



UC DAVIS
BODEGA MARINE
LABORATORY

Maintaining the Health of Endangered White Abalone (*Haliotis sorenseni*) in a Captive Breeding Program

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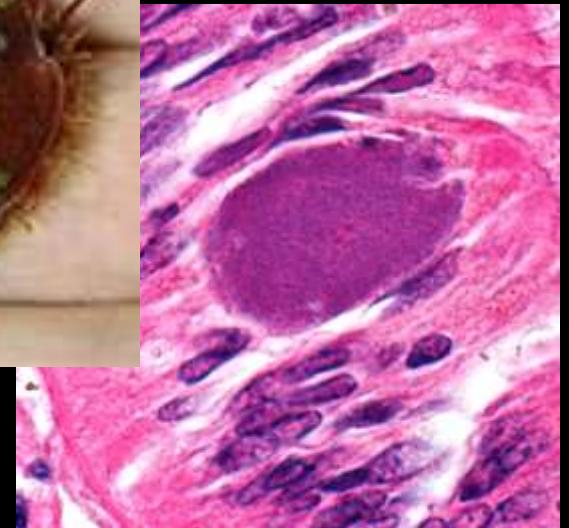
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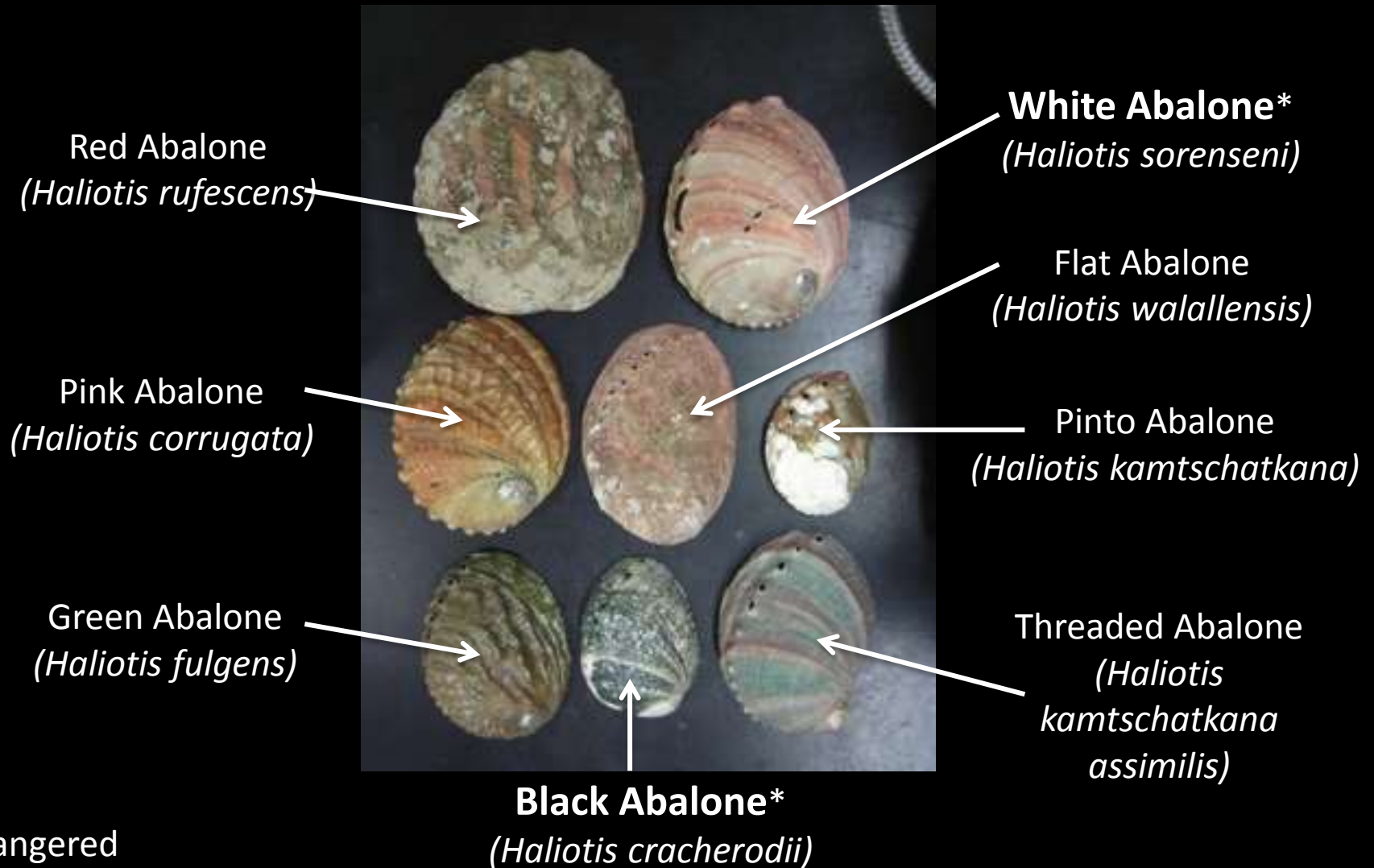
Northwest Fish Culture Concepts Workshop
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Overview

