Property in Wildlife

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Introduction

For millennia, people have relied for a portion of their food supply on edible wild animals. Among the legal issues generated by this practice is when and how a person is permitted to acquire an exclusive right to such an animal.

With respect to wild animals that live on land, that issue has little modern relevance, because relatively few such animals survive today, and most countries sharply restrict people's ability to kill and eat the survivors. With respect to wildlife that live in water, the situation is different. Wild fish and shellfish continue to provide people an important source of food. Consequently, the question of how property rights in them are established and allocated remains salient.

Indeed, debate concerning how that question should be answered is intensifying. In combination, population growth, changing diets, and excessive exploitation of many of the world's fisheries have created a crisis. Analysis of which of the legal regimes that attempt to manage this resource have worked well and which have not can help us resolve that crisis.

The materials that follow aspire to illuminate these issues. We begin with an exploration of the pertinent common law rules and the social practices supported by those rules. We then examine the sharply different legal regimes governing three modern fisheries in the United States – groundfish on Georges Bank; lobsters in Maine; and salmon in Bristol Bay, Alaska. We conclude with a summary of the current state of fisheries throughout the world.

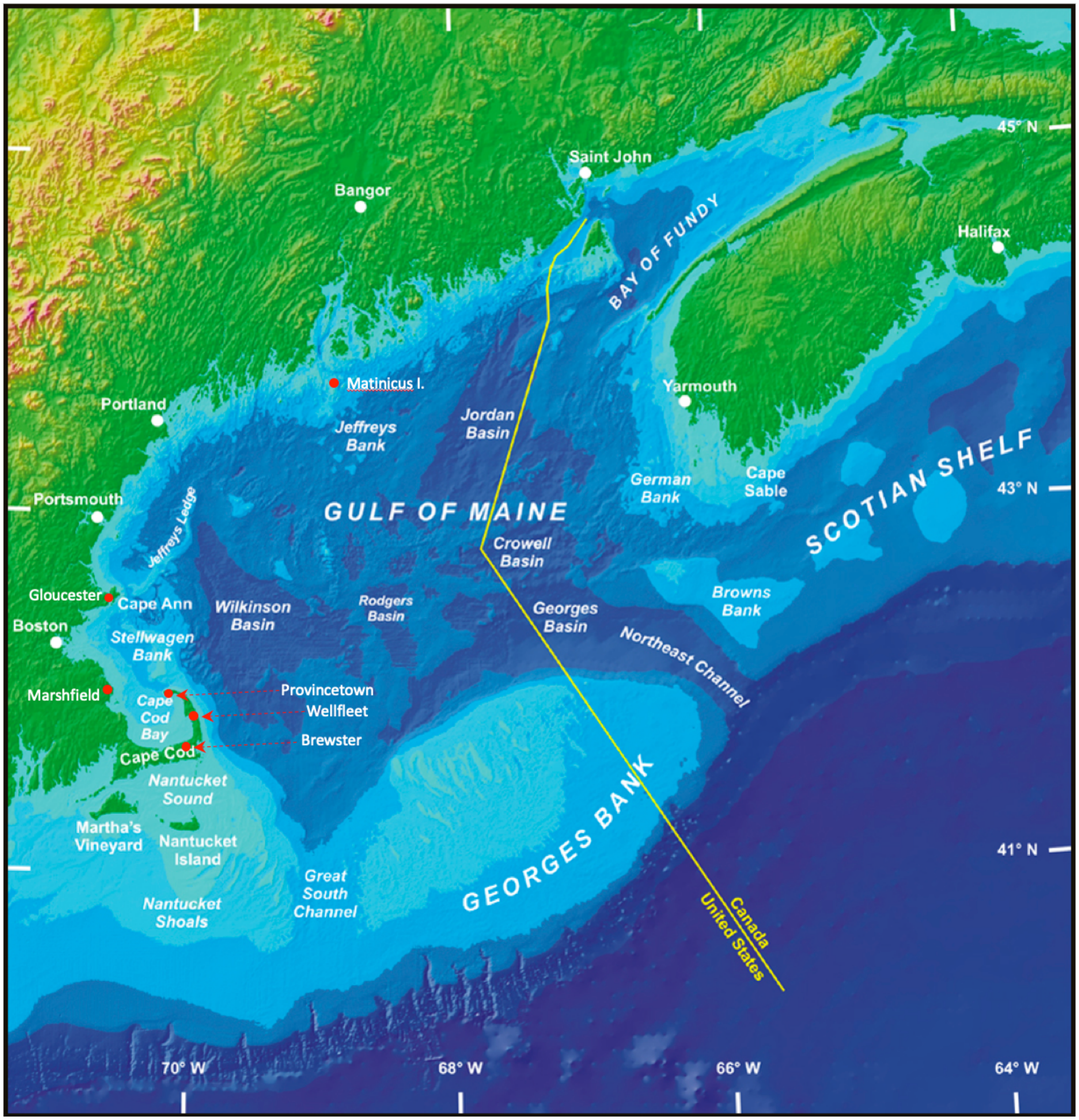
As you read through the materials, try to answer the following questions:

1. Had you been consulted by the captain of the Sea Hope when the boat docked in Marshfield concerning ownership of the contested tuna, what would you have told him?
2. What is the relationship between the common law and custom with respect to property rights in wildlife?
3. What should be the objective(s) of lawmakers today when reshaping the rules governing the acquisition of rights to fish and shellfish?
4. How might lawmakers reconcile or balance the interests of (a) the public at large; (b) groups (such as Native American tribes or "harbor gangs"); and (c) individuals?
5. What rules would best advance the objectives you have identified?
6. Which institution(s) should set those rules?

1. The Common Law

Map of the Gulf of Maine

The locations of most of the towns, islands, and regions discussed in the following pages are indicated on the map below.



Ghen v. Rich
District Court, D. Massachusetts
8 F. 159; 1881 U.S. Dist. LEXIS 131

April 23, 1881

NELSON, D.J. This is a libel to recover the value of a fin-back whale. The libellant lives in Provincetown and the respondent in Wellfleet. The facts, as they appeared at the hearing, are as follows:

In the early spring months the easterly part of Massachusetts bay is frequented by the species of whale known as the fin-back whale. Fishermen from Provincetown pursue them in open boats from the shore, and shoot them with bomb-lances fired from guns made expressly for the purpose. When killed they sink at once to the bottom, but in the course of from one to three days they rise and float on the surface. Some of them are picked up by vessels and towed into Provincetown. Some float ashore at high water and are left stranded on the beach as the tide recedes. Others float out to sea and are never recovered. The person who happens to find them on the beach usually sends word to Provincetown, and the owner comes to the spot and removes the blubber. The finder usually receives a small salvage for his services. Try-works are established in Provincetown for trying out the oil. The business is of considerable extent, but, since it requires skill and experience, as well as some outlay of capital, and is attended with great exposure and hardship, few persons engage in it. The average yield of oil is about 20 barrels to a whale. It swims with great swiftness, and for that reason cannot be taken by the harpoon and line. Each boat's crew engaged in the business has its peculiar mark or device on its lances, and in this way it is known by whom a whale is killed.

The usage on Cape Cod, for many years, has been that the person who kills a whale in the manner and under the circumstances described, owns it, and this right has never been disputed until this case. The libellant has been engaged in this business for ten years past. On the morning of April 9, 1880, in Massachusetts bay, near the end of Cape Cod, he shot and instantly killed with a bomb-lance the whale in question. It sunk immediately, and on the morning of the 12th was found stranded on the beach in Brewster, within the ebb and flow of the tide, by one Ellis, 17 miles from the spot where it was killed. Instead of sending word to Princeton, as is customary, Ellis advertised the whale for sale at auction, and sold it to the respondent, who shipped off the blubber and tried out the oil. The libellant heard of the finding of the whale on the morning of the 15th, and immediately sent one of his boat's crew to the place and claimed it. Neither the respondent nor Ellis knew the whale had been killed by the libellant, but they knew or might have known, if they had wished, that it had been shot and killed with a bomblance, by some person engaged in this species of business.

The libellant claims title to the whale under this usage. The respondent insists that this usage is invalid. It was decided by Judge Sprague, in *Taber* v. *Jenny,* 1 Sprague, 315, that when a whale has been killed, and is anchored and left with marks of appropriation, it is the property of the captors; and if it is afterwards found, still anchored, by another ship, there is no usage or principle of law by which the property of the original captors is diverted, even though the whale may have dragged from its anchorage. The learned judge says:

> "When the whale had been killed and taken possession of by the boat of the Hillman, (the first taker,) it became the property of the owners of that ship, and all was done which was then practicable in order to secure it. They left it anchored, with unequivocal marks of appropriation."

In *Bartlett* v. *Budd,* 1 Low. 223, the facts were these: The first officer of the libellant's ship killed a whale in the Okhotsk sea, anchored it, attached a waif to the body, and then left it and went ashore at some distance for the night. The next morning the boats of the respondent's ship found the whale adrift, the anchor not holding, the cable coiled round the body, and no waif or irons attached to it. Judge Lowell held that, as the libellants had killed and taken actual possession of the whale, the ownership vested in them. In his opinion the learned judge says:

> "A whale, being *feroe naturoe,* does not become property until a firm possession has been established by the taker. But when such possession has become firm and complete, the right of property is clear, and has all the characteristics of property."

He doubted whether a usage set up but not proved by the respondents, that a whale found adrift in the ocean is the property of the finder, unless the first taker should appear and claim it before it is cut in, would be valid, and remarked that "there would be great difficulty in upholding a custom that should take the property of A. and give it to B., under so very short and uncertain a substitute for the statute of limitations, and one so open to fraud and deceit." Both the cases cited were decided without reference to usage, upon the ground that the property had been acquired by the first taker by actual possession and appropriation.

In *Swift* v. *Gifford,* 2 Low. 110, Judge Lowell decided that a custom among whalemen in the Arctic seas, that the iron holds the whale, was reasonable and valid. In that case a boat's crew from the respondent's ship pursued and struck a whale in the Arctic ocean, and the harpoon and the line attached to it remained in the whale, but did not remain fast to the boat. A boat's crew from the libellant's ship continued the pursuit and captured the whale, and the master of the respondent's ship claimed it on the spot. It was held by the learned judge that the whale belonged to the respondents. It was said by Judge Sprague, in *Bourne* v. *Ashley,* an unprinted case referred to by Judge Lowell in *Swift* v. *Gifford,* that the usage for the first iron, whether attached to the boat or not, to hold the whale was fully established; and he added that, although local usages of a particular port ought not to be allowed to set aside the general maritime law, this objection did not apply to a custom which embraced an entire business, and had been concurred in for a long time by every one engaged in the trade.

In *Swift* v. *Gifford,* Judge Lowell also said:

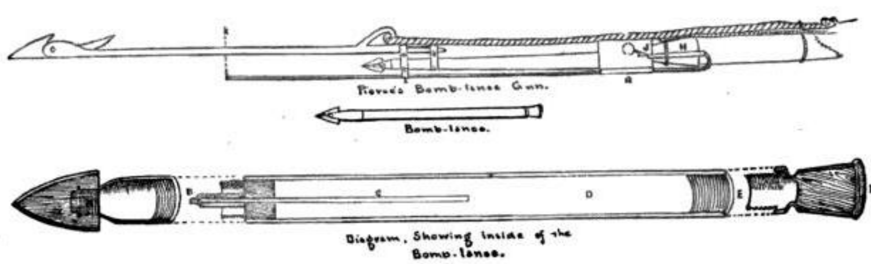
> "The rule of law invoked in this case is one of very limited application. The whale fishery is the only branch of industry of any importance in which it is likely to be much used, and if a usage is found to prevail generally in that business, it will not be open to the objection that it is likely to disturb the general understanding of mankind by the interposition of an arbitrary exception."

I see no reason why the usage proved in this case is not as reasonable as that sustained in the cases cited. Its application must necessarily be extremely limited, and can affect but a few persons. It has been recognized and acquiesced in for many years. It requires in the first taker the only act of appropriation that is possible in the nature of the case. Unless it is sustained, this branch of industry must necessarily cease, for no person would engage in it if the fruits of his labor could be appropriated by any chance finder. It gives reasonable salvage for securing or reporting the property. That the rule works well in practice is shown by the extent of the industry which has grown up under it, and the general acquiescence of a whole community interested to dispute it. It is by no means clear that without regard to usage the common law would not reach the same result. That seems to be the effect of the decisions in *Taber* v. *Jenny* and *Bartlett* v. *Budd.* If the fisherman does all that it is possible to do to make the animal his own, that would seem to be sufficient. Such a rule might well be applied in the interest of trade, there being no usage or custom to the contrary. Holmes, Common Law, 217. But be that as it may, I hold the usage to be valid, and that the property in the whale was in the libellant.

