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How "wild" are hatchery salmon? Conservation policy and the contested framing of nature in Canada and the United States

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Abstract
The idea of the Anthropocene presents a paradox for conservation: to restore and protect wild species and ecosystems, greater human intervention is required through efforts such as artificial propagation. This paradox is evident in efforts to conserve Pacific salmon. Salmon hatcheries produce millions of salmon to augment wild populations and sustain fishing industries, but emerging knowledge about salmon genomics has called into question the "wildness" of hatchery salmon. This article examines how the scientific uncertainties regarding wild species are contested by a range of stakeholders and how particular frames become concretized in policy frameworks. Despite the significance of laws and policies to the governance of such hybrid species, they have received limited attention. Drawing on archival documents, legislation, policies, government reports, and media sources, we conduct a cross-national comparative analysis of how wildness is framed in policy debates in Canada and the United States. We find that hatchery-born salmon occupy a position at the threshold of scientific and cultural definitions of wildness and this ambiguity facilitates political contests among groups with divergent interests in conservation and views of the human–nature relationship. As a result, hatchery salmon have been regulated differently across time and geographic and jurisdictional space. These findings contribute to an expanding literature on conservation in the Anthropocene and managing wild species.

Keywords
Anthropocene, wildness, conservation, policy, framing

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Introduction

Global declines in biodiversity create a paradox for conservation: to restore wildlife and wild spaces, which are conventionally understood as independent of human influence, greater human intervention is typically required (Cantrell et al., 2017). This has prompted debates about whether wildness truly exists, echoing earlier pronouncements regarding the "end of nature" (Latour, 2004; McKibben, 1989; Merchant, 1980). While we acknowledge the paradox of wildlife conservation in the Anthropocene, it appears that the concept of wildness has greater salience in the current environment, rather than a diminishing importance. Advances in our capacity to measure and understand anthropogenic environmental impacts are being coupled with technologies and strategies such as re-wilding, genetic resource banks, captive breeding programs, protected area management, and managed relocation. For many of these conservation approaches, nature is being biologically reconstructed with wildness as the goal. In this paper, using the example of Pacific salmon, we examine how the boundary between wild and not wild species is defined and negotiated in environmental policy.

Pacific salmon have a life cycle that is remarkable. Born in freshwater streams, juvenile salmon undergo a physical transformation to adapt to ocean saltwater, travel thousands of kilometers, and (in most cases) return to the stream where they were born to spawn the next generation (Lichatowich, 1999). However, Pacific salmon are also dependent on human intervention for survival in many geographic areas. Faced with possible extinction resulting from overfishing and other threats, many countries initially turned to hatchery programs to support fishing industries and supplement natural-born populations (Taylor, 2009). Unlike long-term captive breeding programs aimed at rehabilitating species of concern, hatcheries artificially propagate salmon in facilities, where they are reared until juveniles and released into the ocean (Braverman, 2015; Taylor, 2009). Hatcheries are now considered an indispensable conservation tool, but the monumental scope of human intervention into the life cycle of salmon and their ecosystems has created a new dilemma. How do hatchery salmon fit into the landscape of policies designed to manage and preserve wildlife, and to what extent are wildlife conservation policies adaptive to changes in scientific and public understanding of what constitutes "wild" life?

This paper threads these questions through debates surrounding Canada's Wild Salmon Policy (DFO, 2005) and the United States' Endangered Species Act (1973). Both Canada and the United States have established a network of hatcheries from California to Alaska, releasing millions of salmon annually. Both countries have also wrestled with the issue of how to classify and manage hatchery-produced salmon. In Canada, the line between hatchery and wild salmon was drawn in the Wild Salmon Policy after six years of negotiating among scientists, governments, and stakeholders. The same debate followed a different path in the United States, where a series of legal actions brought the question of hatchery salmon's "wildness" under judicial review. Differences in the two countries' approach mean that a salmon swimming freely in the ocean may become "wild" as it traverses geopolitical borders along its migratory route.

While it may seem to be a matter of semantics, there is much at stake in how a "wild" salmon comes to be defined in policy. If hatchery salmon are the same as wild, the population size of wild salmon is higher than if they are not counted as wild. The bigger the population, the fewer the restrictions on fishing, development, and habitat use. If they are not wild, their inter-breeding with natural-born salmon is potentially a threat to the sustainability of wild populations. We use the term "hybrid" to refer to organisms that result from interbreeding between individuals from genetically distinct populations (Allendorf

et al., 2001; Arnold, 1997).[1] In some cases, hybridization can be beneficial by contributing to genetic diversity, extending the range of a species, or as an adaptive response to selection pressures. In other ways, hybridization can also mean extinction as species lose their genetic and morphological distinctiveness, or through the spread of genes correlated with poor survivability (Doremus, 2010; Pfennig et al., 2016).

Pacific salmon are not the only animals to experience hybridization. Similar issues occur in Atlantic salmon (Daniels and Mather, 2017), wildcats (Daniels and Corbett, 2003), zebras (Cordingley et al., 2009), wolves (Braverman, 2015; Fredrickson and Hedrick, 2006; Rutherford, 2018), and owls (Gutierrez et al., 2007). A wide range of "wild" animal and plant species are also augmented and released through large-scale captive breeding programs (Laikre et al., 2010). Despite the significance of laws and policies to the governance of such hybrid species, they have received limited attention. We build on this work to examine how the scientific uncertainties regarding wild species are contested by state and public actors and how they become concretized in policy frameworks.

Policies are a key site where these conflicts play out, as they represent the state's official position on matters where science may be contested, prescribe courses of action, and often allocate resources toward specific objectives. Read together, the US and Canadian policy debates regarding Pacific salmon provide direct evidence of how species can be framed differently over time and across geographic and jurisdictional space. While the question of what is considered a species has long been considered the domain of natural science, multiple human interests and institutions come together to create the regulatory network through which conservation policies are developed and enacted. Debates over the wildness of Pacific salmon and other hybrid species demonstrate the ongoing relevance of the wild/not wild distinction both from conservation and socio-cultural points of reference. Through their categorical indeterminacy in science and politics, hatchery salmon offer an opportunity for empirical and ontological investigation into the processes through which nature is codified and given meaning.

