



Invasive sea squirt *Didemnum vexillum*: testing multiple methods of control

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The invasive species - *Didemnum vexillum*

Invasive colonial sea-squirt native to Japan

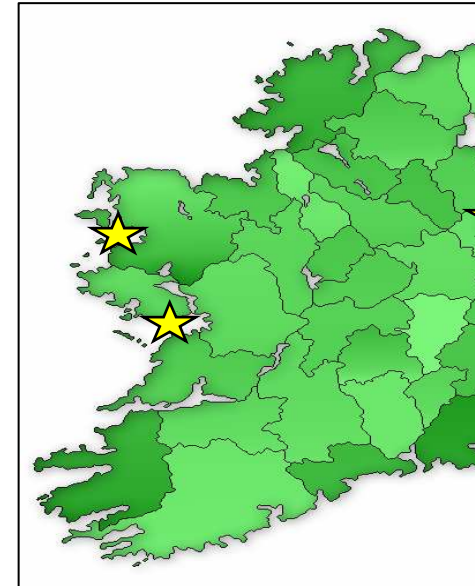
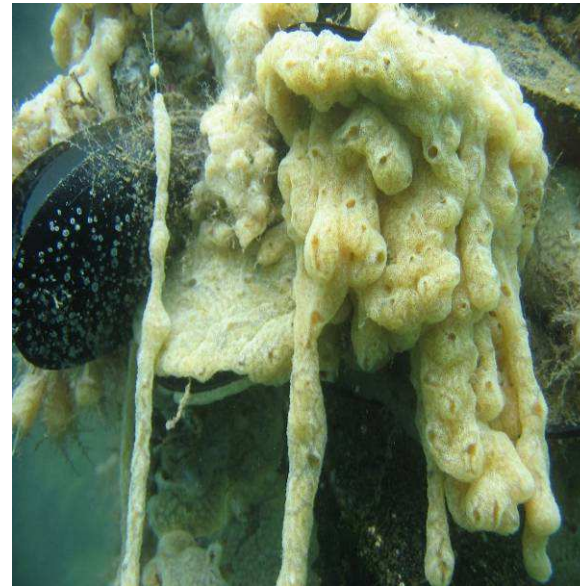
European distribution: Ireland, U.K., France, Italy & The Netherlands

First documented in Ireland in 2005

Extensive fouling of ropes, chains, buoys, boat hulls and pontoons in Malahide marina

Significant negative impacts in natural ecosystems through overgrowth directly competing with native species for space

Fouls aquaculture equipment and commercially important species



Photos: *D.vex* covering mussels (Paul Barter), hull fouling (Damie)

Why are we concerned about *D.vexillum*?

Alters the diversity within marine ecosystems, smothering a wide range of marine organisms

Directly competes with native biota for space -dominant competitor for space in fouling communities

Reduces the complexity of habitats

Disrupt the functioning of ecosystems

Threat to our ecosystems and the services they provide

Economic impacts to aquaculture



D.vex eelgrass photo (Dann Blackwood)

Why are we concerned about *D.vexillum*?

Extensive fouling in aquaculture:

Economically damaging impacts

Inhibits flow of water & food to stock

Fouling of stock and equipment

Increasing labour costs

Biofouling cost to European industry
230 million/year

30 tonnes of *D. vexillum* recorded on
 Mussel farm in New Zealand

Jeopardising functioning of fertile fishing
 grounds in U.S.



Why should we take an active approach to the control of *Didemnum vexillum*?

Aggressive and invasive fouling ascidian species are a major plague suffered by the shellfish industry

Invasive ascidians often cause the most significant damage of all fouling species

Released from the constraints of natural enemy

(Increasing rate of introduction in harbours
Climate change is likely to facilitate the spread of ascidians)

Shellfouling has cost the European industry between 5 and 10% of the industry value



Photo credits: A. Gittenberger, J. Davidson, Fisheries & Ocean Canada, M

Aspects of my research

aim: To identify a **cost-effective** and **time efficient** treatment for the control of *Didemnum vexillum* in aquaculture that would both protect stock and reduce the potential further spread of the species

Contribute to codes of practice for the control of invasive species in aquaculture

steps:

-) Reviewed literature to identify controls
-) Consulted with stakeholders (oyster and mussel farms)
-) Designed an experiment to test multiple options for control
-) Set up & ran my experiment on an oyster farm in Mayo



Options for control?

Biological



Chemical



Mechanical



Bag turning to control *D.vexillum*

Oyster farmers turn bags regularly to reduce the build up of fouling organisms

Exposure during low tides

As a soft bodied organism *Didemnum* is vulnerable to desiccation

Turning also prevents gregarious growth of oysters

Bags are lighter and easier to manage with less fouling

Enables natural flow of water through mesh bags



Vinegar spray as a control for *D.vexillum*

Previously used to remove *D.vexillum* from:

- Aquaculture equipment
- stock transfer
- artificial and natural substrates

Success?

