PUGET SOUND
BENTHIC COMMUNITY ASSESSMENT

SUBMITTED TO

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE
OFFICE OF OCEAN RESOURCES, CONSERVATION AND ASSESSMENT
SILVER SPRING, MARYLAND 20910

PREPARED BY

BARRY A. VITTOR & ASSOCIATES, INC.
8060 COTTAGE HILL RD.
MOBILE, ALABAMA 36695
(334) 633-6100

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INTRODUCTION

The Puget Sound Estuary was sampled during June and July 1997. One aspect of this study was benthic community characterization, which was accomplished via sample collection by National Oceanic and Atmospheric Administration (NOAA) personnel and laboratory and data analysis by Barry A. Vittor & Associates, Inc. (BVA).

METHODS

Sample Collection And Handling

A Young dredge (area = 0.04 m^2) was used to collect bottom samples at each of 33 strata locations (3 station samples per stratum except Stratum 4 with 4) throughout northern Puget Sound. Samples were prescreened through 1.0 and 0.5 mm mesh seives, rescreened to remove formlin and preserved in 70% ethanol by the Washington State Dept. of Ecology's Marine Sediment Monitoring Unit. The preserved, 0.5 mm sample fractions were transported to Vittor & Associate's laboratory in Mobile, Alabama.

Macroinfaunal Sample Analysis

In the laboratory of BVA, benthic samples were inventoried, rinsed gently through a 0.5 mm mesh sieve to remove preservatives and sediment, stained with Rose Bengal, and stored in 70% isopropanol solution until processing. Sample material (sediment, detritus, organisms) was placed in white enamel trays for sorting under Wild M-5A dissecting microscopes. All macroinvertebrates were carefully removed with forceps and placed in labelled glass vials containing 70% isopropanol. Each vial represented a major taxonomic group (e.g. Polychaeta, Mollusca, Arthropoda). All sorted macroinvertebrates were identified to the lowest practical identification level (LPIL), which in most cases was to species level unless the specimen was a juvenile, damaged, or otherwise unidentifiable. The number of individuals of each taxon, excluding fragments, was recorded. A voucher collection was prepared, composed of representative individuals of each species not previously encountered in samples from the region.

DATA ANALYSIS

All data generated as a result of laboratory analysis of macroinfauna samples were first coded on data sheets. Enumeration data were entered for each species according to station and replicate. These data were reduced to a data summary report for each station, which included a taxonomic species list and benthic community parameters information. Archive data files of species identification and enumeration were prepared.

The QA/QC reports for the Puget Sound samples are given in Appendices A1 and A2. Quality control comments on dominant LPIL taxa are given in Appendix A3.

The analytical methodologies utilized for this study were similar to those used in other benthic community characterization reports prepared for NOAA. Macroinfaunal characterization involves an evaluation of several biological community structure parameters (e.g., species abundance, species composition and species diversity indices) during initial data reduction, followed by pattern and classification analysis for delineation of taxa assemblages. Since species are distributed along environmental gradients, there are generally no distinct boundaries between communities. However, the relationships between habitats and species assemblages often reflect the interactions of physical and biological factors and indicate major ecological trends.

Assemblage Structure

Several numerical indices were chosen for analysis and interpretation of the macroinfaunal data. Selection was based primarily on the ability of the index to provide a meaningful summary of data, as well as the applicability of the index to the characterization of the benthic community. Infaunal abundance is reported as the total number of individuals per station and the total number of individuals per square meter (= density). Taxa richness is reported as the total number of taxa represented in a given station collection.

Taxa diversity, which is often related to the ecological stability and environmental "quality" of the benthos, was estimated by the Pielou's Index (Pielou, 1966), according to the following

formula:

$$H' = -\sum_{i=1}^{s} p_i(ln\ p_i)$$

where, S = is the number of taxa in the sample,

i = is the i'th taxon in the sample, and

p_i = is the number of individuals of the i'th taxon divided by the total number of individuals in the sample.

Taxa diversity within a given community is dependent upon the number of taxa present (taxa richness) and the distribution of all individuals among those taxa (equitability or evenness). In order to quantify and compare faunal equitability to taxa diversity for a given area, Pielou's Index J' (Pielou, 1966) was calculated as $J' = H'/ln\ S$, where $ln\ S = H'_{max}$, or the maximum possible diversity, when all taxa are represented by the same number of individuals; thus, $J' = H'/H'_{max}$.

Macroinfaunal data were graphically and statistically analyzed to identify any differences in density and number of taxa per replicate between strata. Data for density and taxa richness (mean number of taxa per replicate) were square root transformed to meet normality assumptions (Shapiro-Wilk W; SAS Institute, 1995). Transformed density and taxa data were analyzed using a one-way ANOVA and post-hoc tests (SAS Institute, 1995). Correlations between density and taxa data and various sediment parameters were calculated using Pearson's Product Moment Correlation Coefficient (SAS Institute, 1995).

Cluster analysis (Boesch 1977) was performed on the faunal data to examine within- and between- strata differences in the Puget Sound stations and to compare faunal composition at each stratum within the site. Both normal and inverse cluster analyses were used in this study. Normal analysis (sometimes called Q-analysis) treats samples as individual observations, each being composed of a number of attributes (i.e. the various taxa from a given sample). Normal analysis is instructive in helping to ascertain community structure and to infer specific ecological conditions between sampling strata from the relative distributions of taxa. Inverse classification (termed R-

analysis) is based on taxa as individuals, each of which is characterized by its relative abundance in the various samples. This type of analysis is commonly used to identify taxa groupings with particular habitats or environmental conditions.

Cluster analysis of both strata collections (normal analysis) and taxa (inverse analysis) was performed using the Czekanowski quantitative index of faunal similarity (Field and MacFarlane 1968). This index is computationally equivalent to the Bray-Curtis similarity measure (Bray and Curtis 1957). The value of the similarity index is 1.0 when two samples are identical and 0 when no taxa are in common. Hierarchical clustering of similarity values is achieved using the group-average sorting strategy (Lance and Williams 1967) and displayed in the form of dendograms.

Both similarity classification and cluster analysis were performed using the microcomputer package, "Community Analysis System 5.0" (Bloom 1994), as modified for use in Vittor & Associate's benthic data management program. Taxa used in these analyses were selected according to their percent abundance and percent frequency. Total densities for each of the selected taxa at a given stratum were ln-transformed [x=ln(x+1)] for the analysis.

HABITAT CHARACTERISTICS

Sediment data for the 33 strata were provided to Vittor & Associates by NOAA and are given in Table 1 and Figures 1 and 2. Sediment composition at the 33 strata varied considerably throughout Puget Sound: percent moisture varied from 29% at Stratum 33 to 247% at Stratum 25; percent solids ranged from 29% at Stratum 25 to 78% at Stratum 33 (Table 1, Figure 1). Stratum sediment varied from 89% sand at Stratum 19 to 1% sand at Strata 8 and 11 (Table 1, Figure 2). The percent total organic carbon (TOC) fraction of the sediment was generally low with all values less than 10% (Table 1, Figure 2).

BENTHIC COMMUNITY CHARACTERIZATION

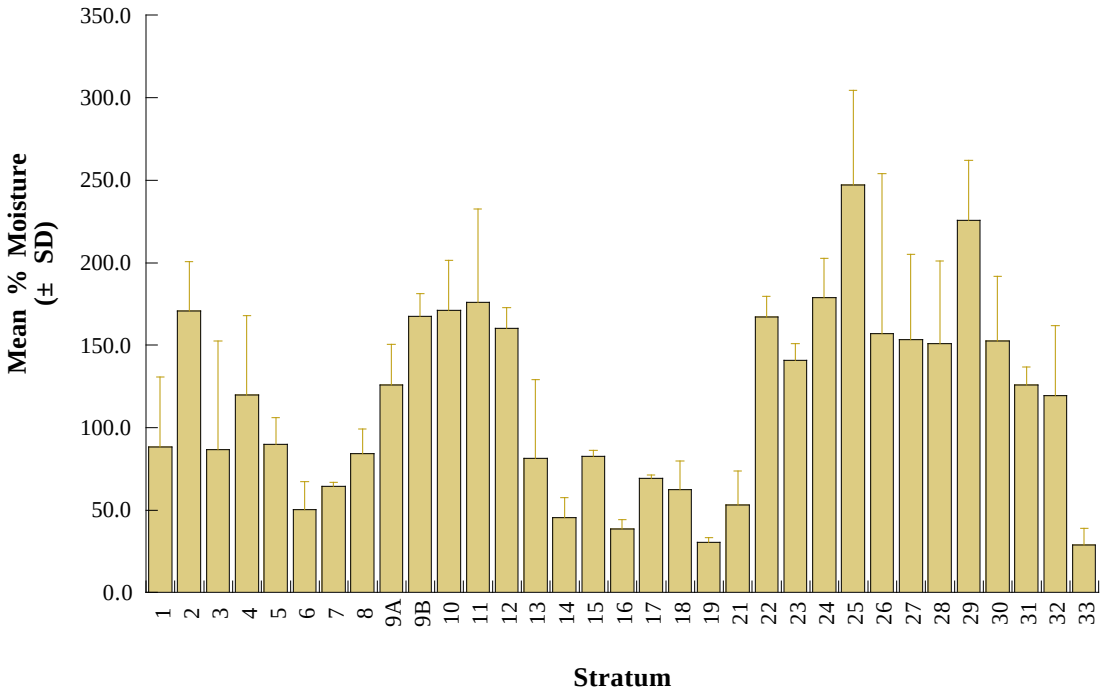
Faunal Composition, Abundance, And Community Structure

Table 2 provides a complete phylogenetic listing for all strata as well as data on taxa abundance and strata occurrence. Microsoft ™Excel (Macintosh version) spreadsheets are being

Table 1. Summary of sediment data for the Puget Sound strata, June-July 1997.

Stratum	N	Mean % TOC	% TOC SD	Mean % Moisture	% Moisture SD	Mean % Solids	% Solids SD	Mean % Sand	% Sand SD	Mean % Silt	% Silt SD	Mean % Clay	% Clay SD
1	3	1.46	0.59	88.43	42.32	55.13	13.90	53.40	22.13	36.73	17.70	5.80	1.18
2	3	1.75	0.30	170.80	29.96	37.23	4.17	5.53	2.87	76.67	3.72	15.17	2.37
3	3	1.02	0.73	86.57	66.02	57.90	18.46	58.97	49.32	31.20	35.38	8.97	8.86
4	4	1.34	0.37	119.90	47.98	46.85	8.46	18.75	13.38	63.08	10.25	14.98	3.46
5	3	1.20	0.15	89.83	16.45	52.93	4.37	15.67	4.54	72.70	4.27	8.80	2.55
6	3	0.76	0.20	50.43	16.97	67.03	8.06	52.43	20.51	38.03	14.64	10.23	6.12
7	3	1.25	0.37	64.50	2.35	60.80	0.87	14.23	15.82	70.53	13.71	12.03	0.81
8	3	1.61	0.06	84.27	15.02	54.50	4.25	1.27	0.06	84.67	1.70	12.00	1.91
9A	3	2.68	0.73	125.97	24.51	44.60	5.02	13.50	19.80	68.13	23.01	14.57	4.93
9B	3	2.68	0.44	167.57	13.86	37.47	1.95	2.40	1.25	74.07	5.70	21.03	0.93
10	3	2.79	0.60	171.40	29.93	37.17	4.37	5.47	5.93	71.30	7.04	19.33	5.72
11	3	2.12	0.09	176.07	56.75	37.17	6.87	1.43	0.38	63.87	13.04	35.27	6.04
12	3	1.85	0.17	160.33	12.34	38.47	1.79	3.57	1.98	69.17	2.59	23.37	5.72
13	3	1.00	0.58	81.67	47.43	58.00	17.14	40.90	45.34	43.13	33.19	14.90	10.88
14	3	0.83	0.24	45.57	12.10	69.03	5.92	76.43	10.76	16.97	8.36	4.47	0.95
15	3	1.41	0.23	82.63	3.71	54.77	1.10	16.00	0.80	61.93	2.02	18.27	0.32
16	3	0.66	0.15	38.40	5.85	72.33	3.05	68.17	4.72	19.17	6.76	6.60	0.36
17	3	1.34	0.23	69.50	2.01	59.00	0.70	18.20	4.91	69.30	8.20	9.67	3.31
18	3	1.01	0.06	62.63	17.39	61.97	6.79	58.93	7.46	35.47	12.46	8.20	1.13
19	3	0.37	0.11	30.47	3.07	76.67	1.76	88.63	6.41	5.27	3.35	2.77	1.65
21	3	0.65	0.22	53.00	20.66	66.23	9.55	41.80	29.37	42.63	22.92	12.03	6.27
22	3	1.50	0.16	167.03	12.78	37.50	1.81	10.63	11.99	67.80	11.61	16.37	4.54
23	3	1.69	0.04	140.87	10.30	41.57	1.76	5.47	3.10	73.47	2.30	17.37	4.75
24	3	1.97	0.09	178.70	23.79	36.07	3.24	3.83	0.97	70.60	3.22	22.17	5.39
25	3	1.83	0.25	247.13	57.38	29.40	5.37	2.97	0.55	69.47	5.75	21.90	2.76
26	3	1.45	0.79	157.10	96.76	44.23	21.20	31.00	37.10	34.77	22.06	28.50	16.86
27	3	1.34	0.14	153.40	51.82	40.73	9.32	2.37	0.91	66.37	5.06	26.57	8.55
28	3	1.70	0.47	151.13	49.88	40.87	7.95	19.73	25.05	54.20	22.40	22.10	2.88
29	3	8.47	1.49	225.70	36.34	30.97	3.55	18.93	7.96	62.77	6.14	8.23	2.11
30	3	5.65	1.40	152.50	39.15	40.20	5.74	24.97	10.79	54.17	15.53	6.17	1.63
31	3	5.48	0.62	126.07	10.71	44.30	2.13	25.10	4.08	61.30	10.44	6.00	2.69
32	3	1.61	0.35	119.40	42.29	46.70	8.75	25.83	19.51	57.57	16.32	16.30	3.70
33	3	0.53	0.69	29.00	9.81	77.80	5.65	87.53	16.67	8.43	13.31	2.00	3.12

Figure 1. Sediment percent moisture and solids data for the Puget Sound strata, June-July 1997



