Matching bird diets with fish data: New insight into avian predation in the Columbia River estuary

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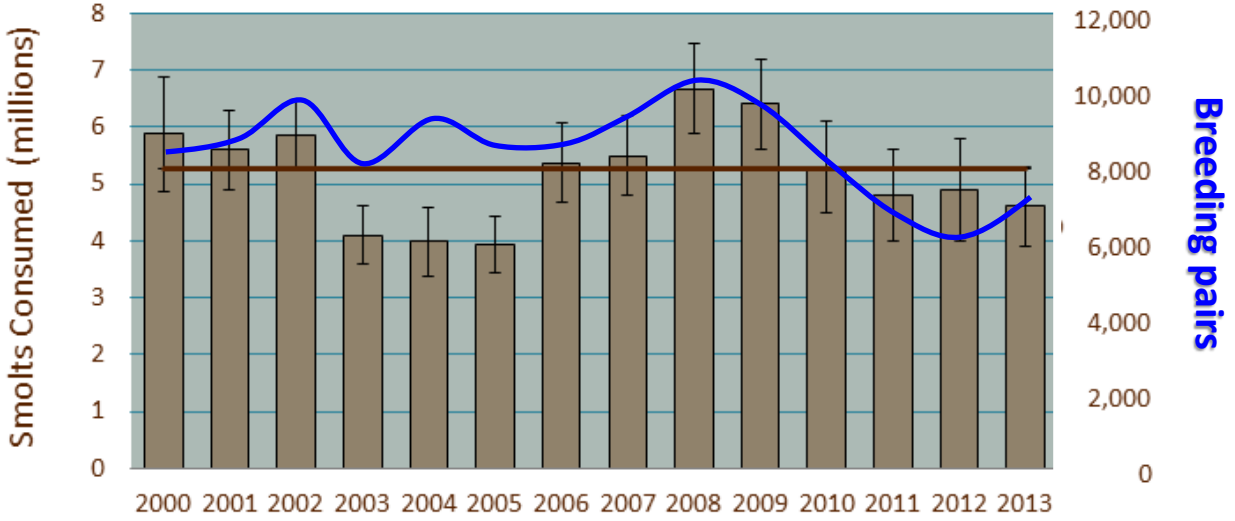
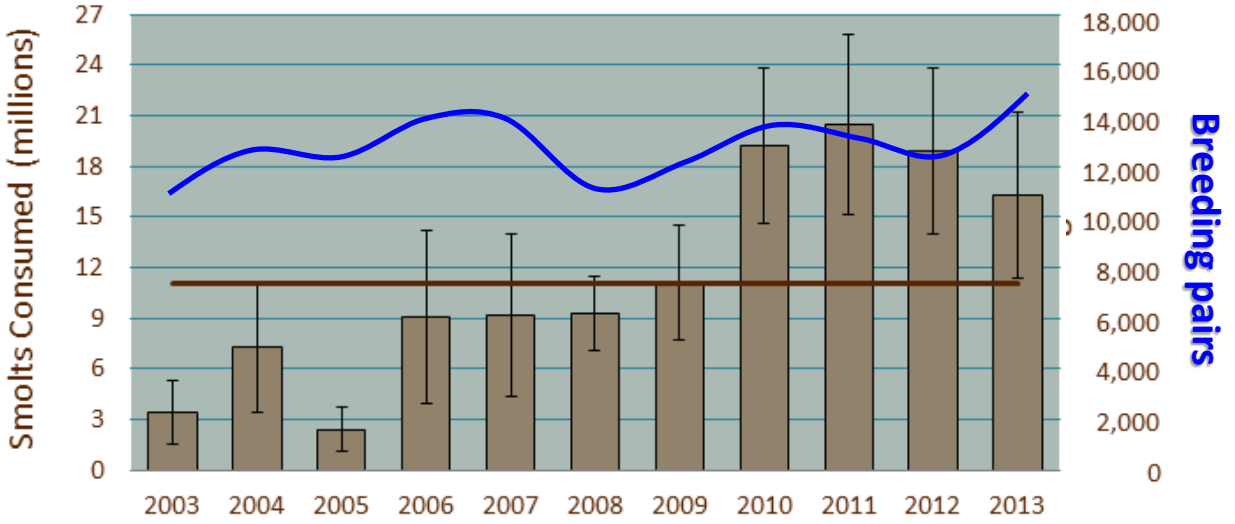
Salmon consumption by birds is highly variable despite ± stable colony sizes

