National Aquaculture Program

USDA APHIS VS Career Services Program
Program Diseases Training Module

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National Aquaculture Program

This course is designed to provide updated information on the major domestic diseases for which Veterinary Services (VS) has program responsibility. It will provide information on surveillance, disease control and eradication for these diseases. It will also give an overview of the duties of a field Veterinary Medical Officer (VMO) as a support worker of VS animal disease programs and how they interact with other units in APHIS.

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1. AQUACULTURE OVERVIEW

Aquaculture has been defined as "the propagation and rearing of aquatic species in controlled or selected environments".[1] Basically, it is a diverse industry which includes production of a variety of species of fish, crustaceans, molluscs and plants. Species raised can range from alligators to zebra fish, and culture systems vary from earthen ponds to fiberglass tanks in climate controlled structures. Over 30% of the seafood consumed in the world is of aquaculture origin. It is projected that by the year 2030, over half of all seafood consumed will be from aquaculture.

Aquaculture is complex in that it involves land and water use, various aspects of production, processing and distribution of food for human consumption, as well as complex issues of human health, clean water, clean air and ecosystem disruption. A number of Federal, State and local government agencies are involved in the regulation of the industry.[2]

To provide a basic overview of the aquaculture industry, a brief description of production methods and primary aquaculture species has been included below.

a. Aquaculture Production Methods

Several kinds of production methods are used in aquaculture and vary with the species raised and the water facilities available. There are basically four types of facilities used in aquaculture: ponds, cages, raceways, and recirculating systems.

1) Earthen Ponds are the most common production system in aquaculture. They vary in size, drainage and water quality depending on the use and needs. Average production in ponds can range from 2,000-10,000 pounds per acre per year (lb/acre/yr).[3]

2) Cage culture of fish uses existing water resources (i.e., lakes, ponds, coastal waters) but encloses fish in a cage or basket, which allows water to pass freely through. One of the main advantages of this system is the ease of harvesting. Production rates in cages is similar to ponds with 1,000-5,000 lb/acre/year possible from a series of cages.[3]

3) Raceways are used almost exclusively for trout production. This production system requires large quantities of inexpensive high quality water (typically obtained from a spring or stream). Raceways are arranged in series and developed on sloping terrain to use gravity to move the water through each unit ("once-through" or "open" system). Production in raceways is greater than ponds or cages, due to the continual exchange of fresh water.[3]

4) Closed recirculating systems refers to production methods that recirculate water rather than passing it through once. Less water is typically needed for this type of system. Most systems are indoors, also allowing for control of environmental temperatures. Production rates vary considerably and depend on the type of system used and farmer's expertise.[GG]

b. Primary Aquaculture Species

There are five principal aquaculture food-fish species reared in the U.S.: catfish, trout, salmon, tilapia and hybrid striped bass, and two categories of non-food fish production (baitfish and ornamental fish).[4] Additionally, crustaceans, molluscs and aquatic plants are important commodities to the aquaculture industry.

1) Catfish, primarily channel catfish (*Ictalurus punctatus),* are by far the largest aquaculture industry in terms of weight of product and value, representing almost 40% of the total aquaculture industry value.[4] The majority of the catfish industry is located in the southern U.S. where longer growing seasons and warmer water is conducive to production. The primary states involved are Alabama, Arkansas, Georgia, Louisiana, and Mississippi.[4]

2) Trout, principally rainbow trout (*Oncorhynchus mykiss*), represents 13% of the total estimated value of the aquaculture industry. Trout farms are spread throughout the country. However, the need for cooler water temperatures year round reflects an increase in farm numbers in certain geographical regions. Idaho produces 50% of U.S. farmed trout, followed by North Carolina at 8.6%.[4]

3) Salmon represents an average of about 3.5% of the total estimated value of the aquaculture industry. Farmed salmon (Atlantic salmon- *Salmo salar* and Pacific salmon- *Oncorhyncus* spp.) are the primary species produced. Maine and Washington are the primary producers of farmed salmon, while Alaska provides the majority of wild harvest salmon for the U.S.[4]

4) Tilapia (*Tilapia* spp.) is a relatively new species to the U.S. aquaculture industry but are an important species worldwide. This species tolerates crowded conditions, poor water quality and are extremely prolific. They are grown in most areas of the U.S, primarily in water recirculation tank systems.[4]

