

# Phenotypes, selection, and ecology of stray hatchery salmon in nature

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149<sup>th</sup> Annual Meeting of the American  
Fisheries Society

The Science of Pacific Salmon  
Conservation: Foundations, Myths, and  
Emerging Insights



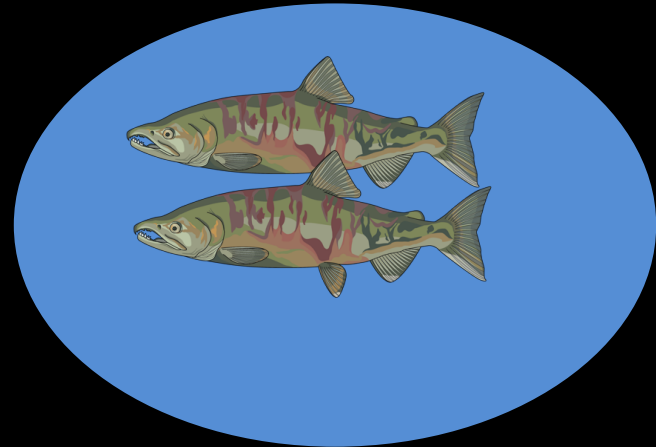
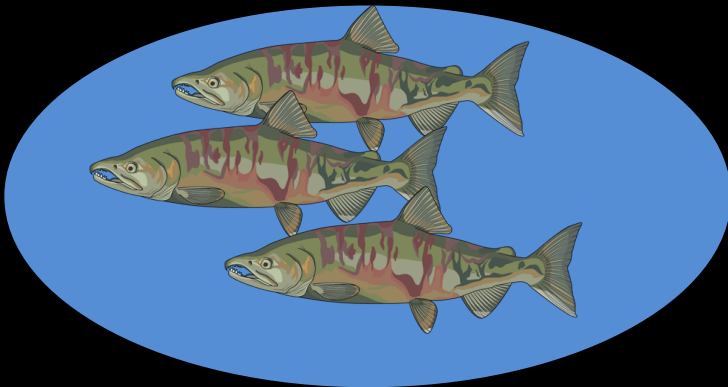
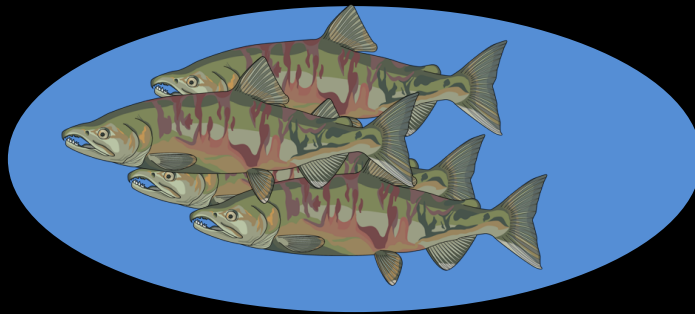
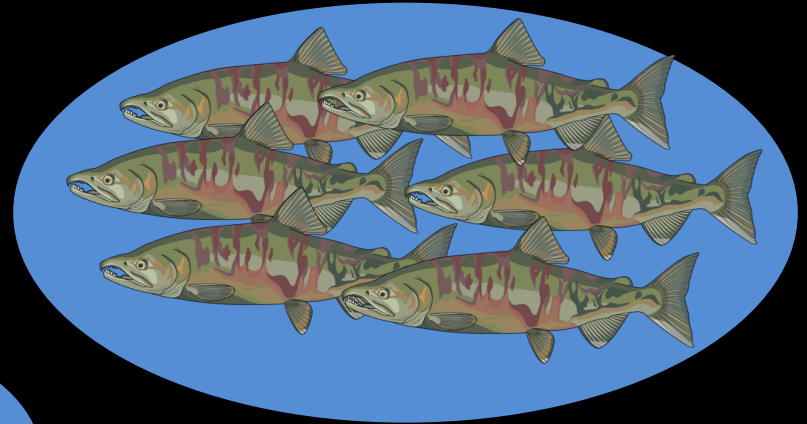
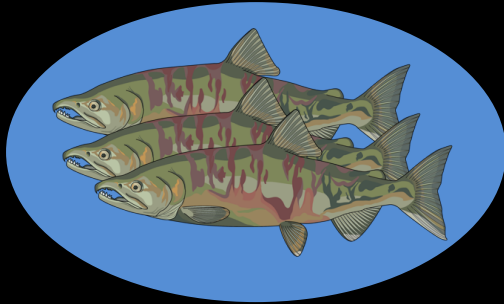
**COLLEGE OF FISHERIES  
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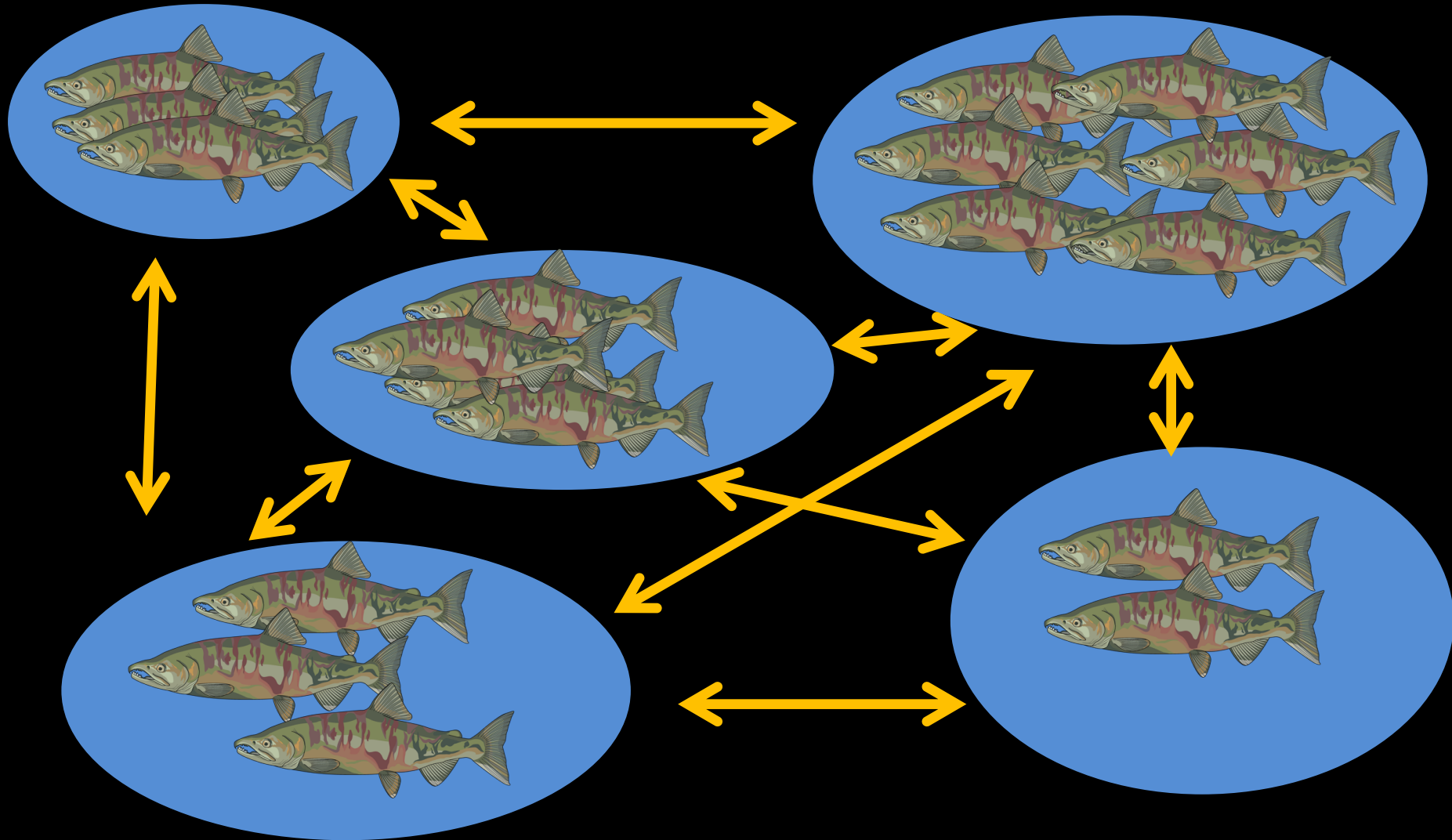


