# FINAL REPORT
# PRELIMINARY VIDEO ANALYSIS OF CORAL, SPONGE, AND METRIDIUM DISTRIBUTION FROM ROCKFISH TRANSECTS MADE WITH THE DELTA SUBMERSIBLE IN SOUTHEAST ALASKA

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## Introduction

Red tree coral (*Primnoa* spp.) and other sessile macroinvertebrates (i.e. large sponges and anemones) provide high-relief habitat for commercially important demersal fishes and have been identified as habitat areas of particular concern (HAPC) by the North Pacific Fishery Management Council (Cimberg 1981; Moretensen et al. 1995; Andrews et al. 2002; Krieger and Wing 2002). Due to variability in morphology and color, at least two species of *Primnoa* (*P. resedaeformis* and *P. willeyi*) have been identified in Alaskan waters (Hickson 1915; Cimberg 1981). Although it has recently been suggested that all Alaskan *Primnoa* are *P. resedaeformis*, taxonomic issues remain unresolved. *Primnoa* spp. exhibits extreme longevity, slow growth, and fragile, branching morphology. Red tree coral is therefore susceptible to fishing disturbance, and recovery from trawl damage appears to be quite slow (Heifetz 1998; Krieger 1998; Fossa et al. 1999; Witherell and Coon, in press). In order to conserve *Primnoa* spp. and other sessile macroinvertebrate populations and determine their ecological relationships, their distributions must be mapped and their substrate affinities determined.

Using video data previously collected from a submersible during rockfish (*Sebastes* spp.) stock assessment surveys in the Eastern Gulf of Alaska, the distribution, abundance, and habitat associations of *Primnoa* and other sessile macroinvertebrates (*Metridium farcimen* and three large sponge morphotypes) are being investigated. A habitat profile for *Primnoa* spp., determined by Cimberg (1981) from published and gray literature and contact with fishermen, associated *Primnoa* spp. with large boulders and exposed bedrock in areas with moderate to high currents and yearly temperatures above 3.7º C. Video transect data in conjunction with habitat information collected at different spatial scales provides an opportunity to quantify habitat associations of *Primnoa* spp. and compare results with those of previous studies. The specific objectives of this study are to: 1) determine the distribution and abundance of *Primnoa* spp. and other sessile macroinvertebrates among three commercial fishing management areas in Southeast Alaska, 2) determine habitat associations for *Primnoa* spp. and other sessile macroinvertebrates within the same study region, 3) age *Primnoa* spp. colonies when possible using an established height-age relationship.

## Methods

Data used for this project was originally collected during rockfish stock assessment surveys with the manned submersible *Delta* between 1990 and 2001 (O'Connell and Carlile 1991, O'Connell et al. 2001). These surveys were conducted within three commercial fishing management areas off Southeast Alaska, East Yakutat (EYKT), Central Southeast Outside (CSEO), and Southern Southeast Outside (SSEO) (Figure 1). Although these surveys were conducted to assess habitat associations and densities of fishes, the videotaped transects resulting from this work are amenable to similar analyses for co-occurring sessile macroinvertebrates. From the pool of available transects, those reaching depths of 130 to 220 meters (a range within the depth distribution of *Primnoa* spp.) were chosen for analysis. This resulted in a total of 71 transects (from 58 dives) to be analyzed among the three areas (26 in CSEO, 23 in EYKT, and 22 in SSEO). All transects ranged in duration from 30 to 60 minutes.

Habitat type was previously characterized throughout each transect using a scheme developed by O'Connell and Brylinsky at ADF&G (Personal Communication). To increase sample size for analyses, similar habitat categories (i.e. large and small boulders) were combined, resulting in 21 categories using one or two of the following descriptors: b (boulder), c (cobble, pebbles, or gravel), f (low-relief pavement), m (mud), r (high-relief broken rock bottom), and s (sand). Each transition in habitat type along a transect was considered a patch and patches of the same habitat type were summed for analysis.

Based on a review of a subset of available transects, invertebrates were enumerated (or a range was determined) and identified using the following taxonomic groupings: *Primnoa* spp., *Metridium farcimen*, and three sponge categories based on morphology. Category A contains pipe-shaped and tubular sponges, Category B contains cup-shaped and vase sponges, and Category C contains lobate, branching, and frilled sponges. Sponges were grouped by morphology because accurate taxonomic identification was not possible from video data. Therefore, groups within a morphotype category should not be considered taxonomically similar. However, investigation into this topic is ongoing and identification to Family or perhaps Genus seems possible in the future. Only invertebrates approximately 30 cm or greater along their major axis (height or width) were enumerated.

Transect length was estimated by recording 5-minute positional fixes for the submersible and summing the distance between fixes along the transect line. Transect width was estimated from distance to fish visible on video which was either noted by the submersible observer or determined with a sonar gun. Discrete patch widths, recorded throughout a transect, were binned into like categories and an aggregate time for each patch was calculated and used to estimate average transect width. Length and width were multiplied for each transect and then summed for each region to estimate total area swept. Using these area calculations and results of video quantification, density was estimated for each macroinvertebrate species or category (listed as a range) for each area and frequency of occurrence (% transects observed) was recorded.

Age and growth estimates for *Primnoa* spp. colonies were calculated using low and high growth rate estimates (1.74 $\pm$ 0.19 – 2.32 $\pm$ 0.09 cm/yr) determined by Andrews et al. (2002) and validated using radiometric techniques. *Primnoa* spp. were measured using a known distance (20 cm) between lasers evident on the video. Estimates were only calculated when the path of the lasers traveled directly over a single *Primnoa* spp. colony and the entire length of the organism was visible.

Using ArcView®'s dynamic segmentation feature, sightings of invertebrates were temporally positioned along the transect lines and plotted against habitat maps to visually depict mega (from kilometers to tens of kilometers, or larger) and mesoscale (tens of meters to one kilometer) habitat associations.

Small-scale [macroscale (one to tens of meters)] habitat associations of the five macroinvertebrate groups were investigated using the Coefficient of Sorensen (for *Primnoa* spp.) and the Jaccard Similarity Measure for binary data (for all other invertebrate groups). Sorensen's similarity coefficient was used for *Primnoa* spp. analyses because it is a more accurate measure when joint occurrences, such as a particular habitat patch and *Primnoa* spp., are rare, as is the case with red tree coral due to it's relative scarcity. Presence of absence of each invertebrate type on each habitat patch was used as the basis for analysis because habitat-specific area calculations were not possible with the available data. In total, 4,331 habitat patches among 66 transects were used in analysis for *Primnoa* spp. while 1,051 habitat patches among 30 dives were used in analysis of other macroinvertebrates.

