Underwater Telemetry
TRACKING AQUATIC ANIMALS
NEWSLETTER
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# MINIATURE RADIO TAG USED TO STUDY SALMONID SMOLT MOVEMENT IN THE COLUMBIA RIVER

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Considerable emphasis has been put into research on juvenile salmon and steelhead and their survival and passage past hydroelectric dams on the Columbia River in the Pacific Northwest. Most studies are conducted with conventionally tagged fish and their capture, release, and recapture. Recently, electronic technicians and biologists of the National Marine Fisheries Service assigned to the Coastal Zone and Estuarine Studies Division's Fish Tracking Program at the Northwest and Alaska Fisheries Center, Seattle, Washington, have developed a miniature radio telemetry fish tag that enables researchers to follow the movement of individual juvenile salmonids (Figure 1).

In preliminary tests in 1979, juvenile coho salmon were tagged with dummy tags, equal in size and weight to the new radio tags, and held 1 month in circular holding tanks. Observations indicated that the tagged fish were able to maintain themselves and feed equally well as untagged control fish. Stress tests in a swimming chamber showed no differences in endurance between test and control fish.

The radio tag is basically rectangular--26 mm long by 9 mm wide by 5 mm thick. Power is supplied by two silver oxide batteries. The transmitter with pulsing unit is assembled on a hybrid circuit substrate, connected

(Continued on Page 3)

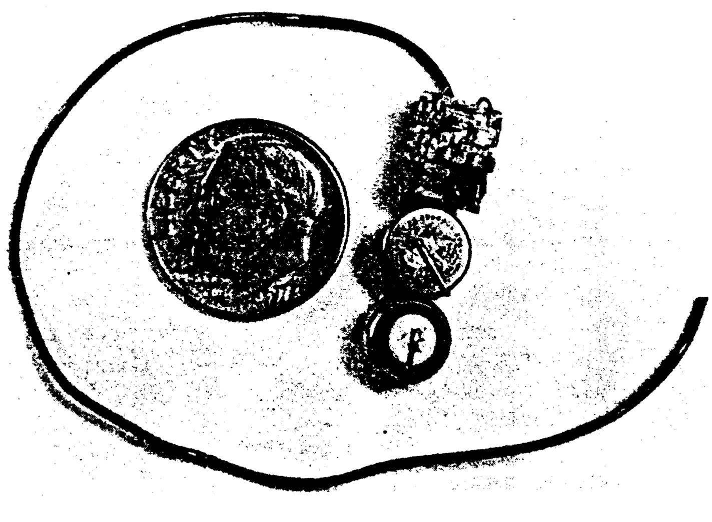

Figure 1. Radio tag for juvenile salmonids before coating and sealing. A U.S. 10-cent coin (17 mm dia) is shown for comparison.

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OPERATED BY UNION CARBIDE CORPORATION · FOR THE DEPARTMENT OF ENERGY

## FROM THE EDITOR

As two articles in this issue indicate, underwater telemetry is finding a place in commercial business outside supplying the needs of behavioral research. As UTN Editor, I applaud this trend. First, it is fun to watch a field in which you did early research and equipment development grow to a state of commercial "maturity." But perhaps most importantly, the trend may have important implications for cost and availability of telemetry gear for our own research uses. Many components of telemetry gear (microcircuits, transducers, crystals) are inexpensive when produced in volume, but expensive (if available at all) for the laboratory that wishes to fabricate a few dozen tags or a single receiver/decoder. The fantastic history of hand calculators shows the impact that commercialization and mass marketing can have on a product which we once thought of as only for "scientific" uses. Is it too much to expect such market performance for our telemetry gear? Probably it is. On the other hand, the fishing industry has turned "exotic" electronic depth sounders into "fish finders" that have a mass market among sports fishermen and which are available at reasonable costs (for excellent electronics) that one would never have expected a few years ago. The solution to costly components may very well lie with the commercial market, which could readily supply our research needs amid a much larger volume of commercial sales.

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to the batteries, coated with a mixture of paraffin and beeswax, and sealed in dental acrylic. The tags operate at an assigned frequency of 30 MHz. Range is approximately 90 meters when the fish is near the surface and decreases rapidly below 9 meters.

The tag is carried in the fish's stomach after insertion through the esophagus, and fish as small as 140 mm were tagged and held successfully. During the field study, fish as small as 143 mm were tagged and successfully tracked; the average size was 182 mm. Great care was exercised in the handling and tagging of these fish.

After 10 years of radio telemetry research with adult salmonids, our tracking personnel found it necessary to develop new tracking techniques to accomodate the reduced range of the miniature tags. Two boats were used because of the size of study area (the forebay was over 1 kilometer wide), the windy conditions, and the limited tag range. The fish's location in relation to the tracking boats was approximated by taking bearings from the two boats with directional antennas, discussing the bearings via two-way radio, and then fixing the location of the fish in relation to the boats. The positions of the tracking boats were simultaneously determined by using horizontal sextant bearings to markers previously installed and surveyed along the shore. Lights on the markers were used for taking sightings at night. Based on the locations of the boats and the location of the tagged fish in relation to the boats, plots were then put on a chart depicting the study area. While this technique was less sophisticated and less accurate than the fixed tracking station technique used for adult radio tags, it did prove to be workable. As more experience is gained and the range of the tag is improved, better tracking techniques will be developed.

During the spring of 1980, a total of 21 spring chinook salmon and steelhead smolts were tagged with the new miniature tags, released into the Columbia River about 6 miles upstream from John Day Dam, and tracked in the forebay as they approached the dam. The routes they swam during spill and nonspill periods as well as their general swimming behavior were monitored. Five of the smolts were tracked to the dam, and all went downstream through the turbines. No smolts were tracked over the spillway, although some appeared to be influenced by the currents created by the spill. One tagged fish was eaten by a seagull, which was subsequently singled out of the flock and tracked for over a kilometer. Another fish turned upstream and was followed for 6 hours before the track was terminated, and one fish was lost when the signal stopped immediately after release of the fish. Tracks ranged from 1 to 16 hours and were terminated for various reasons including: (1) the fish passing downstream over the dam, (2) fatigue among the limited personnel making up the tracking crew, (3) high winds, (4) mechanical failure of the boats, and (5) loss of radio signal.

Studies similar to those conducted in 1980 will take place in the summer of 1981. Modifications currently being made to the tag hopefully will improve the tracking range. Schematics are available from the authors.