The rule of damages is the market value of the oil obtained from the whale, less the cost of trying it out and preparing it for the market, with interest on the amount so ascertained from the date of conversion. As the question is new and important, and the suit is contested on both sides, more for the purpose of having it settled than for the amount involved, I shall give no costs.

Decree for libellant for $71.05, without costs.

Bomb lance



Waif 

Andrew L. Andrews, “Tuna Boats Battle”
Boston Globe, September 17, 1985

Two crews battled in 8-foot seas Saturday over the ownership of a 13-foot bluefin tuna weighing 800 pounds caught off Gloucester near Stellwagen Bank after one boat hooked the fish and lost it and the second boat caught it.

The captains of both boats agree the Sea Hope out of Gloucester hooked the tuna first and the Michelle Lee eventually landed it. They disagree over how the line from the Sea Hope became detached. Michael Galgana, 32, of Quincy, captain of the Michelle Lee, said the tuna line was cut by the Sea Hope’s propeller and then was snared by a line from the Michelle Lee. However, Manuel Liba, captain of the Sea Hope, said the line was still attached after it went under his propeller and his line was cut after the Michelle Lee hooked the fish. Michael Galgana said last night, “That’s absolutely untrue. The line was cut by his own propeller and we snagged the loose line.”

Liba complained that the Michelle Lee did not show his boat the usual courtesy of pulling in its lines when a nearby boat hooks into a fish. However, Galgana said, “We were pulling in all of our lines and we had them all in but one and that was the one that snagged into his loose line.”

Galgana said the 7-man crew of the Sea Hope started yelling immediately, claiming the tuna was their fish. Galgana said when he pulled up his line and saw what had happened, he realized the fish belonged to him and his brother, Thomas, 37. He said he tied a rope to the broken line, which was hooked into the tuna. Thomas had control of the rope and Michael was piloting and trying to bring the tuna to the surface to harpoon it, they said, when the Sea Hope maneuvered in the heavy seas and one of its crewmen jumped down onto the Michelle Lee. After the crewman was on board, he claimed the fish belonged to the Sea Hope. Galgana then continued to try to harpoon the fish and the uninvited boarder offered to do the harpooning for him. Galgana said he replied, “No, my boat, my line, my harpoon, my boat and my fish.”

Galgana said the Sea Hope then came alongside to take off its crewman and, in doing so, rammed the Michelle Lee, jarring it and throwing both brothers to the deck. The crewman jumped back onto his boat. Galgana said he became concerned about what might happen next, fired a distress flare into the air and radioed the Coast Guard.

He said the Sea Hope backed off and, after a struggle of about an hour and half, the tuna was in a position to be harpooned. But then, he said, the Sea Hope, assisted by another boat he identified as the Hope 30, kept circling the Michelle Lee with harpoons at the ready. But the Galgana brothers harpooned the giant and brought it aboard and headed for Marshfield.

Michael Galgana said he radioed the Coast Guard and told them he was coming in and he wanted them to help settle the dispute. When he reached the Green River Marina, he was greeted by two officers from the Scituate Coast Guard station, two men from the state’s Fisheries Wildlife and Recreational Vehicles Department, Marshfield Police and assistant harbormaster Lawrence Bonney 2d. The Sea Hope, in the meantime, had followed the Michelle Lee for 24 miles to shore.

Michael Galgana said they settled the dispute on the land, saying, “Possession is nine-tenths of the law.” He then promptly sold the tuna, which dressed out at 671 pounds at $5 per pound, to two Japanese buyers waiting at dockside for $3,350.

Captain Liba of Gloucester said the boat is owned by the Unification Church, founded by Rev. Sun Myung Moon.

Liba admitted the two boats did circle and try to harpoon the disputed tuna. He said, “At that point all I could think of was that tuna.” Liba also said he moved in close to let his mate board the Michelle Lee to make a claim for the tuna because he believed the line was cut. He also said his boat was damaged by the boom on the Michelle Lee when the Sea Hope came back to pick up the mate.

Liba said he doesn’t think he will press the legal issue of who owns the tuna because, he said, he was told by an unidentified official at dockside the Michelle Lee had legally landed the fish.

Efforts to reach the Scituate Coast Guard Station and law enforcement officials from the state Marine Fisheries Division were unsuccessful.

Michael Galgana said both he and his brother were injured when they fell to the deck after the ramming which, he said, also damaged the Sea Hope. He said he is conferring with his attorney about a possible lawsuit, claiming damages to the boat and for personal injuries.

2. Groundfish on Georges Bank

The Sorry Story of Georges Bank
American Museum of Natural History[1]

What's a Bank?

A bank is a huge shoal—a plateau submerged in relatively shallow ocean waters. A series of immense banks stretches from Newfoundland to southern New England on the edge of the North American continental shelf. The northernmost banks off Newfoundland and Labrador are called the Grand Banks. Georges Bank is an oval-shaped bank, 240 km long by 120 km wide, that lies at the southwestern end of this chain. It is 120 km off the coast of New England and is larger than the state of Massachusetts. Georges Bank is more than 100 m higher than the sea floor of the Gulf of Maine that lies just north of it. During the last Ice Age, when the sea was much lower, Georges Bank was part of the North American mainland.

About 11,500 years ago, the sea rose high enough to isolate the area, creating Georges Island. It was home to many large prehistoric mammals, including walruses, mastodons, and giant sloths, traces of which are sometimes found in fishing nets. They died out around 6,000 years ago, when the water level rose further to submerge the island and turn it into Georges Bank. A prime breeding and feeding grounds for fish and shellfish, in particular cod, haddock, herring, flounder, lobster, scallops, and clam, these North American banks are one of the world's most important fishing resources.

Why is the Fishing So Good at Georges Bank?

Georges Bank is a particularly productive continental shelf. The cold, nutrient-rich Labrador current sweeps over most of the submarine plateau, and meets the warmer Gulf stream on its eastern edge. The mingling of the two currents, along with sunlight penetrating the shallow waters, creates an ideal environment for tiny sea creatures—phytoplankton (photosynthetic algae) and zooplankton (tiny free-floating creatures such as krill)—to flourish, attracting an entire ecosystem of marine animals. On Georges Bank, phytoplankton grow three times faster than on any other continental shelf. They feed the zooplankton, which are then eaten by the larvae of vast numbers of fish such as cod, haddock, and yellowtail flounder. Georges Bank is home to more than 100 species of fish, as well as many species of marine birds, whales, dolphins and porpoises. The combination of tides and the Labrador current create a clockwise flow around the perimeter, circulating eggs and larvae throughout the Bank.

The structural diversity of the seabed plays an important part in the abundance and distribution of different marine species. Fifteen huge canyons descend from the southern half of the Bank. Their craggy walls, out of reach of fishing gear, house many kinds of fish and shellfish. Coarse sediment, originally transported to the bank by glaciers, has been shaped by changes in sea level and the ongoing action of tidal and storm currents to form a variety of marine habitats. For instance, a

[1] Source: https://www.amnh.org/explore/videos/biodiversity/will-the-fish-return/the-sorry-story-of-georges-bank.

rough sea bottom provides juvenile cod with protection from predators and also shelters the smaller organisms which are their optimal food sources. Strong tidal currents sweeping over gravel beds on the eastern edge of Georges Bank create ideal spawning grounds for herring, whose eggs are laid on the bottom and require clean, oxygenated water to hatch.

The Basque Secret

The first Europeans to discover these rich fishing grounds were the Basques, a fiercely independent people from northern Spain. They had salt, which they used to preserve the fish, and by the year 1000 they had established an international trade in salted cod. The Basques kept the location of their fishing grounds a secret for over 500 years, but in 1497 Giovanni Caboto, a Genovese known by the Anglicized version of his name, John Cabot, undertook a voyage for Henry VII of England. Searching for a northern spice route, Cabot instead found 1000 Basque fishing vessels, rocky shores ideal for salting and drying fish, and waters teeming with fish. A legend swiftly grew that the fish were so abundant that they could be scooped out of the water in baskets. Cabot named the place New Found Land and claimed it in the name of England. Italian explorer Giovanni da Verrazano discovered Georges Bank in the early 1500s and named it Armelline Shoals after a papal tax collector. In 1605, English colonists renamed it for St. George.

The Cod Trade Grows

"Fishing opened up in Newfoundland with the enthusiasm of a gold rush," writes Mark Kurlansky in Cod, his book about a fish that changed the world. By the mid-16th century, sixty per cent of all the fish eaten in Europe was cod, and that remained the case for over two hundred years. It was the European hunger for cod that built Boston and turned New England into an international commercial center by the 18th century. Catches of cod and other fish off Georges Bank were so large that the British market became saturated, so Americans expanded to other areas. One was the West Indies, where there was a demand for low-grade salted fish to feed slave laborers. This trade grew when the Gloucester schooner, a fast, two-masted vessel, shortened the sailing time between Georges Bank and the Caribbean in the early 1700s.

In the wake of the American Revolution, fishing rights were hotly disputed. In 1782, the British granted New England fishing rights on the Grand Banks, but these were rescinded after the War of 1812 and remain a source of tension between the United States and Canada to this day.

New Tools for Bigger Catches

The first sign that Georges Bank fish stocks were not inexhaustible was the near disappearance of halibut around 1850, after an intense period of overfishing. The advent of modern fishing technology in the 1900s spelled trouble for many other species.

Well into the 20th century, Georges Bank had been fished using the same tools and techniques that the first settlers had employed: small boats, propelled by sail or oars and fished with handlines, and a single baited hook (perhaps two if a spreader was used) let down with a weighted line and reeled in by hand.

In Europe, on the other hand, where competition and smaller catches provided more incentive, steam-powered trawlers—ships which drag fishing gear behind them—were in wide use by the 1880s. It was not until the 1920s that the technology crossed the ocean and a Boston trawler fleet developed. "Fish could now be pursued," observes Kurlansky, and so they were, across ever-greater distances. The steam-powered otter trawl proceeded to decimate the Georges Bank haddock stock. Diesel power, introduced in 1928, further increased the ships' efficiency.

The Birth of the Fish Stick

The other invention that transformed the fishing industry was the brainchild of Clarence Birdseye, the inventor of frozen foods. Birdseye moved to Gloucester in 1925 and founded the General Seafoods Company at a time when the international market for fresh fish, as opposed to cured or salted, was growing. Filleting machinery was introduced to New England in 1921. The fillets were frozen into blocks and sliced into strips, and fish sticks were shipped to a giant new market of consumers, many of whom never encountered fish in any other form.

After World War II, the advent of huge factory ships and the use of aircraft and sonar to spot schools of fish resulted in unprecedented commercial catches. Through the late '50s, '60s, and early '70s, fleets of factory ships from the Soviet Union, East Germany, Poland, Spain, Japan and elsewhere hauled in hundreds of millions of pounds of haddock and hake, sometimes only twenty km from shore. In an hour, a factory ship could haul in as much cod—around a hundred tons—as a typical 17th-century boat could catch in a season. Wishing to preserve its fish stocks for American fishermen, the U.S. passed the Magnuson Act in 1976. It established American jurisdiction over a 200-mile fishing limit and banned the foreign boats from U.S. waters. In 1984, under international arbitration, Canada was granted the northeast corner of Georges Bank, which lies within 200 miles of Nova Scotia, reducing New England fishing grounds. With the international factory ships gone, Canada and the U.S. missed the opportunity to restore a sustainable groundfish industry, choosing instead to exploit the resource themselves. Domestic fishing fleets expanded rapidly, and offshore commercial fisheries grew and prospered.

