DSR separation for spatial management

Two methods:

1. Multivariate analyses of life history and vulnerabilities
2. VAST (spatio-temporal) modelling of distribution

Kristen Omori (VIMS)

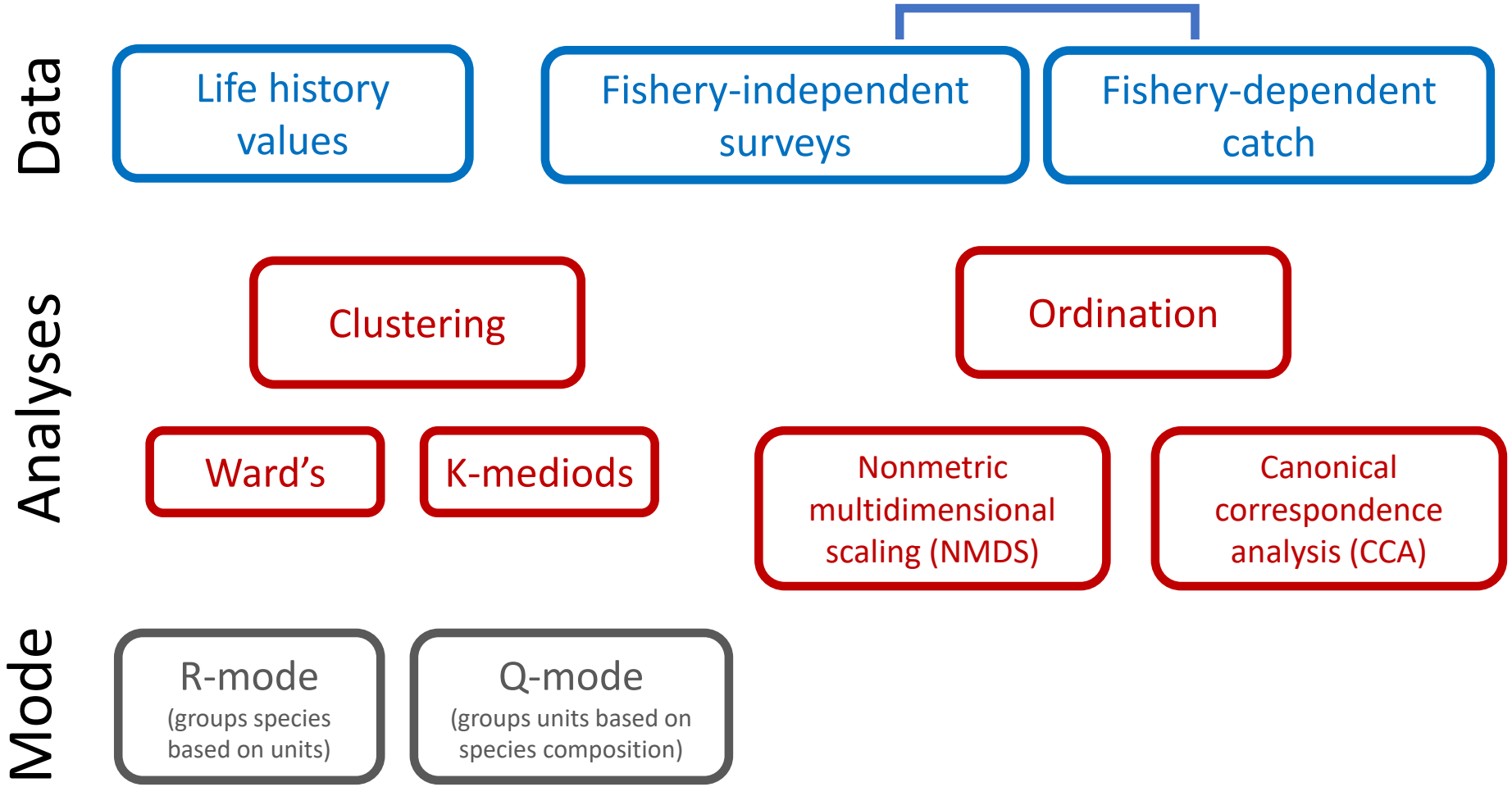
komori@vims.edu

Method 1:

Compare and contrast multivariate analyses to form or validate the assignment of species to complexes

Omori, K.L., Tribuzio, C.A., Babcock, E.A., Hoenig, J.M., 2021. Methods for identifying species complexes using a novel suite of multivariate approaches and multiple data sources: a case study with Gulf of Alaska rockfish. *Frontiers in Marine Science*. 8:663375. doi: 10.3389/fmars.2021.663375

Thank you to Paul Spencer, Craig Faunce, and Dan Goethel for providing comments and edits on earlier versions of the manuscript.


Data
Life history values
Fishery-independent surveys
Fishery-dependent catch
Analyses
Clustering
Ordination
Ward's
K-mediods
Nonmetric multidimensional scaling (NMDS)
Canonical correspondence analysis (CCA)
Mode
R-mode
(groups species based on units)
Q-mode
(groups units based on species composition)

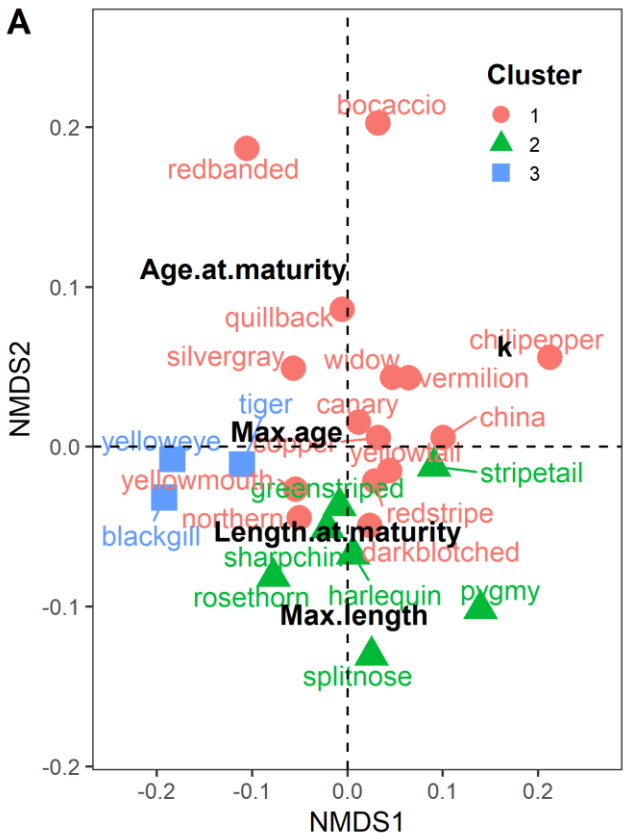
Life history results

Trait	OROX	DSR
Max Age	66 (26 - 106)	87 (50 - 117)
Age-at-maturity	8 (2.5 - 21)	9 (4 - 22)
Length-at-maturity (mm)	329 (200 - 460)	339 (210 - 480)
Max Length (mm)	485 (230 - 909)	516 (319 - 644)
k	0.13 (0.04 - 0.25)	0.12 (0.05 - 0.19)

