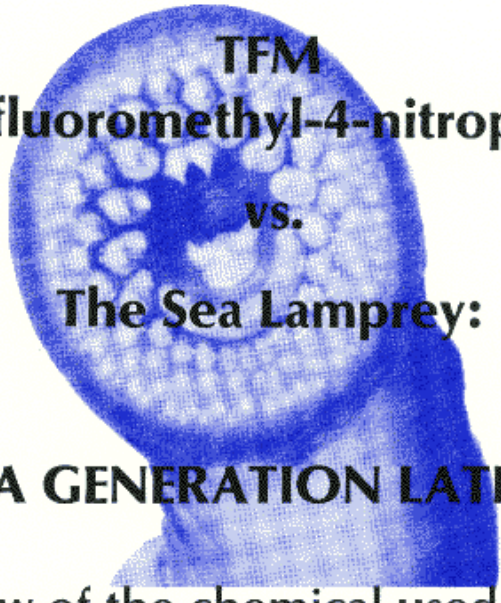


TFM (3-trifluoromethyl-4-nitrophenol) vs. The Sea Lamprey:

A GENERATION LATER

A review of the chemical used to control sea lamprey in the successful rebuilding of the Great Lakes fishery.

Great Lakes Fishery Commission

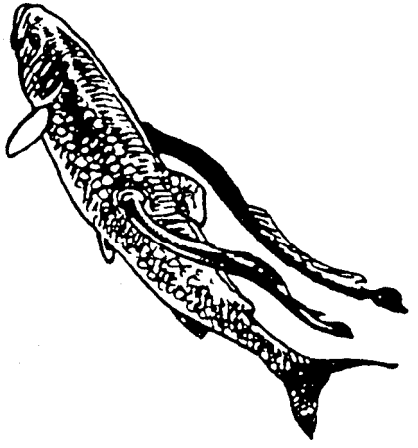
Special Publication No. 85-6

The Great Lakes Fishery Commission was established by the Convention on Great Lakes Fisheries betwen Canada and the United States, which was ratified on October 11, 1955. It was organized in April 1956 and assumed its duties as set forth in the Convention on July 1, 1956. The Commission has two major responsibilities; first, develop coordinated programs of research in the Great Lakes and, on the basis of the findings, recommend measures which will permit the maximum sustained productivity of stocks of fish of common concern; second, formulate and implement a program to eradicate or minimize sea lamprey populations in the Great Lakes.

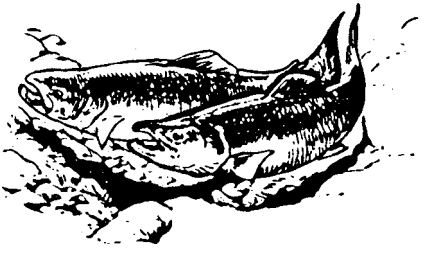
The Commission is also required to publish or authorize the publication of scientific or other information obtained in the performance of its duties. In fulfillment of this requirement the Commission publishes the Technical Report Series, intended for peer-reviewed scientific literature, and Special Publications, designed primarily for dissemination of reports produced by working committees of the Commission. Technical Reports are most suitable for either interdisciplinary review and synthesis papers of general interest to Great Lakes fisheries researchers, managers, and administrators or more narrowly focused material with special relevance to a single but important aspect of the Commission's program. Special Publications, being working documents, may evolve with the findings of and charges to a particular committee. Sponsorship of Technical Reports or Special Publications does not necessarily imply that the findings or conclusions contained therein are endorsed by the Commission.

INTRODUCTION

For thousands of years the Great Lakes of North America (Lakes Ontario, Erie, Huron, Superior and Michigan) were important sources of food fish. However, when the Great Lakes were opened to the Atlantic Ocean via manmade canals in the 1800's, sea lampreys entered for the first time. These predators were a major factor in the decline of the Great Lakes fishery. In its lifetime, each sea lamprey, by attaching to fish and feeding on their body fluids, can kill 40 or more pounds of fish. By 1958, the numbers of lake trout, whitefish and other desirable fish in the Great Lakes had been greatly reduced. The fisheries were devastated.



Today fish populations are abundant and the Great Lakes again rank high as a source of recreational and commercial fisheries. The revival of these fisheries can be directly attributed to the management, research, and regulatory programs of the state, provincial, federal and international natural resource agencies. The sea lamprey control and research programs of the Great Lakes Fishery Commission, as executed by its agents, the U.S. Fish and Wildlife Service and the Canadian Department of Fisheries and Oceans, have been a cornerstone upon which to build. Control of sea lampreys through the use of TFM has not only been highly successful, it has been essential to the revitalization of Great Lakes fisheries.

