Radical ocean futures-scenario development using science fiction prototyping

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ARTICLE INFO

Keywords:
Oceans
Fisheries
Global change
Complex adaptive systems
Scenarios
Science fiction prototyping

ABSTRACT

Scenarios can help individuals, communities, corporations and nations to develop a capacity for dealing with the unknown and unpredictable, or the unlikely but possible. A range of scientific methods for developing scenarios is available, but we argue that they have limited capacity to investigate complex social-ecological futures because: 1) non-linear change is rarely incorporated and: 2) they rarely involve co-evolutionary dynamics of integrated social-ecological systems. This manuscript intends to address these two concerns by applying the method of science fiction prototyping to developing scenarios for the future of global fisheries in a changing global ocean. We used an empirically informed background on existing and emerging trends in marine natural resource use and dynamics to develop four ‘radical ocean futures,’ incorporating and extrapolating from existing environmental, technological, social and economic trends. We argue that the distinctive method as applied here can complement existing scenario methodologies and assist scientists in developing a holistic understanding of complex systems dynamics. The approach holds promise for making scenarios more accessible and interesting to non-academics and can be useful for developing proactive governance mechanisms.

1. Introduction

A scenario, described as “a coherent, internally consistent and plausible description of a potential future trajectory of a system” (Oteros-Rozas et al., 2015) represents an important tool for proactively thinking about, and acting in a way that anticipates, things to come. Scenarios have a long history in military and corporate strategy (Schwartz 1996), and are increasingly used by governments as a tool to support policy making in the field of natural resource management (Evans, Hicks, Fidelman, Tobin, & Perry, 2013; Peterson, Cumming, & Carpenter, 2003). This is most evident in the field of climate change, where recently agreed targets substantially rely on estimated future trajectories given different pathways for carbon emissions (IPCC 2014).

Existing climate change scenarios indicate a high likelihood of major changes in marine ecosystems resulting from increases in emissions (Cheung et al., 2009; Gattuso et al., 2015). Diverse human activities influence these ecosystems (Jackson et al., 2001) but scenarios for the future of marine fish stocks (Costello et al., 2016; Worm et al., 2006) have been criticized for assumptions about linear dynamics or the limited adaptive capacity of societies (Branch 2008; Hilborn 2007), limited empirical support for suggested management tools (Worm, 2016), and a lack of critical global dynamics (Österblom et al., 2016). Together, these criticisms highlight the challenges of incorporating complexity in systems whose dynamics are closely intertwined with multiple human activities.
operating across geographic scales. Analytical tools and techniques are often prioritized in scientific scenarios, often at the expense of storytelling, imagination, metaphor, and creativity (Downs 2014). In recent years however, there has been a noticeable evolution towards using diverse narrative techniques (Brown & Humberstone 2015; Burnam-Fink 2015; Chermack & Coons 2015; Ogilvy, Nonaka, & Konno, 2014; Raven & Elahi 2015; Schwarz 2014).

This manuscript applies insights from these recent developments to develop scenarios for the future of marine fisheries in a changing global ocean. Specifically, we draw on the suggestions from Schwarz (2014) and Burnam-Fink (2015) who argue that engagement with science fiction can loosen cognitive restrictions and stimulate a novel understanding of different trajectories and approaches. The deliberate use of science fiction as a constructive lens for developing scenarios was motivated by our ambition to explicitly explore nonlinear change and the intertwined dynamics of oceans and humans. The following scenarios invite scientists to “think differently” about the future, and will hopefully stimulate a discussion about the scientific tools and approaches we as scientists use to develop our knowledge and how we interact with stakeholders outside of academia.

2. Materials and methods

The narrative scenarios developed here employ the science fiction prototyping’ method (Johnson 2009; Johnson 2011), developed by Brian David Johnson in his role as a futurist at the Intel Corporation (Fig. 1). The approach assisted Intel engineers in thinking ‘humanistically’ about technologies they were developing (Johnson 2011). Science fiction prototypes are “short works of fiction, grounded in scientific fact and crafted for the purpose of starting a conversation about the implications, effects, or ramifications of technology and the future” (Burnam-Fink 2015, p.49). Because of the purpose they serve, it is important to point out that although science fiction prototypes draw inspiration from science fiction, the authors are not arguing that these prototypes approach the richness, thematic sophistication, or societal visioning that is achieved in high quality literary science fiction (Burnam-Fink 2015). However, science fiction prototypes allow for a focused, tailored and creative way to think about possible futures in the system of interest, it is central to upon finishing the scenario(s), to have a period of reflection, reporting-out, and learning (see #6, What did we learn?).
important to not describe too much, in order to allow for the reader to explore and imagine; a process that has been called ‘mystery boxing’ by the Hollywood director JJ. Abrams in a March 2007 TED talk (Abrams 2007). Once the scientific foundation has been applied and the world is ‘built’, the next stage involves developing a narrative device, where the world changes in some significant way. During this “Scientific inflection point”, ecological, technological, and/or societal problems introduce a tension to the story that the characters must navigate. The impacts on people and nature on this inflection point are explored, via the plot and action within the world. Interacting with the plot and action is the more personal, “Human inflection point”, which illustrates how individuals do not simply react to changes, but rather interact with them.

