

Do Urchins respond to El Niños?

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Abstract

We examined populations of three species of urchins at Santa Catalina Island, local ocean temperature, and Oceanic Niño Indices (ONI) collected over 21 years. The urchin populations increased following the 1992-1993 and 1997-1998 El Niños, but subsequently declined. We computed the correlations between the urchin populations, local ocean temperatures, and the ONI. We found moderate correlations between the local ocean temperature and the urchin populations and between the ONI and the ocean temperature anomalies. However, there was insignificant correlation between the urchin populations and the ONI.

Introduction

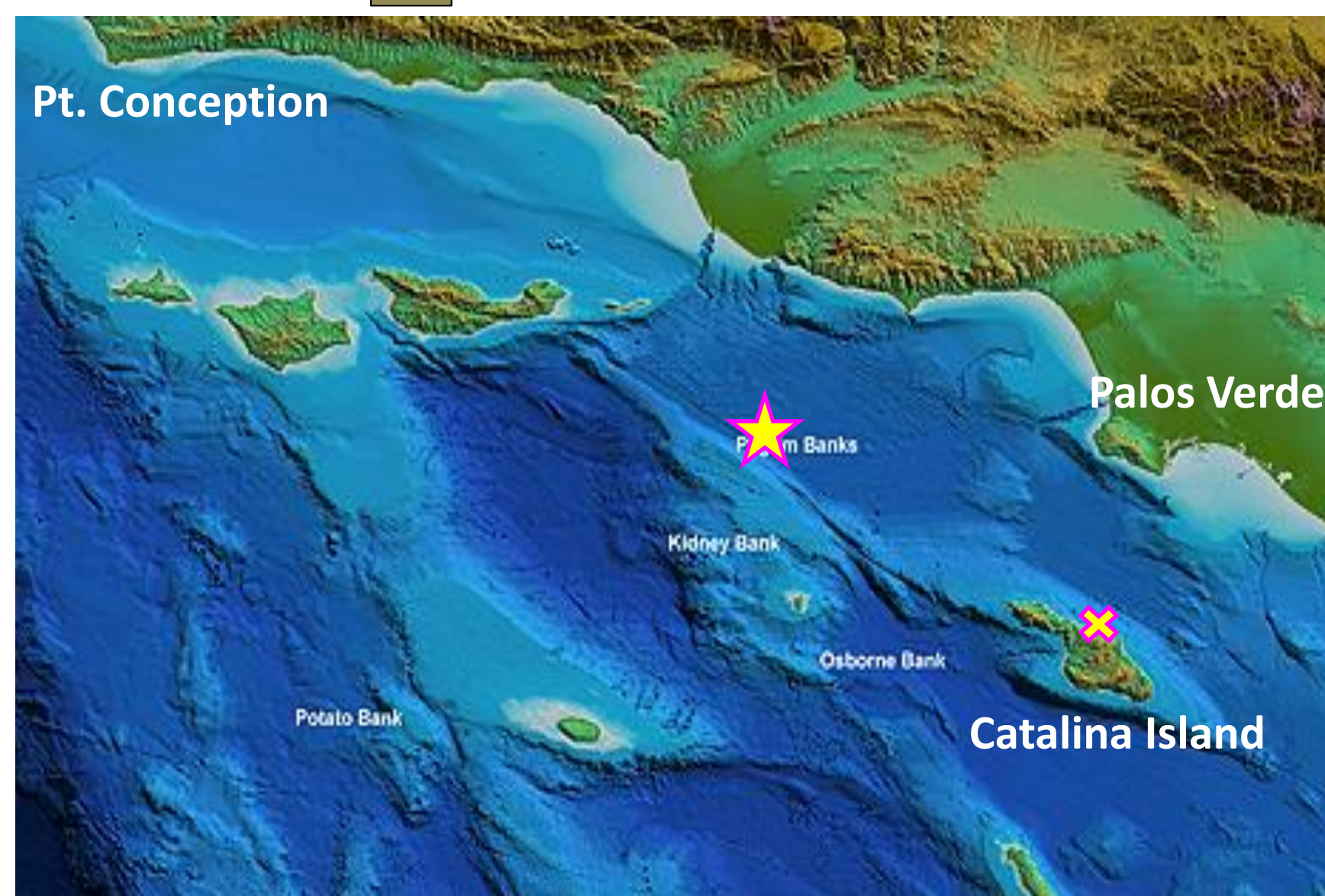
The Catalina Conservancy Divers (CCD) has collected urchin census data at the Wrigley Institute for Environmental Studies (WIES) at Santa Catalina Island since 1992. A study conducted after the first seven years correlated bottom water temperatures, kelp densities and growth rates, and urchin distributions. This period included two El Niños (1992-1993 and 1997-1998). In that time period, there was a dramatic increase in the crowned urchin, *Centrostephanus coronatus*, population. It was suggested that this subtropical species of urchin responded positively to the ocean warming associated with the El Niños. However with such a short collection period bookended by El Niños, that hypothesis could not be answered.