## Results

*Primnoa* spp. was found in highest abundance in EYKT, with between 1.15 and 1.26 colonies per 100 $m^2$, and was at least an order of magnitude more abundant at this site than the two others (0.05 to 0.06 colonies/100 $m^2$ in SSEO and 0.12 to 0.13 colonies/100 $m^2$ in CSEO) (Table 1). In all, 33 of 71 transects contained *Primnoa* spp., with the highest frequency occurring in EYKT (60.9% vs. 50.0% in SSEO and 30.8% in CSEO) (Figure 2). In all, between 1,135 and 1,233 colonies of red tree coral were observed in 313,498 $m^2$ of area swept. Fishes were often observed within and in close proximity to *Primnoa* spp., especially adult and juvenile rockfishes (*Sebastes* spp.) (Figure 3).

Four other macroinvertebrate groups were commonly observed in video transects and quantified. The white-plumed anemone (*Metridium farcimen*) was the most commonly observed macroinvertebrate at a density of 4.65 to 5.86 animals/100 $m^2$ and occurred in the vast majority of transects (83%, in total) (Figure 4, Table 1). Pipe-shaped and tubular sponges (Category A) were the least abundant sponge morph by density, but were present in most (80%) transects (Figure 5, Table 1). Cup-shaped and vase sponges (Category B) were ubiquitous (97% of transects) but not as densely aggregated as branching, lobate, or frilled sponges (Category C, 1.27 to 1.34 animals/100 $m^2$ vs. 1.57 to 2.21 animals/ 100 $m^2$) (Figures 6 and 7, Table 1).

Four analyzed transects were plotted over a habitat map of Fairweather Grounds, interpreted by Dr. H. Gary Greene, Moss Landing Marine Laboratory Center for Habitat Studies, using dynamic segmentation to associate macroinvertebrates with large-scale habitat types (Figure 8). Most sessile invertebrate sightings are noted over hard substrates (see Figures 10–12), as expected. However, several macroinvertebrates occurred in an area classified as sand (Figure 9). This is a result of differences in scale. At large scales (100s of meters to kilometers) used for mapping from remote imagery, local features habitat heterogeneity are often impossible to obtain. Video data is therefore necessary to groundtruth large-scale habitat maps and to determine habitat associations of individual species at finer levels of resolution.

Ages were estimated for 84 *Primnoa* spp. colonies (see Methods) among the three fishery management areas. Most (N = 55) estimates were collected from colonies in the Yakutat (EYKT) region, probably as a reflection of greater local densities. Size estimates ranged from 12 to 250+ cm, corresponding to ages of from 5 to 8 and 104 to 161 years. Histograms and descriptive statistics could not be accurately calculated due to biases inherent to video analysis methods. Due to the available field of view, newly settled colonies and those of extreme longevity were undersampled because they were either impossible to distinguish or else spanned beyond the range of the video. However, most sampled lengths (N = 40) corresponded to ages ranging between 30 and 80 years, underscoring the extreme longevity of red tree coral and its vulnerability to benthic trawling and other anthropogenic disturbances.

As reported by Cimberg (1981), *Primnoa* spp. was found to occur on boulders and heterogeneous habitats containing boulders (Table 2). However, it was most strongly associated with high-relief broken rock (Sorensen's Coefficient = 0.0762, Table 2). *Primnoa* spp. was found to be patchily distributed and rare throughout the study area, occurring on only 231 of 4,331 habitat patches. When present, it often occurs in dense aggregations but these aggregations are not typically extensive. *Primnoa* spp. never occurred on sand or mud and was not highly correlated with low relief pavement (Table 2). The values of Sorensen's Coefficient range from 0 to approximately one (100% correspondence) with .60 usually considered significant. The low values obtained in this study indicate the presence of red tree coral is rare regardless of substrate type.

*Metridium farcimen* was most highly correlated with boulder, boulder/cobble, pebbles, or gravel, cobble, or pebbles, or gravel/high-relief broken rock (Table 3). Sponges of all categories exhibited strong associations with high-relief broken rock and to a lesser extent, boulder, gravel, cobble, or pebbles, and low-relief pavement (Table 3). Negative correlations (weak habitat associations) were difficult to distinguish and require further investigation. Adult and juvenile fishes of commercial importance (esp. *Sebastes* spp.) were observed in close association with (often directly within) sponges, and *M. farcimen*. These invertebrates, like *Primnoa* spp., seem to provide habitat for commercially important demersal fishes. However, they do not share the extreme longevity of *Primnoa* spp. and are more abundant. Their populations are therefore likely to be better less impacted by destructive fishing practices.

## Conclusions and Future Work

The importance of red tree coral (*Primnoa* spp.) as fish habitat has been widely acknowledged and determination of small and large scale habitat associations is necessary to identify and protect stands of *Primnoa* spp. from degradation. Sponges and anemones have also been determined to provide habitat essential to fishes (Lindholm et al. 1999; Elliot and Mariscal 2001; Krieger 2002). Ecological importance; sensitivity to degradation; exposure to adverse activities, events or conditions; and rarity are used by the North Pacific Fisheries Management Council to determine vulnerability of habitat and to make decisions regarding establishment of HAPC. Based on these criteria and the preliminary results and observations from this study, other macroinvertebrates many also serve as EFH and may warrant consideration as HAPC.

This work is ongoing and a manuscript will be submitted to a peer-reviewed journal at project completion. Methods will be slightly revised, based on the results of our work to date, to best determine habitat associations, distribution, and abundance of *Primnoa* spp. and other macroinvertebrates. This study also demonstrates the utility of deriving new information from previously collected submersible dives, thereby increasing the amount of data obtained from this rather expensive survey method.

