

Finding Nemo in Puget Sound:

larval dispersal estimates from genetic parental
identification in brown rockfish
(*Sebastes auriculatus*)

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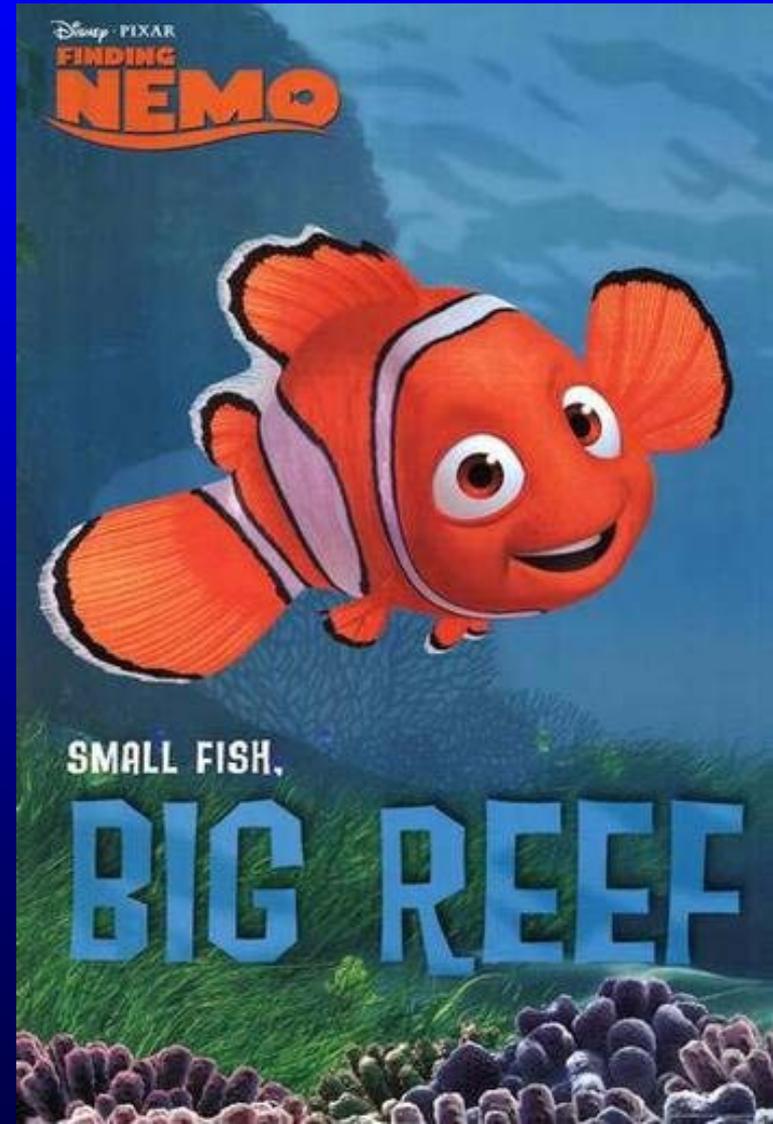
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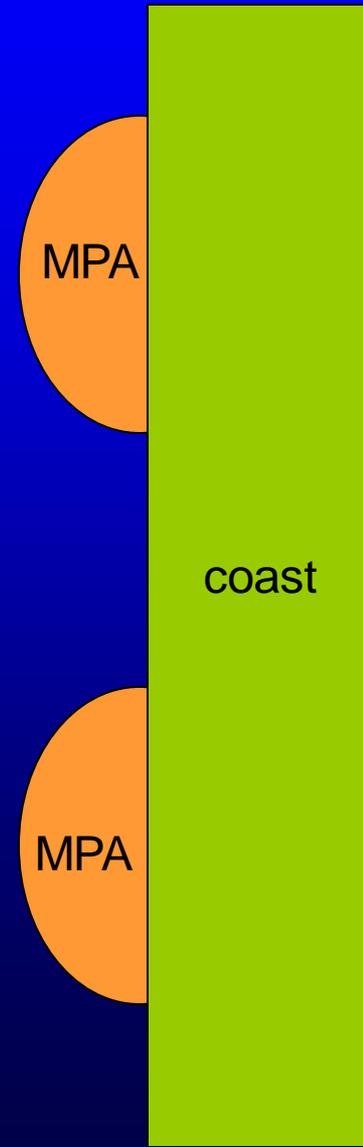
Outline

- **Marine Protected Areas (MPAs) and connectivity**
- **Genetic differentiation vs connectivity**
 - F_{ST}
 - Isolation by distance (IBD)
- **Brown rockfish in Puget Sound**
 - Identification of offspring of known parents
 - Self-recruitment
 - Oceanography
 - Otoliths
 - We found Nemo!



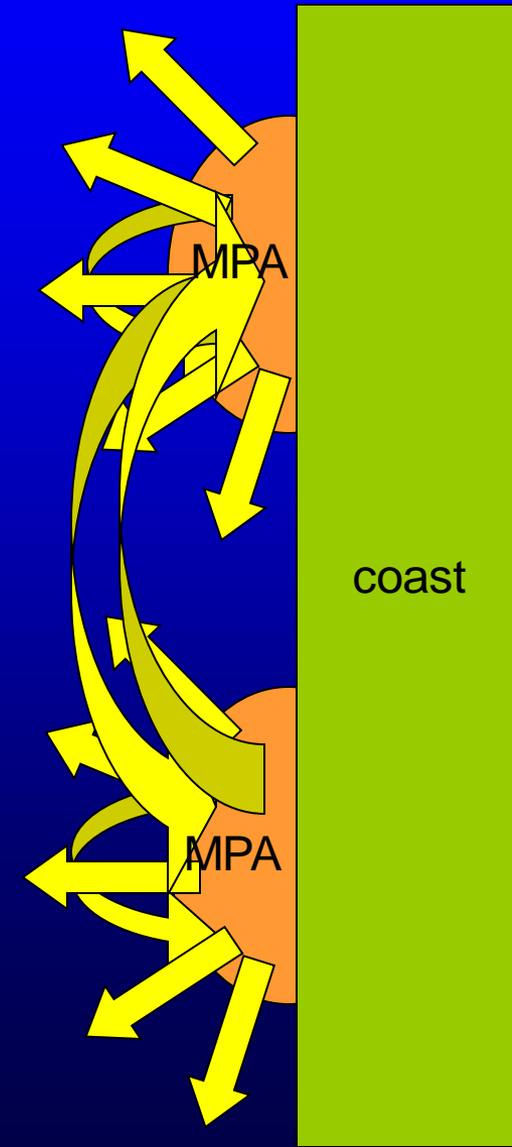
Marine Protected Areas and Fish Dispersal

- **Functions of MPAs**
 - Fisheries conservation
- **Three major questions**
 1. **How much export?**
 - **Benefit to surrounding fisheries**
 2. **How much self-recruitment?**
 - **Benefit to MPA ecosystem**
 3. **How much exchange between MPAs**
 - **Allow gene flow and adaptation to environmental change**
- **Important for MPA design**
 - **Size & spacing**



