



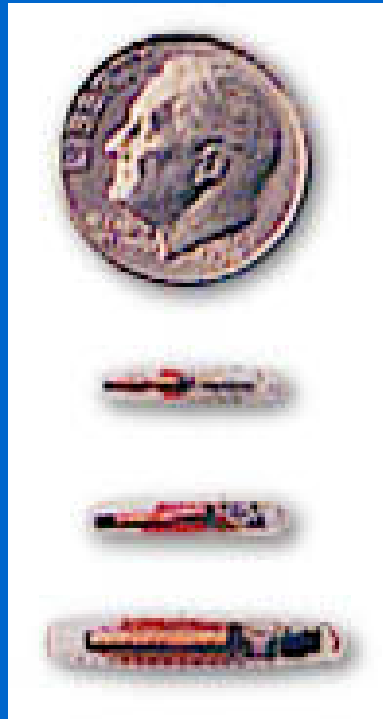
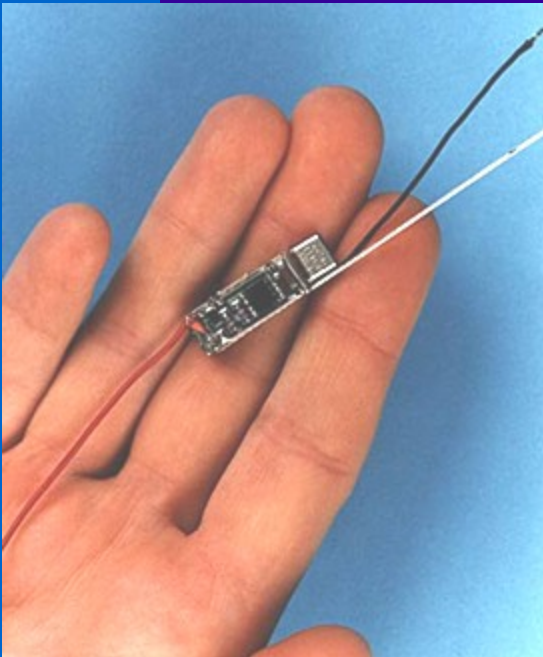
Chapter 19



Advances in Underwater Biotelemetry



19.1 Introduction



- Monitor locations, behavior, physiology of aquatic animals
- Involves attaching to aquatic organism a device that relays biological information
- Relayed via radio signals

