

# Diving into debris: the biology and ecology of biota transported on Japanese tsunami marine debris



Polychaete worm, *Harmothoe imbricata* complex  
California (same species found on Oregon dock)  
(c) Leslie Harris, NHMLAC



Amphipod crustacean *Ampithoe valida*  
Oregon (same species found on Oregon tsunami dock)  
(c) Leslie Harris, NHMLAC

Polychaete worm *Hydroides ezoensis*  
Vladivostok, Russia (same species  
found on Oregon dock)  
(c) Leslie Harris, NHMLAC



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Center, <sup>5</sup>Osaka Museum of Natural History, <sup>6</sup>Moss Landing Marine Laboratories

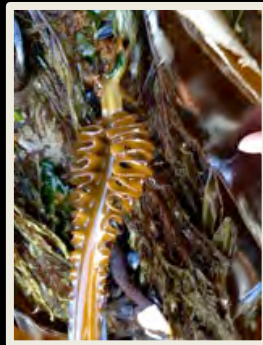
On March 11, 2011, a devastating 9.0 moment magnitude earthquake struck Japan and a 38.38 m tsunami followed

*The disaster claimed nearly 16,000 lives and injured 6,000*





# Newport, Oregon - June 5-6, 2012



Hundreds of species hitched rides to North America on debris from the 2011 Japanese tsunami.

289 species

Researchers studied 634 pieces of tsunami debris.

Earthquake epicentre

Kuroshio Current

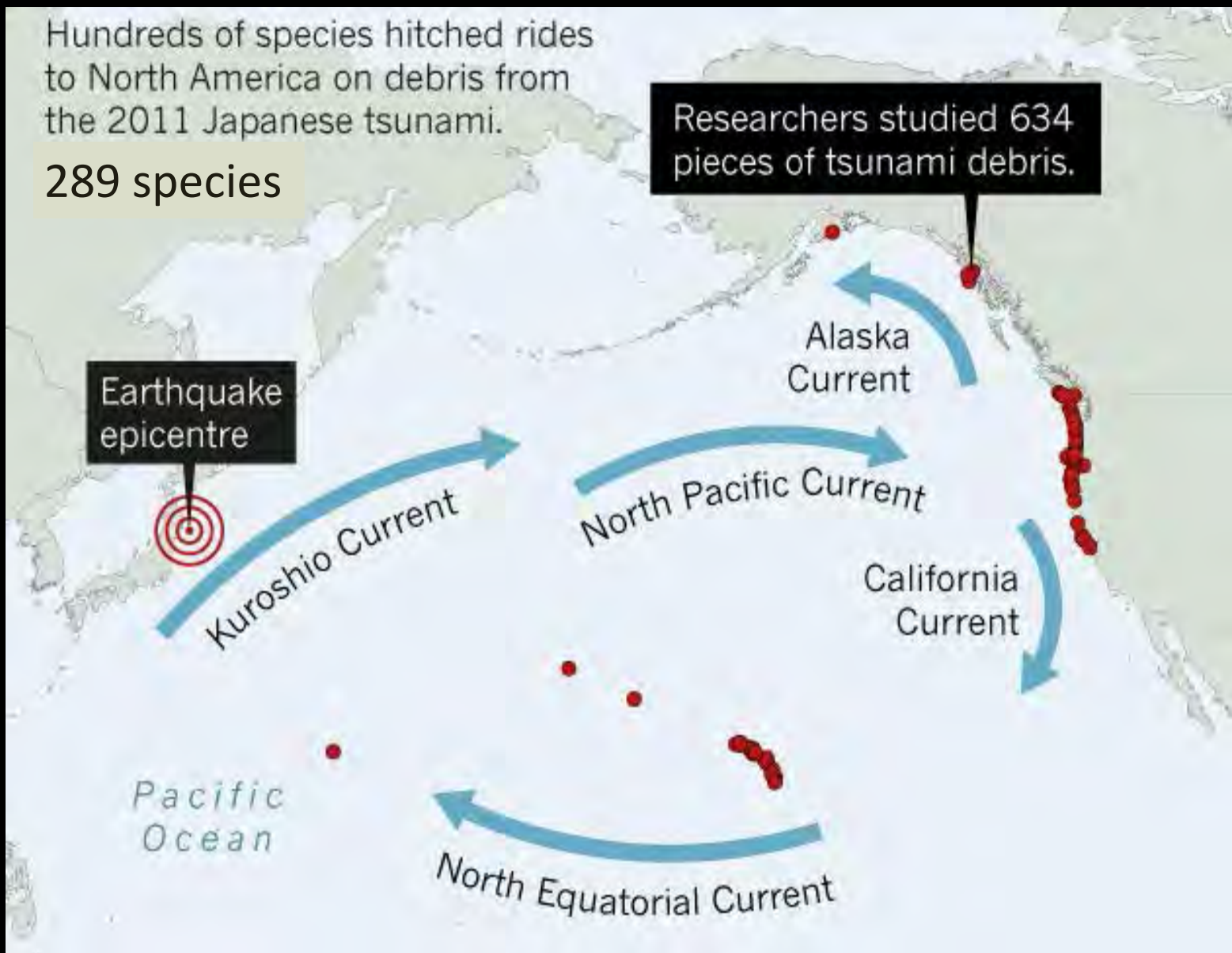
North Pacific Current

Alaska Current

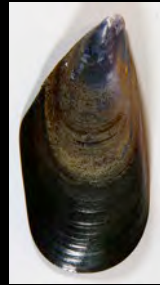
California Current

Pacific Ocean

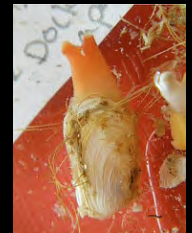
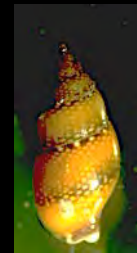
North Equatorial Current