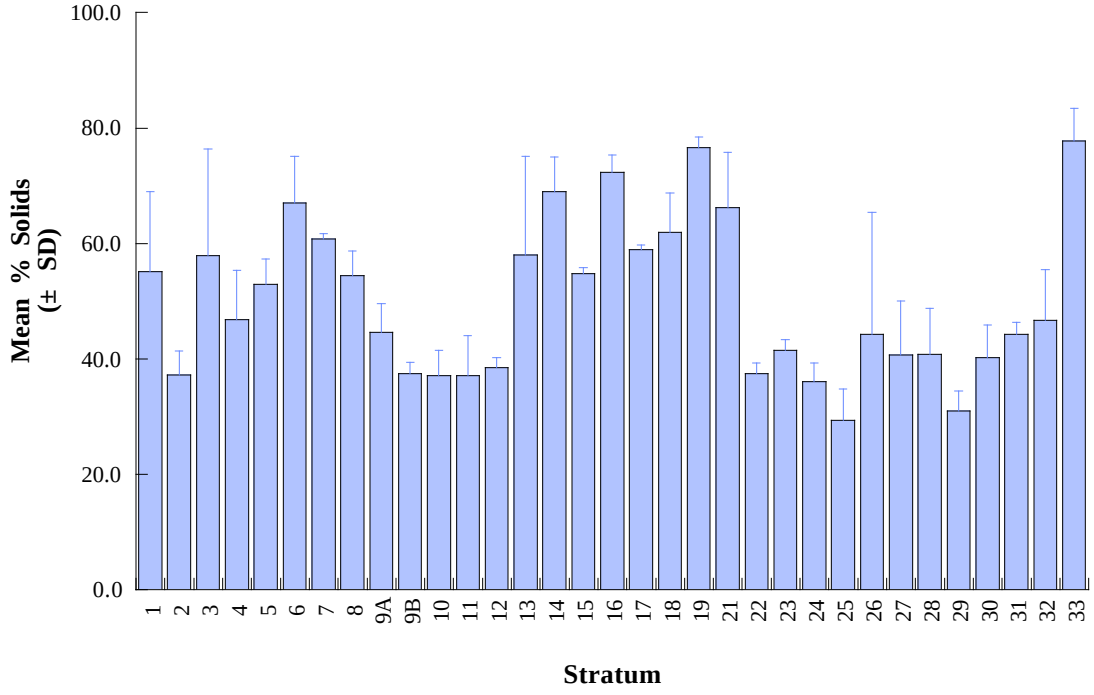
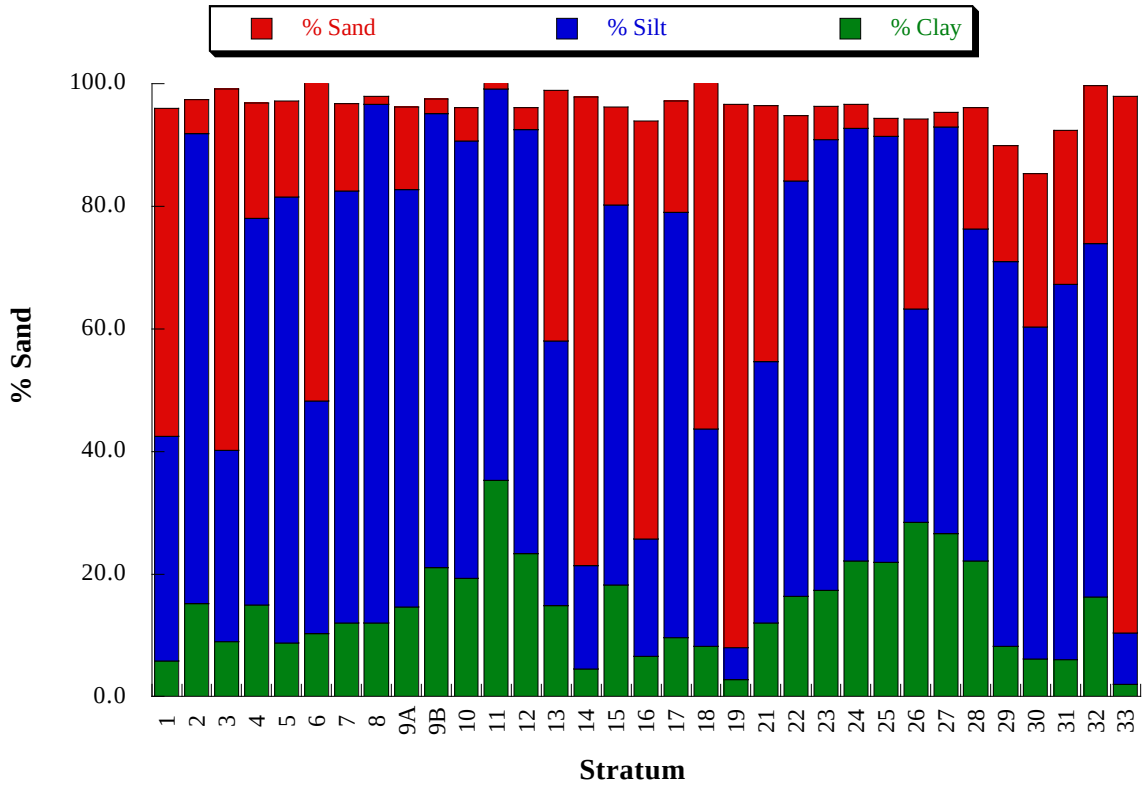


Figure 2. Sediment texture and percent total organic carbon (TOC) content for the Puget Sound strata, June-July 1997.



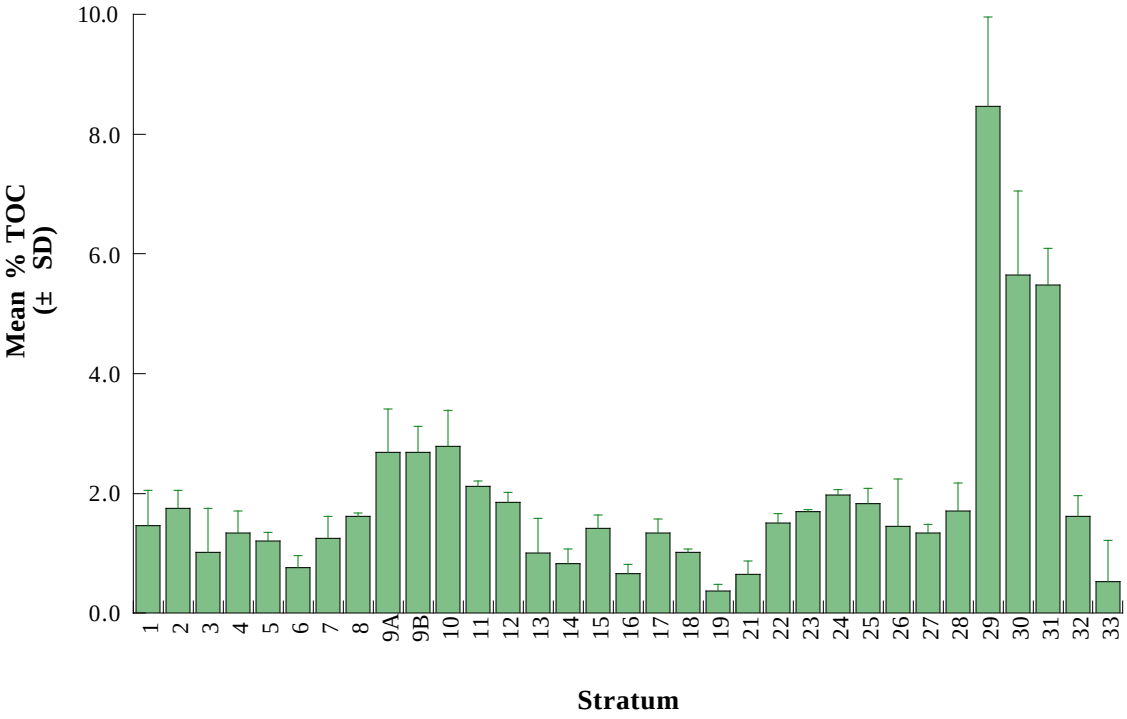


Table 2. Abundance and distribution of taxa for the Puget Sound strata, June-July 1997. Taxa above the shaded line were used in the cluster analysis.

Taxon Name	Phylum	Class	No. of Individuals	% Total	Cummulative %	Station Occurrence	Station % Occurrence
Protomedeia articulata	Ar	Mala	12780	17.871	17.871	23	69.7
Mysella tumida	M	Biva	7538	10.541	28.412	32	97
Eudorella pacifica	Ar	Mala	6436	9.000	37.412	26	78.8
Nephtys cornuta	A	Poly	6086	8.510	45.922	32	97
Oligochaeta (LPIL)	A	Olig	4967	6.946	52.868	28	84.8
Prionospio multibranchiata	A	Poly	1923	2.689	55.557	27	81.8
Axinopsida serricata	M	Biva	1901	2.658	58.215	5	15.2
Kellia laperousi	M	Biva	1785	2.496	60.711	18	54.5
Levinsenia gracilis	A	Poly	1749	2.446	63.157	26	78.8
Foxiphalus cognatus	Ar	Mala	1515	2.119	65.276	17	51.5
Pleurogonium rubicundom	Ar	Mala	1445	2.021	67.296	22	66.7
Cossura pygodactylata	A	Poly	1308	1.829	69.125	28	84.8
Harpiniopsis fulgens	Ar	Mala	1110	1.552	70.678	20	60.6
Yoldia myalis	M	Biva	861	1.204	71.882	18	54.5
Nucula tenuis	M	Biva	845	1.182	73.063	21	63.6
Mediomastus (LPIL)	A	Poly	831	1.162	74.225	29	87.9
Pholoe glabra	A	Poly	796	1.113	75.338	25	75.8
Amphiuridae (LPIL)	E	Ophi	723	1.011	76.349	20	60.6
Orchomene cf. *pinguis*	Ar	Mala	674	0.942	77.292	15	45.5
Semele rubropicta	M	Biva	646	0.903	78.195	11	33.3
Cirratulidae (LPIL)	A	Poly	634	0.887	79.082	18	54.5
Leptochelia savignyi	Ar	Mala	586	0.819	79.901	5	15.2
Vitrinella columbiana	M	Gast	530	0.741	80.642	9	27.3
Tellina (LPIL)	M	Biva	524	0.733	81.375	15	45.5
Lucinoma annulata	M	Biva	501	0.701	82.076	15	45.5
Bivalvia (LPIL)	M	Biva	489	0.684	82.760	28	84.8
Cheirimedeia zotea	Ar	Mala	485	0.678	83.438	8	24.2
Aoroides intermedius	Ar	Mala	467	0.653	84.091	6	18.2
Aphelochaeta (LPIL)	A	Poly	435	0.608	84.699	12	36.4
Prionospio steenstrupi	A	Poly	355	0.496	85.195	24	72.7
Prionospio (LPIL)	A	Poly	343	0.480	85.675	25	75.8
Aricidea lopezi	A	Poly	315	0.440	86.116	13	39.4
Ophelina breviata	A	Poly	280	0.392	86.507	7	21.2
Caprella (LPIL)	Ar	Mala	273	0.382	86.889	6	18.2
Tryphosella sarsi	Ar	Mala	273	0.382	87.271	4	12.1
Rhynchocoela (LPIL)	R		267	0.373	87.644	31	93.9
Photis californica	Ar	Mala	267	0.373	88.017	19	57.6
Exogone lourei	A	Poly	233	0.326	88.343	8	24.2
Leucon nasica	Ar	Mala	231	0.323	88.666	20	60.6
Aphelochaeta monilaris	A	Poly	221	0.309	88.975	10	30.3
Odostomia (LPIL)	M	Gast	212	0.296	89.272	19	57.6
Aricidea ramosa	A	Poly	206	0.288	89.560	7	21.2
Sigambra setosa	A	Poly	204	0.285	89.845	5	15.2
Owenia fusiformis	A	Poly	196	0.274	90.119	10	30.3
Munnogonium tillerae	Ar	Mala	194	0.271	90.390	18	54.5
Euspira pallida	M	Gast	190	0.266	90.656	3	9.1
Leitoscoloplos pugettensis	A	Poly	187	0.261	90.918	20	60.6
Mayerella banksia	Ar	Mala	170	0.238	91.155	5	15.2
Guernea reducans	Ar	Mala	165	0.231	91.386	7	21.2
Sphaerodoropsis sphaerulifer	A	Poly	148	0.207	91.593	17	51.5
Lucinidae (LPIL)	M	Biva	145	0.203	91.796	20	60.6
Leptochelia dubia	Ar	Mala	142	0.199	91.994	6	18.2
Podarkeopsis glabra	A	Poly	141	0.197	92.192	23	69.7
Cumella vulgaris	Ar	Mala	138	0.193	92.384	19	57.6
Glycinde picta	A	Poly	131	0.183	92.568	23	69.7
Mediomastus californiensis	A	Poly	125	0.175	92.742	7	21.2
Nebalia pugettensis	Ar	Mala	123	0.172	92.914	6	18.2
Alvania (LPIL)	M	Gast	121	0.169	93.084	8	24.2
Photis (LPIL)	Ar	Mala	120	0.168	93.251	7	21.2
Heteromastus filiformis	A	Poly	118	0.165	93.416	15	45.5

Table 2 continued:

