Caught in the middle: Bottom-up drivers of top-down impacts on Chinook salmon

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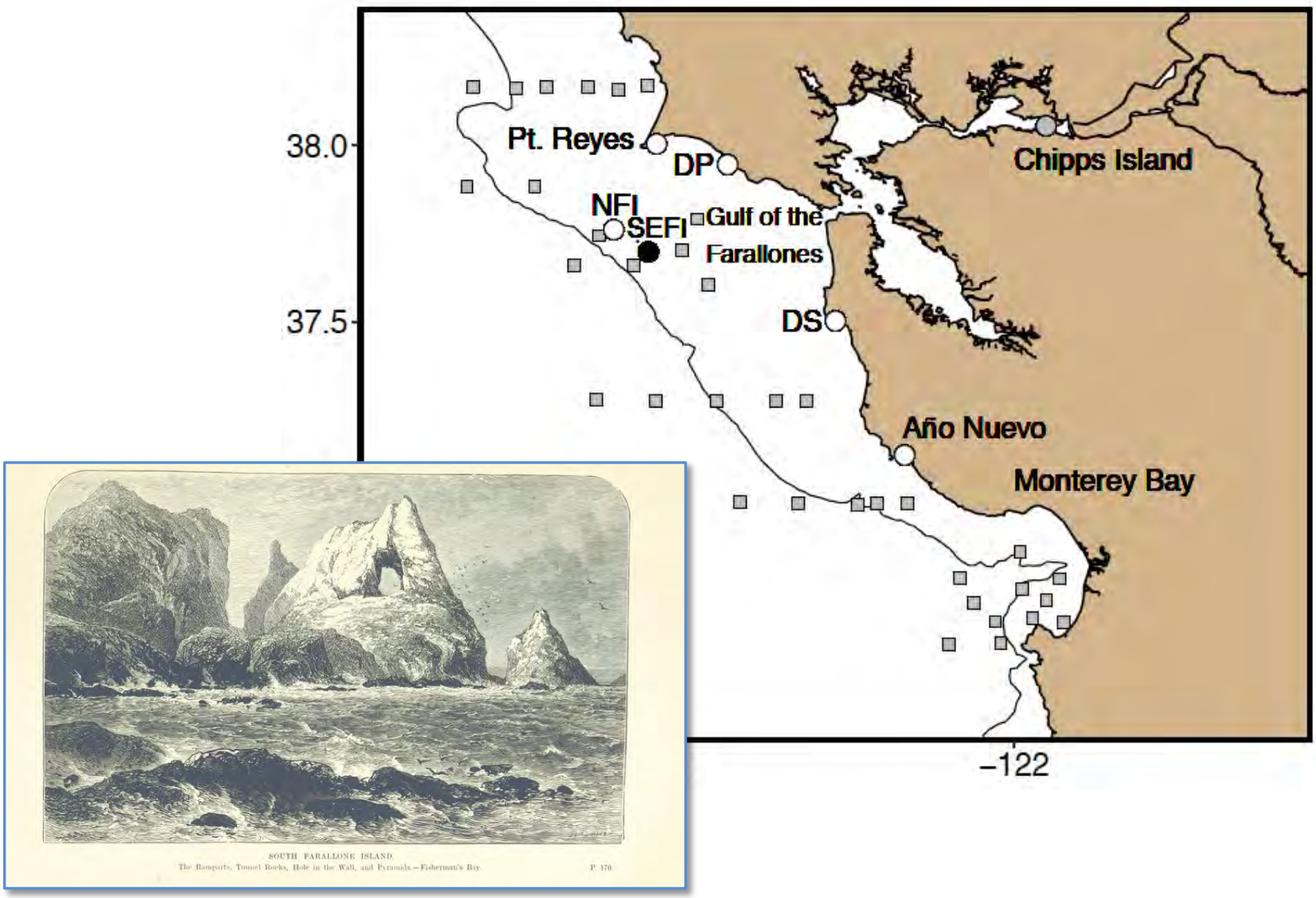
Objectives

Characterize the distributions of Common Murre in central California during years of increased local forage production and during years of poor local production.

Quantify the relative impact of predation on juvenile Chinook salmon with a varying forage base.

Overview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SOUTH FARALLONE ISLAND.
The Ramparts, Tunnel Rocks, Hole in the Wall, and Pyramids.—Fisherman's Bay.
P. 170.

