

Article

Ghosts of the Techno-Fix Ocean? A Short History of *Periphylla periphylla* in the Norwegian Fjords

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Abstract: In 1980, reports of deep-sea jellyfish blooms in Norwegian fjords led researchers to investigate the problem. The helmet jellyfish, *Periphylla periphylla*, has since migrated far north into Arctic waters. This paper examines what happened when the jellyfish blooms were noticed in 1980 from a historical and ethnographic perspective. It traces four research projects and business ideas that proposed solutions to the jellyfish problem and asks how they are representative of the ways in which humans meet the challenges of anthropogenic climate change. The paper concludes that the jellyfish problem was met with a “techno-fix” attitude that sought to “turn a problem into a resource”, which eventually leads to what Julia Livingston has termed “self-devouring growth”. In a final outlook, the article asks how we can engage with questions of conservation from a humanities perspective and concludes that the jellyfish story can help us to ask questions about “conservation for whom”.

Keywords: jellyfish; conservation; alien species; history of marine resources; ocean history; Anthropocene ocean; *Periphylla periphylla*; jellyfish bloom

1. Introduction

The book *Arts of Living on a Damaged Planet*, an anthology of essays by scholars across the humanities and sciences, opens with the words: “The winds of the Anthropocene carry ghosts—the vestiges and signs of past ways of life still charged in the present” (Gan et al. 2017, p. 1). This article seeks to study such a “wind of change” while it blows and to explore some of the ghosts it carries with it into the future. This paper deals with the mass appearance of a so-called “invasive species” (see Russell et al. 2014), a deep-sea jellyfish (see Figure 1 below), in Norwegian waters (Tiller et al. 2015, 2017). Faced with evidence that dramatic changes were happening along its coast, how did the country react to the jellyfish, and where are they now?

In the following, I will examine the roles that the fishing industry, researchers and the government took when they noticed that something had changed in the fjord ecosystems with the arrival of *Periphylla periphylla* from 1980 to 2021.

The newly emerging paradigm of conservation humanities aims at uncovering conservation stories from a multidisciplinary environmental humanities perspective. Is the jellyfish case a conservation story? And if so, what was supposed to be “conserved” in its wake, and for whom? This article seeks to contribute to the paradigm of conservation humanities and gives an example of how to think about conservation by examining a local case of an emerging “alien species” from a contemporary history perspective. I use historical methods inspired by my journalistic investigation to examine a local Norwegian case of a jellyfish invasion and place it into a larger, international context in which addressing and dealing with “alien species” is a growing concern (see Cuthbert et al. 2021; Tricarico 2016).

One strength of the humanities is the ability to examine concepts, frameworks or solutions that are often accepted without further questions by policymakers or in the public debate at large. I am interested in the approaches taken by both scientists and policymakers in responding to react to the jellyfish migrating to the north. By viewing the jellyfish as



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“ghosts” of the future ocean instead of through the lens of the alien species concept, I want to inspire new ways of thinking about human responses to anthropogenic changes in ocean environments. The jellyfish serve as a perfect example. Their appearance is unwanted from a human viewpoint, and therefore, they are treated as pests. In reality, they are primarily a symptom of ongoing changes in ocean ecosystems all around the world. They foreshadow a possible future ocean scenario in which jellyfish will thrive, and other organisms might disappear altogether. In that role, they are ghostlike forerunners of a possible future ocean that humans do not want.



Figure 1. *Periphylla periphylla* known as the helmet jellyfish. Illustration Reviel Meyer.

2. Concepts and Material

This article is inspired by a journalistic piece I wrote in 2018 about an experimental seafood firm set up at the outskirts of rural central Norway (see [Meyer 2018](#)). The firm

intended—and failed—to turn snails, sea cucumbers and eventually jellyfish into food for human consumption. It is the first case that I discuss in a later section about the various research projects that were proposed to tackle the jellyfish question. It started as a peculiar story about a businessperson's quest to process new kinds of seafood in Norway and turned into a much larger and more complex issue that reaches far beyond a single business idea gone awry. I identified an interconnection between research, industry and government that highlights a problem of global relevance, which deserves to be examined from a contemporary historical perspective. The way the jellyfish problem was dealt with confirms a problem that is symptomatic of the Anthropocene, and one that has been recognised by many other scholars who study how human activity plays out in different settings in the Anthropocene ocean (see Duarte et al. 2021; Probyn 2016). Julie Livingston writes in *Self-Devouring Growth*: "When people are thinking about a place in this world and how to improve it, immediately they/we assume that growth must be the basis of that effort" (Livingston 2019, p. 4). If growth in the Anthropocene is the imperative to "improve a situation" or fix a problem, how is growth achieved? For this, the concept of the "techno-fix" is paramount (see Johnston 2020).¹ The growth that humans often seek to achieve in order to improve a situation is facilitated by technology. The story about *Periphylla periphylla* in the Norwegian fjords neatly illustrates these mechanisms of the Anthropocene. While I was researching the jellyfish case, I met with both of these concepts: "self-devouring growth" (Livingston 2019) and the "techno-fix" (see Johnston 2020).

The source material that highlights the mass occurrence of *Periphylla periphylla* in the fjords comes mostly from regional news outlets like NRK Trøndelag², Trønderavisa³ and Adressavisen⁴, but the national newspaper Dagbladet⁵ also picked up the story of the invading jellyfish when researchers became more vocal. As part of my work on the news article, I conducted interviews with researchers and representatives of the industry. The information gathered through these interviews inspired me to investigate this case from a historical perspective (Meyer 2018). Other important sources for insights into the discourse in the local industry and research community were niche publications like *Universitetsavisa*⁶ and *Norwegian SciTech News*,⁷ which publish on research from the Norwegian University of Science and Technology (NTNU) and SINTEF. I used these various news outlets to study how issues concerning the jellyfish came into the public sphere and then seeped into government reports over a period of years as the problem became more visible. I also noticed that scientific publications about *Periphylla periphylla* appeared both simultaneously with and as a consequence of the news of a new species arriving in great numbers in the fjords. For my research, those articles have had two functions: to gain an understanding of the actual ecological problem and to observe how the research community reacted to a perceived ecological threat. Additionally, I kept track of different research projects that were launched in connection with the jellyfish problem and also with related issues like the harvest of "little-utilised resources".⁸ Another important source for understanding the interaction between research, industry and government included government- and industry-funded reports on the *Periphylla periphylla* problem. Finally, I studied government reports about marine resources at large in Norway from the relevant period to examine the country's national goals as a seafood nation.

3. *Periphylla periphylla* Arrives in Norway

The helmet jellyfish is a peculiar creature. It is red in colour and not as mushy and fragile as other species, like the translucent moon jellyfish. Instead, helmet jellyfish have comparably solid bell-shaped bodies and twelve stiff tentacles sticking out from under their "helmet"-like arms ready to grab their prey. Individuals have been found that were believed to have reached 30 years of age (Bazilchuk 2016). They thrive deep in the ocean and avoid direct sunlight.⁹ Until recently, the species was common in waters not further north than the southern part of the North Sea.¹⁰ In the 1980s, however, things started to change. Researchers noticed that helmet jellyfish had started to migrate to Lurefjorden, close to Bergen on the southwest coast of Norway, and began studying this phenomenon

(Mork 2017, p. 93).¹¹ They discovered that the species had begun to move northward. From 1980 up until today, individuals have surfaced and established solid populations in several fjords along the Norwegian coast, some as far as north as Bodø above the Arctic Circle (Mork 2017, p. 94). In recent years, sightings have been recorded as far north as the Svalbard archipelago.¹²

The arrival of the jellyfish in the inner Trondheim fjord is well documented and therefore serves as a good example of how researchers, the government and the fishing industry dealt with this event. In the 1990s, the helmet jellyfish started to appear in the nets of biologist Jarle Mork at the Biological Station in Trondheim. He had been monitoring the cod population in the inner fjord of Trondheim, called Verrabottn and Verrasundet.¹³

The jellyfish appeared as a by-catch and soon found themselves lured into a research project that was originally about the management and regulation of and genetic variation in the cod population in the innermost parts of the Trondheim fjord. Mork found that the cod population declined with the arrival of the helmet jellyfish (Mork 2017, p. 94). Although he was unable to link this decline directly to the jellyfish at the time, he and his colleagues argued, in an article titled “To Adapt or Not Adapt: Assessing the Adaptive Capacity of Artisanal Fishers in the Trondheimsfjord (Norway) to Jellyfish (*Periphylla periphylla*) Bloom and Purse Seiners”, that there was a strong likelihood that the two findings were related (Tiller et al. 2015, p. 267).