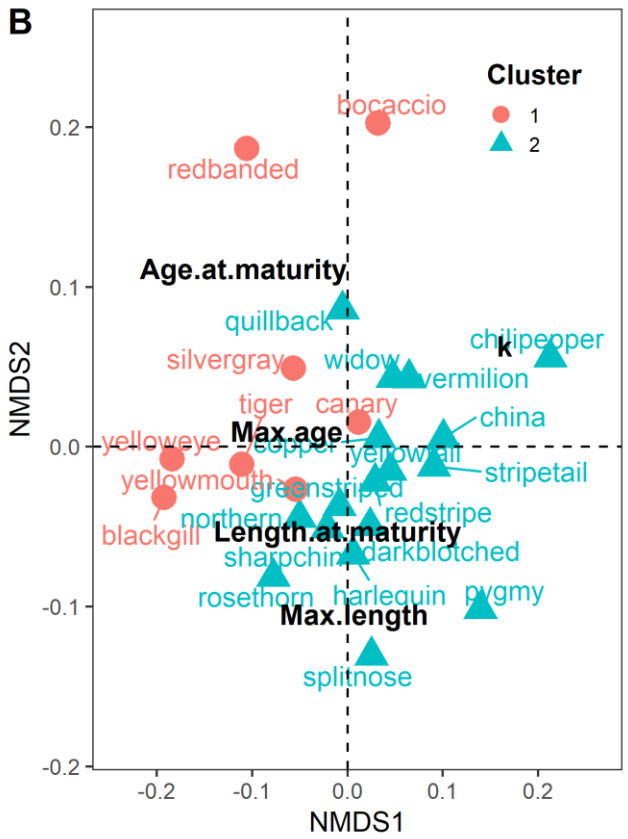
Average
(min – max)

Life history results

Ward's



K-mediods



No. of DSR species

	Ward's	K-mediods
Cluster 1	4	3
Cluster 2	1	4
Cluster 3	2	

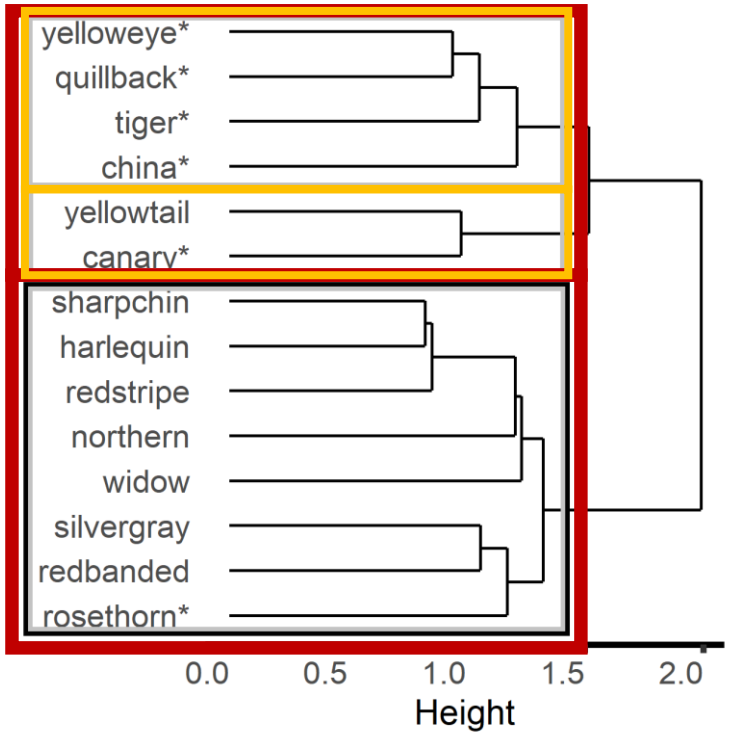
Combined (single) survey & catch datasets

Unit = Gear-Year-Month-Subarea

Gear	**Year**	**Month**	**Subarea**
Fishery:			
Non-pelagic trawl (NPT)	2010-2017	Jan-Dec	
Pelagic trawl (PTR)	2010-2017	Jan-Dec	610 (WGOA)
Longline (Hook&Line; LL)	2010-2017	Jan-Dec	620 (CGOA)
Jig	2010-2017	Jan-Dec	630 (CGOA)
Pot	2010-2017	Jan-Dec	640 (EGOA)
Survey:			650 (EGOA)
Longline	1995-2017	Jun-Aug	
Trawl	1984-2017	May-Aug	

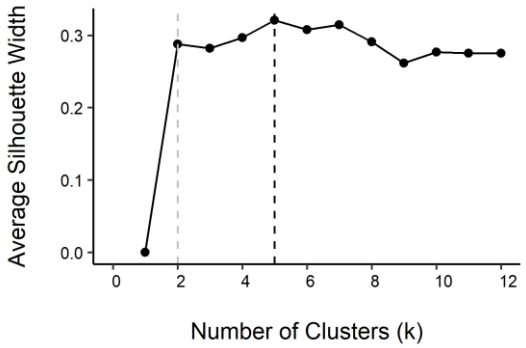
Ward's results (R-mode)

R-mode
(groups species based on units)

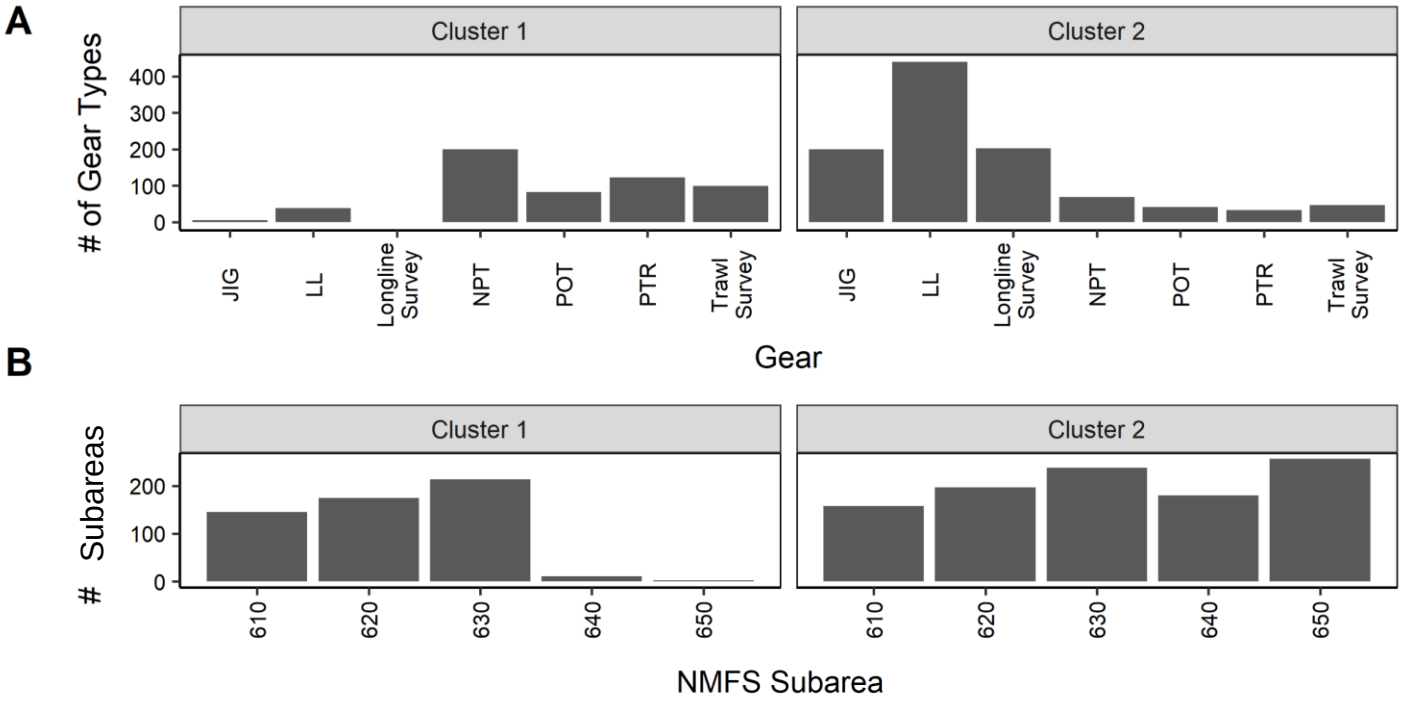


*** = DSR species**

K-mediods results (Q-mode)

