

Interactions between Offshore Aquaculture and Fisheries

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Photo: NOAA

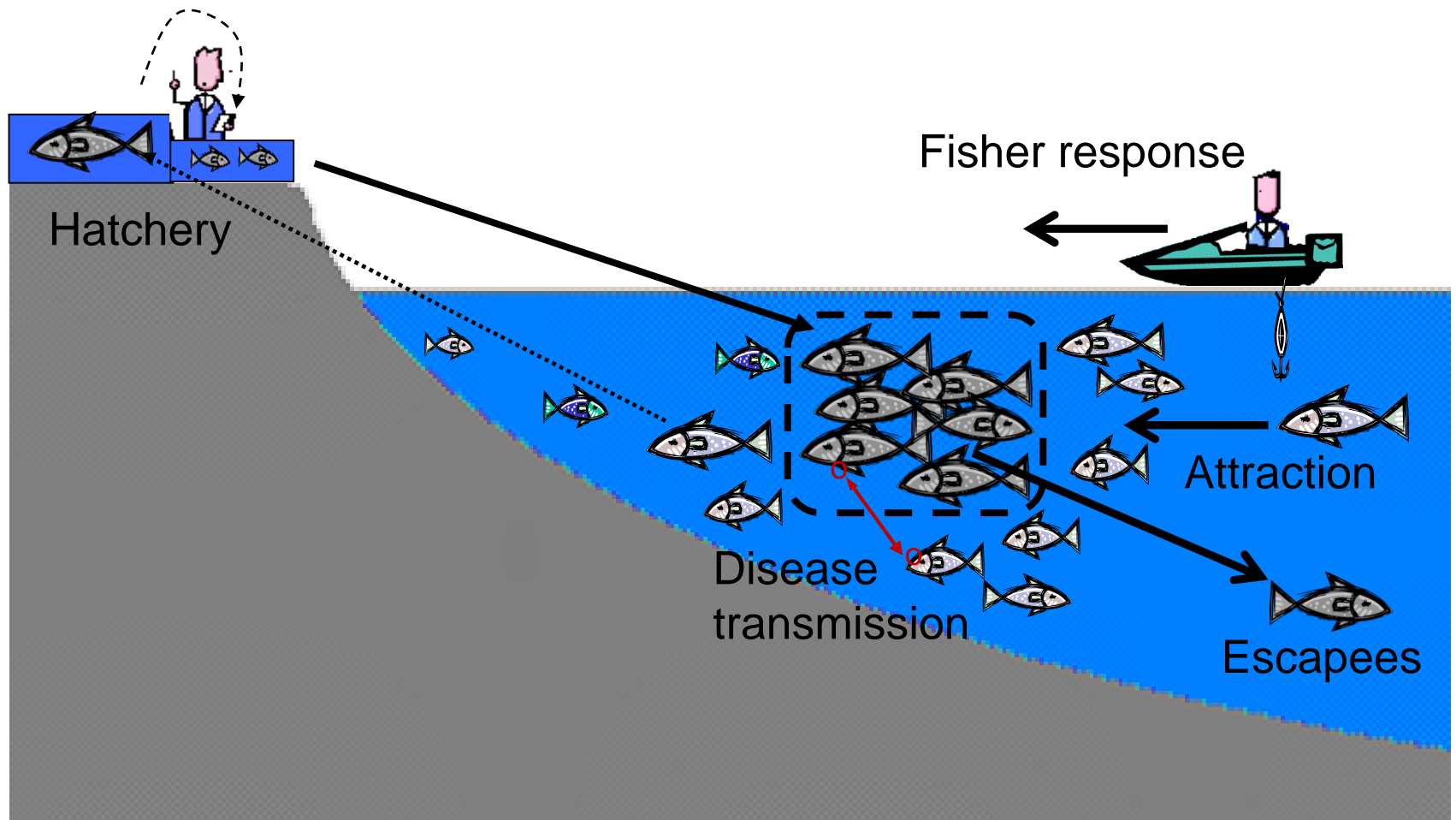
Potential interactions and concerns

- Loss of access to fishing grounds
- Pollution
- Interactions between escaped farmed fish and wild fish
- Attraction of wild fish to cage sites
- Disease transmission
- Fisher responses to altered fishing opportunities
- Market interactions between products

