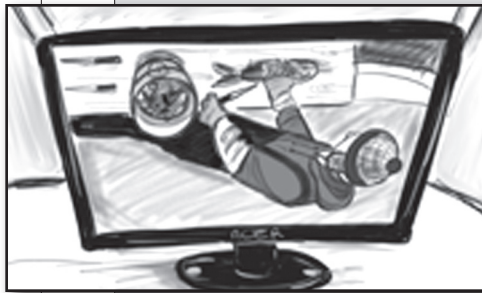
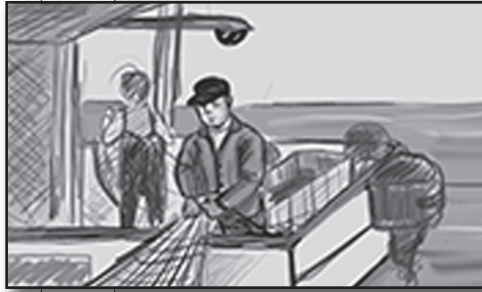




Increasingly, governments are turning to technology to help manage fisheries and assure compliance with regulations. In the United States, however, adoption of electronic monitoring has faced institutional and cultural resistance.



# The Future of Fishing

*With stocks already stressed by over-harvesting, the dual obstacles of population growth and climate change are likely to challenge marine species like never before. And it is here where policy transforms their health from a local issue into an issue of global security*



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Once upon a time, food was a local concern. Diets were largely restricted to foods endemic to a particular locality. The line between producer and consumer was blurred, as nearly everyone in a community played a role in food production. People were more attuned to the health and fecundity of their agricultural lands, waters, and other natural resources because lack of attention could have dramatic and adverse consequences to individuals and their communities.

Today, we are no longer beholden to local cultivars and limited growing seasons in determining what we eat. Instead, we have near-on-demand access to a dizzying array of products from around the globe, aided by the rise of new technologies, the emergence of global supply chains and cheap fuel, and the proliferation of middlemen and supermarkets. While this shift from local to global has greatly benefitted choice and cost, it also has limited the consumer's ability to know where food is from and under what conditions it was grown or harvested. In short, we have become increasingly disconnected from our daily bread.

Few examples illustrate this disconnect — and the local to global shift — better than fish. In the United States, there was a time when people only ate fish native to their region. Local fishermen supplied the local fishmonger with a limited selection of fresh fish caught in local waters. Consumers purchased those fish whole and consumed them

immediately to avoid spoilage. This all changed about fifty years ago with the advent of refrigeration and other technologies and processes, which transformed fishing into a truly global commercial endeavor with huge markets from coast to coast.

Under this new world order, fish can be caught in the middle of the ocean, transported to one or more countries for processing, and then sold in a third, perhaps thousands of miles from the nearest sea. Refrigeration enabled commercial fishers to work longer and farther from shore. Global demand increased and seafood companies with long supply chains introduced consumers to a fantastic array of exotic species, including Patagonian toothfish (rebranded as Chilean sea bass), orange roughy, and yellowfin tuna. New processing and preservation techniques allowed supermarkets to stock fish in various formats — filets, cans, and sticks. Over time, fish became just another commodity product on grocery shelves — recognizable by brand label rather than by species markings — giving consumers little reason to reflect on how a species was caught or what it took to get the fish to their plates.

While the adoption of modern technologies and the growth of global markets have had some benefits for consumers, these developments have not been good for fish. Innovations enabling commercial boats to become more efficient in their catch have also made it much easier to over-fish. Enamored with the promise of these innovations

as well as the prospect of new markets for seafood products, many countries — including the United States — implemented well-intentioned policies aimed at supporting domestic fishing industries. Unfortunately, these measures had unintended consequences and led to the unsustainable harvest of many species. Consequently, many fish stocks saw dramatic declines, which, in turn, required government intervention.

In the United States, the economic and ecological harm wrought by overfishing led Congress to enact amendments to the Magnuson-Stevens Fisheries Conservation Act in 1996 and 2006. The MSA amendments imposed increasing obligations on the government to curb overfishing and rebuild stocks, including a mandate that fisheries managers impose catch limits and use best available science to establish optimum yield — the number that commercial and recreational fishers can catch sustainably each year.

In the two decades since Congress began tackling the issue of overfishing, the National Marine Fisheries Service — the entity within the Commerce Department's National Oceanic and Atmospheric Administration that is charged with the legal response to oceanic endangered species — has worked tirelessly to implement these mandates. Today, the United States has a comprehensive and relatively effective fisheries management regime, and the country has made progress toward rebuilding once-ravaged stocks in its waters. The most recent NMFS study on the health of U.S. fish stocks reveals that 44 have been rebuilt and only 35 are not at maximum sustainable yield. Of these 35, however, 30 are still subject to overfishing.