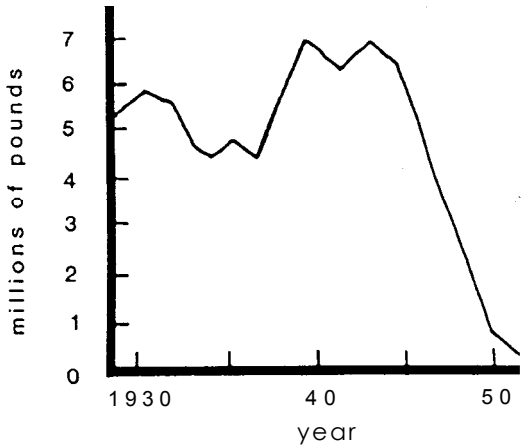


This publication documents the role of TFM in controlling the sea lamprey and the precautions that have been taken to assure the safety of this chemical to people and to the environment. The publication's purpose is to provide information, based on research data, that will help you better understand the use of TFM for control of sea lampreys in the Great Lakes.

TFM vs. The Sea Lamprey: A Generation Later

If you were a news reporter given the assignment of investigating the use of a chemical (TFM) that was to be added to streams for the purpose of controlling sea lampreys, you would need to ask many questions before your story would be complete. You would rely on research studies, facts, and the record of its use.

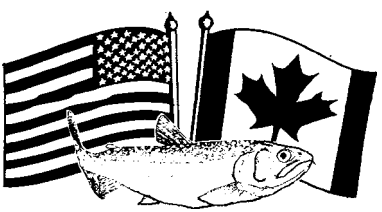
If you were a scientist charged with controlling the sea lamprey, a known killer of fish in the Great Lakes, you would need to ask many questions before you would approve the use of TFM. You would rely on research studies, facts, and technical interpretations of the data.



Drop-off of Lake Trout Production in Lake Michigan

Imagine yourself in the role of a reporter or scientist as you read TFM vs. The Sea Lamprey: A Generation Later.

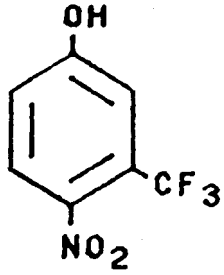
The investigation begins shortly after the end of World War II. The loss of lake trout and other food fish in the Great Lakes to sea lamprey attacks was a prime environmental issue. The people of the United States and Canada wanted action to restore the fisheries in these waters.



The 1955 Convention on Great Lakes Fisheries between the U.S. and Canadian governments established the Great Lakes Fishery Commission. The following year the Commission was organized and given two major responsibilities: (1) to develop coordinated programs of research in the Great Lakes, and, (2) on the basis of their findings, recommend measures which would permit the return of valuable fishes; and to reduce or end the problem of sea lampreys in the Great Lakes.

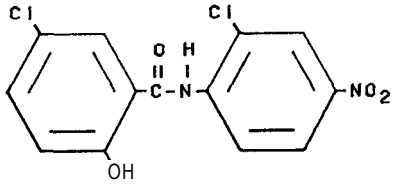
Under the Commission's direction, scientists tested many different ways to control the sea lamprey. Early efforts included dams and electrical fences across streams to stop the spawning runs.

Their research included testing 6,000 chemicals to find one to which lampreys were especially sensitive. They discovered TFM, a chemical that could be put into streams to kill immature sea lampreys. It was determined that, by eliminating the larval lampreys before they were able to attack fish, effective control would be easier and more complete.



TFM

TFM is the primary chemical used in sea lamprey control today. A second compound, Bayer 73 (2', 5-dichloro-4'-nitrosalicylanilide), is sometimes used in combination with TFM or used to treat, or check for, sea lamprey populations in areas where TFM applications are not feasible. The amount of Bayer 73 used is very small - less than one per cent of the amount of TFM that is applied annually. Bayer 73 is approved for use in sea lamprey control. Information on this compound is available from the Great Lakes Fishery Commission or its agents.



BAYER 73

Before TFM could be put into the streams, its use had to be tested for safety by scientists and approved by governmental agencies, today known as the U.S. Environmental Protection Agency (EPA) and Environment Canada. These agencies insure the safe use of chemicals by assuring that guidelines, regulations, and data requirements have been met.

The EPA requires that a pesticide:

(1) has no long-term effect on the environment or on forms of life other than the one it is supposed to control;
(2) does not leave persistent residues;
(3) does not join with other chemicals to form a new chemical with hazardous effects;
(4) does not constitute a health hazard to humans working with the chemical; and
(5) does not have a long-term effect on human or animal life.

If a chemical can meet all these requirements, it is then considered safe for use in the environment.

TFM met all of the test requirements and was approved by the EPA and Environment Canada for use in the sea lamprey control program.

TFM's success in achieving the goal of reducing the number of sea lampreys, and the subsequent successful stocking of lake trout and other desired fish species, are well documented. Fish populations in the Great Lakes have returned along with the food and recreational industries they support.

Our imaginary investigation now shifts to the present time. A new generation of people now lives around the Great Lakes. A generation that has no recollection of the times when food fish were scarce and lampreys dominated the Great Lakes. Over half of the present population in the U.S. and Canada was born after the problem of how to control the sea lamprey had been solved and fish were again thriving in the Great Lakes. The present generation has a new and different list of priorities than their parents. The key issues today include identifying potential health hazards and dangers which may affect our lives and the environment.