Similar findings were reported by fishermen, who were asked to share their experiences with the jellyfish for a study that was conducted in 2014 (Tiller et al. 2015, p. 268). Researchers distributed a questionnaire in which they asked fishers to provide log book information about changes in their catches (see Tiller et al. 2015, p. 262). The results, combined with data from bottom trawling conducted by the researchers, suggested that the jellyfish population had been established for good in the inner fjord around 1998 or 1999 (Tiller et al. 2015, p. 267). The correlation between the increase in jellyfish and the decrease in cod could be explained by the jellyfish’s ability to outcompete cod and other fish for food. In some parts of the fjord, this has led to the jellyfish becoming the top predator in the ecosystem (Tiller et al. 2014, p. 76). By 2005, the advent of *Periphylla periphylla* in Norway had come to the attention of the media (see, for example, Hustad 2007; Kjerkreit 2006; Laukøy 2007). The jellyfish were becoming a problem, and researchers and policymakers began to discuss possible solutions.

4. Jellyfish Research—Business Ideas and Research Projects Intertwine

This section is not an exhaustive list of all of the research projects in Norway that have tried to tackle the *Periphylla periphylla* problem. Rather, it follows four selected projects over a period of about 15 years (from 2005 to 2021) that I found were initially motivated by the first pilot project, which involved the seafood firm Su San Norway AS that featured in my article (Meyer 2018). I selected the three follow-up projects either because they represented a clear continuation of the work of earlier projects, or the same institutions and some of the same researchers were involved. We will see that the projects range from taking a local perspective (Su San AS, LUR and JANUS) to a broader, more international scope (GoJelly).

4.1. Su San Norway AS—An Experimental Seafood Firm (2005–2008/2010)

Several newspaper articles were published about the arrival of *Periphylla periphylla*. They give an insight into the different solutions that were pondered publicly and an overview of those that were realised over the course of a few years. One suggestion was to monetise the jellyfish and make them a food resource. An experimental seafood production plant—Su San Norway AS—was established in 2005 by a Norwegian-Korean businessman named Lee-Chul Ho (Johnsen and Kothe-Næss 2005), widely known as the “Noodle King” in Norway for his brand of instant noodles available in every supermarket in the country (Rosenlund-Hauglid and Rognstrand 2018). Su San was set up on the island of Frøya at the outskirts of the Trøndelag municipality. Although this was not publicly announced or commented on by Lee, we can assume that the location was a strategic choice. The

region is famous for its farmed Atlantic salmon and as the birthplace of one of the biggest global players in the industry, Marine Harvest, now Mowi Salmon (see [Rye 2018](#), p. 194). In fact, the firm was established in parts of an abandoned factory building once belonging to Marine Harvest, which had moved its processing plant from Frøya to Poland in 2003 (see [Frøya Næringspark 2020](#)). Su San Norway AS, we learn from several newspaper articles, was exploring possibilities for processing unusual seafood like sea cucumbers, common whelk and potentially *Periphylla periphylla*. Perhaps because of the novelty value of such specimens for the Norwegian palate, several local newspapers published articles about those business meetings, one including an in-depth description of a jellyfish tasting ([Rørvik 2007](#)).

In the spring of 2005, businessmen from Korea were flown in by private plane to the little plant on Frøya to discuss possible common whelk exports (see [Walhovd 2005](#)). Lee Chul-Ho, the company's co-founder and front man (see [Johnsen and Kothe-Næss 2005](#)), advertised for the quality of Norwegian seafood. One article reported that "Mr. Lee does everything to promote Norway's purity in Korea. On national television, he has stated, "If you cut your finger in Korea, you buy disinfectant. In Norway, you just stick your finger in the water for two minutes".¹⁴ The article closes with the business associates already dreaming of building a bigger runway for the island's private airstrip, in order to be able to transport the common whelk and other seafood directly to Korea, instead of having to go via road to Gardermoen, the international airport in the south of Norway ([Walhovd 2005](#)).

The articles about the experimental seafood firm, together with Jarle Mork's reports about the invading jellyfish, seemed to spark a debate that inspired further business ideas and research projects on the topic. In 2007, the secretary of the Norwegian fisheries department talked about exploring the potential of experimental seafood, asking, "How to commercialise jellyfish and sea cucumbers?" ([Ulriksen 2007](#)). A newspaper published an article about "Monster Jellyfish invading the fjord" ([Eide 2006](#)), and an ad hoc research group was set up to look into "industrializing jellyfish" ([Pettersen 2007](#)). The entire enterprise culminated in a final report from the research group in 2010 titled "Jellyfish—From problem to resource" ([Jelmert et al. 2010](#)), stating that the proliferating jellyfish could create problems for other industries like fisheries and tourism. However, it added, they also had potential market value. The report contained a preliminary market analysis for marketing jellyfish as food. Another suggestion was to extract collagen from jellyfish bells and sell it to the pharmaceutical industry. Thus, the researchers concluded, "There lies an untapped potential to achieve win-win situations" ([Jelmert et al. 2010](#), p. 5). The report also contained a caveat: the research had solely concentrated on *Periphylla periphylla* in the Norwegian fjords and had not explored other jellyfish species. The report stated, "the knowledge about geographical distribution, occurrence, biomass and ecosystem effects of the commonly occurring species of jellyfish in Norway (the fire jellyfish *Cyanea capillata*, *Cyanea lamarckii* and the glass jellyfish *Aurelia aurita*) is deficient" ([Jelmert et al. 2010](#), pp. 8–9).

As part of my research for the 2018 newspaper article, I travelled to Frøya to see the seafood plant. When I got there, I soon discovered that Su San Norway AS was a failure. The experimental seafood endeavour never took off, the plant never went fully into production, and the idea to harvest jellyfish was at best a side note (see [Meyer 2018](#)). Perhaps Su San Norway AS was a useful industry contact, mainly for the researchers looking into the industrialisation of jellyfish, since the government encourages research projects with industry partners and a flagged relevance for society.¹⁵ The original business idea, I discovered, was to make money from common whelk exports—something another firm on the neighbouring island of Hitra, called *Hitramat*,¹⁶ had been somewhat successful in for a couple of years. The Su San project failed, though the reasons for that are mostly guesswork, since none of those who were involved in the project wanted to discuss it. Perhaps they could not garner enough interest among local fishermen; this was also the problem *Hitramat* faced when getting into the common whelk business ([Kvile 2017](#)). By the time of my visit to Frøya, Lee Chul-Ho was deceased ([Rosenlund-Hauglid and Rognstrand](#)

2018). But the failed experiment that started with researchers observing the ever-increasing jellyfish population in the Norwegian fjords and continued with an exotic business idea was only the start of a series of consecutive research and industry efforts that have unfolded in response to the arrival of *Periphylla periphylla*. Those follow-up projects can tell us more about how researchers, industry and government handled the appearance of the “alien” species. What the initial jellyfish food experiment by Su San did for the jellyfish problem at large was to make the public aware of the problem and the possible solutions for getting rid of it. In the following years, new projects were established to look into the issue from different angles.

