An Unexpected Politics of Population

Salmon Counting, Science, and Advocacy in the Columbia River Basin

by Heather Anne Swanson

Through the case of salmon population science in the Columbia River Basin, this article explores how political mobilizations can sometimes use quantitative analysis of populations in unexpected ways. In the Columbia River, both fish counting and such controversial concepts as carrying capacity have served as tools not only for conservation advocacy but also, at times, for probing histories of settler colonialism and building alliances across difference. By examining the unusual case of salmon tallying and research in this region, this article argues that while population biology has been repeatedly used within problematic and even violent state projects, in certain contexts it can also become a practice of multispecies noticing and a catalyst for new coalitions. Based on this example, the article raises broad questions about what renewed attention to population biology might contribute to the growing subfield of more-than-human anthropology. It argues that anthropologists have not paid enough attention to the possibilities for numbers and population concepts to positively contribute to movements for more livable worlds. In light of this example, this article aims to foster additional anthropological attention to the situated and context-specific politics of scientific practices and tools.

When population biology has a dark history, can it also be a productive part of struggles for more-than-human livability?

Through the case of salmon population science in the Columbia River Basin, I explore how political mobilizations sometimes use quantitative analyses of populations in unexpected ways. In the Columbia River region, often controversial scientific practices (such as fish counting) and analytics (such as carrying capacity) have served as tools not only for conservation advocacy but also, at times, for probing histories of settler colonialism and building alliances across difference. By examining the unusual dynamics of salmon tallying and research in this region, I argue that while population biology has been repeatedly used within problematic and even violent state projects, in certain contexts it can also become an art of multispecies noticing (Tsing 2015) and a catalyst for new coalitions.

Based on this example, I raise larger questions about what renewed attention to population biology might contribute to the growing subfield of more-than-human anthropology. How might some of the techniques of population biology be integral to the practices of critical landscape history that this special section seeks to build?[1]

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Seeing Social History in Aggregations

A key challenge for more-than-human anthropology is how to better learn to see social histories in material form. Unable to verbally "interview" animals, plants, or fungi about their life stories, anthropologists have increasingly explored other ways of listening to their experiences of life on an unevenly changing planet. In the case of trees and mycorrhizal fungi, anthropologists Anna Tsing and Andrew Mathews have suggested that a key approach for querying more-than-humans is to pay attention to their bodily forms as biographical expressions (Mathews 2018; Tsing 2013). For many organisms, their shape, or morphology, is fundamentally historical, a response to the contingent social relations of their emergence and development. Using the example of a tree (in dialogue with Mathews), Tsing describes what one can learn about its past relations by looking at its present shape:

> A tree with thick lower branches probably grew up without too many neighbors, even if you find it now surrounded by other trees. If it had grown up in the shade of others, those thick lower branches would not have developed. A tree with multiple trunks may have a fire or an ax in its biography. A gentle concave curve near its base is a sign of coppicing: That stem grew up from a stump. (Tsing 2013:32)

1. For a related intellectual project, see Caple's (2017) work on "critical landscape ecology."

 0011-3204/2019/60S20-0008$10.00. DOI: 10.1086/703392

Anthropologists are increasingly turning to such bodily forms as a technique for exploring questions of patchy environmental change. When one pays attention to something as seemingly ordinary as the shape of a tree trunk, it pulls one into the multiple histories of shifting human-nonhuman engagements within which some beings thrive while others die. In his work on cultivated Italian chestnut trees, Mathews (2018) probes what the shapes of individual trees reveal about how environmental change happens in particular sites. From the bodies of trees, Mathews demonstrates how environmental change emerges at the intersection of struggles between pastoral peasants and the Italian state, trade routes that spread a fungal tree disease, and economic policies that led to decreased forest use and increases in fire. For Mathews, Tsing, and a growing number of more-than-human scholars, close observation of individual organismal bodies has become a core practice for learning how "to perceive larger-scale landscape patterns and to wonder about the causal forces that brought these patterns into existence" (Mathews 2018:402). It is part of the "arts of living on a damaged planet," a practice for noticing the ongoing fragmentation of long-standing more-than-human relations (Tsing et al. 2017).

I build on and challenge this work by asking how we might extend its focus on form to aggregates. How can we probe the relational more-than-human histories that materially shape organismal groups as well as individual bodies? I explore this question through the case of Pacific salmon in the Columbia River Basin, a large watershed that stretches across parts of seven US states and two Canadian provinces. Over the past 200 years, the basin has been radically remade through dam building, mono-crop agriculture, industrial logging, urban development, and indigenous displacement. One way to see the profound more-than-human effects of these changes is through the basin's salmon, who are acutely sensitive to watershed alterations. However, these histories of watershed damage are often difficult to see in individual fish bodies. Rather, they are most visible in the morphing shapes and sizes of aggregate salmon groups, units that fisheries biologists call "populations." In this context, population is a term of kind rather than of number. It refers to a distinct group of salmon that spawn in a particular geographic area at a particular time. Within fisheries biology, salmon are renowned for their diversity of subspecies populations. Because salmon usually return to their natal stream to spawn, a given tributary's fish reproduce with a relatively high rate of endogamy, allowing each group of salmon to form a multigenerational relationship with a particular stretch of stream and its surrounding area.

These populations, I propose, are biographical in ways akin to the trees described by Tsing (2013) and Mathews (2018). They are supraorganismal bodies whose forms are materially emergent within multiple intersecting histories. Yet to read history in salmon populations poses new methodological challenges. To notice embodied history in trees, one can repurpose tools from natural history, such as drawing and photography, which already closely resemble anthropology's ethnographic methods. In contrast, the detailed forms of aggregations are difficult to see via field observation alone. It thus requires some uncomfortable alliances for anthropologists to see the details of these forms. While the shape of a salmon aggregate lies in part in its unique traits—in its coloration, migratory pathways, or run timing—it also lies in the number of its members, as well as in the dynamics among them and with other beings. These aspects of aggregates can sometimes be made more visible through the numerical counting and modeling practices of population biology. While the field of population biology has been widely critiqued in the social sciences, this article explores how, in specific cases, its tools can be repurposed to enhance understandings of how particular landscape patterns have been made and how they might be made otherwise.

In the case of Columbia River salmon, the shapes of populations are brought into relief within a vast technoscientific apparatus of fish counting, genetic analysis, and modeling. Within this context, some of population biology's tools and concepts have been used to critique the vast restructuring of the basins in which salmon spawn, rather than to further rationalize rivers and fish. Indeed, they have become a central part of political mobilizations against the ongoing industrialization of the river basin. As I lay out in more detail below, population biology has often been used in deeply problematic ways, and its ties to eugenics and forced displacements in the name of conservation are clear. Yet the Columbia River is a special case where something else has happened: since the 1990s, salmon population biology has become a catalyst and linchpin for broad political mobilizations that seek to constrain and counter industrialization and landscape damage. In this case, population science has become integral to the partial alliances among scientists and indigenous groups rather than an all-out flash point, and it has served as a key tool in legal claims. As this article explores, the unexpected politics of population biology in the Columbia River are also enabled by the very machinery that has contributed to the river's capitalist reorientation, as the region's exceptionally fine-grained knowledges of salmon populations are made possible by the dams that have facilitated the profound reformulation of the basin.

