Site Fidelity & Movement in Hatchery-Reared Lingcod

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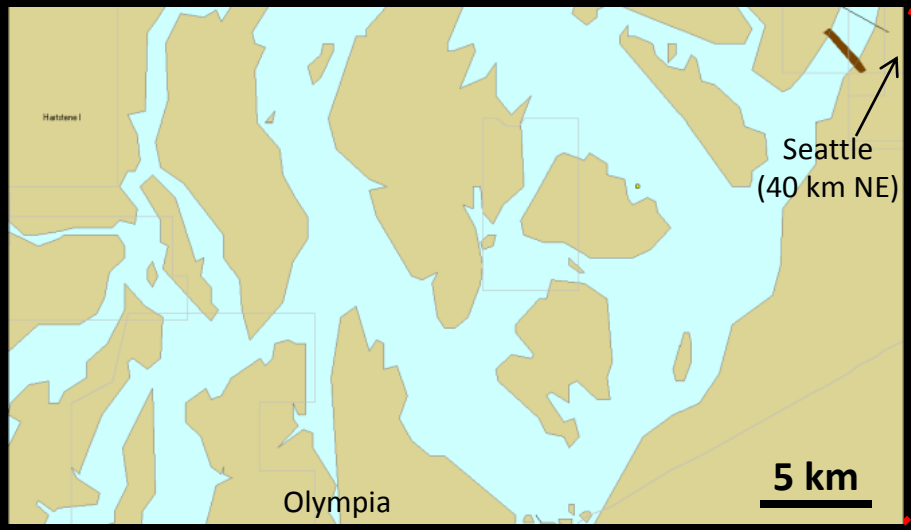
Prized by anglers
Voracious predators
Grow to 1.5 m, 60 kg
Spawn on rocky reefs

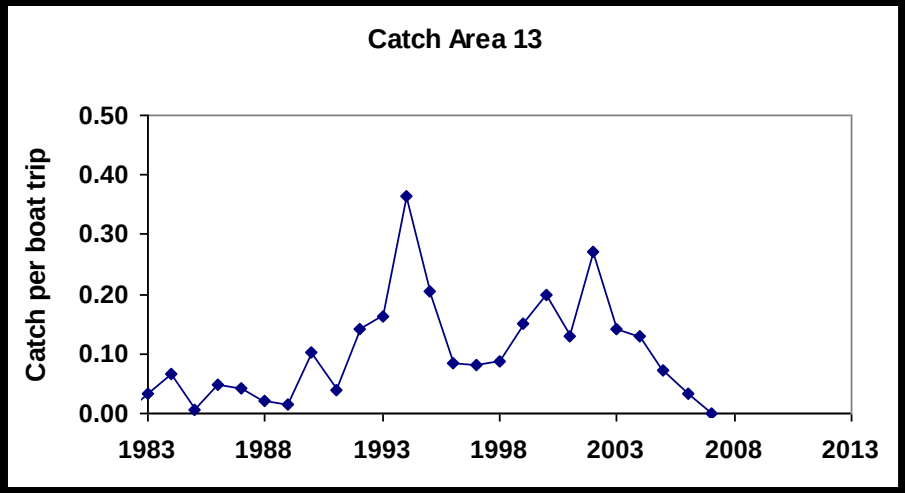
Lingcod (*Ophiodon elongatus*) in Puget Sound, WA

Important historical target of commercial and recreational fisheries

Current fisheries are very restricted (no commercial, 6-week recreational)

Poor Catch Per Unit Effort





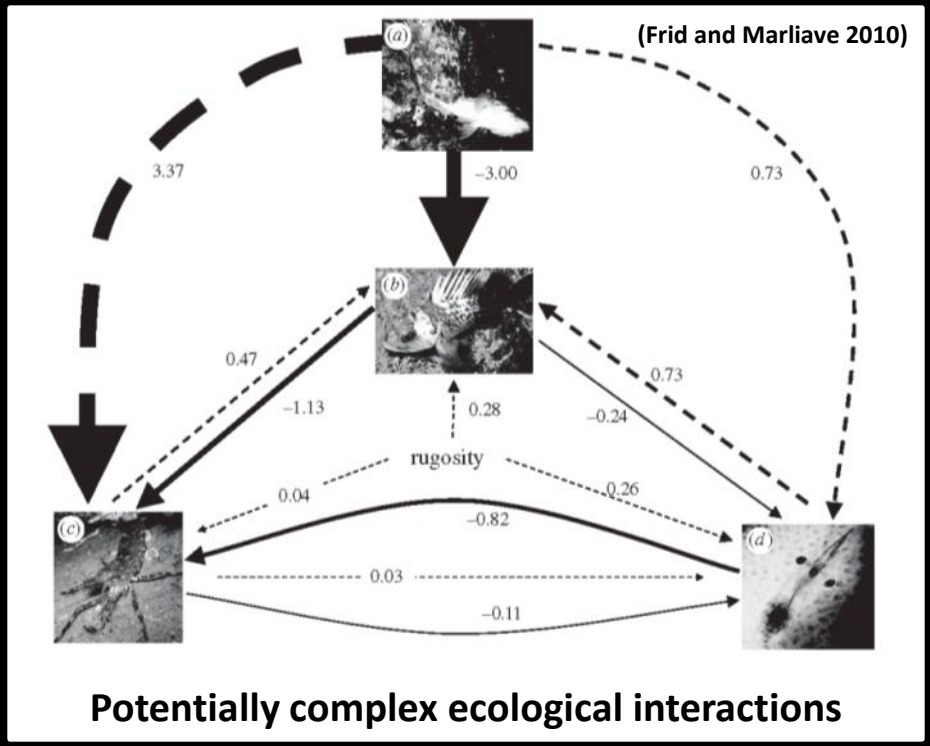
Could stock enhancement be a useful management tool?

What are the benefits and risks of stock enhancement?

Quantify Benefits and Risks → Stock Enhancement

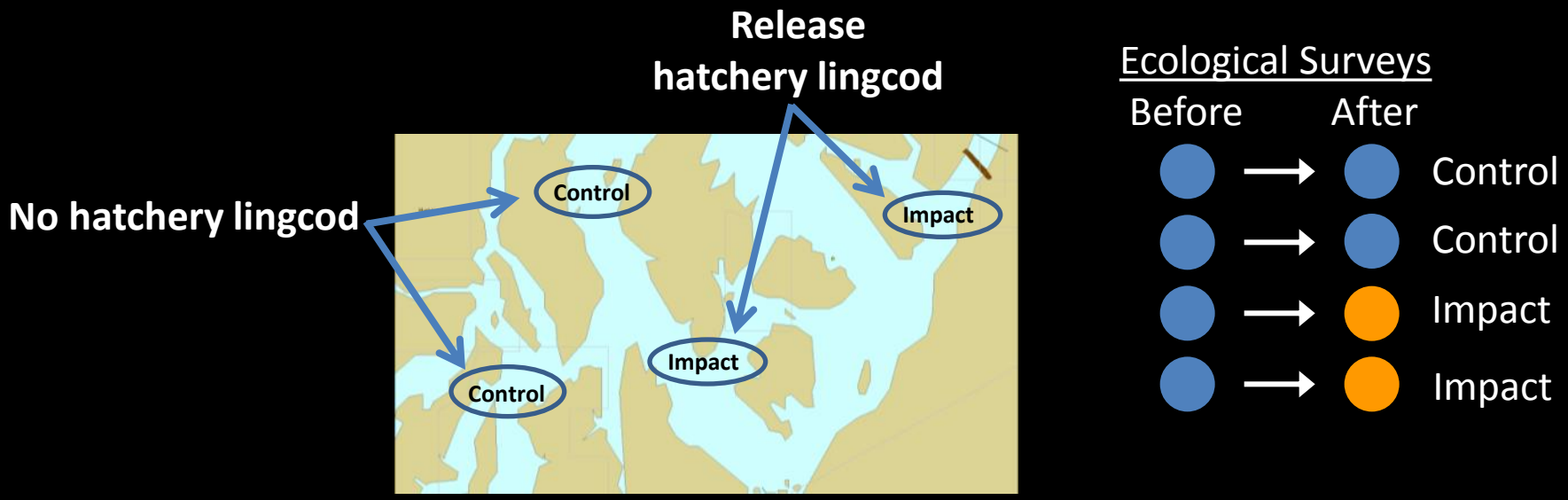
Benefit: Improvement in fishery?

Risks: Genetic: Loss of variation?
Ecological: Fewer wild lingcod?
Impacts to other species?



Potentially complex ecological interactions

Before-After-Control-Impact (BACI) Experiment

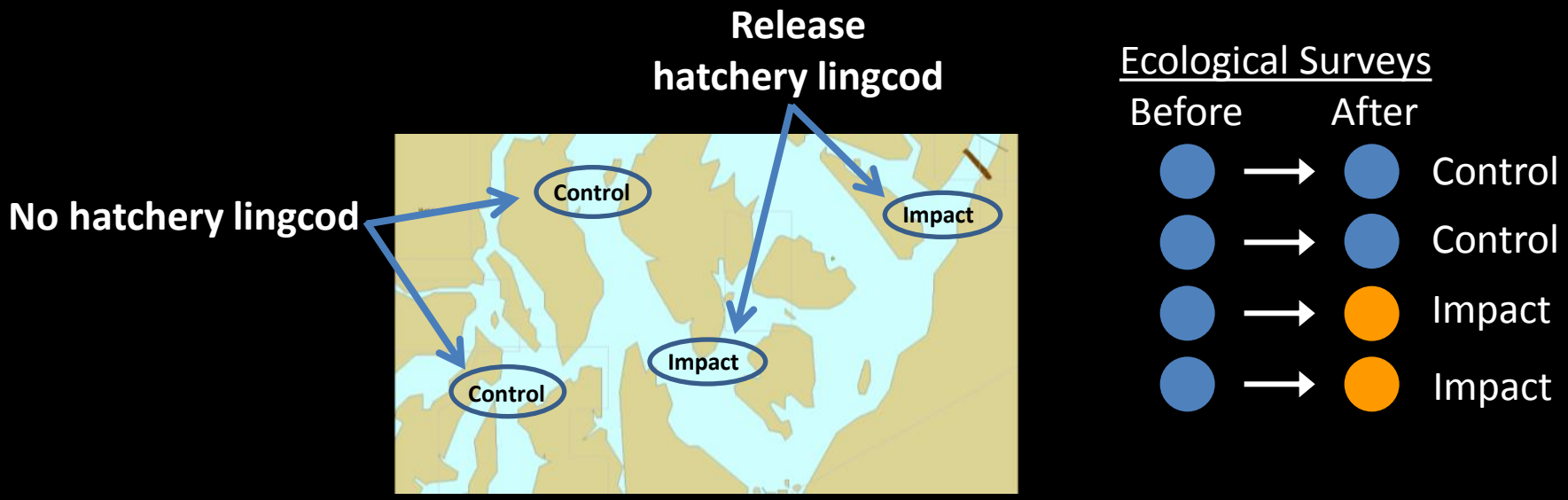


Ecological Impacts (Field Surveys)

