# Effect of a Marine Heatwave on Intertidal Kelp Percent Cover at Wizard Islet, BC

Good, Camryn
cammie.good@gmail.com

## Abstract:

Intertidal species are threatened by warming air and ocean temperatures, as they live near their thermal tolerance. In order to determine how intertidal kelp species respond to a marine heatwave, which brings warmer than average temperatures to an area, a long term monitoring dataset from Wizard Islet, British Columbia was examined. The percent cover of *Alaria marginata*, *Hedophyllum sessile*, *Egregia menziesii*, and *Laminaria setchelli* at varying tidal heights were compared before and after the heatwave. There were significant declines in percent cover for all species after the heatwave in 2017 with total kelp cover dropping from 43% to 13.6%. In 2020, the percent cover for all kelp increased to 26.5%, but this trend is not significant. This indicates there is no significant recovery in kelp from 2017 to 2020. There is large variation in species response in 2020 and highlights the importance of examining individual species trends in order to best protect the rich biodiversity of the rocky intertidal.

## Introduction:

As air and sea temperatures continue to rise, intertidal communities remain threatened (Helmuth 2002). Intertidal species are known to live near thermal limits, as their upper limits are often determined by abiotic stressors such as temperature. This makes them particularly at risk to climate change (Harley 2011). Intertidal organisms in the Pacific Northwest are more at risk to warming temperatures at they experience summer mid-day low tides (Harley 2011).

As the climate continues to change, extreme weather events are expected to be more common. From 2013-2016, a marine heatwave was witnessed off the coast of Vancouver Island and brought warmer than average sea surface and air temperatures (Starko et al. 2019). Subtidal and intertidal kelp species around Barkley Sound, British Columbia saw significant decreases in abundances after the heatwave compared previous baseline sampling period (Starko et al. 2019).

Bamfield Marine Science Centre (BMSC) has been collecting long term monitoring data at Wizard Islet, a small islet near Bamfield, British Columbia since 1997. There have been

documented declines in intertidal kelp percent cover after the marine heatwave at Wizard Islet; however, the 2020 sampling data and analysis of individual kelp species has not been examined (Starko et al. 2019). Overall, this project aims to analyze the trends in biodiversity of intertidal kelps to further understand how the changing climate will impact intertidal kelps of Wizard Islet and other intertidal communities near Bamfield, British Columbia. It is predicted that ( i ) the upper limits of kelp species will show declines in percent cover after the heat wave, and ( ii ) there will be higher percent cover in kelp species in 2020 compared to 2017, as some recovery has occurred.

## Methods:

### Wizard Islet Long Term Dataset:

Bamfield Marine Science Centre has been conducting a long term biodiversity monitoring program to document changes in intertidal biodiversity at Wizard Islet, British Columbia. Starting in 1997, student courses collected biodiversity data for intertidal algae and invertebrates (Cowan et. al, 1997). The site was sampled again in 2001, 2002, 2003, 2007, 2009, and 2017 (Anderson et al, 2017). These datasets are freely available online and were combined with the 2020 percent cover data to examine the biodiversity over the entire 23 year collection period.

Transects were run vertically (perpendicular to the shoreline) from 0.5 meters to 3.5 meters above chart datum to capture the full range of intertidal biodiversity. 0.5 m x 0.5 m quadrats were placed every 0.5 meters to collect data at 7 sampling heights. Percent cover of algae and colonial/ sessile invertebrates was measured for a 0.25 meter x 0.25 meter section (marked with orange tape) of each quadrat (Figure 1). The presence/absence of mobile invertebrates was measured using a 0.25 meter x 0.25 meter section of each quadrat.