Population Biology in the Columbia River

While the study of Columbia River salmon populations has a long history, I begin with a recent moment in which quantitative population analysis has come to matter in a new way. It is July 2017, and I stand along the south bank of the lower Columbia River, the waterway that serves as a border between the states of Oregon and Washington.[2] This river, whose tributaries stretch inland to Wyoming and the western border of Alberta, is known for its Pacific salmon. As I look out across the nearly 5-mile-wide estuary at the river's mouth, there are undoubtedly

2. While this article draws primarily on textual sources, it is grounded in my long-term field research on salmon and fisheries biology in the Columbia River and Hokkaido, Japan (Swanson 2016, 2018).

salmon swimming upstream beneath the water's reflective surface. There are more fish out there, beyond the rotting pilings and abandoned cannery buildings, than there were 20 years ago when 12 of the basin's salmon populations were listed as endangered under the US Endangered Species Act.[3] In 2015, there were 2.3 million fish recorded at the river's first dam, roughly three times more than during the historic lows of the 1990s.[4] But the futures for the descendants of the fish now gliding past me continue to trouble the region's fish biologists, government managers, and tribal leaders. The returns for 2017 and 2018 were again dismal for several stocks, with upriver dam fish counts running roughly half of what they have been in the past several years.[5]

Fisheries biologists knew they were dealing with a damaged river and remade salmon populations, but they were surprised and troubled by these recent numbers. Since the mid-1990s, salmon restoration has been among the most highly funded ecological projects in the United States. Between 1997 and 2001, federal agencies, including the Bonneville Power Administration, the US Army Corps of Engineers, the Department of the Interior, and the Environmental Protection Agency, spent over US$1.5 billion on salmon management (US Government Accountability Office 2002:3). In 2016, the Bonneville Power Administration alone reported spending US$621 million on fish and wildlife management, the vast majority of which went to salmon-related projects.[6] These funds have supported improved upstream and downstream fish passage at dams, fences to keep cattle out of spawning streams, screens to divert young fish away from irrigation ditches, and tree-planting efforts. Most important, environmental managers have worked to reseed rivers with adult spawning fish, by significantly limiting fisheries and using hatchery programs.

Everyone—from fishermen to scientists to indigenous groups—thought the problem for upriver Columbia River salmon was primarily one of passage, with the most significant mortality arising from the dams and fishing nets that cut across migratory routes. River habitats were not pristine, but they appeared ample for supporting salmon spawning and rearing. Dams without fish ladders had reduced the amount of available spawning habitat by about a third, yet estimates of earlier fish populations indicated that prior to European settlement, the number of salmon in the river basin was somewhere between 10 and 16 million fish.[7] Even with only two-thirds of the habitat left, it seemed possible to restore naturally spawning salmon populations to large numbers, if one could just get enough salmon through the gauntlet of dams and nets and back on the river's spawning grounds.

Dealing with the obstacles to fish passage was daunting. But fisheries researchers, the US Army Corps of Engineers, and wildlife managers managed to come up with a semiviable patchwork of techno-fixes: waterslide-like dam bypass tubes, fish transport barges, and carefully timed water releases to move juvenile salmon downstream, along with select area fishing policies, gear changes, and alterations to fish ladders to allow the fish to swim back up. As passage rates improved, people began to imagine that naturally spawning salmon runs might be restored. For much of the twentieth century, the Columbia River Basin had relied heavily on salmon hatcheries to prop up its fish runs via artificial propagation. In the 1990s, managers began to use hatcheries in a new way—to help restore stream-spawning salmon rather than merely replace them.[8] Managers allowed many former hatchery fish to spawn in streams, assuming that they would help rebuild self-reproducing runs. In the early 2000s, it seemed like these practices were partially working: a number of populations of endangered and depressed salmon began to rebound. Then, all too soon, the success began to sputter as their numbers plateaued and even declined again. What was going on?

Experts and laypeople alike expected that greater numbers of stream-spawning salmon would lead to larger numbers of them in the next generations, as salmon gradually recolonized the reaches above the dams that had been made more passable. Ample stretches of spawning streams seemingly lay open, waiting for the fish to return. But this did not happen. As more adult salmon deposited their eggs and milt in the fall, the numbers of juveniles headed downstream in the spring seemed to stagnate rather than increase. These salmon populations seemed to be exhibiting the effects of what ecologists call "negative density dependence" (Independent Scientific Advisory Board [ISAB] 2015). Typically, when salmon have abundant food and habitat, their populations grow quickly. As their population densities increase, their numbers grow ever more slowly as their population growth is constrained by crowding and competition. But why were Columbia River salmon populations unable to expand, when their densities were still far below historic levels? Rivers now appeared to support fewer juvenile fish per kilometer.

This attention to the dynamics of population numbers turned fisheries biologists' attention to river habits. Drawing on fish numbers and the conceptual languages of population biology, they became alarmed that the salmon carrying capacity of the basin's streams appeared to have dramatically decreased. This insight was startling, even for people deeply familiar with the industrialization of the basin. In a summary of a 2015 report, officials openly acknowledged their distress: "Given that regional fish and wildlife agencies and tribes hope to see runs continue to build, the notion that the habitat might not be able

3. https://www.nwcouncil.org/history/EndangeredSpeciesAct.

4. http://www.spokesman.com/stories/2017/mar/12/columbia-river-salmon-forecast-lacks-the-big-numbe/.

5. For detailed fish counts by dam and 10 year averages, see http://www.fpc.org/web/apps/adultsalmon/R_yeartodatecomparisontable_results.php.

6. https://www.nwcouncil.org/media/7491102/2017-2.pdf.

7. This estimate is debated with ranges including 5 to 8.9 million (Chapman 1986) and 5 to 9 million (Independent Scientific Advisory Board [ISAB] 2015), as well as the 10 to 16 million fish (NPPC 1986 in ISAB 2015:5) that I choose to cite here based on 2016 Columbia River Intertribal Fish Commission (CRITFC) arguments for the higher number.

8. See Taylor (1999) for more information about hatchery histories.

to support many more fish because of its limited carrying capacity is disconcerting, even shocking."[9] How could the capacity of these streams have so severely contracted in only a few decades? It appeared that the damage to the basic ecological functions of the basin's rivers was even more pronounced than previously thought.

These insights are part of mounting calls for more holistic forms of watershed restoration that contrast with established approaches that have overwhelmingly invested in improving dam passage. While calls for habitat restoration and attention to widespread watershed damage are not new, the practices and concepts of population biology, including carrying capacity, have been important in describing the profundity of change in ecological structures and generating increased momentum for developing more comprehensive practices of landscape repair.

Uses and Abuses of Population Biology

The use of population biology in the Columbia River region contrasts starkly with the way it has been deployed in other contexts, especially in relation to human groups. Population biology has a bad rap for good reasons. As countless social scientists and humanists have shown, the definition and management of human populations has served as a core technique of modern governance and state power, often with violent and troubling effects (Appadurai 1993; Rabinow and Rose 2006; Rose 1996). Via census making, counting, tracking, and mapping, human population biology has created norms, defined deviance, and made everyday life a site for expert and governmental intervention (Foucault 1977, 2001 [1978]). States have used population biology's statistical genres to pathologize and criminalize ways of being, sometimes using population management as a justification for eugenics and genocide.

