Biogeography of Larval Fishes in the California Current Ecosystem

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The distribution of many marine organisms has changed over past decades

ANNUAL REVIEWS

Annual Review of Marine Science

Climate-Driven Shifts in Marine Species Ranges: Scaling from Organisms to Communities

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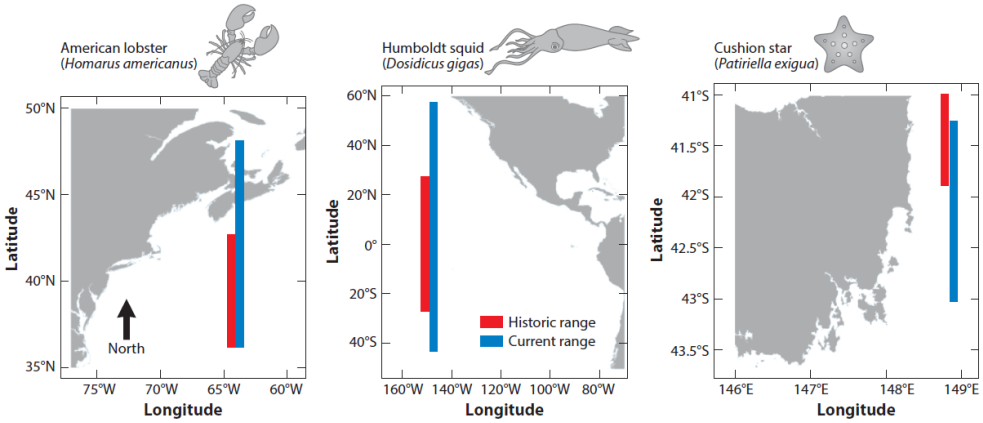


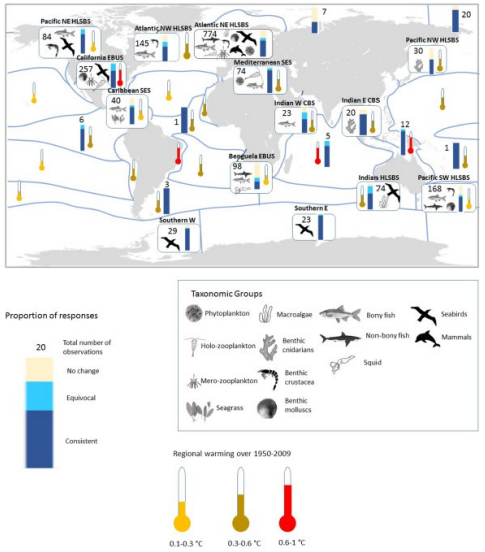
Poleward expansion of range edges by 72 km/decade

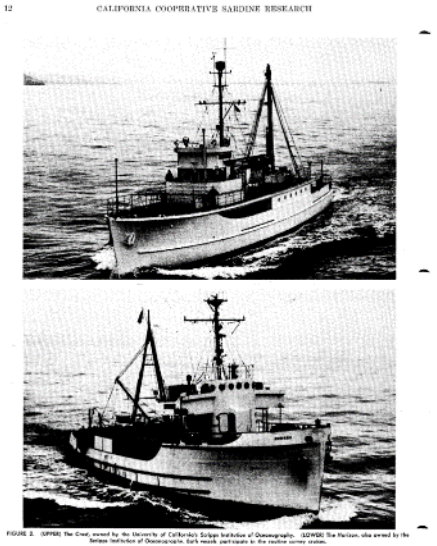
frontiers in Marine Science

REVIEW
published: 04 May 2016
doi: 10.3389/fmars.2016.00062

Responses of Marine Organisms to Climate Change across Oceans

Elvira S. Poloczanska[1,2], Michael T. Burrows[3], Christopher J. Brown[4], Jorge García Molinos[3,5,6], Benjamin S. Halpern[7,8,9], Ove Hoegh-Guldberg[2], Carrie V. Kappel[7], Pippa J. Moore[10,11], Anthony J. Richardson[1,12], David S. Schoeman[13] and William J. Sydeman[14,15]*





Discerning if distributions are changing is contingent on long-term data. Ideally fishery-independent

California Cooperative Oceanic Fisheries Investigations (CalCOFI)