Transoceanic dispersal of the mussel *Mytilus galloprovincialis* on  
Japanese tsunami marine debris:  
An approach for evaluating rafting of a coastal species at sea



Trait-based characterization of species transported on Japanese tsunami  
marine debris: Effect of prior invasion history on trait distribution

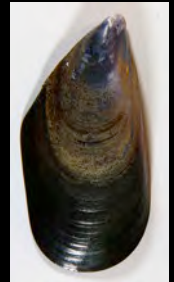




# Transoceanic dispersal of the mussel *Mytilus galloprovincialis*: Methods

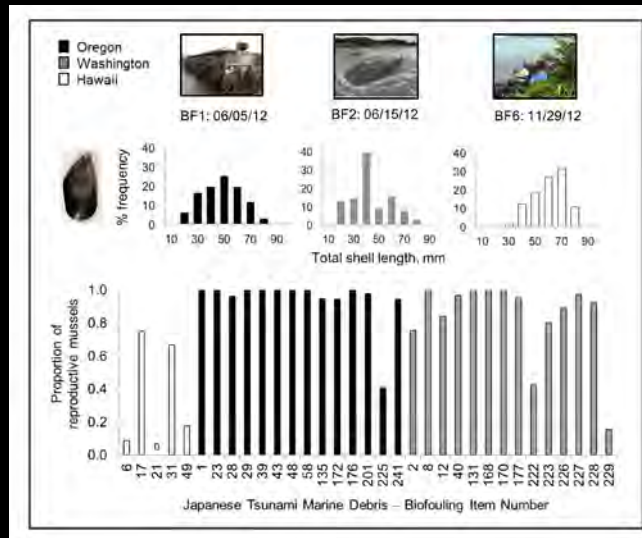


- Genetic species confirmation ( $n = 600$  mussels) mitochondrial cytochrome c oxidase subunit III
- Reproductive state (Biofouling (BF) items,  $n \geq 3$ )



- Size and growth (32 BF items)

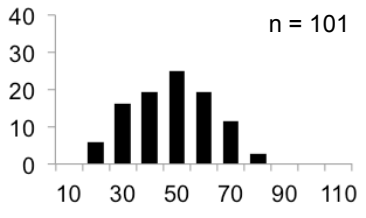
- Structural and chemical shell analysis for growth and transport (17 BF items)



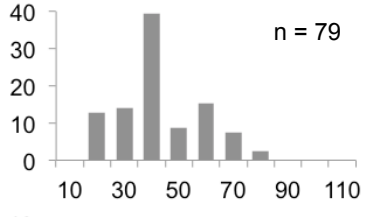
# Mussel Size



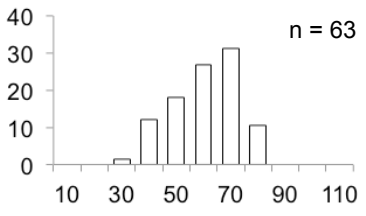
BF1: 06/05/12



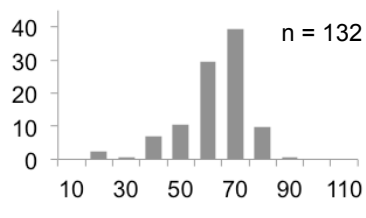
BF2: 06/15/12



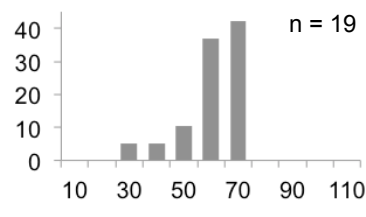
BF6: 11/29/12



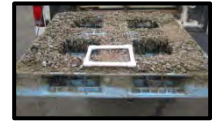
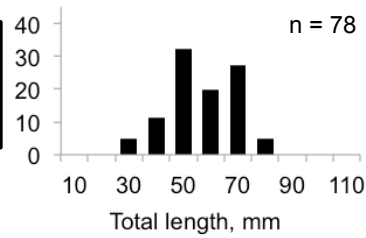
BF8: 12/18/12



