GRAYS HARBOR AND CHEHALIS RIVER
IMPROVEMENTS TO NAVIGATION
ENVIRONMENTAL STUDIES

3 LEVEL

COMMUNITY STRUCTURE AND STANDING STOCK OF EPIBENTHIC ZOOPLANKTON AT FIVE SITES IN GRAYS HARBOR, WASHINGTON

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Using a suction pump, epibenthic zooplankton community structures and standing stock were measured in shallow sublittoral and middle littoral habitats at Cow Point, Moon Island, the Marsh Establishment Site, and Stearn's Bluff, and the lower littoral habitat of a site opposite the channel from Moon Island in Grays Harbor on 7 May 1981. Numerically and gravimetrically dominant organisms included harpacticoid copepods, primarily ectinosomids, and larvae and adult calanoid copepods, particularly _Eurytemora americana_ and _Acartia clausi_. Density and standing crop were somewhat higher at the

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0.00-m tidal elevations than at +2.1-m, except at the Marsh Establishment Site, where both density and standing crop were higher at +2.1-m. It was hypothesized that this relationship reflected the increased tidal and current velocities present at closer proximity to the navigation channel. Habitat disruption or removal associated with widening the navigation channel could potentially impact important prey resources of juvenille chum and chinook salmon and English sole, particularly at Moon Island, where the proportion of available fish foraging habitat in the shallow sublittoral zone is greater than at Stearn's Bluff.

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Community Structure and Standing Stock of Epibenthic Zooplankton at Five Sites in Grays Harbor, Washington

by

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COVER PHOTO: The sampling cylinder (left) and filtering column (right) used to sample epibenthic zooplankton.

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ABSTRACT

Using a suction pump, epibenthic zooplankton community structures and standing stock were measured in shallow sublittoral and middle littoral habitats at Cow Point, Moon Island, the Marsh Establishment Site, and Stearn's Bluff, and the lower littoral habitat of a site opposite the channel from Moon Island in Grays Harbor on 7 May 1981. Numerically and gravimetrically dominant organisms included harpacticoid copepods, primarily ectinosomids, and larvae and adult calanoid copepods, particularly *Eurytemora americana* and *Acartia clausi*. Density and standing crop were somewhat higher at the 0.0-m tidal elevations than at +2.1-m, except at the Marsh Establishment Site, where both density and standing crop were higher at +2.1-m. It was hypothesized that this relationship reflected the increased tidal and current velocities present at closer proximity to the navigation channel. Habitat disruption or removal associated with widening the navigation channel could potentially impact important prey resources of juvenile chum and chinook salmon and English sole, particularly at Moon Island, where the proportion of available fish foraging habitat in the shallow sublittoral zone is greater than at Stearn's Bluff.

1.0 INTRODUCTION

Epibenthic or hyperbenthic[1] organisms are important prey of estuarine and nearshore marine fishes, especially juvenile salmonids (Levy and Northcote 1981; Levy et al. 1979; Sibert and Kask 1978; Simenstad at al. 1979; and Simenstad and Kinney 1978, 1979). Epibenthic crustaceans, especially gammarid amphipods and harpacticoid copepods, are particularly important prey of juvenile salmonids during their early marine residence within or adjacent to estuaries (Healey 1979; Mason 1974: Sibert et al. 1977, in addition to the previous citations). Some studies, in fact, have suggested that estuarine residence time of juvenile salmonids is dependent upon the availability of preferred epibenthic crustaceans (Healey 1979; Simenstad et al. 1979).

Similarly, recent studies of juvenile salmonids migrating through or residing within Grays Harbor have illustrated that epibenthic crustaceans constitute the principal (based on frequency of occurrence and numerical and gravimetric composition) prey resources for most of these fishes (Buechner et al. 1981). As a part of these studies, in May 1980 the shallow sublittoral[2] and lower littoral[3] epibenthic habitats at Moon Island, the principal sampling site within that estuary, were sampled quantitatively over a complete tidal (including day-night) period (Cordell and Simenstad, 1981). Additional, expanded sampling of these habitats at Moon Island and other sites was conducted in May 1981 in order to document variation in community structure and standing crop due to site an tidal elevations.

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[1]Associated with the interface between the bottom and the water column directly above the bottom.

[2]Defined as between 0.0-m to -5-m tidal elevations.

[3]Defined as between 0.0-m and +2.0 m tidal elevations.

The objectives of this expansion of the earlier study were to sample systematically the littoral and shallow sublittoral epibenthic habitats at five sites in order to:

1. Document the community (taxonomic) structure of the epibenthic assemblages;
2. Estimate density and standing crop of the species comprising these assemblages;
3. Determine the differences, if any, in taxonomic structure and standing stock between the different sites and tidal elevations; and,
4. Relate the standing stock and availability of these animals to the previously documented food habits of nearshore fish and to the potential influence of continuing dredging activity in Grays Harbor.

2.0 MATERIALS AND METHODS

Littoral (+2.1 m) and shallow sublittoral (0.0-m) epibenthic zooplankton were sampled at Cow Point, Moon Island, Stearn's Bluff, and the Marsh Establishment Site; the 0.0-m level also was sampled at a site directly across the navigation channel from Moon Island (Fig. 1). These tidal elevations were chosen to represent and contrast two habitats which could be affected differentially by dredging because, although epibenthic zooplankton are distributed throughout littoral and sublittoral habitats, certain assemblages or components (taxa) may be concentrated within a narrow tidal range (Barnett 1968; Feller 1977 and 1980; Pennak 1942, Rees 1940).

The sampling apparatus (Fig. 2) used was a modified suction pump designed for the quantitative sampling of epibenthic communities, identical to that used at Moon Island in May 1980 (Cordell and Simenstad, 1981). Experience has indicated that this sampling method obtains epibenthic

