

# Tracking Technology for Juvenile Salmon

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# Telemetry

'telos': send; 'metros' measurements

## Radio or Ultrasonic

Radio frequencies

1.5 MHz or 1,500,000 cycles per second

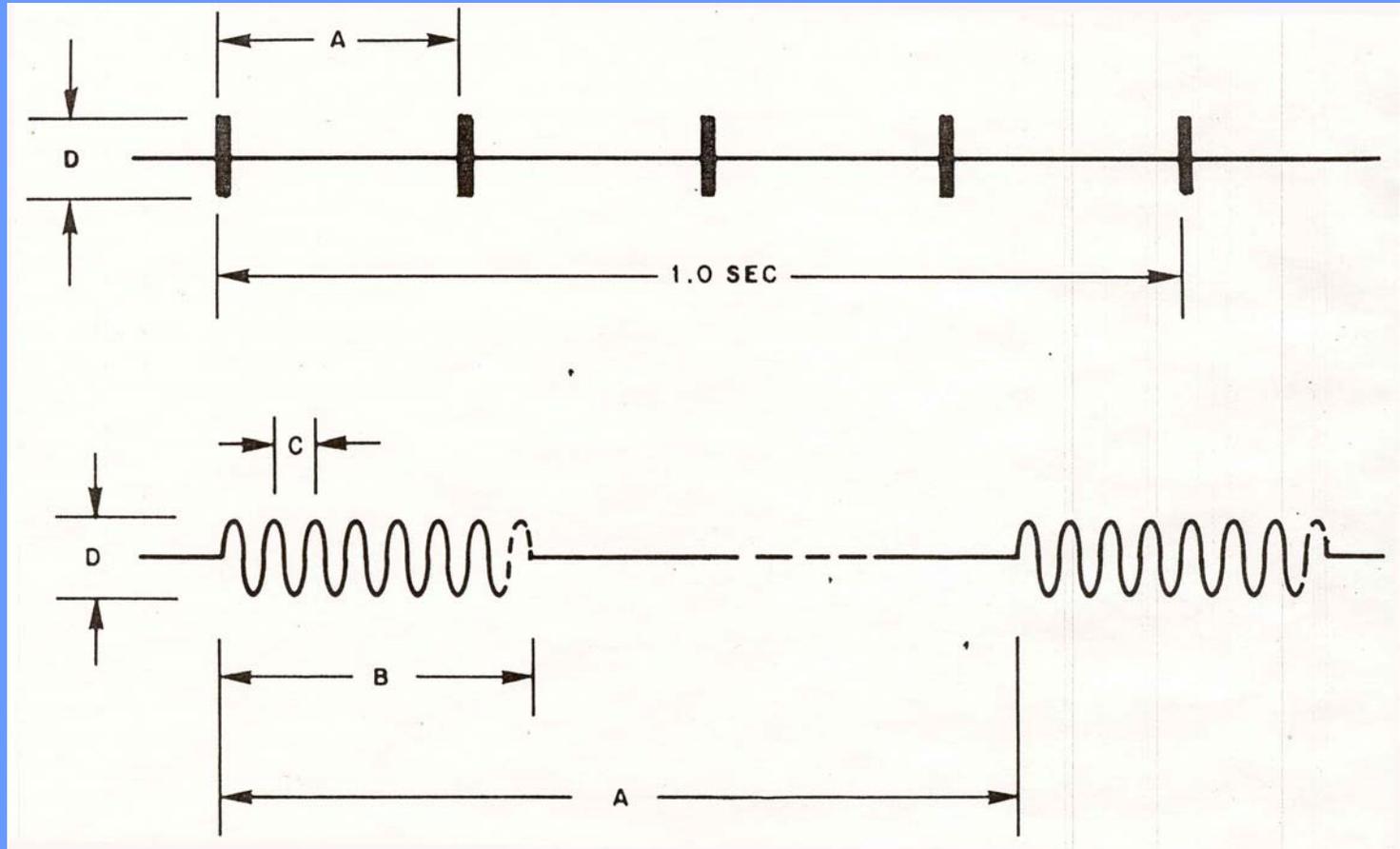
Ultrasonic frequencies:

'ultra': beyond; 'sonic': sound

i.e., beyond human hearing range, i.e., 75 – 16,000 Hz

50 – 120 kHz

# Signal Properties



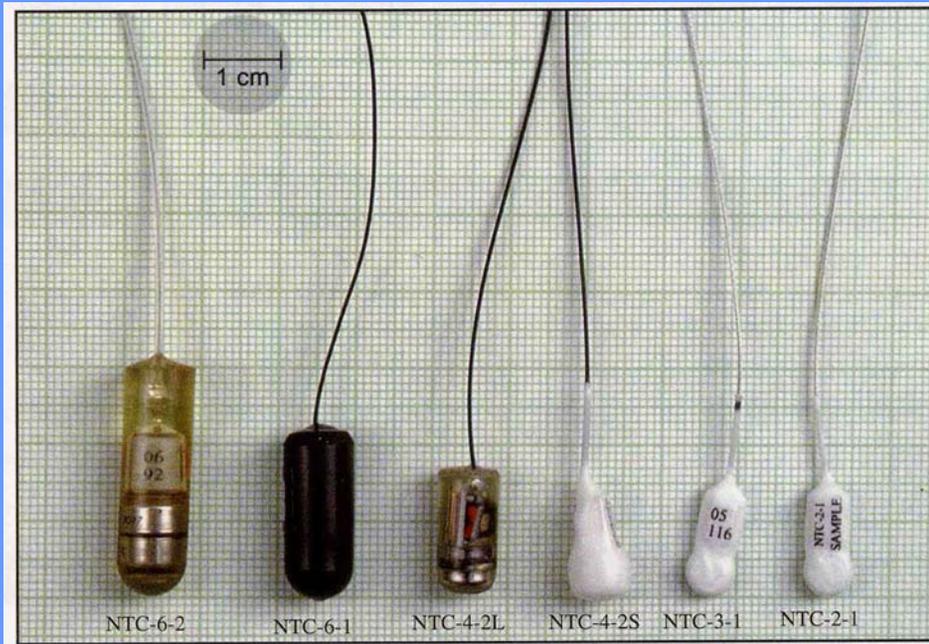
A: Pulse interval, 500 - 1000 ms

B: Pulse length, 10 ms

C: Length of one cycle, 0.025,  
 $1 / 0.025 = 40$  kHz frequency

D: Pulse amplitude