Taxon Name	Phylum	Class	No. of Individuals	% Total	Cummulative %	Station Occurrence	Station % Occurrence
Capitella (LPIL)	A	Poly	115	0.161	93.577	8	24.2
Ischyrocerus anguipes	Ar	Mala	113	0.158	93.735	1	3
Isaeidae (LPIL)	Ar	Mala	113	0.158	93.893	8	24.2
Schistomeringos rudolphi	A	Poly	109	0.152	94.046	9	27.3
Ampelisca agassizi	Ar	Mala	106	0.148	94.194	2	6.1
Montacutidae (LPIL)	M	Biva	102	0.143	94.337	6	18.2
Lirobittium (LPIL)	M	Gast	102	0.143	94.479	7	21.2
Armandia brevis	A	Poly	101	0.141	94.620	19	57.6
Podarke pugettensis	A	Poly	100	0.140	94.760	12	36.4
Scoletoma (LPIL)	A	Poly	92	0.129	94.889	11	33.3
Arcteobea anticostiensis	A	Poly	90	0.126	95.015	13	39.4
Sphaerosyllis californiensis	A	Poly	87	0.122	95.136	3	9.1
Paraleptognathia (LPIL)	Ar	Mala	87	0.122	95.258	2	6.1
Trochochaeta multisetosa	A	Poly	85	0.119	95.377	14	42.4
Heteromastus (LPIL)	A	Poly	83	0.116	95.493	6	18.2
Synchelidium shoemakeri	Ar	Mala	80	0.112	95.605	14	42.4
Lumbrineris (LPIL)	A	Poly	75	0.105	95.710	13	39.4
Malmgreniella macginitiei	A	Poly	75	0.105	95.815	9	27.3
Glycinde armigera	A	Poly	74	0.103	95.918	17	51.5
Cossura (LPIL)	A	Poly	72	0.101	96.019	5	15.2
Gastropoda (LPIL)	M	Gast	66	0.092	96.111	25	75.8
Sternaspis scutata	A	Poly	65	0.091	96.202	12	36.4
Corophium brevis	Ar	Mala	65	0.091	96.293	4	12.1
Phoxocephalidae (LPIL)	Ar	Mala	65	0.091	96.384	17	51.5
Brada villosa	A	Poly	63	0.088	96.472	12	36.4
Lumbrineris cruzensis	A	Poly	63	0.088	96.560	9	27.3
Holothuroidea (LPIL)	E	Holo	58	0.081	96.641	4	12.1
Metaphoxus frequens	Ar	Mala	53	0.074	96.715	5	15.2
Scoloplos acmeceps	A	Poly	49	0.069	96.784	10	30.3
Ophelina acuminata	A	Poly	48	0.067	96.851	5	15.2
Campylaspis biplicata	Ar	Mala	48	0.067	96.918	3	9.1
Capitellidae (LPIL)	A	Poly	46	0.064	96.982	12	36.4
Lumbrineridae (LPIL)	A	Poly	45	0.063	97.045	12	36.4
Aricidea catherinae	A	Poly	44	0.062	97.107	8	24.2
Paraprionospio pinnata	A	Poly	44	0.062	97.168	9	27.3
Mysella (LPIL)	M	Biva	43	0.060	97.228	4	12.1
Diastylopsis tenuis	Ar	Mala	42	0.059	97.287	2	6.1
Semelidae (LPIL)	M	Biva	41	0.057	97.345	3	9.1
Aoridae (LPIL)	Ar	Mala	41	0.057	97.402	7	21.2
Aoroides (LPIL)	Ar	Mala	41	0.057	97.459	2	6.1
Pleusymptes subglaber	Ar	Mala	41	0.057	97.517	11	33.3
Aricidea (LPIL)	A	Poly	40	0.056	97.572	10	30.3
Cumella (LPIL)	Ar	Mala	40	0.056	97.628	7	21.2
Littorina saxatilis	M	Gast	39	0.055	97.683	4	12.1
Nephtys ferruginea	A	Poly	38	0.053	97.736	9	27.3
Corophium (LPIL)	Ar	Mala	36	0.050	97.786	7	21.2
Maldanidae (LPIL)	A	Poly	35	0.049	97.835	10	30.3
Pectinaria (LPIL)	A	Poly	35	0.049	97.884	7	21.2
Magelona longicornis	A	Poly	34	0.048	97.932	4	12.1
Cirratulus spectabilis	A	Poly	33	0.046	97.978	4	12.1
Eteone californica	A	Poly	33	0.046	98.024	11	33.3
Sphaerosyllis ranunculus	A	Poly	32	0.045	98.069	3	9.1
Dentalium (LPIL)	M	Scap	31	0.043	98.112	3	9.1
Harmothoe fragilis	A	Poly	29	0.041	98.153	4	12.1
Spionidae (LPIL)	A	Poly	28	0.039	98.192	15	45.5
Melita sulca	Ar	Mala	28	0.039	98.231	7	21.2
Amathimysis serrata	Ar	Mala	28	0.039	98.270	1	3
Glycera nana	A	Poly	27	0.038	98.308	8	24.2
Mytilus edulis	M	Biva	27	0.038	98.346	13	39.4
Munna ubiquita	Ar	Mala	27	0.038	98.383	3	9.1

Table 2 continued:

Taxon Name	Phylum	Class	No. of Individuals	% Total	Cummulative %	Station Occurrence	Station % Occurrence
Leuconidae (LPIL)	Ar	Mala	27	0.038	98.421	6	18.2
Paraonella spinifera	A	Poly	26	0.036	98.458	2	6.1
Bathymedon pumilus	Ar	Mala	25	0.035	98.493	3	9.1
Dyopedos monacanthus	Ar	Mala	25	0.035	98.528	7	21.2
Hesionidae (LPIL)	A	Poly	24	0.034	98.561	10	30.3
Turbonilla (LPIL)	M	Gast	24	0.034	98.595	9	27.3
Ampharete (LPIL)	A	Poly	23	0.032	98.627	5	15.2
Eteone (LPIL)	A	Poly	22	0.031	98.658	11	33.3
Cardiidae (LPIL)	M	Biva	20	0.028	98.686	7	21.2
Terebellides stroemi	A	Poly	18	0.025	98.711	10	30.3
Columbellidae (LPIL)	M	Gast	18	0.025	98.736	3	9.1
Ophelia limacina	A	Poly	17	0.024	98.760	1	3
Galathowenia oculata	A	Poly	17	0.024	98.783	3	9.1
Antalis (LPIL)	M	Scap	17	0.024	98.807	2	6.1
Synidotea sp.C	Ar	Mala	17	0.024	98.831	6	18.2
Lysianassidae (LPIL)	Ar	Mala	17	0.024	98.855	7	21.2
Mysta barbata	A	Poly	16	0.022	98.877	4	12.1
Syllis alternata	A	Poly	16	0.022	98.899	5	15.2
Diastylis (LPIL)	Ar	Mala	16	0.022	98.922	10	30.3
Heteropodarke heteromorpha	A	Poly	15	0.021	98.943	2	6.1
Onuphis elegans	A	Poly	15	0.021	98.964	4	12.1
Leitoscoloplos (LPIL)	A	Poly	15	0.021	98.985	1	3
Veneridae (LPIL)	M	Biva	15	0.021	99.006	4	12.1
Spiophanes berkeleyorum	A	Poly	14	0.020	99.025	3	9.1
Ampelisca hancocki	Ar	Mala	14	0.020	99.045	5	15.2
Diastylis pellucida	Ar	Mala	14	0.020	99.064	6	18.2
Ampharetidae (LPIL)	A	Poly	13	0.018	99.083	7	21.2
Nereis procera	A	Poly	13	0.018	99.101	3	9.1
Vitrinellidae (LPIL)	M	Gast	13	0.018	99.119	3	9.1
Calliopiella pratti	Ar	Mala	13	0.018	99.137	2	6.1
Amphipoda (LPIL)	Ar	Mala	12	0.017	99.154	8	24.2
Photis bifurcata	Ar	Mala	12	0.017	99.171	3	9.1
Scoletoma tetraura	A	Poly	11	0.015	99.186	3	9.1
Tenonia priops	A	Poly	11	0.015	99.202	4	12.1
Muricidae (LPIL)	M	Gast	11	0.015	99.217	3	9.1
Synidotea nodulosa	Ar	Mala	11	0.015	99.232	1	3
Ampelisca (LPIL)	Ar	Mala	11	0.015	99.248	7	21.2
Oedicerotidae (LPIL)	Ar	Mala	11	0.015	99.263	10	30.3
Pachynus cf. *barnardi*	Ar	Mala	11	0.015	99.278	7	21.2
Eudorella sp.A	Ar	Mala	11	0.015	99.294	1	3
Argissa hamatipes	Ar	Mala	10	0.014	99.308	5	15.2
Sphaerosyllis brandhorsti	A	Poly	9	0.013	99.320	3	9.1
Exogone molesta	A	Poly	9	0.013	99.333	6	18.2
Nuculana minuta	M	Biva	9	0.013	99.346	6	18.2
Caprellidae (LPIL)	Ar	Mala	9	0.013	99.358	4	12.1
Phyllodoce groenlandica	A	Poly	8	0.011	99.369	4	12.1
Pandora (LPIL)	M	Biva	8	0.011	99.381	5	15.2
Diastylis sp.I	Ar	Mala	8	0.011	99.392	3	9.1
Platynereis bicanaliculata	A	Poly	7	0.010	99.401	3	9.1
Paraonidae (LPIL)	A	Poly	7	0.010	99.411	2	6.1
Aricidea minuta	A	Poly	7	0.010	99.421	1	3
Phyllodoce longipes	A	Poly	7	0.010	99.431	5	15.2
Dipolydora (LPIL)	A	Poly	7	0.010	99.441	4	12.1
Syllidae (LPIL)	A	Poly	7	0.010	99.450	3	9.1
Exogone (LPIL)	A	Poly	7	0.010	99.460	5	15.2
Lucina tenuisculpta	M	Biva	7	0.010	99.470	2	6.1
Cyclostremella (LPIL)	M	Gast	7	0.010	99.480	2	6.1
Westwoodilla caecula	Ar	Mala	7	0.010	99.490	6	18.2
Eudorellopsis longirostris	Ar	Mala	7	0.010	99.499	1	3
Tubulanus (LPIL)	R		6	0.008	99.508	4	12.1
Chaetozone commonalis	A	Poly	6	0.008	99.516	1	3
Nephtyidae (LPIL)	A	Poly	6	0.008	99.525	5	15.2

Table 2 continued:

Taxon Name	Phylum	Class	No. of Individuals	% Total	Cummulative %	Station Occurrence	Station % Occurrence
Nephtys caecoides	A	Poly	6	0.008	99.533	3	9.1
Naticidae (LPIL)	M	Gast	6	0.008	99.541	4	12.1
Pontogeneia inermis	Ar	Mala	6	0.008	99.550	3	9.1
Cumella californica	Ar	Mala	6	0.008	99.558	1	3
Pinnotheridae (LPIL)	Ar	Mala	6	0.008	99.567	4	12.1
Spiochaetopterus costarum	A	Poly	5	0.007	99.573	3	9.1
Dorvilleidae (LPIL)	A	Poly	5	0.007	99.580	2	6.1
Ophryotrocha (LPIL)	A	Poly	5	0.007	99.587	2	6.1
Travisia (LPIL)	A	Poly	5	0.007	99.594	3	9.1
Malmgreniella (LPIL)	A	Poly	5	0.007	99.601	1	3
Spiophanes bombyx	A	Poly	5	0.007	99.608	2	6.1
Pseudopolydora kempi	A	Poly	5	0.007	99.615	4	12.1
Yoldia (LPIL)	M	Biva	5	0.007	99.622	3	9.1
Pandora filosa	M	Biva	5	0.007	99.629	3	9.1
Volvulella cylindrica	M	Gast	5	0.007	99.636	2	6.1
Hamineidae (LPIL)	M	Gast	5	0.007	99.643	1	3
Scaphopoda (LPIL)	M	Scap	5	0.007	99.650	3	9.1
Edotia sublittoralis	Ar	Mala	5	0.007	99.657	2	6.1
Monoculodes (LPIL)	Ar	Mala	5	0.007	99.664	5	15.2
Cnidaria (LPIL)	Cn		4	0.006	99.670	4	12.1
Golfingia (LPIL)	S		4	0.006	99.676	3	9.1
Ampharete acutifrons	A	Poly	4	0.006	99.681	3	9.1
Micropodarke dubia	A	Poly	4	0.006	99.687	3	9.1
Ceratonereis paucidentata	A	Poly	4	0.006	99.692	3	9.1
Orbiniidae (LPIL)	A	Poly	4	0.006	99.698	4	12.1
Pilargis berkeleyae	A	Poly	4	0.006	99.704	4	12.1
Polynoidae (LPIL)	A	Poly	4	0.006	99.709	4	12.1
Sabellidae (LPIL)	A	Poly	4	0.006	99.715	4	12.1
Anthuridae (LPIL)	Ar	Mala	4	0.006	99.720	1	3
Munnopsurus (LPIL)	Ar	Mala	4	0.006	99.726	2	6.1
Westwoodilla (LPIL)	Ar	Mala	4	0.006	99.732	3	9.1
Foxiphalus (LPIL)	Ar	Mala	4	0.006	99.737	1	3
Melitidae (LPIL)	Ar	Mala	4	0.006	99.743	3	9.1
Melita (LPIL)	Ar	Mala	4	0.006	99.748	2	6.1
Mysidae (LPIL)	Ar	Mala	4	0.006	99.754	1	3
Sipuncula (LPIL)	S		3	0.004	99.758	3	9.1
Tharyx parvus	A	Poly	3	0.004	99.762	1	3
Onuphis (LPIL)	A	Poly	3	0.004	99.766	3	9.1
Scoloplos (LPIL)	A	Poly	3	0.004	99.771	2	6.1
Phyllodoce hartmanae	A	Poly	3	0.004	99.775	3	9.1
Spio cirrifera	A	Poly	3	0.004	99.779	1	3
Ehlersia heterochaeta	A	Poly	3	0.004	99.783	3	9.1
Mytilidae (LPIL)	M	Biva	3	0.004	99.787	2	6.1
Clinocardium ciliatum	M	Biva	3	0.004	99.792	2	6.1
Chione (LPIL)	M	Biva	3	0.004	99.796	1	3
Thracia (LPIL)	M	Biva	3	0.004	99.800	1	3
Pyramidellidae (LPIL)	M	Gast	3	0.004	99.804	1	3
Paramunnidae (LPIL)	Ar	Mala	3	0.004	99.808	1	3
Ampelisca pugetica	Ar	Mala	3	0.004	99.813	2	6.1
Stenula (LPIL)	Ar	Mala	3	0.004	99.817	1	3
Diastylidae (LPIL)	Ar	Mala	3	0.004	99.821	2	6.1
Tanaidacea (LPIL)	Ar	Mala	3	0.004	99.825	1	3
Actiniaria (LPIL)	Cn	Anth	2	0.003	99.828	2	6.1
Lineidae (LPIL)	R		2	0.003	99.831	2	6.1
Phoronis (LPIL)	Ph		2	0.003	99.834	2	6.1
Chrysopetalum occidentale	A	Poly	2	0.003	99.836	2	6.1
Microphthalmus (LPIL)	A	Poly	2	0.003	99.839	2	6.1
Magelonidae (LPIL)	A	Poly	2	0.003	99.842	2	6.1
Nereididae (LPIL)	A	Poly	2	0.003	99.845	2	6.1
Opheliidae (LPIL)	A	Poly	2	0.003	99.848	2	6.1
Phyllodoce (LPIL)	A	Poly	2	0.003	99.850	2	6.1
Dipolydora caulleryi	A	Poly	2	0.003	99.853	2	6.1
Dipolydora cardalia	A	Poly	2	0.003	99.856	2	6.1

