California Current Fish Climate Vulnerability Assessment

NW and SW Fisheries Science Centers
NOAA Fisheries

Outline

1. Climate Vulnerability Assessment Background

1. Methods

2. Species-level CVA (FMP and ESA-listed species)

3. Salmonid Evolutionarily-Significant Unit CVA

1. Applications

General Vulnerability Assessments

1. Highly Vulnerable

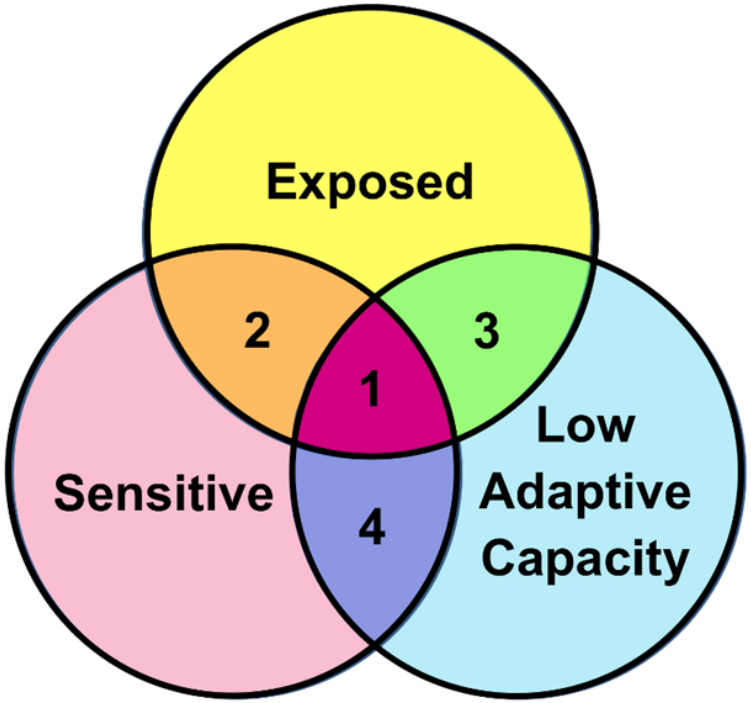
At greatest risk

- Specific research needed
- Interventions generally needed

2. Potential Adapters

May be at risk

- Monitor and support adaptive responses



3. Potential Persisters

May not be at risk

- Monitor population trends

4. High Latent Risk

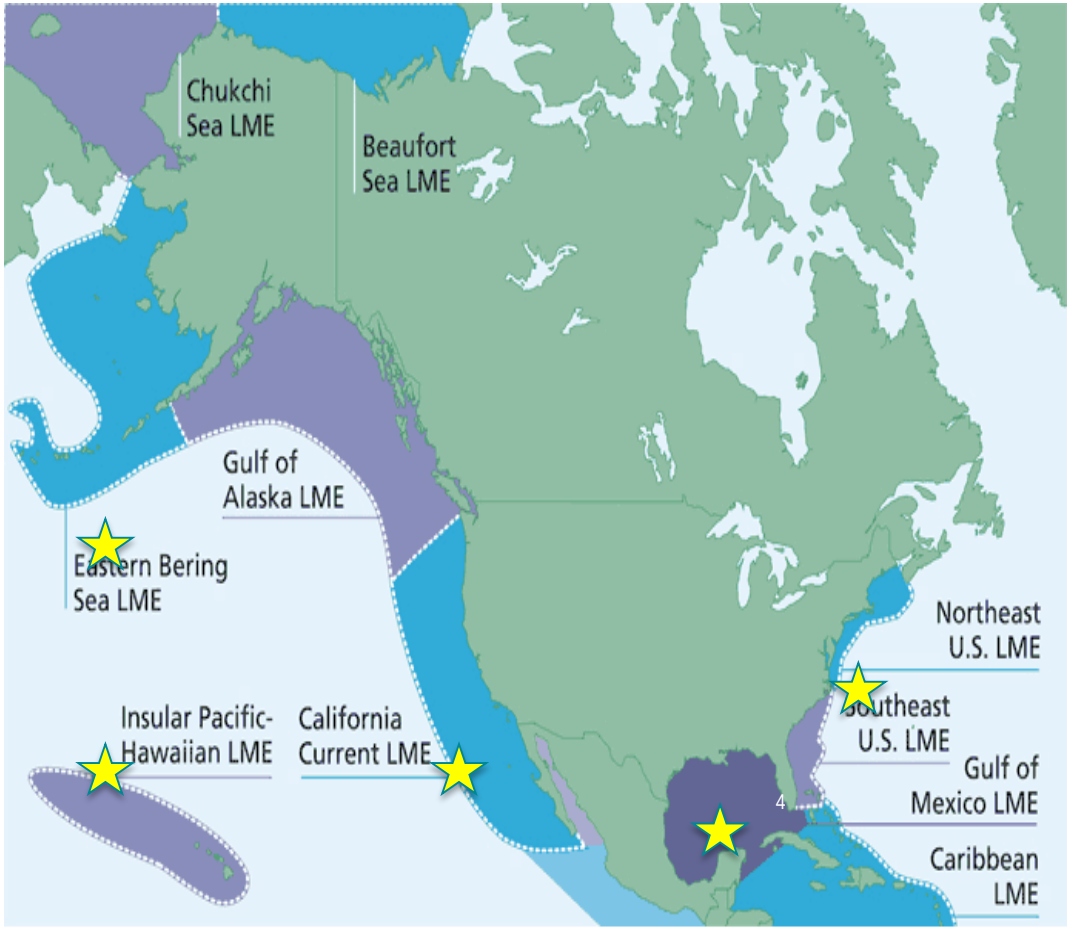
Not currently at risk

- Monitor environment

Foden et al. 2013

NOAA –wide Climate Vulnerability Assessments

1. Complete
   - Northeast
2. In progress
   - Bering Sea
   - California Current
     - Fish
     - Salmon
     - Turtles and mammals
   - South Atlantic
   - Caribbean
   - Gulf of Alaska



Goal and Objectives

Goal:

Assess the vulnerability of FMP and ESA-listed fish species (and subunits) to a changing climate.