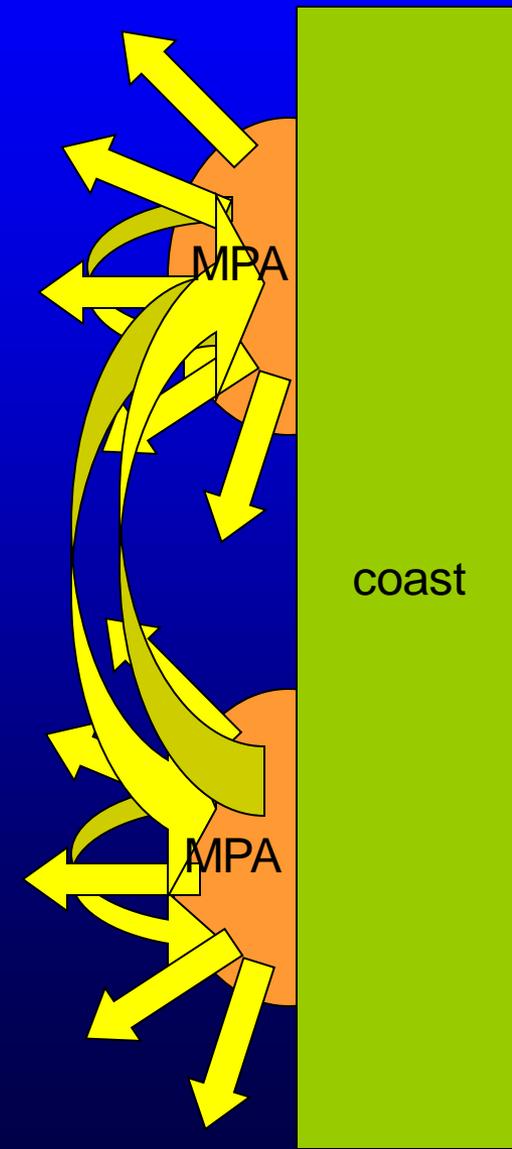
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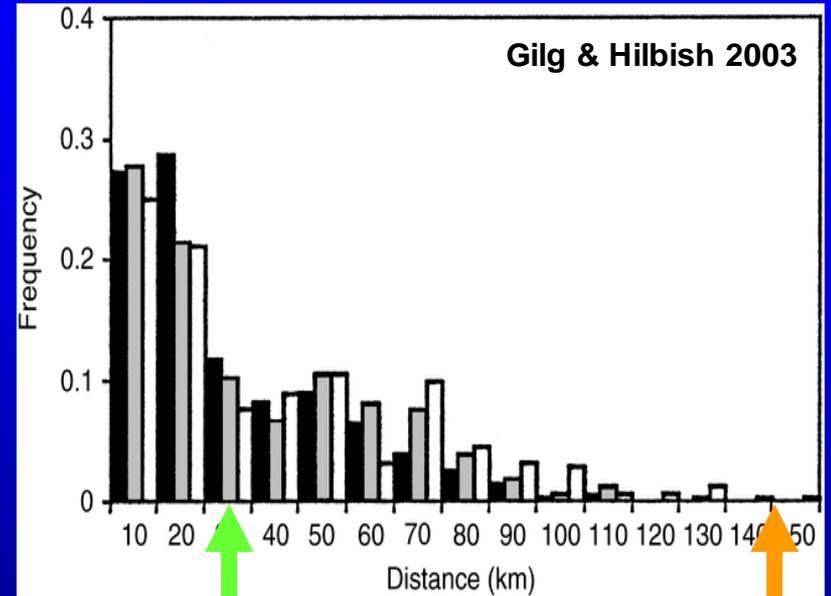
Marine fish dispersal and population genetics

- **Genetic differentiation**

- Population size
- Population history

- **Difference in quantity measured**

- **Ecology**
 - Mean dispersal
 - Short term
- **Genetics**
 - Rare migrants
 - Long term

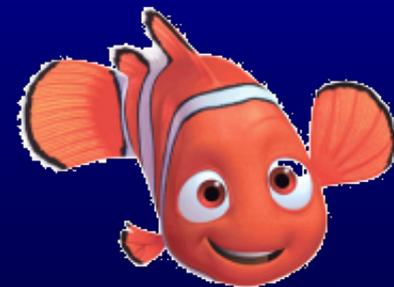
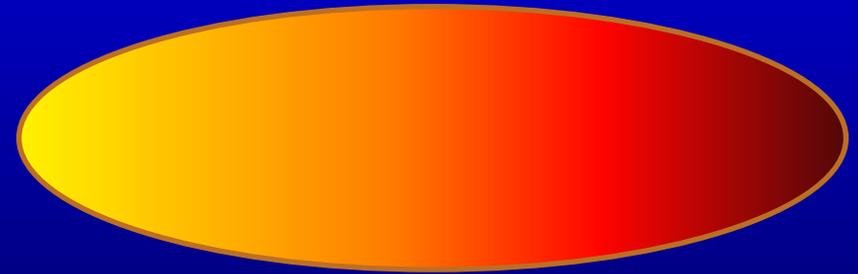
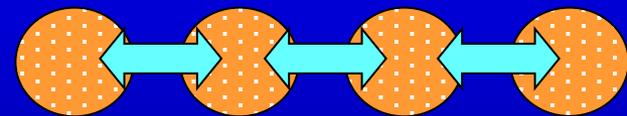
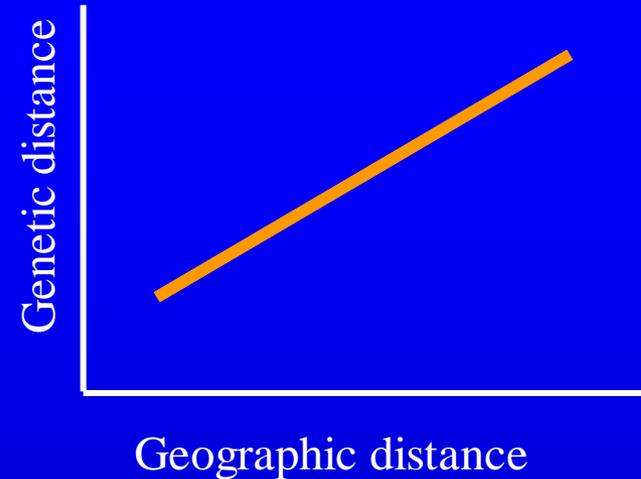


ecology

genetics

Isolation by distance

- **Correlation between genetic and geographic distance**
 - → dispersal distance
 - Migration (mating) between adjacent populations
- **Also for continuous populations**
- **Limited dispersal in many marine species**
 - High self recruitment
 - We should find Nemo!



Brown rockfish

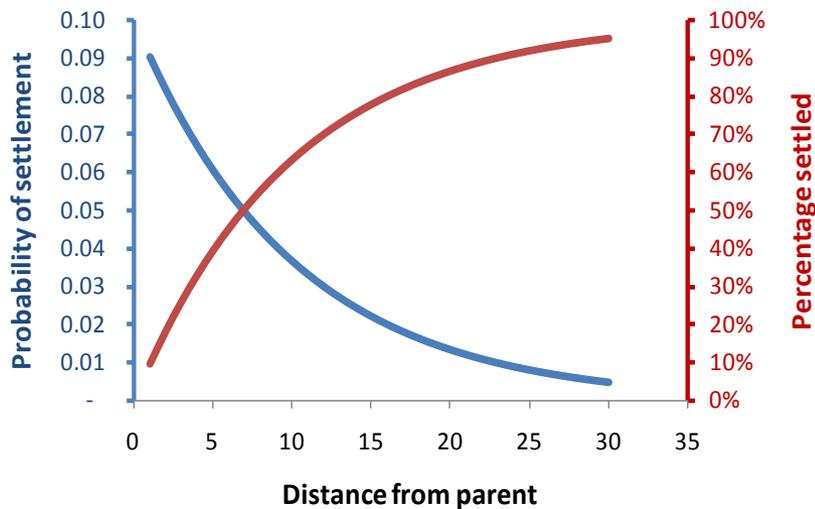
(*Sebastes auriculatus*)

- **Adults**
 - Small home ranges
 - Long lived (~20 y)
 - Mature at ~ 3 years
 - Live bearing
- **Larvae**
 - 3 months pelagic
 - Little known about behavior
- **Habitat**
 - Low relief/shallow/low energy for juveniles
 - High relief/deeper/low energy for adults