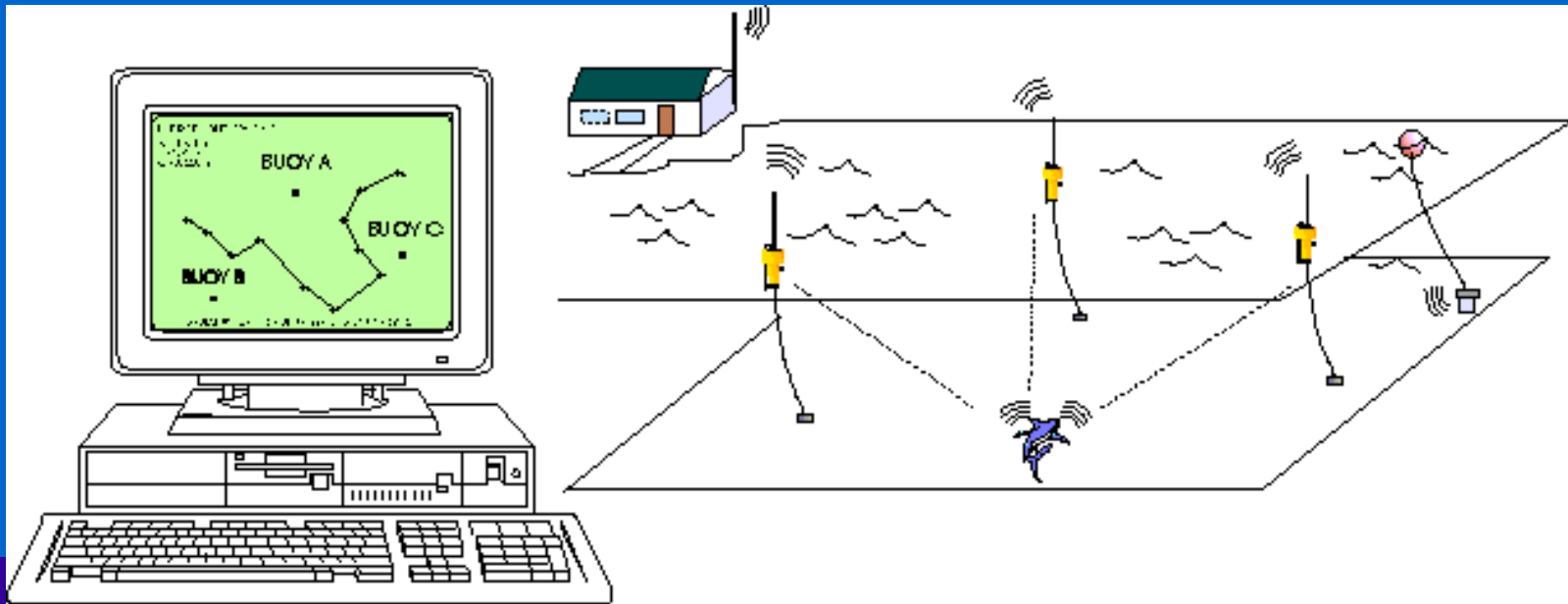
Monitors animals not visible

- Collect data with minimal disturbance
- Means to solve biological problems

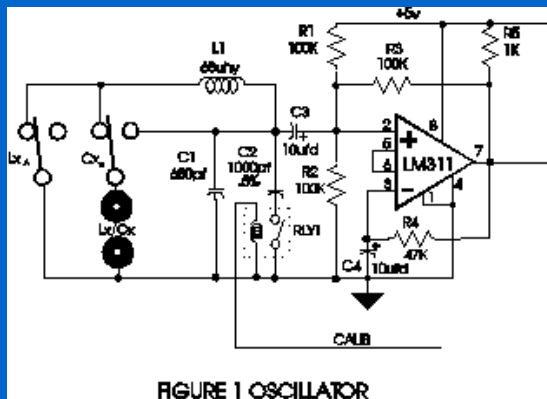


Devices

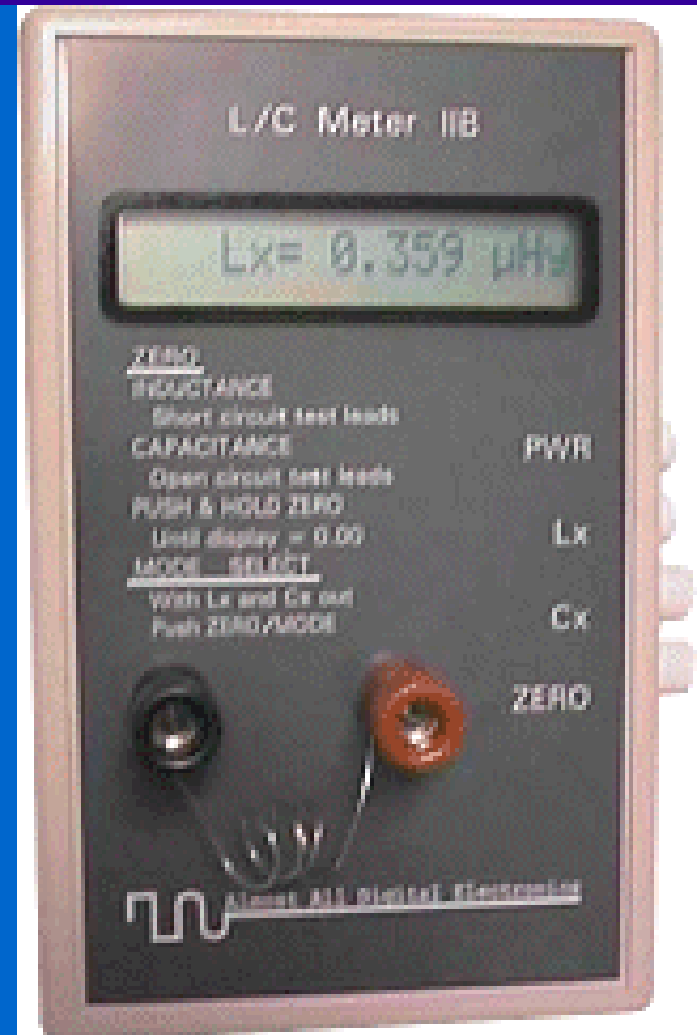
- Transmitter-device attached emits signal
- Transponder-returns a signal in response
 - Active
 - Passive



Transmitter



- Electronic oscillator circuit produces signal
- Measure of frequency is hertz



Factors to consider for telemetry

- Compile testable yes or no questions
- Can the problem be solved using another method?