Defining "wild" life

Whereas sociologists have long discussed the social construction of nature, (Macnaghten and Urry, 1998), the Anthropocene prompts us to consider the social and ecological implications of nature's biological reconstruction. In particular, we focus on the intersection of science and law, two tools that have been deployed in the categorization and management of non-human life. Historically, wildness has been conceived of in rather stark terms—as a binary between wild and tame, or sometimes, in situ versus ex situ (in the case of conservation). However, these distinctions are too limited to capture the multiple dynamic axes of human–wildlife interactions on the boundaries of taxonomic classifications (Braverman, 2014). Here, we take up Braverman's (2015) challenge to rethink how nature is defined, using the example of Pacific salmon and the controversial role that hatcheries play in their conservation and management in Canada and the United States.

Conserving wildness in the Anthropocene

Though conservation relies on scientific knowledge, the question of what constitutes "wildness" is bound up in ideas about nature, culture, and the relationship between humans and the non-human world. Environmental historians, philosophers, and sociologists such as Haraway (1989), Cronon (1996), Nash (2014), Nelson and Callicott (2008), and Vannini and Vannini (2016) have traced the range of Western[2] scientific and cultural

narratives of "wilderness" from dark and dangerous to sublime and pristine, untouched by humans. This binary view of wildness and society, or nature and culture, continues to underpin large-scale conservation policies, such as protected areas and national parks, and it informs a broad range of efforts to conserve and protect nature.

The idea of a separate "nature" has been undermined by the extent of human impacts on the natural environment. Rapid population growth and resource consumption have propelled humanity to the far reaches of the earth, substantially altering the climate and causing mass extinctions (Barnosky et al., 2011; Rockström et al., 2009). The difficult question facing conservationists is what it means to conserve nature in the Anthropocene. One interpretation is that preserving wild nature for its own sake is no longer required. This approach, largely falling under the banner of the "new conservation" movement, has rekindled a longstanding debate. While traditional conservation is focused on preserving and restoring diverse species for their intrinsic and ecological value, new conservationists argue that nature is resilient enough to withstand ecological change, and that the priority should be on harnessing the full benefits of nature for humans (Kareiva et al., 2007, 2012). A point of contention between new conservationists and their critics is novelty. While new conservationists see new ecosystems and introduced species as inevitable, traditionalists have challenged this view on ecological and ethical grounds (Doak et al., 2015; Hunter et al. 2014; Kareiva et al. 2012; Miller et al., 2014; Soulé, 2014). Between the traditional and new camps are others who ask whether we can accept human-influenced nature as legitimate nature (Dudley, 2011; Marris, 2011, 2014; Naeem, 2011). The Anthropocene as a provocative set of ideas has brought to the fore fractures in the landscape of conservation and diverging goals, values, and principles (Minteer and Pyne, 2015). A critical task for social scientists (and a central aim of this paper) is to investigate "how the end of nature scrambles traditional categories of analysis and grounds for action within environmental politics" (Wapner, 2014: 41).

Traditionally, the foundational taxonomic unit for wildlife conservation is a species, which is "an interbreeding group of organisms that is reproductively isolated from all other organisms" (UNEP, 2019: 706). However, human intervention into animal reproduction, intentionally and unintentionally, has produced organisms that do not neatly fit established definitions. How do we reconcile populations that have been altered genetically or behaviorally as a result of human interventions? At what point does genetic interference drift far enough that it creates a new species? And, at what point does human intervention alter how animals are classified in conservation policies? These questions have implications for efforts to protect and restore wildlife, as well as for when and where economic development is curtailed in the name of such protections.

There is a burgeoning interdisciplinary scholarship examining species that challenge or resist biological frameworks. Friese (2013) documents the use of cloning for endangered species preservation in zoos, arguing that the controversy surrounding this practice stems from conflicts in how nature and culture are (and ought to be) intermixed. Fredriksen (2016) uses the hybridization of Scottish wildcats with domesticated cats to demonstrate the limits of species-based conservation. Fredriksen (2016: 697) asks, "If wildcats cannot be neatly separated from feral cats and hybrids then how should conservation practices proceed? And if the line is not drawn at all . . . what are the consequences for the practical task of protecting wild-living cats in Scotland?" The subject of where to draw the line between wild species and their human-influenced cousins is not just scientific, but politically contested. Rutherford (2018)'s study of coywolves and Crowley et al.'s (2017) study of beaver reintroduction in England show that how multiple actors come to contest the wildness of hybrid animals. The categorical indeterminacy of these species provides the scientific and political

space for debate, creating knowledge battlefields (Author, 2011) in which science is marshaled by opposing parties to advance particular interests.

Wildness in law and policy

An understudied aspect of this debate is the way that societal goals for conserving wild species and spaces become concretized in law and policy (McDonald et al., 2016). At a fundamental level, legal frameworks and practices contribute to what Friese (2013) refers to as "world-making". They convey certain ideas about how species should be conserved, protected, harvested, and managed. They also often direct financial and human resources toward particular goals and re-orient existing networks and assemblages around non-human life. A prime example is endangered species legislation, which mobilizes a significant amount of resources, data collection, and conservation efforts, while limiting or halting public and private activities that may affect endangered species or their habitats. The result is that a small number of organisms can have an unusually large political and economic impact if they are listed as endangered (Braverman, 2015; Scoville, 2019). A critical element of this world-building potential is the biopolitical drawing of legal or political boundaries between species that are, or are not, worthy of being conserved. Friese (2013) points out the high value placed on wildness in this regard. Species and organisms deemed wild continue to be the primary objective of conservation efforts.

At a more conceptual level, legal and policy documents reflect and reify particular cultural understandings of the human–nature relationship. More than mere imagery, the meanings that are attributed to nature have consequences for environmental decision making. However, more often than not, nature refuses to conform to the neat and tidy boundaries that the law seeks to establish. In part, this is because nature evolves, producing a tense and frequently conflicting relationship between "static laws" and the "dynamic world" (Doremus, 2010). If the task of social scientists is to investigate how the Anthropocene scrambles traditional categories of analysis, the legal frameworks that govern human–nature interactions warrant consideration.

