Exxon Valdez Oil Spill
Restoration Project Final Report

The Effects of the *Exxon Valdez* Oil Spill on Eelgrass Communities in Prince William Sound, Alaska 1990-95

Restoration Project 95106
Final Report

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May 1997

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Study History: Restoration Project 95106 was initiated in 1989 as Natural Resources Damage Assessment Coastal Habitat Study Number 1 through the USDA Forest Service and in 1990-93 as Subtidal Study Number 2A through the Alaska Department of Fish & Game. A final report entitled The Effects of the *Exxon Valdez* Oil Spill on Shallow Subtidal Communities in Prince William Sound, Alaska 1989-91 was compiled in December 1993. After additional sampling in 1993 (Restoration Project 93047) another final report entitled The Effects of the *Exxon Valdez* Oil Spill on Shallow Subtidal Communities in Prince William Sound, Alaska 1989-93 was completed in June 1995. The emphasis of this report was on the eelgrass community. No field activities were conducted in 1992 and 1994. A final year of sampling occurred in the eelgrass habitat in 1995 under Restoration Projects 95106. The final report included herein presents a comprehensive analysis of the results from the eelgrass habitat for 1990-95. Scientific manuscripts resulting from this work include:

Dean, T.A., L. McDonald, M.S. Stekoll, and R.R. Rosenthal. 1993. Damage assessment in coastal habitats: Lessons learned from *Exxon Valdez*. Pages 695-697. Proc. of 1993 Int. Oil Spill Conf., Mar. 29-Apr. 1, 1993. Am. Petrol. Inst., Washington , D. C.

Dean, T.A., S.C. Jewett, D.R. Laur, and R.O. Smith. 1996. Injury to epibenthic invertebrates resulting from the *Exxon Valdez* oil spill. Pages 424-439 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Dean, T.A., M.S. Stekoll, and R.O. Smith. 1996. Kelps and oil: The effects of the *Exxon Valdez* oil spill on subtidal algae. Pages 412-423 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Dean, T.A., M.S. Stekoll, S.C. Jewett, R.O. Smith, and J.E. Hose. Accepted pending revision. Eelgrass (*Zostera marina*) in Prince William Sound, Alaska: Effects of the *Exxon Valdez* oil spill. Mar. Ecol. Prog. Ser.

Jewett, S.C. 1993. Biological effects of the *Exxon Valdez* oil spill: Coastal habitat: Shallow subtidal regions. Alaska's Wildl. 25(1):22-23.

Jewett, S.C., T.A. Dean, and D.R. Laur. 1996. The effects of the *Exxon Valdez* oil spill on benthic invertebrates in an oxygen-deficient embayment in Prince William Sound, Alaska. Pages 440-447 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Laur, D. and L. Haldorson. 1996. Coastal habitat studies: the effect of the Exxon Valdez oil spill on shallow subtidal fishes in Prince William Sound. Pages 659-670 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Stekoll, M.S., L.E. Deysher, and T.A. Dean. 1993. Seaweeds and the *Exxon Valdez* oil spill. Pages 135-140 *In:* Proceedings Proc. of 1993 Int. Oil Spill Conf., Mar. 29-Apr. 1, 1993. Am. Petrol. Inst., Washington , D. C.

Abstract: Injuries to the shallow subtidal eelgrass community were observed in the heavily oiled portions of Western Prince William Sound following the *Exxon Valdez* oil spill. In 1990, average concentrations of polynuclear aromatic hydrocarbons (PAH) exceeded 4,900 ng g^{-1} in shallow subtidal sediments adjacent to heavily oiled shorelines. Concentrations up to 23,000 ng g^{-1} were observed in individual samples. High PAH concentrations were associated with observed differences in communities at oiled *vs*. reference sites. Dominant taxa within the eelgrass community, including infaunal amphipods, infaunal bivalves, helmet crabs, and leather stars were less abundant at oiled than at reference sites in 1990. Other taxa, including several families of opportunistic or stress-tolerant infaunal polychaetes and gastropods, epifaunal polychaetes and mussels, and small cod, were more abundant at oiled sites. By 1995, there was apparent recovery of most community constituents. PAH concentrations declined to less than 230 ng g^{-1}, and fewer differences in taxa abundance existed between oiled and reference sites. However, not all taxa had recovered fully. Some evidence of slight hydrocarbon contamination still existed at some sites, and three infaunal bivalves, two amphipods, a crab, and a sea star were still more abundant at reference sites than at oiled sites.

Key Words: Eelgrass, epifauna, *Exxon Valdez* oil spill, infauna, Prince William Sound subtidal.

Project Data: *Description of data* - Digital data were developed during the project: (1) Physical characteristics of the sampling sites, including sediment granulometry and hydrocarbon content; (2) density values of eelgrass, large epifaunal invertebrates and fishes; and (3) density and biomass values of dredge-collected infaunal and small epifaunal invertebrates. *Format* - All data are in ASCII format. *Custodian* - Contact Thomas A. Dean, Coastal Resources Associates, Inc., 1185 Park Center Drive, Ste. A, Vista, CA 92083 (work phone: (760) 727-2004, Fax: (760) 272-2207 or E-mail at Coastal_Resources@Compuserve.com. *Availability* - Copies of all data are available on disc for the cost of duplication.

Citation:
Jewett, S.C., and T.A. Dean. 1997. The effects of the *Exxon Valdez* oil spill on eelgrass communities in Prince William Sound, Alaska 1990-95, *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 95106), Alaska Department of Fish and Game, Habitat and Restoration Division, Anchorage, Alaska.

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EXECUTIVE SUMMARY

This report examined injury to, and recovery of, shallow (< 20 m) subtidal eelgrass communities within Prince William Sound (PWS) following the *Exxon Valdez* oil spill. Injury was assessed by examining differences in diversity and abundance of eelgrass, dominant taxa of infaunal and epifaunal invertebrates, and fish at oiled *vs.* reference sites, and examining the relationships between hydrocarbon concentrations in sediments and observed temporal and spatial changes in community composition.

Communities at sites adjacent to heavily oiled shorelines were exposed to higher concentrations of oil than communities at reference sites. However, there was also evidence of oil contamination at some reference sites that were relatively far removed from oiled shorelines. In 1990, average total polynuclear aromatic hydrocarbon (TPAH) concentrations exceeded 4,900 ng g^{-1} in sediments from sites adjacent to heavily oiled shorelines, and were less than 1,290 ng g^{-1} at reference sites. The highest TPAH concentration in any individual sample was in excess of 23,000 ng g^{-1}. Other investigations found up to 2,730 ng g^{-1} TPAH in subtidal sediments (O'Clair *et al.*, 1996b) and 28,000 ng g^{-1} in sediments from sediment traps (Short *et al.*, 1996a) in PWS. Of the samples collected in this study, ten of sixteen from oiled sites, and 5 of 15 from reference sites had PAH signatures comparable to that of *Exxon Valdez* oil.

Possible injury to eelgrass was evident based on a lower density of shoots and flowering stalks at oiled sites following the spill. The same patterns were observed in a second independent study of eelgrass. However, patterns of recovery suggest that these differences may have been due to inherent differences between sites rather than effects of oil. If differences were related to the effects of the spill, it is unlikely that they were caused by toxicity to oil. More likely, differences were caused by boat activity and increased turbidity associated with cleanup efforts.

Communities of infauna and small epifauna differed among sites, and to a lesser extent, among years. Most of the differences were attributed to varying sediment grain-size distributions. However, exposure to *Exxon Valdez* oil also explained a significant proportion of the variation in community composition. Ordination analysis indicated that, in 1990, when TPAH concentrations were highest, communities of infauna and small epifauna were quite different than observed at sites with lower concentrations of TPAH, and were different from the communities observed at the same sites in subsequent years. Discriminant analyses indicated that the concentration of total chrysenes (a PAH analyte indicative of exposure to *Exxon Valdez* oil) explained a small, but significant proportion of the temporal and spatial variation in community structure.

There was little evidence of injury to infauna and small epifaunal invertebrates based on the analysis of community parameters (diversity measures, total abundance, and total biomass), the abundance of higher order taxonomic groups (e.g. bivalves and polychaetes), or analysis of feeding groups. The most evident trend was a higher total abundance at oiled sites that was attributable to a higher abundance of infaunal polychaetes, infaunal gastropods, and epifaunal bivalves. A lack of a stronger indication of effects was probably because the sensitivities of families that made up these higher order groupings differed in their sensitivity to oil, and because concentrations of oil were not high enough to be acutely toxic to most taxa.

Analyses of trends within dominant families of infauna and small epifauna gave a clearer picture of effects. Several families of amphipods, and in particular Isaedae and Phoxocephalidae, and several families of infaunal bivalves were consistently more abundant at reference than at oiled sites in years subsequent to the spill. Amphipods are very sensitive to oil, and the low density of these amphipods at oiled sites was probably caused by acute toxicity to oil. Bivalves, on the other hand, are less sensitive to oil, and differences among oiled and reference sites were probably related to factors other than acute toxicity. The most prevalent pattern among the infauna and small epifauna was higher abundance at oiled sites. Taxa that were more abundant at oiled sites included eight families of infaunal polychaetes, two families of infaunal gastropods, and one family of epifaunal mussels. Most of the infaunal polychaete families have been identified as stress tolerant or opportunistic species, and these were likely more abundant at oiled sites because of organic enrichment associated with oiling. Other families, and especially the epifauna, may have differed because of indirect effects of oil (e.g., reduced competition or predation), or alternatively, because of inherent differences between oiled and reference sites that were unrelated to oiling.

Several of the larger epifauna, including the seas stars *Pycnopodia helianthoides* and *Dermasterias imbricata*, and the helmet crab *Telmessus cheiragonus*, were also probably injured by the spill. All were more abundant at reference sites following the spill. The sea stars are often found above the water line in the intertidal zone, and their lower abundance at oiled sites was likely caused by toxicity to oil. Crabs on the other hand, probably avoided oiled areas.

The dominant fish within the eelgrass habitat were cod. Smaller cod were more abundant at oiled sites following the spill, and this was probably the result of higher densities of potential prey (especially small mussels of the genus *Musculus*) at oiled sites. It is unknown whether prey abundance differed as the result of oiling, or because of inherent differences among sites.

By 1995, there was apparent recovery of most constituents of the eelgrass community. TPAH concentrations declined to less than 230 ng g^{-1}, and there were far fewer differences in the abundance of taxa between oiled and reference sites. However, there were still 2 of 18 samples from oiled sites that had TPAH concentrations in excess of 580 ng g^{-1} and had TPAH signatures comparable to *Exxon Valdez* oil. Two families of amphipods and three families of infaunal bivalves remained more abundant at reference sites, as did leather stars (*Dermasterias*) and crabs (*Telemessus*). Also, there was continued evidence of enhancement of some populations of benthic fauna at oiled eelgrass sites, including several polychaete families and the epifaunal bivalves of the family Mytilidae. While these patterns suggest a lack of complete recovery, it is impossible to discern possible continued impacts of oil from inherent site differences that are unrelated to oiling. This is largely the result of a lack of quantitative pre-spill data with which to compare the post-spill condition of the community.

The Effects of the *Exxon Valdez* Oil Spill on Subtidal Eelgrass Communities in Prince William Sound, Alaska 1990-1995

1.0 INTRODUCTION

The shallow subtidal habitat of Prince William Sound, from the intertidal zone to depths of approximately 20 m, typically has dense stands of kelps or eelgrass, and contains assemblages of polychaete worms, snails, clams, crabs, other crustaceans, sea urchins, and sea stars. These serve as food for coastal-feeding fishes, birds, and marine mammals (McConnaughey and McRoy, 1979; Feder and Jewett, 1981, 1987; Hogan and Irons, 1988; McRoy, 1988; Anthony, 1995), many of which are commercially important (Rosenthal *et al.*, 1977; Rosenthal, 1980; Feder and Jewett, 1987; Kuletz, 1983). Dungeness crab, salmon, Pacific herring, river otters, sea otters, gulls, pigeon guillemots, and a variety of sea ducks, all are dependent on the nearshore subtidal habitat.

In March 1989, the super tanker *T/V Exxon Valdez* ran aground and spilled nearly 42 million liters of crude oil into Prince William Sound (Spies *et al.*, 1996). An estimated 12 percent of this oil was deposited in subtidal sediments (Wolfe *et al.*, 1994), and was a potential threat to subtidal organisms that were exposed to the oil. Shortly after the spill, plants and animals living on or in subtidal sediments were directly exposed to oil dispersed through the water column. Exposure to oil continued as oil leached from intertidal sediments along the shore and as oiled sediments in shallow water were resuspended and redeposited in deeper water (O'Clair *et al.*, 1996a,b; Short *et al.*, 1996a). Based on injuries to subtidal animals that were observed following prior spills elsewhere, in which sizable quantities of oil reached the bottom (e.g., Cabioch *et al.*, 1978, 1980; Kineman *et al.*, 1980; Sanders *et al.*, 1980), it was anticipated that exposure to oil would result in changes in the nearshore subtidal community.

Studies were undertaken shortly after the spill to examine potential injury to the nearshore subtidal community, and have continued in an attempt to evaluate recovery of this community. Earlier reports (Jewett *et al.*, 1995, 1996; Dean *et al.*, 1996a,b) indicated that there were injuries to several subtidal organisms resulting from the spill. These included injuries to plants and animals in a variety of habitats throughout the western portion of the Sound. The most severe and persistent injuries occurred within eelgrass communities found on soft sediments in protected bays. This report provides a comprehensive examination of injuries within the eelgrass community, and updates the state of recovery based on sampling conducted in 1995.

2.0 OBJECTIVE

The objective of this study was to examine the injury to, and recovery of shallow (< 20 m) subtidal eelgrass communities of the plant, invertebrates, and fishes, within Prince William Sound, Alaska that resulted from the *Exxon Valdez* oil spill.

3.0 METHODS

3.1 Sampling Design

The eelgrass habitat was selected for study because of its relative ecological importance, its risk to injury from oil, and its proportion of total habitat in the oiled area. Eelgrass dominates in areas of soft substrate that generally occur in back bays at the mouths of streams. It grows from the bottom to near the water's surface and often forms extensive beds that cover large areas in these back bays. Eelgrass also occurs in scattered patches of soft sediment that occur throughout much of the rocky subtidal zone, but we have restricted our definition of eelgrass habitat to the larger beds. Eelgrass generally extends from just below the intertidal zone to depths of about 5 m below MLLW (mean lower low water). Our studies extended beyond the eelgrass boundary, to depths of 20 m.

A stratified random sampling design was used to estimate the extent of injury to, and recovery of, the eelgrass community. Population parameters (e.g. abundance, biomass, diversity) for the plant, invertebrate, and fish species were measured at matched pairs of oiled and unoiled (or lightly oiled) reference sites. Sites were paired with respect to physical factors to help reduce variability between sites, and to help distinguish possible effects of oiling from natural variability resulting from these physical factors. Sampling was conducted at four pairs of sites in 1990, five pairs in 1991, three in 1993, and four in 1995. For this report, data from only those three pairs of sites sampled in each year were analyzed. (Preliminary analyses indicated that the inclusion of data from other site pairs altered some of the results for individual taxa, but did not provide greater statistical power and did not affect general conclusions regarding the extent of injury (Appendix A). All sites were in Western Prince William Sound, and most were within the Knight Island archipelago where heavy oiling occurred along some shorelines. Sampling was conducted in July to early August in each year.

An initial selection of oiled sites was conducted in the laboratory in winter 1990. Sites were initially chosen based on an overlay of oil information and habitat information on navigation charts. Locations of the eelgrass sites were initially identified, based on information obtained in a preliminary 1989 survey, and by polling knowledgeable biologists familiar with Prince William Sound as to the location of eelgrass beds. Oiled areas were identified, based on the summer 1989 oil survey maps and the September 1989 DEC shoreline surveys (ADEC, 1989). Areas that were moderately to heavily oiled in both surveys were marked as oiled areas. From those oiled areas, we selected 8,200 m sections of shoreline as potential sampling sites. The sites were divided into three groups representing different exposures and geographic regimes: embayments with mouths facing north, embayments in the northwestern quadrant of the Knight Island archipelago with mouths facing west, and embayments in the northeastern quadrant with mouths facing east. One site was then randomly selected from each group. Details of the initial site selection process are described in Appendix B.

Reference sites selected were those indicated as not oiled in both the summer oil survey and the September shoreline assessment. Reference controls were matched with selected oiled sites, as closely as possible, with regard to non-biological factors other than oiling. These factors included geomorphology, aspect, proximity to sources of freshwater input, slope, wave exposure, and water circulation. A matched reference site was randomly selected if more than one existed. Alternate oiled and reference site locations were chosen according to the above criteria, in the event that our initially produced maps proved inaccurate with respect to habitat type, or if references did not match the oiled sites with respect to aspect, wave exposure, etc.

In spring 1990, a site confirmation survey was conducted by boat and plane to insure that preliminary selections of oiled sites were appropriate, and that the reference sites matched these oiled sites with regard to physical aspects. For the oiled sites, all final selections were from our initial list of chosen or alternate sites. For the reference sites, we had to deviate from the initial list and search the western portion of the Sound for an appropriate reference that matched the Sleepy Bay oiled site. Moose Lips Bay was selected based on these surveys. The final locations of sites selected are given in Figure 1. Sites pairing and coordinates are given in Table 1.

The sampling effort was stratified by depth. Three strata were initially selected: 3 to 6 m, 6 to 20 m, and at the mid point of the eelgrass bed (generally < 3m) (Figure 2). The 3 to 6 m stratum was eliminated after 1990 because of cost considerations. The shallower (< 3 m) and deeper (6 to 20 m) strata encompass the range of effects that one would expect at 3 to 6 m. Results from only the two strata sampled in all years are presented here.

3.2 Biological Sampling Methods

At each depth stratum within each eelgrass site, three 30-m long transects were established (Figure 2). These were placed at randomly selected locations along the 200-m section of shoreline selected for sampling. The sites within the eelgrass (< 3 m) depth stratum were placed in what was perceived as the center of the depth distribution of eelgrass. The sites in the deeper stratum were placed at randomly selected depths. Random positions along the shore and random depths were reassigned prior to each years' sampling. Thus, while the same sites were sampled each year, the exact sampling locations within each site differed.

Large motile invertebrates and fishes were counted along each 30-m transect within the eelgrass bed. Divers swam the transect and counted fishes, by species, within a 1-m wide swath to either side of the transect center line and within 3 m of the bottom. These surveys were made prior to other sampling efforts on the transect in order to avoid disturbance to the fish community and to achieve accurate counts of fishes. In 1990 and 1991, all fishes were counted. Cod (family Gadidae) were by far the most abundant family (Jewett *et al.*, 1995; Laur and Haldorson, 1996), and thereafter, only these fishes were counted. Larger sessile invertebrates (non-cryptic specimens of echinoderms and crustaceans larger than 10 cm) were also counted in a 2 m by 30 m band. Small sea stars (less than 10 cm diameter) were counted in a 2-m wide band in 1990, and in a 1-m wide band thereafter.

Along each transect, the number of eelgrass turions (above-sediment portions of the plant arising from the rhizome, usually with 4 or 5 leaves attached) was counted within each of four 0.25-m^2 quadrats. The quadrats were spaced 7.5 m apart, with the initial sampling quadrat placed at a random position along the sampling transect. The number of flowering shoots was counted from within each quadrat in 1990, and from a 1-m wide band along the transect in subsequent years.

Densities of infaunal invertebrates were estimated from two 0.1-m^2 suction dredge samples taken from each of the 3 sampling transects within each depth stratum. One 0.1-m^2 quadrat was sampled from each of the first two eelgrass quadrats on each transect. The dredge samples were taken from the upper left hand corner of each quadrat (determined while facing the shore). Dredge samples collected in the eelgrass bed were taken after the eelgrass was collected.

Samples of infaunal and small epifaunal invertebrates were returned to the University of Alaska, Fairbanks laboratory for sorting, counting, weighing, and identification. All samples were sieved through a 1-mm sieve. The methods are detailed in the Standard Operating Procedure for laboratory processing of the benthic samples (Appendix C). An attempt was made to identify organisms to at least the family level, but there were a few instances when only higher taxonomic levels were assigned to an individual. Many of the more common organisms were identified to the genus and species.

The dredge sampler used for collection of benthic invertebrates was fitted with a collection bag with a mesh size of 1 mm. As a result, organisms smaller than 1 mm were generally not sampled. Those few individuals smaller than 1 mm that remained in the samples were excluded from the analyses. Also excluded from the analyses were organisms that are considered highly motile and non-benthic, such as calanoid copepods, mysids, euphausiids, chaetognaths, and fishes.

Additional fish samples were collected for determination of tissue abnormalities (e.g., hemosiderosis) in 1993 and 1995. The methods and results for these are given in Appendix D.

3.3 Sampling and Lab Analysis of Sediments for Grain Size and Hydrocarbon Content

Sediments were collected from each depth stratum at each study site visited in each year. SCUBA divers collected the sediment samples in pre-cleaned, wide-mouth 4-oz. jars. Divers took two sample jars into the water, cracked the jar's lid just below the water surface, and proceeded to the bottom at each sampling site. There, the jar's lid was removed and the jar was used to scoop sediment to a depth of approximately 5 cm. A 10- to 100-g sample of sediment was obtained at each sampling location. The samples were taken from within 3 m of the buoy anchor marking each sampling station.

One of the collected samples was used to determine sediment composition and the other to determine hydrocarbon concentrations. All samples were numbered, labeled, and frozen aboard the ship. Samples used for the determination of grain size were shipped to the University of

Alaska, Fairbanks for analysis. Analysis of grain-size distributions was by the pipette-sieve method, and the sediment types and grain-size distributions were defined statistically following the conventional grain-size parameters stated in Folk (1980). Sediment data are presented on a percent dry weight basis.

At the end of the field season, all hydrocarbon sediment samples were sent to the Technical Services Task Force, Analytical Chemistry Group (TSTF-ACG), NOAA/NMFS, Auke Bay, Alaska for processing. Samples collected in 1990 and 1991 were sent from there to the Geochemical and Environmental Research Group at Texas A&M University for analyses. The 1993 and 1995 samples were analyzed by TSTF-ACG. Hydrocarbons were extracted from the sediment samples and analyzed for the concentration of various hydrocarbon fractions using gas chromatography combined with a mass spectrometer detector (GC-MS) (Short *et al.*, 1996b). All hydrocarbon data are reported on a dry weight basis (ng g^{-1}).

Chemical analysis of the sediments collected yielded values for several component hydrocarbon analytes. We report the concentrations of total polynuclear aromatic hydrocarbon (TPAH) fractions minus perylene (hereafter referred to as TPAH) and sum of the chrysenes as indicators of the contribution of *Exxon Valdez* oil (Appendix E). Perylene was excluded because it is a naturally occurring PAH compound that is produced diagenetically in marine sediments (Venkatesan, 1988) and is not petroleum derived. Concentrations of TPAH are thought to reflect the distribution of petroleum derived hydrocarbons throughout the study sites (O'Clair *et al.*, 1996a, b). However, a portion of the TPAHs observed may been derived from petroleum hydrocarbons other than *Exxon Valdez* oil, especially diesel fuel. Chrysene concentrations were used as more specific indicators of *Exxon Valdez* oil, because chrysenes are present in crude oil (including *Exxon Valdez* oil) but not in diesel fuel (Bence and Burns, 1995). Both TPAH and chrysene values may include some PAHs from non-anthropogenic sources and from sources other than *Exxon Valdez* oil, however, these represent relative values of oil from the spill that allow us to compare oiled *vs.* reference sites.

Results of the chemical analysis were screened on the basis of surrogate recoveries and minimum detection limits (MDLs). Individual analytes and the summary statistics affected by them were excluded from the analysis if the recoveries of corresponding analyte surrogates fell outside the range 30-150 percent. For example, if the surrogate of one PAH analyte fell outside the acceptable range, the total polynuclear aromatic hydrocarbon (TPAH) concentrations for that sample were excluded from the analysis. Dry weight concentrations of individual analytes reported below MDL were replaced by "0's" for our analyses. The MDL for aromatic hydrocarbons was 1 ng g^{-1}.

It was determined that five of the samples sent to the Technical Services Task Force, Analytical Chemistry Group, NOAA/NMFS in 1990 were improperly analyzed and these were omitted from our analyses.

Criteria were established for comparing hydrocarbon concentrations in sediments with those in *Exxon Valdez* oil (J. Short, Pers. Comm., 1996). The pattern of PAH concentrations in the sediment samples was judged similar to *Exxon Valdez* oil if it met three criteria: (1) the ratio of alkyl dibenzothiophenes (summed) to alkyl phenanthrenes (summed) exceeded 0.3, (2) the ratio of alkyl chrysenes (summed) to alkyl phenanthrenes (summed) exceeded 0.05, and (3) the concentration of alkyl phenanthrenes exceeded 25 ng g^{-1}. This is similar to, but more conservative than, the method used by O'Clair *et al.* 1996a,b in ascribing the *Exxon Valdez* as the source of oil contamination

Sediment samples collected in 1990 and 1991 were also analyzed to determine of carbon and nitrogen isotope concentrations. The methods and results for these are given in Appendix F.

3.4 Data Analysis

3.4.1 Univariate Analysis

The data from the eelgrass community were analyzed using both univariate and multivartiate techniques. Univariate statistical analyses were used to test for differences between oiled and reference sites, between years, and to examine possible interactions between oiling category and year. Metrics analyzed included those associated with sediment grain size; hydrocarbon concentrations; densities of eelgrass, larger epifaunal invertebrates, and fish; and various community and individual taxon measures for infauna collected in dredge samples. Both two-way analyses (testing for differences oil between oiled and reference sites, between years, and interactions between oil category and year) and one-way analyses (testing for differences between oiled and reference sites within each year) were performed using the randomization procedure (Manly, 1991). Separate analyses were performed for each depth stratum. We tested for oil category (oil or reference) and year as the main effects, with pair (arbitrarily assigned as 1 through 3) as a blocking factor. Replicate stations were sampled within each site, and in some cases, replicate quadrats were sampled within each station. In all cases, station rather than quadrat means were used as replicates in the analyses.

The randomization procedure can be briefly summarized as follows. 1) A blocked analysis of variance (ANOVA) was performed, and a sum of squares produced. 2) Next, using the original data set, values for oil code were randomly reassigned to each station value. The ANOVA was then rerun on this new data set. 3) Step 2 was repeated 1000 times. 4) The sums of squares from the ANOVA of the original data set was compared with sums of squares of the 1000 randomly drawn data sets.

The proportion of instances in which the sums of squares for the randomly drawn data exceeded the sums of squares for the original data was recorded. This value is the significance level of the test as described by Fisher (1935). The significance level is interpreted in the same manner as for parametric procedures. If the randomly drawn sums of squares exceeded the sums of squares for the original data 10 percent of the time, then this is equivalent to $P = 0.10$ for an ANOVA.

For benthic invertebrates collected in dredge samples, analyses were conducted on the community parameters (species richness, diversity, total abundance, and total biomass), the abundances of major taxa (phylum, class, order), abundances of different feeding types, and abundances of dominant families. Species diversity measures analyzed included Margalef's species richness index, SR (Green, 1979) and the Shannon index, H' (Shannon and Weaver, 1963). The

Margalef's species richness index is used as a representative index of the number of taxa or species richness component of diversity. It scales the total number of taxa with respect to the total number of individuals, and is calculated as:

$$SR = \frac{S - 1}{\log_e N}$$

Where S = the number of species [taxa]

N = the total number of individuals.

The Shannon index is one of the most widely used measures of diversity and incorporates both species richness and evenness components. The Shannon index, H′, was calculated as:

$$H' = - P_i \log_e P_i$$

Where P_i = the proportion of the total number of individuals occurring in the taxon.

In both of the above indices, taxa identified to family (or above) were used as opposed to species. While diversity indices are normally applied to species, the overall diversity of a community is comprised of hierarchical components (e.g. family, genus, and species) and the concept can be applied to any of these components (Pielou, 1974). Diversity values computed using taxon identifications higher than species have been reported by Lloyd *et al.* (1968), Valentine (1973) and Ferraro and Cole (1990, 1992).

For analyses of feeding group data, individuals in suction dredge samples were categorized as suspension feeders, surface deposit feeders, subsurface deposit feeders, predator/scavengers, or herbivores. Categorizations were generally based on feeding methods used by related taxa (e.g., see Jumars and Fauchald, 1977; Grebmeier *et al.*, 1989; Feder *et al.*, 1990; Feder *et al.*, 1994) because there was little or no information on the feeding mode of most taxa collected. The identification of the feeding modes of marine invertebrates is a common problem in studies addressing trophic analyses and, as a result, are always somewhat subjective. Since some taxa are capable of feeding by more than one mode, the estimated proportion of feeding type(s) was assigned to each taxon. For example, spionid polychaetes were categorized as 50 percent suspension feeders and 50 percent surface deposit feeders. Assigned feeding groups are given in Appendix G.

Our analysis of individual families of benthic invertebrates in dredge samples was limited to the most abundant taxa. Rare taxa, for which there was relatively little statistical power, were eliminated in order to reduce analysis time. Taxa that occurred in fewer than one-sixth of the samples for a particular depth stratum and year were eliminated, and the remaining taxa were ranked. The 15 most abundant taxa in each year and depth stratum were then selected for analysis. Generally, the 15 highest ranking taxa for one year were also the highest ranking for another. However, occasionally a taxon was ranked in the top 15 one year but not another. As a result the number of taxa for which analyses were performed was generally between 15 and 25.

In the univariate analysis of dredge sample data, separate analyses were performed for infaunal and epifaunal organisms. Individual families were assigned either to infaunal or epifaunal groups depending on the habitat of the dominant taxa within the family.

Percent mud was used as a co-variate in all univariate analyses of infauna from the dredge samples. Previous studies of marine benthic communities (e.g., Rhoads, 1974; Grebmeier *et al.*, 1989), and preliminary analyses of our data, indicate that the faunal composition and the abundance of infaunal species is determined to large degree by sediment grain size. While our paired sampling design was generally successful in controlling for grain size, sediment types differed somewhat among some pairs of oiled and reference sites (Appendix H), and percent mud was used as a co-variate to account for these uncontrolled differences.

3.4.2 Multivariate Analysis

Multivariate analyses were used to examine spatial and temporal patterns of overall composition of communities represented in dredge samples, and to test for the correspondence of these patterns with changes in environmental variables. Cluster analysis and two ordination techniques were applied to $ln(x+1)$ transformed abundance data (indiv. 0.1 m^{-2}). The Bray-Curtis dissimilarity coefficient (Bray and Curtis, 1957) was calculated and used to produce dissimilarity matrices for each site and year. Separate matrices were calculated for each depth stratum and for infauna and epifauna. Agglomerative unweighted group-averaging cluster analyses were applied to the dissimilarity matrix to provide the initial classification of sites and sampling times into site/year groups (Clifford and Stephenson, 1975). Nonmetric multidimensional scaling (MDS: Kruskal and Wish, 1978) and principal coordinate analysis (PCO: Digby and Kempton, 1987) were then applied to the Bray-Curtis dissimilarity matrix. Site/year groupings were determined based on general agreement of the clustering and ordination techniques. Gauch (1982) and Olsgaard and Gray (1995) suggest using a number of multivariate procedures and where there is agreement between the various techniques, the observed trends may be interpreted to represent the community structure of the population sampled.

Discriminate analysis was used to examine the degree to which key environmental variables could explain the site/year groups determined by clustering and ordination techniques. Groupings for the discriminant analysis were the groupings determined by cluster and MDS analyses. Key environmental variables used in the analysis were: percent sand, percent mud, TPAH, and chrysene concentrations. Percent sand and mud were used because it is well documented that sediment grain-size characteristics are major determinates of community composition in marine benthic communities (e.g., Rhoads, 1974; Grebmeier *et al.*, 1989).

Other environmental variables including percent gravel and sums of various other hydrocarbon analytes (e.g., non-aromatics, dibenzothiophenes, flourenes, naphthalenes, and phenanthrenes, and alkanes) were not used in the analysis. Percent gravel was excluded as it forms a linearly dependent variable with percent sand and percent mud (i.e., all add up to 100 percent). Other summary hydrocarbon variables were excluded because they were all highly correlated ($r > 0.9$) with either TPAH or chrysene concentrations.

The percent sand and percent mud variables were arcsine[square root (x)] transformed and chrysene and TPAH concentrations were *ln*(x) transformed. Variables were standardized after the transformations were applied. The absolute magnitude of the standardized coefficients of the variables along the discriminate axes represent the contribution (i.e., importance) of each variable to an axis. The percentage of variance accounted for in the environmental data by each axis is included as a cumulative percentage. Variance of each axis can be determined by subtracting the cumulative value for that axis from the cumulative value for the previous axis. All four variables were considered in the discriminate analysis model, as opposed to stepwise procedures, so that the contribution of each variable to the discriminate axes could be assessed.

3.4.3 Interpretation of Statistical Results

Statistical tests were regarded as providing evidence of injury if there were significant differences between oiled and reference sites in 1990 or if there were significant differences between oiled and reference sites in two-way analyses that examined effects of oiling category, year, and their interaction. Recovery from effects of oil was inferred from a lack of significant differences between oiled and reference sites in years subsequent to 1990, or by a significant interaction between oiling category and year in two-way analyses. However, we also relied on the visual examination of plots to indicate the extent of injury and recovery. For example, in some instances there were statistically higher densities at reference sites in 1990 through 1993, but not in 1995. However, in spite of a lack of statistical significance in 1995, mean densities were higher at reference sites, and there was a significant effect of oiling category in the two-way analysis. Such a pattern would suggest injury followed by partial recovery.

The statistical inference for both univariate and multivariate statistical tests is with respect to the sites that were sampled, and not the population of all possible eelgrass sites within Prince William Sound. The extrapolation required to apply the results of the statistical analyses to the population within the entire Sound is a deductive rather than an inductive process, and relies partly on the professional judgment using the weight of all evidence available.

4.0 RESULTS

4.1 Sediment Hydrocarbon

The temporal and spatial patterns in TPAH concentrations in sediments were what one would expect following a major oil spill (Figure 3, Table 2 and Appendix I and J). In general, mean TPAH concentrations were higher in sediments collected from sites adjacent to heavily oiled shorelines than at sites adjacent to unoiled shorelines, and TPAH concentrations declined significantly over time. Furthermore, TPAH concentrations declined more dramatically at oiled than reference sites, resulting in a significant interaction between oiling category and year.

In 1990, mean TPAH concentrations were four to eight times higher at oiled sites. Concentrations averaged about 5,000 ng g^{-1} (5,390 ng g^{-1} at 6 to 20 m and 4,979 ng g^{-1} at < 3 m) at oiled sites and less than 1,300 ng g^{-1} (1,282 ng g^{-1} at 6 to 20 m and 612 ng g^{-1} at < 3 m) at reference sites. In 1990 and 1991, the majority of samples collected at oiled sites had analyte compositions indicative of the presence of *Exxon Valdez* oil (Table 3). By 1993, average concentrations dropped to below 300 ng g^{-1} at oiled sites, and to below 60 ng g^{-1} at references; and by 1995, TPAH concentrations averaged less than 230 ng g^{-1} at both oiled and reference sites and did not differ significantly between sites. However, there were still some indications of continued exposure to oil in 1995. Two samples (one from Bay of Isles and one from Sleepy Bay) had TPAH concentrations exceeding 500 ng g^{-1}, and had signatures comparable to *Exxon Valdez* oil.

A similar pattern was observed with respect to chrysenes, except that the declines over time were not as precipitous, and differences among sites tended to persist (Figure 3 and Table 2). Chrysene concentrations differed significantly at oiled and reference sites, but there was no significant effect of year, and no interaction between oiling category and year.

While TPAH and chrysene concentrations tended to be higher at oiled sites, there were also indications of moderate oil contamination at reference sites. Relatively high concentrations of both TPAH and chrysenes were observed at reference sites in 1990 and 1991, and one-third or more of the samples collected from these sites in 1990 and 1991 had signatures indicative of *Exxon Valdez* oil (Table 3).

There was considerable variability of TPAH concentrations both between and within sites of each oiling category. For example, at oiled sites in the 6 to 20 m stratum in 1990, mean TPAH concentrations at Bay of Isles were over 15,000 ng g^{-1}, while concentrations at Herring Bay averaged only 45 ng g^{-1} (Figures 4 and 5). Of the two samples collected from the deep stratum at Bay of Isles in 1990, one had a TPAH concentration of over 23,000 ng g^{-1}, while the other had a concentration of less than 7,000 ng g^{-1}.

4.2 Eelgrass

Eelgrass (*Zostera marina*) is an aquatic angiosperm with true roots, leaves, and seeds. Patterns of abundance of both eelgrass turions (uprights protruding from the substrate) and eelgrass flowering shoots indicate possible injury as a result of exposure to oil, with recovery by 1995 (Table 4, Figure 6 and Appendix K). There was a significant interaction between oil category and year for turion density ($P = 0.05$) and flowering shoot density was significantly higher at reference sites ($P = 0.02$). For both turion and flowering shoot density, there tended to be higher densities at reference sites in the several years following the spill, with equal or greater densities at oiled sites in 1995. Turion density was significantly greater at reference sites in 1991 ($P = 0.05$), and flowering shoot density was greater at reference sites in 1990 ($P = 0.1$). By 1995, turion density was significantly greater at oiled sites and there were no differences between oiled and reference sites with respect to flowering shoot density.

Most of the relative increase in turion and flowering shoot density was due to a decline at reference sites after 1990, rather than an increase at oiled sites. While these patterns may be the result from an interaction of the effects of oil and natural temporal variability, they suggest that factors other than direct effects of exposure to oil may have been responsible for the observed patterns.

4.3 Infaunal and Epifaunal Invertebrates From Dredge Samples

4.3.1 General Description of the Community

Over 400 taxa (genera and species) of infaunal and small epifaunal invertebrates, with representatives from over 151 families were collected in dredge samples. The infaunal community was numerically dominated by a variety of polychaetes, bivalve and gastropod mollusks, and crustaceans (mostly amphipods) (Table 5; Appendices G and L). The assemblage was typical of infaunal communities from shallow mud and sand bottoms in subarctic waters (Feder and Jewett, 1987; 1988). Spirorbid polychaetes and mytilid mussels (*Musculus* spp.) dominated the epifaunal community. The epifaunal organisms were generally attached to eelgrass liter on the bottom.

4.3.2 Multivariate Comparisons

Cluster and MDS analyses (Figures 7 through 10) indicated that within the infaunal/epifaunal community represented in dredge samples, there was greater spatial than temporal variability. In most instances samples collected from the same sites in different years tended to be more similar than samples collected from different sites in a given year. Also, there was a tendency for sites of a matched pair of sites (e.g., Herring Bay and Lower Herring Bay) to cluster. This is reflective of the intentional matching of sites with respect to physiographic features that obviously have a significant influence on community structure. Clusters of site/years were not as well defined for epifaunal communities in the 6- to 20-m depth stratum compared with infaunal communities and compared with the epifauna within the eelgrass bed. This probably reflects the relative scarcity of epifaunal organisms at these depths as a result of a lack of eelgrass or other physical structures to which epifauna could attach.

In spite of the apparent predominance of non-anthropogenic factors in influencing patterns of similarity, there are several patterns that suggest an oil exposure impact. The infaunal component of the community in the deeper stratum at Bay of Isles was remote in ordinate space from the majority of the other site/years, and the sample from 1990 was extremely remote compared with other years (Figure 7). Bay of Isles generally had higher hydrocarbon concentrations than other sites, and the mean concentration of TPAH at Bay of Isles in 1990 (greater than 15,000 ng g^{-1}) was by far the highest concentration of TPAH observed (Appendices I and J). Also, in the eelgrass bed (< 3 m depth) 1990 samples from Bay of Isles, Drier Bay, and Lower Herring Bay were remote from other site/years (Figure 9). While two of these three sites were classified as unoiled reference sites, sediments collected at all three sites in 1990 had high TPAH concentrations (14,309 ng g^{-1} at Bay of Isles, 1,417 ng g^{-1} at Drier Bay, and 297 ng g^{-1} at Lower Herring Bay, Appendices I and J), and two of the three (Bay of Isles and Drier Bay) had the higher concentrations than any other site.

Discriminate analyses also suggest that while community structure was principally governed by sediment characteristics, it was also influenced by contamination from *Exxon Valdez* oil. In analyses using percent sand, percent mud, TPAH concentrations, and chrysene concentrations as potential explanatory variables, at least 91 percent of the variance in the community composition, based on the community composition indicated by cluster and MDS analyses, could be explained by the first two discriminate axes (Table 6). The percent correct classifications ranged from 91 percent to 100 percent, indicating a strong relationship between the distributions of the variables and the site/year groupings for each data set. The highest proportion of the variance in community structure, based on cluster groupings, was explained by sediment parameters. In all but the epifaunal community within the eelgrass bed, percent mud and percent sand were highly significant contributors to the discriminate model ($P < 0.01$). Chrysenes were also important contributors in all but the infaunal community at < 3 m. Chrysenes had the highest standardized coefficients for most analyses, and made a significant contribution to the discriminate model ($P < 0.10$ for epifauna at < 3, and $P < 0.01$ for both infauna and epifauna at 6 to 20 m).

The relationships between environmental variables and community structure are also evident in overlays of environmental variables on the MDS ordinations (Figures 11-14). Site/year groupings generally exhibited values of percent sand and percent mud of similar magnitudes (Figures 11 and 12). There was a less obvious correspondence of site/year groupings with magnitudes of chrysenes or TPAHs, but samples within a site/year group or within adjacent groups generally had comparable TPAH and chrysene concentrations (Figures 13 and 14).

4.3.3 Univariate Comparisons

Community parameters - Some spatial and temporal patterns for community parameters suggest possible reductions in abundance or diversity as a result of exposure to oil. For infaunal organisms in the deeper waters outside the eelgrass bed, H′ and total abundance were greater at reference sites
($P = 0.04$ for H′; $P = 0.08$ for abundance; Table 7, Figure 15, Appendix M). H′ was significantly higher at the reference sites in 1990, but did not differ significantly in subsequent years. This suggests that there may have been some slight suppression of diversity at oiled sites in 1990, followed by recovery.

By far the more prevalent pattern was one suggestive of possible enhancement from oil, or alternatively from inherent differences among sites that were unrelated to exposure to oil. For infauna within the eelgrass bed, and for epifauna in both depth strata (Table 7, Figures 16-18, and Appendix M), both biomass and abundance were generally greater at oiled sites. Also, H′ was slightly higher at oiled sites for epifauna at depths < 3 m (Figure 18). One would expect that enhancement of biomass or abundance due to exposure to oil would decrease over time as TPAH concentrations decreased. However, some of these parameters were generally higher at oiled sites throughout the study (e.g., total biomass of epifauna at < 3 m, Figure 18) or increased at oiled sites over time (e.g., total abundance and biomass of epifauna at 6 to 20 m, Figure 16), and may have been due to inherent differences among sites. Only species richness for infauna and total abundance of epifauna within the eelgrass bed displayed patterns more easily interpreted as the result of enhancement. Both were higher at oiled sites shortly after the spill, and converged at oiled and reference by 1995, resulting in a significant interaction between oiling category and year ($P \leq 0.05$ for both, Figures 17 and 18).

Major Taxa - The greater overall abundance of infaunal organisms at oiled sites was mostly attributable to a greater abundance of gastropods and to a lesser extent polychaetes (Figures 19-

22). These two groups had significantly ($P < 0.1$) greater abundance at oiled sites in both depth strata (Table 8, Figures 19 and 21, and Appendix N). Infaunal amphipods, on the other hand were significantly more abundant ($P < 0.05$) at reference sites within the eelgrass bed (< 3 m).

Of the epifaunal organisms, there was a greater abundance of bivalves at oiled sites in both depth strata ($P < 0.01$ in both cases), and a greater abundance of echinoderms and gastropods at oiled sites within the eelgrass bed (Table 8, Figures 20 and 22, and Appendix N). There was no evidence that the differences in abundance were diminishing over time, suggesting that the differences may have been unrelated to direct enhancement by oil.

Feeding Groups - There were some indications of effects of oil on the abundance of either infauna or epifauna when grouped by feeding type, especially within the eelgrass bed. Within the 6 to 20 m depth stratum, surface deposit feeders, and to a lesser extent, suspension feeders, were slightly more abundant at reference sites, and predator/scavengers and herbivores were slightly more abundant at oiled sites (Table 9, Figure 23, and Appendix O.). However, there were no significant interactions between oiling category and year, suggesting that the relative proportions of feeding types between oiled and reference sites did not change appreciably over time. Within the eelgrass bed, all groups were more abundant at oiled sites, and especially suspension feeders, herbivores, and subsurface deposit feeders (Table 9, Figure 24, and Appendix O). Possible enhancement of these groups was suggesting by temporal patterns. Abundances of surface deposit feeders, subsurface deposit feeders, herbivores, and predators/scavengers peaked in 1991 at reference sites in the eelgrass bed (< 3m) when moderate amounts of oil were observed there. At oiled sites in the eelgrass bed, peaks in abundance were noted in 1991 or 1993, and then declined in 1995 as TPAH concentrations diminished. However, significant interactions between oiling category and year were noted only for predator/scavengers.

