Apr 6th, 1:45 PM - 2:00 PM

Providing modeling tools on extreme events of climate change to Puget Sound managers

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Providing Resource Managers with Modeling Tools on Extreme Events of Climate Change

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Zhaoqing Yang, Mikaela Freeman, Nathalie Voisin, Ning Sun – Pacific Northwest National Laboratory

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Jude Apple – Padilla Bay National Estuarine Research Reserve

Salish Sea Ecosystem Conference
Seattle, WA
April 6, 2018

Pacific Northwest NATIONAL LABORATORY
Sea Grant Washington
CLIMATE IMPACTS GROUP
NOAA
Padilla Bay National Estuarine Research Reserve

Extreme Events under Climate Change

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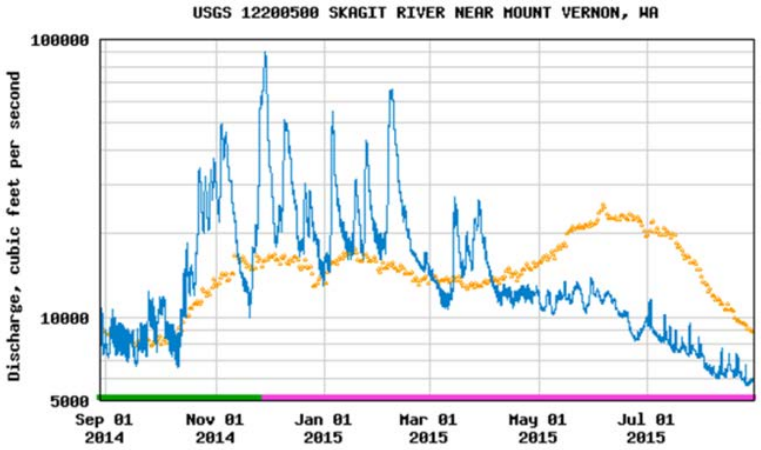
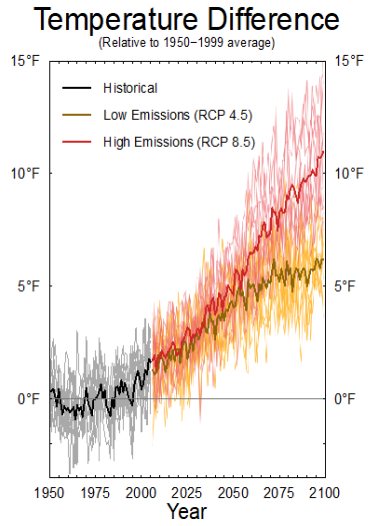
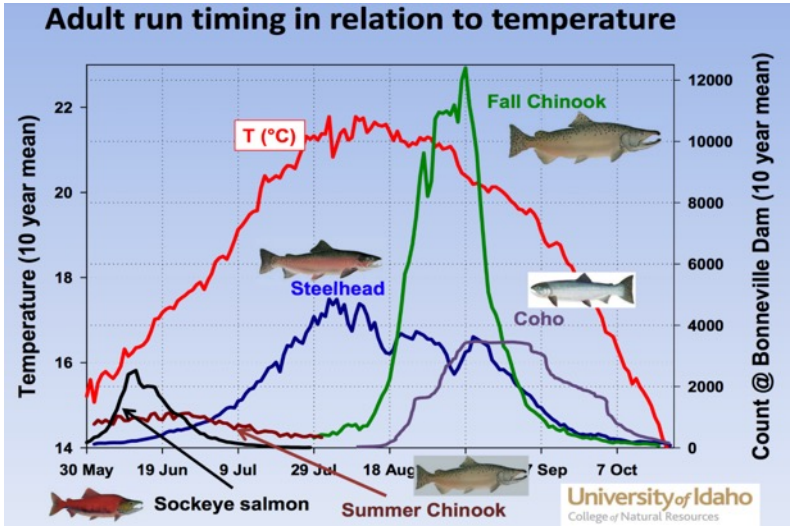
Extreme events may be more important drivers of change than long term climate change averages, particularly for resources like fish, water supplies







Keefer et al. 2015

Competing Water Use in the Face of Climate Change: Integrated Analysis to Support Water Resource Planning for Extreme Events

- Objective:
  - Provide information to assist water resource managers and planners understand the impacts of extreme events on sustainable fish habitat and human water needs in the Puget Sound basin.
- Focus on water resource metrics based on outputs of climate, hydrologic and coastal models
  - Outputs based on existing data, not new modeling runs
- Themes:
  - Sustainable fisheries and other human uses of water in the basin
- Process is stakeholder driven throughout
  - Provide information in formats accessible for planning and management

Puget Sound Sub-basins

Chose two sub-basins of differing size, with different biogeophysical attributes, different stakeholder needs.

