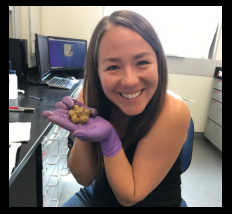
Assessing the potential for competition between P. Halibut and Arrowtooth Flounder in the Gulf of Alaska

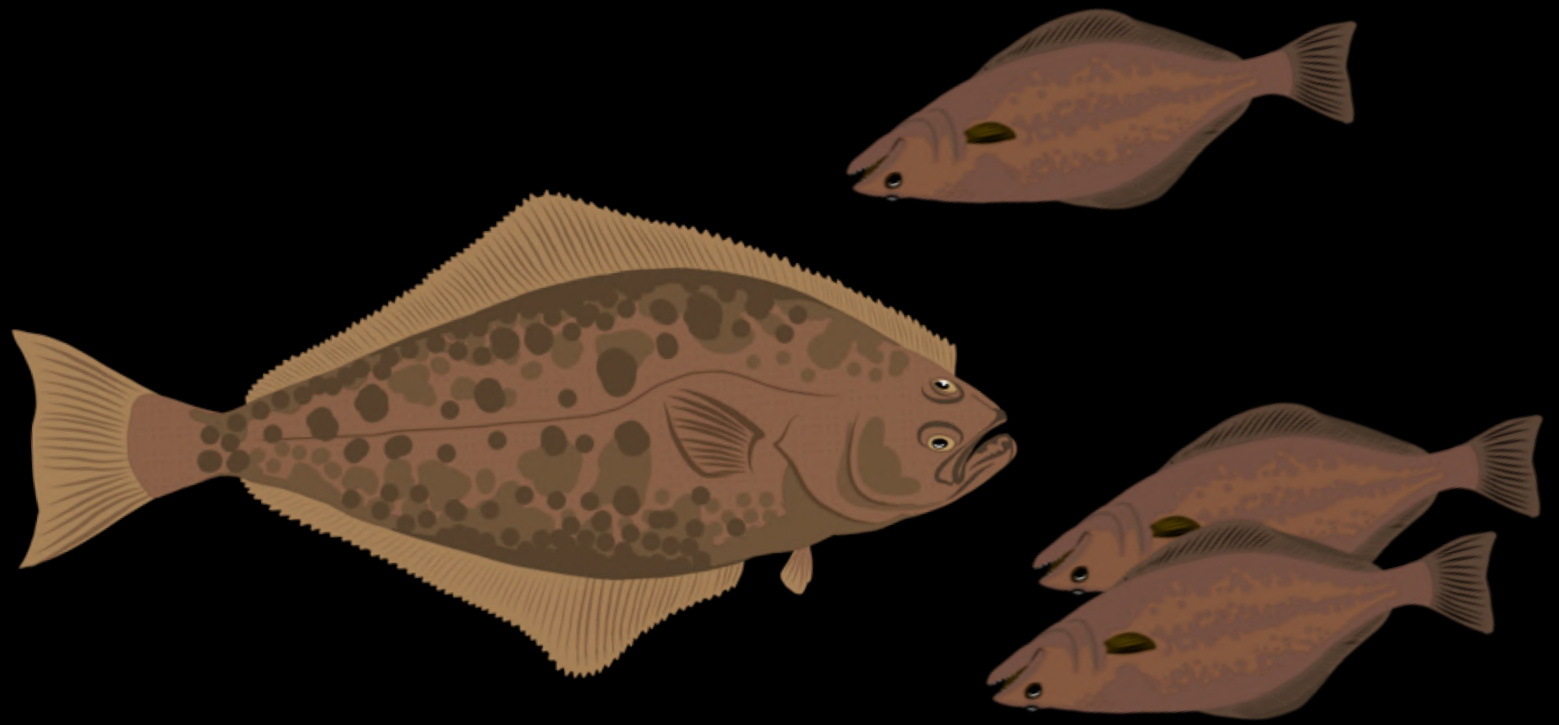

Cheryl Barnes, UAF


Anne Beaudreau, UAF


Lorenzo Ciannelli, OSU


Mary Hunsicker, NWFSC


Richard Yamada, AK Reel Adv.



POLLOCK CONSERVATION COOPERATIVE Research Center

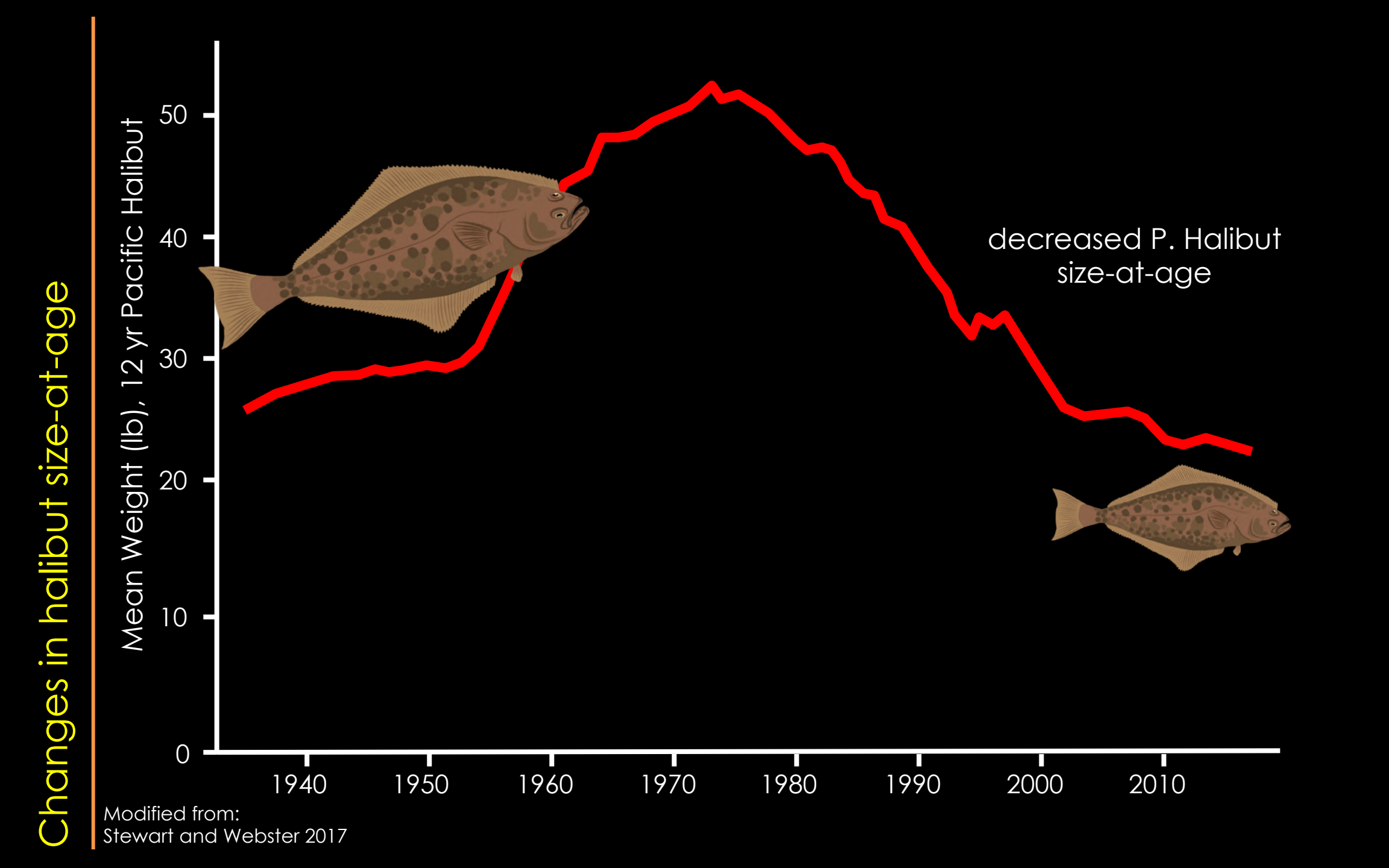
RASMUSON FISHERIES RESEARCH CENTER

- N. Gulf of Alaska Applied Research Award -

UAF COLLEGE OF FISHERIES AND OCEAN SCIENCES
University of Alaska Fairbanks

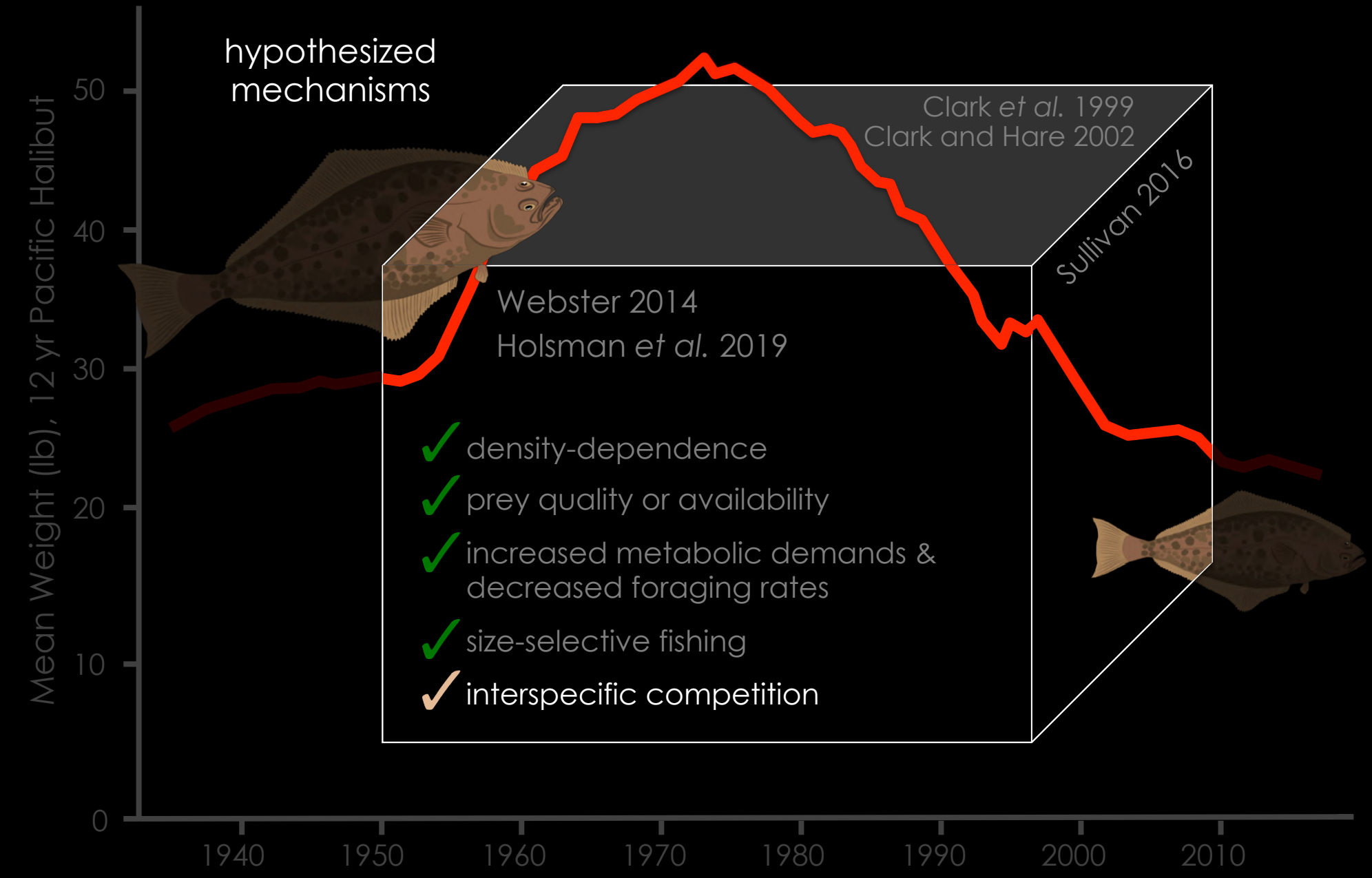
UNIVERSITY of ALASKA SOUTHEAST
SITKA CAMPUS

Changes in halibut size-at-age



Modified from:
Stewart and Webster 2017

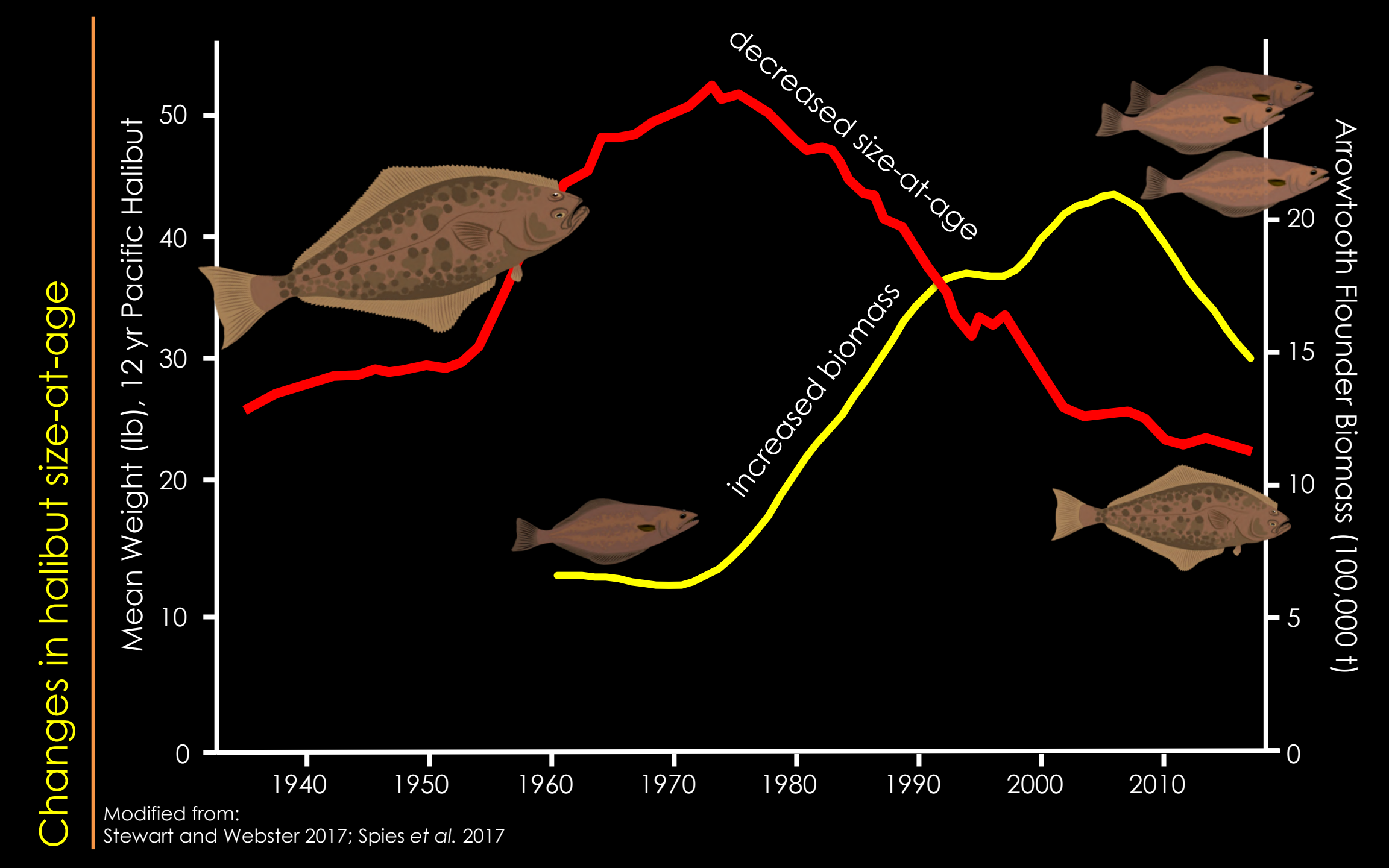
Changes in halibut size-at-age



Modified from:
Stewart and Webster 2017

Loher 2012

Changes in halibut size-at-age



Modified from:
Stewart and Webster 2017; Spies *et al.* 2017

Competition: important driver of population dynamics

- observations typically at fine spatiotemporal scales
  - intertidal, nearshore reefs; high site fidelity
    - direct observations

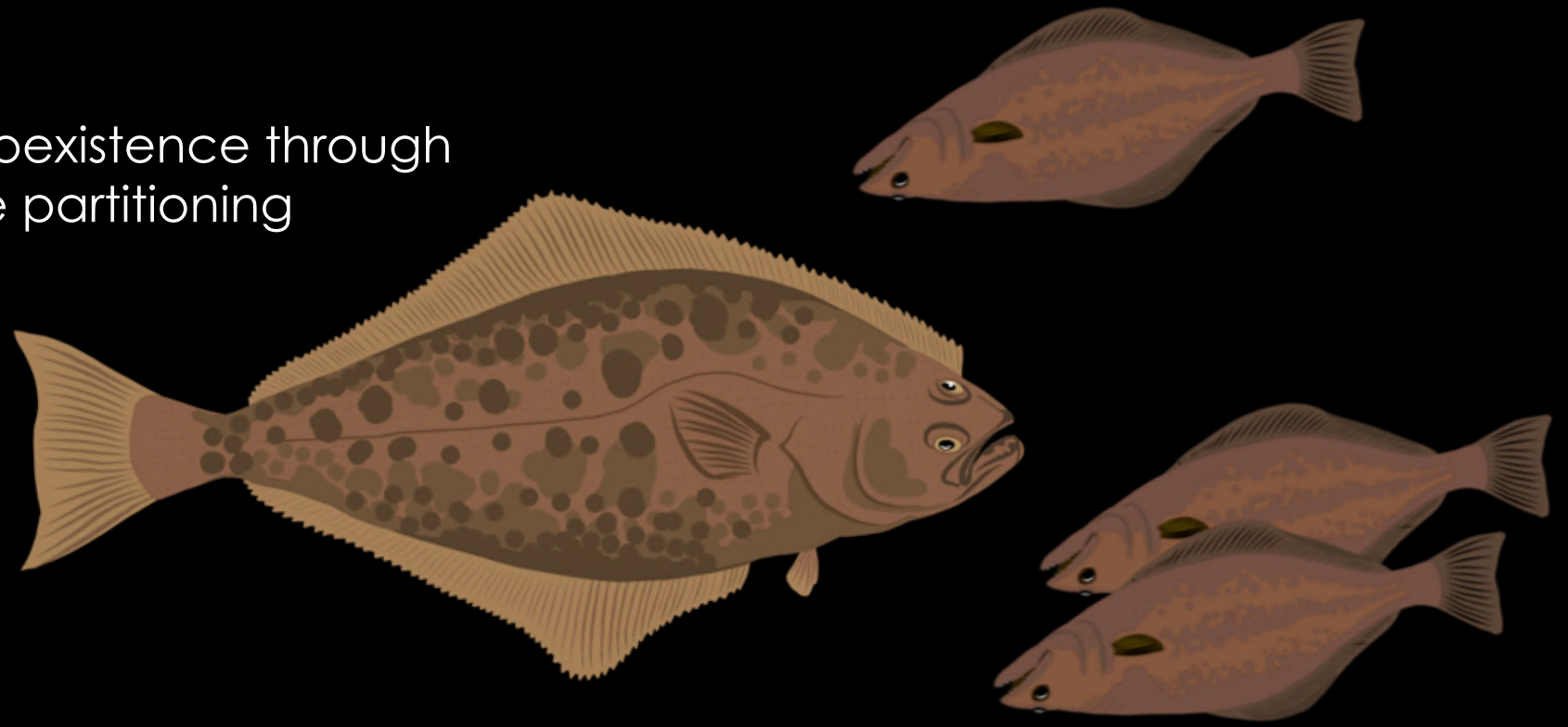
Paine 1980

Hixon 1980

Competition: important driver of population dynamics

- broad spatiotemporal scales -

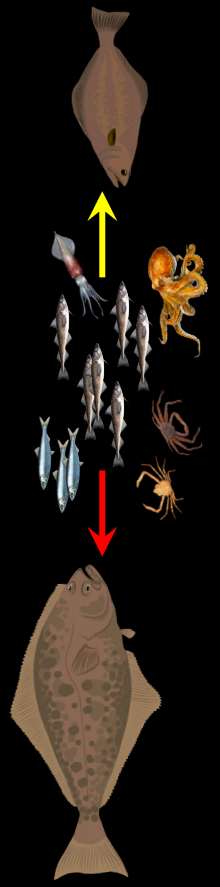
suppose coexistence through resource partitioning

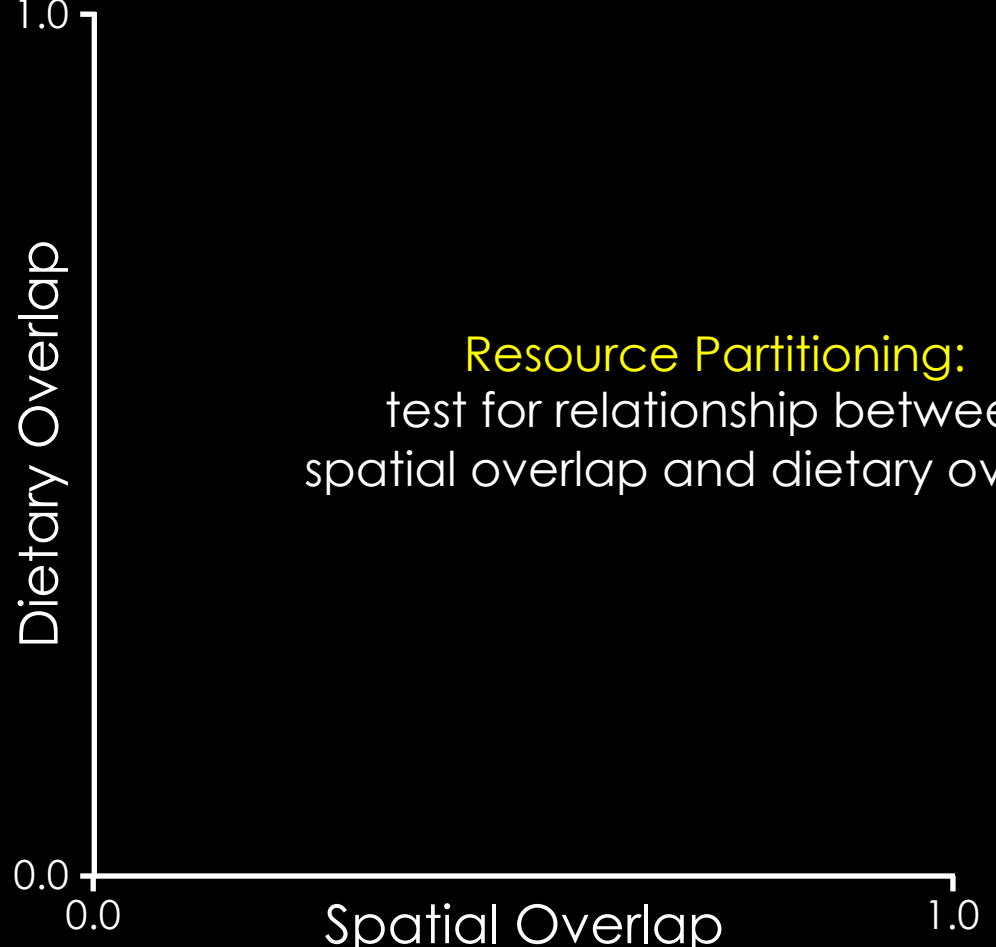


Schoener 1983; Ross 1986
Link and Auster 2013

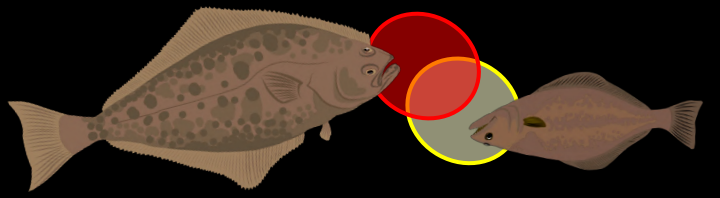
Competition: important driver of population dynamics

