

Anticipatory practices: Shifting baselines and environmental imaginaries of ecological restoration in the Columbia River Basin

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Abstract

Ecological restorationists working to restore species and habitats must make decisions about how to monitor the effectiveness of their actions. In order to do this, they must determine historical baselines for populations by measuring and monitoring reference habitat sites: analog ecological systems that act as controls for comparison. Yet as climate change alters what is possible in terms of habitat restoration, drawing baselines for recovery has become fraught with difficulty. This article examines the epistemic and legal practices of baseline-setting in the case of the Columbia River Basin as well as the ways that ecological restorationists are dealing with the shifting baselines of a climate-changed river. Restorationists do this by altering their epistemic practices, using trained judgment and establishing alternative, anticipatory baselines. While the field of restoration was born out of the idea that environmental repair was about looking to the past, the discipline has transformed to look forward and even to anticipate the future. One way that this is occurring is through re-thinking baselines to reflect emerging environmental and sociotechnical imaginaries, which are enacted through epistemic practice. Anticipatory practices such as baseline-setting help sensitize the field of restoration ecology to the future, while at the same time facilitating the emergence of ideas that will enable scientifically based decision-making to continue to occur within a high level of uncertainty.

Keywords

Baseline, climate change, co-production, restoration, science studies

Introduction

Climate change can be both seen and felt in the Columbia River Basin. The winter of 2014–2015 brought a “snow drought” to the—usually white—peaks of the Cascades and the Northern Rockies. The first six months of 2015 were the warmest ever recorded, and the

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wildfire season was the most severe the region has experienced in modern history (Blunden and Arndt, 2015; National Interagency Fire Center (NIFC), 2017; Vano et al., 2015). These are long-term changes which are being experienced in the short-term, and they are altering the day-to-day work of people engaged in ecological restoration. As one federal restoration manager observed, “climate change is something that we have been living through essentially for the last 50 years. You can already see these trends in the weather stations and at the flow-gauging stations” (R 20, June/2017).

Scientists corroborate the changing climate that Pacific Northwest residents are witness to. Across the basin, rivers and streams are growing warmer (Dalton et al., 2013; Mote et al., 2016). Changes in snowfall and mountain precipitation are impacting fish migration, spawning, and rearing (Rieman and Isaak, 2010). Most watersheds are experiencing a shift from high-elevation precipitation in the form of snow, to rain, raising water temperatures to levels dangerous to salmon (Mantua et al., 2010). In 2015, hundreds of thousands of migrating salmon perished in a massive die-off due to low river flows and fatally high water temperatures (NW Council, 2015). Environmental change is increasingly apparent, and ecological restorationists working to restore endangered salmon habitat in the basin are being forced to adapt their scientific work and management practices in order to meet these changing conditions. These environmental shifts are adding a new layer of complexity and uncertainty to the restoration of salmon habitat (Beechie et al., 2013).

Yet the scientific effort to understand, manage, and restore habitats has never been straightforward. The word “restoration” itself points to a desire to return an ecosystem to a historic state, and restorationists have increasingly been questioning whether a “historic fidelity” is even possible (Hobbs et al., 2013; Light et al., 2013). The shifting environmental baselines introduced by climate change create new challenges for restorationists trying to measure ecological thresholds or establish management goals (Hobbs et al., 2013; Suding and Leger, 2012). Management tools such as ecosystem equilibrium models and historic range of variability are no longer useful because historic conditions no longer exist (Seastedt et al., 2008). Further, it is difficult to manage for change when many of the practices and policies in place today are based on the assumption of a stable climate (West et al., 2009).

Habitat restoration and protection, in addition to species recovery goals, are set through the mechanisms of the Endangered Species Act (ESA), usually drawing on historic baselines. Therefore, as a no-analog future (and present) becomes increasingly apparent, restorationists and environmental managers are struggling to determine the best way to measure success and failure in salmon recovery and habitat restoration. The urgent need for effective solutions for salmon recovery within the restoration community often creates a sense that there is not enough time to employ the scientific method. In this article, I explore what these shifts mean in terms of our understanding of baseline-setting as a practice, as well as the work that baselines do in environmental management. The aim of this research is to understand how restorationists cope with environmental and social changes in baselines. I examine the epistemic practices of restorationists themselves, as well as the regulatory framework that mandates the use and reproduction of particular baselines. Using the case of salmon habitat restoration in the Columbia River Basin, I describe how baseline-setting reflects both sociotechnical and environmental imaginaries. I conclude that, due to the immediate effects of climate change within the basin—and extreme years like 2015—baseline-setting is no longer just about looking to the past but is also about looking to the future: it is an anticipatory practice. In order to deal with this shift, restorationists generate anticipatory baselines that incorporate future imaginaries into their work by altering their epistemic practices, using trained judgment and establishing alternative baselines.

