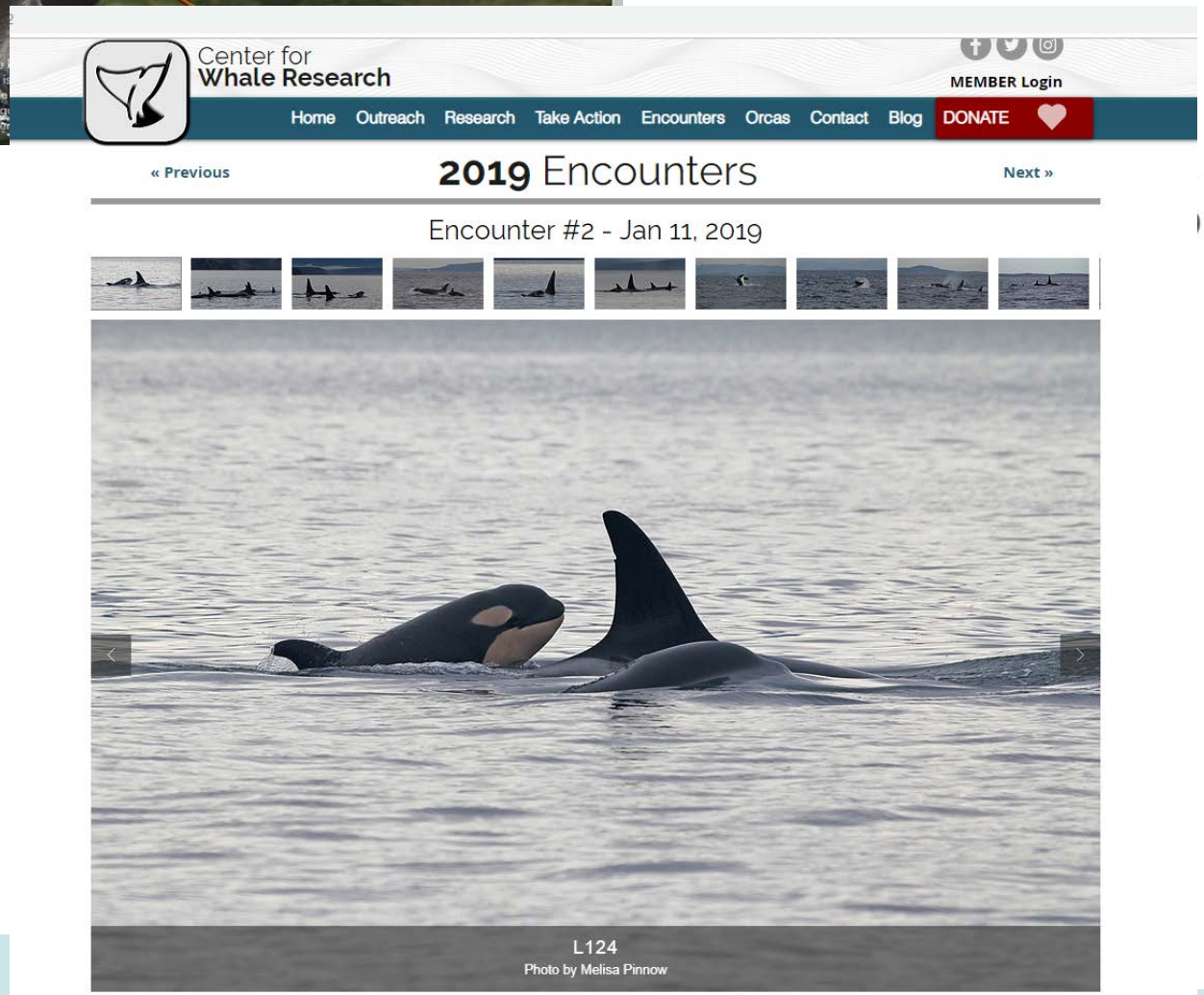
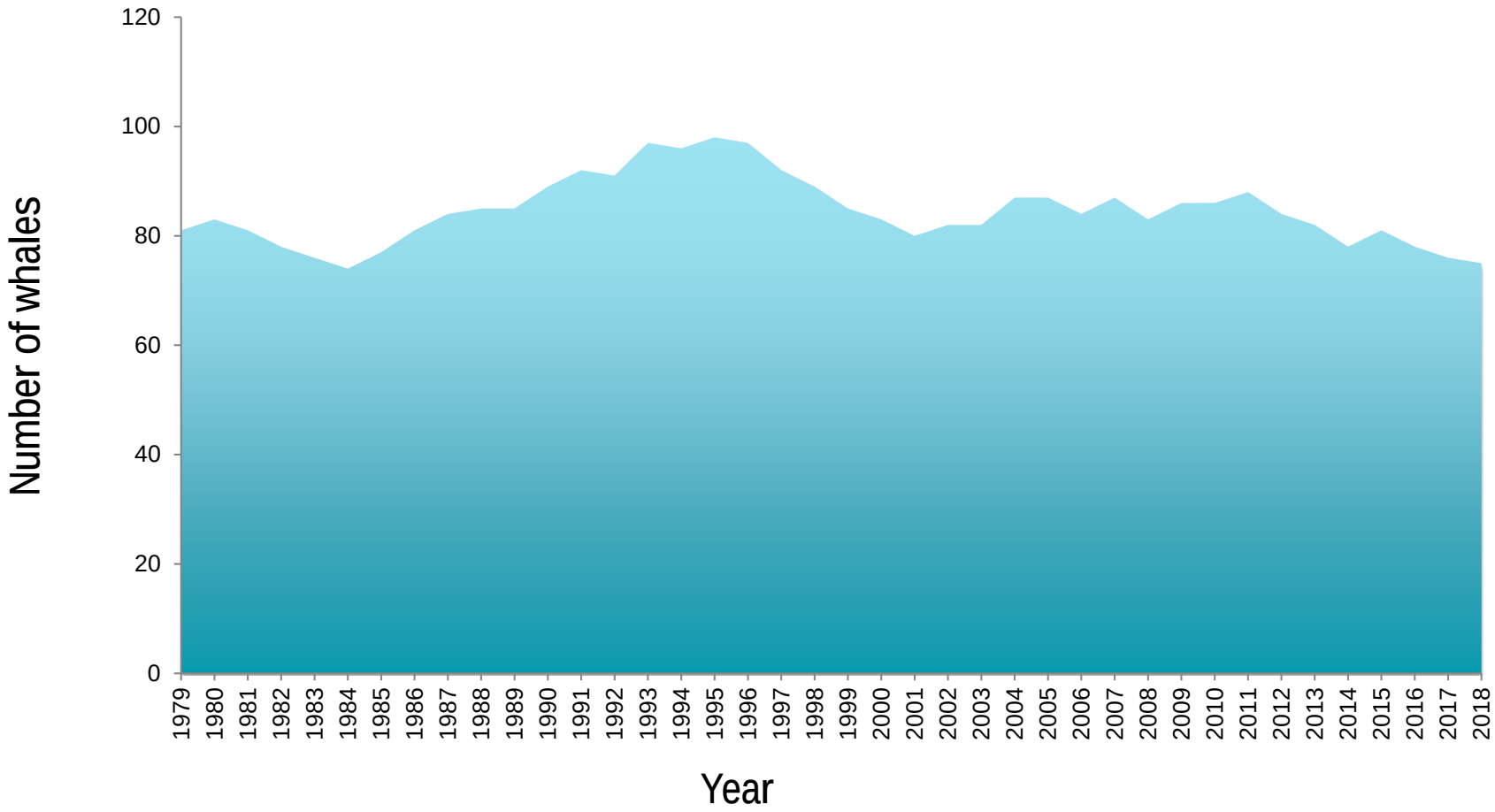
Southern Resident Killer Whale Update March 2019



- New calf L124
- K25 not worsened since Oct

SRKW Population

- Current population of 75 whales including new calf



Winter/Spring 2019

Ongoing health research, observations, sampling (prey, feces, breath)

- Center for Whale Research
- University of WA
- NOAA

Research coordination meetings

Aerial images of pregnant adult female Southern Resident killer whales, documented by their increased width at mid-body. Left shows J17 approximately one month prior to giving birth in 2015; image by NOAA/SWFSC and Vancouver Aquarium's Coastal Ocean Research Institute; right shows K27 (top whale) in September 2018, with her increased body width contrasting to that of her juvenile son (K44, bottom); image by NOAA/SWFSC and SR3. Both images obtained using an unmanned drone piloted non-invasively >100ft above the whales under NMFS research permits 16163 and 19091.

st modified: 9/25/2018

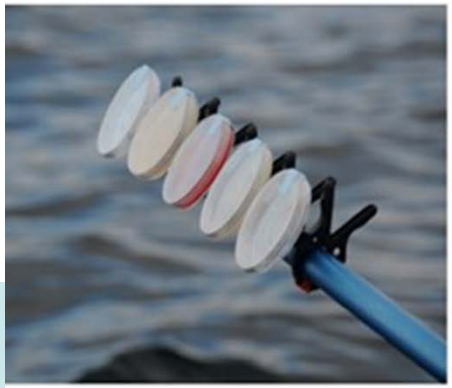
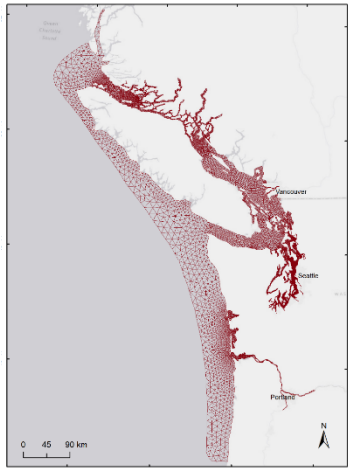


