

Motivation  
ooooooo

Buoys  
ooo

BCCM  
oooo

Populations  
ooo

Ecosystem summaries  
oo

Installation  
oo

# pacea

pacea: An R package of Pacific ecosystem information to help facilitate an ecosystem approach to fisheries management

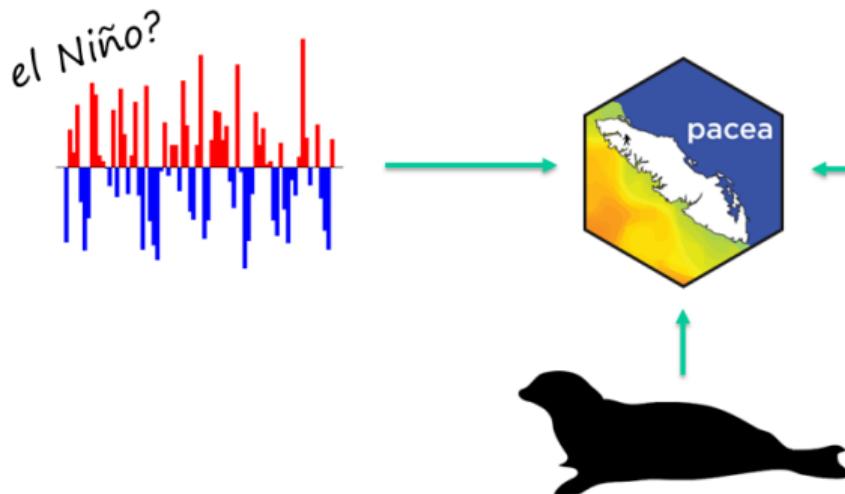
Andrew Edwards and Travis Tai



# pacea: An R package of Pacific ecosystem information to help facilitate an ecosystem approach to fisheries management

Andrew Edwards and Travis Tai

Pacific Biological Station, Fisheries and Oceans Canada, Nanaimo, BC.



pacea palooza, 3<sup>rd</sup> and 14<sup>th</sup> November 2025

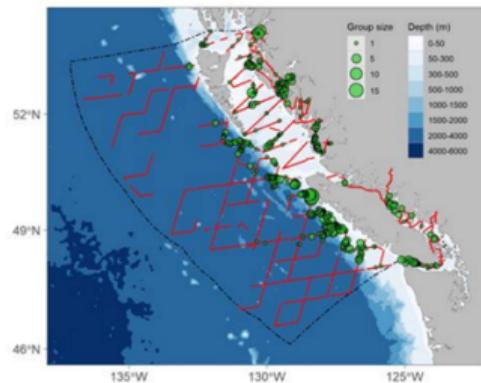


Fisheries and Oceans Canada  
Pêches et Océans Canada



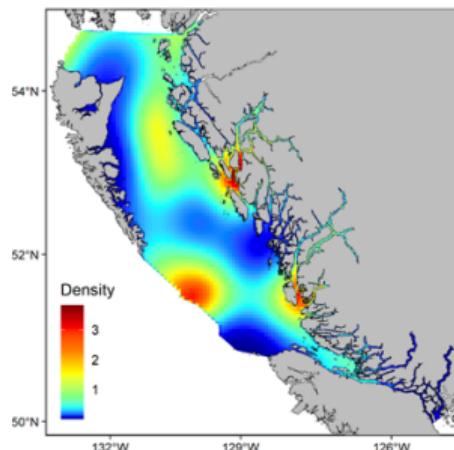
## Motivation (based on a true story)

Survey sightings of Humpback Whales



Modelling →

Estimated densities

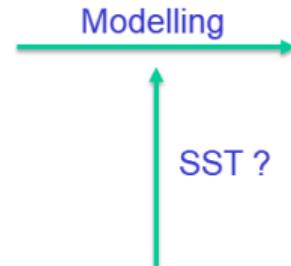
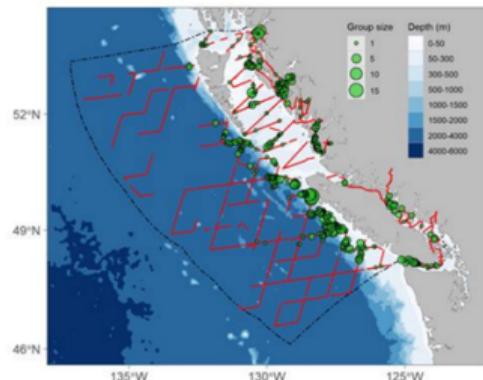


See Doniol-Valcroze et al. (2022) in last year's SOPO report.  
Density plot courtesy Brianna Wright.

