Eyes on the Seas:

A digital political ecology of fisheries monitoring programs

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Abstract

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This dissertation analyzes the emergence of the private fisheries observer industry, and the introduction of digital electronic monitoring technologies, in conjunction with the quota-based management system in the U.S. West Coast groundfish fishery. Through interviews, participant observation and textual and discourse analysis, I investigate how the outsourcing of data collection has impacted fisheries science-management agendas and fishermen, and how digital monitoring reconfigures socioecological relations in fisheries. I synthesize across political ecology, science and technology studies, and digital conservation studies, to theorize the emergence of a digital environmental governance regime in fisheries and conservation more broadly.

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List of Acronyms

AKFSC	Alaska Fisheries Science Center
EEZ	Exclusive Economic Zone
EFP	Exempted Fishing Permit
EM	Electronic Monitoring
EVM	Electronic Video Monitoring
FMP	Fisheries Management Plan
IFQ	Individual Fishing Quota
MSA	Magnuson-Stevens Fisheries Conservation and Management Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Association
NPFMC	North Pacific Fisheries Management Council
NWFSC	Northwest Fisheries Science Center
PCGFMP	Pacific Coast Groundfish Fisheries Management Plan
PFMC	Pacific Fisheries Management Council
PSMFC	Pacific States Marine Fisheries Commission
UNCLOS	United Nations Convention on the Law of the Sea
WCGOP	West Coast Groundfish Observer Program

1 Introduction and Theoretical Grounding

In the last thirty years, fisheries managers, like other forms of conservation management, have begun implementing market-based environmental governance strategies that in effect privatize resource access and control. Measures such individual catch quotas and the enclosure of fishing grounds for conservation as marine protected areas are argued by many to be the most reasonable method for preventing the 'tragedy of the commons'. Situated within a neoliberal fisheries management regime and broader governmental ideology, fisheries science took a distinctly neoliberal turn as at-sea data collection, known as fisheries observation and monitoring, increasingly became outsourced to private research contracting companies in the 1980s.

Fisheries monitoring deploys various human, digital, and geospatial surveillance technologies on commercial fishing vessels, and accompanies market-based management strategies that shift the responsibility for fishery health onto individual fishermen. With the emergence of the private observer contractor industry, there has been a reordering of the relationships between government, science, non-profit, and fishing industry actors. In recent years, the cost burden associated with private observing programs have led to the development of technoscientific solutions which conduct observing and monitoring through video cameras. As with other forms of digital conservation, these technologies have raised many questions, practical, epistemological, and ontological. For example, data governance has struggled to keep pace with technological development, raising concerns regarding privacy and ownership. Because electronic monitoring programs have evolved as a byproduct of neoliberal governance and science, so too one must ask how the political economy of data collection and management might shape scientific and regulatory outcomes, and with what impacts for the environment. What makes fisheries observation and monitoring programs unique to other kinds of conservation for environmental monitoring, is that they are directed at an animal-nature already commodified through human capitalist relations. In other words, rather than serve as yet another mechanism through which nature is commodified (for example such as conservation of charismatic landscapes or fauna) or economized (e.g. valued as with ecosystem services) fisheries observing and monitoring secures the continued commodification of nature through capitalist exploitation through the virtue of science. The assumption is that by rendering human environment relations knowable and measurable, those relations can be managed to achieve optimum economic and ecological potential. Significantly, these relations occur in remote locations at sea, making the visuality of observing and monitoring an integral piece to conservation success.

In this dissertation, I analyze the emergence of the private fisheries observer industry, and the introduction of digital electronic monitoring technologies, in conjunction with the quota-based management system in the U.S. West Coast groundfish fishery, a fishery occurring off the coasts of Washington, Oregon, and California in the United States and targeting fish that swim on or near the ocean floor. My research is motivated by the following questions: How has fisheries observation come to be dominated by a private contract research industry? How has the outsourcing of data collection impacted fisheries science-management agendas and fishermen? How did digital monitoring technology emerge as an outcome of the privatization of fisheries and fisheries science? And how has digital monitoring reconfigured socioecological relations in fisheries?

1.1 The Political Ecology of Fisheries

According to political ecology, ecological systems are historically linked to social, political and economic systems at multiple geographic scales and places (Robbins 2004, pg. 13). Research in political ecology assumes that the costs and benefits of environmental change are experienced unequally by actors and therefore seeks to interrogate the uneven power relations that imbue human-environment interactions. The unequal distribution of burdens and benefits both shapes and is shaped by social, political and economic relations and can reinforce existing inequalities such as unequal access to resources, decision-making power and governance, or access to markets and control of the means of production. Therefore, environmental change and governance can have broad reaching implications for the configurations of power structures in society (Bryant and Bailey 1997; Robbins 2004).

A significant contribution of fisheries political ecologists has been to explore the political and economic processes contributing to the commodification of fisheries (Pitcher and Lam 2015) and the environmental outcomes of commodification. Bestor (2000), for example examines the how Japan's emergence in the global economy triggered the Bluefin tuna's rise as a global commodity through the diffusion of sushi as a trendy cuisine (see also Greenberg 2010 for similar studies of salmon, cod and sea bass). Similarly, studying the industrialization of the tuna fleet, Campling (2012) examines the historical and geographical processes underpinning the development of the tuna fisheries as a "commodity frontier" and the impacts such intensification has had on the environment. St. Martin (St. Martin 2001, 2006; and also Finley 2011) have critiqued bio-economic models of Maximum Sustainable Yield as situating fisheries science and management (and therefore fisheries writ large) within a distinctly capitalist ontology. The implications, of a bioeconomic management regime has been to characterize fishing communities as "site of economic impact and never as a constituent of the economic" (St. Martin 2006, p. 83).

Others have focused on the commodification of access and harvest rights (Campling, Havice, and Howard 2012; Carothers and Chambers 2012; Mansfield 2004a) through transferable quotas, and the impacts for producing inequality in fisheries. Research in the U.S. has been highly critical of what has been termed the 'neoliberalization' of the fisheries, or privatization of fisheries harvest allocations through individual quota programs (Mansfield 2004b, 2004a, 2006; Olson 2011; Pinkerton and Davis 2015; St. Martin 2007). Current U.S. fisheries management evolved out of Hardin's (1968) theory of the 'tragedy of the commons', assuming that in open access common pool resources individuals will prioritize their own economic needs over those of the community, without concern for the long-term sustainability of the resource. Despite arguments that the 'tragedy of the commons' grossly oversimplifies the possibilities and practices of collective governance (Dietz, Ostrom, and Stern 2003; Ostrom 1990), privatization through government regulation has become the dominant model of fisheries management through allocation schemes. A common regulatory practice has to implement IFQ and individual transferable quota (ITQ) programs, which divide the total allowable harvest amongst permit holders who may sell their quota allocations as commodities on the market. And although IFQ/ITQ systems have widely been accepted as a superior governance mechanism for halting and reversing fisheries collapse (Costello, Gaines, and Lynham 2008), Copes (2000, pg. 6) contends that "ITQs have proven to be particularly prone to the creation of new externalities and other inefficiencies, "the enlargement of bycatch or "data fouling" (biasing data because of changes in fishing practices) for example. Others argue that any improvements in fisheries sustainability observed in IFQ/ITQ fisheries are more easily attributed to setting enforceable fleet wide total allowable catch limit, from which quota allocations are derived, rather than through the actual privatization and marketization of quota allocations, the latter of which "has less clear effects on fish stocks" (Carothers and Chambers 2012, p. 43). Similar critiques have been levied by fisheries political ecologists on the privatization of communally managed fisheries in the Global South (Campling and Havice 2014; Campling, Havice, and Howard 2012) and in indigenous communities (De Alessi 2012; Thornton and Hebert 2015).

1.1.1 Biopower

Foucault's concept of biopower has proven a useful analytic for those working at the interface of human-environment relations, seeking to understand how those relations are ordered and the technologies through which they are managed. Biopower marked a shift in how power was exerted over the social body. Foucault locates this shift in 18^{th} century Europe, when governing powers began administering the day-to-day lives and spaces of individuals and communities with a broader goal of improving and securing the well-being of the population. Given that biopower can make live or let die, it has taken on more sinister dimensions in colonialism among other historical periods, for example when used to control and let die indigenous or enslaved peoples. Scientific disciplines emerge as forms of power-knowledge which develop techniques for measuring and assessing different dimensions' population health, and in so doing "brought life and death and its mechanisms into the realm of explicit calculations and made knowledge-power an agent of the transformation of human and environmental life" (Foucault 1988, pg. 143). Yet, scientific forms of power-knowledge "were not simply descriptive. Rather, they would also produce a normative vision for how both individuals and populations *should* behave" (Cavanagh 2018, pg. 405). As such, science and measurement became intrinsically linked to the logics of government and the governing of populations and bodies was rendered an intrinsically scientific endeavor. In fisheries, fisheries science has been intrinsically linked to the managing of both non-human and bodies, in order to let live both fish populations as well as human populations dependent on fish for food

Cavanagh (2018) observes that while Foucault's theory of governmentality has been long favored as an analytical device in political ecology (also as environmentality, green governmentality, etc.), biopower has received comparatively less attention. Similarly, fisheries political ecologists have primarily focused on neoliberal forms of governance deployed in fisheries, without situating much consideration for the ways in which biopolitical concerns may inform such measure. Over the last decade or so, scholars have begun to bringing biopower into the conversation, particularly among those working at the intersection of the environmental humanities and/or animal studies, in order to understand how the mechanisms through which power is wielded in the management of non-human and more-than-human lives. Cavanagh attributes this sea change to new understandings of the relationship between biopower and governmentality. Biopower as a new object of political ecology is then "one amongst several forms of power that can be deployed under a wide range of distinct constellations of governance or governmentality, but also as a form of power that is deeply concerned with the regulation of nonhuman environments and populations as well." (Cavanagh 2018, pg. 408).

Within these 'new frontiers' of political ecology my research is positioned in constellation with work that examines conservation as a 'biopolitical project' which (re)produces asymmetrical relationships that value some lives and not others, with that value being determined according to the material-discursive practices of science. Scientific rendering of the distinctions between valued and worthy of life, or not, privileges those determinations as intrinsic or self-evident (Biermann and Anderson 2017; Cavanagh 2018). Although scholarship on conservation as biopower have examined a variety of more-than-human entanglements (Biermann and Mansfield 2014; Braverman 2014; Braun 2007; Collard 2012; Luke 2000; Youatt 2008), overwhelmingly this research has focused on land-based conservation, with little attention to marine and ocean management regimes (with the exception of Bresnihan 2019). Responding to calls for greater empirical engagement with biopower in human geography, this dissertation develops an ethnographic account of monitoring and observing programs in the West Coast groundfish fishery, to understand how biopolitics works "on the ground" through fisheries science-management (Rutherford and Rutherford 2013, pg. 432).

1.1.2 What can political ecology offer fisheries management?

Applying a political ecology framework to fisheries management raises an important question, namely is science-based policy adequate for coping with fisheries decline given that the issue is one of politics, rather than science? Despite gains in the scientific community's ability to count fish and account for the impact of harvest on fish populations, global fisheries are in a state of decline (Caddy and Cochrane 2001). Fisheries managers, scientists, and economists acknowledge that managing fisheries has as much to do with the politicized economic and socio-cultural relations as with the actual numbers of fish (Caddy and Cochrane 2001).

By taking a relational approach that integrates ecological with social systems, political ecology offers a way for fisheries managers to situate current ecological conditions within their co-constitutive historical, political and economic contexts. As complex and differentiated socio-ecological systems, fisheries require a management approach that recognizes and takes account for the impact of regulatory mechanisms on flows of power within society. As Thornton and Herbert (2015) demonstrate in their work on Alaskan herring fisheries, political ecology creates space for other ways of knowing nature, incorporating local and traditional knowledges with western science informing culturally appropriate policies, thereby also helping to reduce inequality.

As noted above, commercial fishing economies are increasingly integrated with and competing on global markets. Yet unlike agricultural commodities like corn and soybeans, which in the US are stabilized through government subsidies, the prices and revenues of fish sales fluctuate through processes of supply and demand as with most commodities. Commercial capture fishers in the US are competing against farmed and wild capture fisheries all over the world. Fisheries located within 200 miles of shore (the exclusive economic zone or EEZ) are subject to the regulations of their proximate nation/state. Therefore, the pressures and cost barriers enacted on individual fishers and fishing companies can vary widely, despite each competing in the same global market (Crona et al. 2016). With this in mind, a political ecology of fisheries offers two useful mechanisms for informing fisheries policy. First, political ecology emphasizes the analysis of phenomena at multiple geographic scales. In other words, this framework recognizes that power operates at multiple spheres of influence, and holds these multiple spheres in tension with one another rather than isolating concerns with a locational specificity (e.g. local or national issues) (May 2013). Second, though not unrelated, political ecology traces the flows of capital and goods through commodity chain analysis, an approach that is currently lacking in domestic fisheries management. If domestic fisheries were managed with a mind towards the pressures that commercial fishers face through participation in global markets, it opens the possibility for new solutions that would no longer responsibilize fishers for fishery decline and that would consider the impact of global market integration on local environmental conditions.

1.2 Placing fisheries in geography

Steinberg (1999) contends that the ocean is a social space, a space *of* society, a space that is folded into and co-constituted with social life, rather than just a location where life unfolds. Yet geographic research on marine-space has for the most part viewed marine environments as little more than an empty space of mobility and transit between landed destinations. And while historically human geographers have taken the social *land*-scape of terrestrial environments as their object of inquiry, their analytical and methodological tools are equally useful for making sense of the social *sea*-scape and marine world. With oceans covering a majority of the earth's surface, and increasingly at risk of becoming despoiled through pollution, over-harvest of marine species, or exploited for resources such as oil and gas, it is little wonder that there have been repeated calls to action to bring a geographic framework to marine management issues (Anderson and Peters 2014; Peters 2010; Steinberg 1999).

Historically, fisheries management in the US has taken a species specific approach, that is setting catch limits based on models that determine the maximum allowable harvest for a particular species. But over the last two decades, management struggles have included an explicitly place-based approach in the form of ecosystem based management. That is, regulations that consider the impacts of fishing and other activities on how the ecosystem functions as a whole (Pikitch et al. 2004). Sometimes this has resulted in borders and boundaries that exclude people, such as in conservation areas. From a regulatory vantage, this model constructs fisheries as geographic places, an ecosystem, and in terms of their health and productivity (e.g. this place is overfished, this place is not) but ignores human spatial patterns of social and economic relations (Banoub 2013). Yet, although fisheries are acknowledged as having a distinct geography and holding geopolitical significance, 'place' is not theorized or developed conceptually in fisheries policy. Fisheries are, in effect, placeless places (Cardwell and Thornton 2015).

1.2.1 A Critical Place Studies Approach

Critical place studies (CPS) takes 'place' as an entry point for understanding complex social and political relations. Significantly, CPS embraces a conceptualization of place as unbounded by spatial and temporal dimensions, which affords a broad historical and geographic register for contextualizing how places come into being. 'Place' is a location made meaningful and constantly emerging through embodied daily practices. It takes shape at the intersection of social, political, and economic processes that occur at multiple scales. Bucking the notion of place as static and unchanging, CPS takes for granted that places lack temporal fixity as they are products of both past and present occurrences and future imaginaries (Massey 2005, Mills 2012). But places are not merely social constructions, they are socioecological landscapes, brought into being through relational practices between human and more-than-human environments (Banoub 2012). Interrogating the processes of worlding through which places are made sheds light on the ways in which social relationships are ordered around power and access to resources.

To do research on marine policy without engaging critically with place ignores the spatially contingent material conditions which marine policy sets out to govern. That is to say that for all their presumed placelessness, marine environments do vary widely both in their geography and the ways they are socially produced. Fisheries, as places of resource extraction, necessarily reflect spatial patterns of uneven development (Smith 1984). Fishing must occur in particular places at particular times, dependent on regulatory season, fish behavior, and geographic conditions (e.g. currents, tides, weather, etc.). But equally significant, the political economic infrastructure of the fishing industry also 'places' fishing at certain sites and locales (e.g.

icehouses, loading docks, processors, and distributors). The processes through which these sites develop in relation to one another can have profound effects on access to resources, as well as other dimensions of social and environmental well-being. A critical place studies approach offers a reframing of fisheries as relational socioecologies, in which land-based nodes of fishing activity, with fishing grounds, ports, and vessels amongst other places, are networked across varying topological and geographical distances.

Geographers and social scientists working in fisheries have attempted to place fisheries and to understand how spatial imaginaries may differ between different actors. The varying ways in which fisheries are conceptualized as places are significant because they are each "related to a different constellation of specific material, socio-natural relations" (Banoub 2012, pg. 33). Cardwell and Thornton (2015), for example sought to understand how fishers in the United Kingdom placed the fishery in which they worked. Fishers articulated an embodied, experiential understanding of the fishery as a heterogeneous and dynamic place, bounded only by their "territory of personal experience" (pg. 163) and advocated for a place-based management strategy that included social and ecological systems. Other work on indigenous fishing communities in the Pacific Northwest similarly found that sense of place was produced through embodied practices of fishing (in this case clam-digging) and bound up in individual and community identities (Poe, Donatuto, and Satterfield 2016). Bear (2013) has sought to develop a hybrid geography of the Cardigan Bay scallop fishery not by reinserting the human in the marine but by teasing apart the co-constitutive roles of the human and more-than-human in producing the dynamic material environment of the fishery, as well as the rhetorical landscape out of which policy evolved.

Political ecology and CPS offer complementary frameworks for examining fisheries. Each acknowledges that social and power relations are occurring at multiple and simultaneous geographic scales. The notion of scale is particularly important in doing fisheries research because in domestic contexts, there are a variety of, often competing, spatial configurations of power. Management occurs at the state, regional, federal, tribal and international scales. PE adds layers of complexity to this approach by considering the ecological landscape and its relationship to social, political and economic systems.

1.3 Science and Technology Studies

The field of Science and Technology Studies (STS) examines the ways in which science and the technological artifacts are socially constructed and how they serve as channels for power relations (Jasanoff 2004). STS rejects the "common view" of science as a formal activity in which scientists use a systematic, and therefore reproducible, method of observing the natural world and discovering truths about that world (Sismondo 2004). Nor do they accept the adage that technology drives history. Instead, STS makes several assertions about science and technology and their relationship to society. First, science/technology and society are co-producing, STS therefore seeks to analyze the "ways in which science "works" to produce (and circulate) knowledge about the world" (Goldman, Nadasdy, and Turner 2011, pg. 11) and how technology acts as an embodied practice of knowledge and power (Bijker, Hughes, and Pinch 1987; Jasanoff 2004). Second, expertise is a performative social endeavor and ways in which expert status is awarded or contested are highly contextual The boundary work of achieving and maintaining expertise is critical to the scientific project in the process of deciding what does and does not count as a problem for/of scientific or what counts as scientific knowledge, and therefore truth. Third, science and technology are socially situated, developed and enacted by practitioners with their own allegiances, agendas, and socialized natures. As such science and technology both reflect and contribute to wider social conflicts and axis of difference and are inherently political (Goldman and Turner 2011; Haraway 1988; Jasanoff 2004). Fourth, rather than understanding there to be a natural world 'out there' that can be discovered and described by science and acted upon by humans, the world should be understood in terms of networks constituted of bodies that are material, social and discursive, human and non-human, all with their own agency (Latour 1993).

1.3.1 Drawing on STS for new political ecologies

Political ecology and STS have a lot to offer one another in terms of strengthening and broadening their respective contributions and applications, particularly in the realm of resource management. Whereas STS has been effective at questioning the ways in which science about nature is produced, who controls this process, and how this in turn constructs social understandings of the environment, political ecology interrogates how that science is then used in the management and who controls, benefits and loses in the process. Putting each of these to work in environmental management allows us to ask who is making knowledge about the environment, how is that knowledge made, how is that knowledge used and by whom. Similarly, drawing on new materialism affords space for new ways of thinking about the role of non-human and more-than-human actors in shaping environmental outcomes. STS breathes fresh air into a strictly spatial scalar mapping of relationships between actors through topological actor-networks. Yet political ecology prevents a total leveling from taking place by acknowledging flows and concentrations of power (Goldman and Turner, 2011).

1.3.2 Conceptualizing place in STS

Whatmore (1999) offers the framework of 'hybrid geographies' as a response or alternative to the nature/society binary which she contends has characterized the field of geography, as well as environmental discourses. Whatmore adopts a decentered notion of agency that emerges out of networks and interactions to develop a much more relational and enmeshed understanding of the ways in which a host of actants interact and move about in the world. Hybrid geographies are what emerge from these interactions, a kind of new nature in which humans and nature are viewed as always already embedded in the same fabric rather than nature as a place that humans go (Whatmore 1999). Drawing on new materialism, Whatmore (1999, pg. 26) argues for engagements with place that "study the *living* rather than abstract spaces of social life, configured by numerous interconnected agents – variously composed of biological, mechanical and habitual properties and collective capacities – within which people are differently and plurally articulated." Hybrid geographies therefore elaborate Massey's understanding of space as a product of interrelations, inclusive of the human, non-human and more-than-human actants, with a specificity to what are otherwise conceived as 'natural' places.

This 'materialist semiotics' allows for more dynamic understandings of meaning making that go beyond cognitive and linguistic signification to explore the "material processes of inscription" (Knopp 2004; Whatmore 1999, pg. 29). In this understanding of place and agency, "non-human agents are vital to this conception of a network's collective capacity to act because they attach us to one another, because they circulate in our hands and define our social bond by their very circulation" (Latour cited in Whatmore 1999, pg. 28). Network thinking offers an alternative spatial imagination to Euclidian space in that space and proximity are topological, that is to say distance between actors is measured by their location in the networks. This shifts the focus from fixed spaces to "connections, flows, simultaneity, situatedness, contingency and becoming" (Knopp 2004, pg. 126; Müller 2015; Whatmore 1999).

Attributed to Latour (2005), Law (2009) and Callon (1984), Actor-Network Theory (ANT) explores the relationships between all manner of bodies, actors, ideas, objects and elements. While also exploring the many human, non-human and more-than-human actors that make up networks, ANT takes particular interest in the linkages between actors and sees agency as a property of the linkages and networks, rather than of the individual actors (Latour, 2005). Law (2009) maintains that ANT is not a theory but is best understood as descriptive story-telling device for empirical work that is interested in how assemblages form.

Assemblage theory is a product of the post-structuralist thinking of Deleuze and Guattari. Assemblages also refer to the networks, linkages and relationships between human and non-human actors. Although both Latour (2009) and Law (2009) have claimed actor-networks and assemblages are one in the same. Müller (2015) has identified some subtle yet significant differences. Whereas in ANT, actors' power is only realized in and through networks and the act of becoming (e.g. agency is an achievement of the network, not its constituents), the constitutive elements of assemblages possess inherent qualities and potentialities of power and agency external to the assemblages, which influences how they shape the assemblage (Müller 2015). ANT has been described as an "empirical translation of poststructuralism" (Law 2009, pg. 146) and brings to the pairing a set of methods and practices for "tracing associations" (Latour 2005, pg. 5; Müller 2015). Although ANT and assemblage thinking are usually treated as independent intellectual enterprises, putting these frameworks into dialogue would be productive for the ways in which each could draw on and expand the strengths of the other (Müller 2015). For inspiration as to how assemblage thinking and ANT might be applied to an empirical study of human-environment interactions, I look to Laura Ogden's work on the lively entanglements that have constituted what we know to be the Everglades of South Florida. Her book *Swamplife* (Ogden 2011) is a beautifully crafted experiment in landscape ethnography and assemblage thinking. Her tale of the history of the gladesmen boasts a cast of characters including fire, alligators, blood, mangroves and the gladesmen themselves.

1.3.3 Reconceptualizing Fisheries Assemblages

According to the National Marine Fisheries Service (NMFS) a fishery is defined as "a unit determined by an authority that is engaged in raising or harvesting fish" and dimensions that help define the unit include the "people involved, species or type of fish, area of water or seabed, method of fishing, class of boats, and purpose of the activities" (Blackhart et al. 2006, 16). The West Coast groundfish fishery is a complex socioecological assemblage. It encompasses fish species that swim on or near the bottom of the ocean, a few specific pelagic (mid-water) species, humans working on fishing vessels, sea floor ecosystems, and economic infrastructure that supports the fishing industry (Blackhart et al. 2006). The word 'authority' in this definition signals either a management body or body of scientific expertise, which is authorized to define the fishery in questions. Fisheries science is a set of discourses, research practices, and technologies, deployed to assess and monitor the health and status of the fishery, and to inform decisions governing the relationships between its human and more-than-human constituents. Although managers and scientists are clearly integral to the construction of fisheries, they are simultaneously excluded from the social, spatial, and ecological boundaries of the fishery. In other words, in their role as defining authorities, they exist as a "view from nowhere" (Haraway 1988), reflecting and reporting on the objects of their gaze. But as many have argued, science and management are socially situated practices that order, and are ordered by, nature and society through (Jasanoff 2004). Following from this, in this dissertation I adopt a definition of 'fishery' that includes fisheries science-management, as a constitutive part of socioecological entanglements.

I return now to the research questions I outlined at the beginning of the chapter. Fisheries political ecology has given great attention to ways different forms of fisheries privatization has impacted fisheries. I expand this examination to understand the impacts of not just the privatization of fishing rights, but how the privatization of fisheries science. I therefore ask: How has fisheries observation come to be dominated by a private contract research industry? How has the outsourcing of data collection impacted fisheries science-management agendas and fishermen? Drawing on theory from STS which examines the role science and technology in society, and the ways in which technology and science are entangled in relationships of power and the production of nature, I ask: How did digital monitoring technology emerge as an outcome of the privatization of fisheries and fisheries science? And how has digital monitoring reconfigured socioecological relations in fisheries?

1.4 Outline of the dissertation

The dissertation will proceed as follows. In chapter two I will discuss my research methodology, summarizing the methods used for data collection and analysis, and include important dimensions of my positionality as the researcher. Chapter three begins with a brief history of the rise of a fisheries science-management, situating US fisheries policy within global science-management regimes. I focus this discussion with description of the West Coast groundfish fishery, the focus of this case study, and the history of management efforts that have led to the current observing and monitoring programs. In chapter four, I use textual and discourse analysis to examine how 'bycatch' has been constructed as one of the most pressing issues threatening the sustainability of fisheries today. I close with a discussion of how particular discursive framings of bycatch have shaped management interventions. Chapters five and six draw on empirical data collected through interviews and participant observation, as well as analysis of government documents, to develop an ethnography of the science-management assemblage in the West Coast groundfish fishery. Chapter five examines the development and implementation of the fishery observer program and private sector observer industry in the West coast groundfish fishery. Building on the history of the West Coast groundfish fishery laid out in chapter three, I argue that market-based fisheries management strategies, and neoliberal governance more broadly, have incited the development of a neoliberal fisheries science regime. I document the ways in which the roles of state and private entities are reconfigured through the observing and monitoring program, and the impacts this has had on fisheries, fisheries science, and scientists. Chapter six continues this thread by tracing the emergence of an electronic monitoring program in response to neoliberal science-management practices. I reframe this new program as a transition to what I am conceptualizing as a digital environmental governance regime. This reframing complicates previous scholarship on neoliberal science regimes by examining the role of digitality in producing socioecological order. In the final chapter I offer some reflections on the key contributions of this research, and outline areas for future study.

2 Research Design and Methodology

This dissertation develops an ethnographic account of fisheries science-management in the commercial West Coast groundfish fishery, with a focus on the Trawl Rationalization (or Catch Share) program, and associated West Coast Groundfish Observer and Electronic Monitoring (EVM) programs. Geographically, the research is sited in the primary fishery on the West Coast of the contiguous US territory that uses fisheries observers and one of two West Coast fishery currently using electronic monitoring[1]. It is important to note, however, that the nature of fisheries management in the US does not lend itself well to neat, discrete geographic units. Policy is developed through an interplay between state, regional, and federal management bodies; data flows have their own circuitous paths through regional science centers, regional policy commissions, and national and international private third party entities; and most fishermen participate in multiple fisheries managed at different geographic scales (e.g. state and federal), or by different regional management councils (e.g. Pacific and North Pacific). Still adhering to methodological best practices, as will be outlined in the sections to follow, I have attempted to also remain flexible and adaptive, allowing the topological relationships between actors and phenomena to direct data collection rather than bound the empirics according to a preconceived geographic imaginary. Through this topological approach, geographic nodes or clusters of actors or activity have emerged. For example, Seattle, WA and Portland, OR are both significant sites for fisheries science, monitoring, and policy. Similarly, Newport, OR is an important location for fishermen using monitoring technologies. Various sites in the state of Alaska have ancillary significance for secondary fishing income, and through linkages between science, monitoring and policy activities that run parallel to those of the West Coast fisheries.

[1] The Quinault Nation is also piloting electronic monitoring technologies in the commercial Dungeness crab fishery conducted off the coast of Washington.

Although this research focuses on the use of Individual Fishing Quotas (IFQs) for bycatch mitigation and fisheries management, it is important to recognize there are other management methods and logics used in conjunction with or as an alternative to IFQs. The Pacific Fisheries Management Council (PFMC), which is the federally designate management body for the West Coast fisheries, uses Ecosystem Based Fisheries Management strategies in conjunction with market-based management, in order to improve the condition of, or mitigate impacts to marine ecosystems as a broader attempt to improve fish stocks and ecosystem health. The PFMC, has instituted time and area closures for bycatch mitigation, either because the areas are known for their abundance of overfished species (closed as Conservation Areas) or to protect the area's ecological importance as habitat. Although an ecosystems approach and area closures have been accompanied by a host of socioecological implications, analyzing the significance of these measures is beyond the scope of this study which seeks to specifically examine the political economy of scientific approaches associated with market-based management strategies.

Additionally, the research includes a discursive analysis of the emergence of 'bycatch' as a scientific and regulatory object in chapter four. Although bycatch can refer to fish, marine, mammals, sea birds, and other species, I am primarily focusing on the bycatch of finfish in commercial fisheries. This narrowed scope serves the purpose of highlighting the relational and contingent nature of finish bycatch, particularly as a scientific and regulatory object situated and produced through the global capitalist system. This is not to diminish the significance of the bycatch of other species, which are similarly produced through capitalist enterprises, and entangled in complex social, political, and economic networks. Instead my reason for differentiating between bycatches is that while both are contingent, non-finfish bycatch is stabilized as always already negative. In other words, there is never a time when the bycatch of non-finfish species can be leveraged as an economic commodity, nor is there ever an acceptable amount of non-finfish bycatch. Finfish bycatch has a somewhat more complicated set of circumstances in which it can at times be performed as a commodity or when there is an acceptable amount contingent on other economic factors. Therefore, the policies and scientific literature that I review in this chapter center on bycatch with this narrower definition.

2.1 Research Design

This research was conducted in two stages using mixed qualitative research methods. The first stage of research was a textual study of scientific papers, policy documents, and white papers and government reports to understand the production of bycatch, an environmental object in fisheries science-management, through environmental discourse (e.g. managerial, scientific, etc.), and the positionalities and subjectivities that discourse creates. The second stage was an ethnographic study of bycatch monitoring and management programs in the West Coast groundfish fishery, to understand the material-discursive practices through which bycatch is made and the performance and negotiation of environmental subjectivity. I chose to employ a mixed-method research design for two reasons. First, using multiple methods and data types allows for the triangulation of data and is generative of new insights through the integration of complementary research approaches. Second, doing so illuminates the various and always partial knowledges that emerge out of the varied positionalities of different actors, allowing me to engage in more theoretically and empirically productive ways with these different ways of knowing (Elwood 2009).

