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California Current Climate Vulnerability Assessment

Marine Fisheries Advisory Committee

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Methodology Framework

Stock Vulnerability

General Assessment: 65 Species
Salmon Assessment: 33 ESUs

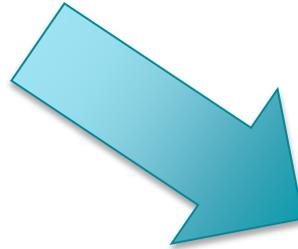
Exposure

- 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

General CVA Preliminary Results



Biological Sensitivity	Very High		Green Sturgeon Yelloweye Rockfish - Puget Sound <i>Chinook salmon</i>	
	High		Coho salmon Sockeye salmon Steelhead Salmon Black Rockfish Bluefin Tuna Bocaccio Rockfish - Puget Sound Canary Rockfish Canary Rockfish - Puget Sound Chum salmon Yelloweye Rockfish <i>Pacific ocean perch</i> <i>Spiny dogfish</i> <i>Yellowtail Rockfish</i>	
	Moderate	Longnose Skate Pacific Cod	Blackgill Rockfish Bocaccio Rockfish Calico Rockfish Chillipepper Rockfish China Rockfish Cowcod Rockfish Widow Rockfish Aurora Rockfish Common Thresher Shark Darkblotched Rockfish Gopher Rockfish Honeycomb Rockfish Kelp Greenling Lingcod Market Squid Mola Pacific Herring Petrale Sole Pygmy Rockfish Rosethorn Rockfish Rougheye rockfish Sablefish Shortbelly Rockfish Southern Eulachon Striped Marlin <i>North Pacific Albacore</i>	
Low	Arrowtooth Flounder Dover Sole Pacific Grenadier	Leopard Shark Northern Anchovy Pacific Sardine Shortraker rockfish Shortspine thornyhead Starry flounder White Shark Blue Shark English Sole Jack Mackerel Jack Smelt Pacific Chub Mackerel Pacific Sanddab Pacific Whiting Rock Sole Shortfin Mako Shark Swordfish Yellowfin Tuna		
	Low	Moderate	High	Very High
Climate Exposure				

<p>Green Sturgeon Yelloweye Rockfish - Puget Sound <i>Chinook salmon</i></p>
<p>Coho salmon Sockeye salmon Steelhead Salmon Black Rockfish Bluefin Tuna Bocaccio Rockfish - Puget Sound Canary Rockfish Canary Rockfish - Puget Sound Chum salmon Yelloweye Rockfish <i>Pacific ocean perch</i> <i>Spiny dogfish</i> <i>Yellowtail Rockfish</i></p>