Watersheds

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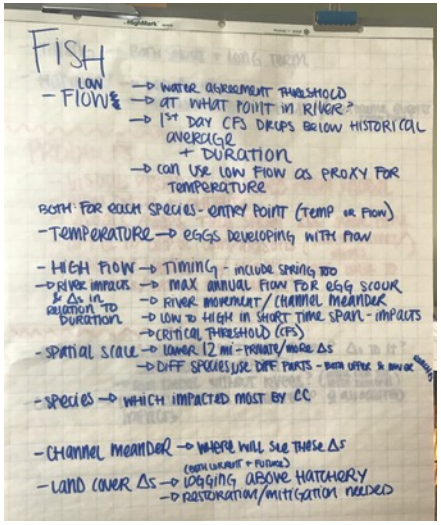
	Dungeness	Skagit
Basin type	Small (65 sq miles) mountainous. Limited lowland area.	Large (over 1,000 sq miles), mountainous with extensive floodplain and river delta
Discharge	Small and seasonal	Largest freshwater discharge to PS
Stakeholder groups	Agricultural community Municipal water management City of Sequim Tribes	Agricultural community Tribes Multiple municipalities Power producers
Salmon	Salmon runs in Dungeness, small estuary connected to Strait	Multiple salmonid runs (greatest contribution to PS salmon), large estuary, discharges to Puget Sound

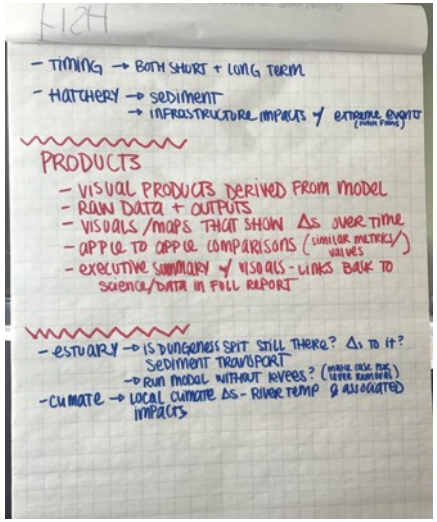
Dungeness River Center

Skagit Watershed Council

Stakeholder engagement

- Stakeholder workshops in Skagit and Dungeness
- Understand impacts on water use management
  - Specifically sustainable fish habitat and human water needs (agriculture and water supply)
  - Determine management needs or concerns for managing under climate change/extreme events
  - How modeling outputs can be best applied to each watershed
  - Most useful Information to meet management concerns, accessible format