# THE USE OF RADIO TRACKING TO EVALUATE THE POWERHOUSE ADULT FISH PASSAGE SYSTEMS ON THE COLUMBIA AND SNAKE RIVERS

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In the spring of 1978, the Project Operations Division Fishery Research Team from the Portland District, U.S. Army Corps of Engineers began using radio tracking as a major tool to evaluate the Bonneville Dam powerhouse adult fish passage system (Figure 1). The objectives of the evaluations are to identify and provide solutions to adult fish passage problems associated with the fish facilities as well as the operation of the dam. Spring run chinook salmon (*Oncorhynchus tshawytscha*) was the

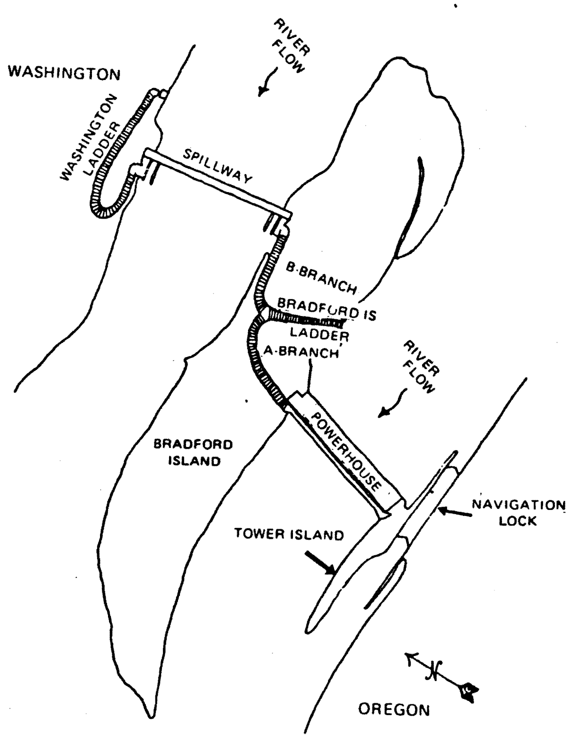


Figure 1. Bonneville Lock and Dam located at Columbia River mile 145.

target species. Because of National Marine Fisheries Service's (NMFS) pioneering experience in this field as well as their electronics expertise, we sought the help of their radio tracking team headed by Ken Liscom and

Lowell Stuehrenberg in Seattle, Washington. For the 1979 and 1980 seasons our combined teams moved the research to John Day Dam. Upon completion of the John Day research the radio tracking effort is scheduled to be moved up to the lower Snake River dams for at least two years.

The basic design of powerhouse adult fish passage systems on the Columbia and Snake Rivers is comprised of large entrances on both downstream ends of the powerhouse with a series of smaller entrances across the downstream face of the powerhouse. All entrances open directly into a common channel, 15 feet - 20 feet wide, called the powerhouse collection channel, that leads from the entrances to the foot of a fish ladder (Figure 2).

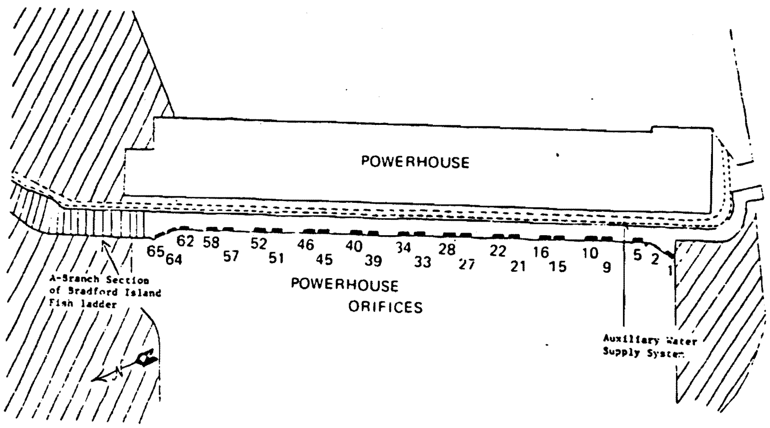


Figure 2. Bonneville powerhouse showing the adult fish passage system. An underwater antenna pair was located at each of the paired powerhouse orifices and at major entrances on both ends of the downstream face of the powerhouse.

The first step in the evaluation process is to collect the test fish with as little stress to the fish as possible. The salmon are captured by use of a diversion ladder, which they ascend volitionally from the main fish ladder. They are then anesthetized in tricaine methanesulfonate (MS-222), tagged, held in a tank of aerated river water until sufficiently recovered and released, preferably at a downstream dam. Capturing and releasing at a downstream dam increases the probability that the fish have never been exposed to the test dam. As there is no dam downstream of Bonneville Dam, the fish are released several miles down river so they are sufficiently recovered from handling before they approach the dam.

The radio tags for these studies consist of a transmitter and batteries sealed within a plastic cylinder, .75 inches in diameter and 3.5 inches long, with an external antenna. The tag has a life of approximately twenty days. It is carried in the stomach of the salmon, except for the antenna, which is a wire extending from the tag and passing through the fish's esophagus to the roof of the mouth, where it is attached by means of a small plastic anchor. Nine frequencies near 30 MHz (10kHz separation) were used in 1978 and 1979, and ten frequencies near 49 MHz (20 kHz separation) were used in 1980.

The first piece of information needed to evaluate the powerhouse fish passage system is the elapsed time between release of the fish and its subsequent passage over the dam. Release time for each fish is noted in a tagging log, along with other biological data. Tagged fish are monitored intermittently as they travel from the release site to the study area. The second time (passage time) is obtained by use of an automatic ladder monitor consisting of two antennas, an antenna switching unit, a search receiver, a logic circuit, and a recording system. One antenna is placed at the exit of the fish ladder, and the other is placed a sufficient distance downstream to allow a difference in signal strength between the two antennas. By interrogating a printout an observer can determine the tag frequency, the date and time of passage, and which ladder was used. By noting the sequence of recorded events, it can also be determined whether the fish exited or fell back down the ladder.

Also important in the evaluation of the adult fish passage system is knowledge of the movement of the fish in the tailrace as it searches for a way into the passage system. The tailraces at Columbia and Snake River dams vary both in size and shape (from a few hundred yards wide to over a mile wide). Tracking fish in the tailrace is accomplished by placing fixed-site tracking stations around the tailrace shoreline. The location of these stations is established by determining their radio reception capabilities as well as their coverage of the tailrace area. Tracking sites are then charted onto maps of the area. Each of the fixed-site tracking stations is equipped with a fixed antenna mount, a compass rose, a directional antenna, a receiver, and a two-way radio. Mobile tracking stations are also used for tracking fish in the tailrace. These are motor vehicles equipped with a door-mounted directional loop antenna, a whip antenna, a direction-finding receiver, a detection and frequency identification search receiver and a two-way radio. The loop antenna is mounted on the driver's door and coupled to a pointer.

All tracking is coordinated by a plotter, who is located in the control center. As tagged fish move into the study area the plotter determines which fish are to be tracked using signal strength of the tag, location and other criteria set up by the program leader. The plotter then informs the trackers which fish will be tracked and when the tracker may expect to be called upon for bearings to those fish.

The fixed-station trackers establish bearings to a tagged fish by tuning their receivers to the frequency of the tag, rotating the antenna until a null point is determined, and then noting the pointer location on the compass rose. In the case of the mobile trackers which do not have fixed compass roses, a landmark is used to express a bearing toward the fish. The plotter calls all stations sequentially and receives the bearings as well as signal strength and quality.

Locations of tagged fish are established by triangulation and plotted in Pacific Standard Time on charts made from an aerial photograph showing the dam, the river channel, the position of the tracking stations with their respective compass roses, and certain dominant landmarks. A time-sequence of these plots (a "track") provides details on the routes taken by the fish in the tailrace. The charts have a superimposed grid system so that each track of a fish can be translated into position versus time from one grid cell to the next (Figure 3).

