MASS-MARKING WARM WATER FISH BY COMPRESSED AIR AND FLUORESCENT PIGMENT

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ABSTRACT

Marking is accomplished by embedding fluorescent pigment into the dermal tissue of fish with compressed air. The principal species evaluated were largemouth bass, *Micropterus salmoides*, bluegill, *Lepomis macrochirus*, redear sunfish, *Lepomis microhophus*, and channel catfish, *Ictalurus punctatus*. Marking rate was approximately 1500-2000 fingerling size fish per hour with a two-man team. Mark detection requires ultraviolet light. Air pressure and application distance are critical factors in marking success. Best results were obtained using an air pressure range of 85-200 psi from a distance of 12 to 18 inches. After 9 months mark retention on largemouth bass and bluegill was 95% and 96.8% respectively. Redear exhibited 100% pigment retention for an 11 month period. Mark retention on channel catfish was 100% during a 10 month experiment. Results indicate marks will be retained by certain species for a much longer period, although mark quality will reduce with time. Mortality resulting from marking was negligible.

INTRODUCTION

Marking fish for later identification is an important tool in fisheries work. Numerous techniques have been devised including fin-clipping, tagging, tatooing and others. Generally, these methods require individual handling of fish and are time consuming if large numbers of fish are involved. In some instances mortality is excessively high because of handling or mutilation. Wegener (1965) in a Florida tagging study reported – "most all fish had various degrees of tag sores. . . Data indicates that undoubtedly higher mortality occurred to the Petersen tagged fish."

In 1959, a new method for mass-marking fish was introduced by Jackson (1959). His technique involved implanting fluorescent pigment into the fish's skin by means of compressed air and a sandblast gun. Jackson reported marking several fish species, but only presented results of marking salmonids. He considered the marks permanent. The longest experiment lasted 112 days.

Phinney (1966) further refined the technique with regard to distance of application, pigment size and air pressure. He concluded an application of "grit size" fluorescent pigment at 80 to 160 psi produced satisfactory results on fingerling sockeye salmon during a 54 day test period. The distance from applicator to fish was 18 inches. Additional work by Phinney, Miller and Dahlberg (1967) determined the granular pigment, 30 to 350 microns in diameter, was retained significantly better (55.0 – 100.0%) than the powder (6.1 – 89.0%), less than 20 microns in diameter, in test periods ranging up to 130 days. They suggested the mass-marking technique was best utilized as a short term method and presented evidence of 100% pigment retention for 130 days. The test fish used were young salmonids and mortality, directly attributable to marking, was negligible.

Previous work with the compressed air-fluorescent pigment technique has been oriented to salmonids. The objective of this study was to evaluate the method on warm water fish and develop further technique refinements. The principal species tested were largemouth bass, *Micropterus salmoides*, bluegill, *Lepomis macrochirus*, redear sunfish, *Lepomis microhophus*, and channel catfish, *Ictalurus punctatus*.

MATERIAL AND METHODS

Equipment used with this marking technique includes: a sandblast gun, equipped with a one quart canister; a source of compressed air (we used SCUBA tanks); a two-stage pressure regulator; a low pressure hose connection; and fluorescent marking pigment. Mark detection, a few hours after application requires long-wave ultraviolet

light (wave length 3,000 to 4,000 A.U.), which is harmless to the viewer. The ultraviolet light is used in conjunction with a portable dark box for identification of marked specimens. Materials are obtainable from several sources, however, at least two companies carry a complete list of supplies. They are Scientific Marking Materials, Seattle, Washington, and Wildlife Supply Company, Saginaw, Michigan.

Fluorescent marking pigment is available in six colors and is a biologically inert material.It is partially soluble in ethyl acetate and most ketones, but is insoluble in water and formaldehyde. Phinney et al. (1967) reported on toxicity tests by one manufacturer and found the pigment relatively harmelss to rabbits. They assumed the pigment was nontoxic to fish because of its insolubility in water. My results found nothing to suggest otherwise. Pigment is available in two size, 50-350 microns (granular) and 3-5 microns (powder). The granular size in green, orange and red colors was used in these experiments.

