



GULF of ALASKA

GULF OF ALASKA INTEGRATED ECOSYSTEM PROGRAM:

Ichthyoplankton Assemblages in the Eastern and Western Gulf of Alaska during Spring and Summer of 2011 and 2013



NOAA FISHERIES



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Introduction

The Gulf of Alaska Integrated Ecosystem Research Program (GOA-IERP) is a four year (2011–2014) multi-disciplinary study examining interactions between physical and biological oceanography to understand how the environment influences the survival of early life history stages (egg to young-of-the-year) and recruitment of five commercially and ecologically important groundfishes: Walleye Pollock (*Gadus chalcogrammus*), Pacific Cod (*Gadus macrocephalus*), Arrowtooth Flounder (*Atheresthes stomias*), Sablefish (*Anoplopoma fimbria*) and Pacific Ocean Perch (*Sebastes alutus*; larvae are presently indistinguishable from other species of rockfish and are therefore reported as *Sebastes* spp.).

Biological and oceanographic surveys in the eastern and western Gulf of Alaska (GOA) were conducted during spring and summer of 2011 and 2013. Results presented here describe seasonal, regional (eastern vs. western GOA) and interannual variation in occurrence, distribution, abundance and larval sizes of the focal species, as well as species diversity in the broader ichthyoplankton assemblages.

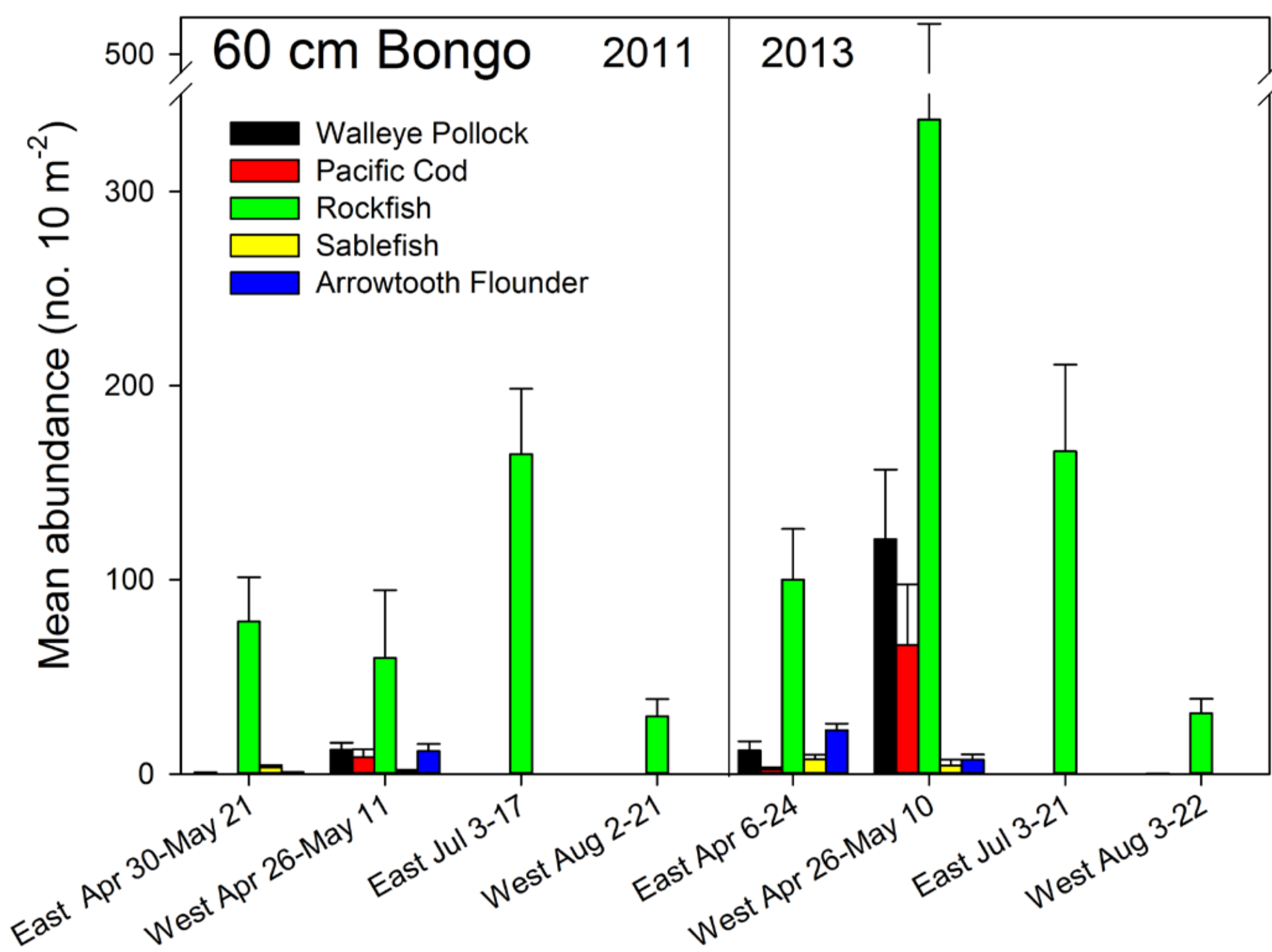
Frequency of occurrence of focal species collected by bongo nets.
Total number of taxa present in samples also shown.