Today the public has a high awareness of the potential dangers of chemicals. The mere mention of the word 'chemical' is often associated with 'danger', therefore, it is important to clearly define the properties of any chemical being used in our environment. A question raised by the present generation is, "Was TFM adequately tested to assure our personal safety, as well as to control the sea lamprey?".

For the answers to current questions about TFM, we must turn to the scientists who know the chemical best. We must question them about what has been done and what knowledge has been gained if we are to face the future with a feeling of security. Questions. such as the following, must be answered.

Q. What is TFM?

A. TFM is a pesticide. The active ingredient in TFM is 3-trifluoromethyl-4-nitrophenol.

Q. How was TFM tested?

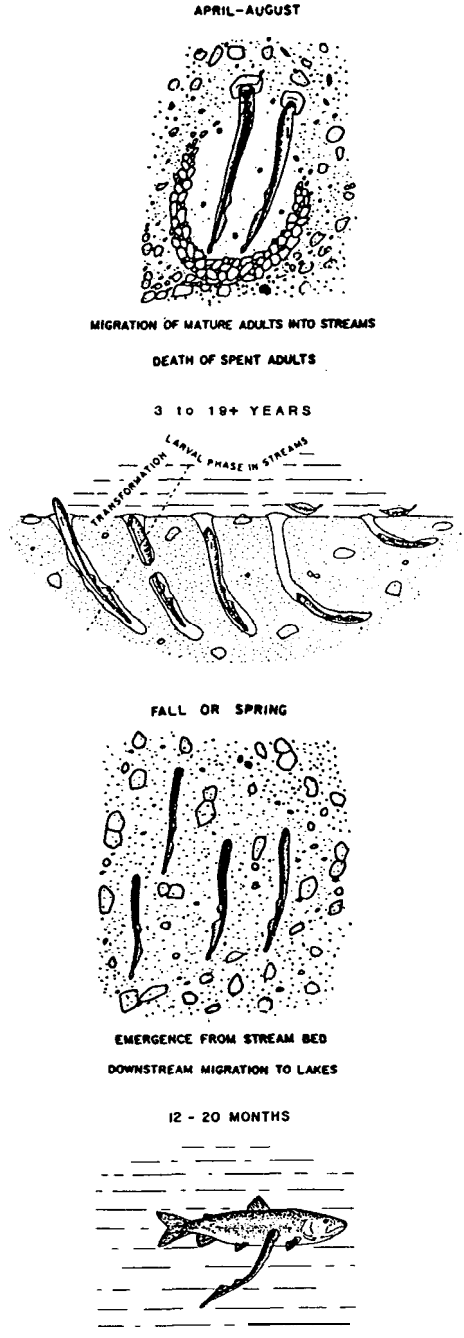
A. TFM was tested in laboratory and field studies according to all of the safety and regulatory requirements of the U.S. Environmental Protection Agency (EPA) and Environment Canada. It met or surpassed all tests for safety and was approved for use. The testing was conducted for over 30 years and has detected no permanent effects on populations of plant or animal life that can be traced to TFM applications.

Q. Because TFM is used to control sea lampreys, it is necessary to understand the life cycle of this predator. What is the connection between the life cycle of the sea lamprey and the frequency of TFM applications?

A. Sea lampreys migrate from the Great Lakes in the spring and early summer to tributary streams where spawning occurs. Like Pacific salmon, the adults die after spawning. Once the eggs hatch, the young larvae move from the nest and burrow into sand or silt where they live for three or more years. During this stage the larvae are harmless and feed on algae and other materials they filter from the water. Young sea lampreys grow to about six inches in length before they develop into the stages that are able to attack fish. This change in body structure is called transformation.

In late summer, fall, and winter the transformers move from the streams to the Great Lakes in search of fish. The next 12 to 20 months are spent feeding on fish. With their large suction-cup mouth, they attach to a fish, cause large wounds, and, while feeding on its body fluids, may kill the fish. Each lamprey kills about 40 or more pounds of fish during the eighteen months that they prey on fish. During this period a sea lamprey grows to approximately a foot and a half in length. While the total life cycle averages about seven years, it may last as long as 20 years.

Effective management of the sea lamprey in the Great Lakes could not have been achieved without scientists knowing and understanding its life cycle. This knowledge made it possible to concentrate control efforts on the stage in the life cycle when sea lampreys were most vulnerable. It was determined that sea lamprey could best be controlled by treating the young larval stages with the chemical TFM.

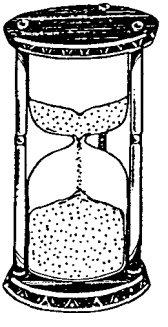


Q. Where is TFM used in the control of sea lamprey, and how often?

A. Tributary streams to the Great Lakes are treated at three to ten year intervals, depending on the abundance, size and age of the larval lampreys. Some streams may require annual treatment because they contribute to lake dwelling populations of larvae. Only about 7% of the total number of streams in the Great Lakes basin have ever been treated with TFM. Of these, only about one-fifth are treated in a given year. Only a portion of each infested stream receives a chemical application because the larval lampreys are usually not found in all feeder streams or headwater areas.