**Acknowledgements**

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**Table 1.** Distribution and abundance of macroinvertebrates in SSEO, CSEO, and EYKT. Area was calculated per transect from length and width estimates (see Methods) and summed for each management region. Ranges are given because exact numbers were often impossible to accurately determine. %FO = frequency of occurrence (% transects in which a species or sponge morphotype was observed). For sponges and *Metridium*, ten transects were analyzed per region. The number of transects analyzed for *Primnoa* was 71, divided as follows: 22 in SSEO, 26 in CSEO, and 23 in EYKT. Totals represent aggregate values from the three management areas and were not weighted.

| | **SSEO** | **CSEO** | **EYKT** | **Total** |
|---|---|---|---|---|
| **Area ($m^2$)** | **49,120 $m^2$** | **44,152 $m^2$** | **40,526 $m^2$** | **133,798 $m^2$** |
| **(Area (m2))** | **(117,764 $m^2$)** | **(114,711 $m^2$)** | **(81,023 $m^2$)** | **(313,498 $m^2$)** |
| ***Primnoa* spp.** | | | | |
| Abundance | 61 to 67 | 143 to 144 | 931 to 1022 | 1135 to 1233 |
| Density/100 $m^2$ | 0.05 to 0.06 | 0.12 to 0.13 | 1.15 to 1.26 | 0.36 to 0.39 |
| %FO | 50.0% | 30.8% | 60.9% | 46.5% |
| ***Metridium farcimen*** | | | | |
| Abundance | 2513 to 3041 | 3387 to 4459 | 316 to 345 | 6216 to 7845 |
| Density/100 $m^2$ | 5.17 to 6.19 | 7.67 to 10.10 | 0.78 to 0.85 | 4.65 to 5.86 |
| %FO | 70% | 90% | 90% | 83% |
| **Category A** | | | | |
| Abundance | 168 to 202 | 125 to 129 | 307 to 312 | 600 to 643 |
| Density/100 $m^2$ | 0.34 to 0.41 | 0.28 to 0.29 | 0.76 to 0.77 | 0.45 to 0.48 |
| %FO | 100% | 50% | 90% | 80% |
| **Category B** | | | | |
| Abundance | 388 to 461 | 445 | 861 to 893 | 1694 to1799 |
| Density/100 $m^2$ | 0.79 to 0.94 | 1.01 | 2.12 to 2.20 | 1.27 to 1.34 |
| %FO | 100% | 90% | 100% | 97% |
| **Category C** | | | | |
| Abundance | 1567 to 2267 | 166 to 219 | 368 to 474 | 2101 to 2960 |
| Density/100 $m^2$ | 3.19 to 4.62 | 0.38 to 0..50 | 0.91 to 1.17 | 1.57 to 2.21 |
| %FO | 90% | 30% | 80% | 67% |

**Table 2.** Habitat affinity of *Primnoa* spp. as determined by the Coefficient of Sorensen for binary (presence/absence) data. Habitat descriptors are as follows: b (boulder), c (cobble, pebble, or gravel), f (low-relief pavement), m (mud), p (pinnacles), r (high-relief broken rock bottom), and s (sand). Values represent correlation between the presence of a habitat type and the occurrence of *Primnoa*. All values listed are extremely low (0.60 is usually considered a significant correlation) as *Primnoa* is scarce and unlikely to be present in a habitat patch of any type.

| Habitat | #Patches | *Primnoa* Occurrences | Sorensen Coefficient |
|---|---|---|---|
| r | 1675 | 110 | 0.0762 |
| b | 1019 | 39 | 0.0220 |
| br | 277 | 32 | 0.0149 |
| bs | 117 | 9 | 0.0040 |
| bc | 284 | 8 | 0.0037 |
| c | 24 | 8 | 0.0035 |
| f | 190 | 6 | 0.0027 |
| cs | 60 | 5 | 0.0022 |
| rs | 85 | 4 | 0.0018 |
| cr | 31 | 4 | 0.0018 |
| bm | 100 | 2 | 0.0009 |
| bf | 60 | 2 | 0.0009 |
| cm | 88 | 1 | 0.0004 |
| mr | 45 | 1 | 0.0004 |
| cf | 10 | 0 | 0.0000 |
| fc | 14 | 0 | 0.0000 |
| fm | 20 | 0 | 0.0000 |
| fr | 24 | 0 | 0.0000 |
| fs | 55 | 0 | 0.0000 |
| m | 65 | 0 | 0.0000 |
| s | 88 | 0 | 0.0000 |
| **Total** | 4331 | 231 | |

**Table3.** Habitat associations of other macroinvertebrates were determined using the Jaccard Measure of Similarity. This measure uses binary data (presence or absence on each habitat patch) to correlate each species or categpory with the available habitat types. Strongest and weakest habitat associations for each macroinvertebrate group are listed below. Numbers in parentheses are similarity values and can be used as an comparative index within and between species-habitat results. Habitat type was binned into 21 categories using one or two of the following descriptors: b (boulder), c (cobble, pebbles, or gravel), f (low-relief pavement), m (mud), r (high-relief broken rock), and s (sand). Habitat types are ordered alphabetically (i.e., dominant habitat type in mixed habitats was not distinguished). A total of 1051 patches were analyzed for the occurrence of macroinvertebrates.

| Habitat Associations | | |
|---|---|---|
| **Macroinvertebrate** | **Strong** | **Weak** |
| *Metridium farcimen* | b - 0.081<br>bc - 0.037<br>cr - 0.034 | bm, cs, fr, fs, mc - 0.0 |
| Category A | r - 0.201<br>b - 0.087<br>f - 0.072 | fs, mc - 0.0<br>cf, cr, cs, mr - 0.004 |
| Category B | r - 0.188<br>bc - 0.123<br>f - 0.092 | fs, mc - 0.0<br>bf - 0.004 |
| Category C | r - 0.184<br>cm - 0.110<br>f - 0.072 | cf, fm, fs, mc - 0.0 |