Caspian terns



Double crested cormorants



Data from www.birdresearchnw.org

Roby et al (2002) showed the importance of alternate prey to tern diets

EFFECTS OF COLONY RELOCATION ON DIET AND PRODUCTIVITY OF CASPIAN TERNS

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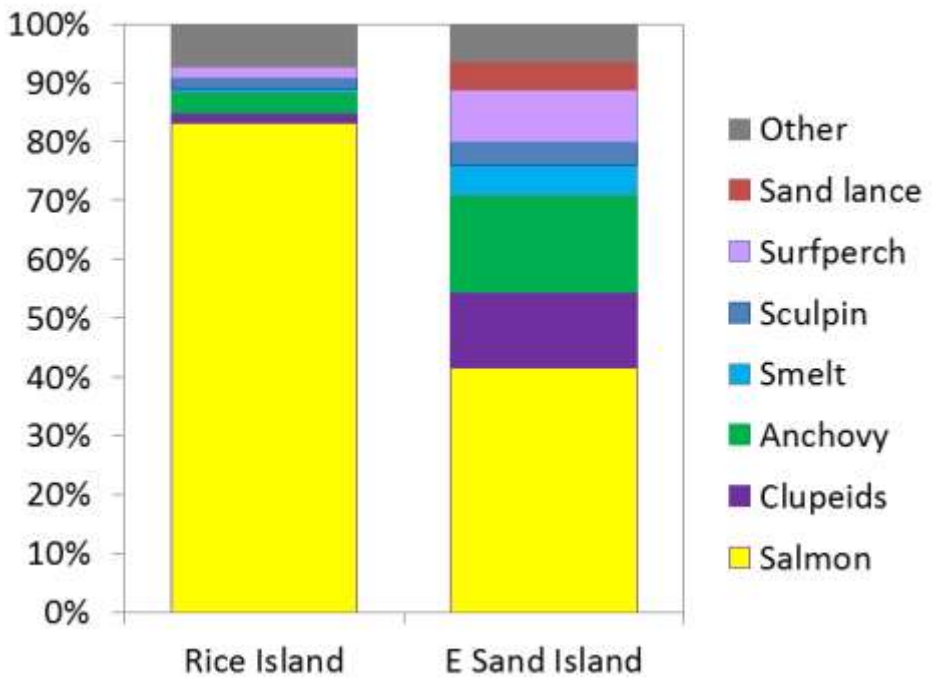
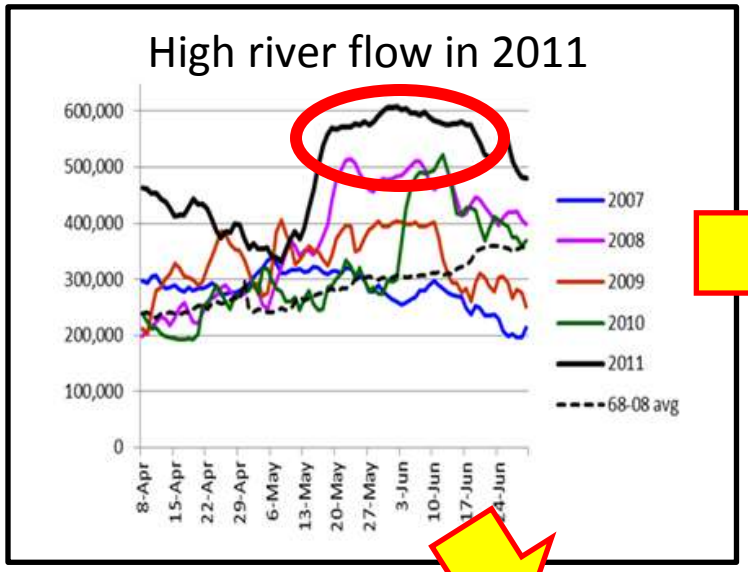
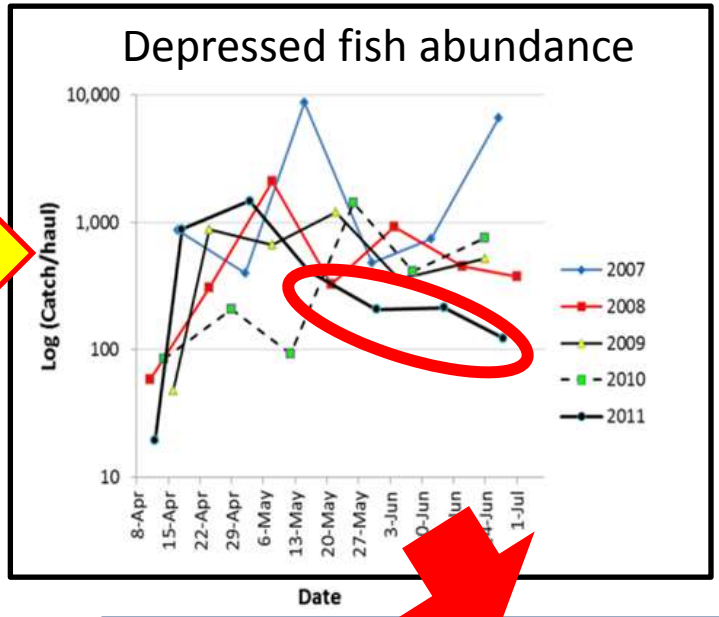
Caspian terns relocated from Rice Island to East Sand Island consumed less salmon and more forage fish