Genetic Impacts (Hatchery & Field)

Fishery Contributions (Creel Surveys)

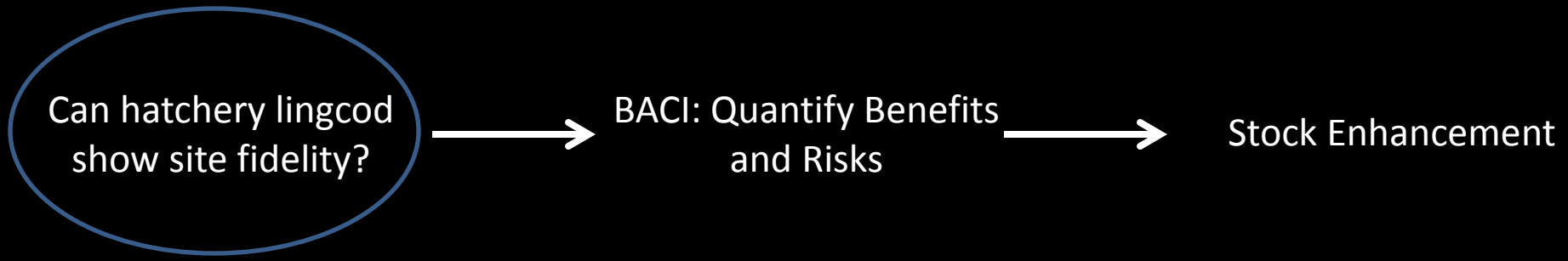
Before-After-Control-Impact (BACI) Experiment



Released fish must show site fidelity!

If not, impact and control sites cannot exist.

To conduct BACI, we need site fidelity



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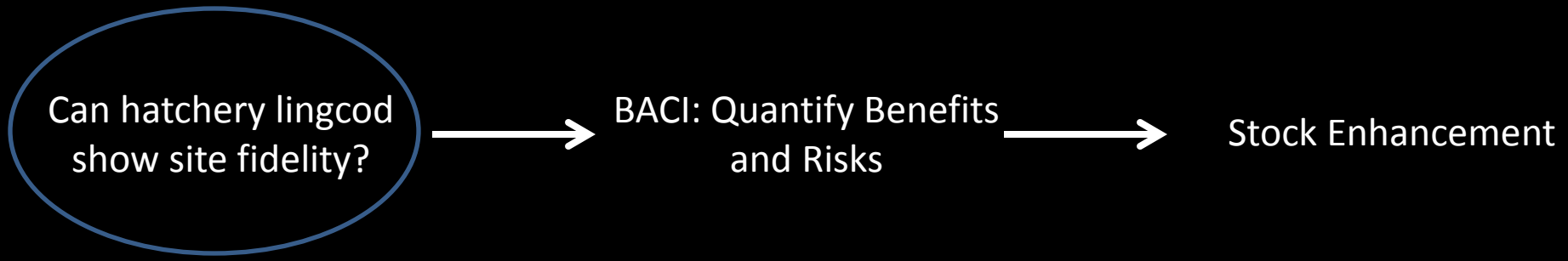

Goal: Find release methods that maximize site fidelity

- -Release age/season
- -Release habitat

Limitation: Release <150 fish to avoid compromising future control and impact sites

Collected Eggs

Raised in Hatchery

Tagged and Released

Collected Eggs

Raised in Hatchery

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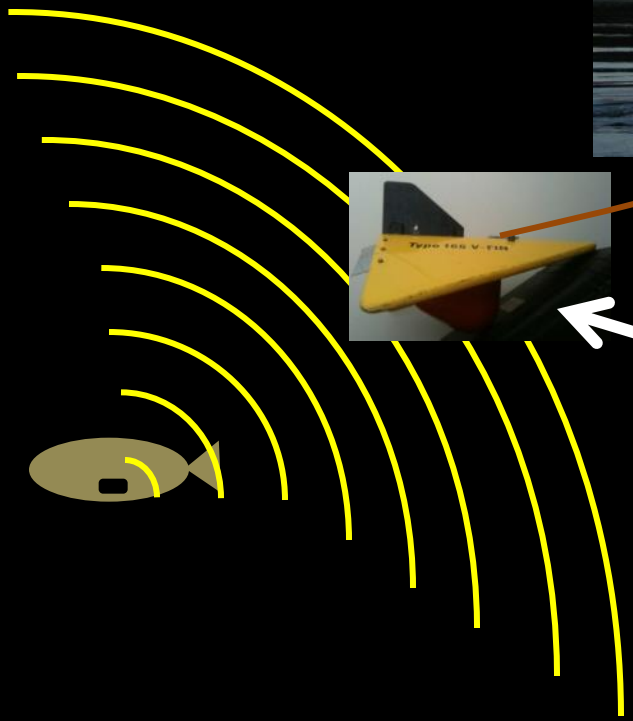


