

PART III

ADMINISTRATIVE OPTIONS IN DISEASE CONTROL

ate pathogens that are not ubiquitous in surface waters and are transmitted primarily through contact between infected and non-infected fish. Hazards of communicable diseases may also be created by the movement of causative organisms or health-related agents, such as research materials, feeding ingredients and biologics. Similarly, drugs or therapeutic agents that may affect the character of pathogens or overall health of fish should be subject to regulated usage.

The effective control of communicable diseases on a regional basis requires mutual understanding by public and private sectors of their accountability for disease control, and the need for development of cooperative procedures and mechanisms which minimize the risks of exposure to communicable diseases. Beneficiaries of such action will include all those who depend on aquatic resources, including fish culturists, sports and commercial fishermen, and those businesses whose economic welfare is dependent on fish culture activities.

This section will summarize the acknowledged levels of accountability of various sectors for controlling communicable diseases, mechanisms for implementing control measures, and recommended procedures for application of regional fish disease control interventions in the Great Lakes basin.

ACCOUNTABILITY FOR CONTROL OF COMMUNICABLE FISH DISEASES

The term "accountability" in this context can be described as the person, office, or unit on which onus is placed to undertake certain actions, and for which they are answerable if those actions are not properly discharged. It is also used here in the ethical as opposed to legal sense, the intention being to ensure that all those involved in or with fish culture are aware of their obligations to participate in the control of communicable diseases.

HATCHERY OPERATIONS

The culture of salmonids in hatcheries in the Great Lakes basin is undertaken to restore naturally spawning populations, to supplement the reproduction of valuable stocks to support populations that do not reproduce naturally (e.g. Pacific salmon species), and to produce fish for market by the private sector. With the growing importance and value of salmonid fisheries, and the steady growth of a fish culture industry within the private sector, the level of production of cultured stocks and the numbers and size of production facilities have increased significantly in recent years.

Fish culture facilities tend to be the primary sites for disseminating fish diseases, because of increased susceptibility of fish to diseases when reared in artificial environments. Owners and managers of these facilities must therefore recognize the potential for dissemination of diseases to the natural environment from facilities under their control. Diseases can be disseminated through hatchery effluents, poor hatchery sanitation procedures, or through inter-station transfer or release of infected eggs and fish. Other hatcheries in the same watershed and, in some cases, natural fish populations can be affected.

Acknowledgement of this accountability in the operation of hatcheries, and in the development of procedures to minimize the risk of spreading disease, will contribute significantly to overall efforts for control of communicable fish dis-

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REGIONAL CONTROL OF COMMUNICABLE DISEASES OF FISH

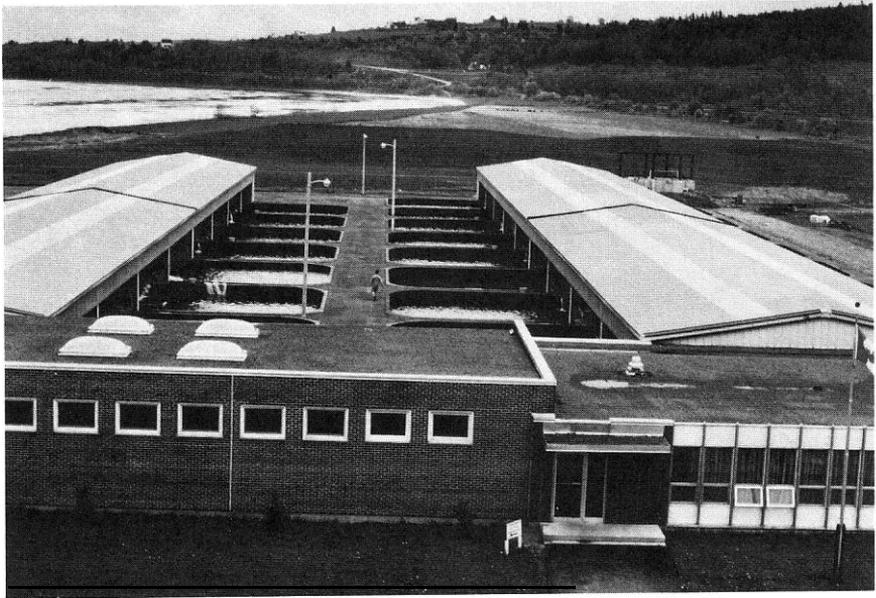
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The watershed of the Great Lakes basin covers a vast area, exceeding 350,000 Km², and traverses eight states (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin), one province (Ontario) and an international boundary (U.S.A. and Canada). Fishery resources in the Great Lakes, after experiencing a period of major decline due to sea lamprey predation and water pollution, are rebounding and supporting major recreational and commercial fisheries. In addition to native fish species, the successful introduction of Pacific salmon for development of sport fisheries has added further diversification to the total fish fauna of the Great Lakes.

