FISHING FOR DATA

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What does it mean when an entire nation is "performing" sustainability? In the Icelandic fishery, data and information technology (IT) have been framed as solutions to overfishing and natural resource management for over thirty years. During this time, the Icelandic government has implemented a series of highly contested natural resource management schemes aimed to protect and preserve the economically valuable resource, from alternating between restrictions on access to the fishing grounds, capping the allowable fishing amount to restricting and limiting fishing efforts.

Throughout these different system implementations, the common thread is a heavy reliance on data and technology as tools to control and manage the fishery sustainably. I argue that framing data as a solution to the issue of sustainability has narrowed our view of the fishery such that both the fish and the people relying on the resource disappear from view, being replaced by data.

In this dissertation, I present data from ethnographic research that demonstrate some of the unintended consequences that have unfolded as a result of this focus on data. I examine the datafication from the ground up, focusing on the perspective of fishermen and captains in particular. Starting with the the moment fish is transformed into data on board a freezer trawler in the North Atlantic, I demonstrate how the fish gain a new life as data with a variety of new roles, different meanings and accompanying political agendas.

Next, I move on to examine changes in the work practices of captains. Look-

ing at the day-to-day responsibilities of the captain, we see an ever-increasing role of governance and surveillance through IT and data. One unintended consequence of this is that the role of the captain - applied craftsman or a blue collar laborer - has expanded to include more white collar tasks without reaping any of the benefits that would come with such a shift (e.g. increased autonomy, elevation in status). Finally, I examine the historical context of the natural resource management system that has prompted these changes, demonstrating a feedback loop between data and new forms of governance.

BIOGRAPHICAL SKETCH

Hrönn Brynjarsdóttir Holmer grew up in Reykjavík, Iceland. She holds a Bachelor's degree in Psychology from the University of Iceland and a Master's degree in Human Factors Engineering from Cornell University. During a summer internship working with Dr. Antonella Pavese at Google, Hrönn discovered a passion for qualitative research methods and decided to structure her dissertation work to accommodate this interest. This doctoral dissertation is the culmination of Hrönn's work at the Information Science Department at Cornell under the tutelage of Dr. Phoebe Sengers. Following the completion of her Ph.D., Hrönn's son Atticus has requested that they go fly a kite and have ice cream. Hrönn looks very much forward to doing just that.

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CHAPTER 1

INTRODUCTION

1.1 Miles ahead: The promise of technology

It is 7pm on a Sunday evening in June and I am driving out of Reykjavík. It is one of those classic summer evenings in Iceland, clear skies and the sun is shining low on the horizon. As I drive further away from the city, the landscape consists of a mountain range to my left, the ocean to my right. Between the ocean and mountains there are fields of moss-covered lava as far as the eye goes.

I am driving to Víkurbyggð, a fishing town of roughly 3000 people on the Southwest peninsula of Iceland. As I turn onto the road that will take me to Víkurbyggð, I notice fish drying racks off the side of the road. Some of these were probably still used by local subsistence fishermen until fairly recently. As fishing has become more of an industry, drying the product outside no longer meets the level of quality required for export and the racks are starting to fall apart and rot.

I am heading to meet AD, one of four crew-members of a privately owned Danish Seine vessel based in a small town. The history of fishing in Víkurbyggð is interesting in that for a long time there was no real harbor, and the fishermen would have to drag their boats on whalebones over lava and into the waters at the beginning of each day and vise versa at the end of their outing.

The fishing waters that were nearby were so good, that this was seen as acceptable effort to be able to utilize them. It was not until the motorized ships

Figure 1.1: Fish drying racks off the road outside Víkurbyggð.

started to be more commonly owned and used in Iceland that the Víkurbyggð community started work on improving the harbor, eventually establishing it as one of the largest ports in Iceland in terms of landings and quota allocation.

As I have seen in other fishing towns in Iceland, many houses and front yards are decorated with items that are connected with the ocean and fishing in Víkurbyggð. Fishing is not just a means to an end, it is a way of living for these people. Next to AD's front door is a large anchor, the door knocker is a miniature anchor and inside I notice a barometer, a compass and an porcelain figurine depicting an old stereotypical skipper. After we have sat in the living room for a few minutes, AD's wife pokes her head in to offer us coffee. It is a treat talking with AD, he is funny and charming and our conversation lasts for well over an hour.

There is a certain gruffness to him and one can see by the way he carries himself that his career has been spent in a very demanding, physical job. In spite of being *"just a crew-member, not a captain"* as he says himself, AD has worked in the fishery since he was barely twenty years old or for over forty years. During this time, the fishery has undergone dramatic changes and AD has witnessed first hand the introduction and uptake of Information Technology (IT) in the industry.

When he joined the profession in the 1970s, the fishery was in a remarkable growth period in part due to minimal fishing during World War II. He also witnessed the transition from working in a minimally governed fishery to a highly contested regime of natural resource management governance. And yet, AD is incredibly proud of the Icelandic fishery as a whole, including how it is managed. He is especially impressed with the fishery specific IT development that takes place in Iceland:

> "We have gotten inquiries from companies in the USA, France, The Netherlands ... they are thinking about changing their vessels over to the Danish Seine ... The Americans are perhaps 20-30 years behind us [Iceland] when it comes to fishing technology and equipment and how we process the catch. They are *molbúar!*"

Being a *molbúi* is a derogatory term that is tricky to translate without providing background into cultural relations between Denmark and Iceland throughout the years. The gist is that *molbúi* is someone who is "backwards" or "behind the times," almost comically so. A parallel in the English language would be *hillbilly*, a term with an equally loaded cultural association in the United States. AD continued:

> AD: ... There is a great amount of technological development going on here...and it's not necessarily from abroad. We invent so much ourselves. ... And if there's something new out there, you will see it on every vessel. ... We are among the most technologically advanced out there. We have been miles ahead with the uptake of IT and this has resulted in us being a strong fishing nation. We are always up for a challenge! If it [the technology] doesn't work, we just move on. Case closed.

As a fellow Icelander, AD's pride resonates with me. Even though he is describing fishery specific IT development and not the fishery directly, what this pride signals to me is that AD is talking about how it is specifically an *Icelandic* innovation or technology is being looked at as an industry standard internationally. That someone from this small island has *"made it,"* and is being recognized outside of the small nation. This recognition to AD, and to other Icelanders, is important. It indicates that Iceland is not backwards, that Icelanders are not uninformed peasants - molbúar - but smart, resourceful people:

> AD: We had visitors on board from the US, Maryland, they were with us for a few days and at afterwards they just said, 'Wow! It's just the four of you and you get 15 tons per tour?!' That [15 tons] is what they would be getting over a whole week. There's just a difference in our capacity. ... It's good to get the foreigners aboard and for them to see that we don't have it too bad. Americans, Canadians, Europeans, they come to *us* for advice and knowledge.

To AD, the beauty in this story is not that he and his colleagues are landing

an impressive amount each tour, but that they impress their foreign colleagues. This can be easily projected onto the fishery as a whole, it is not just an economic backbone for the island nation, it is also a source of outside recognition and admiration. The drive to earn this outside recognition is among the many reasons why the uptake of IT in the Icelandic fishery was so pervasive and rapid.

1.2 Sustainability in the Icelandic fishery

It is easy to understand how the sustainability of the Icelandic fishery would be vitally important to people like AD. Not only does he depend on it for his livelihood, the fishery has also played a significant part in shaping the life of those in his family and friends - sustaining the town of Víkurbyggð. In addition to economic importance, the fishery is also the foundation of his identity. As such, AD is not much different from me, or other Icelanders. As a practice, fishing has sustained the nation for over two centuries, growing from sustenance oriented practice to a global commerce contender. And as a practice, it has been central in shaping the cultural identity of the nation (Durrenberger, 1995; Pálsson, 1996; Willson, 2016).

For AD, then, sustainability is not only about maintaining a natural resource such that it is not over-utilized. Sustainability is also about a long term engagement and investment of time and energy in the fishery, pride in succeeding in industry and being recognized as a global leader at that.

This dissertation is about about a transformation: the uptake and intense focus of IT and data into every aspect of today's fishery. I argue that this transformation is in part due to the way sustainability has been framed as a prob-

lem to be addressed with data, and later, IT and related technology as a way to collect the data. In the next section I provide an overview of the field of sustainable human computing interaction (sHCI), noting opportunities for research that motivated this work.

1.3 Sustainable HCI

The research in this dissertation is inspired by work by DiSalvo, Sengers, and Brynjarsdóttir (2010a, 2010b) and Brynjarsdóttir et al. (2012), focusing on the field of sHCI. As demonstrated by DiSalvo et al. (2010a), a significant amount work in the field of sHCI is oriented towards design interventions aimed to persuade the end user to change their behavior. One type of these interventions comes from the area of ambient awareness designs, aimed to make users *"aware of some aspect of the sustainability of their behavior, or qualities of the environment associated with issues of sustainability"*(DiSalvo et al., 2010a, p. 1977). The other kind of interventions in this category are designed to directly or passively convince users to behave in a more sustainable fashion. This area of HCI is grounded in persuasive computing, and has its roots in the behavioral psychology work of BJ Fogg (Fogg, 2002).

An underlying assumption of this approach when it is applied to a problem area such as environmental sustainability is that it is up to the individual user to change their behavior to maintain or improve environmental sustainability (Håkansson & Sengers, 2013, 2014). As discussed by Brynjarsdóttir et al. (2012), this is problematic for a variety of reasons. For instance, by focusing on energy efficient appliances as a solution to environmental sustainability, we are

likely to miss contexts in which the individual has limited to no control over the appliances where they live, as is the case with many renters and people living in publicly subsidized housing (Dillahunt, Mankoff, & Paulos, 2010; Dillahunt, Mankoff, Paulos, & Fussell, 2009). Further, Håkansson and Sengers' (2013) research findings revealed that their informants felt guilt - for not doing more, or something different to be environmentally sustainable - as an unintended consequence of this focus on the end user or consumer.

While encouraging energy and water preservation is not a bad strategy as such, framing environmental sustainability as an issue that can be addressed with small, incremental behavioral tweaks like the ones mentioned above will severely limit what researchers and scholars have to offer in terms of research and design in this area. For instance, this framing would leave out corporations and governmental agencies as potential agents responsible for instituting change (Thomas, Remy, Hazas, & Bates, 2017). This is not only ineffectual, given the scope of change that is possible on a governmental level versus that of a single household (Aoki et al., 2009; Hirsch, 2010; Hirsch & Anderson, 2010), but also reinforces a flawed notion of users as rational actors, as discussed by Strengers (2008, 2011).

When this particular demarcation of the issue - sustainability is a problem that can be addressed with IT - is applied in the context of the Icelandic fishery, it facilitates the belief or a worldview where simply or only changing consumer behavior is a *sufficient* strategy to address overfishing. However, in learning about AD and his life in the fishery we can begin to understand that such a narrow definition misses many other tangible, and less tangible aspects of what sustainability truly means: maintaining and utilizing a natural resource such

that it can be relied upon for centuries, through a variety of harvesting conditions, with a variety of ever evolving harvesting techniques, as a source of pride and cultural history.

In response to these limitations, the scope of work in the field sustainable HCI has expanded significantly. Now there is a wide variety of work that has as a starting point a notion of sustainability as a complex, multi-faceted issue that touches upon most all aspects of everyday life. This includes research into how scholars and other experts in HCI can learn from and contribute to environmental public policy (Thomas et al., 2017), examining small scale farming practices in the context of "simple living" (Håkansson & Sengers, 2013; Leshed, Håkansson, & Kaye, 2014), looking at "everyday practices" as the site where values, attitudes, habits and routines are shaped (Pierce, Brynjarsdóttir, Sengers, & Strengers, 2011; Pierce, Strengers, Sengers, & Bødker, 2013), politically motivated workshops, providing *"deliberate alternatives to top-down production of both food and knowledge"* (Kuznetsov, Santana, Long, Comber, & DiSalvo, 2016, p. 3516), to employing Design Fiction and Future Studies methodologies to imagine *"possible, probable, and preferable"* futures (Pargman, Eriksson, Höjer, Östling, & Borges, 2017, p. 773).

What all of these recent strands of sustainable HCI have in common is the stance that environmental sustainability is understood to be a long term goal, a way of living (e.g., Håkansson & Sengers, 2013; Pierce et al., 2011, 2013), situated and constrained by regulatory infrastructure (e.g., Pargman et al., 2014; Thomas et al., 2017) and a host of other factors that can constrain or facilitate changes. In short, there is hope that the sHCI community has by and large come to understand that sustainability is not a problem to be "fixed" once and for all. But

this brings up a question of how we can begin to develop ways to unpack this "wicked" problem and, to what extent the HCI community will be capable of addressing it.

Sustainability as a complex, systemic issue

A recent turn towards explicitly considering food systems as a research area for sustainable HCI seems promising. Food systems were defined as a "grand challenge" by Norton et al. (2017), reporting on a workshop they facilitated at CHI earlier in 2017. Taking a holistic stance, Norton et al. (2017) motivated the workshop focus by illustrating that through their scope, global food systems touch upon a multitude of people and contexts like farmers and other food producers, manufacturers, marketing and sales, consumption and waste management. Norton and her colleagues conclude that by including a systems approach, we can start to understand *"interconnected impacts and interdependencies"*of the different aspects of what it means to do sustainable HCI research (Norton et al., 2017, p. 610).

Norton et al. (2017) reported three emerging themes as a result of the Food Systems workshop. These were *trust and accountability, food sovereignty*, and *sustainable food policy*. In terms of *trust and accountability*, the discussion was oriented towards supporting a transparent flow of information from production, to processing, distribution and onwards to waste management. The concept of *food sovereignty* speaks to eradicating inequality in food systems. That is, to prevent the majority of resources from being centrally owned or controlled. Finally, in order for any food system to thrive, it needs to operate in harmony with the

governing policies and regulation -*sustainable food policy* (Norton et al., 2017).

This dissertation stands to make a contribution by adding to this growing corpus of holistic, systems oriented focused sustainable HCI research. Specifically, this research asks what it means to take seriously a complex, wicked problem like sustainability. For instance, what does it mean for sustainable HCI to expand the focus from the single user to include an industry, or a nation? What can be added to our insights by extending our view to historical and cultural events, that in many instances took place decades, or centuries ago?

In the next section I will provide a brief overview of the Icelandic fishery, highlighting how ethnographic research at this particular site can help answering these, and more questions. Similar to many of the solutions presented earlier on in the sustainability HCI literature, the central assumptions in how the fishery is governed is that IT and technology will provide control and clarity. However, after many decades of implementing a natural resource management scheme, aided by IT and focus on data, the Icelandic fishery of today is far from being without problems.

Many of the questions and issues in today's literature regarding sustainable HCI are to be found in the fishery as well. For instance, the theme of *sustainable food policy* from Norton et al.'s workshop (2017) is highly relevant. Similarly, when it comes to *trust and accountability* from that same workshop, it seems like an increased transparency afforded by intense IT use and data creation may be an illusion riddled with information overload, rather than clarity when it comes to untangling the state of the natural resource.

1.4 Sustaining the Icelandic fishery

The Icelandic fishing industry is considered to be one of the larger seafood-producers in the world both in terms of catch as well as in value (Christensen, Hegland, & Oddsson, 2009; FAO, 2016). To sustain this valuable resource, the government has implemented a series of management schemes since the mid 1970s, alternating between restrictions on access to the fishing grounds, capping the allowable fishing amount and restricting and limiting fishing efforts (Gissurarson, 2000).

The natural resource management efforts will be discussed in more detail in Chapter 4, but for now it is enough to know that a key feature of these management schemes is a heavy focus on data as a tool for governing activities in the fishery. An example of this is the role played by two governmental institutions in monitoring and enforcing access restrictions to the resource. These institutions are the Marine and Freshwater Research Institute (MFRI) and the Directorate of Fisheries (DF)[1].

The DF is the administrative arm of the fishery monitoring, responsible for enforcing access restrictions, among other things. The core method of supervision used by the DF is through mandatory reports of the catch, in real time and at landing. The MFRI is in charge of research of the stocks in the fishing waters. Based on data from this research, statistical population projections and more, the MFRI provides advice to the government on how much fishing could be done in the following year without risking a stock collapse.

[1]The MFRI's website: https://www.hafogvatn.is/is
English version: https://www.hafogvatn.is/en.
The DF's website: http://www.fiskistofa.is/
English version: http://www.fiskistofa.is/english

The MFRI also uses data from the DF in the annual advice. In this dissertation, I will demonstrate that the logic that emerges from this data-driven school of thought is that stock size and collapse are under human control, rather than being an outcome of a variety of environmental factors that affect the resource directly or indirectly. Under this logic, our view on fishery practices is narrowed so that the fishery is no longer understood as human beings working to land fish as biological creatures. Instead, the focus is on fish, understood and acted upon through data. In shorthand, we can say that fish become data.

This transformation of fish to data raises many questions, including why this transformation has occurred and what its consequences are, both for sustainability and for the lives of people involved in the fishery. In this dissertation, I will provide a starting point for reflecting on these implications by answering the following questions. How does fish becoming data affect people who work with the fish - in particular fishermen and captains? What are some of the unintended consequences of this shift? How did the logic of IT as a solution for sustainability get established? Further, how has this focus on data as a governing tool affected work practices in the fishery?

In order to address these questions, I present three chapters that each presents a different lens to examine the datafication of the fishery. The three lenses represent different areas where the focus on data has been impactful in terms of work practices and in terms of governance: In order to sustainably govern the fishery, the government relies on a data based approach, couched in advice from marine research and monitoring. In order to govern, data is needed.

But where does this data come from? Chapter 2 examines how one type of data in the fishery is created. While seeming like nothing more than a bureau-

cratic nuisance, a governmentally mandated measurement takes place twice a day each day on board trawlers in the fishery. Examining this process, as fish is transformed into numbers in a spreadsheet, I explain how it is emblematic of the data-oriented logic driving the regulatory framework intended to sustain the fishery today.

The creation of data in the fishery does not happen below deck only. Today's captains and their day to day work are under intense scrutiny as well. Part of the surveillance that takes place is through automatic processes afforded by IT, such as automatic vessel tracking equipment mandated for safety reasons (Guðjónsson, 2007). Other types of surveillance happen as social and cultural practices interact with technological affordances, such as when captains follow or monitor each other using the same technology in addition to other public data such as a constellation of social and official data channels[2].

The actual work of the captain has shifted considerably with new forms of IT. In Chapter 3, I provide a glimpse of what being a captain in today's fishery looks like. As the work has expanded to include more computer oriented and administrative tasks, this has been met with some resistance from a group of captains in the fishery who are of an older generation. This generation of captains came up in the fishery at a time where data as a governance tool was virtually non existent. While recognizing the positive aspects of IT in the workplace, this particular group of captains has had to adjust to new forms of power relationships in their work as a result.

[2]See, for instance the Marinetraffic website, listing the location, previous routes and trajectories of all vessels in the Icelandic fishery:
http://www.marinetraffic.com/en/ais/home/centerx:-19.7/centery:64.6/zoom:5,
or the online information for the most recent catch sales records:
https://rsf.is/heild-sidasta-uppbod

By examining some of the tasks and processes the captain has to accomplish as he goes about his work, we see how a focus on IT and data is implicit in a shift regarding not only the work practices themselves, but also affecting the dynamics of the organizational structure in the fishery as a whole. Formerly, a fiercely independent profession, today's captains have to come to terms with new forms of supervision and governance on land.

Understanding how the fishery creates and uses data for resource management is only part of the story. Stepping back, Chapter 4 looks at the regulatory framework that necessitates the datafication of the fish and created the requirements structuring the work of the captains. In order to understand why fish is transformed into data in the first place, I examine the core assumptions for the natural resource management structure currently in place.

1.5 Methods

The overarching goal of this research is twofold: To understand the experiences of fishermen and captains in the fishery from a personal viewpoint, and to examine the historical trajectory of IT and sustainability in the fishery. For primary data collection, I elected to do ethnographic participant observations to build a nuanced understanding of everyday work practices in the fishery. In addition, I performed semi structured interviews with various stakeholders in the fishery. These methods allowed me to understand how my informants think about and understand the datafication in the fishery, and how this has impacted their work practices (Blumer, 1969; Forsythe, 2001; Lincoln & Guba, 1985; Wolcott, 2008).

Working alongside a crew on board a freezer trawler, I was able to both ex-

perience work in this context and also observe the subtle ways in which data and IT have been integrated in all aspects of the fishery. I relied on archives at the National and University Library of Iceland for documents regarding fishery history (e.g. early marine biology reports, announcements regarding fisher training, newsletters) and technology uptake (e.g. advertising brochures, news media). Finally, I relied on the online archive of the Parliament of Iceland for legal documents, rulings and supplementary materials[3].

My ethnographic fieldwork was done in three major phases. The first phase was during the summer of 2009, when I was a visiting researcher with the EDDA Institute for Excellence at the University of Iceland. During this time, my aim was to build relationships with informants in the fishery while also doing archival research at the National and University Library. I performed seven semi-structured interviews during this period, in addition to over a dozen informal interactions with people working in, or otherwise engaged with the Icelandic fishery (educators, special interest group spokespeople, researchers).

I went on two fishing expeditions during this time as well, on board a Danish Seine vessel and a small motor boat. During the tour on the Danish Seine vessel, I was not allowed to work alongside the crew, due to space limitations. I spent the duration of those 14 hours in the bridge with the captain, using breaks like lunchtime to talk with the crew. The second tour was with an independent fisher on a small 2-3 person motor boat, where I helped during an afternoon of *"leisure fishing"* as the fisher called it, letting out and pulling in with a hand-line off the coast of Reykjavík.

The second phase of my fieldwork took place in the summer of 2010. I lived

[3]http://www.althingi.is/lagas/

in a small fishing village in the Southwest peninsula of Iceland, the home to two large fishing companies as well as many, smaller and independent companies and fishers for two months. During this period, I performed 8 semistructured interviews in addition to jottings and notes from informal interactions with locals, ranging from retired fishermen, wives of fishermen, and staff in one of two large fishing companies.

The third and final period of fieldwork took place in the fall of 2011. I had the opportunity to join a crew on board a freezer trawler for 5 weeks. This provided me with the opportunity to have repeated interactions with crew members and captain, establishing rapport and relationships that continue to this day.

Before this tour, I had to complete a weeklong safety training class mandated for crew-members on all commercial fishing vessels in the fishery. In addition to the safety training class, I was able to attend the 2011 Icelandic Fisheries Exposition[4] courtesy of the captain of the freezer trawler. Attending the Expo, I had multiple informal conversations with exhibitors, IT developers, government officials and researchers, gathering a multitude of information and advertising materials on IT and other technology in the fishery.

The mixture of in-person observations and interviews coupled with historical, archival data have allowed me to understand the scope of the changes in the fishery as they have affected people in their work-life, as well as getting a longer term perspective on a process that has been unfolding for decades at this point. Getting the perspective from multiple individuals allows for a multi faceted understanding of both struggles and successes as new technology and work processes are unfolding on the ground.

[4]http://www.icefish.is/news101/warm-welcome-to-icefish-2011

A note about background and bias

My background may be affecting why I am choosing this particular group, in this particular context. Inspired and encouraged by Nadel-Klein (2003) I feel it is important to divulge the following about my background. I am Icelandic. I come from a line of fishermen. My grandfather supported his family as a fisher with his open motorboat. My father and uncle worked for my grandfather from a very early age, first on land in prepping the nets and lines, and when they were old enough they went out to sea with their old man.

When my father left home, he became a crew member on a trawler, fishing in the sea around Iceland and internationally. It was not until shortly after I was born that he stopped sailing - citing time spent away from family, and safety as the main concerns for this choice. After my father left the sea, he continued work in the fishery as a member of a landing crew for a large fish processing plant.

During school breaks through our teenage years, my brother and I worked in the fishing plant as well. So, to say that the story of the Icelandic fishery feels personal is probably an understatement. While my background may seem ripe for bias, I argue that it has actually proven to be constructive in gaining access to my informants.

I was simultaneously an outsider and an insider to the group no matter what. I strategically offered up my personal connection to my research as a way to establish rapport with my informants. Overall, this was a benefit and not a hindrance to my work as I was able to use my status as an outsider "female, academic" when I needed to ask questions that would perhaps have seemed

naive or awkward coming from an insider in the fishery.

1.6 The structure of this dissertation

The Icelandic fishery is a site where sustainability is being addressed through IT and data. This particular development has been unfolding for decades, as the fishery shifted from a subsistence oriented practice to being a contender in global commerce. Today's fishery is tightly governed through a complex framework of regulations that are enforced through data created by, and through, mandatory IT on board the fishing fleet among other things.

One of many unintended consequences of this intense use of IT is that fish become data. The logic of data as control is a logic which we see frequently deployed in technology design and sHCI. My dissertation addresses, then, the issue of what happens when an entire nation has been "doing sustainable HCI." In particular, my dissertation asks three questions, how does fish become data? How is work affected or transformed when fish become data? Why is fish transformed into data? Through these questions, I unpack bigger conundrums and consequences when a formerly hands-on, physical occupation becomes intensely datafied.

My research brings into focus the effects of intense datafication on three levels. First, I examine datafication as it pertains to the natural resource itself - the fish. Second, I look at working practices in the fishery. Finally, I unpack how the natural resource is managed through focus on data. While this work opens up a new area of study for information scientists, that of information technology in the fishery, the main contribution is an in depth look at the following three areas

and how they relate to current work regarding critical data studies and IT and labor: How does fish become data? Why is fish transformed into data? What happens to professional practice when fish becomes data?

There is a lot of data in the Icelandic fishery. This data is used to understand the current status of the cod stock, as well as a natural resource management strategy. Where does this data come from, and how is it created? In chapter 2, I unpack a mandatory measurement process on board a freezer trawler: the Utilization Factor Measurement (UFM). This chapter details what happens during the UFM inspection, who does it and how, why this process is in place and so on. I follow the trail of the fish and the data about it as each are moved through the processing line. One ends up in a box to be frozen and eventually consumed in Russia. The other ends up in a variety of places on land, for instance in reports to marketing and sales, to the fishery management, and eventually in some form, at the desk of a marine biologist at the Marine Research Institution in Iceland.

As the fish is caught and killed, it gains a new life as data which can be morphed into a variety of metrics depending on the objective; a catch regulation statistic, quality metric, or work performance measurement. I link the UFM inspection to a larger infrastructure of reporting and data collection that is mandated by the state in terms of catch regulation that will be discussed in more depth in Chapter 4.

Next, I look at what happens when IT is placed at the center in a working environment that has historically not been strongly associated with IT. In Chapter 3, I look at how the captains' roles and tasks evolve to meet new and different requirements in their immediate work environment through the uptake

of IT. What does heavy IT focus mean to the captains in terms of their everyday work, training and qualifications? Stepping back, I examine issues that cut through the nitty gritty everyday concerns such as surveillance, knowledge practices and power structures.

