

Introduction

BACKGROUND

Aquaculture has a long history of supplying protein and other products around the world, but a short history of commercial production in the United States (box 1-1). Until the 1950s, aquatic species were produced mainly to supply fish restocking programs, to provide baitfish and sportfish for fee fishing operations, and for direct family consumption; little reached commercial markets. Although trout had been produced for food since the turn of the century, only with the advent of the catfish culture industry did commercial aquaculture gain visibility as a market force.¹

Hundreds of different aquatic species are produced in the United States, including various animal and plant ornamentals, species for environmental remediation, industrial and pharmaceutical feedstocks, and products for biomedical research. Although as many as 30 are commonly cited aquacultural species, fewer than 10 species make up most of U.S. aquacultured food production: catfish, trout, crawfish, salmon, hybrid striped bass, tilapia, and various molluscs (appendix A).

Aquaculture is practiced in every U.S. state and territory, from Atlantic salmon off the coast of Maine to alligators in Louisiana to giant clams on the Pacific islands of Micronesia. Production systems are similarly diverse, ranging from nearshore bottom "seeding" of molluscs to expansive open ponds to high-tech water recirculating systems in warehouses to integrated systems cycling nutrients among

land- and water-based production systems. However, certain aqua-culture systems and certain species are con-centrated in geographic regions (appendix B).

Catfish and trout, for example, are grown in nearly all regions of the country. However, by far the largest volume of catfish produced in the United States is cultured in open ponds in the Mississippi River Delta region. Seventy-five percent of cultured trout is produced in raceways beside the Snake River in Idaho (12). Such concentrations occur, in part, because of the growth rates of certain species in certain water temperatures. For example, the warmwater channel catfish prefers water within 26 and 30° C (78 to 86° F), while coldwater rainbow trout thrive in water temperatures between 10 and 16° C (50 to 60° F) (26).

Regional concentrations also reflect availability of land and water. Prior to development of catfish culture, the Mississippi River Delta region was used for marginally productive rice and cotton farming (22) and had ample groundwater resources; transfer to an open pond system required relatively little capital expenditure. The Hagerman Valley of the Snake River was largely undeveloped prior to trout farming, and the plentiful springs provide a reliable source of water to route through trout raceways.

While shellfish are grown on all coastlines, net pen salmon production is concentrated in the northeast and the northwest. Culture of other marine species can be expected to concentrate in areas with water temperature most suitable to the species (e.g., red drum in the Gulf of Mexico).

Today, aquaculture is touted as the fastest growing segment of U.S. agriculture, based on

¹ For additional information on the historical development of aquaculture in the United States, see R.R. Stickney, *A History of Aquaculture in the United States* (New York, NY: John Wiley & Sons, in press).

Box 1-1: Definitions of Terms Used in This Background Paper

Definitions of certain terms used in the Background Paper are based on current common usage, or based on the specific request of the congressional requesting committees (see discussion below).

Aquaculture: For the purposes of this analysis, aquaculture will include only production of aquatic organisms (finfish, shellfish, and plants) that have been owned by one or more individuals or corporate bodies throughout their rearing period. Practices that include controlled rearing of aquatic organisms during only one part of their life cycle but that are exploitable at any time by the public as a common property resource (e.g., private ocean ranching, commercial and recreational enhancement stocking, and "fattening" of captured stock), were excluded by request of the congressional requesting committees, and are not considered here.

Fish: Unless specifically specified, the term fish is used to include finfish and shellfish. It does not include aquatic plants, reptiles, or amphibians.

Mariculture: Aquaculture operations that take place in nearshore or offshore waters. (Under this definition, mariculture does not include on-land aquaculture using pumped or artificial seawater.)

Offshore Aquaculture: Aquaculture operations that are undertaken in Federal waters of the Exclusive Economic Zone, generally the zone from 3 to 200 miles off the coast of U.S. states and territories.

Seafood: Unless otherwise specified, the term seafood includes edible products derived from fresh- and salt-water species.

Stock Enhancement: Programs designed to increase the stock of fish for exploitation by the public as common property resources are considered stock enhancement programs. These may include efforts to increase stocks for recreational or commercial purposes. Enhancement goals and programs are not included in this analysis.

