

# Phytoplankton and microzooplankton taxonomy biomass from R/V Wecoma multiple cruises in the Northeast Pacific coastal waters off states of Washington and Oregon from 2004 to 2006 (RISE project)

**Website:** <https://www.bco-dmo.org/dataset/3251>

**Version:** 20 March 2009

**Version Date:** 2009-03-20

## Project

» [River Influences on Shelf Ecosystems](#) (RISE)

Contributors	Affiliation	Role
<a href="#">Lessard, Evelyn J.</a>	University of Washington (UW)	Principal Investigator
<a href="#">Kachel, Nancy</a>	University of Washington (UW)	Contact
<a href="#">Gegg, Stephen R.</a>	Woods Hole Oceanographic Institution (WHOI)	BCO-DMO Data Manager

## Table of Contents

- [Dataset Description](#)
  - [Methods & Sampling](#)
  - [Data Processing Description](#)
- [Data Files](#)
- [Parameters](#)
- [Deployments](#)
- [Project Information](#)
- [Funding](#)

## Dataset Description

RISE - Biomass of phytoplankton and microzooplankton taxa groups

### Methods & Sampling

#### Methods for Phototrophic and Heterotrophic Plankton Taxa Sampling,

#### Preservation, Enumeration and Biomass Estimation

(Modified from Frame and Lessard, in press)

Biomass of phytoplankton and microzooplankton taxa groups were measured in the initial samples for dilution experiments off the Washington and Oregon coasts taken during four RISE cruises 2004-2006.

Replicate samples for phytoplankton and microzooplankton identification, enumeration, and sizing were preserved with either acid Lugol's (5% final

conc.) or glutaraldehyde (0.5% final conc.). Glutaraldehyde-fixed samples were stained with DAPI and proflavin, then filtered onto 0.8 $\mu$ m and 0.2 $\mu$ m black polycarbonate membranes (Lessard and Murrell 1996). Slides were stored frozen until analysis onshore.

#### *Microscope counts*

Known volumes of the Lugols-preserved samples were settled in counting chambers for enumeration of ciliates (including mixotrophs), diatoms and larger dinoflagellates. Counts were performed on a Zeiss inverted microscope at 250x magnification. Glutaraldehyde-preserved samples on 0.8 $\mu$ m filters were examined with a Zeiss standard epifluorescence microscope at 400x magnification for enumeration of microphytoplankton including photosynthetic dinoflagellates (typically raphidophyte. Samples on the 0.2 $\mu$ m filters were examined at 1000x magnification for cyanobacteria, picoeukaryotes (and heterotrophic nanoflagellates (>2-10 $\mu$ m).

#### *Biomass estimates*

Picoplankton (cyanobacteria and picoeukaryotes) were sized using images taken with a QImaging Retiga EX charged coupled device (CCD) camera and Image Pro Plus software. Dimensions of all other cells were measured using a computer-aided digitizing system (Roff and Hopcroft 1986). Cell volumes were calculated using appropriate geometric formulas and carbon was calculated using the carbon to volume equations of Menden-Deuer and Lessard (2000) for diatoms, nanoplankton and dinoflagellates, and of Worden et al. (2004) for picoplankton. Ciliate carbon was estimated using the conversion from Putt and Stoecker (1989).

#### **References for further details:**

Lessard, E.J. and M.C. Murrell (1996), Distribution, abundance and size composition of heterotrophic dinoflagellates and ciliates in the Sargasso Sea near Bermuda, Deep Sea Research Part I, 43(7), 1045-1065.

Frame, E.R. Frame and E.J. Lessard. Does the Columbia River Plume influence phytoplankton community structure along the Washington and Oregon coasts? In press. J. Geophysical Res.

Menden-Deuer, S., and E. J. Lessard (2000), Carbon to volume relationships for dinoflagellates, diatoms, and other protist plankton. Limnol. Oceanogr., 45, 569-579.

Putt, M., and D. K. Stoecker. 1989. An experimentally determined carbon:volume ratio for marine "oligotrichous" ciliates from estuarine and coastal waters. Limnol. Oceanogr. 34: 1097-1103.

