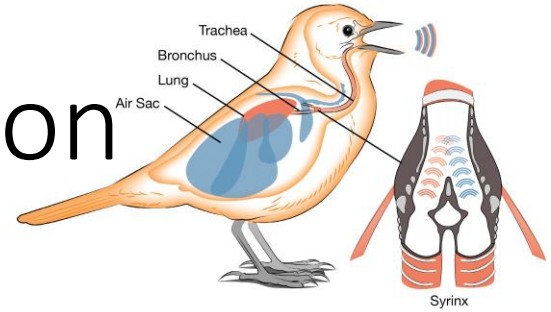
Electric and Acoustic Communication

Zoology 306L – Ethology Lab
TA: Nate Wehr

Acoustic Communication



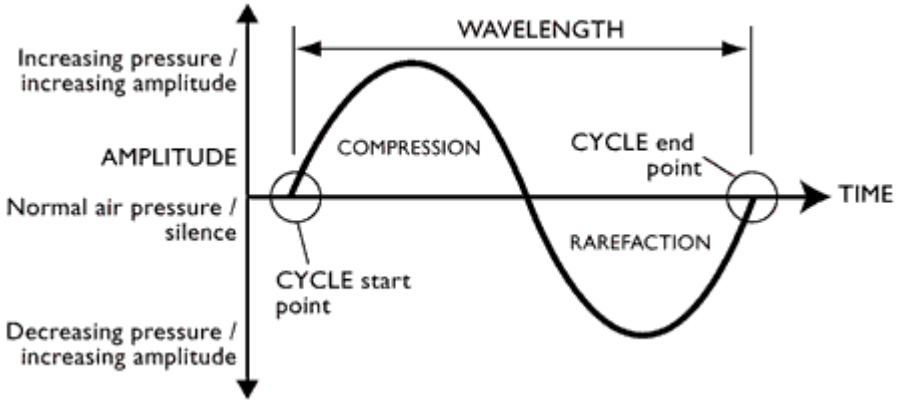
- Animals create sounds that convey meaning to a targeted receiving animal
- The goal of communication is to change the receiver's behavior to benefit the sender
- Examples of sound production mechanisms:
  - Larynx of terrestrial mammals, syrinx of birds, or phonic lips of whales
  - Stridulating of hard or bony parts or appendages
  - Rapidly shaking muscles or striking body parts
- Common reasons for sound production:
  - Courtship
  - Parent/offspring/mate recognition
  - Solicitation or begging calls from offspring
  - Territory defense/aggression
  - Warning to or of predators

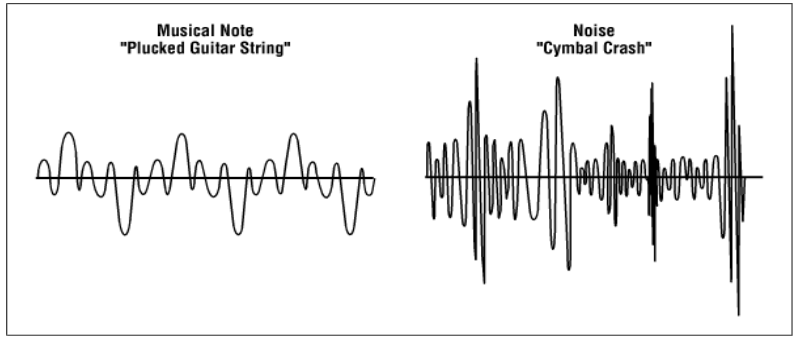
Understanding Sound

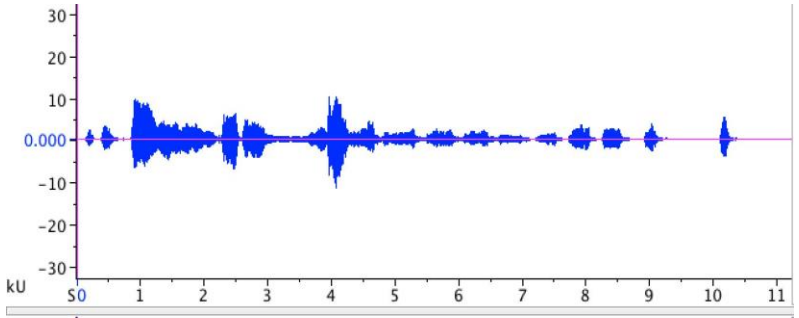
- What makes a sound?
  - The movement of a wave through a medium including gasses, liquids, and solids
- How is sound recorded?
  - Sound waves affect the internal mechanisms of a microphone, causing changes in electric potential across metal plates
  - Software writes the changes in electric potential as data points for storage
- What are common measurements of sound?
  - Pitch, loudness, duration, repetition
- What are common units of those measurements?
  - Pitch is measured in Hertz (Hz = cycles/sec); loudness is measured in decibels (dB); duration in milliseconds; frequency = 1/wavelength