In Chapter 4, I look at why the fishery is so data centric to begin with. To what end is the data used or not used and by whom? What does the structure of access to knowledge production about the fishery say about the people who actually create the data in the first place? I examine the legal framework surrounding the fishery, the natural resource management efforts and related policy work that has been designed and implemented in the fishery.

In Chapter 5, I look at how the three lenses come together to form an overarching theme of the implications of datafication in the fishery. I discuss and situate my findings with literature in sustainable Human Computer Interaction (sHCI), IT and Work and the new field of Critical Data Studies (CDS). Finally, I present an overview of the dissertation and final arguments.

CHAPTER 2

WHEN FISH BECOME DATA

In this chapter, I present data from my time onboard a freezer trawler. The lens I use in this chapter focuses on a mandatory process that takes place during the fish processing stage, the utilization factor measurement (UFM) process. The UFM is the first step in a long line of closely monitored activities onboard fishing vessels in the Icelandic fishery. This process was introduced into law in 1992 (Anon, 1992b), and the data from it informs the quota allocation process for the upcoming fishing year. This particular instance demonstrates a side of data creation that is hidden from view once we are looking at datasets in spreadsheets. That is, the data to monitor the Icelandic fishery is derived from slimy, wet, limp fish surrounded by blood and guts. The route to data starts with the bag.

2.1 "The Bag"

"The bag" is what fishermen colloquially call the fishing net used on trawlers. I have encountered this term exclusively with fishermen, captains, and other professionals who work—or have worked—onboard trawlers, whereas professionals of Danish seine or longline fishing will refer to their fishing equipment by more commonly known terms (seine and longline, respectively). It is easy to see why "the bag" is used for the trawl; it is essentially a gigantic bag. I will refer to the trawl as the bag in my work to reflect how my informants would speak about their experiences.

"What's in the Bag?"

As Captain M starts pulling the bag in, you can't miss it no matter where you are on the ship at the time. The whole vessel starts to rumble even more than usual, and our bodies are hit with the vibrations and mechanical groans as the winch strains to pull the heavy bag out of the ocean. The on-shift crew members responsible for working on the deck will go to the locker room to suit up in waterproof anoraks and helmets before heading out.

Each team member has a specific role outside as they hoist the bag to empty its contents into the hold. There is a significant amount of nontrivial coordination involved since the bag is lifted with two sets of winches in two different locations. One set is controlled by the crew foreman from the stern of the bridge, looking down at the deck; the other set is controlled by a crew member on the deck.

The crew foreman and the crew communicate with hand signals until the bag is above the hold opening, ready to be emptied. Right before the bag is emptied, I find myself holding my breath in anticipation. Smitten with the activities as they unfold in front of me, watching the bag being hoisted and subsequently opened, becomes one of my favorite activities onboard. Figure 2.1 shows the bag being pulled in; to the right, a crew member stands at the ready to receive a cable to connect to the smaller winch as his colleagues connect the small winch cable to the bag.

As the bag is emptied, the contents—today it is red perch—pour onto the deck and into the hold. Image 2.2 shows the hold after the bag has been emptied. Hundreds and hundreds of fish explode onto the deck, and the deck goes from

Figure 2.1: The view from the door, looking towards the deck.

the color of dark rust to bright orange.

Due to the difference in air pressure between the bottom of the ocean and where we stand on the outer deck of the trawler, the fish's eyes bulge out of their heads as their lifeless bodies splatter and splash on the deck. Some look like they are gasping for air, flapping their tails as their muscles spasm. The deck crew cleans up stray catch to the side of the hatch and readies the bag for being submerged another time.

At the beginning of the tour, I would observe the bag coming up from the door leading to the deck or the bridge, observing the crew supervisor's side of this lurching ballet. Without exception, as I stood in the door leading to the deck, I would be joined by a crew member. It could be a crew member who

Figure 2.2: The hold, full of red perch. Two crew members are in the process of untangling fish from the bag.

did not have a particular role on deck or a crew member on the opposing shift, about to start work. Standing in the doorway, they would stay until the bag was fully out of the water before heading back below deck or to the mess.

Heading back to the mess, we would invariably be asked by other crew members: *"so, what's in the bag?"* I found this question to be pretty peculiar at first, remembering my astonishment during my very first outing on a fishing vessel in the summer of 2009. Joining a small crew onboard a Danish seine vessel, I had been taken by surprise at the variety of fish and other marine wildlife that would come up in the seine purse. So why were the freezer trawler guys even wondering about this?

This was not their first time at sea. What could possibly be in the bag other

Figure 2.3: The bag. This was early in the tour; this bag looks to be about 8–10 tons.

than fish? Are they looking for interesting side catch, like shark, or are they worried about German or British mines left over from WWII (surprisingly common still?[1]) Or were they trying to pull my leg, akin to hazing—newbies on fishing ships are often asked to go feed the "*kjölsvín*," a particular piece of structural slats in the keel that also sounds like a name for a pet pig—to get me curious about the contents of the bag when it is only flailing, gasping fish?

As it turns out, that particular question is not part of an elaborate hazing scheme, and the answer is far from simple. While the bag does, indeed, contain fish, it also contains and represents much, much more. In the following chapter, I present a series of mundane activities onboard the freezer trawler that will

[1]News website with a video of the deactivation of a mine, found in 2016 http://www.visir.is/g/2016160109718

demonstrate how we can begin to answer the question of what *really* is in the bag.

Working, Passing, Rapport

In my work onboard, I am stationed in the packing area. It is a relatively safe place for an outsider such as myself to be. The term "safe" applies both to my physical safety in that I am less likely to get seriously injured operating heavy machine equipment, but perhaps more importantly, I am less likely to slow down the production line and the work of the other crew members. As time goes on, the guys expect me to be at my packing station at the beginning of the shift.

I am also expected to take breaks with them, and they give me a hard time when I am late, especially if I am late because Captain M has summoned me. At those times, I get teased about being a slacker, or worse, a brownnoser, getting off work by schmoozing with the captain. My membership as one of the crew is finalized one day when I show up to the packing area after coffee break and one of the crew members has made a sign with my name on it, identifying that particular spot to be "mine" (see Image 2.4). I am truly one of the packing crew now—happily so.

The Packing Work

The packing work takes place below deck after the catch has been processed (e.g., beheaded, gutted, filleted, and skinned), as prescribed by the order we are

Figure 2.4: My packing station; note the personalized sign.

filling each time. We pack whole redfish for Korea, being slowed down as the fish lips frequently get caught on the box edges. Beheaded redfish goes to Japan, 10 to 12 pieces packed in a woven pattern in the box. Cod is usually beheaded, gutted, filleted, skinned, and packed ready to cook.

As I work more shifts in the packing area, I come to understand that packing itself is only a small part of the packing work. The work is varied both in terms of the type of product orders we fill and in the packing area maintenance work. Each packing crew member is responsible for stocking packing supplies for themselves: boxes, plastic liner, writing implements, pans, and metal pan dividers, if needed. As each box is filled, the packer needs to load it into a metal pan. When the metal pan has three boxes, it goes into the flash freezer stack. Each packing crew member is responsible for loading their own metal pans.

The first day I was on packing duty, I lifted the pans by myself. It was important for me to demonstrate that I was both willing and able to follow through with each task. It quickly became apparent to me that even in the middle of work and the rush to get things done, I was being observed very closely. The first time I loaded a full pan, I got cheers and applause from the rest of the crew. For the record, each pan is about 10 kilos (approximately 22 pounds) by itself. Loaded with three 10-kilo boxes, the total weight is around 40 kilos (about 88 pounds).

Lifting the pan itself is not hard, but when you add the constant rocking of the vessel, the wet and slippery floors, and the fact that sometimes, the only available spot in the flash freezer unit requires lifting the pan above one's head, the task gets considerably harder. After one day of packing and lifting by myself, there was an unspoken agreement between me and the guys to help me with loading the pans into the flash freezer. Image 2.5 shows some of the activity in the packing area; one crew member is taking an empty metal pan to his workstation, while two others stand at the packing table, using blue plastic to line boxes.

This is really hard physical work, and I can't help but wonder how the guys' bodies hold up after doing this for years, considering that only recently has there emerged limited discussion of workplace safety in terms of lifting with one's knees and such. I think about the old timers like HK or Ö, who have been doing this more or less since they were teenagers. My respect for the crew continues to grow day by day as I observe just how demanding this work is.

At the packing station, progress, or time, is not measured or understood by looking at the clock, but rather by how quickly we fill the flash freezer shelves

Figure 2.5: The packing area.

behind us or how many boxes we are going through. Are we filling the flash freezers up faster than their operating cycle? That is, are we packing fish faster than we are able to freeze them? Will we have to take a break in packing and start prepping the boxing and freezer storage area with GE? Or, worst case scenario, are we not even filling the flash freezers during our shift, meaning that the bag was small the last time?

Each of these questions will have a different implication, depending on the answers. For instance, a small bag means that we are not fishing much, which will show on the paychecks at the end of tour, whereas fast packing and wait time at the flash freezers means that we probably had a big bag, and we need to adjust our workflow so that there is not a buildup at the front, where the guys on the beheading and gutting machines are.

The best shifts are the ones where the flow from the front of the processing area toward the back and into the freezer storage feels seamless. It is as if we cease to exist as individuals on a work line and morph into an immaculately running machine. It feels intoxicating to me. No time is spent waiting on more fish to come down the line, nor are we scrambling to keep up with what the guys on the beheading and gutting machines are sending our way.

Being in "the zone," or working seamlessly during a shift, makes the time fly. It also means money. After all, that is why we are here. Ó, one of the guys whose role is to man a beheading machine, tells me during one break that he often sings to himself during work, in rhythm to the beheading machine as he slides each piece in place: *"800 krónur! 800 krónur! 800 krónur!"* This roughly translates to the price per kilo for pollock at the time, as he explained it to me; he was reminding himself that while the work could be monotonous and hard, he was earning good money. In his mind, then, the answer to the question of what was in the bag was simple—money. A lot of it, preferably.

Breaks, Belonging, and the Everyday Rhythm

During each shift, we get one or two shorter breaks (approximately 10 minutes) and one longer break (25 minutes or so). On the shorter breaks, the crew goes up one flight of stairs and huddles in a small locker/break room where J, the cook, has brought us an urn of hot coffee. Some afternoons, there were even cookies or chocolate and nuts. The shorter breaks are my favorite. They are intimate due to the confined space and seem more carefree. It's just us huddled together in the small break room.

Figure 2.6: Ó at his workstation, quite possibly singing "800 krónur! 800 krónur!"

The crew can be quiet or talkative, telling jokes, teasing each other, or discussing recent news. Everyone has their usual seats, either around the tiny table or on the floor along the lockers. As a new crew member, I am wedged between AD and H on the bench by the table. H prefers the corner seat, whereas AD must sit on the end of the bench. They wouldn't hear of me, a lady, sitting on the floor. So there I am, squeezed between two big guys on a bench where there is realistically only room for two people.

Like the other members of the crew, I get my fair share of teasing, both on duty and during breaks. At the beginning of the tour, I would frequently get weird sea creatures or bycatch that would otherwise have been discarded sent my way on the conveyor belt: the occasional crab and a variety of otherworldly

Figure 2.7: Break time.

looking critters that I will likely never encounter again. The crew gets a good laugh out of me—a newbie—being startled by these weird beings.

Some of these creatures are truly odd, and on occasion, they are not quite dead when they reach me. I will probably never forget meeting a bright orange, long-legged deep-sea spider, still squirming (pycnogonid, sækönguló). These probably get their name from their similarity to the spiders we encounter on land. However, they are about 10 inches bigger than the average daddy longlegs spider and look more like a hybrid between a crab and a spider.

This type of gentle teasing is enjoyable for a few reasons. First, it simply breaks up the routine and mundane everyday. Second, it demonstrates a level of playfulness that I will learn is fairly prevalent among the crew. Third, it signals

a level of the crew's acceptance of my presence in their midst. They are, on some level, treating me like they would each other. Unlike Geertz's experiences with being "invisible" in Bali (1977), I get the feeling that with this particular cultural group, I am far from invisible. But as time goes on, my presence stops being a novelty.

As time goes on, *I* experience this shift from the novel to the routine as well. Life onboard the freezer trawler assumes a rhythm that is in some ways pleasantly predictable. My days are punctuated by shifts starting or ending, breaks and meals. In the mornings, I check in with Captain M briefly before going to work at noon. After the noon shift, I try to stay awake enough to jot down field notes, as well as eat dinner and work out before getting some sleep so that I can be ready for the midnight shift. I call my mom every few days, and it starts to feel like I am not reporting anything new when we talk. For me, life onboard a freezer trawler in the North Atlantic has become normal.

2.2 What Is Going On?

It was not until three weeks into the new normal that I noticed something going on at work, something so subtle that I nearly missed it. At some point during each shift, S would disappear, only to return with a few pieces of fish in his hands, to be included in packing. The pieces he brought back were nothing out of the ordinary; they did not appear to be salvaged parts of a damaged product. In fact, they were just like any other piece in the packing tray in front of me. After I noticed this pattern, I had to ask him what it was about. It just seemed too systematic or routine to be happenstance. What was he doing? What was

Figure 2.8: The crew was very welcoming and helpful.

special about these fish?

At first, S was surprised that I would be interested in this activity, in particular. To him, this specific task was something that was a complete side note in his daily tasks, one that did not feel important or central in any way other than being a part of things that needed to be done each shift. S explained to me that he was responsible for checking the utilization of the catch during each shift he worked. For this, he used a separate workstation next to the filleting machine, complete with a scale and a backlit cutting board.

I asked if I could join him the next time he did it, and he seemed happy to accommodate my request. However, when it came time for this check during our next shift, he forgot to include me. As I approached him to join in, he felt

Figure 2.9: The UFM station.

compelled to double-check with me if I *really* wanted to know about this task in particular, especially, as he clarified, *"it has nothing to do with technology."* For him to not include me was simply an act of forgetfulness and not malice. This particular task was truly unremarkable to him. I didn't know it then, but I was about to observe how fish become data.

2.3 Creating Data

At the time, the catch we were processing was cod. The final product was what you would think of as the stereotypical cod fillet: beheaded, skinned, and deboned. The fillets were shatter-packed in boxes that weighed approximately 10 kilos (22 pounds). Shatter-packed fish are packed in boxes with plastic lin-

ers between each piece such that an individual piece can be taken out without thawing the entire box. This type of packaging is sold to restaurants or kitchens serving larger groups, hospitals, and other larger workplaces.

At some point in the middle of our shift, I noticed that S had stepped to the side and had most likely started doing the utilization measures. As I joined him at the workstation to the side of the beheading machine, he had already picked a piece of fish from a pile of beheaded cod and was about to weigh it on the scale on the workstation. The fish had not been skinned or processed in any way other than being beheaded.

At the workstation, S had a piece of scrap paper wedged under exposed pipes on the wall; a torn off piece from a packing box that had been discarded—most likely a box that was not properly glued at the printer or something similar. The scrap paper was not completely blank; it had a header of sorts and a column of letters to the left, with additional text and numbers at the very bottom.

Using a blue crayon, he wrote the weight of the beheaded cod on the paper, next to the top letter in the column. After pinning the scrap paper under the pipes again, S put the beheaded fish into a plastic basket and took it over to the filleting machine. There, S handed K, the filleting machine crew member, the beheaded fish. The filleting machine removes backbones (spine) and whatever guts and organs didn't fall out during the beheading process.

K stopped inserting fish into the machine briefly to clear it out before running S's piece through, making sure that S would receive the same piece at the other end of the filleting machine. S went to the side of the machine where the filleted pieces come out, positioning the plastic basket so he would catch the fish

Figure 2.10: S standing by the filleting machine, waiting on samples to be run through by K.

as K sent it through.

Now S had two pieces of fish—two fillets—which he took back to the work-station, grabbing the scrap paper again to record their weight with the blue crayon. Now the two pieces still had the skin, pin and rib bones, and a small portion of the stomach lining. After recording the weight of each piece on the scrap paper, S walked to the skinning machine. Normally, the skinning machine is set up so that it catches the fillets as they come out of the filleting machine. But having given K the heads up, the filleting machine was running empty again, and S could run the two fillets through the skinning machine without other pieces being brought into the mix.

Stationing the plastic basket at the far end of the skinning machine, S put the

two fillets on the conveyor belt at the front of the skinning machine, resulting in two skinned fillets ending up in the plastic basket. Again, S walked the plastic basket back to the workstation at the side of the hallway, weighed each piece, and wrote the results down on the scrap paper.

After inspecting each piece on the cutting board, using the backlight to identify worms and other flaws in the fillets, S cut away whatever stomach lining, bones, or worms remained in each piece and recorded their weight on the scrap paper. This was the last weight information S gathered from the fillets before taking them in the plastic basket to the head of the packing area, where A was putting together baskets of fillets to be shatter-packed. As S placed the fillets on top of the pile next to A's workstation, they immediately blended in with the rest, as if they had never been removed from the batch in the first place.

What I did not understand or *see* at the time was that these pieces did not blend in to either A or S. As A continued to prepare baskets of fish to be packed, he would make sure to pack the pieces S brought over in a separate box so that S's measurements could be repeated and verified after landing if requested by a DF official. After he had returned the fillets to the packing station, S took the scrap paper with the weight measurements to GE, who was in the small office alcove in the back, off of the boxing area. As we walked back to the packing station from GE's work area, S almost sheepishly said something to the effect of *"well . . . that's it. That's the UFM process."*

The activities were, in a way, just as underwhelming as S had warned. Just a series of weighings, before-and-after measurements as the fish were moved through the processing line, without much fanfare. But I have learned that this particular process is not insignificant by any stretch of the imagination. So what

was really going on? What makes weighing a piece of cod a few times during processing special?

What S was doing was measuring the weight of the piece of fish at each point through processing for this particular type of catch, cod fillets. In all, he measured the weight four times: at the beginning when the fish had been beheaded, when the fish had been filleted, when the skin had been removed, and finally, after the last cleaning. The piece he had started with was now a sample, and as he implemented each step of the processing, the weight showed how much of the fish was left at each step.

The goal with these before-and-after measurements was to evaluate how much of the fish would end up as product and how much of the catch was lost or discarded during each step. That is what percentage of the catch was being utilized, thus the name for the UFM process: utilization factor measurements. In the literal sense, the fish were now being represented by the numbers on the scrap paper that S was using to jot down the weight. *This underwhelming, mundane moment was the point at which fish literally become data.*

In the image below, taken during another UFM process, what had been a random fish picked out of a pile in a trough was now sample D32. At the particular point in time when the image was taken, the measurements for each discrete point had been recorded for one sample fillet, whereas S was in the process of gathering data for the other sample.

We see that for sample D32, S has made four measurements, whereas for sample D33 only one measurement has been made, the weight after removing the head, B (Icelandic: Búkur), at 16.76 pounds. The remaining three measure-

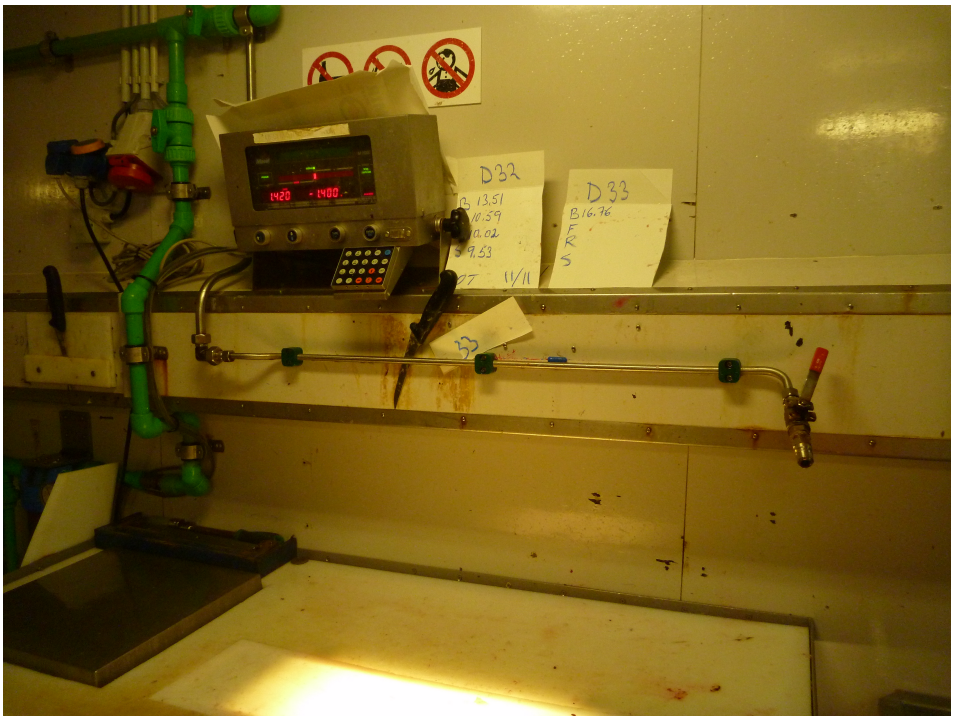

Figure 2.11: Sample D32's data at the UFM station.

ments are for weight after filleting, F (Icelandic: Flakað), after skinning, R (Icelandic: Roðflett), and after final cleaning, S (Icelandic: Snyrt). Like the sample in the UFM process I had witnessed directly with S, these (extra)ordinary pieces of fish used for data creation went on to be packed and would probably later be eaten. But the data went on to a second life beyond S, GE, and the rest of the crew below deck.

2.4 Beyond the UFM

After S handed the scrap paper with the UFM numbers to GE—the crew member in charge of the flash freezer and related inventory—we went back to our spots in the packing area. The longer afternoon break was coming up and, with

it, much-needed coffee. While the UFM process itself was complete as far as S and I were concerned, our samples—now data—were at the beginning point of a journey in which they would amass a multiplicity of new roles and meanings. The new life of the data would have snowballing local and global repercussions for the crew on the ship and other people in the Icelandic fishery.

Part of the reason I had not cottoned to the importance of this moment and what it represented was the nonchalance it was met with by the crew members themselves. In my field notes, I refer to this process as "quality assurance" because that is what it was called by S, the crew member I was watching. There is a small but important distinction between this particular process being for quality assurance (QA) purposes or being a legally mandated UFM.

The QA is easily construed as a typical work process that is implemented to make sure that machines are working properly. For instance, in the case of the beheading part of the process, the QA would address the issue of the machine being calibrated for the type and average size of catch being processed, preventing too much valuable meat being discarded along with the heads.

We imagine this kind of testing to be routine in any workplace, and the findings would be addressed immediately. The machine would be recalibrated if the settings were off, the staff would be given instant feedback and asked to change their process, and so on. The latter kind of testing, the UFM, however, has both immediate and long-term consequences for the captain, his crew, and the vessel itself that go beyond a simple tweak in the current work procedures or tasks at hand.

In the following sections, we move away from the UFM activities onboard

the freezer trawler and take a look at the regulatory side of the UFM through the legal and regulatory texts regarding this process. I examine the direct implications for the crew pertaining to their immediate and future work. Further, I demonstrate how the introduction of the UFM brought with it new forms of infrastructure requirements for governance and supporting industries. Unlike a QA, with local and immediate outcomes, the UFM is a moment at which governmental bureaucracy and fleet-wide surveillance are happening onboard the trawler.

UFM Process and Governance

To understand how the UFM, a series of before-and-after weighings, can have long-term consequences, we need to take a look at what the UFM really stands for in term of the extensive laws, rules, and regulations regarding the fishery. Given the immense economic and cultural significance of the fishery, this industry is—not surprisingly—heavily regulated. It is, after all, an industry that produces foodstuff, an industry that provides employment for thousands of people both on land and at sea, and an industry where the end product is derived from a natural resource that some argue is being threatened with overutilization.

Aside from the UFM being a legally mandated process, what does it specifically mean for the crew onboard? As each captain turns in their UFM data sheets to the DF after a tour at sea, their overall utilization factor (UF) is calculated and updated to a centralized database at the DF. As the fishing year comes to an end, each fishing vessel with a quota in the Icelandic fishery will have a UF number associated with it.

This UF number is, in turn, used when the Minister of Fishery allocates quota to the vessels/their owners for the next fishing year. A vessel with poor utilization of their quota stands a chance of getting less quota allocation in the following year. It is thus in the captain's interest to report "good" UFM data so that his supervisors, the owners of the vessel, will continue hiring him. Underutilization will also shift the margin for profit significantly (e.g., Margeirsson, 2007) which will show in the crew's paychecks as well.

After being enacted into law in 1992, the UFM process has also impacted the regulatory environment in the fishery. The UFM process itself is described relatively vaguely in terms of the actual procedural breakdown, but it is established as the responsibility of a crew member who will have met (unspecified) standards for training and education to perform this particular task (Anon, 1992b). As far as governmental supervision for the UFM, the framework is extensive, however. At the same time the law was introduced, a new government institution was installed that would have as its sole purpose the management and all administrative follow-up of the UFM law (Anon, 1992a).

This institution was the DF. One of the key tasks that the DF was assigned in the UFM law was the supervision and management of the UFM data as it was reported by the fishing vessels' captains. Working under the Ministry of the Fishery, the DF would be responsible for providing the data to the Ministry to use in annual quota allocation calculations. In an accompanying brief, the Minister of the Fishery, Þorsteinn Pálsson, outlines the significant administrative and bureaucratic overhead that the UFM law will entail due to an increased demand for wider distribution and general access to data regarding the fishery (Anon, 1991b). The minister goes on to describe work that the Ministry of

Fishery and the MFRI had been engaged in for a few years prior, developing an electronic database that will house any and all data on the quota system for the Ministry. In addition to the centralized database, specialized software that would enable captains to report catch statistics on a daily basis while at sea was being developed as well.

Control Through Data

I argue that in reading associated news clippings, as well as the legal documentation surrounding the proceedings for the UFM law, a common logic undergirding these moves by the Ministry of Fishery and other related entities starts to emerge. The introduction of the UFM law and the Fisheries Directive along with the creation of a centralized database to manage the fishery all speak to a shared logic that we see evidence of in the fishery today. Touching on different domains, regulations, institutions, and technology, the common thread connecting these events is a logic of control gained through information and data.

The early steps of the UFM process, identifying pieces of fish to transform into samples and recording their data to share with management on land, encapsulate this logic as the basis for the Icelandic Natural Resource Management strategy. That is, in order to successfully manage a natural resource, it first has to be transformed into data. We have seen that this initial requirement is accomplished through the first steps of the UFM.

Following the transformation of fish into data, the logic of the fishery management dictates that the resource is now malleable to manipulation beyond the simple act of harvesting. This transformative act is necessary for planning

activities like allocating quota for the upcoming year—and subsequently, how the UFM is used by the DF. Transforming the resource into data not only allows for planning, however. I argue that it also presents, as an activity, the idea of sustainability or "responsible" fishing, upon which the fishery management rests.

