Phytoplankton and Primary Production

Breakout: Phytoplankton and Primary Production

Navigating the Workshop

Welcome! While we wait, please:

- Introduce yourself in the chat.

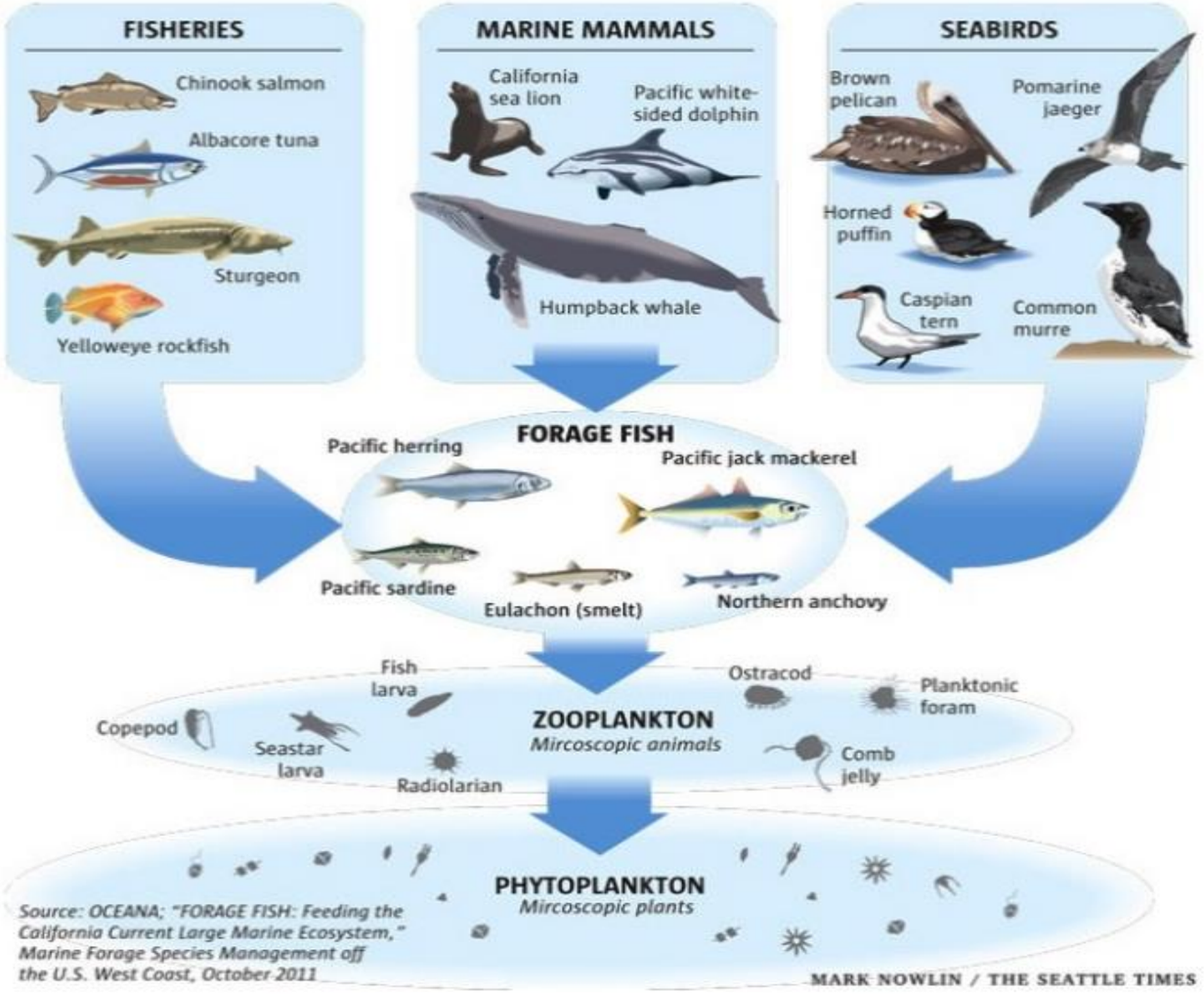
During discussion:

- Add your questions to the chat
- Raise your hand and we'll unmute you

- Discussion is focusing on the driving questions and associated scientific uncertainties. However, please feel to put in the chat any of the following towards brainstorming the future workshop discussion:
  - Who else should be in the room?
  - The "how" of addressing questions raised using modeling

