FINTROL® STREAM AND RIVER USE MONOGRAPH FOR COMPLETE REMOVAL OF FISH

USE IN STREAMS AND RIVERS

These use instructions may be more, but not less, restrictive than use instructions on the product label. Use directions in this monograph provide guidance for conducting Fintrol® (antimycin A) treatments on streams and rivers for complete removal of fish. The term "antimycin" is reserved for the concentration (normally in µg/L or ppb) of active ingredient. The term "Fintrol®" is reserved for the commercial product volume (normally expressed in ml) and is composed of concentrate and diluent. An amount (ml) of Fintrol® is added to water to obtain the desired concentration (µg/L or ppb) of active ingredient antimycin. Fintrol® contains 11% (w/w) antimycin. The unique nature of each application site often requires minor adjustments to method and recommended rate of application within label limits. Should individual stream or river conditions require major deviation from use directions, a Special Local Need 24(c) registration should be obtained from the appropriate state agency.

Under specified environmental conditions (particularly water temperatures between 40 and 80°F and pH values <8.5) antimycin is extremely toxic to fish. In addition, stream gradient, incident sunlight, and submerged organic debris affect toxicity of antimycin. Antimycin is rapidly neutralized in high gradient streams where water is aerated as it cascades over cobble and boulder, where the stream receives direct sunlight much of the day, and organic debris, such as leaf litter, is common. These environmental variables and how they affect distribution and persistence of antimycin should be considered when making a decision to use Fintrol® to eliminate fish from a stream or river (see Section I).

This monograph contains instructions for application and neutralization of Fintrol® for complete removal of fish, identification of environmental variables affecting antimycin effectiveness, determination of effective treatment levels, determination of stream discharge, required safety and technical training, and determination of project effectiveness. Typically, Fintrol® is applied along the stream or river using multiple drip stations to achieve and maintain desired concentrations of antimycin in the treatment zone. Multiple applications of Fintrol® over several years are generally required for complete removal of fish from a stream or river. Each stream may have special challenges to the dispersion and application of antimycin (e.g., beaver ponds) that need special consideration. Application of Fintrol® to a stream should not occur until an applicator's license or permit is obtained from the appropriate state agency. Because local environmental conditions vary, consult with the state fish and wildlife agency to ensure the method and rate of application are appropriate for selected site. The monograph is arranged in the following sections:

I. Considerations and Restrictions

The effectiveness of Fintrol® applications to streams and rivers may be affected by a variety of factors that should be considered during project planning. It is advisable to conduct multiple treatments to ensure complete removal of fish from the project area. This is accomplished by conducting applications until no fish are removed during a subsequent treatment. Conditions of high water pH values (>8.5), low (<40 ºF) and high (> 80ºF) water temperatures, high gradient, and direct sunlight all accelerate neutralization of antimycin. Thus, Fintrol® normally is not applied to flowing waters where pH values > 8.5 or temperatures < 40 °F or > 80 ºF are present due to decreased efficacy. Fish communities containing species more tolerant of antimycin (e.g., ictalurids) may require higher concentrations than those allowed by the label. Thus, antimycin normally is not used for removal of ictalurids, as these fishes are quite tolerant of antimycin. Prior to implementation of a full-scale treatment, bioassays should be conducted to determine proper antimycin concentration during treatment and the most effective spacing of drip stations to ensure complete removal of fish (see Sections III and IV).

Prior to Fintrol® application to a stream or river, determine if any rare and/or protected species occurs in project area. If such species are present, authorization from appropriate state and federal agencies for Fintrol® use is necessary. Do not directly treat domestic water supplies. Contact the appropriate state or local water department to determine if water withdrawal, for domestic, municipal, or agricultural purposes occurs within ½-mile downstream of section of stream or river to be treated. The application of Fintrol® should be coordinated with appropriate agency to ensure no water is withdrawn from the stream or river during Fintrol® application and for the period required for all treated water to flow past the water withdrawal point (typically 8 to 12 hours). There should be no contact by members of public with treated water and no treated water should be used for agricultural or domestic purposes until caged fish placed in treated water can survive for 48 hours.