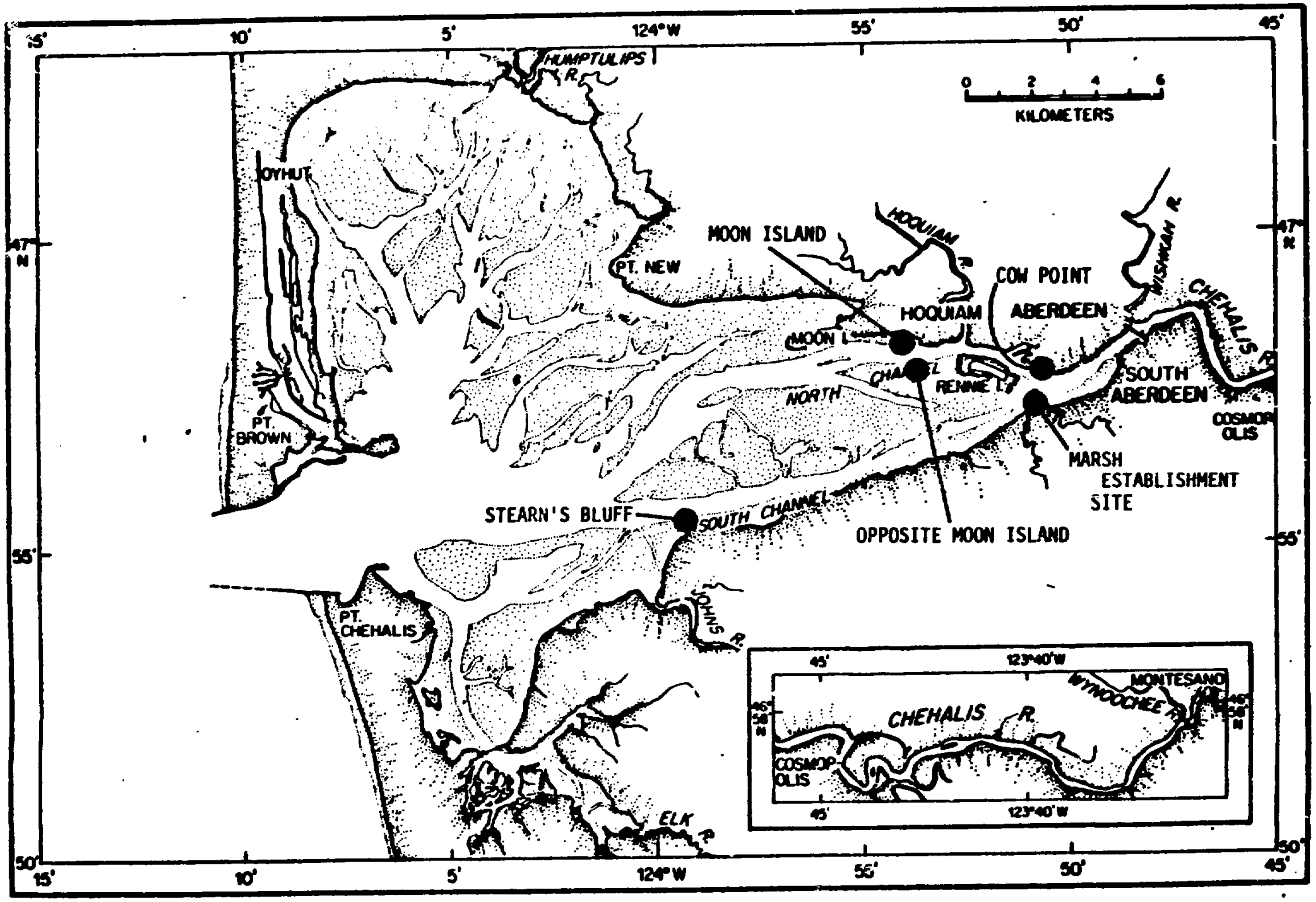

Fig. 1. Location of five epibenthic zooplankton sampling sites in Grays Harbor, Washington, 7 May 1981.

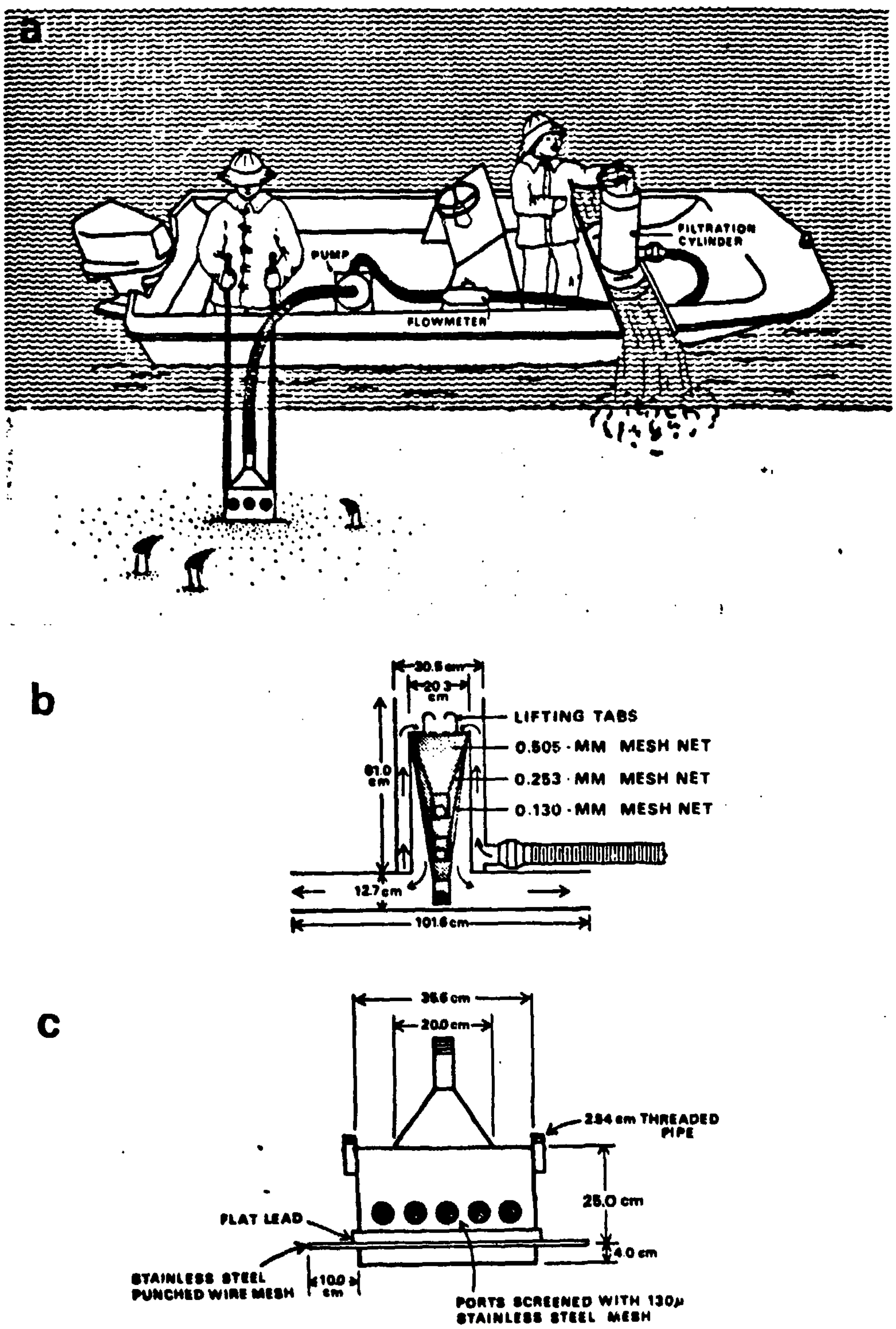

Fig. 2. Epibenthic suction pump system (a) and details of filtering column (b) and sampling cylinder (c) used in sampling epibenthic zooplankton in Grays Harbor, Washington, 7 May 1981.