5) Hybrid striped bass are crosses between female striped bass (*Morone saxatilis*) and male white bass (*M. chrysops*) Most production is primarily located along the eastern seaboard (Maryland, Florida, South Carolina, North Carolina, Virginia and West Virginia), but Texas, Arkansas and California also produce hybrid striped bass.[4]

6) Baitfish includes several species of fish cultured for use as bait for sport fishing. The three main species are the golden shiner (*Notemigonus crysoleucas*), the fathead minnow (*Pimephales promelas*), and goldfish (*Carassius auratus*). The total value of the U.S. cultured baitfish industry is about $61 million. Most baitfish production occurs in the southeastern part of the U.S., with the industry concentrated in Arkansas.[4]

7) Ornamental species commonly cultured for commercial sale are primarily used for aquariums and include guppies, mollies, swordtails, tetras, gouramies and goldfish. Ornamental fish production is limited in geographic distribution to intensive culture on small operations in Florida. In 1993, net sales from Florida alone were estimated to be $46.7 million. Exports of ornamental fish species, worth an estimated $17 million, make these species the highest valued domestic aquaculture export.[4]

8) Crustaceans. Currently the only crustacean species cultured on a large-scale basis in the U.S. is freshwater crawfish. The estimated value of crawfish production represented 12% of the total value of aquaculture in the U.S. in 1992. Louisiana is the primary production area for crawfish, but Texas, Mississippi, Maryland, South Carolina, North Carolina, Florida, Georgia and California all farm crayfish to some degree.[4] The U.S. also has a large shrimp industry primarily based around the Gulf of Mexico and the Hawaiian Islands. Although we currently import more shrimp than we catch or produce domestically, it is a significant industry in the U.S. (Jill Rolland, personal communication).

9) Clams, oysters, and mussels are the primary molluscs (shellfish) cultured in the U.S. with the total production value of these species being an estimated $95 million in 1992. In Hawaii, approximately 31% of the total value of aquaculture production came from shellfish in 1992.[4]

c. Economic Significance

Aquaculture is the fastest growing sector of the animal production industry worldwide. Between 1983 and 1994, the market growth rate for U.S. aquaculture production increased by 120% with an estimated worth of approximately $800 million. U.S. aquaculture accounts for more then 180,000 jobs and has an economic impact of more than $5.5 billion.[5] In 1993, $10.6 billion in fisheries products were imported, while $6.9 billion were exported.[4]

2. HISTORY OF THE USDA INVOLVEMENT IN AQUACULTURE

a. Legislation

Due to the diversity of aquaculture, many Federal agencies are involved and have jurisdiction over various aspects of the industry. These include, but are not limited to, various branches of the U.S. Department of Agriculture (USDA), [Animal and Plant Health Inspection Service (APHIS), Agricultural Research Service (ARS)], the Food and Drug Administration (FDA), Environmental Protection Agency (EPA), the Department of Interior's Fish and Wildlife Service (FWS), the National Oceanic and Atomospheric Administration (NOAA), the Department of Defense's Army Corps of Engineers (COE) and the Department of Commerce's National Marine Fisheries Service (NMFS).[4]

Coordination between the large numbers of Federal agencies involved in aquaculture was addressed by the U.S. Congress when it passed the National Aquaculture Act of 1980. The Act designated the USDA as the lead Federal agency for coordination and dissemination of national aquaculture information.[6] Additionally, it established a Joint Subcommittee on Aquaculture (JSA) to serve as a Federal interagency coordinating group to increase the overall effectiveness of federal research, transfer and assistance programs in aquaculture.

One of the first mandated activities of the JSA was to prepare and publish a National Aquaculture Development Plan.[2] In 1983, the developed Plan addressed the role the Federal government should take in aquatic animal health, (i.e., development of a National aquatic animal health strategy). This interaction with the public aimed to develop a strategy to ensure availability of diagnostic, inspection and certification services, to facilitate the legal movement of aquatic animals, their eggs, and products in interstate and international commerce, and to protect the health and improve the quality and productivity of public and private aquatic animal resources. The Plan was revised in 1996.[2]

The USDA-APHIS has provided assistance to aquaculture producers upon request over the last 30 years. The level of such assistance has increased significantly during the past 15 years as aquaculture continues to gain popularity and grow at a rapid pace.[5] Several services already provided to the aquaculture industry include laboratory diagnostics, certificates of inspection for export, licensure of vaccines and biologics, and disease control and eradication. Additionally, APHIS is also involved in the control of damage by wild birds or other animals to farmed aquatic animals.[7]

