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Subcommittee on Water, Power and Oceans
Oversight Hearing: "The costly impacts of predation and conflicting federal statutes on native and endangered fish species."
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My name is Gary Grossman and since 1981 I have been a professor of animal ecology at the University of Georgia. I received my BSc degree from the University of California at Berkeley in 1975 and my PhD from the University of California at Davis in1979. I would like to thank the Chair and Ranking Member of the Subcommittee on Water, Power and Oceans, for the honor of this appearance and reserve the right to revise my written testimony if further information will aid the Subcommittee.

My primary fields of research are population and community dynamics and habitat selection in fishes and I have published over 115 scientific papers which have been cited over 5000 times. In 2014 I won the American Fisheries Society's Sullivan Award for excellence in fisheries conservation and in 2015 I was elected to the first class of Fellows of that Society.

My expertise in the issue of predation on endangered salmon is based on ~20 years of fisheries advisory work in various forms for the state and federal agencies that manage the Sacramento-San Joaquin Delta. In 2013 I led the public hearing on the effects of fish predation on Steelhead Trout and endangered Chinook Salmon populations in the Delta and senior authored the report produced by the technical panel from the hearing. At present I have completed a general review of the effects of predation on Delta fishes that will be published in the upcoming volume on "State of the Delta Science"

My testimony is based on my experience with endangered Central Valley Chinook Salmon, but the principles I discuss are general and likely apply to many species and habitats. Unfortunately, the endangered salmon in California's Central Valley both live and traverse highly altered habitats, which make it difficult to create a hierarchy of factors limiting their abundance. In addition, many of the factors that are known to negatively affect endangered salmon, such as habitat alterations and water diversions for agriculture, domestic and industrial consumption, and toxicant burdens, are difficult to alter. Consequently, at present it is problematical to assign a value to the potential increases in endangered salmon abundance that will be produced by a reduction in invasive predators versus the potential increases produced by remediation of the many other factors that negatively affect endangered salmon populations (e.g. degraded habitat and flow regimes, contaminants, and artificial structures that disorient salmon and alter migration routes).

For those of you who are not from Pacific States, it should be helpful to briefly review the life history patterns of Pacific salmon. All salmon are born in rivers and streams, and spend between several months and two years in freshwater. The young, called smolts, then migrate downstream through estuaries and out into the open ocean where they quickly grow to adult size. Pacific salmon spend 1-4 years in the ocean before migrating home to their birth streams, reproducing and dying. This complex life history forces Pacific salmon to run a predatory gauntlet beginning with aquatic insects that consume eggs to predatory fishes, birds, mammals, and perhaps a few reptiles and amphibians that consume young salmon and smolts. Indeed, most of the mortality experienced by salmon occurs in the freshwater stage or on the migration to the ocean. Adults also face predation from a few large oceanic fishes such as sharks and mammals like seals and bears. Nonetheless, for hundreds of millions of years Pacific salmon coexisted with native peoples and predators; it is only when humans altered the environment substantially and introduce non-native predators that problems started to occur.

When considering the effects of predators on endangered salmon it also is necessary to examine the impact of proximate and ultimate factors on mortality. Proximate causes are factors that contribute to mortality but are not the main causal factor. They represent factors that even if substantially reduced, may have little effect on mortality. By contrast, an ultimate factor is the primary causal agent influencing a process like mortality. Manipulation of an ultimate factor for predation should produce a significant positive effect on abundance. In general, predation may be either a proximate or ultimate cause of mortality, but for endangered salmon in California's Central Valley it is likely the former rather than the latter. This obtains because, virtually any environmental factor that weakens or disorients a young salmon will increase the probability that it will be eaten by a predator. Unfortunately, endangered salmon in California's Central Valley face a constellation of factors that likely weaken or confuse migrating smolts including: habitat alterations, altered flows and water removals, and contaminants. It is these factors that could easily be the ultimate cause of predation mortality.