Yes Don't do telemetry

19.2 Telemetry Systems

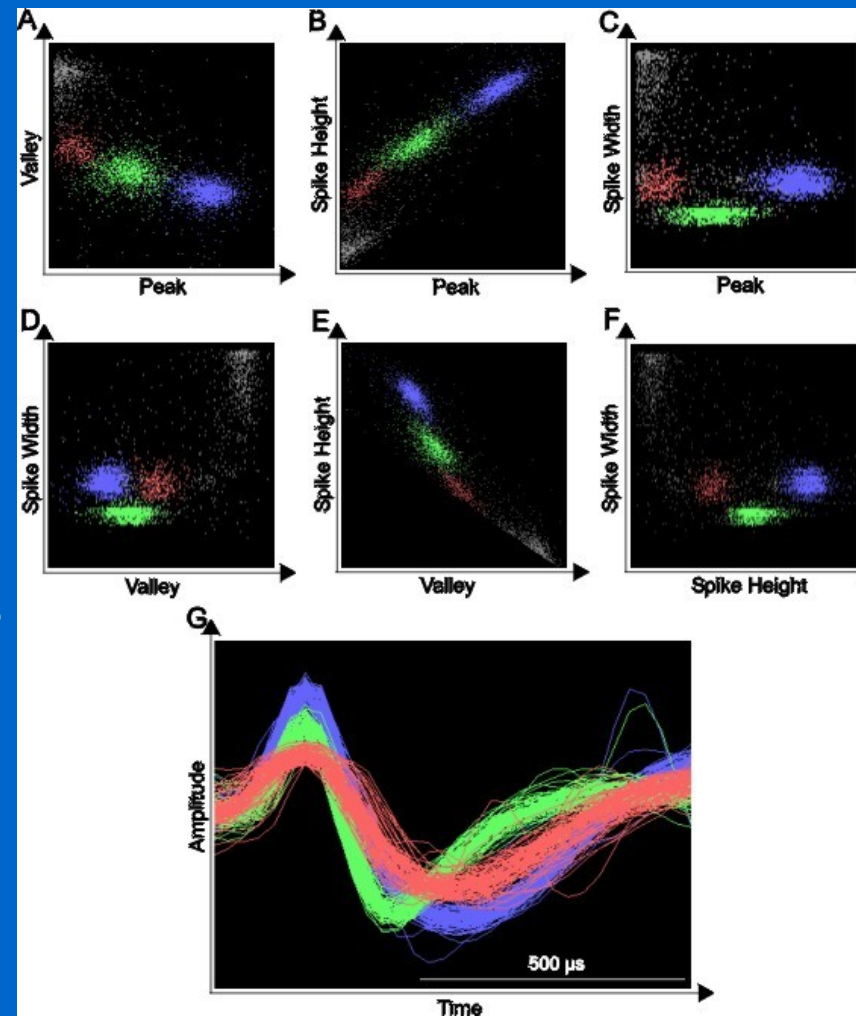


- Origin in late 1950's
- Modified to work underwater in the 1960's



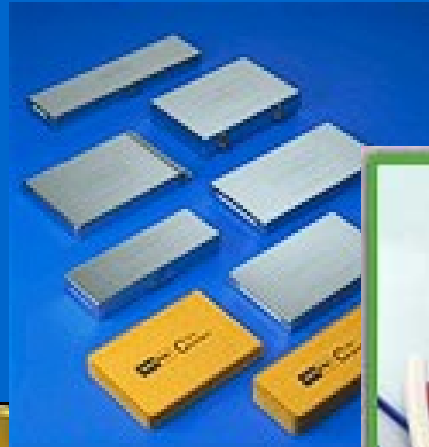
Features Common to Ultrasonic and Radio Systems

- Transmitter signals
 - Continuous wave or pulsing signal
- Continuous more easily detected and recorded
- Pulsing signals use less energy and increase transmitter life



Transmitter encapsulation

- Encapsulated (for compactness) with
 - Epoxy
 - Wax
 - Urethane
 - Silicone
 - Dental acrylic



Transmitter encapsulation (cont.)