Photo: Taylor Shedd

Puget Sound Nutrient Source Reduction Project



Presentation for the Southern Resident Killer Whale Task Force

March 18, 2019

Presented by Dustin Bilhimer, WA Dept. of Ecology, Water Quality Program

Puget Sound Nutrient Source Reduction Project Objectives

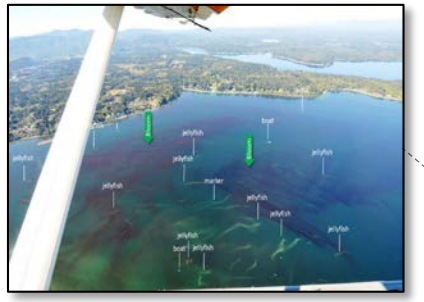
1) Communicate and share science
2) Use the Nutrient Forum to collaboratively develop a Puget Sound Nutrient Management Plan
3) Implement the Plan

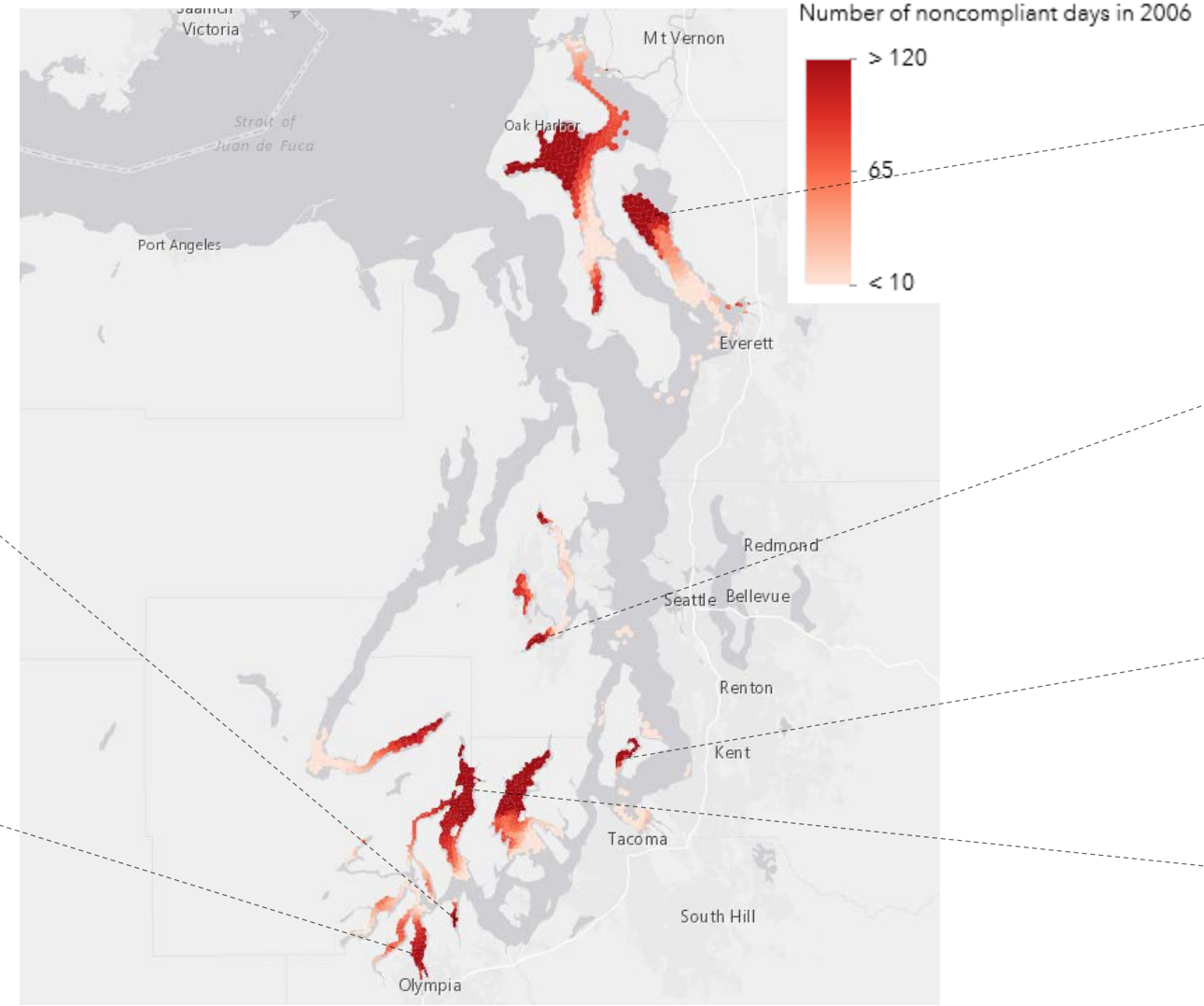
SO THAT WE PROTECT THIS

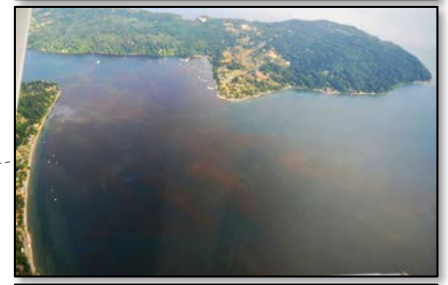
Monitoring and observations complement Salish Sea Model findings