Researchers in geography and beyond have employed ethnographic methods to examine the social and political processes at work in environmental management (Li 2007; Lien 2012; Ogden 2011). Ethnography draws on extended participation and/or observation in the field allowing the researcher to make sense of the social practices of a community and to understand how people create and experience their worlds□ (Herbert 2000; Watson and Till 2010). Yet, while ethnography has historically implied immersion in a particular culture or place for extended periods of time, increasingly researchers employ a mosaic of qualitative methods (St. Martin and Pavlovskaya 2009). When used to study the management of socioecological systems, ethnographic methods provide a means for excavating the epistemic cultures which structure how we know what we know□ about the environment (Knorr-Cetina 1999) and shed light on how scientific and regulatory practices underpin relationships of power and authority in environmental management (Jasanoff 2004). Examining the 'worlding' practices of ecological science and management, lays bare the messiness of such practices (Law and Singleton 2005) and the ontological politics at play (Mol 2002). While this research can be viewed as an empirical exercise that illuminates the dynamics of management practitioners, the role of the ethnographer can also move beyond that of an observer to include collaboration, co-production, or critical intervention (Woelfle-Erskine 2017). Ethnography gives insight into the lived experience of actors enrolled in science-management assemblages, and the emergence of environmental subjectivities in relation to particular socioecological, political, and economic systems (Agrawal 2005; St. Martin and Pavlovskaya 2009).

In addition to studying the ways in which scientists, managers, and other human actors perform nature, ethnography can also illuminate how non-human actors perform natures. In chapter four, I examine the ways in which bycatch is performed by policy and other texts (Asdal, 2012; Sridhar, 2017) and in the concluding chapter I reflect on what new natures are performed through digital monitoring technologies. Subfields such as critical policy ethnography (Dubois 2017) excavate the ways in problems and subjectivities are performed through policy and its implementation, whereas multispecies ethnography (Helmreich and Kirksey 2010, Odgen et al.2013) decenters human perspectives to understand the relational practices through which humans and non-humans *become with* each other.

2.1.1 Critical Discourse Analysis

This study examines both the discourses about bycatch and EVM technology as well as the lived experience of those whose lives are entangled with these objects. Discourse is a particular kind of language about the world that reflects and shapes social processes and individuals' interactions with society and the world. Discourse can be a form of specialized language produced and circulated according to the conventions of particular societal institutions, scientific or regulatory discourse for example, shaping the social (and ecological) spaces those institutions occupy, and producing subject positions in the process (e.g. scientists, law makers, fisheries) (Jaworski and Coupland 2014; Nead cited in Rose 2007). Therefore, it is critical to study material experiences of actors within the contexts of the discursive process in which they are embedded because these are so deeply intertwined.

Adopting a Foucauldian understanding of power moves beyond a unidirectional top-down approach that sees power as being exerted by the state onto fisherman and the environment. Instead, power is understood to be enacted as the disciplining of bodies through discursive practice; subjects, "objects, relations and places" are all produced as are their "ways of thinking and acting" in the world (Rose 2007, pg. 143). To analyze "the ways knowledges are produced, legitimated, and maintained through discourse/discursive practices" I examined the co-production of fisheries science and management as a power/knowledge assemblage and the biopower they enact (Clarke 2005, pg. 150; Foucault 1977). This reframing interrogates how truth claims are constructed and circulated and their significance in producing and maintaining the dominance of scientific and regulatory discourses as regimes of truth (Rose, 2007). By using the groundfish fishery, and the observing and monitoring programs as the site for my analysis, I lend empirical heft and nuance to my reframing of fisheries science-management as a biopolitical project. As Cavanagh argues:

> any given form of governmentality, environmentality, or biopower is constituted in historical- geographical context, and therefore must be empirically and *inductively* analyzed on that basis… it seems pertinent to reiterate that the development of such typologies of environmentality or biopower should not come at the expense of 'efforts to analyze empirical actuality', the messiness of which may occasionally elude tidy categorization even in the form of apparently intersecting 'multiple environmentalities.' (Cavanagh 2018, pg. 412)

2.1.2 Document Analysis

The first phase of research consisted of two steps: 1) document analysis to develop a biographical account of ‘bycatch’, 2) critical discourse analysis to develop an ethnographic account of ‘bycatch’ by understanding the material-discursive practices which produce bycatch in relation with other environmental subjects and political-economic systems. The dual accounts of bycatch reflect a conceptual framework that understands bycatch as both a scientific and regulatory object and more-than-human being engaged in relational process of becoming with other environmental actors.

Text documents are excellent artifacts for contextualizing phenomena within their social and historical moments, and can demonstrate the social processes that contributed to their production (Clarke 2005, Dittmer 2009). This phase of research was instrumental in understanding: 1) the multiple, contextualized definitions of bycatch as they appeared in regulatory and scientific contexts, 2) problem and solution framing: who or what is causing the problem and when and how science is called upon in policy, and vice versa, to ‘solve’ the problem of bycatch 3) the evolution of bycatch mitigation, and its relationship to discursive framings (as outlined in 3), 4) the debates and controversies surrounding bycatch, its monitoring, measurement, and regulation. Examining both policies and other textual documents allows for an intertextual discourse analysis across various discursive objects clarifying how they relate to one another in discursive formations and how they operate within knowledge/power assemblages (Rose 2007). Discourse analysis was used to unveil the institutional apparatuses and technologies which operate to co-produce and maintain relationships of authority between fisheries science and management.

The textual analysis surveyed governmental documents including national and international (United Nations) fisheries-related policy, and other governmental documents including reports, white papers, communications materials, congressional hearings, and the Federal Record. A second survey was done on the scientific literature on bycatch, including conference proceedings. These documents provided important historical and sociopolitical context to narrate the emergence of 'bycatch' as an object of fisheries science-management (Hoefer 2011). Drawing on insights from multi-species ethnography, I treated documents as key informants. I began with a purposive sampling strategy, and then proceeded with a snowball sampling pursuing secondary documents that my key informants referenced. For policies, I began with key national and international legislation including the primary federal fisheries legislative instrument the Magnuson-Stevens Act (MSA), the West Coast Groundfish Fisheries Management Plan, and international policies from the United Nations, and looked for the key words 'bycatch' 'discards' and 'incidental catch'. I also reviewed polices and reports that dealt specifically with bycatch. I reviewed the Federal Record with a targeted search using the aforementioned key words or by date to find records associated with historically significant proposed rulings. Congressional hearings were purposively sampled through a search for the keyword 'bycatch'.

To locate scientific documents, I determined my key informants through an initial Google Scholar search for 'bycatch'. I purposively sampled by analyzing documents with the highest citation counts or with the earliest publication date to locate bycatch in history. I then used snowball sampling by locating the documents and authors most cited by my key informants, and to map the networks of actors and overlapping social spheres involved in bycatch science and management. A reverse citation search allowed me to track bycatch in the scientific literature over time. I reviewed more than 50 documents for this stage.

2.1.3 Archival Research

To provide important historical background and investigate the processes, reactions, and connections that assembled the current fishery science-management regime, I conducted an archival analysis examining fisheries management reports, internal and external reviews, communications materials, websites, technical reports, workshop proceedings, white papers, scientific papers, and industry magazines. I conducted research in person at the Northwest Fisheries Science Center library and through online research. For this stage I synthesized more than 70 individual documents that either addressed the groundfish fishery, EVM, or the observer program.

2.1.4 Interviews

The fieldwork phase of the research employed semi-structured interviews and participant observation. Interviews provide a means for discovering and describing the experiences of actors. I conducted 42 interviews with 40 different actors involved in all aspects of the observer and/or EVM programs on the West Coast. To better understand the network of actors involved, I've developed a typology of actors based on the ways in which they engage with the programs and/or technology. Table 1 provides a summary of the typology and the criteria used to define each type. I've also included the number of actors interviewed from each category, but it is important to note that the types are not mutually exclusive and so an actor may be classified in multiple ways. For example, a fishing industry professional may also be involved in a council working group or advisory committee, so they would be included in the counts for categories 1 and 5. Similarly, a program administrator may also be working in data analysis, research design, or data management, counting them in categories 4 and 6, or they could be serving in more of a person or program management or communications capacity in which case they would only be in category 6.

Table 1: Criteria for interview recruitment

Population	**Number of Interviews**	**Criteria**
1. Fishing Industry Professionals	11	1. Experience using EVM technology onboard a vessel they operate, own, represent, or crewed on 2. Chose to 'opt out' of using EVM technology 3. Representative of a fisheries professional association
2. Onboard Observers	9	1. Experience working in the West Coast or Alaska observer programs
3. Scientists and Researchers	8	1. Experience working with the Observer and/or EM programs 2. Participation on commission working groups or on research studies commissioned for EM and Observer programs
4. Data and Technology Professionals	8	1. Employees of an EVM technology companies involved in program development 2. Staff or contractors who work with EVM data storage, analysis, and reporting for government.
5. Managers and Council Representatives	8	1. Representatives that sit on the PFMC or NPFMC, or sit on a relevant advisory panel, working group, or subgroup

6. Administrators	8	1. Work in some aspect of program administration or development for the EVM or Observer programs at regional or national level.
7. Non-Profit Sector	1	1. Involved in EVM program through public/government partnership or council process

2.1.4.1 Recruitment

I identified my first round of interviewees using purposive sampling. Conducting a targeted search for individuals involved in advisory and working groups associated with the groundfish fishery and other regional and national management bodies involved in the observer program and EVM, I sent introductory emails explaining the research project and inviting them to participate in an interview. I then proceeded with a snowball sampling method in which informants referred me to individuals whom they perceived to be key informants or significant actors in the network. As noted in the scope of research, although the case study has a distinct geography, the West Coast groundfish fishery, actors are networked across space through both topological and geographic relations. Therefore, my 'field site' was not bounded by a discrete geographic location. Despite this point, there do exist geographic nodes of activity and to the extent my resources permitted I conducted field research in those locations. This included a fieldwork trip to Portland, OR and Newport, OR. Portland is home to a data analysis center, where I was able to conduct in-person interviews and participant observation, which will be summarized in the next subsection.

Newport is home to large fleet of fishing vessels that use EVM technology and is a hub for observer activity. I spent a week at that field site recruiting fishermen, conducting interviews, and developing observational knowledge of fleet characteristics and community dynamics. Prior to my arrival, I had several leads on potential interviewees, but once on site I recruited additional participants by intercepting fishermen while walking the commercial fishing docks, screening them as to their knowledge and experience with EVM, and then inviting them to do an interview if they met participation criteria.

Observers were recruited by two methods. First, I posted a study recruitment call in the Association of Professional Observers Facebook group. This organization is operating as an advocacy group for observer rights and safety. They are international in scope, although it primarily focuses on issues facing US observers, and is not affiliated with any governmental or private observer agency. The second method for recruitment was a call for participation printed in the NMFS quarterly observer newsletter. In both recruitment advertisements I provided personal contact information for the observers to reach me, and I indicated that their participation would be anonymous if they so preferred.

2.1.4.2 Interview Procedures

Spradley (2016) outlines three primary categories of interview questions: 1) descriptive questions which allow the interviewer to build a repertoire of the informant's language, 2) structural questions which shed light on how respondent's organize their knowledge, and 3) contrast questions which provide insight into the meaning of various objects and ideas and how the respondent distinguishes between them. Drawing on this conceptual framework, I developed an interview protocol template, that included questions from each of Spradley's categories. Questions were organized according to four thematic or topical areas 1) Practices of informant's work, 2) Observers and EVM in Programs 3) EVM in Practice, and 4) Impacts of EVM. From the template I developed two protocols, one for fishing industry professionals and one for managers/program admins/scientists, that adapted the language to be relevant to their industries. Each interviewee was also asked to define 'bycatch' as it pertained to their orientation within the capitalist fisheries system and science-management assemblage. Interview protocols are included in Appendix A.

Of the 42 interviews, 28 were conducted over the phone. This was due in part to the geographic distribution of my informants. Two of the interviews were follow up interviews, and I conducted two group interviews (two and three people each). All but two interviews were audio recorded, and in the case of one of the group interviews, the interview was only partially audio recorded due to technology failure. Although the study was determined as exempt by the University of Washington Institution Review Board, interviewees underwent a process of either written or verbal informed consent. I provided the interview protocol in advance for those who wished to see it. In-person interviews were primarily conducted in either the person's office or fishing vessel, although four interviews were conducted in a public location such as a coffee shop or restaurant.

2.1.5 Participant Observation

In addition to semi-structured interviews, I conducted participant observation in 2017 and 2018. This included: attending in-person and via conference call working group meetings and ad-hoc committee meetings for EVM and the Groundfish management (both the PFMC and the North Pacific Fishery Management Council), attending presentations on EVM at the 2018 American Fisheries Conference, attending a regional fisheries management council meeting, visiting an EVM data analysis center, and attending relevant talks on observers, groundfish management, and EVM at the School of Fisheries at the University of Washington and at the Northwest Fisheries Science Center. This method allowed me to "participate in the everyday worlds, spatial processes, and place-making practices" of informants and provides better insight into the unconscious 'doings' of actors and their lived experiences (Watson and Till, 2009, p. 126). Participant observation at meetings provided crucial data about who speaks, what exactly is said, affect, spatial arrangements amongst participants, expression, and body language, none of which can be garnered from official public meeting text records or audio recordings (when available). Meetings are attended by a diversity of actors including scientists, policy makers, technology manufacturers, fisherman and fishing industry representatives, and fishing dependent community members, making them a crucial site where power and knowledge are produced, contested, and circulated. Observing the nuances of communication occurring at these meetings helped to uncover interpersonal dynamics and trace the flows and concentrations of power between actors. Field notes were taken either on notepads, as audio recorded voice memos, or on my laptop during and after participant observation sessions. Photos were taken when taken when permitted, although the confidentiality of some of the subject matter limited my capacity to take images in some cases.

In spring of 2018 I visited an EVM data analysis facility, where analysts walked me through the process of reviewing EVM hard drives, and annotating the images. I observed data review for three different kinds of vessels, and the reviewers described the various kinds of discard events that might happen, while also comparing the experience of reviewing EVM videos to their experiences as observers. In the fall of 2018, I attended the September Pacific Fisheries Management Council meeting. I sat in on council process for two days, attended working group and advisory panel meetings, and conducted interviews. Talks and presentations were attended opportunistically, for example I attended the 2018 American Fisheries Society meeting for an unrelated project, and to present preliminary results. This afforded me the opportunity to meet and observe EVM scientists and practitioners presenting on their research, in other words performing their roles as EVM scientists.

2.1.6 Data Analysis

Data was analyzed using a grounded theory framework, and tools from situational analysis more specifically (Clarke 2005, Glaser and Strauss 1967). Grounded theory is both a systematic and creative analysis procedure that allows the researcher to develop theories from patterns and themes that emerge from the observational data (Babbie, 2011; Glaser and Strauss, 1967). Grounded theory offers flexibility and adaptability in exploratory research, where little is known about the topic (Babbie 2011). The study design was well suited for this type of analysis because it employs a variety of observation techniques and the data capture multiple viewpoints. Situational analysis is the most suitable for exploring the multiple and varied perspectives present in the case study because it "provides a means of analyzing the situatedness of less powerful actors and the consequences of others' actions for them and raises issues of discursive constructions of actors and of nonhuman actants." (Clarke 2005). Situational analysis and grounded theory are relational modes of analysis in that data collection, coding and memo writing are conducted simultaneously and as an iterative process. The approach is meant to be generative and therefore done in conjunction with additional memoing, following the precepts of grounded theory.

2.1.6.1 Textual Analysis

Text documents underwent three stages of analysis. Preliminary analysis of the documents employed loose coding according to an open coding process in which patterns and themes were allowed to emerge but I made little effort to organize or structure relationships between code categories. I then refined the coding schema and developed thematic categories based on the discursive formations in the documents and emerging through interview memoing. I then completed a second review and granular coding of the documents in the coding program Atlas.ti.

During a third review of the documents I performed axial coding, to bring out the relationships between codes and code categories, to highlight broader discursive themes, and record more pragmatic historical information and narrative context.

2.1.6.2 Interview and Participant Observation Analysis

Interview audio recordings were transcribed using the online transcription service TEMI. Audio transcriptions were coded using a simplified coding schema developed from themes that emerged during data collection and from the textual analysis coding stage. Throughout the process, I engaged in creative and traditional methods of memoing, including situational mapping and narrative description (Babbie 2011, Clarke 2005). Emergent codes and themes directed further sampling, both in the textual analysis and interview stages (Glaser and Strauss, 1967).

2.2 Researcher Positionality

It is important to make note of several dimensions of my experience and positionality that have shaped the research both conceptually and materially. First and foremost, the idea for this project is situated in my experience as a fisheries biologist, employed for four years in the Southeast fisheries management region of the US. My role was the equivalent of a shoreside fishery observer in recreational fisheries. I was a contract work, contracted directly by a state science-management institution. While working in the field, I encountered deep skepticism and conflict between the fishing and the science-management communities of the others' motives and intentions. I too felt deeply conflicted about my role, and the seeming double standard of expectations for scientific rigor, and institutional impotence. In other words, my role as a 'scientist' meant I was accountable to high standards of data collection and accuracy, yet the agency invested very little effort in actually developing my scientific knowledge. Rather than informing us about the nuance of how our data was used, they instead resorted to giving us generic laymen's science communications messaging to repeat to the public. Similarly, I saw confusion amongst the public as to whether we, as state fish and wildlife representatives, were acting in a scientific, surveillance, or enforcement capacity, and I watched my peers manipulate this confusion and fear to suggest public participation in data collection efforts was compulsory. Further, similar to many observers working in commercial fisheries I experienced precarity, vulnerability, and normalized violence and harassment (levied by both recreational fishers and my male peers) as a female contract worker. These experiences sowed the seeds for the intellectual curiosities that motivated this project.

During the course of this research, my positionality as a graduate student at the University of Washington (UW) also shaped study recruitment and therefore data collection. The UW is home to two prominent fisheries research programs, the School of Fisheries and the School of Marine and Environmental Affairs, which have made the university a significant force in both national and regional fisheries science-management circles. Although I was clear with my informants that I was located in the department of Geography[2], with peripheral connections to the School of Marine Affairs, it was clear that my position as a fisheries focused researcher at the UW afforded me access and/or trust amongst fisheries scientists and managers.

Additionally, while undertaking fieldwork for this project I was employed as a research assistant for a collaborative project between scientists at Washington Sea Grant and the National Marine Fisheries Service Northwest Fisheries Science (NWFSC), funded through the National Science Foundation. The portion of the project I worked on was a qualitative study of the impacts of climate change on West Coast fishing communities, and community strategies for

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[2] Although my home department is Geography I have worked with faculty in the School of Marine and Environmental Affairs, including coursework and have two faculty members on my dissertation committee from that department.

adaptation. While recruiting and conducting interviews for that project, I was also able to recruit fishermen for my dissertation research. Additionally, professional relationships formed through that project led to informational interviews, which informed my research.

Throughout this dissertation, I have theorized and documented the formation particular environmental subjectivities, such as ‘researcher’ or ‘scientist’, and the ways in which these subjectivities are performed through the practices of science and EVM. I would be remiss were I not to also acknowledge the ways in which this study has shaped me as an environmental subject in the fisheries science-management assemblage. For example, my roles as an interviewer and participant, even if ephemeral, bring questions to the conversations and performances in place that reflect my own situatedness, practices of science, and intellectual heritage. Inevitably through this work my participants and colleagues have inquired as to my stance on EVM and fisheries management more broadly, and as I’ve formed and reformed those positions I also position myself in relation or opposition to existing institutions and practices. So too, this research ‘does’ fisheries in a way that is informed by my subjectivity and positionality as a researcher, as a critical social scientist, as a science studies scholar, and as a geographer. As such, it carries with it the potential to shape environmental governance, though it is my ambition that this work will inform or at least inspire alternatives to the status quo.

3 Getting to Know the Fisheries Science-Management Assemblage

No matter the technology of governance employed, fisheries managers are under mandate to develop policies grounded in science with the intent that the fishery be fully exploited while still holding at sustainable levels. In this regard, fisheries science has always been in the service of the capitalist fisheries system, and fisheries science and policy have evolved to co-produce the legitimacy and power of one another. As such, one might assume that science produced under a particular management regime would be shaped by, and in turn shape those management strategies. In this chapter I will briefly summarize the industrialization of fisheries over the last century and the history of fisheries science and management as realized in the Global North. This will serve as a backdrop for the case study through understanding the historical entanglements and configurations of science and management, as they have co-produced one another. I will then move to the specific case study of the project, the West Coast Groundfish Fishery, and track the evolution of the fishery as a commercial entity. The focus of this study is on the trawl rationalization program, a market-based management strategy that came about in 2011. I will describe the shifting management regimes and socio-ecological relations, which have led to the fisheries current science-management assemblage.

3.1 The Co-Production of Fisheries Science and Management

Fisheries biology emerged as a disciplinary field in the early 1900s. Lave (2012) locates the professionalization of science more broadly in the mid- to late- 1800s, noting the rise of university degrees in the sciences, and scientific professional societies and journals. Professionalization becomes a mechanism for the Orientalist racial project of Western, white dominance, as knowledge produced through professional science became a site for exclusion in terms of production access (Lave 2012). International collaborations on ocean and fisheries science began with the establishment of the International Council for the Exploration of the Sea (ICES) in 1902. Member countries were historically, and continue to be, situated in the Global North and the nascent organization's member countries consisted of Russia and five European countries. The US joined ICES in 1912, and in 1930 established the Woods Hole Oceanographic Institute (WHOI), a still prominent center for oceanographic and fisheries research, with the hopes for a niche for the US in the growing "world-wide program of Oceanographic Research" (WHOI n.d.). Although the imaginary of a 'global ocean' had taken hold in the minds of scientists, knowledge about the ocean and exploitable ocean resources demonstrated the uneven geographies of ocean knowledge politics.

According to Hubbard (2014) international collaborations through institutions such as ICES were instrumental in securing research funding from governments, and as such were motivated to serve political ends. In the early years, scientists worked with the aim of modernizing and industrializing the fishing industry. They did so through survey studies to improve knowledge about profitable species so that fishermen could more effectively exploit them and through the development of hatcheries (Finley 2009, Hubbard 2014). The field of fisheries biology slowly grew, but World War II proved a pivotal moment for the professionalization of fisheries science.

Fisheries scientists had been essential in early fisheries commission work that sought to support the fishing industry, yet it was not until after the war that national and international management treaties mandated fisheries science be thoroughly developed for the purpose of informing management decisions, in other words in service of conservation goals. For example, in the 1982 United Nations Convention on the Law of the Sea (UNCLOS), states are charged with maintaining or restoring their fish stocks to a level of harvest with maximum sustainable yield (MSY) and doing so under the guidance of the "best science available." (UN General Assembly 1982).

By the 1950s the discipline underwent what fisheries science expert William Royce describes as a period of professionalization, motivated by political concerns. According to Royce, post-war fisheries research in the U.S. was driven by a growing environmental ethic and public support of conservation research. In a lecture given at the Fisheries Centennial Celebration Royce notes,

> "I define fishery science as a public-service profession that includes management activities, and not just as the pursuit of scientific knowledge about the fisheries" (https://www.nefsc.noaa.gov/history/stories/fsh_sci_history1.html)

This statement demonstrates a culture developing that understands the role of scientist' as enmeshed with that of the politicized role of manager. Despite these blurred boundaries, Royce argues elsewhere that the various social, political, and economic dimensions of fisheries meant that scientists and managers faced very different kinds of challenges. He notes specifically the highly politicized nature of management, implying that the experience of scientists was less fraught with the concerns for sociopolitical outcomes, they merely needed to "approach the scientific problems one by one". He goes on to state:

> whereas the managers faced the overall challenges of making decisions about a complex human activity with the help of a few facts about the fisheries. The researchers had time and isolation; the managers had deadlines for decisions in a political arena" (NOAA NEFSC n.d.).

Similarly, a report by the FAO echoes the apolitical rhetoric of science, while also promoting scientific virtues of accuracy and precision. It is the job of the scientist to render the environment knowable, which allows the manager to render it manageable:

> The fisheries scientists present their data to the commissions but the scientists do not make the final decisions upon regulations. These are made by administrators and politicians both of whom take account of national as well as international interest. It has

> been a feature of regulations within fisheries commissions that short-term national interests tend to outweigh longer terms, or international interests. This tendency is increased if the scientific advice is uncertain or inconclusive…
>
> Thus the fisheries scientist not only has his responsibility to collect data so that he can advise but also the responsibility to collect his data in the best possible manner so that he can advise with confidence and precision. (Holden and Raitt 1974).

The variations in discourse suggest an anxious, if not schizophrenic relationship, between science and management. Some have argued that it was precisely because of the political significance of science, that these artificial boundaries are upheld (Finley 2009, 2011; Finley and Oreskes 2013; Hubbard 2014). In examining the history of MSY in fisheries management, Finely and Oreskes (2013) demonstrate how such a scientifically vacuous and disputed model (Larkins 1988) for understanding fisheries came to be the dominate management technology in the Global North. The concept played an important role in geopolitical agendas, yet upholding a view of Western science as apolitical 'facts' about the environment became justification for using science to serve political ends.

3.2 Industrialization of Fisheries

The rapid industrialization of commercial fisheries during the years following WWII led to more frequent, unintentional, and sometimes fatal encounters between marine species and fishing gear. Although releasing fish was not a new phenomenon, the rate at which it had been happening reached unprecedented levels. A confluence of factors made fishermen more effective, while simultaneously creating conditions that made it either illegal or impractical to keep all of the fish they caught. Technological developments made it easier to find and catch fish in greater volume although with less species selectivity. The advent of refrigeration had profound impacts on commercial fishing and the consumer market. Being able to keep fish cold onboard boats meant fishermen could make longer fishing trips and target more distant waters. It also opened up new markets through refrigerated transportation and paved the way for food inventions. Equipping fishing boats with refrigeration allowed for at-sea processing which allowed for new kinds of product and utilization innovations, invention of the fish stick for example.

As was the case with agriculture, wartime innovation revolutionized the commercial fishing industry (Clapp 2012). Advances in oceanography improved our understanding of fish and their environments, and technological improvements in navigation and sonar carried over to the commercial fleet. The war also had devastating effects on many fishing fleets. Fishing boats were often recruited for wartime efforts and battles brought damage leaving the fleet in vast state of disrepair. Fisheries had also suffered impacts from war at sea, although this is less well understood. With the end of the war, many international postwar governments began directing government subsidies towards rebuilding their fishing industries by updating vessels and improving fishing technology. Developing the fishing industry proved an efficient mechanism for economic development by creating jobs in coastal areas through boatbuilding and producing an export commodity in the form of fish. In the 1960s, updated international fishing vessels began to outpace their aging US counterparts in production and seafood imports began to increase (Hanna 2000). In response, the US set out to "Americanize" the fisheries through policy and regulation to prevent what was perceived to be overexploitation of national resources by foreign fleets.

3.3 Fisheries Management Regimes

As fisheries industrialized, there was growing concern amongst government officials about the impact of increased capitalization on fish stocks. In the US, the first steps towards developing a fisheries management apparatus was the establishment of the U.S. Commission on Fish and Fisheries in 1871 in response to declines in Northeastern. Yet, according to Fredin (1987) there was not consensus as to whether the Commission's role was to make and enforce regulation, or merely to act as an advisory body. The first Commissioner, Spencer Baird's approach to management was to direct public spending on restocking fish to provide a food source, rather than restricting access to the extant though dwindling fisheries (Fredin 1987).

The U.S. Commission on Fish and Fisheries was eventually reorganized as the US Bureau of Fisheries under the purview of the then new Department of Commerce and Labor in 1903. Up to that point, the Department of the Treasury, not the Commission, had overseen commercial fishing activity in the Alaskan fisheries through tax revenues. What few regulations that were passed by Congress pertaining to the Alaskan fisheries were almost exclusively for salmon, and groundfish fisheries went more or less unregulated. When the US Department of the Interior was created in 1939, the Bureau of Fisheries was transferred to their umbrella and later merged with other scientific units to form the US Fish and Wildlife Service. The US Fish and Wildlife Service established a Bureau of Commercial Fisheries to oversee fish stocks and fisheries research.

Although individual nation-states had taken measures to manage fish stocks within their territorial seas (three miles from shore), it was not until the mid-20th century that we see the beginnings of a global management regime. The move towards international oceans and fisheries management was an economic and political project, as much as conservation measure. The oceans were becoming an important site for geopolitical debate as fishing vessels were a vehicle for advancing territorial claims (Finley 2009). In response to the increased ability of fleets to travel great distances from their home ports, many countries, began declaring sovereign rights over what came to be known as the Exclusive Economic Zones (EEZ), the area 200 miles beyond their coastline under the ocean and the resources that lay within those bounds. The

Truman Proclamation of 1945 was one of the first and most significant public national statements. The Proclamation states that:

> having concern for the urgency of conserving and prudently utilizing its natural resources, the Government of the United States regards the natural resources of the subsoil and sea-bed of the continental shelf beneath the high seas but contiguous to the coasts of the United States as appertaining to the United States, subject to its jurisdiction and control (Truman 1945a, Proclamation 2667 1945).

Truman issued a second proclamation that dealt specifically with fisheries stating:

> In view of the pressing need for conservation and protection of fishery resources, the Government of the United States regards it as proper to establish conservation zones in those areas of the high seas contiguous to the coasts of the United States wherein fishing activities have been or in the future may be developed and maintained on a substantial scale. Where such activities have been or shall hereafter be developed and maintained by its nationals alone, the United States regards it as proper to establish explicitly bounded conservation zones in which fishing activities shall be subject to the regulation and control of the United States (Truman 1945b, Proclamation 2668 1945).

According to Finley and Oreskes (2013) the proclamations' unstated aims were to limit Japanese fishing in the Alaskan salmon fisheries. At the same time, the proclamation asserted US claims to high seas territory paving the way for a strong US presence in the Pacific. Although the proclamation worked to appease the concerns of the salmon industry, it had the unintended consequence of contradicting the agenda outlined by fisheries managers overseeing the tuna industry which was heavily dependent on baitfish caught off Latin American coasts (Finley 2009, Finley and Oreskes 2013). Soon after the proclamation was adopted, many countries in the Global South began claiming sovereign control over the EEZs.

In 1958, the first UNCLOS took place in Geneva, resulting in four conventions, which establish a legal framework for maritime activities (Nandan 1987). It was not until the third UNCLOS in 1982 that the international regulatory framework formally conferred on coastal states the exclusive rights to control and exploit the resources within the EEZ, also mandating the management of those resources, although many states had already staked claim to their EEZs through national management instruments.

In the US, the establishment of the National Oceanic and Atmospheric Association (NOAA) in 1970 brought oversight for commercial fisheries back under the Department of Commerce as the National Marine Fisheries Service (NMFS). Just six years later, the Fishery Conservation and Management Act was enacted as the first piece of federal legislation governing marine fisheries, and the first US law to extend federal jurisdiction over the EEZ (200 nautical miles off the coast). The act was amended and reauthorized in 1996 (Sustainable Fisheries Act) and in 2006 as the Magnuson-Stevens Fishery Conservation and Management Act (MSA).

The MSA set the framework for national fisheries management by establishing eight regional fishery management councils, which develop regional fishery management plans through criteria outlined in the act through a set of national standards. The national standards aim to preserve fishery and marine ecosystem health while still maintaining healthy and economically profitable fishing industries and communities, through regulations with minimal expense and impact. Yet, despite this commitment to reducing the burden of environmental management, fisheries have undergone an increased bureaucratization and scientization of policy, resulting in oftentimes expensive, contradictory, and contentious policy outcomes (Weingart 1999).

For example, national standard two mandates that conservation and management decisions be based on the best scientific information available and be politically neutral. While admirable, such aims ignore the highly politicized nature of science. Science is a socially situated practice, enacted by practitioners with their own allegiances, agendas, and socialized natures. As such, science reflects and contributes to broader social conflicts and axis of difference (Goldman and

Turner 2011; Haraway 1988; Jasanoff 2004; Mitchell 2002). Further, national standard eight mandates that, to the extent practicable, fishing regulations consider and minimize negative social and economic impacts on fishing communities. Not only are social and economic impacts inherently political, creating an incompatibility between the two standards, but NS8 acknowledges that science-based decisions, in which science trumps all other considerations, has direct social and economic impacts for commercial fishers and fishing dependent communities.

