission



2015 saw some of the longest stretches of warmer than average water temperature at Bonneville Dam, setting a daily high temperature record nearly 50 times over the summer. During the late spring of 2016, river temperatures followed a similar trajectory in terms of above-normal water temperatures, however favorable weather conditions brought conditions down from record highs later in the season. (Columbia River Inter-Tribal Fish Commission)

(Since 1999 I have requested that the ODFW Commission take action to limit fisheries in thermal refuges with little response. Since then, there have been numerous studies identifying the importance of these thermal areas for migrating salmonids, recommending protection of these areas and their sources. There has been a remarkable lack of interest by government agencies, but now that there is growing evidence that rivers are hotter and salmon are being killed, threatening the ability for salmonids to survive migratory habitats like the mainstem Columbia River to reach their spawning grounds, it could be expected that thermal refuges would be protected and fisheries in them limited. But so far, that expectation has not resulted in effective regulation of fisheries or protection of thermal refuges.)BMB



Smelt: Connecting Humans with Nature

<https://maptia.com/paulcolangelo/stories/the-salvation-fish>

Thanks for the wonderful article, Bill. The return of the Eulachon to the Skeena each year is the first and true sign that spring has begun. After they have spawned the valley opens its eyes – the river banks green up, fry appear in the shallows, cutthroat and char arrive as do the first Chinook.

The wonderful greasy little fish have been neglected because they were of no commercial value, and almost nobody cared about the welfare of the First Nations Peoples for whom the Eulachon were vitally important for consumption and for trade. To facilitate the latter, coastal First Nations built trails inland that stretched for hundreds of miles over rugged mountains and through ancient forests.

Fisheries mismanagement by our Department of Fisheries and Oceans who allowed shrimp trawling in critical areas for eulachon spelled the end of the run in many rivers. Further south, I suspect habitat loss was the reason for their extinction. The creatures need fine sand in which to spawn.

There is no question in my mind that the loss of the huge amount of biomass the eulachon brought to the rivers each year must have had a profound effect on other fish species and the fauna in the coastal valleys. When the candle fish return to the Skeena and Nass the trees are filled with eagles, the sky is full of gulls, pods of sea lions appear in the estuary, and seals are everywhere.

Soldier on,

Rob Brown

