Supplemental Information: Data sources and raw data

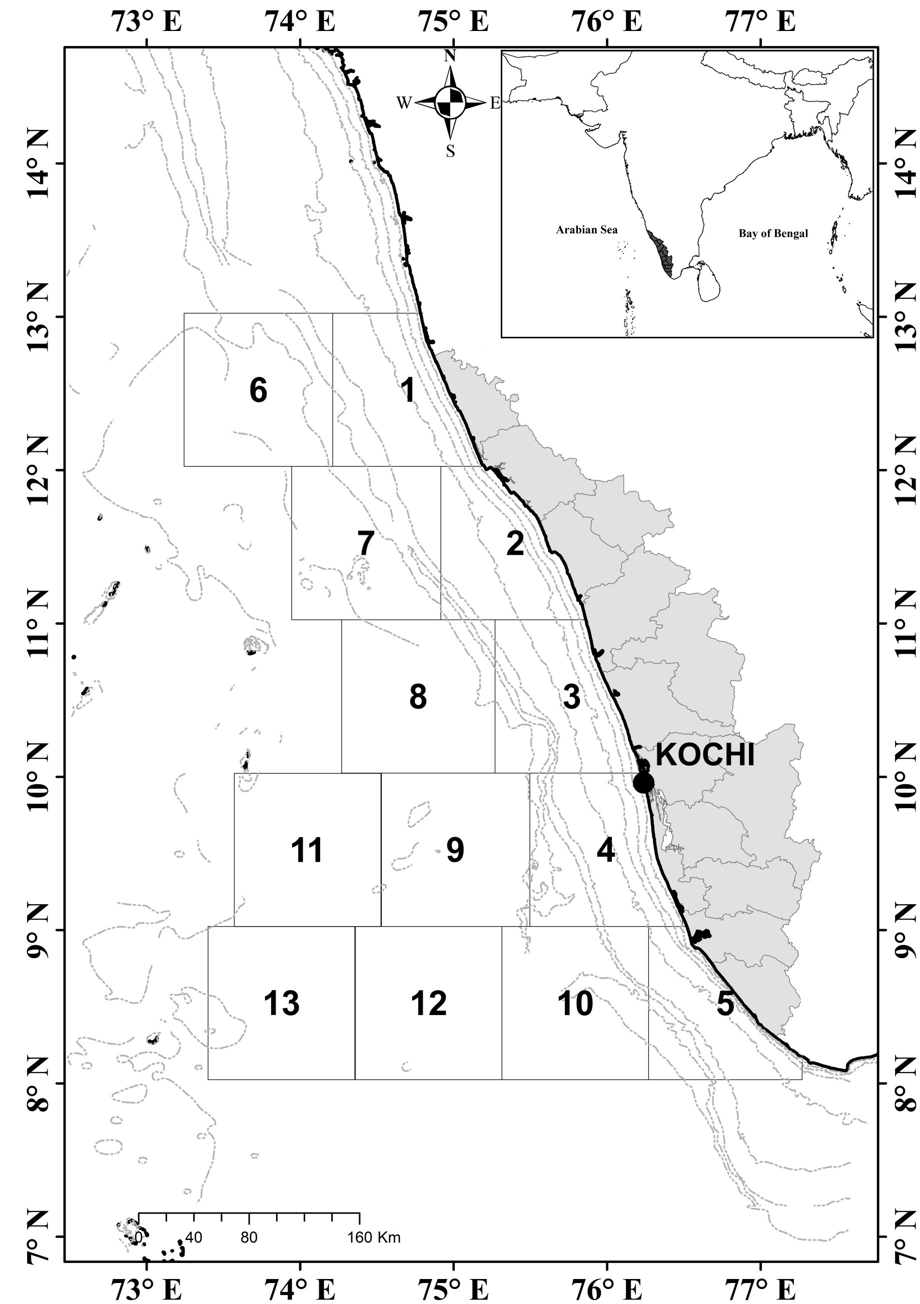

Figure S1. Study area with the boxes used for remote sensing variables, unless noted otherwise in the details. Specifically, the upwelling indices using winds (EMT and W_e) were based on a 0.25 degree grid and all values within 2 degrees latitude of the coast and between 8 and 13 degrees longitude N were averaged.