General CVA Preliminary Results

Number of Species

Climate Vulnerability

Rockfish



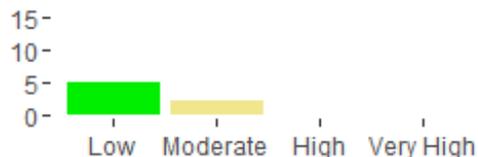
Flatfish Species



HMS



CPS

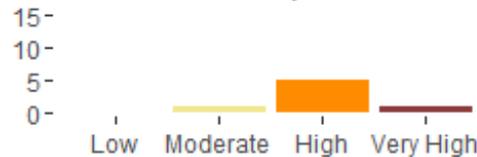


Distributional Change

Rockfish



Flatfish Species



HMS

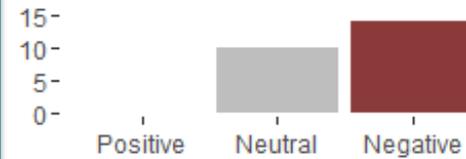


CPS

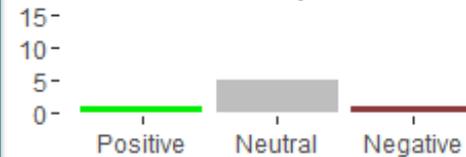


Directional Effect

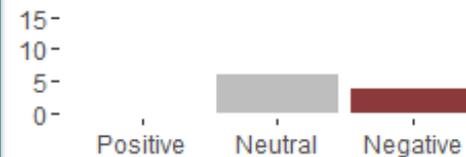
Rockfish



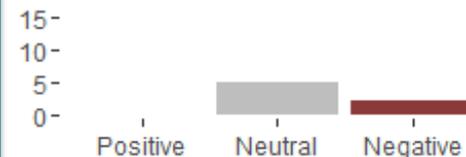
Flatfish Species



HMS



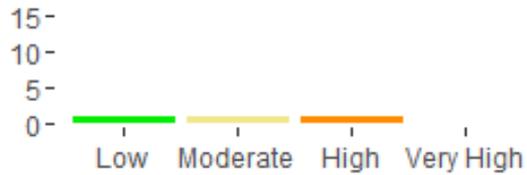
CPS



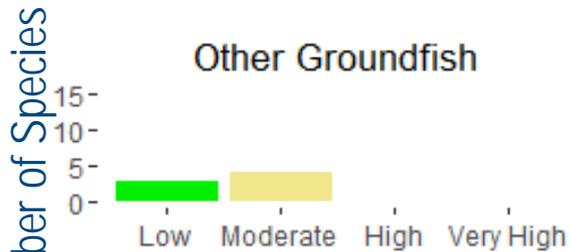
General CVA Preliminary Results

Climate Vulnerability

Elasmobranchs



Other Groundfish

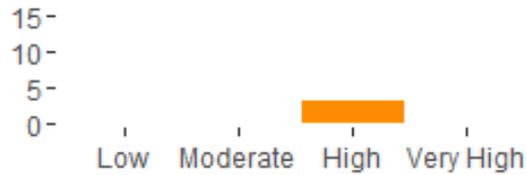


Anadromous Species

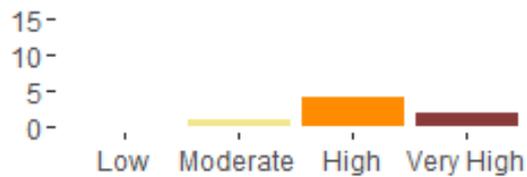


Distributional Change

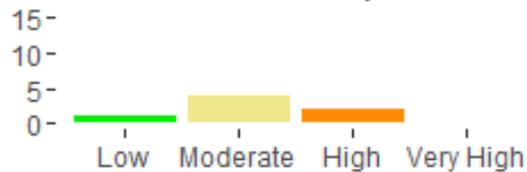
Elasmobranchs



Other Groundfish

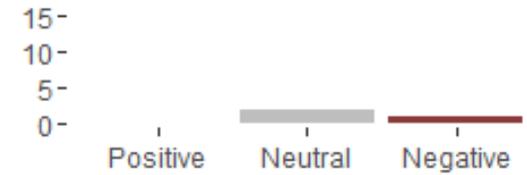


Anadromous Species

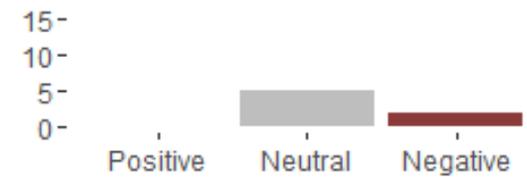


Directional Effect

Elasmobranchs



Other Groundfish



Anadromous Species



CC General CVA Preliminary Summary

- Results show a gradient from marine to anadromous species, with anadromous species having greater climate vulnerability
- Results show a gradient from benthic to pelagic species, with benthic species having greater climate vulnerability.
- Anadromous species are not likely to adapt to climate change by changing distributions, while CPS and HMS are likely to adapt by changing distributions
- The impacts of climate change on CC species are expected to be overwhelmingly neutral to negative, with little positive impacts on species included in this CVA.

CC Salmon CVA Preliminary Results

Sensitivity	Very High			Sacramento River winter-run Chinook Central Valley spring-run Chinook Central Valley fall-run/late fall-run Chinook Central California Coast Coho Upper Willamette River spring-run Chinook Snake River Sockeye	
	High			Southern Oregon/Northern California Coast Coho Upper Columbia River spring-run Chinook California Coastal Chinook Mid Columbia Spring Chinook Puget Sound Chinook Snake River Basin Steelhead Southern California Coast Steelhead Middle Columbia River Steelhead Upper Columbia River Steelhead Puget Sound Coho Puget Sound Steelhead Snake River fall-run Chinook Hood Canal Summer-run Chum Upper Willamette River Steelhead Lower Columbia River Coho Oregon Coast Coho	Snake River spring/summer-run Chinook
	Moderate		Puget Sound Chum Columbia River Chum	Central California Coast Steelhead South Central California Coast Steelhead Northern California Coast Steelhead California Central Valley Steelhead Lower Columbia River Steelhead Lower Columbia River Chinook Lake Ozette Sockeye	
	Low		Puget Sound Pink		
		Low	Moderate	High	Very High
		Exposure			

