The invasion risk of invertebrate species associated with Japanese tsunami marine debris in North America and Hawaii

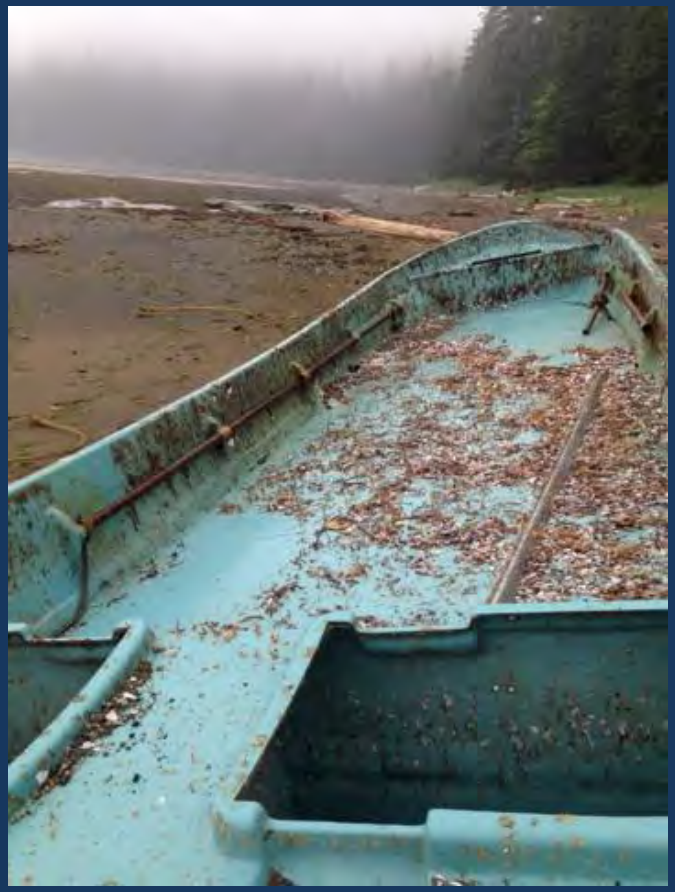
Jocelyn C. Nelson[1], Cathryn Clarke Murray[1], James T. Carlton[2], Michio Otani[3], Gregory M. Ruiz[4], and Thomas W. Therriault[5]

[1] North Pacific Marine Science Organization (PICES)
[2] Williams College - Mystic Seaport
[3] Osaka Museum of Natural History
[4] Smithsonian Environmental Research Center
[5] Department of Fisheries & Oceans Canada

PICES

Assessing the risk of species invasions

- Great Tsunami increased marine debris abundance and variety
- Marine debris carries coastal invertebrate species
- Prioritized species lists created for monitoring
- Species watch lists per state and province



Photos: Lightspeed Digital

Canadian Marine Invasive Screening Tool (CMIST)

- Screening tool that evaluates risk based on invasion likelihood and impacts

- Scored from low (1) to high (3) risk on 17 questions:
  - Present status in the area
  - Rate of introduction
  - Survival
  - Establishment
  - Spread
  - Impact

Photo: Hideaki Maki

- Scores range from 1 (low risk) to 9 (high risk)

CSAS Science Advisory Report 2015/04
Drolet et al. (2016) Biological Invasions 18

Canadian Marine Invasive Screening Tool (CMIST)

- Example impact question:

  What level of impact could the species have on habitat in the assessment area?

  [1] Low or no impact
  [2] High impact in few areas or moderate impact in many areas
  [3] High impact in many areas

- Each question scored qualitatively for certainty
  - Amount of reliable information available
  - Scorer experience with the species

Photo: Lightspeed Digital

CSAS Science Advisory Report 2015/04
Drolet et al. (2016) Biological Invasions 18

Canadian Marine Invasive Screening Tool (CMIST)

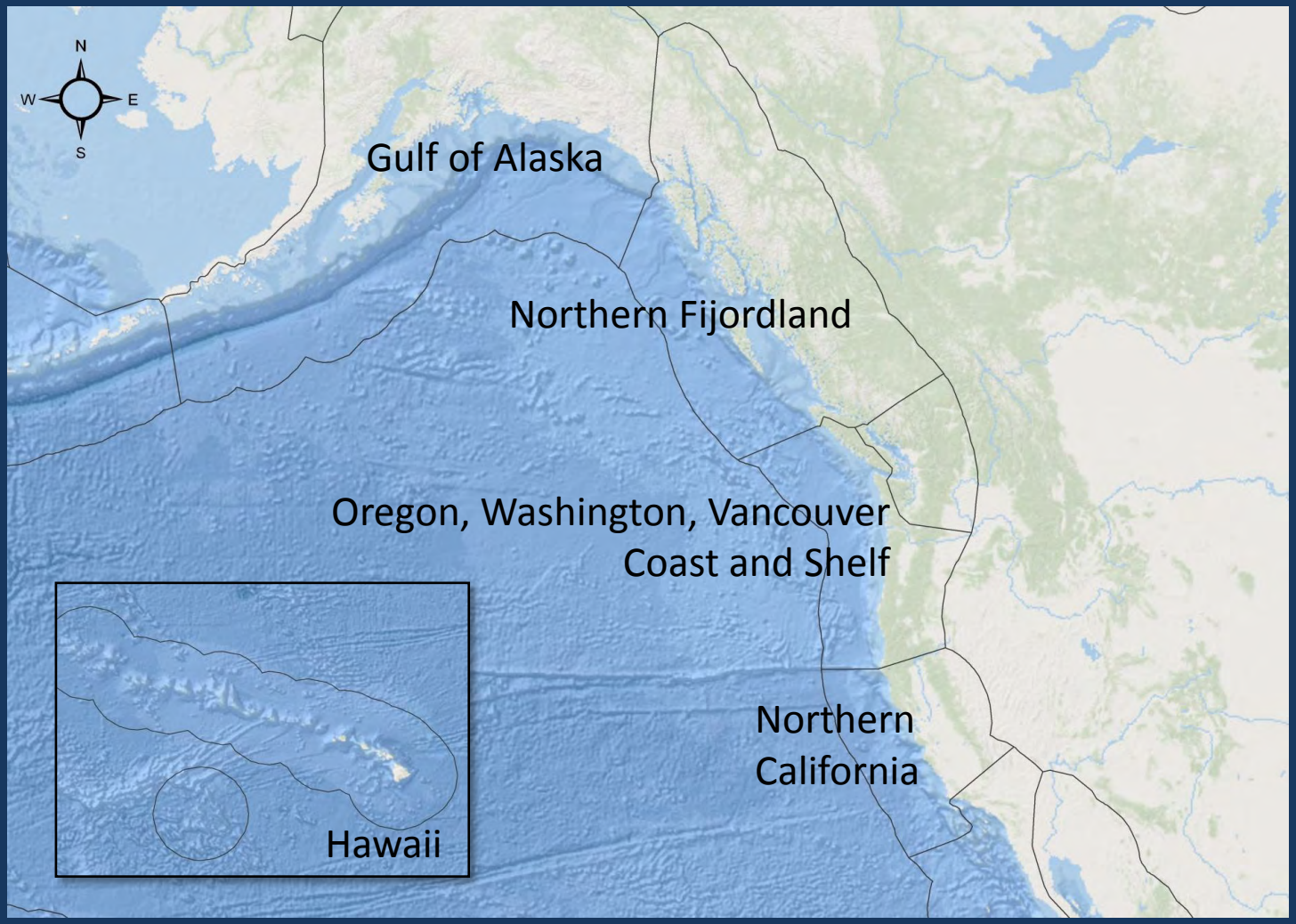
- Each species scored by at least two biologists
- Species list from Japanese tsunami debris created by Dr. Jim Carlton and the taxonomist team
- 164 invertebrate species assessed
- Species evaluated for each of 5 regions

Photo: Lightspeed Digital

CSAS Science Advisory Report 2015/04
Drolet et al. (2016) Biological Invasions 18

Canadian Marine Invasive Screening Tool

Study Regions



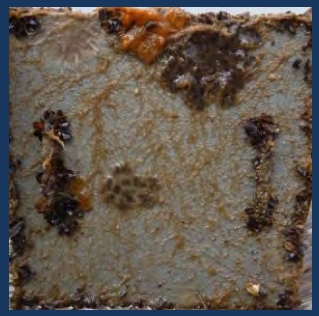
Spalding et al. (2007) BioScience 57(7)

Canadian Marine Invasive Screening Tool (CMIST)