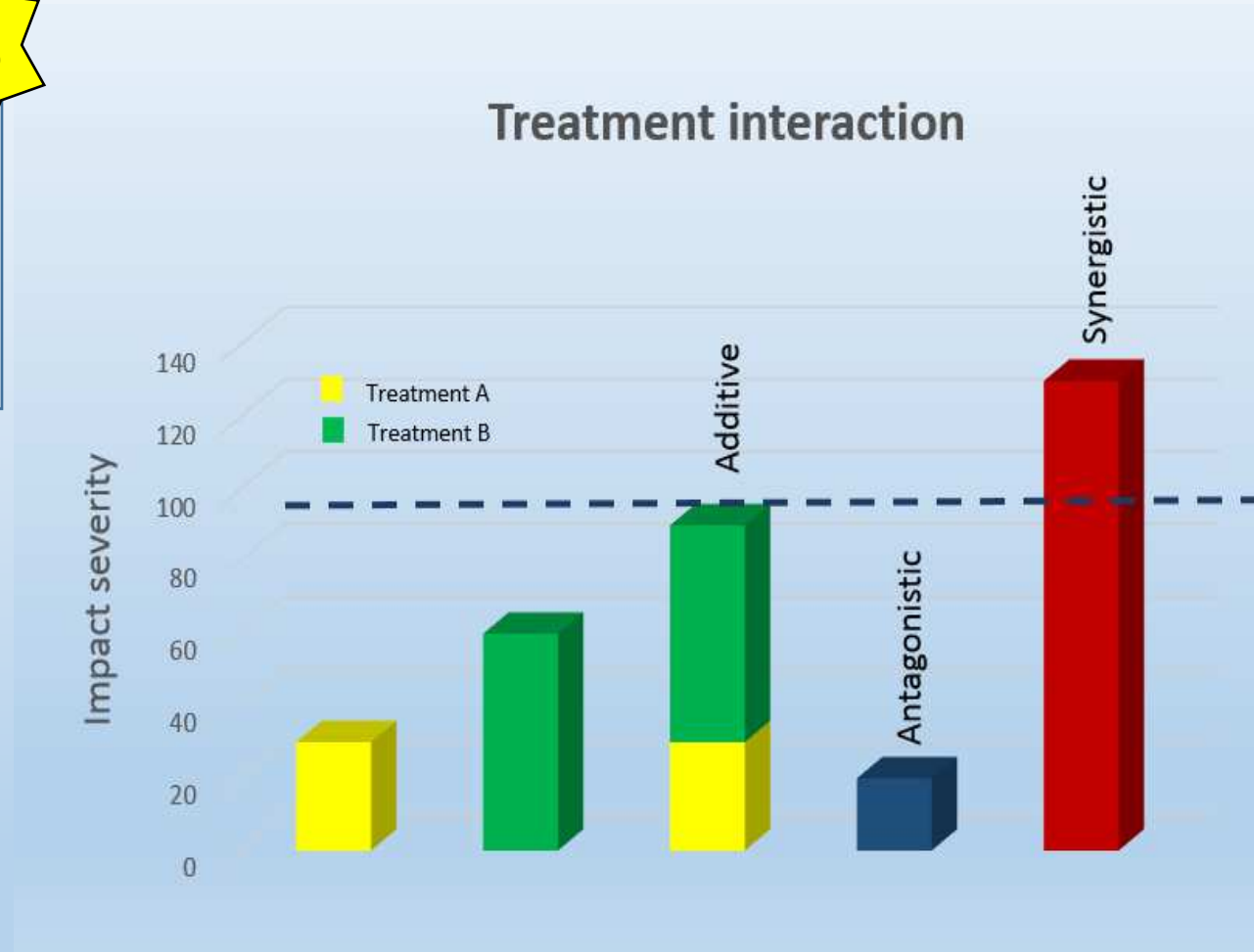
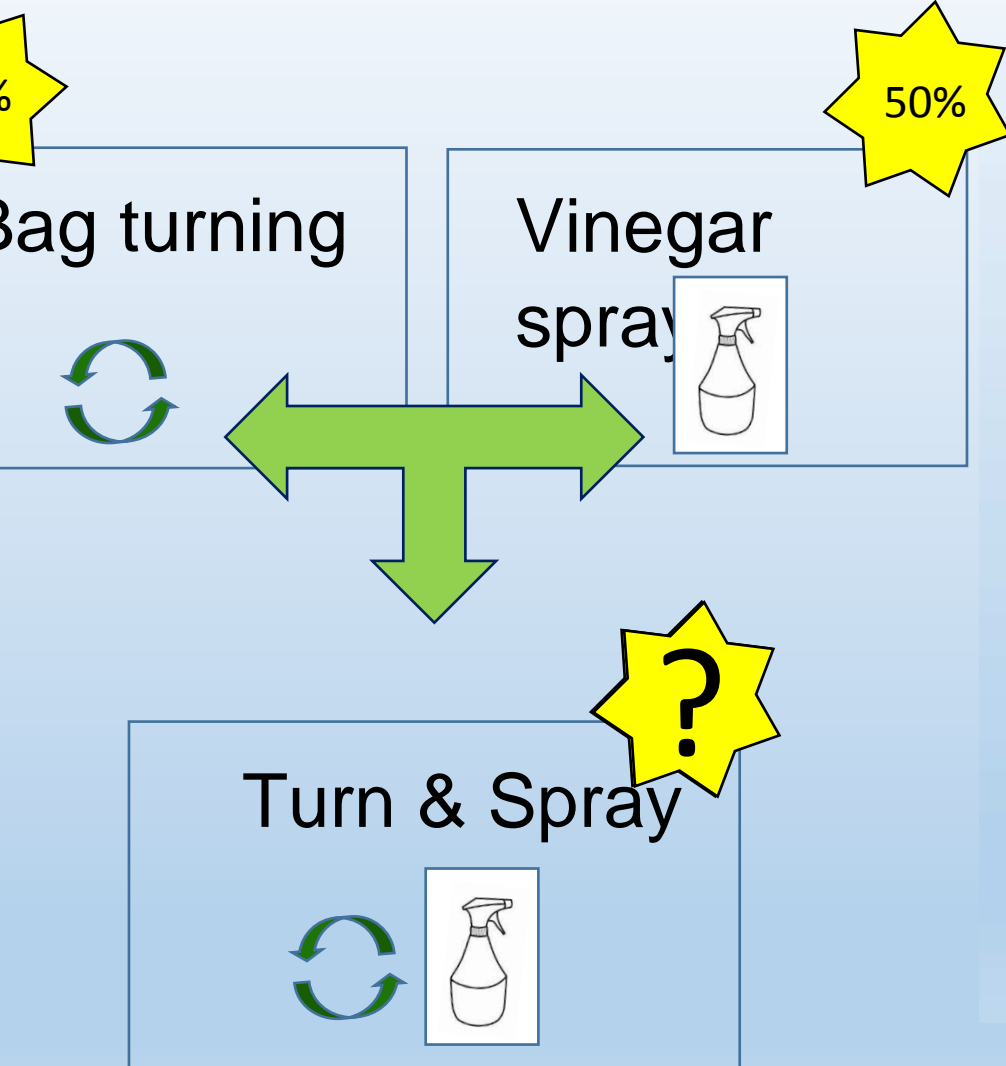
- Up to 80 -100% removal in previous studies