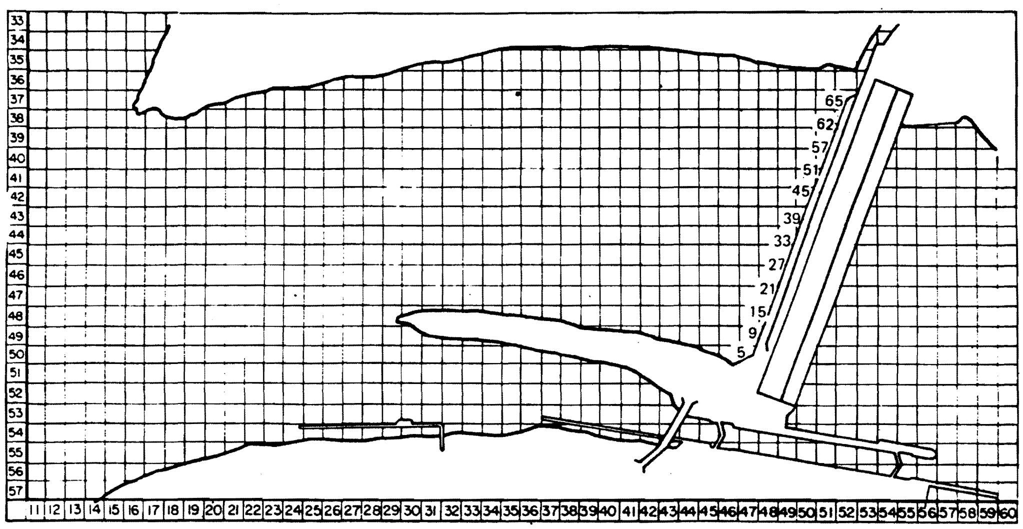


Figure 3. Bonneville powerhouse and tailrace showing the approximate location of each antenna pair and the superimposed grid system.

As the tagged fish approach and enter the powerhouse adult fish passage system, the entrances used and subsequent movement within the system are determined. The exits used to move back into the tailrace are also identified. This information is gathered by use of an antenna-receiver system designed and developed by the National Marine Fisheries Service radio tracking personnel. This antenna-receiver system has undergone considerable evolution since the inception of the combined program. It currently consists of a series of paired underwater antennas (one inside and one outside the collection channel at each entrance), a central switching box, and a 10-channel receiver to check signal strength from each antenna. An underwater antenna is simply a length of coaxial cable with a quarter wavelength section of shielding removed from the submerged end of the cable. The length of the unshielded section is based on the wavelength of radio waves underwater. To keep the antennas underwater, a one to three pound weight is attached to the end of the center conductor. This type of underwater antenna has an omnidirectional beam pattern and the sensitivity of the antenna drops off sharply with distance allowing precise position determination of a tagged fish. The antenna-receiver system operator is notified by the plotter when a tagged fish is approaching the fishway system and is told which area the fish is likely to enter. The operator then switches the central switching box to the outside antenna of several antenna pairs in that vicinity and compares signal strengths. The strongest signal indicates the location of the fish. The inside and outside antenna signal strengths of the antenna pair are then compared to determine if the fish is inside or just outside the collection channel. As the fish moves outside or inside the collection channel the operator can follow its movement by switching through the antenna pairs and comparing signal strengths. This information is then related to the plotter who records the information.

At the conclusion of the tracking season, all data are reviewed and recorded onto magnetic tape. The data are analyzed by computer programs specifically designed for this study.

There are results which have been common to all dams studied. One is that the dams cause delay ranging from an average of two days at Bonneville Dam to five days at John Day Dam. Also, during the period of time spent below the dam the tagged fish exhibit movement ranging from minor searching to many approaches with extensive exploration of all portions of the tailrace. The extensive exploration of the tailrace is not surprising because the entrances to the fishway have flows ranging from 90 to 500 cubic feet per second (cfs) at velocities of five to nine feet per second (fps). This water usually discharges into turbine upwellings of 12,000 to 20,000 cfs at velocities approaching 19 fps at the mouth of the turbine draft tubes. Another common finding is that the fish typically enter the collection channels through the major entrances at the ends of the powerhouse rather than through the smaller orifices in the center of the powerhouse.

Extracted from:

Johnson, Gary A., James R. Kuskie, Jr., Douglas P. Arndt, William T. Nagy, Kenneth L. Liscom, Lowell Stuehrenberg, Gordon F. Esterberg, Charles J. Bartlett, and Charles D. Volz. 1979. Bonneville Dam Powerhouse Collection System Evaluation, 1976-1978. U.S. Army Corps of Engineers and National Marine Fisheries Service. Report to the U.S. Army Corps of Engineers, November 1979 155 pp.

# AN AUTOMATIC FISH TRACKING SYSTEM FOR THE U.S. E.P.A.'s MONTICELLO ECOLOGICAL RESEARCH STATION

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An automatic tracking system controlled by an RCA 1802 microprocessor was developed to locate fish in a 400 m outdoor experimental stream channel at the U.S. EPA Monticello Ecological Research Station. The monitoring network consisted of 12 horizontally polarized antennas spaced at 30 m intervals. The antennas were sequentially switched into a receiver and the signal strength at each antenna was measured. The microprocessor controlled all timing, switching and measurement functions. Each fish tracked by the system was tagged with an implanted radio transmitter which had a unique frequency in the 53 MHz band. Selecting a particular fish for tracking was equivalent to requesting a particular frequency entered into the memory of the receiver. The microprocessor determined which antenna had the maximum signal level and printed this information along with fish number and time of day. Also, to give an estimate of data quality, a signal to noise index was calculated by subtracting an estimate of the background noise from the signal level obtained from the antenna closest to the fish.

During May, 1979, a comprehensive tracking system performance test was made generating 36,000 locations on 10 walleyes, 4 open noise channels, and 2 primary reference transmitters. Each fish was located at 15 min. intervals. Results indicated that the tracking system located radio-transmitters to the nearest antenna with a reliability of 98.7%. Correlations of walleye resting and movement behavior and social organization to environmental variables such as light intensity and food introduction were possible from data produced by the system.

A M.S. thesis by Kathlean C. Zinnel has resulted from the project. A final technical report detailing the engineering and software development is currently in review with the EPA. We anticipate a publication on the walleye behavior in the near future.

Potential applications of this system include experimental observations on fish behavior, relative to environmental alterations such as sublethal toxicant concentrations, changes in habitat and manipulation of population densities.

# RADIO-TAGGED SALMONIDS TO BE TRACKED DURING "ZERO" FLOW IN SNAKE RIVER

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The demands for electricity have increased the need for more effective and efficient use of water at hydroelectric dams throughout the Pacific Northwest. One means to accomplish this is to store water during periods of low power demand to be used at times of peak power demand. At present, this method is used for limited periods at night during low flows in the winter when there are no active migrations of adult anadromous fish moving upstream to spawn.