From Boom to Bust

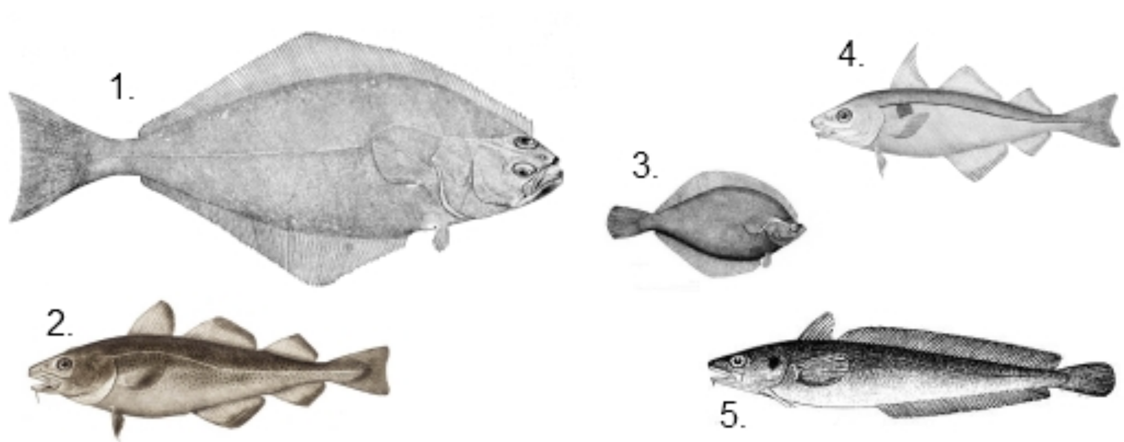
At the same time, inshore stocks dwindled. Many Georges Bank fish populations declined, including cod, haddock, herring, and sea scallops. Local fishermen suspected that few fish were surviving to spawn on the Bank, a breeding ground for well over half of the most commercially valuable fish species. Although the government agencies reluctantly recognized that these stocks were declining, the fishermen's concerns still found few listeners. The New England Council, which had been established by the Magnuson Act, was dominated by commercial fishing interests. Finally, in 1993, Canada declared a moratorium on fishing northern cod and placed strict quotas on other ground species. A 1994 National Marine Fisheries Service assessment of cod stock on Georges Bank found a drastic forty per cent decline over four years, and concluded that the fishing fleet was about twice the size that Georges Bank could sustain.

The waters had been rendered nearly devoid of the prime commercial species that had once filled them. Urgent measures were necessary. On December 7, 1994, officials closed 9600 square kilometers of fishing ground on Georges Bank. The ban was extended indefinitely in April, 1995, and still stands. A March 1997 update reported that while some stocks were beginning to grow again, groundfish were still being fished too hard to regain healthy levels. In January 1999, scientists at the National Marine Fisheries Service in Woods Hole, Massachusetts reported a continued rapid decline in cod stock. Today, fishing continues in certain areas, but it is severely regulated.

An Uncertain Future

Fishermen presume that the damage from overfishing is temporary, but the scientific outlook is far from clear. Kurlansky quotes Ralph Mayo of the National Marine Fisheries Service laboratory in Woods Hole: "there is no known formula to predict how many fish—or in scientific language, what size biomass—are required to regenerate a population or how many years that might take." In the meanwhile, species such as the skate have expanded rapidly in response to the changing species dynamics, with as yet unknown consequences for the Georges Bank ecosystem. Some have become new targets of commercial fishermen. Political pressure to loosen regulations is unending and heedless of nature's timetable. New England fishermen grumble about boats lying idle along the New England coast. Conservationists fear that regulators will ease restrictions before populations are fully recovered. "The problem with the people out here on the headlands of North America," observes Kurlansky, "is that they are at the wrong end of a 1,000-year fishing spree."

Georges Bank Fish



1=Halibut; 2=cod; 3=yellowtail flounder; 4=haddock; 5=hake
Source: https://britishseafishing.co.uk/decline-of-the-georges-bank-fishery/

Georges Bank Cod: Total Commercial Landings

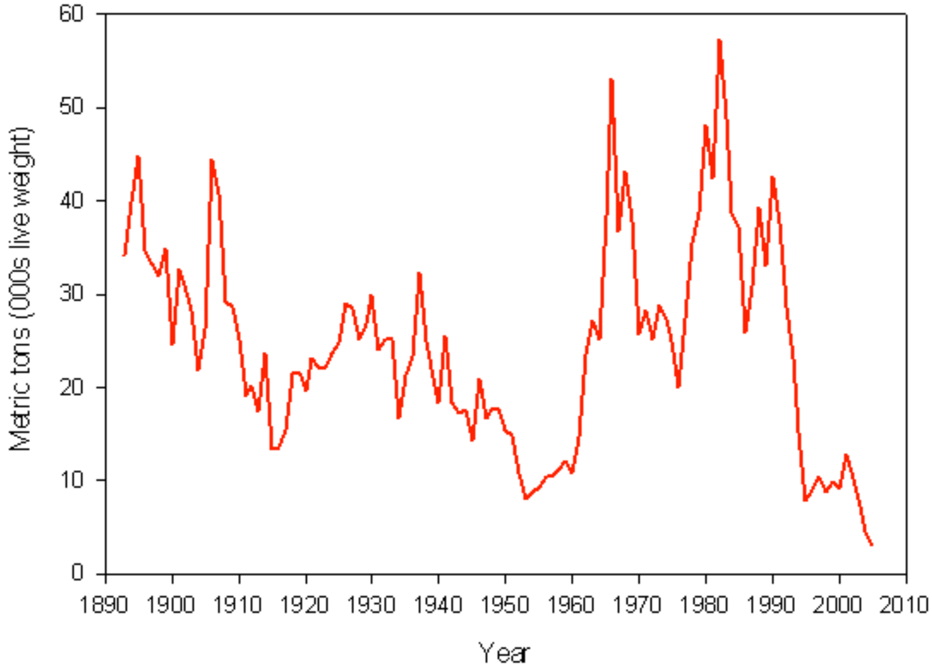


Figure 1.11 Total commercial landings of Georges Bank cod (NAFO Div. 5Z and Subarea 6), 1893-2005.

Source: http://oceansjsu.com/105d/exped_manage/3.html

3. Lobsters in Maine

Timothy Waring and James Acheson, Evidence of Cultural Group Selection in Territorial Lobstering in Maine
Sustainable Science 13 (2018) 21, 22-23

Lobsters are largely sedentary. Mature lobsters have an annual range of only 32 km (Campbell and Stasko 1986). Lobsters are caught with traps that rest on the ocean floor and are marked with a floating buoy. Legally, a state license is required to set lobster traps. But unofficially, one also needs to be accepted as a member of a harbor gang (Acheson 1988). Harbor gangs are lobster-fishing groups that defend an unofficial territory. Territories are defined by geographical features (e.g., coves, ledges, river mouths, buoys), and positioning systems including Loran and GPS, and are typically smaller than 100 square miles (Acheson 2003). As a result, lobster populations can be sustained and defended within these territories. Gangs defend their territories from intruders through verbal warnings and by molesting and destroying the lobster traps of an intruder. But molesting gear is against the law; and victims of trap cutting often retaliate. Thus, both defensive and offensive territorial behaviors carry significant risk.

Harbor gangs are typically small, with as few as eight boats and rarely as many as 50. Gangs are mostly composed of residents of a single harbor town, in which most members have long family histories. Harbor gangs are some of the most important social units in the lives of lobster fishermen. In times of need, members often turn to each other for help, and harbor gangs use a common radio channel in case of emergency. Harbor gangs are also somewhat socially isolated from each other, because harbor towns are separated by the jagged Maine coastline. People often hold negative stereotypes of people from neighboring harbors, and there are fewer friendly contacts than might be expected (Acheson 1988). Competition for lobsters and social status also occurs within harbor gangs. For instance, successful fishermen, or ‘‘highliners,’’ and senior fishermen typically enjoy more power, while poor fishermen or ‘‘dubs’’ are often the butt of jokes and gossip (Acheson 1988).

In the case of lobster, territorialism and conservation practices are economically complementary behaviors. An area is economically defendable if the benefits of ownership outweigh the costs of defense (Brown 1964; Dyson-Hudson and Smith 1978; King 1976). Lobsters can be spatially monopolized because they are relatively sedentary, and lobster territories can generate large profits, even when defending them is costly and risky. Conservation measures complement territoriality because the benefits of lobster conservation efforts accrue to those in control of the territory. Defended territory also enhances conservation efforts by limiting access and facilitating monitoring and enforcement. At first glance, neither conservation nor territoriality require an explanation of cooperation. However, Maine lobster territories are claimed and defended by harbor gangs, not by individuals. Like any human group, gangs must overcome challenges such as coordination, within-group competition, and free-riding to survive and be successful. In comparison to unrestrained solo lobstering, gang membership can cause a reduction in harvest intensity and restrictions on harvesting location, and may entail risky territorial skirmishes. As a result, the present gang-based equilibrium may not be individually efficient. Moreover, we still need to explain how costly behaviors such as restrained harvesting and risky territorial defense emerged in the first place. We argue that group-structured cultural evolution helps explain how territoriality and conservation practices emerged, and why they persist. A brief historical summary provides an overview of the patterns we seek to explain.

Preindustrial era (1700s–1900)

Before lobstering was widely practiced there was no benefit to exclusive ownership of lobster grounds. Prior to the twentieth century, lobstering was conducted from small, unpowered boats, making the range of each fisherman small. Most lobster fishing was done in the summer months when lobsters congregate near shore. These small nearshore areas were exploited by individuals or small groups of kin or neighbors; the areas were generally adjacent to property owned by the fishermen or their families. We call these ‘‘individual territories’’ although they involved more than a single fisherman in some instances. As lobstering became more widespread, fishermen came to benefit from protecting the water they fished, and small harbor group territories arose that were easy to guard and close to home. Although very little information exists on how the territorial system was first formed, it was commonly believed that ownership of land gave the landowner right to fish in adjacent waters.

Informal era (1900–1995)

As lobstering became more common, the territorial competition between lobstermen in densely settled harbors grew increasingly fierce. Eventually, individual territories became unworkable, and fishermen started to cooperate to defend their territories from others. In the 1920s, engines allowed fishermen to range over more water, which allowed territorial growth and spurred conflict between neighboring harbor gangs. Conflicts close to harbors were fought bitterly and resolved with reinforced territorial boundaries. A pattern of harbor gangs protecting exclusive territories appears to have spread along the Maine coast and may share a common cultural lineage with a similar system found in nearby Nova Scotia (Wagner and Davis 2004). Some harbor gangs adopted perimeter defense, voluntary trap limits, and other practices that strengthened group structure. Island communities were often first to implement stronger conservation and territorial measures. These largely informal institutions heavily influenced how lobsters were managed in the twentieth century.

Legal era (1995–present)

From the 1950s, most harbor gangs suffered from internal competition in the form of trap escalation. One solution to the problem was a limit on the number lobster traps a fisherman could set. Efforts to get the legislature to enact a trap limit law failed repeatedly due to disagreements on what the trap limit should be. In frustration, four islands established effective trap limits within their informal territories in the 1970s. Fishermen in different coastal regions preferred different trap limits because they faced different ecological (e.g., density of lobsters) and economic (e.g., distance to market) conditions. Thus, state-wide trap limit proposals failed for decades. In 1995, the Maine Lobster Zone Management Law created a legal territorial system for seven coastal regions, enforced by a professional warden force. The law resolved the 2-decade conflict over trap limits, and established Zone Councils with democratic structure and limited autonomy. Zone councils adopted policies including zone-specific trap limits and limited entry rules which have spread among most zones.

Maine Lobster Now, “Sustainable Lobster Fishing”

A Limited Number Of Lobster Fishing Licenses

To limit the number of lobsters being caught, the first thing the state does is regulate the number of fishermen in the state. These licenses are not easy to come by. Lobstering is a limited-entry fishery and there is a long waiting list to get a license. … Once you complete a lobstering apprenticeship you are on the waiting list - some have been on this list for over a decade! The only way to get around the waiting list is to be grandfathered in (available only if you are a direct descendant of a lobstermen). The waiting list only moves when a lobstermen retires and doesn't renew their license.

To fish in deeper waters beyond three miles of the coast, a federal permit must be obtained from the National Marine Fisheries Service (NMFS), the governing body authorized by the National Oceanic and Atmospheric Administration (NOAA) to administer federal fishing regulations relative to commercial fishing of all kinds. The federal lobstering permits have larger trap limits, closer to 1400 traps, as boats cannot tend their traps as frequently. …

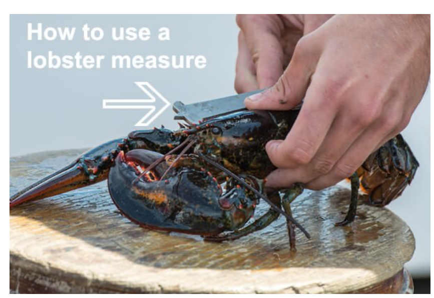
Apprentice Program

There are a number of hours each stern-man (a lobstermen's helper) needs to complete before even being able to apply for a lobster fishing license. This is to help ensure that each lobsterman understands the importance of sustainability. … The apprentice program requires at least 200 days on the water which has to add up to at least 1000 working hours. You need a licensed lobstermen as a sponsor to log hours with.