Methods

In order to study this dynamic, I employ situational analysis (Clarke, 2005), a form of grounded theory (Charmaz, 2005), with archival and policy analysis. The “situation” that was analyzed encompasses both the historical development of the field of salmon habitat restoration and restoration ecology, in addition to the current practices of fisheries biologists, restoration ecologists, habitat restoration managers, and people and institutions involved with developing salmon habitat policy. In order to capture emerging practices and strategies for dealing with climate change, I paid special attention to those people who are on the “front lines”—actually conducting restoration research and monitoring activities, and therefore making epistemic choices. In a region as large as the Columbia River Basin, a study such as this necessarily encompasses a large number of people. Nevertheless, this large-scale ethnography (Ribes, 2014) samples a cross-section of actors from different sectors and locations in order to develop a broad picture, while also going in-depth in a few chosen locations to gain a more detailed perspective.

Over the course of this project (2014–2018) I conducted forty-two 1–1.5 hour interviews with policy-makers, restoration ecologists, and restoration practitioners and managers. The interviews were transcribed and coded using a grounded-theoretical approach. In order to gain a depth of understanding beyond the individual perspectives captured in the interviews, the study included observation at five major regional conferences and associated conference workshops on ecological restoration and salmon recovery themes. At these conferences, I observed emerging topics of concern and engaged in informal discussions with people about how they were struggling with and through these issues in their field. I also took part in virtual workshops and webinars that are held regularly among practitioners in the region. I was generously invited to join restorationists in the field and I was able to participate in management site visits where experiments were being conducted or decisions were being made. These visits were invaluable for contextualizing the issues that participants discussed in interviews allowing me to triangulate emerging topics and concepts. Finally, historical documents at the University of Washington Special Collections,¹ as well as policy documents from organizations in the basin were also analyzed. These interviews as well as the policy and archival analysis form the basis for what follows.

Conceptualizing baselines in the Columbia River Basin

Other scholars in the field of political ecology have also brought an ethnographic sensibility to bear on ecological restoration, including Lave’s (2012, 2016) work on the commodification of river restoration science and its implications. Researchers have characterized the entanglement of economic values in restoration science (Robertson, 2004) and the complexities of restoration and conservation in the Anthropocene (Lorimer and Driessen, 2014). In addition, Gross’ (2010) work on restoration as a large-scale public experiment highlights the way that restorationists deal with uncertainty in their work. Like these previous studies, my work situates scientific work within the localized and specific regulatory objectives and the constraints that legal institutions impose. Extending these socially sensitized, interdisciplinary, in-depth and empirically grounded perspectives on ecological restoration, I focus on individual restoration practitioners as they grapple with climate change and interact with environmental baselines in their own work.

Pauly (1995) described the socially constructed nature of ecological baselines as the “shifting baselines” problem. He used the example of fisheries management targets, in which “each generation of fisheries scientists accepts the stock size and species composition that occurred at the beginning of their careers as the baseline” (430).

According to Pauly (1995), the shifting baselines problem has led to a highly distorted view of marine fish abundance because it does not take into account the much larger fish populations that existed historically. This is the danger in presenting baselines as a pre-given, scientific fact: because baselines are socially constructed, history can easily be erased. To counter this issue, Pauly (1995) recommends taking “anecdotal,” historical evidence into account to determine population numbers on a longer time scale, thereby bringing attention to the ways in which baselines are social and even political.

Indeed, baselines can be both epistemic and legal—in both instances, they are established through sociotechnical processes. To demonstrate this, I draw on concepts from science and technology studies, including epistemic practices and cultures (Knorr-Cetina, 1999), the co-production of science and law (Jasanoff, 2004), and the epistemic use of trained judgment (Daston and Galison, 2007). Because I am focusing on how restorationists deal with climate change—a future-oriented problematic—I also draw on interdisciplinary perspectives on the future in the form of “imaginaries” (Jasanoff, 2015; Peet and Watts, 1996) and “anticipation” (Adams et al., 2009).

In one sense, baseline-setting is an epistemic practice. Epistemic practices involve what might commonly come to mind when we think of laboratory or field work—scientists taking measurements, for instance. But epistemic practices are also on view at conferences, meetings, and online, as knowledge and ideas are exchanged and different epistemic cultures are enacted, negotiated, and performed (Hall, 1997; Knorr-Cetina, 1999). All of this work is, to some extent, a form of epistemic practice in the sense that it makes and remakes the field of ecological restoration and its objects of study. For ecological restorationists, baseline-setting is a ubiquitous epistemic practice that enables comparison across spatial and temporal extents (Alagona et al., 2012).

Restorationists use different kinds of baselines in different ways, making “baselining” a varied practice. Comparisons using “undisturbed” sites as reference baselines, for example, have been fundamental to experimental design in ecological science since the early 1900s (Adams, 1913). Measuring success or failure in ecological restoration not only requires setting historical baselines for populations, but also establishing reference habitat sites: analog ecological systems that act as controls for comparison or a restoration goal. In addition to generating knowledge about the environment, restorationists use baselines to monitor the effectiveness of their actions, and restorationists must therefore either employ existing baselines or establish their own. So, while baselines are critical for measuring change, they are also necessary in order to understand the success or failure of environmental management and mitigation measures—a requirement of environmental laws such as the ESA (Alagona et al., 2012). In addition to being epistemic, baselines are therefore also legal and sociotechnical, acting as one of the key sites of co-production between science and law (Jasanoff, 2004).