**W**hile this modest success is worthy of praise, the reality is that the MSA — as currently implemented — is ill suited to protecting fisheries in the face of 21st century disruption. Specifically, the dual challenges of population growth and climate change are likely to stress fisheries like never before. And it is here

where policy transforms the health of stocks from a local issue into an issue of global security.

According to United Nations projections, global population will increase from 7 billion people today to 11 billion people by the year 2100. The vast majority of this growth will occur in Asia and Africa, which collectively will add 3 billion new mouths. Population growth presents a significant challenge for a planet already under environmental strain, and yet, the oceans stand to play an even greater role in supplying cheap and abundant protein to feed the world. This will be an immense challenge, as global fishing fleets already are traveling to the farthest reaches of the oceans in search of catch.

While many countries are attempting to operate in good faith, others are not. China, for example, has been ranked as the worst offender with regard to illegal, unreported, and unregulated fishing when accounting for its degree of exposure to and quality of response toward the problem. Beijing's malfeasance is amplified by China's status as one of the most important global seafood markets — the top exporter and third-largest importer.

Likewise, climate change is increasingly impacting global fish stocks. Earlier this year, a major United Nations report on the health of oceans and the cryosphere detailed the harm to marine health caused by overfishing and the challenge of food security in a rapidly deteriorating environment due to climate change and other stressors like pollution. Already, warming water temperatures in the northern hemisphere are causing many species to shift northward in search of cooler waters. In the Gulf of Maine, for example, rapidly warming temperatures have caused the lobster range to shift toward Canada — with devastating economic consequences for local fishers in the southern part of New England. This trend will only accelerate as global temperatures continue to climb and will likely lead to increased regional and international conflict as fish stocks cross management boundaries.

*The most recent study on the health of U.S. fish stocks reveals that 44 have been rebuilt and only 35 are not at maximum sustainable yield. Of these 35, however, 30 are still subject to overfishing.*

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## My Experience at Sea Is No Longer “Anecdotal”

The livelihoods of commercial fishermen — owner-operators personally invested in a catch-share fishery — are irrevocably linked to the scientific analyses of the health of the fish stocks they rely on, which in turn inform harvest limits.

New England fishermen spend more time observing our ocean environment than scientists do, yet their self-reported data currently have limited impact on stock assessments and management decisions. That is unfortunate.

Electronic monitoring is changing the data dynamic. And the groundfish fishermen choosing to use EM are thrilled to no longer be considered “anecdotal,” an adjective that is scientifically accurate, but can come across as condescending to those who go to sea to help feed the citizenry.

One version of EM being tested in New England uses cameras to record all fish thrown overboard. Independent auditors check the footage against fishermen’s logbooks, verifying their self-reported data, and allowing the data to be used for quota management.

There are several additional reasons why the fishermen we work with are choosing EM with cameras to secure a sustainable future. I’ll list the most important.

First, EM levels the playing field. The groundfish fishery, which includes cod, haddock, and flounders, has not experienced the rebuilding of fish populations promised by quotas and catch shares. Instead, it continues to suffer from overfishing, likely due to lack of accountability.

Inadequate monitoring of a fishery creates perverse economic incentives. During trips with human observers, fishermen can change practices to artificially reduce the discard estimates used in stock assessments. Honest fishermen who



**John Pappalardo**

Chief Executive Officer  
Cape Cod Commercial  
Fishermen’s Alliance

*“New England fishermen spend more time observing our ocean environment than scientists do, yet their self-reported data currently have limited impact on stock assessments and management decisions. That is unfortunate.”*

report accurately are thus required to lease additional quota to cover their catch, imposing a financial cost that cheaters avoid. EM provides a cost-effective way to have high levels of monitoring to identify and prevent cheating.

Second, EM collects unbiased, verifiable information. Unreported discards and biased discard estimates put bad data into stock assessments and may result in quotas that are not aligned with the reality of fish populations, which can prevent rebuilding despite cuts in quota. Bad data can also produce overestimates in abundance, creating “paper fish” and causing price fluctuations for fish quotas that can’t be caught. Fishermen hope better data will allow managers to set quotas that will help rebuild fish stocks and their businesses at the same time.

Third, EM creates a better monitoring experience. For small boats, weather windows are short and space on deck is at a premium. Not having to coordinate schedules with an observer increases flexibility. Not having an unknown person onboard increases the captain’s peace of mind: everyone on the boat knows where and how to do their jobs and there is one less person to worry about getting home safely.