Dominant Families - Of the twenty-five dominant families in the 6- to 20-m depth stratum, and the twenty-three dominant families within the eelgrass bed, roughly half had densities that differed significantly between oiled and reference sites, or displayed a significant interaction between oiling category and year. These can be roughly divided into three groups: Those that were more abundant at reference sites, those that were more abundant at oiled sites, and those for which there was a significant interaction.

The first group (greater at references) was represented by two amphipod families and three families of infaunal bivalves. Phoxocephalid and isaeid amphipods displayed patterns indicative of injury from exposure to oil, with only partial recovery by 1995. Both were moderately abundant at reference sites (greater than 20 individuals per 0.1 m^2) in both depth strata (Figure 25, and Appendix P), but there were very few isaeids or phoxocephalids at oiled sites, especially in 1990. In 1990 and 1991, phoxocephalids were significantly greater at the reference sites within both depth strata and Isaeidae were more abundant at reference sites in the eelgrass bed (Tables 10 and 11). Both families showed some marginal increase in abundance at oiled sites over time. By 1995 only phoxocephalids were significantly more abundant at reference sites ($P < 0.01$) within the eelgrass bed, but both families were still about ten times more abundant at references.

Infaunal bivalve families that were more abundant at reference sites included Montacutidae and Thyasiridae in the 6- to 20-m stratum (Table 10, Figure 26, and Appendix P), and Tellinidae within the eelgrass bed (Table 11, Figure 26, and Appendix P). Only Montacutidae showed possible signs of increased abundance at oiled sites by 1995, suggesting recovery following injury from oil. The other taxa were consistently more abundant at references, indicating either continued injury, or inherent site differences unrelated to oil effects.

Several other amphipods within the eelgrass bed (< 3 m) were either significantly more abundant at oiled sites (Corophiidae) or displayed a significant interaction between oil category and year (Ischyroceridae and Caprellidae) (Table 11, Figure 27, and Appendix P). All showed similar patterns of abundance over time, with relatively low abundances at both oiled and reference sites in 1990, a peak in abundance at reference sites in 1991, and a peak at oiled sites in 1993. These patterns suggest that these amphipods may have been enhanced by moderate amounts of oil that were present at reference sites in 1991, and at oiled sites in 1993.

There was also one epifaunal bivalve, Mytilidae, that was more abundant at oiled sites within both depth strata (Tables 10 and 11, Figure 28, and Appendix P). Almost all of the Mytilidae that were found were of the genus *Musculus*, small mussels found attached to the blades of eelgrass or on debris at the sediments' surface. These suspension-feeding and brooding mussels were consistently more abundant at oiled sites throughout the period from 1990 to 1995, suggesting that differences in *Musculus* abundance may have been due to factors other than oiling. The density of *Musculus* attached to eelgrass blades was also greater at oiled sites (Table 11 and Appendix Q), indicating that the pattern observed in dredge samples was reflective of the number of *Musculus* attached to eelgrass at these sites.

Within both the eelgrass bed and the 6 - to 20-m stratum, several polychaete and gastropod families were more abundant at oiled sites (Tables 10 and 11, Figures 28 and 29, and Appendix P). This is in keeping with analysis of major taxa which also suggested that there were higher abundances of polychaetes and gastropods at oiled sites. The families that were more abundant at oiled sites included five polychaete families (Amphictenidae, Nereidae, Opheliidae, Sabellidae, and Spionidae), one gastropod family (Lacunidae) in the eelgrass bed, and four polychaete families (Maldanidae, Nephtyidae, Spionidae, Syllidae), and one gastropod family (Caecidae) in the 6 - to 20-m depth stratum. All were consistently higher at oiled sites from 1990 through 1995.

For one epifaunal polychaete family, Spirorbidae, in the eelgrass bed there was a highly significant interaction between oil category and year ($P < 0.01$), as these worms were more abundant at oiled sites from 1990 through 1993, but more abundant at reference sites in 1995 (Table 11, Figure 29, and Appendix P). These are small calcareous tubed worms that are found attached to eelgrass blades, and most of the individuals collected in the dredge sample were attached to eelgrass liter on the bottom. The pattern of abundance for spirorbids suggests that there may have been some enhancement of these worms following the spill, or alternatively, a higher rate of sloughing of eelgrass blades (to which the worms were attached) at oiled sites.

4.4 Large Epibenthic Invertebrates

The sea stars *Pycnopodia helianthoides* (sunflower star) and *Dermasterias imbricata* (leather star) and the helmet crab *Telmessus cheiragonus* were dominant large epifauna within the eelgrass beds (Dean *et al.*, 1996b). Both *Telmessus* and *Dermasterias* were significantly more abundant at the reference sites than at oiled sites ($P < 0.05$, Table 12, Figure 30, and Appendix R) and abundances at oiled and reference sites tended to be higher in 1990 or 1991 than in 1993 or 1995. *Telmessus* abundance declined dramatically between 1990 and 1995 ($P < 0.01$, Table 12), especially at reference sites (Figure 30). By 1993, abundances of *Telmessus* at both oiled and reference sites were very low (less than 1 per 100 m^2) at all sites. *Dermasterias* showed a somewhat similar pattern with declines at both oil and reference sites (albeit not statistically significant) after 1991. These patterns suggest a possible impact of oil, and a lack of complete recovery for these crabs and sea stars.

The pattern of abundance for large (> 10 cm) *Pycnopodia* suggests that these stars were impacted by oiling, but have since recovered. Mean densities of large *Pycnopodia* densities were somewhat higher at reference sites (but not significantly so) in both 1990 and 1991 (Table 12, Figure 30, and Appendix R). In 1993 there was a marked increase in large *Pycnopodia* at oiled sites and a decline at reference sites, and by 1995, there were significantly more large *Pycnopodia* at oiled sites. There was no apparent impact of oil on the abundance of small (< 10 cm) *Pycnopodia*. Large numbers of small stars were found at both oiled and reference sites in 1991 through 1995. Most of the individuals observed were less than 5 cm were attached to the blades of eelgrass, and were apparently feeding on epifauna attached to the plants.

4.5 Fishes

At least fifteen species of fishes were found in eelgrass bed. Pacific cod *Gadus macrocephalus* was the most abundant species, comprising over 90 percent of the total number of fishes (Laur and Haldorson, 1996). The Pacific tomcod *Microgadus proximus* was also present but in lower abundance. Since these two species are so similar in appearance to the divers, there was no attempt to distinguish between the two after 1990. Counts include both species and were classified as the family Gadidae (excluding pollock). A variety of demersal species made up most of the remainder of the fish community.

Small (< 15 cm) cod were significantly ($P < 0.01$) more abundant at oiled sites (Table 13, Figure 31, and Appendix S). The pattern of abundance indicated that small cod abundance was variable over time, but was generally greater at oiled sites. There was no indication of a decline in abundance at oiled sites over time. Large cod abundance varied significantly with year, but did not differ between oiled and reference sites.

5.0 DISCUSSION

5.1 Hydrocarbon Contamination of Subtidal Sediments

TPAH concentrations were generally higher at oiled than at reference sites, and decreased over time. Sampling of subtidal sediments by O'Clair *et al.* (1996a, b) at these as well as other subtidal sites in Prince William Sound revealed similar patterns. Contamination at oiled sites was also suggested by the somewhat lower $\delta^{13}C$ values observed there (Appendix F). While TPAH concentrations were generally higher at oiled sites, relatively high concentrations of TPAHs were also observed at some reference sites where there was little or no oil along the shoreline. This oil often had a signature comparable to *Exxon Valdez* oil. This suggests that oil from the spill had reached subtidal sediments even at sites relatively far removed from heavily oiled beaches. This also suggests that inferences made, with respect to effects of oil at subtidal sites adjacent to moderately to heavily oiled shorelines, are perhaps conservative estimates of injury. If oil concentrations at reference sites were above a threshold that causes biological effects then some injury may also have occurred there. Larger differences in biological responses at oiled and reference sites might be expected, if reference sites had been totally free of oil.

There is some evidence that high TPAH concentrations at some reference sites were due to contamination from sources other than *Exxon Valdez* oil. For example, the average concentration of TPAHs at 20 m depth at the Lower Herring Bay eelgrass site in 1990 was 1908 ng g^{-1}. Further investigation revealed that none of the samples from the Lower Herring Bay deep site contained patterns of TPAHs that were characteristic of weathered *Exxon Valdez* crude oil. The TPAH patterns were more evident of gasoline (possibly contaminated during collection), diesel oil (possibly from clean-up activities) and of submarine oil seeps (Page *et al.*, 1996). At least some of this non-*Exxon Valdez* oil was likely the result of "collateral injury " from cleanup activities, but there is no way of knowing what proportion was from this *vs.* naturally occurring hydrocarbons.

It is important to understand that the hydrocarbon data serve only as indicators of exposure. Relatively few hydrocarbon samples were collected and analyzed, and samples were not collected until summer 1990, more than a year after the spill. Sampling conducted by O'Clair *et al.* (1996a, b) indicated that TPAH concentrations in subtidal sediments were higher in 1989 than in subsequent years. Furthermore, samples that were analyzed for hydrocarbons were not taken from exactly the same location as our biological samples in all cases. Given the degree of spatial and temporal variability in sediment hydrocarbon concentrations, and given that higher concentrations were observed in 1989, prior to biological sampling, it is likely that at least portions of the populations of plants and animals were exposed to much higher concentrations of hydrocarbons than were measured in the sediments. This is supported by observations of TPAH concentrations as high as 28,000 ng g^{-1} in sediments collected from sediment traps at Sleepy Bay in 1989 (Short *et al.*, 1996a) and as high as 40,000 ng g^{-1} in mussels collected from Herring Bay in 1989 (Short and Harris, 1996). It is also suspected that some of the moderately mobile organisms such as sea stars were in the intertidal region during the spill, and were probably too slow to escape direct contact with oil.

Wolfe *et al.* (1994) estimated that from 8 to 16% of spilled oil from the *Exxon Valdez* entered the subtidal region. O'Clair *et al.* (1996a, b) suggested that this was of the same order of magnitude as estimated for the *Amoco Cadiz* (8%), *Tsesis* (3 to 6%), and *Ixtoc* (.5 - 3%) spills. Furthermore, the maximum concentrations of oil in subtidal sediments after the *Exxon Valdez* oil spill were usually within an order of magnitude of the maximum concentration in sediments after other major spills.

5.2 Assessment of Injury to Biological Resources - Effects on Eelgrass

The significantly higher density of flowers at reference sites ($P = 0.02$) and a significant interaction of oiling category and year for turion shoot density ($P = 0.05$), suggest that there may have been injury to eelgrass. Support for this comes from a second set of independent evaluations of the effects of the spill on eelgrass populations in Prince William Sound (Houghton *et al.*, 1991, 1993). In 1990, Houghton *et al.* conducted surveys at six oiled and three reference sites. While three of the oiled sites were in the same bays as ones used in our study, three other oiled sites and the 3 reference sites were different than the sites we sampled. Houghton *et al.* found, as we did, that flowering was less common at oiled than at reference sites, and that mean turion densities were higher (albeit not significantly so) at reference sites. Mean densities of flowering stalks reported by Houghton *et al.* (1991) were very similar to those we reported. In 1990, we estimated mean flowering shoot densities of 3.0 and 8.8 m^{-2} at oiled and reference sites respectively compared to values of 1.7 and 8.4 m^{-2} reported by them. Houghton *et al.* found slightly higher densities of eelgrass shoots than we did (316 m^{-2} at reference sites and 240 m^{-2} at oiled sites in July 1990 compared to our estimates of 190 and 149 m^{-2} at reference and oiled sites, respectively), but the proportional differences among oiled and reference sites were almost identical to those we observed (75 percent *vs.* 78 percent).

Lower densities of shoots and inflorescences at oiled sites in 1990 and 1991 were coincident with higher concentrations of hydrocarbons in the sediments. However, it is unlikely that these concentrations were sufficient to cause the observed effects. Laboratory studies suggest that some hydrocarbons (toluene and diesel fuel) can retard photosynthesis and growth in eelgrass (McRoy and Williams, 1977), but prior field experiments have failed to demonstrate an effect of oil on seagrass density or growth (Ballou *et al.*, 1987). Possible toxicological effects of oil on flowering have not been examined, but can not be ruled out.

Possible injuries to eelgrass more likely resulted from cleanup and monitoring activities. Two (Herring and Sleepy Bay) of the three oiled sites were cleaned and treated (Table 14). On several occasions, we observed bare patches in the eelgrass bed that were the direct result of plants being uprooted by boat anchors, in a manner similar to that described by Walker *et al.* (1989), and this may have been a contributing factor to lower shoot density at oiled sites. Small boats associated with cleanup and monitoring efforts often anchored in shallow water (see photos in Mearns, 1996). There is no documentation of the amount and type of vessel activity associated with the cleanup, however, all shores adjacent to our selected oiled sites were subjected to intense cleaning activities that required extensive vessel support.

The possible reduction in shoot and flower density may also have been the result of lower irradiance levels. Shoreline cleanup efforts (especially high-pressure washing) led to high levels of suspended sediments in the nearshore zone (Mearns, 1996), and presumably reduced light available to eelgrass. Experiments performed elsewhere (Backman and Barilotti, 1976, Dennison and Alberte, 1982, 1986; Dennison, 1987) clearly demonstrate that shading can reduce density of eelgrass, and reductions in seagrass density in Chesapeake Bay and Australia have been attributed to a general degradation in water clarity (Orth and Moore, 1983; Walker and McComb, 1992).

It is also possible that shoot density and flowering at oiled sites was reduced as a result of higher densities of the small mussel, *Musculus* sp. *Musculus* were significantly more abundant at oiled sites, and at some sites (Herring Bay and Sleepy Bay) were at times so dense that they almost completely covered the eelgrass blades and caused the plants to lie along the bottom. The weighing down of eelgrass blades by epiphytes can remove plants from more optimal light regimes that are present higher in the water column (Phillips, 1984), and perhaps more importantly in the case of fouling by *Musculus*, can directly inhibit light penetration to blades. Moderate fouling of eelgrass blades can reduce light penetration by up to 65 percent (Silberstein *et al.*, 1986) and can reduce photosynthesis by 31 percent.(Sand-Jansen, 1977). An increase in fouling of eelgrass has been blamed for reduction in the density of seagrasses in Australia (Walker and McComb, 1992; Larkum and West, 1990).

While the density data suggest possible injury to eelgrass, temporal patterns were not typical of what one would expect if there were injury followed by recovery. The interaction of oiling category and year for the densities of eelgrass turions resulted from a decrease in density at reference sites, while relatively little change in turion density was observed at oiled sites. Also, there was no apparent increase in flowering density at oiled sites between 1990 and 1995. While it is possible that such patterns resulted from an interaction of natural temporal variability and effects of oil, it also suggests that differences among oiled and reference sites may have resulted from inherent differences among sites that were unrelated to the spill.

Qualitative comparisons of pre- and post-spill eelgrass surveys suggest that, if there were injuries to eelgrass, that these were not catastrophic. In 1967, McRoy (1970) examined populations of eelgrass at three sites within Prince William Sound (Redhead Bay, Sawmill Bay, and Stockdale Harbor). His estimates of mean shoot density at these sites ranged from approximately 200 to 700 m^{-2}, and estimates for mean flowering shoot density ranged from approximately 3.5 to 10 m^{-2}. Mean densities in 1990 through 1995 were generally within the range given by McRoy. Mean shoot densities at our sites ranged from about 100 to 200 shoots (turions) m^{-2}, and flowering densities ranged from 1 to 9 m^{-2}. Differences of this magnitude can probably be accounted for based solely on differences in methodologies used by us and McRoy, or upon site difference.

5.3 Effects on Infaunal and Small Epifaunal Invertebrates

Similarity dendrograms and ordination analyses demonstrated that communities of infaunal and small epifaunal invertebrates were generally more similar at the same sites sampled in different years than at different sites sampled in the same year. In addition, selected pairs of sites were generally more similar to one another than sites from different pairs. The analyses suggest that, while all sites were within somewhat comparable habitats in Western Prince William Sound, there was considerable variability among sites, and that the subtle physical differences between sites were important in determining community structure. They also suggest that selection of site pairs was generally successful in that it matched sites of similar characteristics.

While factors other than oil were clearly the most important determinates of community structure, the similarity dendrograms, ordinations and discriminant analyses show indications of the spill. Bay of Isles in 1990 had the highest concentrations of TPAH's, and had a clearly different community than other sites or years, as observed in the dendrograms and ordinations. Several other sites also appeared to be different in 1990 than in subsequent years, and these sites were those with exceptionally high concentrations of TPAH and chrysenes in 1990. Discriminant analyses indicated that the distribution of chrysene was a discriminating variable based on multivariate station groupings. TPAH was never significant to a model. Because of the known importance of the sediment parameters to community structure, the influence of the chrysenes concentrations is not easily determined. The picture is further confused by potential interactions between chrysene concentrations and sediment features. However, the importance of chrysene as a discriminating variable is indicative and supportive of the effects of the spill as suggested above. The analyses of community parameters also showed some indications of injury from oil. By far the more prevalent pattern was one of higher abundance and biomass at oiled sites, suggesting some enrichment due to oiling. The higher abundance at oiled sites was primarily the result of higher densities of infaunal polychaetes and gastropods, and epifaunal bivalves. Higher abundances at oiled sites were also the prevalent pattern among the different feeding guilds, especially within the eelgrass bed (< 3 m). All five groups within the bed were more abundant at oiled sites.

Some reductions in diversity and abundance were observed, but these were less common. Diversity of infaunal organisms was higher at reference sites within the 6- to 20-m stratum, especially in 1990, and there was somewhat higher abundance of infauna at reference sites. Of the higher order taxonomic groups, only infaunal amphipods were more abundant at reference sites, and only within the eelgrass bed. Of the feeding groups, only surface deposit feeders were more abundant at references within the 6- to 20-m stratum.

The patterns that we observed with respect to community measures, and the abundance within higher taxa and feeding groups, were not indicative of a strong community response as a result of exposure to oil. This is somewhat in contrast to observations from prior spills of comparable magnitude. For example, Sanders *et al.* (1980). found that there was a clear reduction ion the abundance of several major taxonomic groups following the *Florida* spill (No. 2 fuel oil) off Massachusetts, and a reduction in both abundance and diversity were observed. The lack of a consistent response with respect to community parameters, feeding groups, and higher order taxonomic groups following the *Exxon Valdez* spill probably reflects the different sensitivities of families within the group, and the lack of high enough concentrations of oil to cause acute toxicity in most taxa. Other spills resulted in higher concentrations of hydrocarbons in sediments (O'Clair *et al.*, 1996b). Furthermore, other spills (e.g. the *Florida* spill) were of more highly refined petroleum products that presumable had higher proportions of more toxic aromatic fractions than *Exxon Valdez* oil.

Patterns among individual families portray a clearer picture of changes that resulted from the spill. The strongest indications of reductions in abundance that may have resulted from the spill were for two infaunal amphipod families, Isaeidae (*Photis* and *Protomedeia*) and Phoxocephalidae amphipods (*Phoxocephalus* and *Paraphoxus*). Both were more abundant at reference than at oiled sites. The differences were greatest in 1990 through 1993, but have persisted to an extent through 1995. These effects were similar to those observed following other oil spills. Massive declines in benthic amphipods were observed following the *Amoco Cadiz* oil spill, and five amphipod species almost totally disappeared from heavily oiled areas subsequent to the spill (Cabioch *et al.*, 1978; Chassé, 1978; den Hartog and Jacobs, 1980; Dauvin, 1982) and only showed partial recovery after two years (Dauvin, 1982). Three other amphipod families showed patterns suggestive of an initial toxic response to *Exxon Valdez* oil followed by recovery. The families Ischyroceridae, Caprellidae, and Corophiidae all had very low abundances at both oil and reference sites in 1990, higher abundances at reference sites in 1991 and higher abundances at oiled sites in 1993.

The lower abundance of several amphipod families at oiled sites was probably, at least in part, the result of acute toxicity of oil. Wolfe *et al.* (1996) tested for toxicity of sediments to amphipods using standard laboratory toxicity tests in both 1990 and 1991. In 1990, there was significant toxicity observed in most intertidal sediment samples collected from oiled beaches, and mean mortalities were significantly greater in sediments from oiled than from reference sites. There was also an indication of toxicity in subtidal sediments. In 1991, significant toxicity was observed at several subtidal sites, including all of our oiled sites (Sleepy Bay, Herring Bay, and Bay of Isles). However, there was also significant toxicity observed at several reference sites, including our Drier Bay site, and there were no significant differences in amphipod mortality at oiled *vs.* reference sites.

Other experimental studies also suggest that differences in amphipod abundance were possibly the result of toxic effects of oil. Busdosh (1981) reported 50 percent mortality in the arctic amphipod *Boeckosimus (Onisimus) affinis* exposed for 10 weeks to mechanically dispersed oil in concentrations (total hydrocarbons) as low as 200 ppb (ng g^{-1}). However, it is unclear whether oil, the dispersent, or a combination of these were toxic. Lee *et al.* (1977) estimated that the amphipods *Gammarus mucronatus* and *Amphithoe valida* began to show toxic effects such as mortality from aqueous extracts of fuel oil at 800 ppb total hydrocarbons, and toxic effects of crude oil were observed when concentrations reached 2,400 ppb. Amphipod abundance in experimental ecosystems decreased by 98 percent during a 25 week exposure to sediments that contained 109,000 ppb hydrocarbons (Grassle *et al.*, 1981; Elmgren and Frithsen, 1982). For relatively short-term exposure, Foy (1982) reported 50 percent mortality in arctic amphipods after 96 hour exposure to dispersed crude oil in measured concentrations of 45,000-162,000 ppb. The amphipod *Anonyx laticoxae* survived an 18 day exposure to sediment containing 292,000 ppb of hydrocarbons (Anderson *et al.*, 1979). It is difficult to make quantitative evaluations of the potential toxic effects of exposure to *Exxon Valdez* oil on amphipod populations based on these prior studies, in part because of the different measures of exposure that were used. However, at least some sites had TPAH concentrations (up to 15,000 ng g^{-1}) high enough to cause mortality in amphipods.

Three infaunal bivalve families were also more abundant at reference sites: Thyasiridae and Montacutidae at 6 to 20 m, and Tellinidae within the eelgrass bed. The principle members of these families were the suspension-or deposit-feeding clams *Thyasira*, *Mysella*, and *Macoma*, respectively. Of these, Montacutidae was the only family showing some signs of recovery. However, it is unlikely that the reduction in bivalves that we noted was due to the acute toxicity of oil. Chassé (1978) observed that some subtidal bivalves (e.g. lamellibranchs, razor clams and cockles) were severely damaged up to four months following the *Amoco Cadiz* spill, although others (*Tellina* and *Mya*) survived well. After the *Tsesis* fuel oil spill, Elmgren *et al.* (1983) found that subtidal *Macoma balthica* (Tellinidae) were found to be highly contaminated with oil (tissue concentrations of 2,000,000 ng g^{-1}), but there were no indications of reductions in population abundance. Abundance and biomass of *M. balthica* increased for three years after that spill. Studies (*in-vitro* and *in-situ*) have shown that intertidal *M. balthica* were adversely affected by exposure to Prudhoe Bay crude oil, but only at much higher concentrations (> 500,000 ng g^{-1}) than we observed (Feder *et al.*, 1976; Shaw *et al.*, 1976; Taylor and Karinen, 1977; Stekoll *et al.*, 1980).

By far the more prevalent pattern among benthic taxa was an significantly greater abundance at oiled sites. This was probably due to an increase in abundance at oiled sites that resulted from the ability of many benthic organisms to take advantage of increased carbon sources made available from the degradation of oil and bioremediation. This is in keeping with observations from prior spills and from observations around natural oil seeps which suggest that toxic effects on benthic organisms generally occur when hydrocarbon concentrations in interstitial water exceed 500 to 1,000 ppb (ng g^{-1}), and that stimulation through enhancement of microbial activity occurs in the range of 20 to 500 ppb. (Spies, 1987). While these values for hydrocarbons in interstitial water are not directly comparable to our measurements of TPAHs in sediments, they suggest that we should expect relatively few toxic effects based on our measured TPAH concentrations. The mean TPAH concentrations we observed in 1990 ranged from 45 ng g^{-1} to 15,253 ng g^{-1}, and the majority were in the range expected to result in enhancement of benthic fauna.

Polychaete families that were more abundant at oiled sites included amphictenids, maldanids, nereids, spionids, sabellids and syllids, most of which have been typically characterized as either opportunistic or stress-tolerant. The amphictenids in the oiled eelgrass habitat were dominated by the subsurface deposit feeders *Pectinaria* spp. Gray (1979) lists *P. koreni* as one that increases in abundance under slight pollution. The subsurface deposit feeding maldanid polychaetes were one of three families that made a rapid recovery in an eelgrass bed oiled by the *Amoco Cadiz* spill (Jacobs, 1980). Spies and DesMarais (1983) showed that petroleum was utilized by the maldanid *Praxillella* as a carbon source in a natural petroleum seep in the Santa Barbara Channel. They suggested the petroleum was used in sufficient amounts to account for greater density of organisms observed in the seep than in a similar nonseep environment.

Two species of nereids, *Nereis diversicolor* and *N. succinea*, are known to increase in abundance under slight pollution (Gray, 1979). *Nereis diversicolor* are highly tolerant to crude oil (Kasymov and Aliev, 1973) and to low oxygen concentration (Henricksson, 1969). *Nereis succinea* from an oiled marsh has been characterized as a resistant species with stimulated population growth (Hyland *et al.*, 1985) and as an opportunist (Boesch, 1977). Presumably other nereid representatives, particularly those in our study (i.e., *Micronereis* sp. and *Platynereis bicanalicata)* behave similarly. Since nereids vary greatly in their feeding modes (i.e., predator, surface deposit feeder, suspension feeder, and mixed feeder, Fauchald and Jumars, 1979) they have an adaptive advantage in disturbed areas such as the oiled portion of Prince William Sound.

Spionid polychaetes have been observed in numerous investigations as classic secondary opportunists in polluted regions (e.g., Sanders *et al.*, 1972; Grassle and Grassle, 1974; Pearson and Rosenberg, 1978; Gray, 1979). This family has the unique ability to utilize different life-history strategies. Their feeding mode is transitional between indirect deposit feeders and filter feeders (Jacobs, 1980) and both benthic and pelagic larvae are represented (Gray, 1979). A member of this family, *Polydora*, flourished in shallow waters immediately following the spill of #2 fuel oil (Sanders *et al.*, 1980). There were at least eight species of spionids, including the genus *Polydora*, that dominated the oiled eelgrass sites in Prince William Sound. Also, the spionid *Pygospio elegans* is an indicator of organic pollution and flourishes on the periphery of heavily polluted zones (Pearson and Rosenberg, 1978).

Some of the faunal increases in oiled habitats were attributable to the small epifaunal, suspension-feeding mussel, *Musculus* spp. Little information is available on the response of these organisms to oil, although considerable information is available on the response of another mytilid mussel, *Mytilus edulis*. The mytilids *Mytilus edulis* and *Modiolus demissus* have been observed to increase respiration and decrease feeding and assimilation when exposed to crude concentrations of 1000 ppb (Table 4 in Hyland and Schneider, 1976). However, *M. edulis* has generally been shown to be extremely hardy and resistant to pollutants, including oil (e.g., Lee *et al.*, 1972; Farrington *et al.*, 1982; Ganning *et al.*, 1983; Viarengo and Canesi, 1991).

It is likely that many of the tolerant species were able to utilize an increased food supply provided by hydrocarbon-utilizing bacteria, or by bacteria stimulated by chemical fertilizers sprayed on adjacent beaches in 1989 and 1990 for the purpose of bioremediation. Significantly higher numbers of hydrocarbon-degrading microorganisms were found at oiled intertidal and shallow (< 20 m) subtidal sediments relative to reference sites in Prince William Sound following the spill (Braddock and Richter, 1994; Braddock *et al.*, 1995, 1996). Six of the sites sampled by Braddock and others were in the same bays that we sampled.

The same general pattern of increased microbial activity has been observed following other oil spills (Colwell *et al.*, 1978; Roubal and Atlas, 1978; Ward *et al.*, 1980; Lizarraga-Partida *et al.*, 1991). Elevated heterotrophic bacterial populations were observed in oil-contaminated beach sand two years after the *Metula* spill in 1974 in the Straits of Magellan (Colwell *et al.*, 1978). An enrichment of the numbers of hydrocarbon-utilizing bacteria relative to total bacteria was observed in sediments collected one year after the *Amoco Cadiz* spill off the coast of France in 1978 (Ward *et al.*, 1980).

Over the four-year period (1989-93) that oil-degrading bacteria were investigated in oiled sediments in Prince William Sound, quantities were greatest in 1990 and steadily declined thereafter (Braddock and Richter, 1994). Although declines were evident, concentrations were generally greater in oiled sediments than in reference sediments, even in 1993. The highest bacterial concentrations in 1993 were in subsurface beach sediments. Their findings tend to agree with our sediment hydrocarbon concentrations which declined from 1990 to 1993, but were still greater at most oiled sites in 1993.

The increases in the abundance of some smaller benthic invertebrate taxa, and especially the epifauna, may also have resulted from an indirect affect of oiling or cleanup on their predators. Significant reductions of both the crab *Telmessus*, and the sea star *Dermasterias* were noted at oiled sites in 1990. These species feed on a variety of invertebrates including spirorbids and *Musculus* (Personal Observations by S.C. Jewett and T.A. Dean). However, experiments conducted in 1993 suggest that predation by crabs and sea stars may not be a major determinant of the distribution and abundance of *Musculus* (Jewett *et al.*, 1995).

It is also possible that some of the increases in abundance were due to a reduction in competition, especially with amphipods. Elmgren *et al.* (1983) noted there was an unusually heavy recruitment of *Macoma balthica* in areas where subtidal amphipods were virtually eliminated following the *Tsesis* spill, and they attributed the increases in *Macoma* to a reduction in competition with the amphipods. Similarly, Van Bernem (1982) attributed a substantial increase in the abundance of oligochaetes on an oiled mudflat to a reduction of corophid amphipod competitors.

An alternative hypothesis for the differences in species abundances at oiled and reference sites is that these sites were inherently different, regardless of the effects of oil. It may be, for example, that predominant current patterns that resulted in the oiling of certain sites were also responsible for the concentration of planktonic larvae and food sources at those oiled sites. Such a hypothesis may explain why certain families, e.g., caecid and lacunid snails, were more abundant at the oiled sites. In the case of *Musculus* mussels their elevated abundances at oiled sites are presumably due to a greater food supply since *Musculus* broods their young and are not subject to dispersal by current. Dissolution rates of calcium sulfate cylinders were measured in 1993 by Highsmith *et al.* (1995) to determine if differences in extent of water movement existed between intertidal oiled and reference sites in Herring Bay, Prince William Sound. In most cases, the dissolution rates were higher on the oiled site of a matched pair, indicative of greater water movement. This tends to support the notion that some oiled sites may be greater concentrating sites, i.e., they received oil as well as higher densities of selected fauna simply because of greater water transport. However, such a hypothesis cannot easily explain why we observed lower abundances of many of the species at oiled sites in 1990.

5.4 Effects on Larger Epibenthic Invertebrates

There was strong evidence of an adverse effect of the spill on populations of two numerically dominant epibenthic invertebrates within eelgrass beds in Western Prince William Sound; the helmet crab *Telmessus cheiragonus* and the leather star *Dermasterias imbricata*. Both were consistently found in lower abundance at oiled sites. Similar patterns were noted in other habitats in Prince William Sound (Dean *et al.*, 1996b). There were also possible adverse impacts of oiling on large *Pycnopodia* in eelgrass beds. Large *Pycnopodia* were more abundant at reference sites in 1990 and 1991, and more abundant at oiled sites by 1995. There were no differences among oiled and reference sites for young-of-year *Pycnopodia*, and exceptionally strong recruitment of these stars in 1993 apparently led to the recovery of the adult population by 1995.

We suspect that the reduction in population densities of *Telmessus* at oiled sites was due to the avoidance of oiled sites by large crabs and the acute toxicity of oil on larvae. While oiling can be acutely toxic to large crabs (Rice *et al.*, 1977, 1979), large crabs are seldom found above the water line (personal observation), and large crabs probably were not exposed to lethal concentrations of oil (or to the rigors of shoreline treatment). Furthermore, crabs can detect oil in relatively low concentrations (Pearson *et al.*, 1980, 1981), are highly mobile, and may have effectively avoided heavily oiled sites. Oiling can also lead to behavioral modifications such as a poor righting response which may in turn lead to higher rates of predation (Burger *et al.*, 1991).

The observed longer term decline in the abundance of *Telmessus* was possibly the result of the effects of oil on recruitment of crabs. Larvae of crabs are particularly sensitive to oil relative to adult crabs and to other invertebrate larvae (see review in Rice *et al.*, 1977) and concentrations of hydrocarbons that were not lethal to adults may have impaired recruitment. Krebs and Burns

(1978) noted similar long-term declines in population density and a general failure of recruitment of fiddler crabs for several years following the West Falmouth oil spill.

In contrast, we suspect that the lower population density of *Dermasterias* and *Pycnopodia* were the result of mortality caused by either oil toxicity or cleanup activities. Sea stars are sensitive to oil (O'Clair and Rice, 1985) and narcosis of sea stars has been observed following oiling both in the laboratory (O'Clair and Rice, 1985) and following an experimental spill in the field (Cross *et al.*, 1987). Unlike many of the species that are common in the subtidal, *Dermasterias* and *Pycnopodia* also can be found intertidally and were likely exposed to much higher concentrations of oil than we measured in subtidal sediments. These sea stars migrate into the lower intertidal areas and often can be found out of the water as the tide drops. As a result, these sea stars become exposed to oil slicks at the waters surface as well as to harm from cleanup activities (especially high pressure hot water cleaning). Many dead adult *Pycnopodia* were observed in the fjordic portion of Herring Bay (Jewett *et al.*, 1996) and along oiled shorelines in the weeks following the spill (Personal communication: J. Bodkin, U.S. Geological Survey, Anchorage, Alaska).

5.5 Effects on Fishes

The prevalence of more young cod at oiled sites than at reference sites is presumably not directly related to oil. Rather, their higher abundance is likely attributable to greater transport of cod larvae and associated food for larvae and young cod at the more dynamic oiled sites. Laur and Haldorson (1996) suggested that increased availability of epifaunal prey, rather than reduction of predators, was responsible for the elevated abundance of young cod at oiled eelgrass sites. Cod at oiled sites had fuller guts with mollusks (e.g., *Musculus* mussels) dominating, and cod from reference sites had more oil-sensitive crustaceans (harpacticoid and colonid copepods and amphipods). It is curious that Ebling *et al.* (1972) also found greater numbers of larvae and young-of-year fishes in oiled sites relative to reference sites in the Santa Barbara Channel immediately following the large oil spill there in 1969.

There was some indication that there were sublethal impacts to some fishes following the spill. Limited sampling and histopathological analyses suggested that there was a higher incidence of hemosiderosis in the livers of some fish taxa, and an indication of lipid and glycogen depletion in the spleens of prickelbacks collected from oiled sites after the spill (Appendix D).

5.6 Assessment of injury and the power of statistical tests

The estimation of the extent of injury to the nearshore subtidal community relies heavily on statistical comparisons of abundance at oiled and reference sites. The oiled sites that were sampled were all heavily oiled and the analysis may therefore represent "worst case" conditions. However, the estimations of the extent of injury are conservative in several important respects. First, there is strong evidence that at least some of the reference sites were impacted by oiling, and it is possible that differences between oiled and reference sites may have been greater if truly unoiled references sites were available. Second, and perhaps more importantly, the analyses conducted had relatively little statistical power to detect differences between oiled and references sites because of small sample sizes and large variances between sites. There were no formal power analyses conducted because these would require very time consuming simulations on a large number of statistical tests. However, a sense of power of the tests can be inferred from the differences between oiled and reference site means that were generally found to be statistically significant (Table 15). For abundances of individual taxa of infauna and small epifauna that differed significantly with $P<0.01$, means at oiled and reference sites generally differed by a factor of more than 20, and always by at least a factor of 3. For cases where $0.01<P<0.05$, there were generally 4 fold differences between means, and for cases where $0.05<P<0.10$, there were generally 3 fold differences in the means. These differences do not reflect actual effect sizes, since the means were unadjusted for differences in substrate and did not account for the paired nature of the statistical design employed. However, they suggest that only relatively large differences between oiled and reference sites could be detected as significantly different using our sampling design, and that the type II error rate (the likelihood of not detecting a true difference) was high.

5.7 Possible Implications of Effects on Higher Trophic Levels

We have little direct evidence of the effects of observed changes in the subtidal organisms that we have studied on higher trophic levels. However, in a general sense, we know that changes in composition of benthic fauna can have serious trophic implications. Many of the species affected in Prince William Sound were of special significance to higher trophic concentrations. For example, Tellinidae, (which include *Macoma* and *Tellina)*, as well as the crab *Telmessus* were more abundance at reference sites, and these are important prey of sea otters (Calkins, 1978; Green and Brueggeman, 1991).

There is also the possibility that subtidal species, especially infaunal and epibenthic invertebrates, may be contaminated with hydrocarbons, and may serve as a pathway of contamination for their predators. Many subtidal benthic invertebrates and small fish are important food resources for bottom-feeding species such as pandalid shrimps, crabs, larger bottom fishes such as halibut, sea ducks, and sea otters (see review in Feder and Jewett, 1981, 1987, 1988; Hogan and Irons, 1988; McRoy, 1988; Koehl *et al.*, 1984). Amphipods, which were among the most severely injured populations in the subtidal are a particularly important food for juvenile fishes, and may have served as an important source of contamination to higher trophic levels.

5.8 Comparisons with Intertidal and Deeper Subtidal Communities

The typical path of oil spilled in the nearshore environment is for most oil to be wind and water-borne to the intertidal regions; substantially less oil is deposited subtidally. Wolfe *et al.* (1994) estimated that of the approximately 35,500 metric tons of oil spilled from the *Exxon Valdez* oil spill about 41 percent reached the shore and about 12 percent was transported to subtidal sediments. Most of the subtidal oil was deposited at depths less than 20 m (Carlson and Kvenvolden, 1996; O'Clair *et al.*, 1996b). O'Clair *et al.* (1996b) concluded that the most likely pathway by which the oil was transported to subtidal sediments was resuspension of contaminated beach sediments followed by nearshore deposition. In light of the pathway of oil it follows that effects on the biota, especially micro- and macro-invertebrates, should be greatest intertidally and lessen as depth increases subtidally. Other oil spills have demonstrated that the greatest effects typically occur in the intertidal region (NRC, 1985).

Numerous studies have focused on the effects of the spill on intertidal invertebrate organisms. Investigations have addressed meiofauna (Fleeger *et al.*, 1996), infaunal bivalves (Houghton *et al.*, 1996b; Trowbridge *et al.*, 1996), epifaunal bivalves (Babcock *et al.*, 1996; Short and Babcock, 1996), epifaunal snails (Ebert and Lees, 1996; Hooten and Highsmith, 1996) and general infauna and epifauna (Gilfillan *et al.*, 1995a, b; Highsmith *et al.*, 1996; Stekoll *et al.*, 1996). Some studies have addressed the effects to the intertidal communities from treating the oiled shoreline (Driskell *et al.*, 1996; Houghton *et al.*, 1996b; Lees *et al.*, 1996). In virtually all of the studies on intertidal invertebrate biota significant impacts from the spill were observed.

Since it is generally perceived that little oil reaches the deep (> 20 m) benthos, few studies have focused in this region. Feder (1995) analyzed infauna from 14 bays in the Sound in 1990 at 40, 100, and > 100 m, and demonstrated no obvious disturbance effects on the biota 16 months after the spill. Armstrong *et al.* (1995) examined the exposure and possible adverse effects of the spill on several species of commercial crustaceans, mollusks, and fin-fishes at depths of 20 to 150 m between 1989 and 1991. They found virtually no evidence of significant adverse effects at either the individual or population levels, regardless of life history stage. These two studies corroborate the notion of minimal disturbance to the benthos from oil in the deeper subtidal region.

5.9 Impacts of Cleanup and Recovery of the Subtidal Communities

Studies of the effects of oiling and cleanup conducted in the intertidal zone have indicated that cleanup activities, and especially the use of hot-water, high-pressure washing of oiled shorelines, was detrimental to intertidal communities, and often slowed recovery of intertidal populations (e.g., Houghton *et al.*, 1991, 1993, 1995, 1996a,b; Lees *et al.*, 1996; De Vogelaere and Foster, 1994; Driskell *et al.*, 1996). It is extremely difficult to make quantitative statements that discriminate among the effects of oiling, subsequent shoreline cleanup, or collateral damage associated with cleanup and monitoring efforts on subtidal communities. While cleanup was often localized on a particular shoreline segment (See Table 14), the effects, including mobilization of oiled sediments and increased boat traffic, were often dispersed over a broader subtidal area. Cleanup activities probably had a detrimental short-term effect on subtidal communities, but we do not know the cost of this relative to the benefit of removal of oil from the system.

The recovery process within benthic infaunal communities following other oil spills generally follows a sequence of events which is as follows: 1) a toxic effect with considerable mortality; 2) an organically enriched period in which opportunistic taxa become extremely abundant; and 3) a period in which opportunists decrease in importance and fauna begin to return to conditions similar to adjacent unoiled areas and/or to a community characteristic of relatively undisturbed conditions (Pearson and Rosenberg, 1978; Glémarec and Hily, 1981; Glémarec and Hussenot, 1981, 1982; Spies *et al.*, 1988). In 1990, the year following the spill, the eelgrass community displayed patterns that were somewhat intermediate between the toxic phase and the enrichment phase. Since then, the majority of the benthic community in Prince William Sound has appeared to completely recovered from the impacts of oil, as there were few differences among oiled and reference communities in 1995. However, there some larger epibenthic invertebrates (some sea stars and a crab), and a two infaunal polychaete families (e.g. Opheliidae and Syllidae) that had not fully recovered by 1995. Furthermore, many infaunal taxa were still more abundant at oiled sites in 1995, indicating possible continued effects of organic enrichment. This is in keeping with observations following the *Amoco Cadez* spill, which suggested that communities in muddy-, fine-sand in the Bay of Morlaix (N. France) took more than a decade to fully recover (Ibanez and Dauvin, 1988). One problem in estimating the state of recovery is that we do not have a very good picture of what the pre-spill conditions were like. As a result, we can not be certain whether continued differences among sites are the result of the spill, or are caused by inherent site differences.

6.0 CONCLUSIONS

The *Exxon Valdez* oil spill caused injury to a number of components of the benthic community within the eelgrass habitat in Western Prince William Sound. These evidence for injury can be summarized as follows:

- There were possible injuries to eelgrass populations. Densities of shoots and flowering shoots of eelgrass were lower at oiled than at reference sites. A separate independent study supported these findings and attribute the reductions to the spill. However, patterns of recovery indicate that differences between oiled and reference sites may have been the result of inherent differences among sites.

- There were differences in the abundance of infauna and small epifaunal invertebrates at oiled and reference sites that were likely related to the oil spill. Discriminate analysis suggested that sediment grain-size characteristics were the most important determinants of community structure, However, concentrations of chrysene, an indicator of the presence of *Exxon Valdez* oil, also explained a significant proportion of the variation within the benthic community.

- There were generally fewer amphipods, and infaunal bivalves at oiled eelgrass sites. Reductions in the abundance of some taxa, and especially several amphipod families, appeared related to acute toxicity of oil.

- There were more infaunal polychaetes, infaunal gastropods, and epifaunal bivalves at oiled sites. Many of the infaunal organisms, and especially the polychaete worms, were either stress tolerant or opportunistic species. The increased abundance of these taxa at oiled sites was probably in response to organic enrichment from the oil and bioremediation used for shoreline cleanup. The increased abundance of epifauna at oiled sties may have been related to factors other than oil.

  There was injury to three dominant epifaunal taxa, sunflower sea stars, leather stars and helmet crabs, that were notably less abundant at oiled sites. These injuries appeared to be in part related to toxicity from oil.

- There were many more young of the year cod within oiled compared with unoiled eelgrass beds. This was likely related to a greater abundance of prey items at oiled sites. It is not known if the differences in prey abundance were spill related.

The fact that abundances of some taxa were apparently reduced while others were enhanced was indicative of the varying sensitivities of the organisms within the community, and the moderate levels of exposure. Exposure to oil was apparently not high enough to result in acute toxicity to most organisms.