Literature suggests that urchin populations, specifically red (*Strongylocentrotus franciscanus*) and purple (*Strongylocentrotus purpuratus*) urchins, should decrease in response to El Niños because those urchins experience high mortality when exposed to temperatures exceeding 23°C.

Here we use the Oceanic Niño Index (ONI), an index used to help identify El Niño events, local water temperatures, and the full CCD urchin census, spanning nearly 22 years and many El Niño and La Niña periods, to determine whether the changes in the Catalina urchin populations are correlated with changes in local water temperatures and to El Niño events.

Local benthic water temperatures were collected for only the first ten years of the Catalina urchin censuses. So surface temperatures from the nearest NOAA buoy spanning the entire census were used in addition to the benthic temperatures collected at WIES.

1 Study Area



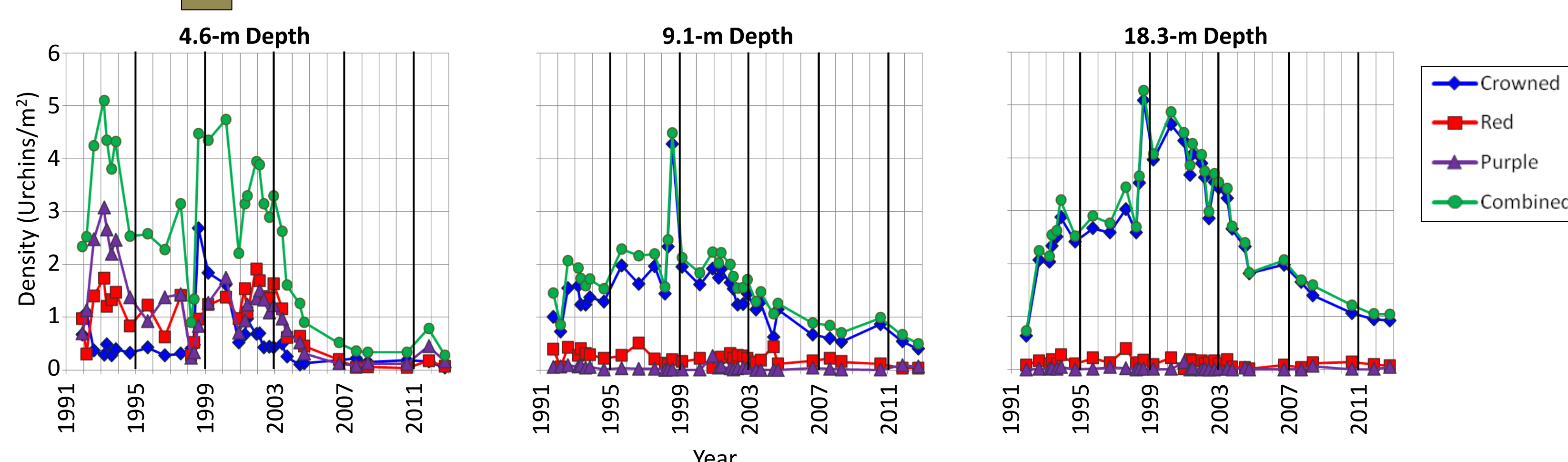
★ NOAA Buoy 46025 ★ Urchin Surveys and At-depth Temperatures