4.2. Nofima LUR (Little-Utilised Species) Report (2000–2011)

In 2011, the Norwegian Seafood Research Fund (FHF) issued an additional report from the Norwegian food research institute Nofima assessing the status of so-called LUR species (Bjørklund and Henriksen 2011), LUR standing for: “Lite utnyttet ressurser”—little-utilised resources. The authors reviewed a collection of reports and presentations about LUR from 2000 to 2011 to examine the knowledge base and early work on these potential future resources.¹⁷ The LUR report is important in respect to the timeline of jellyfish-related projects, because it addresses the issue from the perspective of the fisheries industry. The report was meant to be a guideline for future research funding that could advance the industry. It also included a chapter about common whelk and jellyfish. The chapter on jellyfish is quite sober in comparison to the newspaper article that celebrated the idea of jellyfish as food. To some extent, Nofima’s conclusion is also more cautious than the research group’s report “Jellyfish—From problem to resource” (Jelmert et al. 2010) that had been published the previous year. Nofima concluded that instead of focusing on the commercialisation of jellyfish, “Greater attention should be paid to the ecological and socio-economic problems associated with jellyfish, and destructive fishing should be considered in some defined fjord areas” (Bjørklund and Henriksen 2011, p. 22). The authors nonetheless acknowledged that “this can also provide a basis for the development of commercial processes in the future” (Bjørklund and Henriksen 2011, p. 16). Instead of celebrating the jellyfish as a resource worth exploiting, the report recommends focusing on two other species: “sea urchins and flounder” (Bjørklund and Henriksen 2011, p. 3).

One consideration the authors make in the report is especially important: they state that many of the LUR species they studied could be harvested if fishers were willing to move over to those species. However, they found that fishers were less willing to do so, unless harvesting those species was to become more economically beneficial and easier to execute (see Bjørklund and Henriksen 2011, p. 3). This shows that the mere abundance of a little-utilised species is not incentive enough for fishers to begin harvesting those species, even though there might be a market for them, and even though there are companies like Su San AS who would be willing to sell the produce.

There was actually a pilot project, COJECT, that developed a prototype trawler with a shredder to collect and kill jellyfish, which would have had the potential to be used in the fjords where there were bloom problems. However, the technology was never patented, and I could not find any information on its whereabouts.¹⁸

4.3. JANUS Future Fisheries Scenarios (2012–2015)

The interdisciplinary project JANUS¹⁹ was funded by the Norwegian Research Council to examine the impact of the *Periphylla periphylla* invasion on the local fisheries in the Trondheim fjord. Leigh Bailey, a professor of sociology at NTNU in Trondheim and the project leader of JANUS, spoke to *Norwegian SciTech News* in 2016 about the findings: “If you were to shift fishermen to harvesting jellyfish, then resource managers are in the uncomfortable position of having to manage and protect an invasive species. Do you really want to maintain a stock of jellyfish, which is more of a nuisance species?” (Bazilchuk 2016). However, the project found that local fishers who were interviewed about their willingness to start harvesting new species, like jellyfish, indicated that they would consider

moving over to new species.²⁰ The researchers found that “Overall, the fishermen did not indicate being worse off because of the income loss from cod fishing, since it had been compensated by the income from other activities like increasing opportunities for emerging species, like crab and pollack or mussel farming” (Tiller et al. 2015, p. 267). In *Norwegian SciTech News*, Jennifer Bailey concluded about the situation of the cod fisheries in Trondheim that “they didn’t necessarily want to maximize their profits. What they really wanted was a reasonable lifestyle and for their profession to be able to continue” (Bazilchuk 2016).

The project contributed to understanding the challenges the industry would face in moving over to harvesting other species. Although it had a clearly local scope—the interviewees comprised a group of, respectively, four and seven small-scale fishers in the Trøndelag region that were impacted to varying degrees by the *Periphylla periphylla* invasion—it can still help explain how fishers view the move from one species to another. Although the LUR species report made some clear recommendations about new species to focus on, the report warned that a shift to other species could be challenging as long as the traditional fish stocks could still be exploited. JANUS confirmed this concern, but also showed that fishers would be willing to fish other species, as long as they could continue their work and have a stable income (Tiller et al. 2014). An interesting observation is that nowhere did the researchers mention that the fishers themselves expressed deeper concern for the ecosystem at large, despite the fact that some species seemed to be declining, which made it necessary to “fish harder” for other species. Instead, they were concerned about bigger trawlers from outside the fjord that were allowed to come into the fjord to fill their quotas.²¹

4.4. GoJelly—“A Gelatinous Solution to Plastic Pollution” (2017–2021)

From 2017 to 2021, NTNU was involved in a third project concerning jellyfish. *GoJelly* was a European Horizon 2020 research project looking to find “a gelatinous solution to plastic pollution”.²² From the project webpage, we learn that the aim was to build “microplastic filters made of jellyfish mucus”²³, which would result in “less plastic in the ocean and in turn more jobs for commercial fishers in off-seasons to harvest the jellyfish”.²⁴ The project also mentions using the “biomass” for feed in fish farms and exploring possibilities of human consumption.²⁵ This project was a European collaboration where the focus shifted away from the jellyfish problem in the Norwegian fjords and expanded to other species and areas. NTNU was involved in investigating the mechanisms and prediction of jellyfish blooms.²⁶ The project stated in its first press release that “the life cycle of many jellyfish species is only scarcely explored. Therefore, it is almost impossible to predict when and why a large jellyfish bloom will occur” (see [Press Release 1 n.d.](#)). The Trondheim section of the project’s research outcomes was mostly focused on predicting jellyfish blooms in the fjord and trawling it with the same research vessel—the *Gunnerus*—that had been used in the initial research at Trondheim biological station.²⁷ The team concluded with a long-term study where they showed that *Periphylla periphylla* had been recorded in Trondheim fjord already 100 years ago. Though they were described as invasive species in several publications, the paper raised the question of whether bloom events had actually increased, or whether they were simply more visible because of better surveillance technology (see [Aberle-Malzahn et al. 2023](#), pp. 59–60).

The project’s final conference was held in December 2021, where the main outcomes were presented. The topics of the presentations can be seen on the *GoJelly* website and the EU project website and include the following: *sustainable jellyfish fisheries, aquaculture, tracking blooms, cosmetics, food processing, jellyfish fertiliser, micro- and nanofilters and jellyfish as fishfeed*.²⁸

GoJelly also launched an educational strategy game produced by the Centre for Ocean and Society in Kiel—an interdisciplinary research platform that involves societal actors in projects.²⁹ In the game, the player is led through a fictional coastal town with a once-booming tourism industry that is plagued by a jellyfish invasion. In the role of the mayor, the player must make choices to address the jellyfish problem in cooperation

with the town's science facility. Possible solutions include manufacturing jellyfish burgers, increasing jellyfish fishing and establishing jellyfish aquaculture on land. The beaches become pristine again, leading to an uptick in tourism, which then causes an increase in microplastics in the drinking water. This problem, in turn, is solved by a scientist inventing a filter system using jellyfish mucus. Nowhere in the game is the underlying cause of the jellyfish bloom addressed other than one section, where jellyfish fertiliser is used to decrease the flow of nutrients from agriculture to the coast, which in turn leads the scientist to come up with jellyfish aquaculture to meet the need for more fertiliser. The game illustrates the issue at hand: the focus is to make society grow and prosper with the help of ingenious scientists, who turn jellyfish from a problem into a resource.

I doubt that it was the intention of the game's designers and the scientists involved in the project to give a performance of the "techno-fix" (see [Johnston 2020](#))—the idea that any problem can be solved with a new invention. Solutions inspired by the techno-fix attitude, however, fail to take into account that any technological solution needs to be maintained, and that new problems can arise from new technology, which then require yet another new techno-fix. Journalists Naomi Klein and Elizabeth Kolbert have both published books about recent examples of techno-fixes and the controversies surrounding them ([Klein 2015](#); [Kolbert 2021](#)). Klein argues that climate change itself is often approached with a techno-fix attitude fuelled by our capitalist system (see [Turner 2014](#)). Kolbert presents a number of different examples in which the techno-fix approach was used to reverse environmental degradation. She mentions, for example, an Australian research project in which coral eggs and sperm of different species are mixed in the hopes of creating a sturdy coral that can withstand a more acidic ocean. In an interview, Kolbert explained that this relatively low-tech attempt is one step on the slippery slope of techno-fixes that are well intended; some may even work, but some could have harmful consequences. This concept extends to ideas such as dimming sunlight, hence the title of her book, *Under a White Sky* (see [Osaka 2021](#)). What unifies all the techno-fix approaches is that it is difficult to foresee their consequences.