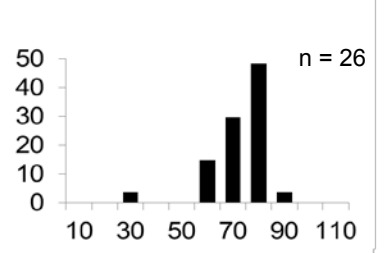
BF12: 12/28/12



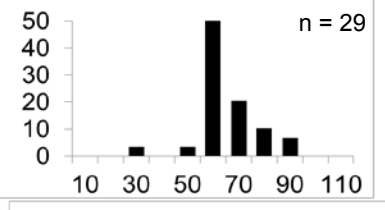
BF23: 02/05/13



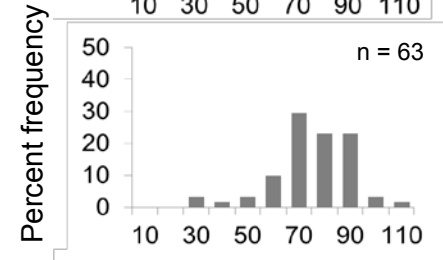
BF24: 02/08/13



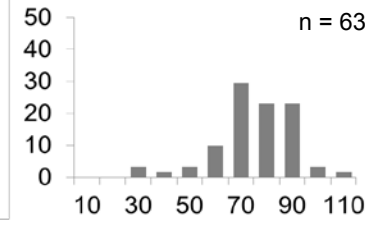
BF28: 02/20/13



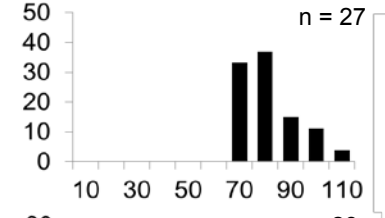
BF40: 03/22/13



BF43: 04/07/13



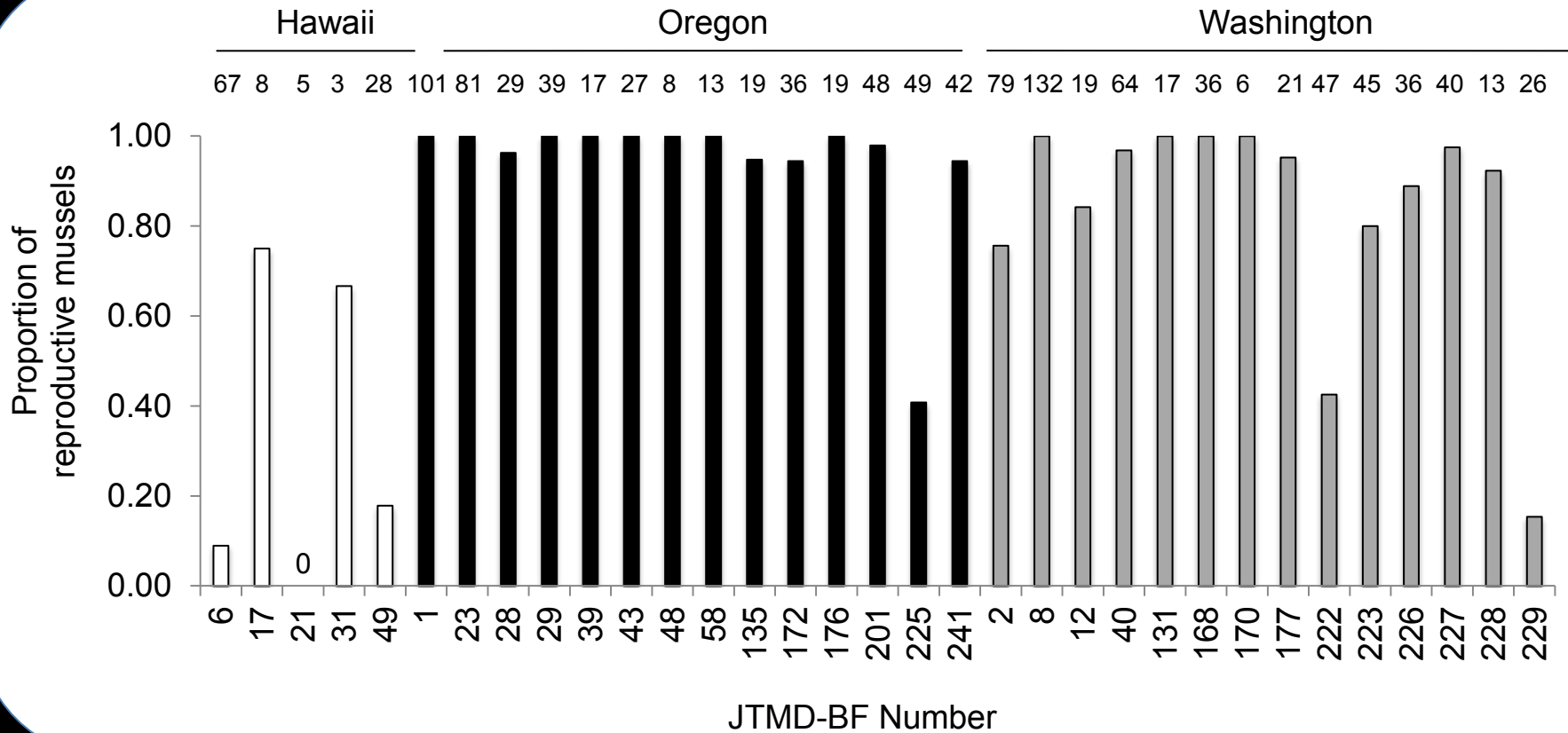
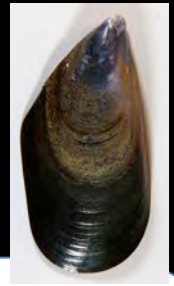
BF49: 03/29/13