Planning for the Magically Unknown: Back to the Bag

The Icelandic fishery of today is a tangle of fishing practices old and new, mixed with a continually evolving resource management infrastructure. As the context of fishing has evolved from subsistence-oriented practice to international trade, the complexity of practices, regulatory framework, and support structure surrounding it also grows.

The UFM process is only one of many ways the datafication of the fishery has taken place and continues to unfold, affecting both fish and fishers. We need not look far to see another example of this onboard the freezer trawler. Let us take a closer look at the role of the flash freezer and inventory manager, GE.

GE's Workspace

After S and I gave the UFM sheets to GE, we returned to the packing area. GE went to work in his office. GE's office is a tiny windowless room adjacent to a packing supply and general storage room. In this area, GE has a small desk with an old desktop tower (PCU) bolted down under the desk, a wired mouse and keyboard on a keyboard tray, and a compact flat computer screen.

Figure 2.12: GE entering boxing data into his spreadsheet. This information will, in part, be used for the mess hall information sheet.

In Image 2.12, we see GE at work, entering the most recently processed box tally from the flash freezers. Out of frame, behind GE, are boxes with packing supplies (rolls of packing tape and labels) and a workbench with parts from filleting, gutting, or beheading machines along with wrenches, screwdrivers, and other tools.

In some places, there is evidence of jerry-rigging efforts that differentiate this small office area from typical office work space on land. The most obvious ones include precautions that I had seen throughout the ship, including that everything large that should not move around as the vessel sways and often lurches in the ocean is bolted or strapped down in some way (zip ties for smaller things and metal strips that have been welded to fit around larger items like the

desktop tower).

The desktop has a non-slip pad on it to prevent items from sliding off, and the equipment is covered in dry fish scales and other dirt that inevitably accompanies the kind of work that happens below deck on a freezer trawler. Looking closer at the image, we can see that GE's keyboard is zip-tied to the keyboard tray. In other ways, this work space is very much what you would expect an office on land to look like, complete with some paperwork and a calculator.

Planning for the Immediate Future

GE's role onboard is to coordinate everything that happens to the catch after it has been processed. That is, packing, flash freezing, boxing, and storing in the deep freezer. For GE to be able to stage and provide the right type of packaging materials for the packing crew, he needs to know what is coming down the line from the processing crew.

In other words, what is in the bag? Is it red perch that only need to be packed six to eight pieces a pack—thus a relatively quick job per pack—or is it cod fillets that are more labor-intensive to process and pack? How big was the bag we are processing now? Do we need to change the processing machine lineup? Has the catch been sold already, or will it be labeled for general fish market auction? These, and many other questions, run through GE's mind as he checks in with ÁB, the crew foreman, and Captain M regarding the type of processing the catch needs.

As with so many tasks I observe onboard, much of the communication and

coordination for these tasks feel very subtle to me. At this point, the majority of this crew has been working on this particular vessel for years, which has resulted in a lot of in-joking and minimalist language at work. I observed this on other vessels with similarly experienced crews.

SB, the captain on a Danish seine vessel with a crew of five, told me that communicating with the crew from the bridge essentially boiled down to a loud whistle. He would whistle once when he wanted the crew's attention, whereas two whistles meant that the vessel was about to turn about and the seine would be coming up. He laughed as he told me that during a social outing with the crew, he had whistled once over dinner, and the entire crew had looked up at him expectantly.

Using shorthand such as "Japanskarfi, stór" (red perch for Japan), GE and the rest of the packing crew know what type of processing and packaging layout is required (beheaded, four to five pieces per box, plastic liner), and we find rolls of blue plastic liner readily available on the shelves next to the flash freezers or even set up on the packing stands for us as we return from break.

While the packing crew packs the "Japanskarfi, stór" GE is in the back, printing bar code labels and getting the boxing area and the plastic strapping machine staged to accommodate this particular processing. From the plastic strapping machine, the boxes are moved via a conveyor belt/elevator into the deep freezer staging area one deck below. As we near the end of the "Japanese: red perch, large" packing activity, GE is already thinking about where the boxes will be stored in the deep freezer.

As there is only one entrance to load and unload the deep freezer, he needs

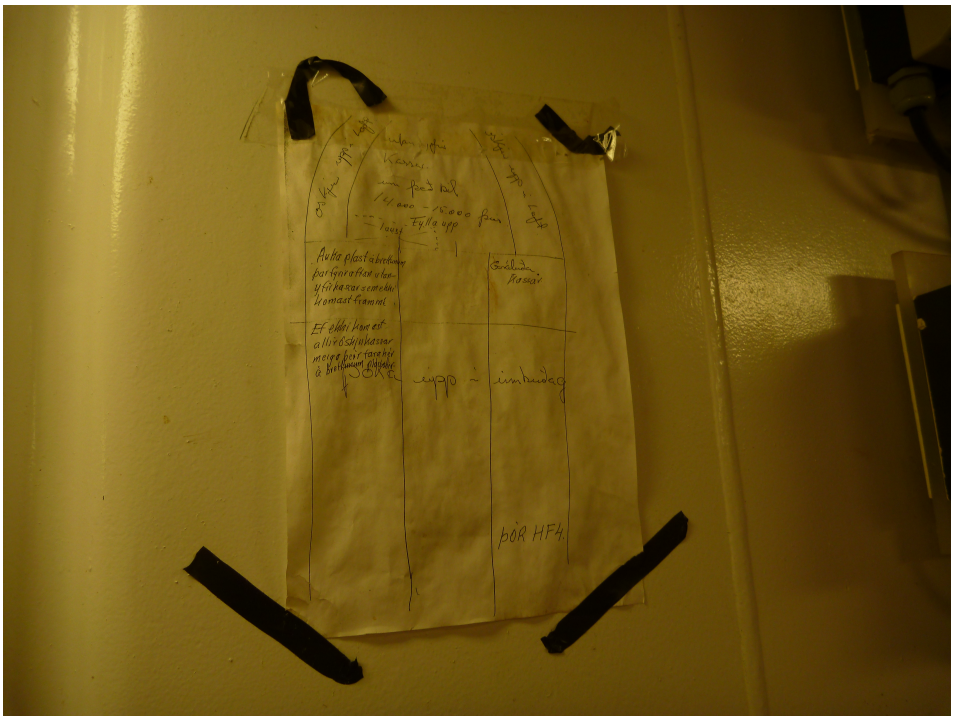

Figure 2.13: The map of the deep freezer.

to plan ahead for what goes in the very back or closer to the front area, where the entrance is. He uses a hand-drawn map (see Image 2.13) that details where boxes can and cannot be stacked all the way up to the ceiling, where different types of catch normally go ("Greenland halibut here"), or ways to deal with overflow ("if you need to put crates here, put in metal separators").

The day I get to help out in the deep freezer, we are almost back to shore, with two days to go until we are back on land. The deep freezer is mostly full, with boxes lined up almost to the entrance. We are still expecting to process catch that will go in boxes of the type that are in the very back of the deep freezer.

Needing to keep boxes with catch that has been processed in the same way

Figure 2.14: Work in the deep freezer. To the left, note the conveyor belt and the tunnel built around it.

together, this presents a logistical issue for GE. Thus, he has set up a conveyor belt that fits through a tunnel of boxes that are more forward in the deep freezer (see Image 2.14). He crawls through the tunnel on top of the conveyor belt and has fellow crew members AF and Ó send boxes his way once he is on the other side.

Planning for the (Un)known

All of GE's activities that I have described above are instances of coordination and planning for an immediate future, where GE is acting on information that is already available in front of him. These are the kinds of situations that could

prompt GE to think something along the lines of "There are so and so many trays of this type of catch processing in the flash freezers, which means we need so and so many boxes to pack and send down to the deep freezer," or "We are running low on plastic liners for the packing crew; I need to go to the storage room and bring a few rolls out to the boxing and packing area."

This kind of envisioning and forethought comes easily to someone who is very experienced at their task, like GE, who has had the role of flash freezer and packing coordinator onboard for some years now.

What differentiates GE's work from that of an office worker on land or an inventory supervisor at a warehouse is the kind of future planning that GE and his superiors Captain M and crew foreman Á engage in on a daily basis. Their planning is oriented around the bag that has yet to be hauled up and out of the sea. That is, organizing the workflow and work space in the processing and packing areas so that it can accommodate the type of catch that is/may be coming in the next time the bag is hauled up onto the deck. *To be clear, this is planning for something that is both unknowable and somewhat knowable at the same time.*

A large trawl that has been pulled along the bottom of the ocean for hours on end *can* and *will* have any number of things in it other than the intended catch. This is part of the appeal of trawler fishing: the catch has the potential to be very large in size, while the captain and crew expend fairly limited effort as such. This indiscriminate catching is also one of the big problems of trawler fishing as argued by its opponents; other than through the size of the mesh, the trawl does not separate between endangered marine wildlife and the intended catch (cite preservation reports, literature re: trawls).

Even though the trawl does not discriminate as such, what we will likely get in the bag at the end of each trawling pull is not completely unknown. In the ocean surrounding Iceland, there are many areas that have been identified as particularly good for specific types of fish due to the environmental conditions in these places, be they seasonally affected or conditions due to the Gulf Stream. For instance, Captain M tells me that red perch is mainly known to be in the areas to the south or southwest of Iceland—even though it has been found in other areas around the island.

Similarly, it depends on the time of day what kind of activity is being displayed by the fish. I learned from HG that Atlantic cod are more likely to hunt for food and be more disperse during daylight than at nighttime, resulting in different imaging results on the fish finder. So in order to bag a large group of cod that moves in shoals, we would be more likely to be successful at night, when the group less active and not as disperse.

By relying on past stock behavior and information from IT to observe current patterns and environmental conditions, the captain and crew feel that they know what is in the bag. The contents of the bag are no longer a surprise. The ocean has lost its status as a system outside of human infrastructure/systems/control and has been integrated into the fishery as a repository for fish.

I argue that this is one outcome of datafication in the fishery. Concretely, this outcome is not about whether the captain has an idea of what is in the bag, but how datafication makes the captains *feel* like they know, now better than ever, what is in the bag. To be clear, this way of thinking is not unique to captains; we see evidence of this logic in marketing and sales when the catch is sold *before*

it has been caught, and in the rhetoric of how the resource is managed through quota allocations for the upcoming fishing year. Through datafication, it seems, we have attained an illusion of control over something that, in reality, is not under our control.

Ultimately, what this means is that when a crew member asks "what's in the bag?" a description of the contents of the bag is not what they care about, but rather what those contents represent. To the captain, a full bag represents, among other things, a successful pull. They are one pull closer to completing the tour at sea. To a crew member, a full bag means a busy shift and money in the bank. To the government officials at the DF, the bag represents more UFM data. The way the Icelandic fishery is managed today, these may be the most valuable contents of the bag.

2.5 Conclusion

In this chapter, I described the packing work onboard the freezer trawler. Working alongside the packing crew, I joined a crew member as he performed what he described offhandedly as QA, something he had to do once during each six-hour shift he worked. Later, in conversation with GE, another crew member responsible for part of the "QA," I learned that what I had observed was not really QA as one would typically understand it. That is, an in-the-moment check to see if the machinery is performing as needed.

Rather, what I had observed was a part of a legally mandated procedure called UFM. In fact, the UFM is as far from an in-the-moment check as possible, as it comes with specialized training, forms, and reports to be filled out and

filed at each stage, complete with follow-up by management and authorities as the vessel comes to shore. Procedural rigmarole aside, the moment the UFM process takes place is the moment that fish are turned into data for the fishery.

As it turns out, this transformation has implications for the captain and his crew that reach beyond the immediate work environment. The UFM plays a role in how the annual quota for the following year is allocated, and it is used (with other factors) to determine how much will be allocated to that particular vessel. For the captain and his crew, this means that it is in their best interest to have "good" UFM numbers to report. By following the path of the UFM data—from the moment it is created to it being reported to the bridge, then to management, then to the authorities—I argue that this practice, while mundane to the crew, illustrates a commitment to what I see as the core logic/mythology of the Icelandic fishery, that management and control of the fishery is only possible through information technology and the datafication afforded by this technology.

This logic bleeds into every aspect of daily life onboard the freezer trawler, from GE posting information sheets in the mess hall that contain updates on what has been caught so far and the related market prices to another crew member singing the phrase *"800 Krónur! 800 Krónur!"* when bored at work, reminding himself that each time he slid fish into the beheading machine, he was earning money.

In other words, as the fish are caught and killed, they gain new life as data that morphs into a variety of metrics, depending on the objective at hand; a catch regulation statistic for marine biologists on land, a quality metric for management, or in the case of the UFM and the crew onboard the freezer trawler,

whose work will only be secure if the vessel maintains the quota allocation in the year to come. In sum, success *of* and *in* the Icelandic fishery is as much based on data and other representations *about* the fish as it is based on the fish themselves.

In the next chapter, I unpack another transformation that has taken place in the Icelandic fishery. As the professional environment has changed to include more information technology in response to the emphasis of the datafication of the fishery, so have the professional roles. Formerly strictly blue-collar laborers, the fishermen and captains of today are situated at the boundary between craft, labor, and clerical information work. Having witnessed the transformation of fish into data, we now turn to people.

CHAPTER 3

IT AND WORK

In this chapter, we take a look at how the work of the captain is shifting as a consequence of the uptake of IT and intense datafication in the fishery. Looking at the day-to-day responsibilities of the captain, we see an ever-increasing role of governance and surveillance through IT and data. One aspect of this is manifested in tasks such as electronic database maintenance and detailed reporting regarding the catch and its processing for the authorities.

In addition to governing what happens in a regulatory sense, today's captains are also under intense scrutiny from corporate management on land by way of marketing and sales staff communicating a need for a particular catch and processing based on updates in sales.

Today's group of captains consists largely of professionals who have worked in the fishery since before it was governed as tightly as it is now. Having come up in their profession during a time when the role of the captain was seen as authoritative and autonomous, today's captains have to contend with being managed, surveilled, and governed on a fairly granular level. I argue that the arrival of IT and data as a governing tool across the fishery has deeply transformed what it actually means to be a captain.

3.1 Safety at Sea

Before joining the crew onboard the freezer trawler, I was required to complete a weeklong training course on safety at sea at the Icelandic Association

Figure 3.1: One exercise in the safety training class required us to get familiar with drysuits, keeping a human chain afloat at sea, and being airlifted. The person being airlifted in the image is me.

for Search and Rescue at Sea (ICE-SAR at Sea). This training is now mandatory for all personnel on fishing vessels (Anon, 1991a). During the week of training, my cohort—16 fishermen and sailors from all over Iceland[1]—and I sat through classes on basic safety measures onboard such as the need to wear helmets and how to attach a line to crew members working on the deck.

We participated in drills on the proper procedures in case we would need

[1]Of these, five were new to the profession, four of which were headed out on their first tours. Of the other, more experienced, fishermen, five owned small vessels or quota and were fishing independently at the time. They were attending the class to maintain their eligibility for employment on commercial vessels; three of my classmates were current crew members on larger commercial fishing vessels, and the last classmate was a crew member on a long-distance commercial freighter.

to evacuate the vessel in an emergency and learned the difference between being pulled from water by safety harnesses, by a person, or by airlifting while adrift at sea. In another lecture, we learned about fire safety protocols and were instructed in the use of oxygen tanks and masks as well as participating in a fire training scenario where we pulled a dummy out of a burning room while wearing protective gear and oxygen. What impressed me the most was how incredibly hard this was in terms of physical labor and how it requires nerves of steel as well.

The lessons of the safety course were not only about safety techniques and drills. They were also about how power works onboard, and it was drilled into our heads that the chain of command was to be honored at all times. In fact, disobeying the captain while at sea is grounds for dismissal. This was not news to most of my fellow classmates, experienced fishermen who were simply attending the class as a mandatory refresher. To me, however, it was truly eye-opening to realize that there are very practical reasons for this strict adherence to the power structure: While at sea, the very first people to respond to *any* kind of an emergency will be the captain and the crew. In case of accidents, the captain is trained and expected to provide advanced first aid and medical help like suturing wounds, providing oxygen, and administering drugs like morphine. In the case of a fire, the captain acts as the fire chief, and in the case of criminal activities, the captain has the power to place members of his crew under arrest, with force if necessary.

Depending on where the vessel is located, it could well be hours until search and rescue would be able to get to the scene. So not only is the captain in charge of the immediate response to the situation, but he is also charged with keeping

everyone calm and focused in the aftermath, whatever it may be. Having a clear chain of command is essential in these instances. I would later learn that even in non-emergency situations, having a clear chain of command can feel tremendously stabilizing to the crew on a freezer trawler. In my experience onboard the freezer trawler, knowing that there was someone in charge felt like an emotional safety net in case the overall crew's mood shifted or some disagreements were to break out. Unlike workplaces on land, we were all stuck onboard the vessel for a long time, with very limited means to escape a dangerous or hostile situation.

I completed the safety training on a Friday afternoon after spending an intense week with my classmates. For many of my classmates, this kind of training is the only type of advanced or diploma-like education they will complete. After going through safety drills, CPR training, the proper ways to lift heavy loads, and talking about the importance of emotional well-being during long tours at sea, the atmosphere was jovial as we participated in a graduation ceremony.

Given the importance of the topics that were covered in this training, it is remarkable to realize that it really only lasted one week. Saying that I felt unprepared for a tour at sea would be an understatement. Throughout the week, as the class had coffee in the lounge during breaks, I was comforted to learn that Captain M was nothing short of a legend, a well-known *"aflakló"*, or a champion captain, well known for bringing in big bags.

In fact, my classmates were incredulous that I, a complete newcomer to fishing, was being allowed to join Captain M's vessel. Upon learning that my access was due to lucky circumstances for me—Captain M is a good friend's brother—

Figure 3.2: Part of the class waiting for the airlifting exercise to start.

and that I was not joining the crew permanently, they immediately asked me to put in a good word for them with the legendary captain.

While I was feeling unprepared, the majority of my classmates were already seasoned fishermen with decades' worth of experience, serious injuries, scars, and even a missing limb to show for it. If not for the fact that this training was mandatory, it is unlikely that they would have felt compelled to attend at all. This safety training and others provided by ICE-SAR has been mandatory for people wanting to work onboard fishing vessels since 2001, although some of my classmates did admit that they were only just now completing it, in 2011. As I was discussing the possibility of joining Captain M for a tour at sea, he presented the training to me as a mandatory safety precaution not only in terms of the law but also for him. Having a "landlubber" getting in the way—because

they do not know how to act in case of an emergency—could make matters worse.

The value he would derive from attending a mandatory refresher, however, was close to none in his opinion. After all, he has been in this profession for decades. To him, these training courses more afforded him a chance to meet colleagues and catch up face-to-face rather than over the radio while at sea.

3.2 Fishing Has Changed

When we think of a captain of a fishing vessel, we pull up an image of a ruggedly handsome man standing at the helm of the bridge, one hand on the wheel and the other raised to his eyes as he peers out toward the horizon. Perhaps this captain is even wearing a wool sweater, has a pipe in his mouth, and sports a beard. Granted, the captain may be ruggedly handsome and have facial hair, but this is not how modern captaincy looks at all.

As I started fieldwork for my research, I would time and time again be left simultaneously speechless and thrilled at the range of IT and other specialized equipment that Icelandic captains have at their disposal for their work. In describing what I had seen, I would often fall back on saying that the working environment for today's sea captain looks like Captain Janeway's command center on board the Voyager. Computer screens, control panels, levers, and knobs are lined up in front of the captain's lounger, a swiveling office chair that is bolted to the floor.

Image 3.3 is a collage of different bridges onboard vessels used for seine,

Figure 3.3: Clockwise, starting top left: Captain K's chair onboard a longliner; Captain M's workstation showing navigation, fish finding, and fishing equipment status screens; View of Captain M's workstation from the back of the bridge; Captain SB's workstation onboard a purse seiner.

longline, and trawling. The vessels vary in size, type of fishing, and processing capacity, but in each case, the captain's workstation is a computer console, not a steering wheel. *This is what fishing looks like today.*

The goal of this chapter is to look closer at how a focus on data in the fishery has impacted changes in the kind of work required of fishing captains. We will see that the modern fishing captain is as much an information or data worker as he is an applied craftsman. In the next sections, I present examples of the kinds of tasks that a captain does while at sea. Some of the tasks are a part of the captain's daily routine and are directly related to what we would think of as a typical task for catching fish, whereas others may be less obviously related to

the role of the captain.

By examining these tasks, we will see how the job of a fishing captain has expanded and changed as IT and data have become more central to the fishery. While at first, it may appear that the captain merely has new, more effective tools for his job, I argue that the focus on data for governance across the fishery has deeply transformed the nature of the profession and changed what it actually means to be a captain.

Reporting the Catch: Moving from Paper Logs to Digital Data Entry

The first suite of tasks I will examine is the reporting work regarding the catch. That is, how much has been caught, what has been caught, where, how, and so on. To do this, the captain uses a customized, proprietary software called the Electronic Catch Logbook (ECL). The ECL is record-keeping software that was specifically designed to create a database of all the fishing activities being done in the Icelandic fishery, and is one of the main ways fishing restrictions are enforced (Anon, 2006) [2].

This electronic database was introduced by law in 2007 as a way to monitor overall fishing activities and catch status in a concurrent fashion and more effectively than before. Up until that time, this recording had been in paper

[2]The software required is provided by the government, but the actual installation, maintenance, and associated tech support are provided by the development company at a price. I have not been able to ascertain the price for these kinds of services from sales representatives, who cite confidentiality and different requirements depending on the company. The feedback I heard from independent fishers was that this aspect of the ECL was not cheap. A subjective, but telling, point.

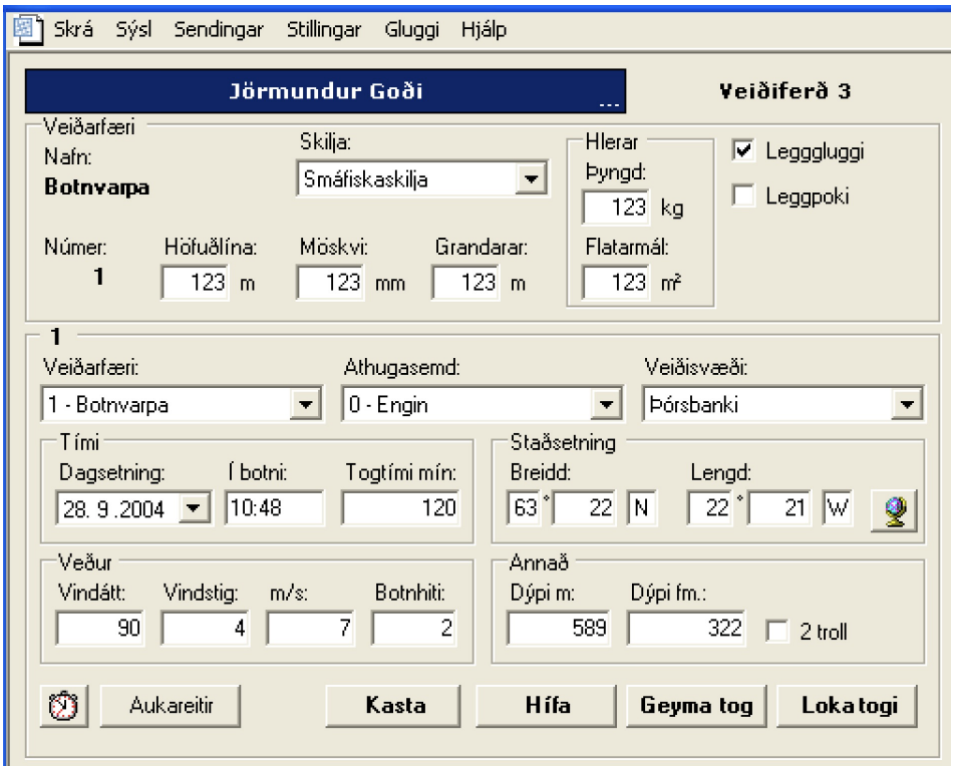

Figure 3.4: A screenshot of the ECL interface for a trawler.

form.[3] The ECL database has a wide range of information about the activities, such as type of fishing gear used, GPS coordinates for each haul, and ambient environmental conditions for both air and ocean.

The data is entered by the captains each time they let out their fishing gear and each time they pull it back in. Each captain has access to their own records in the database, as does the company that owns the quota they are working with. The database for the entire fishing fleet is only accessible to the DF and the MFRI.

Image 3.4 shows a typical interface for a captain on a trawler. The captain

[3]There are still vessels that use paper reporting rather than the software due to loopholes in the law allowing smaller vessels to report on paper for now. Independent fishers with financial constraints can also apply for an exemption from using the ECL.

has options to enter information such as the number of minutes the bag was out (Togtími mín: 120), size and weight of the trawl doors (Hlerar: 123kg, 123 m2), the weather conditions (Veður), and whether a specific filter to prevent catching non-mature fish was in place (Skilja: Smáfiskaskilja). After each pull, the captain must, to the best of his abilities, estimate how much was in the bag and provide information about what was in the bag in terms of type of catch as well. His estimates from the ECL will eventually be matched up with landing reports from unloading at the end of tour.

After the ECL has been filed at the end of tour, the data will be included in work done by marine biologists and other research staff at the MFRI to guide fishing efforts in the upcoming year. The DF will use the data about and from the ECL to monitor the amount caught with regard to the total allowable catch (TAC) for the fishery and the individual transferable quota (ITQ) for the specific vessel. If the captain has not filed the ECL in a timely fashion, for instance, he and the company that owns the ITQ will be penalized by way of a formal warning or by having their fishing license revoked.[4]

The ECL and the data it produces are an example of an officially mandated process where data is used as a tool for governance. Outside of the governmental regulatory related tasks, the captain also has tasks that are imposed by his supervisors; that is, the company that owns the quota being filled on the vessel. In the case of one of the larger fishing companies in Iceland, one of the peo-

[4]It is interesting to note that in every annual report since 2002, violations regarding the catch logbook, and eventually the ECL, have on average been over half of these incidents (See DF reports from 2002–2016). These incidents are not explained in more detail in the reports, but it is clear that there is something amiss in the work process, whether it is of a social or individual nature (passive or active resistance) on behalf of the captains, a technical issue regarding the database functionality, or a regulatory aspect (as is the case with the number of loopholes that are to be found in this particular law). This particular constellation of socio-technical and regulatory issues does bring Levy's (Levy, 2014, 2015) research on EOBR devices monitoring truck drivers to mind. Further examination is warranted.