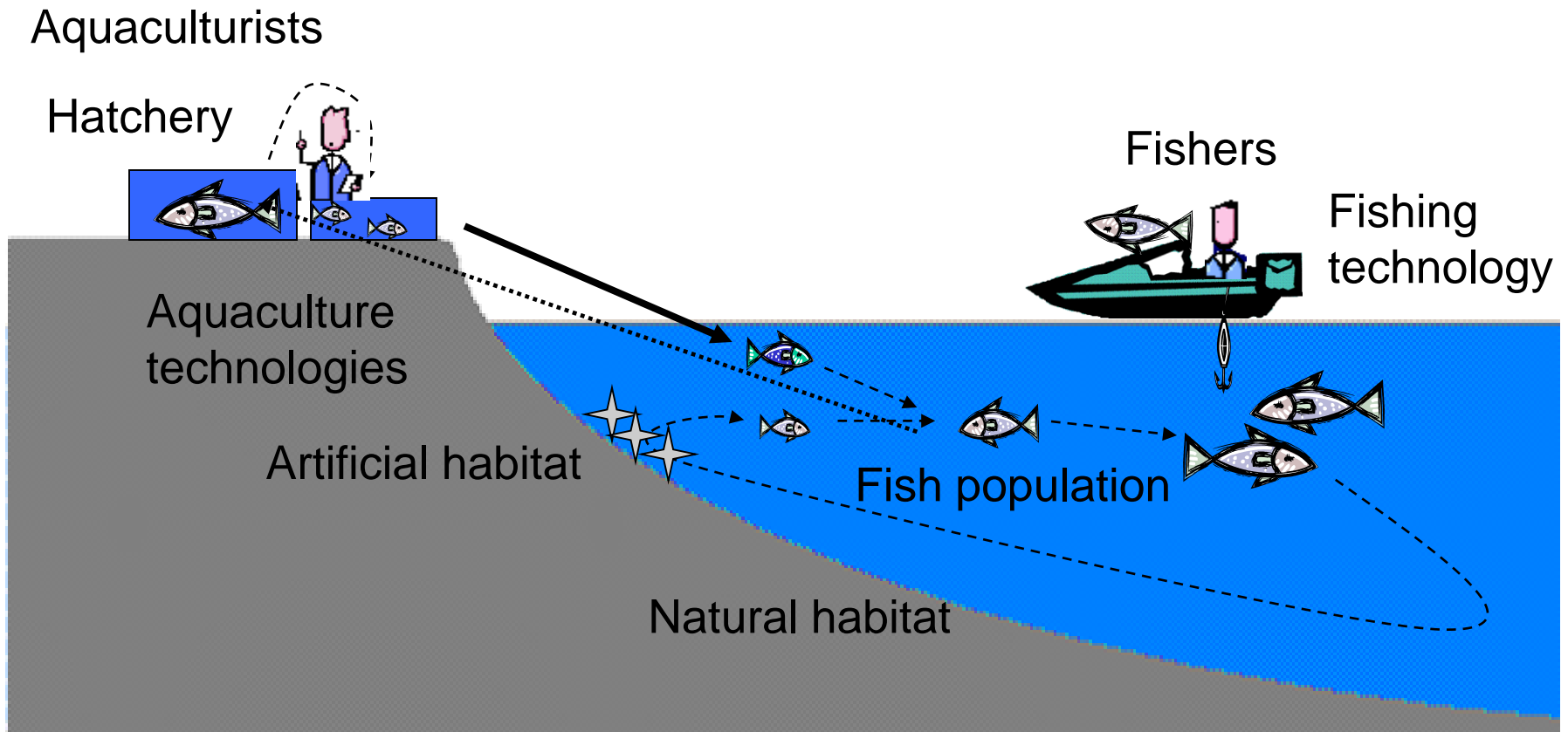
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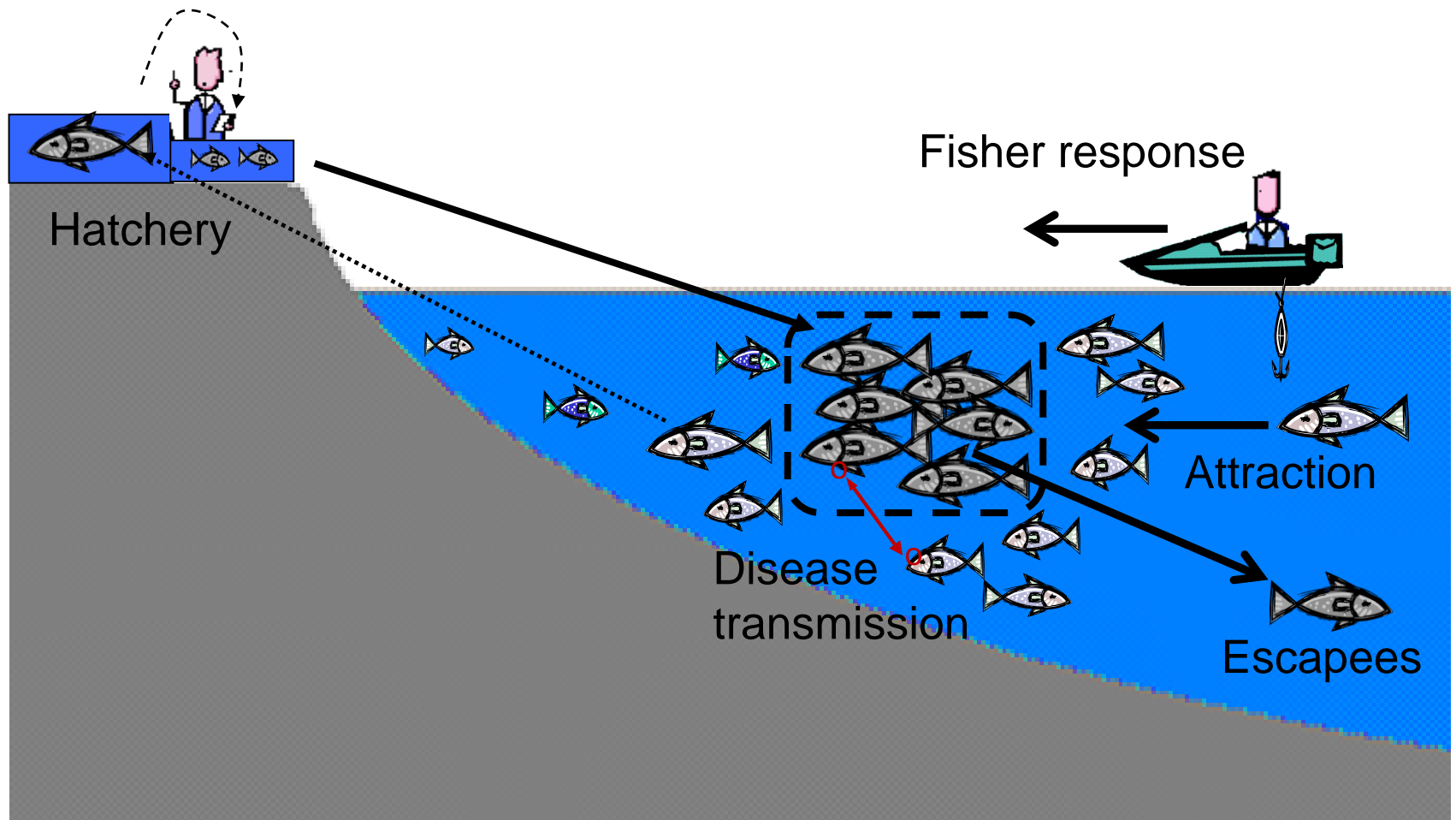
Interactions between Offshore Aquaculture and Fisheries



Much can be learned from the practice and science of fisheries enhancement: hatchery fish and artificial habitat