Objectives:

1. Provide relative vulnerability rankings across species
2. Identify key attributes/factors and life-stages driving vulnerability
3. Identify key data gaps or information needs
4. Provide input to management options at the regional and Council level
5. Contribute, where appropriate, to life-cycle modeling efforts

Overview

- Expert-opinion based
- Two scales
  - Species-level (divided into functional groups)
  - Salmonid-ESU level
- Steps
  - Compile base information
  - Expert scoring
  - Integration of expert scores
  - Present results

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Vulnerability Assessment Details

Exposure

- Sea surface temperature*
- Air temperature*
- Salinity*
- Ocean acidification (pH)*
- Precipitation*
- Currents**
- Sea level rise**

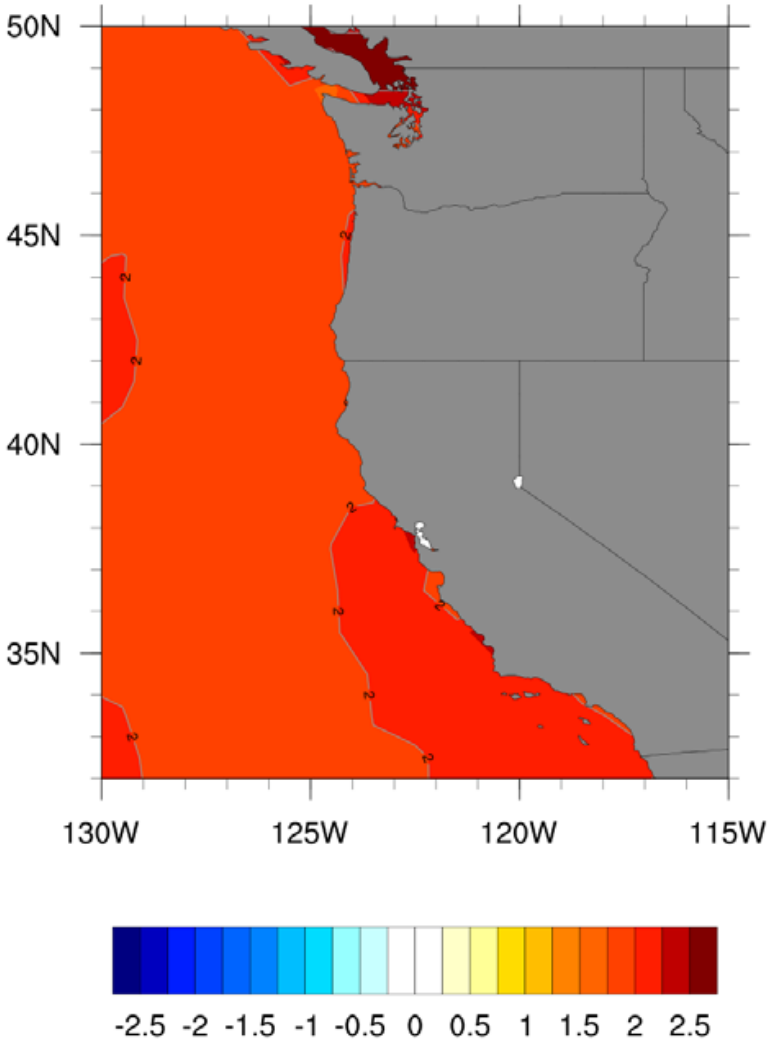
} Quantitative (climate models)

} Qualitative (literature review)

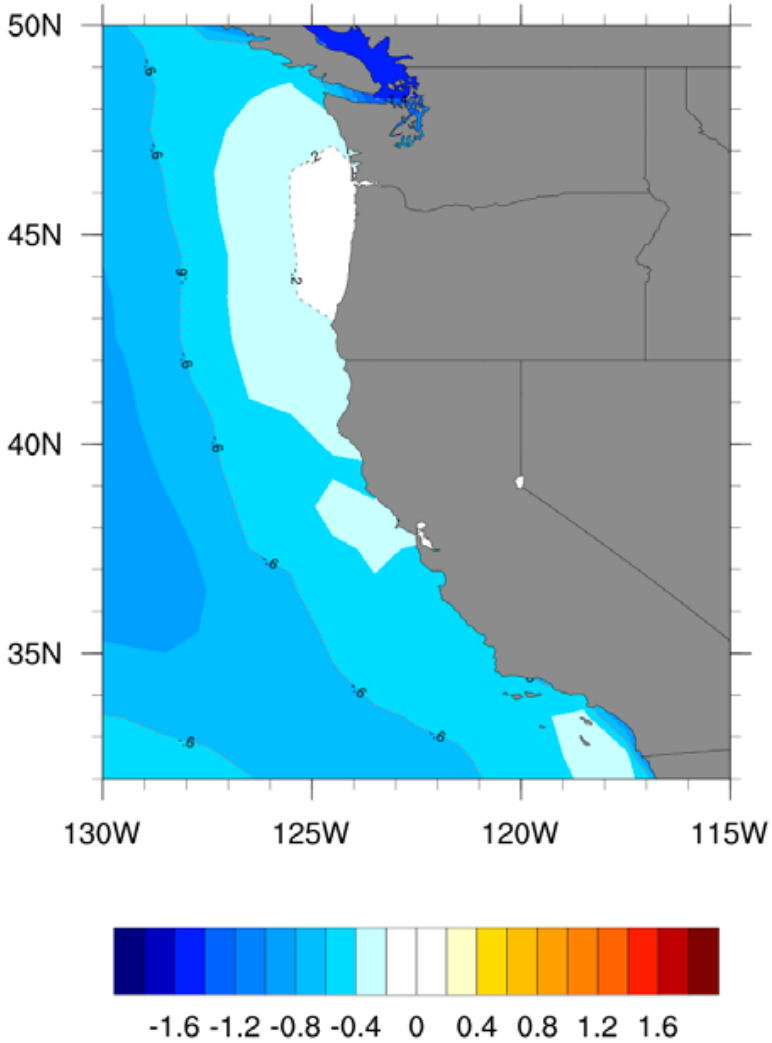
Freshwater habitat-specific temperature and flow } Quantitative (climate models)

