Marine Isopod (*Pentidotea*) Feeding Preferences for Healthy and Wasting Eelgrass (*Zostera marina*)

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Abstract

Despite increasing concerns over infectious wasting diseases among marine macroalga and plants, little is known about preferential herbivory patterns in indicator marine invertebrates like *Pentidotea* isopods in the face of reduced healthy eelgrass thalli. This study tested whether two marine isopod species, *Pentidotea wosnesenskii* and *Pentidotea montereyensis*, prefer to consume healthy vs. wasted eelgrass blades. Individuals from each species were experimentally subjected to feeding trials comparing their consumption of healthy vs. wasted blades. Photographic analysis of blade surface areas pre- and post-feeding were used to quantify the amount consumed by each isopod. When given an option between healthy and wasted blades, both *P. wosnesenskii* and *P. montereyensis* consumed significantly more healthy eelgrass surface area than wasted eelgrass ($t = -2.69$, $p = 0.01$; $t = -2.69$, $p = 0.001$ respectively). These findings support the hypothesis that healthy eelgrass blades are a crucial and preferred food source for marine herbivores over wasted blades, as seen in species within the *Pentidotea* genus. This pattern of preferential feeding has important disease dynamics and competition implications as Eelgrass Wasting continues to infect new blades in the San Juan Island region.

Introduction/Background

Eelgrass

Eelgrass (*Zostera marina*) is a key species in the coastal and estuarine marine ecosystems of the Pacific Northwest. It is a food source and refuge habitat for a wide variety of organisms and is especially important for juvenile fishes such as salmonids and clupeids, which both hold significant ecological and economic value in this region (Fonseca et al. 1982, Chalifour et al. 2019, Fernandez et al. 1993).

Herbivory and Preferential Feeding

The herbivores that feed on *Z. marina* are poorly studied, despite being a crucial link between primary producers and tertiary consumers in marine food webs. Marine isopods and amphipods are especially important indicator species, as recent studies reveal their unique feeding habits in the face of growing concerns over eelgrass wasting disease (hereafter as "EWD").

One study found that the rockweed isopod (*Pentidotea wosnesenskii*) is a common herbivore of *Z. marina* and is known to prefer grazing on healthy eelgrass over wasted eelgrass, while the eelgrass isopod (*Pentidotea resecata*), preferentially selects for wasted eelgrass. Given that eelgrass isopods and rockweed isopods come from the same genus, this suggests that generalizations about preference cannot be made about closely related species, and that additional tests should be conducted to draw sound conclusions about species-specific grazing preferences.

Dwindling Eelgrass

Considering the general decline of eelgrass densities from habitat loss due to urban development, increasing ocean temperature, altered ocean chemistry, and disease, it is crucial to study how various herbivores cope with these stressors when healthy eelgrass is limited (Magel et al. 2022, Short and Wyllie-Echeverria 2009, Groner et al. 2016). Eelgrass habitat in San Juan Island, WA, has seen a significant decrease in density, alongside regional declines in density (45% loss) and complexity (66%) in islands from the nearby province of British Columbia, Canada (Nahirnick et al. 2020.

Eelgrass Wasting Disease

Eelgrass wasting disease, caused by the protist *Labyrinthula zosterae,* results in affected blade tissues becoming necrotic, and is exacerbated by other environmental stressors mentioned above. The dark brown coloration of eelgrass blades indicative of this disease is due to excessive fatty acids on the affected blade's surface (Yoshioka et al. 2019). It is suspected that this fatty acid deposit acts as a dietary niche in marine environments; however, few studies have attempted to demonstrate if the tissue itself shows a benefit or importance for marine herbivore species.

Aim of this Study

Given the previous studies demonstrating opposing feeding preferences in species of the *Pentidotea* genus, this study aims to assess yet another species in the Genus, *P. montereyensis*, and compare through replication, grazing preference in *P. wosnesenskii*. The primary responding variable of these trials is blade surface area, which serves as a direct proxy of the amount of eelgrass consumed by the isopod during feed periods. The amount of eelgrass consumed is represented by the change in blade surface area (final surface area – initial surface area).