There has been apparent recovery of most of the injured components of the system. Hydrocarbon concentrations declined to near background concentrations by 1995, and there were far fewer differences in the abundance of taxa between oiled and reference sites. However, there were still some exposure to *Exxon Valdez* oil at some heavily oiled sties, and some injured resources have apparently failed to recover fully. Two families of amphipods and three families of infaunal bivalves remained more abundant at reference sites, as did leather stars (*Dermasterias*) and crabs (*Telemessus*). Also, there was continued evidence of enhancement of some populations of benthic fauna at oiled eelgrass sites, including several polychaete families and the epifaunal bivalves of the family Mytilidae. While these patterns suggest a lack of complete recovery, it is impossible to discern possible continued impacts of oil from inherent site differences that are unrelated to oiling. This is largely the result of a lack of quantitative pre-spill data with which to compare the post-spill condition of the community.

7.0 ACKNOWLEDGMENTS

We wish to thank the sponsors of this work, the USDA Forest Service (Coastal Habitat Study No. 1) and the Alaska Department of Fish and Game (Air/Water ST2A) for their support, and especially the support of the Project Directors, David Gibbons, Mark Fraker, and Joseph Sullivan. This project required a great deal of effort on the part of many. We would especially like to thank the over 20 divers who helped us collect the data, often under adverse conditions; those who assisted in the sorting and taxonomy of benthic invertebrates, including Kathy Omura and Max Hoberg; those who assisted with data management and analyses, especially Richard Smith, Lyman McDonald, Arny Blanchard, Chirk Chu, and Christopher Kjellmark; A.S. Naidu, for assistance in analyzing sediment samples; R. Khan, for assistance in analyzing hemosiderosis in fishes; and the skippers and crews of our research vessels NIP'N TUCK, JOANNA MARIE, WM. A. McGAW, KITTYWAKE II, and BERING EXPLORER.

8.0 LITERATURE CITED

ADEC (Alaska Department of Environmental Conservation). 1989. Impact maps and summary reports of shoreline surveys of the *Exxon Valdez* oil spill site - Prince William Sound. Report to the *Exxon Valdez* Oil Spill Trustee Council. Anchorage, AK.

Anderson, J. W., S. L. Kiesser, and J. W. Blaylock. 1979. Comparative uptake of naphthalenes from water and oiled sediment by benthic amphipods. Pages 579-584 *In:* Proceedings, 1979 Oil Spill Conference. Washington, D.C.: American Petroleum Institute Publication No. 4308.

Anthony, J. 1995. Habitat utilization by the sea otter (*Enhydra lutra*) in Port Valdez, Prince William Sound, Alaska. M.S. Thesis, University of Alaska, Fairbanks. 300pp.

Armstrong, D. A., P. A. Dinnel, J. M. Orensanz, J. L. Armstrong, T. L. McDonald, R. F. Cusimano, R. S.Nemeth, M. L. Landolt, J. R. Skalski, R. F. Lee, and R. J. Huggett. 1995. Status of selected bottomfish and crustacean species in Prince William Sound following the *Exxon Valdez* oil spill. Pages 485-547 *In:* Wells, P.G., J.N. Butler, and J.S. Hughes, eds. *Exxon Valdez Oil Spill: Fate and Effects in Alaskan Waters, ASTM STP 1219*, American Society for Testing and Materials, Philadelphia.

Babcock, M. M., G. V. Irvine, P. M. Harris, J. A. Cusick, and S. D. Rice. 1996. Persistence of oiling in mussel beds three and four years after the *Exxon Valdez* oil spill. Pages 286-297. *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Backman T. W. and D. C. Barilotti. 1976. Irradiance reduction: effects on standing crops of the eelgrass, *Zostera marina*, in a coastal lagoon. Marine Biology 34:33-40.

Ballou, T. G., R. E. Dodge, S. C. Hess, A. H. Knap and T. D. Sleeter. 1987. Effects of a dispersed and undispersed crude oil on mangroves, seagrasses and corals. American Petroleum Institute Publication No. 4460. American Petroleum Institute, Washington D.C.

Bence, A. E. and W. A. Burns. 1995. Fingerprinting hydrocarbons in the biological resources of the *Exxon Valdez* spill area. Pages 84-140 *In:* Wells, P.G., J.N. Butler, and J.S. Hughes, eds. *Exxon Valdez Oil Spill: Fate and Effects in Alaskan Waters, ASTM STP 1219*, American Society for Testing and Materials, Philadelphia.

Boesch, D. F. 1977. A new look at the zonation of benthos along the estuarine gradient. pp. 245-266 *In:* B.C. Coull, ed. *Ecology of Marine Benthos*, University of South Carolina Press, Columbia, S.C.

Braddock, J. F. and Z. Richter. 1994. Microbiology of subtidal sediments: monitoring microbial populations. Final Report to *Exxon Valdez* Oil Spill Trustee Council, 645 "G" Street, Anchorage, AK.

Braddock, J. F., J. E. Lindstrom and E. J. Brown. 1995. Distribution of hydrocarbon-degrading microorganisms in sediments from Prince William Sound, Alaska following the *Exxon Valdez* oil spill. Marine Pollution Bulletin 30:125-132.

Braddock, J. F., J. E. Lindstrom, T. R. Yeager, B. T. Rasley and E. J. Brown. 1996. Patterns of microbial activity in oiled and unoiled sediments in Prince William Sound. Pages 94-108 *In*: Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. *Proceedings of the Exxon Valdez Oil Spill Symposium*. American Fisheries Society Symposium 18.

Bray, J. R. and J. T. Curtis. 1957. An ordination of the upland forest communities of southern Wisconsin. Ecological Monographs 27:325-349.

Burger, J., J. Brzorad, and M. Gochfeld. 1991. Immediate effects of an oil spill on behavior of fiddler crabs (*Uca pugnax*). Archives of Environmental Contamination and Toxicology 20:404-409.

Busdosh, M. 1981. Long-term effects of the water soluble fraction of Prudhoe Bay crude oil on survival, movement and food search success of the arctic amphipod *Boeckosimus* (=*Onisimus*) *affinis*. Marine Environmental Research 5:167-180.

Cabioch, L., J. C. Dauvin, Mora Bermudez, and C. Rodriguez Babio. 1980. Effects of the *Amoco Cadiz* oil spill on the sublittoral benthos, north of Brittany. Helgoländer Meeresuntersuchungen 33: 192-208.

Cabioch, L., J. C. Dauvin, and F. Gentil. 1978. Preliminary observations on pollution of the sea bed and disturbance of sublittoral communities in Northern Brittany by oil from the *Amoco Cadiz*. Marine Pollution Bulletin 9:303-307.

Calkins, D. G. 1978. Feeding behavior and major prey species of the sea otter, *Enhydra lutris*, in Montague Strait, Prince William Sound, Alaska. Fishery Bulletin 76:125-131.

Carlson, P. R. and K. A. Kvenvolden. 1996. Tracking *Exxon Valdez* oil from beach to deepwater sediments of Prince William Sound, Alaska. Pages 109-120. *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Chassé, C. 1978. The ecological impact on and near shores by the *Amoco Cadiz* oil spill. Marine Pollution Bulletin 11:298-301.

Clifford, H. T. And W. Stephenson. 1975. An Introduction to Numerical Classification. Academic Press, New York. 229 pp.

Colwell, R. R., A. L. Mills, J. D. Walker, P. Rarcia-Tello and V. Campose-P. 1978. Microbial ecology studies of the *Metula* spill in the Straits of Magellan. Journal of the Fisheries Research Board of Canada 35:573-580.

Cross, W. E., C. M. Martin, and D. H. Thomson. 1987. Effects of experimental releases of oil and dispersed oil on Artic nearshore macrobenthos. 2. Epibenthos. Arctic 40:201-210.

Dauvin, J. C. 1982. Impact of *Amoco Cadiz* oil spill on the muddy fine sand *Abra alba* and *Melinna palmata* community from the Bay of Morlaix. Estuarine and Coastal Shelf Science 14:517-531.

De Vogelaere. A. P. and Foster, M. S. 1994. Damage and recovery in intertidal *Fucus gardneri* assemblages following the *Exxon Valdez* oil spill. Marine Ecology Progress Series. 106:263-271.

Dean, T. A., M. S. Stekoll, and R. O. Smith. 1996a. Kelps and oil: The effects of the *Exxon Valdez* oil spill on subtidal algae. Pages 412-423 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Dean, T. A., S. C. Jewett, D. R. Laur, and R. O. Smith. 1996b. Injury to epibenthic invertebrates resulting from the *Exxon Valdez* oil spill. Pages 424-439 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

den Hartog, C. and R. P.W .M. Jacobs. 1980. Effects of the *Amoco Cadiz* oil spill on an eelgrass community at Roscoff (France) with special reference to the mobile benthic fauna. Helgolander Meeresuntersuchungen 33:182-191.

Dennison W. C., and R. S. Alberte. 1986. Photosynthetic response of *Zostera marina* L. (eelgrass) to *in-situ* manipulations of light intensity. Oecologia 55:137-144.

Dennison W. C., and R. S. Alberte. 1985. Role of daily light period in the depth distribution of *Zostera marina* (eelgrass) to *in-situ* manipulations of light intensity. Marine Ecology Progress Series 25:51-61.

Dennison, W.C. 1987. Effects of light on seagrass photosynthesis, growth, and depth distribution. Aquatic Botany 27:15-26.

Digby, P. G. N. and R. A. Kempton. 1987. Multivariate analysis of ecological communities. Chapman and Hall, New York. 206 pp.

Driskell, W. B., A. K. Fukuyama, J. P. Houghton, D. C. Lees, A. J. Mearns, and G. Shigenaka. 1996. Recovery of Prince William Sound intertidal infauna from *Exxon Valdez* oiling and shoreline treatments, 1989 through 1992. Pages 362-378 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Ebeling, A. W., F. A. DeWitt Jr, W. Werner, and G. M. Cailliet. Santa Barbara Oil Spill: Fishes. 1972. *In: Santa Barbara Oil Symposium, Offshore Petroleum Production, and Environmental Inquiry.* Marine Science Institute, University of Santa Barbara, CA.

Ebert, T. A. and D. C. Lees. 1996. Growth and loss of tagged individuals of the predatory snail Nucella lamellosa in areas within the influence of the *Exxon Valdez* oil spill in Prince William Sound, Alaska. Pages 349-361 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Elmgren, R. and J. B. Frithsen. 1982. The use of experimental ecosystems for evaluating the environmental impact of pollutants: A comparison of an oil spill in the Baltic Sea and two long-term, low-level oil addition experiments in mesocosms. Pages 153-165 *In:* Grice, G.D. and M.R. Reeve, eds. Marine Mesocosms. Biological and Chemical Research in Experimental Ecosystems. New York: Springer-Verlag, Inc.

Elmgren, R., S. Hansson, U. Larsson, B. Sundelin, and P.D. Boehm. 1983. The TSEIS oil spill: acute and long-term impact on the benthos. Marine Biology 73:51-65.

Farrington, J. W., A. C. Davis, N. M. Frew, and K. S. Rabin. 1982. No 2 fuel oil compounds in *Mytilus edulis*: retention and release after an oil spill. Marine Biology 66:15-26.

Fauchald, K. and P. A. Jumars. 1979. The diet of worms: a study of polychaete feeding guilds. Oceanography and Marine Biology Annual Review 17:193-284.

Feder, H. M. 1995. Injury to deep benthos. *Exxon Valdez* oil spill State/Federal Natural Resource Damage Assessment Final Report (Subtidal Study 2B [Air/Water Study 2], Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Anchorage, AK.

Feder, H. M. and S. C. Jewett. 1981. Feeding interactions in the eastern Bering Sea with emphasis on the benthos. *In:* D.W. Hood and J.A. Calder, eds. *The Eastern Bearing Sea Shelf: Oceanography and Resources.* U.S. Dept. Commerce 2:1229-1261.

Feder, H. M. and S. C. Jewett. 1987. The subtidal benthos. Pages 347-396 *In:* D.W. Hood and S.T. Zimmerman, eds. *The Gulf of Alaska. Physical Environment and Biological Resources,* Ocean Assessment Div., Alaska Office, U.S. Minerals Management Service, Alaska OCS Region, MMS 86-0095, U.S. Govt. Printing Office, Washington, D.C.

Feder, H. M. and S. C. Jewett. 1988. The subtidal benthos. Pages 165-202 *In:* D. G. Shaw and M. J. Hameedi, eds. *Environmental Studies of Port Valdez, Alaska. Lecture Notes on Coastal and Estuarine Studies, Vol.24.* Springer-Verlag, Berlin, Heidelberg.

Feder, H. M., L. M. Cheek, P. Flanagan, S. C. Jewett, M.H. Johnson, A.S. Naidu, S.A. Norrell, A.J. Paul, A. Scarborough, and D. Shaw. 1976. The sediment environment of Port Valdez, Alaska: The effect of oil on this ecosystem. EPA-600/3-76-086, 322 pp.

Feder, H. M., A. S. Naidu, J. M. Hameedi, S. C. Jewett, and W. R. Johnson. 1990. The Chukchi Sea continental shelf: benthos-environmental interactions. U. S. Dep. Commer., NOAA, OCSEAP Final Rep. 68:25-312.

Feder, H. M., A. S. Naidu, S. C. Jewett, M. J. Hameedi, W. R. Johnson and T.E. Whitledge. 1994. The Northeastern Chukchi Sea: benthos-environmental interactions. Marine Ecology Progress Series 111(1&2): 171-190.

Ferraro, S. P. and F. A. Cole. 1990. Taxonomic level and sample sufficient for assessing pollution impacts on the Southern California Bight macrobenthos. Marine Ecology Progress Series 67:2251-262.

Ferraro, S. P. and F. A. Cole. 1992. Taxonomic level sufficient for assessing a moderate impact on macrobenthic communities in Puget Sound, Washington, USA. Canadian Journal of Fisheries and Aquatic Sciences 49:1184-1188.

Fisher, R.A. 1935. *The Design of Experiments.* Oliver and Boyd, Edinburgh.

Fleeger, J. W., T. C. Shirley, M. G. Carls, and M. A. Todaro. Meiofaunal recolonization experiment with oiled sediments. Pages 271-285 *In:* Rice, S.D., R.B.Spies, D. A. Wolfe, and B. A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Folk, R. L. 1980. *Petrology of Sedimentary Rocks.* Hemphil Publishing Co., Austin Texas. 182 pp.

Foy, M. G. 1982. Acute lethal toxicity of Prudhoe Bay crude oil and Coexit 9527 to arctic marine fish and invertebrates. Ottawa: Environmental Protection Service Report Series, EPA 4-EC-82-3. 62p.

Ganning, B., D. Broman, and C. Lindblad. 1983. Uptake of petroleum hydrocarbons by the blue mussel (*Mytilus edulis* L.) after experimental oiling and high pressure, hot water shore cleaning. Marine Environmental Research 10:245-254.

Gauch, H. G. 1982. Multivariate Analysis in Community Ecology. Cambridge University Press, New York. 298 pp.

Gilfilan, E. S., D. S. Page, E. J. Harner, and P. D. Boehm. Shoreline ecology program for Prince William Sound, Alaska, following the Exxon Valdez oil spill: Part 3 - Biology. Pages 398-443 *In:* Wells, P.G., J.N. Butler, and J.S. Hughes, eds. *Exxon Valdez Oil Spill: Fate and Effects in Alaskan Waters, ASTM STP 1219*, American Society for Testing and Materials, Philadelphia.

Gilfilan, E. S., D. S. Page, E. J. Harner, and P. D. Boehm. 1995a. Shoreline ecology program for Prince William Sound, Alaska, following the *Exxon Valdez* oil spill: Part 3 - Biology. Pages 398-443. *In:* Wells, P.G., J.N. Butler, and J.S. Hughes, eds. *Exxon Valdez Oil Spill: Fate and Effects in Alaskan Waters, ASTM STP 1219*, American Society for Testing and Materials, Philadelphia.

Gilfilan, E. S., T. H. Suchanek, P. D. Boehm, E. J. Harner, D. S. Page, and N. A. Sloan. 1995b. Shoreline impacts in the Gulf of Alaska region following the *Exxon Valdez* oil spill. Pages 444-481. *In:* Wells, P.G., J.N. Butler, and J.S. Hughes, eds. *Exxon Valdez Oil Spill: Fate and*

Effects in Alaskan Waters, ASTM STP 1219, American Society for Testing and Materials, Philadelphia.

Glémarec, M., and C. Hily. 1981. Perturbations apportées á la macrofauna benthique de la baie de carncarneau par les effluents urbain et portuaires. Acta Oecologia, Oecol. Applic. 2:139-150.

Glémarec, M., and E. Hussenot. 1981. Définition d une succession écologique en milieu meuble anormalement enrichi en matièr organique à la suite de la catastrophe de l *Amoco Cadiz*. *In: Amoco Cadiz*, conséquences d une pollution accidentelle par les hydrocarbures. C.N.E.X.O., Paris: 499-512.

Glémarec, M., and E. Hussenot. 1982. A three-year ecological survey in Benoit and Wrac'h Abers following the *Amoco Cadiz* oil spill. Netherlands Journal of Sea Research 16:483-490.

Grassle, J. F. and J. P. Grassle. 1974. Opportunistic life histories and genetic systems in marine benthic polychaetes. Journal of Marine Research 32:253-284.

Grassle, J. F. , R. Elmgren, and J. P. Grassle. 1981. Response of benthic communities in MERL experimental ecosystems to low level, chronic additions of No. 2 fuel oil. Marine Environmental Research 4:279-297.

Gray, J. S. 1979. Pollution-induced changes in populations. Philosophical Transactions of the Royal Society of London Bulletin 286:545-561.

Grebmeier, J. M., H. M. Feder, and C. P. McRoy. 1989. Pelagic-benthic coupling on the shelf of the northern Bering and Chukchi Seas. II. Benthic community structure. Marine Ecology Progress Series 51:253-268.

Green, G. A. and J. J. Brueggeman. 1991. Sea otter diets in a declining population in Alaska. Marine Mammal Science 7(4):395-401.

Green, R. H. 1979. *Sampling Design and Statistical Methods for Environmental Biologists*. John Wiley & Sons, New York.

Henricksson, R. 1969. Influence of pollution on the bottom fauna of the Sound. Oikos 19:111-125.

Highsmith, R. C., M. S. Stekoll, P. VanTamelon, A. J. Hooten, S. M. Saupe, L. Deysher, and W. P. Erickson. 1995. Herring Bay monitoring and restoration studies. *Exxon Valdez* Oil Spill Restoration Project Final Report (Proj. No. 93039).

Highsmith, R. C., T. L. Rucker, M. S. Stekoll, S. M. Saupe, M. R. Lindeberg, R. N. Jenne, and W. P. Erickson. 1996. Impact of the Exxon Valdez oil spill on intertidal biota. Pages 212-237 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Hooten, A. J. and R. C. Highsmith. 1996. Impacts on selected intertidal invertebrates in Herring Bay, Prince William Sound, and after the *Exxon Valdez* oil spill. Pages 249-270 *In:* Rice, S.D., R.B.Spies, D. A. Wolfe, and B. A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Hogan, M. E. and D. B. Irons. 1988. Waterbirds and marine mammals. Pages 225-242 *In:* D.G. Shaw and M.J. Hameedi, eds. *Environmental Studies in Port Valdez, Alaska.* Springer-Verlag, Berlin.

Houghton, J. P., D. C. Lees, H. Teas, H. Cumberland, S. Landino, and W. B. Driskell. 1991. Evaluation of the condition of intertidal and shallow subtidal biota in Prince William Sound following the *Exxon Valdez* oil spill and subsequent shoreline treatment. Volume I. Prepared by Pentec Environmental Inc., and ERC Environmental and Energy Services Co., for NOAA Hazardous Materials Response Branch, Seattle, WA. Report No. HMRB 91-1.

Houghton, J. P., A. K. Fukuyama, D. C. Lees, P. J. Hague, H. L. Cumberland, P. M. Harper, and W. B. Driskell. 1993. Evaluation of the condition of Prince William Sound shorelines following the *Exxon Valdez* oil spill and subsequent shoreline treatment. Volume II. 1991 Biological Monitoring Survey. NOAA Technical Memorandum NOS ORCA 73. NOAA, Seattle, WA.

Houghton, J. P., R. H. Gilmour, D. C. Lees, P. J. Hague, H. L. Cumberland, P. M. Harper, W. B. Driskell, and S. C. Lindstrom. 1995. Evaluation of the condition of Prince William Sound shorelines following the *Exxon Valdez* oil spill and subsequent shoreline treatment. Volume I. 1993 Biological Monitoring Survey. NOAA Technical Memorandum NOS ORCA 82. NOAA, Seattle, WA.

Houghton, J. P., R. H. Gilmour, D. C. Lees, P. J. Hague, W. B. Driskell, and S. C. Lindstrom. 1996a. Evaluation of the condition of Prince William Sound shorelines following the *Exxon Valdez* oil spill and subsequent shoreline treatment. Volume I. 1994 Biological Monitoring Survey. NOAA Technical Memorandum NOS ORCA 91. NOAA, Seattle, WA.

Houghton, J. P., D. C. Lees, W. B. Driskell, S. C. Lindstrom and A. J. Mearns. 1996b. Recovery of Prince William Sound intertidal epibiota from *Exxon Valdez* oiling and shoreline treatments, 1989 through 1992. Pages 379-411 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Hyland, J. L. and E. D. Schneider. 1976. Petroleum hydrocarbons and their effects on marine organisms, populations, communities and ecosystems. Pages 464-506 *In: Sources, Effects and Sinks of Hydrocarbons in the Aquatic Environment. Symposium Proceedings.* American University, Washington. D.C.

Hyland, J. L., J. Kennedy, J. Campbell, S. Williams, P. Boehm, A. Uhler, and W. Steinhauer. 1989. Environmental effects of the PAC BARONESS oil and copper spill. Pages 413-419 *In: Proceedings of the 1989 Oil Spill Conference, San Antonio, TX.* API, EPA, and USCG.

Ibanez, F. and J. C. Dauvin. 1988. Long-term changes (1977-1987) in a muddy fine sand *Abra alba-Melinna palmata* community from the Western English Channel: multivariate time-series analysis. Marine Ecology Progress Series 49: 65-81.

Jacobs, R. P.W. M. 1980. Effects of the *Amoco Cadiz* oil spill on the seagrass community at Roscoff with special reference to the benthic infauna. Marine Ecology Progress Series 2: 207-212.

Jewett, S. C., T. A. Dean, R. O. Smith, L. J. Haldorson, D. Laur, M. Stekoll, and L. McDonald. 1995. The effects of the *Exxon Valdez* oil spill on shallow subtidal communities in Prince William Sound, Alaska 1989-93, *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 93047; Subtidal Study Number 2A), Alaska Department of Fish & Game, Habitat and Restoration Division, Anchorage, AK.

Jewett, S. C., T. A. Dean, and D. R. Laur. 1996. The effects of the *Exxon Valdez* oil spill on benthic invertebrates in an oxygen-deficient embayment in Prince William Sound, Alaska. Pages 440-447 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Jumars, P. A. and K. Fauchald. 1977. Between community contrasts in successful polychaete feeding strategies. *In:* Coull, B. C. (ed.) *Ecology of Marine Benthos*. University of South Carolina Press, Columbia, p. 1-20.

Kasymov, A. G. and A. D. Aliev, 1973. Experimental study of the effect of oil on some representatives of benthos in the Caspian Sea. Water Air Soil Pollution 2(2):235-245.

Kineman, J. J., R. Elmgren and S. Hansson. 1980. The *Tsesis* Oil Spill. U.S. Dept. of Commerce, Office of Marine Pollution Assessment, NOAA, Bolder, Co. 296 pp.

Koehl, P. S., T. C. Rothe and D. V. Derksen. 1984. Winter food habits of Barrow's goldeneyes in southeast Alaska. Pages 1-5 *In:* D.N. Nettleship, G.A. Sanger, and P.F. Springs, eds. Marine birds: their feeding ecology and commercial fisheries relationships. Proceedings of the Pacific Seabird group symposium, Seattle, WA, 6-8 January, 1992. Special publication of the Canadian Wildlife Service, Catalog No. 66-65/1984. Minister of Supply and Services, Canada.

Krebs, C. T. and K. A. Burns. 1978. Long-term effects of an oil spill on populations of the salt-marsh crab *Uca pugnax*. Journal of the Fisheries Research Board of Canada. 35:648-649.

Kruskal, J. B. and M. Wish. 1978. Multidimensional Scaling. Sage Publications. Beverly Hills, CA
93
93 pp.

Kuletz, K. J. 1983. Mechanisms and consequences of foraging behavior in a population of breeding pigeon guillemots. M.S. Thesis, University of California, Irvine.

Larkum, A. W. D., and R.J. West. 1990. Long-term changes of seagrass meadows in Botany Bay, Australia. Aquatic Botany 37:55-70.

Laur, D. and L. Haldorson. 1996. Coastal habitat studies: the effect of the *Exxon Valdez* oil spill on shallow subtidal fishes in Prince William Sound. Pages 659-670 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Lee, R. F., R. Sauerheber, A.A. Benson. 1972. Petroleum hydrocarbons: uptake and discharge by the marine mussel *Mytilus edulis*. Science 177:344-346.

Lee, W. Y., M. F. Welch and J. A. C. Nicol. 1977. Survival of two species of amphipods in aqueous extracts of petroleum oils. Marine Pollution Bulletin 8:92-94.

Lees, D. C., J. P. Houghton and W. B. Driskell. 1996. Short-term effects of several types of shoreline treatment on rocky intertidal biota in Prince William Sound. Pages 329-348 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Lizarraga-Partida, M. L., F. B. Izquierdo-Vicuna, and I. Wong-Chang. 1991. Marine bacteria on the Campeche Bank oil field. Marine Pollution Bulletin 22:401-405.

Lloyd, M., R. F. Inger and F. W. King. 1968. On the diversity of reptile and amphibian species in a Bornean rain forest. American Naturalist 102:497-515.

Manly, B. 1991. *Randomization and Monte Carlo methods in biology.* Chapman and Hall, London. 260 pp.

McConnaughey, T. and C. P. McRoy. 1979. ^{13}C label identifies eelgrass (*Zostera marina*) carbon in an Alaskan estuarine food web. Marine Biology 53: 263-269.

McRoy, C. P. 1970. Standing stocks and other features of eelgrass (*Zostera marina*) populations on the coast of Alaska. Journal of the Fisheries Research Board of Canada 27:1811-1821.

McRoy, C. P. 1988. Natural and anthropogenic disturbances at the ecosystem level. *In:* D. G. Shaw and M. J. Hameedi, eds. *Environmental Studies in Port Valdez, Alaska.* Springer-Verlag, Berlin:329-344.

McRoy, C. P. and S. L. Williams. 1977. Sublethal effects (of hydrocarbons) on seagrass photosynthesis. Final report to NOAA, Outer Continental Shelf Environmental Assessment Program, Contract No. 03-5-022-56, Task Order No. 17, R.U. No. 305. 35 pp.

Mearns, A. J. 1996. *Exxon Valdez* shoreline treatment and operations: Implications for response, assessment, monitoring, and research. Pages 309-328 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

NRC (National Research Council). 1985. Oil in the sea: inputs, fate, and effects. National Academy Press. Washington, D.C.

O'Clair, C. E. and S. D. Rice. 1985. Depression of feeding and growth rates of the seastar *Evasterias troschelii* during long-term exposure to the water-soluble fraction of crude oil. Marine Biology 84:331-340.

O'Clair, C. E., J. W. Short, and S. D. Rice. 1996a. Petroleum hydrocarbon-induced injury to subtidal marine sediment resources. *Exxon Valdez* Oil Spill, State/Federal Natural Resource Damage Assessment Final Report. 77 pp. + Appendices.

O'Clair, C. E., J. W. Short, and S. D. Rice. 1996b. Contamination of intertidal and subtidal sediments by oil from the *Exxon Valdez* in Prince William Sound. Pages 61-93 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Olsgaard, F. and J. S. Gray. 1995. A comprehensive analysis of the effects of offshore oil and gas exploration and production on the benthic communities of the Norwegian continental shelf. Marine Ecology Progress Series 122:277-306.

Orth, R. J., and K. A. Moore. 1983. Chesapeake Bay, and unprecedented decline in submerged aquatic vegetation. Science 222:51-53.

Page, D. S., P. D. Boehm, G. S. Douglas, and A. E. Bence. 1995. Identification of hydrocarbon sources in the benthic sediments of Prince William Sound and the Gulf of Alaska following the *Exxon Valdez* oil spill. Pages 41-83 *In:* Wells, P.G., J.N. Butler, and J.S. Hughes, eds. *Exxon Valdez Oil Spill: Fate and Effects in Alaskan Waters, ASTM STP 1219*, American Society for Testing and Materials, Philadelphia.

Pearson, T. H. and R. Rosenberg. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanography and Marine Biology Annual Review 16:229-311.

Pearson, W. H., P. C. Sugarman, D. L. Woodruff, J. W. Blaylock, and B. L. Olla. 1980. Detection of petroleum hydrocarbons by the Dungeness crab, *Cancer magister* Fisheries Bulletin. 78:821-826.

Pearson, W. H., S. E. Miller, J. W. Blaylock, and B. L. Olla. 1981. Detection of the water-soluble fraction of crude oil by the blue crab, *Callinectes sapidus*. Marine Environmental Research 5:3-11.

Phillips, R. C. 1984. The ecology of eelgrass meadows in the Pacific Northwest: a community profile. U.S. Fish and Wildlife Service OBS 84/24, 85p.

Pielou, E. C. 1974. *Population and Community Ecology: Principles and Methods*. Gordon and Breach, New York. 424 pp.

Rhoads, D. C. 1974. Organism-sediment relations on the muddy sea floor. Oceanography and Marine Biology Annual Review 12:263-300.

Rice, S. D., A. Moles, T. L. Taylor, and J. F. Karinen. 1979. Sensitivity of 39 Alaskan marine species to Cook inlet crude oil and No. 2 fuel oil. Pages 549-554 *In: Proceedings. 1977 oil spill conference (prevention, behavior, control, cleanup)*. American Petroleum Institute, Washington, D.C.

Rice, S. D., J. W. Short, and J. F. Karinen 1977. Comparative oil toxicity and comparative animal sensitivity. Pages 78-94 *In:* D.A. Wolfe (ed). *Fate and effect of petroleum hydrocarbons in marine ecosystems and organisms*. Pergamon Press, N.Y.

Rosenberg, R. 1977. Benthic macrofaunal dynamics, production, and dispersion in an oxygen-deficient estuary of west Sweden. Journal of Experimental Marine Biology and Ecology 26: 107-133.

Rosenthal, R. 1980. Shallow water fish assemblages in the northeastern Gulf of Alaska: habitat evaluation, species composition, abundance, spatial distribution and trophic interaction. Prepared for the National Oceanic and Atmospheric Administration, Outer Continental Shelf Environmental Assessment Project Office, Juneau, AK.

Rosenthal, R. J., D. C. Lees, and T. M. Rosenthal. 1977. Ecological assessment of sublittoral plant communities in northern Gulf of Alaska. Final report to National Marine Fisheries Service, Auke Bay, AK. 150 pp.

Roubal, G. and R. M. Atlas. 1978. Distribution of hydrocarbon-utilizing microorganisms and hydrocarbon biodegradation potentials in Alaska continental shelf areas. Applied Environmental Microbiology 35:897-905.

Sand-Jansen, K. 1977. Effect of epiphytes on eelgrass photosynthesis. Aquatic Botany 3:55-63.

Sanders, H. L., J. F. Grassle, and G.R. Hampson. 1972. The West Falmouth oil spill. I. Biology. Woods Hole Oceanographic Institute Technical Report 72-20. 48 pp.

Sanders, H. L., J. F. Grassle, G. R. Hampson, L. S. Morse, S. Garner-Price, and C. C. Jones. 1980. Anatomy of an oil spill: long-term effects from the grounding of the barge *Florida* off West Falmouth, Mass. Journal of Marine Research 38:265-380.

Shannon, C. E. and W. Weaver. 1963. *The Mathematical Theory of Communication*. Univ. Illinois Press, Urbana. 177 pp.

Shaw, D. G., A. J. Paul, L. M. Cheek, and H. M. Feder. 1976. *Macoma balthica*: an indicator of oil pollution. Marine Pollution Bulletin 7(2): 29-31.

Short, J. W. and M. M. Babcock. 1996. Prespill and postspill concentrations of hydrocarbons in mussels and sediments in Prince William Sound, Alaska. Pages 149-166 *In:* Rice, S.D., R.B.Spies, D. A. Wolfe, and B. A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Short, J. W., D. M. Sale, and J. C. Gibeaut. 1996a. Nearshore transport of hydrocarbons and sediments after the *Exxon Valdez* oil spill. Pages 40-60 *In:* Rice, S.D., R.B.Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Short, J. W., T. J. Jackson, M. L. Larsen, and T. L. Wade. 1996b. Analytical methods used for the analysis of hydrocarbons in crude oil, tissues, sediments, and seawater collected for the Natural Resources Damage Assessment of the *Exxon Valdez* Oil Spill. Pages 140-148 *In:* Rice, S.D., R.B.Spies, D. A. Wolfe, and B. A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Silberstein, K., A. W. Chiffings, and A. J. McComb. 1986. The loss of eelgrass in Cockburn Sound, Western Australia III. The effect of epiphytes on the productivity of *Posidonia australis* Hook f. Aquatic Botany 24:355-371.

Spies, R. B., and D. J. DesMarais. 1983. Natural isotope study of trophic enrichment of marine benthic communities by petroleum seepage. Marine Biology 73:67-71.

Spies, R. B., D. D. Hardin and J. P. Toal. 1988. Organic enrichment or toxicity: A comparison of the effects of kelp and crude oil in sediments on the colonization and growth of benthic infauna. Journal of Experimental Marine Biology and Ecology 124:261-282.

Spies, R. B. 1987. The biological effects of petroleum hydrocarbons in the sea: assessments from the field and microcosms. Chapter 9. pp. 411-467 *In:* D.F. Boesch and N.N. Rabalais, eds. *Long-Term Environmental Effects of Offshore Oil and Gas Development.* Elsevier Applied Science, London and New York.

Spies, R. B., S. D. Rice, D. A. Wolfe, and B. A. Wright. 1996. The effects of the *Exxon Valdez* Oil Spill on the Alaskan coastal environment. Pages 1-16 *In:* Rice, S.D., R.B.Spies, D. A. Wolfe, and B. A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Stekoll, M. S., L. E. Clement, and D. G. Shaw. 1980. Sublethal effects of chronic exposure on the intertidal clam *Macoma balthica.* Marine Biology 57: 51-60.

Stekoll, M. S., L. Deysher, R. C. Highsmith, S. M. Supe, Z. Guo, W. P. Erickson, L. McDonald, and D. Srickland. 1996. Coastal habitat injury assessment: Intertidal communities and the *Exxon Valdez* oil spill. Pages 177-192 *In:* Rice, S.D., R.B.Spies, D. A. Wolfe, and B. A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Strathmann, M. 1987. *Reproduction and Development of Marine Invertebrates of the Northern Pacific Coast.* Univ. of Washington Press, Seattle. 670 pp.

Taylor, A. R. A. 1957. Studies of the development of *Zostera marina* L. I. The embryo and seed. Canadian Journal of Botany 35:477-499.

Taylor, T. L. and J. F. Karinen. 1977. Response of the clam, *Macoma balthica* (Linnaeus), exposed to Prudhoe Bay crude oil as unmixed oil, water-soluble fraction, and oil-contaminated sediment in the laboratory. *In:* D.A. Wolfe, ed. *Fate and Effects of Petroleum Hydrocarbons in the Marine Ecosystems and Organisms*, pp. 229-237. Pergamon Press, New York.

Teas, H., III, H. Cumberland, and D. Lees. 1991. Response of eelgrass (*Zostera marina*) in shallow subtidal habitats of Prince William Sound to the *Exxon Valdez* oil spill - 1990 and 1991. Abstract in Society of Environmental Toxicology and Chemistry; 12th annual meeting, Seattle, Washington.

Trowbridge, C., T. Baker, and J. D. Johnson. 1996. Effects of hydrocarbons on bivalves. *Exxon Valdez* Oil Spill State/Federal Natural Resource Damage Assessment Final Report (Fish/Shellfish Study 13), Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Anchorage, AK.

Valentine, J. W. 1973. Phanerozoic taxonomic diversity: A test of alternate methods. Science 180:1078.

Van Bernem, K. H. 1982. Effects of experimental crude oil contamination on abundance, mortality and resettlement of representative mud flat organisms in the mesohaline area of the Elbe Estuary. Netherland Journal of Sea Research 16: 538-546.

Venkatesan, M. I. 1988. Occurrence and possible sources of perylene in marine sediments - a review. Marine Chemistry 25: 1-27.

Viarengo, A. and L. Canesi. 1991. Mussels as biological indicators of pollution. Aquaculture 94:225-243.

Walker, D. L., and A. J. McComb. 1992. Seagrass degradation in Australian coastal waters. Marine Pollution Bulletin 25:191-195.

Walker, D. L., R. J. Lukatelich, G. Bastyan, and A. J. McComb. 1989. Effect of boat moorings on seagrass beds around Perth, Western Australia. Aquatic Botany 36:69-77.

Ward, D. M., R. M. Atlas, P. D. Boehm and J. A. Calder. 1980. Microbial biodegradation and chemical evolution of oil from the *AMOCO* spill. Ambio 9:277-283.

Wolfe, D. A., and eleven co-authors. 1994. The fate of oil spilled from the *Exxon Valdez*. Environmental Science and Technology 28:561A-568A.

Wolfe, D. A., M. M Krahn, E. Casillas, S. Sol, T. A. Thomas, J. Lunz, and K. J. Scott. 1996. Toxicity of intertidal and subtidal sediments in contaminated by the *Exxon Valdez* Oil Spill. Pages 121-139 *In:* Rice, S. D., R. B.Spies, D. A. Wolfe, and B. A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Table 1. Paired shallow subtidal eelgrass study sites in Western Prince William Sound, 1990, 1991, 1993 and 1995.

SITE NAME	SITE ABBREV.	SITE NUMBER	OILING STATUS	NORTH LATITUDE	WEST LONGITUDE
Drier Bay	DB	14	Control	60° 19.2′	147° 44.2′
Bay of Isles	BI	13	Oiled	60° 23.2′	147° 44.5′
Lower Herring Bay	LH	15	Control	60° 24.2′	147° 48.0′
Herring Bay	HB	16	Oiled	60° 26.7′	147° 47.2′
Moose Lips Bay	ML	18	Control	60° 12.7′	147° 18.5′
Sleepy Bay	SB	17	Oiled	60° 04.0′	147° 50.1′

Table 2. Summary of randomization ANOVA test results for TPAH and Chrysene concentration.

● = greater at oiled sites
O = greater at control sites
X = significant difference exists

●●●, OOO, XXX = $P \le 0.01$
●●, OO, XX = $0.01 < P \le 0.05$
●, O, X = $0.05 < P \le 0.1$
– = $P > 0.1$

TPAH

	1-Way Test				2 - Way Test		
	1990	1991	1993	1995	Oilcode	Year	Interaction
Deep (6-20 m)	●●	●	●●●	–	●●	XXX	XXX
Eelgrass bed (< 3 m)	●●	●	●●●	–	●●	XXX	XXX

Chrysene

	1-Way Test				2 - Way Test		
	1990	1991	1993	1995	Oilcode	Year	Interaction
Deep (6-20 m)	●●●	●●●	●●●	–	●●●	–	–
Eelgrass bed (< 3 m)	●●●	●●●	●●●	–	●●●	–	–

Table 3. Classification of hydrocarbon samples based on the presence of an *Exxon Valdez* oil signature.

		Deep (6 to 20 m)		Bed (< 3 m)		Total	
Year	Oil Control	Number of Samples	Number with *Exxon Valdez* oil	Number of Samples	Number with *Exxon Valdez* oil	Number of Samples	Number with *Exxon Valdez* oil
1990	O	7	2	9	8	16	10
	C	6	2	9	3	15	5
1991	O	9	7	9	6	18	13
	C	8	5	9	2	17	7
1993	O	9	2	9	2	18	4
	C	9	0	9	0	18	0
1995	O	9	1	9	1	18	2
	C	9	0	9	0	18	0

Table 4. Summary of randomization ANOVA test results of density of eelgrass turions and flowering turions.

● = greater at oiled sites
O = greater at control sites
X = significant difference exists

●●●, OOO, XXX	=	$P \leq 0.01$
●●, OO, XX	=	$0.01 < P \leq 0.05$
●, O, X	=	$0.05 < P \leq 0.1$
–	=	$P > 0.1$

	1 - Way Test				2 - Way Test		
	1990	1991	1993	1995	Oilcode	Year	Interaction
Turions	–	OO	–	●●	–	–	X
Flowering Turions	O	–	–	–	OO	XXX	–

Table 5. Ranking of the 15 dominant infaunal and small epifaunal taxa by decreasing density in each depth stratum and year. P = Polychaete, B = Bivalve Mollusk, G = Gastropod Mollusk, and A = Amphipod.

DEEP (6 - 20 m)

Rank	1990 TAXA NAME		1991		1993		1995	
1	Spionidae	P	Spionidae	P	Opheliidae	P	Spionidae	P
2	Lucinidae	B	Opheliidae	P	Spionidae	P	Mytilidae	B
3	Thyasiridae	B	Lucinidae	B	Lucinidae	B	Thyasiridae	B
4	Tellinidae	B	Spirorbidae	P	Thyasiridae	B	Lucinidae	B
5	Opheliidae	P	Thyasiridae	B	Mytilidae	B	Syllidae	P
6	Nephtyidae	P	Syllidae	P	Syllidae	P	Tellinidae	B
7	Mytilidae	B	Tellinidae	B	Capitellidae	P	Sigalionidae	P
8	Spirorbidae	P	Rissoidae	P	Montacutidae	B	Sabellidae	P
9	Syllidae	P	Sigalionidae	P	Sigalionidae	P	Montacutidae	B
10	Amphictenidae	P	Capitellidae	P	Ampharetidae	P	Ampharetidae	P
11	Lumbrineridae	P	Nephtyidae	P	Amphictenidae	P	Isaeidae	A
12	Phoxocephalidae	A	Ampharetidae	P	Nephtyidae	P	Spirorbidae	P
13	Montacutidae	B	Amphictenidae	P	Spirorbidae	P	Maldanidae	P
14	Olividae	G	Caecidae	G	Tellinidae	B	Nephtyidae	P
15	Orbiniidae	P	Mytilidae	B	Oedicerotidae	A	Capitellidae	P

BED (< 3 m)

Rank	1990 TAXA NAME		1991		1993		1995	
1	Spirorbidae	P	Opheliidae	P	Caprellidea	A	Spirorbidae	P
2	Spionidae	P	Mytilidae	B	Spirorbidae	P	Mytilidae	B
3	Mytilidae	B	Spirorbidae	P	Mytilidae	B	Montacutidae	B
4	Lacunidae	G	Caprellidea	A	Opheliidae	P	Lacunidae	G
5	Opheliidae	P	Spionidae	P	Montacutidae	B	Sabellidae	P
6	Caprellidea	A	Montacutidae	B	Syllidae	P	Caprellidae	A
7	Montacutidae	B	Lacunidae	G	Polynoidae	P	Spionidae	P
8	Amphictenidae	P	Rissoidae	G	Sigalionidae	P	Sigalionidae	P
9	Syllidae	P	Polynoidae	P	Spionidae	P	Trochidae	G
10	Capitellidae	P	Syllidae	P	Tellinidae	B	Polynoidae	P
11	Tellinidae	B	Turtoniidae	B	Sabellidae	P	Turtoniidae	B
12	Polynoidae	P	Capitellidae	P	Ischyroceridae	A	Amphictenidae	P
13	Phoxocephalidae	A	Ischyroceridae	A	Capitellidae	P	Phoxocephalidae	A
14	Nereidae	P	Tellinidae	B	Nereidae	P	Rissoidae	G
15	Ischyroceridae	A	Isaeidae	A	Corophiidae	A	Tellinidae	B

Table 6. Results of discriminant analysis of environmental variables with community dissimilarity. F = the F statistic, P = significance of the F statistic, Sig. Ax. = significance of the derived axis, % Var. = cumulative percent variance accounted for by each axis, % Corr. = percent of correct classifications of the original data by the discriminant functions. N/A = not applicable.