Towed hydrophone recorded the unique code of each fish

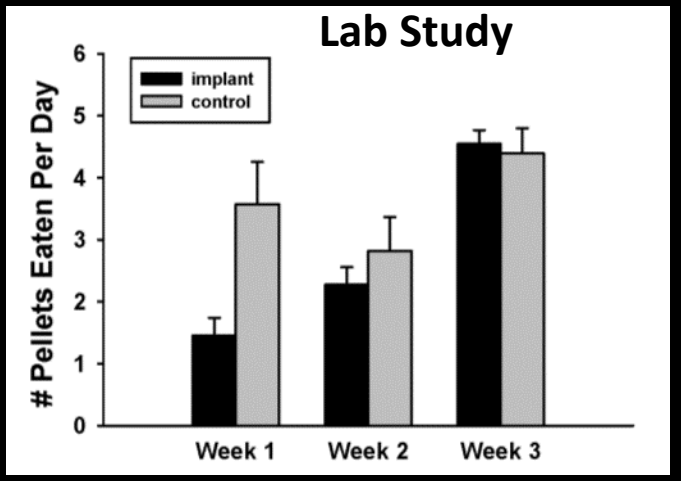
Collected Eggs

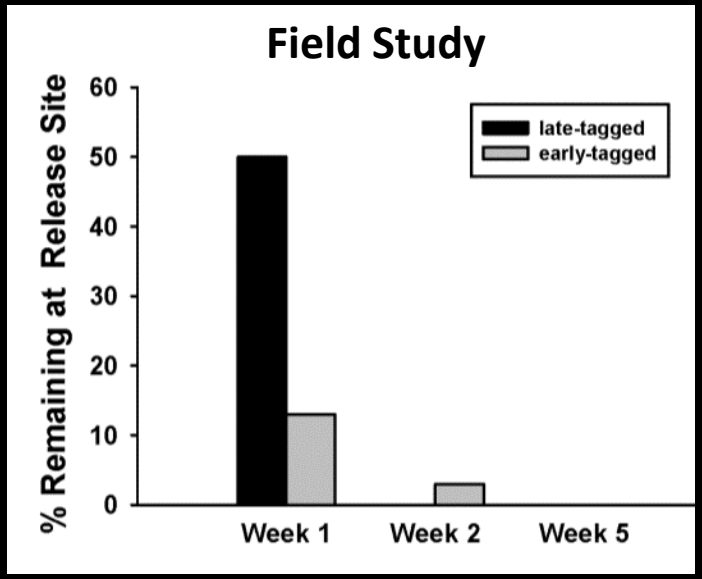
Raised in Hatchery

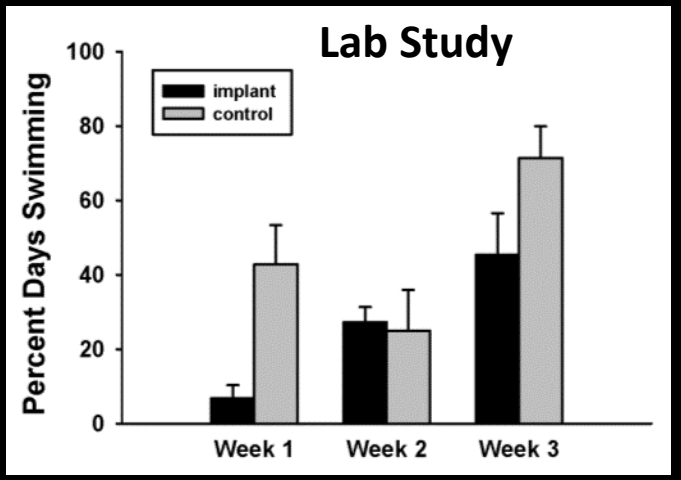
Tagged and Released

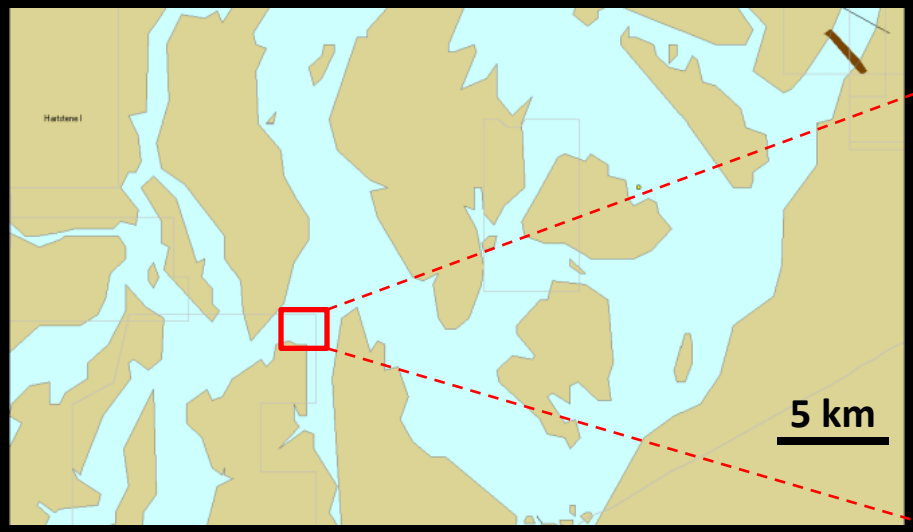
Tag-Effect Study

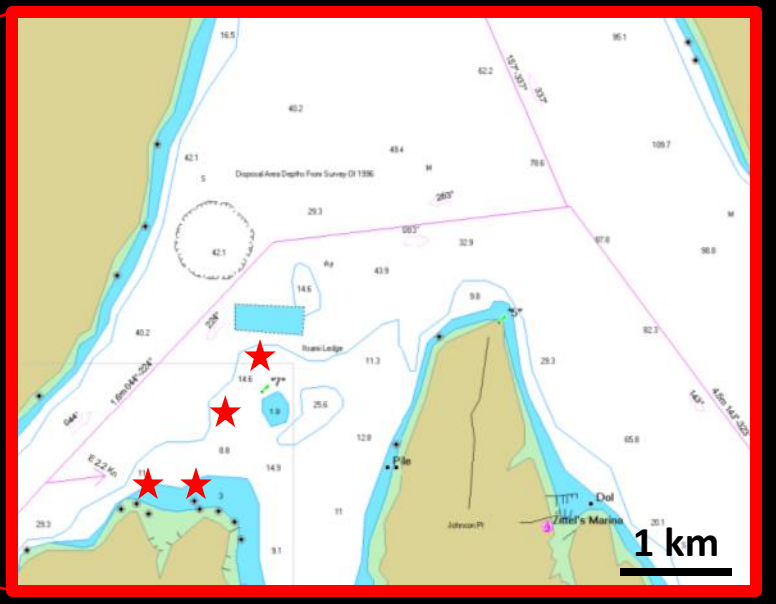
Surgically implanting acoustic tags alters behavior, but holding fish for one month eliminates the effect



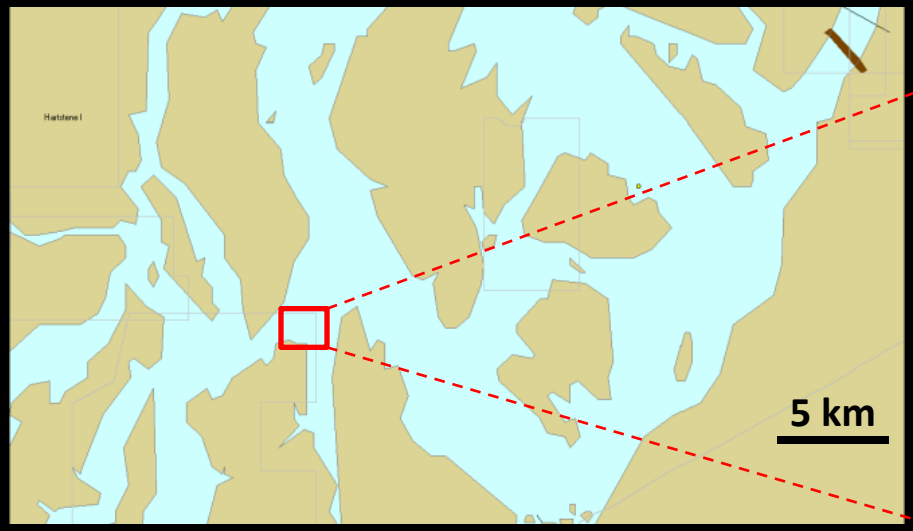


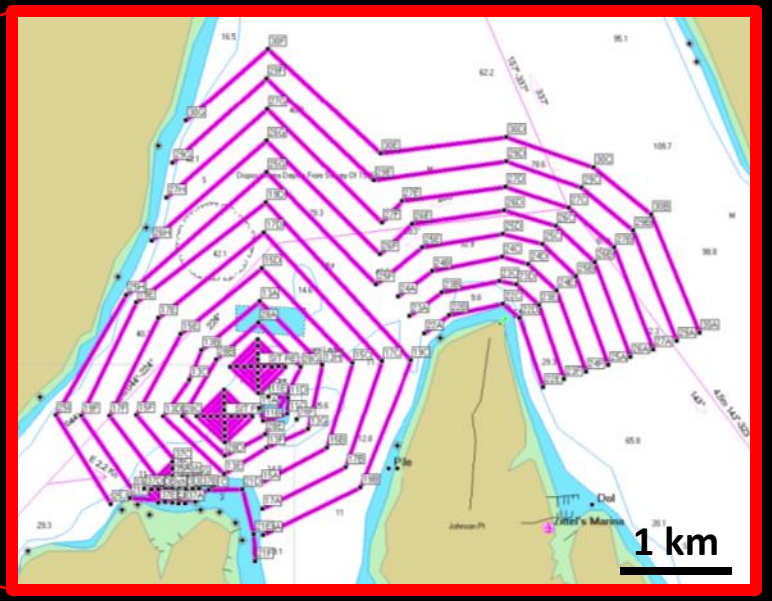






Brood Year	Release Age & Season	Release Depth, Habitat	Size ± SD (mm)
2008	9 months, Fall	5 m, barren (n=12) 5 m, vegetated (n=12)	195 ± 18
2009	11 months, Winter	5 m, vegetated (n=15) 15 m, barren (n=15) 15 m, rocky reef (n=15)	236 ± 18
2008	17 months, Summer	15 m, barren (n=15) 15 m, rocky reef (n=15)	312 ± 12
2008	21 months, Fall	15 m, barren (n=13) 15 m, rocky reef (n=13)	341 ± 15





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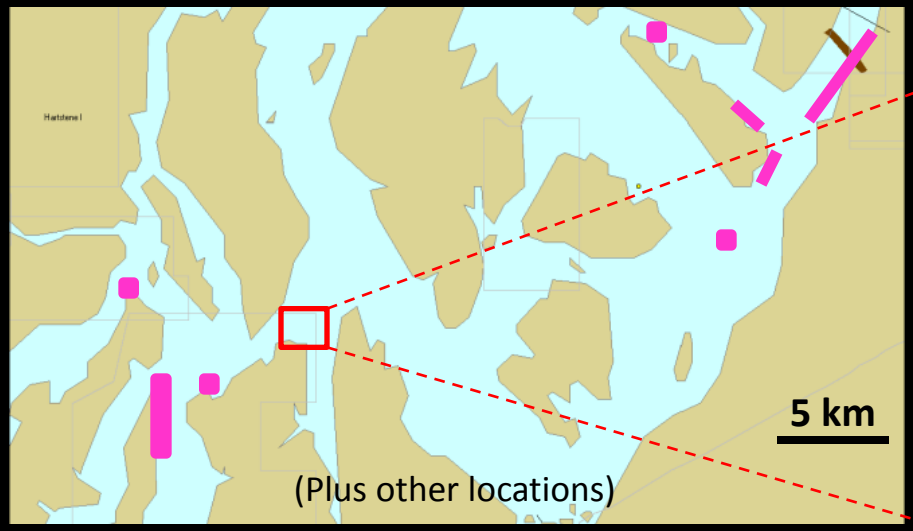