**modelled results (mean & variance)*
***written description only*

SST

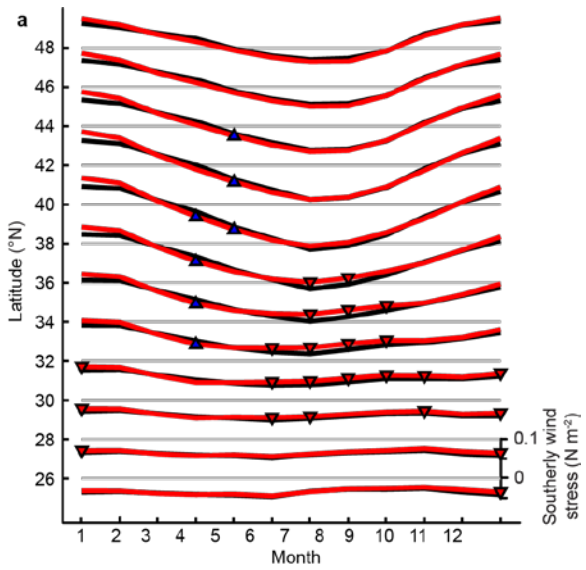


Salinity



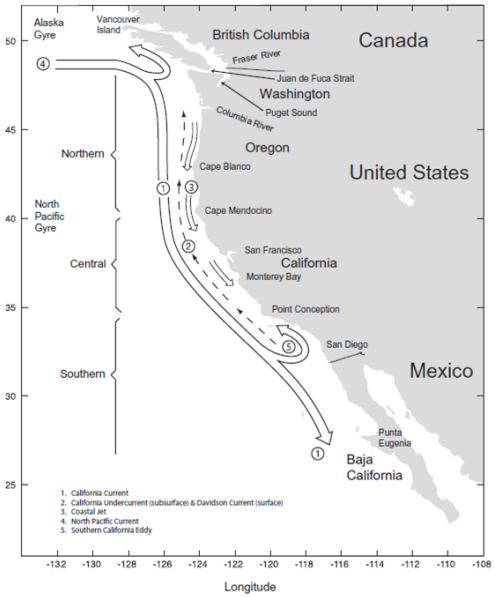
Qualitative Marine Exposure Factors

Phenology of upwelling



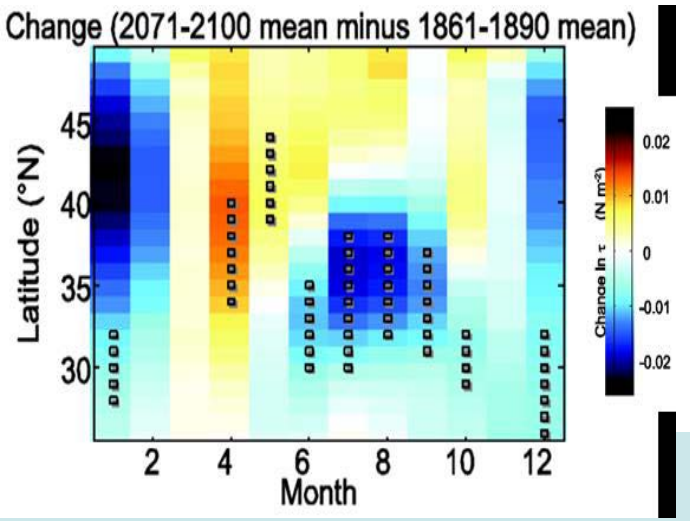
Rykaczewski et al 2015 Figure S5

Ocean currents



Checkley and Barth, 2009

Upwelling-favorable winds



Sea Level Rise

NRC 2012

	2030	2050	2100
South of Cape Mendocino	.04 – .3 meters	.12 – .61 meters	.42 – 1.67 meters
North of Cape Mendocino	-.04 – 23 meters	-.03 – .48 meters	.10 – 1.43 meters

Table 1: Sea level rise projections for the West Coast of the U.S. relative to the year 2000.

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Methodology Framework

Stock Vulnerability

Exposure

- Sea surface temperature
- Sea surface salinity
- Air temperature
- Phenology of Upwelling
- Ocean acidification (pH)
- Precipitation
- Currents
- Sea level rise
- Subsurface Oxygen

Sensitivity

- Habitat Specificity
- Prey Specificity
- Sensitivity to Ocean Acidification
- Sensitivity to Temperature
- Stock Size/Status
- Other Stressors
- Adult Mobility
- Spawning Cycle
- Complexity in Reproductive Strategy
- Early Life History Survival and Settlement Requirements
- Population Growth Rate
- Dispersal of Early Life Stages

Habitat Specificity (Sensitivity)

Scoring Bins:

Low: The stock is a habitat generalist and/or utilizes very common abiotic habitats.

Moderate: The stock strongly prefers a particular habitat.

High: The stock is a specialist on an abundant biological habitat.

Very High: The stock is a specialist on a restricted biological habitat.

5 Point Tally Scoring System

- The scoring for each attribute is done by the experts assigning 5 tallies within the 4 scoring bins
- This gives experts the ability to express uncertainty in their score

Example:

Expert Scores - Low uncertainty scenario			
Low	Moderate	High	Very High
	5		

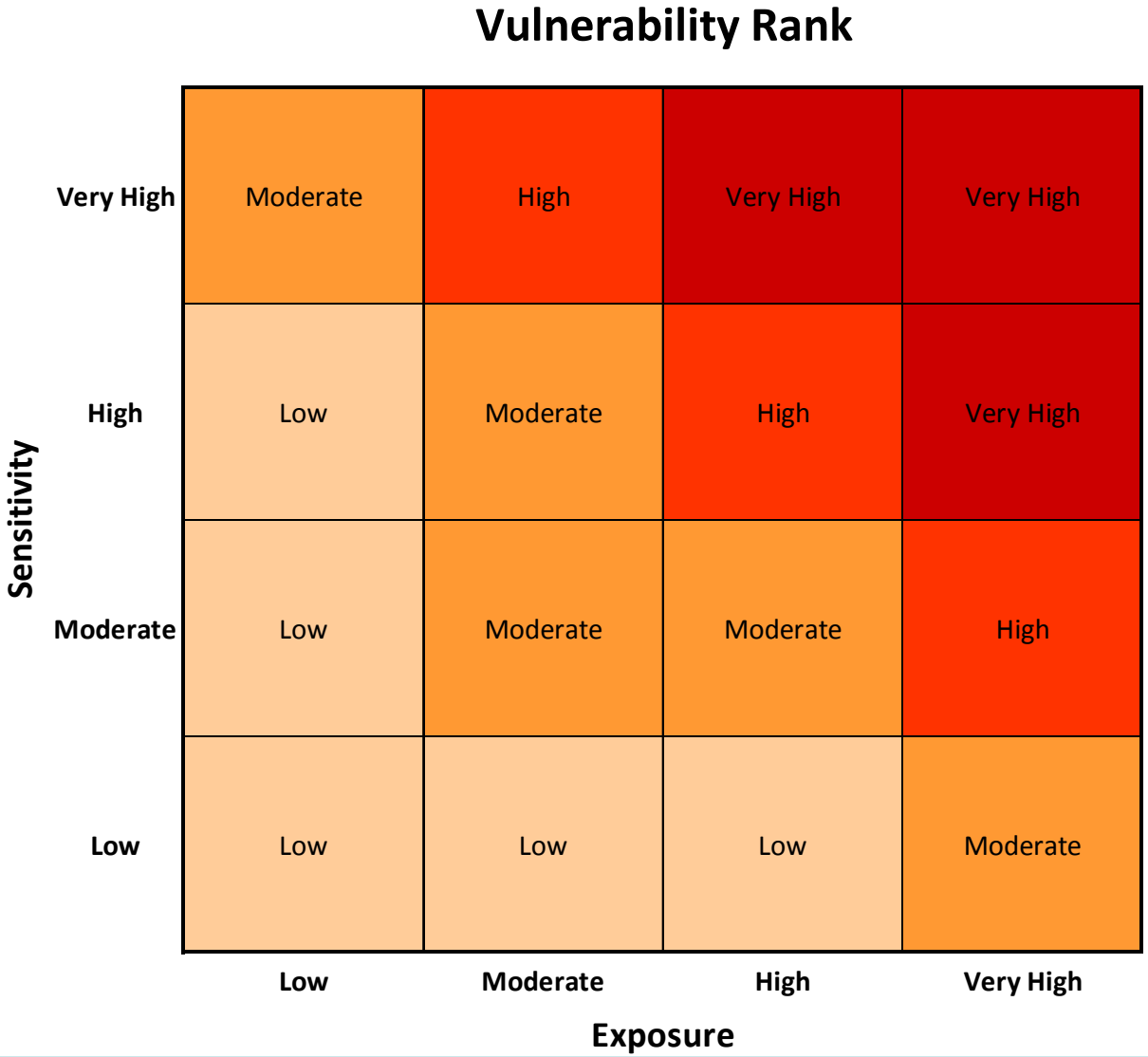
Expert Scores - High uncertainty scenario			
Low	Moderate	High	Very High
1	1	2	1