- broad spatiotemporal scales -





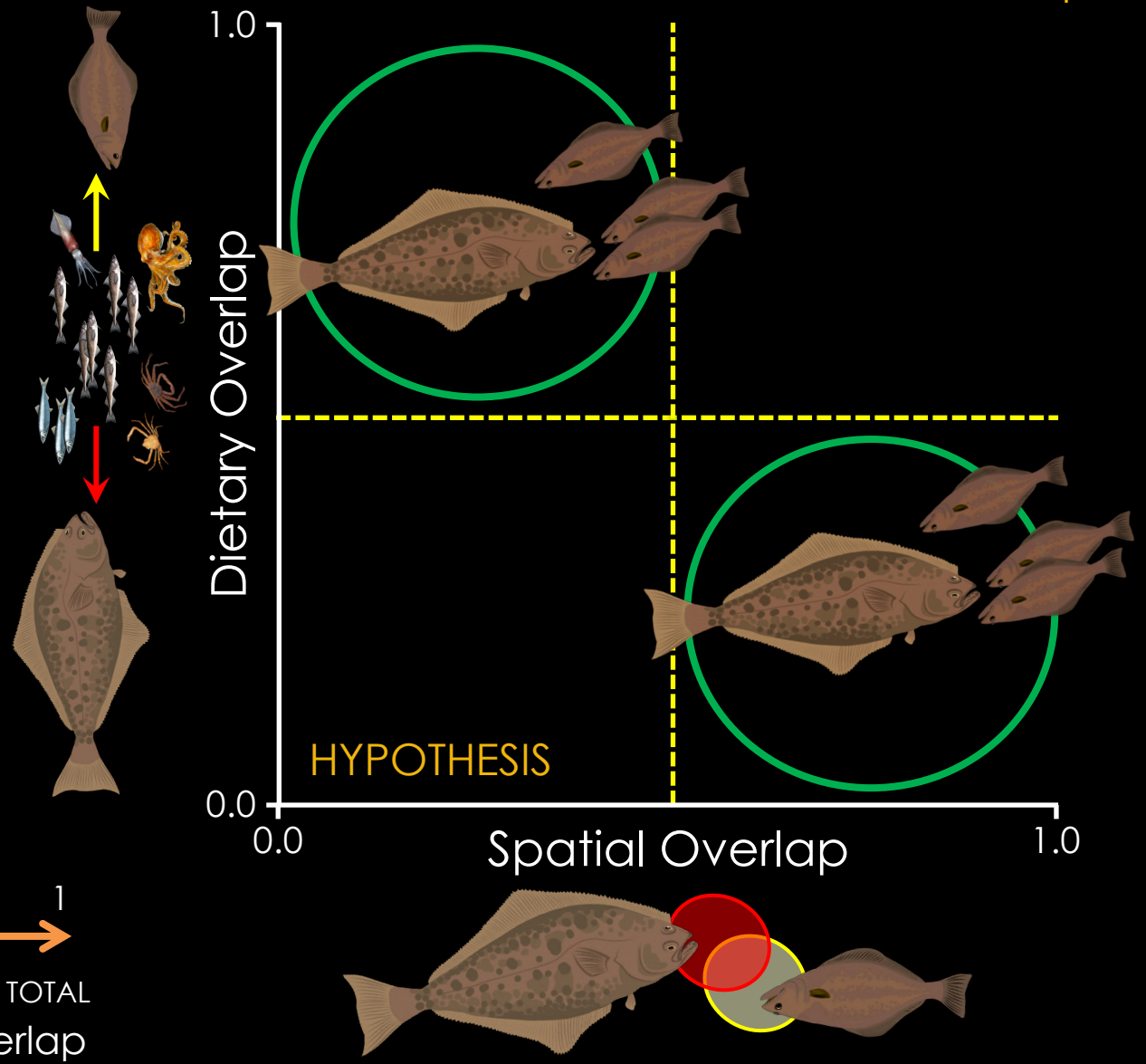
Resource Partitioning:
test for relationship between
spatial overlap and dietary overlap



Schoener 1983; Ross 1986
Link and Auster 2013

Competition: important driver of population dynamics

- broad spatiotemporal scales -



Schoener 1983; Ross 1986
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Competition: important driver of population dynamics

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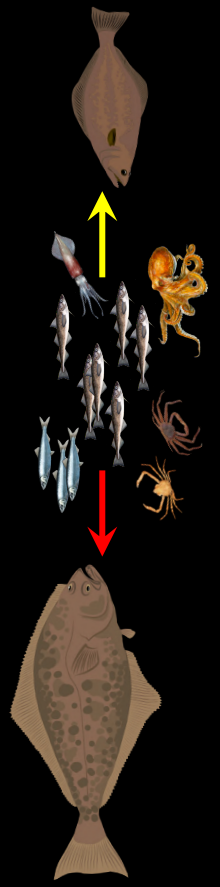
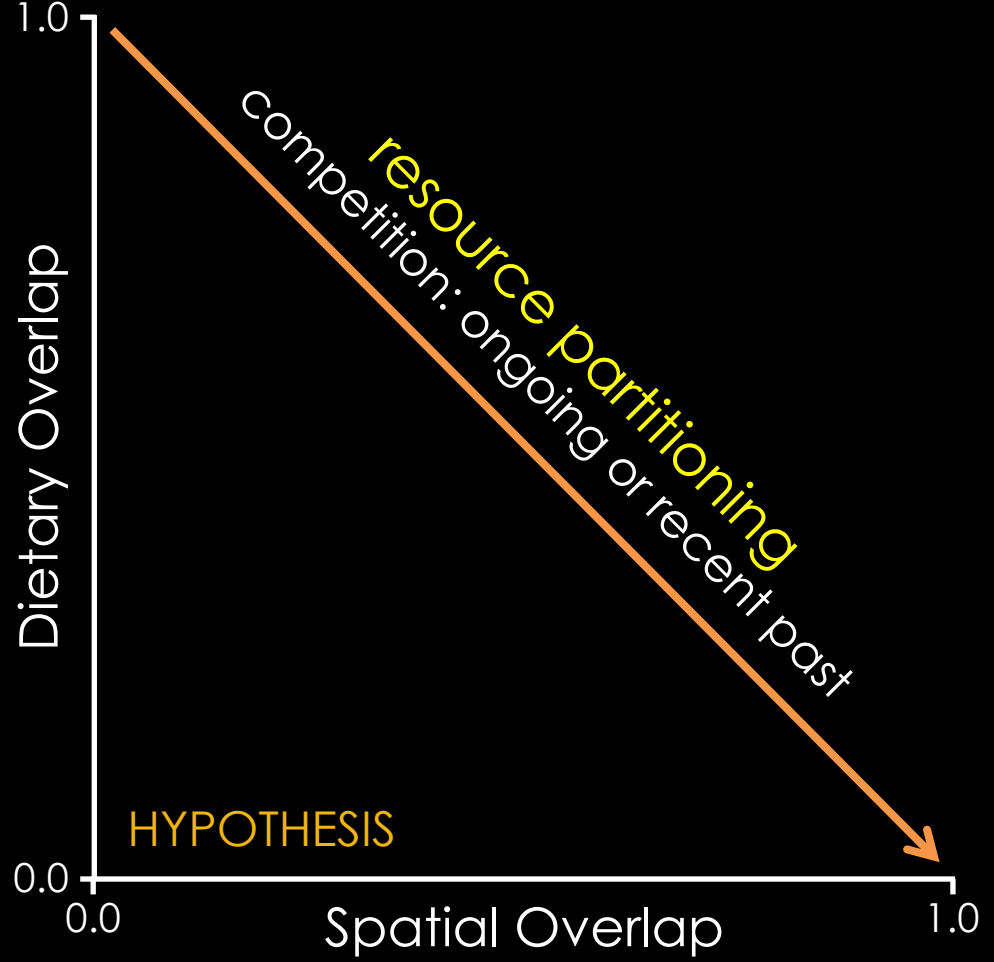
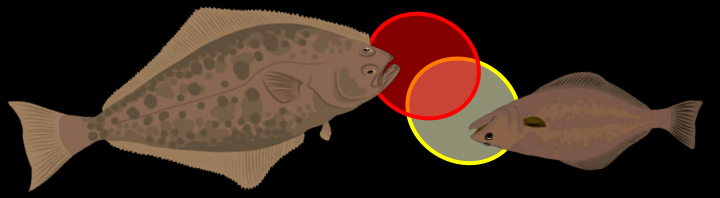






Schoener 1983; Ross 1986
Link and Auster 2013

PLOS ONE

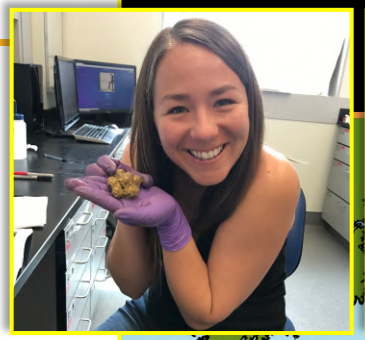
RESEARCH ARTICLE

Assessing the potential for competition between Pacific Halibut (*Hippoglossus stenolepis*) and Arrowtooth Flounder (*Atheresthes stomias*) in the Gulf of Alaska

Cheryl L. Barnes[1]*, Anne H. Beaudreau[1], Mary E. Hunsicker[2], Lorenzo Ciannelli[3]

1 College of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Juneau, Alaska, United States of America, **2** Fish Ecology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Newport, Oregon, United States of America, **3** College of Earth, Ocean, and Atmospheric Sciences, Oregon State University, Corvallis, Oregon, United States of America

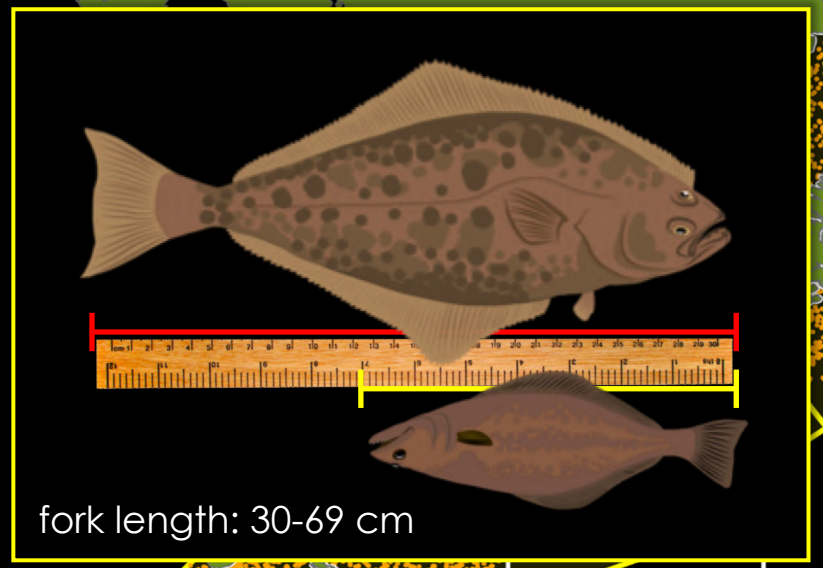
* cheryl.barnes@alaska.edu



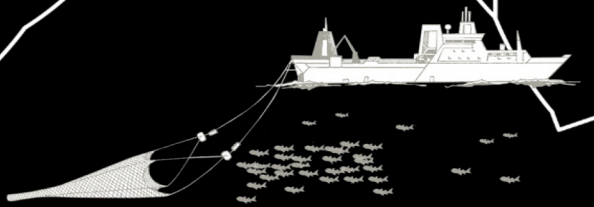
Resource partitioning in the Gulf of Alaska

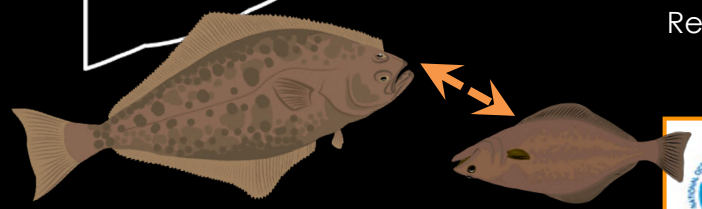
— INPFC Stat. Area
— IPHC Reg. Area

• tow location
8,636 hauls



3A
Yakutat
Kodiak
SE
2C
4A
Chirikof
Shumagin





RACE Division

Resource Assessment and Conservation Engineering

✓ trawl, 1990 to 2017

REEM Program

Resource Ecology and Ecosystem Modeling

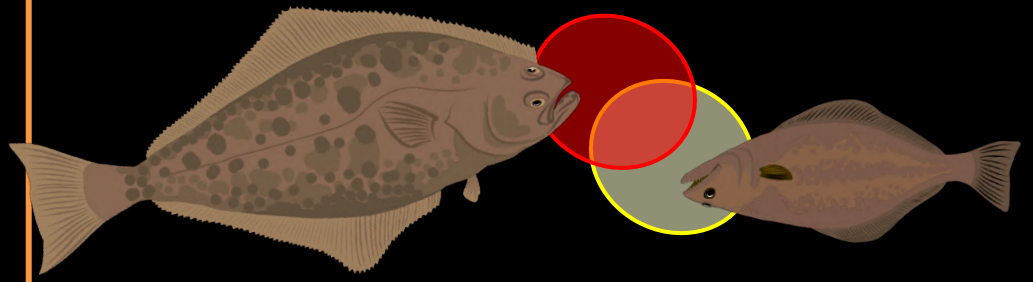
✓ diet, 1990 to 2013

NOAA FISHERIES | ALASKA FISHERIES SCIENCE CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

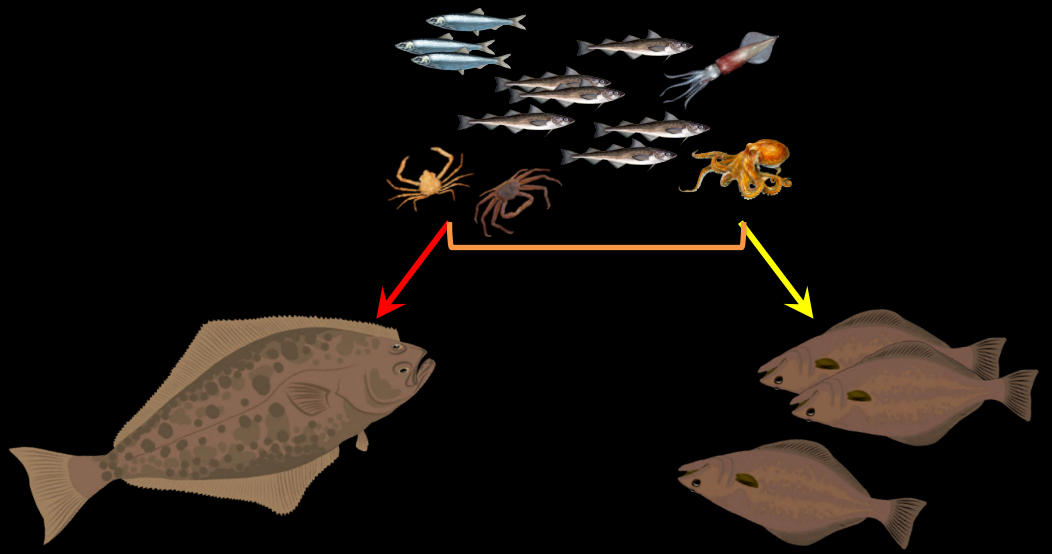
Resource partitioning in the Gulf of Alaska

Are Pacific Halibut and Arrowtooth Flounder partitioning resources?

Spatial Overlap



Dietary Overlap



Resource partitioning in the Gulf of Alaska

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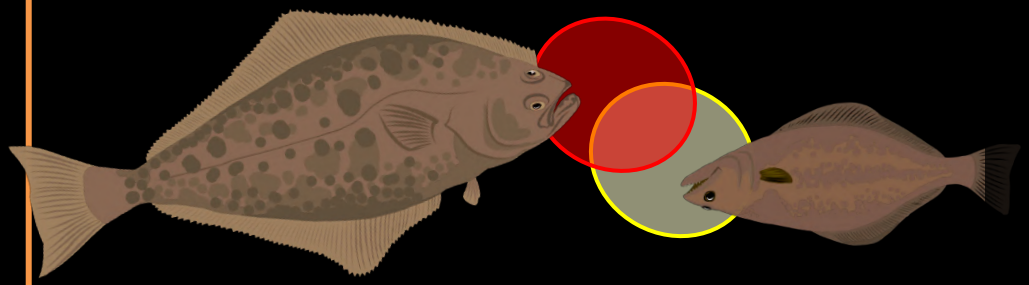
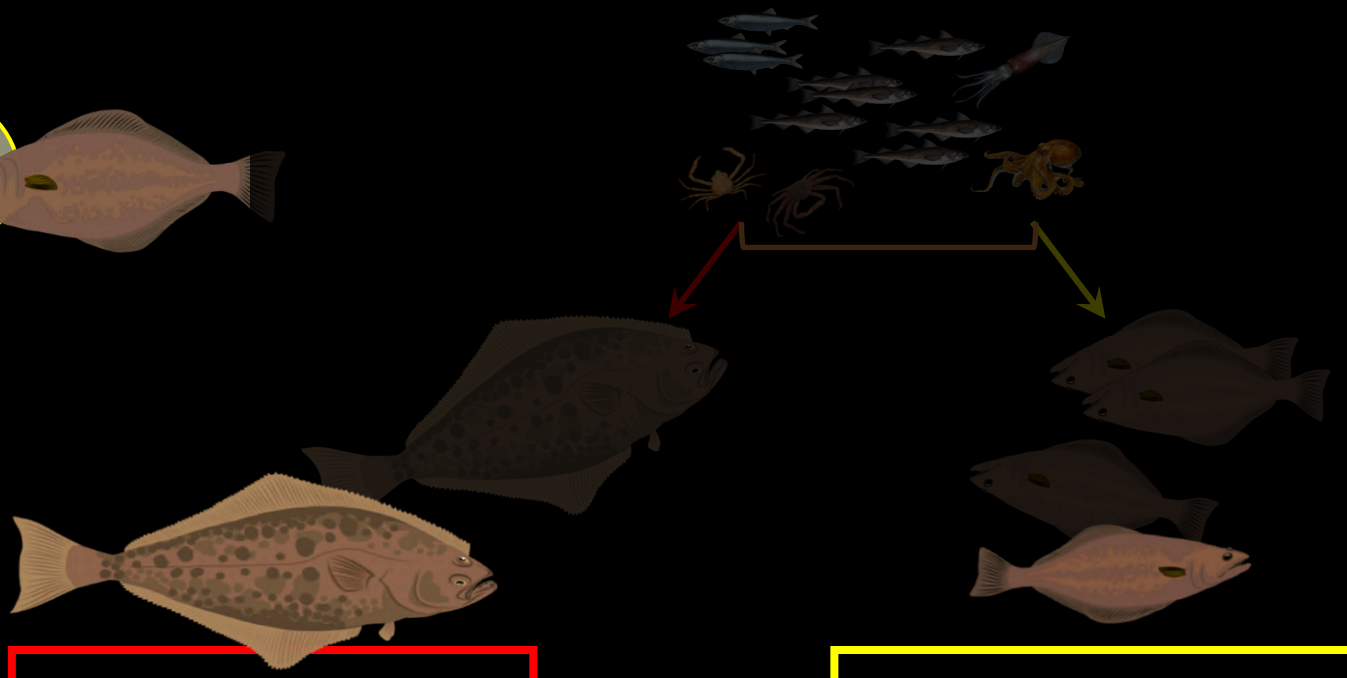
Spatial Overlap