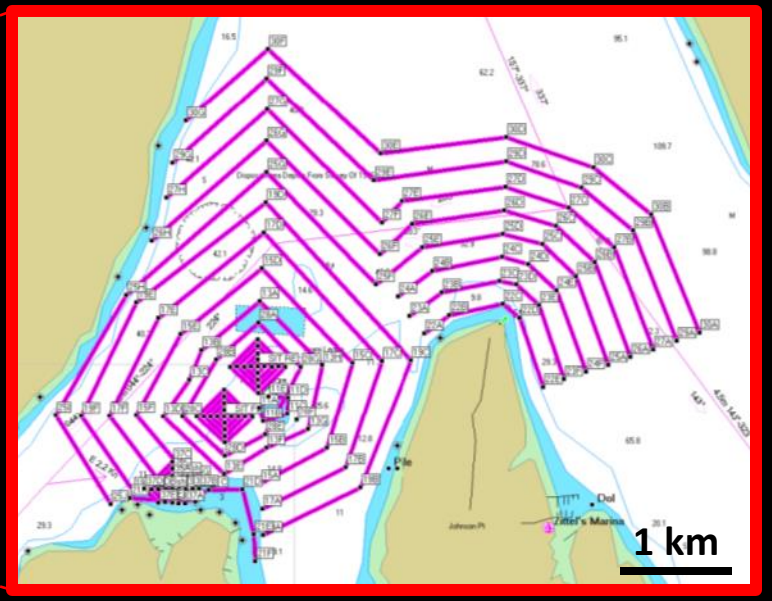

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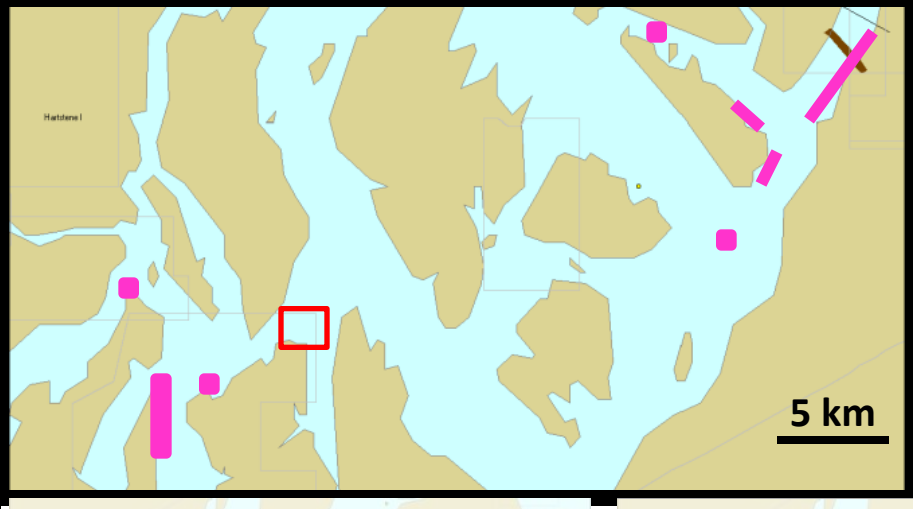
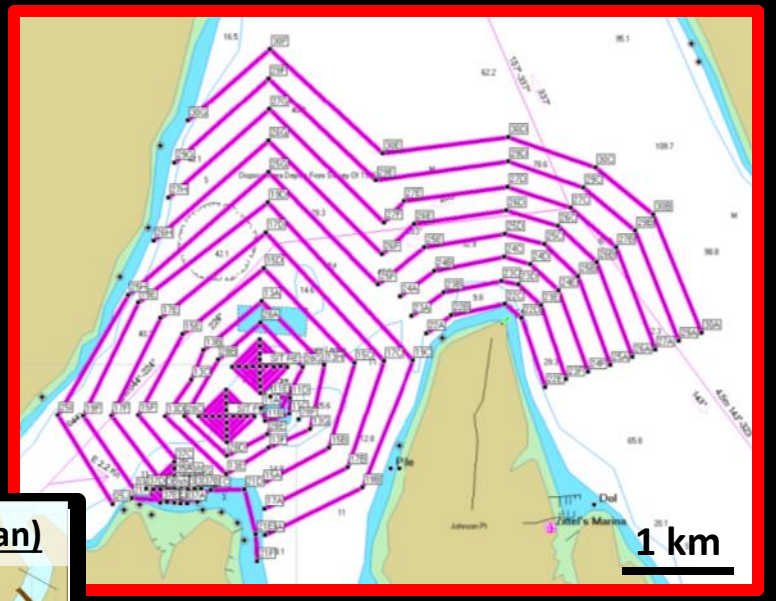
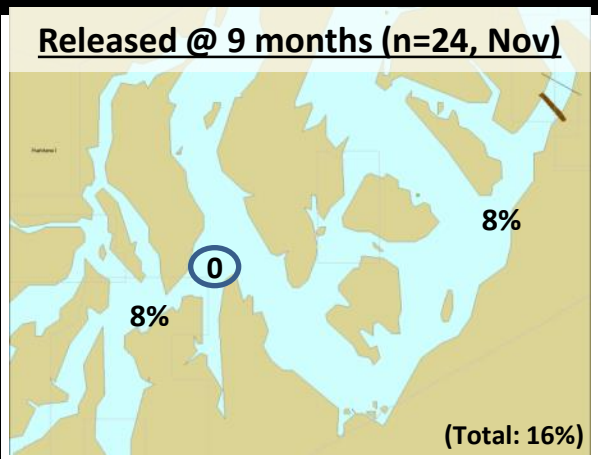
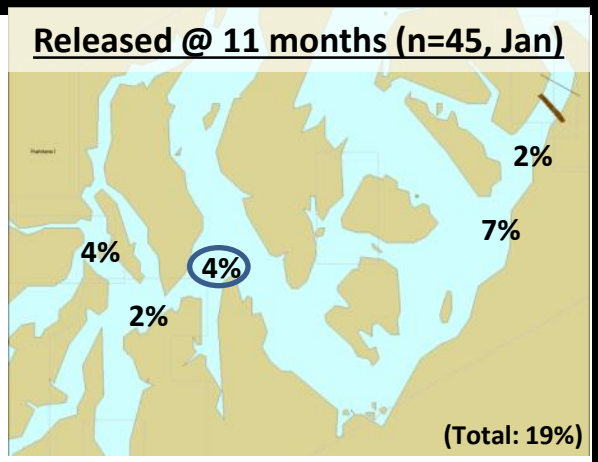
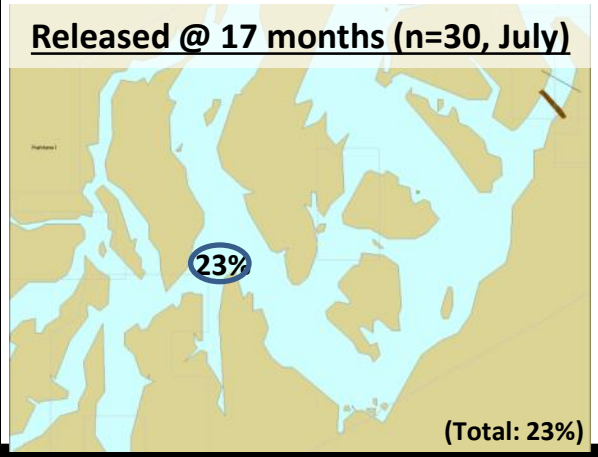
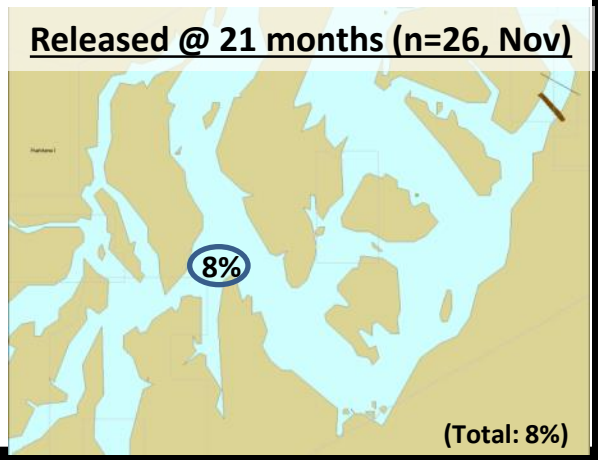












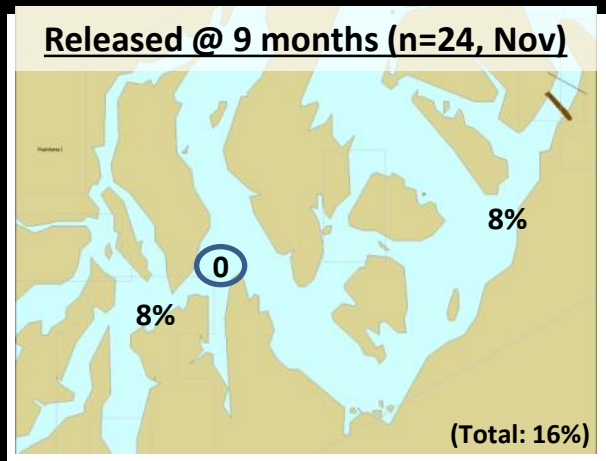
Number inside circle is % detected at release area one year after release

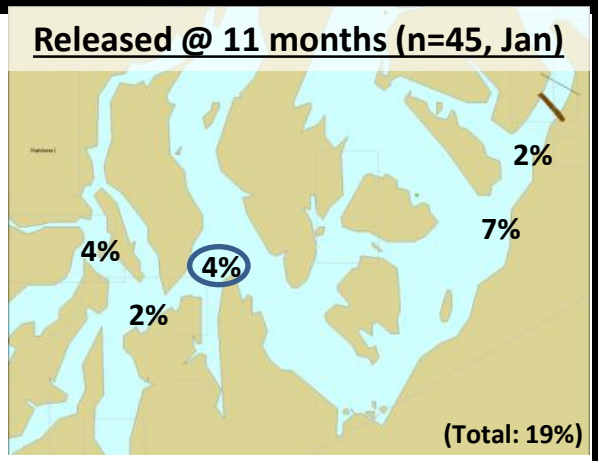
Numbers outside circle is % detected at distant tracks 44 weeks after release

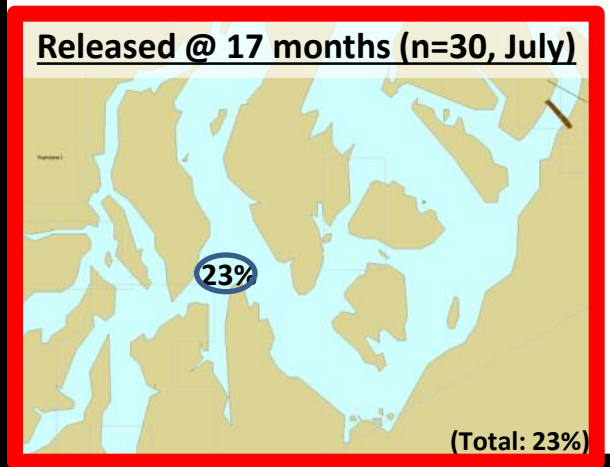
Undetected fish represent mortality or movement to untracked areas

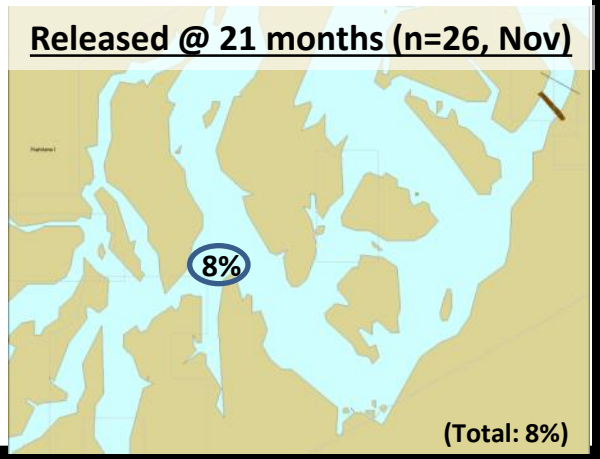
Conclusion

17 month-olds showed the greatest site fidelity and least dispersal.
This age should be sufficient for BACI.