# Transmitters



Radio beacons



Ultrasonic beacon

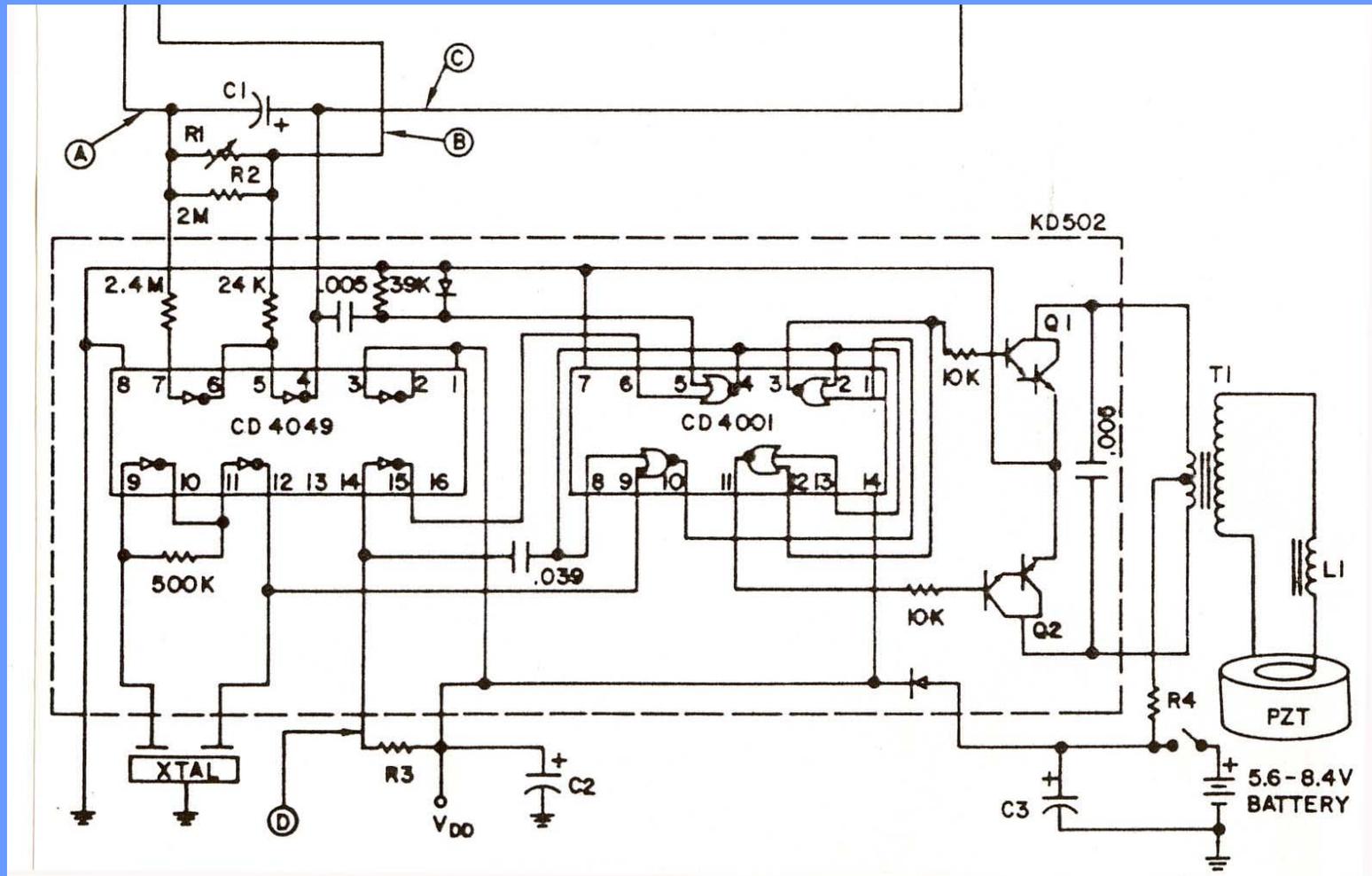
# The 'Guts' of a Transmitter



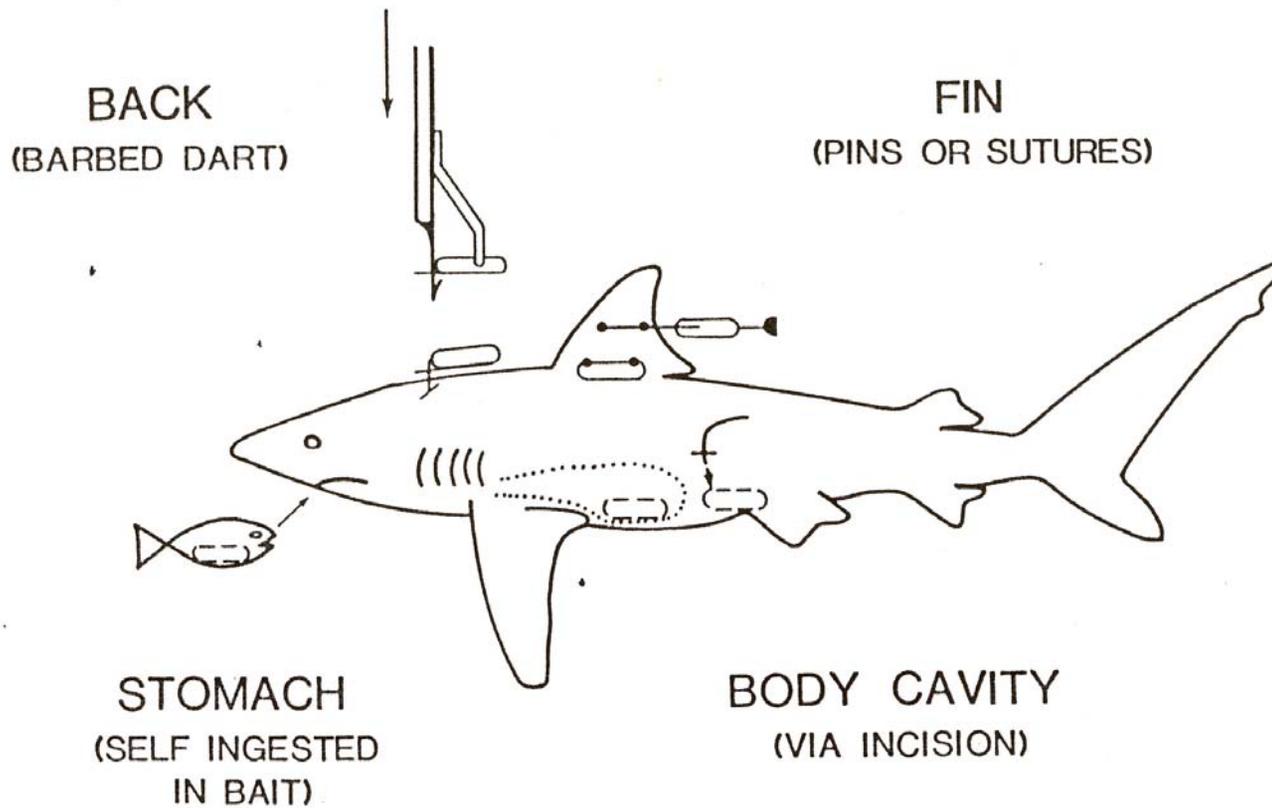
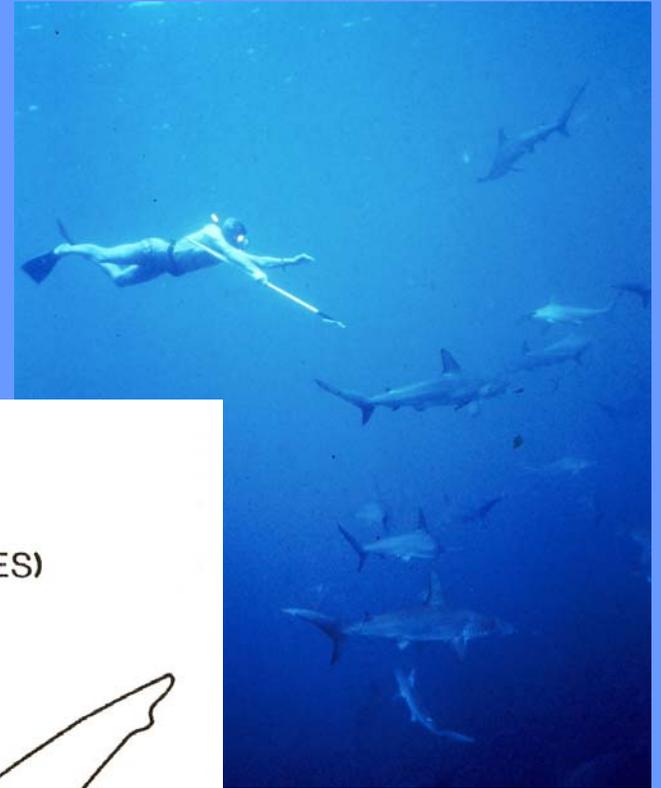
Multi-sensor  
ultrasonic transmitter  
placed on scalloped  
hammerhead sharks