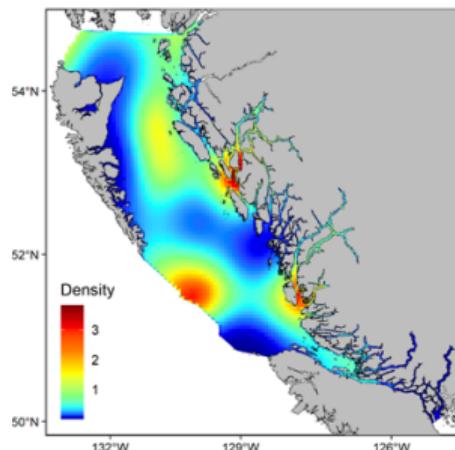


## Motivation (based on a true story)

Survey sightings of Humpback Whales



Estimated densities



# Motivation (based on a true story)

A search for sea surface temperature yields an overwhelming number (341) of choices:

 ERDDAP  
Easier access to scientific data Brought to you by 

## ERDDAP > Search

### Do a Full Text Search for Datasets:

341 matching datasets, with the most relevant ones listed first.  
(Or, refine this search with Advanced Search 

Grid DAP Data	Sub-set	Table DAP Data	Make A Graph	W M S	Source Data Files	Accessible 	Title	Summary	F GDC, ISO, Metadata	Back-ground Info	RSS	E mail	Institution
data			graph	M		public	Sea-Surface Temperature, NOAA ACSPO Daily Global 0.02° Gridded Super-collated SST and Thermal Fronts Reanalysis, 2012-present, Daily (L3S-LEO degrees C)	 F I M	background  	 	NOAA/NESDIS/STAR		
data			graph	M		public	Sea-Surface Temperature, NOAA ACSPO NOAA-20 VIIRS CoastWatch Co-gridded 4km Daily (degrees C)	 F I M	background  	 	NOAA/NESDIS/OSPO		
data			graph	M		public	Sea-Surface Temperature, NOAA ACSPO S-NPP VIIRS CoastWatch Co-gridded 4km Daily (degrees C)	 F I M	background  	 	NOAA/NESDIS/OSPO		
data			graph	M	files	public	Sea-Surface Temperature, NOAA Geo-polar Blended Analysis Day+Night, GHRSST, Near Real-Time, Global 5km, 2019-Present, Daily	 F I M	background  	 	NOAA NESDIS Coast... 		
data			graph	M	files	public	Sea-Surface Temperature, NOAA Geo-polar Blended Analysis Diurnal Correction (Day+Night), GHRSST, Near Real-Time, Global 5km, 2019-Present, Daily	 F I M	background  	 	NOAA NESDIS Coast... 		

# Motivation (based on a true story)

A search for sea surface temperature yields an overwhelming number (341) of choices:

 ERDDAP  
Easier access to scientific data Brought to you by 

## ERDDAP > Search

### Do a Full Text Search for Datasets:

341 matching datasets, with the most relevant ones listed first.  
(Or, refine this search with Advanced Search 

Grid DAP Data	Sub-set	Table DAP Data	Make A Graph	W M S	Source Data Files	Accessible 	Title	Summary	F GDC, ISO, Metadata	Back-ground Info	RSS	E mail	Institution
data			graph	M		public	Sea-Surface Temperature, NOAA ACSPO Daily Global 0.02° Gridded Super-collated SST and Thermal Fronts Reanalysis, 2012-present, Daily (L3S-LEO degrees C)	 F I M	background   	 	NOAA/NESDIS/STAR		
data			graph	M		public	Sea-Surface Temperature, NOAA ACSPO NOAA-20 VIIRS CoastWatch Co-gridded 4km Daily (degrees C)	 F I M	background   	 	NOAA/NESDIS/OSPO		
data			graph	M		public	Sea-Surface Temperature, NOAA ACSPO S-NPP VIIRS CoastWatch Co-gridded 4km Daily (degrees C)	 F I M	background   	 	NOAA/NESDIS/OSPO		
data			graph	M	files	public	Sea-Surface Temperature, NOAA Geo-polar Blended Analysis Day+Night, GHRSST, Near Real-Time, Global 5km, 2019-Present, Daily	 F I M	background   	 	NOAA NESDIS Coast... 		
data			graph	M	files	public	Sea-Surface Temperature, NOAA Geo-polar Blended Analysis Diurnal Correction (Day+Night), GHRSST, Near Real-Time, Global 5km, 2019-Present, Daily	 F I M	background   	 	NOAA NESDIS Coast... 		