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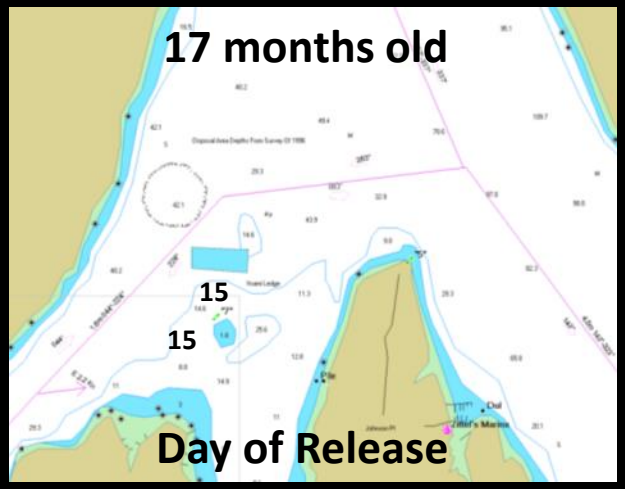
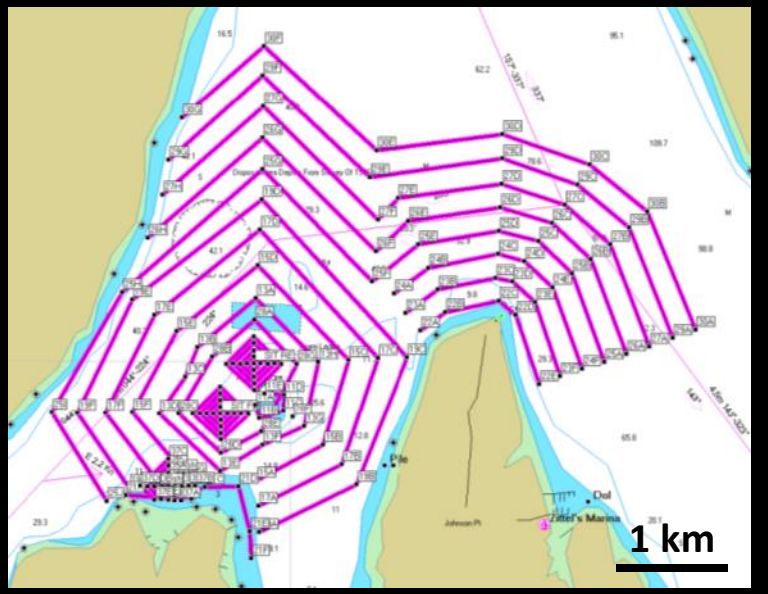
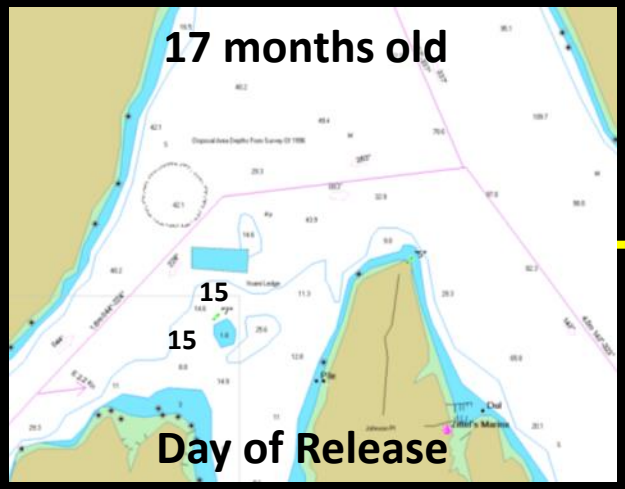
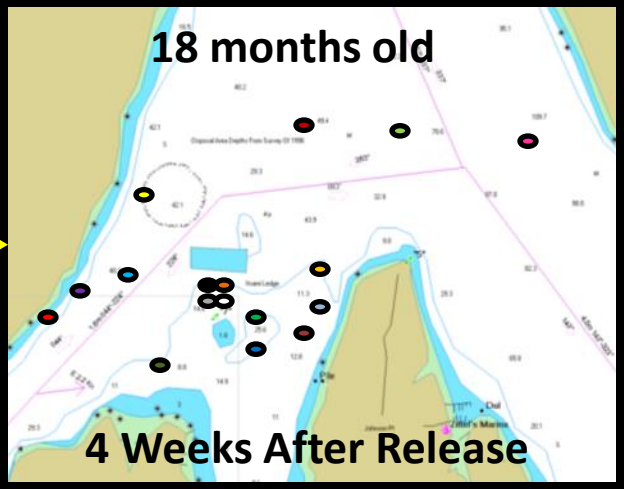




Released at 17 months old





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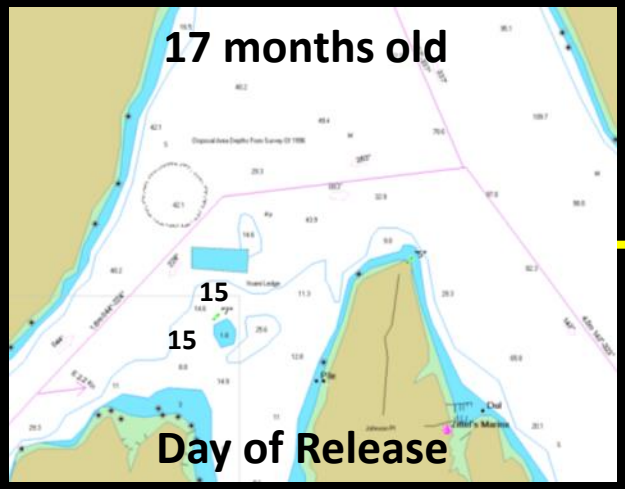

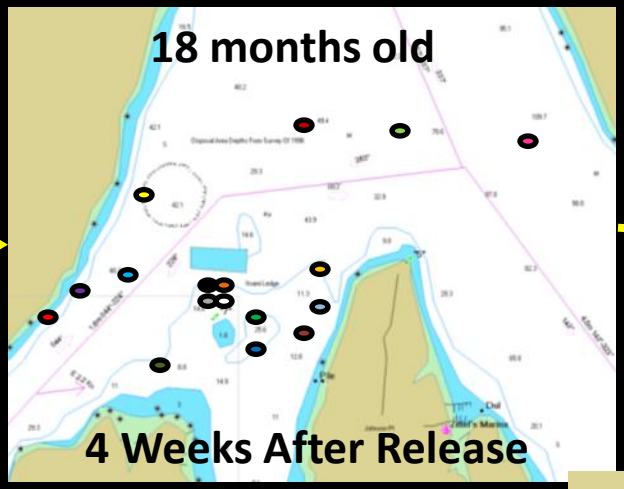

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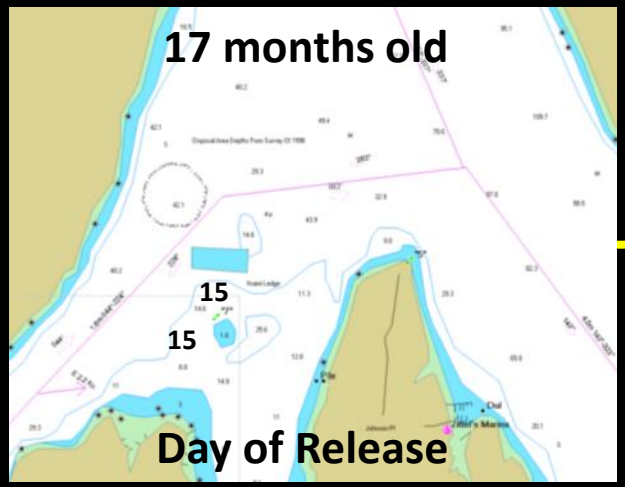

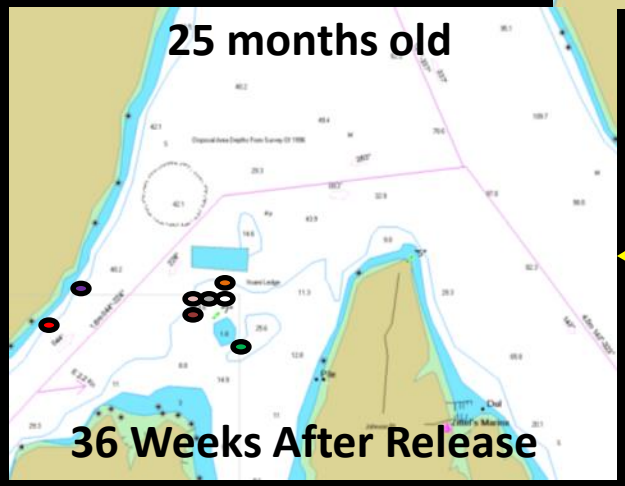

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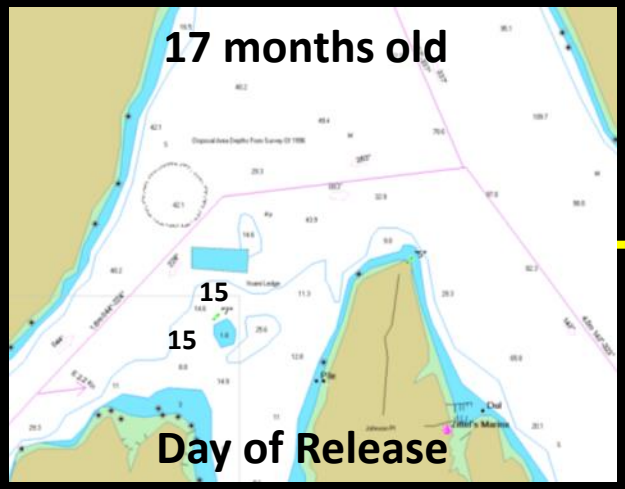

