
Fisheries for the future
EDF
ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

Foreword

Climate change threatens key life support systems of our planet — and the ocean is no different. Even with powerful actions to reduce emissions and massive investments to pull carbon dioxide from the atmosphere, changes in the ocean will grow more profound and accelerate. These changes won't just damage special places like coral reefs and mangrove swamps, but will fundamentally alter ocean ecosystems, impacting fish abundance and where they can be caught. This will affect the ocean's ability to feed the growing human population and threaten the livelihoods of fishermen and others who depend on the "blue" economy. The impacts will be worst in the developing tropics, where the most ocean-dependent and vulnerable populations are concentrated — as well as crucial biodiversity hotspots.

But with thoughtful interventions, these impacts can be significantly reduced, and perhaps even reversed. This series, "Fisheries for the Future," examines the interventions necessary for sustainable fisheries in a climate-driven world. As the series makes clear, we know today what most needs to be done: emplacing sustainable fisheries management around the world as we also work to reduce and then offset emissions. These fisheries challenges will require novel solutions — with a greater emphasis on joint management of shifting fish stocks — but also approaches that protect vulnerable people and ecosystems, especially in the developing tropics. Achieving effective and equitable outcomes may require investments from the developed world to compensate for the damage created by climate change.

The health of our planet, and its ability to meet growing human needs, requires attention — starting right now. We know many of the right things to do, and we must adapt our strategies to truly plan for fisheries for the future.

Table of contents

What will it take to secure healthy fisheries in the face of climate change?

Merrick Burden

Fisheries are a globally-important source of jobs and income and critically important for the food security and nutrition of some of the most impoverished people on the planet. This is increasingly the case as human populations continue to grow. Managing fisheries well is also an important aspect of ecosystem health, as well-managed fisheries help contribute to vibrant and abundant ecosystems. Climate change is already affecting fish populations and will scramble these systems in ways not fully understood. This poses a risk to fisheries, the people who depend on them for their livelihoods and the continued ecological abundance and diversity that we hold dear.

We know impacts on fisheries from climate change will occur — and these impacts are likely to become more severe as we experience the effects of warming already baked into the system. So what needs to change in the face of climate change in order that fisheries can continue to feed people and provide jobs? How can fisheries managers better protect marine ecosystems, ocean wildlife and biodiversity as climate change puts greater stress on the oceans? What should be done to help fisheries transition as climate change takes hold? These are some of the questions policymakers and fishing communities are asking as ocean systems continue to change, and which we'll cover in our blog series.

As we think about what fishery management needs to look like in the future, a few core points are clear.

We must not abandon the fundamentals of good fishery management in the face of climate change.

This means we should not abandon concepts of maximum sustained yield and ecosystem-based fishery management. However, what the application of these fishery management foundations look like may be

different, and what we need to do in order to implement them will require a different set of tactics. Fisheries have always had to deal with change — that is the nature of wild populations and the ocean itself — so some robust approaches for dealing with change have already been developed and used successfully. However, climate change will introduce new kinds of challenges, requiring us to address a different suite of risks than we are accustomed to. And, it will require us to be much more focused on some aspects of conservation and governance compared to what we do today.

We must understand that we should not forget the lessons we have learned so far, but a sustainable future cannot be built on the practices of the past.

Over the past several decades we have learned a great deal about what it takes to manage fisheries well. Some of these lessons have come painfully, and we are admittedly still recovering from some prior mistakes. We must continue to heed these lessons and not forget them, but we also need to allow ourselves to reimagine what fisheries of the future can look like, and set our

goals accordingly. This means that we need to acknowledge that much of what we imagine as a healthy fishery is based on observations of the past that will be increasingly irrelevant, and we will need to establish new expectations, goals, benchmarks and standards that are relevant to a changing world. To get there we will need to help each other — all involved in the fishing community — imagine what is possible in a climate-changed future and what it takes to get there.

We must develop and embrace new tools and approaches.

To create a sustainable future, we will need to get better at aspects of fisheries management we struggle with today. This is particularly the case for international fisheries management. Shifting fish stocks as a result of climate change will require much more international cooperation and will raise important issues of equity between developed and lesser-developed countries. We have already seen how a lack of effective cooperation can lead to overfishing and stock declines among countries with otherwise good domestic management, such as the recent experience in Northern Europe over Atlantic mackerel. Here a shift in the geographic location of mackerel to the north and west brought Iceland and the Faroe Islands into the fishery due to increased abundance in their waters. Disagreements about how to share the harvest of the mackerel stock between relative newcomers, the EU, and Norway led to overfishing and a loss of that fishery's seafood sustainability certification. When it comes to international cooperation, fostering the willingness of countries to work together will require that decisions over shared resources strongly consider principles of fairness equity in order to ensure willingness among cooperating parties.

We must maintain the health of marine ecosystems to build healthy fisheries in the future.

Marine ecosystem resilience ensures ecosystems can handle shocks and disturbances — even those that are unexpected. Research and practice outlines a clear set of steps that socio-ecological systems can do in order to build resilience.

Take the salmon of Bristol Bay, Alaska, often described as one of the greatest migrations of wildlife on the planet. In this ecosystem, habitat complexity, system diversity and management have worked to support a highly productive ecosystem — even in spite of several disturbances and shocks over the decades.

Another example is the impacts to tropical corals around the world. The world's coral reefs are experiencing profound changes and impacts as a result of a changing climate, with recent estimates indicating that half of the Great Barrier Reef was decimated by bleaching events in 2016 and 2017. However, recent coral research gives us hope that some strains of coral can resist high ocean temperatures, making

it clear that genetic diversity is a key component to resilience in the face of climate change. Biological and genetic diversity are crucial to making sure species that can take advantage of a changed world are given the opportunity to do so. And good fisheries management can very likely help retard the impacts of climate on reef ecosystems.

We must address inequity to achieve our goals.

Addressing issues of inequity is necessary for many reasons, including making sure societies are cohesive and can work together constructively to make necessary adaptations. History shows us that the lack of equity can cause problems like social instability and public rejection of policies that may otherwise be sustainable. In Chile, recent decisions concerning management of a squid resource that were perceived as unfair led to large demonstrations and public rejection of a policy that would have otherwise been deemed sustainable. Chilean policymakers have since remedied the situation, but this case is just one example demonstrating the importance of fairness and equity. By striving to avoid the creation of winners and losers in the face of climate change, we can help ensure that society is better able to adapt and embrace the changes we need to make.

Finally, there is much we do not know about climate change and the many risks we will need to manage.

In order to deal with unexpected events that will undoubtedly occur, we will need to get better at implementing more responsive and nimble adaptive management. This includes management systems and policy decision-making processes that are more nimble, but also tools that allow the fishing industry to be more flexible and adapt to changing fishing opportunities on their own as unexpected events occur. Other forms of risks and uncertainty are more identifiable. For example, we know that climate change will alter productivity — and hence the sustainable yield — of fish stocks. However, we do not have a good sense of when these changes will occur, how quickly and what the magnitude of the change will be. Management tools are available that can help with these types of uncertainties, such as ramped harvest control rules that tie fishing rate to changes in biomass. These tools have proven to be robust to climate change uncertainties.

To be clear, society must act to reduce our emissions. If we can do so and also rise to the fishery management challenges by implementing the actions described above, research and experience show that fisheries can continue to produce jobs, yield high amounts of food production and help ensure ocean ecosystems maintain abundant life. To ensure the most sustainable future for ourselves and our planet, reimagining our world amid climate change — and becoming more resilient in the process — is key.

Will fisheries management best practices need to adapt as climate change impacts the ocean?

Merrick Burden

F/V NORTHWESTERN/FLICKR

Doctors say a healthy patient is better able to recover from an injury than an unhealthy one. As our colleagues at the University of British Columbia point out, this is similar to healthy marine ecosystems, where a healthy ecosystem is better able to withstand the effects of climate change compared to an unhealthy one. Managing fisheries right is one of the most important factors for addressing marine ecosystem health. In this blog we will talk about fishery management best practices and their importance in the face of climate change, how those practices may look different as a result of climate-related factors and some recent experiences with fisheries in Lithuania.