Survey Methods

CCD divers conducted periodic censuses of urchins along three permanent 120-m² transects located at 4.6, 9.1, and 18.3-m depths since 1992. The surveys were collected annually and for several years they were conducted quarterly. The transects were located near the intake pipes at Wrigley Institute for Environmental Studies (WIES) on the north side of Catalina Island.

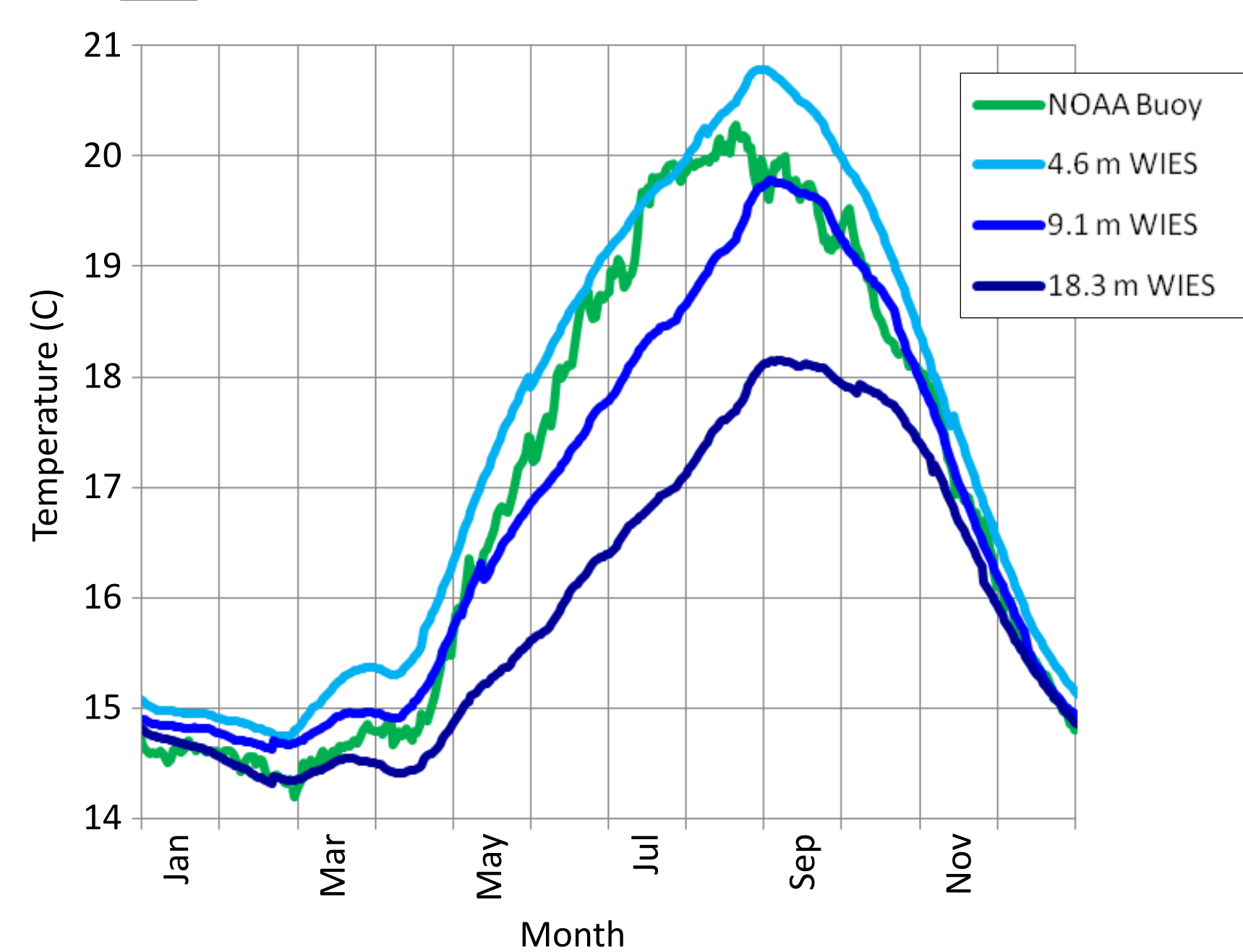
Benthic temperatures were also collected at the three transects. Thermographs logged the temperatures hourly. For the purposes of this study, the temperatures were reduced to monthly averages.