zooplankton samples with minimal contamination from infaunal organisms. Sampling commenced at 1300 Pacific Standard Time (PST) during the flood tide and terminated at 1800 during the ebb tide on May 7, 1981 (Table 1). Duplicate samples of 500 liters (or until the ports on the sampling cylinder became clogged and sediment started entering the system) were obtained at approximately the 0.0 and +2.1-m tide levels. Water temperatures and salinity ranged between 11.3 and 14.0°C and 0.2 and 18.0°/oo, respectively, during the sampling at the five sites (Table 1).

In the laboratory, samples which contained exceedingly large numbers of organisms were systematically subsampled using a standard quartered petri dish or a Hensen Stempel pipette, depending upon the densities of organisms in the sample. They were then sorted to major taxonomic group and subsequently identified as specifically as possible. Wet weights of individual taxa were recorded to the nearest 0.001 g.

Data were encoded and tabulated using the systematic data management and processing systems for neritic and epibenthic zooplankton analyses described in Kinney et al. (1981) and Cordell and Simenstad (1981). In addition to calculating density and standing crop statistics these systems also calculated numerical and gravimetric diversity based upon the Shannon-Wiener diversity index:

$$H' = -\Sigma(p_i \log_2 p_i)$$

where p_i are ratios of the number or biomass of taxa i to the total abundance or biomass, respectively.

Density and standing crop are expressed in terms of m^{-3} of the water column within 0.25 m of the bottom; these values can be divided by four to arrive at equivalent m^{-2} estimates for comparison with similar areal values.

Table 1. Sequential locations, times, tide elevations, tide stage, water depth, temperature, and salinity of epibenthic zooplankton collections in Grays Harbor, 7 May 1981.

Site	Elevation (m from MLLW)	Sample time (PST)	Tide stage	Water depth (m)	Water Temperature (°C)	Water Salinity (°/oo)
Cow Point	0.0	1305-	Flood	1.3	11.5	0.2
Moon Island	+2.1	1330-1335	Flood	0.3	14.0	6.0
" , ".	0.0	1345-1350	Flood	2.0	12.3	8.3
Opposite Moon Island	0.0	1405-1410	Flood	2.4	12.2	9.1
Stearn's Bluff	+2.1	1525-1530	Flood Slack	0.4	13.0	12.3
" "	0.0	1550-1555	Ebb	2.3	12.9	18.0
Marsh Establishment Site	+2.1	1705-1710	Ebb	0.3	13.9	4.3
"	0.0	1730-1735	Ebb	1.4	11.3	4.3
Cow Point	+2.1	1750-1755	Ebb	0.3	11.3	3.8

3.0 RESULTS

3.1 Community Structure

Approximately 60 taxa were identified from the samples; not included in this total were such taxa as unidentified eggs and copepod larvae, because these categories were assumed to be products of adult stages which had already been recognized as discrete taxa (Appendix Table 1). Numerically dominant organisms from all sites and sample elevations combined included harpacticoid copepods of the family Ectinosomidae (38.4%), other harpacticoids (31.6%), and calanoid copepods (10.6%). Gravimetrically, the dominant taxa were other harpacticoids (22.5%), harpacticoids of the family Ectinosomidae (17.2%), and calanoids (12.2%).

Ectinosomids were numerically dominant in five out of the nine samples, with calanoid copepod larvae and adult calanoids predominant at three other sites. In one case, the Stearn's Bluff collection at 0.0-m, cletodid harpacticoids (primarily Leimia vaga) were the most numerous organisms (Figs. 3, 4, Appendix Table 2).

Gravimetrically, ectinosomids were predominant at four sample sites, the calanoids Eurytemora americana and Acartia clausi at several others, and the cumacean Cumella sp. at one, Stearn's Bluff +2.1-m (Table 2). Due to small weights of some individual taxa, however, abundant taxa such as "other harpacticoids" may have contributed significant biomass which is not reflected in the tabulated data.

3.2 Density

The total mean density of epibenthic zooplankton over all sites and tidal elevations was 46,462 organisms m^{-3} (Table 3). Mean densities at the 0.0-m elevation ranged from a low of 30,320 organisms m^{-3} at Moon Island to a high of 93,814 m^{-3} at Cow Point; densities at the +2.1-m elevation were lower, ranging from 3,180 organisms m^{-3} at Moon Island to 61,440 m^{-3} at the Marsh Establishment Site, the latter being the only