Within this complex system comprising large multi-species fisheries managed by many agencies, the culture of salmonids in both public and private sectors has expanded dramatically in recent years to support restoration and augmentation programs for many recreational and commercial fisheries, and for investment purposes in aquiculture business. There are now over 100 government-operated fish culture stations and broodstock collection sites in the Great Lakes watershed, and probably more than 200 privately operated fish culture facilities. These hatchery operations have involved international, inter-regional and intra-regional transfers of live fish and eggs, and massive releases of hatchery-reared fish into rivers and lakes are common occurrences.

The introduction and dissemination of communicable fish diseases through these activities is a potential hazard that could ultimately damage the salmonid fishery resources and affect major business investments if movements of stocks are allowed to take place indiscriminately. Communicable diseases include oblig-



A modern government hatchery used for production of Atlantic salmon smolts for stocking in rivers (T. G. Carey)

eases. It will also enhance public support for aquaculture activities and help foster further expansion of the industry.

STATE/PROVINCIAL GOVERNMENTS

The responsibility for protection of aquatic resources for the benefit of the common interest is vested in governments. This includes governmental administration of fisheries and activities that impact on them. In the U.S.A., this authority has been given to individual states. In Canada, the authority for administration of certain inland fisheries has been delegated to provincial governments (e.g. Ontario).

Within this framework, maintaining the health of natural fish populations is an important factor for which state and provincial authorities are accountable within their state or province. This applies equally to the control of communicable fish diseases as it does to ensuring retention of genetic integrity of stocks, maintaining good environmental quality, and rational exploitation of stocks.

With respect to control of communicable diseases, the objective is to minimize risks of introduction and dissemination of diseases to natural stocks from potential disease sources. Those with the administrative authority must take necessary measures to assure this protection using regulatory options implemented as acts, regulations, policies or guidelines to balance the need for control with the need to operate efficient and economical fish culture units.

State and provincial authorities are also accountable for the protection of innocent parties that might be affected by the actions of others. For example, water is a fluid environment that can quickly and easily carry fish pathogens



Releasing hatchery-reared salmon to supplement natural populations (T G. Carey)

across considerable distances from a disease source. Consequently, a fish culturist who has worked hard to minimize risk of disease outbreaks in his facility may have his efforts negated by a less conscientious operator upstream of his facility. Similarly, the production of vaccines, fish feeds, and therapeutic chemicals is beyond the control of individual hatchery operators. Therefore, the fish health risks introduced through the use of such products should be reviewed and minimized by governments.

Finally, state/provincial authorities are accountable for the conduct of their own fish culture programs, and for setting an example for the private sector. In many instances, production by government stations and scope of distribution to rivers and lakes far exceeds that in the private sector; thus, the risk of disease dissemination through release of stocks is high. Health protection programs and the use of procedures of control the introduction and spread of communicable diseases must be of major importance to state and provincial governments.

FEDERAL GOVERNMENTS

As well as assuming some of the responsibility for aquatic resources within each state or province, federal governments in U.S.A. and Canada are responsible for control of interprovincial or interstate and international activities affecting these resources. In effect, they maintain a national perspective by monitoring internal and external factors that influence the aquatic environment in the respective countries. Federal agencies also provide national leadership in research and the establishment of standards related to fish health and the control of communicable diseases.

