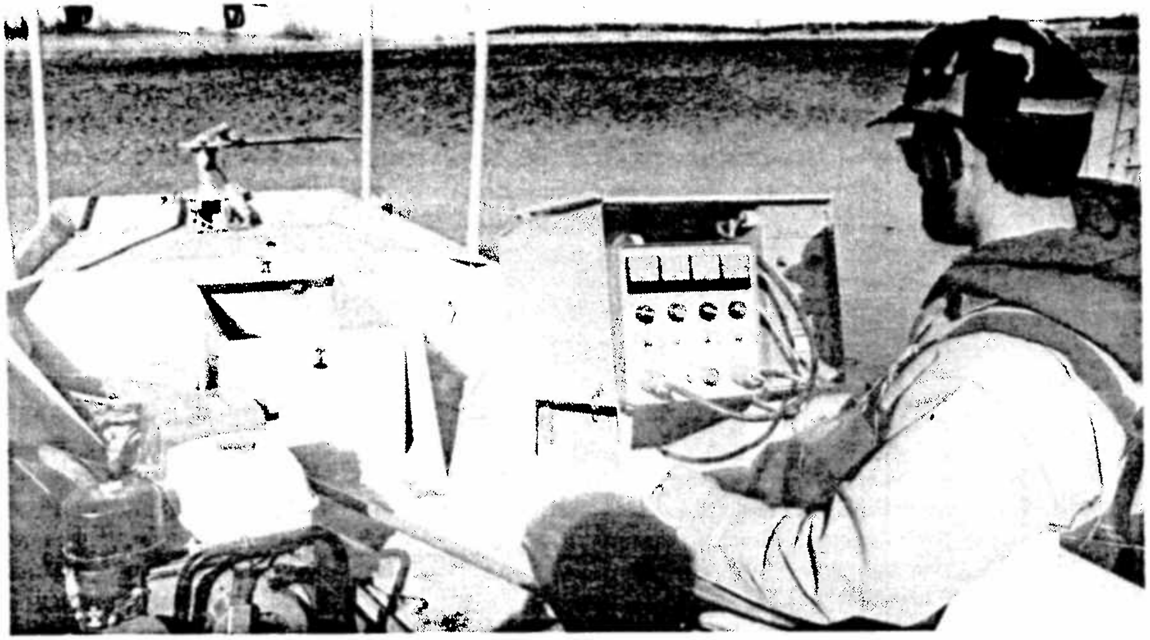

Impacts of electrofishing on *fish*

Editor's note: *Impacts of electrofishing on fish is becoming an important concern. The Electrofishing Injury Network is working hard to help reduce the electrofishing injury on fish. This feature article consists of the abstracts from the electrofishing session at the 1991 and 1992 Annual Meeting of the Western Division of the American Fisheries Society and Darrel Snyder's paper that he gave at the 1992 Annual Meeting of the American Fisheries Society held in Rapid City, South Dakota.*

However, many injured fish do not display such brands or bruises.

Electrofishing-induced spinal injuries have long been associated with use of alternating currents but, until now, were not believed to be a significant problem with pulsed or continuous direct currents. Renewed concern about electrofishing injuries has prompted biologists and managers in several agencies to take a closer look at the situation in their own waters. Recent reports by these salmonids, especially rainbow trout, are also the most frequently targeted species in electrofishing investigations and few other species have been studied as intensively by X-ray or necropsy.

least when using direct or pulsed direct currents. The German authors Halsband and Halsband, in their 1975 book on electrofishing, emphatically stated, and I quote (from the 1984 English translation), "today we are convinced that electrical collecting, repelling, and stunning methods neither cause pain to animals nor injure them internally or externally."

