Management of the Oyster Fisheries in Japan's Ariake Sea and Maryland's Chesapeake Bay: A Comparison

MOMOKO ISHIKAWA and VICTOR S. KENNEDY

ABSTRACT—An estuarine fishery can provide high harvest productivity and economic profit while supporting a traditional way of life in fishing communities. Overfishing may lead to environmental degradation and political conflicts that sometimes may collapse the fishery. Consequently, appropriate management is required for social, environmental, and economic sustainability. To identify similarities and differences in managing two estuarine fisheries for oysters (Suminoe oyster, Crassostrea ariakensis, *and eastern oyster,* Crassostrea virginica*), we used interviews, field observations, and literature research to compare the oyster industries in the Ariake Sea (Japan) and in Maryland's Chesapeake Bay (USA) from historical, political, sociocultural, and environmental perspectives. These industries have different historical, political, and sociocultural backgrounds. However, the two regions have lost most of their oyster resources due mainly to environmental degradation and failure of environmental management, coupled with overfishing and disease in Maryland. The situation in Maryland has also been affected by resistance of the oystering communities to aquaculture. In the Ariake region, fishermen are more amenable to aquaculture but resistant to allowing new participants into the fishery. Based on our findings, we propose that an estuarine fishery management plan should include understanding the history of traditional practices and encouraging cooperation among representatives of industry, politics, and science.*

Introduction

Estuarine fisheries can provide high harvest productivity and economic profit while supporting customary values and longstanding socioculturral practices (i.e., systems of thoughts and behaviors shared by a group). Often, harvesting, processing, and shipping occur close to fishermen's homes, thereby forming resource-oriented communities with a long history of fishing. Such a history can play an important role in developing socioculturral norms accepted by the community (Acheson, 1981; Paolisso and Dery, 2010).

While capture fisheries' production in marine regions worldwide has stabilized in recent decades, the marine aquaculture sector has grown (FAO, 2012), producing ~18 million metric tons (t) of finfish and shellfish in 2011. Oysters are a large part of the shellfish component of aquaculture. We compared two depleted fisheries for oysters (Suminoe oyster, *Crassostrea ariakensis*, and eastern oyster, *Crassostrea virginica*) with different sociocultural backgrounds to determine similarities and differences in their management. We hypothesized that there are common problems, and perhaps solutions, that the industries face in spite of different fishing practices, history, traditional backgrounds, and legal structures.

One industry studied is in the Ariake Sea, a fishing region in western Japan with a long history of government-encouraged aquaculture. The other is the Maryland part of Chesapeake Bay where the idea of private aquaculture is becoming accepted by some (but not all) fishermen after a long history of resistance. In addition to examining fishing practices, we considered attitudes towards cooperation on the part of fishermen (Paolisso and Dery, 2010).

Momoko Ishikawa is at 243 Rollins Avenue, Apt. 202, Rockville, MD, 20852 and Victor S. Kennedy (corresponding author: kennedy@umces.edu) is with the University of Maryland Center for Environmental Science, Horn Point Laboratory, Cambridge, MD 21613.

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Methods

In the summer of 2009, the senior author visited the Saga part of the Ariake Sea to study the history and present conditions of the oyster industry by field observations, interviews of scientists and fishermen, and literature research. Together both authors examined the oyster fishery in Maryland's Chesapeake Bay in 2010 and reviewed its history. To obtain various opinions from different stakeholder groups in Maryland, the senior author interviewed people working in the oyster industry and in restoration programs while also attending public hearings for the oyster restoration plan in the summer of 2010.

Characteristics of the Two Estuaries

The Ariake Sea, located in the west of Kyushu, the southern island of Japan (Fig. 1), is one of the most productive water bodies in Japan. The inner bay forms a broad tidal flat suitable for bivalve fisheries (e.g., Suminoe oyster and tairagi clam, *Atrina pectinata*). Nutrient-rich shallow water provides excellent conditions for farming laver seaweed (nori, *Porphyra yezoensis*), yielding 40% of the total annual production in Japan in recent decades (Sasaki, 2005a).

The Ariake Sea is divided into four fishery jurisdictions based on the borders between the Prefectures of Saga, Fukuoka, Kumamoto, and Nagasaki. Unfortunately, the harvests of marine organisms in all four regions have

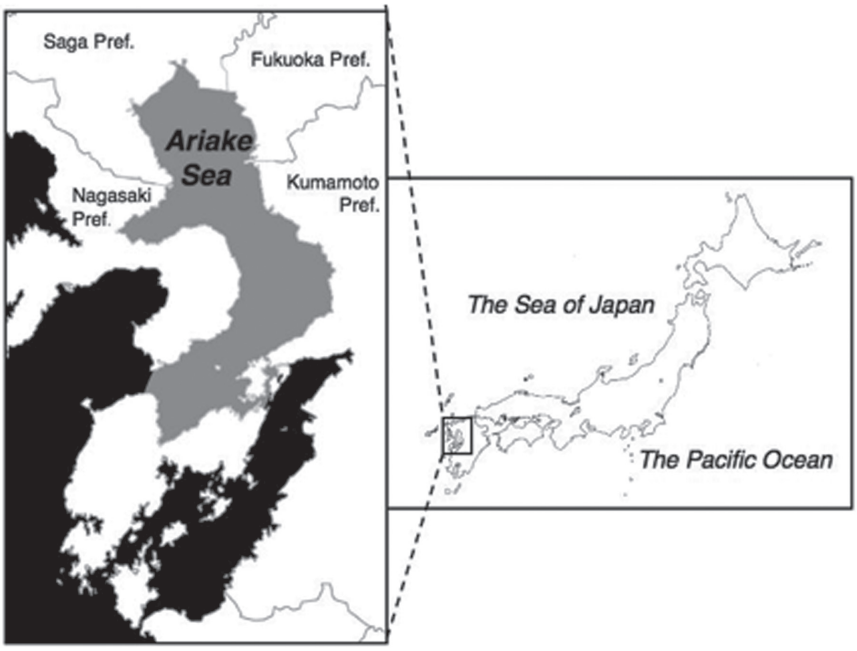

Figure 1.—The Ariake Sea and its four prefectures (Pref.).

decreased since the 1973–80 period (Sasaki, 2005a). These declines are thought to be the result of habitat deterioration due to activities such as land reclamation, river improvement, sand extraction, and port construction that have changed water flow and sediment input (Sasaki, 2005b).