- Hawaii
- Oregon
- Washington

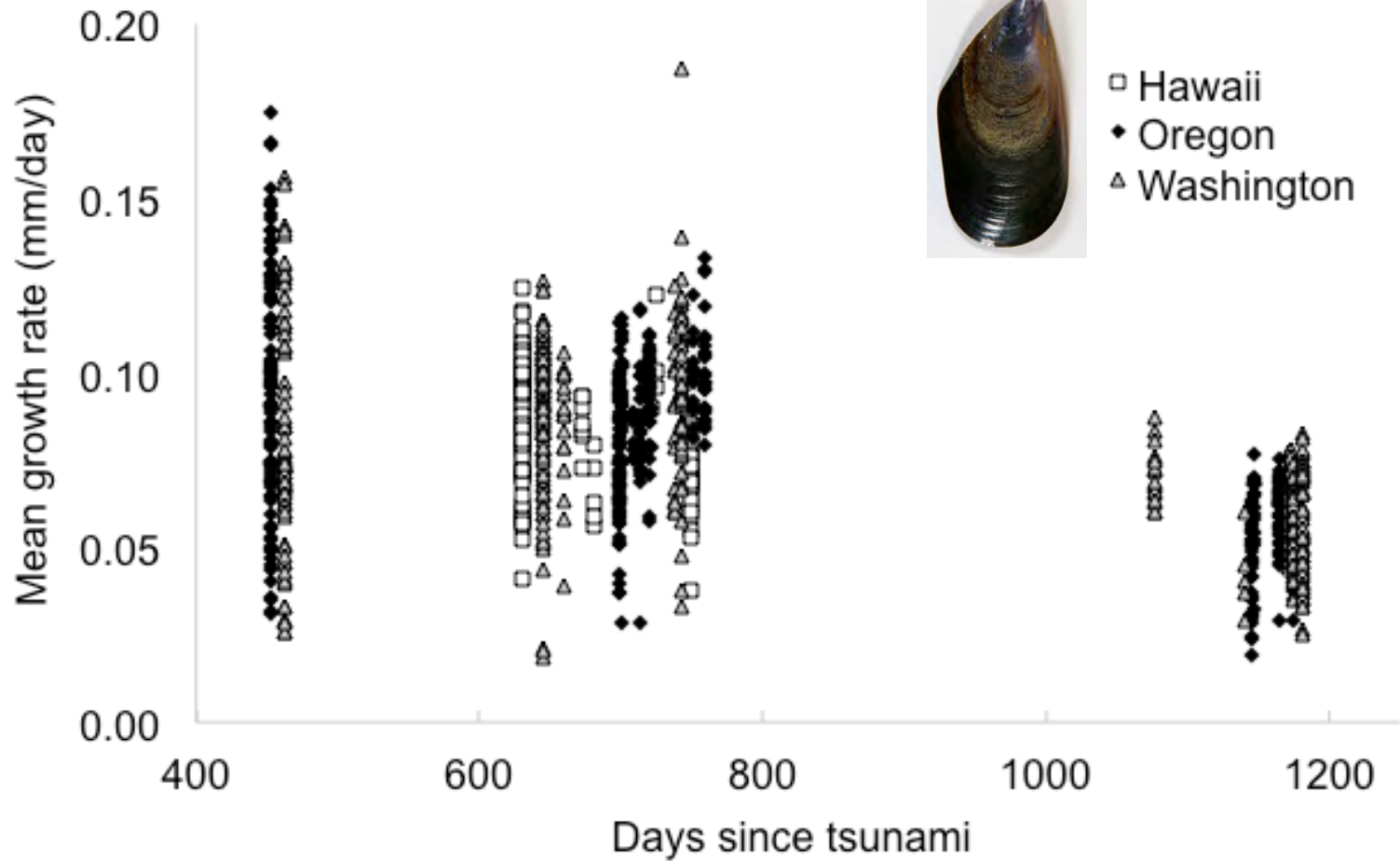
Total length, mm

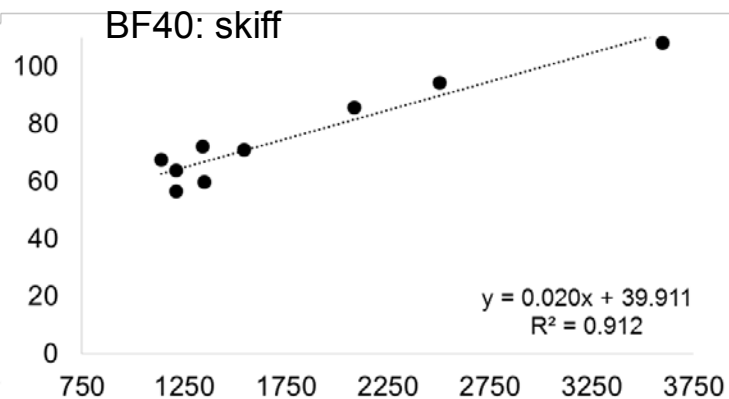
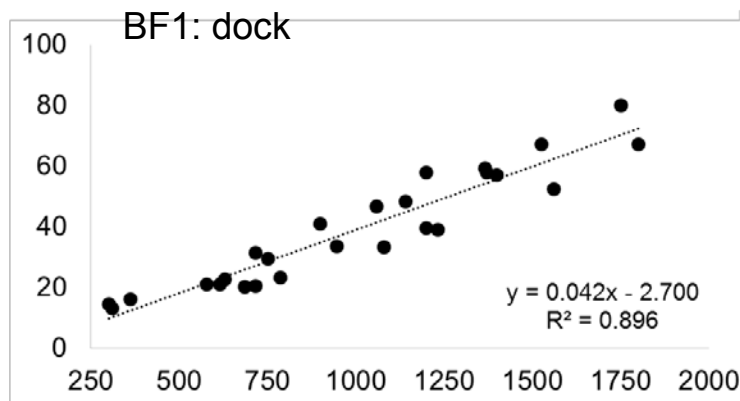
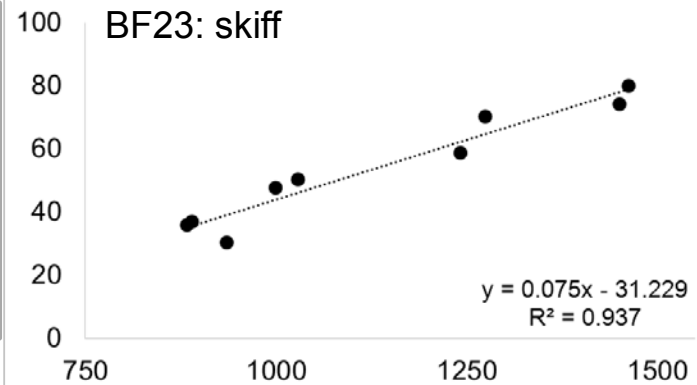
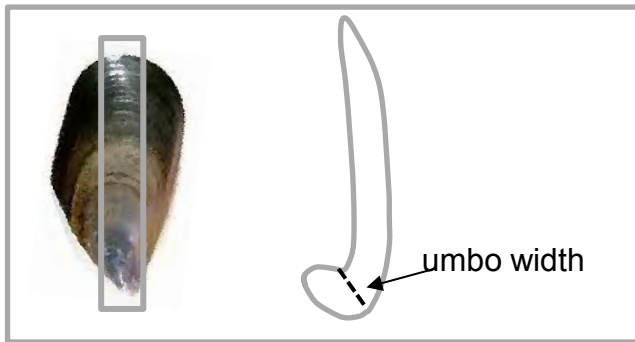
# Reproductive Condition