Conversely, as we have discussed above, knowledge and cultural understandings similarly change over time. As Vannini and Vannini (2016: 27) write, "What may appear as a fixed nature at first sight is instead very much the outcome of practices, discourses, and changing relations." Laws and policies are therefore sites where the nuanced and oft-disputed meanings behind words like "wildness" are reduced to unambiguous prescriptions for action. Moreover, the definition of "species" does not have universal scientific consensus (dubbed the "species problem" in biology) (Coyne and Orr, 2004). To what extent the laws and policies governing wild life adapt to shifts in scientific and public knowledge is a relevant question.

The empirical cases that are the focus of this article take place in two different contexts. In the United States, the debate over the wildness of enhanced salmon played out through a protracted legal battle over multiple years and in multiple jurisdictions. The actors involved represented diverse interests, but to successfully challenge the existing policy framework, they had to frame their arguments and present evidence according to the standards and customs of the United States legal system. This also meant that the power to count hatchery salmon as wild rested in the hands of the judiciary. Canada's debate on wild salmon was channeled through a similarly lengthy but less adversarial public consultation process. Compared to the narrower legal process in the United States, there was a far greater number and diversity of voices feeding into the development of the Wild Salmon Policy. We will return to the significance of these differences. In both cases, the Wild Salmon Policy

and the Endangered Species Act are part of a larger network of policies that regulate salmon hatcheries. However, in Canada, Pacific Salmon hatcheries are largely regulated at the federal level and are concentrated in one province, British Columbia. The situation is much more diverse in the United States, as each state pursues its own plan for hatchery programs, and hatcheries are found in Washington, Oregon, California, and Alaska. Though an in-depth comparison of each of these geographic and socio-political contexts is beyond the scope of this paper, the Endangered Species debate provides a window into how the wildness of hatchery salmon has been publicly negotiated in the United States.

Methodology

Data for this study include archival documents, legislation, policies, government reports, and media sources in the United States and Canada. Data for the United States include judicial opinions and, where available, plaintiff and intervenor complaints for three court cases pertaining to the Endangered Species Act: Alsea Valley Alliance v. Evans (2001) and Trout Unlimited v. Lohn (2007, 2009). These court records are publicly available and were accessed by the first author through Public Access to Court Electronic Records. Canadian data include reports on 22 public consultation meetings and public opinion surveys between 2000 and 2005. These reports were compiled by third party organizations contracted to observe the meetings, as well as produce summaries of the events. A limitation of this archival data is that they are not full transcripts. However, they represent the best available source of information on the consultation process and provide direct quotations from participants. These data were supplemented with an analysis of newspaper articles in both countries during the period of 2000–2010. By combining news media with archival data, we were able to examine how the framing of wildness occurred both in the closed-door spaces of court rooms and meeting rooms and in public discourse.

To understand how wildness is defined in policy contested by various public actors, we employ a framing analysis. Frames are interpretive lenses that give meaning to collective experiences and guide action (Benford and Snow, 2000). Frame analysis has been used effectively in studies of policy debates (cf. Crow and Lawlor, 2016; Hawkins and Holden, 2013), and environmental policy disputes in particular (cf. Buijs et al., 2011; Fünfgeld and Mcevoy, 2014; Hilson, 2015; Lis and Stankiewicz, 2017; Shmueli, 2008). In part, this is because frame analysis is well suited to an analysis of the "political game of interests" (Rein and Schön, 1996: 93). Frames are narratives that inform action and can be countered by actors seeking to influence policy outcomes and achieve particular goals (Dewulf, 2013). By selecting certain words or ideas over others, actors can influence the direction of discussions and decision making. Frames can, therefore, be used strategically to define the problem at hand prescribe particular courses of action, and garner support from others (Snow and Benford 1988: 198). Following Rein and Schön (1996: 93), we employed a frame-critical policy analysis, which has three objectives: (1) to name the issue terrain, (2) to identify the competing frames at work in a policy discourse, and (3) to specify the forums in which the discourse occurs.

The analysis proceeded in two stages. First, we identified competing frames by coding the text for references to "hatchery/ies", "wild", "wildness", "wilderness", and "wildlife" (Rein and Schön, 1996). The relevant passages were analyzed for patterns in how different actors defined the problem of wildness, how they discussed hatchery salmon, what actions they prescribed, and what other frames they contested. The second stage involved a comparative analysis of the two policy debates. We laid out a chronological account of each debate to

consider how shifts in scientific and public understanding of "wildness" have been represented in policy over time and in parallel between the two countries.

There are several advantages of selecting these countries as sites for analysis. First, both countries struggled with how to define "wildness" in policy and use hatcheries to supplement declining wild stocks. Selecting multiple sites for analysis enables us to explore how the definition of a "wild" species varies across time and space, as well as different forums. Second, these countries are connected legally and materially by the nature of the fish they seek to manage. Pacific salmon have a vast geographic range in their migration and cross multiple jurisdictional borders in the process. This means that fishers in one country can intercept and harvest fish produced by other countries. To mediate this conflict, Canada and the US signed the *Pacific Salmon Treaty* in 1985 to ensure that national management of Pacific salmon fisheries management is consistent with the treaty agreement. Salmon can also stray across geopolitical borders, introducing the possibility for a fish born in the United States to cross into Canadian waters (Wadewitz, 2012). In these ways, salmon are active agents in shaping the geopolitical relations between these countries (Sundberg, 2011) but are still subject to a complex legal landscape. This creates the curious case of a "wild" fish that strays across the border and finds itself no longer "wild".

Pacific Salmon, genomics, and the problem of hatcheries

There are seven species of Pacific salmon in North America: Chinook (*Oncorhynchus tshawytscha*), chum (*Oncorhynchus keta*), coho (*Oncorhynchus kisutch*), pink (*Oncorhynchus gorbuscha*), sockeye (*Oncorhynchus nerka*), steelhead (*Oncorhynchus mykiss*), and cutthroat (*Oncorhynchus clarkii*). For decades, many populations of Pacific salmon in Canada and the United States have declined in abundance and genetic diversity.[3] The causes of this decline are numerous and complex, involving overfishing, habitat degradation, hatchery interactions, and dams, compounded by political conflicts over which factor and, more importantly, who is to blame (Johnson et al., 2018; Lichatowich, 2013; Noakes et al., 2000). Salmon hatcheries were devised in the 19th-century to compensate for the vast amount of fishing that was occurring and the proliferation of dams that interrupted salmon habitat (Taylor, 2009). Hatcheries are facilities where workers artificially propagate salmon and rear them to a certain age, before releasing them into freshwater streams. Young Pacific salmon then follow their natural migration routes, traveling great distances across the Pacific Ocean for several years and returning to their natal stream where they spawn and die.[4] Hatcheries in Canada release nearly 300 million juvenile Pacific salmon annually from 23 facilities and the United States produces far more—70 hatcheries release over 2 billion salmon each year (Crafton, 2018; NPAFC, 2018).