In particular, the National Isahaya Bay Reclamation Project of 1989 in the west side of the Ariake Sea (Fig. 2) is considered a major reason for the recent diminished fishery production (Sato, 2006; Yoshino et al., 2007). Tidal flats are an important resource for land reclamation in Japan where 70% of the country is mountainous and not arable. Thus, many reclamation works have occurred since the early modern period of Japan (Sasaki, 2005b).

The Isahaya Bay project was a large-scale public work in which two dikes closed off the entire bay (3,550 ha in total; Fig. 2) to prevent typhoon-fed flooding and to gain agricultural lands (Sasaki, 2005b). The changed system weakened water flows and altered flow directions in the entire Ariake Sea and consequently triggered abnormal physical and biological cycles (Sasaki et al., 2005). Red tides and oxygen deficiencies have often occurred since 1998 (Sasaki, 2005b; Nakata et al., 2010). The reclamation project received broad attention and aroused a national controversy on coastal development and environmental conservation (Kunishima and Miura, 2011).

Chesapeake Bay (Fig. 3), one of the world's largest estuaries, lies on the east coast of the United States. Many tributaries deliver nutrient-rich fresh water that, given the bay's shallow-

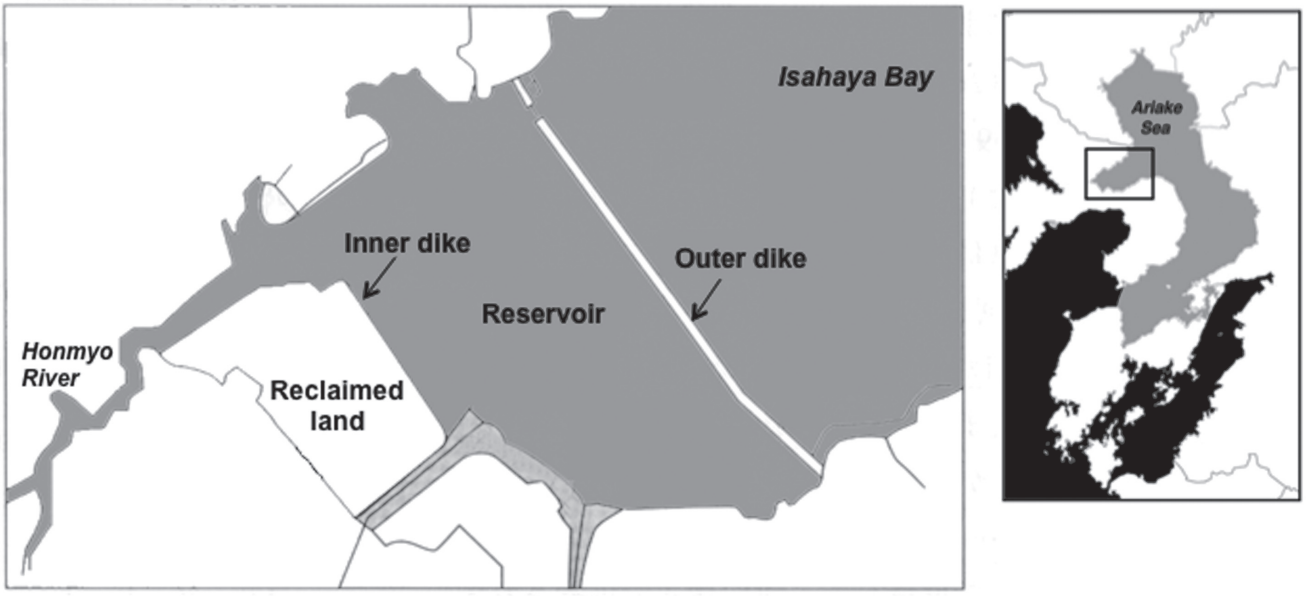

Figure 2.—National Isahaya Bay Reclamation Project (left). Isahaya Bay, on the west side of the Ariake Sea (right), is closed off by the outer dike. The inner dike encloses the reclaimed land (modified after Sasaki, 2005b).

ness (average depth 6.5 m), supports high productivity (Kemp et al., 2005). Many species with commercial value, including the eastern oyster, live in the bay during a part or all of their life.

In addition to harvesting a large quantity of aquatic organisms, Chesapeake residents have historically affected the bay's environment in many ways.[1] The bay is important for transportation and industry, so dredging of shipping channels and pollution from industries and residences have stressed the sensitive estuarine environment. Many farms in the surrounding watershed release large amounts of manure and fertilizer that cause eutrophication (Kemp et al., 2005). In addition, sediments from developed and farmed areas have smothered many three-dimensional oyster bars and hindered the ability of oysters to feed, reproduce, and settle (Smith et al., 2005).