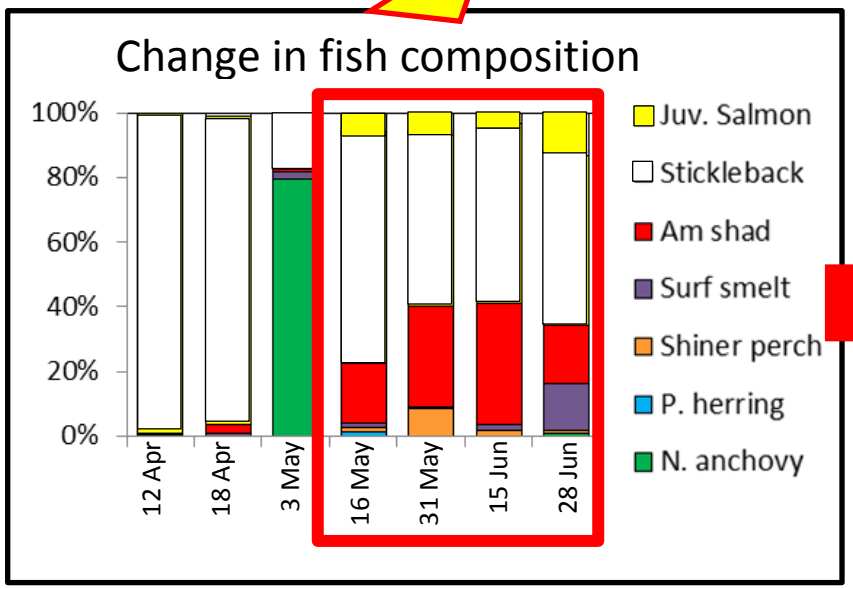


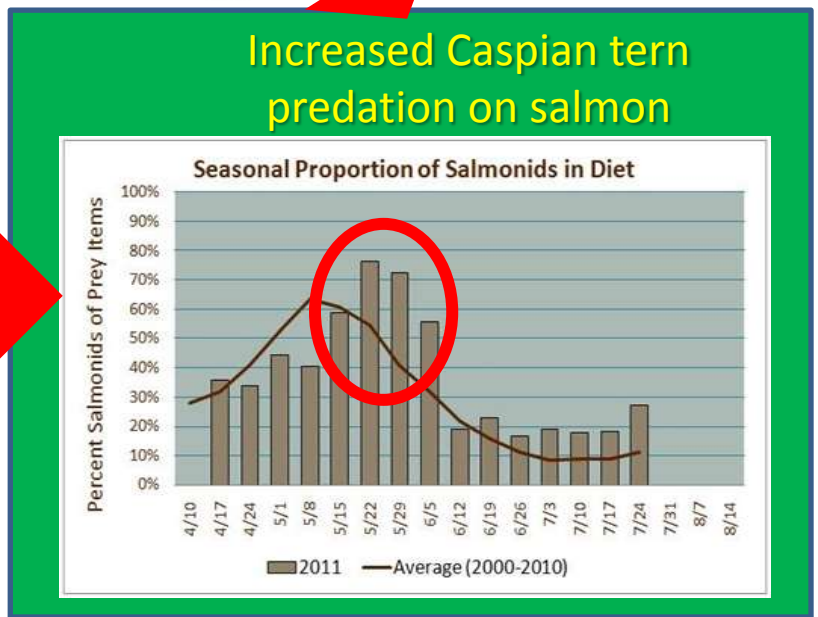
Roby et al. 2002

“Natural” experiments hint at dynamics









Matching fish and bird data to address a critical common question:

Why does avian prey selection vary?

The answer informs:

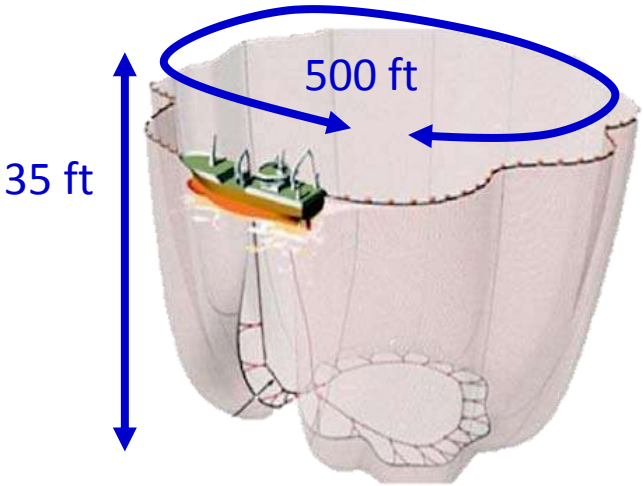
bird breeding success?

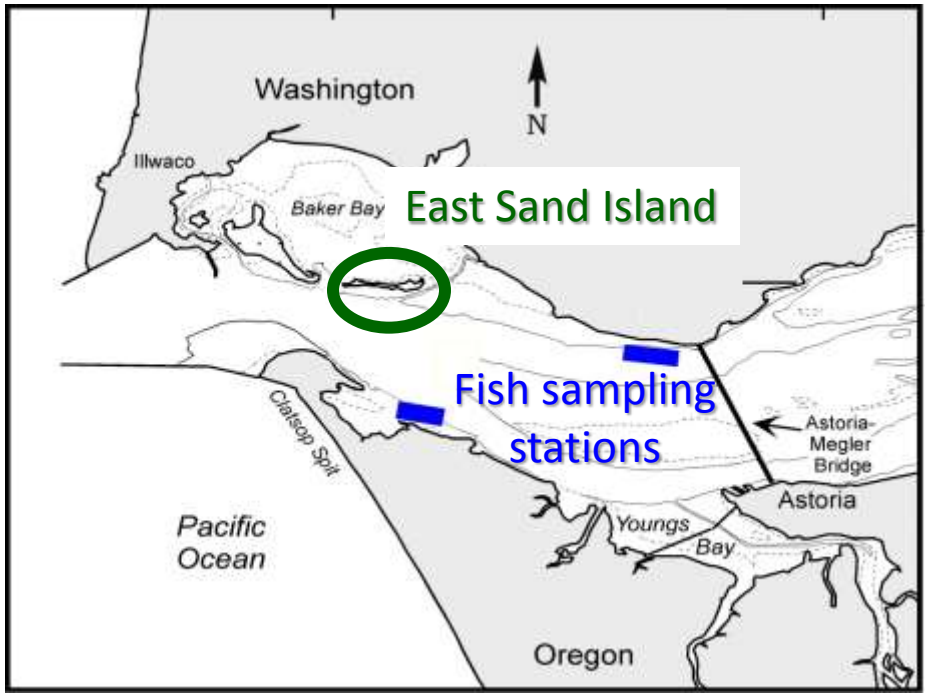
salmon survival?