Techno-fix ideas keep society in a never-ending forward-looking loop. It is an appealing approach, because the techno-fix does not require uncomfortable change; instead, we can continue to buy into the idea of never-ending growth facilitated by future technological solutions to the current environmental crisis. An alternative approach when developing the game could have been to focus on the underlying causes of the jellyfish blooms and to have the player find solutions to counteract those. A game like this would have had a less linear trajectory and would have been more layered and complicated. I want to point out that the game by itself is not representative of the overall results of the GoJelly project. Interestingly, the research outcomes listed on the project page are much less linear and techno-fix-inspired than suggested by the game or even by the project's catchy name, "a gelatinous solution to plastic pollution".³⁰

4.5. Blue Economy and Seafood Ventures—The Role of the Government

In 2005, when the jellyfish first appeared as a news item, policymakers seemed enthusiastic about the prospect of a new seafood venture. The idea to harvest jellyfish and to exploit other species for the fisheries industry and other industries was welcomed. It fit into the existing narrative of Norway as a seafood nation ([Nærings- og fiskeridepartementet 2021a](#)). The government's ocean strategy report from 2019, "Blue Opportunities" ([Departementene 2019](#)), states in the preface: "Norway is a leading ocean nation. The history of Norway is a story about the oceans" ([Departementene 2019](#)). This is the slogan with which Norway reconfirms its national identity: living with and from the sea (see [Holt-Jensen 1985](#)). The jellyfish case is only one example among many opportunistic industry ventures in the country's history that are closely connected to the ocean. In respect to resources coming from ocean-based industries, the story goes back to the start of cod fisheries exports to Europe in 1800 (see [Vik-Langlie 2016](#)), continuing with the oil industry boom in the

1970s (see [Ryggvik 2015](#)) and the establishment of the first fish farms by former fishers in the Norwegian fjords that now sell Atlantic salmon to the world (see [Vik-Langlie 2016](#)).

In the case of the Norwegian jellyfish, too, the government's push to increase exploitation of the oceans plays a role. The Norwegian fisheries department frequently publishes updates on the status of the industry and the oceans, and the enthusiasm for seafood is visible in various official speeches and reports. In 2005, the fisheries minister at the time, Svein Ludvigsen, gave a speech about the future development of the marine industry under the title "The Blue Acre" ([Ludvigsen 2005](#)). Granted, the speech was held at a meeting of the "Norwegian Fishermen's Sales Organisation for Pelagic Fish"³¹, so it is perhaps not so strange that the issue was addressed with enthusiasm. But this way of addressing fisheries and the state of the Norwegian seas resounds in many of the reports that were published between 1999 and 2021. Three consecutive reports about the future of Norway's marine resources—published in 1999, 2006 and 2012—reflect the same tone in their titles: "Norway's opportunities for value creation in aquaculture" ([Norges Muligheter for Verdiskaping Innen Havbruk 1999](#)), "Utilisation of biomarine resources—global opportunities for Norwegian expertise" ([Det Kongelige Norske Videnskabers Selskab and Norges Tekniske Vitenskapsakademi 2006](#)) and "Value creation based on productive seas in 2050" ([Det Kongelige Norske Videnskabers Selskab and Norges Tekniske Vitenskapsakademi 2012](#)).

In recent years, the government has frequently published so-called ocean strategy reports: one in 2017, called "New growth, proud history" ([Nærings- og fiskeridepartementet and Olje- og energidepartementet 2017](#)), and in 2021, "A sea of possibilities" ([Nærings- og fiskeridepartementet 2021b](#)) and "Blue ocean, green future" ([Nærings- og fiskeridepartementet 2021a](#)). Though the term "sustainability" has appeared in the more recent reports, the focus is on growth and prosperity. Less recognition is given to reports and articles that focus on problems connected with overfishing, and there is too little focus on marine conservation zones (see [Jørgensen et al. 2021](#)). In 2020, for example, an article by the Norwegian Institute of Marine Research (Havforskningsinstituttet) revealed that a historic grazing event induced by proliferating sea urchins along the Norwegian and Russian coast could be traced back to coastal overfishing (see [Norderhaug et al. 2021](#)). The topic of overfishing is seldom discussed in the official reports and in the public at large. There is also very little justification for why the government and industry are so interested in developing fisheries for so-called LUR (little-utilised resources) when it is obvious that the push for research in this direction signals a need to move over to new species, because traditional fish stocks are gradually declining (see [Pettersen 2023](#)). All these efforts to fish down the food chain can be seen as reactions to the already looming "aquacalypse" ([Pauly 2009](#)) in Norwegian waters and all around the world. In many government reports about the marine resources in Norwegian waters, the underlying issues are not addressed. The general message has become about feeding the world with sustainable Norwegian seafood, without ever making it explicit what exactly this shift towards "sustainability" entails. The general solution seems to be to pin all hopes on some sort of future technological progress and innovation to maintain growth, while pressuring oceanic ecosystems even more.³²

The idea to monetise the jellyfish—to eat the problem, so to speak—involved selling the jellyfish as food to foreign "markets of interest", meaning in most cases non-Western markets. At least the ideas for collagen production and microplastic filters in the GoJelly project were focused on making the jellyfish produce useful in Norway as well.

5. Conclusions—Jellyfish as Ghosts of the Future Ocean?

All fishery scientists are familiar with the "shifting baseline syndrome" ([Pauly 1995](#)) and the decline in fish stocks globally, yet the practice that is promoted with the techno-fix approach in fishery science and policy perpetuates that effect ([Pauly 2009](#)). Exaggerated hope for future technological solutions to current environmental problems suggests that there is always a way forward, that there are no limits, and that some obscure future technology will be the remedy for the current ecological crisis. The techno-fix ideology

has propelled humans from the deep-sea floor up to the moon and back, but it would be dangerous to rely on it as a cure for overfishing and ecosystem decline.

In relation to the Norwegian jellyfish case, this raises the questions: Do we want the self-devouring techno-fix ocean that is promoted in current fishery science, policy and practice? And whom does it serve?

Following the different research projects, political reports and the public debate over time, we see a proliferation of efforts towards monetising the jellyfish in Norway from 2005 until 2021. The proposed technologies developed from simple destruction trawlers (or shredders) to delicate filter systems. Neither of these ideas has actually been realised at a large scale. The local media seemed most interested in reporting on the jellyfish as a novel foodstuff, or as an exciting new business opportunity. At the same time, Norwegian government reports were focused on exploring new fisheries and securing growth. The call for “more knowledge” about the underlying causes of jellyfish blooms, or even the ecology and biology of jellyfish, remained a constant background noise created by the scientists actually employed in the research projects. When we look at the results of these projects, especially the GoJelly project, we see that the research output is much less directed at technology and produce than the project pitch makes out. The Trondheim team in particular published on the problem of jellyfish blooms and how to forecast them, as well as questions of international governance connected to ocean resources. However, ever since the first *Periphylla periphylla* appeared in the region during the 1980s, and all throughout the various projects that were launched, none of these efforts really tackled the local problem of blooms in the Norwegian fjords. The actual jellyfish continued to migrate north.

The jellyfish-turned-into-a-resource tale is just one of many examples where a problem caused by anthropogenic climate change is approached with a techno-fix attitude that contributes to “self-devouring growth”. It is self-devouring because the many proposed and tested solutions do not address a simple but forceful option: doing less. For example, strict regulations for cod fisheries to see whether the cod can compete with the *Periphylla periphylla* in areas where it is not also predated on by humans. This would have immediate and unforeseen consequence for local fisheries, the seafood industry and consumers. In the long run, the consequences are likely the same wherever *Periphylla periphylla* thrives and cod disappears. Currently, we allow fishing down the food web to utilise “little-utilised species”. But where does that lead us?