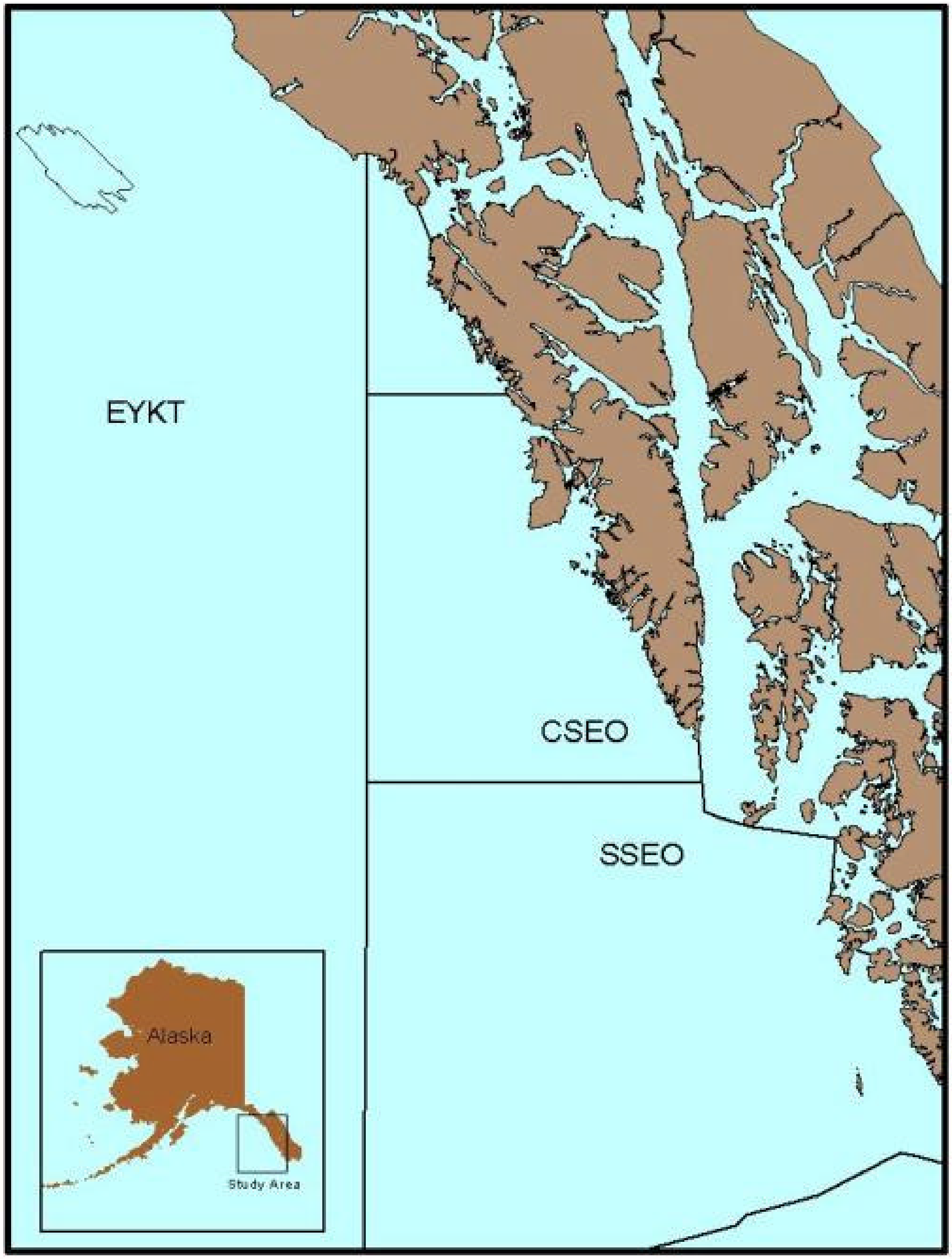


**Figure 1:** Map of of study area. All submersible dives were conducted within three commercial fishery management areas in Southeast Alaska (EYKT = Yakutat, CSEO = Central Southeast Outside, SSEO = Southern Southeast Outside). Outline of Fairweather Ground habitat interpretation is depicted in EYKT.

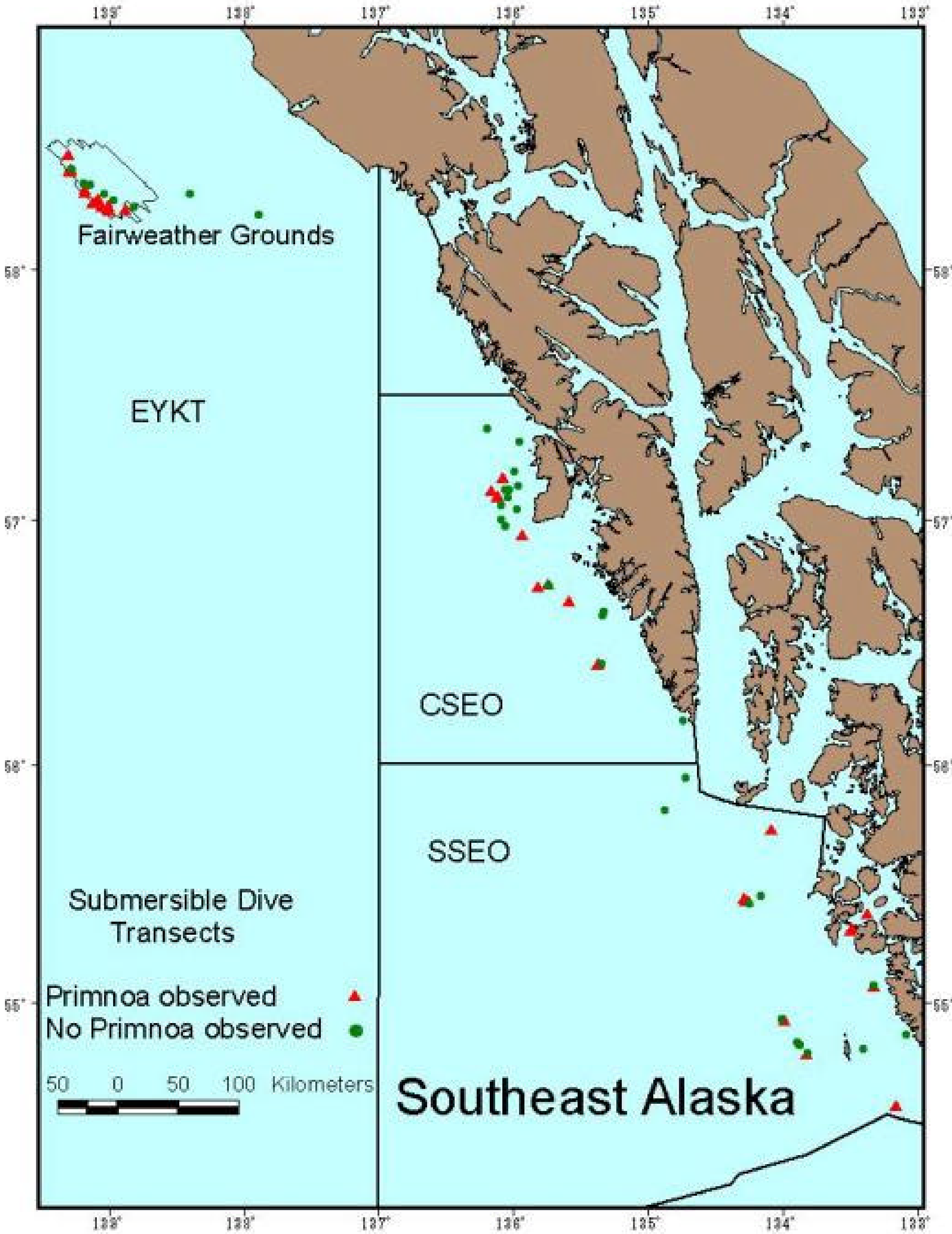


**Figure 2:** Map depicting analyzed transects and their distribution among commercial fishery management areas in Southeast Alaska (EYKT = Yakutat, CSEO = Central Southeast Outside, SSEO = Southern Southeast Outside). *Primnoa* spp. was observed in 33 of 71 transects.