To examine just one of these factors, the presence of contaminants in the Sacramento – San Joaquin Delta; researchers have detected the presence of the following harmful agents: estrogen disruptors, psychoactive drugs, ammonia, Triclosan, and metallic compounds such as selenium, mercury, copper, and aluminum. Before endangered salmon smolts can reach the Pacific Ocean, they must traverse the Delta, where these contaminants are present in concentrations capable of causing abnormal behavior in fishes (Sloman and Wilcox 2006, Connon et al. 2011, Brooks et al 2012, Conner et al. 2016). In fact, Sandahl et al (2007) demonstrate that copper concentrations commonly found in Delta waters produce abnormal anti-predatory behaviors in coho salmon. Their video (http://pubs.acs.org/doi/suppl/10.1021/es062287r) shows control salmon ceasing movement and dropping to the bottom of the tank when exposed to a fright stimulus, whereas fish exposed to copper continue moving around the tank in an agitated and highly visible manner. This behavior almost certainly renders young salmon more susceptible to predation and illustrates the principle of proximate and ultimate causes. In this case, predation would be the proximate cause of mortality but contaminants would be the ultimate cause. The greater the number of factors that stress young salmon, the greater the number of potential proximate causes of mortality and the greater the difficulty of undertaking management actions that will unambiguously result in decreased mortality and increased abundance of endangered salmon.

An additional issue that must be addressed when evaluating the impact of predators on endangered salmon is compensation by other predators. Most predators on salmon are generalized feeders that consume a diverse array of prey. Consequently, a management strategy that reduces the abundance of an invasive predator, say striped bass in the Sacramento – San Joaquin Delta, might not result in an increase in endangered salmon abundance, because another predator might increase in abundance and consume an identical amount of salmon. Even worse, eliminating a predator also has the effect of eliminating a potential prey (young of the predator) for other predators and in the worst case scenario might lead to these predators increasing their predation rate on endangered salmon. The law of unintended consequences is alive and well on Mother Earth.

I have surveyed the scientific literature and ongoing studies on predators of fishes in the Delta (Grossman 2016) and recorded eight species that fed upon endangered salmon: striped bass, largemouth bass and smallmouth bass, black crappie, white catfish, channel catfish, Caspian and California Least Terns. Nonetheless, 24 other predatory species have the potential to feed on endangered salmon. Despite the wide range of potential predators it is problematical to reach a conclusion regarding the effects of predation mortality on California's Central Valley endangered salmon because the data base is neither extensive nor thorough (most data depict the presence or absence of salmon from a few samples). For example, data are completely lacking for some potentially major predators such as river otters. Predation on endangered Chinook Salmon does occur, but its impact on populations of this species cannot be ascertained given the data at hand. Several mathematical models (Lindley and Mohr 2003, Loboschefsky et al. 2012, Nobriga et al. 2013) do suggest that predation may have significant impacts on endangered salmon, but these studies, although yielding insights regarding the potential impacts of predators on this species, have not been verified empirically.

Finally, the history of predator control to increase salmon abundance has not been markedly successful. The Northern Pikeminnow Sport-Reward Program began in 1991 in the Columbia River and pays anglers to harvest predatory size fish (Porter 2010). The program removed over 2.2 million fish during 1998-2009 and is believed to have reduced predation on juvenile salmonids, but positive effects on salmonid populations have been difficult to detect (Carey et al. 2012).

California's endangered Central Valley salmon live and migrate through altered habitats that support a multitude of invasive predators capable of consuming endangered salmon. Control of predatory fishes has the advantage of being logistically feasible (managers can just remove restrictions on catch and gear, or even set a bounty on the fish as per pikeminnow control in the Columbia River). Predator control also is likely more politically tractable than some aspects of habitat remediation such as reducing water exports from the Delta. From a scientific perspective, there is nothing wrong with trying invasive predator control as an experimental management strategy. After all, nature is full of surprises. Nonetheless, I would not predict it will yield clear positive results and it does divert funds from other, potentially more productive management approaches. Based on the evidence at hand, I believe efforts to increase endangered salmon should focus on habitat and flow restoration, contaminant remediation and alteration of artificial structures that disorient and trap fish.

Thank you for the opportunity to address the Committee, I will be glad to answer any questions you may have.

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