American Fisheries Society Symposium 7:335–340, 1990

Equipment, Methods, and an Automated Data-Entry Station for PIT Tagging

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Abstract.—A miniaturized PIT (passive integrated transponder) tag, developed by private industry, was adapted for tagging juvenile salmonids by the U.S. National Marine Fisheries Service. The PIT tag enables individual fish to be identified by a unique 10-digit alphanumeric code read in situ with a detector–decoding system. The body cavity proved to be a satisfactory site for tag implantation, and techniques were tested that gave up to 100% tag retention and high fish survival. Hand-held and stationary automatic tag injectors were developed that allowed tagging of 150–300 fish/h. A computer-based system was designed to automatically record PIT-tag code and associated information, such as fish length and weight. A discussion of tagging technique and required equipment is presented.

The National Marine Fisheries Service (NMFS) has evaluated the technical and biological feasibility of tagging juvenile and adult salmonids with a miniaturized passive integrated transponder (PIT). This PIT tag, developed by Destron-Identification Devices, Inc. (D-IDI)[1,2], consists of an integrated microchip bonded to an antenna coil. The electronic components of the tag are encapsulated in a glass tube about 12 mm long × 2 mm in diameter. Each tag is programed at the factory with one of about 34×10^9 unique (10-digit alphanumeric) code combinations (e.g., 7F7E2136A1). Having no power of its own, the tag is energized by a 400-kHz external signal that enables the tag to transmit a unique 40–50-kHz signal to the interrogation equipment, where the code is immediately processed (decoded), displayed, and (optionally) stored on a computer. The PIT tag system allows for passive (in situ) collection of a tag code from an individual fish without handling the fish.

The body cavity was found to be a satisfactory implant site for the PIT tag, and no detrimental effects of the tag on salmonids (*Oncorhynchus* spp. and *Salmo* spp.) have been observed (Prentice et al. 1984, 1985, 1986, 1987). In 1986, fish-handling and PIT-tagging guidelines were developed for juvenile and adult salmonids, and a computer-based system was developed to automatically record tag code, fish length, and fish weight. Discussions and descriptions of the tagging equipment, tagging technique, and data-recording equipment are presented in this paper. Additional information on the biological evaluation of the PIT tag, monitoring systems, and uses in migration studies are presented elsewhere in this volume (Prentice et al. 1990a, 1990b).

[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service.

[2]Destron-Identification Devices, Inc., Boulder, Colorado.

Tagging Equipment

Two tag-injection systems have been developed: a manual (hand-held) tag injector and a stationary semiautomated system for rapidly tagging large numbers of fish (Prentice et al. 1986, 1987). The tag is implanted with a 12-gauge hypodermic needle in both systems.

The hand-held system consists of a modified plastic syringe that may vary in size from 5 to 10 cm^3 depending on the operator's preference (Figure 1). A hole drilled in the end of the barrel prevents the operator from injecting air into the fish during tagging. A rod attached to the end of the syringe plunger pushes the PIT tag through the needle as the plunger is depressed. This rod, when fully extended, should reach only to the end of the needle, which should be at least 25 mm long. Each tag must be manually inserted into the needle. This procedure is satisfactory for small numbers of fish but becomes ineffective as numbers increase.

We developed a semiautomated injection system for rapidly tagging fish. This bench-mounted unit operates entirely on bottled compressed gas (e.g., carbon dioxide) and incorporates a gas-activated ramrod to push the PIT tag through the 12-gauge needle (Figure 2). The PIT tags for use in

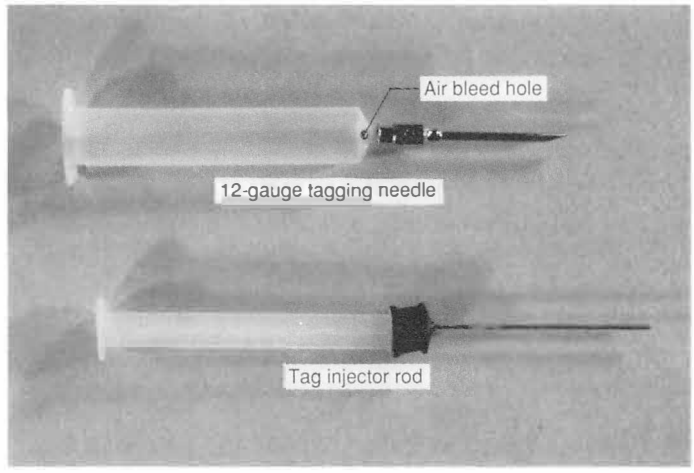

FIGURE 1.—Hand-held PIT-tagging syringe developed by the National Marine Fisheries Service.