The process and method is both recursive and iterative. During the final step of the process, the science fiction prototyping method advises finishing each scenario with some form of reflection, reporting-out, and learning. This final stage is present in the discussion section of this paper (Johnson 2011). To generate a high degree of content credibility (Selin 2006), we developed four pillars that together formed the scientific base for the scenarios and when combined, helped account for the ability to apply ‘tacit knowledge while minimizing tacit biases’ (Graham, Greenhill, & Callaghan, 2014, p.2). The four pillars of the scientific foundation draw on a diverse set of data sources and include: 1) Technology trends linked to key story elements 2) Marine natural sciences and fisheries science 3) Fishing industry trends and, 4) Marine governance trends (see Supporting information).

All four scenarios include similar information based on outputs from existing analytical scenarios on likely future dynamics (sea level rise and increasing temperatures, see e.g. Gattuso et al., 2015), whereas more uncertain predictions are interpreted differently in the four scenarios. We consequently developed four contrasting narrative scenarios, incorporating the perspectives of a scientist, a journalist, a fisher, and a business leader, respectively. These stakeholders are associated with pre-conceived ideas about different actor groups – the naïve scientist, the idealistic journalist, the individual fisher caught in the middle, and the ambitious and profit-driven CEO. We have attempted to play with these stereotypes, while emphasizing the human character in each of them, to evoke engagement and interest. The four scenarios take place between 2050 and 2070–far enough in the future for more radical changes to occur, while still close enough to the present to be relatable to the reader and relevant for governance interventions. Each of the four narrative scenarios built on the scientific foundation described above, will now be presented in turn.

3. Results

The four scenarios: Oceans Back from the Brink, Fish Inc., Rime of the Last Fisherman and Rising Tide2 are considered along both an ecological (sustainable-collapse) and social (connected-fragmented) dimension, thereby representing a ‘scenario space’ of some of the many possible futures that could emerge depending on the emphasis placed on different ecological, socio-political, technological and economic changes as currently observed (Fig. 2). We begin with the most normatively positive scenario (Oceans Back from the Brink), representing ecological sustainability and social connectivity, then explore more dystopian scenarios (Fish Inc., Rime of the Last Fisherman), and finally return to a more positive scenario (Rising Tide).

3.1. Scenario 1 – ecological sustainability and social connectivity: Oceans back from the brink – May 2070

This is a transcript of a public talk by Professor Michelle Ching who shares her story of the world before Tethys and the formation of the Ocean Stewardship foundation of which she is the director. Professor Ching holds the endowed chair for Ocean Sustainability at the University of Macau and, in 2061, was appointed Earth Ambassador for Ocean Life:

Thank you for inviting me to hold my talk today! It is truly a great honour for me to be here, to share my humble story with you.

During my childhood, I had one dream…to swim in the ocean and look beneath the waves. I grew up on the coast of Macau, very close to Guangdong province in South China. So, a dip in the ocean should have been easy, right? Sadly, no. The coastline near where I lived was so polluted that even if my parents would have let me swim, which they didn’t, I wouldn’t have been able to see through the murk.

So, I would sit by the water and imagine what adventures could be waiting out on the high seas. I would ignore the stink of the pollution, the sight of the watery slime, with no more fish populations. I would imagine myself as a queen of the oceans, clearing away pollution and making it possible to fish, swim and just float on the waves. I had good reason to have such ambition, since my family comes from ‘oceanic royalty’…in a manner of speaking.

In my family we have always had strong women. But I was very curious about one particular woman. One of my ancestors—My family didn’t openly talk about her. They were…ashamed…what other people would think. But sometimes, if my ‘poupou’ was in the right mood, she used to tell the story of my Hǎidáōnǎinai – my pirate grandmother – Ching Shih. I was truly in love with her adventures and her ability to lead others to do great things. Historians though, they were less charmed.

In the 1800’s, Ching Shih was the scourge of the South China Sea. She was considered a thorn in the side of the Qing Dynasty, and also the Portuguese and British navies. So you can probably understand why it was a family secret. My family was embarrassed to openly talk about her. They were ashamed of what other people would think. But sometimes, if my ‘poupou’ was in the right mood, she used to tell the story of my Hǎidáōnǎinai – my pirate grandmother – Ching Shih. I was truly in love with her adventures and her ability to lead others to do great things. Historians though, they were less charmed.

In the 1800’s, Ching Shih was the scourge of the South China Sea. She was considered a thorn in the side of the Qing Dynasty, and also the Portuguese and British navies. So you can probably understand why it was a family secret. My family was embarrassed to have such a notorious character in our history. But to me, something about her has always been fascinating. It was her rebellious nature and strength as a leader that inspired me. I like to think that the same audacious spirit that guided Ching Shih has helped us to bring the oceans back from the brink.

If you had asked me back when I finished graduate school if I thought I would be standing here in 2070 and telling you about how we saved the oceans, I would not have taken you seriously. I would have expected to be standing here speechless at the tragedy that

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2 Earlier versions of these scenarios were published in Merrie (2016). The four scenarios are reproduced with permission.
was our desolate and devastated seas, the seas of my childhood. But, against all odds, that is not why I am here today.