- Done by
 - pouring material over components
 - dipping component into material
- Density of should be similar to water



Batteries



- Choice is critical (size)
- Largely determined by battery energy per unit volume/weight
- Other considerations include cost, shelf life and availability

Five types of batteries are used

- **Lithium**

- Highest voltage/unit weight and volume
- Excellent low temperature performance
- Good high temperature performance
- Long shelf life
- Good efficiency
- Low cost



Five types of batteries are used (cont.)

- Mercury oxide
 - Possible health hazard
- Silver oxide
- Alkaline
- Rechargeable nickel-cadmium



Receivers

- Filters input signals, amplifies, and converts to usable form
- Must have good sensitivity
- Must have narrow frequency



- Portable receiver should have rechargeable batteries
- Should have water proof switches and be moisture resistant

Advantages/disadvantages of Ultrasonic & Radio Systems

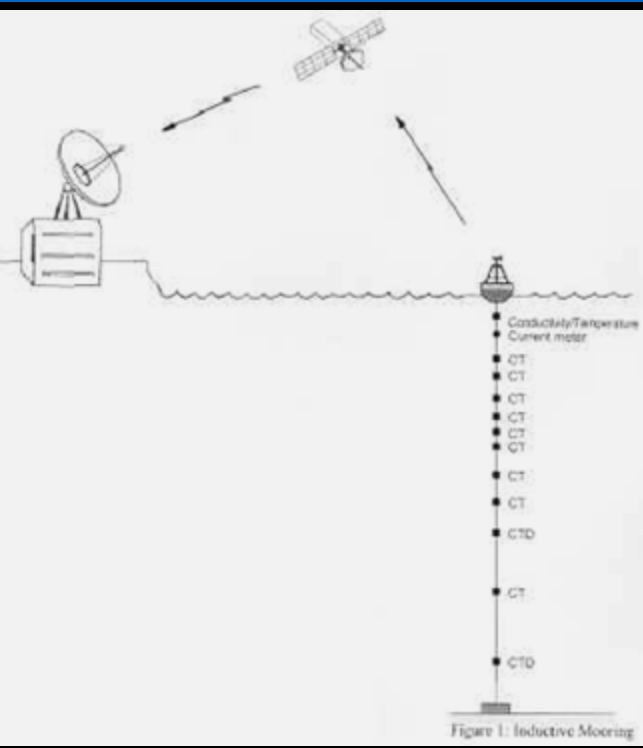
- **With respect to characteristics**
 - **Depth** 45-100 ft.
 - **Water conductivity** high
 - **Current speed** 3mph
 - **Habitat size** 300 square mi.
- **Plant densities** low
- **Temperature gradients** 50 - 85

Ultrasonic telemetry

- Salt and fresh with high conductivity
- Deep water
- Adversely affected by (reduce signal range)
 - Macrophytes
 - Algae
 - Thermoclines
 - Water turbulence
 - Rain drops and boat motors



Radiotelemetry



- Shallow water
- Low conductivity fresh water
- Turbulent water
- Can be used for large areas
- Can be used from shore
- Cannot be used in salt water
- Deflected by objects

Coded and sensing transmitters

- Provide information on
 - Animals identity
 - Physiological variables
 - Behavior
 - Environment
- Often used to identify tagged individuals



Selection of a supplier

- Review literature for names of researchers
- Ask for a reliable manufacturer
- Do not reinvent the wheel

Northern Data Systems, Inc.



Products for Environmental Management

Selection of a supplier (cont.)

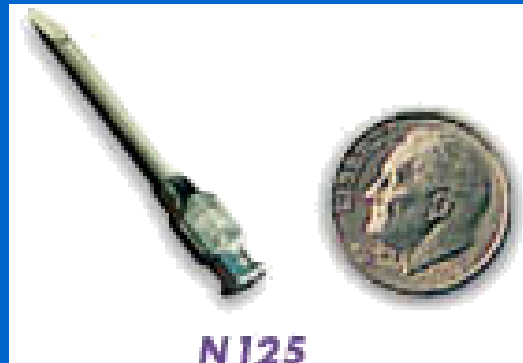
- A firm should
 - Fill orders quickly
 - Repair equipment quickly
 - Loan replacement equipment
 - Offer advice
 - Visit site to solve a problem