Over the last few decades we have learned what it takes to manage fisheries well and have worked with fishing communities around the world to develop robust management plans that are yielding positive results for fish populations and fishing communities.

Some of the elements of fisheries management best practice include:

1. Scientifically determined catch limits
2. Well-defined rights of access
3. Systems of accountability
4. Transparent decision-making processes
5. Adequate enforcement provisions
6. Measures that conserve important habitats

Fisheries can play an outsized role in shaping the health of marine ecosystems and the people who depend on them

Ecosystems with well-managed fisheries tend to be characterized by abundant fish stocks, intact habitats, thriving wildlife populations and robust fishing communities. Inversely, poorly-managed fisheries tend to have high rates of overfishing and habitat damage, and the

surrounding ecosystem suffers. This matters in the face of climate change as healthier ecosystems are in a better position to withstand climate change effects due to abundance, diversity, habitat quality and other factors that comprise attributes of resilience.

Research bears out the relationship between fishery management and ecosystem health

A recent review of different fisheries was done as part of the IndiSeas project which measured ecosystem health, fisheries management and governance. One place that scored high on ecosystem health is the west coast of the U.S. — a place where Environmental Defense Fund (EDF) has worked intensively for the last couple of decades to help get management right. Inversely, places with low ecosystem health scores (such as Tanzania and Guinea) tended to be places where fisheries management and governance also scored low. Now, not every region of the world is in a place where robust implementation of these best practices is possible. In such cases, implementation of basic fishery management is still one of the best steps to take, and should be done with an eye toward continued improvements in that system over time.

As climate change increasingly takes hold, elements of fisheries management best practice won't go away. We will still need to prevent overfishing; we will still need to protect habitats; we will still need to manage fisheries with well-defined access and user rights; and so forth. However, the way in which we deploy these practices may start to look different given the way climate change will disrupt our ecological and social systems.

Collaborating with fishery managers in Lithuania on changing fish populations

One example concerns Lithuania's fishery sector. Not long ago, a couple of us at EDF were contacted by officials within the Lithuanian Fisheries Department. Many fisheries there are managed by a system of individual quotas which help manage the catch of cod, sprat and other stocks off the Lithuanian coast in the Baltic Sea. Lithuania's fishery managers contacted us because they were grappling with a precipitous decline in the populations of Baltic cod and a subsequent explosion in the populations of other species like sprat. The implication of this change in relative abundance has been severe economic strain on cod fishermen while their sprat-fishing counterparts experienced some incredibly lucrative years. This divergence of economic outcomes that has been occurring despite the presence of a good management system was causing political tension that threatened an otherwise sustainable system.

What the Lithuanian fishery sector is experiencing is wholly consistent with patterns that will play out around the world as climate change takes hold. That is, some fish stocks will become more abundant, others less abundant, and this will impact different portions of the fishery differently. These dynamics will create challenges for managers and stakeholders as they grapple with these changing conditions and struggle to ensure that outcomes are equitable in the face of these changes.

So, what is the answer to Lithuania's dilemma?

One solution we were able to identify with our Lithuanian colleagues is the allocation of quota portfolios rather than individual species quotas (or even a bundle of individual quotas). In other words, rather than a case where each vessel has individual quota for cod, individual quota for sprat and so forth, a quota portfolio would allocate each vessel shares of the entire fishery. If a vessel held 3% of the fishery, then each year that vessel would receive 3% of the sustainable catch of cod, sprat and other species. In this way, vessels would be diversified and less prone to suffer from wide swings in abundance of individual species due to ecological conditions. What this looks like at the end of the day is still an example of fishery management best practice — scientifically determined catch limits, well-defined access rights and other measures. They just look a bit different.

Of course, we will want to do our best to implement these types of solutions before problems arise rather than after. This means that we will need to do our best to anticipate the types of change that climate change will bring and to identify and manage for the types of challenges that will arise. This is the topic of our next blog in this series. Stay tuned!

Can looking to the future help preserve a historical fishery against climate change?

Jake Kritzer

In New England, as in many other parts of the world that rely on fishing for food and income, there is a growing need to predict and adapt to climate change as it worsens. One of the most important aspects of dealing with climate change is to look ahead and put in place goals, objectives, scientific research and management practices that are responsive to future conditions. As we anticipate a climate-altered future, we will continue to value healthy ecosystems and the benefits derived from fisheries. However, healthy ecosystems and sustainable fisheries of the future may be very different from what we are used to. The ability of the oceans to support thriving ecosystems and fishing communities will depend heavily on actions we take today.

The New England groundfish fishery

New England's storied groundfish fishery, which targets cod, haddock, a variety of flatfishes and other bottom-dwelling predators, is among the oldest fisheries in the United States. It was once said that a fisherman could walk across the waters of New England on the backs of the formerly plentiful cod, which fueled the regional economy following European settlement. The fishery also created a rich maritime heritage that continues to this day. That fishing heritage first belonged to the Native American peoples who long pre-dated colonization. Today, preserving this iconic fishery and the economy and culture it has built will require looking forward to an ocean evolving under a changing climate.

Fish on the move

The Gulf of Maine and Georges Bank, the complex basin and shallow underwater plateau that together have been the foundation of our regional fisheries, sit at the far southwestern edge of the range of many Northern Atlantic species. Historically, these have been coldwater ecosystems, albeit at latitudes that are typically much

warmer elsewhere, due to the Labrador Current delivering frigid polar waters southward from the Arctic. However, this corner of the Northwest Atlantic now finds itself warming faster than almost any other ocean area on Earth. These warming waters are causing rapid shifts in the distribution of many species, generally to the north and offshore, seeking their preferred water temperatures.

Thus, species we normally associate with the Mid-Atlantic region — black sea bass, summer flounder, striped bass and others — are expected to continue to move north and become more abundant in New England as colder water species push northward. Fishermen in New England will see a shifting mix of species nearest their docks as warming progresses. Governance patterns must also change to manage for the shifting portfolios of stocks that no longer represent historical management decisions.

Climate change is making Atlantic cod recovery difficult, but this geographical shift might actually have some benefits for the future of the species. For many years, cod have become concentrated in a small pocket in the western Gulf of Maine bounded by Cape Ann and Cape Cod. Elsewhere, overfishing has caused near-complete localized extinction. Although warming waters are already decreasing the productivity of cod, spreading the stock more widely across the Gulf of Maine could increase resilience relative to today's much more restricted distribution by hedging bets against localized declines. Important efforts to restore coastal prey fishes that cod feed on, especially sea-run herring, are helping to give cod a chance where they have been lost.

Forward-looking habitat management — anticipating changes in fish populations

If cod return to those areas, they will need time to re-establish. That process will be more complicated in a changing ecosystem, for the nature of seafloor habitats, water temperatures, surrounding fish and invertebrate species and other ecosystem attributes will be different from what cod once knew. It was therefore with laudable foresight that the New England Fishery Management Council and National Marine Fisheries Service together created a fishery closed area along the coast of Maine offshore from Penobscot Bay. That refuge is helping protect important habitats and can enable fledgling spawning groups to grow and possibly serve as a source of replenishment to areas elsewhere in the Gulf of Maine.

Climate change is the source of much uncertainty — examining life histories of popular fish

Of the 20 stocks included in the groundfish fishery, most live primarily away from shore, with some inhabiting the deepest trenches of the Gulf of Maine. But one unique species, the winter or blackback flounder, historically moved inshore to spawning and nursery grounds in estuaries and even salt ponds in the wintertime. Key habitats in those areas, including salt marshes, eelgrass beds and oyster reefs, are especially susceptible to effects of climate change as sea levels rise, waters warm and storms intensify.

These habitat changes, among other impacts, mean that winter flounder are expected to suffer especially strong declines in productivity due to climate change.

However, some winter flounder are known to spawn in offshore areas as well. This means the stock as a whole might have the ability to counteract reduced inshore spawning success, to some degree, by capitalizing on deeper and increasingly colder waters. The effect of this life history diversity on productivity is but one of many scientific uncertainties we must confront in managing the stock, among other uncertainties related to climate change and incomplete accounting of just how many fish are being caught. Untangling these uncertainties and applying our findings to forward-looking management strategies will not be easy, but there are steps we can take in anticipation of changes that will come.