Deep (6-20m) infauna

			Standardized Coefficients			
	F	P-value	Axis 1	Axis 2	Axis 3	Axis 4
Sand	7.39	0.003	0.38	-0.76	-0.65	N/A
Mud	16.18	<0.001	-0.84	-0.55	-0.13	
Chrysene	6.93	0.003	0.86	-1.08	1.30	
TPAH	2.29	0.118	0.73	0.85	-0.82	
Sig. Ax.			<0.001	<0.001	0.004	
Var.			73%	91%	100%	
% Corr.	91%					

Deep (6-20m) epifauna

			Standardized Coefficients			
	F	P-value	Axis 1	Axis 2	Axis 3	Axis 4
Sand	38.00	<0.001	1.27	0.71	-0.20	0.17
Mud	32.88	<0.001	0.10	1.30	0.06	0.22
Chrysene	6.14	0.005	1.56	-0.26	1.47	0.49
TPAH	2.12	0.132	-1.15	0.11	-1.01	-1.40
Sig. Ax.			<0.001	<0.001	0.121	0.744
% Var.			54%	98%	99%	100%
% Corr.	100%					

Bed (<3m) infauna

			Standardized Coefficients			
	F	P-value	Axis 1	Axis 2	Axis 3	Axis 4
Sand	14.58	<0.001	-0.46	-1.11	0.02	N/A
Mud	13.76	<0.001	0.70	-0.95	0.36	
Chrysene	2.31	0.118	-0.57	1.03	0.95	
TPAH	1.58	0.235	0.63	0.039	-1.56	
Sig. Ax.			<0.001	<0.001	0.377	
Var.			87%	99%	100%	
% Corr.	100%					

Bed (<3m) epifauna

			Standardized Coefficients			
	F	P-value	Axis 1	Axis 2	Axis 3	Axis 4
Sand	0.68	0.586	-0.51	0.00	1.26	N/A
Mud	3.07	0.084	-1.09	-0.22	1.02	
Chrysene	2.98	0.089	1.60	-1.32	0.01	
TPAH	1.65	0.246	-1.35	0.49	-0.70	
Sig. Ax.			0.004	0.542	0.494	
Var.			93%	98%	100%	
% Corr.	94%					

Table 7. Summary of randomization ANOVA test results for benthic invertebrate community parameters. Comparisons were made of infauna with mud as a covariate, and of epifauna with no covariate.

● = greater at oiled sites
O = greater at control sites
X = *significant difference exists*

●●●, OOO, XXX = $P \leq 0.01$
●●, OO, XX = $0.01 < P \leq 0.05$
●, O, X = $0.05 < P \leq 0.1$
– = $P > 0.1$

	1-Way Test				2 - Way Test		
	1990	1991	1993	1995	Oilcode	Year	Interaction
Deep (6 to 20 m)							
Infauna							
Shannon Diversity	OO	–	–	–	OO	–	–
Total Abundance	–	–	–	–	O	XX	–
Total Biomass	–	–	–	–	–	–	–
Species Richness	–	–	–	–	–	–	–
Epifauna							
Shannon Diversity	–	–	–	–	–	X	–
Total Abundance	●	–	●	●●	●●●	–	XX
Total Biomass	●●	–	–	●●	●	–	XX
Species Richness	–	–	OO	–	–	–	X
Eelgrass Bed (< 3 m)							
Infauna							
Shannon Diversity	–	–	●	–	–	–	–
Total Abundance	–	–	●●	●●	●●●	–	–
Total Biomass	–	–	–	–	●	–	–
Species Richness	–	●	●●	O	–	X	X
Epifauna							
Shannon Diversity	–	–	–	●●	●	X	–
Total Abundance	●●●	●●	●●●	–	●●●	X	XXX
Total Biomass	●●	●	–	–	●●	XX	–
Species Richness	–	–	O	–	–	X	–

Table 8. Summary of randomization ANOVA test results on the density of major benthic invertebrate taxa.

● = greater at oiled sites
O = greater at control sites

●●●, OOO, XXX = $P \leq 0.01$
●●, OO, XX = $0.01 < P \leq 0.05$
●, O, X = $0.05 < P \leq 0.1$
– = $P > 0.1$

	1 - Way Test				2 - Way Test		
	1990	1991	1993	1995	Oilcode	Year	Interaction
Deep (6-20 m)							
Infauna							
Polychaeta	–	–	–	–	●	X	–
Gastropoda	●	–	–	●	●●●	XXX	–
Bivalvia	–	–	–	–	–	–	–
Amphipoda	–	–	–	–	–	–	–
Other Crustacea	–	–	–	–	–	–	–
Echinodermata	–	–	–	●	–	–	–
Epifauna							
Polychaeta	–	–	–	–	–	–	–
Gastropoda	–	–	–	–	–	X	–
Bivalvia	●●	●●	●●●	●●	●●●	–	–
Amphipoda	–	–	–	●●	–	–	–
Other Crustacea	–	–	–	–	–	–	X
Echinodermata	–	–	OOO	–	–	–	–
Eelgrass Bed (< 3 m)							
Infauna							
Polychaeta	–	–	●●	●●	●●●	–	–
Gastropoda	–	–	–	●●	●●●	–	–
Bivalvia	–	–	–	–	–	–	–
Amphipoda	OOO	–	–	–	OO	–	–
Other Crustacea	–	–	●●	–	–	–	X
Echinodermata	–	–	–	–	–	–	–
Epifauna							
Polychaeta	●●●	–	●●●	–	–	–	XXX
Gastropoda	–	●	●●	–	●●●	–	–
Bivalvia	●●●	●●●	●●●	●●●	●●●	–	–
Amphipoda	–	–	●●	–	–	XXX	XXX
Other Crustacea	–	–	–	–	–	–	–
Echinodermata	●●●	●●●	–	●	●●●	X	X

Table 9. Summary of randomization ANOVA's test results for the density of feeding groups of benthic invertebrates.

	1-Way Test				2-Way Test		
	1990	1991	1993	1995	Oilcode	Year	Interaction
Deep (6 - 20 m)							
Surface Deposit	-	-	-	-	OO	XX	-
Suspension	-	O	-		O	X	-
Herbivores	●●●	-	●●	-	●	XXX	-
Predator/Scavengers	-	-	-	-	●	-	-
Subsurface Deposit	-	-	-	-	-	-	-

	1-Way Test				2-Way Test		
	1990	1991	1993	1995	Oilcode	Year	Interaction
Eelgrass Bed (< 3 m)							
Surface Deposit	-	-	-	●	●	-	-
Suspension	-	●	●	-	●●	-	-
Herbivores	-	-	●●	●	●●	-	-
Predator/Scavengers	-	-	●●	●●	●	-	XX
Subsurface Deposit	-	-	●●	●●	●●	X	-

Table 10. Summary of randomization ANOVA test results for the density of dominant benthic invertebrate families in paired (oiled *vs.* control) site comparisons. Data are for the 6- to 20-m depth stratum.

● = greater at oiled sites
○ = greater at control sites
X = significant difference exists

●●●, ○○○, XXX = $P \leq 0.01$
●●, ○○, XX = $0.01 < P \leq 0.05$
●, ○, X = $0.05 < P \leq 0.1$
– = $P > 0.1$

	1-Way Test				2 - Way Test		
	1990	1991	1993	1995	Oilcode	Year	Interaction
INFAUNA							
Polychaeta							
Ampharetidae	○	–	–	–	–	–	–
Amphictenidae	○○	–	–	–	–	–	–
Capitellidae	–	–	○	–	–	–	–
Lumbrineridae	–	–	○○	–	–	–	–
Maldanidae	●●	●	–	–	●●●	–	–
Nephtyidae	–	–	–	–	●	–	–
Opheliidae	–	–	–	○○	–	–	–
Orbiniidae	–	–	–	–	–	–	–
Sabellidae	●●	–	–	–	–	–	–
Sigalionidae	○○○	–	–	–	–	–	–
Spionidae	–	●	●●	–	●●	–	–
Syllidae	–	–	●	–	●●	–	–
Bivalvia							
Lucinidae	–	–	–	–	–	XX	–
Montacutidae	–	–	–	–	○○	–	–
Tellinidae	–	–	–	–	–	–	–
Thyasiridae	–	–	–	–	○○	–	–
Gastropoda							
Caecidae	–	–	●	●	●●●	–	–
Olividae	●	–	–	–	–	X	–
Rissoidae	–	–	–	–	–	XXX	–
Crustacea							
Oedicerotidae	–	–	–	–	●●	–	–
Isaeidae	–	–	–	–	○	–	–
Phoxocephalidae	○○	○○○	–	–	○○○	XX	X
Echinodermata							
Ophiuroidea	–	–	–	●	–	–	–
EPIFAUNA							
Polychaeta							
Spirorbidae	–	–	–	–	–	–	–
Bivalvia							
Mytilidae	●●	●●●	●●●	●●	●●●	–	–

Table 11. Summary of randomization ANOVA test results for the density of dominant benthic invertebrate families. Data are for the < 3 m depth stratum.

● = greater at oiled sites
O = greater at control sites
X = significant difference exists

●●●, OOO, XXX = $P \leq 0.01$
●●, OO, XX = $0.01 < P \leq 0.05$
●, O, X = $0.05 < P \leq 0.1$
– = $P > 0.1$

	1-Way Test				2 - Way Test		
	1990	1991	1993	1995	Oilcode	Year	Interaction
INFAUNA							
Polychaeta							
Amphictenidae	–	–	–	●●●	●●●	–	–
Capitellidae	–	–	–	●	–	–	–
Nereidae	●●	–	●●	●	●●●	–	–
Opheliidae	–	–	●●●	–	●	XX	–
Polynoidae	–	–	O	–	–	–	–
Sabellidae	●	–	–	–	●●	–	–
Sigalionidae	–	–	–	–	–	X	–
Spionidae	●●	–	●●●	●●	●●●	–	–
Syllidae	–	–	–	OO	–	–	–
Bivalvia							
Montacutidae	–	–	–	–	–	–	–
Tellinidae	–	–	O	O	OOO	–	–
Turtoniidae	N/A	–	–	–	–	–	–
Gastropoda							
Lacunidae	–	–	–	●●	●●	X	–
Rissoidae	–	–	–	–	–	–	–
Trochidae	–	OO	–	–	–	–	–
Crustacea							
Corophiidae	–	O	–	–	●	–	–
Ischyroceridae	–	–	–	–	–	–	XX
Isaeidae	O	OO	OO	–	OOO	–	–
Phoxocephalidae	OOO	OOO	OOO	OOO	OOO	–	–
EPIFAUNA							
Polychaeta							
Spirorbidae	●●●	–	●●●		–	–	XXX
Bivalvia							
Mytilidae	●●●	●●●	●●●	●●●	●●●	–	–
Crustacea							
Caprellidae	–	–	●●	–	–	XXX	XXX

Table 12. Summary of randomization ANOVA test results for the density of large epibenthic invertebrates.

● = greater at oiled sites
O = greater at control sites
X = significant difference exists

●●●, OOO, XXX	=	$P \leq 0.01$
●●, OO, XX	=	$0.01 < P \leq 0.05$
●, O, X	=	$0.05 < P \leq 0.1$
–	=	$P > 0.1$

	1 - Way Test				2 - Way Test		
	1990	1991	1993	1995	Oilcode	Year	Interaction
Pycnopodia (>10 cm)	–	–	–	●	–	–	XXX
Pycnopodia (<10 cm)	–	–	–	–	–	XXX	–
Telmessus	OO	–	OOO	O	OO	XXX	–
Dermasterias	–	O	–	–	OOO	–	–

Table 13. Summary of randomization ANOVA test results for the density of cod (Gadidae - excluding pollock).

● = greater at oiled sites	●●●, OOO, XXX	= $P \leq 0.01$
O = greater at control sites	●●, OO, XX	= $0.01 < P \leq 0.05$
X = significant difference exists	●, O, X	= $0.05 < P \leq 0.1$
	–	= $P > 0.1$

	1 - Way Test				2 - Way Test		
	1990	1991	1993	1995	Oilcode	Year	Interaction
Gadidae (>15 cm)	●●●	–	–	–	–	XX	–
Gadidae (<15 cm)	●●●	●●	●●	–	●●●	–	–

Table 14. Summary of *Exxon Valdez* oil spill intertidal cleanup activity at the shallow subtidal eelgrass study sites in Prince William Sound.

Site Name	Site #	Oil Code[1]	Latitude	Longitude	ADEC Segment #	EVOS Cleanup Activity[2]	Cleanup Date
Drier Bay	14	9	60 19.2	147 44.2	KN0575-A	No Activity	
Bay of Isles	13	1	60 23.2	147 44.5	KN0202-A	No Activity	
Lower Herring Bay	15	9	60 24.2	147 48.1	KN0551-A	No Activity	
Herring Bay	16	1	60 26.7	147 47.2	KN0132B	Rake/till; manual removal; Bioremed.; mechanical treat.	Summer 1990-91
Moose Lips Bay	18	9	60 12.7	147 18.5	No Segment #	No Activity	
Sleepy Bay	17	1	60 04.0	147 50.1	LA017-A, LA018-A, LA019	Rake/till; manual removal; Bioremed.; mechanical treat.	Summer 1989-90
					LA019	Bioremed.	July 1993

[1]Oil Codes: 1 = Oiled 9 = Control
[2]EVOS cleanup activity: information provided by ADEC Oil Spill Response Center, Anchorage, AK.

Table 15. Differences in mean abundance for dominant taxa of infauna that differed significantly between oiled and reference sites. Means were unadjusted for substrate differences.

Taxa	Year		P value for ANOVA	Ratio of Means (largest to smallest)
		6 to 20 m		
Sigalionidae	90		< 0.01	4
Phoxocephalidae	91		< 0.01	3
Mytilidae	90		< 0.01	19
Mytilidae	91		< 0.01	167
Mytilidae	93		< 0.01	192
Mytilidae	95		< 0.01	363
		≤ 3 m		
Amphictenidae	95		< 0.01	21
Opheliidae	93		< 0.01	3
Spionidae	93		< 0.01	4
Phoxocephalidae	90		< 0.01	188
Phoxocephalidae	91		< 0.01	18
Phoxocephalidae	93		< 0.01	5
Phoxocephalidae	95		< 0.01	7
Spirorbidae	90		< 0.01	5
Spirorbidae	93		< 0.01	10
Mytilidae	90		< 0.01	13
Mytilidae	91		< 0.01	7
Mytilidae	93		< 0.01	45
Mytilidae	95		< 0.01	96
		6 to 20 m		
Amphictenidae	90		0.10<P< 0.05	1
Lumbrineridae	93		0.10<P< 0.05	2
Maldanidae	90		0.10<P< 0.05	2
Opheliidae	95		0.10<P< 0.05	2
Sabellidae	90		0.10<P< 0.05	2
Spionidae	93		0.10<P< 0.05	1
Phoxocephalidae	90		0.10<P< 0.05	5
		≤ 3 m		
Nereidae	90		0.10<P< 0.05	9
Nereidae	93		0.10<P< 0.05	5
Spionidae	90		0.10<P< 0.05	3
Spionidae	95		0.10<P< 0.05	11
Lacunidae	95		0.10<P< 0.05	5
Trochidae	93		0.10<P< 0.05	4
Isaeidae	91		0.10<P< 0.05	160
Isaeidae	93		0.10<P< 0.05	14
Capitellidae	93		0.10<P< 0.05	4

Table 15 (Continued). Differences in mean abundance for dominant taxa of infauna that differed significantly between oiled and reference sites. Means were unadjusted for substrate differences.

		6 to 20 m	
Ampharetidae	90	0.05<P< 0.10	3
Capitellidae	93	0.05<P< 0.10	1
Maldanidae	91	0.05<P< 0.10	3
Spionidae	91	0.05<P< 0.10	2
Syllidae	93	0.05<P< 0.10	2
Caecidae	93	0.05<P< 0.10	4
Caecidae	95	0.05<P< 0.10	∞[1]
Olividae	90	0.05<P< 0.10	68
Ophiuroidea	95	0.05<P< 0.10	3
		≤ 3 m	
Capitellidae	95	0.05<P< 0.10	6
Nereidae	95	0.05<P< 0.10	2
Polynoidae	93	0.05<P< 0.10	2
Sabellidae	90	0.05<P< 0.10	24
Tellinidae	93	0.05<P< 0.10	5
Tellinidae	95	0.05<P< 0.10	7
Corophiidae	91	0.05<P< 0.10	3
Isaeidae	90	0.05<P< 0.10	60

[1]. The mean was zero for the control sites.

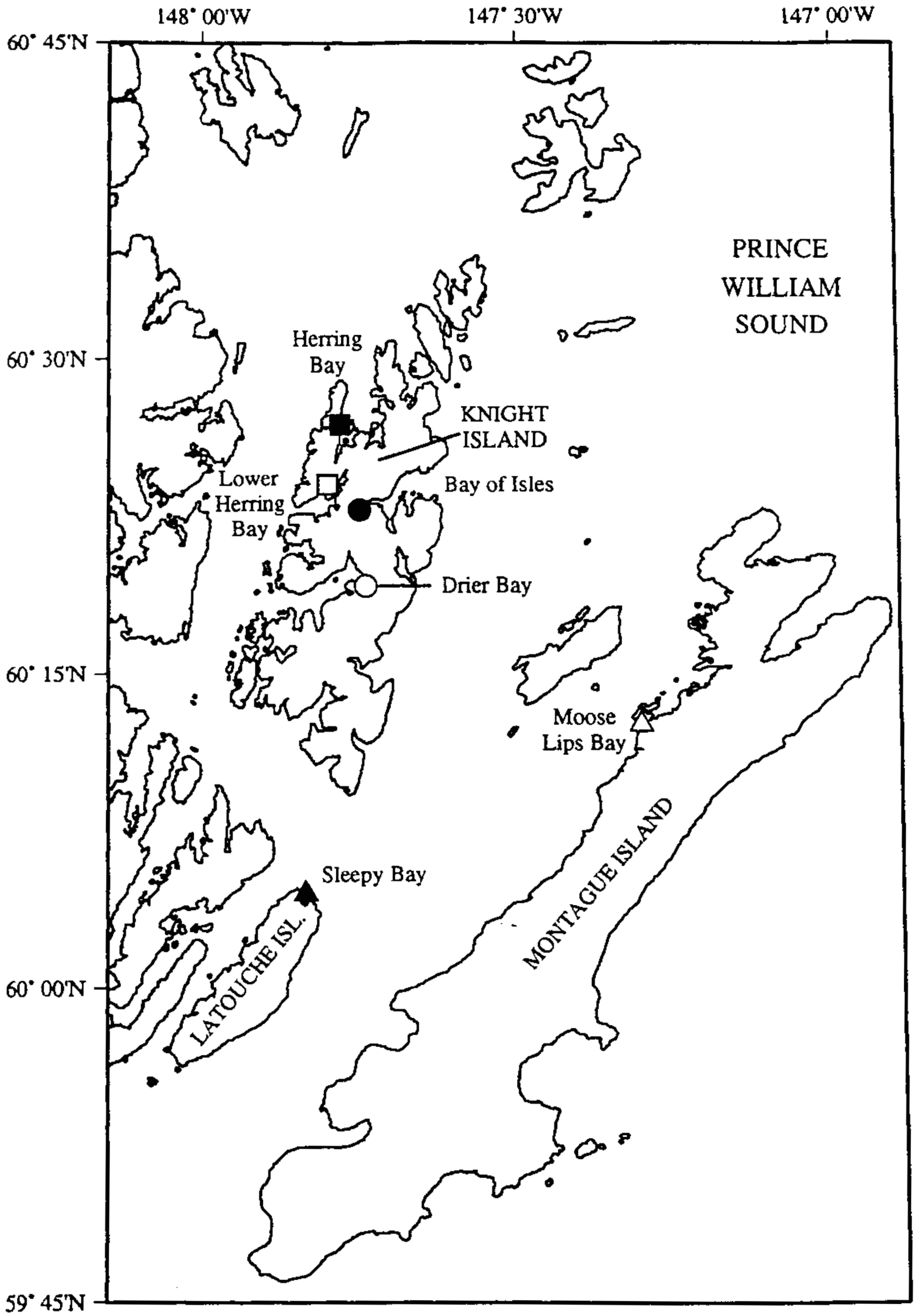


Figure 1. Location of eelgrass sampling locations. Three oiled/reference site pairs are shown; dark symbols are for oiled sites and light symbols are for reference sites.

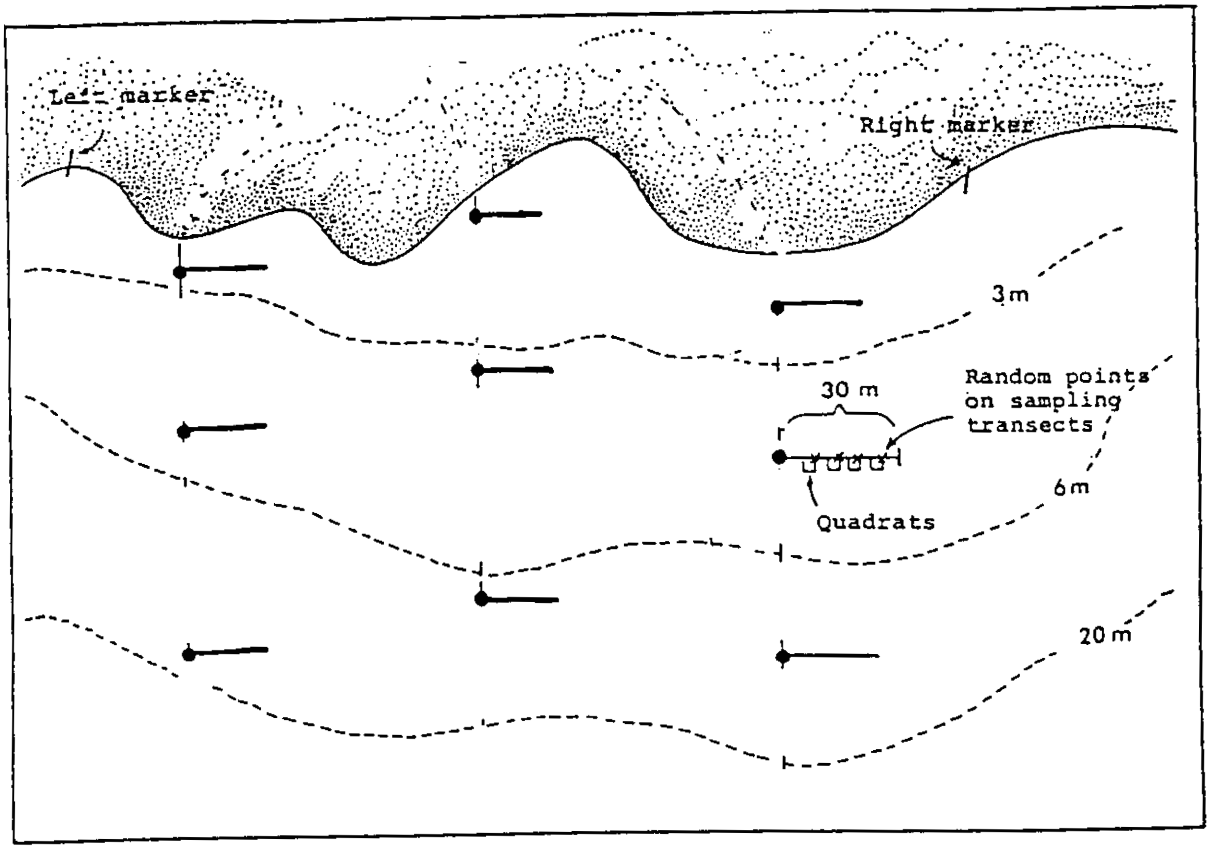


Figure 2. Schematic showing the layout of sampling stations and quadrat locations at eelgrass sampling sites. Only data from 6 to 20 m and < 3 m are reported on here.

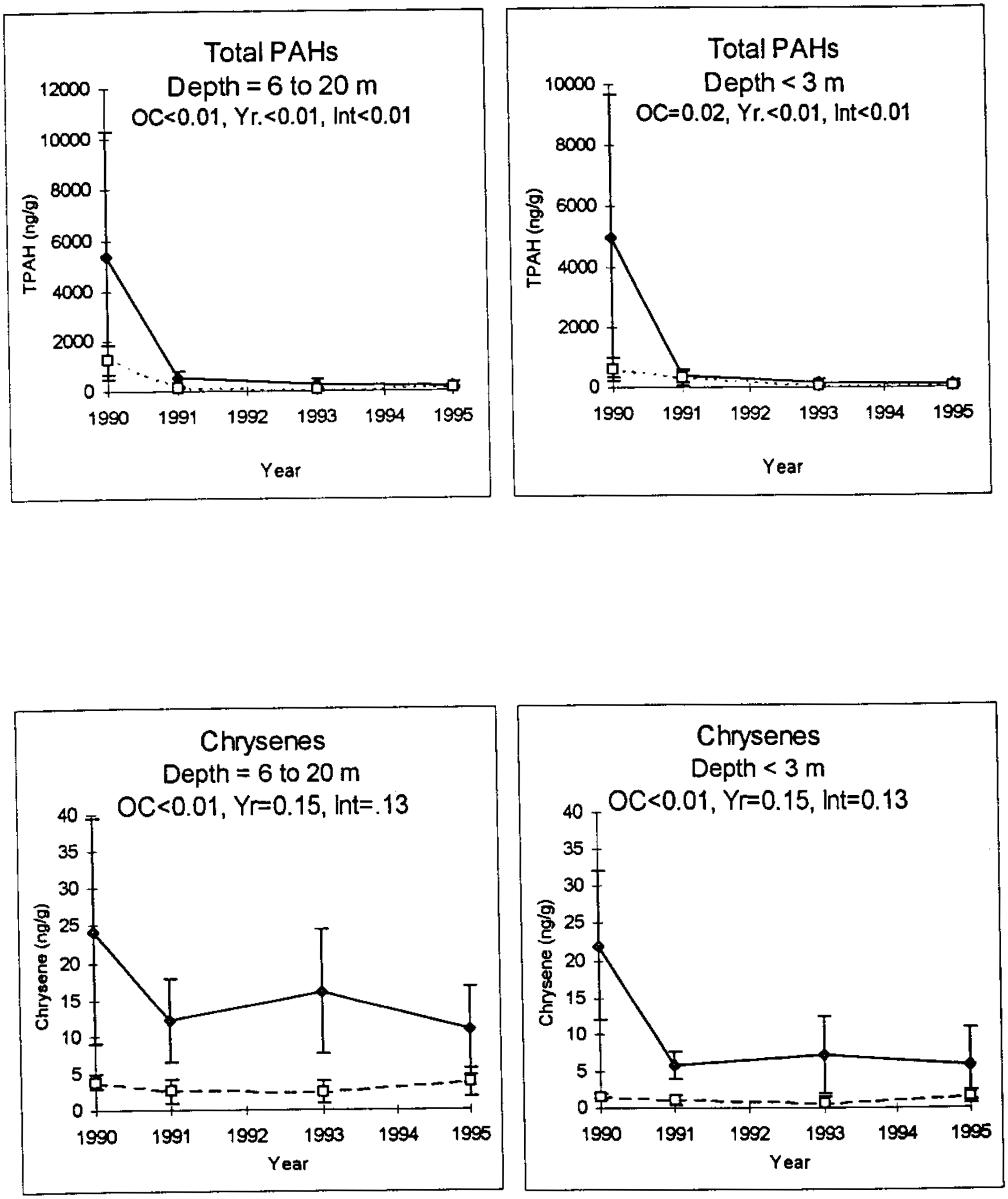


Figure 3. Mean concentrations of TPAHs and chrysenes (+/- 1 SE) at oiled (solid line) and control (dashed line) sites. Two-way ANOVA results are summarized.

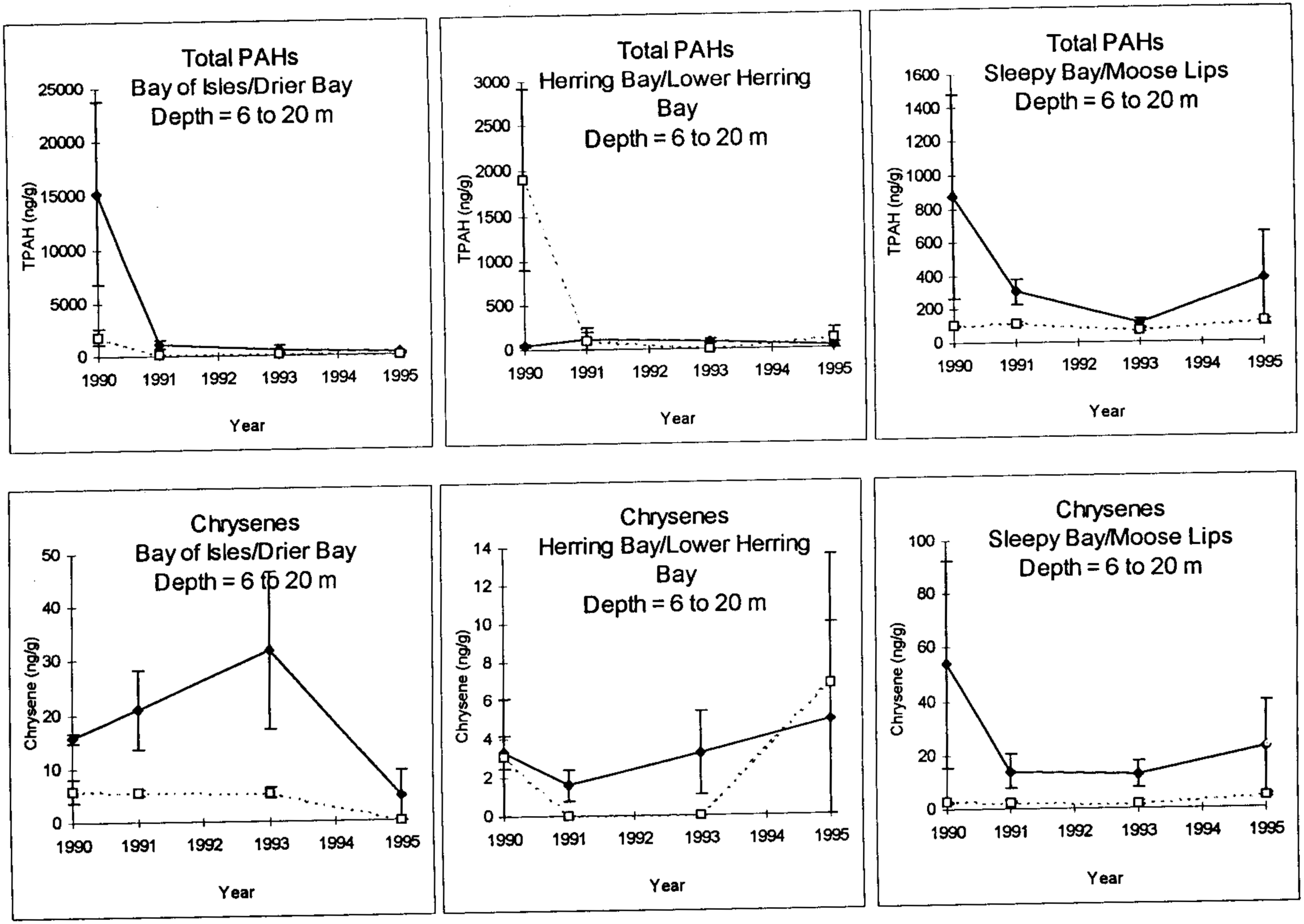


Figure 4. Mean concentrations of TPAHs and chrysenes (+/- 1 SE) at paired oiled (solid line) and control (dashed line) sites at 6 to 20 m depth.

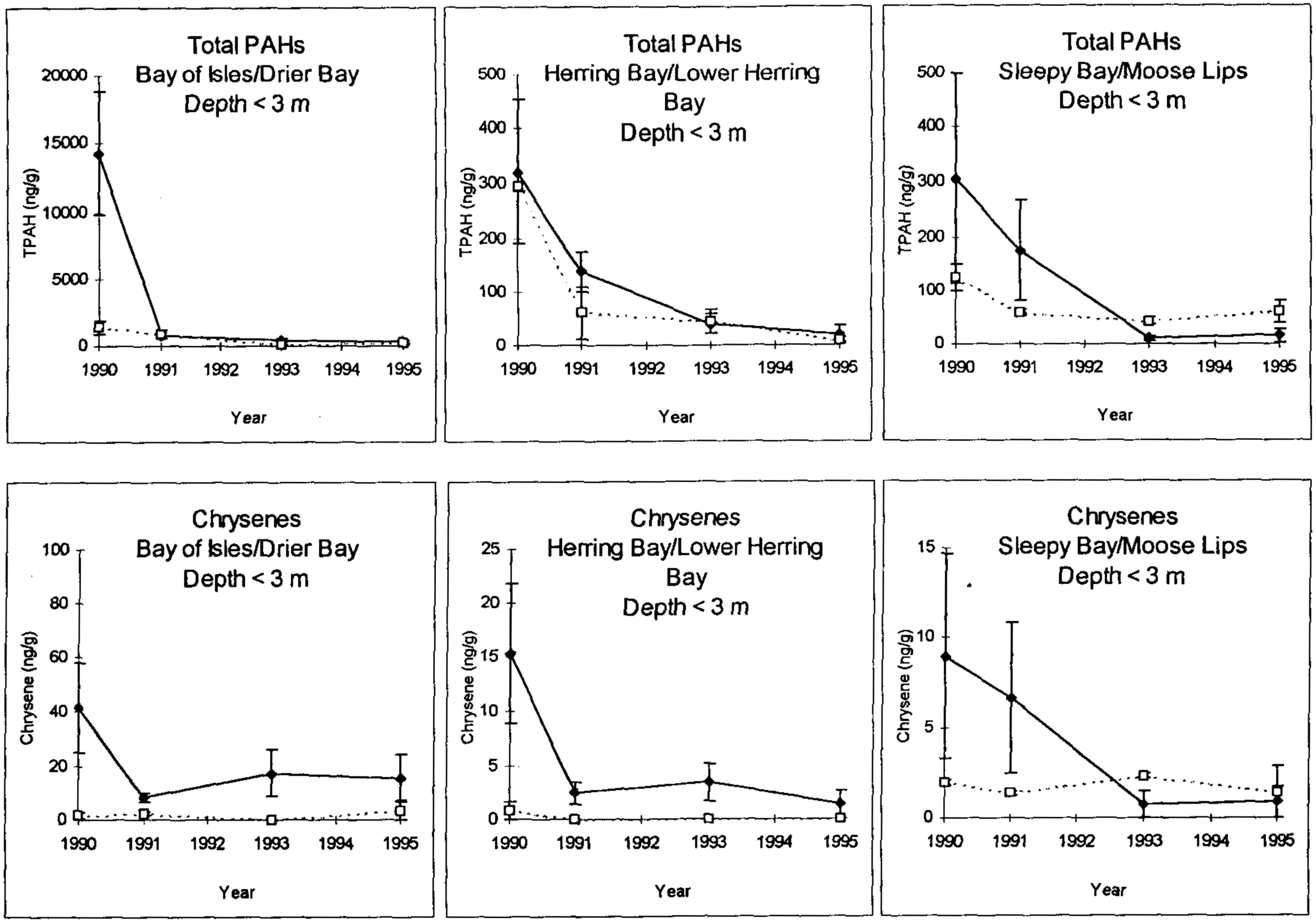


Figure 5. Mean concentrations of TPAHs and chrysenes (+/- 1 SE) at paired oiled (solid line) and control (dotted line) sites at < 3 m depth.

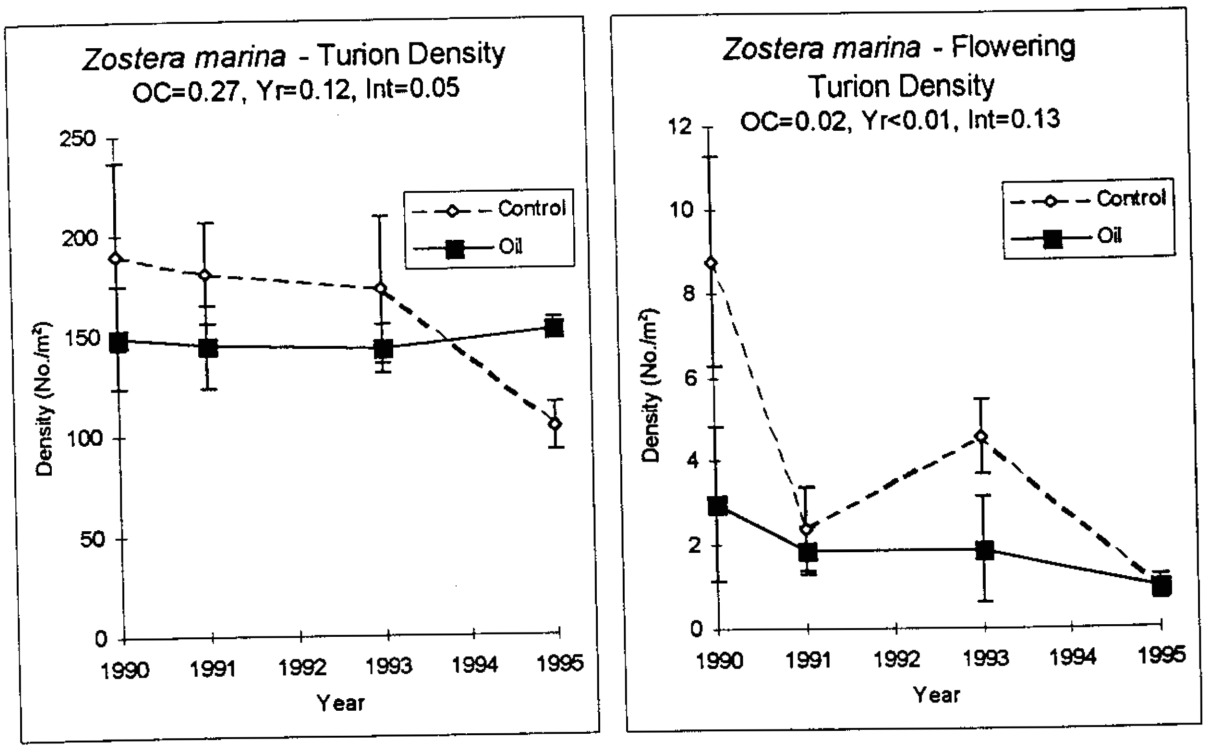


Figure 6. Mean densities (+/- 1 SE) of shoots and flowering shoots of eelgrass, *Zostera marina*. Two-way ANOVA results are summarized.

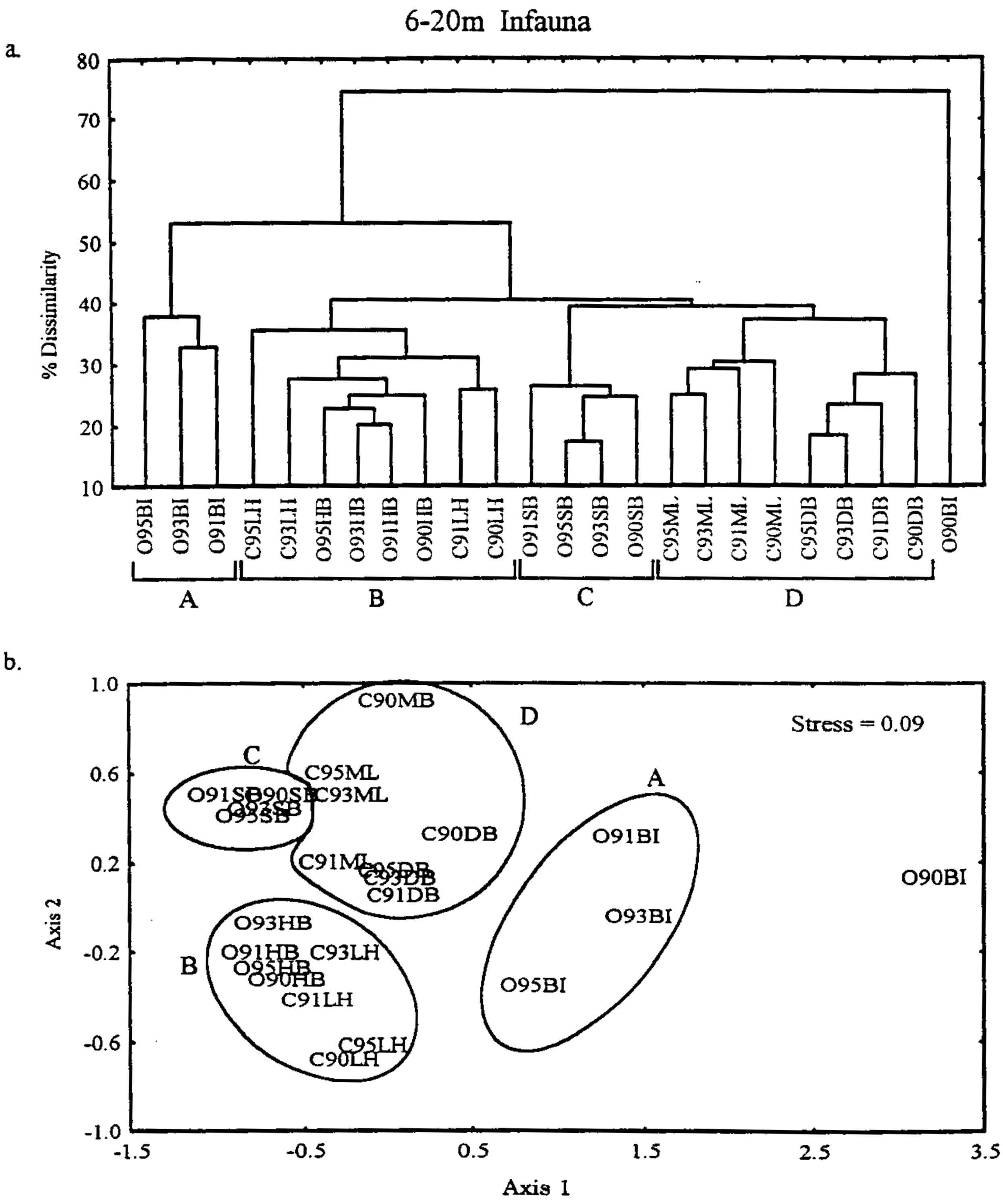


Figure 7. Cluster diagram (a) and MDS ordination (b) of *ln*-transformed infaunal abundance data from 6-20m. Site groups determined by cluster analysis are circled and labeled on the MDS ordination. Sites are labeled as follows: O or C for oiled or control, the year, and the site. Site designations are BI = Bay of Isles, LH = Lower Herring Bay, HB = Herring Bay, SB = Sleepy Bay, ML = Moose Lips Bay, and DB = Drier Bay.

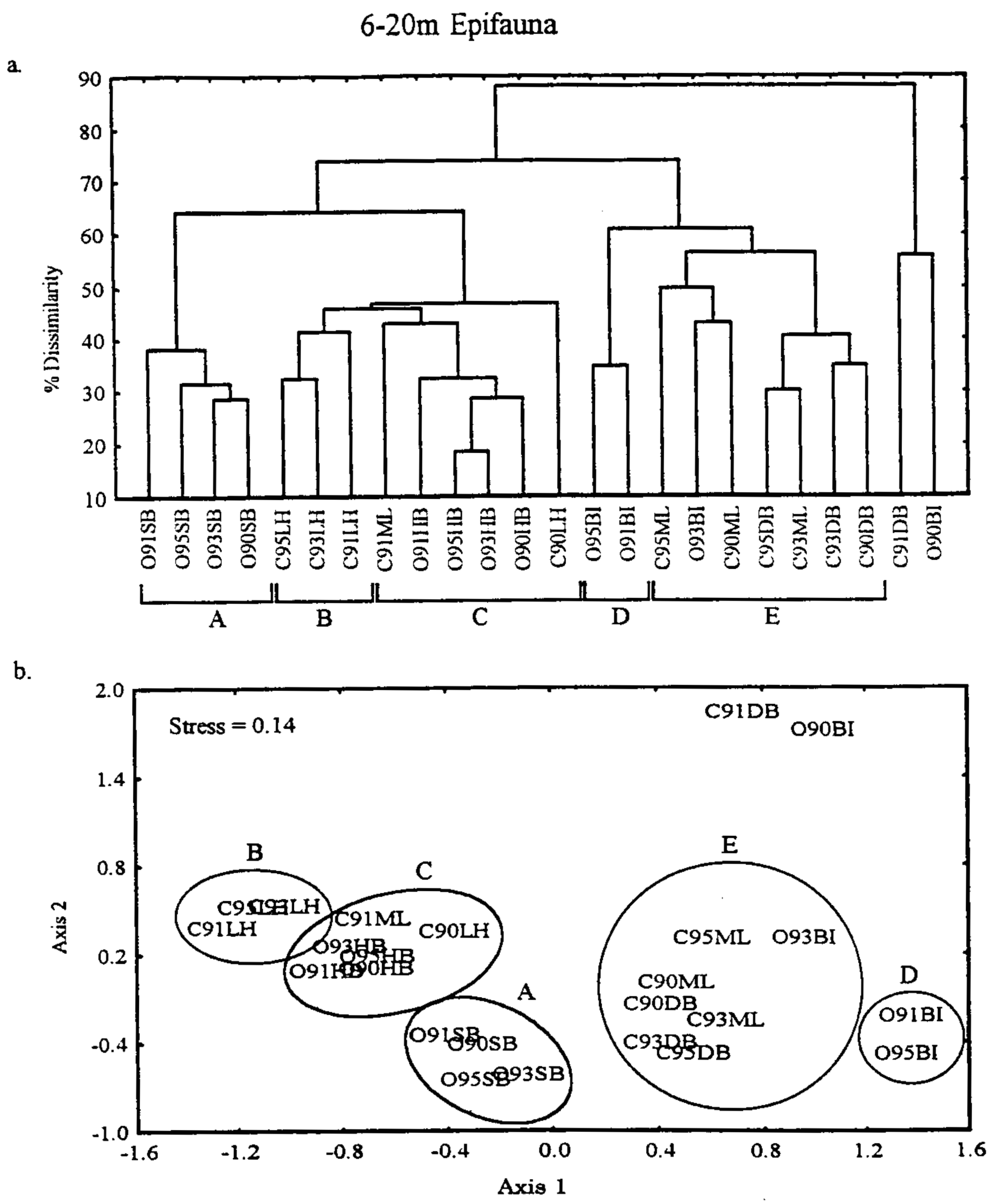


Figure 8. Cluster dendrogram (a) and MDS ordination (b) on *ln*-transformed epifaunal abundance data from 6-20m. Site groups determined by cluster analysis are circled and labeled on the MDS ordination. Site designations are BI = Bay of Isles, LH = Lower Herring Bay, HB = Herring Bay, SB = Sleepy Bay, ML = Moose Lips Bay, and DB = Drier Bay.