Many biologists now acknowledge that the situation is otherwise, at least for some species. They are concerned with the potential effects of such injuries on survival, growth, and well-being of the individuals and populations they are studying, as well as the validity and interpretation of their data. Special sessions on electrofishing injuries were organized by Wade Fredenberg (Montana Department of Fish, Wildlife, and Parks) and held during both last year's and this year's Western Division (of the American Fisheries Society) meetings. Earlier this year, in Switzerland, the European Inland Fisheries Advisory Commission held a workshop on harmful effects. Until the matter is effectively resolved, electrofishing injuries are likely to be the topic for many more sessions and workshops.

Fish Responses in an Electric Field

In an attempt to identify and explain specific factors associated with electrofishing injuries, hypotheses regarding the causes and mechanisms of all fish responses in electric fields are being reexamined. During last year's Western Division session on electrofishing injury in Bozeman, Montana, N. G. Sharber (Coffelt Manufacturing, Inc.) introduced what he refers to as the "Bozeman Paradigm." (Sharber's paper was entitled "Electrofishing Injury New Perspectives" but no abstract was provided for the meeting program.) His hypothesis is that the observed responses of fishes in electric fields, including tetany, narcosis, taxis, and inhibited or undirected motion, are essentially the same types of responses as are observed in humans with epilepsy or when man and other animals are subjected to electroconvulsive therapy.

In an electrofishing field, the strength of the field (i.e., voltage gradient, current density, or power density) is greatest next to the surface of each electrode and rapidly decreases with distance from each electrode. Sharber correlated the more familiar and well-described responses observed in continuous and pulsed direct current fields near the anode with the three principal phases of epilepsy as follows: the zone of tetany (i.e., the zone of highest voltage

If you are interested in this important topic contact any of the names listed after the articles. Finally, I would like to thank Darrel Snyder, Jim Reynolds, and Curt Meyer for their contributions and support.

An Introduction to the Impacts of Electrofishing on Fish

Electrofishing has been a valuable sampling technique in North America for four decades, but it is now in a state of flux. As with most collection techniques, the detrimental effects of electrofishing include death, injury, fatigue, and stress. Mortality can be immediate or delayed. Fish that survive may suffer short-term, long-term, or lifetime handicaps that affect their behavior, health, growth, or reproduction. Significant numbers of surviving but adversely affected fish may ultimately impact community ecology, population size, quality of the fishery resource, and management strategies.

Current Concern Over Spinal Injuries

The current concern over electrofishing injuries was sparked by Sharber and Carothers' 1988 publication in the North American Journal of Fisheries Management. In that paper they documented unexpected injury to the vertebrae and associated tissues (e.g., hemorrhages near the spine) in over half the large rainbow trout they electrofished with modern equipment and pulsed direct currents. We now know that most "brands" or "burn" marks observed externally on electrofished specimens are actually bruises (pigmental discolorations (Lamarque 1991) or subsurface hemorrhages), and that these brands are often associated with and mark the approximate location of damaged vertebrae (McMichael et al. 1991; Fredenberg 1992). Holmes et al. (1990), Wyoming Game and Fish Department (1990, 1991), Meyer and Miller (1991), Newman (1991), Fredenberg (1992), and Hollender and Carline (1992) have documented substantial spinal injury in rainbow, cutthroat, brown, brook, and lake trout, as well as Arctic grayling, northern pike, and walleye. Other studies have documented similar electrofishing injuries in mountain whitefish, white and longnose suckers, channel catfish, bluegill, and paddlefish. In the case of paddlefish, which lack vertebrae, specimens that were killed during one electrofishing event were subsequently dissected and described as having their notochords "completely blown apart" (F. K. Pfeifer, U.S. Fish and Wildlife Service, personal communication). The problem of electrofishing-induced spinal injuries is obviously real and appears to be widespread. One agency, the Alaska Department of Fish and Game, has even imposed a moratorium on electrofishing in waters containing large rainbow trout. My review of electrofishing impacts is, itself, a result of concern for such injuries among endangered species in the Colorado River Basin.