Hypotheses

In this present study, two consumption experiements (one for *P. wosnesenskii* (PW) isopods and another for *P. montereyensis* (PM) isopods) were conducted to determine whether the surface area change in wasted eelgrass is greater than that of healthy blades. For PW isopods, the null hypothesis states that there is no significant difference between surface area change between healthy and wasted eelgrass blades in *P. wosnesenkii.* On the other hand, the alternative hypothesis states that the change in surface area in healthy eelgrass blades will be significantly greater than that of wasted eelgrass blades for *P. wosnesenskii*. Similiarly in PM isopods, the null hypothesis states that there is no significant difference between surface area change between healthy and wasted eelgrass blades in *P. montereyensis. If there is a difference, the alternative hypothesis states that* the change in surface area in healthy eelgrass blades will be significantly greater than that of wasted eelgrass blades for *P. montereyensis*

As an additional goal of the study, is to determine if there is a statistically significant difference in the degree to which PW and PM isopods prefer one blade status over the other. **For preference comparison between the two species** (preference in PW versus preference in PM), the difference in the change in wasted surface area from the change in healthy surface area (Δ healthy - Δ wasted) serves as a proxy value for preference. Positive result values indicate more consumption of healthy blades, and negative result values indicate more consumption of wasted blades. If there is no significant difference between the change in wasted surface area from the change in healthy surface area of *Pentidotea wosnesenkii and P. montereyensis,* resulting values for preference would be similar between PW and PM. Otherwise, a great difference between change in wasted area and healthy area would result in different preference values.

Methods

Isopod and Eelgrass Specimen Collection and Care:

The study species *P. wosnesenskii* and *P. montereyesis* (hereafter referred to as PW and PM respectively) were collected from various sources, including an existing isopod husbandry operation at Friday Harbor Laboratories (Dr. Olivia Graham) and from low intertidal tidepools at Cattle Point and Argyle Lagoon, San Juan Island (Figure 1).

When selecting isopod specimens to be included in the feeding trials, care was taken to select individuals of equivalent size (+/- 1cm in length difference) to eliminate bias in individual feeding rates due to caloric demands. Since the energy expenditures of non-reproductive adults vary significantly from those of juveniles or brooding individuals, the latter were excluded from all feeding trials.

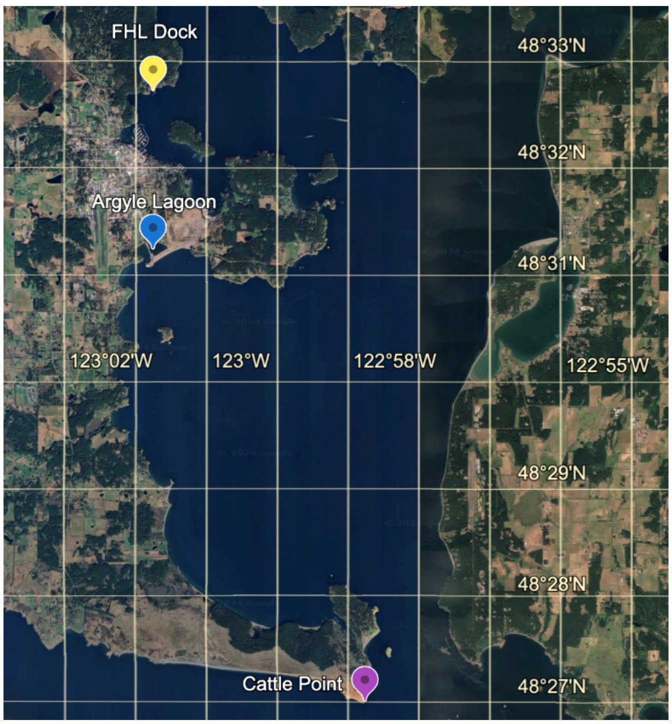

Figure 1. Collection Locations for wild PW and PM isopods and *Z. marina* eelgrass thalli. Eelgrass was collected off FHL Dock (Yellow Marker, 48°32'41"N 123°00'44"W). PW and PM Isopods collected at Argyle Lagoon (Blue Marker, 48°31'12"N 123°00'44"W) and Cattle Point (Purple Marker, 48°26'59"N 122°57'45"W).

Before the experiment, isopods were held in a partitioned sea table with flowing ambient seawater. There was ample space and separation to lower the chances of cannibalism between individuals of each species and predation between individuals of different species.

Diseased and healthy *Z. marina* thalli were collected floating off the Friday Harbor Laboratory (FHL) dock (Figure 1). Like with the isopods, *Z. marina* specimens were housed in sea tables to maintain optimal conditions (flowing seawater) for thalli health. Sectioning of the sea table using

4-by-6-inch Tupperware and lids prevented cross-contamination of diseased and healthy blades, as wasting disease is transmitted through blade-to-blade contact (Short et al. 1988, Muehlstein 1989).