Stakeholders Participating in Workshops

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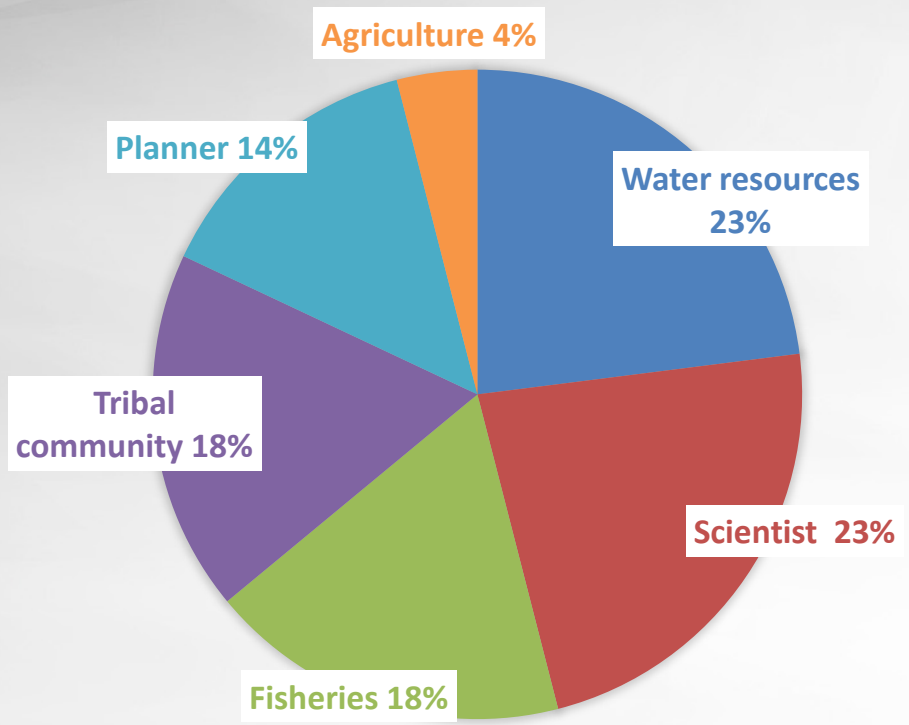
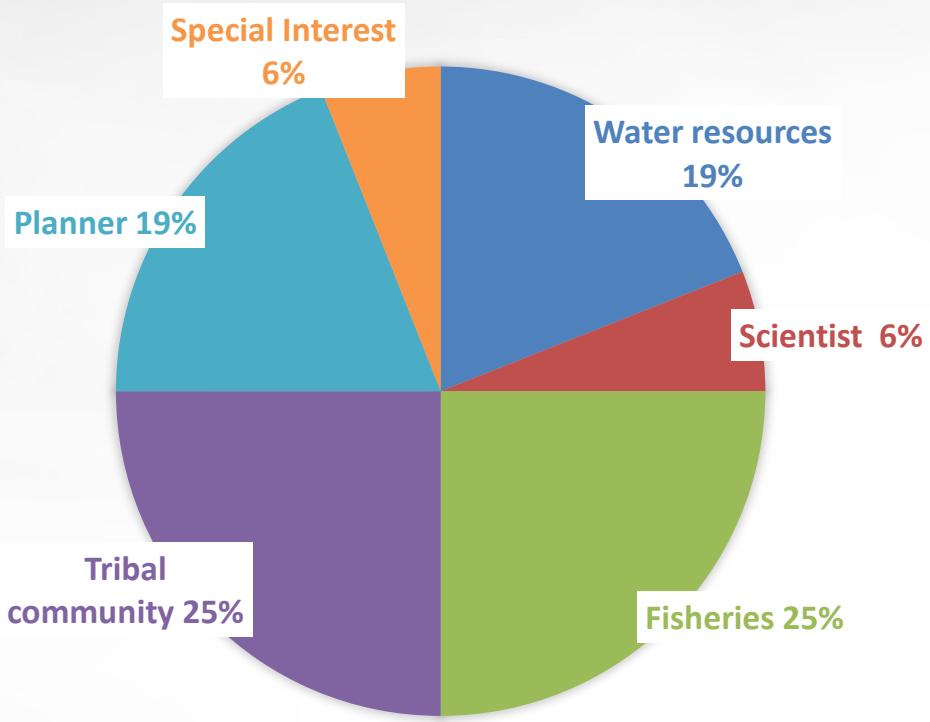
DUNGENESS



SKAGIT



Workshop Outcomes

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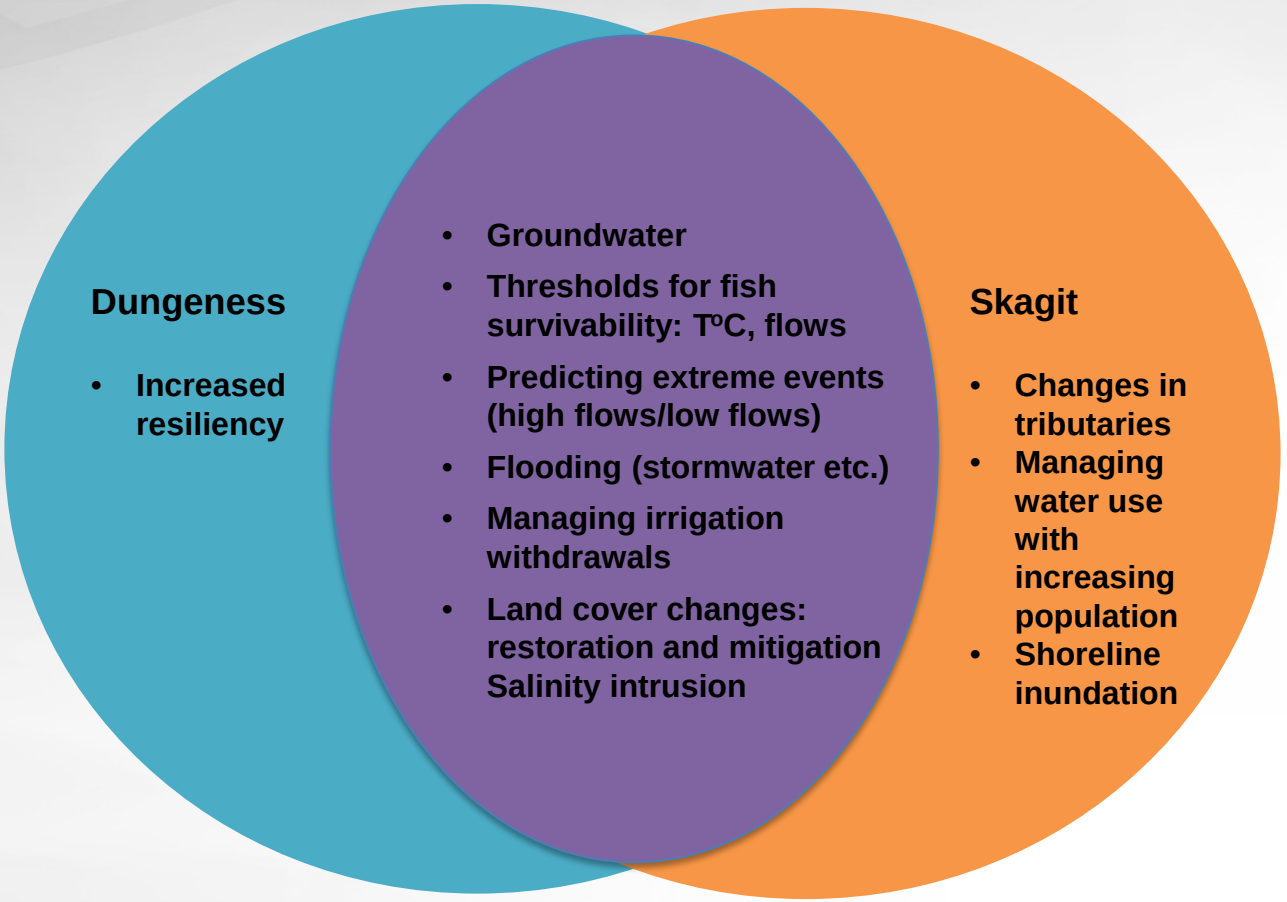