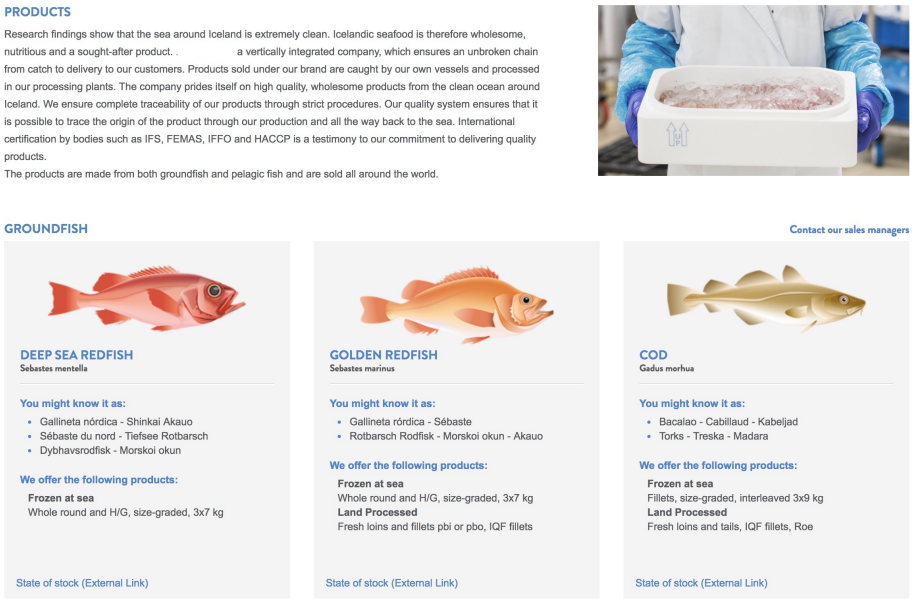

Figure 3.5: A screenshot of some of the products S and others on her sales team are responsible for.

ple who has a say in what tasks await the captains is S, a member of the sales and marketing team. In the next sections, we will learn more about S's role in managing her captain's day-to-day tasks at sea from her desk on land.

New Coworkers on Land: Coordinating with Marketing and Sales

S is from a small fishing town north of Reykjavík, and like my fishermen and captain informants, she grew up in a fishing family. However, instead of going out to fish with her father, she helped out on land, working alongside her mother as they processed the catch. After working in fish processing plants and even out at sea through most of her adult years, S went back to school to get a

technical degree in administration.

She says that her background growing up and working in the fishery is in many ways more valuable than her administration degree for some aspects of her work. She explained that being one of very few women in the office and in this particular profession in the fishery, she is keenly aware of how the captains perceive her input. However, having actual experience in the fishery—being able to speak the lingo—has allowed her to establish a rapport with "her" captains (the captains working for the company).

One of S's tasks is to be in communication with the captains when there are orders for a specific catch or catch processing. In Image 3.5, we see some of the purchasing options S's company offers potential buyers. When an order comes in for a particular type of catch, it is S's responsibility to make sure that the order is filled. It is her responsibility to be aware of what has been caught and processed already, as well, and to figure out which one of the captains needs to be contacted for the remainder of the order. In some instances, an order is filled by more than one vessel, and it takes a lot of back and forth between S and the captains to coordinate efforts and make sure that everyone is on the same page.

A coordinating phone call like this took place one afternoon when I was with Captain M on the bridge. He received a call from his vessel's company salesperson who told him that there was a request for a particular kind of catch that would require us to go to the other side of the island on our tour. While Captain M did agree to do this, he told me after he hung up that this kind of "interference" was annoying, in his opinion. Why could he not be left alone to do what he did best, catch fish, and a lot of it? He grumbled about having to re-chart his route and making sure to keep the landlubbers happy.

Two things stand out here. First is the notion that today, when fishing vessels go out to sea, they are simply going out to fill purchasing orders. That is, when a vessel sets sail, there is already a roster of orders that need to be filled in place. In this worldview, the ocean is no longer a wild unknown but a storage unit that holds purchase orders ready to be picked up. This is very evident in the product listings on the company website, some of which can be seen in Image 3.5.

S uses a specialized database in her work as she has to coordinate between vessels at sea, where they are—heading out, coming back, docked—and order updates, shipping status, and so on. The database is designed to track inventory, further underscoring the idea of the ocean as a storage unit to be managed through data. The database marketing materials underscore this particular mindset as well. A review from a customer on a brochure states:

> *The daily report function saves me so much time—**showing me in an instant how much product we need to fulfill orders** . . . For me in the role of a manager, [software] is first and foremost a management tool, providing me with an overview of everything going on, not to mention how efficient and reliable it is; it's all centralized.*

That is, with a centralized database detailing orders filled and the status of open orders, all that is left is to go fetch the product from stock. Second, as we saw with Captain M, coordinating with people on land while at sea puts the captains in a position of having to answer to someone other than themselves. This is a major change for the older generation of captains who are used to being the ultimate authority onboard their vessels.

In Chapter 2, we saw how fish are transformed into data through work processes that are an outcome of a focus on data as a management tool in the fishery. What we have seen with the examples of the ECL and the marketing and sales coordination with S is that the work of the captain has not been immune to the focus on data, either. To understand how different the work is, it may help to look at how things were when these captains began fishing. In the next section, I present a very brief overview of early learning and training practices in the fishery.

Growing up at the Oar

In spite of being surrounded by particularly rich fishing waters, Icelandic society was largely agrarian until the mid-20th century. Access to fish and fishing was an added benefit for farmers whose lands included natural landing spots for rowboats, a secluded bay or an inlet with natural shielding from breaking waves, enabling relatively safe departure and landing (Karlsson, 2000). Fishing was done on rowboats ranging in size from 2- to 12-person vessels going out each day for coastal fishing. Navigating was done by landmarks; that is, by looking at the coastline, mountains, and hills. So in order to go out, visibility had to be good—no fog, hard rain, snow, or so on. This means that fishing was also a seasonal activity, largely dependent on the weather conditions (Karlsson, 2000; Thór, 2002, 2003). Knowing that Iceland borders the Arctic circle, meaning that winter days have on average of five hours of daylight, whereas summer daylight hours average on 20, will help the reader understand how big a part seasonality played for this kind of fishing at the time.

Knowing *where* to fish was learned partly from knowledge passed down by older generations and partly from experience. As an example, in a collection of oral history of fishing on the southern peninsula of Iceland, one piece consists of a list of 37 fishing areas and the landmarks to be seen from these spots to facilitate navigating by those landmarks (V. Magnússon, 1960). As the editor of the collection explains in the introduction, the knowledge required to create these was garnered over many lifetimes of fishing in that area (Thórarinsson, 1960)

Learning how to use this type of information in conjunction with actual fishing was also a lifelong practice that began at an early age. The teacher in those instances was often a father or an uncle showing the young crewman the ropes as he worked alongside the more experienced men. Magnússon (1990) describes this kind of familial training-through-life as "growing up at the oar."

This was the case for my grandfather Snorri and his sons, my father and uncle. Snorri had a small motorized boat that he used from the 1920s onward. He trained both his sons to help out on the boat from an early age. As my father and uncle grew up and moved to the capital, my grandfather hired and trained other local young men to help out with the fishing. Growing up at the oar continued to be the main method of training in the fishery for decades and up to today. In fact, most of my informants got their start in the fishery in this fashion.

It is easy to see why this was the way people learned skills in the coastal rowboat fishery; the tasks at hand—navigating by landmarks, rowing, preparing nets, catching fish, and processing it—are all applied skills that are very well-suited for learning by doing and hands-on mentoring. However, as sailing

technology changed, so did some of these practices.

Today's Fishermen and Captains are of a Different Generation

Today's older generation of fishermen and captains are members of a group of people who have had to straddle two different experiential worlds in their work. For the most part, this group has been in this profession long enough to have seen some of the regulatory changes (fishing restrictions and quota allocations) being implemented and refined since the mid-1980s. This generation has also seen the introduction of revolutionary information technology innovations such as collision prevention, fine-grained fish finders, automatic mapping software, and other communication technology that has become the norm in today's fishery.

Fishing Captains and Radiologists: Digital Frontiers

The shifts that captains have made in the labor has parallels with how other occupations have changed since the introduction of digital technologies. For example, in the early 2000s, there was a major shift in the working practices and conditions for radiologists as X-ray imaging was increasingly being switched from analog or film-based reading to digital reading being performed on three or more computer monitors at a time.

With this shift came an increase in work-related health issues for radiologists. By going digital, the work of a radiologist had, in many ways, become easier. The quality of the images increased, the different ways in which they

could enhance the images was an improvement over the former static images, and finally, the ability to keep the images, and their annotated and manipulated versions, together was seen as a huge improvement in terms of accuracy.

However, the number of images they had to view this way had risen dramatically from before. Reading X-rays had essentially shifted from being a dynamic, physical work done while standing in front of a light box to a sedentary and intensely repetitive computerized task (Brynjarsdóttir, 2007; Siegel & Reiner, 2003).

Just like the radiologists, the captains are in a profession that has witnessed a transformation in terms of work practices, thanks to innovation in information technology. And as with the radiology reading rooms that had been retrofitted to accommodate new practices, I saw instances of adjustments that had been made in the working environment of the captains, such as ergonomically shaped computer input devices and glare screen overlays. What I didn't know and would slowly find out was that perhaps the biggest change for the captains was how the nature of their work had shifted.

In some ways, the captaincy work itself has not changed; the captains are still responsible for the crew, the vessel, and the catch. However, today, they are also responsible for an impressive amount of reporting about their work to the DF and company management on land. In the following section, I highlight some of the major changes that have come about when it comes to training and education in the fishery.

Learning to Fish Today

One way to understand how data and datafication impact fishermen and captains is to look at how they are trained for their profession today. How we teach people to perform certain tasks can highlight core values and ideas about those tasks. For instance, we have seen that during the subsistence-oriented years in the fishery, growing up at the oar was seen as a reasonable way to learn how to work onboard a boat and on land. There was perhaps less need for a standardized curriculum to ensure that everyone learned the same things in the same way since the majority of the catch was not being distributed commercially.

In the context of today's global fishery, however, we see a different landscape in terms of training. Fishing is no longer a seasonal, feudal, subsistence practice, and this is reflected in the standards surrounding how people are trained to work in the fishery. This applies in particular to the profession of captaincy. To be eligible for the role of a captain on a commercial fishing vessel in Iceland today, one has to complete at minimum 3.5 years of education at one of four institutions that have been approved to provide a degree according to international standards (Anon, 2008a, 1932).

In the summer of 2009, I got a tour of the facilities at the School of Navigation at Reykjavík Technical College[5] from the dean at the time, Magni Óskarsson. The dean gave me an overview of the curriculum structure, and we spoke briefly about the role of the captain and how this has shifted over the years with regard to technology innovation and uptake.

I learned that the main focus of the curriculum at the time was communica-

[5]http://en.tskoli.is/about-us/

tion technology. While navigation remains at the center of the skill sets essential to sailing and fishing, today's captains-to-be spend a significant amount of time in classes learning how to use electronic navigation aids, course plotters, and fish finding equipment, often before they have ever been at sea. In addition to these "standard" captaincy topics, the students also have to complete courses in marketing, economics, human resources, and operations and management.

This breadth of topics speaks to the changes that have happened in the work of a captain but also reflects a change in how the role of the captain is viewed. That is, the captain is not only a navigator and fisher but also an educated professional who works in the context of global commerce. The dean said that he had observed a shift not only in the way captains are trained but also in the make-up of the captains as well. Removing the prerequisite experience at sea has resulted in students who are very proficient in all things technology almost to a fault, in his opinion. The bridge has windows for a reason, he explained. It is important for the captain to be aware of their surroundings in addition to what information there is to be gained from the IT.

He also explained that a large part of the work of the captain was very context-dependent. It is not the same to learn about the role of the captain by reading it in a book versus having done it, having been at sea and understood what that truly means. However, he told me that being a captain is also about being a leader and a manager, and he would be remiss in not providing his students with the tools to succeed in a workplace of global and commercial importance.

We saw previously that the captain's work involves data entry for the ECL and contending with management on land; now we see a similar shift traced

through their education. That is, being a captain today is surprisingly similar to being a mid-level manager in an office. There are supervisory tasks that have to do with being in charge of the crew, maintaining discipline and a good working environment, and then there are administrative tasks such as reports to file to the upper management on land, to the authorities, and to other departments in the company, such as the marketing and sales teams.

It is clear that working in the fishery today has shifted the focus of the tasks the captain is responsible for as well as how captains perceive their work environment and their role in the fishery overall. While the dean of the technical school described the role of a captain as that of a leader, it is not clear that this is how captains feel in their day-to-day activities. With generational differences and new educational structures and standards to contend with, there are many areas of friction when it comes to how captains feel about their work today.

In the following sections, I move from the concrete examples of changed work practices to discuss issues they raise. I have divided these into three areas of concern. The first area regards a conflict in what information and data are held up as legitimate when it comes to how the natural resource is managed. Today's captains are touted as leaders and educated professionals, yet their input is routinely dismissed in a system that is designed to only value scientific data. The second area regards the increase in surveillance of the captain and his work that has happened as IT and data have become more central in the fishery. The final area concerns a subtle organizational restructuring that has slowly taken place as the captain's tasks have shifted to include more intervening and management from land, whether it is in the form of official governance or in the form of company management.

3.3 What Counts as "Real" Knowledge in the Fishery?

The question of who is allowed to have a say in the fishery is a topic that came up in the very first interview I did in the summer of 2009. Subsequently, this was an issue that was brought up by nearly all of my informants. In short, this is the issue of who knows what in the fishery and what is considered legitimate, or codified, knowledge versus tacit or applied knowledge. Codified knowledge is what we would think of as information that can be easily put into words or made tangible in a systematic fashion, whereas tacit or applied knowledge can be built over time through exposure and practice (Collins, 1974).

For the fishermen and captains I have spoken with, it is incredibly frustrating to have years or decades of experience in the fishery without the benefit of being seen as a legitimate authority on the fishery. This is one consequence of growing reliance on data as the primary source for information. To them, it often seems the data on which the fishery management is based reflects a wholly different reality than their own.

K, a captain on a long-liner vessel, explained his frustration this way:

> **The fish has a tail . . . they just can't estimate the size of the stock. They [MFRI] never listen to long-liner captains.** Only when they have to use our vessels for the annual data run, then they listen to us. But outside of that, when we are catching so much [mokveiði] [and telling them], then they don't believe us.
>
> **Us fishermen and captains, we just scratch our heads; we see this so much differently. We spend the year running away from the cod.** [Referencing the quota restrictions on cod] [Chuckles] **It's our**

job to avoid the cod.

K feels that there is too much value placed on the scientist's data when, to him, it is obviously impossible to get an accurate estimate of stock since the fish has a tail and will swim around. This sentiment, that the fish swims around, is connected to one of the work processes that the MFRI uses to get annual stock size estimates.

Each year, the MFRI takes stock samples from close to 400 locations in the Icelandic fishing zone to gauge how well the stock is doing—looking at the range in size, how much is caught on average in these areas compared to previous stock estimates, and so on. The areas where the MFRI will go to get these samples were decided on over 30 years ago and have not been changed significantly in spite of global climate changes that have caused long-term shifts in favorable areas for the stock. The MFRI did incorporate a few areas based on feedback from captains in 1993, but in general, my informants feel like this process needs to be updated, both in terms of locations and in terms of the equipment used to catch.

It was evident to me, as I sat across the table from him, that K was frustrated with feeling like his input did not seem to matter as he shook his head and sighed. Adding to the frustration is the notion that not only is the "official" data reflecting something that the informants do not see as real, but this inaccurate (in their opinion) data is then prioritized over their feedback or input.

HG, an independent fisherman and a board member on the Icelandic Association of Fishing Vessel Owners (AFVO)[6] acknowledges the uncertainty that is

[6]In Icelandic this association is known as Landsamband Íslenskra Útgerðarmanna, LÍU. This association does not exist today in that particular form. In 2014, it joined other commercial

inherent in any data about the fishery and how the MFRI is required by law to provide guidance:

> Data . . . there isn't that much data, but they [MFRI] are required to suggest something. Even though they might as well be reading the fortune out of a teacup . . . It's often like that; they do seem to be willing to talk with us [AFVO] if we have prepared our case [e.g., gathered data].

But understanding the constraints, both logistical and legal, that frame the work of the governmental institution does little to alleviate frustration with how the system is designed to favor input and data for a top-down decision-making process rather than a more democratic setup with input and feedback from people on the ground as well. Earlier in our conversation, HG said:

> Well . . . if we see that the MFRI has made a mistake, then we need to do so much, have so much data to prove anything before we can even get them to the table [to have a discussion]. But to say something positive about them, at least they do eventually come to the table. They know that we have our ways of communicating; some of us are so worked up, but they know how to work with us [the group of fishermen]. But there are just so many species where we don't have any data to base the quota allocation on, just landing reports and stuff like that . . . And yet we [Iceland] are on the leading edge! Our marine research!

interest groups in the fishery to form Fisheries Iceland. Website: http://sfs.is/flokkur/english/

That is, to these captains and vessel owners, it seems like the MFRI discounts input that is not scientific data, be it to increase the allocation for cod (*"It is our job to avoid the cod"*) or to decrease allocation for haddock, for example. K had this to say:

> Everyone was told to go for haddock, but now, we are having problems with it. It's a big deal. That is a case of collaboration [between people making the decisions and fishermen and captains] that should have happened. We [captains] were saying that we needed to protect the haddock and that the cod were doing fine. But then they [MFRI] just did the opposite. They [report] the complete opposite to what we see. When we catch less cod and report it, they increase the allocation. This is so backward to us [captains and fishermen].

What complicates this issue is that in today's IT-focused fishery, the captains and fishermen are the first point in creating the data that is, in turn, used in decision-making when it comes to quota allocation or other fishery management reinforcement tasks. In short, they create the data but have no say in how this data is interpreted. The UFM is an example of this. Just like the fish that are being processed for consumption by someone other than the crew that caught and processed it, so is the data they create. At the heart of this issue is, however, not a simple matter of whether the practical feedback is included in the quota allocations or not, but what appears to be an overall lack of faith in the quota system itself. This may be partly due to early failures in systematic resource management.

The resource management system used by the Icelandic government has gone through a series of revisions since the government gained control of the

fishing areas around Iceland in the mid-1970s. I discuss these systems in more depth in Chapter 4, but for this particular point, it is important to know that they have all been developed with scientists from the MFRI, using historical data in parallel with concurrent data sampling processes.

The first iteration of systematic resource management was deemed a resounding failure after resulting in overfishing, among other things. This failure looms large for my informants and in the general culture, being brought up regularly in discussions about the merits and disadvantages of the resource management efforts (e.g., Anon, 1981; Anon, 2009; Bjarnason, 2015). The early failures of the MFRI to provide a system that would be able to manage the fishery are compounded by a reluctance or unwillingness on the part of the MFRI to acknowledge the amount of uncertainty in early data reports. For a layperson—someone who has not been trained to understand scientific research methods—seeing annual stock estimates and guidance from this governmental institution being "wrong" year after year may not be confidence-inspiring in the first place.

KTh is a population ecologist who has worked as an adviser to the AFVO for over 20 years. In his opinion, an additional issue is that the MFRI has been remiss in how they have presented their scientific findings. That is, in the past, it was done by publishing annual reports and estimates for the cod stock without acknowledging margins for error or unknowns. According to KTh, this put the institution on a trajectory where the annual estimates inevitably never came true. Says KTh,

> For example, I'm just making up a number here, let's say that MFRI would claim that the current size of the stock is 600,000 tons, [and then the MFRI presents it as] "if you [people in fishery] follow the

> fishing advice for this year, next year, the stock may well be 650,000 tons."
>
> But they didn't specify the plus/minus factor. So, the numbers never added up year after year. Then people started asking "do you even know what you are talking about?"
>
> To us [scientists] who work with this kind of stuff, we always factor in the unknown, the probabilities. But to them at MFRI, they said that it would be so hard to present information including that [the unknown]. Some even thought that if they publicly admitted to not knowing everything [having unknowns in the data], then nobody would listen to them, whereas I said that if they would never acknowledge that the data contained unknowns, then they would never be seen as credible [chuckles]. But of course, people's views on that are different both inside the MFRI and outside.

It is easy to see how the MFRI, in their efforts to appear as the authority on the state of the fishery, would not want to admit to having unknowns in their data. This strategy, however, seems to have backfired in that there is now a sense of distrust of this institution in the community. Even though KTh pointed out that the MFRI had to include information on unknowns/margin of error since 2000 or so, it seemed that no matter what the topic regarding the fishery, the MFRI was inevitably described as a conservative, outdated obstacle rather than a valued collaborator by my informants.

At this point, this mistrust feels ingrained, and as such, it is probably very hard to overcome. It remains to be seen whether having a say in how the data is interpreted would ameliorate this long-standing mistrust among the profes-

sionals in the fishery.

Surveillance: A Feature or a Bug?

As we just saw, one key issue that arises from the central role data has acquired in the fishery is conflict about who knows what and what kind of evidence is valued. A second issue that data brings with it is new and increased opportunities for surveillance.

In the next section, I present how today's captains alter their practices to work around the less desirable aspects of being surveilled through IT by competitors, management, and even family. The surveillance of the captains is at once a site where social customs and norms interact with technology in ways that are tremendously beneficial in terms of workplace safety, while also introducing new ways in which the captains—traditionally fiercely autonomous—are increasingly being held accountable for their work.

During my first conversations and observations in the fishery, I was struck by the overwhelming potential for fine-grained surveillance of the work done at sea with the type of IT that is being used by government mandate. As I learned about the technology used on the bridge, from automated route mapping to collision prevention software, I wondered how the captains felt about having their every move at work so publicly available.

Competition in an Era of Surveillance

To understand how this would be an issue, let us consider the case of SB, a captain and co-owner of a small Danish seine vessel in Víkurbyggð. The Danish seine is a type of bag that, instead of being pulled along the ocean floor like a trawl would be, is let out in a circle with the movements of the vessel used to cinch the bag up, like a drawstring bag or purse.

This kind of fishing is usually done on a day-to-day basis, leaving shore before sunrise and coming back early evening, depending on how the day goes. The bag is hauled up more frequently than a bottom trawler bag, or on average, once an hour (bottom trawler bags are pulled in about once every four to six hours).

As SB brings his catch to shore, it is weighed and recorded by an officially trained and certified harbor official. This is to keep track of the quota used against the quota allocated to the vessel. The harbor officials also record any sales information regarding the catch (who is selling or buying), a breakdown of the type of catch, what kind of fishing gear was used, and more.

All this information is available shortly after landing on a web portal that is accessible to stakeholders in the fishery, like quota owners, other captains, and processing companies. In addition to this information, the way SB and his brothers sell their catch is through an auction house. This particular auction house also lists information like catch breakdown and amounts, who caught it, and when.

Figure 3.6 shows how much ungutted code each vessel has landed on September 12, 2017. Each vessel has information listed detailing the type of

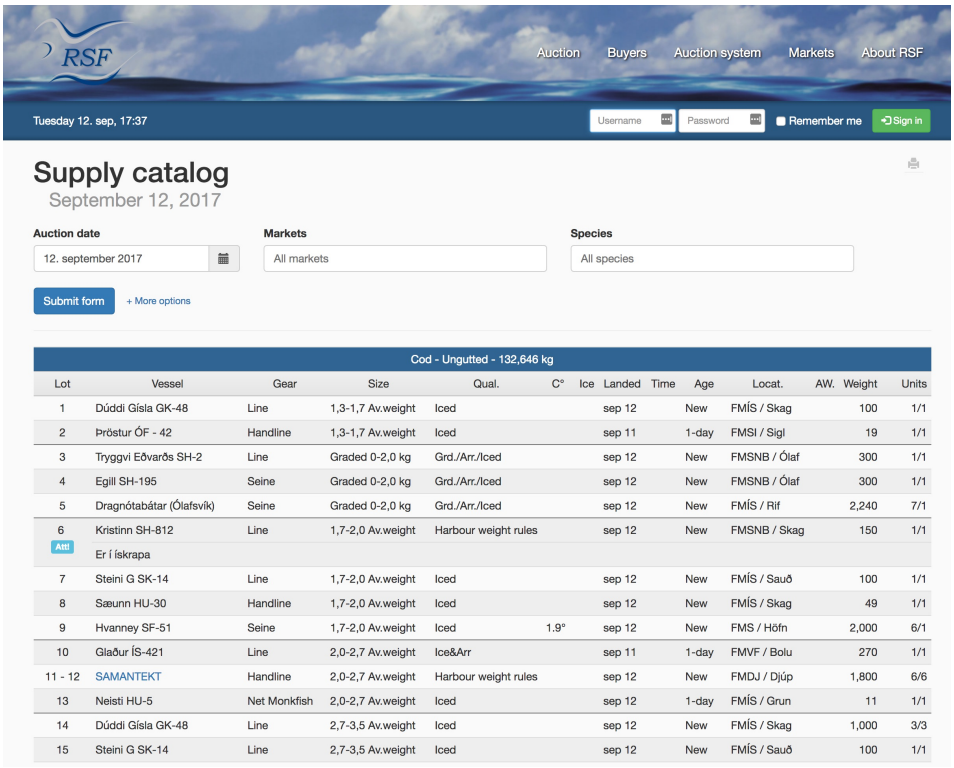

Figure 3.6: Screenshot from the auction house website listing available catch on Tuesday, September 12, 2017.

fishing gear (line, handline, seine), average size of the catch, how it is being stored onboard, and how many units are available for sale.

This information coupled with the publicly broadcast location data through the automatic identification system (AIS) used for collision prevention, would then allow us to see not only where SB went, but also how much he caught, how much he sold, and at what price.

This removes what competitive edge SB would have since his competitors can, based on this information, retrace SB's tour the next day. That is, while SB would have the competitive edge on the first day, once the data from that tour has been listed, the secrecy strategy will not be of much use to him.

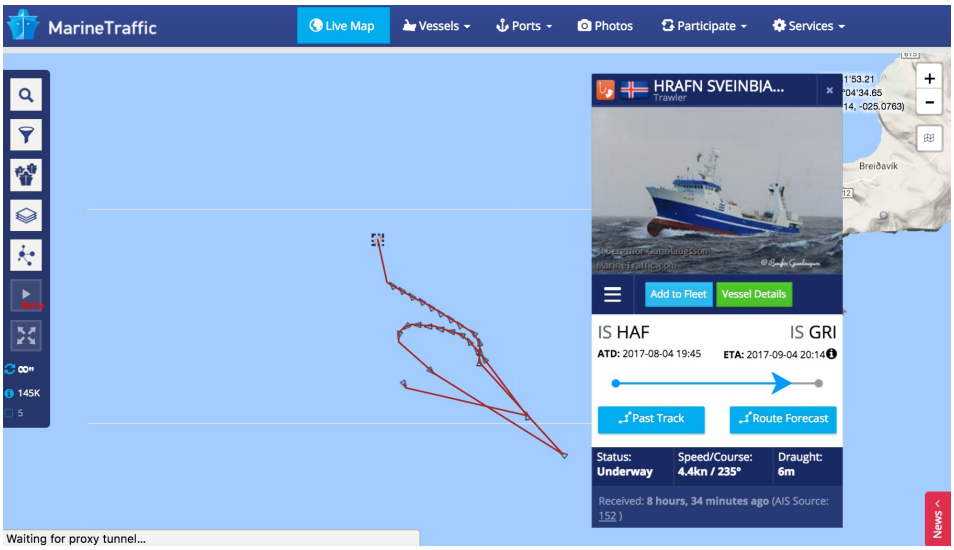

Figure 3.7: Screenshot from the MarineTraffic website, zooming in on the path for the vessel Hrafn Sveinbjarnason.

