

# DO SEASONAL ENVIRONMENTAL GRADIENTS DRIVE BENTHIC COMMUNITY STRUCTURE IN AN ARCTIC KELP BED?



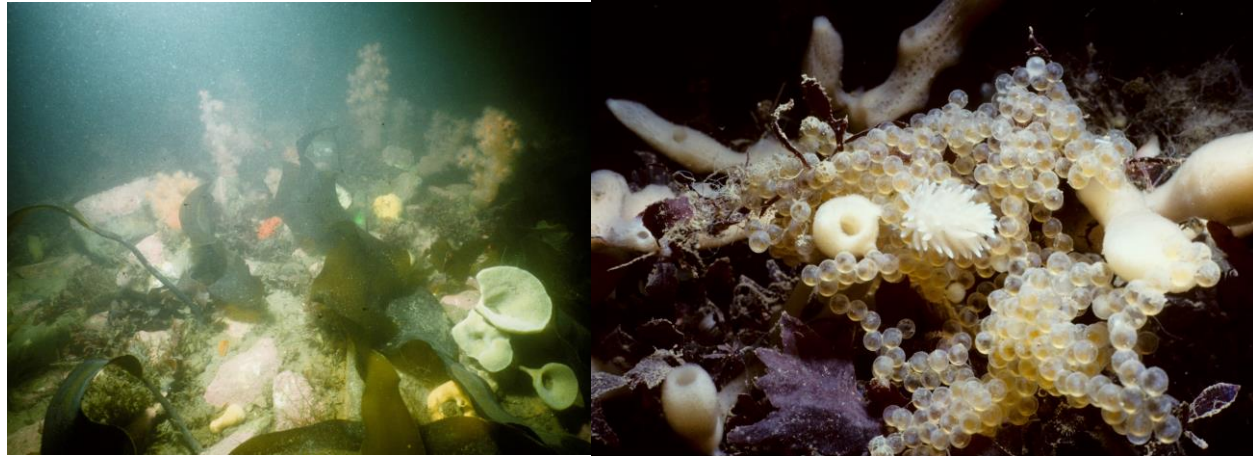
C. E. Bonsell and K. H. Dunton  
University of Texas Marine Science Institute

WSN 2016

# Arctic kelp beds

Need rocky substrate  
+ light

(Luning 1990, Wiencke and  
Amsler 2012)



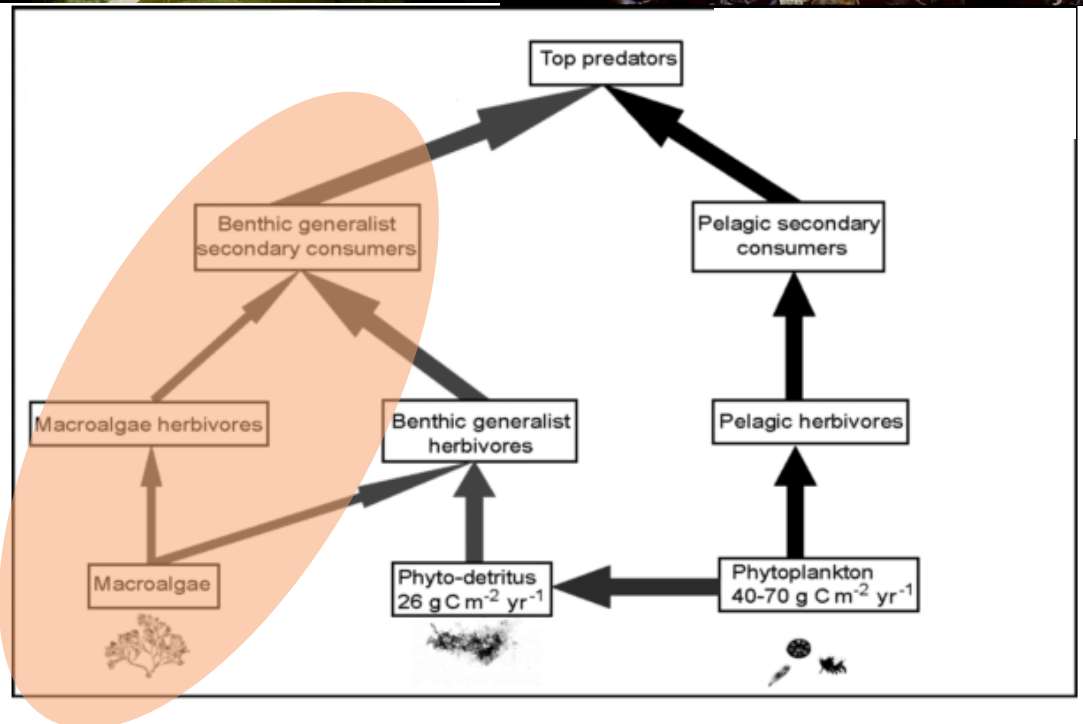
High diversity

High productivity

Promote carbon burial

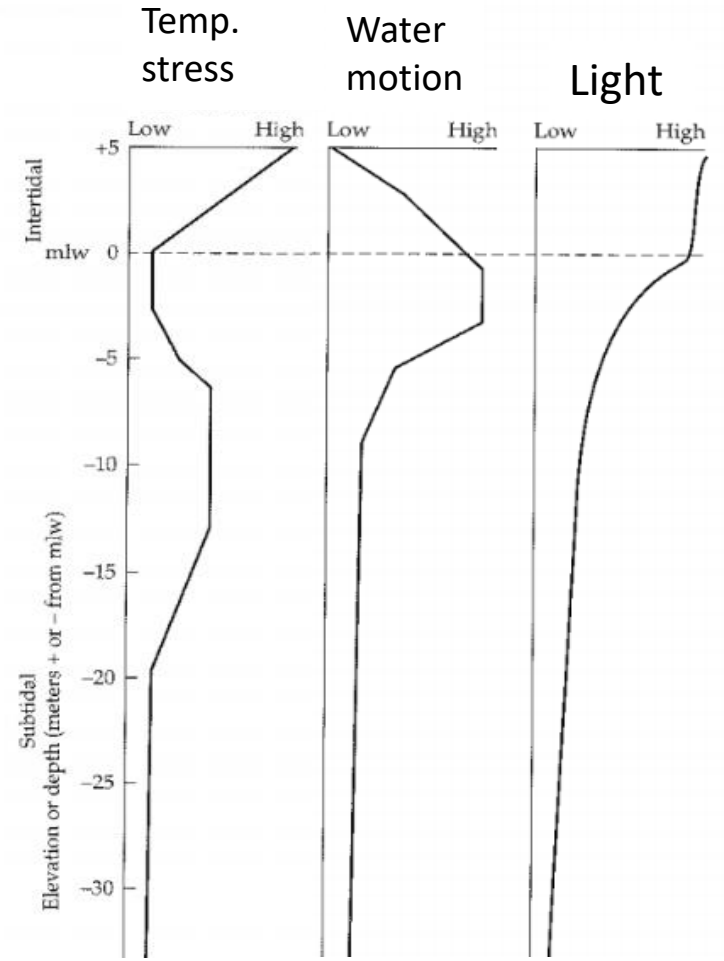
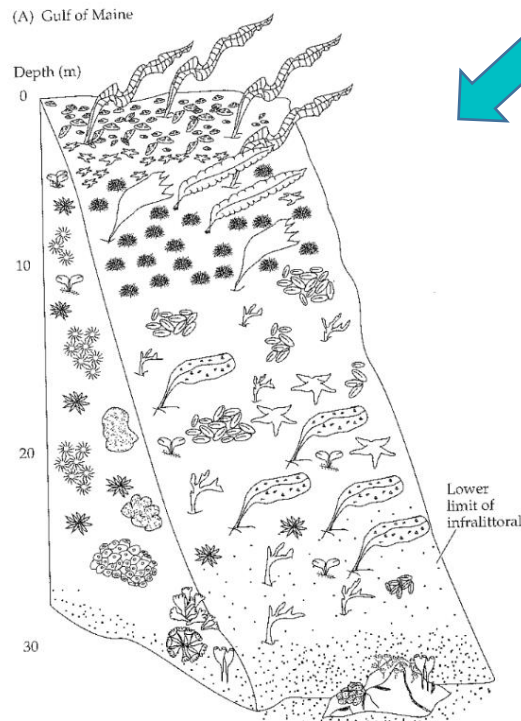
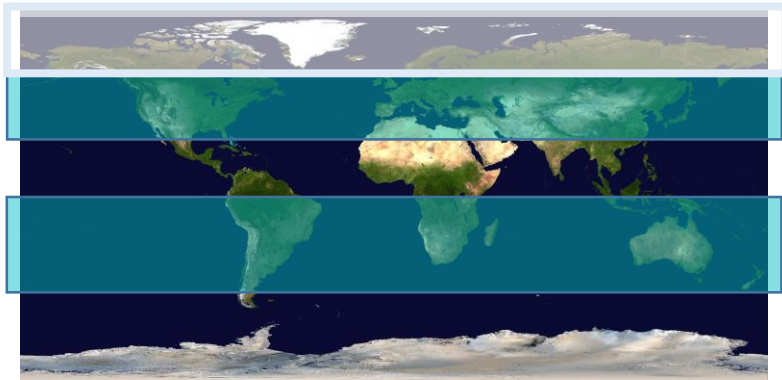
Stabilize food webs

(Wiencke and Amsler 2012,  
McMeans et al. 2013, 2015,  
Krause-Jensen and Duarte 2016)



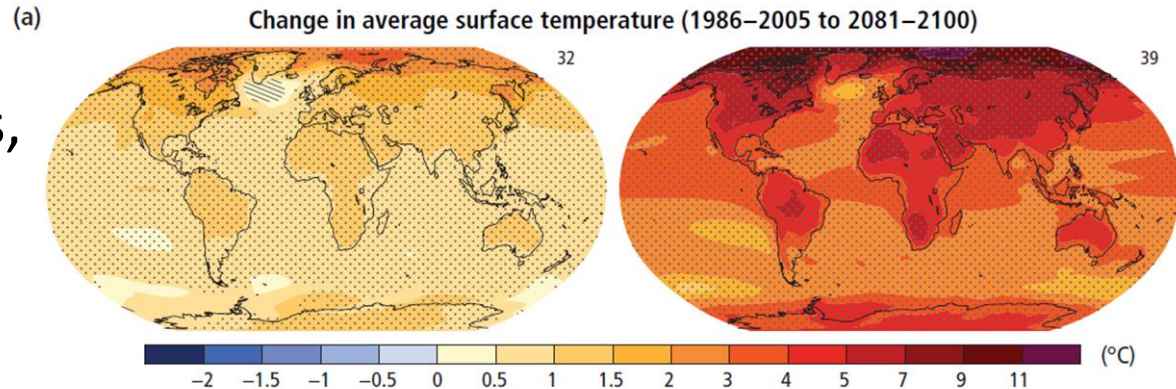
# Physical Drivers of Community Structure

?



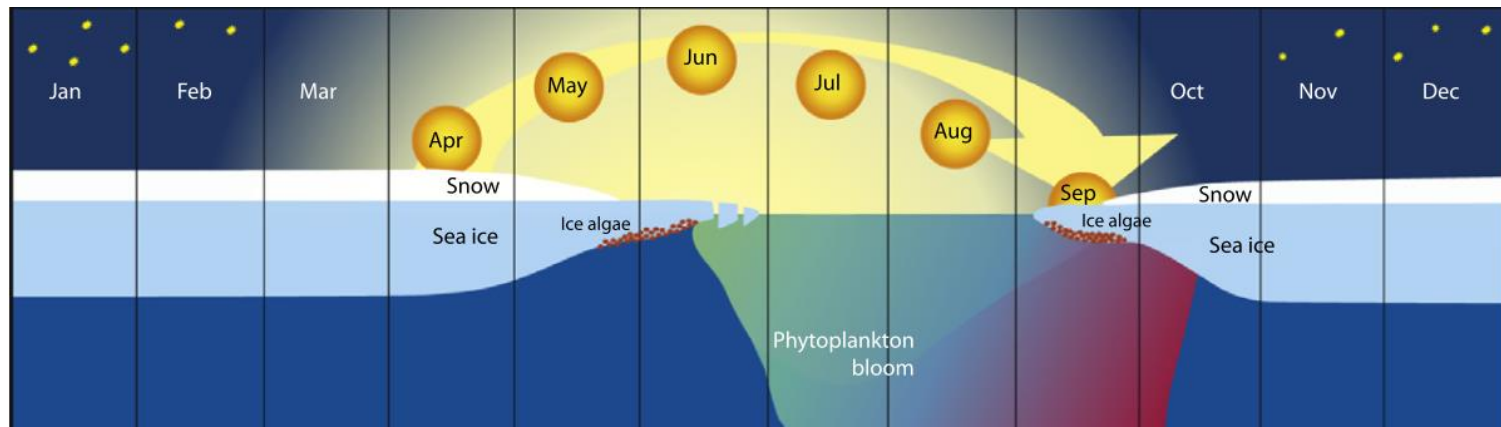
# Creating a Baseline in the Changing Arctic

Increased temps, larger waves, stronger currents, freshening, increased turbidity