Roff, J. C. and R. R. Hopcroft (1986), High precision microcomputer based measuring system for ecological research, Can. J. Fish. Aquat. Sci., 43, 2044-2048.

Worden, A.Z., J.K. Nolan, and B. Palenik (2004), Assessing the dynamics and ecology of marine picophytoplankton: the importance of the eukaryotic component, Limnol. Oceanogr., 49(1), 168-179.

## **Data Processing Description**

### **BCO-DMO Processing Notes**

Generated from original single sheet xls file contributed to BCO-DMO by Evelyn Lessard

### **BCO-DMO Edits**

- spaces in Cruise text field converted to "\_"
- Date formatted to YYYYMMDD
- decimal data values padded to consistent decimal places
- Cruise changed from "RISE\_1,2,3,4" to RISE04W1, etc for consistency with other data sets

[ [table of contents](#) | [back to top](#) ]

---

## **Data Files**

**File****Biomass.csv**(Comma Separated Values (.csv), 7.40 KB)

MD5:d52bee38bbcb53116caa973870938e3b

Primary data file for dataset ID 3251

[ [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 degrees
lat	Latitude	Decimal degrees
date	Local date	YYMMDD
depth	Depth of sample	meters
diatom	diatom biomass	microg Carbon l-1
ciliate	heterotrophic and mixotrophic ciliates	microg Carbon l-1
hdino	heterotrophic dinoflagellates	microg Carbon l-1
pdino	phototrophic dinoflagellates	microg Carbon l-1
crypto	cryptophytes	microg Carbon l-1
peuk	picoeukaryotes	microg Carbon l-1
cyano	cyanobacteria	microg Carbon l-1
pnan	photosynthetic nanoflagellates	microg Carbon l-1
hnan	heterotrophic nanoflagellates	microg Carbon l-1

[ [table of contents](#) | [back to top](#) ]

---

## Deployments

**W0407A**

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/58008">https://www.bco-dmo.org/deployment/58008</a>
<b>Platform</b>	R/V Wecoma
<b>Report</b>	<a href="http://bcodata.whoi.edu/RISE/CruiseReports/RISE-1_Wecoma_CruiseReport.pdf">http://bcodata.whoi.edu/RISE/CruiseReports/RISE-1_Wecoma_CruiseReport.pdf</a>
<b>Start Date</b>	2004-07-08
<b>End Date</b>	2004-07-28
<b>Description</b>	<p>W0407A, RISE-1, RISE1W, RISE04W1 This cruise is the first of four cruises in the RISE program aboard the R/V Wecoma, which was charged with the task of conducting hydrographic surveys. The R/V Pt. Sur conducted studies of the Columbia R. plume frontal structure, mixing processes and zooplankton dynamics concurrently with this cruise on the R/V Wecoma. Cruise Objectives The purpose of this cruise was to make physical, chemical and biological measurements within the plume of the Columbia River and over the shelves north and south of the river mouth, with the objective of determining the effect of the river plume on regional productivity. Historical observations have shown that in spite of weaker upwelling winds the Washington shelf is more highly productive than much of the Oregon shelf. Comparative measurements of biological rates, chemical constituents including iron and other micro nutrients and plankton growth and grazing as well as community distributions were made in the three regions. These data complement data from three moored arrays deployed in the study area, data from a second ship, the R/V Pt. Sur, that focused on mixing rates and large scale physical, nitrate, fluorescence surveys as well as frontal processes, and data from remote sensing and model studies. RISE-1 Figures: Cruise Track Stations and Moorings Wind Events</p>