Treatment details:

- 5 % solution: acetic acid/sea water mix
- 30 seconds spraying bag evenly
- Dispensing ~ 600ml per bag



Combining treatments






























Application of control treatments

Aim: To identify an eco-friendly **cost-effective** and **time efficient** treatment for the control of *Didemnum vexillum* in aquaculture

- How often do these treatments need to be applied?
- When should I apply to these treatments?
- Should I apply these treatments altogether or over a longer period of time?

Frequenc
y
Timing
Variance

Treat
regim

	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00
Spread											
Clustered Early											
Clustered Late											
Spread											
Clustered Early											
Clustered Late											

Experimental Design

Factors



Turn

Levels

Vinegar spray

Frequency

H

L

Variance

C

S

C

S

Timing

E

L

E

L

H

L

C

S

C

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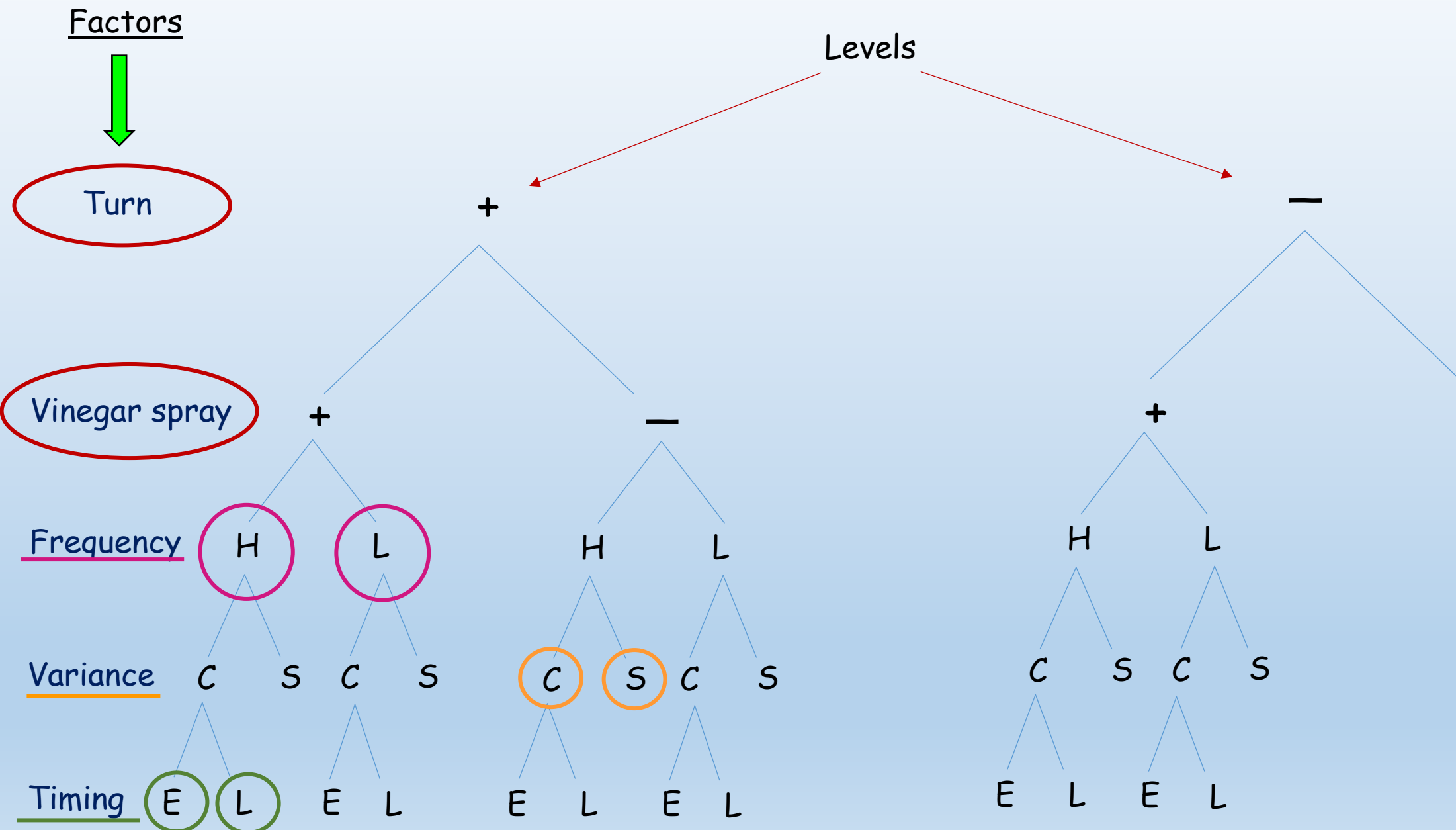
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Controlling *D.vexillum* in aquaculture