Although what I have outlined is the development of a global management regime and the emergence of the US fisheries management body, it is important to note that fisheries management occurs a range of geographic scales (e.g. global, national, regional, community, etc.) and through a variety of instruments and apparatuses. Top-down management apparatuses administered through government can include market-based strategies or enclosures. Market-based management strategies are predominantly found amidst management regimes in the global North. Whereas artisanal, small-scale fisheries and fisheries of the global South have historically been managed through open-access, community-based strategies. In some places there has been a shift towards hybrid co-management approaches in which the state and fishermen or fishing communities share responsibility for management, for example in the state of Washington some fisheries are co-managed by state, federal, and tribal entities.

3.4 History of West Coast groundfish fishery

As previously discussed, in the post-war years of the mid 20th century the US government sought to develop and industrialize the domestic fishing fleet. The West Coast groundfish industry was one of the fastest growing in the US and "this 'race to fish' led to dramatic overcapitalization and a situation in which technology was outpacing regulations" (PFMC and NMFS 2017). The complexities of the groundfish fishery will be discussed in greater detail in the coming sections, but for now it is useful to differentiate between two species sectors: the whiting and non-whiting groundfish fisheries[3]. Between 1970 and 1990 the number of fishing vessels participating the groundfish fishery nearly doubled (286 in 1977 to 472 in 1979). Despite a marked increase in fishing capacity, there were mixed results for actual landings. Catch of Pacific whiting increased by a multiple of a thousand whereas non-whiting groundfish catch peaked in 1983, after which point the fishery declined in both catches and revenues. Shaw and Conway (2007) attribute the decline in fishery production to both the increase in fishing capacity, as well as environmental changes resulting from a series of five extreme El Niño events, which impacted fish migration patterns, growth rates, and mortality. The El Niño's of 1982 and 1997 were two of the strongest on record, and the 1982 event in particular resulted in home and vessel losses amongst fishermen due to financial strain (Shaw and Conway 2007).

Geopolitical factors have impacted the fishery, leading to increased pressure. The passage of the MSA was intended as an effort to "Americanize" US fisheries by reducing the number of foreign fishing vessels exploiting the fisheries within the EEZ (200 miles from shore). On the West coast, the Pacific whiting fishery, first developed by the Soviet Union in the 1960s, had been almost exclusively pursued by foreign vessels. Whiting is a high volume (and lower price) species that is primarily processed at sea on large 'factory' vessels. Soon after the MSA passed, there was a significant decline in the presence of foreign fishermen, who were eventually completely displaced by US fishermen in 1989. Although federal fisheries regulation set out to prioritize access and revenues for US fishermen, the US had not yet developed adequate at-sea processing capacity, nor were there enough shoreside processors for the whiting fishery. In 1978, the US piloted a 'joint venture' program in which US vessels caught fish, which they delivered to

[3] Whiting is a whitefish predominantly found in pelagic waters and targeted as a single-species fishery with midwater trawl (net) gear. This differs from other species in the groundfish fishery which are targeted as species complexes and which are caught with bottom trawl gear, pot traps, or hook and line gear.

foreign factory boats for at-sea processing. The joint venture program continued until 1991 when a US at-sea processing fleet entered the fishery and, with a more-developed shoreside processing infrastructure, took over all processing of US whiting, and making the fishery an entirely domestic venture.

The Pacific Fisheries Management Council (PFMC or 'the Council') established the first Pacific Coast Groundfish Fishery Management Plan (PCGFMP) in 1982, which has since been amended 33 times. The FMP identifies more than 90 species and outlines specifications for their harvest and conservation. Groundfish are defined by the PFMC as fish that, "with a few exceptions, live on or near the bottom of the ocean" including species of rockfish, flatfish, roundish, sharks, and skates (https://www.pcouncil.org). The plan outlines which species and areas are to be managed, the regulations for how to manage those species, and the methods and processes that regulatory bodies must follow for setting rules and catch limits. The PCGFMP's geographic scope extends along the US West Coast from Washington to California, beginning at state water boundary (three-miles from shore) and continuing to 200 miles offshore (the EEZ). In the US, fishery managers use a variety of techniques to manage fishing effort and harvest such as guidelines for fish that are harvested (e.g. length), time and area closures, individual quotas, restrictions on how many fish can be landed by a vessel or in a fishing trip, and restrictions or specifications for fishing gear. Prior to establishment of the PCGFMP, individual states had been responsible for managing the fisheries off of their coastlines. At the inception of the PCGFMP, as evidenced by the rampant increase in vessels, management was primarily conducted through restrictions on gear and amount of fish harvested and little attention was paid to the number new fishers entering the fishery. Internal reviews of the management plan describe groundfish management as "moving from a fishery characterized by high discards and expanding catches and capacity through various initiatives aimed at reducing fishing capacity, and, finally, through the transition to catch shares." (PFMC and NMFS 2017, 2-1).

3.4.1 Fishing Sectors

The current groundfish fishery is divided into five different 'sectors' or regulatory types (Figure 1): limited entry trawl, limited entry fixed gear, open access, recreational, and tribal. Each of these sector designations indicates a distinct set of management measures, gear types, and intended use. Once the PFMC determines the annual catch limits of the various groundfish species, these limits are allocated by sector. Allocations can be coast-wide or subdivided by geographic area.

Limited Entry Fisheries – vessels registered to a federal LE groundfish permits.

Trawl - At-sea Pacific whiting cooperatives:
- *Catcher/processor cooperative*
- *Mothership sector cooperative*

Trawl - Shorebased Individual Fishery Quota (IFQ) program:

Fixed Gear
- *Sablefish tier limit fishery*
- *Limited Entry Fixed Gear (LEFG) trip limit fishery*

Open Access Fisheries
- *Directed OA*
- *Incidental OA*

Tribal Fisheries
- *Pacific whiting midwater trawl*
- *Non-whiting midwater trawl*
- *Bottom trawl*
- *Fixed gear*

Recreational Fisheries
- *Commercial Passenger Vessels*
- *Private Party Vessels*

Figure 1: Fishery sectors, permit requirements, gear, and fishing strategies under the Pacific Coast Groundfish Fishery Management Plan 2016

In 1991, the Council amended the PCGFMP to create a limited-entry sector, which went into effect in 1994. Limited-entry was a tool to reduce fishing capacity by limiting the number of fishing vessels that participate in the fishery through permit restrictions, and setting a moratorium on issuing new permits. The limited-entry sector is further divided between two different gear types, trawl and fixed gear.

Within the trawl fishery there are three sub-sectors or fleets of trawl fishermen delineated by distinct geographic and processing practices: shorebased sector, and at-sea sectors for motherships and catcher/processors (Figure 2). Shorebased operations begin and complete each fishing trip at a port, executing only a few harvest events over the course of a single fishing trip. After a fishing trip, their catch is 'landed' or brought to shore for processing and data collection by federal catch-monitors. Because fish are processed at shore-side facilities, the length of a fishing trip is limited to either the boat's fish hold capacity or the ability to keep the fish fresh post-harvest. Therefore, trips last from a few days to a week.

							Management	
Sector	**Sub-Sector**	**Permits**	**Gear(s)**	**Target(s)**	**Length (m)**	**Depths (m)**	**2002-2010**	**2011- present**
Limited Entry (LE) Trawl		Federal LE permit[1] with trawl endorsement	Bottom Trawl, after Jan 1, 2011 also Hook & Line and Pot gear	Species assemblages	11-29	Wide range	Cumulative two-month trip limits; depth-based closures	Individual Fishing Quotas (IFQ)
	LE California Halibut	CA Halibut permit[2] and LE permit with trawl endorsement	Bottom Trawl	California halibut[5]	9-22	< 55	Cumulative two-month trip-limits; depth-based closures	IFQ
At-Sea Hake	Motherships	LE permit with trawl endorsement	Midwater Trawl	Pacific hake[6]	26-45[4]	53-460[4]	Seasonal (May-Dec) quotas for target and bycatch species of concern	IFQ; Seasonal
	Catcher-processors	LE permit with trawl endorsement	Midwater Trawl	Pacific hake	82-115	60-570	Same as At-Sea Hake Motherships	IFQ; Seasonal
Shoreside Hake		LE permit with trawl endorsement	Midwater Trawl	Pacific hake	17-29	Wide range	Same as At-Sea Hake Motherships	IFQ; Seasonal
Non-Nearshore Fixed Gear	Sablefish endorsed	LE permit with fixed gear endorsement and sablefish quota	Longlines, Pots	Sablefish[7]	11-32	> 145	Sablefish tier quotas; seven month season	
	Sablefish non-endorsed (a.k.a. Zero Tier)	LE permit with fixed gear endorsement w/o sablefish quota	Longlines, Pots	Sablefish, rockfish[8] and flatfish[9]	5-18	> 145	Trip limits	
	Open Access	(none)	Longlines, Pots		3-30	> 64	Trip limits	
Open Access (OA) California Halibut		CA Halibut permit[2]	Bottom Trawl	California halibut	9-22	< 55	Most fishing occurs within CA waters in the California Halibut Trawl Grounds where minimum mesh sizes, seven month season, and minimum size requirements hold	
Nearshore Fixed Gear[3]		CA or OR state nearshore permits and endorsements	Variety of hand lines, pot gear, stick gear, rod and reel	Rockfish, Cabezon[10], Greenlings[11]	3-15	< 110 (usu. < 55 in OR waters)	Federal and CA or OR state nearshore regulations; area closures; two-month trip limits; minimum size limits	
Pink Shrimp		WA, OR, or CA state pink shrimp permit	Shrimp trawl	Pink shrimp[12]	11.5-33	91-256	WA, OR, or CA state pink shrimp regulations; Bycatch Reduction Devices required; trip limits on groundfish landed	

[1]a.k.a., LE permit; all LE permits are issued by Federal agency (NOAA).
[2]Issued by the state of California.
[3]The state of WA does not conduct a nearshore fishery.
[4]Average values for catcher vessels delivering catch to motherships.

Figure 2: Commercial Groundfish fishing sectors (reprinted from NWFCS 2019, WCGOP Training Manual)

Catcher/processors and motherships (also known as factory trawlers) are vessels that go out on extended trips of a month or longer and process their catch at sea. Catcher/processors, as one might assume, both catch and process the fish from a single vessel. Motherships are large processing vessels that either carry a fleet of small catcher boats on board, or that hire catcher boats which deliver their harvest to the mothership at sea.

Shorebased fishing boats include both bottom and midwater trawlers. Bottom trawlers average 65 feet in size (but can range from 25 to 95 feet) and can bring in 15-20 different species in a single harvest event. Although midwater trawlers primarily fish for Pacific whiting (also known as hake) in the at-sea sector, a small percentage fish for rockfish in the shorebased sector. Vessels in the at-sea sector range in size from 125-300 feet.

The limited entry fixed-gear sector consists of fishermen that have permits to fish for groundfish using gear that is set in particular 'fixed' location, and later brought in during a haul event. This gear included lines or pot/trap gear. Within the fixed-gear sector there is an additional permit endorsement for fishermen wishing to target sablefish. The limited entry sablefish fleet is primarily operating out of WA and OR and vessels range in size from 33-95 feet. Although they primarily target sablefish, their bycatch might include spiny dogfish, rockfish, Pacific halibut, and skate. The non-sablefish fixed gear sub-sector averages 34 feet (but ranges from 17-60 feet) and operates primarily out of southern CA. The fleet targets a variety of groundfish to be sold at fresh fish markets, which means that their fishing trips tend to be a few hours or completed in one day (NWFSC, https://www.nwfsc.noaa.gov/research/divisions/fram/observation/data_products/index.cfm).

The recreational sector includes fishermen who catch fish for fun or for personal subsistence use, rather than for sale. This sector also includes a type of commercial fishing operation that operates as a “for-hire” charter boat. The tribal sector includes commercial fishers from the Quinault, Hoh, Quileute, and Makah nations with federally recognized rights to fish certain species in their usual and accustomed fishing grounds off the coast of Washington. Because the tribal fisheries are self-monitored and recreational fishing data is collected by the states, neither of these sectors are monitored through the federal observer programs. Therefore, these sectors are not addressed in this research.

The open access fishing sector is a mechanism for reserving a small amount of groundfish allocation for fishermen who might be targeting groundfish (directed fishery) but do not possess a limited entry permit, or for fishermen who might catch groundfish incidentally, so that these nominal harvests can be accounted for in the annual catch limit. There are no limits on the number of fishermen that can possess open access permits and new permits are continuing to be issued. But there is a blanket limit on either the number or total weight of fish that a permit holder may harvest in a given month or season. This amount is nominal compared to the allocation issued to limited entry permit holders. A fishermen might fish open access if they usually fish for a non-groundfish species for most of the year, but in the off-season of their primary fishery catch and sell groundfish to supplement their income. Open access fishing can be done with any gear type except trawl gear, unless the trawler is targeting one of four exempted species and is catching other groundfish as incidental catch. The open access fleet ranges in size from 10-97 feet, averaging 33 feet, and operates out of all three coastal states.

3.4.2 Status of the Stocks

According to US fishery management definition as outlined in the NMFS Fish Glossary (2006), a species is declared overfished when the fish stock is thought to be exploited at such a rate that it can no longer sustain its population through reproduction. From 1999 to 2002, the PFMC declared nine stocks overfished in the West Coast groundfish fishery.

Overfished stocks are managed through ‘rebuilding plans’; restrictive management measures meant to reduce pressure on the stocks from fishing so that they the population can return to a perceived healthy level of biomass or abundance, with the goal of being able to harvest those species at full capacity once they have been rebuilt. Rebuilding plans often lead to reductions in fishing for other species because of their relationships as species assemblages, or groups that co-occur in a particular habitat in their distinct spatial and trophic interactions. Figure 3 taken from the 2019 West Coast Observer Program Training Manual, presents a list of current overfished, rebuilt, and rebuilding species. Because some species of rockfish such as Cowcod and Yelloweye, have comparatively long life cycles, their rebuilding plans are equally long-lived. This has resulted a host of social and economic consequences and a reconfiguring of livelihoods due to the area closures and other restrictions associated with these species’ rebuilding plans.

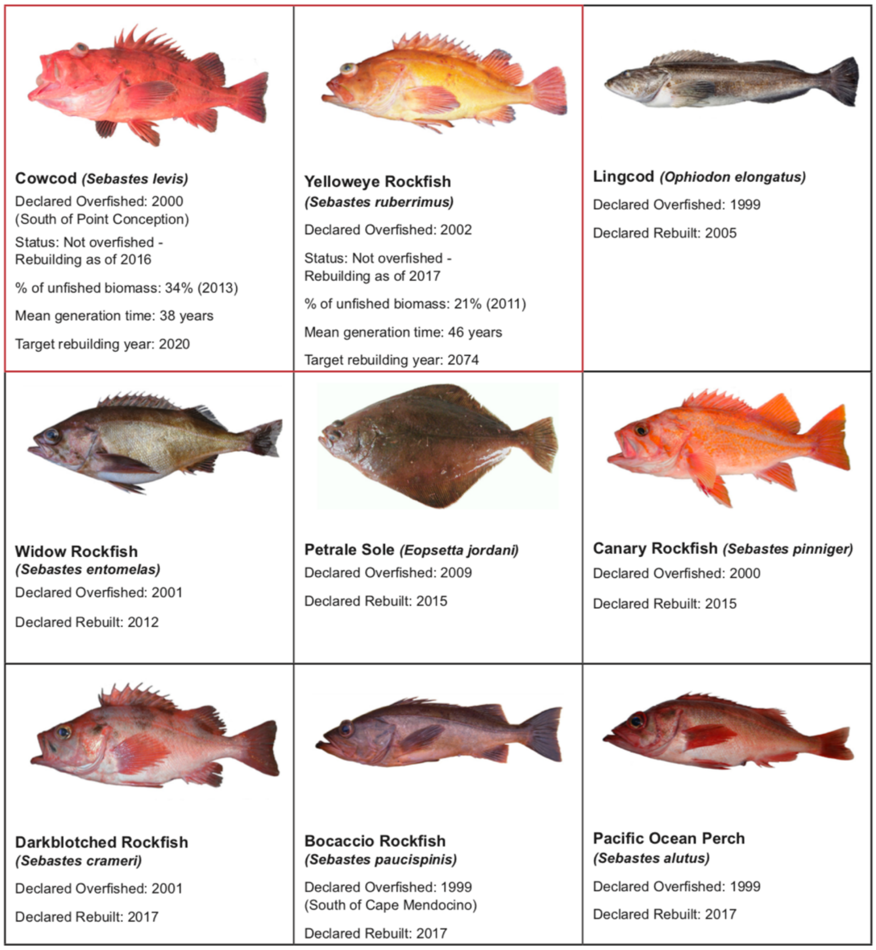

Figure 1-1: Overfished, Rebuilding, and Rebuilt Species

Figure 3: Overfished, Rebuilt, and Rebuilding Species of the Pacific Coast groundfish fishery reprinted from NWFSC 2019.

3.4.3 Fisheries Buy Back Program

In January 2000 the West Coast Groundfish Fishery was formally declared a failure, or economic fishery disaster, by the Secretary of Commerce under Section 312(a) of the MSA. A fishery resource disaster is defined as "a sudden, unexpected, large decrease in fish stock biomass or other change that results in significant loss of access to the fishery resource, which could include loss of fishing vessels and gear, for a substantial period of time… A commercial fishery failure occurs when commerce in or revenues from commerce in the fishery materially decreases or is markedly weakened due to a fishery resource disaster, such that those engaged in the fishery suffer severe economic hardship" (NMFS fisheries.noaa.gov). By this definition, 'disaster' indicates a change in the biophysical environment that triggers a change in fishing practices, whereas 'failure' is used to describe the socioeconomic impacts linked to biophysical changes in the fishery. Hanna (2000, pg.1) summarized the situation facing the West Coast fishery in this way, "The West Coast groundfish fishery is the subject of current attention as the industry struggles through a crisis of biology and economics. The biological expression of this crisis is seven overfished species of groundfish… The economic expression of the crisis derives from reduced fishing opportunities." The 2000 disaster declaration resulted in the appropriation of $5 million in disaster relief funds, which were allocated to the coastal states for relief programs and research.

For a disaster declaration, the biophysical changes in the fishery can be incurred through natural, manmade or undetermined causes, but in any case, the causes must be determined to be beyond the ability of managers to mitigate through regulation. In other words, a disaster declaration allows the Secretary of Commerce to allocate disaster assistance funds, which can be used to help impacted fishing communities, to assess the socioeconomic effects of the fishery failure, and to mitigate or prevent current and future failures.

The groundfish disaster declaration laid the groundwork for market-based management strategies and neoliberalized forms of fisheries management. Managers attributed the groundfish decline to several factors including overcapitalization in the fishery, and misguided management efforts with unsustainable harvest limits. Anticipating a shift to quota-based management, the US government initiated a "buyback" program in 2003 as a stopgap measure to reduce fishing capacity. Congress appropriated $10 million for the program with an additional $36 million loan to the trawl industry. The loan terms outlined a 30-year repayment strategy and that all trawl-caught groundfish were subject to a 5% landings fee, predicting that the program would result in economic benefit in the neighborhood of more than 50% revenue increase per permit for the remaining trawl participants.

The buyback removed 91 vessels (leaving 180 limited entry trawl permits) and their associate federal groundfish permits and any state fishing permits associated with those vessels (PFMC and NMFS 2017). According to the Buyback Business Plan put forth by the PFMC in 1998, the buyback carried with it socioeconomic incentives which were not addressed by previous management measures focused strictly on fish stock health. Further, the buyback plan suggests some of the shortcomings of previous management strategies included increased 'wastage' (i.e. bycatch) and poor data quality, foreshadowing some of the justifications for the imminent catch-share and concomitant monitoring programs.

> Trip limit regulation has diminished the economic efficiency of the fleet, particularly the larger, more productive vessels. As trip limits have been reduced over time, they have affected a larger portion of the fleet
>
> The license limitation system restricted new entrance into the fishery, but increased effort and revised stock assessments have led to considerably lower harvest guidelines. This in turn has led to lower trip limits and even greater economic impacts. *Lower trip limits have led to increased discards and wastage, and degraded the available data on fishery-induced mortality*. The Buyback Committee believes the only method to improve this situation and reverse the trend is to reduce the current fishing fleet. In the absence of outside funding, the industry must fund the purchase of permits.
>
> Reducing fleet capacity would allow the available groundfish resource to be distributed among a smaller fleet, increasing the efficiency of the remaining fleet. In addition, the resulting higher cumulative trip limits and fewer number of vessels *fishing would decrease management-induced discards, reducing waste of the resource and providing more realistic data on fishery-induced mortality*. Future management measures to reduce harvest guidelines and/or trip limits would also be facilitated simply by the fact they would affect fewer vessels. (PFMC Buyback Committee 1998, pg. 3, emphasis added)

Naomi Klein (2007) writes of disaster capitalism as the rollback of government regulations and the rise of private industry in the wake of natural and social disasters. In light of the fleet reduction buyback program, and the ratcheting up of government oversight, one might argue that the fisheries disaster declaration troubles Klein's hypothesis. I would contend, that Klein's framework is still relevant, when thinking fisheries science-management through biopower and environmentality. Although a more complicated management apparatus was one result of the disaster, with regulation came the quota system, and quotas have become a new site of capitalist relations. More interesting yet was the concomitant implementation of a pervasive fisheries observation and monitoring program, and the rise of a privatized monitoring and observing industry. This is consistent with Lave's assertion that the environmental sciences have been particularly vulnerable in the age of the neoliberal science regime because "Research in these fields has been catalyzed by a sense of crisis rather than by scientific breakthroughs "(Lave 2012, pg. 24).

3.4.4 "Rationalizing" the Fishery

As previously documented, political ecologies of marine fisheries have identified quota management systems as a form of neoliberal environmentality. Fishermen are the subjects of these market-based interventions, targeted as rational economic actors who will align their conduct with the desired outcome of governance given the right economic incentives through the privatization of resources.

Despite the buyback, the non-whiting trawl fishery still faced issues and declining catches and revenues. The midwater trawl fishery saw continued growth in the number of fishermen, perhaps attributable to the buyback program and displacement of bottom trawl fishermen. Concern over overcapitalization led the PFMC to institute a limited entry program for the non-tribal whiting fisheries in 2008. As with the other limited entry program, this program only issued permits to fishermen who could demonstrate historic participation in the fishery, effectively preventing new fishermen from entering. “Historic participation” was defined as vessels that had fished the targeted Pacific whiting fishery in at least one qualifying year, which were determined by sub-sector. Anticipating an eventual IFQ program, the limited entry amendment was an interim measure meant to address concerns about overfishing and salmon bycatch.

In 2011, the limited entry trawl sector transitioned to a new, and contentious, catch share system of management. The new system, referred to as the Trawl Catch Share Program or Trawl Rationalization Program, divides the total allowable groundfish catch into shares, which are then allocated to each limited entry trawl permit as a quota. The goals of rationalization were outlined as follows:

> Create and implement a capacity rationalization plan that increases net economic benefits, creates individual economic stability, provides for full utilization of the trawl sector allocation, considers environmental impacts, and achieves individual accountability of catch and bycatch. (PFMC and NMFS 2010, pg. 5)

This was not the first time an IFQ program had been proposed for the West Coast groundfish fishery. According to the program’s five-year review (PFMC and NMFS 2017), managers had considered an IFQ program as early as the 1980s, but abandoned the idea due to the then lack of technological and managerial capacity needed to implement a coast-wide system trading and tracking system. In 1994 the PFMC amended the PCGFMP to implement an IFQ system for the limited entry fixed-gear sablefish fishery. That amendment was never adopted due to a national moratorium on IFQs. In 1996, concerns over the negative socioeconomic impacts of IFQs such as concentration of power, barriers to entry for new fishermen, and inequalities created through the quota allocation process, led Congress to amend the MSA to include what would be a six-year moratorium on new IFQ systems and to prevent any regional council from adopting or amending a local fishery management plan to include an IFQ system during that time. Simultaneously, the NMFS requested that the National Research Council produce a comprehensive report on IFQ programs. Their findings (listed below) led to the conclusion of the moratorium in 2002.

> IFQs should be allowed as an option in fisheries management if a regional council finds them to be warranted by conditions within a particular fishery and appropriate measures are imposed to avoid potential adverse effects. The issues of initial allocation, transferability, and accumulation of shares should be given careful consideration when IFQ programs are considered and developed by regional councils and reviewed by the Secretary of Commerce.
>
> *Congress should lift the moratorium on the development and implementation of IFQ programs established by the Sustainable Fisheries Act of 1996.*
> (National Research Council 1999, pg. 5)

It is worth noting that regulators pursued a quota system in the groundfish fishery to achieve economic stability and income, yet quotas had been banned, if only temporarily, precisely because they tended to produce economic instability and inequality in fishing communities, without clear environmental benefits. As with many neoliberal policies, the quota system was intended to individualize responsibility for environmental health, holding individuals accountable for the economic burdens of resource science and management.

Allocation distribution is based on historic landings records. Bycatch quotas are also allocated based on fishery sub-sector. Prior to the quota system fishermen did not 'own' fish (by regulatory definitions) until they caught them, whereas the quota system gave fishermen and/or fishing corporations private ownership rights over fish they had not yet caught. The new system allocates quota by permit, not by vessel, and in 2014 fishermen were able to start trading, selling, and transferring their quota to other vessels, thereby making the right to access the fish a commodity. To prevent imbalances or monopolies from forming, there are limits set on how many quota shares an individual entity can possess or how many quota pounds a vessel may use. Yet in practice this has proven ineffective since a corporation can control several vessels or subsidiary companies which each have their own quota shares. For each quota share permit there exists a quota share account managed through an online databases administered by NOAA NMFS. For many fishermen, leasing their quota to larger corporations became a more profitable endeavor than practicing their trade.

When the trawl fishery was "rationalized" quota allocation developed through a complex structure based on historic catches. Quotas are allocated differently in each of the trawl fleets. In the shorebased fishery, quotas have been determined for 30 species and allocated to individuals or to fishing corporations. For the non-whiting fleet 90% or the total quota was allocated to fishermen (10% is reserved for an adaptive management program) whereas 80% of the whiting quota in the shore-based fleet was given to fishermen and 20% reserved for processors. At-sea quotas are handled through a co-op program in which allocations are pooled between catcher/processor vessel cooperatives motherships and their affiliated catcher boats.

The trawl rationalization program underwent a five-year review in 2016, to determine the socioeconomic impacts of the program on the fishery, on individual fishermen, and in fishing communities, as well as any changes in how catch was used. The review found that the buyback and rationalization programs were effective in consolidating the groundfish fishing fleet. Although the intention was that such measures would bring economic stability to the trawl fleet, and some economic benefits were realized, consolidation has also produced inequality and socioeconomic instability across fishing communities. Smaller and/or more geographically remote ports were more severely impacted by the trawl buyback program due to job and revenue loss. Secondary impacts include the loss of important fishing infrastructure that supports those fishing in other fisheries out of the same port and a second wave of job loss (PFMC and NMFS 2017, 2010).

The intent of this chapter was to provide history and context which, in the coming chapters, will help elucidate the linkages between the current observation and monitoring programs on the West Coast and global fisheries science-management regimes. As will be explained in chapter five, the observing program originated in the industrialized foreign fisheries of the West Coast and Alaska. Additionally, this chapter demonstrates how overcapitalization brought on by efforts to Americanize the fishing fleet through capital investment, resulted the eventual near collapse of fisheries on the West Coast and an ecological and economic disaster. Disaster, in this case, was used to justify neoliberal management strategies, which are implicated in the development of a scientific industry for fisheries monitoring. In the next chapter I will return to the global scale to examine how the global fisheries science-management regime operates in the production of a global environmental issue, bycatch.

4 The Birth of Bycatch

In the late 20th century bycatch made a splash on the global environmental scene.[4] News media and the environmental conservation sector circulated graphic images of dolphins' fatal encounters with commercial fishing boats, and videos of large nets of fish left dead to waste at sea, having been picked over for only a few choice species. These powerful images brought outcries from an enraged public concerned about the impact of commercial fishing on marine mammals, sea birds, and the marine ecosystem more broadly. Dominant discourse has rendered bycatch a preeminent object in the fisheries assemblage in need of scientific and managerial intervention. Yet, there is little consensus amongst scientists, managers, and fishermen about what 'bycatch' is, how it should be measured and managed, or what impact it is actually having on fisheries. In trying to render this "messy object" knowable and manageable, fisheries scientists attribute the debate to technical, managerial, or epistemological shortcomings (Law and Singleton 2005). A technical explanation might cite the lack of methodological standardization as the reason why bycatch has been so hard to define and measure (Hall and Mainprize 2005, Kelleher 2005). Managerial causes might locate the confusion about bycatch in an overly complex or constantly shifting regulatory landscape (Wallace 1997). An epistemological explanation might argue that bycatch is defined differently dependent on the perspective of the actor, which relates cultural, social, or economic factors (Alverson et al. 1994). Yet none of these approaches questions the ontological assumptions about bycatch on which they are founded, namely that bycatch exists as a discrete singularity. In other words, it exists in the world in an objective fashion and can be measured, monitored, and controlled. Yet,

[4] Bycatch is a term used to describe a wide range of impacts of commercial fishing on animals other than those that fishermen intended to catch.

bycatch does not exist in and of itself. Bycatch can only exist in relation to other actors through heterogeneous processes and practices of enactment.

In this chapter, I contribute to the discussion on bycatch using insights and methods from Science and Technology Studies (STS), critical discourse analysis, and multi-species ethnography. First, I develop a conceptual framework of bycatch as a relational phenomenon to call attention to the social, economic, political, and material life of bycatch as a more-than-human actor, enacted through science, management, and the day-to-day practices of fishing (Helmreich and Kirksey 2010; Lien 2015). Following from this, if bycatch is relational, enacted by various actors, then it is also multiple (Mol 2002). That is to say that bycatch does not exist as a stable and knowable object in the world, but instead is locally situated and contingent, and cannot be removed from the practices which bring it into being. I use the phenomenon of bycatch as an entry point, to examine how environmental problems are co-produced and rendered manageable through various material-discursive practices of science, policy, and monitoring (Barad 2007; Daston 2000; Jasanoff 2004, Latour 2004).

I begin the chapter with an introduction to the key theoretical concepts which inform my analysis. Through a survey of policy and scientific documents about bycatch, I trace bycatch's emergence in science and policy. I also demonstrate that despite a growing body of literature, scientists and managers have continued to recognize and debate bycatch's 'slippery' ontological status (Law and Lien 2012). I then move to an analysis of the different environmental subjectivities, which are performed with and through bycatch. I close with some reflections on the implications of this research for bycatch science and management.

4.1 *Becoming with* the Phenomenon of Bycatch

The word ‘phenomena’ denotes the entangled relations of becoming between ‘bycatch’ and other human and non-human actors. Bycatch understood as a phenomenon is then “a specific intra-action of an 'object'; and the 'measuring agencies'; the object and the measuring agencies emerge from, rather than precede, the intra-action that produces them." (Barad 2007, pg. 128). In other words, the ways in which ‘bycatch’ is measured, monitored, and managed constitute the everyday practices of enacting bycatch, of bringing bycatch into being. “Researching phenomena, then, is a methodological practice of continuously questioning the effects of the way we research, on the knowledges we produce (Barad 2007, pg. 381).” The scientific and regulatory practices through which bycatch is done are underpinned by normative understandings and social, political, economic, and scientific assumptions. These assumptions define the field of possibilities for how bycatch can, and cannot, exist in the world. Investigating the ways in which bycatch is made through science and regulation illuminates the relationship between *how* bycatch is done and *what* bycatch is done.

Studying phenomena is not just a matter of studying an object’s becoming. Phenomena implies a co-productive relationship between object and subject, observer and observed. Each of the constitutive elements are entangled in processes of *becoming with* each other, each shapes and is shaped through relational practices. I augment Barad’s framing of co-productive relationships with Jasanoff’s (2004) definition of co-production as the relational processes through which scientific ideas and technologies develop with the institutions, discourses and representations that make them meaningful. Jasanoff’s idiom of co-production provides explanatory power for disentangling science from political process and sheds light on how scientific knowledge and practice underpin relationships of power and authority through environmental regulation.