Climate Dataset – RMJOC II (CRCC dataset)

- New projections of future hydrology includes:
  - Streamflow
  - Snow pack
  - Other elements of water balance
- Key parameters of this output:
  - Impacts of calibration
  - Hydrological model
  - Downscaling approach
  - Global climate model
  - Green house gas scenario
- Better characterization of uncertainty, improved assessment of future climate scenarios

Watershed Modeling Points: Fish, Ag, and Municipal Water

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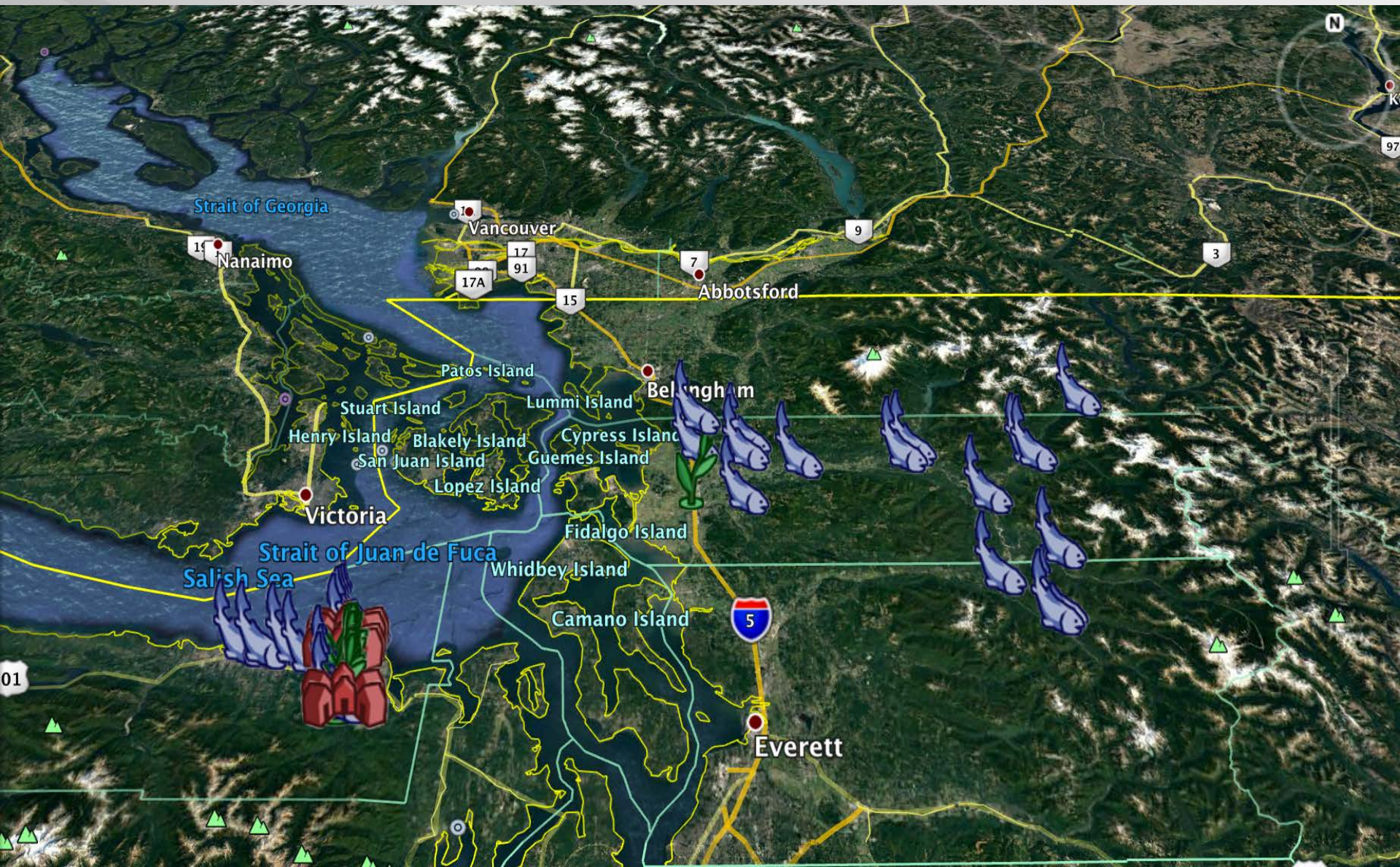