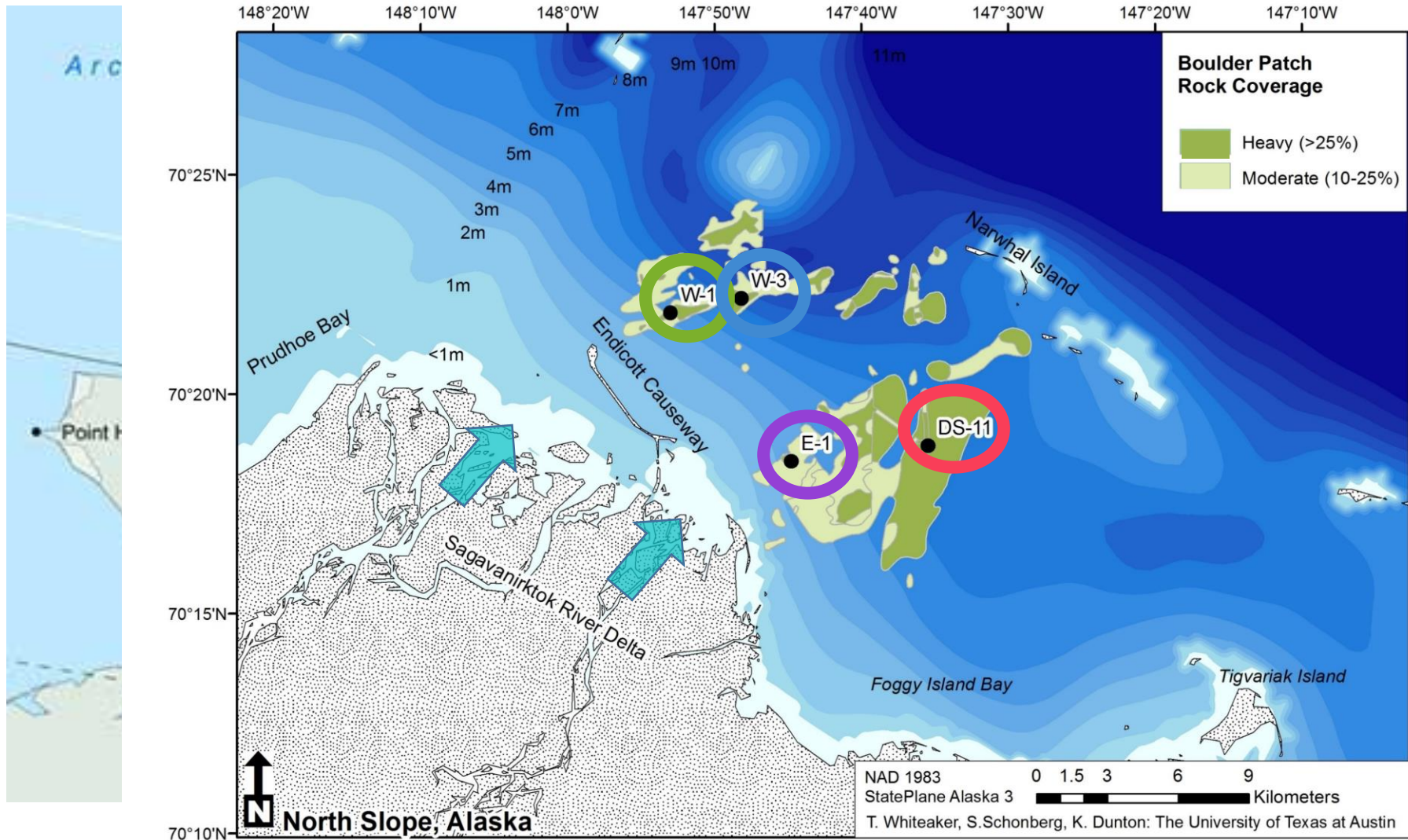


**How do environmental conditions affect community structure?**

High seasonality → have to look at timescales  $\geq 1$  year



# Stefansson Sound Boulder Patch



# Boulder Patch Epilithic Community

Dominant kelp: *Laminaria solidungula*

~ 158 epilithic taxa (Dunton and Schonberg 2000)

~ 78 benthic algal species (Wilce and Dunton 2014)

All but one algal species perennial

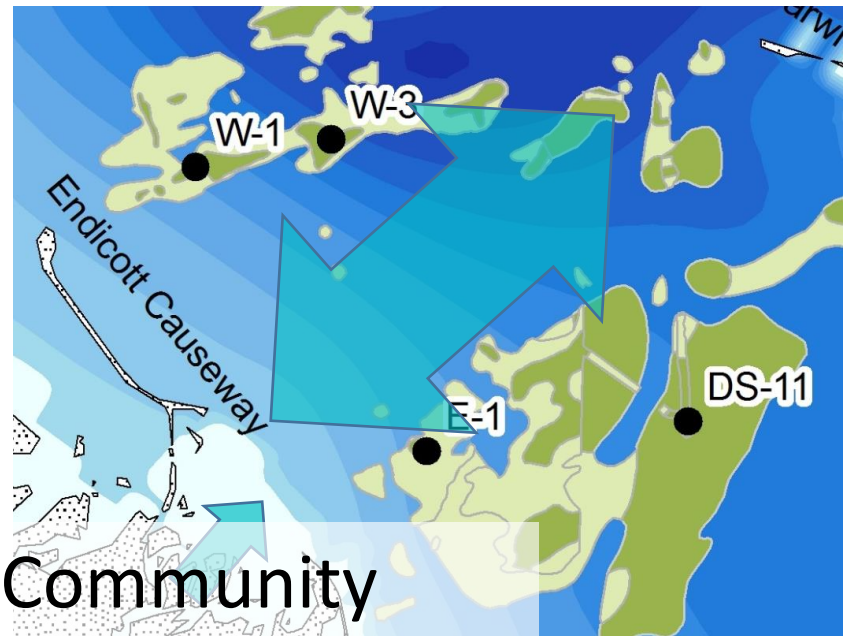


# Research Questions

How does community structure and recruitment change across the Boulder Patch?

Does biotic variation match seasonal abiotic variation?

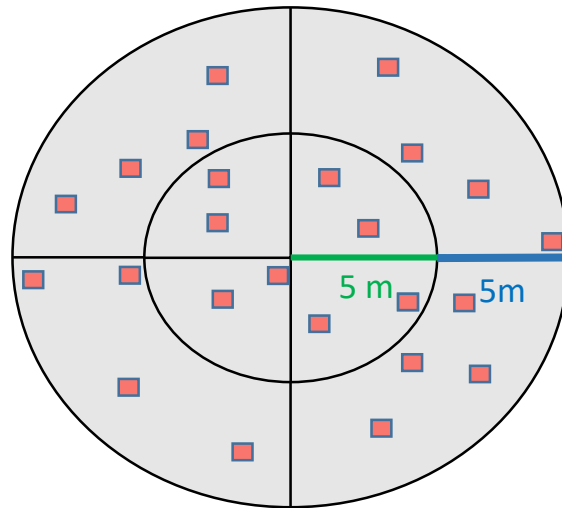
Previous research: Community differences between Boulder Patch sites



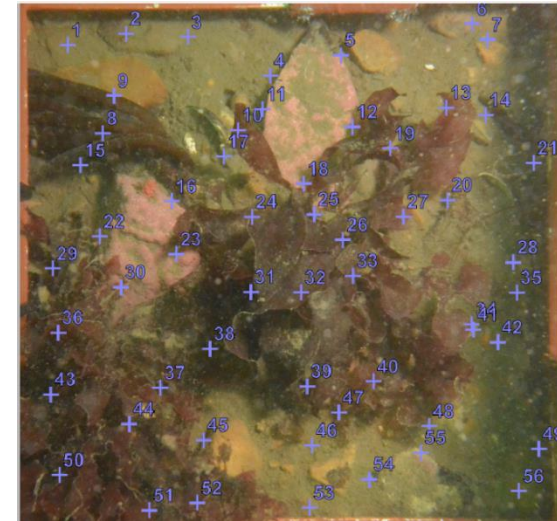
# How does **community structure** and recruitment change across the Boulder Patch?



0.05 m<sup>2</sup> photoquadrat



Stratified haphazard sampling



Percent cover data extraction via CoralNet



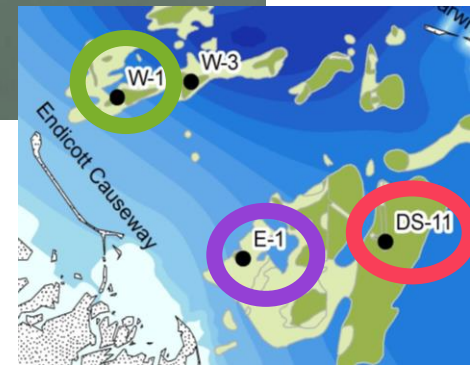
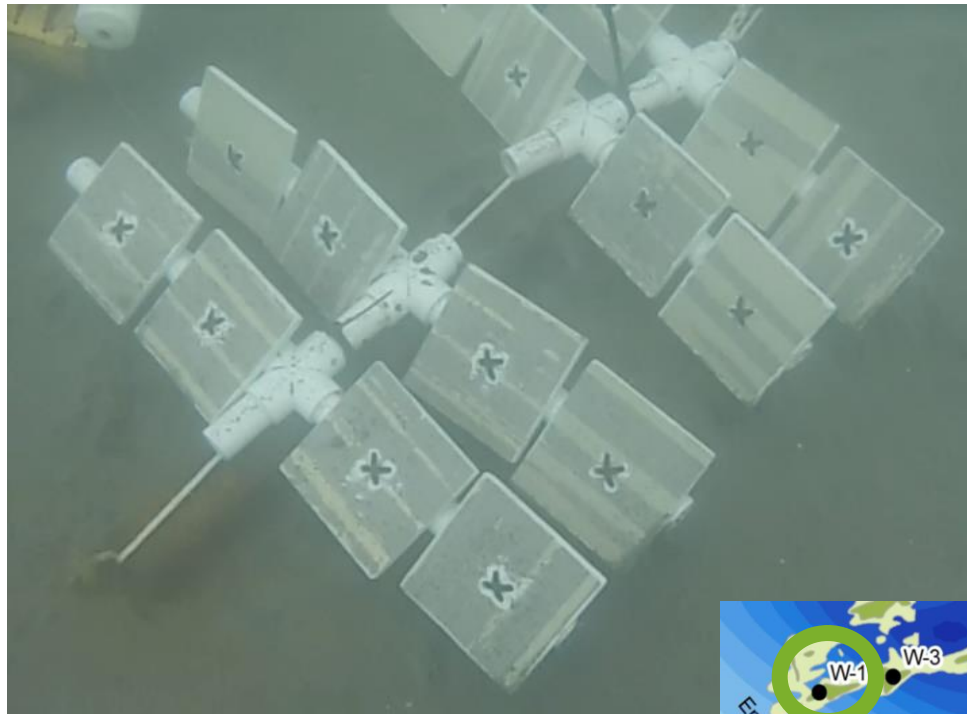
# How does **community structure** and recruitment change across the Boulder Patch?



# How does community structure and **recruitment** change across the Boulder Patch?

Arrays of eight  
10x10cm  
fibercement  
plates

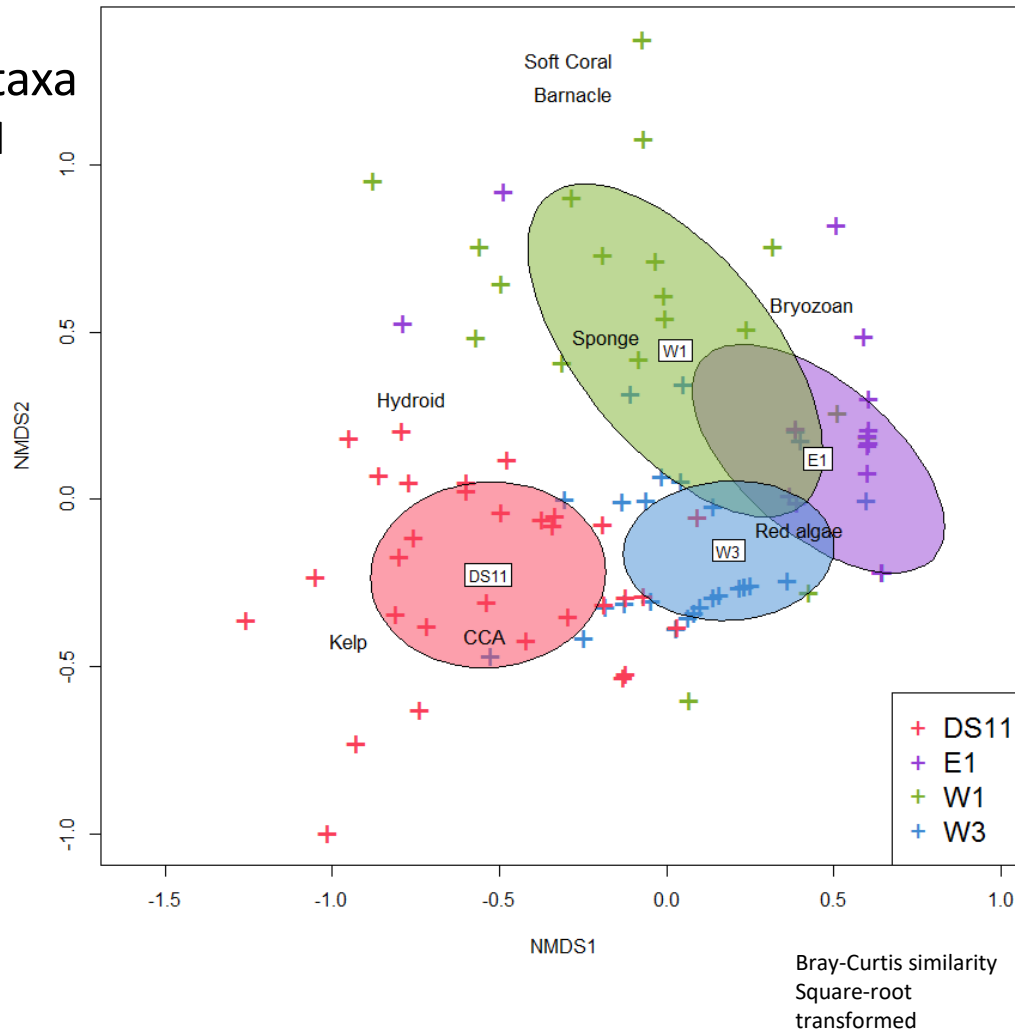
After 1 year:  
Retrieved one 8-  
plate array at  
DS11, E1, and W1