Data Sources

Landings Data

We used landings (in metric tons) of oil sardines in Kerala State 1956-2015. The data were collected and processed into a total landings estimate based on a stratified sampling of landing sites along the southwest coast of India throughout the year. The program is run by the Central Marine Fisheries Research Institute (CMFRI) in Cochin, India. We obtained the data from reports published by CMFRI; see references.

References

CMFRI reports were downloaded from the CMFRI Publication repository http://www.cmfri.org.in.

1956-1968 Antony Raja BT (1969). "Indian oil sardine." CMFRI Bulletin, 16, 1-142.

1968-1978 Pillai VN (1982). Physical characteristics of the coastal waters off the south-west coast of India with an attempt to study the possible relationship with sardine, mackerel and anchovy fisheries. Thesis, University of Cochin.

1975-1984 Kerala Jacob T, Rajendran V, Pillai PKM, Andrews J, Satyavan UK (1987). "An appraisal of the marine fisheries in Kerala." Central Marine Fisheries Research Institute. Report.

1975-1984 Kernataka Kurup KN, Nair GKK, Annam VP, Kant A, Beena MR, Kambadkar L (1987). "An appraisal of the marine fisheries of Karnataka and Goa." Central Marine Fisheries Research Institute. Report.

1985-2015 Provided by CMFRI directly via a data request.

SST Data

We used two primary reanalysis SST data sets: ioSST and ICOADS SST. We also compared to a third non-reanalysis data set. Reanalysis means that the data set uses multiple data sources and may use interpolation to fill in missing values. See Supplement 1 for comparisons of the data sources on a grid.

AVHRR Data For the paper, we used the Daily Optimum Interpolation (OI), AVHRR Only, Version 2.1 data set (oiSST) by the Group for High Resolution Sea Surface Temperature (GHRSST). "AVHRR Only" is in contrast to the "AMSR+AVHRR Product (AMSR = Advanced Microwave Scanning Radiometer).

https://www.ncei.noaa.gov/metadata/geoportal/rest/metadata/item/gov.noaa.nodc:GHRSST-AVHRR_OI-NCEI-L4-GLOB/html

and downloaded from

https://coastwatch.pfeg.noaa.gov/erddap/griddap/ncdcOisst21Agg.html

This data set is on a 0.25 degree and provides complete ocean temperature fields constructed by combining bias-adjusted observations from different platforms (AVHRR satellite instruments, ships, buoys) on a regular global grid, with gaps filled in by interpolation.

The ioSST data were compared to non-reanalysis AVHRR data. For 1981 to 2003, we used the Pathfinder Version 5.2 (L3C) monthly day and night product on a 0.0417 degree grid. These SST data use the Advanced Very-High Resolution Radiometer (AVHRR) instrument on the Pathfinder satellites and were provided by the Group for High Resolution Sea Surface Temperature (GHRSST) and the US National Oceanographic Data Center. This project was supported in part by a grant from the NOAA Climate Data Record (CDR) Program for satellites. For 2004 to 2016, we used the NOAA CoastWatch sea surface temperature (SST) products derived from NOAA's Polar Operational Environmental Satellites (POES). The SST estimates use the Advanced Very-High Resolution Radiometer (AVHRR) instruments on the POES satellites and are on a 0.1 degree grid.

ICOADS The International Comprehensive Ocean-Atmosphere Data Set (ICOADS) is a collection of surface marine data. SST data from 1960 onward were used, which are on a 1 degree grid. The nearshore data (boxes 1 to 5) are not as accurate as the AVHRR-based SST data. The ICOADS data were only used for the regional SST measurements not for nearshore or for the SST-differential based upwelling estimate.

These last two SST data sets were downloaded from the NOAA ERDDAP server:

https://coastwatch.pfeg.noaa.gov/erddap/info/ncdcOisst21Agg/index.html

https://coastwatch.pfeg.noaa.gov/erddap/info/erdAGsstamday/index.html

https://coastwatch.pfeg.noaa.gov/erddap/info/erdPH2sstamday/index.html.

https://coastwatch.pfeg.noaa.gov/erddap/info/esrlIcoads1ge/index.html

The SST values were averaged across the thirteen 1 degree by 1 degree boxes which parallel the bathymetry (Figure S1).

References

The AVHRR data were provided by GHRSST and the US National Oceanographic Data Center. The data were downloaded from NOAA CoastWatch-West Coast Regional Node and Southwest Fisheries Science Center's Environmental Research Division.