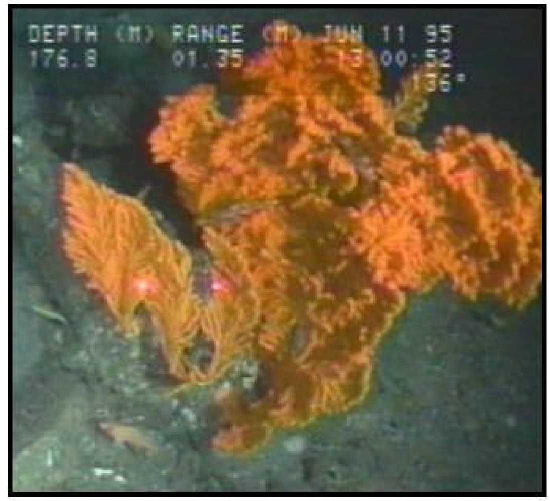


**Figure 3.** Red tree coral (*Primnoa* spp.) - Order Gorgonacea, Suborder Holaxonia, Family Primnoidae. All observed *Primnoa* is likely *P. resedaeformis*. However, due to unresolved taxonomic problems within this genus, we have conservatively classified red tree coral as *Primnoa* spp. Yelloweye rockfish (*Sebastes ruberrimus*), a sharpchin rockfish (*S. zacentrus*), and juveniles (*Sebastes* spp.) are pictured in association with *Primnoa* spp.

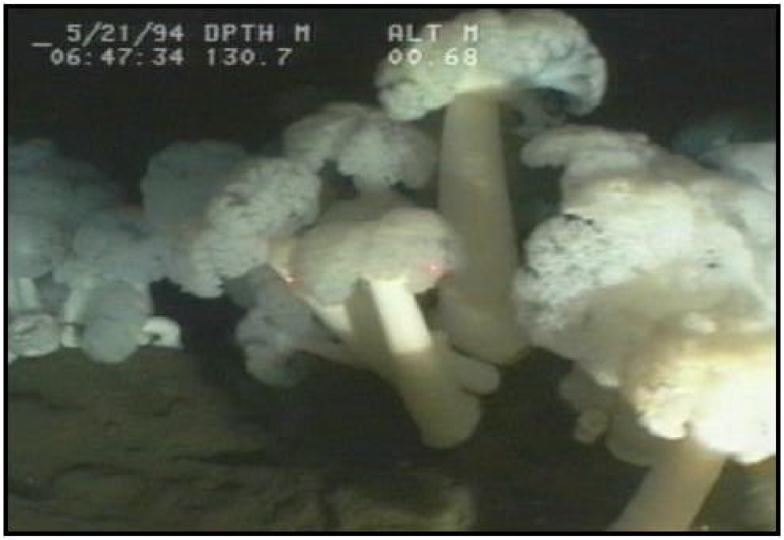


**Figure 4.** White-plumed anemone (*Metridium farcimen*) – Order Actiniaria, Suborder Nyantheae, FamilyMetridiidae. A yelloweye rockfish (*Sebastes ruberrimus*) and a redbanded rockfish (*S. babcocki*) are pictured in association with *M farcimen.*

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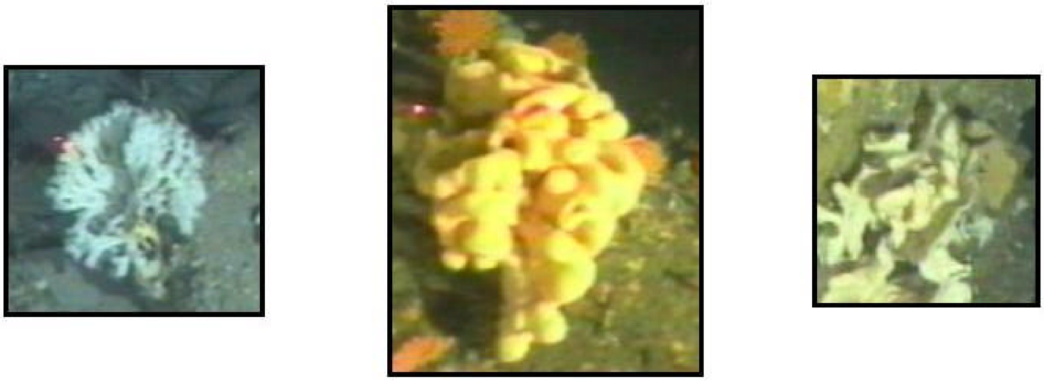
**Sponge Morphotypes** – Sponges were grouped by morphology because accurate taxonomic identification was not possible from video data. Therefore, groups within a morphotype category should not be considered taxonomically similar. Representative examples of each morphotype are listed below categories. Further investigation is being conducted to refine sponge identification to Family or Genus level where possible.

**Figure 5.** Category A - Pipe-shaped and tubular sponges. All sponges in this category have greater heights than diameters.

**Figure 6.** Category B - Cup-shaped and vase sponges. Representatives of this category have greater diameters than heights. Note yelloweye rockfish (*Sebastes ruberrimus*), unidentified rockfish (*Sebastes* spp.), and lingcod (*Ophiodon elongatus*) in association with Category B sponges.