WILDLIFE SUPPLY COMPANY

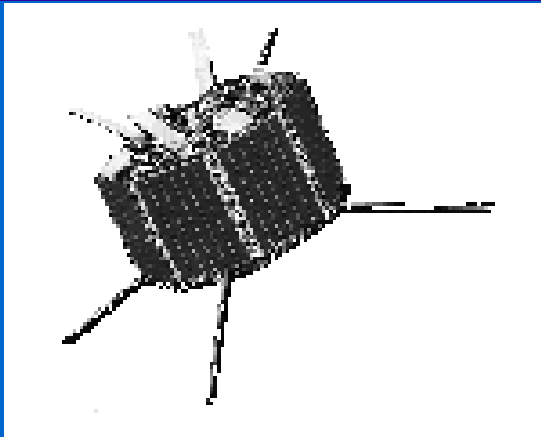


19.3 Methods of attaching transmitters



- Depends on
 - Morphology and behavior of species
 - Nature of aquatic ecosystem
 - Objectives of project

External Transmitters



- Easier and quicker than surgical implantation
- Used for fish spawning and feeding
- Necessary for sensing environmental factors
- Increase drag on swimming organisms



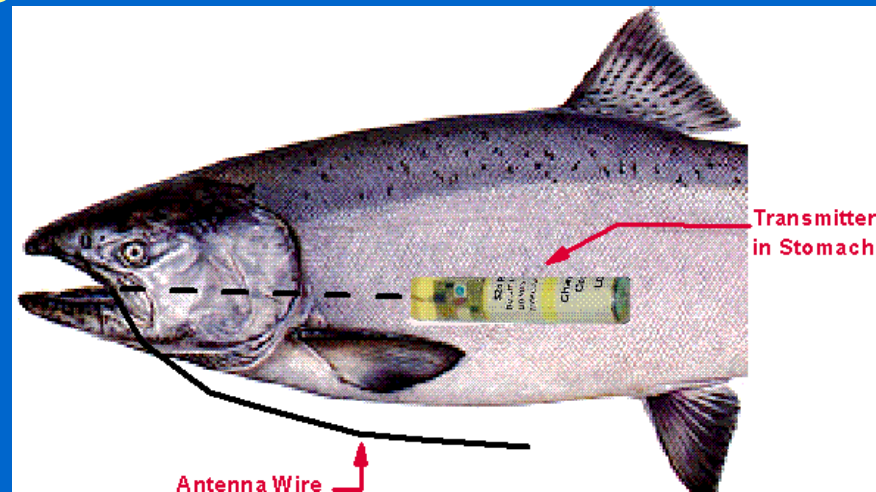
Widest application



- Attaches transmitter alongside dorsal fin
- Surgical needle can be used
- Neoprene placed between fish and plate
- Attach radio transmitter

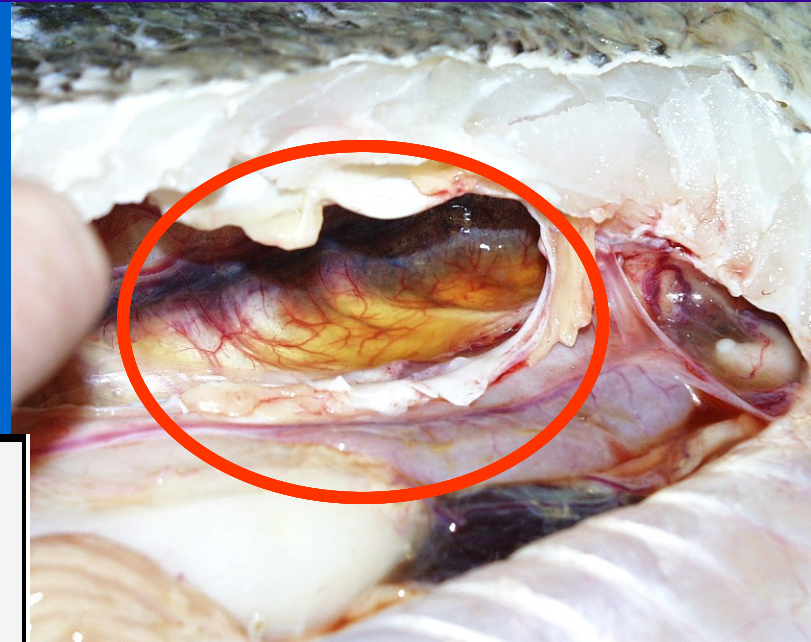
Stomach Inserted Transmitters

- Do not cause drag
- Cannot become snagged
- Less likely to be abrasive
- Can use heavier package
- Can be done quickly
- Short habituation time for fish



