REPORT OF THE EVALUATION OF THE GREAT LAKES FISHERY COMMISSIONS'S PROGRAM OF SEA LAMPREY BARRIER DAMS

(With Appendices)

JANUARY 1988

Great Lakes Fishery Commission

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EXECUTIVE SUMMARY

The Great Lakes Fishery Commission established a Task Force at its annual meeting in May 1984 to evaluate the sea lamprey barrier dam program The objectives of the Task Force were a) to evaluate the effectiveness of the sea lamprey barrier dam program from both a biological and economic perspective, b) to identify successes and shortcomings [illegible] make recommendations concerning further development of barrier dam for management of sea lampreys throughout the Great Lakes.

A total of 30 sea lamprey barrier dams has been installed or modified: 20 in Ontario, 7 in Michigan and 3 in Wisconsin. Most of the barriers are relatively small low head dams located on stream with a mean discharge < 3 m^3/s (107 cfs). These dams are designed to block ~trap~~-~sea lampreys, but pass jumping salmonids. Features commontomstdan-s include a drop in water elevation of at least 45 cm (18 in) during the period of lamprey migration, an overhanging lip, lamprey trapping capability, and a jumping pool to pass salmonids. Larger barrier dam have been installed or modified on 7 larger tributaries (mean discharge > 3 m^3/s) and 3 have incorporated fishways to facilitate passage of migratory salmonids. Other works undertaken as part of the barrier dam program include modifications to natural water falls and a road culvert, and the addition of lamprey traps to a flood control weir.

Administration of the prcgramisdifferentinthetwo countries. In the U.S., the Commission holds the funds and provides financial assistance through a grant application and approval process to individual state agencies who construct barrierdams. In Canada, the funds are held by the Canadian Agent for the Commission and are used by the Sea Lamprey Control Centre in Sault Ste. Marie to implement the barrier dam program. In Canada, barrier dam under&kings are centralized in one office and an engineer is on staff to coordinate design and construction. During fiscal years 1978 to 1986, $2,549,900 U.S. and $1,204,300 Canadian were allocated to the lamprey barrier dam program. The U.S. and Canada have spent 41% and 87% of these funds, respectively.

Liability for personal loss or injury at barrier dams is a serious concern and signs should be posted at each site to warn the public of the dangers associated with dam. Although vandalism at barrier dam has not been a serious problem, it can be minimized by stress- security at those barriers with removable devices (stop logs, fish gates) and by posting signs at barrier dam to explain their purpose. A much greater concern is the possibility of modification or removal of many of the private and local public dams around the Great Lakes built over the years for other purposes, but which are impomt in stopping spawning sea lampreys. This is of particular concern because many of the owners have no inkling of the importance of their dams for sea lamprey control.

The criteria used to select streams and sites on streams for barrier dam installations are similar in the two countries. In Canada, however, lamprey barrier dam are generally placed closer to the stream mouth than those in the U.S. This appears to be the result of the availability of suitable sites. There is concern that barriers placed too close to the mouth of certain streams may either foster the development of larval lamprey populations off-shore, or may become ineffective with higher lake levels. Many barrier dams in Canada use built-in

traps to capture spawning sea lampreys, whereas most in the U.S. employ portable assessment traps. It is unknown which trap design is more efficient. Most U.S. barrier dam have devices to permit drawdown, whereas those in Canada do not. There is concern that the drawdown devices may be tampered with and result in the passage of spawning-phase sea lampreys.

Sea lamprey barrier da~~ have proven successful in blocking the migration of spawning-phase lamprey. Barriers have become an integral part of sea lamprey management, being particularly useful in streams where chemical control is difficult or inefficient. Barriers with traps have an added benefit of removing spawning lamprey from the population because of their fishing-up capability.

Lamprey barriers, ingeneral, arebeneficial in economic terms. They have a net benefit-cost ratio of 3 to 1.

Lamprey barriers reduce the length of stream requiring treatment and consequently not only reduce the dependency on chemical, but also provide a savings in application and chemical costs. Three tributaries, the Saugeen, Salmon, and Stokely required no further chemical treatment following barrier dam construction.

The major adverse effects of lamprey barrier dam are the blockage of non-taqetfishspecies and the impairment of aesthetics. Although lamprey barrier dams can be designed to pass successfully most jumping salmonids, barrier dams may still delay their runs. Lamprey barriers also block forage fish and runs of non-jumping sport fish such as walleye, bass, and northempike.

Shortcomings of the lamprey barrier dam prqramareas follows:

1) no information on the effects of delaying and blocking non-target fish species at lamprey barriers,

2) lack of techmlogytopassnon-jumping fish over barriers,

3) little or no evaluation of various designs for building the minimum sized structure for blocking and trapping lamprey with minimal environmental disruptions,

4) limited experience for building barriers on moderate and large rivers,

5) little mechanism for the two countries and the individual states and province to develop a team approach for designing barrier dams,

6) lack of communication with other owners of dam that block lamprey, and

7) no cost-accounting of expenses orbenefits of operating barrier dams.

Recommendations for a more effective program include the following:

1) developthetechnolcgytopksnon-jumping fish at barrier dams,

2) detennine the impacts on populations of non-target fish species, blocked by lamprey barriers,

3) undertake pre- and post-impoundment studies for dam planned for larger rivers to detenune their impacts on fish passage, stream biota and water quality,

4) develop an experimental facility for testing improved barrier dam designs and more efficient lamprey trap,

5) compare the capture efficiency of presently used lamprey traps at barrier dams, and if required design more efficient traps,

3) determine the effect of lamprey barrier dams on larval lamprey populations foundoff-shore,

7) develop a more cooperative team approach to designing barrier dams and solving specific problems. To facilitate this team approach, it is recommendedthat:

a) the U.S. take full advantage of the Canadian Agent's engineering services for designing barrier dam,

b) aworkshopbe held annually to exchangeinformation,

c) the U.S. appoint a person to coordinate the barrier dam program among the individual states.

If these actions do not result in a more cooperative approach within 3 years, then,

d) a Technical Overview Ccarrmittee should be established to revi~each new barrier dam prcposal.

8) insure adequate funding to maintain the present level of activity, undertake needed d~~~~~rk,and~theprogramtOstateSand other resource managment groups (e.g. Indian tribes) not presently participating,

9) State of Michigan should retain a contract engineer to complete approved barrier dams,

10) each level of government should evaluate its potential liability and insurance protection for personal injury or loss at barrier dams,

11) the Commission should send a letter to owners of non-Commission funded dams asking them to consult with the control agents before undertaking modifications or removals,

12) individual states and province should develop a policy, whereby approval to rebuild or modify a dam which now blocks spawning-run sea lamprey migration, is contingent on maintaining them as harriers to sea lamprey,'

13) individual states and province should incorporate, where possible, lamprey barriers into dams and structures that are being built for other purposes.

14) all lamprey barrier proposals should include an improved economic evaluation,

15) all agencies operat~and~~intainingl~~ybarriersshouldimplementa cost-accounting of expenses and benefits for each barrier.

INTRODUCTION

The sea lamprey population in the Great Lakes is dependent upon reproduction which takes place in only about 430 of the 5,750 tributaries entering the Great Lakes. The Great Lakes Fishery Commission recognizes that barriers, natural or man-made, play an important role in restricting the potentidl spawning area used by sea lampreys in rivers of the Great Lakes Basin. Consequently, the Commission regards construction and maintenance of barriers as an important supphnentto lampricides in the development of an integrated sea lamprey manag~tprcgram

Although some actions were taken in earlier years to block spawning lampreys in some rivers, the Commission intensified this phase in the mid 1970's, and in June 1977 adopted a policy statement (Appendix 1) and guidelines (Appendix 2) for the use of Commission funds for construction, modification, and maintenance of dams designed as barriers to sea lamprey spawning migration.

Through fiscal years 1978 to 1986, the Commission allocated about $2.5 million U.S. and $1.2 million Canadian for barrier dam related activities including planning, construction, and maintenance. Expenditures to September 30, 1986 have been a little over $1 million each for the U.S. and Canadian program. Thirty barrier dams have been modified or constructed to date: 20 in Ontario, 7 in Michigan, and three in Wisconsin, although 7 of these were completed prior to specific funding of the program in 1978.

E&cause of the high capital cost of the program which is expected to continue over the next decade or more, as well as concerns about blocked fish passage and effectiveness of barrier dams, the Commission considered it timely to evaluatethe barrier dam program for its administrative, biological, and cost effectiveness. At the Commission's annual meeting in May 1984, a Task Force was authorized and funded to conduct this evaluation and Terms of Reference (Appendix 3) were approved in September 1984. The objectives of the Task Force were to evaluate the effectiveness of the barrier dam program from both a biological and economic perspective, to identify successes and shortcomings, and make recommendations concerning further devel-t of barrier dams for management of sea lampreys throughout the Great Lakes.

The membership of the Task force consisted Of: Bernard Griswold (Co-Chairman), U.S. Fish and Wildlife Service; Raymond Biette (co-chairman), Ontario Ministry of Natural Resources; Jim Seelye, U.S. Fish and Wildlife Service; Jim Tibbles, Department of Fisheries and Oceans; Donald Reynolds, Michigan Department of Natural Resources; Paul Rugen, U.S. Fish and Wildlife Service; and Aarne Lamsa, Great Lakes Fishery Commission.

The Task Force obtained information on thevarious elements of the program from reviewing existing documents, by interviewing representatives of the various agencies involved with the program, and by visiting most of the barrier dam sites. This is the final report of that Task Force.

BACKGROUND INFORMATION ON EXISTING DAMS

A total of 30 structures has been constructed or modified as barriers to sea lamprey migration to September 30, 1986. Ten are on tributaries to Lake Huron, 9 are on tributaries entering Lake Superior, 7 are on tributaries to Lake Ontario and 4 are on tributaries to Lake Michigan. The location of these barrier dams is shown on the map in Appendix 4. An information matrix on the 30 structures, showing the location, year constructed and/or modified, the type of dam, and special features is provided in Appendix 5. A photograph of eachbarrier site is sham in Appendix 6, except for the East Twin River (Lake Michigan, Wisconsin), the Still River (Lake Huron, Ontario) and the natural barriers on the French and Manitou Rivers (Lake Huron, Ontario). In addition, design drawings for a few lamprey barrier dams are shown in Appendix 7 to illustrate some of the features.

The first sea lamprey barrier dam was constructed in Canada in 1969-70 on the Saugeen River, a large tributary to Lake Huron. This was a multi-purpose facility built to block upstream migration of lampreys as well as to provide a recreational area. The barrier incorporated a trap to remove spawning lampreys and a fish ladder to facilitate the passage of salmonids. This large dam, 180 m (600 ft) long with a 2.7 m (9 ft) drop (weir crest to pool surface) was built by the province and the costs were shared egually by the federal and provincial governments. The dam has not only been effective in blocking lamprey migration, but it also provided useful information on trapping spawning lampreys and passing salmonids. In addition, there has been no successful sea lamprey spawning below the dam and consequently chemical treatment on this river is no longer necessary. The historical perspective of this first lamprey barrier dam is described further in the remarks presented by J.J. Tibbles at the official opening of this structure (Appendix 8).

The second sea lamprey barrier dam constructed in Canada was in 1971 on the Echo River (Lake Huron). This dam has a 1.9 m (6 ft) drop and is constructed with timber cribs filled with rock. A heavy wire mesh screen was embedded into the river bottom on the upstream face to blockmigrating sea lampreys. Because this barrier has been only partially effective in blocking lampreys, it was replaced in 1986 with a new low head barrier with a built-in trap.

In Canada, four other earlier works to block sea lampreymigrations included the following:

1) in the early 1950's the placement of an overhanging lip, by the province, on a road culvert on Harris Creek (Lake Huron),

2) in 1966 the modification and in 1968 the repair, by the province, to an existing provincial dam on the Black Sturgeon River (Lake Superior) following an extensive washout,

3) in 1969-70 the blasting of natural waterfalls on the French River (Lake Huron),

4) in 1974 the modification of an old mill dam on the salmon River (Lake Ontario).

Since 1978, when the Commission intensified the program, work on 14 lamprey barrier dams has been undertaken in Canada. All of these barrier dams, except for the credit River (Lake Ontario) and Humber River, (Lake Ontario) are on small stream, mean disdarge less than 3 m^3/s (107 cfs), and are termed low head barrier dams (Appendix 5). The dams are constructed of either concrete or sheet piling and include a jumping pool to facilitate the passage of salmonids. Low head barrier dams are designed to create a 45 cm (18 in) drop at flaws expected during sea lamprey migration and these dams may be inundated during floods. The designhas evolved over time and most contain a built-in trap to catch spawning lampreys. Traps, however, were not included in the earlier structures built on the Sturgeon River (Lake Huron) and Gimlet River (Lake Superior). There is also no lamprey trap on the Sheppard Creek dam (Lake Superior) because road access to this structure is limited and servicing of the trap would be impractical. In recent designs, additional features have been incorporated to facilitate the passage of salmonids and forage fish. Thesefeatures will be discussed under Design Criteria.

In addition to the construction of low head barrier dams, there has been the reconstruction in 1980-81 of an existing mill dam on the Credit River (Lake Ontario) and the incorporation of lamprey trap to a flood control structure in 1980-81 on the Humber River (Lake Ontario).

The first sea lamprey barrier undertaken in Michigan was an experimental barrier, constructed by the Department of Conservation and operated in 1951 through 1957, on the Black River, a tributary to Lake Michigan. The dam was constructed of wood with the exception of a 23 can (9 in) radius half circle steel lip placed on the crest of the dam to block lampreys. Results from this early work showed that a minimum head of 60 cm (23.6 in) with an overhanging lip was necessary to provide a barrier to spawning-run sea lampreys in the Great Lakes (Stauffer, 1964). subsequent studies, however, have shown that a lower head (45.7 cm, 18 in) is sufficient to stop sea lamprey migrations (Hunn and Youngs, 1980).

The first permanent sea lamprey barrier dam built in Michigan was the replacement in 1974 of an old hydra-electric dam on the Betsie River (Lake Michigan) using Anadromous Fish Conservation Funds. This is a steel sheet piling structure 1.8 m (6 ft) high with a permanent crest and a jumping pool to provide fish passage.

Six other barrier dams have been built in Michigan since 1978 with Commission funds (Appendix 5). These are on small to moderate sized streams with discharges ranging from 0.56 to 9.8 m/s (20 to 350 cfs). All the structures have a design crest of 45.7 cm (18 in) above the average April-May flow, except the Miners River (Lake superior) which has a design crest of 45.7 an (18 in) above the 10 year flood. All are concrete structures with various devices to permit drawdown to normal stream levels, except the West Branch Whitefish River (Lake Michigan) which has a permanent crest. Jumping pools are provided on all structures to facilitate fish passage as well as water control gates or stop logs to provide attraction water forportable assessment trap.

The East Branch AuGres lamprey barrier (Lake Huron), built in 1983, was designed to permit crest adjustments from a base level set at 30.5 an (12 in) above the April-May flow to a maximum of 45.7 cm (18 in) above the 10 year flood flow. Two stop log bays permit drawdown to normal stream level. Fish passage problems developed and modifications were completed in 1986 to resolve the problem. These

modifications included wnstruction of a steel sheet piling coffer dam downstream from the barrier to elevate tailwater level 0.3 m (1 ft), and construction of a jumping pool in the area of the two stop log bays.

The newest variable head lamprey barrier was constructed on Albany Creek (Lake Huron) in 1985. This structure wnsists of concrete wing walls and sill, with a hinged steel plate serving as the barrier. Adjustment of the height of the barrier is accomplished with a cable system and manual winch. This mechanism provides unlimited barrier crest adjustment from the design height tosilllevel.

The three lamprey barrier dams undertaken in Wisconsin are

1) a modification in 1978 to an existing dam on the East Twin River (Lake Michigan), a relatively small river (mean discharge 1.68 m^3/s; 60 cfs), and subsequent repairs in 1983;

2) the construction in 1983 of a low head barrier dam with a jumping pool and portable lamprey trap on the Middle River (Lake Superior), mean discharge 1.12 m^3/s (40 cfs) and;

3) the wnstruction in 1984 of a larger structure with jumping pools and portable lamprey trap on the Brule River (Lake Superior), mean discharge 5.32 m^3/s (190 cfs), and its replacement in 1985 with a dam inwxporatinga fish ladder with a built-in lamprey trap and abservationchambr.

There are four points that should be noted.

1) Nineteen of the 30 barriers (64%) were urdertaken during the last 6 years (1980-86), 9 (30%) were undertaken during 1969-79, and 2 (6%) were developed prior to 1969.

2) No barrier dams have been built on tributaries entering Lake Erie. However,some are proposed for the near future.

3) Only two states, Michigan and Wisconsin, and the province of Ontario, have built barrier dams. This, in part, is as expected because these states and Ontario have the most lamprey producing streams. New York, however, is presently planning to participate in the barrier dam program. Nevertheless, all tributaries in the other states should be evaluated for thepotentialof controlling sea lamprey populations with barrier dams.

4) The 30 sea lamprey barrier dams built to date aanprise only 10% of the natural barriers, old mill dams, culverts, and other water control facilities known to limit stream habitat available to sea lamprey spawning in tributaries entering the Great Lakes. An inventory of these 281 barriers has been compiled and are listed in Appendix 9. The list includes: 167 dams, 109 waterfalls and 5 culverts.

PROGRAM ADMINISTRATION

Institutional Arrangements and Procedural Guidance

Administration of the program is different in the two wuntries. In the U.S., the Commission holds the funds for contracting barrier dam projects with the appropriate agency of the state. Stream selection for dams is done cooperatively by representatives of the individual states and the Commission's Agent, the U.S. Fish and Wildlife Service. Site selection, engineering and wnstruction plans are developed by the appropriate agency of the state with final approval from the U.S. Agent. The agency of the state ensures that both federal and state regulatory requirements and approvals are met. Through a grant application and approval process shown in Appendix 10, the Commission enters intoawntractwiththeagency of the state for acquisition of land, design and wnstruction of the dam, and then provides the funds. Thus, the individual state agencies are the lead agencies for barrier darn wnstruction. To date, only the states of Michigan and Wisconsin have applied for fur&, although it is anticipated that New York State will be requesting funds in the near future. Funding requests are also a possibility from the states of Pennsylvania, and Ohio, and the Bad River Indian tribe in Wisconsin.

In Canada, the procedure is different. Funds for the sea lamprey barrier dam program are held by the Canadian Agent, the Department of Fisheries and Oceans (DFO), for use by the Sea Lamprey Control Centre in Sault Ste. Marie, the Department's headquarters for the program. The Sea Lamprey Control Centre is directly responsible for implementing the barrier dam program in Canada. Working under an Agreement between DFO and the province (Appendix 11), officials of the Sea Lamprey Control Centre undertake the site selection, design and wnstruction. In most cases, however, the Sea Lamprey Control Centre contracts cut the wnstruction. An engineer on staff is responsible for desiqning the barriers and administers wnstruction contracts. Barrier dam undertakings are then listed tier the Memorandum of Agreement between the Agent and the Commission. Since damsbuilt in Canada are not approved directly by the Commission, it does not have the same oversight review over this program as it does in the U.S.

It was evident to the Task Force that there is an advantaqe in the Canadian arrangement of having its own engineer on staff. The engineer was able to develop an appreciation for aesthetic and biological concerns in engineering lamprey barrier dams and consequently was able to improve designs with experience. In wntrast, in the U.S., design responsibilities were left to the individual states, and improvements in design, overtime, were less apparent. Problems with fish passage that develcped at the barrier on the East Branch of the AuGres River (Lake Huron) and at the original dam on the Brule River (Lake Superior) my have been avoided by better communication among the individual states and by consultation with Canada.

It is also evident to the Task Force that both Canada and the U.S. and the individual states have been son-what independent in the devel-t of their lamprey barrier dam programs. Expertise available in one part of the Great Lakes community often has not been used by another. It is the view of the Task Force that this is a major shortcoming of the lamprey barrier dam program.

~ensureabetter~ofinfom&ion,theTaskF~r~erscmmdsth&the federal, state and provincial agencies develop a more cooperative team approach to designing and solving specific prcblerns related to barrier dams. To foster a team approach, the Task Force has three recommendations. First, the U.S. state agencies takebetter advantage of the Canadian engineer in planning and designing future barrier dams. Second, the federal, state, and prwim=ialagenciesmeet annually, in a workshop setting, to share new ideas and technologies. If the Indian tribes become involved as contracting units, then they should also be included in these workshops. The workshops, when appropriate, should be combined with on-site visits to lamprey barrier dams. Funds ($2,000 - $3,000) should be set aside for travel support for the workshops. Third, that a person be appointed in the U.S. to coordinate work being done by the individual states. This individual could be a member of the U.S. Fish and Wildlife Service stationed either at Marquette or the Regional Office in Twin Cities, MN. The coordinators primary duty, as regards the barrier dam program, is to be knowledgeable of all barrier dam activity occurring in the U.S., and act as transmitter of information among state programs. A well-informed coordinator could do much to prevent duplication of effort and mistakes. Further, both the workshops and the coordinator will benefit greatly those states, such as New York, Pennsylvania, and Ohio, as well as other agencies who may want to begin a lamprey barrier dam program.

If these recommendations do not result in a more cooperative and integrated approach to the barrier dam program within 3 years, then the Task Force recommends that a Technical Overview Committee be established to review each new barrier dam proposal and design. The Technical Overview Committee would be comprised of 4 - 6 people who are knowledgeable about building lamprey barrier dams and passing sport fish speciës. The Committee's job would be to review and comment on each newly proposed dam design to ensure that the bast available technology has been included and that mistakes of the past are avoided. The Committee would report to the Commission. The Task Force is reluctant to recommend this measure immediately because it will increase the red tape associated with barrier darnsandmayimrease the time to undertake a project. However, the Task Force feels strongly about the need to develop a more integrated and cooperative team approach to designing lamprey barrier dams and it believes that this measure is necessary if the other measures fail.

Funding

Conditions governing the granting of financial assistance are clear. In the U.S. the allocated funds are held by the Commission and the Commission grants financialassistance upon its approvalof an applicationsubmitted by an individual agency. Up to 100 percent of the costs of site acquisition, design, and construction may be funded, including themstofafishpass. Indirect costs, however, are not funded. Approval for funding is guided by

1) availability of funds,

2) priority rating of the barrier dam,

3) assurance by applicant that the proposed site may be acquired&the dam completed in a timely manner,

4) assurance of proper siting and engineering of the dam,

5) assurance of proper maintenance of the dam subsequent to construction.

In Canada, theallocated funds for the development of barrier dams are provided directly in a block grant to the Canadian Agent. Expenditures are then listed in the Memorandum of Agreement between the Agent and the Commission.

For fiscal years 1978 to 1986, the Commission allocated a total of $2,545,900 in U.S. dollars to the U.S. program and $1,204,300 in Canadian dollars to the Canadian Program (Table 1). This amounts to an average allocation of about $282,900 U.S. and $133,800 Canadian funds per year. During this period the Commission approved projects Costing $2,344,565 (U.S.), or 92% of the U.S. allocation (Table 1). The U.S. spent $1,054,964 or 41% of its allocated funds and 45% of its approved funds. Canada spent $1,051,423 or 87% of its allocated funds (Table 1). With this money Canada installed or modified 16 barrier dams and the U.S. installed or modified 9 (6 in Michigan and 3 in Wisconsin).

It appears that Canada is capable of handling adequately the funds provided. The U.S. has spent a smaller proportion of its funds because Michigan, a major receiverof funds, has been slow in completing its approved barrier dam. This has occurred, in part, because of its lack of personnel allocated to the program (currently less than one person per year). Michigan, however, has concentrated on an accelerated planning program since 1980 and expects an active wnstruc-tion phase from 1986-1990. Michigan's five year plan calls for expending about $250,000 per year through 1990. Funding for many of these, including the Jordan (Lake Michigan), Rifle (Lake Huron), North Branch of White River (Lake Michigan), and Bear Creek (Lake Michigan), has already been approved. At the present time, a barrier dam on the Pere Marquette River (Lake Michigan) has the highest priority and planning for the project is underway. To complete the approved barrier dams in a timely fashion, the Task Force recommends that Michigan retain a contract engineer to assist them with the task.

Although funding for lamprey barriers has been adequate to date, it is anticipated that additional money will be required over the next 10 years. In Canada, 13 barrier dams are projected for construction over this period. Because some of these are larger structures, they will be more costly. In the U.S., Michigan projects a program for the next 10 years similar to the past period. Since other states, such as New York, Pennsylvania, and Ohio, as well as Indian tribes, IMYwanttostartabarriesdamprogram,additionalfundswillbeneededto meet this demand.

Maintenance costs are minimal (approximately 1-2% annually of the value of the dam) as dams are relatively small and new. Maintenance is primarily for maintaining roads to sites and for erosion control around the structures. This cost could increase as dams age or are damaged by floods. In the U.S., maintenance is the responsibility of theindividualstate.

Although such funds are availabie through the Comission, to date the states have borne maintenance costs themselves. Maintenance and other costs associated with lamprey barriers will be discussed in more detail in the economic analysis section of the report.

Table 1. Status of Iqwy E&irrier~~as of 30~, 1986

Fiscal Year	United States (US dollars) Allocated $	Approved $	Expended $	Balance[3] $	Canada (Canadian dollars) Allocated $	Expended $	Balance[3] $
78	150,000	139,062	139,062	10,938	100,000	0	100,000
79	150,000	76,463	0	150,000	100,000	0	100,000
80	222,000		0	222,000	100,000	74,687	25,313
81	335,000		0	335,000	150,000	218,670	(68,670)
82	335,000	1,441,145	0	335,000	206,200[1]	178,245[1]	27,955
83	400,000	176,891	65,057	334,943	165,000	124,019	40,981
84	400,000	248,000	388,545	11,455	144,000	283,206	(139,206)
85	282,500		389,711	(107,211)	151,600	85,596	66,004
86	271,400	263,004	72,589[2]	198,811	87,500	87,000[2]	(500)
TOTAL	2,545,900	2,344,565	1,054,964	1,490,936 1,289,601[4]	1,204,300	1,051,423	152,877[3]
AVERAGE[5]	282,878		117,218		133,811	116,825	

[1] Includes $56,200 to cover a transitional period of April 1 to September 30, 1982; a one time charge which brought Canadian agent's fiscal year in step with Commission's fiscalyear.

[2] Estimates

[3] Difference between allocated and expended

[4] Difference between approved by Commission and expended

[5] Average for 9 years, (1978-1986)

Legal Responsibilities

The Commission's Guidelines for lamprey barrier dams state that "All responsibility and liability for the acquisition of the site and construction, operation, and maintenance of the barrier dam, will be in the agency of the State in the United States, as applicable law may provide. In Canada, this responsibility and liability rests with the Federal government or the Province as they may determine." According to the Federal-Provincial Agreement (Appendix 11), barriers designed solely for sea lamprey control are the responsibility of the federal government and lamprey barriers with other functions (multi-purpose barriers) are the responsibility of the province. The Commission has immunity from suit in the U.S. and Canada.

In spite of the above guidelines, all levels ofgwernment are probably open to claims by individuals suffering injury or loss associated with specific structures. A liability case involving a drowning at the barrier dam on the West Branch of the Whitefish River (Lake Michigan), is pending in the Michigan courts. The outcome of this case may give definition to this issue. Liability, ingeneral, is a major contemporary concern; suits are being filed in growing numbers, and awards are being granted in staggering amounts. The issue in the case of barrier dams is unsettled at this time, but it has the potential for being serious. The Task Force recommends that each level of government (federal, provincial, state) examine this issue with its legal department to evaluate its potential liability and insurance protection. At this point, individual states in the U.S. and the federal gwernment in Canada should post warning signsat each dam site to warn the public of the dangers associated with dams. Examples of types of warning signs being used at various barrier dams are shown in Appendix 12.

Vandalism and Dam Removal

Vandalism of barrier darrr; has not been a serious problem. The few isolated incidents involved the manipulation of stop logs by non-informed users of the dam. There is sane potential for vandalism to occur at barrier dams, particularly at those with adjustable heads, fish gates, or other removable devices. The Task Forcebelievesthat this problem can be minimizedbystressirqsecurityatbarriers that have removable parts, and by posting sighs at barriers to explainto the public the purpose and importance of dams. Many of the barrier dams already have such signs posted and an example is shown in Appendix 13.

A much greater wncern is the possible removal of any of the 167 dam around the Great Lakes built over the years for other purposes, but which are important in stopping spawning runs of sea lampreys. These dams are owned privately or are under authority of local political jurisdictions. Many of the owners either have no inkling of the importance of their dam for sea lamprey wntrol or may not care. To prevent removal of these dams or modifications that might reduce their effectiveness in blocking lamprey runs, the Task Force recommends that a letter be sent by the Commission to the owners. The letter is to express the importance of Stopping sea lampreys and ask that the sea lamprey wntrolagentsbe consulted before undertaking any modifications to the dams. A draft letter for this purpose is included in Appendix 14. The Task Force further recommends that the individual states and province develop a policy, wherein approval to rebuild or modify a dam which blocks sea lamprey migrations is contingent on maintaining them as barriers to sea lampreys. For example, New York State works with the Federal Energy

Regulatory Commission to ensure that any licensing or relicensing of power dams is contingent on maintaining the structure as an impassable barrier to sea lamprey migrations.

The Task Force also recommends that the individual states and the province take advantage of any opportunities to incorporate lamprey barriers into dams and structures that are being built for other purposes. For example, making them part of highway bridge culverts where road construction is planned, or designing them into small-scale hydro-electric power-generating systems as Hunn and Youngs (1980) suggested, or at fish counting fences and other fisheries managemntfacilities.

Setting Priorities for Barrier Dam Construction

The criteria used to select stream for constructing barrier dams are similar in the two countries and include the following:

1) sea lamprey production,

2) availability of a suitable dam site,

3) physical problems related to attaining effective lampricide treatment,

4) specific adverse biological problem associated with chemical treatment,

5) potential reduction in treatment costs with a lamprey barrier,

6) possible multi-purpose dam such as for recreation, fish egg collection site, flood control, fish counting weir, fish barrier, among others.

Obviously, the availability of a suitable site is paramount in setting priorities. The criteria used in both countries to select an appropriate stream site are:

1) downstream from as much lamprey spawning area as practical,

2) accessible for construction and maintenance,

3) public ownership or opportunity to purchase is preferred, or when leasing is necessary, the length of the lease should commensurate with the cost of the barrier dam,

4) proper physical conditions (e.g. stable soil type, appropriate bank height, and moderate to steep gradient to minimize pool size),

5) no archaeologically signifimtsites.