A brief overview of legal baselines in the Columbia River Basin will serve to illustrate this point. There are currently 31 dams that operate on the Columbia River and its tributaries. Due to impacts from these hydropower operations, as well as historical overfishing and environmental degradation throughout the region, there are also 13 salmonid (salmon and trout) species listed as either endangered or threatened under the ESA. The ESA requires the US National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) to develop recovery plans that identify restoration actions needed to reduce threats from federal hydropower operations to the point where populations are self-sustaining and no longer need protection. In order to do this, spatial, temporal, and genetic baselines must be established (Jachowski et al., 2015). Scientists on regional Technical Recovery Teams determine the population numbers necessary to ensure a self-sustaining population over a

100-year period (NOAA Fisheries, 2012). This “desired” status becomes the baseline to which the current status is compared. Using life-cycle and population modeling techniques, the recovery plans outline the “limiting” factors that need to be altered in order to close the gap between the population baseline and the current status (Good et al., 2007). Although they are not regulatory, these recovery plans are used to coordinate and guide restoration efforts throughout the region (NOAA Fisheries, 2012).

Scientists at NOAA Fisheries and the US Fish and Wildlife Service are also required under the ESA to develop scientific assessments, or Biological Opinions (BiOps) that determine ecological impacts and potential jeopardy to the species or its critical habitat. Each BiOp must consider the “effects of the action” (in this case, hydropower operations) which are then added to an “environmental baseline” that “includes all past and present impacts...anticipated impacts...and the impact of State or private actions which are contemporaneous with the consultation process” (50 C.F.R. § 402.12). NOAA Fisheries scientists and consultants produce BiOps that outline these impacts in detail and provide “reasonable and prudent” measures that could minimize them. BiOps are usually several hundred pages in length, take several years to complete, and must be frequently updated. In this way, establishing and monitoring legal baselines has become one of the main drivers of habitat restoration science in the region.

Climate change raises fundamental theoretical and practical issues for riparian and instream habitat restoration in the region, and many restoration practitioners express concern that restoration planning rarely incorporates future climate change scenarios. As climate change takes effect, the legal baselines described above may need to adapt, yet environmental laws like the ESA can be relatively “inflexible” (Gosnell et al., 2017). Work being done on adaptive law therefore considers how the adaptive capacity, processes, and structures within legal institutions themselves can adapt while still maintaining legitimacy (Cosens et al., 2014, 2017). This is proving especially difficult, however, as the dynamic nature of socio-ecological systems can be at odds with the stability that law assumes to achieve (Cosens, 2008; Ruhl, 2012). Further, although baselines are necessary in order to understand the impact of human activities on the environment, it is becoming increasingly difficult to separate long-term and cumulative impacts such as climate change from the impact of an individual activity (Craig, 2014). All of these issues pose problems for restorationists working to monitor and restore salmon habitat using baselines in a changing climate, highlighting the complexities of baselines as both epistemic and legal phenomena.

Environmental and sociotechnical imaginaries

While there is a need to adapt environmental baselines in response to changes at the global scale, baselines are also shaped by how society collectively views and prepares for the future through “sociotechnical imaginaries” (Jasanoff, 2015; Jasanoff and Kim, 2009). Sociotechnical imaginaries are the “collectively held, institutionally stabilized, and publicly performed visions of desirable futures” (Jasanoff, 2015). Therefore, the legal landscape can come to represent these imaginaries through co-production of science and law (Jasanoff, 2004).

While the “sociotechnical imaginaries” literature hails from science studies perspective, political ecologists have also developed analytical perspectives using “environmental imaginaries,” or collective and situated ideas about nature (Peet and Watts, 1996). They describe how environmental management is realized through environmental imaginaries as scientific and natural resource policy programs come to reflect specific ideas about the future environment, as people work to manage it accordingly to meet future national or collective needs and interests (Nesbitt and Weiner, 2001). Environmental imaginaries

highlight the ways in which different narratives and ways of knowing the environment can take hold, thereby facilitating different environmental futures. This can occur through both individual enactment of these imaginaries or regulatory and management regimes that become institutionalized (Davis, 2011). It is important to be clear that imaginaries are not merely ideas in the mind, but they are active in the world, reproducing environments in a particular way and having profound material and structural impacts (Mitchell, 2011).

Considering the role of both sociotechnical and environmental imaginaries brings focus to the ways in which particular ways of knowing—and particular baselines—may be contested or adopted in management practice. As Davis (2011) points out, environmental imaginaries often include both “assessments about that environment as well as how it came to be in its current state” (3). Sociotechnical and environmental imaginaries are therefore related. Much of the science that is produced at a particular time is created in response to a societal information need, and these needs are based on a particular imaginary of what the future should be. The sociotechnical *and* environmental imaginary of the Columbia River Basin, for example, has changed dramatically over the last 100-years. The river basin was transformed during the 20th century into what White (1995) has called an “organic machine,” in which the Columbia and its tributaries were put to “use” through the creation of an industrial-scale hydropower complex. This has had a profound effect on the kind of science being produced in the basin, as well as the baselines being used for that science. New imaginaries are also emerging, however, as environmental protection, tribal treaty rights, and environmental justice gain traction. The institutional and legal landscape as well as the epistemic work being done in the basin have brought different environmental baselines into and out of view over time.