Trap Limit For Each Lobsterman

There are 5,900 legally registered lobstermen and women in Maine. Each license grants the harvester to fish up to 800 traps. Maine does not allow fleets of lobster boats because they want to keep lobster fishing with individual lobstermen, to support the local economy. With literally millions of buoys off the coast of Maine, the industry supports thousands of jobs on shore, not just the people hauling traps.

Maine Lobster Legal Size Limit



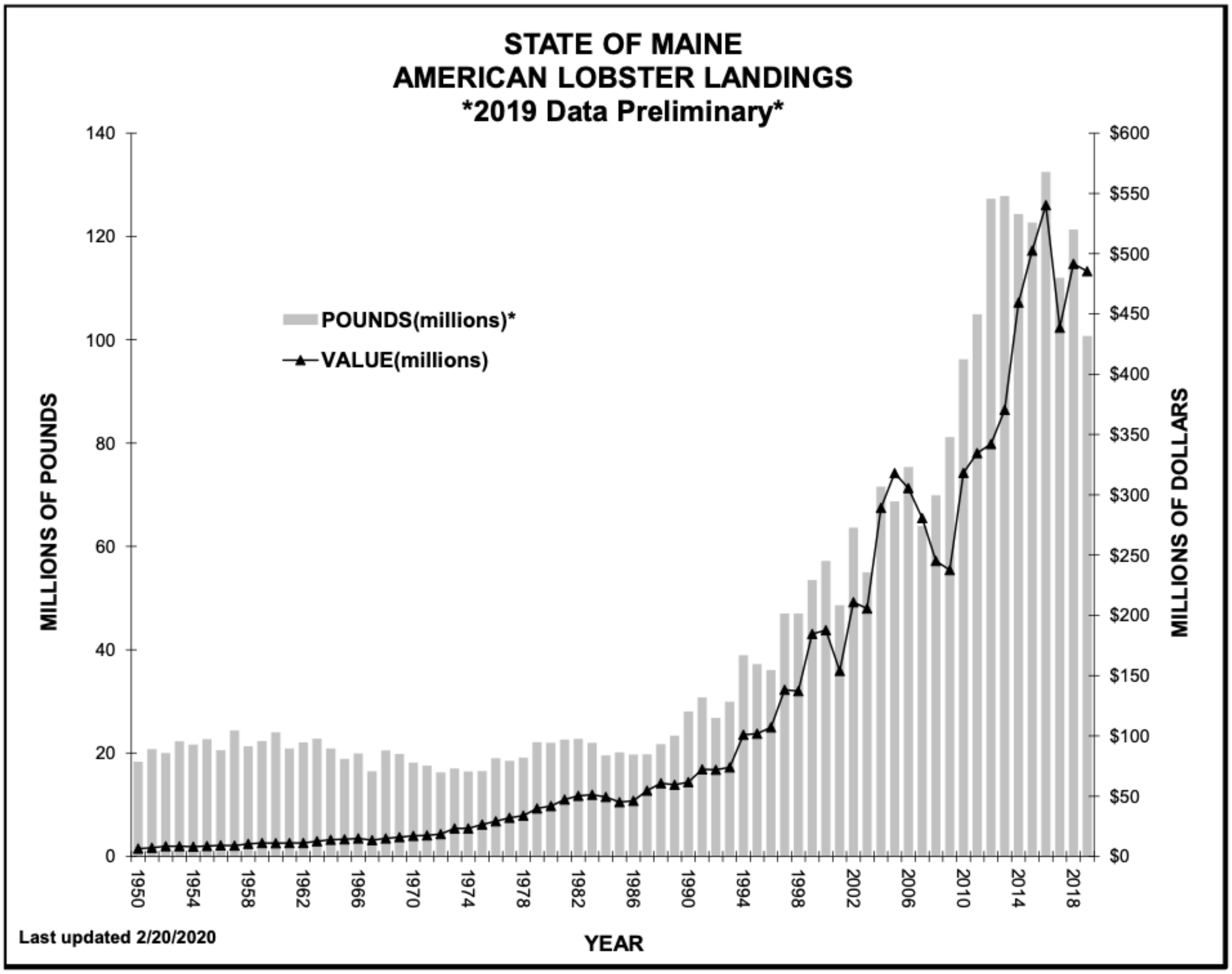
This is the first practice towards sustainability after the trap limit. This regulation limits very small developing lobsters from being harvested, as well as large 'breeder' lobsters. This is a great way to keep lobsters reproducing. Lobsters are measured using a Lobster Measuring Gauge which is used to measure the carapace. Legally harvested lobsters have a carapace (hard shell from eye to beginning of tail) of at least 3.25" but no longer than 5". Each side of the "lobster measure" is used to measure either a small or large lobster so lobstermen quickly know whether it's something they can sell or have to throw back.

Protecting Female Lobsters with Eggs - V-Notching

When a lobstermen pulls up his trap, if he sees a female lobster with eggs under the tail, he knows that it is critical to return this lobster back into the ocean to continue to reproduce. Before he throws the female lobster back in, he will mark one of her flippers on her tail with by taking a small piece of her fin off, in case another lobstermen pulls her up, he will also know not to harvest this particular lobster.

Keeping a v-notch lobster or a female lobster with eggs can result in a large fine. DMR takes this very seriously and have a zero tolerance for fishermen that don't abide by this regulation.

Maine Department of Marine Resources, Lobster Catch 1950-2019



Source: https://www.maine.gov/dmr/commercial-fishing/landings/documents/lobster.graph.pdf

Elinor Ostrom, "A General Framework for Analyzing Sustainability of Social-Ecological Systems"
Science 325 (2009): 419

The world is currently threatened by considerable damage to or losses of many natural resources, including fisheries, lakes, and forests, as well as experiencing major reductions in biodiversity and the threat of massive climatic change. All humanly used resources are embedded in complex, social-ecological systems (SESs). SESs are composed of multiple subsystems and internal variables within these subsystems at multiple levels analogous to organisms composed of organs, organs of tissues, tissues of cells, cells of proteins, etc. (1). In a complex SES, subsystems such as a resource system (e.g., a coastal fishery), resource units (lobsters), users (fishers), and governance systems (organizations and rules that govern fishing on that coast) are relatively separable but interact to produce outcomes at the SES level, which in turn feed back to affect these subsystems and their components, as well other larger or smaller SESs.

Scientific knowledge is needed to enhance efforts to sustain SESs, but the ecological and social sciences have developed independently and do not combine easily (2). Furthermore, scholars have tended to develop simple theoretical models to analyze aspects of resource problems and to prescribe universal solutions. For example, theoretical predictions of the destruction of natural resources due to the lack of recognized property systems have led to one-size-fits-all recommendations to impose particular policy solutions that frequently fail (3, 4).

The prediction of resource collapse is supported in very large, highly valuable, open-access systems when the resource harvesters are diverse, do not communicate, and fail to develop rules and norms for managing the resource (5). The dire predictions, however, are not supported under conditions that enable harvesters and local leaders to self-organize effective rules to manage a resource or in rigorous laboratory experiments when subjects can discuss options to avoid overharvesting (3, 6).

A core challenge in diagnosing why some SESs are sustainable whereas others collapse is the identification and analysis of relationships among multiple levels of these complex systems at different spatial and temporal scales (7–9). Understanding a complex whole requires knowledge about specific variables and how their component parts are related (10). Thus, we must learn how to dissect and harness complexity, rather than eliminate it from such systems (11). This process is complicated, however, because entirely different frameworks, theories, and models are used by different disciplines to analyze their parts of the complex multilevel whole. A common, classificatory framework is needed to facilitate multidisciplinary efforts toward a better understanding of complex SESs.

I present an updated version of a multilevel, nested framework for analyzing outcomes achieved in SESs (12). Figure 1 provides an overview of the framework, showing the relationships among four first-level core subsystems of an SES that affect each other as well as linked social, economic, and political settings and related ecosystems. The subsystems are (i) resource systems (e.g., a designated protected park encompassing a specified territory containing forested areas, wildlife, and water systems); (ii) resource units (e.g., trees, shrubs, and plants contained in the park, types of wildlife, and amount and flow of water); (iii) governance systems (e.g., the government and other organizations that manage the park, the specific rules related to the use of the park, and how these rules are made); and (iv) users (e.g., individuals who use the park in diverse ways for sustenance, recreation, or commercial purposes). Each core subsystem is made up of multiple second-level variables (e.g., size of a resource system, mobility of a resource unit, level of governance, users' knowledge of the resource system) (Table 1), which are further composed of deeper-level variables.

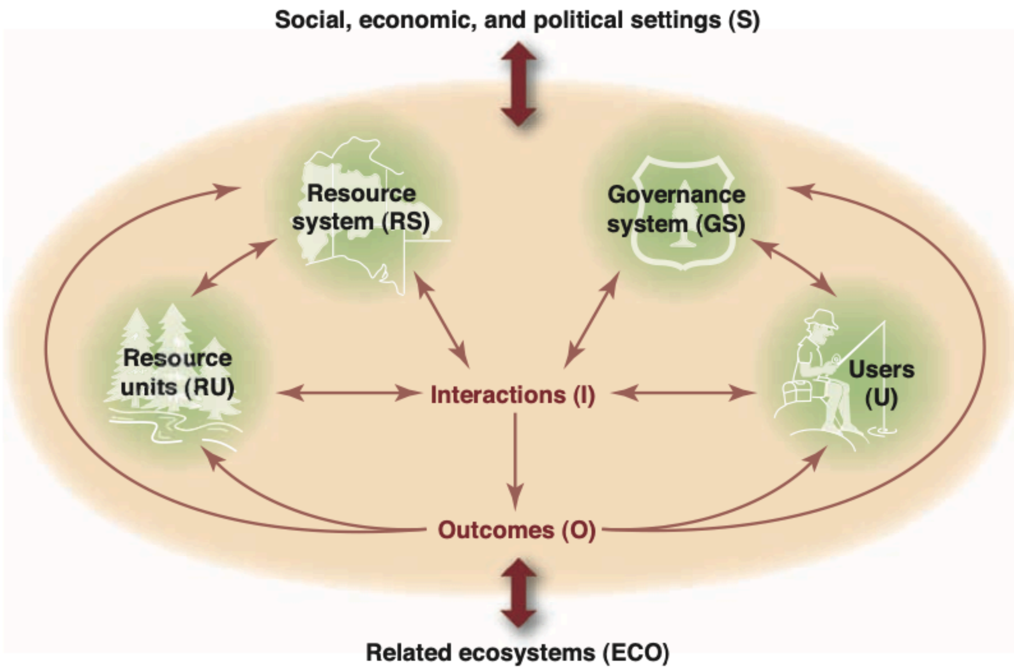


Fig. 1. The core subsystems in a framework for analyzing social-ecological systems.

This framework helps to identify relevant variables for studying a single focal SES, such as the lobster fishery on the Maine coast and the fishers who rely on it (13). It also provides a common set of variables for organizing studies of similar SESs such as the lakes in northern Wisconsin (e.g., why are the pollution levels in some lakes worse than in others?) (14), forests around the world (e.g., why do some locally managed forests thrive better than government- protected forests?) (15), or water institutions (e.g., what factors affect the likelihood that farmers will effectively manage irrigation systems?) (16). Without a framework to organize relevant variables identified in theories and empirical research, isolated knowledge acquired from studies of diverse resource systems in different countries by bio-physical and social scientists is not likely to cumulate.

A framework is thus useful in providing a common set of potentially relevant variables and their subcomponents to use in the design of data collection instruments, the conduct of fieldwork, and the analysis of findings about the sustain- ability of complex SESs. It helps identify factors that may affect the likelihood of particular policies enhancing sustainability in one type and size of resource system and not in others. Table 1 lists the second-level variables identified in many empirical studies as affecting interactions and out- comes. The choice of relevant second or deeper levels of variables for analysis (from the large set of variables at multiple levels) depends on the particular questions under study, the type of SES, and the spatial and temporal scales of analysis.