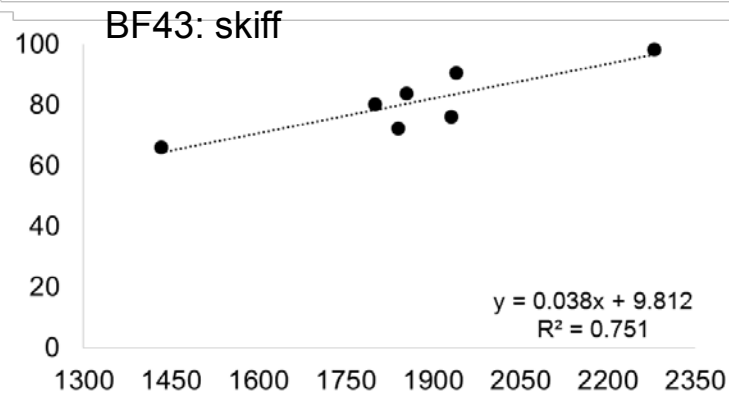
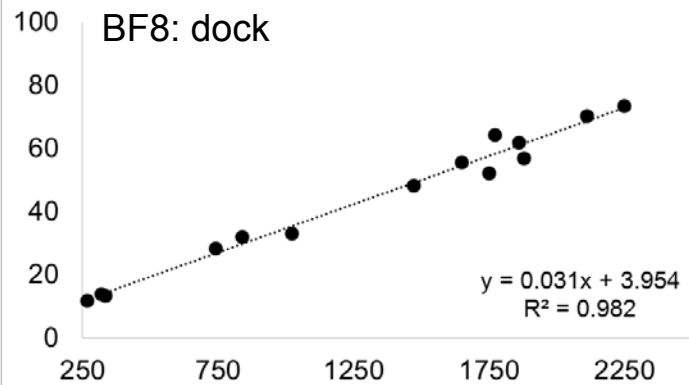


# Growth





Total length (mm)

