Ocean avian predation risk & early marine survival of salmon in the Columbia River Plume

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Question, background, approach

* **Question:** Is seabird predation affecting the marine survival of juvenile salmon *after* salmon exit the estuary and enter the ocean?
* **Background:** Motivated by management need to understand mechanisms affecting the early marine survival of endangered Columbia River salmon populations
* **Approach:** Four-step empirical evaluation of predation impact

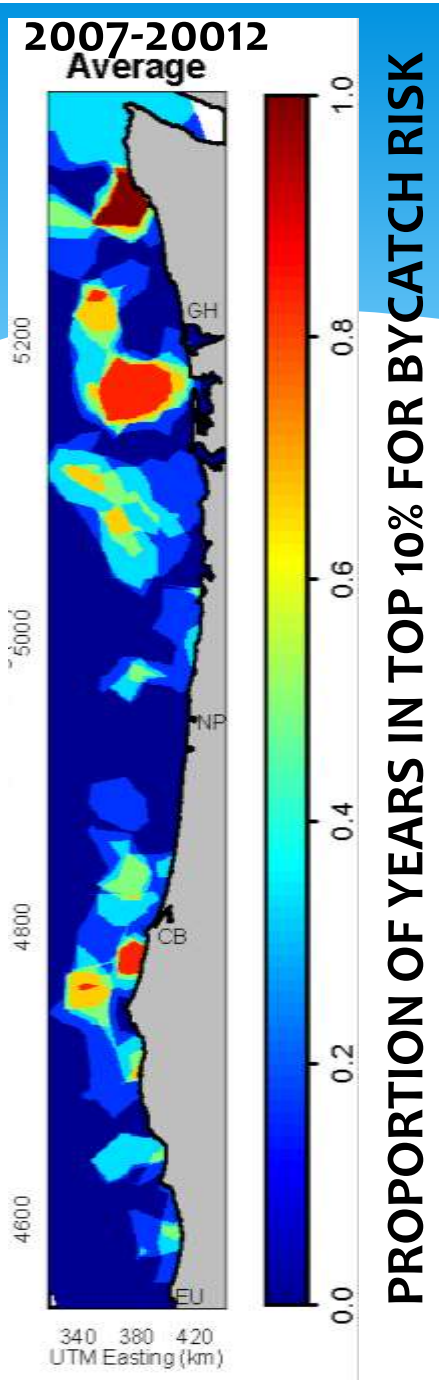
Evaluating predation impact

Four-step evaluation

1. Determine which potential predators are present
2. Identify most abundant predators likely to exert significant impact
3. Quantify predator-prey overlap in time & space, identify areas of high risk
4. Measure or estimate level of prey consumption

Unique data set

- May, June 2003-2012
- Bird transects (lines)
- Salmon trawls, oceanographic stations (stars)
- Common murre colonies (circles)
- 200 m contour (gray line)
- Simultaneous, local covariates
  - Temperature/chl-*a*/salinty @ 3 m, distance to murre colony, distance to shore
- Genetic data on salmon population origins: Teel et al. 2015 Marine & Coastal Fisheries 7(1): 274-300