2 Densities of 3 Urchin Species at 3 Depths



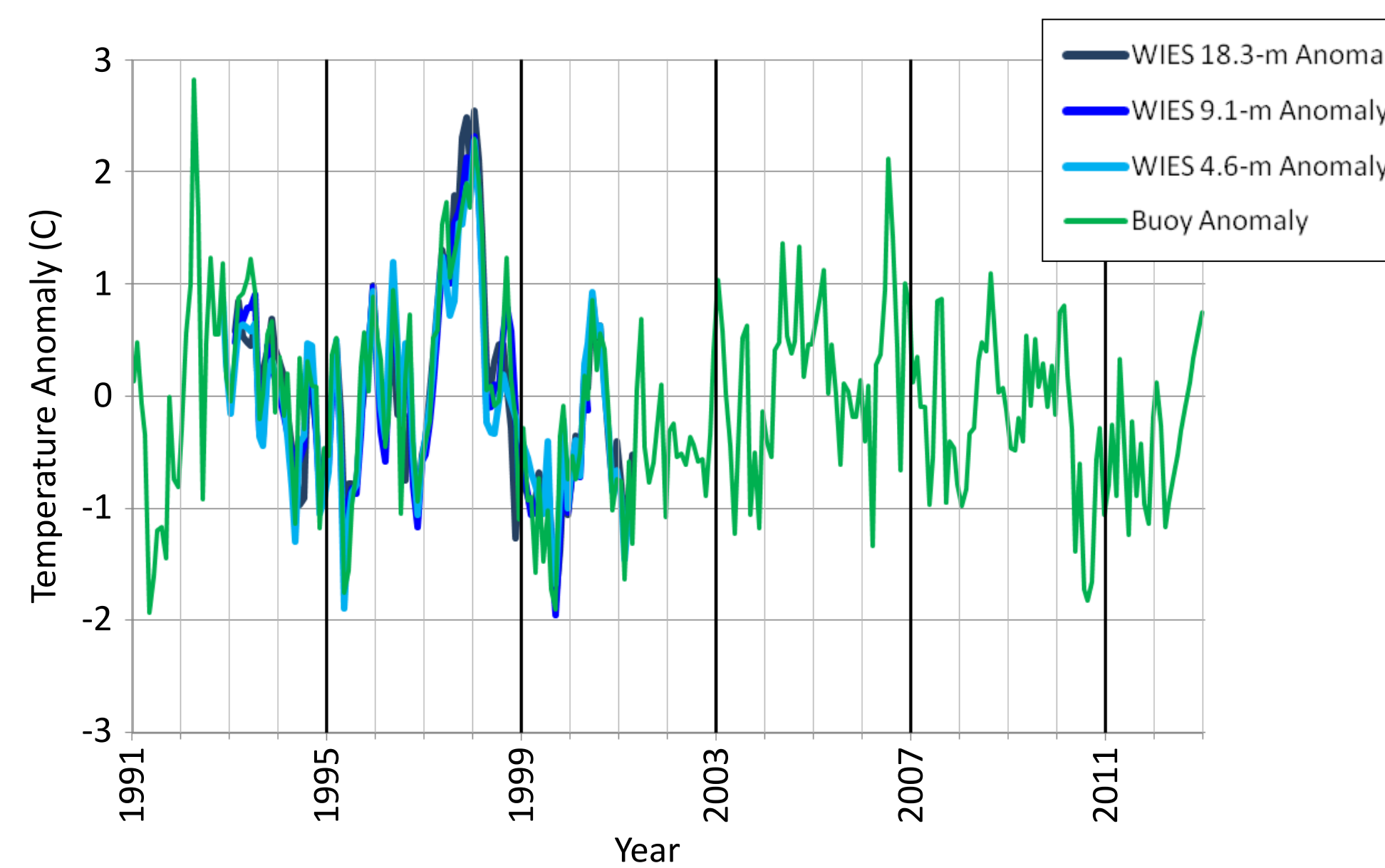
- Purple urchins are most common at the shallowest depth
- Red urchins decrease in density with depth
- Crowned urchins increase in density with depth