Set up experiment on an oyster farm, West coast of Ireland

Ran for 6 months from March till September

Bag treatment corresponded with low tides every 2 weeks



Measuring the effects

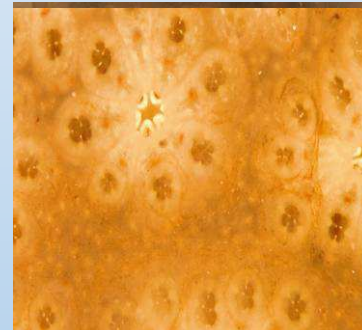
D. vexillum

- Percentage cover
- Percentage of lobes



Biodiversity

- Percentage cover of other fouling organisms (community structure)
- Total fouling biomass

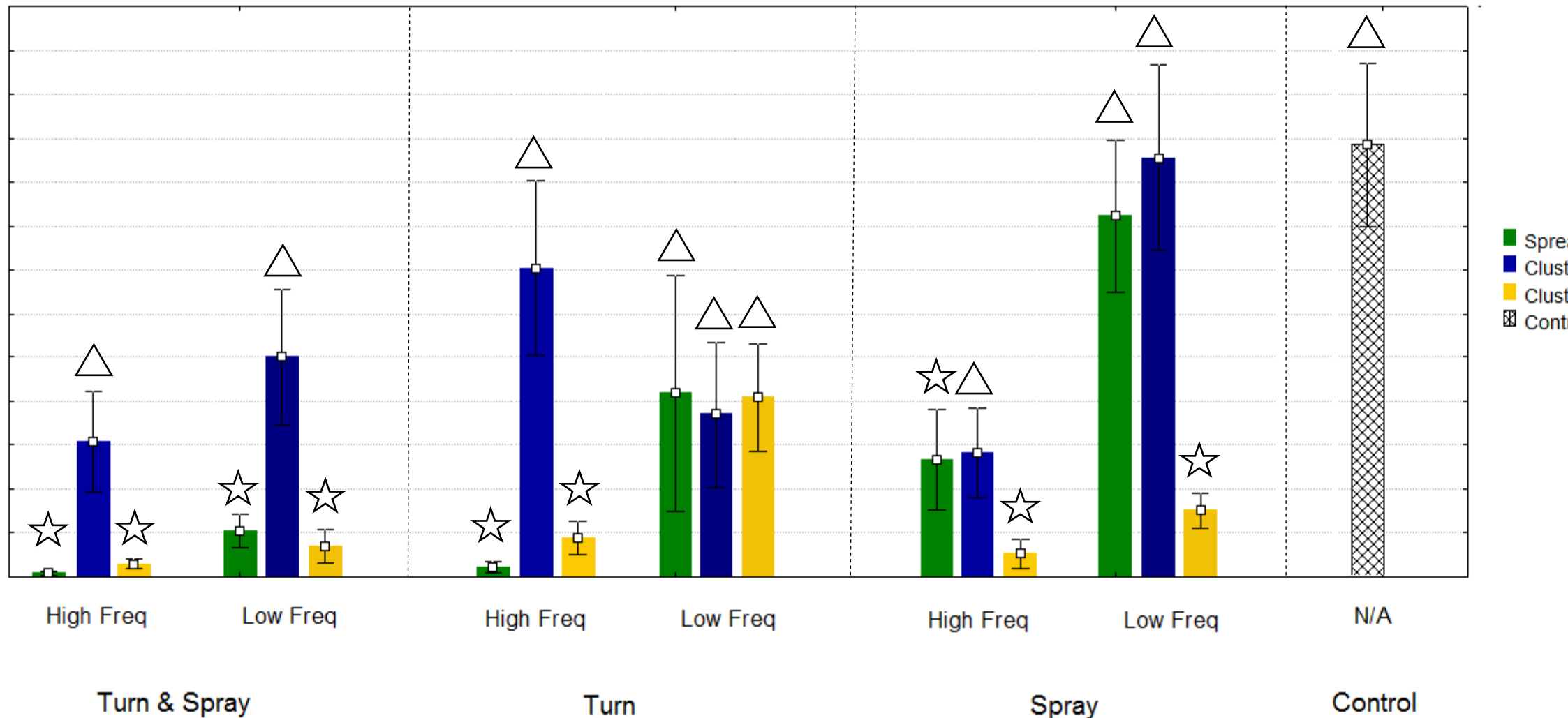


Oyster

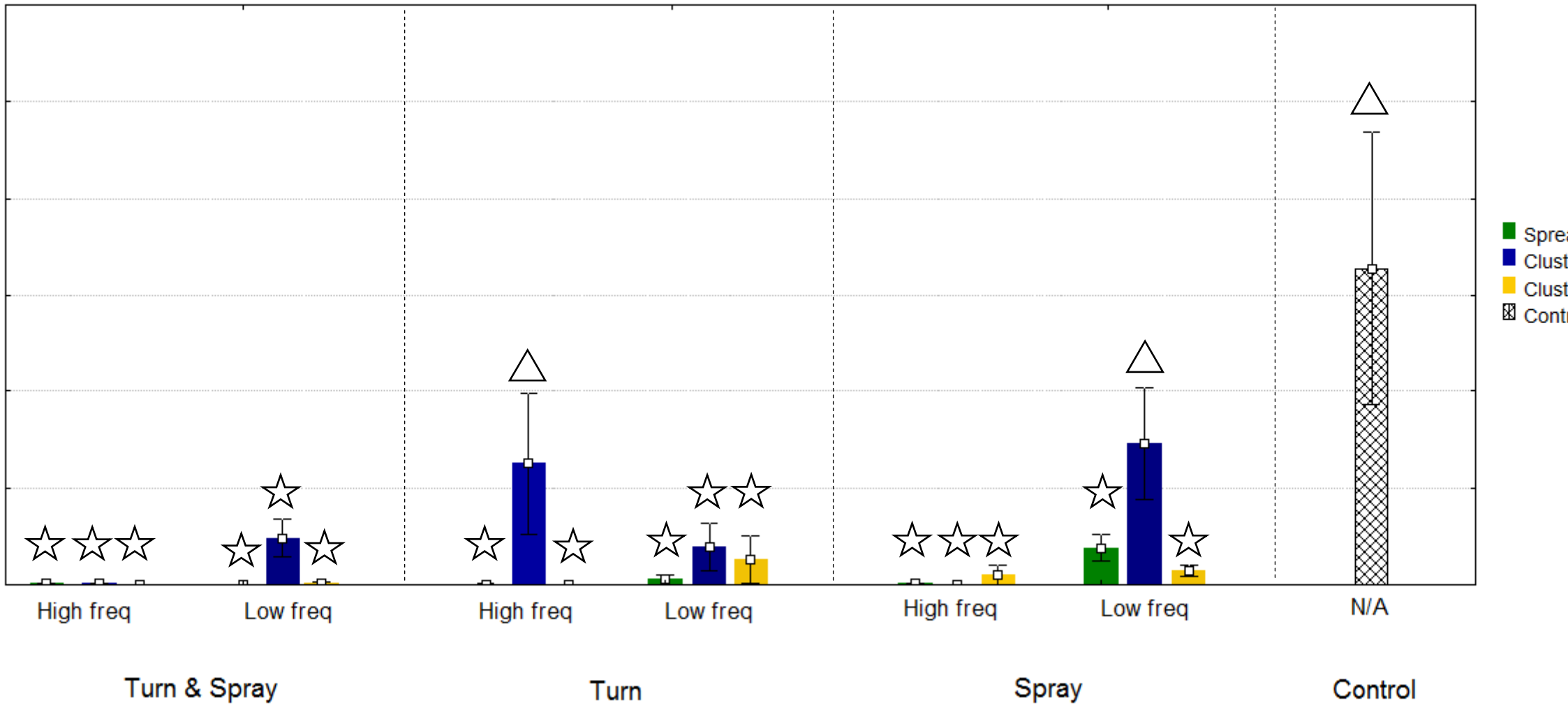
- Percentage mortality
- Growth
- Condition