Marking is accomplished by spraying fish with sufficient air pressure to embed pigment into the epidermis. Fish are held in dip nets and individual handling is not required. Usually 10 to 25 fingerling size fish per net can be marked. If larger fish are used the number should be reduced to assure exposure of each fish to the spray. Immediately after spraying fish can be released.

After marking, fluorescent pigment is visible on sprayed areas of the fish's body, in many instances giving an appearance of "painted" fish. However, most pigment is retained in the slime coating which sloughs off, usually with 24 hours, after returning the fish to water. Afterwards, marks can be detected only with ultraviolet light.

RESULTS

An experimental group of largemouth bass, size range 3.0 – 5.0 inches, were marked with orange pigment at 100 psi. They were released into a hatchery pond supporting a mixed fish population to simulate natural conditions. Fifteen days after marking, a sample check revealed 100% pigment retention and all marks were readily detected by ultraviolet light. A second sample was inspected after 5 months and indicated 88.8% mark retention. At this point mark quality was somewhat reduced with several bass showing evidence of only one or two granules embedded in the skin. The experiment was terminated at 9 months and all bass were removed from the pond and inspected. Mark retention of the test fish was 95%. The number of fluorescent granules retained by each fish was significantly lower. Shortly after marking, all fish exhibited several clusters about the body giving a fluorescent 'peppered" appearance when viewed with ultraviolet light. After 9 months marks were reduced to a few widely scattered granules or one or two small clusters. The reduction in mark quality through time indicates satisfactory mark retention could not be expected for a much longer period.

A second pond experiment with largemouth bass was terminated early because of the difficulty in distinguishing the green fluorescent pigment from the fish's natural body color. Viewed under ultraviolet light bass reflect a greenish hue that can be confused with the green fluorescence. For this reason, the green pigment is not recommended for marking this species. This problem was not detected with other fishes or using other colors.

In laboratory tests using aquaria, adult largemouth bass were successfully marked at 100 psi. Mark retention was 100% for a 77 day test period. A comparable lab experiment with fingerling bass produced 66.6% mark retention for 5 months. Lower results were due to the loss of fluorescent pigment by one fish.

Experiments with bluegill, 3.0-5.0 inches in total length, were conducted in ponds supporting mixed fish populations. Fish were sprayed at air pressures of 85 and 100 psi. After 9 months, recovered test fish exhibited 96.8% mark retention. Mark quality was considerably better during the latter part of the experiment than with largemouth bass. Generally, several clusters of fluorescent pigment were evident on each fish. Results indicate marks would be retained significantly longer. No difference in mark quality was detected for the two air pressures used.

Only one experiment was performed on redear sunfish, involving 2 inch fingerlings held in aquaria. Fish were marked at air pressures of 80 and 100 psi. The

lower pressure resulted in poor quality marks and was discontinued. Individuals sprayed at 100 psi showed 100% pigment retention during an 11 month period. Like bass, redear mark quality was reduced to a few granules after 6 months and could not be considered permanent.

Tests were conducted on channel catfish to determine the necessity of scales for pigment retention. Fish were sprayed at air pressures of 100, 180 and 200 psi. In all experiments mark retention was 100% and of good quality. Test periods ranged from 8 to 10 months and included both pond and aquaria experiments. Primarily, mark retention occurred along the pectoral and dorsal spines. These areas showed little evidence of mark loss through time. Fin rays also retained satisfactory marks, but usually with lower frequency and less pigment. The retention of body marks on channel catfish was low and the quality was not comparable to scale fish. Various air pressures used showed little difference in mark quality although frequency of body marks was higher as pressure increased. Excellent pigment retention by channel catfish indicates fluorescent marks may be permanent or at least retained for a greater period of time than with other species.