That is, before the AIS, the only way to know where your fellow seine fishing captains were was by seeing them with your own eyes or getting their location through the radio. With the AIS, the vessel's trail throughout the course of the day is available for anyone with either a browser (like me) or the AIS display on board. SB had two, one with text output—an early implementation of the technology—and a more recent version that displayed a map with an AIS coordinate overlay showing other vessels.

Just like an online map would function, zooming out brought more vessels into view. Zooming in, conversely, we saw fewer vessels but more detailed information for each. Figure 3.7 is similar to what the captains see on their controls. In this instance, we see the route and other vessel information for a trawler, Hrafn Sveinbjarnarson, off the southwest coast of Iceland.

As we discussed the idea of being so visible at work, SB relayed the story of

exploring an area he normally would not visit during a recent outing. The goal was simply to see if there was any activity (fish) in that area; the day had been slow, and he wanted to change that. All of a sudden, a colleague of his radioed, asking, *"What are you doing there? Are you onto something?"*

To SB, this was a funny anecdote, and while we did joke about his wife being able to keep tabs on him in that way as well, these kinds of instances demonstrate the impact that the regulatory framework and the required IT have on not only the intended work practices but other aspects of the work for the captains as well.

No one I spoke with wanted this technology to go away. The stated purpose of the AIS is to automatically track vessels and to prevent collisions. For Icelandic vessels, this means that the Icelandic Coast Guard tracks the fleet as well. If a distress signal is sent out, the last known whereabouts according to the AIS are used to guide search and rescue teams to the location quickly and efficiently. The benefit of being able to get help when needed far outweighs the cost of being visible and trackable by competitors. But that does not mean that the captains like it. Said SB, *"I can always unplug it!"*

Even though SB would not really unplug the AIS equipment—doing so would kick-start a process in which the Coast Guard would radio the vessel, checking to see if they were in trouble, and possibly send an alert out to nearby vessels—there is a hint of an uneasy alliance here. While the AIS does, at the end of the day, help with locating vessels in trouble at sea, it has also served as a catalyst for new ways in which the captains work (together and against each other).

SB, for instance, has formulated a very specific way in which he communicates with other captains while at sea. During my outing with him, he spent a significant amount of time talking with different circles of colleagues through different communication channels (phone, radio, SMS/texts). As he explained to me, he had a small circle of two other captains on Danish seine vessels from Víkurbyggð that were his closest confidants. They keep a channel on the radio with just the three of them to share strategic information and insight.

However, even in this small group of trusted allies, Captain SB will not divulge everything. For instance, if the bag comes up with a catch that is in high demand. At the time we were out, it was haddock. At the end of the day, he detailed this more secretive strategy to me, the three-day rule:

> On day one, you don't share that much about having come across a fair amount of haddock when you are being asked throughout the day. On day two, you might say, "Oh, yeah, there's something there." On day three, your ruse is pretty much up because people find out simply by looking at what and how much we are landing, and then it is fair game.[7]

AD reflected on instances similar to this in our interview. Instead of relying on a particular personal strategy for warding off competitors, how each captain behaved was rooted in local customs and practices that differed between fishing villages:

> It is weird, not bad blood, per se. But an implicit agreement with the ships in Hafnarvík [similar fishing village, up the coast from Víkur-

[7] Paraphrased based on jottings

> byggð]. If "Bára úr Vör" [name of vessel] was fishing on that spot [bleyða], then that was their spot for the rest of the day. This was different here in Víkurbyggð. Here, we have two to three vessels on top of each other with their bags out. If we were in Hafnarvík, then that would just be our spot.
>
> My captain has had skirmishes with captains on bigger vessels, trawlers, from Vestmannaeyjar [Westman Islands, off the south coast of Iceland]. These guys do not give the seine vessels any breaks. They are rough.

Together, these examples demonstrate the complicated ways in which social customs and norms interact with the technology in the fishery. From AD's example, we see that in spite of it being frowned upon in the nearby community of Hafnarvík, it is seen as the norm to aggressively claim a fishing spot in the community of Víkurbyggð.

To captains in Hafnarvík, fishing spots are on a first come, first served basis, whereas in Víkurbyggð, it is not uncommon for more than one vessel to be angling for the catch in one area. The three-day rule is, thus, Captain SB's strategy to counteract how visible his work and vessel are through the mandated collision prevention software as well as the sales and landing reports listed online.

For Captain M, the visibility of his whereabouts while at sea has played out a little differently. Like Captain SB, he does have different circles of colleagues with whom he shares information and day-to-day communication. But in addition to being surveyed by colleagues, Captain M is also being watched by Thor HF4's company on land. Both the owner of the vessel and salespeople contact him regularly while he is at sea.

As we saw earlier, in one particular instance, Captain M had to change his immediate plans to pursue a different catch to fill an order. Before being automatically tracked, Captain M would have been able to hang up and not worry about being observed with regard to the most recent directive on land. For someone like Captain M, the relationship with the surveillance technology feels and seems more fraught with tension (to me) since it has added what he sees as "interference" from "landlubbers."

While it is not directly the technology that is interfering, it is how the higher-ups in the company are using it in their work with Captain M. Again, for Captain SB, the interference comes in the form of devising subterfuge strategies to maintain a competitive edge rather than from management involvement.

The difference between Captain SB and Captain M is that in Captain M's case, he has to contend with upper management, whereas Captain SB is more in charge of the overall goals for the fishing venture from beginning to end (sailing, catching, and selling).

3.4 Renegotiating What It Means to Be the Boss

We have seen how today's captains are increasingly being surveilled as they go about their work, whether they like it or not. This has a variety of implications, one of which is directly related to the final area of concern. That is, IT is not only being used to monitor the work that the captains do, but the work that the captains do is increasingly involving the use of IT.

We see this in the types of tasks the captains are now responsible for (from

logging catch statistics to charting the vessel course and using computerized interfaces to manage fishing gear) and in the way the bridge itself is set up, with the captain's chair lined up in front of a multitude of computer screens. (See Image 3.3, for example).

The majority of the IT on the bridge is oriented around the tasks of fishing as such, meaning finding fish, monitoring fishing equipment, or keeping an eye on the immediate environment. With the increasing regulatory infrastructure in the fishery, the IT on the bridge is also used to enter data and file reports with management and fishery authorities on land. None of the captains I spoke with talked about their work as being focused on paperwork per se, yet they recognized the slow creep of management obligations and bureaucracy.

That is, it is not as if the captains showed up one day and their wheel and sextant had been replaced by a bank of computer screens. Rather, the pieces of equipment crept in one at a time, perhaps touted as a measure of improvement for the task at hand. This is how large-scale infrastructural change happens. Incrementally and slowly. For people in the Icelandic fishery, this has included necessary renegotiations and redefinitions of what their roles are. Being a captain today means that the overall goal is the same as before. It is still about getting the vessel out to sea, catching fish, turning around, and getting the catch, crew, and vessel safely back to shore. Being a captain today **also** means that a nontrivial amount of work consists of communication with superiors.

The freezer trawler operated by Captain M is the only vessel owned by the company. As such, any and all focus on fishing activities are directed to Captain M and his crew. As we saw in the previous section, the uptake of IT has resulted in increased surveillance of the captain and his work. Thanks to satellite

communications, the vessel is rarely out of reach. This means that the captain is under more pressure to report more frequently on the state of affairs as far as fishing goes.

This is in stark contrast to early work practices, when the vessel and the crew were out of reach during the entire tour except for emergency communications and the occasional radio communication with nearby vessels.

Captain M, for instance, was expected to share reports with management on land every two or three days. In order to be able to report on the status of the fishing progress, Captain M has to rely on information from GE—the crew member we encountered in Chapter 2 who manages the deep freezer inventory.

Let us look again at GE's deep freezer inventory tasks and how they factor into Captain M's communication with management on land. As it turns out, the information sheet that Captain M receives from GE is another instance of the transformation of fish into data. In this instance, the data pertains to the salary of the crew.

The Deep Freezer Inventory Sheet

As the deep freezer slowly fills up during the tour at sea, GE keeps track of the number of packed boxes and what they contain on a spreadsheet. At regular intervals, he sends an update of the spreadsheet to Captain E, who is the relief/nighttime captain for Captain M. Captain E translates the information into an abbreviated report for Captain M, who in turn, shares it with management on land.

Additionally, this one-page overview is posted in the mess hall for the crew. Image 3.8 shows one of these posted sheets. The information sheets typically contain information on the overall value of the catch so far, how many tons have been caught, the number of boxes in the deep freezer, the average price per kilo, and the average catch per day. Then the sheet details how much has been caught of cod, haddock, saithe, and so on.

The last line on the sheet lists what one crewman's share is. On this day, the crewman's share was 749,868 Icelandic króna.[8] That means if the vessel were to go to shore at that point, this would be the salary per person for the common crew members.

This value is then multiplied as the roles and tasks change. For example, the cook gets two crewmen's shares, the engineers multiply the share by three, and so on. The only person on the ship whose share is not publicly known is the captain's.

The information sheet makes very concrete how the fish have been transformed into data; in particular, the monetary value of the catch and what the crew's salary would be based on market projections.

The fact that everybody knows that the information sheet is not only used onboard, but also for Captain M to report to the upper management on land, is also a reminder that Captain M is no longer top dog. Captain M is still the ultimate authority onboard the freezer trawler—for very practical reasons, as we learned in the safety training vignette earlier in this chapter—but in the grand scheme of things, the captain's authority stops there. He still has to answer to management on land and account for his work in ways like the information

[8] at the time of this writing, this is a little over $7,000.

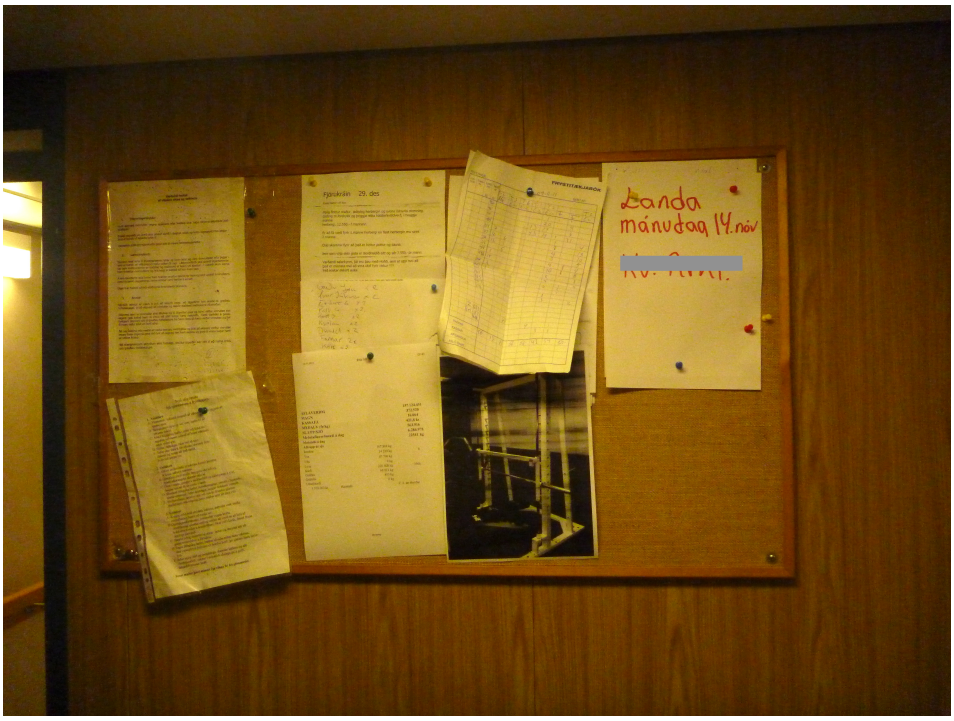

Figure 3.8: The information board in the mess. The information sheet is posted here and updated regularly. Other announcements include an informal update on the deep freezer, a sign-up for a group outing, and labor union rules, among other things.

sheet. In short, being a captain on a freezer trawler today is akin to being a mid-level manager, with administrative and bureaucratic tasks taking up more and more time than previously.

The captain has no choice in these tasks as they arise, and I often witnessed Captain M grousing over what he perceived as the interference of the government officials (most often MFRI) in his work. Captain M has been in this profession for decades now. He is, in my estimation, one of the remaining old-school fishing captains left in the Icelandic fishery. That is, someone who came up in the profession at a time before administrative tasks and regulatory restrictions were as pervasive as they are today. As such, he seems to take any kind of

supervision or regulatory oversight as a slight, a personal affront, especially if the supervision is coming from someone who is not an experienced captain like himself.

In addition to an increase in paperwork and other typical administrative tasks, the configuration of today's responsibilities for the captains also includes incorporating directives from management and the government on how to do his work, and when. In the next section, we will look closer at how this dynamic unfolds on the ground from the perspective of captains.

Stopping Orders

One morning, as I was checking in with Captain M, there had recently been a series of short-term stopping orders for fishing areas nearby [skyndilokun]. These kinds of orders are based on recommendations from the DF and MFRI, and they are initiated when there is a certain amount of juvenile catch being reported for the area in question.

This is intended to protect the spawning stock and reduce discards. The areas where fishing is to be stopped are announced by the DF and MFRI in the form of GPS coordinates that will translate into a square shape on a map where fishing has now been prohibited either for a specified time or until further notice.

What this particular closing meant for Captain M was that we would have to rearrange our route and work around the area, because it is prohibited by law to ignore these orders. We had been fishing in the neighboring area for a while, and according to Captain M, he finds these temporary closings to be

ill-informed—the worst kind of meddling, in his mind.

Calling the staff at the MFRI "monkey brains" (apaheilar), he tells me that when they close areas off like that, it is often for the wrong reasons, in his opinion. To him, it is obvious that the ocean is an ecosystem, and when you completely stop fishing for one particular stock, it will affect another stock.

His example is a closure that was implemented to protect juvenile redfish some years prior. This, in turn, affected pollock, he said. *"I don't know exactly how, but this is connected. Fishing in one area will help keep a balance in that area."*[9] He gets so worked up talking about this that he ultimately half-yells, *"If I were to become the minister of the fishery tomorrow, then I would just fire the entire staff at MFRI, each and every one!"*[10]

To Captain M, temporary closures are yet another manifestation of increased meddling in the fishery. It seems that this kind of meddling goes hand-in-hand with data-driven governance, in the case of the Icelandic fishery. It is not surprising that Captain M sees the observations and feedback on his work from land as meddling.

Data-driven decision-making is, after all, a series of steps of iterations aimed at refining actions until the final product has been achieved: The logic of data-driven design is to maximize meddling. This is in stark contrast to what Captain M's work used to entail—when the decision to refine and iterate on *his*tasks was *his* alone, based on *his* interpretation of *his* surroundings, coupled with *his* experience and knowledge.

This kind of meddling also happens from company management on land,

[9]From fieldnotes
[10]From fieldnotes

now enabled by the ability to monitor the vessel's activities through the AIS. But like Captain M says, seeing something on the computer screen on land is not the full picture. This sentiment is echoed by Captain K, who works for one of the larger fishing companies in a fishing town south of Reykjavík.

> **K: Sure, the vessel owner is the big boss, but this is getting to be too much.** Of course, they have to manage the processing on land and how things are selling . . . **but some of them are overstepping their boundaries, thinking they are the captains . . . It is OK that they see us on the AIS, for instance, but the commands, they . . . they sometimes are just way out there** (út úr kú). Like you could just go onto Facebook and write a formula or a recipe. You can't fulfill all of these wishes.
>
> HBH: They [management] are not physically with you in that context?
>
> K: Yeah, they don't know the whole picture.

What these incidents illustrate is a shift in the captain's authority that has happened slowly over time. Just like the various pieces of equipment and IT that were added to the bridge, the captain's list of responsibilities has shifted to include more and more middle management tasks.

The information sheet work done by GE under Captain M's command is one example, but others include the coordination with marketing staff, and even—as in Captain K's example—instances where the captain is being told how to do their job.

It is not just management or governmental institutions that are watching the

captain's work, however. As we learned with Captain SB's experiences earlier, one of the ways IT has had a direct impact on his work is the increased visibility to others, such as his wife. In my early days onboard the freezer trawler, I also witnessed intense scrutiny of the captain's actions by his own crew.

The Subordinates Are Watching as Well

As visible as the captain may feel to management on land, there are aspects of his work that are invisible to his crew, for example, coordination aspects like calls from sales. That is, getting directives from land that result in an about-face or a sudden change in the route or fishing activities.

These kinds of directives from land are not visible to the crew below deck. What they see and experience are simply what the captain is doing with the vessel (are they moving, is the bag out, etc.), and what orders come down the pipes below deck (type of catch processing required, the type of bag being used).

To them, it looks as if it is the captain who is calling the shots when, as we have seen, that is not always the case. These examples do not include the paperwork and various reporting activities that happen before, during, and after each tour, or the various computer maintenance work required to make the equipment work (refilling paper for the telefax machine, updates to software, coordination with other vessels to avoid collision, and so on).

During the first week at sea onboard the freezer trawler, we seemed to be letting out the trawl in a very haphazard fashion, not always pulling up a full bag. It was not just me thinking this; it was the topic of conversation during breaks and in the mess hall. I remember sitting with my shift-mates during

downtime when the captain's competency came up.

The crew was so frustrated with what they perceived as Captain M's randomness and told me of Captain T, the other captain for the vessel.[11] During what had been a slow week, with not much catch, Captain T's storied aggressiveness with the bag was much preferred over Captain M's zig-zagging efforts. On Sunday, October 23, I wrote the following note:

> *From Fieldnotes: 10232011*
>
> **The crew's spirits are low—they are antsy—we have not been fishing as much as "usual." What is usual? When I ask, they answer "more." :)**
>
> The last tour was apparently a good one, and GE mentioned a tour where they had close to 20,000 boxes earlier this year. That was about 850 tons.
>
> **the conversation mostly revolves around the decision process the captain is exhibiting. The crew believes he is making bad decisions; he is "only chasing" ufsi [saithe] or karfi [redfish], and not focusing on the cod.**
>
> I know from conversations with Captain M that this is partially true; he does want a mix in the bag, or as he says, *"Það er gott að fá smá bland í pokann!"* ("It's great to get a mix in the bag!"). They don't think his strategy of trying and waiting is worthwhile. I hear stories of the other captain—T—who will pull the bag up and move on to a

[11] This particular freezer trawler was almost always out at sea, landing only after four to five weeks or when the deep freezer was full. During landing, the captains would switch over, as well as some members of the crew, depending on their contract. Some crew members worked two months in a row with two months off; others were on a one month on, one month off schedule.

different location if there's "nothing" in the bag after an hour or so. Captain T will know the status of the nothing thanks to information from the aflanemar, sensors in the bag. The crew says that if they [the sensors] don't ping after a short time, he moves on.

Captain M is more of a "wait and see" guy, they say. And this is frustrating to them right now. They are so annoyed!

At the end of the tour, we had filled the ship. In other words, we had a much better tour than the crew was anticipating. Having the benefit of hindsight, one thing does stand out here: Observing the morale below deck and listening to Captain M complain about being micromanaged highlights how the captains are actually being squeezed from both sides.

I had a distinct advantage over the crew in that I saw what the captain was being charged with when I visited the bridge, the phone calls and conversations with the other captains over the radio. The crew only saw the outcomes of what was being decided upon on land or on the bridge.

In this work environment, Captain M is not only tasked with navigating the trawler at sea, but also with two distinct social worlds. One is the world in which he is king and calls the shots onboard one of the larger—and more successful—freezer trawlers in the Icelandic fishery at the time. In this world, he is the one who *seems* to be in charge of where the vessel is going and when the bag is out.

The other is a world where the captain's role is to fill sales orders that come from sales and marketing on land. In this world, the captain can voice his opinion (and Captain M did a lot of that), but at the end of the day, it is management,

marketing, and sales who will decide where Captain M sails next.

In both instances, however, the pressure is on the captain to perform in such a way that benefits the people around him—the crew members and management. He is responsible for the crew's well-being while at sea, and he is responsible for the crew's wages as well.

If he does not pull up big bags, the crew will have a smaller paycheck. As far as the management on land goes, the captain is also responsible for a "good" tour, or a fully packed deep freezer, fulfilling orders.

This load of responsibility for the captain is not necessarily new, but with the increased capacity for monitoring the captain and his vessel's every move, it has brought into sharp focus how regulated and surveilled the captain's work is today. The shift in tasks and intrusion in the work environment of the captains has been enabled in large part by IT such as the collision prevention software that shows where the vessels are at any given time.

However, it is not the IT alone that has caused this shift but also the legal and organizational infrastructure surrounding the work that happens in the fishery that has given rise to the new working class the fishing captains now inhabit. By introducing tasks that are typical to white-collar middle management work, such as data entry in the case of the ECL, to the work of the captain—historically a blue-collar laborer—we see the emergence of what I call a powder-blue-collar worker.

The powder-blue-collar worker is, I posit, a rapidly increasing new class of workers whose responsibilities have expanded or shifted as a result of an increased focus on data as a tool for management and control. In the case of the

captains and fishermen, this shift has highlighted areas that can help expand critical thinking regarding big data. In the next section, I expand on what being a powder-blue-collar worker means in the context of the Icelandic fishery. Like the crew below deck, the captains are at the forefront of information and data creation. yet are limited in their roles and capacity to enact change based on the data they create.

3.5 Blurring Boundaries Between White-Collar and Blue-Collar Work

In this section, I examine issues facing the captains in their work today, arguing that, together, they point to a blurring of white-collar and blue-collar work in the fishery. For my informants, there is no doubt that in general, information technology has changed the practice of fishing for the better. The number one reason they cite for this is the safety of the people in the profession (for statistics supporting this, see Pétursdóttir, Hjörvar, and Snorrason, (2007), looking at accidents and fatalities in the Icelandic fishing fleet 1980–2005).

Some would even argue that the quality of life while at work has improved greatly, enabling benefits from being able to connect with their families (email, social media) more consistently while at sea to being able to engage in various other online activities for entertainment and personal enjoyment.

While my informants are happy about the benefits IT has brought them, I argue that when it comes to their daily work practices, the effects of IT are decidedly more murky. In the case of the Icelandic fishery, this murkiness stems

in part from individual preferences and experiences like comfort level with changes in their work or proficiency with the technology required.

That is, as the types of tasks for the captains have changed to include more IT-oriented work, it ultimately comes down to the individual who has to perform these tasks and how well or smoothly they learn new skills and adapt to new requirements. Similar to all workplaces, some people are more comfortable and proficient around new technology than others.

In my interactions with the captains, I witnessed a range of computer literacy and proficiency as well as attitudes regarding the increased need to rely on computers in general in this work. For Captain M, I learned very quickly that, to him, using computers is a necessary evil for his work. He does enjoy being able to watch the news online, but as for any other issues regarding maintenance and upkeep of the software and hardware, he said: *"Ég kem ekki nálægt þessu!"* or *"I won't touch it with a ten-foot pole!"*[12] Captain M has the luxury of having other crew members around to help with such tasks; the engineers would often be summoned to the bridge for this purpose.

Beyond individual skill levels, differences, and preferences, however, there are larger sets of shifts in work practices that are taking place across the fishery. That is, in order to work as a captain on a commercial vessel in the fishery, it is nearly impossible, and in some instances illegal, to avoid using some of the technology (like the AIS and ECL) in ways that have been prescribed by laws and regulations.

While captains used to have wide discretion about what they did while at sea, and how, day-to-day activities in their work are more now often than not co-

[12]From fieldnotes

determined by outsiders in the form of company management or governmental institutions.

Work Made Visible, Abstract

As we have seen in the various examples of IT and data as tool for governance, it is not only the work practices of the captains that have changed but also the nature of the work. In some ways, the focus on IT and data have rendered the captains' work more abstract through the creation of data while simultaneously making it concrete in new ways through reports and other administrative trails.

In some ways, these regulatory tasks have made the captain's work more visible to management on land, who are on the receiving end of the reports being filed. Conversely, it seems that the increased "meddling" in the captain's work process is mostly invisible to the crew onboard, who tend to analyze the vessel's trajectory and choices of fishing areas out of context. This is exacerbated as the crew members are now in a position to be in communication with crew members on other freezer trawlers, comparing notes.

Onboard the freezer trawler, I saw the "meddling" and the below-deck analyses come together to undermine the authority of the captain. As I learned during the safety training, there are practical reasons for a captain's authority to not be questioned while at sea. However, during daily tasks when there is no acute situation unfolding, the captain is just supposed to get to good fishing spots, according to the crew—ultimately fattening the crew's paychecks. When the captain is operating in what seem to be random ways to the crew, their trust in his ability to have the tour end in a fat paycheck is undermined.

Acting On vs. *Acting With*

So far, we have been looking at how the authority of the captain onboard is shifting. But it is not only that his say-so is being eroded; the regulatory "meddling" has also concretely changed the tasks that the captain actually does as part of his job.

The regulatory "meddling" of the captain's work environment has introduced a series of tasks that have traditionally been seen as white-collar oriented, meaning that the role of the captain, a blue-collar craft in origin, is being blended with what has traditionally been seen as white-collar work. The result is the powder-blue-collar worker I previously mentioned.

One starting point in unpacking what I mean with this term comes from Zuboff's (1988) distinction between white- and blue-collar work as tasks that focus on *acting with* versus *acting on*. *Acting with* is focused on communication and coordination—white-collar roles and tasks—whereas *acting on* is about transforming materials, using equipment—blue-collar work. Put bluntly, *acting with* is focused on manipulating personnel, whereas *acting on* is about manipulating materials or machinery.

In the case of the fishing captains, their work has always included tasks that have to do with coordination of their crew as well as manipulation of materials in the form of fishing activities. That is, the captain is already responsible for both *acting with* and *acting on* in his work. What has changed is that with an increase in the "meddling" from management and governmental bodies, the captain has been more firmly relegated to the role of a middle manager in practice.

This means that the captain is more and more responsible for day-to-day coordination with sales staff on land, keeping them abreast of what has been caught so far in order to fulfill orders. This also means an upswing in paperwork associated with fishery management efforts, such as the ECL and other government-issued forms and procedures. An additional example is the information sheet that the captain has to turn in on a regular basis.

This change and increase in bureaucratic tasks may seem like the captain has shifted fully into the realm of white-collar work, *acting with*. However, the captains do not reap any additional benefits from these activities that would be associated with white-collar tasks in a more traditional working environment, such as a raise in salary or prestige.