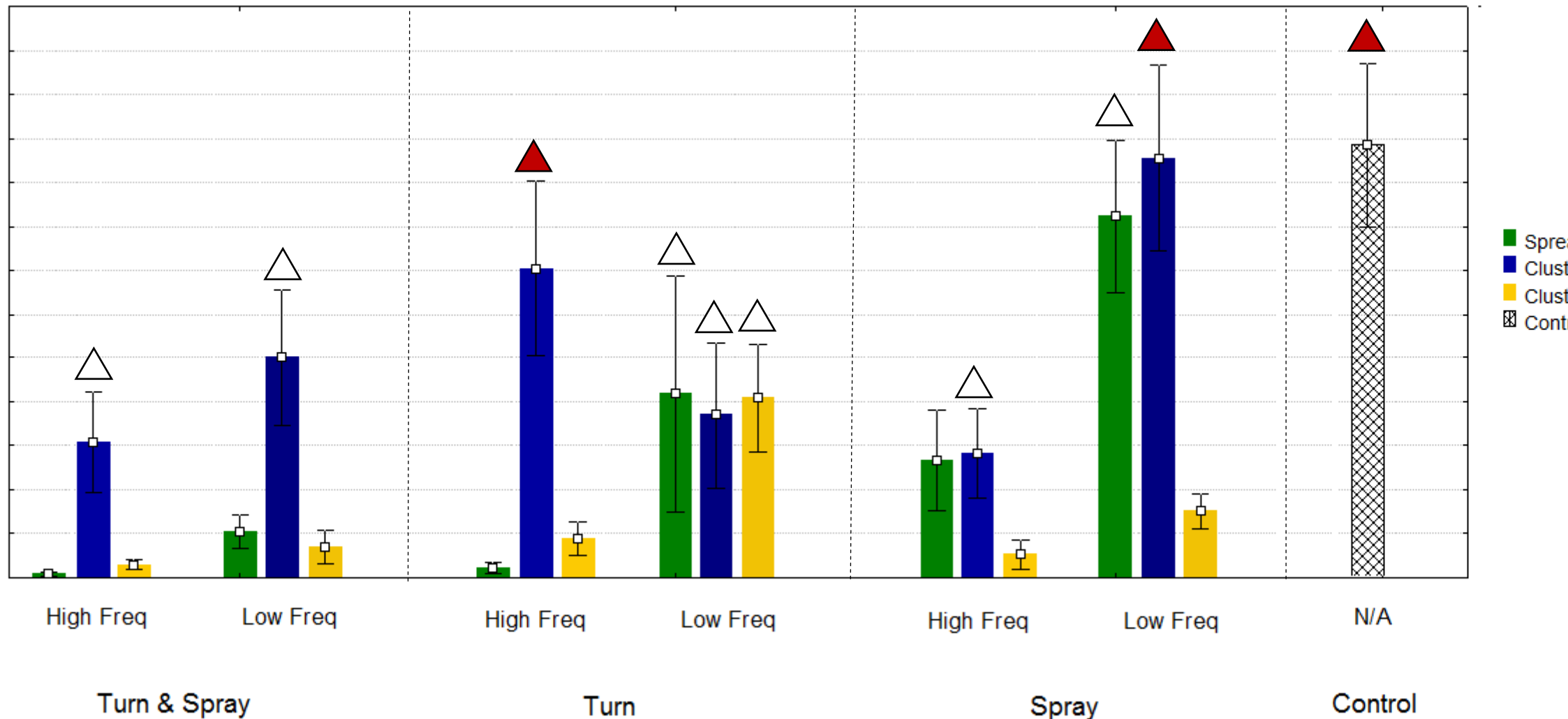
Percentage cover *Didemnum vexillum*



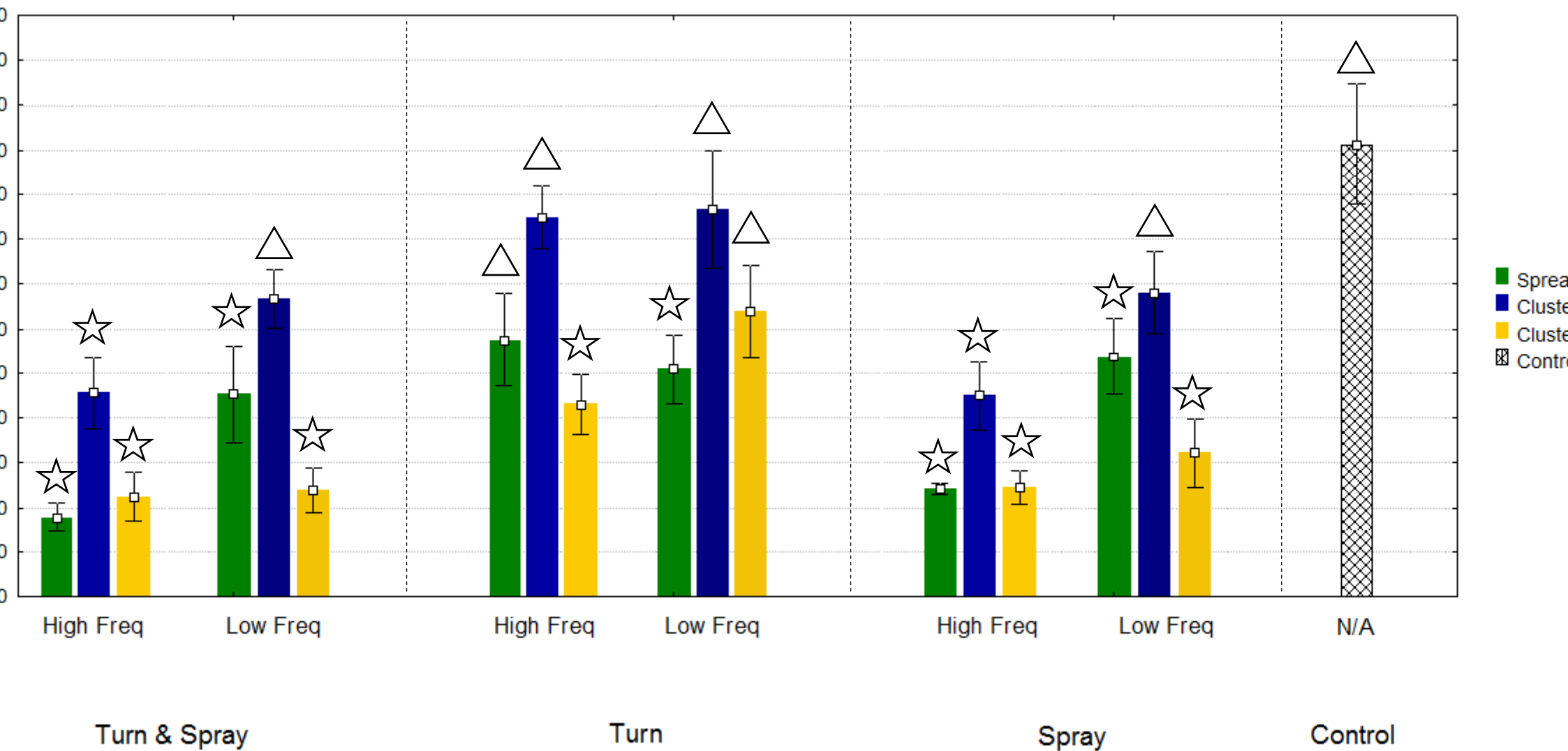
Percentage cover of lobed *Didemnum vexillum*