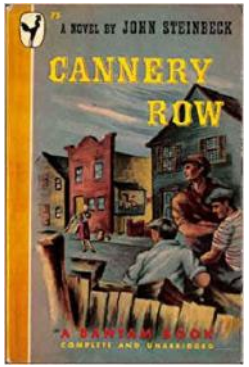
Systematically collecting larval fishes from the California Current Ecosystem since 1949



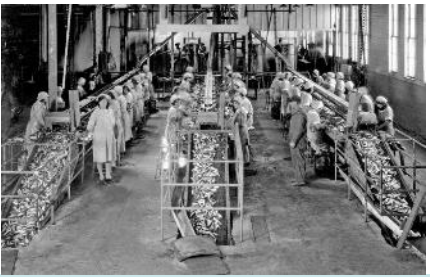
Ehlbert Ahlstrom
Geoff Moser

CalCOFI is a partnership between US federal government (NOAA), state of California (CDFW) and Scripps Institution of Oceanography





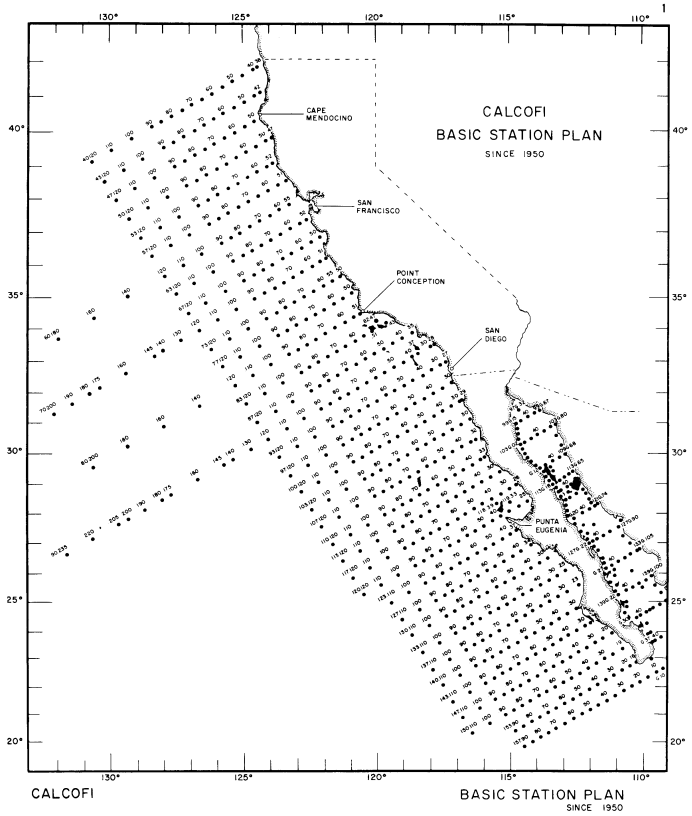
Initial purpose: understand why sardine fishery collapsed in the 1940s



Evolved into a complete marine ecosystem monitoring program



CalCOFI sampling was massive at the beginning:
Monthly samples off California, Baja California and in the Sea of Cortez
3 ships working year round





What does CalCOFI sample?
Biological Oceanography
Since the beginning:
Plankton (larval fish larvae and eggs, pelagic invertebrates)







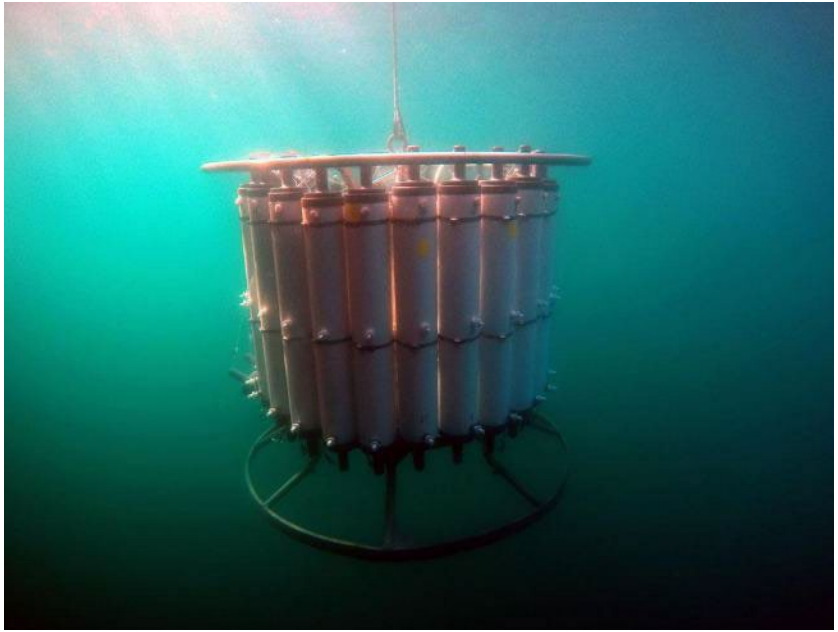
Now: sea birds, marine mammals, environmental DNA, phytoplankton, picoplankton