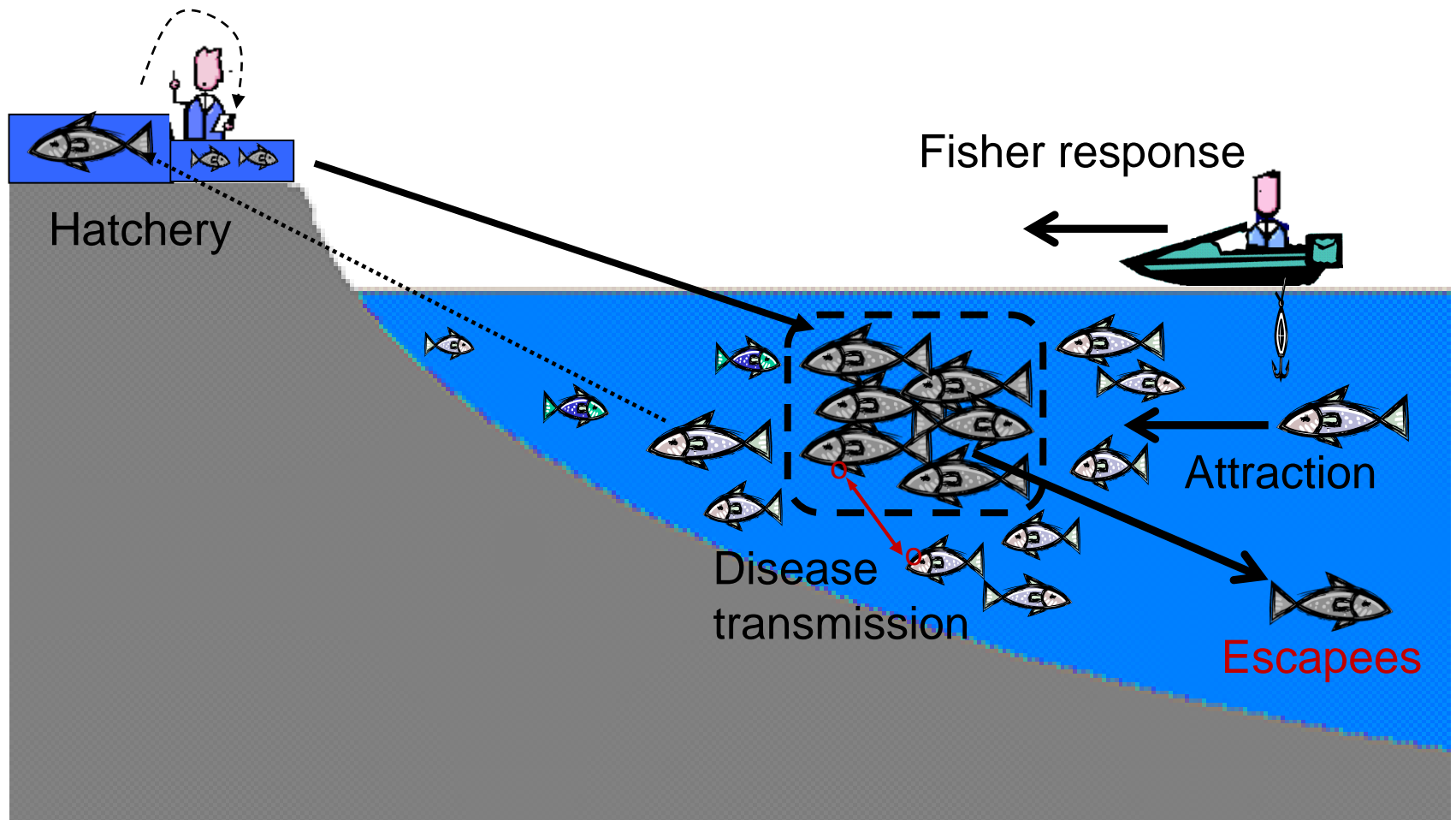


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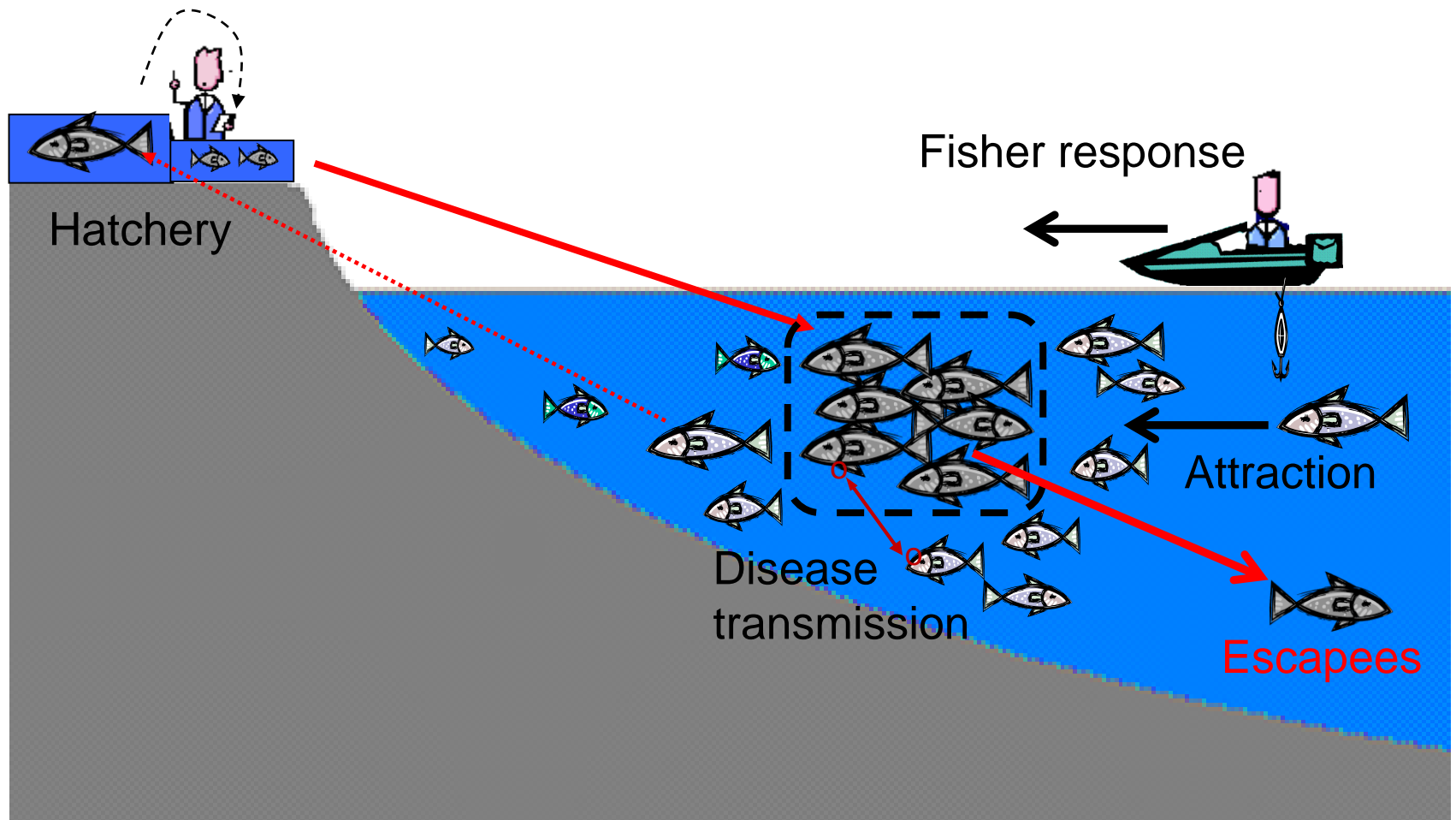
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Escapees

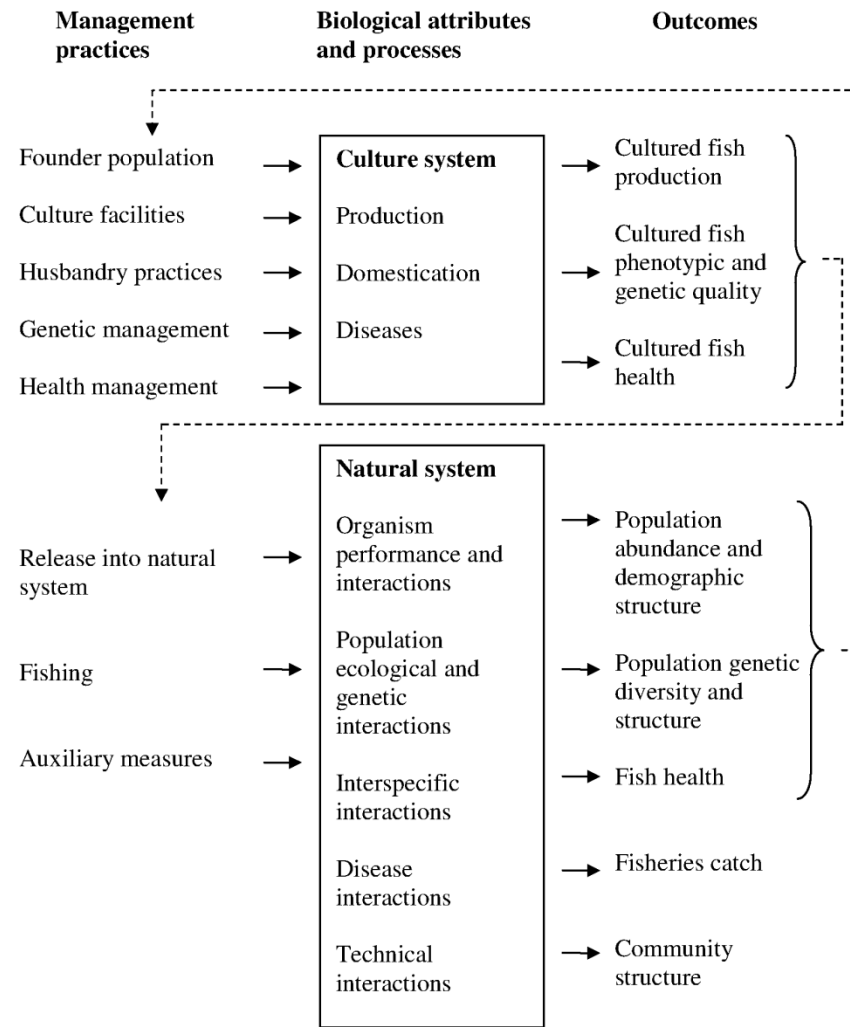


Interactions between Offshore Aquaculture and Fisheries

Escapees



Interactions between farmed and wild fish

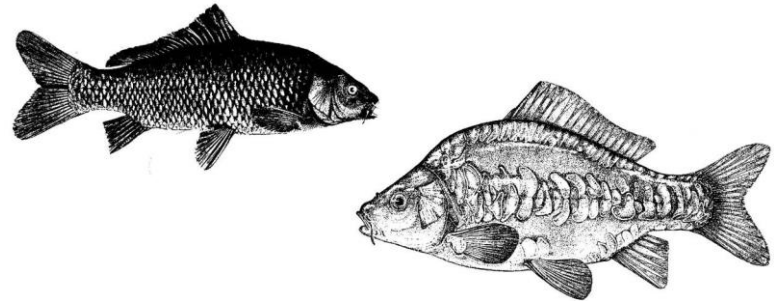


Key factors: relative abundance and conservation status of the wild population

- Most interactions* are strongest when farmed fish are abundant relative to wild fish.
- Small/declining wild populations may be particularly vulnerable to such interactions.
- Consider Atlantic salmon in Norway vs. Almaco jack or red drum in the Gulf