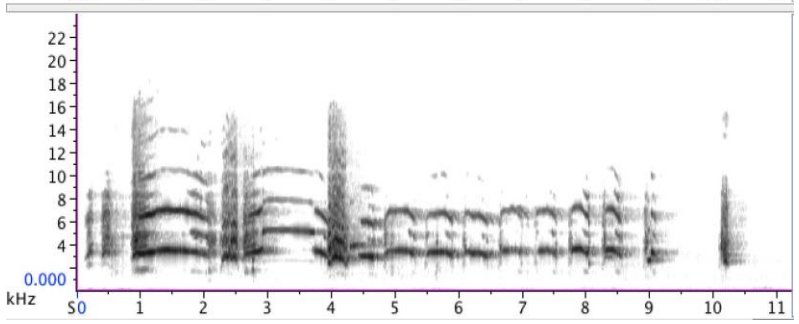
Visualizing Sound Using “Audacity”

- Waveforms
  - Amplitude (loudness) over time
    - Shows the strength of a call as it happens
  - Closer the peaks and troughs indicate higher pitch
- Sonograms
  - Frequency (pitch) over time
    - Shows different pitches and harmonics in the calls
  - Brighter spots indicate louder pitches
- Fourier Transformation
  - Amplitude over frequency
    - Shows pitches’ correspondence with power









What Can We Measure with “Audacity”?

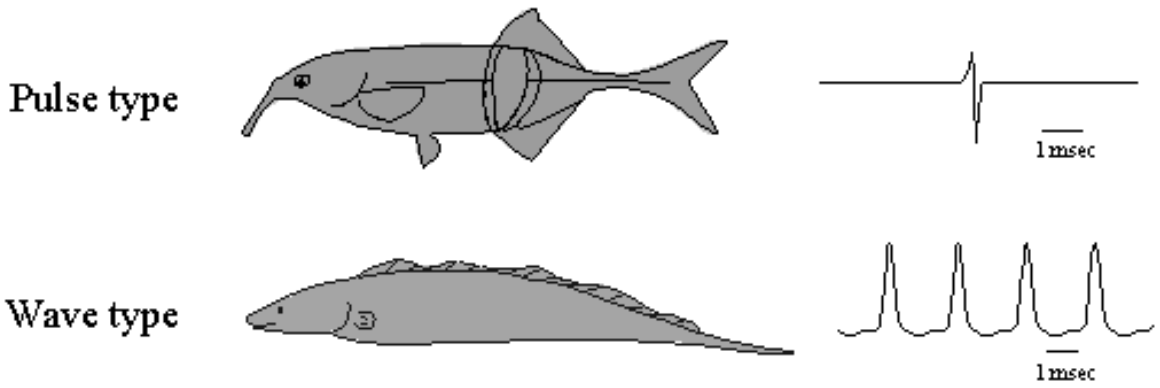
- Examples:
  - Duration
  - Max Frequency
  - Peak frequency
  - Harmonics
  - Pulse rate
  - Inter-pulse interval
  - Pulse amplitude

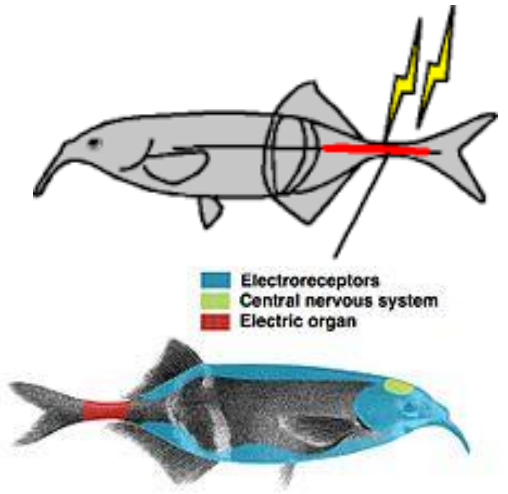
Electric Sensing

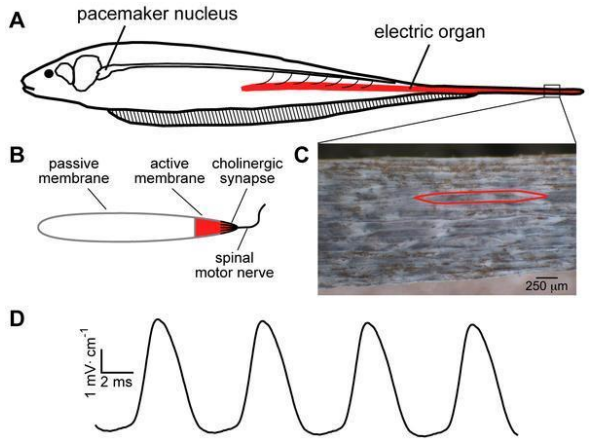
- Many different predators can use electric organs to sense prey
- A few animals can even generate electric shocks for predator evasion or capturing prey
- Weakly electric fishes can sense electric fields AND generate small electric fields of their own, but these are not strong enough to harm others
- These signals are used for communication and electrolocation (like echolocation, but using electrical signals)