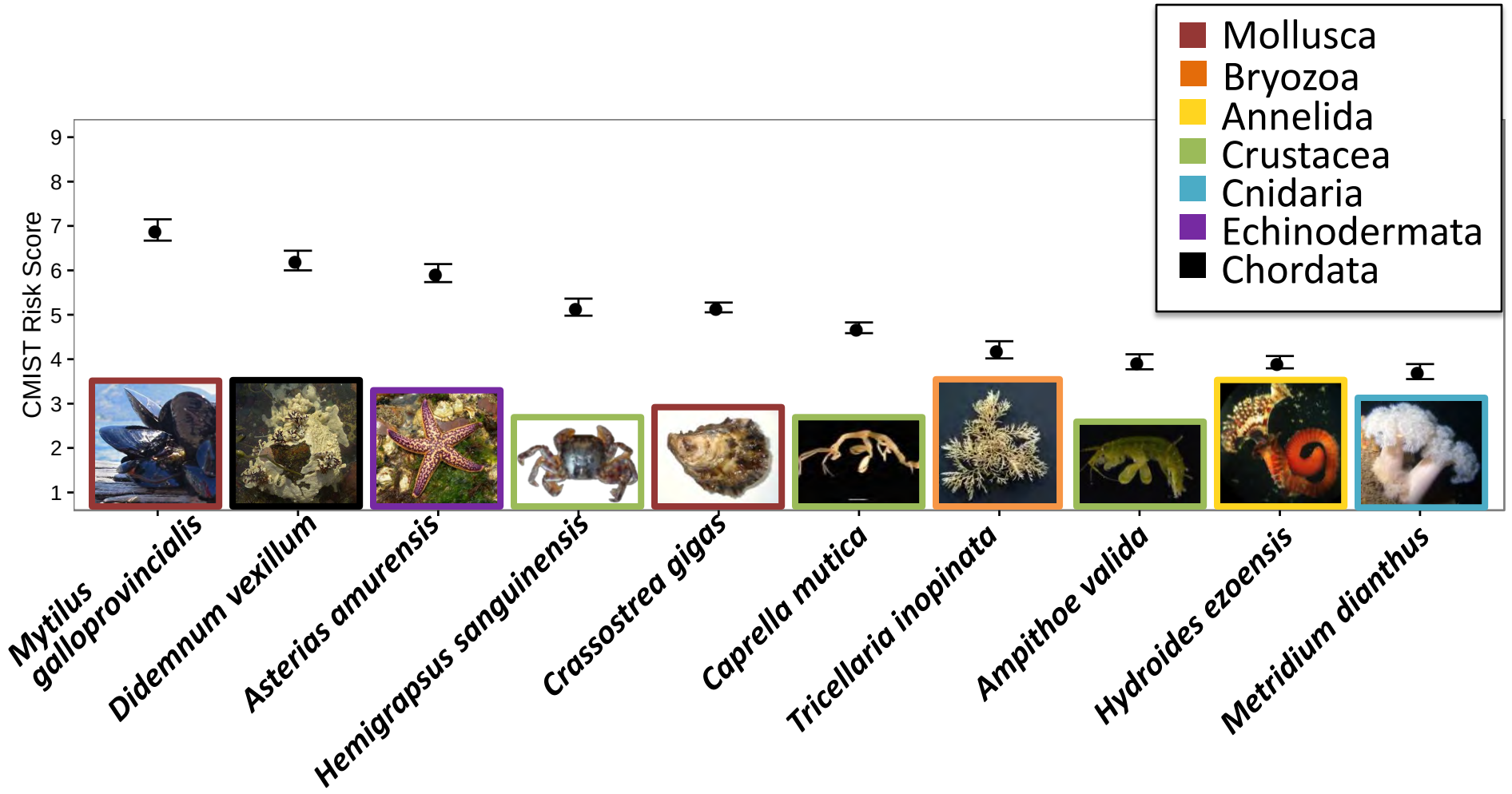
JTMD life history database

- Life history information compiled from global and Japanese literature
- Includes native and non-native locations, vectors, reproduction details, habitats, environmental tolerances, impacts, natural controls, species that are known associates
- Information gathered using a set search protocol
- Will be publically available online once complete



Ten highest risk species



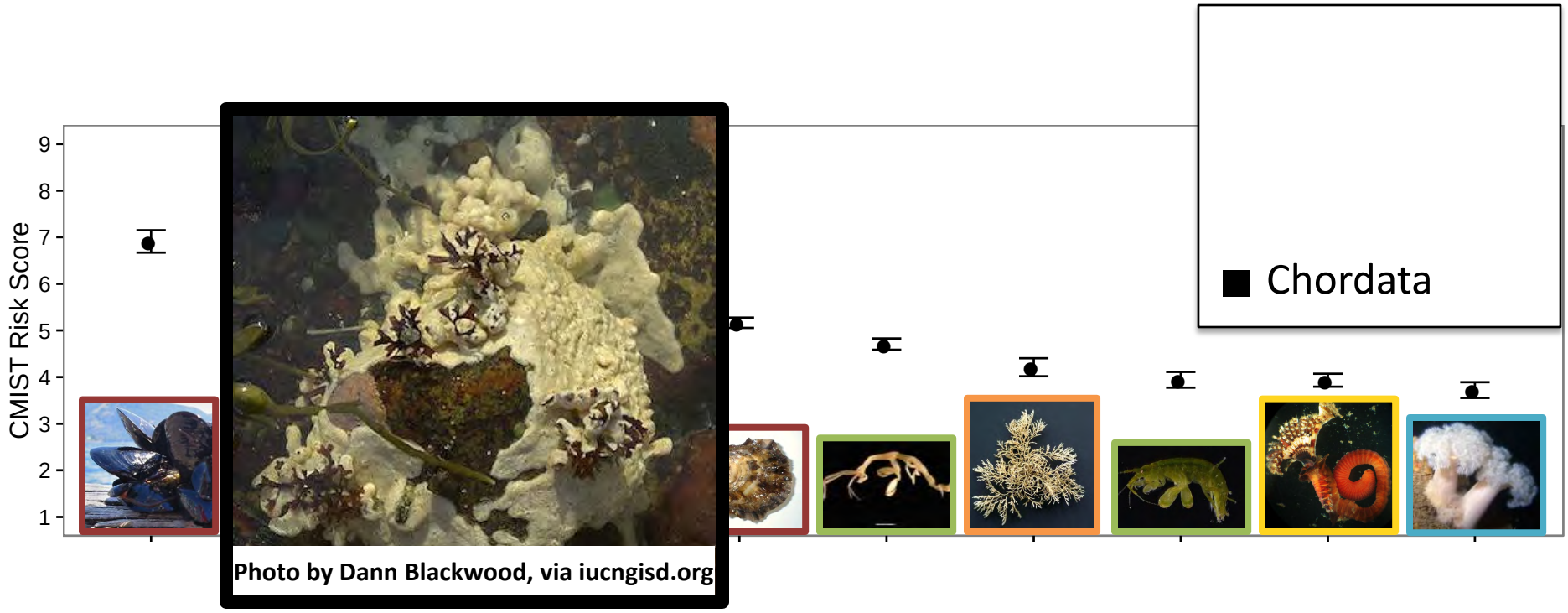
Photos from iucngisd.org, cabi.org, invasions.si.edu, marlin.ac.uk, and Kishikawa (2011)

Ten highest risk species

Mytilus galloprovincialis

Photos from iucngisd.org, cabi.org, invasions.si.edu, marlin.ac.uk, and Kishikawa (2011)

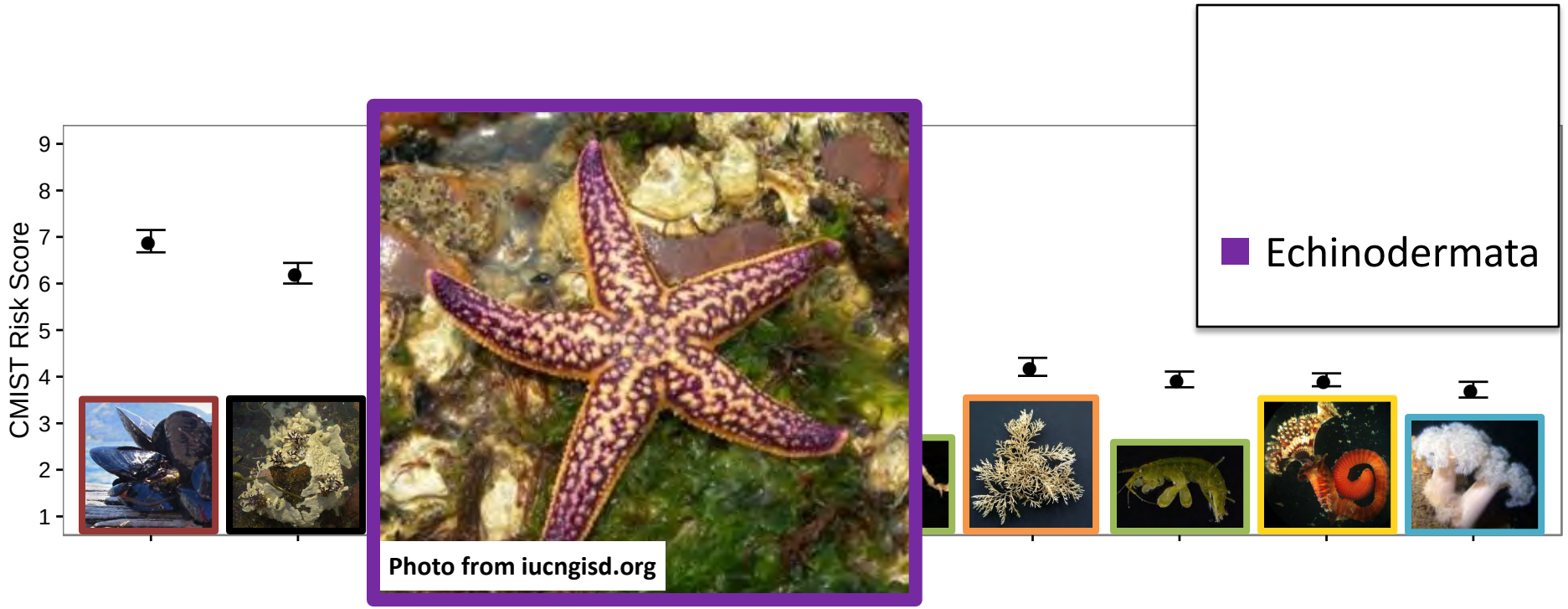
Ten highest risk species



Didemnum vexillum

Photos from iucngisd.org, cabi.org, invasions.si.edu, marlin.ac.uk, and Kishikawa (2011)