60-cm Bongo Net		2011				2013			
		Spring		Summer		Spring		Summer	
Family	Species	East	West	East	West	East	West	East	West
Gadidae	<i>Gadus chalcogrammus</i>	6.14	60.87			21.93	80.77		1.92
	<i>Gadus macrocephalus</i>		23.91			10.53	73.08		
Scorpaenidae	<i>Sebastes</i> spp.	52.63	56.52	89.80	69.81	59.65	42.31	84.06	71.15
Anoplopomatidae	<i>Anoplopoma fimbria</i>	21.05	15.22			28.07	15.38		
Pleuronectidae	<i>Atheresthes stomias</i>	8.77	36.96			55.26	34.62		
Total Taxa Present		38	48	20	20	55	44	23	23

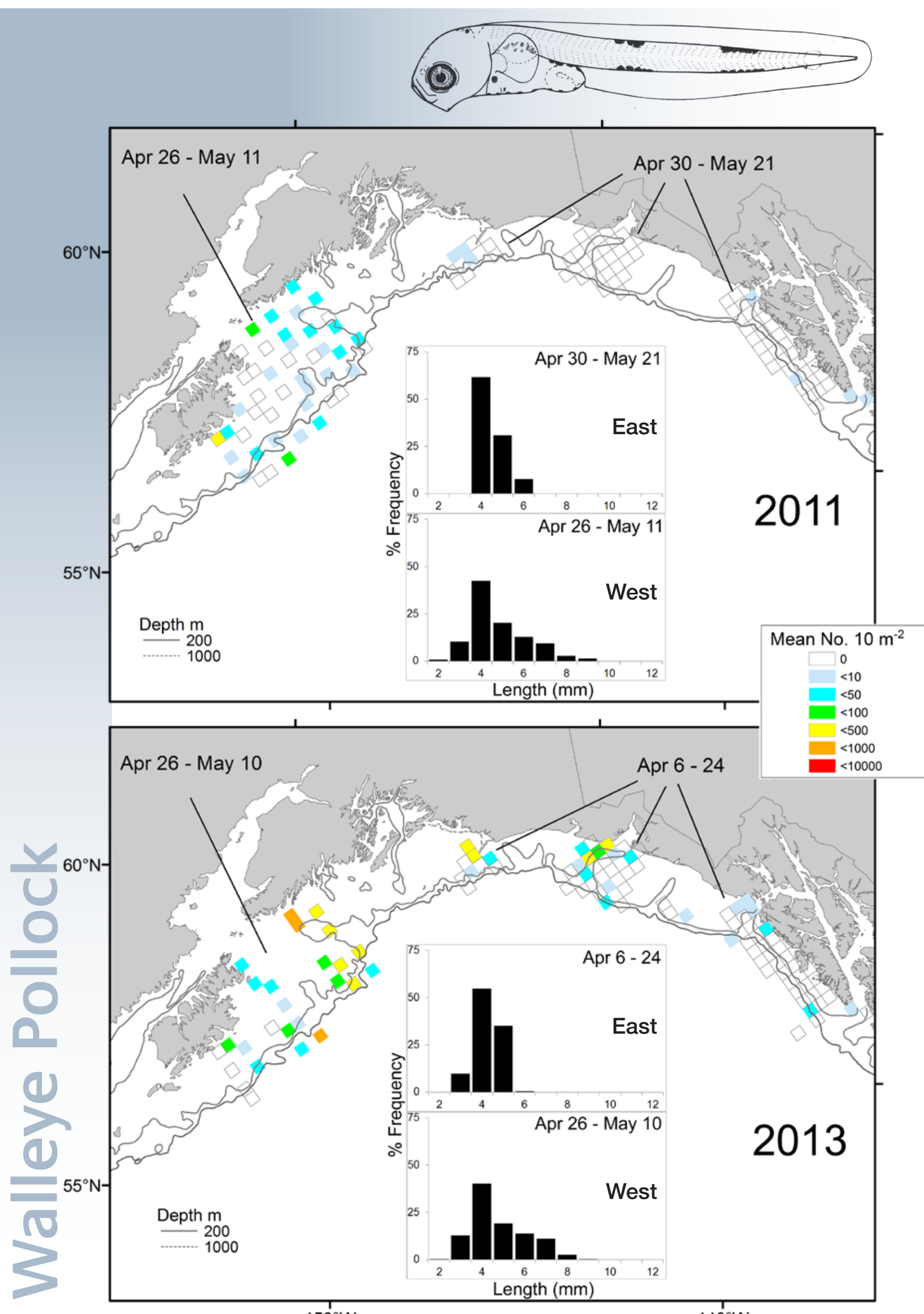
Species Assemblages and Diversity

- Species composition of dominant taxa is similar among regions and years.
- Species diversity is greater in spring than in summer.
- More taxa were present during spring in 2013 in the east than in 2011.
- Total number of taxa in the west was comparable between years.
- Notable differences in levels of occurrence of species between east and west:
 - Higher levels in the east for Sablefish and higher levels in the west for Walleye Pollock and Pacific Cod.
 - Higher levels in the east for bathylagids, *Stenobrachius leucopsarus* (summer only), and *Liparis fuscus*.
 - Higher levels in the west for *Mallotus villosus*, *Hexagrammos decagrammus* and *H. octogrammus*, three cottids, *Bathylagus alascanus*, *Bathymaster* spp., *Anmodytes personatus*, and *Lepidopsetta bilineata* and *L. polyxystra*.
- Rare species occurring exclusively in the eastern GOA have a more southerly distribution into the California Current system (*Paricelinus hopliticus*, *Radulinus boleoides*, *Scorpaenichthys marmoratus*, *Cryptacanthodes giganteus*, *Rhinogobius nicholsii*).
- Rare species occurring exclusively in the western GOA have a more northerly distribution with a southern extent in the GOA (*Aspidophoroides monopterygius*, *Bryozichthys lysimus*, *Stichaeus punctatus*, *Limanda proboscidea*).

Mean abundance (and standard error) of GOA-IERP species in 60-cm bongo samples during each sampling period in spring and summer of 2011 and 2013.