CC Salmon CVA Preliminary Results

<p>Sacramento River winter-run Chinook Central Valley spring-run Chinook Central Valley fall-run/late fall-run Chinook Central California Coast Coho Upper Willamette River spring-run Chinook Snake River Sockeye</p>	
<p>Southern Oregon/Northern California Coast Coho Upper Columbia River spring-run Chinook California Coastal Chinook Mid Columbia Spring Chinook Puget Sound Chinook Snake River Basin Steelhead Southern California Coast Steelhead Middle Columbia River Steelhead Upper Columbia River Steelhead Puget Sound Coho Puget Sound Steelhead Snake River fall-run Chinook Hood Canal Summer-run Chum Upper Willamette River Steelhead Lower Columbia River Coho Oregon Coast Coho</p>	<p>Snake River spring/summer-run Chinook</p>

Status of CC CVA

Status:

Scoring complete

Draft of journal articles targeted for
Fall 2016

At least two papers:

- General assessment
- Salmon specific assessment

Climate Vulnerability Assessment Process

1. Scoping and Planning
 - Define scope (area, stocks, exposure factors)
 - Identify and task leaders, staff, and experts
 - Identify task leaders, staff, and experts
2. Assessment Preparation
 - Species profiles
 - Climate projections
 - Species distributions
3. Scoring
 - Train experts (webinar)
 - Preliminary round scoring (individual)
 - Final round scoring (workshop)
4. Results
 - Tables and figures
 - Sensitivity analysis
 - Final reports
 - Species vulnerability narratives
5. Communication
 - Engage with stakeholders
 - Communicate results:
 - Vulnerability ranks
 - Climate drivers
 - Data gaps
 - Promote use/application



Salmon-specific profile questions

Salmon-specific Sensitivity Attributes

Re-worded to reduce ambiguity for salmon life cycle and closer link to management options

Life-stages

Egg

Juvenile: freshwater, estuary, marine

Adult

Population status: ESA Listing criteria

Threats

Cumulative life cycle effects

Hatchery impact

Other Stressors

Ocean acidification



Exposure attributes

Freshwater

Stream temperature

Stream flow:

Flooding risk

Change in snow/rain mix

Water deficit

Marine

Sea level rise

Sea surface temperature

Currents

Upwelling

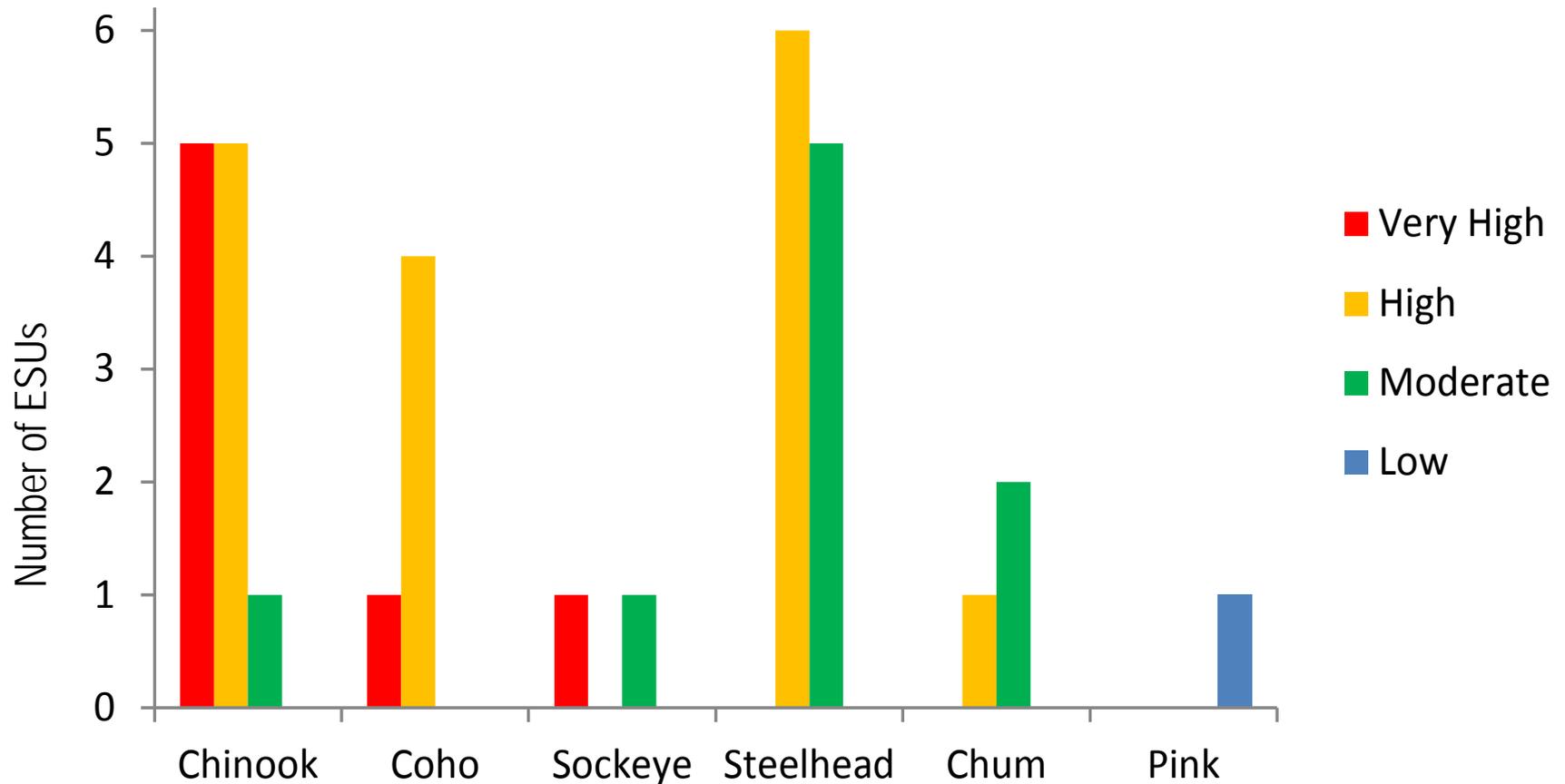
Ocean acidification



Results: Final Vulnerability Ranking

Sensitivity	Very High		<p>Sacramento River winter-run Chinook Central Valley spring-run Chinook Central Valley fall-run/late fall-run Chinook Central California Coast Coho Upper Willamette River spring-run Chinook Snake River Sockeye</p>	
	High		<p><i>Southern Oregon/Northern California Coast Coho</i> <i>Mid Columbia Spring Chinook</i> <i>Upper Columbia River spring-run Chinook</i> California Coastal Chinook Puget Sound Chinook Snake River Basin Steelhead Southern California Coast Steelhead Middle Columbia River Steelhead Upper Columbia River Steelhead Puget Sound Coho Puget Sound Steelhead Snake River fall-run Chinook Hood Canal Summer-run Chum Upper Willamette River Steelhead Lower Columbia River Coho Oregon Coast Coho</p>	<p>Snake River spring/summer-run Chinook</p>
	Moderate	<p>Puget Sound Chum Columbia River Chum</p>	<p><i>Central California Coast Steelhead</i> <i>South Central California Coast Steelhead</i> Northern California Coast Steelhead California Central Valley Steelhead Lower Columbia River Steelhead Lower Columbia River Chinook Lake Ozette Sockeye</p>	
	Low	<p>Puget Sound Pink</p>		
		Exposure		