Table 2 continued:

Taxon Name	Phylum	Class	No. of Individuals	% Total	Cummulative %	Station Occurrence	Station % Occurrence
Rictaxis punctocaelatus	M	Gast	2	0.003	99.876	1	3
Sphaerosyllis (LPIL)	A	Poly	2	0.003	99.859	1	3
Terebellidae (LPIL)	A	Poly	2	0.003	99.862	2	6.1
Pista pacifica	A	Poly	2	0.003	99.864	1	3
Tellinidae (LPIL)	M	Biva	2	0.003	99.867	2	6.1
Hiatella arctica	M	Biva	2	0.003	99.870	1	3
Myidae (LPIL)	M	Biva	2	0.003	99.873	2	6.1
Littorinidae (LPIL)	M	Gast	2	0.003	99.878	1	3
Retusidae (LPIL)	M	Gast	2	0.003	99.881	1	3
Haliophasma geminatum	Ar	Mala	2	0.003	99.884	2	6.1
Stenothoidae (LPIL)	Ar	Mala	2	0.003	99.887	2	6.1
Gammarus (LPIL)	Ar	Mala	2	0.003	99.890	2	6.1
Melita dentata	Ar	Mala	2	0.003	99.892	1	3
Rhynohalicella halona	Ar	Mala	2	0.003	99.895	1	3
Aeginellidae (LPIL)	Ar	Mala	2	0.003	99.898	2	6.1
Pleustidae (LPIL)	Ar	Mala	2	0.003	99.901	2	6.1
Protellidae (LPIL)	Ar	Mala	2	0.003	99.904	1	3
Cumacea (LPIL)	Ar	Mala	2	0.003	99.906	1	3
Neomysis kadiakensis	Ar	Mala	2	0.003	99.909	1	3
Leptochelia (LPIL)	Ar	Mala	2	0.003	99.912	2	6.1
Pseudotanais oculatus	Ar	Mala	2	0.003	99.915	1	3
Araphura sp.A	Ar	Mala	2	0.003	99.917	1	3
Atyidae (LPIL)	Ar	Mala	2	0.003	99.920	1	3
Leptosynapta clarki	E	Holo	2	0.003	99.923	1	3
Melinna (LPIL)	A	Poly	1	0.001	99.924	1	3
Cossuridae (LPIL)	A	Poly	1	0.001	99.926	1	3
Glycera (LPIL)	A	Poly	1	0.001	99.927	1	3
Goniadidae (LPIL)	A	Poly	1	0.001	99.929	1	3
Glycinde (LPIL)	A	Poly	1	0.001	99.930	1	3
Gyptis (LPIL)	A	Poly	1	0.001	99.931	1	3
Rhodine bitorquata	A	Poly	1	0.001	99.933	1	3
Nephtys (LPIL)	A	Poly	1	0.001	99.934	1	3
Ceratonereis (LPIL)	A	Poly	1	0.001	99.936	1	3
Naineris uncinata	A	Poly	1	0.001	99.937	1	3
Phyllodocidae (LPIL)	A	Poly	1	0.001	99.938	1	3
Eulalia quadrioculata	A	Poly	1	0.001	99.940	1	3
Laonice (LPIL)	A	Poly	1	0.001	99.941	1	3
Dipolydora pygidialis	A	Poly	1	0.001	99.943	1	3
Chone magna	A	Poly	1	0.001	99.944	1	3
Laonome kroyeri	A	Poly	1	0.001	99.945	1	3
Polycirrus sp.L	A	Poly	1	0.001	99.947	1	3
Pectinariidae (LPIL)	A	Poly	1	0.001	99.948	1	3
Pholoides aspera	A	Poly	1	0.001	99.950	1	3
Crenella decussata	M	Biva	1	0.001	99.951	1	3
Cardiomya pectinata	M	Biva	1	0.001	99.952	1	3
Hiatellidae (LPIL)	M	Biva	1	0.001	99.954	1	3
Nuculanidae (LPIL)	M	Biva	1	0.001	99.955	1	3
Lyonsia californica	M	Biva	1	0.001	99.957	1	3
Mya pseudoarenaria	M	Biva	1	0.001	99.958	1	3
Acteonidae (LPIL)	M	Gast	1	0.001	99.959	1	3
Planorbidae (LPIL)	M	Gast	1	0.001	99.961	1	3
Scaphandridae (LPIL)	M	Gast	1	0.001	99.962	1	3
Lamellidorus fusca	M	Gast	1	0.001	99.964	1	3
Turbinellidae (LPIL)	M	Gast	1	0.001	99.965	1	3
Cyathura carinata	Ar	Mala	1	0.001	99.966	1	3
Idoteidae (LPIL)	Ar	Mala	1	0.001	99.968	1	3
Munna (LPIL)	Ar	Mala	1	0.001	99.969	1	3
Gnorimosphaerona oregonense	Ar	Mala	1	0.001	99.971	1	3
Ampeliscidae (LPIL)	Ar	Mala	1	0.001	99.972	1	3
Bathymedon (LPIL)	Ar	Mala	1	0.001	99.973	1	3
Gammaridae (LPIL)	Ar	Mala	1	0.001	99.975	1	3
Lagunogammarus setosus	Ar	Mala	1	0.001	99.976	1	3
Metaphoxus (LPIL)	Ar	Mala	1	0.001	99.978	1	3

Table 2 continued:

Taxon Name	Phylum	Class	No. of Individuals	% Total	Cummulative %	Station Occurrence	Station % Occurrence
Lepidepecreum sp.A	Ar	Mala	1	0.001	99.979	1	3
Syrrhoe longifrons	Ar	Mala	1	0.001	99.980	1	3
Amphilochus litoralis	Ar	Mala	1	0.001	99.982	1	3
Ischyroceridae (LPIL)	Ar	Mala	1	0.001	99.983	1	3
Ischyrocerus (LPIL)	Ar	Mala	1	0.001	99.985	1	3
Atylus levidensus	Ar	Mala	1	0.001	99.986	1	3
Mayerella (LPIL)	Ar	Mala	1	0.001	99.987	1	3
Amphipoda Family F	Ar	Mala	1	0.001	99.989	1	3
Cyclaspis (LPIL)	Ar	Mala	1	0.001	99.990	1	3
Leucon (LPIL)	Ar	Mala	1	0.001	99.992	1	3
Campylaspis rubromaculata	Ar	Mala	1	0.001	99.993	1	3
Campylaspis (LPIL)	Ar	Mala	1	0.001	99.994	1	3
Acarina (LPIL)	Ar	Arac	1	0.001	99.996	1	3
Synaptidae (LPIL)	E	Holo	1	0.001	99.997	1	3
Echinoidea (LPIL)	E	Echi	1	0.001	99.999	1	3
Asteroidea (LPIL)	E	Aste	1	0.001	100.000	1	3

Taxa Key

A = Annelida
- Olig = Oligochaeta
- Poly = Polychaeta

Ar = Arthropoda
- Arac = Arachnida
- Mala = Malacostraca

Cn = Cnidaria
- Anth = Anthozoa

E = Echinodermata
- Aste = Asteroidea
- Echi = Echinoidea
- Holo = Holothuroidea
- Ophiuroidea

M = Mollusca
- Biva = Bivalvia
- Gast = Gastropoda
- Scap = Scaphopoda

Ph = Phoronida

R = Rhynchocoela

S = Sipuncula

provided separately to NOAA which include: raw data on taxa abundance and density by station, a complete taxonomic listing with strata abundance and occurrence and QA/QC comments, a major taxa table with overall taxa abundance, and an assemblage parameter table including data on mean number of taxa, mean density, taxa diversity and taxa evenness by station and stratum.

A total of 71,512 organisms, representing 324 taxa, were identified from the 33 strata (Table 3). Polychaetes and amphipods were the most numerous organisms present representing 27% of the total assemblage, followed in abundance by other malacostracan taxa (14%) and oligochaetes (7%). Polychaetes represented 42% of the total number of taxa followed by amphipods (20%), other malacostracan taxa (14%), bivalves (11%) and other molluscs (8%) (Table 3). The percentage abundance of the major taxa at the 33 strata is given in Table 4 and Figure 3.

The dominant taxa collected from the strata were the malacostracan, *Protomedeia articulata*, the bivalve *Mysella tumida*, the malacostracan, *Eudorella pacifica*, the polychaete, *Nephtys cornuta* and Oligochaeta (LPIL) representing 17.9%, 10.5%, 9.0%, 8.5% and 7.0% of the total number of individuals, respectively (Table 2). *Mysella tumida* and *N. cornuta* were the most widely distributed taxa being found at 97% of the strata. The distribution of taxa representing > 10% of the total assemblage at each stratum is given in Table 5.

Station abundance and taxa data are summarized for the 33 strata in Table 6. Mean densities per strata ranged from 808.3 organisms·m^{-2} (SD = 437.6) at Stratum 29 to 54,850.0 organisms·m^{-2} (SD = 45,856.9) at Stratum 6 (Table 6, Figure 4). The total number of taxa collected at each stratum location ranged from 12 at Stratum 29 to 103 at Stratum 19 (Table 6, Figure 5). The mean number of taxa per stratum ranged from 7.3 taxa·rep^{-1} (SD = 4.2) at Stratum 29 to 52.0 taxa·rep^{-1} (SD = 17.0) at Stratum 19 (Table 6, Figure 6).

Table 3. Summary of overall abundance of major taxonomic groups for the Puget Sound strata June-July 1997.

TAXA	Total No. Taxa	% Total	Total No. Individuals	% Total
Annelida				
Polychaeta	136	42.0	19455	27.2
Oligochaeta	1	0.3	4967	6.9
Arthropoda				
Amphipoda	65	20.1	19318	27.0
Other Malacostraca	46	14.2	9738	13.6
Mollusca				
Bivalvia	34	10.5	15541	21.7
Other Mollusca	27	8.3	1416	2.0
Other Taxa	15	4.6	1077	1.5
TOTALS:	**324**		**71512**	

Table 4. Summary of abundance of major taxonomic groups by strata for the Puget Sound data, June-July 1997.

Stratum	Taxa	No. of Taxa	% of Total	No. of Individuals	% of Total
1	Annelida	21	43.8	885	57.3
	Arthropoda	14	29.2	395	25.6
	Mollusca	11	22.9	258	16.7
	Other Taxa	2	4.2	6	0.4
	TOTAL	48		1544	
2	Annelida	20	40.8	939	24.6
	Arthropoda	17	34.7	2646	69.4
	Mollusca	10	20.4	183	4.8
	Other Taxa	2	4.1	47	1.2
	TOTAL	49		3815	
3	Annelida	32	44.4	633	20.2
	Arthropoda	24	33.3	1284	41.0
	Mollusca	14	19.4	1191	38.0
	Other Taxa	2	2.8	25	0.8
	TOTAL	72		3133	
4	Annelida	29	38.7	772	28.4
	Arthropoda	28	37.3	1278	47.0
	Mollusca	15	20.0	600	22.0
	Other Taxa	3	4.0	72	2.6
	TOTAL	75		2722	
5	Annelida	20	38.5	789	21.6
	Arthropoda	15	28.8	2452	67.0
	Mollusca	15	28.8	387	10.6
	Other Taxa	2	3.8	31	0.8
	TOTAL	52		3659	
6	Annelida	35	41.7	1242	18.9
	Arthropoda	25	29.8	1129	17.2
	Mollusca	21	25.0	4163	63.2
	Other Taxa	3	3.6	48	0.7
	TOTAL	84		6582	

Table 4 continued:

Stratum	Taxa	No. of Taxa	% of Total	No. of Individuals	% of Total
7	Annelida	32	50.8	985	24.8
	Arthropoda	20	31.7	2645	66.5
	Mollusca	7	11.1	325	8.2
	Other Taxa	4	6.3	22	0.6
	TOTAL	63		3977	
8	Annelida	18	38.3	672	12.9
	Arthropoda	22	46.8	4427	84.7
	Mollusca	5	10.6	103	2.0
	Other Taxa	2	4.3	22	0.4
	TOTAL	47		5224	
9A	Annelida	20	48.8	501	21.3
	Arthropoda	13	31.7	1802	76.8
	Mollusca	5	12.2	33	1.4
	Other Taxa	3	7.3	11	0.5
	TOTAL	41		2347	
9B	Annelida	13	32.5	498	14.3
	Arthropoda	15	37.5	2847	82.0
	Mollusca	9	22.5	108	3.1
	Other Taxa	3	7.5	20	0.6
	TOTAL	40		3473	
10	Annelida	19	43.2	486	16.5
	Arthropoda	12	27.3	2120	71.8
	Mollusca	11	25.0	334	11.3
	Other Taxa	2	4.5	12	0.4
	TOTAL	44		2952	
11	Annelida	27	71.1	936	86.5
	Arthropoda	3	7.9	33	3.0
	Mollusca	5	13.2	105	9.7
	Other Taxa	3	7.9	8	0.7
	TOTAL	38		1082	
12	Annelida	23	56.1	822	73.7
	Arthropoda	7	17.1	45	4.0
	Mollusca	9	22.0	127	11.4
	Other Taxa	2	4.9	122	10.9
	TOTAL	41		1116	

Table 4 continued:

Stratum	Taxa	No. of Taxa	% of Total	No. of Individuals	% of Total
13	Annelida	43	45.3	889	32.2
	Arthropoda	29	30.5	708	25.6
	Mollusca	19	20.0	913	33.1
	Other Taxa	4	4.2	251	9.1
	TOTAL	95		2761	
14	Annelida	44	45.8	2622	52.8
	Arthropoda	31	32.3	1743	35.1
	Mollusca	15	15.6	580	11.7
	Other Taxa	6	6.3	21	0.4
	TOTAL	96		4966	
15	Annelida	24	35.8	493	21.9
	Arthropoda	18	26.9	743	33.0
	Mollusca	22	32.8	978	43.4
	Other Taxa	3	4.5	40	1.8
	TOTAL	67		2254	
16	Annelida	42	47.2	579	39.3
	Arthropoda	24	27.0	311	21.1
	Mollusca	19	21.3	554	37.6
	Other Taxa	4	4.5	29	2.0
	TOTAL	89		1473	
17	Annelida	41	48.8	1136	58.5
	Arthropoda	26	31.0	322	16.6
	Mollusca	15	17.9	480	24.7
	Other Taxa	2	2.4	5	0.3
	TOTAL	84		1943	
18	Annelida	35	51.5	1076	49.0
	Arthropoda	14	20.6	572	26.0
	Mollusca	16	23.5	529	24.1
	Other Taxa	3	4.4	21	1.0
	TOTAL	68		2198	
19	Annelida	49	47.6	296	20.9
	Arthropoda	30	29.1	106	7.5
	Mollusca	20	19.4	958	67.5
	Other Taxa	4	3.9	59	4.2
	TOTAL	103		1419	
21	Annelida	29	47.5	247	19.5
	Arthropoda	18	29.5	104	8.2
	Mollusca	11	18.0	889	70.2
	Other Taxa	3	4.9	27	2.1
	TOTAL	61		1267	