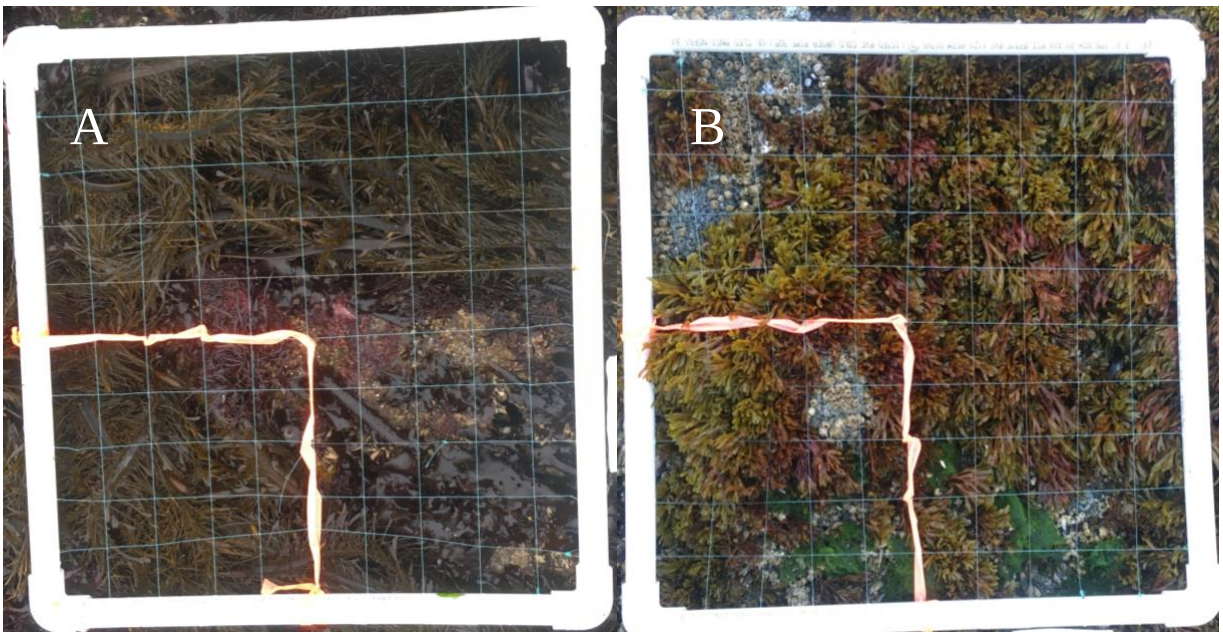


**Figure 1. Example Quadrat Photos from Wizard Islet.** Orange tape represents sampling area. Each square within the orange tape represents 4% cover. **(A)** Example of biodiversity at a1.0 meter tidal height on the exposed shore and **(B)** 3.0 meter tidal height on the sheltered shore.

**2020 Sampling:**

Due to the COVID-19 pandemic, sampling in 2020 was completed by Bamfield Marine Science Centre University Programs personnel using the same methods for transect and quadrat placement as previous years. Photos were taken the of the quadrats, and percent cover for each species was determined by counting the approximate number of squares in which the species was found. The number of squares counted was multiplied by 4 to determine percent cover out of 100%. (Figure 1). Percent cover was calculated for kelp species present at Wizard Islet (Table 1). These photos are the property of Bamfield Marine Science Centre and are being used with the expressed consent of BMSC for the purposes of this project only.

**Table 1**. **Species List for 2020 Percent Cover Analysis**

| **Higher Classification** | **Species Sampled** |
|---|---|
| Laminariales (Kelps –Order within Phaeophyceae) | *Alaria marginata* |
| | *Egregia menziesii* |
| | *Hedophyllum sessile* |
| | *Laminaria setchelli* |

**Data Analysis:**

The mean percent cover and standard error were calculated for each species at each tidal height, exposure, and year. *Hedophyllum sessile* was only present in random years in low abundance, and thus, was only included in the total kelp analysis. At Wizard Islet, kelps are only found in the low intertidal on the exposed shore, so exposed shore data from 0.5 meter to 1.5 meter tidal height was used in analysis. The overall mean percent cover for all years before the 2013-2016 heat wave (1997, 2001, 2002, 2003, 2007, and 2009) was calculated for each species at each tidal height and exposure.

The data was positively skewed and was not normalized even after transformations. As a result, Kruskal-Wallis rank sum test was used to compare the over mean percent cover from before the heat wave to the 2017 sampling year, and the 2020 sampling year. A Dunn's pairwise test with correction was performed following Kruskal-Wallis to determine which sampling periods had significantly different mean percent cover. For kelps, these comparisons were made for each species at each tidal height (0.5 m , 1.0 m, and 1.5 m) and for all tidal heights combined.