Baselining for the ESA

Establishing a baseline for legal purposes is not straightforward. Yet in order to establish population recovery goals for the ESA, scientists had to create a baseline. To do this, they first made assumptions about the size of salmon runs before the river was altered by industrial hydropower. In establishing environmental baselines for the BiOps, predevelopment conditions have usually been defined as existing prior to 1850, and population levels are also estimated for this time (Meengs and Lackey, 2005). Several different methods have been used. For instance, Meengs and Lackey (2005) estimated Native American population levels, their dietary consumption of salmon, and used records of cannery harvest to extrapolate salmon population estimates for coastal Oregon rivers in the late 1800s and early 1900s. Other NOAA Fisheries scientists have looked to historic cannery catch records and set the historic baseline at the year 1900 (Good et al., 2007). These numbers have been coupled with an estimate of the currently available habitat and the possibilities for restoration given all nonhydropower development and land-use impacts that have also affected salmon populations (Meengs and Lackey, 2005). Regardless of the method used in creating the target, scientists estimate that runs of wild fish are now somewhere between 0.4 and 15.4% of historic (1850) levels (Good et al., 2007). Thus, in order to establish a recovery goal, the environmental baseline was already “shifted” from a predevelopment river basin to include all nondam development, such as land-use change, logging, agriculture, and urbanization. This baseline disregards the fact that fish populations may have originally been much higher without pre-dam environmental degradation. Regardless, this baseline population is now used as a regulatory target: the goal that needs to be reached in order to remove a species from listing as endangered or threatened under the ESA.

In addition to using baselines to establish population targets, restorationists also establish baselines for riparian habitat restoration goals. This is a time-consuming process.

Most restorationists design river channels by reconstructing historical habitat analogs. One fisheries ecologist, recalling over two decades of experience, described the complexities in early efforts to establish historic analogs this way:

I started on the ground, working in two watersheds, trying to understand how to restore the watersheds, which had us delve into things like ‘how do you know what is wrong in the first place, how do you identify what has been broken?’ So, that got us into historic reconstructions, and what did the habitat look like historically, pre-100 years ago? Then, once we did that, we were able to figure out the things that are missing or degraded and then we figured, well we know that, so what do we need to do about that? . . . You look at the maps of what the mainstem of the Columbia looked like. There were places where it was an island braided system with channels across the entire valley. Pretty cool. (R 2, March/2017)

Scientists and practitioners use a number of different methods to estimate the historic baseline for the river environment. While some restorationists, like the one quoted above, look to early maps to understand historical conditions, others rely on aerial photography from the 1930s or 1950s for comparison. More recently, LIDAR is becoming the technology of choice for identifying historic stream channels as it highlights subtle elevation changes and contours in the landscape. Regardless of how a historic baseline is established, it is a necessary part of most restoration design processes.

While the epistemic practice of drawing baselines is often framed as routine and objective, the values inherent in them are difficult to ignore when they become the center of legal conflict. A brief history of the legal battle over environmental baselines in the Columbia River salmon BiOps will illustrate this point. The 1993 BiOp claimed that “no-jeopardy,” or no harm would come to the listed fish from hydropower operations in the basin (NMFS III, 524 F.3d at 925). This was disputed, and the legal decision to discard the BiOp stated that the way that risk was calculated, using baseline years with low fish returns, was scientifically unsound (Blumm and Paulsen, 2012). In an attempt to remedy this, NOAA Fisheries issued a new BiOp in 1995, which combined three models in order to evaluate the risk of management alternatives. Again, this BiOp was found, in court, to minimize risk because the effects of dam operations were calculated based on a combination of different baselines (Blumm and Paulsen, 2012). Following this, the 2000 BiOp also used an “aggregate approach” to define the environmental baseline, incorporating models of all salmon life cycles, and in turn minimizing the impact of dams on important life-stages.

The next round of the controversy began with the 2004 Revised BiOp, in which NOAA Fisheries established a new environmental baseline that justified the inclusion of dam operations on the basis that they were nondiscretionary. This was also disputed in court. Before he retired, Judge Redden declared this and the 2008 BiOp legally flawed: one reason being the use of an environmental baseline that included the dams. Upon his retirement, Judge Redden stated that he did not foreclose the eventuality that dams may need to be removed in order to adhere to the ESA’s mandate to prevent extinction “whatever the cost” (*NWF v. NMFS*, 2011). When evaluating environmental baselines for salmon survival in the Columbia River, one sociotechnical and environmental imaginary is often assumed: the presence of dams and a highly regulated river. Yet, according to Judge Redden’s analysis and opinion, this imaginary may need to be reconsidered entirely.