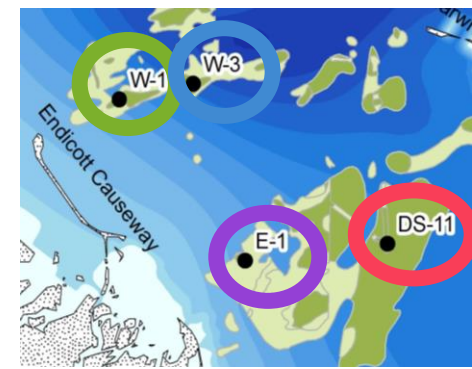
# Community Structure: Benthic Percent Cover

Important taxa  
(SIMPER and  
GLM)

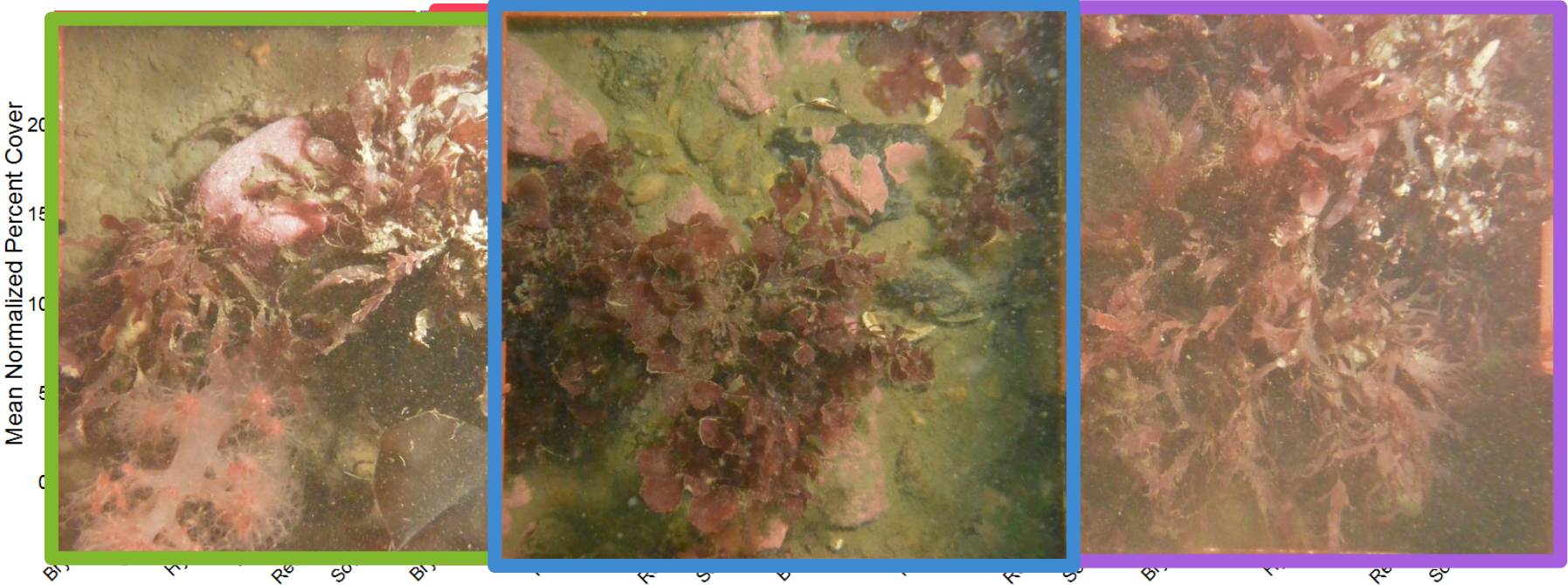
CCA  
Kelp  
Red Algae  
Soft Coral  
Hydroid  
Bryozoan



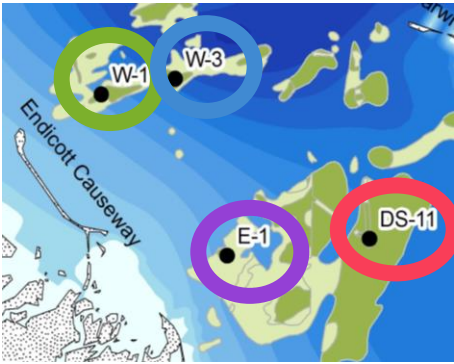
Community structure  
varies by site  
(PERMANOVA,  $R^2=0.43$ ,  
 $p<.05$ )  
Community structure at  
each site is distinct  
(Pairwise PERMANOVA,  
 $p<.05$ )



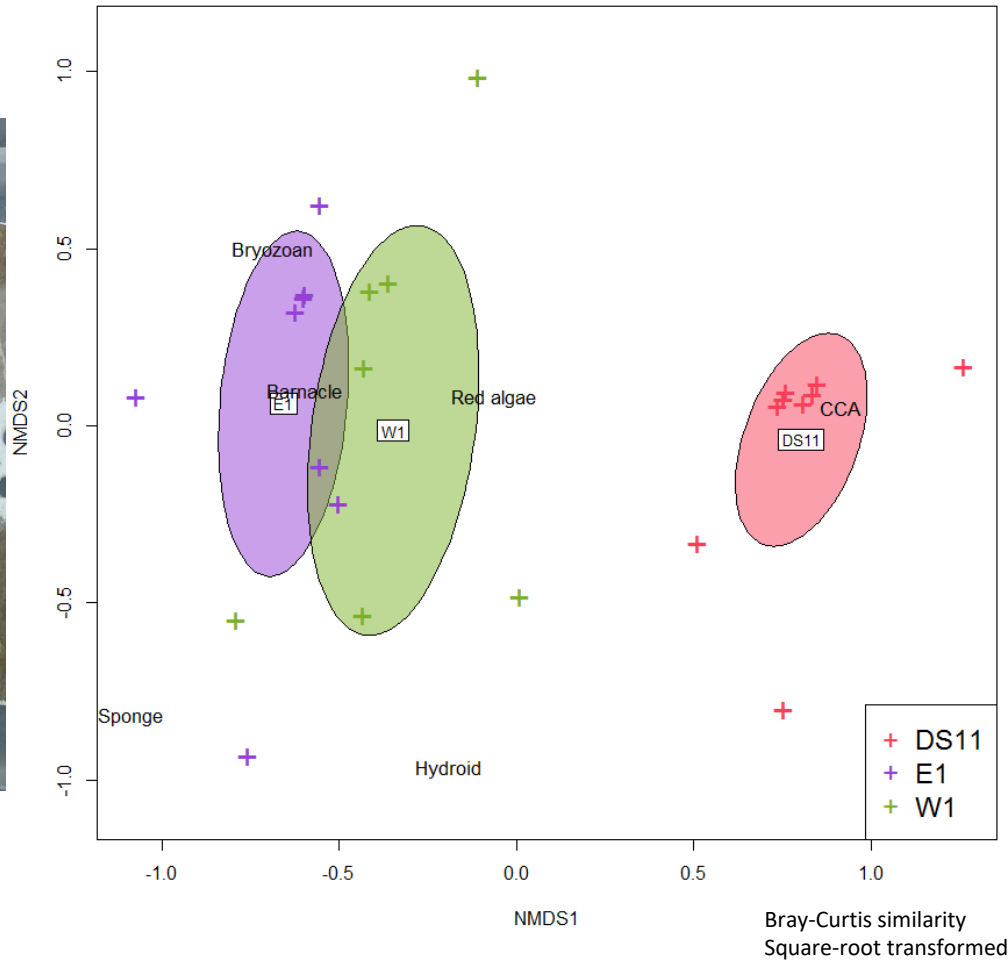
# Community Structure: Benthic Percent Cover



Differences in dominant algae + contribution by invertebrates



# Settlement Tiles



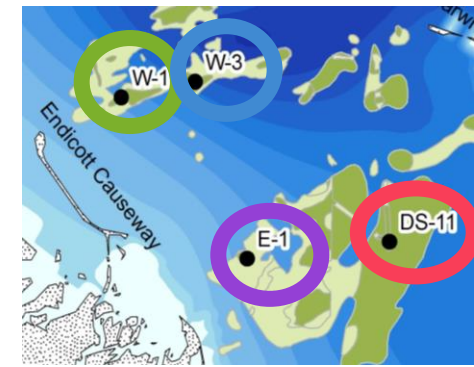
Community structure varies by site

(PERMANOVA,  $R^2=0.65$ ,  $p<.05$ )

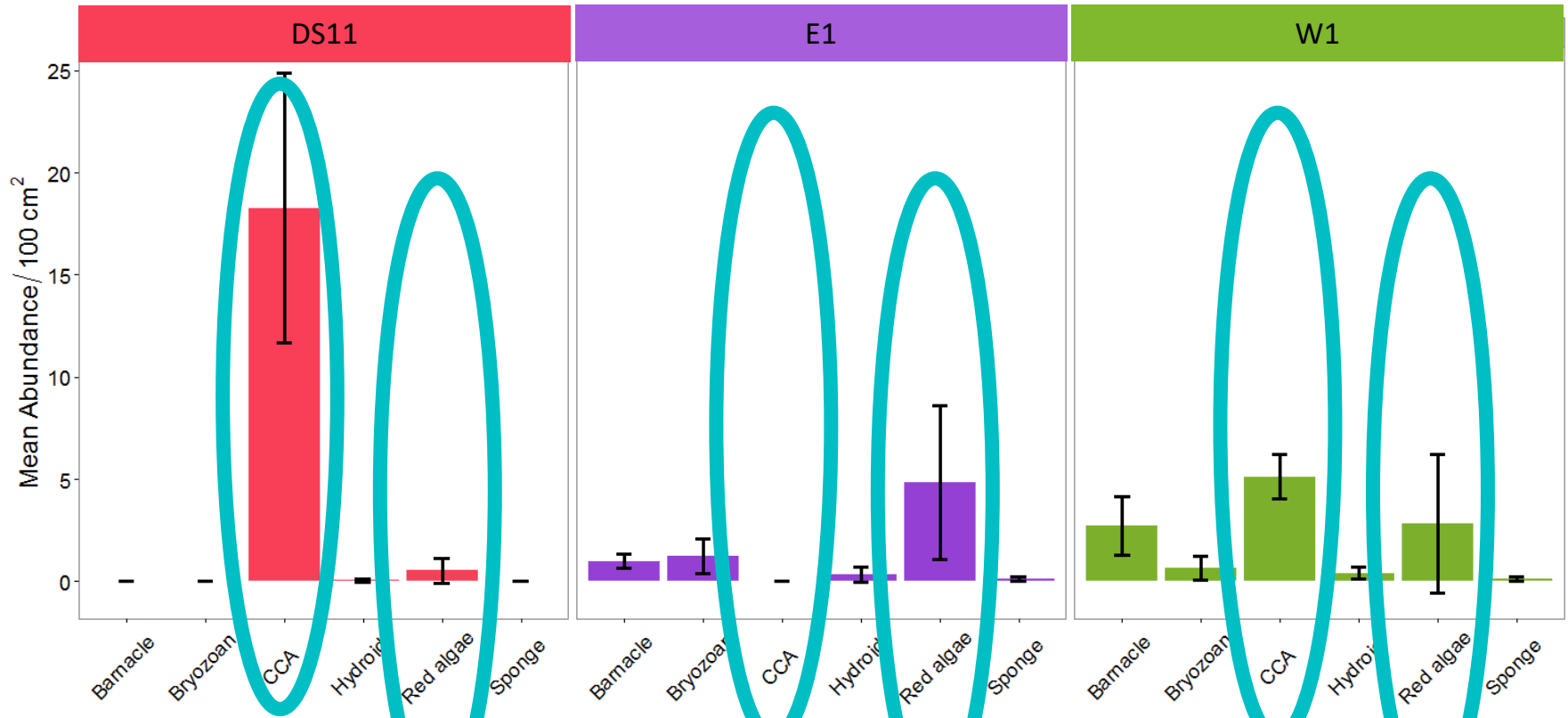
Community structure at each site is distinct

(Pairwise PERMANOVA,  $p<.05$ )

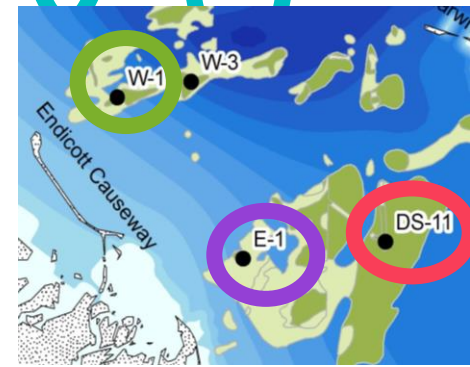
## No kelp!