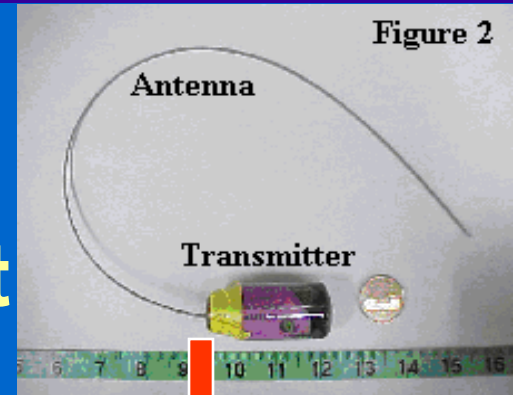
Disadvantages

- Difficult to get in fish's mouth
- May be regurgitated
- May rupture the esophagus or stomach
- External variables are difficult to monitor



Surgically implanted transmitters

- Excellent for physiological transmitters
- Best for long term attachment
- External factors difficult to monitor
- Takes long to perform
- Long recovery period
- More likely to cause infection



19.4 Methods of tracking - Boat

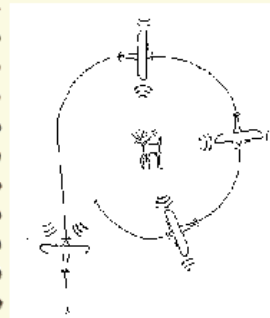
- Stop at specific locations
- Listen for transmitter signals
- Engine off or at low revolutions
- By signal position boat above animal
- Locate animal on map
- Measurements taken



Airplane

- Highly mobile tagged animals
- Greatest detection range for signals
- Very high cost
- Easy to miss animal due to speed
- Locations determined within 100 m

Aerial Tracking



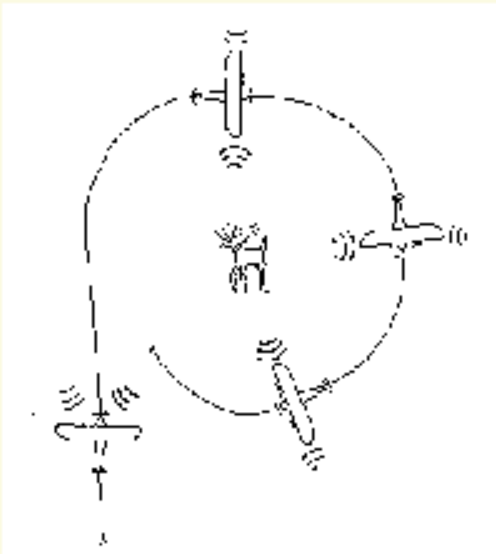
- ✓ Special case of homing
- ✓ Particularly useful for animals that move long distances or are "lost"
- ✓ Fast and efficient
- ✓ Accuracy? Generally within 100-200 m
- ✓ Mapping errors
- ✓ Difficulties in observing animal