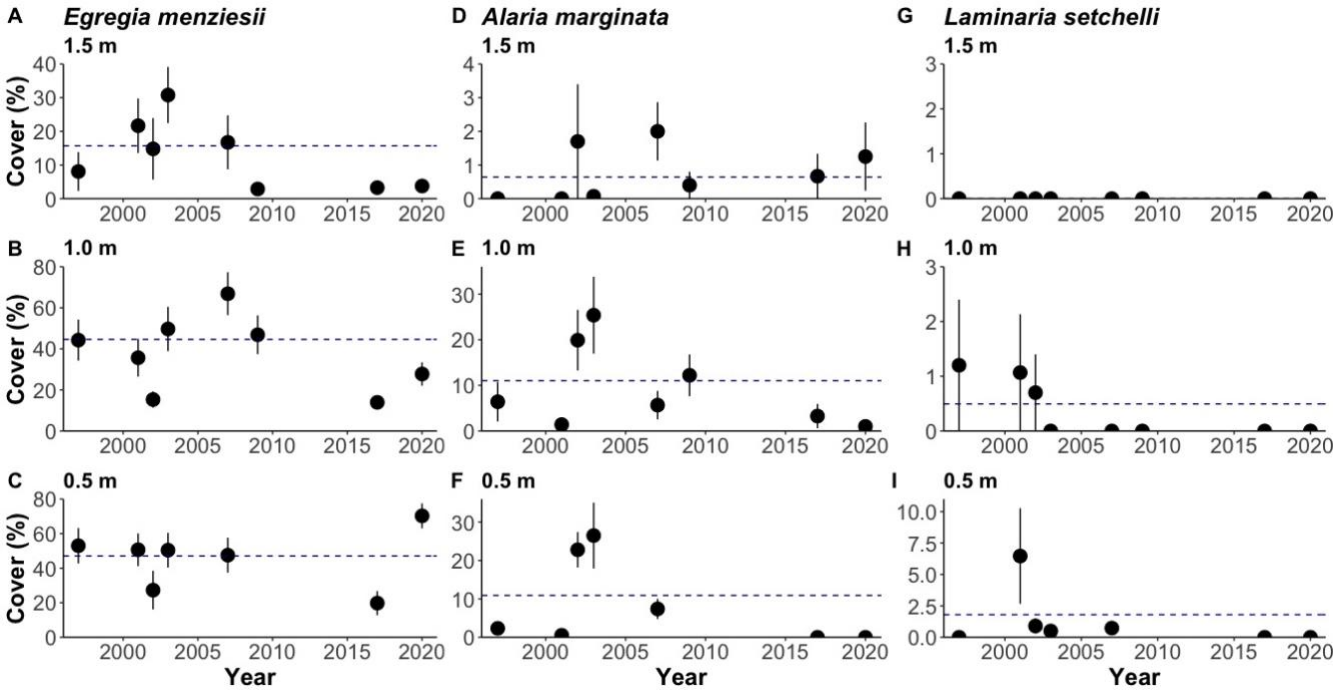


**Figure 2. Average Percent Cover of Kelp Species from 1997 to 2020 at Wizard Islet, BC**. Percent cover (mean ± SE) of *Egregia menziesii* **(A, B, C)**, *Alaria marginata* **(D, E, F)**, and *Laminaria setchelli* **(G, H, I)**, was determined at 0.5 meters **(C, F, I)**, 1.0 meters **(B, E, H)**, and 1.5 meters **(A, D, G)** above chart datum on a relatively exposed shore. The navy dashed lines indicate the mean percent cover of all sampling years prior to the 2013 -2016 heat wave (1997, 2001, 2002, 2003, 2007, and 2009).

## Results:

*Alaria marginata*:

Overall, the average percent cover of *A. marginata* across all 3 tidal heights significantly decreased following the 2013-2016 heatwave, dropping from 7.3% to 1.3% and 0.9% in 2017 and 2020, respectively (Figure 2D, 2E, 2F; $p<0.05$ for both comparisons). There appeared to be an increase in percent cover in 2020 at the 1.5 meter tidal height, but this trend was not significant (Figure 2D). The *A. marginata* present at 1.5 meters during the 2020 sampling appeared to be tattered and not in the best condition (personal observation).

*Egregia menziesii:*

The percent cover of *E. menziesii* significantly decreased from before the heatwave to 2017 (35% to 12%; $p<0.05$; Figure 2A, 2B, 2C). There appears to recovery in 2020 with the percent increasing from 2017 to 25.5%; however, there is not a significant difference between the 2020 and 2017 sampling period, or the before and 2020 sampling period ($p>0.05$ in both comparisons). The large increase appears to mostly come from the 0.5 meter height where there is a significant increase in *E. menziesii* cover compared to 2017 (Figure 2C; $p<0.05$).

*Laminaria setchelli*

There was no *L. setchelli* found in the 2020 sampling period. There are no significant differences found for any comparison at any tidal height (Figure 2G, 2H, 2I; $p>0.05$). *L. setchelli*, when found, was found in low abundances and has not been seen since prior to the heatwave.

All Kelp:

Total kelp cover for all 4 species examined significantly decreased from before the heatwave to 2017 and to the present (2020). The percent cover decreased from 43% to 13.6%, and 26.5% in 2017 and 2020, respectively (Figure 3D; $p<0.05$ for both comparisons). There was no significant difference between the 2017 and 2020 percent cover ($p>0.05$). When examining individual tidal heights, there was no significant difference between before the heatwave and 2020 sampling at 0.5 meter tidal height suggesting some recovery has occurred (Figure 3C).