# Electronic Components in a Transmitter

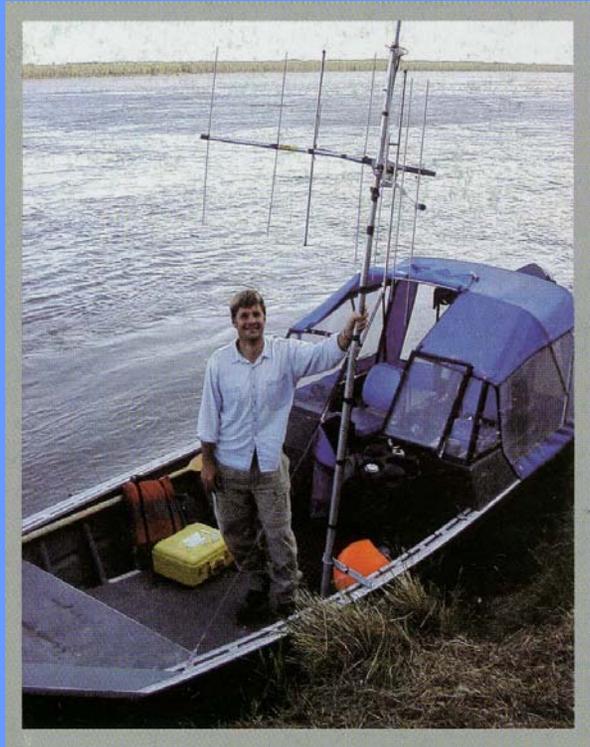


# Tag Attachment



# Radio Tracking

Receiving antenna



Beacon

Radio receiver



# Radio Tracking

## Advantages

- Small size
- Large range in air
- Longevity

## Disadvantages

- Long antenna that penetrates body and causes additional drag, and may cause high mortality due to predation
- Signal propagates only in fresh water, not brackish or salt water.

# Ultrasonic Tracking



Computer  
based-  
decoding



Receiver and  
hydrophone

Coded beacon



# Ultrasonic Tracking

## Advantages

- No external antenna increasing drag
- Similar range in fresh, brackish, and salt water
- Increased longevity by increasing pulse intervals and coding identity

