

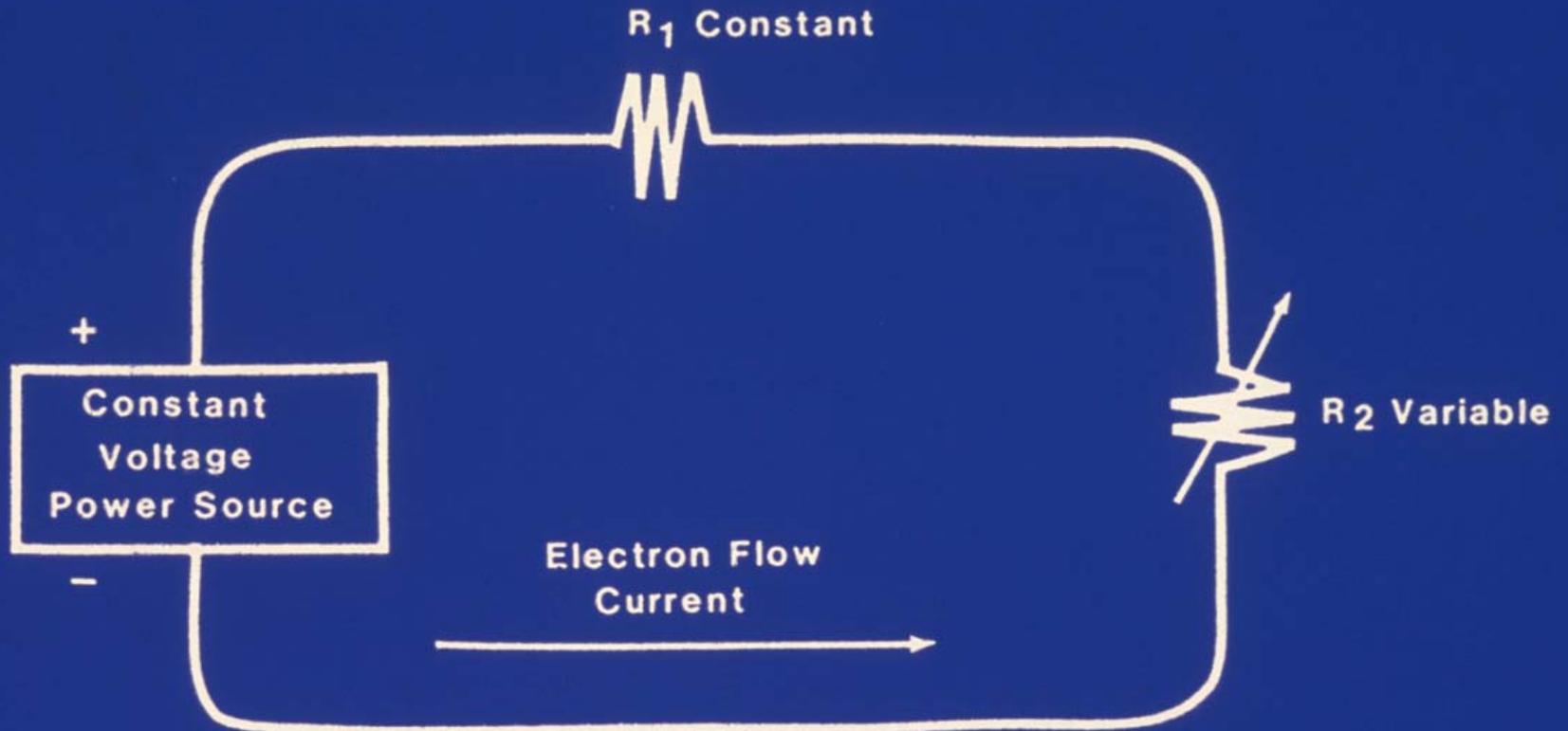
# A Power Threshold Method for Estimating Fish Conductivity

Kolz, A.L. & J.B. Reynolds. 1989. Determination of Power Threshold Response Curves. Pages 15 – 24, *In Electrofishing, A Power Related Phenomenon*. U.S. Department of the Interior, Fish & Wildlife Service, Fish & Wildlife Technical Report 22.