Skagit Watershed:
Mostly Fish, some Agriculture

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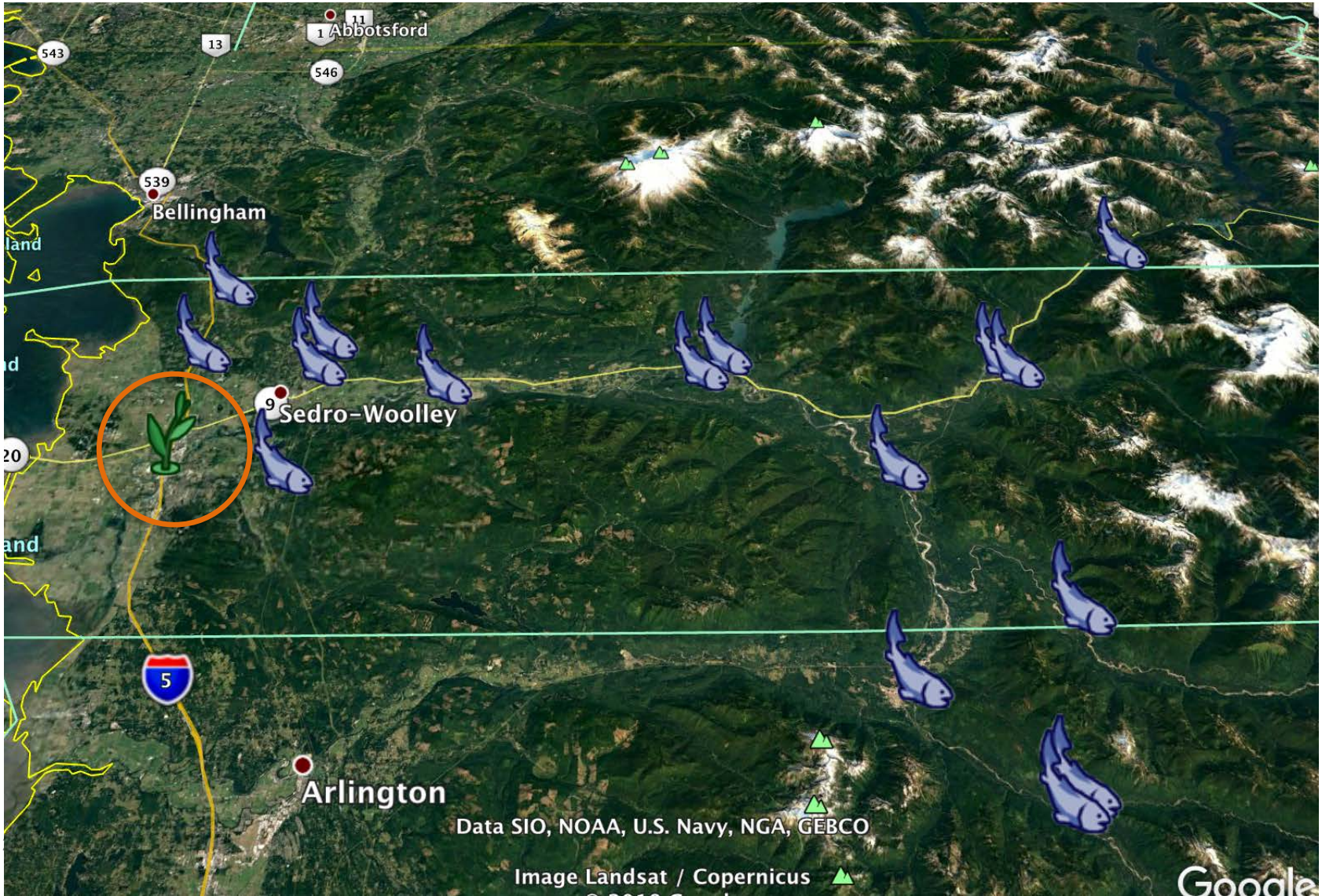