During the late 1990's, aquaculture industry stakeholders requested APHIS to address farm-raised fin fish as "livestock", in efforts to gain similar status and services as more traditional livestock industries. This could lead to development and implementation of regulations and regulatory programs for added control within the industry.[7]

In May 1994, APHIS established the first voluntary certification program in the states of Washington and Alaska.[5] Since then programs have been established in California, Maryland, Pennsylvania, Arkansas and Idaho. Protocols submitted by Texas and Florida are currently under review.[5] Additionally since 1994, APHIS has endorsed export health certificates for a variety of fish species from Chile, Columbia, Greece, Korea and Japan.[5]

Official recognition of aquaculture as a part of agriculture was authorized by the Secretary of Agriculture in the Farm Bill of 1996.[5] Soon after, in 1997, specialized inspection training courses for international and export regulations for aquaculture were offered and attended by federal veterinary medical officers (VMO).[5]

In 1998, APHIS published procedures for diagnostic laboratories to qualify for conducting testing of aquatic animals, embryos, ova and semen intended for export. Since then, twelve diagnostic labs have been approved for diagnostic services specific to the aquaculture industry (www.aphis.usda.gov/vs/nvsl/LabCertification/aquaapplab.htm). Additionally, the National Veterinary Services Laboratory (NVSL) has taken initial steps in developing various diagnostic capabilities for various aquatic species diseases, as well as providing training in diagnostic methods for fish pathogens.[8]

In 1999, APHIS requested public comments on a proposed National Aquaculture Program and services desired by the industry [It was announced as an advanced notice of proposed rulemaking in the *Federal Register* on May 4, 1999].[5,9] Eight public meetings were held throughout the country in 2001 to facilitate public participation and comments.

Farmed raised finfish species used for human consumption have been classified as "livestock". In 2002, The Animal Health Protection Act, officially granted APHIS the specific authority to announce regulations for the protection of the health of farm-raised aquatic animals. This will aid efforts for APHIS to provide more services to the industry. However, future expansion of services and programs will require additional funding primarily from state and local governments and industry.[7]

b. Regulations

As previously mentioned, the aquaculture industry is regulated by many federal and state agencies. Due to the nature of the industry, (i.e., aquaculture and native/game species sharing the same water source) most regulations are state-based.

State regulations vary with great diversity in the authoritative agency (i.e., agriculture agency versus natural resource agency), permitting and reporting requirements and importation restrictions. For example in 1995, almost 65% of the states required health certificates for fish entering, while only 2.7% reported requiring a health certificate when leaving.[4]

However, there are certain broad categories of permits and regulations common to all states: water use, effluent discharge, production, land use and modification, and marketing. A central theme transcends all of these; the protection of natural resources and wild stocks of aquatic animals.

3. CURRENT PROGRAMS

Current APHIS programs serve important aspects of both plant and animal aquaculture, especially those involving disease, pest prevention and wildlife damage management. APHIS has also become involved in facilitating the import and export of aquacultural products because of increased global trade. Some of the specific aquatic animal health activities and services provided by APHIS for aquaculture include:

- Providing diagnostic assistance to aquaculture producers experiencing health problems in their aquatic products (VS-NVSL),
- Endorsing animal health certifications for the exportation of live aquatic species or their products (VS),
- Developing aquatic animal health monitoring and surveillance (VS)
- Issuing permits, licenses, inspections and regulations for domestic manufacturers of veterinary biologics (VS-Center for Veterinary Biologics)
- Assisting with Wildlife damage management and activities (i.e., fish-eating birds) (Wildlife Services [WS])
- Working with other federal agencies (Fish and Wildlife Service [FWS], National Marine Fisheries Services[NMFS]) and the Joint Subcommittee on Aquaculture (JSA) to share information and determine roles for agencies to best meet the aquaculture industry's animal health needs.[10]

a. National Certification and Inspection Program

The USDA-APHIS-VS National Certification and Inspection Program for aquaculture consists of two components: (1) voluntary aquatic animal-health certification procedures and laboratory-approval procedures for fish farms that export internationally and (2) importation of aquatic animals and their animals products. These two complementary aspects of the program ensure that foreign diseases notifiable to the World Organization for Animal Health] will be reported.[11]

Accredited veterinarians have a vital role in signing USDA-APHIS export animal health certificates based on information gathered from farm inspections, onsite sample collections and laboratory submissions. In lieu of the recent MOU between APHIS, FWS, and NOAA, veterinarians are not responsible for signing All health certificates. (Jill Rolland, personal communication). In most cases, herd health management is provided by accredited veterinarians for the commercial salmon industry, with increasing utilization of full-time veterinarians in other marketable product groups, like tropical and ornamental fish.[11]