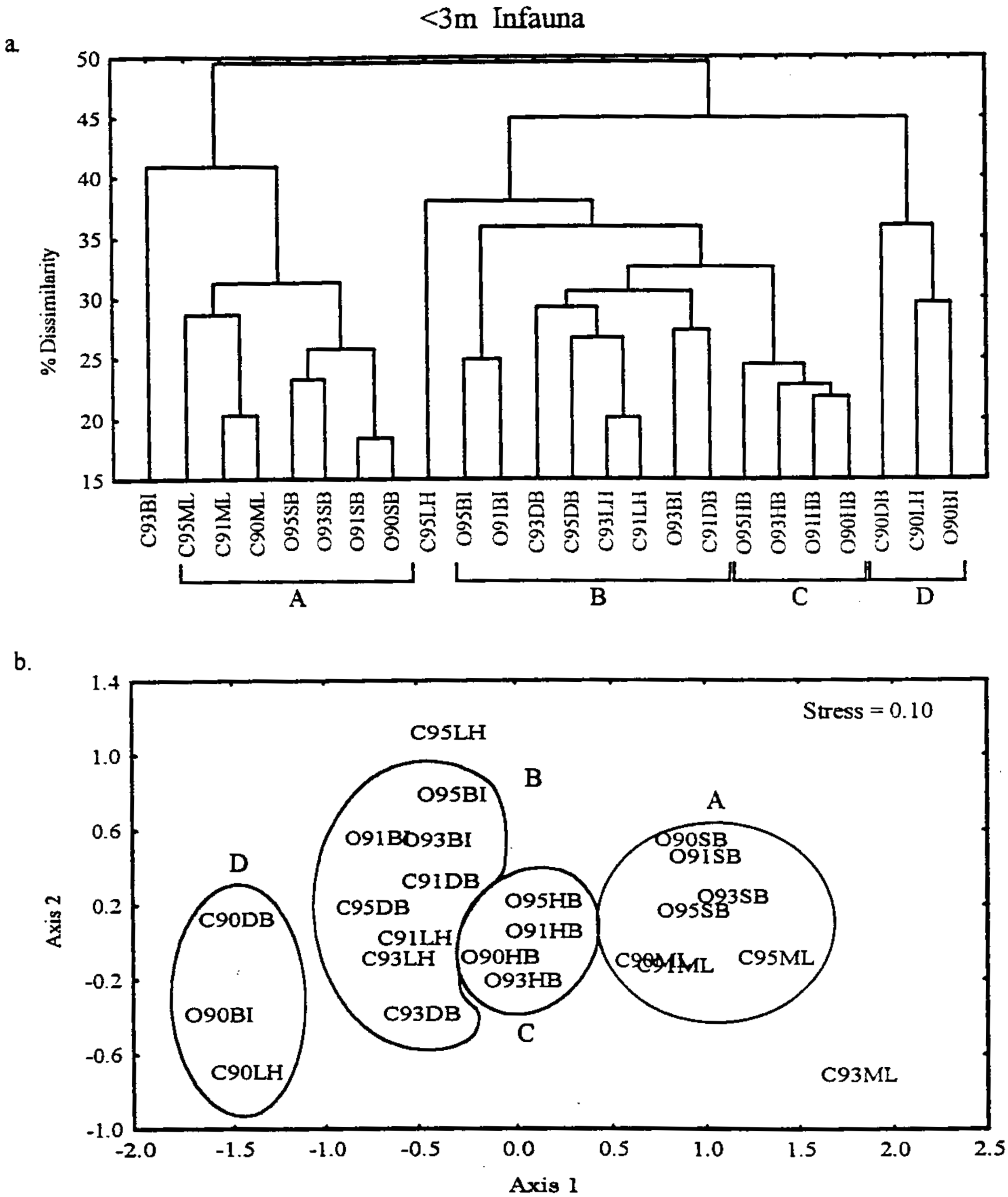


Figure 9. Cluster dendrogram (a) and MDS ordination (b) of *ln*-transformed infaunal abundance data from <3m. Site groups determined by cluster analysis are circled and labeled on the MDS ordination. Site designations are BI = Bay of Isles, LH = Lower Herring Bay, HB = Herring Bay, SB = Sleepy Bay, ML = Moose Lips Bay, and DB = Drier Bay.

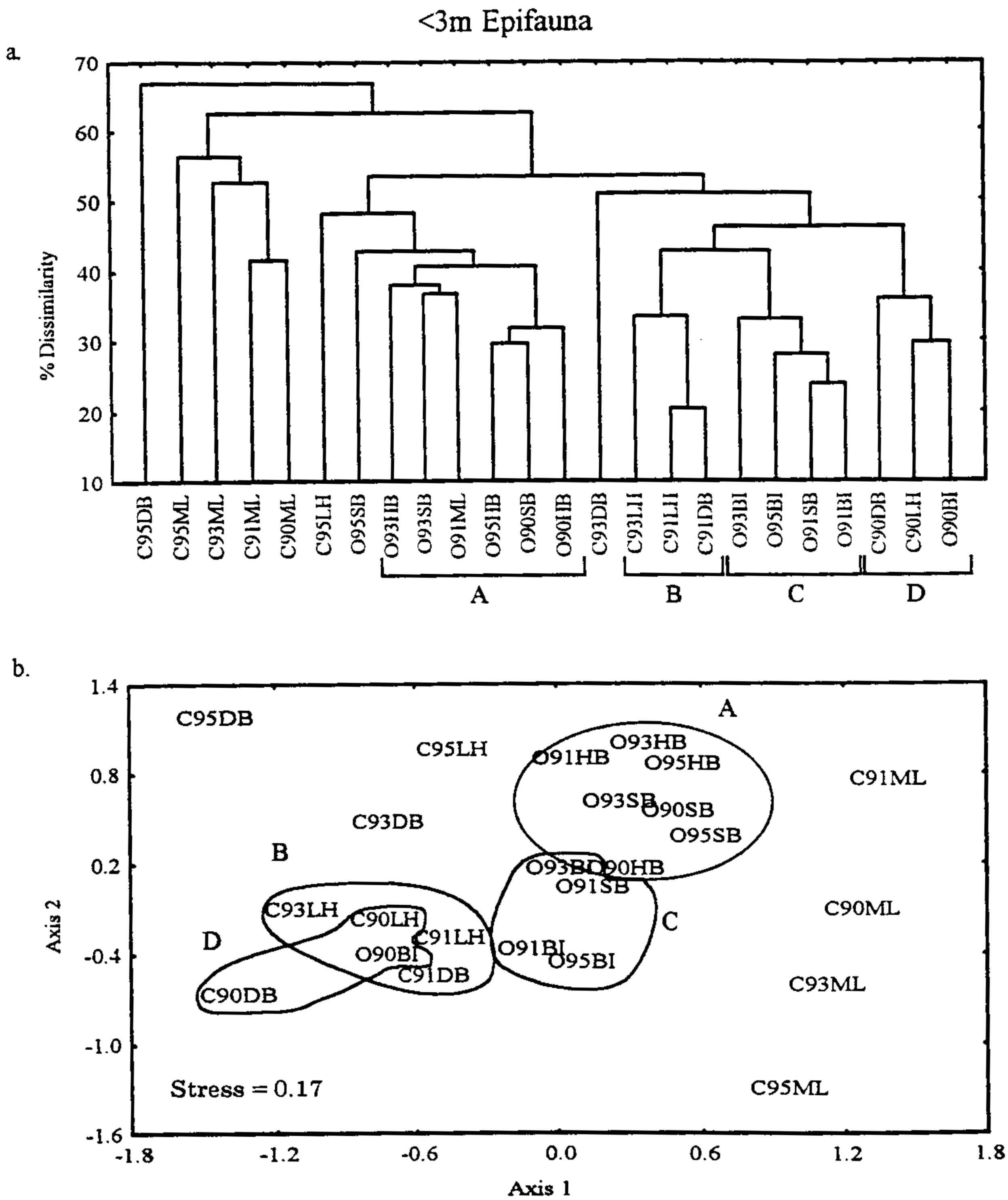


Figure 10. Cluster dendrogram (a) and MDS ordination (b) of *ln*-transformed epifaunal abundance data from <3m. Site groups determined by cluster analysis are circled and labeled on the MDS ordination. Site designations are BI = Bay of Isles, LH = Lower Herring Bay, HB = Herring Bay, SB = Sleepy Bay, ML = Moose Lips Bay, and DB = Drier Bay.

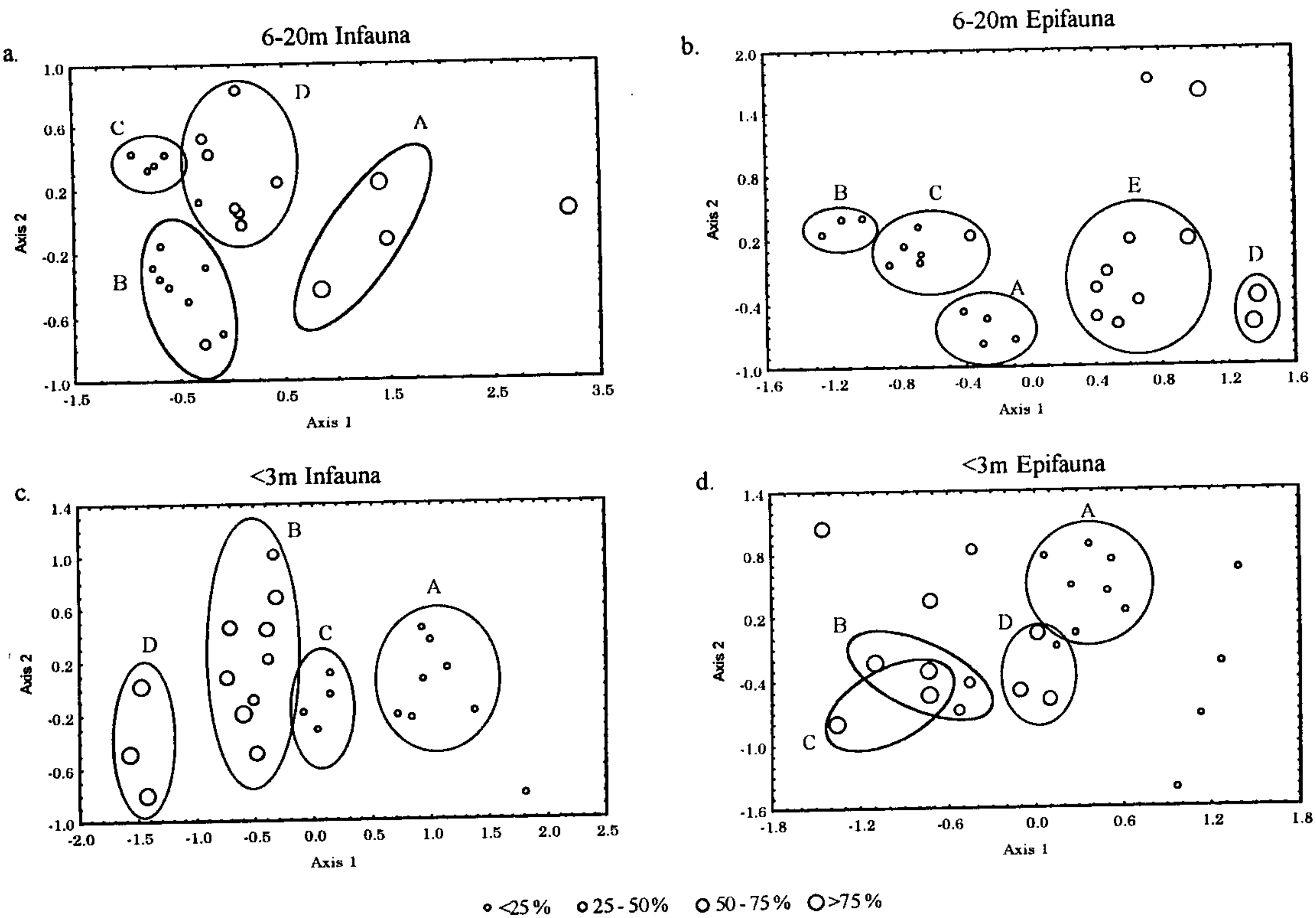


Figure 11. Overlays of percent mud on MDS ordinations of sites. Circles and letters denote site grouping from cluster analysis.

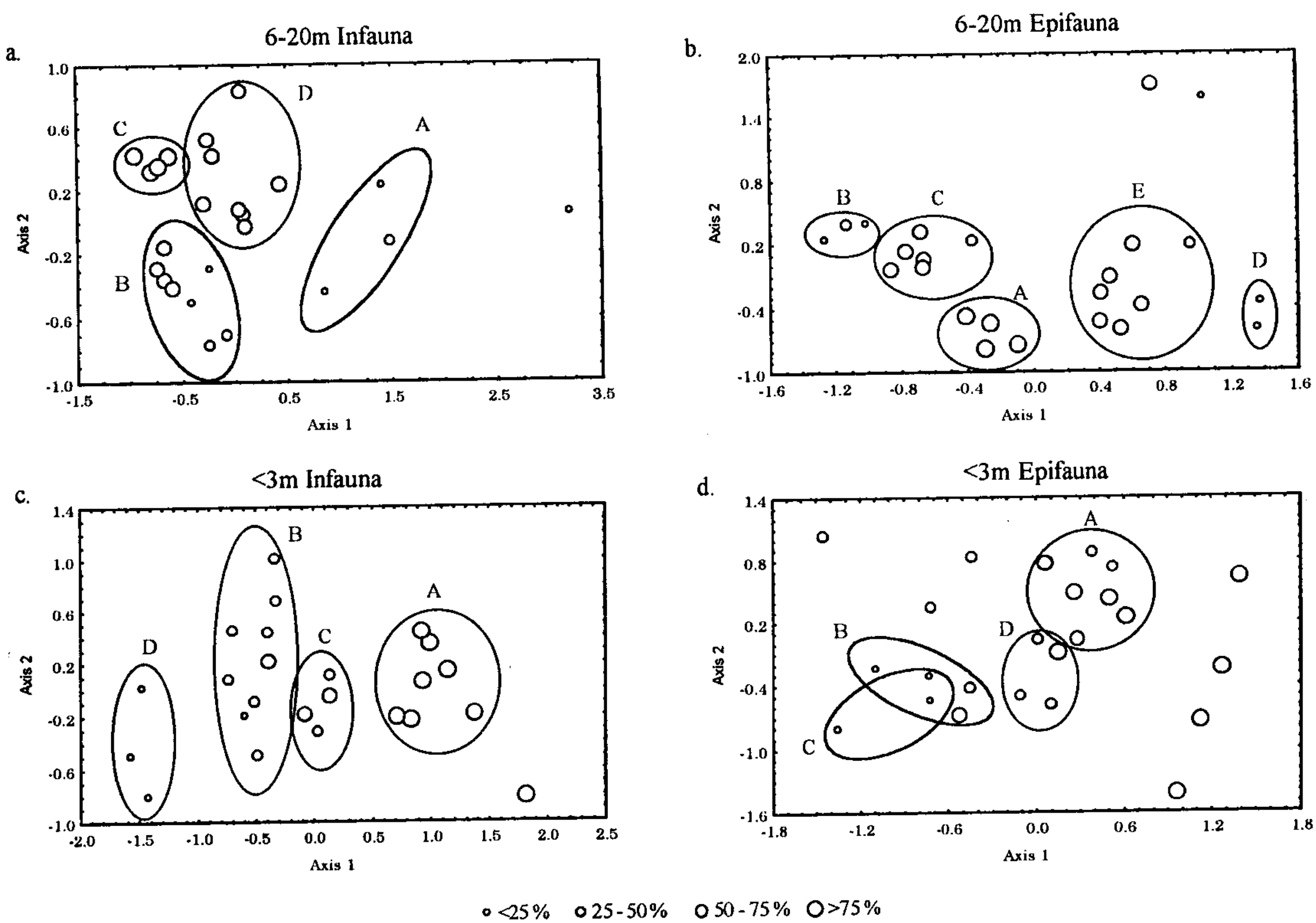


Figure 12. Overlays of percent sand on MDS ordinations of sites. Circles and letters denote site grouping from cluster analysis.

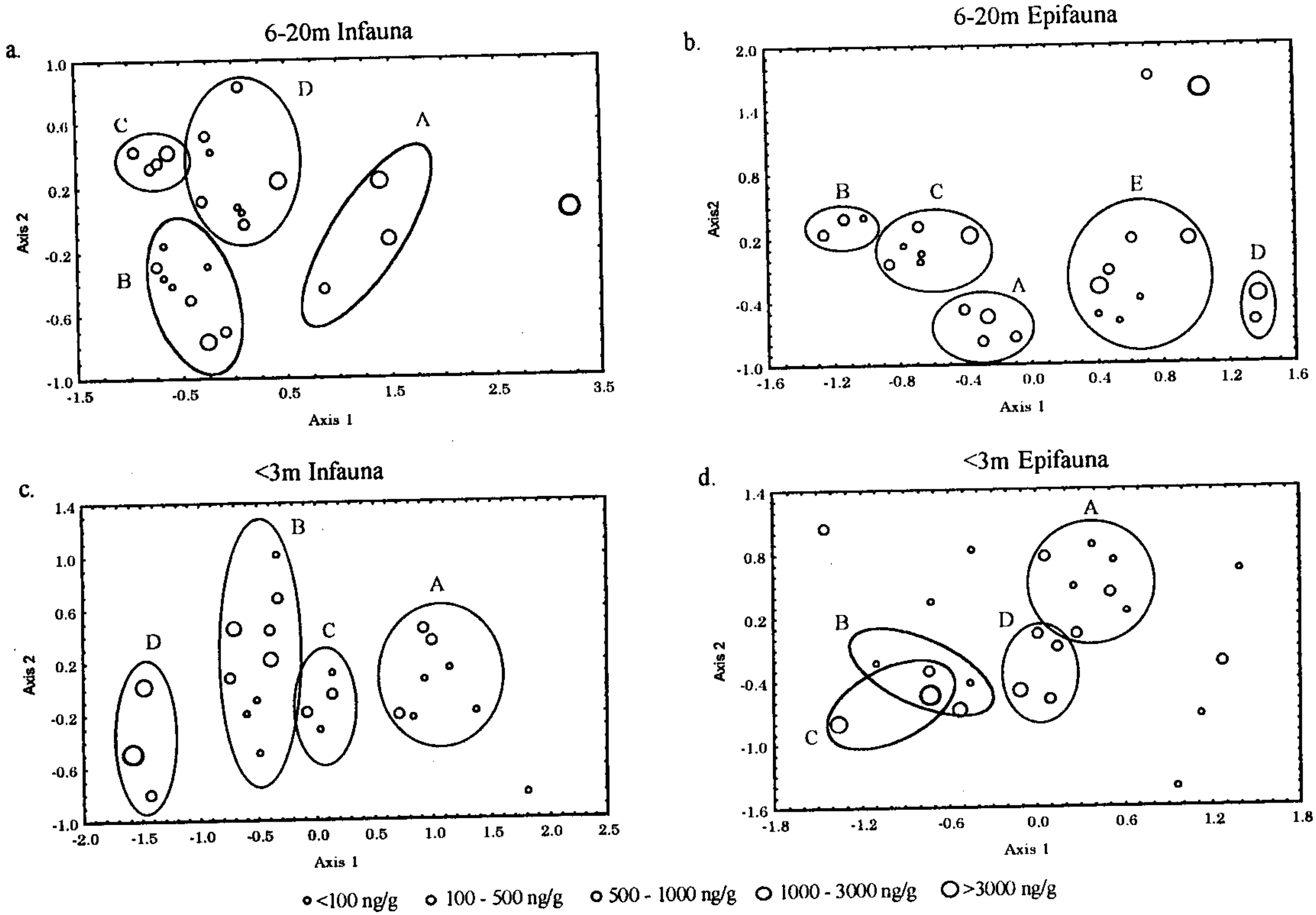


Figure 13. Overlays of TPAH on MDS ordinations of sites. Circles and letters denote site grouping from cluster analysis.

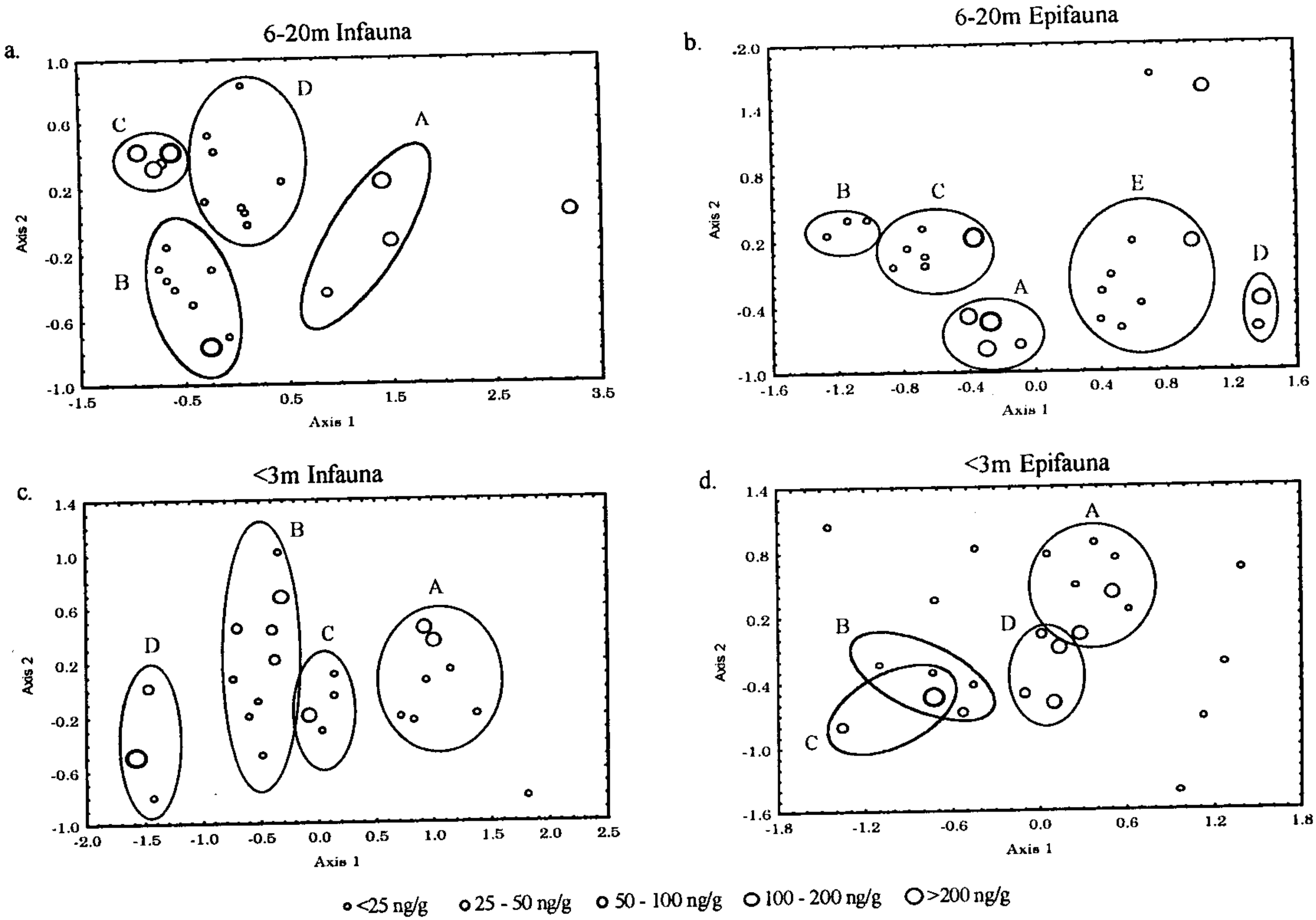


Figure 14. Overlays of total chrysenes on MDS ordinations of sites. Circles and letters denote site grouping from cluster analysis.

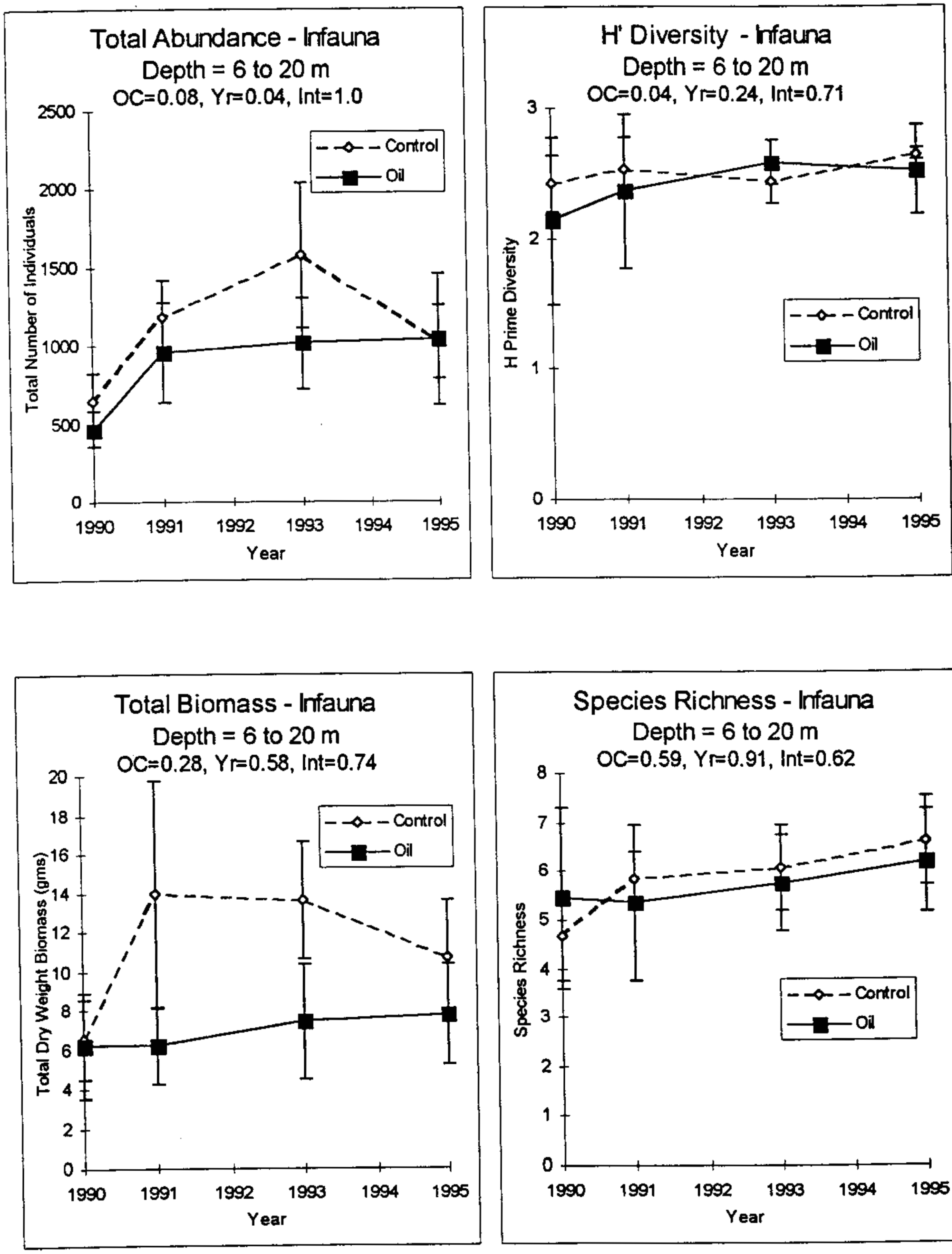


Figure 15. Community parameters (+/- 1 SE) for infaunal invertebrates from dredge samples at 6 to 20 m depth. Two-way ANOVA results are summarized.

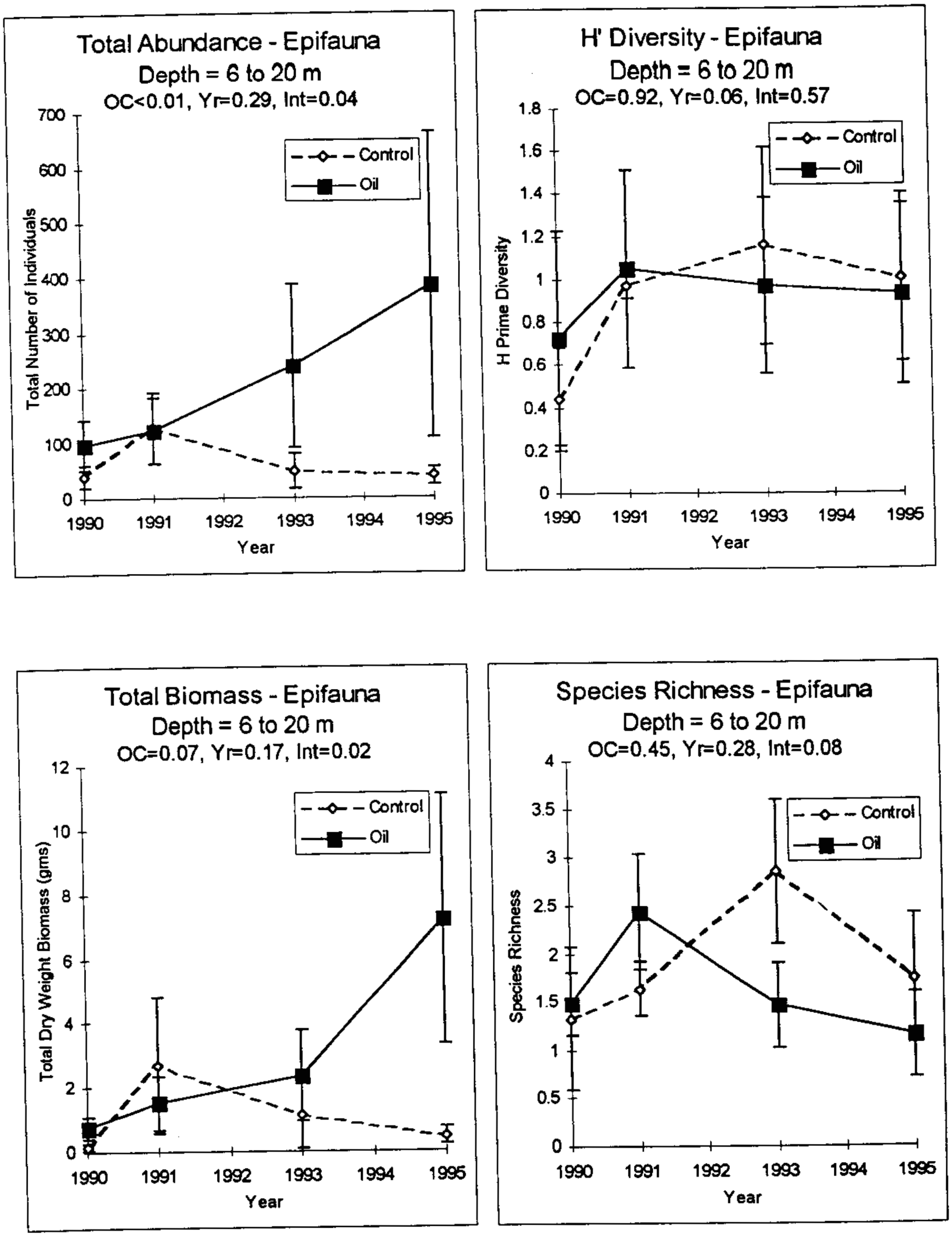


Figure 16. Community parameters (+/- 1 SE) for epifaunal invertebrates from dredge samples at 6 to 20 m depth. Two-way ANOVA results are summarized.

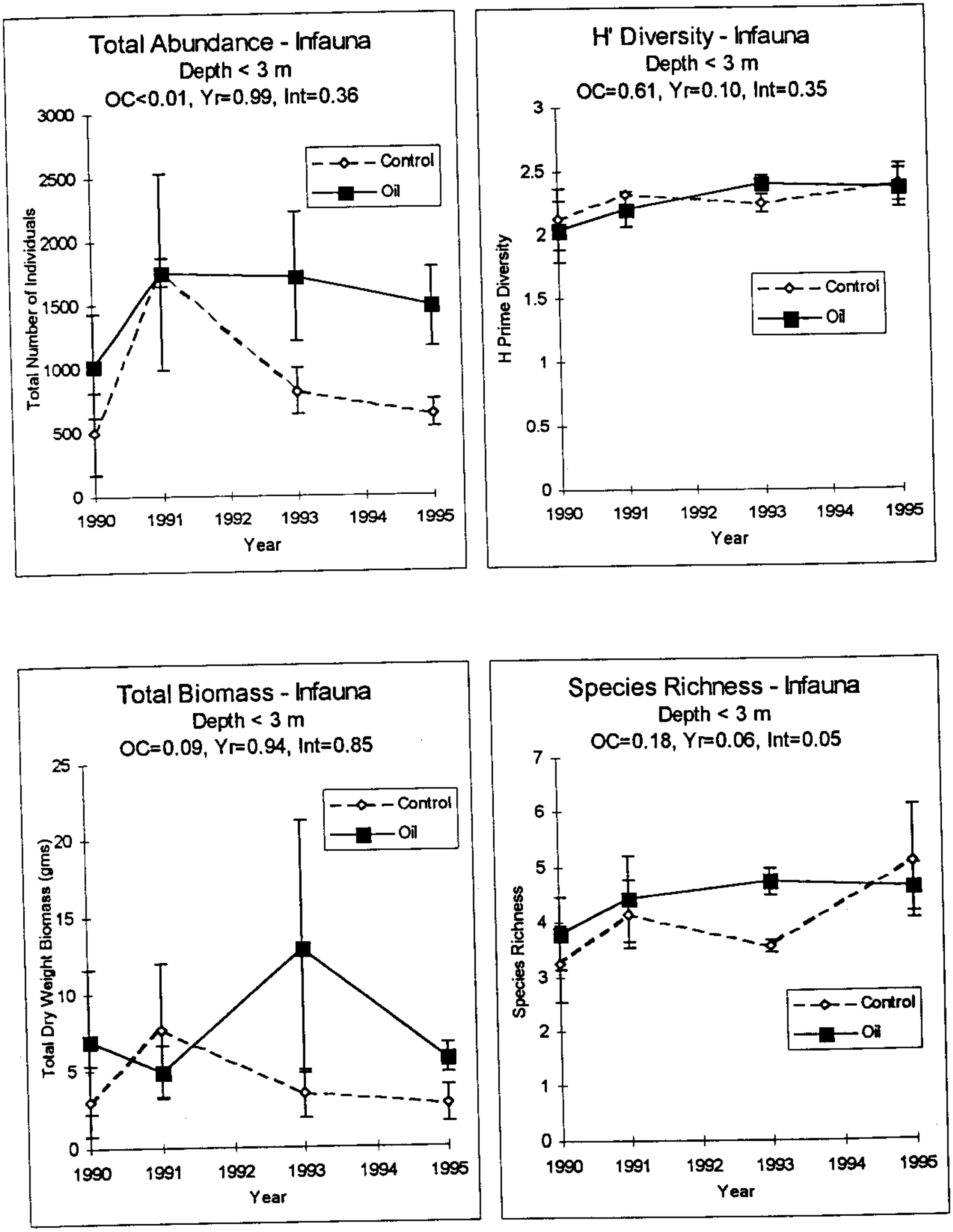


Figure 17. Community parameters (+/- 1 SE) for infaunal invertebrates from dredge samples at < 3 m depth. Two-way ANOVA results are summarized.

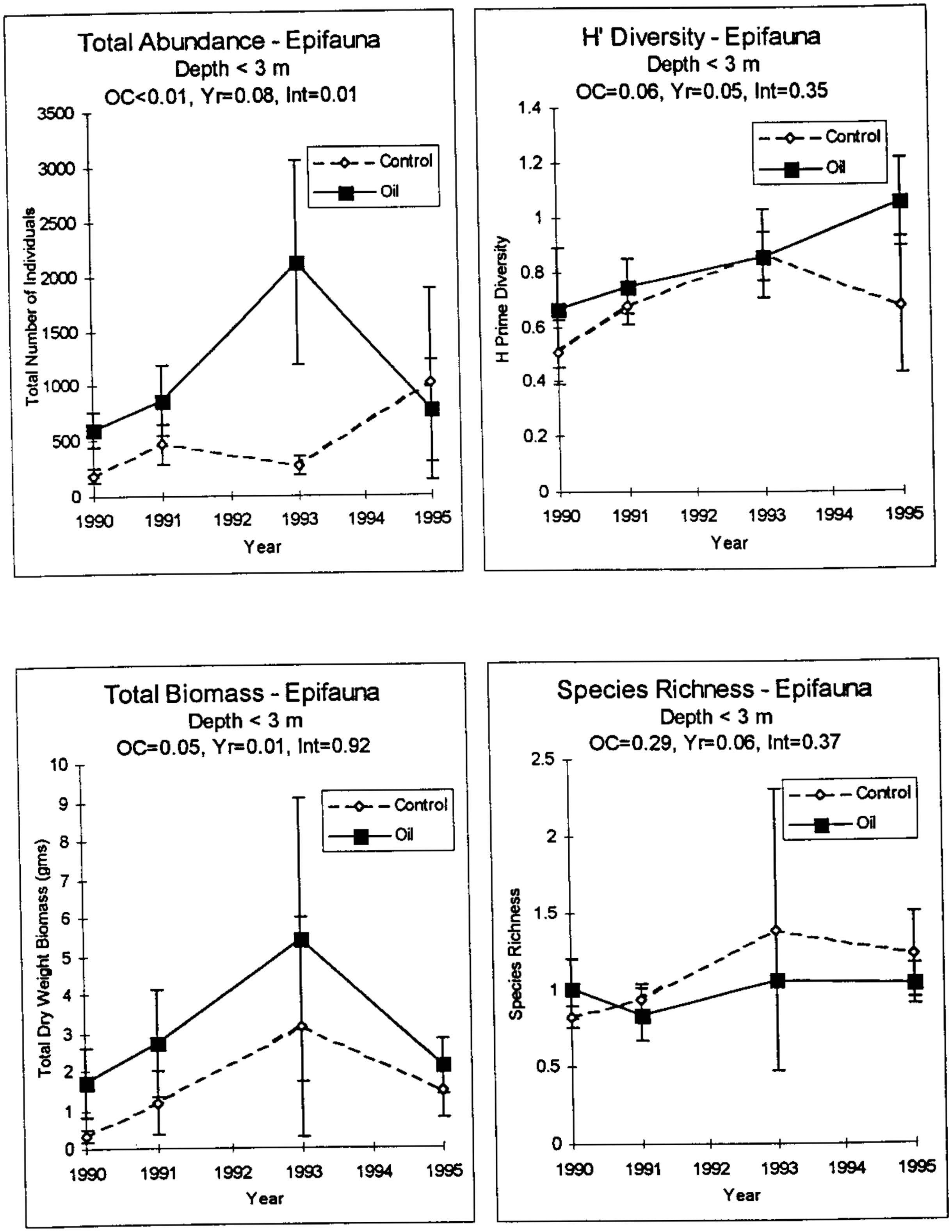


Figure 18. Community parameters (+/- 1 SE) for epifaunal invertebrates from dredge samples at < 3 m depth. Two-way ANOVA results are summarized.

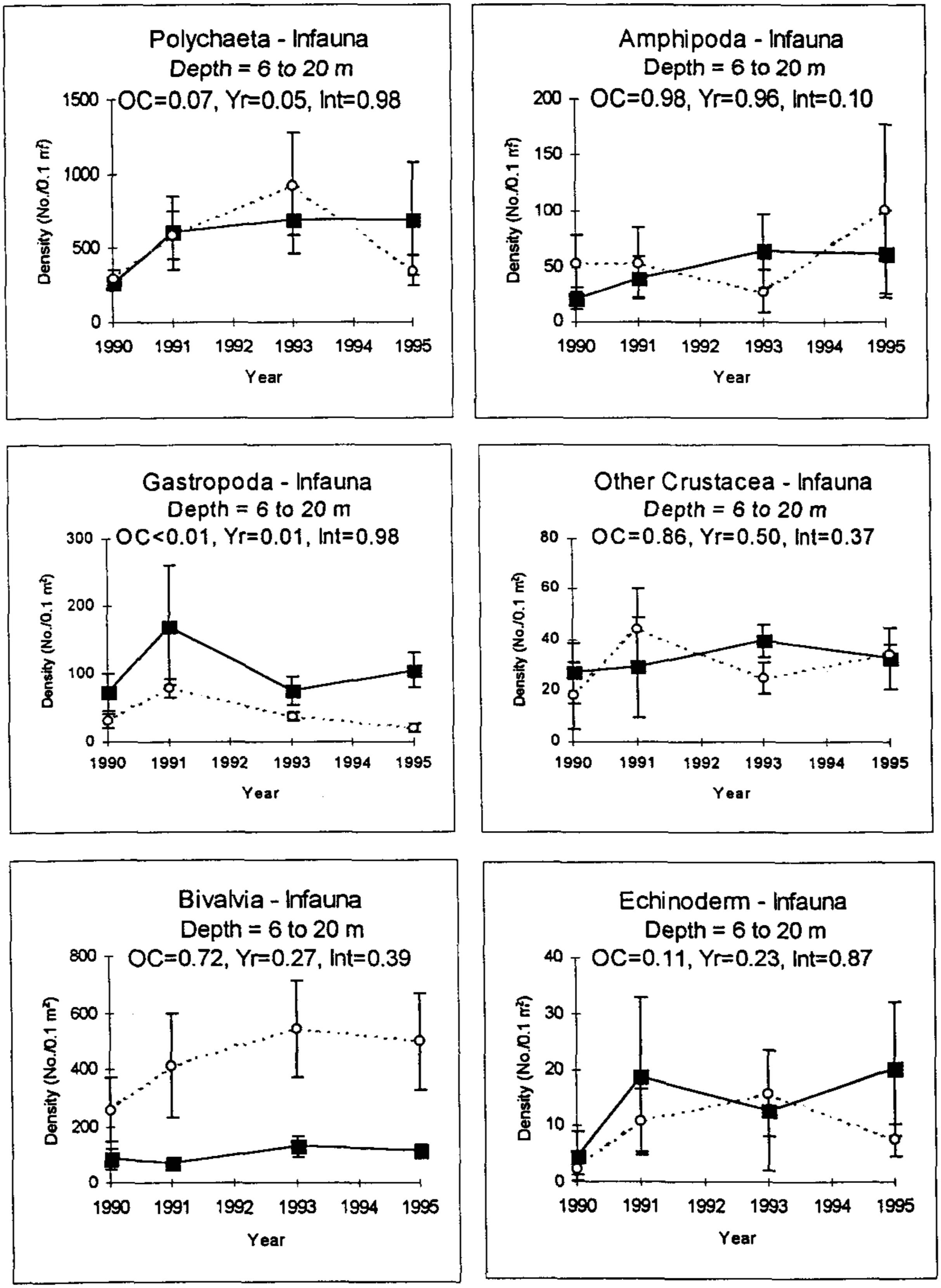


Figure 19. Mean density of major infaunal taxa (+/- 1 SE) in dredge samples from 6 to 20 m at paired oiled (solid line) and control (dashed line) sites. Two-way ANOVA results are summarized.