Dietary Overlap



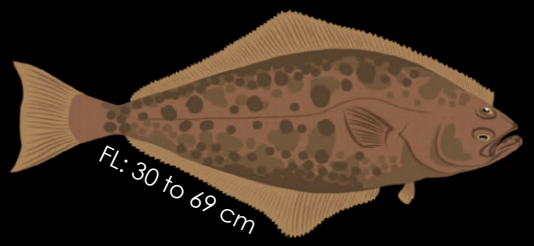
Standardized Abundance

Standardized Abundance

multiply

Spatial Overlap

Resource partitioning in the Gulf of Alaska

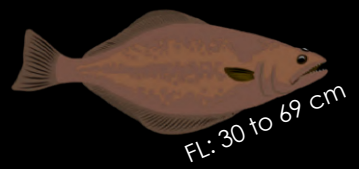


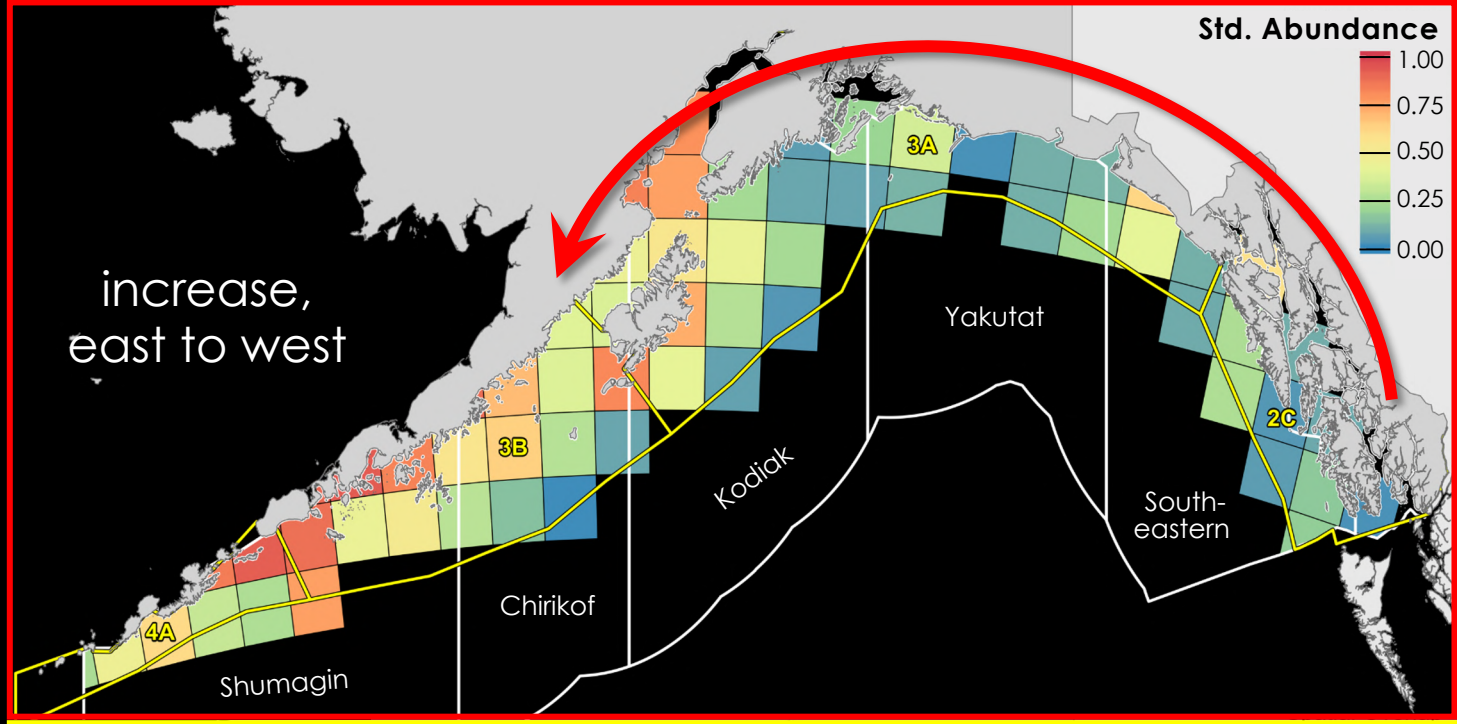
Std Abundance

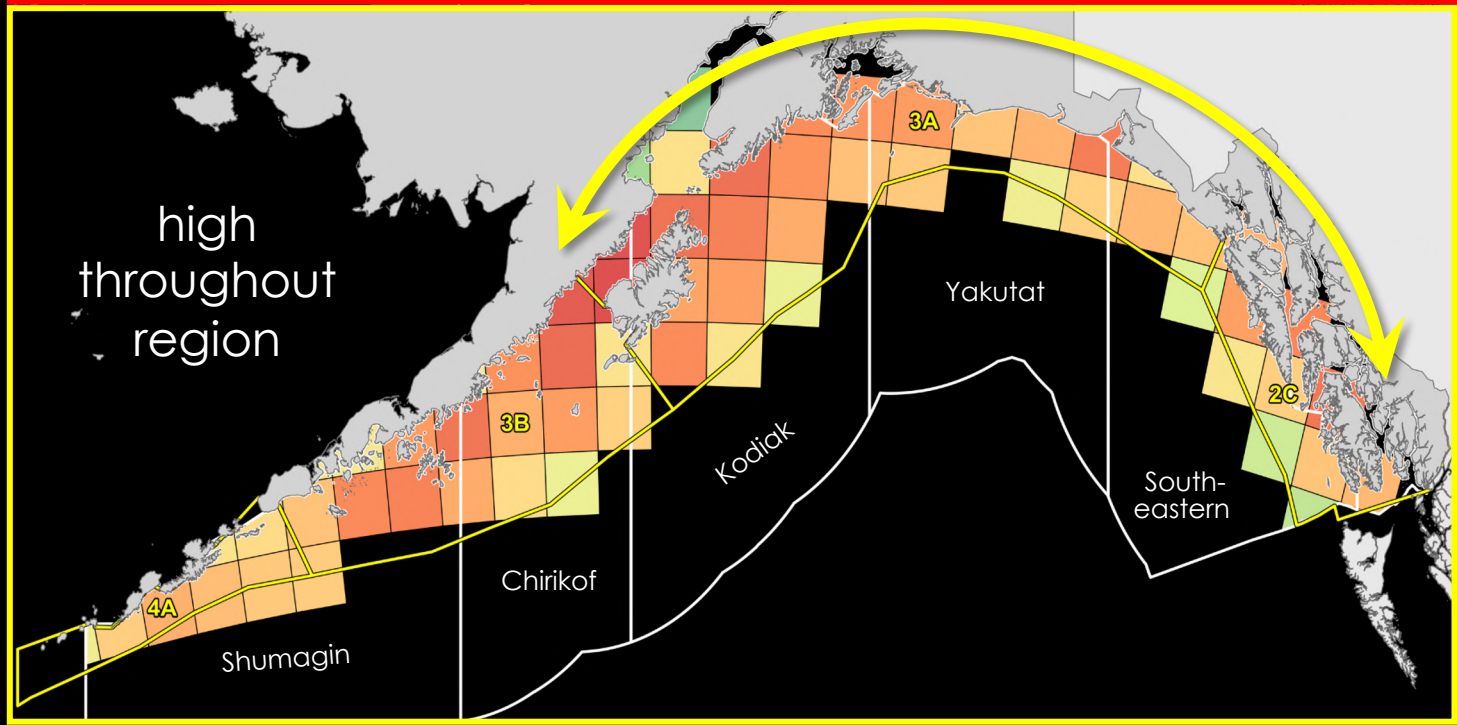
Std Abundance

multiply

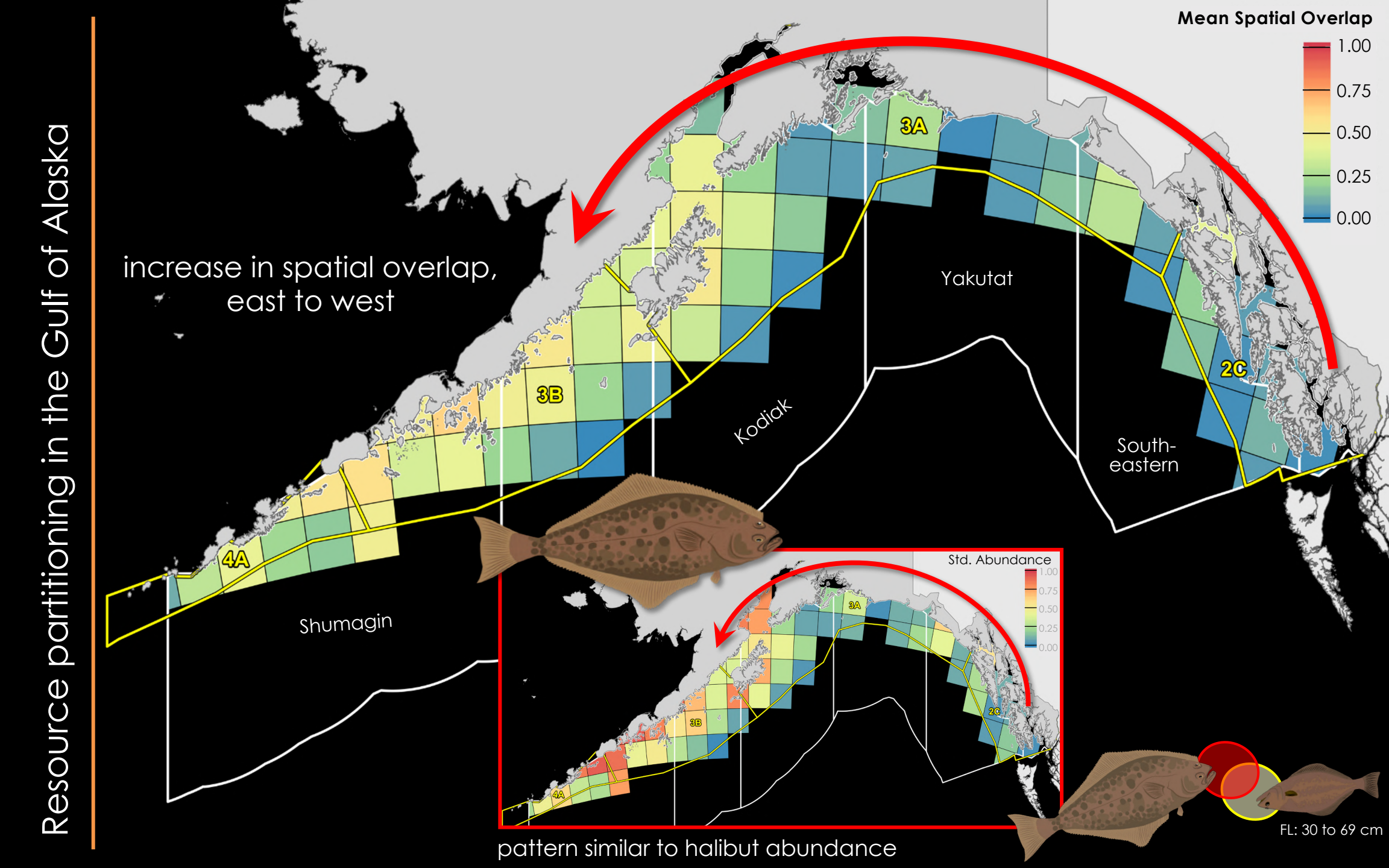
Spatial Overlap





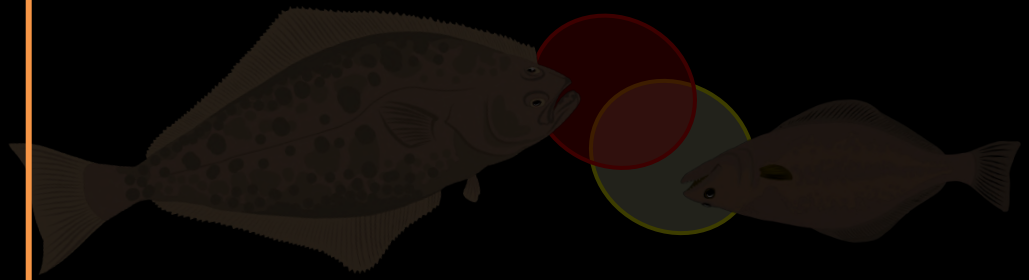


Resource partitioning in the Gulf of Alaska

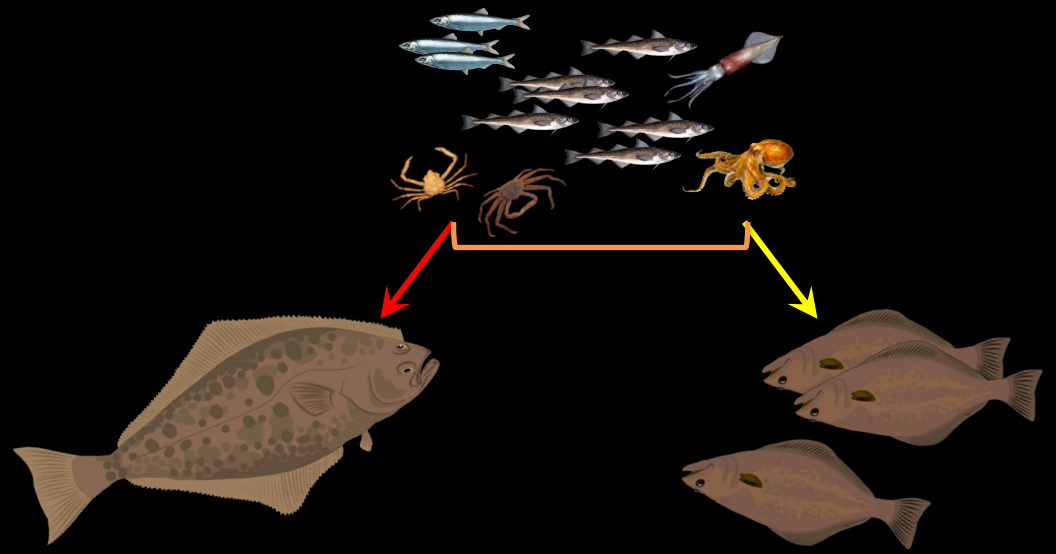


Are Pacific Halibut and Arrowtooth Flounder partitioning resources?

Spatial Overlap

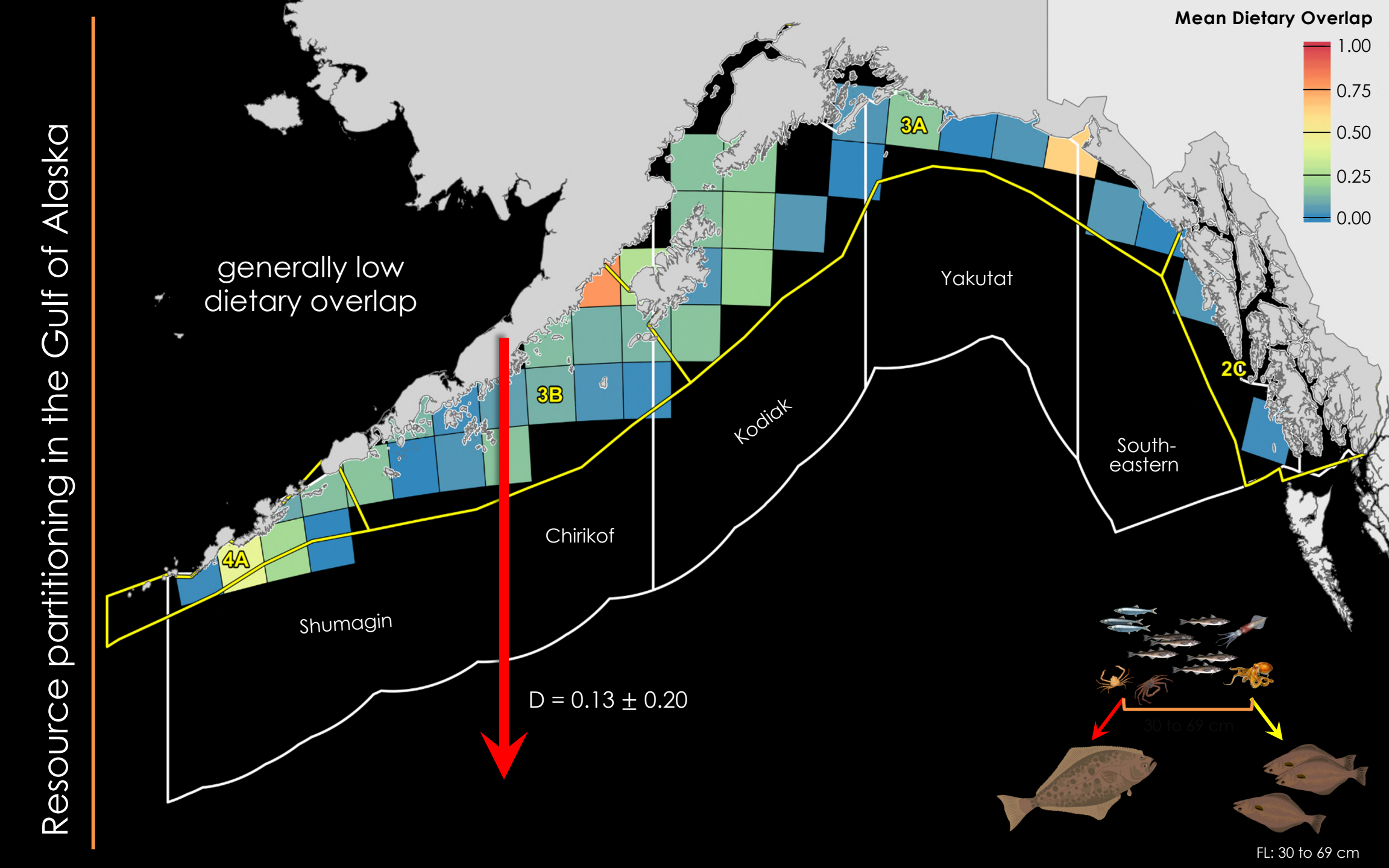


Dietary Overlap

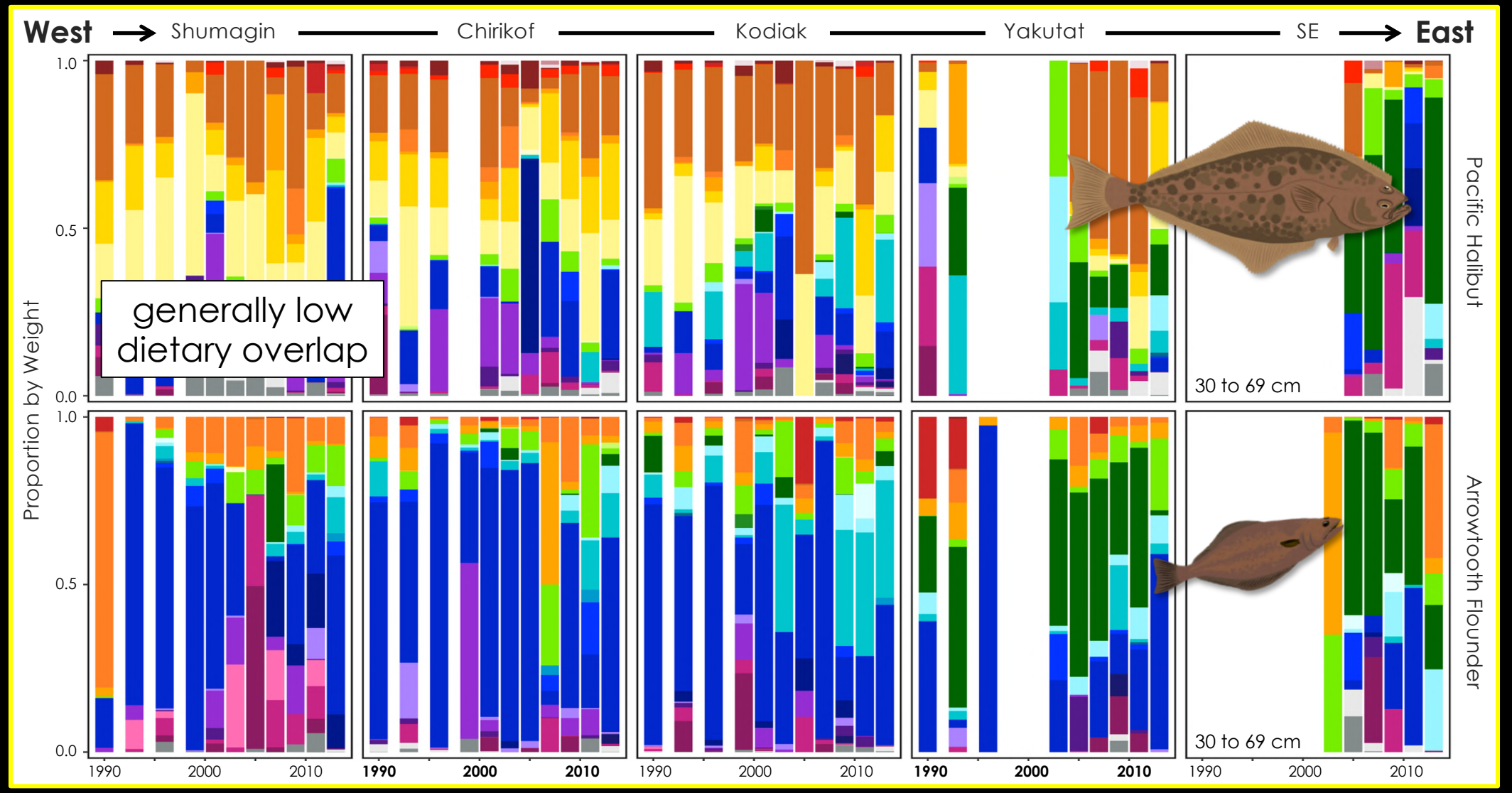


Schoener's Index of Similarity, 1968

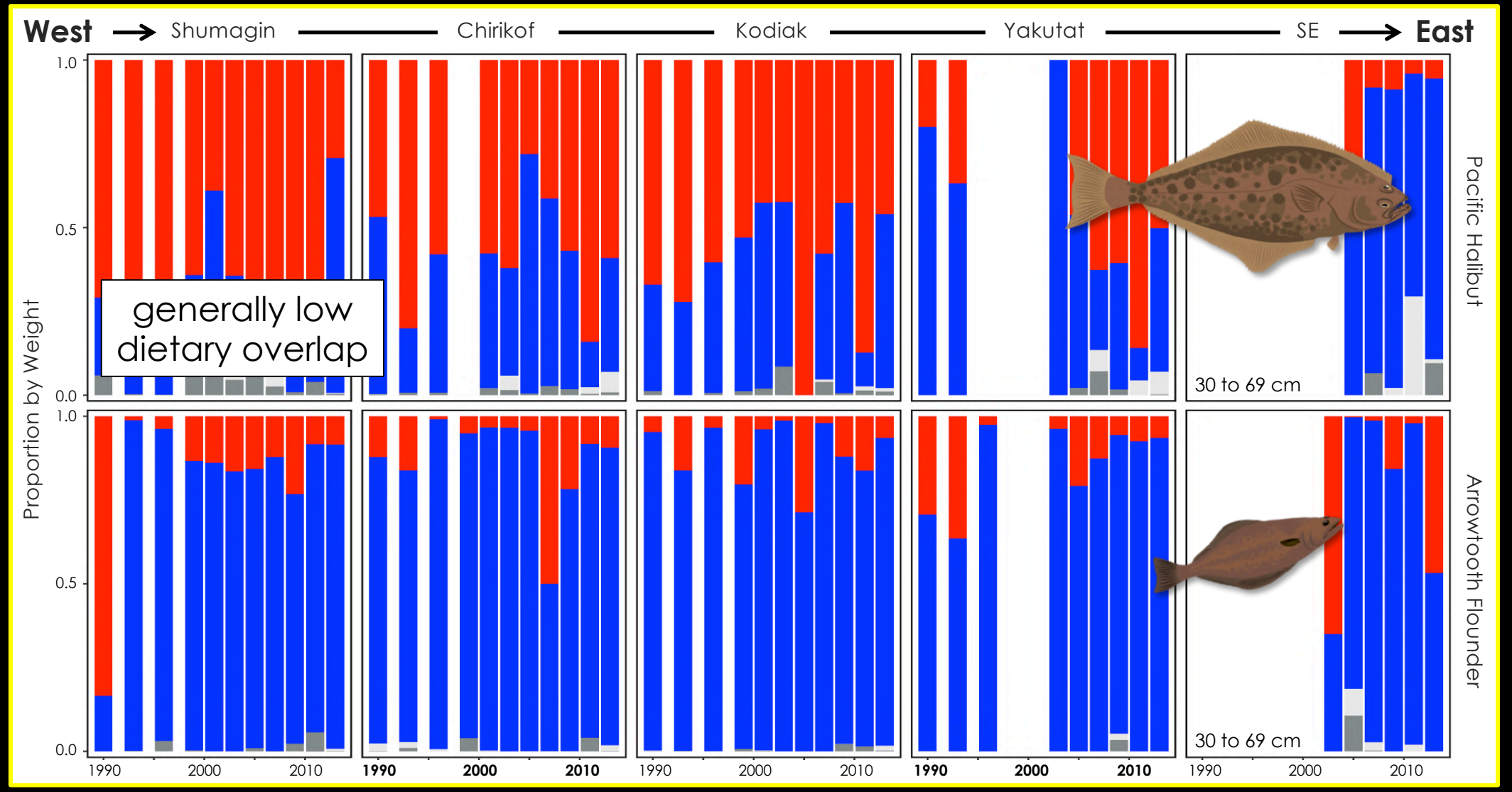
$$D = 1 - \tfrac{1}{2} \Sigma \left| \; \text{proportions of prey consumed} \; - \; \right|$$


Resource partitioning in the Gulf of Alaska
Mean Dietary Overlap
1.00
0.75
0.50
0.25
0.00
generally low dietary overlap
3A
3B
2C
4A
Yakutat
Kodiak
South-eastern
Chirikof
Shumagin
D = 0.13 ± 0.20
30 to 69 cm
FL: 30 to 69 cm

Resource partitioning in the Gulf of Alaska

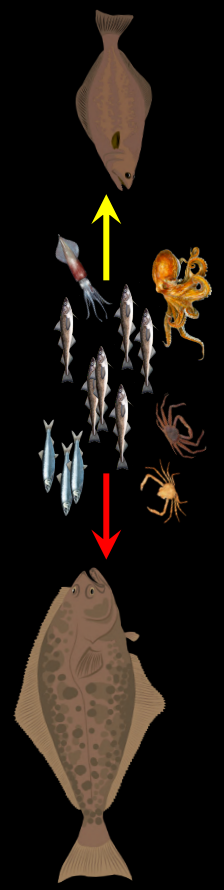


Resource partitioning in the Gulf of Alaska



Resource partitioning in the Gulf of Alaska

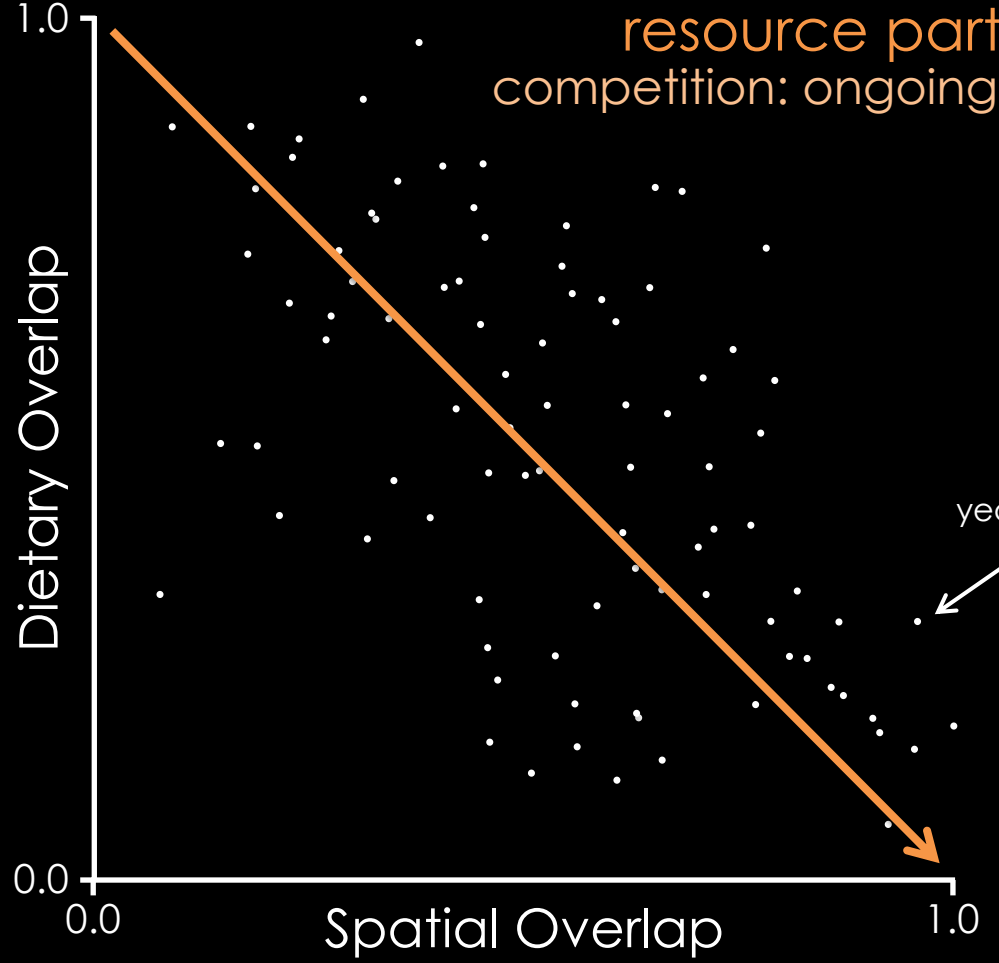
Are Pacific Halibut and Arrowtooth Flounder partitioning resources?