Can we view the jellyfish case as anything else but an elaborate fishing down the food web situation? When techno-fix solutions are pondered for ecological problems, it creates a strong incentive to look for solutions promoting growth and prosperity. Ultimately, those are short-term solutions that fail to address the real problem. Why are we faced with all those invasive organisms or “ghosts of the future ocean”?

In the introduction to this article, I asked whether the jellyfish could be seen as ghosts carried by “the winds of the Anthropocene”, quoting from *Arts of Living on a Damaged Planet*. I am not sure that the editors of that book would agree that the jellyfish are ghosts. They are not extinct creatures of the past; they represent not what is lost, but rather what is gained, because of anthropogenic climate change. I want to argue that they are ghosts in a different reading of the term. Their appearance signals a scary problem that we have called upon ourselves. They continue to migrate north, likely due to a combination of factors, including overfishing and warming temperatures. Their migration and occasional blooms are signs of a changing ocean. Wherever they appear in masses, other organisms are outcompeted and decline. *Periphylla periphylla* are one of the visible signs of a changing ocean caused by human activity. I want to propose that they are a different category of ghost of the Anthropocene: they foreshadow a possible future ocean, and in their wake is death and decline.

6. Outlook—Conservation for Whom?

Conservation humanities can contribute to uncovering the different layers in stories like this one about *Periphylla periphylla* from an interdisciplinary perspective. The strength

of humanities research is the ability ask uncomfortable questions, rather than to look for solutions. Techno-fix approaches can only be identified and remedied when we dare to ask multilayered questions that cannot be answered in a simple way. Policymakers would likely prefer the linear approach exemplified by the GoJelly game. It goes like this: We have a problem, we clearly point out what it is (there is always a single cause), we employ some brilliant scientists, they serve us the best solution, wise policymakers accept this best solution and implement it. We repeat this a few times, and that is how we solve the environmental crisis.

The reality is more muddled and complicated. Repeatedly, we see that “the best available science” is not taken into account in decision making on government levels. Who has the power to decide what the best available science is? Or the best technological solution? For whom and for what purpose? It is not the scientific community alone that holds the key to solving environmental catastrophes. Neither is it in the hands of the techno-fixers. We know that meeting the challenges of the Anthropocene is a multidisciplinary endeavour. In the course of my research on the jellyfish case, never were the jellyfish talked about in any terms other than as alien, a nuisance and a problem. I doubt the jellyfish would welcome being sucked into a shredder or farmed to produce collagen. Yet we humans live in a world in which other beings constantly suffer because of us.³³ Depending on what place those beings occupy in the hierarchy of life, they deserve no name or recognition. They either become resources or are treated as pests.

I believe that conservation humanities can contribute to conservation efforts by uncovering the multilayered, difficult questions that have no definite answer and often create more problems than solutions. Of course, no one likes to entertain them. We have to ask ourselves: what exactly are we conserving, and for whom? When the jellyfish are shredded or otherwise removed, cod thrives; when cod thrives, coastal fisheries thrive. Wherever an alleged equilibrium is disrupted in an ecosystem, “future ghosts” appear. They inform us about a possible future ocean, and our response to them will serve some species and threaten, kill or enslave others. The research interests of the emerging paradigm of the conservation humanities must be in the dark and muddy areas, with low visibility and little oxygen, where the jellyfish thrive.

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Notes

- ¹ The techno-fix approach appears everywhere. Already in 1979, Max Oelschläger wrote about the techno-fix becoming an accepted solution to social problems (see [Oelschlaeger 1979](#), p. 43). More recently, Sabine Höhler has discussed the concept of nature having been turned into a “technogarden”, as it was proposed by former head of the Millenium Seed Bank Paul Smith ([Höhler 2020](#), p. 707).
- ² The Norwegian Governmental Broadcasting Service <https://www.nrk.no/trondelag/> (accessed on 25 February 2024).
- ³ Trønderavisen <https://www.t-a.no/> (accessed on 25 February 2024).
- ⁴ Adressavisen <https://www.adressa.no/> (accessed on 25 February 2024).
- ⁵ Dagbladet <https://www.dagbladet.no/> (accessed on 25 February 2024).
- ⁶ Universitetsavisa <https://www.universitetsavisa.no/> (accessed on 25 February 2024).
- ⁷ Norwegian SciTech News <https://norwegiansciotechnews.com/> (accessed on 25 February 2024).
- ⁸ The projects were Su San Norway AS, Nofima LUR, JANUS, and GoJelly.

- 9 For a description of the species, see, for example, [Ternes \(2020\)](#). “Helmet Jelly—PERIPHYLLA”.
- 10 A long-term study of the changes in light in the Norwegian fjords suggests that the jellyfish thrive in darker environments and that the fjords where jellyfish are more abundant are darker: ([Aksnes et al. 2009](#)). A study published in 2023 stated that individual jellyfish must have been present in the Trondheim fjord for at least 100 years: (see [Aberle-Malzahn et al. 2023](#), p. 59).
- 11 A few research articles were published in the 1990s and early 2000s that attempted to explain the phenomenon. See, for example, ([Sornes et al. 2007](#); [Fosså 1992](#)). See also ([Ugland et al. 2014](#)).
- 12 Currently, the jellyfish have been reported in Sognefjord, Halsafjord, Lurefjord, Vefsnfjord and Trondheimsfjord and Svalbard waters ([Båmstedt et al. 2020](#), pp. 87–88).
- 13 For earlier studies, see ([Mork 1982](#)). Mork published his first findings in the booklet “Verratorsken”. The later outcomes culminated in following article: ([Liu et al. 2018](#)). Another publication that discusses the findings of the project is ([Tiller et al. 2017](#)).
- 14 Walhovd, “Fristet Av Kongsnegler. Koreanerne Vurderer å Kjøpe 1200 Tonn Kongsnegler i Året Fra Frøya”.
- 15 See ([Brandt 2014](#)). A more detailed account of research funding in Norway from a historical perspective is ([Brandt et al. 2019](#)).
- 16 Hitramat is a Norwegian seafood firm: <https://hitramat.no/about-hitramat/?lang=en> (accessed on 25 February 2024).
- 17 See the full research material on page 31–35 of the Nofima report.
- 18 There is one presentation by Mork in which the COJECT technology is mentioned. It can be accessed through the project database: ([Jelmert and Mork 2010](#)). There is also a feasibility study in the project database: ([Grønlie 2010](#)).
- 19 See <https://app.cristin.no/projects/show.jsf?id=442399> (accessed on 25 February 2024): “In 2012, Mork joined a coalition of biologists and social scientists from NTNU and SINTEF to work on the three-year-long JANUS project, funded by the Research Council of Norway and designed to look at options and future scenarios for the Trondheim Fjord fishing community in response to the Periphylla invasion and other changes more generally”. In ([Bazilchuk 2016](#)).
- 20 For the local stakeholder workshop, see ([Tiller et al. 2014](#)).
- 21 See ([Tiller et al. 2015](#)), To Adapt or Not Adapt: Assessing the Adaptive Capacity of Artisanal Fishers in the Trondheimsfjord (Norway) to Jellyfish (*Periphylla periphylla*) Bloom and Purse Seiners. *Marine and Coastal Fisheries*, 7: 271. <https://doi.org/10.1080/19425120.2015.1037873>. They write: “The fishers affected by jellyfish in the Trondheimsfjord, believe they were unfairly impacted by top–down decisions allowing for rest quotas being distributed liberally to purse seiners and allowing them to enter the fjord where artisanal fisheries had their livelihoods. This allowance was voiced to be a bigger hindrance of adaptive capacity for the fishermen than the jellyfish, with expressions such as “vacuuming the fjord of fish””.
- 22 ([Horizon 2020](#)) See also the projects website ([Woldmann et al. n.d.](#)).
- 23 See the weppage of the project at <https://web.archive.org/web/20230402120706/>, <https://gojelly.eu/about/>, <https://gojelly.eu/about/> (accessed on 25 February 2024).
- 24 See note 23 above.
- 25 One outcome was testing the jellyfish as fertilizers: ([Reinsch and Emadodin 2020](#)).
- 26 In work package two. see [Cant et al. \(2021\)](#). “Jellyfish risks and interactive maps and app for jellyfish bloom forecasting”. Public report of GoJelly EU project. Work Package 2, Activity 4. Available online: <https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5e9029da6&appId=PPGMS> (accessed on 25 February 2024).
- 27 ([Halsband et al. 2018](#)) For the outcome for this section of the project, see ([Cant et al. 2021](#)). There was also a newspaper article about commercialising the jellyfish. See ([Bazilchuk 2018](#)).
- 28 All reports of the project are in the Horizon 2020 project database: GoJelly, Horizon 2020 Grant, <https://doi.org/10.3030/774499>.
- 29 The game is discussed and evaluated by researchers in one of the summary reports: ([Tirre et al. 2022](#)).
- 30 Several research articles had no direct link to the GoJelly produce (a mucus filter, fish feed or consumption). Instead, they covered ocean acidification, plastic and the governance of biodiversity internationally. See, for example, ([Tiller et al. 2019a, 2019b](#); [Rotter et al. 2020](#)).
- 31 See <https://www.sildelaget.no/en/sildelaget/about-us/who-are-we/> (accessed on 25 February 2024).
- 32 See ([Nærings- og fiskeridepartementet 2021a](#), p. 8): “Regjeringen ønsker å skape økt internasjonal forståelse for sammenhengen mellom havets økonomiske betydning og havets miljøtilstand. I 2018 tok statsminister Erna Solberg initiativ til det internasjonale Høynivåpanelet for en bærekraftig havøkonomi (hav panelet). Basert på 16 vitenskapelige delrapporter, tre spesialrapporter og en hovedrapport, la de 14 panellandene i desember 2020 frem en ambisiøs handlingsplan. Havpanelets arbeid viser at det haster med å utvikle god havforvaltning verden over for å oppnå de miljømessige, økonomiske og sosiale målene i FNs 2030-bærekraftsagenda”.
- 33 The strength of the environmental humanities is that we can allow ourselves to explore other perspectives. Deborah Bird Rose, Thom Van Dooren and Matthew Chrulew have demonstrated some of the suffering that occurs due to human activity, despite well-intended conservation efforts: ([Bird Rose et al. 2017](#)).

