INTRODUCTION

T.G. CAREY
Department of Fisheries and Oceans
Ottawa, Ont.

and

D.B. GOLDTHWAITE
U.S. Department of the Interior
Fish and Wildlife Service
Newton Comer, MA

Fish culture has assumed increasing importance in North America as an alternative strategy for increasing production from the aquatic resource. Coincidental with the expansion of culture activities has been an increase in the incidence and spread of fish diseases which, in turn, stimulated extensive related research and surveys. Publications are currently available that describe the distribution of many fish disease agents, disease detection and identification procedures, fish pathology, and treatment methods (Amlacher 1970; Davis 1953; Mawdesley-Thomas 1972; Roberts 1978; Roberts and Shepherd 1974; Snieszko 1970; Van Duijn 1973; Warren 1981). However, the subject of planned programs for the reduction of risk exposure to diseases, as a specific approach for improving fish health, has not been adequately covered in the literature.

The purpose of this "Guide to Integrated Fish Health Management in the Great Lakes Basin' is to create an awareness on the part of fish culturists and administrators of the benefits of implementing continuous, integrated disease control procedures rather than reacting to disease problems as and when they arise. Information is presented in the Guide on important factors that contribute to the introduction and dissemination of fish diseases, and the measures available to reduce the risks of disease exposure.

The Guide is sub-divided into six parts, including sections on The Fish Health Management Problem (Part I), Disease Control Options in Hatchery Management (Part II), Administrative Options in Disease Control (Part III), and Integrating Fish Health Management Options (Part IV). For reference purposes, information on fish diseases of concern in the Great Lakes region is provided

(Part V), as well as scientific terms, common and scientific names of selected fish species, training needs (Part VI), and details of the Great Lakes Model Fish Disease Control Program.

In Part I, The Fish Health Management Problem, clarification is provided on the actions, reactions and interactions of the host/pathogen/ environment complex in fish culture, and the delicate balance that must be maintained between these factors if disease outbreaks are to be avoided. No single approach to providing good health can be effective on its own. Steps must be taken to prevent stress in the host, to provide an environment that is more favorable to the host than to the pathogen, and to prevent introduction or to reduce the density of pathogens. The importance of pre-planning to integrate these actions into a comprehensive program for individual fish culture operations is emphasized.

Communicable fish diseases are generally concentrated in or close to fish culture operations, thus, efforts to reduce or eliminate the incidence of diseases should focus first on these sites. Fish culture, in the context of this Guide, includes all strategies involving confinement of fish in aquatic ecosystems and ranges from extensive culture (close-to-natural environment) to intensive systems characterized by specialized rearing facilities, high stock densities, use of artificial feeds, and partially or wholly controlled environments.

Part II of this Guide provides a range of options available to producers, individual hatchery managers, or program administrators for reducing the risk of exposure to diseases in fish culture facilities. For each option, information is provided on the purpose of the action, what goals can be achieved, the basic facilities and equipment required, and a general assessment of the effectiveness of options in different situations. Subject areas relate to disease prevention, disease control, and eradication of disease.

In Part III, Regional Control of Communicable Diseases of Fish presents broader strategies for reducing risk of introduction and spread of fish diseases, offering approaches that are regional, state/provincial, or national in scope. Control measures described take into account the threat of disease to natural as well as cultured populations, and serve to protect innocent parties and good operators who have developed high hygiene standards. Reference is made to accountability for fish health protection at different levels of administration, and regulatory mechanisms available for control of communicable diseases are described.

Part IV, Synthesis of a Fish Health Management Program, provides the basis for, and explains the importance of, integrating fish health management with all other fish culture activities to maximize health protection. It also identifies the parallel between integrated fish health management and integrated pest management in agricultural science and stresses the need to coordinate all control methods into a unified program directed at optimal control.

Finally, because the field of fish health encompasses a wide range of biological and technical disciplines, three Appendices and a Glossary have been included to identify sources of training and information, to describe the Great Lakes Fish Disease Control Program, to clarify scientific terms, and to list the scientific and common names of fish species referred to in the text. Names of fishes used in the text are the accepted common names in North America.

Mention of drugs or chemicals in this volume does not constitute recommended use. Readers should always follow recommendations on the product

label. If the desired use is not specified, the Food and Drug Administration should be contacted before a product is used. Likewise, the use of brand names or model numbers does not in any way constitute recommendation or endorsement of any products or equipment.