Q. What is the duration of a TFM stream treatment?

A. The amount of TFM metered into the stream is that needed to expose larval lampreys for 12 hours and to produce a predetermined concentration of TFM. The length of exposure combined with the concentration adds up to a lethal dose. After concluding the chemical application, the treated water moves downstream with the flow. The treated water, called a “bolt”, will move rapidly with strong currents and slowly in pools and flat stretches of the stream. Normally, the bolt has passed a given point in 12 to 24 hours.



Q. How much TFM (chemical/water ratio) is put into the streams to control the sea lamprey?

A. TFM concentrations used for sea lamprey control generally range from 3 to 9 parts of chemical per one million parts of water and are expressed as parts per million (ppm). This is a concentration comparable to adding 3 to 9 teaspoonsful of chemical to approximately 1,300 gallons of water.

Q. What health hazard would result if an excessive amount of TFM was accidentally spilled into the water?

A. Tests have been conducted on rats and hamsters using daily doses of an extremely high concentration (5,000 ppm) in their diet over periods ranging from 90 days to three generations of animals. No adverse effects were observed. The test dosage used is equivalent to a 150-pound person drinking 179,000 eight-ounce glasses of TFM-treated water each day. Based on this information, the potential dangers from an accidental spill are almost non-existent.

Q. Can you see TFM in the water?

A. TFM is yellow in color. The addition of any amount of colored liquid, however small, can cause a temporary coloration of clear water. Downstream movement of the treated water, coupled with dilution, will normally remove any color within 12 to 24 hours.

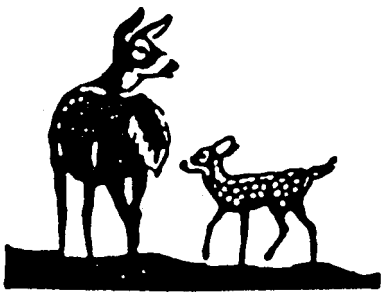
Q. What if it gets on my skin?

A. During almost 30 years of using TFM for sea lamprey control, personnel applying the chemical have reported no unusual skin reactions to straight TFM or to water treated with TFM. Laboratory tests have confirmed that there is little cause for concern about contact with the compound. Tests using a very concentrated solution (37.9%) of TFM were conducted on the shaved skin of New Zealand white rabbits for eight hours at a time, five days a week, for three consecutive weeks. No adverse effects were noted other than slight thickening of the skin in the application area.

Q. What if I should drink water containing TFM?

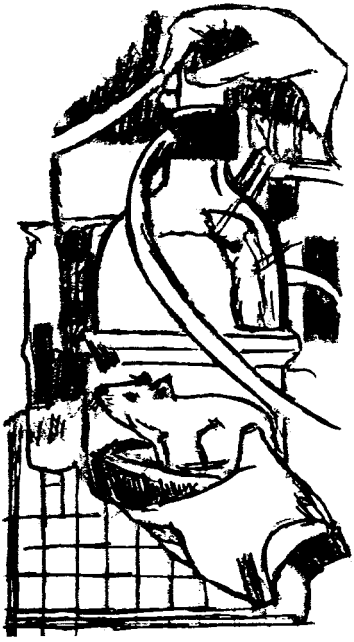
A. TFM was put in the drinking water of laboratory animals. Even the highest tested levels had no measurable effect on body weight, feed consumption, feed efficiency, or body functions, for all groups of males and females. Rats, hamsters and dogs that were fed up to 5,000 ppm of TFM daily in their feed, over a 2-year period, all developed normally. Slightly lower feed consumption because of taste, and consequently lower body weights, were noted for all three species.

The acceptance of TFM treated water by deer and cattle has also been tested. When given a choice of treated and untreated water, deer drank freely of both. Cattle, however, seemed to prefer the untreated water. No effects of the chemical were observed in either deer or cattle tested over periods up to six weeks.



Q. If I drank TFM treated water, would it cause me to gain or lose weight?

A. Many of the laboratory animals consumed less food and water treated with TFM because of the change in taste. Daily feeding of food and water containing TFM levels of 5,000 ppm in tests for ninety days, two years, or through three generations in rats and hamsters showed no effects on growth, health or survival. A slight drop in body weight was noted, perhaps due to taste avoidance. Dogs fed the same high dosage in their diet for ninety days also showed only a slightly lower body weight.



Q. What can residents or others who may draw their water supply from a treated stream do to avoid drinking TFM?

A. Persons along a treated stream may note the pale yellow color in the water as the treatment passes. If it is necessary to draw water from the stream during that time, and the user wishes to avoid contact with TFM, filtration through activated charcoal will effectively remove all the compound. Unfiltered water may have a faint odor or slight chemical flavor but it is not harmful.

Q. If cows drink water containing TFM will it affect their milk or meat?

A. In a study conducted with cows, each animal was given a dose of 15 gallons of water containing double the maximum stream application of TFM. Most of the compound passed through the body and was discharged in the urine within 24 hours. Milk from the first milking contained low concentrations of TFM. These levels had decreased by 80% in the second milking. After 26 hours, no traces could be detected in the milk.