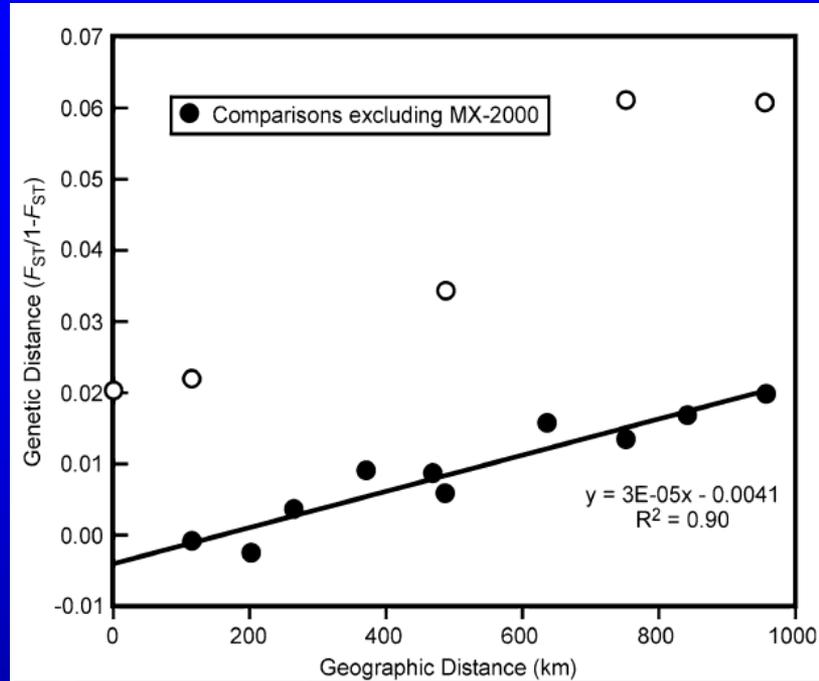


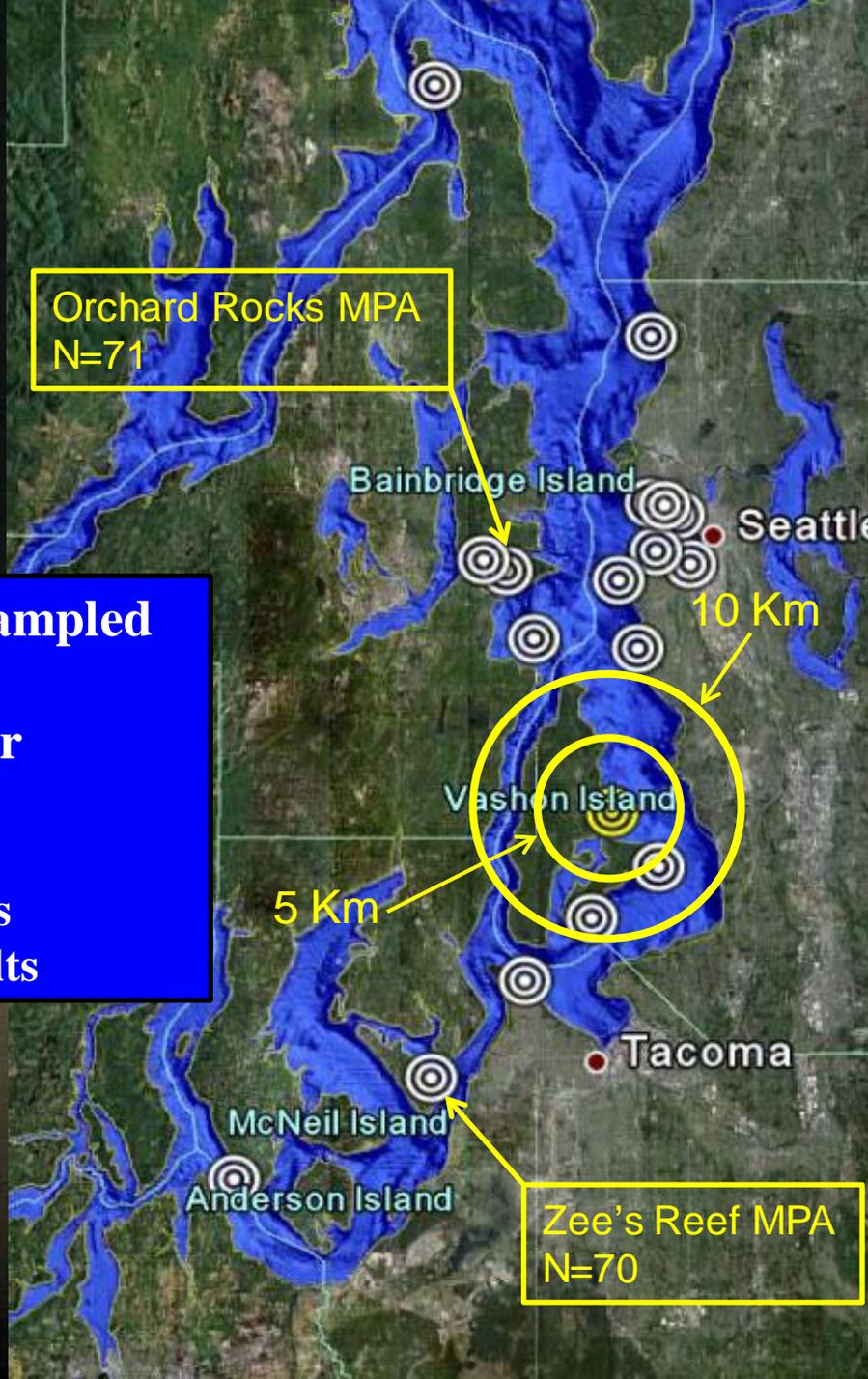
Brown rockfish (*Sebastes auriculatus*)

- Genetic differentiation in CA
 - Isolation by distance
 - Mean dispersal ~ 10 km
 - 40% of larvae should settle within 5 km

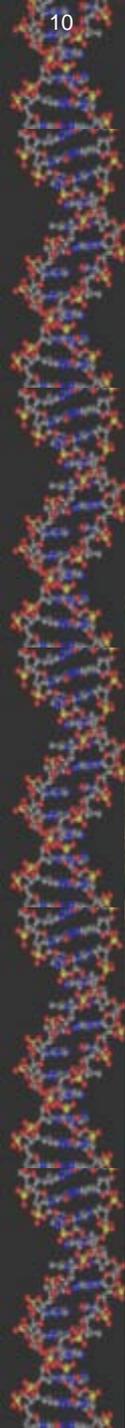


Buonaccorsi, Kimbrell, Lynn, & Vetter. 2005.
Conservation Genetics





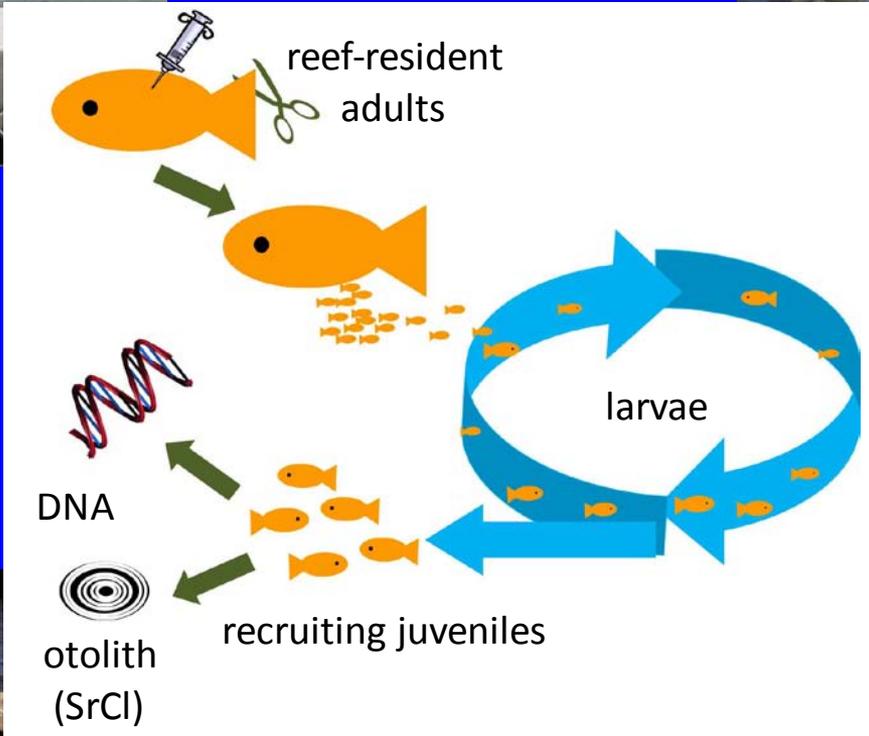
- 1837 fish sampled
- Point Heyer
- 469 adults
 - > 50%
- 578 juveniles
- 240 sub-adults