Logic Rule

Sensitivity - Exposure Component Score = Logic Model

- Very high = 3 or more attribute scores ≥ 3.5
- High = 2 or more attribute scores ≥ 3.0
- Moderate = 2 or more attribute scores ≥ 2.5
- Low = less than 2 attributes scores ≥ 2.5

Vulnerability Scoring Rubric



Experts also scored

- Data quality
- Likelihood of distributional change
- Likelihood that net climate effects would be positive, neutral or negative

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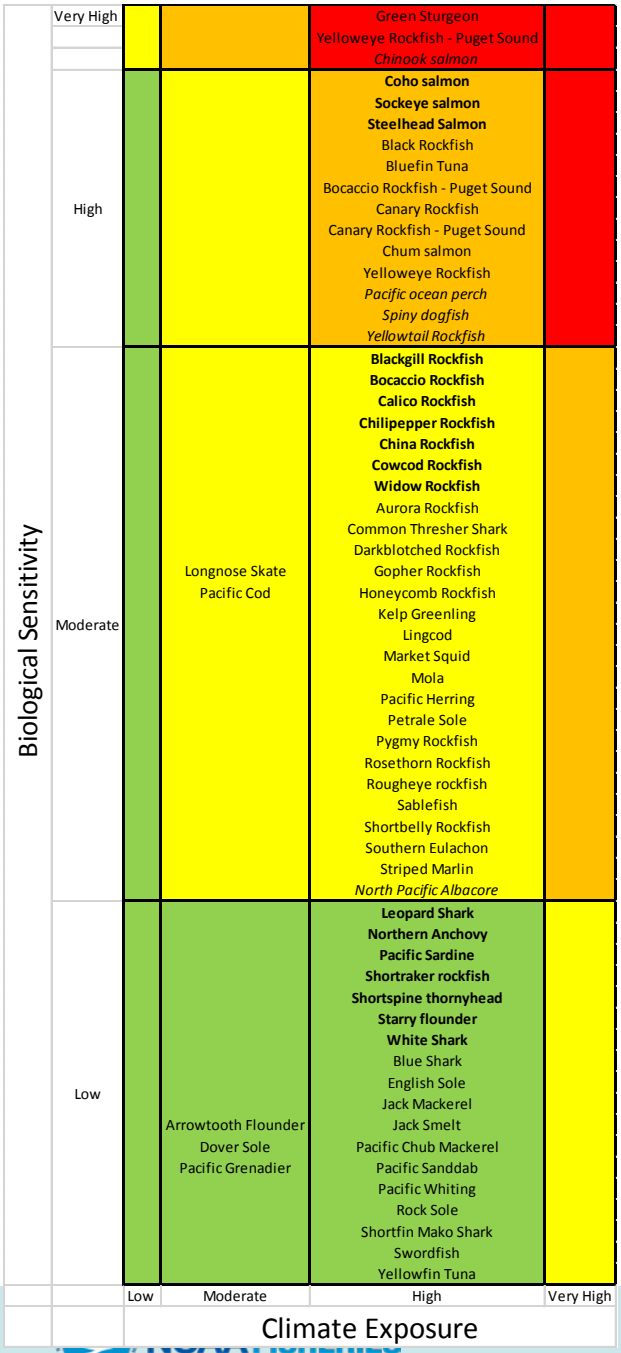
Species-Level CVA Results

Biological Sensitivity	Climate Exposure: Low	Climate Exposure: Moderate	Climate Exposure: High	Climate Exposure: Very High
Very High			1 salmon 1 Other anadramous 1 Puget Sound rockfish	
			2 Puget Sound rockfish 5 Rockfish 1 HMS 4 salmon 1 Elasmobranch	
Moderate		1 Elasmobranch 1 Other Groundfish	15 Rockfish 4 HMS 3 Other groundfish 1 Other anadramous 2 CPS 1 Flatfish	
Low		2 Flatfish 1 Other Groundfish	5 HMS 4 flatfish 5 CPS 2 Other groundfish 1 Elasmobranch 1 Rockfish	