II. Determination of Stream Discharge

Determine stream discharge with flow meter or by float method. Discharge determinations should be made where the channel is straight, flow is laminar, depth and streambed materials are uniform and objects do not block or disrupt flow.

Use a flow meter to estimate water velocity at 10 or more points along a transect oriented perpendicular to streamflow. Depth can be measured with topset rod on which flow meter is mounted. The mean velocity should be determined at each point and is accomplished by taking the measurement at 0.6 of water column depth if depth is less than 3 feet and at 0.2 and 0.8 of water column depth if depth is greater than 3 feet. Each measurement point represents the center of a cell, the width of which is half the distance between adjacent measurements. Stream discharge (Q) is calculated by summing the discharge calculations for individual cells. To minimize error, discharge from any individual cell should not exceed 10% of total discharge. Stream discharge should be made near the time of treatment and during the time of day of the treatment. Stream discharge should be rechecked using a simple staff gauge (e.g., a rock on the edge of the water line) at the time of treatment. Stream discharge is calculated by equation:

$$\textbf{(1)} \qquad Q = \sum (V \cdot D \cdot W) \qquad \textbf{where}$$

Q = stream discharge (ft^3/s)
V = mean velocity of cell (ft/s)
D = depth of cell (ft)
W = width of cell (ft).

Alternatively and less accurately, discharge can be estimated by recording time required for a semi-buoyant object, such as an orange, to float a given distance. Float time for the object should be determined for a minimum of 5 feet in slow-velocity streams and 10 to 20 feet in moderate to rapid velocity streams. Divide the surface width into three equal sections (this may not be feasible for streams narrower than 10 feet). Water depth should be measured in the center of each section at a minimum of 3 points, and averaged. Time required for float to move specified distance should be measured at least 3 times for each section, and averaged for discharge calculation. Stream discharge is calculated by equation:

$$\textbf{(2)} \qquad Q = (W \cdot D \cdot L \cdot C) \div T \qquad \textbf{where}$$

Q = stream discharge (ft^3/s)
W = mean surface width for all stream sections (ft)
D= mean depth for all three sections (ft)
L= mean distance traveled by float for all three sections (ft)
C = constant (0.8 for rough and 0.9 for smooth bottoms)
T = mean time for float to travel mean distance L for all three sections (s).

III. Conducting Bioassays

A bioassay using caged sentinel fish is the simplest way to evaluate the site-specific performance of antimycin for the purpose of choosing an application rate. To conduct a bioassay, place 3 to 5 fish (the target species or closely related species) in each of five buckets that have been filled with treatment site water. Water in the first bucket has antimycin at the highest anticipated application rate. The second, third and fourth buckets have consecutive 50% serial dilutions of the first bucket (e.g., 10, 5, 2.5 and 1.25 ppb antimycin). The last bucket contains no antimycin and serves as the control. Buckets are placed in the stream to maintain water temperature for the anticipated treatment duration of 4 to 8 hours. It may be necessary to provide air to the fish for the duration of the bioassay. Determine survival in the buckets throughout the expected duration of the treatment (4 to 8 hours) then, replace treated water in buckets with clean water and monitor survival for a total of 24 hours. The minimum effective dose is when all fish are stressed (e.g., abnormal swimming behavior) within 6 hours and are dead within 24 hours. Travel time bioassays can give an approximate indication of drip (application) station intervals (see Section IV). For example, release antimycin at the expected concentration and duration into the stream at a particular point and place caged sentinel fish at various locations downstream to determine minimum effective distance (e.g., that which kills all fish in 24 hours).

The response times for fish relative to the different antimycin concentrations in this bioassay gives the applicator a tool for estimating the concentration of antimycin required during the treatment. The response to caged fish at various locations gives the applicator a tool for estimating the intervals between drip stations. During the treatment, caged fish are placed immediately upstream of each consecutive station, and the response times are used to ascertain whether antimycin concentrations are remaining stable, increasing or decreasing through the treatment zone.