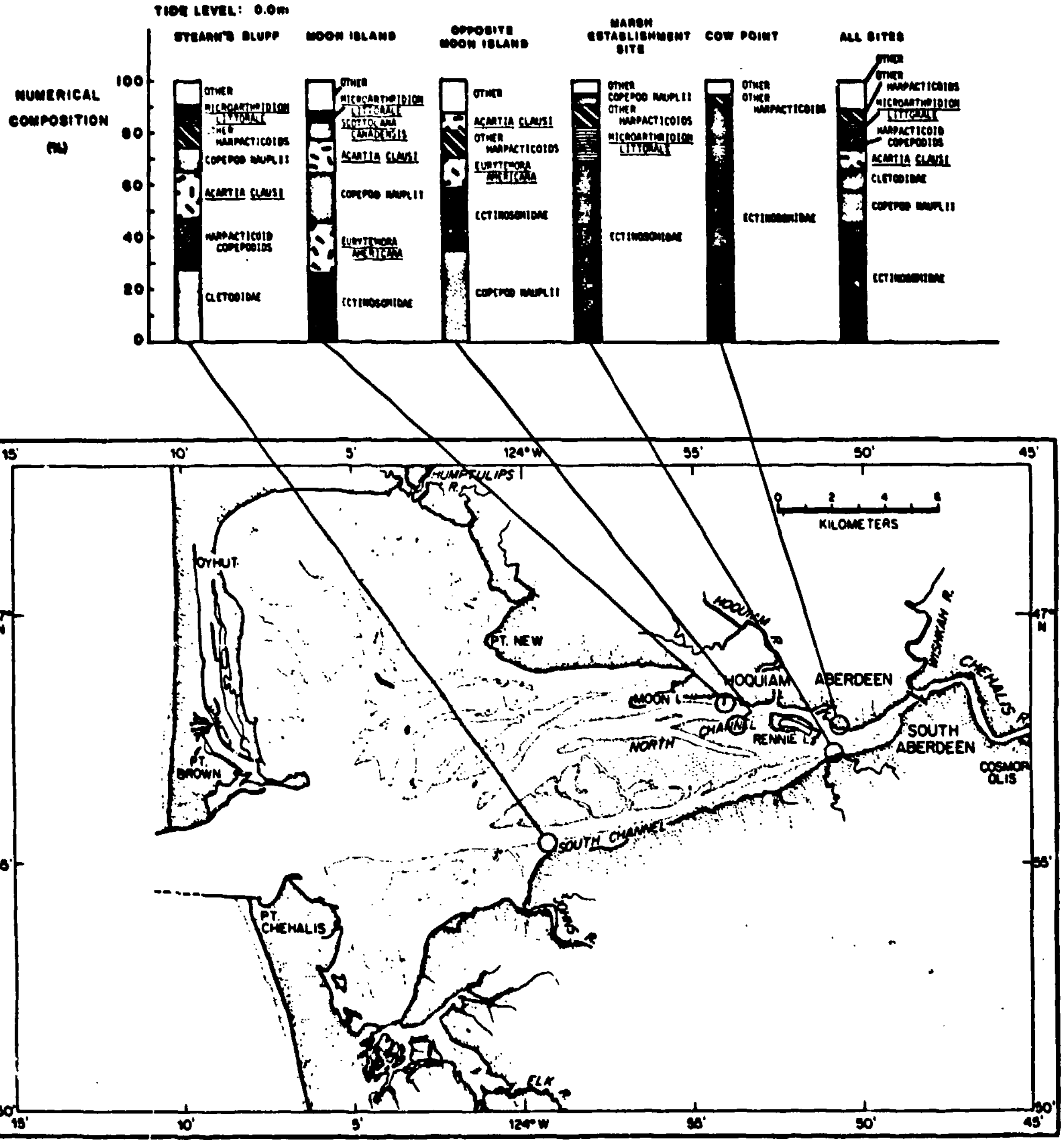

Fig. 3. Numerical composition (%) of epibenthic zooplankton at five sites and overall at the 0.0-m tidal elevation in Grays Harbor, Washington, 7 May 1981.

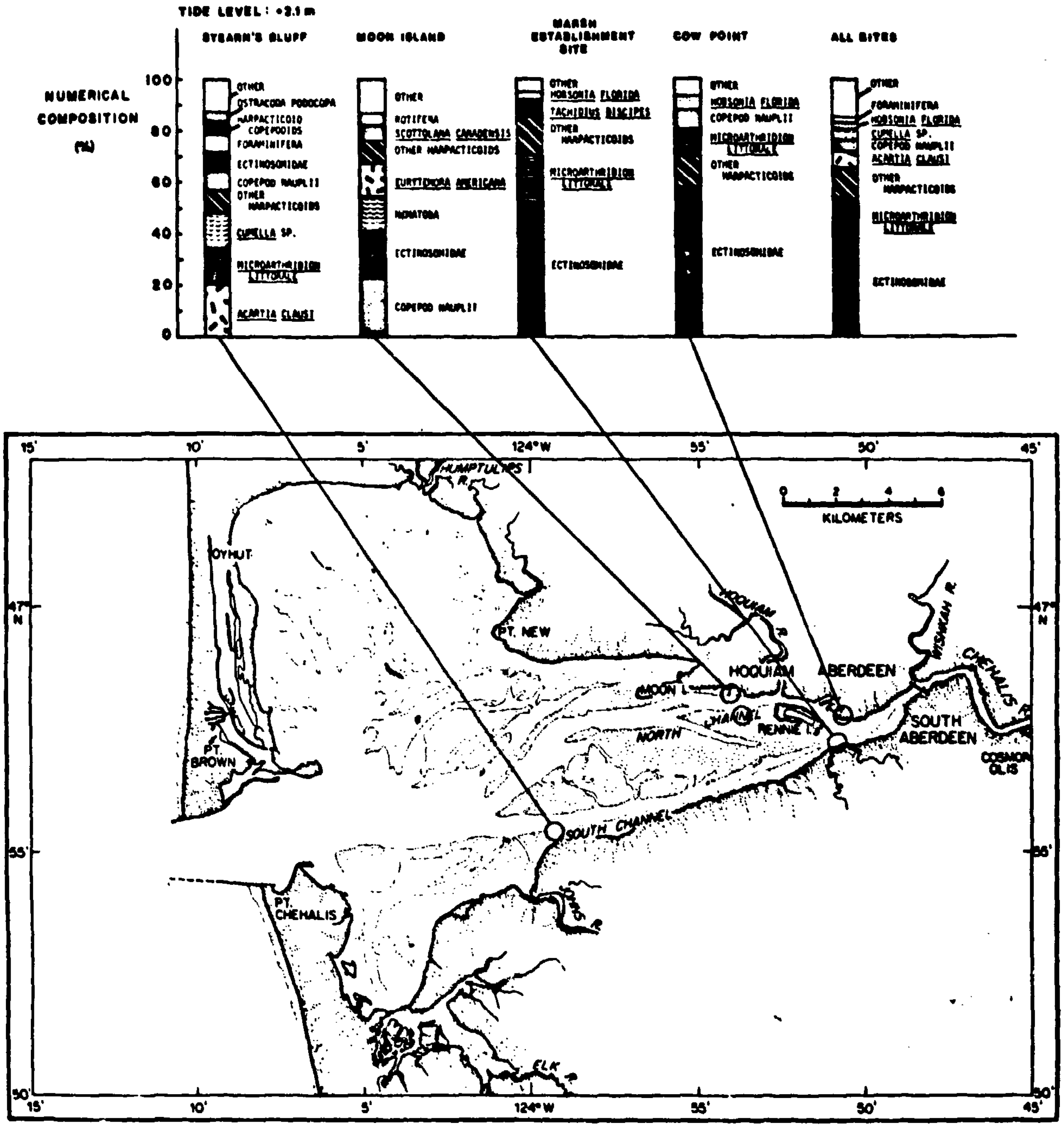

Fig. 4. Numerical composition (%) of epibenthic zooplankton at four sites and overall at the +2.1-m tidal elevation in Grays Harbor, Washington, 7 May 1981.