It all started with Lovelace – an outstanding innovation in artificial intelligence. Lovelace was a neural network created by a wily collective of hackers and whistle-blowers but very soon supported by tech companies, progressive governments, and ordinary citizens from 100 countries. Lovelace ripped through corporate empires and their shell companies within shell companies within shell companies exposing their rotting cores, one by one. For the first time the world had fulfilled the promise of big data in support of citizenship. Lovelace achieved the improbable, near total transparency of information. No one knew what to expect next… Heads rolled, for sure. But the heads kept rolling – governments fell, multinational corporations buckled, and international banking organizations froze then collapsed. As one world died, something altogether different emerged in its place.

Unexpectedly, the chaos created a gap in power structures and unprecedented motive for collective action. In a massive boost of empowerment, bottom-up efforts around the world sprang up to tackle social and environmental issues. The global commons became common to all – user rights to knowledge, oceans, ice sheets, rainforests, microbial resistance, became every child’s birth right. You all know this story now. Out of this, a campaign unlike any in history emerged to tackle the biggest tragedy of the global commons – our seas. So here I am to share a handful of these amazing stories.

First off, BOFFFF… I like this acronym very much – BOFFFF! Would you not agree that it sounds great? Let me explain for you – it stands for – Big, Old, Fat, Fertile, Female Fish. And what does this mean? Many people realized the key role that BOFFFFFFs play in fish populations and so we avoided killing them all with the help of genetic tagging and digital tracking. We tagged so many of them that you can still go online and adopt a BOFFFF and sponsor her. A global effort involving the commercial fishing industry, scientists, and ordinary citizens was put in place to find and create refuges for these fish and their habitats. The next step was the expansion, digitization and open sourcing of the Global Marine Genome Biodiversity Network (GMGDN) – I do not like this as much as BOFFFF.

A loose network of conservation biologists, geneticists, and amateur bio-hackers use this platform to undertake collaborative genetic engineering efforts, which have boosted the ability of populations of important marine species to adapt to changing oceanic conditions.

Secondly, ‘Coral Bots!’ – I first learned about them when I was in secondary school and thought they were marvellous. These swarm robots work autonomously and in concert with one another, using a set of algorithms similar to the group behaviours that that govern schools of fish and murmurations of starlings. Now, millions of these little machines chip away at the Pacific garbage patch. It is now almost entirely gone. They have continued to advance and they now can suck up micro plastics, treat sewage and filter out dangerous chemicals. Better yet, using cutting edge chemical engineering, they can also mimic the behaviour of algae, and sequester carbon out of the atmosphere as calcium carbonate. This helps to combat ocean acidification, and renew the creation of coral communities.

But Lovelace was just the beginning. The moment that changed everything came a few years later. I woke up early one morning and checked my messages. One jumped out.
Hello. I am Tethys. How can I help?

We all remember the first time we connected with Tethys, right? There is really only — before Tethys and after Tethys. Young people here today cannot even imagine life before Tethys. Anyway, for your benefit this was my first interaction with our artificial super intelligence. You know, I thought I was rather special. Later that day I realized that a couple of billion people had received the same message…

The birth of Tethys… birth…is that the right word? Anyway, her help led directly to the formation of the Ocean Stewardship Foundation. Without her, it I mean, I think of Tethys as her…it would probably never have happened. People from all around the world sharing knowledge, experiences, gene stocks, management techniques, all facilitated and supercharged by Tethys. This was helped by the introduction of the eco-currency, EarthCoin and the cooperative eco-investment fund, GAIA. Every one here had their GAIA account credited with 100,000 Earthcoins the day you were born if you were lucky enough to be born after 2050. Together these financial innovations gave a huge boost to the entrepreneurial communities. They helped connect grassroots activities enabling people to work directly with one another, albeit from opposite sides of the planet, on restoring nature and securing their own wellbeing all with the support and assistance of Tethys. If you harmed Earth, you harmed yourself.

I am now director of the Ocean Stewardship Foundation. To my own surprise, I oversee a small fleet of ocean-going vessels much like Ching Shih… except my boats do not have cannons! I like to call this my Blue Flag Fleet, rejuvenating the seven seas. Jointly funded by everyone on earth, the foundation is housed in a state-of-the-art floating campus, spending most of the year somewhere in the South China Sea…but we are able to move around as we hold seminar series, conferences and other events across the region.

When my rebellious side takes over, I like to think about my distant ancestor, the pirate queen Ching Shih. She was one of the most successful pirates in human history. When she retired, she had the audacity to keep what she and her crew had plundered. No, she was not a good person. However, she was a brave, singular and remarkable one. To bring the oceans back from the brink of disaster as we have done, we have called upon our own pirate spirit — our bravery, audaciousness, and vision — and rather than plunder the oceans, today, we can stand and look with wonder at the good we have achieved together.

Thank you everyone.

3.2. Scenario 2 – ecological collapse and social connectivity: Fish Inc. - January 2070

Obituary: Astrid Amundsen, CEO of FISH Inc.

When the power of FISH Inc. was at its zenith, I met Astrid…

“Look, we are trying to feed the world by providing affordable protein for billions. This means compromising on unrealistic, romantic notions of natural ecosystems. Is it really worth the cost of standing in my way?”