Bioassays are also used to determine the adequacy of potassium permanganate ($KMnO_4$) neutralization (see Section VII). Place caged fish (the target species or a close relative) in stream 30 minutes travel time downstream of the neutralization $KMnO_4$ drip. If all fish survive for 48 hours, then the $KMnO_4$ neutralization was complete.

IV. Placement of Fintrol® Application Sites

The biological activity of antimycin diminishes rapidly once applied to water either due to physical degradation/alteration or binding to organic material. Consequently, multiple application stations are usually necessary to maintain toxic levels of antimycin in the treatment zone. Application stations should be spaced about 10 to 40 minutes water travel time apart (about 300 to 1,200 feet) depending on factors that may neutralize antimycin. A travel time of 10 to 20 minutes may be necessary if the treatment reach is in bright sunlight, has substantial water turbulence (waterfalls and cascades), or contains aquatic plants or a muddy stream bottom. A travel time of 30 to 40 minutes may be appropriate if the treatment reach is out of direct sunlight, has a low gradient without turbulence, and has a rocky substrate. Bioassays using caged fish should be conducted to ensure that application stations are spaced sufficiently close so that no fish survive

between stations (see Section III). Caged fish are placed immediately upstream of each application station. To determine travel time between sites, release a fluorescent dye, such as Rhodamine WT, and measure time required for dye to move from release to observation point. The dye is detected visually or with a fluorometer. Antimycin should be dispensed at each application site for 4 to 8 hours.

V. Fintrol® Application Rate

The concentration and duration of antimycin and spacing of drip stations needed to eliminate all fish in the treatment zone is dependent on target species and environmental conditions associated with the stream or river (see Table 1, Fintrol® Use Direction Leaflet). Typically, treatment time increases with the interval length between consecutive application sites. To achieve a complete a kill of fish, treating at a lower concentration (e.g., 5 ppb antimycin versus 10 ppb antimycin) will require longer treatment duration (e.g., 8 hours versus 4 hours). For sensitive species, such as salmonids and centrarchids, antimycin concentrations of 5 ppb may be sufficient in waters with temperatures greater than 60 °F or 7.5 ppb in waters with temperatures less than 60 °F. Cyprinids may require antimycin concentrations up to 20 ppb in waters with temperature less than 60 °F. Bioassays, using site water, are recommended to determine the effective concentration for target species and water body (see Section III).

The amount of Fintrol® (equal amounts of concentrate and diluent) needed to achieve a specified concentration at each application site in a stream (Equations 1 & 2) for a specified time interval is determined by equation:

$$\textbf{(3)} \qquad A = Q \cdot H \cdot X \cdot 1.013 \qquad \textbf{where}$$

A = amount of Fintrol® (ml)
Q = stream discharge (ft^3/s)
H = hours of treatment
X = desired stream concentration of antimycin (ppb).

The amount of Fintrol® (ml) needed (Equation 3) to achieve 7.5 and 10 ppb antimycin concentration for 4-hour, 6-hour, and 8-hour treatments at various stream discharges is provided by table:

Stream	4-h Treatment		6-h Treatment		8-h Treatment	
Discharge (ft^3/s)	7.5 ppb	10 ppb	7.5 ppb	10 ppb	7.5 ppb	10 ppb
0.1	3	4	5	6	6	8
0.2	6	8	9	12	12	12
0.3	9	12	14	18	18	24
0.4	12	16	18	24	24	32
0.5	15	20	23	30	30	41
1.0	30	41	46	61	60	82
2.0	61	81	91	122	122	162
3.0	91	122	137	182	182	243
4.0	122	162	182	243	244	324

5.0	152	203	228	304	304	405
10.0	304	405	456	608	608	810

VI. Application of Fintrol® to Stream

Fintrol® is best applied to the stream from an airtight container (5-gallon containers are frequently used) that dispenses at a constant rate, using Mariotte bottle principle. Other devices (e.g., peristaltic pumps) that provide a constant flow are also appropriate. The container should be filled with filtered (e.g. sieve or cheesecloth) water from the stream. The amount of Fintrol® added to the container is determined by Equation (3). The mixture is dispensed from the container at a constant rate determined by equation:

(4) $F = R \div T$ where

F = container dispensing rate of diluted Fintrol® (ml/min)
R = container volume (ml),
T = treatment time period (usually 240-min [4-h] to 480-min [8-h]).