**W0505C**

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/58010">https://www.bco-dmo.org/deployment/58010</a>
<b>Platform</b>	R/V Wecoma
<b>Report</b>	<a href="http://bcodata.whoi.edu/RISE/CruiseReports/RISE-2_Wecoma_CruiseReport.pdf">http://bcodata.whoi.edu/RISE/CruiseReports/RISE-2_Wecoma_CruiseReport.pdf</a>
<b>Start Date</b>	2005-05-29
<b>End Date</b>	2005-06-21
<b>Description</b>	<p>W0505C, RISE-2, RISE2W, RISE05W2 This cruise is the second of four cruises in the RISE program aboard the R/V Wecoma, which was charged with the task of conducting hydrographic surveys. Cruise information and original data are available from the NSF R2R data catalog. The R/V Pt. Sur, concurrently with this cruise on the R/V Wecoma, conducted studies of the Columbia R. plume frontal structure, mixing processes and a Triaxis survey of the shelf</p>

**W0508**

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/58012">https://www.bco-dmo.org/deployment/58012</a>
<b>Platform</b>	R/V Wecoma
<b>Report</b>	<a href="http://bcodata.whoi.edu/RISE/CruiseReports/RISE-3_CruiseReport_Daily.pdf">http://bcodata.whoi.edu/RISE/CruiseReports/RISE-3_CruiseReport_Daily.pdf</a>
<b>Start Date</b>	2005-08-04
<b>End Date</b>	2005-08-26
<b>Description</b>	<p>W0508, RISE-3, RISE3W, RISE05W3 This cruise is the third of four cruises in the RISE program aboard the R/V Wecoma, which was charged with the task of conducting hydrographic surveys. The R/V Pt. Sur, concurrently with this cruise on the R/V Wecoma, conducted studies of the Columbia R. plume frontal structure, mixing processes and a Triaxis survey of the shelf Stations and Moorings</p>

**W0605B**

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/58015">https://www.bco-dmo.org/deployment/58015</a>
<b>Platform</b>	R/V Wecoma
<b>Report</b>	<a href="http://bcodata.whoi.edu/RISE/CruiseReports/RISE-4_Wecoma_CruiseReport_F_TDP.pdf">http://bcodata.whoi.edu/RISE/CruiseReports/RISE-4_Wecoma_CruiseReport_F_TDP.pdf</a>
<b>Start Date</b>	2006-05-21
<b>End Date</b>	2006-06-13
<b>Description</b>	W0605B, RISE-4, RISE4W, RISE06W4 This cruise is the fourth of four cruises in the RISE program aboard the R/V Wecoma, which was charged with the task of conducting hydrographic surveys. Cruise information and original data are available from the NSF R2R data catalog. The R/V Pt. Sur, concurrently with this cruise on the R/V Wecoma, conducted studies of the Columbia R. plume frontal structure, mixing processes and a Triaxis survey of the shelf

[ [table of contents](#) | [back to top](#) ]

---

## Project Information

### River Influences on Shelf Ecosystems (RISE)

**Website:** <http://www.ocean.washington.edu/rise>

**Coverage:** Northeast Pacific, coastal waters off states of Washington and Oregon

### **River Influences on Shelf Ecosystems (RISE) - A Study of the Columbia River Plume A Multi-Institutional Collaborative Project Sponsored by the National Science Foundation**

In 2004 an interdisciplinary study "River Influences on Shelf Ecosystems" (RISE) was initiated to determine the extent to which alongshore gradients in ecosystem productivity might be related to the existence of the massive freshwater plume from the Columbia River. RISE was designed to test three hypotheses: - During upwelling the growth rate of phytoplankton within the Columbia plume exceeds that in nearby areas outside the plume being fueled by the same upwelling nitrate.

- The plume enhances cross-margin transport of plankton and nutrients.
- Plume-specific nutrients (Fe and Si) alter and enhance productivity on adjacent shelves.

Within those constraints, RISE provides the first comprehensive interdisciplinary study of the rates and dynamics governing the mixing of river and coastal waters in an eastern boundary system, as well as the effects of the plume formed by the mixing processes on rates, standing stocks and community structure of plankton in the local ecosystem. The RISE project, includes 4 field and two different numerical model applications. We collected simultaneous measurements of water chemistry, phytoplankton growth and grazing rates, zooplankton populations, water currents, and turbulent mixing. These are being combined with data from satellites, radar, and moorings, as well as detailed numerical simulations, to develop a deeper understanding of this important ecosystem.