3 Seasonal Temperatures



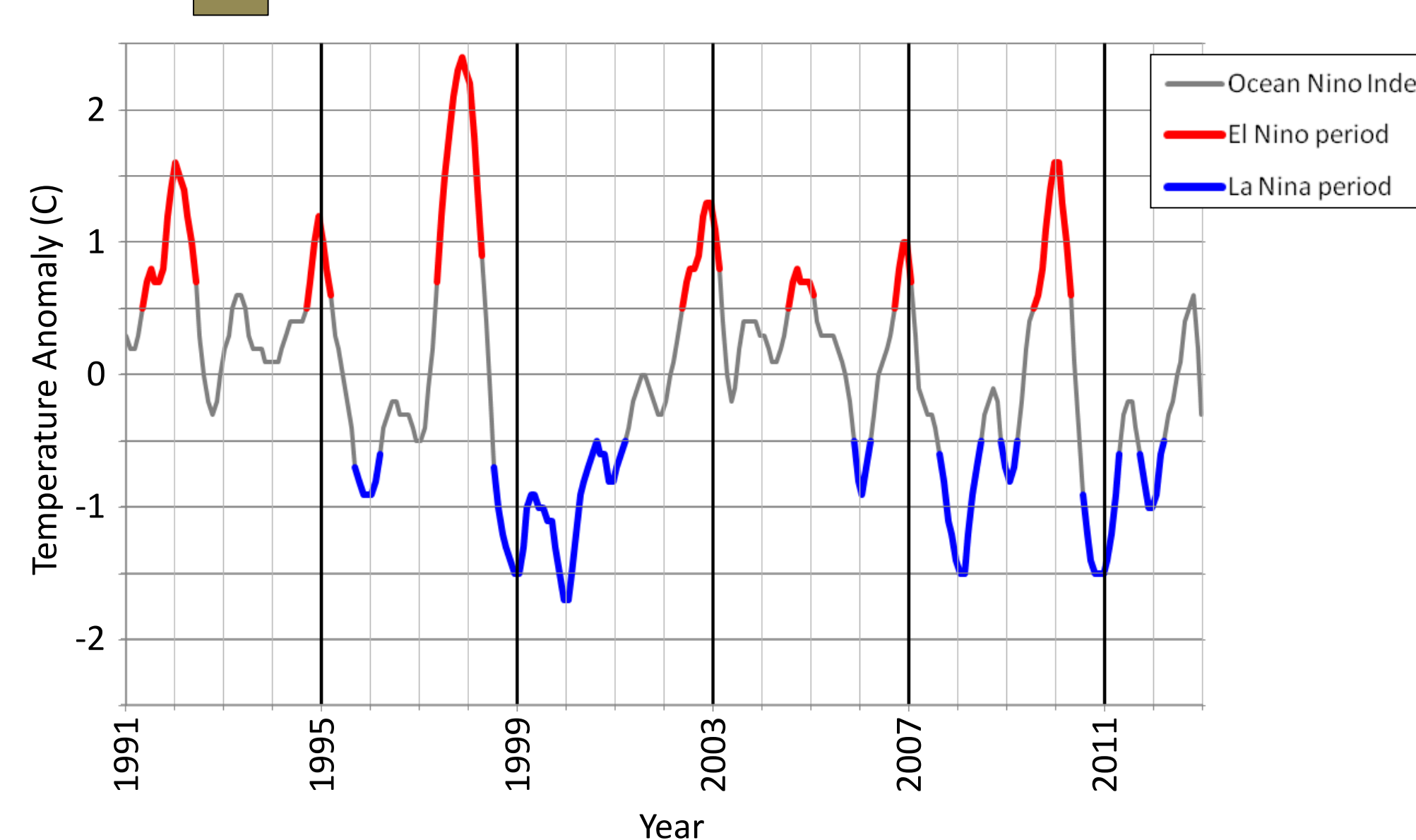
- 22 years of SST measured at NOAA buoy 46025
- 10 years of benthic water temperatures measured at WIES
- Maximum temperature occurs later in the year as the depth increases