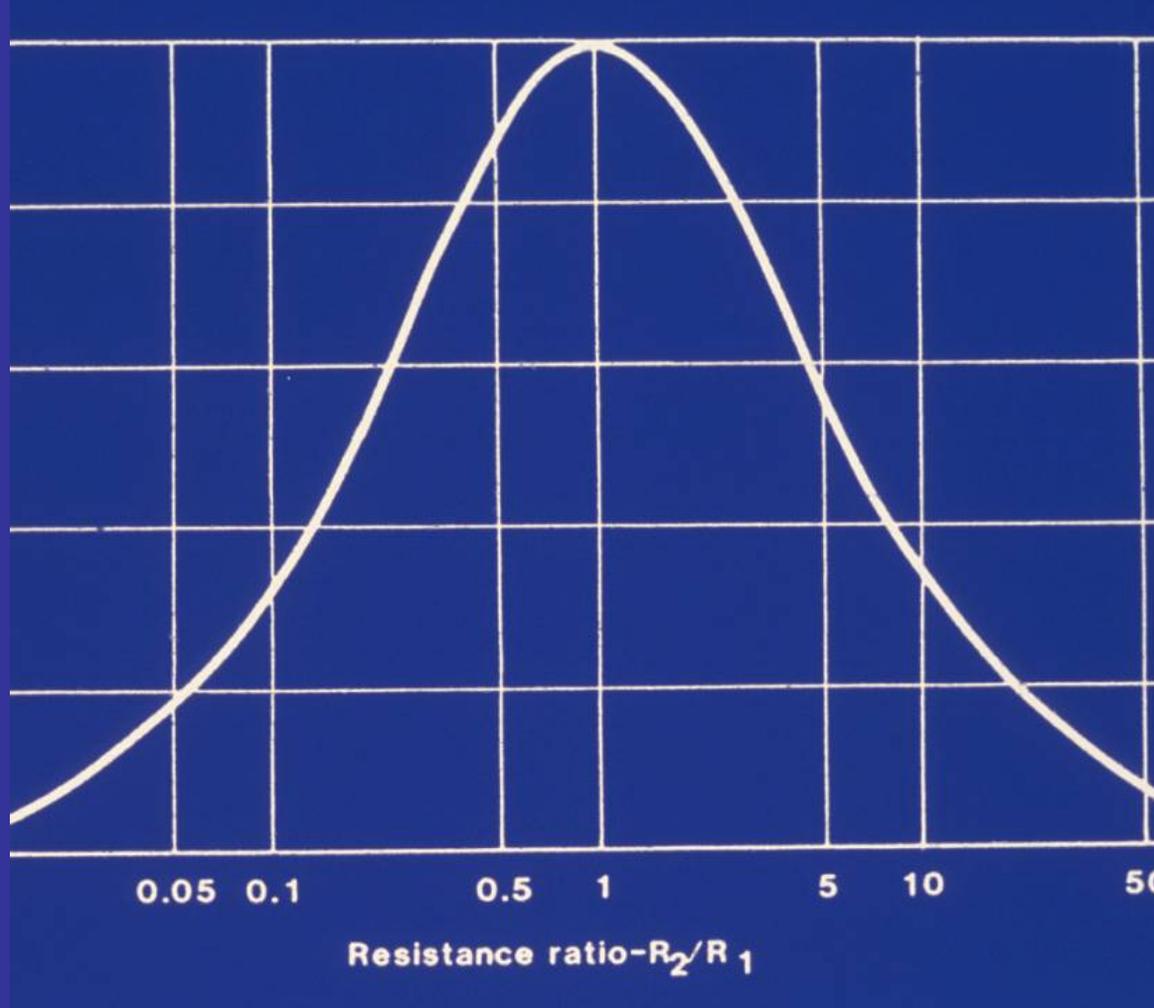
Tab 5

# Purpose of Experiment

- Demonstrate power threshold method
- Estimate “effective” conductivity of goldfish
- Compare results with other reported values