Discussion: Definitions

Differing definitions of aquaculture cause considerable problems with use of data and with determination of the Federal role in aquaculture. A common definition of aquaculture would include propagation or cultivation of any aquatic organism during any part of its lifecycle to increase population regardless of purpose. The Joint Subcommittee on Aquaculture uses such a definition: "the farming of aquatic animals and plants" (14). Under this definition, aquaculture presumably would include private for-profit production of organisms in controlled environments, hatchery and release programs for profit or for common stock enhancement, and even deliberate protection of wild populations from predators or other adverse influences. The JSA definition also implies that aquaculture is a form of agriculture, while the National Marine Fisheries Service considers at least marine aquaculture (mariculture) a specialized form of the U.S. fishing industry (36).

The National Aquaculture Act defines aquaculture as: the propagation and rearing of aquatic species (finfish, molluscs, crustaceans, or other aquatic invertebrates, amphibians, reptiles, or aquatic plants) in controlled or selected environments, including, but not limited to, ocean ranching (except private ocean ranching of Pacific salmon for profit in those states where such ranching is prohibited by law).

Thus, the primary national aquaculture legislative language can be construed to include hatchery and release programs conducted by individuals or corporations for profit, but not efforts designed to enhance commercial fisheries, whether public or private.

On the other hand, the National Oceanic and Atmospheric Administration is mandated to use aquaculture "to enhance stocks of fish and shellfish whose populations are below long-term potential yield due to overfishing or habitat degradation" (37), expanding the definition beyond that of the National Aquaculture Act. Conversely, the U.S. Department of Agriculture's Noninsured Crop Disaster Assistance Program defines aquaculture species as "any species of aquatic organism grown as food for human consumption or fish raised as feed for fish that are consumed by humans, and which is propagated and reared in an aquatic medium by a commercial operator on private property in water in a controlled environment" (60 CFR 26669). Under this definition, aquaculture includes neither private ocean ranching, stock enhancement, nor non-edible product aquaculture such as ornamental fish production.

OTA's chosen definition of aquaculture is adapted from the definition developed by the United Nations Food and Agriculture Organisation and accepted by much of the international community (32). Legislative recognition of a single definition of aquaculture that could apply to all federal policies and programs would significantly improve data collection and interpretation, and likely reduce unnecessary confusion.

a fourfold increase in domestic output of fish, shellfish, and aquatic plants between 1980 and 1990 (12). By 1993, USDA estimated that the value of U.S. aquaculture products had reached \$760 million (8).

Despite that auspicious cast, domestic aquaculture production accounts for only about 10 to 15 percent of the U.S. seafood supply. Most still is provided by capture fisheries and imports from other nations. (See appendix C for a brief description of aquaculture policy and development in other nations.)

Originally, a goal of the domestic seafood industry was to increase seafood consumption to 20 pounds per capita by the year 2000. With per capita consumption hovering between 14.5 and 15.5 pounds in the last several years, this goal is now seen as unrealistic (10). Seafood consumption is strongly affected by consumer perceptions of safety and quality, familiarity and ease of preparation, and price.

Despite the recent expansion in aquaculture production, pound-for-pound, seafood is more expensive than beef, pork, or poultry products. Further, consumers are more familiar with the latter; and brand-labels, generic advertising campaigns, convenience of preparation, and fast-food marketing accentuate the differences (11). (For comparison, U.S. annual per capita consumption of meat (boneless equivalent) is approximately 187 lbs. Major components are: turkey--14 lbs/capita; chicken--47 lbs/ capita; pork--49 lbs/capita; and beef--62 lbs/ capita (1).)

Aquaculture products as a proportion of total seafood consumption is gradually rising, likely reflecting increased availability (e.g., year-round supply) and favorable prices compared to wild-caught seafood. This may also portend growing consumer recognition of the nutritional value of seafood in general and confidence in the quality of aquacultured products in particular. Hopes for aquaculture as a growth industry, especially for economically

troubled rural and coastal communities, remain high.

A BRIEF HISTORY OF FEDERAL INVOLVEMENT IN U.S. AQUACULTURE

Aquaculture-related hatcheries and fisheries research were spurred in the United States in the late 19th century by sport fishermen lobbying for artificial propagation of sport fish. This mission was shuttled among various federal organizations until it moved in 1939 to the newly created Fish and Wildlife Service (FWS) in the Department of the Interior (29). In 1956 the mission was divided into the Bureau of Sport Fisheries and the Bureau of Commercial Fisheries. The former remained a charge of the FWS,² and the latter was moved in 1970 to the National Oceanic and Atmospheric Administration (NOAA) and renamed the National Marine Fisheries Service (NMFS). Thus, the FWS and NMFS share a common history of aquaculture research and development.

The first attempts at commercial aquaculture were in salmon ranching and trout farming at the turn of the century, but it was not until the 1960s that the federal government directed attention specifically at private, commercial culture. FWS laboratories for investigation of fish drug clearance, fish genetics, and aquaculture of warmwater species were created, and research results were shared with U.S. Department of Agriculture experiment stations and extension services to transmit to the farmers.