The ICOADS data were provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their web site at http://www.esrl.noaa.gov/psd/

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Huang, Boyin; Liu, Chunying; Banzon, Viva F.; Freeman, Eric; Graham, Garrett; Hankins, Bill; Smith, Thomas M.; Zhang, Huai-Min. (2020): NOAA 0.25-degree Daily Optimum Interpolation Sea Surface Temperature (OISST), Version 2.1. [indicate subset used]. NOAA National Centers for Environmental Information. https://doi.org/10.25921/RE9P-PT57. Accessed November 10, 2020.

Upwelling Data

Four upwelling indices were used: a SST nearshore offshore differential (degree Celcius), the nearshore SST (degree Celcius), the Ekman Mass Transport perpendicular to the coast (kg m^{-1} s^{-1}), and Ekman Pumping at the tip of India (m s^{-1}). The The SST data were downloaded from the NOAA CoastWatch ERDDAP server. See the SST data description above. The Ekman Mass Transport and Ekman Pumping were computed from the meridonal and zonal winds from the Reanalysis Data ERA5 monthly Wind velocities downloaded from the Asia Pacific Data-Research Center ERRDAP server. ERA5 uses both the QSAT and ASCAT scatterometer measurements. See Supplement 3 for comparisons of the wind products.

The SST differential upwelling indices (degree Celcius) were computed from the ioSST data set (see above in SST section) which is based on AVHRR and thus accurate close to the coast.The SST-based UPW index is the difference between the neashore box (1 to 5) and a box 3 degrees longitude offshore at the same latitude.

The Ekman Mass Transport (EMT) index of upwelling is based upon Ekman's theory of mass transport due to wind stress. The index is computed from the `ektrx` and `ektry`, which are the x- and y- components of Ekman Transport (kg m^{-1} s^{-1}) computed from the longitudinal and latitudinal wind speeds. The functions for computing EMT are below; we used a coast angle of 158 degrees for the India west coast near Kochi

(74.5E 11.5N). The `ekrtrx` and `ekrtry` were computed for latitude 8 to 13 and up to 2 degrees longitude from the coast. The values were then averaged to give a coastal average.

We used monthly winds from the ERA5 Reanalysis product from the European Centre for Medium-Range Weather Forecasts (ECMWF). Using monthly winds (as opposed to daily winds) in the EMT calculation does lead to bias, however monthly winds have been used in many recent papers (see citations in the main text) on upwelling in this region, and our paper sought to test indices that have been previously used. We used the winds closest to the sea surface. See Supplement 3 for a full discussion of the EMT (and Ekman Pumping) calculations along with comparisons of different wind products.