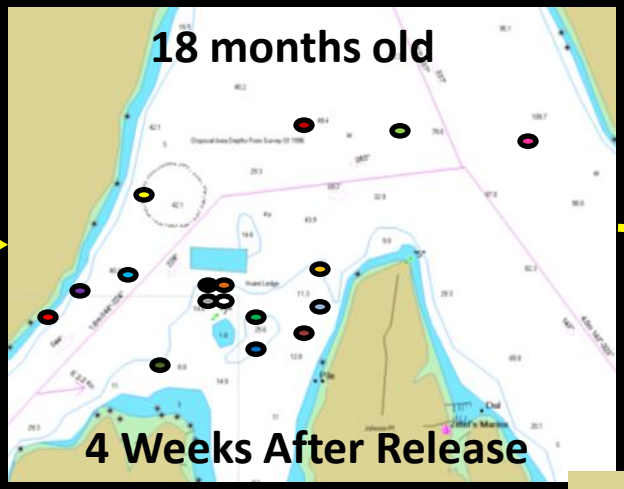

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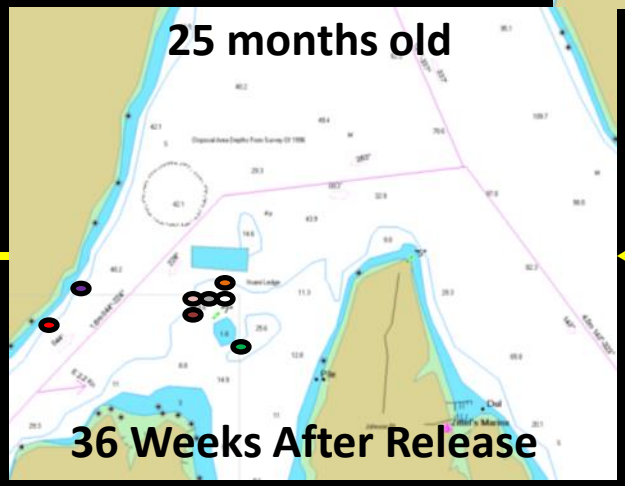
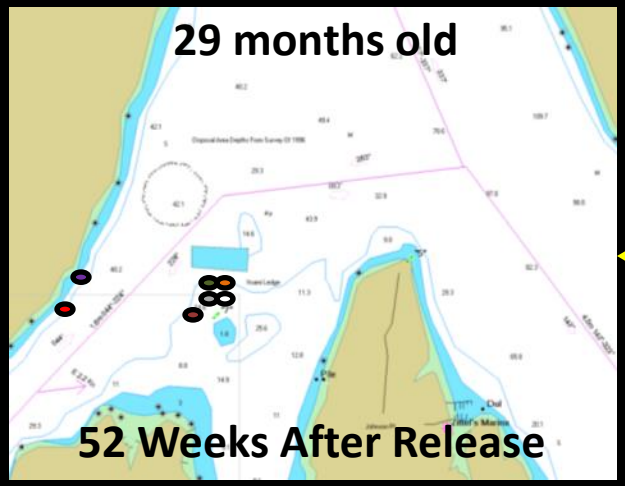
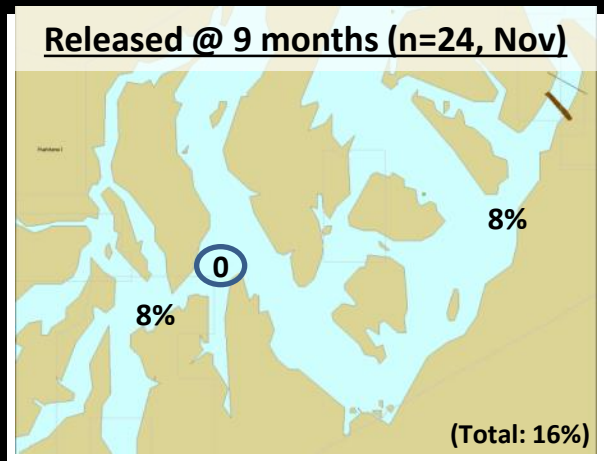
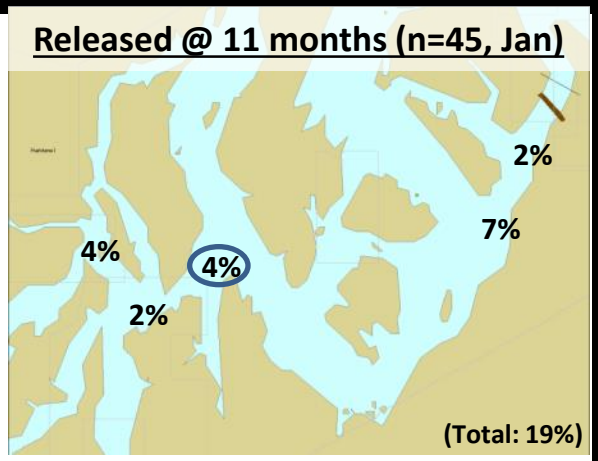
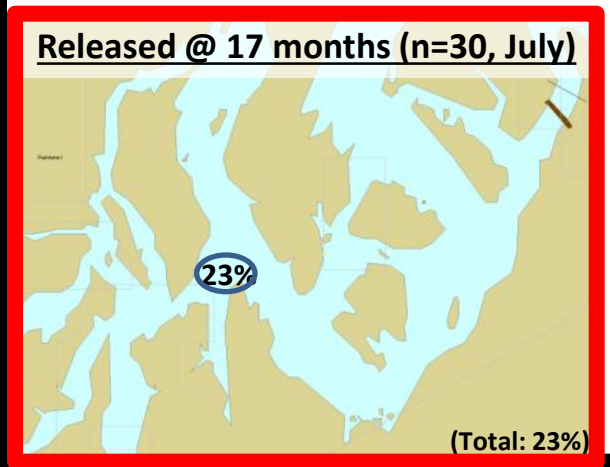
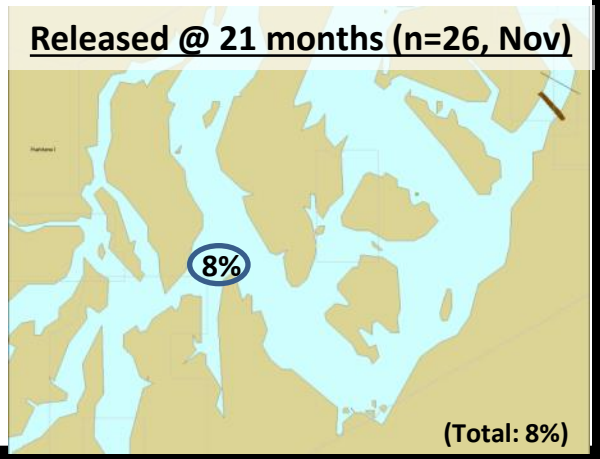




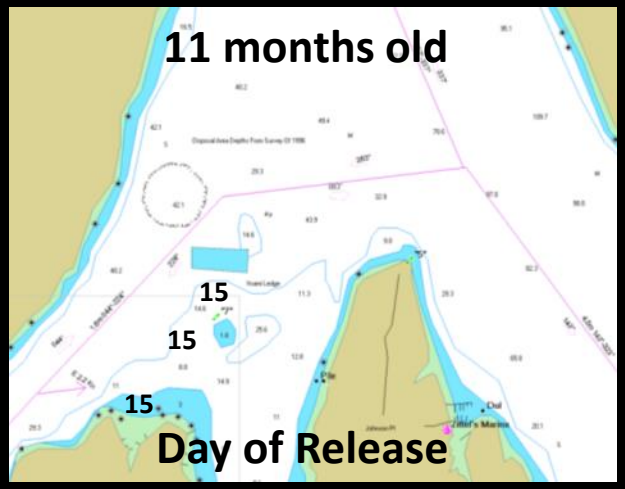


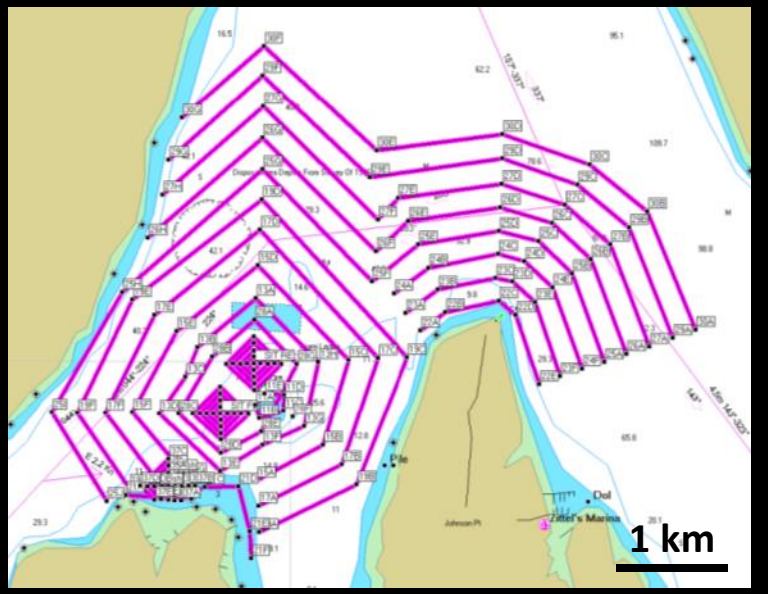




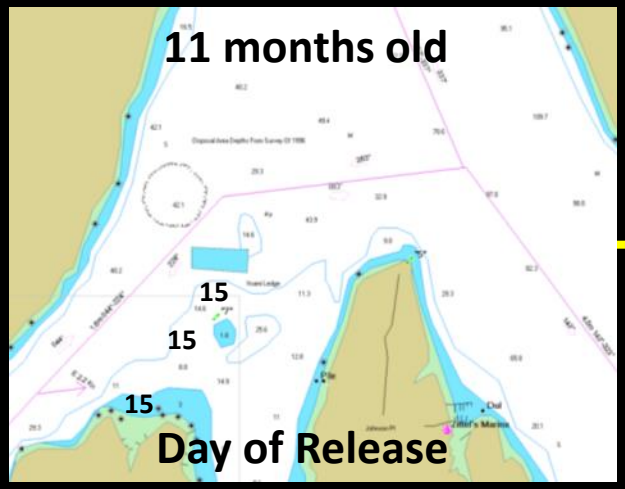


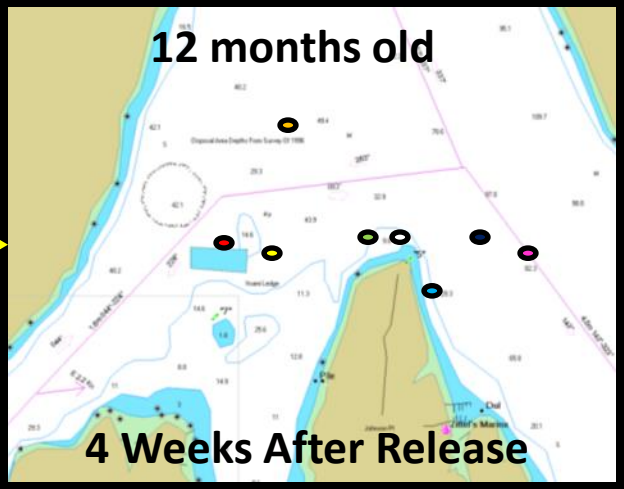
Fish locations approximately one year after release