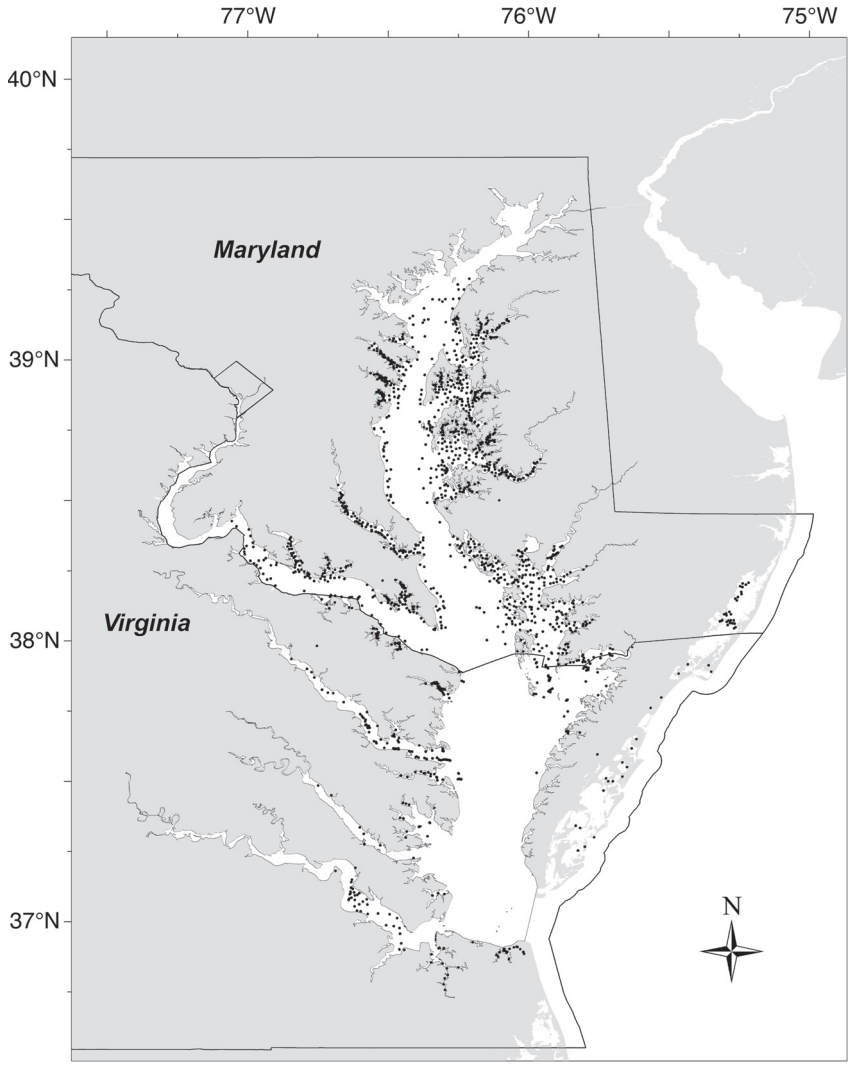

Figure 3.—Chesapeake Bay, with charted oyster bars shown as dots. Courtesy of Maryland Sea Grant, College Park, Md.

Brief History of the Oyster Industries

Ariake Sea

The Ariake Sea was the largest oyster-producing area in Japan in the early twentieth century. Farming Suminoe oysters in the region began around 1884 (SFAC, 1998). Oyster spat that settled on bamboo stems placed in the lower Kashima River were transplanted offshore to higher salinity where they grew faster and were subsequently harvested in 10–12 mo. This method became popular among fishermen who made large profits. Production steadily increased in the late 1800's and peaked in 1919, representing ~60 % of the total production in Japan that year (Fig. 4; SFAC, 1998).

Unfortunately, an historical flood in 1953 produced a large volume of freshwater runoff containing the agricultural pesticide parathion. This pollution killed most farmed oysters and other shellfish in the sea (SFAC, 1998). To rescue the local fishermen from financial crisis, Saga Prefecture promoted nori farming as an alternative source of income (SFAC, 1998). Nori farming had been introduced to the Saga region in 1904 from Kumamoto Prefecture, where it was very profitable.

Later, Japan experienced a breakthrough in nori production after the discovery of the conchocelis phase of the plant (Drew, 1949) that enabled farmers to understand the life history of nori and store seeds for culture purposes. Given the depleted bivalve populations, it seemed reasonable for Saga Prefecture to encourage the fishermen to shift from oyster farming to nori farming by supporting their economic and technical needs (Kawamura, 2002).

Regrettably, while preparing a flat bottom for nori farming, the Prefecture damaged oyster bars and smothered oyster shells that serve as settlement substrate (SFAC, 1998) because such farming requires planting wooden posts that support meshes to which nori attaches. Oyster abundances and their ecological services have diminished. For example, Iyooka et al. (2008) estimated that the filtration

[1]Bay Barometer. A health and restoration assessment of the Chesapeake Bay and watershed in 2010. Online at www.chesapeakebay.net/documents/cbp_59306.pdf (accessed 2 June 2014).

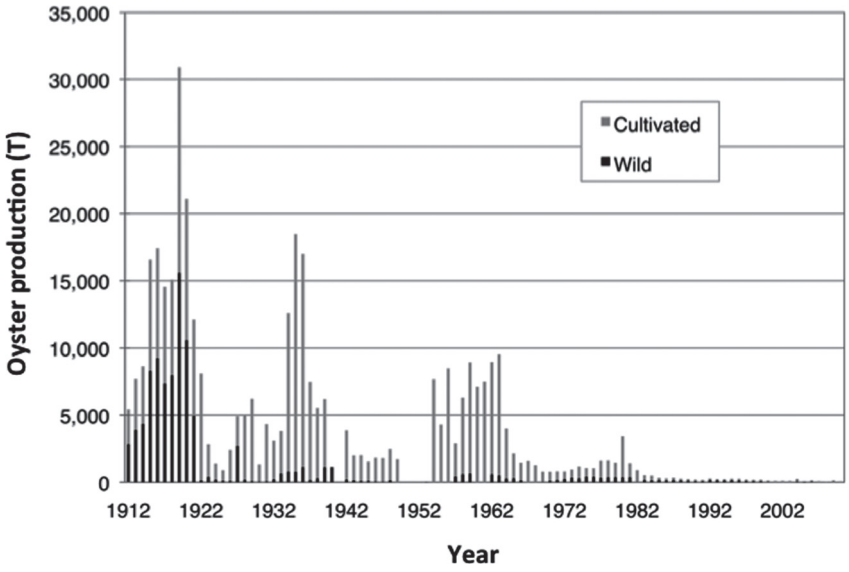

Figure 4.—Reported landings of wild and cultivated oysters in the Saga part of the Ariake Sea from 1912 to 2010. Courtesy of Saga Prefectural Ariake Fisheries Research and Development Center.

capacity of oysters in the inner Ariake Sea has decreased to 10% of that in 1978.

