

# KELP DEFORESATION IMPACTS HEALTH AND REPRODUCTION OF RED ABALONE IN NORTHERN CALIFORNIA

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## ABSTRACT

The bull kelp (*Nereocystis luetkeana*) is a foundation species of the kelp forest ecosystem in northern California, providing important food and habitat for many fish and invertebrate species. Since 2014, the bull kelp has been decimated by a combination of warm water and overgrazing by purple urchins, causing starvation conditions for the economically-important red abalone (*Haliotis rufescens*). We tracked the impacts of recent starvation conditions on the reproductive and body condition of red abalone by comparing recent body and gonad index (2015-2017) relative to an unimpacted baseline time period (2000-2009). Gonad index was calculated as the estimated gonad volume divided by a cubic index of shell size. Body condition was calculated based on the total body weight divided by the cubic index of shell size. Sixty red abalone samples were taken during each survey, and dimensions of the shell, body, and gonad were measured. The body condition index was the lowest ever observed in 2015-2017 (< 0.19), progressively declining each year (baseline: > 0.20). The gonad index was the lowest ever observed during 2016 and 2017 (< 100), less than 25% of baseline values. These results show that the red abalone have been starving in the wild for multiple years in a row, and that very little energy is being allocated to their reproductive system. In addition to increasing the potential for mortality due to starvation, the loss of reproductive output for these populations will limit the recovery potential of the red abalone fishery in northern California.

## METHODS

### Data Collection

#### Fishery Dependent Survey:

- Visual Health Assessment
  - April-June 2016, 2017
  - Shrinkage score recorded (Figure 5)
- Quantitative Healthy Assessment
  - Pre-potential impact (2000-2009) and post-potential impact (2016, 2017)
  - Calculated health indices

### Health Indices Calculations

#### Gonad:

- EGV  
= Estimated Gonad Volume<sup>1</sup>
- Gonad Index  
$$= \frac{EGV}{Shell\ Size\ Index}$$

#### Body Condition:

- Body Condition Index  
$$= \frac{Total\ Body\ Weight}{Shell\ Size\ Index}$$

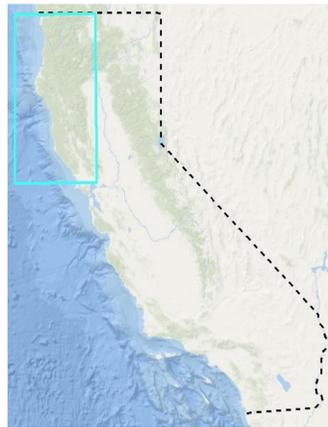


Figure 3. North of San Francisco affected by the decrease in Bull Kelp population.

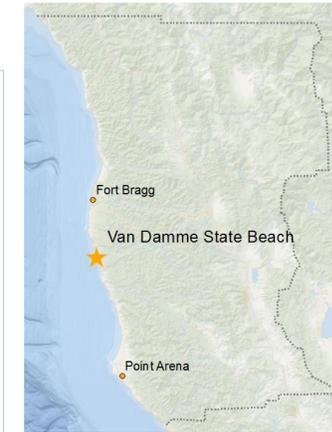


Figure 4. Fishery dependent surveys conducted at Van Damme State Beach.

## DISCUSSION

- Individuals that visually seem unimpacted (shrinkage 0) are greatly impacted reproductively by environmental conditions
- Approximately 25% of the population have even worse body conditions and gonad index than shrinkage 0
- Future population productivity of the fisheries will be negatively impacted

## CONCLUSION

- Shrinkage score is a useful tool to assess relevant health of individual Red Abalone
- Shrinkage of abalone is not due to a known disease in the area<sup>2</sup>
- Future of the Red Abalone fisheries is uncertain
- Continued research and monitoring of the Red Abalone population is vital

## INTRODUCTION



A) 2012 B) 2016



C) 2008 D) 2016

Figure 1. A) Bull kelp population in Sonoma County between Ocean Cove and Salt Point in 2012 taken by Kevin Joe. B) Same location taken in 2016 by Cynthia Catton. GIS map of the aerial kelp located in Van Damme State Beach in 2008 (C) and 2016 (D).

- Bull Kelp decline >90% since 2014 in Northern California
- Kelp and other algae important food source for Red Abalone
- Important recreational Red Abalone Fisheries

## RESEARCH QUESTIONS



1. What proportion of Red Abalone caught in the fisheries are effected by the latest environmental conditions?
2. What is the relationship between shrinkage score and Red Abalone health indices?

Figure 2. Red Abalone taken by Kevin Joe.

