

# Kelp forests as sentinels of ecosystem change? 2014-2015 heatwaves offer a test.

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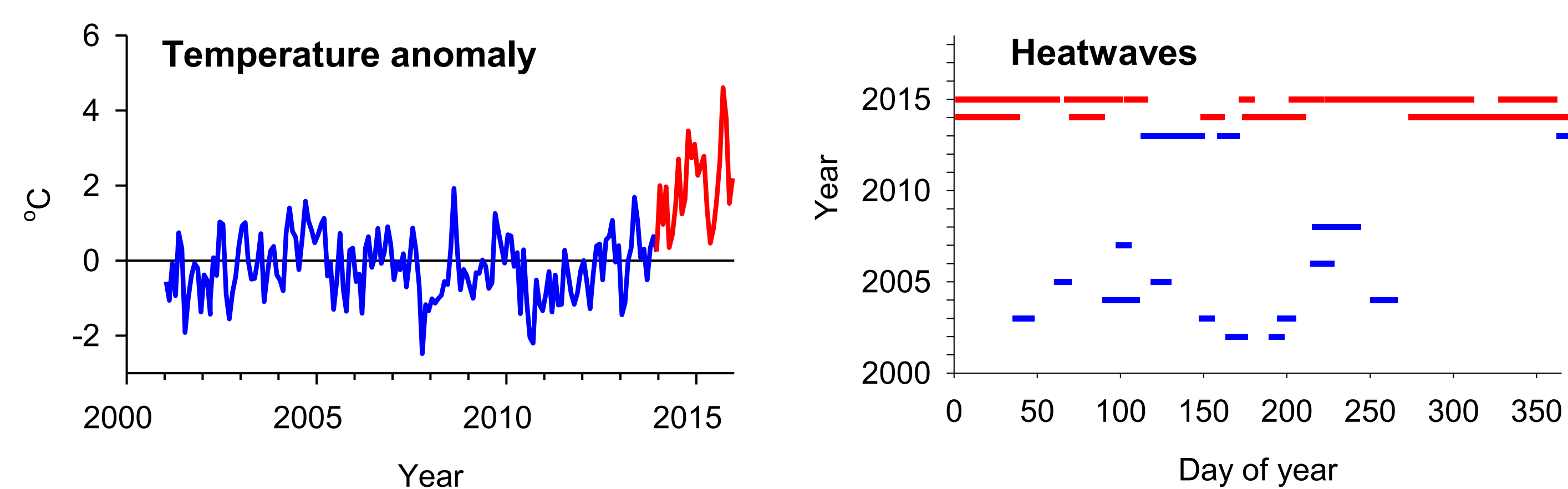
## Why sentinels?

- Species that respond rapidly to changing conditions serve as 'sentinels' of impending climate change effects on *entire ecosystems*.
- True sentinels can reduce the cost and complexity of ecosystem monitoring and management.
- False sentinels lead to a false sense of security.
- The growth, physiology and ecological importance of giant kelp make it an ideal sentinel candidate....