The overall RISE sampling strategy was to compare mixing rates, nutrient supply, and phytoplankton production, grazing and community structure within the plume and outside the plume; i.e. on the shelf to the north of the river mouth, presumed more productive, and on the shelf to the south of the river mouth, presumed less productive, as well as in the important "plume lift off" area (the region where the plume loses contact with the bottom) near the river mouth and the plume "near field". The backbone for this project consists of data collected during four cruises that took place in the seasonally high-flow period (May-June) in each of three years (2004-06) and in a low-flow period in the second year (August, 2005). The sampling was spread over three years to attempt to include interannual differences in processes related to wind and river flow variability. The 21-day length of the cruises ensured that a variety of circulation and growth regimes, including upwelling and relaxation/downwelling and neap/spring tides, were observed.

The field studies used two vessels operating simultaneously. The R/V Wecoma obtained primarily biological and chemical rate data: a) at individual stations on cardinal lines north and south of the river mouth (off Grays Harbor, WA and Cape Meares, OR) and near the river mouth; b) at selected process study stations; and c) at fixed stations near the river mouth during strong neap and spring tides (time series). A towed sensor package

was used to obtain micronutrient samples near the sea surface on cardinal lines and other selected transects. Underway measurements included macronutrients (N, P, Si), dissolved trace metals (Fe, Mn), supplemented with discrete samples from the underway system (microscopy, FlowCAM and particulate trace metals). At CTD stations vertical profiles (0-200 m where possible; and 500 m at selected stations) of T, S, vertical shear and currents, dissolved O<sub>2</sub>, in vivo fluorescence, PAR, chlorophyll a, dissolved macronutrients (NO<sub>3</sub>, NH<sub>4</sub>, urea, PO<sub>4</sub>, SiO<sub>4</sub>), dissolved trace metals, and heterotrophic and autotrophic plankton composition were obtained. Surface drifters were used to follow the mixing of individual plumes and to provide information on surface currents.

On the R/V Pt. Sur, synoptic mesoscale and fine-scale features were sampled with underway measurements of near-surface T, S, velocity, particle size and concentration, PAR, transmissivity and fluorescence and nitrate+nitrite. The Pt. Sur's Triaxus tow fish provided high-resolution sections of T, S, zooplankton (Laser-OPC), PAR and transmissivity, fluorescence, particle size and concentration (LISST-FLOC25X), UV absorption and nitrate (Satlantic ISUS) and radiance/irradiance (7 channels) through the upper water column to 50 m. Rapidly-executed transects of turbulence and fine-structure were also carried out using the Chameleon profiler; these provide full-depth profiles of T, S, optics (880 nm backscatter and fluorescence), turbulence dissipation rates and turbulent fluxes every 1-3 minutes. During selected periods, transects were repeated hourly to capture the high-frequency evolution in the plume's nearfield and river estuary. Acoustics (surface-deployed 1200 kHz ADCP and 120 kHz echosounder) were used to image fine-scale features of the velocity and backscatter fields, resolving fronts, nonlinear internal waves, and turbulent billows.

The temporal context for observed variability was provided by an array of moored sensors deployed in the plume near field as well as on the shelf north and south of the plume (complemented by the pre-existing long-term estuarine and plume stations of the CORIE/SATURN network. To better resolve regional differences, moorings were moved farther north and south to the cardinal sampling lines after the first year of the program. Surface currents were mapped hourly from shore using HF radar with two simultaneously operating arrays, one with a 40 km range and a 2 km range resolution, the other with a 150 km range and a 6 km range resolution. Satellite ocean color, sea surface temperature, turbidity and synthetic aperture radar (SAR) were also obtained when available.