Weakly Electric Fish

- Mormyrid and Gymnotiform fishes
- Two different lineages (not closely related)
- Electric organ near tail generates a dipole around the bodies, which fish can detect with electroreceptors around the head and body
- Gymnotiform fishes generate continuous sin waves
- Mormyrid fishes generate variable pulse trains

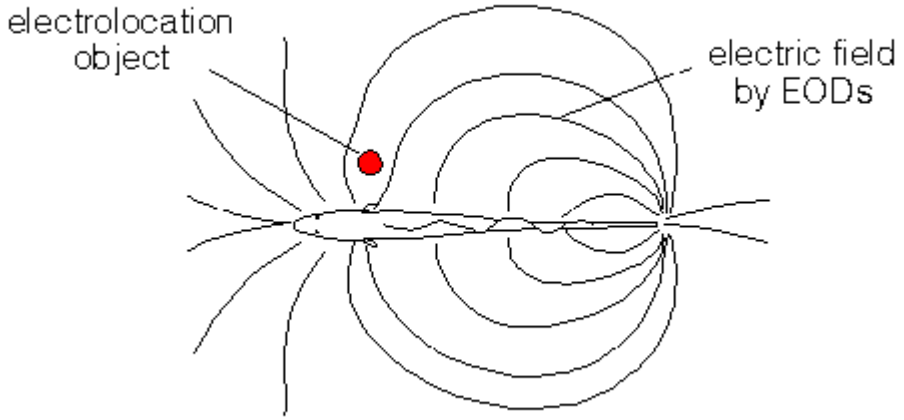


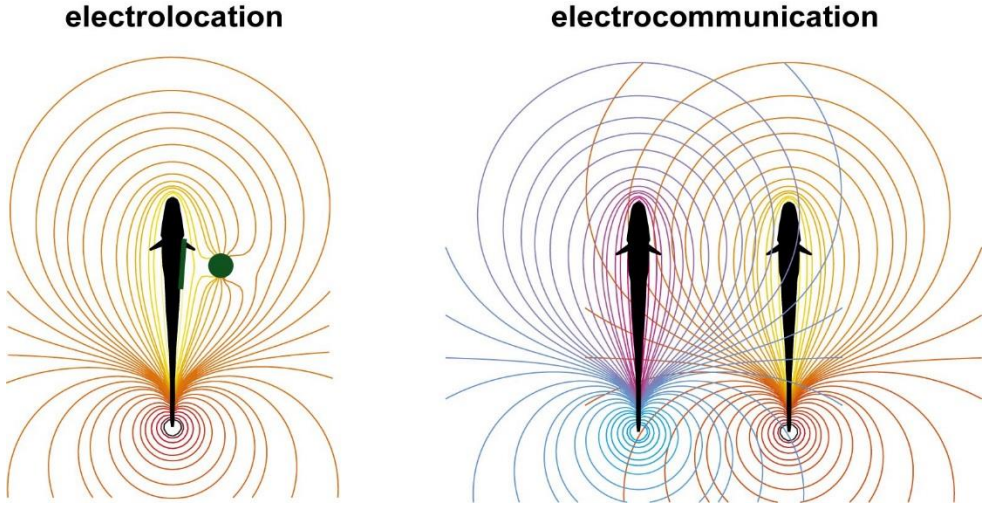


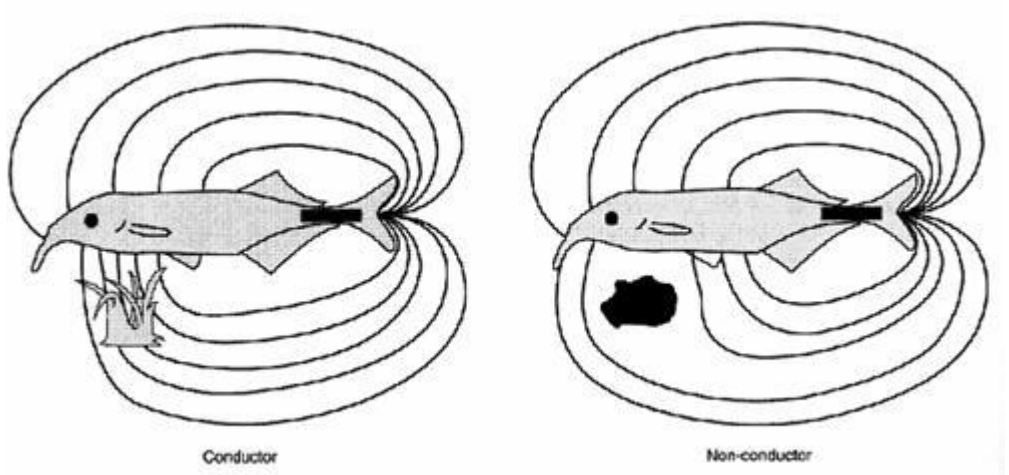


How Electric Fish “Feel” the World

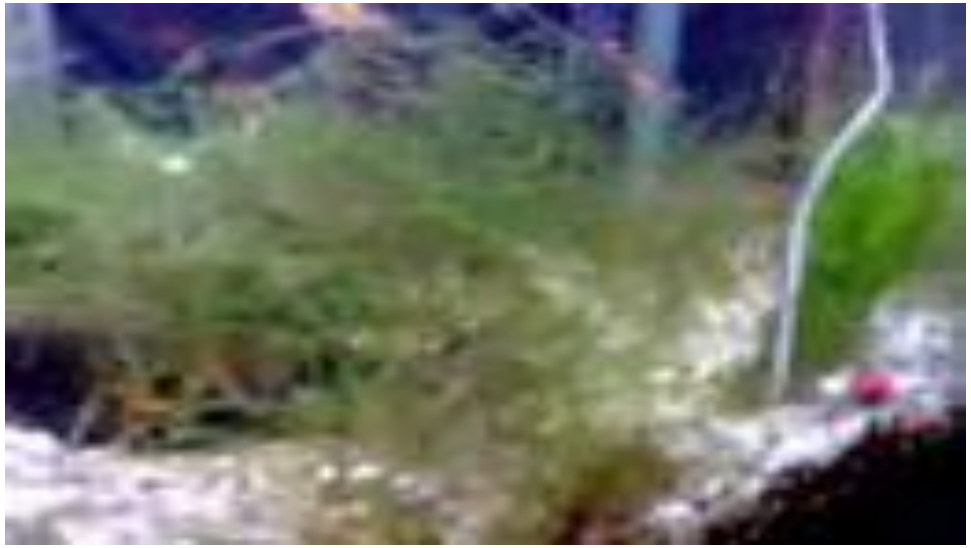
- The electric field is always uniform when fish is in empty water
- Changes to the area around fish disrupt the electric field, such as:
  - Objects in the electric field
  - Other electric fish

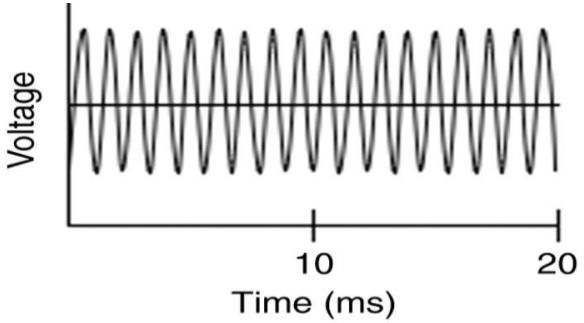


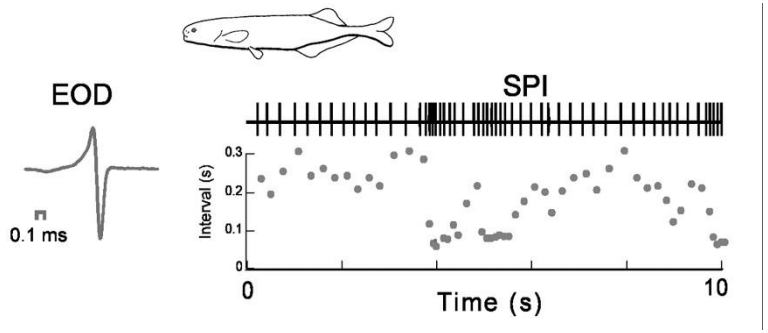




Videos of Electric Fish







Remember: the fish aren't producing sound; they're producing electric pulses, which are fed into a speaker

Today’s Activities

- First, we don’t have electric fish; we’ll be using the videos and waveforms provided in this presentation to study them
- Second, we’ll record crickets in the lab
- Third, we’ll go outside and record birds
- Fourth, we’ll come inside and load the recordings to your computers
- Finally, we’ll use “Audacity” to examine the recordings

Assignments

- Lab report: a 2-3 page report on how a sensory system (of your choice) works for a given animal lineage or species, how this system is used, and its adaptive value to the animal you chose; you must cite at least 3 scholarly sources

- In two weeks (4/20), you'll have an auditory quiz
  - Questions will ask you to identify animals based on audio playbacks, waveforms, and spectrograms; you may also be asked to draw rough sketches of spectrograms
  - The sound files and information you need to study can be found at:
    - < http://www.hawaii.edu/behavior/306/LabAcoustics/index.html >