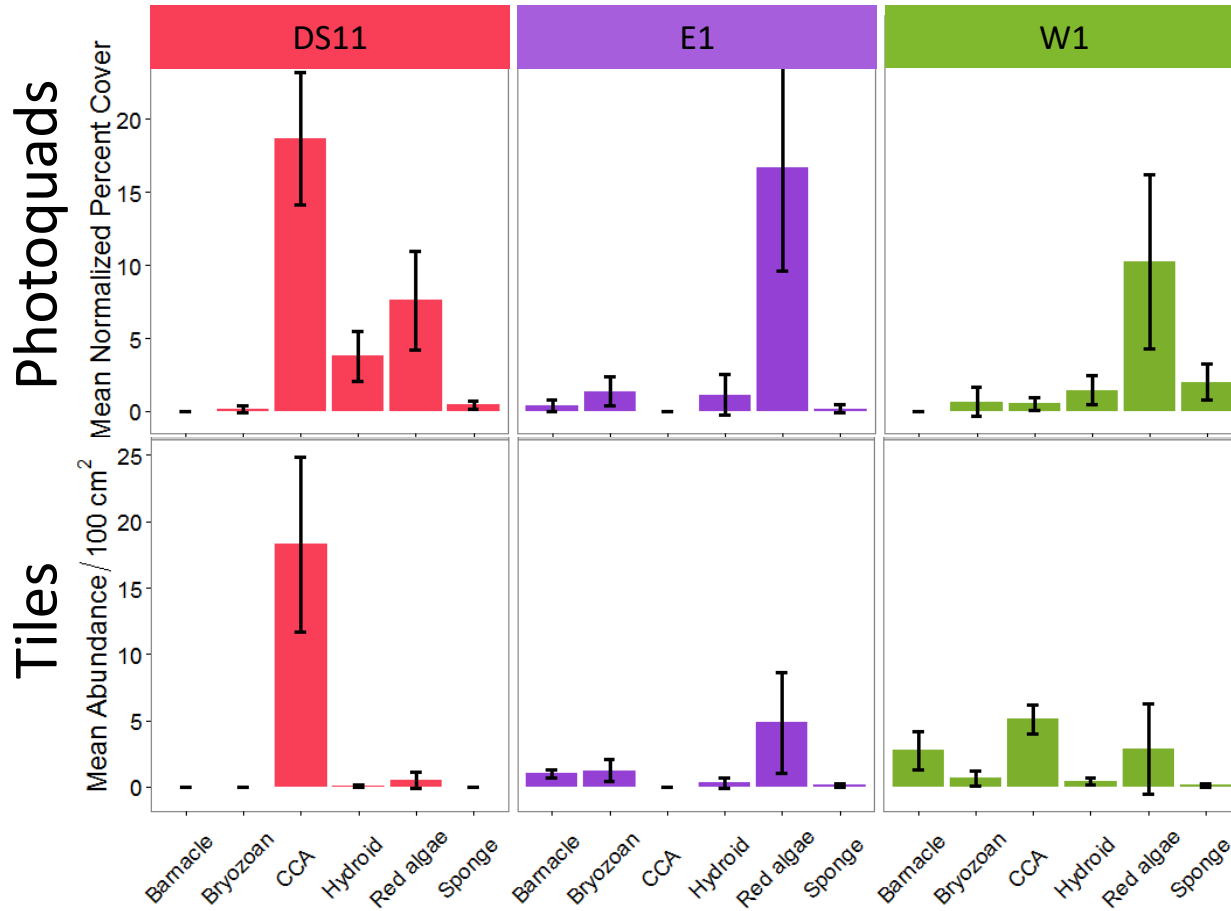
# Settlement Tiles



Differences in dominant algae

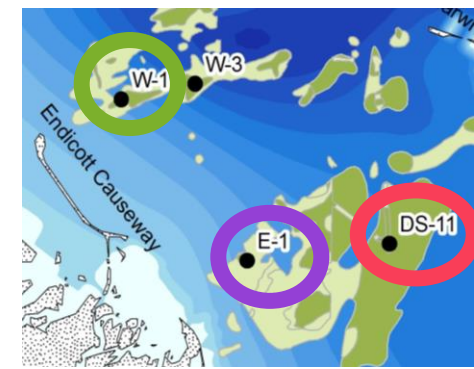


# Recruited + established community patterns

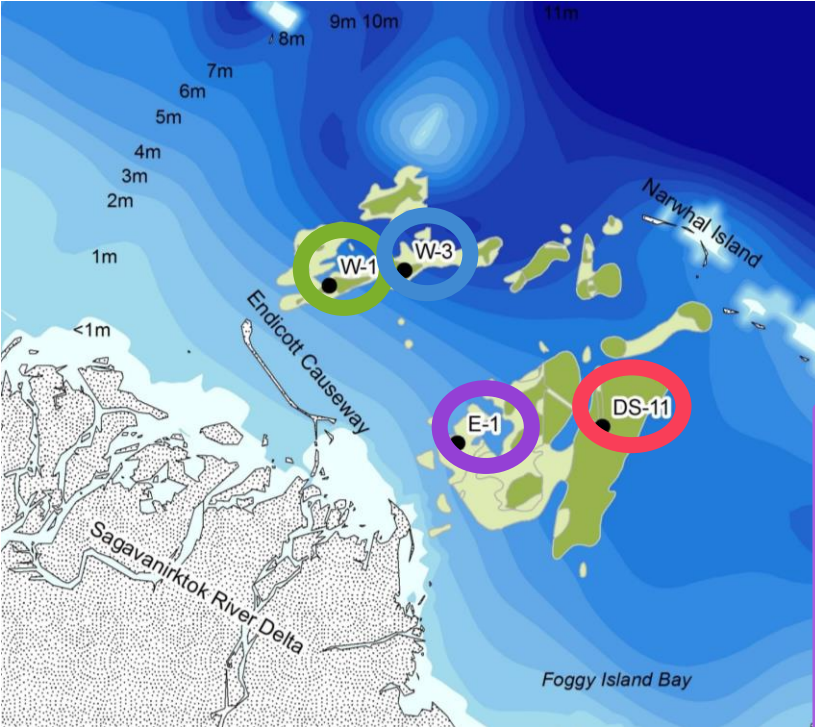


Tile abundance correlated to photoquad percent cover at DS11 ( $\rho=0.94$ ) and E1 ( $\rho=0.94$ ), but not at W1 ( $\rho=-0.31$ )

Community differentiation starts before establishment

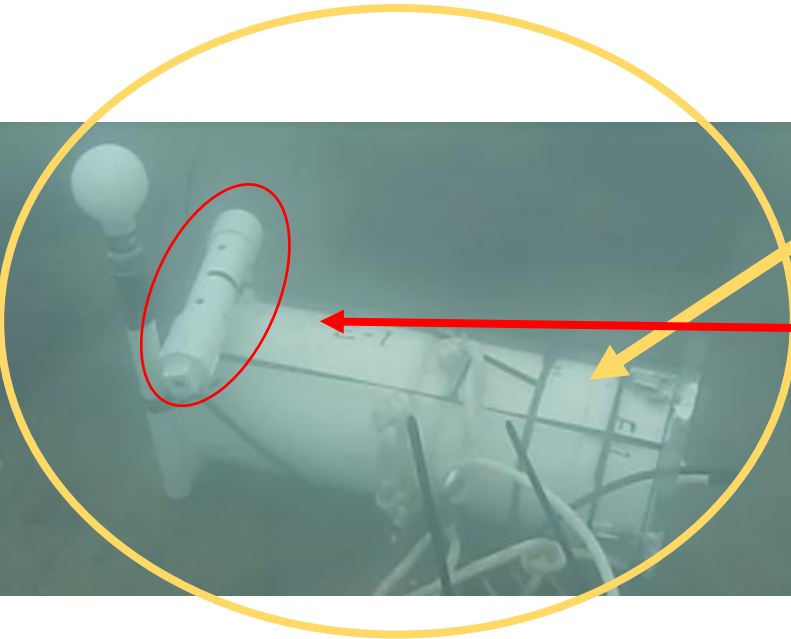


# Does this biotic variation match seasonal abiotic variation?





# Does this biotic variation match seasonal abiotic variation?



Light

-LiCOR Irradiance dataloggers

Temperature and Salinity

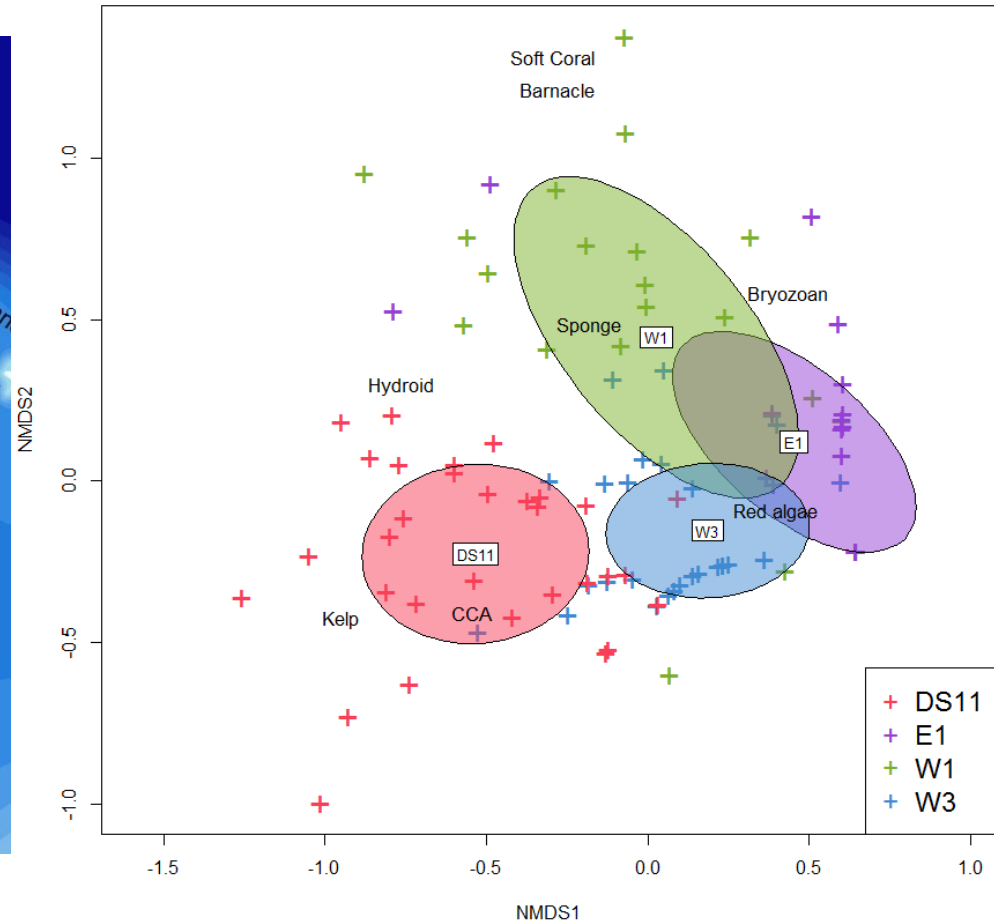
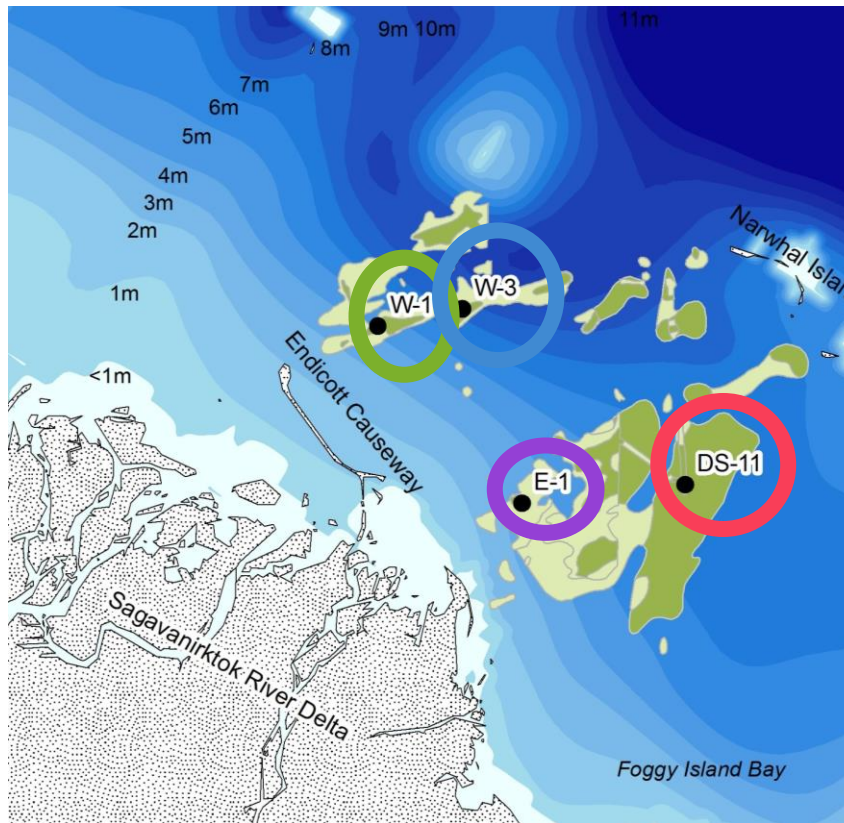
-HOBO U24