The Bonneville Power Administration (BPA) is seeking permission to extend the period of "zero" flow storage (storing water with only the allowable minimum flow being discharged through the dam). Daily storage hours would be extended and the number of months when storage would take place would be increased. The extension would then encompass critical times when salmon and steelhead are moving upstream to spawn. The economic and energy benefits derived from the extended storage plan would be great, but flow patterns, velocities, and water levels would fluctuate considerably. These fluctuations could cause many problems for agricultural and recreational interests, tugboat operations, anadromous fish populations, etc.

The National Marine Fisheries Service in cooperation with BPA is scheduled to radio tag and track steelhead and chinook salmon in the Snake River from July through September, 1981. The objective is to study the effects "zero" flow conditions will have on adult steelhead and chinook salmon migrating upstream past the dams (travel rates, fish passage at dams, and specific fish behavior). Radio-tagged fish will be released and tracked during "zero" flow storage (test) and "normal" dam regulation (control). The conditions will be alternated weekly.

A 30-mile section of the Snake River between Lower Monumental Dam and Little Goose Dam will be studied. Cooperation by the U.S. Army Corps of Engineers will enable both dams to be operated in such a way as to provide the necessary test conditions. Experimental fish will be tagged internally with radio beacon tags and externally with color-coded flag tags. Flag tags are used to identify radio-tagged fish as they swim past the fish counting facilities at the dams. They also aid in later tag recoveries. As many as 600 radio-tagged fish, each with its own identifiable code, could be released during the study.

Tagged fish will be under surveillance 24 hours a day. Recording monitors, developed by our electronic technicians, will be used to monitor fish as they approach the dam and also to record the date and time fish exit the fishways and pass the dam. Vehicles equipped with tracking equipment will act as mobile units at Little Goose Dam to monitor specific fish movement and behavior. Occasional surveys will be conducted by boat and aircraft to observe the distribution of tagged fish between the dams.

Results of the study will be a major factor in determining the feasibility of extending the water storage periods.

## RADIOTRACKING RARE FISHES GREEN RIVER, UTAH

Harold M. Tyus
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Vernal, Utah (84078)
Ph-801-789-0354

The U. S. Fish and Wildlife Service initiated a radiotelemetry program in the Green River, Utah March 1980. Major objectives included an investigation of major movements, habitat preferences and spawning of endangered Colorado squawfish (Ptychocheilus lucius); however, another rare fish, the razorback sucker (Xyrauchen texanus), was also radiotelemetered in 1980.

Six Colorado squawfish (TL 508-707mm) and one razorback sucker (TL 510mm) were surgically implanted with AVM fish modules (SM-1 units). Radiotransmission was in the 40.660 - 40.700 MHz range. Omni-directional whip and bi-directional loop antennae were used from shore, boat and airplane. Smith-Root SR-40 and RF-40 receivers were employed.

Implanted Colorado squawfish were tracked 4½ weeks to over 4 months, when field work was terminated. The razorback sucker was followed for almost 5 months. Field observation was better than anticipated in spite of high water conductivity (175-1950 micromho). Shallow water (less than 3 m) and the initial sedentary nature of most of the implanted fishes aided to partially overcome difficulties with high conductivity. The use of an airplane during the 1980 season was needed to simultaneously follow several fish in over 550 km of river.

An expanded program is planned for 1981. We plan to radiotelemeter subadult fish in addition to adults and to implant more fish. I would appreciate suggestions from others who have experience with radiotelemetry in water with conductivities in excess of 600 micromho. We are particularly interested in increasing our effective range of reception.

## Address Correction

In the January, 1980, issue of UTN, the new address of AVM Instrument Company was given incorrectly due to a typographical error. Please note the correct address is: AVM Instrument Co.
3101 West Clark Road
Champaign, IL 61820

## NEWS AND VIEWS FROM THE READERS

### A Better Measure of Animal Activity Areas

One of the difficulties in making use of common methods for home range analysis is that unrealistic habitats are often calculated as the center of activity. The "average" location for a fish on a grid map of a dendritic lake may be on dry land! Thus, simple methods that merely outline the area occupied are often just as useful as detailed statistical programs. The question: "What constitutes the habitat most often utilized?" is left unanswered, except subjectively.

A "new" measure looks promising, and it is described in a recent publication (K. R. Dixon and J. A. Chapman. 1980. Harmonic mean measure of animal activity areas. Ecology, 61(5):1040-1044.). Although the examples used are for terrestrial applications, the methods are equally applicable to aquatic telemetry studies.

The harmonic mean measure of animal activity appears to have certain advantages over previous methods of calculating home ranges. The harmonic mean center is a close approximation of the true activity center, the bias depending only on the grid density that is chosen. Isopleths of animal activity can be determined that define home ranges of any shape and are related directly to the intensity of activity. Within the home range-delimiting isopleth, lower valued isopleths can be used to define core areas of activity. These features of the harmonic mean measure make it possible to compare an animal's activity with its habitat whether homogeneous or heterogeneous.

Time series analyses of sequential measures of the harmonic mean center of activity can be used to determine shifts in the home range, such as caused by pollutants. Values of isopleths for the same series would show contraction or expansion of the home range through time. The authors believe that the true test of the utility of this method must await further application and analysis with more species under varied conditions. UTN readers could do just that.

Copies of the computer program and reprints of the article are available from the authors at the Appalachian Environmental Laboratory, Gunter Hall, Frostburg State College, Frostburg, Maryland 21532 USA.

- The Editor

### Deep Sea Tracking

We have been developing a hydrophone arrangement for deep sea tracking. The hydrophone flotation case is lowered to a depth below the thermocline and towed in the direction of the transmitter. This avoids thermocline disruption of the signal (See UTN 10(2) -Ed.). We have been tracking silver eels from the continental shelf to the slope and tracking the homing of yellow eels.

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Largemouth Bass Behavior

I (Knopf) have recently completed the field work on a two year radiotelemetry study of largemouth bass. An abstract of the study is below. I am currently analyzing the results and I feel my findings will contribute to the understanding of largemouth bass behavior and movement. I also feel I may be able to provide some insight into such telemetry topics as how long it takes a fish to adjust to tagging surgery and some cautions involved in making deductions from telemetry data.

Eight largemouth bass, surgically implanted with radio-transmitters, were tracked throughout Lake Isabella (an 800 acre impoundment) during the summers of 1979 (2 fish) and 1980 (6 fish). Over 1000 monitoring observations determined that bass frequently established day areas and separate night areas. The day area was usually small; the night area (or foraging area) was often large. Some bass had day areas that were rather deep (15-20 ft) and cover-oriented; other bass remained shallow (5-10 ft), and were weed-oriented. Shallow, weed-oriented bass traveled more throughout the day than deeper, cover-oriented bass. Bass shared night feeding areas; day areas appeared to be more territorial, with some compatibility between equally-sized fish. Night foraging areas were shallow (3-8 ft), weed flats. Largemouth bass displayed cyclic periods of activity; daytime periods were characterized by limited movement, nighttime periods by active movement. Movement and apparently feeding activity were greatest at night (nocturnal). In their nighttime foraging activity bass would sometimes travel distances exceeding a mile. When bass moved to or from day/night areas or from one lake area to another, they followed breaklines. Bass were able to return directly to day areas without search behavior even when on a large weedy flat. Light intensity may indirectly limit bass depth distribution. Bass were most commonly associated with light intensities below 10 ft. Low light intensity appears to trigger movement to and from day/night areas. Prime bass habitat is located on a drop-off that provides access to various shallow water (food shelf) areas. Prime habitat also contains some form of cover, e.g., a submerged tree, brush, channel band, etc., or aquatic weeds (more subordinate fish). The most productive areas for daytime fishermen (in the summer) would be breaklines with steep, deep drops immediately adjacent to a large, weedy flat. The most productive areas for nighttime fishermen would be large, shallow, weedy flats immediately adjacent to deep water areas. Theoretically, the best spot in the lake to catch largemouth bass would be the steepest dropoff that contains a break (e.g., a submerged tree) and is adjacent to the largest weedy flat in the lake.