While hatcheries are remarkably successful in getting salmon to survive from eggs to juvenile fish (85–95% of hatchery salmon make it through this stage, compared to 1–5% in the natural environment), they fare poorer than natural-born salmon in later life stages (Reisenbichler et al. 2004). Advances in genomics have provided some insights into why this is the case (Araki and Schmid, 2010). Several studies have found hatchery-reared fish tend not to survive as well as naturally born salmon (Araki et al., 2007; Chittenden et al., 2008, 2010; Christie et al., 2016; Irvine et al., 2013). When hatchery salmon mate with natural-born populations, they pass on their genetic material. Over several generations, populations can become dominated by genes that are maladapted to the natural environment, resulting in lower reproductive success (Christie et al., 2014). In some places, this has become acutely problematic. In the Columbia River, the largest river in the Pacific Northwest, approximately 80% of its salmon are of hatchery origin (US Fish and

Wildlife Service, no date, a). A study of salmon genetics in the Wenatchee River, which connects to the Columbia in Washington, found that the size and age of salmon returning to spawn were significant genetic factors contributing to low reproductive fitness of hatchery fish (Williamson et al., 2010). The wildness of hatchery salmon is not only a relational question—whether humans have had a hand in raising them—it is also a biological question, as salmon have been genetically altered through selection pressures associated with rearing in hatchery environments. Although we are limiting our analysis to the realm of conservation policy, it is important to note that the notion of "wild" as applied to salmon carries a different meaning in the seafood industry. Wild salmon producers, restaurants, and supermarkets frequently promote wild salmon as a sustainable option, particularly when contrasted with industrial salmon farming (Hébert, 2010). In this context, hatchery salmon are considered "wild", even though they are reared in non-wild environments.

The United States and the Endangered Species Act

Two questions drove debates in the United States around "wild" salmon: (1) can/should hatchery salmon be counted when listing wild salmon as endangered? and (2) how should the government deal with the threats that hatchery salmon pose to naturally spawned salmon? These questions were put before the courts in a series of lawsuits where plaintiffs and intervenors challenged the policies and practices of the United States government.[5]

Endangered species and the National Marine Fisheries Service

The primary vehicle for conserving and protecting species at risk of extinction in the United States is the Endangered Species Act. There are several challenges with implementing the Act. For one, it lacks a clear definition of what is considered a "wild" species. This ambiguity is a problem in cases where segments of a wildlife species are propagated and released, interbreeding with the natural population. Another difficulty is that, in many cases, there are distinct groups *within* a species that have different life histories, genetic profiles, and chances of survival or extinction. The Act recognizes this and defines a species as "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature" (Section 3-15).

In the 1990s, the National Marine Fisheries Service (NFMS) issued several policies that sought to implement the Endangered Species Act. To deal with the challenges discussed above, the Fisheries Service instituted the Evolutionarily Significant Unit Policy in 1991 (NMFS, 1991). This policy introduced the term "evolutionarily significant unit" (ESU) to identify genetically distinct salmon populations below the species level. Where hatchery fish are released into rivers that already have a wild population, an ESU can contain both hatchery and naturally spawning fish.

The Fisheries Service drafted a second policy—the Interim Hatchery Listing Policy (NMFS, 1993)—to provide guidance on how to incorporate hatchery fish in its endangered species assessments. If hatchery salmon are counted as wild, large releases of hatchery fish may make it appear as though the whole population is healthy when in fact the natural population is in danger of extinction. Hatchery fish would then fall under the protections afforded to endangered species. The Interim Hatchery Policy emphasizes the agency's responsibility to recover "natural populations" and that hatcheries should be limited in recovery programs to avoid risks to natural fish. When listing endangered species, the policy directed the Fisheries Service to count *only* the natural population. There was an exception for cases where the natural population is in imminent danger of extinction and

hatchery fish are essential for recovery. In other words, the Interim Hatchery Policy made a distinction between hatchery and wild salmon and prioritized protections for wild, naturally spawning fish.[6]

Alsea Valley Alliance v. Evans (2001)

The first challenge to the wildness of hatchery salmon centered on the protection of a population of coho salmon. In 1998, the Fisheries Service submitted the ESU for Oregon Coast coho salmon to be listed as threatened. In accordance with the Interim Hatchery Policy, the Fisheries Service did not count hatchery stocks which made up as much as 87% of the salmon population (Alsea Valley Alliance v. Evans, 2001). If they did count hatchery fish in their assessment, the population would not have been classed as endangered. Thus, where to draw the line between what counts as a wild salmon is at the heart of this case.

Protections for the newly listed stock meant that industrial activities were halted on the Klamath River, including logging activities, road building, and irrigation for farming. This provoked a legal challenge of the Fisheries Service policy by the Alsea Valley Alliance, a group of building industry, farm, and property rights advocates. The Alsea Valley Alliance took the Fisheries Service to court, arguing that the agency's decision violated the terms of the Act by making a distinction between hatchery and wild Coho salmon. They cited a previous judgment in Arizona that found that "distinctions below that of subspecies . . . are not allowed under the ESA" (Alsea Valley Alliance v. Evans, 2001: 4). In other words, since hatchery and wild salmon are part of the same ESU, the Fisheries Service could not exclude hatchery salmon from the listing. The Alsea Valley Alliance was successful in framing hatchery salmon as genetically indistinguishable from natural salmon. The presiding judge found that the Act requires listings of whole species or subspecies, writing:

> The NFMS listing decision creates the unusual circumstance of two genetically identical Coho salmon swimming side-by-side in the same stream, but only one receives ESA protection while the other does not. The distinction is arbitrary. (Alsea Valley Alliance v. Evans, 2001: 4)

Oregon coast coho were delisted from the Endangered Species Act, business resumed, and the Fisheries Service was ordered to revise its policies.