Consider, for example, the elevation in salary and, possibly, status that would follow a promotion for a front desk clerk moving into the role of office manager. While not tangible, it is seen as a step upward or a positive career trajectory for our hypothetical employee, who now may take on responsibilities beyond answering phones or logging in visitors.

These new responsibilities shift the front desk clerk out of the realm of *acting on* into the realm of *acting with* as they now, quite possibly, have to manage entry-level staff or coordinate various intra-office affairs. When it comes to the captains, however, the shift in tasks to include white-collar work has not resulted in an upward-oriented career trajectory or an elevation in status.

In sum, one consequence of the increased focus on IT in the fishery is that a captain's work contains both white-collar and blue-collar aspects. This may sound neutral, or even positive—after all, white-collar work is frequently as-

sociated with more pay, more autonomy, and higher social status. However, I argue that a key aspect of the powder-blue labor is that it does not actually involve an elevation of status for the captain, nor does it entail more autonomy. On the contrary, it looks like the captains' autonomy is being decreased, if anything.

To my informants, this was a core concern in their day-to-day work. For someone like Captain M, a seasoned professional, it felt like an insult to have to make accommodations in his work for landlubbers, as we have seen in his description of working with government officials inspecting rust on board fishing vessels. For Captain K, it was frustrating to be in a position to observe changes in the fishery and feel like this was not taken seriously by marine biologists or policy makers.

Another expectation often associated with white-collar work is that the middle management worker will be able to rise through the ranks toward higher level management—and with that will come an increase in autonomy, salary, and status. I argue that this is an important distinction of the powder-blue-collar worker. At the end of the day, the captains have nowhere "higher" to go in their career trajectory unless they leave the profession of being a captain behind. They are, thus, stuck for life in a middle management role, without the associated benefits.

Powder-Blue-Collar Work

Taken together, I define the powder-blue-collar work as a melding of tasks from blue-collar and white-collar work. This melding comes without the benefits tra-

ditionally associated with white-collar work such as an upwardly mobile career trajectory, an increase in status or authority, or autonomy regarding certain aspects of the work. The powder-blue-collar worker is, paradoxically, responsible for more coordination and collaboration than the blue-collar worker, without having the ability to influence aspects or scope of the collaboration as such.

3.6 Conclusion

In this chapter I showed how the work of the captain has changed as the fishery has become increasingly IT and data oriented. For context, I presented an overview of how people used to learn how to work in the fishery by "growing up at the oar." That is, through apprenticeship and applied learning. As the fishery has become increasingly centered on IT and data, this practice has shifted and commercial vessel captains are now required to complete a minimum of three and a half year of standardized curriculum in addition to one year of on the job training. During a tour of one of the captaincy technical schools, I learned that a major focus of the curriculum for today's captains has shifted from apprenticeship toward learning to operate the variety of IT equipment in the bridge through simulator exercises.

Being a captain in the fishery today has changed in more ways than how certifying and training for captaincy happens. These changes are evident in how the captain's work environment is set up, with a slew of computer consoles and related accessories at the center of the bridge. In addition, the scope of responsibilities that fall under the purview of the captain's role have expanded in two distinct ways.

First, today's captains are increasingly responsible for a range of administrative and bureaucratic tasks such as filing reports, maintaining digital databases and coordinating with superiors on land. In this chapter, we saw an example of this in the changes in how the catch is reported through a digital database (ECL), that in turn is used by the DF to monitor concurrent quota use for each vessel as well as overall fishery status. Second, in the case of commercial fishers, the captains are in constant communication with sales and marketing staff on land, getting updates regarding the goals for each tour. To demonstrate this, I provided a glimpse into the role of S, a sales manager on land, and how one aspect of her job is to communicate and coordinate fishing efforts with a fleet of captains with the company.

The increase in need for coordination from land in addition to new administrative tasks has resulted in what the captains see as an unwelcome intrusion to their domain and autonomy. As the captains are responsible for more white collar tasks without traditional benefits (autonomy, prestige, rise in ranks), they are not absolved of their blue collar tasks. I argue that these shifts in work practices, both applied and interpersonal, are contributing to an emergence of a new type of laborer. I term this new class the powder-blue collar worker. That is, a new class of formerly blue collar workers whose responsibilities have now expanded to increasingly include tasks that have traditionally been exclusively white collar, such as administrative coordination and management of superiors and people working under them.

Having seen the transformation of fish into data, and how the captain's role has expanded to include a combination of traditional captaincy and new administrative and bureaucratic tasks, I move to examine *why* the fishery is data

centric. Unpacking the historical context that gave rise to the way the governance is structured today, the logic of control through data becomes visible. In the next chapter I look at the natural resource management structure in the fishery, revisiting the data from the UFM process as it is used to make decisions about the upcoming fishing season.

CHAPTER 4

IT AND GOVERNANCE

In this chapter, we take a look at what happens to the data after it has been created in the fishery. Before we dive into the meat of the chapter, however, I want to present a vignette from one of my earliest days of fieldwork, in the summer of 2009. This vignette demonstrates how central the fishery is in the Icelandic culture and provides a glimpse of the ongoing discord regarding how it is managed.

"We Are the State!"

June 5, 2009.

I am in a cab on the way to meet with Anna (my host at the EDDA center) for the first time. The cab driver has the radio set to *Útvarp Saga*—a conservative talk show oriented radio station. I had arrived in Iceland a couple of days earlier, so I was jet-lagged and feeling spacey. It took me a few beats to realize that the topic for the day was the coastal fishing directive that had been recently announced by the Ministry of Fisheries in Iceland. *"Very appropriate,"* I remember thinking, *"I am on my way to start my fieldwork, and this is just a perfect example of how central the fishery is! What a good sign!"* I reach for my notebook with the goal of jotting a quick field note.

The coastal directive that was being discussed had been introduced by the Minister of the Fisheries earlier that year, in April, and it was about to be approved as an ordinance amendment to the fishery management law later in the summer (Anon, 2006, 2008b). One goal of this directive was to strengthen

smaller fishing ports and communities by allowing smaller fishing producers close to unlimited catches when using handlines near the coast during the months of June, July, and August. Smaller fishing producers would not need to buy quota, and it was hoped that this would encourage renewal of people in the fishery. The directive—met with equal parts enthusiastic support and dismay—was introduced as a temporary installment for one year, but it has been renewed each year since (Anon, 2006, 2008b) .

Looking out the car windows, I was jarred out of daydreaming by a caller to the radio show yelling *"Við erum ríkið! Ég og þú!"* ("We are the State! Me and you!"). Emphasis on "we," "me," and "you." He went on, arguing that the quota and any access to the fishery should not belong to any one company or person. In his opinion, the fishery belongs to the people, and as such, the people should have more say and get more monetary benefit from it. To him, the quota system felt broken, and he did not trust the government to fix it, since, from where he stood, they had gotten us in this quota mess to begin with. Thus the *we, me, and you.*

In comparison to any conversation about the quota system in Iceland I had heard throughout my life, this one was nothing out of the ordinary. Growing up in a family of people working in the fishery in one way or another, the fishery and how it was or was not being managed was a common topic. In fact, as I listened to the radio show, I thought something along the lines of "I hope I can get away with this research without having to get in too deep with the quota; it can't be that related to IT use in the fishery . . ." Boy, was I wrong.

The caller was angry, expressing his opinion that the system is only set up to benefit crooked insiders, the "sægreifar" and larger fishing companies "gob-

bling up" all the quota from the rural areas to keep for themselves. Sægreifi is loosely translated as sea baron. This is a derogatory term used for people who have come to own larger shares of the quota, often through inheritance, and who ended up selling their shares "away" from the fishing town for which they had been earmarked.[1] The caller's sentiments were that the people in charge of the quota allocations and finances for the country are rotten, and measures like this were only being introduced so that they would *appear* to be invested in helping rural areas rather than providing any actual solutions for the people in the country.

The various anti-quota sentiments expressed by the callers is, as I stated, not unique or uncommon in Iceland. As I talked with more and more people in the fishery throughout my fieldwork, it started to become abundantly clear that the quota would, indeed, be a big factor in my research.

Overview of This Chapter

In the previous chapters, we saw how today's fisherman or captain is now one in a long chain of data and information workers, frequently situated at the first point of data capture and creation in the process. Now, we take a look at what happens to the data after it has been created at sea. The goal of this chapter is to examine how and why the Icelandic fishery is so centered on data to begin with. To that end, this chapter will be broken up into five main sections, which

[1]The ability to sell the quota is one of the more disputed aspects of the quota system, as this has resulted in the situation the caller was describing. Quota used to be anchored to a particular area as a measure to safeguard the local economy. As this is no longer the case, smaller fishing towns and areas are slowly being drained of the ability to maintain stable economic conditions. This has been described extensively by e.g. (Eythórsson, 1996a, 1996b, 2000; Karlsdóttir, 2008; Kokorsch, Karlsdóttir, & Benediktsson, 2015).

I outline below.

First, I examine some of the practices and underlying assumptions that are entailed in building a statistical data model for stock population management purposes. This section is called *Modeling Nature.* By investigating the assumptions that go into making a statistical model about the fishery, we are presented with a worldview that is designed to accept a very specific type of input. For the Icelandic fishery, this kind of input is data.

In the second section, *Governing the Icelandic Fishery*, I present an overview of how the Icelandic fishery is governed today. By examining the foundations for the resource management scheme that has been implemented in the fishery, I expose a close link between data and governance of the fishery. The current resource management system has been through a series of iterations since its inception in the mid-1980s, but a consistent theme in these different versions is the assumption that in order to manage the fishery successfully, data is a prerequisite.

Third, I present a historical overview of data collection in the fishery that reaches back to the late 19th century. In *Data as a Tradition*, we learn that some of the core assumptions in the current resource management structure stem from a long tradition of data-oriented focus. In particular, I present the Cod Wars, a protracted conflict between the Icelandic government and the United Kingdom focused on governance of the Icelandic fishing waters. The Cod Wars demonstrate that by relying on the tradition of data collection in the fishery, the Icelandic government was able to bolster their argument for exclusive governance of the fishery. A key item in that particular argument was a scientific report presented by the MFRI—colloquially called the Black Report.

In the fourth section, *A Pattern Emerges*, I present a pattern that has emerged with regard to the focus on data and fishery management efforts. As the Icelandic government has implemented and iterated different versions of the natural resource management scheme, each of these iterations have been informed by advice from the MFRI. As more data becomes available regarding the stock—through official work performed by the MFRI or as a by-product of automation in the fishery—newer forms of governance have been introduced that, in turn, produce new forms of data. Moving forward, these new forms of data will spur new forms of governance, and so on. This, I argue, is a feedback loop.

Building on how an increased reliance on data has played out in the fishery, the fifth section of this chapter, *The View from the Ground*, takes a look at how the quota as part of a feedback loop is working out on the ground. As we saw in the short story about the radio show, the quota is a large part of the social consciousness in Iceland. To people who make their livelihoods in the fishery, this is no less true. To my informants, the feedback loop that is embedded in the quota system brings up issues regarding power imbalance and further fuels mistrust in a system that feels rigid and impervious to change as well.

Together, the five sections demonstrate the intricate context of the natural resource management system in Iceland. At the end of the day, it is not about the resource or access to the resource alone, but rather it is about the interplay between history, culture, and political context and how this constellation affects people on the ground as well. Moving on to the first section below, we start to unpack this complex story by looking at what kind of work is being done with the data created in the fishery.

4.1 Modeling Nature

SL is an industrial engineer who specializes in statistical models for fishery management strategies. SL's work deals with the kind of datasets that S, GE, and Captains V and K have all contributed to in one way or another through the UFM or the ECL, as we saw in chapters 2 and 3. When I spoke with SL, she was working on a doctorate degree at a university in Sweden with a focus on statistical modeling and simulations of fishery management efforts.

A part of SL's graduate work focused on the effect of different access control measures on stock size, growth, and renewal. Specifically, she examined a variety of fishery industry related factors (e.g., number of jobs, profit margins) and how, according to different statistical models, these would impact the stock health overall. In addition, SL was interested in comparing different management strategies by looking at how they impacted predefined biological, economic, or social indicators.

As SL explained it to me, population models are used to understand interactions of factors like time, population size, and age distribution within a particular species. In the case of fishery management, a population model can be used to determine how much to harvest in the context of sustainability or to prevent stock collapse. This is the strategy that is used in the Icelandic fishery, and it falls under the role of the MFRI to run models and simulations like SL described.

SL's doctoral work was funded by an international industry and university research collaboration between Iceland, Norway, Faeroe Islands, Denmark, Spain, Italy, Portugal, and the United Kingdom. The project coordination for

the collaboration was managed by a large food R&D company in Iceland where SL worked as an industrial engineer. The overarching goal for this research collaboration was to examine the feasibility of a bottom-up model in fishery management. That is, to investigate how to actively include fishery professionals like fishermen and captains in the planning and execution of the resource management strategy through interviews, workshops, and other collaborative efforts. This particular strategy was seen as the opposite of the hierarchical, top-down approaches commonly employed in many European fisheries at the time, including the Icelandic quota system. The Icelandic fishery was selected as one of the four test cases for this project because it is a single country fishery with sufficient data available. This would make modeling and simulation "not too difficult," as SL described it.

SL's specific role in the project was to statistically model and test different fishery management proposals, run simulations, and verify which models or elements within models indicate successful management strategies per the project's predefined success factors. The data for the models came from the MFRI in Iceland as well as the DF, meaning it was data collected in part by people like the fishermen on my crew.

SL explained that this type is commonly used to model population growth in ecology and is known as a logistics function model. Image 4.1 shows a simple logistics function. A model of this kind describes the dynamic relationship between population size (P) over time (t) as these are impacted by growth rate of the population (r) and carrying capacity (K), or the maximum population size of the species that can be sustained indefinitely in ideal environmental conditions.

According to SL, the type of population growth model she was using for this

$$\frac{dP}{dt} = rP \cdot \left(1 - \frac{P}{K}\right)$$

Figure 4.1: Simplified formula for a logistics function, as used by SL.

project works particularly well with the type of resource management efforts that have been applied in Iceland since 1983:

> SL: A simple model like this does not handle drastic changes . . . but it is an especially good fit for the Icelandic case study or the way fishing is managed in Iceland . . . because it [the fishing effort] is managed so efficiently, well . . . [pause] . . . the pelagic species have more unexpected incidences. But it is enough to have a simple model [for the demersal stock].
>
> HBH: So you're saying that because of the management efforts in the Icelandic fishery, that they are so controlled, that it is unlikely we will see a collapse of a particular [demersal] stock without warning signs? That it is unlikely that it will be due to human intervention [like overfishing]?
>
> SL: Exactly. This project is not about that [drastic changes]. They [researchers at MFRI] know more about that. They will look at things like climate change and such.

That is, the reason why SL can use what she describes as a *"simple model"* in

her work is because the data collected in today's fishery comes from a system that is designed to elicit such data through procedures like landing reports, the ECL, or the UFM. In other words, the fishery is managed in such a way that it will generate data that keep it within SL's simple model.

Later on, SL stated that the risk of a collapse in the Icelandic fishery was minor for the same reasons a simple model will work in making projections about it. That is, because the stock size is used to determine the cap on what is allowed to be caught, the fishery will not deplete the spawning stock. SL elaborated by saying that a simple model works because the stock is "simple" in that it does not typically dramatically increase or decrease, given the frequency it is being checked, meaning due to the way the fishery is set up, there is automatic and constant data collection happening every day. Any major trends or shifts would happen in a longer time frame than from month to month or year to year. If, for instance, the average growth or decline for the stock for year 0 is X, then we are not too concerned if the average each year is one off from the year prior. However, if we were to look at the data over a longer period of time, then a trend could be detected.

SL made sure to tell me that she was aware of the fallacy in the assumption that the data she had access to was providing a complete picture; that even though the data was official or presented as a complete dataset, there are aspects that are missing. For instance, the data collection efforts may not be consistent between locations, instruments and standards may change over time, or as SL said, because the type of data available may not be the type of data that fits the goals or outcome targets.

If the data about the fishery only tells half of the story, then what is missing

from models and projections?

> SL: What I always think about these models, I would have liked to see more of the social factors being included, because, you know, there is a lot of knowledge on it already, so that things shouldn't go so badly like happened in other European fisheries. These [social factors] are like human issues that are ruining things, as far as I can see . . . too many participants [fishing] and such. I feel like we are not incorporating the social factors [the knowledge of the social factors] and having them translated into measurable factors.
>
> HBH: What do you mean "translated into measurable factors?"
>
> SL: So that they can be incorporated into the model, that we can look at them that way. They [social factors] are always looked at on the side [next to the model, not in the model]. Biology and economy and stuff like that are always incorporated into the models, whereas the social factors are simplified dramatically. We could do more of that. It is a growing field, social modeling.

What makes SL's point even more poignant is that natural resource management schemes are ultimately not implemented to control the natural resource itself, but rather the human behavior regarding the resource around access and utilization. In order for a resource to not be overutilized, understanding the context in which it is being used is important. That is, there is a marked difference in how a resource is used if the goal is subsistence versus industry production.

For instance, it was not until under the threat of a possible cod stock collapse—after decades of aggressive (over)harvesting by Icelanders and other

nation states—that a systematic access management scheme was devised and implemented for the Icelandic fishery. Until that point, the resource had been aggressively utilized by multiple nations, and there was limited centralized supervision or monitoring as such.

For SL, one of the more interesting features of the project that funds her doctoral work was the involvement of and goal to include actors from the ground up. To her, this indicated an attempt to include more of the social factors through more systematic involvement of stakeholders who are absent from standard population and ecology models. However, as we continued talking, it became clear that she did not believe that this kind of involvement would end up happening in Iceland after all.

> HBH: Do you envision a mixed approach like this being implemented in Iceland?
>
> SL: Not in Iceland . . . the system is a monolith—it is so hard to change. The quota is so complicated; we have customized it to the Icelandic situation. It is hard to imagine such a drastic change to the system. I know that the stock will be fine because I know that the catch is determined from the stock . . . basically from the stock size.

In the case of SL, and how her work fits into the narrative about the fishery, she told me that it felt strange for her to be an expert on a project where the goal was to include more actors from the ground up. She pointed out that she had never even been at sea, and that for her, this project was a means to very specific ends—a graduate degree. She found it ironic that her very remote and abstract involvement was more likely to affect policy than the actions and insights from

people in the fishery—for whom the outcome would be far more relevant at the end of the day.

SL's work is literally and figuratively removed from the Icelandic fishery. In looking at the underlying assumptions of data modeling, we see the shift from viewing the fish as a gift to something that can be optimized through statistical manipulations. As is, the quota system is not designed to incorporate input from stakeholders like fishermen or captains at any point. As SL pointed out, social factors like lived experiences are not suitable for use within that particular framework. We will see later on in this chapter that SL's sentiments were frequently echoed by my informants—people who work in, and depend on, the fishery for their livelihoods. And yet, in today's fishery, this is normal.

After talking with SL about data modeling, one question that haunted me was *how did we get so far away from the fish?* From fishing itself? How is it that SL, a PhD student located in Sweden, can make these models and simulations that could potentially be used for decision-making for the fishery in Iceland? Why will something like her work, data models, be seen as more valid than input from people who have worked in the fishery for most of their lives?

Taking an even bigger step back, how did we go from viewing fish and other marine wildlife in the Icelandic fishery as an entity beyond human control, a "gift from God," to an entity that is a statistical certainty to be manipulated, modeled, and managed? We have already seen a smaller version of this shift during the UFM process, and we now turn to unpacking the context in which these transformations are taking place.

The overall shift from thinking about the natural resource as a gift to an

entitlement or a right is a shift in which the fishery as a whole has come to be seen as a mathematical system to be optimized. In other words, the gift has been transformed into something that needs to be managed for optimization. I argue that in order to understand this move, we need to examine the basis for how the natural resource came to be governed, and how it is governed today. In the next section, I present an overview of the governance structure of the Icelandic fishery.

4.2 Governing the Icelandic Fishery

In my brief overview of the fishery in Chapter 1, I mentioned that the Icelandic fishery is managed by way of quota allocations, colloquially, "the quota." Today's version of *the quota* is a result of a series of attempts to control or limit efforts and access to catch the fish that have been modified and changed since its initial implementation in the mid-1980s.

The namesake for the quota is an annual assignment of quotas or shares for fishing in the fishery. The amount of quota for the entire fishery—TAC—is determined by the Ministry of Fishery and is based on recommendations provided by the MFRI. The TAC consists of multiple ITQ shares that are each associated with fishing vessels and their owners.

The TAC is the recommendation for the amount of fish that the entire industry as a whole could safely catch, whereas the ITQ is a subset of the TAC and is the total amount that each individual vessel may catch. The ITQ is not a fixed amount but, rather, a percentage of the TAC. That means that each year, depending on the TAC amount, the ITQ amount will vary. If the TAC is 100 pounds of

cod one year, an ITQ of 4% will be 100 pounds times 0.04, or 4 pounds (these numbers do not reflect the actual amounts in question—those are closer to a little over a million tons—but are used here merely for demonstration).

We have already encountered the two main institutions that are involved with the governance of the fishery, the MFRI and the DF. These two institutions work together but have two distinct roles in the fishery. The MFRI's main role is to provide scientific advice and guidance on the state of the fishing stocks around Iceland. This work is done in a variety of ways, including by mining UFM reports, conducting in-person observations on fishing vessels, and conducting annual research expeditions at sea. The DF is the management complement to the MFRI's research and scientific advice role. To enforce fishing activities staying within the TAC for the fishery as a whole, and the ITQ on the individual vessel level, the administrative part of the management structure—the DF—relies on data from landing reports as well as reports from captains at sea.

From this high-level view of the quota system, we start to see how data plays a central role in the management of the fishery. From the way the system is set up to factor in data about the status of the marine wildlife through the MFRI to administrative day-to-day activities at the DF informed by data gathered through mandated work processes onboard fishing vessels, data is used both to establish the boundaries for acceptable, legal, activities in the fishery and as means to monitor those activities.

In the discussions regarding the UFM and the ECL in Chapters 2 and 3, we saw how data is central in monitoring and enforcing activities in the fishery. One of the main goals in this chapter is to examine *how* or *why* this focus on data

is in place to begin with. While we can see traces of the logic that the fishery is something to manage through data—through population models similar to what SL does or to monitor through daily reports from vessels at sea—we have not yet seen how this heavy reliance on data was established.

Next, I present a brief discussion of early data collection efforts in the fishery. This historical account will illustrate that while the fishery may not have historically been rigidly managed through data, the tradition of marine research is extensive in Iceland. I argue that this particular fact about the fishery was crucial to the process of gaining control of the fishery in two ways. First, it laid the groundwork for building a database about the fishery, establishing a mindset where in order for anyone to claim to know anything about the fishery, it was expected that this knowledge was built on systemic data. Second, due to this long history and tradition, the Icelandic government had the advantage of claiming superior knowledge when it was in debates about who would get to manage the fishery.

4.3 Data as a Tradition

In spite of not being exclusively governed by the Icelandic government, the fishing waters have been studied in one form or another since the late 19th century (Friðriksson, 1940b). The very first systematic studies of the fishery were done by a natural scientist and biology teacher named Bjarni Sæmundsson. Sæmundsson's studies were funded by the Icelandic Parliament, and his findings were reported to the Danish Crown—the governing nation of Iceland at the time. Later, in 1903, the Danish Crown started official marine research in the

fishery, aided by Sæmundsson, who was hired as a local consultant (Friðriksson, 1940a).

The main goal of Sæmundsson's early research efforts was to establish a general knowledge base about the fishery, looking at what types of fishing activities were happening, how the catch was being processed, and so on. Sæmundsson traveled from place to place, documenting both what kinds of catch were had and how it was processed, as well as interviewing local fishermen about the history of fishing in that area. A common thread throughout Sæmundsson's reports is advocacy for a more systematic, incorporated approach to managing the natural resource through shareholder practices and unionizing fishermen (e.g., Sæmundsson, 1895, 1896, 1897).

In his first published report from 1895, he even went so far as to argue strongly for the establishment of the role of an official marine biologist, a consultant to the government in matters of fishing research and control, as well as serving as an expert on best practices in the fishery for the practitioners themselves. Scientific, systematic observations were the key to successful experimentation and management of the fishery, according to Sæmundsson.

In fact, in one of the earliest reports, Sæmundsson recounts the promising growth and dramatic decline and failure of experimental river trout and salmon farming in 1883–1888. He concludes that if only there had been a marine biologist on hand specifically to oversee the efforts, the experiments would not have failed because the biologists would have been able to systematically gather data and consult on the undertaking (Sæmundsson, 1897).

It would not be until 1965, or 70 years later, that Sæmundsson's vision of an

organization entirely devoted to the study of the fishing waters would be established. This organization was the MFRI. Given the cultural and economic significance of the fishery, it may seem surprising that it was not until the mid-1980s that any systematic, government-driven supervision of the resource utilization started to take form.

Next, I discuss the conflict between Iceland and other fishing nations that ensued as the Icelandic government started taking formal steps to secure governance over the fishery. I argue that this conflict was resolved in part due to the tradition of data collection in the fishery in Iceland. In gaining governance of the resource, the tradition of marine research further bolstered a logic of data as a means to control the fishery.

The Cod Wars and the Black Report

Following World War II, the Icelandic government started taking steps to gain exclusive governance over—and economic benefits from—the fishing waters around the island. Due to these expansion efforts, there was considerable tension between Iceland and the other nations that had been fishing around Iceland[2]. Following increasing acceptance of this practice in the international community, most of the foreign fishing nations accepted Iceland's claim to exclusive governance[3]. The United Kingdom, however, was not in a hurry to give up their access and use of the valuable resource. What followed was a series of

[2]Among the nations that had been fishing around Iceland were the United Kingdom, Russia, France, Belgium, and Germany

[3]Iceland was not the only nation attempting to claim exclusive governance over fishing areas. In fact, Argentina, Chile, and Peru had already claimed maritime zones following President Truman's proclamation of September 28, 1945, on the continental shelf (*Harry S. Truman: Proclamation 2667*, 1945). According to the United Nations, this proclamation was in part driven by concerns regarding overfishing, pollution, and economic rights.

drawn-out conflicts between Iceland and the United Kingdom starting in the fall of 1975.

These series of conflicts came to be known as the Cod Wars, since the most common and valuable catch in the fishing grounds surrounding Iceland was (and remains) cod. They were not wars in the conventional understanding, and fallout was limited to material damages to vessels on both sides in addition to destruction of British fishing equipment. In reading about the skirmishes, it is, however, evident that these confrontations were far from peaceful negotiations. Neither nation was willing to give up control or access to the economically important natural resource without a fight.