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## Gold Fish Study

At the University of Eastern Washington we are just beginning an ultra-sonic tracking study of goldfish at a small lake near here. Clear Lake, once a commercially important trout fisheries, has recently been over-run by Carrasius auratus. Our purpose is two-fold. First, we wish to determine if the entire population of goldfish aggregate in one location prior to fall freeze-up. If so, we feel the entire population can eventually be removed. Second, we wish to determine if certain types of sensory cues can be used to attract fish to a certain location.

We invite anyone with information about tracking cyprinids or their sensory perception to contact us at the address or telephone number below.

Stephen Krival & Allan Scholz
Department of Biology
Science Building
Eastern Washington University
Cheney, Washington 99004
(509) 359-7965

## Research Opportunities in Australia

A wide spectrum of research takes place at the laboratory here (we have a brochure and newsletter which we will send to interested persons). My own research is on the biology and ecology of the eggs and larvae of coral reef fishes. I am looking into the possibility of using mini-transmitters, neutrally bouyant, to simulate the dispersal of fish eggs released over the reef.

The Lizard Island Lab is open for use by bona fide researchers from anywhere in Australia or overseas. I would like to see programs start on the tracking of tropical coral reef animals (e.g. fishes, large molluscs, etc.). Interested readers of UTN are invited to write if they would like to start projects here. There is potential to work on the migration and behavior of the Black Marlin!

Dr. Barry Goldman, Director
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Evaluation of Stocking Northern Pike in Ohio Lakes

We have surgically implanted temperature-sensitive radio tags in nine adult northern pike that were stocked in a southern Ohio reservoir several years ago. We are using telemetry to determine habitat preference and the thermal experience of pike in a warmwater situation. The temperature data, field-generated growth data, and consumption and respiration measurements from a concurrent laboratory study will be used to refine a bioenergetics computer model for simulation of pike growth. The suitability of other lakes for stocking northern pike will be assessed with growth simulations based on limnological records, telemetry-generated habitat selection information, and forage fish and food selection data.

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A New Newsletter

A firm called Wyoming Biotelemetry, Inc., is issuing a monthly newsletter called "WBI BioGram." Its objective is to acquaint life scientists who deal with data collection from wildlife, domestic livestock, or experimental animals with the techniques of radio telemetry. The authors promise (and have already sent some) articles on animal tracking, physiological monitoring, how to interpret receiver specifications, and surgical procedures. The orientation is largely terrestrial, but general principles can apply to aquatic studies as well. The company manufactures and sells a variety of telemetry equipment, and currently is promoting its heart rate monitor for terrestrial animals (brochure available). If you would like to receive "WBI BioGram," write Dick Weeks or Don Panley, Wyoming Biotelemetry, Inc., 1225 Florida Avenue, Longmont, Colorado 80501 (tel. 301-772-5948).

- Editor

Skipjack Tuna Tracking

We will be participating in the International Skipjack Programme conducted by the International Commission for the Conservation of the Atlantic Tunas (ICCAT). This program includes the tracking of skipjack by ultrasonics tags (CF BERCY research team).

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Centre National pour 15 Exploitation
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Thermoregulatory Behavior of Fish

We are conducting research on thermoregulatory behavior of freshwater fishes in a water body that is entirely influenced by rather heavy thermal pollution (+10.5°C). The system we are using is underwater telemetry, in which we are comparing body temperature and water temperature.

Draulans Dirk
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Belgium

Radiotelemetry Tracking White Amur and Turtles at Lake Conway

As part of the Aquatic Plant Control Research Program, the U.S. Army Engineer Waterways Experiment Station (WES) is conducting research to develop biological methods for control of problem aquatic plants. A project was initiated in 1976 at Lake Conway, Florida, to evaluate the use of the white amur fish (*Ctenopharyngodon idella*) as an operational control method for the excessive growth of hydrilla (*Hydrilla verticillata*).

The white amur, also called the "Asian grass carp," is a species native to eastern Asia that has shown a decided preference for hydrilla. The study was designed not only to test the value of the fish as an agent for controlling hydrilla but also to assess its effects on various components of the Lake Conway ecosystem.

The effects of the introduction of the white amur into Lake Conway are being monitored by various agencies with WES serving as project manager-coordinator. Aquatic plant/fish and herpetofaunal studies were performed by the Florida Department of Natural Resources (DNR) and the University of South Florida, respectively.

Since the stocking of Lake Conway with white amur in September 1977, aquatic plant sampling operations by the Florida DNR indicated a definite reduction of the hydrilla resulting from the fish's presence. What needed to be determined was a correlation between fish movement within the lake system and the decline or occurrence of the macrophytes as a function of time. The examination of this problem indicated that tracking fish movements at comparable time intervals to the other data-collection efforts would provide the needed information. WES was responsible for developing and providing the tracking equipment to be used by the Florida DNR.

Since the beginning of the radiotelemetry tracking effort at Lake Conway in May 1979, more than twenty white amur have been tagged and tracked by DNR personnel. The tags are approximately 11 cm in length, 3 cm in diameter, weigh an average of 61 g (less than 1 percent of the average weight of the tagged fish), and have a design life of 4 years. Only fish weighing between 13 and 18 lb were tagged, thus representing the average size in Lake Conway.

Parallel with the aquatic macrophyte sampling and white amur tracking efforts, the University of South Florida (USF) is conducting a study to determine the impact of the introduced white amur on the resident herpetofaunal species. A major part of this effort is the development of a typical movement history for the predominant herpetofaunal species such that variations in these movement patterns can be detected as the amur reduce the amount of vegetation available for consumption in the lake system.

These studies are described in an information bulletin which is available from the Corps of Engineers (see Keown, M. P. in the bibliography of this issue of UTN).