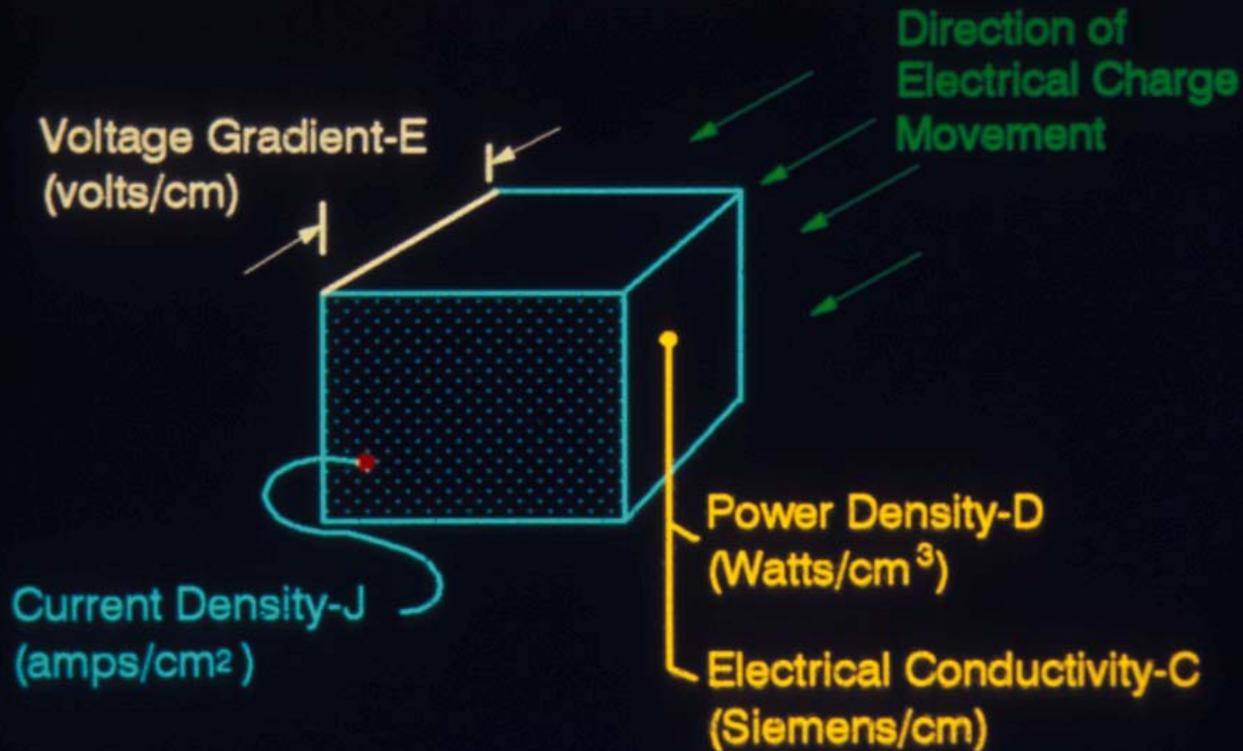


- Conceptual experimental electrical set-up
- Two resistors (loads) in a circuit wherein one resistor is constant and the other varies



- Power transfer curve; when the resistances (or conductances) of two loads in a circuit are the same, maximum power is transferred from one load to the other