Short term experiments were performed on other fishes to determine their acceptance to marking. No effort was made to evaluate mark retention through time. The list of species showing a satisfactory response is as follows:

Redbreast sunfish -- *Lepomis auritus*
Dollar sunfish -- *Lepomis marginatus*
Warmouth -- *Chaenobryttus gulosus*
Seminole killifish -- *Fundulus seminolis*
Mosquito fish -- *Gambusia affinis*
Fathead minnow -- *Pimephales promelas*
Golden shiner -- *Notemigonus crysoleucas*
Sailfin molly -- *Mollienesia latipinna*
Nile tilapia -- *Tilapia aurea*

DISCUSSION

Results have shown the compressed air and fluorescent pigment technique to be an effective means of mass-marking several species of warm water fish. A high per cent of mark retention was found for a longer period (9 to 11 months) than the previous maximum period of 130 days tested on salmonids (Phinney et al., 1967). The technique is not restricted to use on scale fish as demonstrated by excellent pigment retention on pectoral and dorsal spines of channel catfish.

Air pressure, application distance, and pigment flow proved to be critical factors in obtaining satisfactory marks. Best results were obtained with air pressures between 85 and 200 psi depending on species. Below a pressure of 85 psi marks were of poor quality and usually sloughed off in a short time. Best air pressure tested for all species was 100 psi, although cannel catfish exhibited somewhat better mark quality at higher pressures. Air pressure above 125 psi is not recommended for small centrarchids. In some instances, fingerling bluegill and redear sunfish were killed by spraying at 125 to 180 psi. Application distance should be from 12 to 18 inches and an exposure time of 1 to 2 seconds is sufficient. Marking pigment should be kept free of moisture for best results. Moisture will cause pigment to lump or cake and create excessive clogging of the spray gun. Attempts at mixing pigment and water into a slurry for spraying proved unsuccessful.

The technique is a fast and relatively inexpensive method of marking fish. A two-man team can mark 1500-2000 fingerling size fish per hour. Initial cost of marking and detection equipment is approximately $116.00, excluding air supply and fluorescent pigment. Thereafter, fish can be marked for $3.00 to $4.00 per thousand; the cost of the marking pigment. Phinney et al. (1967) reported a four-man team marking 33,000 fish per hour at a cost of $3.40 per 1,000 fish.

Each of the three colored pigments tested retained sufficient fluorescence for easy detection throughout the experiments. Some loss of brilliance was noted with the orange and green colors, but did not prevent later identification. No change in fluorescence was found with the red pigment and this color was most readily detected.

Survival and growth of marked fish was normal during the test period. Whether growth interfered with mark retention was not investigated. Largemouth bass exhibited the highest growth rate and their reduced mark quality may suggest some correlation.

A disadvantage with the compressed air and fluorescent pigment technique is the required use of ultraviolet light for mark detection. However, in studies where the investigator desires exclusive knowledge of marked fish this character would be desirable. Also, detection rate is only 5-10 seconds per fish for a trained worker.

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CERTAIN ADVANTAGES OF SIMPLE FORMULATION IN FISH STUDIES AND STATISTICS

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ABSTRACT

The growth of fish is an important factor in the useful studies of fish populations. There are several well known methods of comparing growth of fish. Only one will be discussed in this paper. This method uses the formula $W = KL^n$ where W is weight in grams, k is a constant, L is length in millimeters, and n is a power, usually near 3. This paper will espouse a variant of the formula, equating $W = KL^3$. Here, the variable n becomes a constant 3, eliminating the vagaries of n; and the constant k now becomes a variable K changing with length, in order to maintain mathematical validity. K varies with L in this paper although it could be made to vary with W and to some approximate degree with age. It will be shown that the equation holds regardless of the size of the fish. The advantage of the simplified hyperbolic equation is that it reduces the imput to three variables. So one variable which usually varies with length becomes the sole means of comparing the plumpness and condition of fish. This eliminates the fuzzy mathematical judgment involved when both changes in a constant and a power are involved in comparisons. It will be shown by illustration and example that this concept readily lends itself to simple single setting computer type solutions for K, L or W; and to available tabular solutions in both English and metric systems. Thus, a method and three aids are proposed to decrease the effort and increase the reliability and usefulness in fisheries studies.

The world needs protein. Water provides the environment for production of such protein, and fish are a well known and highly acceptable source. Fish may well be the healthiest basic food. There are various yardsticks for measuring fish production, such as money value, tons of fish, and various breakdowns by fisheries. Age-weight