Triangulation

- Bearings from two or more locations

Aerial Tracking

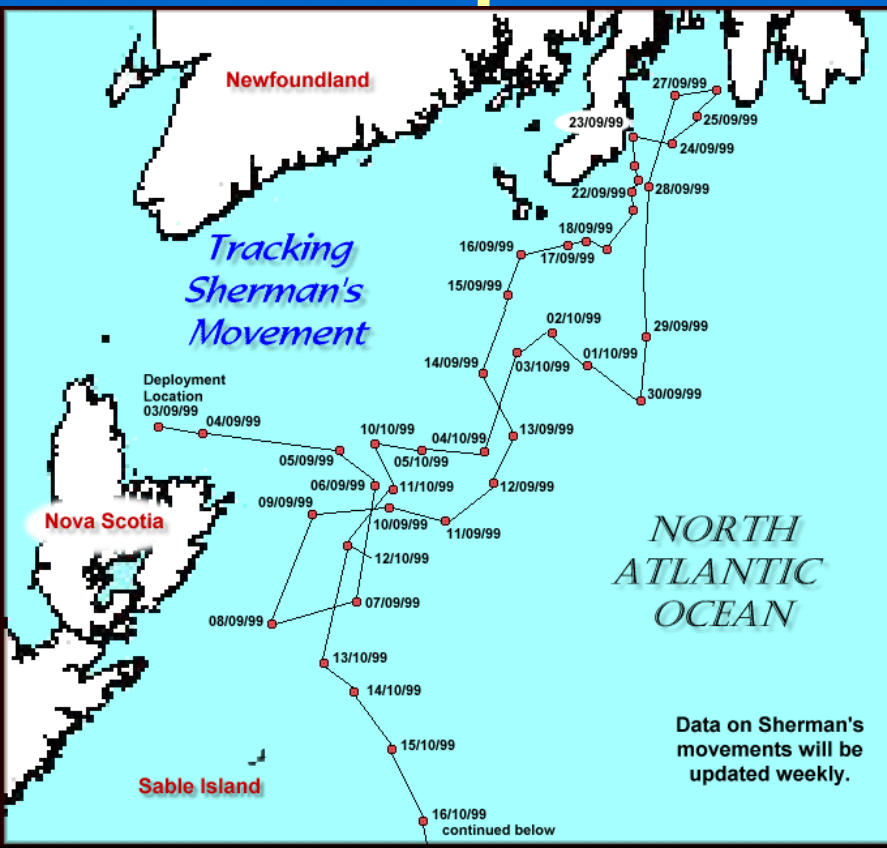


- ✓ Special case of homing
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- Move receiving unit between locations
- Great error by moving animals

Appearance at fixed locations

- Receivers set at certain locations
- Record presence or absence of transmitter



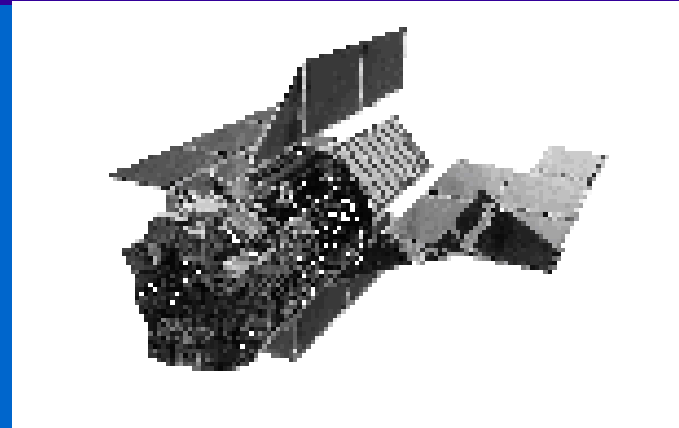
Automatic tracking system



- Measure time taken by signal to travel through water
- Very accurate
- Must have strong signal
- Animals must be in home range

Satellite telemetry

- By satellite
- Track remote, wide ranging animals
- Usually used on larger animals



Automatic Data Recording

- Automatically decoded and recorded
- Absence or presence of signal on strip chart
- Manual- one animal at a time
- Timers may be used
- More elaborate
 - Electronic data sheets
 - Data collection computers
 - Microcomputers



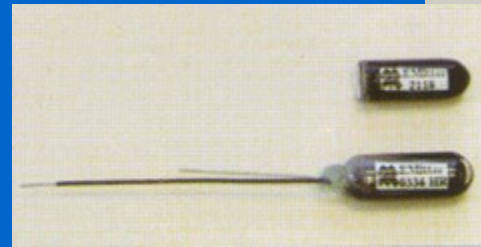
19.5 Sampling and processing - Field Considerations

- Have spare for everything
- Store transmitters in padded boxes
- Store in refrigerator if not used for long (batteries)
- Activate transmitters days before testing



Field Considerations (cont.)