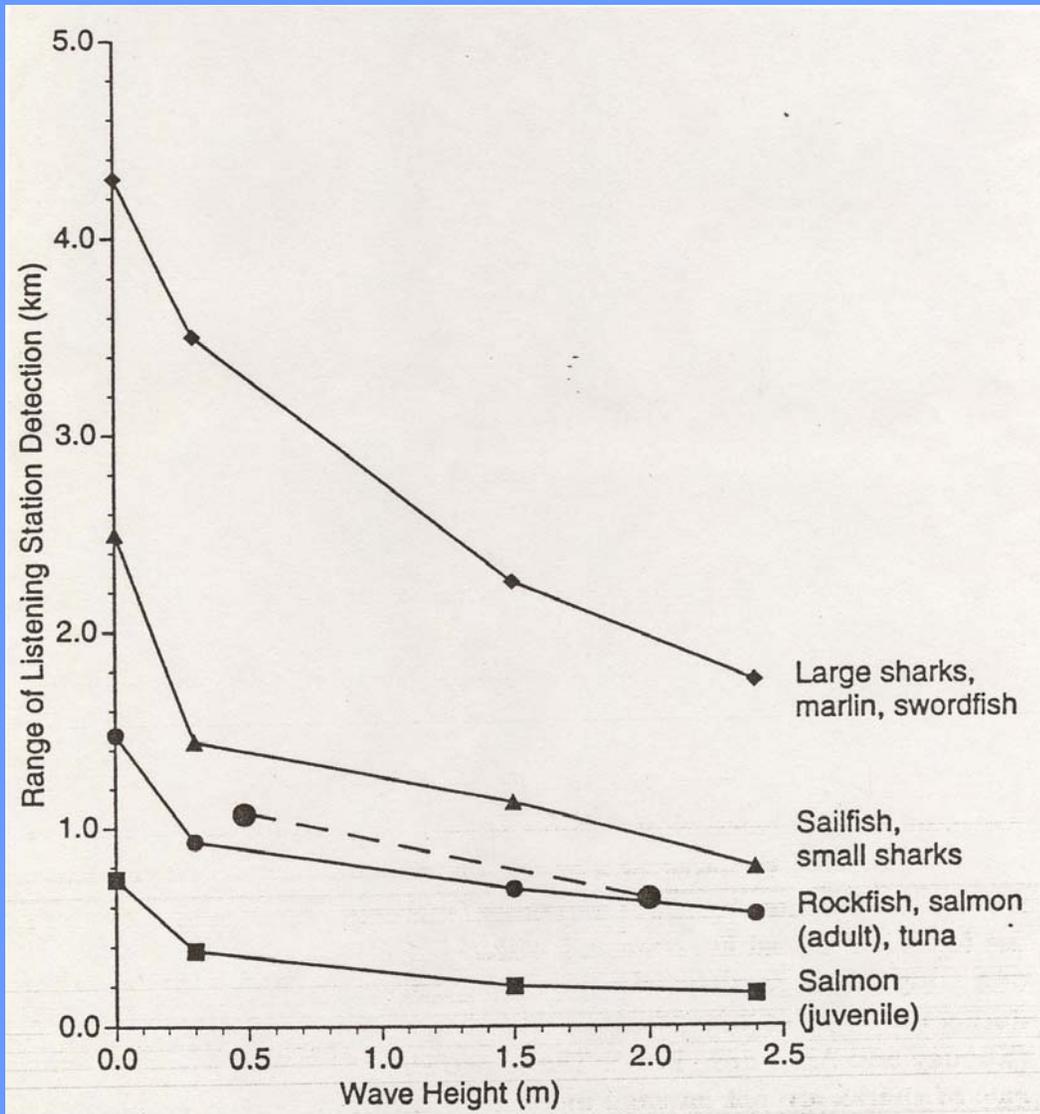
## Disadvantage

- Slightly larger size due to PZT

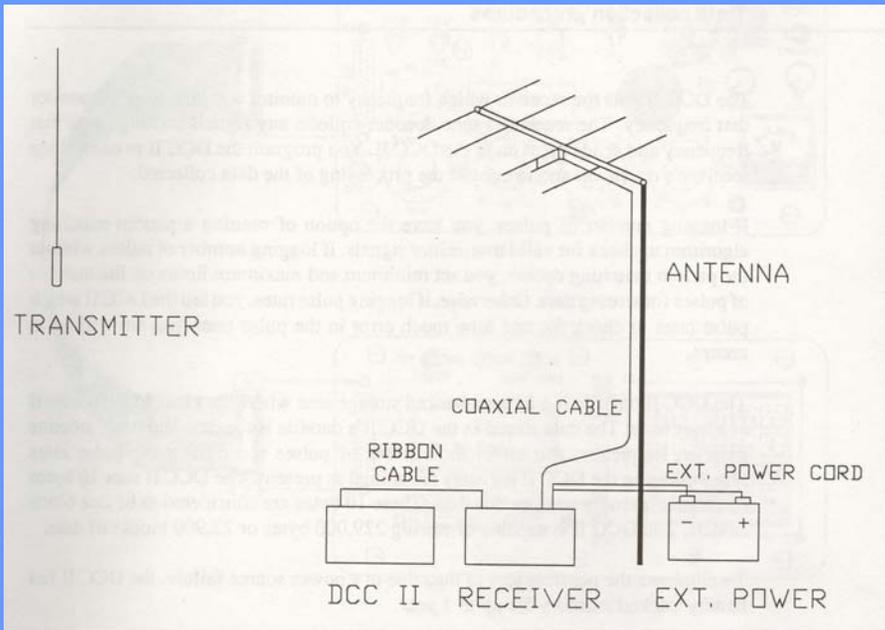
# Ultrasonic Telemetry

## Range of Reception

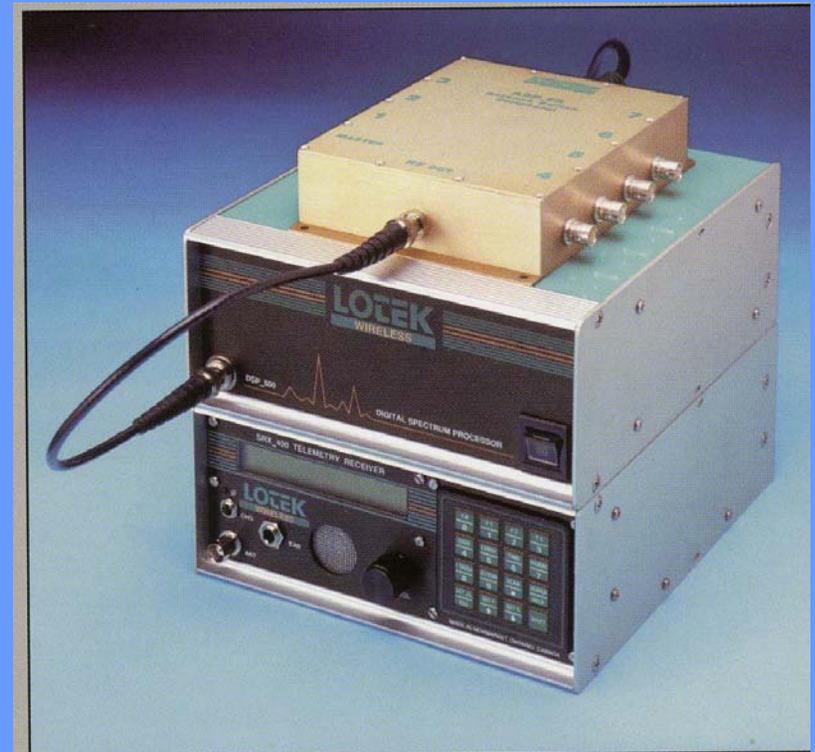
Detection distance in 'free' acoustic field of 500 m, hence, beacon can be detected as it passes across the diameter of a sphere with a diameter of 1000 m