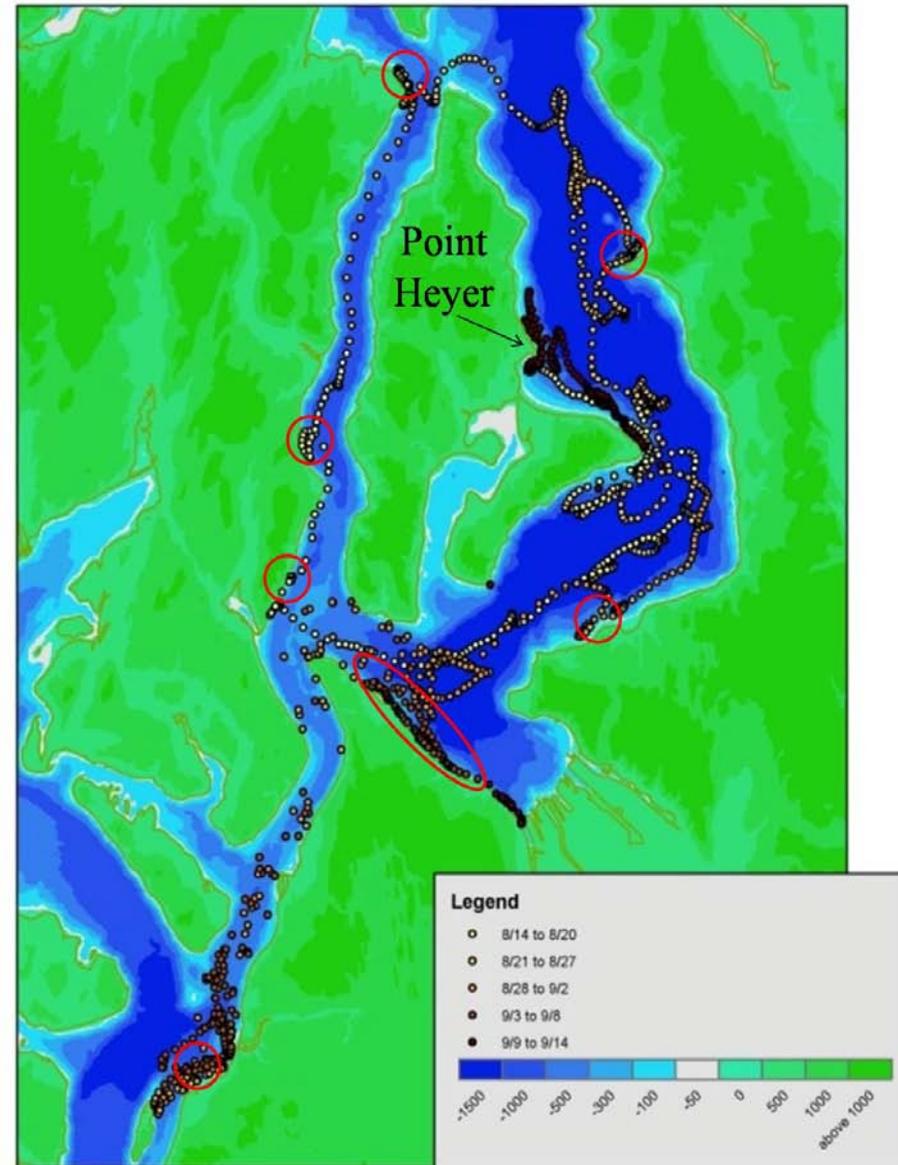
How to find Nemo



Oceanography
Otoliths
Genetics



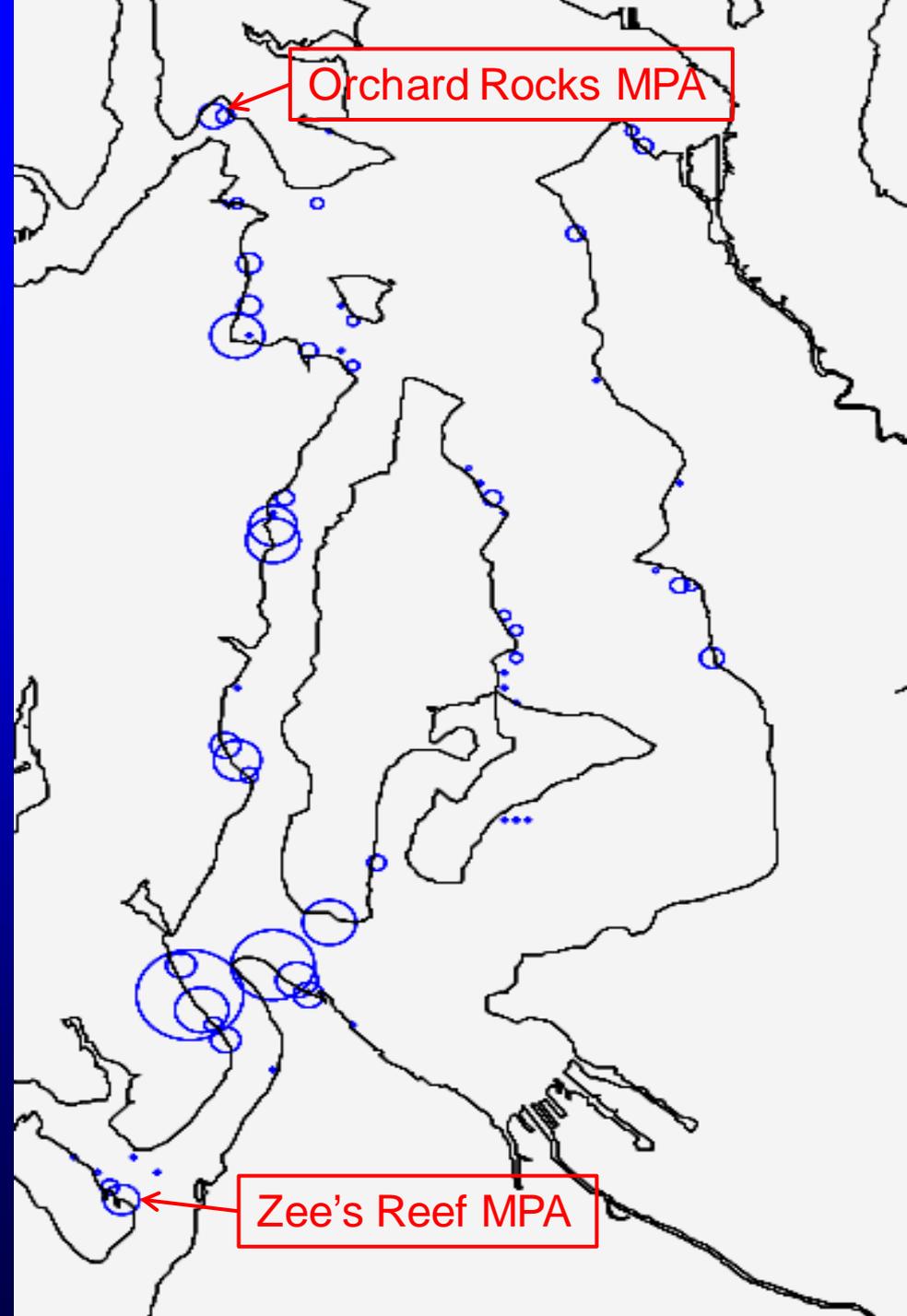
Oceanography

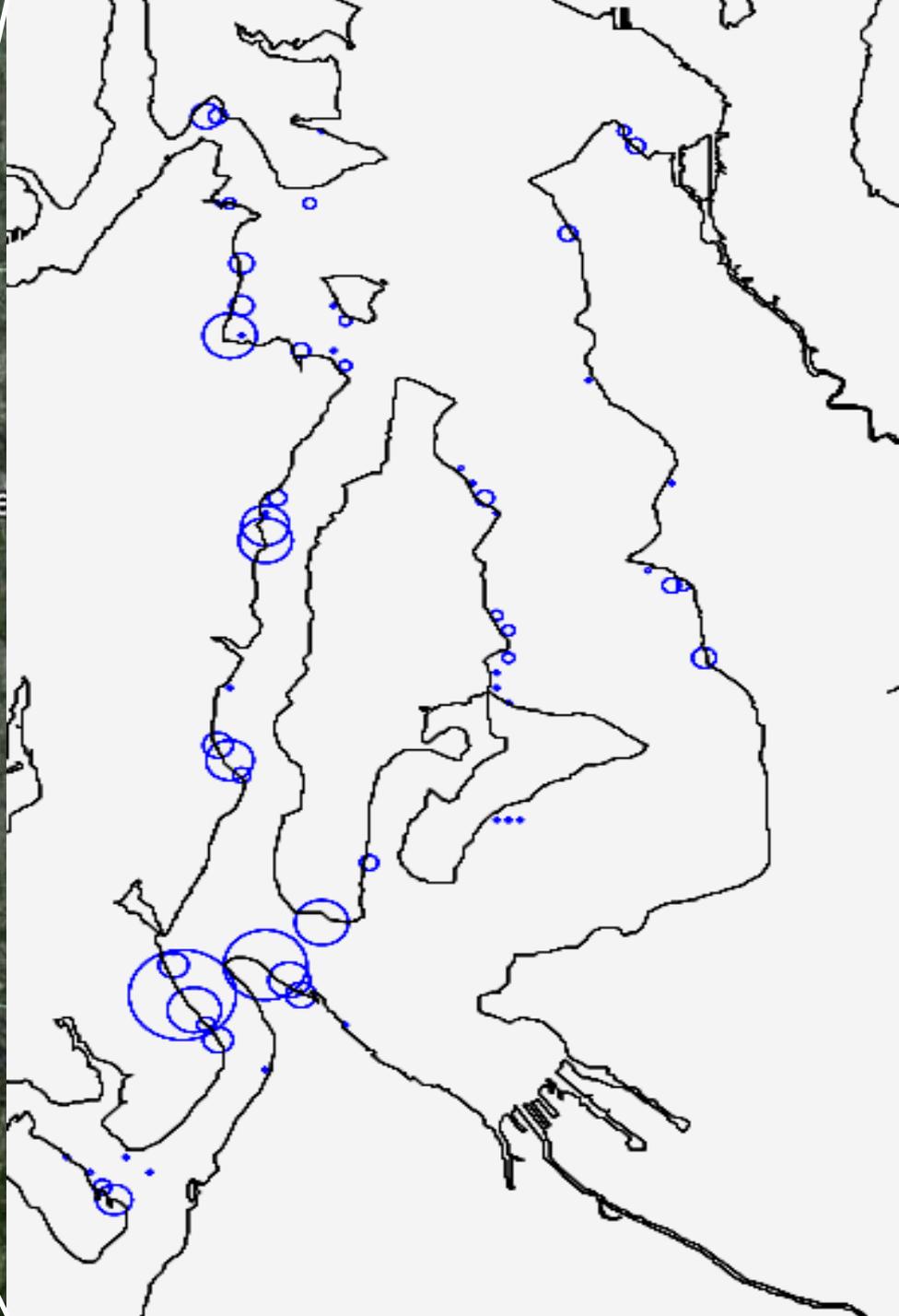
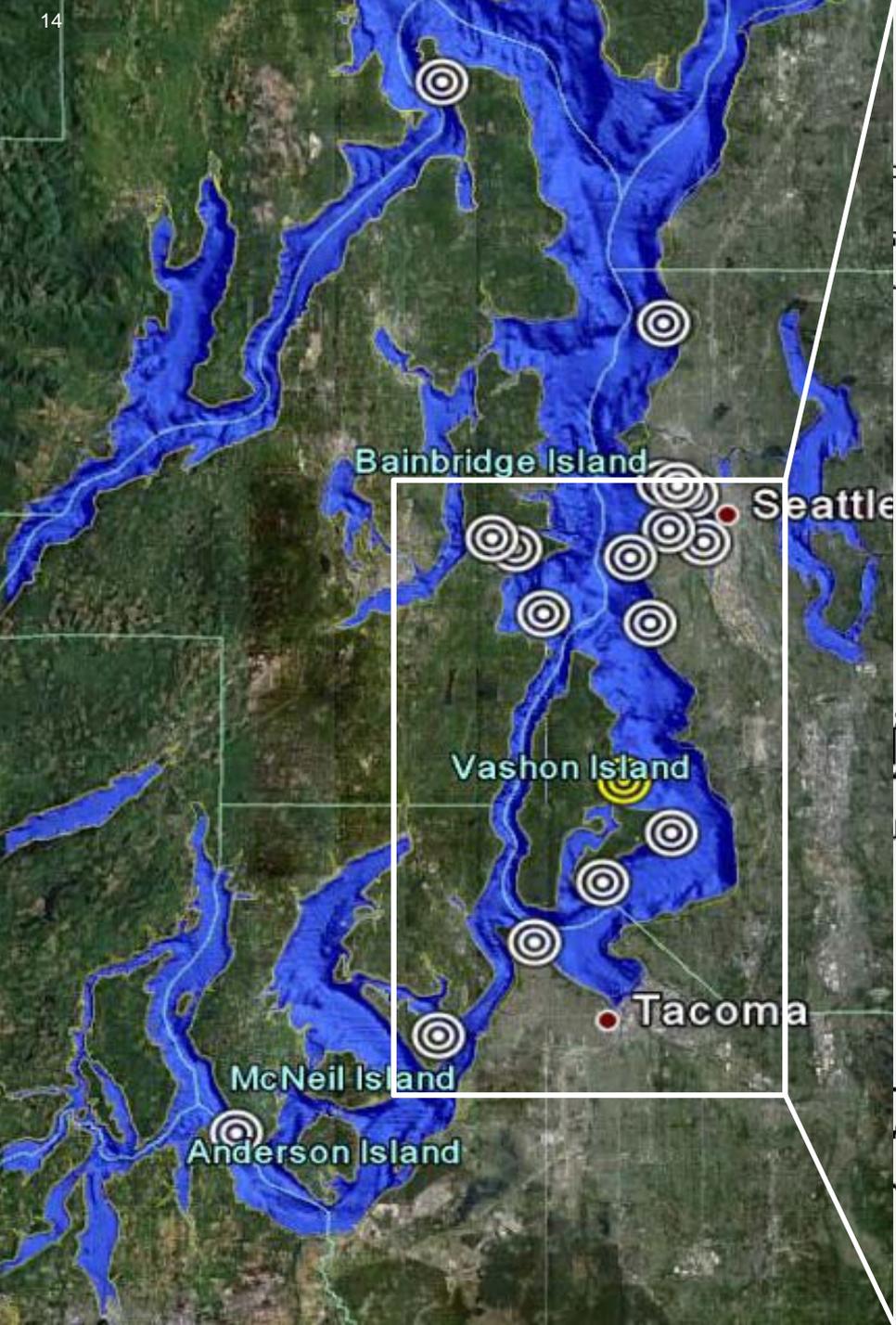


0 2,500 5,000 10,000 15,000 Meters