Chesapeake Bay

The Chesapeake Bay was once the greatest oyster-producing region in the world, and the fishery's decline has long drawn attention from a broad range of academic disciplines including ecology, economics, politics, history, and environmental anthropology (Brooks, 1891; Kennedy and Breisch, 1983; Keiner, 2009; Paolisso and Dery, 2010). Even with today's depressed fishery, some people living on the bay shores still earn their livelihood by oystering, processing, and marketing.

The eastern oyster has supported not only large economic profits (Lipton, 2008) but also helped develop a rich cultural heritage in the region (Chambers, 2006). The traditional ways of harvesting oysters with oyster tongs and dredging sailboats are favorite symbols of the bay's fishing culture.

Moreover, Paolisso (2005) believes that the core of the heritage of watermen (the local term for fishermen in the bay involved in various fisheries, including oystering) is their own cultural value about work and providing for their families. Watermen usually come from traditional fishing families living in the coastal community. They believe that working on the bay is a right reserved for them, the only way of living they can rely on, and a way they are proud of and responsible to keep (Paolisso, 2005). This shared value among watermen has led to conflict with management regulations (described below). Watermen share an underlying assumption that living resources in the bay should not be managed by humans because watermen can sustain their way of life so long as God allows them and they work hard (Paolisso, 2002).

Over time, political conflicts have resulted in failure of appropriate resource management (Kennedy and Breisch, 1983). Keiner (2009) described Maryland's longstanding debate on private leasing of oyster grounds for aquaculture from the perspective of both scientists and watermen. On one side, scientists like Brooks (1891) urged the state to lease oyster bottoms for farming, believing this to be the best solution for the declining industry. On the other side, watermen opposed leasing, fearing that this would put control of the resource in the hands of seafood processors who already influenced the industry by owning facilities essential for preparing oyster products (Green et al., 1916).

As a result of these differences between scientists and watermen, with the watermen's wishes being deferred to by politicians (Kennedy and Breisch, 1983), the state has often failed to incorporate scientific knowledge into resource management while the harvest has declined (Fig. 5). Presently the standing stock is estimated to be <1% of that of the nineteenth century (Wilberg et al., 2011). Although Maryland has made many efforts to restore the wild population and the industry, the efforts often failed or made limited progress (Kennedy et al., 2011). Recently, however, policymakers, fishermen, seafood processors, scientists, and environmentalists have cooperated in an Oyster Recovery Partnership to develop new and innovative restoration plans (Kennedy et al., 2011).

Management Issues in Both Regions

Ariake Sea: Resistance to New Ideas or New Participants Entering the Fishery

Japan maintains an intensive coastal fishery and aquaculture industry through a fishery coordinating system established by the Fishery Cooperative Law of 1948 and the Fishery Law of 1949 (Yamamoto, 1995). Under these laws, local governments plan a comprehensive use of coastal waters and grant exclusive fishery rights to qualified fishermen. Area Fishery Coordinating Committees are established that allow local Fishery Cooperative Associations to be administrative bodies in each jurisdiction, aiming for a democratic administration where local fishermen's opinions count greatly in any decision-making process. This management scheme is acclaimed for its effectiveness in dealing with region-specific fishing conflicts. However, management has a tendency to focus

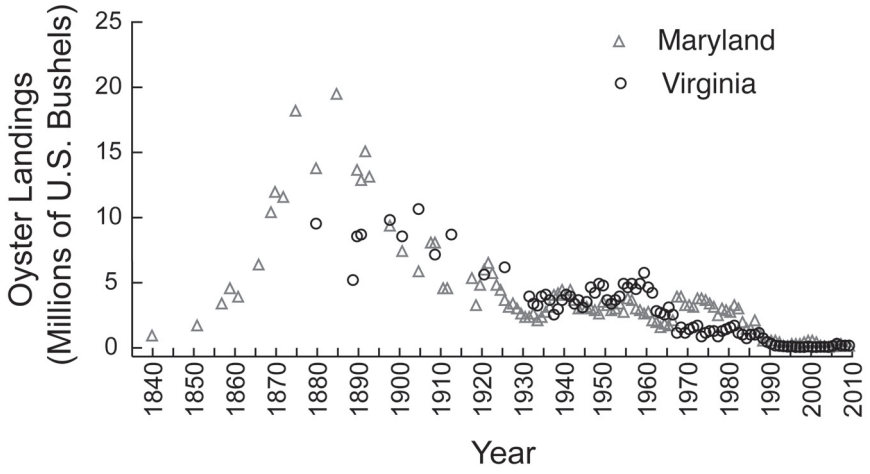

Figure 5.—Reported landings of oysters in Maryland and Virginia during peak harvests and subsequent declines (from Kennedy et al. (2011) with permission).

on productivity and profitability (e.g., Uchida et al., 2010) and may lack a sense of resource conservation (Sato, 1978), which can be incompatible with sustainable resource use.

Important features of Japanese fishery management are its concept of sea tenure, dedicated access to marine resources, and co-management structure by fishermen and local government (Makino and Matsuda, 2005). The sea tenure concept involves the ownership of the aquatic environment and natural resources just as on land in an effort to improve fishery management (Kalland, 1990). Japan developed the concept through a history of national change, economic growth, and fishery development.

Centuries ago in Japan, the aquatic environment and organisms were considered to be common resources and there was no control on access to them in the Taiho Code, the first full-fledged law in the early eighth century. The code stated that "yields from the mountain, river, bush, and aquatic environment belong to nobody" (Kaneda, 2003). In the Middle Ages, however, a feudal system developed where local lords governed territory and people. At the same time, fishery regulations developed region by region because there were emerging fishing conflicts as a result of fishery development.

The sea tenure concept developed for the purposes of conflict avoidance in light of feudalistic governance of aquatic yields (Ruddle, 1992). The customary sea tenure concept was stipulated in 1743 as a set of standard fishery regulations in Urahou or fleet law by the feudal government, which stated that coastal waters were considered to be extensions of the land and thus a part of the feudal domain (Makino and Matsuda, 2005).