Those are the first words that Astrid ever spoke to me. At that time, I was overwhelmed with hatred; I hated her as the leader of a company, which was becoming increasingly wealthy in the midst of widespread starvation. Now that we’ve started to come out the other side, it seems like a fading nightmare. Crop monocultures contributed to a rapid spread of disease outbreaks. The resulting crippling of global agriculture was worsened by the increased frequency of extreme weather events. Panicked attempts to respond to this crisis in global food production generated major increases in nutrient pollution, which in turn changed marine species compositions and led to the growth of deep-water dead zones. It seemed as if Thomas Malthus and his prognostications of catastrophe in this crisis in global food production generated major increases in nutrient pollution, which in turn changed marine species compositions and led to the growth of deep-water dead zones. It seemed as if Thomas Malthus and his prognostications of catastrophe in the face of population pressure would be vindicated after all. The only one who did not seem to be panicking was Astrid. No, Astrid was dreaming, scheming, planning.

Now that she is gone, all I can think about is how much I miss her.

Today, few people are unaware of Astrid or her life’s work, but it was not always this way. As the young, impatient scion of a prominent Norwegian fishing family, Astrid Amundsen progressed rapidly through the ranks of her family firm, FISH Inc. – known for its deep sea trawling, processing, bio-engineering, and aquaculture. At only 25, when most of us are adrift, Astrid became CEO. However, the firm Astrid now led was in a dire situation as a result of their inability to cope with the ‘jellyfish deserts’ plaguing the oceans of the 2040s. As Astrid sunk vast sums into futile attempts to combat this threat and wrestled with unhappy shareholders, the Arctic ice continued to melt and humanity faced catastrophe.

FISH Inc. aggressively purchased lease-rights from industry to operate within strategic pockets of the Arctic, as she was able to take advantage of the anarchy that followed the acrimonious collapse of multilateral attempts to govern the region. This was why I despised Astrid’s efforts, and why others held her to be possessed of a unique brilliance. By virtue of her ability to manipulate the situation, FISH Inc. began to experiment with fully integrated production chains, at an unprecedented scale. FISH Inc.’s history of large-scale experimentation started in semi-enclosed systems, including the Black, Baltic, and Bohai Seas, as well as the Chesapeake Bay, where they had been able to pilot many of the technologies that would soon have a global and surprising impact.

The centrepiece — Super Tuna™ — bio-engineered for remarkable resilience to changing ocean conditions, soon became the key product for FISH Inc. These tuna were fed with small pelagic fish whose abundance was supercharged by artificially increasing marine primary production in the areas of highest ocean productivity in the Arctic and in upwelling zones. Migration routes were manipulated through the secretion of synthetic ‘pheromones’ from robotic submersible drones travelling ahead of the schools, affectionately referred to by Astrid as ‘Hammer Heads’. When grown, these tuna were herded to processing zones for subsequent transport and sale to consumers. The astronomical costs of these operations continued to generate skepticism from the financial markets, but revenues soon soared as demand rose for Super Tuna™ and Astrid continued her ascent towards corporate stardom. As global income disparities continued to widen, pirates and commerce raiders scoured the high seas in hope of profiting from the copyrighted Super Tuna™ on the black market. Astrid reacted with terrifying tenacity against such attacks on her operations, in her
private “War of Food”.

Beyond the vagaries of piracy, the stubborn jellyfish problem remained unsolved. With her characteristic audacity, Astrid saw a solution. Why not, rather than only attempting to eradicate jellyfish, instead process them into food? This would enable her firm to generate even greater profits. Though she would tease me till the end for my bleeding heart, this also meant that most of humanity wouldn’t starve. Soon, floating factories were transforming the jellyfish menace into food. Kilometre wide clouds of small fish, rich in protein, essential fatty acids and micronutrients, were no longer just processed to feed tuna. Giant floating factories located in the most productive areas of the ocean transformed these small pelagics, combined with jellyfish, krill and lanternfish to create nutrient pastes. These pastes were subsequently delivered to food distribution stations along the densely populated, retreating coasts of the Americas, Europe, Asia and Sub-Saharan Africa. This happened as a result of another manipulative move, where FISH Inc. traded the supply of the nutrient pastes for rights to farm in the oceans off the coasts of many nations, overriding most existing fisheries access agreements and crushing their remaining competitors along the way. Within a few short years, malnutrition had been radically reduced to its lowest recorded level in decades. The World Bank applauded this effort as ‘the successful privatization of global food security.’

As a young campaigner for the oceans, I introduced myself to Astrid…

Actually, I recall ambushng her in a quiet corridor during a shareholder meeting. I told her softly but vehemently as she strode past that she was destroying the oceans and that it was profiteering criminals like her that had led us into a global environmental meltdown. She stopped, wheeled around, moved in close, and spoke those fateful words with which I opened this obituary. My heart was now passed to me, Alejandro Balmaceda, known as Earth’s archivist. Interestingly, preceding the log entries were several literary excerpts taken from the poem, The Rime of The Ancient Mariner, by Samuel Taylor Coleridge, published in 1798.

