Seasonal variation in an Oregon population of the colonial tunicate *Didemnum vexillum*

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OREGON INVASIVE SPECIES COUNCIL

INTRODUCTION

- Invasive species have dramatically altered the structure and function of several marine ecosystems, particularly coastal and estuarine habitats[1].
- The effects of invasive species in the US cost an estimated $120 billion per year[2].

Figure 1. *Didemnum vexillum*, the carpet sea squirt, colony. Photo credit: Dan Blackmann.

- The invasive colonial tunicate *Didemnum vexillum* (*D. vex*, Fig. 1) is native to Japan[3], and is widespread in other temperate areas.
- *D. vex* can survive in a wide range of environmental conditions: temperature (-2 to 24°C), salinity (10-36), depth (0-81m), and settlement substrate (artificial structures, loose cobble, and over healthy communities)[4].
- In the winter, *D. vex* colonies regress, but do not die completely[5].
- In other *D. vex* studies, this pattern has been strongly correlated to seasonal fluctuations in temperature and salinity[6,7].
- **The objective of this study is to track the seasonal variation in the Winchester Bay, Oregon *D. vex* population.**
- **We hypothesize that *D. vex* cover is greater in fall than in spring, and that this cover is directly correlated with salinity.**

METHODS

Survey Site

- The study occurred in the "Triangle" at the mouth of the Umpqua River in Winchester Bay, OR where the Umpqua Aquaculture company operates its suspended longline oyster farm (Fig. 2).
- A United States Forest Service dive team performed subtidal surveys in May and September from 2011-2016.
- Divers followed vertical subtidal oyster culture lines from the surface to the bottom, along which they counted and measured *D. vex* colonies.