**Figure 7.** Category C - Branching, lobate, and frilled sponges.



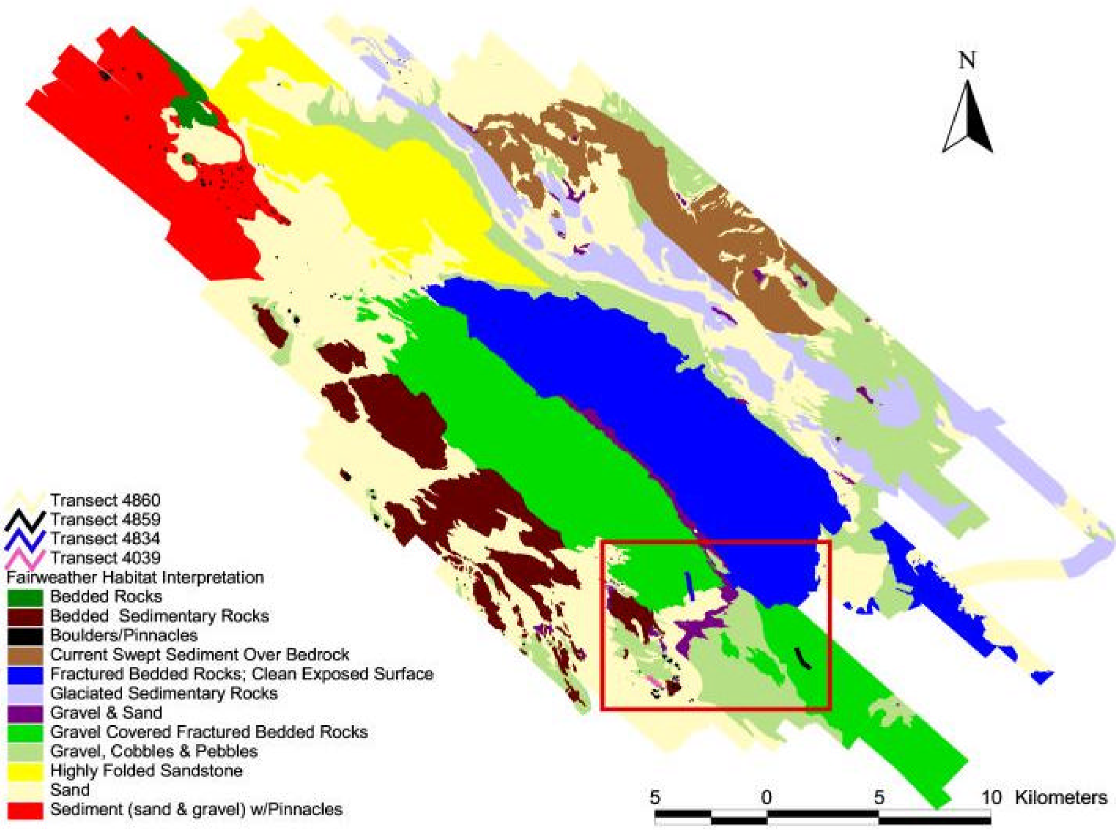



**Figure 8.** Habitat interpretation of Fairweather Grounds within the Yakutat (EYKT) management area (see Figures 1&2). Highlighted are four transects depicted in greater detail in Figures 9-12.

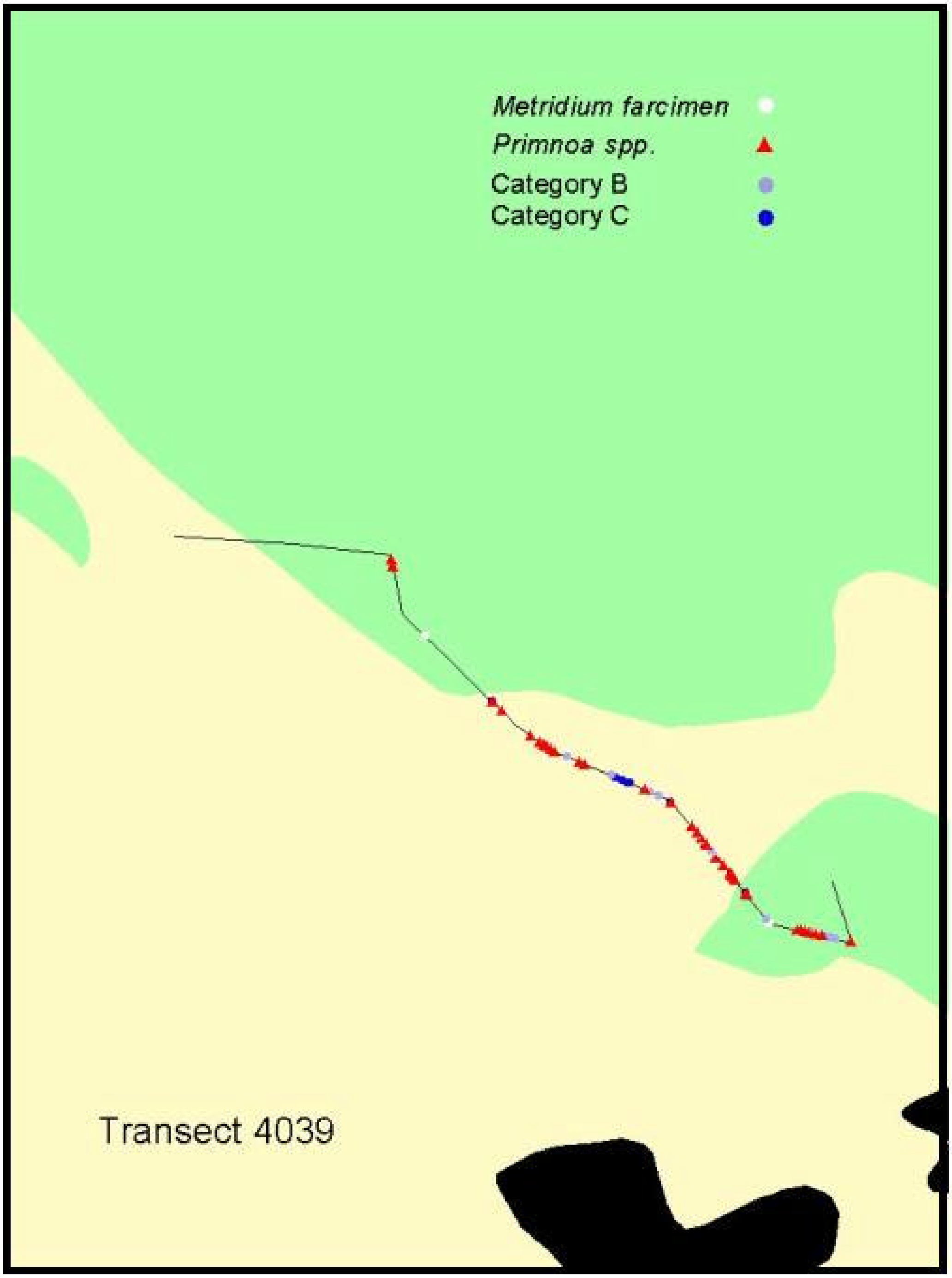



**Figure 9.** Detailed depiction of macroinvertebrates observed in Transect 4039 draped over a habitat interpretation of a portion of the Fairweather Grounds Region (EYKT). Large-scale habitat types along this transect consist of sand and gravel, cobbles, and pebbles.

