Growth rate and microplankton grazing rates collected from cruises AT11-17, AT11-30, TUIM14MV, TN200, W0306A, W0308C from the Coastal Waters off Washington State and Vancouver Island; 2003-2006 (ECOHAB-PNW project)

Website: https://www.bco-dmo.org/dataset/3230
Version: 30 January 2009
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Project
» ECOHAB - Pacific Northwest (ECOHAB-PNW)

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Table of Contents

Dataset Description

ECOHAB/PNW - Growth rate and microplankton grazing rates

Methods & Sampling

Methods for In situ Phytoplankton Growth and Grazing Rate Measurements

Growth rate and microzooplankton grazing rates on total, >5 and were measured on the Washington coast on six ECOHAB PNW cruises from 2003-2006.

Estimates of in situ phytoplankton growth rate (µu, d-1) and grazing (g, d-1) of

size-fractionated Chl a (5 µm) were determined simultaneously using the seawater dilution technique (e.g., Landry et al. 1995). Seawater was collected
from the depth corresponding to 50% surface irradiance and was typically between 3 and 5 m depth. Particle-free filtered seawater (FSW) was made by first pooling the water of several Niskin bottles into a 50 L polyethylene carboy and then gravity filtering this water through an in-line cascade of 3 µm and 0.2 µm Pall-Gelman pleated capsule filters and into a 20 L polycarbonate carboy. Experimental bottles (2.5 L polycarbonate bottles) were filled to pre-determined levels with FSW. All containers, tubing, and in-line filters were acid-cleaned prior to use with 5% (v/v) HCl acid and rinsed copiously with deionized water.

Clean techniques were used throughout all experimental and sample manipulation.

Whole seawater (WSW) was drained from several Niskin bottles (same cast as FSW) using silicone tubing wrapped with 200 µm mesh into a 50 L polyethylene carboy.
The WSW was kept well-mixed by gentle stirring with a polyethylene plunger.
The WSW was siphoned from the 50 L WSW carboy into the experimental bottles containing the PFW to reach either three (0.1, 0.5, and 1.0 WSW) or five (0.1, 0.2, 0.4, 0.7, and 1.0 WSW) target dilution levels.
Experimental bottles were amended with nutrients to achieve enrichments of 10 µmol L-1 nitrate (NaNO3), 0.63 µmol L-1 phosphate (NaH2PO4 * H2O), 10 µmol L-1 silicic acid (Na2O3Si * 9H2O),
and 3 nmol L-1 Fe (Fe in 2% HCl) to the ambient water concentrations. An additional set of 1.0 WSW bottles were filled without nutrient amendments to test for potential
nutrient limitation phytoplankton communities. Duplicate samples were randomly taken from the WSW carboy during water disbursement for chlorophyll, preserved samples and nutrients.

Dilution treatment bottles were placed in clear Plexiglas tubes covered with mylar film to simulate the in situ irradiance. The tubes were secured to a revolving wheel
(1 rpm) submerged in a Plexiglas on-deck incubator and incubated for 24 h. The temperature inside the incubator was maintained near in situ levels by continuously flowing surface seawater. Incident photosynthetically active radiation (PAR, umol quanta m-2 s-1) was measured with a Hobo Par Smart Sensor and data logger mounted on the incubator, and water temperature was monitored with a submerged Hobo Water Temp Pro data logger.