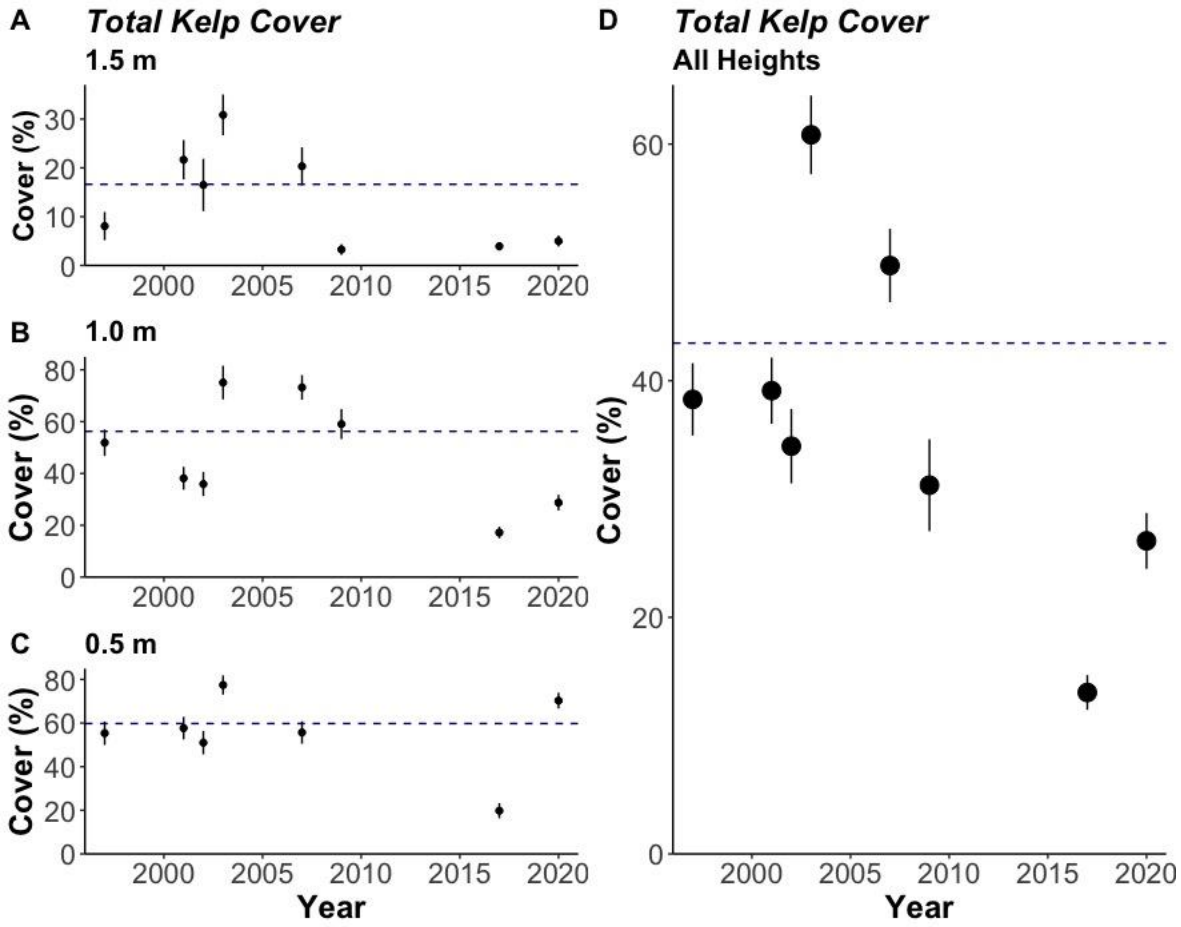


**Figure 3. Overall Trend in kelp cover at Wizard Islet, BC from 1997 to 2020.** Average percent cover (mean ± SE) of *Egregia menziesii*, *Alaria marginata*, *Laminaria setchelli*, and *Hedophyllum sessile* at **(A)** 1.5 meter, **(B)** 1.0 meter, and **(C)** 0.5 meter tidal heights. **(D)** Mean of the above- mentioned species across all heights (0.5, 1.0, & 1.5 m). The navy dashed lines indicate the mean percent cover of all sampling years prior to the 2013 -2016 heat wave (1997, 2001, 2002, 2003, 2007, and 2009).

## Discussion:

(i) Total kelp cover at Wizard Islet significantly declined following the heatwave and has not significantly recovered in 2020. ( ii) When examining each tidal height, higher tidal heights show less recovery suggesting that the harsher abiotic stresses are causing a decrease in kelp cover at their upper limits (Harley 2011; Starko et al. 2019).

When examining any one species and a single tidal height, overall patterns were difficult to discern and seem to be species specific. For example, *E. menziesii* appears to have recovered to the pre-heatwave condition at 0.5 meters, but not at 1.0 or 1.5 meters. This could be due to the increased heat stress at its upper limit making it more difficult for *E. menziesii* to recover after the 2013-2016 heat wave (Harley 2011).

In the case of *Alaria marginata*, however, there was continued decline in 2020 at both 0.5 and 1.0 meters indicating that kelp recovery may require more time or not be possible in the warming conditions at Wizard Islet. At 1.5m, however, there appeared to be a slightly increase in percent cover compared to previous years. This pattern could be due to some kind of sampling chance. In total, a very small amount of *A. marginata* was found during the 2020 sampling, and it seems unlikely it would be able to recover at 1.5m tidal height.

*Laminaria setchelli* showed declines in the early 2000s and has not been seen intertidally at Wizard Islet since 2007, prior to the heatwave, suggesting that a different stressor was responsible. *Laminaria setchelli* was originally found lower in the intertidal, so it is possible the warming air temperatures caused the upper limits of *L. setchelli* to retreat down the shore until there was no room left (Harley 2011).

The lack of kelp recovery in 2020 as a whole could be due to continued warming conditions even after the heatwave diminished. Some of the patterns of percent cover show some complementarity between Egregia and Alaria. At 1.5 meter height, when *Egregia* appeared to have a decreased in cover, Alaria appeared to have an increase. The opposite was true at 0.5 and

1.0 meter tidal heights, *Egregia* appeared to increase and Alaria remained in low abundance. An alternate explanation is interspecific competition between the species where they partition space to continue to coexist in the same intertidal region.