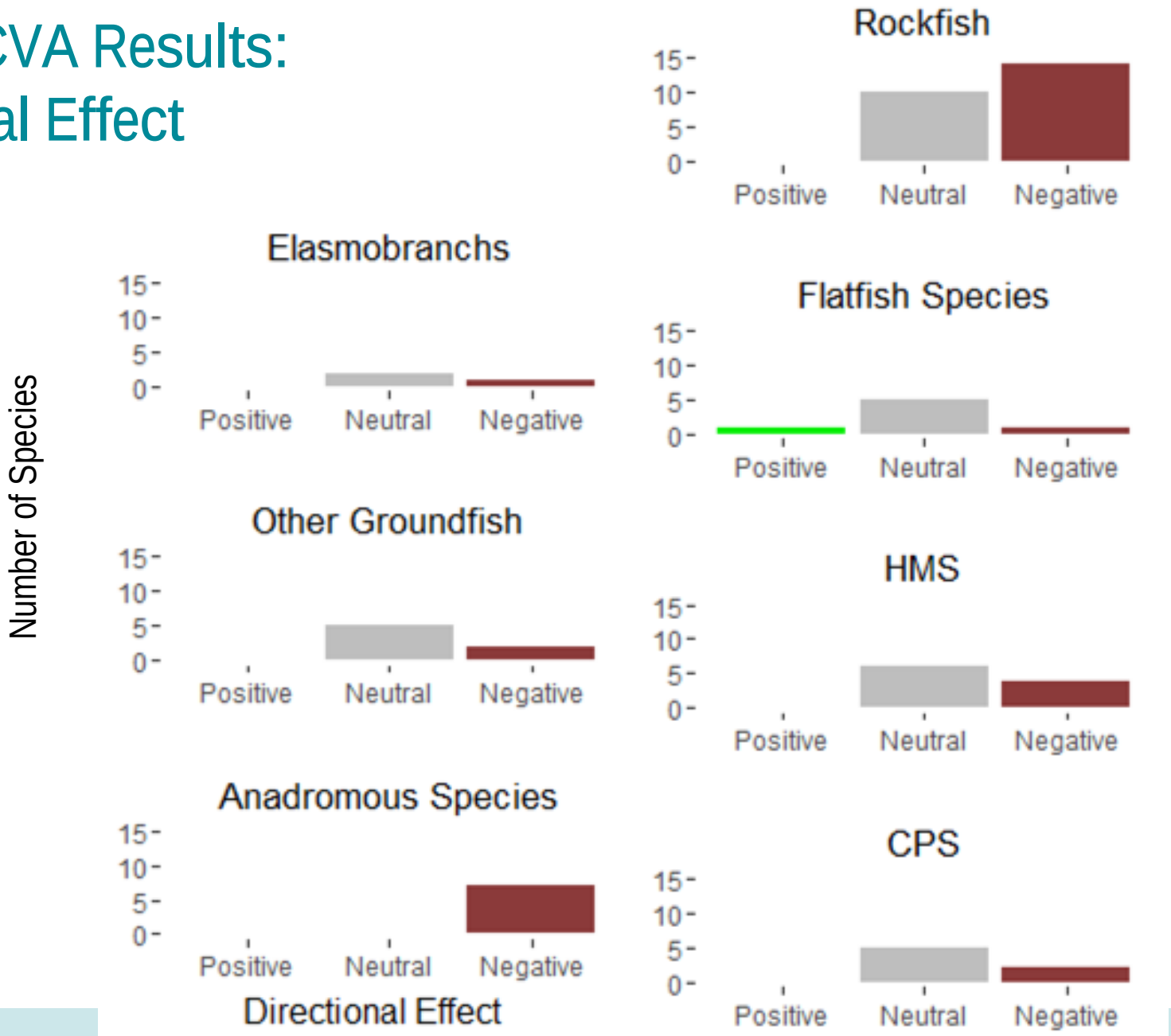
General CVA Results: Logic Rule Ranks



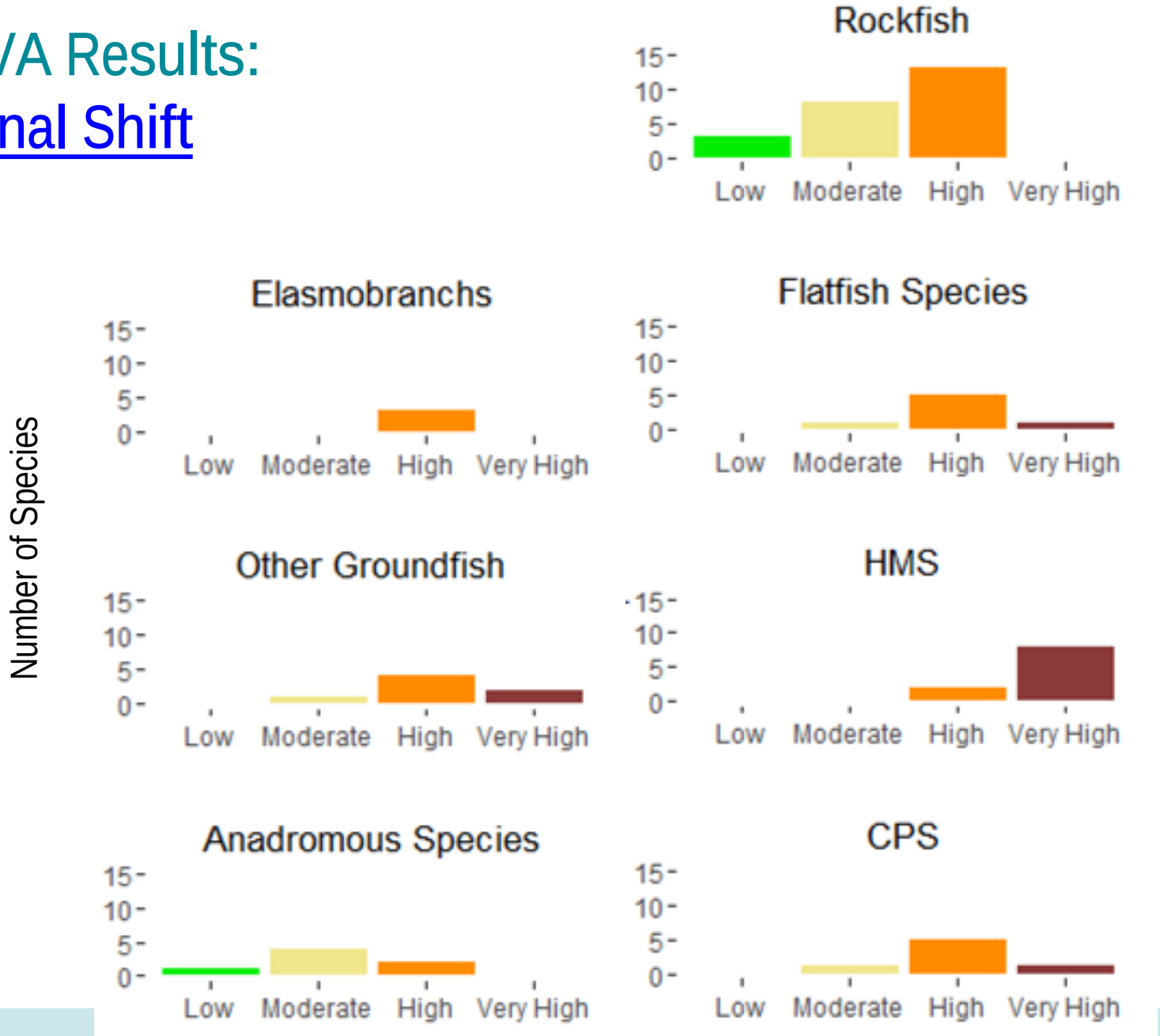
Green Sturgeon
Yelloweye Rockfish - Puget Sound
Chinook salmon

Coho salmon
Sockeye salmon
Steelhead Salmon
Black Rockfish
Bluefin Tuna
Bocaccio Rockfish - Puget Sound
Canary Rockfish
Canary Rockfish - Puget Sound
Chum salmon
Yelloweye Rockfish
Pacific ocean perch
Spiny dogfish
Yellowtail Rockfish

General CVA Results: Directional Effect



General CVA Results:
Distributional Shift



CC General CVA Summary of Results

- The most vulnerable species groups are dominated by anadromous or rockfish species
- The least vulnerable species groups are dominated by HMS, CPS, and groundfish (excluding rockfish)
- Reproductive strategy and related attributes drove variation in sensitivity scores
- Changes in air temp and precipitation drove variation in exposure
- Anadromous species are not likely to change distributions, while CPS and HMS are likely to change distributions
- Climate change impacts are expected to be overwhelmingly negative or neutral

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Salmon-specific climate vulnerability assessment