References

- Aberle-Malzahn, Nicole, Mari-Ann Østensen, Charlotte Volpe, and Sanna Majaneva. 2023. Long-term dynamics, population structure and connectivity of the helmet jellyfish *Periphylla periphylla* in a Norwegian fjord and adjacent waters. *Journal of Plankton Research* 46: 59–71. [CrossRef] [PubMed]
- Aksnes, Dag L., Arvid Staby, Nicolas Dupont, Stein Kaartvedt, Øyvind Fiksen, and Jan Aure. 2009. Coastal water darkening and implications for mesopelagic regime shifts in Norwegian fjords. *Marine Ecology Progress Series* 387: 39–49. [CrossRef]
- Bazilchuk, Nancy. 2018. A Day in the Life of a Jellyfish Hunter. *Norwegian SciTech News*. Available online: <https://norwegianscitechnews.com/2018/10/a-day-in-the-life-of-a-jellyfish-hunter/> (accessed on 11 October 2018).
- Bazilchuk, Nancy. 2016. Jellyfish Invaders: Trondheim Fjord in Transition. *Norwegian SciTech News*. Available online: <https://norwegianscitechnews.com/2016/07/jellyfish-invaders-trondheim-fjord-in-transition/> (accessed on 20 July 2016).
- Båmstedt, Ulf, Henry Tiemann, Ilka SÖtje, and Monica Bente Martinussen. 2020. Fecundity and early life of the deep-water jellyfish *Periphylla periphylla*. *Journal of Plankton Research* 42: 87–101. [CrossRef]
- Bird Rose, Deborah, Matthew Chrulew, Thom van Dooren, and Cary Wolfe. 2017. *Extinction Studies*. Columbia: Columbia University Press.
- Bjørklund, Oddrun, and Edgar Henriksen. 2011. Anbefalinger for Videre Satsing på LUR-Arter (23/2011). Nofima. Available online: <https://nofima.brage.unit.no/nofima-xmlui/bitstream/handle/11250/2504578/Rapport+39-2011.pdf?sequence=2&disAllowed=y> (accessed on 25 February 2024).
- Brandt, Thomas. 2014. Forskningsrådenes Historie 1946–2016—Et Overblikk og en Invitasjon. *Forskningspolitikk*. Available online: <https://www.fpol.no/forskningsradenes-historie-1946-2016-et-overblikk-og-en-invitasjon/> (accessed on 25 March 2014).
- Brandt, Thomas, Vera Schwach, Mats Ingulstad, Eirinn Larsen, and Marte Mangset. 2019. *Avhengig Av Forskning (De Norske Forskningsrådenes Historie)*. Oslo and Bergen: Fagbokforlaget. Available online: <https://www.fagbokforlaget.no/Avhengig-av-forskning/19788245021325> (accessed on 25 February 2024).
- Cant, James, Owen Jones, Jamileh Javidpour, Nicole Aberle-Malzahn, Ingrid Ellingsen, Sanna Majaneva, and Jan Dierking. 2021. *Jellyfish Risks and Interactive Maps and App for Jellyfish Bloom Forecasting* (Public Report of GoJelly EU Project. Work Package 2, Activity 4) [Public Report of GoJelly EU Project. Work Package 2, Activity 4]. Available online: <https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5e9029da6&appId=PPGMS> (accessed on 25 February 2024).
- Cuthbert, Ross N., Zarah Pattison, Nigel G. Taylor, Laura Verbrugge, Christophe Diagne, Danish A. Ahmed, Boris Leroy, Elena Angulo, Elizabetha Briski, César Capinha, and et al. 2021. Global economic costs of aquatic invasive alien species. *Science of The Total Environment* 775: 145238. [CrossRef]
- Departementene. 2019. Blå Muligheter, Regjeringens Oppdaterte Havstrategi. Available online: https://www.forskningsradet.no/siteassets/publikasjoner/2019/nfd_havstrategi_2019_norsk_uu.pdf (accessed on 25 February 2024).
- Det Kongelige Norske Videnskabers Selskab, and Norges Tekniske Vitenskapsakademi. 2006. Utnyttelse av Biomarine Ressurser—Globale Muligheter for Norsk Ekspertise. Available online: https://www.ntva.no/wp-content/uploads/sites/2/2019/08/biomarine_ressurser-no-2006.pdf (accessed on 25 February 2024).
- Det Kongelige Norske Videnskabers Selskab, and Norges Tekniske Vitenskapsakademi. 2012. Verdiskaping Basert på Produktive Hav i 2050. Available online: <https://www.regjeringen.no/globalassets/upload/fkd/vedlegg/rapporter/2012/verdiskaping-rapport-010812.pdf?id=2322968> (accessed on 25 February 2024).
- Duarte, Carlos M., Lucille Chapuis, Shaun P. Collin, Daniel P. Costa, Reny P. Devassy, Victor M. Eguiluz, Christine Erbe, Timothy A. C. Gordon, Benjamin S. Halpern, Harry R. Harding, and et al. 2021. The soundscape of the Anthropocene ocean. *Science* 371: eaba4658. [CrossRef]
- Eide, Lars Otto. 2006. Monstermaneten invaderer fjorden. *Adresseavisen*, November 25.
- Fosså, Jan Helge. 1992. Mass occurrence of *Periphylla periphylla* (Schypozoa, Coronatae) in a Norwegian fjord. *Sarsia* 77: 237–51.
- Frøya Næringspark. 2020. Frøyaportalen. Available online: <https://www.fr%C3%B8yaportalen.no/nringsliv/2020/8/9/fr%C3%B8yaportalen> (accessed on 15 September 2020).
- Gan, Elaine, Anna Lowenhaupt Tsing, Heather Anne Swanson, and Nils Bubandt. 2017. Introduction Haunted Landscapes of the Anthropocene. In *Arts of Living on a Damaged Planet*. Minneapolis: University of Minnesota Press. Available online: <https://www.upress.umn.edu/book-division/books/arts-of-living-on-a-damaged-planet> (accessed on 25 February 2024).
- Grønlie, Atle. 2010. Feasibility Study—Value of Jellyfish as a Resource and Removal of Jellyfish in the Sea. Merit Maritime Innovations, for COJECT. Available online: <https://www.fhf.no/prosjekter/prosjektbasen/900289/> (accessed on 25 February 2024).
- Halsband, Claudia, Sanna Majaneva, Aino Hosia, Per Arne Emaus, Frank Gaardsted, Qin Zhou, Ole Anders Nøst, and Paul E. Renaud. 2018. Jellyfish summer distribution, diversity and impact on fish farms in a Nordic fjord. *Marine Ecology Progress Series* 591: 267–79. [CrossRef]
- Holt-Jensen, Arild. 1985. Norway and the Sea: The shifting importance of marine resources through Norwegian history. *GeoJournal* 10: 393–99. [CrossRef]
- Horizon. 2020. GoJelly Grant Agreement No 774499. Available online: <https://cordis.europa.eu/project/id/774499> (accessed on 25 February 2024).
- Höhler, Sabine. 2020. Earth, a Technogarden. *Geschichte Und Gesellschaft* 46: 706–28. [CrossRef]