Although Department of Agriculture (USDA) and Land-Grant University scientists had been

² At the peak of its operations in the mid-1970s, the FWS operated nearly a hundred hatcheries nationwide. As of 1994, the FWS operated 73 hatcheries and nine fish health laboratories. Most FWS fisheries research centers/laboratories were transferred to the National Biological Service in 1994. Legislative proposals are under consideration to transfer some or all of these aquaculture-related laboratories to the U.S. Department of Agriculture.

conducting experiments and assisting farmers with fish pond management for years, USDA's formal involvement in aquaculture began with the Saltonstall-Kennedy Act for Commercial Fisheries (15 U.S.C. 713 et seq.) that in 1954 required the Department of the Interior (DOI) to conduct research and educational services to be paid by USDA. The Fish-Rice Crop Rotation Farming Program Act of 1958 (16 U.S.C. 778 et seq.) also required cooperative work by USDA and DOI, and created the FWS Fish Farming Experimental Station at Stuttgart, Arkansas--the first center devoted expressly to development of commercial aquaculture.

Also in the 1960s, concern grew over lack of a cohesive national ocean policy. The Stratton Commission, created by the Marine Resources and Engineering Development Act of 1966 (33 U.S.C. 1101 et seq.), recognized aquaculture as a coastal use that should be included in a national ocean policy. The Commission also recommended that an independent ocean agency be created, and be given the mission (among others) to advance marine aquaculture. The National Oceanic and Atmospheric Administration (NOAA) subsequently was formed in 1970 as a semi-autonomous agency within the Department of Commerce (DOC), and assigned to develop aquaculture through the National Marine Fisheries Service, its coastal zone programs, and the newly established National Sea Grant College Program.

Aquaculture was mentioned in detail in the National Sea Grant College and Program Act of 1966 (33 U.S.C. 1121 et seq.), which recognized that "aquaculture, as with agriculture on land, ... can substantially benefit the United States" (29). In fact, the Sea Grant College Program was specifically designed to mirror the Land-Grant College program established for land-based agriculture, with teaching, research, and extension services.

Following the formal designation of FWS and NOAA as agencies with responsibilities for aquaculture, and during the gradual development of aquaculture expertise in USDA, the Congress passed numerous pieces of

environmental protection and resource management legislation affecting the development of aquaculture, involving still more agencies in the development of aquaculture. The plethora of agencies, programs, and laws resulted in confusion and conflict.

By 1980 one report identified 120 federal statutory programs having a significant impact on development of aquaculture; however, less than one-half required a direct compliance response on the part of the culturist (2). The 1978 National Research Council report, *Aquaculture in the United States: Constraints and Opportunities* observed that "constraints on orderly development of aquaculture tend to be political and administrative, rather than scientific and technological" (19).

NATIONAL AQUACULTURE POLICY

The first major national aquaculture policy bill was the National Aquaculture Development Act of 1975 and 1976, which immediately engendered opposition from several of the agencies involved in aquaculture. Most of the tasks proposed already were being conducted by these same agencies; thus, there was concern that traditional programs were being challenged (17). The National Aquaculture Development Act of 1975 and 1976 was never passed.

The 1976 United Nations Food and Agriculture Organization Conference on Aquaculture prompted preparation of the National Aquaculture Organic Act. The bill proposed the establishment of a national aquaculture plan,³ authorized appropriations of approximately \$40 million for aquaculture research and development over a three-year period, and established a \$100 million loan guarantee program for the industry. At the time, this bill was considered the most

³ A national plan "to develop programs and encourage activities which will coordinate domestic aquaculture efforts, conserve and increase the availability of fishery resources, and create new industries and job opportunities."

significant in the political development of U.S. aquaculture. Although the bill attempted to unify the interests of government agencies, industry, and researchers, opposition continued. The most widespread disagreement regarded identification of a single agency to coordinate and oversee U.S. aquaculture activities. At the time, the Departments of Commerce and Interior were formally responsible for aquaculture support and wanted to continue in this role; the U.S. Department of Agriculture did not advance itself as a lead agency (17). The National Aquaculture Organic Act of 1976 was not passed.