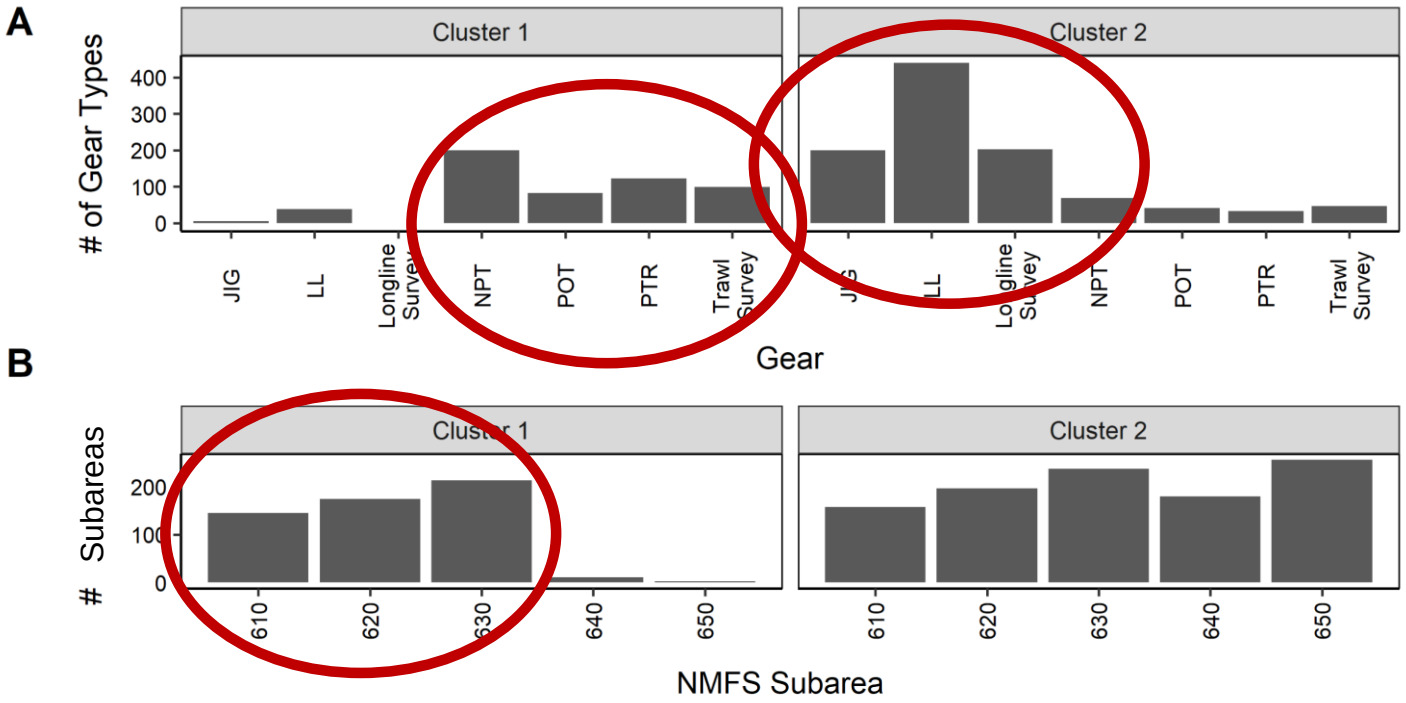


Q-mode
(groups units based on species composition)



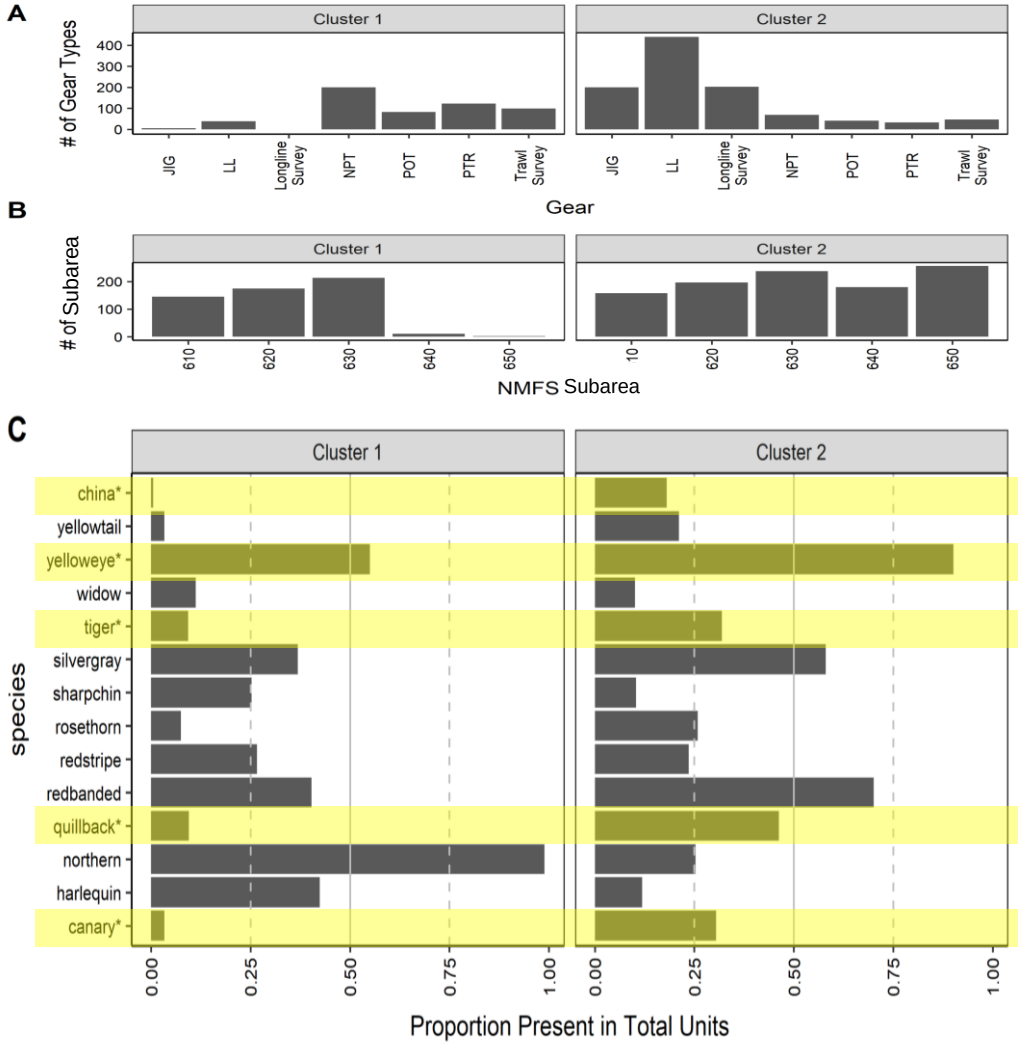
K-mediods results (Q-mode)

Q-mode
(groups units based on species composition)



K-mediods results (Q-mode)

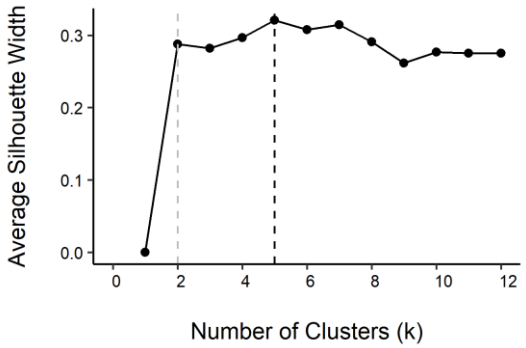
Q-mode
(groups units based on species composition)