In each replicate dilution bottle, the nutrient-amended net growth rate (k_n) was determined according to k_n = ln(N1/N0)/t1-t0, where N1 and N0 are the final total and size-fractionated Chl a concentration at time 1 (t1) and time 0 (t0), respectively. The intrinsic rates of growth (µ, d-1) and mortality due to grazing by microzooplankton (g, d-1) of the size fractionated Chl a were calculated by linear regression of net growth rate (k_n) in each nutrient amended dilution bottle against the fraction of WSW, Di. Growth (µ) was determined by extrapolation of the regression to the ordinal intercept, where Di (proportional to grazing mortality, g) becomes zero, and hence, $k_n = \mu_n$. Because nutrients were added to the treatment bottles, if phytoplankton growth is limited by in situ nutrient
concentrations, μ_n is a potential growth rate. When nutrient-limited growth was observed in the 1.0 WSW control bottles, the in situ intrinsic rate (μ_{un}), was estimated from $\mu_n = k_{un\ 1.0} + g$, where $k_{un\ 1.0}$ is the net growth rate in the 1.0 WSW treatment without added nutrients (Landry et al. 1995). Microzooplankton grazing on Chl a size fractions was determined by the slope of linear regressions of kn and Di. On two occasions dilution regressions showed evidence of saturated grazing kinetics (Gallegos 1989).
For these experiments, µ was calculated using the linear portion of the regression, while g was calculated using $g = \mu_n - k_{n\ 1.0}$, where$k_{n\ 1.0}$ is the net growth rate in
the nutrient-enhanced 1.0 WSW dilution treatment.

Further details on measuring Pseudo-nitzschia-specific rates in these experiments can be found in:

Olson, M.B., Lessard, E.J., Cochlan, W.P., Trainer, V.L., 2008. Intrinsic growth and microzooplankton grazing on toxigenic Pseudo-nitzschia spp. diatoms from the coastal northeast Pacific. Limnol. Oceanogr. 53, 1352-1368.

Data Processing Description

BCO-DMO Processing Notes

Generated from original file ECOHAB_PNW_phyto growth and grazing rates.xls
contributed to BCO-DMO as a single sheet xls file by Evelyn Lessard

BCO-DMO Edits

- Parameter names modified to conform to BCO-DMO convention

- date reformatted to YYYYMMDD

- "" symbols in parameter names changed to "lt","gt"

- spaces in Cruise and Station text fields converted to "_"

- decimal data values padded to consistent decimal places

[table of contents | back to top]

Data Files

File
Growth.csv (Comma Separated Values (.csv), 7.75 KB) MD5:ed654ce78de563f5726081ba95d43df8 Primary data file for dataset ID 3230

[table of contents | back to top]

Parameters

Parameter	Description	Units
dilExID	Experiment number	text
Cruise	Cruise name and number	Text
CTD	CTD number	Text
Station	Standard station ID	Text
lon	Longitude	decimal degs (West is negative)
lat	Latitude	decimal degs (South is negative)
date	Local date	YYYYMMDD
depth	Depth of sample	Meters
tot_chl	Initial total chlorophyll concentration for dilution experiments	micrograms l-1
gt5_chl	Initial chlorophyll concentration > 5 µm	micrograms l-1
lt5_chl	Initial chlorophyll concentration	micrograms l-1
tot_u	In situ phytoplankton growth rate of total community	d-1
gt5_u	In situ phytoplankton growth rate of total community on the >5 um phytoplankton	d-1
lt5_u	In situ phytoplankton growth rate of total community on the	d-1
tot_g	In situ microzooplankton grazing rate of total phytoplankton	d-1
gt5_g	In situ microzooplankton grazing rate on the >5 µm phytoplankton	d-1
lt5_g	In situ microzooplankton grazing rate on the	d-1

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Niskin bottle
Generic Instrument Name	Niskin bottle
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

[table of contents | back to top]

Deployments

AT11-17

Website	https://www.bco-dmo.org/deployment/58003
Platform	R/V Atlantis
Report	http://bcodata.whoi.edu/ECOHAB_PNW/ECOHAB_Cruise3_Report.pdf
Start Date	2004-09-08
End Date	2004-09-28
Description	AT11-17: This is ECOHAB_3 (ECOHAB Cruise 3). Third cruise of the 6 ECOHAB-PNW cruises. Numbered sequentially from Cruise_1 - Cruise_6 as ECOHAB_1 - ECOHAB_6. Original cruise data are available from the NSF R2R data catalog