Ten highest risk species



Asterias amurensis

Photos from iucngisd.org, cabi.org, invasions.si.edu, marlin.ac.uk, and Kishikawa (2011)

Ten highest risk species

Hemigrapsus sanguinensis

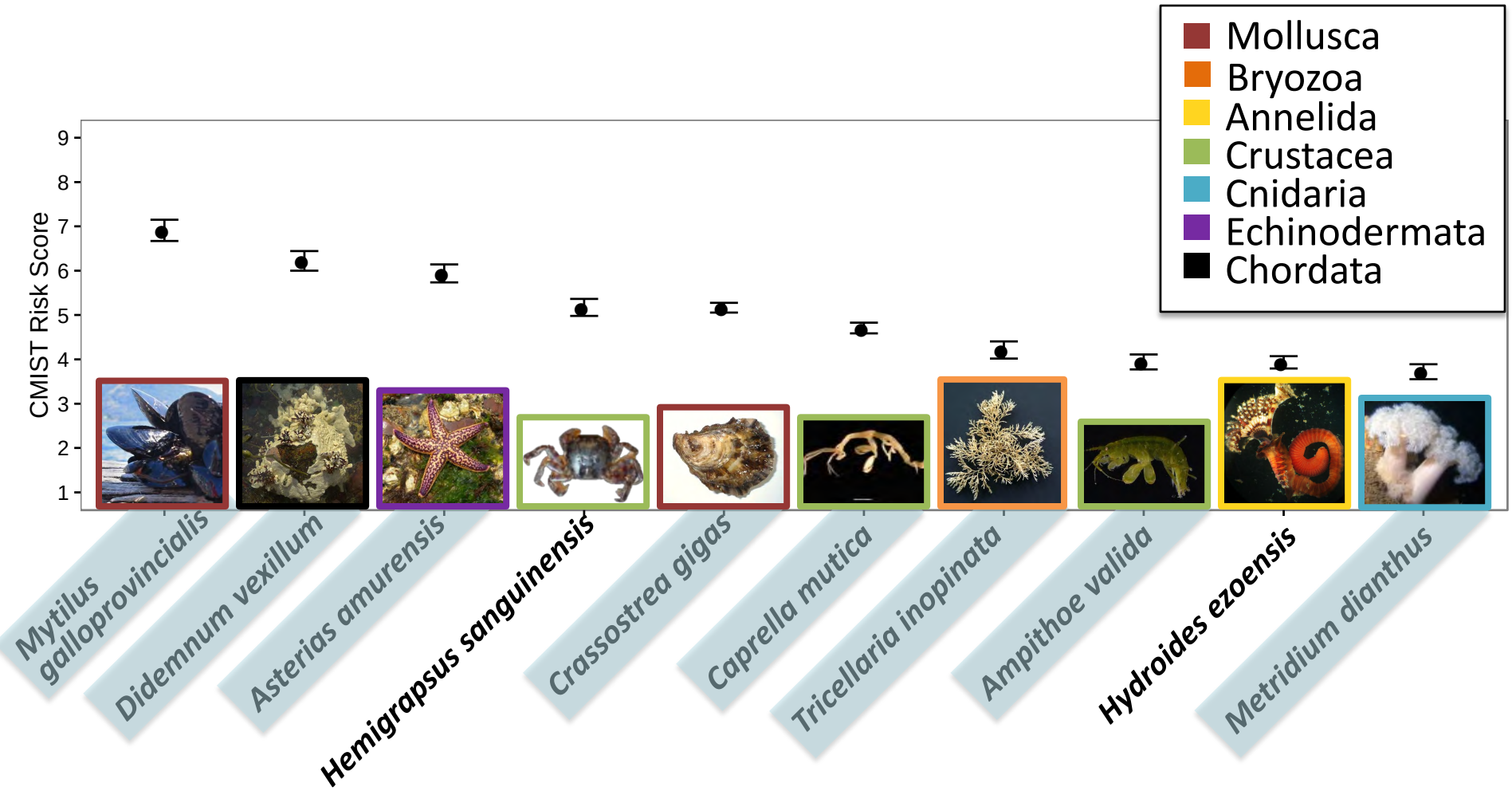
Photos from iucngisd.org, cabi.org, invasions.si.edu, marlin.ac.uk, and Kishikawa (2011)

Ten highest risk species

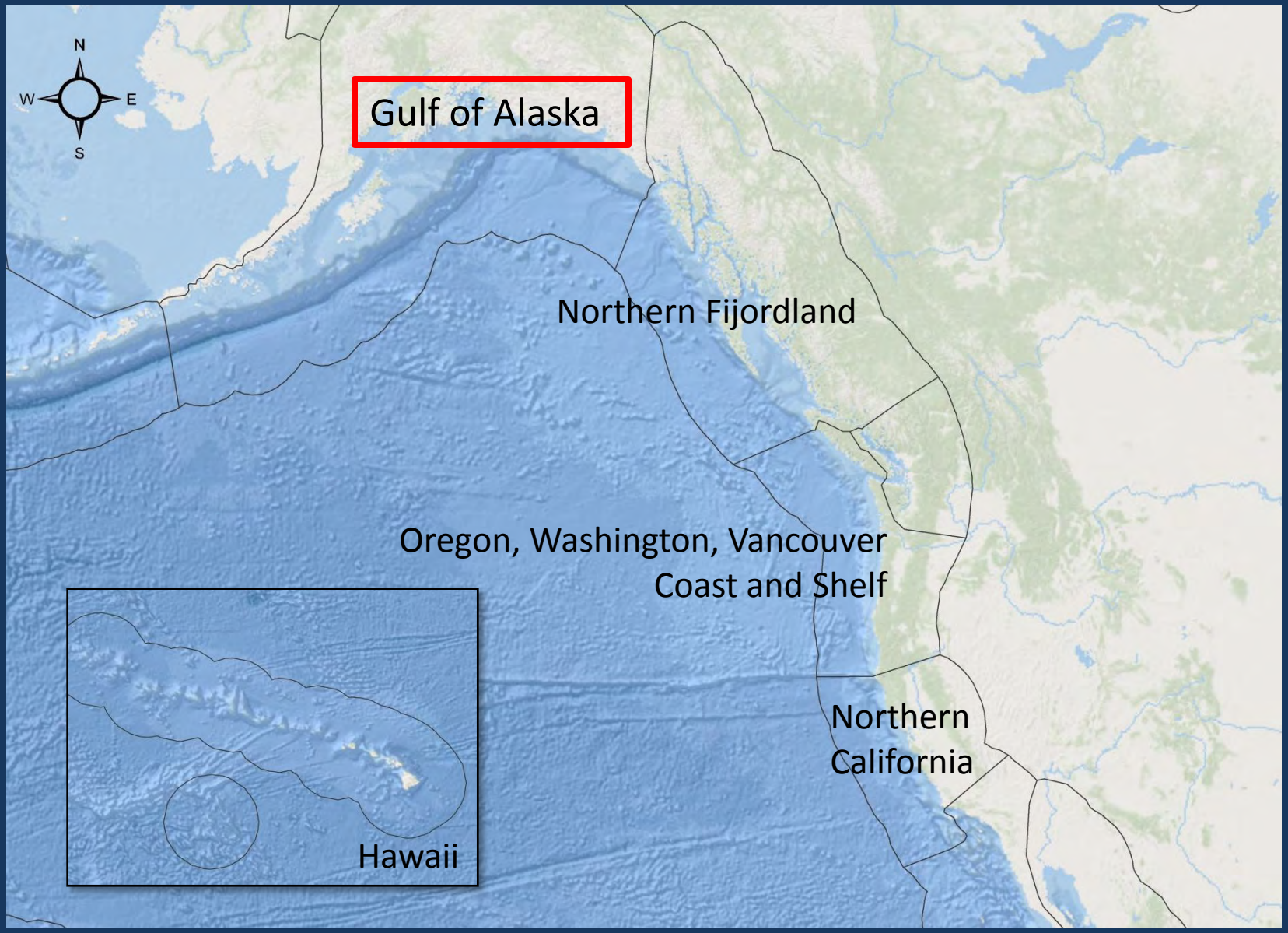
Crassostrea gigas

Photos from iucngisd.org, cabi.org, invasions.si.edu, marlin.ac.uk, and Kishikawa (2011)

