

OHRC Advisory Committee

“Magnetic Navigation”

11 March 2013

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Geomagnetic Report
11 March 2013

Professor & Senior Scientist
OSU - OHRC

Salmon Geomagnetic Orientation

- The “BIG IDEA” (ocean migration)
 - HOW do salmon DO it?
 - Orientation, homing, migration, navigation
 - Homing: straying
- Why is it important to Oregonians?
 - Salmon management, conservation, harvest
 - Hatchery: Wild considerations; Homing & straying
 - Coastal energy development



Adult homing migration

Home river to Pacific Ocean back to home river

We know that they do it

HOW? MECHANISMS?

Freshwater Orientation

General acceptance of “olfactory” recognition

- A) Hasler – olfactory imprinting
 - B) Nordeng – kin recognition
 - C) Dittman et al. – incubation imprinting
-
- But olfaction can NOT explain large scale ocean migration



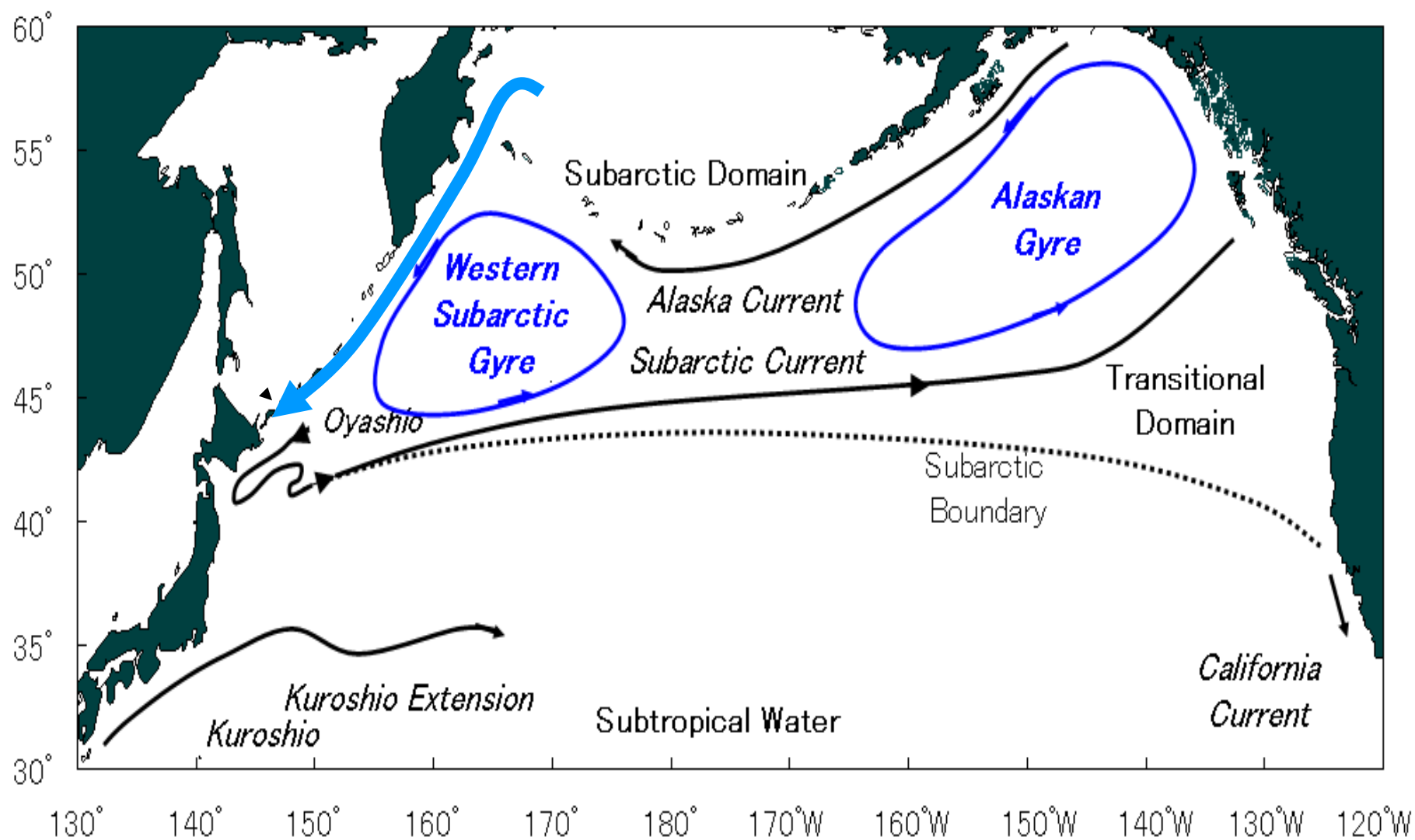
Art Hasler

**Olfactory imprinting hypothesis for salmon homing –
smolts (stream odours)**



Hans Nordeng

**An alternative hypothesis for salmonid homing – kin
recognition – chemical cues**



Ocean Migration

LOTS of suggestions over many years:

- oceanic currents (passive drift)

- time-compensated sun compass

- polarized light

- celestial (stars)

- “magnetism”

COMPASS vs MAP **AND** Compass



North Pacific Ocean

Where are you?

Where are you going?

How do you plan to get there?

Ocean Migration

oceanic currents (passive drift) - imprecise
time-compensated sun compass – fog,
clouds, water depth, etc.

polarized light – water depth, etc.

celestial (stars) – fog, clouds, water depth,
etc.