What does CalCOFI sample?

Physical Oceanography

Since the beginning:

Physical Oceanography (depth-specific temperature, salinity, dissolved oxygen, phosphate)



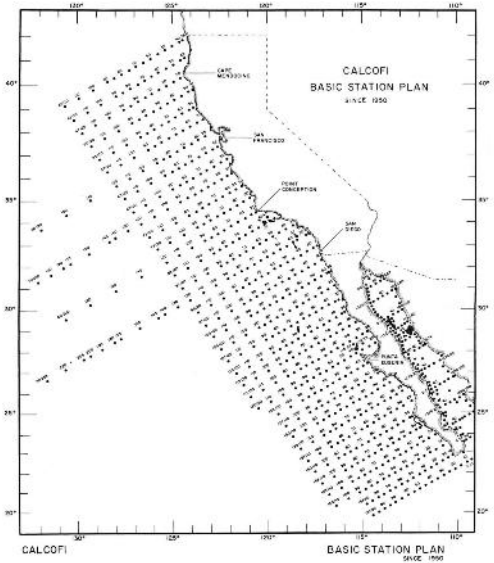


Now: 6 nutrients, chlorophyll, PAR, carbonate chemistry, organic carbon and nitrogen

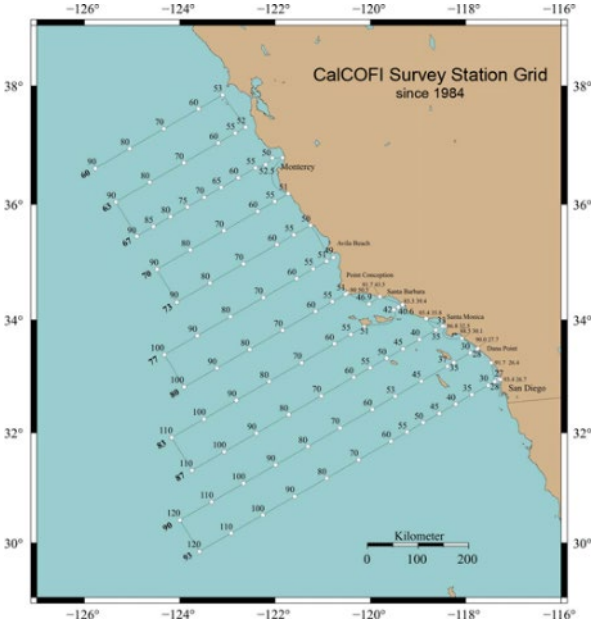


Investigaciones Mexicanas de la Corriente de California (IMECOCAL)