Many specific population concepts, like the notion of carrying capacity evoked by the Columbia River fisheries biologists, have equally troubling reputations. Carrying capacity, crudely put, is understood as the maximum number of individuals of a particular species that a geographical area can support.[10] It has a thoroughly dirty history in relation to discussions of human population. Wrapped up with neo-Malthusianism, Garrett Hardin's (1968) "tragedy of the commons," and Paul Ehrlich's (1978) "population bomb," carrying capacity has been integral to horrifically flawed propositions for human population management that ignore histories of colonialism, imperialism, and capitalist modes of production. Asserting that the fundamental rule of planet Earth should be "Thou shalt not exceed the carrying capacity," Hardin argued for a "perverse moral economy" in which North American and European countries should offer no international aid on the grounds that any support to poor countries merely encourages their residents to have more babies and strain the earth's life support systems for the rest of "us" (Höhler 2014:110; see also Höhler 2006). Third World famines, within Hardin's logic, are "natural" events that should be allowed to run their course in order to assure that national populations remain within their alleged carrying capacities.

Social scientists have rightly criticized such propositions in the strongest terms possible, and as a result, our default orientation toward the concept of carrying capacity has been to reject it. In opposition to Hardin-esque analyses, we have built a politics that stresses inequalities of distribution rather than material limits or capacities. These politics have not been superseded; unjust distribution continues to be the core dynamic of our times. But as anthropologists increasingly turn to multispecies ecologies and landscapes as objects of study, questions of number, population, and capacity can no longer be entirely set aside. In certain configurations, attention to animal and plant populations can be a powerful tool in the study of the patch dynamics and landscape structures of which they are an integral part. The traits of particular patches shape not only who can use and inhabit them but also how many beings can do so. For example, fragmenting a forest via industrial logging may not immediately lead to a local extinction, but it may reduce the number of birds and mammals an area can support (Andren 1994). Inversely, changes in organismal numbers can affect ecological relationships within patches. For example, if the number of deer that use a given patch declines, there will almost certainly be changes in that area's vegetation, as it becomes subject to less grazing.

In relation to animals and plants, the politics of population concepts, such as carrying capacity, have been diverse and multiple, as the concepts have been deployed by different people as part of contrasting initiatives. To be sure, carrying capacity and related population concepts have often been part and parcel of governance projects that aimed at managing landscapes for capitalist production. Emergent within questions of rangeland management, carrying capacity has been part of colonial projects that dispossessed African communities by fostering land privatization, under the logic that private ranches have higher carrying capacities and can maintain higher cattle densities and thus represent a more efficient mode of land use (Sayre 2008). Such arguments continue to shape land management in many parts of the world from southern Africa, where stock owners operating in communal areas are marginalized by government policies that set overly restrictive limitations on grazing in collectively held lands, to northern Norway, where related ecological concepts are used by the state to demand reductions in Sami reindeer herds in the name of conservation (Benjaminsen et al. 2006, 2015).

Yet uses of carrying capacity have never been politically consistent. While carrying capacity has served as a handmaiden of

9. From the summary provided on the official Northwest Power and Conservation Council website: https://www.nwcouncil.org/fish-and-wildlife/fw-independent-advisory-committees/independent-scientific-advisory-board/density-dependence-and-its-implications-for-fish-management-and-restoration-in-the-columbia-river-basin-and-july-2016-addendum.

10. For an excellent historical overview of the concept, see Sayre (2008). For more detailed analysis of the concept within rangeland science, see also Sayre (2017).

colonial capitalism in some places, this is not the case in all locales. For example, in the late nineteenth-century US West, it was sometimes used as a tool to critique industrial overstocking and predator elimination programs. One of the most iconic examples comes from the writings of conservationist Aldo Leopold in which he sought to use notions of carrying capacity and population dynamics to point out the pernicious logics of industrial rangeland management. In an oft-cited passage of his *A Sand County Almanac*, Leopold poetically redescribed the ecological crisis on Arizona's Kaibab Plateau in the late 1920s and 1930s, when its number of mule deer exploded from 4,000 to 100,000 after the US government sponsored the mass killing of predators[11] as part of broader landscape management practices designed to foster cattle production and sport hunting (Worster 1994:270–271; see also McCulloch 1986):

> I now suspect that just as a deer herd lives in mortal fear of its wolves, so does a mountain live in mortal fear of its deer. And perhaps with better cause, for while a buck pulled down by wolves can be replaced in two or three years, a range pulled down by too many deer may fail of replacement in as many decades. So also with cows. The cowman who cleans his range of wolves does not realize that he is taking over the wolf's job of trimming the herd to fit the range. He has not learned to think like a mountain. Hence we have dustbowls, and rivers washing the future into the sea. (Leopold 1970 [1949]:140)

The Making of Salmon Numbers

Leopold's work (1970 [1949]) points toward the multiple political possibilities of population concepts in general, and carrying capacity, in particular. Yet how are population concepts made to do particular kinds of work in given contexts? In contrast to the examples from Africa and Norway, population biology in the Columbia River is not a government imposition. Instead, it is an impressive achievement—the result of decades of popular activism by partially allied groups. How, in the specific case of Columbia River salmon, have concepts and techniques from population biology become central to efforts to craft more livable landscapes?

The answer is tied, to some degree, to the role of dams in the Columbia River Basin. While the industrialization of the Columbia River began in the late nineteenth century with large-scale logging and salmon canning, it hit its zenith in the 1930s. In 1929, the US Army Corps of Engineers recommended the construction of a series of dams on the Columbia River, whose purposes would be wide-ranging, offering an economic power pack of irrigation water, flood control, locks for improved ship traffic, and electricity production. The goal of the dams was to reengineer not only the river's flows but also patterns of land use across the entire basin, ushering in large-scale mono-crop grain cultivation and energy-intensive industries such as aluminum smelting. In the early 1930s, Franklin D. Roosevelt and other government officials agreed to back the initiative as a part of the New Deal's employment initiatives, and by 1934, construction was underway on Grand Coulee and Bonneville dams, two facilities on the Columbia's main stem.[12]

From the moment the dams were proposed, white commercial fishermen and Indian tribes were outraged by the damage dams were going to cause to salmon by impeding their passage. Grand Coulee Dam, located on the upper main stem Columbia, was built without fish ladders, blocking access to over 1,000 miles of prime salmon spawning habitat. While ladders were installed at Bonneville, its location in the lower part of the river also raised concerns because such a large percentage of salmon spawned above it and would thus be impacted by any extra challenges it would pose.

The US federal government would have simply sacrificed the basin's salmon runs in the name of progress, development, and looming wartime necessity. Indeed, the government initially claimed that the dams would have little impact on the fish. Yet an awkward alliance of wealthy cannery owners, unionized white fishermen, outdoor enthusiasts, and American Indian groups challenged this outrageous claim, which sought to paper over the impending destruction of the Columbia's salmon runs and their own ways of life. They flooded the opinion pages of regional newspapers with their arguments against what amounted to the government's usurpation of the river and petitioned government officials and representatives to address their concerns.