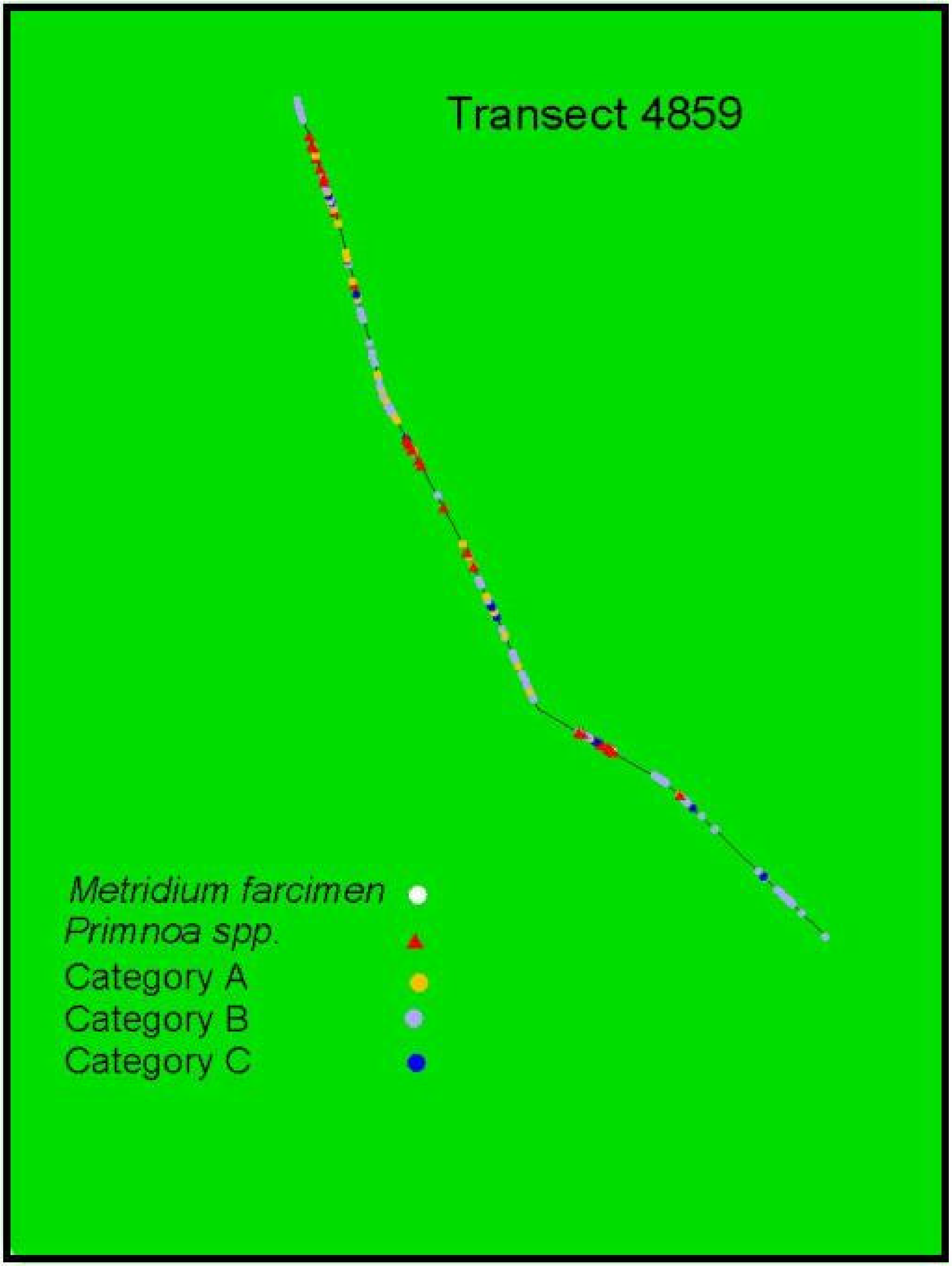



**Figure 10.** Detailed depiction of macroinvertebrates observed in Transect 4859 draped over a habitat interpretation of a portion of the Fairweather Grounds Region (EYKT). The large-scale habitat type along this transect is gravel-covered fractured bedded rock.