Scientific objects are also a product of the 'epistemic cultures' of their time (Knorr Cetina 1999). Epistemic cultures, or the cultures of scientific communities of practice, are similarly situated within broader sociocultural milieu. Unearthing a scientific object's history reveals a great deal about an epistemic culture's "machineries of knowledge production" or how knowledge was made at the particular cultural moment unfolding when an object was born. Examining how scientific objects come into being sheds light on broader social and political processes shaping how that phenomena gains currency as a matter of concern [cite Latour matters of concern]. In other words, an object's history tells much about who is allowed to define the problem, and who decides what counts and how to count it. When the histories of scientific objects go unexamined, the objects become naturalized, or taken for granted as always already part of an external nature. What naturalization obscures is that the way scientists count, measure, and define objects is culturally and historically contingent, and ontologically significant in the object's becoming. Bycatch emerged at a time when the dominant environmental discourse emphasized concern over population growth and resource exploitation and new understanding of natural resources as finite (Ehrlich 1978, Meadows et al. 1974). The 'limits to growth' discourse was in sharp contrast to the ethos that had guided fisheries science and management up to that point: primarily modernizing and industrializing a domestic fishing fleet. This was also a time with the mainstream environmental movement in the US began pushing for more government accountability and oversight for environmental health. Significantly, bycatch also came about at a time when neoliberal ideology promoted individuality and self-actualization.

Understood as a relational phenomenon, then what of the actors with whom bycatch is becoming with? What work does the practice of enactment do for the human and more-than-human actors who perform bycatch? What can bycatch tell us about the histories of human and fish relations, and the ways that those histories inform the present? To make sense of these questions I look to the work of Haraway (2008) and Ingold and Palsson (2013, read through the work of Marianne Lien 2015). These thinkers trouble longstanding dualisms of nature/culture or biological/social that contribute to notions of human exceptionalism. Haraway writes of the ways in which humans and their more-than-human companions are linked through "interspecies dependency" (Haraway 2008, pg. 11). Becoming is always becoming with and our relations and serve not to simply broaden perspectives on the world but to define what worlds are possible. Ingold and Pálsson (2013) employ the term 'biosocial becoming' as a more integrated approach that folds social and biological together to understand humanity as a process of becoming rather than a product of exclusively social or biological domains. This is not to say these concepts are direct analogs. Haraway (2008) is interested the relations of becoming with other beings, particularly investigating the *histories* of entanglement and the violence and hierarchical relations that have ensued. Whereas, Ingold and Pálsson (2018) examine processes *in the making,* with special emphasis on renarrating within the biosocial framework what has been historically characterized as the biological domain.

Employing multi-species ethnography Lien uses these relational ontologies to understand salmon as a more-than-human actor entangled in processes of becoming with human aquaculture farmers. Rather than existing as a biological entity external and prior to human being (i.e. a nature 'out there') Lien posits that salmon are 'done' through a variety of embodied and heterogeneous practices (of aquaculture, capitalist trade, policy-making, etc.). As such, salmon are locally situated and contingent. In documenting the affective relational practices of doing farmed salmon, Lien troubles dominant discourses about exploitative capitalist social relations. Domestication, according to Lien, has been written as a static destination that marks the 'after' of modernity, or has been employed as a tool for ordering and categorizing human-animal relations in hierarchical fashion. Lien re-narrates domestication as not just a technique for ordering relations, but as a generative site of more-than-human entanglements. Thinking bycatch through relational ontologies allows me to examine how enacting bycatch is also enacting the positions of scientist, fisherman, fisheries manager (among others). Further, understanding bycatch through histories of entanglement, opens up new ways of understanding how actors have been reassembled in new socioecological, political, economic orientations through iterative and multiple performances of bycatch over time.

4.1.1 Material-Discursive Practices

Discourse is a particular kind of language about the world that reflects and shapes social processes and individuals' interactions with society and the world. Discourse can be a form of specialized language produced and circulated according to the conventions of particular societal institutions, scientific or regulatory discourse for example, shaping the social (and ecological) spaces those institutions occupy, and producing subject positions in the process (e.g. scientists, law makers, fisheries) (Jaworski and Coupland, 2014; Nead cited in Rose, 2007). Therefore, it is critical to study material experiences of actors within the contexts of the discursive process in which they are embedded because these are so deeply intertwined. A Foucauldian understanding of power moves beyond a unidirectional top-down approach that sees power as being exerted by the state onto fisherman and the environment. Instead, power is understood to be both productive and constraining. Power operates through discourse to organize and administer social life, but in doing so it creates subjects, objects, relations, and places, both defining and limiting how they are acted *on* and act *in* the world and made meaningful (Rose 2007). To analyze "the ways knowledges are produced, legitimated, and maintained through discourse/discursive practices" I will examine the co-production of fisheries science and management as a power/knowledge assemblage (Clarke 2005, pg. 150; Foucault 1977). This reframing interrogates how truth claims are constructed and circulated about fisheries and their significance in producing and maintaining dominant scientific and regulatory discourses as regimes of truth (Rose 2007).

Tracing the material-discursive production of bycatch over time, I highlight the various practices and spaces through which bycatch has been made and remade. This analysis will set the stage for understanding how particular framings of environmental issues, such as bycatch, define the range of possible actions that managers, scientists, and fishermen can take. The discursive construction of bycatch privileges certain world views over others, normalizing certain relations and interventions as 'common sense,' limiting what alternatives might be possible. A critical lens that troubles the taken-for-grantedness of bycatch, its causes, consequences, and solutions, also sheds light on the institutional practices which are bound up with discursive framings and the ways in which material-discursive practices serve to order social life.

4.1.2 The Bycatch Conundrum: What counts?

Colloquially, bycatch is a 'catch all' phrase to describe fish that are caught unintentionally. Fishermen will usually 'target' or try to catch a certain species or assemblage of species, with a particular size and gender makeup. Bycatch might happen if on a 'haul', the process of bringing in fishing gear for a harvest event, the fisherman captures fish of another non-target species, fish that is smaller or larger than they are able to keep, or more fish than intended. Bycatch can face many fates. A fishermen may choose to 'discard' or release the bycatch at sea, or keep it for personal consumption. For those bycatch that are 'landed' or brought to shore for processing, they could be sold on the market in the primary sector as a food commodity or sold into the secondary sector for processing into animal feed, fish oil, or other kinds of products.

The overarching discourse about bycatch within fisheries science-management names bycatch as "one of the most important challenges facing fisheries managers" (H.R. Rep. No. 104–171, June 30, 1995, at 27). Yet as troubling as the material production of bycatch is, the discursive production of bycatch has also been a thorn in the side fisheries scientists and managers. The ongoing debate within the scientific community about how exactly to define 'bycatch' is well-documented (Alverson et al. 1996; Davies at al. 2009; M. Hall 2015; Hall and Mainprize 2005). Alverson (1994), one of the foremost experts on bycatch, published a brief summary of bycatch science in which he states "a clear discussion of the bycatch issue has and continues to be frustrated and muddied by *what is meant by bycatch*" (emphasis added). Writing 20 years later, Martin Hall, Head of Bycatch Programs at the Inter-American Tropical Tuna Commission reiterates Alverson's point in saying, "the concept of bycatch could not be defined to everyone's satisfaction. We are still there, and the inconsistency of the definitions muddles many discussions" (Hall 2015).

How is it that such a well-known and oft-cited environmental issue remain so ambiguous? 'Bycatch' first gained public attention when charismatic marine megafauna such as dolphins and sea turtles were caught and killed in the tuna and shrimp fisheries in the 1960s and 70s (Alverson 1999, Hall personal communication November 7, 2018, Hall and Mainprize 2005). Widespread public outcry and advocacy from environmental conservation groups spurred legislation specifically targeted at reducing bycatch. This leads to an obvious point of departure: that the term is applied to a variety of species and contexts of encounter with fishing gear including harvestable finish, marine megafauna, and seabirds. Regulations within the US are multiple and varied in an attempt to accommodate the different practices and circumstances in which bycatch is made manifest. There are currently three regulatory instruments through which bycatch is managed nationally including the MSA, the Marine Mammal Protection Act, and the Endangered Species Act, as well as international agreements and the National Marine Fisheries Service openly acknowledges that although they all have bycatch provisions, each defines bycatch differently.

The ambiguity of what counts as bycatch is felt at many points in the fisheries science-management assemblage, and when the system does break down there can be profound juridical, punitive, and scientific outcomes. I will offer two examples to highlight how debates over defining bycatch manifest in management and science. Although I offer these examples as representative of debates using an artificial separation between 'bycatch management' and 'bycatch science', it important to recognize that debates in each realm bleed into one another and are co-constitutive.

I first compare the definitions of bycatch in two significant US bycatch management documents, the MSA (1996) and a study conducted by NMFS entitled *Managing the Nation's Bycatch* (NMFS 1998). The MSA is the primary piece of federal legislation regulating fisheries. The bycatch provision was included in the 1996 reauthorization of the MSA, a time when concern about bycatch was building momentum nationally, as I will discuss later in this chapter. Around the same time, NMFS released, *Managing the Nation's Bycatch*, a report aimed at assessing bycatch in the various US fisheries and the efforts in place to reduce bycatch, and making recommendations for bycatch management. As Table 2 demonstrates, the authors of *Managing the Nation's Bycatch* adopt a more liberal and inclusive definition of bycatch than the MSA for several reasons. First, so that the document can make recommendations for science and management that are relevant to the goals of other legislative documents such as the aforementioned Marine Mammal Protection Act and Endangered Species Act. Second, the authors assert that the plan's definition is more practical for meeting scientific goals and gathering data whereas the MSA definition functions more clearly for fisheries management purposes. Finally, the more inclusive definition is consistent with that employed by ICES, Alverson et al. (1994), and other FAO documents situating the document within broader global bycatch discourses.

Table 2: Comparison of Bycatch definitions in two US management documents.

MSA	Managing the Nation's Bycatch
Bycatch: fish that are harvested in a fishery, but that are not sold or kept for personal use, and includes both economic and regulatory discards.	Bycatch: fishery discards, retained incidental catch, and unobserved mortalities resulting from a direct encounter with fishing gear
2. Fish only (i.e. Excludes sea birds or other marine mammals) 3. Fish that are discarded only, fish caught unintentionally but used for some other purpose don't count 3. Fish that are brought on deck only	• Includes both finfish and animals other than finfish species (e.g. Sea birds, dolphins) • Includes all unintentionally caught fish, even if they were not discarded (e.g. sold, consumed) 2. Fish that are brought on deck, released at sea, or unknown interactions with fishing gear

What this example highlights are the complex and often contradictory regulatory structure in which fishermen and managers are operating and which produces bycatch in different ways both materially and discursively. In later chapters I will develop this discussion through empirical data in which fishermen, scientists, and managers reflect on the experience and impacts of navigating the complex regulatory landscape.

Why might these differences matter? According to scientific rhetoric:

> These inconsistencies are now having profound implications on ocean governance the world-over. A failure to clearly define bycatch leads to a failure to fully appreciate the impact this often unmanaged, undocumented, biomass removal is having on the marine environment. The term bycatch as currently applied has thus been ineffective, leading to questions as to the usefulness, applicability and relevance of the term in today's fisheries. (Davies et al. 2009)

In other words, how we define bycatch shapes how we study, measure, and estimate its impacts, which in turn informs science-based management. This argument also promotes a linkage between on the one hand, effective management and environmental outcomes, and on the other precise, accurate, and reliable scientific knowledge about the environment. An underlying assumption implicit in this argument is that there is an objective and stable object to measure, a unified bycatch.

The privileging of science and measurement also promotes fisheries scientists to a particular expert status, integral to developing a thorough and accurate knowledge of bycatch and to solving the ‘bycatch problem.’ But as science studies scholars argue, scientific knowledge is performative. Rather offering a neutral and objective retelling of some static external nature, the authority with which science is invested privileges a particular set of environmental “realities”, actions, and outcomes. “It has the tendency to create the world in its own image because only what is counted counts” (Turnhout, Neves, de Lijster 2014 pg. 594).

Management discourse suggests a more nuanced understanding of the complexities of bycatch, and recognizes that measurement is only part of the equation. The passage below highlights a collaborative model for addressing bycatch in which scientists are one of several actors in the network from whom solutions can emerge.

> Regionally, the causes and implications of bycatch share some characteristics, but often differ since the status of exploitation of resources and the way fisheries are prosecuted and managed can vary substantially. Bycatch management can be accomplished with a

> wide variety of measures, depending on the specific characteristics of fisheries. As a result, no single solution to the "bycatch problem" exists. Rather, fishermen, managers, scientists, conservationists, and other interest groups must work together to craft a balanced approach to addressing bycatch—one that will promote the sustainability of our nation's living marine resources.
>
> The definition in this plan recognizes that, particularly in a multispecies fishery, target catch is not a static concept, but may change by fishing season, day, or even set (NMFS 1998, National Bycatch Strategy).

What these statements demonstrate is that rather than existing as a static object that can be measured and modeled, bycatch is a relational phenomenon, contingent on a host of political, economic, social, and material conditions. When social, political, and technoscientific lifeworlds overlap in particular configurations, bycatch is called into being and invested with meaning through material-discursive practices. Throughout the rest of the chapter, I will return to the bycatch conundrum by offering a new conceptual framework for understanding bycatch as relational, multiple, and contingent.

4.2 Emergence of Bycatch in Fisheries Science-Management

In the following section I will outline the history of bycatch as an object of fisheries science-management. My analysis will tack between policy, government reports, and scientific literature to trace how the practice of releasing fish, or discarding, evolved into the behemoth of 'Bycatch' a global fisheries crisis. To understand the emergence of bycatch, we must look to the evolving narrative within fisheries science-management discourse around practices of waste in commercial fishing. Attitudes about why 'waste' happens, why it is meaningful, and why we should stop it reflect broader trends within fisheries science-management.

4.2.1 Discards: practices and ecological crisis

As early as 1906, Congress approved an act making it illegal to "wantonly waste or destroy any food fish" harvested within the 3-mile territorial seas off the coast of Alaska (Fredin 1987, pg. 7). Fredin, writing on the history of the Alaskan groundfish fishery, suggests that this concern for waste was more symbolic than anything. The act was passed at a time when the it was thought that "in relation to our present modes of fishing, a number of the most important sea fisheries. . . are inexhaustible" (T. H. Huxley, "Inaugural Address: Fisheries Exhibition, London, 1883," cited in Hubbard 2014).

Citing numerous historical reports from the evolving US Fisheries management apparatus, Fredin (1987) contends that salmon were the only Alaskan fisheries of interest to US regulators. Despite bycatch and discarding bycatch being a pervasive practice amongst commercial fishermen in the Alaskan fisheries, few punitive measures were taken by managers to reduce those practices. Both cod and halibut were emerging profitable fisheries in the late 19th and early 20th centuries, but they were thought to be of such abundance that there was little risk of overexploitation. Furthermore, it was precisely the profitability of these fisheries that led to discarding another species (Fredin 1987).

Although the 1906 Congressional act sought to mitigate fishing 'waste', Alverson et. al (1994) cites the 1923 US-Canada Fisheries Halibut Convention as the explicit emergence of bycatch in regulation. Fisheries managers in the US and Canada became increasingly concerned over bycatch in the Alaskan fisheries, especially as those fisheries underwent rapid industrialization in the post-War years of the 1950s.[5] In particular, foreign fishing by the Japanese trawl fleet targeting groundfish in these waters, was thought to be impacting halibut and crab fisheries through their bycatch[6]. As management concern about discards increased, the scientific community took interest and in 1975 the International Council for the Exploration of

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[5] These fisheries were managed by the International North Pacific Fisheries Commission, the International Halibut Commission, and the Alaska state Fish and Wildlife Service.

[6] As early as 1968 a monitoring program had been proposed to track the incidental catch of halibut in the Japanese trawl fleet (although it did not go into operation until 1972) (Fredin 1987). The foreign vessel monitoring program will be discussed in greater detail in chapter five.

the Seas (ICES) passed a resolution (4:22) which emphasized the importance of collecting discard data and sharing that data at annual meetings.

In 1983, The Food and Agricultural Organization (FAO) Fisheries and Aquaculture Department published a circular on the issue of fisheries discards (Saila 1983). The paper proposed a methodology for estimating discards and offered some initial estimates of discards for prominent fisheries around the globe. The focus was not on bycatch per se, but fisheries discards more, a move that was strategic rather than oversight. The author delineates the difference between bycatch and discards as follows: discard catch is catch that is thrown back and not used in any way whereas bycatch is catch that is caught incidentally to the species of interest (pg. 1). Saila (1983) goes on to elucidate the difference with an example comparing two different sets of fishing practices, which gives some insight into why he chose to focus his research on discarding rather than bycatch:

> Not all bycatch is discarded. There is a clear distinction between, on the one hand, the small vessels of most of south and southeast Asia, making daily trips, and which retain most of their catch, and on the other, the larger trawlers - for example the standard US "Gulf of Mexico" type - which make long trips, and where limited freezing capacity means that most of the by-catch is discarded" (pg. 3)

This distinction is significant for several reasons. First, Saila is clearly citing discards rather than bycatch as the problem. Second, he signals the relationship between bycatch, discarding, and industrial fishing practices. Third, the example identifies a distinct geography of bycatch emerging, which locates problematic practices of discarding in the industrial fisheries of the global North. Throughout the report, Saila makes clear that discarding is problematic for social and ethical reasons, more so than bioecological concerns. Writing at a time when neo-Malthusian discourses about food scarcity, development, and environmental resources loomed large, Saila argues that we should care about discards because they represent waste of a viable protein source.

> The problem raised by discarding has often been seen as a single problem, that of the waste occurring when potentially good food is thrown over the side. (Saila 1983 pg. 13)
>
> The annual quantity of fish discarded at sea is a very significant potential increment to the anticipated near-term future needs by mankind for animal protein… Because edible species form a large part of the discard catch, social pressures are increasing in a protein-deficient world to either utilize the by-catch for food or animal feed or to reduce its magnitude by means of selective fishing gear" (Saila 1983, pg. 1)

This framing also leads Saila to reason that discards are a product of technical and economic drivers. Much discarding happened when vessels using trawl gear, large nets that are dragged along the ocean floor or through the pelagic (midwater) ocean environments, would bring aboard more species that are not economically profitable enough to warrant taking up prime real estate in their freezers, leading the fishermen to discard those species. The solution, according to Saila, was to develop markets for these fish to produce economic incentives for fishermen to keep incidental catch. Fish, in this framing, were a resource to be exploited for human use. "The wastage in throwing back fish into the sea should be seen as no worse than the underutilization of some stocks (squids, mesopelagic fish, etc.) or the overfishing of others" (Saila 1983, pg. 13).

A decade later, the FAO published a second report on bycatch, FAO Technical Paper 339 (Alverson et al. 1994). Alverson et al. (1994) marked the first attempt to assess the scope of bycatch at regional and global scales. The substantive report reviewed 800 papers on bycatch to estimate global bycatch levels, highlight the biological, ecological, social, and economic impacts of discarding, and summarize policy approaches and potential future management directions. According to Alverson et al. (1994) bycatch was on the order of magnitude of 25% of commercial fishing harvest globally.

Among the authors of the report was Dayton Alverson, one of the most prolific and well known researchers of bycatch even today. Alverson was the first director of the NMFS Northwest Fisheries Science Center (NWFSC) when it was established in Seattle, WA in 1971. In 1980, after retiring from the NWFSC, Alverson co-founded the private fisheries science consulting firm Natural Resources Consultants Inc. (NRC) in Seattle. While at NRC, he co-authored FAO Technical Paper 339 and became an internationally renowned expert on bycatch.

Alverson et al. (1994) is by far the most cited paper on bycatch and is quoted in reports from scientific, policy, and conservation sectors. Their work signals a change in terminology from ’discards’ to ‘bycatch’ and a discursive shift that elevated bycatch from a local and regional issue to a global environmental phenomenon. This is both a cause and product of the paper’s resonance within the science-management community. The production of bycatch as a global threat to fisheries provided a target for fisheries science-management at a time when fisheries production and health had been on the decline. The significance of this shift was not lost to Alverson who acknowledges “the escalation of bycatch (discarding) to a global priority has had the tendency for bycatch to take on a life of its own” (1999, pg. 10). Bycatch gained traction as a unifying force insofar as mangers now had a task, to save fisheries by managing bycatch and to manage bycatch through the best available science. Once again the co-productive forces of fisheries science-management were called on to produce bycatch as an object that could be made knowable, and measurable.

A year after Alverson et al. was published, the FAO member nations adopted the Code of Conduct for Responsible Fisheries. The Code was an attempt to summarize the numerous fisheries regulations that had been adopted by various national and international bodies, and outline principles and goals for a unified approach to global fisheries health and management.

Despite its often cited significance as an instrument and guide for fisheries management, critics note that the Code lacks the regulatory teeth of law as adoption is voluntary. That an international management document of this scale directly addresses the 'bycatch problem' gives some indication that bycatch had in fact arrived on the global fisheries science-management agenda.

4.2.2 Becoming bycatch: Re-assembling fisheries science and management

As illustrated in Figure 4, there had been a growing body of scientific literature on bycatch through the 1970s and 80s, and scientific interest in bycatch spiked around the time of Alverson et al.'s writing. Several authors cite the emergence and escalation of bycatch in fisheries science-management in the 1980s and 90s.

> "At this time by-catch really started to develop into a priority issue in fisheries as can be seen from the sharp rise in scientific publications on the topic." (Hall and Mainprize 2005, pg. 135)

> "Bycatch has been called the fishery resources issue of the 1990s, and considerable efforts have been expended in recent years to document and control bycatch. "(Wallace 1996)

> "[Bycatch] is neither a new fisheries management issue nor a new problem. Bycatch has been with us as an integral component of fishing since humans began to use the world seas, lakes, rivers and streams as sources of food…What is new, however, is the explosive growth of bycatch as a major management issue over the past decade, and the formal national and international recognition that bycatch in many world fisheries constitutes important waste and raises conservation, ecological and economic issues requiring the priority attention of managers." (Alverson et al. 1994)

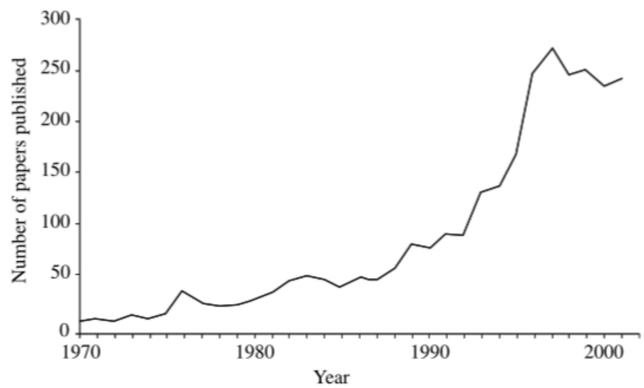

Figure 4: Time series for the number of scientific journal articles indexed on Cambridge Scientific Abstracts on the topic of "fisheries by-catch" reprinted from Hall and Mainprize 2005

But within the scientific and managerial discourses on bycatch there is some disagreement as to which came first, the science or the management. According to Alverson et al. (1994) scientists were the first to appreciate the severity and threat of bycatch, whereas management and industry remained woefully ignorant and unresponsive to the mounting bycatch issue.

> where discard is a concern, it is usually characterized as a narrow problem, such as waste of a potential food source, interference with fishing operations, or excessive kills of high-valued commercial (for example, prohibited species) or protected species." With few exceptions, this observation aptly conveys the attitude still held by a significant sector of fishermen and fisheries managers.

Yet, in the early 90s, the fishing industry had already begun organizing a series of workshops in the US regarding how to deal with the bycatch issue. They were responding to negative public perceptions about commercial fishing, and a critical environmental conservation sector, which saw bycatch as a byproduct of a careless, wasteful, and greedy fishing industry. The general sentiment that came out of these workshops was that there was a dearth of scientific information, which caused misconceptions, mistrust, and inaccuracies. These efforts, I would argue, indicate anything but apathy on the part of the fishing industry.

In 1996, the American Fisheries Society organized a two-day symposium on bycatch in conjunction with their 1996 national meeting. The symposium brought together fisheries scientists, managers, extension agents, and other fish and wildlife professionals. Speaking on a panel at the Fisheries Society symposium, Steven Murawski, then chief population dynamist for the NMFS Northeast Fisheries Science Center, made two noteworthy observations on bycatch science. First, that interest in bycatch from the scientific community had been a relatively recent venture.[7] This assertion contradicts Alverson's framing of bycatch as a long standing matter of concern for the scientific community. Second, Murawski asserts that bycatch science up to that point had been inadequate to inform management decisions reliably, and that science had only just begun to reach a volume and quality to be able to inform management in meaningful ways (Murawski 1996).

Murawski's assertions seem inconsistent with timeline of bycatch science outlined by Hall and Mainprize in Figure 4. Their study suggests that bycatch publications had steadily increased in the 80s and 90s, doubling just after the bycatch symposium (as one might expect). He also seems to contradict Alverson's claims to a long-concerned scientific body. In sussing out the discursive work of Murawski's statements, it is somewhat unclear if they imply a unification or rupture with fisheries science-management. While on the one hand, Murawski might be signaling a pivotal moment or tipping point in which fisheries science-management are reassembled with and through bycatch. On the other hand, his statements can be read as an extension of technocratic discourse that displaces responsibility for the bycatch issue on science. Fisheries management is mandated to be science-based, rendering issues technical and scientific, therefore if management isn't producing the desired results, then the solution is to more science and more data.

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[7] This point was exemplified by the fact that the 1996 Fisheries Society symposium at which he was speaking was the first organized attempt to address bycatch as a scientific community.

The same year as the bycatch symposium, bycatch emerged for the first time in federal legislation as National Standard 9 in the 1996 reauthorization of the MSA. The standard states "Conservation and management measures should to the extent practicable 1) minimize bycatch and 2) to the extent bycatch cannot be avoided minimize the mortality of such bycatch". The MSA goes on to mandate that Regional Council develop Fisheries Management Plans (FMPs) which "establish a standardized reporting methodology to assess the amount and type of bycatch occurring in the fishery". In the hearings leading up to the reauthorization of the MSA and the introduction of National Standard 9, Senator Ted Stevens of Alaska (and one of the original authors of the MSA) spoke at congressional hearings about the new bycatch provisions. His statements made clear that public sentiment laid blame for bycatch on the fishing industry and poor management. It is little wonder that managers may have sought to enroll scientists into carrying some of the fault.

> The waste reduction provisions of S. 39 are particularly needed now, Mr. President. Under S. 39, the regional councils will be required to include measures in every fisheries management plan to prevent overfishing… We continue to support having management decisions made in the regions themselves. But if the fisheries management councils have allowed a fishery to become overfished, we want it to be stopped immediately. (Stevens September 18, 1996)

To support the new bycatch legislation NMFS released the first national statement on bycatch as the report *Managing the Nation's Bycatch* (1998). The report was intended as a conservation and management strategy for assessing and reducing. In the report, NMFS develops a geography of bycatch making recommendations for quantifiable 'bycatch objectives' at national and regional scales. It also makes recommendations for "data collection, evaluation, and management actions necessary to attain the objectives" and to set a benchmark for assessing the effectiveness of national bycatch management measures. Although the discourse of bycatch as waste continues to be a dominant theme, unlike earlier neo-Malthusian discourses (Saila 1983), the issue with bycatch is that it is produced as threat to sustainability rather the underutilization of a viable food source.

> "Bycatch concerns stem from the apparent waste that discards represent when so many of the world's marine resources either are utilized to their full potential or are overexploited. "(Saila 1983, pg. vi)

> "Inherent in this goal is the need to avoid bycatch, rather than create new ways to utilize bycatch (Managing the Nation's Bycatch 1998, pg. 2)."

The 1990s can best be characterized as a time when the fervor around bycatch at both the national and international scale mounted and energy was directed at developing policy instruments for managing bycatch. Scientific literature had also grown tremendously through this time, peaking in the late 90s. Yet, by the mid-2000s bycatch still remained a pervasive problem.

4.2.3 Count, Monitor, and Measure

If the dominant discourse of the 1990s was characterized by a move to manage, the discourse of the 2000s had an overarching theme of monitoring and measuring. Although they are the most cited paper on bycatch, Alverson et al.'s (1994) findings came under criticism for inaccuracy in estimation (see Hall and Mainprize 2005, Alverson 1999). In 2005, the FAO issued an update to Alverson et al.'s report which reported a new estimate of global discard tonnage at 7 million, less than half what Alverson et al. estimated. This discrepancy could potentially indicate a sharp decline in bycatch. According to Hall and Mainprize (20) a more likely reason is due to gross over or under estimation and lack of consistency across methodologies for defining and measuring bycatch.

> there is in most instances inadequate data to determine the real biological, ecological, economic, or socio-cultural impact of discards. Nevertheless, data do suggest that survival of most discarded species is low, declines in some non-target species have been significant, overfishing often involves a significant discard component, and shifts in species dominance and the occupation of certain ecological niches have been in part due to discarding. The extent to which discarding alone and not the fishing process as a whole is responsible for these shifts is, however, unclear. (Alverson et al. 1994)

In the absence of successful bycatch management measures, a new discourse emerged which emphasized data precision and accuracy as the keys to decreasing bycatch. In other words, bycatch management had failed to make substantive improvement because there was not enough data collected and the data that did exist needed to improve.

In 2004, the US released a guide for regional management councils to develop bycatch monitoring programs. Evaluating Bycatch: A National Approach to Standardized Bycatch Monitoring Programs (Cornish, Powers, and Benaka 2004) was intended to develop a national standard for monitoring and reporting bycatch. The bycatch working group reviewed and summarized the variety of tools available for monitoring concluding that:

> All of the methods may contribute to useful bycatch estimation programs, but at-sea observation (observers or electronic monitoring) provides the best mechanism to obtain reliable and accurate bycatch estimates for many fisheries. Often, observer programs also will be the most cost-effective of these alternatives.
>
> At-sea sampling designs should be formulated to achieve precision goals for the least amount of observation effort, while also striving to increase accuracy. (Cornish, Powers, and Benaka 2004)

At-sea observers became a standard data source in many fisheries. These were fisheries biologists who went out to sea with fishermen to count and collect biological data about the fish the fishers harvested and released. Although observers provided an abundant and reliable data source, these programs were expensive to run. Scientists and managers were bumping up against cost constraints that limited their ability to collect comprehensive data, despite cost-sharing between government and industry in some cases.[8] As Crowder and Murawski (2011) put it:

> The lack of comprehensive monitoring programs in most areas to assess bycatches and integrate them into population and multispecies models seriously impedes a full understanding of bycatch consequences and the efficacy of measures for their amelioration.

[8] The observer program is the topic of the next chapter and I will develop a more thorough discussion of these issues.

Yet as the following passage indicates, despite a discourse of standardization, data collection is also a relational phenomenon dependent on a host of political and economic factors.

> The appropriate precision standards for the estimates of bycatch depend on the management objectives, the management uses of the estimates, the precision of other information used with the bycatch estimates to make management decisions, and the cost of increasing the precision of the bycatch estimates. Ideally, standards of precision would be based on the benefits and costs of increasing precision. More often though, managers specify the available budget for estimating bycatch and then scientists determine the precision that can be achieved for that budget. In either case, the precision will be a function of a number of fishery-specific factors. For these reasons, this report specifies precision goals, rather than precision standards (Benaka and Dobrzvnski 2004).

I return now to the question of which came first, the management or the science. Based on the archive, the two emerged simultaneously through co-productive relations, as a science-management assemblage. In US policy, bycatch emerged with laws protecting bycatch of in the 1970s, with fisheries specific bycatch regulation coming into place in the 90s. Similarly, as Figure 4 illustrates, bycatch began appearing in the scientific literature in the 70s and 80s, and reached its peak around the same time that US and international regulations were coming into force.

4.3 Bycatch as Multiple

The scientific and managerial debates about bycatch are underpinned by ontological assumptions that bycatch exists as a discrete singularity. As such, scientists and managers have, with little success, attempted to measure, monitor, and control bycatch by through standardized measures and tools. Yet, bycatch does not exist in and of itself. Bycatch can only exist in relation to other actors through heterogeneous processes and practices of enactment, and if bycatch is relational, then it is also multiple (Mol 2002). That is to say that bycatch does not exist as a stable and knowable object in the world, but instead is locally situated and contingent, and cannot be removed from the practices which bring it into being.