Enter climate change

Establishing reference sites and analogs for comparison has always been challenging for restorationists, but now, choosing a historic analog environment to serve as a habitat

restoration goal has become fraught with difficulty (Williams and Jackson, 2007). One restorationist in the Columbia River Basin described their experience of the changing climate this way: “When you are on this roller coaster you are like: Whoa! Slow down! It’s very difficult. It’s very difficult to try to get some scientific answers in such volatile systems” (R 18, May/2017). In order to deal with this, alternatives to establishing a historic reference site are becoming increasingly common. Due to the effects of climate change, many prominent ecologists have recognized the need to broaden the meaning of ecological restoration to include “novel” or “hybrid” ecosystems (Clewett, 2009; Hobbs et al., 2006; Hobbs and Cramer, 2008). Some restorationists have proposed using a “dynamic reference” that accounts for change in both reference and restoration sites (Hiers et al., 2012). These ideas have helped broaden the goal of restoration to include states other than historic baselines or analogs. For example, by conceptualizing “anthropocene baselines,” it may be possible to triage historic remnant ecosystems, while at the same time recognizing the reality of irreversible ecological change in highly altered and human-dominated ecosystems such as regulated rivers like the Columbia (Kopf et al., 2015). There is a fear, however, that abandoning historic baselines for recovery and restoration goals could lead to people “gaming” the system (Ruhl and Salzman, 2011), changing points of reference in ways that could minimize biodiversity (Kopf et al., 2015), or succumbing to the shifting baselines problem identified by Pauly (1995). These fears were often voiced among participants in this study.

Restorationists throughout the Columbia River Basin are also re-thinking how they establish baselines in their own scientific work. One person who coordinates restoration efforts on a large section of the river described the shift this way:

A lot of what we do is look at the historic template and try to imitate the historic template. We don’t really look at how the historic template is really going to change, with a change in precipitation and temperature and all of that kind of stuff. So, I don’t know if what we are doing is going to be successful in the long term. It’s a big issue. We are talking about it but I think the idea that everybody is really so stuck on is this historic template and restoring natural processes, which is good for sure, because it is something that we all feel very comfortable with. The whole idea of novel ecosystems is not something that people are comfortable with. (R 26, July/2017)

This quote highlights how restorationists struggle to come to terms with the changes taking place in their ecological system, but it also demonstrates that they feel challenged to create new understandings of ecological possibilities and baselines.

It is also difficult to measure effectiveness when changes that are taking place are shifting the environmental baseline of the region itself. As climate change takes effect, these large-scale shifting baselines are becoming the “new normal.” One restoration manager, working across a broad region, recalled a large project in the headwaters, lamenting:

We did all of this work and it should produce all of these extra fish. But, simultaneously to that, the water temperature has also increased. And the ocean condition has been terrible. So, what is the interaction of all of that stuff? How do I measure my little activity here, which I am doing specifically to increase the number of fish *here*? That has gotten more complicated. It is more complicated, and it is difficult to do. But that is where a lot of the effort is going. To try to see that stuff and to try to tease it out. (R 24, July/2017)

Indeed, sorting out the effect of a single restoration action in a complex system like the Columbia River Basin is already very complex. The restoration manager quoted above continued:

Even if you have a perfect method of monitoring all of those things, the interaction of them is complicated... the adults are going back out into a terrible ocean in an eight or ten-year cycle,

which you have to wait through to see the benefit. Humans have a really hard time being patient. You might only get two or three of those cycles in your whole scientific career. How do you make the managers wait through that to see if it really paid off or not? It is hard. (R 24, July/2017)

As this quote illustrates, the complexities of long-term monitoring are compounded by climate change. Temperatures, streamflows, and tide levels are becoming more variable and extreme, and some restorationists have been forced to abandon long-term monitoring sites altogether: climate change effects have rendered some comparisons impossible.

Conceptualizing alternative baselines

In place of the traditional, historic, baselines for the river, restorationists are beginning to think in terms of more recent baselines in order to understand what might be possible in terms of restoration in a changed climate. One of these recent future-oriented baselines is 2015. According to climate models, the future does, indeed, look like the record-warm year of 2015 (Dalton et al., 2013). Winters will be warmer and wetter and summers will be dryer and hotter, resulting in low snowpack and decreased streamflows with higher water temperatures—all detrimental to salmonid survival (Nolin et al., 2012). Restorationists throughout the basin are trying to understand and adjust to this change, and the experience of living through 2015 is facilitating the creation of a new, more recent, yet none-the-less helpful, baseline. One restoration manager, working in the desert-steppe of the central basin told of their experience:

2015 kind of gave us a little bit of a reality check: Oh, wow! . . . It was a really tough summer . . . It was stressful. It was like, ‘if this is what it is going to be like, it is not going to be fun.’ Stream temperatures were just totally lethal. Totally lethal. (R 16, May/2017)

After living through the “new normal” of 2015, many people described it as if they had peered into the future. This experiential aspect of the year 2015 is a feature that many restorationists recalled. In actually seeing and feeling the effects of climate change, many spoke of altering their restoration monitoring and designs to look ahead to this climate-changed future. Instead of looking to historical baselines, the more recent baseline of 2015 is serving as a future baseline for what is to come, and for what the river might be restored *to*.