Dungeness Watershed: Fish, Agriculture, Municipal Water

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Metrics

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Variable	*Possible to Estimate?*	*Dungeness*	*Skagit*	*Fish*	*Agriculture*	*Municipal*	*Time Step / Duration*	*Metric*	*Units*	*Abs or % change?*
Groundwater flux into river / puget sound (esp. during drought)	N	Y	Y			Y				
Groundwater flux into tributaries	N		Y			Y				
Peak Flow Statistics (magnitude)	Y	Y	Y		Y	Y	1-day	100-yr	CFS	%
Peak Flow Statistics (magnitude)	Y	Y	Y		?	Y	1-day	25-yr	CFS	%
Peak Flow Statistics (magnitude)	Y	Y	Y	?			1-day	10-yr	CFS	%
Peak Flow Statistics (magnitude)	Y	Y	Y	Y			1-day	2-yr	CFS	%
Peak Flow Statistics (magnitude)	Y		Y	Y			1-day	cms, quantile	CFS	%
Peak Flow Statistics (duration)	Y	Y	Y			Y	x days	days	Days	Days?
Peak Flow Statistics (timing)	Y	Y				Y	1-day	Annual Max	Day of	Days
Peak Flow Statistics (timing)	Y		Y	Y		Y	1-day	Spring Max	Day of	Days
Peak Flow Statistics (timing of change)	Y	Y	Y			Y	1-year	days	Year	Year
Low Flow Statistics (magnitude)	Y	Y	Y			Y	1-day	10-yr	CFS	%
Low Flow Statistics (magnitude)	Y	Y	Y			Y	1-day	2-yr	CFS	%
Low Flow Statistics (magnitude)	Y	Y	Y	Y	Y		1-day	cms	CFS	%
Low Flow Statistics (duration)	Y	Y	Y	?	Y	?	x days	days	Days	Days?
Low Flow Statistics (timing)	Y	Y	Y		Y	Y	1-day	Annual 7-day Min	Day of	Days
Drought	Y	Y		Y	Y		x days/months	cms, quantile		
Snowpack (Apr 1)	Y	Y					1-day	Apr 1st SWE	mm	%
Snowpack (melt timing)	Y	Y	Y			Y	1-day	Date of 10mm	Day of	Days
Snow/Rain Dominance (abs change)	Y	Y					1-year	Ratio of Apr 1 SWE to Oct-Mar	Unitless	Abs. Change
Snow/Rain Dominance (timing of change)	Y	Y		Y	Y	Y	1-year	Ratio of Apr 1 SWE to Oct-Mar	Year	
Coastal Flooding: depth and extent	N		Y							
Extreme Precipitation Statistics	Y	Y	Y				day	mm, quantile	mm, quantile	% change
Irrigation withdrawals	N	Y	Y	Y	Y	Y				
Off-channel storage/detention	N	Y	Y							
Groundwater recharge	N	Y	Y							
Groundwater storage / optimization	N	Y	Y							
Vegetation (best suited for future	N	Y								
Vegetation (projected change)	N	Y								
Vegetation (invasive species)	N		Y							
Sediment transport/deposition in	N	Y	Y							