Specialization of veterinary expertise is increasing as the number of APHIS-endorsed health certifications for international countries also rises. This development will require APHIS to provide biennial specialty training as a form of continuing education to those who desire to serve in this field.[11]

b. Monitoring and Surveillance

Prior to 1995, monitoring and surveillance for fish diseases did not exist at a national level in the U.S. Currently, the USDA-Center for Epidemiology and Animal Health (CEAH) develops programs for monitoring the health of aquatic species. Data is typically provided by industry, private veterinarians, or diagnostic laboratories. Periodic on-premise data collection may be undertaken for the purpose of generating national and regional estimates of aquatic animal health parameters.[4]

c. National Aquatic Animal Health Plan

The National Aquatic Animal Health Plan (NAAHP) is being developed by the NAAH Task Force commissioned by the JSA and is expected to be completed by 2006. The plan is anticipated to provide for efficient, safe and effective national and international commerce of aquatic animals, protection of cultured and wild aquatic animals from foreign pests and diseases, the U.S. to meet its legal trade obligations and the availability of diagnostic and certification services.

d. Infectious Salmon Anemia Indemnification Program

Following the discovery of infectious salmon anemia (ISA), a foreign animal disease, in a young salmon cage in Maine on February 15, 2001, APHIS entered into a cooperative ISA control program with Maine, per their request. The program was implemented to help safeguard the salmon industry from future incursions of this exotic disease. The state's industry voluntarily depopulated about 900,000 salmon, worth nearly $11 million.[7,12]

Following the emergency declaration by the Secretary of Agriculture, an interim rule was published, providing indemnification for fish depopulated due to ISA.[7] On December 2001, the USDA-APHIS authorized approximately $8.3 million to implement an ISA control and indemnity program for farm-raised fish in the United States. The funds were used to assist the state of Maine in depopulation, disposal, clean-up, and disinfection efforts, as well as for indemnity payments, surveillance, epidemiology, diagnostic support and training of producers and veterinarians.[11-13]

The ISA program also established procedures for the prevention and containment of ISA in farm-raised Atlantic salmon. Indemnity payments are only made to producers when established procedures and standards are followed. Program administration consists of individuals from regulatory agencies and industry, who make recommendations to the Area Veterinarian-in-Charge (AVIC), ISA Project Manager or the Maine Department of Natural Resources (DNR) Commissioner.[7]

Surveillance sampling is conducted by APHIS on a monthly basis (at a minimum – typically more frequently) at high- and low-risk zone net-pen sites throughout the Gulf of Maine. Additionally the National Marine Fisheries Services takes wild fish samples in the Gulf of Maine. The U.S. Fish and Wildlife Service routinely samples wild and culture fish species while conducting their national wild fish health survey.[7]

e. Spring Viremia of Carp Indemnification Program

In June 2002, the first case of spring viremia of carp (SVC) in the United States was confirmed in North Carolina and Virginia. On March 25, 2003, the USDA-APHIS authorized approximately $11.7 million to implement a SVC control and indemnity program. The funds were used to assist the states of North Carolina and Virginia with epidemiology, surveillance and an indemnification program.[14]

Additionally the program developed standards to enable producers to have their aquaculture establishments declared SVC-free. Ongoing routine monitoring occurs on a monthly basis.[11]

4. ROLE OF THE VETERINARY MEDICAL OFFICER (VMO) IN THE NATIONAL AQUACULTURE PROGRAM

The VMO field officer is principally involved in the certification of animal health for exportation. This is primarily done for trout eggs and ornamental species but may include others. The Area Veterinarian-in-Charge (AVIC) in all states is authorized to endorse health certificates for aquaculture species.

The certification process has many steps. First, a federally accredited veterinarian will conduct a site visit to evaluate the farmer's facility. The required diagnostic samples are then gathered and submitted to an APHIS approved laboratory. After test results are received, the veterinarian can complete the animal health certificate. The certificate should identify the product being shipped, the farm location and the lot identity. A health certificate is only valid for one export country. The certificate is then forwarded by the accredited veterinarian to the AVIC, who will endorse it and forward a copy to the national headquarters.[6]

For a producer to maintain export trading rights, they must maintain a log of all health certificates and shipments exported. Records should include the animal health certificate number, destination country, species, and number of animals or live eggs. Each month the producer or accredited veterinarian for the farm must send a copy of these records to the AVIC.[6]

5. INVOLVEMENT OF OTHER AGENCIES, STATES AND INDUSTRY

Many other federal agencies are involved in various aspects of the aquaculture industry.