Eutrophication Indicators

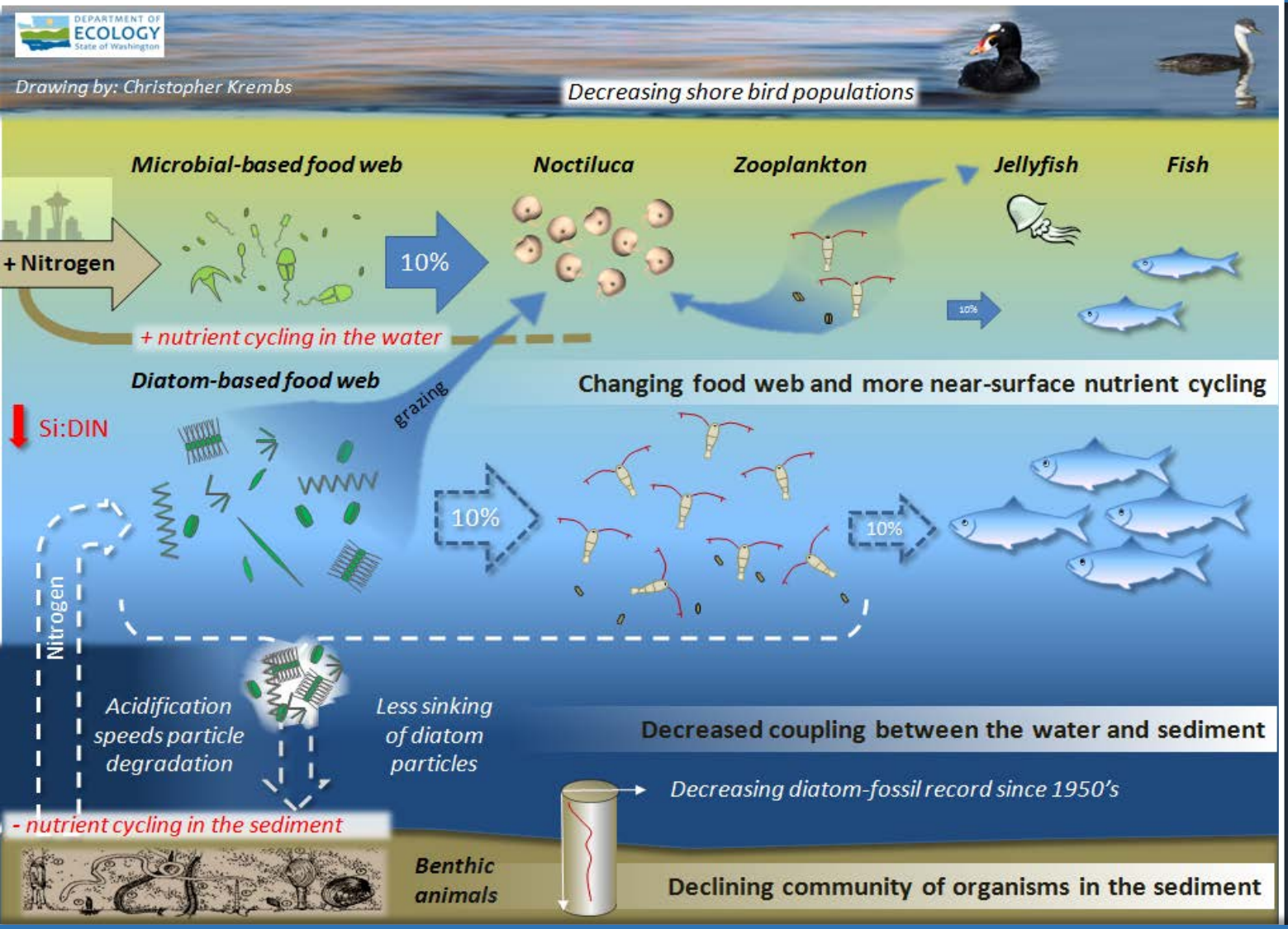
- Algae blooms
- Jellyfish Smacks







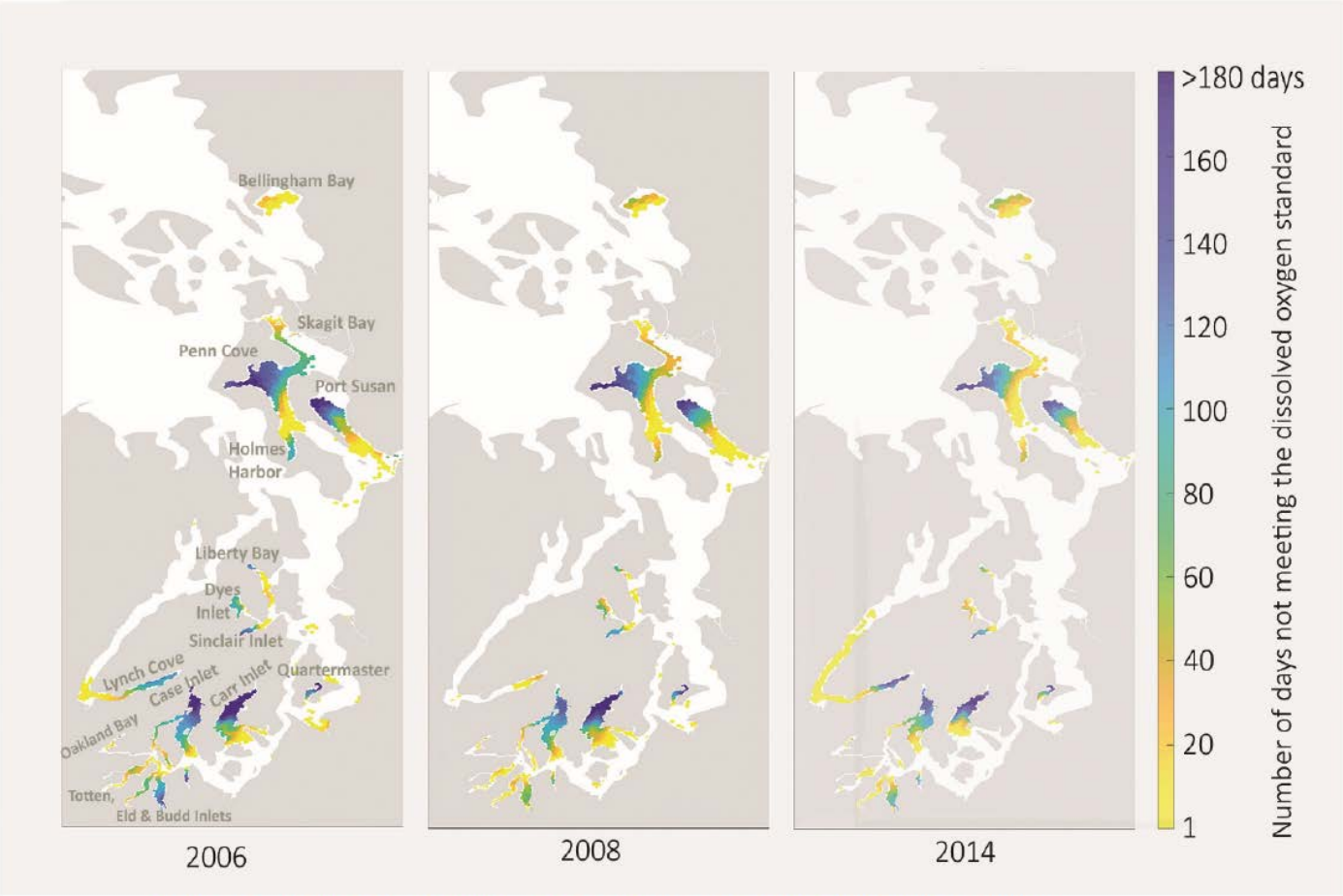
Excess human nutrients are changing the base of the marine food web



- A less favorable food web that keeps material at the surface.
- Potential for toxics to enter the pelagic food web (vs animals in the sediment)
- Climate could accelerate changes

Newly published Salish Sea Model results

- Total human sources cause DO depletions below standards for extended durations
- Most impacted areas are also biologically productive areas
- Technology based levels of treatment for WWTPs can reduce the low DO problem by around half.



* Figure ES2. Number of days not meeting the dissolved oxygen water quality standards for the years 2006, 2008, and 2014.

Explore results at http://bit.ly/ssmresultsmap

**Volume 1: Model Updates and Bounding Scenarios. Ecology Publication #19-03-001*

A range of necessary solutions

Both point and nonpoint source reductions are needed

And we must continue to protect and restore ecological function

Floodplains by Design

· REDUCING RISK, RESTORING RIVERS ·

Nutrient Forum

Collaborative meetings for stakeholder and tribal engagement with Ecology engineers, scientists, and policy-makers

- 2018 Forums
  - Discussed the science, water quality objectives, and the Salish Sea Model
- 2019 Forums
  - Learning from other U.S. coastal estuaries examples
  - Sharing and learning from current nutrient reduction examples in Puget Sound
  - Opportunity for input to the next round of modeling and evaluation
  - Identifying creative opportunities for implementation and funding

Puget Sound Action Agenda & MWQ Implementation Strategy

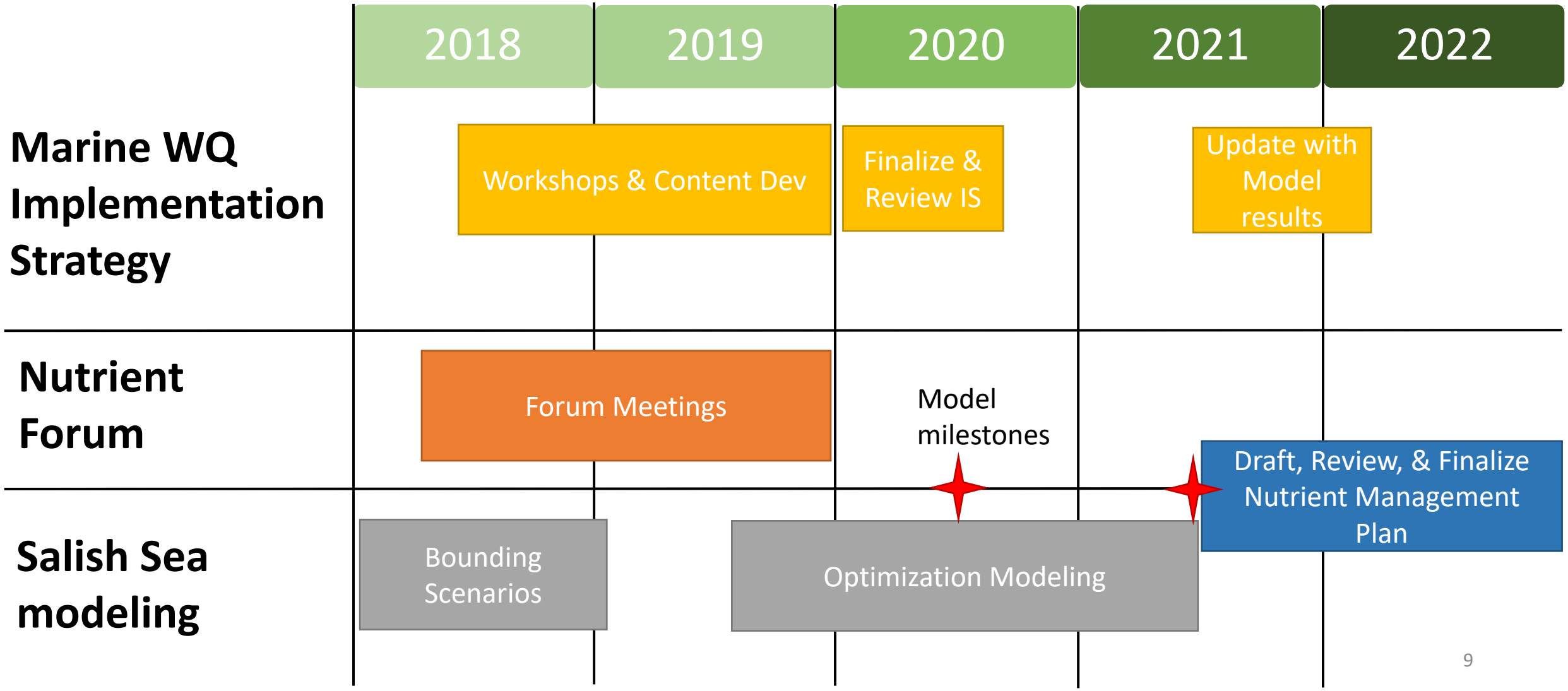
Interdisciplinary team of local experts helping to:

- Identify nutrient sources, stressors, and contributing factors that affect the dissolved oxygen Vital Sign
- Identify strategies and priorities to improve dissolved oxygen in Puget Sound

GOAL

Connect Puget Sound recovery goals with Ecology's Puget Sound Nutrient Management Plan

High-level Project Schedule

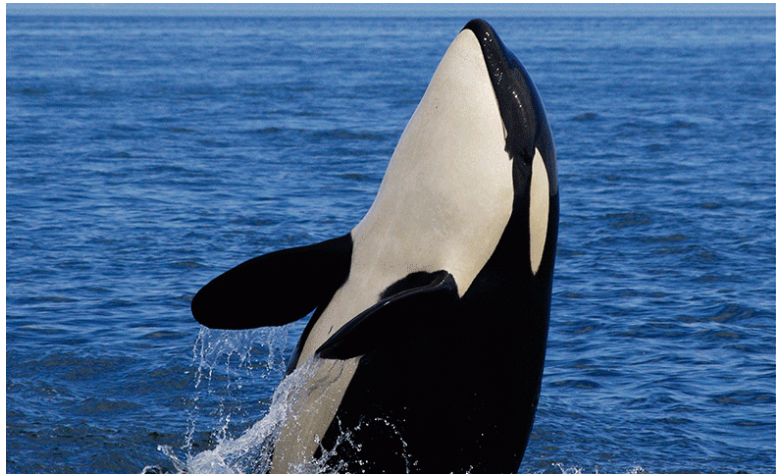


Connections with Orca Recovery

- Puget Sound ecosystem recovery depends on reducing human nutrient sources to increase resiliency during worst climate years

- Good marine water quality is critical for a healthy food web and supports salmon and orca recovery

- Task Force could consider nutrient recommendations from the Forum and MWQ IS



Primary Contact

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WA Department of Ecology, Water Quality Program
(360) 407-7143
Dustin.Bilhimer@ecy.wa.gov