Several other bills were unsuccessfully advanced between 1976 and 1980, including the National Aquaculture Organic Act of 1977 and the Aquaculture Policy Act of 1977. The issue of a lead agency continued to be controversial, with some bills proposing DOC as lead agency and others promoting USDA (17). Two prominent analyses conducted by the Congressional Research Service (33) and the National Academy of Sciences (1978) called for designation of a lead agency:

"Although aquaculture has an active constituency, it has little political power within the framework of interest groups competing for government attention. To insure a reasonable rate of development for aquaculture, a uniform set of aquaculture policies must be established. A lead agency must direct, guide, support, coordinate, and be responsible and accountable for activities among the relevant federal agencies." (19).

Meanwhile, the Food and Agriculture Act of 1977 (7 U.S.C. 3101 et seq.) identified aquaculture as an area requiring a new federal initiative, and included aquaculture among the basic functions of USDA. This gave USDA authority to expand into aquaculture activities, but did not provide specific instructions or funding. The Act also designated USDA as the lead federal agency for research in the food and agricultural sciences, and included aquaculture in the definition of food and agricultural

sciences. This seemed to indirectly indicate conferral of aquaculture lead agency status on USDA, but the legislative language did not specifically state this (17).

Concern remained that, under USDA's guidance, freshwater aquaculture would monopolize federal support for aquaculture. Marine aquaculture supporters pushed for passage of the National Aquaculture Act of 1978 that designated DOC as the lead agency; however President Jimmy Carter vetoed the legislation because of its high fiscal demands. The following year brought another attempt to pass legislation designating Commerce as the lead agency. Although the 1979 bill reduced the amount of the financial support requested, it was not passed by the Congress (17).

In September 1980, Congress reached an agreement with regard to the future of U.S. aquaculture, and the National Aquaculture Act (NAA) became law (U.S.C. 16 U.S.C. 2801, et seq.). The Act states that it is "in the national interest, and it is the national policy, to encourage the development of aquaculture in the United States." The NAA gives principal responsibility for the development of U.S. aquaculture to the private sector, but jointly assigned three federal agencies aquacultural-related responsibilities--the Departments of Agriculture, Commerce, and Interior.

The 1980 NAA only vaguely defined the responsibilities of each Department, stating that they were to be determined based on prior law, and "the experience, expertise, and other appropriate resources that the Department of each such Secretary may have with respect to the action required under the activity concerned." Some six months earlier an Interagency Agreement was reached among the Departments of Agriculture, Commerce, and Interior regarding "Designation of Areas of Responsibility in Aquaculture" (appendix D). In general, USDA was acceded responsibility for research and support activities for private freshwater aquaculture, DOC was determined responsible for marine and estuarine species,

and the DOI was responsible for technical research on freshwater finfish for recreational and commercial purposes. All three agencies were to coordinate their work on anadromous species (those migrating between fresh- and saltwater). Provision for a waiver from this division of responsibilities was made in case that "some crossing of these lines of division" would become "necessary to advance national objectives in aquaculture."

In addition to defining agency responsibilities, the Interagency Agreement contained provisions for coordination of federal activities in aquaculture.⁴ The 1980 NAA formally designated the Joint Subcommittee on Aquaculture (JSA) the coordinating body for all federal activities related to aquaculture (box 1-2), with a goal of increasing the overall effectiveness and productivity of federal aquaculture research, transfer, and assistance programs. Chairmanship of the JSA was originally planned to rotate among Secretaries of the three primary Departments.

The Secretaries of the three relevant Departments also were instructed to develop a National Aquaculture Development Plan to identify aquatic species with significant potential for culturing on a commercial or other basis (e.g., stock enhancement), and to recommend actions to be taken by public and

private sectors to achieve that potential.⁵ The first National Aquaculture Development Plan was completed by the JSA in September 1983, providing the first comprehensive federal identification of priorities in U.S. aquaculture development.

The National Aquaculture Act of 1980 has been reauthorized twice: as amended by the National Aquaculture Improvement Act of 1985 (Public Law 99-198) and as further amended by the Food, Agriculture, Conservation, and Trade Act of 1990 (Public Law 101-624). Amendments to the NAA have been relatively minor, with one exception. The National Aquaculture Improvement Act of 1985 specifically established the Department of Agriculture as "the lead federal agency with respect to the coordination and dissemination of national aquaculture information" and designated the Secretary of Agriculture as permanent chair of the Joint Subcommittee on Aquaculture.