To illustrate one use of the SES framework, I will focus on the question: When will the users of a resource invest time and energy to avert “a tragedy of the commons”? Garrett Hardin (17) earlier argued that users were trapped in accelerated overuse and would never invest time and energy to extract themselves. If that answer were supported by research, the SES framework would not be needed to analyze this question. Extensive empirical studies by scholars in diverse disciplines have found that the users of many (but not all) resources have invested in designing and implementing costly governance systems to increase the likelihood of sustaining them (3, 6, 7, 18).

A theoretical answer to this question is that when expected benefits of managing a resource exceed the perceived costs of investing in better rules and norms for most users and their leaders, the probability of users’ self-organizing is high (supporting online material text). Although joint benefits may be created, self-organizing to sustain a resource costs time, and effort can result in a loss of short-term economic gains. These costs, as well as the fear that some users will cheat on rules related to when, where, and how to harvest, can lead users to avoid costly changes and continue to overharvest (6). Accurate and reliable measures of users’ perceived benefits and costs are difficult and costly to obtain, making it hard to test theories based on users’ expected net benefits.

Multiple variables that have been observed and measured by field researchers are posited to affect the likelihood of users’ engaging in collective action to self-organize. Ten second-level variables (indicated by asterisks in Table 1) are frequently identified as positively or negatively affecting the likelihood of users’ self-organizing to manage a resource (3, 6, 19, 20). To explain why these variables are potentially important for understanding sustainability and, in particular, for addressing the question of when self-organization activities will occur, I briefly discuss how they affect perceived benefits and costs.

Social, economic, and political settings (S)

S1 Economic development. S2 Demographic trends. S3 Political stability.
S4 Government resource policies. S5 Market incentives. S6 Media organization.

Resource systems (RS)	*Governance systems (GS)*
RS1 Sector (e.g., water, forests, pasture, fish)	GS1 Government organizations
RS2 Clarity of system boundaries	GS2 Nongovernment organizations
RS3 Size of resource system*	GS3 Network structure
RS4 Human-constructed facilities	GS4 Property-rights systems
RS5 Productivity of system*	GS5 Operational rules
RS6 Equilibrium properties	GS6 Collective-choice rules*
RS7 Predictability of system dynamics*	GS7 Constitutional rules
RS8 Storage characteristics	GS8 Monitoring and sanctioning processes
RS9 Location	
Resource units (RU)	*Users (U)*
RU1 Resource unit mobility*	U1 Number of users*
RU2 Growth or replacement rate	U2 Socioeconomic attributes of users
RU3 Interaction among resource units	U3 History of use
RU4 Economic value	U4 Location
RU5 Number of units	U5 Leadership/entrepreneurship*
RU6 Distinctive markings	U6 Norms/social capital*
RU7 Spatial and temporal distribution	U7 Knowledge of SES/mental models*
	U8 Importance of resource*
	U9 Technology used

Interactions (I) → outcomes (O)

I1 Harvesting levels of diverse users	O1 Social performance measures (e.g., efficiency, equity, accountability, sustainability)
I2 Information sharing among users	O2 Ecological performance measures (e.g., overharvested, resilience, bio-diversity, sustainability)
I3 Deliberation processes	O3 Externalities to other SESs
I4 Conflicts among users	
I5 Investment activities	
I6 Lobbying activities	
I7 Self-organizing activities	
I8 Networking activities	

Related ecosystems (ECO)

ECO1 Climate patterns. ECO2 Pollution patterns. ECO3 Flows into and out of focal SES.

*Subset of variables found to be associated with self-organization.

Size of resource system (RS3). For land-related resource systems, such as forests, very large territories are unlikely to be self-organized given the high costs of defining boundaries (e.g., surrounding with markers or fences), monitoring use patterns, and gaining ecological knowledge. Very small territories do not generate substantial flows of valuable products. Thus, moderate territorial size is most conducive to self-organization (15). Fishers who consistently harvest from moderately sized coastal zones, lakes, or rivers are also more likely to organize (13) than fishers who travel the ocean in search of valuable fish (5).

Productivity of system (RS5). A resource system's current productivity has a curvilinear effect on self-organization across all sectors. If a water source or a fishery is already exhausted or apparently very abundant, users will not see a need to manage for the future. Users need to observe some scarcity before they invest in self-organization (19).

Predictability of system dynamics (RS7). System dynamics need to be sufficiently predictable that users can estimate what would happen if they were to establish particular harvesting rules or no-entry territories. Forests tend to be more predictable than water systems. Some fishery systems approach mathematical chaos and are particularly challenging for users or government officials (21). Unpredictability at a small scale may lead users of pastoral systems to organize at larger scales to increase overall predictability (22, 23).

Resource unit mobility (RU1). Due to the costs of observing and managing a system, self-organization is less likely with mobile resource units, such as wildlife or water in an unregulated river, than with stationary units such as trees and plants or water in a lake (24).

Number of users (U1). The impact of group size on the transaction costs of self-organizing tends to be negative given the higher costs of getting users together and agreeing on changes (19, 20). If the tasks of managing a resource, however, such as monitoring extensive community forests in India, are very costly, larger groups are more able to mobilize necessary labor and other resources (25). Thus, group size is always relevant, but its effect on self-organization de- pends on other SES variables and the types of management tasks envisioned.

Leadership (U5). When some users of any type of resource system have entrepreneurial skills and are respected as local leaders as a result of prior organization for other purposes, self- organization is more likely (19, 20). The presence of college graduates and influential elders, for example, had a strong positive effect on the establishment of irrigation organization in a stratified sample of 48 irrigation systems in Karnataka and Rajasthan, India (16).

Norms/social capital (U6). Users of all types of resource systems who share moral and ethical standards regarding how to behave in groups they form, and thus the norms of reciprocity, and have sufficient trust in one another to keep agreements will face lower transaction costs in reaching agreements and lower costs of monitoring (20, 26, 27).

Knowledge of the SES (U7). When users share common knowledge of relevant SES at- tributes, how their actions affect each other, and rules used in other SESs, they will perceive lower costs of organizing (7). If the resource system regenerates slowly while the population grows rapidly, such as on Easter Island, users may not understand the carrying capacity of the resource, fail to organize, and destroy the resource (28).

Importance of resource to users (U8). In successful cases of self-organization, users are either dependent on the RS for a substantial portion of their livelihoods or attach high value to the sustainability of the resource. Otherwise, the costs of organizing and maintaining a self-governing system may not be worth the effort (3, 7, 15).

Collective-choice rules (GS6). When users, such as the Seri fishers in Mexico (29) and forest user groups in Nepal (30), have full autonomy at the collective-choice level to craft and enforce some of their own rules, they face lower trans- action costs as well as lower costs in defending a resource against invasion by others (5).

Obtaining measures for these 10 variables is the first step in analyzing whether the users of one or more SESs would self-organize. Data analysis of these relationships is challenging, because the impact of any one variable depends on the values of other SES variables. As in most complex systems, the variables interact in a nonlinear fashion (8–10). Furthermore, although the long- term sustainability of SESs is initially dependent on users or a government to establish rules, these rules may not be sufficient over the long run (7, 18).

If the initial set of rules established by the users, or by a government, are not congruent with local conditions, long-term sustainability may not be achieved (8, 9, 18). Studies of irrigation systems (16, 26), forests (25, 31), and coastal fisheries (13) suggest that long-term sustainability depends on rules matching the attributes of the resource system, resource units, and users. Rules forbidding the harvest of pregnant female fish are easy to monitor and enforce in the case of lobster, where eggs are visibly attached to the belly, and have been important in sustaining lobster fisheries (13). However, monitoring and enforcing these rules have proven more difficult in the case of gravid fish, where the presence of internal eggs is harder to assess.

Comparative studies of rules used in long- surviving resource systems governed by traditional societies document the wide diversity of rules used across sectors and regions of the world (21). Simple blueprint policies do not work. For example, the total allowable catch quotas established by the Canadian government for the west coast of Canada led to widespread dumping of unwanted fish, misrepresentation of catches, and the closure of the ground fishery in 1995 (32). To remedy this initial failure, the government re-opened the fishery but divided the coastal area into more than 50 sectors, assigned transferable quotas, and required that all ships have neutral observers onboard to record all catches (32).

Furthermore, the long-term sustainability of rules devised at a focal SES level depends on monitoring and enforcement as well their not being overruled by larger government policies. The long-term effectiveness of rules has been shown in recent studies of forests in multiple countries to depend on users' willingness to monitor one an- other's harvesting practices (15, 31, 33, 34). Larger- scale governance systems may either facilitate or destroy governance systems at a focal SES level. The colonial powers in Africa, Asia, and Latin America, for example, did not recognize local resource institutions that had been developed over centuries and imposed their own rules, which frequently led to overuse if not destruction (3, 7, 23).

Efforts are currently under way to revise and further develop the SES framework presented here with the goal of establishing comparable databases to enhance the gathering of research findings about processes affecting the sustainability of forests, pastures, coastal zones, and water systems around the world. Research across disciplines and questions will thus cumulate more rapidly and increase the knowledge needed to enhance the sustainability of complex SESs. Quantitative and qualitative data about the core set of SES variables across resource systems are needed to enable scholars to build and test theoretical models of heterogeneous costs and benefits between governments, communities, and individuals and to lead to improved policies.

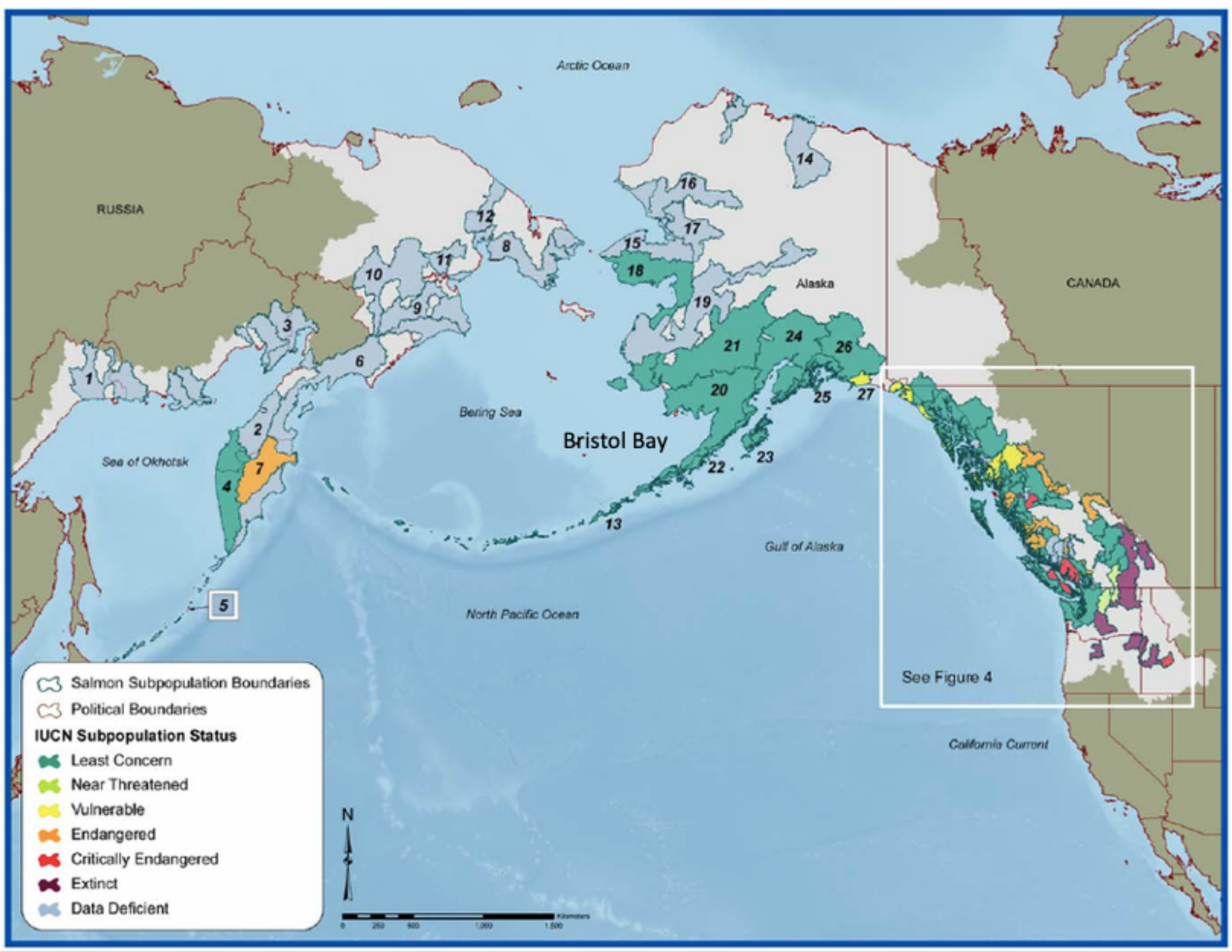
4. Salmon in Bristol Bay

Approximately half of the sockeye salmon consumed in the world come from Bristol Bay, Alaska. That fishery has been highly productive since approximately 1976. Indeed, the 2019 season was the most productive on record: 56.3 million fish returned to the bay to spawn, of which 43 million were harvested. Biologists regard the fishery as healthy.