Experimental Setup:

As discovered in previous iterations of this experiment, isopod grazing takes place within a few (~6) hours, and if ambient external temperatures remain at 10°C, isopods do not risk overheating and do not require flowing seawater to survive (Graham et al. 2023). This temperature is the average water temperature of marine environments surrounding San Juan Island during the springtime and can be replicated using artificial cold room setups (SeaTemperatureInfo, n.d.). Twenty plastic containers, 10-cm in diameter, acted as mesocosms and housed individual PW and PM specimens.

A 5-hour starvation period induced hunger in the isopod specimens as they went without available food. Housing isopods individually reduces chances of cannibalism (as observed between species of PW and PM in the pre-experiment phase of the project) and mitigates any influence that competition might have on food preference once blades are introduced.

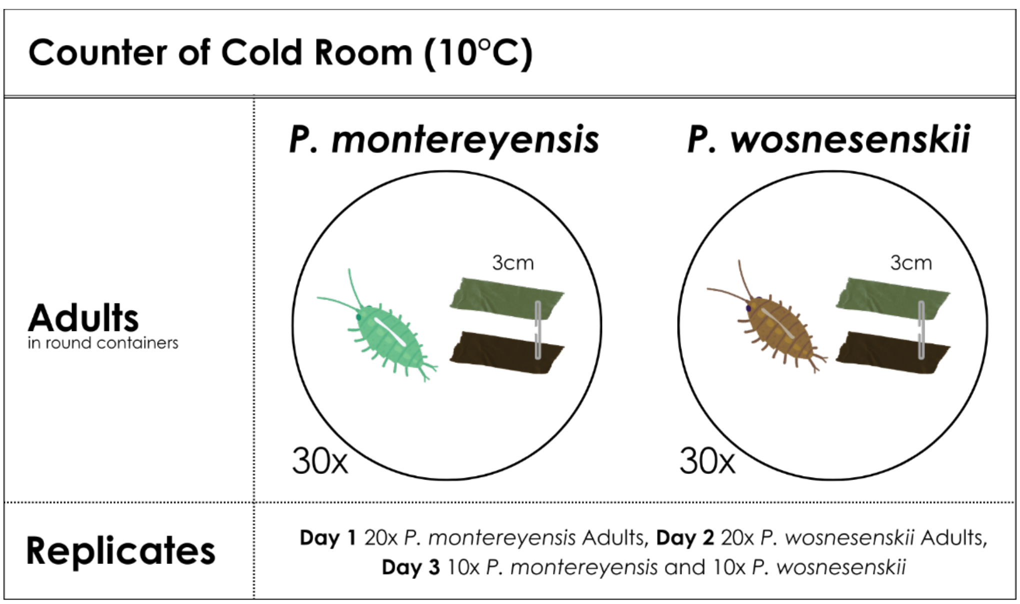

Figure 2. Experimental setup for feeding preference trials. Round plastic containers, referred to as "mesocosms," house individual isopods alongside two 3-cm blades of healthy and wasted eelgrass. The replicates section describes experimental setup schedule.

Just before the feed period, 20 3-cm blades of wasted *Z. marina* and 20 3-cm blades of healthy *Z. marina* were cut, placed onto a labeled transparency sheet with blade pairs arranged by mesocosm (wasted blades on the right of the pair, and healthy on the left of a pair), and scanned using a Canon LiDE Document Scanner and Driver software. On the resulting TIFF format image, the orientation of healthy and wasted blades are mirrored, so wasted blades are leftmost, and healthy are rightmost in each pair (Figure 4). Using ImageJ software, researchers developed binaries of color scans, which are simplified black and white copies of the eelgrass transparency image, to analyze the initial Surface Area before the feeding period with the "wand" and "measure" tools.

After initial measurements, blades were stapled to one another to sink both strands to the bottom of each mesocosm (Figure 3). Stapling the blades does leave small holes in the thallus itself. The hole size was assumed to be negligible across all treatments since all blades would have the same reduction in size due to the staple itself, not impacting the data significantly enough to warrant an alternative design.

This marks the start of a 6-hour feed period where blades were accessible in each mesocosm (Figures 2 and 3). The 6-hour feed period ensures that isopods can fully explore their mesocosms and latch onto blades should they desire to feed. Wasted eelgrass sinks, and healthy strands float, as seen in our holding tanks before the experiment. Given previous reports of isopod escapees from earlier feeding preference experiments, researchers covered the mesocosms with paper towels and Tupperware lids to secure *Pentidotea* into their habitats without interfering with available gas/oxygen flow (Graham 2019).