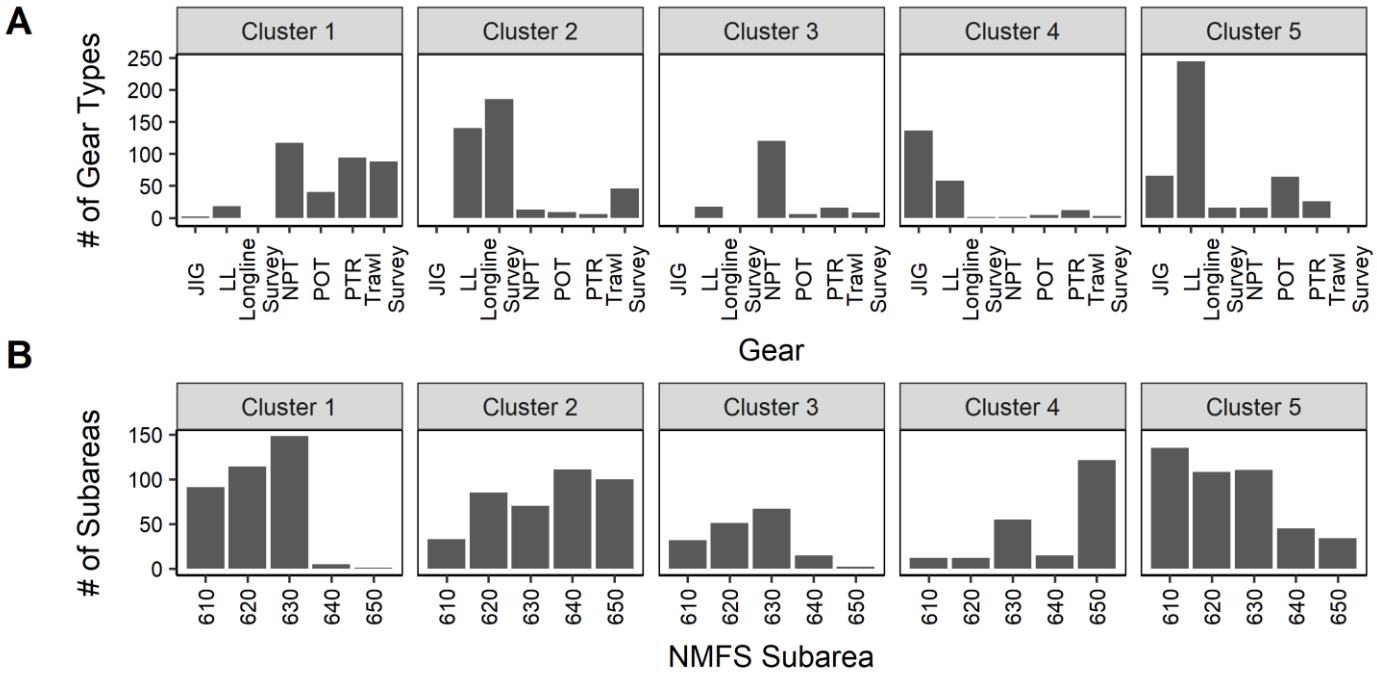


Higher proportion of DSR species in Cluster 2

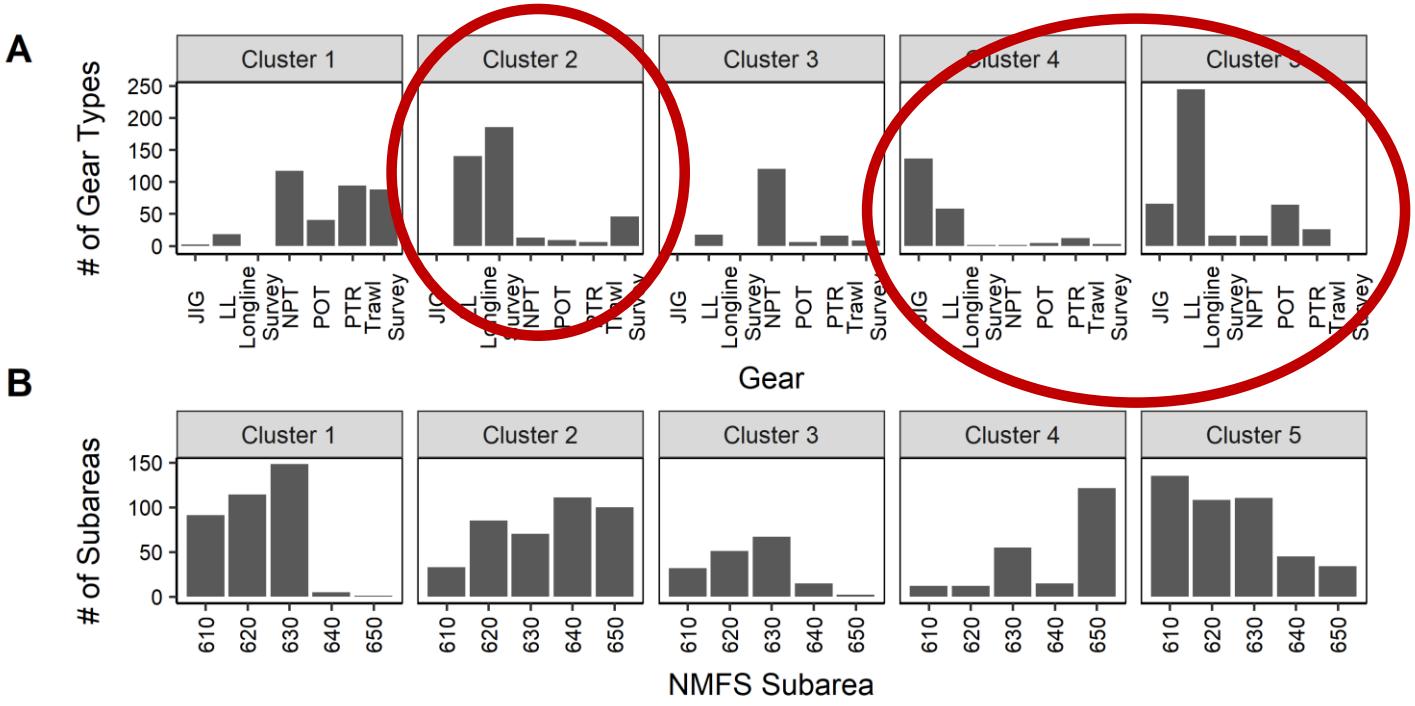
DSR species

K-mediods results (Q-mode)