Likely requires extensive data wrangling to be usable, which usually takes way, way, longer than anticipated.

So the SST analysis did not happen.

# Motivation

- Revised Fisheries Act: “... the Minister shall take into account the environmental conditions affecting a fish stock.”
- Yet <50% of DFO's stock assessments currently use environmental data.
- Only 28% of assessments in Pacific Region.
- Leading cause of not using environmental data is availability of the data.

# Motivation

- Revised Fisheries Act: “... the Minister shall take into account the environmental conditions affecting a fish stock.”
- Yet <50% of DFO's stock assessments currently use environmental data.
- Only 28% of assessments in Pacific Region.
- Leading cause of not using environmental data is availability of the data.
- Open Data is great, but can be hard to convert raw data into usable information.
- Primary audience is DFO stock assessment scientists, but usable by anyone (with a minimal working knowledge of R).

## Hence... pacea

- Released in November 2023.
- Maintained and extended since then.
- Include vignettes that walk users through various features.
- All data (except oceanographic model output) is saved within the package
  - no further downloading required
  - not relying on external websites being functional.
- Code is completely open source: transparent, traceable, and transferable.

# pacea palooza 2025

- Given quite a few talks, but not done a detailed how-to presentation
- Gave short talk to Molecular Genetics Section
- Claire thought of hosting a workshop

## Day 1

- motivation and overview (this talk)
- overview of GitHub site
- we will walk through example code of each type of data and model output
  - based on the vignettes that are rendered on GitHub
  - so you do **not** need to frantically copy everything down that we type
- options:
  - people play with relevant outputs on their own?
  - look at people's questions? work through one together?
  - troubleshoot any installation issues

# pacea palooza 2025

## Between Day 1 and Day 2

- carry on digging into the package
- wrangle any of your own data that you want to use with pacea outputs to investigate a problem
- try some analyses

## Day 2

- people say what they have done
- any problems we can work through together
- people could plug away individually (or in pairs/groups, particularly if some people are less familiar with R) and we help out
- whatever else people want

Motivation  
ooooooo

Buoys  
●○○

BCCM  
oooo

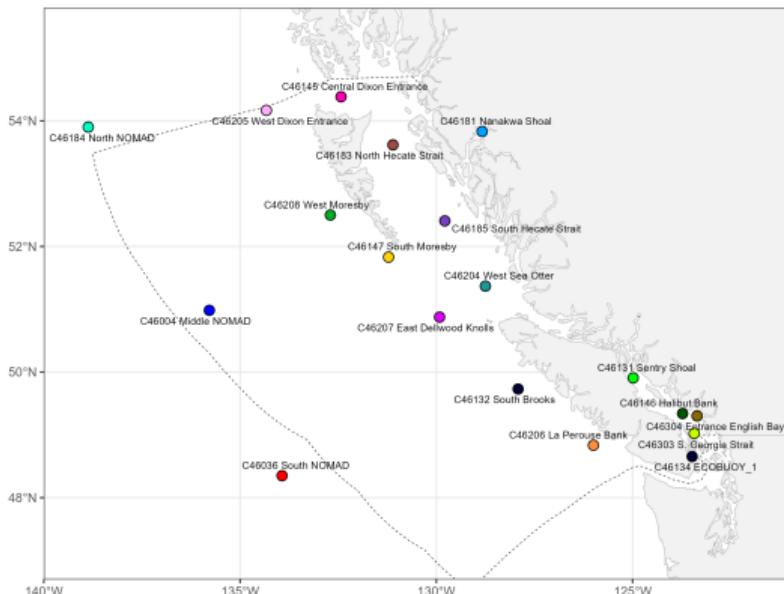
Populations  
ooo

Ecosystem summaries  
oo

Installation  
oo

# Sea surface temperature data from buoys

Data from 19 buoys maintained by DFO/ECCC (Environment and Climate Change Canada), hosted through CIOOS (Canadian Integrated Ocean Observing System).