Finally, EM can provide regulatory flexibility. Because EM can provide 100 percent coverage, with verifiable data, fishermen who opt into the program have been offered opportunities to fish in areas that otherwise are closed to commercial activity. In certain situations, they also can fish more than one fishery a single trip, because what they catch and how they catch it are visible. These incentives help overcome a natural resistance to cameras on deck and make EM a good choice for accountable fishermen, not punitive enforcement for scofflaws.

As more fishermen turn to EM as a tool, a few significant hurdles remain. Fishermen still have concerns about who watches their video for what purpose, how video access is controlled, and how long it is stored. The National Oceanic and Atmospheric Administration needs to build the information infrastructure to support this new data stream and make it readily available for science and management. If multiple agencies within NOAA can learn to share data infrastructure and a single data stream, there is tremendous potential for using EM to reduce the reporting burden on fishermen, streamline monitoring and reporting systems, and to improve data accuracy.

Ultimately, the risk posed by these dual challenges is so significant that global fisheries are destined for failure if governments continue to use 20th century regulatory concepts and technologies to manage the modern commercial industry. But there is hope. A recent report by a high-level panel of leaders in government argues that more sustainable fisheries management would help to save the oceans. So we have the power to flip the paradigm, but that requires systemic change that cannot be done solely by the individual consumer or business — it necessitates a comprehensive and consistent approach across a whole market sector. Thus, it is incumbent upon governments to transition toward 21st century management regimes and upon the commercial fishing industry to incorporate the newest technologies and practices.

It is for this reason that governments must mandate the adoption of electronic monitoring and reporting in their fisheries. What we call EM/R consists of a range of hardware and software inputs that includes everything from electronic logbooks to record trip data by fishers to video cameras that capture information on location, catch, and discards. It has the potential to revolutionize both fishing and fisheries management by allowing companies to work more intelligently and by enabling governments to manage resources in near-real time. These technologies — only recently entered into the market — have been made possible by the rise of Big Data analytics and the proliferation of the Internet of Things and have the potential not only to help managers ensure the sustainable and transparent harvest of fisheries resources (thereby mitigating potential conflict) but also to reconnect consumers to their food.

While EM/R has been embraced in certain jurisdictions — including the United Kingdom, Canada, and New Zealand — in the United States the technology is still considered experimental and the government has experienced a series of challenges that impede its widespread adoption. To begin with, NMFS is hamstrung by

antiquated hardware and software systems that inhibit the agency's ability to share data across regional and program offices (not to mention with external partners). Complicating matters is the fact that the agency faces resource constraints, inhibiting its ability to upgrade systems quickly and efficiently. This, in turn, makes it exceedingly difficult to picture a time when NMFS is able to effectively build the data management systems needed to make EM/R truly effective. The agency faces a future in which it will handle terabytes of data but does not yet have the capacity or the mandate to undertake the steps necessary to ensure the proper processing and storage of the information gathered by vessels.

Two additional impediments are the MSA itself, which mandates the “confidentiality of information,” and NMFS's archaic and draconian policy interpretation — known as the Rule of Three (which the agency never actually codified as a rule)— which instructs the agency to withhold information requested about fewer than three vessels

fishing in a particular area. These legal and policy constructs have their genesis in the historical concerns of fishers, who at one time retained a distinct market advantage by keeping their working locations and techniques a trade secret. This rationale for confidentiality, while legitimate, has begun to carry less weight in an era of video cameras, catch shares, mobile devices, and GPS. Nevertheless, confidentiality and the Rule of Three persist to this day — even though they inhibit NMFS and its partners from managing marine resources in accordance with the mandate of the MSA to use the best available scientific information.

While one could make the rather circular argument that EM/R's lack of penetration into the U.S. commercial fishing industry is prima facie evidence that such data are not available, this assertion could easily be dismissed if NMFS were to mandate a more modern reporting structure. But to make such a pronouncement could result in additional cost to fishers — at least in the short term. Some in the commercial industry have ef-

*Electronic monitoring and reporting, or EM/R, consists of a range of hardware and software inputs ranging from vessel logbooks to video cameras that capture information on location, catch, and discards*

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# In New Zealand, a Lone Boat Is a Pilot Project

**A** brave new maritime initiative has launched in New Zealand. The Electronic Monitoring fisheries program is the very first in the world to establish a more transparent conversation between the fishing industry and the public over how fish are caught, handled, and managed.