Tableau tool - Skagit

- Peak Flow for 100 year flood

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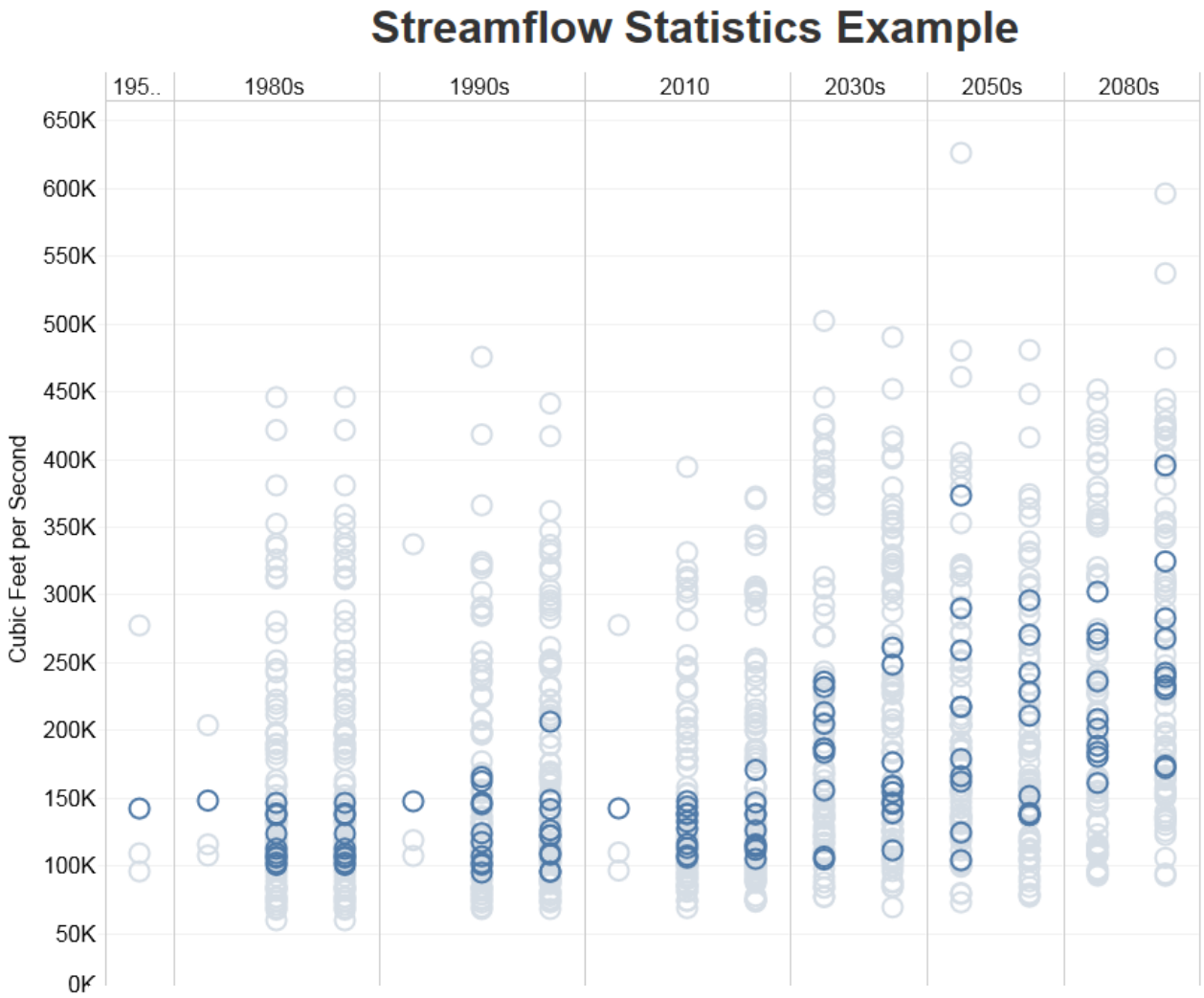
Location
- Dungeness River at Dunge...
- Skagit River near Mount V...

Metric & Period
- Monthly Average, 1
- Monthly Average, 2
- Monthly Average, 3
- Monthly Average, 4
- Monthly Average, 5
- Monthly Average, 6
- Monthly Average, 7
- Monthly Average, 8
- Monthly Average, 9
- Monthly Average, 10
- Monthly Average, 11
- Monthly Average, 12
- Low Flow Stats, 2
- Low Flow Stats, 10
- Peak Flow Stats, 2
- Peak Flow Stats, 10
- Peak Flow Stats, 50
- Peak Flow Stats, 100

Downscaling, Parameter Set, Hydro Model
- Historical, P1, PRMS
- Historical, P1, VIC
- Historical, P2, VIC
- Historical, P3, VIC
- BCSD, P1, PRMS
- BCSD, P1, VIC
- BCSD, P2, VIC
- BCSD, P3, VIC
- DYNAMICAL, P1, P...
- DYNAMICAL, P1, VIC
- DYNAMICAL, P2, VIC
- DYNAMICAL, P3, VIC
- MACA, P1, PRMS
- MACA, P1, VIC
- MACA, P2, VIC
- MACA, P3, VIC

4 historical datasets

3 future predictions, for two IPCC climate scenarios (w/ and w/o CO_2 mitigation)



Historical Data and Future Scenarios

Tableau tool - Dungeness

- Peak Flow for 10 year flood

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Location
- (•) Dungeness River at Dunge...
- ( ) Skagit River near Mount V...