4 WIES and Buoy Temperature-Anomalies



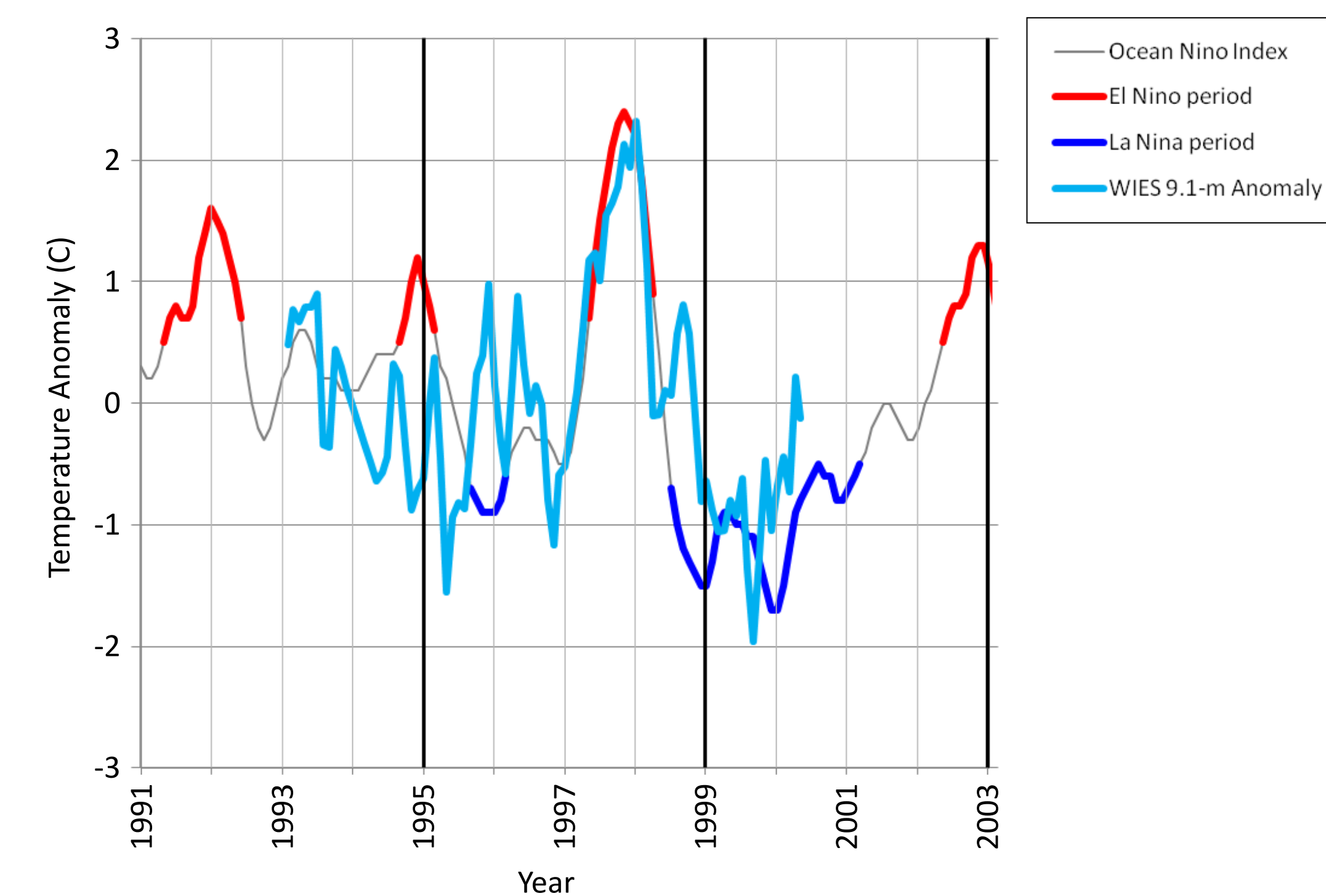
- Buoy and WIES temperature anomalies align in time and magnitude
- Peak measured temperature of 23.7°C at 4.6 m at WIES occurred in September 1997, with an average temperature of 22°C for that month