M. Emery

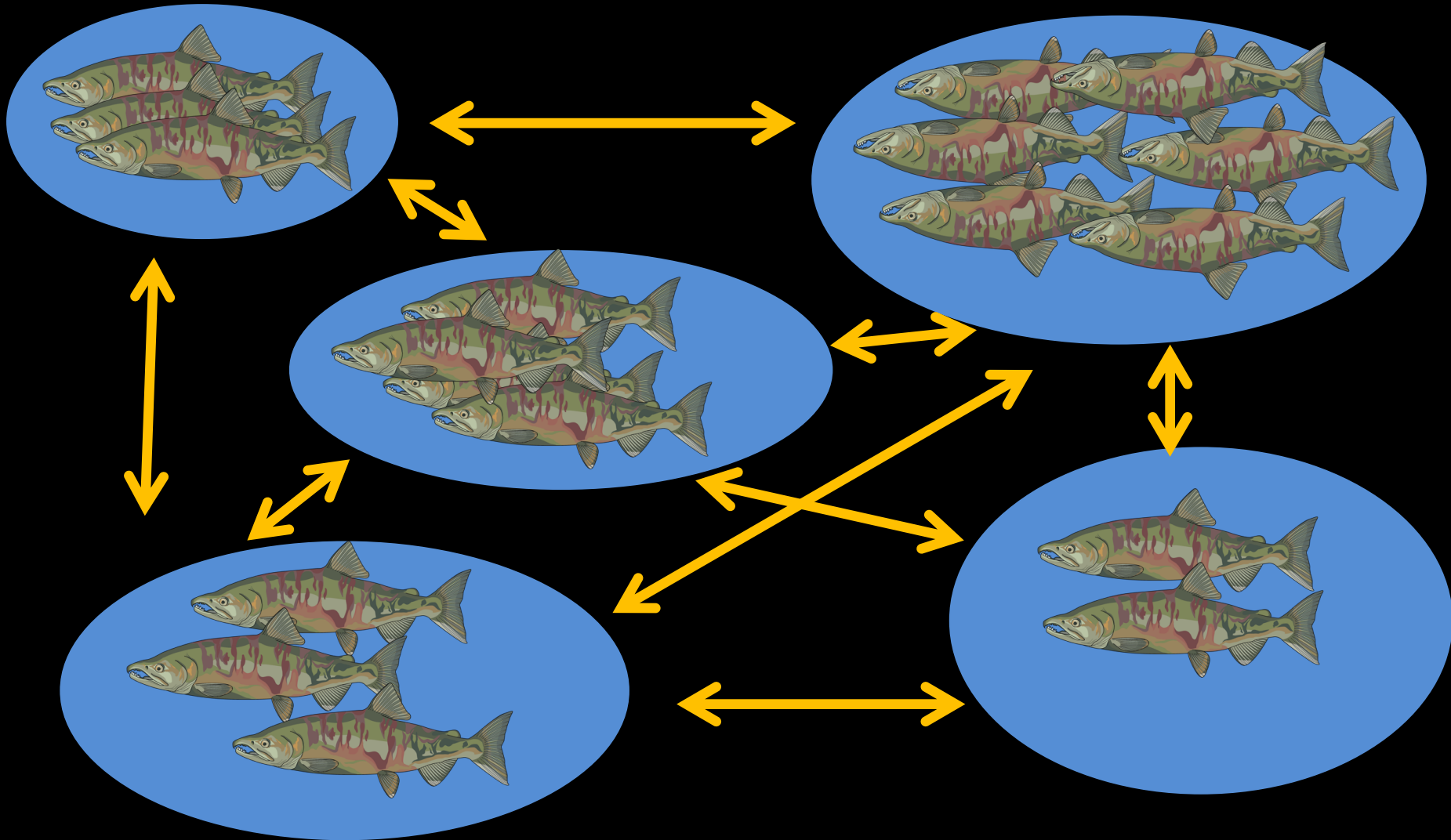
# Salmon function as metapopulations



# Straying binds metapopulations

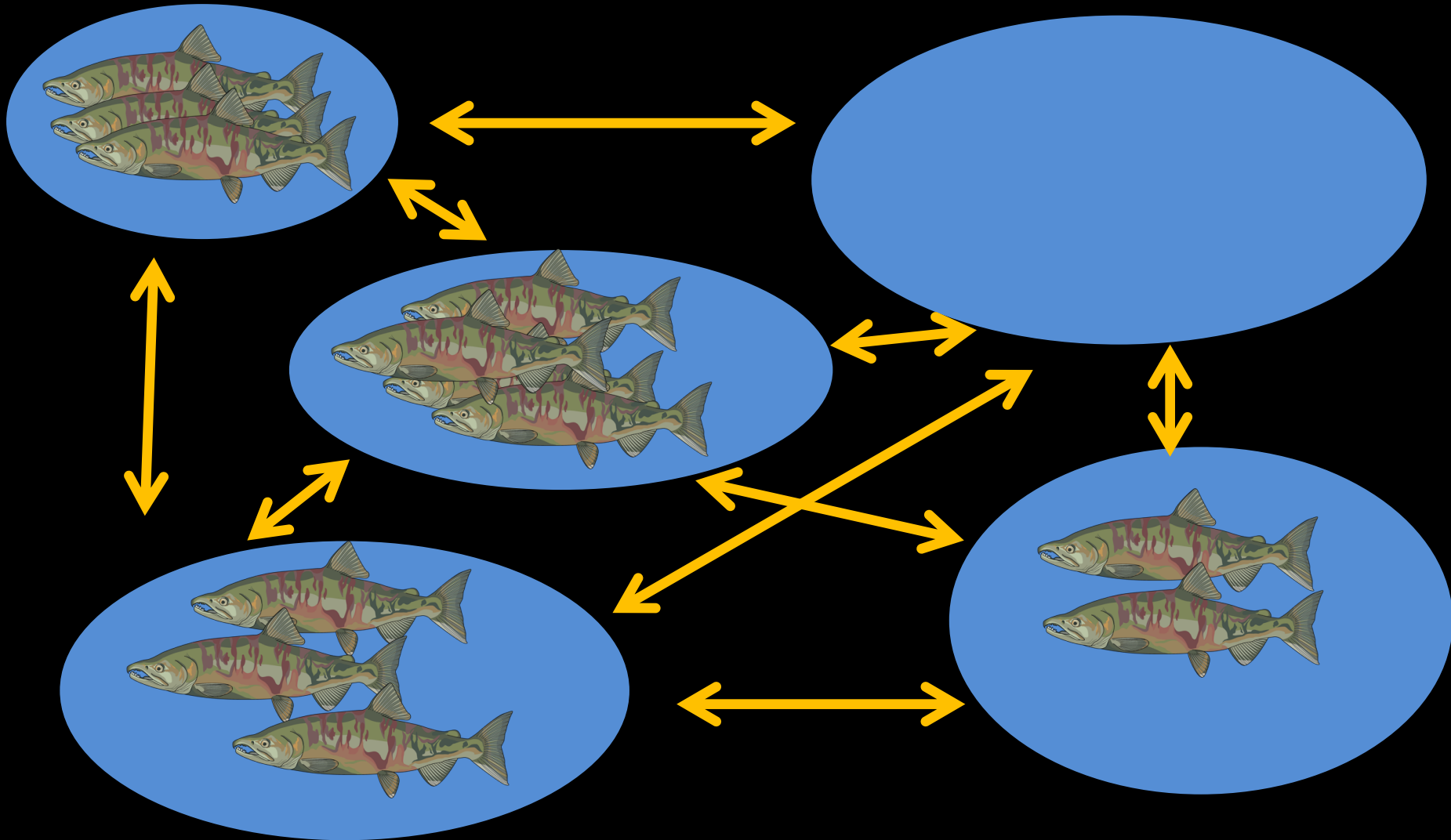


# Straying facilitates (re)colonization

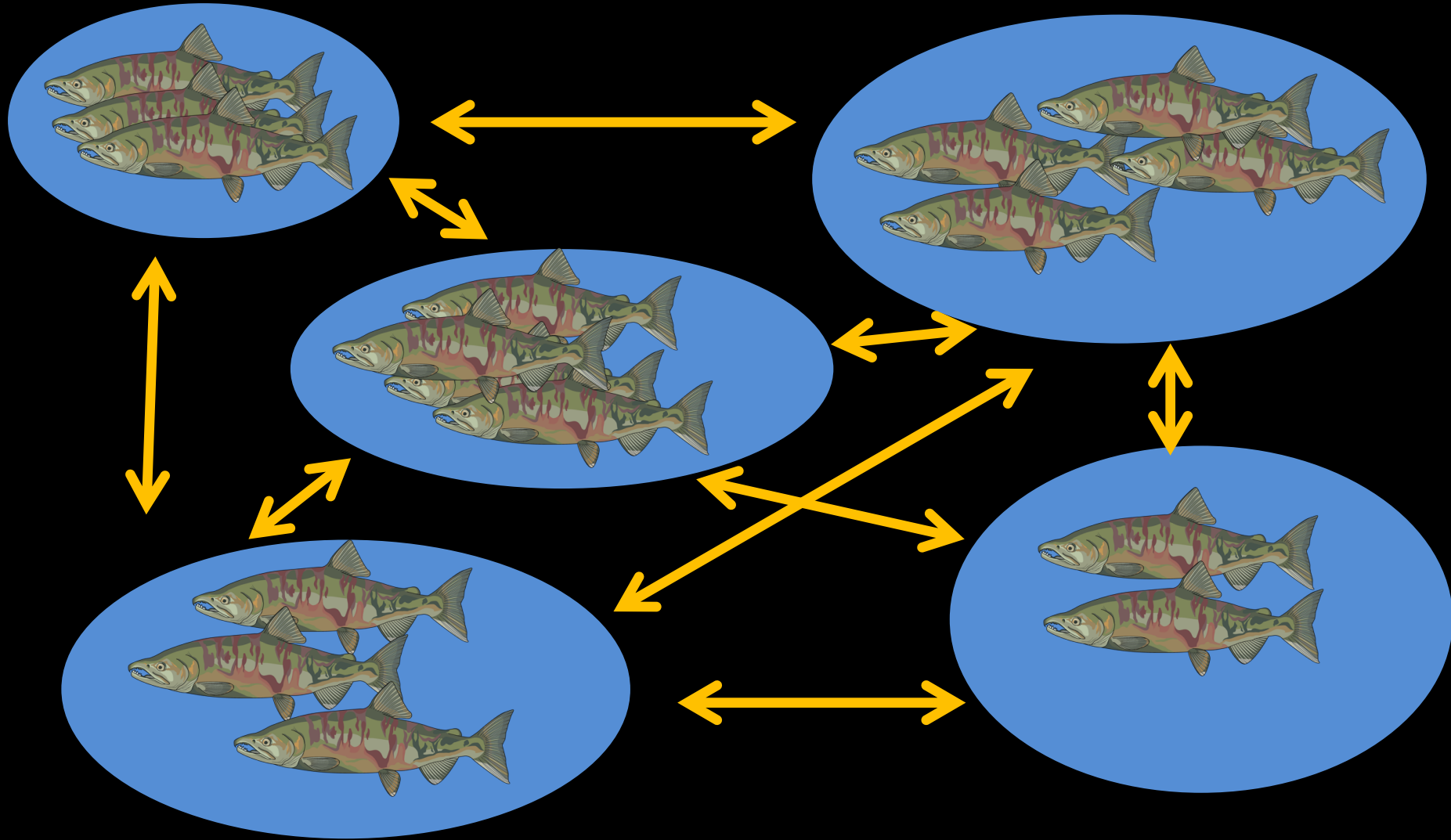




# Straying facilitates (re)colonization



# Straying mediates the flow of individuals and genes



# Straying is a biological phenomenon and conservation concern



# Straying is contributing to the loss of local adaptation in nature

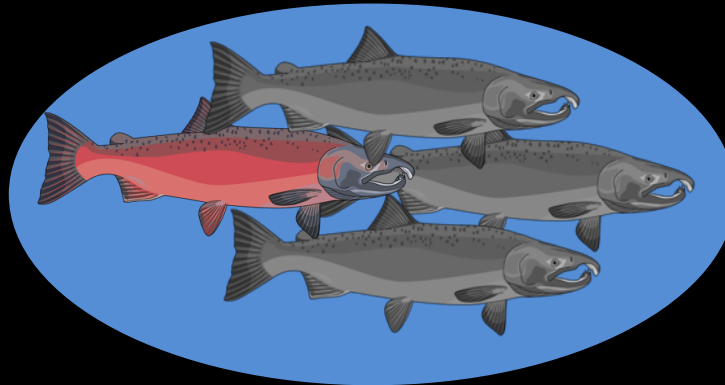
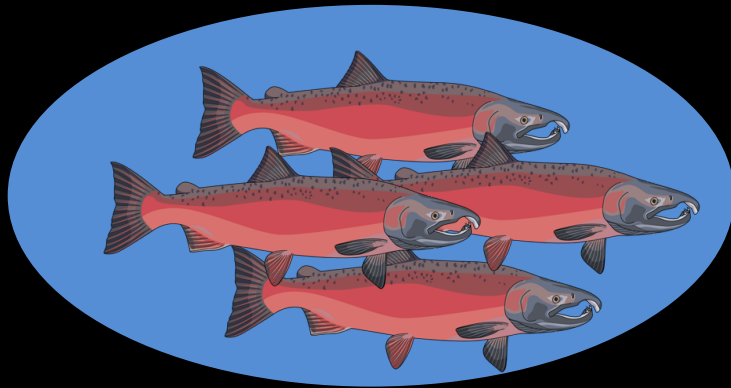
Q: What do we know about strays that might mediate the fitness consequences of wild/hatchery interactions?