In 1938, the year that Bonneville Dam went online, these efforts forced the US Congress to admit that the dams were likely to harm the salmon and to pass legislation, called the Mitchell Act, that aimed to mitigate their harms. The Act authorized funding for fish hatchery construction, the screening of irrigation channels to prevent fish from getting caught in them, and other measures to maintain salmon numbers in the midst of the growing degradation of the basin's rivers. At the same time, salmon advocates, including the Oregon and Washington state fish commissions, pressured for documentation and mitigation of the dams' effects: they called for fish counting as a mode of holding the government accountable.[13] Their appeals ensured that from the completion of Bonneville Dam in 1938, the US Army Corps of Engineers recorded the number of adult salmon that passed through its fish ladders every year on the way upstream.[14] As other major dams were completed on the main stem Columbia and various tributaries, they too were pressured to count fish, with demands for additional data over time, including downstream juvenile counts,

11. These predators included mountain lions, wolves, bobcats, and coyotes.

12. For more on Grand Coulee's history, see Pitzer (1994).

13. https://www.nwcouncil.org/reports/columbia-river-history/fishpassage.

14. Other forms of salmon research also increased around the same time.

redd (salmon spawning nest) counts, and other research on fish numbers.[15]

As a result of these dam-based fish counts, there is extraordinarily accurate data on upriver adult fish numbers with a vast political and technical apparatus for tallying fish, including elaborate protocols jointly overseen by NOAA Fisheries, state fish and wildlife agencies, the intertribal council, as well as the Corps of Engineers.[16] Fish passage data is coordinated and made publicly available via the Fish Passage Center, created through a federal program. Advocates have had to iteratively insist on a right to good dam data, demanding more rigorous oversight of fish numbers in 2000, then suing the government in 2006, when a US Senate Appropriations Subcommittee tried to dismantle the fish passage center.[17]

The quality of the numbers that these efforts have produced stands in sharp contrast to many animal population measurements, which are often speculative at best. It is impossible, for example, to precisely count the numbers of ocean-dwelling fish, such as bluefin tuna. One can only make rough population estimates based on various sampling methods, all of which are riddled with uncertainties. Similar challenges arise for migratory mammals on land and at sea: depending on how and when one samples, researchers can easily end up with significantly different population estimates. Under such conditions, population numbers for many species remain questionable due to the impossibilities of direct counting (Link 2003).

Columbia River salmon numbers do not suffer from such problems. Since the construction of the dams, it has become possible to track upriver Columbia River salmon with rare precision. At Bonneville Dam, for example, trained fish counters sit in front of a window into the fish ladder from 4:00 a.m. to 8:00 p.m. from April 1 through November 30, directly counting the fish that pass through. At night and during off-seasons, the view into the fish passage window is video-recorded, and counters later review the tape.[18] The data from these fish counts is not flawless: slightly different procedures are used at various dams, and video-recording was not used in early decades, requiring estimates of nighttime fish passage. Yet the counts remain exceptional, especially when combined with their spatial distribution. Because there are 14 dams that count fish at various points across the upper basin, the overall data from the dam system allows one to parse the numbers of fish headed to different spawning grounds.

Political Possibilities of Salmon Population Science

This data became essential in the next round of efforts to keep salmon runs alive and facilitated more elaborate engagements with emerging forms of population research in conservation biology. By the 1990s, dam counts showed upriver salmon numbers at perilously low levels; indeed, they were so low that several groups of upriver salmon seemed candidates for listing under the Endangered Species Act (ESA). As soon as salmon advocates appealed for ESA status, it pulled salmon into new practices of counting and population biology.

In April 1990 the Shoshone-Bannock Tribe was the first group to petition the National Marine Fisheries Service to list the Snake River sockeye as an endangered species; only 2 months later, a coalition that included Oregon Trout, the Oregon Natural Resources Council, the Northwest Environmental Defense Center, American Rivers, and the American Fisheries Society filed additional requests for federal protections for Snake River spring, summer, and fall Chinook.[19] Such calls for ESA listing were made viable by the dams that killed the fish and remade their watersheds; the petitioners had numbers to back up their claims of a salmon crisis: they could say with a certain degree of authority that the number of naturally reproducing Snake River spring/summer Chinook, who must pass eight major dams, had dropped to a mere 1,822 adults by 1994[20] from 100,000 in the 1950s (ISAB 2015:22).[21]

Yet these endangered species petitions precipitated a deeper engagement with population biology. Rather than following typical biological definitions of "species," the Endangered Species Act defines the term to apply equally to what would typically be considered subspecies units. Slightly revised in 1978, the definition of "species," which retains legal force today, includes "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" (Waples 1991:12). If groups of salmon were going to be made protectable under the ESA, they needed to be identifiable and trackable as "distinct population segments."

Columbia River salmon counts already divided fish into categories based on their species (Chinook, sockeye, coho, steelhead), run timing (spring, summer, fall, winter), and spawning location (upper/lower river, name of tributary basin). Such classifications were largely based in the long-standing vernacular observations of both American Indian and white residents, who noted and named visually distinct subspecies of salmon. While the ESA accepted these already recognized groups of

15. The Army Corps began researching downstream passage on some tributary dams in 1960. https://pubs.usgs.gov/of/2017/1101/ofr20171101.pdf.

16. https://www.nwp.usace.army.mil/Missions/Environmental-Stewardship/Fish/Counts/ as well as https://www.wildsalmoncenter.org/wp-content/uploads/2008/07/SFPH-Chapter-6-Fish-Counting-at-Large-Hydroelectric-Projects.pdf.

17. http://congressionalresearch.com/RS22414/document.php?study=The+Columbia+River+Basins+Fish+Passage+Center.

18. See the following website for fish counting times and methods at dams in the Columbia River: http://www.fpc.org/currentdaily/HistFishTwo_7day-ytd_Adults.htm.

19. https://www.nwcouncil.org/reports/columbia-river-history/endangeredspeciesact.

20. https://www.nwcouncil.org/reports/columbia-river-history/endangeredspeciesact.

21. Although pre-dam numbers require extrapolation from harvest statistics and other data and are thus less certain, estimates indicate that there were approximately 1.5 million of these fish in the early 1900s. See https://www.nwfsc.noaa.gov/publications/scipubs/techmemos/tm200/sum.htm.

salmon as distinct population segments and listed 12 salmon aggregations over the course of the 1990s, ESA regulations compelled additional attention to salmon groupings and their population dynamics. ESA protections are a powerful political tool: they can be used to mount lawsuits, mandate changes in dam operations, demand land use changes, and generate funding for scientific research.

Yet to make ESA protections work, one needs highly detailed population data. Because the ESA aims to prevent extinction and actively promote self-sustaining aggregations of organisms, population dynamics are critically important to its work, as scientists use them to track numbers and try to alter conditions to keep kinds alive. While, in human-centered debates, attention to population dynamics is often linked to fears of "too many" (i.e., overpopulation), in contemporary conservation biology, it is more often tied to concerns about loss, extinction, and "too few" (e.g., Boyce 1992; Soulé 1987). The ESA also frames population biology as a tool for learning how to repair ecological damage: by monitoring population numbers, one can explore whether or not particular interventions increase the vitality of specific organismal aggregations.

With the ESA listing of salmon groups in the 1990s, the amount of research on their population dynamics—on how they live and die—increased dramatically. While it is difficult to calculate the exact amount of money spent researching, sustaining, and restoring salmon runs in the Columbia River Basin, some estimates put the number for the Pacific Northwest region at around US$3 billion a year by the early 2000s (Hering 2005). In recent years, the Bonneville Power Administration (the agency that administers the dam's power sales) has been obligated to spend about US$500 million annually on Columbia River salmon restoration and research.[22] Some of these dollars trickle down not only to federal scientists but also to nonprofit scientific research groups, university labs, state commissions, and tribal agencies to undertake salmon-related activities.