Moving forward it is important to consider how individual kelp species will respond to air and sea surface heat stressors, as the patterns may not be as straightforward. One must know how a particular kelp species will response to stressors in order to effectively protect it against climate change. It is especially important to monitor heat stress of kelps in the Pacific Northwest, as they are expected to face harsher conditions than location in Southern California (Helmuth 2002). There is still much to know about how other groups of intertidal seaweeds will response to climate change, and if their patterns are similar to kelp, each species could have a specific response. This indicates species should be monitored individually to ensure the most accurate pattern is being recorded.

## Conclusion:

While there is some variability between species, the overall trend shows a significant decrease in kelp cover at Wizard Islet following a marine heatwave with higher tidal height less likely to shown recovery. Species specific metrics must be taken into consideration in order to effectively monitor and protect the biodiversity of intertidal zones.

## Acknowledgements:

Thank you to Bamfield Marine Science Centre for permitting the use of the 2020 Wizard Islet photo quadrats in this project. Thank you to UBC Faculty of Science for providing the opportunity to take BIOL 342: Integrative Biology Laboratory. Thank you to the BIOL 342 teaching team for putting together such an engaging and informative online course. The

opportunity to develop scientific writing skills is so valuable, and I am so thankful to be able to live and learn on the traditional, ancestral, unceded territory of the xʷməθkʷəy̓əm (Musqueam) First Nation.

## References:


Anderson, Lauren, Sidney-Rae Flumerfelt, Gemma Macfarlane, and Taesagh Mckay. 2017. Long-term monitoring in Barkley Sound: A temporal analysis of intertidal biodiversity on Wizard Islet, British Columbia from 1997 to 2017. Coastal Biodiversity and Conservation Student Report, no. 444. Bamfield, BC: Bamfield Marine Sciences Centre.

Cowan, Janet E., Karen Leonard, Kathryn Oliver, Dora Repard, Judith Shapiro, and Shana Shubs. 1997. Barkley Sound intertidal long-term monitoring: rocky substrate methodology.

Harley CDG. Climate change, keystone predation, and biodiversity loss. Science. 2011; 334: 1124– 1127.

Harrington, Angela, Sabrina Kratchner, Leah Meth, and Josh Silberg. 2009. Long term monitoring of the rocky intertidal on Wizard Island in Barkley Sound. Coastal Biodiversity and Conservation Student Report, no. 330. Bamfield, BC: Bamfield Marine Sciences Centre.

Helmuth B, Harley CDG, Halpin PM, O'Donnell M, Hofmann GE, Blanchette CA. Climate change and latitudinal patterns of intertidal thermal stress. Science. 2002; 298: 1015–1017.

R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

Starko, S., Bailey, L. A., Creviston, E., James, K. A., Warren, A., Brophy, M. K., ... & Neufeld, C. J. (2019). Environmental heterogeneity mediates scale-dependent declines in kelp diversity on intertidal rocky shores. *Plos one*, *14*(3), e0213191.


## Appendix:

**Appendix Table 1. Results of Kruskal-Wallis and Dunn Tests.** All heights is the comparison when looking at all 0.5, 1.0, and 1.5 meter tidal heights (except for *Laminaria setchelli* where it is only 0.5 and 1.0 meter heights). Bolded values indicate statistical significance. Benjamini-Hochberg method used to adjust p-values for multiple comparisons. For comparisons, 2017 – 2020 indicates the mean values from 2017 and 2020 were compared, etc. Before represents the sampling period before the heat wave; years include: 1997, 2001, 2002, 2003, 2007, and 2009.

| Species | Tidal Height | Comparison | Adjusted P Value |
|---|---|---|---|
| *Alaria marginata* | 0.5 | 2017 – 2020 | 1.000 |
| | | Before – 2017 | **0.003** |
| | | Before – 2020 | **0.027** |
| | 1.0 | 2017 – 2020 | 0.509 |
| | | Before – 2017 | 0.135 |
| | | Before – 2020 | **0.027** |
| | 1.5 | 2017 – 2020 | 1.000 |
| | | Before – 2017 | 0.764 |
| | | Before – 2020 | 1.000 |
| | All Heights | 2017 – 2020 | 0.906 |
| | | Before – 2017 | **0.004** |
| | | Before – 2020 | **0.002** |
| *Egregia menziesii* | 0.5 | 2017 – 2020 | **0.021** |
| | | Before – 2017 | **0.038** |
| | | Before – 2020 | 0.133 |
| | 1.0 | 2017 – 2020 | 0.278 |
| | | Before – 2017 | **0.011** |
| | | Before – 2020 | 0.212 |
| | 1.5 | 2017 – 2020 | 0.679 |
| | | Before – 2017 | 0.480 |
| | | Before – 2020 | 0.352 |
| | All Heights | 2017 – 2020 | 0.185 |
| | | Before – 2017 | **0.004** |
| | | Before – 2020 | 0.270 |
| *Laminaria setchelli* | 0.5 | 2017 – 2020 | 1.000 |
| | | Before – 2017 | 0.383 |
| | | Before – 2020 | 0.411 |
| | 1.0 | 2017 – 2020 | 1.000 |
| | | Before – 2017 | 0.635 |
| | | Before – 2020 | 1.000 |
| | 1.5 | 2017 – 2020 | NA |
| | | Before – 2017 | NA |
| | | Before – 2020 | NA |
| | All Heights | 2017 – 2020 | 1.000 |
| | | Before – 2017 | 0.280 |
| | | Before – 2020 | 0.201 |
| All Kelp | 0.5 | 2017 – 2020 | **0.010** |
| | | Before – 2017 | **0.001** |
| | | Before – 2020 | 0.537 |
| | 1.0 | 2017 – 2020 | 0.281 |
| | | Before – 2017 | **0.001** |
| | | Before – 2020 | **0.035** |
| | 1.5 | 2017 – 2020 | 0.733 |
| | | Before – 2017 | 0.600 |
| | | Before – 2020 | 0.566 |
| | All Heights | 2017 – 2020 | 0.181 |
| | | Before – 2017 | **0.0001** |
| | | Before – 2020 | **0.046** |