Accountability of the two federal governments with respect to the control of communicable diseases is similar to those of state/provincial governments, but on a much broader scale. Federal governments are accountable for the health of aquatic resources in each nation as a whole (including transboundary shipments), for the protection of innocent parties, and for the federal hatchery programs throughout each country.

MECHANISMS FOR IMPLEMENTING DISEASE CONTROL MEASURES

To fulfill their obligations for disease control, accountable authorities have basically three mechanisms through which control measures can be implemented. These options vary in the degree of control that can be applied, although each can be as effective as the others depending on the circumstances in which they are used.

GUIDELINES

Guidelines recommend voluntary compliance to stated procedures and practices which, if adhered to, will reduce the risk of exposure to diseases. Guidelines can be formulated and implemented at any level in a program structure.

POLICIES

Formal policies are statements of intent, usually approved at the highest level of authority. They are developed as a result of forecasting, planning, and decision-making and must aim at achieving conformity in conception and realization. While not enforceable, policies require strict adherence within the organization which initiated them and can also provide protection from external influences.

STATUTES

Statutes are enforceable acts and regulations promulgated by governments and written into law. They are the least flexible of the three mechanisms available for initiating disease control interventions and are costly to maintain. However, they provide the greatest potential for achieving uniform compliance with disease control procedures because of their legal status.

The legality of statutes demands that they be judiciously planned and formulated. They set the standards for fish health and disease control, and provide details of enforcement procedures as well as designate penalties and incentives for compliance. Finally, with the potential for litigation, statutes are likely to be utilized and tested in court actions.

DEVELOPMENT OF REGULATORY OPTIONS TO CONTROL COMMUNICABLE DISEASES IN THE GREAT LAKES

Since the active salmonid culture industry in the Great Lakes basin involves both public and private sectors, a wide variety of culture strategies, and uses of

cultured stocks, it is sometimes necessary to make broad interventions to reduce the risk of introducing and disseminating communicable diseases. A range of measures is available to hatchery operators to control diseases, but individual efforts are not always sufficient to provide the protection needed against communicable diseases.

Prevention should be given priority in developing effective measures to reduce the risk of exposure to communicable diseases. In the absence of disease agents, there can be no threat from diseases. A second, but still important, consideration involves control and eradication after pathogens have been detected. Consideration must also be given to the development of regional disease control measures that will achieve the necessary control, to moderation of direct and indirect impacts on industry, and to assessment of the cost of administration and enforcement activities. Resolution of conflicts and generation of public acceptance for disease control regulations will require co-operative effort and understanding if the proposed measures are to achieve their objectives.

Implementation of regulatory options can have negative as well as positive effects. On the negative side are the costs of services for administration, enforcement, and inspection of facilities and disease diagnostics: trade disruptions; the need for indemnification and insurance programs when eradication and rehabilitation are involved; and the potential for litigation. Alternatively, well-planned regulatory programs increase awareness of fish health considerations and provide assurance to new and expanding fish culture enterprises. They can generate confidence in stocks originating from disease-free operations and expand the market potential for products. Finally, they set an example which can be emulated by others, contributing to the overall improvement in fish health status.

The planning, design, implementation, evaluation and updating of controls are important components in the use of regulatory options, and it is logical that these procedures should be undertaken sequentially as described below.

STEP ONE: REVIEW OF Activities FOR POTENTIAL DISEASE RISKS

Opportunities for the introduction and dissemination of communicable diseases are always present in salmonid culture programs undertaken in the Great Lakes region. Potential hazards exist in what might otherwise be considered routine hatchery procedures, and it is important that the potential disease impact of these activities be understood and acted on.

1. Transportation of Fish

The movement of fish stocks from one region or country to another has been recognized as one of the major factors involved in dissemination of diseases. This applies to transfers of wild, as well as cultured, fish because wild fish also can be carriers of disease agents.

In the context of the Great Lakes, communicable diseases of salmonids could be transmitted when:

- a. Eggs, juveniles or broodstock are imported from sources outside the Great Lakes watershed to support hatchery production programs;
- b. Stocks at any stage are transferred between hatchery facilities within a state/province or between regions;

- C. Hatchery-reared fish are released into rivers and lakes to create fisheries or to enhance natural production of wild stocks.