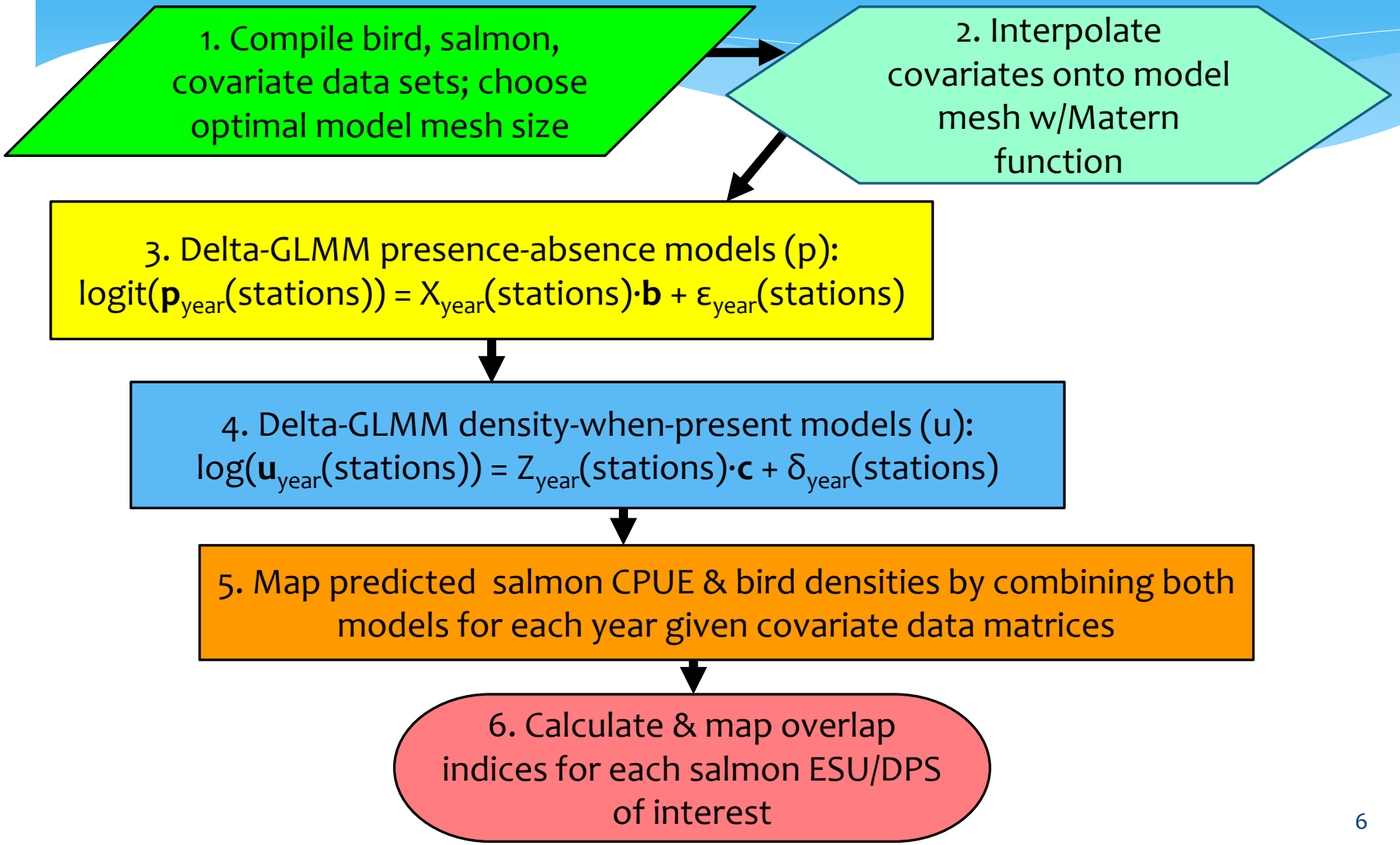


Predator-prey overlap & predation risk

Modify Ward et al. 2015 (Ecological Applications)

* Assume spatial & temporal overlap represents potential risk
* Model data distributions w/covariates
* Identify spatial-temporal overlap
* Quantify risk with an overlap index
* Map high-risk areas

Flow diagram – data to model output



Chinook salmon populations of interest

Six (6) threatened/endangered, two (2) unlisted
(additional groups in Teel et al. 2015, Marine & Coastal Fisheries)

Interior yearlings

* Snake River spring (T)
* Mid/upper Columbia spring (E)
* Snake fall (T)
* Upper Columbia summer/fall

Lower Columbia yearlings

* West Cascade spring (T)
* Willamette spring (T)