Export Health Certificates. In 2004, APHIS, the US Fish and Wildlife Service (FWS) and the National Oceanic and Atmospheric Administration - Fisheries (NOAA Fisheries) entered into a Memorandum of Understanding (MOU) on the issuance of health certificates for the export of live aquatic animals (Jill Rolland, personal communication). This agreement recognizes the legal authorities and mandates of these agencies and delineates their responsibilities in the issuance of animal health certificates for the export of live aquatic animals to foreign countries. It is in place for not more than three years (2007) at which time it may be extended for an additional three years. The MOU establishes APHIS as the lead agency with responsibility for export health certificates for farm-raised aquatic livestock cultured in the U.S. and its territories. The NOAA Fisheries is the lead agency with responsibility for export health certificates for marine wildlife or feral aquatic animals (i.e. animals existing outside the confines of a government owned or leased, or privately owned or leased farm site) that are in captivity or captured from the wild. The FWS is the lead agency with responsibility for export health certificates for freshwater wildlife and feral aquatic animals, in captivity or captured from the wild. Export health certificates for wild and feral diadromous aquatic animals (i.e., salmon or marine sturgeon), is a shared responsibility between NOAA Fisheries and FWS.

Other Agency Involvement in Aquaculture. Additionally, the FWS provides migratory bird depredation permits based on APHIS recommendations.[5] The Food and Drug Administration (FDA) has the responsibility for the assurance of seafood safety. The Center of Veterinary Medicine (CVM) division of the FDA is responsible for the regulation of animal drugs, animal feeds and veterinary medical devices. The U.S. Environmental Protection Agency (EPA), regulates several programs involved in aquaculture such as the management of effluents and residual wastes, water quality, effluent discharge standards, discharge of wastewater to surface water. Additionally, the

EPA works in conjunction with the U.S. Army Corps of Engineers to implement the Clean Water Act in protecting natural wetlands.[15]

6. DISEASE INFORMATION

The physical spread of disease in aquaculture differs from spread of disease in traditional livestock, due to the nature of the aquatic environment and physiology of the aquatic organisms. Many potential disease pathogens are continually present in the aquatic environments which, under natural conditions are not pathogenic due to the natural defense mechanisms of aquatic species. Decreased resistance to disease may be a result of multiple factors including physical stress or injury.[4]

There are a wide variety of diseases that affect various aquaculture species and over 13 are listed on the OIE's list of notifiable diseases (http://www.oie.int/eng/maladies/on_classification.htm#ListeA). Two of the listed diseases, Infectious Salmon Anemia (ISA) and Spring Viremia of Carp (SVC), were diagnosed in the U.S. in 2001 and 2002, respectively. Monitoring and eradication programs were implemented by USDA-APHIS-VS following the outbreaks.

a. Infectious Salmon Anemia (ISA)

1) Agent. Infectious salmon anemia (ISA) is a foreign animal disease of Atlantic salmon (*Salmo salar*) listed by the OIE as a notifiable disease.[15] It is caused by an emerging orthomyxovirus and is also known as hemorrhagic kidney syndrome.[17] Although only Atlantic salmon are clinically affected by the virus, other wild fish species (the sea run brown trout and the rainbow trout) are susceptible to infection.[15]

The ISA virus is very similar to members of the influenza family (also an orthomyxovirus). Some basic influenza virus family principles can be applied when trying to understand the ISA virus. The ISA virus can mutate and evolve. It can also change rapidly by recombination of virus genetic elements. For this reason there are significant molecular differences that exist between various ISA virus isolations (i.e., "Norwegian", "Scottish" and "North American").[15,21]

2) Transmission. Transmission occurs by direct contact with infected fish (mucus, blood, viscera, trimmings, and feces), or by contact with fomites, such as equipment contaminated with parts from infected fish or people who handled infected fish.[17] Sea lice can also play a role in transmission of ISA.[17] Sea lice are copepod arthropods of the Genera *Lepeophtheirus* and *Caligus.* Species of both infest Atlantic salmon and live in their mucus layer, where they attach, and suck blood or cause sores. Both genera can also cause stress to fish, which adversely affects their immune response.[7] *Lepeophtheirus* species are generally regarded as capable of transmitting ISA.