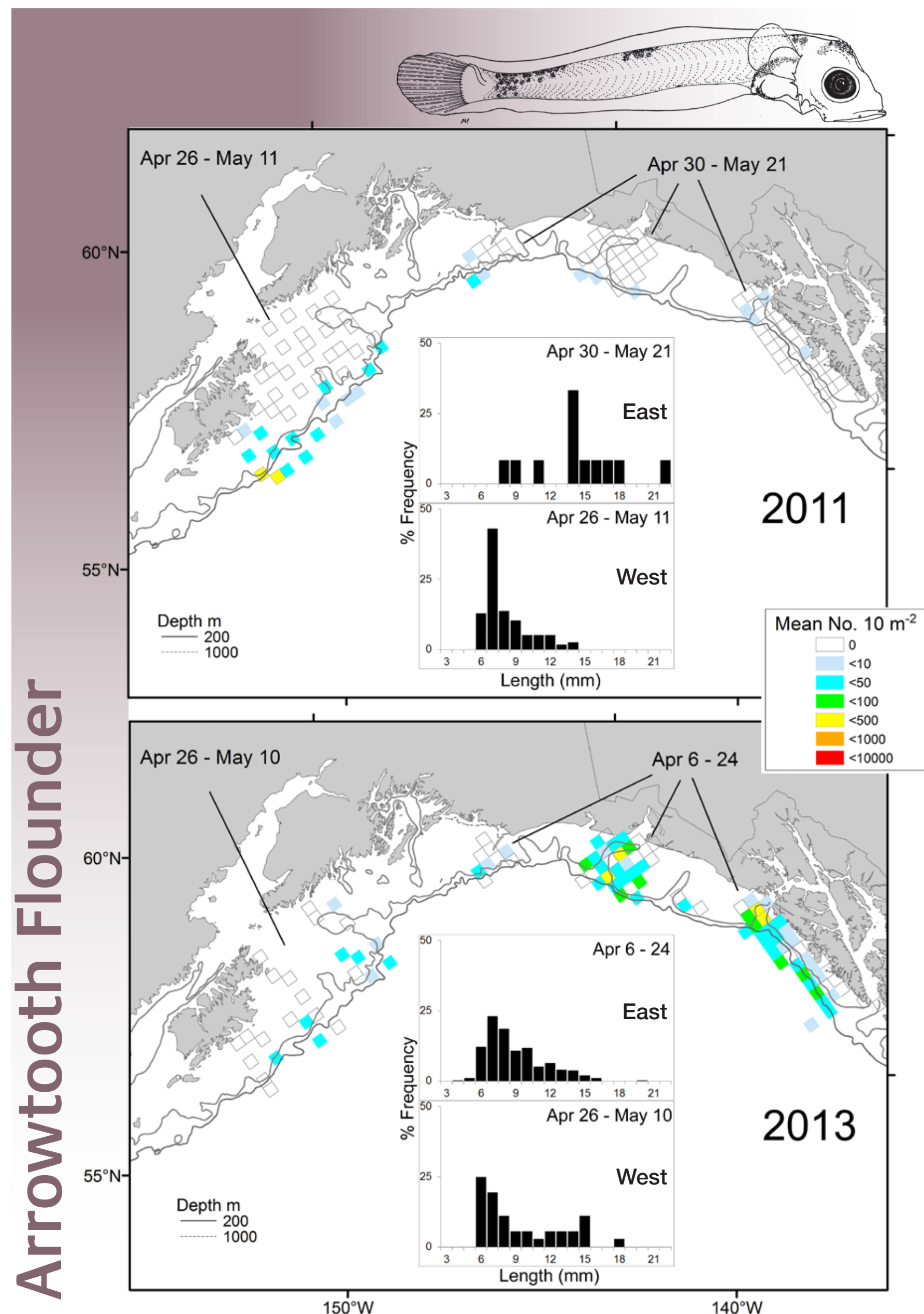


GOA-IERP Focal Species



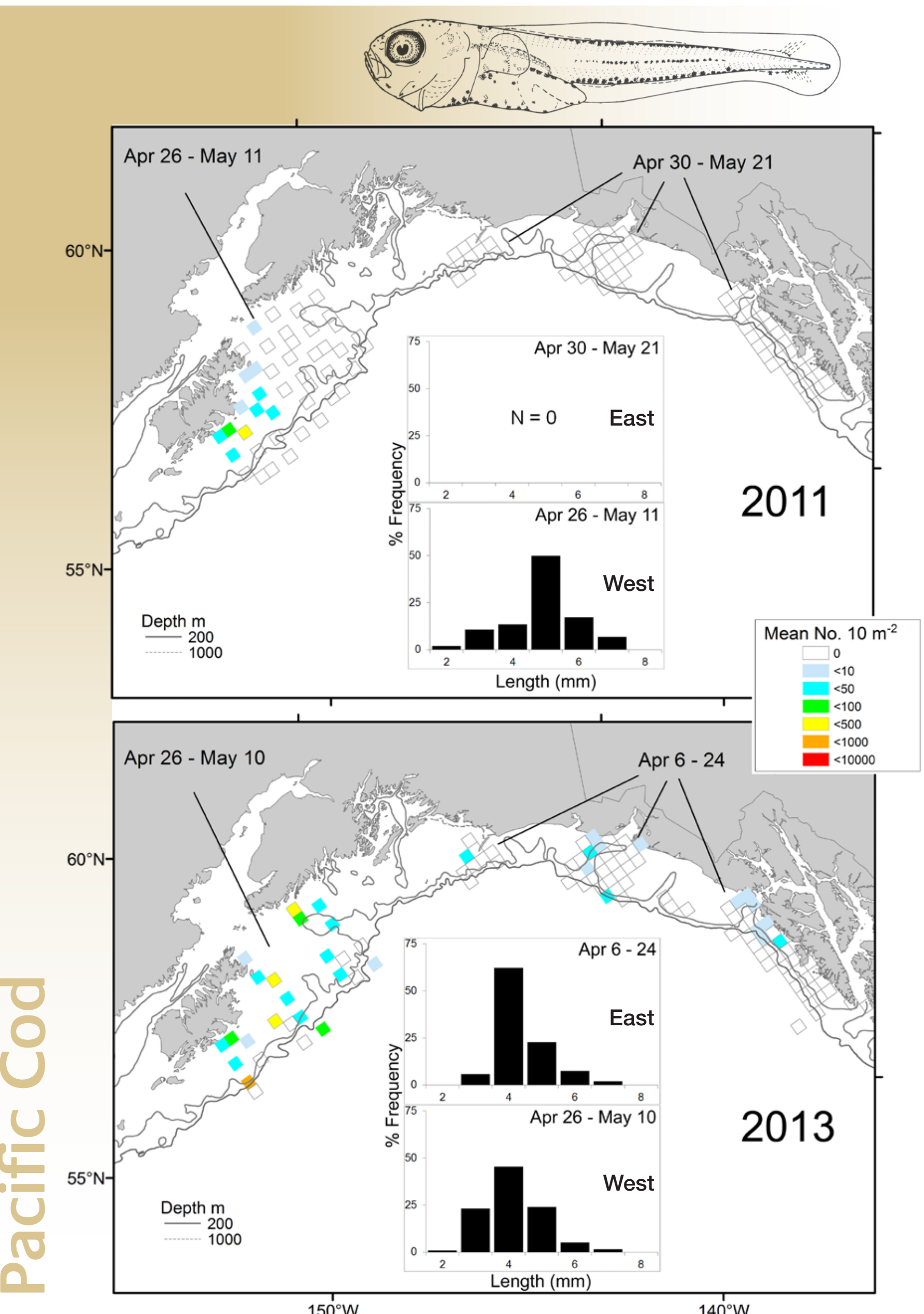
Spawning Ecology – Peak spawning of pelagic eggs (deep in the water column) in early spring over shelf and in association with sea valleys and troughs

- Larvae scarce in eastern GOA in 2011
- Higher concentrations in both eastern and western GOA in 2013
- Length frequency distributions similar between regions and years