Interior subyearlings

* Snake River fall (T)
* Upper Columbia summer/fall

Results – Step 1

1. Potential predators

* 40-45 bird species
* ≥80% of all birds were sooty shearwaters, common murres

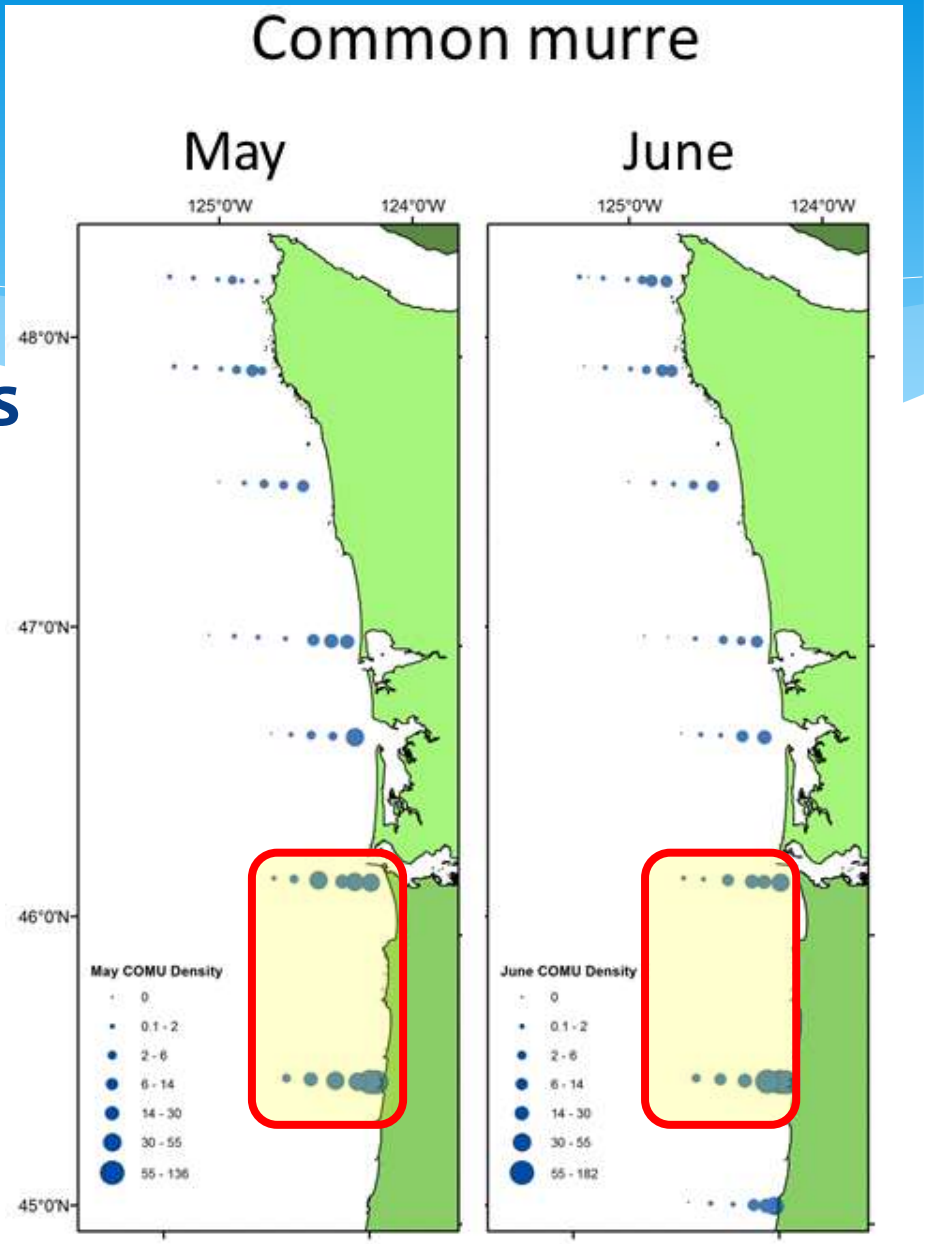
Species	MAY Count	MAY % of grand total	JUNE Count	JUNE % of grand total
Sooty shearwater	8560	41.4%	15972	50.4%
Common murre	7961	38.5%	10322	32.6%
Rhinoceros auklet	453	2.2%	450	1.4%
Western X glaucous-winged hybrid gull	448	2.2%	679	2.1%
Unidentified gull	417	2.0%	207	0.7%
Pink-footed shearwater	327	1.6%	1354	4.3%
Unidentified phalarope	301	1.5%	7	0.0%
Immature gull	298	1.4%	221	0.7%
Sabine's gull	288	1.4%	0	0.0%
Pacific loon	270	1.3%	24	0.1%
Red-necked phalarope	223	1.1%	1	0.0%
Cassin's auklet	192	0.9%	488	1.5%
Western gull	127	0.6%	130	0.4%
Black-footed albatross	72	0.3%	489	1.5%
Northern fulmar	16	0.1%	408	1.3%
Caspian tern	4	<0.1%	259	0.8%
Other species	711	3.4%	684	2.2%
GRAND TOTALS	20668	100.0%	31695	100.0%