In other studies on dairy cows involving dosage levels triple that used in the tests mentioned above, there were no noticeable changes in body functions, no alterations of behavior, and no changes in feed consumption or milk production. No traces of TFM were present in the flesh 24 hours after dosing.

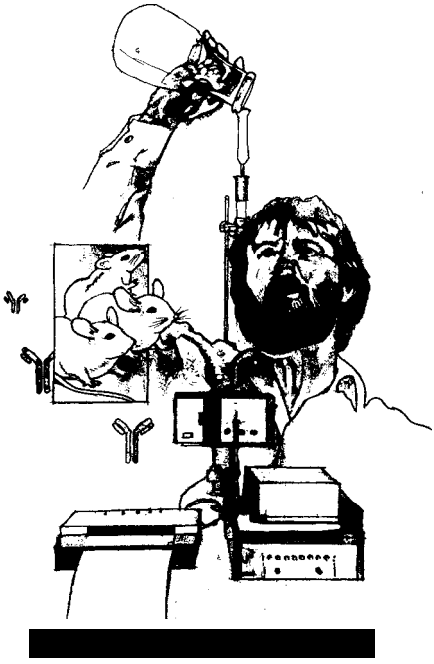
Q. Does TFM cause muscle, kidney, liver or other physiological problems in humans?

A. Existing evidence shows that consumption of up to 5,000 ppm TFM in the water or food of several species of warm-blooded animals has no measurable effect. Warm-blooded animals quickly convert TFM to a form that can easily be passed out of the body without affecting organs or body functions.

Q. What about effects of TFM on the fertility or reproduction capabilities of those exposed to the chemical?

A. Possible effects of TFM on the reproduction of warm-blooded animals were evaluated in studies on rats and hamsters. A concentration of 5,000 ppm was fed daily in the diet through three generations, beginning 16 weeks prior to mating of the original parents. The dosage had no effect on reproductive performance. All functions, survival, and growth were good in the three generations. Litter sizes were normal. Fertility, mating and development of the young were not affected. Young rats and hamsters grew and developed normally.

Long-term studies have shown that TFM does not affect sexual performance, pregnancy, or development of the young. These studies also indicated that TFM does not affect the ability to sire or produce normal offspring.



Q. Could it cause birth defects in offspring?

A. Many of the studies were conducted to answer concerns about human and animal safety over several generations. None of these tests showed any effects on the normal development of young during pregnancy or after birth. Studies were conducted in rats and rabbits to determine if TFM given to pregnant animals would lead to birth defects in the offspring. Large dosages were given to rats through stomach tubes during days 6 through 15 of pregnancy. Rabbits received the same treatment on days 6 through 18. A comparative dosage for humans would be equal to drinking nearly 6,580 gallons of TFM treated water daily. Results of the tests showed no birth defects and no changes in the litter size, sex ratio, or weights of the young.

Q. Might swallowing TFM cause genetic disorders?

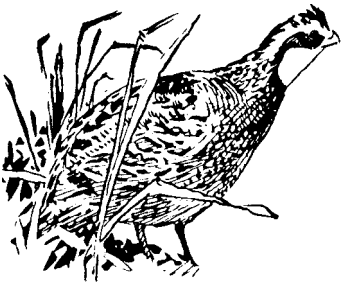
A. Studies have shown that TFM does not affect the genetic make-up of organisms. Three generations of rats and hamsters fed TFM continuously in their diet showed no negative effects among the offspring. A test designed specifically to check for mutations showed no alterations from the normal due to TFM.

Q. Is there any evidence that TFM might cause cancer?

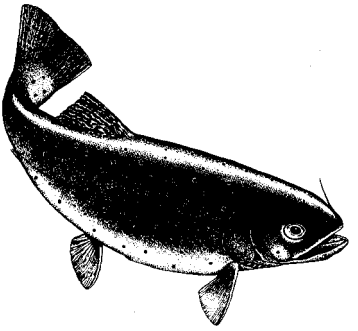
A. This concern was studied in long-term evaluations that extended over several generations, during which animals continuously received the chemical in their diet. Ninety-day, two-year and three-generation studies were conducted in rats and hamsters. Dogs were used in a six month study. No cancerous growths or tumors were observed in any of these studies

Q. Most of the questions to this point have been directed to effects that TFM might have on humans and mammals. What are its effects on birds, fish and invertebrates, such as insects, clams, aquatic worms, etc.?

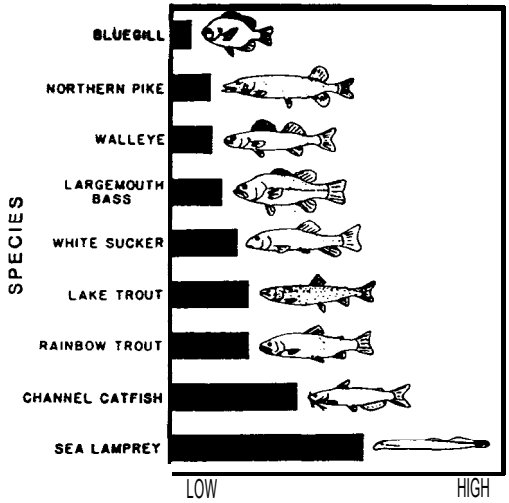
A. Birds. Studies were conducted on birds that live in close association with water (mallard ducks and ring-billed gulls) or on land (bobwhite quail and California quail). These tests showed that the levels of TFM used in sea lamprey control are far below those that affect any of the birds tested. In all tests, the dosage levels that affected birds far exceeded those to which they would be exposed during sea lamprey treatments. Treated stream water poses no threat to aquatic or land birds.