AT11-30

Website	https://www.bco-dmo.org/deployment/58004
Platform	R/V Atlantis
Report	http://bcodata.whoi.edu/ECOHAB_PNW/ECOHAB_Cruise4_Report.pdf
Start Date	2005-07-07
End Date	2005-07-27
Description	AT11-30: This is ECOHAB_4 (ECOHAB Cruise 4). Fourth cruise of the 6 ECOHAB-PNW cruises. Numbered sequentially from Cruise_1 - Cruise_6 as ECOHAB_1 - ECOHAB_6 Original cruise data are available from the NSF R2R data catalog

TUIM14MV

Website	https://www.bco-dmo.org/deployment/58005
Platform	R/V Melville
Report	http://bcodata.whoi.edu/ECOHAB_PNW/ECOHAB_Cruise5_Report.pdf
Start Date	2005-09-02
End Date	2005-09-22
Description	Cruise TUIM14MV is also known as ECOHAB_5 (ECOHAB Cruise 5) the fifth cruise of the 6 ECOHAB-PNW cruises; numbered sequentially from Cruise_1 - Cruise_6 as ECOHAB_1 - ECOHAB_6. Cruise information and original data are available from the NSF R2R data catalog.

TN200

Website	https://www.bco-dmo.org/deployment/58006
Platform	R/V Thomas G. Thompson
Report	http://bcodata.whoi.edu/ECOHAB_PNW/ECOHAB_Cruise6_Report.pdf
Start Date	2006-09-11
End Date	2006-10-04
Description	Cruise TN200 is also known as ECOHAB_6 (ECOHAB Cruise 6) the sixth of 6 ECOHAB-PNW cruises that are numbered sequentially from Cruise_1 - Cruise_6 as ECOHAB_1 - ECOHAB_6. Cruise information and original data are available from the NSF R2R data catalog.

W0306A

Website	https://www.bco-dmo.org/deployment/58001
Platform	R/V Wecoma
Report	http://bcodata.whoi.edu/ECOHAB_PNW/ECOHAB_Cruise1_Report.pdf
Start Date	2003-06-02
End Date	2003-06-23
Description	W0306A: This is ECOHAB_1 (ECOHAB Cruise 1) First cruise of the 6 ECOHAB/PNW cruises. Numbered sequentially from Cruise_1 - Cruise_6 as ECOHAB_1 - ECOHAB_6. .

W0308C

Website	https://www.bco-dmo.org/deployment/58002
Platform	R/V Wecoma
Report	http://bcodata.whoi.edu/ECOHAB_PNW/ECOHAB_Cruise2_Report.pdf
Start Date	2003-08-30
End Date	2003-09-19
Description	W0308C: This is ECOHAB_2 (ECOHAB Cruise 2). Second cruise of the 6 ECOHAB-PNW cruises. Numbered sequentially from Cruise_1 - Cruise_6 as ECOHAB_1 - ECOHAB_6.

[table of contents | back to top]

Project Information

ECOHAB - Pacific Northwest (ECOHAB-PNW)

Coverage: Off the Pacific Northwest coast

ECOHAB-PNW is a 5-year multi-disciplinary project that will study the physiology, toxicology, ecology and oceanography of toxic Pseudo-nitzschia species off the Pacific Northwest coast.

This program studies the physiology, toxicology, ecology and oceanography of toxic Pseudo-nitzschia species off the Pacific Northwest coast, a region in which both macro-nutrient supply and current patterns are primarily controlled by seasonal coastal upwelling processes. Recent studies suggest that the seasonal Juan de Fuca eddy, a nutrient rich retentive feature off the Washington coast serves as a "bioreactor" for the growth of phytoplankton, including diatoms of the genus Pseudo-nitzschia. Existing ship of opportunity data are consistent with the working hypothesis that the seasonal Juan de Fuca eddy is an initiation site for toxic Pseudo-nitzschia that impact the Washington coast and that upwelling sites adjacent to the coast are less likely to develop toxicity.