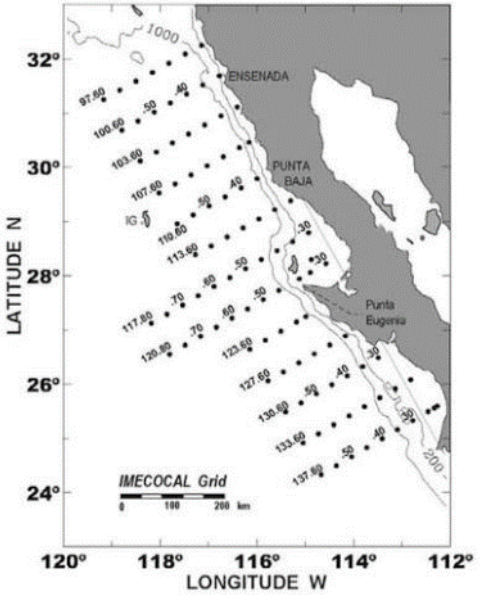
1949-1984



1984-present



1997-2019







Combined CalCOFI and IMECOCAL data

463 larval fishes

1960-2016







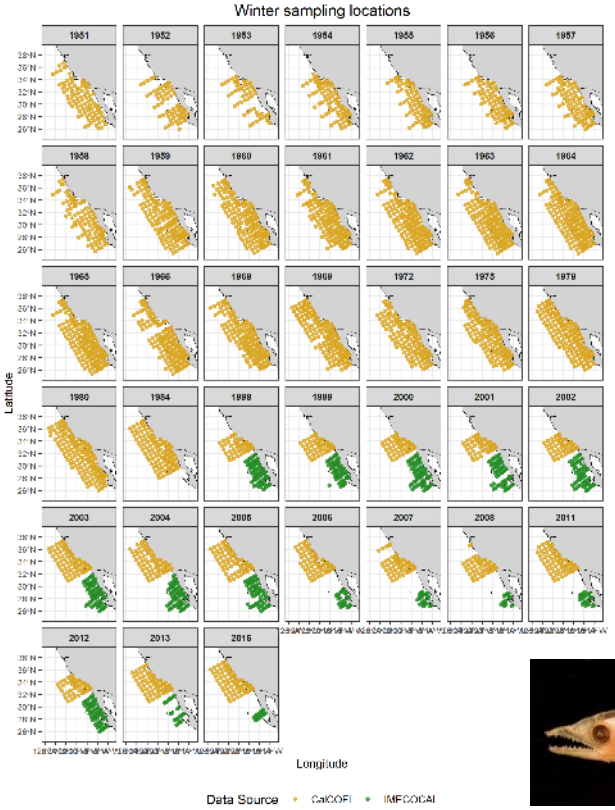




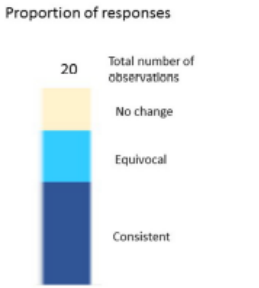








Questions



Has center of gravity (COG) changed poleward?

TABLE 1 | Observations of changing abundance in species classified as cold, warm, and cosmopolitan in their thermal preferences.

Response	Cold species	Warm species	Cosmopolitan species
Total observations	293	346	138
Increase	21%	52%	39%
Decrease	52%	19%	39%
No change	27%	29%	22%

Thermal affiliation is assigned in relation to the sampled region.

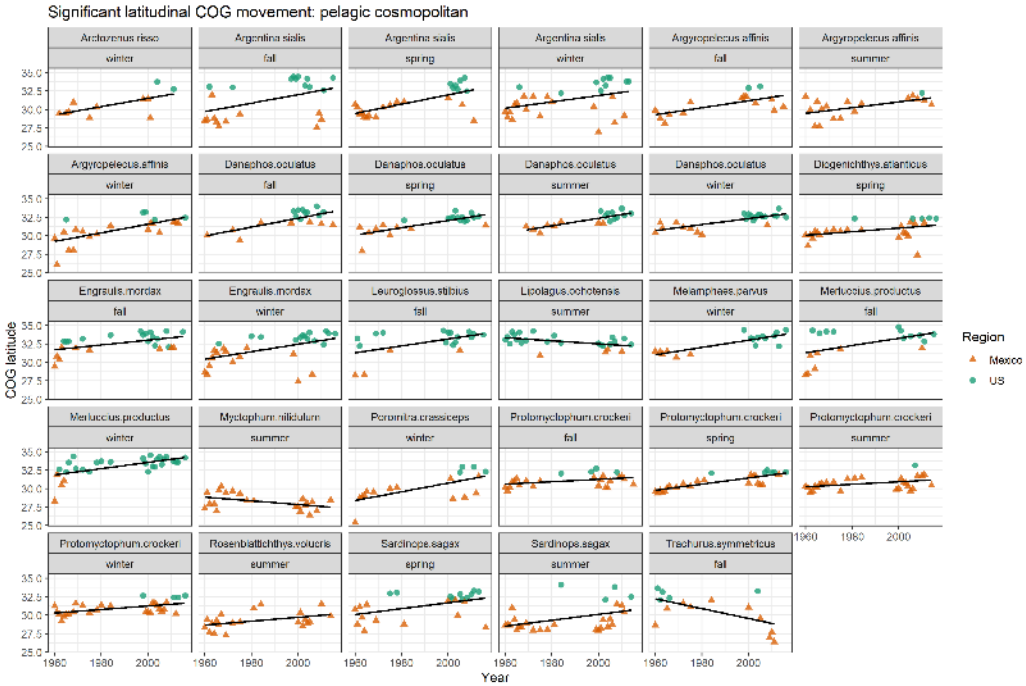
Does species range (north, cosmopolitan, south) or adult habitat (benthic or pelagic) affect COG?