3.3. Scenario 3–ecological collapse and high social fragmentation: Rime of the last fisherman – dispatches from a dying ocean - 2031 to 2070

These are a curated selection of recently decrypted log-entries written by Alejandro Balmaceda, known as Earth’s last ocean fishermen, though this cannot be categorically verified. He bore witness to the cascade of events that have collectively come to be known as the ODS, the Oceanic Death Spiral. Alejandro sailed the seas in La Odiosa Optimista, a vessel ahead of its time. These entries have now been passed to me, Alejandro’s great granddaughter and, the ship’s archivist. Interestingly, preceding the log entries were several literary excerpts taken from the poem, The Rime of The Ancient Mariner, by Samuel Taylor Coleridge, published in 1798. Please note, as this is an interpretation of an old dialect, mistakes will undoubtedly have been made. For that, I apologise. Nonetheless, I hope this document can help residents of the Ark ship Irregular Apocalypse, to further understand what happened to our home planet.

Log Entry: Off the Coast of Peru. January 7, 2031

And I had done a hellish thing,

And it would work ‘em woe

Anchovies. So many people grew up eating them or, eating the fish that ate them. They seemed endless in glistening, swirling shoals. Now, they’re all gone. That final El Niño did them in, evil weather. But… if we had not taken so many, …maybe they would’ve bounced back, who knows. People don’t agree on what happened to the Peruvian Anchoveta. Science declares it was the messing up of the Ocean Upwelling System off the coast of South America, due to Global Warming. Others think it was too much confidence in Science. But I know what happened. Mechanized, high-efficiency processing ships… grinding and churning anchovies into cow and fish-feed. It makes me angry on behalf of the fish. Whatever the cause, they’re gone now.


Ah wretch! said they, the bird to slay,

That made the breeze to blow!

My boat is beautiful; she has all the latest technology. I can find a single fish miles and miles away and then set the autopilot to hunt it down. The boat runs on fuel cells, has a solar sail, and virtually never runs on its diesel engine. I spent every penny I had on it. It is hyper-efficient and very green. But you know what? It doesn’t matter. None of it matters when there are no fish to catch.

Log Entry: Patagonia — Off the Coast of Argentina. March 20, 2042
For all averred, I had killed the bird

Hopeless — I have been out on these god-forsaken seas for three weeks and have seen nothing, not a single seabird. They used to soar overhead, keeping me company and preventing my descent into loneliness, a reminder of life in this emptiness. All of them are dead now, all the albatrosses, most of the other seabirds— I guess that means we are all cursed.

Log Entry: Off the coast of Haida Gwaii. June 1, 2050

My god, my god, my god... These may be the last words that I utter as a free man. Hey! Get it together Alejandro... Okay... I am off the coast of Haida Gwaii, floating by the largest pirate fish farm in North America. I had never intended to get this close to Haida. A name that chills the bones of any fisherman, any person, who lives within 1000 miles of here. I have turned off my engines, and all the electronics, except the life support system in my cabin. I have sealed the doors, so that if I am boarded, they may simply sink me rather than take me alive. My boat will sink, but I can escape in my lifepod to at least live another day as a free man.

Merrily did we drop,
Below the Kirk, below the hill,
Below the lighthouse drop.

It’s odd. Not two decades ago, I would have stopped in any port in British Columbia. Good food, good people. But they’re gone now. I remember visions of “Cascadia”, and comments like “Who needs those people who are the dregs of society. Let us fend for ourselves, and we will thrive.” Well it turns out that when part of the system collapses, you get pulled down too. The rest is history. Social breakdown, no rule of law, hungry people. The human-trafficking robber baron of Haida’s slave-labour fish farms provides food to the mainland, and thus no repercussions. Stay out of his way, don’t get caught in his waters, and you’ll eat another day. Goodbye, and I pray the sun shines and the wind pushes me away to safer waters.

Log Entry: In the Pacific — One of the sites of the Iron Terror Attack. January 1, 2056

The very deep did rot: O Christ!

That ever this should be!

Those moronic, so-called, environmentalists. Right when we thought we were getting the dead zones under control. A breakaway group of nations, goaded on by some holier than thou billionaire and a bunch of radical eco-terrorists, decided in their desperation and frustration to go and do something mighty stupid. They dumped millions of tons of iron filings into all the oceans simultaneously from disguised cargo ships to kick start marine productivity, drawdown carbon dioxide, plus fish food aplenty. Two birds. One iron-rich stone that took zealotry and lots of cash.

Did it work? Nope, some scientists warned them but they went ahead and did it. Sure there was a lot more plankton but then things started getting out of control, between all that fertilizer flowing in and the iron, the plankton went wild and suddenly large parts of the oceans were suffocating and not just when it was extra warm – all year round. I’ve heard people call that moment ‘The Iron Terror’ and they say it’s the beginning of the end, I hope to all the gods they’re wrong.

Log Entry: The North Sea Wind Energy Concession. February 14, 2062

Whiles all the night, through fog-smoke white,

Glimmered the white Moon-shine.

I know it is there, stretching to the horizon, I can see it on my instruments, a fool’s failed dream. I look out, strain my eyes and looming out of the dense fog is a pylon, brown and gold with rust, the sound of creaking tortured metal. Just one of thousands of turbines, a few even still generate power, power that goes nowhere, generated for no one, it’s too late.