In Canada, lamprey barrier dams are placed generally closer to the stream mouth than these in the U.S. This difference may result from the availability of suitable sites and not from applying different criteria. There is concern, however, that barriers placed too close to the mouth of certain streams may promote the development of new off-shore larval populations or aggravate existing infestations. With dams close to the stream mouth, larval lamprey have a shorter distance to drift before they reach the lake where they may escape exposure to lampricide treatment. Such escapement seems apparent in the Manistique River (Lake Michigan) where a large adult run is blocked by an old existing dam about 2 km (1 mile) from the mouth. A significant, and hard-to-control, population is present in the estuary and off this stream's mouth. In addition, increasing lake levels may decrease the effectiveness of dams that are too close to the stream mouth. This situation occurred on Graham Creek (Lake Ontario) where it was necessary to increase the height of the barrier dam to accommodate the recent increase in lake level. To address the concern of placing lamprey barriers too close to the mouth

of certain streams, the Task Force recommends that the effect of barrier dams on off-shore populations of larval lamprey be investigated.

Agencies have used these criteria to develop priority lists of tributaries to receive consideration for barrier dam funding. These lists continue to undergo refinementas current biological, economic, and engineering data become available. This mechanism has proven effective in providing for construct'ion on a priority basis. It has also identified many lamprey producing streams which are unsuitable forbarriercmstruction.

Desiqn Criteria

The common criteria for design of barrier daws include

1) the ability to withstand a 100 year flood,

2) a downstream apron and bank stabilization materials topreventwashout and erosion,

3) a drop of at least 45 cm or 18 in (weir crest to pool surface) duringthe period of lamprey spawning migration',

4) an overhanging lip to be installed on the downstream side of the crest as an additional barrier to lampreys,

5) facilities such as a jumping pool or fish pass to accommodate the passage of anadromous salmonids,

6) provisions to trap spawning-run lampreys,

7) consideration of recreational use where appropriate,

8) major consideration of safety at all barriers.

Cmstruction materials are concrete or sheet piling. concrete can be molded into more aesthetically pleasing designs and can be used in areas where bedrock is close to the surface. However, sheet piling is generally cheaper and has the advantage that it can be adjusted for height if any modifications are required.

There are two major differences in design of lamprey barrier dams between Canada and the U.S. First,Canadians prefer to build dams with built-in traps whereas the U.S. preference is for portable traps that can be placed along the dam wherever they are most effective in catching lampreys. It appears to the Task Force that the built-in traps may be more effective than portable ones because built-in traps are not subject to human error or tampering and dam design can direct attracting water through built in traps more effectively. Since the Task Force believes that sea lampreys blocked by barriers should be removed to prevent them from spawning elsewhere, the Task Force recommends that the efficiency of built-in and portable traps be compared and the most efficient used. The second major difference in design relates to reducing water levels behind the dam after sea lamprey spawning runs are completed. In the U.S., barrier dams have various devices, such as stop logs or gates, to permit drawdown to normal stremlevels. This featureallows for the flushing of sediment from the head pond, facilitates the passage of non-target

fish species, and maintains at least for part of the time, the free flowing characteristics of the river: In Canada, most of the dams do not have drawdown devices. The Task Force recognizes the advantages that these dratiowndevices provide, but it is concerned that they may allcw the passage of spawniq-phasesea lampreys through tampering or human error. The Task Force urges that all due care be taken in scheduling and operating these devices and protecting them from access by the general public so not to pass accidentally spawning-phase lampreys.

Recent designs of barrier dam include some special features to facilitate the passage of salmonids and forage fish at lamprey barriers. One of these featumsis a modification to the 15-30 can (6-12 inch) overhanging steel lip of lamprey barriers. When it was observed that some salmonids could not pass over a lamprey barrier because they jumped into the overhang, the Canadian Agent designed and installed a shorter, down-curved overhang (7-10 cm, 3-4 in) made from a section of steel pipe. This curved lip allows salmonids easier passage wer the barrier without jeopardizing the blockage of sea lampreys. It is noteworthy that the experimental lamprey barrier on the Black River (Lake Michigan) wasdesigned in the early 1950's with a curved lip. Other features for improved fish passage include the use of a) steel plates or fish gates inbarriers that can be remvedoropened subsequent to sea lamprey migration to facilitate the passage of forage fish or salmonids, b) structures (submerged weir) situated downstream frcmthebarrierdam to elevate and maintain the level of the water in the jumping pool, and c) a lower spillway on the crest to maximize flow (attractionwater) through the jumping pool during periods of law flow. Again, the Task Force recognizes the advantages that these features provide, but is concerned that some of these measures may allow the upstream passage of lampreys. The Task Force urges that the advantages and disadvantages of these features be weighed carefully before incorporating them into future lamprey barrier designs.

Further, there are three other innovative ideas for designing lamprey barrier dams of the future. They include a) a removable barrier, b) a new type lamprey trap, and c) an electric fish barrier. The recently constructed barrier dam on Albany Creek (Lake Huron) in Michigan employs a gate, hinged at the bottom, that can be lowered to sill level following lamprey migration. This feature provides lamprey control without permanently damming the river. This removable barrier concept may have application for other sites where it is not practical or desirable to build a permanent dam. The two most recent barrier dam (Still River and Ecfio River, Lake Huron) in Canada include a new idea for a lamprey trap. This new type of lamprey trap wntainsawnnecting&e for capturing lamprey from both sides of the stream. If this method is successful, it shauld be used in designing future lamprey traps.

In the period 1951-79, various types of alternating and direct currentelectric barriers were used in several rivers to block spawning runs of sea lamprey, but their effectiveness was difficult to evaluate (Hunn and Youngs, 1980). But a new type of electric fish barrier that uses a graduated electric field and submerged electrodes mounted on the stream bottom is being tested by Michigan to block salmon and sea lamprey runs. This new approach to using electricity to control lamprey populations without blocking stream flow awaits the results of these field tests. The Task Force encourages these innovative approaches to designing lamprey barriers.

Although significant progress has been made in designing barrier dams, particularly for relatively small streams, there is still a need for further studies. For example, traps could be designed to be more effective by determining the optimum shape, size and position of its entrance. Similarly, little is known about using attraction water or other attractants, such as lights or sound, to enhance trapping of lampreys. Further, many options for dam and trap designs have not been tested, nor have there been any systematic comparisons of different structures at the same site under the same flow conditions. In order to build the smallest sized structure that will blodk and trap sea lampreys with minimal environmentaldisruptions, comparative data need to be collected on different designs. Therefore, there is a need to w&uct tests in a semimntrolled situation where factors like flow, pool depth, standing wave, trap entrance and shape can be regulated. The Task Force recommends that an experimentalfacilitybe established to urdertake these studies. This experimental facility will be discussed in more detail later in this report. Furthermore, effortsneed to be directed toward developing innovative barriers for larger rivers where many of the major lamprey runs take place and chemical wntrolcostsarehigh.

Biological Implications

When properly constructed according to the guidelines mentioned previously, sea lamprey barrier dams, in the short-term at least, have proven successful in limiting stream habitat available for lamprey spawning. It is the opinion of the Task Force that this is a significant a&kv=t. The barrier dam program is still relatively new, however, and long term data on its effectiveness in controlling sea lamprey reproduction and the impact on non-target fish species in many streams are limited. Population assessment of spawning-phase and larval sea lampreys should be continued and, in some cases, intensified on blocked streams to evaluate the barriers' effectiveness over a wide range of flow conditions. Further, escapement can still occur if a) dams are not maintained, b) dams are not operated properly (e-g., gates for fish passage or drawdown devices are opened during time of lamprey runs), c) dams are vandalized (e.g. stop logs are removed), d) lampreys go werattackdto fish, e) lampreys are transported by bixds, f) lampreys pass over barrier dams during floods, or g) lampreys are placed above dams by people. Therefore, periodic assessment must continue above dams and the need for occasional treatment above dams may still be necessary.

Lamprey barrier danrs have becoaneanintegralpartoflamprey~g~t~are particularly useful on streams where chemical control is difficult or inefficient. Trap used in conjunction with dams have an added benefit of removing spawning lamprey from the population because of their "fishing-up" capability. These captured animals are also useful for the sterile male release prqram. Because lamprey barriers reduce the length of stream requiring chemical treatment, the exposure of other sensitive fish and invertebrate species is reduced. Occasionally, chemical treatment on the stream may be eliminated completely as occurred on the Saugeen River (Lake Huron), Salmon River (Lake Ontario) and Stokely Creek (Lake Superior).

Because low head barriers impound little water, generally less than 0.2 ha (0.5 acre), changesin temperature regimes and invertebrate populations resulting from the impoundments are probably inconsequential. As the barrier dam program is extended to larger streams requiring larger dams and consequently larger impoundments, there is an increasing possibiliQ for adverse environmental impacts.

The major documented adverse effect of sea lamprey barrier dams which has caused both the public and government agencies concern, has been the blockage of non-target fish species. However, part of this concern has been addressed adequately. Through experimentation, lamprey barriers have evolved to the point where they can be designed to pass jumping sport fish, such as rainbow trout, brown trout, who salmon, and chinook salmon, under most conditions. This is a considerable accomplishment and is one of the successes of the lamprey barrier dam program. In spite of this achievement, fisheries management agencies are still concerned. First, fishways ardj~ingpoolsmayselectagainstthepassageof large, robust and repeat spawning females and consequently these structures may select against a gene pool that contains high survival characteristics. Second, barriers delay and concentrate the fish run immediately below them. This causes enforcement problems where fish may be vulnerable to poaching, and may force fish to spawn in less suitable habitat. Third, non-jumping fish species, such as walleye, northern pike, bass, and forage fish, are blocked at all lamprey barriers. Although lamprey barriers have not been built to date on tributaries supporting significant runs of walleye or northern pike, the blockage of forage fish is a concern of unknown magnitude. Further, cur knowledge of the effects of barrier dam delaying and blocking non-target fish species is sparse to non-existent

To address these wncems, the Task Force has three recommendations.

1) It is recommended that the technology be develop& to accommodate the passage of important non-jumping sport fish, such as walleye, bass, northern pike, and forage fish. The Task Force views this lack of technology to pass non-jumping fish as a significant shortcoming in the lamprey barrier dam program and as an obstacle to the expansion of the program to non-salmonid tributaries. The devel-t of a fish pass for non-jumping fish could be a joint undertaking by lamprey control and fisheries management agents. Lamprey wntrol agents would benefit by expanding the barrier dam program to those tributaries with significant runs of walleye, northern pike, and other species. Fisheries management agencies would benefit by being able to pass these fish at existing barriers and consequently enhance their production.

2) It is recommended that studies be undertaken at streams with low head barriers to determine the effects of blocking non-target fish species, such as forage fish and large size jumping fish. These studies should commence 2-3 years prior to planned construction so pre- and post-impoundment data can be compared.

3) It is recommended that sites with larger impoundments, pre- and post-impoundment studies be conducted to examine the impacts of barrier dams on stream biota, water quality, fish habitat and fishpassage.

The experimental facility recommended earlier for testing designs for better barriers and lrvlrvlrvlrvlrvlrvlrefficientlampreytrapscouldalsobeusedtotestnewmethodsto pass sport and forage fish at lamprey barriers. Also, questions concerning the ygeofnon-target species wuldbeaddressed at the experimental facility. For instance,'can a low head barrier dam with jumping pool pass large, robust female rainbow trout? Does delaying a run of rainbow trout result in some trout not

passing wer the barrier dam? The experimental facility could be developed on a suitable stream close to a sea lampxeywntrolcentreorresear& station where expertise on fish handling and behavior is available. Or, the facility could be combined with some other fisheries management work and become a multi-purpose tool. For example, the experimental facility could be combined with a fish counting fence or other fish barrier. This would serve to reduce costs as well as to foster a closer working relationship between lamprey control and fisheries management agencies.

Gther adverse effects of lamprey barrier dams are the impairment of aesthetics and the effect on canoe and boat passage. It is the opinion of the Task Fomethat barrier dams have been designed as aesthetically pleasing as possible. Furthermore at some sites the most progressive techniques available have been used to stabilize stream banks and restore thenatural features of the stream. portage signs and pathways for boaters have been provided at some of the U.S. barriers to facilitate canoe and boat passage.

Although the Task Force did not measure public opinion wnceming effects of lamprey control, it is apparent from many newspaper articles and talking to sportsmen during visits to some of thebarrier sites that public acceptance of the necessity for lamprey control is widespread and the program, in general, is accepted as undertaken. Scarespecialinterest groups prefer one method of control wer another. For example, those who harvest Hexagenia (mayfly larvae) for fish bait are opposedto chemical control. Other public groups are cpp3sedtobarri~ because they block fish runs or impair the free flowing characteristics of rivers.

Much of the adverse reaction to barrier dams has been offset, in local areas, by greater concerns wer the use of chemical control. Because chemical treatments have caused occasional fishkills and temporarily reduced invertebrate and fish populations, it has instigated public w-. But, it has been shown that significant fish kills seldom occur (Dahl and Mcdonald, 1980) and when they do, they are usually the result of added stsessfrcanfactorssuchahi~~~, law oxygen levels, or spawning conditions of fish. Most invertebrate populations recover within six weeks to one year after treatment (Gilderhus and Johnson, 1980).

Public wncerns over lamprey barriers are addressed by the appropriate fishery management agency and through the environmental assessment process. It is noteworthy that the lamprey barrier dam program received anegative declaration of environmental impact (Great Lakes Fishery Commission, 1979).

ECONOMIC ANALYSIS

To evaluate the econcmiceffectivmess of the sea lamprey barrier program, an analysis was conducted for most of the 30 barrier dam described in this report. Five structures (Ember, French, Harris, Manitou and Black Sturgeon) were excluded from the analysis because there were insufficient data on their capital costs. The economic analysis consisted of three stages:

1) estimating annual costs of each barrier dam,

2) estimating annual benefits of each barrier, and

3) comparing costs to benefits by computing a benefit-cost ratio for each barrier.

Estimating Annual Costs

The annual costs were placed into two categories:
a) depreciation of the capital cost and b) operation and maintenance costs. Since the barriers were wnstruct&werapericdof15years,capitalw6tsforeachdam were brought to a common basis by converting them to 1985 prices using the Construction Price Indexes for Ontario (Ontario Ministry of Treasury and Economics, 1985). It was assumed thatwnstructionwsts for Michigan and Wisconsin are similar to those for Ontario. The computed 1985 capital costs or replacement Costs are shown in Table 2.

Depreciation was annualized by assuming a 100 year life for the four large dams (Credit, Saugeen, Betsie, and Brule) that were constructed, a 50 year life for the two old dam (Salmon and East Twin) that were modified, and a 60 year life for all the other dams (low head barriers or small dams) that were built. The 100 year life expectancy is consistent with the value used for dams built for flood control purposes (Ontario Ministry of Natural Resources, 1984). The 60 and 50 year life expectancies werewnsidered reasonable estimates for the smaller structures. (Mac Cdell, Ontario Ministry of Natural Resources, Queen's Park, T&onto, pers. comm. and Tom McAuley, Sea Lamprey control Centre, Sault Ste. Marie, pers. comm.). Since there are no accurate data on the costs of operating and maintaining sea lamprey barriers, annual maintenance and operating costs were estimated at 2% of the capital costs for the old existing dam (Salmon and East Twin), 1.5% of the capital wstforthenewlaqerdams (Credit, Saugeen, Betsie and Brule) and 1% of the capital cost for all the other dams (low head barriers or small dams). These assumptions are consistent with the 1 to 2 per cent of capital cost that is generally used for estimating these costs at Canadian dam (Ontario Ministry of Energy, 1986). The annual wstsareshmnonTable3.

Table 2. CAPITAL COST OF SEA LAMPREY BARRIER DAMS

Dam	Year Built or Reconstructed	Original Capital Cost $	Multiplier	1985 Replacement Cost $
salmon	1974	13,274	2.22	29,468
	1976	5,671	1.86	10,548
	1978	3,047	1.61	4,906
	1980	718	1.33	955
	1985	10,000	1.0	10,000
				Total 55,877
Lakeport	1984	21,760	1.03	22,413
Shelter Valley	1985	42,520	1.0	42,520
Graham	1983	58,400	1.05	61,320
Duffin	1980	65,266	1.33	86,804
	1984	17,326	1.03	17,845
				Total 104,649
credit	1980	140,000	1.33	186,200
	1981	128,000	1.22	156,160
				Total 342,360
Saugeen	1970	250,000	3.20	800,000
Sturgeon	1979	39,947	1.45	57,923
Still	1986	88,037	0.95	83,635
Kaskawong	1981	30,170	1.22	36,807
Echo	1971	40,985	3.00	122,955
	1973	6,545	2.55	16,690
	1977	11,827	1.72	20,342
	1979	616	1.45	893
	1983	5,330	1.05	5,596
	1986	46,375	0.95	44,056
				Total 210,532
Sheppard	1984	38,619	1.03	39,777
Stokely	1980	17,637	1.33	23,457
	1984	1,225	1.03	1,262
				Total 24,719

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Table 2. CAPITAL COST OF SEA LAMPREY BARRIER DAMS

Dam	Year Built or Reconstructed	Original capital Cost $	Multiplier	1985 Replacement Cost $
Carp (Sable)	1983	50,600	1.05	53,130
Gimlet	1980	20,015	1.33	26,620
AuGres	1983	128,628	1.05	135,059
Albany	1985	41,766	1.0	41,766
Betsie	1974	156,826	2.22	348,154
Days	1983	98,210	1.05	103,120
Whitefish	1980	89,100	1.33	118,503
Miners	1978	35,600	1.61	57,316
Misery	1984	167,000	1.03	172,010
East Twin	1978 1983	12,662 900	1.61 1.05	20,386 945 Total 21,331
Brule	1984 1986	208,000 325,000	1.03 0.95	259,230 308,750 Total 567,980
Middle	1983	76,463	1.05	80,286

Table 3. ESTIMATED ANNUAL COSTS OF SEA LAMPREY BARRIER DAMS

Dam	Annual Depreciation $	Annual Operating & Maintenance $	Total Annual $
Salmon	1,117	1,117	2,234
Lakeport	373	224	597
Shelter Valley	709	425	1,134
Graham	1,022	613	1,635
Duffin	1,744	1,046	2,790
credit	3,424	5,135	8,559
Saugeen	8,000	12,000	20,000
Sturgeon	965	579	1,544
Still	1,394	836	2,230
Kaskawong	613	368	981
Echo	3,509	441	3,950
Sheppard	663	398	1,061
Stokely	412	247	659
Carp (Sable)	885	531	1,416
Gimlet	444	266	710
AuGres	2,251	1,351	3,602
Albany	696	418	1,114
Betsie	3,481	5,222	8,703
DaYS	1,719	1,031	2,750
Whitefish	1,975	1,185	3,160
Miners	955	573	1,528
Misery	2,867	1,720	4,587
East Twin	427	427	854
Brule	5,680	4,631	10,311
Middle	1,338	803	2,141

Estimating Annual Benefits

There is little infomtion available on the ewnomic benefits of lamprey barrier dam. Hence, our estimates of the annual benefits were confined to a) the estimated savings in chemical treatment costs for each tributary following barrier dam placement and b) the additional benefits accrued from the two multi-purpose dams on the Credit and Saugeen tributaries. These annual. benefits are in 1985 dollars and are shown in Table 4. Although the dam on the Credit River provides no savings in chemical treatment costs because it is only partially effective as a lamprey barrier, it has a benefit to the province as it is used to collect salmon eggs each fall. It is estimated that this benefit is worth $25,000, as it would cost this amount each year to construct an equivalent bamier on this river to trap salmon. The dam on the Saugeen Riverattracts s-ports fishermen. Creel census data indicate that the direct fisheries benefits, at the dam site of sports fishermen are $110,000 per year (1982 dollars). About one-half of these benefits my be attributable to the dam since it causes the wncentration of fish which attract the fisherman. Thus, $66,000 in 1985 dollars ($55,000 X 1.2 = 60,000) my be attributable to the dam (Ontario Ministry of Natural Resources, 1984). The otherbenefits of lamprey barriers, which are excluded from our estimates, are discussed below.

Benefit-Cost Ratio

The benefits and wsts were compared by computing a benefit-cost ratio. The ratios are shown in Table 5. They range from 0.5:1 to 6.8:1. The low value of 0.5 for thebarriers on the Betsie and Middle rivers indicatethe Worst case' barrier dams in ewnomic tern-s, and the highvalue of 6.8 for the barrier on the Saugeen River indicates the 'best case'. The high ratio for the Saugeen River reflects the additional recreational fisheries benefits obtained from this structure. But, excluding the fisheries benefits, the ratio for the Saugeen River barrier is 1.9:1; reflecting a favorable financial investment. Benefits exceeded wsts for 16 (64%) of the 25 lamprey barriers examined In aggregate, the net benefits for the 25 lamprey barriers total about $266,000 per year, whereas the costs are about $88,000, providing a benefit-cost ratio of 3 to 1 (Table 5). This indicates that lamprey barriers, in general, compare favorably in economic terns.

Discussion

Since there is no accurate account~ of the operating and mainteMncecosts of lamprey barriers, it is virtually impossible to kncwh~reasonableourwst estimates are. Further, since many of the smaller barrier dam, particularly the lawheadbarriers that are over-topped during high flows, are a relatively new concept in dam design, there are no data on which to predict their life expectancy and consequently calculate annualdepreciationwsts.

Table 4. ESTIMATED ANNUAL BENEFITS OF SEA LAMPREY BARRIERS

Dam	Annual Savings in Chemical Treatment $	Other Annual Benefits $	Total Annual Benefits $
Salmon	7,860		7,860
Lakeport	1,080		1,080
Shelter Valley	2,850		2,850
Graham	2,500		2,500
Duffin	2,650		2,650
credit	0	25,000	25,000
Saugeen	70,100	66,000	136,100
Sturgeon	3,630		3,630
Still	4,750		4,750
Kaskawong	2,940		2,940
ECho	9,000		9,000
Sheppard	780		780
Stokely	1,430		1,430
Carp (Sable)	3,580		3,580
Gimlet	560		560
AuGres	6,560		6,560
Albany	1,120		1,120
Betsie	4,805		4,805
Days	2,040		2,040
Whitefish	6,675		6,675
Miners	1,175		1,175
Misery	2,985		2,985
East Twin	2,437		2,437
Brule	9,349		9,349
Middle	1,030		1,030

Table 5. COMPARING BENEFITS AND COSTS OF BARRIERS DAMS

Dam	Annual Costs $	Annual Benefits $	Benefit/Cost Ratio $
Salmon	2,234	7,860	3.5
Lakeport	597	1,080	1.8
Shelter Valley	1,134	2,850	2.5
Graham	1,635	2,500	1.5
Duffin	2,790	2,650	0.9
credit	8,559	25,000	2.9
Saugeen	20,000	136,100	6.8
Sturgeon	1,544	3,630	2.3
Still	2,230	4,750	2.1
Kaskawong	981	2,940	3.0
Echo	3,950	9,000	2.3
Sheppard	1,061	780	0.7
Stokely	659	1,430	2.1
Carp (Sable)	1,416	3,580	2.5
Gimlet	710	560	0.8
AuGres	3,602	6,560	1.8
Albany	1,114	1,120	1.0
Betsie	8,703	4,805	0.5
Days	2,750	2,040	0.7
Whitefish	3,160	6,675	2.1
Miners	1,528	1,175	0.7
Misery	4,587	2,985	0.6
East Twin	854	2,437	2.8
Brule	10,311	9,349	0.9
Middle	2,141	1,030	0.5
TOTAL	$88,250	$266,736	3.6

Although we chose a conservative figure of 60 years, it is only with time that more accurate estimates can be made. However, for one structure, Denny's Dam on the Saugeen River, we were able to compare our estimates of costs with those from another study. This comparison follows:

Annual Cost	OMNR, 1984 Report	This Study
Depreciation	$8,500	$ 8,000
Operation and Maintenance	$8,700	$12,000
Total	$17,200	$20,000

Hence, our estimate of costs may be reasonable, at least for the larger structures.

Benefits reported in this economic analysis have been umkrestimted. First, savings in maintenance costs resulting frcxnless&emicaltr&nmthavenotbeen added to the benefits because of insufficient data. The cost of maintaining the equipment, such as boats, motors, trailers, vehicles, used for chemical treatment has been estimated at $3,500 to $4,000 per stream. Thus, a 50% reduction in treatment effort subsequent to lamprey barrier dam installation could result in a $1,700 to $2,000 savings in maintenance per stream.

Second, intangible benefits of lamprey barriers have not been included. Intangible benefits include such item as:

a) ecological benefits obtained from not killing fish or other aquatic organisms, such as Hexagenia, which may occur with lampricide treatment and the consequent public concern associated with these kills,

b) benefits obtained from keeping lamprey out of areas that are difficult to treat with chemical or where chemical treatment is less effective.

c) benefits obtained from not having to rely entirely on chemical treatment, particularlywhenthereis only one supplier of the chemical.

These benefits, however, are offset to some extent by the intangiblecosts such as:

a) losses in fish production because of blocked spawning migrations of some fish species at barrier dams.

b) increases in law enforcement efforts because barriers may concentrate sport fish resulting in pcba&ingandtreqassingcor@aints.

Third, benefits of lamprey barriers to the Great Lakes fishery have not been included. The Great Lakes sports fishery is presently estimated as a $2-4 billion per year industry - and the commercial fishery a $270 million per year industry

(Talhelm, 1987). Many of these valuable sport and commercial fish depend upon lamprey control, without which the fishery would be greatly diminished. Assuming that a modest 20% of this fishery is attributable to lamprey control, the benefit of lamprey control is $400-800 million per year ($2-4 X 10^9 X .2 = $400-800 million). The total annual cost of lamprey control is $7 million (annual barrier dam cost is < 30%). Therefore, the benefit-cost ratio of lamprey control, mainly based on lampricide, would be 57-114 to 1 (400/7 = 57 and 800/7 = 114). Thus, if barrier dam wntrol costs the same as chemical control, the actual benefit-cost ratio for barrier dams is much greater, by a factor ranging from 57-114, than shown in Table 5.

To the knowledge of the Task Force, this is the first economic examination of lamprey barrier dams. Although there is a paucity of information available not only on the costs, but especially on wnverting thebenefits accrued from lamprey barriers into dollar values, the Task force believes that an ewnomicanalysis of lamprey barriers is a worthwhile erx3eavour. For instance, an economic assessment can provide guidance in evaluating the options for controlling lamprey on a particular tributary. A proposal for a barrier dam with hi~costsard~~~ benefits should not be undertaken without first completing a more thorough evaluation of the other alternatives. Also, the public is demanding reasonable returns and more accountability for its dollars. Administrators and legislators increasingly rely on benefit-cost and related economic assessments to provide measures of accountability. Therefore, the Task Force makes two recommendations regarding lamprey barrier dams and economic values.

1) To provide guidance in evaluating the altermtives for controlling lamprey, the Task Force recommends that each proposal for a lamprey barrier include a more detailed economic evaluation.

2) To improve the accountability of the lamprey barrier program, the Task Force recommends that each agency operating and maintaining lamprey barriers implement cost-accounting of expenses and benefits of each barrier.

The Task Force, however, recognizes thedifficulty in quantifying the costs and benefits of lamprey barriers. Thus, the Task Force believes that a decision to build or not to build a barrier dam should not be based solely on a benefit-cost ratio. Rather, the recommended detailed economic evaluation should be used as one of several tools to evaluate al~~ybarrierdamproposal.

RECOMMENDATIONS

Throughout the report, the Task Force has made several recommendations for a more effective sea lamprey barrier dam program. These recommendations are summarized as follows:

Recommendations to Develop Technology and Information For Building Better Barrier Dams

To address the concerns of blocking non-target fish species at lamprey barriers,

1) **it is recommended that the technology to accommodate the passage of non-jumping** sport fish, **such** as walleye, **northern** pike, **and** bass be **developed.**

This could be a joint undertaking by both the lamprey control and fisheries management agents. Lamprey control agents would benefit by expanding the barrier dam program to those tributaries with significant runs of walleye, northern pike, bass ard other fish species. Fisheries management agencies would benefit by passing these fish species at existing barriers and consequently increasing the productive capacity for these species.

2) **it is recommended that studies be undertaken to determine the effects on blocking non-target fish species, such as forage fish, large salmonids that might be incapable of jumping during reproductive migrations, and non-jumping sport fish.**

To identify potential environmental impacts of larger barrier dams,

3) **it is recommended that pre- and post- impoundment studies be conducted** at **the sites for dams planned for larger rivers to determine their impacts on** fish passage, stream biota, arrl water quality.

To obtain information for building better dams, designing more efficient lamprey traps, testing new methods to pass sport and forage fish at lamprey barriers and determining the potential of barrier dams to influence off-shore populations of sea lamprey,

4) it is **recommended that an experimental** facility be ckvelopedki&re~of **the information required could be obtained.**

Many options for dam and trap designs need testing and there have been no systematic comparisons of structures at the same site under similar flow conditions. At an experimental facility, flow could be regulated and a variety of designs could be tested in a semi-controlled situation.

5) it is also reccmnendedUntstWiesbe **conducted at various barrier dams to compare the capture efficiency of built-in and portable traps currently in use, and if required, design a more efficient trap.**

6) it is also recommended that a study be undertaken to determine whether barrier dams near stream mouths increase existing off-shore populations of larval lamprey by encouraging spawning below dams and subsequent larval drift into the lake.

Recommendations to Exchange Information and Develop Team Approach

Each country has been somewhat independent in the development of its lamprey barrier program. Expertise available in one part of the Great Lakes community has often not been used by another. To ensure a better exchange of information on barrier dams among the control units, individual states, and province,

7) it is recommended that both countries develop a more cooperative team approach to designing barrier dam and solving specific ptxblems. lb facilitate this team approach, it is recommended that:

a) the U.S. take better advantage of the Canadian Agent's engineer in project planning and design through consultation, on-site project review, and even direct contracting for engineering services as work load allows,

b) the sea lamprey control units, the individual states, province, and other resource management groups meet annually in a workshop setting to share new ideas and technologies.

c) U.S. Fish and Wildlife Service appoint a person to coordinate the lamprey barrier dam work among the individual states.

If these actions do not result in a more cooperative and integrated approach to the barrier dam program within 3 years, then it is recommended that,

d) a Technical Overview Committee be established to review each new barrier dam proposal.

Recommendations Regarding Funding

Funding for barrier dam has averaged about $283,000 U.S. and $134,000 Canadian per year since 1978. To maintain the present level of undertakings, tc undertake the needed darel~~ work, arBtO~theprogramtOthoseStateS and other resource management groups (e.g., Indian Tribes) not presently participating,

8) it is recommended that sufficient funding be provided for the present and future levels of undertakings.

To expedite construction of barrier dams in the U.S.,

9) it is recommended that the state of Michigan retain a contract engineer to complete the approved barrier dams.

Recommendations Regarding Liability

Liability for personal loss or injury at barrier dam is unclear. With the trend toward court approval of large settlements in liability cases, the potential exists for legal problems.