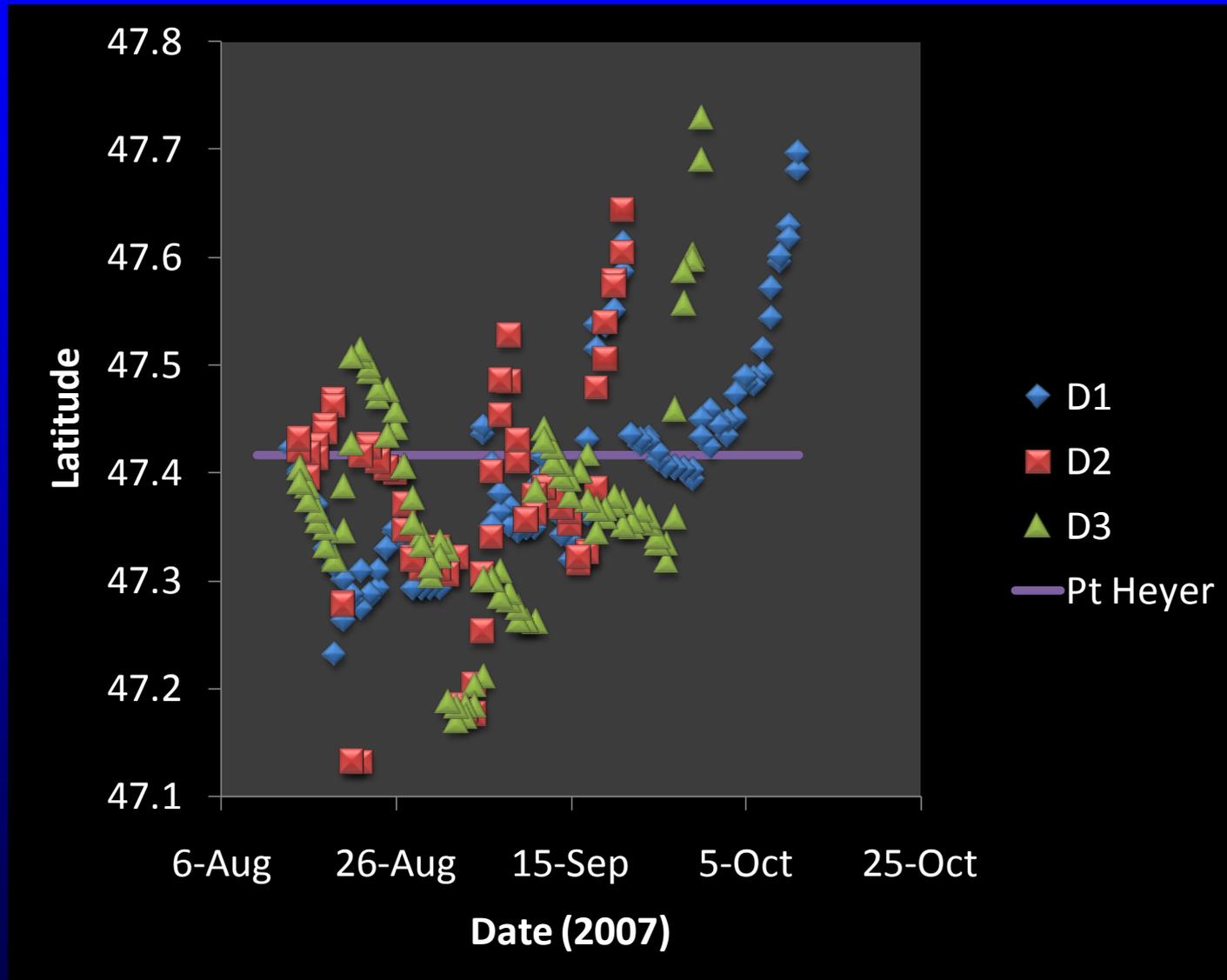
PRISM Oceanographic model

- Drifter tracks broadly corresponds to PRISM oceanographic model
- Used to predict larval dispersal
 - Passive particles
 - Released at Point Heyer
 - Predicted settlement sites