* Exceptions: introduction of invasive fish or parasites/pathogens

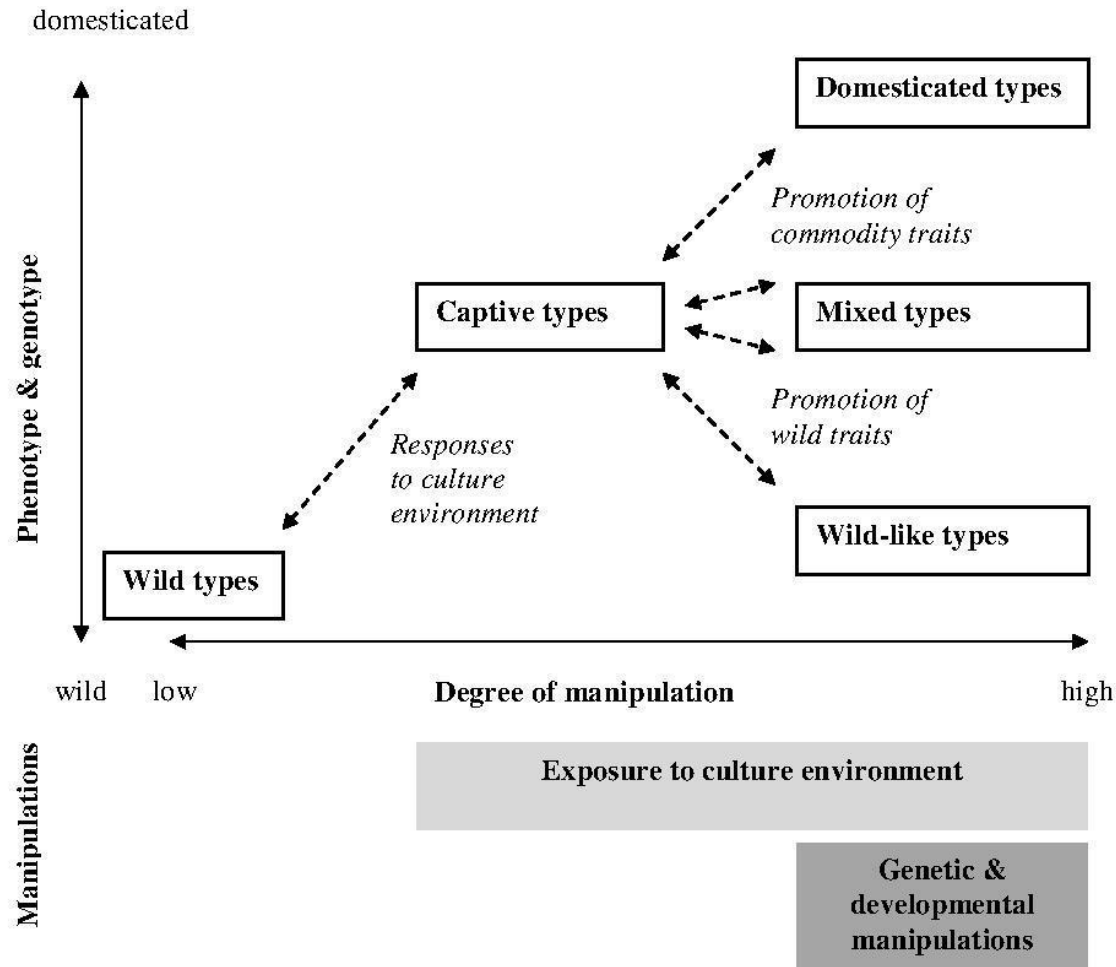
Cultured fish undergo a process of domestication



Domestication involves (Price 2002):

- genetic changes occurring over generations and
 - developmental effects (phenotypic plasticity) recurring during each generation
- Improved performance in culture
- Reduced performance (fitness) in the wild