The current Secretary of Agriculture has stated a strong commitment to U.S. aquaculture and supports cooperation among federal agencies:

I am committed to strong leadership by the Department of Agriculture of Federal programs to support the private U.S. aquaculture industry. . . The Department also

⁴ During the political hearings through 1977 and 1978, federal agency staffs took the initiative to form an inter-agency group to maintain communication with regard to aquaculture. They were officially authorized as a subcommittee on aquaculture within the Inter-Agency Committee on Marine Science and Engineering. Early in 1979, under the Committee on Atmosphere and Oceans and the Committee on Food and Renewable Resources, a new Joint Subcommittee on Aquaculture was appointed by the Federal Coordinating Council for Science, Engineering and Technology. It replaced the Inter-Agency Committee, but its goals, of increasing the effectiveness of aquaculture research and development, were essentially the same (17). The Interagency Agreement formally recognized the Joint Subcommittee on Aquaculture as the group most suited to coordinate Federal activities in aquaculture. The National Oceanic and Atmospheric Administration has suggested that the 1980 Interagency Agreement be updated to "reflect the current coordination protocols...(and) to reduce confusion and conflict over agencies' responsibilities and functions" (36).

⁵ The JSA currently is revising the National Aquaculture Development Plan, to focus on the Federal government role in U.S. aquaculture, and addressing opportunities in: research and development; regulatory framework; extension, education, training, outreach, technology transfer, and communications and information services; product quality assurance; aquatic animal health; new animal drug approvals; animal damage control; marketing, statistics, and economic services; export promotion; financial services and incentives; and partnerships and improved coordination in support of aquaculture development. The JSA anticipates release of the revised plan in summer 1996 (21). The National Oceanic and Atmospheric Administration has suggested that the JSA should "put forward an interagency national plan which recognizes the capabilities of each of the federal agencies, which has not been adequately done to date" (36).

Box 1-2: Joint Subcommittee on Aquaculture

The Joint Subcommittee on Aquaculture (JSA) was formally established in the National Aquaculture Act of 1980 to serve as a federal government-wide coordinating group to increase the overall effectiveness of federal research, transfer, and assistance programs in aquaculture, and to provide recommendations for federal aquaculture policy. The JSA operates under the National Science and Technology Council in the Office of the Science Advisor to the President. While receiving no direct funding, the JSA generally is thought a model coordinating mechanism for federal activities carried out by many agencies. The JSA is composed of the following people or their representatives:

- Secretary of Agriculture (Permanent Chair)
- Secretary of Commerce
- Secretary of Interior
- Secretary of Energy
- Secretary of Health and Human Services
- Administrator of the Environmental Protection Agency
- Chief of Engineers, U.S. Army Corps of Engineers
- Administrator of the Small Business Administration
- Administrator of the Agency for International Development
- Chairman of the Tennessee Valley Authority
- Director of the National Science Foundation
- Governor of the Farm Credit Administration, and

Heads of other federal agencies as deemed appropriate by the Director of the Office of Science and Technology Policy.

The JSA also has developed a number of Task Forces, Working Groups, and Steering Committees to help it set priorities and coordinate federal activities in certain substantive areas deemed particularly important to the future of U.S. aquaculture. These groups are composed of representatives of government agencies, private sector organizations, and members of the scientific/academic community. Subject areas include:

- Aquaculture Information and Technology Transfer
- Aquaculture Statistics and Economics
- Aquaculture Waste Management
- Federal Legislation and Regulatory Activities
- Quality Assurance in Aquaculture Production
- National Aquatic Animal Health Management Strategy

SOURCE: Joint Subcommittee on Aquaculture, 1992

recognizes that other Federal agencies, especially the National Oceanic and Atmospheric Administration, have strong programs and interests that support both private and public aquaculture. The Department strongly supports cooperation and collaboration with other agencies in the

development of programs and policies that can support private U.S. aquaculture (6).

Specification of each Department's responsibilities, however, still requires concurrence among the three Secretaries and continues to be based on prior designation of responsibilities in

law or by executive action, or the experience and expertise of each Department.⁶

State Roles in National Aquaculture Development

Congress' decision to give the private sector responsibility for development of aquaculture in the 1980 NAA was made, in part, in response to prior independent establishment of university research and extension programs and individual state promotional programs (29). The 1983 National Aquaculture Development Plan reiterated this, noting that "much of the increased production occurred prior to the passage of the National Aquaculture Act because sufficient incentive and motivation in the private sector existed for the aquaculture industry to expand," although it did acknowledge the contributions made by various sectors of the federal government (15).

Also, Congress recognized that the states, rather than the federal government, have direct responsibility for fish and wildlife policy and programs, and land and water use planning, including determination of priority uses for the coastal zone. Federal pre-emption of these states rights and laws have been limited and controversial (34). States also interpret and implement many federal programs, including many environmental and food sanitation laws (2,29). Finally, many states have created statutes that mirror federal laws such as the National Environmental Protection Act and the Federal Food, Drug, and Cosmetic Act, requiring aquaculturists and others to comply with potentially more stringent requirements to permit development (25). In fact, most laws

that specifically authorize, permit, or control aquaculture operations are found at the state level (18).