The Reanalysis Data ERA5 monthly 3d Wind velocities were downloaded from

http://apdrc.soest.hawaii.edu/erddap/griddap/hawaii_soest_66d3_10d8_0f3c.html. Our function to compute the EMT perpendicular to the coast was:

```
getEMT <- function(u, v){
  dat <- list()
  pa <- 1.22 # kg/m3 air pressure
  omega <- 7.272205e-05 #(rad/s)
  f <- 2*omega*sin(pi*dat$latitude/180) #Coriolis parameter
  # Compute tau; get taux and tauy from u and v
  uv_mag <- sqrt(dat$u^2+dat$v^2) # wind speed
  tau  <- pa*Cd(uv_mag)*uv_mag*uv_mag # wind stress
  tauy <- pa*Cd(uv_mag)*uv_mag*dat$v
  taux <- pa*Cd(uv_mag)*uv_mag*dat$u
  EMT <- tau/f
  # MASS TRANSPORT IS PERPENDICULAR TO WIND
  # u/taux positive is west to east wind so into india w coast
  # wind blowing west to east means EMT toward equator (negative)
  EMTy <- -1*taux/f
  # v/tauy negative is wind blowing south toward equator
  # Negative v (south) means EMT to west (off-shore)
  # EMTx is the one that drives upwelling since coast is mostly n-s
  # Negative EMTx = directed offshore = positive upwelling
  EMTx <- tauy/f
  dat$uv_mag <- uv_mag
  dat$tau <- tau
  dat$taux <- taux
  dat$tauy <- tauy
  dat$EMT <- EMT
  dat$ektrx <- EMTx
  dat$ektry <- EMTy
  return(dat)
}
```

```
EMTperp <- function(ektrx, ektry, coast_angle) {
  pi <- 3.1415927
  degtorad <- pi/180.
  alpha <- (180 - coast_angle) * degtorad
  s1 <- cos(alpha)
  t1 <- sin(alpha)
  s2 <- -1 * t1
  t2 <- s1
  perp <- (s1 * ektrx) + (t1 * ektry)
  para <- (s2 * ektrx) + (t2 * ektry)
```

```
  return(list(perp=perp, para=para))
}

getEkmanPump <- function(dat, res){
  # dat is the ektrx and ektry for a grid
  # dat has latitude, longitude, ektrx and ektry
  # res is the grid resolution; 0.25 deg for the ERA5 wind data
  dat$Wey <- NA; dat$Wex <- NA; dat$We <- NA
  lons <- sort(unique(dat$longitude))
  lats <- sort(unique(dat$latitude))

  # constants
  # h is 1 degree lat or lon in meters
  h.meter <- function(lat){
    m_per_deg_lat <- 111132.954 - 559.822 * cos( 2 * pi * lat/180 ) +
                      1.175 * cos( 4 * pi * lat / 180)
   m_per_deg_lon <- 111132.954 * cos ( pi*lat/180 )
   return(list(lat=m_per_deg_lat, lon=m_per_deg_lon))
  }
  psw <- 1023.6 #kg/m3 density of sea water

  if(length(lats)>2)
    for(lat in (min(lats)+res):(max(lats)-res)){
      dEMTy.lat <- (dat$ektry[dat$latitude==(lat+res)] -
         dat$ektry[dat$latitude==(lat-res)])/
         (2*res*h.meter(lat)$lat)
      Wey <- dEMTy.lat/psw
      dat$Wey[dat$latitude==lat] <- Wey
    }
  if(length(lons)>2)
    for(lon in (min(lons)+res):(max(lons)-res)){
      dEMTx.lon <- (dat$ektrx[dat$longitude==(lon+res)] -
      dat$ektrx[dat$longitude==(lon-res)])/
         (2*res*h.meter(dat$latitude[dat$longitude==(lon+res)])$lon)
      Wex <- dEMTx.lon/psw
      dat$Wex[dat$longitude==lon] <- Wex
    }

  dat$We <- dat$Wex+dat$Wey

  return(dat)
}
```

References

SST data: These data were provided by GHRSST and the US National Oceanographic Data Center. This project was supported in part by a grant from the NOAA Climate Data Record (CDR) Program for satellites. The data were downloaded from NOAA CoastWatch-West Coast Regional Node and Southwest Fisheries Science Center's Environmental Research Division.

ERA5: Hersbach, H., Bell, B., Berrisford, P., et al. The ERA5 global reanalysis. Quarterly Journal of the Royal Meteorological Society. 2020; 146: 1999–2049. https://doi.org/10.1002/qj.3803

ERA5 website: https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era5

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Precipitation Data

We used three precipitation data sets off the southwest coast of India. Two are satellite derived and one is based on land gauges.

The National Climatic Data Center provides basic information on the Global Precipitation Climatology Project (GPCP) Precipitation data set. The data set consists of monthly precipitation estimates (average mm/day) from January 1979 to the present. The precipitation estimates merge several satellite and in situ sources into a final product. Data are provided on a 2.5 degree grid. The GPCP Precipitation data are provided by the NOAA/NCEI Global Precipitation Climatology Project and were downloaded from https://www.ncei.noaa.gov/data/global-precipitation-climatology-project-gpcp-monthly. Two boxes were defined, one off the Kerala coast and one off the Karnataka coast, and the average values of all grid points within these boxes were used. The boxes are Kerala Lat(8.75, 11.25), Lon(73.25, 75.75) Karnataka Lat(13.75, 16.25), Lon(71.25, 73.75)

The land gauge data set is a monthly rainfall (in mm) area weighted average for each state in India starting from 1901 onwards based on rain gauges. The data are provided by the India Meteorological Department (Ministry of Earth Sciences). The 1901 to 2014 data were downloaded from the Open Government Data Platform India https://data.gov.in. The 2015 and 2016 data were extracted from the yearly Rainfall Statistics reports (see references).