10) **it is recommended that each level of government evaluate its potential liability and insurance protection for personal injury or loss at barrier dams.**

Recommendations Regarding Private and Other Dams and Structures

There are many dams on tributaries to the Great Lakes that were built over the years for other purposes, mwbicbare important in stopping sea lamprey migrations. These dams are under authority of private owners or local political jurisdictions and many of the owners have no inkling of the importance of their dams for sea lamprey control. To prevent removal of these dams, or modifications which may negate their effectiveness as sea lamprey barriers,

11) **it is recommended that a letter be sent by the Commission to the owners of these dams asking that they consult with the control agents before undertaking any modifications to the dams, and**

12) **it is recommended that the individual states and province develop a policy whereby approval to rebuild or modify a dam which now blocks spawning-run sea lamprey migration, is contingent on maintaining them as barriers to sea lamprey.**

To expand and promote the barrier dam program,

13) **it is recommended that the individual states and the province take advantage of the opportunities to incorporate lamprey barriers and/or traps into water related structures, such as culverts, fish counting fences, or flood control dams, that are being built for other purposes.**

Recommendations Regarding Cost-Benefit Analysis

To provide guidance in evaluating the alternatives for controlling lamprey,

14) **it is recommended that each proposal for a lamprey barrier include an improved economic evaluation.**

To improve the accountability of the lamprey barrier program,

15) **it is recommended that each agency operating and maintaining lamprey barriers implement cost-accounting of expenses and benefits of each dam.**

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ACKNOWLEDGEMENTS

The Task Force acknowledges, with thanks, the assistance received from Tom McAuley and Stan Dustin at Sea Lamprey control Centre, Sault Ste. Marie, Ontario; Bill Swink, U.S. Fish and Wildlife Service, Hammond Bay Biological Service, Hammond Bay, Michigan and Bill Beamish, University of Guelph, Guelph, Ontario.

A P P E N D I X 1

Great Lakes Fishery Commission's Policy Statement

for

The Role of Dams in an Integrated Sea Lamprey

Control Program

Great Lakes Fishery Commission

ESTABLISHED BY CONVENTION BETWEEN CANADA AND THE UNITED STATES TO IMPROVE AND PERPETUATE FISHERY RESOURCES

POLICY STATEMENT

THE ROLE OF DAMS IN AN INTEGRATED

SEA LAMPREY CONTROL PROGRAM

Barriers, natural or man made, play an extremely important role in limiting the number of streams used by spawning sea lampreys or in restricting the potential spawning area within a river system. Since the sea lamprey population in the Great Lakes is dependent upon reproduction which takes place in only about 400 of the 5,750 tributaries entering the Great Lakes, the Commission regards construction of barriers as a valuable and practical supplement to lampricides in development of an integrated sea lamprey control program.

Among the major advantages which may be realized through the installation of properly designed barrier dams in selected sea lamprey producing streams are:

1. more efficient control on streams where physical characteristics make lampricide treatment difficult, expensive, or ineffective;

2. savings in time, man power, and related costs through a reduction in stream miles requiring periodic lampricide treatment;

3. reduced dependency on chemicals;

4. reduced lampricide purchases in the face of rising costs and a potentially limited supply;

5. reduced quantity of lampricides added to the environment; and

6. restoration and/or survival of non-target species in some streams.

The benefits from dams designed specifically for sea lamprey control far outweigh the disadvantages. Proper design and knowledgeable selection of streams and sites should minimize possible adverse effects such as increased water temperatures, silting, and interference with upstream movement of anadromous fish. Aquatic invertebrate populations will not be significantly affected by barrier dams.

In view of the foregoing, the Commission strongly endorses the installation of barrier dams as part of an integrated control program. Direct participation by the Commission is limited except for possible financial assistance to States and the Province to construct devices designed specifically for sea lamprey control. The Commission, however, strongly urges the Great Lakes States and the Province of Ontario, in concert with their respective federal governments and in cooperation with this Commission, to initiate an active barrier dam program to enhance the efficiency and effectiveness of the sea lamprey control program in the waters of the Great Lakes. The Commission recognizes that action by the States and Province must be taken within the constraints imposed by laws or regulations of the individual agency.

12/1/75

A P P E N D I X 2

Great Lakes Fishery Commission's Guidelines

for

Barrier Dam Program for Sea Lamprey Management

Great Lakes Fishery Commission

ESTABLISHED BY CONVENTION BETWEEN CANADA AND THE UNITED STATES TO IMPROVE AND PERPETUATE FISHERY RESOURC

GREAT LAKES FISHERY COMMISSION

Guidelines for

Barrier Dam Program for Sea Lamprey Management

A. POLICY

"The Commission strongly endorses the appropriate installation of barrier dams as part of an integrated program for sea lamprey management. Direct participation by the Commission is limited except for possible financial assistance to States and Province to construct devices designed specifically for sea lamprey management. The Commission, however, strongly urges the Great Lakes States and the Province of Ontario, in concert with their respective federal governments and in cooperation with this Commission, to initiate an active barrier dam program to enhance the efficiency and effectiveness of the sea lamprey management program in the waters of the Great Lakes. The Commission recognizes that action by the States and Province must be taken within the constraints imposed by laws or regulations of the individual agency.'!

B. POTENTIAL BENEFITS

1. More efficient control on streams where physical characteristics make lampricide treatment difficult, expensive or ineffective;

2. Savings in time, manpower and related costs through a reduction in stream miles requiring periodic lampricide treatment;

3. Reduced dependency on chemicals;

4. Reduced lampricide purchases in the face of rising costs and a potentially limited supply;

5. Reduced quantity of lampricides added to the environment; and

6. Restoration and/or survival of non-target species in some streams.

C. POTENTIAL ADVERSE EFFECTS

1. Turbidity during construction.

2. Impairment of aesthetics.

1451 Green Road l Ann Arbor, Michigan 48105 l Telephone: (313) 662-3209 / FTS 378-2077

3. Blockage of migration of some fish.

4. Effect on canoe and boat passage.

D. GOAL

To assist cooperating fishery agencies install barrier dams at appropriate sites, established by the agencies, on sea lamprey producing tributaries of the Great Lakes, where the benefits in improved lamprey management and reduction of cost of lamprey management justify the cost of barrier dam installation, provided the adverse effects and environmental impacts of a dam are acceptable.

E. ROLE OF THE COMMISSION

The Commission will provide financial assistante through a grant program of funds available for this purpose, to appropriate agencies of the eight Great Lakes States, the Canadian Agent and the Province of Ontario for the acquisition or leasing of sites for barrier dams and for the design and construction of barrier dams, or alteration of existing dams to make them effective lamprey barriers, subject to the conditions set forth in Sections F through J.

F. ROLE OF THE STATES AND PROVINCE

1. The appropriate agency of the State, Canadian Federal Government or Province will acquire or lease the site and design, construct, and maintain the barrier dam. All responsibility and liability for the acquisiton of the site and construction, operation and maintenance of the barrier dam, except as provided in paragraph 2, will be in the agency or the State in the United States, as applicable law may provide. In Canada, this responsibility and liability will rest with the Federal Government or the Province as they may determine. The title, lease or agreement for a site for a barrier dam and for the barrier dam appurtenances will be acquired and held by the appropriate state, provincial or Canadian federal government agency.

2. Regular operation and maintenance of sea lamprey barrier dams may be paid by the Canadian Agent of the Commission from funds made available to the Agent in the annual Memorandum of Agreement between the Commission and Department of Fisheries and Oceans Canada for lamprey management. Funding for regular operation and maintenance of lamprey barrier dams in the Great Lakes States may be supplied by the Commission to the appropriate State agency from the Commission's budget for lamprey management. Major repair or reconstruction projects, to be eligible for Commission funding, must be submitted to the Commission, in accordance with the provisions of Section H and I, in the same manner as a request for funds to construct a new barrier dam and be approved by the Commission.

G. ROLE OF THE CANADIAN AND UNITED STATES AGENTS

The Canadian and United States Agents will be responsibile for the functions given them in Section K. The Agents will serve as technical advisors to the Commission in

reviewing applications, in inspecting the progress and completion of barrier dam projects funded in part or totally by the Commission and in analyzing and evaluating the results of the barrier dam program. Since lamprey management is a responsibility of the Federal Government in Canada, the Canadian Agent may be the grantee for financial assistance from the Commission for barrier dam projects in Canada.

H. CONDITIONS GOVERNING THE GRANTING OF FINANCIAL AID BY THE COMMISSION

1. Financial assistance will be granted only on approval by the Commission of an application from the appropriate agency of the State, Canadian Federal Government or Province, made pursuant to Section I.

2. The Commission may grant up to 100 percent of the actual costs of acquisition of a site and of the design and construction costs of a barrier dam. Indirect and overhead costs of the central or a subsidiary office of the agency making an application shall not be included in the costs to be paid from the Commission% grant. If a dam is to be built to serve purposes in addition to a sea lamprey barrier, the financial assistance provided by the Commission shall not exceed the costs that would have been incurred if the dam had been designed and built solely to act as a sea lamprey barrier.

3. Upon approval of ‘an application, the Commission shall enter into a contract, as provided in Section J, covering the use of the grant funds.

4. In the use of funds for barrier dams appropriated to the Commission by the Canadian Government, first priority will be given to construction of barrier dams on Canadian tributaries of the Great Lakes. In the use of funds for barrier dams appropriated to the Commission by the United States Government, first priority will be given to United States tributaries of the Great Lakes. When barrier dam construction is completed in either country, the Commission will review the total barrier dam program giving particular thought to provision for future funding of construction and maintenance requirements.

5. In acting upon applications for financial assistance to construct barrier dams, the Commission will be guided by the following considerations and procedures to be developed:

   a. Availability of funds.

   b. Priority rating of the barrier dam.

   c. Assurance by the applicant that the site can be acquired, and the dam constructed within a specific time.

   d. Assurance by the applicant of proper surveillance and maintenance of the dam.

I. APPLICATION FOR FINANCIAL ASSISTANCE

Application for financial assistance shall be made on a form provided by the Corn mission.

J. CONTRACT

The contract between the Commission and the agency receiving a grant shall include:

1. Description of the project to be undertaken.

2. Amount of the grant.

3. Requirement for appropriate progress and completion reports.

4. Requirement of an annual report on operation and maintenance of the project.

5. Appropriate provision excluding the Commission for liability relating to site acquisition, and construction, operation and maintenance of the barrier dam.

K. OPERATIONS

1. Submission, at the time of budget preparation by the Commission, by the States and the Canadian Agent, in accordance with its agreement with the Province of Ontario, of funding required for the next fiscal year for regular operation and maintenance of barrier dams constructed with Commission funds and of estimated requirements for the next two fiscal years for funds for the construction or major repair or reconstruction of lamprey barrier dams. Requests for funds for emergency repair or reconstruction of barrier dams may be submitted to the Commission at any time.

2. Continuation of barrier dam site acquisition and construction program, refined and modified on basis of preceding years' experience and results. To be done by Commission, Secretariat, United States and Canadian Agents, States and Province.

3. Concurrent analysis and evaluation of the results of the barrier dam program in terms of improved effectiveness and efficiency of lamprey control. To be done by the United States and Canadian Agents.

Adopted by the Great Lakes Fishery Commission, 16 June 1977.

Revised by the Great Lakes Fishery Commission, 9 September 1981.

A P P E N D I X 3

Terms of Reference

for

The Task Force to Assess the Sea Lamprey

Barrier Dam Program

Terms of Reference for the Task Group to Assess the GLFC Barrier Dam Program

In the May 1984 Executive Meeting of the GLFC, the Commission approved forming a Task Group to assess the Barrier Dam Program and appropriated $15,000 in barrier dam funds to support it.

Biette, Griswold and Lamsa met in Ann Arbor on August 22 to formulate the following schedule and outline the strategic approach for the Task Group.

A. OBJECTIVE

The objective of the task group is to evaluate the effectiveness of the GLFC barrier dam program from both a biological and economic perspective, to identify successes and shortcomings, and make recommendations concerning further development of barrier dam for control of sea lampreys throughout the Great Lakes.

B. MEMBERSHIP

Dr. Raymond Biette Co-chairman	Ontario Ministry of Natural Resources Fisheries Branch Queen's Park, Toronto, Ontario
Dr. Bernard Griswold[1] Co-chairman	U.S. Fish and Wildlife Service Great Lakes Fishery Laboratory Ann Arbor, Michigan
Dr. James Seelye[2]	U.S. Fish and Wildlife Service Hammond Bay Biological Service Hammond Bay, Michigan
Mr. Donald Reynolds	Michigan Department of Natural Resources Fisheries Division Lansing, Michigan
Mr. Paul Rugen	U.S. Fish and Wildlife Service Marquette Biological Station Marquette, Michigan
Dr. J. James Tibbles[3]	Department of Fisheries and Oceans Sea Lamprey Control Centre Sault Ste. Marie, Ontario
Mr. Aarne Lamsa	Great Lakes Fishery Coxmnission Ann Arbor, Michigan

The Co-Chairmen also wish to preservethe right to call upon other experts if and as the need arises.

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[1]Current affiliation: U.S. Department of Commerce National Sea Grant College Program
Marine Advisory Services
Rockville, Marylard

[2]Representative of the Great Lakes Fishery Commission's Board of Technical Experts (BOTE).

[3]Retired, October, 1 9 8 6

C. OUTLINE OF STRATEGIC APPROACH

I. **Background information on existing dams.**

II. Engineering
A. Collect existing information on GLFC guidelines
B. Designcriteria in use

III. Biological
A. Effectiveness in blocking lamprey
B. Fish passage/blockage
c. **Environmental** impact
D. Sits selection criteria between and within rivers

Iv, Administrative
A. Institutional arrangements
B. Procedural guidance
C. Legal
D. Funding
E. Dam removal

V. **Economic**
A. Use **background** information for costs
B. Identify benefits
C. Identify costs
D. Cost/benefit analysis

VI. Information needs
A. Gaps in knowledge, data, resear&needs
B. Experimental dam facility

VII. Recommendations

D. DETAILED OUTLINE OF' STRATEGY

I. **Background information on existing dams**
- A. **Location**
- **B. When constructed**
- c. cost
- D. Type
- E. Trapping facilities
- F. Special situations
- G. **Treatment cost without dam**
- H. Treatment saving with dam
- I. Other fish species for passage-blockage

II. Engineering
- A. Collect **existing information** on GLFC guidelines
- B. Designcriteria
  1. Adequacy of funding for **planning** function - **preengineering**
  2. What's needed for particular project - engineering perspective
  3. Selection criteria of dam sites

III. **Biological**
- A. Effectiveness in blocking lamprey
  1. Analysis of known information
  2. Inspection-representative sites
     - a. Large dam
     - **b. Low head dams**
     - c. **Multi-purpose** darns
- B. Fish passage/blockage
  1. **Evaluate concern**
  2. Evaluate passage facilities - inspection
  3. **Evaluate represen**tative public perceptions
  4. **Examine philosophical attitudes related to management approach**
  5. Monitor fish **populations**
- c. **Environmental impact**
  1. **Reduced exposure** to lampricide
  2. Effects of **impoundment**
  3. Aesthetics
  4. Effects of dam on non-target organisms
- D. Site selection criteria between and within rivers

Iv. Administrative
- **A. Institutional arrangements**
  1. **Define present arrangements**
  2. Evaluate effectiveness in building dams and addressing other user **needs**
- **B. Procedural guidance**
  1. **Define and evaluate approval/review process**
  2. **Define and evaluate contracting procedures**
- c. Define legal **responsibilities**
- **D. Funding**
  1. **Adequacy**

a. For construction
b. Projection of money required for next:
(1) 5 year period
(2) 10 year period
c. For maintenance
(1) existing
(2) 5 years
(3) 10 years

E. Dam removal - manipulation by others
1. Extent of problem
2. Examples
3. Procedure to deal with this

V. Economic
A. Use background information for costs
B. Identify benefits
C. Identifycosts
1. Construction
2. Maintenance
3. Biological
D. Cost/benefit analysis using best approach to quantification that information allows

VI. Identify Information needs
A. Gaps in knowledge, data, research needs
B. Experimental dam facility

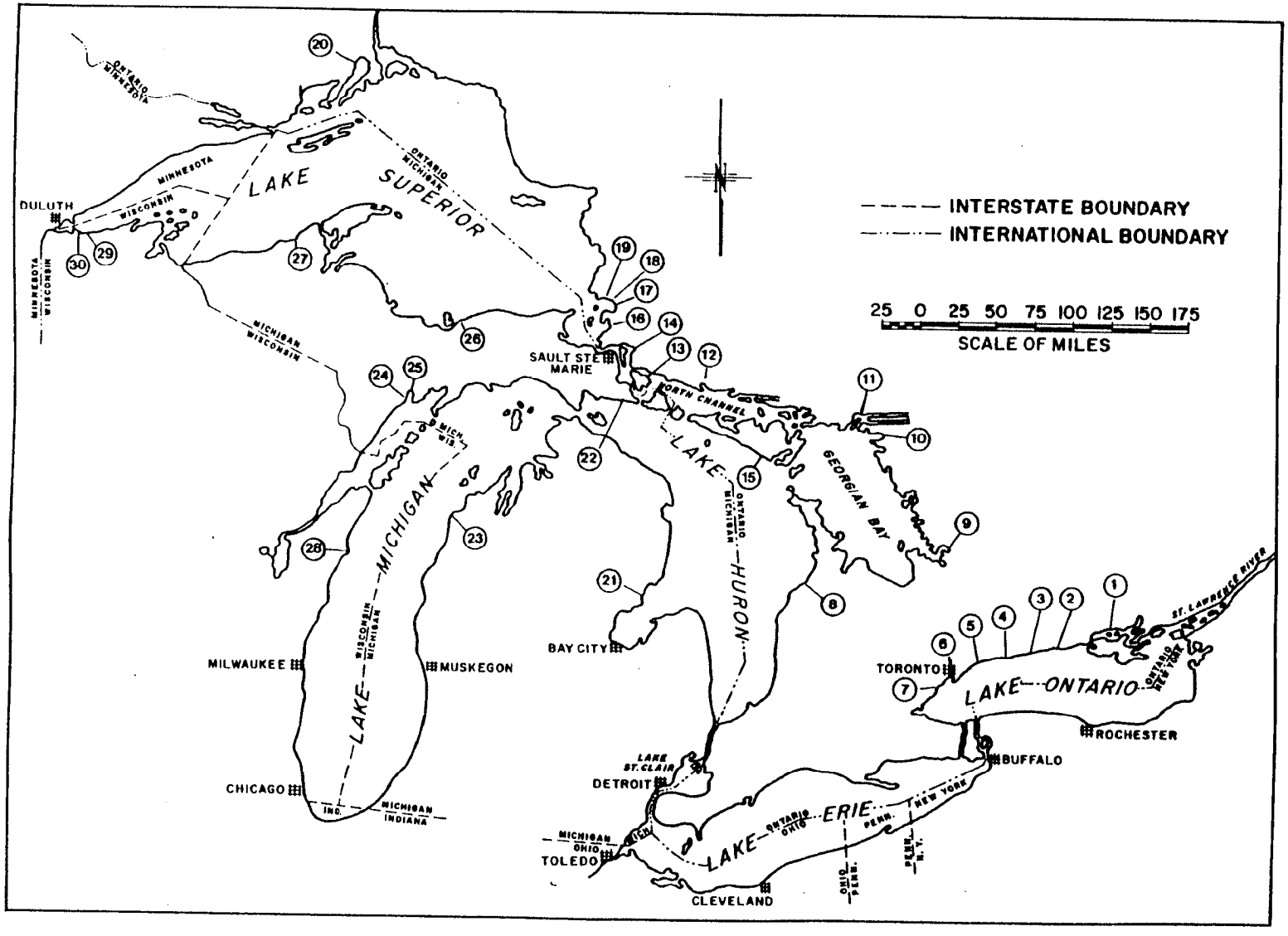
VII. Recommendations

A P P E N D I X 4

Map of the Great Lakes Showing Location

of

Sea Lamprey Barrier Dams



Tributaries

A. Ontario

1. Salmon
2. Lakeport
3. Shelter Valley
4. Graham
5. Duffin
6. Humber
7. Credit
8. Saugeen
9. Sturgeon
10. Still
11. French
12. Harris
13. Kaskawong
14. Echo
15. Manitou
16. Sheppard
17. Stokely
18. Carp (Sable)
19. Gimlet
20. Black Sturgeon

B. Michigan

21. East Branch AuGres
22. Albany
23. Betsie
24. Days
25. Whitefish West Branc
26. Miners
27. Misery

C. Wisconsin

28. East Twin
29. Brule
30. Middle

Map of the Great Lakes showing the tributaries where the 30 sea lamprey barriers are located.

A P P E N D I X 5

Information Matrix

on

Sea Lamprey Barrier Dams

A. Ontario Sea Lamprey Barrier Dams

Tributary	Discharge m^3/s (cfs)	Lake	Location Lat N	Location Long W	Township	Const. Year	Type	Features
1. Salmon	10.3 (386)	Ontario	44°13'	77°13'	Village of Shannonville	1974-80	modified old mill dam	
2. Lakeport	0.45 (16)	Ontario	43°59'	77°54'	Cramahe	1984	low head dam, concrete	built-in lamprey trap, jumping pool
3. Shelter Valley	0.85 (30)	Ontario	43°58'	78°00'	Haldimand	1985	low head dam, concrete	built-in lamprey trap, jumping pool, removable steel plates for passing salmonids
4. Graham	0.88 (31)	Ontario	43°54'	78°35'	Town of Newcastle	1983	low head dam, steel sheet piling	built-in lamprey trap, jumping pool, curved overhang lip
5. Duffin	2.75 (98)	Ontario	43°50'	79°03'	Town of Pickering	1980 1984	low head dam, steel sheet piling	built-in lamprey trap, junpiny pool
6. Humber	5.8 (207)	Ontario	43°39'	79°29'	City of Toronto	1981-82	flood control structure	addition of lamprey traps to structure
7. Credit	7.9 (282)	Ontario	43°34'	79°42'	Town of Streetsville	1980-81	reconstructed old mill dam	fishway
8. Saugeen	56.3 (2,011)	Huron	44°30'	81°19'	Saugeen	1969-70	concrete multi-purpose dam	built-in lamprey trap, fishway
9. Sturgeon	1.3 (46)	Huron	44°43'	79°43'	Tay	1979	low head dam, steel sheet piling	fish pass gate for passiny salmonids, jumping pool
10. Still	2.3 (82)	Huron	45°49'	80°32'	Henvey	1986	low head dam, steel sheet piling	built-in lamprey trap with connecting pipe, jumping pool

A. Ontario Sea Lamprey Barrier Dams (Continued)

Tributary	Discharge m^3/s (cfs)	Lake	Location Lat N	Location Long W	Township	Const. Year	Type	Features
11. French	180.0 (6,428)	Huron	46°00'	80°31'	Blair	1969-70	improved natural falls	
12. Harris	0.4 (14)	Huron	46°18'	83°02'	Day	early 1950's	modified culvert 1.4m drop	
13. Kaskawong	0.51 (18)	Huron	46°09'	83°50'	Hilton	1980,81	low head dam, concrete	built-in lamprey trap, jumping pool
14. Echo	3.4 (121)	Huron	46°34'	83°56'	Kehoe	1971-83	1.2m timber crib dam	built-in lamprey trap
						1986	low head dam, steel sheet piling	built-in lamprey trap with connecting pipe
15. Manitou	2.6 (93)	Huron	45°36'	82°06'	Tehkummah	1983	improved natural falls	jumping pools
16. Sheppard	1.2 (43)	Superior	46°45'	84°12'	Deroche	1984	low head dam, gabions and mortar	junping pool
17. Stokely	0.8 (28)	Superior	46°48'	84°24'	Havilland	1980,84	low head dam, steel sheet piling	built-in lamprey trap, jumping pool
18.Carp(Sable)	1.25 (45)	Superior	46°57'	84°34'	Fisher	1983	low head dam, steel sheet piling	built-in lamprey trap, junping pool
19. Gimlet	0.51 (18)	Superior	46°50'	84°39'	Herrick	1979-80	low head dam, steel sheet piling	junping pool
20. Black Sturgeon	24.2 (864)	Superior	48°55'	88°23'	Lyon	1966-68	modified provincial dam	

B. Michigan Sea Lamprey Barrier Dams

Tributary	Discharge m^3/s (cfs)	Lake	Location Lat N	Location Long W	County	Const. Year	Type	Features
21. AuGres East Branch	2.80 (100)	Huron	44°13'	83°42'	Iosco	1983	low head dam, concrete	stop logs for drawdown, lamprey trap (portable), added jumping pool,
						1986	modified	coffer dam
22. Albany	0.56 (20)	Huron	45°59'	84°05'	Chippewa	1985	low head dam, concrete	hinged gate for lowering crest, jumping pool, lamprey trap (portable)
23. Betsie .	2.8 (100)	Michigan	44°36'	86°05'	Benzie	1974	replacement of old dam, steel sheet piling	permanent crest, jumping pool
24. Days	2.2 (78)	Michigan	45°54'	87°02'	Delta	1983	low head dam, concrete	lift gate for drawdown, jumping pool, lamprey trap (portable)
25. Whitefish West Branch	9.8 (350)	Michigan	46°11'	86°58'	Alger	1980	low head dam, concrete	permanent crest, jumping pool, lamprey trap (portable)
26. Miners	1.26 (45)	Superior	46°29'	86°32'	Alger	1978	>lm head dam, concrete	stop logs for drawdown, lamprey traps (portable)
27. Misery	1.26 (45)	Superior	46°59'	88°59'	Ontonagon	1984	low head dam, concrete	slide gate for drawdown. jumping pool, lamprey trap (portable)

C. Wisconsin Sea Lamprey Barrier Dams

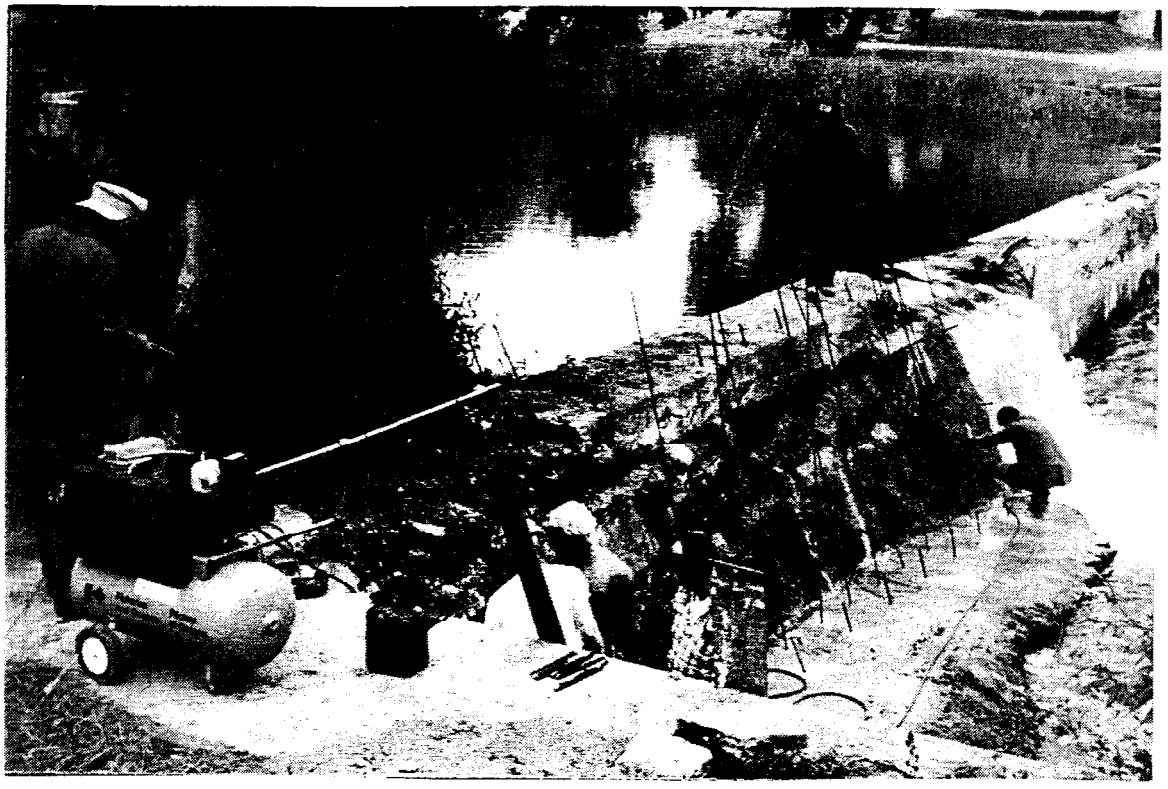
Tributary	Dis- Charge m^3/s (cfs)	Lake	Location Lat N	Location Long W	County	Const. Year	Type	Features
28. East Twin	1.68 (60)	Michigan	44°14'	87°38'	Manitowoc	1978	modified existing dam	stop logs for drawdown
						1983	repaired	
29. Brule	5.32 (190)	Superior	46°42'	91°36'	Douglas	1984	concrete >lm head dam	lamprey trap (portable), stop logs for drawdown, jumping pools
						1986	replacement	fish ladder, built-in lamprey trap, observation chamber
30. Middle	1.12 (40)	Superior	46°39'	91°48'	Douglas	1983	low head dam	lamprey trap (portable), jumping pool

A P P E N D I X 6

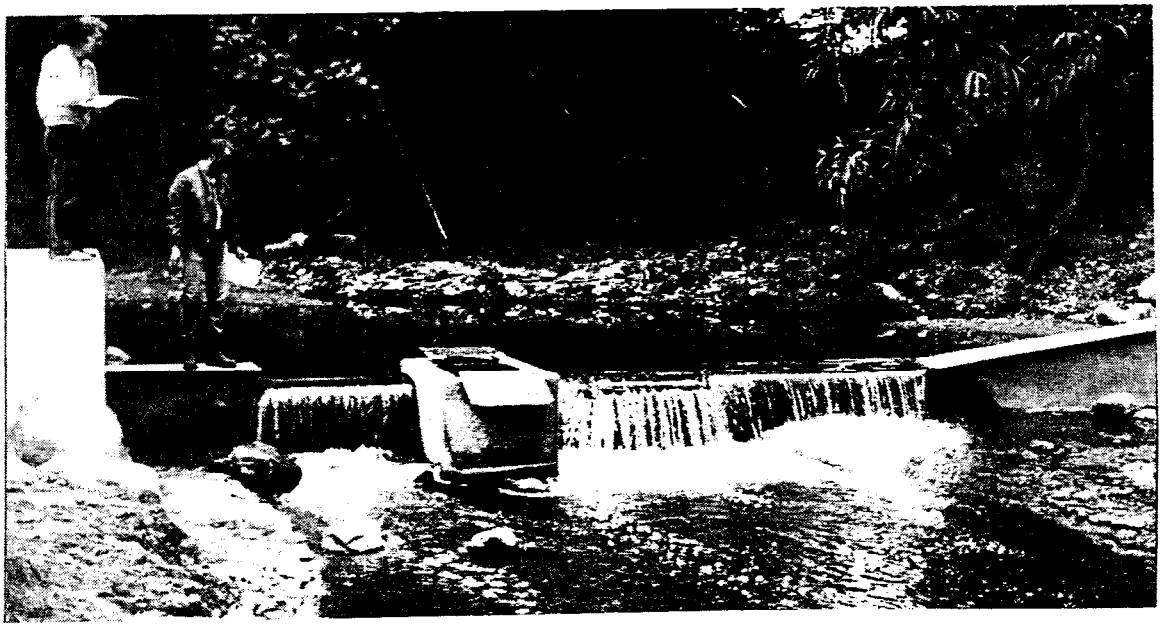
Photographs

of

Sea Lamprey Barrier Dams

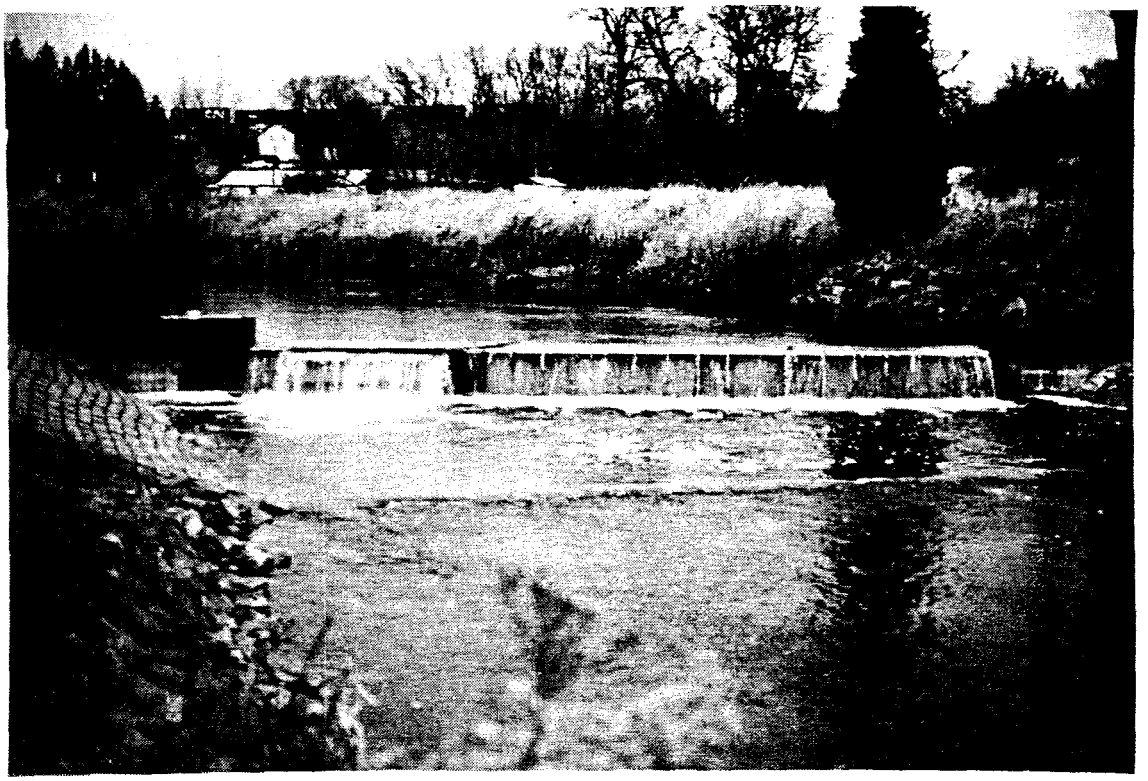


1. Sea lamprey barrier dam on the Salmon River, Lake Ontario, Ontario. Recent maintenance to the face of the old mill dam that was modified in the 1970's to block the passage of spawning-phase sea lamprey.