Current speed

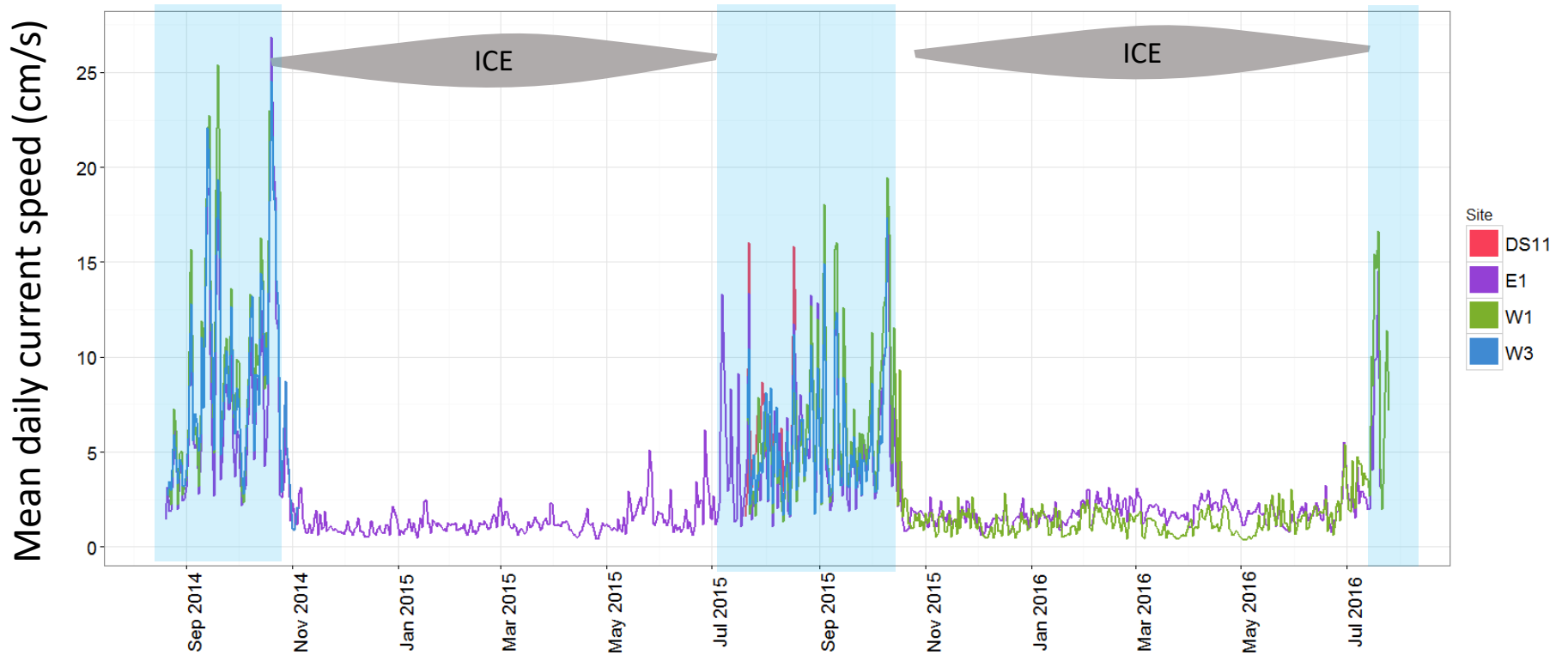
- Sea Horse Tilt Current Meters



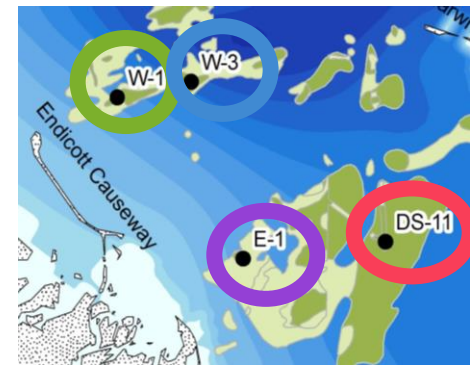
# Expect E1 and DS11 to be distinct



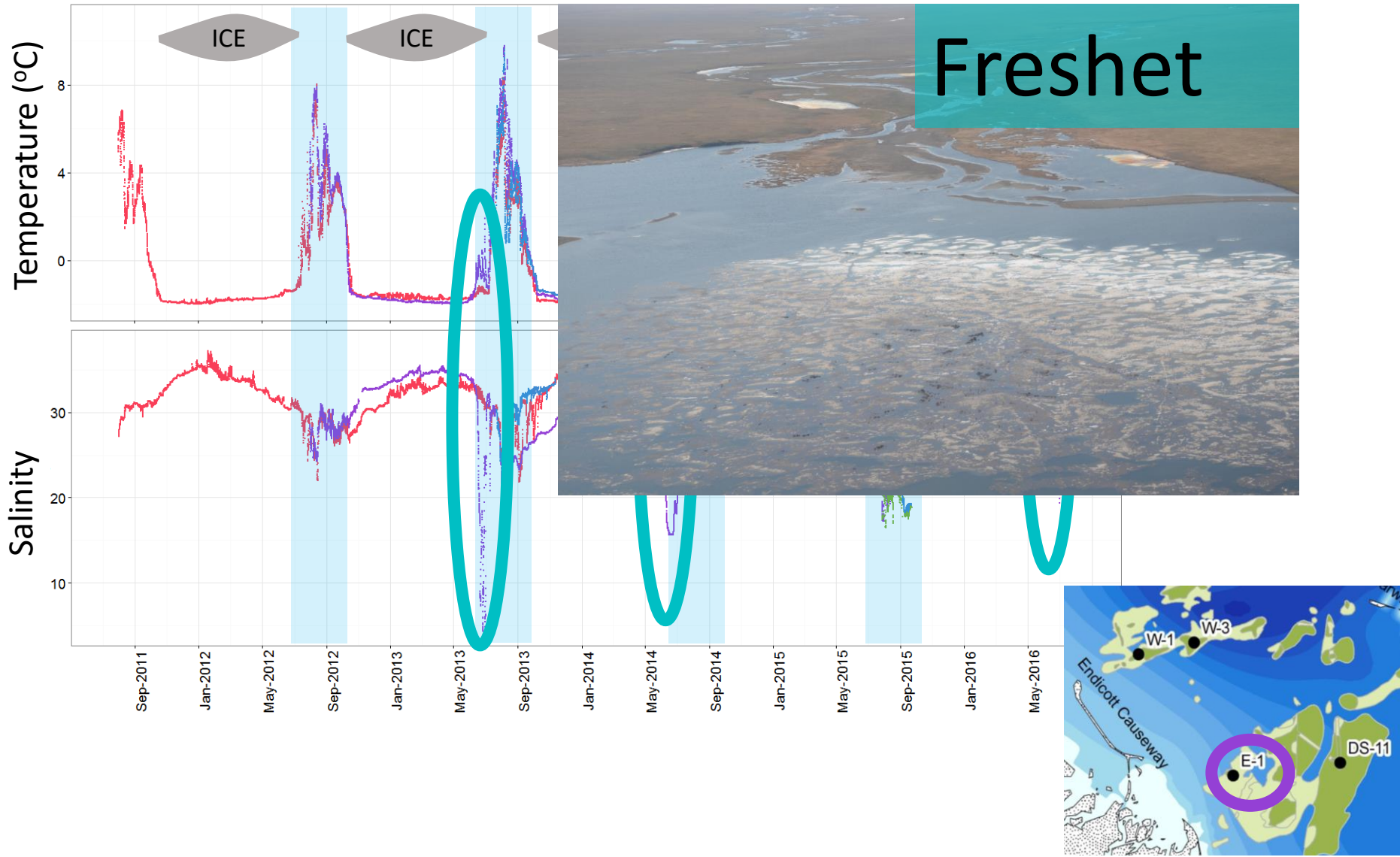
# Current Speed



Similar current speeds at all sites



# Temperature and Salinity

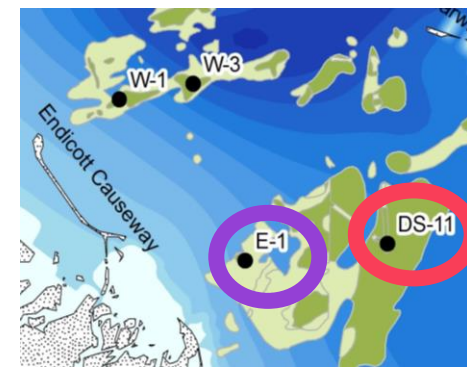


# Nearshore = highly influenced by river runoff

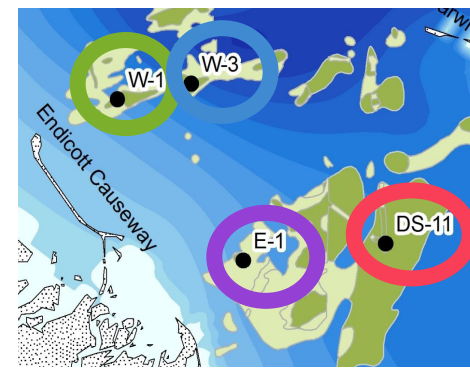
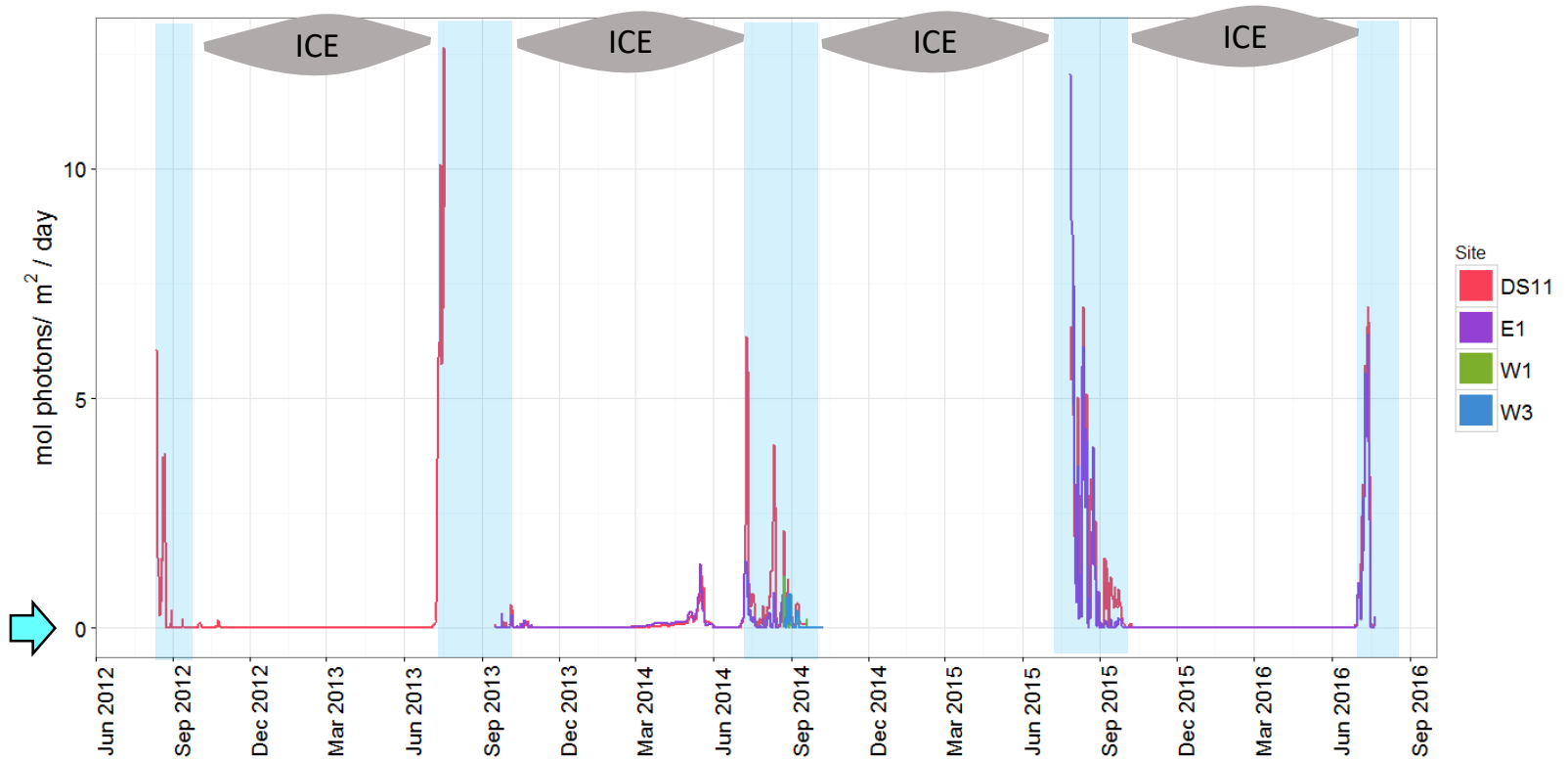
Site	Mean Sal	Std Dev Sal	Mean Temp	Std Dev Temp	# complete years sampled
DS11	32.60	3.18	-0.82	1.95	5
E1	30.60	4.72	-0.41	2.52	3
W1	-	-	-1.12	1.65	2
W3	31.65	4.37	-0.61	1.43	Temp: 3 Sal: 1



