LOTEK ENGINEERING INC.
— A LOTEK GROUP COMPANY —

Telemetry System Design Overview

There are two fundamental types of research applications for which Lotek supplies radio and acoustic telemetry equipment.

Manual Tracking studies
Fixed Station Datalogging studies

Traditional *manual tracking* is often employed when studies are conducted to determine gross fish movement, migratory patterns, location of spawning grounds etc. In early telemetry applications, researchers would study a small number of fish (e.g. <10), with a specific frequency assigned to each fish for every "beeper" transmitter (tag) used. These tags were subsequently tracked using non-scanning receivers. Studies of this type are relatively low in cost from a telemetry equipment perspective.

Today, a greater number of researchers rely on *scanning* receivers for manual tracking. A scanning receiver automatically listens at each frequency for small periods (defined by the user) of time. When a valid signal is detected, the scan cycle can be suspended to locate the animal. Once located, the scanning routine is resumed until a signal from another individual is heard...etc. The Suretrack STR_1000 is an example of a manual scanning receiver, while the SRX_400 can be configured to function either as a manual scanning receiver or as an automatic datalogger.

Fixed station datalogging systems in wide use today were first introduced by Lotek Engineering in the late 1980's. The SRX_400, which represents the nucleus of our datalogging telemetry systems, is a rugged, 4 MHz bandwidth receiver that provides the basis for cost-effective systems for remote data acquisition. Its initial use was to assist researchers in determining fish movements around hydropower facilities.

In such applications, a receiver(s) is deployed to automatically scan for frequencies in use. Whenever a valid transmitter signal is detected, the date, time (hour, minute, second), frequency, pulse rate, signal strength, for each detected signal is logged by the receiver. Data collected in this form are referred to as "*Events*".

Continuous data collection throughout the study period results in the ability to gather more data than is otherwise feasible through typical manual tracking methods. Assuming one transmitter per frequency with a 10 kHz spread between transmitter frequencies, up to 400 tags could be automatically monitored.

The researcher periodically downloads stored data via one of the RS-232 serial ports of the SRX_400 receiver, using proprietary software (included with receivers configured with this capability) and an MS-DOS/Windows based computer. Compiled data are thus presented for further analysis.

While this technology enhanced study possibilities, a single antenna telemetry system presents limitations, insofar as a system's ability to precisely monitor localized movement of individuals, particularly in large numbers.

A second generation of datalogging receivers thus evolved, with the capability to scan a number of antennas sequentially. Datalogging SRX_400 receivers configured with antenna switching capability can monitor up to eight antennas. In this configuration, the receiver scans for all used frequencies, either sequentially by antenna or simultaneously in selected (by the user) antenna groups. All related event data are logged by the receiver, including identification of the antenna at which the signal was detected. A receiver configuration with this capability is the SRX_400 with W21 firmware.

From a statistical perspective, the greater the sample size, the easier it is to support research conclusions. The telemetry systems described provide that capability. In certain applications however, high sampling rates of large study

populations in relatively small study areas, once again define upper limits to this design, as the number of frequencies used and the number of antennas deployed in a system can increase the total cycle time required to scan at each valid frequency and at each antenna.

As total cycle time required to monitor individuals moving through a reception zone of a telemetry system increases and the time spent by individuals in a reception zone decreases, so increases the possibility that individuals can move into and out of a reception zone without being logged. While an effectively defined antenna switching strategy can reduce this possibility, the potential for individuals moving into and out of a reception zone without being logged is also dependent upon such application specific factors as size of the study population and size of the study area.

To address applications in which these telemetry design factors become a consideration, Lotek developed its *"digitally encoded" system*.

In conventional pulsed telemetry systems, each tagged fish is typically assigned a separate frequency (while varying beat rates of transmitters allows multiple transmitters on one frequency, there is a corresponding variance in their operational life). The coded system however, uses a proprietary coding scheme, as well as frequency, to identify transmitters. Through pulse code discrimination, up to 170 transmitters can be placed on the same frequency, with each transmitter having its own distinct "signature" code.

Systems designed for coded operation thus minimize number of frequencies required. This has the effect of significantly reducing scan time and increases the number of individuals that can be effectively monitored. When sequential and simultaneous group antenna switching functions are utilized in a coded system, the researchers' data gathering capabilities are at an order of magnitude higher than that which is available using conventional pulsed telemetry systems.

An example of this type of system is represented in the *SRX_400 configured with W30 firmware with antenna switching capability.*

Lotek also designed the *DSP_500* Digital Spectrum Processor specifically for use in complex projects that involve monitoring large study populations moving in close proximity. Examples of applications in which this type of system is used include fish passage evaluation and entrainment through dam structures and hydropower facilities. Designed to interface with an SRX_400 configured to interpret coded transmitters, the SRX/DSP station described is capable of monitoring up to 25 frequencies simultaneously, with up to 170 individuals on each frequency.

Continued DSP_500 system development led to introduction of FAS-7 antenna switching, which affords scanning of up to 25 frequencies at up to seven antennas virtually simultaneously. Other application specific options available include remote data acquisition from fixed stations via radio modem or satellite link.

There are obvious financial, design and logistical considerations to all of these scenarios. By working closely with research partners and identifying considerations particular to use of a telemetry system(s) in a project, we are able to assist in designing a system that optimizes study results. Based upon individual study objectives, the complexity of the required telemetry design may underscore the need for assistance in system deployment through our engineering support. Our biologists, design and applications engineers can work with the researcher at their site to ensure that all of the components which comprise the telemetry system, are deployed so as to maximize system performance and its data gathering capabilities.

Through commitment to continued research into the development of radio, acoustic and biotelemetry products, Lotek Engineering looks forward to pursuing opportunities to work in partnership with fisheries and wildlife researchers.