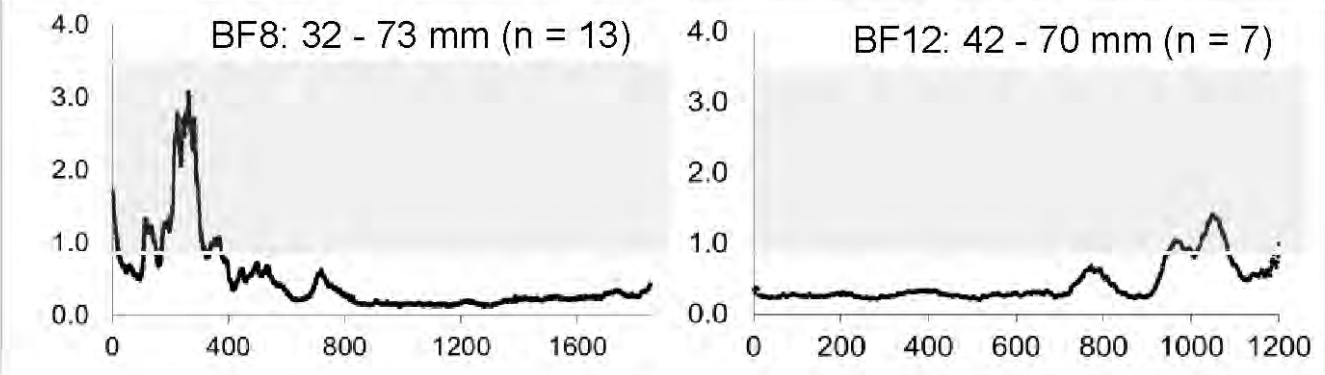
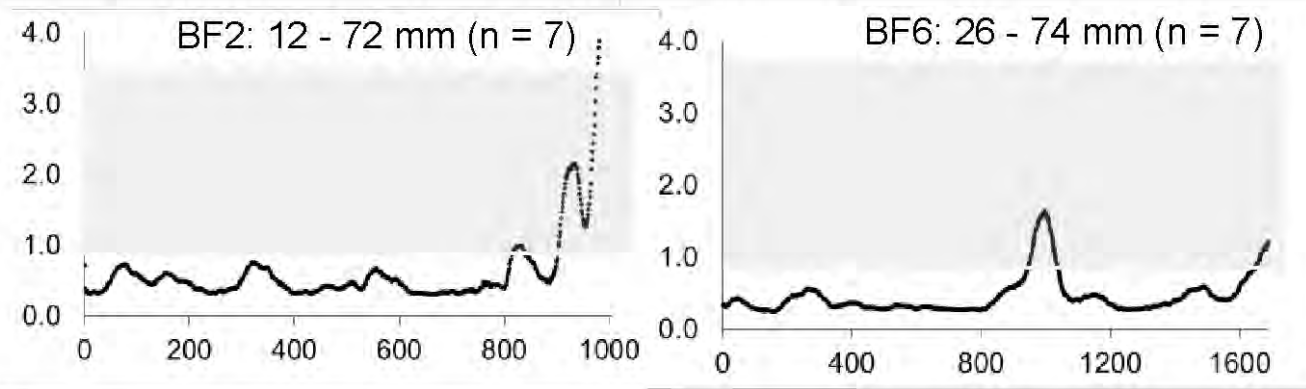
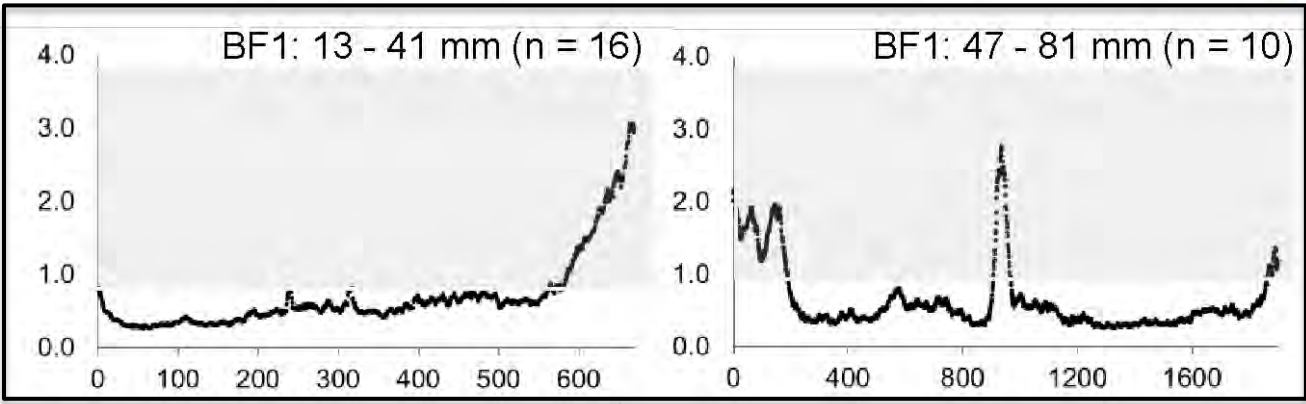


Umbo width ( $\mu\text{m}$ )

# Shell Chemistry : Barium/Calcium



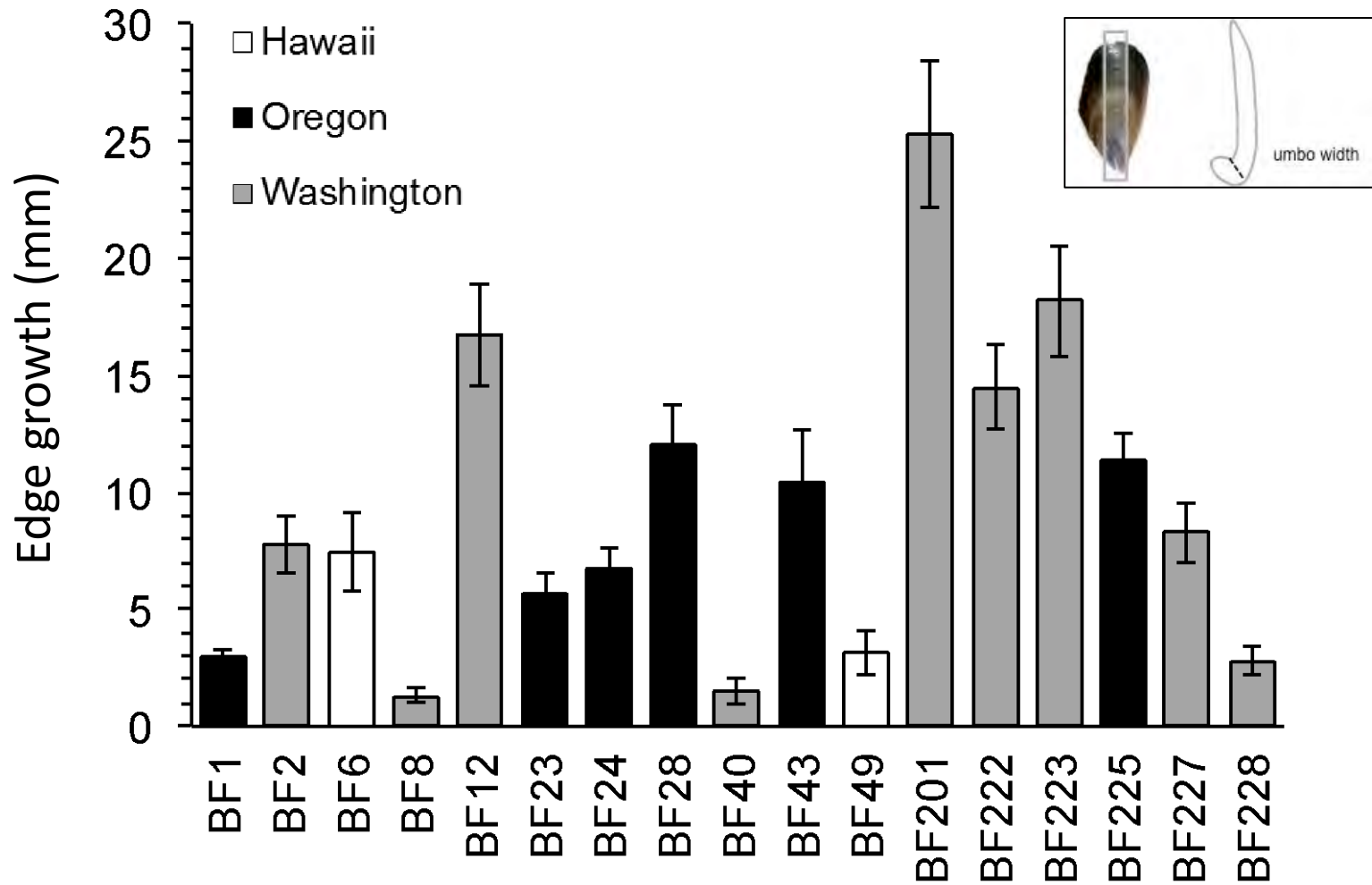
Shell Ba:Ca ( $\mu\text{mol/mol}$ )