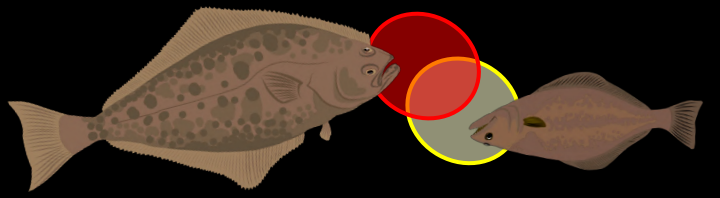


HYPOTHESIS

resource partitioning

competition: ongoing or recent past

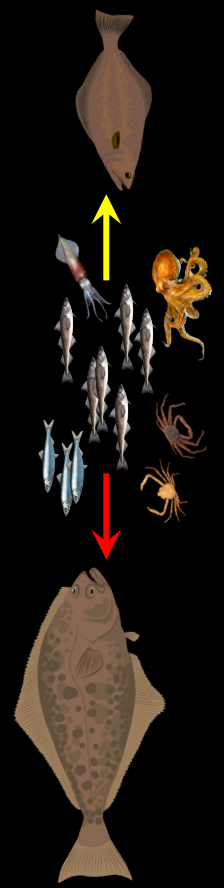




Schoener 1983; Ross 1986
Link and Auster 2013

Resource partitioning in the Gulf of Alaska

Are Pacific Halibut and Arrowtooth Flounder partitioning resources?



0 — 1

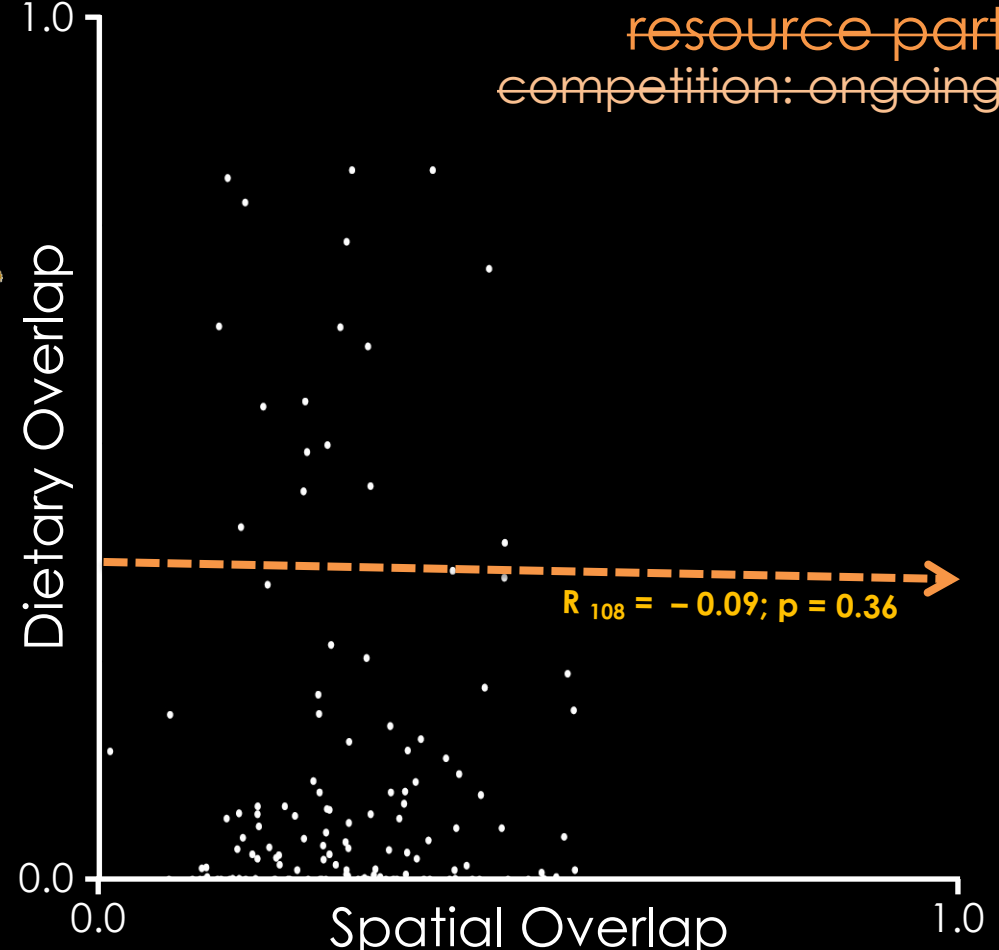
NONE — TOTAL

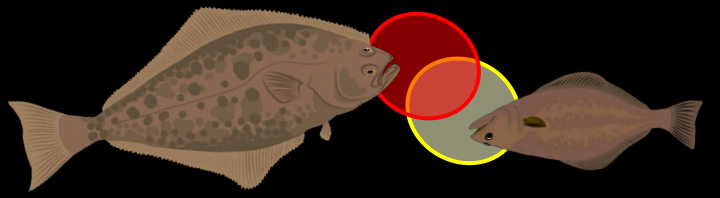
Degree of Overlap

FINDINGS

~~resource partitioning~~

~~competition: ongoing or recent past~~





Schoener 1983; Ross 1986
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Why didn't we see evidence of resource partitioning?

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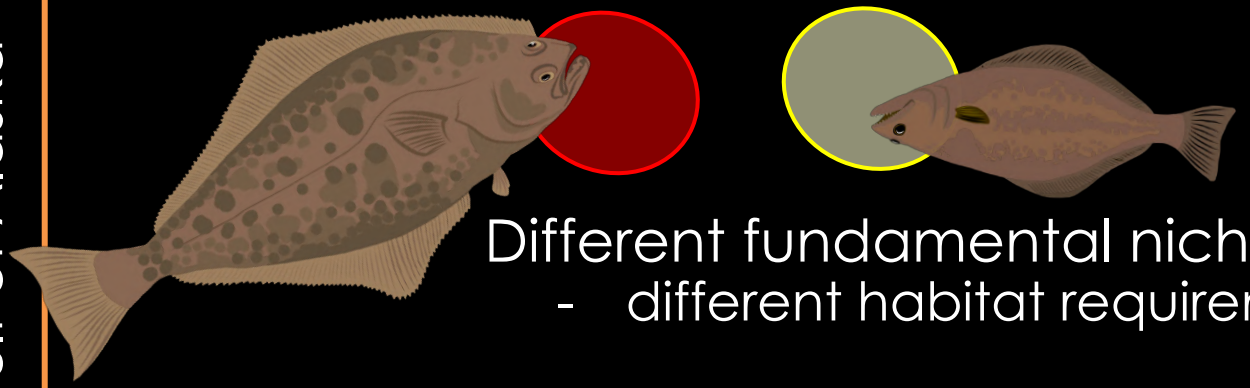


Different fundamental niches
- different habitat requirements

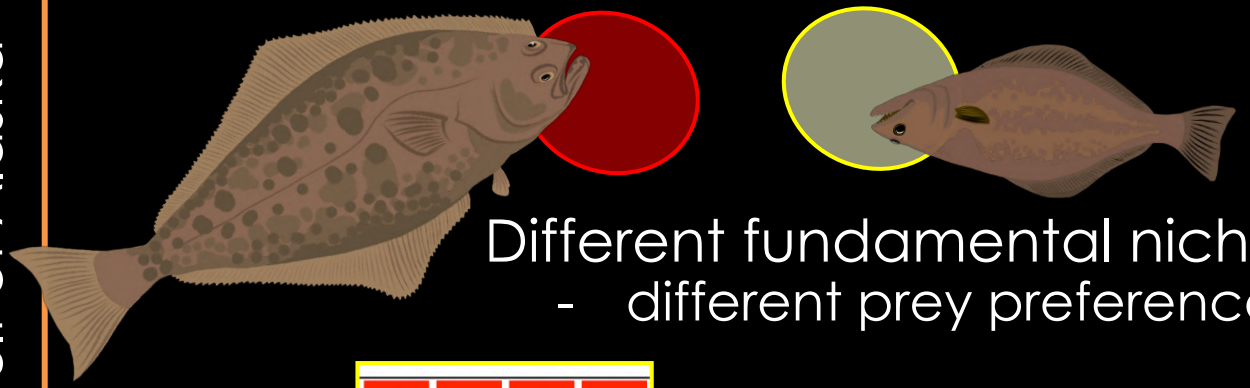
Shallow Depths
0 to 100 m

Moderate-Deep Depths
75 to 450 m

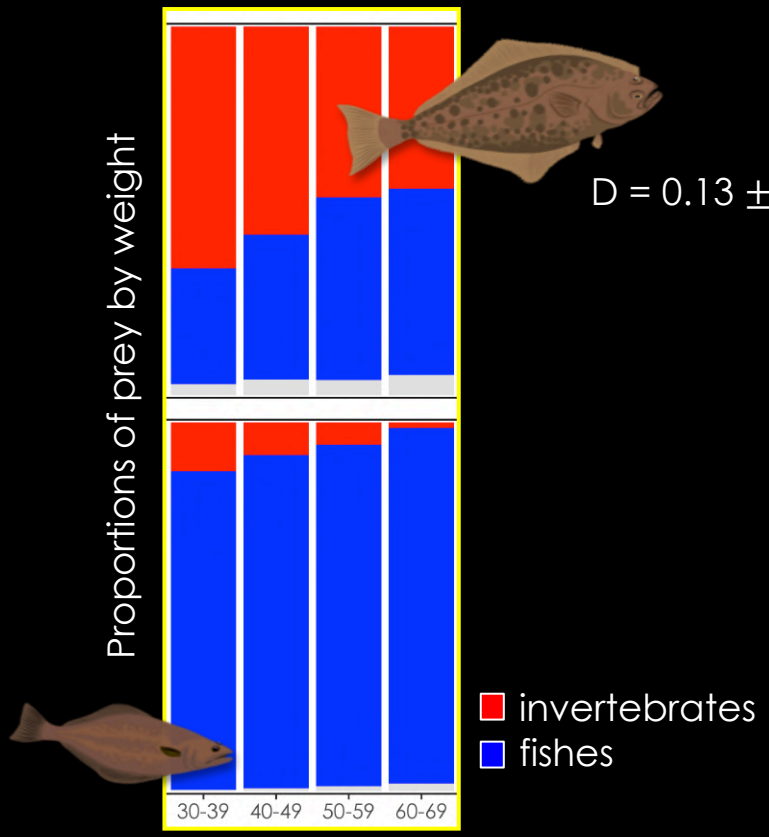
Colder
Bottom Temperatures
< 3°C | << 9°C

Warmer
Bottom Temperatures
> 4.5°C | >> 9°C

Why didn't we see evidence of resource partitioning?

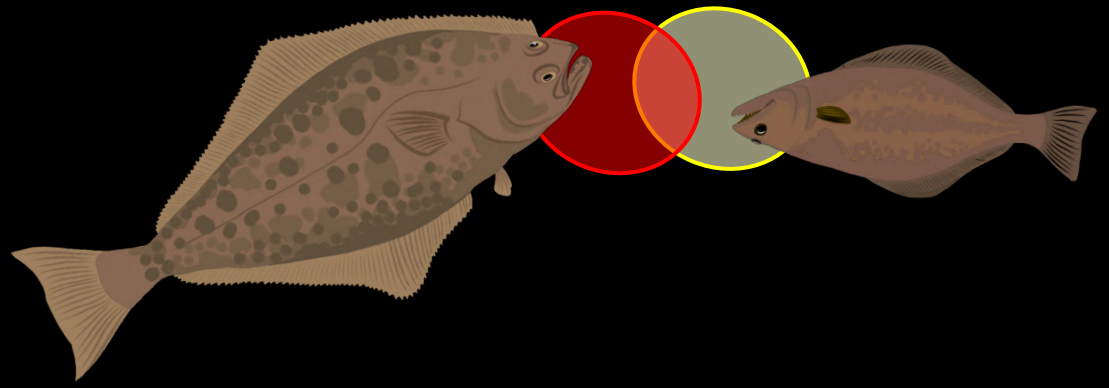


Different fundamental niches
- different prey preferences



D = 0.13 ± 0.20

Why didn't we see evidence of resource partitioning?



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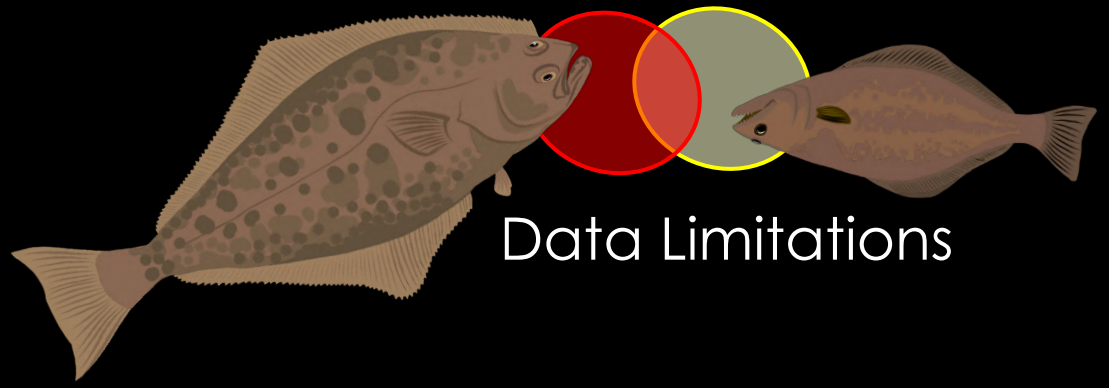
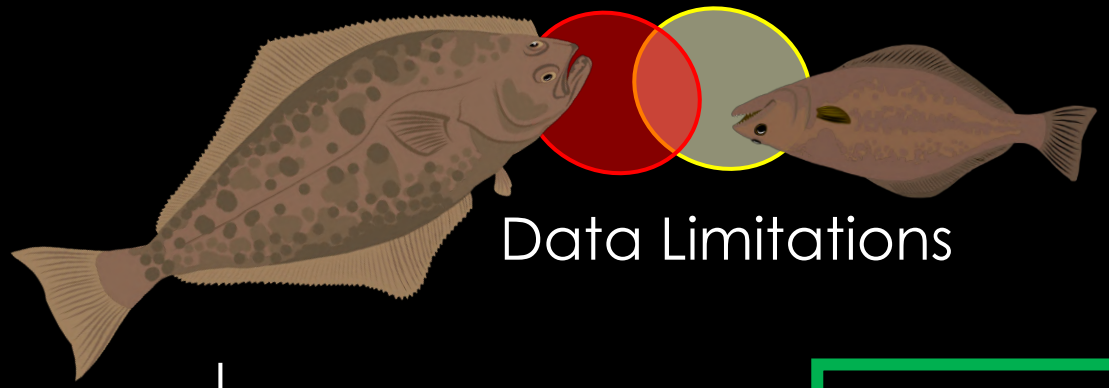


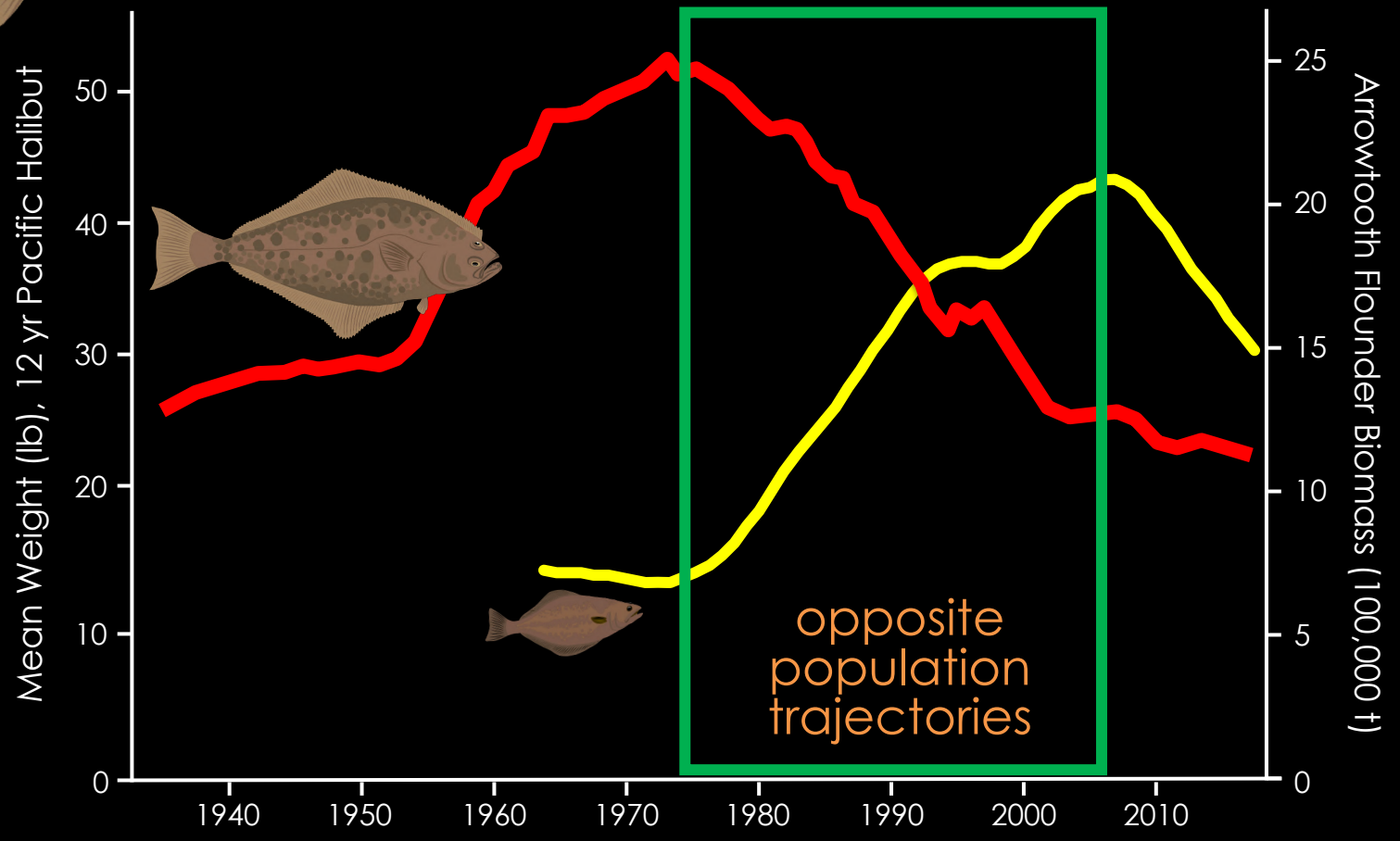
Data Limitations

Resource partitioning in the Gulf of Alaska

Why didn't we see evidence of resource partitioning?



Data Limitations



Resource partitioning in the Gulf of Alaska

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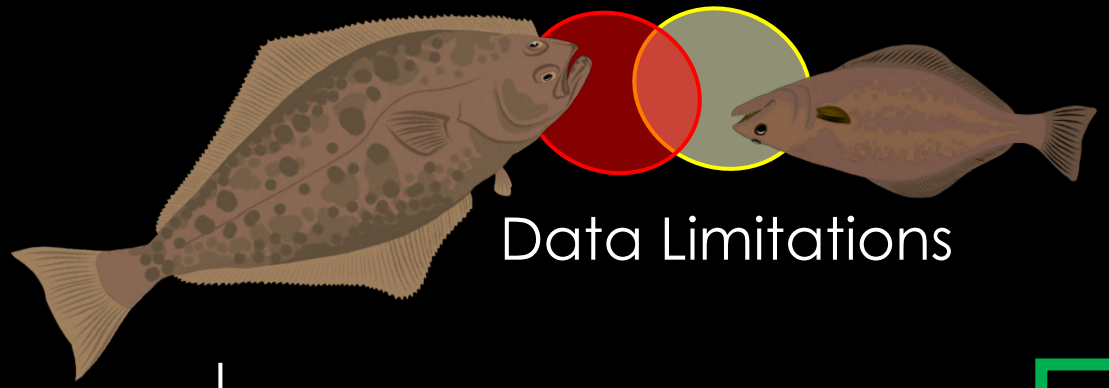
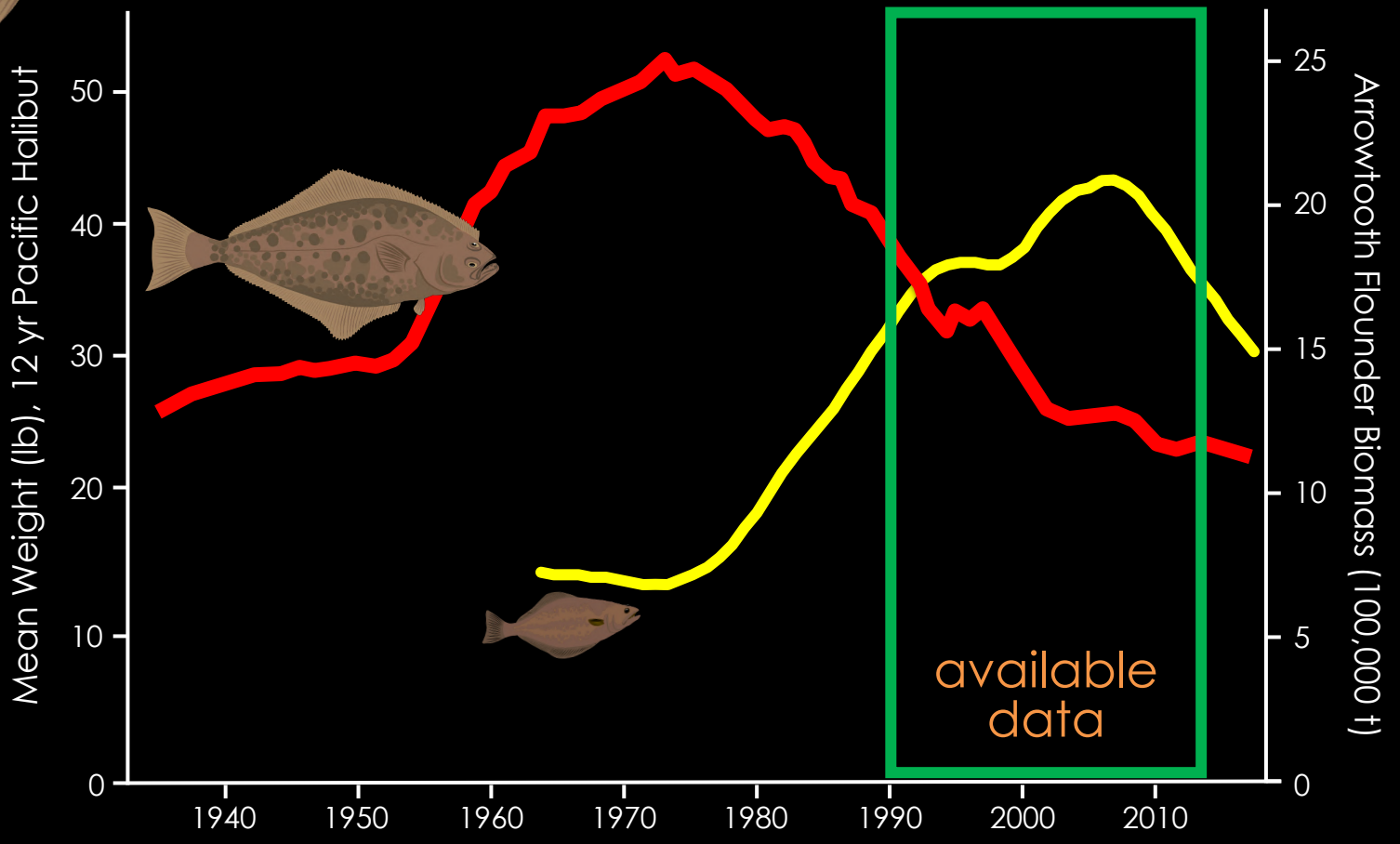


Data Limitations



Resource partitioning in the Gulf of Alaska

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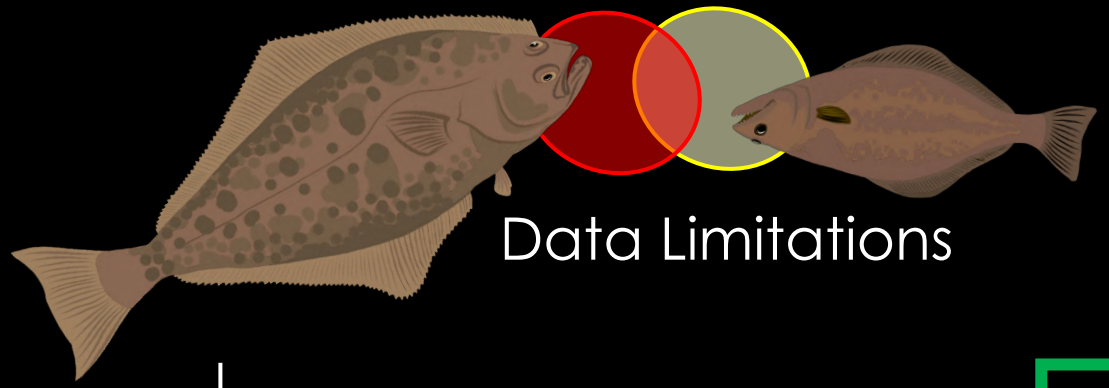