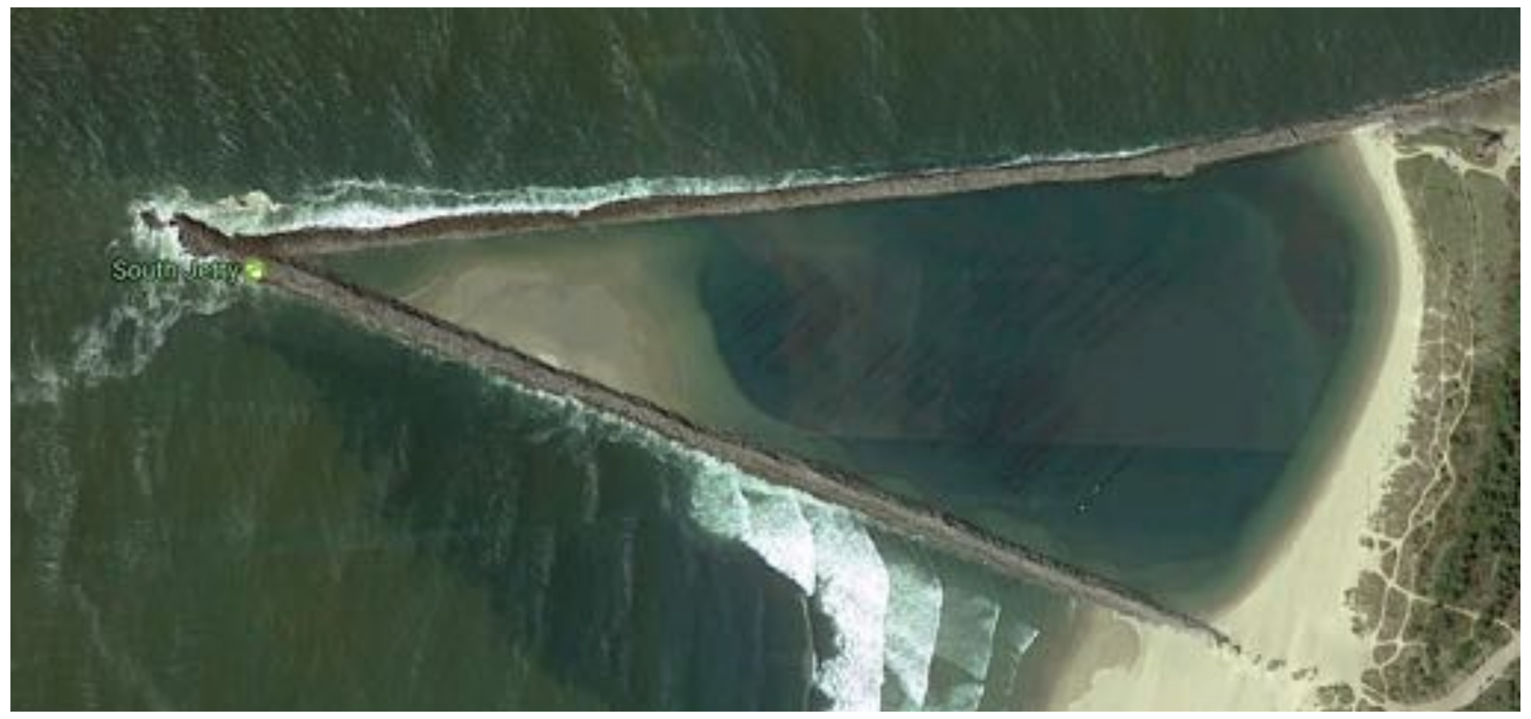


Figure 2. Survey area, the "Triangle" (43°39'54.5"N 124°12'40.3"W)[8]. The two jetty-structured walls prevent water exchange over short periods of time. Umpqua Aquaculture oyster suspension float lines are visible as dark hash marks.

Statistical Analyses

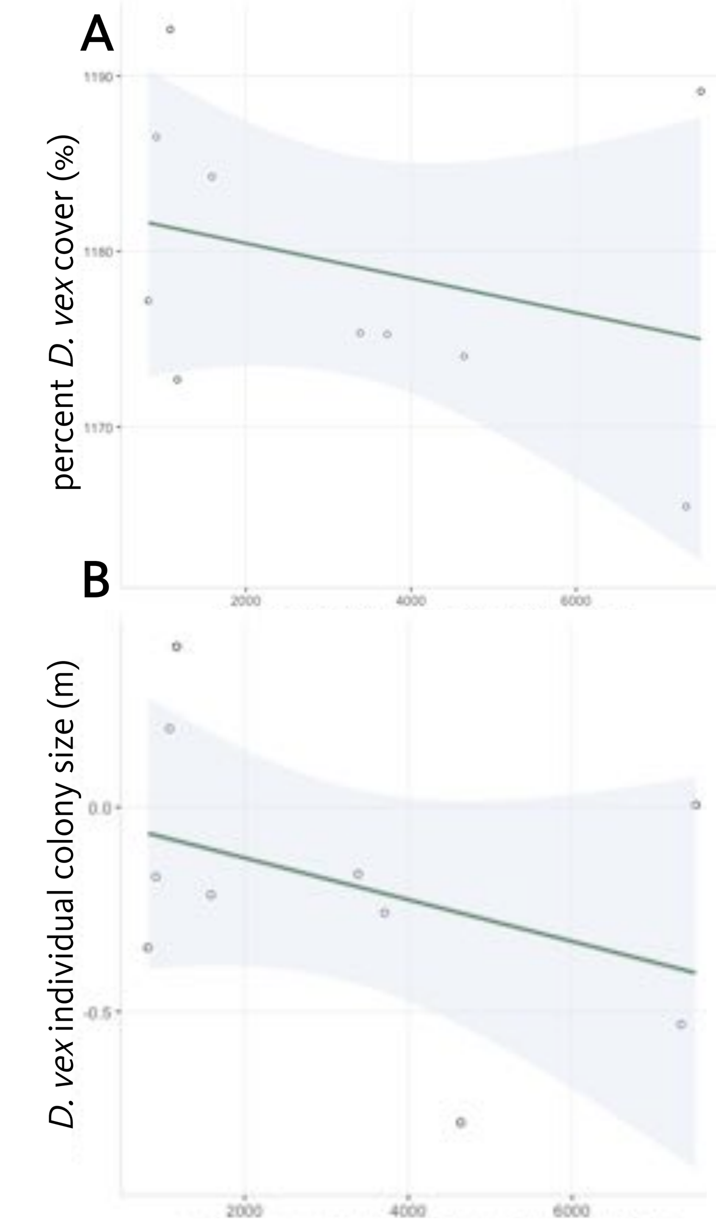
- We used the 30-day average Umpqua River output prior to the survey date as a proxy for salinity.
- We regressed box-cox-normalized[9] (R package "TeachingDemos") averages of individual colony length (m), total length of line covered (m), and proportion of line covered (%) to the Umpqua River (USGS Station #14321000[10]) discharge (m^3/s).
- We performed two-sample t-tests to compare each of these measurements between overall spring and fall averages.