Table 4 continued:

Stratum	Taxa	No. of Taxa	% of Total	No. of Individuals	% of Total
22	Annelida	38	64.4	917	45.4
	Arthropoda	7	11.9	108	5.3
	Mollusca	12	20.3	970	48.0
	Other Taxa	2	3.4	26	1.3
	TOTAL	59		2021	
23	Annelida	33	67.3	1911	87.6
	Arthropoda	4	8.2	102	4.7
	Mollusca	9	18.4	153	7.0
	Other Taxa	3	6.1	15	0.7
	TOTAL	49		2181	
24	Annelida	43	71.7	623	66.6
	Arthropoda	3	5.0	26	2.8
	Mollusca	13	21.7	269	28.8
	Other Taxa	1	1.7	17	1.8
	TOTAL	60		935	
25	Annelida	32	68.1	739	63.0
	Arthropoda	8	17.0	127	10.8
	Mollusca	6	12.8	305	26.0
	Other Taxa	1	2.1	2	0.2
	TOTAL	47		1173	
26	Annelida	37	52.1	519	55.1
	Arthropoda	23	32.4	288	30.6
	Mollusca	9	12.7	110	11.7
	Other Taxa	2	2.8	25	2.7
	TOTAL	71		942	
27	Annelida	28	59.6	720	80.0
	Arthropoda	8	17.0	99	11.0
	Mollusca	9	19.1	76	8.4
	Other Taxa	2	4.3	5	0.6
	TOTAL	47		900	
28	Annelida	32	50.0	417	52.9
	Arthropoda	17	26.6	85	10.8
	Mollusca	13	20.3	276	35.0
	Other Taxa	2	3.1	10	1.3
	TOTAL	64		788	

Table 4 continued:

Stratum	Taxa	No. of Taxa	% of Total	No. of Individuals	% of Total
29	Annelida	6	50.0	28	28.9
	Arthropoda	6	50.0	69	71.1
	Mollusca	0	0.0	0	0.0
	Other Taxa	0	0.0	0	0.0
	TOTAL	12		97	
30	Annelida	16	47.1	92	36.8
	Arthropoda	14	41.2	143	57.2
	Mollusca	4	11.8	15	6.0
	Other Taxa	0	0.0	0	0.0
	TOTAL	34		250	
31	Annelida	27	58.7	99	49.5
	Arthropoda	14	30.4	39	19.5
	Mollusca	4	8.7	60	30.0
	Other Taxa	1	2.2	2	1.0
	TOTAL	46		200	
32	Annelida	40	54.1	749	43.1
	Arthropoda	21	28.4	152	8.8
	Mollusca	11	14.9	763	44.0
	Other Taxa	2	2.7	72	4.1
	TOTAL	74		1736	
33	Annelida	22	43.1	110	28.8
	Arthropoda	16	31.4	106	27.7
	Mollusca	11	21.6	162	42.4
	Other Taxa	2	3.9	4	1.0
	TOTAL	51		382	

Figure 3. Percent abundance of major taxonomic groups for the Puget Sound strata, June-July 1997.

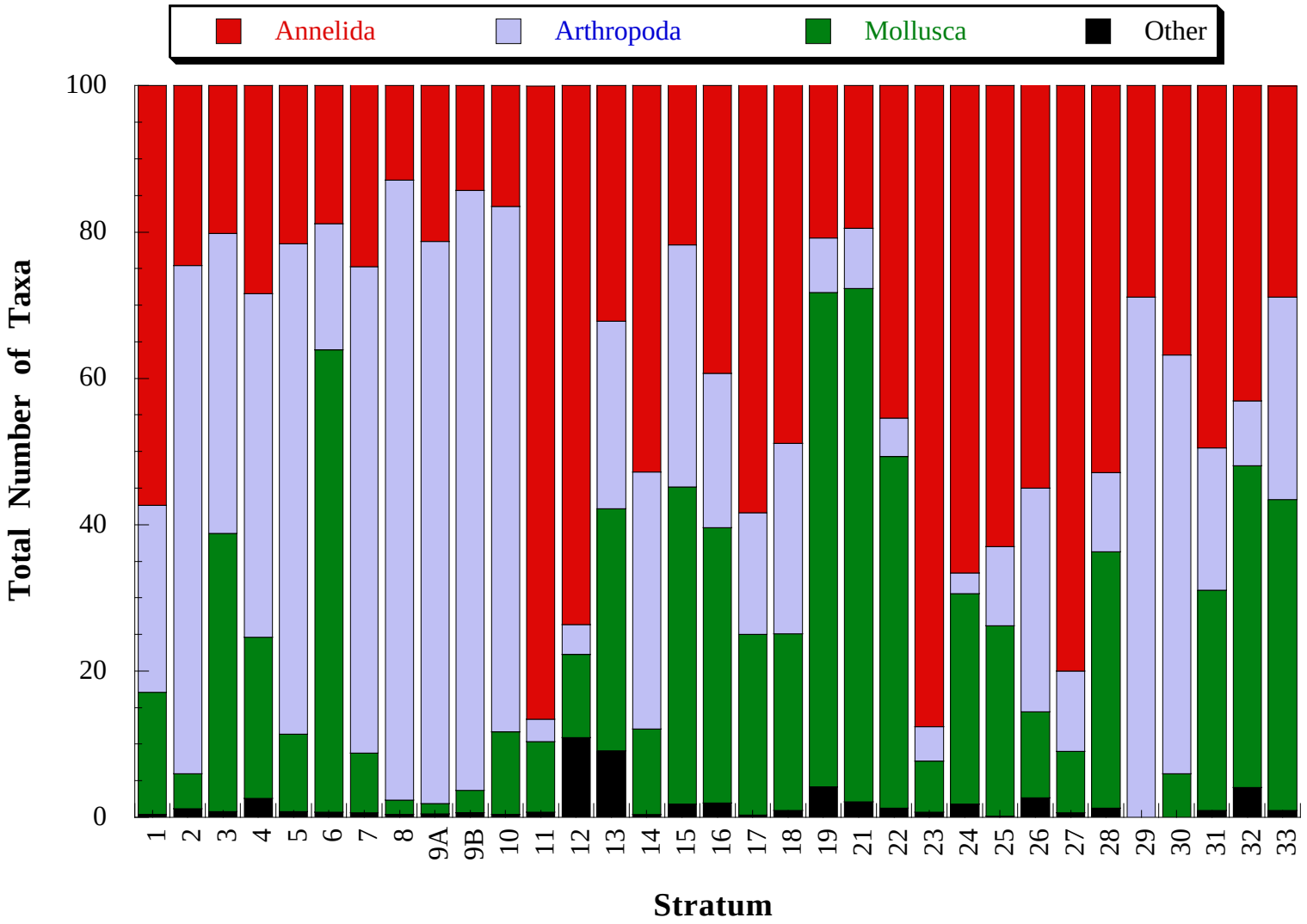


Table 5. Percent abundance of dominant taxa (> 10% of the total) for the Puget Sound strata, June-July 1997.

	STRATUM																						
TAXA	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**21**	**22**	**23**
ANNELIDA																							
Polychaeta																							
Capitella (LPIL)																							
Mediomastus californiensis																							
Cirratulidae (LPIL)																							
Aphelochaeta (LPIL)												21.6											
Cossura pygodactylata																						16.8	
Nephtys cornuta	43.8	11.0		13.3	12.5				11.1			31.8	33.9			11.2							11.9
Levinsenia gracilis													11.6										
Sigambra setosa																							
Prionospio (LPIL)																							
Sphaerosyllis ranunculus																							
Oligochaeta																							
Oligochaeta (LPIL)															37.8			29.3	23.2				58.8
MOLLUSCA																							
Bivalvia																							
Bivalvia (LPIL)																							
Semele rubropicta																							
Lucinoma annulata																							
Tellina (LPIL)																				13.7			
Yoldia myalis																19.4							
Axinopsida serricata																					57.9	37.8	
Mysella tumida	14.5		32.3			52.9								23.1			20.2		16.2	10.9			
Kellia laperousi				13.1												10.1		16.6		23.1			
ARTHROPODA																							
Malacostraca																							
Pleurogonium rubicundom											23.4												
Aoroides (LPIL)																							
Harpiniopsis fulgens																10.8							
Cheirimedeia zotea											12.4												
Protomedeia articulata		57.9	21.9	27.6	34.5		45.5	47.4	41.2	43.5	13.7												
Guernea reducans																							
Eudorella pacifica				12.9	20.5			19.4	28.9	25.7	10.2			10.9		16.0							
Leptochelia dubia																							
Leptochelia savignyi															11.6								
Nebalia pugettensis																							
ECHINODERMATA																							
Ophiuroidea																							
Amphiuridae (LPIL)													10.3										

Table 5 continued:

TAXA	STRATUM 24	25	26	27	28	29	30	31	32	33
ANNELIDA										
Polychaeta										
Capitella (LPIL)							11.2	15.0		
Mediomastus californiensis	11.9									
Cirratulidae (LPIL)				10.7						
Aphelochaeta (LPIL)										
Cossura pygodactylata		18.7								
Nephtys cornuta	15.5		13.4	11.3						
Levinsenia gracilis		13.0		37.2						
Sigambra setosa	15.4									
Prionospio (LPIL)							10.4			
Sphaerosyllis ranunculus								11.5		
Oligochaeta										
Oligochaeta (LPIL)										
MOLLUSCA										
Bivalvia										
Bivalvia (LPIL)									11.8	
Semele rubropicta									23.8	
Lucinoma annulata					13.1					
Tellina (LPIL)										
Yoldia myalis										
Axinopsida serricata	14.9	19.9								
Mysella tumida								20.5		16.8
Kellia laperousi										11.8
ARTHROPODA										
Malacostraca										
Pleurogonium rubicundom										
Aoroides (LPIL)						37.1				
Harpiniopsis fulgens										
Cheirimedeia zotea										
Protomedeia articulata										
Guernea reducans			15.4							
Eudorella pacifica										
Leptochelia dubia							16.8			
Leptochelia savignyi										
Nebalia pugettensis						26.8	29.6			
ECHINODERMATA										
Ophiuroidea										
Amphiuridae (LPIL)										

Table 6. Summary of benthic macroinvertebrate data for the Puget Sound stations and strata, June-July 1997.

Summary by Station					Summary by Stratum							
Stratum	Station	No. Taxa	Abund	Density	Mean No. Taxa	Taxa (SD)	Mean Density	Density (SD)	Total No. Taxa	Total No. Indvs	H'	J'
1	1	40	983	24575	23.0	14.8	12866.7	10174.2	48	1544	2.17	0.56
1	2	16	314	7850								
1	3	13	247	6175								
2	1	37	1008	25200	26.7	10.0	31791.7	9237.5	49	3815	1.7	0.44
2	2	17	1113	27825								
2	3	26	1694	42350								
3	1	46	1821	45525	33.7	11.0	26108.3	17426.6	72	3133	2.35	0.55
3	2	25	473	11825								
3	3	30	839	20975								
4	1	38	337	8425	37.0	8.2	17012.5	10466.5	75	2722	2.57	0.6
4	2	27	1289	32225								
4	3	36	513	12825								
4	4	47	583	14575								
5	1	30	951	23775	30.7	2.1	30491.7	5875.0	52	3659	2.08	0.53
5	2	33	1387	34675								
5	3	29	1321	33025								
6	1	54	1124	28100	47.7	5.5	54850.0	45856.9	84	6582	2.08	0.47
6	2	44	4312	107800								
6	3	45	1146	28650								
7	1	43	1578	39450	34.0	12.3	33141.7	25699.9	63	3977	2.26	0.54
7	2	39	2204	55100								
7	3	20	195	4875								
8	1	28	799	19975	31.7	4.0	43533.3	22917.0	47	5224	1.92	0.5
8	2	31	1795	44875								
8	3	36	2630	65750								
9A	1	18	840	21000	21.3	10.4	19558.3	17681.6	41	2347	1.74	0.47
9A	2	33	1459	36475								
9A	3	13	48	1200								

Table 6 continued:

Summary by Station					Summary by Stratum							
Stratum	Station	No. Taxa	Abund	Density	Mean No. Taxa	Taxa (SD)	Mean Density	Density (SD)	Total No. Taxa	Total No. Indvs	H'	J'
9B	1	24	1260	31500	23.7	1.5	28941.7	15298.8	40	3473	1.81	0.49
9B	2	25	501	12525								
9B	3	22	1712	42800								
10	1	31	2242	56050	23.3	6.7	24600.0	27550.9	44	2952	2.45	0.65
10	2	20	521	13025								
10	3	19	189	4725								
11	1	21	289	7225	24.3	3.1	9016.7	1582.8	38	1082	2.42	0.67
11	2	25	409	10225								
11	3	27	384	9600								
12	1	31	562	14050	25.0	5.3	9300.0	4607.3	41	1116	2.5	0.67
12	2	21	360	9000								
12	3	23	194	4850								
13	1	33	1092	27300	47.3	14.5	23008.3	6794.2	95	2761	3.02	0.66
13	2	47	607	15175								
13	3	62	1062	26550								
14	1	45	1191	29775	51.0	8.7	41383.3	16721.9	96	4966	2.62	0.57
14	2	61	2422	60550								
14	3	47	1353	33825								
15	1	39	601	15025	38.0	4.6	18783.3	4301.6	67	2254	2.72	0.65
15	2	33	714	17850								
15	3	42	939	23475								
16	1	50	308	7700	50.7	5.0	12275.0	6707.7	89	1473	3.41	0.76
16	2	56	366	9150								
16	3	46	799	19975								
17	1	36	495	12375	41.3	19.6	16191.7	10153.1	84	1943	2.91	0.66
17	2	63	1108	27700								
17	3	25	340	8500								
18	1	40	730	18250	41.3	4.2	18316.7	4775.3	68	2198	2.86	0.68
18	2	38	925	23125								
18	3	46	543	13575								