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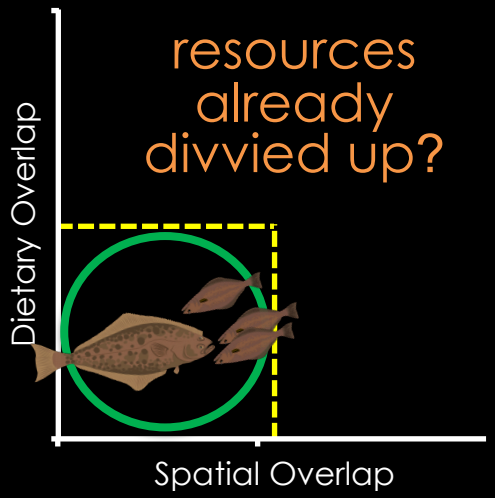

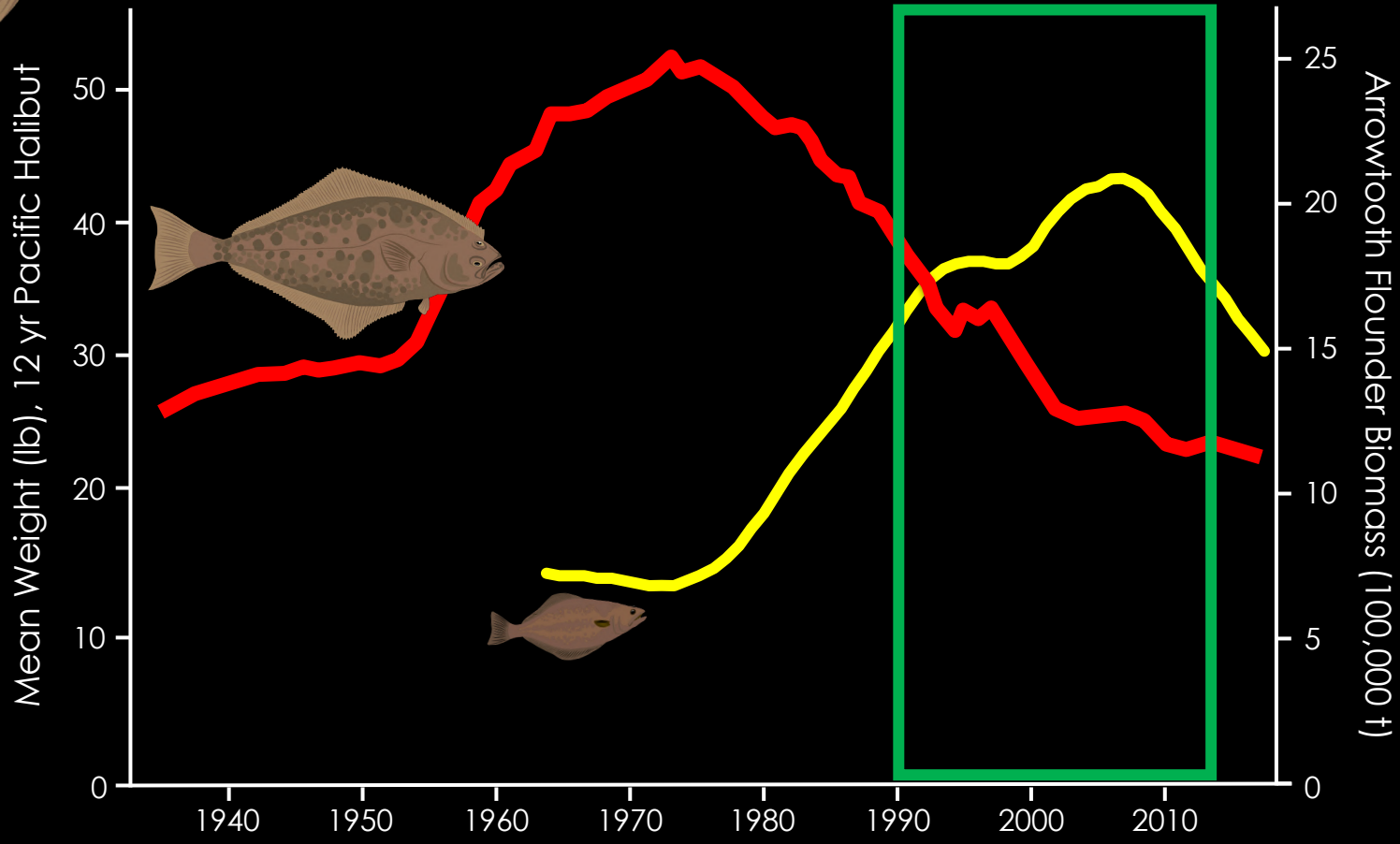

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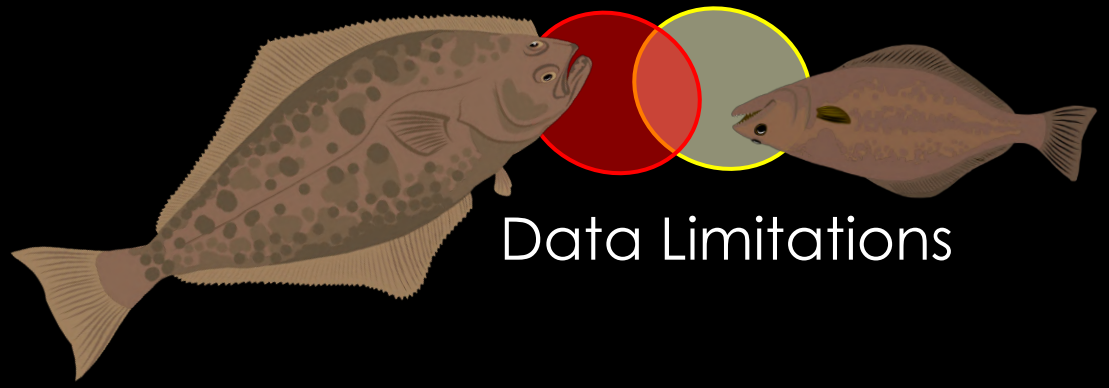
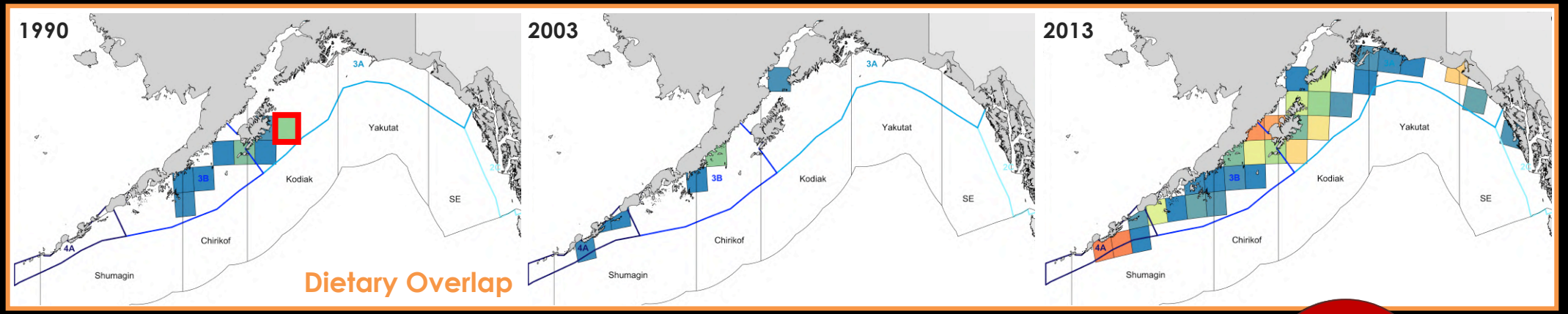


Data Limitations

low signal to noise ratio

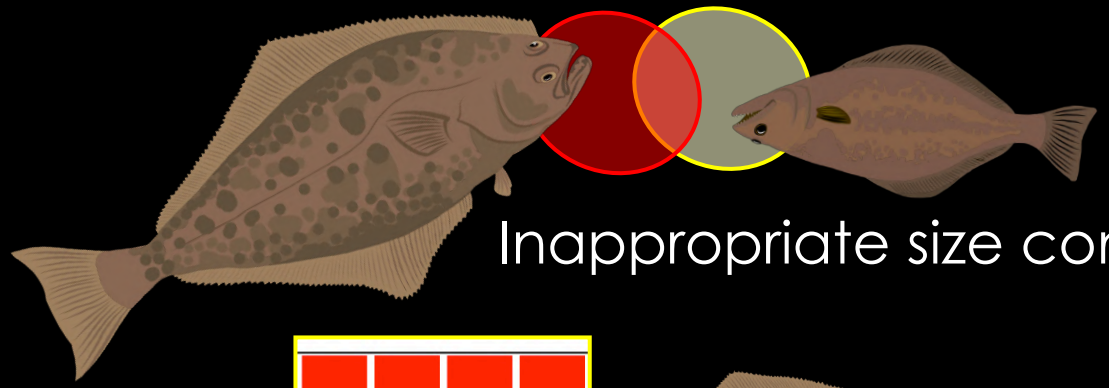


Dietary Overlap

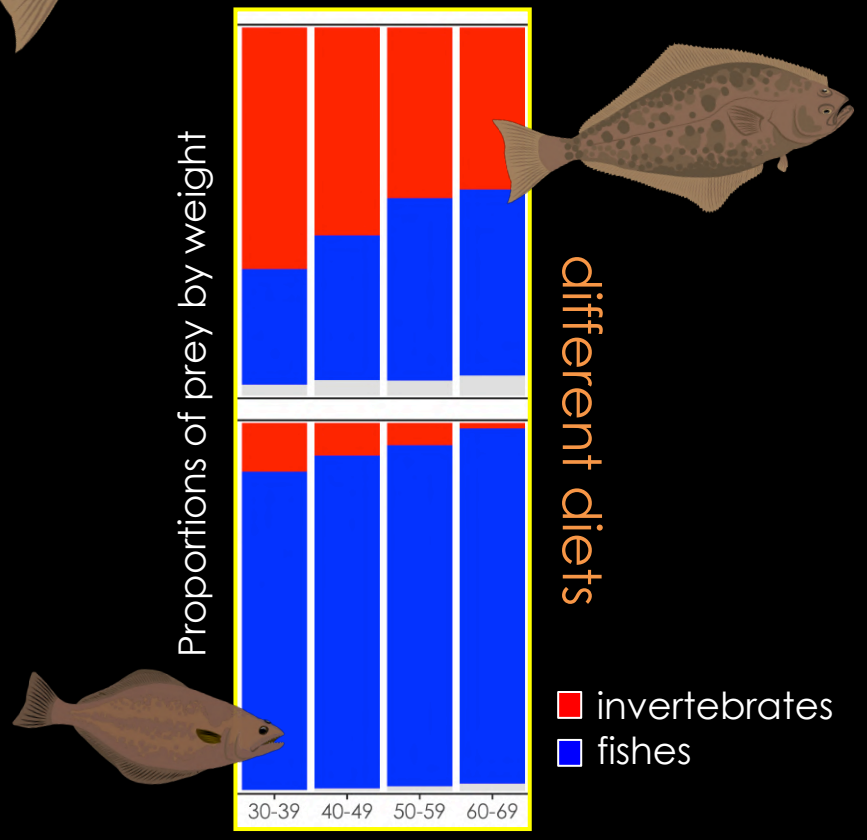
- sparse sampling for diets
- large (100 km X 100 km) grid cells

Resource partitioning in the Gulf of Alaska

Why didn't we see evidence of resource partitioning?



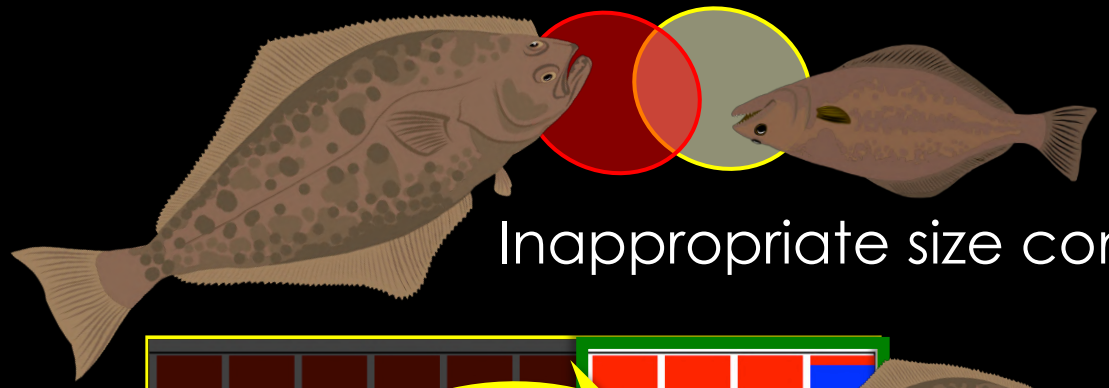
Inappropriate size comparisons



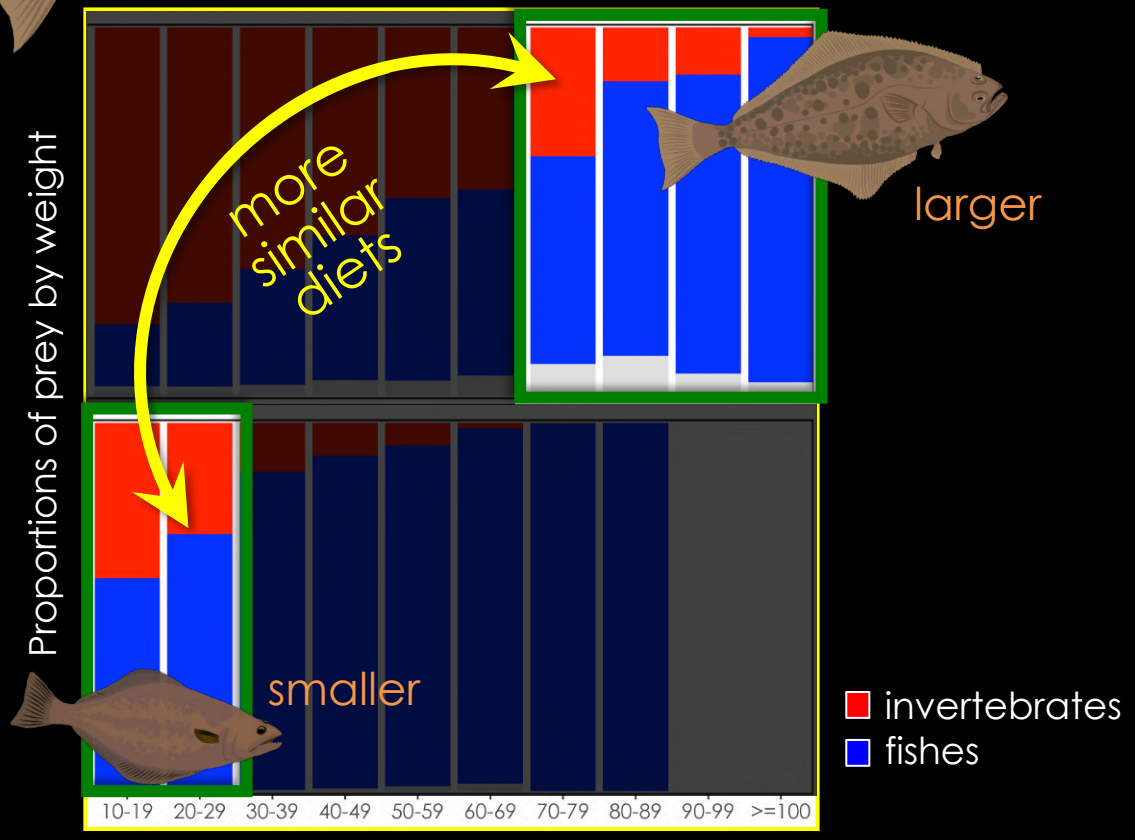
same lengths

FL: 30-69 cm

Why didn't we see evidence of resource partitioning?



Inappropriate size comparisons



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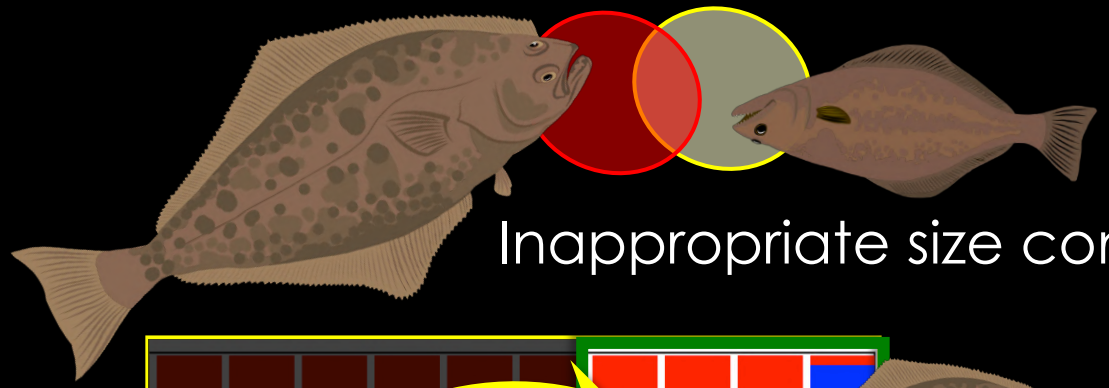
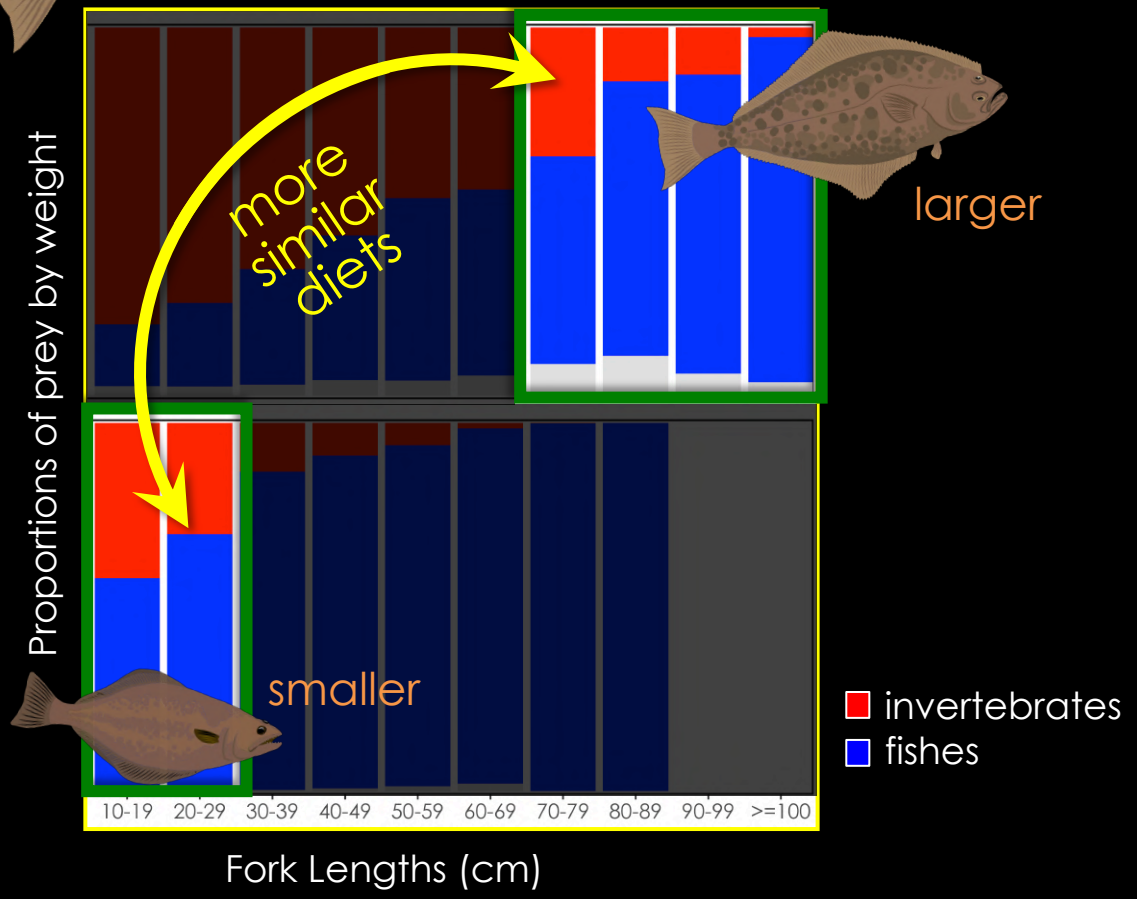
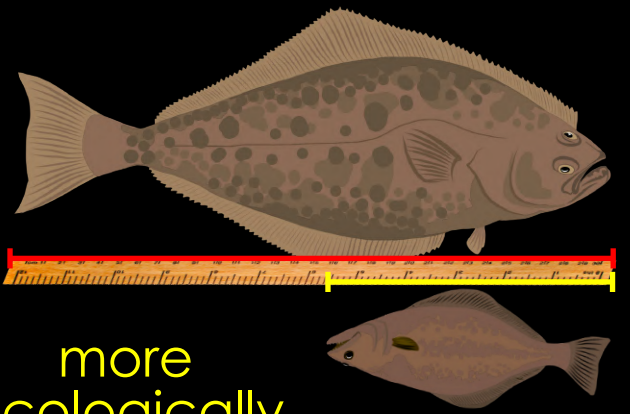


Inappropriate size comparisons





more ecologically relevant?