Results – Step 2

2. Most abundant predators

Highest mean densities by transect

* Common murres
  * Columbia River
  * Cape Meares

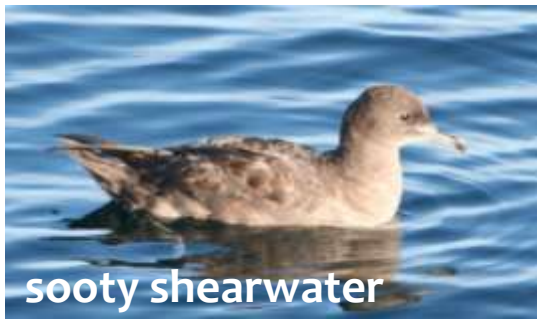


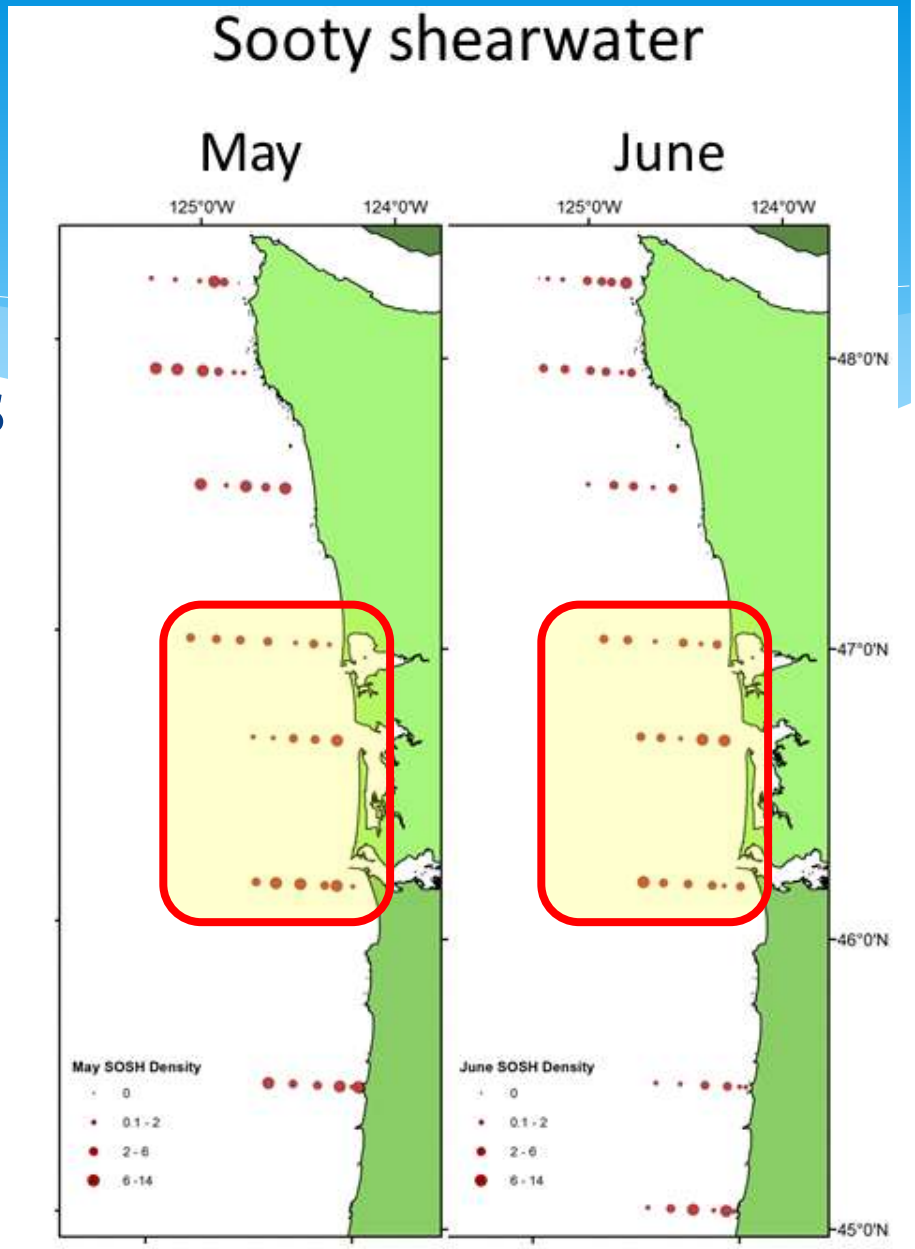
Results – Step 2

2. Most abundant predators

Highest mean densities by transect

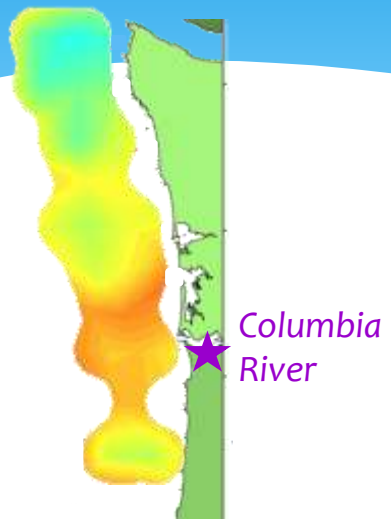
- Sooty shearwaters
  - Columbia River
  - Willapa Bay
  - Grays Harbor