72 km/decade

How far have they moved?

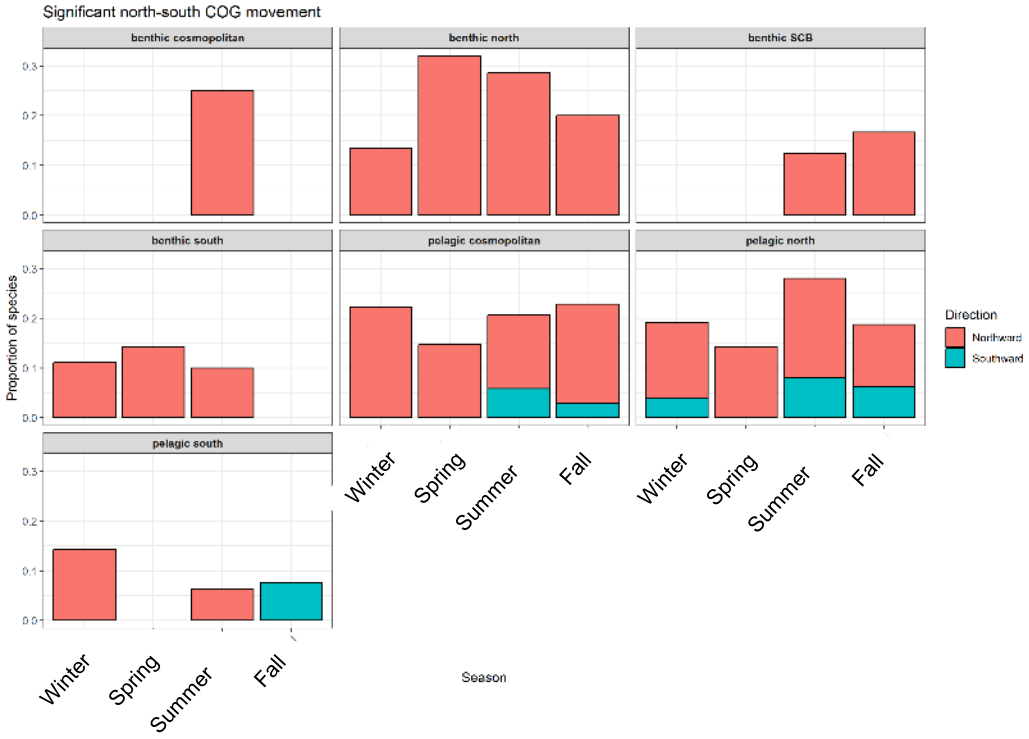
Poloczanska et al. 2016
Front. Mar Sci

Preliminary Results



Depending on adult habitat and geographic distribution, the Center of Gravity of between 12 and 41% of species shifted in at least one season