Metric & Period
- ( ) Monthly Average, 1
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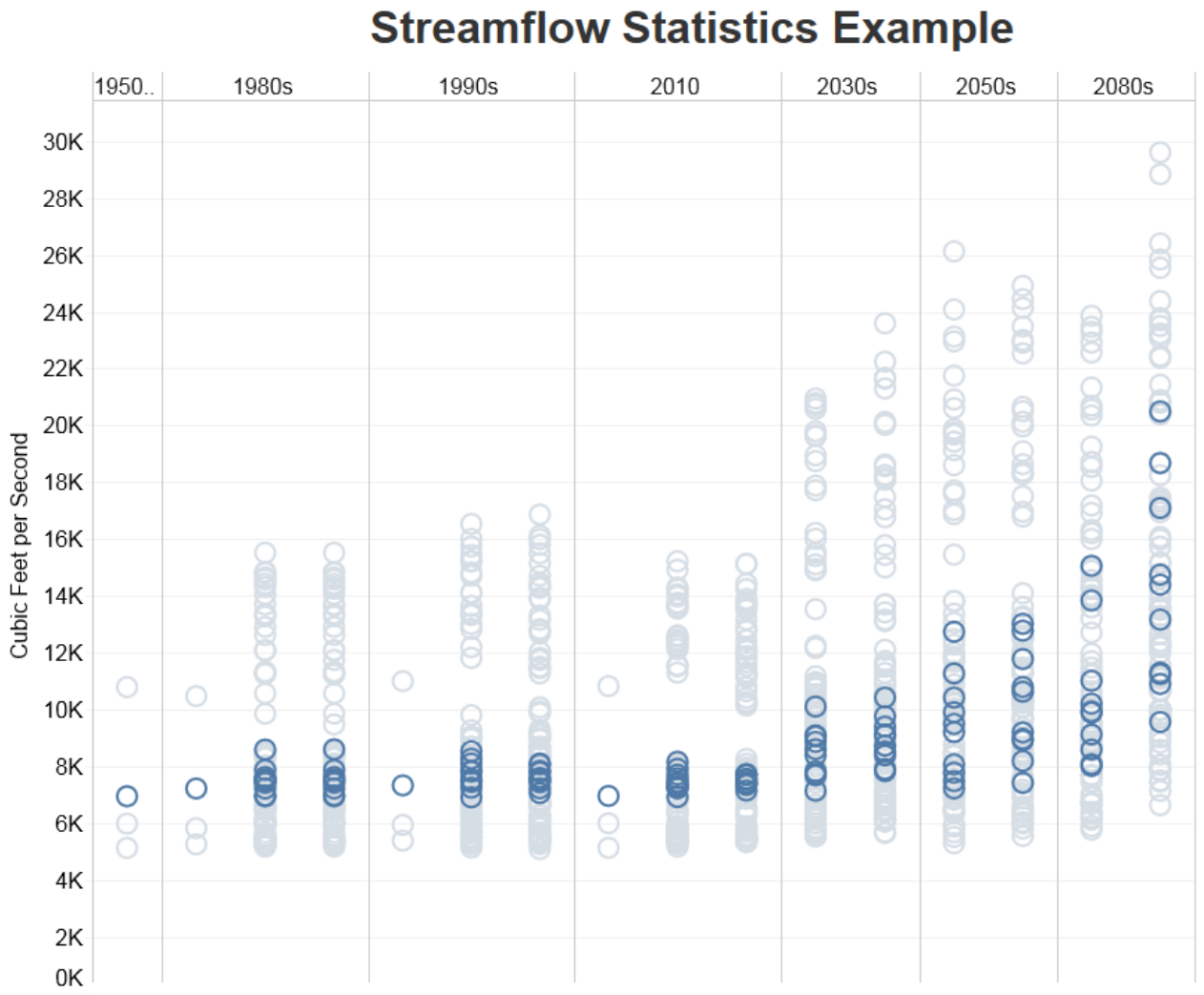
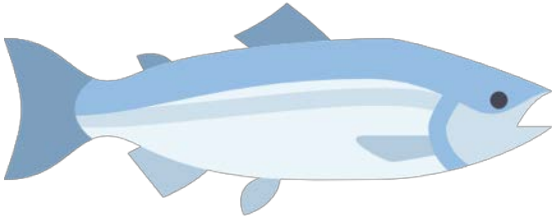


Historical Data and Future Scenarios

Outcomes and Next Steps

- Finishing up outputs
  - Webinar for stakeholders in May/June
- Develop and test outputs
  - Likely interactive, web-based, but functionality will be decided by stakeholders



- Limitations
  - Metrics that this project couldn't address
  - Unable to model certain outcomes due to available models and/or time limitations
- Report and paper with findings and pathway forward

Thank you!

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We gratefully acknowledge the support of the NOAA Climate Program Office and our program officer, Nancy Beller-Simms.