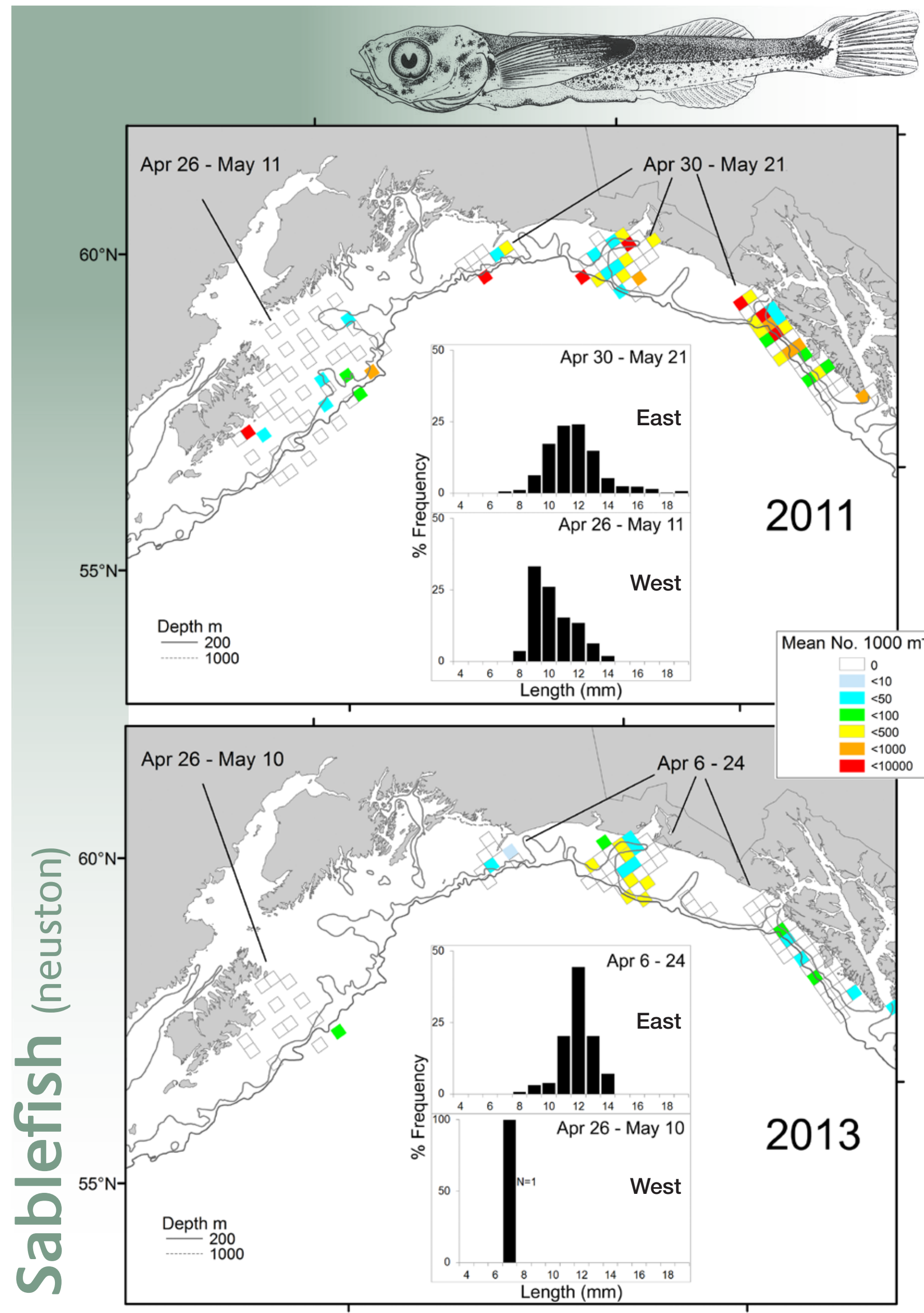
Spawning Ecology – Release of pelagic eggs deep in the water column over the slope in early winter

- Highest concentrations of larvae over slope and in association with troughs