The slides, recording, and synthesis will be available on [Puget Sound Institute's website]

Primary Production & Phytoplankton Breakout



2013, 2016 PSEMP Monitoring Gaps Work

QUESTION 10: <u>Is the ecology of phytoplankton, including nuisance and harmful algal bloom (HAB) species, in Puget Sound well understood?</u>

- **BIG GAP: Spatial and temporal resolution of phytoplankton species and abundance.**
- The time-scale for changes in phytoplankton abundance is short and spatially variable, requiring more frequent monitoring and in more areas. This applies to both HAB and non-HAB species. *For example, shifting between a diatom-dominated food web to microbial-dominated food web (e.g., Noctiluca) has large consequences in reducing the amount of carbon (food) available to higher trophic levels, such as fish and benthic biota.*
- Only chlorophyll is monitored regularly for most programs, but conversion to C is too variable to be meaningful for most applications.
- **BIG GAP: No phytoplankton rates are being monitored (production, respiration, and sinking)***

Setting the stage: addressing observed changes at the bottom of the food web

Long term changes observed (Ecology's 27 Stations≈1999 to 2018):

Silicate:DIN & near-bottom: surface Chl A

Seasonal changes in Stratification & Chl A

Seasonal changes in DO, N, salinity & temp

DEPARTMENT OF ECOLOGY State of Washington

Source: See presentations by Christopher Krembs at Puget Sound General Nutrient Forum, July 19, 2017 and PSEMP phytoplankton group, May 18, 2022 for data plots

What are the impacts and why it matters to marine life and nutrient cycling? -focus of this presentation?

Hypothesis of change under discussion in regional monitoring forums

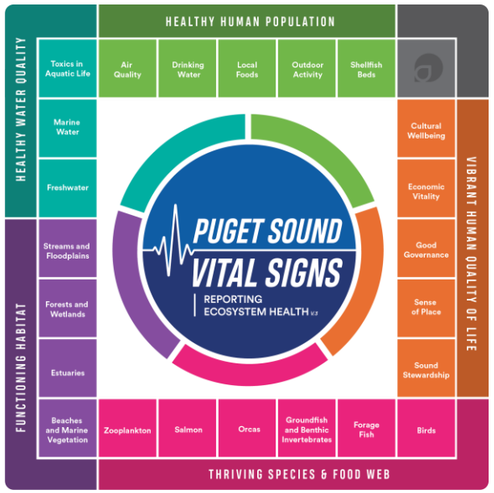
PSEMP

PUGET SOUND ECOSYSTEM MONITORING PROGRAM

Vulnerability is largely impacted by ocean and river impacts on physics – a focus of other breakout group today

Opportunity for Modeling<>Modeling

Current Efforts: Complementary Monitoring & Modeling



Primary Productivity & Phytoplankton Indicator Workshop Series

PSEMP

PUGET SOUND ECOSYSTEM MONITORING PROGRAM

PSEMP Marine Waters Work Group

5 workshops 2022-2023 to develop:

- State of Knowledge
- Existing Data
- Framework for developing monitoring & future indicators

Improved Monitoring

Research, Modeling, and Monitoring to Reduce Uncertainties

PUGET SOUND INSTITUTE
UNIVERSITY of WASHINGTON | TACOMA

SALISH SEA MODELING CENTER
UNIVERSITY of WASHINGTON

Address technical uncertainties & advance modeling tools for decision-making.

- Facilitate scientific workshops and regional collaboration
- Convene Model Evaluation Group
- Lead complementary model runs
- Expand access to models, outputs, tools, and scientific knowledge