Table 2. Proportion of total abundance (%N) and biomass (%B) of epibenthic zooplankton contributed by dominant taxa at five sites and two tidal elevations in Grays Harbor, Washington, 7 May 1981.

Taxa	Site / tidal elevation (m)	Cow Point 0.0	Cow Point +2.1	Marsh Establishment Site 0.0	Marsh Establishment Site +2.1	Moon Island 0.0	Moon Island +2.1	Opposite Moon Island 0.0	Stearn's Bluff 0.0	Stearn's Bluff +2.1
Ectinosomidae	%N	89.9	58.4	69.2	51.8	26.2	18.3	23.5	3.0	7.1
	%B	43.6	14.9	36.6	12.3	16.5	10.8	6.6	5.5	4.3
Microarthridion littorale	%N	1.2	10.6	13.0	19.0	4.2	3.2	1.5	7.9	13.7
	%B	3.9	6.7	6.5	13.5	2.6	8.1	3.3	5.5	3.3
Eurytemora americana	%N	0.1	0	0	0	13.9	12.6	11.6	2.1	1.0
	%B	0.7	0	0	0	36.2	13.5	26.8	5.8	1.7
Hobsonia florida	%N	0	5.6	1.8	3.4	0	0	0	0	0.1
	%B	0	11.9	4.6	5.0	0	0	0	0	0.7
Gnorimosphaeroma oregonensis	%N	0	0.8	0	0	0	0	0	0	0
	%B	0	8.2	0	0	0	0	0	0	0
Acartia spp.	%N	0	0	0	0	12.4	0	7.1	17.9	20.9
	%B	0	0	0	0	4.0	0	4.4	17.8	5.0
Cumella sp.	%N	0	0.1	0	0	0.26	0	0.8	1.3	13.3
	%B	0	0.8	0	0	1.32	0	3.8	5.5	27.2

site where the density at +2.1 m exceeded that at 0.0 m. Despite high density, the lowest coefficient of variation was found at the 0.0 m elevation at Cow Point. Stearn's Bluff at 0.0 m had the second highest density estimate and the highest coefficient of variation. The total mean density for all samples taken at the 0.0-m elevation was 58,019 $\pm$ 26,882 organisms m^{-3}, as compared to 32,015 $\pm$ 24,985 m^{-3} for the samples from +2.1 m. Mean densities of harpacticoid copepods, the dominant taxa overall, ranged from 1,220 organisms m^{-3} at the +2.1-m Moon Island site to 89,155 m^{-3} at the Cow Point 0.0-m elevation (Table 4).

3.3 Standing Crop

Estimates of standing stock based on wet weights showed trends similar to those observed in the densities. Mean biomass from the 0.0-m tidal elevation sample ranged from 0.220 g m^{-3} at the Marsh Establishment site to 0.460 g m^{-3} at Stearn's Bluff (Table 3). The range was somewhat lower at the +2.1-m tidal elevation, from 0.020 g m^{-3} at Moon Island to 0.340 g m^{-3} at Stearn's Bluff. As with densities, the combined total mean biomass from the 0.0-m tidal elevation (0.321 g m^{-3}) was considerably higher than that from the samples taken at the +2.1-m elevation (0.205 g m^{-3}).

3.4 Diversity

Community diversity based on both abundance and biomass of organisms was typically higher for assemblages at the +2.1-m elevation than for those taken at the 0.0-m tidal elevation (Figs. 5 and 6). There was also an indication of decreasing numerical diversity with increasing distance into the upper (inner) estuary, i.e., from Moon Island to the Marsh Establishment Site.

4.0 DISCUSSION

As in the earlier study of the epibenthos of Moon Island (Cordell and Simenstad, 1981), the dominant animals in the May 1981 collections

Table 3. Mean (± s.d.) density (no. m^{-3}) and standing crop (g m^{-3}) of epibenthic organisms at five sites and two tidal elevations in Grays Harbor, Washington, May 1981. Coefficient of variation (about mean) is parentheses.

Site	Tidal elevation (m)	Total density ($\bar{x}$ + 1 s.d. no. m^{-3})	Total standing crop ($\bar{x}$ + 1 s.d. g m^{-3})
Cow Point	0.0	93,814±1, [illegible] (0.02)	0.383±0.081 (0.21)
	+2.1	22,360±14,878 (0.67)	0.140±0.085 (0.61)
Marsh Establishment Site	0.0	37,200±35,921 (0.97)	0.220±0.198 (0.90)
	+2.1	61,440±25,060 (0.41)	0.320±0.170 (0.53)
Moon Island	0.0	30,320±10,522 (0.35)	0.260±0.085 (0.33)
	+2.1	3,180±1,556 (0.49)	0.020±0.028 (1.41)
Opposite Moon Island	0.0	51,580±39,287 (0.76)	0.280±0.283 (1.01)
Stearn's Bluff	0.0	77,180±76,226 (0.99)	0.460±0.311 (0.68)
	+2.1	41,080±45,538 (1.11)	0.340±0.424 (1.25)
Total		46,462±37,741 (0.81)	0.269±0.206 (0.77)