- More abundant in the western GOA in 2011 and in the east in 2013
- Larvae larger in the east relative to the west, particularly in 2011



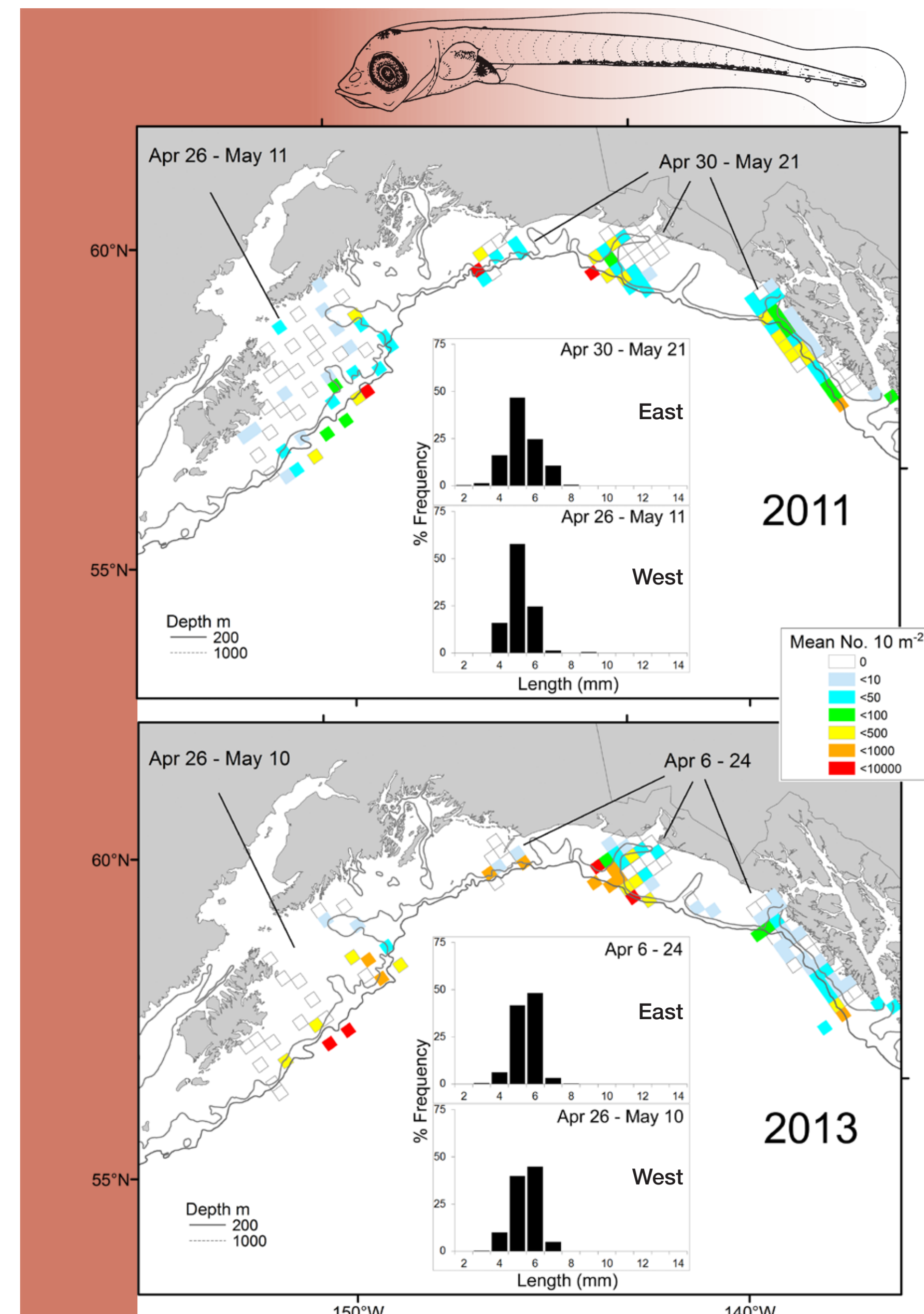
Spawning Ecology – Single batch spawning of semi-demersal eggs in shelf waters, early spring