NASA's Tropical Rainfall Measuring Mission (TRMM) website provides background on the TRMM precipitation data (https://pmm.nasa.gov/). 1997 to 2015 monthly precipitation estimates on a 0.25 degree grid were downloaded from the Tropical Rainfall Measuring Mission (TRMM) website. The data were averaged in the 2.5 x 2.5 degree boxes 1 to 13 used for the other satellite data.

References

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Purohit MK, Kaur S (2016). "Rainfall Statistics of India - 2016." India Meterorological Department (Ministry of Earth Sciences). http://hydro.imd.gov.in/hydrometweb/.

Kothawale DR, Rajeevan M (2017). Monthly, seasonal and annual rainfall time series for all-India, homogeneous regions and meteorological subdivisions: 1871-2016. Report, Indian Institute of Tropical Meteorology..

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https://www.ncei.noaa.gov/data/global-precipitation-climatology-project-gpcp-monthly/access/.

Chlorophyll Data

We used Chlorophyll-a products developed by the Ocean Biology Processing Group in the Ocean Ecology Laboratory at the NASA Goddard Space Flight Center.

For 1997 to 2002, we used the Chlorophyll-a 2014.0 Reprocessing (R2014.0) product from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) on the Orbview-2 satellite. These data are on a 0.1 degree grid with units of mg m^{-3}. See reference below.

For 2003 to 2017, we used the MODIS-Aqua product on a 4km grid with units of mg m^{-3}. These CHL data are taken from measurements gathered by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua Spacecraft. See reference below.

Both CHL data sets were downloaded from the NOAA ERDDAP server:

https://coastwatch.pfeg.noaa.gov/erddap/info/erdSW1chlamday/index.html

https://coastwatch.pfeg.noaa.gov/erddap/info/erdMH1chlamday/index.html.

The CHL values were averaged across the thirteen 1 degree by 1 degree boxes which parallel the bathymetry (Figure S1).

References

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NASA Goddard Space Flight Center, Ocean Ecology Laboratory, Ocean Biology Processing Group. Moderate-resolution Imaging Spectroradiometer (MODIS) Aqua Chlorophyll Data; 2014 Reprocessing. NASA OB.DAAC, Greenbelt, MD, USA. https://dx.doi.org/10.5067/AQUA/MODIS/L3M/CHL/2014

Hu C, Lee Z, Franz B (2012). "Chlorophyll aalgorithms for oligotrophic oceans: A novel approach based on three-band reflectance difference." Journal of Geophysical Research: Oceans, 117(C1).

Ocean Climate Indices

We used the following ocean climate indices: Oceanic Nino Index, Dipole Mode Index, Pacific Decadal Oscillation index and Atlantic Multidecadal Oscillation index.

The Oceanic Nino Index (ONI) is one of the primary indices used to monitor the El Nino-Southern Oscillation (ENSO). The ONI index is 3 month running mean of ERSST.v5 SST anomalies in the Niño 3.4 region (5°N-5°S, 120°-170°W)], based on centered 30-year base periods updated every 5 years.
The ONI was downloaded from the National Weather Service Climate Prediction Center

http://www.cpc.ncep.noaa.gov/data/indices/oni.ascii.txt

The DMI is the monthly Dipole Mode Index. The DMI is defined by the SSTA (SST anomaly) difference between the western Indian Ocean (10°S–10°N, 50°E–70°E) and the southeastern Indian Ocean (10°S–0°, 90°E–110°E). The data were downloaded from

https://www.esrl.noaa.gov/psd/gcos_wgsp/Timeseries/Data/dmi.long.data The original data source is the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) via the page

http://www.jamstec.go.jp/frcgc/research/d1/iod/e/iod/about_iod.html.

The PDO is the Pacific Decadal Oscillation. The PDO index is defined by the sea surface temperature anomaly over the North Pacific Ocean (north of 20°N). The data were downloaded from the NOAA Physical Sciences Laboratory:

https://psl.noaa.gov/tmp/gcos_wgsp/data.143.131.2.6.325.11.4.55

The AMO is the Atlantic Multidecadal Oscillation. The AMO index is based on sea-surface temperature anomalies in the North Atlantic Ocean. The data were downloaded from the NOAA Physical Sciences Laboratory:

https://psl.noaa.gov/tmp/gcos_wgsp/data.143.131.2.6.325.11.25.33

References

Saji NH, Yamagata T (2003). “Possible impacts of Indian Ocean Dipole mode events on global climate.” Climate Research, 25(2), 151-169.