- Hustad, Kari. 2007. Manet truer torsken. *NRK Schrødingers Katt [TV]*, April 26.
- Jelmert, Anders, and Jarle Mork. 2010. Maneter: Globalt i Norge og i Trondheimsfjorden. Available online: <http://www.fhf.no/prosjekter/prosjektbasen/900289> (accessed on 25 February 2024).
- Jelmert, Anders, Aslak Kristiansen, Jarle Mork, Arnt-Ivar Kverndal, and Afl Albrigtsen. 2010. Report. *Sluttrapport, Maneter—Fra problem til resurs*. Available online: <https://www.fhf.no/prosjekter/prosjektbasen/900289/> (accessed on 25 February 2024).
- Johnsen, Christer S., and Tomas Kothe-Næss. 2005. Nuddel-konge åpner sneglefabrikk. *Adressavisa*. Available online: <https://www.adressa.no/nyheter/trondelag/i/oWAeKW/nuddel-konge-apner-sneglefabrikk> (accessed on 25 February 2024).
- Johnston, Sean F. 2020. *Techno-Fixers: Origins and Implications of Technological Faith*. Montreal: McGill-Queen's University Press.
- Jørgensen, Indal Lis, Even Moland, Vivian Husa, Tina Kutti, Alf Ring Kleiven, and Gro van der Meeren. 2021. Marint Vern—Havforskningsinstituttets Ekspertvurdering av Utfordringer og Status for Arbeid Med Marint Vern og Beskyttelse i Norge. Available online: <https://www.hi.no/hi/nettrapper/rappport-fra-havforskningen-2021-9> (accessed on 25 February 2024).
- Kjerkreit, Paul Ola. 2006. Monstermanet truer fjordfisket. *Trønderavisa*, November 30.
- Klein, Naomi. 2015. *This Changes Everything—Capitalism vs. the Climate*. London: Penguin Books Ltd.
- Kolbert, Elizabeth. 2021. *Under a White Sky The Nature of The Future*. New York: Penguin Random House.
- Kvile, Kjersti. 2017. Krabbeprodusenter fortsetter med sneglprosjekt Interessen for kongsnegl er laber blant fiskere, men HitraMat gir ikke opp. *Fiskeribladet*, August 17.
- Laukøy, Eva. 2007. Toktreportasje fra F/F “Gunnerus” i Trondheimsfjorden. *NRK Trøndelag “MidtNytt”*, April 17.
- Liu, Yajie, Rachel Gjelsvik Tiller, Jarle Mork, and Å. Borgersen. 2018. Emerging jellyfish and its significance in local fisheries—A Perihpylla periphylla story in the Trondheimsfjord. *CIESM Workshop Monographs* 50: 218. Available online: https://ciesm.org/online/monographs/50/CIESM_Monograph_50_Scientists_And_Fishers_171_180.pdf (accessed on 25 February 2024).
- Livingston, Julie. 2019. *Self-Devouring Growth: A Planetary Parable as Told from Southern Africa*. Durham: Duke University Press. [CrossRef]
- Ludvigsen, Svein. 2005. Foredrag på Representantskapsmøte i Norges Sildesalgslag: Stortingsmelding nr. 19. Marin Næringsutvikling—Den blå åker. February 6. Available online: https://www.regjeringen.no/no/dokumentarkiv/Regjeringen-Bondevik-II/fkd/Taler-og-artikler-arkivert-individuelt/2005/stortingsmelding_nr-19_om_marin/id269749/ (accessed on 25 February 2024).
- Meyer, Tirza. 2018. Quallenkönig. *Frankfurter Allgemeine Zeitung*. November 23. Available online: <http://www.faz.net/aktuell/race-to-feed-the-world/wie-mr-lee-die-welt-mit-quallen-ernaehren-wollte-15904086.html> (accessed on 25 February 2024).
- Mork, Jarle. 1982. Genetic Variation in Atlantic Cod (*Gadus morhua* L.): A Quantitative Estimate from A Norwegian Coastal Population. *Hereditas* 96: 55–61. Available online: <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1601-5223.1982.tb00033.x> (accessed on 25 February 2024). [CrossRef]
- Mork, Jarle. 2017. Verratorsken. In *Verran Historie og Museumslag Årbok 2017. 27. Årgang*. Verran: Verran museums- og historielag, pp. 75–105.
- Nærings- og fiskeridepartementet. 2021a. Blått Hav, Grønn Fremtid. Regjeringens Satsing på Hav Og Havnæringer. Available online: <https://www.regjeringen.no/contentassets/564afd76f1e34ccda982f785c33d21b9/no/pdfs/211524-regjeringens-havrapport.pdf> (accessed on 25 February 2024).
- Nærings- og fiskeridepartementet. 2021b. Havbruksstrategien—Et Hav Av Muligheter. Available online: <https://www.regjeringen.no/no/dokumenter/havbruksstrategien-et-hav-av-muligheter/id2864482/> (accessed on 25 February 2024).
- Nærings- og fiskeridepartementet, and Olje- og energidepartementet. 2017. Ny Vekst, Stolt Historie Regjeringens Havstrategi. Available online: https://www.regjeringen.no/contentassets/097c5ec1238d4c0ba32ef46965144467/nfd_havstrategi_uu.pdf (accessed on 25 February 2024).
- Norderhaug, Kjell Magnus, Kjell Nedreaas, Mats Huserbråten, and Even Moland. 2021. Depletion of coastal predatory fish sub-stocks coincided with the largest sea urchin grazing event observed in the NE Atlantic. *Ambio* 50: 163–73. [CrossRef] [PubMed]
- Norges Muligheter for Verdiskaping Innen Havbruk. 1999. [Utredning fra Arbeidsgruppen for havbruk oppnevnt av Det Kongelige Norske Videnskabers Selskab og Norges Tekniske Vitenskapsakademi]. Det Kongelige Norske Videnskabers Selskab og Norges Tekniske Vitenskapsakademi. Available online: <https://www.ntva.no/wp-content/uploads/sites/2/2019/08/havbruk-19991.pdf> (accessed on 25 February 2024).
- Oelschlaeger, Max. 1979. The Myth of the Technological Fix. *The Southwestern Journal of Philosophy* 10: 43–53. [CrossRef]
- Osaka, Shannon. 2021. Geoengineering: What Could Possibly Go Wrong? Elizabeth Kolbert's Take, in Her New Book. *Bulletin of the Atomic Scientists*. Available online: <https://thebulletin.org/2021/02/geoengineering-what-could-possibly-go-wrong-elizabeth-kolberts-take-in-her-new-book/> (accessed on 25 February 2024).
- Pauly, Daniel. 1995. Anecdotes and the shifting baseline syndrome of fisheries. *Trends in Ecology and Evolution* 10: 430. [CrossRef]
- Pauly, Daniel. 2009. Aquacalypse Now The End of Fish. *The New Republic*. Available online: <https://newrepublic.com/article/69712/aquacalypse-now> (accessed on 28 September 2009).
- Pettersen, Trond Erling. 2007. Manet Til Middag? Norsk Forskningsprosjekt Vil Gjøre Slimete Sjødyr Til Delikatesse. *Dagbladet*. Available online: <https://www.dagbladet.no/magasinet/manet-til-middag/66358509> (accessed on 9 July 2007).
- Pettersen, Vibeke Lund. 2023. Nedgang i Kvoteråd for Torsk, Hyse Og Blåkveite. *Havforskningsinstituttet*. Available online: <https://www.hi.no/hi/nyheter/2023/juni/nedgang-i-kvoterad-for-torsk-hyse-og-blakveite> (accessed on 22 June 2023).