Salmon recovery domains

Salmon-specific Sensitivity Attributes

Life-stages

- Egg
- Juvenile: freshwater, estuary, marine
- Adult

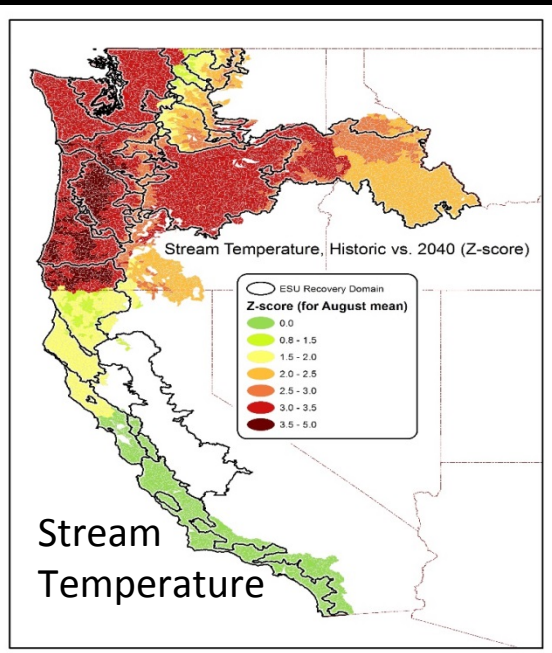
Population status:

- Viable salmon population criteria

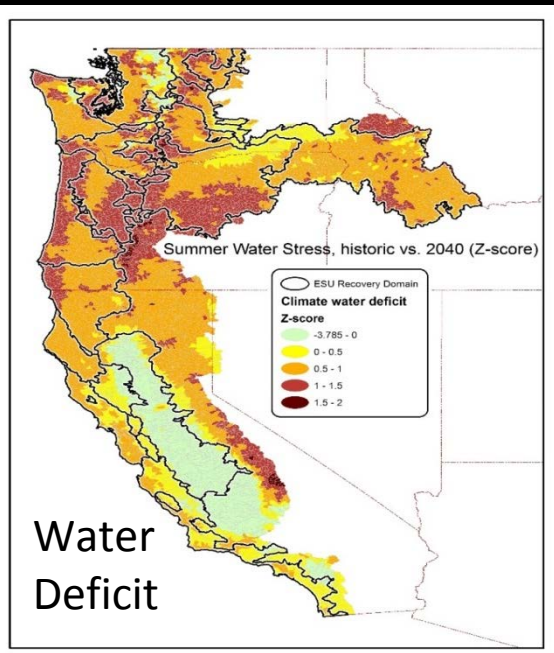
Threats

- Cumulative life cycle effects
- Hatchery impact
- Other Stressors

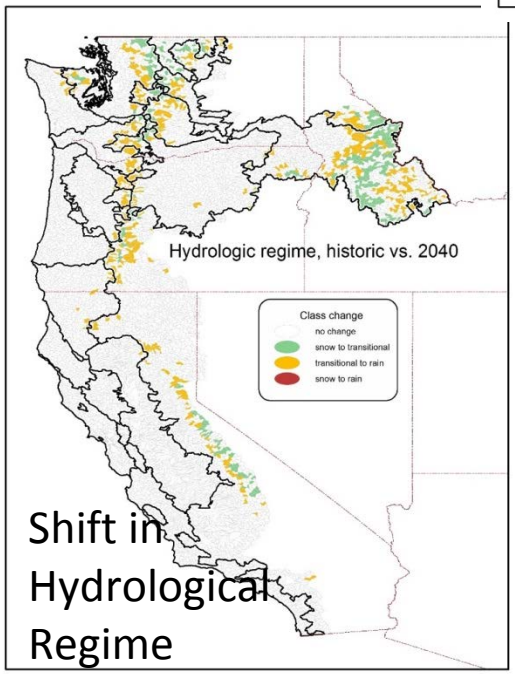
Freshwater exposure factors



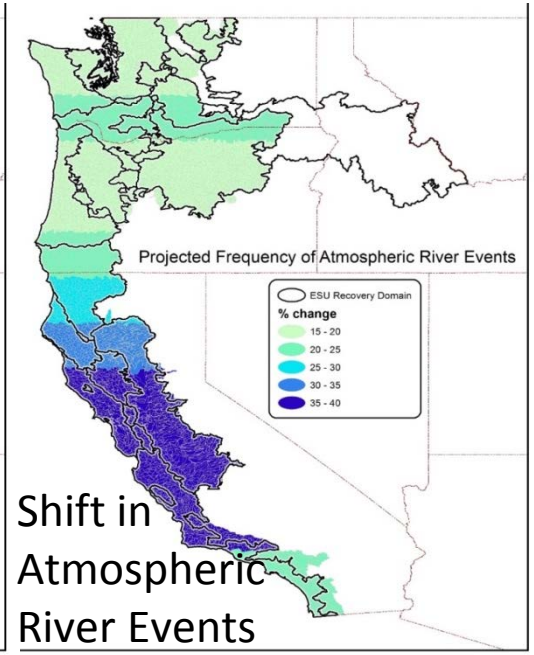
Stream Temperature



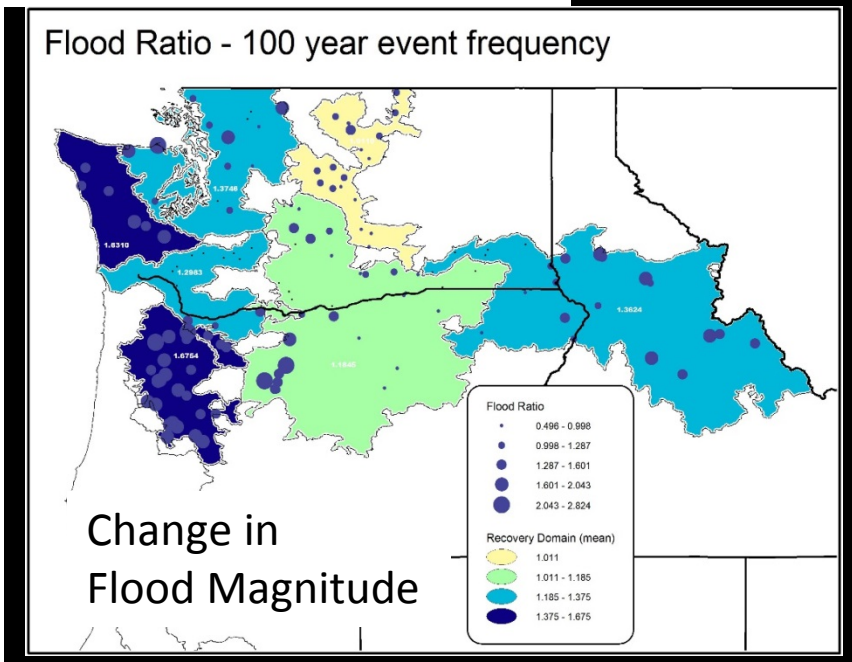
Water Deficit



Shift in Hydrological Regime

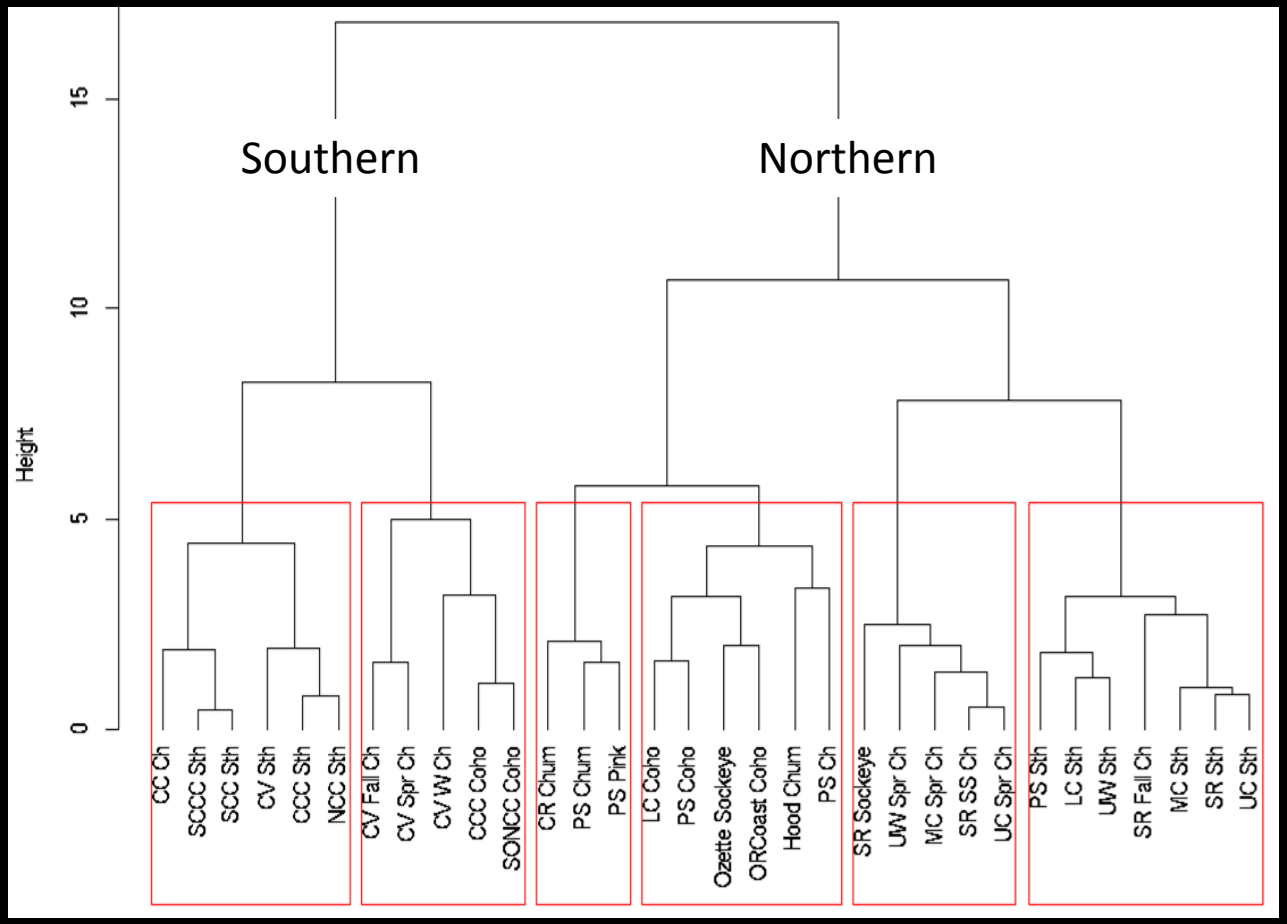


Shift in Atmospheric River Events



Change in Flood Magnitude

Cluster analysis of all attributes



California steelhead

California Chinook and Coho

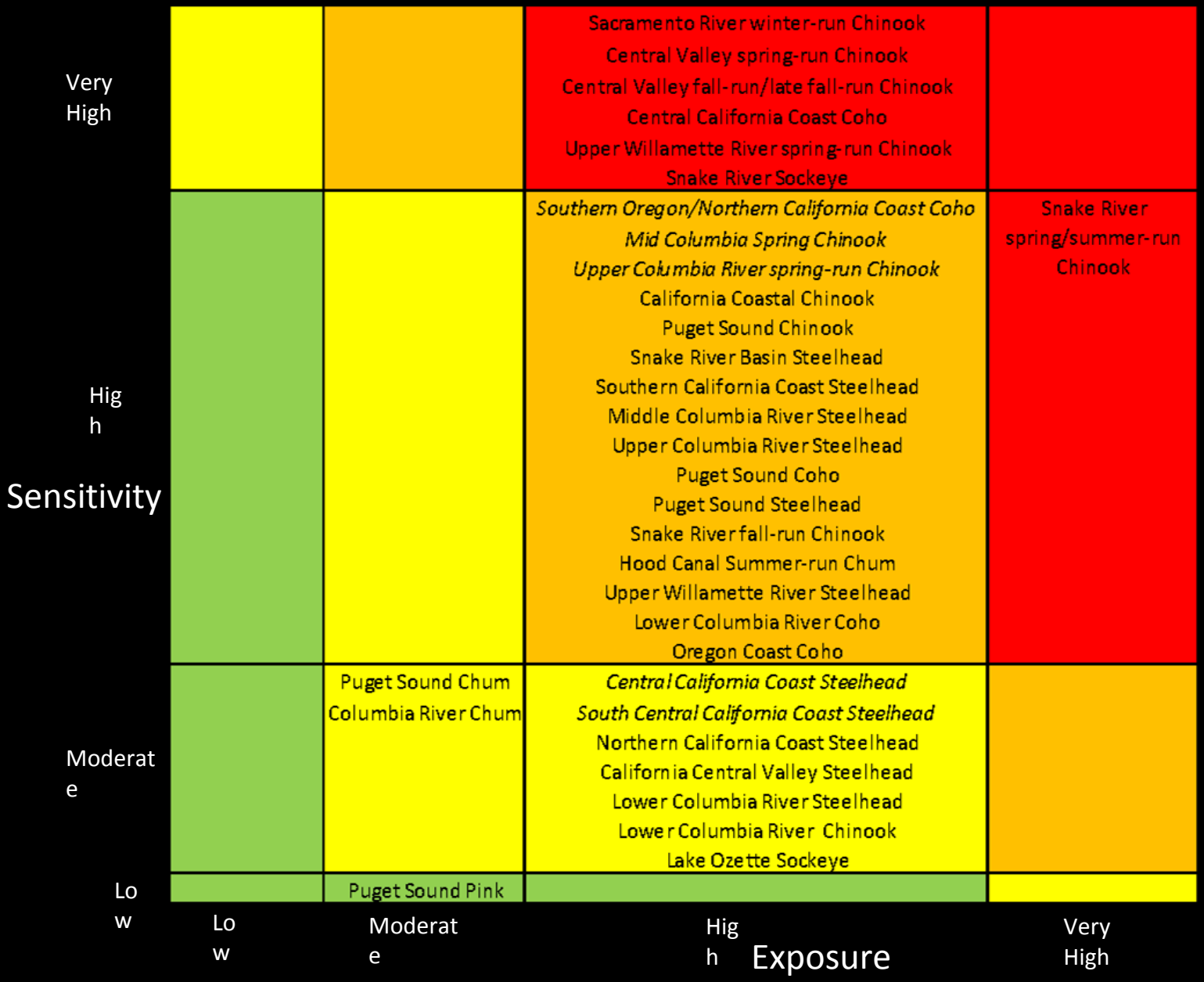
Pink and Chum

Western OR/WA

Interior Chinook Sockeye

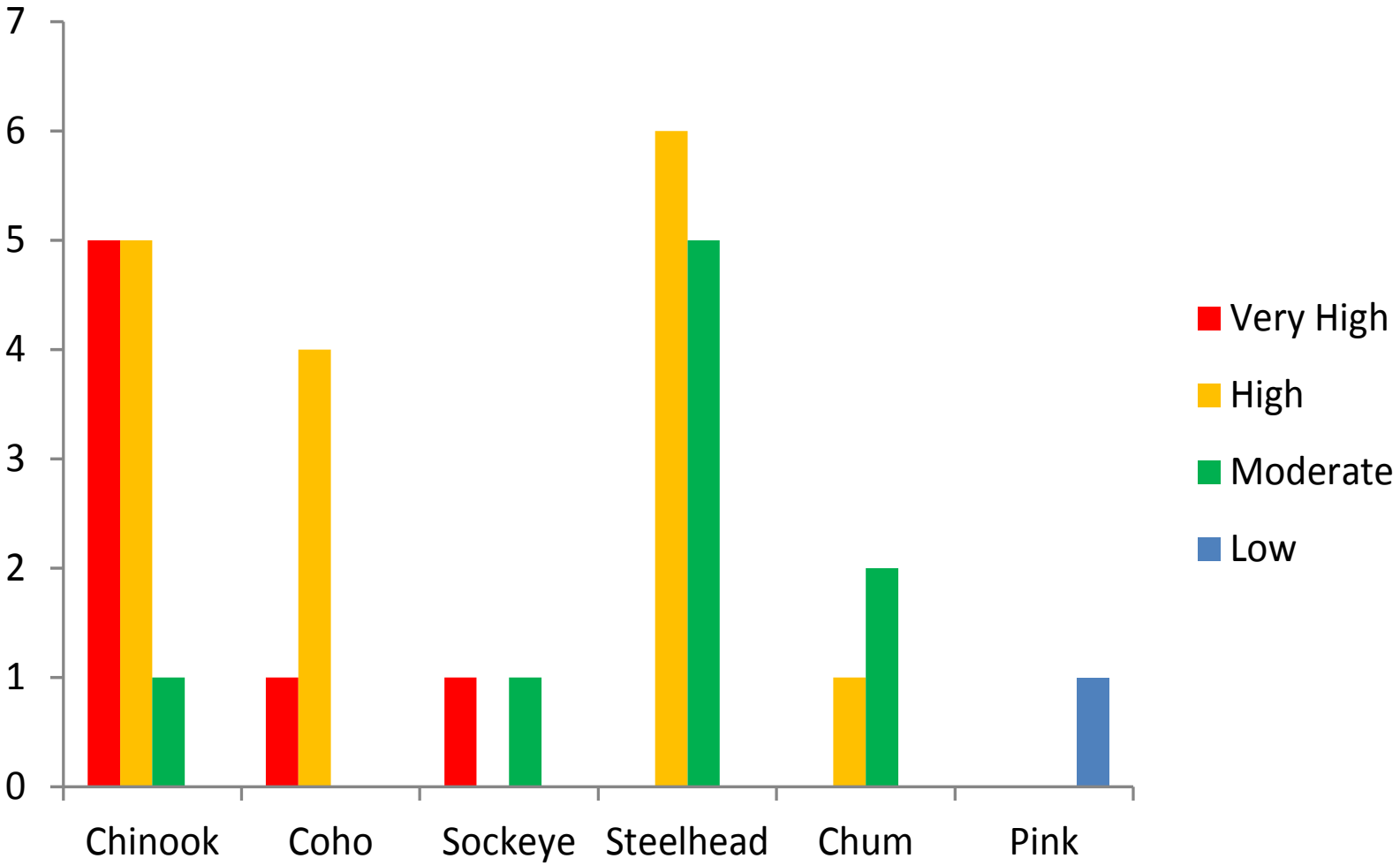
Northern steelhead

Results I: Final Vulnerability Ranking



Central Valley Chinook
Southern coho
Spring Chinook
Interior sockeye

Spread of vulnerability within each species



Hotspots:
High sensitivity and high exposure in the same life stage

	Adult	Juvenile	Egg	Estuary	Marine
Exposure:	*Stream Temperature*	*Regime Shift/Tstream (*both)*	*Flooding*	*Sea Level Rise*	*Upwelling*
	Snake River spring/summer-run Chinook	Snake River spring/summer-run Chinook*	Sacramento River winter-run Chinook	Central Valley fall-run/late fall-run Chinook	Central Valley fall-run/late fall-run Chinook