- Absent in eastern GOA in 2011, but present at low levels of abundance in 2013
- Most abundant in the western GOA – higher concentrations in 2013 than 2011
- Larvae slightly larger in 2011 relative to 2013 in the west but similar sizes in both regions in 2013



Spawning Ecology – Spawning in winter over slope and basin – eggs and newly hatched larvae occur deep in the water column but subsequently larvae become neustonic

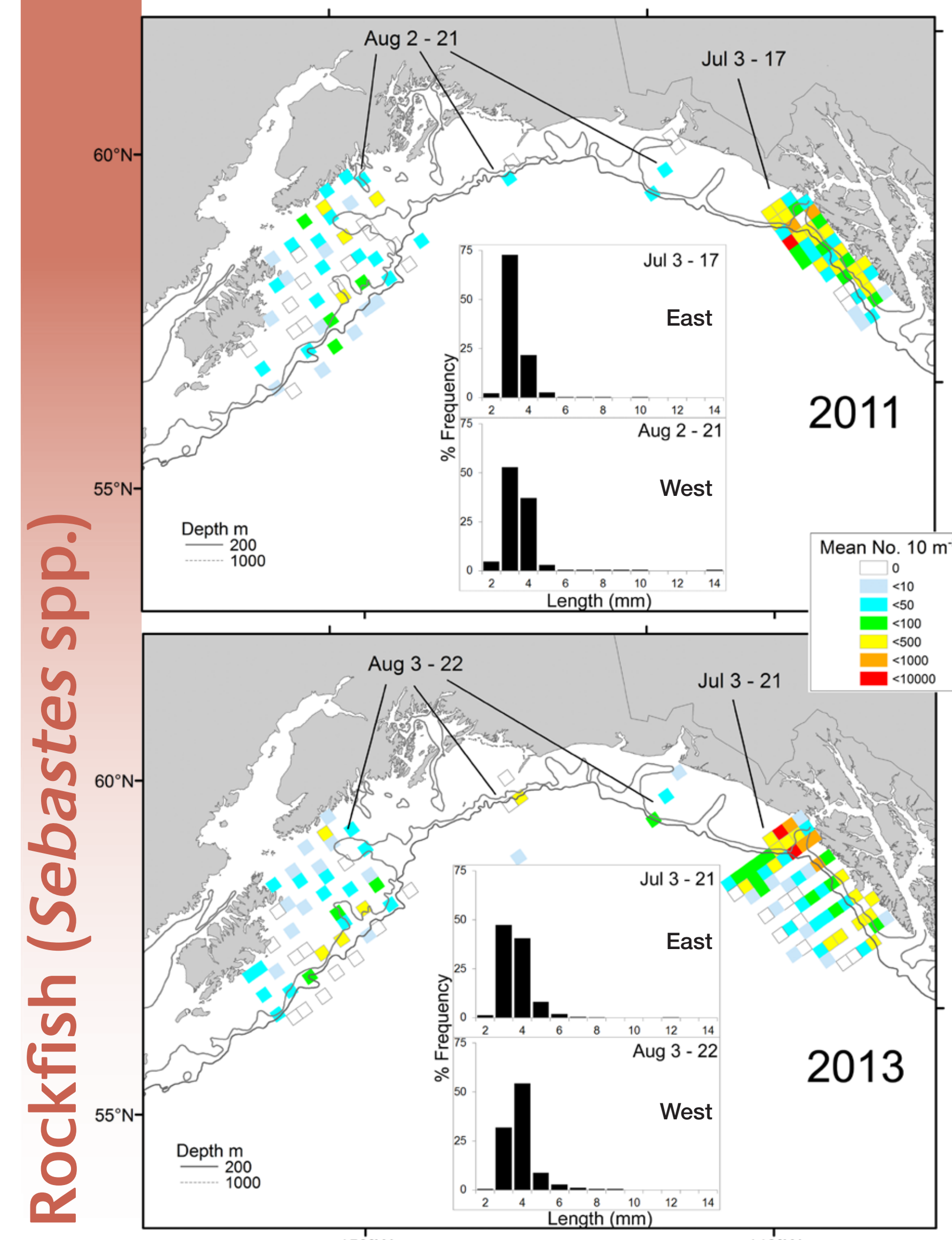
- More abundant in eastern than in the western GOA
- Higher concentrations of larvae in 2011 than in 2013 in both regions
- Larvae slightly larger in the east than in the west



Spawning Ecology – Larvae extruded during spring and summer months over slope and outer shelf

Spring cohort

- Highest concentrations associated with slope and troughs
- Patterns of distribution and abundance and larval lengths similar between regions and years
- Mean abundance in spring 2013 in western GOA was elevated due to extremely high concentrations at two slope stations (mean abundance histogram figure)



Summer cohort

- Larval sizes smaller than in spring indicating new cohort of larvae (likely different species)
- Wider distribution over shelf and slope than spring cohort
- Patterns of distribution and abundance and larval lengths similar between regions and years

Observations and Future Considerations

Interannual Comparisons

- Overall, species diversity was greater in 2013 than 2011.
- Walleye Pollock and Pacific Cod were more abundant in 2013.
- Sablefish was more abundant in 2011.