So why has electrofishing injury with modern equipment and pulsed direct current not been recognized or considered as a potentially serious problem until now? Probably because we have come to expect some injury, and even mortality, as a by-product of most fish collection techniques, and because the electrofishing injuries of immediate concern are often not externally obvious. If captured fish appear to recover sufficiently to swim away and there are no notable external injuries, we typically consider fish "unharmed" and assume they will continue to grow and behave normally. Indeed, electrofishing is often considered the most effective and least damaging of available collection techniques. Recognized authorities on electrofishing have for decades emphasized its benign qualities, at

Still, some biologists (e.g., Nehring 1991; Schneider 1992) note that years of electrofishing, even with alternating current in at least one case, have not greatly affected the specific populations of trout or other fish they manage or monitor. They, therefore, suggest that the occurrence of electrofishing injuries in their situations is either very low or insignificant with respect to the well-being of the population. Indeed, observations to date suggest that many, if not most, fish that suffer spinal injuries do survive (Horak and Klein 1967; Spencer 1967; Hudy 1985; Reynolds 1992; Schneider 1992); X-rays of captured specimens in frequently electrofished populations often reveal old spinal injuries that have healed. A few studies are currently underway or planned in Alaska, Colorado, and Montana to determine the effects of electrofishing-induced spinal injuries on long-term survival and growth of trout (Reynolds et al. 1992; L. Zeigenfuss and E. P. Bergersen, Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, personal communication ; S. Dalbey and T. McMahon, Montana State University, personal communication) and northern pike (Reynolds et al. 1992).

If electrofishing injuries occur in notable numbers but do not significantly affect population size, structure, and recruitment of the affected fishes, perhaps we should still be concerned about resource quality. For some fish, spinal injuries will result in permanently bent backs or related deformities that sometimes do not become obvious until well after the responsible electrofishing event. But for many fish, electrofishing injuries might only be detected with X-rays or upon dissection, possibly on a fisherman's dinner table.

Evidence to date suggests that trout, char, and probably salmon are much more susceptible to electrofishing-induced spinal injuries than most other species. However,

gradients immediately around the anode of most fields) is essentially the zone of grand mal responses, the next zone, narcosis, is petit mal, and the more distant zones of both taxis and inhibited or undirected motion are automatism. (Taxis toward an electrode, usually the anode, appears to be a unique response of organisms submerged in unipolar electric fields.) The distinction between tetany (grand mal), in which the muscles are stiff or rigid, and narcosis (petit mal), in which the muscles are limp or relaxed, is very important with respect to adverse impacts, but this distinction has often been overlooked in electrofishing investigations and much of the literature.

Causes of Adverse Impacts

Many adverse effects of electrofishing on juvenile and adult fish, particularly severe stress, unrecoverable fatigue, and respiratory failure, are caused by excessive exposure to high field intensities in the zone of tetany (grand mal). Respiratory failure as a result of tetany is the leading cause of electrofishing mortality. The zone of tetany can be minimized by judicious selection of electrode size, configuration, and power output to reduce field strength immediately around the electrodes. The adverse effects of tetany can also be reduced by modifying the electrofishing operation to facilitate rapid removal of fish stunned near the electrode.

The compressed, broken, or misaligned vertebrae and (or) associated hemorrhages and tissue damage we refer to as spinal injuries are caused by sudden, momentary, but powerful contractions of the body musculature-epileptic seizures according to Sharber. As I noted earlier, these spinal injuries have been acknowledged for decades but were attributed primarily or solely to tetany, especially in alternating current fields. We now know that such injuries can occur in very significant numbers with pulsed direct current and to a much lesser extent with continuous direct current. It also appears that these injuries can occur anywhere within the effective zones of an electric field (tetany, narcosis, and taxis). They may even occur in the zone of inhibited or undirected motion and possibly beyond in the zone of reactive detection (perception) where fish become aware of the field but, aside from twitches or shudders, still maintain control of their own responses. If spinal injuries do occur at field intensities less than required for taxis, it is possible that the incidence of spinal injury among fish that avoid or escape the effective portion of the field might be at least as great as among those that are caught.