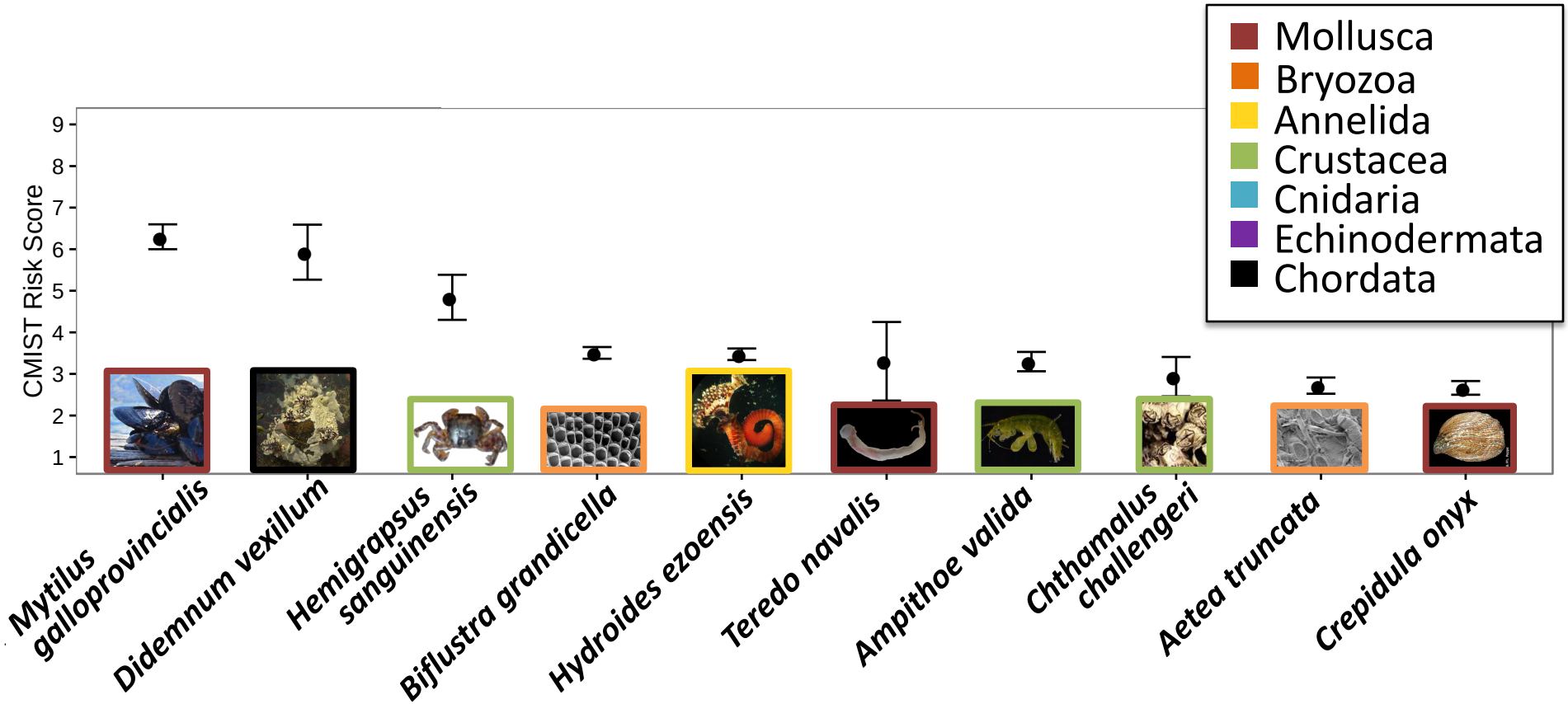
Many species are already present



Photos from iucngisd.org, cabi.org, invasions.si.edu, marlin.ac.uk, and Kishikawa (2011)

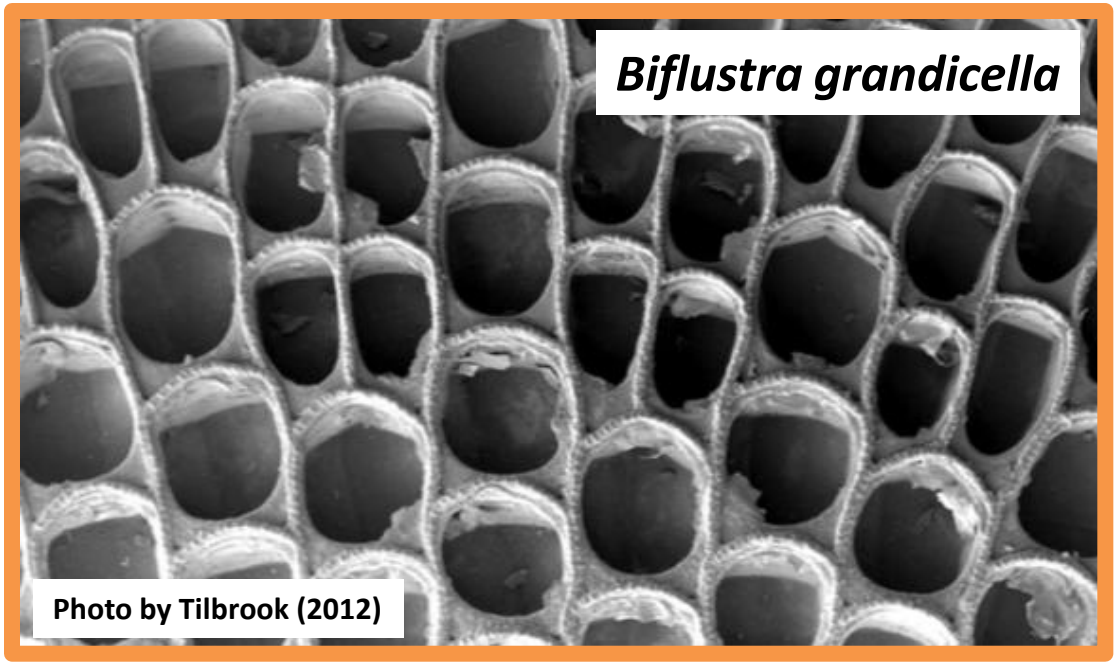

N
W
E
S
Gulf of Alaska
Northern Fijordland
Oregon, Washington, Vancouver
Coast and Shelf
Northern
California
Hawaii

High risk species - Gulf of Alaska



Photos from iucngisd.org, cabi.org, invasions.si.edu, marlin.ac.uk, kotobank.jp, De Blauwe (2009), Tilbrook (2012), and Kishikawa (2011)