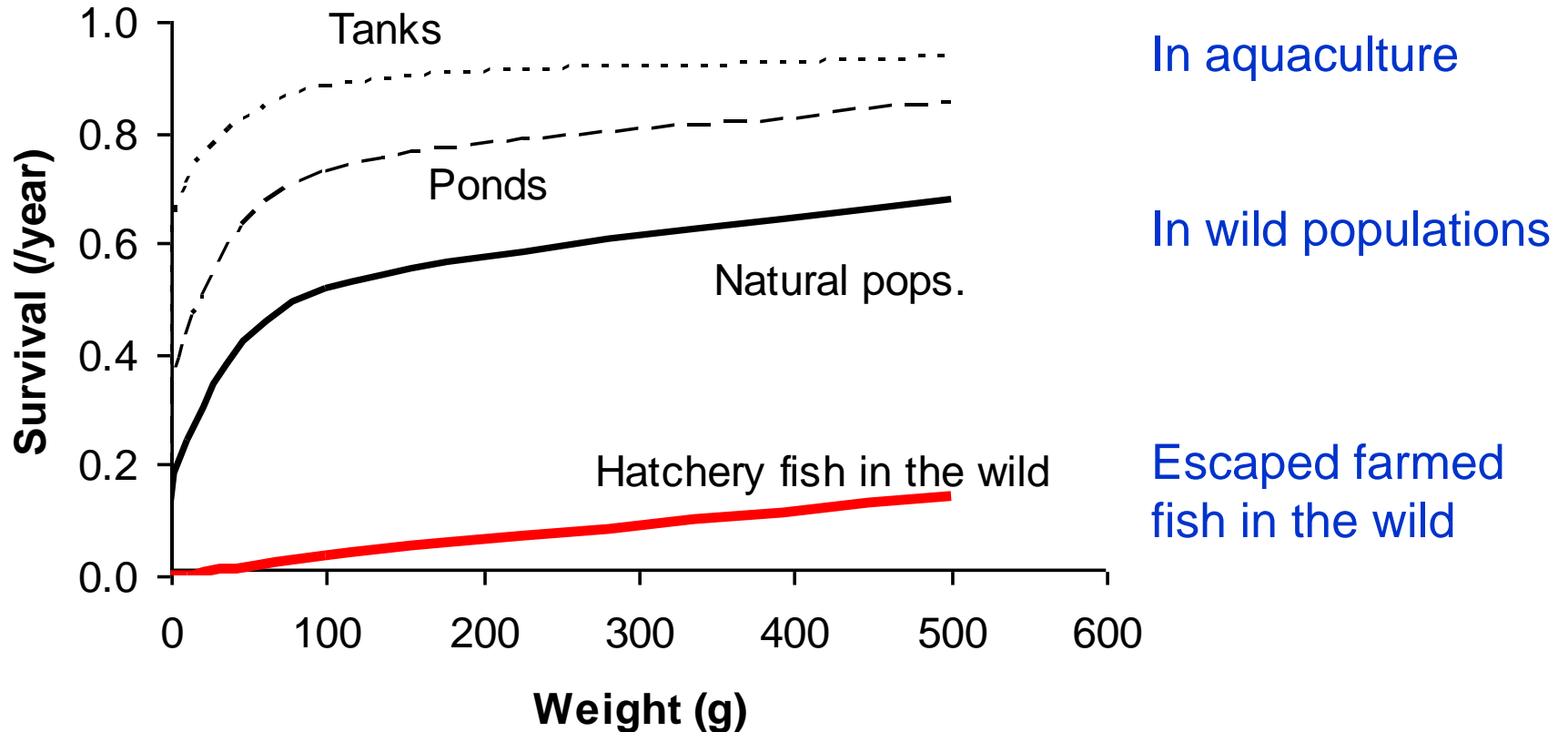
Processes and modes of domestication



Natural vs. aquaculture environment

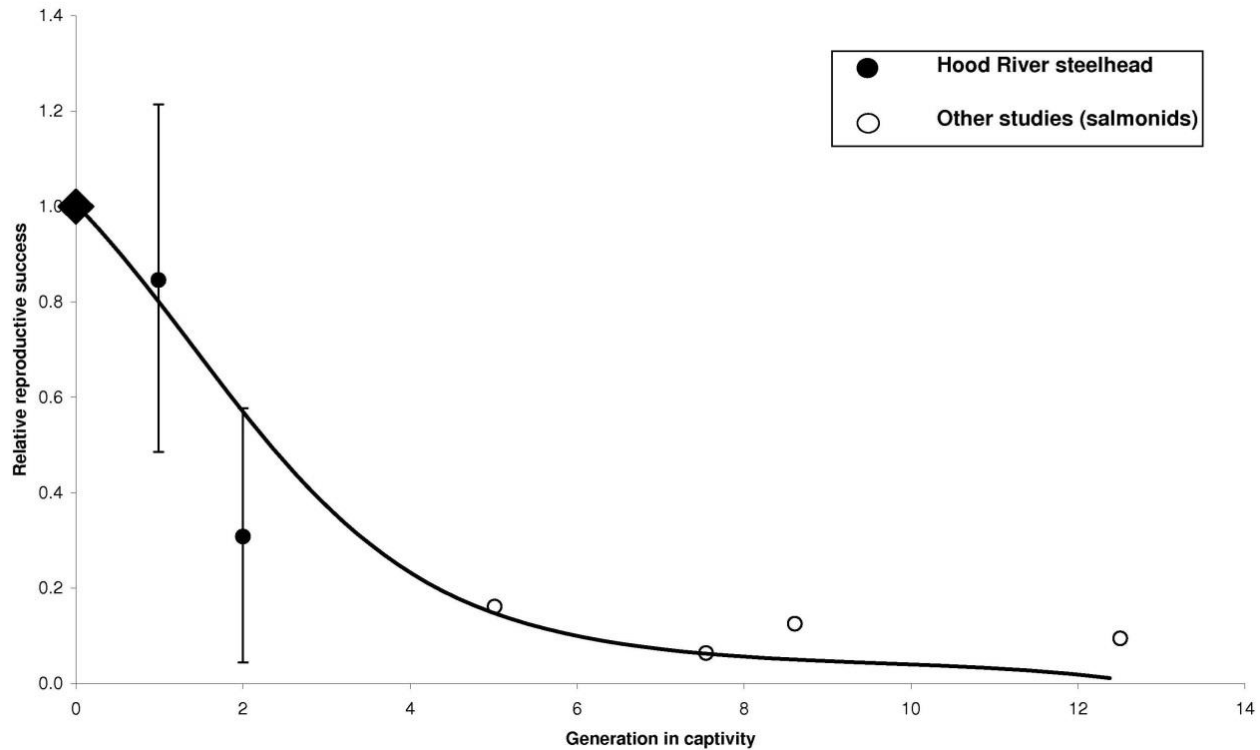
Attribute	Natural habitats	Aquaculture
<i>Overall extent</i>	Large, often open	Small, confined
<i>Complexity</i>	High	Low
<i>Resource availability</i>	Lower than uptake capacity, unpredictable	Matching or exceeding uptake capacity, predictable
<i>Predation risk</i>	High	Very low
<i>Disease risk</i>	Variable	High (but controllable)
<i>Population density</i>	Low	Very high
<i>Disturbance</i>	Rare	Very common
<i>Selection</i>	Natural, sexual	Artificial, natural

Comparative survival of fish



Based on data from Lorenzen 1996, 2000

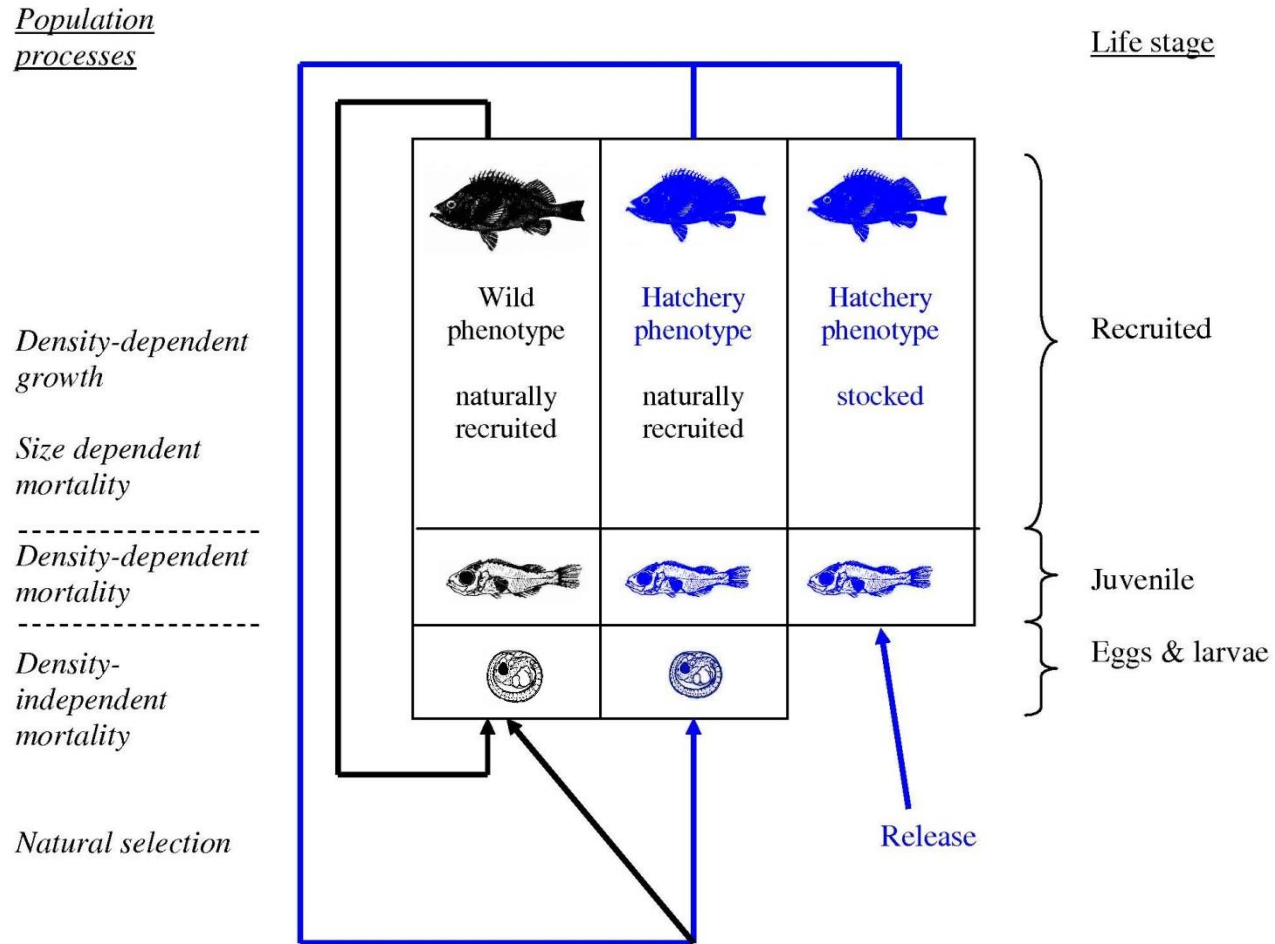
Genetic loss of fitness—in-the-wild vs. number of generations in captivity



Araki et al. *Conservation Biology* 21: 181-190, 2007

How do escapees interact with wild conspecifics?