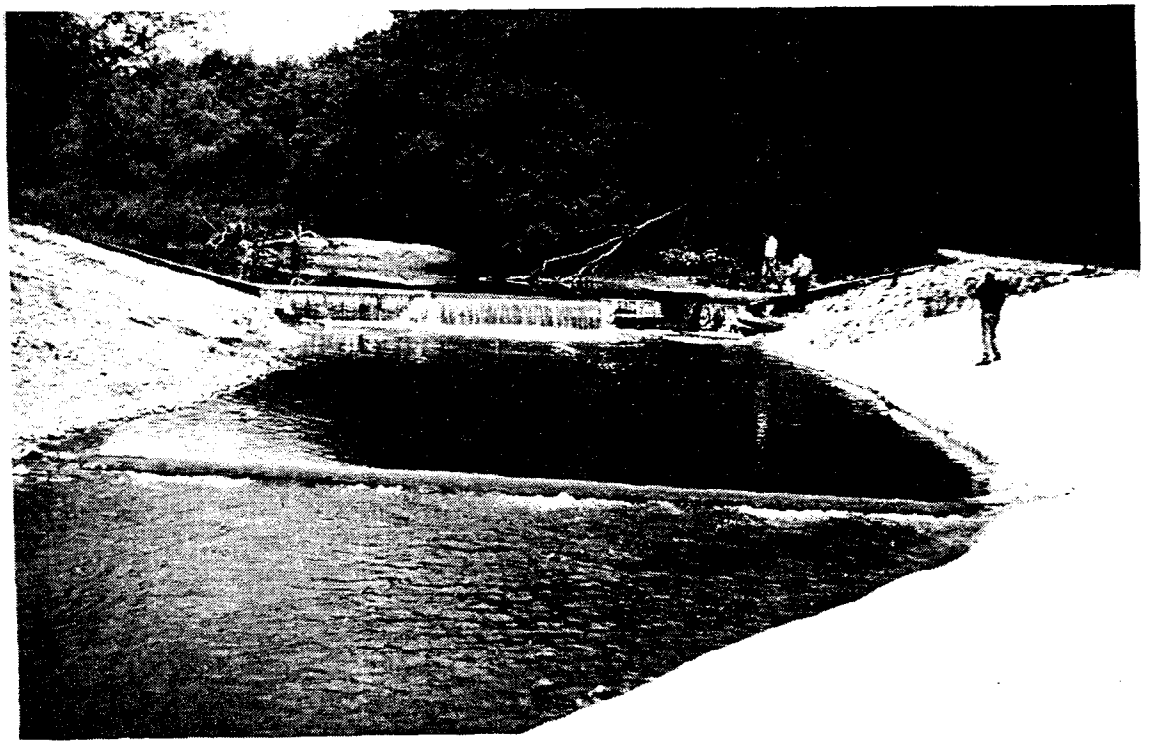


2. Sea lamprey barrier dam on Lakeport Cre&; Lake Ontario, Ontario. It is a low head lamprey barrier dam with a built-in lamprey trap constructed in 1984.

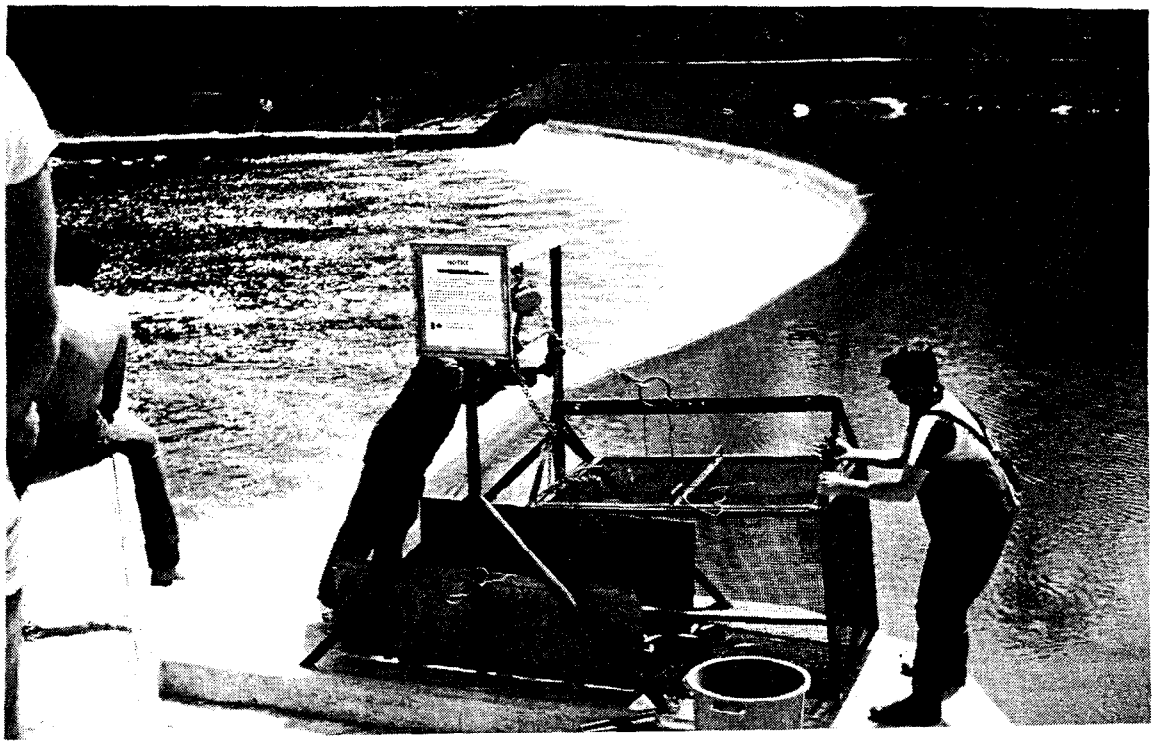
Note: Barriers are numbered in the same order as those in the Matrix (Appendix 5)



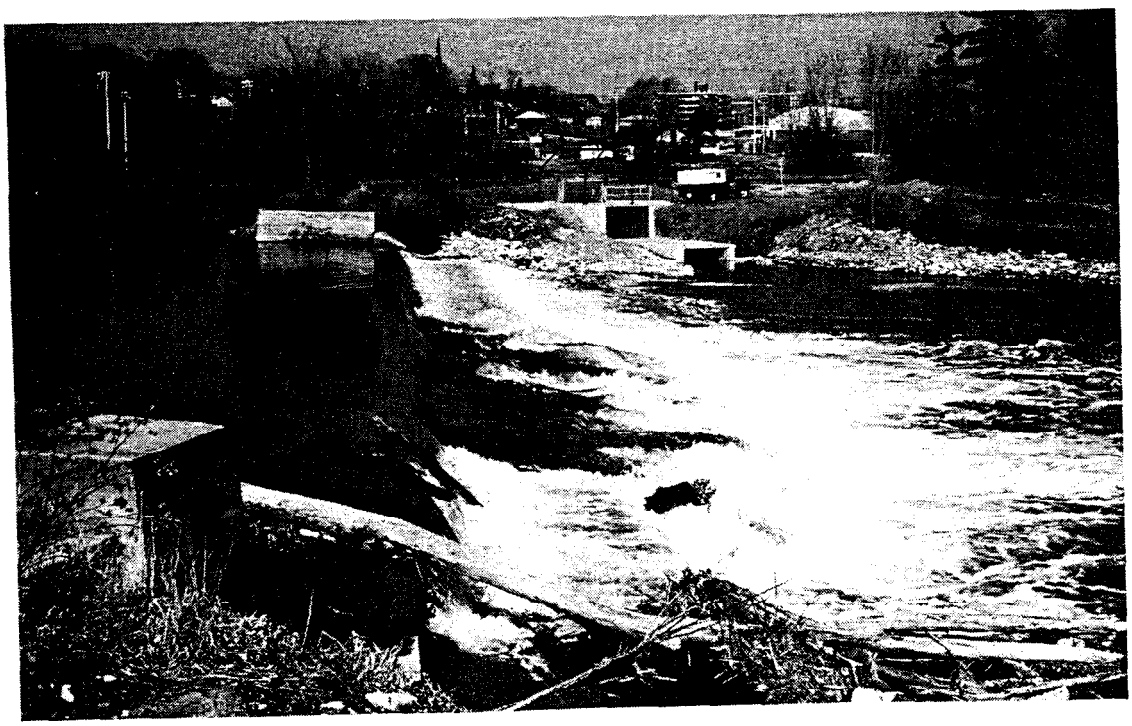
4. Sea lamprey barrier dam on Graham Creek, Lake Ontario, Ontario. It is a low head barrier dam constructed of steel sheet piling in 1983 and has a built-in lamprey trap and jumping pool.



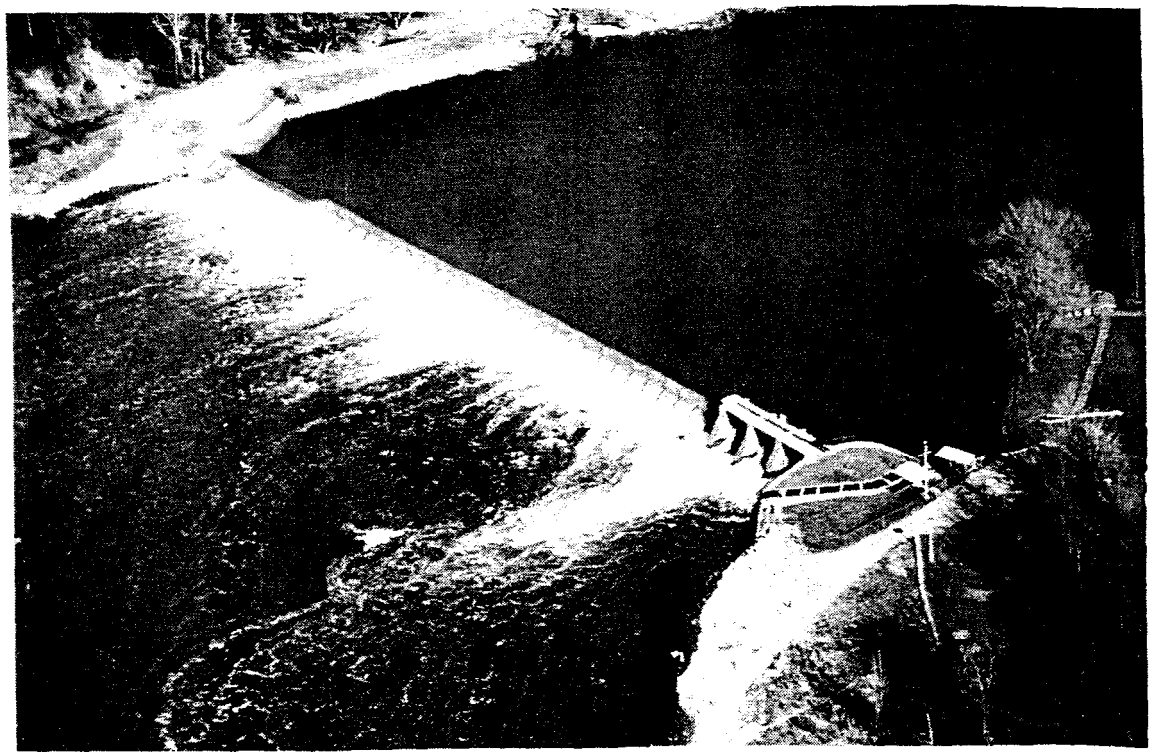
5. Sea lamprey barrier dam on Duffin Creek, Lake Ontario, Ontario. It is a low head barrier dam constructed of steel sheet piling and has a built-in lamprey trap and jumping pool. Note the structure downstream from the barrier to elevate and maintain the head of the jumpiqpool.



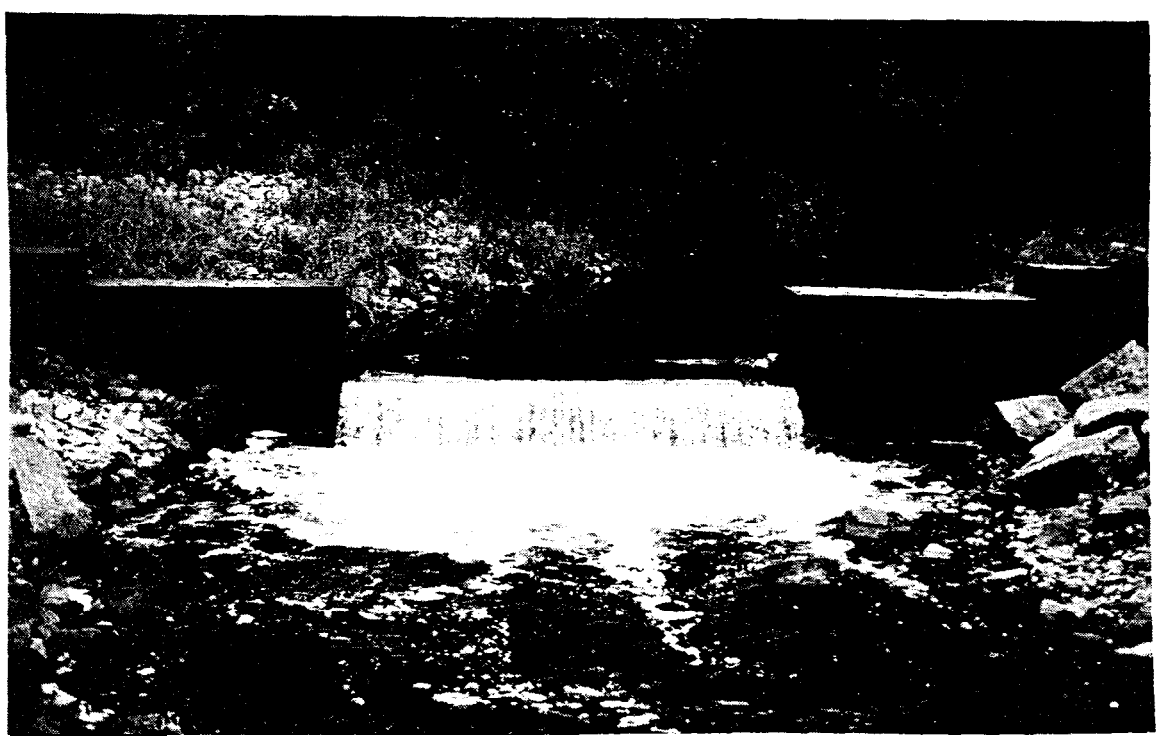
6. Sea lamprey trap on the Humber River, Lake Ontario, Ontario. The lamprey trap is incorporated to a flood control structure. A sign explaining the lamprey control program is shown as well.



7. Sea lamprey barrier dam on the Credit River, Lake Ontario, Ontario. The barrier dam was reconstructed in 1980-81 from an existing mill dam. A fishway built by the province is shown as well.

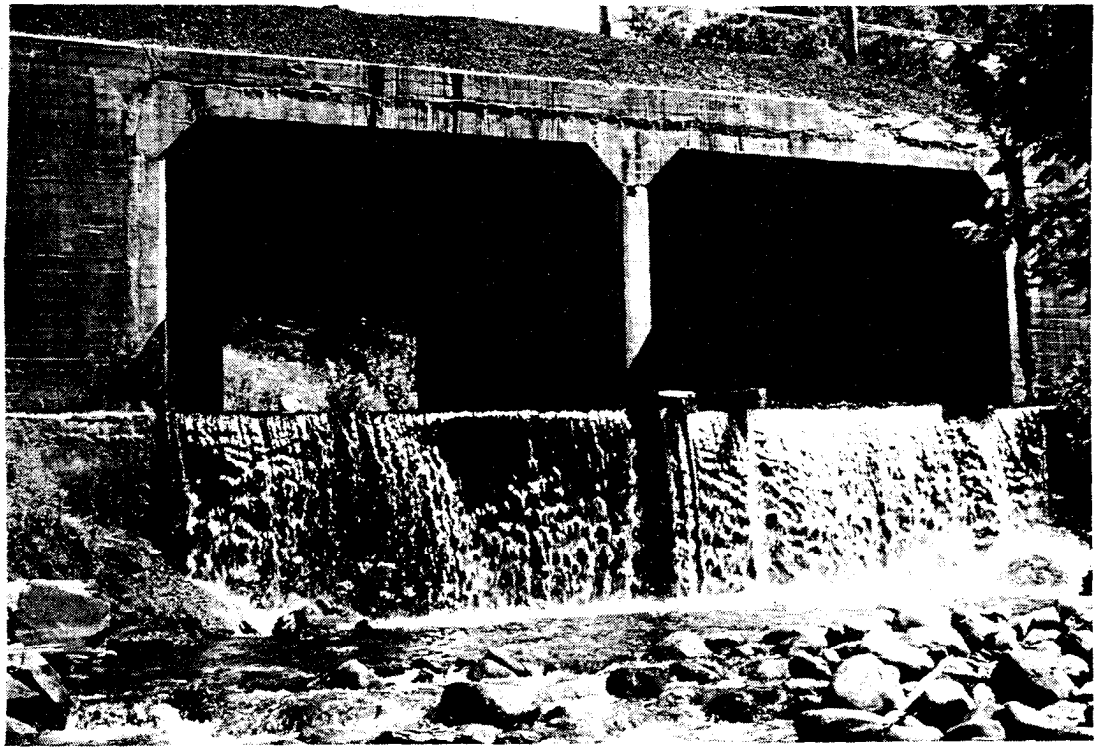


8. Sea lamprey barrier dam on the Saugeen River, Lake Huron, Ontario. This is the first barrier dam constructed in Ontario. It is a large multi-purpose dam, 180 m long (600 ft) and 2.7 m high (9 ft), built in 1969-70 with federal-provincial funds. A fishway and a lamprey trap are included.

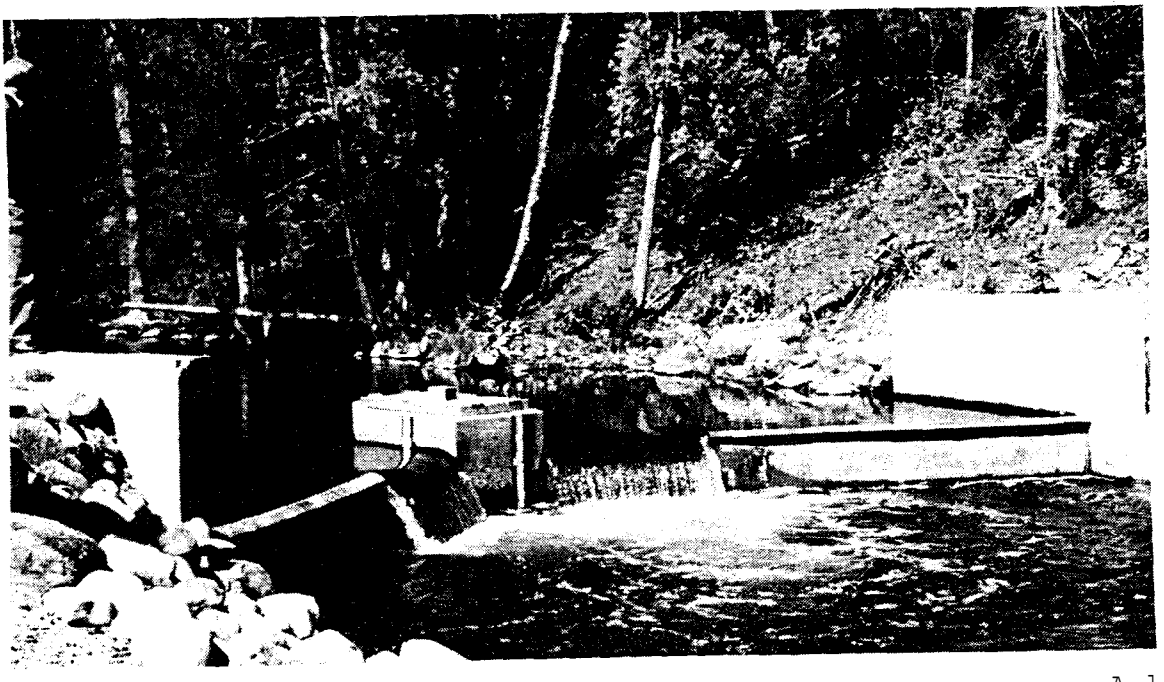


9. Sea lamprey barrier dam on the Sturgeon River, Lake Huron, Ontario. It is one of the earlier low headbarrier dams constructed in 1979 with steel sheet piling. It has a fish pass gate and jumping pool for passing jumping salmonids, but no lamprey trap.

Note: Photographs for sites No. 10 (Still River) and No. 11 (French River) are not included.



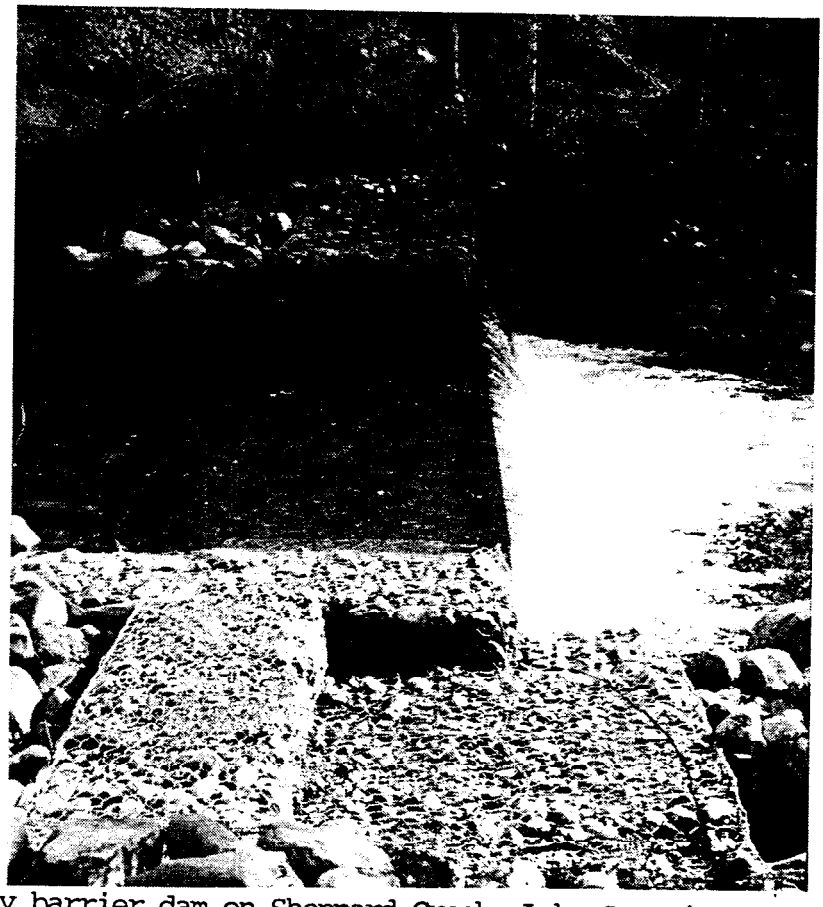
12. Sea lamprey barrier dam on Harris Creek, Lake Huron, Ontario. A culvert was modified to block sea lamprey migrations.



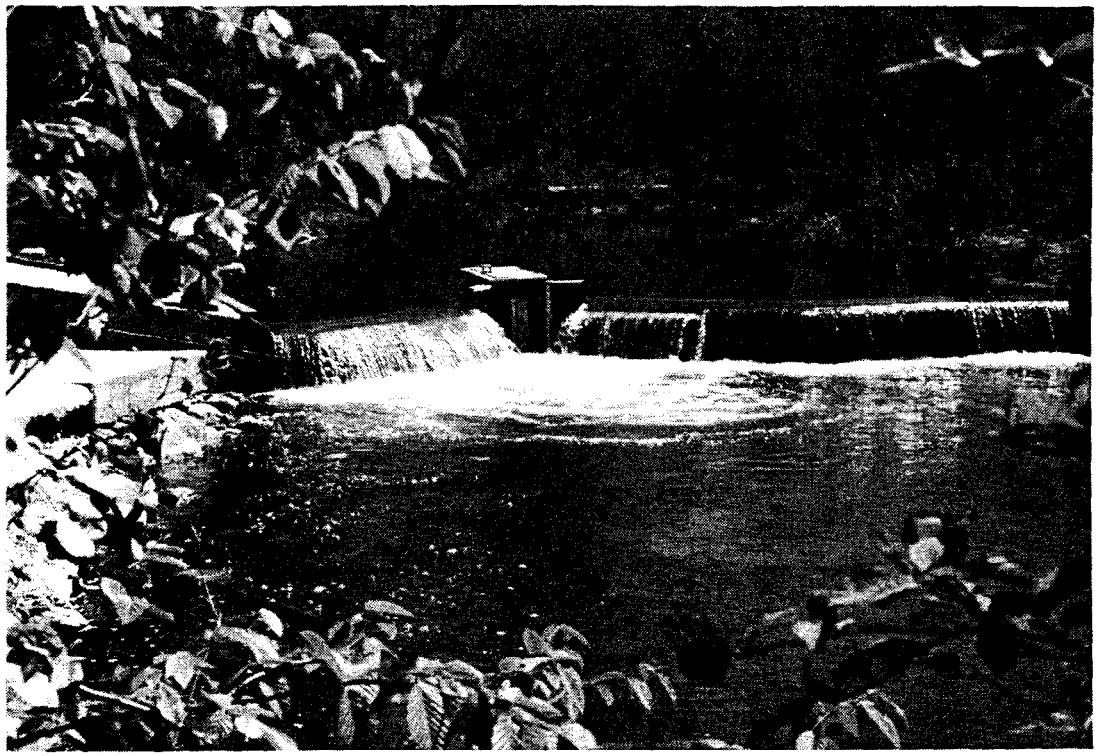
13. Sea lamprey barrier dam on Kaskawong River, Lake Huron, Ontario. A low head barrier dam constructed in 1980-81 of concrete. It has a built-in lamprey trap and jumping pool.

Note : Photograph for site No. 15 (Manitou River) is not included.