In short, the same dams that rent the river apart also made it possible to count fish and model their populations: not only do they allow for the highly accurate counting of adults within their ladders, but they also provide economic and physical infrastructure for other forms of counting that have produced even more detailed knowledge about salmon populations. Via mandated ESA mitigation and research funding, partially garnered from dam profits, scientific researchers have been able to conduct countless studies of salmon numbers and movements that exceed those of their upstream migration through the dams. Using the physical form of the dam and its passage points, researchers have been able to implement relatively accurate technological systems for monitoring the number of juvenile fish who pass downstream through the dams en route to the sea. Furthermore, with the research funds made available through dam mitigation monies, they have been able to implement a variety of ambitious marking, tagging, tracking, and trapping practices across the river basin to learn not only about salmon numbers but also about their broader interactions with their worlds. Such numerical data has also been increasingly coupled with genetic research, enabled by the same funds, which seeks to explore chromosomal patterns to better understand how to protect the diversity within and across salmon groups. In short, this wealth of diverse data has led to the ability to track and model Columbia River salmon population dynamics with an uncommon degree of empirical detail.

It is important to note that such research has been the work not only of government scientists: university researchers, nonprofit groups, and American Indian tribes have also made successful claims to salmon mitigation and research funds. The mobilizations of American Indian tribes are especially noteworthy here, as they have asserted that their treaty rights to comanagement include rights to participate in salmon population science. Both individual tribes and the collaborative Columbia River Intertribal Fish Commission (CRITFC) maintain active fisheries research divisions, including a CRITFC-run fish genetics laboratory.[23] The science of salmon populations has thus emerged from the burgeoning amount of research at the interface of these overlapping but nonidentical agendas. It is a patchwork of passionate initiatives that demand government resources, rather than a unified state project.

Noticing Changed Relations

These vast troves of salmon population data and research continue to catalyze new forms of politics in the Columbia River Basin as insights from population biology create spaces for possible alliances. Let us return to the case of upriver salmon carrying capacity that I laid out in some detail above. Despite the concept's record of pernicious use, this articulation of carrying capacity appears to be generating possibilities for more livable futures by both making visible the profound damage to the watershed and fostering more widespread engagement with the ongoing legacies of settler colonialism.

In the case of Columbia River salmon, carrying capacity calls attention to the extensive webs of relations within which salmon populations thrive and wither. Where earlier approaches to salmon restoration focused on improving dam passage, the detailed tracking of salmon population dynamics and the use of carrying capacity models show that such a single-fix approach is wildly insufficient for sustaining salmon and the ecologies with which they are intertwined. While population biology and concepts like carrying capacity have often been criticized for

22. http://www.cbbulletin.com/431437.aspx. However, cuts are currently on the table. See http://www.cbbulletin.com/441848.aspx.

23. https://www.critfc.org/fish-and-watersheds/fishery-science/hagerman-genetics-laboratory/. See also descriptions of tribal fish plans and science at http://plan.critfc.org/2013/spirit-of-the-salmon-plan/technical-recommendations/restoring-fish-passage/ and http://plan.critfc.org/2013/spirit-of-the-salmon-plan/about-spirit-of-the-salmon/traditional-ecological-knowledge-and-science/.

their single-species focus, in the case of Columbia River salmon, attention to fish numbers is provoking deeper engagement with broad sets of ecological relations.

To be clear, one does not need carrying capacity to see that the Columbia River Basin has been profoundly reconfigured by settler colonialism and industrial capitalism. Analyzing the region through other academic approaches, historian Richard White astutely described the Columbia River basin as an "organic machine"—a place fundamentally altered by human labor, but where nonhuman processes continue to matter (1995:59). Yet the more recent work on upriver salmon carrying capacity shows how the mechanization of the river has had even more profound impacts than those White presented when he penned his history of the river nearly 25 years ago. It highlights how watersheds are losing the basic ecological relations necessary to carry even modest numbers of salmon.

In the emic language of Columbia River fisheries biology, it appears the upriver salmon are experiencing "negative density dependence at lower densities" or, put otherwise, that their populations reach a level above which they seem unable to increase at numbers much lower than they did in the past.[24] In some cases, these new limits to fish numbers—to the carrying capacity of tributaries—are shockingly low. In the most extreme case, the Chinook salmon populations in the Columbia's Salmon River tributary—which were heavily affected by dam passage issues—declined 90% between the 1960s and late 1990s, with no significant loss in the physical quantity of rearing habitat (Achord, Levin, and Zabel 2003). Now, with improved dam passage, fish numbers should be quickly rebounding, but they are not. Based on the recent population research, it appears that density-dependent stream mortality—or deaths due to insufficient stream resources—are kicking in almost immediately and are seriously constraining the populations of salmon that try to inhabit these areas. Some tributary streams now seem to have carrying capacities that are less than half of what they were a little over 50 years ago (ISAB 2015:24).[25]

These numbers—together with other insights from salmon population research—have shocked scientists into taking the effects of the basin's profound systemic changes more seriously. While highly responsive to watershed changes, salmon populations are not fragile, per se. For the last 4–6 million years, they have morphed with the rapidly changing geology of the Columbia Basin. As glaciers and landslides have blocked off tributaries and epic floods have scoured spawning beds, salmon have become experts in quickly adapting to and inhabiting new and altered river stretches. With high levels of intraspecific diversity, behavioral flexibility, and speedy evolution at the population level, salmon have been resilient to massive changes in the rivers in which they dwell throughout the Pleistocene and Holocene (Schtickzelle and Quinn 2007).

River carrying capacity has likely always been a limiting factor for Pacific salmon. Indeed, the most plausible explanation for the evolution of these fishes' migratory life cycle is that the ocean's vast food webs allowed them to grow to large sizes and develop sizable populations that would not be possible with the more limited nutrient sources in rivers. But even as they pack on about 95% of their body mass in marine environments, salmon remain highly dependent on streams—not only as a spawning location but also as a juvenile feeding and rearing site (Pearcy 1992). Most of the salmon species in the Columbia River require significant growth and maturation before they are able to successfully make their way downstream and undergo the physiological transformation necessary for inhabiting saltwater environs. For this, they need to eat—as well as hide from those who want to eat them.

Yet as the research on carrying capacity highlights, many upriver reaches of the Columbia are offering dramatically less food and fewer prime hangout spots than they once did. These watershed changes are at once monumental and subtle—physical alterations to channel structure, hydrology, and sediment delivery, along with food web modifications. Logging, diking, cattle watering, and the decimation of beaver populations are among the forces that have reduced or modified riparian vegetation. The loss of shade has led to higher water temperatures, while the loss of stream bank complexity and in-stream wood has decreased hiding places and increased erosion. With fewer streamside plants, there is also less food in the water itself, as "about half the food energy that sustains fish in small streams enters in the form of terrestrial invertebrates that fall into streams from riparian vegetation" (ISAB 2015:59).