The electric-field characteristic, or combination of characteristics, responsible for seizures resulting in spinal injuries have not yet been conclusively identified. Although there is at least one study that suggests otherwise (Newman 1991), the leading candidate appears to be pulse frequency (McMichael et al.1991; N. G. Sharber, Coffelt Manufacturing Inc., unpublished manuscript and data). Below a certain upper limit (probably between 100 and 200 hertz or cycles per second), lower pulse frequencies generally result in lower incidences of spinal injuries. The actual stimulus inducing seizures might not be the pulse per se but the switching on and off of the current or the sudden change in voltage differential that results. In a 1990 publication, Lamarque noted Continuous direct current is considered by most electrofishing authorities to be the least harmful and fatiguing current available. Since there is no frequency component in smooth, continuous direct current, muscular seizures and consequent spinal injuries might not be expected. However, spinal injuries do occur with continuous direct current, although the incidence is usually much lower than with alternative currents (Spencer 1967; McMichael 1991 notes from oral presentation; Fredenberg 1992). Perhaps the explanation for these injuries is that when electrofishing, continuous direct current is manually and sometimes frequently switched on and off, effectively producing one or a whole series of long-duration pulses.

It is not yet known whether injuries such as bleeding at the gills or vent and damage to internal organs are also caused by violent contractions or another effect. At least some of these injuries, particularly bleeding at the gills, have been observed in certain species of fish while under taxis well outside the zone of tetany (W. A. Fredenberg, U.S. Fish and Wildlife Service, personal communication).

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This article was written by Darrel E. Snyder, Larval Fish Laboratory, Colorado State University, Fort Collins.

that a single pulse, and sometimes a low voltage, can be sufficient to cause violent contractions. Perhaps the twitches or quivers sometimes used to identify species-specific thresholds for the zone of reactive detection (perception) are just such contractions or seizures.

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THE EFFECT OF ELECTRIC CURRENT ON RAINBOW AND CUTTHROAT TROUT EMBRYOS

Tests were conducted to determine if electric current has an effect on the survival of trout embryos. In the first series of tests, rainbow trout eggs were subjected to one of three treatments. In the first treatment, eggs were exposed to current from an electro shocker. In the second treatment, eggs were handled in the same exact way as those exposed to electric current but without current. This was done to separate the effect of handling from the electroshock effect. In a third treatment, eggs were exposed to a standardized mechanical shock, to determine if the sensitivity coincided with the same sensitive period as to electric current. Different groups of rainbow trout eggs were exposed to one of the three treatments on days 2, 4, 6, 8, 10, 12, 14, 16, 18, 22, or 26. This was from two days post fertilization to two days prior to hatch. On each treatment day three replicates of 200 eggs each were placed into the exposure chamber where they were gently poured into a nylon basket and exposed to the output from a Coffelt BP 6 backpack shocker for ten seconds. The shocker output was measured at 0.6 amps, pulse was 250 Hz, and voltage gradient was measured at 0.9-1.0 volts per cm. The second group was handled in the same way but the electricity was not applied. The data shows that the most sensitive period in the development of the eggs was at day 8 post fertilization. Eggs exposed to electric current on day 8 had the highest mortality rate (approximately 60%) while the eggs handled in the same manner with no electricity experienced a mortality rate of approximately 25%. Eggs which received the physical shock had their highest mortality (99%) at day 8. The baseline mortality for all groups was 20%. In further tests with cutthroat trout eggs it was shown that the length of time and voltage are also correlated to mortality. Results of tests in which eggs were placed into artificial redds will also be presented. Results from these tests show that the above voltage and current can have an effect on the survival of rainbow trout eggs. This work implies that electroshocking in streams where trout have recently spawned may be detrimental to survival of the embryos.