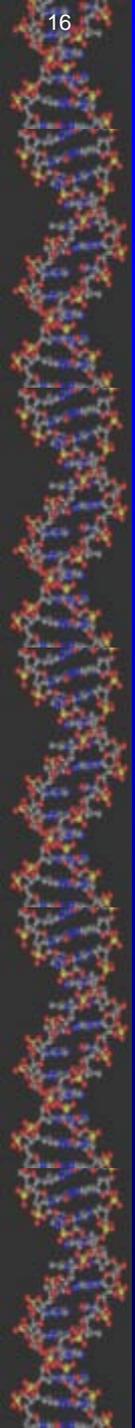
Seasonal variation in drifter trajectories



Otolith microchemistry

Transgenerational tagging with SrCl

- **Sr replaces Ca in hard parts**
- **Successfully transfers to pre-parturition larvae – How?**
- **Detected with micro-probe or laser ablation**

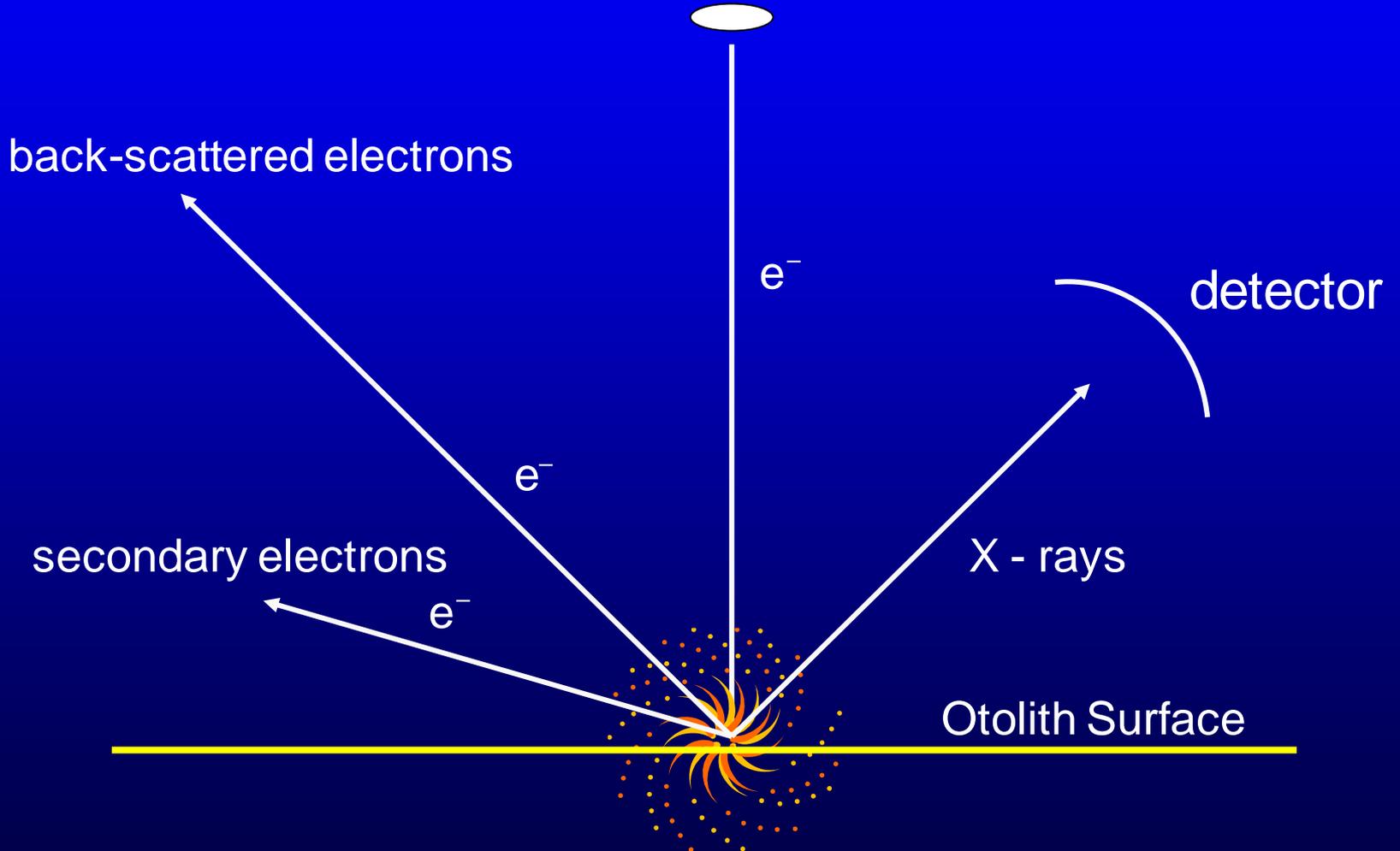


Otolith microchemistry

Sr detection

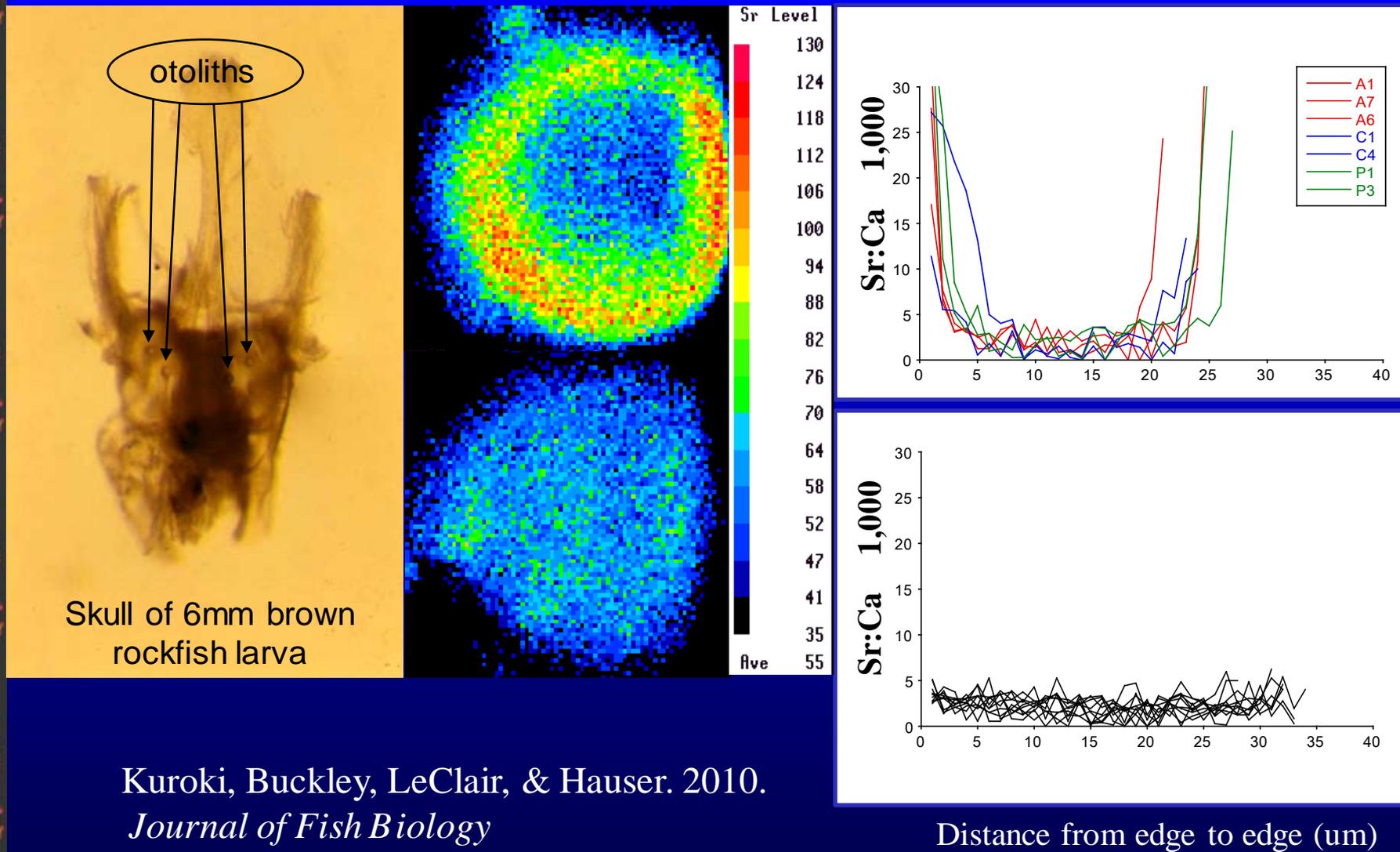
Electron Source

15 kV 12nA



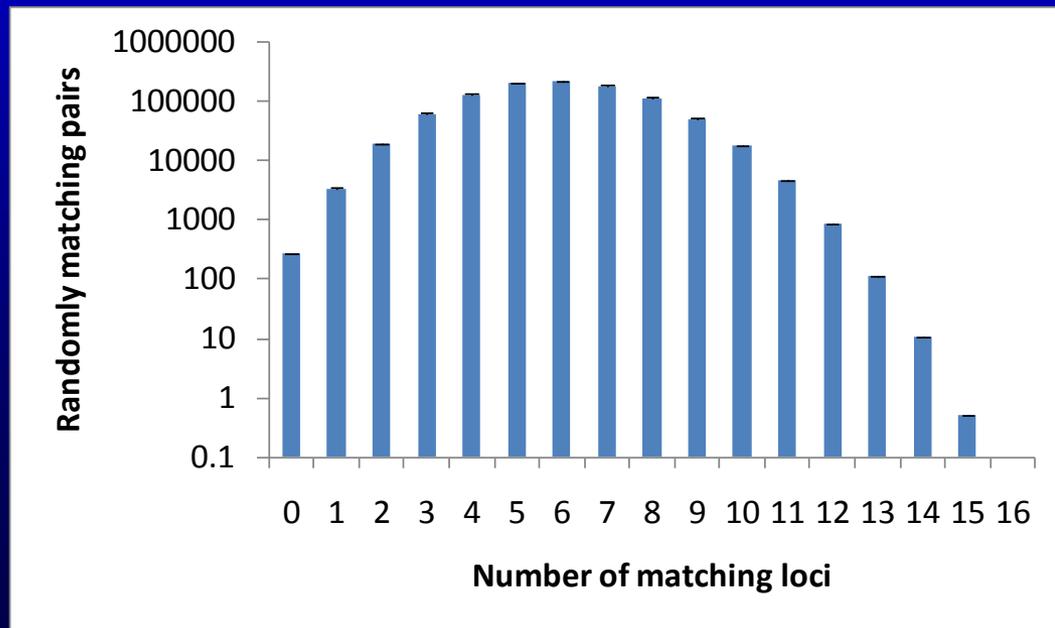
Otolith microchemistry

Results



Genetic parentage assignment