SOME IMPORTANT INFECTIOUS DISEASES OF SALMONIDS

Severe epizootics among salmonid fishes can be caused by a variety of physical, chemical, and biological disease agents. Although the importance of physical and chemical agents cannot be disregarded, these are seldom a problem in fish cultural facilities with adequate and reliable water supplies. Biological agents of infectious disease include viruses, bacteria and parasites, each of which presents complex and challenging control problems in the Great Lakes basin.

According to Wolf (1972), fish viruses fit the known patterns established for animal virology in general. They cannot be seen by the light microscope, require a living cell in which to replicate, and, for the most part, are unaffected by therapeutic drugs and chemicals used to control bacterial and parasitic diseases of fish. Infectious pancreatic necrosis (IPN) has been diagnosed in several locations in and around the Great Lakes basin and, at present, is the only important viral disease of salmonids known to be established in the basin. Infectious hematopoietic necrosis (IHN) has occurred at isolated locations in Minnesota and New York, but neither of these cases were located within the Great Lakes basin and both outbreaks were eradicated. IHN continues to be a persistent, serious problem on the West Coast of North America. Viral hemorrhagic septicemia (VHS) has not been reported in North America but causes serious economic impact on trout producers in Western Europe. IPN and IHN infections cause serious losses of fry and fingerlings, VHS can cause heavy mortalities among older fish. Both IPN and IHN can be spread through the shipment of contaminated eggs taken from virus-carrying adult spawners. Viral hemorrhagic septicemia may also be egg-transmissible, but it is spread primarily through the transfer of carrier fish and possibly through the shipment of frozen fish. Avoidance is the best procedure for minimizing the threat of viral diseases.

Bacterial diseases have long been a source of serious problems for cultured salmonids. External infections, like those caused by gill disease bacteria, are common and often costly. Columnaris disease, caused by *Flexibacter columnaris* can occur as a superficial external problem and as a systemic infection. Both forms of columnar-is may require antibiotic therapy for control in certain cases. Furunculosis, a disease caused by *Aeromonas salmonicida* is commonly associated with less than ideal environmental conditions for the cultured fish stock. Enteric redmouth (ERM), caused by *Yersinia ruckeri,* is a new problem in the Great Lakes basin. Its spread has been traced through the introduction of carrier fish from Idaho where the disease is well established. Bacterial kidney disease (BKD) remains a particularly insidious bacterial infection because it can be transmitted with eggs from infected adults, cannot be effectively controlled with antibiotics, and often does not become apparent until the affected fish are more than a year old. Each of these diseases presents significant control problems, some of which defy prompt solution.

Two parasitic diseases of salmonids are designated for special consideration in the Great Lakes basin. Whirling disease, caused by *Myxosoma cerebralis,* has

been a major concern since it was first detected in Michigan in 1968. It remains a potentially serious problem but, thus far, it has been effectively confined to certain watersheds of Michigan's lower peninsula. *Ceratomyxa shasta* is a serious problem at some trout and salmon facilities on the West Coast of North America. It has not been detected in the Great Lakes basin.

Other important viral, bacterial and parasitic diseases of cultured fish can be more troublesome than those listed here. The listed diseases, however, have been identified by the conservation agencies in the Great Lakes area for specific prevention and control efforts. Specific information is provided on these diseases later in this compendium and mention will be made of these diseases when describing various options for dealing with the particular disease.

REFERENCES

Amlacher, E. 1970. Textbook of fish diseases. D.A. Conroy and R.L. Herman (trans.). TFH Publications, Inc., Neptune City, NJ. 302 p.

Davis, H.S. 1953. Culture and diseases of game fishes. Univ. of Calif. Press, Berkley, CA. 332 p.

Mawdesley-Thomas, L.E. (ed.). 1972. Diseases of fish. Academic Press, London. 380 p.

Roberts, R.J. 1978. Fish Pathology. Balliere Tindall, London. 318 p.

Roberts, R. J., and C. J. Shepherd. 1974. Handbook of trout and salmon diseases. Fishing News Books Ltd., Surrey, England. 168 p.

Snieszko, S.F. (ed.). 1970. A symposium on diseases of fishes and shellfishes. Am. Fish. Soc., Spec. Publ. No. 5. Bethesda, MD. 526 p.

Van Duijn, C. 1973. Diseases of fishes. Charles Thomas, Springfield, Il. 372 p,

Warren, J.W. 1981. Diseases of hatchery fish: a fish disease manual. U.S. Fish and Wildlife Service, Twin Cities, MN. 91 p.

Wolf, K. 1972. Advances in fish virology: A review 1966-1971, p. 305-331. In L. E. Mawdesley-Thomas, (ed.). Diseases of fish. Symp. Zool. Soc. London, Symp. No. 30. Academic Press, New York, NY.