Fish data: Estuary Purse Seine (EPS) study

Focus on spring outmigration of juvenile salmonids

- Sampling at edges of deep channels with purse seine
- Mid April to late June
  - every other week (2007-13)
- 6-8 sets per station per trip





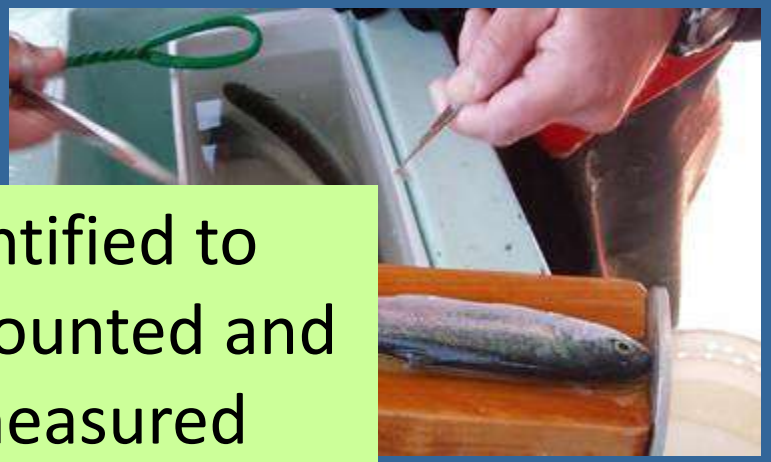

Setting the net


Pulling the net on deck


Pursing the net


Fish crowded in bunt

Sorting, counting and measuring fish



All fish identified to species and counted and a subset measured

Extensive dataset on estuarine fish community

Tern Diet Composition

- Observations of whole fish carried back to colony to feed mates or chicks
- Diet by frequency converted to diet by biomass using length-weight relationships for each prey type

Cormorant Diet Composition

- Lab analysis of stomach contents of collected cormorants
- Diet by biomass using relative biomass in each stomach

Common fish and bird diet data

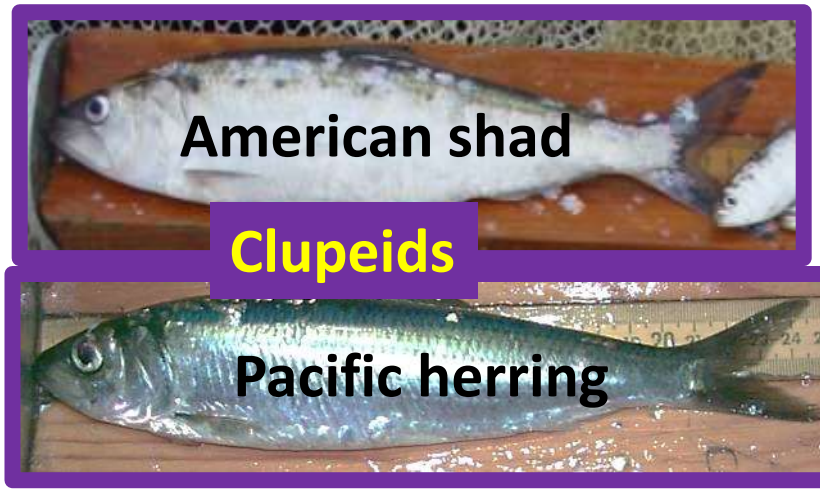
- Data averaged over 2 weeks periods (mid Apr-late June)
- Six years (2007-2012)
- Fish biomass by species or group (e.g., Clupeids)
  - relative biomass (%)
    - all groups (tern and cormorant diets)
  - absolute biomass (g)
    - all groups (tern diet only)

Bird diets from East Sand Island

Research questions

1. Does EPS fish community represent bird diets?
   - does it capture their prey field?
2. Are bird diets related to the abundance of fish?
3. Are birds selecting for/against certain prey?
4. Does environmental variation influence fish community and predation rates?