# Depiction of Electrical Terms in Water



- “Power density cube”
- Represents a cube of water in an electric field
- Terms apply to 2<sup>nd</sup> form of Ohm’s Law

**Medium 1 (water)**



**Incident power**



**Diverted power**



**Medium 2 (fish)**



**Transferred power**

**Note that:**

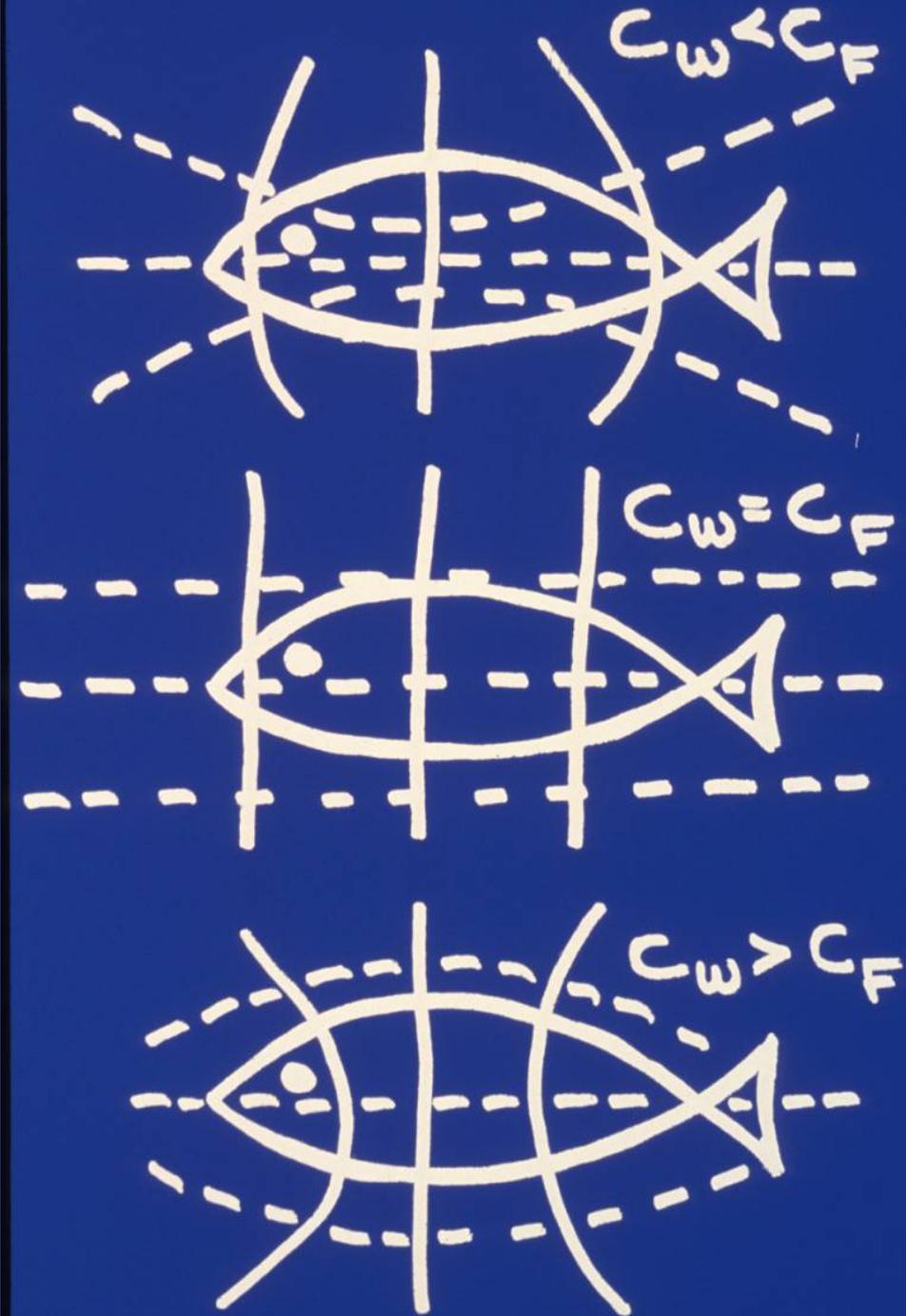
**Incident Power = Diverted Power + Transferred Power**