“magnetism” – some evidence, but limited,
compass function

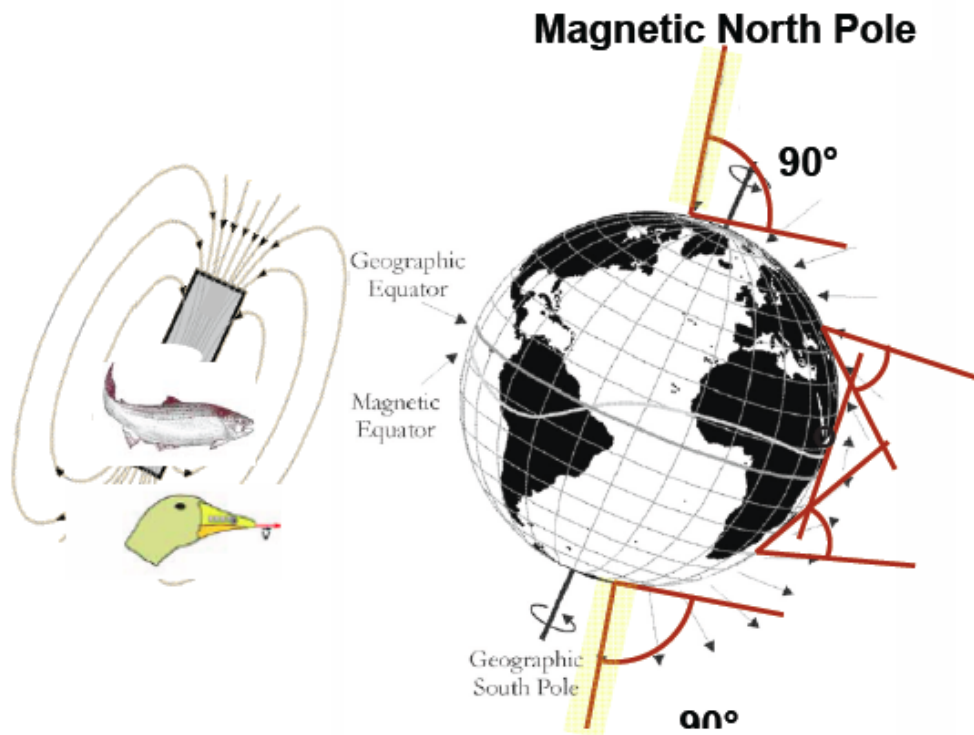
COMPASS vs MAP AND Compass

Putman et al. 2013

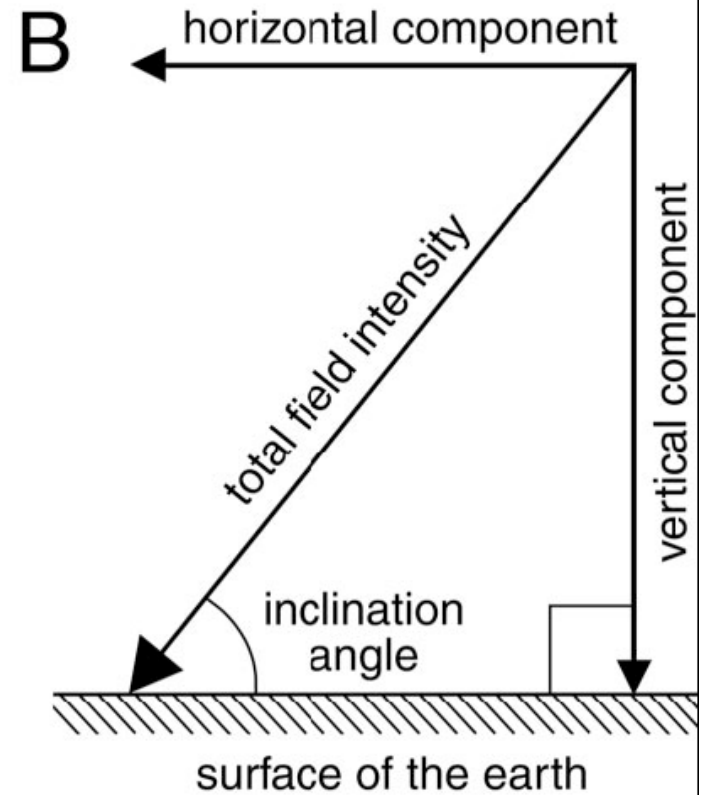
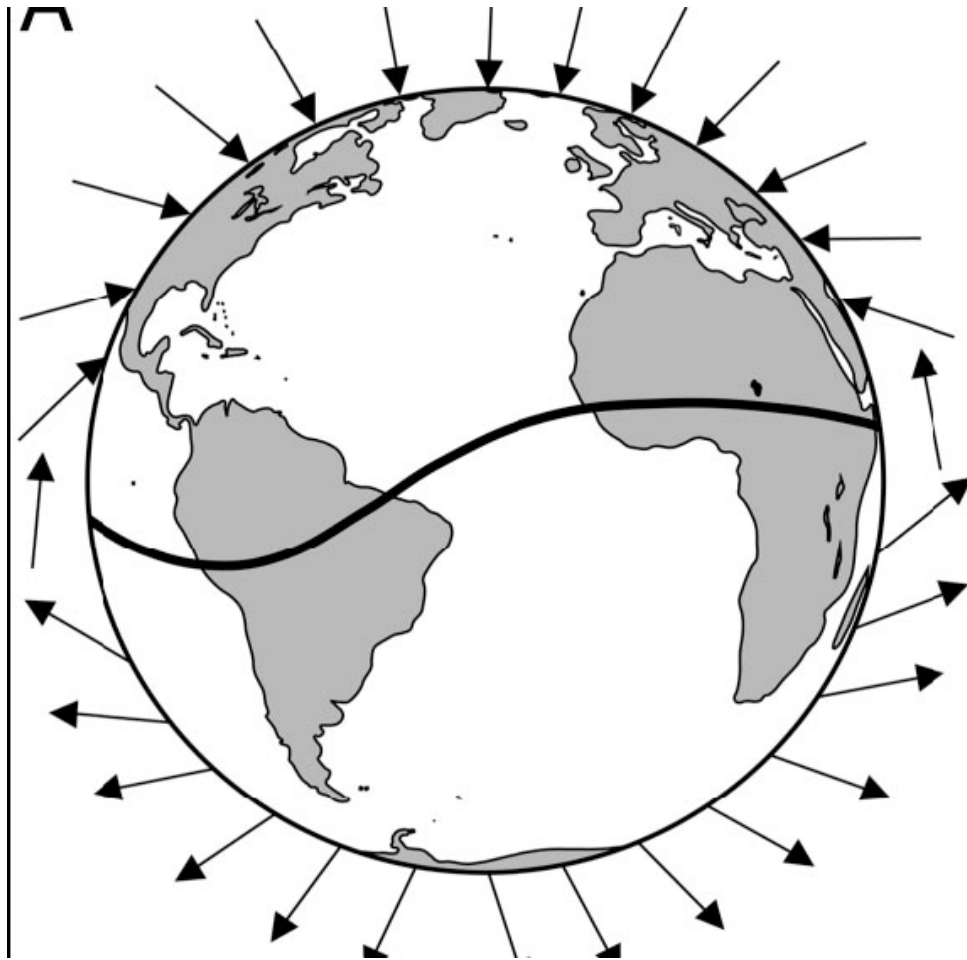
- Hypothesis
- Prediction
- Test – Fraser River sockeye salmon diversion rate (50 years data)
- Results – confirm prediction
- Map **AND** compass
- (paper is in DropBox folder for Advisory Committee)