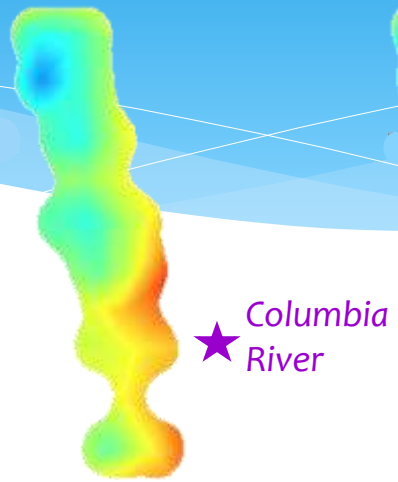
Results – Step 3

Snake spring yearlings

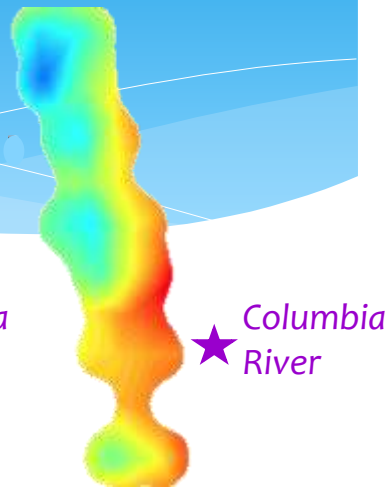


Mid/upper Columbia spring yearlings

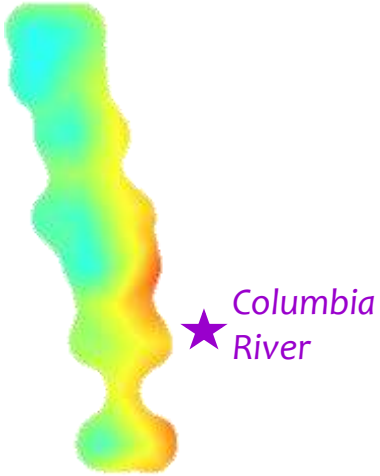
Snake fall yearlings



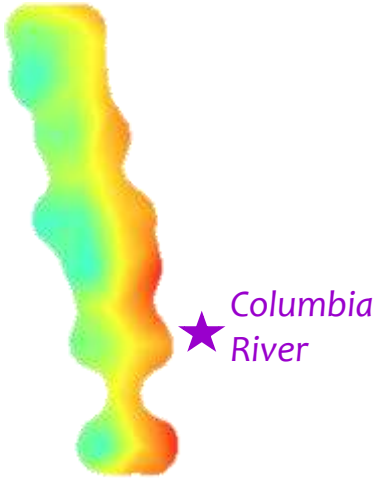
Upper Columbia summer/fall yearlings

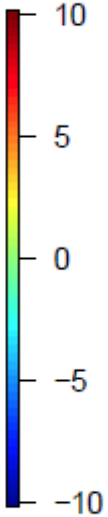


West Cascade spring yearlings



Willamette spring yearlings



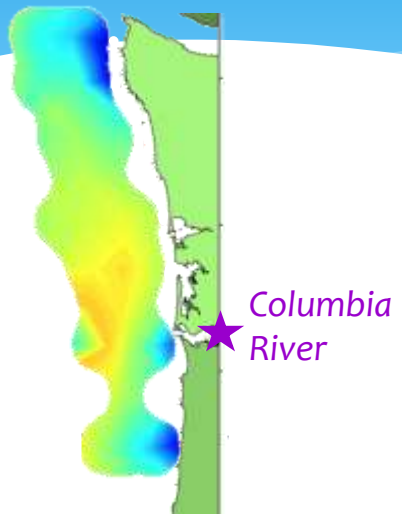


3. Quantify overlap

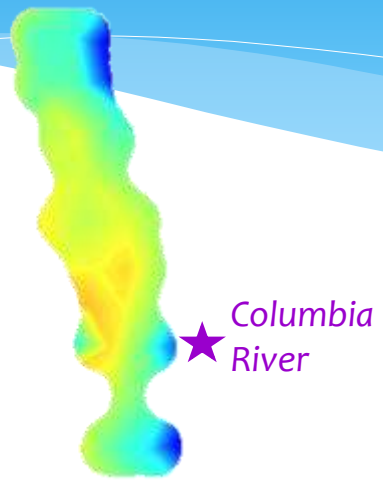
Median overlap index – common murre, May