Written by William P. Dwyer, U.S. Fish and Wildlife Service, 4050 Bridger Canyon Road, Bozeman, Montana and Wade Fredenberg Montana Department of Fish, Wildlife and Parks 1400 South 19th Street, Bozeman, Montana.

ELECTROFISHING INJURY AND MORTALITY IN COLORADO USING THE COFFELT VVP-2C (2000 WATTS) WITH 60 CYCLE PULSED VOLTAGE

The COFFELT VVP-2C electrofishing unit has been exclusively used in Colorado's coldwater stream research project for the past decade. It has been used on walk-shocking operations in streams up to 100 feet wide and on boat shocking operations using aluminum Jon boats and rafts. The walk-shocking operation uses an array of 4-5 positive DC throw electrode pioneered by the Montana Department of Fish, Wildlife, and Parks. The operating output power range is 1000-2000 watts.

Colorado has experienced no problems with electrofishing-induced injury or mortality to rainbow or brown trout with the walk shocking electrode array. The study areas are all in high visibility-heavy angler use situations under the scrutiny of concerned anglers. Two-pass electrofishing operations results in 50% to 99% of the study section trout populations being captured. Walk electrofishing-induced mortality rates are known to be in the 0.1% - 0.5% range.

Boat shocking operations occasionally result in injury manifested in either permanent spinal disfigurement (lordoscoliosis upon healing) or death. Although no quantitative studies have been done, circumstantial evidence indicates permanent injury and/or mortality rates on boat electrofishing operations are in the range of 1% to 5% or less.

These low injury and mortality ratio are believed to be the result of three important factors. First, the conductivity of most coldwater trout streams in Colorado is generally less than 100 micromhos/cm2 and rarely more than 200 micromhos/cm2. Second, water temperature during electrofishing operations are rarely more than 15 C, most often in the 0-10 C range. Third, rapid removal from the energized field, usually in 1-2 seconds, reduces the time, intensity, and severity of galvanonarcosis, greatly reducing the injury and mortality rates. Written by R. Barry Nehring Colorado Division of Wildlife, 2300 S. Townsend Avenue, Montrose, CO 81410

SPINAL INJURY IN TROUT ELECTROFISHED WITH A COFFELT VVP-15 OR CPS (TM) SYSTEM

We investigated the occurrence of spinal injuries in trout collected by single-pass, pulsed DC electrofishing using a Coffelt VVP-15, or a Coffelt CPS(TM) shocker, and the occurrence of spinal injuries in trout collected on the fourth pass of a multiple mark-recapture population estimate using a Coffelt VVP-15 shocker. Output on the CPS(TM) was set at 460-470 V. Output on the VVP-15 was set at 370-390 V, 40 pulses/s, and 20% duty cycle. The electrofishing was done from a small raft.

Spinal injuries were determined from X-rays of the collected fish. The mean percentage occurrence of spinal injuries in trout collected from a single electrofishing pass using the VVP-15 was 8% (N=45). A single electrofishing pass using the CPS (TM) resulted in a mean percentage determine the extent of delayed short-term mortality. Samples were collected after seven days using the same settings as were initially used (and a sample was seined from the control group) and were placed on ice and necropsied within two hours of collection. Fish were examined for spinal injury by filleting the fish on both sides and visually determining the presence or absence of spinal column damage and associated hemorrhaging in surrounding musculature. An injury was classified by either the actual spinal displacement/compression or by hemorrhaging in musculature surrounding the spinal column. A total of 114 fish were necropsied. Fish from the control group showed no signs of injury. Injury rates ranged from 4% to 53% with the higher pulse rates producing the higher injury rates. When data were pooled there was a significant ($P < 0.01$) positive correlation between fish length and electrofishing-induced injury. Larger fish appeared to be more susceptible to injury. Only one fish (of over 100 exposed to electrofishing) died during the seven day period following the initial electrofishing treatments. The two electrofishing runs could have increased the injury rates (theoretically, this could have doubled injury rates). We noted a relationship between the chromatophore stimulation (often referred to as "bruising" or "burning") and the incidence of injury. It appears that short-term mortality due to the electrofishing conducted in this hatchery environment was negligible. Incidence of injury due to electrofishing was, however, very high (with some settings) and should be considered to