Orientation: Do Salmon have an app for that?

Magnetic Fields

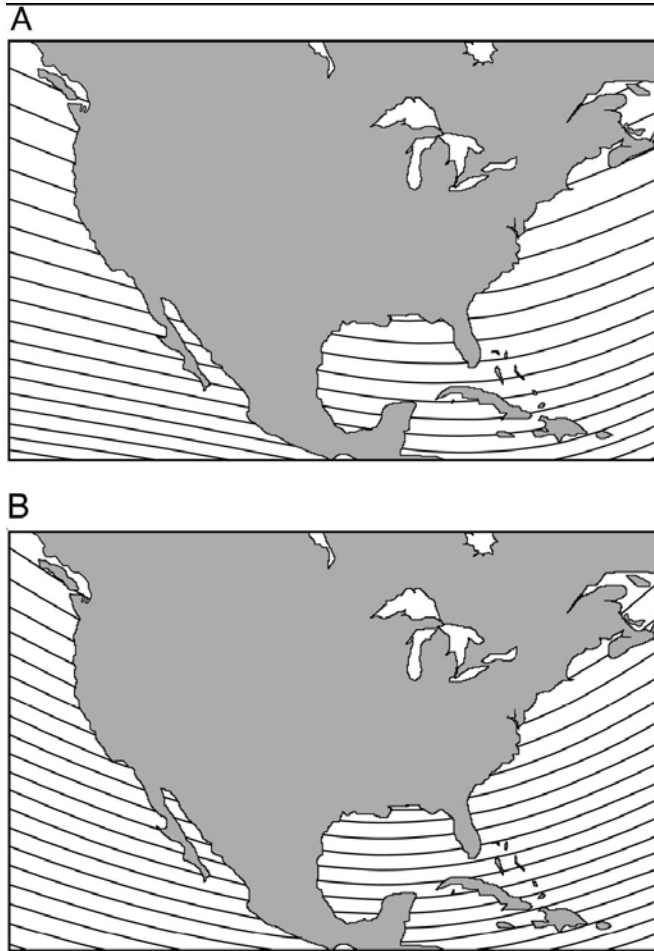


Geomagnetic Field

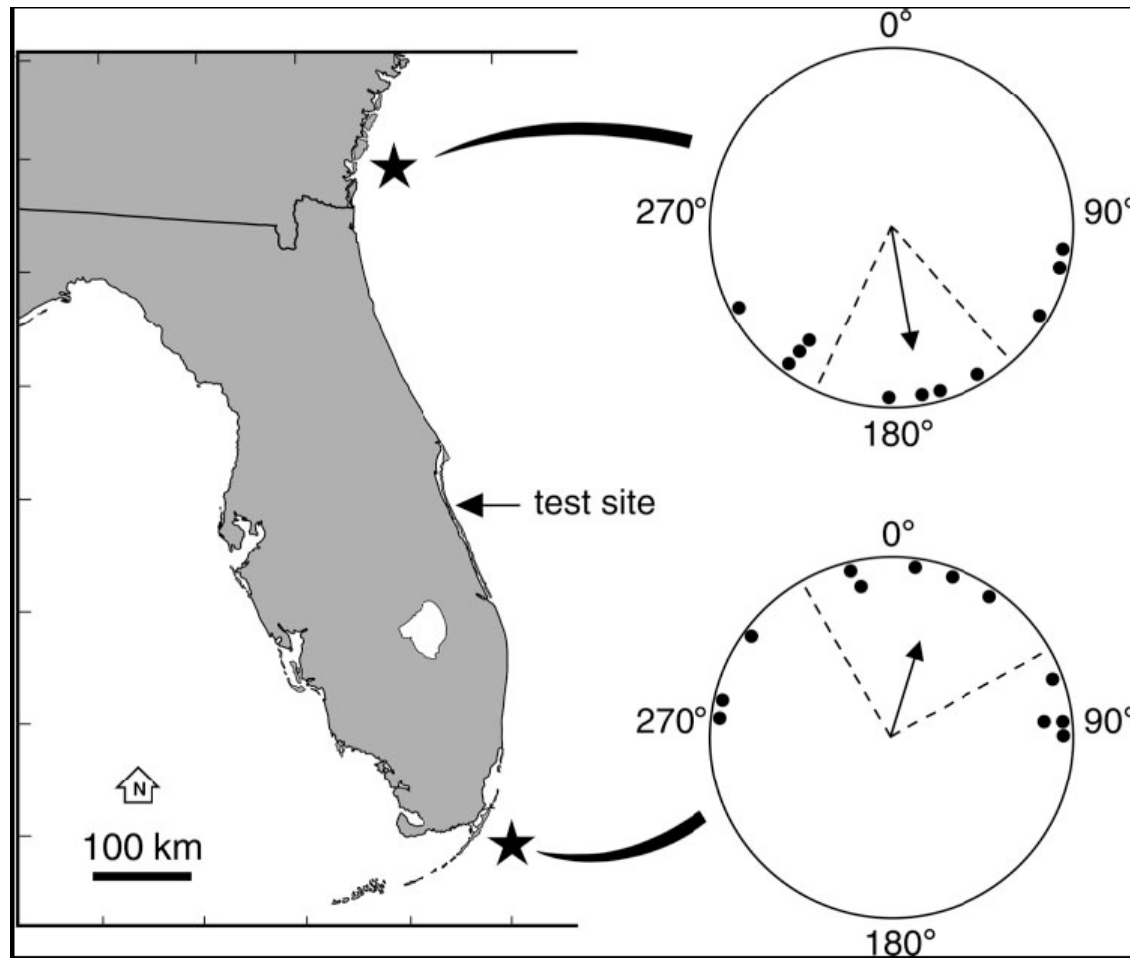


Geomagnetic

- inclination and intensity



Juvenile sea turtles magnetic displacement



Putman et al. - OHRC

- **Hypothesis**
- Magnetic sensitivity develops early (embryos); juveniles imprint on magnetic coordinates at ocean entry; returning adults use geomagnetic map and compass to return to area of ocean entry (then rely on olfactory cues)
- **Predictions**
 - Test embryos, juveniles and adults



Research Team

David Noakes, Ken Lohmann, Tom Quinn, Andy Dittman, Jennifer Nielsen, Carl Schreck, Michael Banks (Pete Klimley, Nathan Putman, Sam Chan)