- **Mendelian inheritance**
 - Offspring match parents at one allele at each locus
 - May match by chance
 - 1000 adults x 1000 offspring: 1 million comparisons
- **16 Microsatellites**
 - Avg 45 alleles / locus
 - Low chance of random match
 - Low chance of false positive parent offspring pairs



We found Nemo!

- **7 Nemos**

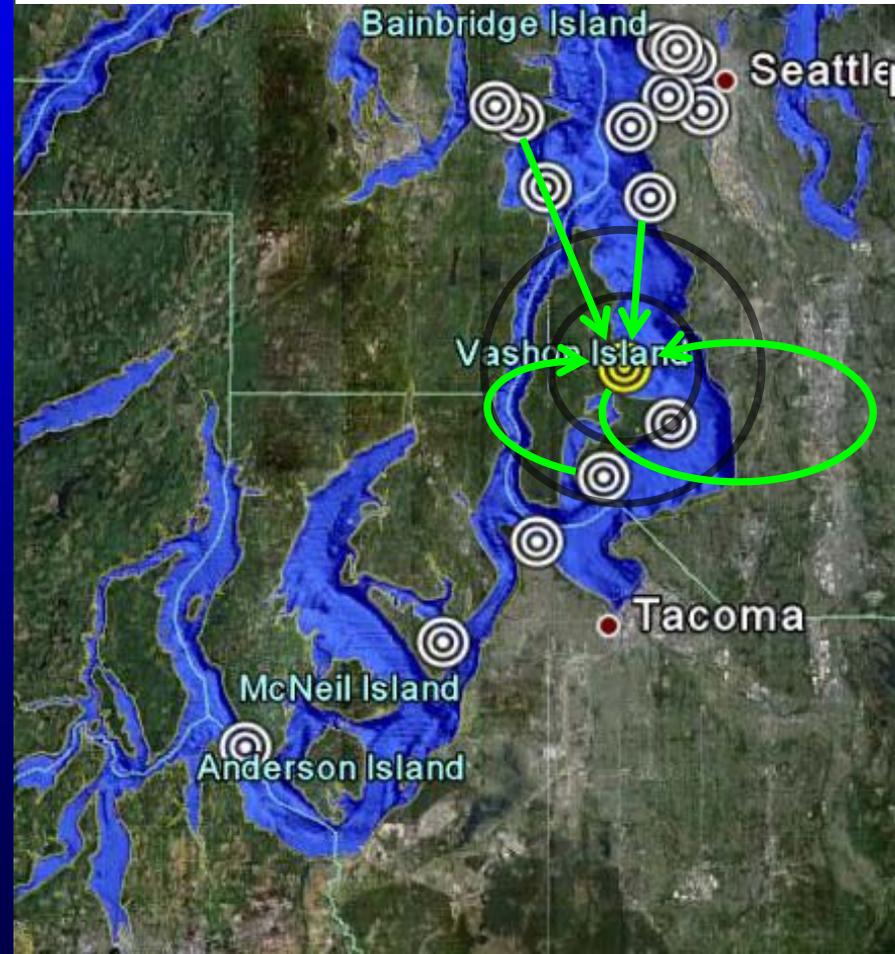
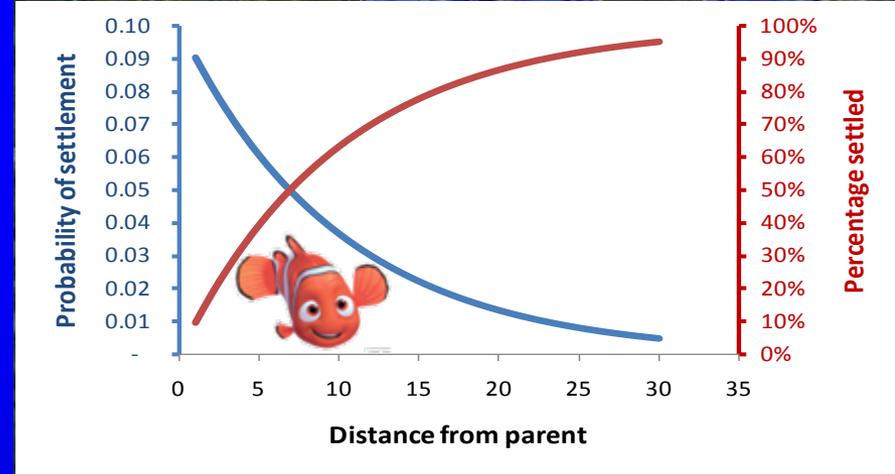
- offspring of known parents at Point Heyer
- 4 from parents at Point Heyer
 - 1 with both parents
- 3 from elsewhere