- Distortion of electric fields by fish

- Three conditions:
  - water conductivity less than fish (low  $C_w$ )
  - water and fish conductivities equal (med  $C_w$ )
  - water conductivity greater than fish (high  $C_w$ )

- $C_w$  = water conductivity
- $C_F$  = fish conductivity

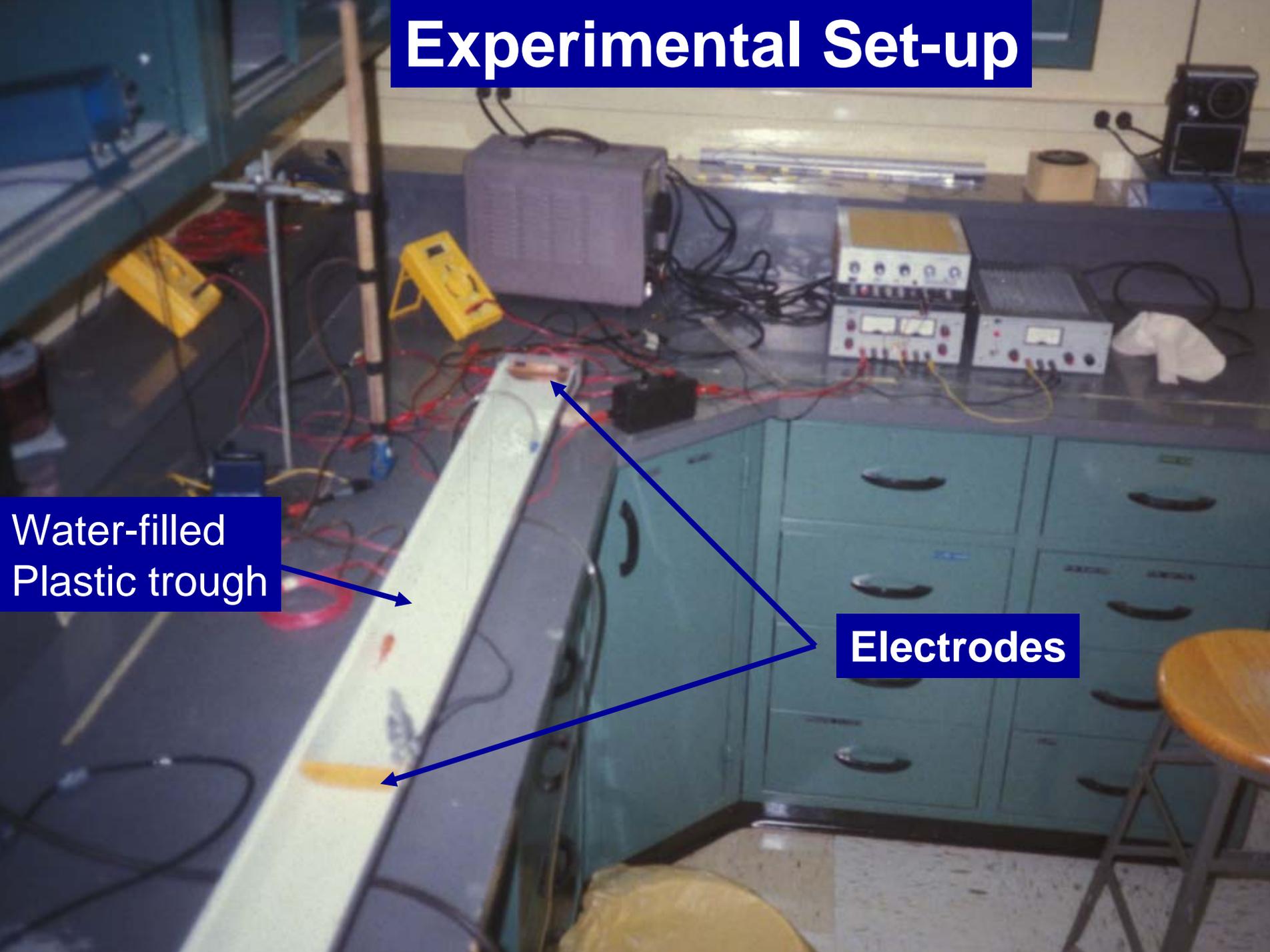
— = voltage surfaces  
- - - = current pathways