Project webpage: https://ecology.wa.gov/Water-Shorelines/Puget-Sound/Helping-Puget-Sound/Reducing-Puget-Sound-nutrients

Phase 1 Salish Sea Model Results webmap: bit.ly/ssmresultsmap

Potential effects of warming and acidification on Southern Resident Killer Whales

Terrie Klinger
School of Marine and Environmental Affairs
University of Washington
Washington Ocean Acidification Center

The ocean has taken up about 31% of the carbon dioxide released by industry and deforestation [Gruber et al. 2019]

CO_2 in the atmosphere causes ocean warming

CO_2 in the water causes ocean acidification

Ocean Warming and Production

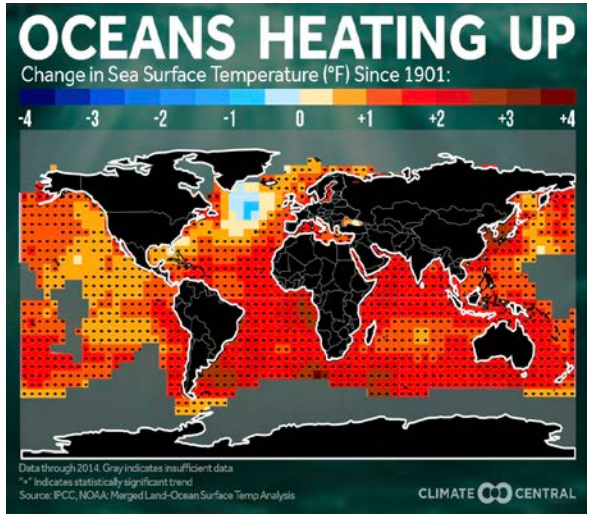


Image: Climate Central

Net Primary Production could increase or decrease under conditions of warming [Taucher and Olschlies 2011]

Salmon may have higher food consumption rates and require more prey under warmer conditions [Daly and Brodeur 2015]

Ocean Warming and Kelp

Nereocystis

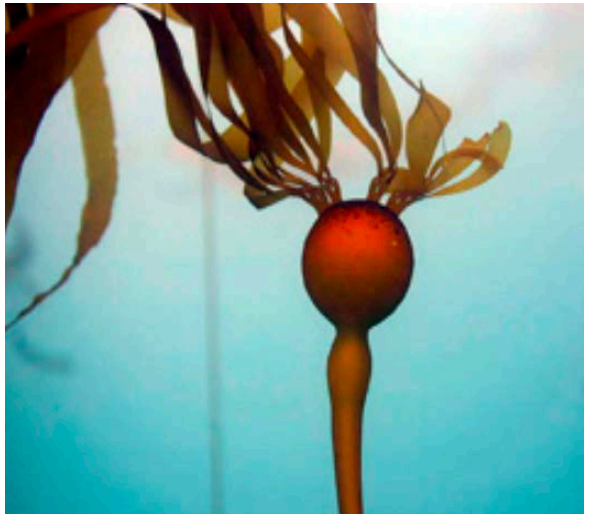


Image: Wikipedia

Ocean warming can reduce kelp abundance [Provost et al. 2016], causing loss of critical habitat for fish

Ocean Warming and HABS

Pseudonitzchia

Image: WA ECY

Ocean warming has already facilitated intensification of HABs [Gobler et al. 2017]

Ocean warming will continue to increase the risk of HABs [Moore et al. 2015]

Ocean Warming and Ocean Acidification

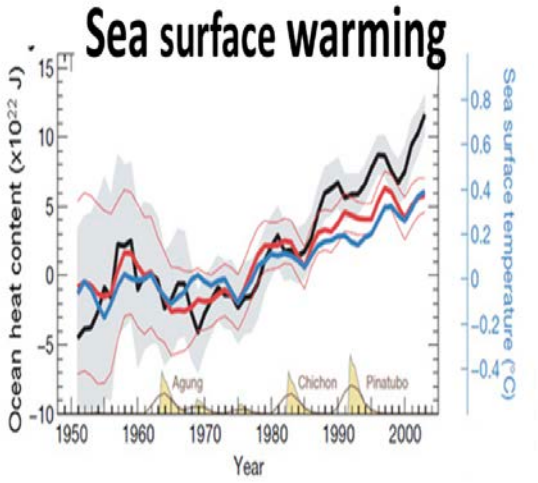


Image: CSIRO

The effects of OA tend to be intensified as water temperature increases [Kroeker et al. 2013]

Ocean Acidification and Marine Organisms

Mytilus

Image: uw.edu

OA tends to reduce survival, growth, calcification, development, and abundance across most species studied, especially calcifying organisms [Kroeker et al. 2013]

OA can affect behavior in vertebrate species [Munday et al. multiple publications]

Ocean Acidification and Food Webs

Limacina

Image: climate.gov

Zooplankton shells are thinner under OA conditions

Calcification rates decline

Changes in behavior occur

[Bednarsek et al., multiple publications]

Ocean Acidification and Food Webs

Euphasia

Image: Peter J Bryant

Krill are negatively affected by OA, with consequence for prey availability

[McLaskey et al., 2016]

Ocean Acidification and Food Webs

Pink salmon

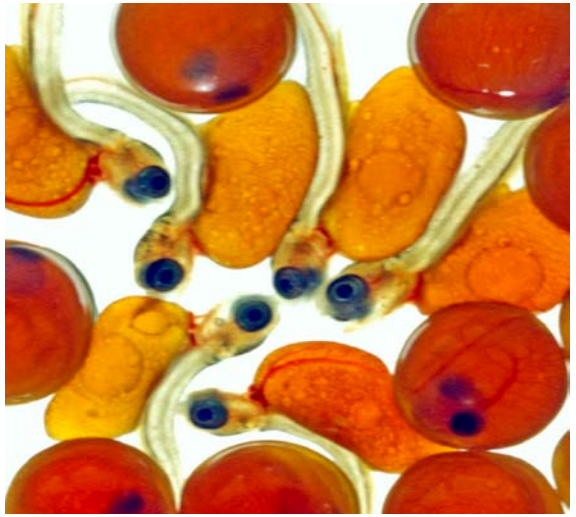


Image: public domain

Early stages of pink salmon show changes in critical life-history and behavioral traits in response to OA [Haigh et al. 2015, Ou et al. 2015]

Ocean Acidification and Food Webs

Pink salmon

Image: J. Weinberg

Predator detection is affected in juvenile Coho salmon exposed to OA [Williams et al. 2018]

Ocean Acidification and HABS

Pseudonitzchia

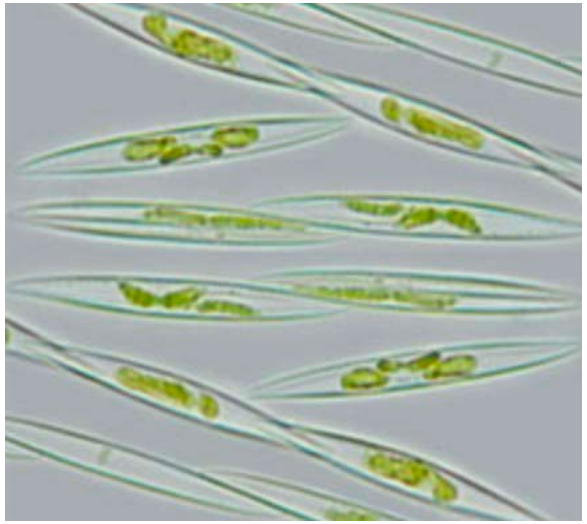


Image: NOAA

Harmful algae grow faster and produce more toxin under OA conditions [Tatters et al. 2015, Cochlan et al. 2016, Eberlein et al. 2016, Ou et al. 2017]

Domoic acid can cause seizures, stranding, and mortality in pinnipeds [Gulland et al. 2002, Goldstein et al. 2007]

Ocean Acidification and HABS

Heterosigma

Image: cfb.unh.edu

Heterosigma is known to cause mortality in finfish and to negatively affect copepods

Heterosigma can increase growth and become more toxic under OA and warming [Cochlan et al. 2016]

Ocean Acidification and Contaminants

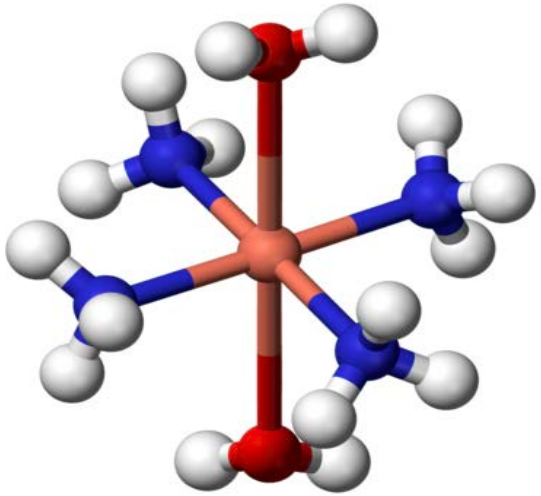


Image: Wikipedia

Bioavailability of metals could change under OA conditions [Stockdale et al. 2016]

Moderate increases in availability of iron and copper could occur [Gledhill et al. 2015]

Effects of OA and contaminants could cause additive physiological effects [Roberts et al. 2013]

Ocean Acidification and Sound

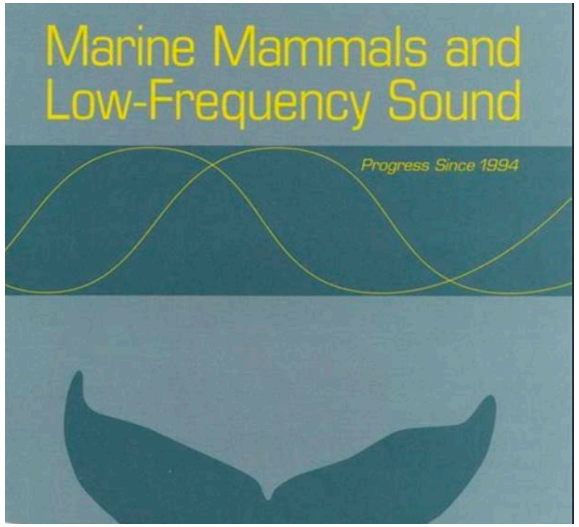


Image: NRC

Sound at frequencies important for marine mammals will travel significantly farther under OA conditions