INJURY OF WILD BROOK TROUT BY BACKPACK ELECTROFISHING

Most studies of injuries caused by electrofishing have been conducted on large brown trout and rainbow trout in medium- or high-conductivity waters. The objective of this study was to assess internal injuries of wild brook trout that were captured with alternating current (AC) and pulsed direct current (PDC) backpack electrofishing units in four, small, infertile streams. We used x-ray and autopsy to assess injury rate of 579 brook trout captured by electrofishing and 89 captured by angling. Fish total length averaged 136 mm and ranged from 87 to 237 mm. Injuries consisted of internal hemorrhages, spinal misalignment and fracture, or both. We found 74 hemorrhages and 91 spinal injuries. Injury rate was not significantly different ($P < 0.05$) between current types: 26% for AC and 22% for DC. Less than 7% of angled trout had injuries. Injury rate increased with fish length, ranging from 13.9% for fish <125 mm to 42.1% for those >175 mm. Among spinal injuries, an average of six vertebrae were damaged, usually in the posterior region of the spinal column between the dorsal and anal fins. We conclude that even for relatively small trout in infertile waters, the incidence of electrofishing-induced injury can be significant. The relation of these proposed guidelines to minimize spinal injury are included. Written by Wade Fredenberg, Montana Department of Fish, Wildlife and Parks, 1400 S. 19th, Bozeman, Montana 59715, (406) 994-6938.

SPINAL INJURY OF WALLEYE CAUSED BY PULSED DC ELECTROFISHING

Walleye ranging from 183 mm to 475 mm total length were captured in 1991 by pulsed DC electrofishing and analyzed by x-ray photography and autopsy for spinal injuries. Of the 30 fish examined, 9 (28% had spinal injuries involving fractured vertebrae and rupture of dorsal arteries). Two pulse rates were tested (30 and 120 pulses per second), and no difference was found in the injury rate. Experiments using larger sample sizes and controls, and experiments on the effect of electrofishing on walleye egg viability, are being conducted in 1992. Written by Lee E. Newman, U.S. Fish and Wildlife Service, Office of Fishery Assistance, Ashland, Wisconsin 54806, (715) 682-6186.

INJURY AND SURVIVAL OF NORTHERN PIKE AND RAINBOW TROUT

occurrence of spinal injuries of 13% (N=110). The trout collected and x-rayed on the fourth pass of the multiple mark-recapture population estimate, using the VVP-15, were not recaptures (i.e., were unmarked fish). An average of 30% (N=65) of these trout suffered spinal injuries. We concluded that under the conditions present during this work, the CPS (TM) and VVP-15 worked comparably (i.e., good electrotaxis and relatively low spinal injury). Also it appeared that fish not netted and handled suffered spinal injuries. We could not categorize these fish as having been shocked similarly to netted and handled fish, but missed by the netter, or as fish that escaped on the "fringes" of the electric field. Written by Curt Meyer and Dirk Miller, Wyoming Game and Fish Department, Laramie, WY 82070

ELECTROFISHING INJURY AND SHORT-TERM MORTALITY IN RAINBOW TROUT IN A HATCHERY ENVIRONMENT

Four groups of hatchery-reared rainbow trout were exposed to different direct current voltages and pulse rates from a battery-powered backpack electrofisher. The fish collected with the various settings were then subjected to our typical data collection handling, including: anesthetizing (MS-222), measuring length and weight, collecting scale samples, and tagging (anchor tags in fish > 200 mm). A control group was not exposed to electrofishing. The five groups were monitored daily for seven days following the initial electrofishing treatments to deleteriously affect the fish sampled until proven otherwise. Written by Geoffrey A. McMichael, James N. Hindman, James P. Olsen, Washington Department of Wildlife.