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Department of the Army
Waterways Experiment Station
Corps of Engineers
P.O. Box 631
Vicksburg, Mississippi 39180

*** *** *** *** ***

## NEW EQUIPMENT

### Sea-Trace Ultrasonics Find Diverse Commercial Applications

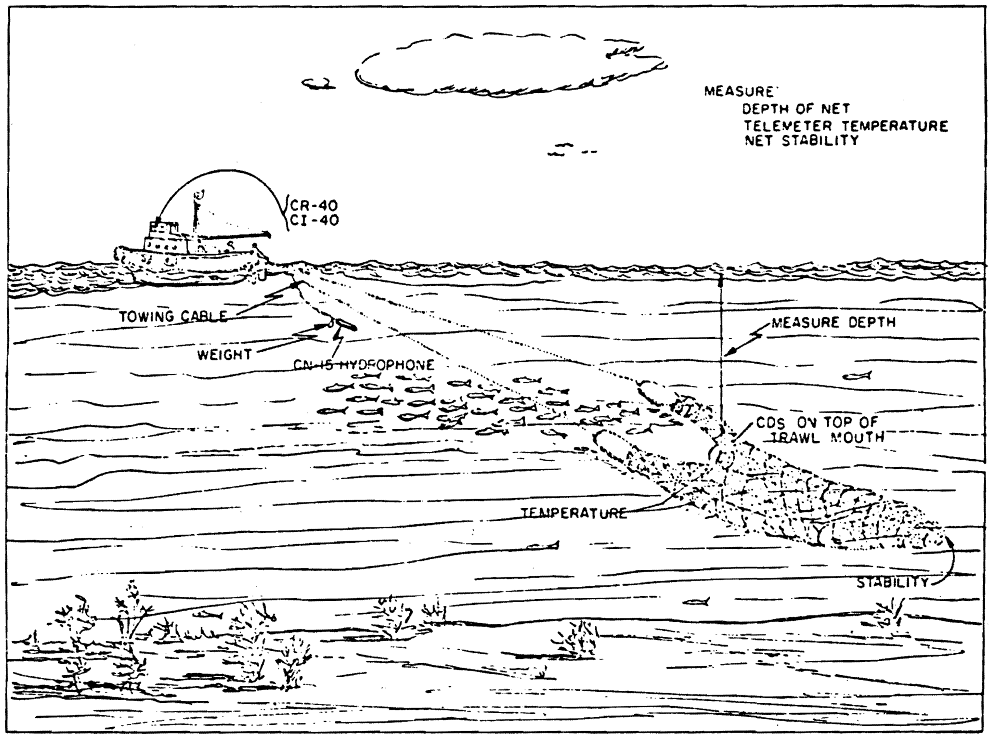
Communications Associates, Inc., engineers and manufacturers of marine electronics equipment, offer a variety of commercial uses for ultrasonic transmitters and receivers under the registered system name of "Sea-Trace." The uses go beyond those of aquatic behavioral research that are most familiar to readers of UTN. Applications are many and varied, and new ones are being found every day. The system employs simple beeping transmitters and ones with temperature and/or depth sensing. Applications include:

Fishing:
- a) Relocating traps without buoys
- b) Relocating equipment lost overboard or snagged
- c) Locating long lines
- d) Fishing or dragging to specific temperature or depth strata
- e) Relocating productive locations

Ocean Research:
- a) Marking underwater positions
- b) Continuous telemetering of information such as temperature, pressure, current intensity or direction, etc.
- c) Underwater personnel monitoring
- d) Relocating lost equipment

Lifesaving:
- a) Attach to lifejackets to assist man-overboard location in rough seas
- b) Attach to divers and submersibles to monitor location

Figure 1. Communications Associates, Inc. ultrasonic "Sea-Trace" system used for measuring depth and temperature of a commercial fishing trawl. Transmitters attached to the net relay data to a hydrophone attached to the hull or towed (as shown). Data are displayed in the cabin where towing adjustments can be made immediately.




NET DEPTH / TEMPERATURE (Figure 2)

Examples of Sea-Trace systems are briefly described below. They suggest the innovative commercial uses that can be made of underwater telemetry equipment. The basic system of transmitters (pingers), directional or omnidirectional hydrophones, and receivers can be adapted to suit particular needs. For full Sea-Trace literature, application information, pricing, and specifications, contact Donald J. Merten, Sea-Trace Sales, Communications Associates, Inc., 200 McKay Road, Huntington Station, New York, NY 11746, telephone (516) 271-0800.

1. Man or Equipment Overboard

Rough seas are encountered by any and all vessels on the open sea, whether commercial fishing boat, tanker, oil platform, ocean racer, or pleasure craft. Under these weather conditions, a man overboard is often unnoticed until it is too late.

Communication Associates, Inc.'s "Sea-Trace" equipment can provide for the immediate recognition of a man overboard and permits the "homing in" on the victim.

Sea-Trace equipment necessary for first "alerting," and second the "locating" of a man overboard consists of an omni-directional hydrophone (CN-15 special) and a directional hydrophone (CS-40), a transmitter or "pinger" (CDS), an ultrasonic receiver (CR-40) and a threshold detector/alarm generator.

The omni-directional hydrophone (CN-15 special) would be mounted in a fixed position on the hull so that it has good underwater "visibility" in all directions. This hydrophone is normally connected to the receiver (CR-40) which is left on at all times. When it picks up a signal, it sounds an audible alarm located in either the electronics room or the wheelhouse. The alarm rings until it is manually disabled. At this time, the omni-directional hydrophone is replaced by the directional hydrophone (CS-40), in order to provide "direction finding" capability.

The directional hydrophone is mounted looking "dead ahead." The vessel is then turned until the signal is the strongest, and then the boat is carefully maneuvered toward the man overboard.

The last piece of equipment necessary is the "pinger" (CDS). The pinger is activated by CAI's new "Sea Switch" which is triggered by its immersion in water, producing an automatic "man overboard" signal. This pinger may be attached to a lifejacket, survival suit, flotation vest, etc.

The Sea-Trace system's up to three mile range (dependent upon water conditions and other environmental factors) is unhampered by the conventional limitations of visibility, especially in rescue operations conducted at night, in fog, or other areas of poor visibility. These characteristics make Sea-Trace the ideal method for prompt location of a man overboard.

Equipment or cargo lost overboard also presents a costly problem to today's exploration or commercial vessel, especially in areas where adverse weather conditions prevail. Sea-Trace can provide rapid recognition and relocation of equipment lost overboard using the same system just described. A transmitter is attached to any piece of equipment which could possibly be lost overboard, and its function is activated by the "Sea Switch."

2. Geophysical Exploration

Today's geophysical exploration employs sensitive, sophisticated and expensive equipment. It is imperative that losses of towed equipment be cut to a bare minimum. These losses can occur when the towing cable (streamer) is severed. These losses often occur under the best of conditions, but especially so under adverse weather conditions, such as fog and storm, when search for the lost apparatus is most difficult. "Sea-Trace" can provide for timely recovery of lost streamers and/or equipment and minimize otherwise large financial losses.

Modern geophysical exploration instruments are often towed in succession on a cable referred to as a "streamer," which may exceed one mile in length. These instruments are located in succession along its entire length. The value of a single operational streamer with these instruments is in excess of several hundred thousand dollars.

Sea-Trace equipment involved with the relocation of a lost "streamer" consists of one or more underwater transmitters or "pingers" (CDL series using industry accepted mechanisms for easy attachment to the streamer), a directional hydrophone (CS-40), and an ultrasonic receiver (CR-40).