The year 2015 represented a critical test for restoration in the region. As a result of this “test,” many restorationists are adapting their management practices. For example, they are planting different species of trees that will tolerate future conditions and including more shade in their design criteria to keep streams cool. Yet these adaptations also extend to more fundamental changes in scientific work, including re-thinking the focus of restoration ecology to anticipate the future. As one restoration practitioner put it: “Everything has changed . . . I, personally, believe that going back is not a realistic goal” (R 34, July/2017). This shift is reflected in the baselines that are now being used as environmental references. Another fisheries biologist who implemented and monitored large-scale projects recalled:

We talk about climate change a lot and what it might mean for the work that we do. But it is always kind of hard to wrap your head around what it actually means as far as action. When we design a project, we take all of our data from the stream gauges and we say: what is the average minimum flow or the base minimum flow that we can expect?...We use all of our gauging records to tell us that. If that is all history, it might not reflect what is coming in the future and we might

be off. We got that lesson in 2015, possibly...it's like, well, this is what it is going to be like in the future. (R 17, May/2017)

As restorationists like the one quoted above search for a way to deal with the changes that they are experiencing, the future and baselines become increasingly entangled.

Anticipating baselines and making judgments

As new environmental baselines emerge through the epistemic practices of restorationists in the basin, they are being mobilized to help anticipate the future and rethink relationships to the past. Anticipation is an affective state of “thinking and living toward the future,” and it can permeate epistemic practice (Adams et al., 2009: 246). Anticipatory practices are being fostered, in which scientists “think” and “live” toward the future (Adams et al., 2009). Adams et al. (2009) refer to this as a “politics of temporality,” in which we not only have a moral responsibility to “secure the best possible futures,” but we recognize that certain technoscientific futures “ratchet up” hopefulness and give possibility (256). Science, therefore, plays a role in “reconfiguring ‘the possible’” (Adams et al., 2009: 246), and the practice of anticipation, as well as other forms of “anticipation work” are key strategies that ecological restorationists are using to adapt. According to Steinhardt and Jackson (2015), “anticipation work” involves “practices that cultivate and channel expectations of the future, design pathways into those imaginations, and maintain those visions in the face of a dynamic world” (1). These include practices that can connect to individuals and cultures through future visions, or imaginaries, and travel across spatial and temporal scales (Steinhardt and Jackson, 2015). Anticipatory practices such as baseline-setting help sensitize the field of restoration ecology to the future, while at the same time facilitating the emergence of ideas that will enable scientifically based decision-making to continue within a high level of uncertainty.

One way that restorationists are orienting their work to alternative baselines is by establishing metrics that will remain useful in a changed climate. Metrics for understanding change in novel ecosystems include “future habitat condition,” which incorporates model projections, “functional diversity,” which recognizes resilience in an ecosystem (Suding and Leger, 2012), or even measuring biodiversity (Ankersen and Regan, 2010) or ecosystem services (Evers et al., 2018). Restorationists are recognizing the need for different benchmarks for success, or what one restorationist referred to as ways of “seeing through metrics.” For example, as water and air temperatures increase, lowering stream temperature is emerging as an important metric for success, and creating shade through vegetative planting and connecting streams to cooling ground water is now becoming a focus of restoration design. In response, increasing water temperature monitoring and setting benchmarks for temperatures at restoration sites is now common practice. As new information emerges about the kinds of restoration actions that mitigate climate change effects, new metrics for monitoring are thus being developed by restorationists as well as policy-makers.

Yet many of these new metrics are difficult to operationalize. For instance, it is difficult to create metrics for some ecosystem attributes because they are often difficult to “see” through metrics. Measuring the length and geomorphology of anastomose, or complex, braided streams is difficult and time consuming, and no standard metrics have been developed. Similarly, quantifying functional diversity is highly complex, yet this indicator may be one of the most important in terms of climate change, as ecosystems that have a mixture of species serving functionally diverse roles may be more able to mitigate extremes of temporal

variability (Suding and Leger, 2012). New types of indicators and new monitoring protocols are thus being developed to deal with this shortcoming. Anticipating and purposefully designing metrics for the future is therefore an important strategy that restorationists are using to deal with shifting environmental baselines.

While concepts like novel ecosystems are becoming more widespread, the implications for management are still contentious, as they shift the environmental imaginary of the river and change the way that restoration is conducted. The ESA requires salmon to be recovered at “whatever the cost,” but creating habitat for this recovery in a climate-changed river may require anticipating new baselines. To compensate for this paradox, I found that restorationists working in the field often make decisions on a day-to-day basis, experimenting with and altering the river landscape as they try to restore salmon habitat, manage for future climatic change, and deal with high levels of scientific uncertainty and indeterminacy. Restorationists practice this anticipatory work in many ways, including utilizing predictive modeling to understand what future conditions will be like, creating more adaptive restoration plans, and relying more on restoration efforts upstream or downstream of an individual site. Drawing on Daston and Galison (2007), I use the term “trained judgment” to describe this practice. Trained judgment involves an “expert” making decisions about what they are observing. Because I am focusing here on the epistemic practice of baselining, I will draw out the ways in which “trained judgment” is increasingly used to bridge the gap between the experience of 2015 and the anticipation it brings to the baselining practices of restorationists.