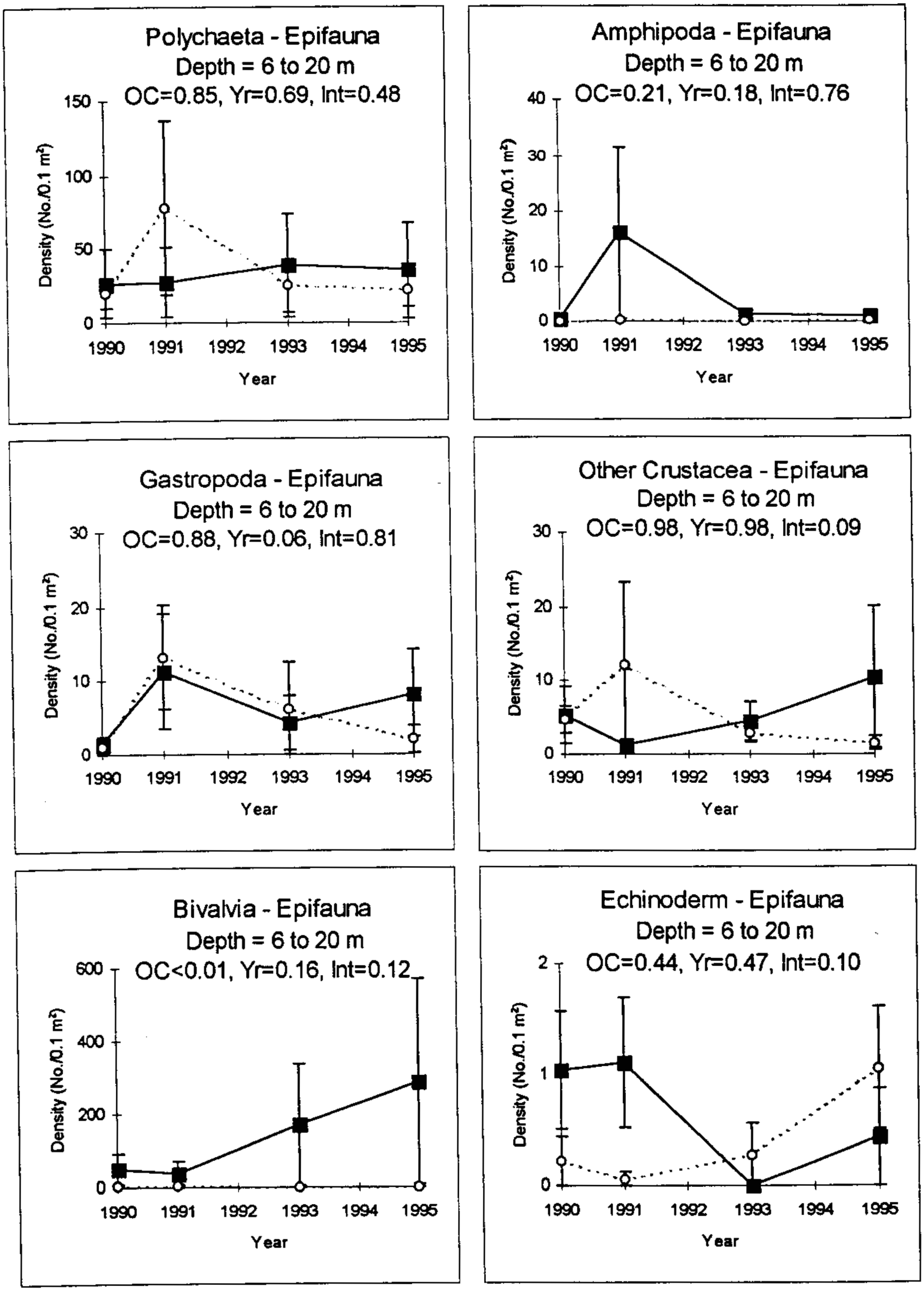


Figure 20. Mean density of major epifaunal taxa (+/- 1 SE) in dredge samples from 6 to 20 m at paired oiled (solid line) and control (dashed line) sites. Two-way ANOVA results are summarized.

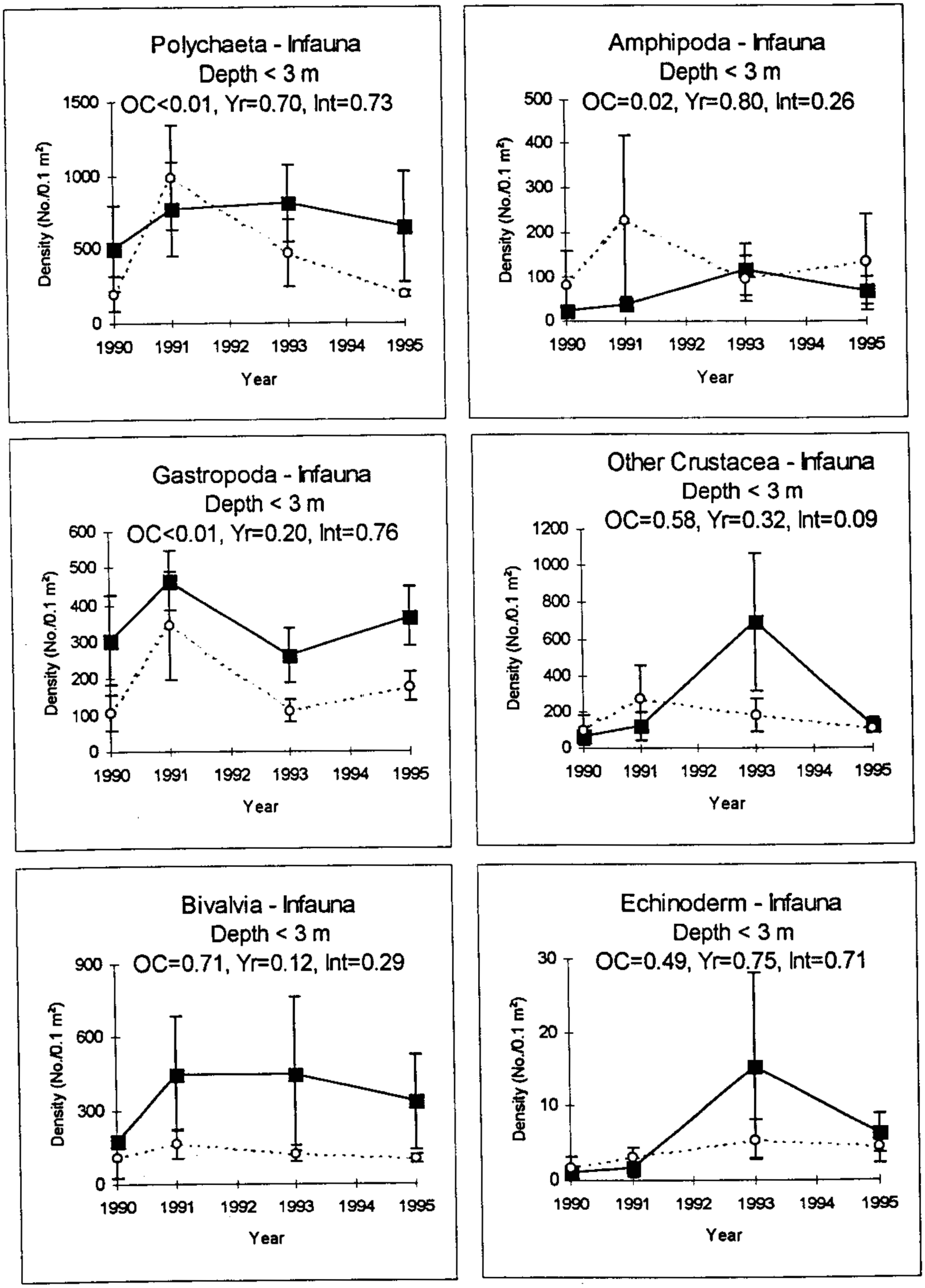


Figure 21. Mean density of major infaunal taxa (+/- 1 SE) in dredge samples from < 3 m depth at paired oiled (solid line) and control (dashed line) sites. Two-way ANOVA results are summarized.

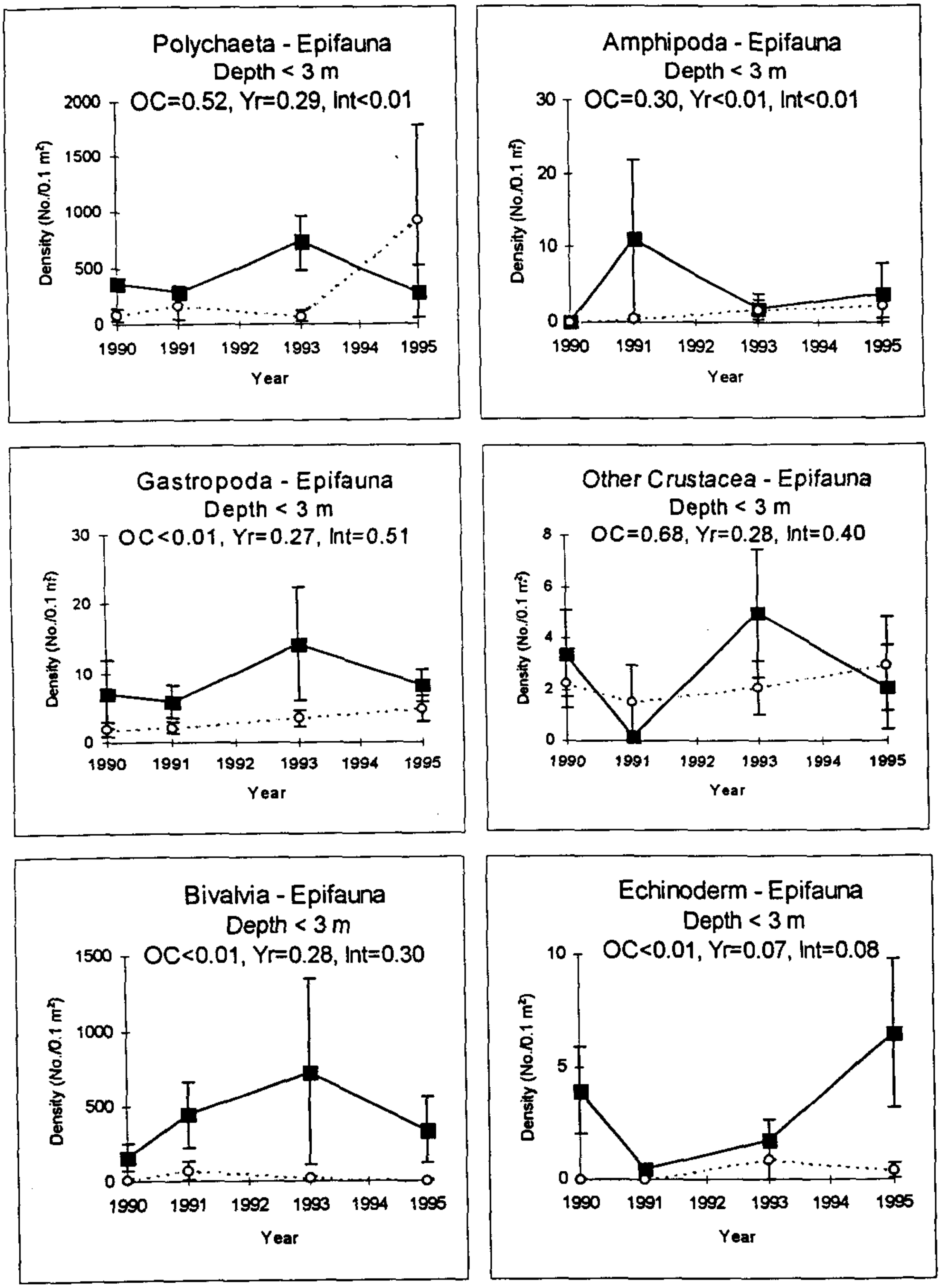


Figure 22. Mean density of major epifaunal taxa (+/- 1 SE) in dredge samples from < 3 m depth at paired oiled (solid line) and control (dashed line) sites. Two-way ANOVA results are summarized.

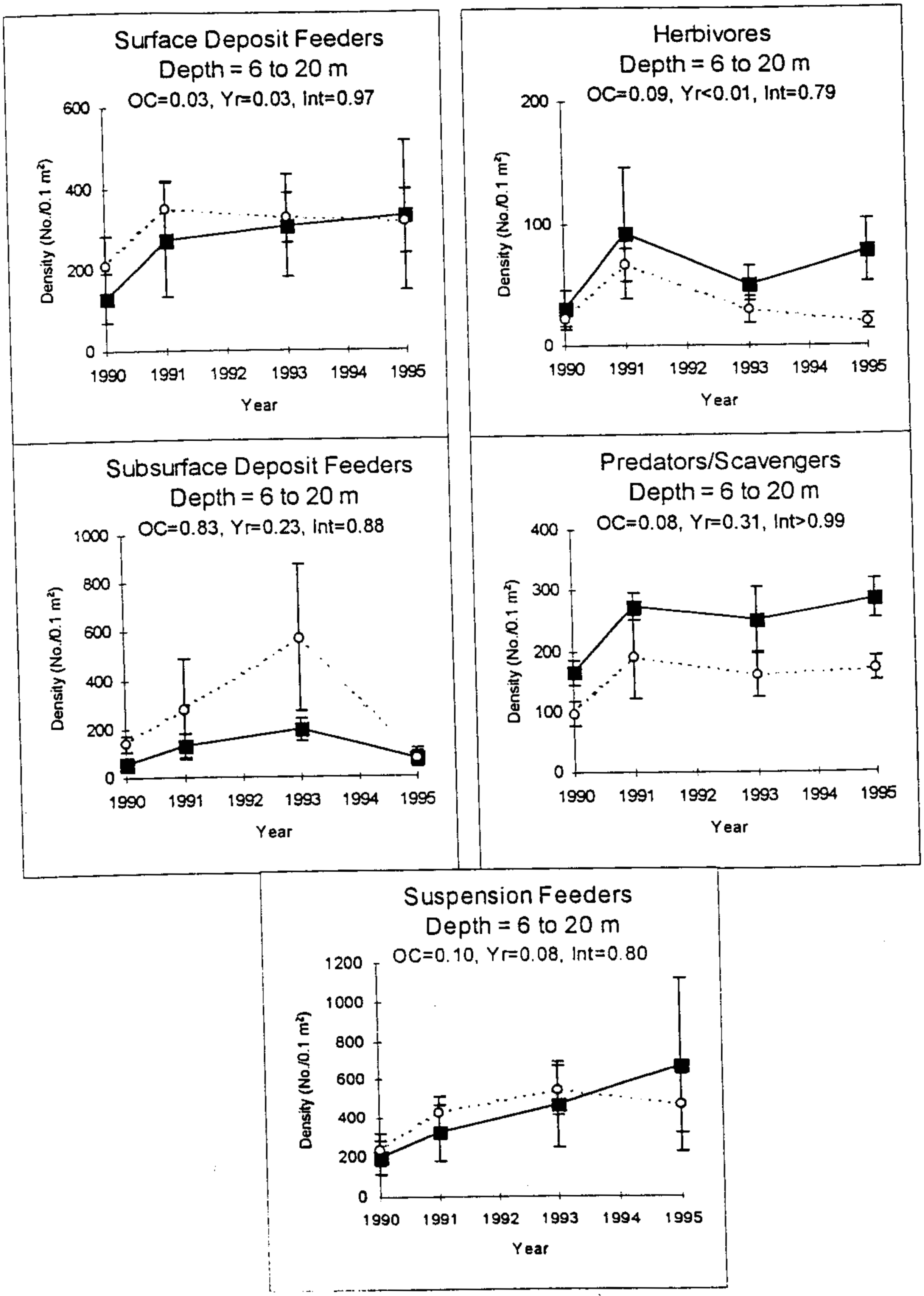


Figure 23. Mean density of five different feeding groups (+/- 1 SE) from paired oiled (solid line) and control (dashed line) sites at 6 to 20 m depth. Two-way ANOVA results are summarized.

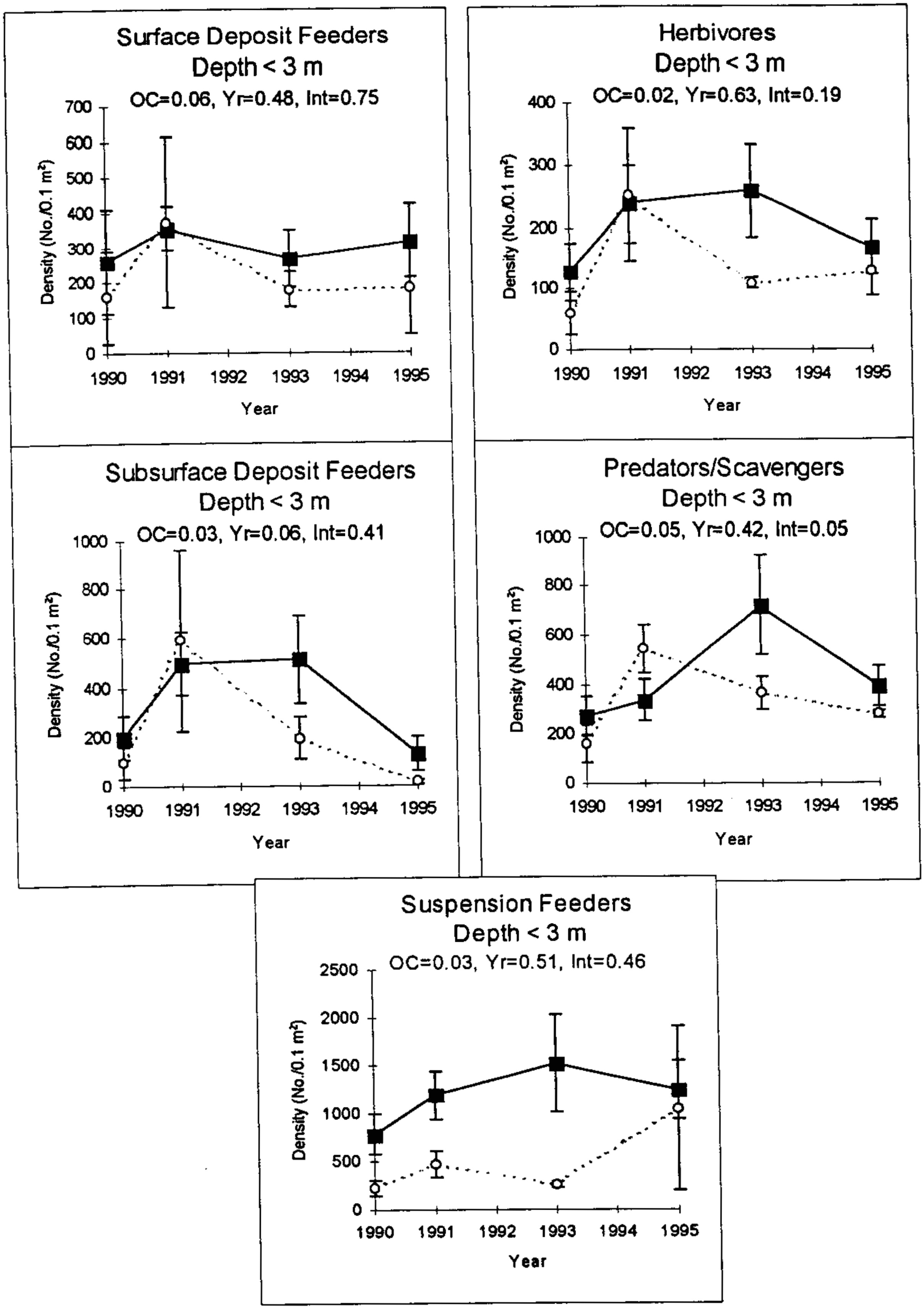


Figure 24. Mean density of five different feeding groups (+/- 1 SE) from paired oiled (solid line) and control (dashed line) sites at < 3 m depth. Two-way ANOVA results are summarized.

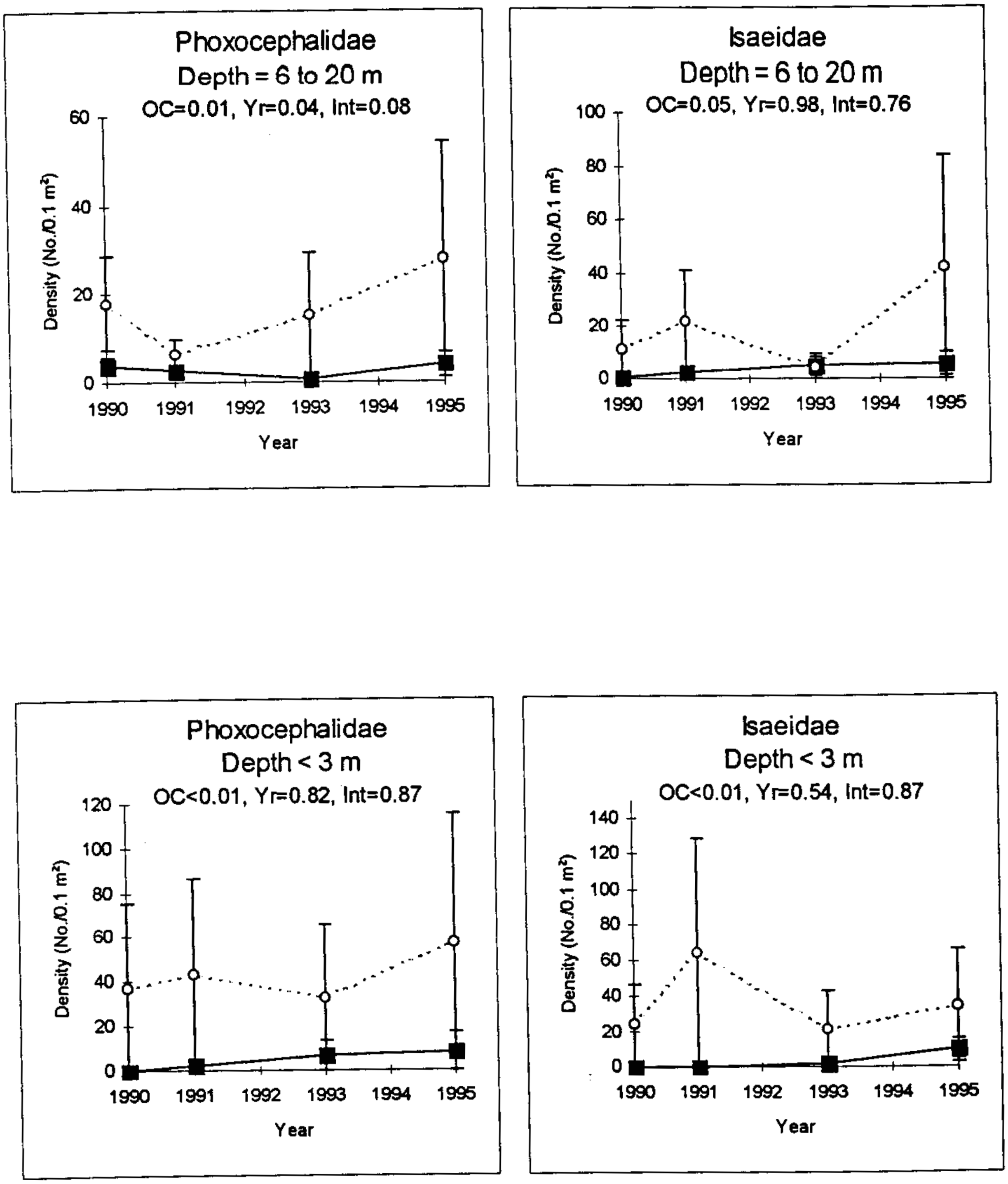
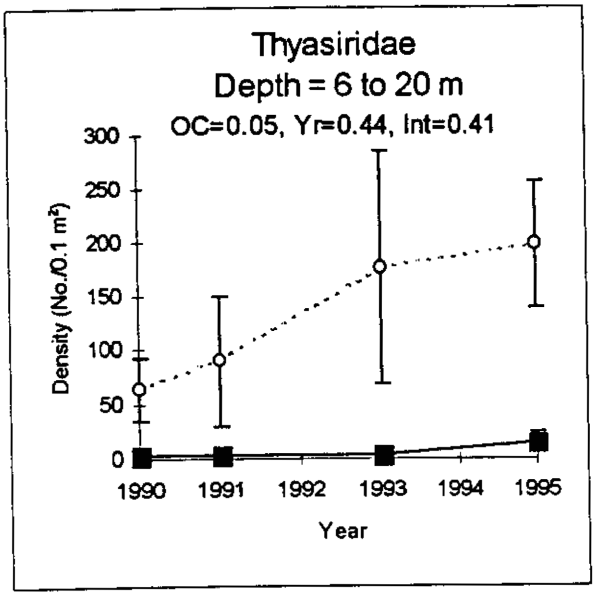
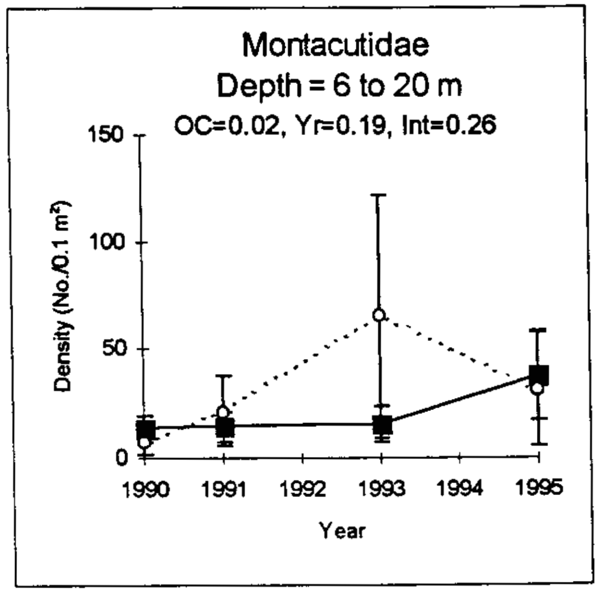


Figure 25. Mean density of dominant families of amphipods (Phoxocephalidae and Isaeidae) (+/- 1 SE) in dredge samples at paired oiled (solid line) and control (dashed line) sites. Two-way ANOVA results are summarized.





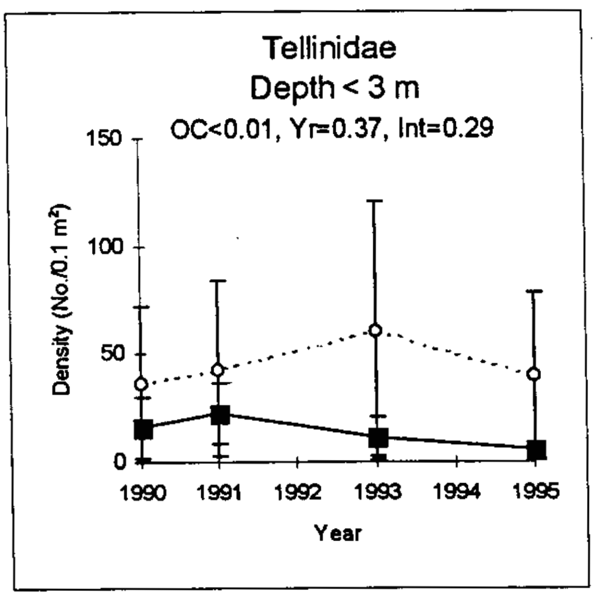


Figure 26. Mean density of dominant families of infaunal bivalves (Thyasiridae, Montacutidae and Tellinidae) (+/- 1 SE) in dredge samples at paired oiled (solid line) and control (dashed line) sites.

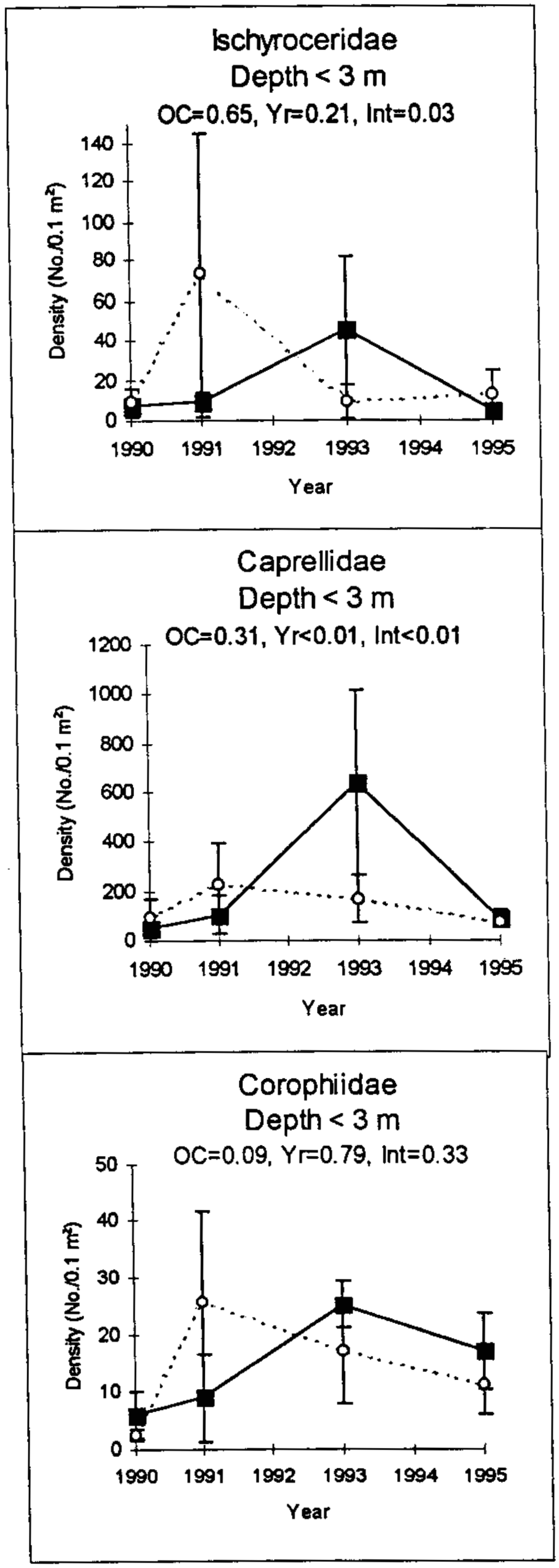


Figure 27. Mean density of dominant amphipods (Ischyroceridae, Caprellidae and Corophiidae) (+/- 1 SE) in dredge samples at paired oiled (solid line) and control (dashed line) sites. Two-way ANOVA results are summarized.

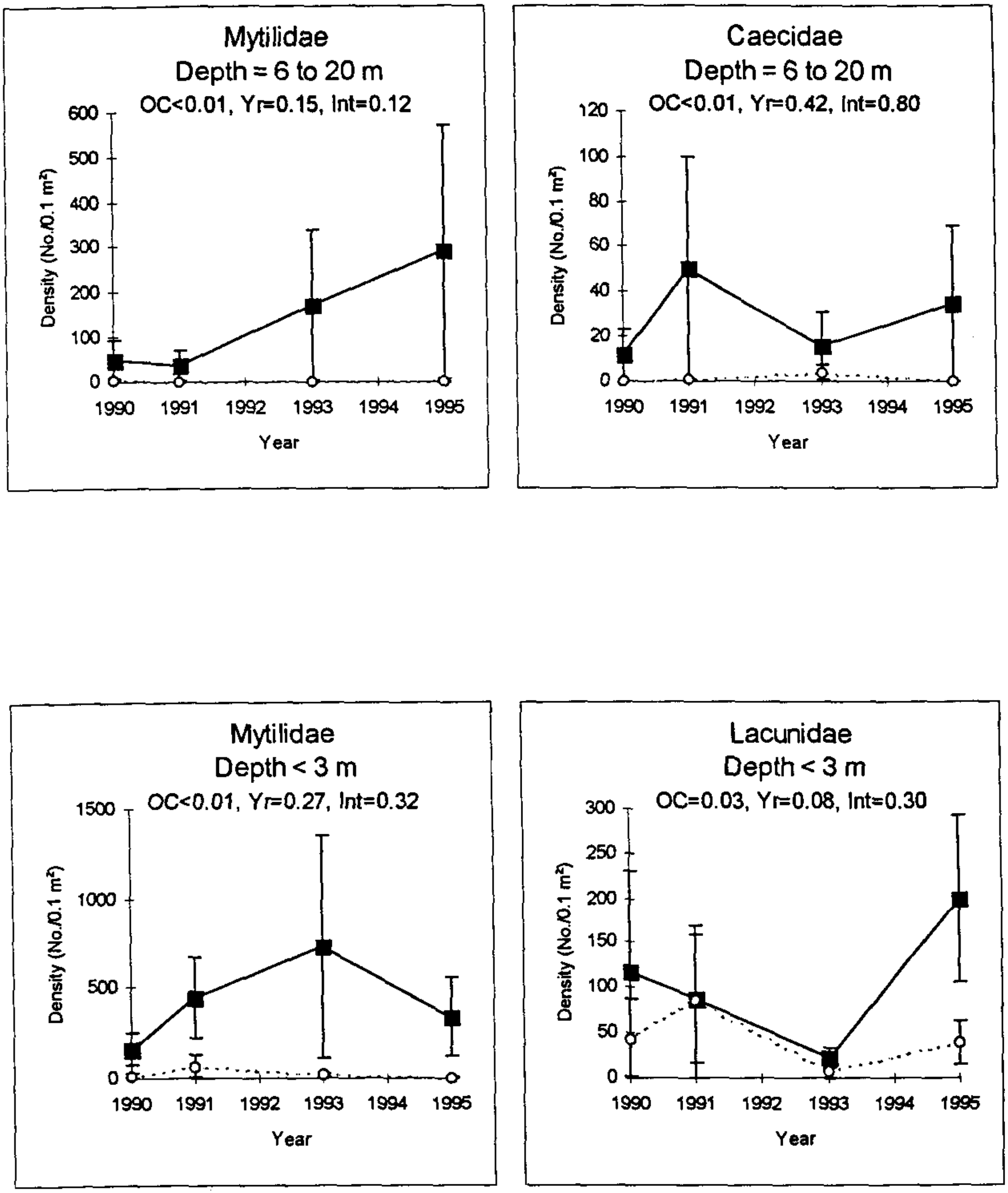


Figure 28. Mean density of dominant families of infaunal gastropods (Caecidae and Lacunidae) and epifaunal bivalves (Mytilidae) (+/- 1 SE) in dredge samples from paired oiled (solid line) and control (dashed line) sites.

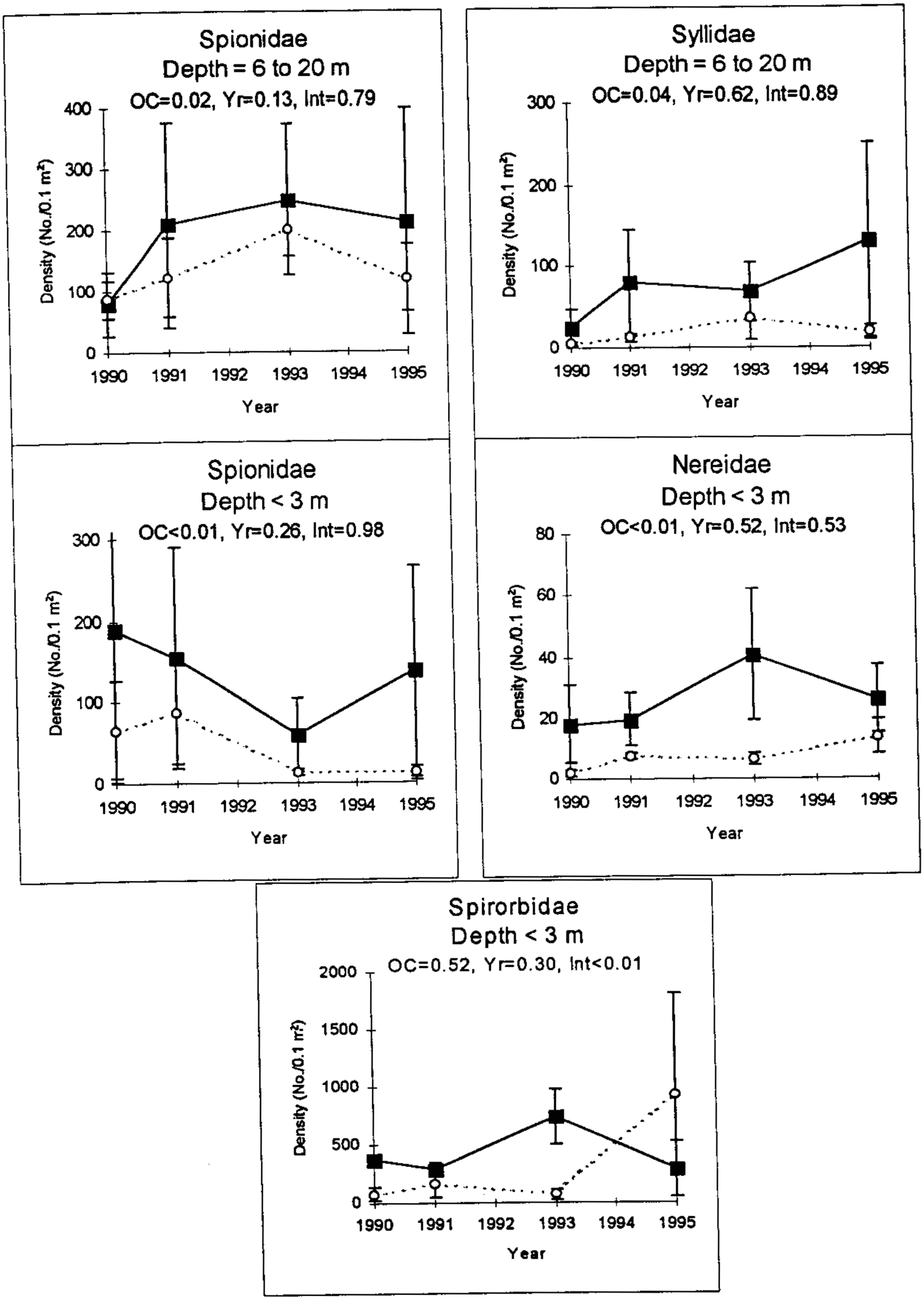


Figure 29. Mean density of dominant polychaete families (+/- 1 SE) at paired oiled (solid line) and control (dashed line) sites. Two-way ANOVA results are summarized.

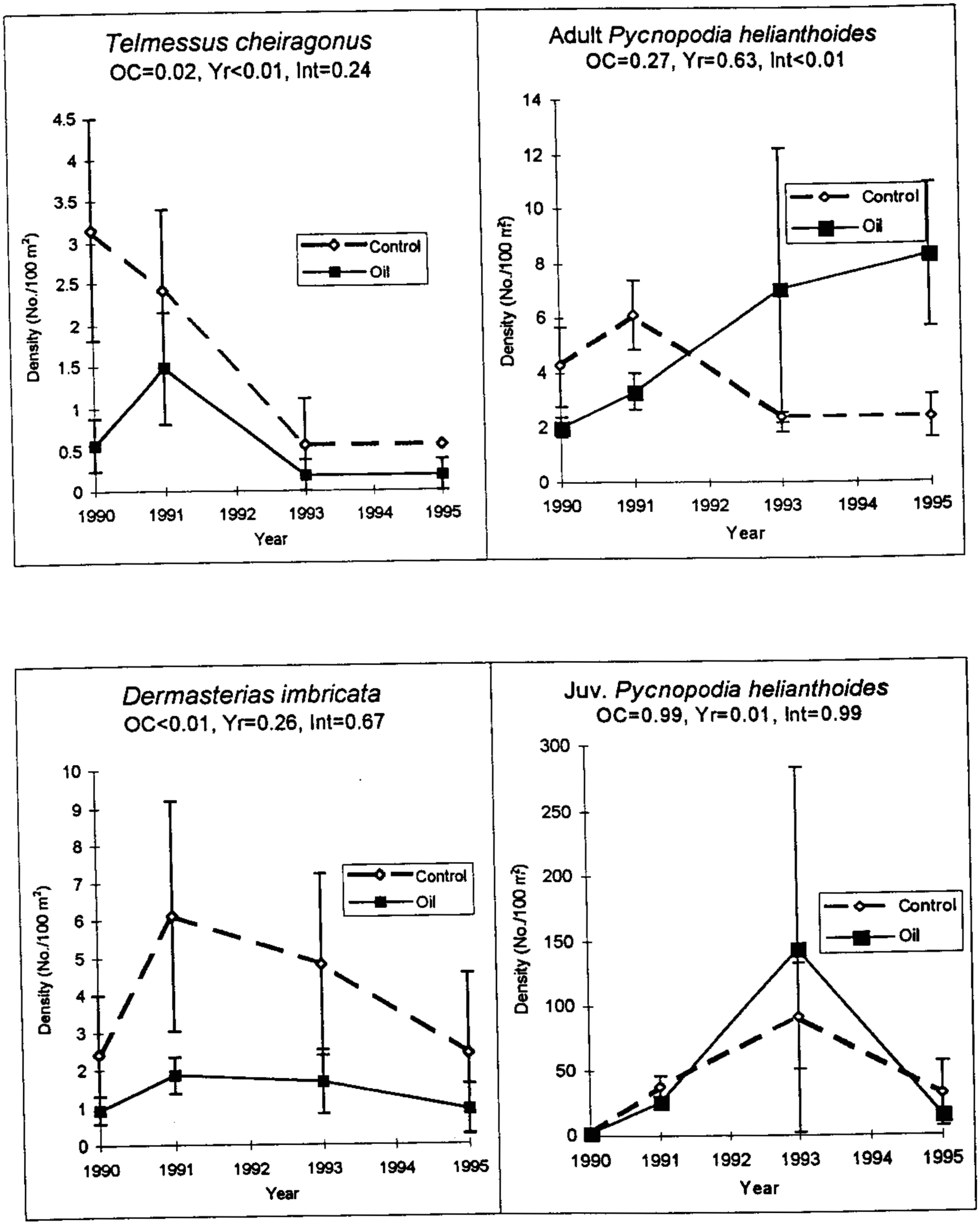


Figure 30. Mean density of Telmessus cheiragonus, Dermasterias imbricata and large (>10 cm) and small (< 10 cm) Pycnopodia helianthoides (+/- 1 SE) at paired oiled (solid line) and control (dashed line) sites.

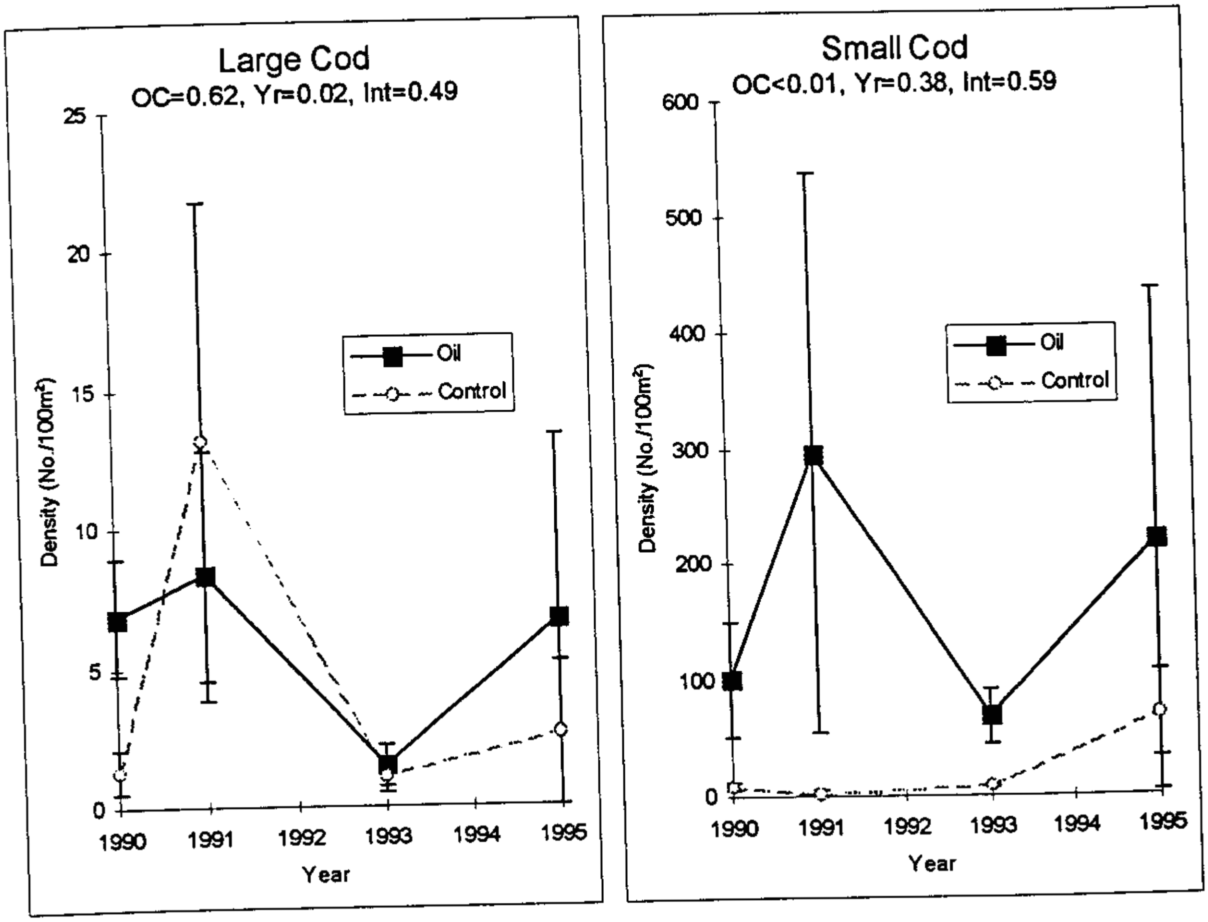


Figure 31. Mean density of small (< 15 cm) and large (> 15 cm) cod (+/- 1 SE) at paired oiled and control sites. Two-way ANOVA results are summarized.