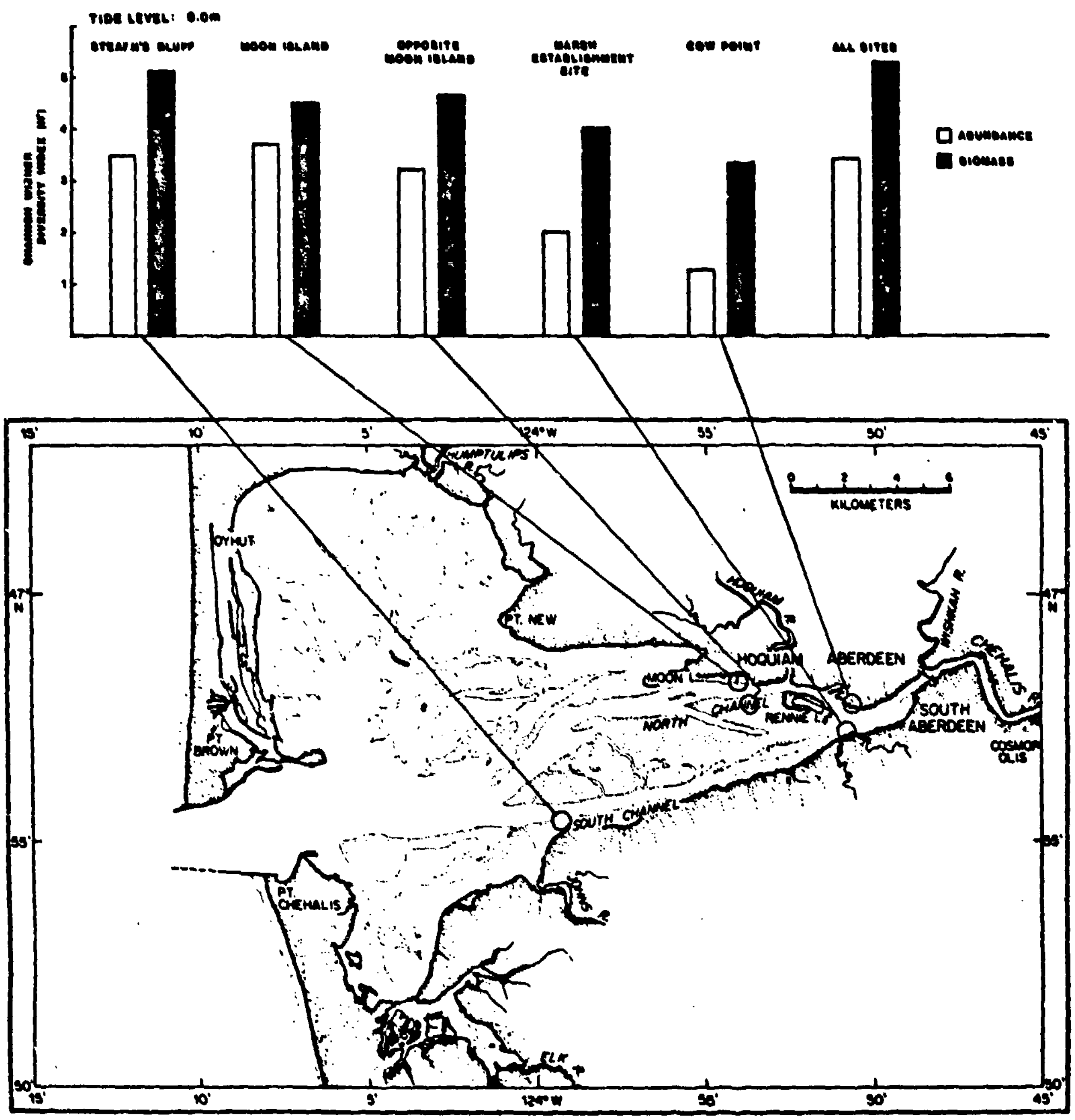

Fig. 5. Numerical and gravimetric diversity (Shannon-Wiener) of epibenthic zooplankton at five sites and overall at the 0.0-m tidal elevation in Grays Harbor, Washington, 7 May 1981.

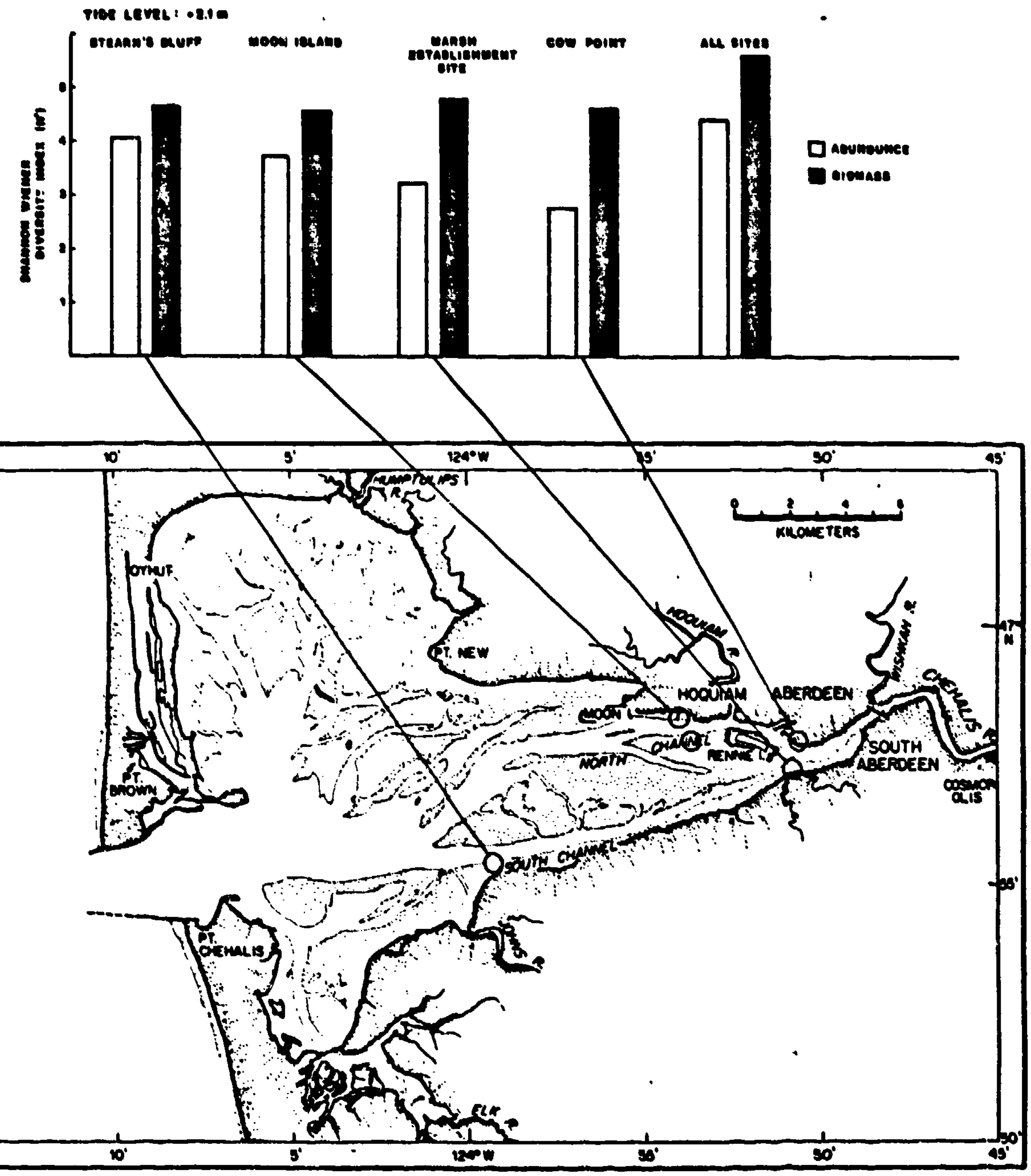

Fig. 6. Numerical and gravimetric diversity (Shannon-Wiener) of epibenthic zooplankton at four sites and overall at the +2.1-m tidal elevation in Grays Harbor, Washington, 7 May 1981.