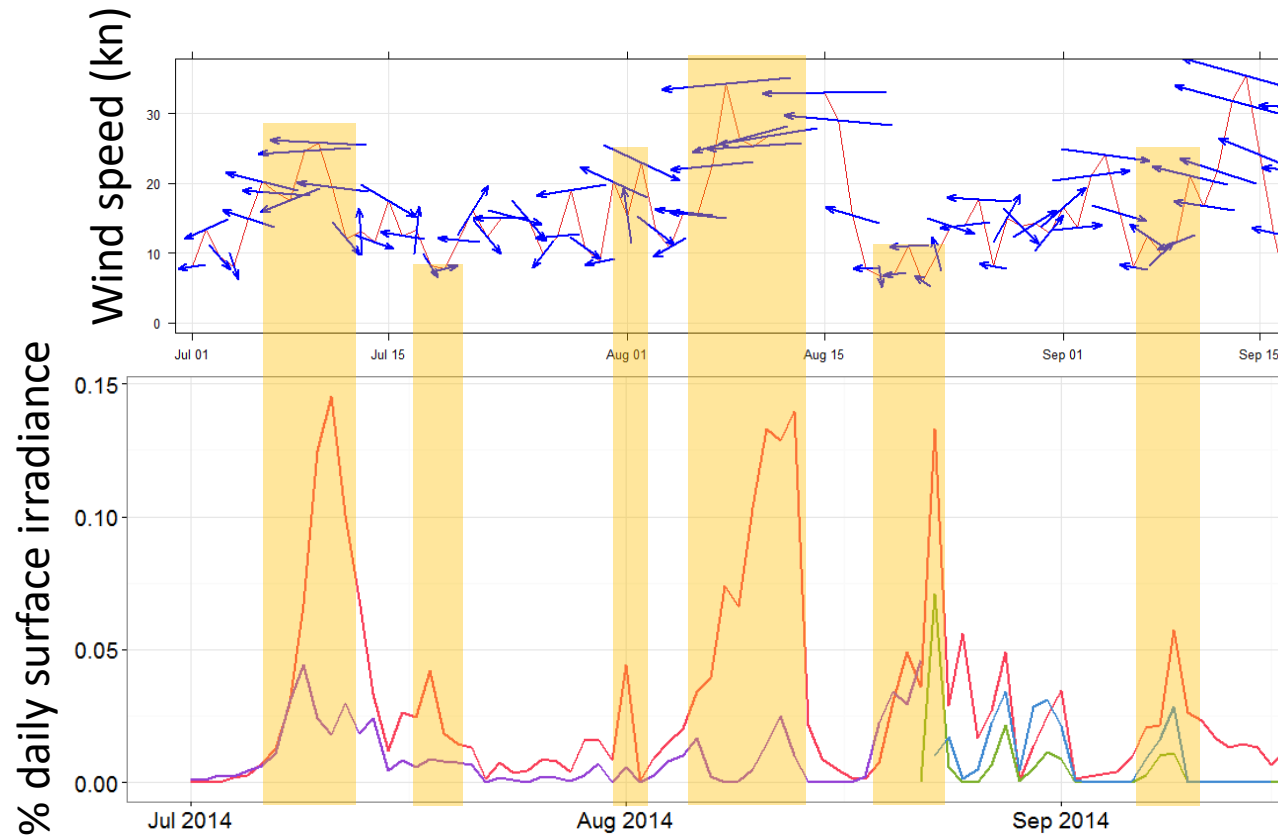
Salinity + Temperature → Community structure



# Photon Flux



# Photon Flux vs Wind: Wind Speed + Direction

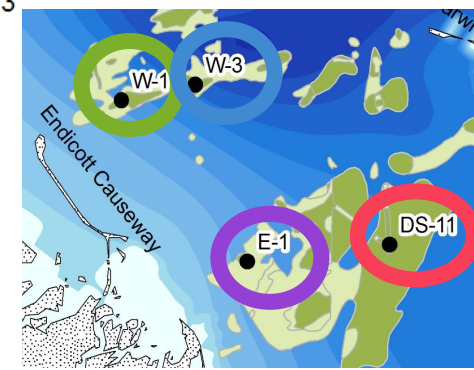


Easterly winds or low winds

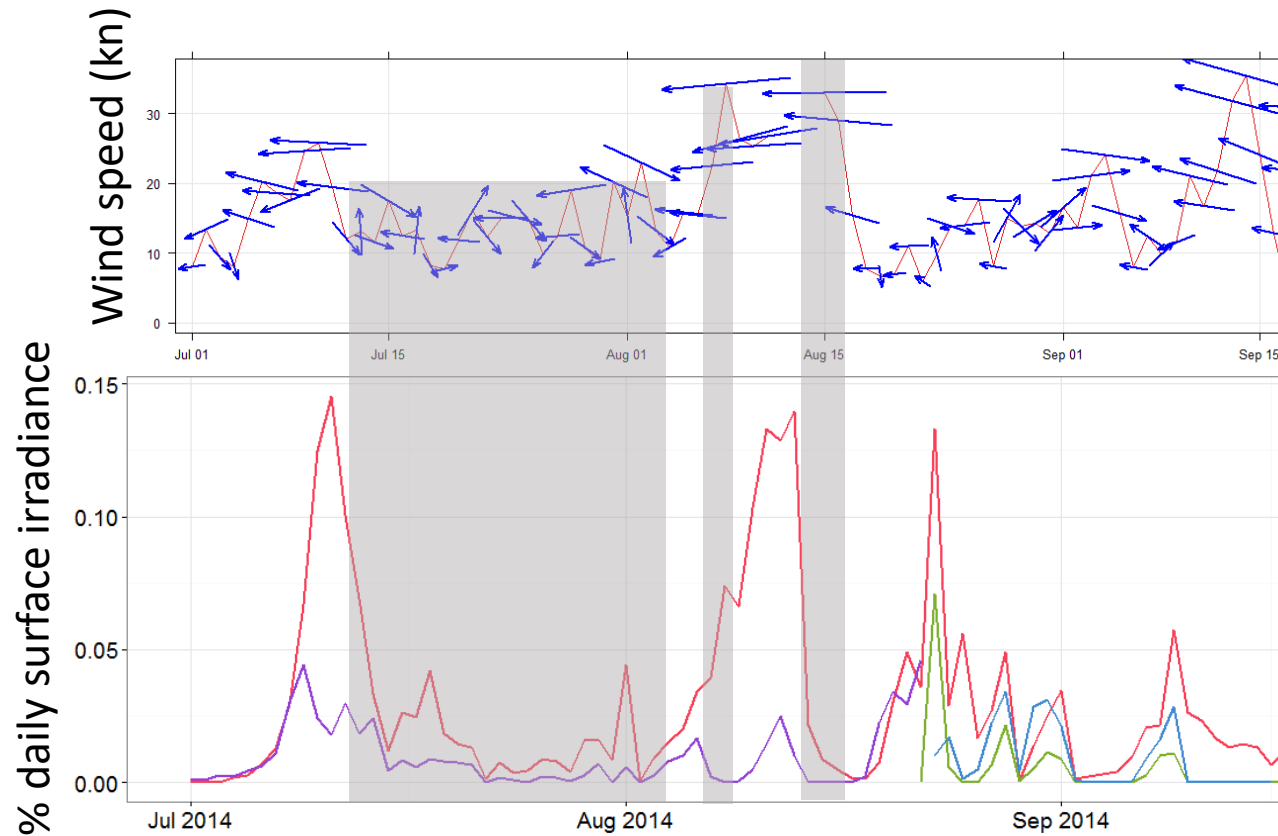


Light

- Site
- DS11 (Red circle)
  - E1 (Purple circle)
  - W1 (Green circle)
  - W3 (Blue circle)



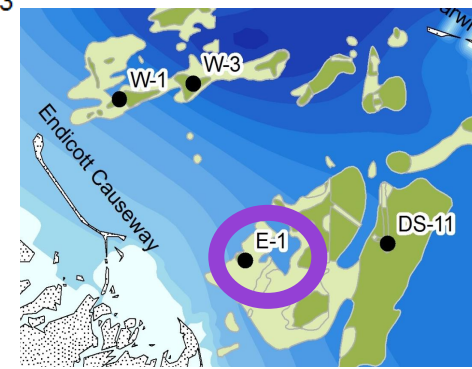
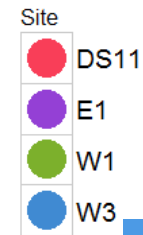
# Photon Flux vs Wind: Wind Speed + Direction