Two independent regulatory regimes seem responsible for this success: the Limited Entry program, administered by the Commercial Fisheries Entry Commission; and a set of restrictions on when and how fishermen are permitted to fish, administered by the Alaska Fish & Game Department.

Not all observers, however, think this combination of rules is ideal. As you read through this case study, consider ways in which it could be improved.

Map of the Pacific Salmon Fisheries



Range-wide map of assessed sockeye salmon and their status as determined by the International Union for the Conservation of Nature. Source: Peter Rand et al., "Global Assessment of Extinction Risk to Populations of Sockeye Salmon," PLoS One 7:e34065 · April 2012

Breena Apgar-Kurtz, Factors Affecting Local Permit Ownership in Bristol Bay
(MA Thesis, University of Washington 2012)

Shortly after Alaska became a State in 1959, there became an increasing need to restrict access to Alaska's state fisheries to maintain the value of the resource. The value of the resource was declining because there were so many new non-Alaska resident participants entering the fishery and harvests were declining, causing per capita economic returns to decrease significantly.

At the time, restricting access to Alaska fisheries was unconstitutional due to Alaska's Constitution Section 15, which stated "no exclusive right or special privilege of fishery shall be created or authorized in the natural waters of the State." In 1972, following some of the worst salmon runs in Bristol Bay on record, a Constitutional amendment was passed, amending Section 15 to allow participation in fisheries to be restricted on the basis of resource conservation requirements or "to prevent economic distress among fishermen and those dependent on them for a livelihood".

In 1973, following passage of the amendment, Alaska's Limited Entry Act was enacted. There were three main objectives of the Act: (1) to increase the economic earnings of the Alaskan fishing industry; (2) to enhance biological management of the fishery and (3) to assure resident fishermen of participation of their local fishery. The Commercial Fisheries Entry Commission (CFEC) was established to administer the program. The license type Limited Entry program is CFEC's only regulatory management tool.

A point system was established to determine who would be eligible to receive permits. Points were awarded based on a combination of previous participation in the fishery and economic dependence. To help people apply for limited entry permits, CFEC employed agents to travel around the State to hand out applications. People had to demonstrate they had fished during the qualifying years to receive a permit.

People who were denied permits could appeal. Appeals sometimes lasted for many years. Many people who were denied a permit but successfully appealed are still fishing today. After permits were issued, they were freely transferable by inheritance, gift or sale….

Frank Homan, Chairman CFEC, "30 Years of Limited Entry"
Conference Presentation, 2006

The Limited Entry law was enacted in 1973. Some key features of the program were to 1) require issuance to natural persons only, 2) prohibit permit leasing, 3) prevent the use of permits as collateral for loans, and 4) allow for free transferability. The Limited Entry law also defined entry permits as a use-privilege that can be modified by the legislature without compensation. Free transferability has resulted in maintaining high percentages of residents within Alaska's fisheries and has been upheld by Alaska's Supreme Court. Permit holders are free to transfer their permits to family members or any other individual who is able to participate in the fishery by means of gift, inheritance or sale.

Through 2005, a total of 16,264 limited entry permits have been issued in 65 fisheries. Over 80 percent of permits issued were initially issued to Alaska residents. As of year- end 2005, there were 14,536 remaining entry permits. Between initial issuance and the end of 2005, 1,728 had been eliminated, primarily due to cancellation of non-transferable permits (non-transferable salmon hand troll permits account for over 1,000). Distribution of permits at year-end 2005 was as follows:

- 23% held by nonresidents,
- 38% held by rural Alaskans who live in the area of their permit fishery,
- 6% held by rural Alaskans who live in an area that is not local to their permit
- fishery,
- 24% held by Alaskans who live in an urban community local to their permit
- fishery, and
- 9% held by Alaskans who live in an urban community that is not local to their
- permit fishery.

This distribution has changed over time. Total permit holdings by nonresidents has risen since initial issuance. The reason is mainly due to migration (Alaskan permit holders moving out of state), however, and not permit sales from Alaskans to non-Alaskans. Permit holdings by nonresidents have declined as the net result of transfer activity by nearly 100 permits since initial allocation.

The most significant decline in permit holdings among Alaska resident types is from rural Alaskan permit holders living in an area local to their fishery (ARLs). Migrations of permit holders within and outside Alaska have led to a net decline in permit holdings by rural and urban Alaskans local to their fishery. Permit holdings of ARLs have also declined due to net transfer activity. Total permit holdings by ARLs have declined by 605 permits due to net transfer activity, 728 as the net result of migration, and 600 due to cancellation. However, of all permits held by Alaskans, Alaska rural residents hold more than 50%.

Across all years and fisheries, permits have been transferred at a rate of 9%. The annual transfer rate has ranged from 6% to 13%, with lower rates in recent years and higher rates in earlier years of Limited Entry. According to 1980 through 2005 Commercial Fisheries Entry Commission transfer survey data, nearly 50% of those permits that have transferred to rural Alaskans local to their fishery have been transferred as gifts. Approximately 50% of transfers to rural Alaskans local to their fishery are from immediate family. The same resident type has received only 45% of their permit transfers through sales. All other resident types have received their permits as gifts at a rate of 27-29% and through a sale type transaction at a rate of 65-67%. Of those permits sold to Alaskans, 27% (2,836) have been financed by state authorized lenders. This is an option only available to Alaska residents, and it has clearly been helpful to Alaskan fishermen purchasing permits.

Aleut boys want to be fishermen and will take on the title and role at an early age. School-age children tend to fish for salmon because it is a summer activity, does not conflict with the academic year, and is considerably safer than other fisheries. Children's knowledge of fishing is detailed and impressive, even at the political level. They "grow up on boats." Parents recognize that fishing presents fewer opportunities than ever before, yet the enthusiasm for fishing is so contagious that they are reluctant to steer children down other career paths. There was a brief emigration of people after permits were distributed, but now the local Aleut population is expanding. With fewer Aleut-owned permits, fathers are often faced with choosing which son gets a permit.

There is both the internal desire and external social pressure on men to fish. Despite this, the majority of young men can never hope to be full participants, especially those outside the larger families who are not linked to those with permits. Crewmen are often career crewmen, and they strive to get on profitable boats with successful captains. While all crewmen desire to own their own boat and permit, becoming a captain is extremely difficult unless you are in a position to inherit. There are a few cases of young men fishing as crew and successfully saving for a permit of their own, but this is rare.

There are no women captains in the King Cove fleet, however a few women crew. They are usually linked to the captain or crew as spouses, partners, or family. Women do not strive to be equal to men in fishing because the social rewards come from parenting and village roles. Successful fishermen require successful marriages, with women supporting their husbands' activities and in the *valued* role of motherhood. At the same time, marriages often stabilize with newfound fishing success. Women's status is linked to the status of their fishermen and they keep close tabs on men's successes and failures.

Members of elite permitted families tend to marry or partner with one another, and thus the majority of families who initially received permits are the ones that still have them (Figure 4), only they are now more widely distributed within those families. Aleut women tend to want to partner with Aleut men who have a future in fishing. The age-sex structure of King Cove demonstrates a ratio of men to women over age 18 as 1.66:1 (Census 2000), and transient fishermen increase this difference during fishing seasons. There are more men than available female partners and more men than there are fishing permits. However, there is also a scarcity of the "right kind of man" for women to marry, meaning there are few available stable fishermen, or men who have been able to fill prestige criteria in relation to fishing, although this does not necessarily preclude sexual relationships. Fishing access in this regard is necessary for attracting women.

Since young men are often limited or delayed in their desired level of fishing participation within an inherently volatile business, occupationally and culturally displaced men create communitywide stress. Many of these men live with or are supported by their parents, even if they are parents themselves. The option to leave the village further magnifies cultural displacement and job stress because many have limited training outside of fishing. In poor fishing years, husbands may leave the village temporarily to find work, leaving their spouses and children in the care of extended family. Law enforcement officers agree that bad fishing seasons raise crime rates, and some wives fear bad fishing years because of the potential for spouse abuse. Good fishing years do not necessarily mean harmony either, since hedonistic behavior often increases.

Possessing a boat and permit is a concrete index of a man's ability to meet his family obligations. Security in old age is achieved through the successes of one's children. Elders who were not able to pass permits to sons are vulnerable and dependent upon family and friends to stock their freezers. Elders who have survived the volatility of the fishing industry mourn the early days before permits "spoiled all our fishery." They saw the most prosperous years of the salmon industry, but are witnessing their children struggle with these structural disadvantages while waiting to inherit permits and boats or hoping for good crewing jobs. Some will not be able to have a future in fishing.

Alaska Commercial Fisheries Entry Commission
CFEC Permit Holdings and Estimates of Gross Earnings in
The Bristol Bay Commercial Salmon Fisheries, 1975-2017

(November 2018)

Table 1-12. CFEC Estimated Value of Bristol Bay Salmon Drift Gillnet Permits

Year	S03T Permit Sales	Nominal		Real	
		Permit Value	Standard Deviation	Permit Value	Standard Deviation
1982	114	$95,936	-	$243,687	-
1983	101	$98,923	-	$243,454	-
1984	88	$116,905	-	$275,801	-
1985	89	$117,983	-	$268,773	-
1986	97	$124,605	-	$278,679	-
1987	80	$130,137	-	$280,803	-
1988	75	$173,406	-	$359,301	-
1989	48	$248,802	-	$491,825	-
1990	61	$216,033	-	$405,157	-
1991	58	$207,800	$26,150	$373,979	$47,062
1992	62	$193,000	$29,000	$337,193	$50,666
1993	61	$199,600	$20,500	$338,588	$34,775
1994	76	$165,700	$19,850	$274,065	$32,832
1995	83	$195,000	$22,900	$313,638	$36,832
1996	64	$171,800	$11,950	$268,398	$18,669
1997	63	$153,800	$23,850	$234,888	$36,424
1998	68	$99,500	$14,800	$149,628	$22,256
1999	51	$89,700	$10,100	$131,976	$14,860
2000	64	$80,500	$15,100	$114,589	$21,494
2001	73	$34,700	$11,250	$48,027	$15,571
2002	90	$19,700	$3,000	$26,842	$4,088
2003	116	$29,300	$4,550	$39,033	$6,061
2004	85	$37,000	$4,400	$48,012	$5,710
2005	142	$51,200	$9,250	$64,261	$11,610
2006	99	$75,000	$5,850	$91,190	$7,113
2007	147	$79,400	$5,000	$93,867	$5,911
2008	88	$89,800	$5,550	$102,236	$6,319
2009	101	$78,300	$6,500	$89,462	$7,427
2010	127	$102,100	$15,350	$114,772	$17,255
2011	85	$143,900	$15,600	$156,810	$17,000
2012	80	$110,800	$12,350	$118,293	$13,185
2013	86	$100,400	$13,950	$105,642	$14,678
2014	75	$149,500	$11,150	$154,795	$11,545
2015	53	$148,200	$22,200	$153,267	$22,959
2016	64	$109,300	$13,200	$111,628	$13,481
2017	76	$133,300	$6,050	$133,300	$6,050

Job Monkey

Alaska Salmon Gillnetting Jobs

Gillnetting is a harvesting technique employing fine-filament nets that are set like a giant badminton net across the path of migrating salmon. The top edge is held up by floats, and the bottom is pulled down by a heavy lead line forming a wall in the water that entangles fish by their gills.

There are two basic gillnetting methods, “set” and “drift” gillnetting. Set gillnets are commonly used along the shorelines near the mouths of rivers in remote areas of Alaska. Natives and rural families use set nets for subsistence fishing, but the technique is less commonly used by the commercial fishing industry; JobMonkey focuses on drift gillnetting.