EFFECT OF ELECTROSHOCK VOLTAGE, WAVE FORMS, AND FREQUENCY ON TROUT EGG MORTALITY

Electrofishing has been shown to sometimes cause injury to fish. Tests with trout eggs have also shown that this technique may be having more detrimental effects than previously thought when shocking over redds. In the laboratory we showed that eggs can be killed during the sensitive period by electroshock. In the field eggs placed into artificial redds were also susceptible when exposed to the same voltage gradient using the same equipment. We have continued to study the effects of electroshock on egg mortality to better define threshold levels. In this paper we report the results of a test defining the effects of continuous DC, pulsed DC at two different frequencies, and CPS, all at two different voltages. Written by William P. Dwyer and David A. Erdahl, U.S. Fish and Wildlife Service, 4050 Bridger Canyon Road, Bozeman, Montana 59715 (406) 587-9265.

injuries to mortality remains to be explored. Written by Bruce Hollender, Pennsylvania Fish and Boat Commission, 450 Robinson Lane, Bellefonte, Pennsylvania 16823-9616, (814) 359-5118, and Robert Carline, Pennsylvania Cooperative Fish and Wildlife Research Unit, Pennsylvania State University, Merkle Building, University Park, Pennsylvania 16802, (814) 865-4511.

EVALUATION OF ELECTROFISHING-INDUCED SPINAL INJURIES RESULTING FROM FIELD ELECTROFISHING SURVEYS IN MONTANA

Examination of 693 trout sampled from Montana rivers by electrofishing was conducted to document the incidence and severity of electrofishing-induced spinal injury; 769 hemorrhages and 2,647 injured vertebrae were documented, categorized, and described. Substantial evidence demonstrated that 60 Hz pulsed DC current results in excessive injury rates to both rainbow trout (60-98%) regardless of waveform (rectified sine-wave or square-wave), water conductivity (33-900 umhos/cm), or equipment design variables. Longer trout did not show a noticeable trend toward higher injury rates, but fish with "brand" marks did exhibit higher spinal injury rates. Limited sampling of Arctic grayling, sauger, and shovelnose sturgeon did not reveal spinal injury problems with these species. A discussion of electrofishing efficiency and

CAPTURED BY ELECTROFISHING

During 1990 and 1991, we conducted studies in controlled environments and the field to determine the effects of various electrical waveforms on large northern pike and rainbow trout. The results were quite different for the two species. Pulsed DC (30-60 Hz, 100-400 V) produced spinal injury rates among northern pike of only 5-12%, but the rate increased to 29% when a 120-Hz waveform was applied at 300-600 V. In field trials, we caught three northern pike with 60-Hz pulsed DC for every one caught with DC or 30-Hz pulsed DC. Survival and growth of injured and control groups of northern pike held for nearly 1 year in a lake were not significantly different. However, all types of conventional pulsed DC (20-60 Hz), as expected, produced spinal injury rates of 40-60% in hatchery rainbow trout. Only DC and CPS(TM) produced injury rates under 18% in the hatchery. During field trials, injury rates among rainbow trout were lower with CPS(TM) than DC, but DC produced higher capture rates in the low-conductivity (30 uS/cm) water. Survival of shocked rainbow trout held in a hatchery was 65% after 203 d; most of the deaths occurred in the first 30 d. We concluded that DC and CPS(TM) should be further evaluated for electrofishing rainbow trout. Electrofishing-induced injuries and associated problems clearly vary among species. Results from rainbow trout studies do not imply that electrofishing-induced injuries are a widespread problem. More species must be studied. Written by James B. Reynolds, Stafford M. Roach, and Thomas T. Taube, Alaska Cooperative Fish and Wildlife Research Unit, 158 Arctic Health Research Building, University of Alaska Fairbanks, Fairbanks, Alaska 99775-0110, (907) 474-7661.