Fish. Lampreys are fish, and fish vary significantly in their ability to tolerate TFM. Observations and tests have been conducted on 36 species of fish that occur in the Great Lakes Basin. Of these, sea lampreys are much more susceptible to the toxic effects of TFM than the other species. This difference from other fish is based on the inability of sea lampreys to metabolize or change the chemical structure of TFM so it can be discharged from their bodies. Most other fish have this capability and, therefore, are more resistant to TFM. The difference in the lampreys' reaction to TFM from other fish living in a stream must be determined by on-site testing. If the resident fish in a stream are already stressed by some other factor, such as pollutants, low oxygen levels, high water temperatures, or spawning, the effects of TFM may change dramatically.

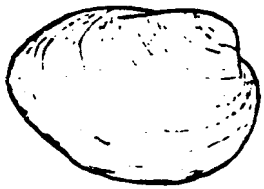


Occasionally the on-site tests do not reveal the full extent of the existing stresses, and minor fish kills may occur. Such instances do not happen often. When they do, usually only low numbers of fish are involved, and the fish kills are limited to localized areas.



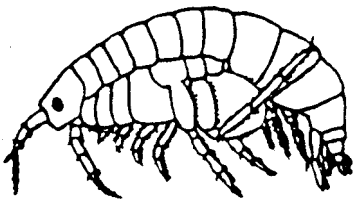
Comprehensive studies on walleye spawning have shown that TFM treatments do not affect the fertilization, development, hatching, or survival of eggs and fry. Incubation of rainbow trout eggs subjected to TFM proceeded normally with good survival of the hatched fry.

Invertebrates. The insects, snails, clams, aquatic worms and other creatures without backbones that live in streams are collectively known as invertebrates. There are hundreds of species and types of such organisms in a normal stream system and they vary in their resistance to TFM. The great majority of stream invertebrates such as crayfish, scuds, and clams survive TFM treatments. However, certain groups of organisms, such as aquatic earthworms and the larvae of some mayfly species are sensitive to TFM. Some individuals in the populations are likely to be killed by TFM applications.



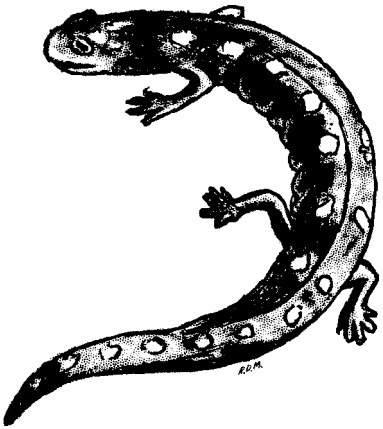
Surveys conducted before and after treatments indicate that there may be a marked reduction in the abundance of sensitive species immediately after

treatment. Such reductions are temporary. Studies conducted over the 18 months following TFM applications have shown a rapid recovery by the affected species. Within months, usually before the end of the summer, the populations have returned to original levels, both in numbers and weight.



Recolonization occurs rapidly because organisms drift downstream from the untreated portions of the stream system. Another reason for the rapid recovery is related to the fact that most streams are treated only once in several years. As a result, no significant permanent impact on populations of sensitive species occurs. No species is known to have been eliminated from a stream during the many years of TFM treatments.

Other Animals. Tadpoles and salamanders are susceptible to the chemical and are sometimes killed. It should be noted that most of these species generally have left the streams for shore habitats by the time of the year when TFM treatments begin. There is no evidence that TFM has caused the catastrophic decline or disappearance of any species.



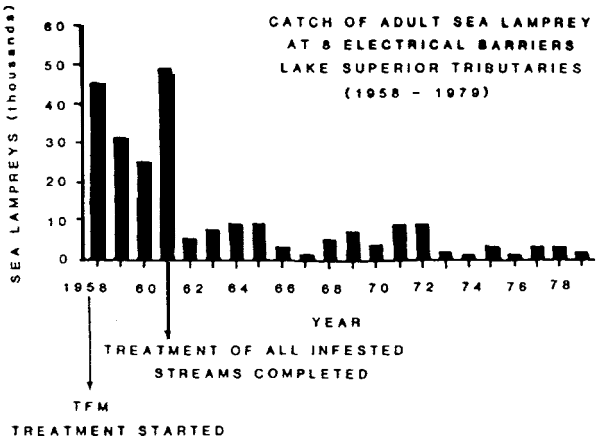
Q. Does TFM leave harmful residues in organisms or the mud of treated waters?