This change will occur in surface ocean waters by mid century [Brewer and Hester 2009]

Summary

Image: Seattle PI

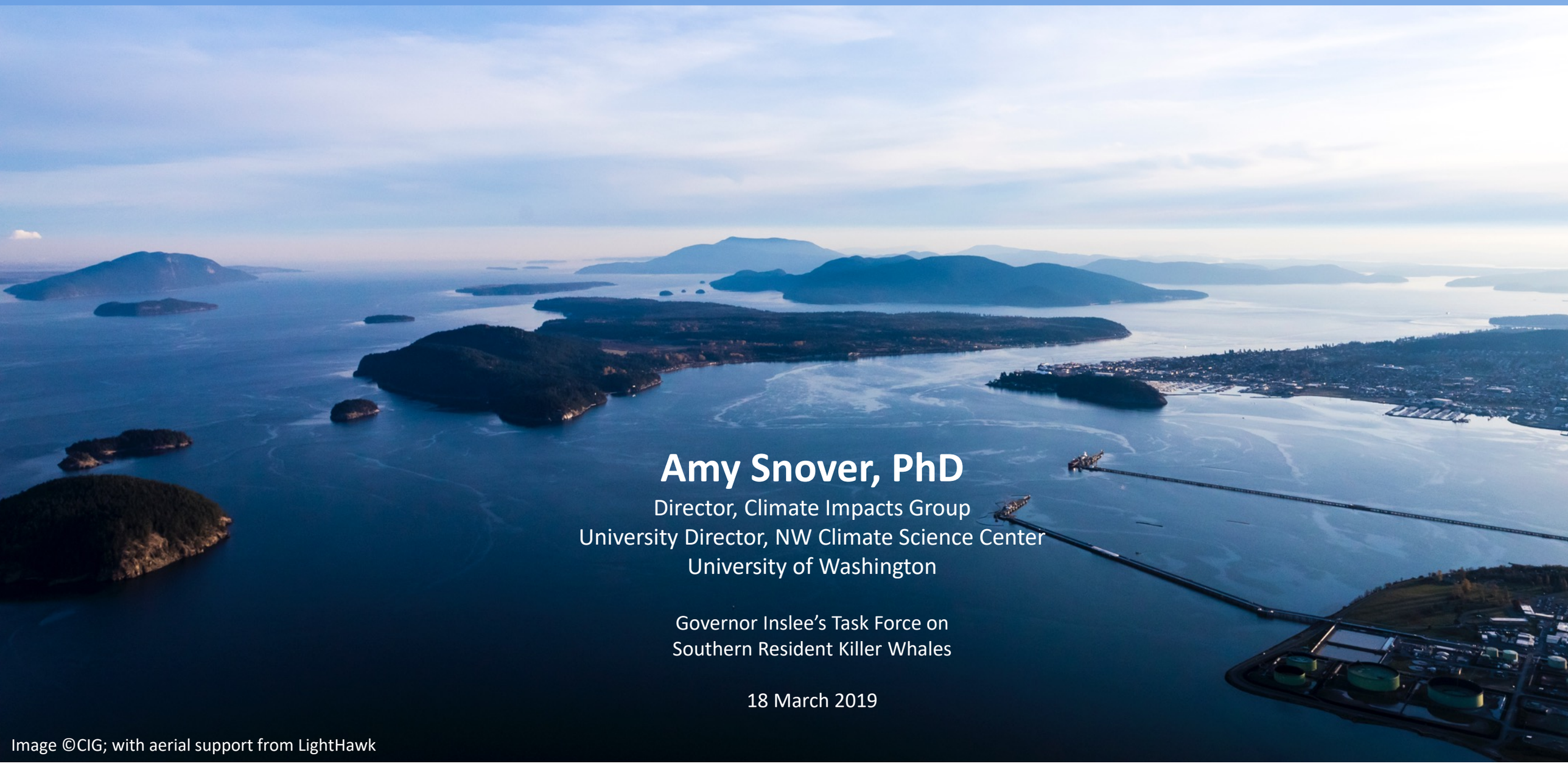
Salmon in Puget Sound will be challenged by warming, OA, and associated stressors

This suggests a need to reduce threats to the fullest extent possible and to enhance salmon production to account for losses due to environmental change

Climate Change and Puget Sound Orca

The implications for Puget Sound's Southern Resident Killer Whales of climate change impacts on coastal and upland systems.

CLIMATE IMPACTS GROUP
UNIVERSITY of WASHINGTON
College of the Environment



Amy Snover, PhD
Director, Climate Impacts Group
University Director, NW Climate Science Center
University of Washington

Governor Inslee's Task Force on
Southern Resident Killer Whales

18 March 2019

Image ©CIG; with aerial support from LightHawk

CLIMATE IMPACTS GROUP

Since 1995

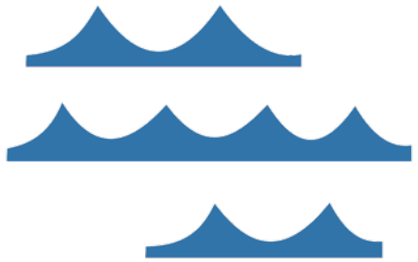
The University of Washington Climate Impacts Group supports the development of climate resilience by advancing understanding and awareness of climate risks & enabling action to manage those risks.

Projected climate changes in WA state

Warming

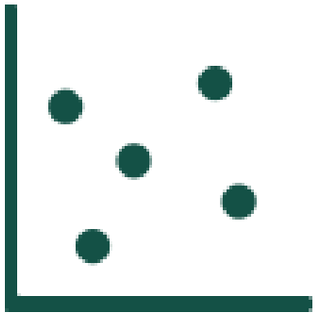
Heavier rains

Less snow,
earlier melt



Rising seas

Streamflows:
Higher highs
Lower lows



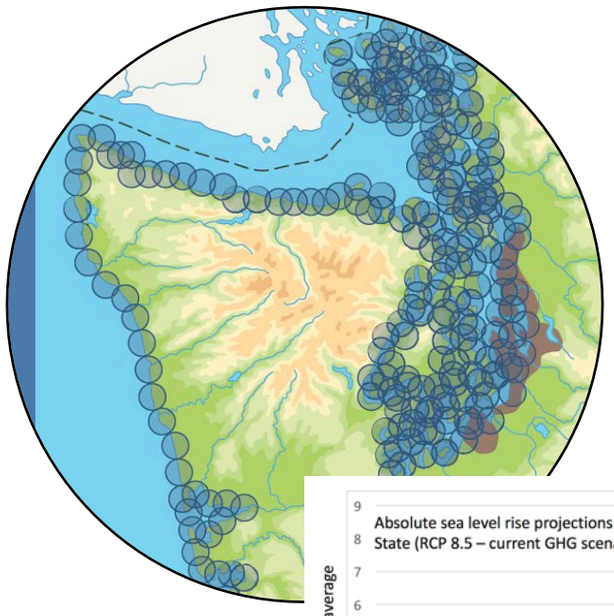
Ongoing natural
variability

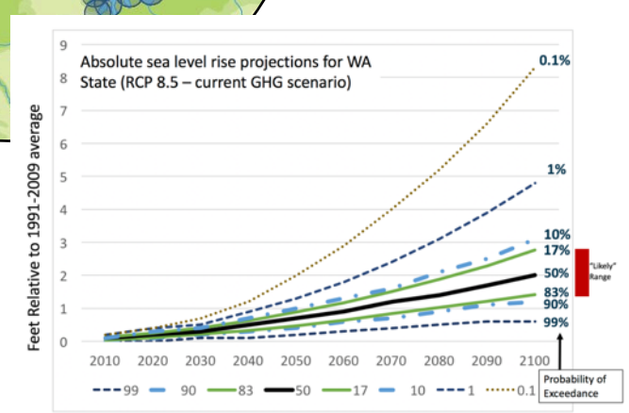
Images NMFS, Ecology, NOAA

Coastal & estuarine habitat

Image ©CIG; with aerial support from LightHawk

Sea level rise drives loss of coastal habitat important for juvenile salmon and their prey





Sea level rise:

~8” (6-11“) by 2050

2’ (1.4-2.8‘) by 2100

Permanent habitat inundation & loss

More frequent coastal flooding

Larger floods in coastal rivers

For example:

The area flooded in the Skagit River floodplain during a 100-year flood event could increase ~75% on average by the 2080s (compared to the 1980s) because of both sea level rise and higher river flows. (Lee et al. 2014)

More of some (salt marsh, transitional marsh, tidal flat), less of other (estuarine beach, brackish marsh, tidal swamp, tidal freshwater marsh) Puget Sound coastal habitats. (Glick et al. 2007)

Miller et al. 2017

Image ©CIG; with aerial support from LightHawk

Freshwater habitat

Image ©CIG; with aerial support from LightHawk

Climate change will cause widespread changes in freshwater salmon habitat

Higher high flows will increase egg & fry mortality, reduce availability of slow water habitat, reduce salmon returns.

Large floods have been observed to reduce Chinook returns to the Skagit.

Climate change will cause widespread changes in freshwater salmon habitat

Lower low flows will decrease available habitat, exacerbate increasing stream temperatures.