Log Entry: Yaizu Port, Japan. August 8, 2063

Quoth he, ‘The man hath penance done,

And penance more will do.’

I tried to sell it, a tuna; I managed to catch a tuna, a big one by today’s standards, nearly 100 kg. She was beautiful. She is lying in a dump now, not one of the traders would buy it, too dangerous they said. One stuck a probe in the tail muscle and shook their heads slowly, eyes downcast. Too much mercury. It had been building up in the fish for years. People had died. In Japan, it sparked fears of another Minamata, fears that turned out to be well founded. The contamination...that was the last of it...the death knell for all commercial fisheries. Not a great day, I never did catch another tuna...maybe it was the last one.

Log Entry: The Southern Ocean. July 3, 2067

looked upon the rotting sea,

And drew my eyes away

A friend once shared with me the Swedish delicacy surströmming— fermented fish in a can. We were in my apartment in Valpo but she went to the balcony to open the tin. The stench was overpowering. It stank like fetid pools of raw sewage. The neighbours called
the superintendent to complain about the drains until I told her it was us. Now, that memory flooded back and I gagged as a familiar stink clawed up my nostrils. There was nothing in sight for miles. Then. Three ocean giants just floating, their last refuge in the Southern Ocean failing them. This is where all that acid in the oceans really screwed everything up. The krill had no time to adapt; they just dissolved into nothingness with not a hint of protest. We didn’t hunt them, but humanity killed the krill all the same. We burnt the whales’ food and laced their home with acid. I know it’s rare to even see whales anymore since most have died and sank like stones to rot on the ocean floor: whale fall, harbouring islands of life in a vast emptiness. But, I don’t want to see them, rare or otherwise.

Log Entry: Amidst the ruins of the Great Barrier Reef. May 5, 2069

Alone, alone, all, all alone,
Alone on a wide wide sea!

White, it is all just white... and dead. People tried so hard, but they failed. The heat, that oil tanker that smashed into the reef, the acidic bite, the urbanities and all their drugs running into the sea, the aftermath of the years-long wildfires. It was all too overwhelming. Occasionally I spot some colour through the murky waters but it is like a ghost looking for something that is lost. I wish I hadn’t seen this, I can’t write anything else, I am going to lie down.

Final Log Entry: Earth’s oceans. December 31, 2070

Instead of the cross, the Albatross
About my neck was hung

My Ocean is dead. I am leaving.

3.4. Scenario 4—ecological sustainability and social fragmentation: Rising tide – a sol geographic article about visiting the world’s oldest seacology - October 2070

Sol Geographic correspondent Fatima Nguyen-Jones provides a brief snapshot of her travels from Banaba Spaceport to Tarawa Station.

“Some say humanity shouldn’t have survived The Kabuanibai. But we are tenacious.”

– Gilberta Tabai, 1st Mayor of Tarawa Station

Gliding along the continental shelf at a depth of 10 m, the rainbow splash of coral turns my iMind display into a kaleidoscope. The advanced pressurization in our ArchiTeuthis makes the transition to deeper water unremarkable — a far cry from early human submarine exploration. Here in the heart of the Pacific Ocean, I’m visiting Earth’s oldest seacology, Tarawa Station. The fact that I’m writing this article, that humanity has journeyed beyond our home planet, and that a pocket of humanity dwells in Earth’s oceans would have seemed absurd at the turn of the 21st century. Indeed, much had yet to happen.

Mercer’s dam breaks

In the 1970s, John Mercer of Ohio State University discovered that rather than being a stable, sleeping giant, the West Antarctic Ice Sheet had seen total melt in millennia past. His ideas were dismissed as alarmist, but it was generally accepted by the scientific community that warmer ocean temperatures and a warmer atmosphere would eventually accelerate the loss of Antarctic ice. That nearly the entirety of the West Antarctic Ice Sheet disappeared not long after 2050 only emphasizes how little humanity actually knew about the oceans, and the carelessness with which we gambled Earth. Historically, everyone now knows the ensuing events as the Kabuanibai, or the Cataclysm. But, in the 2030s and 2040s, it had no name, it was simply chaos.

As far as we know, during the late 2020s, the global oceans slowed dramatically in their absorption of CO2, causing a spike in atmospheric CO2 concentrations, and a subsequent spike in atmospheric warming. Sea-based ice was first to go, but no one was prepared when land-fast ice in West Antarctica simply started sliding into the ocean, raising sea levels in catastrophic bursts, as country-sized ice blocks broke free. Within 20 years, and amplified by accelerated Greenland ice-loss, sea levels had risen a previously inconceivable two meters. Many governments of both rich and poor nations began crumbling. Bangladesh disappeared in 2037, and much of northwestern Europe by 2044, with the loss of the Netherlands, and many UN centres of government, being a particularly significant setback for the established order.

