Global Domination
Understanding the spread of two invasive seaweeds using digital herbarium records and distribution modeling techniques

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Seaweeds

• Diverse group of primary producers found in marine, estuarine, and aquatic ecosystems.

• Foundation species which create habitat structure.

• Provide food, substrate, and shelter for other marine organisms.
Invasive Seaweeds

• 277 species worldwide.¹

• Ecological impacts
  • Reduce biodiversity
  • Compete with native species
  • Alter habitat structure
What makes an invader?

- Transport to new region
- Habitat suitability
- Geographic expansion
Distribution Modeling

• Tool for assessing large-scale biogeographic questions
• Combine environmental data with species occurrence data
• Make predictions in geographic space
• Popular in climate change research
Undaria pinnatifida

- Cold-temperate kelp
- Native to Japan and coastal Asia
- Since 1970s, has become invasive in Europe, Australia, South America, California.
- Forms dense upright canopy
Undaria pinnatifida
Dasysiphonia japonica

• Native to Japan and coastal Asia
• Red filamentous algae
• Since 2011, has spread from Connecticut to New York to Maine.
• Also invasive in Europe
Dasysiphonia japonica
Project Goals

• To create accurate species distribution models for these two species, and use those models to address the following two questions:

  • *Undaria pinnatifida* – Does the Northwest Atlantic represent suitable habitat for this species, if it were to arrive here?

  • *Dasysiphonia japonica* – Does the current range of this species in the Northwest Atlantic represent the full possible extent that it could inhabit?
MaxEnt

- Maximum Entropy modeling technique
- Open source software produced by Phillips et al. (2004).³,⁴

Environmental Raster Data + Species Occurrence Data → Habitat Suitability Predictions
Data Sources

• Environmental Data:
  • Bio-ORACLE

• Species Occurrence Data:
  • Macroalgae Herbarium Portal (MHP)
  • Ocean Biogeographic Information System (OBIS)
  • Global Biodiversity Information System (GBIF)
Model Building

- Environmental variables:
  1. Sea Surface Temperature
  2. Current Velocity
  3. Sea Ice Thickness
  4. Surface Nitrate
  5. Surface Phosphate
  6. Salinity

- 70% training, 30% validation

- Number of points used for each species:
  - Undaria: 167
  - Dasysiphonia: 155
Model Output: *Undaria*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Percent Contribution</th>
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<tr>
<td>Sea Surface Temperature</td>
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<td>Salinity</td>
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<td>Sea Ice Thickness</td>
<td>7.3</td>
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<td>Phosphate</td>
<td>4.9</td>
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<tr>
<td>Current Velocity</td>
<td>1.2</td>
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Model Output: *Dasysiphonia*

<table>
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<tr>
<td>Phosphate</td>
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Discussion: Undaria

[Map showing Undaria distribution]

[Image of Undaria kelp]

Envirolink.govt.nz
Discussion: **Undaria**

http://www.scoop.co.nz, L. Patston

Envirolink.govt.nz
Discussion: Dasysiphonia
Discussion: *Dasysiphonia*
Conclusions

• *Undaria pinnatifida*
  • Poses a potential threat to the Northwest Atlantic and the Gulf of Maine

• *Dasysiphonia japonica*
  • Likely to continue spreading northward

• Thoughts on Distribution Models
  • Work in progress – will continue to refine models
  • Useful for testing large-scale hypotheses and big pictures questions in marine ecology
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References


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