Table 6 continued:

Summary by Station					Summary by Stratum							
Stratum	Station	No. Taxa	Abund	Density	Mean No. Taxa	Taxa (SD)	Mean Density	Density (SD)	Total No. Taxa	Total No. Indvs	H'	J'
19	1	52	540	13500	52.0	17.0	11825.0	2460.6	103	1419	3.13	0.67
19	2	35	360	9000								
19	3	69	519	12975								
21	1	40	478	11950	32.0	11.4	10558.3	8226.3	61	1267	2.1	0.51
21	2	19	69	1725								
21	3	37	720	18000								
22	1	48	807	20175	34.3	13.1	16841.7	8905.8	59	2021	2.43	0.6
22	2	33	270	6750								
22	3	22	944	23600								
23	1	31	1169	29225	27.3	4.7	18175.0	9641.4	49	2181	1.76	0.45
23	2	29	459	11475								
23	3	22	553	13825								
24	1	22	218	5450	30.3	7.6	7791.7	2028.9	60	935	2.93	0.71
24	2	37	356	8900								
24	3	32	361	9025								
25	1	25	641	16025	25.7	3.1	9775.0	5467.9	47	1173	2.66	0.69
25	2	23	235	5875								
25	3	29	297	7425								
26	1	59	541	13525	36.3	19.6	7850.0	5113.6	71	942	3.27	0.77
26	2	25	257	6425								
26	3	25	144	3600								
27	1	32	325	8125	26.3	6.0	7500.0	1677.2	47	900	2.44	0.63
27	2	27	351	8775								
27	3	20	224	5600								
28	1	26	193	4825	34.3	9.7	6566.7	1570.5	64	788	3.23	0.78
28	2	45	315	7875								
28	3	32	280	7000								
29	1	6	32	800	7.3	4.2	808.3	437.6	12	97	1.82	0.73
29	2	12	50	1250								
29	3	4	15	375								

Table 6 continued:

Summary by Station					Summary by Stratum							
Stratum	Station	No. Taxa	Abund	Density	Mean No. Taxa	Taxa (SD)	Mean Density	Density (SD)	Total No. Taxa	Total No. Indvs	H'	J'
30	1	7	21	525	13.0	13.1	2083.3	3074.5	34	250	2.49	0.71
30	2	28	225	5625								
30	3	4	4	100								
31	1	27	92	2300	22.0	5.0	1666.7	549.1	46	200	2.96	0.77
31	2	17	55	1375								
31	3	22	53	1325								
32	1	41	530	13250	44.3	5.8	14466.7	3895.2	74	1736	2.93	0.68
32	2	41	453	11325								
32	3	51	753	18825								
33	1	34	141	3525	18.7	16.6	3183.3	2977.2	51	382	3.19	0.81
33	2	21	239	5975								
33	3	1	2	50								

Figure 4. Mean macroinvertebrate densities for the Puget Sound strata, June-July 1997.

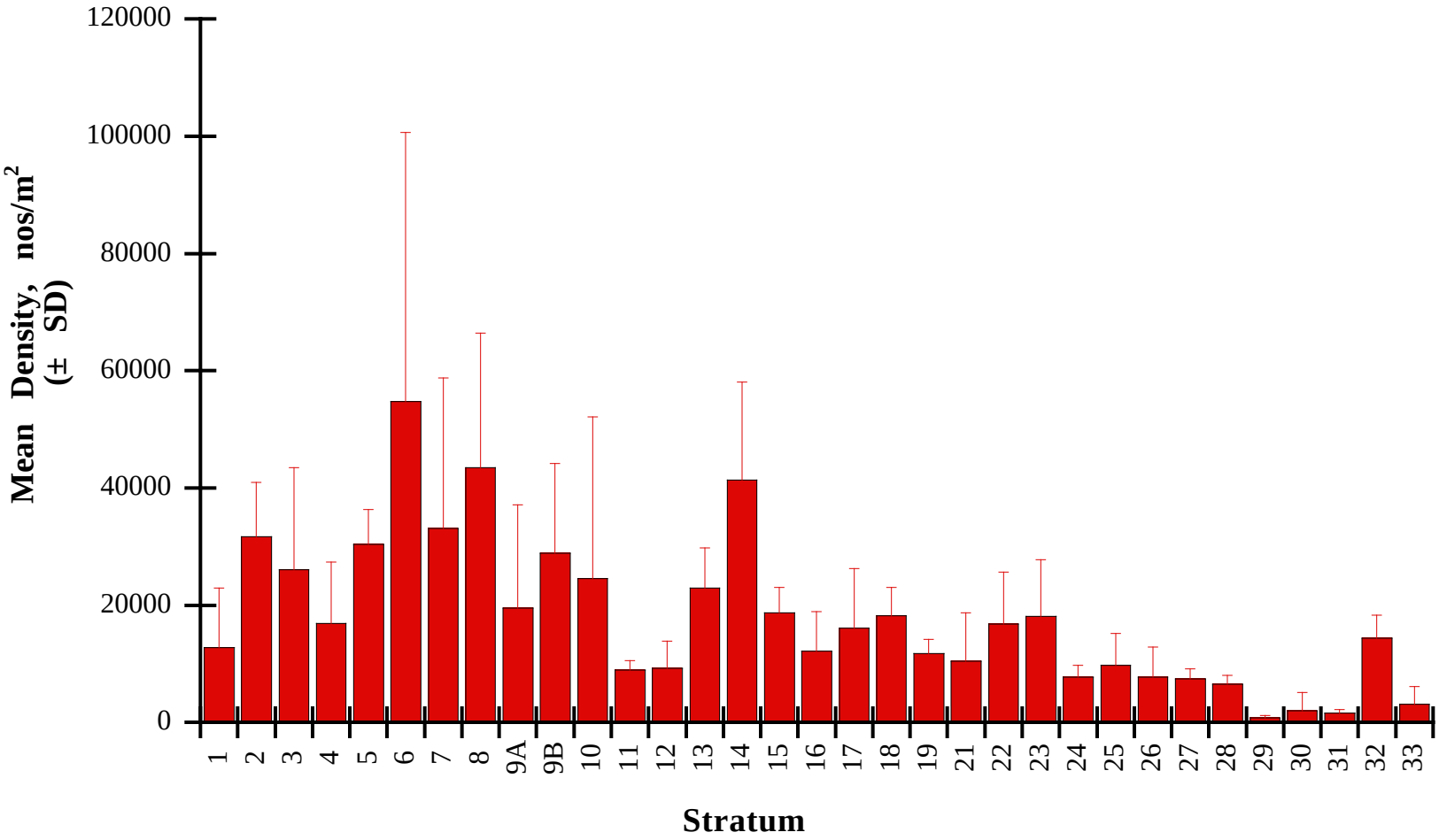


Figure 5. Number of taxa collected from the Puget Sound strata, June-July 1997.

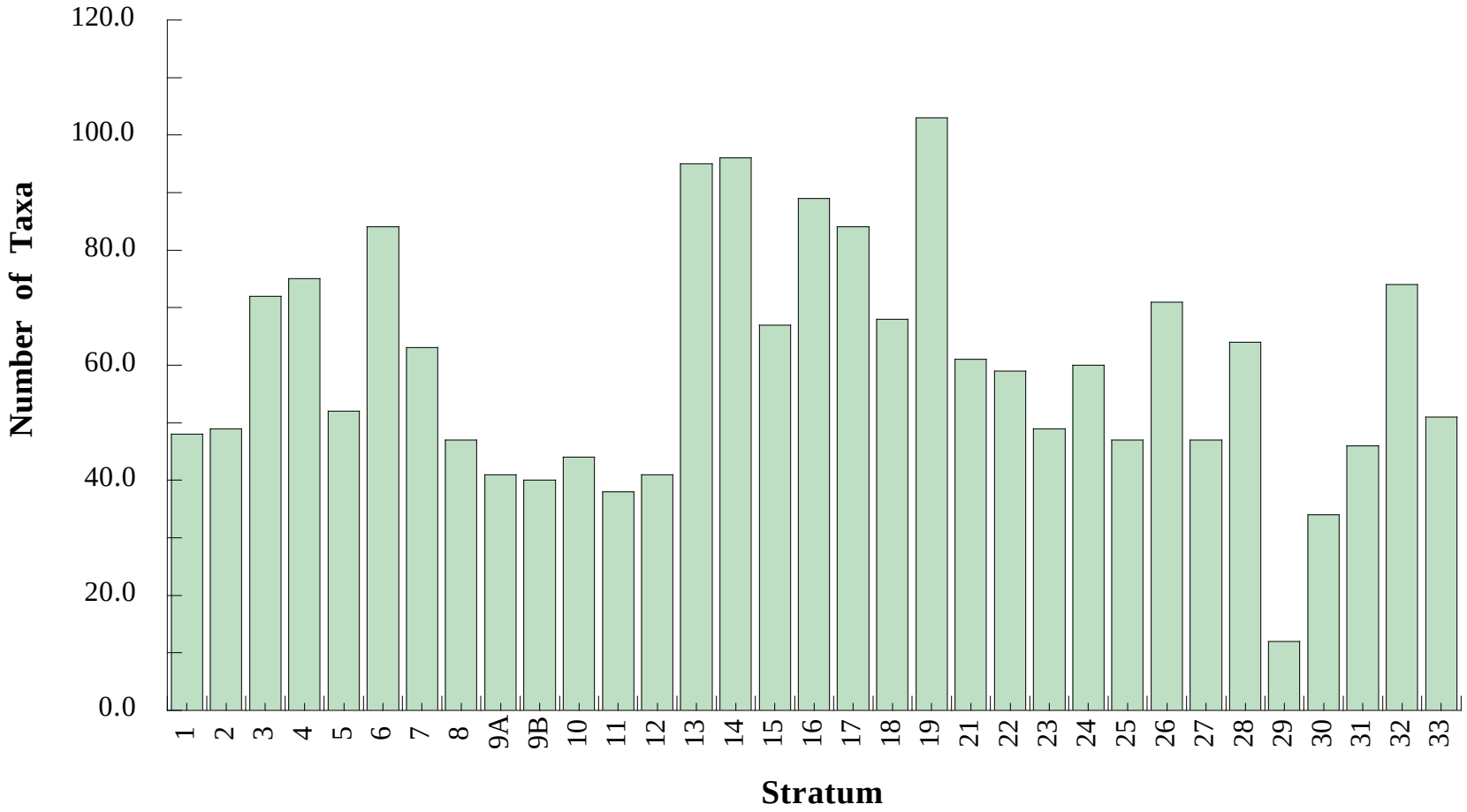
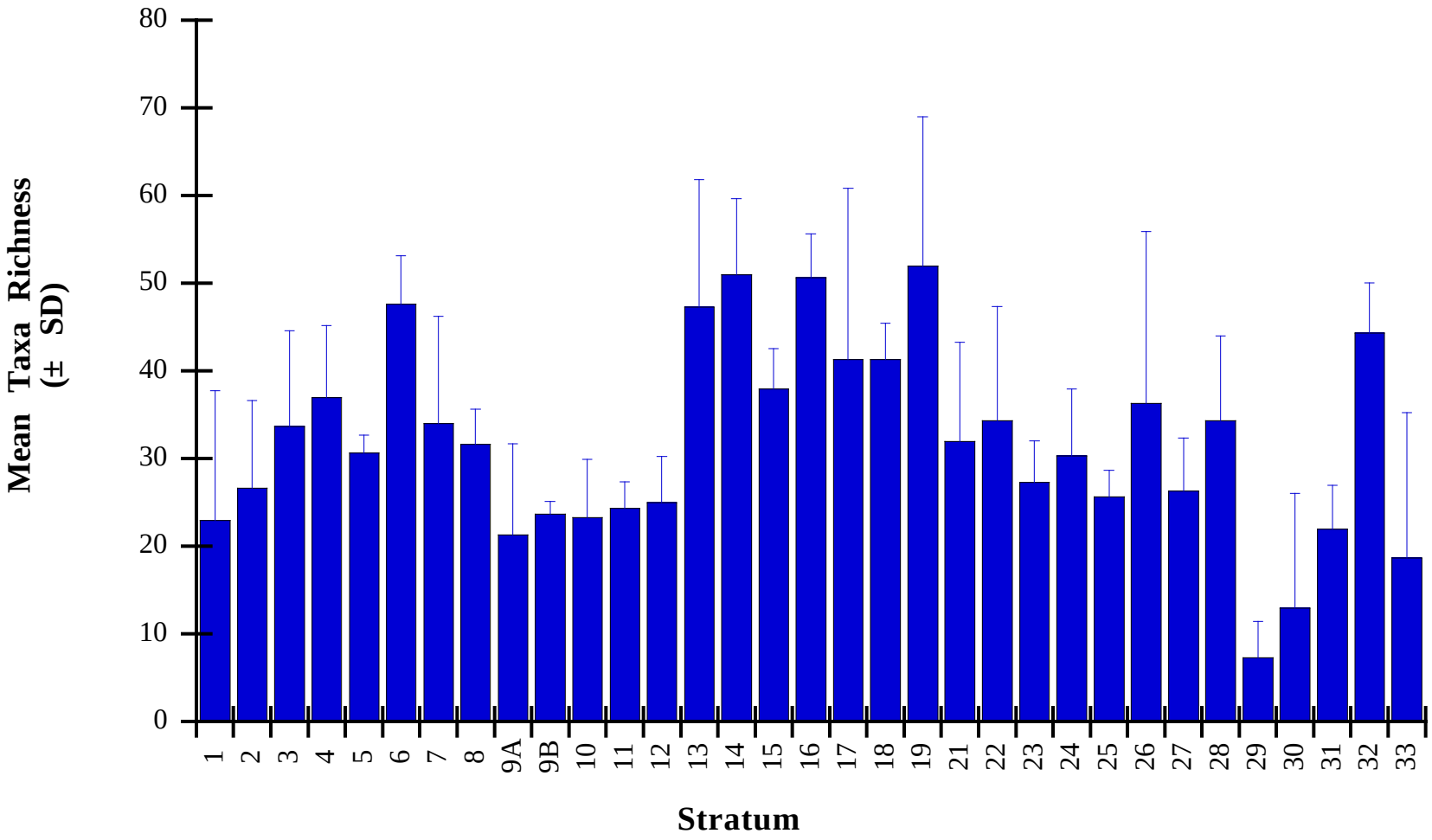


Figure 6. Mean number of taxa per replicate (taxa richness) for the Puget Sound strata, June-July 1997.