Spread of ESUs within each species



Prioritization of life stage risk

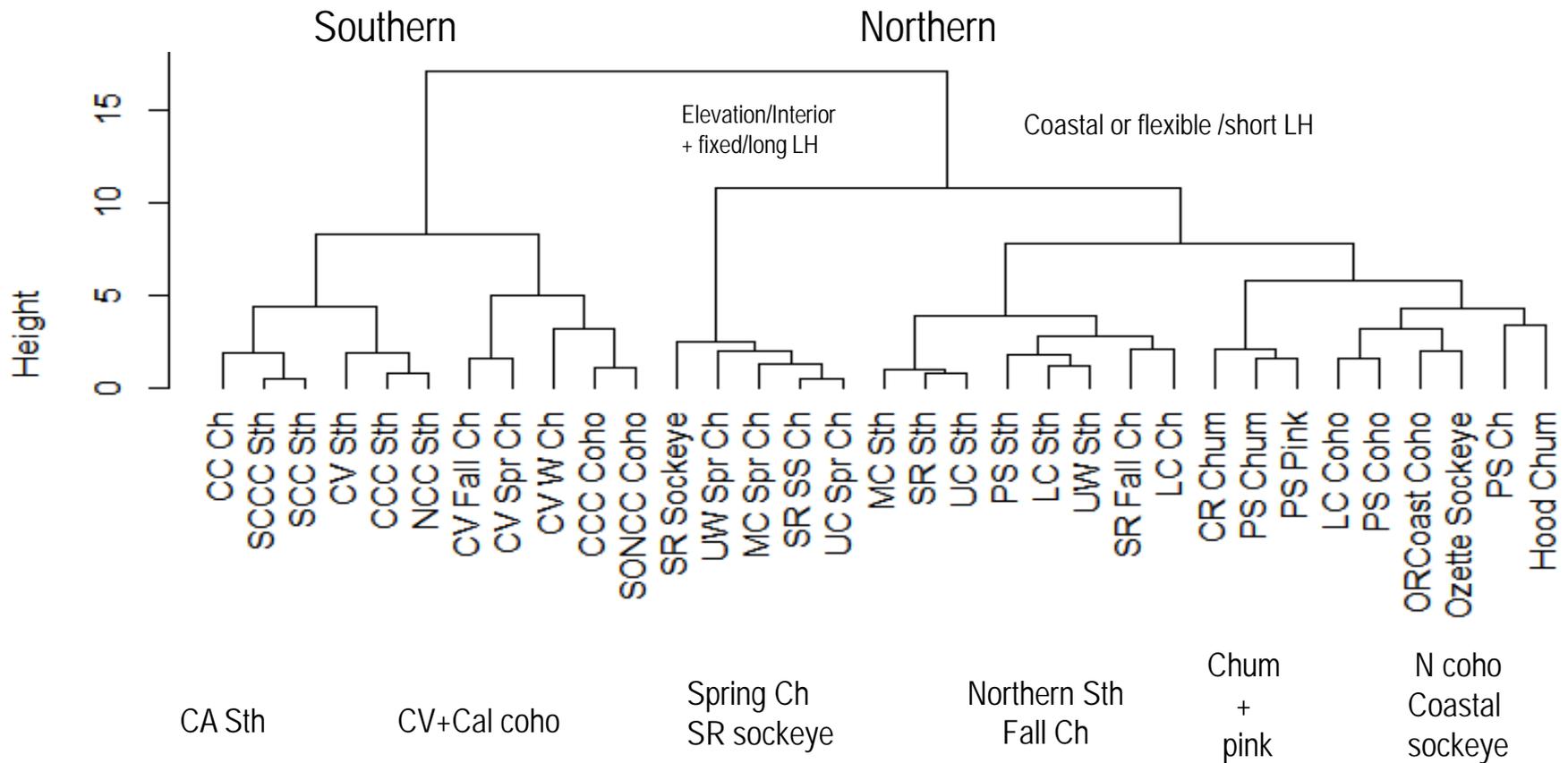
Paired sensitivity and exposure risk both >3.2

	Adult	Juvenile	Egg	Estuary	Marine
<i>Exposure:</i>	<i>Stream Temperature</i>	<i>Regime Shift/Tstream (*both)</i>	<i>Flooding</i>	<i>Sea Level Rise</i>	<i>Upwelling</i>
	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		

Habitat actions targeting stream temperature

Habitat actions targeting estuary and early marine stage and Sacramento River temperature

ESUs clustered by scores



CC Salmon CVA Preliminary Summary

- Results show latitudinal and longitudinal gradients, with southern and interior ESUs having greater climate vulnerability.
- Results show correlations between life history sensitivity and exposures that might amplify vulnerability.
- Life history adaptation might be possible in some ESUs.
- The impacts of climate change on CC salmon are expected to be overwhelmingly negative, with little positive impacts on species included in this CVA.