While long-term, rigorous monitoring programs are clearly important in the broader scope of species recovery, more immediate information is also required. Restorationists need to know whether or not their riparian planting or floodplain reconnection project is making a difference in lowering stream temperatures because salmon survival may immediately depend on it. They also need to know if their engineered log-jams and channels are withstanding flooding events and behaving the way they expected. To answer these questions, many restorationists have decided to simply use their own expert interpretation, or “trained judgment.” In the case of restoration monitoring, this often involves simply taking a walk around a restoration site and drawing conclusions about its success. While some restorationists would rather (or are required to) monitor to quantify their environmental impacts, this kind of inference is common.

In order to understand effectiveness of restoration efforts, agencies such as NOAA Fisheries conduct large-scale monitoring programs. Yet some restorationists have found them unable to provide information on a temporal and spatial scale that is relevant to their individual projects, especially as decisions need to be made to counter the effects of climate change. In order to deal with this shortfall in information, some restorationists have worked quickly to come up with their own monitoring programs. A restoration manager recalled the process:

We cobbled together some funds to jury-rig together a monitoring plan...we had spawning survey crews going through and we just kind of by hook or by crook got this monitoring together. We were spending a lot of money and we were putting a lot of work in on the ground and we really didn't know what was going on. (R 16, May/2017)

These kinds of “quick and dirty” monitoring programs are commonplace and point to a local-scale adaptation in scientific practice that embraces trained judgment, an anticipatory practice of a highly skilled individual scientist.

One person who has worked to establish rigorous monitoring protocols for decades found that going back to “the old science” and “just going on a good old-fashioned walk” around

a restoration site provided useful insight (R 11, April/2017). Some scientists described their field walk as monitoring practice. Walking throughout the site, they could observe where structures withstood high water or where groundwater was infiltrating the floodplain. According to one restoration project manager,

Those [observations] are extremely helpful . . . I don't need to be a statistician. All I need to say is, 'This project is designed like this, and was intended to do this. And, this is what it looks like once it was finished, five years later or seven years later'...what I need to know is how did this design element in this hydrologic, geomorphic situation affect the fish habitats. That is what I'm after. (R 8, April/2017)

Due to financial and time constraints, these kinds of on-the-ground observations may be the only monitoring activity that some restoration sites receive. But, in the absence of a formal field study, many consider those judgments to be sound enough to warrant decision-making. Practices like the ones described above, which incorporate the trained judgment of individual scientists are helping to verify larger-scale assumptions and inferences. These inferences are then useful in diverse ecological circumstances throughout the basin, all of which are anticipating the localized effects of climate change in different ways.

This practice, of shifting to alternative, future, and more recent baselines is further reflected in environmental modeling and engineering design. As another restoration ecologist explained, when using models: "the farther out you get, the less specificity our plan has" (R 16, May/2017). This lack of specificity in prediction is often countered by extra caution in design, including a "factor of safety" (R 8, April/2017) just in case environmental conditions turn out to be worse than climate models predict: yet another way that restorationists are anticipating the future.

In the end, historic baselines may become unusable, as restorationists abandon them in favor of trend analysis. As one researcher, whose work focused on hydrologic modeling and planning pointed out:

I think with the emphasis on a baseline, on the need to get a baseline, we may be losing the long-term trend. If we can't get the baseline, maybe we should be looking at the trend. I understand that it's a challenge but I also see a scientific and disciplinary paralysis, we could call it. There are all of these things that could be confounding [the baseline] so until we sort all of those out, we can't do anything. I'm a proponent of learn by doing. Sometimes just starting to do something allows you to learn something which allows you to do it better. So that's my response to that. (R 33, July/2017)

This is a kind of "learning by doing," which involves inference through trained judgment, and it is informed by witnessing a changing climate and the anticipation that this experience enables. By working with alternative, anticipatory baselines, including more recent ones such as 2015, restorationists are able to make progress in their work, employ different imaginaries, and anticipate the future.

Conclusions

In May 2016, Judge Simon remanded the 2014 Supplemental BiOp, in part because it did not "properly analyze the effects of climate change" (*NWF v. NMFS*, 2016). Judge Simon's declaration about the need to incorporate climate change into environmental baselines highlights a shift from thinking about environmental baselines as historic to more recent, or even future, conditions. As I have shown, climate change can render historic environmental baselines unviable, and the scientists, institutions, and practitioners involved in baseline-setting

are forced to anticipate a climate-changed future environment—possibly forced to “shift” their baselines, in a similar sense to the ways that Pauly (1995) described.