4.3.1 Political and Economic Bycatches

Bycatch emerges at the nodes where fish, fishermen, policy, and the market interface, through regulations, market fluctuation, species lifecycles, and the material practices of fishing. This produces political and economic bycatches. For example, according the MSA (2007), the primary piece of federal legislation regulating fisheries, bycatch is:

> defined as fish that are harvested in a fishery, but that are not sold or kept for personal use, and includes both economic and regulatory discards. Economic discards are fish that are discarded because they are of undesirable size, sex, or quality, or for other economic reasons. Regulatory discards are fish that are caught but discarded because regulations do not allow fishermen to retain the fish; for example, fishermen may be required to discard fish under a certain size or of a specific species for conservation reasons.

There are several important pieces of information worth noting in this definition. First, the fate of the fish has no bearing on whether it qualifies bycatch. It doesn't matter if the fish is returned to the ocean alive or thrown in the waste bin back at the dock, it is considered bycatch. Second, the MSA definition introduces two particular subcategories of discarded bycatch, or bycatch that is released, regulatory and economic discards. These classifications are significant in that they highlight the ways in which bycatch is discursively and materially produced through fisheries management regimes and the global capitalist food system.

Management has adopted two strategies for handling bycatch: 1) preventative or technical solutions which focus on gear and area closures, and 2) mitigative or administrative solutions which tend to be market-based. I will first discuss administrative solutions and return to technological solutions later in this section.

4.3.1.1 Market-Based Environmental Governance

Administrative interventions are aimed at reducing discards that have been harvested, and tracking and mitigating the impacts of bycatch once it has occurred. The predominant model has been market-based quota systems and quota trading or taxes and subsidies (Pascoe 1997).

Market-based privatized management evolved out of Hardin's (1968) theory of the 'tragedy of the commons', assuming that in open-access (or common pool) fisheries, individuals will prioritize their own economic needs over those of the community, without concern for the long-term sustainability of the resource. Despite arguments that the 'tragedy of the commons' grossly oversimplifies the possibilities and practices of collective governance (Dietz, Ostrom, and Stern 2003; Ostrom 1990), privatization through government regulation has become the dominant model of fisheries management through allocation schemes. These strategies privatize and commodify resource access by conferring to fishermen or fishing corporations an exclusive allocation of the fishery resource. Individual fishing quotas (IFQ/ITQ) divide the total allowable catch amongst permit holders who may sell or trade their quota allocations.

Quotas have been the predominant bycatch management intervention in the US. The passages below offer a taste of the discursive production of quotas as a panacea for bycatch.

> With respect to the lack of appropriate incentives, the most fundamental problem is that most fishery management regimes do not create clearly defined and enforceable property rights for fish in the sea, which would allow the market mechanism to be used to allocate fish among fishermen and among competing uses. Instead, fish are allocated to fishermen on a first-come-first-served basis—that is, the race for fish is used as the allocation mechanism. This means that individual fishermen do not pay for the fish and other living marine resources they use. Therefore, fishermen have an incentive to use too much fish as bycatch, just as they each would have an incentive to use too much fuel if fuel were free to them or grossly underpriced (Managing the Nations Bycatch 1998)

> Many in industry ultimately believe, however, that individual fishing quotas (IFQs) will be the most effective approach to reducing discard and waste. Given time to fish more slowly and cleanly, as would be the case under IFQs [individual fishing quotas], fishermen believe they will use more of their catch, change fishing patterns, and achieve many of the results being imposed on the current regime through excess regulation of bycatch. (Pautzke 1996, n.p.)

> "By introducing full accountability through catch quotas instead of landing quotas the fisher's incentive to optimize the value of his catch by discarding less valuable fish would be replaced by his incentive to use selective fishing methods to optimize the value of his total removals from fish stocks. "(Gislason 2015, pg. 29)

The quota system has been highly contentious in the field of fisheries science-management (for a summary of the debates in the fisheries science literature see Acheson, Appollonio, and Wilson 2015). Although some have argued that the quota system has been so successful as to reverse fisheries collapse (Costello, Gaines, and Lynham, 2008), other research calls into question their effectiveness for improving the overall sustainability of fisheries and marine ecosystems (Branch 2009, Pauly 1996). Copes (2000, p. 6) contends that "ITQs [individual transferable quotas] have proven to be particularly prone to the creation of new externalities and other inefficiencies, "the enlargement of bycatch for example. ITQs can disincentivize a fisherman from keeping all of his catch. For example, fish buyers pay fishermen by the pound for their fish, logically this would incentivize keeping larger fish (as long as they were legal size) and throwing back small, less profitable fish. Others argue that any improvements in fisheries sustainability observed in IFQ/ITQ fisheries are more easily attributed to setting enforceable fleet wide total allowable catch limit, from which quota allocations are derived, rather than through the actual privatization and marketization of quota allocations, the latter of which "has less clear effects on fish stocks" (Carothers and Chambers, 2012, p. 43).

Quota systems are born out of longstanding assumptions within fisheries management about science-based management founded on the principal of Maximum Sustainable Yield (MSY). MSY is a bioeconomic model that links the abundance of fish stocks and the reproductive potential with exploitation effort. St. Martin (2001, 2006; and also Finley, 2011) have critiqued MSY as situating fisheries science and management (and therefore fisheries writ large) within a distinctly capitalist ontology. This is significant because it defines the field of possibilities for how actors are situated in the fisheries assemblage, the motivations, actions, and identities they are able to take on.

4.3.1.2 Commodification of waste

Bycatch could also be ‘trashfish,’ undesirable species that have no economic value and that are caught by accident. Some scientists and policy-makers define bycatch as only incidentally caught species, those species which were not intended to be caught, no matter the reason for release. “Bycatch has the added problem in that it may involve the capture and mortality of species of no concern to a fisher but of direct concern to another fisher that normally targets the species discarded. Thus bycatch may foster a number of socio-economic tradeoffs” (Alverson 1999, pg. 6).

As outlined in the previous section, economic bycatches, such as trashfish, have had a troubled past in fisheries science-management. Often times these species are unmanaged, meaning there is no government oversight as to how much is harvested and little if any data collected on the health of the stock. Yet despite a lack of direct economic impact from their removal, their significance as bycatch has grown with the move towards ecosystem-based fisheries management. Trashfish may fall into a transitional zone, transitioning from ‘bycatch to ‘catch’ (Wallace 1996) an ontological shift that hinges on the emergence of new markets and therefore their ability to become lively capital. In recent years, chefs and environmentalists have begun developing a niche market around trashfish. Trashfish represent a node of contention within the network of environmental governance and neoliberal conservation. One might argue that this presents yet another neoliberal market-based strategy for mitigating bycatch, one that bumps up against the aims of fisheries conservation by increasing demand for species lacking management infrastructure to ward off crisis.

4.3.2 Technoscientific Bycatches

Two distinct themes have emerged within fisheries-science-management in which produce bycatch through technoscientific relations: bycatch as a technical problem to be addressed through technological development, and bycatch as a scientific problem to be addressed through monitoring and measuring. I addressed the first theme while tracing the history and emergence of bycatch, so here I will focus on technological bycatches.

A distinctly technocratic discourse foregrounds fishing gear as the culprit in the bycatch issue.

> Bycatch occurs if a fishing method is not perfectly selective. A fishing method is perfectly selective if it results in the catch and retention only of the desired size, sex, quality, and quantity of the desired species without other fishing-related mortality. Very few fishing methods are perfectly selective and typically the discard survival rate is less than 100 %; therefore, bycatch is a source of fishing mortality in most fisheries. (National Bycatch Reduction Strategy 2004)

Framing bycatch as a technical problem limits the sphere of possible interventions to technical solutions. Technological fixes are classified as either gear centric, such as developing new or improved fishing gears (for example specifying mesh size on a trawl net) or spatiotemporal fixes in which season and area closures are instituted to prevent bycatch from occurring in the first place.

In 1992, the American Fisheries Society published a draft policy on the development of bycatch reduction devices. The following passage from that article illustrates how each of the themes work in tandem to discursively produce bycatch as a technoscientific object. The second paragraph links technological solutions with the broader narrative of bycatch and fisheries sustainability.

> Most fisheries are fully exploited and many are subjected to numerous other adverse environmental stresses. Significant mortalities of juvenile finfish can decrease spawning

> stock potential and yields available to fisheries, and this population stress can also contribute to serious decreases in stock abundance" (Perra 1992, pg. 28).
>
> Modifications of some of the present fishing gear types, especially those that use small-mesh nets, or development of new gears or fishing methods that reduce bycatch could lead to considerable reductions in waste of juvenile finfish and other nontarget species. These savings would increase productivity and stability in commercial and recreational finfisheries (pg. 29)

Technological framing also works to define the environmental subject positions of fishermen and scientists. Siting bycatch as a product of gear selectivity implicitly locates responsibility with individual fishermen. Equally troubling is that a focus on individual vessels and gear types pulls attention away from the relationship between fisheries bycatch and widespread industrialization of fishing. In the example above, although Perra acknowledges that fisheries are "fully exploited" this rendering obscures the processes of industrialization, commodification, capitalist expansion, and global trade through which fisheries are exploited.

The technocratic narrative was written into policy through the 2006 reauthorization of the MSA which mandated the development of technological fixes through the Bycatch Reduction Engineering Program.

> Not later than 1 year after the date of enactment of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, the Secretary, in cooperation with the Councils and other affected interests, and based upon the best scientific information available, shall establish a bycatch reduction program, *including grants, to develop technological devices and other conservation engineering changes designed to minimize bycatch*, seabird interactions, bycatch mortality, and post-release mortality in Federally managed fisheries. (MSA 109-479 SEC. 316.16 U.S.C. 1865, emphasis added)

Much public funding is directed to the support scientists, in collaboration with fishermen, to develop technological solutions. Such an arrangement demonstrates the ways in which the fisheries have been reassembled under shifting management and science regimes (Lave 2012b) differently orienting fisheries science with capitalist processes. As noted in chapter three, fisheries science emerged out of a need to industrialize and modernize the fleet. Yet now because fishermen became so successful through those efforts, scientists are needed to mitigate the effects. As will be discussed in the next chapter, this move is more than ironic as it gave way to the development of a fisheries science industry.

4.3.3 Lively Bycatches

I expand on Collard and Dempsey's (2013) notion of 'lively commodity' to understand the significance of life and death as factors that orient bycatch within the capitalist fisheries assemblage. Lively commodity indicates a commodity that is living and for which the condition of living is an inherent dimension of its value. Though not a commodity in and of itself, bycatch is constituted through the commodification of non-human life. It is precisely the 'liveliness' of bycatch that either renders commodification possible at some later date (i.e. caught and sold by another fishermen) or that allows bycatch to contribute the 'labor of life' to increasing stock biomass (i.e. through reproduction and stock estimates).

Mortality is a central concept to fisheries science. Mortality is the rate at which fish of a given population die. Fisheries scientists categorize mortality as either 'natural mortality' meaning the number of fish dying non-fishing related deaths, and 'fishing morality' or death as a result of encounters with fishing gear. Bycatch shares a complicated relationship with the concept of mortality. For some scientists, bycatch is an object defined by mortality, whereas in other cases it is merely the potential of mortality that makes bycatch a matter of concern.

> Bycatch mortality affects the sustainability of fisheries and the benefits that these resources provide the nation in two ways. First, it increases the uncertainty concerning total fishing-related mortality… Second, bycatch mortality precludes some other uses of fishery resources. For example, juvenile fish that are subject to bycatch mortality cannot contribute directly to the growth of that stock and to future directed catch (Managing the Nation's Bycatch 1998, pg. 2).

Recasting bycatch through the lens of liveliness makes visible the spatial and temporal dimensions of enactment, in other words when and where bycatch is done. On a material level, bycatch 'lives' in some places and not others, that is to say particular habitats and environments may be more amenable to the species assemblages that lead to bycatch. Regulations might close off an area or specify a fishing "season" prohibiting the harvest of certain species outside of those space/time enclosures thereby producing bycatch when regulation and fishing practices misalign.

Habitat, thought differently, signals the social and technoscientific ecologies in which bycatch thrives. Bycatch is rendered knowable through a variety of social and scientific practices and technologies: through fisheries science data collection, in the models that predict species assemblages, life cycles, and migration patterns, through regulations and fishery management plans, in fishermen's logbooks, in geospatial data collected by at-sea fisheries observers or electronic monitoring systems. These practices and technologies are performed by human and non-human actors such as fisheries observers, policies, fishermen, data analysts, and fisheries managers at various sites such as in the scientist's office, in the scientific literature; in a data processing center; on the fishing vessel; in the meeting rooms and policies. For example, the practice of fisheries observing is meant to document bycatch, and takes for granted that bycatch is object, always already existing in the world. But bycatch becomes important through differently orientations to liveliness, and death, and the very act of monitoring bycatch can produce bycatch as mortality.

> Complicating the bycatch issue is a federal regulation requiring trawlers to keep halibut on board until the haul has been sampled by fishery observers on-board the vessel. Under current regulations, halibut are moved into holding bins with the rest of the catch and only returned to the water hours later. Approximately 80% of the halibut are dead at this point (Woodley 2015, n.p.).

Therefore, more than merely locations where actors can bear witness to bycatch, the spaces of bycatch are actually constitutive of the spaces of possibility, the lively habitat, where bycatch becomes in relation to human and non-human actors.

4.4 Bycatch as Relational

Material and discursive practices produce bycatch in a variety of places, spaces, and lifeworlds. Inherent in the discourses and discursive practices that give bycatch meaning and form are environmental subject positions which form the basis of how various actors exists in relation to the environment and others. When actors perform bycatch, they also perform themselves. These subject positions offer a structure through which people and institutions can be categorized, rendering them legible and knowable through a prescribed set of abstracted characteristics. These subject positions in turn make possible (or limit) the range of actions, feelings, intentions, and responsibilities to whom they are assigned. Although each of these subject position or categories represents a community of practice; individual bodies are the site where environmental subjectivities are performed and enforced.

In this section, I will discuss three arenas out of which subject positions emerge: fishermen, fisheries scientists and managers, and the public and environmental conservation sector. These categories are not meant to imply tidy boundaries, but instead should be understood as a series of overlapping social spheres. Actors often move between spheres or may take on multiple subjectivities at one time, imbricating their various characteristics in nuanced ways. Within each category there are also subcategories which can manifest as differently ordered actions and expectations through competing or contrasting discourses. Finally, the environmental subject positions I outline are not static categories, but are also relational and contingent. The subject positions produced in relation to bycatch have shifted over time and through the reworking of environmental, scientific, and managerial discourses. In later chapters, I will draw on interview data to develop this analysis to better understand how individuals internalize, perform, and experience these environmental subjectivities through the material and discursive practices of fishing, science, monitoring, and management.

4.4.1 The Public and Environmental Conservationists

The common scientific and managerial narrative is that bycatch became a matter of concern at the behest of the public and environmental conservation sector. Consumers were outraged by images of dolphins bloodied and battered by tuna nets, developing a negative public perception of commercial fishing as a dirty and environmentally devastating industry (Hall 2015). This led scientists, industry, and managers to rally their efforts to address the 'bycatch issue' through policy, science, and technological developments.

The 'concerned public' and 'environmentalist' have remained important actors in the production of bycatch. Though in *becoming with* bycatch through neoliberal environmental governance regimes these positions have taken on a distinctly neoliberal flavor. For example, a fairly recent market-based management strategy has been the development of third-party sustainability certifications which provide compliant fishers with access to new markets. The public is produced as consumer activist, enacting bycatch through sustainable consumption choices (Gislason 2015).

4.4.2 Fishermen

Bycatch is discursively constructed first and foremost as a product of fishing. In a material sense this is true, the practice of fishing is an inherent means through which bycatch is brought into being. Yet such a reductionist framing naturalizes 'bycatch' as an immanent characteristic of fishing. This framing also obfuscates the ways in which bycatch is produced through non-fishing practices, such as through the contingent and dynamic classification schemes of science and regulation, as well as the social, political, and economic systems in which fishing practices are enacted.

In the U.S., public perception of commercial fishing and fishermen was that they were wasteful and unnecessarily exploitative (Alverson 1994). This framing echoes scientific discourse which frames bycatch as a product of individual choices made by irresponsible fishermen. Rarely does the scientific discourse situate fishermen's activities within the broader political economy of the commercial fishing industry and regulatory structure or the global fish market.

> the fisher should receive increased quotas (catch quotas) to reflect that all fish are accounted for and he should be given the freedom of choice of method in conducting his fishery, to make his own methods work for the best result. (Gislason 2015)

> Emerging ideas include effort reduction, incentive programs, and individual transferable quotas that move the responsibility for bycatch reduction to the individual vessel level. The authors feel major gains against the global bycatch problem are likely to occur as such shifts towards individual responsibility take place. (Alverson et al. 1994)

The literature would suggest that fishers themselves have internalized these subjectivities. For example, in a paper co-authored by a former commercial fisherman and a representative from a non-profit representing fishing communities the authors state "We think fishermen who do the best job of reducing their bycatch should be rewarded with more opportunity to fish. What better way to encourage ingenuity?" (Johnson and Childers 1999, pg. 89). But they present a more nuanced assessment of the role of fishermen in reducing bycatch then merely weeding out the greedy and reckless. In the same paper they foreground fishermen's knowledge and expertise as a driver for change "How to actually reduce bycatch? Ask professional fishermen. No one knows gear, operational conditions and fish behavior better "(Johnson and Childers 1999, pg. 88).

The managerial discourse on bycatch offers an interesting counter-discourse that situates bycatch within broader economic and political systems. Further it positions fishermen as acting in relation to managers, highlighting the interdependencies between management and fishing practices.

> Why is there excessive bycatch? A common response to this question is that *greed or lack of concern by fishermen results in excessive bycatch mortality. This line of reasoning ignores the decision-making environment in which individual commercial, recreational, and subsistence fishermen find themselves*. Bycatch mortality results from the fishing practices that are based on prevailing *regulatory and economic circumstances* and personal preferences. Thus, decisions made by individual fishermen and fishery managers are interdependent and jointly determine the levels of bycatch mortality. (Managing the Nation's Bycatch, pg. 17, emphasis added)

4.4.3 Fisheries Scientists and Managers

As much of the chapter has argued, the fisheries science-management assemblage has evolved as a mutually reinforcing and deeply intertwined assemblage through the coproduction of the institutions of fisheries science and fisheries management. The course of coproduction was charted in the 1950s in the mandate of management through 'best available science'. Yet as these fields have evolved in tandem, notions of objectivity and specialization also required a distancing, if only symbolic, between institutions and a distinction manifested through subject positioning of 'scientist' and 'manager'.

In tracing the material history and emergence of bycatch earlier in this chapter, I demonstrate how scientists and managers have discursively situated themselves in relational to one another. Materially, fisheries scientists and managers share physical and social spaces through the regional NOAA fisheries science centers and on regional fisheries management councils and committees. Fisherman also serve in advisory roles on council committees, as representatives of their community or local professional fishing organization. In some cases, fishermen may work as paid council members making management decisions.

Fisheries management discourse continues to be a site for geopolitical posturing. Management documents are fraught with nationalist rhetoric indicating management should be enacted to ensure the "greatest net benefit to the nation". Similarly, as the passage below shows, the US fisheries science-management assemblage is positioned as a global leader, an assertion that discursively links successful management with 'sound science' obscuring the politicized nature of science and management.

> The United States is a global leader in sustainable fisheries management and protected species conservation. NOAA Fisheries' core mission is to promote productive and sustainable fisheries and conserve and recover protected species—all backed by sound science and an ecosystem-based approach to management. (National Bycatch Reduction Strategy 2015)

4.5 Conclusions

For the last 40 years, bycatch has been a significant focus of fisheries science and management garnering national and international imperatives for standardized measurement and reporting, and a host of mitigative management measures. Yet bycatch has evaded clear definition and maintains a perennial fisheries concern. In this chapter, I have argued that foundational to bycatch debates are ontological assumptions about bycatch as a stable and knowable environmental object. Scientific and managerial discourse have fortified this assumption. Read through relational ontologies, I argue instead for an understanding of bycatch as multiple, and that the material-discursive practices of science and policy enact not a single bycatch but bycatches which are both situated and contingent.

Taking a relational approach that integrates social and ecological processes, offers a way for fisheries managers to situate current ecological conditions within their co-constitutive historical, political and economic contexts. As complex and differentiated socio-ecological systems, fisheries require a management approach that recognizes and takes account for the impact of regulatory mechanisms on flows of power within society. Several have argued that the only way to truly reduce bycatch is by reducing overall fishing effort, but bringing the industrial fishing system to a halt is an unlikely outcome. Although focusing on bycatch offers a good starting place for examining the impacts of fishing practices on fisheries, adopting such a narrow lens also limits the field of possible options and interventions. In the next chapter I will trace the emergence of one prevalent bycatch intervention, the fisheries observer program.

5 Neoliberal Fisheries Science Regimes

> "the at-sea data must be derived from independent third party systems, as opposed to self-reporting systems, in order to provide reliable and credible data." (Gislason 2015, pg. 27)

Political ecology examines how environmental management and conservation decisions and understandings about environmental degradation are situated in broader political and economic forces, within historical and geographic contexts. The site of political ecology research is often the management process, some research also examines the application of environmental science in the production and politicization of environmental management landscapes. Yet authors interested in the politicization of knowledge making *and* the application of that knowledge in environmental management argue that political ecology could engage more thoroughly with both of these processes (Forsyth 2003, Lave 2012b). Fisheries management, and environmental policy generally, is a highly scientized and politicized endeavor. Managers must seek out the 'best available science' to justify their decisions to state institutions and civil society. Science, too, is highly politicized along many axes such as the determination and funding of particular research agendas, and who gets access to what data and how that data is valued, used and legitimated as knowledge.

In short, fisheries science and management are deeply entangled and politicized. If a political ecology of fisheries seeks to understand the uneven power geometries of management, fisheries science must also be examined. Ignoring fisheries science as a fisheries political ecologist obscures 1) the ways in which shifts in one necessarily precipitate changes the other, 2) following from one, the iterative processes and outcomes through which science and management co-produce one another 3) the performativity of science-management, or otherwise put the worlding practices inherent in categorizing, monitoring, measuring, and managing the environment and the science-oriented environmental subjectivities produced in the process and 4) the material consequences for the human and more-than-human world.

Despite these linkages, there has been little investigation of the fisheries science-management assemblage. Geographers have examined the ontological politics of data representation, particularly spatial data, and the economic and political outcomes of these endeavors (Boucquey et al. 2016; St. Martin 2001). Yet this critique was more distinctly sited on data management, practices, rather than scientific practices of data collection. Historians have taken a more direct approach to examining the politicization and geopolitical significance of fisheries science (Finley 2009, 2011; Finley and Oreskes 2013; Hubbard 2014). Although these efforts provide valuable insights, what is missing is an understanding of the ways in which *current* and *future* fisheries are made, nor do these accounts document empirically the impacts on people and the environment.

In this chapter I will address these lacunae through an empirical case study of the West Coast groundfish fishery observer and monitoring programs. Drawing on insights from Foucauldian thought, and Science and Technology Studies, I develop a political ecology of fisheries science-management. Fisheries observation is a mandated data collection and surveillance program in which scientists are placed aboard fishing vessels to observe fishermen at work. Synthesizing theory from the political ecology literatures on neoliberal fisheries governance (Mansfield 2004; Pinkerton and Davis 2015), environmentality (Agrawal 2005, Fletcher 2010), and neoliberal science regimes (Lave 2012b; Lave, Mirowski, and Randalls 2010), I examine how the adoption of neoliberal management strategies has shaped fisheries science, and with what socioecological outcomes. In developing a political economic analysis of the fisheries observation and monitoring industry, this study contributes empirical data to research on the neoliberalization of science in environmental management. My focus on fisheries and marine environments extends the geographic and ecological scope of this literature, which has been primarily land or riverine based. My analysis troubles previous understandings of environmentality as following strictly neoliberal logics.

I re-narrate the fisheries observer program as a site of disciplinary environmentality, which produces environmental subjects in both fishermen and observers, through the moral imperatives of clean fishing and good science respectively. Yet, because fisheries observation and monitoring is bound up with neoliberal governance strategies, namely the quota system, this case study demonstrates not just "multiple environmentalities" (Fletcher 2010) in action, but actually co-producing one another. The impacts of these environmentalities, or technologies of environmental governance, include 1) cementing the privatization of fisheries by producing a privatized fisheries science with pervasive technoscientific infrastructures 2) exacerbating inequalities between fishermen and fishing communities through the political economies of scientific practice, and 3) reshaping the eco-social environment of the fishery.

In chapter three I developed a history of the fishery under the Magnuson-Stevens Fisheries Conservation and Management Act (MSA), and the shifting socioecological and political-economic conditions as the fishery transitioned from an open access system to a quota management system. This history links current conditions in the West Coast groundfish fishery to historical capitalist and geopolitical processes such as move to Americanize the US fishing fleet on the West Coast, the fisheries collapse wrought by fleet overcapitalization, and the move to neoliberal management strategies in response. Building on that history, I link technologies of neoliberal governance to the widespread implementation of the fishery observer program and private sector observer industry. Based on archival research and interview data, I document the ways in which the roles of state and private entities have been reconfigured, and the emergence of a neoliberal fisheries science regime through the observing and monitoring program in the West Coast groundfish fishery. Using empirical data from interviews with fishermen, observers, fisheries managers, and program administrators, participant observation, and document analysis I develop an ethnographic account of fisheries observation, highlighting the ways in which observers are disciplined through rigorous, routinized data collection practices. The coupling of fisheries observation with monitoring (i.e. regulatory compliance accounting) blurs the boundaries between science, surveillance, and enforcement, thereby enrolling fisheries observers in the imbricated technologies of discipline deployed on fishermen. I highlight how the multiple forms of environmentality have differently oriented observers and observer provider companies within the fisheries capitalist assemblage, and assess the material impacts and outcomes. I close with a discussion of some of the broader implications of neoliberal science and disciplinary environmentality for the future of fisheries science and conservation, particularly the recent introduction of electronic video monitoring as a second wave of neoliberalization in the monitoring industry.

5.1 Environmentality

Researchers have adopted the term 'Environmentality' (from Foucault's governmentality) to describe the logics and techniques by which the environment and people are rendered governable, situating them in particular socioecological relations (Agrawal 2005; Gabrys 2016; Irrera 2015; Luke 1999). The fisheries science-management assemblage in the groundfish fishery provides an interesting empirical case for examining "multiple environmentalities" (Fletcher 2010), and the ways in which their respective discourses, technologies, and subjects, are deployed in relation, co-producing the authority of one another. Foucauldian scholarship has tended to treat biopower, disciplinary power, and governmentality as separate though related entities, but more recent interpretations of Foucault's work suggest that these concepts are imbricated in ways that require more nuanced and critical examination (Cavanagh 2018, Fletcher 2010, Glenn 2018). Fletcher (2010) proposes a framework of 'multiple environmentalities', to understand the coexistence of competing positions and techniques of governance put forth in the biodiversity conservation debate. Fletcher acknowledges the need to vet this framework through empirical ground truthing, in so doing, my research also expands this scope of the framework by 1) using this framework to understand not competing but complimentary environmentalities and 2) demonstrating the co-productive relationships that link them.

My research is informed by Agrawal's (2005) conceptualization of environmentality as disciplinary power capable of producing new environmental subjectivities, or politicized subject positions always already performed in relation to the environment. In this register, disciplinary environmentality is enacted through socioecological practices, material and discursive, which emerge in particular institutional contexts. For Agrawal, studying the impact of forest conservation on rural residents in India, as management regimes shifted from top down governance to decentralized local councils, residents were enrolled in practices of governance which transformed their beliefs and practices about the environment and their relationship to it. Disciplinary environmentality, produces self-regulating subject by ascribing ethics and norms to particular socioecological practices. Through the routinization of these practices, human and more-than-human subjects are situated in relation to one another in politicized relationships.

5.1.1 Disciplinary Environmentality through Scientific Practice

I theorize fisheries observation and monitoring programs as a site of disciplinary environmentality, in which the observers and fishermen are oriented as environmental subjects through the material and discursive practices of science and management. The moral imperative driving disciplinary action is that of doing good science and collecting data with accuracy and precision. Yet, as I will elaborate later in this chapter, the observer program has both scientific and surveillance components. The material-discursive practices through which science is performed are often times synonymous with the practices through which observers surveil fishermen. But fishermen are not the only actors subject to the governmental gaze, observers too are subjected through their data and reporting practices. 'Data' therefore serves as a technology of government and of the self; it is both a site where disciplinary environmentality is enacted but also a practice through which observers perform their environmental subjectivities.

I am not the first to examine science, surveillance, and data through the lens of environmentality (Braverman 2014; Turnhout, Neves, and de Lijster 2014), but my work differs from and contributes to this literature in several ways. Braverman (2014) examines the use of wildlife surveillance cameras, their work conceptualizes surveillance as a technology for managing and 'making' non-human life through measurement and data. Although I too take the use of surveillance for conservation management as my object of study, surveillance in my case places the gaze on human/non-human *interactions*, and is implicated in the broader biopolitical project fisheries science-management not only through enumerating but also through the disciplining of bodies. Turnhout, Neves, and de Lijster (2014) develop the concept of 'measurementality' "to signify an 'art of neoliberal governance' that emerges from privileging scientific techniques for assessing and measuring the environment" in order to carve the environment into discrete and interchangeable (i.e. tradable) units. Underpinning measurementality are insights from STS, particularly the processes of worlding that occur through scientific performances of nature (Turnhout, Neves, and de Lijster 2014; Turnhout

2018). In other words, the act of naming and categorizing objects in the world as worthy of measurement and measureable instills power in particular forms of knowledge making, usually Western science, and the people and institutions who set research agendas. Turnhout argues that standardization and measurability enroll more-than-human actors in capitalist relations through market-based forms of environmental governance. This read on surveillance and scientific measurement emphasizes *transparency*, that is to say making nature knowable through measurement, as "a key principle of neoliberal environmental governance next to effectiveness and efficiency" (Turnhout, Neves, and de Lijster 2014, pg. 582). My own reading of scientific practice understands measurement and data collection as a routinized and normative material-discursive practice. Measuring and monitoring, in this light, are significant in that by making nature knowable, they also advance scientific ideologies of accuracy and precision, and environmental subjectivities of good scientists and honest fishermen.

5.2 Neoliberalization of Science

Pestre (2003) develops the term 'science regime' to describe the milieu out of which scientific research emerges, including the political and economic conditions, the relationships between knowledge producers and the agencies and institutions to which they are beholden. In the global North, a neoliberal science regime reigns (Lave 2012b; Lave, Mirowski, and Randalls 2010). When we consider that environmental management relies on the "best available science", it seems obvious that in order to understand the flow of power between environmental actors, studying relations of power in the production of environmental knowledge and the relationship between science and management would be of highest priority. Yet, as Lave (2012b, pg.19) notes,

> Political ecologists and critical nature/society scholars have a long history of studying the application of environmental physical science… we have paid comparatively little

> attention to the production of environmental knowledge claims even though we cannot understand environmental management frameworks and policies applied at our field sites without analyzing the knowledge claims that enable them.

This assertion holds true for scholarship on fisheries and fisheries management. Considerable work has interrogated the suite of fisheries management strategies most prominently featured in fisheries of the global North, such as quota systems, community management, sustainability certifications, and conservation enclosures (Bresnihan 2016, 2019, Campling, Havice, and Howard, 2012; Mansfield 2004; St. Martin 2007; Pinkerton and Davis 2015; for a summary of this literature see Carothers and Chambers 2012). Although debates linger as to what actually constitutes the 'neoliberalization of nature' (Castree 2008), scholars of fisheries management overwhelmingly conclude that fisheries governance is driven by neoliberal values such as enclosure, privatization, and market-based incentives. Although political ecologists have foregrounded the manifestations of neoliberalism on fisheries management, and the repercussions for fishing communities, the implications for science are equally relevant. In a special issue they edited for *Marine Policy* on the neoliberalization of North American fisheries, Pinkerton and Davis signal the impact of neoliberal ideology on fisheries science, particularly the shifting roles of state and private actors.