consisted of previously documented estuarine forms such as euryhaline harpacticoids and the calanoid Eurytemora americana, and such coastal marine forms as Acartia clausi. However, the harpacticoid Leimia vaga, which was dominant in the 0.0-m collection at Stearn's Bluff and common at other sites, has apparently not been previously reported on the Pacific Coast: it was first reported in the stomachs of shad (Alosa sapidissima) from the Nova Scotia region, and was found in rock-pool algae and "Corophium mudflats" in New Brunswick (Willey 1929).[2]

Densities of epibenthic zooplankton found at the five sites in Grays Harbor in May 1981 fall well within the range of densities found at the 0.0 elevation at Moon Island in May 1980 (Cordell and Simenstad 1981) and in similar littoral and shallow sublittoral marine and estuarine habitats using similar sampling techniques (Houghton et al. 1981, Simenstad et al. 1980a,b). Densities of harpacticoid copepods, the dominant epibenthic taxa, were also quite comparable (overall $\bar{x}$ = 32,573 m^{-3}) to those found during the 1980 diel epibenthic sampling at Moon Island (overall $\bar{x}$ = 28,368 m^{-3}) (Cordell and Simenstad 1981) and to densities found using the same sampling apparatus in May 1980 in the Columbia River estuary ($\bar{x}$ = 28,508 m^{-3}) (Houghton et al. 1981). However, if these volumetric densities are converted to areal estimates based upon m^2 using the method described in Cordell and Simenstad (1981) the resulting densities (Table 4) were considerably lower than those described for either infaunal harpacticoids in both estuarine and marine habitats in this region (Kask and Sibert 1976, Feller 1977, 1980; Crandell 1967), or for other epibenthic zooplankton in nearshore marine communities in the region (Simenstad et al. 1981a,b). Harpacticoid

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[2]This demonstrates a common problem with the treatment of harpacticoid fauna of this region; the lack of documentation of cosmopolitan forms and of taxonomic and ecological literature on Pacific Coast Harpacticoida makes identification, recognition and discussion of the ecology of common forms difficult.

Table 4. Mean density (no. m^{-3} and no. m^{-2}) of harpacticoid copepods at five sites and two tidal elevations in Grays Harbor, Washington, May 1981.

Site	Tidal elevation (m)	Density of harpacticoid copepods $\bar{x}$ no. m^{-3}	$\bar{x}$ no. m^{-2}
Cow Point	0.0	89,155	22,289
	+2.1	17,980	4,425
Marsh Establishment Site	0.0	34,060	8,520
	+2.1	56,520	14,135
Moon Island	0.0	12,820	3,205
	+2.1	1,040	260
Opposite Moon Island	0.0	18,040	4,510
Stearn's Bluff	0.0	48,760	12,130
	+2.1	14,780	3,700
Total		32,573	8,130

densities were roughly equivalent however, to those found by epibenthic sled sampling in the Nanaimo River estuary (Sibert et al. 1977). These comparisons suggest that variation in the composition and standing crop of epibenthic zooplankton, particularly harpacticoid copepods, is primarily a function of variable estuarine habitats, although different sampling techniques prevent direct comparisons.

There is little if any published information as to the relationship between standing stock or diversity of epibenthic zooplankton and tidal elevation. Feller (1977, 1980) described the maximum density of a sand-dwelling meiobenthic harpacticoid, Huntemannia jadensis, to occur about MLLW. Several recent studies of marine epi- and infaunal macroinvertebrates in more hard-substrate habitats of this region have indicated a general decrease in diversity and abundance from low to high tidal elevations (Smith and Webber 1978, Nyblade 1977, Webber 1979). This general trend does not appear to apply to the finer sediment habitat in the Grays Harbor estuary, where related investigations of the benthic infauna at the same sampling sites (as we sampled) indicated lower diversity, but consistently and considerably higher densities of organisms at the +2.1-m elevation than at 0.0-m (R. Albright, unpublished data). This is in marked contrast to our documentation of epibenthic zooplankton communities, where considerably lower density but usually higher diversity were found at the +2.1-m elevation.

This apparent difference in the density and diversity of epibenthic and benthic infaunal animals at different tidal elevations may be due to different physical factors influencing their occurrence. Macroinvertebrate communities can be affected greatly by substrate size and stability and the tidal elevation at which they occur. For example, mid-littoral rock or cobble communities are often dominated by one or two species of barnacles; the result is high density and biomass but low community diversity. Epibenthic zooplankton communities, on the other hand, may be less affected by substrate character and tidal elevation than by tidal movement and current velocities producing resuspension of sediments. This idea is supported by recent studies which have indicated that epibenthic zooplankton communities in estuarine areas consist of both planktonic and benthic meiofaunal components (Cordell and Simenstad 1981; Houghton et al. 1981, Sibert, in press). If estuarine tides and currents also influence the structure of benthic communities (Warwick and Uncles 1980; Wildish and Kristmanson 1979) and epibenthic zooplankton communities are created and maintained by associated boundary layer turbulence (Bell and Sherman 1980 Sibert, in press), then higher densities at the 0.0 m elevations of the Grays Harbor sites sampled, which are located closer to the channels, may be the result of greater resuspension of meiofauna into the epibenthic environs than at the higher tidal elevation.

One might therefore expect that particular taxa which are most subject to tidal and current effects would dominate the epibenthic zooplankton community at the 0.0-m elevations, including meiofaunal harpacticoids which are easily suspended in the water column and calanoid copepods which are truly planktonic. It has been demonstrated that densities of these organisms at Grays Harbor can be greatly affected by tide stage and height (Cordell and Simenstad, 1981). The results of this study show higher densities of the planktonic calanoids Acartia clausi and Eurytemora americana, and of harpacticoids, particularly ectinosomids, at the 0.0-m elevations, this is consistent with the hypothesis of a larger role of current-manipulated communities at this elevation. Verification of this hypothesis would require further stratified sampling of the epibenthic zooplankton community coincident with fine resolution measurement of current velocities at various tidal elevations.