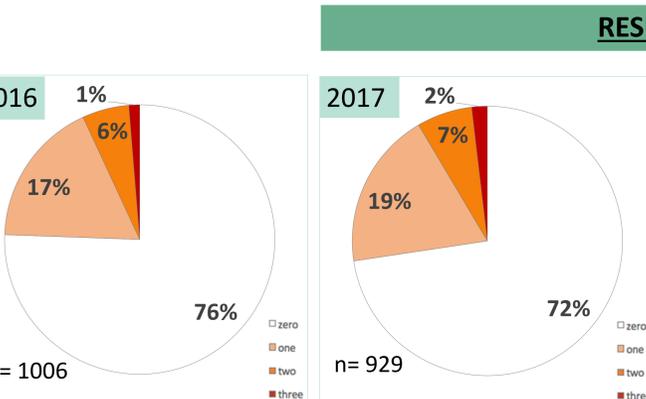
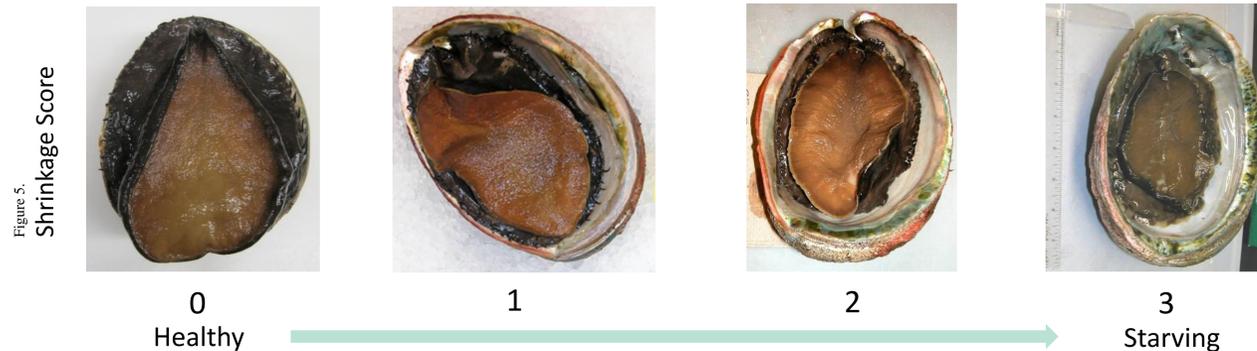


Figure 6. Percentage of each shrinkage score of abalone catch from Van Damme in 2016 (left) and 2017 (right).

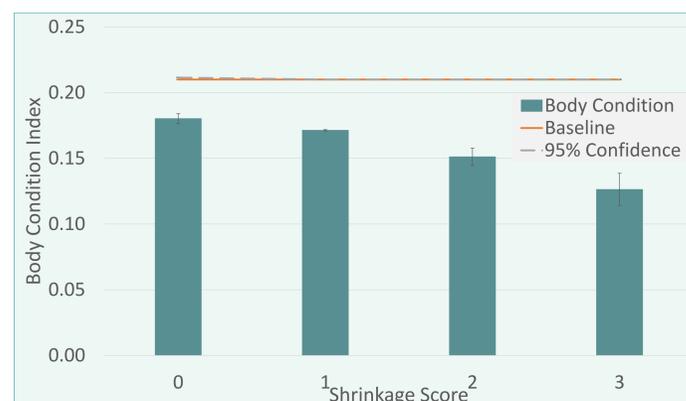


Figure 8. Body condition decreases as shrinkage score increases based on data from 2016 and 2017. All shrinkage scores are below the 2000-2009 baseline.

## RESULTS



Figure 7. Photos of a large healthy gonad (left) and a shrunken gonad (right) from different individual Red Abalone taken by Laura Rogers-Bennett.

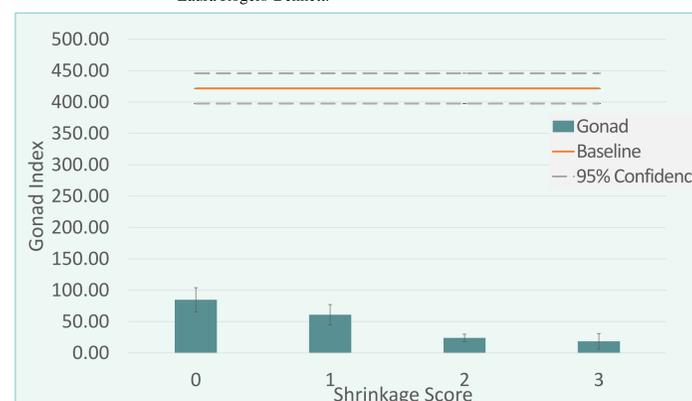


Figure 9. Gonad index decreases as shrinkage score increases based on 2016 and 2017 data. Gonad index are well below baseline and 95% confidence for all shrinkage scores.



Figure 10. Bull kelp underwater taken by Kevin Joe.

## REFERENCES

- <sup>1</sup> Tutschulte, T. C. and J. H. Connell (1981). "Reproductive biology of three species of abalones *Haliotis* in southern California." *Veliger* 23(3): 195-206.
- <sup>2</sup> Dr. Jim Moore, *Personal Communication*

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