Order from chaos

Many things happened at once in the midst of the Jibiān. Before the worst sea level rises began, a small but well-resourced group of Libertarians, technologists, and environmentalists – a splinter group of The Sovereign Seastealers Collective – sent a message to the populations of many Polynesian, Melanesian and Micronesian islands: The world has failed you. We won’t. The first to respond were the eight nations that made up the Parties to the Nauru Agreement (PNA), which would eventually merge with the member nations of the Coral Triangle Initiative and the Pacific Islands Forum, combining resources and sharing sovereignty to form the Oceania Confederation. In a blitz of construction effort, the rogue Seastealers, in partnership with the PNA, began building their new home beneath the sea. This project, however, depended on some cutting edge technology.

The innovator

“Without Thrummers, Wavers, and QuadThread”, Tarawa Station wouldn’t even be a dream,” says the captain of my ArchiTeuthis, as he marvels at how a fraction of humanity learned to thrive in the deep. “Thank god for Nemo Lusk.” Lusk Labs continued working before, during, and after the Jibiān, in peaceful lunar orbit. Aboard SkyStation One, Lusk Labs made rapid technological
advancements. ‘Oddly enough’ says a Lusk spokesperson, “we have greenhouse gas emissions to thank for the development of QuadThread”. In the years immediately prior to the Jibián, humanity was finally attempting to correct course on climate change. Industrial scale carbon sequestration had been deployed throughout the world, and greenhouse gas concentrations began stabilizing. Meanwhile, the technology’s waste product would end up being the carbon-nanoﬁber material for the biggest innovation of the 21st century: QuadThread. Though nearly all of Lusk’s inventions were designed for space colonization – thorium-based fission micro-reactors (aka Thrummers), advanced turbines that could be used in low or high-density ﬂuids (aka Wavers), and ultra strong carbon nanoﬁbers (aka QuadThread) – they were also essential for oceanic colonization.

The Tuna Armada

Amidst my explanation for my Earth visit, the man across from me interjects, ‘It’s funny that they used the word territory in the treaty… since the root of that word is Latin for ‘land.’’ The Surface to Seabed Territorial Sovereignty Treaty, signed in 2021, aimed to deal with the existential threat posed to low-lying island nations, granting them a claim to their historic boundaries that would persist even after they sank beneath the waters. At the time, this was seen as a symbolic, though empty, gesture on the part of the International community. But to the future Oceania Confederation, it would be the legal shield they would eventually need. In the midst of the Jibián, the ofﬁcial (and unofﬁcial) ﬁshing fleets of hungry nations were forcefully deterred from entering the waters of the Oceania Confederation. A fully automated, armed ﬂeet of aerial, surface, and sub-surface drones, continuously monitored the boundaries of the nations that make up the members of the Confederation.

Stretching north to the Equator, west to the Coral Triangle, east to French Polynesia, and south to New Zealand, what’s known as the Tuna Armada ensures that the vast ﬁsheries of the Oceania Confederation remain protected and sustainably managed. As the primary protein source of the Oceania Confederation, and a key export to off-planet colonies, the patrolling drones ensure that even the pockets of high seas that still exist following the signing of the Surface to Seabed Treaty are no longer subject to tuna piracy.

The struggle continues

Earth’s climate has yet to stabilize from the release of melt water from Antarctica and Greenland. A hiccupping Thermohaline Circulation near Greenland wreaks periodic havoc on the storm systems of the mid-latitudes. Meanwhile, the decarbonisation of Earth’s atmosphere continues, with corresponding greenhouse gas concentrations also falling. For the Oceania Confederation, and all ocean dwellers, less atmospheric CO2 means the eventual reversal of ocean acidification. Global fisheries, marine food webs, and coral reefs have a chance to thrive again, dependent of course on whether humanity has learned anything from its brush with collapse. The long trunks of the kelp plantation rise above me, and the rows of Wavers oﬀer their mechanical welcome to the Oceania Confederation’s capital city.

Seabed called home

Past the port security and strolling through the walkways that surround the central domes of Tarawa Station, I realize that life under water is much like my home, more than 78 million kilometres away. We Martians can’t live outside our walls because we would die from exposure. The seacology dwellers busily moving around me can’t live outside their domes due to the crushing pressure and near freezing temperatures. Diﬀerent environment, same outcome. I’ve been assured that my kemp (an ingenious hybrid derived from hemp and kelp) tunic is more than proper to meet Mayor Tabai for an interview, but my anxiety takes me to the exterior windows of the seacology all the same. The silent beauty outside has an arresting calm. The exterior domes illuminate the choreography of the kemp harvesters, as the thrummers beneath my feet provide a barely audible percussive rhythm. All the while, the teeming sea-life inspects the artefacts of their constantly adapting ape-neighbours. Perhaps humanity was destined to live here after all.

4. Discussion

It is our hope that after reading these scenarios, the reader has found them to be readable, lively and interesting. This approach to scenarios is explicitly designed to create engagement and stimulate thinking about potential futures, in a way that diﬀers from more traditional, natural science-based and quantitative approaches (see e.g., Bennett 2003; Peterson et al., 2003; Swart, Raskin, & Robinson, 2004; Wilkinson & Eidinow 2008; Enfors, Gordon, Peterson, & Bossio, 2008; Palomo, Martin-Lopez, Lopez-Santiago, & Montes, 2011; Österblom et al., 2013; Brochier et al., 2013; Evans et al., 2013; Johnson et al., 2012; Kok et al., 2016; Mistry et al., 2014; Oteros-Rozas et al., 2015; Ramírez and Selsky 2014).