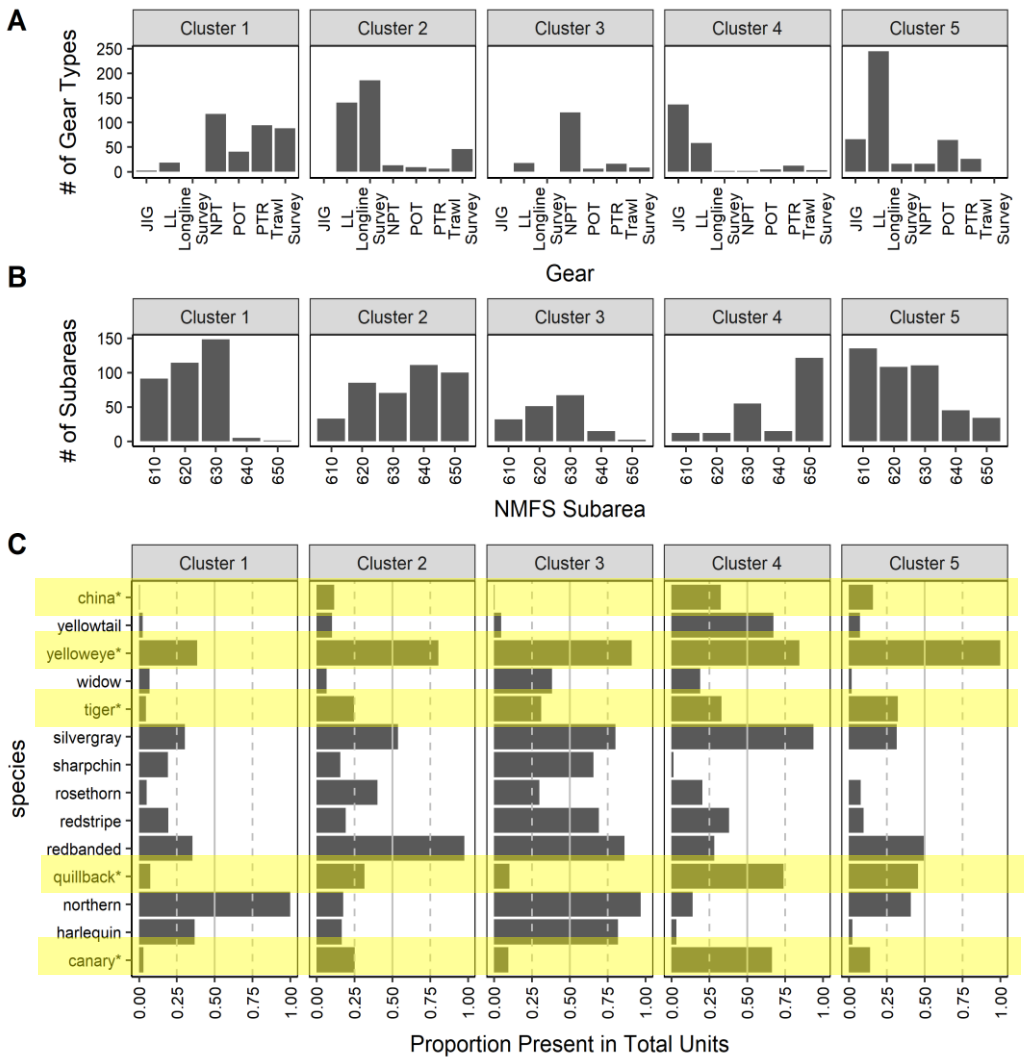




K-mediods results (Q-mode)



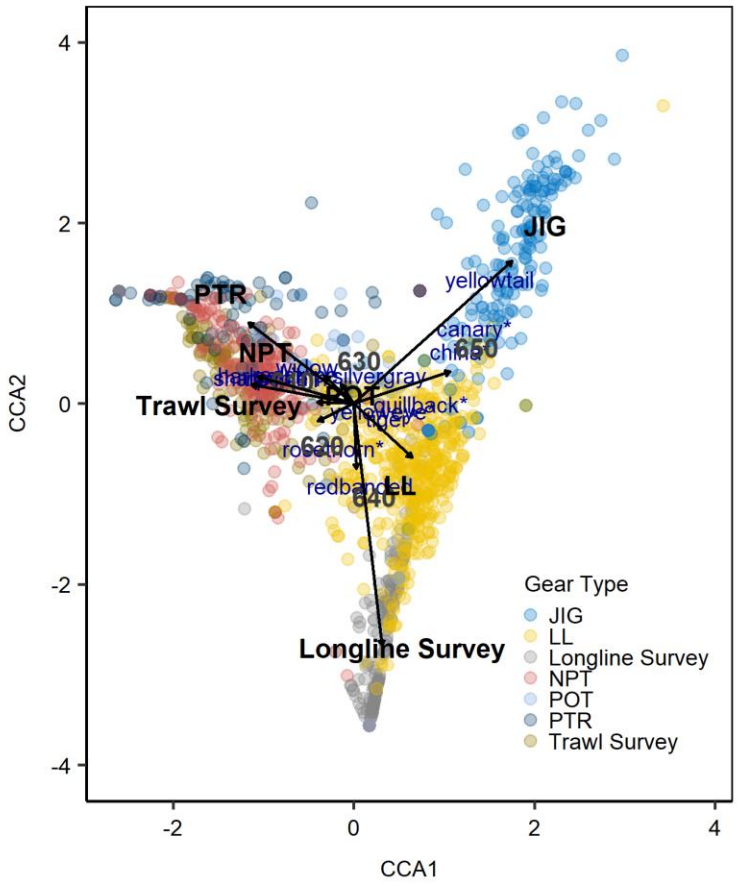
K-mediods results (Q-mode)