The basic premise in most controls on movements of fish is to apply the principles of risk management and to permit transfer only of those stocks that are considered free of specific fish pathogens. Uncontrolled traffic of salmonids into and within the Great Lakes basin would present a high level of risk for the introduction and dissemination of communicable diseases.

2. Introduction of Exotic Fish Species

The impacts of introducing non-indigenous fish species into new waters have been well documented (Courtenay 1973; Regier 1968; Vooren 1972) and include the potential risk of transferring diseases with exotic species. "Introduction of a pathogen via transplants of an exotic species to an area where evolutionary adaptation and partial immunity have not been acquired among native stocks, has the potential to destroy native populations. Conversely, the success of the planned introduction of an exotic species could be limited by the impact of local diseases on the introduced stocks" (Anon 1979). Other factors that must also be considered when introducing exotic species include competition with indigenous species, habitat destruction, genetic implications, and assessment of the commercial value of the introduced exotic species with its potential impact on indigenous species and the environment.

Coho, chinook, and pink salmon, and steelhead trout have all been introduced to the Great Lakes basin in recent years and several species have established naturally spawning populations. Coho and chinook salmon depend on artificial propagation for recruitment, and their populations are controllable to some degree. With fisheries managers continually striving to expand and diversify fisheries to meet increasing demands from recreational and commercial fishermen, the tendency is to search for additional new species and sources of broodstock that might result in improved fisheries. Strict regulatory control and detailed assessment of the impact of introductions of exotic species are therefore desirable to minimize the potential risk of introducing and disseminating communicable fish diseases through this avenue.

3. Emergency Disease Outbreaks

If regulatory measures are promulgated to control the movement of fish stocks, the introduction of disease agents could still occur. If serious fish diseases are involved that could threaten cultured and natural fish stocks, and that have not been recorded in a region or country despite extensive surveys, they could be considered as "emergency" diseases.

Prompt eradication of a disease can be used to prevent further dissemination to new areas. Speed of action is an essential factor if eradication procedures are to be effective. This depends largely on the degree of planning and preparation that precedes the outbreak of an emergency disease, and on the cooperation and collaboration that can be generated at short notice.

Important considerations that should be examined when developing regulatory programs for the eradication of emergency diseases include

naming of the diseases and their causative agents, responsibility for coordination and decision-making, establishment of quarantine zones, assessment of potential success of eradication procedures, post-eradication monitoring to determine success, availability of replacement stocks, and compensation for losses (indemnification) suffered by the private sector. These factors require input from and supervision by skilled professionals, and the overall costs of eradication procedures and indemnification should not be under-estimated.

A recent example of the introduction and spread of what might be classified as an emergency disease was documented for *Myxosoma cerebralis* (whirling disease) by Hoffman (1970) in the U.S.A. This disease, which can cause high mortalities during the early life cycle of certain salmonid species, has now been recorded in the Great Lakes states of Michigan, Ohio and Pennsylvania, having been first introduced to the U.S.A. in 1956. Although whirling disease does not lend itself easily to normal eradication procedures, such as the destruction of stocks and disinfection of facilities, these measures, together with establishment of quarantine or buffer zones, could have slowed or prevented dissemination of the disease as widely as it is now recorded.

4. Production and Use of Biologics

The use of biologics, specific antisera, and vaccines for pathogen identification and control of fish diseases has increased as the aquaculture industry has expanded. Use of non-indigenous pathogens for research and live vaccines are also potential hazards for spreading communicable diseases. Regulatory mechanisms and procedures for the control of similar biologics are already well-developed in the agricultural and human health sectors, and can be used as models for developing appropriate controls for biologics related to communicable fish diseases.

5. Other Hazards

Although not related directly to communicable diseases, interventions by government agencies should be considered for control of the production and use of chemotherapeutics in fish feeds. Routine inspection and certification procedures, and requirements for labelling and efficacy and safety testing of these products should be part of any fish health protection program affecting the Great Lakes region.