High risk species - Gulf of Alaska



Bryozoa

#4. CMIST score: 3.51

High risk species - Gulf of Alaska

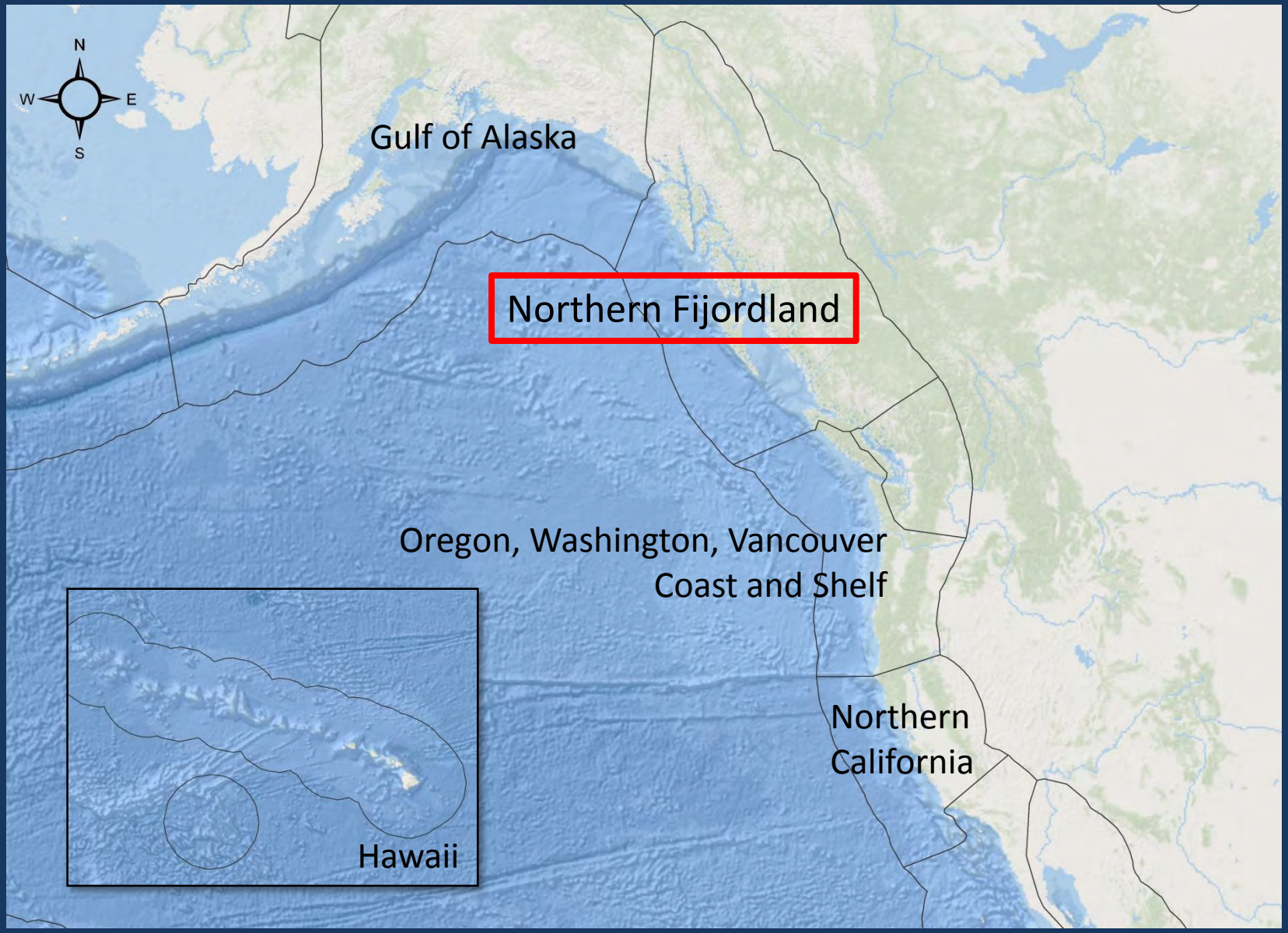
Annelida

#5. CMIST score: 3.47

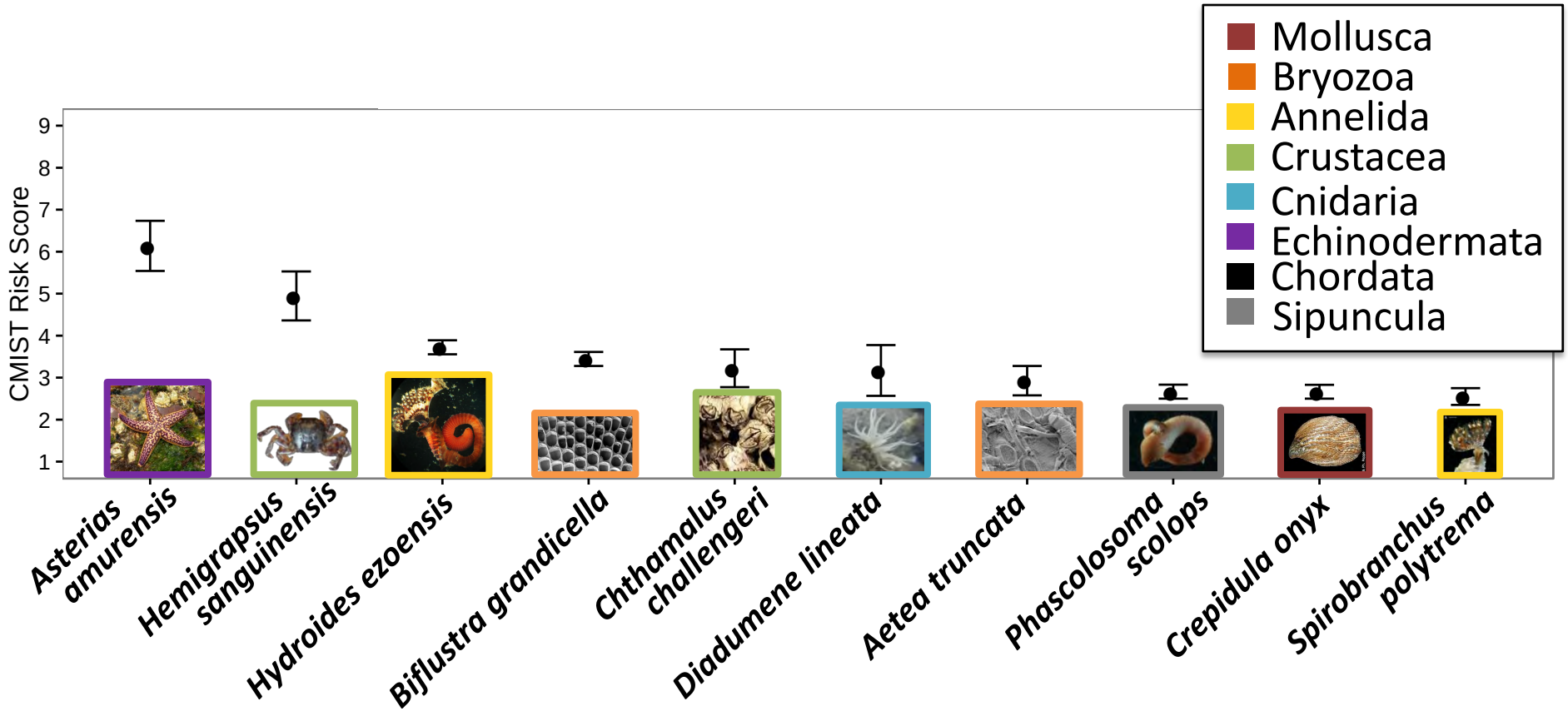
High risk species - Gulf of Alaska

Crustacea

#7. CMIST score: 3.30


N
W
E
S
Gulf of Alaska
Northern Fijordland
Oregon, Washington, Vancouver
Coast and Shelf
Northern
California
Hawaii

High risk species – Northern Fijordland



Photos from iucngisd.org, cabi.org, invasions.si.edu, marlin.ac.uk, kotobank.jp, sci.hokudai.ac.jp, Kupriyanova et al. (2015), De Blauwe (2009), Tilbrook (2012), and Kishikawa (2011)

High risk species – Northern Fijordland

Crustacea

#5. CMIST score: 3.22

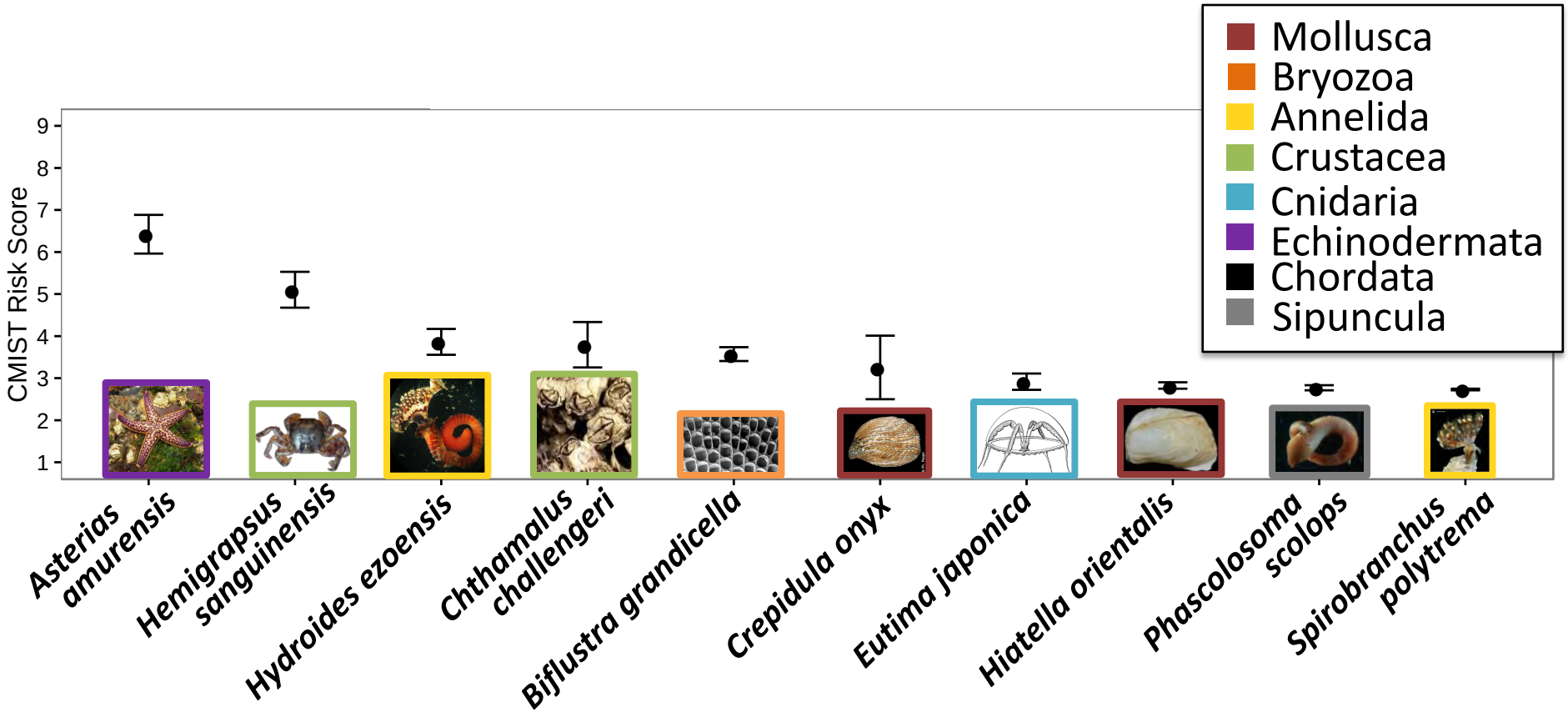
High risk species – Northern Fijordland

Cnidaria

#6. CMIST score: 3.17


N
W
E
S
Gulf of Alaska
Northern Fijordland
Oregon, Washington, Vancouver
Coast and Shelf
Northern
California
Hawaii