3) Clinical signs. Clinical signs of ISA generally appear 2-4 weeks after the initial infection. Fish are most frequently affected after being in sea water for one year and salmon are raised in saltwater for a portion of their life cycle. Signs of disease can include lethargy, swelling and hemorrhaging of the liver, kidney, spleen or other organs. Exopthalmos (bulging eyes) may also be seen, as well as pale, anemic gills. The posterior gut may be darkened and fluid may be present in the body cavity.[15,17] Liver cells, leukocytes and immature erythrocytes are target cells for replication of ISA virus.[17,21]

Mortality is highly variable and can range from 2-50% depending on stocking density, sea lice status, etc.[17,18] Severity of the disease is also influenced by virus strain, dose, method of exposure, fish strain and species, fish age class and water temperature.[15]

4) Epidemiology. ISA was first isolated in Norway in 1984 and has since been found in Canada, Nova Scotia, the Faroe Islands (a protectorate of Denmark), Scotland, Chile and the United States.[17] The first identification of ISA in the U.S. occurred in an aquaculture net-pen in Maine in February 2001. The virus was detected in one of six cages stocked with young salmon (smolts). By December 2001, 19 cases of ISA had been confirmed in 16 net-pen sites in Maine.[7] Fish deaths averaged about 150 per day.[17]

In April 2001, APHIS entered into a cooperative ISA control program with Maine, per the state's request, to help safeguard the salmon industry from future incursions of this exotic disease. The Secretary of Agriculture declared an emergency due to the severe economic threat to the industry as well as the viability and sustainability of salmon aquaculture in the U.S.[3,7,13]

In an attempt to control the ISA outbreak, the state's salmonid industry voluntarily depopulated about 900,000 salmon, worth nearly $11 million.[7,12] This loss is even greater when capital expenditures such as labor costs and equipment are considered. Additionally, the outbreak had international trade ramifications, affecting salmon trade in other states that were not affected by the outbreak. Following this declaration of emergency, an interim rule was published, providing indemnification for fish depopulated due to ISA.[7,12]

The ISA indemnification program established standards and procedures for the prevention and containment of ISA from farm-raised Atlantic salmon. Indemnity payments are only made to producers when established procedures and standards are followed. These requirements include:[7]

a) Establishment and maintenance of a veterinary client-patient relationship with an APHIS-accredited veterinarian. The ISA Program Veterinarian must be informed, in writing, of the name of the accredited veterinarian;
b) Cooperation and assistance of producers in periodic on-site disease surveillance, testing and reporting activities;
c) Development and implementation of biosecurity protocols for use at all finfish sites and participant- operated vessels. The protocols must be submitted to the ISA Program Veterinarians;
d) Development of a site-specific ISA action plan for the control and management of ISA. This plan should define the response activities to be undertaken upon disease detection and notification procedures in the event the disease emerged at the site;
e) Participation in Maine's integrated pest management (IPM) program for the control of sea lice on salmonids.
f) Submission of a complete and current fish inventory for each participant-leased finfish site to the ISA Program Veterinarian;
g) Maintenance and availability of mortality data for each participant-leased finfish site and pen in production to the ISA Program Veterinarian;
h) Cooperation with and assisting of APHIS in the completion of biosecurity audits at all participant-leased finfish sites and participant-operated vessels. This helps to assess the efficacy of the biosecurity protocols established by the participants to reduce the risk of introducing and spreading ISA into and between marine sites and cages.[7,12]

The ISA indemnification program administration consists of seven individuals from the regulatory agency and industry. The ISA Technical board makes recommendations to the USDA-APHIS AVIC, ISA Project Manager or the Maine DNR Commissioner.[7]

Surveillance sampling is conducted by APHIS on a monthly basis at high- and low-risk zone net-pen sites throughout the Gulf of Maine.[22] Additionally the National Marine Fisheries Services takes wild fish samples in the Gulf of Maine and the U.S. Fish and Wildlife Service routinely samples wild and culture fish species while conducting their national wild fish health survey.[7] By early 2003, no disease outbreaks of ISA in Maine were found through routine monthly surveillance samples; all tested negative. In all, 17 sites (holding 1,561,000 fish) were depopulated. However, in June and July 2003, two new sites were found to be positive for ISA. Both sites were depopulated.