Population model for enhanced fisheries



Some generic results

Strongest interactions when:

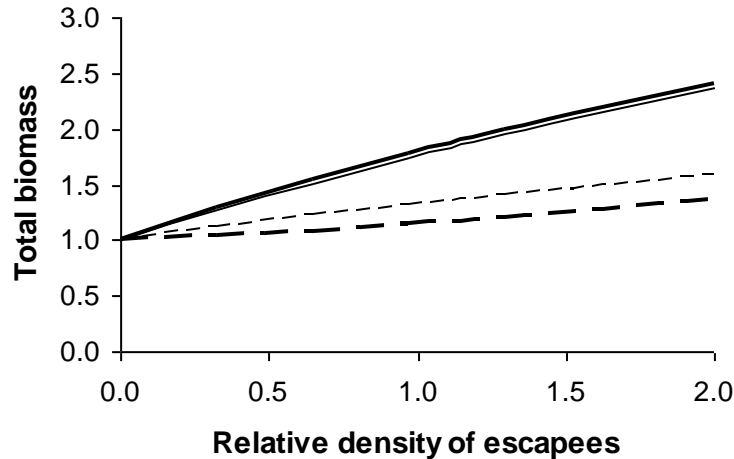
- farmed fish abundance is high relative to wild
- maladaptation to life in the wild is only moderate and genetically based.

→ When farmed fish abundance is very low relative to wild fish, interactions are minimal.

→ When farmed fish abundance is high, alternative husbandry and genetic management approaches can give very different outcomes

Impacts of farm escapees on wild populations: effects of survival and reproduction

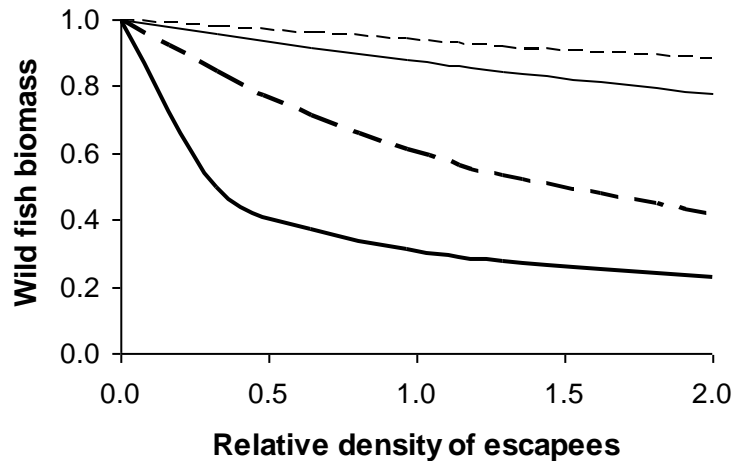
Total
biomass



Wild-like survival, no reprod.
Wild-like survival, reprod.

Low survival, no reprod.
Low survival, reprod.

Wild type
biomass

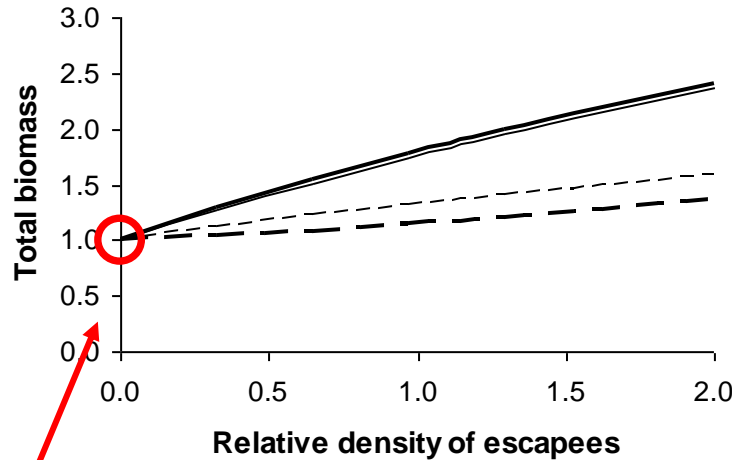


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Impacts of farm escapees on wild populations: effects of survival and reproduction

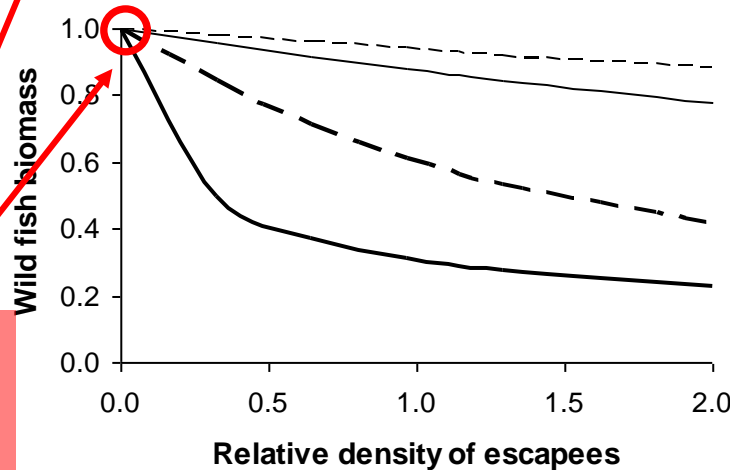
Total biomass



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Low survival, no reprod.
Low survival, reprod.

Wild type biomass



Low survival, no reprod.
Wild-like survival, no reprod.

Low survival, reprod.
Wild-like survival, reprod.

If the number of escapees is very low, non of this matters

Minimizing risks from escapes: alternatives

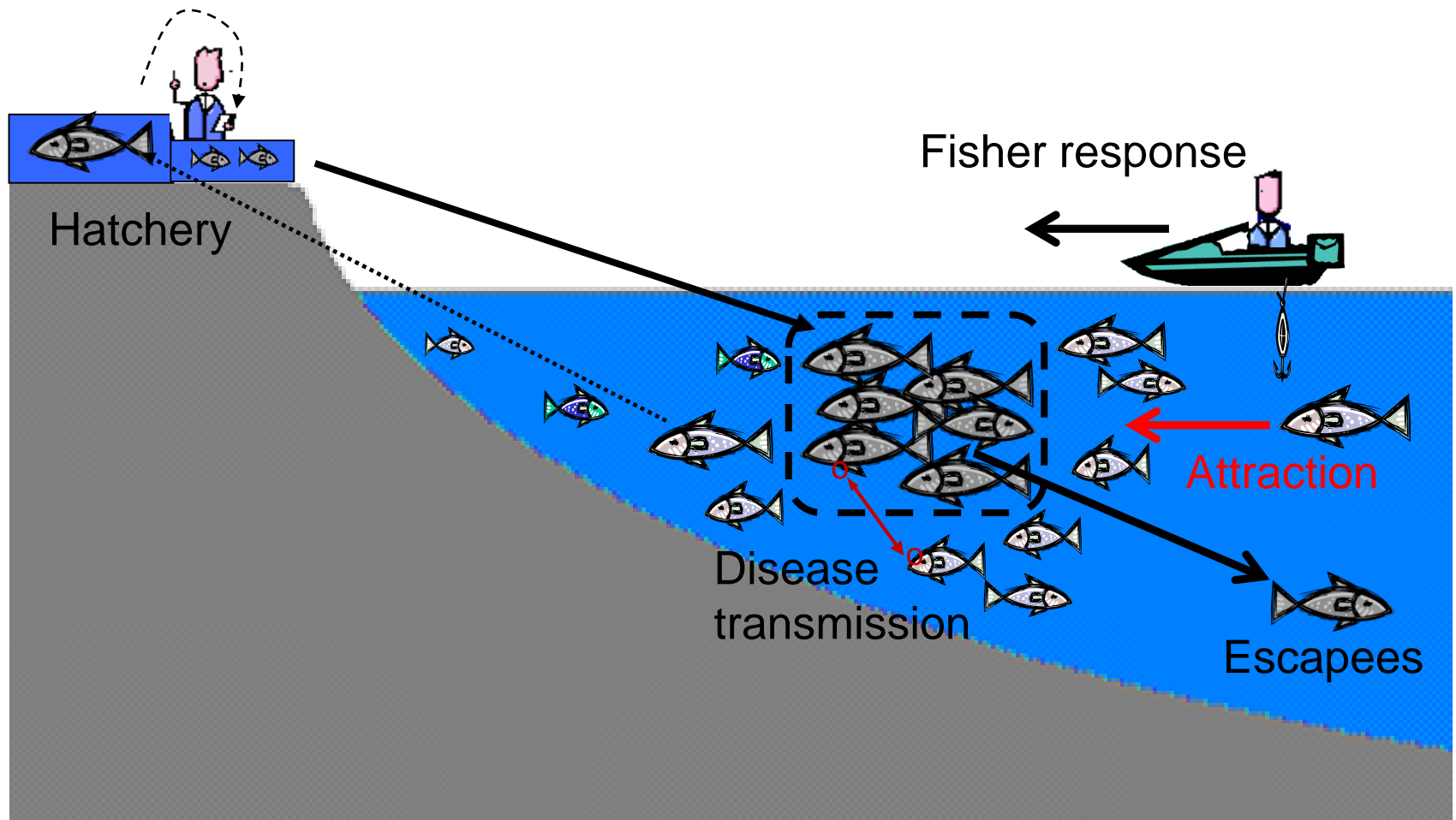
1. Reduce escapes (review when and where escapes occur and improve facilities/management)
2. Produce sterile fish (triploids)
3. Advance domestication: benefit aquaculture and reduce performance in the wild (multiple traits?)
4. Preserve wild attributes in cultured fish (stock structure, adaptation)
5. Multiple measures (1–3) may be most effective