RESULTS

Table 1. Two-sample t-tests between average seasonal measurements. P-values significant at the α <0.05 level are marked with an asterisk (*).

	spring $\bar{x}$	fall $\bar{x}$	t	df	p-value
length of line covered (m)	4.03	6.13	3.062	143	**0.002***
proportion of line covered (%)	26.6	18.9	2.176	161	**0.03***
individual colony length (m)	0.596	0.898	3.220	946	**0.001***
abundance (colonies per line)	6.74	6.51	0.3093	150	0.8
pre-survey 30-day average Umpqua River discharge (m^3/s)	151	31.6	4.697	4	**0.008***

- **_D. vex_ colony abundances between spring and fall were not significantly different (p = 0.8) (Table 1).**
- **Significant differences between spring and fall occurred for: length of line covered (m; p = 0.002), proportion of line covered (%; p = 0.03), individual *D. vex* colony lengths (m; p = 0.001), and Umpqua River discharge (m^3/s; p = 0.008).**



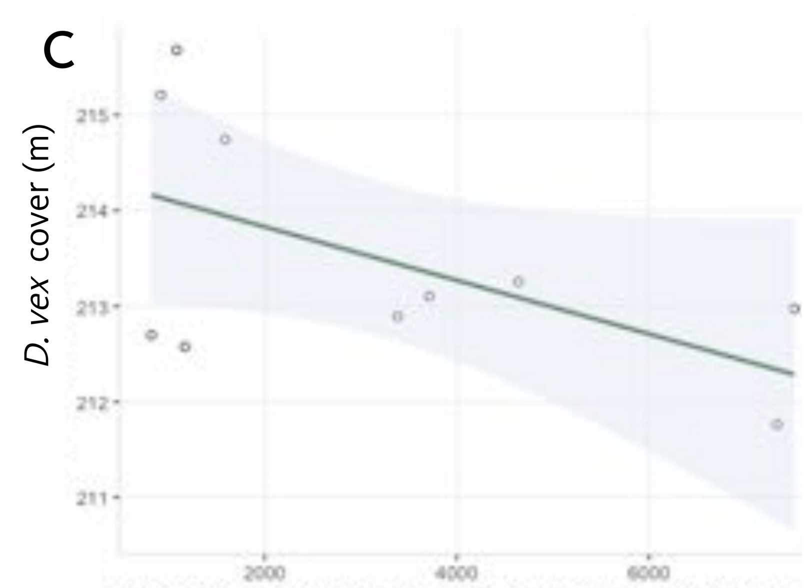


Figure 3. Linear regression models of the prior 30-day average Umpqua River discharge (m^3/s, a proxy for salinity) and average **A)** percent *D. vex* cover per line (%; $\lambda = -1.40$; $r^2 = 0.06$; p = 0.5); **B)** individual colony size (m; $\lambda = -0.10$; $r^2 = 0.1$; p = 0.4; and **C)** total *D. vex* cover per line (m; $\lambda = -3.13$; $r^2 = 0.3$; p = 0.09). Blue area represents regression 95% confidence interval. Each point is a seasonal survey average. Dependent variable values are box-cox normalized, where $f(y) = (y^{\lambda} - 1) / \lambda$.

- **Umpqua River discharge did not significantly predict variance in the dependent variables of average *D. vex* cover per line ($r^2 = 0.3$), percent *D. vex* cover per line ($r^2 = 0.06$), or individual *D. vex* colony size ($r^2 = 0.1$) (Figure 3).**

CONCLUSIONS

- **We have determined that this Oregon *D. vex* population experiences seasonal regression in size but not total colony death, as has been reported for other populations; but, salinity is not a causal factor of this regression from fall to spring.**
- It is possible that our proxy for salinity was not appropriate for this analysis.
- Another environmental factor such as temperature could be a stronger correlative agent of regression.

LITERATURE CITED & ACKNOWLEDGMENTS

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