5 Oceanic Niño Index



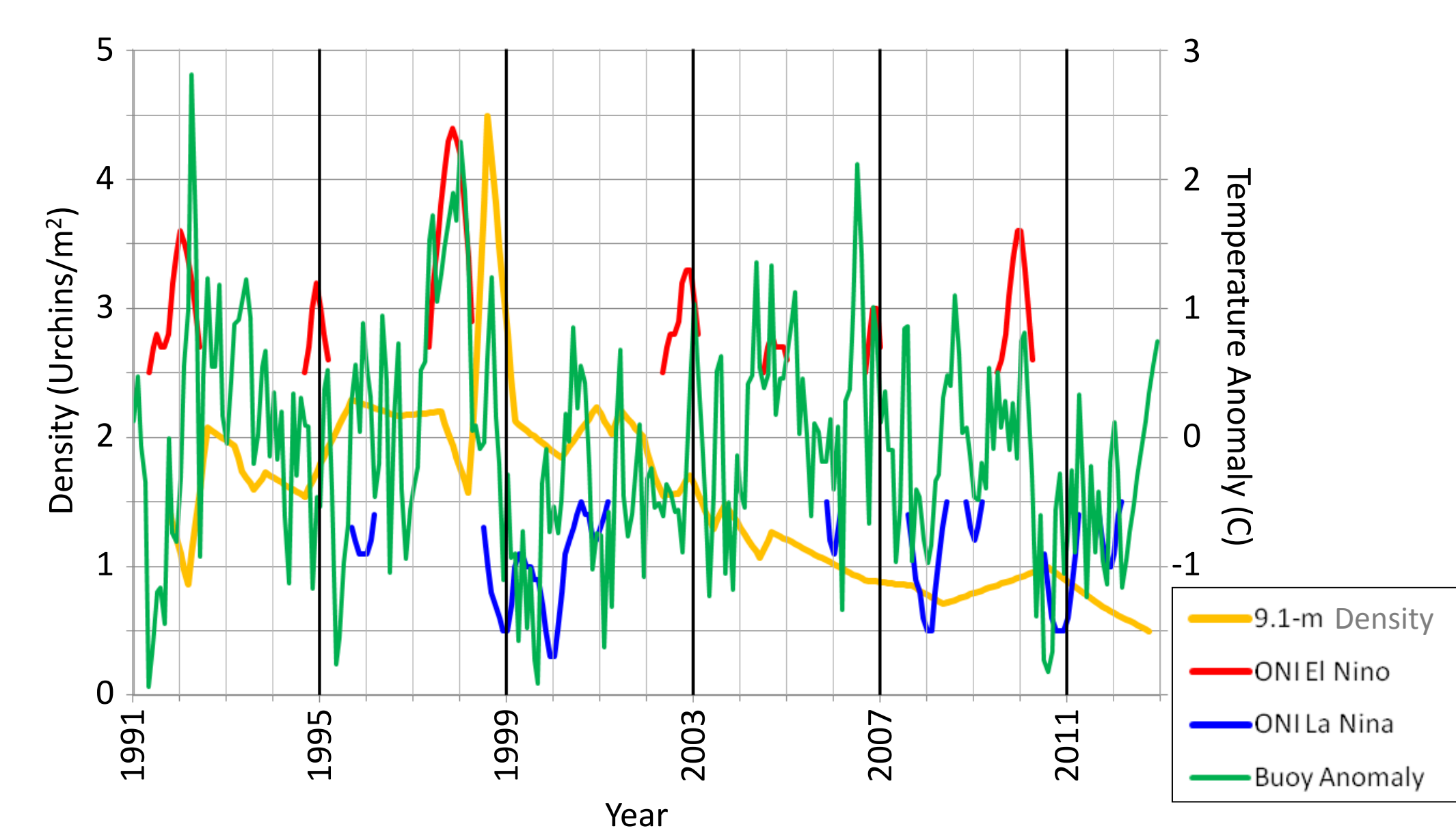
- Oceanic Niño Index (ONI) computed by NOAA Climate Prediction Center
- Likely El Niño and La Niña periods highlighted in red and blue, respectively