Appendix A.

A comparison of analyses conducted with three vs. four or five site pairs in 1990 and 1991.

Appendix Table A-1. A comparison of analyses using three site pairs *vs.* four or five site pairs in 1990 and 1991.

● = greater at oiled sites
O = greater at control sites
X = significant difference exists

●●●, OOO, XXX = $P \leq 0.01$
●●, OO, XX = $0.01 < P \leq 0.05$
●, O, X = $0.05 < P \leq 0.1$
– = $P > 0.1$

	1990		1991	
	3 Pairs	4 Pairs	3 Pairs	5 Pairs
EELGRASS				
Turions	–	O	OO	–
Flowering Turions	O	O	–	–
INFAUNA (6 to 20 m depth)				
Polychaeta				
Ampharetidae	O	–	–	–
Amphictenidae	OO	–	–	–
Capitellidae	–	–	–	–
Lumbrineridae	–	–	–	
Maldanidae	●●	●●	●	●
Nephtyidae	–	–	–	–
Opheliidae	–	–	–	–
Orbiniidae	–	–	–	
Sabellidae	●●	–	–	–
Sigalionidae	OOO	O	–	–
Spionidae	–	●	●	●
Syllidae	–	–	–	–
Bivalvia				
Lucinidae	–	–	–	–
Montacutidae	–	–	–	–
Tellinidae	–	–	–	–
Thyasiridae	–	–	–	–
Gastropoda				
Caecidae	–	OO	–	–
Olividae	●	–	–	
Rissoidae	–	–	–	–
Crustacea				
Oedicerotidae	–	–	–	–
Isaeidae	–	–	–	–
Phoxocephalidae	OO	–	OOO	–
Echinodermata				
Ophiuroidea	–	–	–	–
SMALL EPIFAUNA (6 to 20 m depth)				
Polychaeta				
Spirorbidae	–	–	–	–
Bivalvia				
Mytilidae	●●	–	●●●	–

Appendix Table A-1 (continued). A comparison of analyses using three site pairs *vs.* four or five site pairs in 1990 and 1991.

● = greater at oiled sites
○ = greater at control sites
X = significant difference exists

●●●, ○○○, XXX = $P \leq 0.01$
●●, ○○, XX = $0.01 < P \leq 0.05$
●, ○, X = $0.05 < P \leq 0.1$
– = $P > 0.1$

	1990		1991	
	3 Pairs	4 Pairs	3 Pairs	5 Pairs
INFAUNA (< 3 m depth)				
Polychaeta				
Amphictenidae	–	–	–	–
Capitellidae	–	–	–	–
Nereidae	●●	–	–	–
Opheliidae	–	–	–	–
Polynoidae	–	–	–	–
Sabellidae	●	–	–	–
Sigalionidae	–	–	–	–
Spionidae	●●	●	–	–
Syllidae	–	–	–	–
Bivalvia				
Montacutidae	–	–	–	–
Tellinidae	–	–	–	–
Turtoniidae	N/A	N/A	–	–
Gastropoda				
Lacunidae	–	–	–	–
Rissoidae	–	–	–	–
Trochidae	–	○○○	○○	○○○
Crustacea				
Corophiidae	–	–	○	○
Ischyroceridae	–	–	–	–
Isaeidae	○	○	○○	○○
Phoxocephalidae	○○○	○○○	○○○	–
SMALL EPIFAUNA (< 3 m depth)				
Polychaeta				
Spirorbidae	●●●	●●	●●●	–
Bivalvia				
Mytilidae	●●●	●●●	●●●	–
Crustacea				
Caprellidae	–	–	–	–
LARGE EPIBENTHIC INVERTEBRATES				
Pycnopodia (>10 cm)	–	○	–	–
Pycnopodia (<10 cm)	–	○	–	○
Telmessus	○○	–	–	○
Dermasterias	–	○	○	–

Appendix B.

Standard operating procedure for field activities in the shallow subtidal eelgrass habitat in Prince William Sound, Alaska, 1990.

Appendix B. Standard operating procedure for field activities in the shallow subtidal eelgrass habitat in Prince William Sound, Alaska, 1990.

1.0. Definitions

Study site - An area of coastline to be sampled; study sites may be defined as moderate-heavily oiled, unoiled (control).

Site baseline - A line connecting the endpoints of the study site, approximately 200 m long.

Station transect - A line perpendicular to the site baseline extending from the 0 tide depth out to a depth of 20 m, at locations selected randomly within a study site. There are three station transects along a site baseline.

Depth strata - Subsets of the site in various depth ranges.

Sampling depth - Randomly selected points in the depth strata on a station transect.

Sampling transect - A 30-m line following the contour to the right of a station transect along which subtidal sampling is conducted.

Quadrat - A 0.25 m^2 (0.5 m by 0.5 m) plot for photography and plant studies randomly located along a sampling transect; also, a 0.1 m^2 plot for infaunal studies randomly located along a sampling transect.

2.0. Preliminary Study Site Selection

Eelgrass - Sites where eelgrass is present within the PWS area were identified by Kim Sundberg, Rick Rosenthal, and the NOAA staff of Chuck O'Clair and Stanley Rice. Oiled eelgrass beds were selected that were indicated as moderately to heavily oiled (along at least 1/2 km of shoreline) on both July and September oil maps. This resulted in 9 potential sites. One of these (Perry Island) was eliminated from consideration because there was no adequate control. The other 8 were placed into 3 groups: Group 1 are bowls on the eastern side of the islands, with mouths facing North (site # 2 on Naked Island, site # 3 on Latouche Island, and site # 7 in Snug Harbor). Group 2 is in the northwest quadrant of the Knight Island group (#3 on Disk Island and #'s 4 and 5 in Herring Bay). Group 3 are sites within Bay of Isles (8 and 9). Order of preference for sampling of sites within groups was determined based on the presence of DEC/NOAA sampling sites used in 1989. If hydrocarbon samples were taken at all sites within a group, then sites were selected at random. These were as follows:

Area	Selected	Alter. 1	Alter. 2
Bowls	6	7	2
NW	5	3	4
Bay of Isles	9	8	

Control sites were selected that were not oiled on both the July and September oil maps, that were in the same geographic region, and were of similar aspect and exposure. The control site for the Bay of Isles site was in Drier Bay.

3.0. Study Site Confirmation and Site Descriptions

Site confirmation - An aerial and ship based survey of all potential study sites was made in April, 1990. Tom Dean, Rick Rosenthal, and Dave Laur flew the Sound, examined each site from the air to insure that habitat types were correctly defined and that control sites resemble oiled sites with regard to geomorphology. Sites accessible by float plane were visited. Some study sites were marked with a pink paint mark on the shore line. Other sites have distinguishing features that allow sites to be identified. Photographs and/or videos were taken of each site. Those sites inaccessible by plane were visited by Tom Dean and Troy Tirrell aboard a boat.

Site Descriptions - A description of each site follows.

Site # 13 - Bay of Isles. This is an oiled *Zostera* (eelgrass) site. It is located within ADEC segment # KN0202-A. Site center is 100 m east of a salmon stream, along the southern shore of the western arm of the bay. The substrate is small cobble and silt. No site marks were made.

Site # 14 - Drier Bay (Northeast cove). This is a control *Zostera* (eelgrass) site. It is located within ADEC segment # KN0575-A. Site center is 100 m west of the western most of 2 salmon streams along the southern shore of the cove. Substrate is mixed cobble with softer silt sediment. No site marks were made.

Site # 15 - Lower Herring Bay. This is a control *Zostera* (eelgrass) site. It is located within ADEC segment # KN0551-A. Site is at the mouth of a salmon stream near the northern extreme of the western arm of the bay. No site mark was made. Site center is the salmon stream. The substrate is cobble with silt.

Site # 16 - Herring Bay. This is an oiled *Zostera* (eelgrass) site. It is located within ADEC segment # KN0132B. Site is at the mouth of a salmon stream about 2/3 of the way into the bay on the western shore. Rebar that are painted pink mark an ADEC underwater transect. A site marker (flashing) was placed on a fallen tree just to the north of the site. The substrate at the site is cobble with silt.

Site # 17 - Sleepy Bay, Latouche Island. This is an oiled *Zostera* (eelgrass) site. It is located within ADEC segment #'s LA017-A - LA018-A. Site is in the southern most part of the bay, at the mouth of a salmon stream. The site center is the mouth of the salmon stream. Rebar that are painted pink mark an ADEC underwater transect. No site marks were made.

Site # 18 - Moose Lips Bay - Northeast Montague Island. This is a control *Zostera* (eelgrass) site. Site is in a small embayment due east of the Northern tip of Little Green Island. There are 2 salmon streams at this site. The southern most is an active stream. The northern most dead ends in a marsh behind the cobble berm. The site center is marked with a small buoy placed off the northern most stream, about 200 m from shore. The substrate is mostly silt and sand with some cobble.

4.0 Stratified Sampling in Eelgrass Habitat

4.1 Station Setup

A. All eelgrass sampling sites will be marked with a single paint mark on the shore at the center of the site. Set sampling locations as follows: Locate the center marker of the study site. Drop buoys approximately 100 m to either side of the marker. Drop the buoys so that an imaginary line connecting them is parallel to the site baseline, just offshore of any visible eelgrass. Snorkeling may be required to identify the outer margin of the eelgrass bed. Start the skiff approximately 30 m to the right of the right buoy and approach the buoy at a constant rate of speed. (Determine left versus right when facing the site from the sea). Record the time required to cover the distance from approximately 30 m from the right buoy to the left buoy. Do not vary the speed of the boat during this operation and maintain a constant distance from shore.

B. Divide the time by 3 (e.g., 7.2/3 = 2.4 Min). Select a random number on the calculator and multiply the two values (e.g., 2.4 X 0.8978 = 2.15 min). Add (Total Time)/3 to the result and 2 (Total Time)/3 to the result. For example, 2.15 min, 2.15+2.4 = 4.55 min, and 4.55+2.4 = 6.95 min are the random starting points at which to start the station transects when measured from the left hand side and traveling at the same speed. Buoys to mark the starting point of each station transect will be dropped at 2.15 min, 4.55 min, and 6.95 min when measured from the left hand side of the site.

C. At each station, a small boat will be driven seaward from nearshore along a course perpendicular to the site baseline, dropping marker buoys at randomly preselected depths in each of the depth strata. The original buoy marking the station transect will be retrieved after the marker buoy is dropped in the first depth stratum. The protocol for random selection of positions for the buoys is: (1) for each station transect select a random number (proportion) between 0.0 and 1.0, (2) multiply the range of depth in each strata by the proportion. For example, if the random proportion is 0.35, the depth (D) in the two depth strata would be:

3-6 m	D = 0.35 x 9 m + 2 m = 5.2 m
6-20 m	D = 0.35 x 9 m + 11 m = 16.2 m

All depths should be corrected to mean low low water using output from TIDE1 software for the region closest to the sampling site. A schematic of a hypothetical site layout is presented in Appendix Figure B-1.

Divers #1 and 2 enter at the buoy on the outer margin of the eelgrass bed and drop to the buoy anchor. They then swim a tape from the buoy on a compass course perpendicular to shore until no more eelgrass is observed. The distance from the buoy to the inner margin of distribution eelgrass is recorded. The divers then swim back the tape to 1/2 the distance to the buoy and mark the station with a pop float. This process is repeated for each transect station, establishing 3 stations per site in the center of the distribution of eelgrass.

4.2 Sampling Fish

Two divers swim to the bottom at the deepest of the two marker buoys. Diver # 1 attaches a 30 m fiberglass transect tape to the anchor and swims a 30 m isobathyal sampling transect to the right (facing shore). The diver visually counts fish, by species, within 2 m of the transect line and within 3 m of the bottom. Non-cryptic specimens of echinoderms and crustaceans larger than 10 cm will also be counted in this 2 m by 30 m band.

Diver # 2 swims along the sampling transect from the buoy anchor recording a 2 m by 30 m video transect pointing the camera down toward the substrate.

After a 2 minute wait 3 m off the end of the transect, the divers swim side by side with the transect line between them, each diver counting the number of benthic fishes within a 1 m band on their side of the transect tape. An attempt will be made to count all individuals of length 5 cm or larger.

Following completion of the deepest transect the two divers will move up to the next shallowest marker buoy and repeat the procedure. Identical procedures as described above for the deepest sample transect will be followed at the sample stations in the shallower depth strata.

4.3 Sampling Eelgrass

Eelgrass will be sampled only along the sampling transect that lies within the eelgrass zone. Divers #3 and 4 will harvest all eelgrass from each of the 4 0.25 m^2 quadrats per depth stratum. The turions of the plants will be cut approximately 1 cm above the sediment surface. The plants will be bagged underwater and returned to the boat. There, the number of turions per quadrat will be counted, and all turions in each quadrat weighed. In addition, we will note the number of flowering stalks per quadrat, and count the number of seeds per stalk in the first 10 seed stalks encountered per quadrat.

4.4. Sampling Infaunal Invertebrates

Infaunal invertebrates will be sampled in a 0.1 m^2 airlift sample from each of first two quadrats per station transect. Station transects to be sampled include both those within the eelgrass zone and those outside of the eelgrass. Two divers will go to a sampling transect which still has the 30 m tape. Within the bed Diver #5 swims the tape until reaching the first two 0.25 m^2 quadrat frames left from sampling eelgrass. The 0.1 m^2 dredge samples will be taken from the upper left hand corner of each quadrat (determined while facing the shore). Diver #5 then vacuums all material within the 0.1 m^2 frame, to a depth of 10 cm, using an airlift sampler. Diver #5 then swims to the second 0.25 m^2 quadrat and repeats the procedure. On transects outside the bed, two 0.1 m^2 quandrats are placed at predetermined randomly-selected distances along the 30 m transect. (Only 2 small quadrats are sampled for benthic infauna at each station transect). On board ship all airlift samples will be preserved in 10% buffered (using sea water) formalin.

4.5. Sediment Samples

Sediments will be collected from each depth stratum at each study site. All samples will be taken from the second of three sampling stations, located approximately in the middle of each sampling site. SCUBA divers will collect the sediment samples in pre-cleaned, wide-mouth 4 oz. jars. Diver #6 will take two sample jars into the water, cracking the jars' lid just below the water surface, and proceeding to the bottom at each sampling site. There, the jar's lid will be removed and the jar will be used to scoop sediment to a depth of approximately 5 cm. A 10 to 100 g sample of sediment will be obtained at each sampling location. The samples will be taken from within 3 m of the buoy anchor marking each sampling station when possible. If the sediment can not be collected near the buoy, samples will be taken at the closest adjacent patch of loose sediment. After Diver #6 collects sediment samples he then rolles up the tape and collects the 0.25 m^2 quadrats (only in the eelgrass bed) on the return swim.

One of the collected samples will be used to determine hydrocarbon levels and the other to determine sediment composition and carbon isotope ratios. All hydrocarbon sediment samples will be numbered sequentially, labelled, sealed with evidence tape, signed, and frozen on board. At the end of the field season, all hydrocarbon sediment samples will be sent to the Technical Services

Task Force, Analytical Chemistry Group (TSTF-ACG), NOAA/NMFS, Auke Bay, Alaska for processing. Hydrocarbons will be extracted from the sediment samples and analyzed for the concentration of various hydrocarbon fractions using gas chromatography combined with a mass spectrometer detector (GC-MS).

The samples to be used for the determination of grain size and carbon isotope ratios will also be numbered, labelled, and frozen aboard the ship. These will then be shipped to the University of Alaska Fairbanks for analysis. In the laboratory each of these samples will be split into two subsamples. One fraction will be used for analyses of grain size and the other for the analysis of organic carbon stable isotope ratios.

Sediments will be analyzed for their grain sizes by the usual pipette-sieve method, and the sediment types and grain size distributions defined statistically following the conventional grain size parameters stated in Folk (1980).

4.6. Physical Measurements

Salinity and temperature will be measured at the middle sampling transect within each depth stratum. Measurements will be made at depths of 0.5 m below the surface, 2 m below the surface, and 0.5 m above the bottom using a YSI temperature/salinity meter.

5.0. Special Notes on Sample Collection for Sediments, Water, and Fish

5.1. Collecting Fishes for Food Habits, Condition Factor and Hydrocarbon Concentration Studies

Following completion of the above sampling, a collection of fishes will be made to assess diets, condition factor, and maximize collection of two species: (1) a commonly occurring benthic feeding species (kelp or whitespotted greenling if possible) and (2) a commonly occurring midwater feeding species (dusky=planktivore or black=piscivore if possible). Twenty to 25 individuals of each species are desired from each site. Fish will be collected at sites at least 50 m from the nearest sampling transect if possible.

Techniques including diver spearing, hook and line fishing, and diver operated hand nets will be used in an attempt to collect fish.

Collected fishes will be measured (fork length) and weighed. Selected tissues and/or organs will be removed and treated as specified in the documents detailing collection and handling of samples for hydrocarbon analyses (State/Federal damage assessment plan, analytical chemistry, collection and handling of samples, August 9, 1989, Auk Bay Lab Attorney Work Product). Tissue samples and organ samples should consist of 1 g per fish for 15 fish. Their stomachs will then be excised and fixed in 10% formalin.

5.2. Collecting Sediment and Bottom Water Samples

Two samples of sediment will be collected at each station transect, 3 m to the right of the buoy anchor. One sample will be used to determine hydrocarbon levels and the other to determine grain size. The following protocol will be followed: Collect sediment by scooping directly into the opened sample container. Scoop to a 5 cm depth to obtain 10- 100 g of sediment (equivalently 4 oz. jars will be filled to just below the shoulder). If sediment is not readily available at the point then collect the closest available material, including small rocks and organic material, along the sampling transect avoiding the locations of study quadrats for plant and animal collections. After returning the jar to the surface, loosen the lid and pour off approximately 2 cm of water to allow room for expansion of the sample upon freezing. All sediment samples are to be numbered sequentially, tagged, logged, sealed with evidence tape, and frozen.

All samples collected in the procedures described above will be handled and documented as specified in the protocols for sample accountability and chain of custody.

6.0 Data Analysis

All data will be entered and stored in an "INGRESS" database at the University of Alaska, Fairbanks. Data analyses will be supervised by Dr. Lyman McDonald.

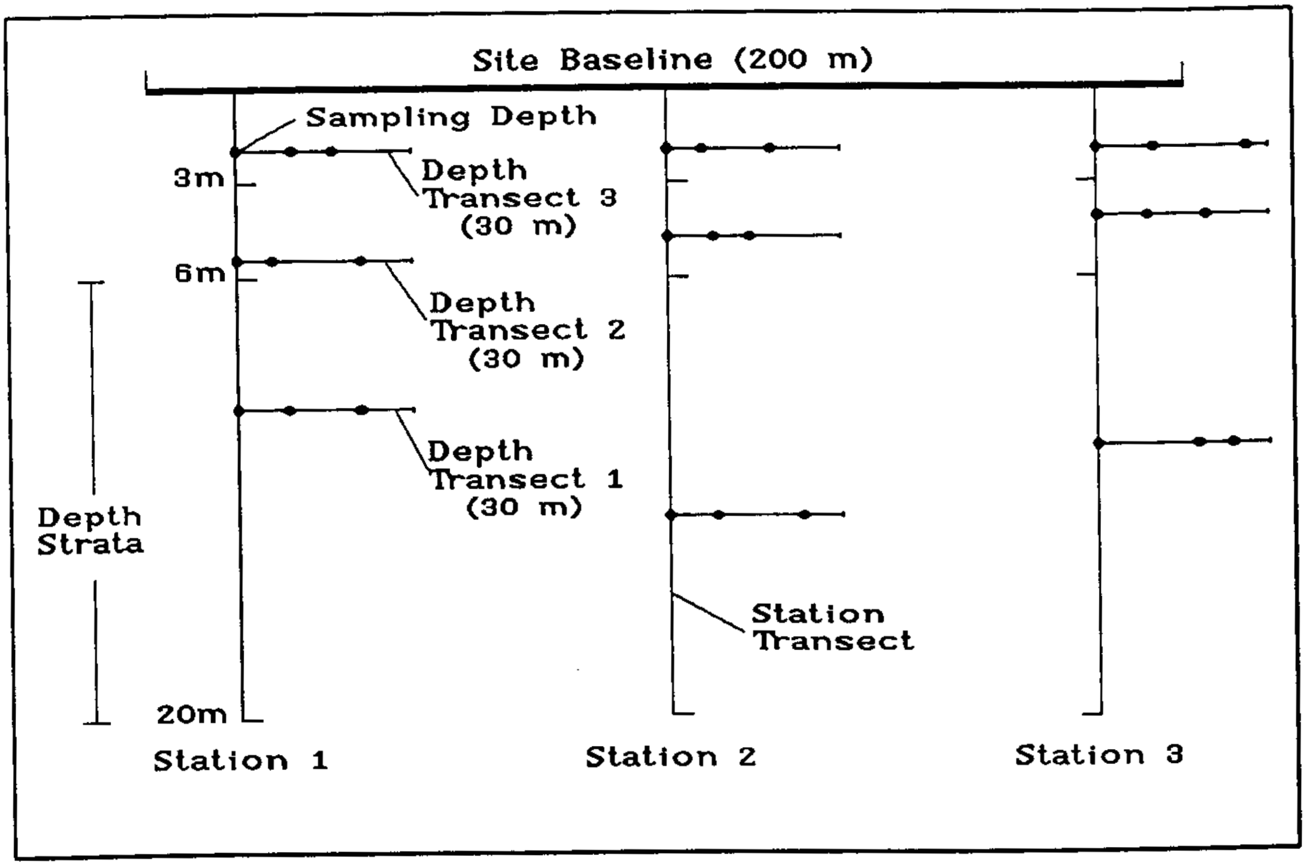
The generic form of analysis for all data gathered will be a comparison of oiled vs control sites using t-tests or nested analyses of variance. In studies where more than one site is sampled, sites will be the primary sampling unit, with various degrees of subsampling within a site. For some experimental studies, there will be no replication of sites, and the primary sampling unit will be stations within sites.

7.0 Schedule

The 1990 field schedule for the subtidal studies is given below.
Sampling schedule for 1990 subtidal studies in Prince William Sound.

```
1  Apr 1  May  1  Jun  1  Jul  1 Aug 1 Sep 1 Oct 1

   Recon.
   I----I
                Stratified Sampling
                      Eelgrass
                            I----I
```



Appendix Figure B-1. Hypothetical site layout for sampling in the eelgrass habitat.

Appendix C.

Standard operating procedure for laboratory treatment of benthic invertebrate samples from shallow subtidal habitats in Prince William Sound, Alaska, 1990,1991, 1993 and 1995.

Appendix C. Standard operating procedure for laboratory treatment of benthic invertebrate samples from shallow subtidal habitats in Prince William Sound, Alaska, 1990, 1991, 1993 and 1995.

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1. Chain-of-custody forms containing information on all samples received from the field operations are to be stored in a locked file cabinet in Room 118 O'Neill Building, UAF.

2. Preservative for all 0.1 m^2 airlift samples are immediately changed from formalin to 50 % isopropyl alcohol upon arrival in Fairbanks. Samples are then placed in a secure storage area at UAF. Samples are stored in white, air-tight, liquid-tight 5-gallon buckets appropriately labeled for contents. The samples, chain-of-custody forms and field notes containing additional sample-specific information must be retrieved from the locked file cabinet. These notes should be referred to when working up samples.

3. While working under the fume hood, rinse each sample with running water for a few minutes to remove alcohol. Samples should be washed onto a 1 mm-mesh screen and then placed on a sorting tray with sufficient water to cover the sample.

4. All rare, large (>1 cm) organisms are removed from the sample for processing later. The Laboratory Supervisor examines the remaining biota and associated material to determine if subsampling is warranted. If the amount of material to sort is more than one liter or if several thousand organisms are estimated to be present, necessitating numerous hours of processing, then a decision to subsample will be made.

5. Subsampling: Remove all large pieces of debris. Agitate the sample to insure that all animals are randomly dispersed in the pan. Evenly distribute (by spooning) debris among 16 jars (each jar is 6.25% of the whole). Between each spoonful, gently mix the debris to insure random distribution of organisms. To determine the appropriate number of subsamples, randomly select subsamples, count all organisms in each one and calculate the coefficient of variations for two subsamples, three subsamples, etc., through all sixteen subsamples if necessary. The least number of quadrats necessary to give a coefficient of variation 12.5% or less is an appropriate number of subsamples. The coefficient of variation expresses sample variability relative to the mean of the sample. This procedure will be carried out on all samples requiring subsampling. Subsample size (%) will be included on the Benthic Analysis Form for each taxon. For those rare, large organisms removed prior to subsampling the percent subsampled would be 100%.

6. For each sample or subsample, sort all animals to the family level of identification (except for organisms whose identity is known and those that dominate in density or biomass). Place each type into a petri dish of 50% isopropyl alcohol. Counts (see item 7) and blotted-dry wet weights (see item 9) are determined for each taxon and recorded on the laboratory Benthic Analysis Form. This form is filled out in the UAF laboratory during the processing of the 0.1 m^2 airlift samples. A new form is necessary for each sample and new pages added as needed. Instructions for each field on the sheet follows:

Page:	Begin each sample with page 1.
Date:	The date the sample is analyzed.
Recorder:	The initials of the person filling out the form.
Reviewer:	The initials of the person reviewing the form and the date reviewed.
Site No.:	The number designated to each study site. Copy from sample label. Left justify.

Date:	Date sample was taken (year, month, day).
Station:	One of three randomly-selected lines perpendicular to the site baseline extending from the 0 tide depth out to a depth of 20 m.
Transect:	One of two randomly-selected lines following the depth contour to the right of a station transect.
Depth:	The randomly-selected depths in the two or three depth ranges (<3, 3-6 and 6-20 m) where samples were taken.
Quadrat:	One of two randomly-selected 0.1 m^2 plots along a transect (only quad 1 for 1989 data).
Taxon:	Lowest practical taxonomic level for each organism.
Taxon Code:	A numeric code for each taxon; established by the National Oceanographic Data Center. Left justify.
% Sampled:	The percentage of the sample that was examined for taxonomy, counts and weights. Right justify.
Count:	Total count of taxon group in the sample.
Wet Weight:	Total blotted-dry wet weight in grams (with three places to the right of the decimal) of the taxon.
Individual Length:	Currently not needed, leave blank.

7. Counting of Sample Organisms:

A. Counts whole organisms where possible; fragmented organisms follow the procedures below.

B. Amphipods may be in two parts (head plus pereon, abdomen plus telson). The sum of the numbers of whole amphipods and anterior parts will constitute the total number.

C. The total number of isopods will equal the number of whole organisms plus the number of separate heads.

D. The total number of polychaetes will equal the number of whole organisms plus the number of anterior parts will constitute the total number.

E. The number of whole bivalves plus the number of partial shells (greater than one-half of whole shell) will constitute the total number of bivalves.

F. Since bryozoans and hydroids are colonial forms and are typically fragmented their presence in a sample only receives a count of one.

8. Calibration: The Mettler PM200 electronic balance will be calibrated by a Mettler serviceman within 60 days prior to the initiation of weighing samples. Calibration checks will be made monthly by the Laboratory Supervisor using standard NBS traceable weights.

9. The wet weight of each taxonomic group and/or species is determined using a Mettler PM200 (0.001-200 g) balance. Working with one taxonomic group and/or species at a time, organisms are first transferred onto absorbent, bibulous paper and blotted until the paper fails to absorb more moisture (approximately 1-2 minutes), and then weighed. The weights are entered onto the data sheets. Taxon weighing <0.001 g will be recorded as 0.0005 g.

10. A collection of voucher specimens is made as a reference for all identifications to the genus

and/or species. These specimens will be maintained by UAF.

11. In order to assure accuracy and consistency in processing the samples, systematic quality control checks are performed by the project's Laboratory Supervisor. Quality control checks will not be performed by the same individual who originally processed the sample. Approximately five percent of the samples will be rechecked. Discrepancies in the categories of identification, weight, and count shall not exceed three percent in each category. If they do, another one percent will be checked. If these are also out of compliance, then all samples to date will be reanalyzed.

12. After lab analyses are completed, each group and/or species is put into a vial with an appropriate label. All vials are put together by sites with the field tag. These samples are securely stored at UAF.

Appendix D.

Hemosiderosis in nearshore fishes of Prince William Sound subsequent to the *Exxon Valdez* oil spill.

Appendix D. Hemosiderosis in Nearshore Fishes of Prince William Sound subsequent to the *Exxon Valdez* oil spill.

Introduction

Crude oil or its water soluble components are known to induce histopathological effects in fish following chronic exposure (McCain *et al.*, 1978; Solangi and Overstreet, 1982; Haensly *et al.*, 1982; Khan and Kiceniuk, 1984; Khan, 1990). One such effect is hemisiderosis, an abnormality characterized by excessive deposition of a yellow-brown pigment, hemosiderin, in the tissues of vertebrate animals. Hemosiderin, which results after excessive destruction of erythrocytes, in fish concentrates in discrete areas in liver and spleen called melanomacrophage centers. There is evidence that a variety of pollutants suppress the immune response causing fish to become susceptible to infection (e.g., Zeeman and Brindley, 1981; Weeks and Warriner, 1984). Additionally, potentially harmful hydrocarbons may be bioaccumulated and passed on through the food chain. Because of these concerns, a small study was initiated to ascertain the extent of hemosiderosis in selected nearshore fishes in Prince William Sound following the *Exxon Valdez* oil spill.

Methods

Fishes were examined in 1993 for the presence of hemosiderosis, an indicator of exposure to pollutants, including petroleum (Khan and Nag, 1993). It can be demonstrated by a monospecific stain, Perl's Prussian Blue. Fishes were collected in the intertidal and shallow (< 6 m) subtidal region of the eelgrass beds in Herring Bay (oiled) and Lower Herring Bay (control) in July 1993. Approximately 30 specimens of pricklebacks (*Anoplarchus* spp.) and 30 crescent gunnel (*Pholis laeta*) were collected by hand, dipnet, and pots, preserved in 10% buffered formalin, and sent to Dr. R.A. Khan, Memorial University of Newfoundland, for analysis.

Results

Limited histological information was compiled on selected fishes in 1993. Examination of formalin-fixed sections of liver from ten pricklebacks and spleens from ten crescent gunnels revealed multifocal centers of hemosiderin in all specimens examined from the oiled Herring Bay site. No pigment centers were observed in prickleback and crescent gunnel tissues taken from the reference site (R.A. Khan, pers. commun. 1993). Storage product (lipid and/or glycogen) depletion was observed in 11 of 15 pricklebacks from Herring Bay, and none of 15 pricklebacks from Lower Herring Bay.

Discussion

In 1993, hemosiderosis was observed in crescent gunnels collected from an oiled site in Herring Bay, but was not observed in fishes collected from an unoiled reference site in Lower Herring Bay, suggesting that some fish species were still being exposed to oil as late as four years after the spill. This observation is in spite of the relatively low TPAH levels observed in 1993. Mean concentration of TPAH's were relatively low in 1993 in sediments from subtidal eelgrass beds in Herring Bay and Lower Herring Bay; in July it had diminished to 39.80 and 44.77 ng g^{-1}, respectively. Hemosiderin was reported in yellowfin sole *Pleuronectes aspera*, quillback rockfish, *Sebastes maliger*, and kelp greenling, *Hexagrammos decagrammus*, following the spill (Khan and Nag, 1993) and in plaice, *Pleuronectes platessa*, following the *Amoco Cadiz* oil spill off the coast of France (Haensly *et al.*, 1982). Exposure of fish to petroleum hydrocarbons is known to induce hemosiderosis (Khan and Nag, 1993). While other stressors can also cause hemosiderosis, there were no other known pollutants at the Herring Bay site. Hemosiderin in tissues disappears within approximately six weeks after removal from the pollutant (R.A. Khan, Pers. Commun. 1993) suggesting recent exposure of the fish.

We do not know if the presence of hemosiderosis has led to declines in population of crescent gunnels. There were no apparent effects on gunnel densities in eelgrass beds in 1990, but we have not made quantitative observations on gunnel population densities since then. However, the presence of this bioindicator of oil suggests that some contamination of fishes, and potentially other taxa, persisted as of summer 1993.

These findings are corroborated, in part, by the finding of Collier *et al.* (1996) in which nearshore (< 30 m) benthic flatfishes showed continuing exposure through the first two field seasons after the spill, and even after more than two years there was still some evidence of increased exposure of fishes from these habitats.

Literature Cited

Collier, T.K., C.A. Krone, M.M. Krahn, J.E. Stein, S.L. Chan, and U. Varanasi. 1996. Petroleum exposure and associated biochemical effects in subtidal fish after the *Exxon Valdez* oil spill. Pages 671-683. *In* S.D. Rice, R.B. Spies, D.A. Wolfe, and B.A. Wright, Editors. Proceedings of the *Exxon Valdez* oil spill symposium. American Fisheries Society Symposium 18.

Haensly, W.E, J.M. Neff, J.R. Sharp, A.C. Morris, M.F. Beom. 1982. Histopathology of *Pleuronectes platessa* L. from Aber Wrac'h and Aber Benoit, Brittany, France: long-term effects of the *Amoco Cadiz* crude oil spill. Journal of Fish Disease 5:365-391.

Khan, R.A. 1990. Parasitism in marine fish after chronic exposure to petroleum hydrocarbons in the laboratory and to the *Exxon Valdez* oil spill. Bulletin of Environmental Contamination and Toxicology 44:759-763.

Khan, R.A. and J.W. Kiceniuk. 1984. Histopathological effects of crude oil on Atlantic cod following chronic exposure. Canadian Journal of Zoology 63:2038-2043.

Khan, R.A. and K. Nag. 1993. Estimation of hemosiderosis in seabirds and fish exposed to petroleum. Bulletin of Environmental Contamination and Toxicology 50:125-131.

McCain, B.B., H.O. Hodgins, W.D. Gronlund, J.W. Hawkes, D.W. Brown, M.S. Meyers, J.H. Vandermeulen. 1978. Bioavailability of crude oil from experimentally oiled sediments to English sole (*Parophrys vetulus*) and pathological consequences. Journal of Fisheries Research Board of Canada 35:657-664.

Solangi, M.A. and R.M. Overstreet. 1982. Histopathological changes in two estuarine fishes, *Menidia beryllina* (Cope) and *Trinectes maculatus* (Bloch and Schneider), exposed to crude oil and its water-soluble fractions. Journal of Fish Disease 5:13-35.

Weeks, B.A. and J.E. Warriner. 1984. Effects of toxic chemicals on macrophage phagocytosis in two estuarine fishes. Marine Environmental Research 14:327-335.

Zeeman, M.G. and W.A. Brindley. 1981. Effects of toxic agents upon fish immune systems: a review. pp. 1-60. *In*: R.P. Sharma (ed) Immunologic considerations in toxicology, Vol II. CRC Press, Boca Raton, Florida.

Appendix E.

Polynuclear aromatic hydrocarbons (PAHs) that were analyzed from sediments of shallow subtidal eelgrass study sites in Prince William Sound, 1990-95.

Appendix E. Polynuclear aromatic hydrocarbons (PAHs) that were analyzed from sediments of shallow subtidal eelgrass study sites in Prince William Sound, 1990-95. They represent PAHs from various sources, including *Exxon Valdez* crude oil and other petroleum products. Compounds with an asterisk (*) represent PAHs most characteristic of weathered *Exxon Valdez* crude oil (source: TSTF/ACG, NOAA/NMFS, Auke Bay, Alaska).
** C1-Naphthalene = 1 -Methylnaphthalene + 2-Methylnaphthalene.

PAH Analyte	Abbreviation
Naphthalene*	Naph
C1-Naphthalene**	C1naph
C2-Naphthalene*	C2naph
C3-Naphthalene*	C3naph
C4-Naphthalene*	C4naph
Biphenyl*	Biphenyl
Acenaphthylene	Acenthy
Acenaphthene	Acenthe
Fluorene*	Fluorene
C1-Fluorene*	C1fluor
C2-Fluorene*	C2fluor
C3-Fluorene*	C3fluor
Dibenzo(b,d)thiophene*	Dithio
C1-Dibenzo(b,d)thiophene*	C1dithio
C2-Dibenzo(b,d)thiophene*	C2dithio
C3-Dibenzo(b,d)thiophene*	C3dithio
Phenanthrene*	Phenanth
C1-Phenanthrene*	C1phenan
C2-Phenanthrene*	C2phenan
C3-Phenanthrene*	C3phenan
C4-Phenanthrene*	C4phenan
Anthracene	Anthra
Fluoranthene	Fluorant
Pyrene	Pyrene
C1-Fluoranthene*	C1Fluoranth
Benz(a)anthracene	Benanth
Chrysene*	Chrysene
C1-Chrysene*	C1chrys
C2-Chrysene*	C2chrys
C3-Chrysene	C3chrys
C4-Chrysene	C4chrys
Benzo(b)fluoranthene	Benzobfl
Benzo(k)fluoranthene	Benzokfl
Benzo(e)pyrene	Benephy
Benzo(a)pyrene	Benaphy
Perylene	Perylene
Indeno(1,2,3-c,d)pyrene	Indeno
Dibenz(a,h)anthracene	Dibenz
Benzo(g,h,i)perylene	Benzop

Appendix F.

Stable carbon isotope ratios ($\delta^{13}C$) of Prince William Sound subtidal sediments, subsequent to the *Exxon Valdez* oil spill.

Appendix F. Stable carbon isotope ratios ($\delta^{13}C$) of Prince William Sound subtidal sediments, subsequent to the *Exxon Valdez* oil spill.

Introduction

Numerous investigations have demonstrated the usefulness of stable carbon isotope ratios ($\delta^{13}C$) of organics in sediments and waters in identifying marine regions contaminated with petroleum (e.g., Calder and Parker, 1968; Spies and DesMarais, 1983; Anderson *et al.*, 1983; Eganhouse and Kaplan, 1988). The premise in these investigations was that carbon derived from various organic pools has a characteristic $\delta^{13}C$ value, e.g., the $\delta^{13}C$ of terrigenous C3 plants = -25 ‰ (Hong, 1986; Naidu *et al.*, 1992), marine phytodetritus = -21 ‰ (Fry and Sherr, 1984), seagrasses = -10 ‰ (McConnaughey and McRoy, 1979), and Prudhoe Bay crude oil = -30 ‰ (Magoon and Claypool, 1981). In principle, therefore, the $\delta^{13}C$ of marine sediments could, based on an isotope mixing equation (Calder and Parker, 1968; Eganhouse and Kaplan, 1988), help to estimate the proportion in the sediment of organic matter derived from various natural or anthropogenic pools. Based on the above premise, we have attempted to examine the possibility of subtidal sediment contamination by *Exxon Valdez* crude oil in Prince William Sound.

Methods

Sediments for determination of carbon isotope ratios were collected from each depth stratum at each study site visited in 1990 and 1991. All samples were taken from the second of three sampling stations, located approximately in the middle of each sampling site. SCUBA divers collected the sediment samples in pre-cleaned, wide-mouth 4 oz. jars. Divers took two sample jars into the water, cracked the jars' lid just below the water surface, and proceeded to the bottom at each sampling site. There, the jar's lid was removed and the jar was used to scoop sediment to a depth of approximately 5 cm. A 10 to 100 g sample of sediment was obtained at each sampling location. The samples were taken from within 3 m of the buoy anchor marking each sampling station when possible. If the sediment could not be collected near the buoy, samples were taken at the closest adjacent patch of loose sediment.

One of the collected samples was used to determine sediment composition and the other to determine hydrocarbon concentrations. The samples were numbered, labelled, and frozen aboard the ship. The samples for sediment composition were then shipped to the University of Alaska Fairbanks for analysis. In the laboratory each of these samples was split into two subsamples. One fraction was used for analyses of organic carbon stable isotope ratios and the other for the analysis of grain size.

Organic carbon and nitrogen in bottom sediments were estimated on dry carbonate-free sample powders using the CHN analyzer. All OC/N ratios in this report are computed on a weight to weight basis of OC and N. The $\delta^{13}C$ analysis was made by Coastal Science Laboratories, Inc. (Austin, Texas) on carbonate-free sediments, using a VG 602E mass spectrometer. The results are expressed relative to the PDB Standard, with a precison of 0.2 ‰. The mean $\delta^{13}C$ values of the oiled and unoiled samples were statistically compared using the nonparametric Mann-Whitney U Test. Differences between means at $P > 0.05$ were considered insignificant.

Results

Analysis of the OC/N ratios indicated that the ratios were significantly greater ($P < 0.05$, t-test) at the oiled sites in two out of four pairs. Both Herring Bay (Site 16) and Sleepy Bay (Site 17) had higher values than their respective controls.

Stable carbon isotope values ($\delta^{13}C$) from 1990 sediments within the eelgrass bed (Appendix H-1) revealed a difference in only one of the four site-depth transect pairs. The values at the oiled Herring Bay eelgrass bed (Site 16) were significantly more negative ($P = 0.01$; Mann-Whitney U Test) than at unoiled Lower Herring Bay eelgrass bed (Site 15). An insufficient number of samples precluded making the same comparisons for 1991 (Appendix H-2).

Using pooled treatment data, no significant differences ($P > 0.05$) were detected between $\delta^{13}C$ values from oiled and control eelgrass sites in 1990. However, in 1991, the $\delta^{13}C$ values of oiled sediments (-22.2 ‰) were significantly lower ($P = 0.03$) than that of the unoiled sediments (-20.4 ‰).

Discussion

The finding of similar $\delta^{13}C$ values in 1990 sites, was contrary to our expectations. Initially, we postulated that the $\delta^{13}C$ of unoiled sediments in the Sound would be relatively higher (less negative values) than the values for the oiled sediments. We assumed that any marked contamination of sediments from the Sound with Prudhoe Bay crude oil would shift the $\delta^{13}C$ of the oiled sediments to more negative values. The discrepancy between our postulation and the analyzed $\delta^{13}C$ values for unoiled and oiled sediments suggests that either oiled sediments were not markedly contaminated with oil or control sites were also oiled. Analyses of TPAH and chrysenes from these same sediments revealed significantly more of both groups of anlytes at oiled sites in both years (Text Table 2). Some control sediments were contaminated with oil, thereby making it difficult to statistically distinguish differences between treatment groups. In 1990 and 1991 33 % and 41 %, respectively, of the control sites had the presence of an *Exxon Valdez* oil signature (Text Table 3). Alternatively, it is possible that petroleum intercalated into the sediments was overwhelmingly diluted by natural organic material (e.g., eelgrass debris). As noted previously, lower $\delta^{13}C$ values were determined for the 1991 oiled sediments, in comparison with unoiled sediments. It is possible that the source of the lower $\delta^{13}C$ values in the 1991 sediments is petroleum from the adjacent heavily-oiled beaches. Perhaps sufficient oil had accumulated in the subtidal region by 1991 so that an isotopic signature of oil could finally be detected there. Thus, it appears that at least some oil reworked from the beaches, either by storm waves or tides, is carried offshore and may accumulate in the subtidal region.

In conclusion, we believe that in Prince William Sound sediments, unless heavily contaminated with petroleum, $\delta^{13}C$ values are of limited use to assess the extent of sediment contamination by crude oil. It is suggested that additional $\delta^{13}C$ analysis, using GC-IRMS, on the methanol and benzene soluble material (e.g., saturated and aromatic hydrocarbons) of oiled and unoiled sediments (Anderson *et al.*, 1983), could provide a more useful index of detecting petroleum contamination of the Prince William Sound sediments than $\delta^{13}C$ analysis on gross organics of sediments.

Literature Cited

Anderson, R.K., R.S. Scalan, P.L. Parker and E.W. Behrens, 1983. Seep oil and gas in Gulf of Mexico Slope sediment. Science. 222: 619-621.

Calder, J.A. and P.L. Parker, 1968. Stable carbon isotope ratios as indices of petrochemical pollution of aquatic systems. Environ. Sci. and Tech. 2:535-539.

Eganhouse R.P. and I.R. Kaplan, 1988. Depositional history of recent sediments from San Pedro Shelf, California: Reconstruction using elemental abundances, isotopic composition and molecular markers. Mar. Chem. 24:163-191.

Fry B. and E.B. Sherr, 1984. $\delta^{13}C$ measurements as indicators of carbon flow in marine and freshwater ecosystems. Contrib. Mar. Sci. 27:13-47.