# Sea surface temperature data from buoys

The data are saved as a tibble in pacea:

```
buoy_sst
# A tibble: 211,524 x 3
  date      stn_id    sst
  <date>    <fct>   <dbl>
1 1988-08-05 C46004  12.8
2 1988-08-06 C46004  12.7
3 1988-08-07 C46004  12.5
4 1988-08-08 C46004  12.5
5 1988-08-09 C46004  12.6
6 1988-08-10 C46004  12.6
# i 211,518 more rows
```

# Sea surface temperature data from buoys

The data are saved as a tibble in pacea:

```
buoy_sst
# A tibble: 211,524 x 3
  date      stn_id    sst
  <date>    <fct>   <dbl>
1 1988-08-05 C46004  12.8
2 1988-08-06 C46004  12.7
3 1988-08-07 C46004  12.5
4 1988-08-08 C46004  12.5
5 1988-08-09 C46004  12.6
6 1988-08-10 C46004  12.6
# i 211,518 more rows
```

```
tail(buoy_sst)
# A tibble: 6 x 3
  date      stn_id    sst
  <date>    <fct>   <dbl>
1 2024-12-13 C46304  8.04
2 2024-12-14 C46304  8.00
3 2024-12-15 C46304  8.09
4 2024-12-16 C46304  7.92
5 2024-12-17 C46304  8.35
6 2024-12-18 C46304  8.43
```

Motivation  
ooooooo

Buoys  
oo•

BCCM  
oooo

Populations  
ooo

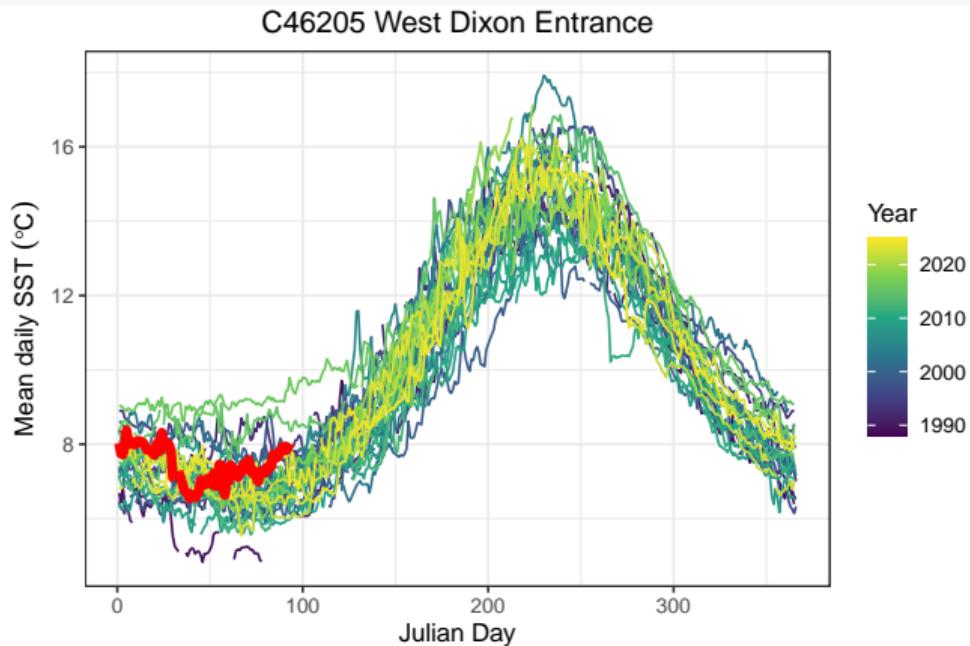
Ecosystem summaries  
oo

Installation  
oo

# Sea surface temperature data from buoys

Plot data from a single buoy for all years, the default is for buoy C46205:

```
plot(buoy_sst)
```