STEP TWO: QUANTIFICATION OF RISKS AND ASSESSMENT OF IMPACT OF INTERVENTIONS

The objectives of any intervention to control communicable diseases should be to minimize risks at the least cost and to create as little disruption of the industry as possible. Control measures should be workable, acceptable and implementable within the constraints of budgets, manpower allocations and existing technology, and should focus on those activities that present the greatest degree of risk.

Not all activities of concern present the same degree of risk for introduction and spread of communicable diseases. The risk of transferring diseases is lowest in dead fish destined for the consumer market. In live organisms, egg stages present the least risk, especially since procedures have been developed for

treatment of broodstock and disinfection of eggs to reduce the potential for vertical transmission of disease from brood stock to progeny. The greatest risk, on the other hand, occurs in the transfer of broodstock because stresses of sexual maturation significantly increase the possibility of disease.

Fish that are known to be carriers of disease agents need not necessarily exhibit overt signs of disease. Bacterial kidney disease, for example, might be detected in very low incidence in the carrier state at a hatchery yet the facility may never experience an epizootic (M. Campbell, Canada Department of Fisheries and Oceans, Halifax, N.S., personal communication). Similarly, many wild fish are carriers of pathogens that will only cause an epizootic if the fish are held in a stressful environment. Consideration should be given, then, to whether control measures must be applicable to carriers of the diseases as well as those in which overt signs have been found.

Different species of fish are more disposed to infection by certain disease agents than others. Enteric Redmouth Disease, caused by *Yersinia ruckeri* is more prevalent in rainbow trout than in any other salmonid species. On the other hand, furunculosis has been detected in a wide-range of hosts from cold, cool and warm waters and measures to control this disease would have to apply to more than just a few target species.

A primary requirement for quantifying risks of disease introduction is the need for an extensive and detailed data base in the geographical region of concern. A considerable body of knowledge on disease distribution has been developed in the Great Lakes region by state, provincial and federal fish pathologists. In addition, sensitive diagnostic protocols are available and disease control procedures have been developed. This provides a strong base for developing programs considered necessary for controlling communicable diseases in the region.

In assessing the impact of potential disease control interventions, consideration must be given to the state of development of the aquaculture industry, its economic importance, and aquatic resource usage. These factors can influence decisions on whether controls are necessary at all, and on the types of interventions required to control communicable diseases.

When information on potential disease threats has been analyzed and quantified, long-term projections can be prepared to anticipate where the risks of disease exposure are greatest and what types of control options are available, if needed. The distribution of pathogens of concern can be mapped, disease-free zones established, and control measures can be formulated which reflect the concerns of fish culturists and other users of the aquatic environment.

STEP THREE: MECHANISMS FOR **REDUCING** PERCEIVED RISKS

A. GENERAL PRINCIPLES

The need for controls to prevent the introduction and dissemination of communicable diseases is not disputed. The dilemma is to decide on the degree of control required and to select an appropriate strategy to achieve the desired results. It is also important to ensure that there is good communication between public and private sectors, to develop a common perception and knowledge of the problems to be addressed, and to formulate interventions that are equally applicable to public and private fish culture programs and operations.

Some of the alternative interventions that can be made for disease control include bans, zoning, and establishment of quarantine areas and facilities. Bans can control factors such as the movements of fish and use of drugs, although their benefits are most apparent when used as interim measures to react to unforeseen or emergency situations. As a long-term option, bans are restrictive and rigid, and reduce the potential to provide flexibility needed for growth in a diverse aquaculture industry.

The concept of zoning is well recognized in the agriculture sector as a means of controlling the spread of animal and plant diseases. This is based on the variable distribution of diseases that are found in some areas and not others. Thus, there is little risk of transferring a specific disease if animals or fish are moved from one clear zone to another. The zoning concept is equally applicable to fish diseases, provided that there is an adequate history of testing for disease prevalence on which designation of disease-free zones can be based.

Quarantine procedures, used to control the introduction of diseases, involve retention of newly-imported fish stocks in quarantine facilities for prescribed periods to ascertain whether they are carriers of disease agents. This strategy is most relevant for controlling communicable diseases that have never been recorded in a country or region, and requires use of sophisticated holding facilities with capabilities for total disinfection of any effluents. Adoption of this principle places a heavy cost burden on the regulating agencies for the construction and maintenance of quarantine facilities, and is most appropriately used for special situations such as introduction of exotic species.