And now, EM provider Snap Information Technologies has installed hardware on *FV Chips*, a small inshore fishing vessel run by Karl Warr. The SnapIT technology utilizing AI, by monitoring what is happening on the boat, is able to categorize vessel activity and, eventually, distinguish the size and species of the fish caught.

Life-long commercial fisherman Warr believes transparency is essential for consumers to make informed choices. In his view, people should know how their fish is caught so their purchases reflect their values and choices. So, he became the first in the world to provide a transparent view of commercial fishing by streaming his on-board camera live on the internet. It's a real-time view of the fishing activity on his vessel and shows customers how the fish on their plate originated.

Motivated to provide genuine insight into how the seafood we eat is produced rather than painting a less realistic picture (or rather than painting a more idealistic picture), the skipper of *FV Chips* wants people informed before they decide what they purchase.

The innovator recognizes we all have a role to play in the sustainable harvest of the seafood we love to eat. From the fishing boat to the kitchen table, we must ensure everyone understands how the choices they make impact the sustainability of our fisheries. When a consumer is informed, they're empowered to make choices that



**Chris Rodley**

CEO and Founder  
Snap Information  
Technologies Ltd.

*"We anticipate both the fisherman and the public will benefit from increased transparency and proof of sustainable practices through this innovative live-streaming project."*

either reward or penalize fishermen based on their purchase. Together, we are collectively responsible for securing and ensuring environmentally respectful fishing practices. We all live with the consequences of food production, good or bad, for a very long time depending on our actions and purchases.

We anticipate both the fisherman and the public will benefit from increased transparency and proof of sustainable practices through this innovative live-streaming project, which started December 15. Warr will be able to demonstrate the increased value of his fish because he's operating ethically and sustainably.

By live-streaming his catch he is able to establish trust and demonstrate his fish are harvested with care. Ultimately, all consumers, from the homemaker to the high-end eatery, can control their purchasing options. As the data will be available to everyone, all will have the opportunity to shape the market through supply and demand.

This initiative is not a standard EM program. Normally, an EM program only provides video and sensor data for auditing and enforcement of catch limits and safe, legal fishing practices. In a standard EM program the biggest cost is human

reviewers watching the video. This video is usually transferred from the vessel via the swapping of physical harddrives to be viewed in the SnapIT cloud service by fishermen (as the data is rich with business intelligence), but also provisioned to governments or third-party review services. The new SnapIT system is able to transmit that data using cutting edge compression technology via cellular LTE networks when the vessel sails into range.

The project with *FV Chips* is a huge departure from a standard compliance-focused EM program. It is the first to attempt to engage and educate the public in real-time.

The SnapIT system consists of cameras and sensors and AI-optimized hardware on board vessels and allows the wireless transmission of data for compliance, interactions with protected species, and catch discharge. The system also provides protection for those who are following ethical fishing practices, giving an impartial record of activity and events. Finally, EM has considerable value for fishermen in planning and business intelligence. It is exciting to see this technology begin to be used for adding value to a fisher's operation.

To experience the live-stream, visit [www.betterfish.co](http://www.betterfish.co).

fectively leveraged the fear of added costs to advocate against widespread incorporation of EM/R in the United States.

Undoubtedly, the cost to fishers of hardware systems will be more expensive than the existing Vessel Monitoring System, which NOAA has subsidized, and more expensive than human observers, for which NOAA pays all the cost. However, it is also likely that the incorporation of EM/R will yield the rise of business-analytics services that capitalize on the wealth of data gathered during a fishing trip — thereby creating cost savings for boats. Ultimately, transitioning to EM/R should include a discussion about potential economic incentives to foster adoption of the technologies, but cost should not be used as an argument against incorporating the technology, nor as an argument against the availability of the best science and data — there are ways of spreading the load to get the needed data in the quest to forestall an oceanic food-chain crash.

Beyond cost concerns, EM/R faces resistance from fishers who are unwilling to endure the cultural shift toward modernization, as it will require greater oversight of and transparency in their operations. EM/R, if adopted, will reveal ways in which overfishing and bycatch are occurring now — and these insights could spur regulatory and management changes that might upset business as usual. Additionally, fishers view the incorporation of EM/R as an incursion on their personal privacy and this, like cost, has become a common refrain against imposing the technology.

The fishers have a point. They argue that the installation of EM/R on their vessels is akin to installing cameras in their homes, since they live on the boats while at sea. Understandably, fishers fear that EM/R technologies utilizing cameras will result in their images being sent to the government, and further worry that these images might be released to the broader public under the Freedom of Information Act or used in some other way against them without their approval. Complicating matters is the fact that there is no specific protection in NMFS regulations addressing the privacy rights of fishers.