Figure 3. (Left) PW individual housed in mesocosm with stapled pair of wasted (left blade) and healthy (right blade) eelgrass. (Right) 20-mesocosm setup with PW.

After the 6-hour feed period, mesocosm coverings were removed, and *Z. marina* blades were carefully separated from staples and arranged on a transparency sheet (again, by mesocosm). The sheet was then scanned using the same protocol as the initial measurements and returned to our holding tanks to feed standby isopod specimens. All specimens were collected and returned to the holding tanks.

This experimental setup was repeated for the remaining PM isopods, followed by another experimental setup of half (10 individuals) PW and half (10 individuals) PM.

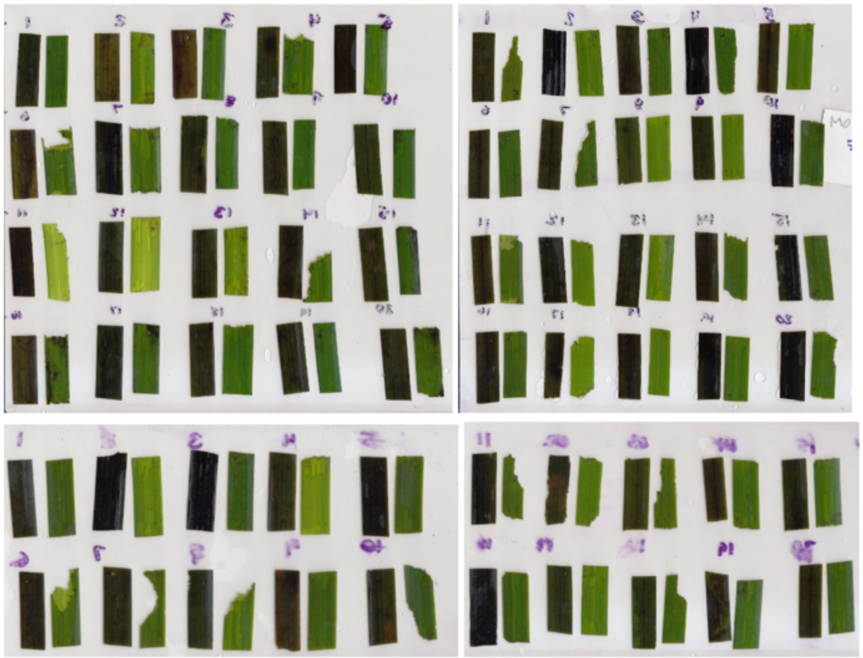

Figure 4. Post-feeding eelgrass color scans from PW (left) and PM (right) trials. Color is indicative of eelgrass health, with wasted eelgrass are leftmost, darker colored strips, and healthy eelgrass are rightmost, lighter green strips. Blade shape, not color, is important for ImageJ surface area measuring and processing.

The overall experiment took place over three days, with day one focusing strictly on 20 specimens of PW, day two working on 20 individuals of PM, and day three working with 10 PW and 10 PM for a total of 30 replicates for each species.

Experiment Cleanup/Waste Management:

In the days following the experiment's end, all remaining isopods were moved to the long-term husbandry setup. Leftover eelgrass blades were used as food for herbivorous invertebrates in long-term housing in the lab, and larger thalli with rhizomes still attached were returned to the water off FHL dock.

Data Management and Processing:

Pre-feeding and post-feeding surface area measurements of eelgrass derived from the ImageJ software were used to calculate total eelgrass surface area consumed for each blade.

For each isopod species, a two-tail t-test was used to evaluate the difference in the amount of healthy eelgrass consumed versus the amount of wasted eelgrass consumed. If a preference is determined for each species, a "preference value" can be calculated by using the formula: Amount consumed wasted – Amount consumed healthy. Positive preference values (>0) mean that the isopod in question consumed healthy eelgrass, while negative preference values (<0) mean that the isopod consumed wasted eelgrass. Another t-test of the average preference values *between* the two species can evaluate if there is a significant difference between preferences for eelgrass health status (healthy versus wasted).