A. TFM breaks down to nonharmful substances when exposed to sunlight. It does not remain in plants, animals, soils or water for long periods of time. Most organisms rapidly discharge TFM from their bodies so there is little accumulation in their tissues. In the Great Lakes, studies of lake trout up to 12 years of age showed no traces of TFM even though many treatments had been made in streams tributary to the lake in which they were caught. TFM is not persistent in the

environment or in organisms exposed to treated water. There should be no concern that TFM residues may accumulate in the food chain.

Q. During the many years of its application, has the sea lamprey developed any resistance to this chemical?

A. Before a stream treatment is made, on-site tests are conducted to determine the amount of TFM needed for effective control in that stream. A comparison of records on the concentrations needed in streams that have been treated up to ten times shows no change in the effect of TFM on sea lampreys. The data indicate that the sea lamprey has not developed any immunity or **resistance to** TFM.



Q. If TFM is so successful in sea lampreys, why are there still lampreys present in the Great Lakes?

A. Certain streams have such low numbers of larval sea lampreys that it would not be cost effective to treat those streams. Other streams, such as the St. Mary's River, are too large for treatment to be feasible. Also, some larvae have taken up residence in lakes at the mouths of streams where TFM treatments may not reach them.

SUMMARY

We hope this review has provided the information needed to answer questions being asked "a generation later" concerning TFM and its use in controlling sea lampreys in the Great Lakes.

Persons interested in more information about the Great Lakes Fishery Commission and its fishery and sea lamprey programs should write to:

Great Lakes Fishery Commission
1451 Green Road
Ann Arbor, Michigan 48105
USA

Questions about the operation of the sea lamprey control program may be addressed to:

Sea Lamprey Control Centre
Department of Fisheries and Oceans
Huron Street, Ship Canal P.O.
Sault Ste. Marie, Ontario
CANADA P6A 1PO

Ludington Biological Station
U.S. Fish and Wildlife Service
229 S. Jebavy Drive
Ludington, Michigan 49431
USA

Marquette Biological Station
U.S. Fish and Wildlife Service
446 E. Crescent St.
Marquette, Michigan 49855
USA

Information on technical questions related to the studies described in this brochure is available from:

National Fishery Research Laboratory
U.S. Fish and Wildlife Service
P.O. Box 818
La Crosse, Wisconsin 54602-0818
USA

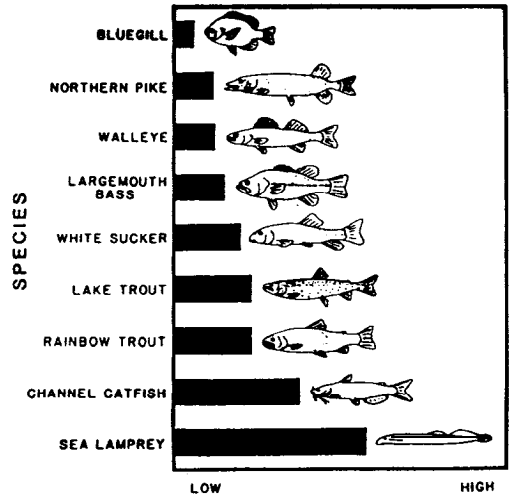
ACKNOWLEDGEMENTS

The Great Lakes Fishery Commission thanks the scientists, support staffs and administrators in the state, provincial and federal natural resource agencies who have worked so diligently over the years to plan and execute the research which has produced the results described in this booklet. In addition, appreciation is expressed to those responsible for the skillful presentation of the information and the reviews by personnel from several agencies.

CITATION

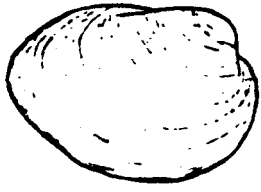
Great Lakes Fishery Commission. 1985. TFM vs. The Sea Lamprey: A Generation Later. Great Lakes Fish. Corn. Spec. Pub. 85-6.17 pp.

Occasionally the on-site tests do not reveal the full extent of the existing stresses, and minor fish kills may occur. Such instances do not happen often. When they do, usually only low numbers of fish are involved, and the fish kills are limited to localized areas.



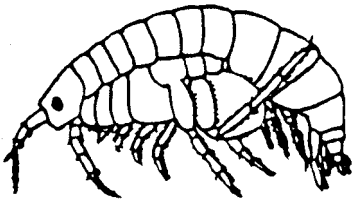
Comprehensive studies on walleye spawning have shown that TFM treatments do not affect the fertilization, development, hatching, or survival of eggs and fry. Incubation of rainbow trout eggs subjected to TFM proceeded normally with good survival of the hatched fry.

Invertebrates. The insects, snails, clams, aquatic worms and other creatures without backbones that live in streams are collectively known as invertebrates. There are hundreds of species and types of such organisms in a normal stream system and they vary in their resistance to TFM. The great majority of stream invertebrates such as crayfish, scuds, and clams survive TFM treatments. However, certain groups of organisms, such as aquatic earthworms and the larvae of some mayfly species are sensitive to TFM. Some individuals in the populations are likely to be killed by TFM applications.