Agricultural irrigation—provided by the dams—further affected fish habitat. Water extraction has reduced overall stream flows, which has further raised in-stream temperatures. Furthermore, the water that makes its way back to rivers after agricultural use is contaminated with herbicides that are causing reductions in the aquatic plants and algae that underpin salmon food supplies (ISAB 2015:60),[26] and there is emerging evidence that endocrine-disrupting chemicals may be causing additional problems for salmon and other species (Arkoosh et al. 2017; Scholz et al. 2000). In addition, the oil and grease loads of Columbia basin streams have increased 100% between 1977 and 2000, a joint effect of agricultural activity, urban runoff, and municipal wastewater discharge (ISAB 2015:62).

24. There is substantial evidence of compensatory mortality (see Achord, Levin, and Zabel 2003, as well as ISAB 2015).

25. It is not as if things are going all that well in the ocean, either. Salmon populations in Alaska and Japan have indicated possible ocean density effects (see Swanson 2018). While ocean survival rates may be decreasing for Columbia River salmon, all evidence seems to indicate that the loss of freshwater habitat quality is currently the most limiting factor for population size.

26. While this section exclusively references the ISAB report, that report offers an extensive review of relevant literatures and bases its assertions on numerous other studies.

Abandoning the Upper River

These changes—and the shape of current salmon populations—are largely the result of explicit political decisions, including the willingness of Euro-American salmon advocates to betray American Indian communities. Soon after the 1930s' anti-dam movements that demanded fish counting and mitigation, Euro-American fishermen and cannery owners accepted a deal that protected their interests but sacrificed upriver salmon populations and the needs of the American Indian groups that depended on them. While dams and the agriculture they sponsored have disproportionately affected the river's upper reaches, the funds to mitigate such effects have been largely directed to the lower river. The disproportionate decline of upriver stocks was part of a concerted effort to largely abandon the upper river and redistribute fish to the lower sections of the basin.[27]

As dams made it tougher for upriver salmon to survive, fisheries managers offered hatcheries as a solution. The goal of hatcheries was to make "salmon without rivers"—to maintain fish runs at the same time that the river was remade into a source of hydropower and irrigation water (Lichatowich 1999). Hatcheries collect gametes from adult fish, fertilize and hatch their eggs, and then raise the resulting young fish until they are ready to migrate to the ocean. At that point, they release them into a nearby stream, where they then swim to the ocean alongside stream-born fish. Today, hatchery fish make up 80% of total Columbia River salmon numbers, while only 20% of the region's salmon begin their lives in its rivers.[28] These hatcheries have been consistently located in the lower sections of the Columbia River. From 1946 to 1980, the Columbia River Fisheries Development Program (CRFDP) used Mitchell Act funds to construct or expand 26 hatcheries, all but two of them in the lower portions of the river (Allen 2003). Furthermore, among the more than 1 billion juvenile hatchery salmon released into the Columbia River between 1959 and 1970 under federal dam mitigation programs, 99% were produced either below Bonneville Dam or in the area just above it, and fewer than 1% were released in the upper river (Allen 2003). Other mitigation hatcheries established outside of the CRFDP also showed a consistent "spatial discontinuity between impact and mitigation," with the hatcheries located far downstream from the dams whose effects they were supposed to mitigate (Allen 2003; see also Taylor 1999).

Hatcheries were systematically sited below Bonneville to maintain and even supplement the number of fish available for white commercial fishermen, while intentionally neglecting the tribes' treaty rights to fish.[29] Although there were once robust American Indian fisheries throughout the basin, by the mid-twentieth century, white commercial fishermen held exclusive control of the lower Columbia River, while Indian fishermen were limited to harvest grounds above Bonneville Dam. By ignoring Indian rights and lives, industrial fisheries and industrial power could ostensibly be made compatible. Since a 1974 court decision reaffirmed existing treaty agreements, Columbia River Indian groups have been able to claim 50% of the river's harvestable salmon that pass through their designated upriver sites. But this long-standing neglect of upriver salmon populations in favor of lower river stock enhancement means that salmon populations have been remolded such that the bulk of fish now spawn at or below Bonneville Dam.[30]

Population and the Reimagination of Upriver Salmon

American Indian leaders have fought against this reshaping of salmon populations since the start of dam construction and lower river mitigation. They gained substantial recognition of their loss of fish and the neglect of treaty rights in the 1970s, when they mounted several successful legal claims.[31] Still, while this decade marked the beginning of fisheries comanagement, the fish passage rates through dams remained poor—especially for out-migrating juveniles—and there was not enough pressure on the US Army Corps of Engineers to substantially change dam operations and technologies.[32] Under these conditions, upriver fish restoration was nearly impossible. In the 1990s, however, the situation began to change: lower river hatcheries were generating poor returns and Euro-American fisheries were plagued by season closures and low catches. Furthermore, a growing number of fisheries scientists and Euro-American members of the public increasingly came to view salmon not as a natural resource for commercial harvest but as an integral part of ecological and biodiversity conservation. Hatchery salmon were no longer seen as acceptable replacements for stream-spawning salmon, who were now viewed as a "keystone species" with an outsized role in sustaining regional ecological processes.

27. A 1946 federal government report states that the Mitchell Act funds should be oriented toward "developing the salmon runs in the lower tributaries to the highest level of productivity." https://oregonencyclopedia.org/articles/mitchell_act_1938_/#.WZFaTYpLfdc. See also Cone and Ridlington 1996 and Taylor 1999.

28. http://www.oregonlive.com/pacific-northwest-news/index.ssf/2016/07/columbia_river_fishing_plan_co.html.

29. This was not the first time hatcheries were used to dispossess American Indians. In 1877, e.g., US Fish Commissioner Livingston Stone evicted Clackamas Indians from an established fishing area in order to reduce competition with a hatchery (Taylor 1999).

30. For an extended historical discussion of these issues, including relevant court cases, see https://www.nwcouncil.org/reports/columbia-river-history/indianfishing.

31. The legal nuances of these cases are complex, but for a quick overview in relation to the founding of CRITFC in 1977, see https://www.critfc.org/about-us/critfcs-founding/.

32. It is important to note that the tribes still do not have full hatchery comanagement: http://plan.critfc.org/2013/spirit-of-the-salmon-plan/institutional-recommendations/tribal-hatchery-management/.

Fisheries population research was clearly essential to revitalized Euro-American interest in upriver fish in both scientific and wider popular contexts. Dwindling dam fish counts were published in regional newspapers, along with mounting concerns about the possible extinction of some salmon groups. Within this context, tentative and partial alliances between Euro-American conservationists and American Indian communities once again emerged. As Euro-Americans became interested in salmon via concepts such as ecological function, keystone species, and genetic uniqueness, they began to have a renewed interest in the upper basin as an important site for salmon diversity and conservation. Within these new conservation imaginaries, the lower river, once seen as a haven for below-dam hatchery production, was recast as a place of partially domesticated and genetically inferior hatchery fish who lacked the complex population structures and ecological relations of the more "wild" upriver fish.

In the midst of these shifts, which included the ESA listing of some salmon groups, government agencies became more interested in supporting and collaborating with tribal fisheries initiatives that aimed to actively aid upriver fish populations and their watersheds. In the 1990s, for example, tribal organizations were able to make claims on funds from the Bonneville Power Administration (BPA) to establish upriver fish hatcheries and expand their upriver salmon conservation programs. Despite the role of hatcheries in Indian dispossession in the mid-twentieth century, the tribes have made use of them—along with other fisheries biology tools—within their own efforts to restore upper river fish.