ELECTROFISHING INJURY NETWORK

At the Rapid City, SD business meeting of the Fisheries Management Section, 14 September, 1992, an "Electrofishing Injury Network" was formed. The accompanying feature article by Darrel Snyder provides an excellent introduction to the scope of electrofishing injuries to fish. The objective of the network is to provide a forum for information exchange on the subject of electrofishing-related injuries in fish. The primary vehicle for this information exchange will be the FMS newsletter. We anticipate that through the newsletter a list (network) of interested people/entities will be created, and from that list people will be able to contact others who have similar interests or needed expertise. It is also hoped that as people investigate the extent of injuries in their electrofishing operation or pursue solutions, they will contribute that information to the FMS newsletter.

Coordinators have volunteered to serve as contacts for facilitating exchange of information. Those coordinators are: Bruce Hollender (801/359-5118, Northeast), Lee Newman (705/682-6186, North Central), Curt Meyer (307/745-4046, Western), and UN-NAMED (Southern). Curt Meyer has also agreed to serve as chair of the network to assist in overall communication within the network.

We hope this network will also provide some direction in pursuing answers to electrofishing injuries in fish. The types of information we see this network addressing are:

1 How wide-spread is this problem? People who feel they don't have any electrofishing injuries; how closely have they really looked?

2 Most recent information seems to be primarily on salmonids. How much variation is there among fish species in susceptibility to electrofishing injuries?

3 What types of equipment are biologists using (manufacturer, inflatable boats, hard-bottom boats, shore-based operations, backpack operations, etc.)? What types of current (AC, DC, pulsed DC) and characteristics of those currents (pulse trains, voltages, etc.) have been examined? What appears to effectively collect fish without injury or with minimal injury?

4 Can there be any agreement on what constitutes a minimal/acceptable amount of injury?

5 What components of any given electrofishing operation can be or should be modified to minimize injuries?

Included in this issue is a survey form to solicit members to the network. Return the completed surveys, along with a self-addressed stamped envelope, to Curt Meyer, WY Game and Fish Dept., 528 South Adams St., Laramie, WY 82070. Members of the network will receive a compilation of the survey, including a complete listing of all network

____ manufactured (list manufacturer)

Anode Configuration for Boat electrofishers

____ Fixed Boom(s)

____ Number of anode(s)

____ Spherical anode

____ "Wisconsin Ring" anode

____ Other anode

____ Throwable anode

Pulsator used (model and manufacturer)________________

Generator used (power and manufacturer)________________

SHORE BASED EQUIPMENT

____ Number of anodes used

____ Number of cathodes

____ "Home-made"

____ manufactured (list manufacturer)

Pulsator used (model and manufacturer)________________

Generator used (power and manufacturer)________________

BACKPACK SHOCKERS

____ Battery powered

____ Generator powered

Model and Manufacturer________________

Strengths and weaknesses of equipment listed.

____

members.

Electrofishing Injury Network Membership

Name ______________________________

Affiliation ______________________________

Address ______________________________

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Phone (______) ______________________________

FAX (______) ______________________________

Interest in group

____Informational only (receive information)

____Contribute information and expertise

Electrofishing Equipment Used

BOAT EQUIPMENT

____ Raft

____ Jon Boat

____ Other Boat (Please specify)______________________

____ "Home-made"

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What work are you currently doing (or have you done) on electrofishing injury?

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Has concern over electrofishing injury affected the way you do business?

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Can you contribute a newsletter item?

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Please return this form, along with a self-addressed stamped envelope to: Curt Meyer, WY Game and Fish Dept., 528 South Adams St., Laramie, WY 82070.