In the fall of 1975, the MFRI published their annual fishery report. What makes this particular report interesting in the context of the Cod Wars is one of the major findings presented therein. The report warned of an imminent stock collapse for the Atlantic cod if fishing efforts were not dramatically limited. It truly is telling that this report would come to be known by members of the fishery as the Black Report, highlighting how serious a stock collapse would be for the Icelandic fishery.

In the following years, the findings in the Black Report were questioned and challenged by people in the industry and government alike. However, during the Cod Wars, the report ended up being used for leverage in negotiations with the British, according to the director of the MFRI at the time, Jakob Jakobsson:

> In the fall of 1975, when the Black Report was published, we were in the midst of the Cod Wars. No-one in Iceland criticized the findings then; quite the opposite, in fact, it was seen as advantageous to bring

> "The Black Lady" along to London and use her to beat the English. (Jakobsson, 1979, p. 715)

While it may not have been a complete surprise that the marine wildlife in the waters surrounding Iceland were perhaps being harvested too aggressively to be sustainable in the long run, the report served as a strong argument for limiting access to the fishery. What is interesting is that *during* the Cod Wars, the debate about the validity of the Black Report was put aside because the report was being used to gain control over the fishery. It is this line of questioning that Jakobsson refers to in the text above: *"No-one in Iceland criticized the findings then; quite the opposite in fact"*(Jakobsson, 1979, p. 715).

I cannot argue that the resolution of the Cod Wars can be attributed to the Black Report alone. However, I argue that in being used in the process of negotiations over the resource, the Black Report presents a moment where the tradition of data and research in the fishery was moved to the center of the Icelandic fishery. Before the expansion efforts and the Cod Wars, there had been limited centralized management of the fishery. Having eventually secured control of the EEZ after the Cod Wars, the big question facing the Icelandic government was how to manage and sustain this economically valuable natural resource.

It was at that moment that today's Icelandic Natural Resource Management strategy for the fishery started to take the form of a systematic, centralized control structure governed by heavy reliance on data from scientific marine research. I can see a clear line from the rhetoric in Bjarni Sæmundsson's initial publications on the Icelandic fishery, arguing for centralized control of the fishery based on data, to the data-driven management efforts that guide the fishery today.

In this and the previous section, we learned about the historical tradition of data collection in the fishery and the context in which the governance of the fishery was established. I now present a look at the relationship between data and governance as it has co-evolved in the Icelandic fishery.

4.4 A Pattern Emerges

Today, data in the fishery comes from research done by MFRI biologists and through mandatory reporting functions like catch weighing at the end of a tour, the ECL that the captains maintain (from Chapter 3), and the UFM that we encountered in Chapter 2. In addition to these official reporting functions, data capture happens naturally as part of the workflow in a digitized workplace: Where did they go? What did they catch? How did they catch it? Did it all sell? Was it smooth sailing, or was the weather bad? Did that particular trip come out in the black on the books? How much was each shipmate's share?

This kind of information and data will inherently grow with each activity while at sea. In other instances, the data that is created is a direct outcome of the system as it is set up today. For instance, the multiyear database on the fishery is a result of the centralized database into which the ECL reports are entered or any large-scale data used for models and simulations like the ones SL works with.

Similar to how the work practices of the captain have crept to being heavily oriented toward the use of information technology, there has been a creep toward data creation as a central practice in the Icelandic fishery. And like the slow pace of the changes in the work practices, the data creation focus has

emerged slowly.

However, while the emphasis on data as a management tool has slowly crept to center stage in the fishery, we have already seen that data and assumptions regarding this data about the fishery have existed in some form since Sæmundsson's early research efforts in the late 19th century. That is, embedded in Sæmundsson's early work reports is the assumption that data is necessary for successful management and utilization of the resource. The theme of "more data is needed" continues to echo in today's publications in the fishery MFRI reports. So what happens when this is the focus? One outcome is that any efforts to manage will be steeped in data.

More Data Drives New Forms of Governance

Looking through the series of natural resource management schemes that have been implemented since the EEZ was established, we can trace an ever-increasing emphasis on data as management tool. This trajectory also demonstrates one way in which tracking and statistics spawn new forms of management efforts. From the earliest systematic form of fishery management after the EEZ to the current system structure in place, these iterations have all been informed by research done by the MFRI.

Stepping back, we start to see a pattern emerging. As we saw earlier, one argument for the Cod Wars between Iceland and the UK being brought to a halt was the threat of overfishing the cod stock. Iceland, with a long tradition and infrastructure of marine research, was in a place to provide data that demonstrated a dire need for a drastic reduction in cod fishing. When Iceland gained

control over the fishery, the resource had only been loosely monitored or regulated up until that point. The major task before the Icelandic government was, thus, to come up with a strategy to prevent the collapse of the cod stock while simultaneously striving to continue the harvest of the resource and maintain it in economic terms.

As the Icelandic government implemented a series of restrictions limiting either access to or efforts in the fishery, organizations with specific roles with regard to these restrictions started to emerge as well. The DF is an example of an institution that was established in response to an increasingly complex regulatory framework. As the governing infrastructure grew for the fishery (both in terms of institutions and regulatory framework), data collection and related practices in the fishery also expanded. An example of this is the UFM process we encountered in Chapter 2. Other examples of data collection and creation growth are to be found in the shift toward automatic data capture that is inherent in much of the technology that has been developed for the fishery[4].

In sum, one reason why Iceland was able to successfully argue for the EEZ was the tradition of data collection about the resource. The initial management efforts were evaluated based on data that were being collected concurrently as well as the historical data. As the amount of data about the fishery grew, organizations specifically oriented around this particular data were instituted. In turn, these new institutions called for new forms of data.

[4]See, for example, CATSAT, a satellite service that promises to "Help fishermen get the most out of their fishing campaigns by providing very accurate oceanographic data
and marine weather information in "near real-time" directly onboard the fishing vessel.
(http://www.catsat.com/catsat-fish-software/),
or Innova, a software suite for fish processing that will "maximize yield and throughput, conform to quality standards, and ensure food safety" (https://marel.com/fish-processing/innova)

This pattern, I argue, is a feedback loop. That is, to govern the resource, the government looks to data. As the data grows, new government institutions come into play to specifically manage this data. The management of the data requires governmental framework in the form of new regulations and laws, which in turn, require more data to inform further decisions.

4.5 The View from the Ground

In the context of the feedback loop between data and governance, SL's role as a data modeling engineer may not seem all that unusual. The prioritization of the ability to work with and read data over hands-on, applied experience in the fishery is something that my informants are both keenly aware of and frustrated with. In this section, I present examples where the assumptions for resource management setup and people's experiences in the fishery are at odds.

The Feedback Loop Is Impervious to Change

The cyclic nature of the feedback loop, the continuous revisions and iterations of the fishery management, have resulted in a system that, to my informants, feels entrenched and/or resistant to change. One of the ways in which the system feels set or entrenched is manifested in a hopelessness that in spite of new research or data and new developments in fishery management, the Icelandic system will just stay the same.

When I spoke with SL about the project she was working on, she told me that what she had found particularly appealing was the notion of incorporating

feedback/input from key players who rely on the resource rather than basing policy strictly on a top-down organizational structure. But when I asked SL if she thought that the bottom-up approach would be something we would see in the Icelandic fishery, she was not optimistic:

> SL: No. Not in Iceland. It is such a monolith. We had . . . [pauses] . . . the quota system is so complicated, and it has been adapted specifically to the Icelandic context. It is hard to imagine such drastic changes [to organizational structure]. [I see this as] . . . a method for fisheries where the stock is more endangered and there is more chaos [biologically and in terms of management/supervision of the fishery]. [Her disclaimer is that she is not talking on behalf of the project, but as herself, not in any official capacity.]

SL's view of the quota system being monolithic or resistant to change is echoed by HG's frustration as a fishing quota owner and participant in the fishery:

> HG: Look . . . if we see that the MFRI has made a mistake [in estimates, guidance], then we have to do so much [work, data collection], so much data to prove anything before we can even get them to the table [to talk with us] . . . It is often like that, and then it is hard to get them to talk with us and consider a re-evaluation. Understandably so. But they have made mistakes, with the pollock and the halibut and the catfish. But they are willing to talk if we are prepared.

That is, to HG, the quota system and the organizational/management struc-

ture supporting it are not set up to work with feedback or input that are not a result of the system as such. Affecting change, then, feels nearly impossible to the people who rely on the fishery for their livelihood.

HG's comment also speaks to the feeling that many informants expressed over time, that no matter what they saw and experienced, their feedback and observations were dismissed out of hand. This, I argue, is one outcome of the feedback loop unpacked above. It seems like there simply is not room for non-traditional data or applied knowledge between escalating data needs and governing tactics.

Mistrust of Governmental Institutions

Another set of issues that arises in unison with the current structure of data-driven governance can be understood by reflecting on a previous management system, the Scraping Day System. The systems of access and effort limitations in the fishery came out of a situation where there was a dire threat to the cod stock; that is, following the Cod Wars, where Iceland gained exclusive governance over a fishery that seemed to be on the verge of a stock collapse. The urgent task of designing and implementing a strategy to preserve and protect the resource resulted in a system that limited efforts. This was done by putting a limit on the number of days where it was allowable to go fishing for cod, specifically. This system was the Scraping Day System ("Meginatriði íslenskrar sjávarútvegsstefnu", 2009).

A System That Failed: The Scraping Day System

With the Scraping Day strategy, there was no cap on the amount of cod each vessel could catch during these days, other than the cap set for the entire fleet. The total cap—the TAC—was based on recommendations to be issued annually from the MFRI. On the days when cod fishing was restricted, you were still allowed to catch cod, but the ratio of cod in the overall share was not allowed to be higher than 15 per vessel (Runólfsson, 1999). In terms of other catch, such as capelin, halibut, or haddock, there were no other limits than the MFRI-recommended TAC for the whole industry.

The annual fishery meeting reports and other documents from the Ministry of Fishery, and news coverage about this system as it was introduced, show the system being talked about as a reasonable, albeit somewhat flawed, solution to the problem of overharvesting of the cod stock short of a complete moratorium (e.g., Anon, 1980; Dór, 1984; lg, 1984).

In the end, this approach backfired spectacularly as there was no limit on the number of vessels in the fishery. In spite of a one-third reduction in the number of cod-sanctioned days in the years between 1977 and 1981, it soon became clear that this strategy was having the opposite effect (Schopka, 1980). The number of active fishing vessels in Icelandic waters increased by about 75 per cent, and instead of reducing the amount of cod being harvested, the actual reported catch numbers ended up being consistently far above what the MFRI recommended (Gissurarson, 2000; Runólfsson, 1999).

Effectively, this first come, first served strategy led to cod being overfished and an over-investment in the fishery in general (Árnason, 1993; Herbertsson

& Zoëga, 2002). Economist Gissurarson describes this system as *"a 'Derby', that is a competitive rush to harvest as much fish as possible during allowable fishing days. The objective became the largest possible catch in the shortest possible time, regardless of cost."* (Gissurarson, 2000, p. 14-15).

The failure of the effort to create a restriction system to preserve and protect cod stock was verified in the fall 1983 report by the MFRI (Jakobsson, 1984). This report detailed spawning stock at an all-time low and an overall lower quality of the stock that was essentially on the brink of collapse in spite of yearly reductions in total actual catch since 1981.

After five years of limiting efforts as a strategy to manage the fishery, landing reports showed more cod being harvested than what had been recommended by the MFRI and the government. In 1983 alone, the overall catch ended up exceeding the recommended amount by about 100,000 tons. In addition, there was serious over-investment in the fishery in the form of new vessels being added to the fleet without older vessels being retired to make room. A system that was meant to preserve the cod stock had essentially created an environment that supported perverse incentives to catch as much cod as possible during cod-fishing days as opposed to the actual goal of less cod being harvested.

Failure Sows the Seeds for Mistrust of Official Entities in the Fishery

I believe that this first epic failure in controlling access to the fishery set the stage for a deep mistrust of the process of limiting access, no matter what that process might be. While data from the MFRI was used to negotiate control over the fishery, it seems like the MFRI is haunted by these early instances of access

control in the fishery. Not only is the MFRI seen as having failed in providing reliable information—the cod stock did not collapse after all—but the catch amount recommendations provided by this institute every year are seen as too conservative by people in the fishery (cite).

Ironically, it is not the MFRI that actually implements most of the things that people complain about. It is staff from the DF that come onboard to do tests, and it is based on recommendations from the DF that there are temporary closures of specific fishing areas within the EEZ. In my informants' minds, however, it seems that the MFRI and whatever the perceived failures of the quota system are, are irrevocably intertwined.

After the Scraping Days, the ITQ

After the Scraping system failed, the government started phasing in a system that would eventually become a pure ITQ. The Organization for Economic Co-operation and Development (OECD) defines ITQ as follows: "A type of quota (a part of a TAC) allocated to individual fishermen or vessel owners and which can be sold to others" (OECD, 2005). The quotas represent shares in the national TAC. They are permanent, perfectly divisible, and fairly freely transferable.

The implementation feels more political than scientific, where the political gain is centralized around larger companies and larger urban areas rather than the rural and remote individual fisheries. As Karlsdóttir (2008) discusses, the transformation of fish from a natural resource available to anyone with a fishing vessel into a limited-access property that can change hands on paper *"changed the ideology among decision makers and companies involved"* (Karlsdóttir, 2008, p. 1).

The fishing was no longer about making ends meet but, rather, about creating wealth.

The switch/introduction to ITQ was a turning point that was felt by fishermen, in particular, those in remote rural areas, who are frustrated with how the ITQ process has panned out. To them, the ITQ has failed, like the Scraping Day System, but rather than the ITQ system being revised, it is unlikely that it will be changed at all.

OA, an independent fisher in a small fishing town, says that the shift to ITQ resulted in a lot of money being created through the act of buying and selling quota shares that were subsequently taken out of the fishery. That is, the people who sold their shares did not reinvest in the fishery.

> HBH: You are your own boss, am I right? OA: Well, I am more like a slave to the system. HBH: Why do you say that? OA: Well, the 1983 act of limiting fishing was fine; we had been ruthlessly exploiting the cod stock since we got all the new trawlers in the 1970s. So we had to have a quota system to limit the use. We were told that it would be only for a few years, and if it did not work, we would go back to the Derby [Scraping system].
>
> **I don't like the Derby, I am all for preserving the stock, but I'm not a fanatic like my friends in the MFRI. Well, then we allowed money to enter the system [with the ITQ], and all hell broke loose.**
>
> Men who had been in the fishery for years, decades, and had good experience . . . but they wanted out. This allowed them to quit the fishery. Fine . . . but it was just too much money that then ended

> up leaving the fishery. ... **We are . . . the Icelandic nation is still suffering the consequences today.**

AD, a crew member on a small vessel from the same town, shares OA's sentiment:

> **Today, everything is a mortgage in the bank** . . . [The quota] is supposed to belong to the people, according to the constitution, but banks and companies have mortgages through the roof that are linked to quota on some ship.
>
> **Without the quota, the ship is worthless . . . but the moment you have a ship with quota, they make some X value for the ship [laugh]. It is just incredible math, and it just gets worse. It is like a net that you get more and more tangled in.**

These fishing professionals understand and support the reasoning behind limiting access to the fishery; it is a *"safety valve"* that *"makes sure we are not doing permanent damage"*[AD]. But even though they understand and accept the reasoning behind the ITQ, it is its correlated effects—the monetization of the natural resource and how the ITQ shares have slowly gathered into few hands—that gives them cause for concern.

What is at stake is not just quota, as AD points out:

> **We have become serfs, in a sense . . . having to take multiyear loans in order to participate in the fishery** . . . if you need more quota for cod, you have to rent it from a fishery in Akureyri [on the

> opposite part of the country from where AD lives] so that we can fish more here.

AD explains how fishermen, by participating in the system, are committing themselves financially by taking out mortgages that ultimately prevent them from leaving the fishery. It is not enough to know the craft or have a vessel; one has to have quota to fish.

> All of a sudden, you have this thing called "capital gain," and those who started in the fishery have sold out. They sold what belonged to the nation [the quota]. **The ones who are doing it (fishing) today . . . they took out significant mortgages and became serfs in order to buy their way into the profession.**

For an independent fisherman like OA, this is one of the biggest issues. He does not own quota, and he has, until recently, rented a small share from a local fishing company. Buying quota is too big an investment for him, and he believes he would not be able to do so. Even if he has not taken out a mortgage, as in AD's example, OA said he feels like a slave. He is beholden to the system in that he has a crew he is responsible for, a vessel to maintain, storage for vessel equipment, and other associated operating costs. Yet, like he said earlier, he is not his own master, he cannot *"leave the fishery"* like other people before him have done. In OA's words, being in the fishery as it is structured today, is *"like a horror movie."*

4.6 Conclusion

In this chapter I looked at what happens to the data after it has been created in the fishery. The way the fishery is structured today, fishermen and captains are at the beginning of a long chain of data workers. It has not always been so, and in this chapter, the goal was to examine why and how the fishery is centered on data.

To that end, I presented SL and her work for a multinational research project. The overall goal of the research project was to examine the feasibility of more systemic input from all actors in the fishery - a bottom up management strategy - over a more traditional top down strategy. In particular, SLs work was to use data from the MFRI and other sources in the fishery to build statistical models to project different fishery management outcomes. For each model, SL tried to identify how different parameters such as changes in the TAC would impact the overall fishery management success.

I argue that in SL's work, we see the basic presumptions of the fishery governance structure today. That is, in order to make any kind of decisions about the fishery, data is needed. Looking at the governance structure in the fishery, we see how data is used to inform everyday work like in the case of the ECL and to plan and implement governance through data modeling and future projections on an annual basis.

Focus on data in the Icelandic fishery is not a new phenomenon. There is a long tradition of data being collected and analyzed in and about the fishery, going as far back as late 19th century (Sæmundsson, 1895, 1896, 1897; Friðriksson, 1940a). I argue that this history, coupled with concerns of cod stock col-

lapse, was instrumental in helping the Icelandic government gain control over the EEZ in the name of preserving the resource. Looking at the series of management schemes that have been implemented to protect and preserve the resource since the mid 1980's, a pattern emerges that resembles a feedback loop.

That is, to govern the fishery, the government looks to data collected through official processes like the ECL in addition to official research by the MFRI. As the data about the fishery grows through these practices, new institutions have been established explicitly to manage the data. This is the DF, the administrative arm of the fishery monitoring.

I argue that the feedback loop demonstrates the logic of data as essential in the fishery. As data is created, collected, aggregated, through everyday processes in the fishery, it requires new forms of governance. As these new forms of governance are implemented, they result in the need for, and creation of more data to operate and fulfill their official duties.

Stepping back, I looked at the implications of the feedback loop from the perspective of fishermen and captains. To my informants, one of the main outcomes of the resource management system structure is what they describe as a rigid system that is impervious to change. For independent fishers, the system also feels difficult to work in, and even harder to leave due to the significance investment of money and time (it is "like a horror movie"). One reason for this, I argue, is the logic undergirding the structure of the system. That is, to manage the fishery, data - scientific data, to be specific - is needed. There simply are not provisions made for data that is different as in the case of observations by captains and fishermen through the years.

This inability or inflexibility to allow for input from the bottom up, has resulted in a power imbalance between the people creating the data in the fishery (fishermen, captains) and the people who make decisions about the fishery based on the data. The imbalance is manifested in a severe mistrust of the system, especially the MFRI and its staff (*"... if we see that the MFRI has made a mistake... we have to do so much, so much data to prove anything"*). This situation is not helped by the way the ITQ has ended up prioritizing urban areas, centralizing wealth in the system at the cost of smaller, rural fishing communities.

What we have then, is a system that is rigid, breeds inequality and as I argued in ch. 3, is shifting things in more ways than simply sustaining the fishery. I argue that in understanding the historical, cultural and political context that gave rise to the system as it is today helps us understand why sustainability framed as an environmental concern to be addressed by data simply does not capture the complex socio-economic concerns of the people working in, and depending on, the fishery. This matters for the field of sHCI because when we step back to understand what the kind of data-driven systems that many in technology design are working towards, we start to realize there are a lot of social issues beyond sustainability narrowly defined. I will return to this point in the dissertation conclusion.

CHAPTER 5

CONCLUSION

In this dissertation I presented three lenses to examine how the datafication of the Icelandic fishery has unfolded. Each of the main chapters in this dissertation present a particular lens demonstrating the datafication. The first lens explores the process of how data is created and how fish are transformed in this process of datafication to both a natural resource and a commodity. The second lens examines the work processes of the people whose job it is to do this transformation. The third lens looks at the regulatory context that gives rise to these processes and how that has changed in recent years.

The research for this dissertation was undertaken in 2011, motivated by issues related to the field of sHCI at the time. Since then, a new field of research has emerged that is of particular relevance to the findings of this work. This is the field of critical data studies (CDS). While I will unpack the broader implications of the work in the context of sustainable HCI, I will also examine how this research relates to work in critical data studies.

Specifically, I structure this chapter in five sections. First, I look at the broader implications for sHCI with regards to the findings presented. Second, I situate my findings within the context of research in the field of IT and Work. Third, I discuss my findings in the context of some of the main concerns and research trajectories within CDS. Fourth, I present future research opportunities in the fields of sHCI and CDS. Finally, I present a summary of this dissertation.

5.1 Implications for sustainable HCI

The goal of the research presented in this dissertation was to address issues that came out of critical engagement with the sustainable HCI literature. In particular, it sought to challenge and address the field's narrow definition of sustainability (e.g., Brynjarsdóttir et al., 2012; DiSalvo et al., 2010a, 2010b) and my frustration regarding sustainability oriented work based on short term engagement in the field.

In particular, my goal was to examine what sustainability meant to people working in the Icelandic fishery, a site of tremendous IT uptake in the last few decades. Had the introduction of IT helped with managing the resource sustainably, or had the capacity for more direct fishing activities impacted the fishery in a different way? How had the dramatic uptake in IT affected working practices in the fishery? A key goal in answering these, and more, questions was to ground my understanding of sustainability in the fishery in the experiences and views of my informants. To that end, I chose ethnographic methodologies like participatory observations and semi-structured interviews (Blumer, 1969; Forsythe, 2001; Lincoln & Guba, 1985; Wolcott, 2008).

As my fieldwork unfolded, it quickly became apparent that what had been my initial - naive, perhaps - understanding of the concept of sustainability was ill suited to match with what my informants were experiencing. In fact, even the term "sustainability" only ever once came up in a conversation with an informant without being prompted in some way by me. This was during the last phase of my fieldwork, on board the freezer trawler. It was noon and we were having breaded cod for lunch. As HK and I entered the mess, he exclaimed jok-

ingly: *"Þetta er bara sjálfbærni! Við étum það sem við veiðum!"* or *"Look at us being sustainable! We eat what we catch!"* This - bringing up the term of sustainability - was so unusual, that I jotted it down verbatim.

On the surface, it seemed to me as if my informants did not really think much about sustainability as such. When I would bring it up, my informants stressed that sustaining the resource was important and that they would never be party to "killing the golden goose." [1] It was not until I gained a deeper insight into how the resource is governed and how this impacts the people in the fishery that my understanding shifted. It is not that my informants do not care about environmental sustainability or sustaining the fishery. Rather, to them, the concept of sustainability is entangled with so many other, immediate and long term concerns that as such, it is as if the concept itself gets washed out and loses its potency.

For small scale fishers like AD and Captain SB, for instance, the sustainability of the fishery is about things like livelihood, family, pride, and community. In the case of captains with larger companies, like Captain M and Captain K, sustainability is about being able to bring in big bags *now* and to keep on being able bringing the big bags *in the future*. Finally, from a governance point of view, sustainability is about having enough (or getting more) data to make sure that the resource can be utilized in an optimal fashion and sustain the economy of Iceland.

[1] From interview with HG: "Þeir stilla alltaf upp sjómanninum upp eins og hann ætli að veiða síðasta fiskinn. Það var auglýsing á MTV þar sem þeir sýndu sjómann hlaupandi á eftir ströndinni á eftir síðasta fisknum. En í raun og veru, þetta er eins og að drepa gullgæsina ef þú ætlar að drepa síðasta fiskinn" / "The fisherman is always painted as having the ultimate goal of getting the last fish. There was a commercial on MTV for a while showing a fisherman running after a fish on the beach, jumping on it. But seriously, it is like killing your golden goose if you catch the last fish!"

What I have found, then, is that when it comes to the way sustainability has been framed in relation to the Icelandic fishery it is not so much oriented towards environmental consideration as it is built on a rhetoric of data as a way to control and manage a natural resource so that it can continue to provide support for all of the disparate concerns mentioned above. As I argued in Chapter 2, the bag and what it contains mean different things to different people at different times (work, data, fish, money).

This also applies to the way sustainability can be framed for the fishery, whether it is in strictly environmental terms - preserving a natural entity - or in economic terms - sustaining a livelihood. For people in the fishery, the economic sustainability will inevitably come first, as they need to make a living before they can focus on the environmental aspect of their livelihood. However, as their livelihood is derived from a natural resource, they can not ignore the environmental impact of their actions either. Sustainability framed strictly as an environmental or an economic issue does not capture this very real paradox.

As far as implications for sHCI go, I argue that the focus towards unpacking food systems as discussed by Norton and colleagues (2017) promises to capture this complexity to a certain extent. In particular, by paying attention to food policy and related governance, we can expand our focus to include other aspects of sustainability than environmental concerns only. As an example, by looking at the entire chain of food production - from seed to sales - we can start to understand ways in which all actors can be held accountable for environmental and social justice implications from their practices, rather than focusing on consumers only (Norton et al., 2017). One consequence of datafication in the fishery is a disparity that appears when we examine what happens to the data that the

fishermen and captains create, and are impacted by in turn (Chapter 2). That is, through their jobs, the fishermen and captains create data that ultimately is used to determine their ability to work in the upcoming year. While this data directly impacts the fishermen and captains, they have no say in how the data is interpreted or wielded after they have created it due to the way the resource is managed, leaving them in a position of limited agency. Understanding how inequalities like this happen and that they are an (unintended) outcome of a larger system brings focus to the issue and opportunities for more equity.

What looking toward food systems does, however, is to expand the definition of sustainability to an *on-going, systemic concern* rather than a delimited and finite problem (e.g., Adger & Jordan, 2009; Ostrom, 1990, 2009). The concept of food sovereignty (Norton et al., 2017), is relevant in this context, as it focuses on who has control over the food production processes at which stages in the food system. Håkansson's (2012; 2014) work, however, has demonstrated that small scale farming may not be a freely chosen or manageable lifestyle for everyone. Focusing on the broader systems responsible for sustainability reveals power inequities between various actors involved in datafication. The inequality between data producers versus data manipulators is related to issues of data sovereignty which I will unpack in the section on CDS.

5.2 IT and work

There is no doubt that the captain's work and responsibilities have shifted as changes in governance and infrastructure continue to unfold in the Icelandic fishery. Looked at individually, each of these changes or tweaks may not lead us

to think much of it. Stepping back, however, a pattern of increased surveillance and remote control at work through various work processes through IT starts to come into focus. This, I argue is one of the biggest changes in the work for the captains as IT has entered their workplace.