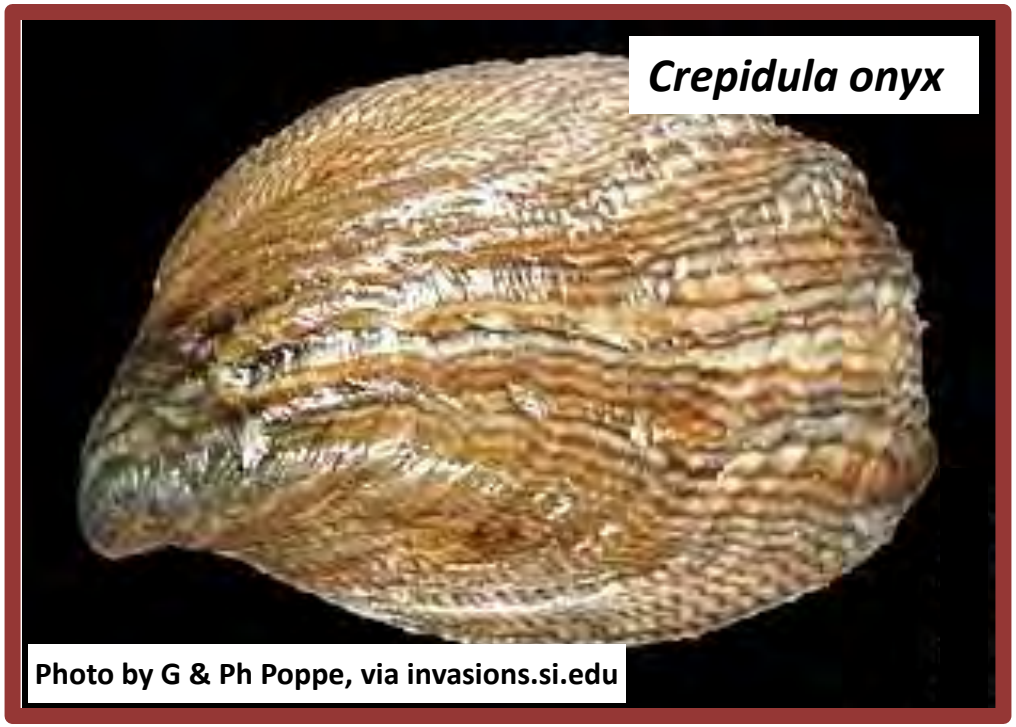
High risk species – BC, Washington, and Oregon



Photos from iucngisd.org, cabi.org, invasions.si.edu, kotobank.jp, sci.hokudai.ac.jp, Kupriyanova et al. (2015), hasangulesci.com, Tilbrook (2012), Uchida (1925), and Kishikawa (2011)

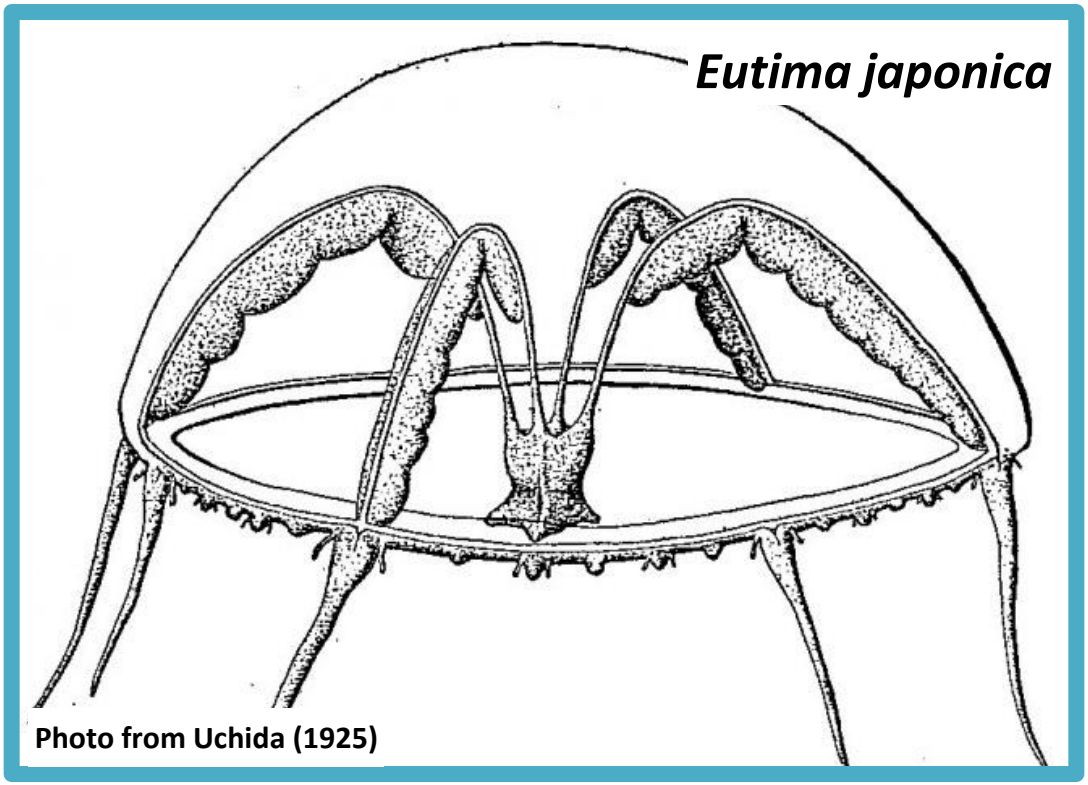
High risk species – BC, Washington, and Oregon