# Radio Listening Stations



Automated monitoring system of Lotek, ca. cost \$7,000



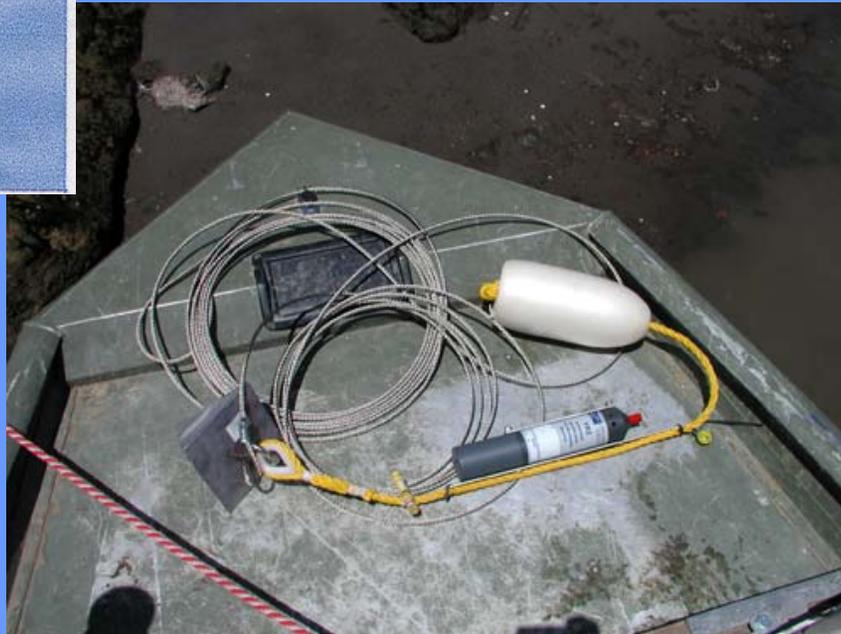
Automated monitoring system of Advanced Telemetry Systems (ATS), ca. cost \$7,000

# Ultrasonic Listening Stations



Vemco Ltd., V7 smolt tag (\$300 ea)