ANOVA analyses were performed on transformed density and taxa data for the Puget Sound strata (Table 7). There were highly significant differences in between strata. Results of post-hoc tests for density and taxa differences between strata can be found in Appendices B and C.

There were significant correlations between various sediment characteristics and mean density per stratum and the mean number of taxa per stratum (Table 8). There was a significant negative correlation and a significant positive correlation between strata densities and sediment percent moisture and percent solids, respectively. There was a significant positive correlation between mean number of taxa per stratum and sediment percent solids, percent sand and percent fines, and a significant negative correlation with sediment percent moisture and percent silt (Table 8).

Taxa diversity and evenness for the Puget Sound strata are given in Table 6 and Figure 7. Taxa diversity (H') varied considerably and ranged from 1.70 at Stratum 2 to 3.41 at Stratum 16. Taxa evenness (J') also exhibited considerable variation and ranged from 0.44 at Stratum 2 to 0.81 at Stratum 33 (Table 6, Figure 7).

Cluster Analysis

Normal (strata) and inverse (taxa) cluster analyses were performed on the Puget Sound data set and displayed as dendrograms (Figs. 8 and 9). Count data for the 30 taxa selected were included in a matrix of strata and taxa groups (Table 9). These taxa accounted for 86.1% of the total macroinfaunal assemblage.

Clustering of the 33 strata can be interpreted at a four-group level (≈ 15 – 28% level of similarity). Group A contained Strata 29, 30 and 31 which had the highest sediment percentage TOC and the lowest densities of all strata sampled. Group B contained only Stratum 33 which had the highest percentage of sand in the sediment of all the strata, and had a density and taxa richness slightly higher than strata in Group A. Group C contained a complex of strata with high sediment percent moisture and dominance by the bivalves, *Semele rubropicta* and *Axinopsida serricata* and the polychaete family Cirratulidae. Group D contained the remaining strata.

Table 7. ANOVA results for density and taxa differences among strata for the Puget Sound stations, June-July 1997.

DENSITY DATA

Shapiro-Wilk W Test for Normality

W= 0.97 Prob < W = 0.21

ANOVA Table

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	32	217699.51	6803.11	**3.867**	**< 0.0001**
Error	67	117876.37	1759.35		
Total	99	335575.87	3389.66		

TAXA DATA

Shapiro-Wilk W Test for Normality

W= 0.97 Prob < W = 0.10

ANOVA Table

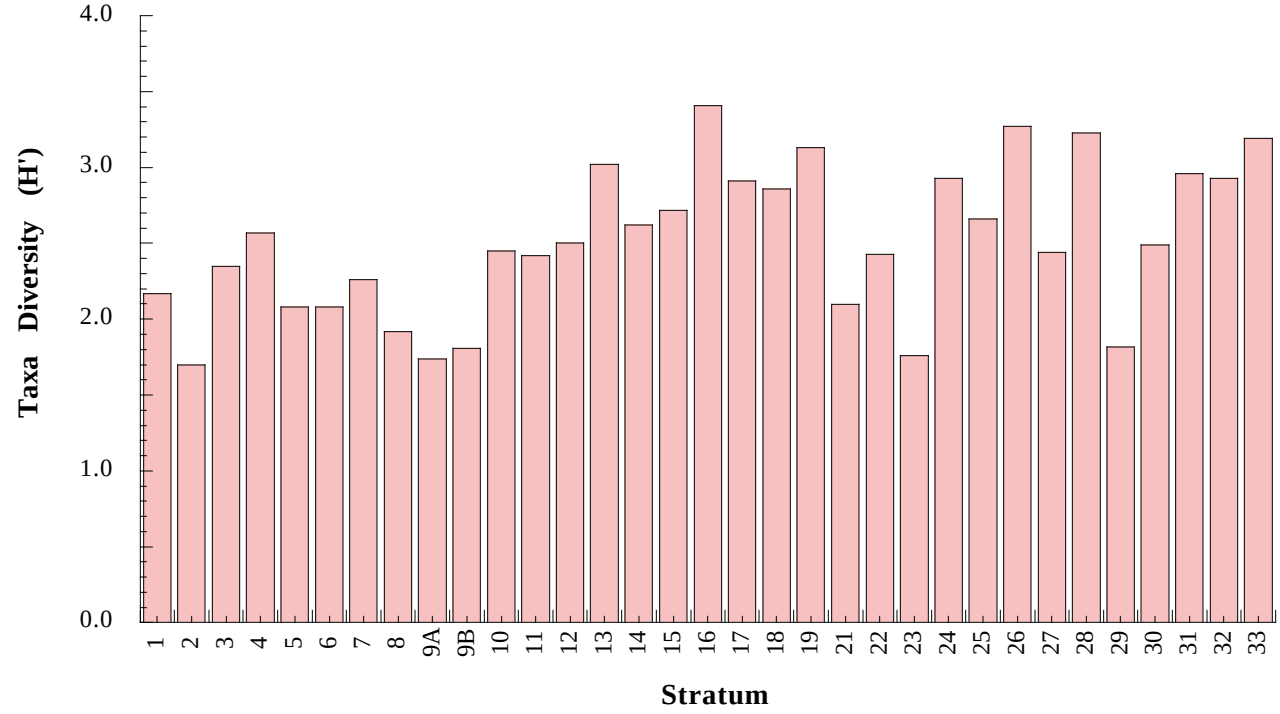
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	32	102.74	3.21	**3.71**	**<0.0001**
Error	67	57.98	0.87		
Total	99	160.72	1.62		

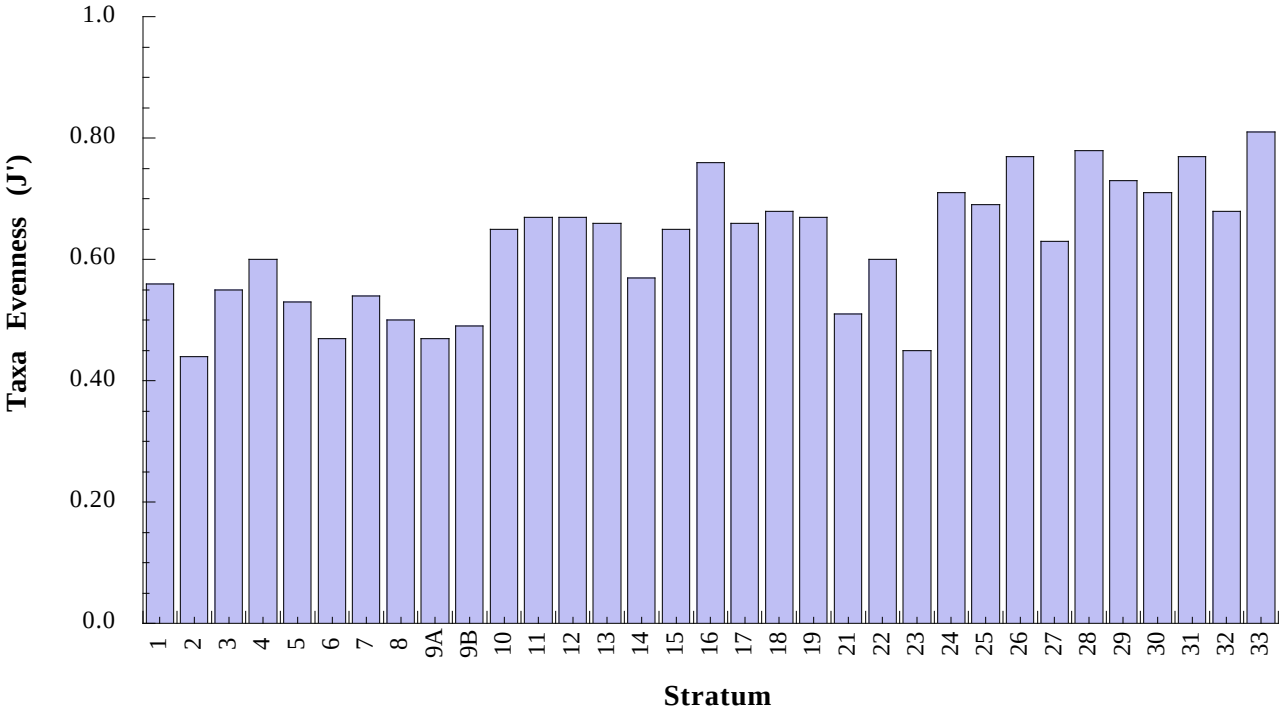
Table 8. Correlation coefficients for the Puget Sound strata, June-July 1997.

Variable	by Variable	Pearson Product Moment Correlation Coefficient	Sign. Probability	Sign.
Density	% Moisture	-0.2918	0.0032	*
Density	% Solids	0.2494	0.0123	*
Density	% Sand	0.0364	0.7189	ns
Density	% Silt	0.0688	0.4964	ns
Density	% Clay	-0.0867	0.3911	ns
Density	% Fines	0.0296	0.7701	ns
Taxa	% Moisture	-0.4986	<0.0001	*
Taxa	% Solids	0.4795	<0.0001	*
Taxa	% Sand	0.3145	0.0014	*
Taxa	% Silt	-0.2970	0.0027	*
Taxa	% Clay	-0.1134	0.2611	ns
Taxa	% Fines	-0.2752	0.0056	*

*= significant; ns = not significant

Figure 7. Taxa diversity and evenness for the Puget Sound strata, June-July 1997.





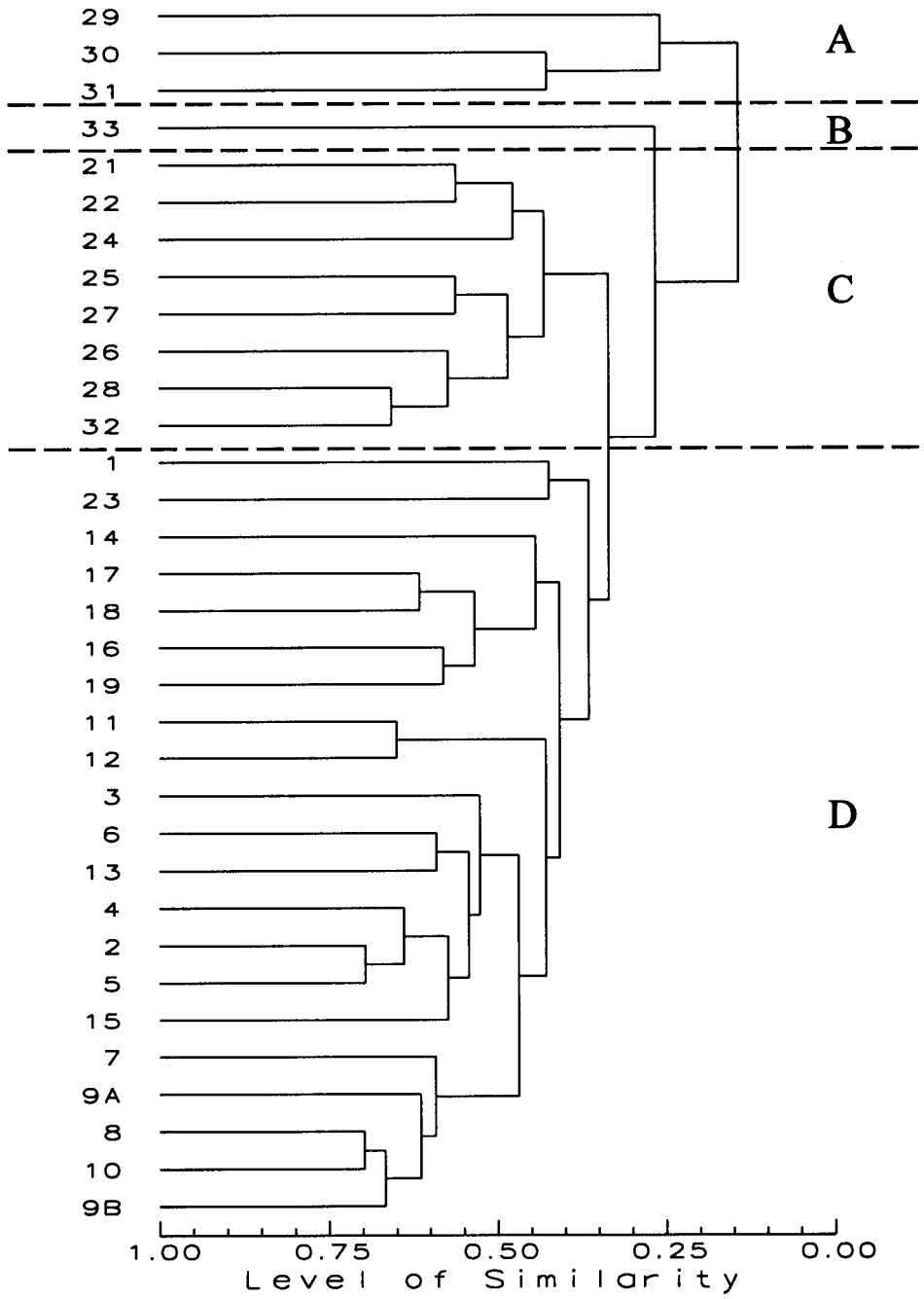


Figure 8. Stratum dendrogram from the cluster analysis for the Puget Sound Strata, June-July 1997. Bolded letters indicate strata groups.