Altered regimes of selection

straying

Reproductive interactions

Consequences



Hatchery Environment

Wild Spawning Grounds



# #1 Straying is influenced by phenotype



Beach habitats



Creek habitats

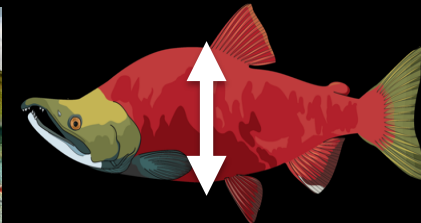




# #1 Straying is influenced by phenotype

Strays tended to be morphologically similar to the recipient population

Beach habitats



Avg. body depth  
Ca. 170 mm

Creek habitats



Avg. body depth  
Ca. 130 mm

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Strays tended to be morphologically similar to the recipient population

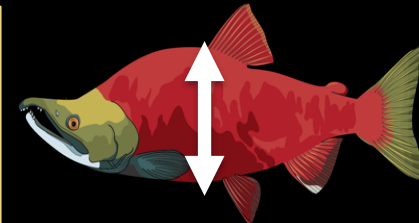


Avg. body depth  
Ca. 125 mm

Beach

Creek

Beach habitats



Avg. body depth  
Ca. 170 mm

Creek habitats



Avg. body depth  
Ca. 130 mm

# #1 Straying is influenced by phenotype

Strays tended to be morphologically similar to the recipient population

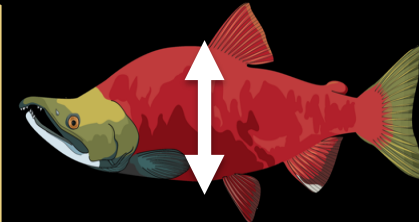


Avg. body depth  
Ca. 155 mm

Beach



Beach habitats



Avg. body depth  
Ca. 170 mm

Creek



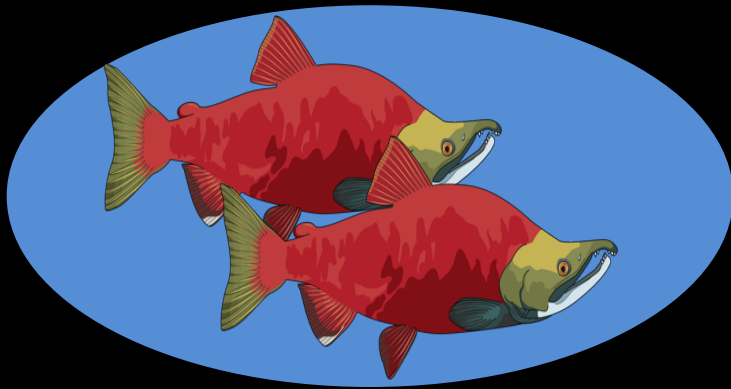
Creek habitats



Avg. body depth  
Ca. 130 mm

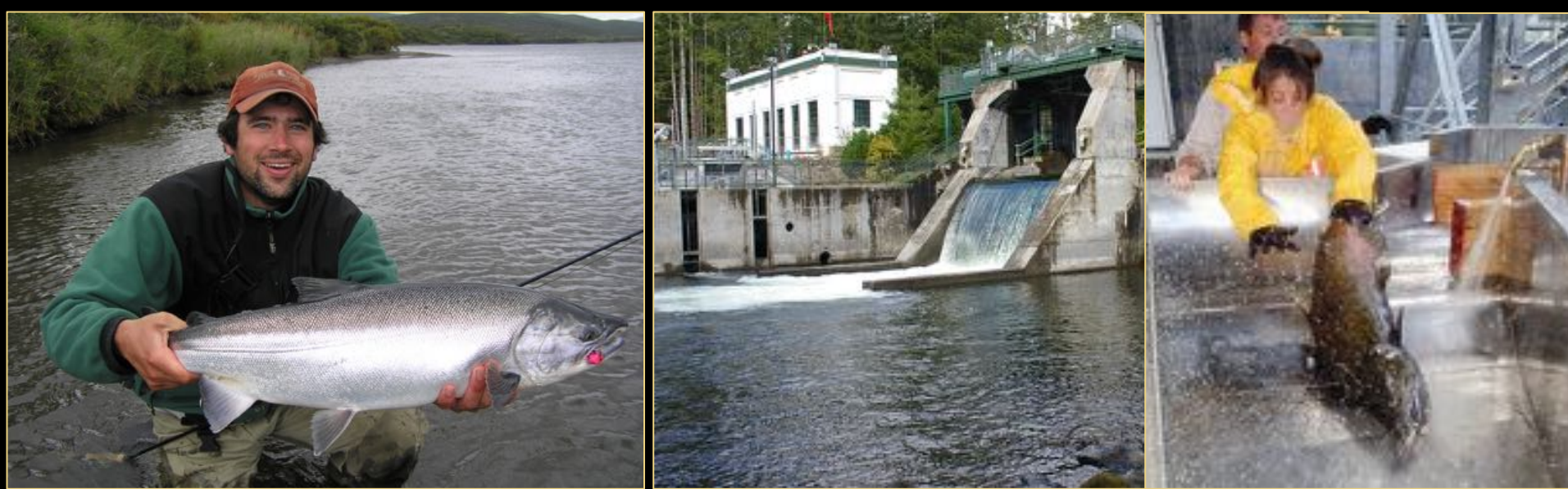
# #1 Straying is influenced by phenotype