Yet, while some tribal efforts have produced promising results, overall plans to restore upriver salmon runs, especially the large-scale government initiatives, have produced worrisome results, as described in the initial vignette about the loss of upriver carrying capacity. Despite the growing use of upriver hatcheries—federal, state, and tribal—in a conservation mode (i.e., to increase stream-spawning fish numbers and to seed salmon recovery), salmon populations are struggling to become self-sustaining.

In this context, concepts like carrying capacity and density dependence are helping to make vivid the profound systematic damage of the region's watersheds. These forms of population biology are also forcing Euro-American conservationists to more directly engage the settler colonial histories bound up with the structure of Columbia River salmon populations. It appears likely that the sacrifice of upriver salmon populations within dam construction, mitigation practices, and hatchery siting may be a significant factor not only in the current low numbers of fish but also in the difficulties of fish population recovery. This is the issue that shows up as a decrease in stream carrying capacity, or what one group of fisheries biologists has called "the ghost of impacts past" (Achord, Levin, and Zabel 2003:335).

Drawing on a term from conservation science more generally, fisheries biologists describe salmon as "ecosystem engineers," or species that have outsized effects on the creation, modification, and maintenance of habitats (Jones, Lawton, and Shachak 1994). When adult salmon return to a river to breed, they do not merely spawn the next generation of fish. Rather, they spawn entire ecologies. In the process of digging their stream-bottom nests, they radically alter stream substrates, aquatic macroinvertebrate populations, and algal production with substantial effects on stream metabolic processes (Moore 2006; Moore, Schindler, and Scheuerell 2004). But perhaps most important are the nutrients—marine-derived phosphorous and nitrogen—that they carry in their bodies and deposit in streams when they die after spawning. Salmon fertilize the nutrient-poor watersheds they inhabit in ways that may have profound feedback effects for the survival of their offspring. Numerous scientific studies have shown that nutrients from salmon carcasses affect vegetation patterns (Helfield and Naiman 2001), invertebrate densities (Hocking and Reimchen 2002), and even songbird populations (Christie and Reimchen 2008).

This growing body of research indicates that salmon carrying capacity is significantly impacted by recent salmon population size (Achord, Levin, and Zabel 2003), suggesting that the twentieth-century decisions to neglect upriver salmon populations may have so severely starved aquatic systems of nutrients and disrupted fundamental nutrient cycling patterns that the rivers have little to offer to the larger numbers of fish who are now trying to recolonize their reaches. Some fisheries managers wonder if they may now be caught in a double bind. Has the carrying capacity of many streams fallen so low that their salmon populations are too small to be viable without inputs of hatchery fish? Indeed, it currently appears that some upriver salmon populations may be dependent on the addition of hatchery fish, as the reproduction rates dip below replacement levels (ISAB 2015:116). Such data have served to further amplify concerns.

Precarious and Partial Alliances

Overall, such insights—gleaned from population research—have encouraged Euro-American scientists to pay more attention both to the earlier abandonment of the upper river and to the forms of pronounced systemic damage it may have caused. While there remain points of disagreement between the tribes and other salmon advocacy and scientific groups, this growing attention to carrying capacity is nonetheless a moment of partially overlapping concerns. Upper river carrying capacity research has been undertaken by scientists with a variety of institutional affiliations, and the Columbia River Intertribal Fish Commission is among the entities that co-commissioned a 2015 independent scientific review of salmon density dependence and river carrying capacity.[33]

33. This is the ISAB 2015 document, available at: https://www.nwcouncil.org/fish-and-wildlife/fw-independent-advisory-committees/independent-scientific-advisory-board/density-dependence-and-its-implications-for-fish-management-and-restoration-in-the-columbia-river-basin-and-july-2016-addendum.

While tribal leaders do not need fish population research to remind them of the ways that settler colonialism and industrial expansion have remade the Columbia Basin, they do seek its insights for how to tailor their practices of repair. Would it be best to increase the number of spawning salmon in the upper river through the addition of hatchery fish in order to expand circulating nutrients, refertilize rivers, and kick-start core ecological processes? Or might large numbers of hatchery salmon inadvertently reduce the genetic fitness of naturally spawning fish and further imperil their futures?[34] The tribes, along with Euro-American fish advocates, seek better data. Working carefully with concepts like carrying capacity and density dependence rather than wholly rejecting them, tribal scientists contest some of the population arguments of nontribal managers by using scientific practices in different ways. What, they ask, about the evidence—including traditional knowledge, archaeological findings, and early catch data—that historic population numbers were even higher than currently accepted estimates, pointing toward even greater losses of fish? In a similar vein, they take up the details of population models, questioning whether salmon density dependence data might more closely resemble a Beverton-Holt curve than a Ricker curve, meaning that—contra current governmental policies—it might be important to invest in additional upriver hatcheries to refertilize rivers with more fish.[35]

Population biology is likely not a language of salmon that tribal groups would choose were it not legible to and effective within state and legal frameworks. Neither is it likely to have become the preferred choice for white fishermen or even, for that matter, environmental activists. Yet at the same time, it cannot be simply dismissed as an ontological opposition of technoscientific governance. Salmon population numbers are a hard-won political accomplishment—a way of fighting to hold the state accountable for the harm it has wrought on the Columbia River Basin's fish. It is a nontrivial project to which people with a variety of backgrounds and stakes have contributed, and where the numbers and models themselves have opened new spaces for collaboration.

At the same time, however, it is important to point to the limits of this kind of political mobilization, which is made clear through the case of Pacific lamprey (*Entosphenus tridentatu*, also called *Lampetra tridentata*). Lamprey are elongated jawless fish who visually resemble eels; like salmon, they migrate between rivers and the ocean and thus must also pass through the Columbia River's dams. While they have suffered declines concurrent with those of salmon, lampreys—a highly significant being and food for tribal members, but not for white residents—have received comparatively little attention. While they have sometimes been included in fish counts, lamprey numbers are spotty. For example, at Bonneville Dam, lamprey were included in daytime fish counts in 1938–1969, 1993, part of 1997, and then, from 1998 onward (Moser and Close 2003). But even when they were tallied, the measures used to count them—designed for salmonids—were inappropriate and inadequate for adult lamprey, which, unlike salmon, are nocturnal and disproportionately pass through dams at night (Moser et al. 2002).

Tribal groups have struggled to highlight the plight of lampreys, which are sometimes seen as repulsive and snake-like and were deemed "trash fish" by early fishery managers (Wicks-Arshack et al. 2018). Without a long-standing salmon-like mobilization to demand their tracking and monitoring, lamprey have little data. As a result, lamprey conservation has been more constrained than enabled by practices of counting and population science. In 2004, a petition to consider Pacific lampreys for ESA protections was rejected due to an absence of research and solid numbers. While tribes are beginning to garner more attention for lampreys, the support for their monitoring and research remains far less robust than for salmon. So, too, do their legal protections. In 2008, six tribal groups signed the Columbia