Refine Research Actions

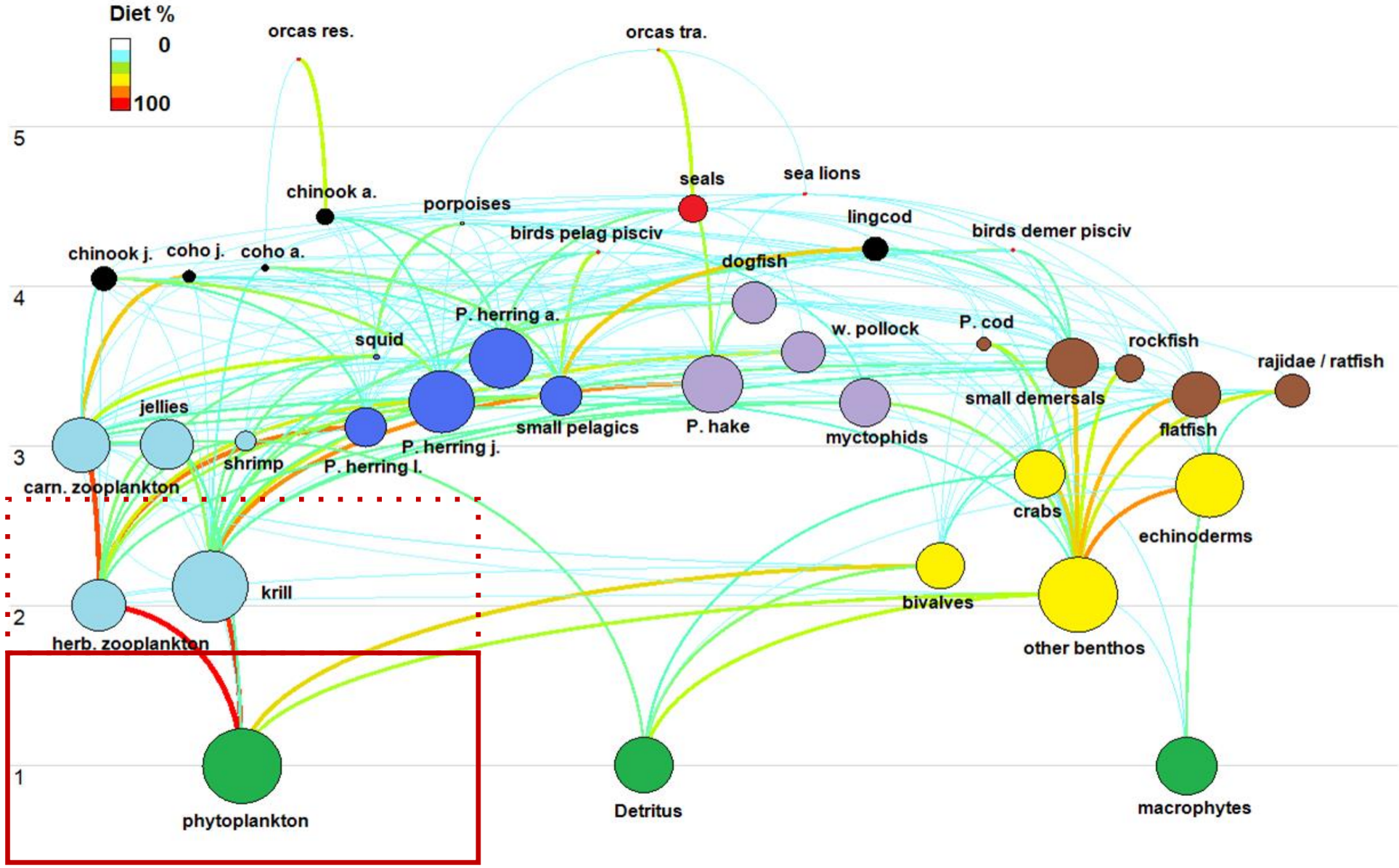
Terms & Definitions

	Standard Definition	Other Definitions	Typical Units
Phytoplankton	Loose term, includes unicellular autotrophs, mixotrophs and heterotrophs	Only photosynthetic cells (auto/mixotrophs)	
Bloom	Loose term, large increase in cell density (Smayda paper)	Density above certain threshold (e.g., Chl >30 μg/L)	
HAB species	Any species that can have a toxic or harmful effect on other organisms (usually above a certain density)	Any species that can negatively affect the environment (e.g., [illegible]) Only toxigenic species	
Biomass	Total dry weight	Carbon content	mg C/m^3, pg C/cell
Primary Production	Rate of carbon assimilation (gross and net) –big discussion - agreed a rate		mg C/m^2/yr, mg C/m^3/yr
Chlorophyll-*a*	Cell-bound, measured in the lab following some extraction protocol, usually by collecting cells on a filter - discrete water samples - extraction	Proxy for biomass or PP	mg/m^2, mg/m^3 or μ/L
Chlorophyll Fluorescence	*In vivo* chlorophyll fluorescence, usually measured *in situ*		RFU (relative units), mg/m^3

Rate vs. Concentration!