the injector are contained in a removable clip that allows them to gravity-feed into the breech of the tagging machine. Each clip is loaded with about 150 tags. A sliding weight at the top of the clip helps deliver tags to the breech of the injector. A foot-operated switch activates the gas-ram. After injecting the tag, the plunger retracts, which allows a new tag to drop into position for the next implantation. Adjustments to the speed of the gas-ram operation and length of gas-ram exten-

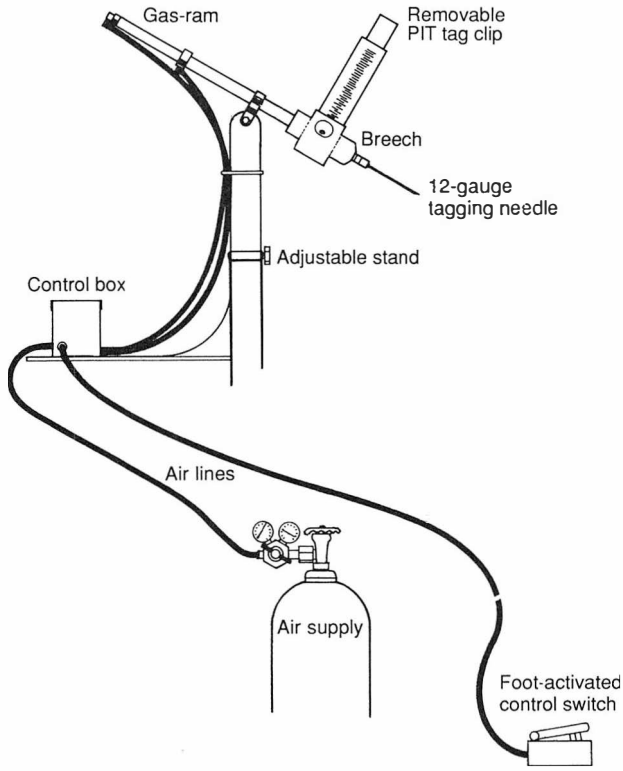

FIGURE 2.—Diagram of the semiautomatic PIT tag injector developed by the National Marine Fisheries Service.

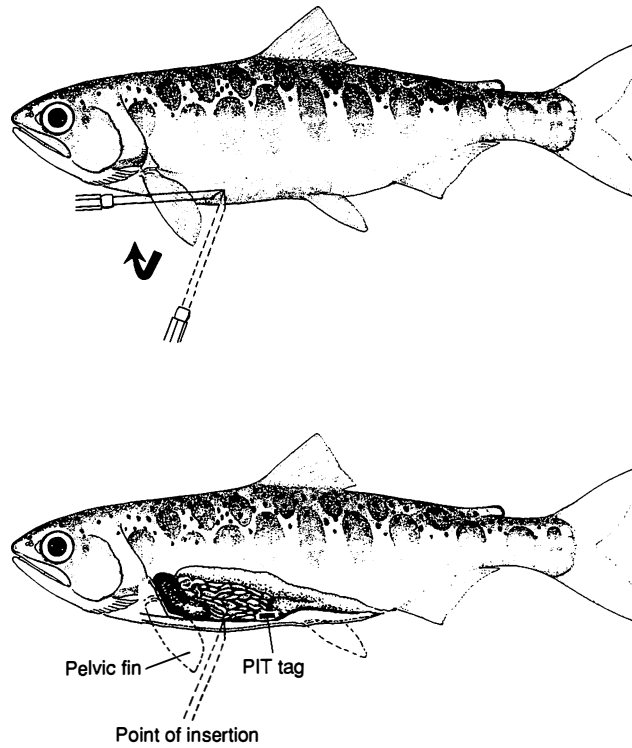

FIGURE 3.—Illustrated implantation of PIT tags, showing point of insertion through the body wall musculature, needle injection angle to implantation site, and position of the implanted PIT tag within body cavity.

sion can be made. The tagging rate with the semiautomated injector—over 300 fish/h—is more than double that of the hand-held unit.

Tagging Methods

The following methods were developed for inserting the PIT tag into the body cavity of juvenile and adult salmonids. The needle is inserted anteroventrally and the tag implanted posterior to the pyloric caeca in the area of the pelvic girdle. The following fish-handling and PIT-tagging guidelines have been developed: the fish should be in good health with no signs of disease; feeding should be suspended 2 d prior to tagging; all fish should be anesthetized for tagging; and fish should be fed a post-tagging maintenance ration for 3 d so the gut does not expand and force the tag through the unhealed needle wound.