States' policies, programs, and attitudes towards aquaculture, however, vary greatly. Some, like Hawaii, Florida, Maine, and Mississippi actively promote aquaculture development. Others have developed state policies or even plans, but established few programs to assist the industry. A few may retain fish and wildlife laws that directly conflict with aquaculture development (box 1-3).

Just as the aquaculture industry has sought recognition and support at the federal level, they have actively sought governmental assistance at the state level. Part of the current concerns of the aquaculture industry reflect the uncertain and uneven treatment of aquaculture at the state level. Federal-level definitions and policy, some proponents hope, would promote uniformity in state and local regulations perceived as unnecessary or unfair hindrances to aquaculture development.

CURRENT CONGRESSIONAL INTEREST

Congressional interest regarding the federal role in U.S. aquaculture focuses on reauthorization of present legislation, deliberation over proposed new legislation, and reconsideration of the amount and allocation of federal funds spent on aquaculture development. In addition, significant reorganization and mission realignment among federal agencies is occurring and even more sweeping changes have been proposed for the future. Such changes are affecting agency roles, responsibilities, and commitments in aquaculture and likely will have even more effect in the next few years. A great deal of uncertainty exists among some key agencies about their future aquaculture responsibilities (20).

⁶ The National Oceanic and Atmospheric Administration has recommended that the JSA develop a formal voting structure to resolve contentious issues. "The voting structure should give equal weight to all three lead agencies (Department of Agriculture, Department of Commerce, and Department of Interior). Further, a dispute resolution escalation process for issues not resolved in the JSA should be developed. This process will help to resolve the confusion and conflict over agencies' responsibilities and functions. Consideration should also be given to permanent funding of the JSA for better coordination and consistency in policy implementation over time (36).

BOX 1-3: Distinguishing Between Wild and Cultured Product

As declining wild fish stocks come under increasing protection (37), aquaculture producers may be adversely affected by state regulations designed to protect wild populations of the same species. Fishermen are regulated by laws that specify the size and number of organisms they may possess, the season in which they may be caught, and the waters from which they may be harvested. States commonly also have regulations governing the interstate transport of aquatic organisms to protect against the introduction of disease or injurious organisms. Such laws may hinder aquaculture production or reduce the sale of aquacultured products, making it difficult for aquaculture to supply markets no longer satisfied by wild caught fish.

Organisms produced in aquaculture facilities are not always exempt from restrictions designed to protect wild resources. For example, possession of striped bass was illegal in the mid-eighties in Maryland due to a harvest moratorium (3). This regulation did not differentiate between farm-raised and wild caught fish. Similarly, cultured rainbow trout, coho salmon, and white sturgeon raised in Georgia were considered wild fish and confiscated by state authorities in one case (30). Even processed products may be prohibited from sale to protect wild species: Ohio passed a law that banned the sale of catfish nuggets because there was no way to determine whether the product was derived from farm-raised or wild caught catfish (28).

When conflicts arise between aquaculture producers and state resource protection regulations, definitive methods for distinguishing wild caught organisms from cultured products are needed. Several methods are available. Morphological characteristics such as body shape may be used to differentiate some cultured organisms from wild-caught ones. For example, cultured trout may have rounded 'bullet' shapes and eroded fins caused by abrasion from concrete tanks (27). Gene probes have been used to differentiate striped bass from hybrid striped bass (9) and organisms can be physically or chemically marked (e.g., shellfish and salmon) facilitating identification. In cases where differentiation is difficult, maintaining records and extensive documentation may also provide a method for identifying and tracking cultured products.

However, states may choose to disallow transshipment or sale of aquaculture products even when they comply with federal inspection and nationally-recognized certification programs. For example, Massachusetts has prohibited introduction of clams beneath the states' size limit due to concerns about creating a "black market" in under-sized clams (23;24). This prohibits sale of both seedstock and small clams in Massachusetts by out-of-state aquaculture ventures. In addition to reducing the potential market for any out-of-state producing firm, this also could prohibit Massachusetts aquaculturists from purchasing improved seedstock for grow-out, potentially hindering their competitive position. A number of states grant aquaculture exemptions to certain seafood product rules designed to protect wild resources given certain assurances of their source. A federally promulgated, nationally recognized aquaculture product identification system might assist states to reduce these constraints to interstate trade. The National Aquaculture Act was slated for reauthorization in 1993,⁷ but agreement on certain provisions was not reached prior to debate on the 1995 Farm Bill. The Administration's 1995 Farm Bill Proposal includes reauthorization of the National Aquaculture Act with several amendments (35). Also currently up for reauthorization are the Regional Aquaculture Centers, the National Research Initiative, and other USDA programs that do or could support aquaculture development.