Summer minimum streamflow amounts expected to become even lower in all Puget Sound watersheds, decreasing 16 to 50% on average for the 2080s, compared to the 1980s. *(Mauger et al. 2015)*

Climate change will cause widespread changes in freshwater salmon habitat

Photos: CNN, Ashley Ahearn

Increasing stream temperatures will

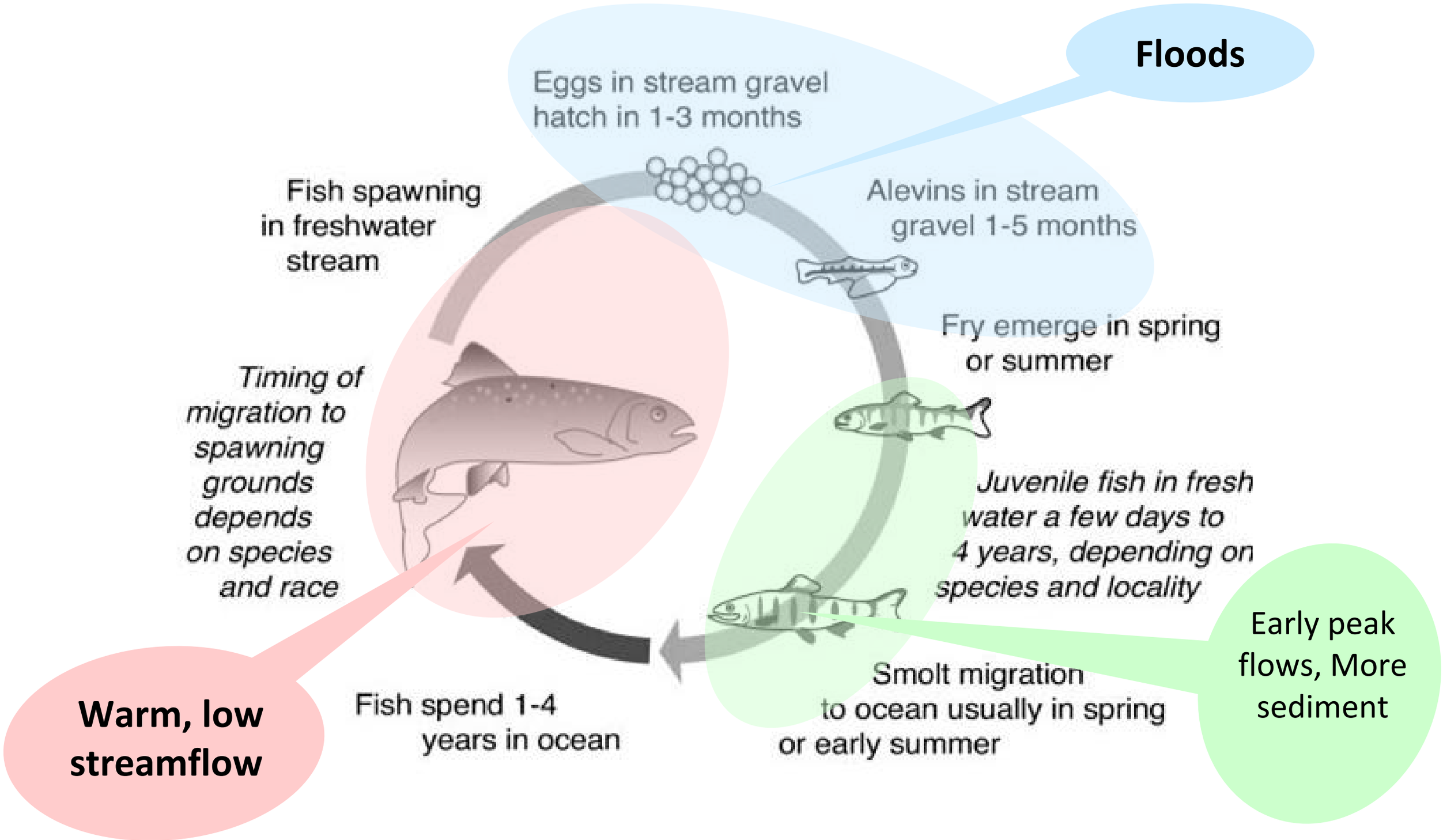
- shift location of suitable habitat for coldwater fish upstream,
- reduce availability of thermally suitable habitat during hot summer months,
- delay or prevent salmon migration,
- increase juvenile growth,
- increase disease susceptibility,
- favor invasive species

Climate change will cause widespread changes in freshwater salmon habitat

Increased sediment loading in rivers & streams, caused by glacial retreat, heavier rains and wildfire, will decrease salmon egg survival.

For example: The average amount of sediment transported down the Skagit River past Mt. Vernon is projected to quintuple in winter in the 2080s, compared to the 1980s.

Salmon affected throughout lifecycle



Modified from Wilderness Society (1993)

Toxics

Image ©CIG; with aerial support from LightHawk

Climate change may increase mobilization & transport of toxics

Multiple factors at play:

Sea level rise

Stormwater

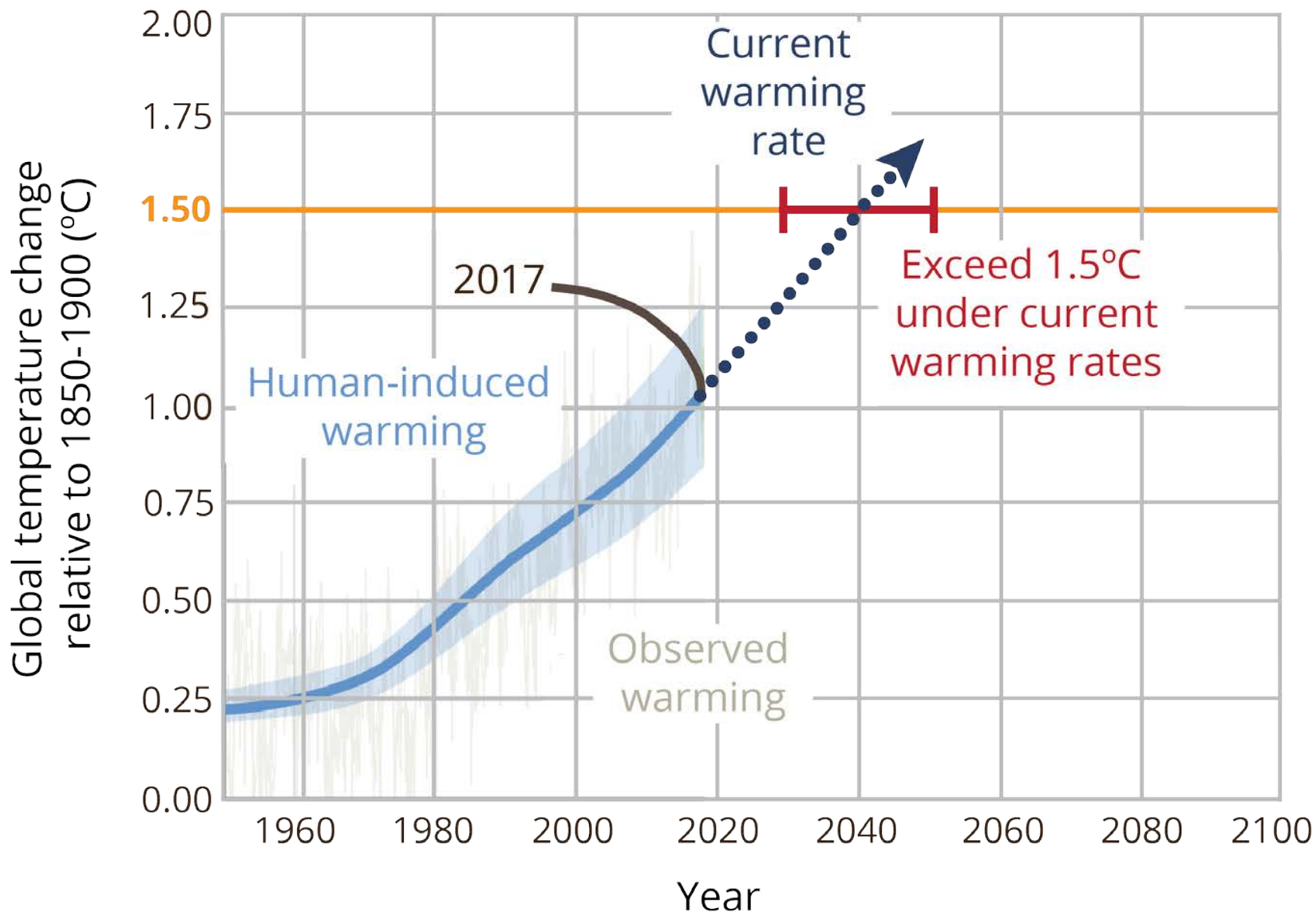
River floods

Increased sedimentation

Photos: Ecology

How much & how fast will climate change?

If current rates of warming continue, global warming could reach 1.5°C as soon as 2030



Modified from IPCC 2018

Warming of 1.5°C will significantly challenge Washington's communities, economy and ecosystems

Change with 1.5°C	Risks
More very hot days (above 90°F) ↑ 67%	Heat-related illness and deaths Warmer streams stressing salmon More frequent harmful algal blooms
Reduced snowpack (April 1st snow water equivalent) ↓ 38%	Reduced water storage Irrigation shortages Winter and summer recreation losses
Higher winter streamflow (October-March) ↑ 16%	River flooding Costly stormwater management and flood protection Negative effects on salmon populations

Change with 1.5°C	Risks
Lower summer streamflow (April-September) ↓ 23%	Reduced summer hydropower Conflicts over water resources Negative effects on salmon populations
Sea level rise ↑ 1.4 feet	Coastal flooding and inundation Damage to coastal infrastructure and communities Bluff erosion

Data: NCA 2018, Climate Impacts Group, Miller et al. 2018
Figure: Climate Impacts Group

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… but we're on the path to ***more*** warming

What would it take to avoid 1.5°C of warming?