Conservation implications: *i)* phenotypic-specific straying may reduce fitness costs to wild populations by matching individuals to habitats where they are better-suited, and *ii)* phenotypes produced from hatcheries may have habitat/phenotypic-specific impacts on recipient populations



# #2 Phenotypes of strays are subject to selection

Tracking success of straying colonists accessing habitat blocked for 102 years



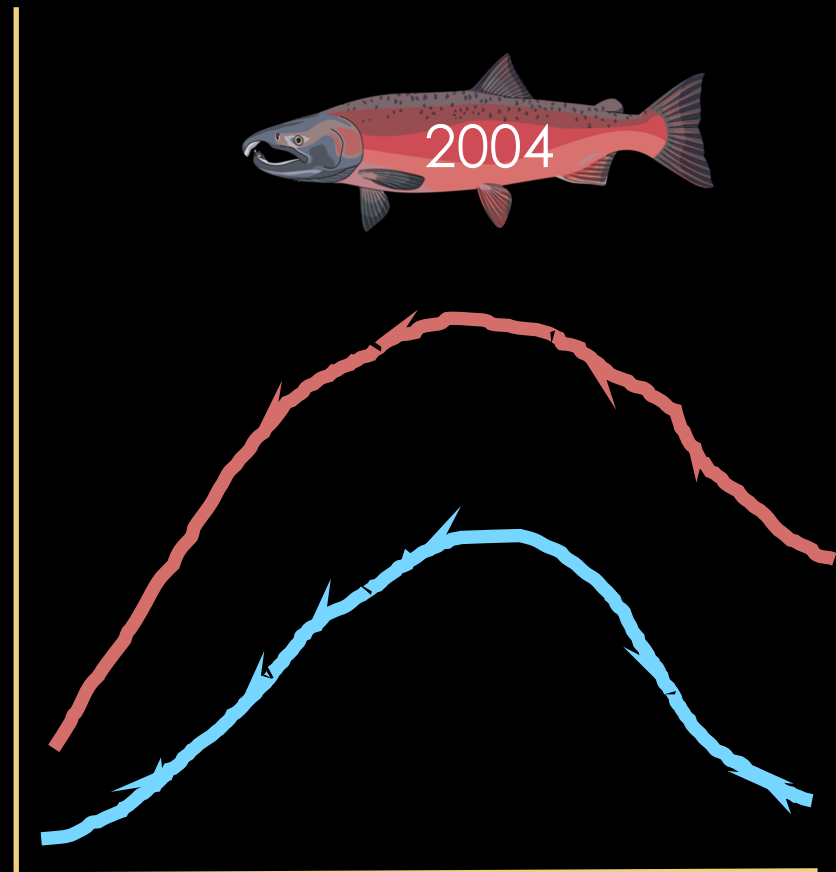
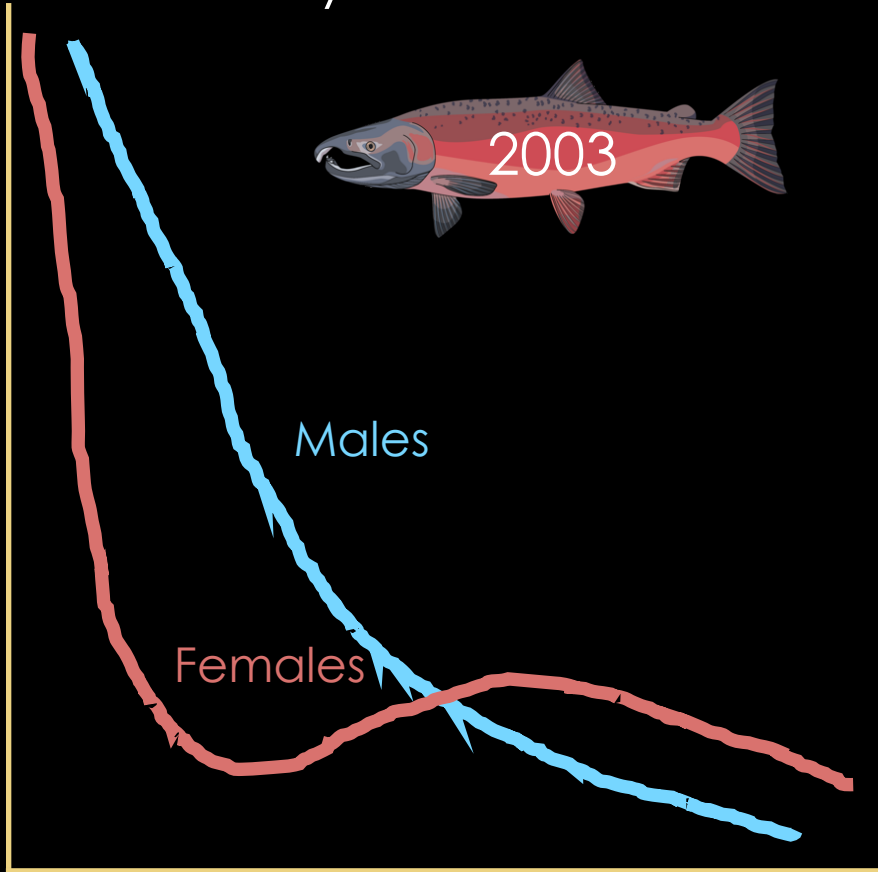
Anderson et al. 2010. Molecular Ecology 19: 2562-2573



# #2 Phenotypes of strays are subject to selection

Strong selection on heritable phenotypes- variation between sexes and years

Reproductive Success (# offspring)