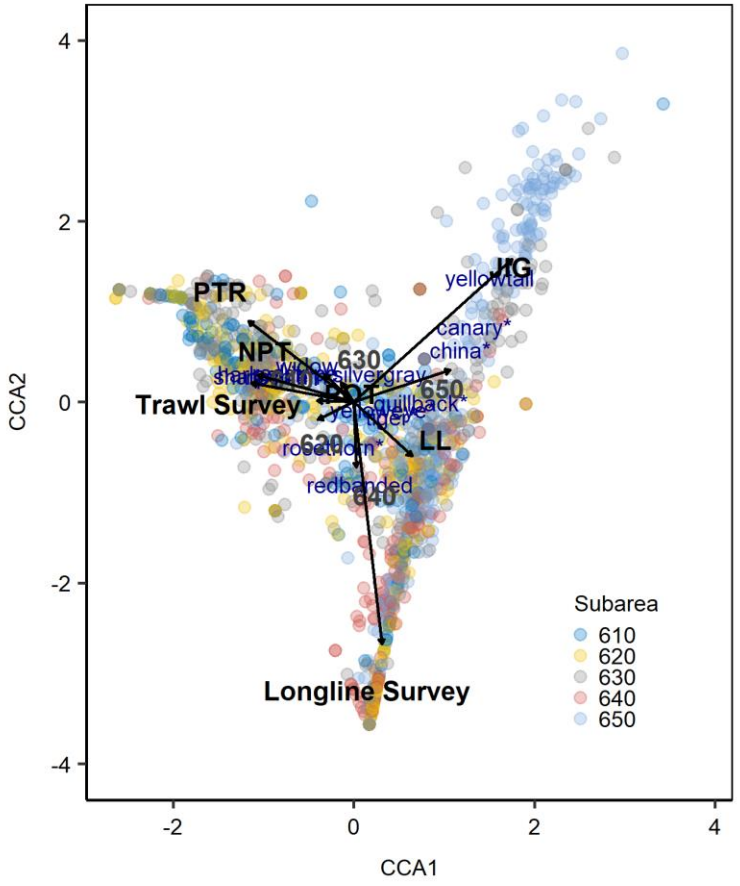


Higher proportion of DSR species in Cluster 2, 4, & 5

DSR species

CCA



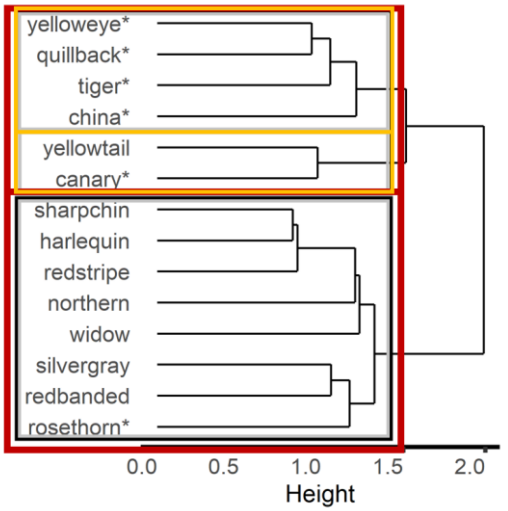


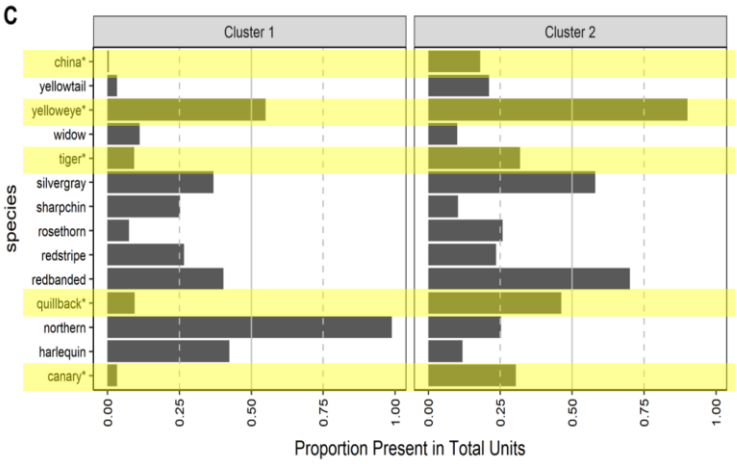
- Distinct groups of LL, Jig, and Longline Survey.
- Mixed trawling gear types.

- Mixed strata (i.e., subarea)

Multivariate analyses conclusions

GOA Other Rockfish (Trawl gear and pot fishery)	GOA Demersal Shelf Rockfish (Longline gear)
blackgill	canary
bocaccio	china
chilipepper	*copper*
darkblotched	quillback
greenstriped	rosethorn
harlequin	tiger
northern	yelloweye
pygmy	
redbanded	
redstripe	
sharpchin	
silvergray	
splitnose	
stripetail	
vermilion	
widow	
yellowmouth	
yellowtail	





Method 2:

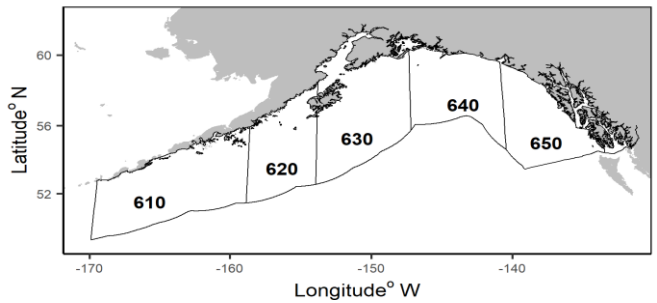
Using VAST (spatio-temporal species distribution model) to examine the spatial and temporal relationships among rockfish

Omori, K.L., Thorson, J.T., *In review*. Identifying species complexes based on spatial and temporal clustering from joint, dynamic species distribution models. *ICES Journal of Marine Science.*

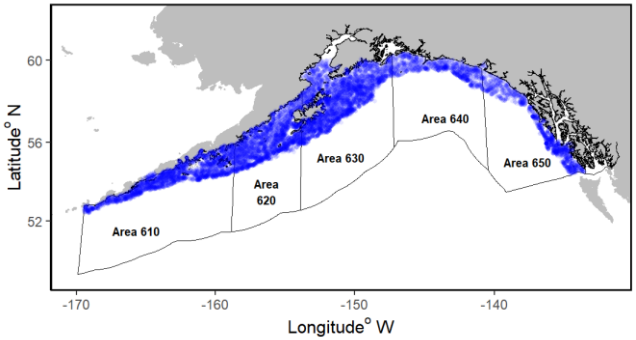
Thank you to Cindy Tribuzio, Jason Cope, and Dan Goethel for providing comments and edits on earlier versions of the manuscript.

VAST (Spatio-temporal species distribution model)

Method 1: Broad-scale



Method 2: Fine-scale



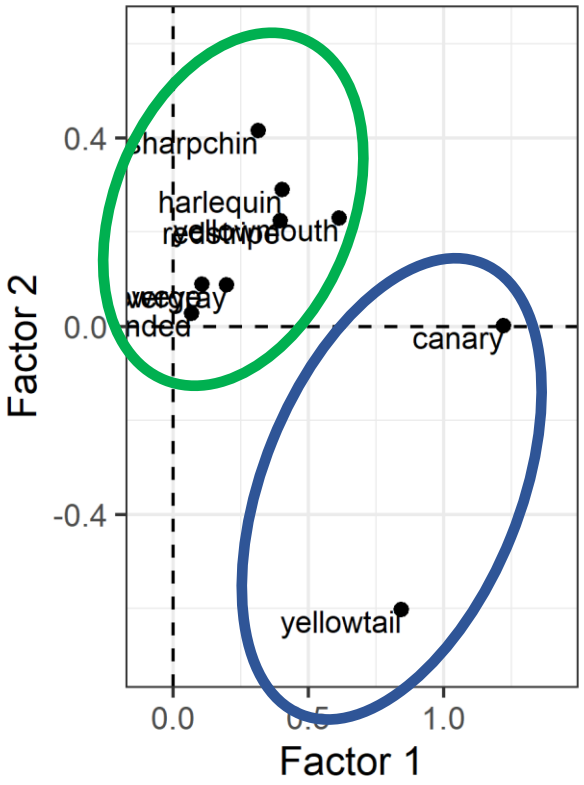
Model

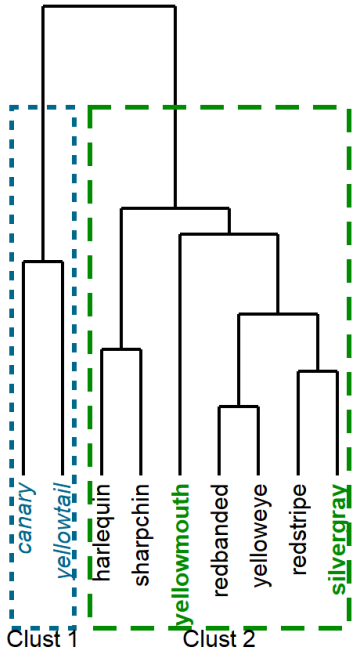
- Poisson-link delta-gamma
- Temporal variation ~ random walk
- Spatial variation
- Mesh with 500 knots and 10 x 10 km^2 grid
- 9 rockfish (> 1% total biomass)

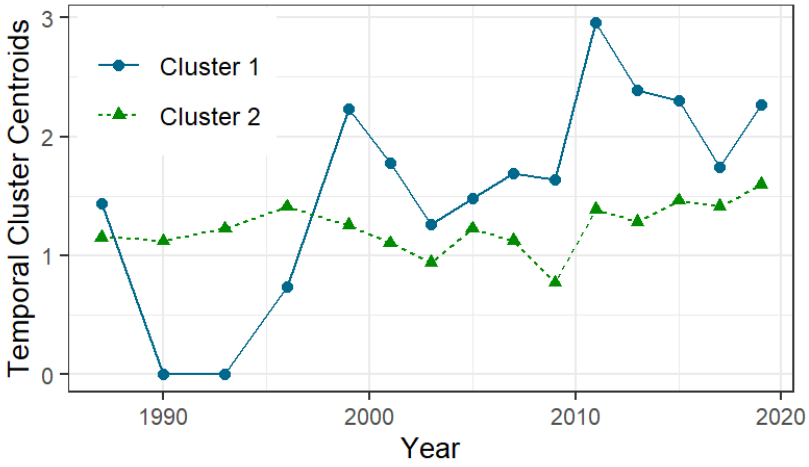
Derived quantities

- Computed single, joint covariance matrices for the spatial and temporal components
- PCA rotation on spatial and temporal loading matrices
- Applied Ward's clustering on covariance matrices
- Calculated temporal and spatial estimates for each grouping