Overview

- Background of the questions
- Data sources and methodologies
- Results
- Taking an ecosystem perspective

Background of the questions

- Seabirds may make up a significant impact on salmon survival. In central California, juvenile salmon make up 10% of the diet of piscivorous birds.
- There is the potential for increased overlap between predators and salmon as the prey field and environment vary.
- This impact on salmon may be greater as alternative prey resources are limited.

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Data sources and methodologies

Type	Series	Source	Years
Common murre	Abundance (ind.)	Point Blue	1983-2012
	At-sea density (km^2)	RREAS	1996-2010
	Diet composition (% FO)	Point Blue	1983-2012
	Trip duration (minutes)	Point Blue	1984-2012
	Size of prey (mm)	Point Blue	1983-2012
Forage base	Rockfish (ln(CPUE+1))	RREAS	1983-2012
	Northern anchovy (CPUE)	RREAS	1983-2012
Chinook salmon	Length at Chipps Isl. (mm)	USFWS	1983-2012
	Survival (%)	RMIS	1983-2012
Environment	March upwelling at 39°N (m^3/sec./100 m of coastline)	PFEL	1983-2012
	Average discharge during April (cfs; USGS station 11390500)	USGS	1983-2012

Data sources and methodologies

Relate survival to variability in freshwater flow, upwelling, prey, Common Murre population size.

betareg(Survival ~ Freshwater discharge in April
+ Upwelling in March
+ (Upwelling March)^2
+ Rockfish Abundance
+ Murre Population
+ Interaction(Rockfish*Murre)

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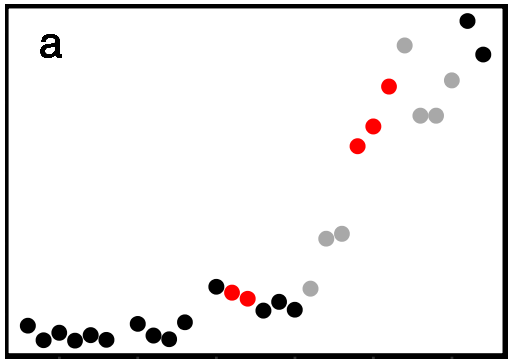
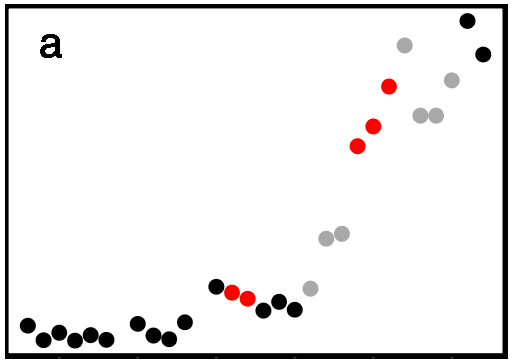
Common Murre distribution and population size