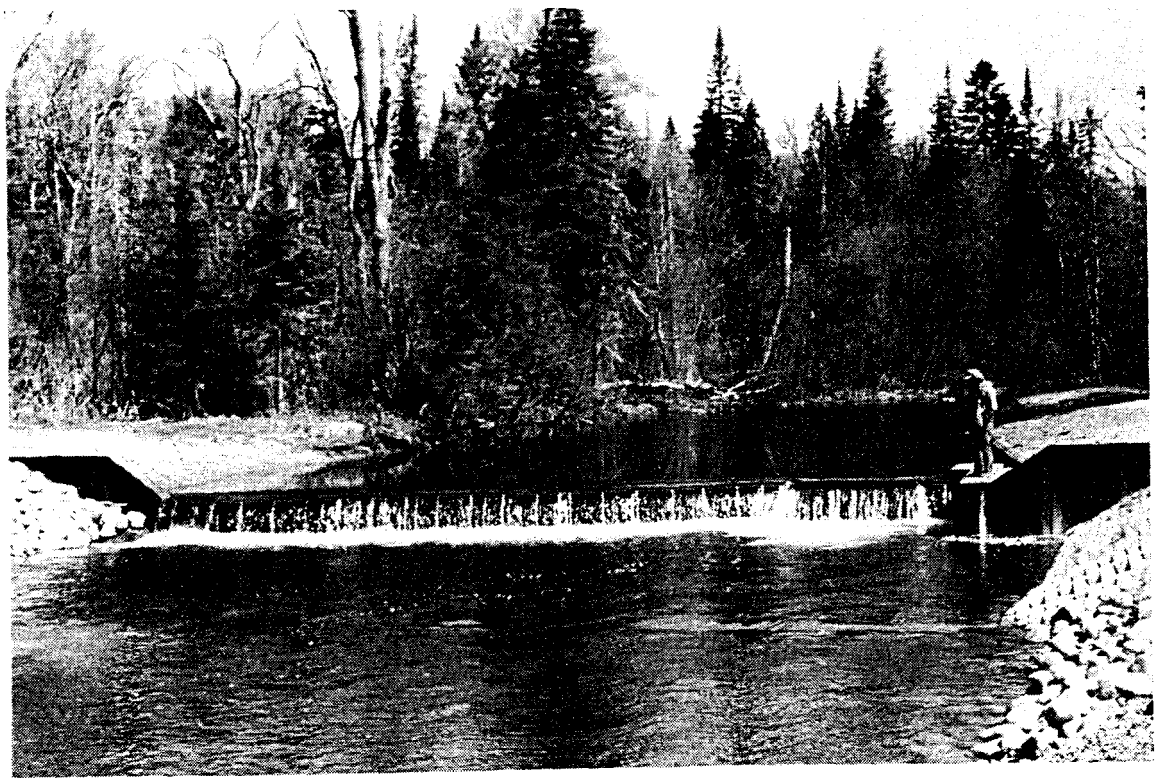
14. Sea lamprey barrier dam on the Echo River, Lake Huron, Ontario. A 1.2 m (4 ft) dam constructed in the early 1970's with timber cribs. This structure is being replaced in 1986 with a new dam constructed of steel sheet piling.



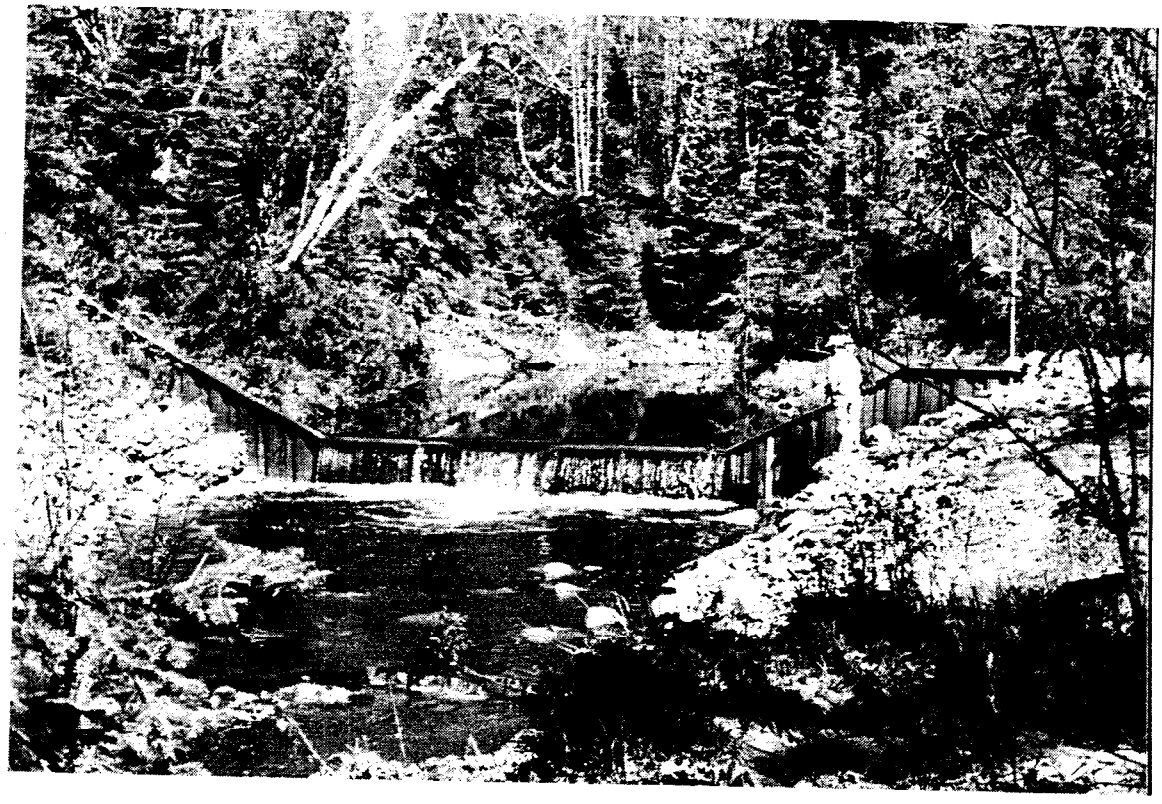
16. Sea lamprey barrier dam on Sheppard Creek, Lake Superior, Ontario. It is a low head barrier dam constructed in 1984 with gabions and has a jumping pool, but no lamprey trap.



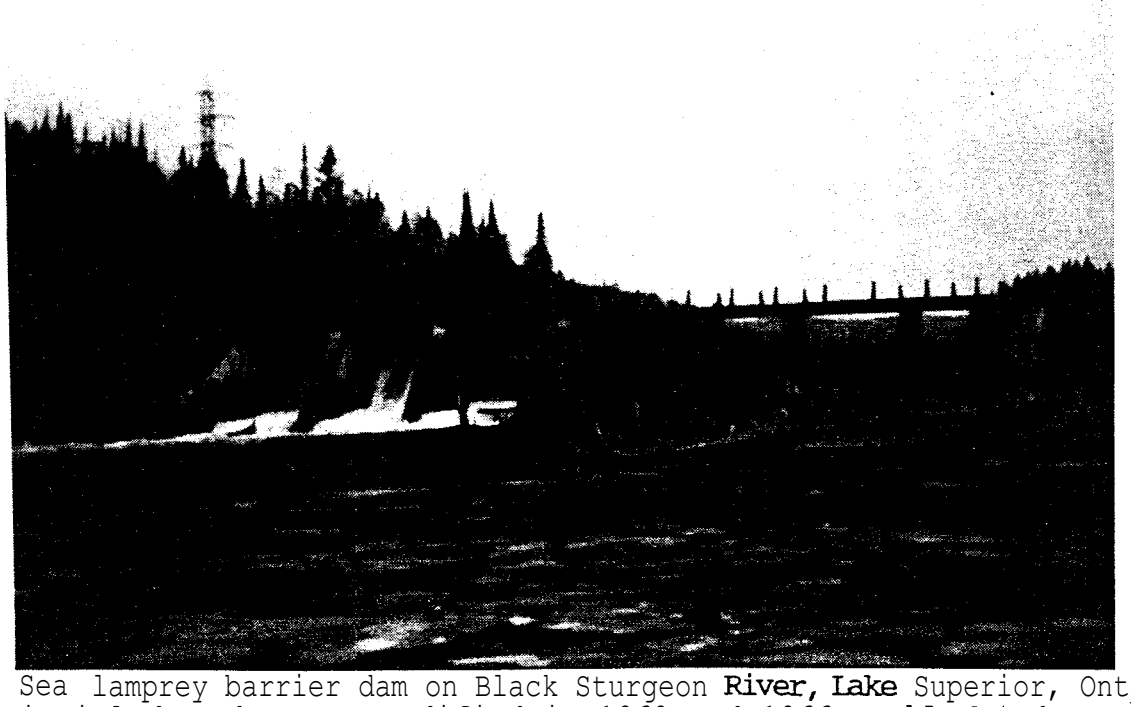
17. Sea lamprey barrier dam on Stokely Creek, Lake Superior, Ontario. A low head barrier dam constructed with steel sheet piling in 1980. It has a built-in lamprey trap and jumping pool.



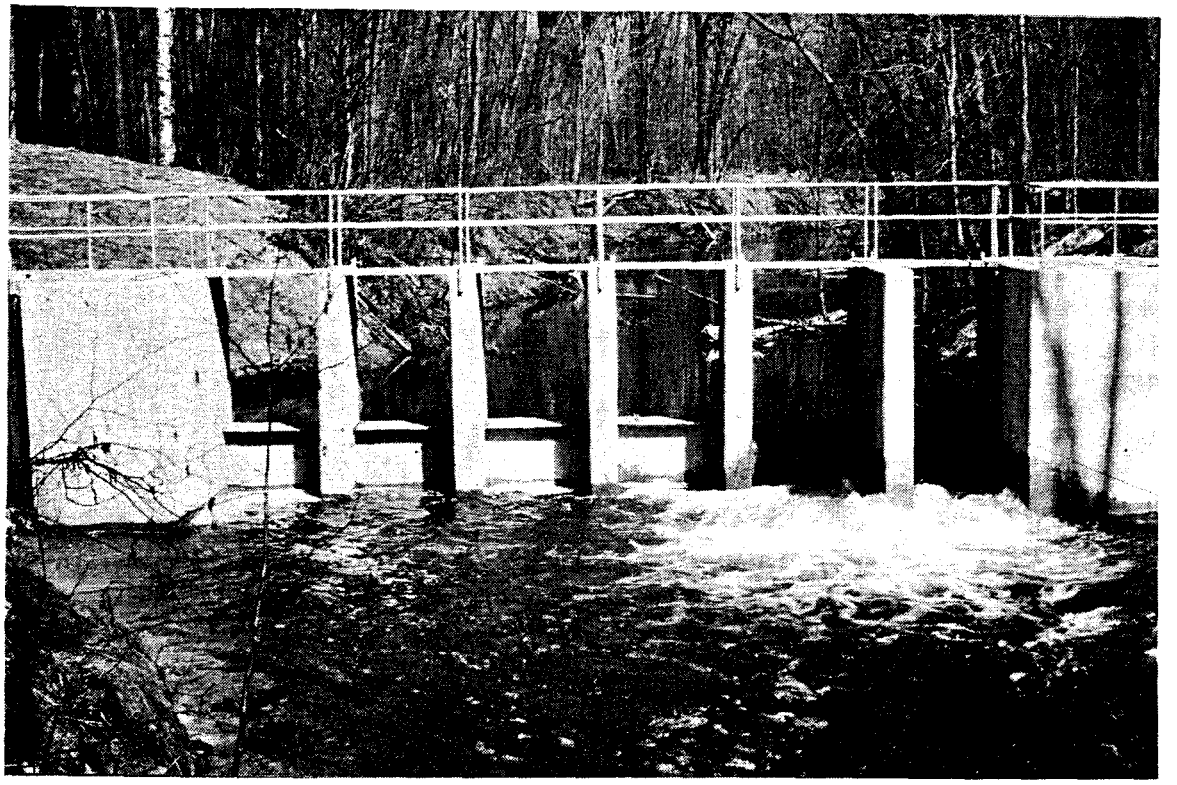
18. Sea lamprey barrier dam on Carp River (Sable), Lake Superior, Ontario. A low head barrier dam constructed with steel sheet piling in 1983. It has a built-in lamprey trap and jumping pool.



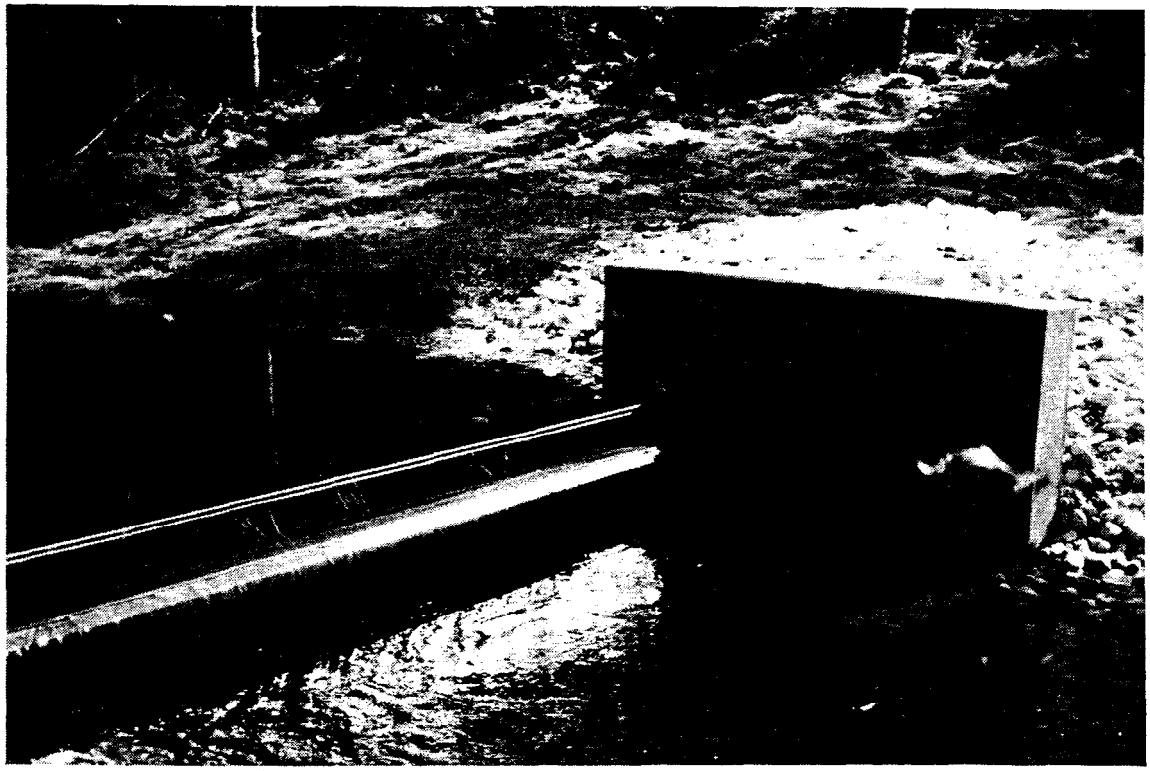
19. Sea lamprey barrier dam on Gimlet Creek, Lake Superior, Ontario. It is one of the earlier low head barrier dams constructed in 1979-80 of steel sheet piling and has a jumping pool, but mtatrap for lamprey.



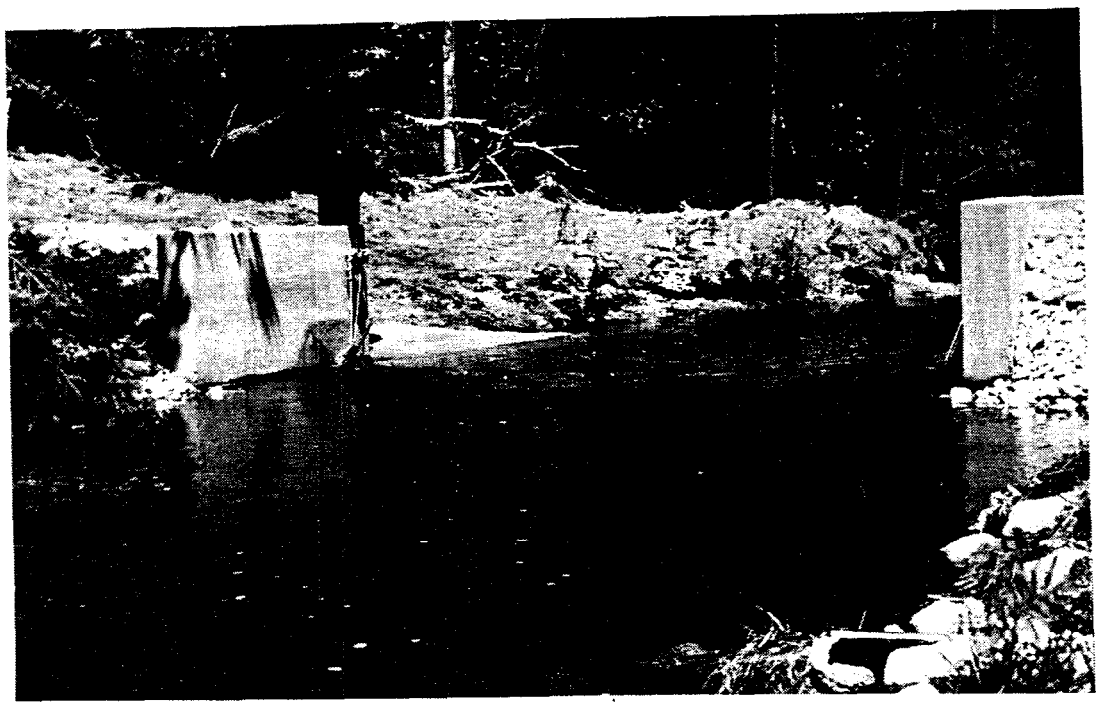
20. Sea lamprey barrier dam on Black Sturgeon River, Lake Superior, Ontario. A provincial dam that was modified in 1960 and 1966 to block the passage of spawning-phase sea lamprey.



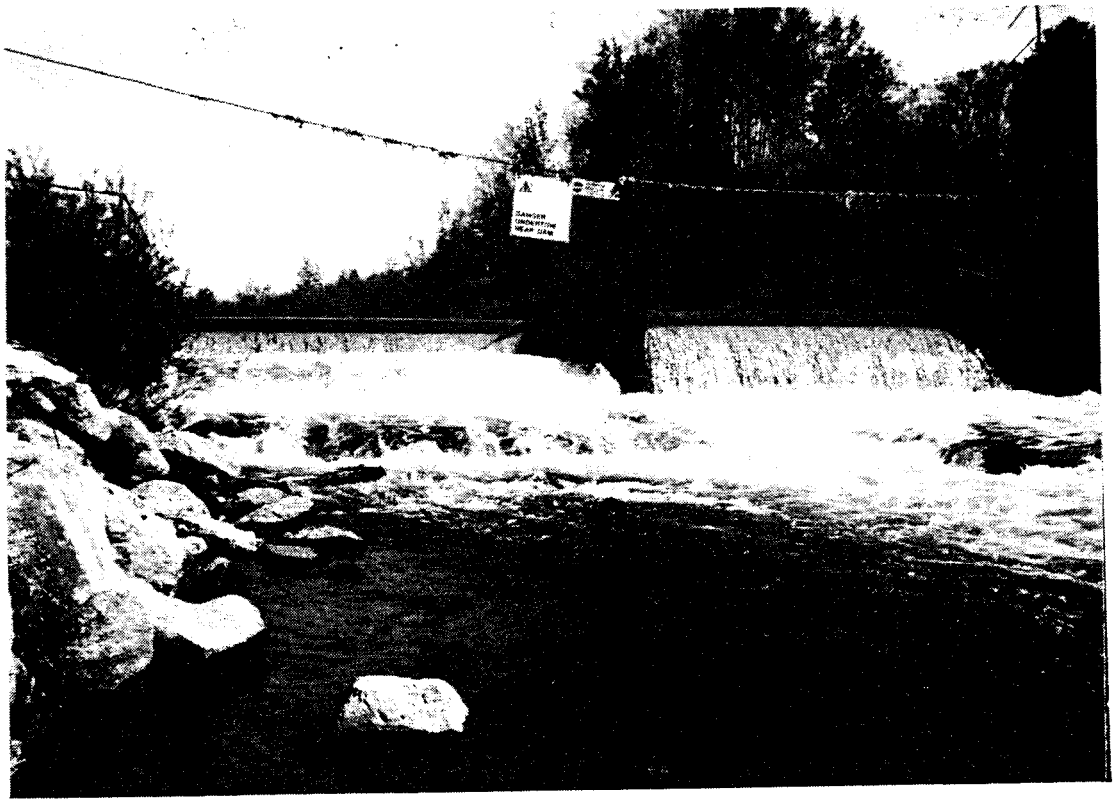
21. Sea lamprey barrier dam on the East Branch of AuGres River, Lake Huron, Michigan. A low head concrete dam constructed in 1983 with 2 stop-log bays to permit drawdown. In 1986 a coffer dam was constructed downstream to elevate the tailwater level and a jumping pool was added in the area of the stop log bays to facilitate fish passage. It has facilities for attaching portable assessment traps.



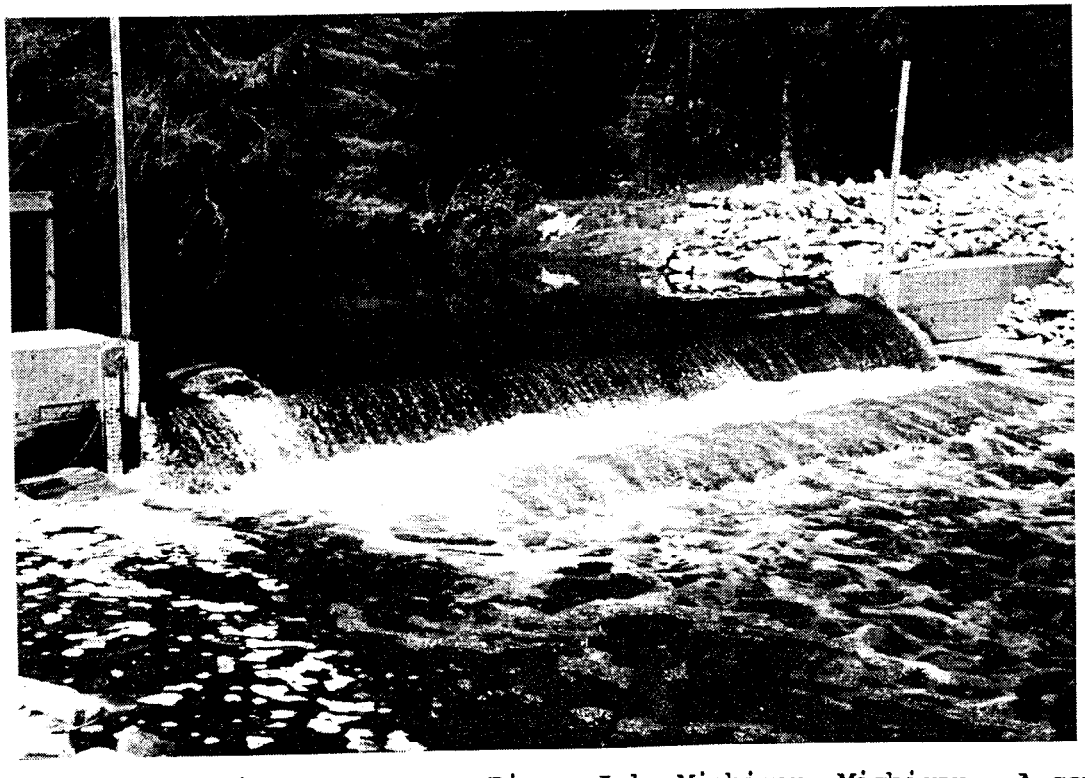
22a. Sea lamprey barrier dam on Albany Creek, Lake Huron, Michigan. The dam has a hinged gate to permit lowering during the non-lamprey migration period as well as a jumping pool and portable assessment traps. Adjustment of the height of the barrier is achieved by a cable and manual winch.



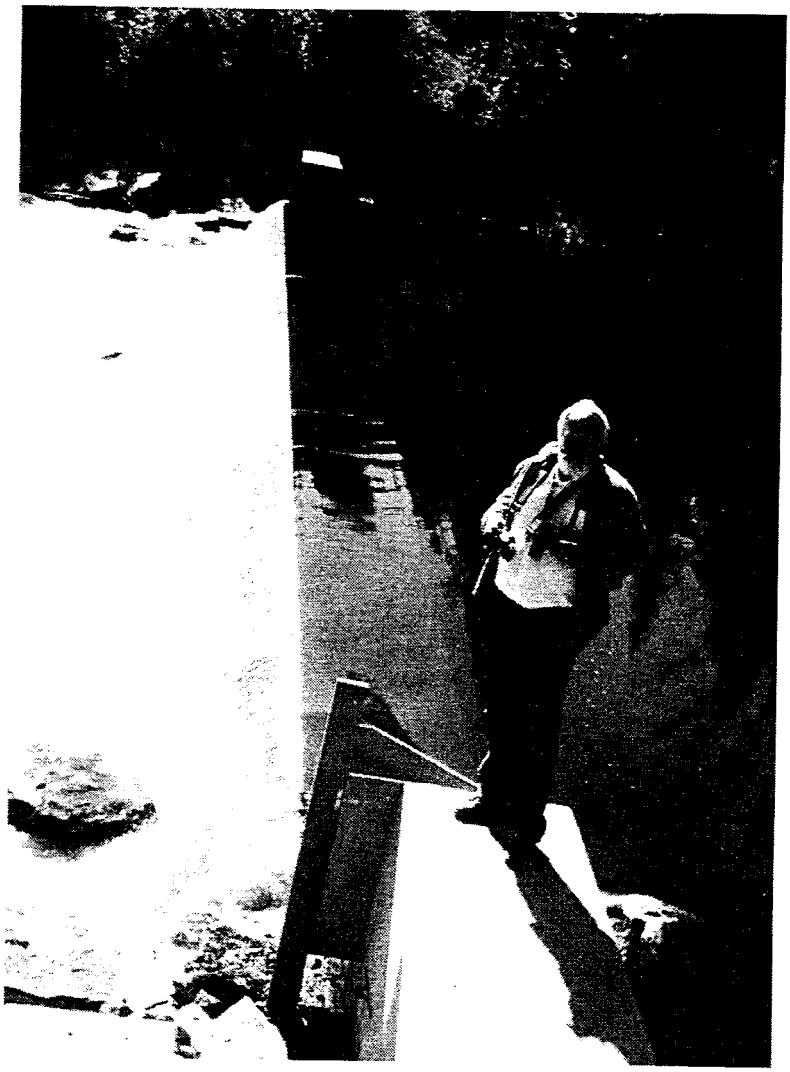
22b. Barrier dam on Albany Creek in July with gate lowered to allow for fish passage.



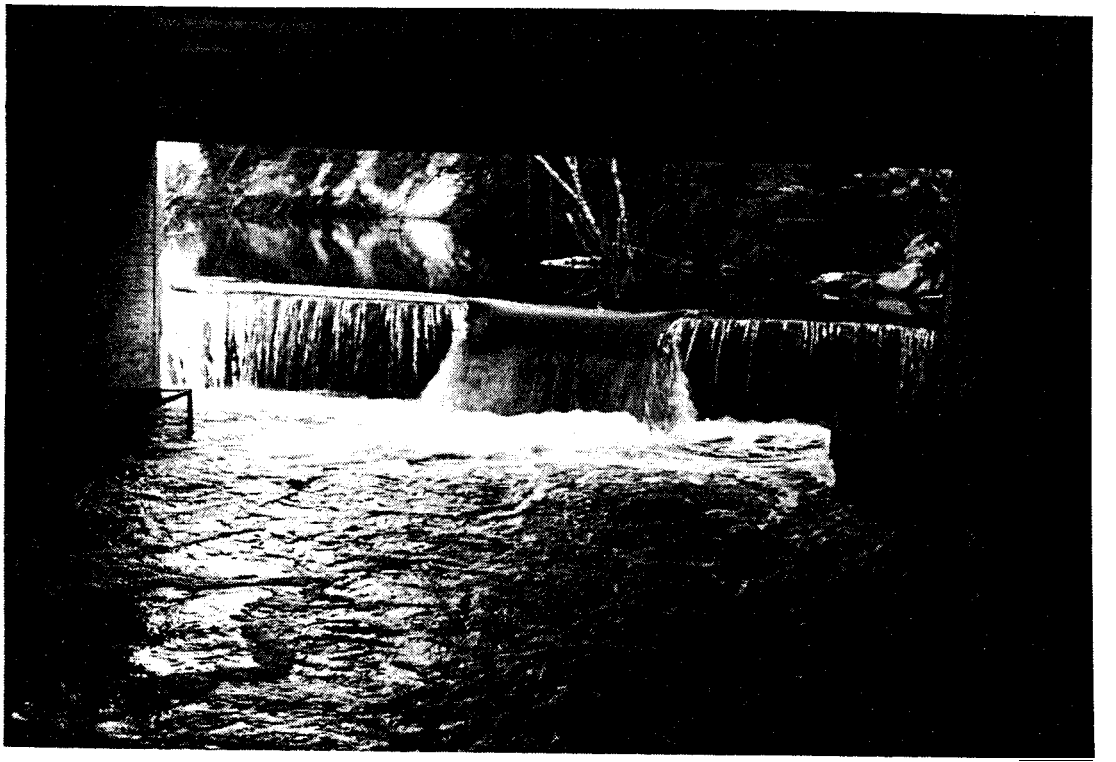
23. Sea lamprey barrier dam on the Betsie River, Lake Michigan, Michigan. An old hydra-electric dam was replaced in 1974 using Anadromous Fish Conservation Funds. It is a steel sheet piling structure, 1.8 m high (6 ft) and has a jumping pool.



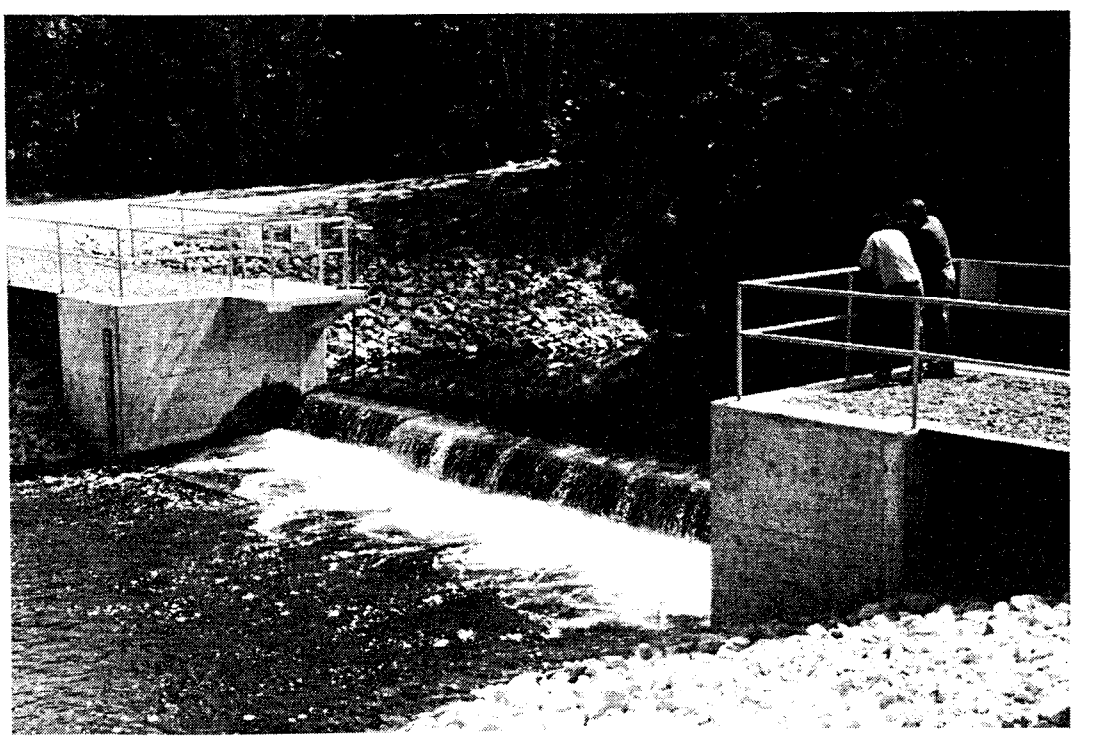
24. Sea lamprey barrier dam on Days River, Lake Michigan, Michigan. A concrete low head barrier dam constructed in 1983 with a lift gate to permit drawdown. It has a jumping pool and portable assessment traps.