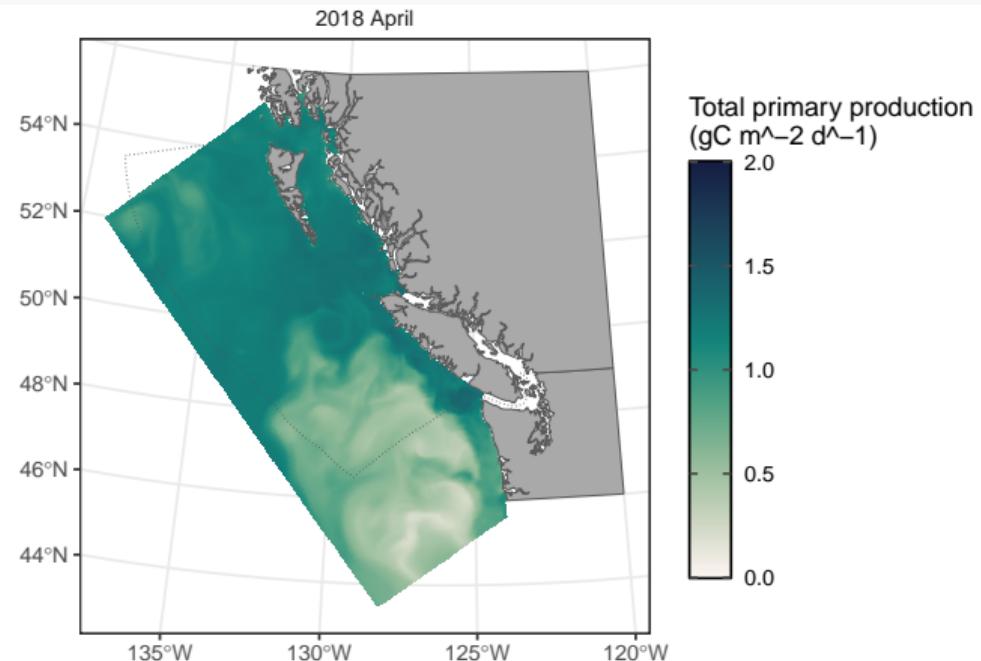
# British Columbia Continental Margin (BCCM) model

Physical biogeochemical oceanographic model

- Peña et al. (2019), *Deep-Sea Research II*.
- we interpolate to regular **2 km x 2km grid**
- **161,025 cells**
- monthly from 1993-2019
- huge filesizes required hosting outputs on Zenodo not GitHub

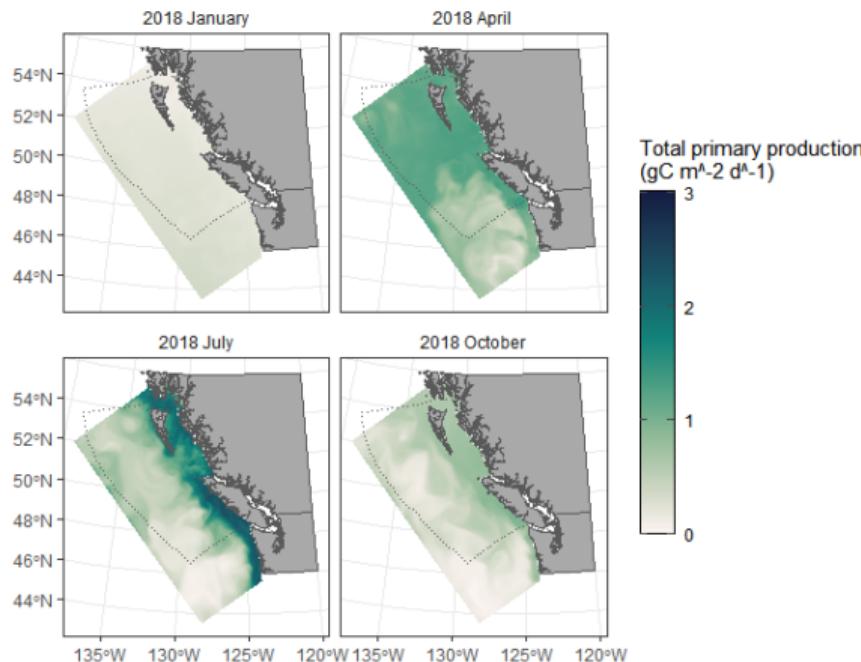
# Built in plotting - primary production in April 2018

```
plot(bccm_primaryproduction_full())
```



# Built in plotting - primary production throughout 2018

```
plot(bccm_primaryproduction_full(),  
     months = c(1, 4, 7, 10))
```



# Available variables

The variables are:

- dissolved oxygen concentration
- pH
- salinity
- temperature
- depth-integrated phytoplankton
- depth-integrated primary production.