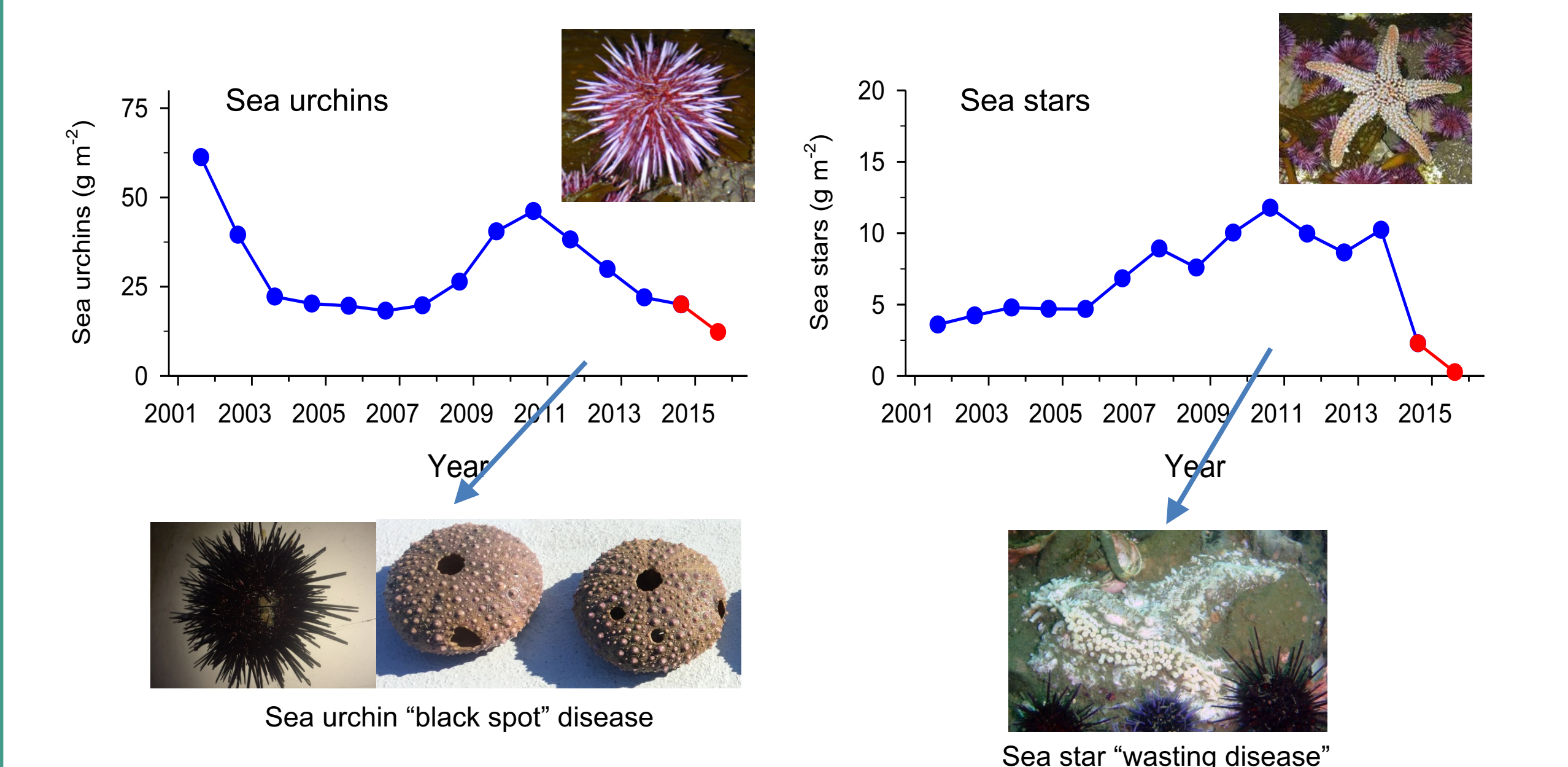
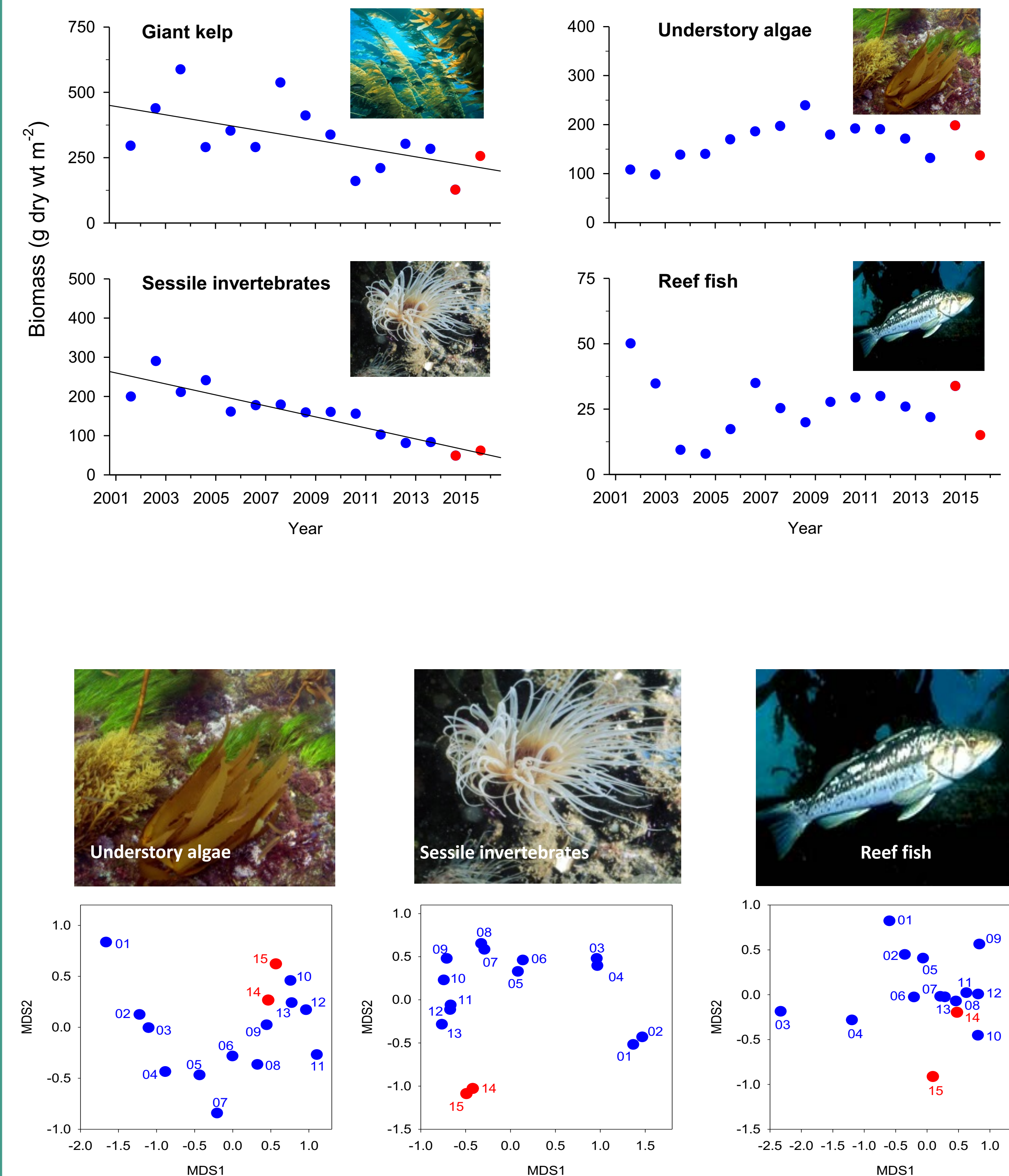
...but time series data that encompass the most severe ocean warming event on record suggest otherwise.