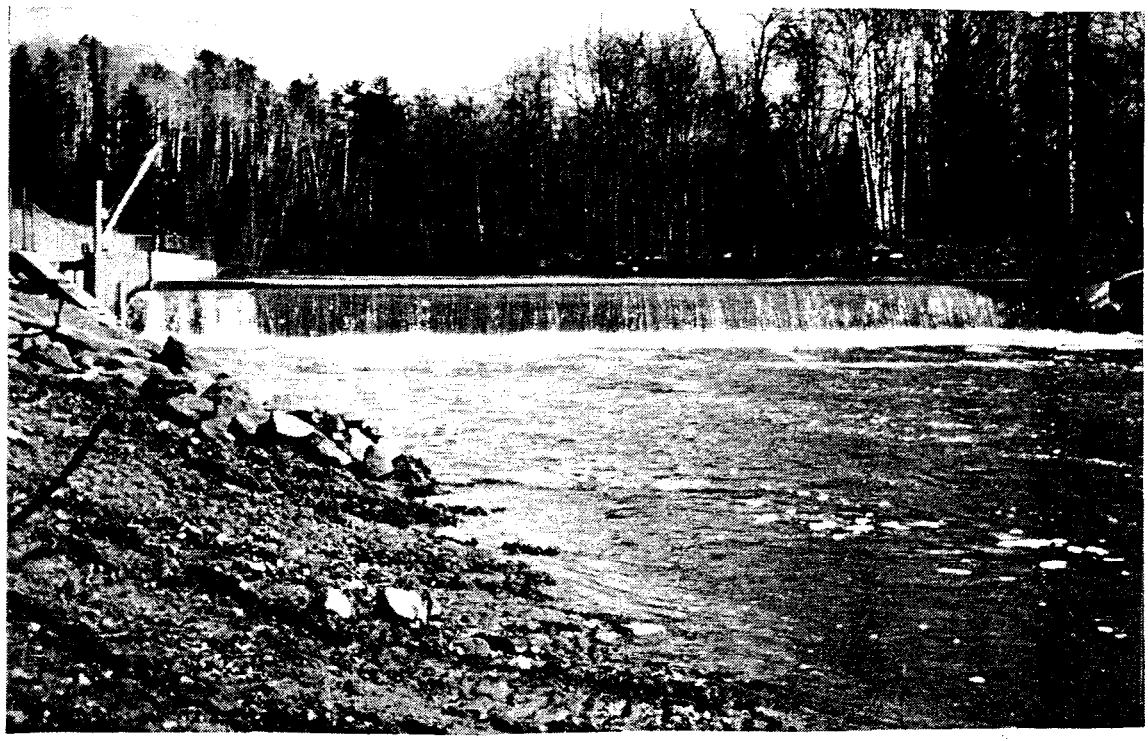
25. Sea lamprey barrier dam on West Branch of Whitefish River, Lake Michigan, Michigan. A low head concrete dam constructed in 1980. It has a permanent crest, jumping pool and portable assessment traps.



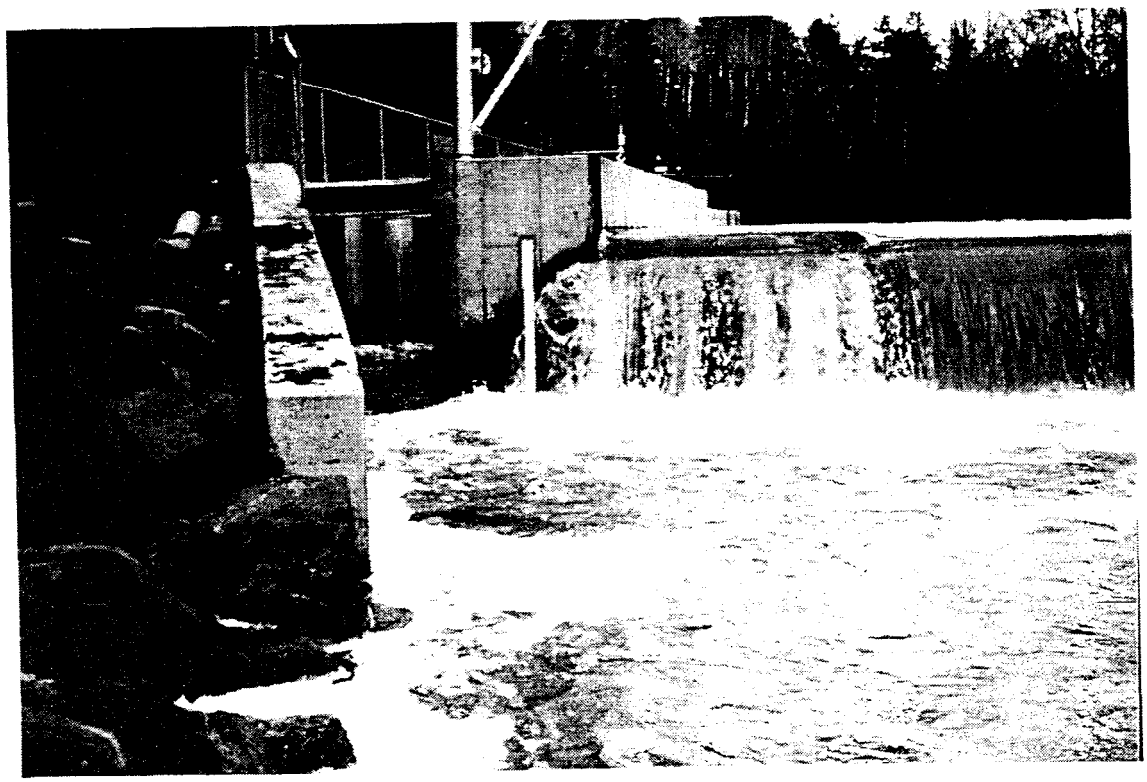
26. Sea lamprey barrier dam on Miner's River, Lake Superior, Michigan. A > 1 m head concrete dam constructed in 1978 with stop logs to permit drawdown. It has a jumping pool and portable assessment traps.



27. Sea lamprey barrier dam on the Misery River, Lake Superior, Michigan. A low head barrier dam constructed of concrete in 1984 with a slidegate to permit drawdown. It has a jumping pool and portable assessmenttra~.
Note: **Photograph for site No.** 28 (East Twin River) is not included.



29a. Sea lamprey barrier dam on the Brule River, Lake Superior, Wisconsin. This concrete dam was reconstructed in 1986 and has a fishway with a built-in lamprey trap and observation chamber.



29b. The entrance to the fishway on the Brule River sea lamprey barrier dam; spring, 1986.

30. Sea lamprey barrier dam on the Middle River, Lake Superior, Wisconsin. It is a low head dam constructed of concrete in 1983 with a jumping pool and portable lamprey traps.