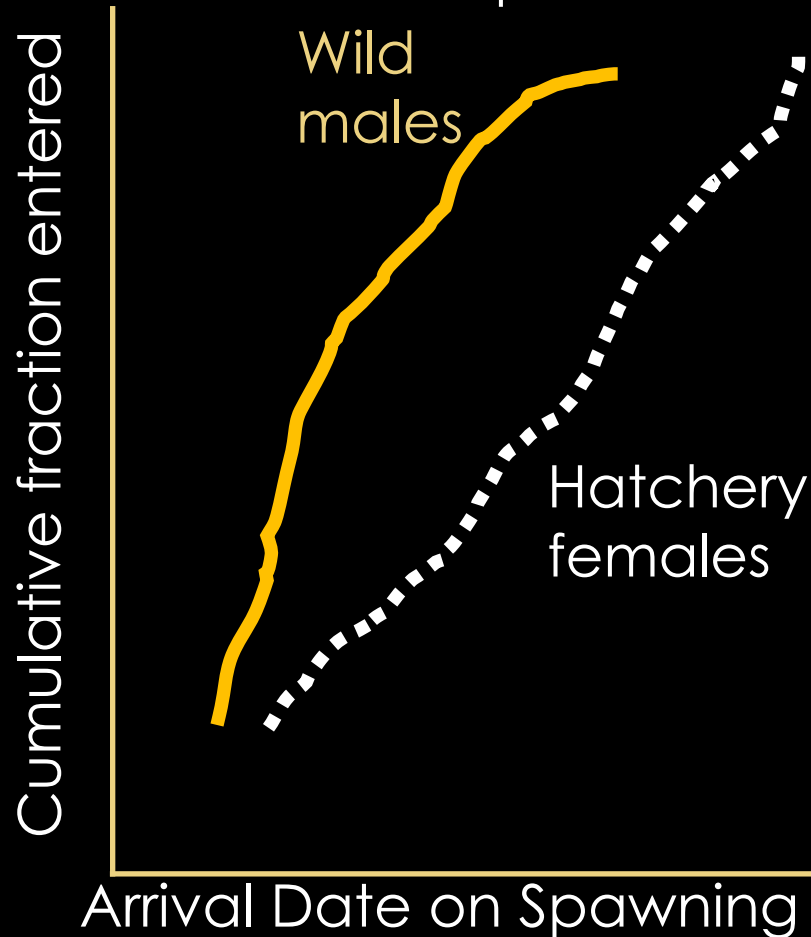


Arrival Date on Spawning Grounds

Redrawn from Anderson et al. Fig. 2

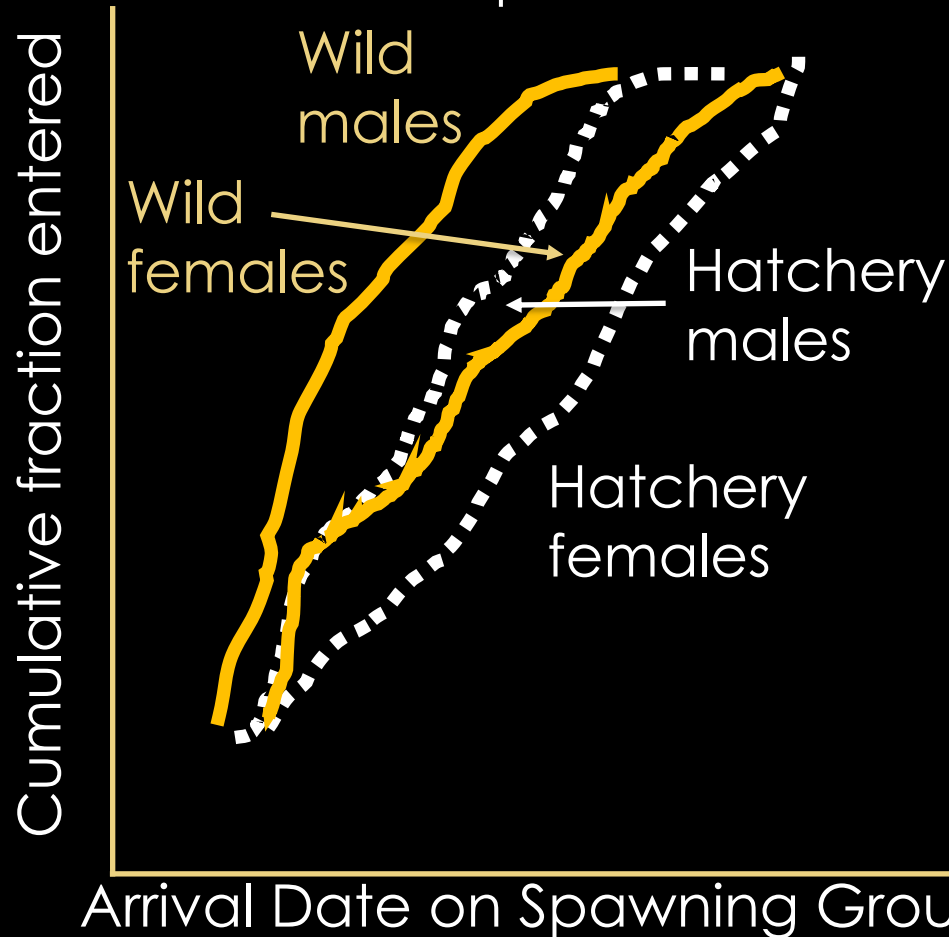
# #2 Phenotypes of strays are subject to selection