B. CONTROL OF FISH DISEASES IN THE GREAT LAKES BASIN

The mechanisms that have been used for implementing controls related to communicable fish diseases in the Great Lakes basin are summarized below:

1. Guidelines

Within the Great Lakes region, the use of voluntary compliance to guidelines is best exemplified in the Great Lakes Fishery Commission's model fish disease control program (Appendix III). This program relies on voluntary adherence to guidelines related to traffic in eggs and fish, releases of fish, and routine monitoring of diseases in government fish culture facilities within the Great Lakes basin. The guidelines are designed to reduce the risk of introduction and spread of diseases within the basin.

Similarly, formation of the Great Lakes Private Fish Health Protection Cooperative represents a new initiative to control fish diseases within the private sector. This Cooperative has allied itself with the Great Lakes Fish Disease Control Committee, and will endeavor to use guidelines to control communicable diseases of concern in the region. Representation of the Cooperative on the GLFDCC will also lead to improved communication and understanding with respect to disease control problems and help direct effort towards common goals.

2. Policies

For example, in 1977 the Ontario provincial government reaffirmed its long-standing position that no importation of salmonids would be allowed for commercial purposes. A major consideration in this stance was the prevention of

introduction and spread of communicable fish diseases. Only special lots of salmonids have been imported since then for research purposes, when appropriate disease control safeguards have been incorporated in the holding facilities.

3. Statutes

In the U.S.A., national regulations have been promulgated (Title 50) pertaining to the control of communicable fish diseases, requiring that all salmonids imported into the country be certified free of whirling disease (*Myxosoma cerebralis*) and viral hemorrhagic septicemia (VHS). The degree of regulation related to communicable diseases in individual states in the Great Lakes basin varies considerably according to the perceptions and understanding of respective disease risks by the several state fishery agencies.

In Canada, Fish Health Protection Regulations implemented in 1977 apply to the importation of salmonids into the country as well as to their shipment between provinces. These regulations were designed to prevent the introduction and spread of infectious salmonid diseases through inspection of production sources of fish stocks (rather than individual shipments of fish), and to control the movement of infected fish stocks. Complementary to these regulations, a Manual of Compliance was prepared to provide guidelines for producers; to explain the roles of administering officers and inspection officials; and to outline the sampling, handling, and diagnostic procedures that constitute inspections leading to certification (Anon 1977). These "national" regulations governing movement of salmonids are supplemented by provincial regulations in Ontario which deal specifically with the introduction and transfer of fish stocks within that province.

STEP FOUR: EVALUATION and IMPROVEMENT of CONTROL MEASURES

An important aspect of administering interventions to control communicable diseases is to establish mechanisms for evaluation of the success of measures implemented. Active feedback and assessment of effectiveness provide the basis for modification and improvement of controls and provide an opportunity for the identification of new risks. It is also desirable to provide mechanisms for regular communication between private and public sectors to stimulate discussion and mutual understanding of disease concerns.

These functions can be provided by individuals or groups of people designated as focal points to coordinate regular review and evaluation of interventions. In the context of the Great Lakes, the Great Lakes Fish Disease Control Committee and the Canadian National Registry of Fish Diseases undertake the functions of review and evaluation of the effectiveness of control measures. These institutions collect, collate, and distribute verified information and regularly evaluate the Great Lakes model fish disease control program and Fish Health Protection Regulations, respectively. In addition, by taking advantage of their central status related to fish health concerns in the basin and the information they receive, they are able to:

1. Maintain a close watch on the geographic distribution and incidence of diseases, and to assess their biological and economic impact:
2. Serve as a coordinating center in the event of fish health emergencies:

3. Identify and evaluate new risk situations for the introduction and dissemination of communicable diseases;
4. Provide periodic reports, analyses, and assessments on the state of fish health in their respective regions/jurisdictions;
5. Provide health histories of sources of live fish and eggs;
6. stimulate and support research related to fish health and disease control.

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