Climate uncertainty and responsive fishing rates — aligning good policy to biology of stocks

One of the central elements of any fishery management strategy is a harvest control rule, or HCR, which typically determines how many fish can be caught based on how many fish there are in the water. An HCR is arguably where science most directly confronts policy in fisheries management, as it reveals a great deal about

the objectives of the fishery, policy requirements, scientific understanding and uncertainties and risk tolerance. In many fisheries, the HCR is simply to fish at a fixed but precautionary rate of fishing mortality that strikes a balance between achieving high yields when the stock is large, but not overfishing when the stock is smaller. Such a "fixed-F" approach can be effective when productivity fluctuates around an average level, as is the norm in any ecological system, but does not change in a consistent direction.

But species that are expected to decrease or increase consistently, like winter flounder, break this rule, which means a different approach is needed. When facing climate-driven declines in productivity that are exacerbated by scientific uncertainty, the HCR must be more responsive. Even if we do not understand all of the biological changes taking place, fishing mortality should decrease in real time as we detect declines in the stock and can then rise again with evidence of recovery. Such an approach is not yet used in the New England groundfish fishery, but could be adopted much more readily than other more complex management reforms. Indeed, neighboring fisheries in the Mid-Atlantic region have implemented this very approach.

New England can have abundant fisheries

For those of us who call New England home, the groundfish fishery has sculpted our waterfronts, history, folklore and cuisine. It can remain an indelible part of our region, as long as we look to the future while we embrace the past. The ecosystem will function differently as climate change continues to unfold and we must anticipate and prepare for that future. Strategic use of protected areas and responsive harvest policies, alongside other actions like recovery of prey fish and improved monitoring to track changes and impacts, can help us keep pace with a changing ocean.

Although climate effects on New England's ocean are especially strong, we know that these impacts are occurring around the world. In next week's blog, we'll delve into building and strengthening international institutions to allow for collaboration between countries as the fish they rely on change in abundance and distribution.

DAVIDE GORLA/FLICKR

How can building and strengthening international institutions help achieve climate resilient fisheries?

Kristin M. Kleisner

History is written in no small part through the conflicts over shared resources between neighboring countries, as each party tries to maintain its share of the pie. But in the ocean, these issues tend to be exacerbated. One of the key ocean resources is fish, which are out of sight and mobile, swimming long distances to find optimal breeding or feeding grounds. Now, with rapidly warming ocean waters due to climate change, the stakes are even higher as fish shift out of areas where they've traditionally been found, often crossing international boundaries.

But there is a path out of conflict and toward sustainability. Ideally, discrete populations of fish — called "stocks" — that swim in the waters of two or more countries will be cooperatively managed by those countries to ensure the sustainable and equitable harvest of those fish throughout their range. In practice, the world's success at managing stocks across international borders is mixed at best — and climate change will make this even harder as stocks move to find waters more to their liking. As stocks enter new jurisdictions, new agreements will need to be created and existing international agreements will need to be reworked to ensure these stocks are managed sustainably. Given the world's limited success to date at international fisheries management, one key question we should ask is: how do we get better at working cooperatively?

We will discuss how a dramatic shift in the location of one fish species resulted in a "fish war" that engulfed the northeast Atlantic. We will contrast this management failure with a successful international management scheme and discuss the factors that appear to have made that effort successful. The goal is to illuminate lessons from these experiences in order to help make future cooperative efforts a success — so people and nature can prosper together. The health of ecosystems and the livelihoods and food security for millions of people are at stake.

The Mackerel Wars — What happens when agreements don't reflect reality on the water

Until the early 2000s, an abundance of Atlantic mackerel was centered in waters divided among the European Union, Norway and the Faroe Islands, and agreements were in place among these countries regarding how to manage that shared stock sustainably. However, partly due to a warming ocean, the mackerel drifted north and west from their historic grounds. By 2007, fishermen in Iceland were also catching mackerel in relatively large numbers.

As Iceland increased its catch of mackerel, the countries that historically caught the species sought to maintain their same share of the harvest pie. They maintained catch rates similar to historic levels while Iceland unilaterally increased its catches. This resulted in an increase in overall catch, overfishing of the resource and the loss of that fishery's Marine Stewardship Council (MSC) sustainability certification in 2012. Not long thereafter, the EU began to threaten Iceland with trade sanctions over its take of mackerel, and the conflict escalated, with each side blaming the other. The threat of sanctions ultimately resulted in Iceland reducing its take of mackerel, which resulted in MSC recertification in 2016. However, despite some progress in returning the fishery to sustainability, overfishing of the mackerel resource and conflict among users continues. MSC certification was suspended in 2019, and the EU has again threatened Iceland with trade sanctions over its take of mackerel — a clear sign that tensions over this resource are far from over.

The "mackerel wars" are just one example of shifts in the distribution of fish stocks causing significant challenges for fisheries managers on an international scale. Similar examples can be found in other places around the world, and these shifts (and the resulting challenges) are only going to become more frequent as climate change continues to warm ocean waters. Countries need to proactively work to build agreements that can accommodate shifting locations of fish stocks. Fortunately, there are successful models that can help guide these efforts.

Pacific skipjack tuna— What happens when countries collaborate in real time

While Pacific skipjack tuna are widely distributed throughout the western and central Pacific Ocean, most of the catch occurs in the waters of eight Pacific Island countries (Micronesia, Kiribati, the Marshall Islands, Nauru, Palau, Papua New Guinea, the Solomon Islands

and Tuvalu). Alone, each of these countries would have little ability to manage skipjack tuna in a sustainable fashion. However, these countries elected to band together under the Nauru Agreement, collectively managing skipjack tuna in their exclusive economic zones, or EEZs, which together encompass an immense geographic area that covers a significant proportion of the range of Pacific skipjack tuna. This provides them with enough leverage to sustainably manage the fishery together. The Parties to the Nauru Agreement (known to many as the PNA) limit fishing effort on skipjack tuna and do so in a way aligned with scientific advice. They also follow other elements of fishery management best practice, such as well-defined user rights and accountability. The result is a well-managed fishery that has been certified as sustainable by the Marine Stewardship Council.

While the PNA provides an example of an international agreement that is working to promote the sustainable fishing of a shared resource, these types of arrangements are unfortunately not commonplace around the world. In fact, in many places, reaching a working agreement is hampered by international disagreements that may have nothing to do with fish. So, why have international agreements been successful here and not in other parts of the world? There are many factors that determine whether an international agreement will be successful, including:

- All parties to the agreement gain from cooperation;
- The principles of fairness and equity guide decisions about allocation and access;
- The parties have similar goals in terms of stock and yield size; and
- The parties have a common understanding of the science concerning stocks of interest.

These elements must often be built sequentially, such as starting with the development of baseline scientific information about the fishery and changes in the environment that affect it and a shared understanding of that knowledge among the respective scientific agencies of different countries. Without this common understanding, it can be difficult for countries to make progress negotiating the management of shared stocks. One example of the development of this type of shared knowledge base is the work that Environmental Defense Fund is doing with fishery science agencies in Chile, Peru and Ecuador, covered in a recent blog post.