34. This is an issue of uncertainty and ongoing debate. Conservation-oriented hatcheries have clearly been a lifeline for endangered and threatened populations that might otherwise have disappeared. The most extreme example is a sockeye strain that spawns in Redfish Lake, in the far-inland reaches of the Columbia Basin. Between 1991 and 1998 only 16 adult sockeye returned to spawn, and all were taken into a special captive breeding program. By 2014, 460 naturally spawned and 1,200 hatchery-spawned sockeye returned to the lake—with an approximately 95% retention of the population's remaining genetic variability. See https://www.nwfsc.noaa.gov/news/features/idaho_sockeye/index.cfm. Yet large-scale hatcheries may impede the restoration of naturally spawning salmon. Although the data are debated, the 130–150 million juveniles released annually from more than 200 hatcheries may compete with stream-born young (ISAB 2015:62). Because they are fed prior to release, hatchery smolts are often larger than the stream-born fish and may put pressure on already limited food resources. A multiyear study of 30 coho salmon streams indicated that while hatchery releases increased the overall density of young fish, they decreased the abundance of stream-born juveniles. When these cohorts later returned to spawn as adult fish, the hatchery-origin salmon produced fewer offspring per fish than the stream-born ones, so the overall number of salmon in the streams did not increase in the next generation (Nickelson et al. 1986 in ISAB 2015). While there is no doubt that hatchery programs can significantly enlarge fishing harvests, the degree to which hatchery supplementation can foster stronger stream-reproducing salmon populations remains unclear. There are numerous risks to hatchery supplementation, including changes in genetic diversity and loss of unique traits, risk of disease transmission from hatchery settings, and fish numbers that exceed the carrying capacity of streams and sometimes even parts of the ocean (Naish et al. 2008:64). Because hatchery stocks are rarely identical to those they are used to supplement, they can be less well adapted to the specifics of a given patch, and their introduction can cause substantial declines in the adult-to-adult reproductive success of the populations they join, driving their numbers even lower if supplementation ceases (Araki et al. 2008).

35. The information in this paragraph comes from the July 22, 2015, CRITFC letter in response to the ISAB report. The letter is available at https://www.nwcouncil.org/sites/default/files/isab2015-1critfc2015.pdf. The ISAB reply to the letter, which contains additional information, is available at https://www.nwcouncil.org/fish-and-wildlife/fw-independent-advisory-committees/independent-scientific-advisory-board/density-dependence-and-its-implications-for-fish-management-and-restoration-in-the-columbia-river-basin-and-july-2016-addendum.

Basin Accords, a 10-year agreement (now extended until 2022) on fisheries protection and conservation primarily in relation to salmon. Within that agreement, the tribes also negotiated for some conservation and research initiatives for lamprey, yet these "voluntary agreements" pale in legal force compared to an ESA listing (Wicks-Arshack et al. 2018).

Reconsidering Population within More-than-Human Anthropology

Population biology is no panacea. Yet neither is it the outright evil that social scientists and humanists have sometimes assumed it to be. While it has been used within many racist and violent projects, the political roles of population biology have been more varied than scholars have typically recognized. This multiplicity does not absolve population biology from its great sins; however, it points toward ways that the tools of the field might be productively engaged, especially within the growing field of more-than-human anthropology.

While numbers are a problematic proxy for justice and thriving, they can help highlight how particular landscape arrangements sustain certain ways of life over others. In this way, they offer powerful tools for probing what Donna Haraway, a science and technology studies scholar, has presented as one of the central political and ethical questions of more-than-human worlds, that of "who lives and who dies and how" (2016:2). It is no stretch, I argue, to see population numbers as material-semiotic expressions of the livability of landscapes for particular beings. At present, extinctions and ecological simplifications are mounting concerns not only for biologists but also for scholars in the humanities and social sciences (Kolbert 2014; van Dooren 2014). In our growing attention to ecological relations, might we want to consider the potential possibilities for population biology as one method, among many, for learning more about how extinctions unfold, as well how we might build arrangements to facilitate survival and regeneration?

Although it may seem counterintuitive, the quantitative measurements and ahistorical models of the population sciences can indeed play a role in building less mechanistic and more historical approaches to landscapes. As we have seen in the case of carrying capacity and Columbia River salmon, attention to population dynamics has pulled some Euro-American salmon advocates into deeper engagement with the political choices to sacrifice the upper basin by showing the profound ways that those processes have fundamentally remade the basin's ecological forms. For some salmon advocates, changing numbers have served as a way of noticing alterations in processes and patterns in fuller breadth and depth.

This discussion returns us to the question of how more-than-human anthropologists might examine social history in the form of aggregations as well as individual bodies. In the case of entities like trees, mycorrhizal fungi, and lichens, which grow throughout their lives and whose shapes are less genetically linked, it makes good sense to take the organismal body as the site for inquiries about embodied and material histories. Yet for many animals, it may be the collective body of the aggregate—what natural scientists call a population—that most clearly records their contingent encounters with an ever-changing world. While the restructuring of the Columbia River watershed also leaves marks on the genes, bones, and tissues of individual salmon, its effects are most clear in the torqued shapes of its aggregates—in the changed dynamics of dwindling upriver stocks and the vast growth of hatchery stocks below Bonneville Dam. When we extend more-than-human approaches to these plural bodies, population techniques become an integral part of our historical toolbox.

Furthermore, despite social scientists' distrust of population methods, they may indeed hold potential as a site for collaboration and cross-field engagement. This is a moment when the practices and politics of population biology are themselves unstable and changing, as binaries of organism/environment increasingly implode.[36] Today, the concept of "carrying capacity" is to ecology and population biology as "culture" is to anthropology: a term infinitely contested within the discipline and often anachronistically used beyond it.[37] As biologists become increasingly alert to the ways that organisms actively reshape the worlds they inhabit, they are coming to view carrying capacity as something that is relationally and iteratively produced via the interactions of multiple species, geophysical processes, and human land use practices (e.g., Simberloff 1998). Who or what, they ask, is "carried"—species, biomass, or relations? Within these broad changes, biologists—like anthropologists—are increasingly committed to seeing ecological interactions in historical and relational terms rather then in mechanistic ones.

This article is not a call to throw caution to the wind: there remain many cases where population biology continues to have pernicious effects and deserves the most pointed critiques. It also remains a common technology of elite power and governance. Yet, as the Columbia River shows, it can also become an integral part of multilayered political projects, catalyzing partial alliances that have mobilized against the state-sanctioned destruction of salmon runs and struggled to hold the federal government accountable via fish counting. In the case of the basin's salmon, population statistics and modeling have been more than a strategic tool for talking back to the state in a technoscientific language that it can hear: they are also a part of diverse efforts to restitch the frayed patchwork of the Columbia

36. See Tsing et al. (2017) for several examples of broad changes in the biological sciences. The ISAB (2015) report shows such changes in relation to population biology and salmon population science, in particular.

37. As one wildlife biologist wrote, carrying capacity "is a term any barbershop biologist can use in confident ignorance," since it "is a whole, broad band concept, not an exact idea" (Giles 1978:194–195; see also Dhondt 1988). Biologists have long recognized that landscapes are dynamic—often with major seasonal variations—and have debated how to define a carrying capacity that is constantly in flux (Clarke 1954 in Dhondt 1988:340). Some biologists have preferred to think of carrying capacity as conceptual rather than calculable, but others indeed define it in mathematical terms (i.e., Odum 1953).

River Basin and its fish populations. In light of this example, this article hopes to foster more anthropological attention to the highly situated and context-specific politics of scientific practices and tools.

Acknowledgments

I would like to thank the Wenner-Gren Foundation staff, conference participants, special section editors, and two anonymous reviewers. Special thanks are due to Anna Tsing and Andrew Mathews for their feedback during revisions and to Colin Hoag for his insightful comments on an earlier draft.

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