In the following sections I will highlight the areas in which these changes have unfolded. Starting with Control through IT, I demonstrate the history of control in the workplace has revealed concerns with deskilling and abstraction. In the case of the captains, for instance, my findings indicate a more complex series of consequences.

Control through IT

There is a long history of IT being used for control of work and workers in the work environment (Barley, 1990; Kling, 1996; Levy, 2014; Suchman, 2002; Braverman, 1974). In the context of industry and blue collar labor, this control can be accomplished through automation and abstraction (Zuboff, 1988). That is, by introducing automation into the workplace, work processes will shift and restructure the work environment such that it requires less craft or skill on the part of individual workers (Barley, 1990; Braverman, 1974).

As the work becomes less skilled, the autonomy of the worker is reduced through limiting potential for decision making (Zuboff, 1988). That is, narrowing the scope of the work that requires independent thought and problem solving results in the worker being manageable. This particular aspect of automation has been described as deskilling, where local or experiential knowledge is encoded in the automatic processes (Braverman, 1974). Outside of blue collar

and industrial type work, however, Barley argued that these deskilling effects of IT at work were lessened, or at most temporary (1990). That is, *the context* in which the IT is used, *how*, and in particular *by whom*, matters.

As IT and data have taken the center stage in the bridge on board fishing vessels, there are certainly some aspects of the work that have been rendered more abstract (Zuboff, 1988; Braverman, 1974). For instance when it comes to steering a fishing vessel, the captain no longer stands at the helm, but can adjust the speed and direction on a computer monitor. The act of steering is no longer experienced through physical turning of the rudder, but instead becomes abstracted through the pushing of buttons and turning of knobs. The captains' experience, however is changing far beyond just abstraction. While Zuboffs paper mill workers experienced a great deal of changes in their workplace, their overall tasks did not change (1988). The paper mill workers were still in charge of specific aspects of the paper making process. The captains, on the other hand, are experiencing an increase in administrative and coordination tasks *in addition* to their traditional sailing and fishing tasks. That is, one consequence of the increased focus on IT in the fishery is that captain's work now contains white collar and blue collar aspects.

This may sound neutral or even positive - after all, white collar work is associated with more pay, more autonomy, and higher social status (Zuboff, 1988). However, the captains do not reap any of the benefits that traditionally come with this kind of a shift. If anything, they feel increasingly under surveillance and subject to orders from management, marketing and sales on land - or "landlubbers meddling" as they would call it - informing them of changes in the itinerary regarding what to catch and so on.

I would argue that deskilling is too simplistic a term to describe the changes that are happening in the work of the captains, although as we have seen, the changes in their work are significant. While there are some aspects of the work that are disappearing or being replaced with automation, deskilling does not capture the complex shift in power dynamics that is unfolding at the same time. This is where Barley's (1990) contextual distinction comes into play. The context in which IT is introduced matters in the effects it will have. Barley also argues that when we introduce IT into the workplace, we see shifts in how the workers relate to their supervisors and crew. In the case of the captains, this relational change manifests in what I termed as powder blue collaring (Chapter 3). That is, the captains are being squeezed from both above (management) and below (crew) through increased visibility and accessibility in their work.

One example of this is the automatic monitoring of vessel locations, mandated for safety reasons. In Chapter 3, I argued that one unintended consequence of this particular use is Captain SB's wife and colleagues checking in on him as he is out at sea. While Captain SB may not see this as a particularly egregious invasion of his privacy, it is not a big leap to imagine a more fiercely competitive environment where Captain SB may change his mind. While his wife's surveillance of his ship is a welcome benefit which lowers her anxiety when he is out to sea, a competitor's monitoring of his location potentially threatens his and his crew's economic livelihood. It is not just about surveillance, then, but about the context in which the surveillance takes place and why that determines the ultimate effect (Barley, 1990; Orlikowski, 2000). In the case of Captain SB, he is a mostly independent fisher who owns his own vessel and the quota share in company with his two brothers. For Captain SB there is no management to contend with. For commercial captains like Captain M or Captain K, however,

the same technology - AIS vessel tracking - has radically different implications.

While all vessels in the Icelandic fishing fleet are required to be registered and trackable via the AIS, it is not until the captain of the vessel is working in a context where he has to answer to management on land, that this particular aspect of IT-as-control is revealed. Like we saw in Chapter 3, not one of the captains I spoke with wants this particular technology to go away, personal safety while at sea trumps concerns regarding privacy in that regard. However, this particular technology in conjunction with communication technology have made their work practices visible in new and differents way than just being dots on a radar screen or a map.

That is, to someone like S, whom we encountered in chapter 3 (in "Reporting the catch: Moving from paper logs to digital data entry"), who is intimately knowledgeable about the fishery, seeing one of "her" captains' vessels in an area that is rich in a particular stock means a very specific thing other than just the location. For instance, this particular captain would be in a good place to fill an order for the stock. Or, if the captain has no orders for that stock, then what is he doing there? In following up, by calling the captains, S is orchestrating some aspects of her work which aim to optimize the fulfillment of orders. However, she is also contributing to what the captains see as "meddling."

Autonomy and remote control

Relying on the informating aspect of coordinating technologies is not unique to the Icelandic fishery (Zuboff, 1988; Yates, 1993). It stands out as we observe the captain's work, as this particular aspect of surveillance happens from afar,

but its impact is experienced very locally or personally (Suchman, 1995; Zuboff, 1988). Studying long distance truckers, Levy found that through the use of Electronic On Board Recorders (EOBRs), aimed to prevent the truckers from driving to the point of exhaustion or beyond, the truck drivers now have to contend with their day to day work practices, whether they are driving or resting, being visible to managers (Levy, 2014, 2015).

As is the case with the captains in the Icelandic fishery, this level of managing in the day to day goes against what may have initially drawn them to this particular profession. Both professions are strongly associated with hypermasculinity, autonomy and aggression in a physically demanding (and sometimes dangerous) work environment (Levy, 2016). I believe that the key factor in determining how or to what extent the captain is impacted by these changes in the work environment is the social context in which this change is happening. That is, how are the roles and relationships with superiors and crew members shifting? Further, to what degree is the captain still seen as an authority of his work?

Local vs. Expert Knowledge

Being observed and managed from afar also speaks to the issue of local versus expert knowledge (Wynne, 1992). As Captain K lamented in Chapter 3, in regards to this kind of interaction: *"Sure, the vessel owner is the big boss, but this is getting to be too much..."*. That is, he recognized his place in the organizational context, that of a captain on a ship owned and managed by a corporation. However, what management may have seen as simply doing their jobs, K saw

as "meddling" and overstepping their boundaries. Later on in our conversation, the issue of localized knowledge versus remote knowledge came up. To Captain K, knowing where the vessel was on a map and being able to read about the weather conditions online was simply not the same as physically being *there*.

To the Captains, this difference between embodied experience and remote knowledge amplifies the negative aspect of being managed from land. This tension between localized and remote knowledge, or local versus expert knowledge is not uncommon in professions where there is a great deal of applied craft and hands-on learning on the job as in fishing, farming, or livestock management (e.g., Eythórsson, E, 1998; Johannes, Freeman, & Hamilton, 2000; Odom, 2010; Wynne, 1992). That is, as these professions become more industrialized, the captains and farmers are subject to more management of their domain, changing how they relate to people around them in the workplace. In the next section I look at how IT and data at the center of the fishery speak to the field of CDS.

5.3 Implications for Critical data studies

Since doing my fieldwork, a new field that critically engages with the implications of data has emerged. This is the field of critical data studies (CDS). Like the long tradition of IT being used to monitor work and workers, there is a long history of "governments, science and citizens producing and utilizing data in order to monitor, regulate, profit from, and make sense of the world" (Kitchin, 2014, p xv). It is not until fairly recently, however, that we are beginning to grasp the sheer enormity of data that is being created every day, all over the

world (Crawford, 2014).

Kitchin and Lauriault frame CDS as "research and thinking that applies critical social theory to data to explore the ways in which they are never simply neutral, objective, independent, raw representations of the world, but are situated, contingent, relational, contextual, and do active work in the world." (Kitchin & Lauriault, 2014, p. 7)That is, rather than looking to ways in which data can provide information in the aggregate, work in this field is committed to understand the variety of complex implications of data and to focus on data in a socio cultural and economic sense.

In their introduction to a special issue to Big Data Society devoted to CDS, Iliadis and Russo (2016) highlight the kind of work that has been addressed with a CDS lens. This "loose knit group of frameworks, proposal, questions and manifestos" deal with a variety of themes that all speak to Big Data science, addressing topics ranging from environmental issues, food and agriculture, and governance (Iliadis & Russo, 2016).

With regard to the Icelandic fishery, then, it becomes very clear that my work speaks to the kinds of concerns and research questions that are prominent in the CDS community at this point. Either by reaffirming some of those concerns for this particular group (e.g. regarding surveillance) or by bringing up alternative angles, or new sets of questions for scholars of CDS to consider (e.g. regarding data sovereignty).

So far, most CDS work is grounded in research on social media, consumer activities and workplaces. That is, the primary concern is the datafication of people and their behavior. This dissertation looks at how other things - fish

- become datafied. What does it mean for concerns regarding surveillance or privacy when the data in question is not just about people? Further, how do we approach the issue of participation and sovereignty of data when it comes to data creation for work that has implications outside of work?

I have identified two areas in particular, where my work is poised to make a significant contribution in framing and shaping the field going forward. These are broadly construed as privacy and surveillance, and data work and sovereignty.

Privacy and Surveillance

A central concern in research regarding CDS is the erosion of privacy and increase in surveillance tactics afforded by the datafication of most all aspects of our lives (e.g., Kitchin & Lauriault, 2014; Levy, 2013; Levy & Barocas, 2017). In the case of the Icelandic fishery the issue of privacy at work presents itself in ways that are slightly different from the concerns presented by Ajunwa, Crawford, and Schultz (2017) or Andrejevic (2009). Let's consider the different experiences of Captain SB, the independent fisher and Captain M, the commercial trawler captain.

As we saw in Chapter 3, captain Captain SB is an independent fisher in the small fishing village of Víkurbyggð. He is in fierce competition with other fishers in his fishing village and nearby. By being required by law to have his vessel's location automatically broadcast in the fishery, coupled with the public listing of auction data regarding the catch, whatever competitive edge Captain SB would have in terms of coming across a school of fish is removed. This

happens through a process that is intended for Captain SB's safety but has been appropriated by his competitors as well. I argue that we need to think about this particular example in the context of what it means to work in a profession that is increasingly under scrutiny. While Captain SB was good humored about it, and presented funny anecdotes about unanticipated ways in which this particular technology could be used, Captain M had the opposite reaction, getting visibly annoyed when receiving calls from management on land, requesting changes in his work plan or similar.

This comes back to IT as control at work and how Captain M feels this intrusion into his work practices to be very detrimental. The AIS then, is an example of a technology that on one hand is an invaluable life saving tool and on the other hand, a tool that is increasingly being appropriated to surveil the captains as they do their jobs. As such, the technology gives supervisors and managers access to a much more fine grained account of what the captain does while at sea - making the captain's work processes visible and thus available for further scrutiny and input.

This speaks to the point brought up by Sewell and Wilkinson (1992) that in some instances it is less about being surveilled at work, than it is about the ability to make the work processes one's own. That is, an unintended outcome of this visibility is that to the captains it feels as if they are increasingly being asked to relinquish control of their work, and by extension their authority and expertise. The surveillance then, is not a problem due to privacy being invaded, but rather that it can lead to situations where the autonomy and power of the captains is being challenged.

Data work and sovereignty

Research in the area of "Data work and sovereignty" relates to the kind of work that accompanies goes into and around data, that is, the work of the creating, maintaining, interpreteting, and manipulating of data. This area is grounded in arguments that data are man-made and have material aspects (e.g., Gitelman, 2013; Bowker & Star, 2000). Further, research in this area defines data as locally constituted and shaped by a myriad of factors that are outside the technical context (Levy, 2014, 2015, 2013; Passi & Jackson, 2017; Pine & Liboiron, 2015). That is, data does not exist in a digital form only. The digital is often preceded, and shaped by material practices. Finally, there is a momentum to develop new methods to understand better "the socio-material constitution of data objects and flows as data move between different sites of practice," or *data journeys* (Bates, Lin, & Goodale, 2016, p 1). Building on the sustainability literatures and the notion of food sovereignty (Norton et al., 2017), I refer to this as *data sovereignty*, which can be understood as a critical engagement with issues regarding who has access, and who is impacted by the material, social, cultural and economic aspect of data.

Data makes the world go around today. From social media data being mined and manipulated to further political agendas (Granville, 2018), to optimize our living arrangements (Hill & Mattu, 2018) to managing access to a natural resource like in the Icelandic fishery, data touches on most all aspects of our lives in some form. It is easy to understand the appeal of data when collected in such amounts, the common lore regarding data is that having more data implies more knowledge or insight (Dourish & Bell, 2011; Kitchin, 2014; Mosco, 2005).

boyd, and Crawford (2012) describe this appeal as one defining aspect of Big Data as a cultural phenomenon: "the widespread belief that large data sets offer a higher form of intelligence and knowledge that can generate insights that were previously impossible, with the aura of truth, objectivity, and accuracy." (boyd & Crawford, 2012, p. 663) That is not to say that Big Data is not capable of providing us with great insights regarding the phenomena they are applied to. Mosco (2005), argues that while it is important to recognize that some stories about technology and Big Data are myths, it may be more interesting to understand in what ways they motivate us.

The Quantified Self (QS) movement [2] is an example of the ways such data stories motivate us. Driven by the desire to manage their health, QS proponents wear a mix of self-monitoring gadgets and sensors[3] to gather data on physical activities and sleep patterns, as well as logging what they eat and so on (Neff & Nafus, 2016). Armed with this data, the premise is that the individual is in charge of their (good) health, being able to tweak their activities to live their best lives, as it were.

Williams (2015) presented a beautiful account of his own quantified journey and the work (emotional and physical) required on the way. He illustrated with empathy both the allure and pitfalls of the rationalizations that undergird this activity - noting the struggle he had with coming to terms with his skepticism as a critical scholar, and as an individual genuinely wanting to lose weight and lead a healthy lifestyle: "*While I remain cautious of the approaches of many of these systems, I learned that my conflicted position need not be hypocritical, and reflects the joys and capabilities that can be found in reduction, and the freedom to be found in*

[2] http://quantifiedself.com/, https://www.economist.com/node/21548493
[3] A common example would be a Fitbit: https://www.fitbit.com/

control." (Williams, 2015, p 129)

In addition to the allure of control and more information, it is also easy to forget that all data are artificial, in a sense. While data may *represent* real phenomena in the world, they are no more than a collection of facts and statistics that have been created with specific purpose in mind (Gitelman, 2013). In chapter 2, we saw that data created through the UFM process is essentially no more than a before-and-after measure of a piece of fish as it is moved through a processing line. What complicates matters further is the fact that data can be - or always is? - political (Bowker & Star, 2000). That is, through being man-made and created with a particular purpose in mind, data represents man-made categories and classification schemes designed to further some agenda or exclusion or inclusion (Bowker & Star, 2000).

Bowker and Star's (2000) examination of the classification scheme for homosexuality in the Diagnostic and Statistical Manual of Mental Disorders (DSM) is a powerful illustration. While simultaneously making homosexual people visible (and thus fit to be made into data) by way of "diagnosing" their sexual orientation, the act of this classification also pathologized homosexuality, rationalizing further discrimination against gay folk at the time (Cooper, 2004; Zucker & Spitzer, 2005).

But what do these assertions regarding data mean to the Icelandic fishery? Why is it important to underscore the man-made and political nature of the data that is used to govern a natural resource? If the Quota is based on marine wildlife data and statistical models, how can it be man-made or political?

First, in looking at the UFM process in Chapter 2 we have a striking example

of the literal creation of data. Not only does the UFM process demonstrate the "unnatural" aspect of the data in the fishery, it also provides a reminder that no matter how clean or crisp the data will look in spreadsheets and data models, the source of the data - in this case, fish - is always grounded in an unruly, messy reality.

Second, in Chapter 4, we saw how data is used to govern the resource so that it is sustainable. By not framing this data as man made or artificial we stand at risk to equate *the idea* of this data about the fishery - any data, "good" or "bad" - with the sustainability of the fishery itself. That is, the act of collecting or creating data will then *stand in* for activities that are more likely to facilitate the fishery being sustainable in the long run.

Third, the political nature of the data about the fishery is less about the fish it represents and more about the ways in which the data can be used after it has been created. Fishermen and captains are not only creating data through most aspects of their daily activities at work, they are also affected by how this data is interpreted and used to govern their livelihood. Being the first in a long chain of people who touch the data as it moves from the initial instantiation as UFM data, the fishermen and captains disappear from view and are replaced by specialists and expert data modelers, engineers and politicians manipulate this data to make decisions regulating the fishery - and by extension, these mens' livelihoods. This is similar to what happened in the case of the Cumbrian sheep farmers as presented by Wynne (1992). In that case, the conflict was regarding how to interpret scientific evidence regarding radioactive waste in rain from the Chernobyl disaster and how it would affect livestock farming in the area of Cumbria, England. Information, warnings and feedback from local farm-

ers were ignored in favor of scientific advise, resulting in a tremendous loss of income for those farmers, and fractured relations between the scientific community and the general public. In the case of the fishery, like in Cumbria, local knowledge is less important than expert knowledge.

In chapter 4, I unpacked a feedback loop between data and new forms of governance. This loop, I argue is fueled by the mythology and promise of data and IT as a tool for a sustainable, optimized future. By accepting the power of the mythology to motivate this feedback loop, we become more aware of the pitfalls to which such a mythology could also lead. One of these would be framing sustainability as an issue to be optimized through simplified metrics resulting in an increased focus on gathering *more* data rather than changing policies or incentives in the resource management system. That is, similar to the argument presented by Scott (1998) and Brynjarsdóttir et al. (2012), this narrowing of vision means that we are blind to other ways in which we could be addressing the sustainability of the fishery for instance.

As is, the system is weighed to favor central, largely commercial, producers rather than individual, smaller scale fishers. Centers for production have shifted to larger urban areas as a result of the ITQ aspect of the Quota. Additionally, by simply mandating specific technology to be used for participation in the fishery (AIS, ECL), the system has raised the bar for participation through money. This required hard- and software can be prohibitively expensive to buy and to update.

This particular point was explained to me by informants like independent fisher OA. However, it is not just small scale fishers who experience this particular aspect, even mid-sized commercial vessels' bridges have a bric-a-brac feel to

them, where some of the technology in the bridge is upgraded but not all. Reminiscent of arguments for bricolage in design approaches (Vallgårda & Fernaeus, 2015; Vallgårda, Grönvall, & Fritsch, 2017), or heirloom status and designing for non-obsolescence (Blevis, 2007), this study reinforces the need for information scientists and designers to pay increasing attention to how their technological interventions and innovations can be developed to both work with pre-existing systems as well as systems that stand the test of time. Otherwise such technology development risks further exacerbating global economic divides.

5.4 Limitations and Future Work

It is increasingly clear that data has become one of the more important currencies in and out of the workplace. The datafication of the Icelandic fishery provides an example of some of the implications that an intense data focus brings out. In particular, I have demonstrated cascading changes that have taken place in work processes and infrastructure surrounding the fishery from the perspective of the fishermen and captains. These changes, I have argued, are both intended and unintended consequences of changes in the governance structure in the fishery.

This work is focused on the perspective of fishermen and that of captains. Thus there are a few voices missing from this account. For instance, my work does not examine in depth, the experiences of people on the "other side" of the changes in the fishery, such as people working in fishing companies on land, administrators with the government, policy makers and others. Further research into how the datafication of the fishery has unfolded from land is warranted.

As an example, we have seen that there have been major shifts that include an increase in paperwork and reporting-related tasks for the captains. It is reasonable to think that these shifts are being felt by government administrators whose roles include tasks like the coordination of these reports, data aggregation and analysis, and other regulatory enforcement related work. It remains to be seen whether these roles are born out of the need to manage a recent swell of bureaucracy and administrative tasks on land, or if existing roles have been subjected to similar strains as we saw in the case of the captains.

Another group of actors missing from this account is marine biologists working with the MFRI. As a group, these professionals are often equated with the MFRI by my informants and by extension are seen as inflexible and insensitive to immediate concerns of captains and fishermen in their day to day activities on board. Their perspective on the way the Quota system has unfolded in concert with new ways to monitor the fishery is an essential addition to this story and will have to be looked at in more depth. Finally, related to the area of data sovereignty and data journeys (Bates et al., 2016), this dissertation has presented the very beginning and creation of data as it is created on board a freezer trawler in the north Atlantic (Chapter 2). This data then reappears as it is being used to create models for future fishing activities (Chapter 4). I can not speak to the work that went into managing this data between those two points in the process.

From what I can see in the work that went into creating the data, and the kinds of mistakes, changes and "fudges" that were alluded to as the data was being prepared to be reported upwards, there is a very rich research opportunity in following data in the fishery all the way to the desk of a government of-

ficial on land, working on quota allocations for the upcoming year, for instance. Much like missing voices from administrators and marine biologists, the complete journey of data about fish remains to be unpacked. Doing so would illustrate very concretely the man made nature of data, how data amasses additional meaning and purpose as it moves through the network of people who touch on it in one way or another for their work. In addition to making these often invisible aspects of data more visible, I believe that the lens of data journey could be a very fruitful way to understand further the implications of the inequality between the data creators (fishermen, captains) and data administrators, and hopefully help to bridge that gap.

5.5 Final Summary

As I was starting to formulate plans for this work, I would time and time again be asked two kinds of questions. One was what kind of system I was going to be designing as a result of my fieldwork. The other was how I was planning on learning anything about sHCI from Icelandic fishery. This dissertation should provide the answer to both of these questions in long form. The following is a more structured, and to-the-point answer.

First, my intent with this work was never to gather information to build a system of any kind for the fishery. In fact, I agree very much with Dourish's (2006) argument: Ethnography is neither a requirement gathering tool, nor a helper method towards designing systems within the field of HCI. Rather, I saw the potential of ethnography for providing insights that go beyond design implications. Such ethnographic interventions do not immediately result in tech-

nological solutions. Instead the goal of such interventions is to problematize the intersections of IT with the "wicked problem" of sustainability.

Indeed, as the first few days of my fieldwork passed, I became even more convinced that embedding more IT into the context of the Icelandic fishery would not add anything other than more noise - or smog (Shenk, 1997) - to a situation already overloaded with information. As it turns out, it is unlikely that there will ever be an app to address sustainability when it comes to the context of natural resources and our use (or overuse) of them.

I argue that the case of the Icelandic fishery provides an example of the messy, man-made reality of data. Further, this case is an example of the many unintended consequences that happen when data and technology are framed as solutions to complex issues like the sustainability of a natural resource. The value of ethnographic work like mine, then, is to highlight these issues.

To demonstrate this, I will return to data from my fieldwork, coupled with a recent development that has taken place in the Icelandic fishery. As I demonstrated, one of the many ways the Icelandic fishery is through landing reports and the ECL. One goal of these reports is to ensure that if a vessel comes to shore with catch that is over the allowable quota limit, the quota owner will be gets a heavy fine. It would then seem straightforward that each captain then watches what is coming on board to make sure to stay within the limits through curtailing their fishing efforts or relying on their knowledge about the fishery - e.g. what is likely to come in the bag depending on where the vessel is.

However, when I witnessed the act of a crew-member throwing overflow catch overboard in the summer of 2009, I realized that the "official" story of the

success of the natural resource management efforts in the fishery may be missing a significant part of the reality of day-to-day fishing practices. The captain, without directly agreeing to allow his crew to engage in this unlawful activity, casually explained to me that everybody did it, since in spite of 'avoiding' cod - that is, going to fishing grounds where cod is less likely to be at - it still showed up in the nets.

Discarding catch that is over the limit in this way has continued to be an issue that peaked in November of 2017 when videos showing systemic discarding taking place on a large commercial vessel were "leaked" to the media in Iceland (Seljan, 2017; Seljan & Kjartansson, 2017). The discarding that was happening in these videos was that of less valuable catch that had been caught earlier in the tour, to make space for more valuable catch.[4]

In response, the DF started the regulatory process to install video cameras on all fishing vessels in the fishery in April of this year. The goal with the video cameras is to remotely monitor and catch any perpetrators of discarding (Seljan, 2018). As I have demonstrated in this dissertation, the fishermen and captains are already under heavy scrutiny in their workplace in the fishery. I have demonstrated that these forms of surveillance are not without problems - for instance in the case of landlubbers "meddling" or in new avenues for competition through location based technology (AIS, Chapter 3). Further, the idea of adding non-stop video surveillance on board fishing vessels seems problematic to me based on Ajunwa, Crawford, and Schultz's (2017) discussion regarding the worker's right to privacy. This issue is particularly salient in the fishery due to the fact that when on board the fishing vessels for weeks and months at a

[4]To be clear, I do not believe that discarding is a practice that only fishermen or captains are responsible for. Rather, I believe that they are acting on directives from management on land, to bring the most valuable catch to shore.

time, the line between private and public is tenuous to begin with. Complicating matters even further is the possibility of the data in these videos being used to examine - and problematize - other behavior than initially planned (Puschmann & Burgess, 2014; Andrejevic, 2009), leading to further power inequalities and distrust between the fishermen and captains, and the fishery administrators.

I argue that the logic undergirding these actions on the behalf of the DF is the very same I have been unpacking in this dissertation. That is, that through IT and data - automatic video surveillance - the DF will be able to monitor these illegal activities, and prevent them from happening. Gathering more data on what is being caught and how, as well as monitoring discarding practices is not going to solve the dilemma of overfishing or discarding. I believe that by focusing on more data capture alone may propagate or deepen the disconnect between fishermen and captains, and the government. That is, what my research shows is that the issue of discarding less valuable catch, or catch that is over the limit, will not be solved with increased surveillance through video cameras. I posit a more grounded starting point is a closer look at the incentives and the regulatory structure that drive this kind of behavior.

As I mentioned in the beginning of this chapter, the field of CDS has emerged since I started my fieldwork. While CDS has arisen separately from sHCI, my case study demonstrates how issues around the use and proliferation of data are relevant to sHCI. I argue that CDS is an important ongoing resource for reframing efforts in sHCI to move a way from a too-simple reliance on data for control. Understanding what role data and datafication are playing matters for sHCI because this will allow us to understand what the kind of data driven systems that many in technology design are working towards. I recommend

critical data studies - in particular data journeys as defined by Bates (Bates et al., 2016) - as an essential touch point for sHCI researchers to reflect on and push forward the impact of their systems in the world. As this dissertation shows, the journey of how fish become data reveals the complexities regarding the datafication of natural resources, the actors and institutions working with them, and the structures of governance that emerge in response.

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