Commonly-caught estuary fishes

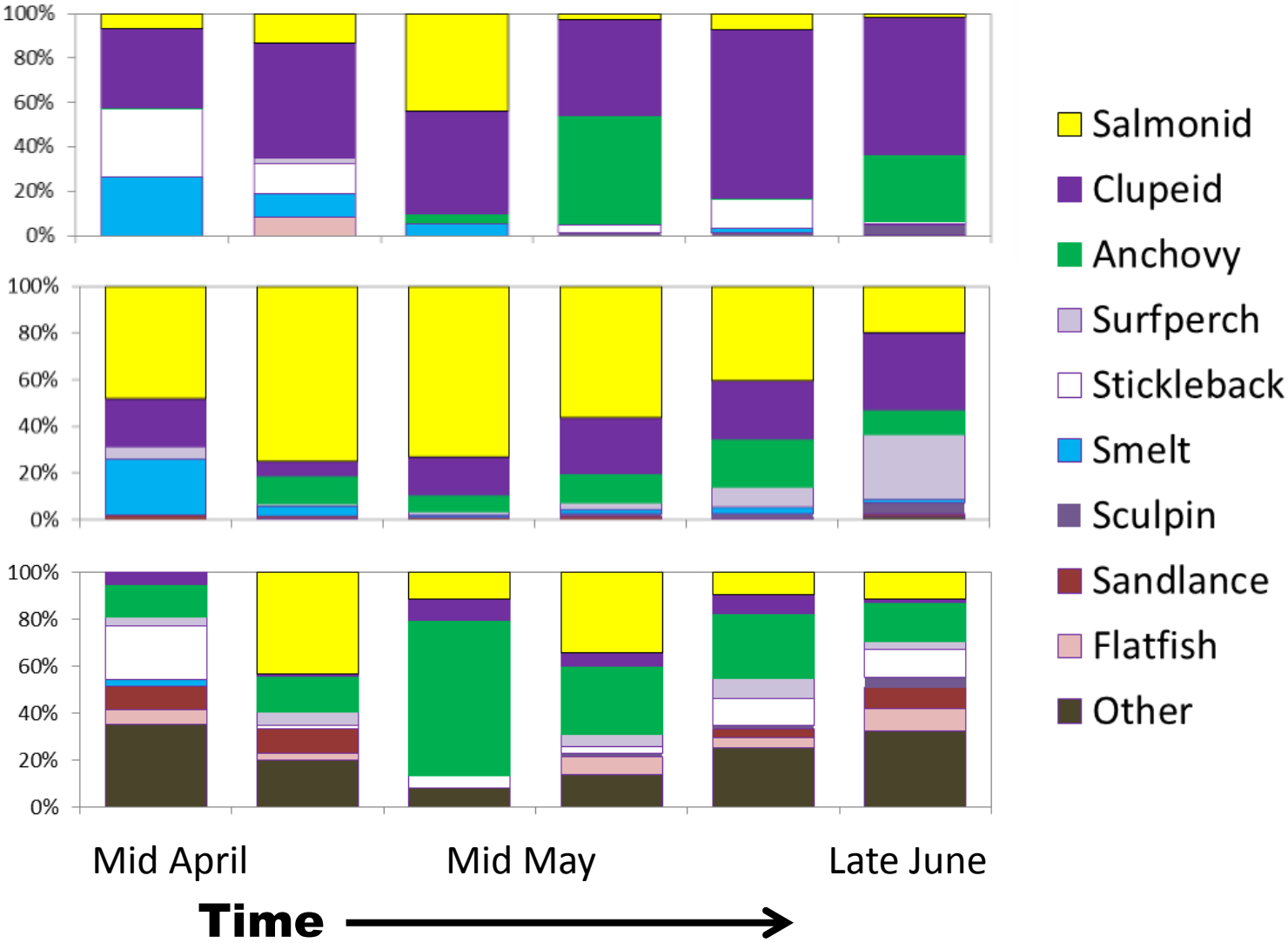


2010 example: birds generally selecting fish caught in EPS study, but high temporal variation