In the mid-nineteenth century, this customary fishery management by local government became radically converted into central management when the feudalistic government of the Tokugawa family was overthrown and replaced by the Meiji government. The new government exchanged many customary laws and systems for European-style ones in a radical modernization (Ruddle, 1992). In this process, Japan's seas were nationalized and a fishing license system issued by the central government replaced the traditional local management scheme. However, this transition ended in failure due to increasing fishing conflicts caused by too many newcomers entering fisheries (Makino and Matsuda, 2005). The traditional management scheme had controlled the number of fishery participants adequately so the Meiji government replaced the failed fishery law by the Meiji Fishery Act of 1910, which was based on traditional local management (Makino and Matsuda, 2005).

However, one problem remained. The feudalistic custom in the closed fishing communities did not allow fair fishing opportunities to all community members. Traditional ruling families wanted to control the region that they had fished for generations and the law allowed them to renew their fishery right as long as they wished. Fishermen suffered from expensive rents for fishing grounds over which the ruling families claimed virtual ownership. Consequently many fishing grounds occupied by ruling families were not used for fishery purposes because of the expensive rent (Sato, 1978).

Reformed fishery laws were established after World War II with the goal of democratic management by working fishermen themselves and an optimal use of fishing grounds (Makino and Matsuda, 2005). The laws require a Prefectural Governor to develop a comprehensive plan for managing fishing grounds and renewing a fishery right every 5 or 10 years. At present, productive fishery grounds are intensively exploited under the current law.

The coastal water around Japan is divided into 66 areas, with each under the jurisdiction of the littoral Prefecture (Kaneda, 2003). To practice coastal fishing or aquaculture, an individual or a group has to obtain a fishery right granted by the Prefectural Governor that allows exclusive use of water for a defined fishery with defined equipment in a defined area. However, obtaining a fishery right is not an arbitrary process but occurs through an administrative process (described later) established by the 1949 Fishery Law that distributes coastal habitat to resource users according to a comprehensive fishery plan established by the local government (SPFD, 2009).

Another purpose of the fishery coordinating system is to protect the rights of fishermen, who have been socially vulnerable over time, by reflecting their opinion in decision-making and by diminishing the influence of

Table 1.—Flow chart of the 12 steps in the fishery coordinating system by which a Prefecture's Governor, the area Fishery Coordinating Committee, and local fishermen participate in the process (Kaneda, 2003).

Governor	
	1. Receives a fisherman's request for starting or continuing a fishery.
	2. Explores feasibility of the requested fishery.
	3. Prepares a plan for fishery use of coastal waters.
	4. Presents the Committee with the plan.
Fishery Coordinating Committee	
	5. Holds a public hearing.
	6. Delivers the Committee's opinion of the plan to the Governor.
Governor	
	7. Announces a definitive plan to the public.
Fisherman (or Fishermen)	
	8. Applies for a fishery right.
Governor	
	9. Consults the Committee about granting a fishery right to applicants.
Committee	
	10. Qualifies and prioritizes the applications.
	11. Reports the Committee's recommendations to the Governor.
Governor	
	12. Grants (or rejects) a fishery right to applicants.

wealthier families and the Governor's own authority. Thus the law requires that each Prefecture's Fishery Coordinating Committee play a substantial role in the adjustment process. The committee is independent of the Prefectural government and advises and checks the Governor's decision so as to reflect fishermen's intentions. It has 15 members—nine elected fishermen, four academic experts appointed by the Governor, and two representatives of the public interest appointed by the Governor. The Governor cannot make any decision without hearing the committee's opinion.

The administrative process (Table 1) requires the Governor to prepare a plan of how to use his/her jurisdictional marine area, based on fishermen's requests. Types, areas, periods, and districts for aquaculture are defined in this plan. Fishermen apply for a fishery right[2] for a certain type of aquaculture based on the Governor's plan. If more than one fisherman applies for a certain aquaculture sector, the Governor qualifies and prioritizes the applicants according to the priority order defined by the new Fishery Act (Kaneda, 2003).

Thus, the first priority is the local Fishery Cooperative Association, then the local management organization, and then other categories, namely:

1) Fishermen are preferred over others,
2) Individuals are preferred over a company,
3) District residents are preferred over others,
4) Persons with experience in the same sort of fishery are preferred over others without such experience, and
5) Fishery experience in the same sea area is preferred over experience in another area.
6) Basically, experienced fishermen living in the district and belonging to the local Fishery Cooperative Association are given priority.

In addition to the system of protective fishery rights, a fishery is supported by the government in technological and financial aspects (Fisheries Agency of Japan, 2008). Technologically, a Fishery Experiment Station administered by the Prefectural government helps local fishermen with technical and legal issues as well as encouraging smooth communications between fishermen and government (Short, 1989).

The Experiment Station periodically investigates local yield, environmental conditions, and particular problems such as disease prevalence, and provides fishermen with scientific and legal advice. When a group of fishermen hopes to start a new aquaculture project, the station may arrange an experiment to determine feasibility and establish a protocol and may hold workshops on new technologies. These technical supports encourage fishermen to try new approaches and avoid failures.

Here is an example of how the system works. In 2001, a group of Ariake fishermen started oyster aquaculture using a rafting method. They had harvested the infaunal tairagi clam by the traditional method of using diving helmets but the clam population had declined drastically since the Isahaya Bay Reclamation Work began.[3] Further, the diving method using heavy equipment became physically difficult as the fishermen aged.