Distance along umbo from settlement to outer edge ( $\mu\text{m}$ )



# Coastal growth prior to landing – coastal interception

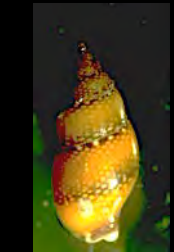


# Trait-based characterization of species transported on Japanese tsunami marine debris: Effect of prior invasion history on trait distribution

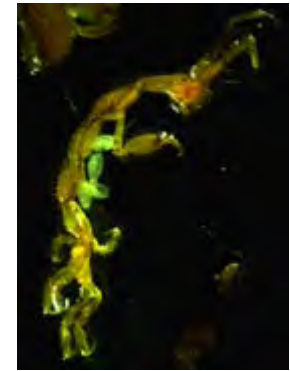
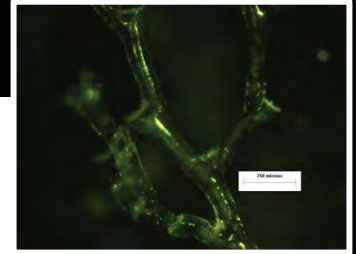
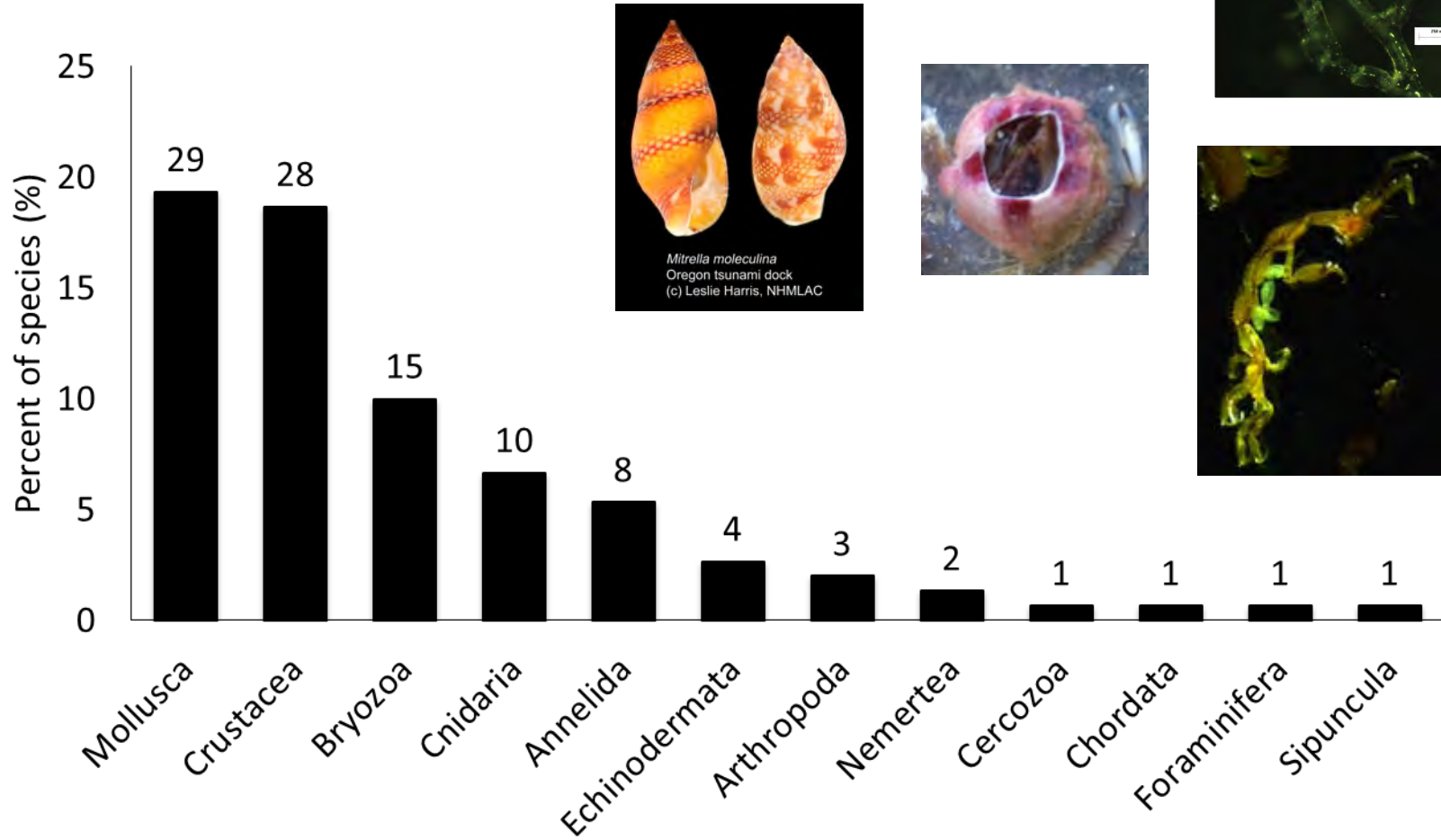
Distributional, environmental, and life history traits for 92 JTMD species