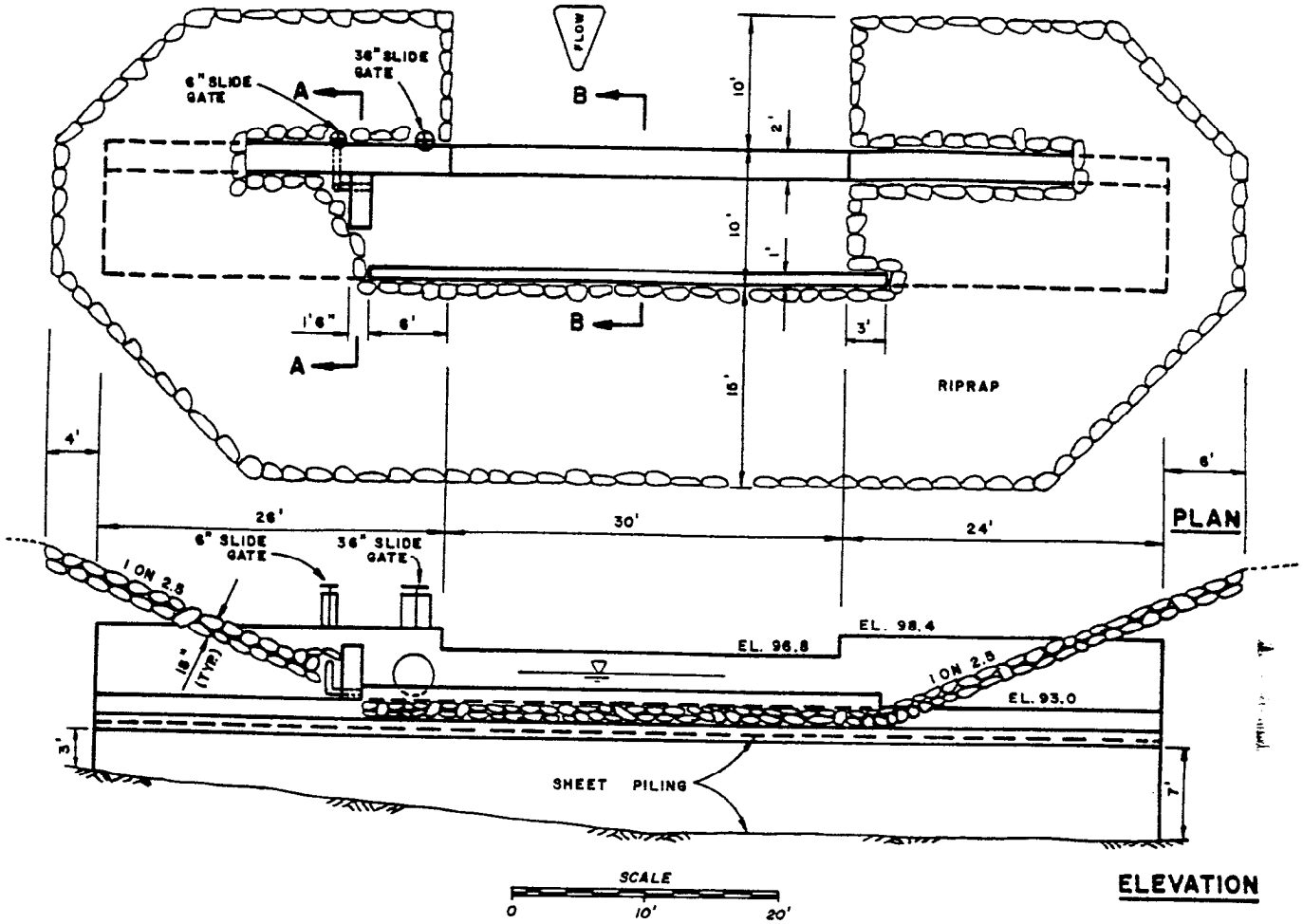
APPENDIX 7

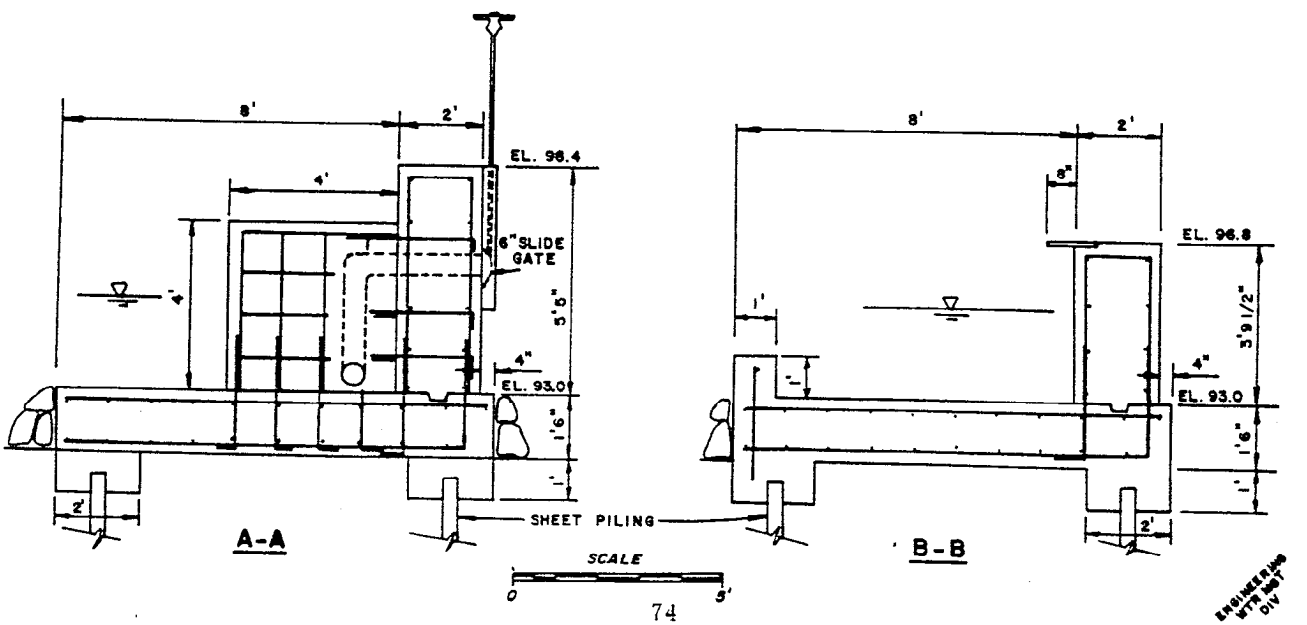
Design Drawings

of

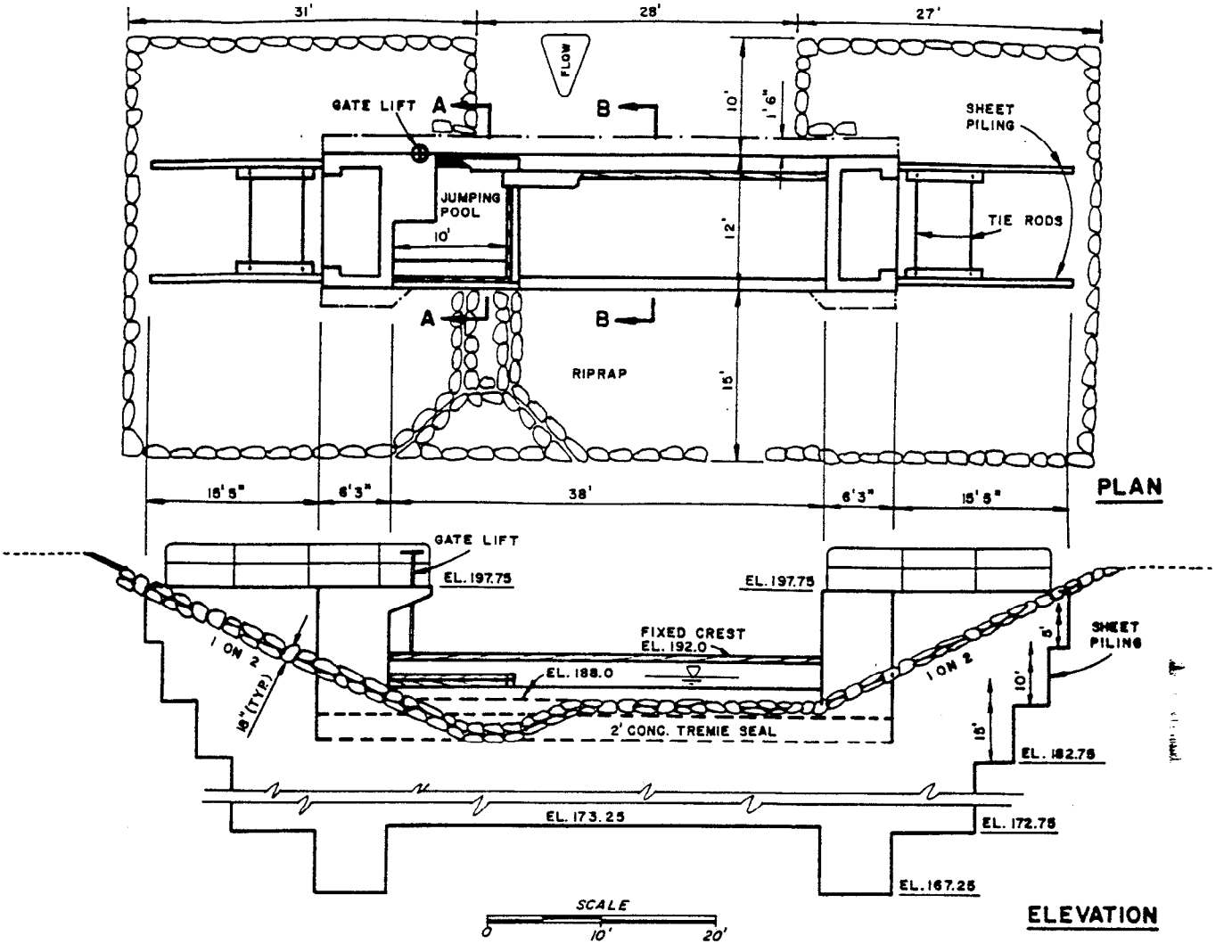
Sea Lamprey Barrier Dams

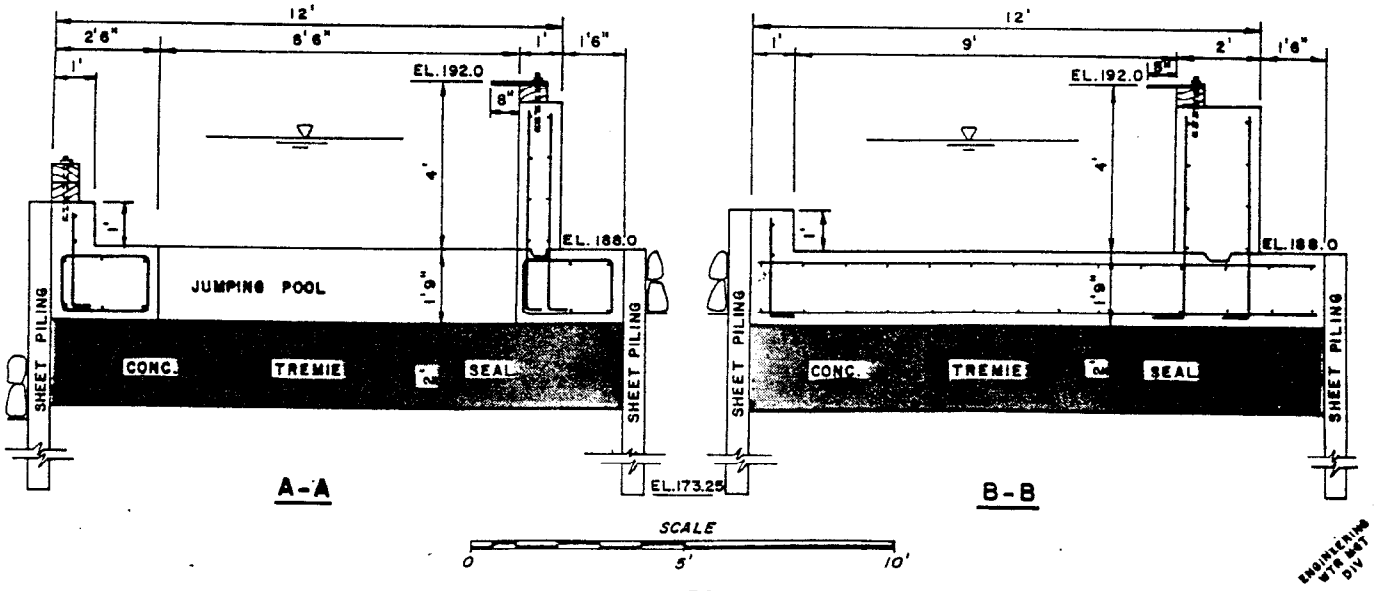
DAYS RIVER LAMPREY BARRIER





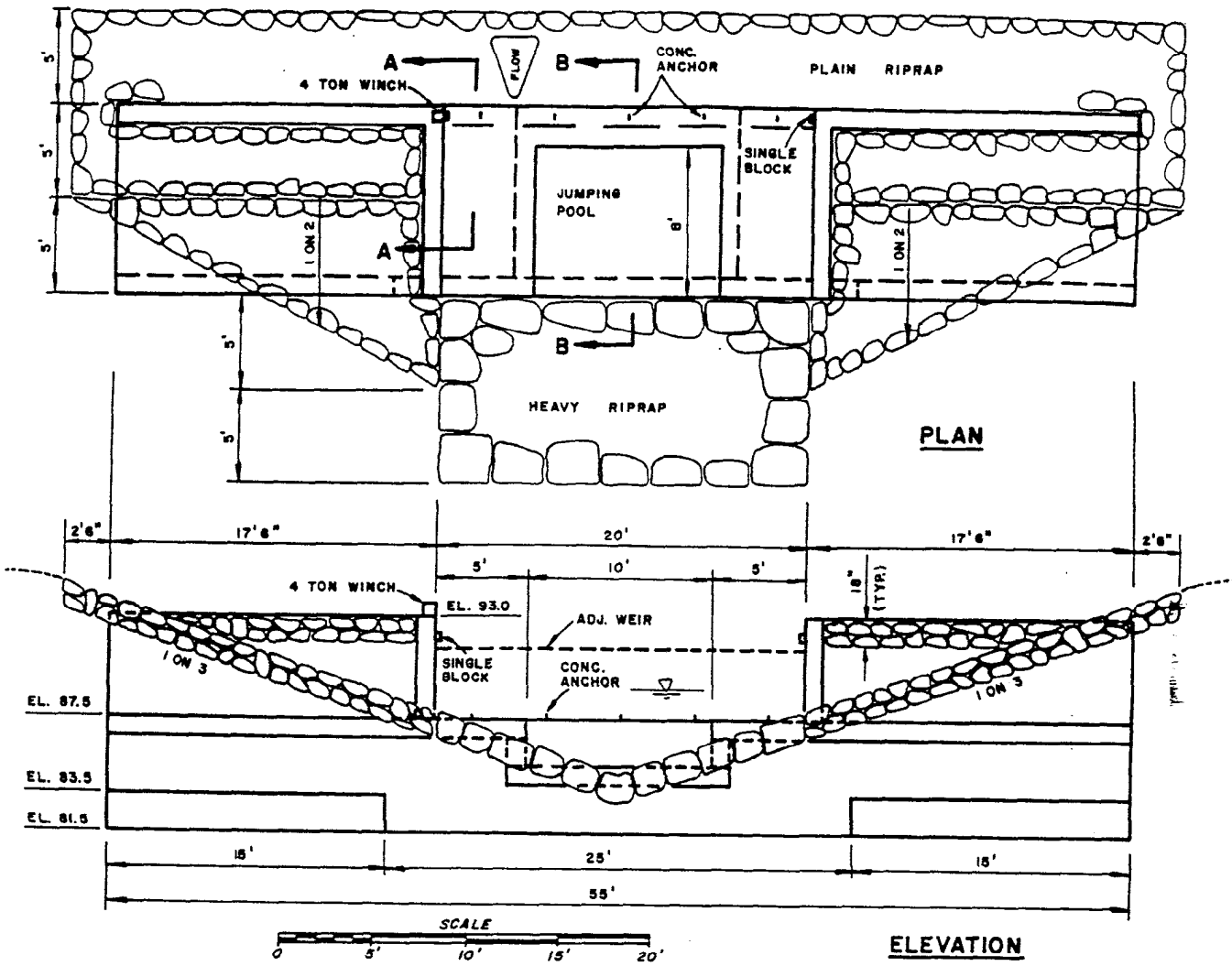
MISERY RIVER LAMPREY BARRIER

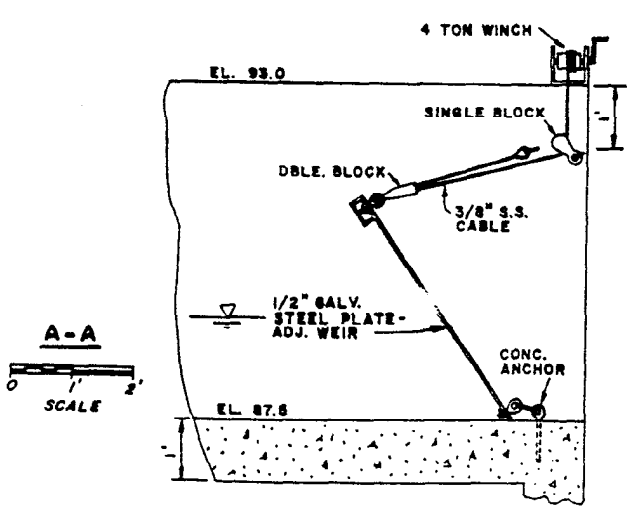


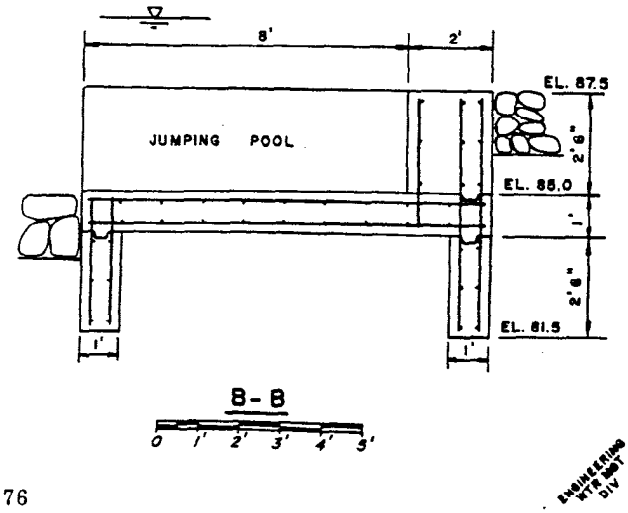


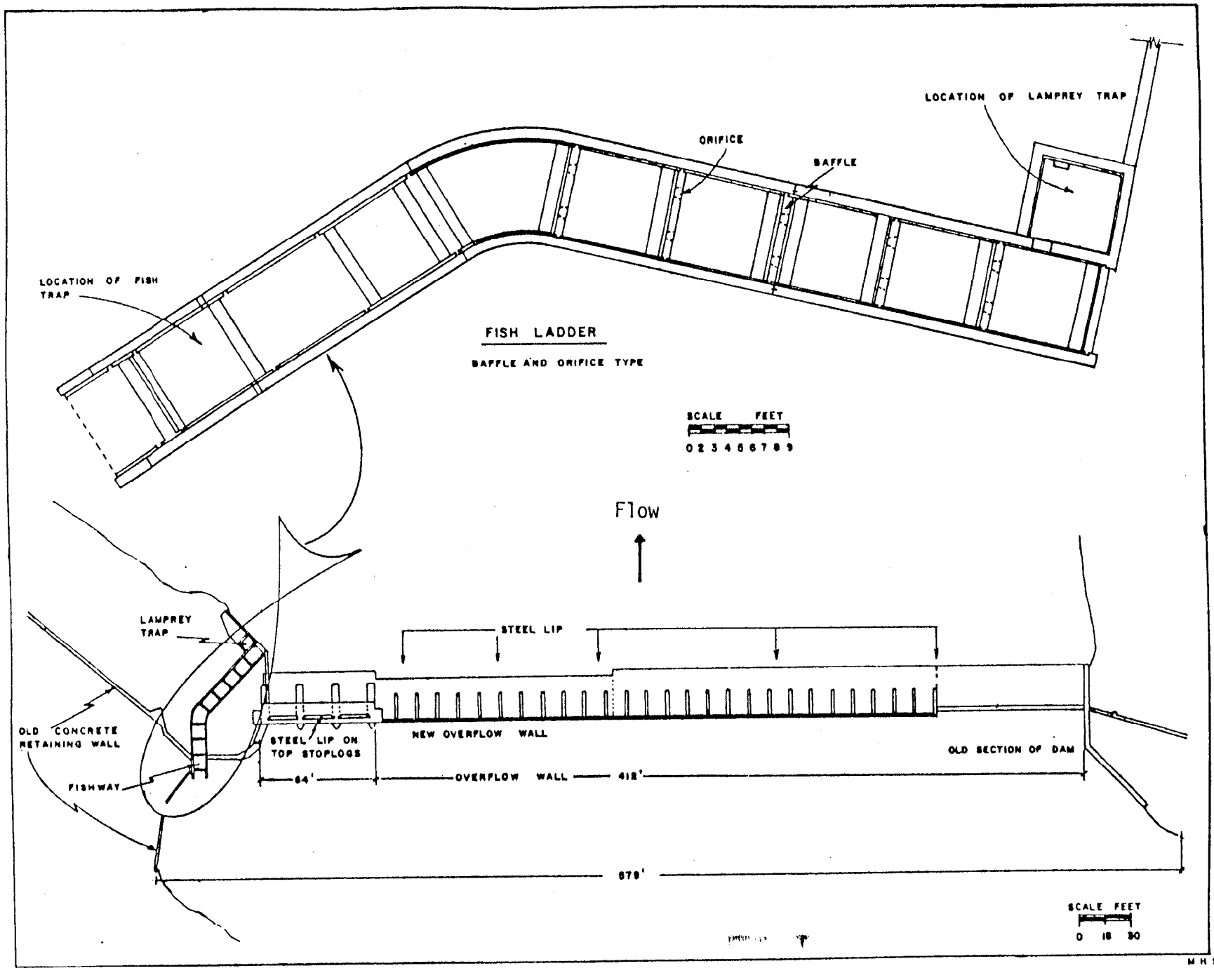
ENGINEERING WITS MAT DIV

ALBANY CREEK LAMPREY BARRIER



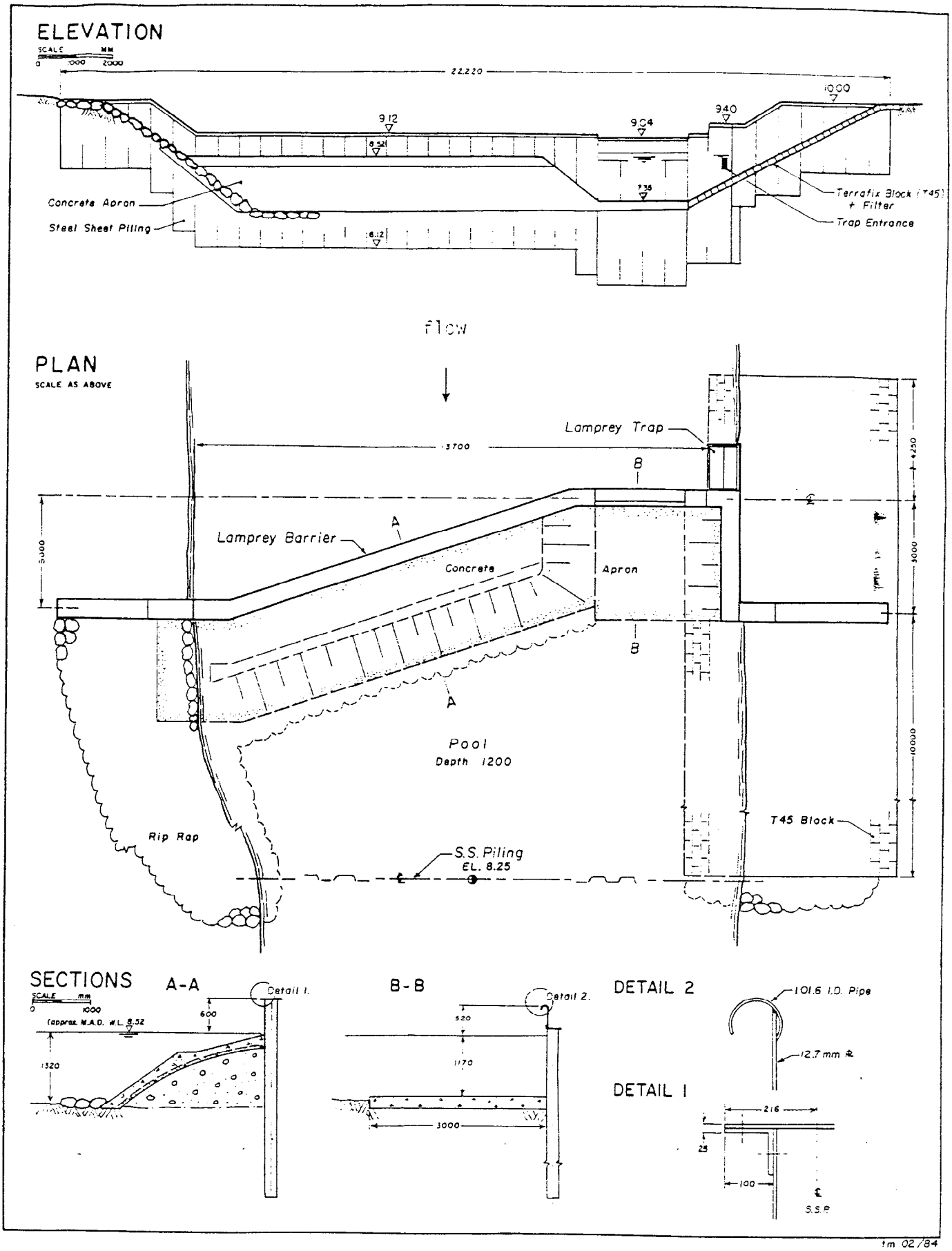




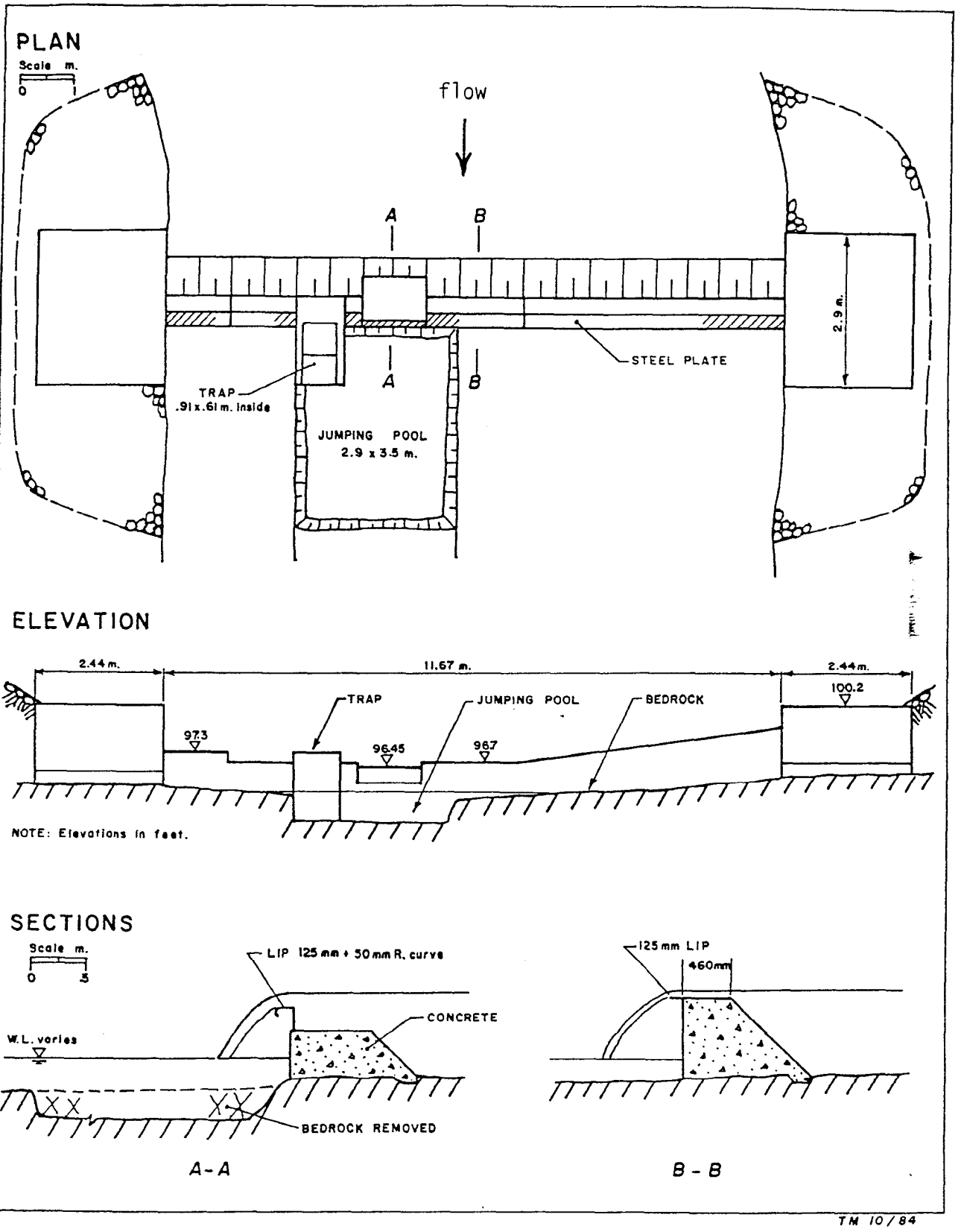


Saugeen River Lamprey Barrier

Carp River (Sable) Lamprey Barrier

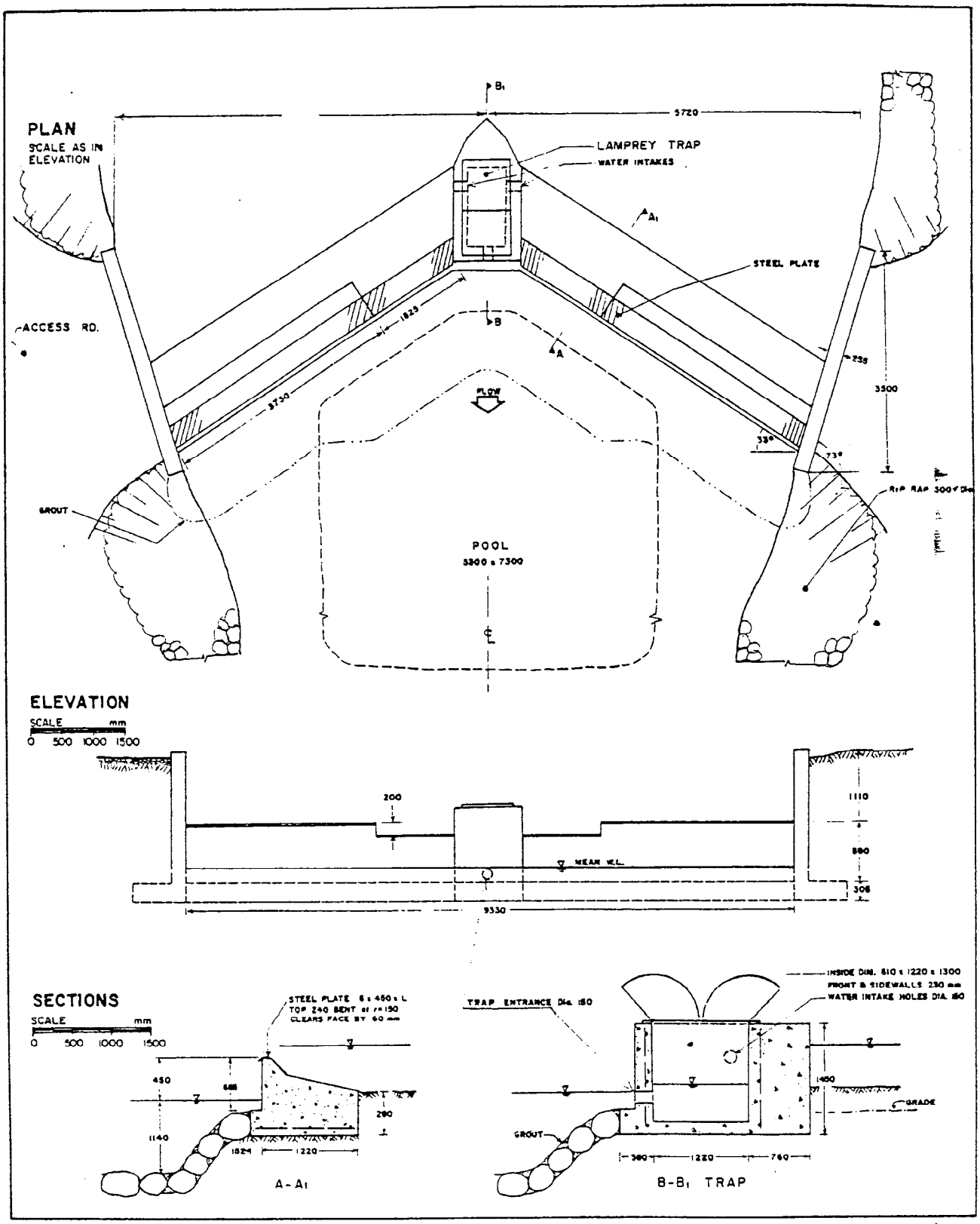


Lakeport Creek Lamprey Barrier



TM 10/84

Kaskawong River Lamprey Barrier



A P P E N D I X 8

Remarks Presented at the Official Opening

of

Denny's Dam Lamprey Barrier and Fishway,

Saugeen River, Ontario, May 21, 1971

by

J.J. Tibbles

SEA LAMPREY CONTROL EXPERIMENT,
[illegible] ON STREET,
CANAL POST OFFICE,
SAULT STE. MARIE, ONTARIO.

CANADA

OUR FILE NO.
NOTRE DOSSIER Nº

YOUR FILE NO.
VOTRE DOSSIER Nº

DEPARTMENT OF FISHERIES AND FORESTRY
MINISTÈRE DES PÊCHES ET DES FORÊTS
SAULT STE. MARIE, ONT

For presentation at the Official
opening of tho
DENNY'S DAM LAMPREY BARRIER AND FISHWAY
Saugeen River, Ontario
May 21, 1971

I feel that it is appropriate that I be asked to speak at the official opening of Denny's Dam on the Saugeen River. Prom the first tentative discussions, more than four years ago, I have been an advocate of this dam, and have actively participated in all stages of its design and development. There are many reasons why the completion of this project should be a source of satisfaction to all concerned. In the first place it represents a progressive step in Federal-Provincial co-operation for managing the fisheries resources. It benefits the sea lamprey control experiment by reducing the cost of *treating* the Saugeen River with lamprice, since only one treatment from the Walker-ton area will be required to rid the river of resident sea lamprey larvae. Subsequent treatment will only be necessary below Denny's Dam on a four-year cycle at a saving of about $100,000 per treatment for the lampricide alone.

Responsibility for sea lamprey control rests with the International Great Lakes Fishery Commission, and it becomes therefore a Federal function to designate the Canadian agent for the control program and to furnish the funds necessary to carry out its share of the program. *When* the implementation of control measures involves, as it does in this case, a large capital works outlay on Canadian soil, it no longer is appropriate for the Commission to provide the funds. This project has been quite properly an entirely Canadian venture. With equal propriety it is a joint Federal-

Provincial undertaking, for although its cost might have been justified by the reduction in cost of lampricide treatments alone, yet Denny's Dam is not simply a sea lamprey control structure. It also will benefit the Ontario Department of lands and Forests in its rainbow trout management program, it will afford an opportunity to help manage any salmon stocks that may develop, and it provides a desirable recreational area for angling and boating. I am hopeful that similar co-operative projects may be undertaken in other watersheds, particularly in Lake Ontario tributaries where we are now involved in treatments to destroy sea lamprey.

The attractiveness and utility of this structure is a credit to its builders, and should be a source of satisfaction to the engineertig section of the Department of Lands and Forests, and to their consultants in the Department of Fisheries and Forestry.

The main purpose of the structure is to stop sea lamprey from reaching their spawning grounds in the headwaters and thus limit the area that will require treatment with lampricide in the future. Lamprey limited to the spawning areas below the dam may find conditions unsuitable because of higher temperatures, and they may not be able to spawn in this area successfully. If this is the case then it would eliminate the need for further treatments and constitute a substantial economic benefit to the Commission.

A secondary purpose of the structure, as far as sea lamprey control is concerned, is that we can collect sea lamprey in the trap that is incorporated into the fishway. Comparing the number of lamprey collected from year to year we will be better able to assess our effect on the lamprey population in Lake Huron with our chemical treatment program.

Sea lamprey have also been harvested in the past. Records of lamprey fisheries in Europe date back to the Romans who are said to have

considered them a regal food. Many of the English kings regarded lamprey as a great delicacy, and it is reported that King Henry 1st died from eating a surfeit of lamprey. We are not the first to trap lamprey in the Saugeen River; for many years until his death in 1964, Mr. Teodore Roze, a Latvian, commercially fished the Saugeen for sea lamprey. They were caught in wicker baskets called "Litzberg traps" that were formed from willow and dogwood canes found along the shoreline. The traps were placed across sections of the river and the lamprey were caught as they attempted to leap through the spaces between the traps. As many as 900 lamprey were collected in one night, and as many as 10,000 by this manner in one spring's fishery. The lamprey were marinated, smoked, canned and then marketed locally or in the Toronto area. Mr. Roze delighted in selecting a plump lamprey from the roasting oven when a number of people were watching, and proceeded to consume the delicacy as one would eat a banana. This can be done because the sea lamprey does not have any bones, only a cartilaginous supporting structure.

Sea lamprey normally start their spawning migration in mid-April, however until mid-May this year we had only collected the odd straggler. We were somewhat concerned whether or not the lamprey would find their way into the trap when the opening is only a narrow six foot long slit, and the entire structure is approximately 600 feet long. However it was only last week that an ice cover stretched across the mouth of the Saugeen River at Southampton and this phenomenon would create a thermal barrier to upstream migrating lamprey. Sea lamprey do not start their migration until the water temperature reaches 50°F. I am happy to report that the ice barrier has disappeared and that lamprey have now found their way into the river and into the trap (26 were collected two days ago; - yesterday, and ___ today— giving a total to date for -lamprey.

Finally Denny's Dan provides an interesting link with the past, for it stands on the site of the original Denny's Dam built just over one hundred years ago to provide power for a number of mills. I am sure that this dam will be *even more* productive and beneficial than were its colourful predecessors.

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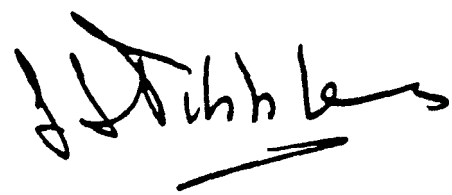


A P P E N D I X 9

Inventory

of

Existing Structures Blocking

Sea Lamprey Migrations

Inventory of existing dam, structures and falls that limit Stream habitat available to sea lamprey. Most of these struties are complete barriers to lamprey. Tributaries are listed geographically for each lake and jurisdiction.

Lake and Jurisdiction	Tributary	Description	Distance to mouth or confluence km	mile
Lake Superior Province of Ontario	Pigeon River	Pigeon Falls	2.0	1.2
	Pine River	Falls	4.0	2.5
	Cloud River	Culvert at Highway 61	8.0	5.0
	Kaministikwia River	Kakabeka Falls	48.0	29.8
		Corbett's Creek - falls	9.0	5.6
		Whitefish River - falls	40.0	24.9
	Neebing-McIntyre Rivers	Dam near high school(Neebing)	5.0	3.1
		Dam at Lake Head University (McIntyre)	5.0	3.1
	Current River	Falls and dam	.4	0.2
	MacKenzie River	Falls	0.5	0.3
	Pearl	Falls	2.0	1.2
	Wolf River	Falls	15.0	9.3
	Black Sturgeon River	*Camp 43 Dam lamprey barrier	16.0	9.9
	Stillwater Creek	Falls	5.0	3.1
	Polly creek	Railroad culvert	3.0	1.9
	Nipigon River	Alexander Dam and Powerhouse to Helen Lake	13.0	8.1
	Jackfish River	Falls	10.0	6.2
		Limestone Creek-falls	1.0	0.6
	Cypress River	Falls	5.0	3.1
		Falls on tributary near powerline	0.5	0.3
	Little Gravel River	Falls	6.0	3.7

Lake and Jurisdiction	Tributary	Description	Distance to mouth or confluence km	mile
	Graved. River	Falls	16.0	9.9
	Pays Plat River	Falls	6.0	3.7
	steel River	Falls	10.0	6.2
	Prairie River	Falls	4.0	2.5
	Little Pic River	Falls	35.0	21.7
		Martinet Creek - falls	3.0	1.9
		Glory Creek - rapids	10.0	6.2
	Pic River	Manitou Falls	96.0	59.7
		Kagiano River - falls	0.2	0.1
		Nama Creek- falls	5.0	3.1
	white River	Falls	4.0	2.5
	Michipicoten River	Scott Falls Dam	19.0	11.8
	Sal-d River	Falls	0.5	0.3
	Agawa River	Falls	13.0	8.1
	Pancake River	*Gimlet Creek laqXey barrier dam	0.1	0.06
		Falls on main river	15.0	9.3
	carp (Sable) River	*Lamprey barrier dam	1.0	0.6
	Batchawana River	Falls	12.0	7.5
	Chippewa River	Falls at Highway17	2.0	1.2
	Harmony River	Series of rapids & falls	5.0	3.1
	Stokely creek	*Lamprey barrier dam	1.0	0.6
	Goulais River	Whitman Falls	80.0	49.7
		*Sheppard Creek lamprey barrierdam	0.4	0.2
		Robertson Creek - falls	3.0	1.9
		Northland Creek - falls	0.1	0.06

Lake and Jurisdiction	Tributary	Description	Distance to mouth or confluence km	mile
	Big carp River	Falls	10.0	6.2
		Falls on tributary	4.0	2.5
	Little Carp RiVer	Falls	10.0	6.2
	East Davignon River	Culvert at Algoma Central Railway bridge	5.0	3.1
Lake Superior State of Michigan	Pendills Creek	Dam	0.8	0.5
	Tahquamenon River	Falls	28.0	17.4
	- Collins creek	Falls	1.1	0.6
	Betsy River	mm	14.2	8.7
	Dead River	Sucker Dam	8.0	5.0
	Sable Creek	Falls	0.3	0.2
	Hurricane River	Falls	0.2	0.1
	Beaver Lake Outlet			
	- Little Beaver Creek	Falls	1.4	0.9
	Mosquito River	Falls	2.7	1.7
	Miners River	*Lamprey barrier dam	1.9	1.2
	Munising Falls Creek	Falls	0.6	0.4
	Anna River			
	- Wagner creek	Falls	0.3	0.2
	Furnace creek			
	-Hanson Creek	Falls	2.9	1.8
	- Gongeau creek	Falls	2.4	1.5

Lake and Jurisdictim Tributary	Description	Distance to mouth or confluence km	mile
Au Train River	Dam/Falls	8.7	5.4
- Joels Creek	Dam	1.8	1.1
Rock River	Dam	0.2	0.1
Deer Lake Outlet			
Deer Lake Inlet	Falls	0.3	0.2
Laughing Whitefish	Falls	11.6	7.2
sand River	Dam	2.1	1.3
Chocolay River	Falls	33.5	20.8
Carp River	Dam	8.5	5.3
Dead River	Dam	2.1	1.3
Harlow creek			
-Nash Creek	Falls	1.4	0.9
- Bismark Creek	Falls	2.1	1.3
Little Garlic River	Falls	6.9	4.3
Big Garlic River	Dam	2.3	1.4
Iron River	Dam	2.7	1.7
Salmon Trout River	Falls	13.0	8.1
Pine River			
- Mountain Stream	Falls	1.4	0.9
Huron River	Falls	11.3	7.0
Ravine River	Falls	12.9	8.0
Slate River	Falls	1.3	0.8

Lake and Jurisdiction	Tributary	Description	Distance to mouth or confluence km	mile
	silver River	Falls	6.3	3.9
	Falls River	Falls	0.6	0.4
	Sturgeon River	Dam	69.8	43.3
	- otter River	Dam	0.8	0.5
	-w. Branch sturgeon	Falls	44.7	27.8
	Eliza Creek	Dam	1.1	0.7
	Big Gratiot River	Falls	1.6	1.0
	Salmon Trout River	Dam	1.0	0.6
	Elm River	Falls	1.3	0.8
	Misery River	*Lamprey barrier dam	3.5	2 . 2
	Ontonagon River			
	- West Branch Ontonagon	m m	5.1	3.2
	- Middle Bran&	Falls	44.4	27.6
	- Baltimore River	Falls	5.1	3.2
	- East Branch Ontonagon	Dam	66.5	41.3
	-Jumbo River	Falls	7.1	4.4
	Little Iron River	Falls	2.9	1.8
	Union river	Falls	3.4	2.1
	Black River	Falls	1.1	0.7

Lake and Jurisdiction	Tributary	Description	Distance to mouth or confluence km	mile
Lake Superior State of Wisconsin	Montreal River	Falls/Dam	0.5	0.3
	Bad River	Falls	70.8	44.0
	- white River	Dam	34.6	21.5
	- Potato River	Falls	20.9	13.0
	- Brunsweiler River	Falls	15.6	9.7
	Brule River	*Lamprey barrier dam	9.8	6.1
	Poplar River	Dam	24.1	15.0
	Middle River	*Lamprey barrier dam	8.2	4.2
	Amnicon River	Falls	16.7	10.4
	Nemadji River			
	- Black River	Falls	11.9	7.4
	- Net River	Falls	8.5	5.3
	- Little Net River	Falls	1.9	1.2
Lake Superior State of Minnesota	St. Louis River	mm	33.2	20.6
	sucker River	Falls	0.3	0.2
	Gooseberry River	Falls	1.3	0.8
	Split Rock River	Falls	1.3	0.8
	Poplar River	Falls	0.3	0.2
	Arrowhead River	Falls	1.3	0.8

Lake and Jurisdiction	Tributary	Description	Distance to mouth or confluence km	mile
Lake Michigan State of Michigan Peni(Lower	Carp Lake Outlet	Dam	16.7	10.4
	Big Stone Creek	Dam	1.6	1.0
	Big Sucker Creek	Dam	5.8	3.6
	Wycamp Lake Outlet	Dam	2.9	1.8
	Bear River	Dam	0.3	0.2
	Jordan River			
	- Deer Creek	Dam	1.1	0.7
	Boyne River	Dam	6.4	4.0.
	Elk Lake Outlet	Dam	0.3	0.2
	crystal River	Dam	10.0	6.2
	- River	Dam	8.7	5.4
	Platte River	Dam	26.7	16.6
	Betsie River	*Lamprey barrier dam	20.3	12.6
	- Crystal Lake Outlet		1.6	1.0
	Manistee River	Dam	49.1	30.5
	- Little Manistee River	Dam		
	-Bear Creek	Dam	47.8	29.7
	Pere Maquette River			
	-Kinney Creek	Dam	0.2	0.1
	- Baldwin River	Dam	8.5	5.3
	-Danaher Creek	Dam	0.3	0.2

Lake and Jurisdiction	Tributary	Description	Distance to mouth or confluence km	mile
	Pentwater River			
	- South Branch mm		7.7	4.8
	- Crystal Creek Dam		6.8	4.2
	White River Dam		52.0	32.3
	Muskegon River Dam		81.6	50.7
	Grand River Dam		60.0	37.3
	- Sand Creek Dam		6.9	4.3
	Kalamazoo River mm		37.8	23.5
	- Swan Creek m m		4.3	2.7
	St.Joseph River Dam		38.5	23.9
	- Paw Paw River Dam		36.0	22.4
(Upper Peninsula)	Millecoquins River			
	- Three Mile Creek Dam		0.3	0.2
	- Jocko Creek Dam		1.4	0.9
	Gulliver Lake Dam Cutlet		3.4	2.1
	Manistique River			
	man River mm		2.3	1.4
	Parent Creek Dam		2.1	1.3
	Whitefish River			
	- Haymeadow Creek	Falls	8.4	5 . 2
	- West Branch	*Lamprey barrier dam	18.3	11.4

Lake and Jurisdiction	Tributary	Description	Distance to mouth or confluence km	mile
	Days River	*Lamprey barrier dam	6.9	4.3
	Cedar River			
	-WaltonRiver	Dam	15.1	9.4
	Menominee River	Dam	4.0	2.5
Lake Michigan state of Wisconsin	Peshtigo River	Dam	19.2	11.9
	Oconto River	Dam	24.0	14.9
	Ahnapee river	Dam	12.8	7.9
	East Twin River	*Lamprey barrier dam	14.4	8.9.
Lake Huron Province of Ontario	Manitou River	*Falls improved to block lamprey	1.0	0.6
	Mindemoya River	Dam at Mindemoya	9.0	5.6
	Root River	Falls on main river and tributaries	54.0	33.6
	Garden river	Old dam and chute	60.0	37.3
	Echo River	*Lamprey barrier dam to Echo Lake Falls on Echo and tributaries	2.0	1.2
	sucker-	Falls	0.3	0.2
	Kaskawong River	*Lamprey barrier dam	1.0	0.6
	Thessalon River	Rydal Bank Dam	34.0	21.1
		Bridgeland Creek, Little Rapids	2.0	1.2
	Mississagi River	Redrock Falls Dam	29.0	18.0
		*Culvert on Harris Cr. at Bolton River	14.0	8.7
	Blind River	Dam at Blind River	0.2	0.1
	Lauzon Creek	Dam at Lauzon Lake	1.0	0.6

Lake and Jurisdiction	Tributary	Description	Distance to mouth or confluence km	mile
	Serpent River	Falls at Highway 17	10.0	6.2
	Spanish River	Dam at Espanola	72.0	44.7
	Aux Saubles	Chutes		
	Kagawong River	Falls	1.0	0.6
	Chikanishing River	Falls	2.0	1.2
	French River	*Recollet Falls	15.0	9.3
		Horseshoe Falls	20.0	12.4
		Little French Cut	20.0	12.4
	Wanapitei River	Sturgeon Chute	9.0	5.6
	Still River	*Lamprey barrier dam	5.0	3.1
	Magnetawan River	Falls	8.0	5.0
	Naiscoot River	Dam at Naiscoot Lake	10.0	6.2
	Boyne River	Falls near Highway 69	8.0	5.0
	Muskoka River	Three Rock Chuteake Cutlet	4.0	2.5
	Severn River	Dams above Gloucester Pool		
		whites	0.1	0.0
		Little Chute	0.1	0.0
		Big Chute	1.0	0.6
	Sturgeon River	*Lamprey barrier dam	1.0	0.6
	Nottawasaga River	Nicolston Dam	72.4	45.0
		Glen Huron Dam - Mad River to L. Huron	53.0	32.9
		Dam - Boyne River at Alliston		
		Dunedin Dam - Noisy River to confluence	3.0	1.9
	Silver Creek	Dam	3.0	1.9
	Beaver River	Thornbury Dam	1.0	0.6
	Sydenham River	Dam	2.0	1.2

Lake and Jurisdiction	Tributary	Description	Distance to mouth or confluence km	mile
	Sauble River	Sauble Falls	2.0	1.2
	Saugeen river	*Denny's Dam lamprey barrier	4.0	2.5
	Lucknow River	Port Albert Dam	1.0	0.6
Lake Huron State of Michigan	Albany Creek	*Lamprey barrier dam	1.3	0.8
	Little Black River	Dam	3.5	2.2
	Cheboygan River System			
	-Black River	Dam	8.5	5.3
	-Pigeon River	Dam	42.3	26.3
	- Cornwall Creek	Dam	1.8	1.1
	- Sturgeon River			
	-clubcreek	Dam	5.5	3.7
	- Maple River	Dam	11.1	6.9
	Occueoc River	mm	5.8	3.6
	Au Sable River	Dam	19.3	12.0
	Tawas River			
	- Silver Creek	Dam	8.5	5.3
	East AuGres	*Lamprey barrier dam	17.4	10.8
	Rifle River			
	- Wells Creek	m m	0.6	0.4
	- West Branch Rifle River	mm	17.5	10.9

Lake and Jurisdiction	Tributary	Description	Distance to mouth or confluence km	mile
	Saginaw River System			
	- Tittabawassee River	Dam	53.3	33.1
	-PineRiver	Dam	54.9	34.1
	- Chippewa River	Dam	80.5	50.0
	- Shiawasee River	Dam	22.2	13.8
	-Flint River	Dam	70.8	44.0
	- Cass River	Dam	26.9	16.7
	Black River	Dam	27.8	17.3
	St. Clair County			
Lake Erie Province of Ontario	Catfish Creek	Bradley Creek -sawmill dam	2.0	1.2
	Big Otter Creek	Dam below Otterville Sta. 143	65.0	40.4
		Stoney Creek dam at Sta. 128	3.0	1.9
	Big Creek	Dam at Delhi	70.0	43.5
		Venison Creek Dams	17.0	10.6
		Deer Creek Conservation Dam		
		several dams on trib.		
	Potters Creek	Dam (Sta. 8)	2.0	1.2
	Young Creek	Dam (Sta. 6)	4.0	2.5
	Grand River	Dam at Dunneville	8.0	5.0
		Dam at Caledonia	49.0	30.4
		Dam at Brantford	96.0	59.7
Lake Erie State of New York	Buffalo River			
	- Cayuga Creek	Dam in Lancaster	16.0	9.9