**Appendix Table 2. Wizard Islet Percent Cover Data from 2020.** Data for previous years can be found at in online database (Harrington 2009, Anderson 2017).

| Exposure | Transect number | Tidal Height | *Alaria marginata* | *Egregia menziesii* | *Hedophyllum sessile* | *Laminaria setchelli* |
|---|---|---|---|---|---|---|
| Exposed | 1 | 1 | 16 | 48 | 0 | 0 |
| Exposed | 1 | 1.5 | 4 | 28 | 0 | 0 |
| Exposed | 1 | 2 | 0 | 0 | 0 | 0 |
| Exposed | 1 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 1 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 1 | 3.5 | 0 | 0 | 0 | 0 |
| Exposed | 2 | 0.5 | 0 | 52 | 0 | 0 |
| Exposed | 2 | 1 | 0 | 20 | 0 | 0 |
| Exposed | 2 | 1.5 | 0 | 0 | 0 | 0 |
| Exposed | 2 | 2 | 0 | 0 | 0 | 0 |
| Exposed | 2 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 2 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 2 | 3.5 | 0 | 0 | 0 | 0 |
| Exposed | 4 | 1 | 0 | 20 | 0 | 0 |
| Exposed | 4 | 1.5 | 0 | 0 | 0 | 0 |
| Exposed | 4 | 2 | 0 | 0 | 0 | 0 |
| Exposed | 4 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 4 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 4 | 3.5 | 0 | 0 | 0 | 0 |
| Exposed | 6 | 0.5 | 0 | 40 | 0 | 0 |
| Exposed | 6 | 1 | 0 | 56 | 0 | 0 |
| Exposed | 6 | 1.5 | 0 | 0 | 0 | 0 |
| Exposed | 6 | 2 | 0 | 0 | 0 | 0 |
| Exposed | 6 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 6 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 6 | 3.5 | 0 | 0 | 0 | 0 |
| Exposed | 7 | 0.5 | 0 | 64 | 0 | 0 |
| Exposed | 7 | 1 | 0 | 4 | 0 | 0 |
| Exposed | 7 | 1.5 | 0 | 0 | 0 | 0 |
| Exposed | 7 | 2 | 0 | 0 | 0 | 0 |
| Exposed | 7 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 7 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 7 | 3.5 | 0 | 0 | 0 | 0 |
| Exposed | 9 | 1 | 0 | 8 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Exposed | 9 | 1.5 | 0 | 8 | 0 | 0 |
| Exposed | 9 | 2 | 0 | 0 | 0 | 0 |
| Exposed | 9 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 9 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 9 | 3.5 | 0 | 0 | 0 | 0 |
| Exposed | 11 | 1 | 0 | 36 | 0 | 0 |
| Exposed | 11 | 1.5 | 0 | 0 | 0 | 0 |
| Exposed | 11 | 2 | 0 | 0 | 0 | 0 |
| Exposed | 11 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 11 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 11 | 3.5 | 0 | 0 | 0 | 0 |
| Exposed | 13 | 1 | 0 | 52 | 0 | 0 |
| Exposed | 13 | 1.5 | 0 | 0 | 0 | 0 |
| Exposed | 13 | 2 | 0 | 0 | 0 | 0 |
| Exposed | 13 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 13 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 13 | 3.5 | 0 | 0 | 0 | 0 |
| Exposed | 16 | 1 | 0 | 4 | 0 | 0 |
| Exposed | 16 | 1.5 | 0 | 0 | 0 | 0 |
| Exposed | 16 | 2 | 0 | 0 | 0 | 0 |
| Exposed | 16 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 16 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 16 | 3.5 | 0 | 0 | 0 | 0 |
| Exposed | 21 | 1 | 0 | 8 | 0 | 0 |
| Exposed | 21 | 1.5 | 0 | 0 | 0 | 0 |
| Exposed | 21 | 2 | 0 | 0 | 0 | 0 |