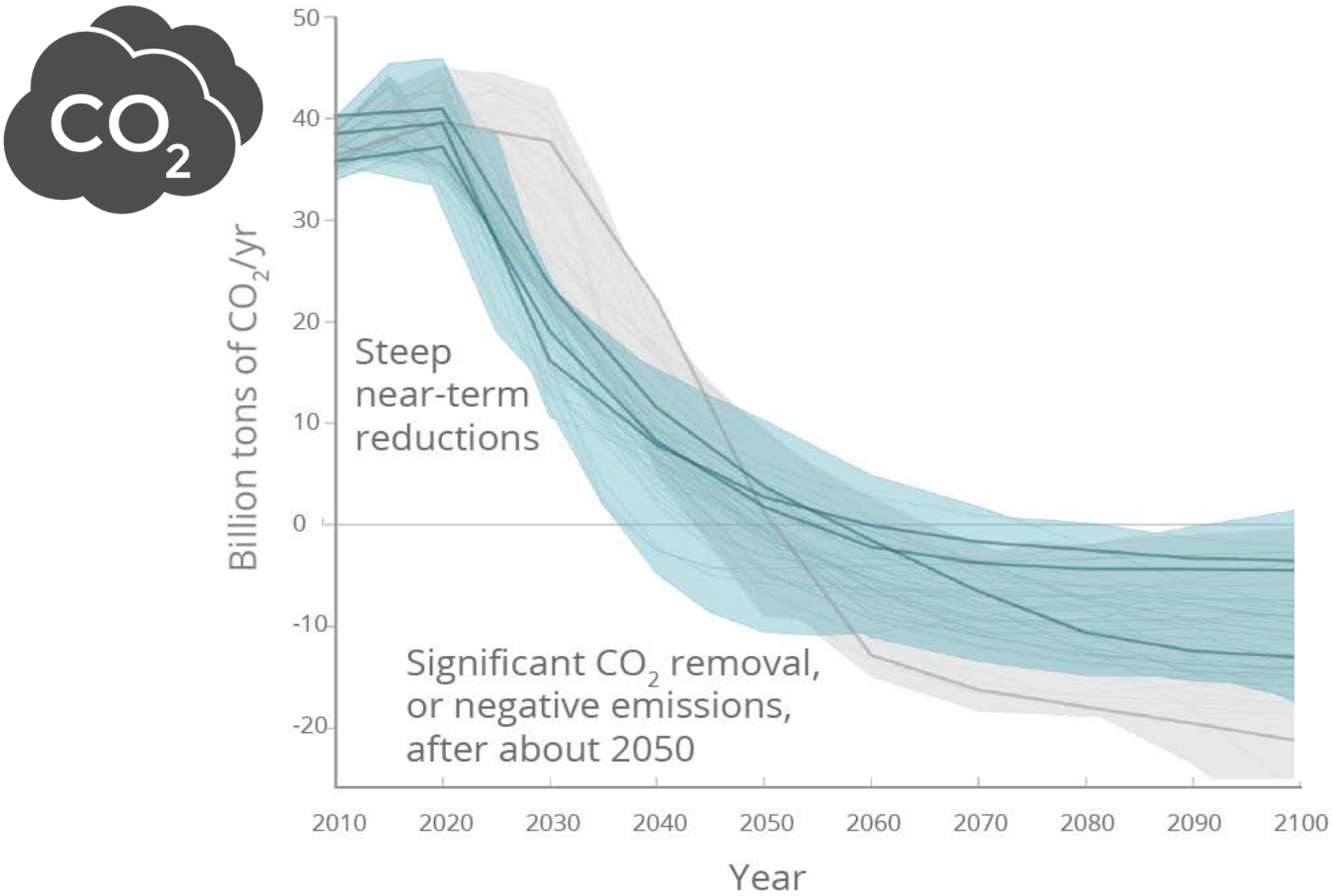
Stabilizing temperatures at <u>any level</u> requires <u>net-zero</u> emissions

As long as more CO_2 is added to the atmosphere than is removed, as is currently the case, global temperatures will continue to increase.

IPCC 2018

Limited time left to limit warming to 1.5°C

but we have options



Modified from IPCC 2018

The extent of harm from global warming depends on…

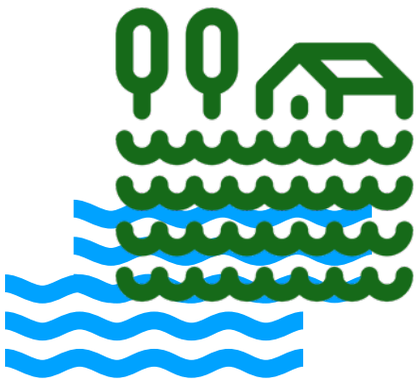
How much warming occurs

Local resilience to warming's impacts

Today's actions shape tomorrow's risks through…

Choices about energy use, fuel type … greenhouse gas emissions

Deciding whether to plan & manage our communities, economy & ecosystems for the climate of the future or the climate of the past



Climate change will affect Southern Resident Orca by

Reducing prey availability (stressing salmon populations across all components of their freshwater and coastal lifecycles)

Increasing toxic mobilization from coastal and freshwater inputs

Climate change will affect Orca recovery by

Increasing urgency and significance of recovery efforts needed

Potentially comprising the efficacy of recovery actions

These issues can be addressed by

Evaluating changing risks, implementing commensurate recovery actions and working to avoid negative effects from others' climate adaptation responses

Addressing the root cause of climate impacts

Amy Snover

UW Climate Impacts Group

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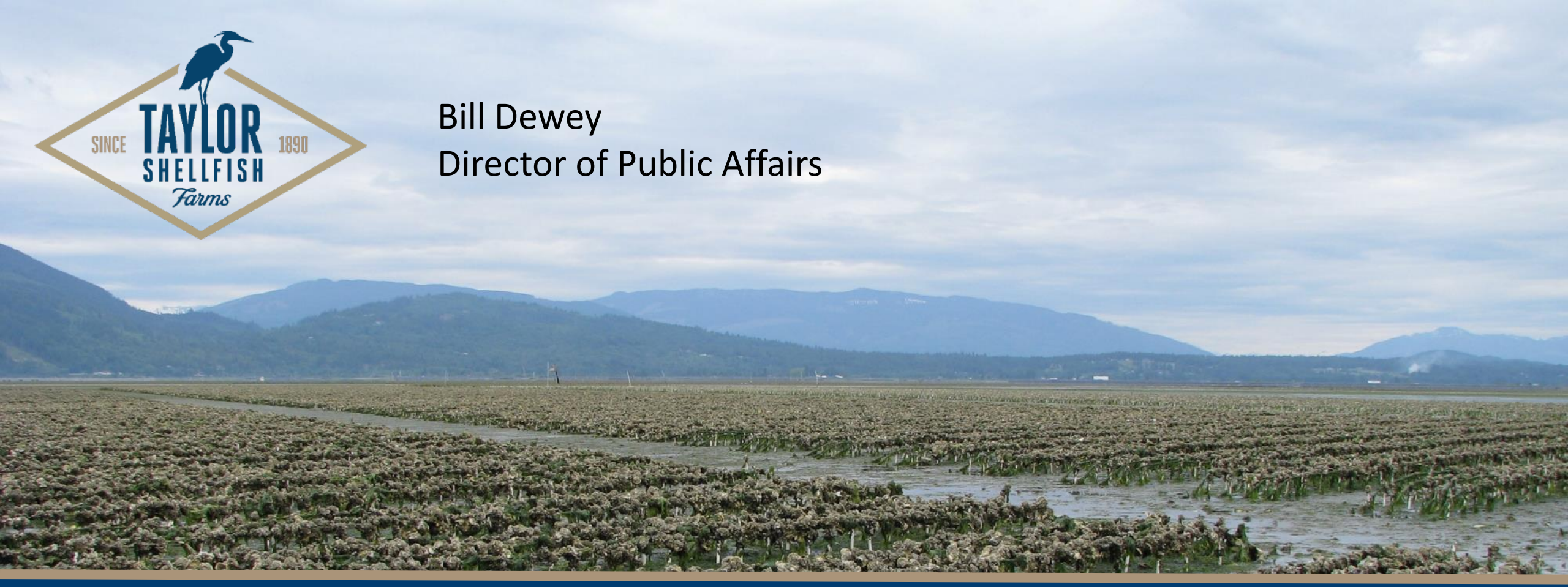
cig.uw.edu