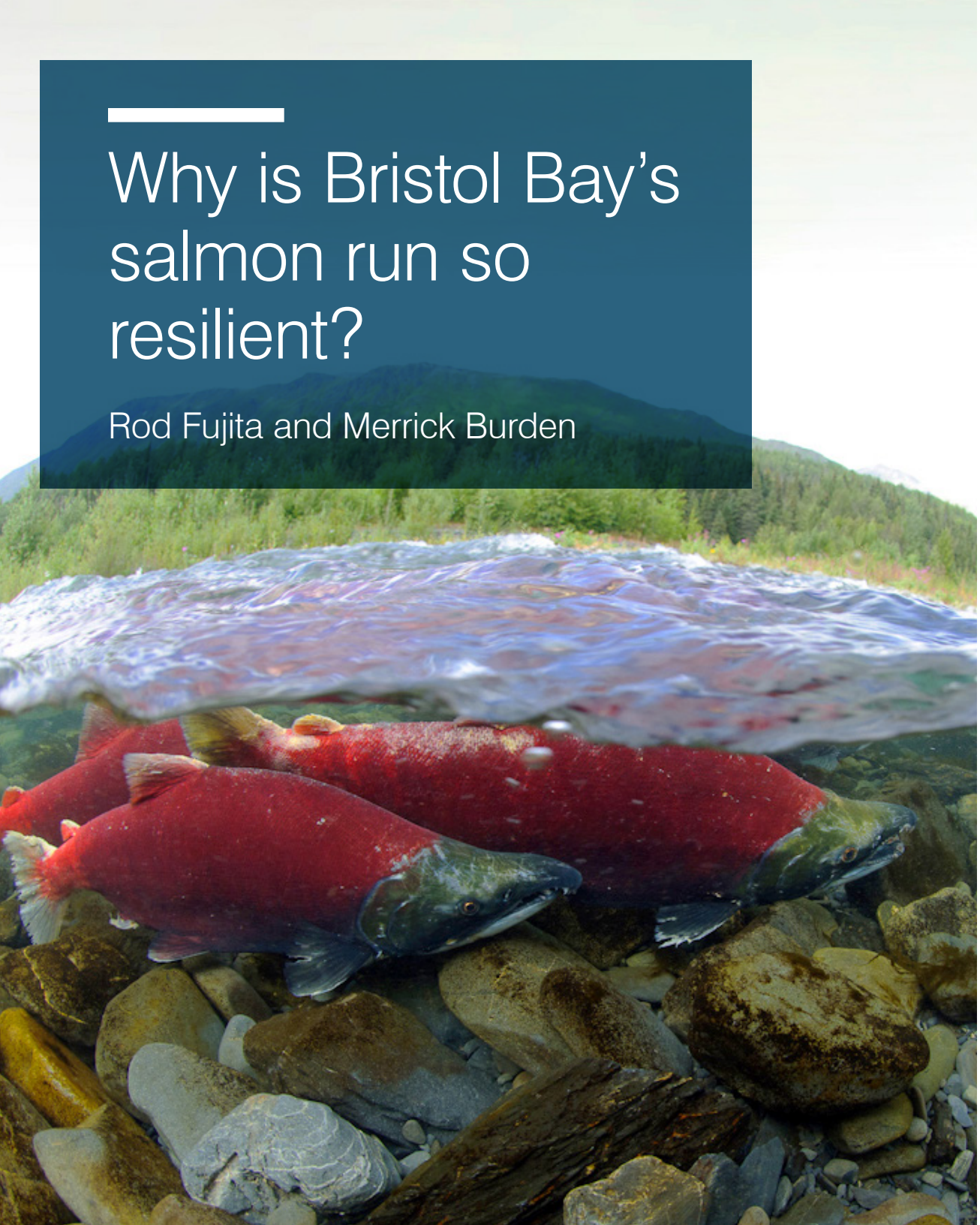
Building international agreements that work

As climate change causes fish distributions to shift poleward, strong stock-sharing arrangements like the PNA will be increasingly important around the world. By working together, Pacific Island countries have been able to promote the sustainable fishing of skipjack tuna in the Pacific.

Building international cooperation to sustainably harvest stocks as they shift across EEZs will be a challenge. However, there are examples of successful agreements based on strong science where parties promote practices that foster trust and buy-in among themselves and with new entrants to the system. These examples give us guidance in building fair and equitable allocations and access arrangements, which will help ameliorate the negative effects of climate change on fisheries so fish and people can be more resilient and realize a prosperous future.

Why is Bristol Bay's salmon run so resilient?

Rod Fujita and Merrick Burden



Bristol Bay, Alaska, supports the largest sockeye salmon fishery in the world. The annual salmon run is often described as one of the greatest wildlife migrations on Earth. This salmon run has a large economic impact, generating over $280 million directly to fishermen and supporting about 14,000 seafood-related jobs. This is in addition to the important subsistence and cultural role it plays for many communities in the region. Bristol Bay salmon have remained abundant for over a century despite intensive fishing and climate change. Why?

Diversity matters a lot for the resilience of salmon stocks and fisheries. Five major rivers drain into Bristol Bay, and each river system contains a number of tributaries with high levels of habitat complexity. There are also five distinct salmon species that return to the system at various times of the year. Within each species and river system, there are many genetically distinct subpopulations. This diversity in habitats, run timing and genetics seems to be critical for hedging against catastrophic declines in salmon abundance.

In the Bristol Bay watershed, natural disturbances occur fairly frequently. Trees and rocks fall into rivers, altering small patches of habitat. Earthquakes and floods change large swaths of habitat pretty dramatically. Very high temperatures have been recorded in some habitat patches, perhaps reflecting climate change impacts. In some cases, certain habitats don't change much in response to disturbance, but in other cases habitat quality — and hence salmon survivorship and abundance — has declined drastically within habitats. Sometimes, an entire river system becomes less amenable to salmon production and so the run size decreases in that river. Nevertheless, regardless of the scale of disturbance, the system as a whole — and the salmon within it — has remained very productive.

One factor that contributes to the ecological resilience

of this system seems to be that the habitat patches undergo change and adaptation naturally. For instance, habitat areas will accumulate materials and energy and become relatively stable. This is followed by a disturbance of some kind (earthquake, high water, etc.) and a subsequent release of the accumulated materials and energy. The system then reorganizes itself — sometimes basically the same habitat reappears in the same place and sometimes new habitats are created elsewhere. Importantly, the habitat patches undergo these cycles at different times. Of equal importance is the lack of anthropogenic stresses (other than climate change) that disrupt the natural processes that form habitat and give rise to the complexity, diversity and variation necessary for resilience.

It would be impossible for humans to manage the extremely heterogeneous habitat patches that make up the habitat mosaic of the Bristol Bay watershed better than nature does. Instead, the state and local communities oppose activities that would reduce heterogeneity (pollution, dams, levees, etc.) and habitat quality. The community is united in resisting development (like the Pebble Mine) that would disrupt the natural processes that shape diversity and productivity in the system. However, recent developments at the federal level have drastically increased the risk of mine development in spite of local opposition. Such a development poses an enormous risk to the continued ability of the Bristol Bay ecosystem to support the abundance of salmon we have come to know and expect.

Notwithstanding the threat posed by a development like the Pebble Mine project, the Bristol Bay watershed is managed primarily to maintain natural processes and structures to support the salmon run and the associated fishery, which is the main source of employment, revenue, culture and sustenance for the entire region.

It is possible that there are several trade-offs associated with this kind of management. One trade-off might be high volatility in some places in exchange for the resilience of the salmon population as a whole. For example, in 2018 Lake Beverly (only 0.01% of global salmon habitat) produced 13% of global wild salmon yield. Other trade-offs exist where some salmon yield may be forgone when fishery restrictions are put in place in order to meet upriver salmon escapement goals (the number of fish that must escape the fishery and return to inland habitats to spawn each year in order to maintain desired yields over the long term).

Alaska strives to achieve its salmon population sustainability goals in several ways. They use habitat carrying capacity models, set escapement goals, project population size, monitor the exploitable population in real time, engage in in-season management measures, adjust season length, limit effort and make other changes to control fishing mortality.