The long-term program goal is to develop a mechanistic basis for forecasting toxic Pseudo-nitzschia bloom development here and in other similar coastal regions in Eastern Boundary upwelling systems.

Specific study objectives are:
- 1.To determine the physical/biological/chemical factors that make the Juan de Fuca eddy region more viable for growth and sustenance of toxic Pseudo-nitzschia than the nearshore upwelling zone;
- 2. To determine the combination of environmental factors that regulate the production, accumulation, and/or release of domoic acid (DA) from Pseudo-nitzschia cells in the field;
- 3. To determine possible transport pathways between DA initiation sites and shellfish beds on the nearby coast.

The scientific operations of this study included obtaining multi-disciplinary data from a large scale grid, sampling water properties while following a drifter, deployment of surface drifters, satellite imagery, laboratory studies using water collected at selected sites, and numerical modeling of both the circulation

and chlorophyll concentration. Water samples included macronutrients, iron, particulate and dissolved domoic acid, Pseudo-nitzschia species and numbers. Experiments were done to estimate growth and grazing rates. Moored arrays were deployed to provide time series of currents and water properties from May to October, each year from 2003-2006. Numerical modeling studies on a fine scale grid focused on the seasonal development
of the Juan de Fuca eddy and its change in structure during selected wind conditions. Conditions favorable to release of phytoplankton from the eddy region were assessed.

After four years of field work the research team is able to describe a possible sequence of events necessary to ingestion of domoic acid by coastal shellfish:
(1) Plankton must become concentrated in the bloom source region. ECOHAB PNW studies suggest this requires
a period of downwelling-favorable or lightly fluctuating winds.
(2) Next the plankton must undergo stress sufficient to cause an increase in cellular toxin: in the Juan de Fuca eddy region toxin can be found on any survey of the region in both early and late summer within a 21 day time scale.
(3) Patches of toxic plankton must then escape from the offshore source region. For the Juan de Fuca eddy region
escape is favored during upwelling-favorable wind conditions that allow the geostrophic constraint of the eddy circulation pattern to be broken.
(4) The patch must move alongshore to sites with shellfish populations, and
(5) must retain its toxicity during the time period of transport. For a toxic source in the Juan de Fuca eddy this requires southward advection across the shelf, as occurs during periods of upwelling-favorable winds in summer and early fall. ECOHAB PNW studies show that toxin can be maintained in the 7-14 days required for transport. For an Oregon source such as Heceta bank to impact the Washington shelf, this requires northward
advection across the shelf, as occurs during periods of downwelling-favorable winds in spring.
(6) Last, the toxic patch must move onshore to coastal beaches and/or estuaries,
(7) where it must remain there for a period sufficient for significant ingestion by shellfish.

Cruises/Platforms:
Cruise = ECOHAB-PNW cruises, numbered sequentially from
Cruise_1 - Cruise_6 as ECOHAB_1 - ECOHAB_6.

Cruise_1=ECOHAB_1, R/V Wecoma, W0306A, June 2-23, 2003 Cruise Report
Cruise_2=ECOHAB_2, R/V Wecoma, W0308C, August 30 - September 19, 2003 Cruise Report
Cruise_3=ECOHAB_3, R/V Atlantis, AT11-17, September 8-28, 2004 Cruise Report
Cruise_4=ECOHAB_4, R/V Atlantis, AT11-30, July 7-27,2005 Cruise Report
Cruise_5=ECOHAB_5, R/V Melville, TUIM14MV, September 2-22, 2005 Cruise Report
Cruise_6=ECOHAB_6, R/V Thomas G. Thompson, TN200, Sept. 11- Oct. 4, 2006 Cruise Report

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0234587
National Oceanic and Atmospheric Administration (NOAA)	NA170P2789

[table of contents | back to top]