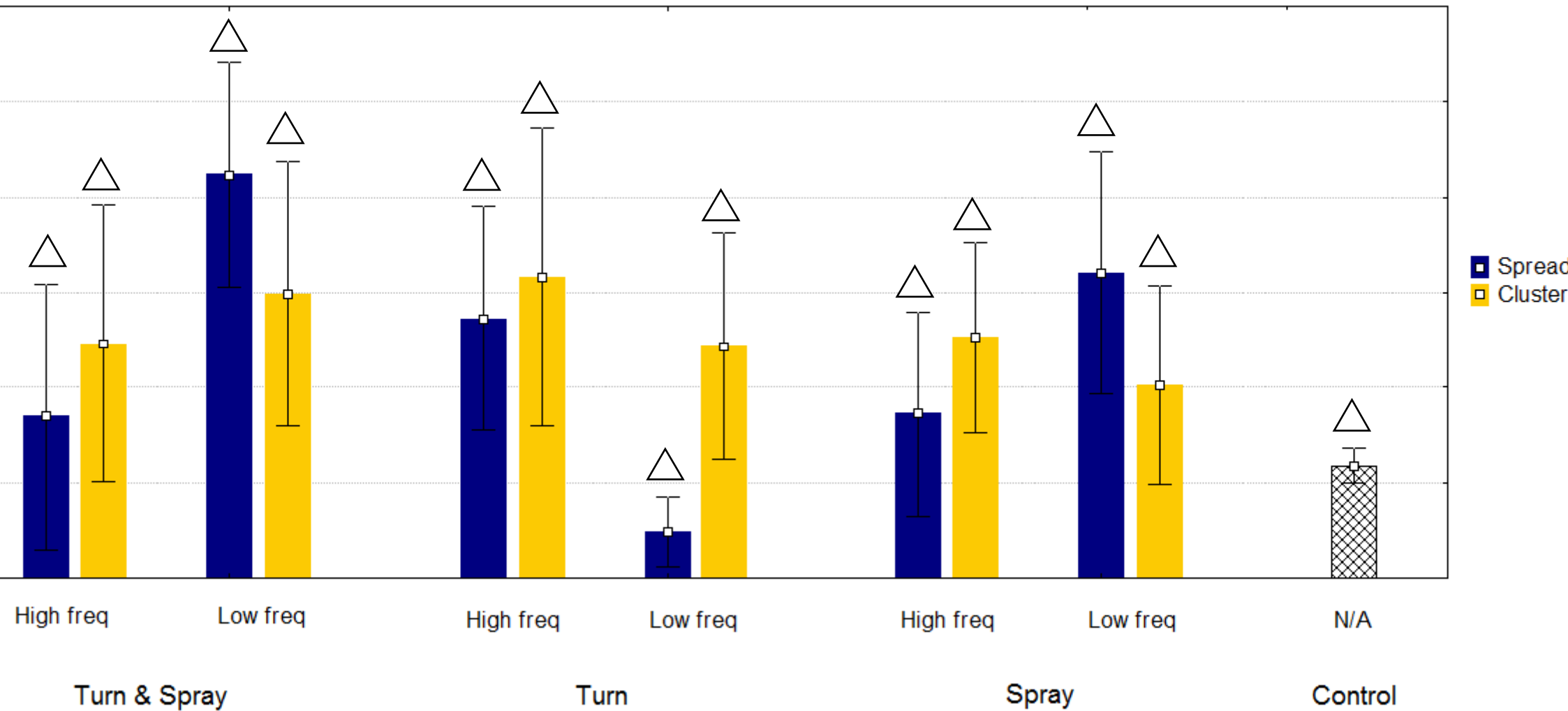
Percentage cover *Didemnum vexillum*



Total fouling biomass on oyster bags



Oyster percentage mortality



	Turn & Spray						Turn						Spray					
	High			Low			High			Low			High			Low		
	Spread	Clustered Early	Clustered Late	Spread	Clustered Early	Clustered Late	Spread	Clustered Early	Clustered Late	Spread	Clustered Early	Clustered Late	Spread	Clustered Early	Clustered Late	Spread	Clustered Early	Clustered Late
Reduced cover over D.vex	★	✗	★	★	✗	★	★	✗	★	✗	✗	✗	✗	✗	★	✗	✗	✗
Reduced % cover over D.vex	★	★	★	★	★	★	★	✗	★	★	★	★	★	★	★	★	✗	★
Reduced fouling biomass	★	★	★	★	✗	★	✗	✗	★	★	✗	✗	★	★	★	★	✗	★
Lower mortality	★	⊗	★	★	⊗	★	★	⊗	★	★	⊗	★	★	⊗	★	★	⊗	★
Most effective treatment	✓	✗	✓	✓	✗	✓	✗	✗	✓	✗	✗	✗	✗	✗	✓	✗	✗	✗