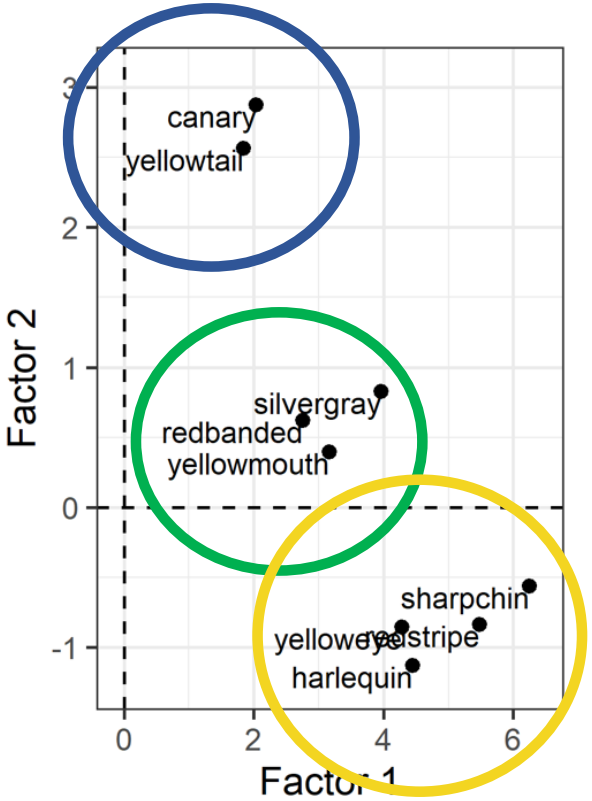
Temporal component

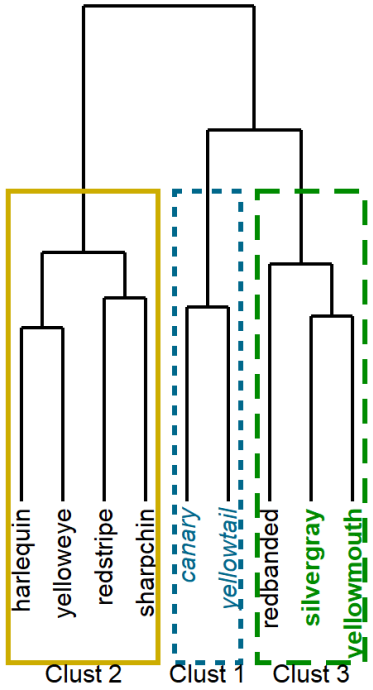


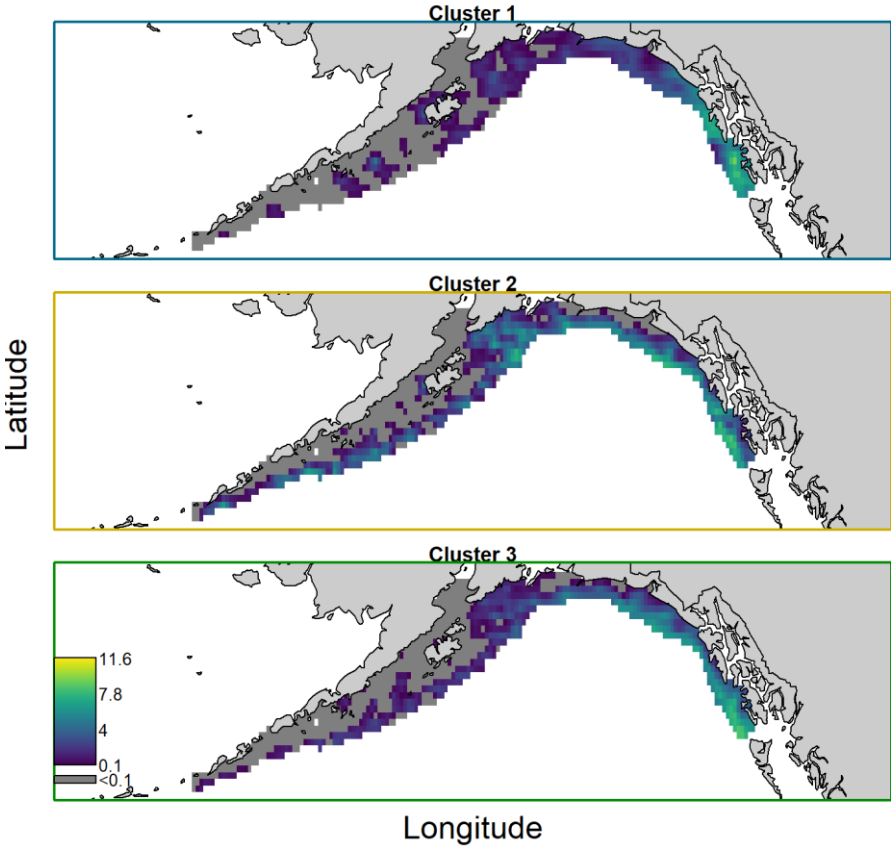




Spatial component



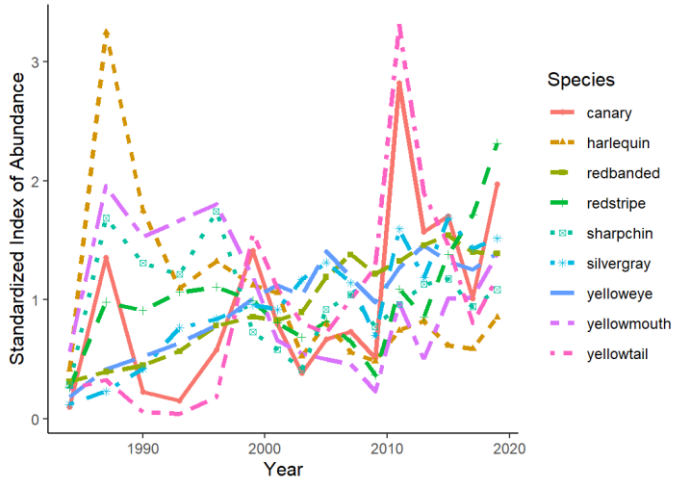


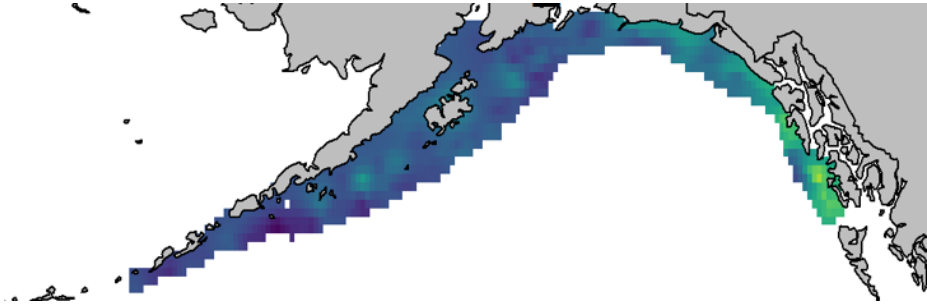


Conclusions from spatio-temporal species distribution models

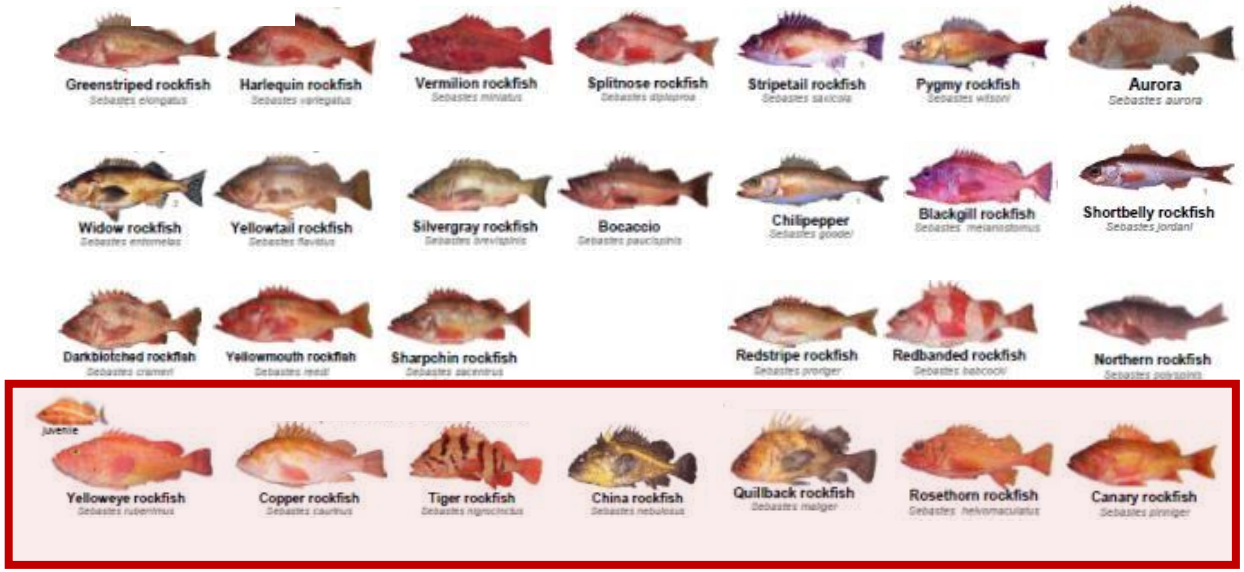
GOA Other Rockfish species:

- Less temporal synchrony
- High spatial overlap for some species
- Canary & yellowtail consistently grouped together
- Note: canary & yelloweye only DSR species included in VAST model



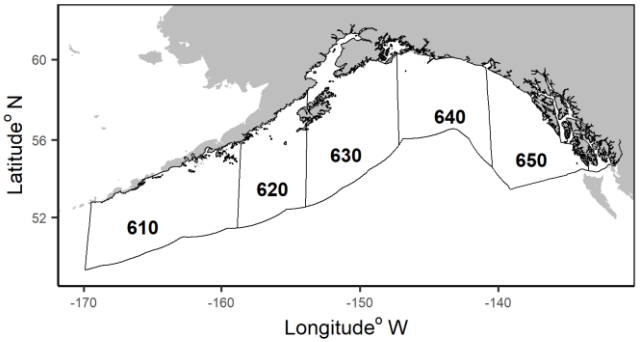


Combined recommendations based on Method 1 & Method 2 for GOA Other Rockfish species assignment

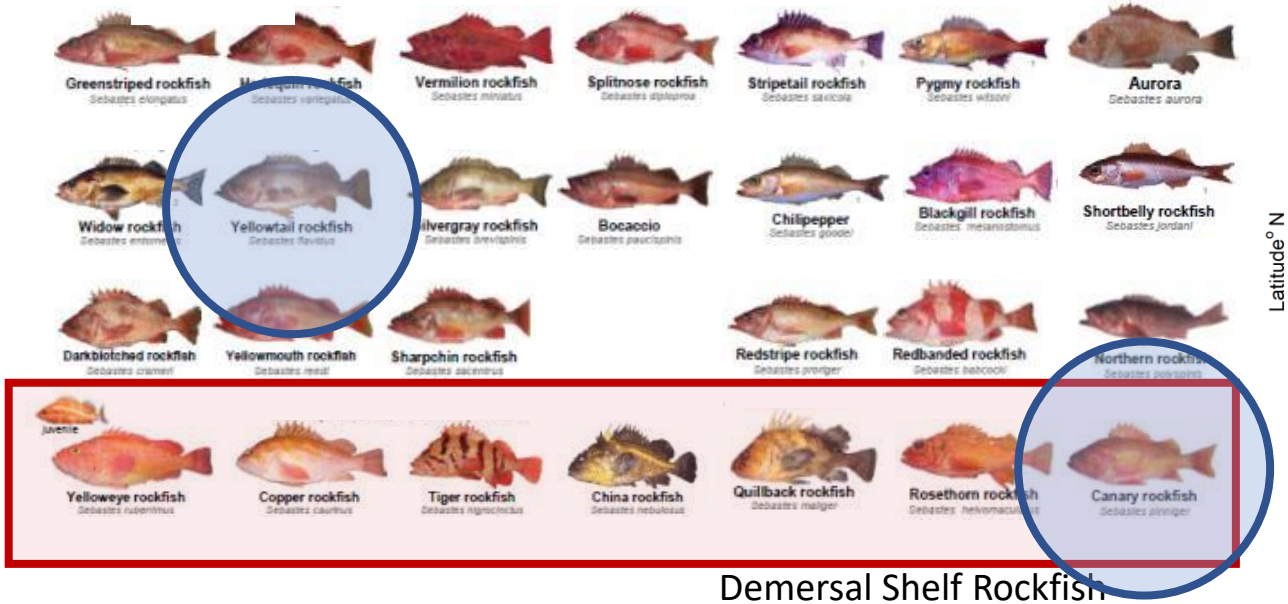


Demersal Shelf Rockfish Complex

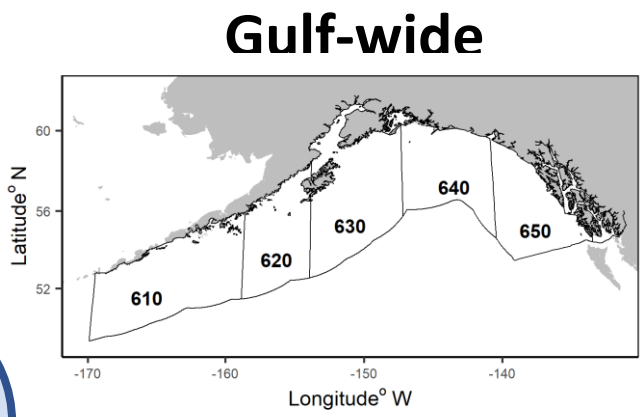
Gulf-wide



Combined recommendations based on Method 1 & Method 2 for GOA Other Rockfish species assignment



Demersal Shelf Rockfish Complex



Request to PT/SSC

Step 2: *With input from the agency, the public, and its advisory bodies,* ***the Council (and NMFS) should identify the economic and management implications and potential options for management response to these findings and identify the suite of tools that could be used to achieve conservation and management goals.***

Guidance or ideas on how to achieve this?

Step 2???

- Council is requested to initiate a regulatory amendment to modify 50 CFR Part 679 to accommodate changes to both the OR and DSR complexes
- Are there additional economic and management considerations to be addressed by staff?

EXAMPLE ABCs and OFL

	Western GOA	Central GOA	Eastern GOA		Total
			West Yakutat	E Yakutat/ Southeast	
Area ABC (t)	46	125	34	238	**443**
OFL (t)					**648**