The ruling was criticized by environmentalists and fishers as ecologically disastrous. Patti Goldman of the Earthjustice Defense Fund called it an "attack on salmon listings" (Goldman, 2001: 1). Bill Bakke, director of the Native Fish Society, said he feared "It may mean 20 populations along the West Coast could be delisted" (Robinson, 2001: 2). Some directly contested the court's and the Alsea Valley Alliance's framing of hatchery and wild salmon as indistinguishable. Jason Miner, conservation biologist for Oregon Trout, said the decision was "catastrophic . . . There is a factual finding that hatchery fish and wild fish are genetically the same, which is both inaccurate and vastly oversimplifies the complex biology of Oregon's native fish" (Barnard, 2001). A group of environmental and fishing organizations appealed, but were denied, while the Alsea Valley Alliance put public pressure on the Fisheries Service to follow through with the court's orders to amend the Interim Hatchery Policy. Russ Brooks, the attorney representing Alsea Valley, told U.S. Newswire, "Environmental litigation groups lost their appeal . . . and now they are trying to skirt the law by politicizing the issue. It's clear they're trying to pressure the administration, but this is a matter of law, not politics" (US Newswire, 2004). In addition to framing the hatchery-wild debate as apolitical, Brooks emphasized the need to align policy with science, saying,

"It remains to be seen if the new policy will be based on sound science and meet the legal requirements of the ESA. If the new policy is too little, too late, we'll be back in court."

Trout Unlimited v. Lohn (2007, 2009)

In the wake of *Alsea Valley Alliance v. Evans*, the Fisheries Service revised its Interim Hatchery Policy following nearly six months of public engagement and expert review.[7] The Final Hatchery Listing Policy (2004) maintained the term ESU, but now required that hatchery fish be considered in determining whether a species should be listed under the Endangered Species Act. Hatchery fish are counted as wild if they are *genetically similar* to the natural population:

> [Hatchery fish] with a level of genetic divergence between the hatchery stocks and the local natural populations that is no more than what would be expected between closely related populations within the ESU (a) are considered part of the ESU, (b) will be considered in determining whether an ESU should be included in any listing of the ESU . . . (NMFS, 2004: 37215)

The agency reassessed the Upper Columbia steelhead along with 27 Pacific salmon ESUs that had been listed as endangered or threatened. The Upper Columbia steelhead were heavily impacted by the construction of the Grand Coulee Dam in 1939, which cut them off from thousands of kilometers of spawning habitat. By 1997, the population had dwindled and was not self-sustaining, so it was listed as endangered. During the reassessment in 2004, the Fisheries Service considered the contributions of hatcheries along the Columbia River. They redefined the ESU to include both naturally spawning steelhead and steelhead from six hatchery stocks which were genetically similar. The estimated population size increased with the addition of the hatchery stocks, so the new ESU was downlisted from endangered to threatened.

The decision to downlist Upper Columbia steelhead triggered a lawsuit in 2007. This time, the plaintiffs were a group of conservationists comprised of environmental groups such as Trout Unlimited and the Sierra Club, and fishers from the Federation of Fly Fishers. They argued that by counting hatchery fish as wild, the Fisheries Service violated its mandate to protect natural populations and to comply with the Endangered Species Act. The plaintiffs framed hatchery fish as genetically and physiologically distinct from wild fish, stating:

> In sharp contrast to the evolutionary processes that promote diversity in wild fish, hatcheries produce uniformity by mass producing salmon, often from relatively few adults, and selecting for certain traits. (Trout Unlimited, 2005: 8)

They further questioned the legitimacy of the Fisheries Service' revised Hatchery Listing Policy:

> The Hatchery Listing Policy is highly controversial, lacks scientific support, and undermines the mandates of the ESA. . . . The inclusion of hatchery fish in wild ESUs is likely to adversely affect threatened and endangered salmon and steelhead, to contribute to cumulative impacts that are escaping NMFS's scrutiny, and to be highly uncertain in light of the lack of scientific support for the policy. (Trout Unlimited, 2005: 15)

A group of intervenors representing the building industry, the farming industry, and property rights advocates joined the lawsuit, opposing the conservationists. Citing the ruling in *Alsea Alliance v. Evans*, they countered that the policy once again violates the Endangered Species Act by distinguishing between hatchery and naturally spawning fish. The intervenors were concerned that unnecessary listings would interfere with their livelihoods. The Fisheries Service defended its policy, arguing that it is consistent with the Act and with the best available science. The district court found in favor of the conservationists. The decision was based on two findings. First, the Final Hatchery Listing Policy violated the Act and the Fisheries Service' mandate to protect natural populations by including hatchery fish as wild and by discounting the harmful effects of hatchery fish on natural populations.

> The status determination of the Upper Columbia River steelhead ESU provides a clear example of how an evaluation of the entire ESU distracts from the risks faced by natural populations and departs from the central purpose of the ESA. (Trout Unlimited v. Lohn, 2009: 20)

Second, the district judge found that listings must be based exclusively on the status and trends of natural populations.

The Fisheries Service appealed the 2007 decision to the highest federal judicial authority, the US Court of Appeals for the Ninth Circuit. In 2009, the appeals court reversed the decision. While they agreed with the lower courts that natural-born fish are the primary focus of the Endangered Species Act and the Fisheries Service, they found that hatchery fish are not being simply counted as wild. In determining whether a species is endangered, the Fisheries Service considers both the positive and negative effects of hatchery stocks on natural populations. This satisfies the mandate and the requirements of the Act. However, the court stopped short of deliberating the "wildness" of hatchery fish and acknowledged the ongoing scientific debate:

> Trout Unlimited and NMFS are engaged in a good faith disagreement that is supported by science on both sides; indeed, . . . there is no scientific consensus concerning the relationship between hatchery and natural fish. In such situations, we stay our hand. (Trout Unlimited v. Lohn, 2009: 3282)

As for the intervenors, the appeal judges concluded that the *Alsea Valley Alliance v. Evans* decision does not require hatchery and wild fish to be treated equally; rather, it finds that if hatchery fish and wild fish are part of the same ESU, they cannot be listed differently under the Endangered Species Act. The Upper Columbia steelhead and the other 26 populations were reassessed based on entire ESUs including hatchery fish that were genetically similar to natural fish (Henry, 2004). In total, the process lasted 16 years, from the development of the first hatchery listing policy in 1993 to the conclusion of *Trout Unlimited v. Lohn* (2009).