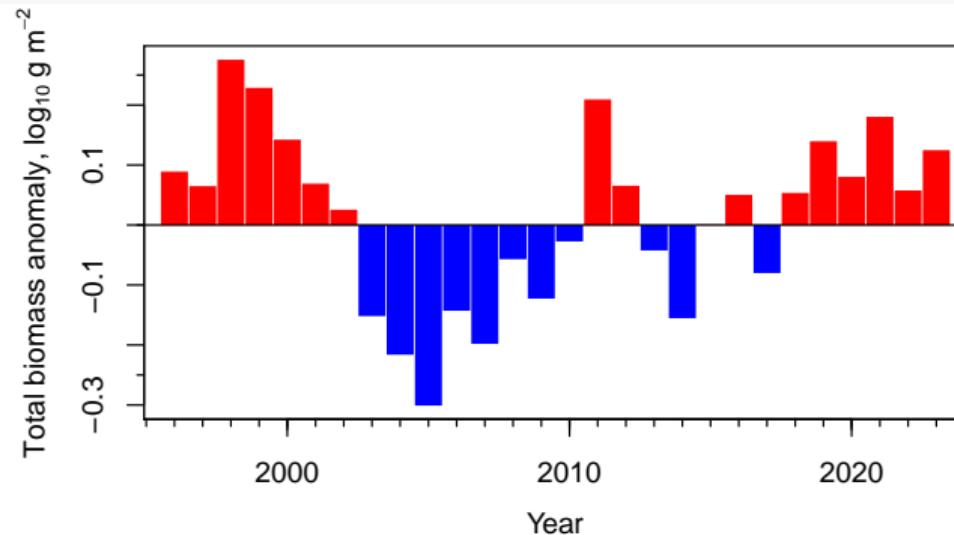
For applicable variables these are given for

- sea surface
- 0-40 m integration
- 40-100 m integration
- 100 m to the sea bottom
- sea bottom.

# Zooplankton in the Strait of Georgia

- anomalies of zooplankton biomass since 1996 (Perry et al., 2021)
- extended by Kelly Young each year for SOPO; 25 species groups

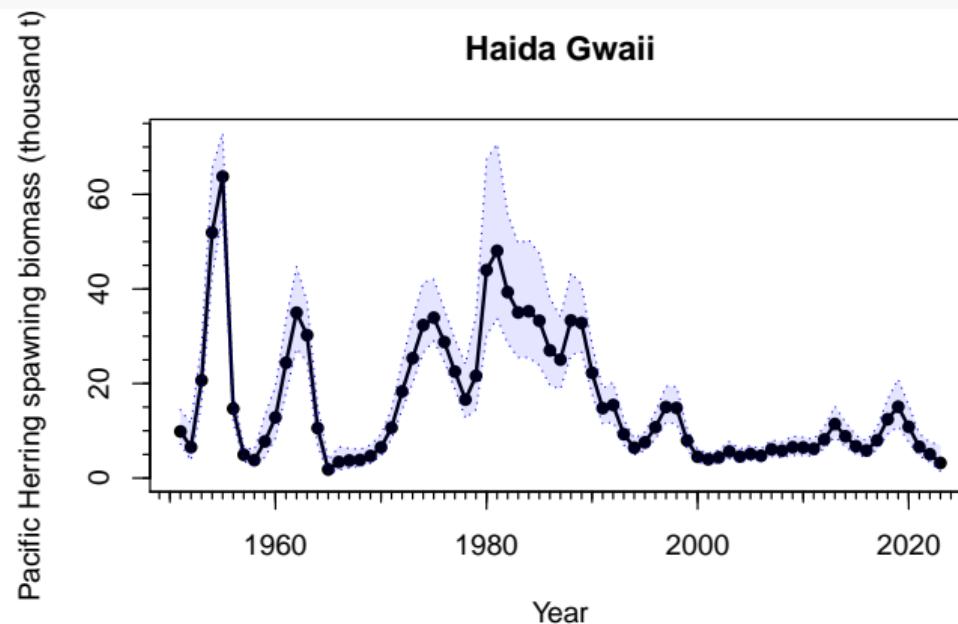
```
plot(zooplankton_sog)
```



# Pacific Herring biomass (five stocks)

New and updating annually from stock assessments (Cleary et al.):