PLOS ONE

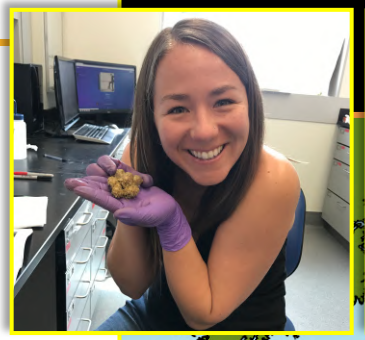
RESEARCH ARTICLE

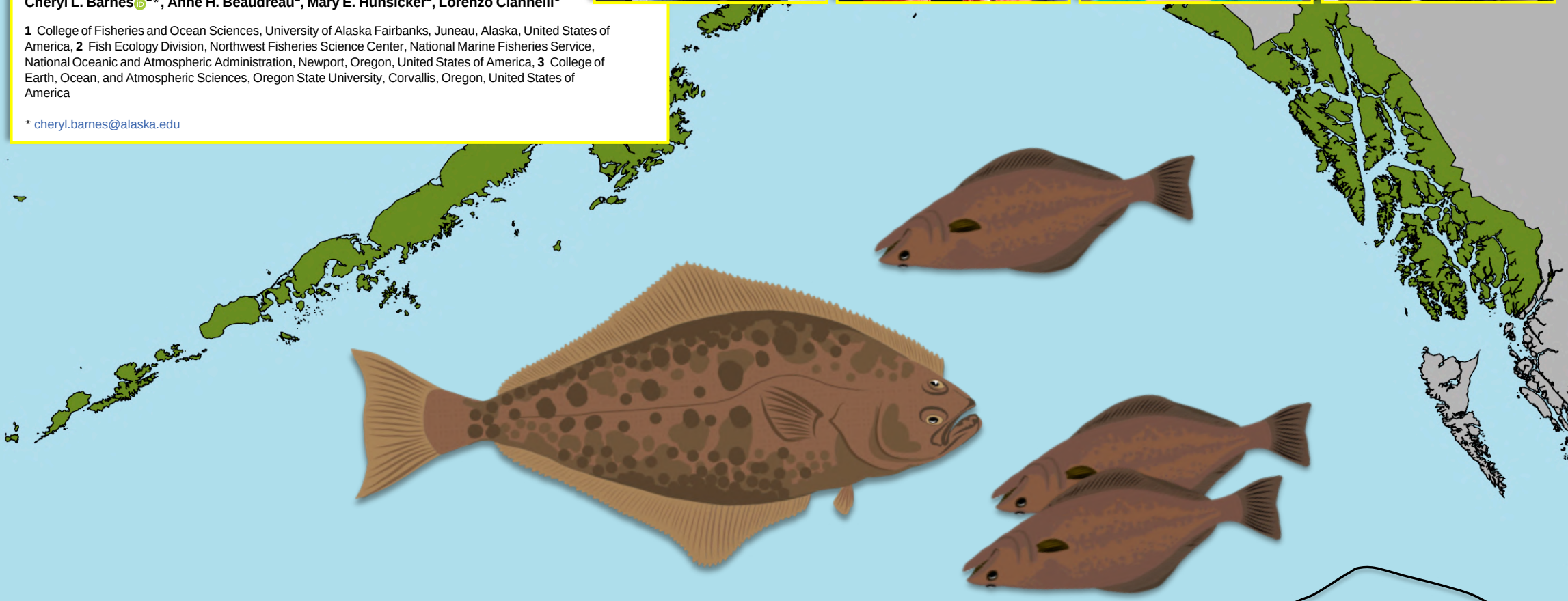
Assessing the potential for competition between Pacific Halibut (*Hippoglossus stenolepis*) and Arrowtooth Flounder (*Atheresthes stomias*) in the Gulf of Alaska

Cheryl L. Barnes[1]*, Anne H. Beaudreau[1], Mary E. Hunsicker[2], Lorenzo Ciannelli[3]

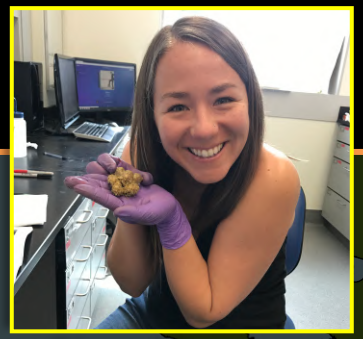
1 College of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Juneau, Alaska, United States of America, **2** Fish Ecology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Newport, Oregon, United States of America, **3** College of Earth, Ocean, and Atmospheric Sciences, Oregon State University, Corvallis, Oregon, United States of America

* cheryl.barnes@alaska.edu



PROJECT 1: Broad-scale resource comparisons among similar body sizes



Cheryl Barnes

Anne Beaudreau

Richard Yamada

Marine and Coastal Fisheries

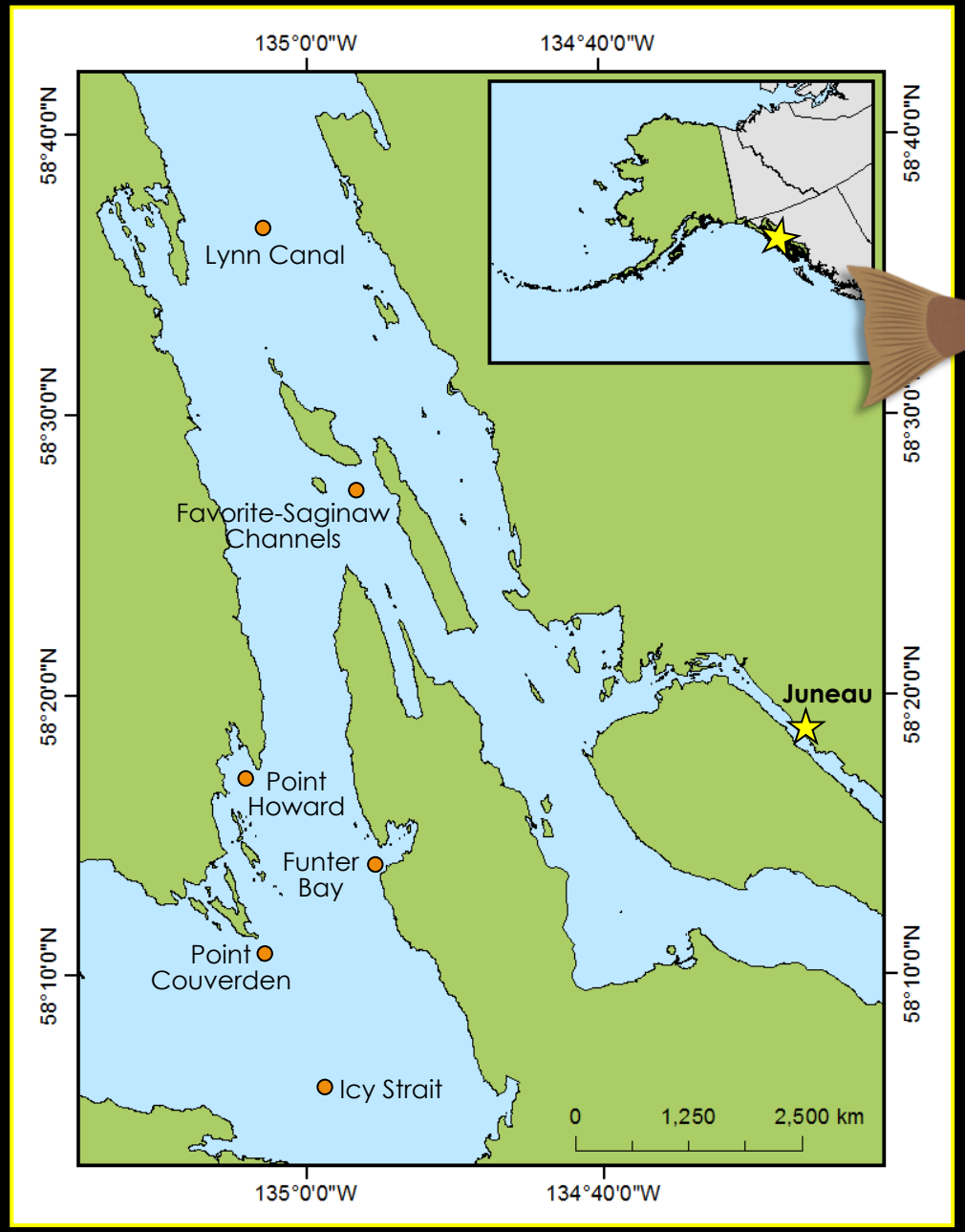
Dynamics, Management, and Ecosystem Science

in review

PROJECT 2: Fine-scale prey consumption according to multiple size metrics

Gape Width (mm)

Dietary overlap in nearshore Southeast Alaska

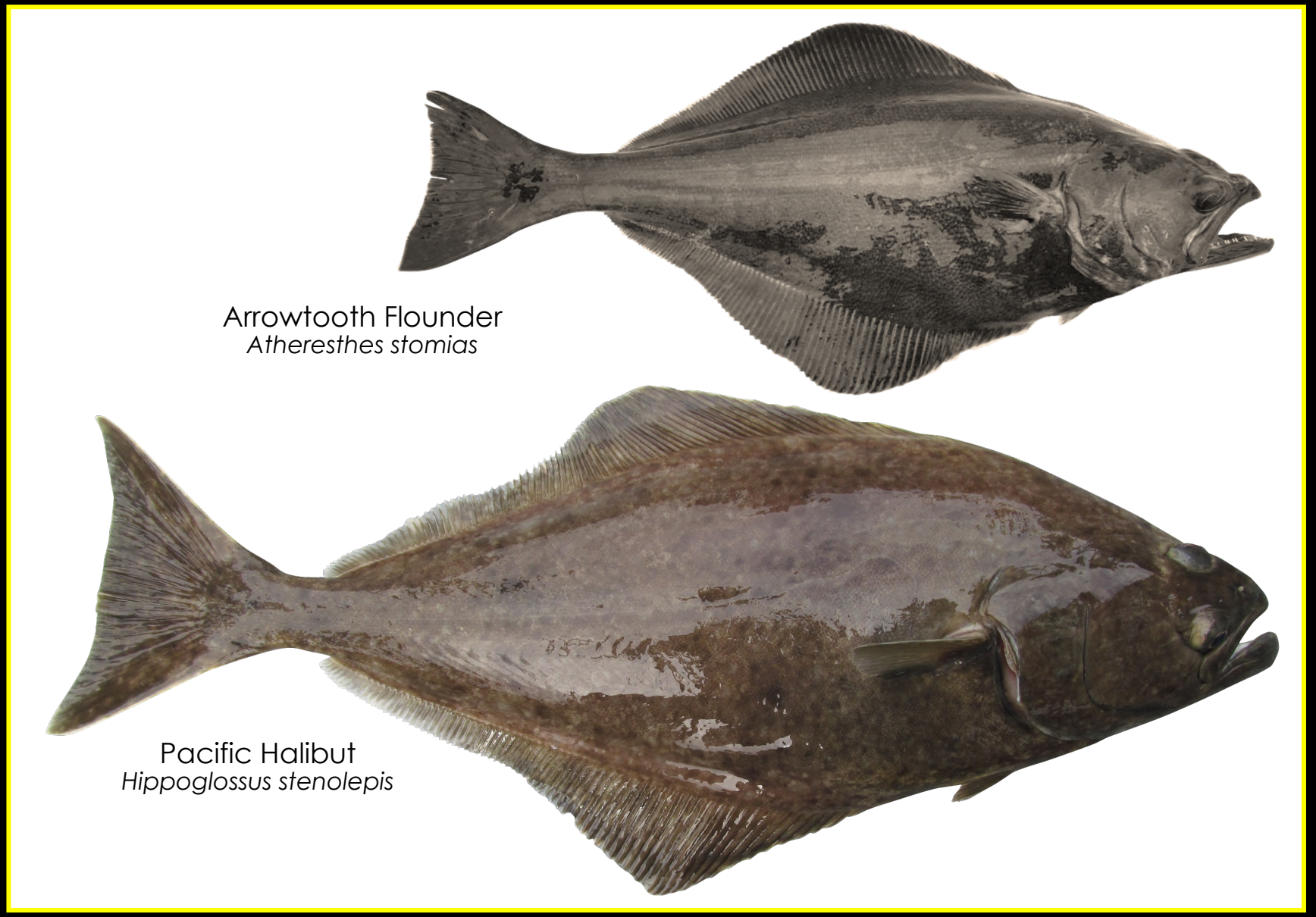


2015 & 2016
Jun to Aug

1,362 fish
169 stomachs

1,526 fish
920 stomachs

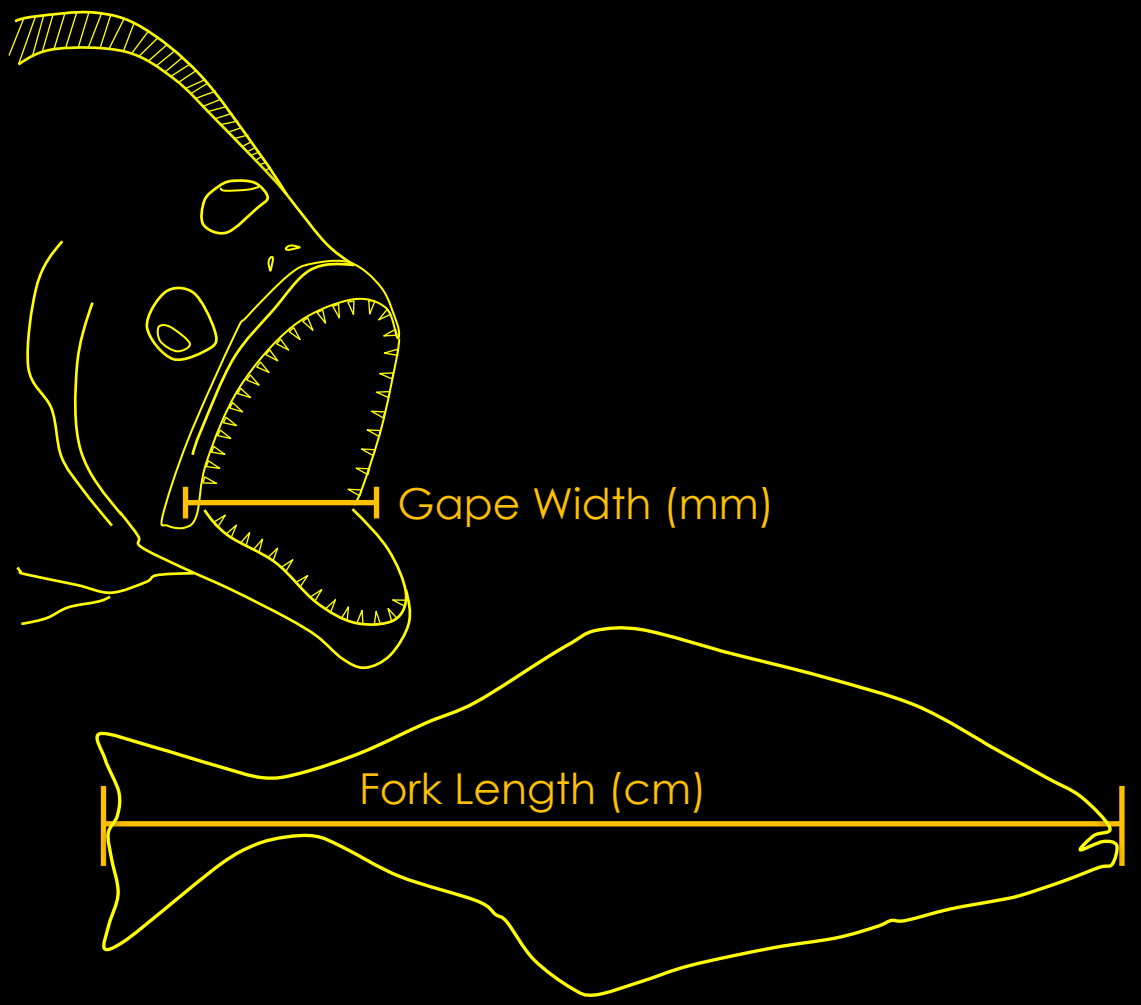
How does our metric of size affect interpretations of resource partitioning?

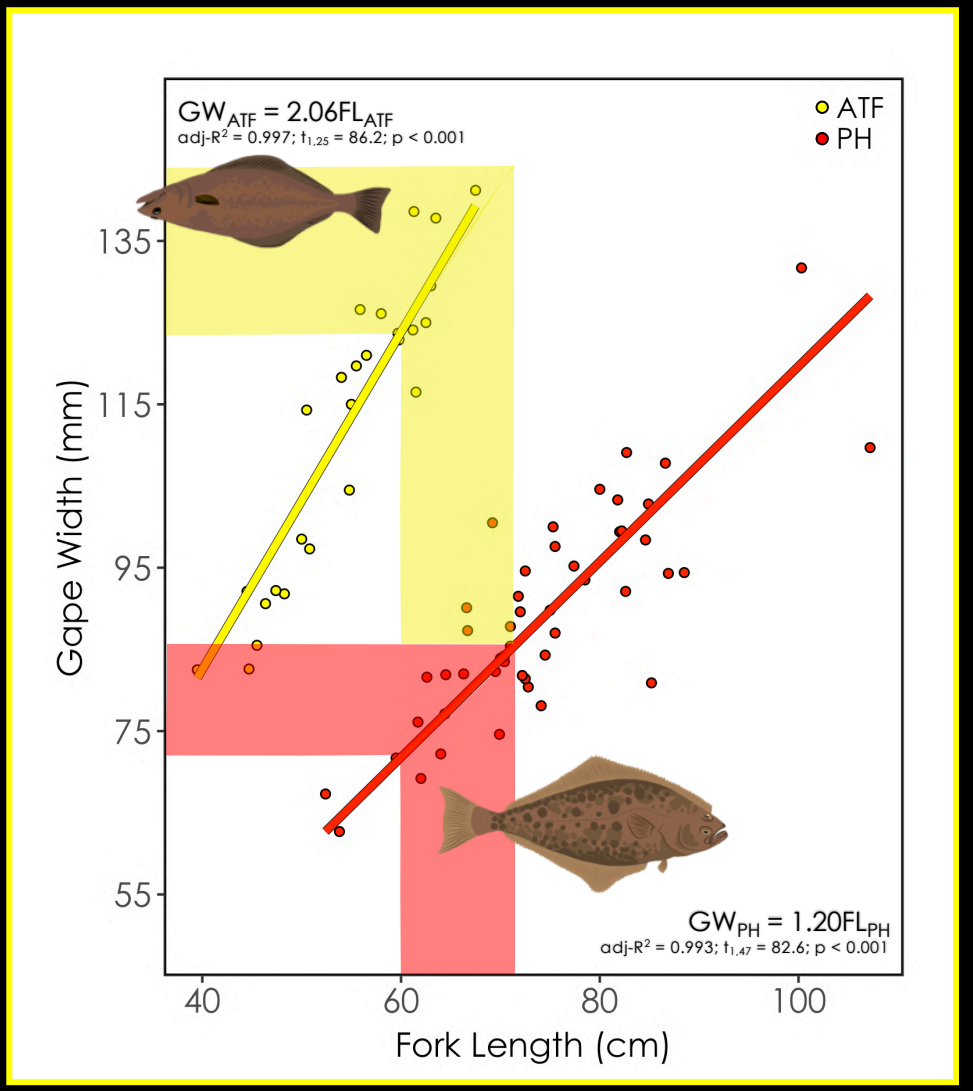


larger gape

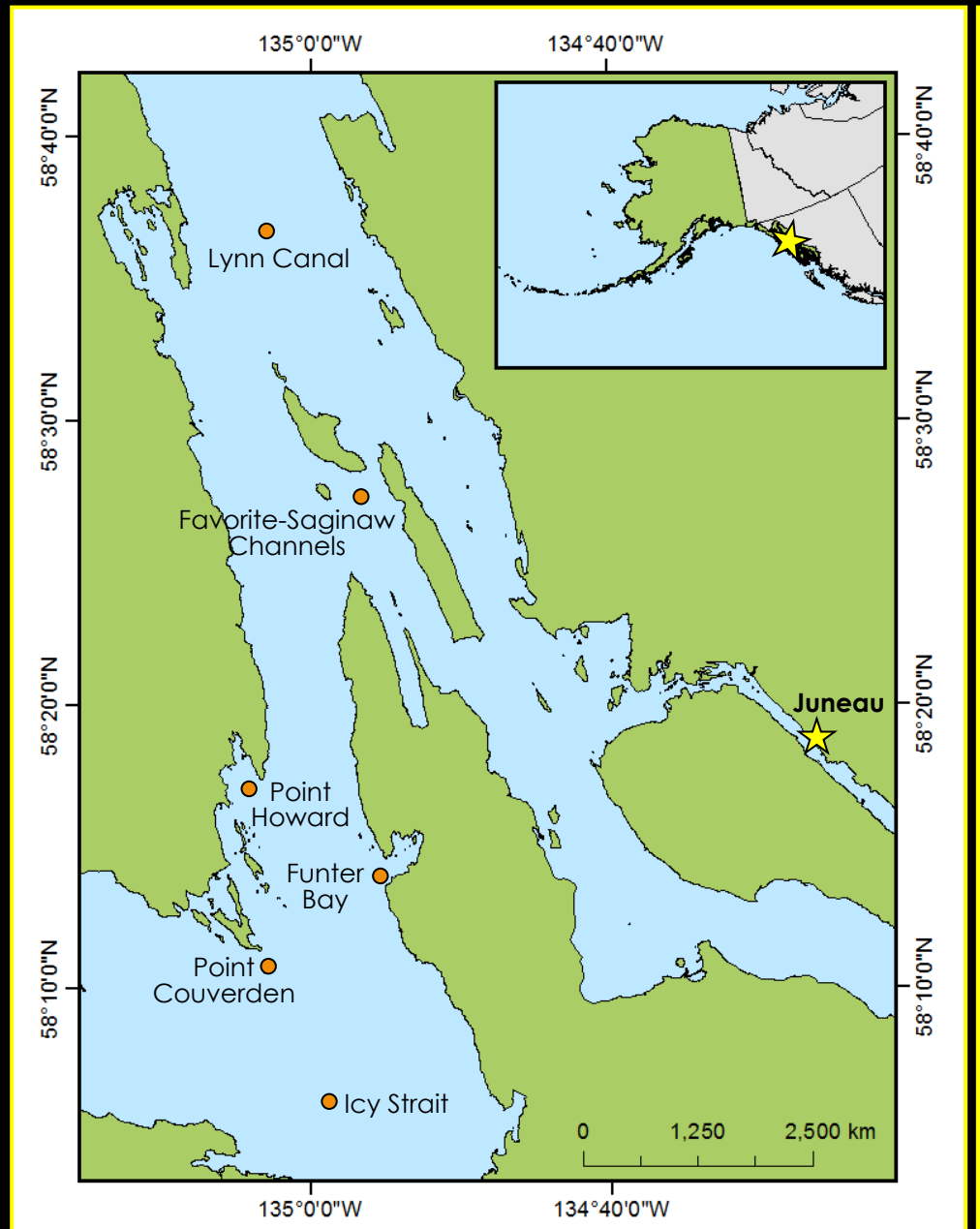
smaller gape

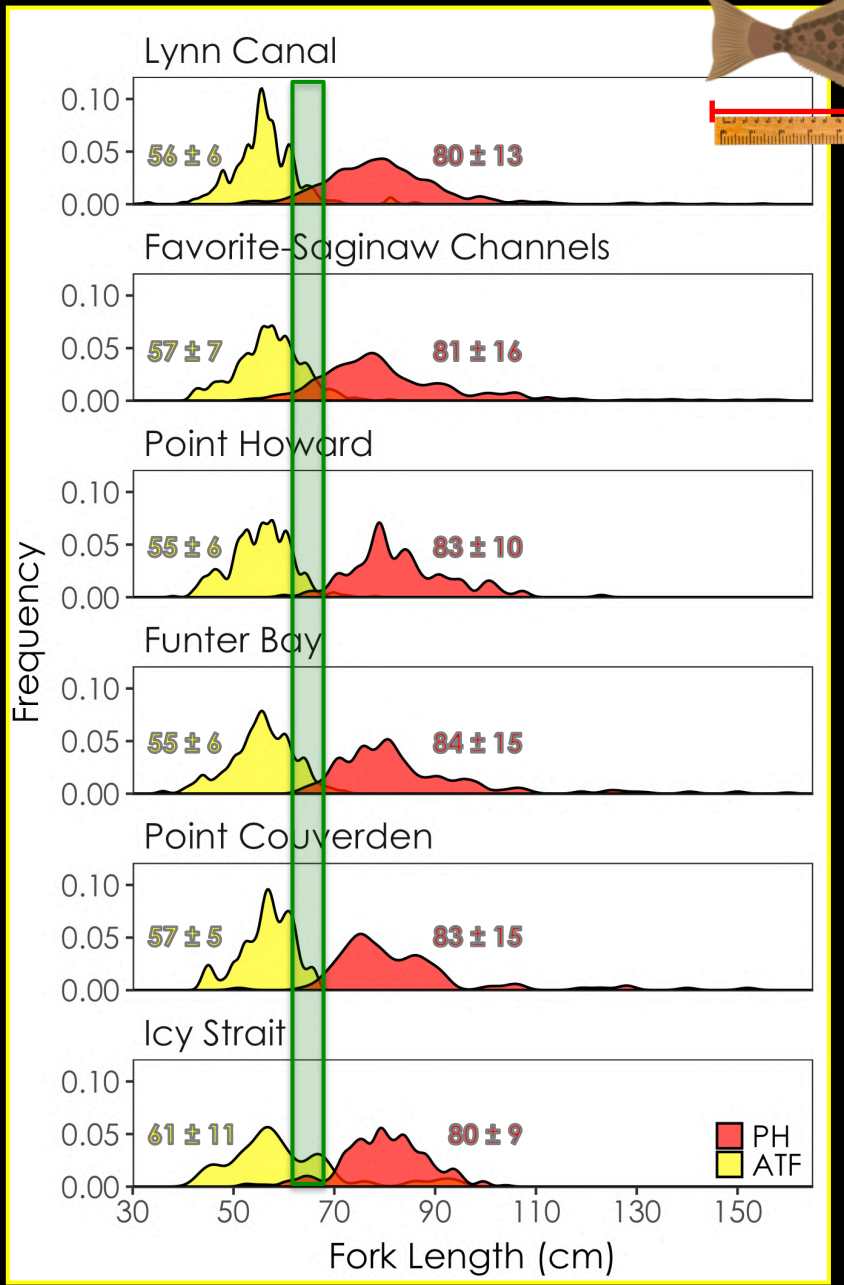
How does our metric of size affect interpretations of resource partitioning?