Canada's *Wild Salmon Policy*

Around the time that the Fisheries Service was navigating the courts, Canada was engaged in its own salmon debate. The more that the Canadian government sought to protect wild salmon, the more it was confronted by the question of where hatchery fit in its approach to "wildness". Although the Canadian debate was less adversarial in structure, it was no less contentious. Richard Beamish, a leading federal salmon biologist for Fisheries and Oceans Canada, told the Globe and Mail that the complexity and emotions involved make the hatchery controversy akin to a religious debate (Mickleburgh, 2001).

A new era of conservation

The 1990s were a time of crisis for Canadian fisheries management. Fishing rates had reached historic highs in the late 1980s and early 1990s and there was an assumption among fisheries managers that any problems with abundance could be solved through increasing hatchery production (DFO, 1998). Despite hatchery supplementation, Pacific salmon were steadily declining "partly due to natural causes but also exacerbated by the inability of managers to detect and react to changes in abundance in a timely fashion" (Noakes et al., 2005: 504). Faced with mounting public and political pressure, Fisheries and Oceans released a series of documents shifting their approach from maximizing economic returns to conservation and genetic diversity as the highest priority for the department (Irvine, 2009). A small number of scientists and policymakers were tasked with realizing this new policy direction through the creation of a "wild fish policy", the first such policy in the country.

The Wild Salmon Policy is an ambitious and progressive effort. It identifies three objectives: (1) safeguard the genetic diversity of wild Pacific salmon, (2) maintain habitat and ecosystem integrity, and (3) manage fisheries for sustainable benefits. Similar to the Endangered Species Act's "ESUs", the Wild Salmon Policy introduced the term "Conservation Units" to aggregate of salmon populations with similar genetic profiles, life histories, and geographic distribution. The Wild Salmon Policy was noteworthy for two reasons. First, it was preceded by an unusually lengthy consultation process that sought input from Indigenous groups, stakeholders, and the general public. This engagement was planned for six months but stretched to six years. Ultimately, the government held 16 community forums with over 650 attendants and six stakeholder meetings with nearly 50 representatives from Indigenous communities, fishing industries, NGOs, and academics. Input was collected through response forms distributed at events and from online submissions (Dovetail Consulting Inc. et al., 2000a, 2000b). These meetings were sites for the public to debate a range of issues pertaining to the policy—including hatcheries, economic sustainability, habitat protections, and genetic diversity.

Defining "wild" life

The most significant feature of the Wild Salmon Policy is that it sets out a definition of a "wild" salmon. Prior to the Wild Salmon Policy, hatchery salmon were not distinguished from wild in conservation laws,[8] which define wildlife as animals that are "wild by nature" (Canada Wildlife Act, 1985; Species at Risk Act, 2002). However, this provides little guidance for how to classify and manage populations that have been propagated and released (Braverman, 2015). According to the policy (2005: 1), wild salmon are those that have "spent their entire life cycle in the wild and originate from parents that were also produced by natural spawning and continuously lived in the wild."

This was a departure from the debate taking place in the United States, where the question was whether hatchery fish can be counted as part of a wild population. Here, the definition is explicit in stating that a salmon born in a hatchery is not a wild salmon. Wildness, instead, is a matter of degrees of separation and lineage. The Wild Salmon Policy also introduces the dimension of *time*. In populations that are no longer "wild", there is a possibility that a salmon born in a hatchery may spawn in natural environment. Over two generations, the progeny of these fish become "wild", painting a more complicated picture of the relationship between hatchery and wild salmon. As James Irvine, one of the policy's authors, explains, "We recognised that a 'continuum of wildness' exists for salmon"

(Irvine, 2009: 144). The continuum Irvine describes is not based exclusively on a biological spectrum of "wild" and "captive" genetics, but rather a social one, among people with different views of what they consider to be the criteria for a "wild" salmon.

Diverse views on the meaning and consequences of "wildness" were present in the consultation process. The framework put forth in the Wild Salmon Policy was the first time that a line had been drawn so publicly between wild and hatchery salmon. There was little public disagreement with the policy's emphasis on genetic diversity. Instead, there were differing views on the extent to which hatchery fish can be used to restore wild populations. Academics held the strongest views against the wildness of hatchery fish. The dominant frame advanced by academics was that hatcheries pose risks to wild salmon, with several arguing that there is no proof that hatcheries can be used to rebuild endangered or threatened populations. The priority should instead be on moving away from hatcheries and further reliance on human interventions. In an article for the Globe and Mail (Mickleburgh, 2001: 2), University of British Columbia Professor Carl Walters said,

> There's something crazy about a system where you continue to do something when there is so little benefit... We have to get rid of this engineering mentality that doesn't want to trust Mother Nature, that believes we humans can fix any problem that we humans create. We need to be patient. Let the recovery of our forests drive the recovery of our salmon.

Environmental NGOs used a similar framing to discuss hatchery risks to wild salmon. The David Suzuki Foundation criticized the policy for being "silent on the future of high-capacity hatcheries, which have been important for maintaining large-volume, mixed-stock fisheries that have been so destructive to individual runs" (Dovetail Consulting Inc. et al., 2000a: 20). NGO representatives expressed concerns about the genetic influence of domesticated hatchery genes on wild salmon, citing examples such as the Straight of Georgia where hatchery Coho "seem to have displaced the wild salmon" (Dovetail Consulting Inc. et al., 2000b: 13). An alternative suggestion was raised at one of the NGO meetings: that hatcheries should be evaluated in terms of the genetic diversity of the salmon they produce and their fitness.