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Attraction of wild fish to cages

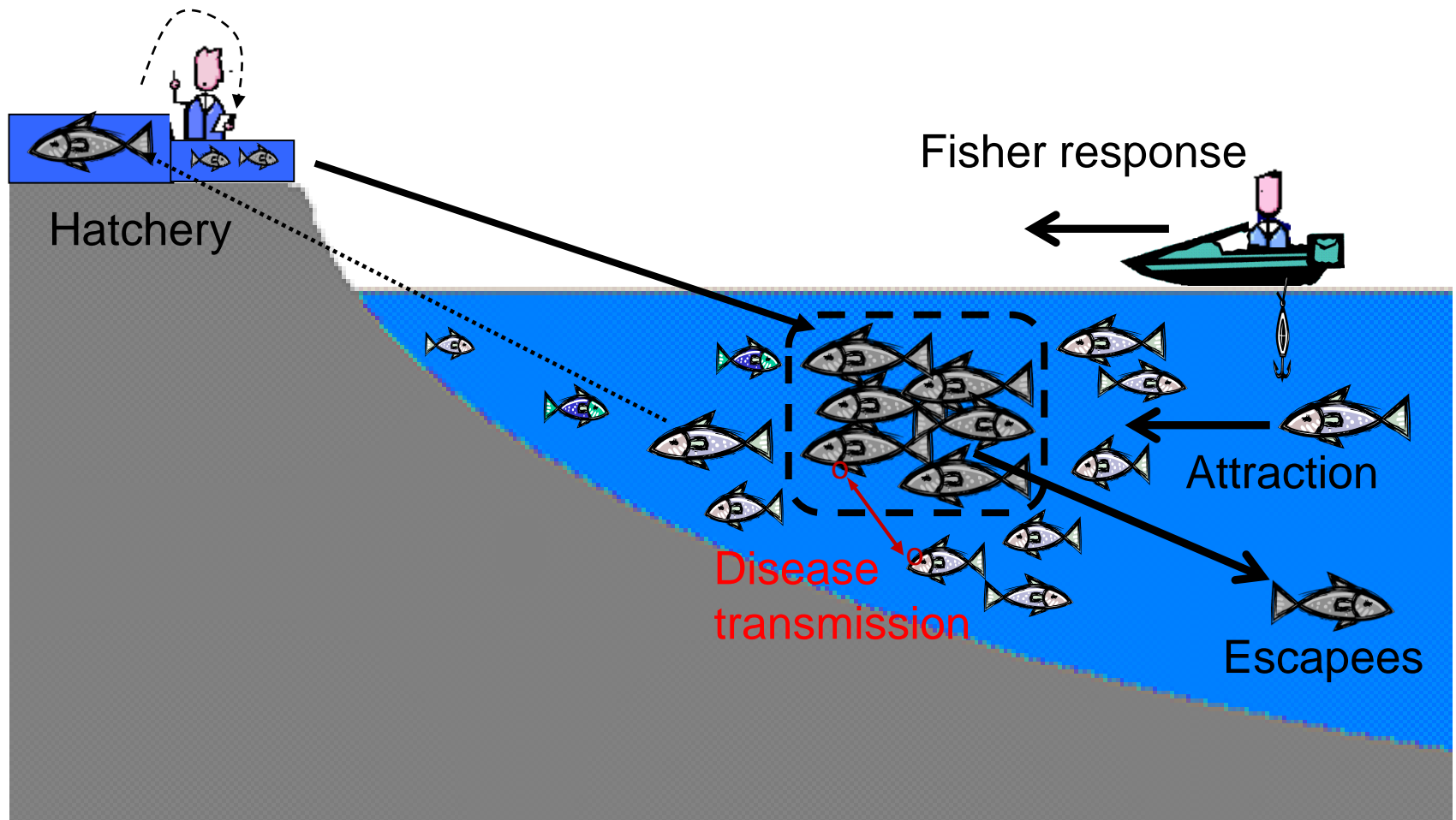


Attraction and aggregation of wild fish

- Cage aquaculture operations have impacts on the behavior of wild fish
- Attracting and aggregating fish in ways similar to fish aggregation devices or artificial reefs
- Enhances the scope for certain biological interactions such as disease transmission
- Enhance harvesting opportunities for fishers.

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Disease (parasite) transmission