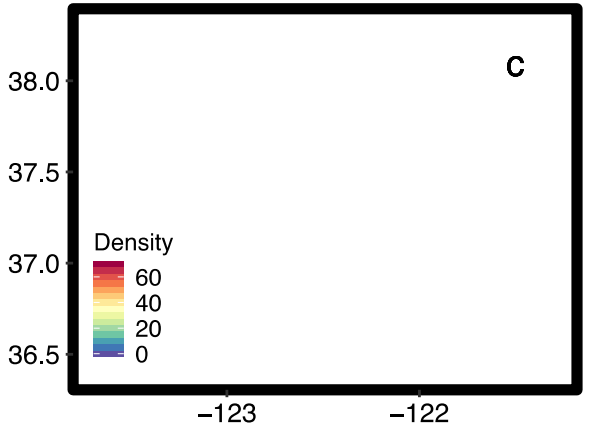
- Population size is increasing



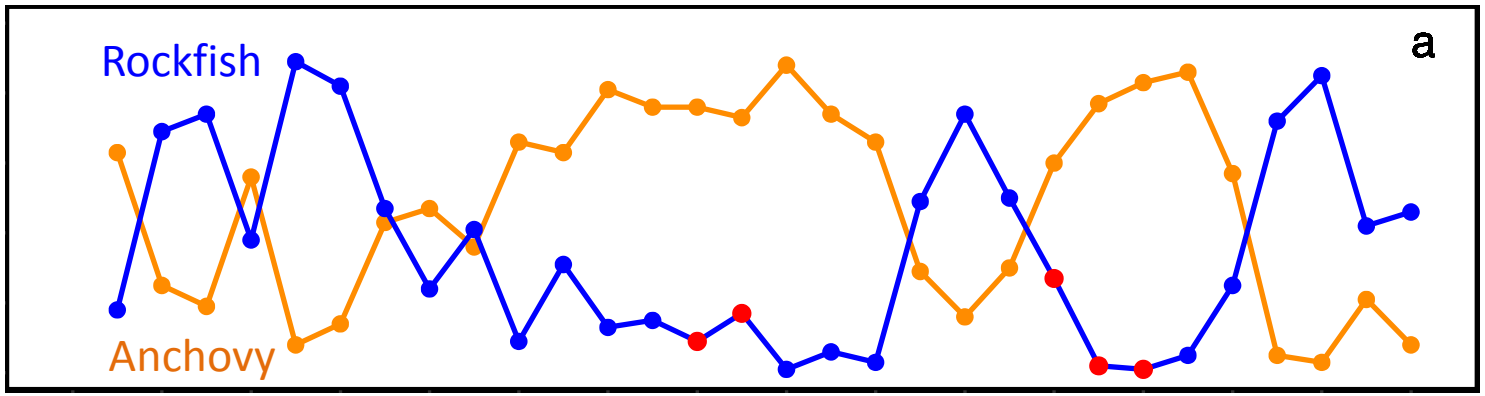
Common Murre distribution and population size

- Population size is increasing
- During year of improved production locally Murre are dispersed
- During years of reduced production locally Murre concentrate on shelf where anchovy or more abundant.



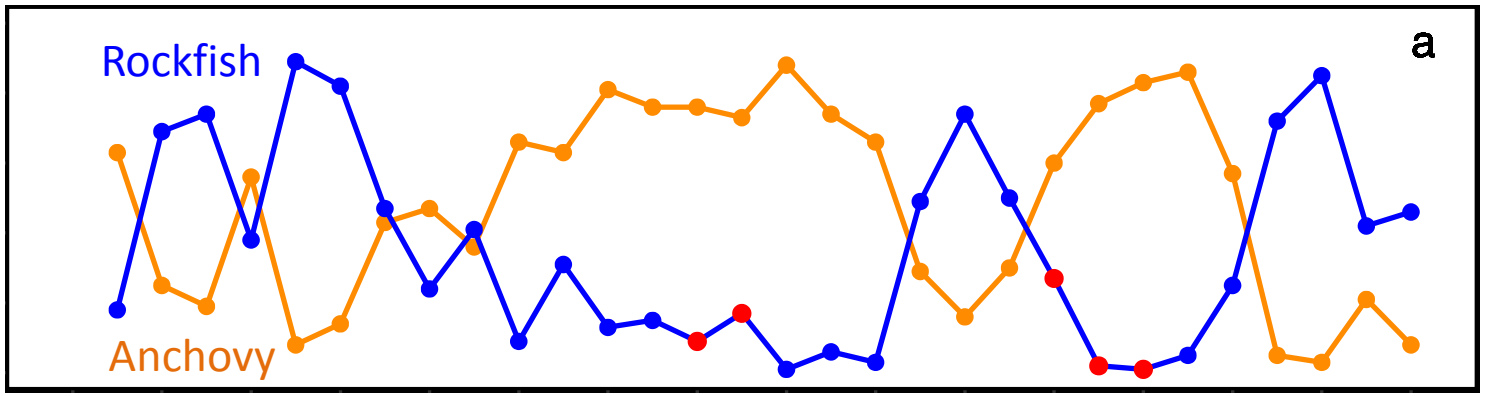


Common Murre diet



http://www.seadocsociety.org/newsarchive/october2012update.html

Common Murre diet



Length (mm)