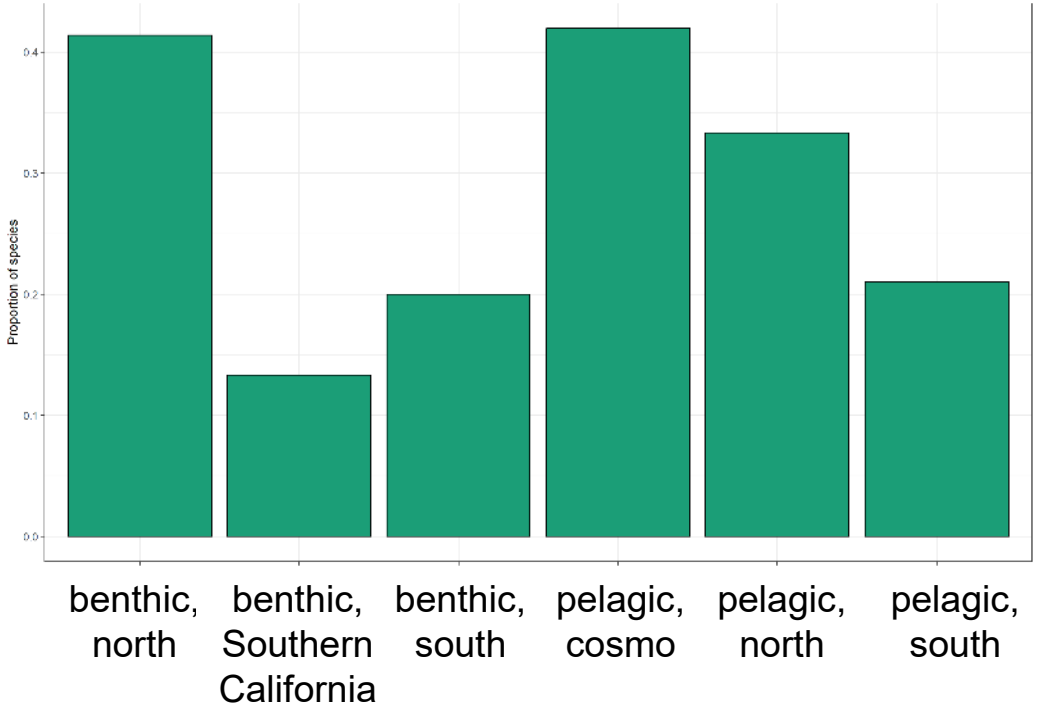
Preliminary Results



Vast majority of significant shifts were poleward (north)

Preliminary Results

Proportion of species with sig. northward movement

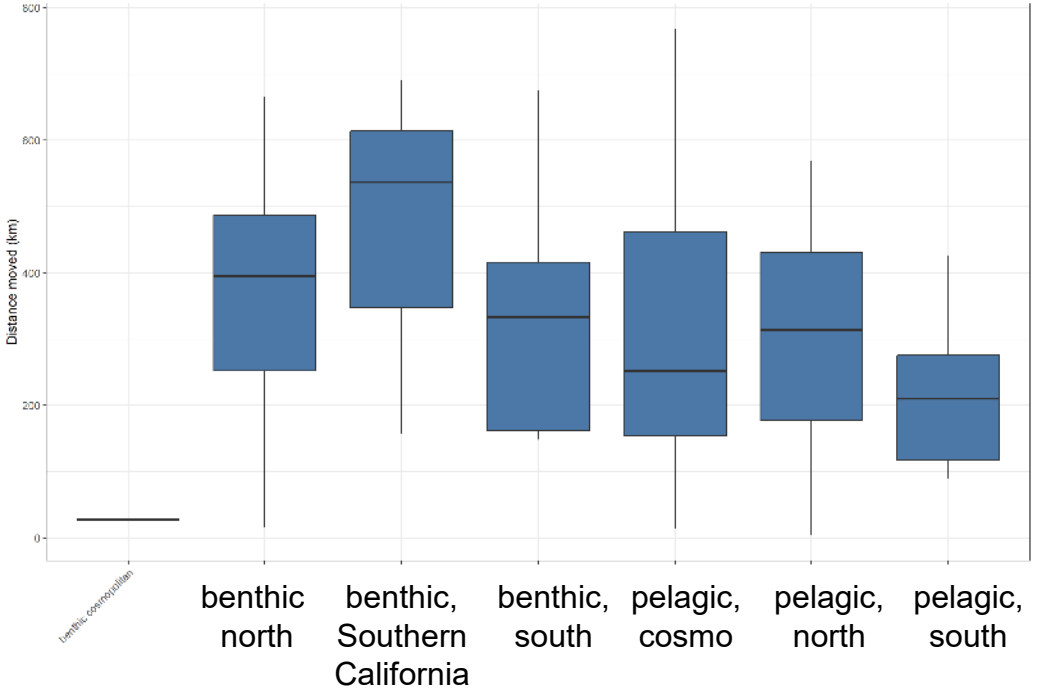


Cosmopolitan and northern species tended to move more

Adult habitat did not seem to matter

Preliminary Results

Center of Gravity movement (km)



Northward movement was between ~200 and 600km

~33 to 100 km/decade

No obvious difference between species groups

Next Steps

Bring in 1950s data

Use SDM TMB to model abundances and more accurately delineate species distributions

Examine patterns in Inertia, Leading Edge and Trailing Edge

Examine patterns of species richness

Incorporate temperature, salinity, oxygen and phosphate into the models

Collaboration and friendship is key.