Results

After three days of data collection and blade scanning, initial and final surface area measurements for diseased and healthy blades for *P. wosnesenskii* and *P montereyensis* trials from the ImageJ digital photograph processing software were compiled into a single data set. Change in surface area was calculated by subtracting initial surface areas from final surface areas for each blade in each mesocosm. The change in healthy blade area was lower in PW trials, with -21.150mm^2 reduction in tissue compared to just -1.062 mm^2 in healthy tissue (Table 1 and Figure 5). A similar average was calculated for PM isopods, with a -20.056 mm^2 reduction in surface area for healthy tissue, and -0.877 mm^2 in wasted tissue (Table 1 and Figure 5). Healthy eelgrass had the highest values for average change surface area in both groups. "Change in surface area" is synonymous with the "area consumed".

Table 1. Average and Standard Deviation of change in surface area across two species PW and PM derived from complete raw data (See Appendix A and B). Yellow highlighted p-values indicate significance (<0.05)

	Rockweed: *P. wosnesenskii* (PW)		Monterey: *P. montereyensis* (PM)	
	Δ Healthy Area	Δ Wasted Area	Δ Healthy Area	Δ Wasted Area
Average (mm^2)	-21.150	-1.062	-20.056	-0.877
T-Test P-Value	0.01*		0.0001*	
Standard Deviation	40.693	4.259	24.466	5.081

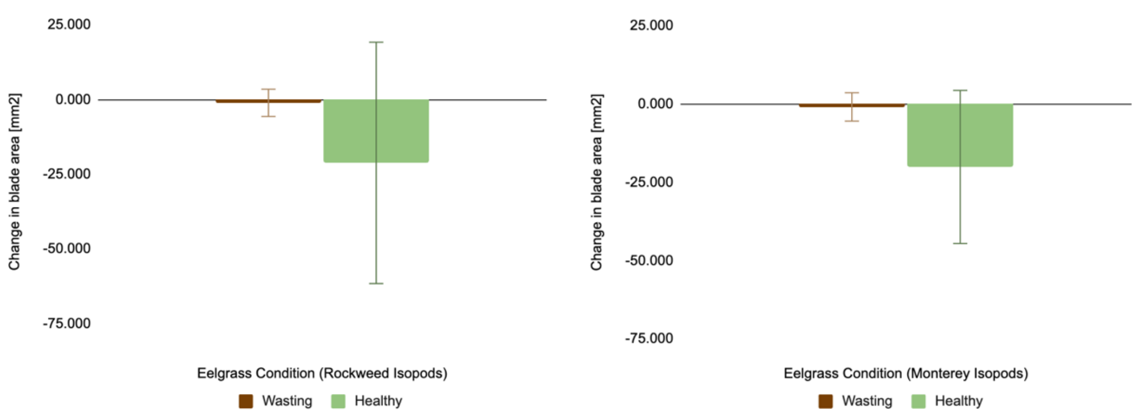

Figure 5. Average Change of Surface Area between Healthy vs. Wasted Eelgrass for PW (Left) and PM (Right). Error bars represent standard deviations within each treatment group, with the highest variation seen in healthy eelgrass consumed by PW isopods (right)

After calculating the average change in areas, a two-tailed t-test determined a significant difference between the change in Healthy Surface Area versus the change in Wasted Surface Area for PW Isopods ($t = -2.69$, $p = 0.01$). Another two-tailed t-test determined a significant difference between change in Healthy Surface Area versus change in Wasted Surface Area for PM isopods (t = -2.69, p = 0.001).

Another t-test between the average preference value (Change in Wasted - Change in Healthy) in PW isopods and in PM isopods revealed that there is no significant difference (p>0.05) between the two values (Table 1 and Figure 6). Results were derived from the two preference datasets (Appendix A and B) alongside further processing in the preference (Change in Wasted - Change in Healthy) raw data (Appendix C)

Table 2. *T-Test Results* for feeding preferences of PW and PM derived from complete data set (See Appendix C). The resulting p-value is not significant (>0.05).