ey

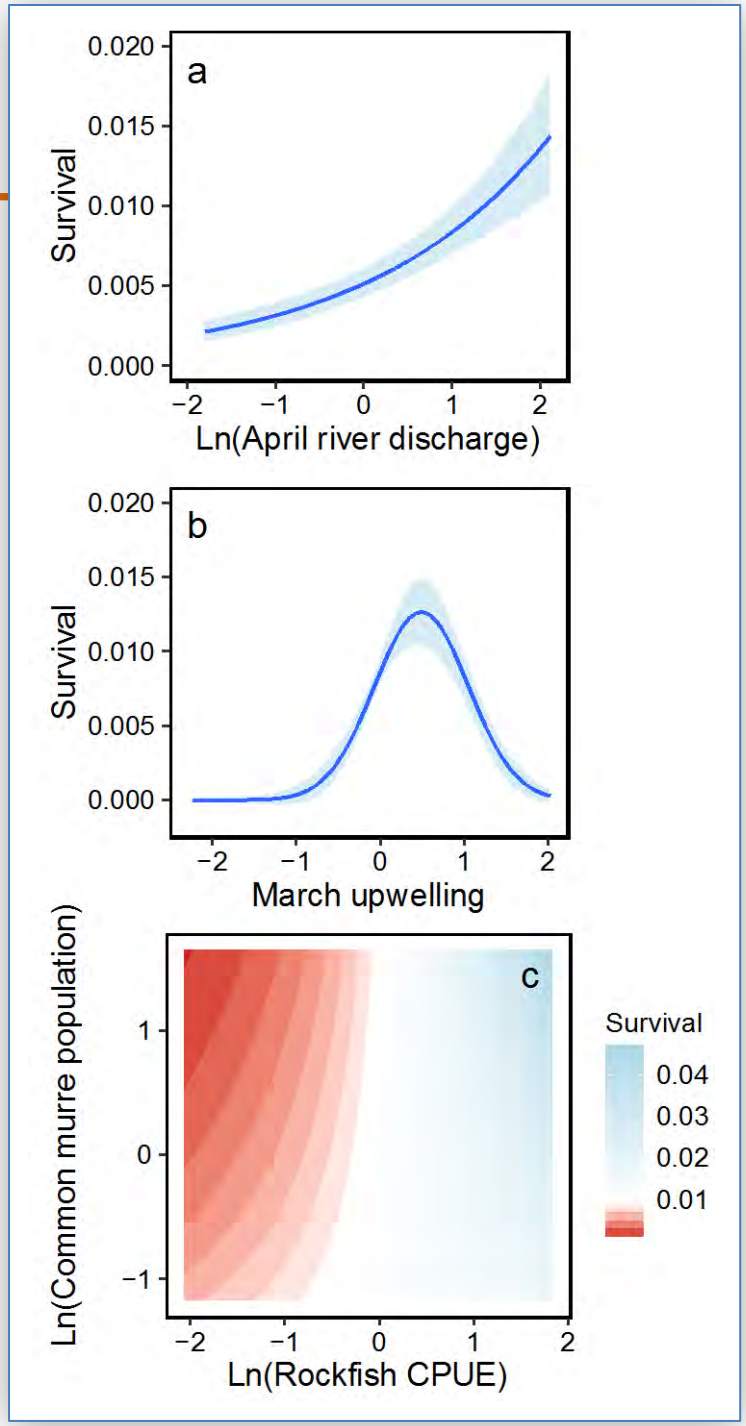
Anchovy Prey

Modeling salmon survival

Covariate	estimate	Std. Error	Z-Score	p-value
Intercept	-4.78	0.11	-43.94	<0.0001
Ln(Discharge April+1)	0.49	0.12	4.07	<0.0001
March upwelling	1.58	0.54	2.91	0.0036
(March upwelling)^2	-1.61	0.54	-2.99	0.0028
Ln(Rockfish CPUE + 1)	0.53	0.11	4.74	<0.0001
Common murre abundance	-0.05	0.11	-0.52	0.6154
Interaction between rockfish and common murre	0.23	0.11	2.17	0.0301

Modeling salmon survival

There is indication of survival being substantially lower when rockfish abundance is low and Common Murre population size great.



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Taking an ecosystem perspective

Evidence indicates that freshwater practices can improve survival by promoting larger fish.

As well, winter preconditioning (upwelling) is critical to setting up an environment conducive to early salmon survival.

Common Murre prey on salmon more when the local environment does not promote local production of prey and leads to increases of anchovy on the shelf.

As the population of Common Murre continues to increase, there may be an associated increase in variability of salmon survival.

Taking an ecosystem perspective

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Modeling salmon survival

It is worth noting that detrended data does not have interaction