One large user of hydrographic vessels locates the transmitters approximately at one-third the length of the streamer, two-thirds the length, and at the end, insuring that even if the streamer is severed in several places, each severed portion would have a transmitter. The CDL series pinger has a 10-watt power output, coupled with up to a 10-mile operating range (dependent upon water conditions and other environmental factors), providing optimum signal coverage. These transmitters have proven not to interfere with seismic equipment, due to the fact that the pingers are on a relatively high frequency, while seismic instruments are sensitive to lower frequencies.

The directional hydrophone is used in conjunction with the receiver aboard ship. When aimed directly at the transmitter, it registers the strongest signal and as the boat (hydrophone) is turned away from the signal, it becomes progressively weaker.

Once located, the streamer is easily retrievable due to its neutral bouyance. Sea-Trace can prevent both the costly loss of geophysical streamer equipment and significantly reduce their expensive "time is money" relocation.

3. Long Line Fishing Equipment Recovery

Long line gear lost at sea presents both an expensive and frustrating loss to today's commercial long-line fisherman. Whether the set is dragged offshore by a passing tanker, lost in a storm, cut by sharks or a passing freighter, or simply drifted away, the problem remains the same, "How do I relocate my gear quickly and economically?"

Communication Associates, Inc.'s "Sea-Trace" equipment can relocate long-line gear both fast and feasibly in a manner similar to the geophysical streamer.

4. Long Line - "Fish On"

A device which would provide immediate notification of a "fish on" could be an extremely valuable tool to today's commercial long line fisherman. Such a device would enable the fisherman to tell what time the majority of "hook ups" occur, tell the individual hooks on which there are strikes, enable the fisherman to pull an individual fish aboard at night (saving the fish from being eaten by sharks), and allow him to make an educated decision of which end of the long line to pull first (in accordance with which end has the most fish). Communication Associates Inc.'s "Sea-Trace" can provide the fisherman with this information.

The Sea-Trace system used to indicate to the fisherman a "fish on" consists of a directional hydrophone (CS-40), an ultrasonic receiver (CR-40), and a series of transmitters or "pingers" (CDS). The transmitters (CDS) would be attached at the hooks and would be activated through the use of a magnetic switch which would activate the pinger when a fish is hooked. One pinger could be connected to a tandem pair of hooks, providing "hook up" data for both. Pingers could also be programmed with particular codes in order to provide for individual identification.

The signal from the transmitter would be picked up by the directional hydrophone (CS-40) which may be mounted on the bow or side of the vessel and rotated to face the direction of the long line. The signal would then be heard as an audible pulse from the receiver (CR-40), which is connected to the hydrophone.

5. Net Depth/Temperature

It has been common knowledge for years among fishermen that certain species of fish are found in waters of certain temperature and/or depth. It is also known that these temperature zones may differ from the surface temperature due to depth, currents, thermoclines, etc. Therefore, it follows that if temperature and depth may be ascertained as that desirable to the fish sought, it is there that the commercial fisherman would set his nets.

Communication Associates, Inc.'s "Sea-Trace" can put this information within the grasp of the commercial fisherman, both accurately and economically, adding a bit of "science" to the "art" of fishing.

"Sea-Trace" equipment as used for net depth/temperature telemetering consists of an ultrasonic transmitter or "pinger" (CDS), "MUX" (multiplex, that is both pressure and temperature), an omni-directional hydrophone (CN-15 special), a receiver (CR-40) and a decoder and indicator (CI-40).

The pinger, which emits ultrasonic pulses, would be attached to the front of the net and would transmit depth/temperature data. The stability of the trawl can also be monitored by the pinger and will appear as fluctuations in depth, according to the stability or non-stability of the net. Transmission of depth information from the net would also provide the fisherman with the exact depth of the trawl itself. This depth could then be altered by either retrieving or letting out more cable.

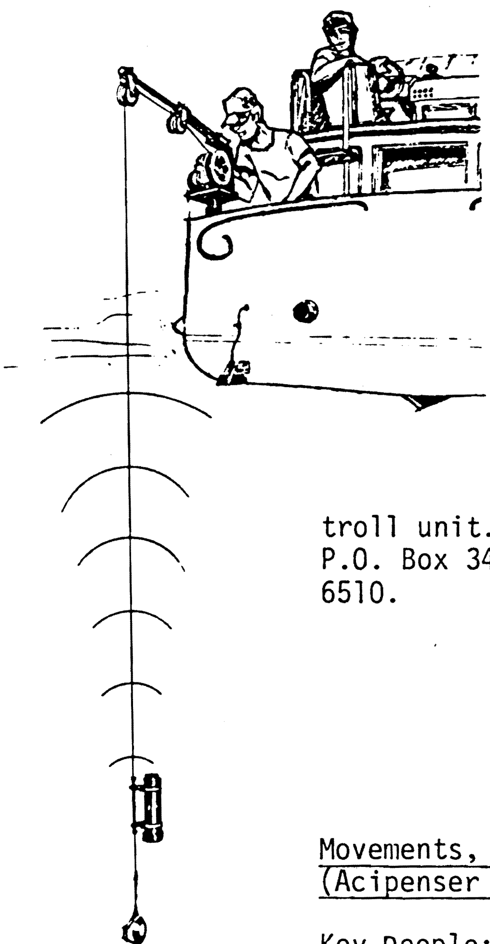
The omni-directional hydrophone could be towed astern of the vessel by a downrigger or individual cable, and weighted, to provide for the optimum signal, or a hydrophone could be mounted on the underside of the hull.

The signal received by the hydrophone is then fed to the receiver into the wheelhouse. The output of the receiver goes to the decoder/indicator. The indicator then decodes the pulses into the desired units of measurement (e.g. feet, fathoms, meters, degrees Farenheit, degrees Celsius, etc.).

TDP-2 Advanced Digital Data Processor

Although designed for terrestrial wildlife research, this unit by Telonics is finding its way in increasing numbers to the marine field. The small unit consumes very little power, and is being used to display both precise inter-pulse interval data and precise signal strength information with the receipt of each pulse. It provides outputs for both parameters to recorders simultaneously. Sexton Photographics of Oregon now offers fully submersible housings, complete with "bump" cases for products in this configuration. Temperature accuracies of 0.1 to 0.01°C can be attained with this device when used with Telonix RF transmitters. Performance is also good when used with various ultra-sonic systems. The DB function allows one to measure path loss in the water and "pattern" hydrophones with a high degree of accuracy. Contact David Beaty, Telonics, 1300 West University Drive, Mesa, Arizona 85201 (telephone 602-834-1773).

Fish Hawk[R] Markets a Downrigger Temperature Sensor



Downrigger trolling gear is common for both the commercial and sports fisherman. The key is locating the depth of trolling where the fish are found. Fish Hawk Electronics has now marketed a downrigger temperature sensor that uses ultrasonic telemetry to monitor water temperature in order to find the thermal strata preferred by the fish species sought (See UTN 4(1) and 10(1) for articles on temperature telemetry to determine fish temperature preferences). Called "Thermo Troll," the sensor can be used to depths of 200 ft (60 m). The sensor simply attaches on the downrigger cable (see figure) and it transmits the temperature data by ultrasonic pulses to a hydrophone attached to the boat. No modifications are needed for standard commercial downriggers to accomodate the thermo troll unit. Available from Fish Hawk Electronics Corporation. P.O. Box 340, Crystal Lake, Illinois 60014 (telephone 815-459-6510.