EPS fish community

Caspian tern diets

DC cormorant diets



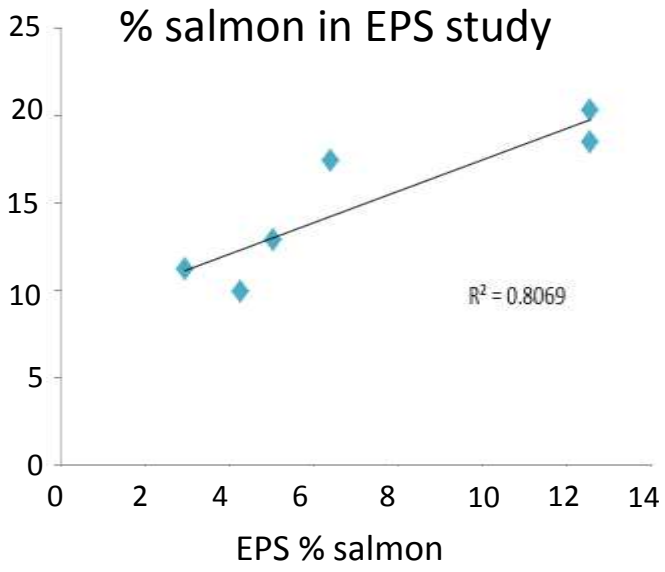
Spearman correlations between fish groups in avian diets (%) and the EPS study (% or g)

	DC Cormorant		Caspian tern	
Species	**EPS(%)**	**EPS(g)**	**EPS(%)**	**EPS(g)**
Anchovy	0.38**	0.27	0.26	0.27
Clupeid	0.22	0.20	0.11	0.31*
Salmon	0.31*	0.22	0.44**	.68**
Sculpin	0.34**	0.41***	0.28	0.27
Smelt	0.03	-0.04	0.36**	-0.19
Stickleback	0.62***	0.43**	0.16	.38*
Surfperch	0.23	0.25	0.18	0.19

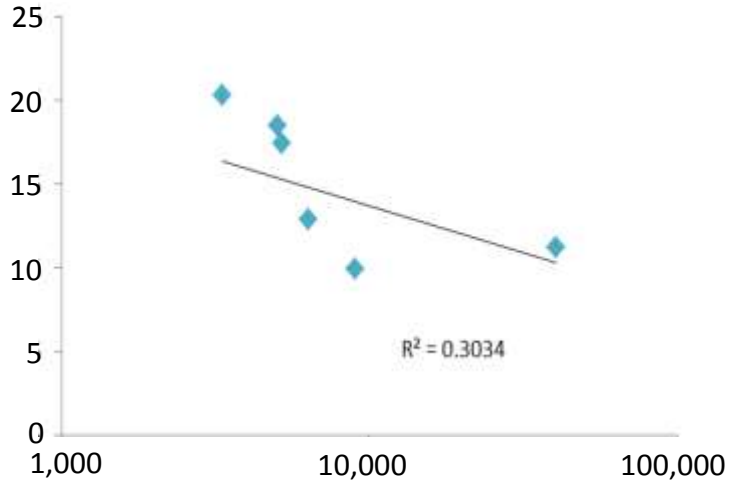
* $P < 0.10$; ** $P < 0.05$; *** $P < 0.01$

Annual cormorant consumption of salmon reflects abundance of salmon and non-salmon in EPS study