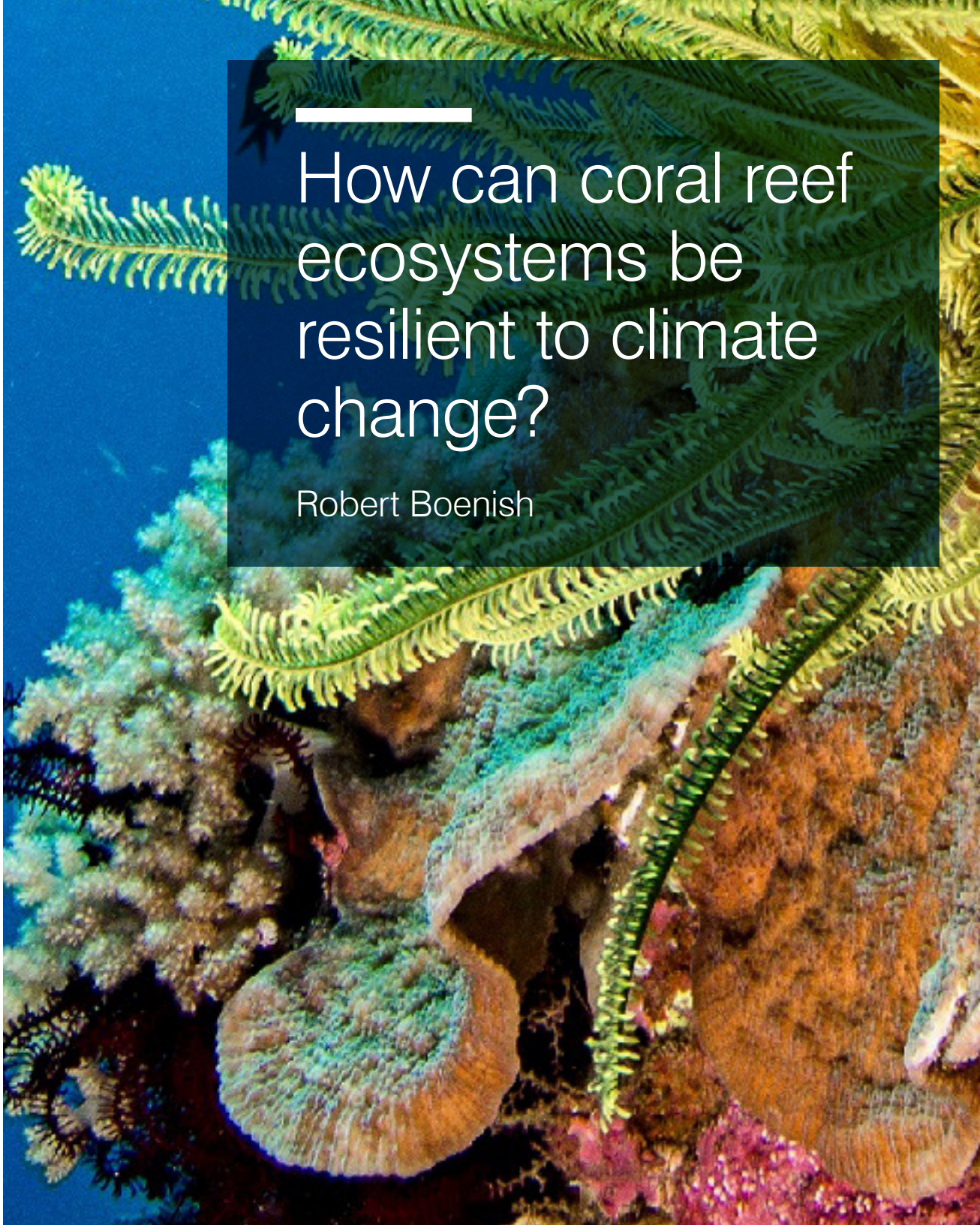
This comprehensive management strategy requires the capacity to plan, project into the future, monitor performance of the fishery and rapidly adjust management measures — all hallmarks of a management system that helps foster resilience. It also reflects some degree of humility and an acknowledgement of the limits of predictability, meaning that management measures are not set based just on model projections, but rather on a combination of projections and real-time fish counts.

There are several other aspects of this social-ecological system that may contribute to its resilience. The strength of the salmon run is very salient and observable by all, providing feedback to fishery stakeholders about the efficacy of management and their own fishing practices. There is also a collective memory of the overfishing, stock depletion and fishery collapses resulting from a more shortsighted management approach enacted prior to statehood in 1959. The fact that the current management system focuses on salmon escapement is associated with abundant runs for decades following statehood. This helped engender faith and trust in the current management system and contributed to the enshrinement of these management principles in the state's constitution.

The ecological resilience of the Bristol Bay system appears to be related to the high degree of genetic diversity within the salmon meta-population, habitat patchiness and un-synchronized adaptive cycles that occur within the habitat patches. Policymakers add to the resilience of the system by ensuring that salmon management focuses on sufficient numbers of salmon returning each year to spawn, rather than on maximizing yield. There is widespread trust in this management approach due to recent successes and a memory

of early fishery failures due to more shortsighted approaches. Our experience here gives us one example of what ecosystem resilience looks like, and how that resilience can be supported by the people who depend on the resource most.

Stay tuned for more stories of fisheries resilience in this series. We are looking forward to working with stakeholders to help ensure that future fisheries and fishing communities are resilient to climate change.



KENDRA KARR

How can coral reef ecosystems be resilient to climate change?

Robert Boenish

Coral reefs are highly vulnerable to climate change and are already experiencing mass coral bleaching and die-off events worldwide. It's no secret that coral reefs need our help. Recent estimates indicate that half of the Great Barrier Reef was decimated by bleaching events in 2016 and 2017. This trend is alarming on many levels. Coral reefs are a hotbed of biodiversity and abundance, and coral reef fisheries are critically important to the livelihood and food security concerns of millions of people — many of whom live in developing countries.

In the face of climate change, the question becomes: Are there ways we can improve the resilience of tropical reef systems so they can withstand or adapt to changing ocean conditions? In this post we'll talk about some recent research we've co-authored with the University of Maine and University of California, Santa Barbara that gives us some hope for coral reef ecosystems. This research shows how coral reef systems have been made more resilient in the Caribbean and indicates that fisheries management has a strong role to play in fostering this resilience.

Recent research gives us some hope for coral reefs

These findings are encouraging because they go against the common perception that future generations will only be able to experience these natural treasures through photos and videos from a bygone era.

This research focuses on the island of Bonaire, which is lauded as one of the last healthy coral reefs in the Caribbean. It is no accident that reef species here have managed to proliferate even after significant environmental disturbances like warming waters and coral disease. Our results show that smart fishing regulations and environmental protections have contributed to the island's almost unparalleled ability to recover from these large environmental disturbances. Several years ago, coral cover in Bonaire dropped by nearly 25% following damage from a hurricane and a coral bleaching event. However, after less than a decade, corals had recovered to pre-bleaching levels — something very unique compared to other places in the Caribbean.

One of the biggest factors for Bonaire's ecosystem resilience is the abundance of herbivorous fish, like parrotfish. Often when a reef experiences a disturbance, harmful algae displaces and outcompetes coral. In Bonaire, fishing regulations and protections have ensured a large

PAUL ASMAN/FLICKR

abundance of parrotfish, a species that actively serves as an algae hedge trimmer. In other words, coral recovery in Bonaire occurred following hurricane and bleaching events in part because the presence of herbivores like parrotfish kept harmful algae in check.

What could this mean for other coral reefs?

The dynamic between herbivorous fish and climate change uncovered in Bonaire is a feedback mechanism. Unmanaged fishing and climate change together can be perilous to coral reef ecosystems. Being aware of species interactions such as these is one aspect of resilience practice, and in this case, the solution is to reverse this feedback loop in order to help facilitate coral reef recovery. This is done by ensuring healthy populations of herbivorous fish.

Even in the Caribbean, Bonaire is not alone in its mission of working toward managed ecosystem resilience. There are a variety of ways to address these types of feedbacks and to maintain ecological balance through implementation of different types of fishery management practices. In several places where Environmental Defense Fund (EDF) works, such as in Belize and Cuba, spatial protections and other measures are being deployed in ways that maintain populations of important herbivores. The health of these systems indicates that they too are displaying resilience. In these Latin American-Caribbean countries, the use of spatial measures and other types of fishery management approaches are being deployed in ways that can enhance reef resilience.