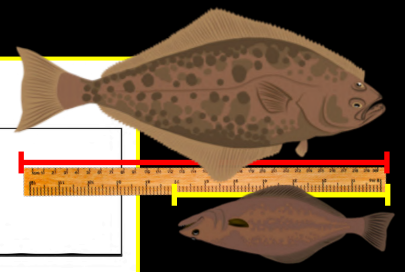




Dietary overlap in nearshore Southeast Alaska

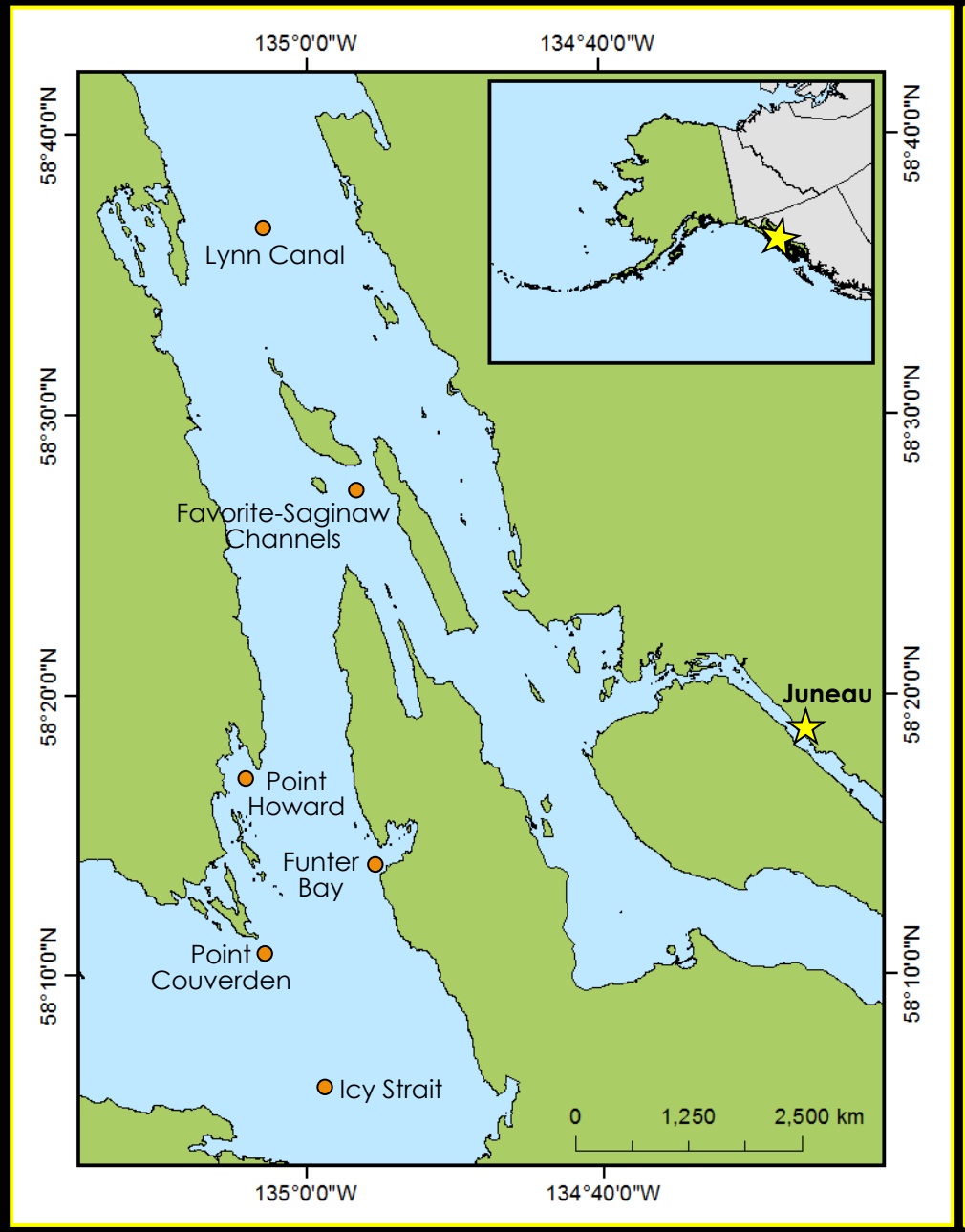


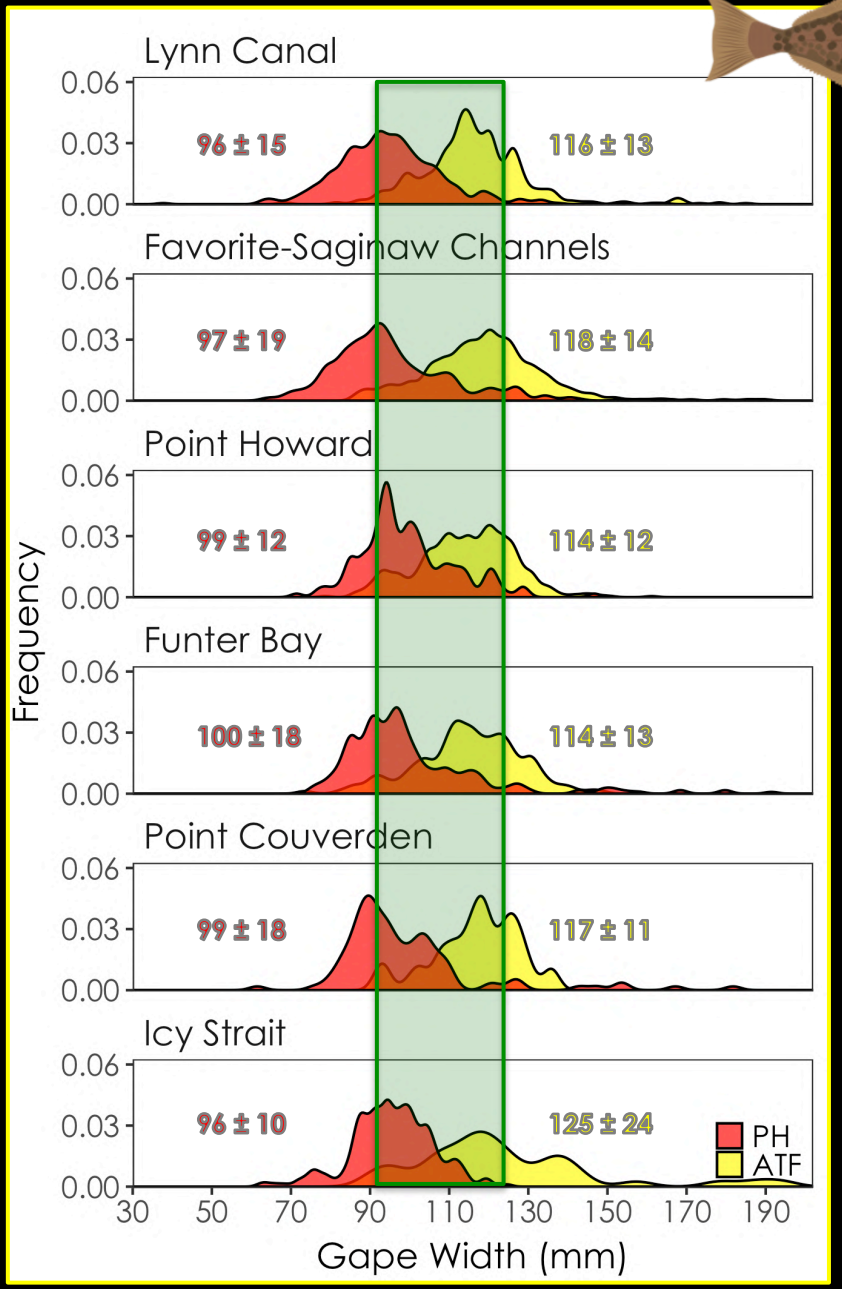


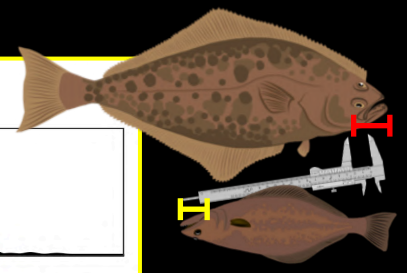


Low overlap by fork length

Dietary overlap in nearshore Southeast Alaska



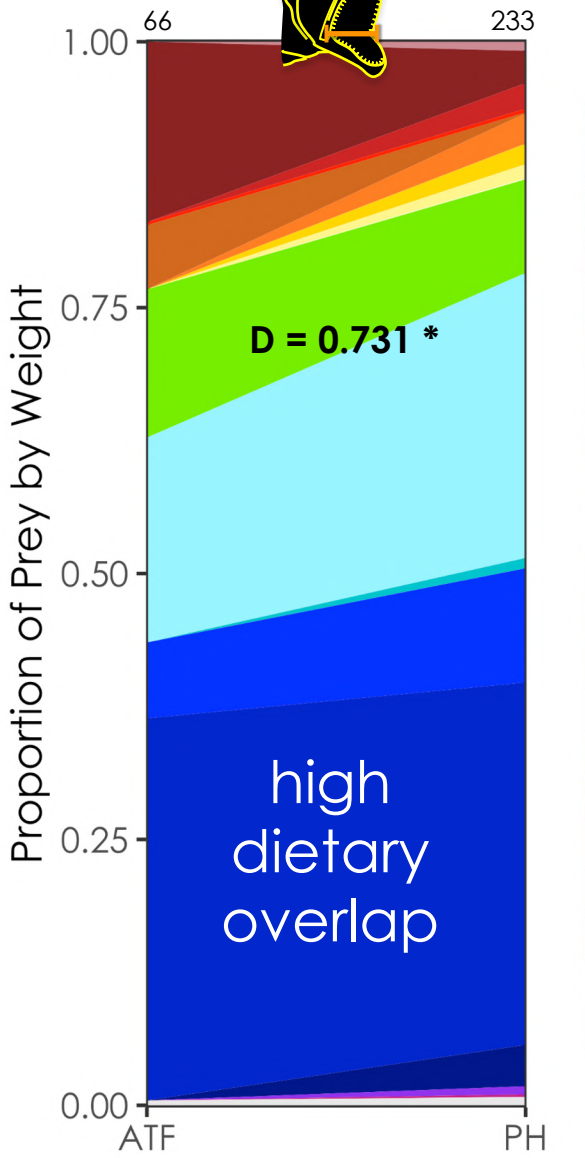




Much greater overlap by gape width

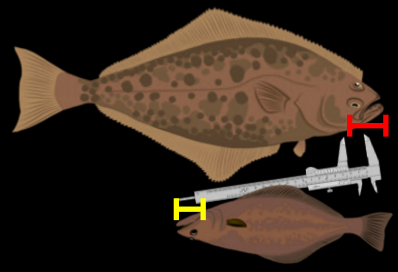
Dietary overlap in nearshore Southeast Alaska

* comparable sites only

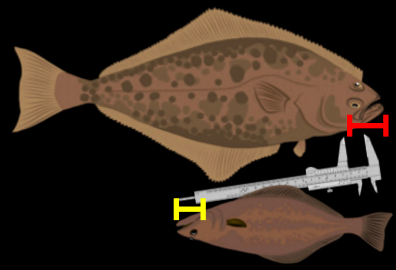


molluscs
squids
octopuses
crabs/shrimps
pandalid shrimps
king crabs
spider crabs
Tanner/Snow Crab
Dungeness Crab
hermit crabs
skates/rays
unidentified fishes
Pacific Herring
Pacific salmon
pollock/cod
Walleye Pollock
Pacific Cod
rockfishes
flatfishes
benthic material
other

Gape Width: 96-115 mm



Dietary overlap in nearshore Southeast Alaska



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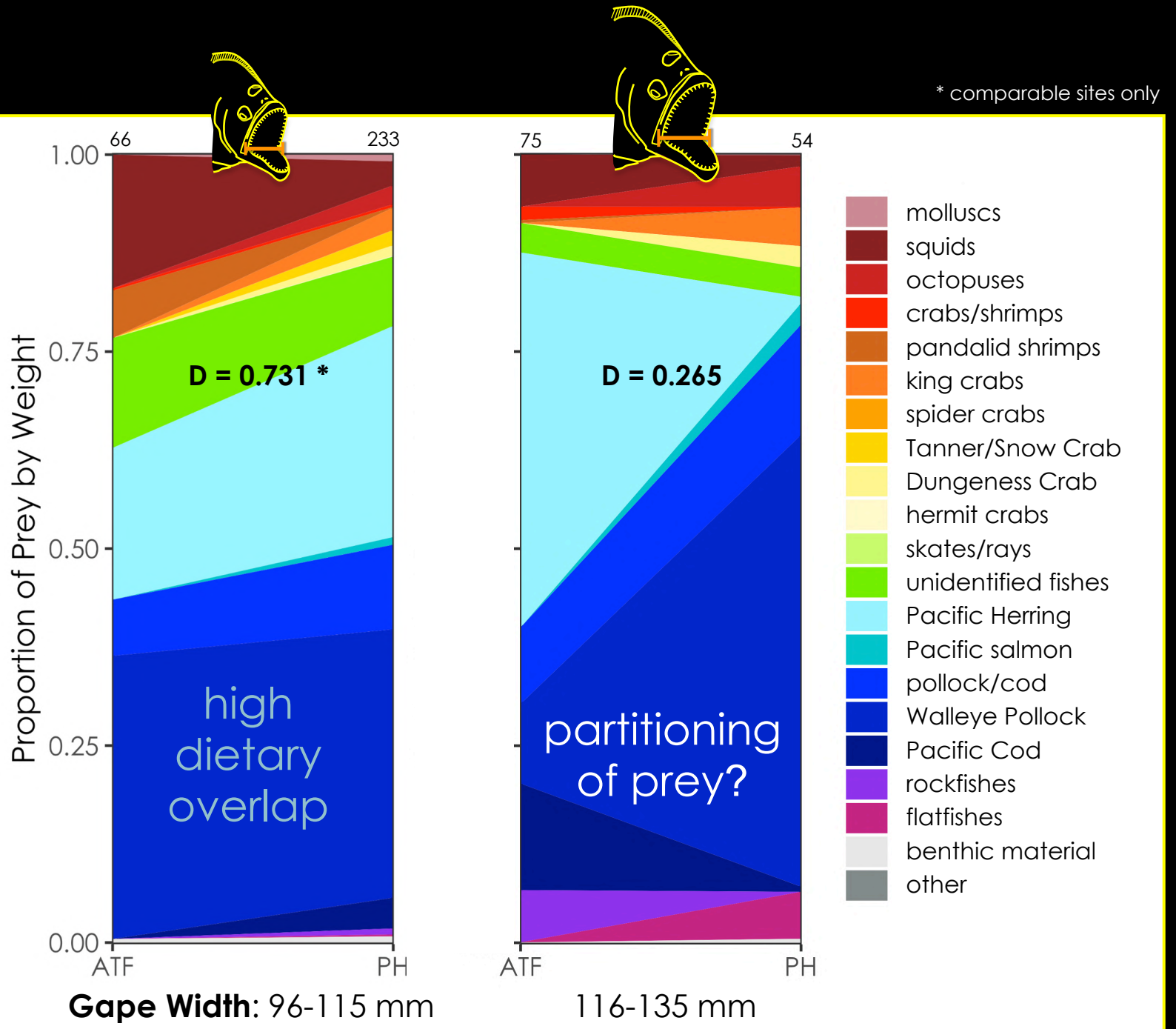


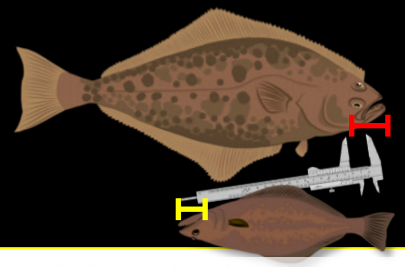
Gape Width: 96-115 mm

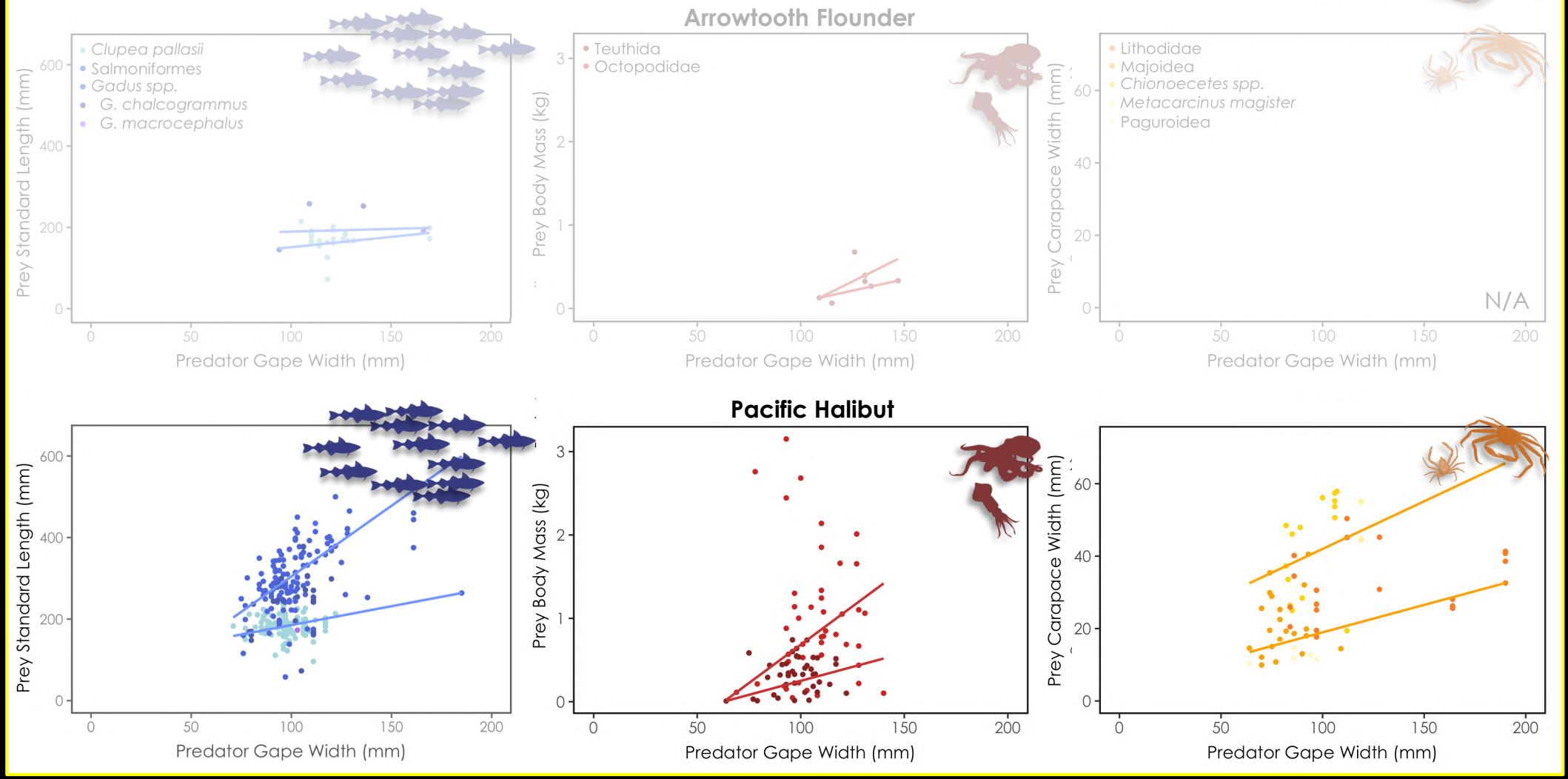
116-135 mm

Dietary overlap in nearshore Southeast Alaska

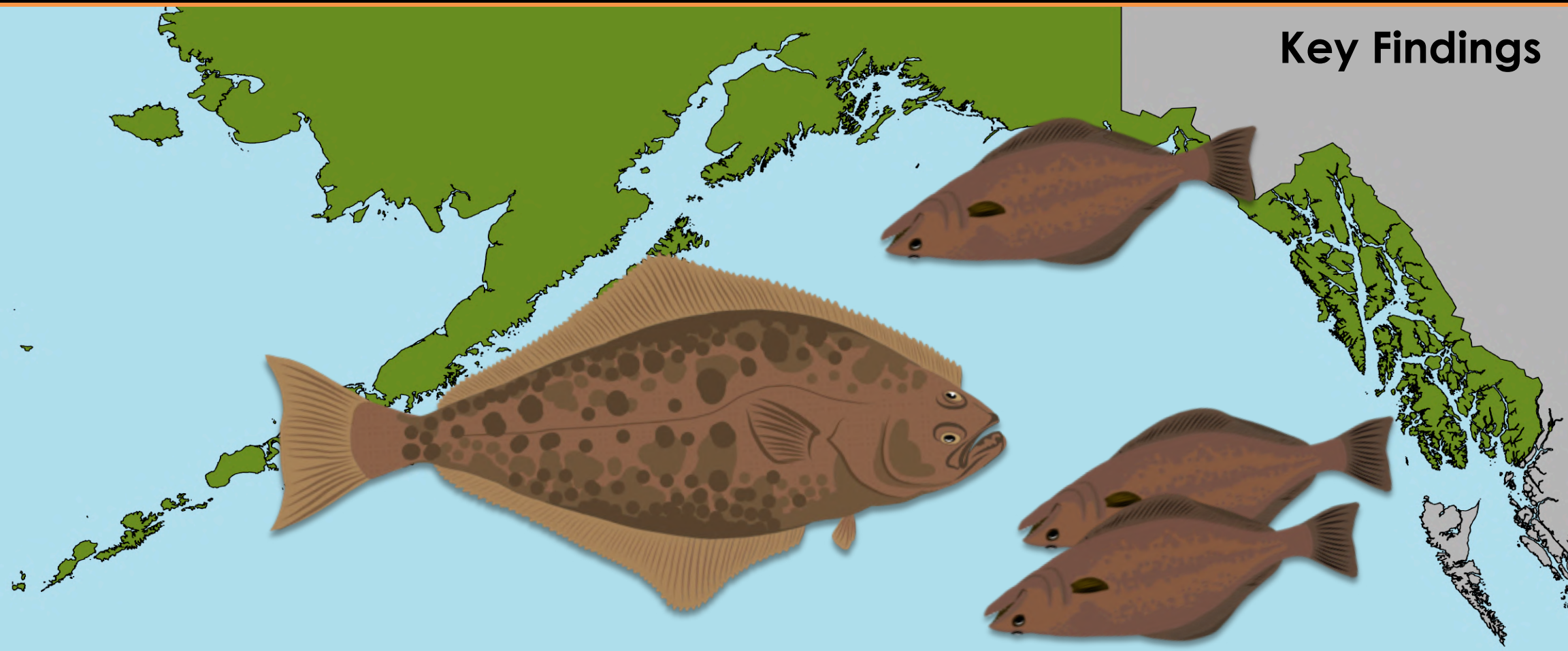
evidence of gape limitation for P. Halibut