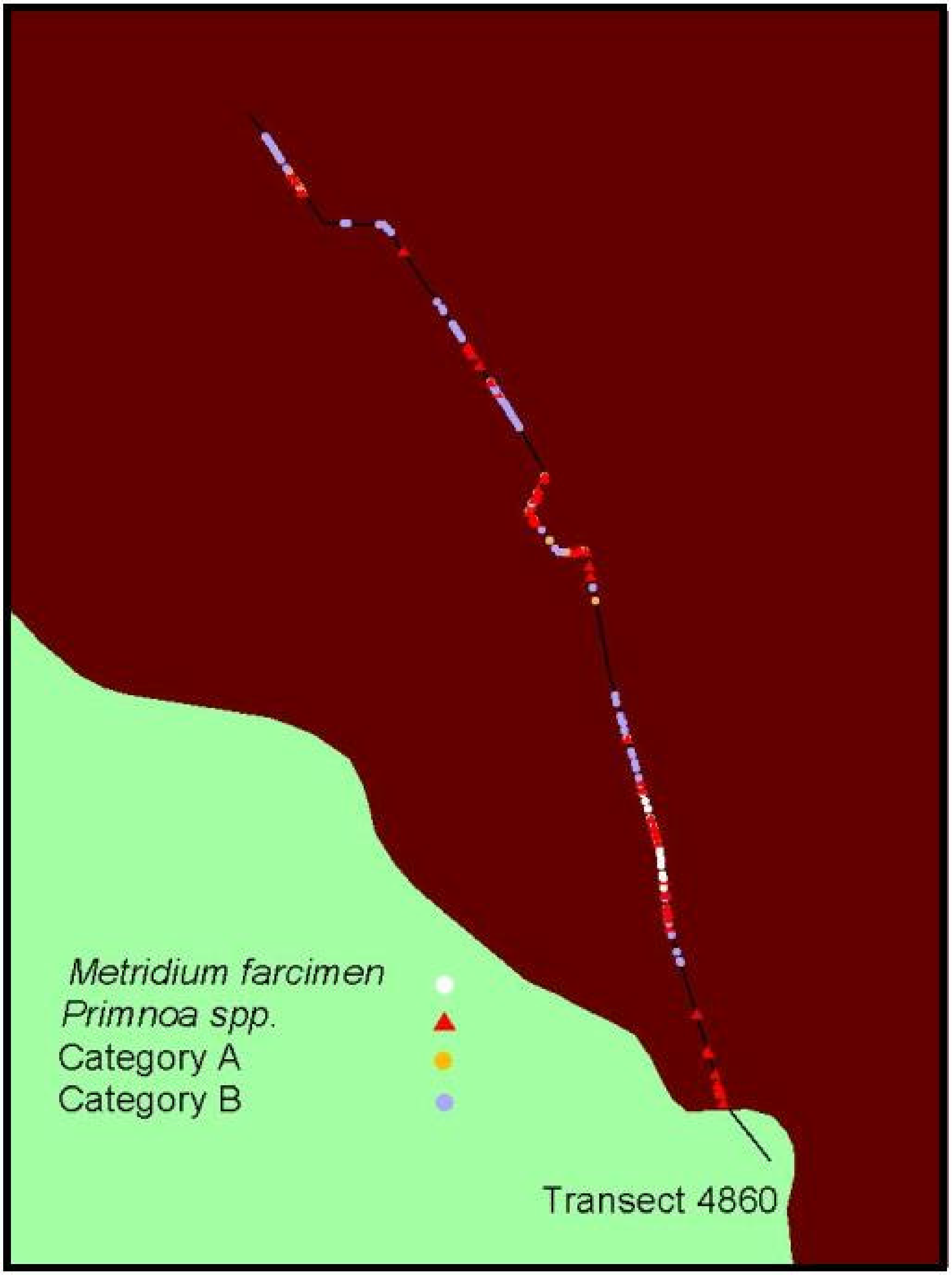



**Figure 11.** Detailed depiction of macroinvertebrates observed in Transect 4860 draped over a habitat interpretation of a portion of the Fairweather Grounds Region (EYKT). Large-scale habitat types along the transect consist of bedded sedimentary rocks and gravel, cobbles, and pebbles.

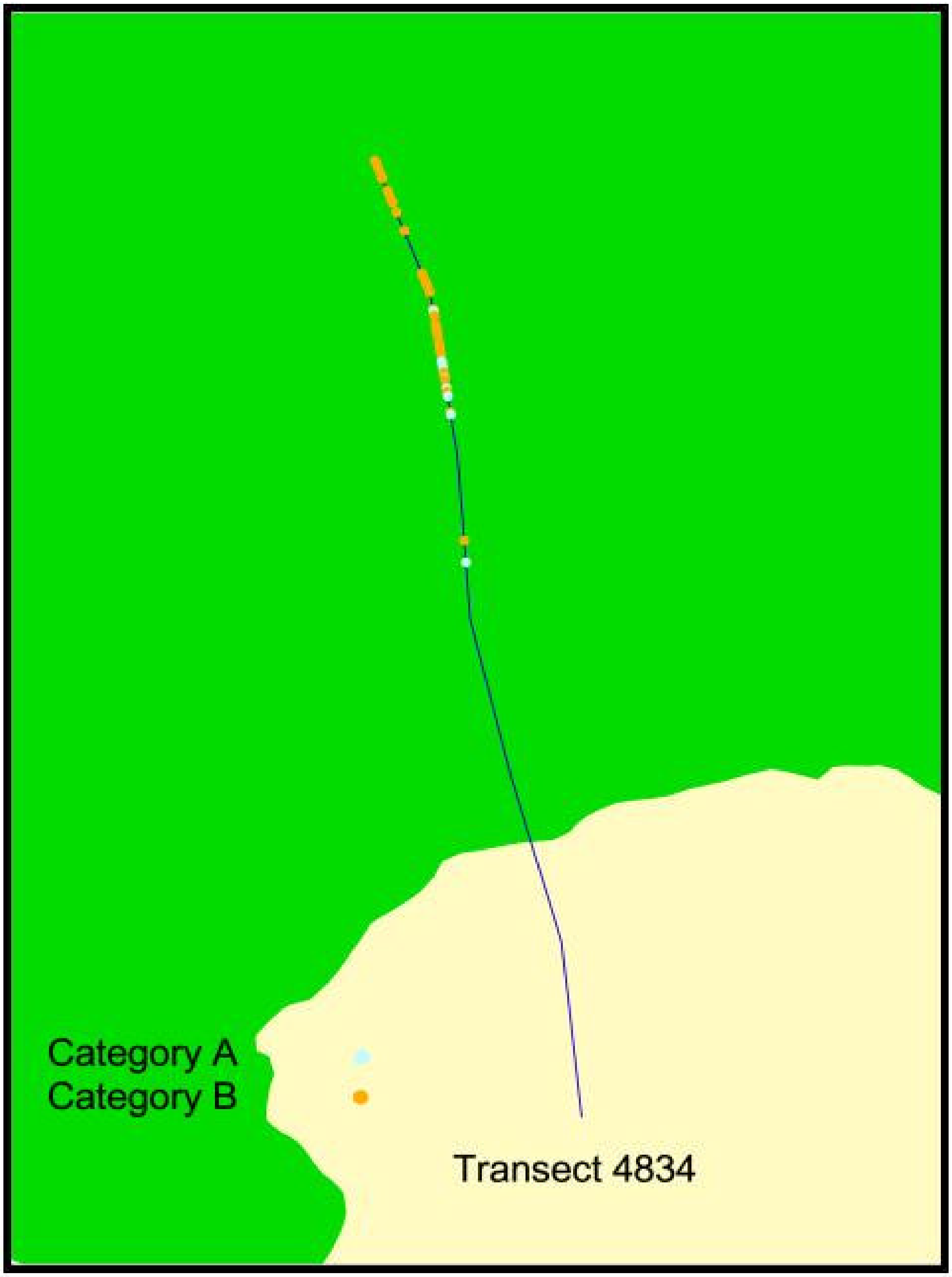



**Figure 12.** Detailed depiction of macroinvertebrates observed in Transect 4834 draped over a habitat interpretation of a portion of the Fairweather Grounds Region (EYKT). Large-scale habitat types along the transect consist of sand and gravel-covered fractured bedded rock.