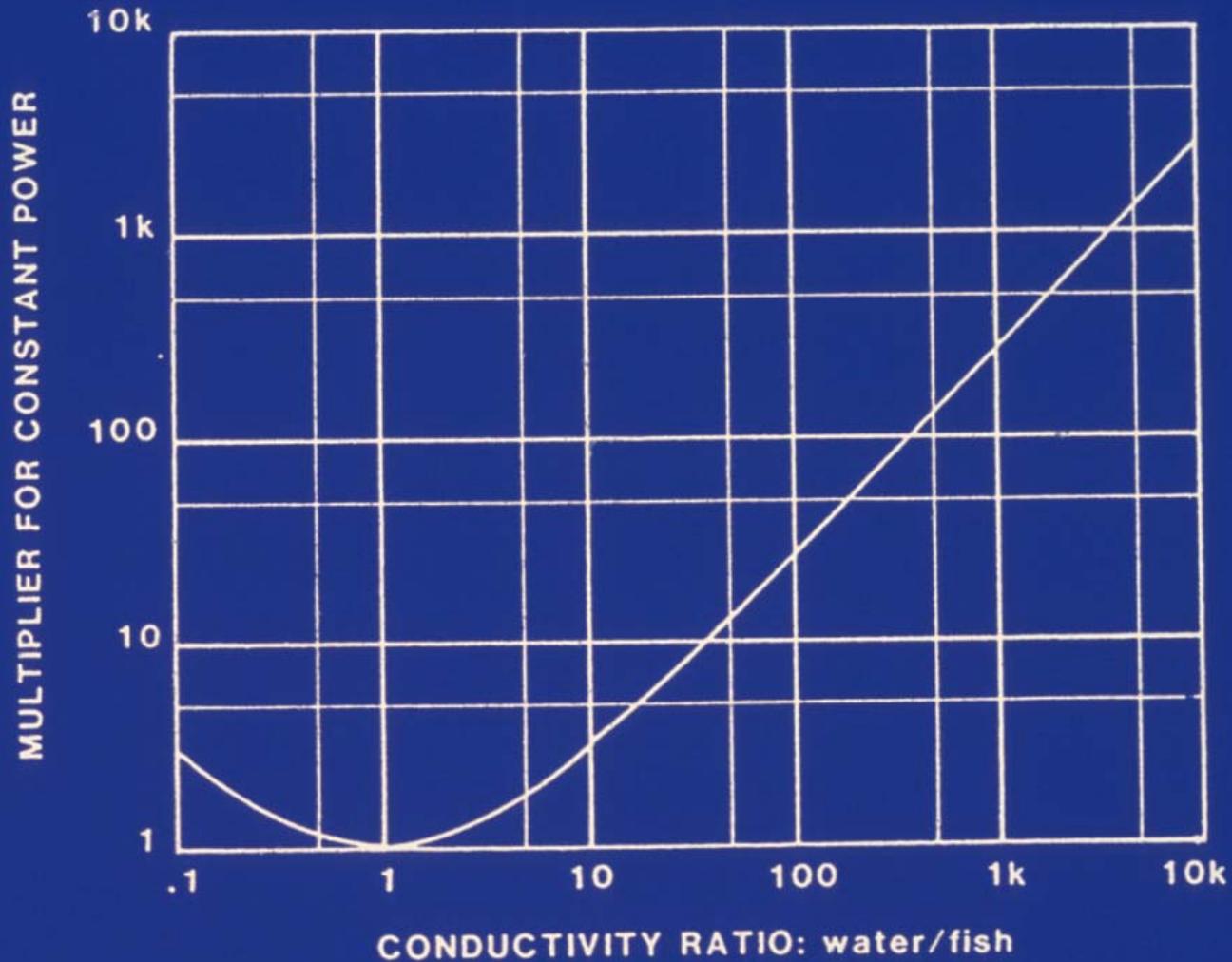


# Experimental Set-up

Water-filled  
Plastic trough

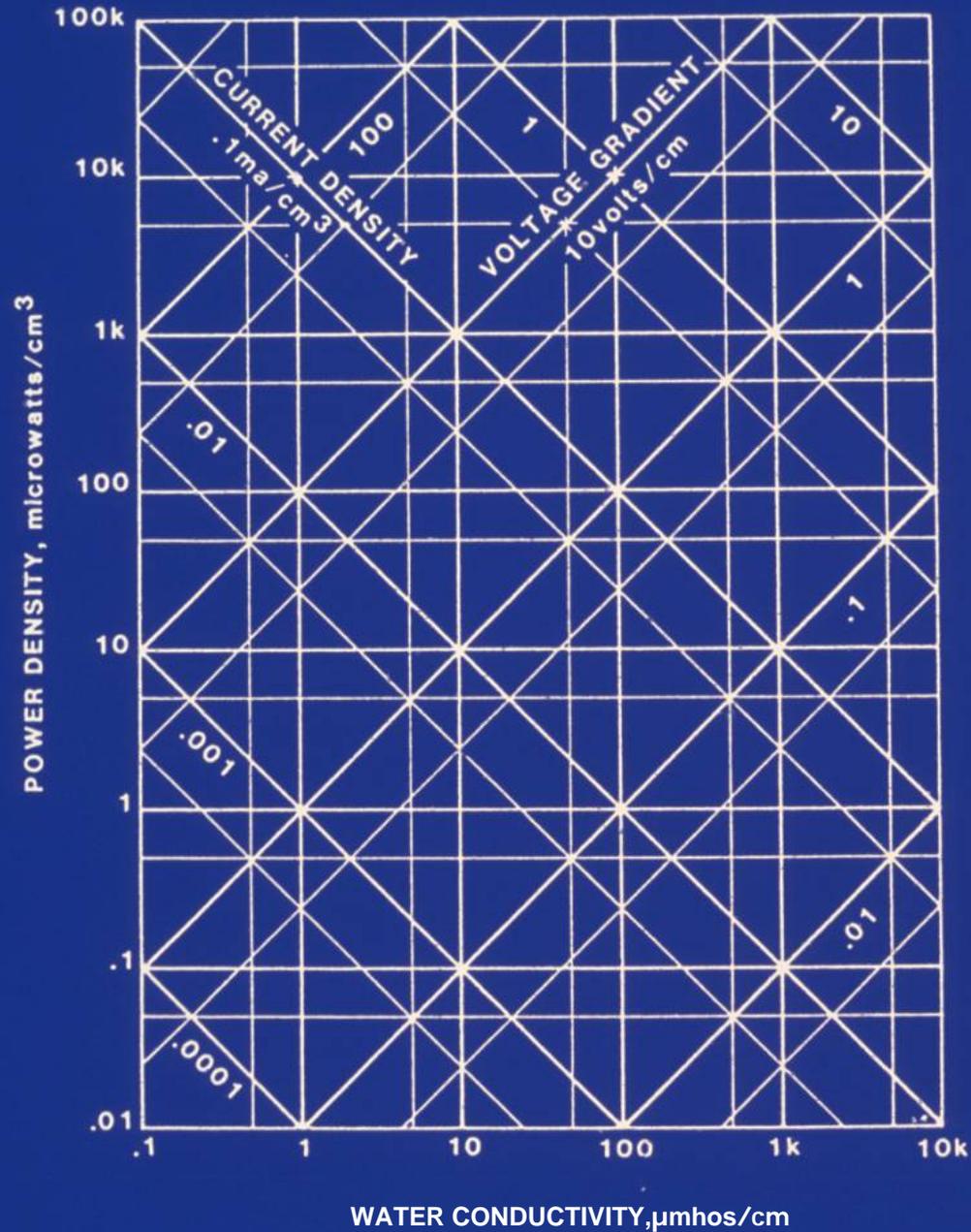
Electrodes