Climate Prediction Center. El Nino-Southern Oscillation.

https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/enso.shtml

NOAA Physical Sciences Laboratory. Pacific Decadal Oscillation.

https://psl.noaa.gov/pdo/

van den Dool HM, Saha S, Johansson Å (2000). “Empirical orthogonal teleconnections.” Journal of Climate, 13, 1421–1435.

Mantua NJ, Hare SR, Zhang Y, Wallace JM, Francis RC (1997). “A Pacific interdecadal climate oscillation with impacts on salmon production.” Bulletin of the American Meteorology Society, 78, 1069-1079.

Enfield DB, Mestas-NuÃ±ez AM, Trimble PJ (2001). “The Atlantic Multidecadal Oscillation and its relation to rainfall and river flows in the continental U.S.” Geophysical Research Letters, 28, 2077–2080.

Raw Data

Table S1. Landings data and environmental covariates, part 1. W=Oct-Mar Kerala landings. S=Jul-Sep Kerala landings. Values have been rounded to 2 digits. ns- = nearshore (0-80km) boxes 2 to 5 in Figure 1 (main text). r- = regional (0-160km) boxes 1 to 5 and 7 to 10. o-Precip is precipitation over the ocean; l-Precip is precipitation over land.

Year	W	S	Jun-Jul o-Precip	Apr-May o-Precip	Jun-Jul l-Precip	Apr-May l-Precip	Jun-Sep Bakun UPW	Jun-Sep coastal EMT	Jun-Sep We tip	Jun-Sep SST-diff UPW
1956	9.76	5.19	NA	NA	611.10	251.45	NA	NA	NA	NA
1957	12.27	9.81	NA	NA	853.65	225.70	NA	NA	NA	NA
1958	11.02	8.99	NA	NA	668.00	244.30	NA	NA	NA	NA
1959	10.15	8.56	NA	NA	1014.25	248.95	NA	NA	NA	NA
1960	12.27	10.27	NA	NA	615.60	373.30	NA	NA	NA	NA
1961	11.58	9.26	NA	NA	1075.85	297.30	NA	NA	NA	NA
1962	11.19	8.49	NA	NA	598.00	283.75	NA	NA	NA	NA
1963	10.66	8.18	NA	NA	556.75	126.70	NA	NA	NA	NA
1964	12.33	10.42	NA	NA	566.80	89.05	NA	NA	NA	NA
1965	11.61	10.41	NA	NA	531.40	162.15	NA	NA	NA	NA
1966	12.01	10.96	NA	NA	549.05	131.30	NA	NA	NA	NA
1967	12.06	10.23	NA	NA	641.55	157.50	931.11	NA	NA	NA
1968	12.06	10.97	NA	NA	1002.65	111.65	2216.34	NA	NA	NA
1969	11.66	9.62	NA	NA	684.65	172.30	1027.24	NA	NA	NA
1970	12.06	10.76	NA	NA	546.70	210.90	584.32	NA	NA	NA
1971	11.72	9.87	NA	NA	769.10	215.25	815.40	NA	NA	NA
1972	10.97	9.37	NA	NA	558.10	261.75	794.72	NA	NA	NA
1973	11.21	9.85	NA	NA	600.25	125.70	1067.60	NA	NA	NA
1974	11.40	9.63	NA	NA	635.55	174.75	998.95	NA	NA	NA
1975	10.94	9.43	NA	NA	697.85	143.00	959.12	NA	NA	NA
1976	11.38	9.12	NA	NA	419.15	105.15	1054.11	NA	NA	NA
1977	11.26	9.75	NA	NA	676.45	204.35	1270.40	NA	NA	NA
1978	11.54	9.73	NA	NA	722.40	235.35	1639.26	NA	NA	NA
1979	11.25	10.15	7.13	0.64	622.55	84.85	1682.78	-1087.51	9.83	NA
1980	10.72	8.69	7.28	2.97	749.95	110.05	1250.51	-1189.04	8.65	NA
1981	11.80	10.29	8.01	3.16	701.10	121.10	564.19	-1149.29	8.83	0.97
1982	11.63	10.26	7.92	2.01	561.85	104.30	262.33	-1133.71	9.92	1.03
1983	11.71	8.77	5.53	0.33	453.00	44.55	949.40	-1174.91	8.60	0.73
1984	11.39	9.55	8.25	3.98	748.10	123.35	1186.72	-1602.71	10.92	1.42
1985	10.76	9.86	6.83	4.50	608.80	160.40	1306.33	-1621.21	11.14	1.13
1986	9.19	5.24	7.05	2.46	461.35	94.90	1365.76	-1682.67	11.42	1.23
1987	9.43	10.36	4.53	2.30	396.80	82.75	1075.50	-1377.96	10.50	0.62
1988	11.24	9.85	12.44	3.25	507.05	167.40	453.01	-1257.44	10.71	0.65
1989	11.46	11.22	8.56	3.53	554.10	155.45	579.77	-1694.33	11.21	1.04
1990	11.50	10.97	5.94	3.29	582.00	265.15	653.88	-1783.02	10.51	0.89
1991	10.42	9.49	11.92	1.49	1000.80	105.20	574.93	-1491.14	9.70	0.57
1992	9.88	8.80	8.99	4.07	793.55	130.70	676.15	-1310.65	12.21	0.80
1993	9.80	9.69	9.30	2.97	716.60	112.75	637.71	-1488.76	11.14	0.76
1994	6.57	5.91	8.72	4.01	900.25	147.90	575.00	-1266.01	6.94	0.89
1995	9.67	8.27	6.69	1.96	597.95	245.25	701.69	-1366.14	11.85	0.90
1996	10.64	9.29	7.67	2.16	634.20	99.30	621.31	-1641.69	12.44	0.70
1997	10.57	9.61	8.29	1.97	757.35	97.10	691.06	-946.29	7.02	0.54
1998	10.93	10.09	8.42	2.66	686.95	106.35	439.74	-1407.18	14.11	0.51

