Ecological Impacts of the Extreme 2015-2016 El Niño in the Central Equatorial Pacific

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4th International Symposium on Effects of Climate Change on World’s Oceans, Washington DC, June. 4-8, 2018
Outline

1. Background of El Niño in the Central Equatorial Pacific (CEQ)
2. Extreme 2015-2016 El Niño – CEQ
   1. Oceanographic – CEQ/Jarvis
   2. Ecological – CEQ/Jarvis
      1. Corals
      2. Productivity – Fish
      3. Seabirds
3. Climate Change and SST Trends in the CEQ (short/long term)
   2. Extended Range
4. Conclusions
Background of El Niño in the Central Equatorial Pacific
Extreme 2015-2016 El Niño - Oceanographic
Extreme 2015-2016 El Niño - Oceanographic

Average of El Niños since 1981

- 1982/83: +.51°C
- 1986/87: +.52°C
- 1991/92: +.71°C
- 1994/95
- 1997/98
- 2002/03
- 2004/05
- 2006/07
- 2009/10
- 2015/16

Average of El Niños

Jarvis
Extreme 2015-2016 El Niño - Oceanographic

Degree Heating Weeks (DHW) – percentile method

Degree Heating Weeks (DHW) – NOAA MMM method

Cumulative DHW

OISST

Jarvis Island

Title: 6 Decades of Coral Bleaching on a Central Pacific Reef

Coral Bleaching and Mortality events: Pacific Islands

April 2015  November 2015  May 2016

Jarvis Island – 35.8 DHW; 43 consecutive weeks above bleaching threshold of 28.7°C
Extreme 2015-2016 El Niño – Biological - Corals

>95% Decrease in Coral Cover at Jarvis Island

23-31% Decrease at Howland & Baker Islands

For more detail on responses of corals by depth and taxa, see Vargas-Angel et al. (in review)

Brainard et al. (2018)

Barkley et al. (in revision, NatCommsBio)
Extreme 2015-2016 El Niño – Oceanic Productivity

Mean Chl a – all Decembers 2002-2016

Mean Chl a – Nov - Dec 2015

Region of Interest

Brainard et al. (2018)
Extreme 2015-2016 El Niño – Oceanic Productivity

Cessation of upwelling during strong El Niño events
Enhanced upwelling during strong La Niña events

Brainard et al. (2018)
Extreme 2015-2016 El Niño – Biological – Productivity/Fish

- Total reef fish biomass had small decline during 2015-16 El Niño, but recovering by 2017.

- Coral associated fish biomass had significant decline following 96% loss of coral.

- Chl a (productivity) plummeted during 2015-16 El Niño, but recovered by 2017.


Brainard et al. (2018)
Extreme 2015-2016 El Niño – Biological - Seabirds

19 seabird counts from 1973–2016 showed a negative relationship between the abundance of most species and the Niño-3.4 index.

RTTR – *Phaethon rubricauda* (red-tailed tropicbird)

MABO – *Sula dactylatra* (masked booby)

BRBO – *S. leucogaster* (brown booby)

RFBO – *S. sula* (red-footed booby)

GRFR – *Fregata minor* (great frigatebird)

LEFR – *F. ariel* (lesser frigatebird)

GRAT – *Onychoprion lunatus* (spectacled tern)

SOTE – *O. fuscatus* (sooty tern)

WHITE – *Gygis alba* (white tern)

Indicates lack of reproduction
Climate Change and SST Trends (1981-2017)

OISST Anomalies & Trends

Region of Interest (5°N-5°S, 180°W-150°W)

El Niño

La Niña

Neutral

+0.166°C/decade

Jarvis Island (0.63°N–1.37°S, 159°–161°W)

+0.098°C/decade
Climate Change and SST Trends (1950-2017)

ERSST Anomalies & Trends
Jarvis Island (0.63°N–1.37°S, 159°–161°W)

+0.075°C/decade

HadiSST Anomalies & Trends
Jarvis Island (0.63°N–1.37°S, 159°–161°W)

+0.038°C/decade

ERSST

Jarvis Island

Cumulative Heat Stress Anomaly at Jarvis (degC-day)


EN3.4_SeverityClass
Minor
Major

8 °C-days in 64 years. R² = 0.85, p = 0.059

HadiSST

Jarvis Island

Cumulative Heat Stress Anomaly at Jarvis (degC-day)


EN3.4_SeverityClass
Minor
Major

35 °C-days in 64 years. R² = 0.82, p = 0.071
Climate Change & Cumulative Heat Stress Trends (1900-2017)

ERSST

Major Event Time Series: 13.448 °C-days in 116 years. R² = 0.79, p = 6.2e-05

HadiSST

Major Event Time Series: 9.016 °C-days in 116 years. R² = 0.83, p = 0.0142

ERSSTv4 Region of Interest (5°N-5°S, 180°W-150°W)

Major Event Time Series:
1.516 °C-days in 64 years.
R2 = 0.9, p = 0.59

HadiSST

Major Event Time Series:
0.31 °C-days in 64 years.
R2 = 0.91, p = 0.91
Climate Change is Driving More Extreme El Niños in CEP

Weller et al. (2016) Sci Adv
Conclusions

- Long-term warming trend in the Indo-Pacific Warm Pool
- Corresponding warming trend across the CEP during major El Niño events,
- Record high SST and Chl-a anomalies across the CEP in association with the extreme 2015-2016 El Niño
  - disrupted coral reef and seabird communities,
  - especially at Jarvis Island, where catastrophic coral bleaching and mortality were observed
Next Steps

1. Barkley et al. – Coral core thermal stress bands over the past 60 years
   a) Jarvis (in review)
   b) Howland and Baker Islands (June 2018)

2. Monitoring coral reef recovery and resilience
   a) Jarvis Island (July 2018 and beyond)
   b) Howland and Baker Islands (June 2018 and beyond)

3. Examining relationships between tuna and other pelagic fisheries and increasingly strong El Niño events in CEP associated with climate change

4. Examining effects of increasingly strong El Niño events in CEP on driving ecological impacts of ocean acidification

5. Examining effects of increasingly strong El Niño events in CEP on seabird populations
Thank You!

Questions?

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