6 ONI and 9.1-m WIES Temperature Anomalies



- 1997-1998 El Niño evident in the ONI and in the 9.1-m WIES temperature anomaly
- 1994-1995 El Niño and 1995-1996 La Niña evident only in the ONI

7 ONI, Buoy Temperature-Anomalies, and Urchin Densities at 9.1-m



- Buoy temperature anomalies align somewhat with the ONI
- 9.1-m WIES urchin density (mostly Crowned) show some correspondence to the buoy anomaly
- 9.1-m WIES urchin density show no correspondence to the ONI except an extreme increase in density ten months after the peak of the 1997-1998 El Niño

8 Peak Measured Correlations

| Pair | Correlation Coefficient | Lag (Months) |
|--|-------------------------|--------------|
| ONI & Buoy Anomaly (22 years) | 0.49 | 0 |
| ONI & 9.1-m WIES Temperature Anomaly (10 years) | 0.64 | 0 |
| ONI & 9.1-m WIES Urchin Density (22 years) | 0.27 | -10 |
| 9.1-m WIES Temperature Anomaly & 9.1-m Urchin Density (10 years) | 0.52 | -11 |
| Buoy Anomaly & 9.1-m WIES Urchin Density (22 years) | 0.23 | -9 |
| ONI & Random Noise | +/- 0.1 | |

- ONI and WIES temperature anomalies had moderate correlation (55-70%)
- ONI and Buoy temperature somewhat correlated (49%)
- ONI and WIES urchin densities not correlated (14-27%)
- WIES urchin densities and WIES temperature anomalies moderately correlated (41-52%) and the Buoy anomaly and the urchin densities had similar correlations for the same 10-year period
- Buoy anomaly and the urchin densities had insignificant correlations (11-23%) when measured over the full 22-year period

Summary

Twenty-two years of urchin censuses at Santa Catalina Island show increases in the population that appear to correspond to two El Niños early in the time series. The crowned urchin density steadily declined at each of the survey depths after 2000. At the 4.6-m depth, the red and purple urchin densities also increased at roughly the same time as the two El Niños and also decreased after 2000.

To determine if the changes in the urchin populations were related to changes in water temperature or to El Niños, we correlated the census time series with local benthic and surface ocean temperatures, and the Oceanic Niño Index. We found a 50% correlation between the local ocean temperature and the urchin populations within a 10-year period. However, when the entire urchin census (22 years) was correlated with local surface temperatures, the correlation became insignificant (23%).

There was insignificant correlation between the urchin populations and the ONI.