Fintrol® should be dispensed directly into center of stream from airtight containers. Because antimycin neutralizes rapidly, containers should be spaced to ensure maintenance of lethal concentration for target species. Container spacing is largely dependent upon water travel time and gradient (see Section IV). Each container should be checked at least every 30 minutes to ensure the proper dispensing rate of diluted Fintrol®. Each container must be under the direct control of an applicator at all times. Typically, containers should be discharged at relatively the same time, but in a downstream sequence, throughout the treatment area to prevent target species avoiding lethal concentrations of antimycin. Normally, cages containing live fish should be placed at downstream terminus of each treatment reach, just upstream of the next container to ensure that a lethal concentration of antimycin has been applied. Backwaters, seeps, and springs along stream course should be treated with backpack sprayers as they may harbor fish. Care should be taken not to over-treat by applying large quantities of Fintrol® in backpack sprayers. Sprayers should be charged with 0.1 to 0.2% v/v solution of Fintrol®, and the total amount of Fintrol® used in backpack sprayers should not exceed 20% of total amount used in all airtight containers (see Sections IV and V).

VII. Neutralization

Although antimycin typically neutralizes naturally within 900 to 1,500 feet (30 to 45 minutes travel time) downstream of the most downstream Fintrol® dispensing site, neutralization stations should be used to ensure that antimycin does not persist beyond the project area. In higher gradient streams, neutralization will occur more rapidly. Neutralization stations that dispense the oxidizer potassium permanganate ($KMnO_4$) are located at downstream terminus of the treatment zone. The project area includes the treatment zone and the neutralization zone of approximately 30 minutes travel time (approximately 1,200 feet). Potassium permanganate is generally dispensed as a liquid into the middle of the stream with same type apparatus used to dispense Fintrol®,

although on larger streams a larger reservoir (100 gallons or more) or granular permanganate using a screw-type auger are generally used.

A concentration of 1 mg/L $KMnO_4$, above the background permanganate demand of the stream water (generally around 1 mg/L $KMnO_4$) generally is sufficient to neutralize antimycin. It is desirable to maintain 1 mg/L $KMnO_4$ residual at the end of the neutralization zone. Thus, a neutralization rate of approximately 3 mg/L $KMnO_4$ is typically used, depending on the background permanganate demand of the water (1 mg/L $KMnO_4$ to neutralize antimycin + 1 mg/L $KMnO_4$ background demand + 1 mg/L $KMnO_4$ residual at end of zone). *In-situ* fish bioassays should be conducted to verify potassium permanganate demand and levels necessary to neutralize antimycin (see Section III). Fish residing in the neutralization zone may be killed as antimycin is oxidized and potassium permanganate is reduced.

Estimate the background permanganate demand of the streambed in the neutralization zone prior to Fintrol® application. Prior to application, test the neutralization operation by applying $KMnO_4$ to achieve an instream concentration of 2 mg/L for 1 to 2 hours (or longer if necessary) and measuring $KMnO_4$ residual at the end of the neutralization zone (30 minutes downstream). Residual $KMnO_4$ may be measured by using a variety of analytical methods (e.g., DPD Colorimetric Method or Spectophotometric Standard Method). $KMnO_4$ residual over time will stabilize as the background permanganate in the streambed is used up. If the $KMnO_4$ concentration at the end of the neutralization zone is not 1 mg/L then, proportionately increase or decrease the rate of $KMnO_4$ drip. Wait an hour and take another measurement; repeat the procedure as necessary to assure 1 mg/L residual level of $KMnO_4$ at the end of the neutralization zone. This ensures that antimycin does not persist beyond the neutralization zone.