* * * * * * * * * *

NEW TELEMETRY PROJECTS

Movements, habitat preferences and ecology of lake sturgeon (*Acipenser fulvescens*).

Key People: Robert A. Bellig
Biology Department
Gustavas Adolphus College
St. Peter, Minnesota 56082

Equipment: Radio telemetry

Location: Minnesota River

Response of smallmouth bass to changes in water volume, velocity, and turbidity in a stream

Key People: R. W. "Larry" Larimore
Illinois Natural History Survey
Natural Resources Bldg.
Urbana, Illinois 61801

Equipment: Radio telemetry

Location: Illinois

A comparison of activity patterns and behavior among largemouth, smallmouth and largemouth X hybrid bass

Key People: Larry Larimore, Bill Childers and Homer Buck
Illinois Natural History Survey
Urbana, Illinois 61801

Equipment: Radio telemetry and a strip chart recording system

Location: A small Illinois lake

Movements of young muskellunge and the efficiency of various capture techniques in a rearing pond subject to winter-kill conditions

Key People: Bruce Gilbertson
Minnesota Department of Natural Resources
1200 Warner Road
St. Paul, Minnesota 55106

Equipment: Radio Telemetry, shore towers

Location: Rearing ponds, St. Paul, Minnesota

Daily Activity, haul-out patterns and movements with respect to pack ice by Leopard Seals (Hydrurga leptonyx)

Key People: Sheridan Stone, Don Siniff and V. B. Larry Kuechle
Ecology and Behavioral Biology Dept.
318 Church Str., 108 Zoology Bldg.
University of Minnesota
Minneapolis, Minnesota 55455

Equipment: Radio telemetry; saltwater activated shut-off switch to conserve transmitter energy

Location: Antarctica

Predator-prey interaction between pike and perch

Key People: John F. Craig
Freshwater Biological Association
The Ferry House
Far Sawrey, Ambleside
Cumbria LA 22 OLP
England

Equipment: Ultrasonic tags

Location: English Lake District

Spawning movements of brown trout in Lake Ontario and a tributary

Key People: James M. Haynes
Dept. of Biological Sciences
State University College
Brockport, NY 14420
tel. (716) 395-2785

Equipment: Radio telemetry

Location: Lake Ontario, New York State

Slamonid behavior during "zero" flow in the Snake River (see article this issue)

Key People: Kenneth L. Liscom, Lowell C. Struehrenberg, Gordon F. Esterberg, and Charles J. Bartlett
Coastal Zone and Estuarine Studies Division
Northwest and Alaska Fisheries Center
National Marine Fisheries Service
2725 Montlake Boulevard East
Seattle, Washington 98112
Telephone (206) 442-4368

Equipment: Radio telemetry

Location: Snake River, Washington State

Goldfish aggregations in fall and winter (see News and Views)

Key People: Stephen Drival and Allan Scholz
Department of Biology
Science Building
Eastern Washington University
Cheney, Washington 99004

Equipment: Ultrasonic telemetry

Location: Clear Lake, Washington

Radio tagging of Atlantic Sturgeon

Key People: Theodore I. J. Smith
Marine Resources Institute
P.O. Box 12559
Charleston, S.C. 29412
Telephone (803) 795-2897

Equipment and Location: (Not available)

Tracking walleye in the upper Mississippi River

Key People: Randy Duncan
Natural Resources Assistant
Department of Natural Resources
State Office Building
3550 Mormon Coulee Road
La Crosse, WI 54601

Equipment: Radio telemetry

Location: Upper Mississippi River

Effects of discontinuous hydroelectric releases on habitat selection by northern pike in a downstream reservoir

Key People: Paul Brown, Charles Coutant
University of Tennessee, Knoxville, and Oak Ridge National Lab
c/o Environmental Sciences Division
Oak Ridge National Laboratory
Oak Ridge, TN 37830
Telephone (615) 574-7386, FTS 624-7386

Equipment: 53 MHz radio telemetry, boat and truck-mounted yagi antenna, temperature-sensing tags, magnetic tape field data recorder, data processing computers

Location: Melton Hill Reservoir (Clinch River), Tennessee (affected by hydroelectric releases from Norris Dam)

Seasonal distribution of adult striped bass in Lake Whitney and the Brazos River, Texas

Key People: Charles Mulford
Texas Parks and Wildlife Department
6200 Hatchery Road
Fort Worth, Texas 76114
Telephone (817) 732-0761

Equipment: Brumbaugh ultrasonic tags and digital readout receiver (pulse rate and frequency)

Location: Lake Whitney and Brazos River, Texas

# CALL FOR PAPERS

## THIRD
## INTERNATIONAL CONFERENCE ON WILDLIFE BIOTELEMETRY

**to be held at the**

**UNIVERSITY OF WYOMING**

**July 27,28, 1981**

### PROGRAM

The purpose of this conference is to provide a forum for such topics as the design and fabrication of wildlife biotelemetry systems, the application of these systems, and the extraction and analysis of the information contained in wildlife biotelemetry derived data. The design of experimental protocol so as to exploit the advantages of biotelemetry for wildlife studies will be given special consideration.

### EXHIBITS

Exhibits are welcome. Commercial exhibits are encouraged. There is no charge for exhibits. If you have equipment or other materials to exhibit or display, please plan to do so. Time will be reserved for attendees to visit exhibits.

### DEADLINE DATES

**Receipt** of abstract (200 words, one page) .......... March 13, 1981

Notification of acceptance will be sent ............... April 3, 1981

**Receipt** of completed paper, camera ready ............ May 1, 1981

Program Distribution ........................... May 15, 1981

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Send all abstracts to:
ICWB c/o Dr. Francis M. Long
Department of Electrical Engineering
University of Wyoming
P.O. Box 3295
University Station
Laramie, Wyoming 82071

# CONTINUING BIBLIOGRAPHY OF UNDERWATER TELEMETRY

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# POST SCRIPTS

## UTN to be Available on Microfiche

As this issue is going to press, the Editor has made arrangements to put back issues of the newsletter on microfiche. Demand for past issues continues to rise as more telemetry projects are being initiated and as more new researchers want to quickly become familiar with techniques and equipment. Issues before 1977 are in very short supply. The remaining copies of these early issues have been restricted to libraries that agree to retain them. Microfiche is one way to economically reproduce back issues without adding to storage problems.

Microfiche consists of transparencies of the document's pages mounted on a 10.5 x 15 cm file card. Up to 98 pages can be included on one transparency card. The cards themselves can be easily reproduced and filed in a standard index file cabinet (the "5 x 7 inch" size). Microfiche readers are becoming increasingly common in offices as micrographics are used to solve problems of long-term storage of important documents. One inexpensive reader is the Model 7700 from GAF Corporation, Office Systems Products, 140 West 51 Street, New York, NY 10020. They will supply a listing of distributors in your area. The 18X lens is the most convenient, although magnifications up to 37X are available.

For microfiche copies of the newsletter, contact the Editor. A small charge may be necessary, but details have not been worked out.

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