Year	W	S	Jun-Jul o-Precip	Apr-May o-Precip	Jun-Jul l-Precip	Apr-May l-Precip	Jun-Sep Bakun UPW	Jun-Sep coastal EMT	Jun-Sep We tip	Jun-Sep SST-diff UPW
1999	11.45	10.80	7.42	5.22	653.85	282.40	453.43	-1271.77	9.17	0.94
2000	11.20	11.31	5.18	4.82	488.50	110.40	710.33	-1579.93	12.01	0.96
2001	11.11	10.78	9.07	7.39	648.30	238.25	661.91	-1608.59	9.98	0.95
2002	11.98	11.15	5.54	4.52	404.95	228.80	600.95	-1732.19	11.00	1.02
2003	11.88	10.83	10.15	1.87	518.10	108.55	627.16	-1350.33	9.19	0.97
2004	11.90	11.04	6.97	4.65	545.80	353.60	921.00	-1464.15	10.71	1.02
2005	11.82	10.91	6.72	4.73	756.00	170.10	956.08	-1496.50	10.98	1.29
2006	11.87	10.81	4.97	5.62	573.25	297.10	1029.44	-1120.20	7.43	0.74
2007	12.01	11.00	11.90	3.26	866.75	173.05	851.51	-1137.68	7.28	0.72
2008	11.51	11.06	8.74	2.55	493.35	91.15	685.70	-1076.27	7.83	0.45
2009	11.58	11.21	8.07	4.61	680.55	129.10	905.05	-1194.75	10.80	0.97
2010	12.27	10.63	10.02	3.86	649.55	165.05	373.33	-1340.18	10.30	1.02
2011	12.18	11.01	6.85	4.11	664.45	143.40	519.07	-1229.90	7.19	0.99
2012	12.44	11.71	5.78	1.94	402.60	140.65	666.39	-1290.93	8.62	0.91
2013	11.40	9.92	8.88	3.36	936.45	84.30	762.91	-1602.39	9.00	1.21
2014	11.30	10.76	5.05	3.31	566.10	173.35	864.24	-1414.09	10.39	0.90
2015	NA	10.20	8.32	3.62	687.95	174.65	581.45	-1067.67	9.41	0.71

Table S2. Landings data and environmental covariates, part 2.