| Exposed | 21 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 21 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 21 | 3.5 | 0 | 0 | 0 | 0 |
| Exposed | 26 | 1 | 0 | 32 | 0 | 0 |
| Exposed | 26 | 1.5 | 0 | 12 | 0 | 0 |
| Exposed | 26 | 2 | 0 | 0 | 0 | 0 |
| Exposed | 26 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 26 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 26 | 3.5 | 0 | 0 | 0 | 0 |
| Exposed | 32 | 0.5 | 0 | 80 | 0 | 0 |
| Exposed | 32 | 1 | 0 | 60 | 0 | 0 |
| Exposed | 32 | 1.5 | 0 | 0 | 0 | 0 |
| Exposed | 32 | 2 | 0 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Exposed | 32 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 32 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 32 | 3.5 | 0 | 0 | 0 | 0 |
| Exposed | 34 | 0.5 | 0 | 76 | 0 | 0 |
| Exposed | 34 | 1 | 0 | 32 | 0 | 0 |
| Exposed | 34 | 1.5 | 0 | 12 | 0 | 0 |
| Exposed | 34 | 2 | 0 | 0 | 0 | 0 |
| Exposed | 34 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 34 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 34 | 3.5 | 0 | 0 | 0 | 0 |
| Exposed | 37 | 0.5 | 0 | 88 | 0 | 0 |
| Exposed | 37 | 1 | 0 | 0 | 0 | 0 |
| Exposed | 37 | 1.5 | 0 | 0 | 0 | 0 |
| Exposed | 37 | 2 | 0 | 0 | 0 | 0 |
| Exposed | 37 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 37 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 37 | 3.5 | 0 | 0 | 0 | 0 |
| Exposed | 47 | 1 | 0 | 64 | 0 | 0 |
| Exposed | 47 | 1.5 | 16 | 0 | 0 | 0 |
| Exposed | 47 | 2 | 0 | 0 | 0 | 0 |
| Exposed | 47 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 47 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 47 | 3.5 | 0 | 0 | 0 | 0 |
| Exposed | 49 | 0.5 | 0 | 92 | 0 | 0 |
| Exposed | 49 | 1 | 0 | 0 | 0 | 0 |
| Exposed | 49 | 1.5 | 0 | 0 | 0 | 0 |
| Exposed | 49 | 2 | 0 | 0 | 0 | 0 |
| Exposed | 49 | 2.5 | 0 | 0 | 0 | 0 |
| Exposed | 49 | 3 | 0 | 0 | 0 | 0 |
| Exposed | 49 | 3.5 | 0 | 0 | 0 | 0 |
| Sheltered | 4 | 0.5 | 0 | 0 | 0 | 0 |
| Sheltered | 4 | 1 | 0 | 0 | 0 | 0 |
| Sheltered | 4 | 1.5 | 0 | 0 | 0 | 0 |
| Sheltered | 4 | 2 | 0 | 0 | 0 | 0 |
| Sheltered | 4 | 2.5 | 0 | 0 | 0 | 0 |
| Sheltered | 4 | 3 | 0 | 0 | 0 | 0 |
| Sheltered | 4 | 3.5 | 0 | 0 | 0 | 0 |
| Sheltered | 7 | 0.5 | 0 | 0 | 0 | 0 |
| Sheltered | 7 | 1 | 0 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Sheltered | 7 | 1.5 | 0 | 0 | 0 | 0 |
| Sheltered | 7 | 2 | 0 | 0 | 0 | 0 |
| Sheltered | 7 | 2.5 | 0 | 0 | 0 | 0 |
| Sheltered | 7 | 3 | 0 | 0 | 0 | 0 |
| Sheltered | 7 | 3.5 | 0 | 0 | 0 | 0 |
| Sheltered | 11 | 1 | 0 | 0 | 0 | 0 |
| Sheltered | 11 | 1.5 | 0 | 0 | 0 | 0 |
| Sheltered | 11 | 2 | 0 | 0 | 0 | 0 |
| Sheltered | 11 | 2.5 | 0 | 0 | 0 | 0 |
| Sheltered | 11 | 3 | 0 | 0 | 0 | 0 |
| Sheltered | 11 | 3.5 | 0 | 0 | 0 | 0 |
| Sheltered | 13 | 1 | 0 | 0 | 0 | 0 |
| Sheltered | 13 | 1.5 | 0 | 0 | 0 | 0 |
| Sheltered | 13 | 2 | 0 | 0 | 0 | 0 |
| Sheltered | 13 | 2.5 | 0 | 0 | 0 | 0 |
| Sheltered | 13 | 3 | 0 | 0 | 0 | 0 |
| Sheltered | 13 | 3.5 | 0 | 0 | 0 | 0 |
| Sheltered | 18 | 1 | 0 | 0 | 0 | 0 |