Mollusca



#6. CMIST score: 3.26

High risk species – BC, Washington, and Oregon



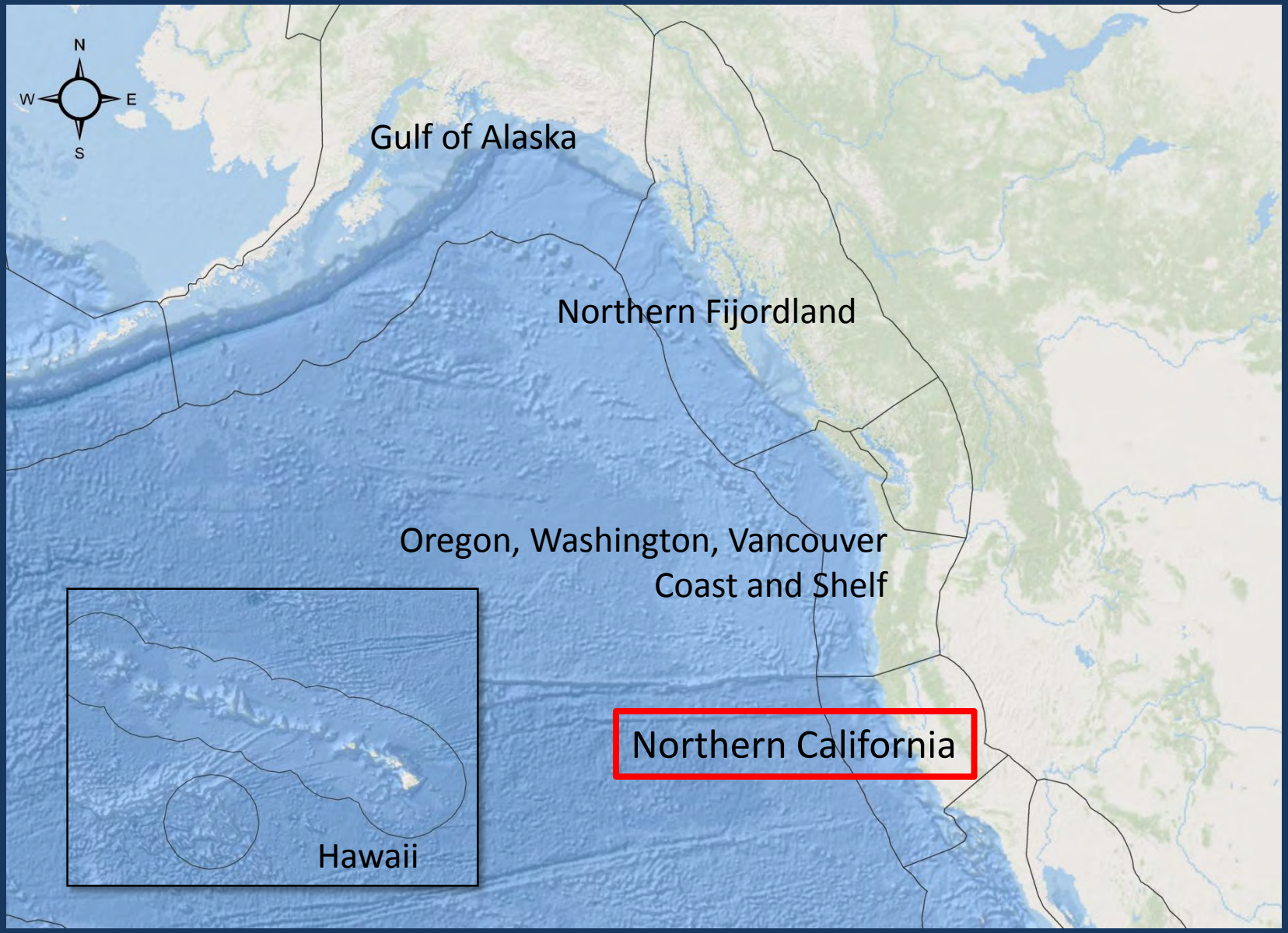
Cnidaria

#7. CMIST score: 2.92

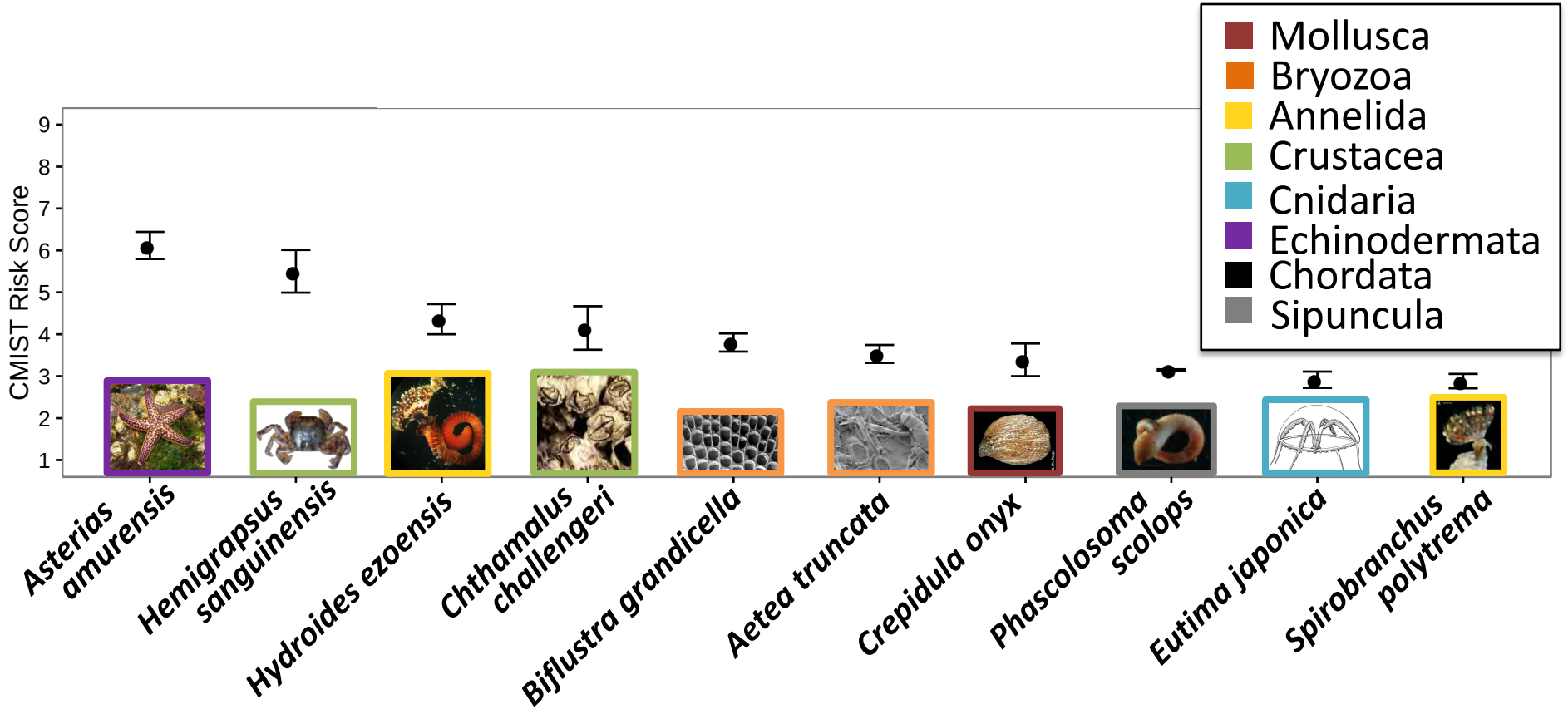
High risk species – BC, Washington, and Oregon

Mollusca

#8. CMIST score: 2.83

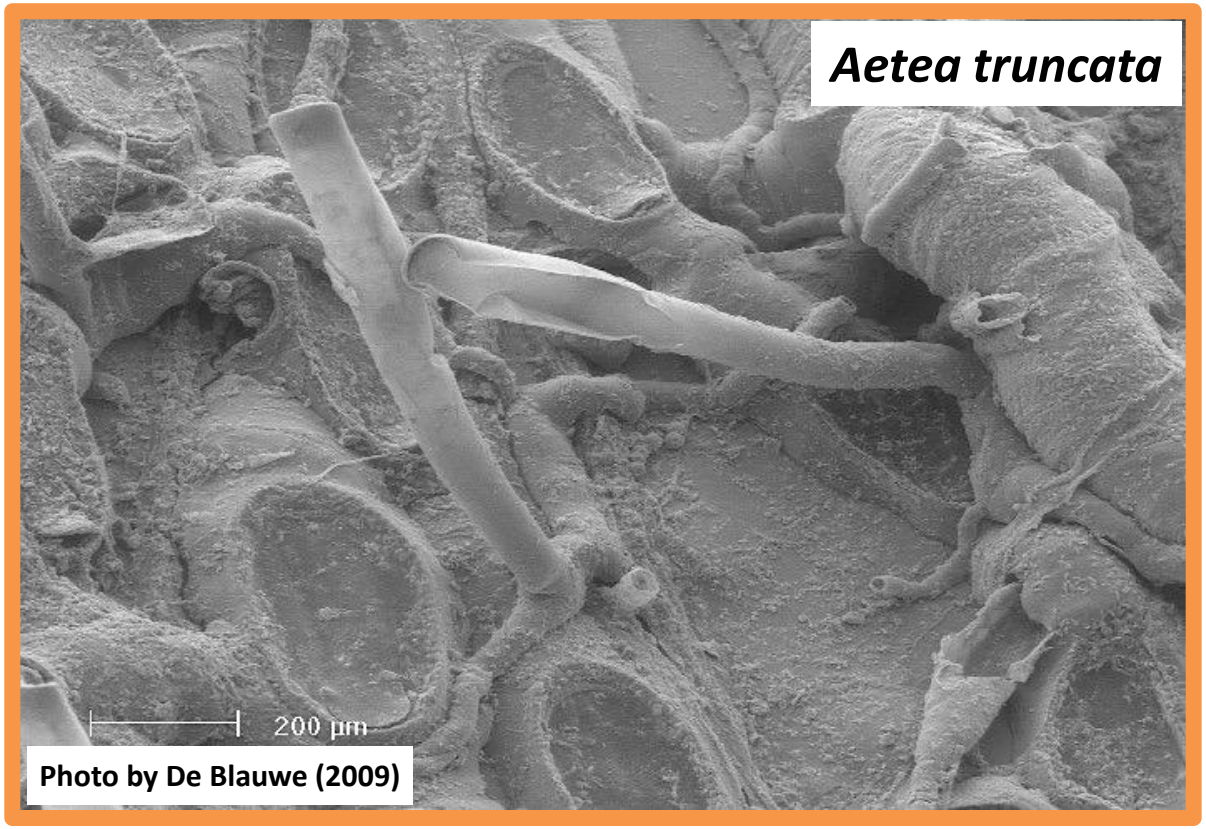

N
W
E
S
Gulf of Alaska
Northern Fijordland
Oregon, Washington, Vancouver
Coast and Shelf
Northern California
Hawaii

High risk species – Northern California



Photos from iucngisd.org, cabi.org, invasions.si.edu, kotobank.jp, sci.hokudai.ac.jp, Kupriyanova et al. (2015), De Blauwe (2009), hasangulesci.com, Uchida (1925), Tilbrook (2012), and Kishikawa (2011)