	Rockweed: *P. wosnesenskii* (PW)	Monterey: *P. montereyensis* (PM)
Preference Average	20.089	19.1784
T-Test P-Value	0.9	
Standard Deviation	41.103	24.923

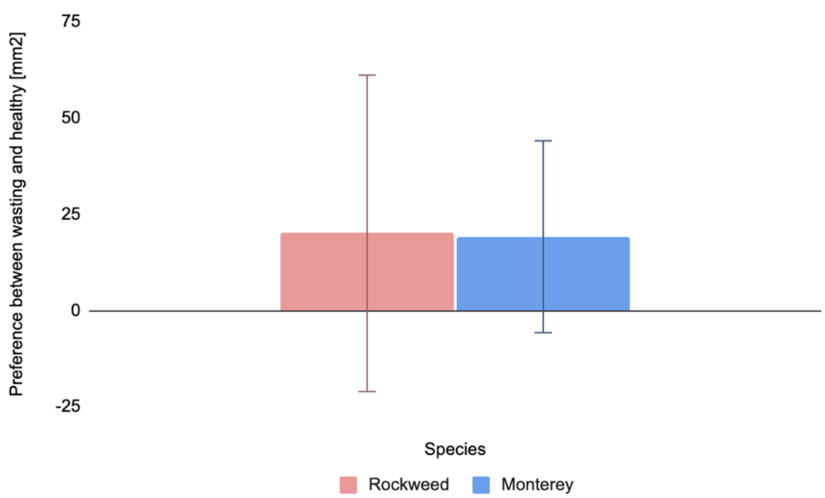

Figure 6. Preference (Change in Wasted - Change in Healthy) values between Healthy vs Wasted Eelgrass for species *PW* and *PM.* Difference between the two preference values of the two species is not significantly different.

As there is no significant difference in the preferences of the two isopods (p-value of t-test > 0.05 threshold, **both species prefer the healthy eelgrass to the same/similar degree.** In contrast to the previous study which revealed differing preferential feeding of two members of the *Pentidotea* genus (*P. wosnesenskii* versus *P. resecata*), the two species of this study exhibit the same preference for consuming healthy eelgrass (Graham 2023).

Discussion

Isopod Feeding Preference and Consumption Patterns

In both experiments, testing for preference and eelgrass consumption in *Pentidotea wosnesenskii and P. montereyensis,* the change in healthy blade surface area exceeded the change in wasted blade surface area, meaning both species consumed a significantly higher amount of healthy eelgrass tissue than wasted tissue. In addition to this finding, quantifying preference as a function of change in healthy surface area minus wasted surface area showed that both species shared preference values around ~20mm^2, indicating that more healthy tissue was consumed over wasted tissue. These preference values did not differ significantly between the two species, reinforcing the degree of feeding preference similarity for these two *Pentidotea* species.

Isopod Distribution

Given that the data confirms a preference for healthy vs. diseased blades in both these species, its application *in situ* raises flags for concern over both eelgrass and herbivores/consumers that depend upon its ecosystem functions. At the herbivore level, competition between PW and PM may occur when their ecological niches and distributions overlap. Furthermore, as healthy eelgrass continues to decline, an increase in competition and the niche overlap in these organisms may lead to other unexpected effects in the overall trophic cascade. A potential decline in herbivore populations due to eelgrass density decrease may be a precursor to higher-level predators facing food scarcity. This is a similar relationship observed in other marine ecosystems where invertebrate herbivore population declines cause a detrimental collapse of bottom-up control and pressures higher consumers for resources (Mather 2013). Overall, this study's discovery of healthy tissue preference/pressure by PW and PM isopods underlines the importance of healthy eelgrass blade abundance and urges the prioritization of eelgrass conservation efforts, specifically within the San Juan Islands Archipelago.

Life History Stage and Preference

Given the abbreviated scale of this study, which focuses on only two species of adult specimens within *Pentidotea*, many future iterations and follow-up studies can further improve general understandings of herbivory and disease dynamics of this genus of marine isopod and *Zostera marina*. One route of interest is to examine isopods' preferences at varying life history stages. Metabolic needs and energy expenditure shift throughout the life cycle of most organisms that experience distinct life stages, especially in marine invertebrates. Throughout this experiment, some isopods were observed to be molting, falling inactive, or rotating upside down for extended periods of time (Iwasa et al. 2022, Salemaa 1986). These differences in energy expenditure and behaviors across treatments were not accounted for nor measured in this experiment, meaning that isopods exhibiting behaviors aside from feeding and idling were still included in the study.

Isopod molting might expend considerable time and energy solely on the molting process and won't eat at all, or vice versa. It is currently unknown which end of the behavior spectrum these isopods currently lie with this behavior. Similar assumptions of feeding fluctuations could be made for isopods beginning to brood, as previous literature examining invertebrate brooding behavior shows that parental energy expenditure for brooding individuals is higher than for free-spawning individuals (Jaekle 1995). A new experimental design controlling for isopod behavior and other energy-expenditure variables may reveal how life history influences preferences, and if one stage or behavior warrants flexibility in preference when additional energy reserves are limited.