While these concerns are understandable, personal privacy should be safe from disclosure because of constitutional protections and federal law, including the MSA and FOIA. Nevertheless, NMFS can and should do more to reinforce its commitment to safeguarding the personal privacy of the industry's workers.

Another challenge facing the widespread implementation of EM/R in the United States concerns the right of data ownership and use, given that fish stocks are a public resource and not private property. Fisheries data remain valuable to vessels, and in framing their opposition to electronic monitoring, companies cite concerns over the security of this type of proprietary and confidential business information. Effectively, fishers fear that electronic monitoring will lead to government's releasing to the public (and competitors)

information related to methods and locations. As with data related to personal privacy, however, fisheries data are already afforded strict protection under existing legal mechanisms, including the MSA and certain exemptions under FOIA, and these protections are a major reason that it is so difficult for fisheries managers to share data among themselves.

In theory at least, 21st century rules regarding fisheries data and privacy rights should be comparatively easy to draft and implement — especially when compared to today's thornier problems of internet privacy and personal data security. However, it is worth pausing for a moment to point out that it may be the case that the present legal and regulatory regime — conceived during a much different moment in the history of the industry — prioritizes the wrong elements of data security, ultimately at the expense of better management decisions, which in turn hurts not only the species, but also the fishers themselves.

While principles governing proprietary information and confidential business information likely made sense at the time they were conceived,

*The present legal and regulatory regime — conceived during a much different moment in the history of the industry — may prioritize the wrong elements of data security, hurting not only the species but also the fishers themselves*

it may be that they are less relevant in today's era of open information and the needed trend toward traceability. In the past, it was possible for fishers to hide the locations of their operations from each other as if they were trade secrets so that disclosure of proprietary information and confidential business information could negatively impact an individual business. This is no longer the case in an era of satellite photos, drones, and other technologies that enable competitors to keep tabs on one another.

Moreover, both market and international legal mechanisms seem to have diminished the significance of and need for confidentiality. On the market side, as environmental concerns have begun to enter the consuming public's minds, there has been an increasing desire for traceability "from hook to plate." In response, fishers are now providing the public once-proprietary VMS data — formerly exclusively used for fisheries monitoring and enforcement — along with the location of the catch. This has enabled consumers to be able to use an app on their phones to trace the origin of fish purchased in the grocery store, and increasingly, large retail buyers are seeking this information to build consumer confidence in their products.

On the legal side, meanwhile, traceability data — including location and gear disclosures — are increasingly becoming necessary for U.S. products to compete abroad — or even to be exported. For example, the European Union's Common Fisheries Policy requires certain certifications — including the area in which the product was caught — to be on the package of imported fish.

**T**he unfortunate reality is that market drivers and international legal obligations — not government leadership — are the primary drivers forcing U.S. commercial fishing companies to even think about incorporating EM/R. This dearth of senior leadership — within NOAA, the Department of Commerce, the Office of Management

and Budget, the National Security Council, and the White House — is partially attributable to the fact that the current administration is deep in climate denial. The head of NMFS recently testified to Congress that he could not speculate on the impacts of climate change on fisheries, ignoring the prevailing scientific research on this issue.

Without leadership, NMFS will continue to go underfunded year after year, and red herring policy and legal arguments regarding privacy and confidential business information will carry sufficient weight to impede implementation of EM/R. Until U.S. officials see the future of U.S. fisheries for what it really is — a significant global security vulnerability — U.S. fisheries management will continue to flounder and EM/R will remain the promising technology of tomorrow.

At present, fisheries science and management are trapped in a time capsule, while being crushed by the weight of 21st century problems. As managers are forced to employ outdated methods of counting the catch, those whom they manage continue to capitalize on technological developments to harvest fish at unsustainable levels. All the while, modern challenges continue to put even greater stress on fisheries resources so that stocks are once again on the precipice of decline.

Ultimately, society is running out of time to reverse a problem that we cannot even begin to accurately quantify. Managers in business and government need EM/R in order to begin quantifying the problem so that we are in a better position to scope potential fixes. Utilizing the tools of Big Data, artificial intelligence, and the Internet of Things, conservation advocates, commercial and recreational fishers, and consumers have the potential to all benefit from sustainably managed fish stocks.

All it takes is leaders willing to harness these modern tools for the greater good. If there is any country in the world that is capable of serving in this pathbreaking role and proving that technology can help to move to that sustainable economy, it is the United States. The time to exercise that leadership is now, before it is too late. **TEF**

*The unfortunate reality is that market drivers and international legal obligations — not government leadership — are the primary drivers forcing U.S. commercial fishing companies to even think about incorporating EM/R*