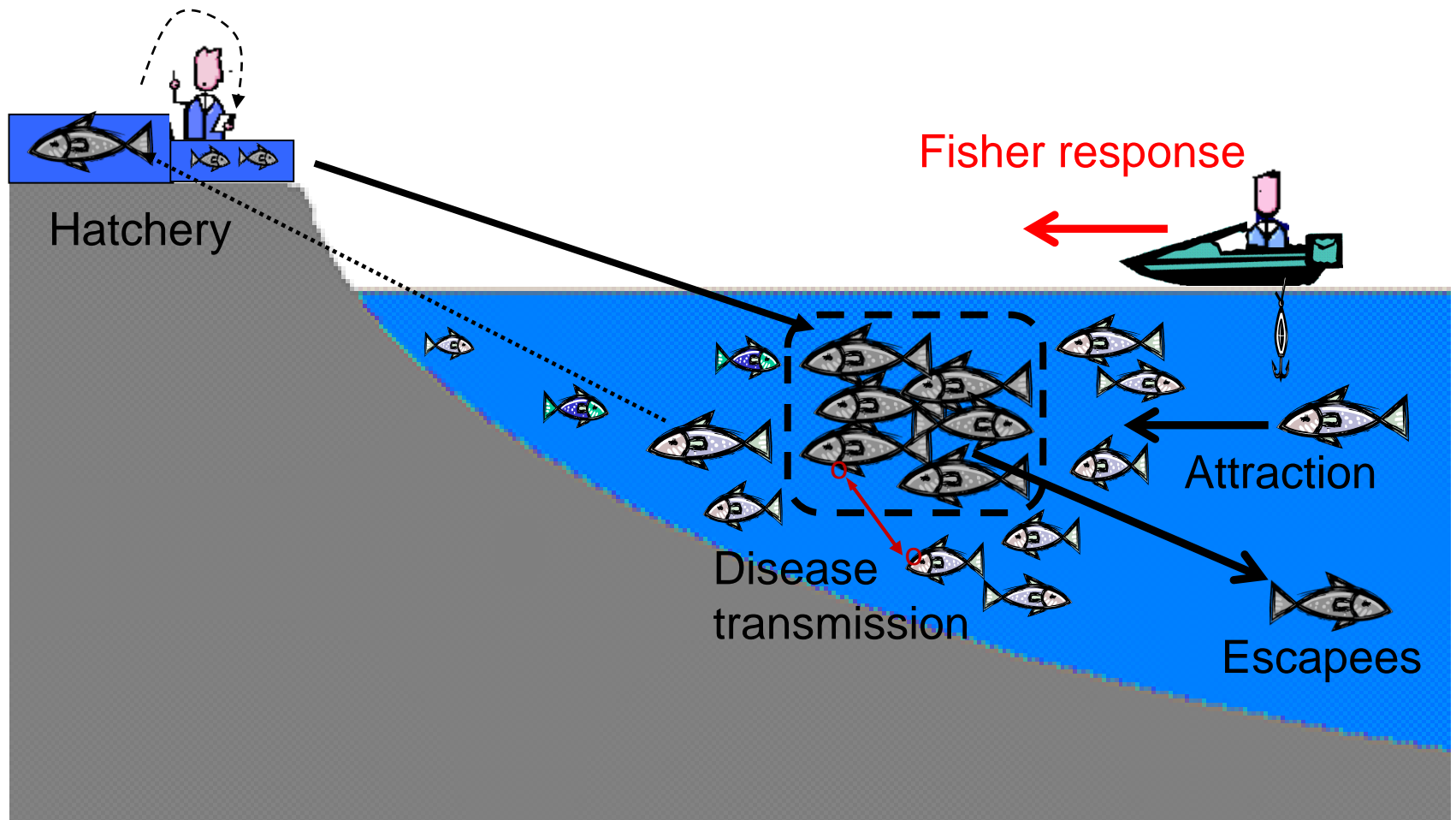


Disease (parasite) transmission

- Formulated feed & low predation in culture largely eliminate transmission of macroparasites with complex life cycles
- High density in culture enhances transmission of microparasites with direct life cycles (e.g. bacteria, viruses, sea lice) and may lead to evolution of higher virulence
- Open nature of cage farm allows transmission of microparasites to wild fish
- Health management (vaccination, treatment) on the farm is key to minimizing risk of transmission to wild stocks but is not always sufficient

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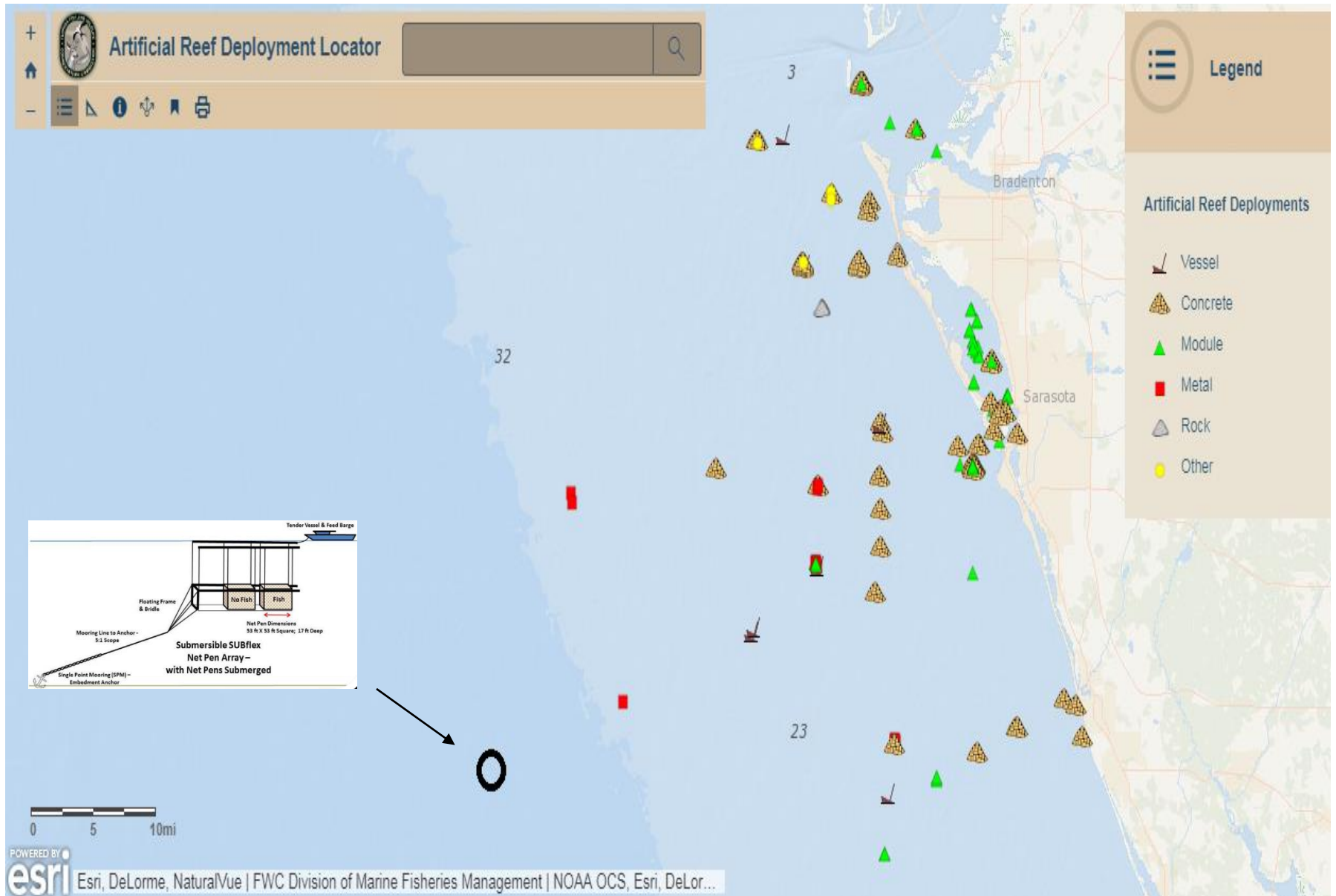
Fisher responses



Fisher responses

- Fishers may seek out harvesting opportunities provided by escaped farmed and aggregated wild fish.
- Can reduce interactions between farmed and wild fish
- Can affect the exploitation level of wild stocks in ways similar to fish aggregating devices.
- Potential for complex interactions with fisheries that require concerted attention from both sectors

Velella Epsilon cage as a FAD/AR



Conclusions and outlook (I)

- Good conceptual understanding of potential interactions between offshore aquaculture and fisheries
- Increasingly sophisticated quantitative models and tools for risk assessment and management planning
- Learning from fisheries enhancements

Conclusions and outlook (II)

- Small-scale pilot projects for the culture of native species that are abundant in the wild pose limited risks
- Provide important empirical information on interactions with fisheries that can help to test and refine models, risk assessments and management plans.
- Fisheries interaction studies should complement pilot aquaculture projects.
- Studies should be accompanied by a stakeholder process involving fisheries and aquaculture stakeholders.

Conclusions and outlook (III)

Some issues and approaches are likely to change when/if the industry expands and develops, due to:

- Increase in numbers of facilities
- Increase in number of farmed fish and escapees
- Advancing domestication
- Emerging diseases