In the Garden of the Queens in Cuba, fishing communities recently enacted a sustainable fishing law that is poised to advance

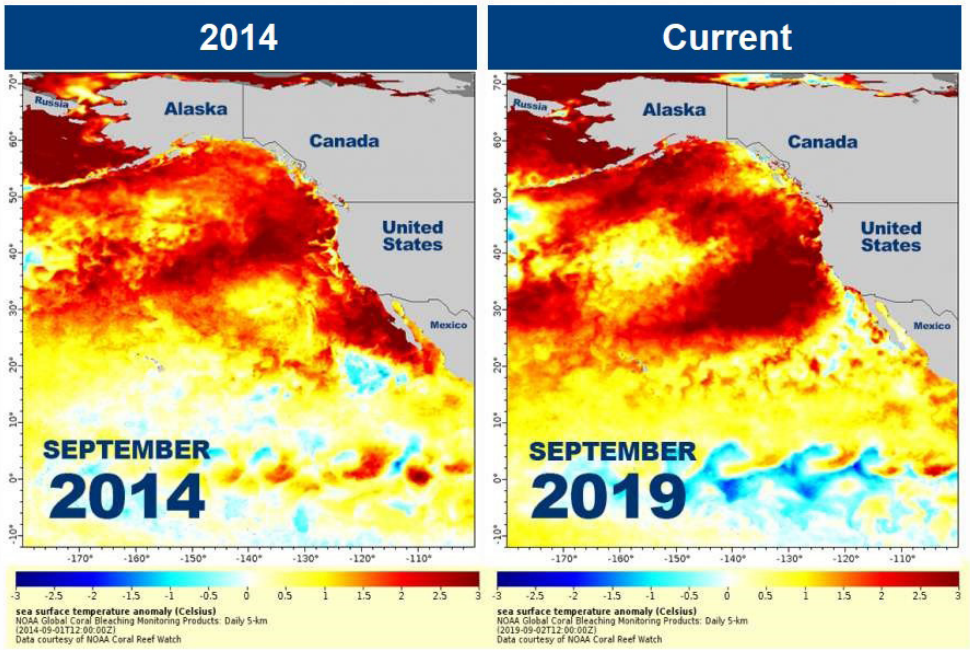
Cuba's goals of protecting its natural environment for more fish in the future, more fishing jobs and prosperous marine ecosystems including coral reefs. Cuba has set aside more than 250 natural reserves spanning over 20% of its territory. One of the most spectacular reef systems in Cuba, the Garden of the Queens is one of Cuba's natural reserves. The implementation of reserve status has resulted in a substantial increase in the abundance of fish species and the system is displaying greater resilience than other systems around the Caribbean.

In Belize, the nationwide system of managed access resulted in higher fish catch for fishermen while reducing illegal fishing by 60% and expanding marine protected areas (MPAs) from 3% to 10%. Coral reefs the world over also have potential to recover if local communities are able to identify and manage the threats they can control, including fishing pressure, pollution and habitat destruction.

While these examples give us some hope for coral reef ecosystems, we must be clear that the global community needs to reign in our emissions if the oceans of the future will support thriving coral reef ecosystems. Building resilience of highly vulnerable ecosystems can help — but only so much. In the face of some limited disturbances, these experiences show that coral reefs can be made more resilient, and fishing practices have a large role to play. We will continue working with fishing communities around the world to apply and adapt these lessons learned in the Caribbean to other coral reef ecosystems.

The return of the blob: How can we help fisheries adapt to warming waters?

Rod Fujita



There's a lot we don't know about how climate change will unfold. Unexpected events will occur, and when they do we will need to adapt and learn from those experiences. Here's a story about one of these climate surprises: the "warm blob" in the Pacific Ocean. Scientists observed a warm blob of water forming off the U.S. West Coast in September, five years to the month after a similar blob wreaked havoc on marine ecosystems and fisheries in this region. It's enormous, stretching from southern California all the way to Alaska. When the first blob formed in 2014, whales started to feed in nearshore waters and got entangled in fishing gear. Thousands of young sea lions stranded themselves on beaches. A huge harmful algal bloom formed, contaminating shellfish. Multiple fishery disasters were declared.

Forecasters say the 2019 blob could break up and dissipate harmlessly. But — because they are scientists — they also say that if the cold water upwelling from deeper layers of the oceans slackens, the blob could expand instead. So, there is a lot of uncertainty. The good news is that a new monitoring system is now in place that actually detected the warm blob while it was forming this year. This could help natural resource managers and the fishing industry plan and adapt in real-time.

Even better, the National Oceanic and Atmospheric Administration has convened a group of experts to interpret the monitoring data and provide advice to working groups of fishermen, fishery managers and others that formed along the West Coast in response to the first blob.

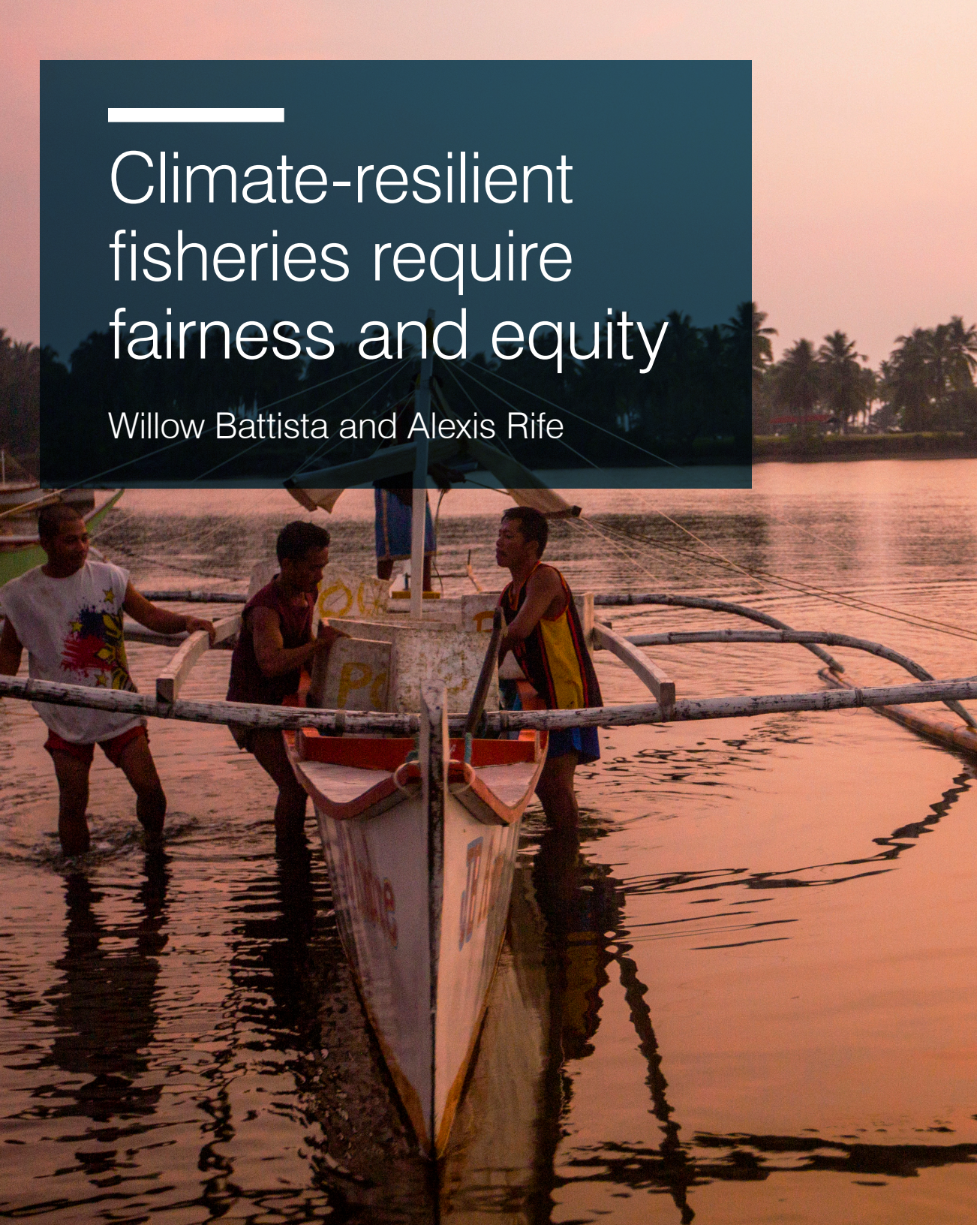
This illustrates the first steps toward responsible adaptation to changes in the ocean, some of which may become more frequent or intense as a result of climate change. Marine heat waves (the scientific term for warm blobs) seem to be increasing in intensity, perhaps as part of a long-term increase in ocean temperature as the ocean absorbs heat from the atmosphere.