⁷ During the 103d Congress, five bills that specifically focus on aquaculture were introduced for legislative consideration, but none became law. These bills focused on providing a national aquaculture policy and on topics specific to aquaculture research and development. Other legislation considered during the 103d Congress that mentions aquaculture include the Marine Mammal Protection Act (aquaculture proposed as an activity that does not justify harming or harassing marine mammals), the Clean Water Act (proposed exclusion of aquaculture from new wetlands regulations), the Magnuson Act (proposed that aquaculture be excluded from regulations on fisheries), and Disaster Assistance (proposed emergency loans to aquaculture farms substantially affected by disaster).

Determination of the future functions and funding of the National Sea Grant College Program, the National Marine Fisheries Service, and the Fish and Wildlife Service also are on the legislative agenda.

In addition, several Congressional members have introduced or have expressed interest in introducing new legislation to address unmet needs of aquaculture development in the United States. Several proposed bills include provisions to enhance marine aquaculture in largely through NOAA's Sea Grant College Program and Coastal Resources Management Program. Other bills establish a national policy and program for managing aquaculture development in federal waters.

The debate over a federal role in and home for aquaculture continues today. Despite varied attempts to promote cohesion and cooperation, federal agencies continue to vie for aquaculture funding, program lifetimes are uncertain, and aquaculturists still seek a strong national aquaculture policy and supporting federal presence.

REFERENCES

1. *Agricultural Outlook*, table: "Per Capita Consumption of Major Food Commodities," U.S. Department of Agriculture, Economic Research Service, Commodity Economics Division, May 1994.
2. Aspen Research and Information Center, "Aquaculture in the United States: Regulatory Constraints," Report to the U.S. Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C., Mar. 16, 1981.
3. Baker, B., "Striped Bass Success Spawns New Legislation," *BioScience* Vol. 44 No. 8, September 1994.
4. Department of Fisheries and Oceans, Communications Directorate, "A Guide to Federal Government Programs," Ottawa, Ontario, Canada, 1993.
5. Erbacher, J. E., International Trade Specialist, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Silver Spring, MD, Memorandum on "Defensible Statistical Data on Aquaculture" prepared for the Office of Technology Assessment, June 16, 1995.
6. Glickman, D., Secretary of Agriculture, Statement made April 11, 1995 provided to the Office of Technology Assessment by Hank Parker, Aquaculture Coordinator, U.S. Department of Agriculture, Washington, DC, May 1, 1995.
7. Grieve, I., "Dismantling Government Science and Technology Policy: Getting Hit by A Mack Truck," *Journal of Irreproducible Government Agencies* R(1P):1972-1995, July 20, 1995.
8. Hanfman, D.T., "The Status and Potential of Aquaculture in the United States," (Beltsville, MD: U.S. Department of Agriculture, National Agriculture Library, Aquaculture Information Center, July 1993).
9. Harrell, R.M., Xu, X.L. and Ely, B. 1993. Evidence of introgressive hybridization in Chesapeake Bay *Morone*. *Molecular Marine Biology and Biotechnology* 2: 291-299.
10. Harvey, D., "Aquaculture Situation and Outlook," Commodity Economics Division, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 1994, AQS-13.
11. Harvey, D., "Outlook for U.S. Aquaculture," *Agriculture Outlook '94--Prospects for Livestock and Aquaculture* (Washington, DC: U.S.