Yet, this shift can pose problems when environmental baselines are not only epistemic but legal in nature. Although baseline creation that considers climate change is rare when setting legal standards, baseline choices become critical when considering whether or not they can be used for adaptation policy (Ruhl and Salzman, 2011). Ruhl and Salzman (2011), for instance, argue that baselines become ineffective when a past can no longer be clearly “leveraged” for legitimacy. This may be the case in regions where a climate-changed future is more difficult to conceptualize and imagine than the standard, historical-basis for restoration and recovery. Yet in the Columbia River Basin, climate change is already being keenly felt and experienced, as years like 2015 become the “new normal.” Therefore, the experience of living through 2015 is being leveraged for a future imaginary. This is seen in the way that restorationists themselves are shifting to look to future, anticipatory, baselines.

This is a “dual futurity” (Weber, 1946) in which humans are oriented toward the future and allow this future to guide their present actions, and it constitutes an epistemic and conceptual shift for a field like ecological restoration: a field which has been guided by the past since its inception. Weber pointed out the fundamental way that, while scientific inquiry is based on present data and past-based causal analysis, it is still fundamentally about future-making projects (Adam, 2009). Therefore, the future-oriented actions of scientists are critical to understand, and it is these future imaginaries of the environment that guide natural resource management and the science that it entails. Much like designing baselines for legal purposes, baseline-setting in the scientific practice of restoration is linked to future environmental and sociotechnical imaginaries of the Columbia River Basin, and both are produced through anticipatory work.

The controversy over establishing environmental baselines for the Columbia River salmon BiOps demonstrates how a seemingly “natural” baseline is not only established through a complex socio-political process, but also brings to light the ways in which environmental imaginaries are enacted through epistemic practice. While there are other ways to set standards for regulatory policy, historic baselines are still some of the most commonly used regulatory tools (Ruhl and Salzman, 2011). For ecological restoration and species recovery, looking to historic environmental states and population levels can be useful because they serve to effectively frame a complex issue. Historic baselines also have rhetorical appeal because they are easy to understand and imagine. These historic baselines, however, may even assume prior conditions that did not actually exist (Ruhl and Salzman, 2011). We can see these tensions played out in the way that baselines are contested in the BiOps, as well as the epistemic practices that inform ESA policies.

Most importantly, baseline-setting enables and constrains environmental management through legal mandates and comes to reflect specific sociotechnical and environmental imaginaries. Despite their seemingly ephemeral nature, sociotechnical imaginaries help produce knowledge in particular ways, becoming embedded in epistemic work. Restoration ecologists and practitioners produce these imaginaries by using particular baselines that are put in place by the courts through recovery metrics and restoration planning. If the environmental baselines of the river assume hydropower operations, commercial fishing in the ocean, and irrigation withdrawals, restorationists are tasked with factoring these effects into their planning, their monitoring, and their modeling. Some restorationists optimistically see the recovery plans that include dam operations as a “working hypothesis that we can have hydropower and salmon too” (R 21, June/2017). Others, including the courts, are not so optimistic that salmon can be recovered in a highly regulated river.

This study has shown that instead of looking to the past, baseline-setting can be an anticipatory practice that links future environmental and sociotechnical imaginaries to management actions through scientific work. These practices, and the social construction of baselines are observed in the ways that restorationists anticipate the future in their own work, as well as the ways that environmental baselines are fought over in court. The science of ecological restoration in the Columbia River Basin has been co-produced along with the physical transformation of the river into a highly regulated, industrial one, demonstrating the ways in which environmental baselines come to reflect specific sociotechnical imaginaries of nature.

Yet the issue of shifting baselines strikes at a deeper contradiction between technocratic standards and metrics of success in a legal context such as the ESA and the unpredictable and highly stochastic nature of ecological processes. The field of restoration was born out of the idea that environmental repair was about looking to the past. But over time, the discipline has transformed to look forward and even to anticipate the future. This has been a crucial adaptation, but it has not come easily. Restoring to a projected future environment, as opposed to a historic baseline, involves predicting what that future may be, but it also involves the imagination and anticipation of an individual scientist, performed through their practice.

Restorationists in the Columbia River Basin are already experiencing climate change. They have been living through it for the last 50 years (Dalton et al., 2013). The snowless winter, drought, and high temperatures of 2015 were a window into one potential future. These potential futures are being anticipated and actions to adapt to them (or prevent them) are being purposefully considered. This is not the same as embracing a technological modernity to “solve” environmental and societal problems. Instead, it is a recognition that there are places within science where different goals and intentions are facilitated or hindered by different sociotechnical and environmental imaginaries. One of these sites is in the co-production of baselines, where, in the Columbia River, a climate-changed future is already being anticipated and enacted through the work of restorationists.

Highlights

- The practice of determining baselines for epistemic and legal purposes is pervasive in conservation and ecological restoration.
- Determining environmental baselines is complicated by climate change.
- Baselines facilitate and embody particular sociotechnical and environmental imaginaries.
- The paper describes ways that scientists deal with shifting baselines in their work by creating anticipatory baselines.

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1. University of Washington Libraries Special Collections, Harlan Holmes Papers, Acc. 2614-001.

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