Results – Step 3

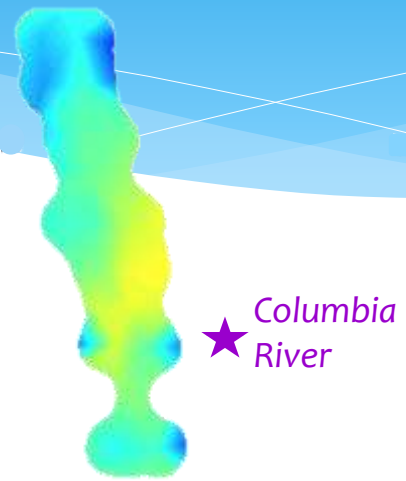
Snake spring yearlings



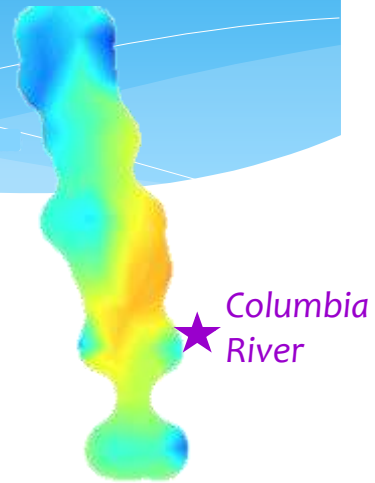
Mid/upper Columbia spring yearlings



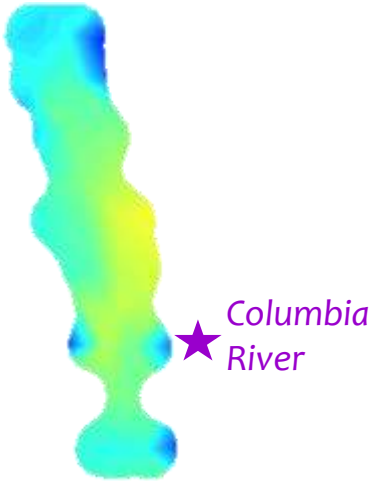
Snake fall yearlings



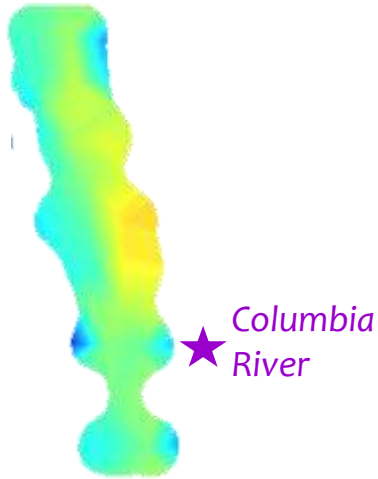
Upper Columbia summer/fall yearlings



West Cascade pring yearlings



Willamette spring yearlings



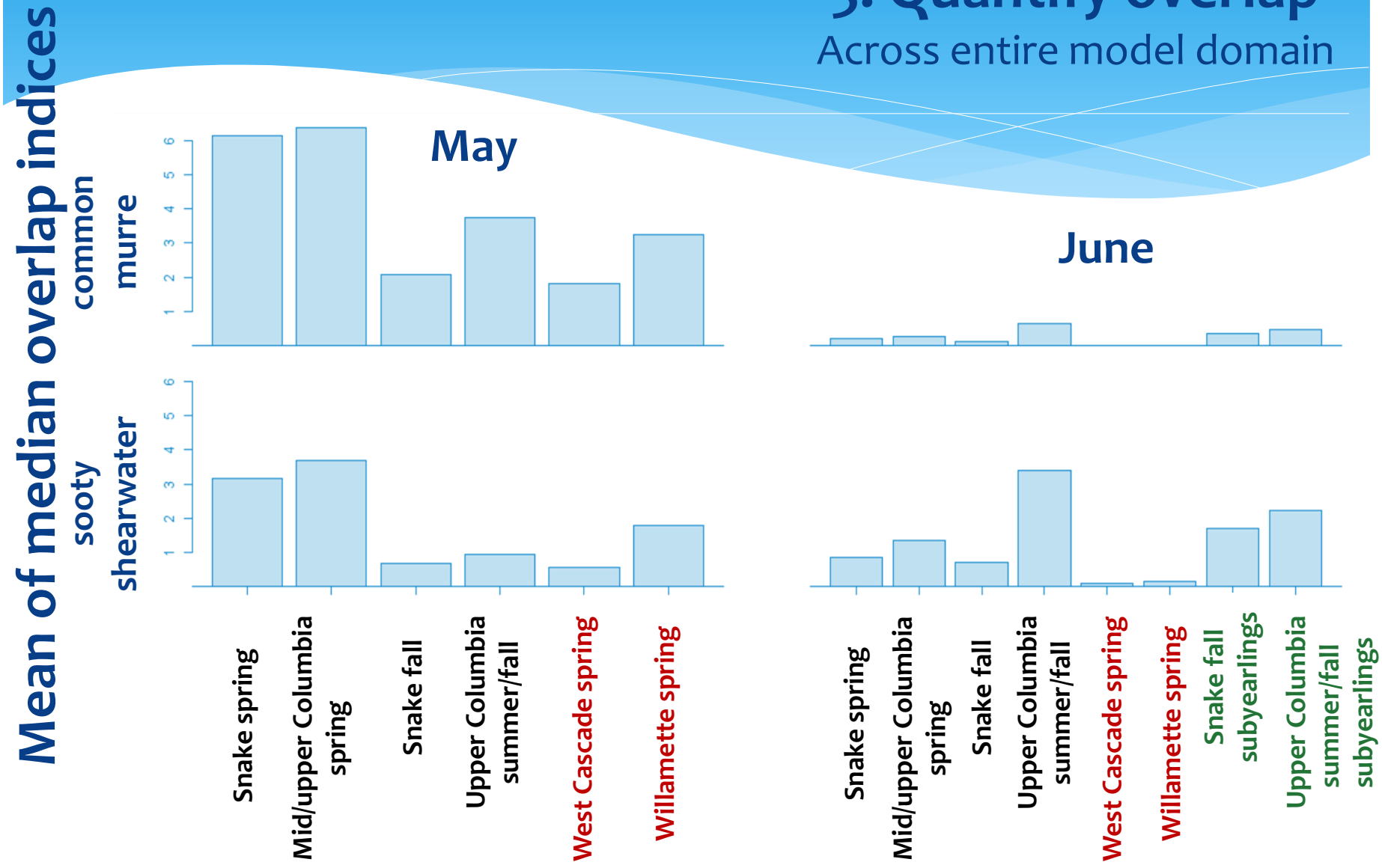
3. Quantify overlap

Median overlap index – sooty shearwater, May

Results – Step 3

3. Quantify overlap

Across entire model domain



Ocean avian predation - three take home messages

* Predation risk differs by salmon ESU/DPS & predator type
* There is *consistently high overlap* in the region between Cape Meares and Grays Harbor
  - Plume area most directly influenced by Columbia River discharge
* When we look for evidence of ocean avian predation (Step 4), the logical place to look is between Cape Meares and Grays Harbor in May

Acknowledgments & thanks

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* ALL heavy lifting for models: Burke & Hunsicker modifying & subduing the "unruly" R-code form Ward et al. 2015

Brian

Mary