Year	Apr-May r-SST	Oct-Dec ns-SST	Jun-Sep ns-SST	Jul-Jun ONI	Jul-Jun PDO	Jul-Jun AMO	Sep-Nov DMI	2.5 yr ave r-SST ICOADS	2.5 yr ave r-SST AVHRR
1981	29.67	28.13	27.29	-0.15	0.87	-0.09	-0.43	28.68	NA
1982	29.19	29.02	27.20	0.08	0.19	-0.11	0.58	28.62	NA
1983	29.18	28.31	27.66	1.54	1.00	-0.20	-0.10	28.62	28.48
1984	29.34	27.87	26.24	-0.48	1.45	-0.14	-0.43	28.62	28.49
1985	29.29	28.15	26.49	-0.68	0.48	-0.31	-0.09	28.37	28.29
1986	29.18	27.88	26.55	-0.33	0.90	-0.27	-0.01	28.25	28.13
1987	29.56	29.18	27.97	0.94	1.40	-0.17	0.33	28.30	28.19
1988	29.73	28.63	27.49	0.64	1.49	0.08	-0.24	28.70	28.53
1989	29.36	28.32	26.74	-1.23	-0.20	-0.12	-0.20	28.86	28.69
1990	29.17	28.56	26.95	0.02	-0.02	-0.10	-0.08	28.62	28.43
1991	29.70	28.41	27.70	0.38	-0.90	-0.05	0.17	28.52	28.35
1992	29.46	28.15	26.94	1.12	0.54	-0.17	-0.49	28.58	28.48
1993	29.34	28.27	27.16	0.21	1.10	-0.26	-0.03	28.49	28.41
1994	29.18	28.37	27.02	0.20	1.30	-0.26	0.64	28.39	28.24
1995	29.54	28.44	27.22	0.57	-0.24	-0.02	-0.15	28.56	28.34
1996	29.25	28.08	27.13	-0.65	0.88	0.04	-0.74	28.68	28.39
1997	29.68	29.21	28.02	-0.08	0.62	-0.06	1.10	28.66	28.45
1998	30.30	28.27	27.78	1.64	1.46	0.19	-0.50	28.91	28.71
1999	28.89	28.03	27.18	-1.21	-0.63	0.24	0.01	28.97	28.75
2000	29.07	28.59	27.09	-1.17	-0.98	0.06	-0.05	28.69	28.49
2001	29.57	28.54	27.09	-0.51	-0.35	0.00	-0.18	28.47	28.33
2002	29.68	28.86	27.39	-0.01	-0.76	0.12	0.39	28.48	28.45
2003	29.93	28.49	27.74	0.65	1.07	0.06	-0.03	28.88	28.65
2004	29.27	28.71	26.94	0.26	0.54	0.23	0.04	28.97	28.68
2005	29.64	28.20	27.21	0.53	0.65	0.23	-0.28	28.97	28.65
2006	29.01	28.78	27.65	-0.35	0.12	0.24	0.63	28.66	28.45
2007	29.76	28.44	27.60	0.29	-0.13	0.22	0.22	28.76	28.59
2008	29.33	28.94	27.70	-1.12	-0.74	0.12	0.12	28.87	28.61
2009	29.69	28.68	27.11	-0.37	-1.35	0.01	0.07	28.91	28.67
2010	30.28	28.43	27.37	0.75	0.28	0.21	-0.27	28.99	28.77
2011	29.40	28.99	27.27	-1.15	-0.91	0.23	0.43	28.85	28.67
2012	29.10	29.15	27.59	-0.64	-1.38	0.06	0.28	28.84	28.64
2013	29.65	28.54	26.70	-0.07	-0.80	0.20	0.04	28.86	28.64
2014	29.94	28.76	27.60	-0.17	0.10	0.07	0.13	28.72	28.65
2015	29.97	29.32	28.33	0.57	1.59	0.09	0.50	28.79	28.73

Table S2. Landings data and environmental covariates, part 3.

Year	Jul-Sep log CHL	Oct-Dec log CHL
1997	0.03	-0.85
1998	1.38	0.01
1999	1.41	0.08
2000	1.67	-0.49
2001	1.51	-0.06
2002	1.84	-0.27
2003	2.12	0.22
2004	2.49	-0.01
2005	1.75	0.70
2006	2.07	-0.14
2007	1.69	-0.28
2008	1.57	-0.43
2009	1.90	1.04
2010	1.92	0.38
2011	1.84	0.25
2012	1.52	-0.14
2013	1.71	0.04
2014	1.73	-0.54
2015	0.94	-0.63