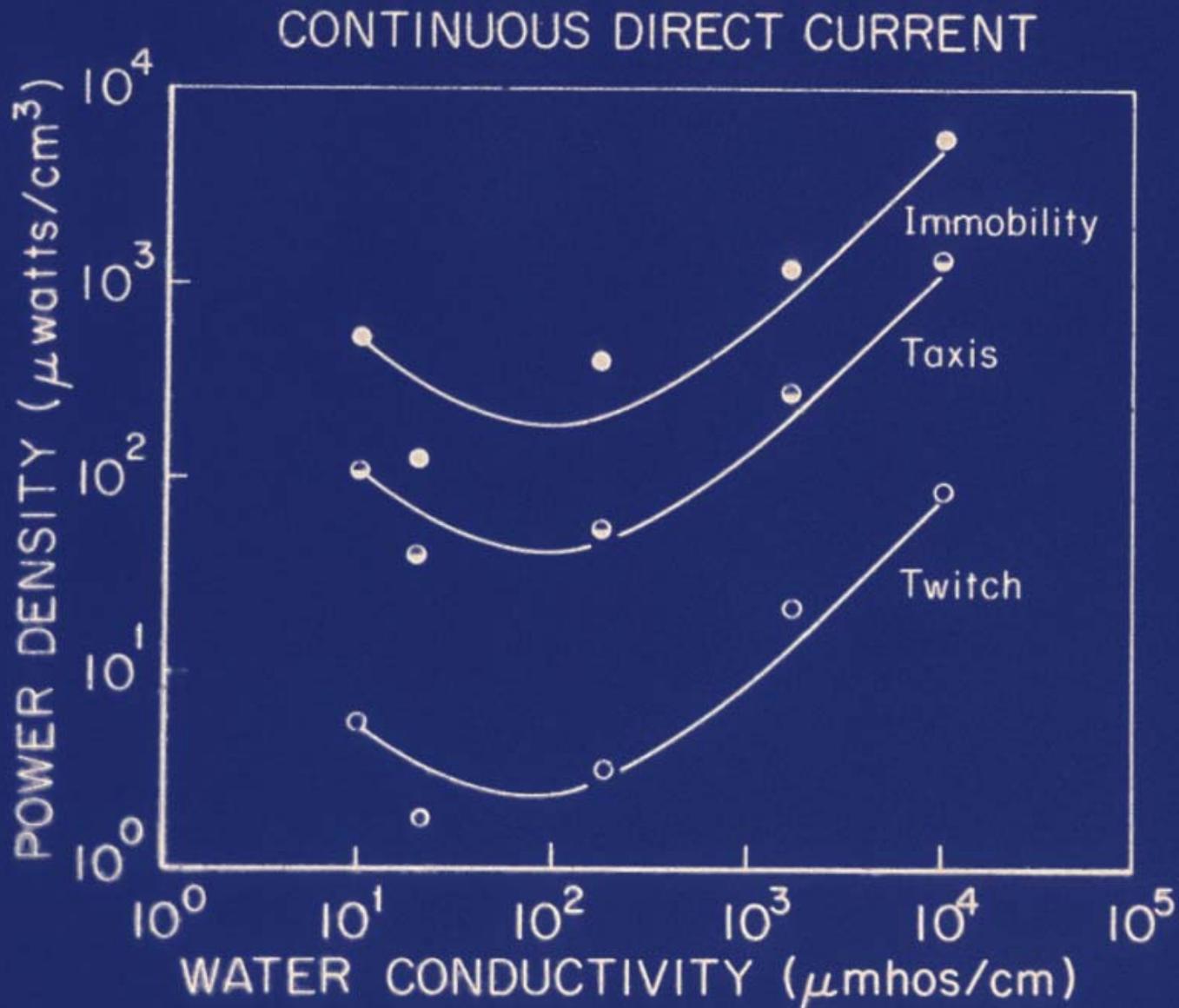


- Curve for predicting the increase in power necessary to maintain a constant transfer of power