Released at 11 months old





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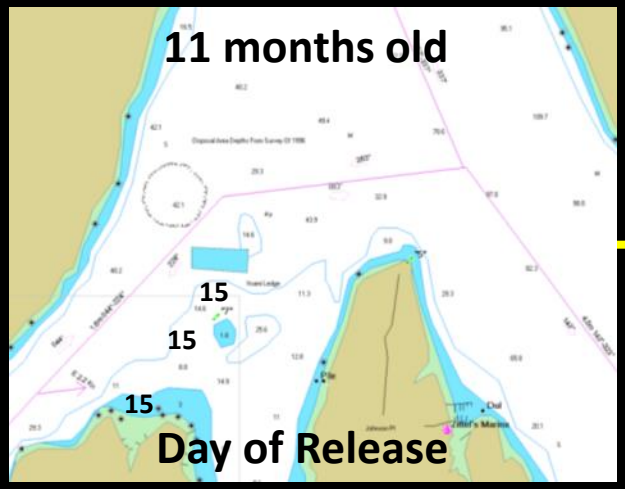

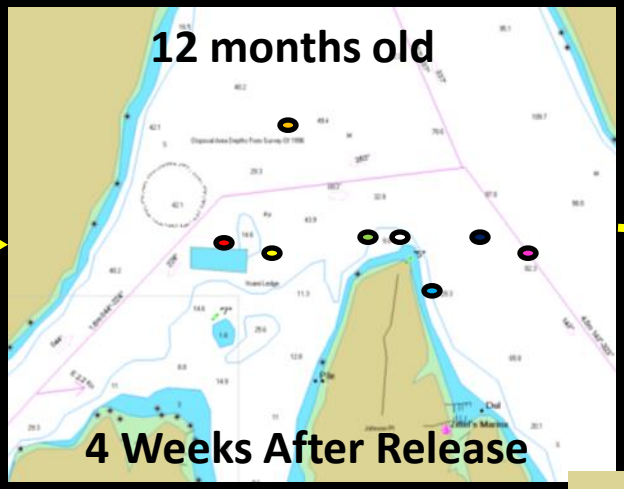

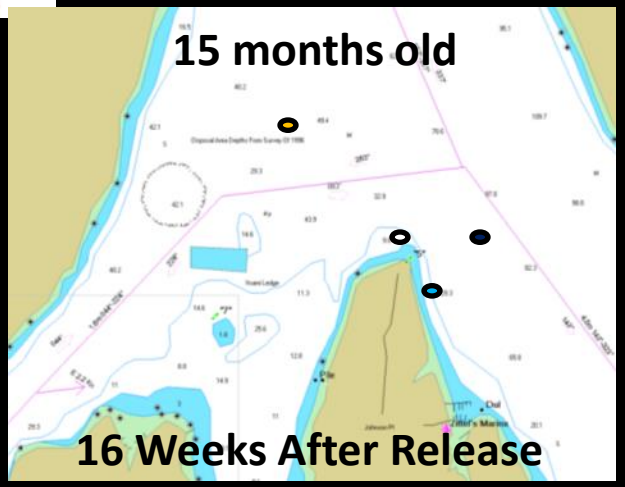

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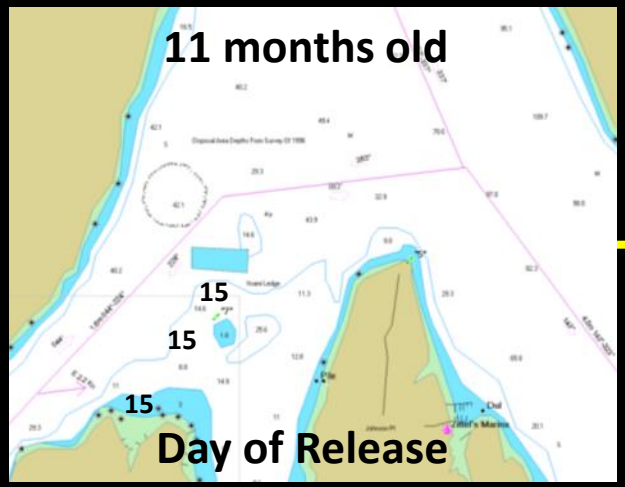

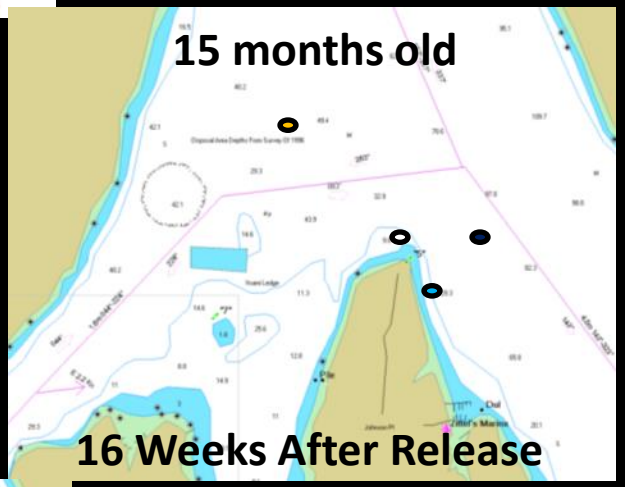

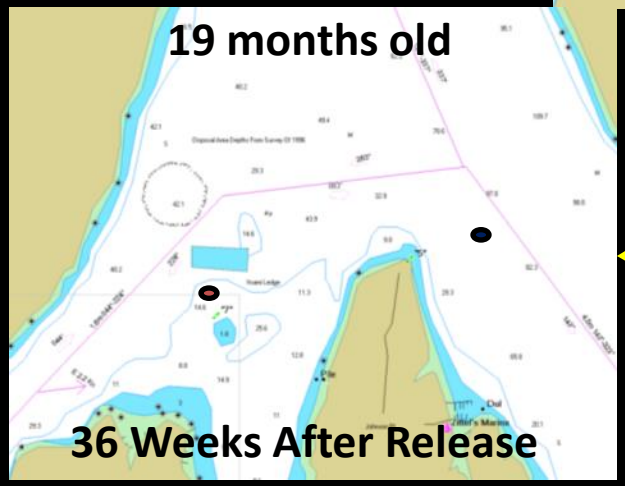

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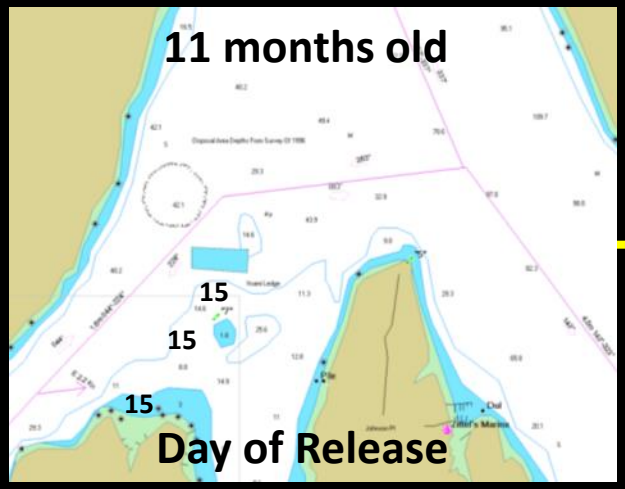