> sweeping budget cuts to fisheries and ocean science and management budgets stemming from neoliberal policies have necessitated a reconceptualization of the roles played by both state and citizenry in the regulation of ocean activities. Faced with diminishing resources, government fisheries and ocean management agencies have been increasingly forced to rely on a diverse array of public–private partnerships with universities, nongovernment organizations, and private corporations in order to carry out their mandates. This fits seamlessly into the neoliberal view that the state should assume more of an overseeing role and share more responsibilities with the private sector (Pinkerton and Davis 2015, pg. 307).

The fisheries monitoring and observing program in the West Coast groundfish fishery bears the marks of the neoliberal science regime under which it emerged. Most salient is that the programs are overseen by state regulatory bodies, but the work of data collection is predominantly outsourced to private contract research organizations. Scholarship on contract research organizations has primarily looked at how these companies are employed in bioscience clinical trials (Mirowski and Van Horn 2005) although Lave's (2012a) research on the role of private contractors in shaping stream ecology and restoration marks a significant contribution to the political ecology literature on knowledge production.

Several characteristics of neoliberal science regimes typify the West Coast fisheries monitoring and observing programs. Under neoliberal science regimes knowledge production falls prey to what Lave (2012b) describes as the "tyranny of relevance", meaning that scientific inquiry is driven by market needs (Gibbons et al. 1994). In academia, this has shaped scientific practice in that either scientists develop research programs based on funding availability and directives. For both academic and 'extracurricular science', or science outside of the academy, the tyranny of relevance means research has been redirected from curiosity driven to being guided by the development of marketable knowledge 'products'. In fisheries observation, private research companies are able to garner contracts based on their ability to provision a service (i.e. data collection) efficiently and at a competitive low cost. In this chapter I will focus on this characteristics, but will introduce a second characteristic in the conclusion of the chapter and to be developed more fully in next chapter.

5.3 Fisheries Observation and Monitoring

An "observer" (also known as fisheries observer or at-sea observer) is "any person required or authorized to be carried on a vessel for conservation and management purposes by regulations or permits under [the MSA]" (MSA, 2007). To state this more plainly, federal fisheries law requires that commercial fishing boats fishing under certain permitting structures take a take a person with them on fishing trips who is acting as a representative of the state and who is performing tasks with the intended objective of improving the sustainability of the fishery. To that end, observer programs have several goals which are often pursued simultaneously, although not always in complimentary ways as confusion and tension sometimes arises. According to regulations, the goals are scientific data collection, or compliance monitoring.[9] I've termed these different goals (and their associated material-discursive practices) 'observing as science' and 'monitoring as surveillance' respectively. In the 'observing as science' narrative, observers are referred to as "highly trained biologists" whose primary function is to collect scientific data used for developing conservation plans and stock assessments which inform management decisions. Conversely, 'monitoring as surveillance' is intended to ensure fishers are complying with fishing regulations, particularly quota allocations. Monitoring surveillance practices consist of counting how many fish are caught or discarded, in essence measuring for presence or absence of a particular phenomenon of interest, as well as performing walk through to ensure the vessel meets safety standards. One interviewee who deals with program administration explained the difference between these observer roles to me, noting the importance of the nuance:

> When you use the word monitoring, that word has a different meaning to different people, so for example, this is just from my aspect, observers monitor things, which I see in a way as just watching so for example let's say an observer is on a boat where they are not supposed to discard, you're just watching, are they doing that, so it's basically a flag yes or no, that's monitoring. Versus if you are actually getting your hands in there and collecting data as in catch composition that's truly catch composition collection randomly selected its more than just a flag of yes or no. So I would be careful when you use the word monitoring because it may mean something different to other people and especially in the EM world, monitoring is very different… The difference is people are actually getting their hands on the fish getting their hands on the organisms and collecting data versus just standing back and watching is this happening yes or no." (EVM02)

[9] In some fisheries observer programs have the specific goal of documenting marine mammal or protected species interactions. Although the observers in the fisheries I focus are all required to document these types of interactions, should they occur, that primary goals for observation are either scientific data collection or quota compliance monitoring.

Despite the seemingly clear distinction between these roles, it is not uncommon for observers to work in both capacities simultaneously. Furthermore, observers, whether observing or monitoring, are expected to document and report any activities they deem suspicious or illegal. As I will discuss later in the chapter, the distinctions between whether an observer was doing science or doing surveillance because far more critical with the implementation of the quota program, and the shift in program funding structure.

Some fisheries also require ‘catch monitors’, a person based at a shore side commercial receiving facility that oversees the process of fish accounting when fish are ‘landed’ (i.e. removed from the vessel on land and sold or discarded). It is not uncommon for someone who is working as an at-sea observer to switch roles and become a shore side catch monitor once the boat docks. The redundancy is apparent in this fisherman’s explanation, “then came the catch share program and that was going to be 100% monitored, which in my opinion is actually 200% monitored because our observer gets off the boat and then does it again at the cannery” (EVM16).

5.3.1 History of the Observer Program

In the early 1970s, the US NMFS began placing observers on foreign vessels fishing in the in the Northwest and Alaska fisheries. The first observer program was initiated in the California tuna fishery, to collect data on dolphin bycatch. The second program put US observers aboard foreign fishing vessels in the North Pacific and Alaskan fisheries, to track halibut catch and trawl bycatch. Both of these programs were the product of US relations with international management commissions. With the onset of the MSA in 1976, and the subsequent American Fisheries Promotion act in 1980, the observer program expanded to increase coverage of foreign vessels fishing in US waters and to observe domestic fisheries (as previously noted the MSA extended

US territorial waters to 200 miles offshore, expanding the geographic scope of the domestic fisheries).

By 1990, all foreign fleet activity in the West Coast and Alaskan fisheries had ceased, making the foreign observer program obsolete. At the same time, the North Pacific Fishery Management Council (in Alaska) initiated a domestic fishery observer program, the North Pacific Groundfish Observer Program, which is one of the largest observer program in existence today.[10] Throughout the 1990s, the West Coast whiting fishery carried observers voluntarily. Although by and large the whiting mid-water trawl fishery is considered a 'low bycatch' fishery, the bycatch of concern in the fishery is chinook salmon, a species monitored under the Endangered Species Act. Because there was no regulation, and therefore no funding or administrative apparatus to oversee the program through the PFMC or the Northwest Fisheries Science Center, these efforts were supported through the Alaska Fisheries Science Center and the North Pacific Observer Program (Brooke 2015).

After the fisheries disaster declaration in 2001 NMFS instituted regulations, which put in place the West Coast Groundfish Observer Program (WCGOP). The WCGOP is a collaborative partnership between the NMFS and the Pacific States Marine Fisheries Commission (PSMFC). The PSMFC is an interstate agency representing Alaska, Washington, Oregon, California, and Idaho operating as a neutral party (meaning they have no regulatory authority). They serve in a variety of capacities, including coordinating research and managing data and can act as the primary contractor on federal, state, or otherwise issues grants. This final point has proved significant in recent debates and transitions in the electronic monitoring program, which I will

[10] This program was restructured in 2013 after coming under much criticism that there was sampling bias through the vessel selection process. The program required 100% observer coverage for vessels greater than 125 ft., and 30% observer coverage for vessels 60-124 ft., vessels under 60 ft. were not sampled. A 2004 report determined that vessels sampled less that 100% needed a more statistically sound selection method. The NPFMC has been developing an EVM program in this fishery to overcome the challenges of placing an observer on vessels under 60ft.

discuss in later chapters. When the program was initially put in place, it was federally funded and observers were required to sample 25-30% of the fishing trips happening in the fishery.

When the state implemented the quota program in 2012, the WCGOP was split into two sector specific observer training and deployment models: catch share (quota) and non-catch share (limited entry and open access) (Figure 5). Within the quota program, there was a shift in management towards responsibilizing individual fishermen through “100% accountability”. The Non-Catch Share fisheries were still required to have observers, but the difference is that they sample a much smaller percentage of trips, dependent on the fishery and ‘sector’ or gear type used (https://www.psmfc.org; PFMC and NMFS 2017). Because the catch share program makes up a larger segment of the sector than the non-catch share, a much larger percentage of observer’s hours are going to the trawl program (9,128 observed days in the catch share and 1,883 days in the non-catch share program in 2012) (NMFS 2013).

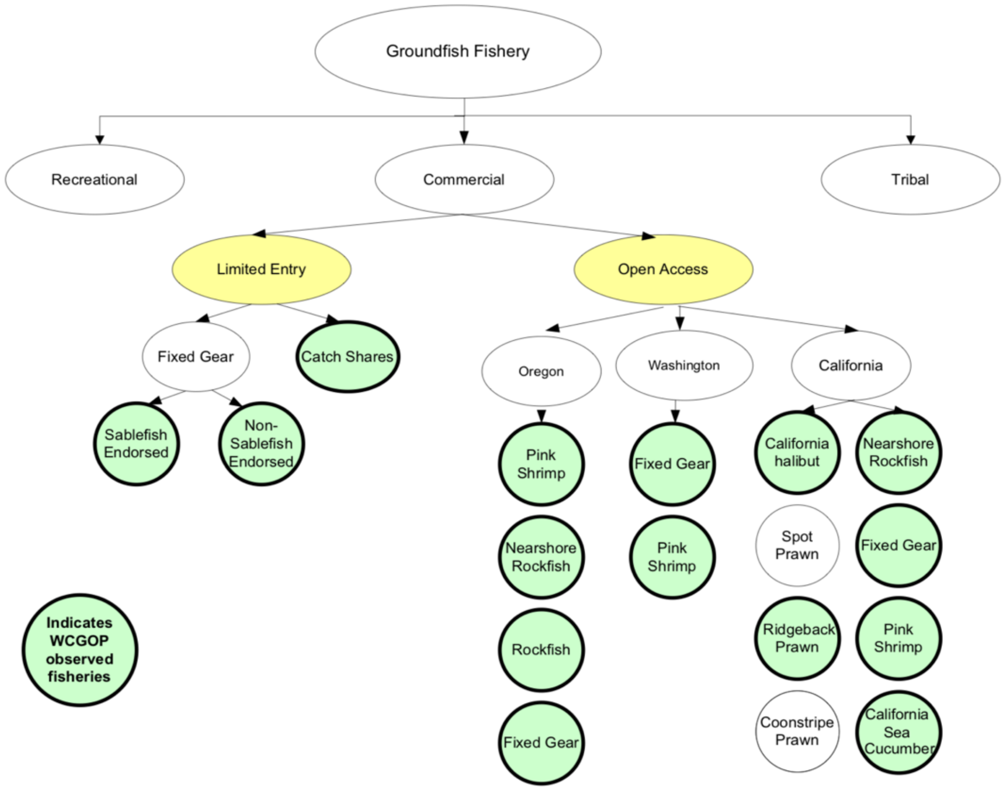

Figure 5: Fisheries Sectors Observed in the WCGOP (Reprinted from NWFCS 2019, WCGOP Training Manual)

Everything a fisherman catches in the quota system, whether it is discarded or landed, counts against their individual quotas. The logic of the quota system is that it is supposed to counteract the 'tragedy of the commons' scenario and disincentivize bycatch. Economists and managers assume fishermen act as self-interested rational actors, and that in open access fisheries, there is little economic incentive for them to not discard, even if the gains are only short term with long term detriment to the fishery. Quotas are meant to make fishermen accountable for what they catch and release. Yet, many have argued that quota systems create perverse incentives for fishermen to engage in dishonest and irresponsible and unsustainable fishing behaviors. Therefore, managers decided, there needed to be additional measures in place to surveil fishermen 100% of the time to ensure 100% accountability (PFMC and NMFS 2010). In other words, they must carry an observer during all fishing trips, to account for all catch and discard of species for which quota is allocated. Under the quota system, fishermen now owned part of the fishery, so mangers determined that because they had a vested interest, the cost of monitoring should be borne by those with a stake in the fishery.

5.3.2 Becoming an Observer

Observers are required to have a Bachelor's Degree with a strong background in the biological sciences. Qualified candidates undergo a certification process that entails a three-week training program. For the West Coast and North Pacific observer programs, these trainings take place in Seattle. Observers in the WCGOP are provided a training manual more than 600 pages in length, which instructs them in a variety of topics needed to perform the technical and social tasks of their jobs. For example, they learn procedures for data documentation and reporting, error review and quality control, the logics of random sampling, and rigorous sampling protocols, which are dependent on gear type and fishery. After a fishing trip they complete a briefing with a staff member at the science center. In order for an observer to maintain their 'certification' needed for deployment, they receive regular performance assessments and evaluations which document their data quality, and must pass a yearly fish identification exam.

Observers hold a liminal position as both a private contractor and a representative of the state. Observer providers are third party companies with whom observers are contracted. Technically, the provider company serves as the observer's employer, but all certification, training, debriefing, and performance review is done by the Federal science center for the region. Although observers are required to report fisheries or other legal infractions, they are not endowed with any power to enforce the law. They are, however, able to prevent a boat from leaving the dock if they do not pass a Federally mandated safety check.

5.3.3 Observer Data

As with most natural resources, fisheries management is highly scientized and decisions are mandated to rely on the 'best available science'. Stock assessments are a key component of how marine management decisions are made. A "stock assessment" is a process through which fisheries scientists use models to make "trained judgements" about fish stocks, particularly in relation to changes in socioecological conditions. Assessments make claims about the current conditions of a fish stock, such as the health of the stock and whether it is overfished or subject to overfishing, and also offer predictions about the future status of the stocks under different scenarios. Scientists use a variety of data streams for stock assessments, but data primarily fall into three categories: data collected about fish (biological/abundance), and data collected about human-fish interactions (catch). Biological and catch information that are collected by observers are framed as a critical data source for estimating the current and future health of a fishery. Catch data describe human-fish encounters, such as removals, releases, or unintended encounters with fishing gear. This data is used to characterize anthropogenic pressures on a stock. Observers also collect biological data from the fish that are brought in for harvest, providing stock assessment scientists information about the lives of the individual fish (reproduction, age, size, patterns of movement, mortality) which is generalized to the stock (https://www.fisheries.noaa.gov/national/fisheries-observers/using-observer-data, https://www.nwfsc.noaa.gov/research/divisions/fram/observation/data_products/index.cfm).

Observer data is widely recognized as the gold standard for bycatch calculations and fisheries management more generally (Brooke 2015) and observer are understood to be "critical to fisheries management" (Interview, EVM05). Observers are the 'eyes on the sea'. Managers and scientists assume that without observer data there is no way to know what is actually happening on fishing vessels at sea, despite self-reporting requirements for fishermen such as logbooks (Interview, EVM03). In the groundfish fishery, one of the main goals of the WCGOP is to collect data on discard rates, or bycatch. As the quote below indicates, the onset of the observer program signaled a distinct shift from reliance on speculative modeling to data driven regulatory logics. Additionally, this also signals a change in how bycatch is done through science and management practices, and a growing emphasis on the materiality of bycatch, and its measurability.

> Before 2001 the groundfish fisheries were managed mainly through landed catch with limited data available to support the commonly used discard estimates. This approach required discard modeling with little to no actual discard data. Since the onset of the WCGOP in 2001 discard information has been collected by observers greatly improving the discard estimates (PSMFC website as of April 2019, https://www.psmfc.org)

There is some danger inherent in this kind of regulatory framing, although this is not to dispute the importance of fisheries data. Foremost is that this framing conflates the health and sustainability of fisheries with the amount of data we have about them. Equally troubling is that data are depicted as mirroring the environment, divorced of the broader social and political processes from which they emerge and obscuring the ways in which data produce the environmental objects they are intended to describe (Gabrys 2018).

Observer data can take many forms, but at a minimum they describe a vessel's catch such as the composition of species, lengths, weights, and sex, and biological samples from harvested fish, and descriptive information about each 'haul' or harvest event while also producing trained judgment such as estimating the vessels bycatch (incidental catch or discards), and the condition of fish released at sea (NWFSC Observer Program webpage as of April 2019, https://www.nwfsc.noaa.gov). Data about catch is used for quota management in the vessel accounting system. Information about what is landed and what is discarded undergoes a process of extrapolation to estimate ‘total catch’, and that data is made available 11-12 months after the fishing year has ended (NMFS and PFMC 2017). Monitoring data and observer data are often spoken about interchangeably.

5.3.4 Ordering Life

Observer companies, fishermen, and fisheries regulations all play a role in ordering the spatial and temporal dimensions of observer life. To that end, observing is packaged as a lifestyle, and ascribed a particular adventure-bound wanderer aesthetic. These discourses are produced in brochures and job advertisements, but also through observers’ understandings of themselves. For example, a brochure about the observer program distributed by the NMFS Alaska Fisheries Science Center describes working as observer as “adventurous and rewarding”. Observers to-be, receive information to prepare them for “life as an observer”, including safety at-sea training and basic information about the fisheries management process and regulations.

Fisheries observation is a physically, mentally, and emotionally strenuous job. As one former observer put it “It's a very passive title for a very active job. “Observer” to me, that's somebody who stands and watches. No observers are up to their armpits in fish and crab sorting through them and sampling. And we're out there on the deck too in the weather.” (EVM35). Observers live aboard the boats to which they are signed during fishing trip assignments which can last a day to several weeks in the US fisheries (longer trips may happen in international fisheries). While on assignment, observers share quarters, meals, and facilities with crew members, usually in confined spaces. Though their presence is mandated, it is not always welcome, and may in fact displace a crew member or the captain from their bunk, either forcing them to sleep on the floor or miss the fishing trip altogether. Life at-sea subjects observers and fishermen alike to extreme weather conditions, bodily ailments such as sea sickness, the perils of treacherous sea conditions and bar crossings, and injuries. While at sea, communication with land-based networks and medical attention may be limited or nonexistent. This segmentation of observer life and fragmentation from the wider observer community can have negative repercussions. As one former observer explained "observers are out there on the boats. They're out at sea for long periods of time. They are working on their own, sometimes physically and socially hostile situations and trying to collect data. Um, it can be a little isolating" (EVM35).

Unlike a traditional job with fixed hours or shifts, observers are on call during their contracted periods and must be physically present and ready to report to duty when a vessel notifies them of fishing trip. They sometimes must travel to ports far from home, and may be at sea for days or weeks at a time. Observing follows the schedule of the fishermen, and fishing can occur at all hours or on a 24-hour schedule. It is not uncommon for an observer to work a shift lasting 10 hours or more, to have short breaks for sleep and rest between observing shifts, or to be roused from sleep during the night to observe a haul. For example, one observer explained the how an 'average' workday on the vessel might start.

> captain and crew are required to give the observer a 15-minute notice that they are hauling back or hauling gear. What this means is I'm sleeping on my bunk. Someone comes in, yells at me or pokes me and says, Hey, we're hauling back. And typically it takes me about 15 minutes to get there and get ready. So then I have to hop out of the bunk, get my deck sheets and get my rain gear on, get my sample stations set up and get ready to just sample (EVM22)

The kind of gear used may impact when, how long, or how often a fishing haul, and therefore observer shift, will last. An observer in the partial coverage fishery said " we might do as little as an hour a day work, I've also done a 36-hour day" (EVM22). Gear type will also dictate the spatial configuration of observer work, and therefore whom they get to interact with on a boat. This subtle ordering of time and space, structures the daily lives of observers both on and off the clock.

Scientific, political, and economic dimensions of a particular observer program and fishery also play a role in ordering what one observer I spoke with termed the 'social structure' of the program, with drastic implications for the observer's experience. For example, in a partial coverage program, a program that only requires an observer for 30% of fishing trips, the vessels, captains, and crew, are far less experienced with carrying observers, resulting in greater incidence of harassment or issues with providing accommodations (EVM22).

5.3.5 Epistemic Virtues and the Scientific Self

> "Observers can take pride in the knowledge that their work is essential to effective fisheries management in the North Pacific" (North Pacific Fisheries Science Center Brochure)

Observers seek to become good scientists through careful disciplining and regulating of the scientific self. Doing so produces observers as docile environmental subjects, eagerly internalizing the epistemic virtues of institutional statistical sampling protocols, objectivity, and accuracy. Deviancy is characterized by poor data quality, under producing data, or breaking from protocol. It is useful to think with Daston and Galison (2007, pg. 187) who theorize the internalization of scientific virtues as disciplining the scientific self "by rules of method, measurement, and work" noting that "a lack of sufficient discipline indicated character flaws".

As with most jobs, observers demonstrate their qualifications through the breadth and depth of their experience. They quantify these dimensions through 'days at sea' (rather than years observing) or number of vessels or fisheries observed. While I was recruiting observers for this research, this was usually one of the first pieces of information that they would share with me during an interview or recruitment screening. During our interviews, observers would account with great detail and precision their daily activities, taking care to note corrections if they had disordered or forgotten a step. These mimetic encounters signaled to me the ways in which observers render scientific their own experiences and performances of themselves. In the following quote, an observer explains to me the steps taken once they got a deployment order from a field coordinator:

> I'm in a hotel. So I frantically packed my things because it takes, they want to leave in two hours, which means I need to complete the vessel safety checklist before they sail. So I quickly pack all my things and check out of the hotel and make sure that I have all of my essential gear packed properly and my baskets. And then I collect my sampling gear, which are my baskets from the storage container where we keep it, and then I call a taxi or take the shuttle bus to the vessel where after. well at this point I've already contacted the vessels. telling them that I'll be there at such and such a time. that I anticipate being there at two o' clock, if you will., And then I take the shuttle or the taxi to where the boat has told me they will be. I board the vessel, introduce myself that I am their observer. And ask if we could please complete the vessel safety checklist and then a hand him over any appropriate paperwork, that I need to, it's usually some sheet introducing me. (EVM22)

5.3.6 Surveillance through Science

Although their presence serves as a form of disciplinary surveillance, extending the gaze of the state over fishermen, they too are under constant surveillance. Through the careful and omnipresent observation of observers at work, the institution of science-management is able to mold their practices. Standards which are used to measure the performance of an observer are determined by historic records for a particular vessel, fishery, or fish's life cycle. The data an observer collects therefore serves as a conduit for surveillance, both of their own performance and that of fishermen. Data errors result in disciplinary actions or interventions to understand, modify, and regulate the observer's behavior, but more subtly such infractions call into question their identities as professional scientists. Therefore, it is through ritualized practices of sampling, record keeping, and data entry and management that observer regulate their own bodies and behaviors and perform their subjectivities.

The culture of surveillance is inculcated early on in an observer's career, as demonstrated by this description of an observer's first 90 days of deployment.

> early in those 90 days, or at least within halfway, they have to go in for what we call a mid-cruise where we have different field offices. So they have to go meet and sit down with our field office person and they kind of look at their data because now you have their true raw data in hand… and so this whole time we're monitoring. Then ultimately what will happen is they will come back after 90 days maximum so they can only go to see for maximum 90 days and they will physically come to Anchorage or come to Seattle and sit down with somebody, a debriefer, and they will go through their data with a fine tooth comb and they will interview them like you and I are interviewing each other. (EVM02)

Technology has come to play an important role in allowing observers to surveil and regulate themselves. Tablets are now used for raw data collection and data submission. Observers can enter the data as they collect it at sea, and the program will flag data entry errors or missing data either in real time or during an error report once the observers are back on shore (EVM34).

Beyond the rigors of actual data collection, observers are expected to perform the role of 'scientist' by governing the conduct of their everyday activities, in accordance with normative societal expectations. In the 'Observer Qualifications' section of the training manual it states:

> WCGOP observers have an important image to maintain as professional scientists. Observers must avoid behaving in any manner that could adversely affect the public's confidence in the integrity of the observer program, the data provided, or other observers. Since observers reside in the same small communities as their vessel crews, maintaining a professional attitude both on and off the vessel is very important.
> (NWFSC 2019, WCGOP Training Manual, pg. 2-5)

In other words, an observer's ability to maintain public perceptions of how a scientist *should* act in their interpersonal dealings is conflated with their ability to actually adhere to standards of data quality. Although an observer must conduct themselves as scientists through the specific tasks of their work, for example while collecting data during a fishing haul, they must also perform this identity by other mechanisms during daily life on the boat when not observing (e.g. between fishing hauls, while sleeping, while eating dinner), or in the community where they live. These expectations not only constitute a kind of emotional labor, but also imply that observers are always under the watchful gaze of society. Surveillance is pervasive in all aspects of an observer's life, and they are subject to the possibility of being surveilled at all times.

5.4 Observer Administrative Apparatus

There are numerous observer programs operating nationally and internationally in fisheries all over the world such as in the Pacific and South Pacific, Eastern and Western Atlantic, Indian, and Antarctic Oceans, as well as in the Mediterranean and Irish Seas. Management can occur at the state and/or national level, or sometimes falls to international fishery management bodies in the case of highly migratory species such as tuna which is overseen by the Inter-Tropical Tuna Commission.

In the US, the MSA tasks regional management councils with developing observer programs for the fisheries under their purview. NOAA NMFS Office of Science and Technology operates a National Observer Program, which supports and coordinates regional programs. Regional observer programs determine the goals for their particular program (e.g. monitoring, data collection, etc.) based on the idiosyncrasies of the fishery and the fishery management plan, the data needs of stock assessment scientists, and permit requirements. Based on this information they will outline an 'observer coverage plan' which delineates how and where observers are distributed across fisheries and fleets and sampling methods and protocols. There are currently 11 observer programs operating across the six management regions in the US. According to the most recent annual report I could find (NMFS 2014), in 2013 there were 917 observers deployed across 48 different fisheries logging 77,610 days at sea (down from 974/83,000 the year prior).

There are several observer programs currently operating along the West Coast and in Alaska. Programs are linked to particular fisheries (e.g. groundfish or at-sea hake), regional management and science centers and regulatory bodies, and fishery maritime geographies. The goals and objectives of each program are dependent on the management plans, conservation agendas, and permitting structures of the specific fishery in which they are deployed. Goals take one or more of three foci: observing for marine mammal, protected species, and seabird interactions; monitoring for regulatory compliance; and scientific data collection for fisheries management. This research focuses on the shore-based fishery observer programs that also use EM systems, primarily the West Coast Groundfish Observer Program (WCGOP) with mention of the North Pacific Groundfish and Halibut observer program for reasons outlined in chapter two.

5.4.1 Contract Research Organizations in Fisheries Observing

Originally, observers were hired as Federal employees and NMFS found job candidates through the Civil Service Commission register. Because the work was difficult and often seasonal, it was not uncommon for employees to resign after a few seasons, exhausting the pool of potential candidates from the register. In response, the Fisheries Service decided to hire observers as contract workers, rather than federal employees. The first exclusive contract for observers was established with University of Washington School of Fisheries, in 1975 (a second contract was awarded to Oregon State University in 1978). When the MSA expanded the observer program to domestic needs, NMFS needed to increase the number of observers on staff. Officials assumed that a national effort to reduce the federal workforce meant they would not be granted the necessary personal ceiling needed. A supplementary observer program was authorized in 1983, to allow NMFS to meet additional observer needs in the foreign fisheries through approved private contract observer companies, paid directly by foreign vessels (US Government Accountability Office 1985). By 1996, the observer workforce had been completely outsourced to private industry.

The decision to make third party contracts the dominant model was fraught and soon came under scrutiny. In 1983, at the request of House and Senate subcommittees, the US General Accountability Office (GAO) conducted a review of the Foreign Fishing Observer Program. Of the many issues raised by that report, including safety and health issues, training, and data use, the GAO found several issues with the contract observer arrangement. First, there was debate as to whether and observing was an "inherently governmental function" thereby precluding it from being eligible as a commercial activity under policy (OMB Circular A-76). Furthermore, because NMFS oversaw the training and debriefing of contract observers, Federal employees were in effect establishing an employer-employee relationship, which violated civil service laws (GAO 1985). Although NMFS was aware of these potential violations when considering moving to a contract workforce, they still adopted the model. The argument, as per the GAO report, was that NMFS believed that they would not be able to meet observer staffing needs due to limitations on staffing ceilings resulting from Federal rollbacks meant to downsize the workforce. Yet, the GAO report found that NMFS never fully explored either the actual staff ceiling or the cost of provisioning research services in house. Ultimately the report found that NMFS was in violation of policy because the employee-employer relationship between contract observers and Federal employees.

5.4.2 Observer Provider Companies

Despite early concerns about the use of private companies, a robust third party provider industry has come to dominate fisheries observation. Observer providers must be certified by NMFS to be able to do business. Four companies currently operate in the West Coast and Alaskan fisheries: Alaskan Observers Inc, MRAG Americas Inc, Saltwater Inc, TechSea International Inc. The company coordinates hiring, transportation, benefits and salary, and coordinates contracting with fishing vessels and observer deployment. Observers are hired as contractual workers, and contracts can vary in length from a single fishing trip to more than a year.

Prospective provider companies must obtain permits to provide observer or catch-monitor services. The process entails submitting an application to NMFS (renewed annually) and once awarded the provider can contract directly with fishing vessels. The application requires information commensurate to a basic job application and cover letter. Prospective provider companies must list their prior experience and qualifications as administrative units (e.g. hiring, recruiting, personnel relations, placing and supporting a remote workforce) and describe their ability to satisfy the list of provider responsibilities outlined in federal regulation. Regulations pertaining to observer providers primarily define expectations around managerial and administrative tasks, e.g. how to conduct communications with program officers, observers, and vessels, guidelines for insurance, safety, gear replacement, maintaining and submitting records as requested etc. There are only a few stipulations related to scientific tasks, and these are minimal at best, for example providers must make sure that data is kept confidential and may not release data without observer permission, they must ensure that biological samples are transported safely. Finally, provider companies must provide a list of all affiliated personal and board members, describe the organizational structure, and list any potential conflicts of interest, criminal charges, and performance ratings on other Federal contracts. Conspicuously absent from the application is any reference to the scientific practices or ethics of the observer provider (https://www.westcoast.fisheries.noaa.gov/fisheries/management/groundfish_permits/groundfish_fisheries_permits.html).

5.4.3 Observer Program Funding

> We need continued funds for re- search. If something becomes a real high-profile issue, it gets funding for two or three years. Then all of a sudden everybody goes on to the next problem…At some point, I see us moving to where the industry is going to have to fund some of the research. (Alaska Sea Grant 1996, pg. 148)

Funding has been a longstanding issue for fisheries data collection. Historically, the observer program was funded through industry and indirectly through Congressional conservation and fisheries management allocations. After the National Observer Program was established in 1999, Congress began directly appropriating funds to support the program budget (NMFS 2013). There are two categories of costs associated with observers 1) program administration which includes training, gear, debriefing, and data management and 2) observer fees such as salary, insurance, and transportation. Federal allocations cover program administration costs, and funding sources for observer and electronic monitoring technology fees differs by region and observer program. In some regions, fees and technology costs are funded through industry either by an ex-vessel tax on landed catch, or the fees are paid directly by the vessel to the observer or technology provider company in what is known as a 'pay-as-you-go' or third party system. In other cases, the program is subsidized by the federal government.

In the West Coast groundfish fishery, the dominant funding model (known as service delivery model) is the pay-as-go system in which vessels contract directly with certified observer provider companies. This third party system is associated with the quota program. A second system also operates in which the federal government funds the observer fees for the limited entry and open access fisheries (non-quota). In these instances, observers are employed by the PSMFC through a federal contract.

Prior to the quota system, observer's fees were paid in entirely by the federal government. But because the quota system required a ratcheting up of observer coverage, the costs were two high for the Federal government to carry. Therefore, the quota system marked two steep adjustments for commercial fishermen. Not only were suddenly subject to 100% coverage (up from 25%) but they were also incurring the expense of observer fees. This was in addition to the buyback loan repayment fee they had begun incurring in 2004 and a controversial cost recovery fee taxed on landings to cover the administrative costs for the government to oversee the quota system. In an effort to buffer the economic impacts from such a dramatic change, the Federal government subsidized the West Coast observer program observer fees from 2011-2015, handing over total coast burden to industry in 2016 (PFMC and NMFS 2017). According to a five-year review report issued by the PFMC and the NMFS (2017), in 2015 vessels' average monitoring cost was $402 per day, or four percent of revenues, for either observer or electronic monitoring. For reference, in 2013 the national observer program had a budget of about $70.5million, $17 millions of which was industry funded. The WCGOP received $10.5 million in Congressional funds with an additional $1.6 million paid by industry (this was up from 2012 when industry paid only $247,000 as the quota program Federal subsidy began reducing).