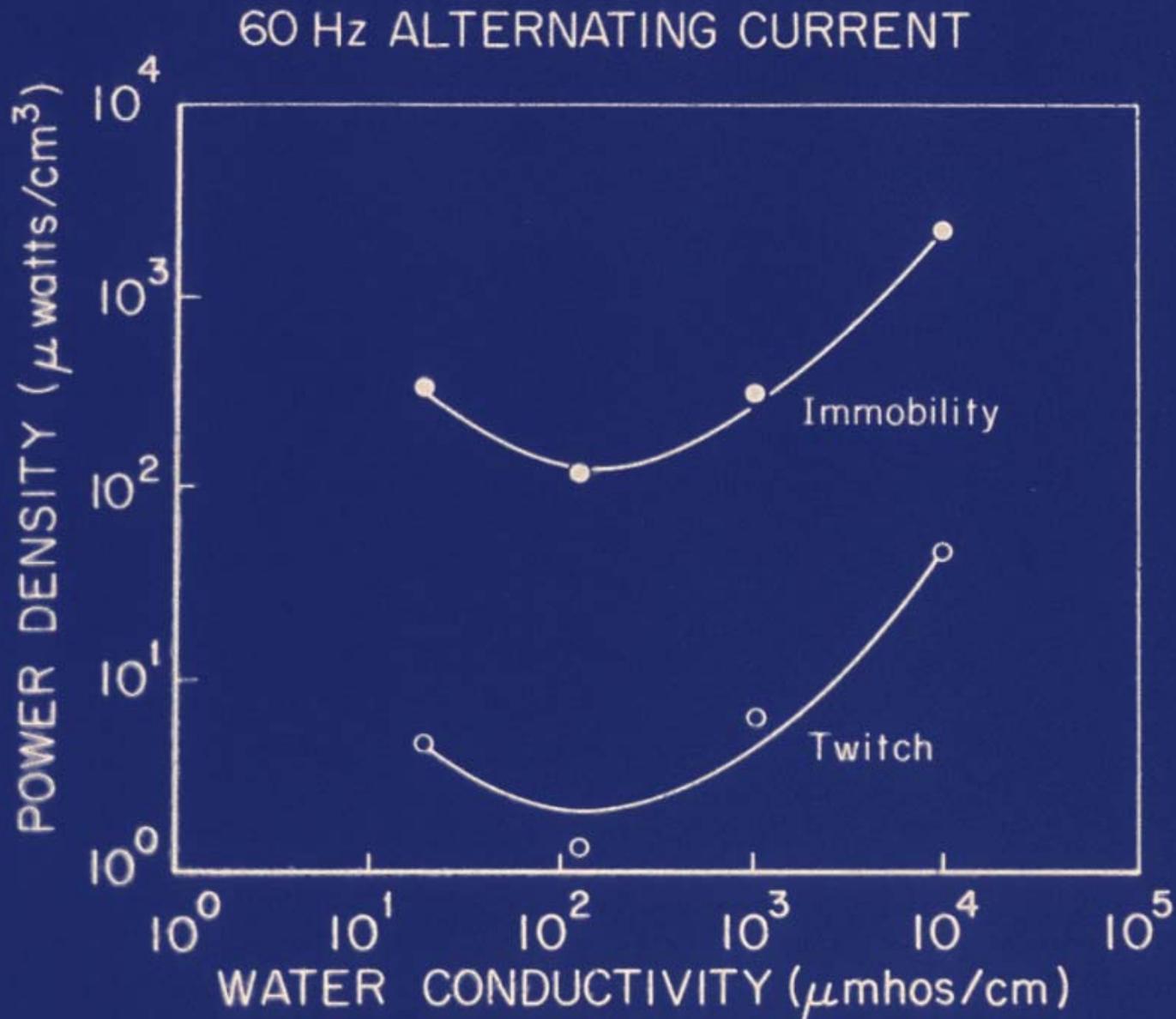
- Power density chart
- Used as template to chart fish response data



# Electroshock response of goldfish to a DC waveform



# Electroshock response of goldfish to an AC waveform



# Results Table

Waveform	Response	Power density @ matched	Fish conductivity
DC	Twitch	2.4	69
DC	Taxis	41	82
DC	Stun	179	83
PDC, 50 pps, 2 ms, (10%)	Stun	103  *Note: using a pulse width of 5 ms (25%), D@ matched = 100	145
AC	Twitch	2.1	119
AC	Stun	126	156

# Other Studies

Species	Fish Conductivity Range ( $\mu\text{mhos/cm}$ )	Reference
Carp	787 – 1,085	Whitney & Pierce (1957)
Sockeye Salmon	505 – 1,256	Monan & Engstrom (1963)
Various	280 – 3,130	Sternin et al. (1972)

# Conclusions

- Fish response related to power density magnitude
- Power density curves conform to power density theory
- Power thresholds varied among waveforms
- Fish conductivity estimates much lower than values in literature (therefore, “effective fish conductivity”)