We must all continue to work on reducing greenhouse gas emissions and increasing natural carbon sinks like forests and soil — and also the ocean's biological carbon pump — to slow global warming down in order to reduce impacts and costs. But the earth is already warming, and we are locked into even more warming no matter what we do because of past emissions and reductions in carbon sinks, so we have to work toward solutions within our current reality.

The best way to do that is to monitor, interpret data, plan ahead and adapt. Even the best monitoring data are useless unless people who understand the data and ocean ecosystems interpret them and provide guidance to stakeholders and managers. And then, of course, managers have to promulgate regulations that take projected changes in the ocean into account; stakeholders have to comply with the regulations; and the regulations have to be evaluated to see if they work so they can be adjusted as needed.

These are the basic tenets of effective fisheries management — monitoring, data interpretation, science-based regulations, strong accountability measures and adaptive decision-making. This will remain the recipe for success in the face of climate change, but the science, as well as the management goals and benchmarks, will need to be updated to reflect changing ocean conditions.

Along the West Coast, the monitoring system is in place, and experts have been convened to interpret the data. It remains to be seen whether the other elements for successful adaptation will be put into place. Will resource managers take the monitoring data into account when setting regulations? Will stakeholders buy in to those regulations and comply with them? Will the regulations be regularly evaluated in order to make them better and more responsive to more changes in the ocean? The stakes are high, given the wide-ranging impacts of warm blobs.



Climate-resilient fisheries require fairness and equity

Willow Battista and Alexis Rife

Issues of social equity and fairness are central to functioning societies across the globe. When there is the perception of systematic unfairness — or an imbalance of equity within a society or group — unrest is sure to follow. You can see this playing out in real-time just by turning on the news.

The same dynamics apply to the allocation of natural resources, especially those that relate directly to human well-being, including food, health and shelter.

Fisheries are no different — and their systems of governance and management are deeply woven into the social fabric of many societies around the world. This means that issues of unfairness and inequity in fisheries have an outsized impact on many nations that rely on fish for food, nutrition and livelihoods, which are most prevalent in the developing tropics and Global South. And these issues will only become more critical as we factor climate change impacts into the equation, since those burdens will fall most heavily on the shoulders of those who are least prepared to deal with the weighty consequences.

In fact, successful fisheries governance systems can be severely undermined by even the perception of inequity. In the worst cases, unfair access can be enough to induce conflict, and “fish wars” can result. Even without such overt fights, lack of buy-in to management systems among all participants can undermine management effectiveness, with both social and ecological consequences. Where sustainable management systems are not yet in place, inequity also affects the feasibility of achieving necessary reforms.

Further, in the context of climate change, inequity hinders the ability of a society to adapt as ecological systems change. As important and valuable target species increasingly move away from their historical locations, the durability of management systems will be put to the test.

Failure to adapt in the face of climate change will undermine a society's efforts at sustainability.

Of course, inequity is bad, all by itself. And inequity exists at many scales, not just within the ambit of a particular fishery or fishery management system. At the very largest scale, inequity exists where developed nations are disproportionately responsible for climate pollution that disproportionately impacts the developing tropics. These regions are home to many of the world's most vulnerable people and much of the world's most important biodiversity centers. It is time to push our collective understanding of climate change to identify not only the likely winners and losers, but also to find ways to make sure that impacted people are treated fairly, as even those changes already baked into global climate change are realized.

A Case Study: Squid Wars in Chile

Chile is in the news this month as protests, both violent and peaceful, have erupted around the country and have become a "national crisis." Protests — some in the millions of people — are still going strong. These protests were spurred by rising costs and growing inequities in the country. However, this wasn't the first time this year that Chile was rocked by social unrest. In January, protests erupted over access and gear types in the important Humboldt squid fishery, resulting in increased access for the small-scale fleet and gear changes for the industrial fleet.

In the current global political context, where millions of people are engaging in protests, it may seem like the use of one gear or another to catch squid is a small issue to spur such unrest and violence. However, what the so-called "squid war" has in common with these other protests around the world is that, at heart, they are rooted in issues of inequity and the societal power imbalances created by it.

In the early 2000s, the Humboldt squid's range began to change, partly driven by climate change, poleward along the southern coast of Chile, prompting more fishers — both artisanal and industrial — to want to take part in this fishery. In January 2019, the Chilean government, seeking sustainability of the fishery, introduced a bill that sought to prohibit the use of mid-water trawls (the favored gear of the industrial sector). The industrial fleet immediately pressured for a veto. At this news, however, the small-scale sector began protests and demonstrations, claiming that the trawl fishing results in overfishing and ecosystem damage, and citing the industrial sector's historically powerful influence on policy decisions that impacted both groups.

LUCIANO HIRIART-BERTRAND

The squid war is a testament to the challenges of equity and fairness that fishers and fishery managers are beginning to (and increasingly, must) grapple with the world over as climate change causes fishery ranges to shift and harvests to change. In fact, climate change-driven "fish wars" are already happening in other places too, and as the effects of climate change progress, we can expect them to happen more and more. These conflicts point to a critical lesson for our efforts to build climate resilience in global fisheries: if fishing communities and nations are going to be able to transform and adapt to changing conditions, decisions and interventions must be guided by the principles of equity and fairness. If they are not, progress will be hindered and outcomes will be worse.

Equity and Sustainable, Climate-Resilient Fisheries

Inequity, both driven by and leading to systemic prejudice and power imbalances, has existed the world over since long before the impacts of climate change began to surface, including in fisheries management disputes around the world. It is critical that we not let the onset of overt climate change disguise or conceal these pre-existing conditions or obscure underlying culpabilities.
It is clear, however, that climate change is going to worsen existing fisheries access and potential fish production inequities, both within and across groups.

Some of the most vulnerable and historically-marginalized peoples around the world, especially those in the developing tropics, will be hit hardest by climate

change impacts. This is true at a global scale, where research shows that individual fish stocks will move poleward and total fish production potential will move away from coastal communities in the developing tropics, where reliance on local fisheries for livelihoods and food security is highest. At the local or sectoral scale, these mostly small-scale fishers are particularly vulnerable, with less financial flexibility and higher degrees of reliance on specific places and species. Thus, it is both a moral and a practical imperative that climate-resilience-building efforts address and reduce the resulting fisheries inequities.

But there are other reasons to let the principles of fairness and equity drive climate-resilience interventions in fisheries management and governance. One is that inequity drives instability and lowers social cohesion, and when paired with changing access to resources, it will reduce the resilience of societies, limiting their ability to transform and adapt to the effects of climate change.

Truly sustainable fisheries management should also ensure that effective solutions are successfully taken up and implemented. One way to do this is by making sure impacted groups are part of decision-making processes. Doing so helps to ensure plans and policies adequately consider the full range of implications, and it also increases social buy-in to policy change and ensures that new management measures are perceived as legitimate.

These are among the most important factors for ensuring successful implementation of, and compliance with, changes in management that aim to build climate-resilient fisheries. In addition, inclusive, participatory decision-making facilitates the incorporation of critical local knowledge from impacted communities who likely have good ideas about the best ways to mitigate and adapt to the oncoming changes!

In addition, as developed world societies accelerate their financial contributions to those on the receiving end of damage caused by climate emissions, there are many ways to focus investments in ways that offset impacts on the most vulnerable populations. In the fisheries arena, that can include direct investments in climate-smart fisheries management and governance, but also in “blue carbon” projects that can dampen negative effects of rising seas and intensifying storms while simultaneously improving essential habitats for fish populations, such as mangrove swamps and seagrass beds. Properly designed fisheries management and blue carbon portfolios can help reinforce each other, while reducing negative effects on both human and natural communities. Resources are already available from the Green Climate Fund and other sources to begin trying this idea out.