5.5 Impacts of Neoliberal Fisheries Science Regimes

Time and again the private company 'service delivery model' has come under criticism for issues related to conflict of interest and jeopardizing data quality and accuracy. Observer programs using the model, in the North Pacific, have undergone internal and external reviews, all of which have cited issues with the private contractor model and recommended finding alternatives or developing more direct government oversight (GAO 1985, MRAG 2000, NOAA Office of Science and Technology 2000, Office of Inspector General 2004). Most criticisms target the relationships that emerge when vessels contract directly with observer providers, as I will detail below.

Nevertheless, cases in which the Federal government contracts directly with a provider, and the provider Federal certification system, are found to be similarly fraught. In both instances, there are few mechanisms for actually assessing provider performance. In the case of certification, the provider is in no way obliged to uphold standards for data quality or accuracy as they have no contractual arrangement with NMFS (MRAG 2000, Office of Inspector General 2004). According the 2005 and 2006 National Observer Reports, NMFS contracted with an advisory organization to update their contractor request for proposals (RFP) reflecting the OIG recommendations for including performance based language and measures. I was not able to locate any information as to whether the updated RFPs were evaluated, or how it changed the actual proposal evaluation and contracting process.

One of the biggest concerns with the private observer provider industry is precisely that the companies must operate according to capitalist logics. As private companies, they compete against other provider companies for vessel contracts. Companies might compete in overt ways, such as offering their services at the lowest cost to the vessel, or in more discrete ways (i.e. minimizing HR issues such as safety or other observer violations, which will be discussed in a later section). Two reviews of the contract observer provider model conducted in 2000, specifically identified competition between companies as jeopardizing the scientific integrity of the program, as noted in the quotes below. Despite this concern raised in 2000, the pay-as-you-go model was adopted to meet observer coverage needs for rationalization in 2011.

> competition amongst certified companies creates an environment where the quality of data is not a consideration. The observer companies consider the goals of the NMFS secondary to the needs of industry under the current SDM [Service Delivery Model], and in reality they need to in order to remain competitive. In this way, cost concerns outweigh data quality concerns. (NOAA Office of Science and Technology 2000, pg. 332).

> The existence of competition for industry clients amongst the observer companies has eroded the confidence in the reliability of the data, particularly when there is virtually no

> mechanism for government control over observer company performance (other than decertification) (MRAG 2000, pg. 53)

As a business, observer companies prioritize their bottom line. Federal regulations set minimum standards for observer pay, to which observer companies must adhere. In order to cut costs, they look to dimensions of the business that are not federally regulated, such as data quality and quantity. One observer from a partial coverage fishery explained the translation work they must do between states and provider company expectations.

> There's some wiggle room or discrepancy between what are the observer provider expects of their observer as far as work and between what NOAA and the observer program expects of the Observer. The Observer wants you to collect as much data as possible and still be safe, so if you do 18 hour days every day for a month, then they want you to do that. (EVM22)

This discrepancy arises because observer companies, in the partial coverage program, are required to pay observers overtime when they work for more than 8 hours during a trip day. For example, if they are at sea three days, anything over 24 hours logged for the trip would be paid overtime. Therefore, the observer provider discourages observers from working overtime, and too much overtime or overtime too frequently will result in a warning from their employers.

5.5.1 Geographies of Science and Inequality

Observer and monitoring costs and program fees are a point of contention amongst fishermen and between fisheries and fishing communities. As such, program cost and funding is an important site of power relations in the observing and monitoring programs. As noted in chapter three, the buyback and rationalization programs created geographic inequalities between fishing communities along the West Coast due to job loss, and loss of fishing revenues and infrastructure. Similarly, the loss of vessels and permits impacted scientific infrastructure. Fisheries observers or often placed in a particularly active port community, or in a port complex, to reduce time and travel expenses as they move between vessel assignments. When ports lose vessels, reducing overall need for a local observer, the observer might be relocated or sited in more active ports. This makes the observer less physically available to the remaining fleet, requiring more coordination and future planning, and limiting short notice trips that capitalize on good weather windows. It also increases the observer costs of remaining vessels that must compensate observer travel time and expenses. As this fisherman's quote illustrates:

> take Bellingham, Washington for instance, it's a remote area for the, for the observer base, you know, there's boats in the wintertime when the 14 hours from the fishing grounds, they get an observer. They either have to hotel them, some will just stay on the boat, the costs, they get way more down in Monterey down in mid California. Observers don't live down there, so they have to get there and then the weather turns bad. And so the costs are constantly they're being told, you know, you have to pay the transportation fees. And so their observer might cost them much more than $520 a day by the time they add on. (EVM16)

Additionally, reduced fishing infrastructure limits the availability of shore side monitors, as noted by a program administrator:

> we have seen in this program, particularly with EM coming onboard, that has made it very difficult for remote ports to operate because when EM takes the place of the observer when at sea, most of these observers, when they come back to shore, they take off their observer hat and put their catch monitor hat on. And so they serve as, the monitor and the plant. But if you don't have that observer because you're a replaced it with a camera and there's no one to fill that role (EVM21)

As noted in the introduction to this chapter, the pursuit of science and surveillance as simultaneous goals in the observer program has been cause for confusion and agitation. One of my interviewees, a fishery manager and former observer, explained emphasized the scientific aspects of the program, yet acknowledged the concerns over surveillance.

> It's a way that you get on the ground data, biological data catch data that then is used to make fisheries management decisions and biological decision. It's an important aspect of there… A number of the fisherman still think it's like big brother and having to have, it'd be like a farmer having to have a cop with them all the time out while they're harvesting, it's more about collecting the biological data than any sort of waiting for them to do something wrong. (EVM35)

The quota system has only served to magnify these tensions by ramping up the use of contract research organizations, and restructuring the program funding structure. Under the 100% coverage program, the state is no longer able to cover the costs of observing, and the stated program goal of compliance monitoring for catch accounting shift the burden to fishermen who must 'pay to play'. Yet catch accounting alone does not provide scientific and biological data. At the risk of losing a critically important data stream, managers are then left with the choice of either doubling up on observers, one Federally funded and one industry funded, or having industry funded observers collect scientific data for stock assessments. Adding one observer to a vessel is already no small task, therefore adding a second observer would not only likely be deemed a redundancy and poor use of resources, but would also likely be physically impossible given the limitations of vessel and crew capacity. According to one fisherman I spoke with, NMFS has recouped the data loss by having the industry paid observer fill in the gaps.

> I think we are paying a far undue burden, more than we have to be paying because basically the goal for IFQ is to account for IFQ species or account for what you catch and kill… It's a hundred a hundred percent accountability. So I'm not catching something that's not getting counted. Well yes they [observers] do that but they also spend a lot of the time on the science things, things that make no difference to my fishery at all. And some of them do have something pertaining to my fishery, but have nothing to do with catch accounting and have more to do with sizing and aging and doing things for stock assessments and doing things for... Well I don't even know what a lot of it is for, but the observers spend a lot of time doing that, and I'm paying for it. Yeah. I feel I'm paying for it. (EVM15)

5.5.2 Career Scientists

Outsourcing observer contracting to private companies has impacted fisheries observers as well. In addition to questionable safety standards and health benefits, and inadequate support and/or recourse in cases of harassment or assault (DiCosimo 2017), contracting through an observer provider company, rather than through the federal government has stymied the growth of 'observing' as a profession, and retention rates are an ongoing issue for programs nationwide.

According to the 2004 Office of Inspector General's program review, observers felt "it would be beneficial to both them and the program if they better understood how their data collection efforts fit into the NMFS mission." (2004, pg. iii). The report recommended that more training on data usage could both improve ongoing issues with observer retention and data collection practices. Yet my interviews suggest that the programs operating in the West Coast and North Pacific place little emphasis on educating observers about how data is used. When asked if observers had much interaction with stock assessment scientists, one of the primary data users, administrative informants indicated that more could be done to develop those kinds of opportunities. The quote below is from one administrator, it indicates that while they intentionally keep the details around data usage somewhat vague, the motivation is to ensure disciplined compliance. The assumption is that, should observers have too much knowledge about how data is used, they may break from protocol.

> We don't really explain to the observers how the data is used, we explain to the that it is used and it's important and that it's important to follow our protocols and we give them some generic examples…you don't want to send those signals that one kind of data is more important than the other. (EVM02)

The costs associated with observers have proven a major obstacle both for maintaining fully Federally funded program, and for many vessel owners (PFMC and NMFS 2017). Yet the quotes below suggest that observers are not the ones benefiting from high daily fees, but instead the profits are absorbed by the provider companies. In 2016, the National Observer Program conducted an Observer Retention Survey. Below are two quotes from observer comments reported in their preliminary results:

> To retain observer, treat them and pay them as professionals. *Observers should be Federal Government employees under NOAA*. Observers need a daily sea-day pay (not hourly pay) that takes into account the highly dangerous nature of their jobs (working within the most dangerous industry in the USA). *I am making $20,000 less per year now than I was doing a similar observing job almost 20 years ago*. That is

> because the contractors are maximizing their profits while minimizing the wages and benefits of their observer employees.
>
> When I first started Observing in 2011, we had a sea day rate. *When pay changed to an hourly rate I saw my yearly salary significantly decrease***.** I've never worked so hard and sacrificed so much of my life for such meager pay. When the pay rate changed, that's when I began to look for other employment opportunities.
> (DiCosimo 2017)

Despite these complaints, several of the observers I spoke with stated they had begun observing because of the comparatively high wages. To put these seemingly contradictory positions into perspective, many observers enter into the field as their first job after college, potentially shouldering student loan debt. Observing may not offer competitive wages for a career, but comparatively may offer a higher salary than other entry level positions, with the added incentives of low cost of living, and the opportunity to travel. Further, there are still a small percentage of observers that go on to develop a career in fisheries management. While not all observers advance to careers in fisheries, many who work in upper and mid-level administrative and scientific roles got their start as observers. Almost all of the manager and program administrators that I spoke with had been observers. Observing, therefore, serves as an important mechanism through which people who make decisions that impact fisheries and fishermen can actually experience those realities. As one such administrator explained:

> It's good for our young scientists, if you look around NOAA, how many people were prior observers? Richard Merrick, who was our chief scientist for fisheries, who recently retired as an ex observer. Bill Carr, who was the northeast fishery science center director. He was a former observer. It's a great way for people coming out of school, natural scientists to, really get immersed into a fishery and if you have that perspective and you go on into fisheries management or science, I think it just makes you so much more effective at your job because you get it right, you've seen it, you know, it, you can use those experiences to sort of hone in on your work. (EVM21)

Another fishery manager and former observer discussed the ways in which being an observer has informed their work as a manger. Observing provided them a clearer understanding of fishermen's experience, but also contextualized the data they used in the socioecological conditions in which it was collected.

> I honestly think my observer experience has partially helped open the door for every job I've had since then… having that experience with the observer program. When talking to fishermen, I was able to understand what they meant when they talked about what they were doing out on the water…
>
> You know, a lot of fisheries managers rely on observer data, understanding where that data comes from and how it's selected, it made it easier to understand how I could use that data … It makes it easier for me when thinking about, okay, if we change this regulation for the fixed gear, sablefish fishery, what's that going to mean to the individual vessel? It helps me trying to keep that in mind because I've had that firsthand experience on the boat. (EVM35).

Fishermen too, are aware of the potential futures for fisheries observers. And some take this into consideration in their relations with observers on their boats.

> I view them as people living life, maybe using it as a stepping stone to further their education. And most likely being somebody else who's going to work in to managing a fishery, at least now they have some experience. (EVM16)

5.5.3 Actors in Capitalist Assemblages

That they are made subjects through different technologies of power orients observers and observer providers differently as actors in the capitalist fisheries assemblage. This shapes both the experiences of each, and the relations that unfold between them and other actors in the network.

In my interviews with administrators, no one voiced concern over potential conflict of interest in the third-party observer provider system.[11] Yet several administrators made reference to a general concern, and the safeguards put in place, to protect against observer conflict of interest.

[11] At the time of data collection there was an ongoing debate both at the national level and in the regional management council regarding switching to a third party review system for electronic monitoring data. This will be discussed in the next chapter.

> You know if the vessel's contracting a provider to put an observer on the boat. We're there to make sure that the integrity is there and that the observers are independent of bias and they don't have any sort of financial interactions with the boat that would, you know, could influence the numbers that they provide. (EVM21)

An external review of the program makes the double standard apparent.

> One apparent inconsistency between the two processes is that while lack of integrity of data quality is a valid reason to decertify an observer, it appears to not be a reason for decertifying an observer company, hence the current SDM appears to not hold observer companies responsible for their employees' work. (MRAG 2000, pg. 55)

Observer providers compete against each other for industry contracts, as with any business model, in order to maintain a competitive edge, a business must keep their client base or employers happy (NOAA Office of Science and Technology 2000). If an observer reports a vessel for a safety or harassment violation, the vessel can be kept in port and prevented from fishing. Vessels are also able to request or refuse to work with particular observers. The 2000 Management Control Review explains is this way, "The line between who is working to please whom is blurred, which may leave the observer feeling responsible for pleasing the fishing industry… it is obvious that none of the parties involved in this part of the service delivery model have NMFS as the client" (NOAA Office of Science and Technology 2000, pg. 332).

The contract observer delivery model creates precarity for observers in other ways too, by making them vulnerable to harassment and unsafe or unhealthy work conditions. This is not to say that all observers are harassed, or to characterize all fishermen as insensitive to observer health and safety. For example, fishermen I spoke with reflected on their own efforts to ensure observer comfort and safety. Similarly, the observers I spoke with had reported overwhelmingly positive experiences at sea, though some had encountered 'difficult' vessels and captains they tended to be the exception rather than the rule. Their language and description of some boats as having a reputation for being 'difficult' indicates a culture within the observer and agency community that normalizes particular kinds of behavior as status quo or simply an unpleasant but necessary aspect of the job.

Although no observer that I spoke with reported experiencing harassment there is information to suggest that harassment is not only widespread but that observers are unlikely to report that information because they are at will employees with little job security. Almost half of the respondents of a NMFS observer retention study indicated that they had been harassed during their deployment. Of those who experienced harassment, only a third reported it to supervisors, and many of those who did report the incident expressed dissatisfaction with how their case was handled. Of those who chose not to report harassment incidents, more than 30% said it was because they did not think NMFS would take any actions for recourse and more than 15% stated they were concerned about retaliation or damage to their professional reputation (DiCosimo 2017).

A former observer who now works on issues of observer safety emphasized in our interview the need for more transparency around the observer program noting that both what observers see and the kinds of harassment some is "completely secret. Nobody knows how much it is happening" (EVM05). The Association of Observing Professionals (APO) argues that confidentiality requirements have also limited public oversight of the observer program. What they are referring to is data confidentiality, as mandated by the MSA. Under law, all data is kept confidential, and only certain data can be shared with the permit holder for the vessel generated the data. This would include about catch composition, catch accounting, or biological data, information which is aggregated for public use and fisheries statistics. Social information recorded by the observer, for example things that they witnessed or experienced, gets recorded in their logbook and submitted to NMFS, but this information is not publicly available nor is it made available to the vessel permit holder (EVM21). What my informant was indicating is that observers who experience harassment would record that information in their logbook, but because of confidentiality and data protection standards, that data only goes to NMFS with no public records. To that end, they stated that NMFS was making no effort to formally track or report observer harassment reports.

> they keep saying that, you know, [observers] we're critical to fishery management, but, you know, it's not, their actions are different than what they're saying because, they're not, the agencies aren't keeping track of the harassment or protecting observer safety. The amount of effort that's being poured into, EM is way, way, way, way more. Then, you know, doing research to protect observers, so that's one of our big complaints. (EVM05)

5.6 Conclusions

Foucault posited an understanding of power as having the potential to be both productive and constraining. The productive nature of power is exemplified in this case. Neoliberal government rollbacks created the opening for the contract research organizations model in fisheries observation and monitoring. Just two decades later, the fisheries disaster declaration provided the impetus for an observer program in the groundfish fishery. Although the program relied on contract research organizations, it still had direct government oversight since contracts were run through the PSFMC. When managers implemented the quota system, the demand for a more robust industry observer industry increased. Rationalizing the groundfish fishery resulted in three important consequences for West Coast observer program.

First, the addition of quotas meant a reconfiguring of program goals, and observer roles, situating observers as important actors in the web neoliberal capitalist social relations. Observers were now used to account for quota allocations, and this was reflected in changes to observer training programs which began including information on quota regulations and bycatch retention requirements (NWFSC Fisheries Observation Science website as of April 2019, https://www.nwfsc.noaa.gov).

Second, the observer coverage requirements increased from 25% coverage to 100% coverage for commercial fishermen participating in the Catch Share Program, with fishing industry taking over the burden of observer costs. The new coverage model created inequality between fishing vessels related to costs, and further exacerbating fleet consolidation and geographic patterns of inequality based on access to observers.

Third, the shift to operating through a pay-as-you-go model meant even less government oversight over observer providers, and a dramatic increase in the number of contracts garnered by the private observing industry. In 2011, the year the trawl rationalization 100% observer coverage requirements were implemented, the WCGOP observed 9,305 sea days, more than double the previous year,[12] (NMFS 2012). Given that are only a few observer providers operating in the region, one might assume this led to large economic gains for these companies.

As will be discussed in the next chapter, the added costs of 100% monitoring became too onerous for the fishing industry. This has led to the development and implementation of electronic monitoring technologies, with the logic that cameras will provide a less expensive alternative to human observers. This constitutes a new wave of neoliberalization of science because much of the technology and data analysis infrastructure are privatized and proprietary. Yet this also represents a distinctly different tack in that the regime operates through both the logics of neoliberalism and technoscientific digitization. Some of the key debates about EVM is data ownership and use beyond intended purposes for fisheries management, with potential futures of data commodification and dispossession (Thatcher, O'Sullivan, and Mahmoudi 2016).

[12] That same year the observer program nationwide set a record for number of sea days observed. From 2001 to 2012 the number of sea days observed nationally increased from roughly 52,000 to 82,000 (NMFS 2013).

A second characteristic of neoliberal science regimes relevant to this case study is the privatization of knowledge through intellectual property protections. Differently put, under neoliberal science regimes we see the enclosure and/or appropriation of the 'knowledge commons' for the purposes of capital accumulation (Lave 2012b). I argue that this characteristic is germane to understanding how neoliberalism is reconfigured in newly emergent digital environmental science-governance regimes.

Juxtaposing the difference in the ways in which observer provider companies and observers are rendered governable, the power geometries between the two actors become apparent. Each is subject to a distinct kind of environmentality, environmentalities that are entangled in processes of coproduction and mutual legitimation. The quota program is a technology of neoliberal environmentality, and through which the state establishes the 'rules of the game'. As a complex regulatory apparatus, the quota system underwrites the market for fishing access rights. This apparatus is also complicit in the development and legitimation of the private observer provider industry. As a kind of power/knowledge, fisheries science-management provides the justification of observers by advancing a regime of truth in which: 1) more data equals more sustainable fisheries, 2) data, and data providers, must be constantly surveilled to ensure accuracy, and 3) the best way to regulate the resource, is by regulating the behavior of fishermen through a market-based incentive system, but that system can only flourish through constant monitoring of behavior and of the system itself.

Disciplinary power normalizes epistemic virtues of objectivity and renders observers docile and compliant through the routinized practices of science. Yet, as Turnhout (2018) argues, the practical effects of systems of ordering life through the techniques of measurement are always contingent. Local realities often buck the model in practice. More significantly, that while routinized practice is a site for subject formation, the situated agency of actors also makes practices a powerful (potential) site of resistance or contestation. “From this perspective, standardized measurement and monitoring systems produce subjects that are able to simultaneously work with, against and around the measurement and monitoring systems in place” (Turnhout 2018, pg. 367). Observers operate in interstitial spaces between industry, observer provider companies, and the institution of fisheries science-management. They must juggle the expectations of their employers to be a productive though economical work force, with their own environmental subjectivities to do good science. Meanwhile, navigating their own precarity in the capitalist assemblage both as an expendable labor force and as an unwelcome surveillance presence on fishing boats, and the potential for emotional or physical violence that that entails.

6 Eyes on the seas: Monitoring under digital environmental governance regimes

This chapter contributes to the literatures on digital conservation and environmental governance by examining the use electronic video monitoring technologies in fisheries, and unpacking the social, political, and regulatory implications of digital surveillance as data collection. Although there has been a great deal of attention on the role of technology for geographies of conservation (Adams 2019), few have explicitly focused on the use of technology for fisheries management (Toonen and Bush 2018). To begin to fill this gap, I analyze empirical data on the use of EVM in the West Coast groundfish fishery, collected through interviews with actors from the fishing industry, environmental non-profits, fisheries management, and the technology and data analytics sectors. Building on the arguments from previous chapters about the impact of neoliberal environmental governance regimes on the practices of science and management I propose the conceptual framework of digital environmental governance regime to understand how digitization has reconfigured these practices, and the new logics that underwrite this regime,

6.1 Digital Conservation Technologies

Digital technologies have become significant actors in environmental conservation, monitoring, and management (Adams 2019; Arts, van der Wal, and Adams 2015; Gabrys 2016; van der Wal and Arts 2015). My research builds upon the growing body of critical scholarship, which seeks to better understand what new natures and environmental subjectivities digital technologies produce. Several fruitful threads include the use of social media for conservation activism (Büscher 2016, Hawkins and Silver 2017), the deployment of digital surveillance and tracking technologies to document animals (Adams 2019) and sometimes humans (Sandbrook, Luque-Lora, and Adams 2018) in nature, or the use of drones and other wartime technologies to monitor conservation areas through ‘green militarization’ (Duffy et al. 2019; Neumann, 2004).[13]

A second body of literature relevant to this research brings insight from STS and critical data studies to bare on environmental science. This scholarship examines the epistemological and ontological implications of environmental big data, such as the emergence of global data infrastructures (Edwards 2010), the production of new environmental objects (Gabrys 2016) the emergence of new fields of data-oriented environmental sub-disciplines (Helmreich 2010). Others have questioned the role of environmental Big Data as an agential actor in environmental governance (Ascui, Howard, and Lovell 2018), and the challenges risks associated with displacing ‘conservation by algorithm’ in which he deployment of such tools moves conservation decisions further away from people affected by them and further into the hands of remote decision-makers, or the technicians who devise the algorithms on which they rely. (Adams 2019, pg. 345).

In fisheries, digital conservation technologies are now being incorporated into fisheries monitoring, meaning they are used to collect information to assess the effectiveness of management or compliance plans (Blackhart et al. 2006).[14] These technologies usually have a geospatial dimension either to track compliance with enclosure-based regulation, geopolitical boundaries, or to develop conservation cartographies (Verma, Wal, and Fischer 2015) of fish species. Examples of fisheries conservation and management technologies include drone surveillance and satellite tracking devices to monitoring off-shore fishing, cameras and other detection devices deployed on nets to reduce bycatch or assess biomass and fishing practices

[13] For an excellent summary of the geographic literature on conservation technologies see Adams 2019.
[14] The Food and Agricultural Organization and other international regulatory bodies use the term monitor, surveillance, and control interchangeably with monitoring, particularly to describe efforts to combat illegal, unreported, and unregulated (IUU) fishing.

(Toonen and Bush 2018), and video cameras and sensor systems rigged to fishing vessels to track fish harvest events.

To understand the role of digitization in shaping the socio-spatial practice fisheries science and management (Ash, Kitchin, and Leszcynski2016), I draw on several key insights and questions from digital environmental conservation, and critical data studies (Boyd and Crawford 2012; Dalton and Thatcher 2014; Kitchin 2014). First, how can the turn to big data in fisheries be understood? What are the impacts for fishermen when the use of surveillance technology in conservation and management outstrips the institutional frameworks for its governance (Adams 2019)? How does the development, implementation, and regulation of digital technologies enable or diminish existing power relations, and what new constellations of actors are produced? What is the role of data in these new configurations, particularly in producing new environmental commodities?

6.2 Digital Environmental Governance Regimes

In an op-ed piece for the Wall Street journal, the CEO of the Environmental Defense Fund (EDF), described the recent explosion of technological innovation in environmental scenes and governance as 'Fourth Wave Environmentalism". Fourth wave environmentalism, he argues, offers hope "at this moment of widespread frustration with our government's inability to address those problems, it can provide momentum outside the political arena." (Krupp March 21, 2018). A touchstone of this new wave of environmental governance are the new constellations of relations between scientists, private industry, and conservation organizations. As such, "Fourth Wave tools are leveling the playing field by giving groups such as Environmental Defense Fund capabilities once reserved for governments." (Krupp March 21, 2018).

I argue in this chapter that these new configurations of actors, and power, suggest a regime shift from neoliberal to digital environmental governance. Digital environmental governance regimes are guided by the logic that the only route to lasting environmental conservation is through the implementation of digital technologies, which carry with them the virtues of scalability, transparency, and the data they produce is more economic and technical efficient, comprehensive, and granular than other sources. It is argued that the constant surveillance capabilities of digital technologies increases transparency and comprehensiveness of the data they produce (Gupta 2010). Digital environmental governance regimes operate within capitalist logics. Under this new regime the role of government is now responsible for creating the conditions for a competitive and economically productive market for technology and data service providers because "If agencies expect EM providers to reduce costs, be competitive, and risk capital, they have a responsibility to support business environments that reward creation of intellectual property and new technologies." (Sylvia, Harte, and Cusack 2016, pg. 6).

A dominant discourse of the digital environmental governance regime (digital regime) is the modernization of fisheries management. Modernization discourse in this case reproduces technocratic ideas about sustainable development, that both continued exploitation, and environmental stewardship are possible through technological innovation, improved data collection, and management. A report on EVM produced by The Nature Conservancy and a private environmental research agency states, "There is a need to modernize fisheries management, collect reliable data on fishing operations at sea, and unlock the economic and environmental potential of fisheries worldwide, and EM has a critical role to play in realizing this future. " (Michelin et al. 2018, pg. 6). This renders a future imaginary in which unlocking fisheries' economic potential is inextricably linked to digital environmental governance through data.

Data becomes an important environmental commodity, and 'rights to data' constitute an extension of the intellectual property rights so prevalent under neoliberal science regimes (Lave 2012b). According to Kate Wing, a consultant who builds collaborations between NGOs, technology and fishing industries, and government, data ownership

> opens a large window for new data products and opportunities… Vendors could provide business analytics to vessels and fleet managers, fishermen could attach images to shipments to visually document a fish's journey from boat to plate, or fishing associations could form data trusts where members share and sell their data (Wing 2018, n.p.).

Under this regimes, fishermen must now develop themselves as dealers in data, not just fish. As an article in a popular fishing industry attests "Whether you are aware of the importance of analytics or have no idea what the term means, I hope I can convince you that developing analytic solutions is the next big step we as an industry should take. If you don't think the implementation of data analytics is important, bear with me, because it is, and it is the future, and we are one of the last industries to adopt data driven business models (Klingeneberg August 1, 2018).

In Table 3 I've outlined other dimensions of digital environmental governance regimes, and compare these different dimensions to neoliberal environmental governance. In the remainder of the chapter, I will use empirical data as examples of some of these characteristics.

Table 3: Characteristics of Environmental Governance Regimes

Neoliberal Environmental Governance Regime	Digital Environmental Governance Regime
1. Commodification of fishing rights 2. Discourse: Modernize fisheries, industrialization 3. Epistemic virtue: Trained judgment and objectivity 4. Data: Heterogeneous, statistically sound, 5. Industry: Observer Provider Companies (Contract Research Organizations) 6. Competitive market for data collection services 7. Infrastructure: Observer Program, rights, safety, and labor protection; gear provisioning - government responsible 8. Humans are an asset 9. Role of Government: scientific training, data management and analysis 10. Nonprofits act as watchdogs over fishing industry	1. Commodification of data rights 2. Discourse: Modernize fisheries management 3. Epistemic virtue: transparency and scalability 4. Data: Economically efficient, comprehensive (granular), fast 5. Industry: Technology vendors, third party data storage and analysis providers 6. Competitive market for data storage and analysis, technology provision 7. Infrastructure: Technology installation and maintenance, data storage and analysis - private industry, fishermen 8. Humans are a liability 9. Role of government: support business environment 10. Nonprofits partner with industry (and others) subsidize technology advocacy, development, usage

As discussed in chapter six, the US has historically used human scientists for fisheries monitoring. Since the implementation of the quota system, and the exorbitant costs of associated monitoring and observing requirements, there has been a move to find less costly alternatives to the current observer program. Rather than question the private observer provider model, and assuming there is no alternative to 100% observer coverage and surveillance, fisheries managers, scientists, fishermen and observer program administrators have sought out less costly ways to monitor and observe fisheries. In recent years, remote, digital video monitoring has emerged as a supplement, and potential substitute to human observers. A quote from one interviewee involved with technology development is illustrative of the dominant discourses about EVM “we're moving to the point where machines can self-navigate a lot of the tasks that humans can do they're less prone to errors and we can collect much larger data quantities much more quickly and cheaper.” (EVM07).

The US began piloting EVM technologies in the early 2000s, but it has primarily been in the last 5 years that Federal and regional fisheries management bodies have begun aggressively pushing to implement EVM in regulation. Federal Policy Directive 30-133 serves as a blanket recommendation process offering guidance to regional management councils on how to develop, implement and fund electronic technologies in regional FMPs. Although it is up to each council to determine the appropriateness of EM to the management of their respective fisheries, overwhelming NMFS’ stance encourages the adoption of electronic technology, and EVM in particular, when possible (National Marine Fisheries Service, 2014).

Since 2014, the fixed gear, bottom trawl, and midwater trawl (whiting) sectors fishing in the West Coast Groundfish had been experimenting with EVM through what is known as an Exempted Fishing Permit (EFP). EFPs allow fisheries to experiment with new management tools before they go into official regulation, and work out any issues prior to going into regulation, to help eliminate the need for amendments once a rule is in place. For the EVM the permit exempts boats from having to carry observers, so that they can explore different options for implementing EVM.

At the time of this research, the National Marine Fisheries Service (NMFS) was pushing to put the first ever national EVM policy on the books, which would cover whiting and fixed gear. Many working on developing the regional EVM program for the West Coast argue the move for Federal regulation is premature. The regulation was one of the key issues discussed at the Pacific

Fisheries Management Council meeting I attended and many of my interviewees raised concerns about the regulation. As this interviewee explained, although the EFP has been operating for four years, the fishermen and local managers do not feel ready to fully write EVM into policy.

> The National Marine Fishery Service is hell bent on having the first in the record regulation federal program for EM and that's whiting, in the country. It's like, what are you getting a cash prize for it? Or why? Why are you so set to put something in regulation? It's so hard to change federal regulations; it's such a long process. Why would you want to go with something that's not ready? But they're pushing forward. (EVM12).

The drive to modernize fisheries management is so strong that NMFS is ignoring those concerns, potentially creating tremendous bureaucratic issues down the road for fishermen.