- White Abalone History
- Endangered Status and the White Abalone Recovery Plan
- Monitoring for Infectious Disease and Pests
- Treatment of Infected and Infested Captive Abalone



Abalone Species Found on the Pacific Coast of North America



White Abalone (*Haliotis sorenseni*)

- First described in 1940
- Estimated life span is 35-40 years
- Deepest occurring abalone species in California (most abundant between 25-65m)
- Broadcast Spawners



Adult White Abalone are usually between 5 to 8 inches long

White Abalone (*Haliotis sorenseni*)



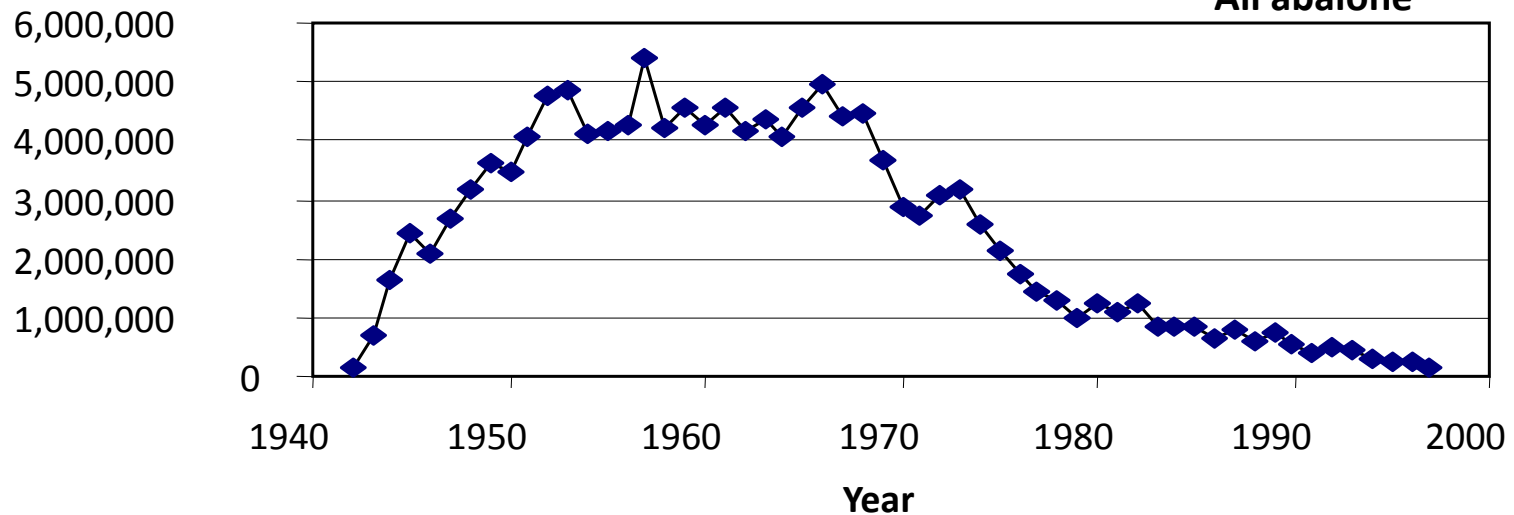
Distribution

- Range: Point Conception, California to Punta Abreojos, Baja California
- Population in California has been reduced to 1% of its historic size
- Population in Mexico is being studied, but remains largely unknown