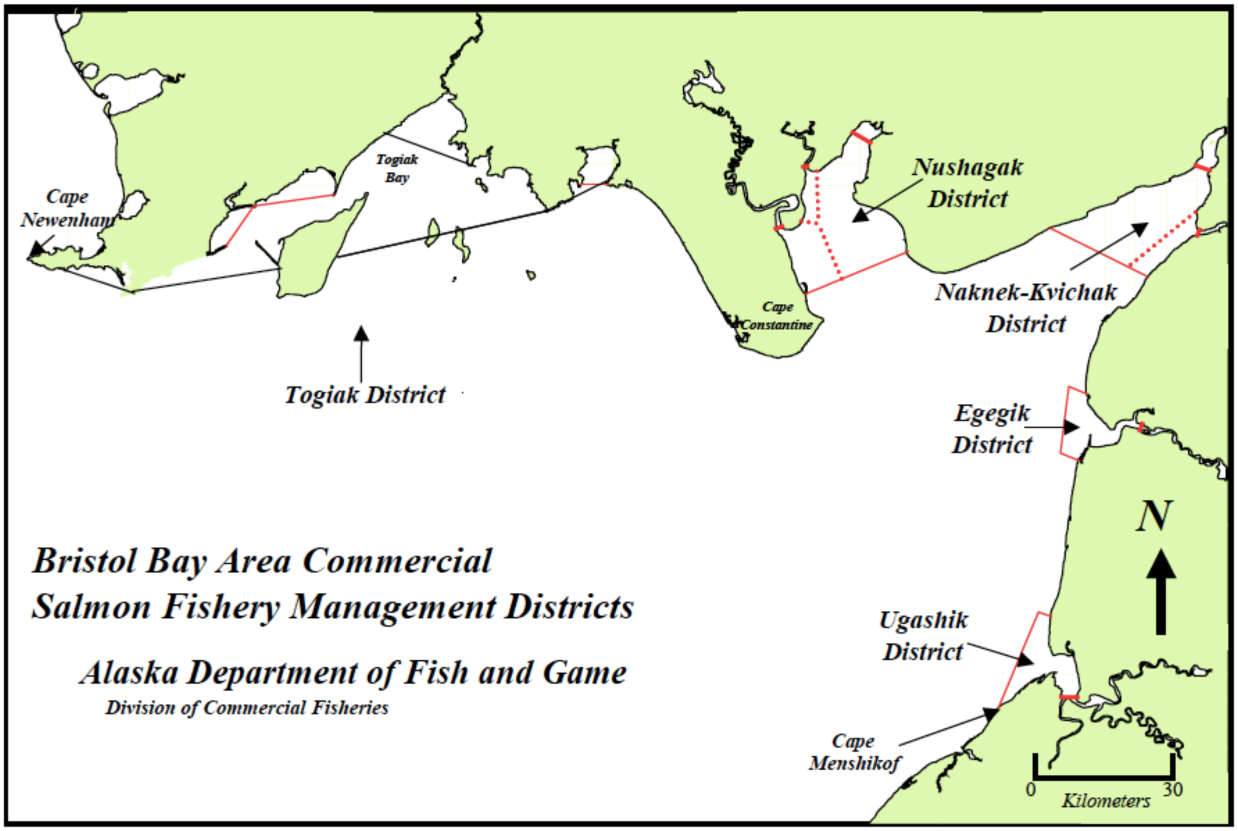
Drift gillnets are lowered off the stern or bow of a boat and allowed to drift freely in deep water, entangling fish that swim into them. A single “set” may last anywhere from a few minutes to the better part of a day, depending on currents, the weather, and the number of fish being caught. The net is slowly pulled in when the floats along the top begin to jiggle vigorously. The entangled fish are pulled up and shaken out of the net and then thrown into the hold. The net is then reset, and the process begins again.

Gillnetters are recognizable by the large drum, which looks like a giant spool, mounted on the stern or bow that sets and retrieves the net. In Bristol Bay the drum is kept on the back (stern) of the boat….

The Department of Fish and Game tightly regulates all commercial fishing openings in Alaska. They allow gillnetters to fish anywhere from zero to seven days a week depending on region, number of fish caught, strength of salmon run, etc. The duration of an “opening” is usually either 12 or 24 hours. Between openings, fishermen make repairs, prepare for the next opening, rest, and enjoy the beauties of the region. Inexperienced gillnetters usually earn about five percent of the boat’s gross income, while experienced deckhands make between 8-12 percent, which usually works out to between $4,000 and $7,000 for a two-month season.

Quick Facts: Gillnetting

- Boat size: around 30 feet
- Crew members: skipper plus one, sometimes two
- Hours: long for two to three days, then a few days off
- Average crew share: S.E. and S.W., 8-10 percent of gross, $4,000-$7,000 for two months; B.B., five percent of gross for greenhorns, 8-12 percent of gross for experienced crew members, $8,000-$12,000 for six weeks
- Deckhand duties: running nets, cooking, cleanup
- Pros: good-sized crew shares, a lot of days off
- Cons: long hours, somewhat difficult for greenhorns to get jobs



5 AAC 06.330. Gear
(a) Salmon may be taken with set and drift gillnets only in the districts described in 5 AAC 06.200. Salmon may be taken with set gillnets on the northwest shore of Kvichak Bay from the Naknek-Kvichak District boundary south to 58° 43.80' N. lat., 157° 42.70' W. long.

5 AAC 06.331. Gillnet specifications and operations
(a) Gillnet mesh size restrictions are as follows:
(1) gillnet mesh size may not exceed five and one-half inches during periods established by emergency order for the protection of king salmon and in the Naknek-Kvichak and Ugashik Districts from June 1 through July 22; …

(b) No gillnet may be more than 29 full meshes in depth, including the selvages.

(c) Except as provided in 5 AAC 06.333, a person may not operate or assist in the operation of a drift gillnet exceeding 150 fathoms in length or a set gillnet exceeding 50 fathoms in length. …
(e) Except as provided in 5 AAC 06.333, a vessel registered for salmon net fishing may not have on board it or any vessel towed by it, during an open fishing period, more than 150 fathoms of

drift gillnet gear in the aggregate. Additional gear may be transported to another district under conditions specified by the department.

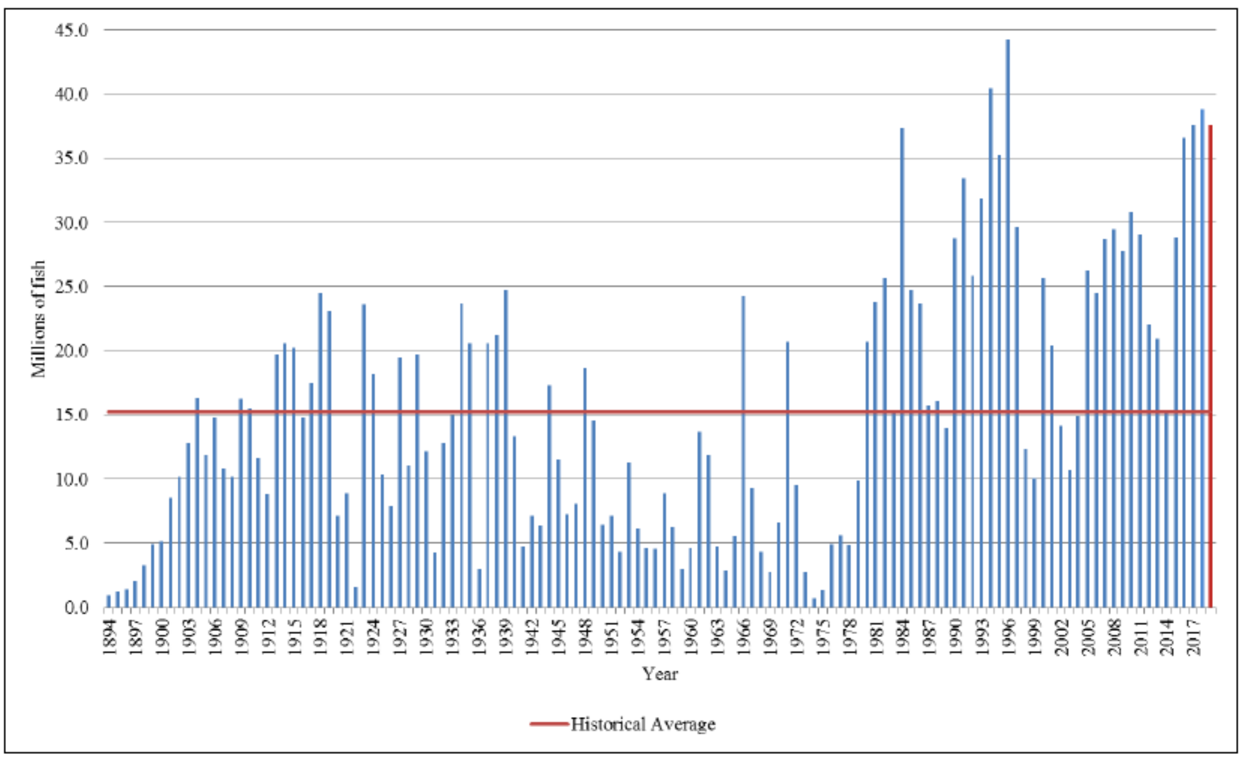
(f) A person may not operate more than two set gillnets, and the aggregate length of set gillnets operated by that person may not exceed 50 fathoms in length. …

(h) Set gillnets shall be operated in substantially a straight line.

(i) A set gillnet must be set on an area of a beach that, at mean low tide, is connected by exposed land to the shore or to land not covered at high tide…

(m)(3) in the Egegik District, from one mile south of Big Creek to Big Creek, no part of a set gillnet may be more than 1,000 feet from the 18-foot high tide mark or 450 feet from the 13-foot high tide mark…

Bristol Bay Commercial Sockeye Salmon Harvests



Source: *Poetter, A. D., and J. Shriver. 2018. 2018 Bristol Bay sockeye salmon processing capacity survey summary. Alaska Department of Fish and Game, Special Publication No. 18-08, Anchorage.*, p. 12

Alaska Department of Fish and Game
2022 Bristol Bay Sockeye Salmon Forecast

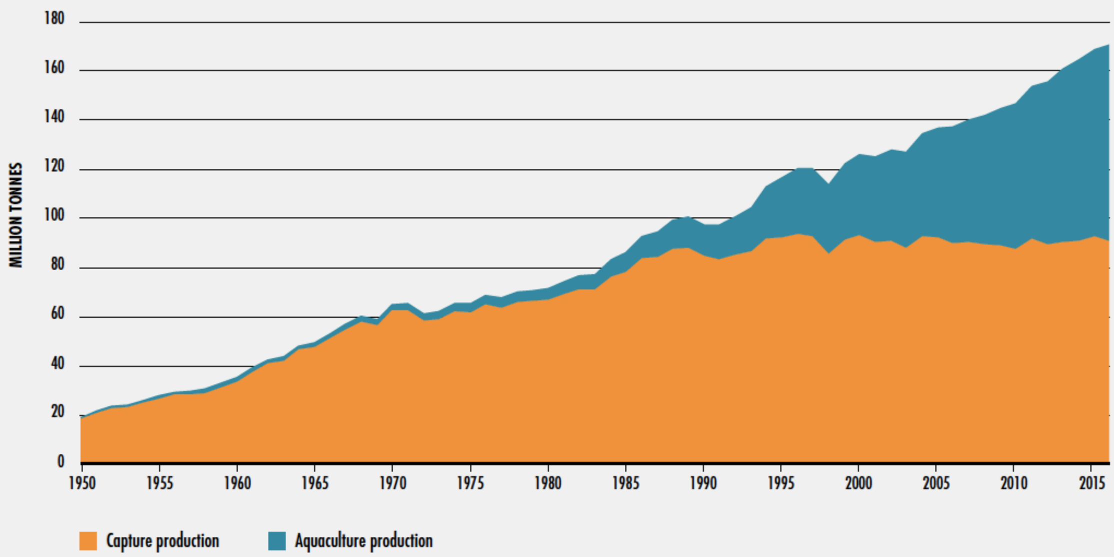
A total of 75.27 million sockeye salmon (within a range of 61.01–89.54 million) are expected to return to Bristol Bay in 2022 (Table 1). This is 44% larger than the most recent 10-year average of Bristol Bay total runs (52.09 million) and 111% greater than the long-term (1963–2021) average of 35.73 million fish. All systems are expected to meet their spawning escapement goals. The forecast range is the upper and lower values of the 80% confidence interval for the total run forecast. The confidence bounds were calculated from the deviation of actual runs and run forecasts from 2004 through 2021.