Rafting oyster aquaculture has been profitable with relatively less physical labor in various regions across Japan (Imai, 1971) and, as mentioned, the Ariake region once benefited from the transplanting method in the 1910's before nori farming began. So, in 2001 the Ariake Fisheries Experimental Station planned and supervised a 1-yr experimental rafting program in collaboration with the fishermen. The yield from the experiment was 8.4 t of oysters from three rafts, worth an estimated ¥4 million (~$US39,400).[4]

Prefectural governments may also support local fishermen financially when it benefits the community, including investing in new aquaculture businesses under certain conditions. Thus the Saga Fishery Department funded the 2001 experiment by purchasing the yields and sharing one-third of the costs over the years as follows: ¥5.75 million (~$US56,600) for oyster rafts, ¥4.79 million (~US$47,200) for an oyster washer machine, and ¥1.88 million (~$US18,500) for ultraviolet sterilizers.[4]

The department also invited an academic expert to a workshop held in 2006 to solve a mortality problem in the fishery.[4] The Saga Distribution Department advertised the oyster products to local supermarkets as well as restaurants in Tokyo and other Asian cities. The department helped establish a local oyster brand "Takezaki Oyster" and is encouraging a new tour-

[2]There are three types of coastal fishery rights: "fixed gear fishery right" for large-scale set net fisheries; "common fishery right" for seine fisheries, small-scale set net fisheries, and capturing stationary aquatic animals; and "demarcated fishery right" for aquaculture. Here, we focus on the administrative process of obtaining demarcated fishery rights.

[3]Minematsu, H. A fisherman from Ooura district of Saga's Ariake Sea, summer 2009. Personal commun.

[4]Aramaki, H. Saga Ariake Fisheries Research and Development Cent., Ashikari, Saga, Jpn., summer 2009. Personal commun.

ism attraction "Takezaki Oyster Road" where visitors sample locally grown oysters in small coastal restaurants or from vendors, contributing to the local economy.

With successful results, the Fishery Coordinating Committee advised the Saga Governor to add a demarcated fishery right in the Ooura district for rafting oyster aquaculture in the fishery ground plan of 2003. Then the Ooura Fishery Cooperative Association applied for and received this right so that its members can practice rafting aquaculture.

There are strengths and weaknesses in this management system. On the positive side, it requires a close relationship between a Prefectural government and practitioners. By exchanging information and opinions frequently, both groups can work together to deal with new businesses and changing circumstances. The government's financial and technical support may encourage fishermen to develop new aquaculture methods and projects and to improve their practices to increase their livelihood. Such strong cooperation has overcome technical and financial problems and elevated Japan's fisheries to some of the most developed in the world. The system seems to be working well in systematic use of coastal waters as well as protecting fishermen's rights in decision-making processes.

On the negative side, the exclusive fishery-right system may prevent newcomers from entering the fishing community. The process of qualification and prioritization for fishery-right applicants is protective and favorable to local fishermen, so that it is almost impossible for an applicant to get a demarcation right without living locally and belonging to the local Fishery Cooperative Association. This is considered unfortunate because many fishing communities have aging and declining populations (Lim and Matsuda, 1995), so newcomers should be welcomed. Also, the Fishery Act prohibits a Governor from renewing a fishery sector that has not been productive for years (Kaneda, 2003), which may preclude innovative enterprises that take time to develop constant yields.

Some Japanese fishery sociologists find that the fishery-right and fishery-coordinating systems may be reinforcing conservativeness in fishing communities and helping feudalistic customs to remain (Sato, 1978). For example, the leadership of the nine fishing representatives in the committees usually includes the "boss" of the community, that is, someone from an influential family (Iwakiri, 1969), even though the coordinating system was established to protect the fishermen. Bosses tend to enjoy the "honorary post" instead of pursuing public benefit for the community and optimum use of the fishery resource. It may take some years for the fishing community to become aware of the need for public welfare because the traditional way of thinking has passed on for generations (Sato, 1978).

Another negative aspect is that the current management structure lacks a sense of environmental protection (see the destruction of oyster bars described earlier). The system helps control excess competition among resource users that causes overexploitation, but there are no strict regulations for harvests or for intense aquaculture; it is up to the rules a local committee makes (Sato, 1978). It seems reasonable to have a third party assess environmental issues, since opinions by a committee can be overly favorable to fishermen because 9 of the 15 committee members are fishermen.

We conclude that the Japanese system manages conflict and governs water use in a way that is consistent with the traditions of the fishing community. The commitment of the government to the development of fishing and aquaculture has helped build the fishery industry to its present level. However, with the emerging problems of an aging fishing community and environmental degradation, the management system should be reformed from the closed way among the fishing community to being open to the whole society in order to deal with more complicated situations surrounding a fishery.

Maryland: Historic Disregard for Private Aquaculture

Although Maryland was one of the first states to realize that one solution to the decline in wild populations is promoting private oystering on leased grounds (Brooks, 1891), and although many scientific surveys and recommendations were made as the fishery declined, the industry resisted moving from harvesting public beds to private culture (Kennedy and Breisch, 1983; Keiner, 2009). Recommendations that leasing should be encouraged were generally ignored by politicians because of pressure from watermen who opposed private culture.

Based on statements by Brooks (1891) and Green et al. (1916), Kennedy and Breisch (1983) proposed that watermen in years past were afraid of losing their valued independence if corporations leased oyster beds, thereby shutting the watermen out or forcing them to work for an employer rather than independently (see also Keiner, 2009). Watermen typically thought that harvesting oysters from Maryland waters was a privilege for Maryland residents alone and there should be no control over it. Also, they doubted the possibilities of oyster cultivation on formerly nonproductive ground. While leasing recommendations were intended to make use of habitat where oyster bars no longer existed, most watermen did not believe that spat settlement and restoration of oyster bars would occur on such barren bottoms (Green et al., 1916).

As a result of this strong resistance, Maryland failed to establish an oyster aquaculture industry, and wild populations were harvested with traditional capture methods and under limited restrictions until recently (described below) while much of the rest of the world encouraged the growth of aquaculture.

As landings declined, many watermen left the fishery in the 1970's and became builders, carpenters, tugboat operators, prison guards, etc.[5] In the

[5]Webster, D. Univ. Md., Wye Res. & Educ. Center, Queenstown, Md., summer 2010. Personal commun.