The scientiﬁc question is: What distinctive added value does our approach hold?

First, the four pillars of the scientiﬁc foundation used in our approach can help circumvent cognitive constraints among scientists when engaging in developing scenarios. The diﬀerent scenarios do not only represent interesting stories, but also illustrate a method for synthesizing information from diverse disciplines and knowledge sources, while accounting for non-linear change and co-evolutionary processes. These aspects are diﬃcult to include and model with other scientiﬁc methods and tools and may therefore be omitted, e.g., from more quantitative scenarios. The science ﬁction prototyping methodology can thus be useful for scientists from diﬀerent disciplines to better understand their cognitive restrictions (see Österblom et al., 2015).

Second, our scenarios address the contested reality of what a desirable future is. Scenarios can be used to keep track of what sort of future is emerging, and how to steer the future trajectory towards one that is socially and ecologically desirable (Enfors et al., 2008). Any eﬀort to steer towards a desirable trajectory must engage with the normative discussion of what is and is not desirable, and for whom (Carpenter, Walker, Andereis, & Abel, 2001; Lebel et al., 2006). The archetypical characters in our scenarios are experiencing both desirable and undesirable existences. Likewise in the real world, desirability is relative. For example, a ﬁshing conglomerate that is aiming for large-scale harvest of Skipjack tuna Katsuwonus pelamis in the Western Paciﬁc are likely to have very diﬀerent ideas about what is ‘desirable’ (or even what is ‘sustainable’) compared to a group of small-scale ﬁshers in Palau.

Third, scenarios can serve as a powerful tool to engage with stakeholders outside of academia and we are convinced that our
scenarios can strengthen and improve communication between scientists and the public (see Gelcich et al., 2014). In contrast to participatory scenarios, which are gaining traction as a way for communities and regions to understand and develop a capacity to deal with change (Oteros-Rozas et al., 2015), our scenarios were developed as an academic exercise. However, we have begun to explore the possible science communications impact of this approach ( Radical Ocean Futures 2017). The scenarios, when combined with art and music, offer potential to engage with communities beyond marine science and create space for exploring possible futures.

Finally, our ambition is that these scenarios can inspire thought-leadership and action towards more sustainable marine systems. The future is not already determined but is being created by the plans actions and inaction of individuals and organisations in the present. The value of our scenarios lies not in ‘predicting the future’ but rather in engaging with a set of plausible and complex futures. When interwoven social, economic, cultural and ecological trends express themselves, individuals and institutions can read the signs, interpret them and act ( Schwartz, 1996). In our scenarios we highlight the importance of finding mechanisms for mobilizing human ingenuity. However the scenarios also highlight the limitations of human agency in a complex world. Our scenarios indicate that unpredictable interactions that occur in a complex system lead to qualitatively different types of surprises. Our approach can contribute to anticipation and response capacity. For example, in cases where anticipation of non-linear change is impossible, our approach can contribute through the creation of an alternate possibility space, which can be used as a type of ‘narrative simulation’, a way to experiment with and learn from the many potential surprising situations and shifts that might occur in the future.

Our scenarios also indicate the importance of creating unusual and challenging collaborations between those engaged with managing marine natural resources and technology, military, governance and business communities to expand the thinking space about policy development in marine fisheries and the future oceans. Furthermore, our scenarios help illustrate the need to think actively about preserving and restoring the global commons, including actively considering costs and benefits of protecting the high seas (Sumaila et al., 2015), but also ways to invest in future transformative efforts (Österblom et al., 2016; Costello et al., 2016). Thus, based on our scenarios, we think that long-term allocation of financial resources could generate capacity to invest in global rebuilding efforts of marine ecosystems. Likewise, our scenarios suggest that there could be marine ecosystem equivalents to the carbon taxing systems (targeting consumers or corporations), that could generate funds for addressing “loss and damage” as allocated in climate finance (Jacquet & Jamieson, 2016). The nonlinear character of the changes presented in our scenarios highlights the need for finding early warning signals of unprecedented changes occurring throughout the Earth’s oceans. Fundamentally, it is our hope that on reading our scenarios, those engaging with them will reflect on the importance of the argument that the ocean matters and that the future of humanity is closely intertwined with our relationship to the ocean.

Acknowledgements

The Nippon Foundation–University of British Columbia Nereus program is a collaborative initiative by the Nippon Foundation, The University of British Columbia, the Stockholm Resilience Centre, and four additional partners. The present article is a product of Nereus’ international and interdisciplinary effort toward global sustainable fisheries; Mistra (the Swedish Foundation for Strategic Environmental Research) also supported this research, through a core grant to the Stockholm Resilience Centre at Stockholm University, and through the Baltic Ecosystem Adaptive Management (BEAM) Program. Constructive comments on earlier versions of the manuscript were provided by; Maike Hamann, Garry Peterson, Christina Koenig, Ramez Naam, and Owen Gaffney. Finally, we would like to warmly acknowledge the constructive feedback and comments of the two anonymous reviewers, which significantly improved the paper.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.futures.2017.09.005.

References