5) Diagnosis. Preliminary diagnosis of ISA can be made by virus isolation, RT-PCR and indirect fluorescent antibody test. Diagnostic procedures are standardized and their description can be obtained from the OIE's 2003 Manual of Diagnostic Tests for Aquatic Animals.[19,20] All official diagnostic tests must be performed by a USDA-APHIS-approved laboratory.[7] The only diagnostic laboratory approved to address ISA specifically is MicroTechnologies, Inc. in Richmond, ME.[8]

6) Prevention and Control. There is currently no cure for ISA. Regulations on general hygienic measures are being drafted. Cleaning and disinfection of net-pen cages and associated structures are a vital part of ISA control. Power washing, scraping, steaming, or all three methods are effective methods for cleaning and disinfecting net-pen cages, primary nets, and predator nets.[7,21]

Vaccination has the potential to be an effective means of controlling ISA. If vaccines being tested prove to be efficacious, restocking affected zones with vaccinated smolts could reduce the incidence and spread of ISA. APHIS has approved permits for ISA vaccine distribution in the high-risk zones of Maine's Cobscook and Passamaquoddy Bays. [11]

APHIS' goal for the ISA indemnification program is to control and contain the disease through rapid detection and depopulation of infected or exposed salmon. This is done by assisting states with epidemiology, surveillance and indemnification programs.

7) Public Health Consequences. Infectious salmon anemia is not considered a zoonotic disease. There are no public health consequences.

8) Economic Impact. Salmon production in Maine exceeds 36.2 million pounds annually, with a value of $101 million. The outbreaks of ISA in Maine have cost the state's salmonid industry approximately $11 million, following the voluntary depopulation of about 900,000 salmon.[7,12] This loss is even greater when capital expenditures such as labor costs and equipment are considered. Additionally, the outbreak had international trade ramifications, affecting salmon trade in other states that were not affected by the outbreak.

APHIS implemented an ISA indemnity and control program instituting surveillance sampling requiring high- and low-risk areas to undergo monthly testing at all salmon netpen sites in the Gulf of Maine. $6.3 million paid the indemnity for the depopulation and cleanup and disinfection of 1.5 million infected and exposed Atlantic salmon. An additional $2 million will be used for program activities such as disposal, continuing execution of surveillance programs, epidemiology, and

diagnostic support. Additional funding for continued support for the ISA control program has been requested.[7,12,13]

During fiscal year 2002, indemnification paid up to 60% of the expense of purchase, destruction and disposition of animals and materials contaminated by or exposed to ISA.[12] In order to receive indemnity for fish destroyed because of ISA, claimants must participate fully in the cooperative ISA control program administered by APHIS and the state of Maine.

b. Spring Viremia of Carp (SVC)

1) Agent. SVC is a OIE notifiable disease.[18] It is a viral disease of fish, primarily common carp (*Cyprinus carpio*) but can also affect several other species of fish (i.e., food fish, ornamental fish [koi and goldfish] and baitfish.)[18,23] It is caused by *Rhabdovirus carpio*, a virus with predilection for endothelium, resulting in vascular leakage and loss of fluid balance. The disease is an acute, highly contagious systemic disease. The gill is the most common portal of entry.

2) Transmission. Transmission of SVC occurs horizontally. Infected culture or wild fish may shed the virus via feces, urine, gill and skin mucus or skin blister exudates.[18] Clinically and subclinically infected fish may serve as reservoirs for the virus. Blood sucking parasites (i.e., carp louse [*Argulus foliaceus*] and leech [*Pisciola geometra*]) can serve as passive vectors and transfer the virus to healthy fish. Vertical transmission may also be possible since SVC virus has been found in ovarian fluids. However, there have been no outbreaks among fry and fingerlings', suggesting this is probably not an important route of transmission. The virus is able to maintain infectivity for long periods in water or mud (even after drying), making mechanical transfer a potential route of transmission as well.[18,23]

3) Clinical signs. The optimal temperature for development of SVC in experimentally infected carp is between 16-17°C (60.8-62.6^{o}F).[18] Experimentally, 90% of fish died within 5-17 days after infection at these temperatures.[18] Mortality is delayed at lower temperatures (11-15°C [51.8-59°F]) and the percentage of fish that die is similar. Mortality is greatest while temperatures increase from 7-14°C (44.6-57.2^{o}F), therefore most natural outbreaks are seen in the spring.[18] Once water temperatures reach 20-22°C (68-71.6^{o}F), infection can still occur but clinical disease does not develop. Under natural outbreak conditions, mortality can range from 30-70%.[23]