2006 oyster season there were only 628 watermen reporting a harvest in Maryland compared with 2,520 in the 1999 season.[6] Harvesting oysters provides the remaining watermen with income during the fall and winter months that supplements their income in other months from fishing for blue crab, *Callinectes sapidus,* and harvesting eels, *Anguilla rostrata,* and other commercial species of fish.[5] Fishing for oysters also helps maintain the watermen's self-identity as workers in the bay who can provide a valuable product (Paolisso and Dery, 2010).

Many Marylanders value watermen and the oyster industry as part of the bay's cultural heritage; it has been argued that harvesting and use of oysters connects people to the bay (Paolisso et al., 2006). However, Maryland's oyster industry is sustainable only because it is heavily supported by taxpayers. Although an oyster rehabilitation fee is assessed on each bushel of harvested oysters, restoration of "natural" or public oyster bars is largely paid for by government agencies to maintain a traditional way of life (Webster, 2003). A major change in the industrial structure was needed.

This change began when the State of Maryland proposed an Aquaculture Lease Law in 2009 and an Oyster Restoration and Aquaculture Development Plan in 2010 as a result of discussion among politicians, fishermen, managers, scientists, social scientists, and environmentalists. The plan contains two primary goals: "1) to establish an expanding and sustainable population of native oysters in significant portions of Chesapeake Bay and its tributaries and 2) to establish a private aquaculture industry that emerges as a major economic contributor to the State of Maryland while maintaining a more targeted and scientifically managed oyster fishery."[7]

The plan is based on two principles. First, the state established sanctuary networks where oyster harvest is prohibited to allow wild populations to reproduce over generations, thereby potentially allowing the development of disease-tolerant strains that can spawn while protected from harvest. Eventually the sanctuaries will be expanded from the current 9% of Maryland's portion of the bay to 25%. Second, the state made thousands of acres of bottom that were previously off-limits available for leasing, including 95,000 acres of depleted natural oyster bars that are no longer harvested by the commercial oyster fishery. In addition, the leases can now be held by corporations and nonresidents.[8]

Goal 1 of the plan involves planting juvenile (seed) oysters to enhance existing oyster bars or to establish a new population on barren bottom. A constant supply of disease-free oyster seed is essential, so the state's hatchery productivity has increased to as much as 1.2 billion spat on shell in 2013.[9] The hatchery seed is planted by watermen hired for the task.

Goal 2 of the plan is to promote private aquaculture. A few private firms, such as Marinetics, Inc.[10], began aquaculture earlier (1999) and have expanded their activities since. Marinetics has grown ~10 million oysters in raft culture and has sold ~1 million oysters each year (Kobell, 2010). New initiatives by others are also underway, aided by provisions in the Aquaculture Lease Law that remove red-tape obstacles on developing aquaculture and establish a regulatory framework. There are Aquaculture Enterprise Zones where leases are already established by the state and in which individuals can begin farming without obtaining their own permit.

Shifting to aquaculture will greatly change a waterman's working life, and many watermen understandably raised concerns at meetings on the new initiatives. Complaints focused on doubts about the validity of past and proposed restoration efforts, including the expanded sanctuary program, and fears about changed livelihood. Some comments detailed in a watermen's brief presented in public hearings included (personal observations):

- "Watermen across the state will be competing for oysters on fewer public bars, but we have not been given ample time or resources to transition to aquaculture."
- "The DNR (Maryland's Department of Natural Resources) is ill-equipped to provide access to loans."
- "A bottom-cultivated oyster market would not be competitive during the regular oyster season."
- "To undertake top-water aquaculture I would need to develop a new market."
- "Obtaining shell is an obstacle for any watermen transitioning to aquaculture."

These comments are certainly important to the watermen. Whether their concerns will be borne out will take time to determine.

Comparisons and Analyses

Despite the similar estuarine environment, communities surrounding each bay in our study have different sociocultural features. Fishermen in the Ariake Sea—and in Japan generally—value cooperation among community members and obligation for the rules and orders the local community regulates (Lim and Matsuda, 1995). This attitude influences relationships between fishermen and management agencies. Contrarily, Maryland watermen value their independence. Working as freelancers, exploring the bay as they wish, and hunting wild animals that bring a high profit—this lifestyle seems to be what they are proud of and want to keep as a heritage (Paolis-

[6]Maryland oyster harvest: bushels, value, effort 1975–2006. www.dnr.state.md.us/dnrnews/infocus/ 032706hvalue.pdf (accessed 2 June 2014)

[7]Maryland's Vision for Oysters. www.dnr.state.md.us/fisheries/oysters/pdfs/GovernorsOfficeSlidesFinal.pdf (accessed 2 June 2014).

[8]Oyster Restoration & Aquaculture Develop. Proposed Reg., www.dnr.maryland.gov/fisheries/oysters/oysterrestoration&aquaculturedevelopmentproposedregulationsfactsheet.pdf July 2010 (accessed 2 June 2014).

[9]Horn Point Oyster Hatchery, http://hatchery.hpl.umces.edu (accessed 2 June 2014).

[10]Mention of trade names or commercial firms is for identification only and does not imply endorsement by the National Marine Fisheries Service, NOAA.

so, 2002). While Maryland watermen often push back against management decisions and dislike being controlled, Ariake fishermen are more accepting of management agencies because the agencies are "insiders" in the fishery community. The Japanese fishermen even ask fishery agencies for assistance and advice.

As to fishery practice, Ariake fishermen seem flexible in how they maintain their livelihood, with some having moved from oyster farming to nori farming and others from harvesting tairagi clams to culturing oysters. Maryland fishermen seem prouder of and wedded to their established lifestyle. Many also regard aquaculture as completely different from fishing and as not their business, as seen in their resistance to its development.

This difference in attitudes may be partly due to the difference in the length of history of aquaculture in the two countries. For many decades, Japanese aquaculture has been a major industry in a nation that has emphasized food self-sufficiency and that supports exporting high-value products.

In the Ariake Sea region, the Saga Prefectural government supported nori farming because the seaweed is a highly profitable product (Sasaki, 2005b) and now supports oyster culture as a new economic driver. In contrast, Maryland's political leaders historically inhibited expansion of oyster culture by limiting acres for leasing and prohibiting non-Maryland residents and corporations from holding leases (Kennedy and Breisch, 1983; Keiner, 2009).