Non-easterly winds or high winds



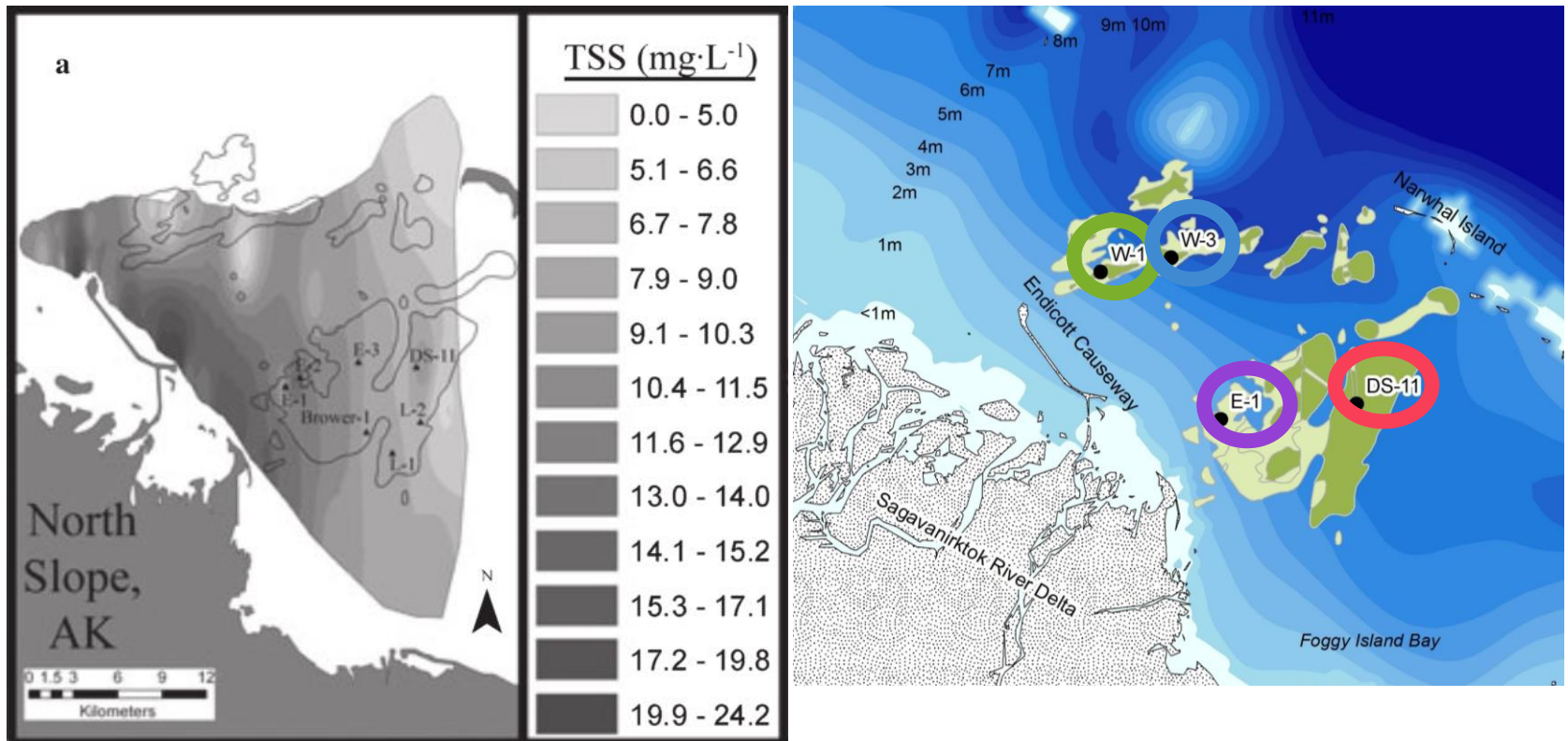
Less light at shallow site





Shallow = more turbid → less light in summers

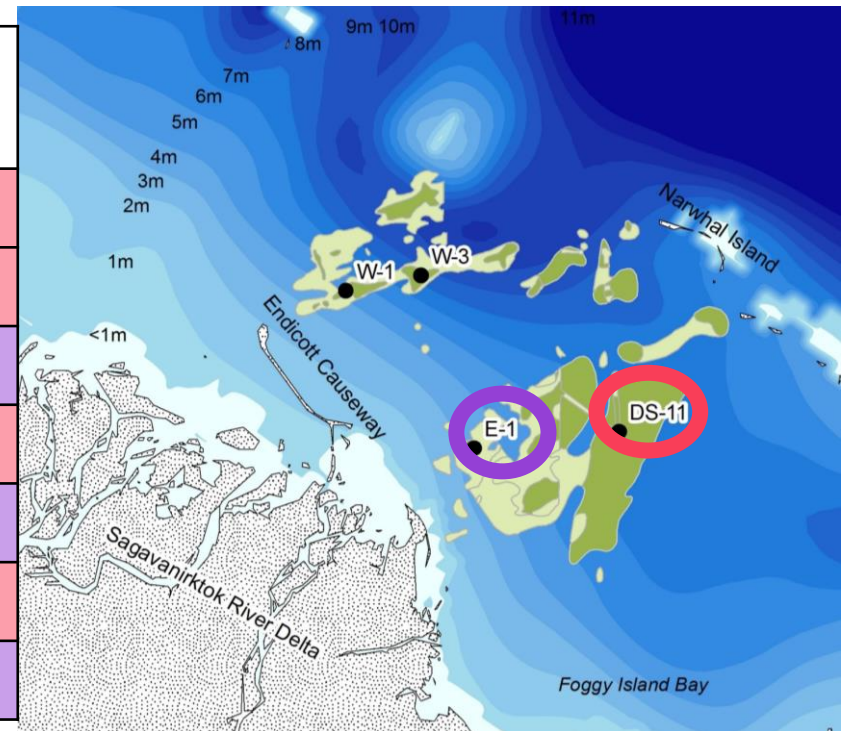
## Suspended Sediments



(Aumack et al. 2007)

Shallow = more turbid → less light in summers

Year	Site	Estimated annual photon flux (mol/m <sup>2</sup> /year)
2013	DS11	109.55
2014	DS11	97.03
	E1	46.63
2015	DS11	183.19
	E1	162.58
2016	DS11	92.06
	E1	70.49



**Understory of CA kelp forest:  
~4000 mol photons/m<sup>2</sup>/year**

(R. J. Miller et al. 2011)

# Conclusions

Freshwater + turbidity gradient

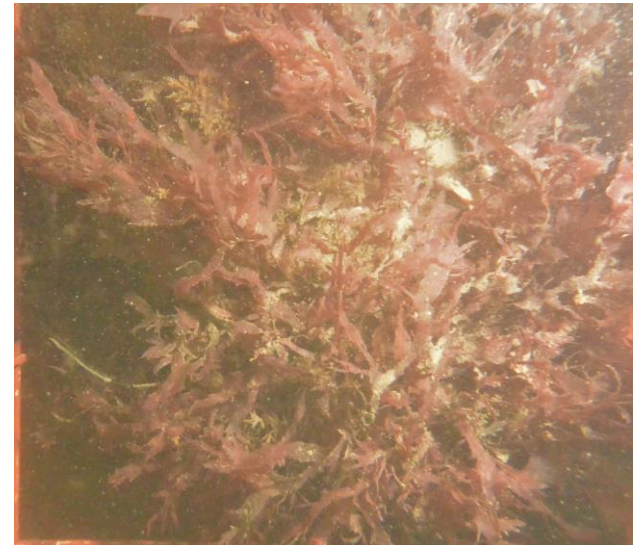
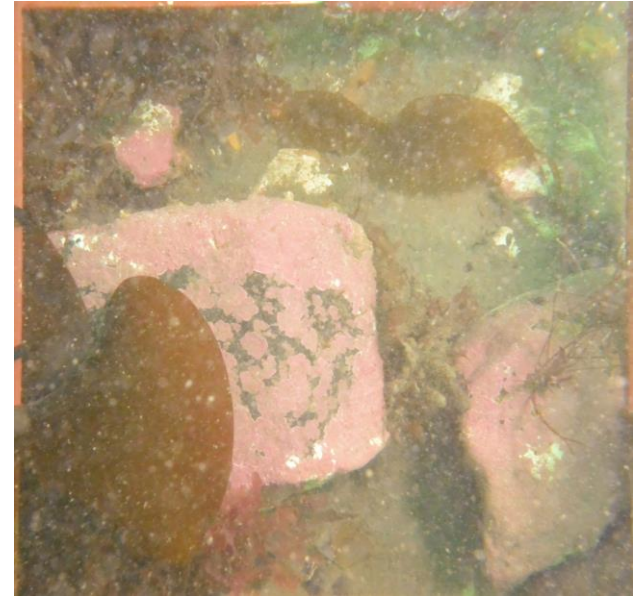
➡ Differences in community structure

Low salinity events and low light inshore

➡ Big decrease in CCA, less kelp, much more red algae

- May influence invertebrates, but need more sampling

Need to capture key seasonal events to understand spatial differences



# Conclusions

Implications of climate change

Longer ice free season

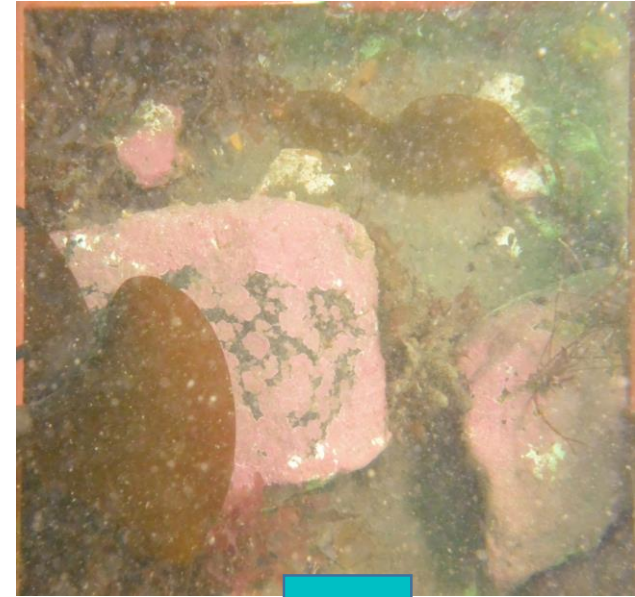
Freshening

Higher turbidity

(Jones et al. 2008, Moore 2012, Morison et al. 2012, Wood et al. 2015)



Changes in community structure



# Acknowledgements

## Field Team

Phil Bucolo

John Dunton

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## Logistical Support

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Lindsay Scheef

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**BOEM**  
BUREAU OF OCEAN ENERGY MANAGEMENT

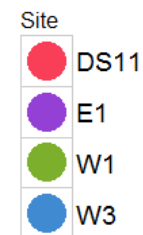
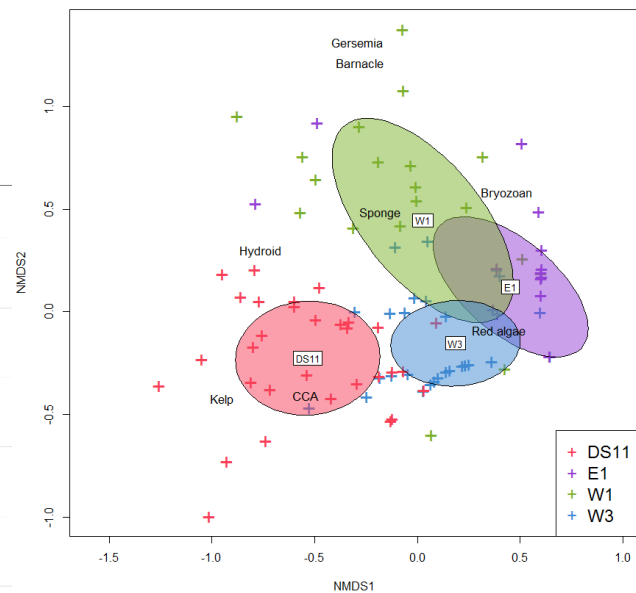
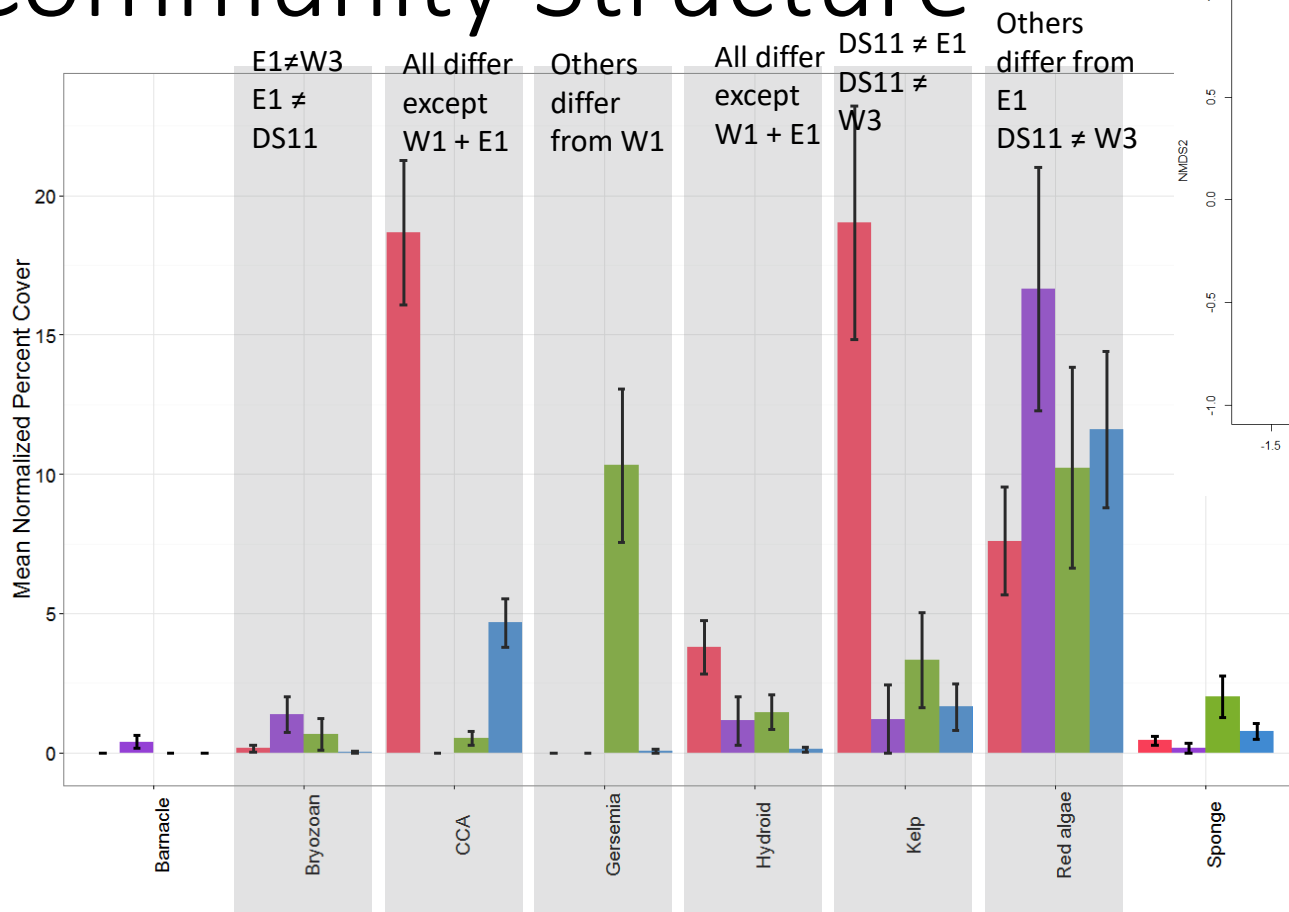


Thank you!