| Sheltered | 18 | 1.5 | 0 | 0 | 0 | 0 |
| Sheltered | 18 | 2 | 0 | 0 | 0 | 0 |
| Sheltered | 18 | 2.5 | 0 | 0 | 0 | 0 |
| Sheltered | 18 | 3 | 0 | 0 | 0 | 0 |
| Sheltered | 18 | 3.5 | 0 | 0 | 0 | 0 |
| Sheltered | 26 | 1 | 0 | 0 | 0 | 0 |
| Sheltered | 26 | 1.5 | 0 | 0 | 0 | 0 |
| Sheltered | 26 | 2 | 0 | 0 | 0 | 0 |
| Sheltered | 26 | 2.5 | 0 | 0 | 0 | 0 |
| Sheltered | 26 | 3 | 0 | 0 | 0 | 0 |
| Sheltered | 26 | 3.5 | 0 | 0 | 0 | 0 |
| Sheltered | 29 | 1 | 0 | 0 | 0 | 0 |
| Sheltered | 29 | 1.5 | 0 | 0 | 0 | 0 |
| Sheltered | 29 | 2 | 0 | 0 | 0 | 0 |
| Sheltered | 29 | 2.5 | 0 | 0 | 0 | 0 |
| Sheltered | 29 | 3 | 0 | 0 | 0 | 0 |
| Sheltered | 29 | 3.5 | 0 | 0 | 0 | 0 |
| Sheltered | 31 | 0.5 | 0 | 0 | 0 | 0 |
| Sheltered | 31 | 1 | 0 | 0 | 0 | 0 |
| Sheltered | 31 | 1.5 | 0 | 0 | 0 | 0 |
| Sheltered | 31 | 2 | 0 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Sheltered | 31 | 2.5 | 0 | 0 | 0 | 0 |
| Sheltered | 31 | 3 | 0 | 0 | 0 | 0 |
| Sheltered | 31 | 3.5 | 0 | 0 | 0 | 0 |
| Sheltered | 32 | 0.5 | 0 | 0 | 0 | 0 |
| Sheltered | 32 | 1 | 0 | 0 | 0 | 0 |
| Sheltered | 32 | 1.5 | 0 | 0 | 0 | 0 |
| Sheltered | 32 | 2 | 0 | 0 | 0 | 0 |
| Sheltered | 32 | 2.5 | 0 | 0 | 0 | 0 |
| Sheltered | 32 | 3 | 0 | 0 | 0 | 0 |
| Sheltered | 32 | 3.5 | 0 | 0 | 0 | 0 |
| Sheltered | 36 | 0.5 | 0 | 0 | 0 | 0 |
| Sheltered | 36 | 1 | 0 | 0 | 0 | 0 |
| Sheltered | 36 | 1.5 | 0 | 0 | 0 | 0 |
| Sheltered | 36 | 2 | 0 | 0 | 0 | 0 |
| Sheltered | 36 | 2.5 | 0 | 0 | 0 | 0 |
| Sheltered | 36 | 3 | 0 | 0 | 0 | 0 |
| Sheltered | 36 | 3.5 | 0 | 0 | 0 | 0 |
| Sheltered | 39 | 0.5 | 0 | 0 | 0 | 0 |
| Sheltered | 39 | 1 | 0 | 0 | 0 | 0 |
| Sheltered | 39 | 1.5 | 0 | 0 | 0 | 0 |
| Sheltered | 39 | 2 | 0 | 0 | 0 | 0 |
| Sheltered | 39 | 2.5 | 0 | 0 | 0 | 0 |
| Sheltered | 39 | 3 | 0 | 0 | 0 | 0 |
| Sheltered | 39 | 3.5 | 0 | 0 | 0 | 0 |
| Sheltered | 41 | 0.5 | 0 | 0 | 0 | 0 |
| Sheltered | 41 | 1 | 0 | 0 | 0 | 0 |
| Sheltered | 41 | 1.5 | 0 | 0 | 0 | 0 |
| Sheltered | 41 | 2 | 0 | 0 | 0 | 0 |
| Sheltered | 41 | 2.5 | 0 | 0 | 0 | 0 |
| Sheltered | 41 | 3 | 0 | 0 | 0 | 0 |
| Sheltered | 41 | 3.5 | 0 | 0 | 0 | 0 |
| Sheltered | 43 | 0.5 | 0 | 0 | 0 | 0 |
| Sheltered | 43 | 1 | 0 | 0 | 0 | 0 |
| Sheltered | 43 | 1.5 | 0 | 0 | 0 | 0 |
| Sheltered | 43 | 2 | 0 | 0 | 0 | 0 |
| Sheltered | 43 | 2.5 | 0 | 0 | 0 | 0 |
| Sheltered | 43 | 3 | 0 | 0 | 0 | 0 |
| Sheltered | 43 | 3.5 | 0 | 0 | 0 | 0 |
| Sheltered | 44 | 0.5 | 0 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Sheltered | 44 | 1 | 0 | 0 | 0 | 0 |
| Sheltered | 44 | 1.5 | 0 | 0 | 0 | 0 |
| Sheltered | 44 | 2 | 0 | 0 | 0 | 0 |
| Sheltered | 44 | 2.5 | 0 | 0 | 0 | 0 |
| Sheltered | 44 | 3 | 0 | 0 | 0 | 0 |
| Sheltered | 44 | 3.5 | 0 | 0 | 0 | 0 |
| Sheltered | 46 | 0.5 | 0 | 0 | 0 | 0 |
| Sheltered | 46 | 1 | 0 | 0 | 0 | 0 |
| Sheltered | 46 | 1.5 | 0 | 0 | 0 | 0 |
| Sheltered | 46 | 2 | 0 | 0 | 0 | 0 |
| Sheltered | 46 | 2.5 | 0 | 0 | 0 | 0 |
| Sheltered | 46 | 3 | 0 | 0 | 0 | 0 |
| Sheltered | 46 | 3.5 | 0 | 0 | 0 | 0 |
| | | | | | | |