Another difference in attitude involves water use. Japanese coastal waters have been used primarily for fisheries and aquaculture. Thus there are no complaints from shoreline residents for having aquaculture facilities in their view; rather, those facilities are considered a component of the nostalgic scenery of fishing villages. In Chesapeake Bay, multiple uses include boating, recreational fishing and hunting, and vacationing in addition to commercial fishing. Thus, shoreline property owners sometimes complain that the scenery is marred by fishery and aquaculture facilities.

Some Potential Lessons

What lessons can be learned from the two oyster industries with very different backgrounds? Although the two regions have very different histories, there are two common problems that might be instructive in coastal fishery management in general.

Failure of Integrative Management of Living Resources and the Environment

Comparisons of the two oyster industries reveal the importance and difficulty of integrative management of living resources and the environment. Although the two estuaries were originally capable of supporting extensive oyster populations, their oyster industries have almost collapsed due to lack of a self-sustaining oyster population and a suitable environment.

However, the history of the two regions also shows that fishery management in both tends to focus on increasing profit; the environment and even some fished species often gain less recognition. Thus the Saga prefectural government damaged oyster beds instead of trying to restore them while preparing acres of flat grounds so that oyster farmers could shift to profitable nori farming. Management in the past prioritized the immediate economic needs and lacked an understanding of the need to maintain a suitable environment that sustains productivity of many species. However, managers and nori farmers now recognize that oyster bars play a vital role in the biological and physical cycles in the ecosystem that also help sustain nori farming.

The Isahaya Bay Reclamation Project also revealed conflicts of interest that degraded the environment and delayed restoration. After the work was completed, Ariake fishermen faced historically low yields of nori and farmed shellfish (Kunishima and Miura, 2011). Although fishermen and scientists in the region attempted to stop the project, it was 10 years before a court ordered the national government to discontinue the work and open floodgates. This delay happened because the reclamation project was supported by the government which wanted to distribute money and create jobs by public works, by residents who wanted to prevent flooding, and by farmers who wanted to increase their agricultural land.

Overall, a decline in oyster production due partly to the failure of resource management occurred in both regions (oyster diseases also became a problem in Maryland; Ewart and Ford, 1993). Integrative management of target species and the surrounding environment is necessary, but in reality it may be less regarded and more difficult to implement because of various human factors. Such failure of environmental management may happen in any estuarine fishery because causative factors seem common—a productive but sensitive environment, lack of foresight in fishery management, intensive and competing human activities in coastal waters, and political conflicts.

Exclusiveness and Conservative Attitudes

Another common problem is that the tradition or culture of a fishing community sometimes causes conflicts with management practices. Although a fishing industry may need to change fishing practices as catches decline or environmental regulations change, the exclusiveness and conservative attitudes of some fishing communities may slow the necessary change. A fishing village forms a unique community based on shared concerns that are common to fishing—uncertainty in catch, weather, and sea conditions; dangerous labor; special skills; rituals; and other region-specific issues make fishermen and their families feel a sense of community (Acheson, 1981). Fishing practices have been passed on through generations among the shoreside families, which make fishermen feel that they are a part of an important heritage.

This shared sense sometimes makes the community tend to ignore sugges-

tions from outsiders, perhaps because fishermen see themselves as experts. In Maryland, watermen have long opposed scientific advice that they should shift to farming oysters to avoid the effects of overfishing. This strong opposition based on fishermen's beliefs and experience, combined with political conflict, delayed change in the industry for over a century (Kennedy and Breisch, 1983; Keiner, 2009). Even today, some Maryland fishermen assume that management regulations based on scientific insights are totally wrong.[11]

In Japan, the exclusivity of the fishing community is reinforced by management schemes. Although the systems of fishery right and fishery adjustment work well in conflict avoidance, they give a great advantage to local fishermen in water use (see list of priorities cited earlier that are used by a Governor in assessing applications). This may prevent individuals new to the region from entering the fishing community with new insights. So, while the Ariake fishermen switched among target species (Suminoe oysters, nori, tairagi clams), they remained conservative with regard to welcoming "outsiders."

Nowadays, resource management includes issues that require a broad outlook and cooperation beyond small communities. A fishing community may benefit from listening to and communicating with people from the surrounding society in order to deal with increasingly complicated issues in coastal water use today.

Concluding Remarks

Our work has led us to conclude that understanding sociocultural and political attitudes is necessary to support effective fishery management in a region. So, in addition to efforts to rehabilitate degraded environments, to initiate ecosystem-based management, and to encourage aquaculture, managers may do well to consider the following points.

[11]Naylor, M. D. Shellfish Prog. Assist. Dir., Md. Dep. Nat. Resour., Annapolis Md., summer 2010. Personal commun.

Culturally Sensitive Management

Although there are common characteristics and tendencies among fishing communities (see above), comparisons of the two oyster industries revealed that they have very different backgrounds in terms of fishing practice, management schemes, water use, characteristics of fishermen, and attitudes toward aquaculture. Understanding these backgrounds is important when developing a particular management scheme in order to encourage compliance. For example, the fishery coordinating system works well in the Ariake Sea where cooperative associations have played a vital role in conflict avoidance, but it may not work in Chesapeake Bay where fishermen work individually and value their independence.

Cooperation Among Science, Industry, and Politics

To achieve the goals outlined above, close communication among science, industry, and politics will be vital because, as we have shown, management failures could be attributed to conflicts among stakeholders. In Maryland, the Oyster Recovery Partnership might enable management to incorporate broad insights from academic experts, resource users, and decision-makers into practice.

Although culturally sensitive management and cooperation among stakeholders are important in successful fishery management, the second of these two factors is perhaps among the most important because our comparisons of the two oyster industries suggest that sound scientific, sociocultural, and political insights will not be reflected in a management practice if there is not a cooperative relationship among stakeholders.

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