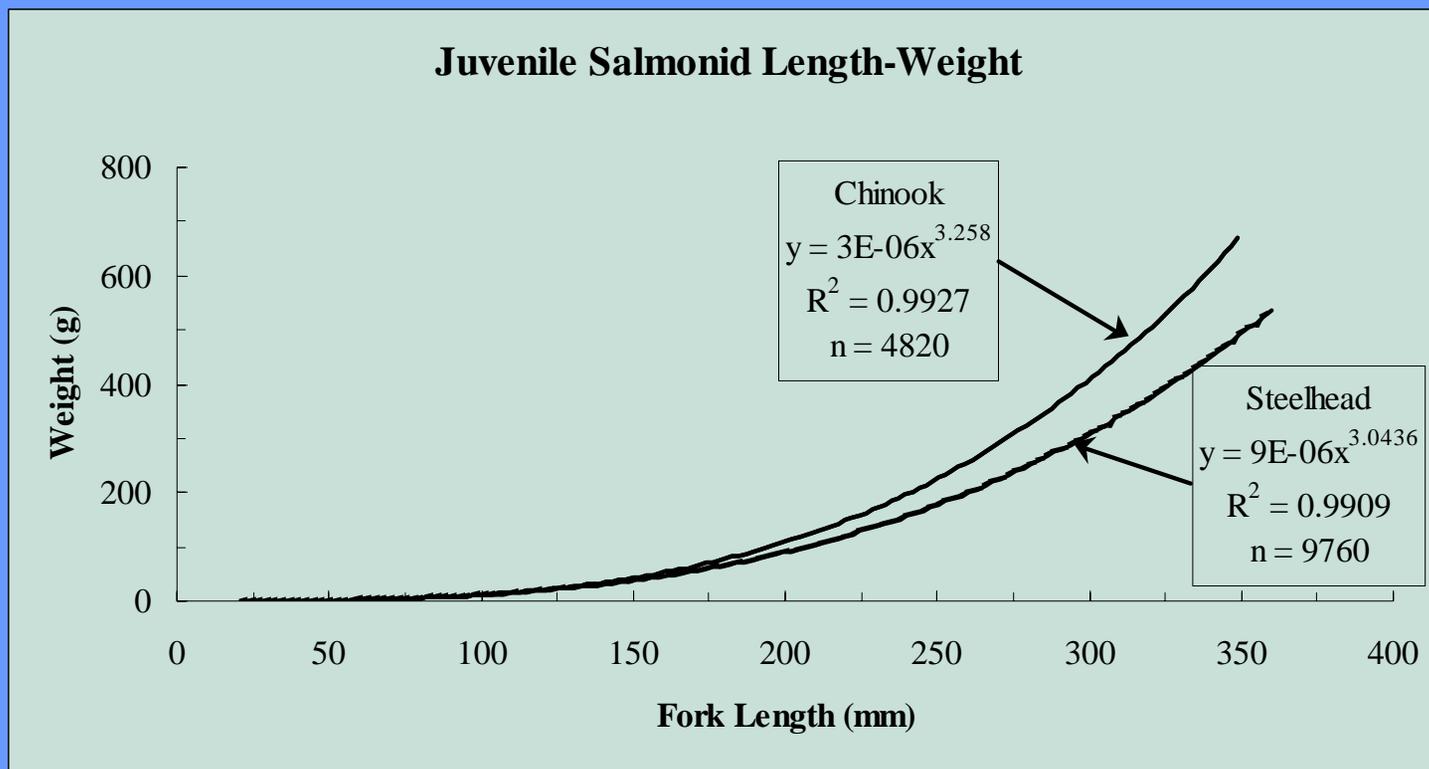
Mooring used in Sacramento River



V02 monitor (\$1,070 ea)



# Selection of Tag

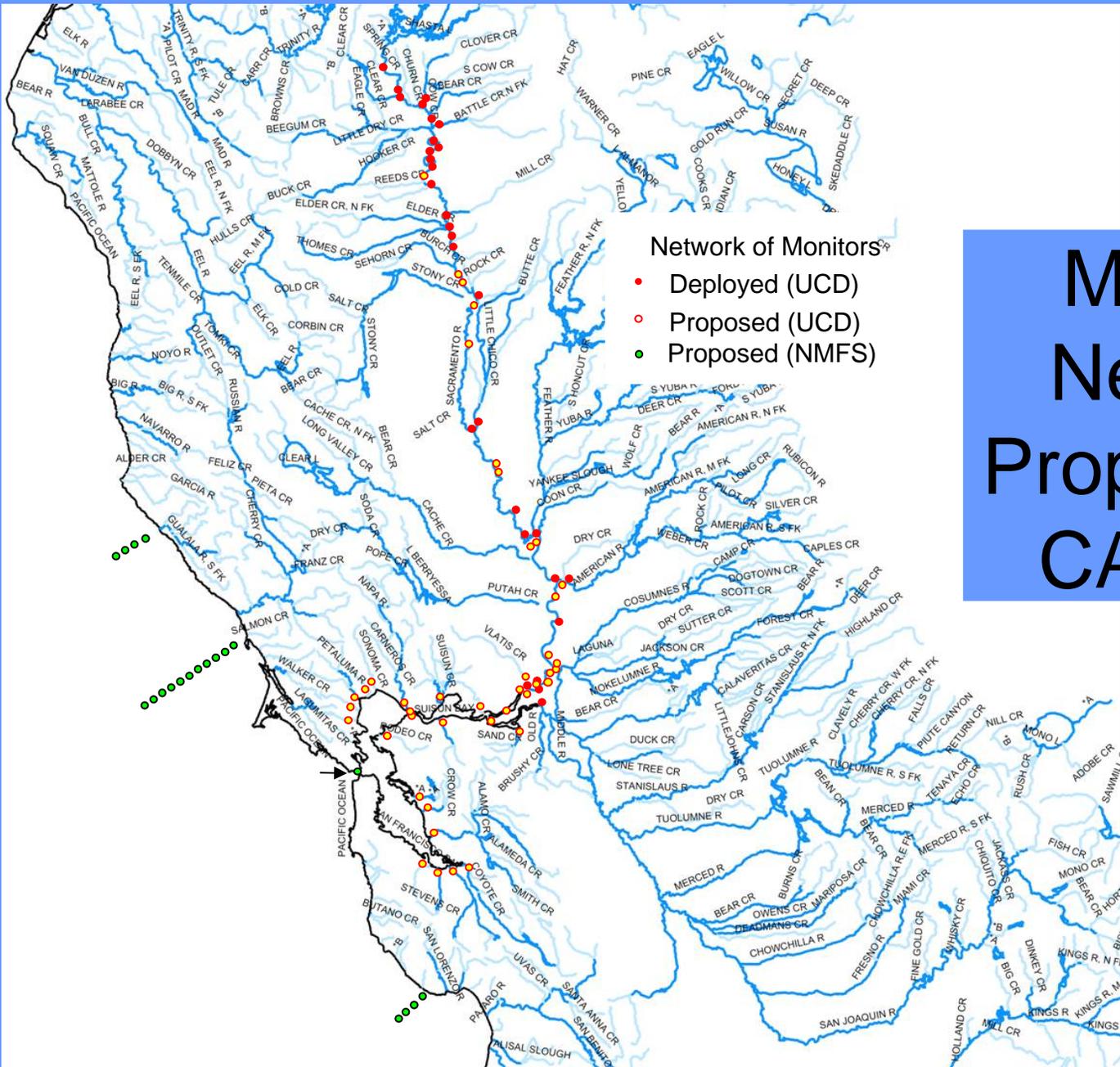


## Requirements

- Battery life of 60 days – duration of migration from the Coleman hatchery to Golden Gate
- <8% of mass of fish