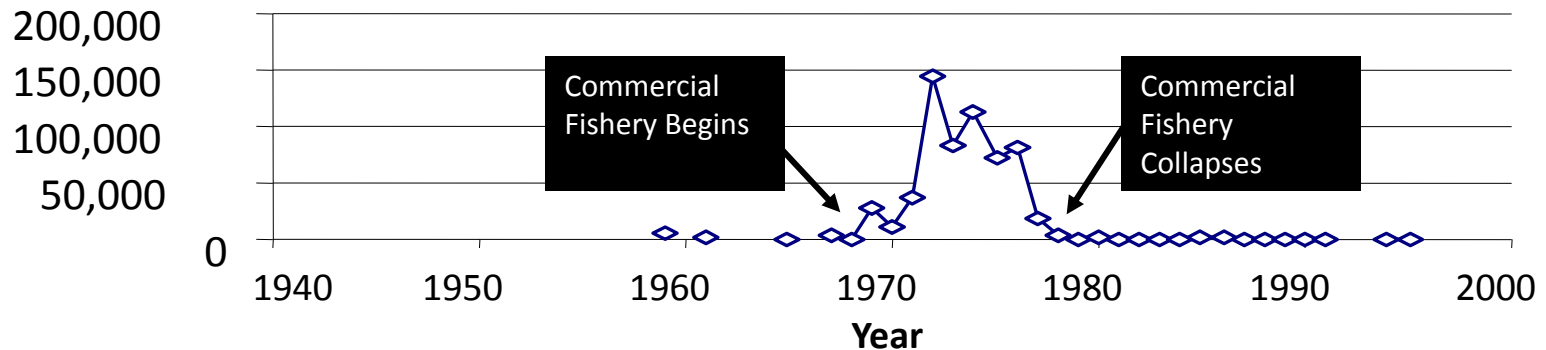


Commercial Fishery Landings (In Pounds)

All abalone



White abalone



Endangered Status and Recovery Plan



1999

Center for Biological Diversity
and Marine Conservation
Institute both petition for ESA
listing

May 29, 2001

White abalone becomes first
marine invertebrate to be
listed as an endangered
species

2001

Captive breeding produces
more than 100,000 juvenile
white abalone

2002

95% of these offspring die
from disease

2008

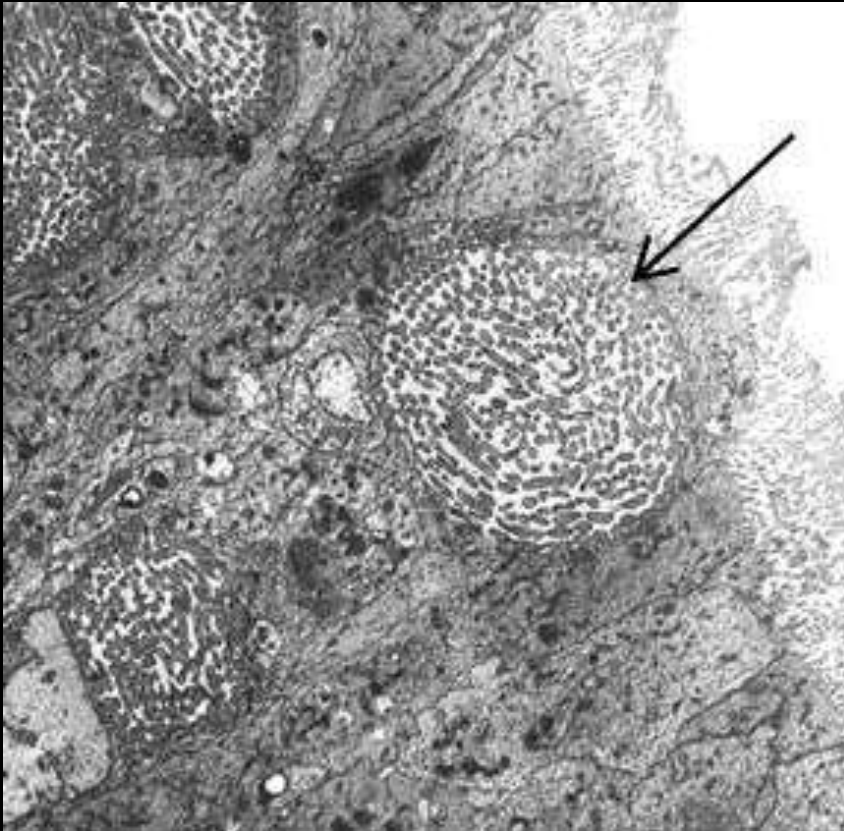
NMFS published the White
Abalone Recovery Plan