At the opposite end of the spectrum were groups advocating hatchery production should continue, or even increase. Two frames were advanced here: one deemphasizing the risks posed by hatchery fish and one emphasizing the similarities of hatchery and wild salmon. Commercial fishers predominately employed the first frame, arguing that production is essential and should be a high priority to address recent declines. Among sport fishers, many participants denied or expressed doubts that hatchery fish had any negative effects on wild fish. In its submission, the BC Federation of Fly Fishers wrote, "Is there any hard evidence that salmon runs have deteriorated as a result of loss of genetic diversity attributable to enhancement operations?" (Dovetail Consulting Inc. et al., 2000a: 16). In a similar vein, the Campbell River Guides Association expressed "profound concern with regard to what might be termed the over-zealous pursuit of biodiversity, a goal to be achieved regardless of negative social and economic impacts" (Dovetail Consulting Inc. et al., 2000a: 21). Many sport fishers also employed the "similarity" frame, expressing skepticism of the genetic purity of wild fish. Participants using this frame questioned whether there are any stocks that have not been influenced by hatchery fish. At the meeting of commercial fishery representatives, participants argued that there is too much emphasis on the cultural value of salmon, with many agreeing with the sentiment, "They're just fish" (Dovetail Consulting Inc. et al., 2000a: 15).

First Nations participants expressed both concerns about the risks of hatchery fish to wild populations and support for continuing enhancement. Genetic diversity was frequently identified as the highest priority. The Nuu-chah-nulth Tribal Council called for the government to more clearly commit to conserving the full range of genetic adaptations and restoring the diversity of populations, using hatcheries as a last resort in the face of extinction. A participant at the Haida Gwaii forum said, "our priority should be to sustain wild fish; those are the only fish that will continue to sustain Haida Gwaii; we should be very careful in proceeding down the path of cultivation" (Dovetail Consulting Inc. et al., 2000a: 28). At the same time, there were acknowledgments from participants that hatchery salmon play vital roles in some communities. A Sliammon First Nations speaker at the Sechelt forum identified several benefits of First Nations-run hatcheries: "[They are] important to keep for the food-fish they provide – we get many people who come down and get the carcasses we don't use here when they are still fresh" (Dovetail Consulting Inc. et al., 2000a: 50). An anonymous submission at a community meeting wrote, "Half our community is First Nations people and they depend on fishing for their survival" (Dovetail Consulting Inc. et al., 2000a: 51). There was a similar sentiment expressed by some fishers: "If we have to make a choice between no fishing and putting hatchery fish in, I know where my priorities lie" (Dovetail Consulting Inc. et al., 2000a:15). What is clear is that defining something as wild has social consequences as well as ecological implications, and wildness is one factor among many for people that depend on the continued presence of salmon.

Discussion

Two dominant frames emerged in the debates: hatchery salmon as genetically indistinguishable from wild salmon, and hatchery salmon as a threat to wild salmon. The act of counting fish can drastically change depending on how hatchery fish are defined. Given the unruly cross-boundary migration patterns of salmon, this means that decisions in the United States about how hatcheries should be run can have significant spillover effects in Canada.

Over roughly the same time period, Canada and the United States have wrestled over how to locate hatchery fish in wildlife conservation, but moments of agreement between the two countries have been brief (Table 1). Regulatory boundaries between Canada and the US were drawn irrespective of ecological processes or Indigenous governance (Wadewitz, 2012). The result is a varied policy landscape where salmon traverse legal and jurisdictional borders, as well as definitions of wildness. This is more than a legal oddity—it has material consequences for how fisheries and hatcheries impact their surrounding environments.[9]

These divergent approaches represent attempts to redefine conventional notions of wildness as the absence of humans, and to translate this into policy. In the United States, the discourse took on a static, binary approach where hatchery fish were framed as either "genetically similar" to natural-born salmon or not. Early policies of the Fisheries Service, the arguments of the plaintiffs, and the judicial rulings and policies reflected an essentialist view of hatchery fish that assumes they have been and will continue to be a static entity, wild or not. The revised Fisheries Service policy allows for some discretion in assessing genetic similarity, but wild salmon remain the default baseline against which hatchery salmon are measured. In contrast, the Wild Salmon Policy introduces a temporal component in the form of its "two-generation" rule, where the benchmark is a fish's distance from the hatchery system. As a result, the policy recognizes the *potentiality* (Grove, 2009) of hatchery fish, the fluidity of genetics, and the role of adaptation to different environments (human-engineered and natural) in the criteria for wildness. This exemplifies recent academic literature in ecology, geography, and environmental studies that is rethinking the meaning

Table 1. Timeline of policy definitions of hatchery/wild relationship.

Period	Policy/legal case	Hatchery salmon status	
	(US/CA)	*United States*	*Canada*
Prior to 1993		No distinction	No distinction
1993–2001	Interim Hatchery Listing Policy, 1993 (US)	Not wild	
2001–2004	*Alsea Valley Alliance v. Evans* (2001) (US)	Wild	
2004–2005	Final Hatchery Listing Policy, 2004 (US)	Wild if genetically similar to natural-born salmon	
2005–2007	Wild Salmon Policy, 2005 (CA)		Not wild, but wild
2007–2009	*Trout Unlimited v. Lohn* (2007) (US)	Not wild	in two generations
2009–Present	*Trout Unlimited v. Lohn* (2009) (US)	Wild if genetically similar to natural-born salmon	

of wildness as relational (Minteer and Pyne 2015; Van Horn and Hausdoerffer, 2017; Vannini and Vannini, 2019; Wuerthner, 2014). Shiva (2017: 88) argues "if we are going to redefine wildness, we have to simultaneously redefine humans as cocreators" who actively cultivate the wild. Many Indigenous knowledge systems similarly view nature as dynamic, animate, and that emphasize the entanglements between humans and their surroundings (Atleo, 2010; Berkes, 2017; Vannini and Vannini, 2019).