	Mid Columbia Spring Chinook	Mid Columbia Spring Chinook*		Central Valley spring-run Chinook	
	Snake River Sockeye	Upper Columbia River spring-run Chinook		Sacramento River winter-run Chinook	
	Upper Willamette River spring-run Chinook	Southern Oregon/Northern California Coast Coho			
Key:	Interior Columbia		Central Valley		

Wrap up

- Products:
  - 2 manuscripts in prep;
  - Species narratives and vulnerability scores
- Management Uses
  - Prioritizing actions (match to key life stages or exposures, etc.)
  - Informing decisions about precautionary approaches
  - Not a quantitative tool
- Science Uses
  - Identify stocks that should be highest priority for incorporating environmental parameters into assessments and life cycle models
  - Identify priority monitoring
  - Fishing or other human community vulnerability assessments

A true group effort

- 52 Narrative and Profile Authors
  - NWFSC
  - SWFSC
  - UW
- 16 Scorers
  - NMFS
    - Bograd, Boughton, Crozier, DeWar, Haltuch, Hazen, Huff, Jordan, Mantua, McClure, Nelson
  - Mark Carr – UC Santa Cruz
  - Ryan Ryckaczewski – U. S. Carolina
  - Jason Dunham – USFS
  - Peter Moyle – UC Davis

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Questions?