- insufficient prey size data for Arrowtooth Flounder



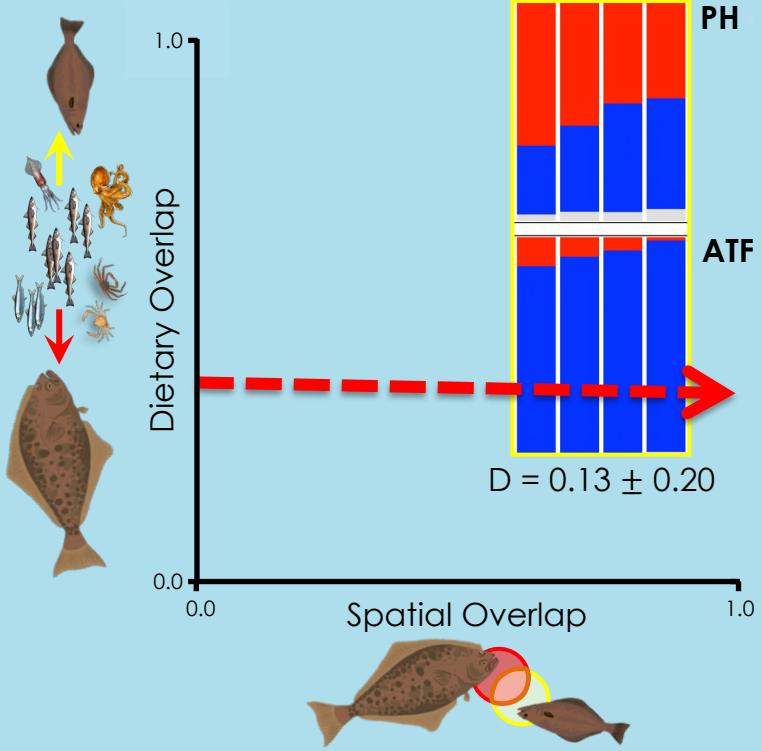


Potential for competition between P. Halibut and Arrowtooth Flounder



Potential for competition between P. Halibut and Arrowtooth Flounder

Key Findings

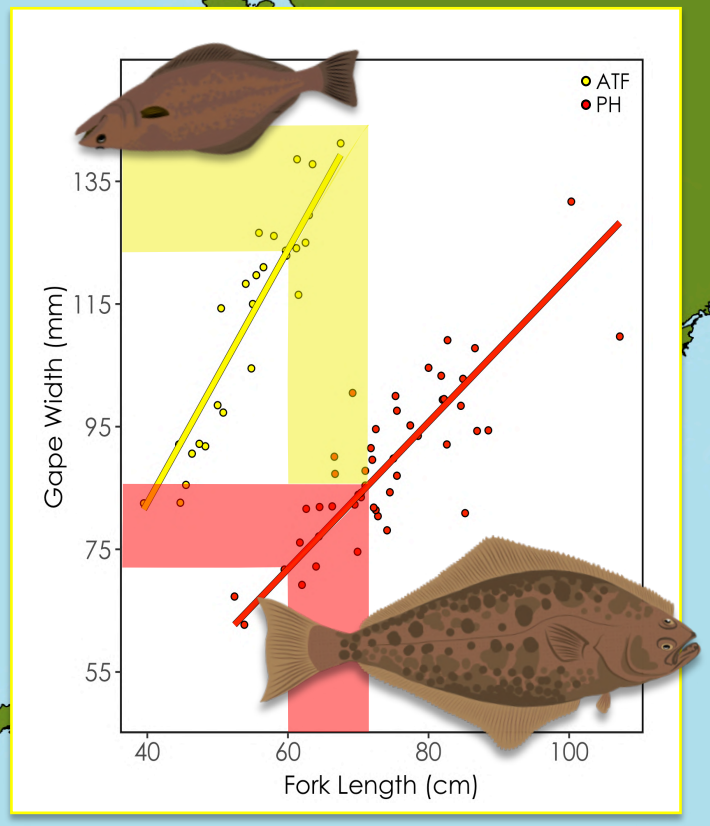


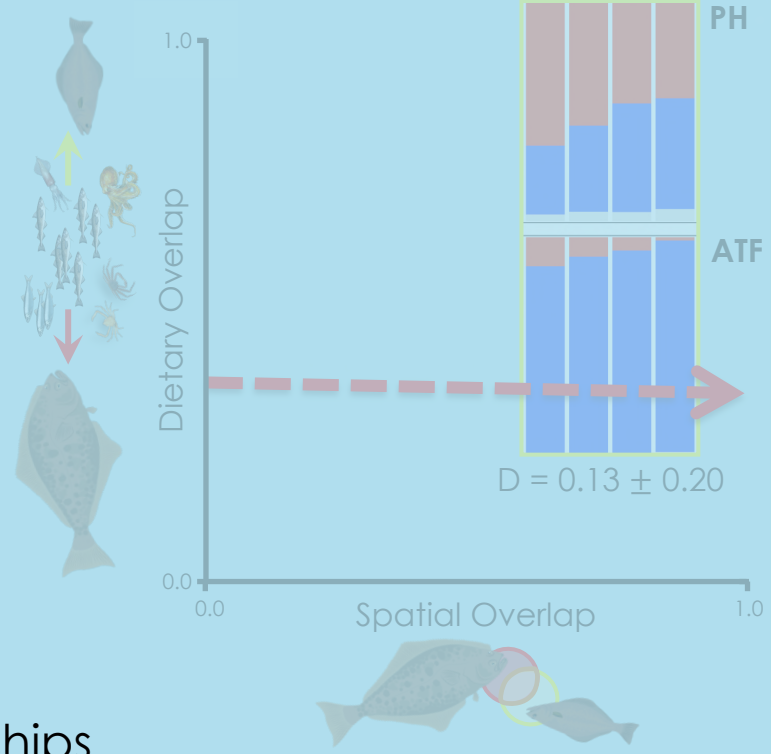
Gulf of Alaska: little dietary overlap

- no evidence of resource partitioning

Potential for competition between P. Halibut and Arrowtooth Flounder

Key Findings



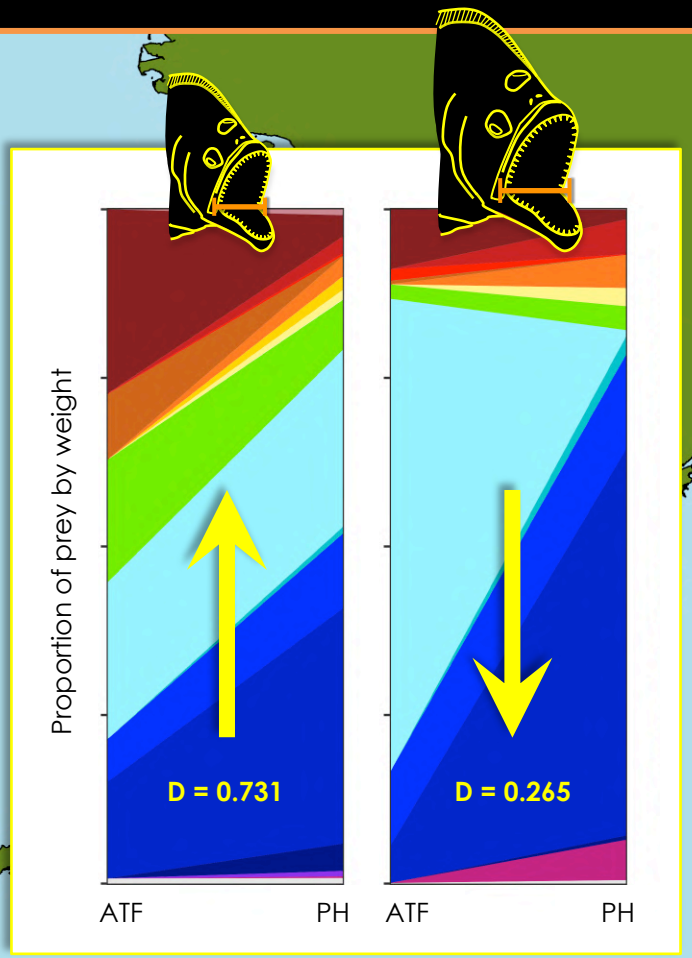


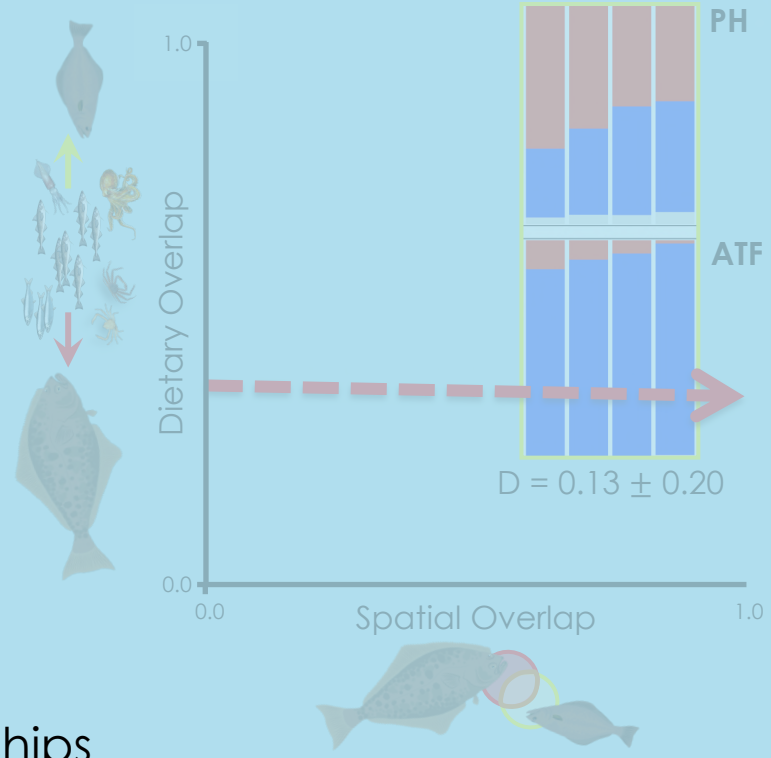
Gulf of Alaska: little dietary overlap
- no evidence of resource partitioning

SEAK: different body size – gape size relationships

Potential for competition between P. Halibut and Arrowtooth Flounder

Key Findings

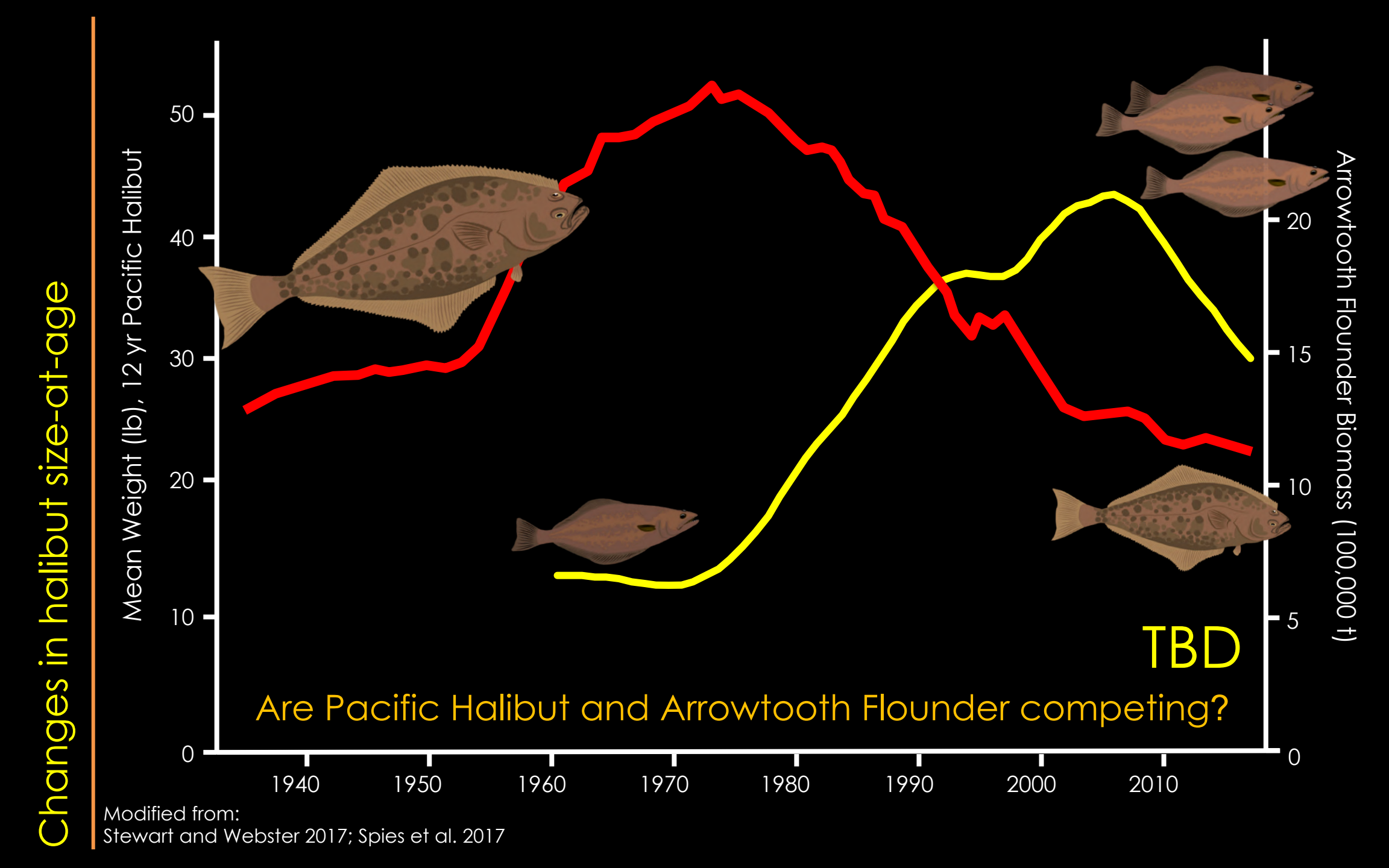




Gulf of Alaska: little dietary overlap
- no evidence of resource partitioning

SEAK: different body size – gape size relationships
- partitioning of prey at larger gape sizes

Changes in halibut size-at-age



Modified from:
Stewart and Webster 2017; Spies et al. 2017

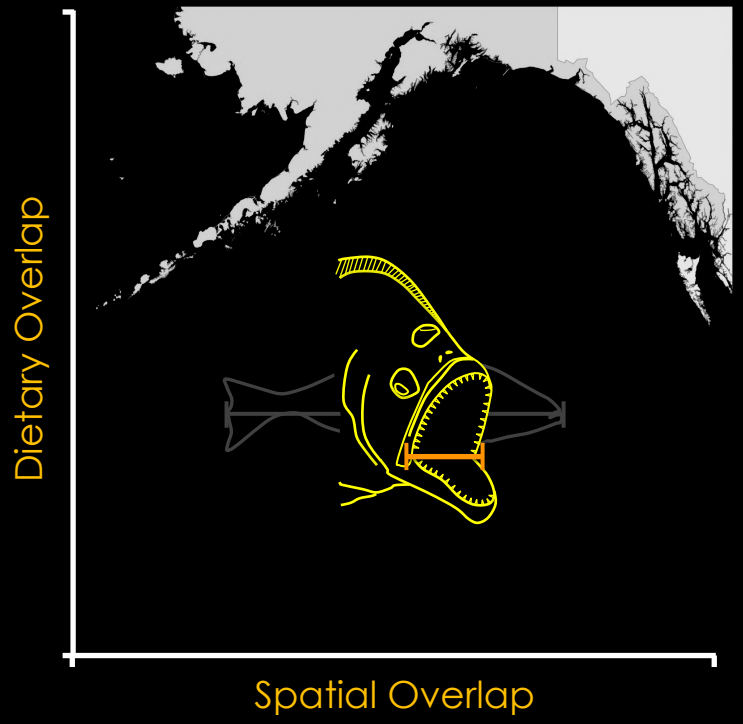
NEXT STEPS

Are Pacific Halibut and Arrowtooth Flounder competing?

NEXT STEPS

Are Pacific Halibut and Arrowtooth Flounder competing?

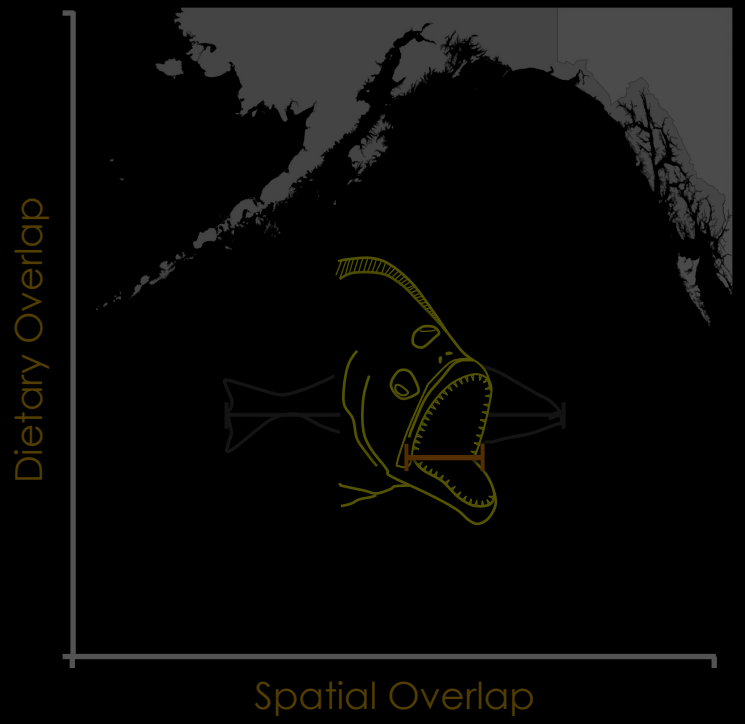
Assess resource partitioning at broad scales using gape as metric of size

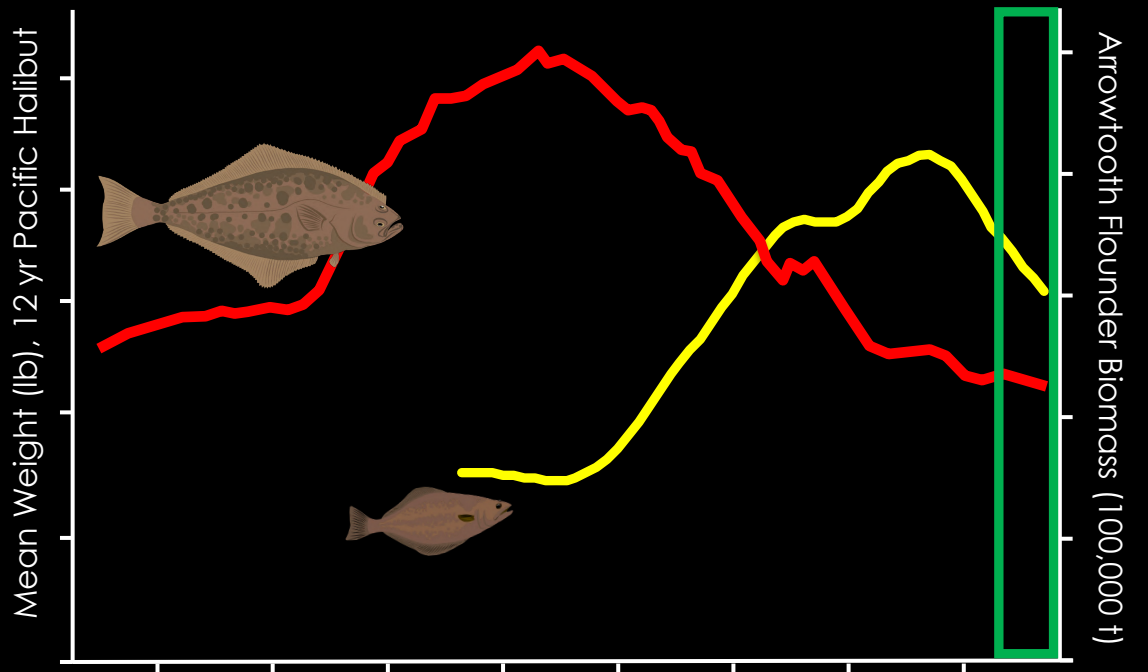


NEXT STEPS

Are Pacific Halibut and Arrowtooth Flounder competing?

Assess resource partitioning at broad scales using gape as metric of size

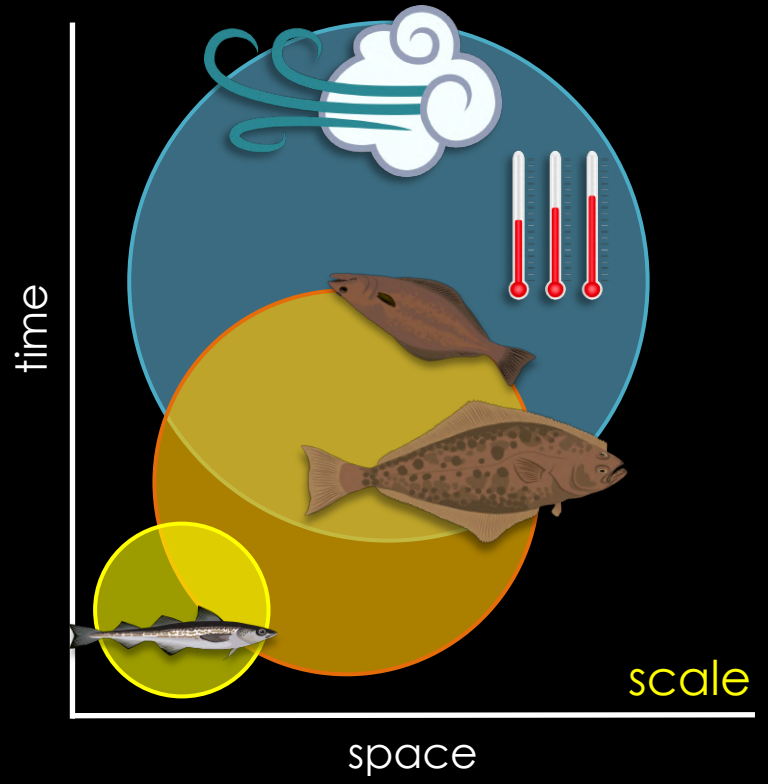


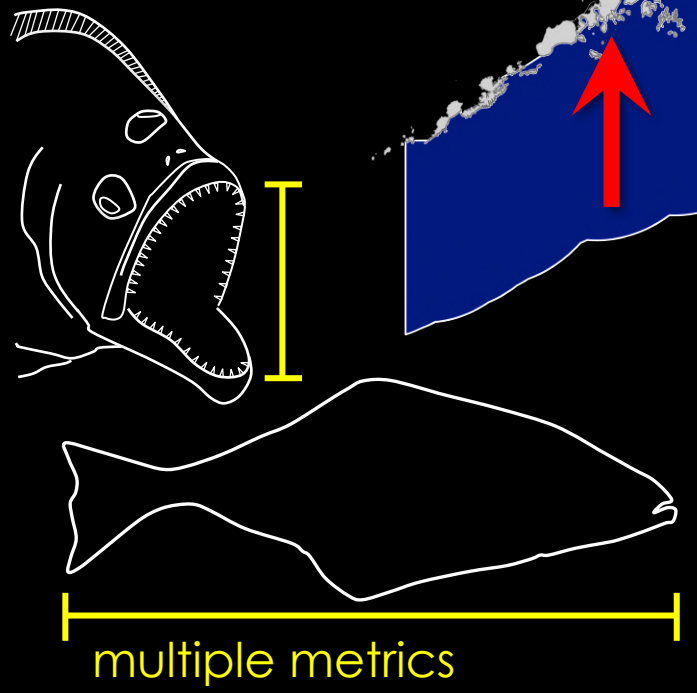


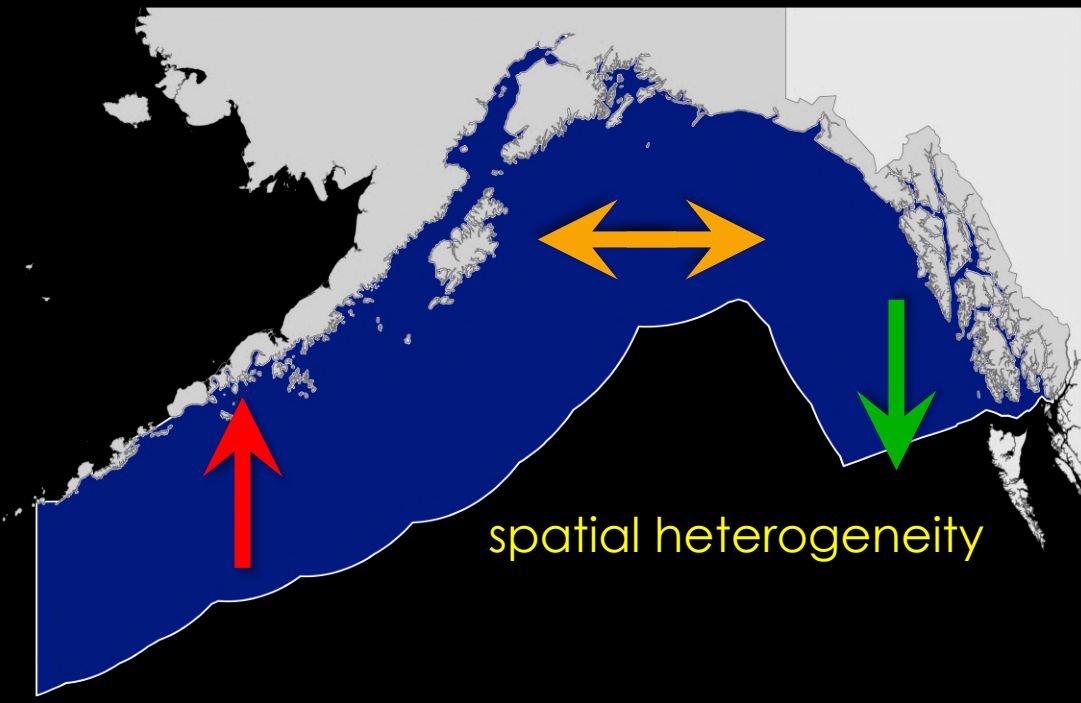
Extend time series to include stabilizing halibut size-at-age and decreasing arrowtooth biomass

NEXT STEPS

When assessing competition, it is important to account for:







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Subsurface Style

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International Pacific Halibut Commission

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https://github.com/cheryl-barnes/