## Ocean temperature rises in 2013-2015



- Fourteen years of data (2001–2015) at nine kelp forests in the shallow (7 – 10 m depth) coastal waters of the Santa Barbara Channel
- Unprecedented temperature anomalies
  - Positive temperature anomalies (red) beginning December 2013 through 2015. Daily deviations as high as + 5.8 °C, monthly deviations averaging as much as + 4.6 °C
- Unprecedented occurrence and duration of marine heatwaves
  - 58% of the days during 2014 and 2015 (red) met the criteria of a marine heatwave compared to only 3.4% during the previous 13 years (blue).
  - Duration of heatwaves averaged 3x longer during 2014-2015 compared to 2001–2013 (39 days vs. 12 days)

## Ecological Responses



### Biomass

- Biomass of the kelp forest community largely unresponsive to extreme warming
- Kelp and sessile invertebrates declined across the 15-year record, but no more dramatically during the warming event

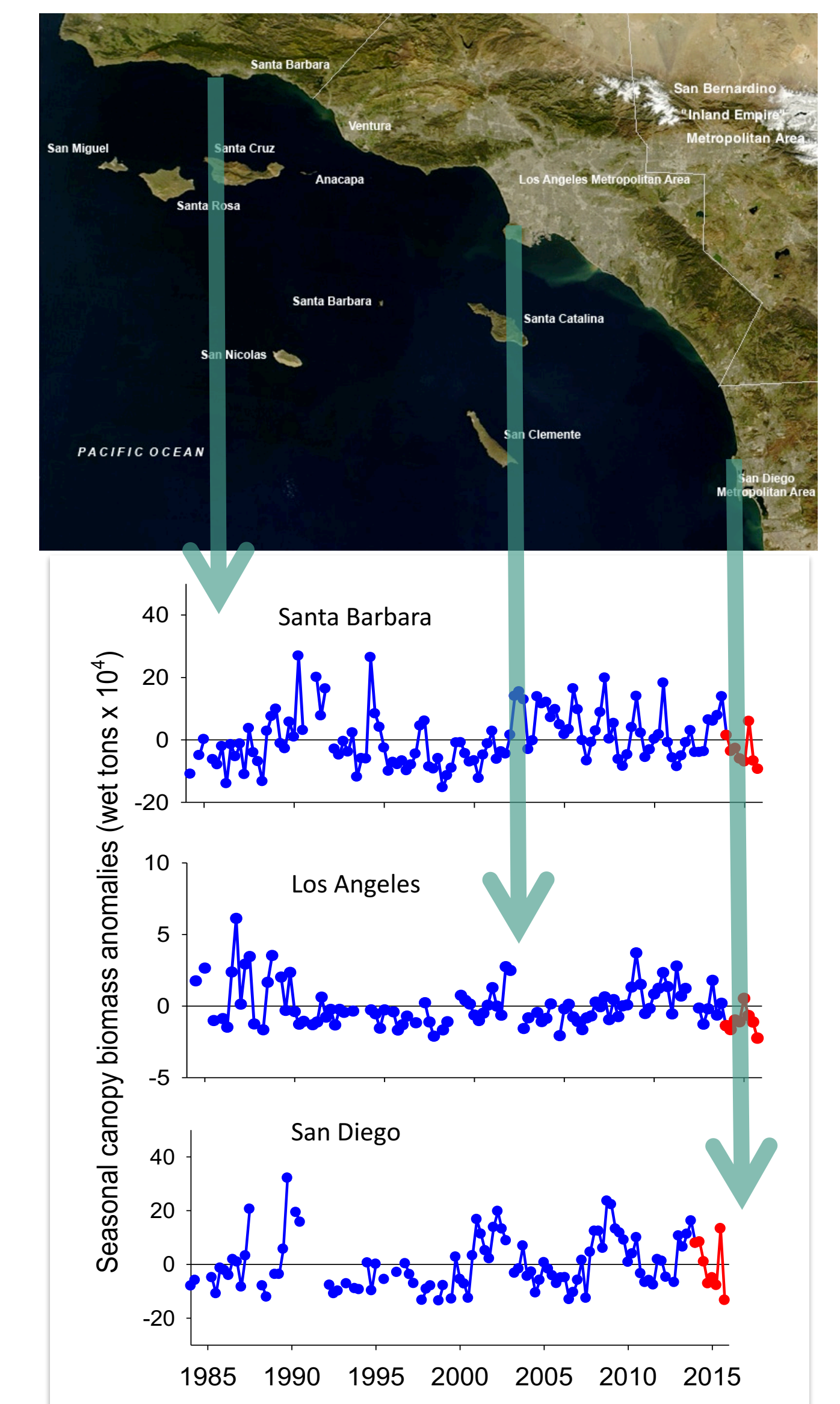
### Community Structure

- Species composition of understory algae and reef fish during the warm years did not differ from the cool years
- Species composition of sessile invertebrates differed slightly (21% dissimilarity) between cool and warm years

### Disease

- Declines in sea urchins and sea stars due to disease outbreaks linked to the warming.
- Decreases in these important consumers has so far not led to corresponding increases in their prey

## Satellite Data Confirm *in situ* Patterns



- Landsat imagery allows unprecedented view of long-term large-scale kelp dynamics.
- Seasonal kelp anomalies during 2014-2015 were well within the range observed during the 30-year time series.

## Conclusions

- Climate anomalies offer opportunities to test expectations of ecosystem responses to climate change.
- A lack of an expected response reveals knowledge gaps and limitations in forecasting ability, underscoring the importance of long-term data.
- Coastal managers that rely too heavily on untested sentinel species to detect ecosystem level effects may be lulled into a sense of complacency and miss opportunities to avert greater damage.

Reed et al. 2016, Nature Communications