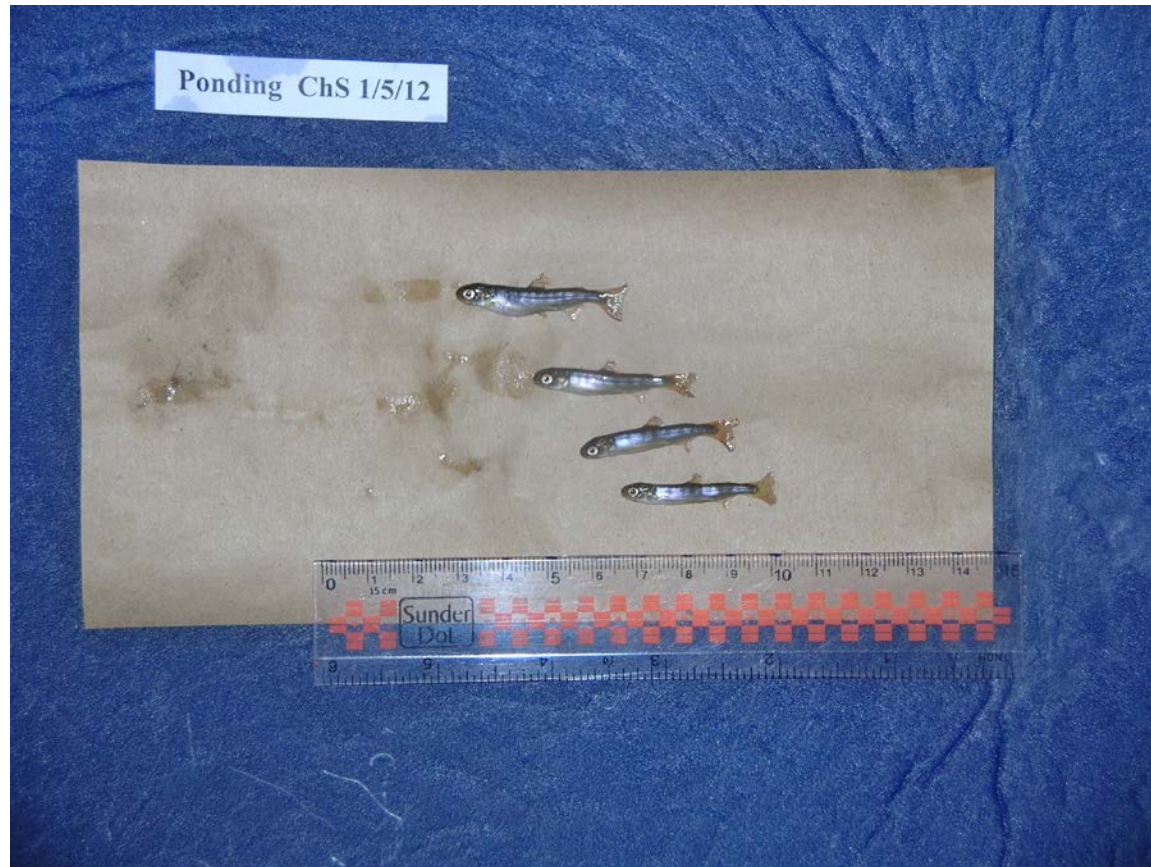
Geomagnetic Studies - OHRC

- Embryos – Chinook and steelhead
 - Vertical movements in gravel
- Juveniles – Chinook and steelhead
 - Magnetic “displacement”
- Adults – salmon and steelhead
 - Magnetic “displacement”



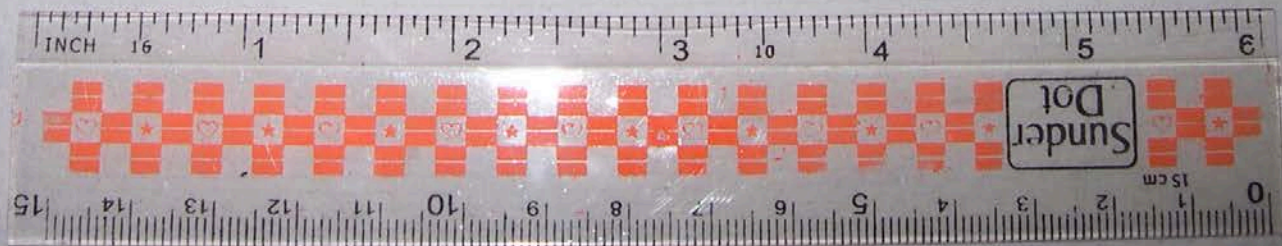
Embryo orientation

Vertical movement in substrate



Embryo and Juvenile behavior – imprinting?

Natural vs Wild magnetic environment







Education & Outreach

- Adult salmon - fishers
- Hatchery influences on homing and straying
- Citizen science – watershed councils, STEP
- OCAMP – students
- OSU – student research topic course

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