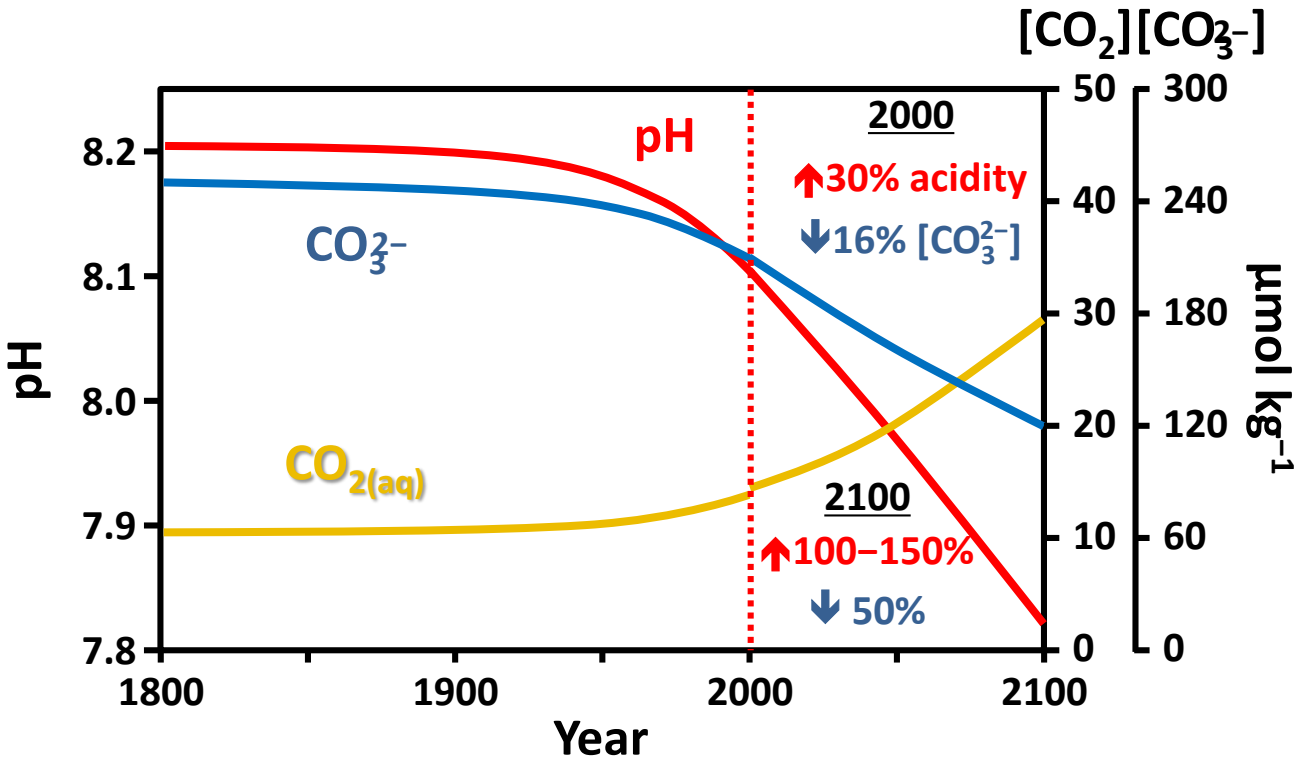
COLLEGE OF THE ENVIRONMENT
UNIVERSITY *of* WASHINGTON



Bill Dewey
Director of Public Affairs

Impacts of Ocean Acidification on West Coast Shellfish Aquaculture

Ocean chemistry changes from anthropogenic carbon dioxide

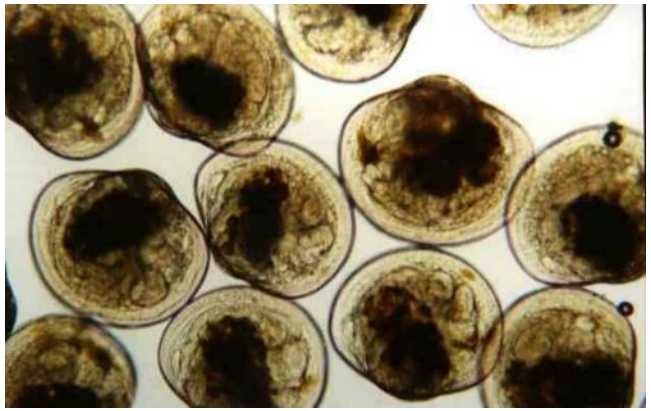


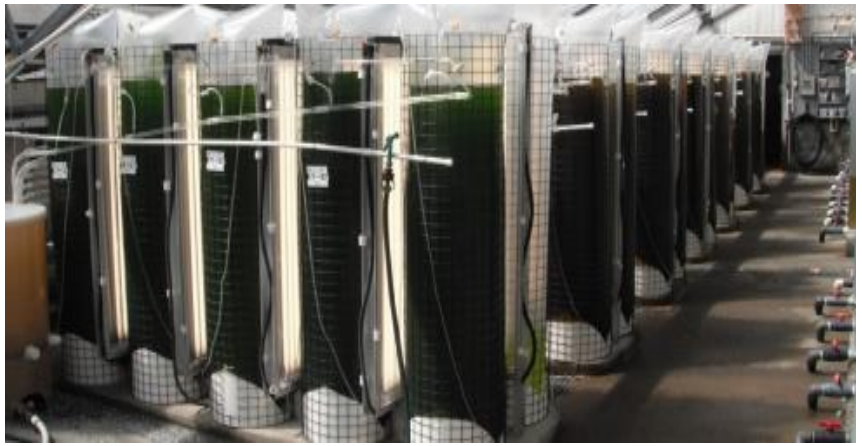
Wolf-Gladrow et al. (1999)

Shellfish seed production

Taylor Shellfish Farms Hatchery
Dabob Bay, Washington (USA)

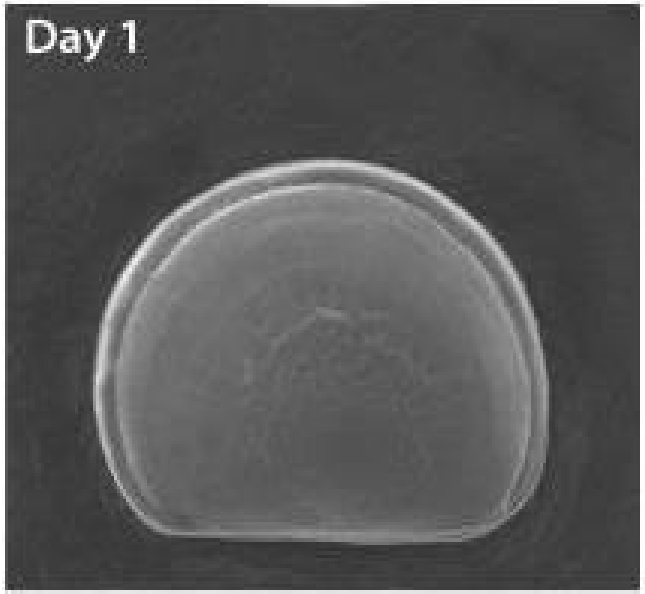
Shellfish seed production



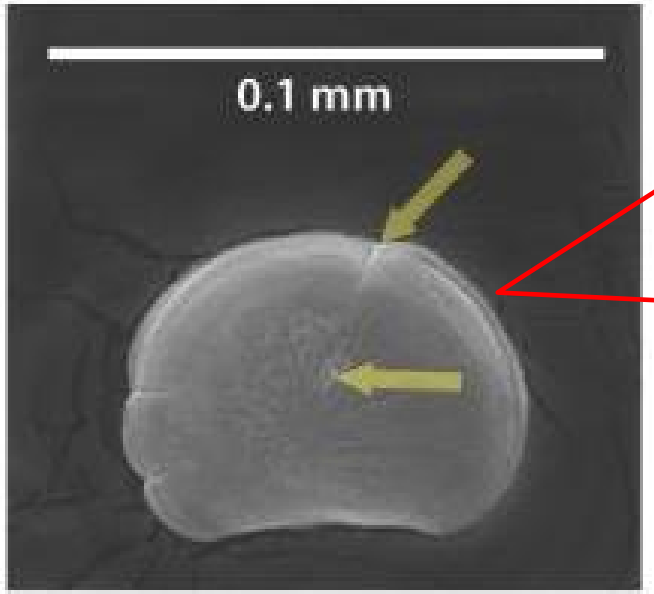


Day old oyster larvae

Healthy



Not healthy



What happens when there are not enough carbonate ions in the water!

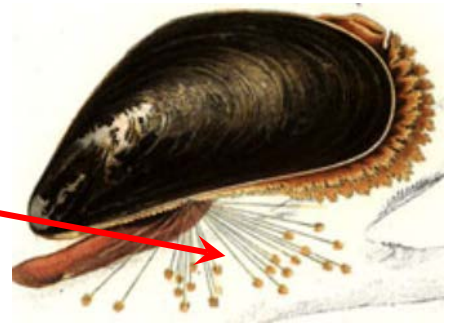
SEM photo: OSU Brunner/Waldbusser

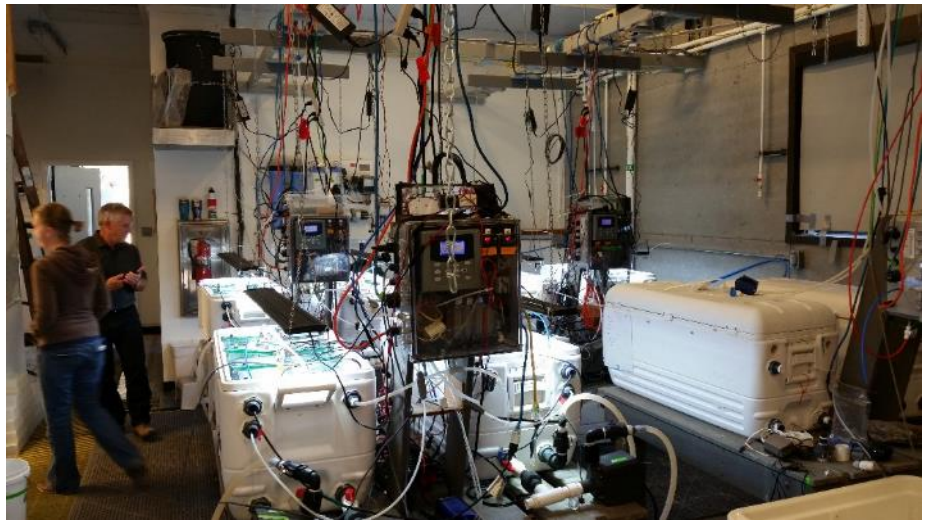
~ 1 week old oyster larvae

With inadequate carbonate ions oyster larvae run out of energy before forming their feeding and swimming organ (velum) and die

OA impact on mussels

- University of Washington research
- Weaker byssal threads
- Thinner shells





Panic/Adaptation

- Ramped up monitoring and research
- Treating hatchery rearing water
- Breeding ocean acidification resistant oysters
- Expanded seed production in Hawaii
- Experimenting w/ seaweed/seagrass refuges

Red Box Pictures

Seaweed/Seagrass refuge

Questions?

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