Two modeling systems were developed or enhanced during RISE. The system developed specifically for RISE employed a structured grid model (ROMS) and was used in hindcast mode (MacCready et al., 2008). The CORIE/SATURN modeling system (Baptista, 2006)- based on two unstructured-grid models (SELFE, Zhang and Baptista, 2008; and ELCIRC, Zhang et al., 2004)- was used in both near real-time prognostic mode and multi-year hindcast mode. Both modeling systems incorporated the estuary in the simulation domain (although at different resolutions) and used realistic river, ocean and atmospheric forcing conditions, tidal forcing, and Columbia River estuary forcing. Wind/heat flux model forcing for ROMS was derived from the 4 km MM5 regional wind/heat flux model. SELFE and LCIRC were also forced by MM5. Conditions on open boundaries were provided by ~9 km resolution models from the Navy Research Laboratory (NRL) (NCOM); ROMS used the smaller domain NCOM-CCS NRL model, SELFE and ELCIRC used the larger domain Global-NCOM model. The biological model is a four-box ("NPZD") nitrogen-budget model that tracks nutrients, phytoplankton, zooplankton, and detritus in every cell of the ROMS grid. The rich RISE biological dataset allowed model validation against not just stocks (chlorophyll, microzooplankton, nutrients) but rates (phytoplankton growth and grazing) directly, a level of validation that is seldom possible. These rate observations also allowed the setting of key model parameters (e.g., zooplankton ingestion rate and mortality) empirically (Banas, et al., 2008).

#### **References:**

Banas, N. S., P. MacCready, and B. M. Hickey (2008), The Columbia River plume as cross-shelf exporter and along-coast barrier, doi:10.1016 Cont. Shelf Res., 2008.03.011

Baptista, A. M. (2006), CORIE: the first decade of a coastal-margin collaborative observatory, Oceans'06, MTS/ IEEE, Boston, MA.

Hickey, B.M., and the RISE PIs. River Influences on Shelf Ecosystems: Introduction to the RISE Volume, Cont. Shelf Res., in press.

MacCready, P., N. S. Banas, B. H. Hickey, E. P. Dever, and Y. Liu (2008), A model study of tide- and wind-induced mixing in the Columbia River Estuary and Plume, doi:10.1016/j. Cont. Shelf Res. 2008.03.015.

#### **RISE Cruise Reports and Figures:**

##### **2004 RISE-1**

RISE04W1=R/V Wecoma, W0407A, July 8-28, 2004



[Cruise Report](#)  
[Cruise Track](#)  
[Stations and Moorings](#)  
[Wind Events](#)

RISE2004=R/V Point Sur, (tbd), July 8-28, 2004

[Cruise Report](#)

### **2005 RISE-2**

RISE05W2=R/V Wecoma, W0505C, May 29-June 21, 2005

[Cruise Report](#)

[Cruise Track](#)

[Stations and Moorings](#)

[Wind Events](#)

RISE2005a=R/V Point Sur, (tbd), May 29-June 21, 2005

[Cruise Report](#)

### **2005 RISE-3**

RISE05W3=R/V Wecoma, W0508, August 4-August 26, 2005

[Daily Cruise Report](#)

[Lessard Cruise Report](#)

[Peterson/Shaw Zooplankton Report](#)

[Cruise Track](#)

[Stations and Moorings](#)

[Wind Events](#)

RISE2005b=R/V Point Sur, (tbd), August 2-August 27, 2005

[Cruise Report](#)

[Cruise Log](#)

### **2006 RISE-4**

RISE06W4=R/V Wecoma, W0605B, May 21-June 13, 2006

[Cruise Report 1](#)

[Cruise Report 2](#)

[Cruise Track](#)

[Stations and Moorings](#)

[Wind Events](#)

RISE2006a=Leg 1, R/V Point Sur, (tbd), May 21-May 31, 2006

[Cruise Report Leg 1](#)

RISE2006b=Leg 2, R/V Point Sur, (tbd), June 2-June 12, 2006

[Cruise Report Leg 2](#)

[ [table of contents](#) | [back to top](#) ]

---

## **Funding**

<b>Funding Source</b>	<b>Award</b>
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-0239089</a>

[ [table of contents](#) | [back to top](#) ]