A previous study on *Idotea balthica* isopods revealed that juvenile diets differed from adult forms of the same species (Sturaro et al. 2010). Originally, the present study aimed to compare feeding preferences of juvenile isopods to adult isopods across multiple species, *P. wosnesenskii*, *P. montereyensis*, and the Eelgrass isopods, *P. resecata*. However, during initial testing phases before the experiment, juvenile isopods did not consume enough eelgrass blade surface area to be detected by scanning equipment nor ImageJ processing. This topic of life stage and life history feeding preference would be interesting to explore if technology allows for precision measurements of blades consumed by much smaller isopods, and if sample sizes are large enough to detect small surface area changes.

Preferences in Other *Pentidotea* Species

As mentioned above, the present study aimed to test preference in *P. resecata* individuals as well. Given previous studies revealing *P. resecata* preference for consuming wasted blades, it would be beneficial to confirm this result and do the first study of simultaneous preference trials between *P. resecata* and the others examined today (*P. wosnesenskii* and *P. montereyensis*) (Graham et al. 2023). However, many issues arose with collecting *P. resecata* specimens. During collection efforts at Argyle Lagoon, only one *P. resecata* was found. Shortly after collection, a PW isopod escaped from a different partitioned area of the sea table and ate the *P. resecata* isopod in between check-ins.

Even though eelgrass isopods were not studied in this experiment, these results still provide valuable insight into the dynamics of other competitors to *P. resecata*, given that they often overlap in ecological niches and distribution. Given that we observed more consumption of healthy eelgrass, a continuation of this pattern in other *Pentidotea* species could suggest heightened resource limitation issues should eelgrass wasting persist or even get worse into the future.

Preference and Disease Transmission

Studies specifically examining the transmission of eelgrass wasting disease are also unique opportunities to explore whether preferential herbivory on healthy or wasted blades by *Pentidotea* is accelerating or decelerating disease spread in local eelgrass meadows. In a study by Murray and colleagues in 2024, two potential hypotheses address *P. resecata*'s role in eelgrass disease transmission. Given that it is known they prefer wasted blades, one hypothesis claims that herbivores targeting diseased blades help decrease blade-to-blade transmission of wasting since less wasting tissue is available to contact healthy tissue. However, an opposing hypothesis suggests that wasting-targeted herbivory may increase disease spread, as herbivore-to-blade contact outweighs direct blade-to-blade contact (Short et al. 1988). While it was concluded that *P. resecata's* role is aligned with the overall decrease in transmission and disease severity (Murray et al. 2024), it would be interesting to expand this research to other species of *Pentidotea*, like those examined in our experiment. Now that it is known which species within *Pentidotea* prefer healthy and wasted blades, quantifying and comparing severity or rate of eelgrass wasting spread with isopod feeding preference can expand the current knowledge base of herbivory-disease dynamics in this specific relationship.

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Appendix

Appendix A. Complete Dataset for Pre- and Post-Feed Surface Area Measurements

Mesocosm	PW				PM			
	Initial Healthy Area	Initial Wasted Area	Final Healthy Area	Final Wasted Area	Initial Healthy Area	Initial Wasted Area	Final Healthy Area	Final Wasted Area
1	277.082	285.610	277.178	284.518	264.311	310.265	188.566	311.652
2	305.839	300.878	299.474	304.418	327.309	307.099	328.033	306.131