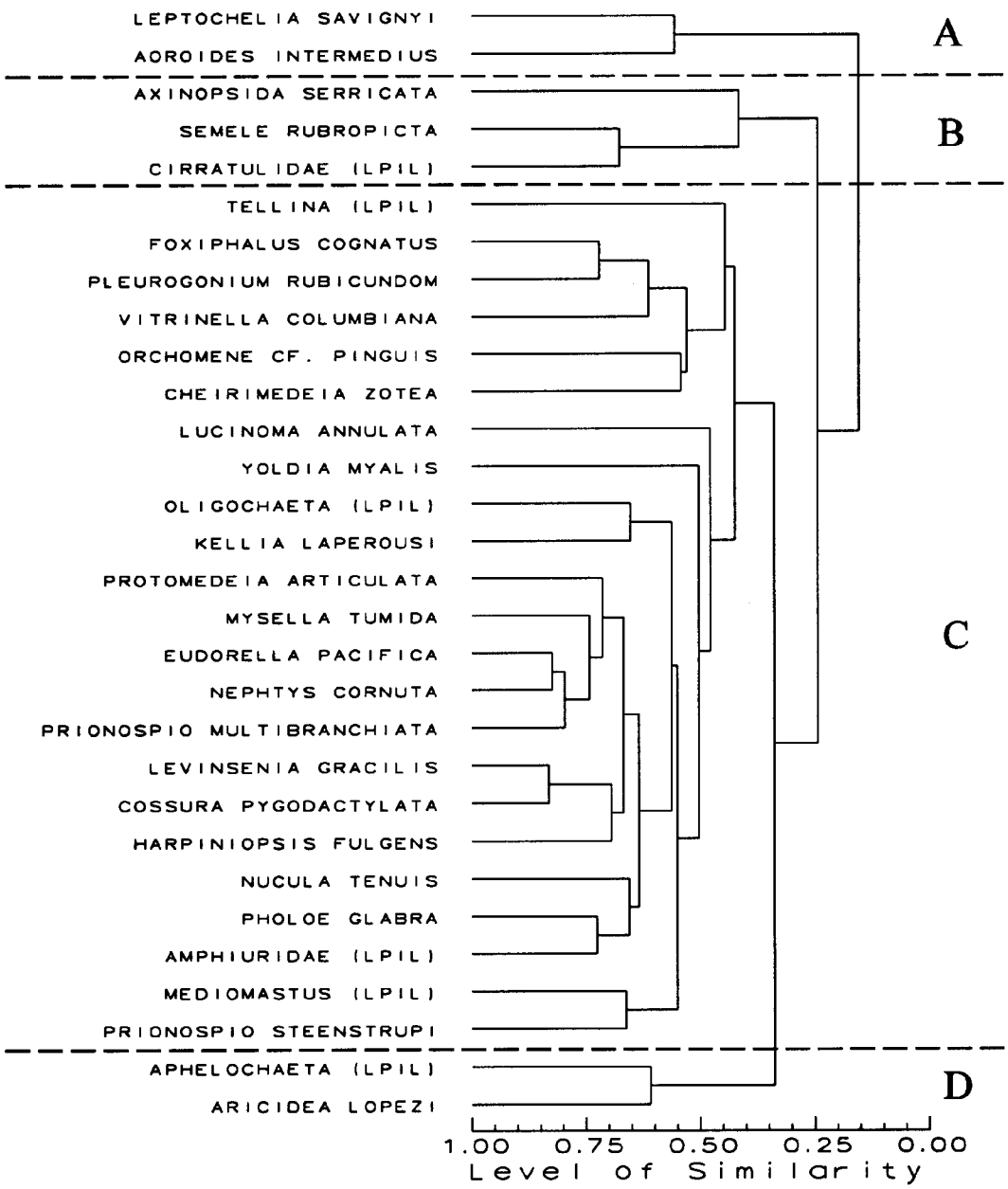


Figure 9. Taxa dendrogram from the cluster analysis for the Puget Sound Strata, June-July 1997. Bolded letters indicate taxa groups.

Table 9. Stratum and taxa 2-way table from the cluster analysis for the Puget Sound data, June-July 1997.

TAXA	29	30	31	33	21	22	24	25	27	26	28	32	1	23	14	17	18	16	19	11	12	3	6	13	4	2	5	15	7	9A	8	10	9B	
Leptochelia savignyi										1					576			3						5				1						**A**
Aoroides intermedius	1					89						1			366			6	4															
Axinopsida serricata					734	764	139	233		31																								
Semele rubropicta				1	9	6	2	50	47	32	75	413		7															4					**B**
Cirratulidae (LPIL)					18	74	4	59	96	8	56	135	12	121		2	8	16	10	10			2				1		2					
Tellina (LPIL)												1			3	1	5	23	195			4	238	39			6	2	3	2	1	1		
Foxiphalus cognatus				6	24	1									103	65	83	28	5			221	159	38			2		131	57	219	205	168	
Pleurogonium rubicundom					8					2		2			4	52	3	11	7	1	1	1	20	6	2	1	1	14	85	18	449	692	65	
Vitrinella columbiana															6	14	1	2	6										189		78	200	34	
Orchomene cf. *pinguis*		1	3													3	149	66	1				11	31	4		318		56	7	9	7	8	
Cheirimedeia zotea																5	4	16						53						2	33	365	7	
Lucinoma annulata											103	116					18		3	49	31	20	42	22	1	3	3	86	2			2		
Yoldia myalis					72	136	46	18	1						5	2	6	10	18	17	28		12	32	10			438				7	3	
Oligochaeta (LPIL)	5	3	1	7	9	93	2			52		57	23	1282	1877	570	509	144	49	3	13	2	7	116	23	26	47	33	7	1			6	
Kellia laperousi				45			4							26	55	322	85	60	328	2		108	28	84	357	24	27	228				1	1	
Protomedeia articulata				1	7			14	13				22		59	7	161	74	1		2	687	204	62	750	2207	1263	80	1808	966	2475	405	1512	**C**
Mysella tumida		2	41	64	11	16	28	1	1	11	2	12	224	91	284	83	356	297	154	29	51	1012	3484	639	21	71	276	67	32	27	21	78	52	
Eudorella pacifica					31	8	16	40	28	34	20	70	123			10	114	9	6		19	15	518	302	351	333	750	360	390	679	1016	302	892	
Nephtys cornuta		1	3	14	37	104	145	71	102	126	73	35	677	259	12	10	188	66	44	344	378	226	293	208	362	418	458	252	284	261	205	211	219	
Prionospio multibranchiata						18	14	61		18	60	82	61	7	4	13	23	20	2	8	24	203	59	258	51	251	175	48	40	135	49	17	222	
Levinsenia gracilis				1	9	31		152	335	40	45	88	4		1	26	23	18		15	129	25	465	90	100	75	5	49	11	2	9		1	
Cossura pygodactylata			3	1	11	339	15	219	61	19	11	25		2		55	24	8	1	21	84	18	97	43	34	76	37	40	31	4	26	3		
Harpiniopsis fulgens					2			63	22	8	15	11								30	20	18	25	55	92	67	83	244	22	61	85	56	131	
Nucula tenuis					34	18			7		1	5			1	9	36	25	88		10	2	235	39	120	6	9	63	92			34	11	
Pholoe glabra						1	11			12	27	11	16		4	8	21	16	5	67	36	46	28	31	84	41	44	6	18	1	52	185	25	
Amphiuridae (LPIL)														2	10	4	15	13	48	3	115	21	30	243	67	43	28	37	2	4	15	8	15	
Mediomastus (LPIL)		1		7	4	4	6	2		6	6	12	11	6	69	56	33	25	17	19	22	1	10	4	4		1	3	314	39	142	5	2	
Prionospio steenstrupi		5	4			15	2	17	3	17	2	8	8	5	2	6	17	91	21			7	5	6	3		3	3	94		11			
Aphelochaeta (LPIL)						1	13							55	1	94	15	1	3	234	13			3		2								
Aricidea lopezi							1	21		3				15		87	59			50	50	1	11	7	5			5						**D**
		A		**B**				**C**															**D**											

Clustering of the 30 taxa in the 33 strata could be interpreted at a four–group level (≈ 15 - 30% similarity; Table 9 and Fig. 9). Group A was represented two amphipod taxa, *Leptochelia savignyi and Aoroides intermedius* which were found in high densities only at Stratum 14 (Table 9). Group B included three taxa found in high densities at locations normally classified in Strata Group A above. Group C included a complex of taxa found across the numerous strata. Taxa Group D contained the polychaetes, *Aricidea lopezi* and *Aphelochaeta* (LPIL) found in high densities at Strata 11, 12, 17 and 18 (Table 9; Fig. 9).

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APPENDIX A

QUALITY CONTROL REWORKS

Client/Project: NOAA

Work Assignment Title: Puget Sound 1997

Work Assignment Number: Task Number: 6

Sorting Results:

Sample #	% Accuracy
1-2	100%
1-3	100%
2-6	99%
9A-28	100%
11-32	100%
11-33	100%
23-2-69	100%
25-3-76	100%
26-3-79	100%
27-82	100%
28-85	100%

Taxonomy Results:

Sample #	Taxa	% Accuracy
4-12	Crust./Moll.	97.6%
7-21	Crust./Moll.	99%
8-25	Crust./Moll.	99%
9B-59	Crust./Moll.	98%
10-31	Crust./Moll.	97%
14-42	Crust./Moll.	97.9%
22-1-65	Crust./Moll.	97.6%
23-1-68	Crust./Moll.	97%
24-1-71	Crust./Moll.	95.7%
25-2-75	Crust./Moll.	96%
33-3-100	Crust./Moll.	100%
28-84	Crust./Moll.	99.4%
4-13	Poly./Misc.	99.6%
6-17	Poly./Misc.	99%
6-19	Poly./Misc.	99.3%
9A-26	Poly./Misc.	98.4%
9B-60	Poly./Misc.	97.7%
12-35	Poly./Misc.	95.7%
14-41	Poly./Misc.	98%
14-42	Poly./Misc.	99.3%
21-2-63	Poly./Misc.	100%

28-83	Poly./Misc.	100%

Taxonomy Results:

Sample #	Taxa	% Accuracy
29-3-88	Poly./Misc.	100%
32-95	Poly./Misc.	97%

Description of outstanding issues or deficiencies which may affect data quality: None

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Signature of QA Officer or Reviewer Date

QUALITY ASSURANCE STATEMENT

Client/Project: NOAA

Work Assignment Title: Puget Sound 1997

Work Assignment Number: Task Number: 6

Description of Data Set or Deliverable: 100 Benthic macroinvertebrate samples collected in June and July of 1997; VanVeen grabs.

Description of audit and review activities: Judged accuracy rates were well above standard levels for sorting and taxonomy. Laboratory QC reports were completed. Copies of QC results follow (see attachment.) All taxonomic data were entered into computer and printed. This list was checked for accuracy against original taxonomic data sheets.

Description of outstanding issues or deficiencies which may affect data quality: None

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Signature of QA Officer or Reviewer Date

_____

Signature of Project Manager Date

Appendix A3. QA/QC comments for dominant LPIL taxa in the Puget Sound dataset June-July 1997.

Taxon Name	Phylum	Class	No. of Individuals	% Total	Cummulative %	Station Occurrence	Station % Occurrence	QA/QC Notes
Protomedeia articulata	Ar	Mala	12780	17.871	17.871	23	69.7	
Mysella tumida	M	Biva	7538	10.541	28.412	32	97	
Eudorella pacifica	Ar	Mala	6436	9.000	37.412	26	78.8	
Nephtys cornuta	A	Poly	6086	8.510	45.922	32	97	
Oligochaeta (LPIL)	A	Olig	4967	6.946	52.868	28	84.8	marine and some estuarine specimens only identified to class
Prionospio multibranchiata	A	Poly	1923	2.689	55.557	27	81.8	
Axinopsida serricata	M	Biva	1901	2.658	58.215	5	15.2	
Kellia laperousi	M	Biva	1785	2.496	60.711	18	54.5	
Levinsenia gracilis	A	Poly	1749	2.446	63.157	26	78.8	
Foxiphalus cognatus	Ar	Mala	1515	2.119	65.276	17	51.5	
Pleurogonium rubicundom	Ar	Mala	1445	2.021	67.296	22	66.7	
Cossura pygodactylata	A	Poly	1308	1.829	69.125	28	84.8	
Harpiniopsis fulgens	Ar	Mala	1110	1.552	70.678	20	60.6	
Yoldia myalis	M	Biva	861	1.204	71.882	18	54.5	
Nucula tenuis	M	Biva	845	1.182	73.063	21	63.6	
Mediomastus (LPIL)	A	Poly	831	1.162	74.225	29	87.9	anterior portions only, pygidium needed for species ID
Pholoe glabra	A	Poly	796	1.113	75.338	25	75.8	
Amphiuridae (LPIL)	E	Ophi	723	1.011	76.349	20	60.6	immature specimen
Orchomene cf. *pinguis*	Ar	Mala	674	0.942	77.292	15	45.5	
Semele rubropicta	M	Biva	646	0.903	78.195	11	33.3	
Cirratulidae (LPIL)	A	Poly	634	0.887	79.082	18	54.5	anterior fragment, posterior needed for specis ID
Leptochelia savignyi	Ar	Mala	586	0.819	79.901	5	15.2	
Vitrinella columbiana	M	Gast	530	0.741	80.642	9	27.3	
Tellina (LPIL)	M	Biva	524	0.733	81.375	15	45.5	due to small size, external and internal characters were not apparent
Lucinoma annulata	M	Biva	501	0.701	82.076	15	45.5	
Bivalvia (LPIL)	M	Biva	489	0.684	82.760	28	84.8	crushed and/or juvenile specimen
Cheirimedeia zotea	Ar	Mala	485	0.678	83.438	8	24.2	
Aoroides intermedius	Ar	Mala	467	0.653	84.091	6	18.2	
Aphelochaeta (LPIL)	A	Poly	435	0.608	84.699	12	36.4	damaged and/or immature specimen
Prionospio steenstrupi	A	Poly	355	0.496	85.195	24	72.7	
Prionospio (LPIL)	A	Poly	343	0.480	85.675	25	75.8	missing identification characters
Aricidea lopezi	A	Poly	315	0.440	86.116	13	39.4	

APPENDIX B

Appendix B. Tukey-Kramer HSD post-hoc results for differences in density between strata for the Puget Sound data, 1997. ns = not significant; * = significant.

	6	8	14	2	5	7	9B	3	13	10	15	18	23	4	22	9A	17	32	19	16	1	25	21	11	12	24	27	26	28	33	31	30	29
6	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*	*	*	*	*
8	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*	*	*
14	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*	*	*
2	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*	*
5	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*
7	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*
9B	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*
3	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
13	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
10	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
15	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
18	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
23	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
9A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
32	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns
28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns
33	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns
31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns
30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns
29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

APPENDIX C

Appendix C. Tukey-Kramer HSD post-hoc results for differences in taxa between strata for the Puget Sound data, 1997. ns = not significant; * = significant.

	19	14	16	6	13	32	18	17	15	4	26	28	22	7	3	8	21	5	24	23	27	2	25	12	11	9B	10	31	1	9A	33	30	29
19	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*	*
14	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*	*
16	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*	*
6	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*
13	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*
32	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*
18	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*
17	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*
15	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*
4	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*
26	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*
28	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*
22	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*
3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns	ns
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns	ns
9B	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns	ns
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns	ns
31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns	ns
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns	ns
9A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns	ns
33	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns	ns
30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	ns
29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–