- Overall, Arrowtooth Flounder was more abundant in 2013. The substantial difference in abundance in the east between years may be a spatio-temporal overlap between earlier sampling in 2013 coinciding with the onshelf movement of small larvae from spawning areas over the slope.
- Future work will test the hypothesis that interannual differences in temperature and the timing of the spring bloom motivate interannual variations in abundance.

Spatial Comparisons

- No differences in overall species diversity were found between the eastern and western GOA.
- Walleye Pollock and Pacific Cod were most abundant in the western GOA and Sablefish was most abundant in the eastern GOA. Levels of abundance of Rockfish and Arrowtooth Flounder were comparable between regions.
- Future investigations of differences in species diversity and abundance between regions will examine physics in relation to spawning biomass, spawning phenology, landscape ecology, physical forcing, and secondary production.

Larval Lengths

- Variation in larval sizes among the GOA-IERP focal species is intriguing and seems to indicate that except for Rockfish, larvae were larger overall in the east relative to the west (despite earlier sampling in the east in 2013) and that larvae may have developed faster in 2013 relative to 2011.
- Seasonal variation in larval lengths and distribution patterns indicates a separate spring cohort (includes Pacific Ocean Perch) associated with the slope and troughs, and a summer cohort of smaller larvae with more extensive distribution over the shelf that may be a different species.
- Future investigations into variations in interannual and regional size patterns of larvae will examine differences in adult spawning locations, timing of spawning, and timing of sampling.