3	279.924	304.586	283.882	301.376	305.706	317.911	303.235	318.368
4	349.938	278.655	302.455	283.912	295.796	311.098	257.661	312.31
5	288.967	275.208	296.621	268.231	328.388	291.156	325.364	290.215
6	361.248	309.266	286.938	306.941	295.893	291.962	294.072	288.79
7	354.256	338.544	343.795	341.177	295.961	310.883	218.643	308.078
8	288.806	360.239	278.747	360.859	309.031	319.132	309.831	319.372
9	258.957	326.633	266.897	317.655	293.247	285.721	290.062	282.801
10	268.168	316.027	266.564	310.661	306.977	345.057	308.668	340.469
11	286.483	266.671	264.949	270.763	321.455	278.437	305.611	277.87
12	376.869	306.793	380.442	307.504	296.427	315.576	283.744	325.427
13	281.089	303.235	282.435	308.454	323.978	336.952	325.289	343.179
14	352.593	314.640	186.381	313.636	322.037	316.008	281.779	316.242
15	258.448	322.172	249.005	317.881	318.759	308.46	311.263	305.339
16	287.831	304.629	279.082	303.199	308.243	329.23	305.298	329.316
17	319.325	345.991	321.940	341.173	298.549	242.031	264.28	237.731
18	355.070	321.657	363.385	315.463	276.203	300.985	274.061	301.265
19	281.670	319.555	273.701	324.590	319.612	305.361	317.624	314.839
20	320.822	330.795	313.633	323.471	328.268	343.125	302.091	352.89
21	302.894	275.703	301.455	276.35	256.055	312.772	187.389	313.036
22	332.046	336.314	331.067	330.216	287.115	269.747	266.607	256.166
23	292.932	316.28	294.425	319.035	292.781	323.254	229.132	321.444
24	327.54	312.887	328.087	313.629	326.837	237.139	317.97	235.718
25	301.539	305.093	311.437	310.799	326.203	315.457	308.806	311.665
26	324.111	279.478	264.759	279.609	331.338	375.865	324.455	374.553
27	286.836	322.261	196.274	323.278	326.172	301.984	322	300.361
28	321.302	293.206	224.538	287.153	282.977	314.534	234.108	313.269
29	323.713	297.521	322.406	293.826	328.379	289.931	317.612	279.729
30	306.972	311.544	246.813	310.447	337.357	307.436	326.434	300.019

Appendix B. Complete Dataset Averages for Change in Healthy and Wasted Eelgrass Surface Area

Mesocosm	PW		PM	
	Change in Healthy Area	Change in Wasted Area	Change in Healthy Area	Change in Wasted Area
1	0.096	-1.092	-75.745	1.387
2	-6.365	3.540	0.724	-0.968
3	3.958	-3.210	-2.471	0.457
4	-47.483	5.257	-38.135	1.212
5	7.654	-6.977	-3.024	-0.941
6	-74.310	-2.325	-1.821	-3.172
7	-10.461	2.633	-77.318	-2.805
8	-10.059	0.620	0.8	0.24
9	7.940	-8.978	-3.185	-2.92
10	-1.604	-5.366	1.691	-4.588
11	-21.534	4.092	-15.844	-0.567
12	3.573	0.711	-12.683	9.851
13	1.346	5.219	1.311	6.227
14	-166.212	-1.004	-40.258	0.234
15	-9.443	-4.291	-7.496	-3.121
16	-8.749	-1.430	-2.945	0.086
17	2.615	-4.818	-34.269	-4.3
18	8.315	-6.194	-2.142	0.28
19	-7.969	5.035	-1.988	9.478
20	-7.189	-7.324	-26.177	9.765
21	-1.439	0.647	-68.666	0.264
22	-0.979	-6.098	-20.508	-13.581
23	1.493	2.755	-63.649	-1.81
24	0.547	0.742	-8.867	-1.421
25	9.898	5.706	-17.397	-3.792
26	-59.352	0.131	-6.883	-1.312

27	-90.562	1.017	-4.172	-1.623
28	-96.764	-6.053	-48.869	-1.265
29	-1.307	-3.695	-10.767	-10.202
30	-60.159	-1.097	-10.923	-7.417
	Rockweed: *P. wosnesenskii* (PW)		Monterey: *P. montereyensis* (PM)	
	Δ Healthy Area	Δ Wasted Area	Δ Healthy Area	Δ Wasted Area
	Units in mm^2		Units in mm^2	
Average	-21.150	-1.062	-20.056	-0.877
T-Test P-Value	0.01		0.0001	
St Dev	40.693	4.259	24.466	5.081

Appendix C. Complete Dataset for Preference Values

Preference PW	Preference PM
-1.188	77.132
9.905	-1.692
-7.168	2.928
52.740	39.347
-14.631	2.083
71.985	-1.351
13.094	74.513
10.679	-0.56
-16.918	0.265
-3.762	-6.279
25.626	15.277
-2.862	22.534
3.873	4.916
165.208	40.492
5.152	4.375
7.319	3.031

-7.433	29.969
-14.509	2.422
13.004	11.466
-0.135	35.942
2	68.93
-5.119	6.927
1.262	61.839
0.195	7.446
-4.192	13.605
59.483	5.571
91.579	2.549
90.711	47.604
-2.388	0.565
59.062	3.506

	Rockweed: *P. wosnesenskii* (PW)	Monterey: *P. montereyensis* (PM)
Preference Average	20.089	19.1784
T-Test P-Value	0.9	
Standard Deviation	41.103	24.923

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