High risk species – Northern California



Bryozoa

#6. CMIST score: 3.53

High risk species – Northern California

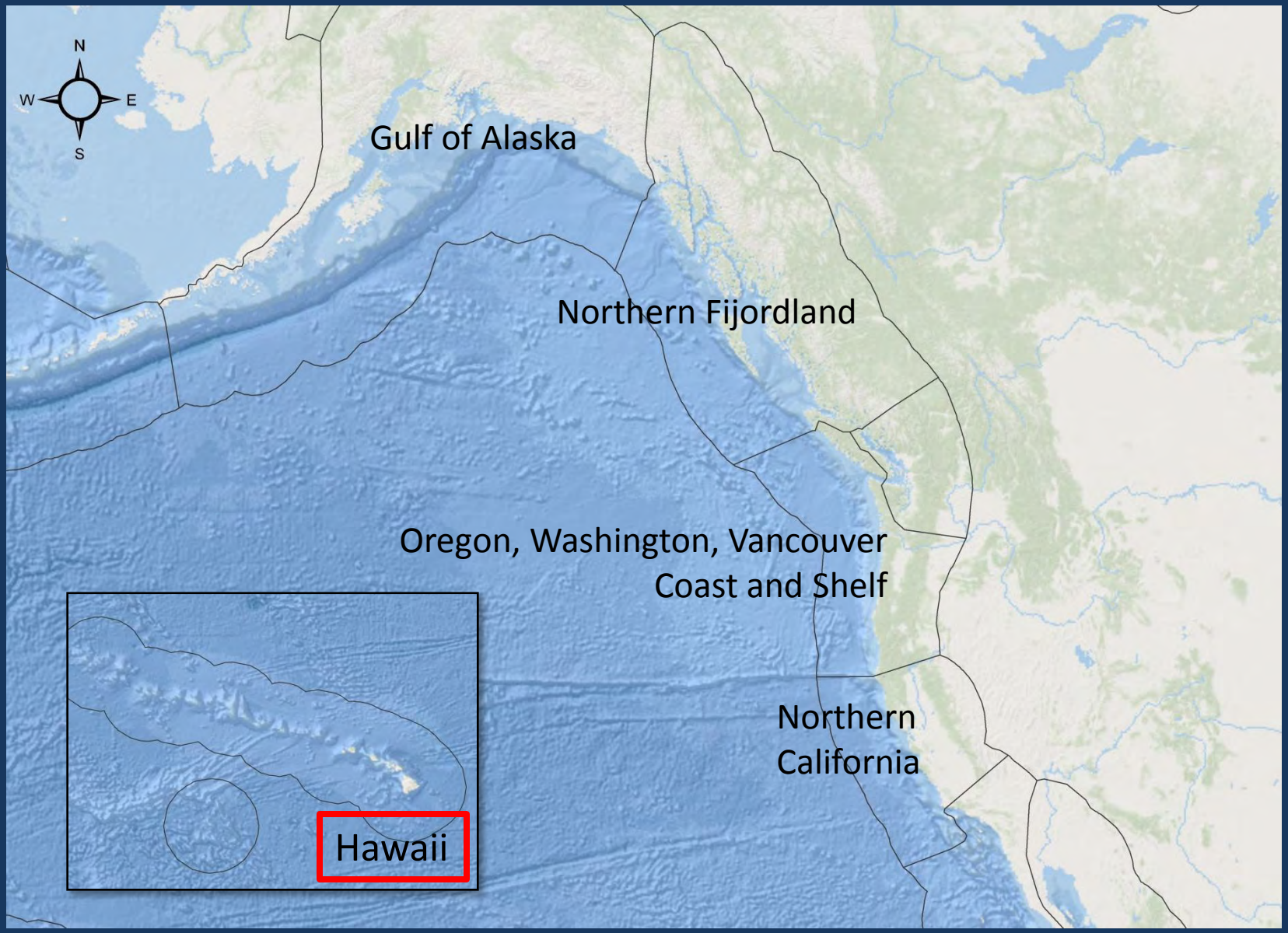
Sipuncula

#8. CMIST score: 3.15

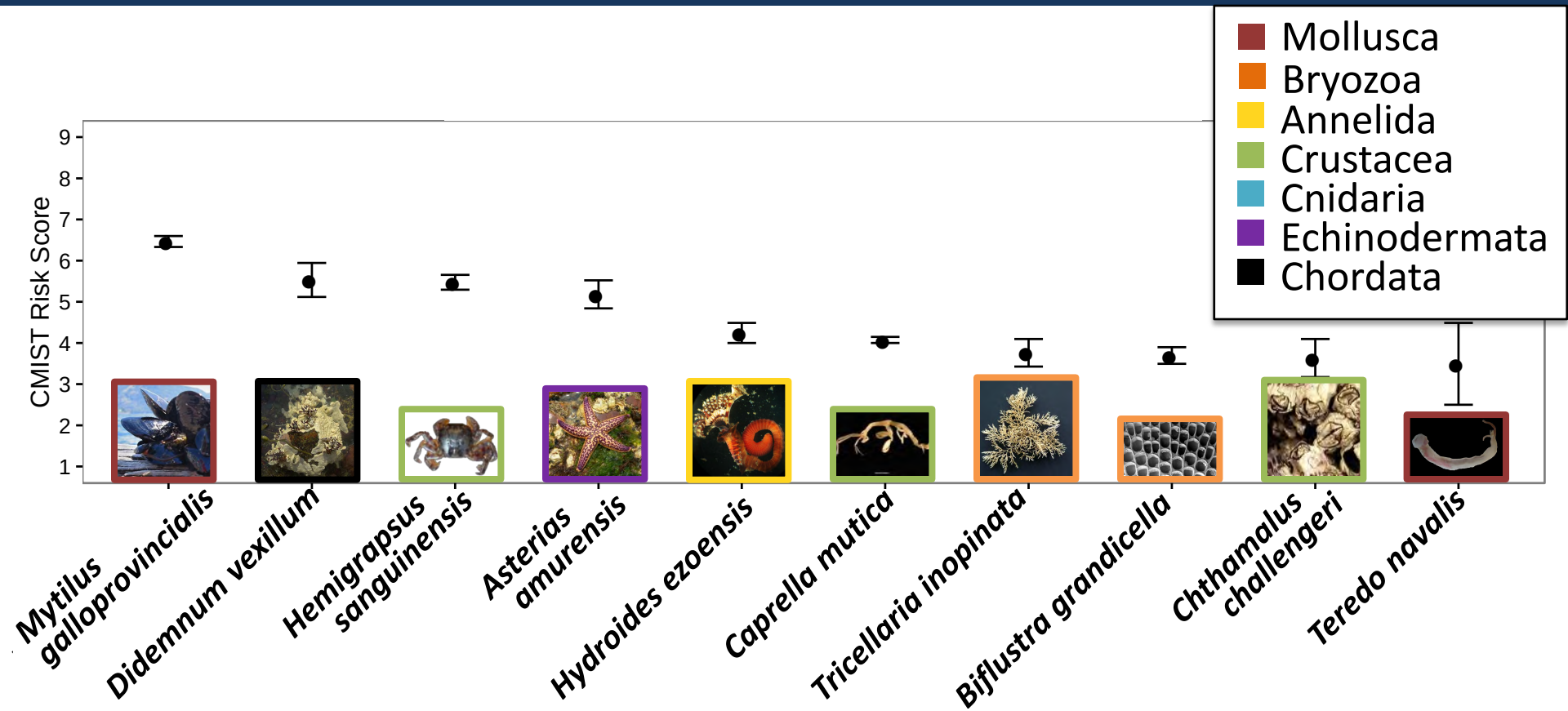
High risk species – Northern California

Annelida

#10. CMIST score: 2.88


N
W
E
S
Gulf of Alaska
Northern Fijordland
Oregon, Washington, Vancouver
Coast and Shelf
Northern
California
Hawaii

High risk species – Hawaii



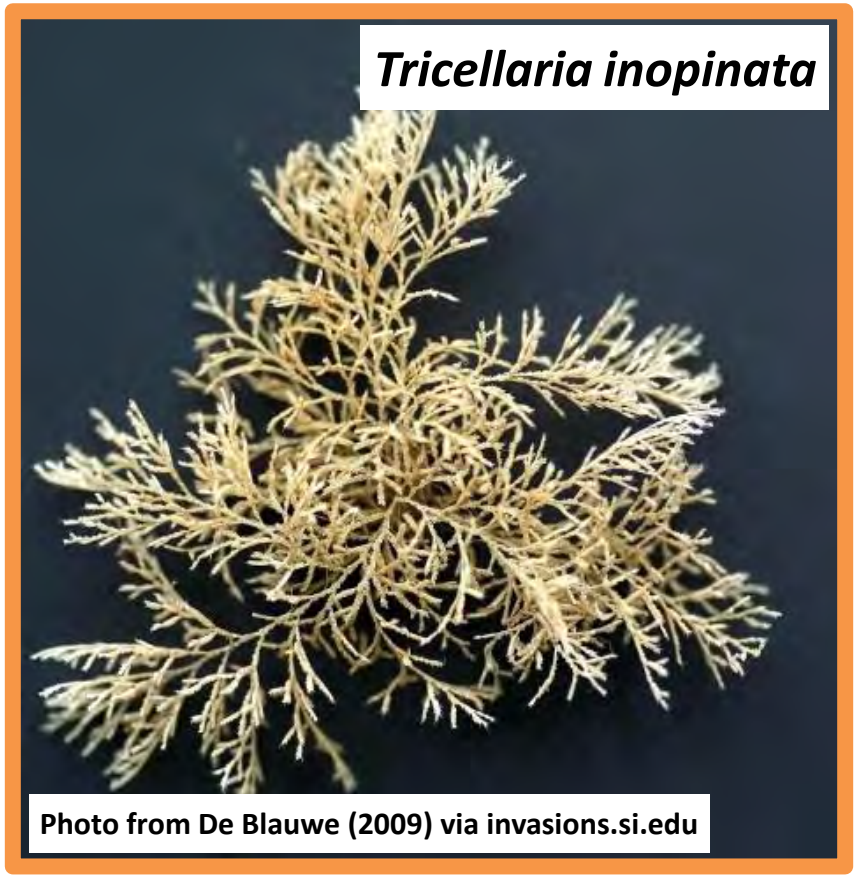
Photos from iucngisd.org, cabi.org, invasions.si.edu, kotobank.jp, sci.hokudai.ac.jp, Tilbrook (2012), and Kishikawa (2011)

High risk species – Hawaii

Crustacea

#6. CMIST score: 4.07

High risk species – Hawaii



Bryozoa

#7. CMIST score: 3.76

High risk species – Hawaii

Mollusca

#10. CMIST score: 3.50

Interpretation of CMIST scores

Equal weight given to invasion likelihood and possible impact

Impact scoring is based on known impacts

Species without known impacts, due to lack of previous invasion history or lack of study, are scored lower

Species not in the top 10 may not be low risk

Continued monitoring is recommended

Summary

- Many well-known global invaders found on Japanese tsunami debris
- CMIST evaluates risk based on invasion likelihood and impacts
- Prioritized lists per region focused on species that are not already present
- Continued monitoring is necessary because species not assessed as high risk may not be low risk
- Next steps: risk scoring for algae species

Photo: Dann Cutter

Acknowledgements

This research is funded by the Ministry of the Environment of Japan through the North Pacific Marine Science Organization (PICES)

Database researchers: Janson Wong and Reva Gillman

CMIST scorer: Danielle Scriven

Collaborator: Jessica Miller