Determine stream discharge (from Equations 1 or 2). Dispense $KMnO_4$ from container at constant rate that will provide desired stream concentration. A 2.5% w/v (10 pounds $KMnO_4$ crystals in 50 gallons of water) potassium permanganate solution is dispensed at a constant concentration using equation:

$$\textbf{(5)} \qquad \mathbf{LF = Y \cdot 70 \cdot Q} \qquad \textbf{where}$$

LF = flow of liquid 2.5% $KMnO_4$ solution (ml/min)
Y = desired $KMnO_4$ concentration in stream (mg/L)
Q = stream discharge (ft^3/s).

Alternatively, $KMnO_4$ crystals can be added directly to the stream using a mechanical auger or other device using equation:

$$\textbf{(6)} \qquad \mathbf{SF = Y \cdot 1.7 \cdot Q} \qquad \textbf{where}$$

SF = flow of solid $KMnO_4$ crystals (g/min)
Y = desired $KMnO_4$ concentration in stream (mg/L)
Q = stream discharge (ft^3/s).

A cage with live fish should be placed at the end of the neutralization zone (approximately 1,200 feet and 30 minutes travel time) downstream of neutralization station to ensure that stream water is neutralized. Dispensing potassium permanganate should begin about 1 hour before Fintrol® is expected to arrive at the neutralization site and continue, at a minimum, for 1 hour following passage of all treated water from upstream sections, normally determined by travel time from the furthest Fintrol® upstream application site. This procedure will result in the neutralization of the vast majority of antimycin applied during the treatment. However, extremely low levels of antimycin may kill fish over a prolonged period of time, and the only way to confirm that a toxic level of antimycin is no longer present in the stream is to perform live fish bioassays. Fish should survive in the treated waters in the absence of potassium permanganate for 48 hours before the antimycin is deemed completely neutralized. Backup neutralization applicators should be available at the neutralization site

VIII. Collection of Dead Fish

To eliminate the opportunity for human exposure by consuming antimycin-contaminated fish, recoverable dead fish should be collected and disposed of consistent with the requirements of the local land use or fish and wildlife agency.

IX. Public Notification

To ensure public safety and limit liability, signs should be posted in the treatment area warning against contact with treated water and consumption of dead fish during Fintrol® treatment and for a 48-hour period of time after treated waters are neutralized. Signs should be posted at normal entrance routes (trails and roads) to the treatment area. Signs should clearly display dates of treatment, when consumptive water-use is safe, and agency to contact for additional information. High public-use areas may be closed to the public until the antimycin in the water has been neutralized for 48 hours.

In areas where livestock or pets may be exposed to the Fintrol® and potassium permanganate, owners should be notified so they can prevent access to treated water by their animals during the treatment.

X. Safety and Technical Training

Among field personnel involved in a stream treatment, at least the project leader must be a state-certified pesticide applicator. On larger projects, state certified applicators for each application and neutralization crew is desirable. Depending upon project, it may be prudent to advise area medical facilities of activities. Prior to treatment, the project leader should provide safety briefing to all personnel. At a minimum, the briefing should ensure that all personnel understand Fintrol® label instructions, the Fintrol® Stream and River Use Monograph, Material Safety Data Sheets (MSDSs) for compounds used in the treatment, symptoms of antimycin poisoning, emergency care, personal protective gear (PPE), general pesticide safety, chain of command, location of first aid stations, and communication network. Each participant should be provided with appropriate PPE to

ensure safe and successful application. No one with contact lens should be in direct contact with antimycin.

It is strongly recommended that at least the project leader have successfully completed a training course on piscicide use (e.g., U.S. Fish and Wildlife Service National Conservation Training Center FIS2132 or equivalent) within 5 years of the application. This will ensure that the project has the latest information on application methods and safety precautions.

XI. Personal Protective Equipment (PPE)

Each piscicide applicator must wear at a minimum goggles and pesticide resistant gloves (i.e., nitrile) as PPE when applying Fintrol® to a stream. To further minimize possible applicator exposure, it is recommended that each applicator also wear protective outer clothing such as Tyvek® disposable coveralls. Long-sleeve shirts and felt-sole boots are also recommended. Each applicator should have a personal eye sprayer and sufficient fresh water for a day. At a minimum, each crew (e.g. application, neutralization, fish collection) has a radio that enables communication among crews.