Finally, examining climate-change impacts and challenges through an equity lens can help to identify and address the underlying drivers of both inequity and climate change, thereby leading to the creation of impactful, lasting solutions. Thus, equity must be an input to climate-resilience decision-making, not just an output of it.

How to address equity in climate-resilient fisheries work is a challenge the world over. But, it is essential to begin moving forward now to factor these needs into climate-smart fisheries designs in order to make the rapid adaptations and transformations societies will need to make to deal with climate change.Fortunately, scientific knowledge can help guide that process in three particular focus areas:

1. Distribution of benefits and damages. In building climate-resilient fisheries, care must be taken to ensure there are no clear winners and no clear losers as a result of climate change. This applies to the distribution of benefits and damages within groups, as well as across groups at an international scale — and everything in between. In particular, when considering the implications of climate change on the developing tropics, equity considerations dictate that the developed world must provide support to impacted communities as systems transition.

2. Truly participatory decision-making processes. As discussed above, to be equitable, decisions made regarding both the interpretation of climate-impact information and the best course of action to respond must be transparent, inclusive and human-centered. Many tools, resources and approaches exist to help facilitate participatory fishery management decision-making, and these same tools can be valuable as we work toward climate resilience.

3. Recognizing and respecting the identities of different groups and individuals. Different group identities (e.g., race, gender, class, age, etc.) can be associated with different levels of marginalization and vulnerability and with differential abilities to participate in decision-making and to adapt to change. We need to understand how each impacted group perceives climate impacts, build capacity for management in order to empower marginalized groups and increase their agency and foster discussions where individuals and groups can work together, support one another and learn from each other.

When we look at impacts of climate change on fisheries through an equity and fairness lens, society can develop higher-leverage, more impactful and more sustainable solutions. By building fisheries management in a way that promotes fairness and equity, the world can foster social resilience, which in turn will help support the transformative change necessary to create thriving fisheries and fishing communities in the future.

Building Fisheries for the Future

Merrick Burden

Climate change is here and can only get worse. This promises to scramble the oceans in ways we do not yet fully understand, and it poses nothing short of an existential risk to marine ecosystems and the people that rely upon them for livelihoods and food security. Yet, the future is not without hope. If we can stem emissions, there is reason to believe that the sea can continue to host abundant and diverse life and support the economic, social and food needs of society. But we must get started now.

As we wrap up this series, multiple efforts are underway — or have recently commenced — to move global society to address the effects of climate change on fisheries. Just this fall, we have seen the importance of addressing climate change in fisheries highlighted in the IPCC Special Report on the Ocean and Cryosphere in a Changing Climate, at events during UN Climate Week, at the FAO International Symposium on Fisheries Sustainability, and shortly, at COP25 (often referred to as the "Blue COP"). Early next year the High Level Panel for a Sustainable Ocean Economy will release its findings. These high-visibility global events are serving a much-needed purpose in raising the specter of this issue and motivating global society toward constructive change. The question, of course, is "how will society react?"

In this series, we have drawn upon our experiences to outline several key priorities, focus areas and strategies that practitioners around the world can embrace in order to build more resilient fisheries and to ensure that society reacts in the most constructive manner possible. These key priorities, focus areas and strategies can be described as:

1. Ensure effective fishery management and governance is in place

Addressing climate change effects on ocean fisheries will require a certain level of fishery management sophistication. This means that, in places where effective management and governance does not yet exist, the first step must be the establishment of effective management and governance and the implementation of best practice. Without it, there's very little that can be done to address climate change effects.

2. Anticipate and plan for future change

Looking ahead and planning for the future can help us avoid problems that may otherwise arise. When we look toward the future, we should ask ourselves whether all aspects of management and governance systems are set up appropriately in the face of future change. For instance, we should ask ourselves questions like: Are our existing fishery management goals appropriate? Are management plans focused on the correct geographies? Are scientific evaluation tools set up in ways appropriate for future conditions? Are management benchmarks appropriate for future conditions? What sort of conflicts (allocation or otherwise) will arise in a future world? And, what sort of risks does the future hold in store to the integrity of the management system? By anticipating these changes ahead of time, we can begin the important process of adaptation and transition before problems occur.

3. Enhance international cooperation

Most fish stocks are expected to move as a result of climate change, and this means that the geographic scale of management must change along with it if we hope to manage stocks sustainably across their range. That means we must get better at international cooperation. Fortunately, there are successful models that we can learn from.

4. Build general resilience of the ecosystem to help respond to the unknown

We must humbly acknowledge two important aspects of climate change: 1) That there is a lot we do not know about how climate change will unfold, and 2) it would be impossible for mankind to manage all consequences of climate change even if we could foresee them. When we acknowledge these realities, the rational response is to help ensure marine ecosystems are made resilient. This means elevating the importance of things like genetic and biological diversity, habitat complexity and connectivity, ensuring adequate population sizes of marine species and more. By bolstering these kinds of resilience attributes in marine systems, we can help that system to resist and recover from climate-related shocks — including those that we do not anticipate.

5. Use the principles of fairness and equity to drive policy decisions

Inequity is already a concern at global and local levels and climate change promises to exacerbate these problems, with societies in developing equatorial nations standing to suffer the most severe consequences. Such inequity of effects raises many moral issues, especially when we consider that many places that will suffer from climate change are the places that have contributed the least to it. Therefore, working to address and reverse these inequities is simply the right thing to do. However, issues of inequity and fairness also relate directly to the acceptance and durability of sustainable fishery management systems. In the face of climate change, we will be asking large swaths of society to make large adaptations and transformations as the ocean system changes around us. History shows us that society is far more likely to embrace and continue to support these kinds of changes when society perceives the process as fair and the outcomes are equitable. Thus, addressing issues of fairness and equity are important for two reasons:

1. it's a moral obligation on the part of the developed world, and
2. our success at implementing climate-smart fishery management depends on it.

While shifting standard approaches to align with these key strategies may seem complicated, in reality, learning and adapting are an inherent part of effective fishery management. Indeed, many would say that the ideal governance system would be based on ecosystem-based adaptive management, which inherently relies on flexibility and improvements through time. However, climate change will release greater and faster changes than expected, requiring more nimble adaptation. As events unfold, we will need to view them as learning opportunities and adapt management, science and monitoring in ways commensurate with that experience. This will help us to continually get better at refining our approaches to fisheries management in the face of climate change.

Doing all of this on a global scale is a tall order. However, the fact is that we are already doing these things in many places. As we do so, we are learning a great deal from these experiences that we can use to help advance climate-smart fishery reforms elsewhere.

National Headquarters
257 Park Avenue South
New York, NY 10010
212-505-2100

edf.org
resilientseas.org

Austin, Texas
301 Congress Avenue
Austin, TX 78701
512-478-5161

Bentonville, Arkansas
1116 South Walton Boulevard
Bentonville, AR 72712
479-845-3816

Boston, Massachusetts
18 Tremont Street
Boston, MA 02108
617-723-2996

Boulder, Colorado
2060 Broadway
Boulder, CO 80302
303-440-4901

Chicago, Illinois
200 East Randolph Street
Chicago, IL 60601
312-235-3120

Raleigh, North Carolina
4000 Westchase Boulevard
Raleigh, NC 27607
919-881-2601

Sacramento, California
1107 9th Street
Sacramento, CA 95814
916-492-7070

San Francisco, California
123 Mission Street
San Francisco, CA 94105
415-293-6050

Washington, DC
1875 Connecticut Avenue, NW
Washington, DC 20009
202-387-3500

Beijing, China
C-501, Yonghe Plaza
28 Andingmen East Road
Dongcheng District
Beijing 100007, China
+86-10-6409-7088

Jakarta, Indonesia
Jl. RS Fatmawati Raya No.15
Komplek Perkantoran Golden Plaza
Blok E No.12
Jakarta Selatan 12420 Indonesia
+62-21-769-8829

La Paz, Mexico
Revolución No. 345
E/5 de Mayo y Constitución
Col. Centro, CP 23000
La Paz, Baja California Sur, Mexico
+52-612-123-2029

London, UK
6 Borough High Street
London, SE1 9QQ, UK
+44-203-310-5909