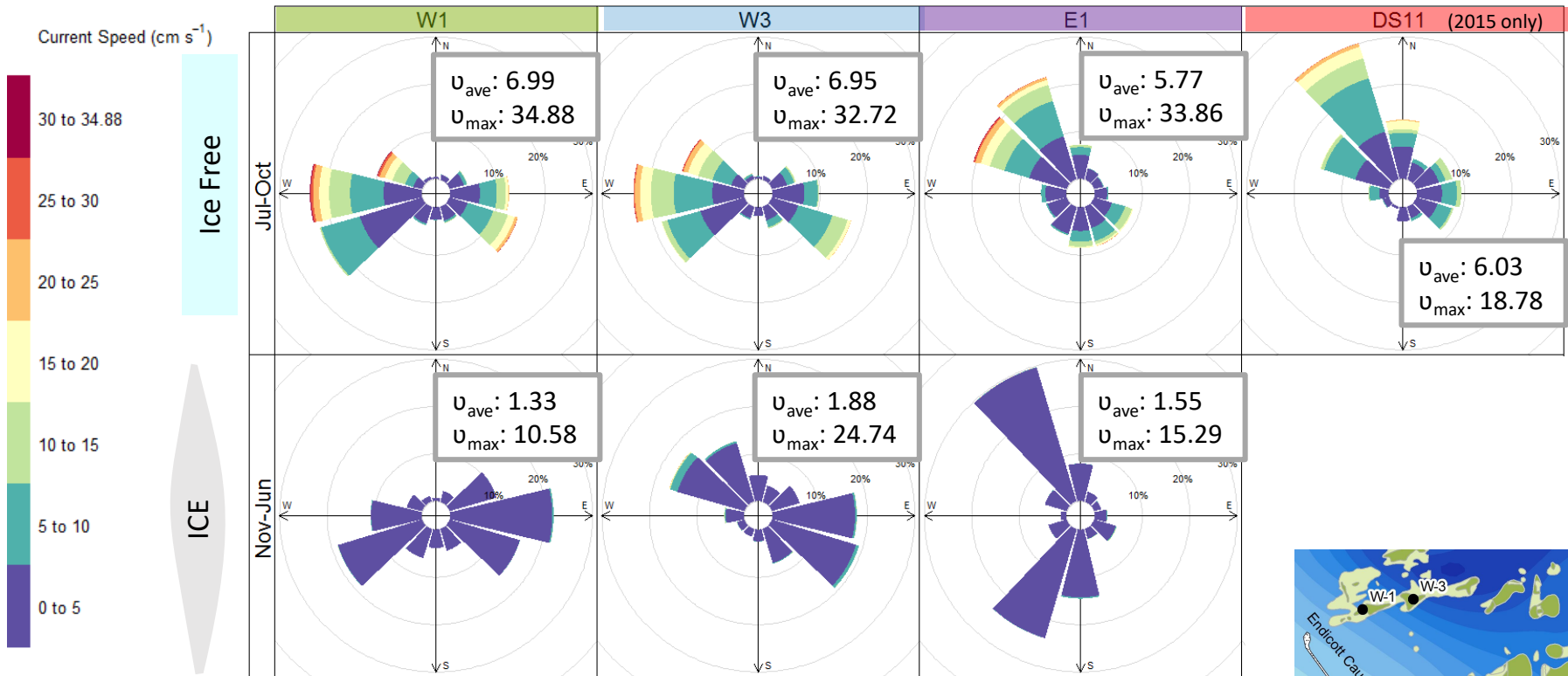
[christinabonsell.wordpress.com](http://christinabonsell.wordpress.com)

Twitter: @c\_bonsell

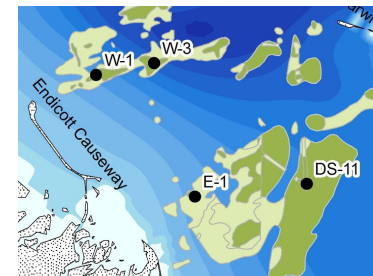
# Community Structure



# Current Direction (cm/sec)

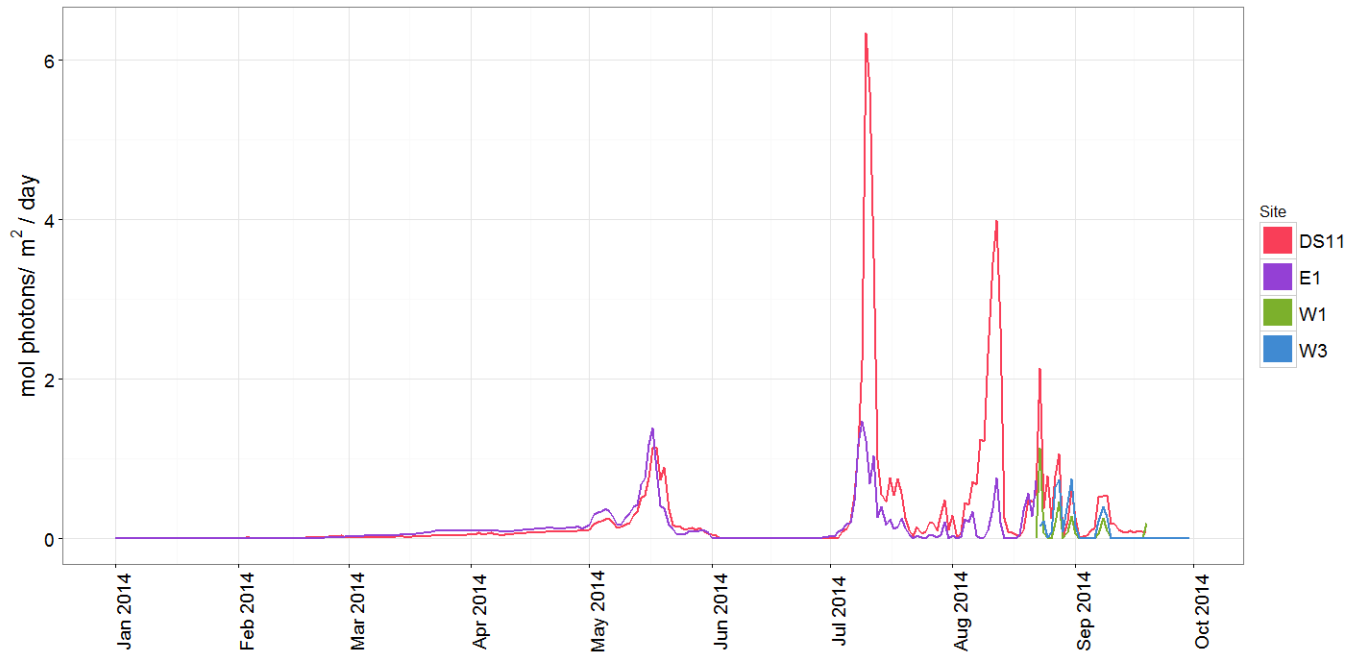


W1/W3 have different current directions than E1/DS11

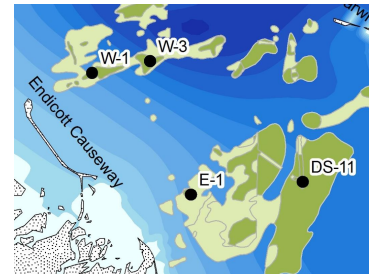
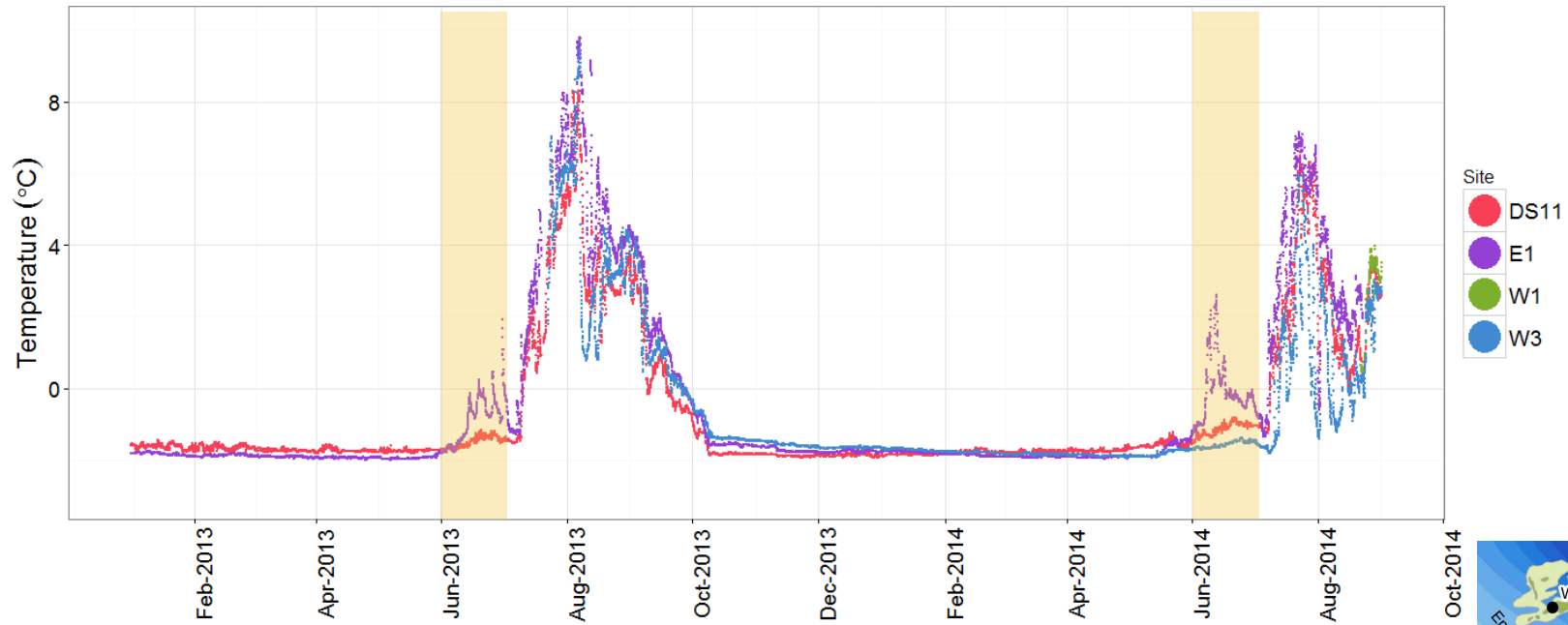




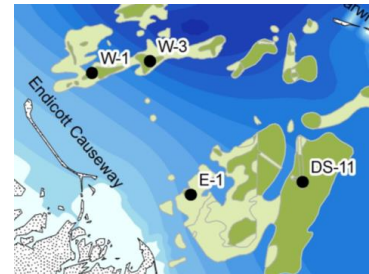
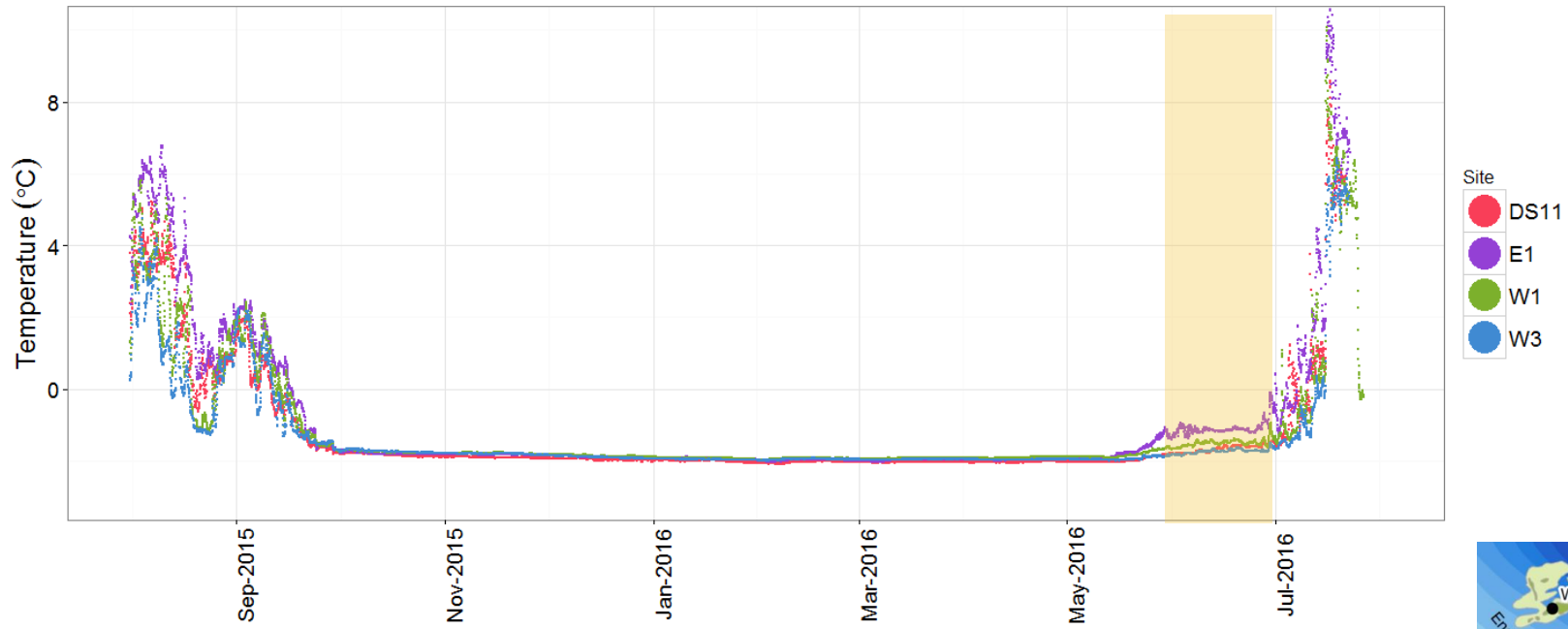
# Clear Ice



# June Temperatures



# June Temperatures



# June Salinities