- **818 juveniles and sub-adults sampled**

- 50 % adults sampled
- 0.5% of juveniles
- 4% self recruitment

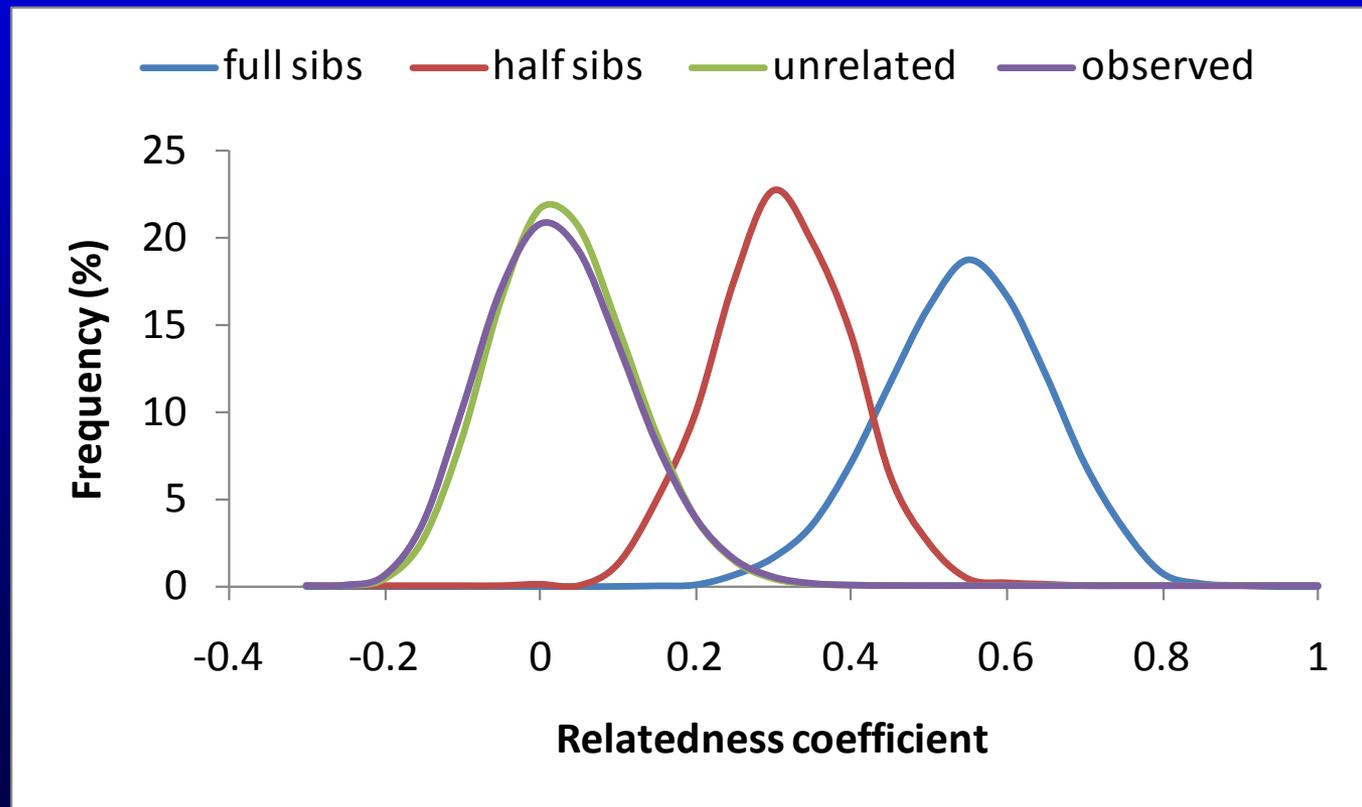
- **Mean dispersal distance 10km**

- 40% settlement expected within 5 km
- No juvenile habitats nearby



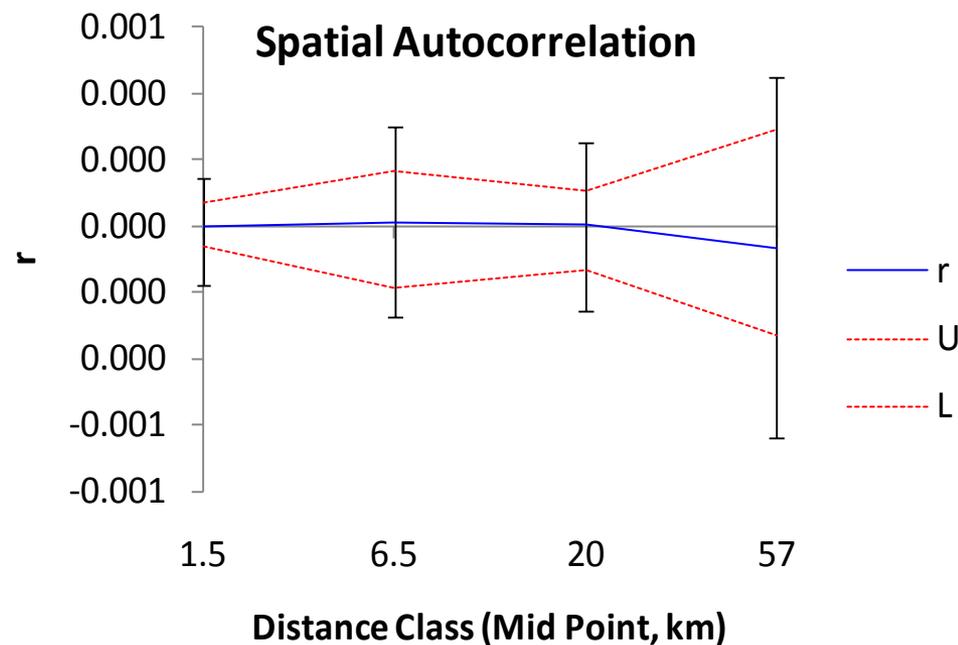
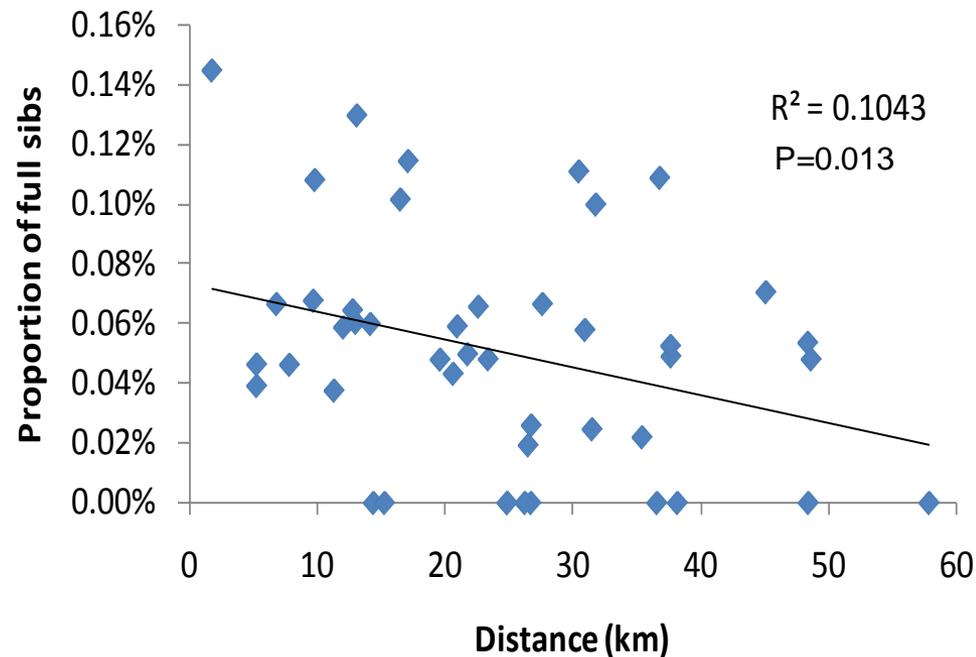
What about sister/brother kinships?

- **Should dispersal resolve like parent offspring**
 - Preliminary results
- **High power**
 - Can distinguish full sibs from unrelated



Full siblings in pairwise comparisons

- **Isolation by distance**
 - Lower proportion of full sibs at larger distances
- **No evidence of isolated populations?**
 - Global $F_{ST} = 0.000$, 99% CI
 - High power of marker set
 - $F_{ST} > 0.0005$
 - **Spatial autocorrelation**



Conclusion

- **We found Nemo!**
 - But not as many as expected
- **Low self recruitment**
 - Origin of Nemos random
 - **But small sample size**
 - But some evidence for isolation by distance from kinship
- **Implication**
 - Puget Sound populations well connected
 - Source vs sink populations?
- **Methodological**
 - Parentage assignment works
 - **Multidisciplinary approach**



Acknowledgements

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- SAFS

- **Laboratory**

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- Lyndsay Newton
- Melissa Baird

- **Sampling**

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