Compare 30 species with and 62 species without invasion history

Non-metric Multi-Dimensional Scaling  
Multi-Response Permutation Procedure (group effect)  
Indicator “Species” Analysis (ID traits)



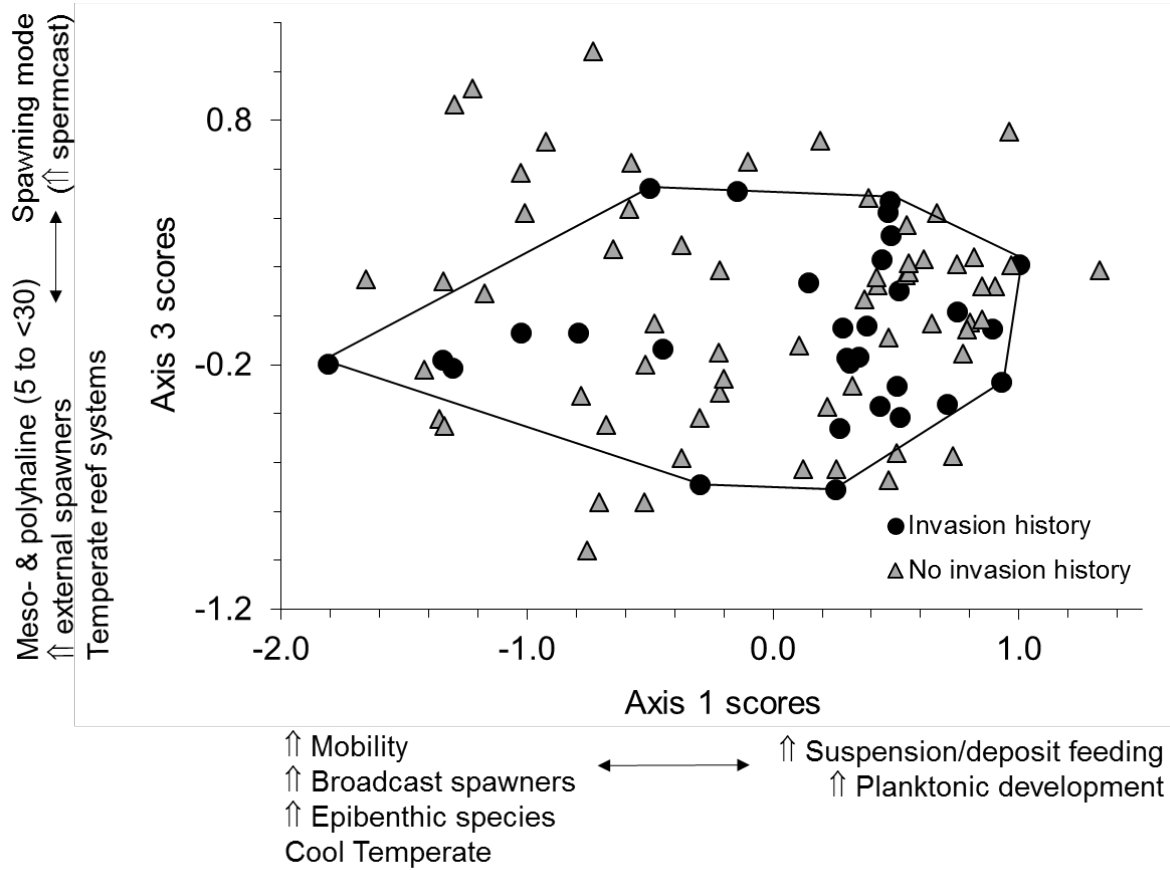
# Phylogenetic Representation





Stress = 11.6  
89.8% of variance

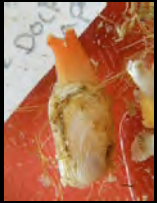
MRPP  
A = 0.03, P < 0.01





JTMD species with prior invasion history were more common:

- On artificial and hardpan substrates
- In fouling, flotsam & temperate reef ecosystems
- Tolerant of wider range of salinities
- In subtropical & tropical temperatures

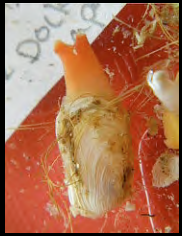


Identified 35 (of 62) species with no invasion history that overlapped with those species with invasion history





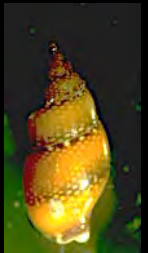
*Mytilus galloprovincialis* settled pre- and post-tsunami , grew relatively rapidly, arrived capable of reproduction



Key traits differentiated JTMD species with and without known invasion history



A quantitative trait analysis for prioritization of species with no invasion history (35 out of 62 species)



Working hypothesis regarding traits that may increase the propensity for rafting coastal invertebrates to invade novel regions



Contributes to our understanding of marine debris as a transport vector





# Collaborators & Acknowledgements

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# Comments or Questions?