- Press Release 1. n.d. Jellyfish: Disgusting? Useful! Rotter A (2018). "Dissemination Activity—Virtual". "List. GoJelly EU Project. Work Package 9, Activity 9.1, 20 Pages. Available online: <https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5c9f843d2&appId=PPGMS> (accessed on 25 February 2024).
- Probyn, Elspeth. 2016. *Eating the Ocean*. Durham: Duke University Press.
- Reinsch, Thorsten, and Iraj Emadodin. 2020. Response of Jellyfish Based Fertilizers on Soil and Plant Growth [GoJelly EU Project. Work Package 6, Activity 6.1, 35]. Available online: <https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5cbaa86a8&appId=PPGMS> (accessed on 25 February 2024).
- Rosenlund-Hauglid, Signe, and Andrea Rognstrand. 2018. Nudelkongen Mr. Lee er død Chul Ho Lee, Mannen Som Introduserte Norge for Snarkokte Nudler, er død, 80 år Gammel. VG. Available online: <https://www.vg.no/nyheter/innenriks/i/5V39K6/nudelkongen-mr-lee-er-doed> (accessed on 25 February 2024).
- Rotter, Ana, Katja Klun, Janja Francé, Patricija Mozetič, and Martina Orlando-Bonaca. 2020. Non-indigenous Species in the Mediterranean Sea: Turning From Pest to Source by Developing the 8Rs Model, a New Paradigm in Pollution Mitigation. *Frontiers in Marine Science* 7: 178. Available online: <https://www.frontiersin.org/articles/10.3389/fmars.2020.00178> (accessed on 25 February 2024).
- Rørvik, Guro. 2007. Sjøpølse og maneter—Maten er Servert. *Universitetsavisa*. Available online: http://gamle.universitetsavisa.no/dok_470b6215077807.40538715.html (accessed on 10 September 2007).
- Russell, James C., Nurul S. Sataruddin, and Allison D. Heard. 2014. Over-invasion by functionally equivalent invasive species. *Ecology* 95: 2268–76. [CrossRef]
- Rye, Johan Fredrik. 2018. Labour migrants and rural change: The "mobility transformation" of Hitra/Frøya, Norway, 2005–2015. *Journal of Rural Studies* 64: 189–99. [CrossRef]
- Ryggvik, Helge. 2015. A Short History of the Norwegian Oil Industry: From Protected National Champions to Internationally Competitive Multinationals. *Business History Review* 89: 3–41. [CrossRef]
- Sornes, Tom A., Dag L. Aksnes, Ulf Båmstedt, and Marsh J. Youngbluth. 2007. Causes for mass occurrences of the jellyfish *Periphylla periphylla*: A hypothesis that involves optically conditioned retention. *Journal of Plankton Research* 29: 157–67. [CrossRef]
- Telnes, Kåre. 2020. *Helmet Jelly—PERIPHYLLA*. Available online: <http://www.seawater.no/fauna/cnidaria/periphylla.html> (accessed on 28 February 2024).
- Tiller, Rachel, Elizabeth De Santo, Elizabeth Mendenhall, and Elizabeth Nyman. 2019a. The once and future treaty: Towards a new regime for biodiversity in areas beyond national jurisdiction. *Marine Policy* 99: 239–42. [CrossRef]
- Tiller, Rachel, Francisco Arenas, Charles Galdies, Francisco Leitão, Alenka Malej, Beatriz Martinez Romera, Cosimo Solidoro, Robert Stojanov, Valentina Turk, and Roberta Guerra. 2019b. Who cares about ocean acidification in the Plasticene? *Ocean and Coastal Management* 174: 170–80. [CrossRef]
- Tiller, Rachel Gjelsvik, Åshild Løvås Borgersen, Øyvind Knutsen, Jennifer Bailey, Hans Vanhauwaert Bjelland, Jarle Mork, Lionel Eisenhauer, and Yajie Liu. 2017. Coming Soon to a Fjord Near You: Future Jellyfish Scenarios in a Changing Climate. *Coastal Management* 45: 1–23. [CrossRef]
- Tiller, Rachel Gjelsvik, Jarle Mork, Russell Richards, Lionel Eisenhauer, Yajie Liu, Jens-Fredrik Nakken, and Åshild Løvås Borgersen. 2014. Something fishy: Assessing stakeholder resilience to increasing jellyfish (*Periphylla periphylla*) in Trondheimsfjord, Norway. *Marine Policy* 46: 72–83. [CrossRef]
- Tiller, Rachel Gjelsvik, Jarle Mork, Yajie Liu, Åshild Løvås Borgersen, and Russell Richards. 2015. To Adapt or Not Adapt: Assessing the Adaptive Capacity of Artisanal Fishers in the Trondheimsfjord (Norway) to Jellyfish (*Periphylla periphylla*) Bloom and Purse Seiners. *Marine and Coastal Fisheries* 7: 260–73. [CrossRef]
- Tirre, Frederike, Rachel Tiller, and Jörn Schmidt. 2022. *GoJelly Game, Deliverable 7.8 Dissemination level (PU) 774499-GoJelly*. Available online: <https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5e9047a40&appId=PPGMS> (accessed on 25 February 2024).
- Tricarico, Elena. 2016. Do alien invasive species and climate change foster conservation behaviour? *Aquatic Conservation: Marine and Freshwater Ecosystems* 26: 228–32. [CrossRef]
- Turner, Jenny. 2014. This Changes Everything: Capitalism vs. the Climate by Naomi Klein—Review. *The Guardian*. Available online: <https://www.theguardian.com/books/2014/sep/19/this-changes-everything-capitalism-vs-climate-naomi-klein-review> (accessed on 19 September 2014).
- Ugland, Karl I., Dag L. Aksnes, Thor A. Klevjer, Josefin Titelman, and Stein Kaartvedt. 2014. Lévy night flights by the jellyfish *Periphylla periphylla*. *Marine Ecology Progress Series* 513: 121–30. [CrossRef]
- Ulriksen, Vidar. 2007. Orientering om Departementets Politikk for Utnytting av nye Artar. Available online: <https://www.regjeringen.no/no/no/dokumentarkiv/stoltenberg-ii/fkd/Taler-og-artikler/2007/orientering-om-departementets-politikk-f/id485004/> (accessed on 25 February 2024).
- Vik-Langlie, Kristoffer Lund. 2016. Norges fiskeri- og kysthistorie Bind V: Over den leiken ville han rå—Norsk havbruksnærings historie [The game for which he wanted to master: The history of Norwegian fish farming]. *Scandinavian Economic History Review* 64: 297–98. [CrossRef]

Walhovd, Hanne Mette. 2005. Fristet av Kongsnegler. Koreanerne Vurderer Å Kjøpe 1200 Tonn Kongsnegler i Året Fra FRØYA. *Adressavisen*. Available online: <https://www.adressa.no/okonomi/i/O3OaQA/fristet-av-kongsnegler> (accessed on 25 February 2024).

Woldmann, Susanne, Peter Krost, and Levent Piker. n.d. GoJelly—A Gelatinous Solution to Plastic Pollution. Available online: https://crm-online.de/en/gojelly_eng/ (accessed on 25 February 2024).

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