The point of needle entry for PIT tagging depends on fish size. For salmonids less than 200 g, we recommend a point just posterior to the pectoral fins alongside the midventral line (Figure 3). On larger fish, the point should be anterior to the pelvic girdle, again just off the midventral line. For all fish, the bevel of the needle should face away from the body, and the needle should be held at a 20–45° angle, depending on fish size (less angle for smaller fish). Needle pressure should be just enough to penetrate the body wall. Once the needle passes through the body wall musculature, the syringe angle should be decreased until the barrel parallels the body wall. The needle is then inserted farther until its point is posterior to the pyloric caeca near the pelvic girdle, and the tag is implanted. Correctly implanted PIT tags have up to 100% retention and little measurable effect on fish survival (Prentice et al. 1986, 1987).

Tagging equipment is disinfected with 60–90% ethanol periodically during tagging and when moved from site to site. The semiautomatic injector is cleaned after 300–400 taggings by running an ethanol-soaked pipe cleaner through the needle and breech to remove accumulated fish mucus and scales. Care should be taken to keep the tag clip dry; otherwise, surface tension will interfere with tag delivery.

No appreciable host tissue response or infection resulting from tagging procedures has been observed in salmonids. Tagging wound condition,

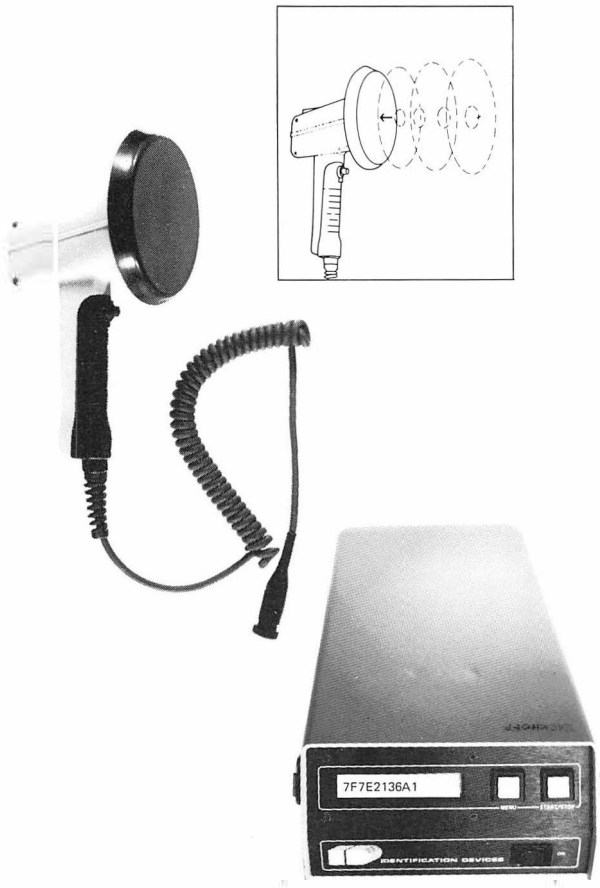

FIGURE 4.—Portable (battery-powered) PIT tag detector–decoder; the detector receives pulses from a tag, which the decoder displays in alphanumeric code.

tag placement within the body cavity, and histological effects on the tag have been examined for groups of juvenile fall chinook salmon *O. tshawytscha* and sockeye salmon *O. nerka* up to 19 cm long (Prentice et al. 1986, 1987). The needle puncture wound appeared to close almost immediately, and as early as 2 weeks after tagging, little visible evidence of external trauma remained at the injection site. Most of the tags stayed in place posterior to the pyloric caeca. Normal scar tissue usually replaced the dermis and underlying muscle tissue within 3 weeks. Complete healing usually occurred 4–6 weeks after tagging.

Computer-Interfaced PIT-Tagging System

After tagging, tag presence and code are verified with a detector decoding system. The system can be portable, consisting of a battery-powered, hand-held scanner, or it can be interfaced with a computer. The portable detector–decoder[3] displays the tag number (code) on a liquid crystal display (LCD) screen and can store over 1,000 code combinations for subsequent retrieval via a computer (Figure 4). The portable unit is useful for field applications when tagging and interrogating small numbers of fish. A stationary, computer-interfaced system is used when tagging larger numbers of fish.

An integrated system for PIT-tagging fish and recording tag code, fish length and weight, and written comments was assembled and tested under field conditions (Prentice et al. 1987). This computerized system makes it possible to maintain individual records for large numbers of fish. It

[3]Model numbers for Destron-Identification Devices, Inc., equipment: D-IDI Loop Detector FS-5102; D-IDI PIT tag Decoder/Detector HS-5101.