Stray hatchery chum salmon arrive later than wild individuals- but still overlap



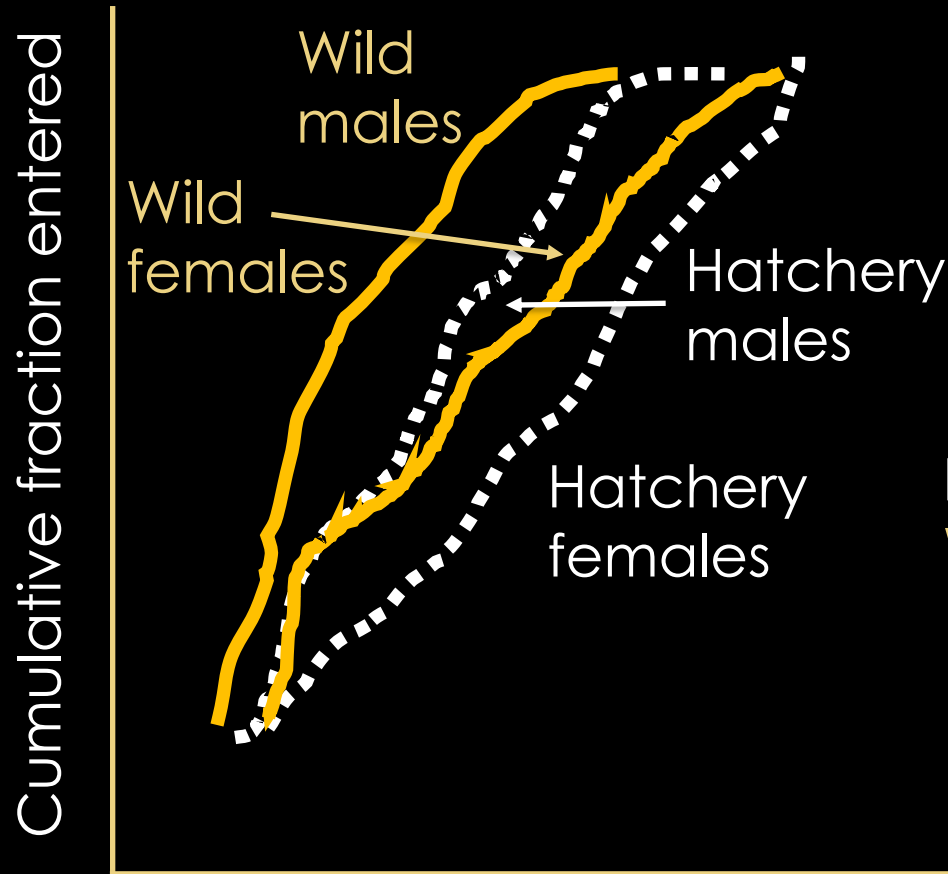
# #2 Phenotypes of strays are subject to selection

Stray hatchery chum salmon arrive later than wild individuals- but still overlap



# #2 Phenotypes of strays are subject to selection

Run timing associated with egg retention by females

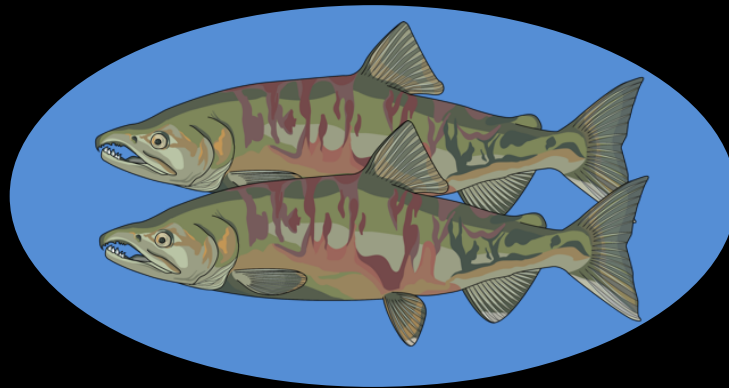


Hatchery females: 47% retention  
Wild females: 19% retention

Arrival Date on Spawning Grounds

## #2 Phenotypes of strays are subject to selection

Conservation implications: *i)* success of strays is shaped by heritable life history traits such as run timing though selection is likely variable among sexes and years and *ii)* interactions on the spawning grounds can occur even among divergent life histories





# Learn more!

Today at 3:40 pm Convention Center A9



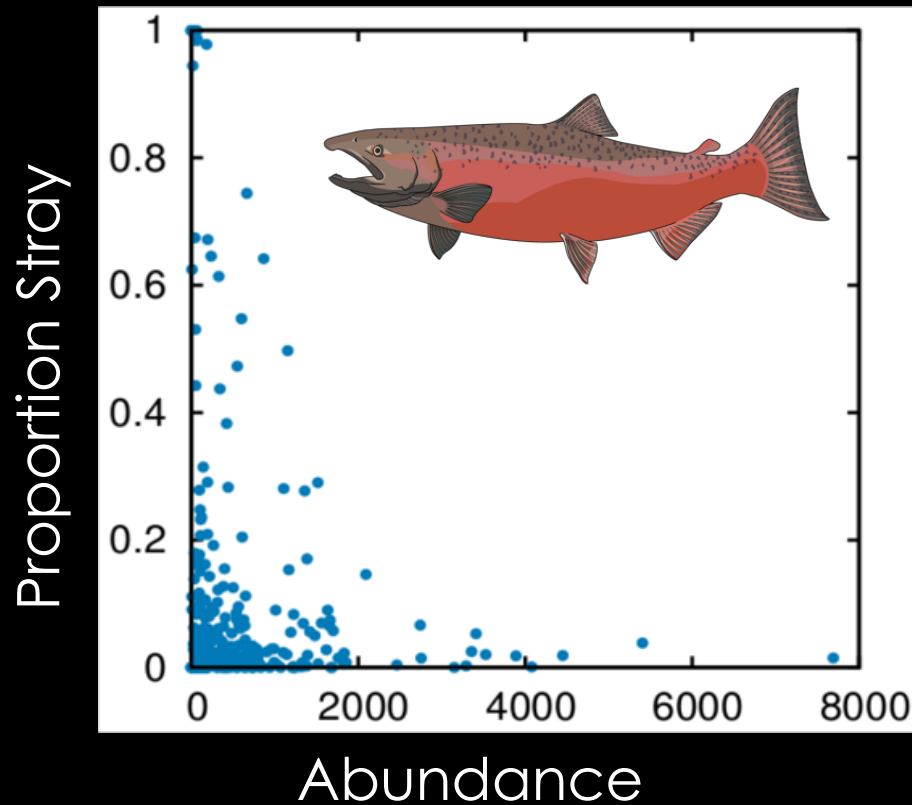
Julia McMahon  
Ecology of adult hatchery and  
wild pink salmon on spawning  
grounds of Prince William Sound,  
Alaska