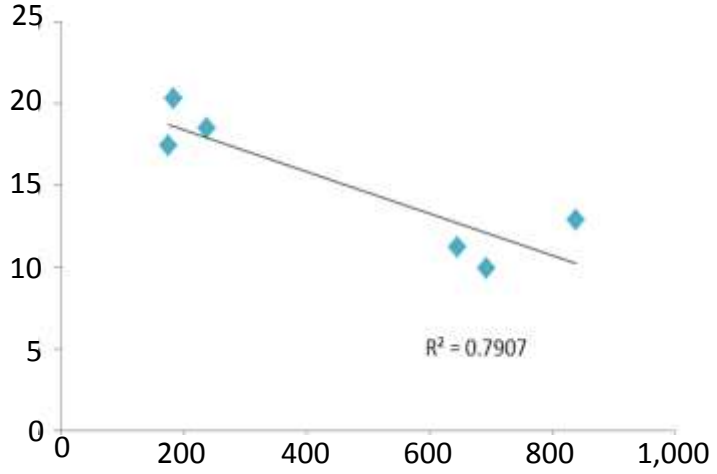
Annual % salmon in cormorant diets



Biomass of marine fish in EPS study



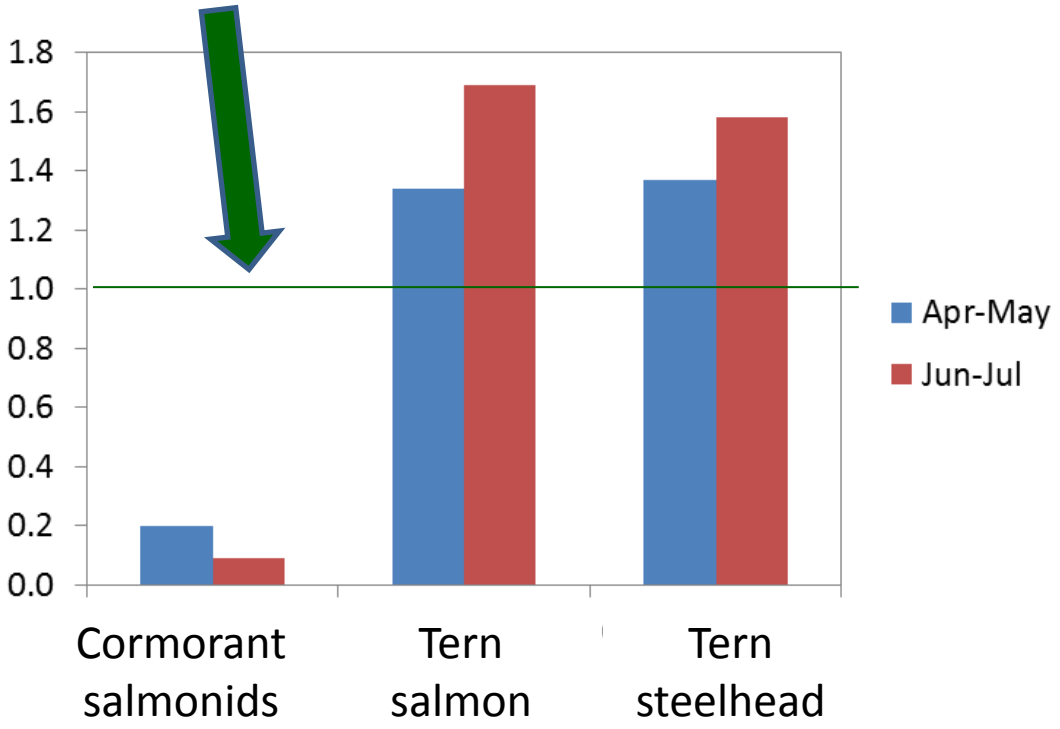
Biomass of estuarine fish in EPS study



Terns are strongly selecting for salmonids, cormorants are not

1.0 = 10x greater % biomass in diets than in fish data

Log of odds ratio



Summary and conclusions (1)

- Purse seine fish data representative of bird's prey field despite:
  - Fish data collected for entirely different reasons
  - Foraging differences between terns and cormorants
  - Bird foraging areas much larger than seine area
- Availability of alternate prey **does** impact salmon consumption
  - Both marine and estuarine fish influence cormorant diets
  - Majority of tern diet consists of non-salmonids

Summary and conclusions (2)

- Marked differences in salmon selectivity between bird species
  - Terns strongly selecting for salmon, cormorants are not
- Future environmental variation (e.g., upcoming El Niño) will likely influence alternate prey and therefore predation on salmon
- Better understanding of prey availability/predation linkage needed for intelligent management of birds and fish