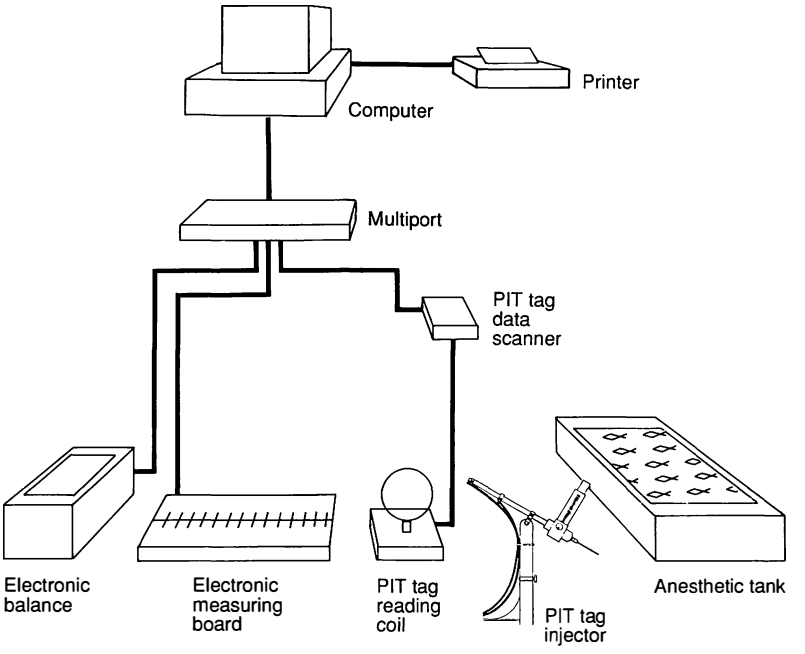

FIGURE 5.—Diagram of a PIT-tagging station linked to a computer.

consists of several commercially available components (Figure 5). A portable PIT tag decoder is connected to a tabletop loop detector measuring 150 × 150 mm. This detector system is used to interrogate, decode, and transmit the tag code through a multiport[4] to a computer compatible with MicroSoft-Disk Operation System (MS-DOS) and a printer for storage. Length (±1 mm) and comments (custom configured) are documented with a digitizing board[5] and weight (±0.2 g) via an electronic balance[6]. Information from the digitizing board also is routed through the multiport to the computer and printer.

An important part of the system is the computer program that controls information flow to and from the computer. The program[7] is written in Turbo Pascal, and the computer files are in ASCII (text) format. These programs are menu-driven and allow custom configuration that can be accessed at any time during program operation (e.g., length or weight may be optional or mandatory selections). In addition, a menu selection is available to allow length, weight, and additional comments to be recorded for fish without PIT tags.

The procedure for using the system requires several steps. First a fish is removed from an anesthetic bath and injected with a PIT tag. The fish is then manually passed through the tag-detection loop. The tag code appears on the computer screen (all information displayed on the computer screen is in an expanded format for ease of reading), an audible tone is emitted by the data scanner, and a light appears on the scanning loop. The operator then places the fish on a protective plexiglass cover fitted over the digitizing board, with the fish's head positioned against a stop that acts as a zero reference point. An electronic stylus is activated at the point where the length measurement is to be taken. Length information is displayed under the PIT-tag code on the computer screen. Next, the fish may be weighed on the electronic balance, placed in a recovery tank, or returned to the rearing area. Weight information appears on the computer screen beneath the tag code and the length information. Comments may be keyed into the file at any time via the digitizer board or computer. All information is entered automatically into the computer, and a printed hard copy is made when the next PIT-tagged fish

[4]Model 525-H from Bay Technical Associates, Bay Saint Louis, Mississippi.

[5]Model 23120-9 with kit 23064-03 from CalComp Corporation, Anaheim, California.

[6]Model FY3000 from A & D Engineering Inc., Milpitas, California.

[7]The program was written by David Brastow of the Northwest Fisheries Center, National Marine Fisheries Service, Seattle, Washington.

transmits its tag code. The tagging and documentation rate for this system, when used with an automatic PIT-tag injector, is in excess of 300 fish/h.

Summary

PIT tags last throughout the life cycle of their hosts. They can be detected and decoded in living fish in fresh and salt water, and they eliminate the need to anesthetize, handle, restrain, or kill fish during data retrieval. Used with computer stations, they allow repeated identification and measurements of individuals within a population. The automated weighing and measuring station can be run with or independent of PIT-tag analyses and should have broad application in fisheries management.

Acknowledgments

We thank the Bonneville Power Administration for funding this project (83-319).

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