Least effective treatment	4 th		4 th	1 st		1 st			2 nd						3 rd			

Acknowledgements

I would like to give a heartfelt thanks to everyone who helped me throughout my PhD

r Tasman Crowe

r Jan-Robert Baars

rainne O'Brien, Mary Hannan, Catherine Morrison & Mo Mathies (B.I.M)

ean O'Grady

addy & Margaret Grady

ara Murphy

argaret & Danny

hne, David, Mary, James, Helen & Claire

ursary students & everyone who helped me over the summer

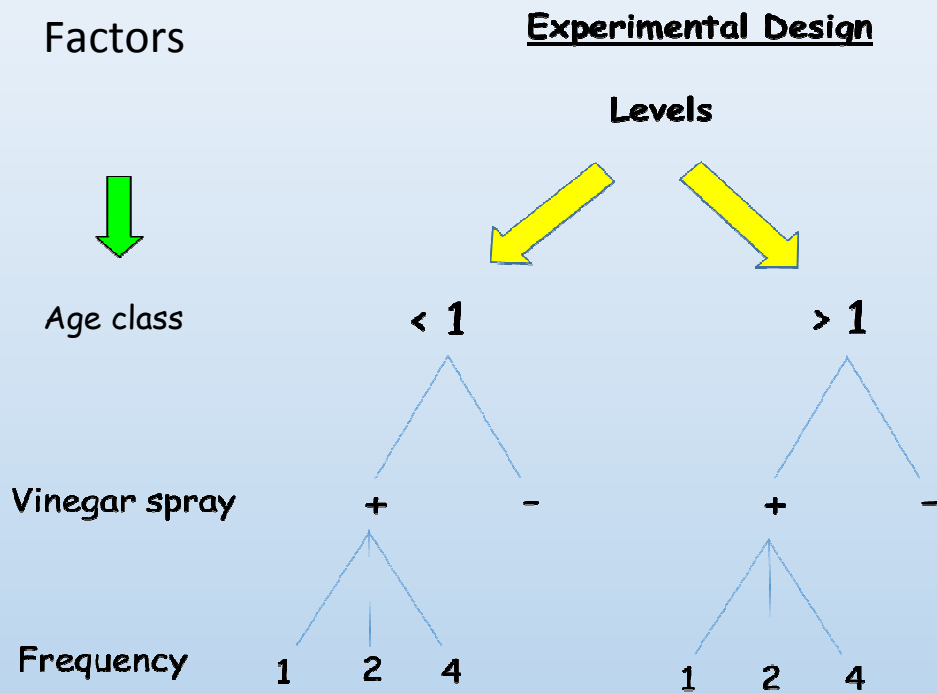
ise, Megan, Suni, Christena, Lisa, Regina & Eric

aroline, Paul, Chloe, Silvia & Camila

aine, Dorothy, Rosie, Phil & Will

I.M for generously supporting my work

Impact of treatments on juvenile vs. adult oysters



Response variables

- 1) Oyster mortality
- 2) Oyster growth
- 3) Oyster condition