XII. Project Evaluation and Subsequent Treatment(s)

Two treatments are the minimum necessary to remove all fish from a stream. Typically, three or four treatments are necessary to remove all fish. Although, in rare instances, a single treatment may eliminate all fishes, certainty is gained only with a subsequent treatment yielding no fish. Number of treatments depends upon stream complexity and efficiency of treatments. Visual surveys, traps, and electrofishing do not provide definitive proof of complete elimination. Each treatment should be separated by a season, if not a year; doing so increases likelihood that fish surviving one treatment will move into habitat that is more susceptible to lethal concentrations of antimycin. Separating consecutive treatments also reduces potential long-term effects of treatment on aquatic invertebrate community.

Unintended fish kills outside of the original treatment area should be reported to the appropriate agency and a report of adverse effects should be filed with the U. S. Environmental Protection Agency under Section 6(a)2 of the Federal Insecticide, Fungicide and Rodenticide Act. This report should contain a thorough description of the extent of nontarget mortality (species and number affected) and the conditions under which the incident occurred.

Distance between each application station, amount of Fintrol® added to each container, and time application begins from each container should be recorded. All bioassays upstream of application stations should be checked within 4 hours of cessation of piscicide application. If bioassay fish are alive, distance between stations within reach should be reduced during next application (assuming physical conditions, such as stream discharge, remain the same). If possible, reason (e.g., organic debris, spring seep inflow, pH, or direct sunlight) for sub-lethal antimycin concentration should be determined. Accurate recording of data is essential for planning any subsequent treatments.

Post-treatment sampling with electrofishing gear (at least 2 weeks post-treatment) is recommended to gage relative success of a treatment and to determine general occurrence of surviving fish. Unless discharge changes or stations were too far apart in previous treatment, application stations should be located at same interval as previous treatment. Caged fish are located at appropriate intervals to ensure lethal concentrations of Fintrol® are applied to the stream. If no fish are found in the stream, and no bioassay fish survive the second or subsequent treatments, the area can be considered fishless.

Generally, fish are not reintroduced into a stream for at least 3 months, if not a year, after the last Fintrol® application. Time interval between last treatment and fish stocking is dependent upon recovery of forage base (particularly, macroinvertebrates).

XIII. Transportation, Decontamination, and Spill Containment

No special arrangement is needed for transporting Fintrol® but ensure that adequate padding is in the Fintrol® Fish Toxicant Kit to protect against breakage of the Fintrol® diluent and Fintrol® concentrate glass bottles. All Fintrol® is transported in labeled service containers. Potassium permanganate should be transported in separate service containers. All personnel involved in the application are required to be conversant with antimycin toxicity, the product MSDS, the spill contingency plan, and have proper protective clothing and eyewear protection.

All mixing and loading operations are conducted within a bermed area lined with plastic that has the capacity to contain all of the volume of the material at the site, or within the treatment site. A certified aquatic pest control applicator must be present during mixing, loading, and application operations. The person in charge of the treatment, the certified applicator, should conduct a reconnaissance of the treatment area. When handling the concentrated material, protective goggles and chemically resistant gloves must be worn, and protective clothing (e.g., Tyvek® coveralls) is recommended. Personnel should wash thoroughly with soap and water after handling material.

Should the material spill onto the ground, immediately contain the spill to prevent contamination of adjacent areas. Shovels and other hand tools are used for immediate containment and channelization of the spilled material into a containment area. The following actions must be taken as necessary to contain a spill on the ground: (1) Stop the spillage at its source; (2) Dike-in pools, as appropriate; (3) Materials such as clay, soils, or straw are used to absorb standing material; and (4) Spill site is neutralized with potassium permanganate, as necessary. Major spills are reported to the supervisor of the treatment and he/she will inform cooperating agencies, as required. Disposal of contaminated material is done in accordance with state law.