- Test transmitter before attaching to animal
- Cover receivers with plastic bags
- Dry out receivers after use
- Discharge nicad battery before recharging



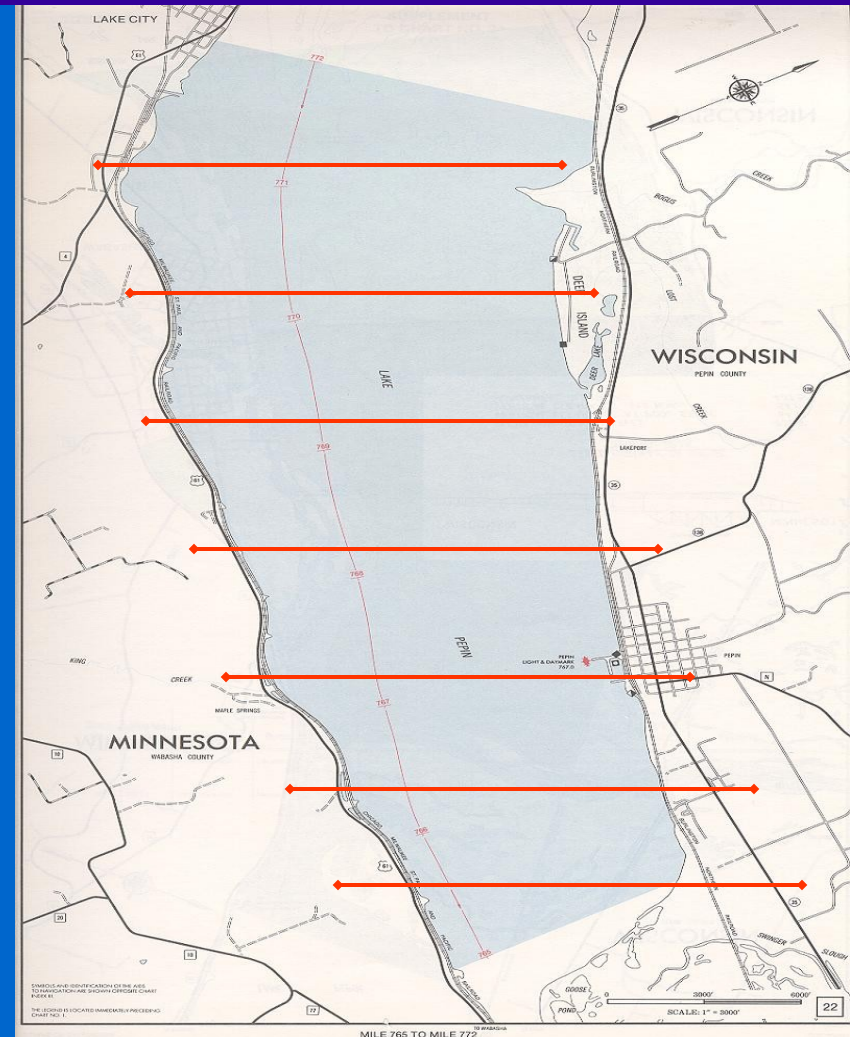
Sampling size considerations

- Number tagged depends on
 - Cost
 - Labor
 - Availability of animals
 - Type of data desired
 - Method of analysis



Methods of Searching

- Use equally spaced transects
- Vary starting point each day



Sampling time

- Do not sample same time every day
- All hours sampled equally
- Choose days and time randomly

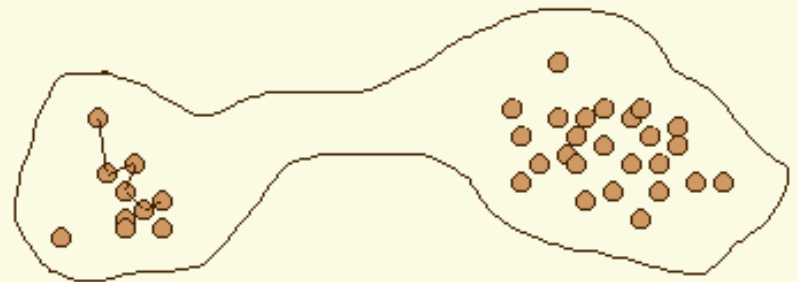


Data Plots

- Draw bearings on plot board
- Each animal gets a x and y coordinate

Temporal Independence: Problems II

- ✓ If animals are migrating for instance, problems may arise (McNay et al. 1994)
 - A few long distance moves stretches range



- The result is a bimodal point distribution

- Statistical programs can plot scattergrams

Data analysis

- Usually done with computer
- Define biotelemetry



Population of interest

- Experimental unit
- Hypothesis to be tested
- Present in appropriate units

H_0

H_a