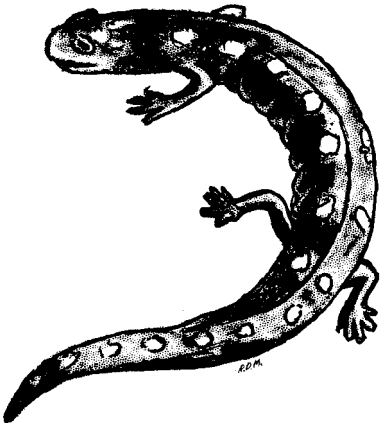
Surveys conducted before and after treatments indicate that there may be a

treatment. Such reductions are temporary. Studies conducted over the 18 months following TFM applications have shown a rapid recovery by the affected species. Within months, usually before the end of the summer, the populations have returned to original levels, both in numbers and weight.



Recolonization occurs rapidly because organisms drift downstream from the untreated portions of the stream system. Another reason for the rapid recovery is related to the fact that most streams are treated only once in several years. As a result, no significant permanent impact on populations of sensitive species occurs. No species is known to have been eliminated from a stream during the many years of TFM treatments.

Other Animals. Tadpoles and salamanders are susceptible to the chemical and are sometimes killed. It should be noted that most of these species generally have left the streams for shore habitats by the time of the year when TFM treatments begin. There is no evidence that TFM has caused the catastrophic decline or disappearance of any species.



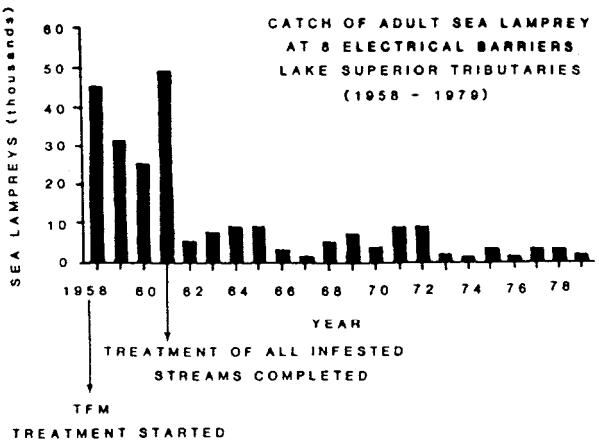
Q. Does TFM leave harmful residues in organisms or the mud of treated waters?

A. TFM breaks down to nonharmful substances when exposed to sunlight. It does not remain in plants, animals, soils or water for long periods of time. Most organisms rapidly discharge TFM from their bodies so there is little accumulation in their tissues. In the Great Lakes, studies of lake trout up to 12 years of age showed no traces of TFM even though many treatments had been made in streams tributary in the lake in which they were

environment or in organisms exposed to treated water. There should be no concern that TFM residues may accumulate in the food chain.

Q. During the many years of its application, has the sea lamprey developed any resistance to this chemical?

A. Before a stream treatment is made, on-site tests are conducted to determine the amount of TFM needed for effective control in that stream. A comparison of records on the concentrations needed in streams that have been treated up to ten times shows no change in the effect of TFM on sea lampreys. The data indicate that the sea lamprey has not developed any immunity or resistance to TFM.



Q. If TFM is so successful in sea lampreys, why are there still lampreys present in the Great Lakes?

A. Certain streams have such low numbers of larval sea lampreys that it would not be cost effective to treat those streams. Other streams, such as the St. Mary's River, are too large for treatment to be feasible. Also, some larvae have taken up residence in lakes at the mouths of streams where TFM treatments may not

SUMMARY

We hope this review has provided the information needed to answer questions being asked "a generation later" concerning TFM and its use in controlling sea lampreys in the Great Lakes.

Persons interested in more information about the Great Lakes Fishery Commission and its fishery and sea lamprey programs should write to:

Great Lakes Fishery Commission
1451 Green Road
Ann Arbor, Michigan 48105
USA

Questions about the operation of the sea lamprey control program may be addressed to:

Sea Lamprey Control Centre
Department of Fisheries and Oceans
Huron Street, Ship Canal P.O.
Sault Ste. Marie, Ontario
CANADA P6A 1P0

Ludington Biological Station
U.S. Fish and Wildlife Service
229 S. Jebavy Drive
Ludington, Michigan 49431
USA

Marquette Biological Station
U.S. Fish and Wildlife Service
446 E. Crescent St.
Marquette, Michigan 49855
USA

Information on technical questions related to the studies described in this brochure is available from:

National Fishery Research Laboratory
U.S. Fish and Wildlife Service
P.O. Box 818
La Crosse, Wisconsin 54602-0818
USA

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It is the policy of the Great Lakes Fishery Commission to carry out the following and other activities related to the use of lampricides for sea lamprey management:

- meet all regulatory requirements associated with the registration and safe use of lampricides;
- assist other agencies in their reviews and studies of lampricides;
- expedite the development and use of alternative methods of sea lamprey control within the context of integrated management of sea lamprey;
- refine lampricide formulations and application methods and timing;
- continue internal projects designed to identify any short or long-term environmental effects of lampricide application; and
- make information on lampricides available to the public.