- Department of Agriculture, Dec. 1, 1993), pp. 39-45.
12. Harvey, D., "Aquaculture: A Diverse Industry Poised for Growth," *FoodReview*, vol. 14, Oct.-Dec. 1991, pp. 18-23.
 13. Hess, A., "Policy Issues for Aquaculture in Federal Waters," paper prepared for the Office of Technology Assessment, September 1994 (Springfield, VA: National Technical Information Service, 1995).
 14. Joint Subcommittee on Aquaculture, "Aquaculture in the United States: Status, Opportunities, and Recommendations," Report to the Federal Coordinating Council on Science, Engineering, and Technology, Office of Science and Technology Policy, Executive Office of the President, Washington, DC, May 1992.
 15. Joint Subcommittee on Aquaculture of the Federal Coordinating Council on Science, Engineering and Technology, *National Aquaculture Development Plan* vol. 1 and 2, Washington, DC: U.S. Department of the Interior, September 1984).
 16. Malone, R. F., "The Future of Recirculating Systems in the U.S. Aquaculture Industry," contract paper prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, 1994 (Springfield, VA: National Technical Information Service, 1995).
 17. Nash, C. E., "Structure of US Aquaculture" *Food Policy*, August 1979, pp. 204-215.
 18. National Research Council, *Marine Aquaculture--Opportunities for Growth* (Washington, DC: National Academy Press, 1992).
 19. National Research Council, *Aquaculture in the United States: Constraints and Opportunities* (Washington, DC: National Academy Press, 1978).
 20. Parker, H.S., Broussard, M. and Jensen, G., U.S. Department of Agriculture, letter to the Office of Technology Assessment, U.S. Congress, Washington, DC, August 16, 1995.
 21. Parker, H., Aquaculture Program Coordinator, U.S. Department of Agriculture, and Chair, Joint Subcommittee on Aquaculture, letter announcing proposal to revise the National Aquaculture Development Plan, May 2, 1995.
 22. Perez, K., Bailey, C., and Waren, A., "Catfish in the Farming System of West Alabama," IN: Bailey, C., Jentoft, S., and Sinclair, P. (eds.) *Aquacultural Development: Social Dimensions of an Emerging Industry* (Boulder CO: Westview Press, 1995).
 23. Royal, T., Vice President for Sales and Marketing, SeaPerfect, Charleston, SC, letter to Jill Fallon of Kaye, Failcow, Richmond & Rothstein, Boston MA, Aug. 28, 1995.
 24. Royal, T., "Potential Sources of Federal Assistance and Financial Aid for Aquaculture," contract paper prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, July 1994 (Springfield, VA: National Technical Information Service, 1995).
 25. Rychlak, R.J., and Peel, E.M., "Swimming Past the Hook: Navigating Legal Obstacles in the Aquaculture Industry," *Environmental Law*, vol. 23, no. 3, 1993, pp. 837-868.
 26. Stickney, R.R., *Principles of Aquaculture* (New York NY: John Wiley & Sons, Inc., 1994).
 27. *The Seattle Times*, "More Atlantic Salmon, Likely Farmed in B.C., Ending

- up in Alaska Nets," Dec. 18, 1994, p. B14.
28. Thomas, S.K., Vertrees, R.L., and Floyd, D.W., "Aquacultural Marketing Law: Assessing State-Level Regulatory Approaches in the North Central Region" *Journal of Applied Aquaculture* vol. 2(1) 1993, pp. 65-84.
29. Tiddens, A., *Aquaculture in America: the Role of Science, Government, and the Entrepreneur* (Boulder, CO: Westview Press, 1990).
30. Trosclair, C., "David Cochran May Finally Get His Day in Court," *Water Farming Journal*, Vol. 10 No. 5, April 10, 1995, p. 3.
31. United Nations, Food and Agriculture Organization, Fisheries Department, "Review of the State of World Fishery Resources: Aquaculture," FAO Fisheries Circular No. 886 (Rome, Italy: UNFAO, 1995).
32. United Nations, Food and Agriculture Organization, Fisheries Department "Aquaculture Production 1986-1992," Fisheries Circular No. 815 Revision 6, (Rome, Italy: UNFAO, 1993).
33. U.S. Congress, House Of Representatives, Committee on Merchant Marine and Fisheries, "Aquaculture," Statement of Dr. Robert Schleser before the Subcommittee on Fisheries and Wildlife Conservation and the Environment, and the Subcommittee on Oceanography, 94th Congress, 1st and 2nd sessions, 1975-1976, p. 590.
34. U.S. Congress, Office of Technology Assessment, *Harmful Non-Indigenous Species in the United States* OTA-F-565 (Washington, DC: U.S. Government Printing Office, September 1993).
35. U.S. Department of Agriculture, "1995 Farm Bill--Guidance of the Administration" (Washington, DC, 1995).
36. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, material provided to the Office of Technology Assessment to clarify NOAA policy, September 7, 1995.
37. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, "1995-2005 Strategic Plan Environmental Stewardship Portfolio--Build Sustainable Fisheries," (Washington, DC: USDOC, Revised December 1994).
38. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, "United States Trade in Edible Fishery Products 1992-1993" (Washington, DC: USDOC, June 1994).
39. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Fisheries Statistics Division, "Fisheries of the United States--1993" (Washington, DC: U.S. Department of Commerce, 1993).