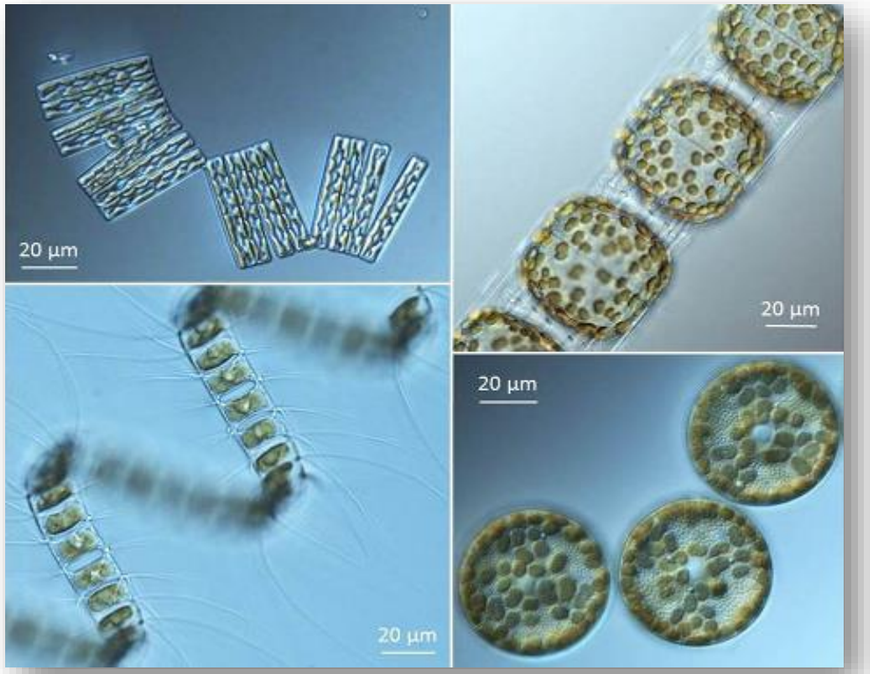
Developed and refined at the first Vital Sign workshop. Available here.

Phytoplankton Role & Function in Salish Sea Food Web



LLTK - Strait of Georgia ecosystem model – D. Preikshot & I. Perry, Fisheries and Oceans Canada