# #3 Straying is density-dependent

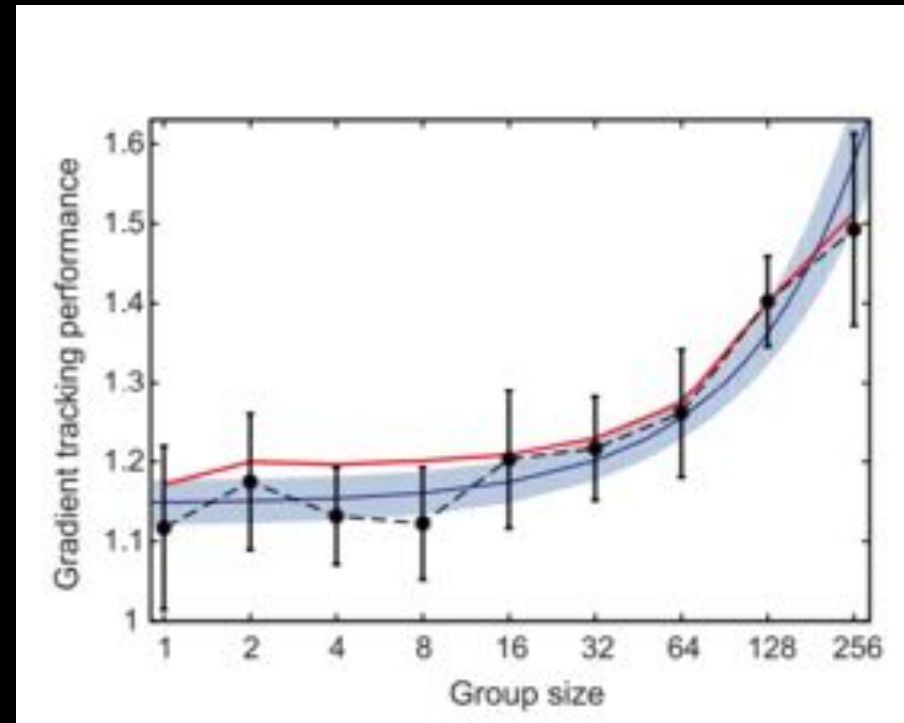


# #3 Straying is density-dependent

Straying increases non-linearly with declining abundance, consistent with predictions of social behavior and collective navigation



Westley et al. 2015. Ecology 96: 2823-2833



Berdahl et al. 2013. Science 339: 574-576



# #3 Straying is density-dependent

Social interactions are critical for successful navigation in many animals on the move



Westley et al. 2015. *Ecology* 96: 2823-2833

Berdahl et al. 2016 *Fish & Fisheries* 17, 525-542

Berdahl et al. 2017 *Animal Behaviour* 126, 221-229

Westley et al. 2018 *Phil Trans R. Soc.* 373, 20170004

Berdahl et al. 2018 *Phil Trans R. Soc.* 373, 20170009

Yeakel et al. 2018 *Phil Trans R. Soc.* 373, 20170018

# #3 Straying is density-dependent

Conservation implications: social straying may:

i) catalyze the colonization of new habitats (when populations are small) and maintain reproductive isolation and local adaptation (when populations are large)

and ii) compound the threats of declining population size by increasing straying. A warning: the loss of local adaptation may be a harbinger of numerical population collapse (sensu Berdahl et al. 2016 Movement Ecology 4: 18)





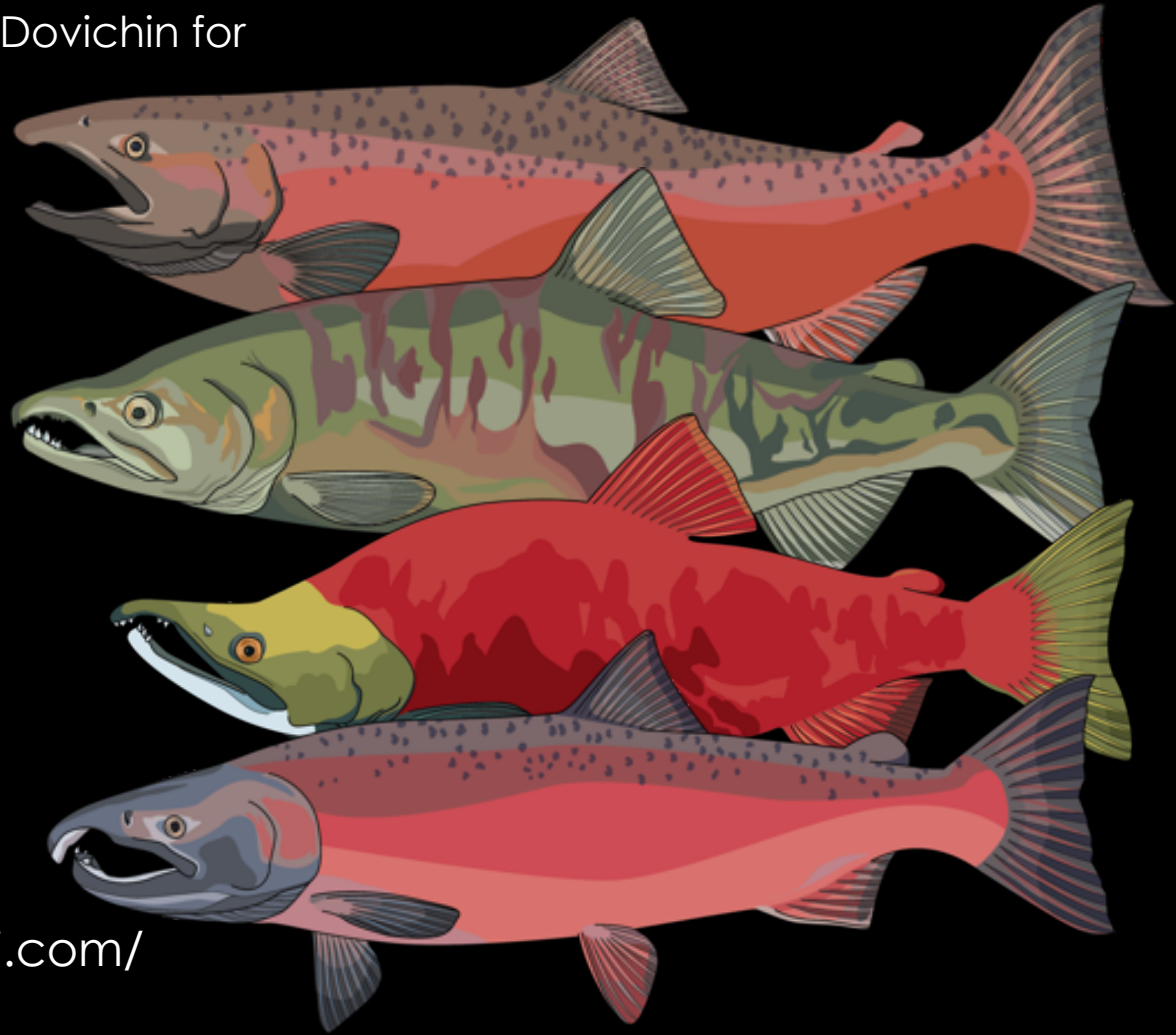
# Concluding thoughts

- Straying is not an aberration: it is a biological phenomenon and conservation concern
- The 'choice' of where to stray is influenced by phenotype
- Phenotypes of strays are under selection and influence reproductive success
- Hatchery and wild fish do interact on the spawning grounds even when phenotypes are divergent
- Declining population size may result in increased straying and greater susceptibility to gene flow, which may accelerate the erosion of local adaptations
- Will straying be hero or villain in a rapidly changing world?



# Acknowledgements

Many thanks to the Gordon and Betty Moore Foundation and in particular the vision and tireless work of Erin Dovichin for salmon conservation



<https://www.katie-kobayashi.com/>