Withering Syndrome

- First discovered off the channel islands in 1985
- Can affect all species of abalone
- Signs of disease:
 - Shrinkage of foot muscle
 - Lethargy
 - Decreased food consumption



Candidatus Xenohalictis californiensis (CXc)



Transmission electron micrograph showing a colony of the CXc bacterium in the gut of an abalone

- *Rickettsiales* prokaryote
- Obligate intracellular bacterium
 - Infects the mucosal epithelium of the gastrointestinal tract
 - Replicates within intracytoplasmic, membrane-bound vacuoles
- Not cultivatable on fish media or fish cell lines

Candidatus Xenohalictis californiensis (CXc) Detection



Necropsy



Feces Samples
(Non-Lethal)

Histology

Post-esophagus tissue



In Situ
Hybridization



qPCR
(Friedman et al.
2014)



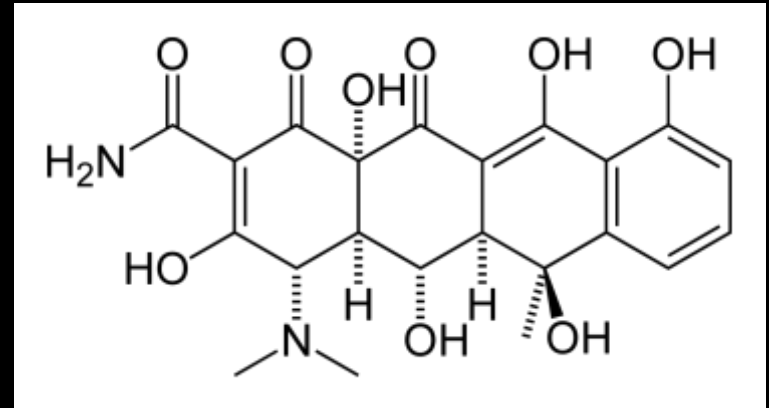
Testing White Abalone for CXc

- Transmitted through untreated seawater
- Routine qPCR testing at Bodega Marine Laboratory and five other partner facilities
 - Feces samples collected on monthly, quarterly, or biannual basis
 - DNA Extracted using a QIAamp Fast Stool Mini Kit
- Detect emerging infections before signs occur
 - Antibiotic Treatment



Antibiotic Treatment

- Antibiotic: Oxytetracycline (OTC)
 - Informed by previous treatments on fish
 - Effective treatment of infections caused by Rickettsiales species
- Methods to administer OTC:
 - Intra-muscular injections (Friedman)
 - Incorporate into artificial diet
 - Bath (Moore et al.)