The types of frames advanced by actors were shaped by the venue of the policy debate. While the Fisheries Service engaged in public consultations when revising the policy, the major shifts in the status of hatchery salmon were driven by legal tugs of war over the dividing line between wild and hatchery salmon, with businesses seeking to prevent what they saw as unnecessary endangered species protection. For example, the Alsea Valley Alliance used legal precedent and the original intent of the Endangered Species Act to make their case. In contrast, the Canadian frameworks regarding hatchery salmon were driven by an extended public consultation process. There, a broader array of actors, including academics and First Nations, could discuss a wider range of frames, such as cultural values and food sovereignty. It also allowed for more reflection on the part of actors themselves, rather than through legal counsel. These protracted public engagements meant that Canada had no formal policy response to the potential threat of hatchery salmon until 2005, nearly a decade after the United States began to deal with the risks. However, Canada's policy remained stable. When Fisheries and Oceans conducted another round of public consultations in 2018, the overwhelming response was that the policy should not be changed, suggesting that there remains strong support across stakeholders and over time (DFO, 2017). This is a remarkable feat since, as Taylor (2009: 4) notes, salmon politics have historically been divisive and solutions to stock declines are "elusive because participants have little in common." Although scientific knowledge played a central role, this suggests that careful attention to process is critical in the development of wildlife policy.

Conclusion

The process of defining and categorizing wild salmon in policy is founded in what Foucault calls a "grid of knowledge constituted by natural history" (Foucault, 2005). Natural history, through taxonomy, assigns an order, a structure, and a specific language to nature by

isolating what can be observed. Advances in genomic science have rendered visible what was previously invisible, enabling debates about the genetic similarity of salmon at the subspecies level. However, new scientific knowledge has not settled the question of whether hatchery salmon pose risks to natural populations. Instead, the uncertainty became an opportunity through which salmon were framed through culturally and historically specific lenses, including Western scientific knowledge and economic interests (Lien and Law, 2011). The commodification of wild salmon, the value of access to water, the value of commercial and recreational fishing industries—these factors underscore what is at stake in debates over labels such as "sustainable", "wild-caught", "natural", as well as "endangered" or "wild" (Foley and Hébert, 2013; Hébert, 2010; Knapp et al., 2007).

The debates over hatchery salmon show that wildness remains relevant, even as the idea of the Anthropocene takes hold in public discourse. Wildness in these instances operates as both a means of separating or differentiating nature, and as a benchmark against which the success of conservation efforts is measured. At stake is not only the sustainability of the species, but also the sustainability of industries and communities that rely on continued propagation of salmon. Thoreau (1862) famously wrote that "In wildness is the preservation of the world." While this is clearly reflected in the legal frameworks aimed at conserving wild salmon, the curious case of hatchery salmon flips Thoreau on his head. Through hatcheries, humans intervene into the agency, evolution, and genetic makeup of salmon that hybridize with their natural-born counterparts, blurring the wild/not wild boundary in policy and in practice. Human activity has so greatly altered the life cycles, productivity, and habitats of species around the world that conservation in the Anthropocene is increasingly reliant on further intervention—in other words, "In humans is the preservation of wildness."

However, the reality is far more complex. Human intervention through hatcheries has been shown to genetically alter the salmon they were created to conserve. In doing so, they destabilize the meanings and that have been ascribed to wild salmon as well as their place in human political and ecological assemblages. The Anthropocene can prompt conversations about how we relate to the non-human aspects of environments, and our obligations to "better science, better politics, and new forms of human–environment relation" (Lorimer, 2015: 34). The cases presented here show different attempts to wrestle with the ambiguity and the tension between the neat lines drawn by policy and the wild life that defies such boundaries. Rather than viewing this tension solely as a problem to be solved, we suggest that it provides an opportunity to examine how state actors reconcile scientific uncertainty, conflicting claims to nature, and the ambiguous place of organisms altered through human intervention.

Highlights

- This article examines how scientific uncertainties regarding wild species are contested by a range of stakeholders in policy debates
- We conduct a cross-national comparative analysis of how wildness is framed in policy debates in Canada and the United States
- We find that hatchery salmon have been regulated differently across time and geographic and jurisdictional space
- Scientific and political uncertainty about the wildness of hatchery salmon facilitates contests among groups with divergent conservation interests
- These findings contribute to an expanding literature on conservation in the Anthropocene and managing wild species

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Notes

1. Among social scientists, the term hybrid has also been used to refer to a bridge between the ontological separation of nature and society (Whatmore, 2002).
2. The Western view of wilderness as empty supported the dispossession of Indigenous lands through the legal doctrine of terra nullius and continues to inform contemporary environmental management (Mawani, 2007; Suchet, 2002; Watson, 2014). For some discussions of Indigenous perspectives on wildness, see Atleo (2011), Selin (2003), Nadasdy (2005), and Vannini and Vannini (2019).
3. There is significant variation in the health of stocks in the Pacific Ocean by species, geographic area, and time period (Ruggerone and Irvine, 2018; Ruggerone et al., 2010). Alaska's salmon fisheries, for example, are not yet experiencing declines in abundance (Arnold, 2009).
4. Steelhead are an anadromous form of rainbow trout. Steelhead and sea-run cutthroat trout migrate to the ocean and back to their spawning grounds multiple times, unlike most other Pacific salmon species that spawn only once before dying (US Fish and Wildlife Service, no date, b).
5. Although they are not represented in the lawsuits discussed here, Native American tribes are active participants in the operation of Pacific salmon hatcheries, in scientific research on hatchery-wild relations, and in the policy-making process (Colombi, 2012; Columbia River Inter-Tribal Fish Commission, 2020; Hess et al., 2012; Northwest Indian Fisheries Commission, 2016). It is also worth noting that in the US, hatchery salmon are legally defined as treaty fish (U.S. v. Oregon, 1969; U.S. v. Washington, 1975). This means they are counted as part of the total harvestable runs, to which Columbia River treaty tribes are entitled 50%.
6. This distinction does not apply to progeny of hatchery fish who return from the ocean and spawn in the natural environment.
7. For the Fisheries Service's response to public comments on the policy, see NMFS (2005).
8. Fishing regulations in British Columbia distinguished between hatchery and wild salmon to stipulate catch limits (British Columbia Sport Fishing Regulations, 1996). However, this distinction was not specified in environmental protections for endangered species or in policies aimed at conservation.
9. This issue is part of a broader debate about the impact hatcheries have on surrounding ecosystems. For example, there are studies showing that hatcheries contribute to a loss of salmon-derived nutrients in surrounding ecosystems, as these salmon return to hatchery facilities rather than the natural environment (Warren and McClure, 2012).

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