The relationship between the epibenthic zooplankton community of Moon Island and epibenthic predators, juvenile salmonids and English sole, was discussed previously (Cordell and Simenstad, 1981). Various epibenthic organisms, particularly cumaceans and harpacticoid copepods, were found to be major prey items, depending upon predator species. Two species of juvenile salmonids, chum (Oncorhynchus keta) and chinook (O. tshawytscha) and juvenile English sole (Parophrys vetulus) caught in shallow sublittoral and lower littoral habitats at Moon Island and Stearn's Bluff, were found to prey principally upon harpactiocids and the cumacean, Cumella sp. (Buechner et al. 1981). Chum preyed primarily upon harpacticoids, secondarily upon Cumella, while chinook preyed primarily upon Cumella sp. There were no obvious differences between the prey spectra at the two sites. Juvenile English sole caught in the shallow sublittoral and lower littoral habitat at Moon Island were also found to prey upon harpacticoid copepods, especially Scottolana canadensis, Corophium amphipods and Cumella.

The present study documents well-developed epibenthic communities at various sites in the Grays Harbor estuary which would serve as important prey resources to juvenile fish. Cumella sp. was most prevalent at Stearn's Bluff, especially at the +2.1-m tidal elevation, but also occurred at the 0.0-m tidal elevation at Moon Island and opposite Moon Island and at the +2.1-m tidal elevation at Cow Point (Table 2). Harpacticoid copepods occurred in maximum density at the lower tidal elevations at all sites except at the Marsh Establishment Site, where the density at +2.1-m was almost twice that at 0.0-m (Table 4). In the case of these two important prey taxa, therefore, effects of habitat disruption (i.e., dredging or filling) would vary according to the tidal elevation of the area impacted. Cumella sp. populations would be relatively unaffected by pertubations at lower tidal levels, except perhaps at Moon Island where Cumella are common at 0.0-m. Harpacticoids, on the other hand, would be more impacted at the lower tidal elevations. Harpacticoid populations at the Marsh Establishment Site, and perhaps throughout the broad mudflat habitat along the South Channel which that site represents, may be affected throughout the tidal range to +2.1-m.

Whether the actual harpacticoid species preferentially consumed by the juvenile salmonids and English sole would be differentially impacted is impossible to predict without more detailed taxonomic identification of the harpacticoids consumed by these predators than is presently available (Buechner et al., 1981).

Based upon the time which these shallow sublittoral and littoral habitats are inundated by the tide and available for utilization (i.e., foraging) by epibenthic-feeding fishes, the lower tidal elevations would provide a greater proportion of the available prey. Thus, the foraging habitat at lower elevations should not be considered comparable to higher elevation habitat even though prey densities might be equivalent or higher in the latter habitats. Accordingly, widening of the existing navigation channel would remove a greater proportion of the foraging habitat for juvenile chum salmon and English sole at Moon Island, where the area of alternative, the middle littoral habitat is not as extensive as at Stearn's Bluff. Due to their foraging on Cumella, juvenile chinook salmon would be less affected unless a large proportion of the middle littoral habitat were to be removed.

Nondestructive disruption of the epibenthic zooplankton community may, however, be short-term due to rapid recolonization of disturbed habitat via tidal or other resuspension of unaffected sediments and organisms. Rhoads et al. (1977) illustrated that meiofauna (defined by them as organisms <1000 μ and >300 μ in length) were important early colonists of dredge spoils, e.g., approximately three months after cessation of dredge spoil disposal. Sherman and Coull (in press; reported in Thistle 1980) reported that harpacticoids had recolonized a defaunated littoral mudflat plot within 12 hr and Thistle (1980) found that recolonization of small (~5 cm), disturbed patches took approximately 24 hr. Thus, as long as the surface sediment and near-bottom hydrological characteristics were not altered to the point of changing sediment size structure and stability, return to a representative epibenthic zooplankton community should be rapid, i.e., within one to three months. Dramatic changes in substrate character, on the other hand, would probably result in an unpredictable succession to a different epibenthic community structure and standing stock.

5.0 SUMMARY

1) Epibenthic zooplankton at shallow sublittoral (0.0-m) and middle littoral (+2.1-m) habitats of Cow Point, Moon Island, the Marsh Establishment Site, and Stearns Bluff, and the lower littoral habitat of a site opposite the channel from Moon Island were sampled quantitatively on 7 May 1981, using an epibenthic suction pump.

2) Numerically and gravimetrically dominant organisms included harpacticoid copepods, primarily ectinosomids, and the larvae and adults of calanoid copepods, particularly *Eurytemora americana* and *Acartia clausi*.

3) The mean total density of epibenthic organisms ranged from 3,180 organisms m^{-3} at the Moon Island + 2.1 m site to 93,294 m^{-3} at the Cow Point 0.0-m site. Density and standing crop were somewhat higher at the 0.0-m elevations than at +2.1-m, except at the Marsh Establishment Site, where both density and standing crop were highest at +2.1-m.

4) Community diversity based on both abundance and biomass of organisms was higher for samples from +2.1 m than for those taken at 0.0 m.

5) The standing stock of epibenthic zooplankton in Grays Harbor was found to be comparable to that found previously at Moon Island, and at other estuarine areas in the region.

6) It was theorized that the phenomenon of lower numbers of organisms and higher diversity at the +2.1-m sites than at the 0.0 m sites reflected the increased tidal and current velocities present at closer proximity to the navigation channel,

accounting for both resuspension of meiobenthic fauna as well as lateral transport of pelagic taxa.

7) The littoral and shallow sublittoral epibenthic zooplankton community at Grays Harbor consisted primarily of previously documented estuarine organisms, some of which have been shown to be important prey of juvenile fish.

8) Habitat disruption or removal could potentially impact important prey resources of juvenile chum and chinook salmon and English sole. Cumaceans would probably be affected primarily at higher tidal elevations, and harpacticoid copepods primarily at lower tidal elevations. Although there were no major differences in prey spectra of these fish species at Moon Island and Stearn's Bluff, it was suggested that the impact of widening the navigation channel would be greater at Moon Island due to the higher proportion of available fish foraging habitat in the shallow sublittoral zone.

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7.0 APPENDICES

Appendix Table 1. Computer-tabulated raw data from epibenthic zooplankton samples

Appendix Table 2. Percentage of numerically dominant organisms at different sites and elevations at Grays Harbor, Washington

The above appendices are available from Seattle District, Corps of Engineers, upon request.