Bath Administration of Oxytetracycline

Advantages:

- Consistent dosage of drug
 - Uptake of the drug is independent of behavior
- Treat multiple animals at once--
no handling required
- Negligible mortality

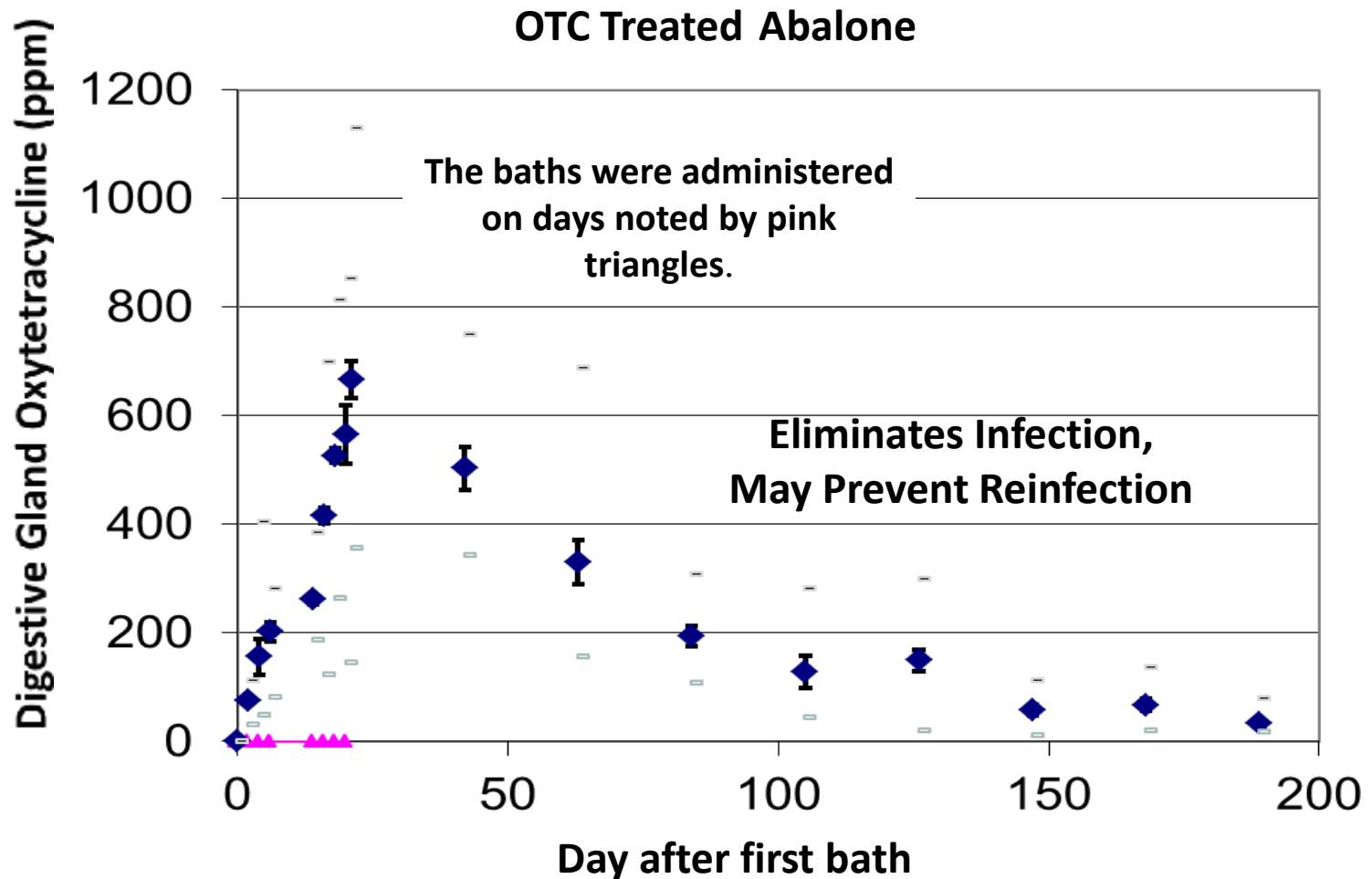
Disadvantages:

- Expensive
- Wastewater

Eight (8) 500ppm OTC baths,
Each bath lasts 24 hours



Antibiotic Kinetics in Abalone Tissue



Shell-Boring Organisms

Sponges

(*Cliona celata californiana*)



Bivalves

(Clam: *Panitella conradi*)



Polychaetes

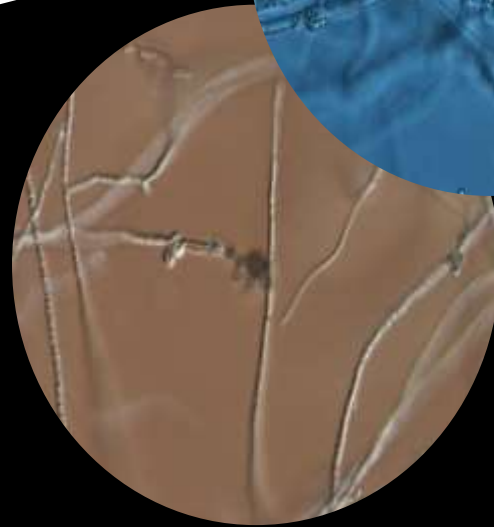
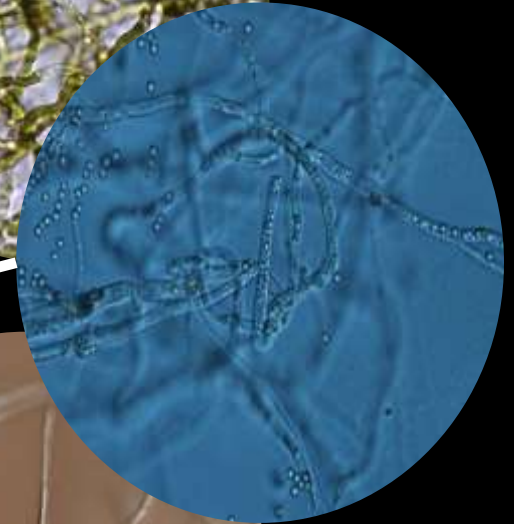
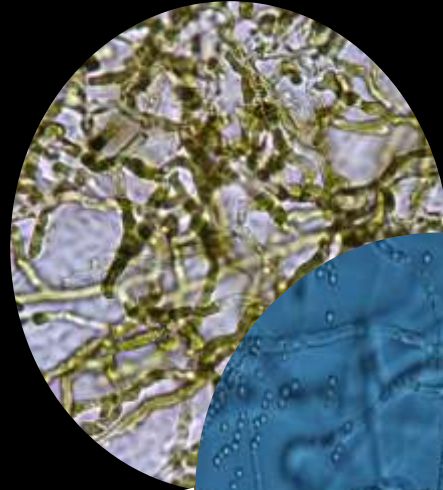
(*Polydora* spp)



Shell Lesions



White Abalone with Shell Lesion



Waxing Treatment to Eliminate Shell Boring Organisms



Beeswax
(66%) and
Coconut Oil
(34%),
~70°C



Waxing Treatment to Eliminate Shell Boring Organisms

- Initial application, followed by subsequent applications on a routine basis
- Eliminates sponges, bivalves, and polychaetes
- 100% abalone survival