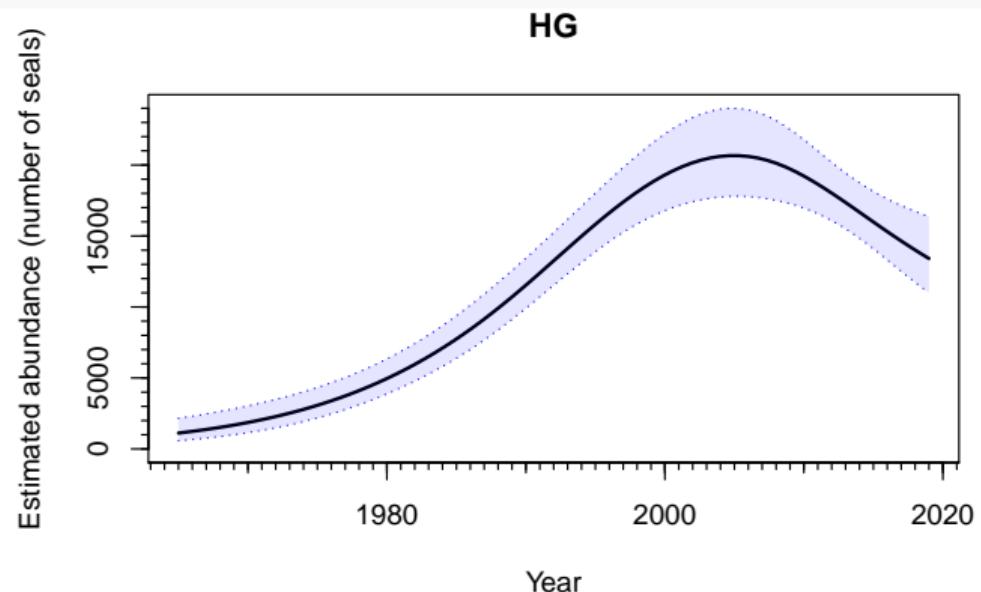
```
plot(herring_spawning_biomass,  
      region = "HG")
```



# Pacific Harbour Seals

Estimated abundances for seven regions (and coastwide) were calculated by DFO (2022; SAR 2022/034), and included here:

```
plot(harbour_seals,  
      region = "HG")
```



Motivation  
ooooooo

Buoys  
ooo

BCCM  
oooo

Populations  
ooo

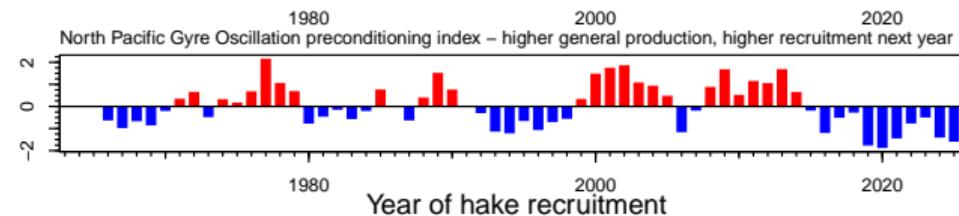
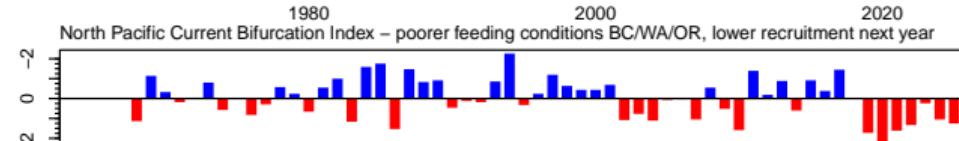
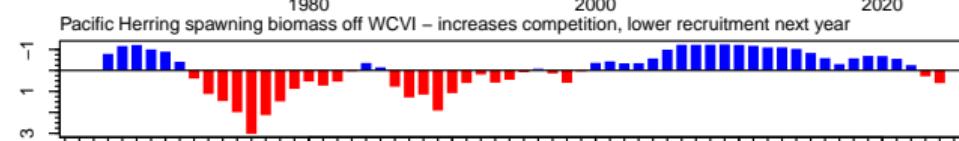
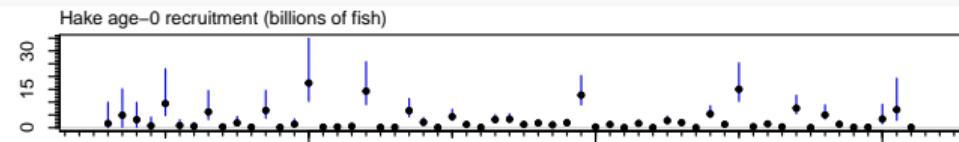
Ecosystem summaries  
●○

Installation  
oo

# Ecosystem summaries

Stock-specific ecosystem summary – [Johnson et al. \(2025\)](#)

[ecosystem\\_summary\\_hake\(\)](#)