Initial signs of disease manifest as changes in the behavioral patterns of the fish. Affected fish will seek slow moving water or lie on the bottom. The fish will become sluggish, non-responsive to stimuli, swim on their side or rest in abnormal positions as the disease progresses. Respirations rates also decrease. Externally, several non-specific physical signs can be seen. The skin becomes darkened and the belly swollen. Petechial and ecchymotic hemorrhages and exopthalmos (bulging eyes) are common. Long, thick, mucoid cases may also be observed from the vent.[18,23] Internally, edema can be found in all organs as well as in the body cavity; hemorrhages occur in the swim bladder and the intestines will be inflammed.[18]

4) Epidemiology. SVC has been reported in many countries (Europe, the Middle East, and Asia) and recently has been reported in South and North America. SVC is a World Organization for Animal Health (OIE) notifiable disease.[18]

The first identification of SVC in the U.S. was made in July 2002 in North Carolina. In April of that year, a local hatchery began experiencing a 10% death rate per week in juvenile koi (colored, ornamental strains of the common carp). Diagnostic samples were sent an APHIS approved

diagnostic laboratory (University of Arkansas- Pine Bluff Laboratory) and then forwarded to the OIE reference laboratory in the United Kingdom. Diagnosis of SVC was confirmed on July 5, 2002. Further investigation identified four infected ponds (150,000 koi). Of the fish found affected, 15,000 died and the remainder (135,000) were depopulated. The affected ponds were subsequently drained.[23] The hatchery is no longer experiencing signs of SVC but the potential source of infection was not identified. More recently (2004), the virus has emerged in wild common carp populations in Wisconsin and Illinois and in a backyard pond in Washington and a koi facility in Missouri.[24,25]

5) Diagnosis. Immunological tests, such as the direct immunofluorescence (IF) or enzyme-linked immunosorbant assay (ELISA), can be used for diagnosis, but should be followed by virus isolation and virus neutralization test (the confirmatory identification test).[18] Description of diagnostic procedures can be obtained from the OIE's 2003 Manual of Diagnostic Tests for Aquatic Animals (http://www.oie.it/eng/normes/fmaunal/A_00021.htm).[26] All official diagnostic tests must be performed by a USDA-APHIS-approved laboratory.[8] Four diagnostic laboratories are approved to address SVC specifically: University of Arkansas-Pine Bluff; MicroTechnologies, Inc.; Pennsylvania Animal Diagnostic Laboratory System; and Washington Animal Disease Diagnostic Laboratory.[8]

6) Prevention and Control. Successful treatment of fish infected with SVC has not been accomplished. Additionally, there is no approved vaccine for SVC in the U.S.[23] Control measures include use of disease-free source water, iodophore disinfection of eggs and periodic chemical and physical disinfection of ponds and equipment.[18,23] New fish should be purchased from an SVC-free source.[18] Minimizing stress and overcrowding, as well as sanitary disposal of dead fish is recommended.[23] Rearing fish at a water temperature of 19-20°C (66.2-68°F) has been suggested, but the cost effectiveness of heating water in certain climates can be prohibitive.[23]

7) Public Health Consequences. Spring viremia of carp is not considered a zoonotic disease. There are no public health consequences.

8) Economic Impact. In 1998, the U.S. had 39 facilities that produced carp as a food fish, with sales totaling $1.3 million. North Carolina had only one facility that produced stocker carp intended to be raised as food fish. In 2001, the U.S. exported $1.8 million worth of live carp, almost exclusively to Canada.[23]

9) SVC Control Program. To control SVC, the Secretary of Agriculture declared an emergency that threatens the livestock industry of this country and authorized the transfer and use of funds necessary from appropriations to establish the program.

SVC can likely be controlled and contained within high-risk zones through surveillance, quarantine, and best-management practices. Control of SVC may require depopulation (with cleaning and disinfection) of all sites holding infected fish, but the risk of loss of valuable stock without indemnification makes it unlikely that farmers will report outbreaks. Because farmers have no obligation to report the occurrence of fish diseases to APHIS, the agency's surveillance efforts are compromised. Therefore, establishing a SVC indemnity and control program allows USDA Veterinary Services to determine the prevalence of the disease in the U.S. and provide the necessary funding for broad farmer participation.[11,14]

According to the OIE, in order to maintain SVC-free status as a country, zone, or aquaculture establishment, an official fish health surveillance or control program must have not detected SVC for at least the previous two years. APHIS is implementing an SVC indemnity and control program with plans to develop SVC program standards and provide ongoing routine monitoring and surveillance that will enable producers to have their aquaculture establishments declared SVC free.[11,22]

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