A run of 75.27 million sockeye salmon would allow for a potential harvestable surplus of 61.82 million fish; 59.94 million fish in Bristol Bay and 1.88 million fish in South Peninsula fisheries. A Bristol Bay harvest of this size is 75% greater than the most recent 10-year average harvest of 34.24 million which has ranged from 15.38 million to 42.94 million, and 170% greater than the long-term average harvest of 22.22 million fish (1963 to present).

5. The Global Situation

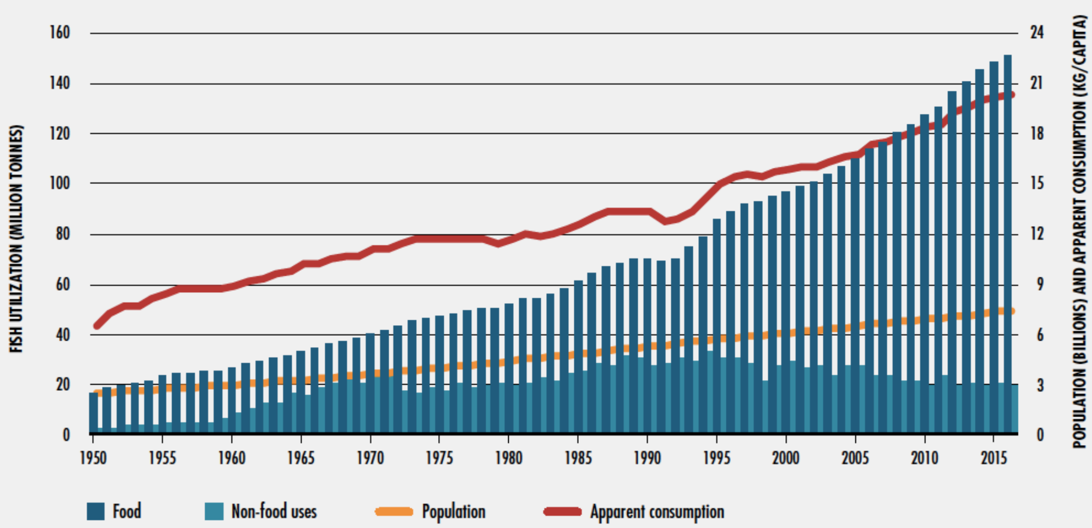
United Nations, Food and Agriculture Organization, “The State of the World Fisheries and Aquaculture”
2018

FIGURE 1
WORLD CAPTURE FISHERIES AND AQUACULTURE PRODUCTION



NOTE: Excludes aquatic mammals, crocodiles, alligators and caimans, seaweeds and other aquatic plants

FIGURE 2
WORLD FISH UTILIZATION AND APPARENT CONSUMPTION



NOTE: Excludes aquatic mammals, crocodiles, alligators and caimans, seaweeds and other aquatic plants

TABLE 1
WORLD FISHERIES AND AQUACULTURE PRODUCTION AND UTILIZATION (MILLION TONNES)[a]

Category	2011	2012	2013	2014	2015	2016
Production						
Capture						
Inland	10.7	11.2	11.2	11.3	11.4	11.6
Marine	81.5	78.4	79.4	79.9	81.2	79.3
Total capture	**92.2**	**89.5**	**90.6**	**91.2**	**92.7**	**90.9**
Aquaculture						
Inland	38.6	42.0	44.8	46.9	48.6	51.4
Marine	23.2	24.4	25.4	26.8	27.5	28.7
Total aquaculture	**61.8**	**66.4**	**70.2**	**73.7**	**76.1**	**80.0**
Total world fisheries and aquaculture	**154.0**	**156.0**	**160.7**	**164.9**	**168.7**	**170.9**
Utilization[b]						
Human consumption	130.0	136.4	140.1	144.8	148.4	151.2
Non-food uses	24.0	19.6	20.6	20.0	20.3	19.7
Population (*billions*)[c]	7.0	7.1	7.2	7.3	7.3	7.4
Per capita apparent consumption (*kg*)	18.5	19.2	19.5	19.9	20.2	20.3

[a] Excludes aquatic mammals, crocodiles, alligators and caimans, seaweeds and other aquatic plants.
[b] Utilization data for 2014–2016 are provisional estimates.
[c] Source of population figures: UN, 2015e.

FIGURE 14
GLOBAL TRENDS IN THE STATE OF THE WORLD'S MARINE FISH STOCKS, 1974–2015

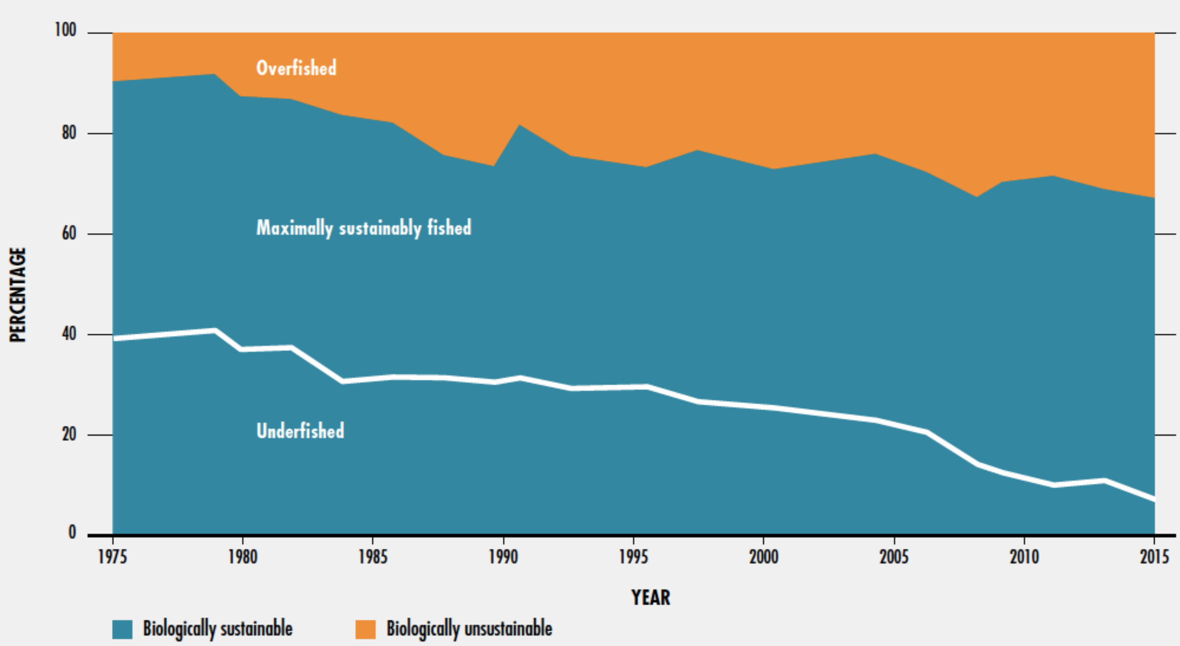


TABLE 2
MARINE CAPTURE PRODUCTION: MAJOR PRODUCER COUNTRIES

Country		Production *(tonnes)*		% Variation		Variation, 2015 to 2016 *(tonnes)*
	Average 2005–2014	2015	2016	2005–2014 (average) to 2016	2015 to 2016	
China	13 189 273	15 314 000	15 246 234	15.6	−0.4	−67 766
Indonesia	5 074 932	6 216 777	6 109 783	20.4	−1.7	−106 994
United States of America	4 757 179	5 019 399	4 897 322	2.9	−2.4	−122 077
Russian Federation	3 601 031	4 172 073	4 466 503	24.0	7.1	294 430
Peru Total	6 438 839	4 786 551	3 774 887	−41.4	−21.1	−1 011 664
Excluding anchoveta	989 918	1 016 631	919 847	−7.1	−9.5	−96 784
India	3 218 050	3 497 284	3 599 693	11.9	2.9	102 409
Japan[a]	3 992 458	3 423 099	3 167 610	−20.7	−7.5	−255 489
Viet Nam	2 081 551	2 607 214	2 678 406	28.7	2.7	71 192
Norway	2 348 154	2 293 462	2 033 560	−13.4	−11.3	−259 902
Philippines	2 155 951	1 948 101	1 865 213	−13.5	−4.3	−82 888
Malaysia	1 387 577	1 486 050	1 574 443	13.5	5.9	88 393
Chile Total	3 157 946	1 786 249	1 499 531	−52.5	−16.1	−286 718
Excluding anchoveta	2 109 785	1 246 154	1 162 095	−44.9	−6.7	−84 059
Morocco	1 074 063	1 349 937	1 431 518	33.3	6.0	81 581
Republic of Korea	1 746 579	1 640 669	1 377 343	−21.1	−16.0	−263 326
Thailand	1 830 315	1 317 217	1 343 283	−26.6	2.0	26 066
Mexico	1 401 294	1 315 851	1 311 089	−6.4	−0.4	−4 762
Myanmar[a]	1 159 708	1 107 020	1 185 610	2.2	7.1	78 590
Iceland	1 281 597	1 318 916	1 067 015	−16.7	−19.1	−251 901
Spain	939 384	967 240	905 638	−3.6	−6.4	−61 602
Canada	914 371	823 155	831 614	−9.1	1.0	8 459
Taiwan, Province of China	960 193	989 311	750 021	−21.9	−24.2	−239 290
Argentina	879 839	795 415	736 337	−16.3	−7.4	−59 078
Ecuador	493 858	643 176	715 357	44.9	11.2	72 181
United Kingdom	631 398	65 451 506	701 749	11.1	−0.4	−2 753
Denmark	735 966	868 892	670 207	−8.9	−22.9	−198 685
Total 25 major countries	**65 451 506**	**66 391 560**	**63 939 966**	**−2.3**	**−3.7**	**−2 451 594**
Total other 170 countries	**14 326 675**	**14 856 282**	**15 336 882**	**7.1**	**3.2**	**480 600**
World total	**79 778 181**	**81 247 842**	**79 276 848**	**−0.6**	**−2.4**	**−1 970 994**
Share of 25 major countries	***82.0%***	***81.7%***	***80.7%***			

[a] Production figures for 2015 and 2016 are FAO estimates.

TABLE 11
WORLD EMPLOYMENT FOR FISHERS AND FISH FARMERS BY REGION (thousands)

Region	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016
Fisheries and aquaculture										
Africa	2 392	4 175	4 430	5 027	5 250	5 885	6 009	5 674	5 992	5 671
Asia	31 296	39 646	43 926	49 345	48 926	49 040	47 662	47 730	50 606	50 468
Europe	530	779	705	662	656	647	240	394	455	445
Latin America and the Caribbean	1 503	1 774	1 907	2 185	2 231	2 251	2 433	2 444	2 482	2 466
North America	382	346	329	324	324	323	325	325	220	218
Oceania	121	126	122	124	128	127	47	46	343	342
Total	**36 223**	**46 845**	**51 418**	**57 667**	**57 514**	**58 272**	**56 716**	**56 612**	**60 098**	**59 609**
Fisheries										
Africa	2 327	4 084	4 290	4 796	4 993	5 587	5 742	5 413	5 687	5 367
Asia	23 534	27 435	29 296	31 430	29 923	30 865	29 574	30 190	32 078	31 990
Europe	474	676	614	560	553	544	163	328	367	354
Latin America and the Caribbean	1 348	1 560	1 668	1 937	1 966	1 982	2 085	2 092	2 104	2 085
North America	376	340	319	315	315	314	316	316	211	209
Oceania	117	121	117	119	122	121	42	40	334	334
Total fishers	**28 176**	**34 216**	**36 304**	**39 157**	**37 872**	**39 411**	**37 922**	**38 379**	**40 781**	**40 339**
Aquaculture										
Africa	65	91	140	231	257	298	267	261	305	304
Asia	7 762	12 211	14 630	17 915	18 373	18 175	18 088	17 540	18 528	18 478
Europe	56	103	91	102	103	103	77	66	88	91
Latin America and the Caribbean	155	214	239	248	265	269	348	352	378	381
North America	6	6	10	9	9	9	9	9	9	9
Oceania	4	5	5	5	6	6	5	6	9	8
Total fish farmers	**8 049**	**12 632**	**15 115**	**18 512**	**19 015**	**18 861**	**18 794**	**18 235**	**19 316**	**19 271**