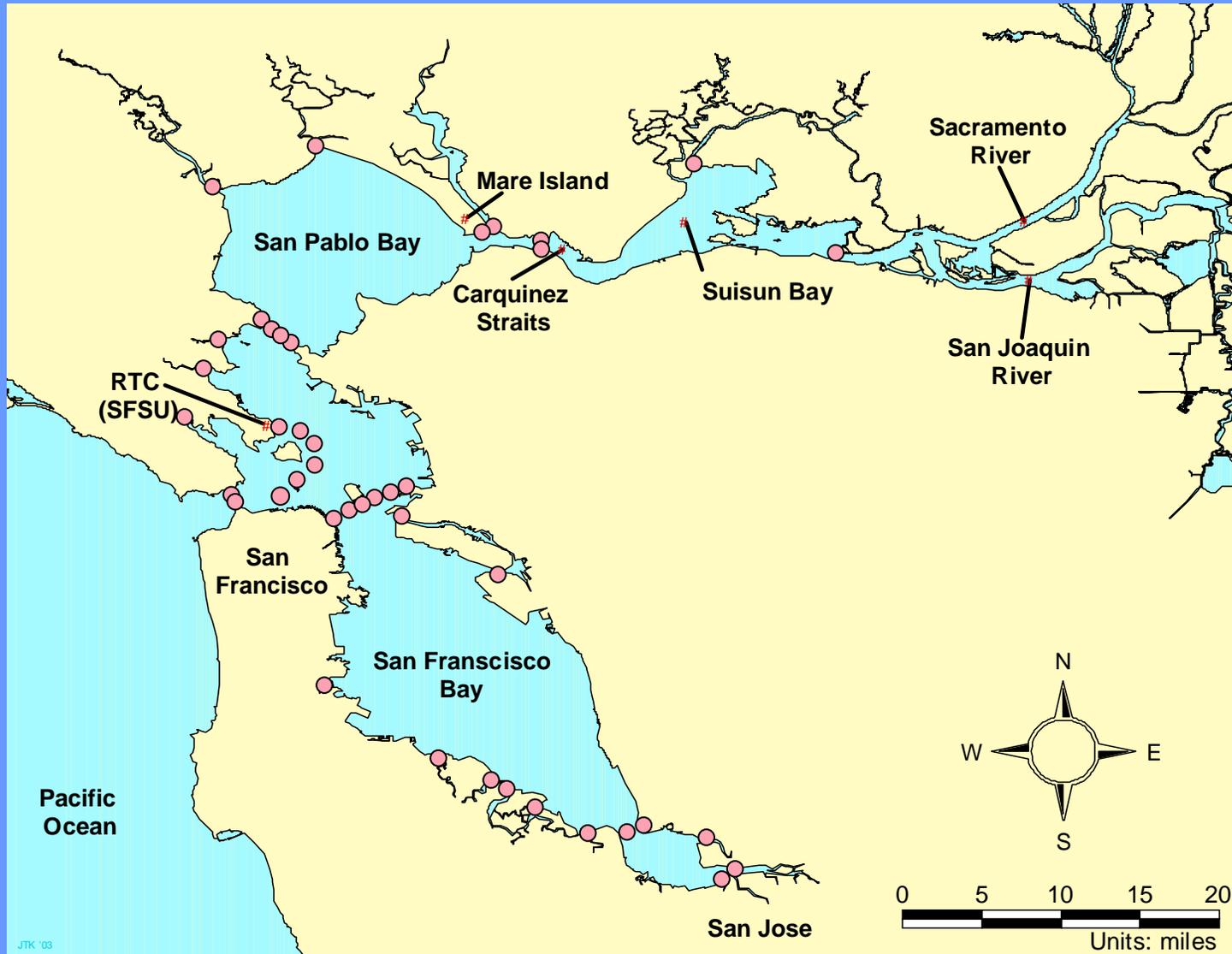
## Selection: V7-4L coded beacon

- Beacon with 1.9 g mass, 7 mm diameter, and 20.5 mm length
- 4.9% of 37 g, 150 mm FL Chinook
- 2.3% of 78 g, 78 mm FL steelhead



# Monitor Network Proposed to CALFED

# Monitor Network in S.F. Bay



# Contributions to Electronic Monitoring System

- **CALFED:** 200 beacons on Chinook and steelhead smolts during Yrs 1-3 and additional monitors in river and bay
- **NMFS:** Salary support for B. MacFarlane, S. Lindley, and A. Ammann and array of monitors across Golden Gate (although funds are yet available for maintenance)
- **Army Corps of Engineers:** 50 monitors and 30 tags, used to study the effect of dredging on salmonid smolts in bay, with monitors placed across San Rafael Bridge and around Angel Island
- **Oakland Port:** monitors, which will be deployed at port and across Bay Bridge
- Seeking funds from **Moore Foundation** to establish four offshore arrays, one off Monterey, Point Reyes, Bodega Bay, and Gualala, where surface currents are being monitored in real time by the LIDAR array

# Conclusion

- This is a real opportunity to unite academic scientists (UC Davis), agency scientists (CF&G, DWR, NMFS, U.S. Fish & Wildlife), and consulting scientists from private companies in a collaborative study to monitor the movements of salmonid smolts as they migrate out of the Sacramento River
- The objective – to determine the rates of movement and survival under annually varying environmental conditions – information essential to the management of the species in the watershed