Motivation  
ooooooo

Buoys  
ooo

BCCM  
oooo

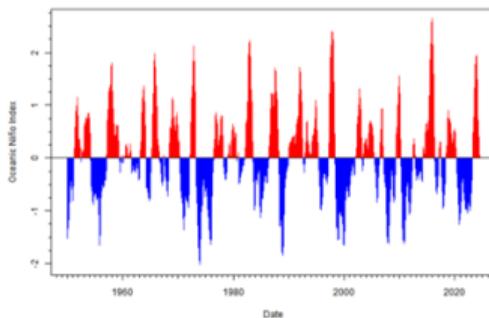
Populations  
ooo

Ecosystem summaries  
○●

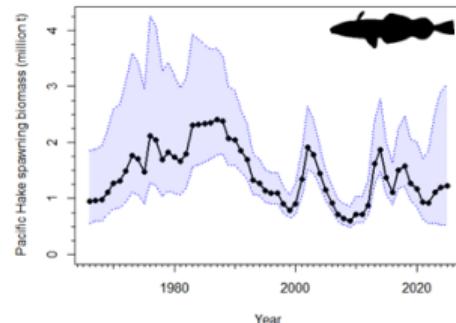
Installation  
oo

# Other information

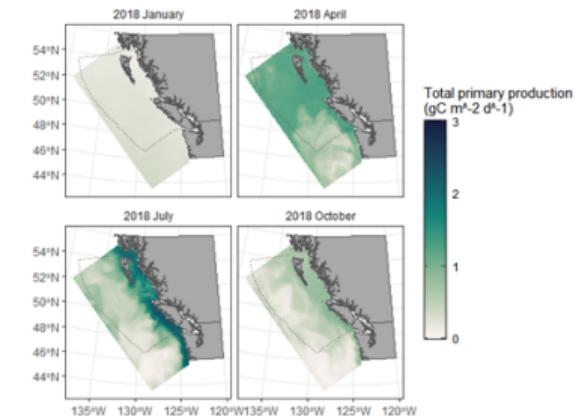
plot(oni)



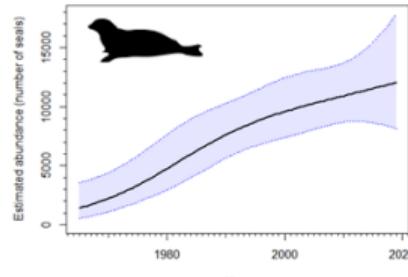
plot(hake\_biomass)



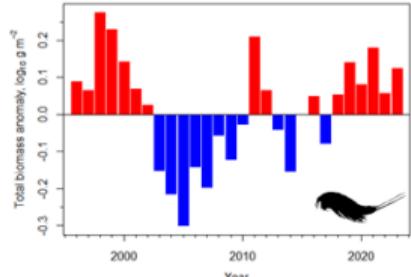
plot(bccm\_primaryproduction\_full(),  
months = c(1, 4, 7, 10))



plot(harbour\_seals,  
region = "WCVI")  
wcvi



plot(zooplankton\_sog)



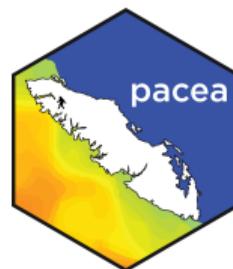
> buoy\_sst

```
# A tibble: 211,524 × 3
  date      stn_id    sst
  <date>    <fct>    <dbl>
1 1988-08-05 C46004 12.8 
2 1988-08-06 C46004 12.7 
3 1988-08-07 C46004 12.5 
4 1988-08-08 C46004 12.5 
5 1988-08-09 C46004 12.6 
# 211,514 more rows
```



# Installation

- <https://github.com/pbs-assess/pacea>
- can read vignettes online



*We wrangle the data so you don't have to*

```
citation("pacea")
```

Edwards AM, Tai TC, Watson J, Peña MA, Hilborn A, Hannah CG, Rooper CN, Flynn KL, Oldford GL (2024). "pacea: An R package of Pacific ecosystem information to help facilitate an ecosystem approach to fisheries management."  
<https://github.com/pbs-assess/pacea>.

# pacea palooza 2025

## Day 1

- overview of GitHub site
- walk through example code:
  - time series
    - buoy SST
    - climatic and oceanographic indices
    - population estimates
    - Fraser River discharge
  - spatial data/outputs
    - OISST temperature records
  - spatial data/outputs with depth layers
    - BCCM model output
    - HOTSSea model output
- people play with relevant outputs on their own?
- look at people's questions? work through one together?
- troubleshoot any installation issues