Observed Changes & Hypotheses of Drivers



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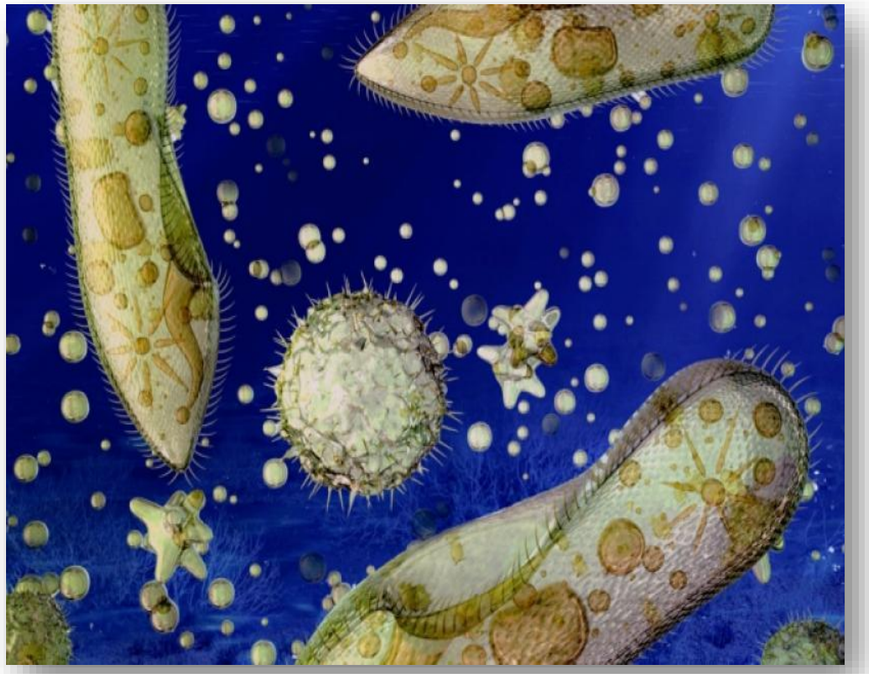
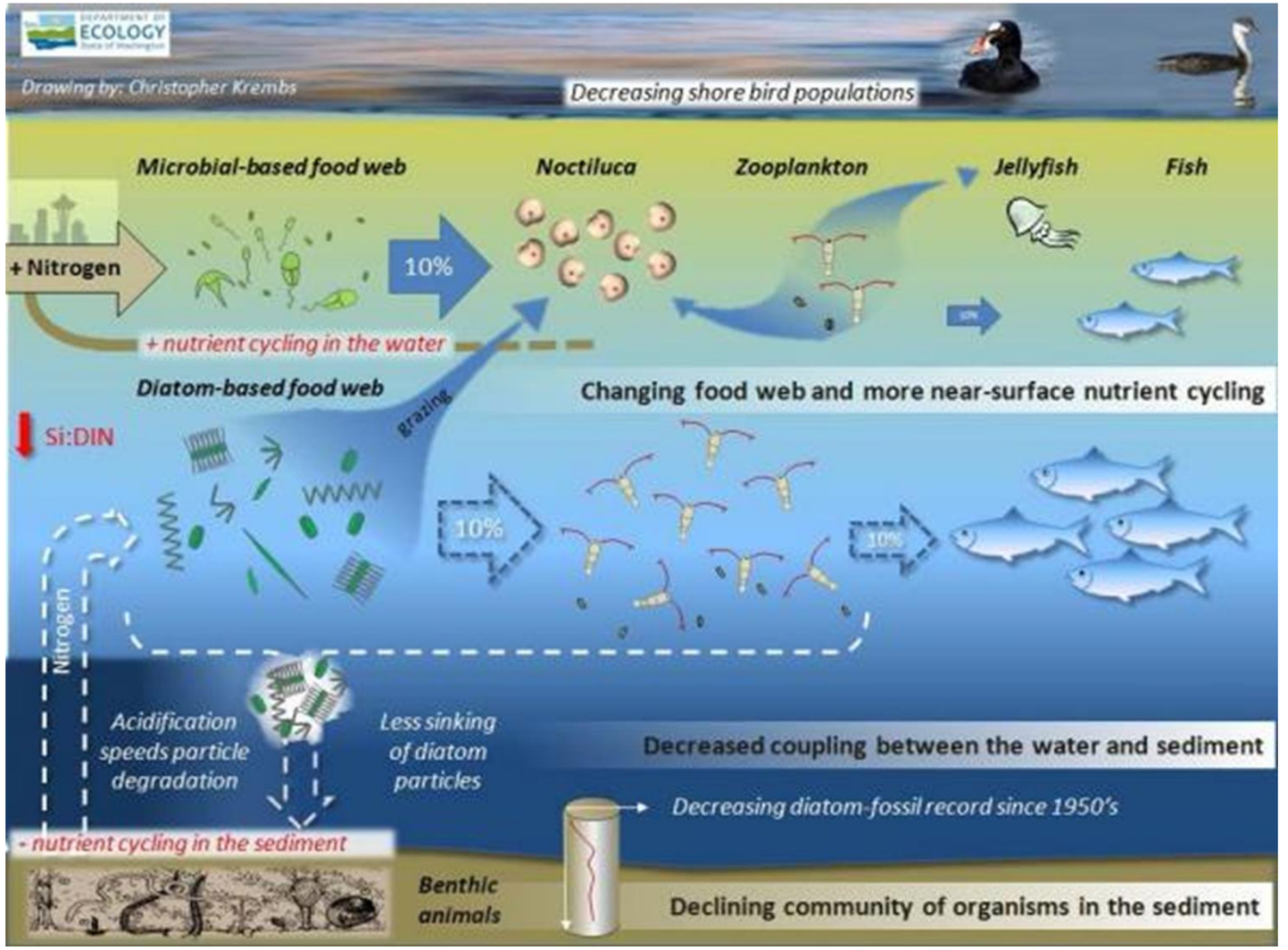


Observed Changes & Hypotheses of Drivers

Christopher Krembs. Eyes Over Puget Sound. Publication No. 13-03-075. Washington Dept. of Ecology, June 2013

Observed Changes & Hypotheses of Drivers



Christopher Krembs, Washington Dept. of Ecology

Questions and Answers

Discussion: Check on priorities moving forward

Next steps at these workshops:

1. Dive deeper on addressing uncertainties in changes observed, and hypothesis identified

Hypothesis of change under discussion in regional monitoring forums, e.g.:

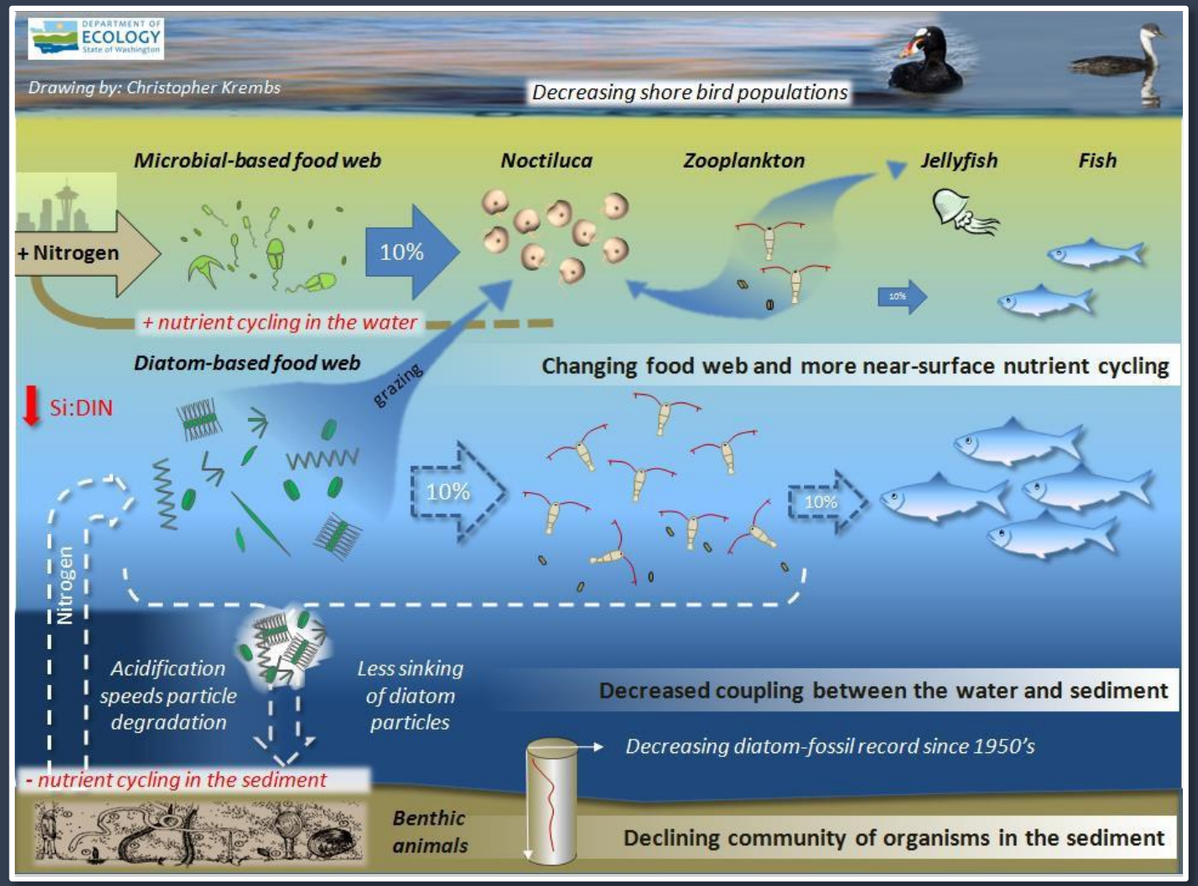
- Climate change and local human contribution to change in physics/euphotic nutrient availability
- Nutrient balance > lower level food webs
- Diatom > microbial food web

What prioritization of different parts of the physics of the system on the availability of nutrients of the euphotic zone would to address some of these hypothesis

Hypothesis: Changes in the lower food web

"Supporting science varies in strength. See last slide for details on each topic".

HS-1: Climate change has the effect of magnifying human nutrient contribution to Puget Sound and shifts the food web in the summer months.



HS-2: Changes in the nutrient balance affect the growth conditions of the lower levels of the marine food web.

HS-3: In summer, the microbial food web has gained importance relative to the productive, diatom-based food chain.

HS-4: The organic particle export to deeper water changed in response to shifts in the lower-trophic levels of the food web.

Source: See presentations by Christopher Krembs at Puget Sound General Nutrient Forum, July 19, 2017