6.2.1 Monitoring Technologies in Practice

EVM operates as a system on a fishing vessel. The components include video cameras on the vessel's exterior to document fish brought in during a net or line haul, sensors fixed to hydraulic components to signal the onset of a fishing event so that the camerawomen will start recording, GPS sensors to link location, a control center in the pilot house so that fishermen can oversee system operations, and in some cases a satellite modem. Figure 6 is a commonly used informational diagram for white papers and other reports, produced by one of the leading EVM providers. Video monitoring technologies are developed and maintained by third party companies, and purchased by fishermen, who then pay the companies yearly maintenance fees. The most widely used electronic monitoring system in the West Coast and Alaska fisheries was developed by a single company, Archipelago Marine Research, and they run a proprietary software on the devices, although Saltwater Inc, an observer provider company, has developed an open source alternative to the Arichepalgo system. Representatives from each of these companies hold positions on the Pacific Fisheries Management Council (PFMC) and the North Pacific Fisheries Management Council (NPFMC) and sit on Electronic Monitoring working groups for these advisory bodies. Although these companies manage the development and maintenance of EVM technologies, data analysis and storage for the West Coast groundfish fishery is currently overseen by the Pacific States Marine Fisheries Commission (PSMFC).[15]

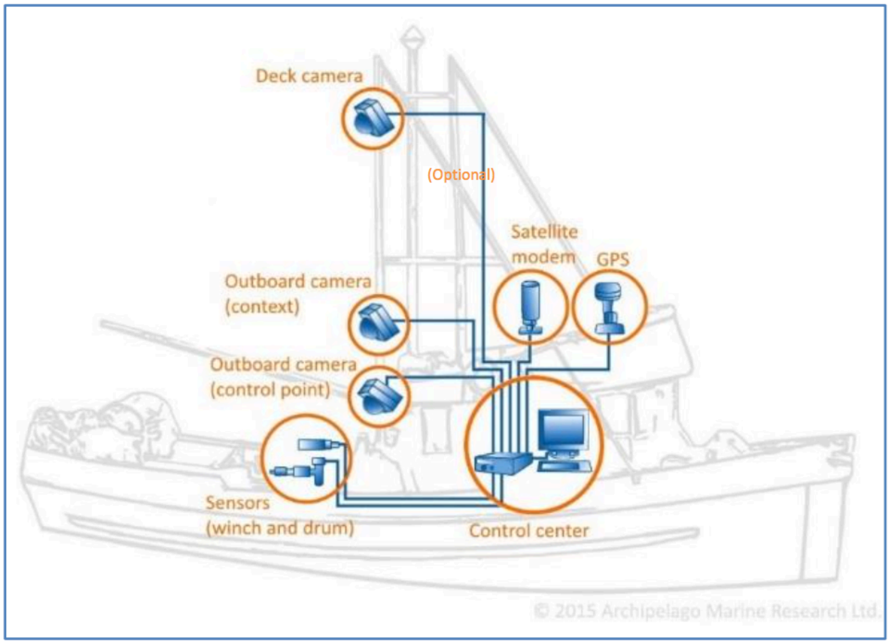

Figure 6: Diagram of an EM system distributed by Archipelago Marine Inc.

Whereas observers record harvest numbers incrementally, EVM results in a constant video stream spanning either the entire length of a fishing trip or a harvest event. The volume of data accrued through EVM is anticipated to continue scale up with more widespread use of EVM devices. Scientists and technology professionals are exploring automated algorithmic data review techniques to expedite analysis. For example, researchers are experimenting with computer vision and facial recognition software for fish accounting and ID. Using algorithms programmed with fish identification metrics, computers could identify all catch and discards, drastically reducing the volume of video data human researchers would need to review, thereby also cutting analysis time and costs (NOAA Fisheries, n.d.).

[15] As noted in chapter five PSMFC is a neutral Federally funded agency that partners with the Pacific Fisheries Management Council on the observer and EVM programs.

6.3 Technology outpaces governance

In the rush to modernize fisheries management and develop effective EVM technologies, many issues have emerged related to the more mundane aspects of administering technology and data. Digital data stream from videos are not simply a digital analog to observer data. Digital technologies bring with them a host of ontological, empirical, managerial, and technical concern such needing clear definitions and objectives, data privacy, ownership, storage, analysis, cost: in short, they require a new regime of data, technology, and environmental governance practices. Many involved in the planning and development processes have been grappling with these challenges along the way (Office of Policy and Electronic Monitoring Working Group 2013; Sylvia et al. 2017). Yet despite these concerns, there was a push to implement the technologies, and to do so quickly. As one person involved in developing the EVM program explained:

> It felt very rushed and I understand why it's because it was costing people money every year and there's a big push from headquarters to want to implement them. So that made it challenging and didn't allow us to maybe explore the full breadth of options that maybe we would have and maybe taking some time to have some more forward thinking on, well if we implement, what problems are we going to face?
>
> I really don't feel like we had the time to do that. And now that's what we'll be wrestling with next. Okay. We have a program but now we're going to start amending regulations working through, now we're in the weeds. It would have been nice to maybe anticipate some of that work ahead of time there. We had a lot of pressure to, to get something implemented, which we did and I think we've done a good job with what we're given. (EVM21)

6.4 Data Ownership and Privacy

With the observer program, fishermen are considered to be the owners of data produced about their fishing activities. This data is managed by the Federal government freely[16] and fishermen may request that data that observers collected on their vessel. 'Ownership' in this case

[16] I use the word 'freely' to denote that fishermen do not pay the government directly as a one-for-one to store their data. However, with the trawl rationalization, fishermen participating in the quota program began paying a cost recovery fee as small a percentage of revenues for general program administration, which may include data storage and management.

means that the government remains in possession of the data, but is bound to confidentiality and privacy standards. Although the data is made available to stock assessment authors and scientists, analyses must be aggregated when there is data from fewer than three vessels, to prevent revealing information about vessel landings, location, or other fishing practices. Other than scientists or managers, fisherman are the only entities able to access the data collected on their boats.

6.4.1 Ontologies Data

With respect to confidentiality and privacy, EVM currently falls under the blanket regulations of observer data. I spoke with someone involved in observer advocacy who argues it was these protections that led to the proliferation of EM projects.

> the [2006] reauthorization of the Magnuson Stevens Act happened and suddenly everything was secret and they specifically added EM in the definition of observer information… the public could not have access to these videos; they couldn't be verified. So then that's when you saw this explosion of EM projects all over the nation (EVM05)

In practice, the rules regarding privacy and confidentiality have not been as clear and simple. First of all, there is still debate as to what the 'data' from EVM actually is: the raw video footage or the counts and observations rendered from video review. Not only is this point significant from an ontological standpoint, but doing data in different ways has far reaching implications for the costs and processes for data storage, analysis, and regulation. The data object is what is held for record retention purposes. Although, for the time being, EVM data is generically classified as observer data for confidentiality purposes, there are concerns as to how final federal regulation of EVM will handle privacy, access, and confidentiality. An administrator working on the regional implementation plan explained the some of the concerns:

> it's one thing what an observer, could recollect versus having a camera running all the time. Right. And the information you could extract from those are different. And so I think with EM fishermen would have some more concerns about, well, what sort of

> liabilities does this open up for me? As far as, you know, there's often lawsuits between crewman and captains, can they just get this video now? Insurance claims or something? How long can enforcement hang on to this video and peruse it, looking for violations? That kind of thing is, I think, and rightfully so. It troubles fishermen. (EVM21)

6.4.2 Contract Research Organizations 2.0

During the EFP, the cost of data storage and review was covered by a Federal grant awarded to the PSMFC. As with the observer program, the intention was to transition to industry baring those costs. At the time of research, the regional management body was exploring the option of switching to a competitive third party review system in which, instead of PSMFC handling all data review, private review companies would compete for contracts with fishermen to review and manage their data. Because this new model creates the potential for conflict of interest (much in the same way that that third party observer contract system did), NMFS would do a secondary audit of contractor data to ensure data integrity. Fishermen would incur additional costs for this secondary audit. Despite opposition from many involved, NMFS has been pushing regional management bodies to move to the third-party data analysis system.

6.4.3 Commodifying the Rights to Data

Whereas under a neoliberal fisheries governance regime, the quota system commodified the rights to fish, the digital environmental governance regime commodifies the ‘rights to data’ about fishing activities. When data becomes an actor in the capitalist fisheries assemblage, data ownership becomes a function of property rather than just privacy concerns. In a system where fishermen pay for the data collection technologies, data storage, and data analysis, ownership takes on additional meaning. I spoke with someone from the nonprofit sector who has been working with fishermen to develop an EVM program. One of EVM’s selling points, they argue, is that it empowers fishermen by giving them ownership over their data, and therefore voice in political process.

> I was trying to impress upon them the power of having your own data set about what you're fishing activity is and that, that's kind of how fishing now in this realm where a lot of stocks are depleted, there's a lot of concern… I see the evolution of the fishing business needing to gather its own data to protect itself and to have a voice and to contribute to our understanding of stocks and, and, and what's happening as climate change makes everything happen faster and faster (EVM14)

Under a digital environmental governance regime participation in political process is coupled with 'rights to data' as an extension of private property rights in fisheries.

6.4.4 Infrastructure and Data Management

Transitioning to the digital born data of EVM as coded objects will call for new coded infrastructures (Brügger and Finnemann 2013; Kitchin and Dodge 2011) and with this comes the need to store, manage, and analyze data at a scale far greater than traditional observer data collections methods have mandated. As one program administrator explained:

> you had a lot of videos, takes up a lot of electronic storage, you know, so there's that cost to it. Whereas with observer programs, we, we have paper data, existing databases we feed it into. We don't have the same challenges as like I need $80,000 in servers to store all these terabytes of video imagery. (EVM21)

While cost is often argued to be the biggest incentive to switch from observers to EVM, the actual costs for EVM are still unknown. NOAA has funded cost comparison studies to determine if EM would be more or less cost effective than observers. The results reveal a complex financial picture of EM implementation, suggesting costs could be as little as one-third, or more than twice that of the at-sea observer program annually. (NOAA Fisheries Greater Atlantic Regional Fisheries Office and Northeast Fisheries Science Center, 2015a, 2015b; Office of Policy and Electronic Monitoring Working Group, 2013). But beyond just startup costs, the cost of storing and analyzing data is still not fully accounted for, because the government has not established a clear definition of what the data is or how it will be handled.

> They're also kind of on the hook for paying for that storage. They also understand if, if we the agency pull all that video data in, it becomes a federal record, in which case

> federal record records rules apply and we're at this point keeping it indefinitely, because we haven't quite sussed out what the records retention rules are going to be. That's an ongoing discussion. (EVM21)

The quote above from a program administrator demonstrates the wide range of possibilities for data management. With the potential to store that volume of data indefinitely, some fishermen apprehensive to sign on to the EVM plan.

6.5 Digital Inequality in Fisheries

Despite the fact that it was meant to alleviate the cost burden of observers, the introduction of EVM has actually magnified inequality for many vessels. Smaller groundfish trawl vessels would benefit most from an alternative to human observers. These vessels tend to be owner operated, with lower revenues, and the increased observer costs associated with the quota program have disproportionately affected this sector, and made it difficult for some of them to stay in business (PFMC and NMFS 2017). Yet, material and technological obstacles have limited their ability to adopt EVM. Groundfish trawlers target species assemblages, and many of the species are too difficult to identify through video image and it is too labor and time intensive to sort all of the species in a haul such that the cameras can visually log all catch (EVM21).

At the same time, whiting vessels have widely implemented EVM. As described in chapter three, whiting is a single species, high volume, high revenue, and low bycatch fishery dominated by relatively larger vessels and corporate operations. Although the fishery is low bycatch, the current management plan requires fishermen to have 100% observe coverage. In my interviews with fishermen and those involved in the observer and EVM programs, the sentiment was that observers on catcher boats (boats that catch whiting for processing on either a mothership in a shore side facility) do very little other than visually verify the captain's records on catch and discard. These vessels tend to operate as 'maximized retention' fisheries, meaning discarding is done during shore side processing (this is because they do not sort their catch at sea). In the rare instance that a vessel does discard at sea, it is usually the result of safety or operational issues. Because there is no biological data collection, the fishermen and their representative professional associations have advocated to get a Exempted Fishing Permit, a temporary exception to legislation that allows them to pilot alternative management strategies, for EVM, and through this have found it to be a less costly option. To that end, much scientific and regulatory effort has gone in to developing an EVM program for the whiting fishery to alleviate the observer cost burden, yet this sector was also suffering the least comparatively (EVM21). As one fishermen explained to me:

> So the one group that probably doesn't need help off setting costs is whiting, you know, they're knocking on the door to a 90 to 100% attainment rate. The fishery is wonderful for them. And yet, and so they get another, there was no bitterness here by any means. It's apples and oranges, but they get the golden ticket, they get to use the EVM and they do save a substantial amount over $520 a day [on observer costs]. (EVM16)

Program developers are aware of these inequalities, but the deeper they get in the process of program development, the harder it is to mitigate these issues.

> I touched a little bit on the efficiency of it, of having a third party system versus could we have put a mechanism in place to actually get funds and implement a sort of a combined observer program, and that likely would've brought costs down for everyone rather than, you know, we haven't seen that across all sectors (EVM21)

The quote above from someone working on developing the West Coast EVM program illustrates how the rush to modernize fisheries management, and the emphasis on privatizing the data analysis system, are key factors in the unequal access and experience of EVM.

6.6 Conclusions

In this chapter I analyzed the use of EVM in the West Coast groundfish fishery, summarizing some of the key debates and concerns voiced by fishermen, fisheries managers, and other involved in developing, implementing, and administering an EVM program. To contextualize these concerns within broader theories of digital and environmental governance, I proposed a new framework for understanding how digitization is shaping science and management in fisheries through the conceptualization of digital environmental governance regime. Through empirical examples from my case study, I flesh out how this regime operates on the ground.

Many of the actors involved have set out with good intentions to develop a method for collecting information about fisheries, that will support health fisheries with the least possible detriment to fishermen. Yet many unanticipated and unintended consequences have ensued such as insurmountable observer costs, barriers to access for fishermen to retain observers, and legal and punitive issues for fishermen attempting to operate in the midst of a murky regulatory environment.

Equally significant, though absent from the discussions I've observed, are discussion about how data management companies serve to benefit from new data storage practices. Where will these servers be and who will administer them? Some have speculated that in the future, cloud storage will present a viable option for EVM data. What might this mean if global corporations such as Google or Amazon become environmental data gatekeepers?[17]

[17] Corporate actors such as Google have already begun partnering with nonprofits and NGOs on fisheries governance initiatives (http://globalfishingwatch.org).

7 Conclusions

In this dissertation I adopted a conceptualization of fisheries, inclusive of science-management as a co-productive, socioecological assemblage. It is co-productive in that the institutions of 'science' and 'management', and their associated practices, discourses and identities, emerge through mutual and simultaneous social, political, economic and ecological processes, as research in political ecology and science and technology studies (STS) demonstrates (Bassett and Peimer 2015; Jasanoff 2004). Therefore, any examination of environmental policy in practice necessarily implies a critical examination of the epistemic cultures with which policy is co-produced. Fisheries science-management is a socioecological assemblage in that the relationships between human and more-than-human actors are constitutive elements influencing the social and ecological ordering that science and management perform (Pickering 1995). Like actor-network theory (Law 1994), assemblage thinking assumes that the processes of social ordering are emergent rather than a static formation: relationality is key. Assemblage is useful for understanding spatially and temporally contingent amalgamations of socioecological elements (Anderson & McFarlane 2011; Müeller 2015).

Political ecology assumes that the costs and benefits of environmental change are experienced unequally by actors and therefore seeks to interrogate the uneven power relations that imbue human-environment interactions, and the ways in which environmental management magnifies or mediates inequality. Further, geographic scale is a dimension integral to research and analysis in political ecology (Neumann 2009; Zimmerer and Bassett 2003). In chapter three I began with a history of the global fisheries science-management regime. This narrative set the stage for thinking across scale to understand how the current issues in the West Coast fishery, and the monitoring programs meant to mitigate those concerns, are situated within broader historical global networks and processes. First, the fisheries on the West Coast and in Alaska were a significant site for geopolitical tension given the history and significance of foreign fisheries in this region. Sectors within the current groundfish fishery began as foreign fisheries. Efforts to “Americanize” the fishery in the 1970s and increase US fishing capacity ultimately resulted in an overcapitalized fishing fleet, and the eventual fisheries disaster in the early 2000s. Additionally, in the wake of fleet overcapitalization, the impacts this had on the fishery were used to justify neoliberal management measures such as consolidation and privatization of the fishery. A second related linkage can be found in the emergence of the observer program. The program was first established to monitor the foreign fishery, and later developed in the fisheries of the North Pacific. When the West Coast groundfish fishery was declared a disaster, that provided the impetus for the West Coast observer program.

The theoretical assumptions that I draw on from STS include an understanding of reality as performative and multiple (Mol 2002), and an interest in the intra-actions between the objects of scientific study and the practices which bring those objects into being (Barad 2007).

Building on these ontological foundations, my work synthesizes across three bodies of literature: the political ecology of fisheries, the neoliberalization of environmental science; and digital conservation studies. Fisheries political ecology has focused on the political and economic processes contributing to the commodification of fisheries (Pitcher & Lam, 2015), and the privatization and commodification of the rights to fish through quota programs (Mansfield 2004b, 2004a, 2006; Pinkerton and Davis 2015). Work on the neoliberalization of environmental science examines the impact of political and economic forces on the production of environmental science, especially the privatization and commodification of knowledge and knowledge production (Lave 2012b). Digital conservation studies questions how technologies used for environmental conservation science and management shape human-environment relations, and what new natures and environmental subjectivities are produced through their deployment (Adams 2019).

Situated at the nexus of these bodies of work, my research asks the following research questions: How has fisheries observation come to be dominated by a private contract research industry? How has the outsourcing of data collection impacted fisheries science-management agendas and fishermen? How did digital monitoring technology emerge as an outcome of the privatization of fisheries and fisheries science? And how has digital monitoring reconfigured socioecological relations in fisheries?

What I found was that the emergence of the private contract research industry model for fisheries observation can be attributed to neoliberal government rollbacks of the 1970s and 80s, during which the implementation of the quota program brought about the expansion of the private observer provider industry. The outsourcing and privatization of observer services had several important impacts. Service providers are no longer accountable to fisheries managers or science centers and instead compete for business from fishing vessels. This shifts the priority of observer provider companies from data quality to cost effectiveness and increasing profit margins. Yet, despite repeated internal and external critiques of the third-party provider model, it continues to dominate in the US. The implementation of the quota program brought about sweeping changes to the observer program, since, in order to be effective, fisheries scientists and economists argued that quotas require 100% observer coverage to ensure fisherman are complying with regulation. This has had profound impacts on fishermen who are not able to shoulder the cost of observers or who lack access to observers due to changes in local fishing infrastructure. Digital monitoring was intended to assuage some of these issues, but has only served to magnify economic inequality in the groundfish fleet while also introducing a host of additional concerns about data privacy, ownership and environmental governance.

Key Contributions

This dissertation makes several contributions. First, my analysis of bycatch marks the first attempt to bring critical social science to bear on fisheries bycatch research. Integration of critical social science with fisheries research brings to light the social inequalities and power relations which shape how environmental issues such as bycatch are manifested, as well as the ways in which the materiality of nature (in this case fish and fisheries) contribute to power relations. Additionally, my approach moves beyond that more commonly adopted by marine social science (and conservation social science more broadly; Bennett et al. 2017), which examines the social impacts of policy and the human dimensions of environmental change, by also considering the impacts of fisheries *science* on human-environment relations. The power relations that produce environmental outcomes such as bycatch, also shape how bycatch is studied, by whom, and what renderings of the issue and its solutions gain currency. Although fisheries scientists and managers acknowledge the social dimensions of bycatch, these are often reduced to unidirectional forces: for example, a need for economic incentives to change fisher behavior. My work reframes fisheries as heterogeneous socioecological assemblages, demonstrating that bycatch is as much a product of the material-discursive practices of fisheries science and management as it is of fishing. As I argue in chapter four, a relational understanding of bycatch allows fisheries managers to situate current socioecological conditions and events within their co-constitutive historical, political and economic contexts. Doing so opens the field of possibility for how fishery sustainability is defined and addressed. In a practical sense, scientific and management interventions could be more adaptive and refined to discrete geographic scales that map on to material socioecological conditions rather than arbitrary regional boundaries. More significantly, in some cases by generalizing bycatch and responses to bycatch which lack nuance to local and site specific conditions, the cure is worse than the disease so to speak. That is to say that using technology to monitor, count, and measure bycatch sometimes requires fishermen to engage in practices that actually jeopardize the health of fish they intend to release. Additionally, understanding the discursive mechanisms through which bycatch is produced can redirect attention away from a singular rendering of what is in fact a multiple environmental issue.

A second significant contribution of this research is that it breaks new conceptual ground in the political ecology of fisheries. Fisheries political ecology has elucidated the impacts of fisheries management—particularly neoliberal regulation—on fisheries and fishing communities. My work takes a different tack by conceptualizing *science-management* as a co-productive socioecological assemblage, irreducible to its constitutive elements. This ontological shift refocuses attention on how science and management co-produce the agendas, discourses and practices of each other. My analysis in chapter five focuses on neoliberal science-management regimes and develops the first political economy of fisheries observation, revealing the impact of neoliberal management on fisheries observation programs, one of the most significant data sources for fisheries science and management. This chapter also contributes empirical heft to the science studies literature on neoliberal science regimes, and expands the field by focusing specifically on marine (rather than land-based or riverine) socioecological systems.

In chapter five, I locate the emergence of the private contract research industry model for fisheries observation in neoliberal government rollbacks of the 1970s and 80s. Socioecological conditions culminating in the 2001 fisheries disaster declaration resulted in increased onboard observer employment, and the expansion of the private observer provider industry. Despite many concerns about how privatization is impacting data collection and quality, the third-party observer provider model continues to dominate. I juxtapose the positioning of observers to that of observer providers in relation to the capitalist fisheries assemblage, to demonstrate the different environmentalities, or technologies of environmental governance, at work in fisheries science-management. Observers seek to become good scientists through careful disciplining and regulating of the scientific self. Doing so produces observers as docile environmental subjects, eagerly internalizing the epistemic virtues of institutionalized science. At the same time, they must navigate their position as precarious actors in the capitalist fisheries assemblage and the material embodied impacts they experience, such as harassment, health and safety risks, or punitive actions which call into question their identities as scientists. Rather than disciplinary power, observer provider companies are made subject to neoliberal environmentality, and the logics thereof.

Whereas previous research in fisheries political ecology examines how quota programs produce social and economic inequalities (Mansfield 2004), my research complicates this understanding by calling attention to the compounding impacts of neoliberal science and management regimes. When individual fishing quotas were implemented in 2011, observer coverage increased from 30% to 100%, and meant a reconfiguring of observer program goals—and roles—situating observer scientists as important actors in capitalist social relations. The increase in observer coverage reconfigured how the third-party model was enacted: although it had previously operated primarily through public-private partnerships between government and observer providers, the administrative load of 100% coverage became too much for fisheries managers and federal and regional science agencies to bear. Fishermen began contracting directly with third-party observer companies for observer services, creating economic inequality between the fishermen that were now responsible for covering the costs of observing, and further exacerbating fleet consolidation and geographic patterns of inequality based on access to observers.

Additionally, when fishermen started contracting directly with observer providers, it removed managers and federal science centers from having direct oversight over the day-to-day performance of observer provider companies, the quality of the data they produce, and the observer labor relations. Because science centers were still in charge of training fisheries observers, individual observers were made responsible for all aspects of data quality, precision, and accuracy, rather than their corporate employers. Being situated differently than observer provider companies in the capitalist fisheries system not only makes observers the subjects of disciplinary power enacted by the state, but it also produces observers as a precarious workforce at risk of health and safety issues.

Finally, my work contributes a new conceptual framework for understanding the transition to digital conservation technologies in environmental science-management. Drawing on insights from digital geographies and critical data studies, I contend that the use of EM in fisheries represents more than simply a digital analog to observers. Instead, EM exemplifies a regime shift towards digital environmental governance. This regime has a number of distinctive characteristics, which I outline in chapter six. Two of the most salient are: 1) how relationships between environmental actors are reconfigured, and the newly emergent roles of government, private, and non-profit sectors in environmental conservation and management and 2) the coupling of the rights to fish with rights to data. Whereas under the neoliberal fisheries management regime, quotas and fishing rights became tradable commodities, more recently, digital governance regimes commodify data as digital objects which are embedded in different capitalist assemblages. For example, their value is differentiated and commodified (collected, managed and analyzed for a fee by providers) and marketed to fishers as information about fisheries, which they subsequently can market to managers or industry partners.

As conservation science and management become increasingly digitized and datafied, humans become ever more reliant on technology and big data for how they come to know and understand the environment. In my own case study, where technology is replacing humans, one is left to ask what are the implications for the knowability of the ocean when managers and scientists become deterministically dependent on technology? As my interviews highlighted, many managers and program administrators draw heavily on their experiences as observers, which afforded them ways of knowing the ocean that can only be garnered through the embodied practice of life at sea. In the translation to data and digital object, I would argue that what is lost are the affective socioecological relationships that constitute equally important ways of knowing. Perhaps another angle this analysis could take would be to theorize the digital turn within fisheries science-management, and conservation more broadly, as a form of digital environmentality, producing human and more-than-human beings as digital environmental subjects.

Limitations to the research

As with any research, there are limitations to this study which I hope to address in future work. First, as summarized in my methodology chapter, I imposed a set of geographic boundaries on my study, confining it primarily to the West Coast region. Fisheries science-management assemblages are spatially unique, contingent on socioecological practices, actors and materialities, which vary over place and time. Therefore, adopting a different geographic scope or scale, or doing a comparative analysis across places, would contribute to a more robust and nuanced understanding of how science-management is enacted in relation to geographically specific social, political, economic, and ecological processes. For example, comparing the use of EVM in the East and West Coast regions of the US might highlight how ecological differences between fisheries shape the implementation of technology or how economic and political processes produce geographically unequal capitalist relations, resulting in different scientific and management practices.

Another limitation to this study is the lack of a variety of perspectives from non-governmental environmental organizations and the public regarding the use of digital technologies for bycatch management. Although I interviewed one representative from a mainstream environmental organization, perspectives from a variety of organizations would allow for deeper understanding of the power relations within and discourses of the non-profit sector. This is particularly significant given the role of this sector in shaping conservation management agendas, as demonstrated in the case of bycatch.

Future research directions

Through this research, I have brought theoretical insights from science studies and digital geographies of conservation to extend understandings of the political ecology of fisheries. Rethinking fisheries as digital political ecologies opens up many new questions and avenues for future research. Digital technologies used for environmental science-management are lauded for their scalability, and there are efforts underway to develop global fisheries monitoring programs. One important direction, therefore, would be to examine the role of digital technologies in producing global science-management regimes and environmental subjectivities. Questions in this vein might include: When surveillance infrastructures network actors across vast social and spatial distances, where are the nodes of power located? What is the political economy of global knowledge infrastructures, particularly when many of those infrastructures are reliant on proprietary hardware and software, yet are funded through government, philanthropy, and industry? What geographic and environmental imaginaries are produced by the visuality of these technologies and how does this inform governance? Additionally, a touchstone of digital environmental governance is the significance of non-profits and non-governmental organizations as environmental actors directly implicated in the research, development, and uptake of conservation technologies. Future research is needed to interrogate the differently configured relationships between private, public, and non-profit sectors and industries under digital environmental governance regimes in order to understand the power geometries among actors, which has important implications for who gets to participate in resource management, how participation is defined (and by whom), what that means on the ground (or in the ocean) for accessing resources, and the environmental outcomes that are produced.

An excellent future case study would be Global Fishing Watch (GFW). In 2016 Google, in partnership with Oceana (an ocean conservation organization) and Skytruth (a conservation organization specializing in satellite surveillance) launched GFW, a public platform for global fisheries surveillance. GFW transforms data from infrared satellites and vessel tracking systems (which they obtain from governments around the world) into an online real-time map and data portal. With the aim of "Sharing the view from space to motivate people to protect the environment" (www.skytruth.org) GFW produces surveillance as an act of environmental citizenship by making geospatial vessel tracking data publicly accessible on the web. Programs to export digital conservation technologies are reminiscent of green revolution and development technology transfer discourses, yet with the added dimension of data, its governance, salability, and control.

Another future direction would be to take a critical physical geography approach by integrating critical marine social science with fisheries science and marine ecology (Lave et al. 2018). Work in this vein would examine the impacts of digital environmental governance on fisheries, for example how natures are materially and discursively reconstituted through digital data. A critical physical geography approach could, for example, examine if and how changes to fishing practices related to EVM (e.g. total discard retention, different handling of bycatch for camera capture) have impacted fisheries and fish populations. Another example would be to explore how geographies of inequality created by EVM in the commercial fishing industry map on to the actual distribution and location of commercially available fish species. Conversely, critical physical geography also illuminates how biophysical processes shape complex relationships of power. It would be interesting to examine the ways in which the materiality of different ecosystems, fish, and fisheries, assist or resist digital science-management agendas.

Another important direction would be to contribute to interrogating the importance of geographic scale in fisheries. As sites of economic, social, and biophysical processes future work could look at the deployment of technologies, such as tracking devices to prevent fish fraud, which are intended to shorten the distance between producer and consumer in an increasingly global supply chain. Another direction would be to examine how shifting habitats and fish migration patterns related to global climate and ocean change is taken up by advocates of geo-locative technologies. Finally, I would argue there is much to be explored in thinking about the linkages between the global processes and individual bodies in fisheries. One example would be to theorize how territorialization is enacted through observer bodies who are deployed in foreign fisheries, or how observers and fishermen are networked through social media and personal communication devices.

I do not question the utility or effectiveness of monitoring, particularly digital monitoring, for environmental science and management. Instead, I hope that this work brings the reader to wonder what alternatives might exist, which have been rendered unimaginable in the discursive landscape of neoliberal and digital science-management regimes. How might fisheries management contribute to more ethical, caring, relations to the ocean? Renarrating science-management as practices of care, one might ask: 1) If and how care is done (or done differently) through the various practices of fisheries monitoring? 2) What are the sites of care and who or what is doing the caring or being cared for? In other words, how might care work reciprocally between human and non-human actors. And finally 3) how might different practices of care through monitoring produce different ways of knowing and therefore, different worlds?

I do not argue for the inevitability or prioritization of digitality in environmental governance. Such a stance would at best be reductionist and at worst summon the trope technological determinism. Instead it has been my intention to call attention to the ways in which digital technologies are currently deployed in conservation science and management, and the socioecological assemblages that have emerged through digitally mediated ecological, political and economic practices of fisheries science and management. While they may not be inevitable, the materiality and sociality of digital technology mandates the development of new technological, scientific, and governance infrastructures, further cementing their role in current and future fisheries.

Appendix A

Interview Questionnaire Fishermen

Part 1: Practices of fishing

1. What does your current fishing operation look like (fisheries, boat size, species, gear)?
2. From your perspective:
    a. How do you define bycatch?
    b. How does bycatch relate to monitoring programs?
3. What you do with bycatch when it's encountered (actual steps of handling)?

Part 2: Observer and EVM Programs

4. Tell me about your experience with observers
    a. what is your relationship like to observers when they aren't collecting data?
    b. What have been the challenges to carrying observers?
    c. What have been the positive aspects?
5. What do you think of the observer program?
    a. Why is it important?
    b. What are the goals, successes?
    c. Limitations, issues, lessons?
6. Tell me about your experience with EM/EVM technology.
    a. When and why did you decide to use it?
    b. How was the transition for you?
    c. What have been the challenges to using EM/EVM?
    d. What have been the positive aspects?
7. What are some of the EVM criticisms or debates?

Part 3: Using EM

8. Can you walk me through what you need to do to go on a trip using EM/EVM?
    a. What happens if something breaks or doesn't work?
    b. Who does the installation, maintenance and repair?
    c. How do you submit the data?
9. How does having observers differ from having EVM onboard?
10. What training did you get on EM/EVM?

Part 4: Impacts of EVM

1. Has using EM changed any aspect of your fishing or the fisheries?
11. Who in the fleet benefits most from using EVM? Least?
12. Have you seen new/different jobs or infrastructure developing to sustain the technology?

Interview Questionnaire Managers/Scientists

Part 1: Practices of Science/Management

1. Tell me about your job: How did you get involved in the EVM/Observer program?
2. From your perspective:

a. How do you define bycatch?
b. How does bycatch relate to monitoring programs?

Part 2: Observers and EVM in practice

3. Tell me about the observer program
a. Why is it important?
b. What are the goals, successes?
c. Limitations, issues, lessons?
4. Tell me about the switch to EM/EVM technology.
. Goals, successes?
a. Limitations, issues, lessons?
b. What were the points of friction in discussions?
5. What is EM 'data'
. How does the data collected from observers differ from data collected from EVM?
a. Do you define it as observing or monitoring, science or something else?

Part 4: Impacts of EM

6. Has using EM changed any aspect of fishing, fisheries, or management?
7. Who in the fleet benefits most from using EVM? Least?
8. Have you seen new/different jobs or infrastructure developing to sustain the technology?

Part 5: EVM in Policy

9. How has policy evolved for EVM?
10. Any obstacles or adaptations?

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