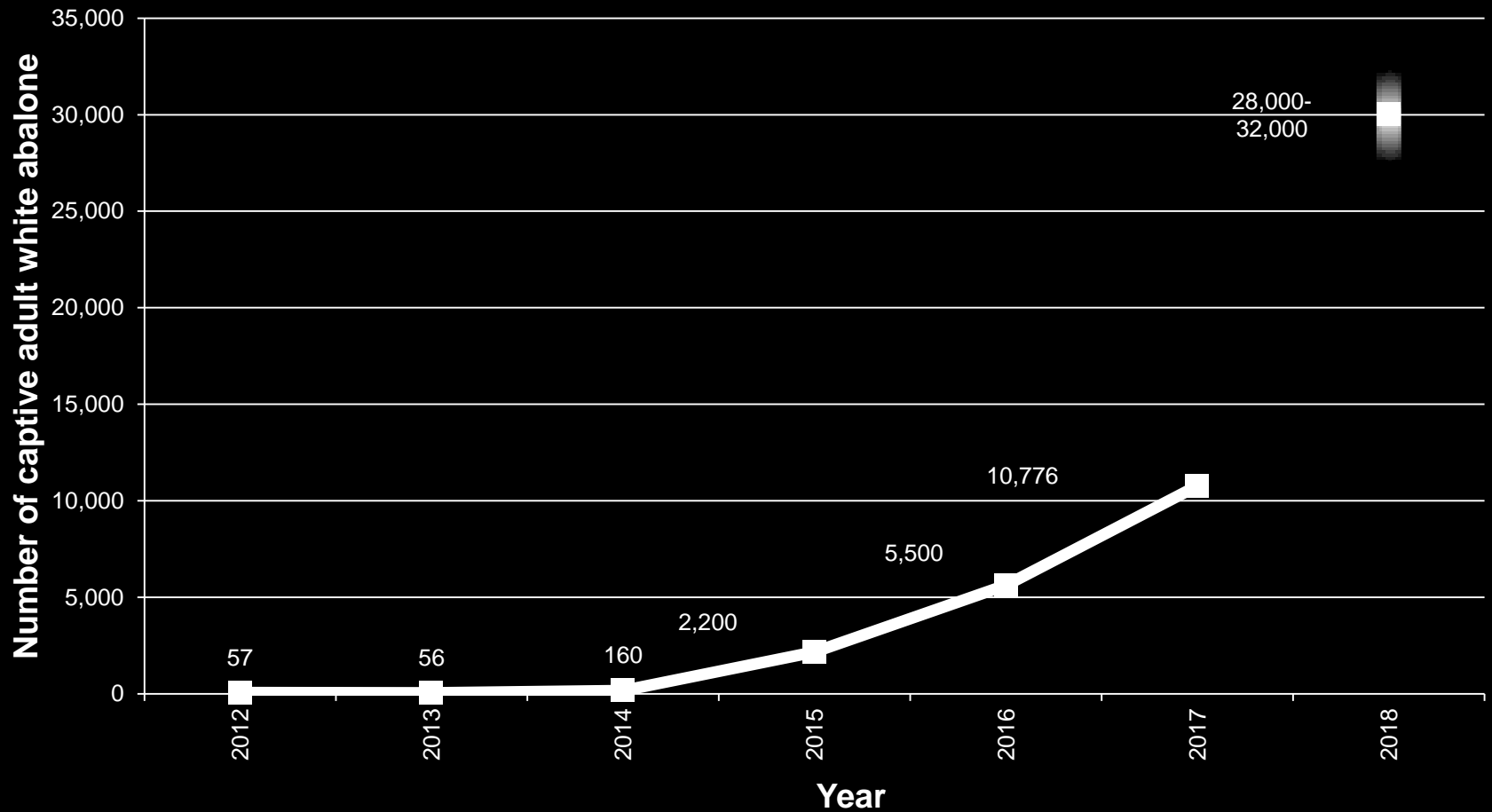
Wild-origin White Abalone Broodstock

Summary

- Routine monitoring ensures that infected abalone are treated promptly
 - No mortalities **solely** attributed to infection with CXc in captive white abalone since program's inception
 - Program on track for outplanting due to health maintenance
- Decline in mortalities due to shell boring organisms and opportunistic microbes
 - Successfully eliminated *Polydora* worm using the waxing treatment



Spawning Success



Health Maintenance and Disease Management has played, and is continuing to play, an integral part in the recovery project!

Acknowledgments

BML White Abalone Team

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Websites

CDFW Shellfish Health Lab:

<https://www.wildlife.ca.gov/Conservation/Laboratories/Shellfish-Health>

White Abalone Recovery Project at Bodega Marine Lab:

<http://bml.ucdavis.edu/research/research-programs/saving-white-abalone/>