Lake and Jurisdiction	Tributary	Description	Distance to mouth or confluence km	mile
	Cattaraugus Creek	Dam at Springville	62.0	38.5
	- South Branch	Falls	4.0	2.5
	Canadaway Creek	Falls in Fredonia	4.0	2.5
Lake Erie State of Ohio	Grand River	Dam at Harpersfield	48.0	29.8
	Chagrin River	Dam at Willoughby	8.0	5.0
Lake Ontario Province of 0ntario	Amastercreek	Falls	7.0	4.4
		Dam on Sulphur Creek	5.0	3.1
	Oakville creek	Scotch Block Dam	38.0	23.6
		Kelso conservation Dam	28.0	17.4
	credit River	*Lamprey barrier dam	15.0	9.3
		Dam at Norval	39.0	24.2
	Humber River	*Dam at Old Mill	4.0	2.5
	Don River	Dam near Bloor Street	5.0	3.1
	Rouge River	Dam near Steeles Ave.	17.0	10.6
		Dam on Little Rmge near Steeles	11.0	6.8
	Duffin Creek	*Lamprey barrier dam	6.0	3.7
	Oshawa Creek	Dam	17.0	10.6
	Harmony Creek	Dam near Highway 2	4.0	2.5
	Bowmanville Creek	Goodyear Dam (obstacle)	3.0	1.9
		Bowmanville Dam (breached	4.0	2.5
	Graham Creek	*Lamprey barrier dam	1.0	0.6
	Port Britain creek	Dam	9.6	6.0
	Ganaraska River	Corbett's mm	3.0	1.9

Lake and Jurisdiction	Tributary	Description	Distance to mouth or confluence km	mile
	Cobourg Brook	Pratts Dam (East Branch)	3.0	1.9
		Conservation Authority Dam (west Branch, obstacle)	0.1	0.0
	Shelter Valley Creek	*Lamprey barrier dam	0.4	0.3
	Lakeport Creek	*Lamprey barrier dam	1.0	0.6
	Salem Creek	Blyth's Dam	2.0	1.2
	Smithfield Creek	Dam near Smithfield	4.0	2.5
	Mayhew creek	Old mill dam	2.0	1.2
	Moira River	Lott's Dam (Belleville)	1.0	0.6
	Salmon River	*Shannonville Dam lampreybarrier	3.0	1.9
	Napanee River	Dam at Napanee	6.0	3.7
Lake Ontario State of New York	Black River	Dam, Mill St., Watertown	14.9	9.3
	Stoney creek	Dam in Henderson	6.1	3.8
	South Sandy Creek	Falls at Monitor Mills Rd.	11.0	6.8
	Skinner Creek	Dan at Mannsville	14.0	8.7
	Salmon River	Dam at Altmar	27.4	17.0
	- Beaverdam Brook	Dam at hatchery	0.5	0.3
	Grindstone Creek	Dam at Fernwood	11.0	6.8
	Snake Creek	Dam at Rte. 11	14.0	8.7
	Little Salmon River	mm in Mexico, Hwy 104	11.0	6.8
	- Black Creek	mm in Mexico, Hwy 104	1.2	0.7

Lake and Jurisdiction	Tributary	Description	Distance to mouth or confluence km	mile
	catfish Creek	Dam	1.5	0.9
	Oswego River	Dam at numerous locations on maïnstreams of Oswego, Oneida, and Seneca rivers but most are bypased by navigation locks.		
	- Big Bay Creek			
	- Dykeman Creek	Dam in Mallory	0.4	0.3
	- Fish creek	Lower dam in Camden	45.8	28.4
	- E. Branch	Dam above Taberg	11.2	7.0
	- Little River	Dam at Carterville	19.2	11.9
	- Scriba Creek	Ihmathat&ery	0.6	0.4
	- Cold Spring Brook	Dam at Haskins Road	0.9	0.6
	-HallBrook	Dam at Hall Corners	4.8	3.0
	Rice creek	Dam at Hwy 104A	0.8	0.5
	Nine mile Creek	I%matHanniblCenter	20.0	12.4
	Sterling Creek	Dam at Sterling	8.6	5.3
	- Sterling Valley Creek	Dam at Sterling Valley	6.4	4.0
	Red Creek	Dam at Red Creek	10.0	6.2
	Wolcott creek	Bridgeapron, Furnace Road	4.0	2.5
	Sodus Creek	Dam at Glenmark	4.2	2.6

* Indicates one of the 30 lamprey barriers described in this report.

APPENDIX 10

Great Lakes Fishery Commission's Application

for

Funds to Acquire Land and/or Construct or Repair

A Barrier Dam to Stop Spawning Runs of Sea Lamprey

GREAT LAKES FISHERY COMMISSION (GLFC)

GLFC CODE NO. ____

APPLICATION FOR FUNDS TO ACQUIRE LAND AND/OR
CONSTRUCT OR REPAIR A BARRIER DAM TO STOP
SPAWNING RUNS OF SEA LAMPREY
(See attached procedures for aid in completing application)

SECTION I - APPLICANT/RECIPIENT DATA

1. APPLICATION ☐ OR NOTICE OF INTENT ☐ If notice of intent, anticipated date of application submission _____

2. LEGAL APPLICANT/RECIPIENT
   - Applicant name: _____
   - Organization: _____
   - Address: _____
   - Contact person (name and phone _____

3. LOCATION OF PROPOSED BARRIER DAM (Attach map)
   - Stream name: _____ State or Province: _____
   - County, Township: _____
   - Location on stream: _____

4. LAND ACQUISITION ☐ ; NEW BARRIER DAM ☐ ; REPAIRS/MODIFICATIONS TO EXISTING STRUCTURE ☐

5. AMOUNT OF FUNDING REQUESTED: Fill in either A or B and complete C.
   A. Total cost estimate $ _____
   B. Amount requested from GLFC $ _____
   C. Other funding - explain amounts and source _____
   D. Basis of cost estimate attached. If not attached, explain _____

6. TYPE OF APPLICATION:
   (a) New
   (b) Revision
   (c) Continuation
   (d) Augmentation
   Enter appropriate letter ☐

7. TYPE OF CHANGE (For 6b or 6d)
   (a) Increase dollars
   (b) Decrease dollars
   (c) Increase duration
   (d) Duration
   (e) Other (Specify) _____
   Enter appropriate letter ☐

8. A. GENERAL DESCRIPTION OF BARRIER DAM (length, height during 'normal' discharge, construction type and materials, etc.)

   B. ENGINEER'S PLANS, SPECIFICATIONS, ETC. ATTACHED: YES ☐ ; NO ☐ . If no, please explain _____

   C. IS DAM FOR SEA LAMPREY CONTROL ONLY? YES ☐ ; NO ☐ . If no, state other uses

9. STATUS OF LAND (Check A or B and complete C if appropriate).
   A. ☐ Government owned: Federal ☐ ; State ☐ ; Province ☐ ; County ☐ ; City ☐ ; Town/Village ☐ ; Other ☐ : _____
   B. ☐ Privately owned - details if appropriate _____
   C. ☐ Describe arrangements for land and access

(Form BDA 10-77a)

SECTION I (cont.)

10. DATE FUNDS REQUIRED _____ | 11. ESTIMATED DATE OF COMPLETION _____

12. ENVIRONMENTAL ASSESSMENT APPROVED ☐ YES; ☐ NO. If no, explain

_____

_____

13. FEDERAL, STATE, OR PROVINCIAL PERMITS REQUIRED: YES ☐ ; NO ☐ :

Explain _____

_____

14. A. WILL THE DAM AFFECT ANY LISTED ENDANGERED SPECIES: YES ☐ ; NO ☐ .

If yes, explain _____

_____

B. WILL THE DAM AFFECT KNOWN SITES OF SIGNIFICANT ARCHAELOGICAL OR HISTORICAL INTEREST: YES ☐ ; NO ☐ . If yes, explain _____

_____

SECTION II - CONFIRMATION

15. THE APPLICANT CERTIFIES THAT:

a. To the best of my knowledge and belief, data in this preapplication/application are true and correct, the document has been duly authorized by the governing body of the applicant and the applicant will comply with the attached assurances if the assistance is approved.

16. DATE SIGNED

19 _____ _____ _____

YEAR MONTH DAY

17 CERTIFYING REPRESENTATIVE:

A. TYPED NAME AND TITLE _____

B. SIGNATURE _____

FOR COMMISSION USE

SECTION III - GLFC ACTION

18. AGENCY NAME AND ADDRESS

19. APPLICATION RECEIVED

19 _____ _____ _____

YEAR MONTH DAY

20. GLFC PRIORITY

A. Priority Number

_____

B. Revised Priority

_____

21. ACTION TAKEN

☐ AWARDED
☐ REJECTED
☐ RETURNED FOR AMENDMENT
☐ DEFERRED
☐ WITHDRAWN

22. FUNDING

Amount Approved _____

Date of Approval _____

Date of Contract _____

SECTION IV - APPLICANT OR GLFC

23. REMARKS - for use by applicant or GLFC

Remarks continued on reverse side ☐

(Form BOA 10-77b)

APPLICANT PROCEDURES FOR SECTION I

If additional space is required to complete some questions, use REMARKS (23) or separate page.

1. Hark appropriate box. "Application" is self-explanatory. "Notice of intent" may be used to alert GLFC that application will be forthcoming later. This will assist GLFC in establishing priorities for dispensing funds for construction of barrier dams.

2. Legal name of applicant/recipient, name of primary organizational unit which will undertake the activity, complete address of applicant, and name and telephone number of person who can provide further information about this request and will act as liaison with GLFC.

3. Mostly self-explanatory. You may add "Range" and "Section" or similar site identification following name or number of Township where such information is commonly used.

4. Mostly self-explanatory. Check more than one box if appropriate; e.g., if you intend to acquire land AND construct a new barrier dam on it.

5. A - Self-explanatory.

   B - The GLFC may be requested to share in the cost, funding may be spread over several fiscal years because of various inherent delays, or funding may be for the sea lamprey control part of a multi-purpose barrier.

   C - Self-explanatory.

6. Use appropriate code letter. Definitions are:

   (a) New - a submittal for the first time for a new protect.
   (b) Revision - a modification which may result in funding change (increase or decrease)
   (c) Continuation - an extension for an additional funding/budget period for a project the agency initially agreed to fund for a definite number of years.
   (d) Augmentation - a requirement for additional funds for a project previously awarded funds in the same funding/budget period. Project nature and scope unchanged.

7. Complete only for revisions (item 6b), or augmentation (item 6d).

8. A. Self-explanatory.
   B. Self-explanatory.
   C. Self-explanatory.

9. A. If owned by county, city, town/village, or other, please put name in blank space provided.
   B. If land is owned by more than one owner it should be noted. If land is owned by a corporation or some organization, name should be noted. If owned by a private individual, name is not essential.
   C. Specify whether land is being purchased or leased (also duration and renewability of lease), or by informal agreement with owner, or other.

Application (con't)

10. Self-explanatory
11. Self-explanatory
12. Self-explanatory
13. Self-explanatory
14. Self-explanatory

Applicant Procedures for Section II

15. Self-explanatory
16. Self-explanatory
17. Name and title and signature of authorized representative of legal applicant

BOTE: Applicant completes only Section I and II. Section III is completed by GLFC.

GLFC Procedures for Section III

18. Self-explanatory
19. Self-explanatory
20. A - Priority number from GLFC list of sea lamprey streams suitable for barrier dams

B - GLFC may advance the priority of a stream that is "ready to go" or for other reasons. Conversely, problems with sites may lower GLFC priority.

21. Self-explanatory. Use remarks section to amplify where appropriate.
22. Self-explanatory

Applicant/GLFC Procedures for Section IV

23. Use back of page for further remarks and check box at bottom of page.

ASSURANCES FOR BARRIER DAM CONSTRUCTION AND LAND ACQUISITION PROJECTS

ASSURANCES

The Applicant gives assurance and certifies with respect to the grant that:

1. It possesses legal authority to apply for the grant, and to finance and construct the proposed facilities; that a resolution, motion or similar action has been duly adopted or passed as an official act of the applicant's governing body, authorizing the filing of the application, including all understandings and assurances contained therein, and directing and authorizing the person identified as the official representative of the applicant to act in connection with the application and to provide such additional information as may be required.

2. It will have sufficient funds available to meet the non-Great Lakes Fishery Commission's share of the cost for construction projects. Sufficient funds will be available when construction is completed to assure effective operation and maintenance of the facility for the purposes constructed.

3. It will obtain approval by the Great Lakes Fishery Commission or designated authority of the final working drawings and specifications before the project is advertised or placed on the market for bidding; that it will construct the project, or cause it to be constructed, to final completion in accordance with the application and approved plans and specifications; that it will submit to the Great Lakes Fishery Commission for prior approval changes that alter the costs of the project, or its design; that it will not enter into a construction contract(s) for the project or undertake other activities until the conditions of the construction grant program(s) have been met.

4. It will provide and maintain competent and adequate architectural engineering supervision and inspection at the construction site to insure that the completed work conforms with the approved plans and specifications; that it will furnish progress reports and such other information as the Great Lakes Fishery Commission may require.

5. It will operate and maintain the facility in accordance with the minimum standards as may be required or prescribed by the Great Lakes Fishery Commission and applicable Federal, State, and local agencies for the maintenance and operation of such facilities.

6. It will give the Great Lakes Fishery Commission or designated authority through any authorized representative access to and the right to examine all records, books, papers, or documents related to the grant.

7. It will cause work on the project to be commenced within a reasonable time after receipt of notification from the Great Lakes Fishery Commission that funds have been approved and that the project will be prosecuted to completion with reasonable diligence.

8. It will not dispose of or encumber its title or other interests in the site and facilities during the period of Great Lakes Fishery Commission interest.

9. It will establish safeguards to prohibit employees from using their positions for a purpose that is or gives the appearance of being motivated by a desire for private gain for themselves or others, particularly those with whom they have family, business, or other ties.

(11-77)

GREAT LAKES FISHERY COMMISSION (GLFC)

GLFC Code No.

PROJECT AGREEMENT FOR CONSTRUCTION OF BARRIER DAM FOR SEA LAMPREY CONTROL

1. AGENCY

2. CONTACT - Name and telephone

3. LOCATION OF PROPOSED BARRIER DAM
   - Stream name
   - State or Province, County, Township
   - Location on stream

4. AGREEMENT PERIOD	5. TOTAL EST. COST	6. GLFC COST	7. COOPERATORS SHARE
From: To:	$	$	$

8. SPECIAL PROJECT CONDITIONS BY AGENCY

9. The agency also agree to execute the project in accordance with the following attached documents:
   A. Great Lakes Fishery Commission's "Barrier Dam Program for Sea Lamprey Control
   B. Application by agency
   C. Assurances

10. APPROVED FOR AGENCY
    SIGNATURE TITLE DATE

11. SPECIAL PROJECT CONDITIONS BY GLFC

12. APPROVED FOR GREAT LAKES FISHERY COMMISSION
    SIGNATURE TITLE DATE

(Form BDP 10-77)

GREAT LAKES FISHERY COMMISSION (GLFC)

GLFC Code No.
Number of this amendment

AMENDMENT TO PROJECT AGREEMENT FOR FUNDS TO ACQUIRE LAND AND/OR CONSTRUCT OR REPAIR A BARRIER DAM TO STOP SPAWNING RUNS OF SEA LAMPREY

The above stated Project Agreement is amended as set forth below. The parties agree that all other terms and conditions as set forth in the Agreement, the Applicaitort, and any amendments thereto shall remain in force.

PURPOSE OF AMENDMENT

- ☐ Extend Agreement period to: _____
- ☐ Revise estimated project costs as set forth below
- ☐ Other (specify)

Revision of estimated costs:

	Total estimated costs prior to amendment	Revision (+ or -)	Revised total estimated costs
Cooperator's share			
GLFC share			
Total costs			

REASON FOR AMENDMENT

COOPERATOR - (Name and Address)

SIGNATURE TITLE DATE

APPROVED FOR GREAT LAKES FISHERY COMMISSION

SIGNATURE TITLE DATE

(Form BDC 10-77)

APPENDIX 11

Federal/Provincial Agreement

cm

Sea Lamprey Barrier Dams

AGREEMENT made in **triplicate** the 17th day of October

1983.

BETWEEN

ThE **GOVERNMENT** OF CANADA, as represented **herein** by the **Minister** of **Fisheries** and Oceans, hereinafter referred to as "Canada", the Party

OF THE FIRST PART:

- and -

THE GOVERNMENT OF ONTARIO, as represented **herein** by thr **Minister** of **Natural** Resources, and the Minister of Intergovernmental Affairs, hereinafter referred to as "Ontario", the Party

OF THE **SECOND** PART,

WHEREAS Canada and Ontario are **desirous** of cooperating in a **programme** for the construction and maintenance of lamprey barriers on selected streams situated In the Province of Ontario and to that end have agreed to share the costs of such **programme.**

NOW THEREFORE THIS AGREEMENT WITNESSETH that the parties hereto agree as follows:

1. In this **Agreement,**

(a) "Single purpose barrier" means a barrier designed and installed solely to **inhibit** the passage of lamprey; and

(b) **"Multi**-purpose barrier" means a barrier designed and **installed** Per **more** than one USC, one of which Is to **inhib**it the passage of **lamprey.**

2. (1) Before the construction of a single purpose **barrier** Is undertaken pursuant to this Agreement, the site therefor shall be agreed upon by the parties hereto.

(2) Where the site for a single purpose barrier is on public lands within the tneanlng of the Public Lands Act R.S.O. 1980 Chapter 413, the administration and control of the public lands necessary for the site will be transferred to Canada on condition that when it Is agreed by the parties that such public lands are no longer necessary for lamprey control, the administration and control of the public lands will be transferred back to Ontario,

(3) Where the site for a single purpose barrier Is on privately owned land, the acquisition cf such land will be effected by Canada at its expense.

(4) Pursuant to the Agreement, Canada, with the authorization of Ontarlo, will design, plan and construct any single purpose barrier.

(5) The undertaking of a single purpose barrier will comply with the requirements of the Federal Environmental Assessment and Review Process.

3. Canada, with the uthorltatlon of Ontario, will operate and maintain at Its expanse any single purpose barrier constructed pursuant to this Agreement so long as the barrier Is used for lamprey control.

4. (1) When the parties hereto agree that any single purpose barrier Is no longer necessary for lamprey control,

(a) Ontarlo may require Canada to remove any such single purpose barrier and to restora the site thereof to the state in which it was before the construction of the single purpose barrier thereon and the cost of such removal and restoration shall be paid by Canada, and Ontario shall have the right of first refusal to purchase the said land if the land was previously acquired from a private owner and should Canada wish to roll it; or

(b) Ontario nay require that any such single purpose barrier remain In place, and,

(I) Where the barrier was constructed on public land acquired from Ontario, Canada Shall transfer administration and control of the said land and barrier to Ontarlo upon payment to Canada of the sum of $1.00,

or

(ii) Where the barrier Is situated on land other than land described in subclause (i), Ontario shall acquire title to both the land and tht barrier upon payment to Canada of an amount equal to the fair market value of the land.

(2) In the evtnt that Ontario wishes to have a single purpose barrier left in place, in accordance with clause (b) of subparagraph (1) , Ontario may requi re Canada at the expense of Canada to put the single purpose barrier in a state of repair satisfactory to Ontario before the transfer of title thereto to Ontario.

(1) Before the construction of a multi-purport barrier is undtrtaksn pursuant to this Agreement, the site therefor shall be agreed upon by the parties hereto.

(2) Where tht site selected for the multi-purpose barrier Is on public lands withln the meaning of the Public Lands Act R.S.O. 1980 Chapter 413, tht multi-purpose barrier shall be constructed thereon.

(3) Where the site selected or part thtreof for the multi-purpose barrier Is on prlvately owned land, the acquisition of such land will be effected by Ontario and the costs thereof shall be shared equally.

(4) *In* accordance with the requirements of Canada respecting the lamprey control portion, Ontario will design, plan and construct any multi-purpose barrier constructed pursuant to

to this Agreement and, In the design, planning and construction may use Its own personnel or may retain the services of a contractor.

(5) Where pursuant to this Agreement a multi-purpose barrier is constructed, the design, planning and construction costs thereof shell be shared by the parties hereto to the extent that Canada shell pay en amount equal to the cost of erecting a single purpose barrier and Ontario shall pay the balance.

(6) Canada agrees to pay the Treasurer of Ontario the costs referred to in subparagraphs (3) and (5) within 30 days after receiving from Ontario invoices therefor.

(7) Invoices for costs submltted under subparagraphs (3) end (5) shall be certified by the Chief Accountant of the Ministry of Natural Resources.

(8) The undertaking of a multi-purpose barrier will comply with the requirements of the Ontario Environmental Assessment Act.

6. (1) In accordance with the requirements of Canada respecting the lamprey control portion, Ontario will operate and maintain ail multi-purpose barriers erected pursuant to this Agreement.

(2) The costs of operating and maintaining any such multi-purpose barrler as a sea lamprey barrler will be borne by Canada.

(3) The costs of operating end maintaining any such muitl-purpose barrier for purposes other than sea lamprey control will be borne by Ontario.

(4) Canada agrees to pay to the Treasurer of Ontario the costs referred to in subparagraph (2) within 30 days after receiving from Ontario invoices therefor.

(5) Invoices for costs submitted under subparagraph (2) shell be certified by the Chief Accountant of the Ministry of Natural Resources.

7. (1) When the parties hereto agree that any multi-purpose barrier is no longer necessary for lamprey control,

(a) Ontario may remove any such multi-purpose barrier end restore the site thereof to the state to which it was before the construction of the multi-purpose barrier thereon end the costs of such removal and restcratlon. shall be divided between Ontario and Canada in the same proportion as the costs of construction of the multi-purpose barrier were shared and, In the event that the multi-purwse barrier Is situated on land

(I) selected pursuant to subparagraph (2) of peregraph 5 hereof, Ontario shall retain ownership of the said land: and

(ii) where the land was acqui red by Ontario pursuant to subparagraph (3) of paragraph 5 hereof,

Ontario shell retain ownership of said land upon payment to Canada of its contributions towards the acquisition of the said land.

(b) Ontario mey require that any such multi-purpose berrler remain In place, and

(I) Where the barrier Is situated on land selected pursuant to subparagraph (2) of paragraph 5 hereof, Ontario shall retain ownership of the said lend;

and

(ii) Where the berrler is situated on land pursuant to subparagraph (3) of paragraph 5 hereof, Ontario shall retain title to both the lend end the barrier upon payment to Canada of Its contribution towards the acquisition of the raid land.

8. This Agreement may be terminated by mutual consent given in writing and signed by the parties thereto.

IN WITNESS WHEREOF the parties hereto have executed this Agreement, Canada under the hand and seal of the Minister of Fisheries and Oceans and, Ontario under the hands and seals of the Minister of Natural Resources and the Minister of Intergovernmental Affairs.

SIGNED, SEALED AND DELIVERED
in the presence of

HER MAJESTY THE QUEEN in
right of Canada

Witness as to the execution by
The Honourable Pierre De Bane

Pierre De Bane
Minister of Fisheries and Oceans

Witness as to the execution by
The Honourable Alan W. Pope, Q.C.

Alan W. Pope
Minister of Natural Resources
for the Province of Ontario

Witness as to the execution by
The Honourable Thomas L. Wells

Thomas L. Wells
Minister of Intergovernmental Affairs
for the Province of Ontario

A P P E N D I X 1 2

Warning Signs

at

Sea Lamprey Barrier Dams

1. A warning sign for canoeists posted at the lamprey barrier dam site on the Middle River, Lake Superior, Wisconsin.

2. A warning sign for canoeists posted at the lamprey barrier dam on the Brule River, Lake Superior, Wisconsin.

3. A warning sign for canoeists posted at the lamprey barrier dam site on the West Branch Whitefish River, Lake Michigan, Michigan.

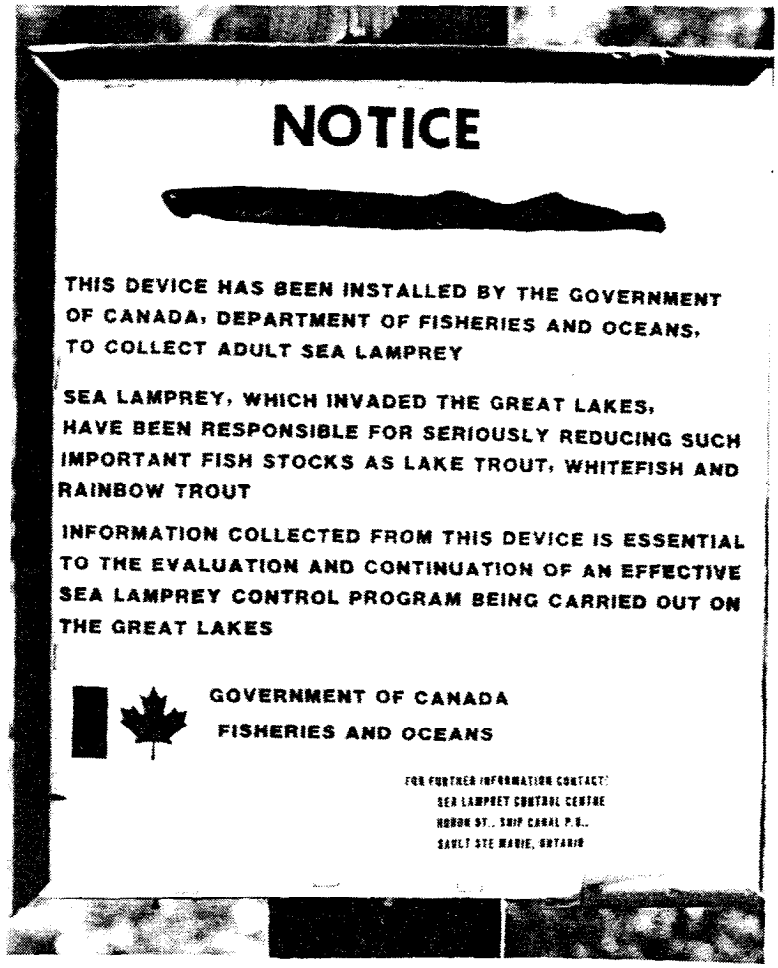
4. A sign posted at a Canadian barrier dam site to warn the public that it is illegal to fish within 25 m (27 ft) downstream of a dam.

A P P E N D I X 1 3

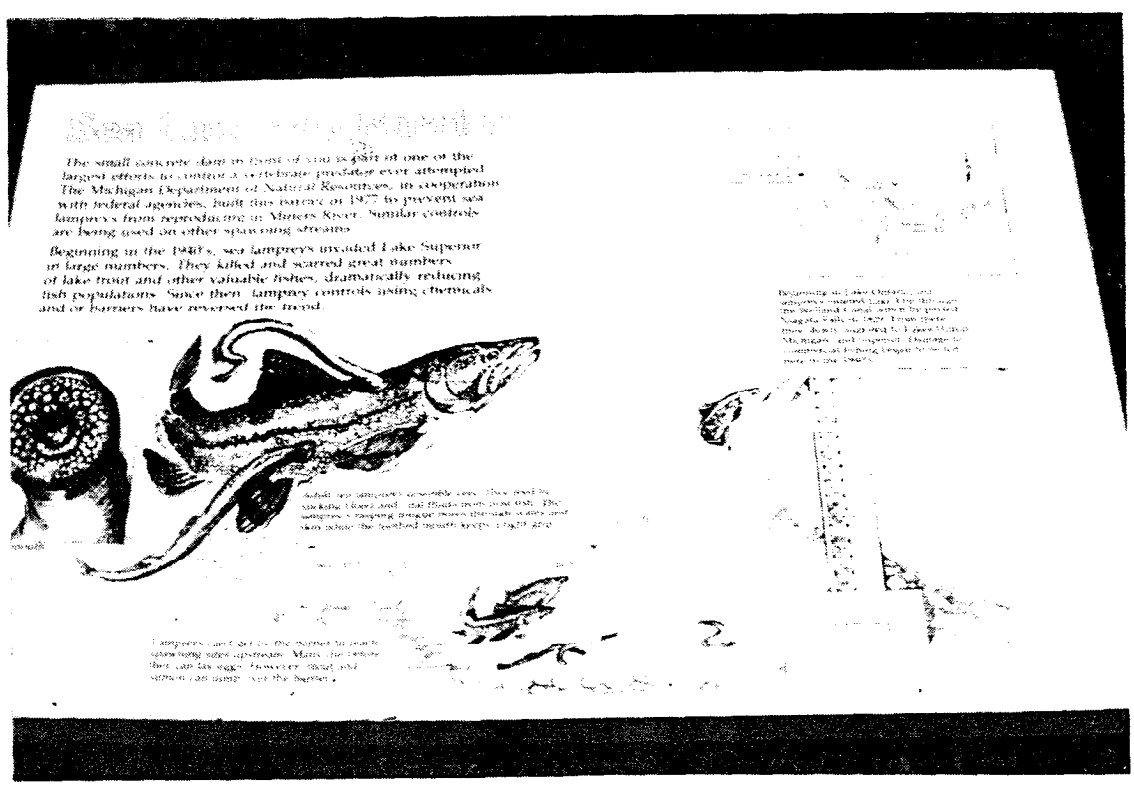
Information Signs

at

Sea Lamprey Barrier Dams



1. A sign posted at a Canadian lamprey barrier dam site to inform the public.



2. A sign posted at a U.S. lamprey barrier dam site to inform the public.

APPENDIX 14

Draft Letter

to

Owners of Dams Stopping Spawning-Run Sea Lamprey

Draft Letter

To Owners of non-Commission Funded Dams:

The _____ River has been identified as one of the sea lamprey spawning tributaries to Lake _____ . As you may be aware, lampreys attack a variety of fish in the Great Lakes including lake trout, rainbow trout, brown trout, salmon, and other species. Consequently, sea lamprey are very harmful to the rehabilitation of the fisheries of the Great Lakes.

Your dam, _____ is an important barrier for blocking the upstream migration of spawning-phase sea&prey. Blocking their migration is important because it reduces the amount of spawning habitat accessible to the adult lanpreyandreduces the number of young produced. Hence, your dam helps to control lamprey and this enhances the Great Lakes fisheries.

If you are planning ti remove or make some alterations to your dam, please contact your sea lamprey control agent. The address and telephone number are given on the back of the enclosed brochure on the Sea Lamprey Management Program in the Great Lakes.

I thank you for your attention to this matter.

_____

Executive Secretary, GLFC