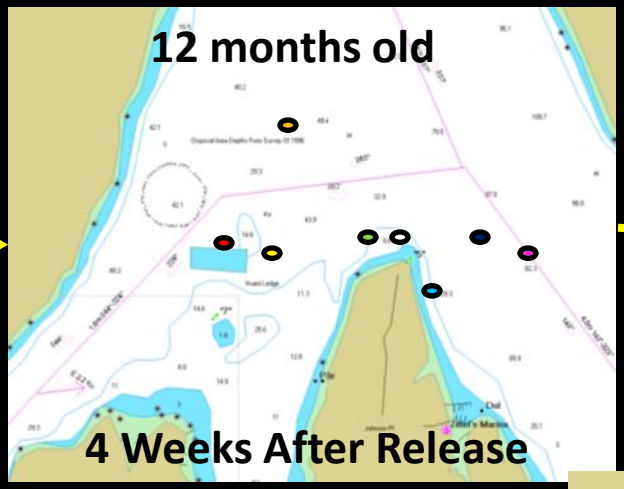

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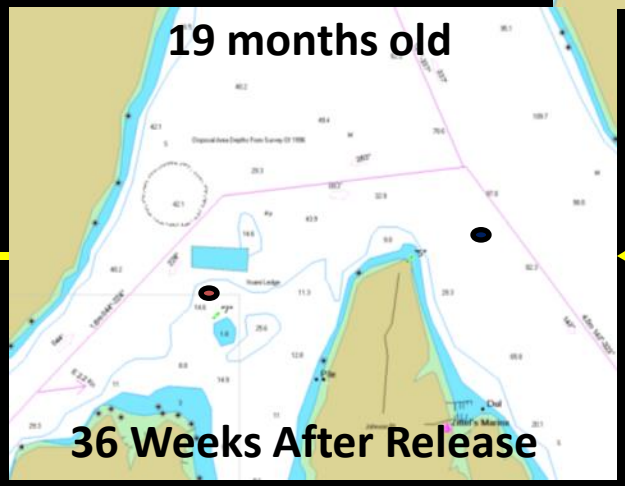
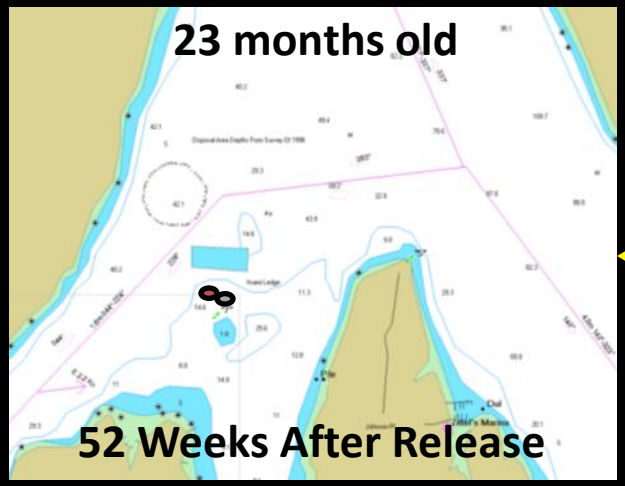
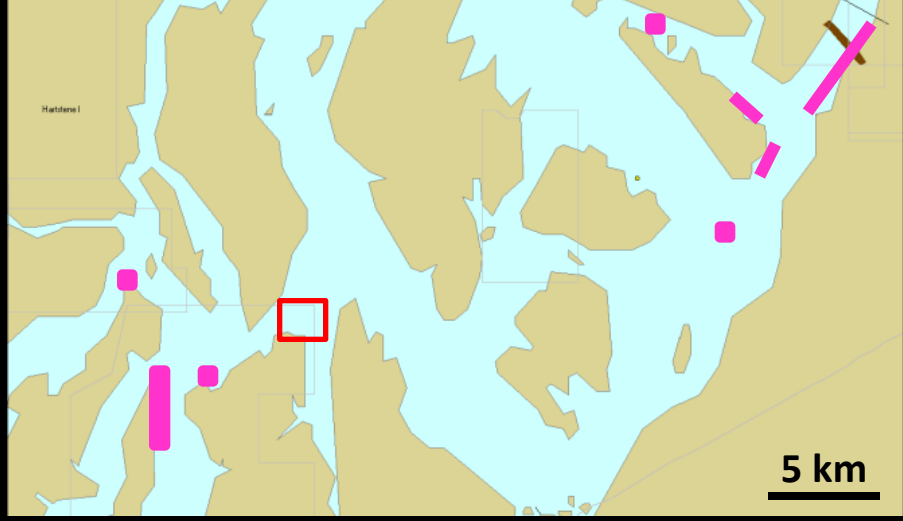
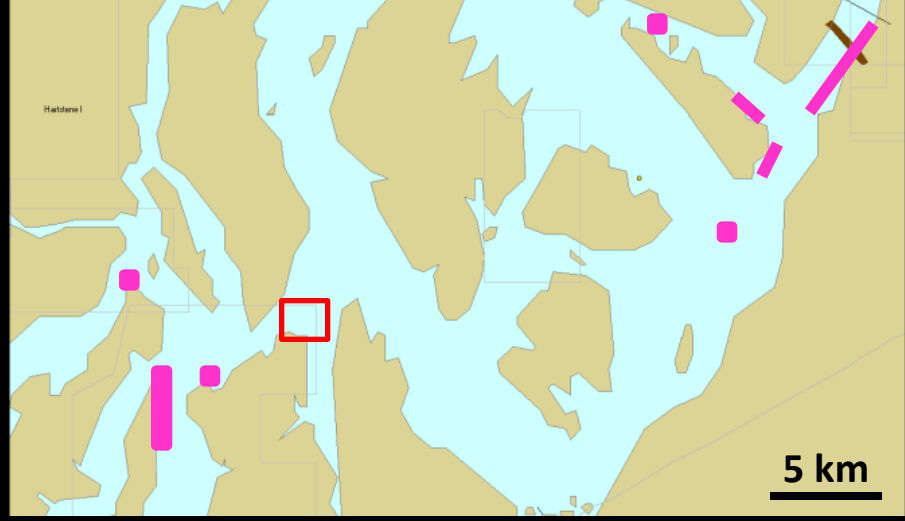






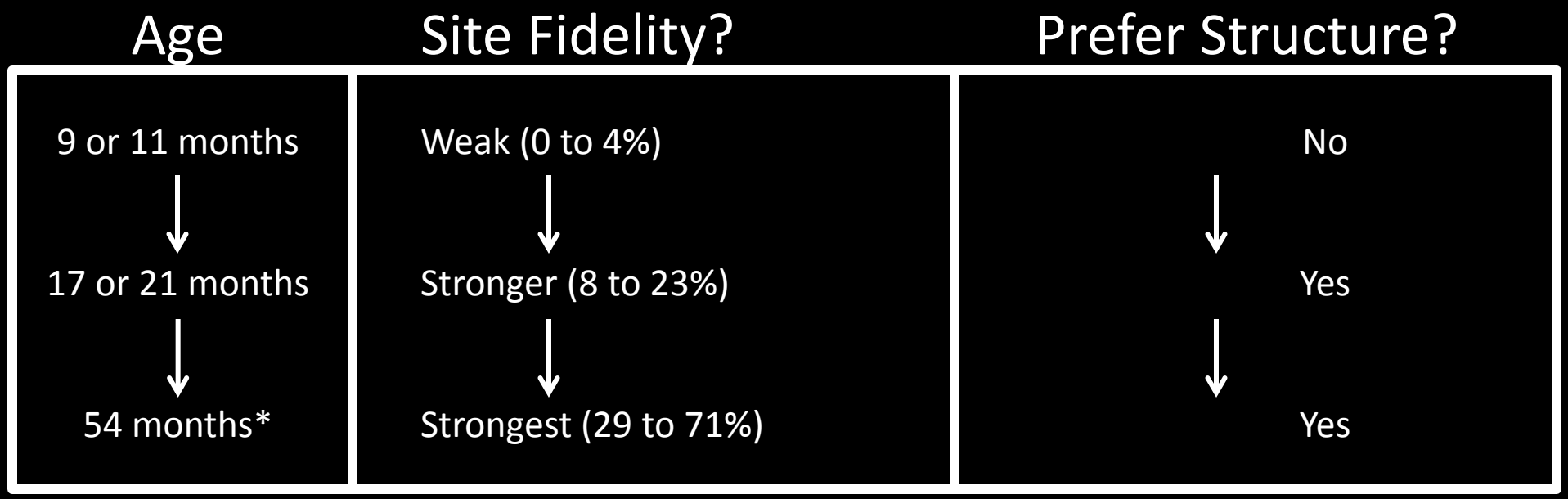
Released at 11 months old



Released at 11 months old

Structured habitat is rare in South Puget Sound, so presence on that habitat indicates a preference, not random movement.

Life History of Hatchery Lingcod



*Lee et al. in press, Environmental Biology of Fishes

Life History of Hatchery Lingcod (Wild)

Age	Site Fidelity?		Prefer Structure?	
9 or 11 months	Weak (0 to 4%)	(?)	No	(No)
↓	↓		↓	
17 or 21 months	Stronger (8 to 23%)	(?)	Yes	(Yes)
↓	↓		↓	
54 months*	Strongest (29 to 71%)	(45%**)	Yes	(Yes)

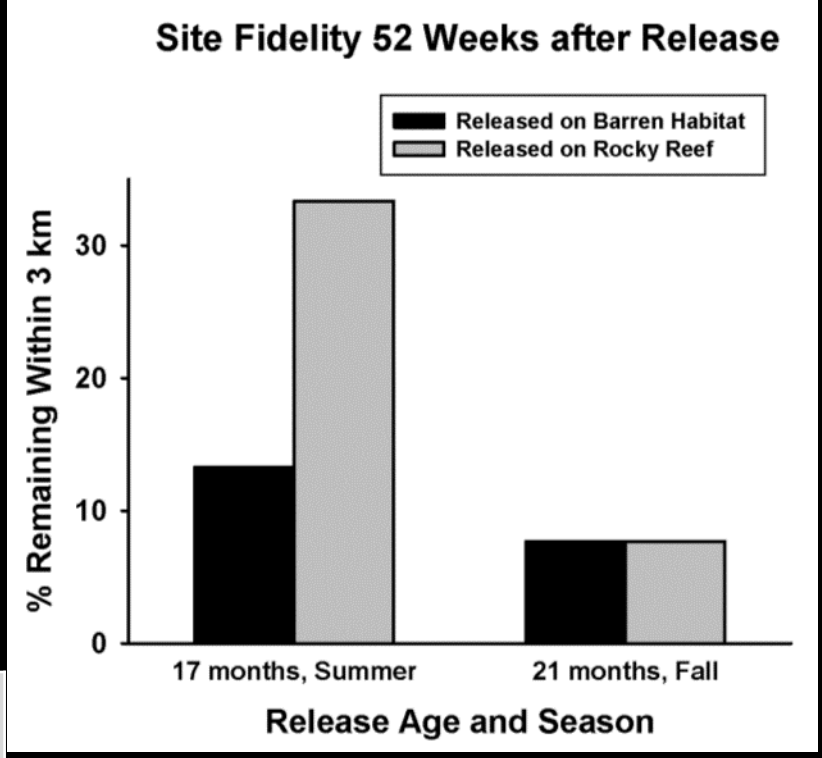
Conclusion: At least for these measures, hatchery lingcod behave like wild lingcod

*Lee et al. in press, Environmental Biology of Fishes

**Bishop et al. 2010, PLoS One

Release Habitat

Brood Year	Release Age & Season	Release Depth, Habitat
2008	9 months, Fall	5 m, barren (n=12) 5 m, vegetated (n=12)
2009	11 months, Winter	5 m, vegetated (n=15) 15 m, barren (n=15) 15 m, rocky reef (n=15)
2008	17 months, Summer	15 m, barren (n=15) 15 m, rocky reef (n=15)
2008	21 months, Fall	15 m, barren (n=13) 15 m, rocky reef (n=13)



Conclusion

For BACI, we will release 17-month old lingcod onto rocky reef habitat.

Summary

Release Methods

- Best release age/season was 17-months/summer
- Releasing onto rocky reef habitat may promote fidelity

Summary


Larvae that will be released in July 2012

Release Methods

- Best release age/season was 17-months/summer
- Releasing onto rocky reef habitat may promote fidelity

BACI Experiment

- If repeatable, 23% fidelity & no nearby dispersal should enable future BACI
- Habitat preference data will help us select future control and impact sites

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Larvae that will be released in July 2012

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- Best release age/season was 17-months/summer
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BACI Experiment

- If repeatable, 23% fidelity & no nearby dispersal should enable future BACI
- Habitat preference data will help us select future control and impact sites

Other Implications

- Hatchery & wild fish showed similar movement patterns & habitat affiliations
- Life history data will be helpful in planning full-scale enhancement releases

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Lingcod Rearing and Tracking

Matt Cook, Jeff Atkins, Ken Massee, Rob Endicott