Hong, G.H., 1986. Fluxes, dynamics and chemistry of particulate matter and nutrient regeneration in the central basin of Boca de Quadra, southeast Alaska. Ph.D Thesis, University of Alaska Fairbanks, AK, 225 pp.

Magoon, L.B. and G.E. Claypool, 1981. Two oil types on North Slope of Alaska--implications for exploration. Amer. Assoc. Petroleum Geol. Bull. 65:644-648.

McConnaughey, T. and C.P. McRoy. 1979. $\delta^{13}C$ label identifies eelgrass (*Zostera marina*) carbon in an Alaskan estuarine food web. Mar. Biol. 53:263-269.

Naidu, A.S., H.M. Feder, N. Foster, C. Geist and P.M. Rivera, 1992. *Macoma balthica* Monitoring Study at Dayville Flats, Port Valdez. Final Report Submitted to Alyeska Pipeline Service Co. Inst. Marine Sci., Univ. Alaska. pp.80.

Spies, R.B. and D.J. DesMarais, 1983. Natural isotope study of trophic enrichment of marine benthic communities by petroleum seepage. Mar. Biol. 73:67-71.

Appendix G.

Benthic invertebrate families and higher taxa from shallow subtidal eelgrass sites in Western Prince William Sound, 1990, 1991, 1993 and 1995.

Appendix G. Benthic invertebrate families and higher taxa from shallow subtidal eelgrass sites in western Prince William Sound, 1990, 1991, 1993, and 1995. Relative proportion of feeding modes are based on literature reviews; SF = suspension feeder, SDF = surface deposit feeder, SSDF = subsurface deposit feeder, P/S = predator/scavenger, HERB = herbivore. Presence of each taxon in each year and depth statum is noted by "X". Depth Stratum T1 = 6-20 m, T3 = < 3 m.

			Epifauna/	Feeding Mode					Sampling Year and Depth Stratum							
Taxon	Code	Common Name	Infauna	SF	SDF	SSDF	P/S	HERB	90T1	90T3	91T1	91T3	93T1	93T3	95T1	95T3
RHYNCHOCOELA	430000	Ribbon Worms	E/I	0	0	0	1	0	X	X	X	X	X	X	X	X
LINEIDAE	430302	Ribbon Worms	I	0	0	0	1	0	X	X			X	X	X	X
POLYCHAETA	500100	Polychaetes	E/I	0.15	0.15	0.15	0.3	0.15	X	X	X	X	X	X	X	X
POLYNOIDAE	500102	"	I	0	0	0	1	0	X	X	X	X	X	X	X	X
POLYODONTIDAE	500104	"	I	0	0	0	1	0	X		X		X		X	
SIGALIONIDAE	500106	"	I	0	0	0	1	0	X	X	X	X	X	X	X	X
CHRYSOPETALIDAE	500108	"	I	0	0	0	1	0					X			
PHYLLODOCIDAE	500113	"	I	0	0	0	1	0	X	X	X	X	X	X	X	X
HESIONIDAE	500121	"	I	0	0	0	1	0	X	X	X	X	X	X	X	X
SYLLIDAE	500123	"	I	0	0.334	0	0.333	0.333	X	X	X	X	X	X	X	X
NEREIDAE	500124	"	I	0.333	0.334	0	0.333	0	X	X	X	X	X	X	X	X
NEPHTYIDAE	500125	"	I	0	0	0	1	0	X	X	X	X	X	X	X	X
SPHAERODORIDAE	500126	"	I	0	0	1	0	0	X		X	X	X	X	X	X
GLYCERIDAE	500127	"	I	0	0	0	1	0	X	X	X	X	X	X	X	X
GONIADIDAE	500128	"	I	0	0	0	1	0	X	X	X	X	X	X	X	X
ONUPHIDAE	500129	"	I	0	0.334	0	0.666	0	X	X	X	X	X	X	X	X
LUMBRINERIDAE	500131	"	I	0	0.334	0	0.333	0.333	X	X	X	X	X	X	X	X
DORVILLEIDAE	500136	"	I	0	0	0	1	0	X	X	X	X	X	X	X	X
ORBINIIDAE	500140	"	I	0	0	1	0	0	X	X	X	X	X	X	X	X
PARAONIDAE	500141	"	I	0	1	0	0	0	X	X	X	X	X	X	X	X
SPIONIDAE	500143	"	I	0.5	0.5	0	0	0	X	X	X	X	X	X	X	X
MAGELONIDAE	500144	"	I	0	1	0	0	0	X		X		X	X	X	X
CHAETOPTERIDAE	500149	"	I	1	0	0	0	0	X		X	X	X	X	X	X
CIRRATULIDAE	500150	"	I	0	1	0	0	0	X	X	X	X	X	X	X	X
ACROCIRRIDAE	500151	"	I	0	0.5	0.5	0	0	X		X		X		X	
FLABELLIGERIDAE	500154	"	I	0	0.5	0.5	0	0	X		X		X		X	
SCALIBREGMIDAE	500157	"	I	0	0	1	0	0	X		X	X	X	X	X	X
OPHELIIDAE	500158	"	I	0	0	1	0	0	X	X	X	X	X	X	X	X
CAPITELLIDAE	500160	"	I	0	0	1	0	0	X	X	X	X	X	X	X	X
ARENICOLIDAE	500162	"	I	0	0.5	0.5	0	0		X						X
MALDANIDAE	500163	"	I	0	0	1	0	0	X		X	X	X	X	X	X
OWENIIDAE	500164	"	I	0	1	0	0	0	X	X	X	X	X	X	X	X
SABELLARIDAE	500165	"	I	1	0	0	0	0			X		X		X	
AMPHICTENIDAE	500166	"	I	0	0	1	0	0	X	X	X	X	X	X	X	X
AMPHARETIDAE	500167	"	I	0	1	0	0	0	X	X	X	X	X	X	X	X

Appendix G. Continued.

Taxon	Code	Common Name	Epifauna/ Infauna	Feeding Mode SF	SDF	SSDF	P/S	HERB	Sampling Year and Depth Stratum 90T1	90T3	91T1	91T3	93T1	93T3	95T1	95T3
TEREBELLIDAE	500168	"	I	0	1	0	0	0	X	X	X	X	X	X	X	X
TRICHOBRANCHIDAE	500169	Polychaetes	I	0	1	0	0	0	X		X		X		X	
SABELLIDAE	500170	"	I	1	0	0	0	0	X	X	X	X	X	X	X	X
SERPULIDAE	500173	"	E	1	0	0	0	0	X		X		X	X	X	X
SPIRORBIDAE	500178	"	E	1	0	0	0	0	X	X	X	X	X	X	X	X
POLYGORDIIDAE	500205	"	I	0	0	0	1	0			X		X	X	X	X
GASTROPODA	510000		E/I	0	0.25	0	0.5	0.25	X	X	X	X	X	X	X	X
ARCHAEOGASTROPODA	510200	Limpets	E	0	0	0	0	1	X		X	X	X	X		X
FISSURELLIDAE	510204	Snails	E	0	0	0	0	1			X		X		X	
LOTTIDAE	510205	"	E	0	0	0	0	1	X		X	X	X	X	X	X
LEPETIDAE	510207	"	E	0	0	0	0	1	X		X	X	X	X	X	X
TROCHIDAE	510210	"	I	0	0	0	0.5	0.5	X	X	X	X	X	X	X	X
LACUNIDAE	510309	"	I	0	0.334	0	0.333	0.333	X	X	X	X	X	X	X	X
LITTORINIDAE	510310	Periwinkle	E	0	0.334	0	0.333	0.333			X					
RISSOIDAE	510320	Snails	E/I	0	0	0	0	1	X	X	X	X	X	X	X	X
CAECIDAE	510336	Caecum	I	1	0	0	0	0	X	X	X	X	X	X	X	X
CERITHIIDAE	510346	Snails	E/I	0	1	0	0	0								X
EULIMDAE	510353	"	E/I	0	0	0	0	0	X				X			
TRICHOTROPIDAE	510362	"	E/I	0.5	0	0	0	0.5	X		X		X		X	
CALYPTRAEIDAE	510364	"	E	0.5	0	0	0	0.5	X		X		X		X	X
LAMELLARIIDAE	510366	"	E/I	0	0	0	1	0							X	X
NATICIDAE	510376	"	E/I	0	0	0	1	0					X			
MURICIDAE	510501	"	E/I	0	0	0	1	0	X							
COLUMBELLIDAE	510503	"	E/I	0	0	0	0	1	X		X		X			X
NASSARIIDAE	510508	"	E/I	0	0.334	0	0.666	0	X	X	X	X	X	X	X	X
OLIVIDAE	510510	"	E/I	0	0	0	1	0	X	X	X	X	X	X	X	X
MARGINELLIDAE	510515	"	E/I	0	0	0	1	0							X	X
TURRIDAE	510602	"	E/I	0	0	0	1	0	X	X	X	X	X	X	X	X
PYRAMIDELLIDAE	510801	"	?	0	1	0	0	0	X	X	X	X	X	X	X	X
CEPHALASPIDEA	511000	Bubble Shells	E/I	0	0	0	1	0	X		X	X	X	X	X	X
CYLICHNIDAE	511004	"	E/I	0	0	0	1	0	X	X	X	X	X	X	X	X
PHILINIDAE	511005	Paperbubble	E/I	0	0	0	1	0	X							
GASTROPTERIDAE	511007	Batwing Seaslug	E/I	0	0	0	1	0	X	X	X	X	X	X	X	X
DIAPHANIDAE	511009	Paperbubble	E/I	0	0	0	1	0	X			X			X	X
ATYIDAE	511012	Glassy-bubble	E/I	0	0	0	1	0	X		X				X	X
SACOGLOSSA	512300	Nudibranchs	E	0	0	0	0	1		X	X	X	X	X	X	X
STILIGERIDAE	512306	"	E	0	0	0	0	1				X				X

Appendix G. Continued.

Taxon	Code	Common Name	Epifauna/ Infauna	Feeding Mode SF	SDF	SSDF	P/S	HERB	Sampling Year and Depth Stratum 90T1	90T3	91T1	91T3	93T1	93T3	95T1	95T3
NUDIBRANCHIA	512700	"	E	0	0.25	0	0.5	0.25	X	X	X		X	X	X	X
DORIDACEA	512800	"	E	0	0.5	0	0.5	0					X	X		X
DORIDIDAE	513003	Nudibranchs	E	0	0	0	1	0		X						X
ONCHIDORIDIDAE	513105	"	E	0	0	0	1	0		X	X	X	X	X	X	X
CORAMBIDAE	513107	"	E	0	0.5	0	0.5	0		X						X
TETHYIDAE	513408	"	E	0	0	0	1	0					X	X		X
OPISTOBRANCHIA	518100	"	E/I	0	0.25	0	0.5	0.25		X		X				X
POLYPLACOPHORA	530000	Chitons	E	0	0	0	0.5	0.5	X	X	X	X	X	X	X	X
LEPTOCHITONIDAE	530201	"	E	0	0	0	0.5	0.5	X		X		X		X	
ISCHNOCHITONIDAE	530302	"	E	0	0	0	0.5	0.5	X		X	X	X		X	X
MOPALIIDAE	530307	"	E	0	0	0	0.5	0.5	X			X				X
BIVALVIA	550000	Bivalves	E/I	0.333	0.334	0.333	0	0	X	X	X	X	X	X	X	X
NUCULIDAE	550202	Nutclam	I	0	0	1	0	0	X		X		X	X	X	X
NUCULANIDAE	550204	"	I	0	0	1	0	0	X	X	X		X		X	X
GLYCYMERIDAE	550606	Clams	I	1	0	0	0	0	X		X		X		X	
MYTILIDAE	550701	Mussels	E	1	0	0	0	0	X	X	X	X	X	X	X	X
PECTINIDAE	550905	Scallops	E	1	0	0	0	0	X		X		X		X	
ANOMIIDAE	550909	Jingles	E	1	0	0	0	0			X	X				X
LUCINIDAE	551501	Clams	I	0.5	0.5	0	0	0	X	X	X	X	X	X	X	X
THYASIRIDAE	551502	"	I	1	0	0	0	0	X	X	X	X	X	X	X	X
UNGULINIDAE	551505	"	I	0.5	0.5	0	0	0	X		X	X			X	X
KELLIDAE	551508	"	I	0.5	0.5	0	0	0						X		X
MONTACUTIDAE	551510	"	I	1	0	0	0	0	X	X	X	X	X	X	X	X
TURTONIIDAE	551514	"	E/I	0.5	0.5	0	0	0			X	X	X	X	X	X
ASTARTIDAE	551519	"	I	1	0	0	0	0	X		X		X		X	
CARDIIDAE	551522	Cockles	I	0.5	0.5	0	0	0	X	X	X	X	X	X	X	X
MACTRIDAE	551525	Clams	I	1	0	0	0	0			X					
TELLINIDAE	551531	"	I	0.5	0.5	0	0	0	X	X	X	X	X	X	X	X
VENERIDAE	551547	"	I	1	0	0	0	0	X	X	X	X	X	X	X	X
MYIDAE	551701	"	I	1	0	0	0	0	X	X	X	X	X	X	X	X
HIATELLIDAE	551706	"	E/I	1	0	0	0	0	X	X	X	X	X	X	X	X
LYONSIIDAE	552005	"	E/I	1	0	0	0	0	X	X	X	X	X		X	X
THRACIIDAE	552008	"	I	1	0	0	0	0	X		X		X			
CUSPIDARIDAE	552010	"	I	0	0	0	1	0	X		X		X		X	
DENTALIIDAE	560001	Tuskshells	I	0	0.5	0	0.5	0	X						X	
PYCNOGONIDA	600000	Sea Spiders	E	0	0	0	1	0							X	X
CRUSTACEA	610000	Crustaceans	E/I	0.25	0.25	0	0.5	0	X	X	X	X	X	X	X	X

Appendix G. Continued.

Taxon	Code	Common Name	Epifauna/ Infauna	Feeding Mode					Sampling Year and Depth Stratum							
				SF	SDF	SSDF	P/S	HERB	90T1	90T3	91T1	91T3	93T1	93T3	95T1	95T3
BALANOMORPHA	613400	Barnacles	E	1	0	0	0	0	X	X	X		X		X	X
CHTHAMALIDAE	613401	"	E	1	0	0	0	0	X							
BALANIDAE	613402	"	E	1	0	0	0	0		X	X	X	X			X
CUMACEA	615400	Cumaceans	I	0	1	0	0	0	X	X	X	X	X	X	X	X
LAMPROPIDAE	615401	"	I	0	0.5	0	0.5	0	X	X	X	X	X	X	X	X
LEUCONIDAE	615404	"	I	0	0.5	0	0.5	0	X		X		X		X	X
DIASTYLIDAE	615405	"	I	0.5	0	0	0.5	0	X	X	X	X	X	X	X	X
NANNASTACIDAE	615408	"	I	0	1	0	0	0	X		X		X		X	X
BODOTRIIDAE	615409	"	I	0	1	0	0	0	X		X		X		X	
ISOPODA	615800	Isopods	E/I	0	0.5	0	0.5	0						X		X
GNATHIIDAE	615901	"	E/I	0	0	0	1	0	X							
ANTHURIDEA	616000	"	E/I	0	0	0	1	0					X			
SPHAEROMATIDAE	616102	"	E	0	0	0	1	0								X
LIMNORIDAE	616105	"	E	0	0	0	0.5	0.5			X	X			X	X
IDOTEIDAE	616202	"	E	0	0	0	1	0						X		X
MUNNIDAE	616312	"	E/I	0	0	0	1	0	X	X	X	X	X	X	X	X
AMPHIPODA	616900	Amphipods	E/I	0.333	0.334	0.333	0	0	X	X	X	X	X	X	X	X
ACANTHONOTOZOMATIDAE	616901	"	E/I	0.25	0	0	0.5	0.25			X				X	
AMPELISCIDAE	616902	"	I	0	1	0	0	0	X		X	X	X		X	X
AMPHITHOIDAE	616904	"	E/I	0	0	0	1	0	X	X	X	X		X	X	X
AORIDAE	616906	"	E/I	0	1	0	0	0	X	X	X	X		X		X
ATYLIDAE	616909	"	E/I	0	0.5	0	0.5	0						X		X
CALLIOPIIDAE	616912	"	E/I	0	0	0	0	0			X					
COROPHIIDAE	616915	"	I	0.5	0.5	0	0	0	X	X	X	X	X	X	X	X
DEXAMINIDAE	616917	"	E/I	0	1	0	0	0	X	X	X	X	X	X	X	X
EUSIRIDAE	616920	"	E/I	0	1	0	0	0	X	X	X	X	X	X	X	X
GAMMARIDAE	616921	"	E/I	0	1	0	0	0	X	X	X	X	X	X	X	X
HAUSTORIIDAE	616922	"	E/I	0	1	0	0	0								X
HYALELLIDAE	616923	"	U	0	1	0	0	0					X		X	
ISAEIDAE	616926	"	E/I	0	1	0	0	0	X	X	X	X	X	X	X	X
ISCHYROCERIDAE	616927	"	E/I	0	0.5	0	0.5	0	X	X	X	X	X	X	X	X
LYSIANASSIDAE	616934	"	E/I	0.25	0.25	0	0.5	0	X	X	X	X	X	X	X	X
OEDOCEROTIDAE	616937	"	E/I	0	1	0	0	0	X	X	X	X	X	X	X	X
PHOXOCEPHALIDAE	616942	"	E/I	0	0.666	0	0.334	0	X	X	X	X	X	X	X	X
PLEUSTIDAE	616943	"	E/I	0	0.5	0	0.5	0	X	X	X	X	X		X	X
PODOCERIDAE	616944	"	E	0	1	0	0	0			X				X	
STENOTHOIDAE	616948	"	E	0	1	0	0	0			X	X	X	X	X	X

Appendix G. Continued.

Taxon	Code	Common Name	Epifauna/ Infauna	Feeding Mode SF	SDF	SSDF	P/S	HERB	Sampling Year and Depth Stratum 90T1	90T3	91T1	91T3	93T1	93T3	95T1	95T3
SYNOPIIDAE	616950	"	E	1	0	0	0	0	X		X		X			
CAPRELLIDAE	617100	Caprellids	E	0.25	0	0	0.5	0.25	X	X	X	X	X	X	X	X
DECAPODA	617500		E	0	0	0	1	0	X	X	X	X	X	X	X	X
PLEOCYEMATA	617800	Shrimps	E	0	0	0	1	0			X	X	X		X	X
CARIDEA	617900	Shrimps	E	0	0	0	1	0						X		X
HIPPOLYTIDAE	617916	"	E	0	0	0	1	0	X	X	X	X	X	X	X	X
PANDALIDAE	617918	"	E	0	0	0	1	0	X	X		X		X		X
CRANGONIDAE	617922	"	E	0	0	0	1	0	X	X	X		X		X	X
PAGURIDAE	618306	Hermit Crabs	E	0	0	0	1	0	X	X	X		X	X	X	X
BRACHYURA	618400	"	E	0	0	0	1	0					X			
MAJIDAE	618701	"	E	0	0	0	1	0						X	X	X
ATELECYCLIDAE	618802	"	E	0	0	0	1	0		X	X	X		X	X	X
CANCRIDAE	618803	"	E	0	0	0	1	0			X			X		X
SIPUNCULA	720000	Peanut Worms	I	0	1	0	0	0							X	
SIPUNCULIDAE	720001	"	I	0	1	0	0	0	X		X		X			
PRIAPULIDA	740000		I	0	0.334	0	0.666	0					X		X	
PHORONIDA	770000		E/I	1	0	0	0	0		X	X	X	X	X	X	X
BRACHIOPODA	800000	Lamp Shells	E	1	0	0	0	0					X			
CANCELLOTHYRIDIDAE	800507	"	E	1	0	0	0	0	X							
ASTEROIDEA	810400	Sea Stars	E	0	0	0	1	0	X	X	X		X	X	X	X
SOLASTERIDAE	811301	"	E	0	0	0	1	0					X			
ASTERIIDAE	811703	"	E	0	0	0	1	0	X		X	X		X		X
OPHIUROIDEA	812000	Brittle Stars	I	0	0.334	0	0.666	0	X	X	X	X	X	X	X	X
AMPHIURIDAE	812903	Brittle Stars	E/I	0.5	0.5	0	0	0		X	X	X	X		X	X
ECHINOIDEA	813600		E	0	0.25	0.25	0.25	0.25			X	X		X		X
STRONGYLOCENTROTIDAE	814903	Sea Urchins	E	0	0.5	0	0	0.5	X	X	X	X	X		X	X
ECHINARACHNIIDAE	815502	Sand Dollars	I	0.5	0.5	0	0	0	X	X	X	X	X	X		X
HOLOTHUROIDEA	817000	Sea Cucumbers	E/I	0.5	0	0.5	0	0					X	X	X	X
CUCUMARIIDAE	817206	"	E	0.5	0	0.5	0	0	X				X		X	
SYNAPTIDAE	817801	"	I	0	0	1	0	0	X		X	X		X	X	X
UROCHORDATA	840000	Tunicates	E	1	0	0	0	0	X		X	X	X	X		X
ASCIDIACEA	840100	"	E	1	0	0	0	0	X		X	X	X	X	X	X
PYURIDAE	840602	"	E	1	0	0	0	0						X		X

Appendix H.

Granulometric composition, organic carbon (OC), nitrogen (N), OC/N ratios and stable carbon isotope ratios ($\delta^{13}C$) of surficial sediments from eelgrass sites in Prince William Sound, Alaska, 1990.

Appendix H. Distribution of sediment-grain sizes in eelgrass habitats.

Sediment grain-size distributions are given for each sample collected (Appendix Tables H-1 through H-4). Means and standard errors for percent mud and percent sand, and results of two-way and one-way randomization analyses of variance are given in Appendix Table H-5, and are summarized in Table H-6 and Figure H-1. One-way tests indicated that there was no significant differences in the percent sand or mud between oiled and control sites within a given year except for the marginally significant (P=0.09) higher percentage of mud at control sites in 1993. Two-way analyses indicated that, over all four years sampled, there was a significantly higher proportion of sand at oiled sites at 6 to 20 m, and a higher proportion of mud at control sites at < 3 m depth. Also there were differences among years in the < 3 m depth stratum, for both percent mud and percent sand. Percent mud was higher, and percent sand lower, in 1990 compared to subsequent years, especially at control sites.

It is unlikely that any of these differences were related to the effects of the spill. Differences between oiled and control sites were opposite of what one might expect as a result of the spill. The washing of sediments from heavily oiled beaches during cleanup of these shorelines (Mearns, 1996) would be expected to cause an increase in finer sediments at oiled sites. Instead there was a higher percentage of coarser sediments at these sites. Also, differences between years were primarily attributable to differences at control sites, where there was no oiling or cleanup.

Appendix Table H-1. Granulometric composition, organic carbon (OC), nitrogen (N), OC/N ratios and stable carbon isotope ratios ($\delta^{13}C$) of surficial sediments from *Zostera* (eelgrass) habitats in western Prince William Sound, Alaska, Summer 1990.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Silt %	Clay %	Mud[2] %	Mz Mean	δ Sort	O C mg g^{-1}	N mg g^{-1}	OC/N	$\delta^{13}C$
Bay of Isles Site (13)	Oiled	1	1	gs16	0.00	13.62	44.79	41.59	86.38	7.52	2.82	51.63	7.92	6.50	
		2	1	gs17	0.00	2.05	48.51	49.44	97.95	8.25	2.33	58.08	9.05	6.40	-22.10
		3	1	gs18	0.00	3.44	41.68	54.89	96.57	9.07	2.39	59.93	9.46	6.30	
				Mean	0.00	6.37	44.99	48.64	93.63	8.28	2.51	56.55	8.81	6.40	
		1	2	gs19	0.00	4.96	43.28	51.77	95.05	8.33	2.46	57.16	7.73	7.40	
		2	2	gs20	0.00	3.46	38.13	58.41	96.54	8.80	2.44	63.08	7.46	8.50	
		3	2	gs21	0.00	7.02	45.28	47.70	92.98	8.03	2.57	50.26	6.90	7.30	
				Mean	0.00	5.15	42.23	52.63	94.86	8.39	2.49	56.83	7.36	7.73	
		1	3	gs22	0.00	2.51	19.15	78.34	97.49	9.42	2.37	63.45	10.61	6.00	-18.20
		2	3	gs23	0.00	2.52	24.00	73.49	97.49	9.37	2.66	86.07	5.73	15.00	-24.10
		3	3	gs24	0.00	0.31	47.08	52.62	99.70	7.50	2.43	48.60	7.50	6.50	-22.30
				Mean	0.00	1.78	30.08	68.15	98.23	8.76	2.49	66.04	7.95	9.17	-21.53
Drier Bay Site (14)	Control	1	1	gs25	0.00	67.49	27.00	5.51	32.51	3.87	1.44	34.29	3.26	10.50	
		2	1	gs26	38.86	33.87	19.44	7.83	27.27	1.83	3.56	22.72	2.96	7.70	-21.90
		3	1	gs27	0.00	68.18	22.32	9.50	31.82	3.63	3.19	13.43	2.13	6.30	
				Mean	12.95	56.61	22.92	7.61	30.53	3.11	2.73	23.48	2.78	8.17	
		1	2	gs28	0.00	38.84	43.51	17.65	61.16	5.83	3.25	17.02	2.50	6.80	
		2	2	gs29	79.54	17.54	1.53	1.67	3.20	-3.80	3.49	1.94	0.28	6.90	
		3	2	gs30	40.17	41.92	8.33	9.58	17.91	0.13	4.35	8.31	0.98	8.50	
				Mean	39.90	32.77	17.79	9.63	27.42	0.72	3.70	9.09	1.25	7.40	
		1	3	gs31	0.00	18.18	36.53	45.30	81.82	7.45	3.13	40.43	4.65	8.70	-20.40
		2	3	gs32	3.27	16.25	55.67	25.82	80.49	6.50	3.39	35.08	5.67	6.20	-20.40
		3	3	gs33	0.00	3.93	39.80	56.27	96.08	8.93	2.82	51.93	8.31	6.20	-17.90
				Mean	1.09	12.79	44.00	42.46	86.13	7.63	3.11	42.48	6.21	7.03	-19.57

[1]Depth Transects 1 = 6-20 m, 2 = 3-6 m, 3 = < 3 m [2]Silt and clay

Appendix Table H-1. Continued.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Silt %	Clay %	Mud[2] %	Mz Mean	δ Sort	O C mg g^{-1}	N mg g^{-1}	OC/N	$\delta^{13}C$
Herring Bay Site (16)	Oiled	1	1	gs61	22.53	46.65	20.37	10.45	30.82	2.43	3.59	7.69	0.81	9.50	-23.00
		2	1	gs63[3]								6.22	0.56	11.10	
		3	1	gs65	11.39	76.24	7.38	5.00	12.38	0.18	2.59	10.01	0.83	12.10	
				Mean	16.69	61.45	14.19	7.73	21.60	1.31	3.09	7.97	0.73	10.90	
		1	2	gs62	0.00	86.42	5.53	8.06	13.59	2.72	2.07	7.43	0.69	10.70	
		2	2	gs64	58.64	33.38	1.38	6.60	7.98	-1.92	4.91	5.45	0.48	11.40	
		3	2	gs66	74.62	15.13	4.36	5.90	10.26	-3.53	4.63	0.91	0.15	6.00	
				Mean	44.42	44.98	3.76	6.85	10.61	-0.91	3.87	4.60	0.44	9.37	
		1	3	gs67	23.62	60.09	7.70	8.59	16.28	1.10	4.94	9.12	0.77	11.80	-20.70
		2	3	gs68	3.35	86.60	2.34	7.72	10.06	2.03	2.06	4.35	0.45	9.70	-21.40
		3	3	gs69	0.00	69.28	13.38	17.34	30.72	5.20	3.35	19.92	1.93	10.30	-21.00
				Mean	8.99	71.99	7.81	11.22	19.02	2.78	3.45	11.13	1.05	10.60	-21.03
Lower Herring Bay Site (15)	Control	1	1	gs52	57.45	34.86	3.34	4.34	7.68	-1.87	4.26	13.06	1.31	10.00	
		2	1	gs53	0.00	41.39	27.46	31.15	58.61	6.08	3.34	52.38	5.21	10.10	-23.00
		3	1	gs54	52.06	26.34	7.03	14.58	21.61	0.98	3.91	9.50	1.02	9.30	
				Mean	36.50	34.20	12.61	16.69	29.30	1.73	3.84	24.98	2.51	9.80	
		3	2	gs55	94.11	0.71	5.18	0.00	5.18	-1.88	1.29	0.52	0.11	4.70	
		2	2	gs56	69.22	16.84	3.08	10.87	13.95	-0.23	3.37	5.54	0.56	9.90	
		1	2	gs57	93.65	0.52	1.66	4.16	5.82	-1.88	1.62	12.11	1.97	6.11	
				Mean	85.66	6.02	3.31	5.01	8.32	-1.33	2.09	6.06	0.88	6.90	
		1	3	gs58	4.87	6.23	30.73	58.17	88.90	8.67	3.42	77.49	11.73	6.60	-16.20
		2	3	gs59	9.76	10.79	46.70	32.74	79.44	5.97	4.62	62.81	7.39	8.50	-18.90
		3	3	gs60	0.00	5.00	14.10	80.40	94.50	9.63	2.38	108.92	11.51	9.50	-17.50
				Mean	4.88	7.34	30.51	57.10	87.61	8.09	3.47	83.07	10.21	8.20	-17.53

[1]Depth Transects 1 = 6-20 m, 2 = 3-6 m, 3 = < 3 m [2]Silt and clay [3]Insufficient quantity for complete analyses.

Appendix Table H-1. Continued.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Silt %	Clay %	Mud[2] %	Mz Mean	δ Sort	O C mg g^{-1}	N mg g^{-1}	OC/N	$\delta^{13}C$
Sleepy Bay Site (17)	Oiled	1	1	gs34	0.00	83.03	12.66	4.31	16.97	3.17	1.29	7.65	1.18	6.50	
		2	1	gs35	0.00	90.97	3.24	5.80	9.04	2.52	1.89	8.76	1.15	7.60	-23.60
		3	1	gs36	0.00	92.19	3.51	4.29	7.81	2.47	1.39	5.90	0.76	7.80	
				Mean	0.00	88.73	6.47	4.80	11.27	2.72	1.52	7.44	1.03	7.30	
		1	2	gs37	0.14	90.39	5.30	4.18	9.48	2.85	1.08	7.60	0.79	9.60	
		2	2	gs38	0.00	99.21	0.74	0.00	0.74	2.32	0.62	4.55	0.60	7.60	
		3	2	gs39	0.00	97.69	2.31	0.00	2.31	2.65	0.81	4.40	0.64	6.90	
				Mean	0.05	95.76	2.78	1.39	4.18	2.61	0.84	5.52	0.68	8.03	
		1	3	gs40	0.44	86.23	9.68	3.64	13.33	2.78	1.08	5.03	0.94	5.40	-21.10
		2	3	gs41	0.18	94.12	2.19	3.50	5.69	2.32	0.88	3.94	0.67	5.80	-22.80
		3	3	gs42	0.28	98.80	0.93	0.00	0.93	1.88	0.72	5.11	0.60	8.50	-23.00
				Mean	0.30	93.05	4.27	2.38	6.65	2.33	0.89	4.69	0.74	6.57	-22.30
Moose Lips Bay Site (18)	Control	1	1	gs43	0.00	62.86	33.03	4.10	37.14	4.07	1.05	5.81	0.85	6.80	
		2	1	gs44	0.00	40.99	40.88	18.13	59.01	5.85	3.30	5.30	1.00	5.30	-22.10
		3	1	gs45	0.00	60.14	34.47	5.39	39.86	4.03	1.42	3.76	0.55	6.80	
				Mean	0.00	54.66	36.13	9.21	45.34	4.65	1.92	4.96	0.80	6.30	
		1	2	gs46	0.00	85.00	15.00	0.00	15.00	3.42	0.68	3.36	0.49	6.90	
		2	2	gs47	0.00	85.34	11.11	3.55	14.66	3.10	0.93	3.55	0.58	6.10	
		3	2	gs48	14.12	78.45	4.86	2.57	7.43	1.80	2.65	2.56	0.44	5.80	
				Mean	4.71	82.93	10.32	2.04	12.36	2.77	1.42	3.16	0.50	6.27	
		1	3	gs49	0.00	90.01	5.93	4.07	10.00	3.20	0.69	2.59	0.41	6.30	-23.00
		2	3	gs50	0.00	83.35	8.24	8.41	16.65	3.18	2.20	3.19	0.52	6.10	-21.80
		3	3	gs51	29.36	59.89	4.96	5.79	10.75	0.23	5.01	3.33	0.50	6.70	-22.30
				Mean	9.79	77.75	6.38	6.09	12.47	2.20	2.63	3.04	0.48	6.37	-22.37

[1]Depth Transects 1 = 6-20 m, 2 = 3-6 m, 3 = < 3 m [2]Silt and clay

Appendix Table H-1. Continued.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Silt %	Clay %	Mud[2] %	Mz Mean	δ Sort	O C mg g^{-1}	N mg g^{-1}	OC/N	$\delta^{13}C$
Clammy Bay Site (25)	Oiled	1	1	gs70	0.00	77.16	14.37	8.47	22.84	3.58	2.19	7.89	0.82	9.60	
		2	1	gs72	0.00	90.89	1.98	7.13	9.11	2.77	2.29	4.89	0.70	7.00	-22.40
		3	1	gs74	0.00	84.45	7.33	8.22	15.55	3.32	1.90	6.52	0.82	8.00	
				Mean	0.00	84.17	7.89	7.94	15.83	3.22	2.13	6.43	0.78	8.20	
		1	2	gs71	0.00	93.27	2.39	4.34	6.73	2.60	0.98	3.89	0.68	5.70	
		2	2	gs73	0.00	98.53	1.42	0.00	1.42	2.40	0.62	4.52	0.77	5.90	
		3	2	gs75	0.00	99.83	0.17	0.00	0.17	2.07	0.93	4.16	0.62	6.70	
				Mean	0.00	97.21	1.33	1.45	2.77	2.36	0.84	4.19	0.69	6.10	
		1	3	gs76	0.00	96.66	3.34	0.00	3.34	2.58	0.55	4.75	0.72	6.60	-22.40
		2	3	gs77	0.00	98.63	1.37	0.00	1.37	2.28	0.69	4.69	0.65	7.20	-21.90
		3	3	gs78	0.00	90.51	4.33	5.16	9.49	2.30	1.60	6.16	0.81	7.60	-21.60
				Mean	0.00	95.27	3.01	1.72	4.73	2.39	0.95	5.20	0.73	7.13	-21.97
Puffin Bay Site (26)	Control	1	1	gs79	0.00	31.73	40.87	27.39	68.27	6.33	3.57	15.51	2.27	6.80	
		2	1	gs81	21.43	66.95	5.00	6.62	11.62	1.13	4.73	6.38	0.95	6.70	-22.30
		3	1	gs83	0.00	84.54	7.37	8.09	15.46	3.20	1.69	5.95	0.80	7.40	
				Mean	7.14	61.07	17.75	14.03	31.78	3.55	3.33	9.28	1.34	6.97	
		1	2	gs80	0.00	89.27	6.75	3.98	10.73	1.63	2.43	4.01	0.68	5.90	
		2	2	gs82	73.45	17.32	2.91	6.33	9.23	-1.95	3.06	6.91	0.84	8.20	
		3	2	gs84	1.33	95.90	2.77	0.00	2.77	2.02	0.97	4.20	0.68	6.20	
				Mean	24.93	67.50	4.14	3.44	7.58	0.57	2.15	5.04	0.73	6.77	
		1	3	gs85	0.24	80.41	19.35	0.00	19.35	2.43	1.30	4.11	0.65	6.30	-22.70
		2	3	gs86	0.00	96.22	3.78	0.00	3.78	2.63	0.60	4.80	0.76	6.30	-22.30
		3	3	gs87	0.00	98.59	1.40	0.00	1.40	2.18	0.65	3.96	0.64	6.20	-22.70
				Mean	0.08	91.74	8.18	0.00	8.18	2.41	0.85	4.29	0.68	6.27	-22.57

[1]Depth Transects 1 = 6-20 m, 2 = 3-6 m, 3 = < 3 m [2]Silt and clay

Appendix Table H-2. Granulometric composition, organic carbon (OC), nitrogen (N), OC/N ratios and stable carbon isotope ratios ($\delta^{13}C$) of surficial sediments from *Zostera* (eelgrass) habitats in western Prince William Sound, Alaska, Summer 1991.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Silt %	Clay %	Mud[2] %	Mz[3] Mean	δ[3] Sort	OC mg g^{-1}	N mg g^{-1}	OC/N	$\delta^{13}C$
Bay of Isles Site (13)	Oiled	1	1	25	0.00	30.98	45.09	23.94	69.03	6.39	3.09	112.40	11.40	9.90	
		2	1	26	0.10	7.04	86.16	6.97	93.13	4.33	1.44	110.70	11.20	9.90	-21.10
		3	1	27	0.00	18.79	45.63	35.58	81.21	10.00	5.20	111.00	10.90	10.20	
				Mean	0.03	18.94	58.96	22.16	81.12	6.91	3.24	111.37	11.17	10.00	
		1	3	28	0.00	33.82	34.78	31.40	66.18	9.03	7.22	144.40	11.60	12.40	
		2	3	29	0.00	30.69	40.46	28.84	69.31	6.80	3.46	63.40	4.00	15.90	-24.10
		3	3	30	0.00	29.32	60.41	10.27	70.68	3.98	1.58	155.20	12.90	12.00	
				Mean	0.00	31.28	45.22	23.50	68.72	6.60	4.09	121.00	9.50	13.43	
Drier Bay Site (14)	Control	1	1	13	1.45	61.54	30.73	6.28	37.01	3.62	1.52	46.10	3.50	13.20	
		2	1	14	1.00	61.80	18.06	19.14	37.20	3.50	1.57	42.30	2.90	14.60	-22.60
		3	1	15	44.83	36.07	9.28	9.82	19.10	0.54	3.28	28.00	2.90	9.60	
				Mean	15.76	53.14	19.36	11.75	31.10	2.55	2.12	38.80	3.10	12.47	
		1	3	16	4.25	49.72	30.98	15.05	46.03	3.90	1.45	62.90	6.10	10.30	
		2	3	17	0.69	75.95	18.35	5.01	23.36	2.09	1.32	60.60	4.70	12.90	-21.50
		3	3	18	0.22	43.16	31.34	25.28	56.62	3.95	1.81	69.20	6.90	10.00	
				Mean	1.72	56.28	26.89	15.11	42.00	3.31	1.53	64.23	5.90	11.07	

[1]Depth Transects 1 = 6-20 m, 3 = < 3 m

[2]Silt and clay.

[3]Some mean and sorting values were not calculated because all relevant percentiles could not be obtained from the cumulative curve.

Appendix Table H-2. Continued.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Silt %	Clay %	Mud[2] %	Mz[3] Mean	δ[3] Sort	OC $mg\ g^{-1}$	N $mg\ g^{-1}$	OC/N	$\delta^{13}C$
Herring Bay Site (16)	Oiled	1	1	34	37.08	46.77	12.93	3.22	16.15	12.47	4.30	17.50	1.50	11.70	
		2	1	35	27.54	61.38	8.29	2.79	11.07	0.59	3.29	3.80	0.50	7.60	-22.10
		3	1	36	48.65	42.90	7.57	0.88	8.44	-1.65	4.08	9.50	0.90	10.50	
				Mean	37.76	50.35	9.60	2.30	11.89	3.80	3.89	10.27	0.97	9.93	
		1	3	37	12.24	68.73	14.21	4.83	19.03	1.42	2.84	15.20	1.30	11.70	
		2	3	38	64.54	30.82	3.45	1.20	4.64	-1.25	1.90	3.10	0.30	10.30	-21.60
		3	3	39	13.11	73.78	5.76	7.36	13.12	1.92	3.16	24.10	1.50	16.10	
				Mean	29.96	57.78	7.81	4.46	12.26	0.70	2.63	14.13	1.03	12.70	
Lower Herring Bay Site (15)	Control	1	1	40	90.89	7.25	1.86	1.00	1.87	-3.18	1.32	25.10	2.70	9.30	
		2	1	41	91.19	2.23	3.81	2.76	6.58	-4.07	2.16	50.10	5.50	9.10	-21.70
		3	1	42	15.51	47.85	24.73	11.90	36.64	3.12	5.05	84.50	4.60	18.40	
				Mean	65.86	19.11	10.13	5.22	15.03	-1.38	2.84	53.23	4.27	12.27	
		1	3	43	0.00	25.93	18.87	55.21	74.08	6.57	3.82	66.60	4.30	15.50	
		2	3	44	20.49	45.57	11.13	22.81	33.94	3.80	6.54	40.00	3.80	10.50	-15.50
		3	3	45	73.32	21.59	2.38	2.71	5.09	-2.20	2.85	7.10	0.60	11.80	
				Mean	31.27	31.03	10.79	26.91	37.70	2.72	4.40	37.90	2.90	12.60	

[1]Depth Transects 1 = 6-20 m, 3 = < 3 m
[2]Silt and clay.
[3]Some mean and sorting values were not calculated because all relevant percentiles could not be obtained from the cumulative curve.

Appendix Table H-2. Continued.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Silt %	Clay %	Mud[2] %	Mz[3] Mean	δ[3] Sort	O C mg g^{-1}	N mg g^{-1}	OC/N	$\delta^{13}C$
Sleepy Bay Site (17)	Oiled	1	1	46	1.12	91.41	3.74	3.74	7.47	3.17	1.00	10.00	0.90	11.10	
		2	1	47	0.21	95.18	4.62	0.00	4.62	1.72	1.28	6.80	0.70	9.70	-22.90
		3	1	48	0.34	91.82	4.75	3.08	7.83	3.12	0.80	5.10	0.50	10.20	
				Mean	0.56	92.80	4.37	2.27	6.64	2.67	1.03	7.30	0.70	10.33	
		1	3	49	0.58	88.52	9.15	1.00	10.15	2.95	0.74	8.20	0.80	10.30	
		2	3	50	0.00	97.09	2.91	0.00	2.91	2.36	0.58	5.20	0.50	10.40	-22.50
		3	3	51	0.00	96.51	3.49	0.00	3.47	1.35	0.78	6.30	0.60	10.50	
				Mean	0.19	94.04	5.18	0.33	5.51	2.22	0.70	6.57	0.63	10.40	
Moose Lips Bay Site (18)	Control	1	1	52	84.77	15.24	0.00	0.00	0.00	-5.18	3.27	3.60	0.60	6.00	
		2	1	53	0.00	67.66	32.34	0.00	32.34	3.68	0.49	24.40	2.00	12.20	-22.10
		3	1	54	0.00	72.18	27.82	0.00	27.82	3.63	0.57	5.20	0.60	8.70	
				Mean	28.26	51.69	20.05	0.00	20.05	0.71	1.44	11.07	1.07	8.97	
		1	3	55	0.00	92.84	7.16	0.00	7.16	3.43	0.43	3.40	0.40	8.50	
		2	3	56[4]								4.90	0.70	7.00	-19.70
		3	3	57[4]								4.40	0.60	7.30	
				Mean	0.00	92.84	7.16	0.00	7.16	3.43	0.43	4.23	0.57	7.60	

[1]Depth Transects 1 = 6-20 m, 3 = < 3 m
[2]Silt and clay.
[3]Some mean and sorting values were not calculated because all relevant percentiles could not be obtained from the cumulative curve.
[4]Insufficient quantity for complete analysis.

Appendix Table H-2. Continued.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Silt %	Clay %	Mud[2] %	Mz[3] Mean	δ[3] Sort	O C $mg\ g^{-1}$	N $mg\ g^{-1}$	OC/N	$\delta^{13}C$
Clammy Bay Site (25)	Oiled	1	1	7	0.24	77.97	11.24	10.55	21.79	3.44	1.78	8.80	1.10	8.00	
		2	1	8	0.38	92.83	4.80	1.99	6.79	3.12	0.52	7.50	1.00	7.50	-22.70
		3	1	9	0.12	92.77	2.12	4.99	7.11	2.29	1.36	6.20	0.90	6.90	
				Mean	0.25	87.86	6.05	5.84	11.90	2.95	1.22	7.50	1.00	7.47	
		1	3	10	0.07	92.04	6.05	1.84	7.89	2.36	0.86	6.20	0.70	8.90	
		2	3	11	0.11	96.49	2.04	1.29	3.33	1.90	0.63	6.90	0.80	8.60	-22.10
		3	3	12	0.10	95.95	2.29	1.75	4.04	2.29	0.74	5.30	0.70	7.50	
				Mean	0.09	94.83	3.46	1.63	5.09	2.18	0.74	6.13	0.73	8.33	
Puffin Bay Site (26)	Control	1	1	1	1.68	73.82	20.26	4.24	24.50	2.11	1.82	14.10	1.40	10.10	
		2	1	3	42.32	52.88	3.66	1.14	4.80	0.02	3.13	5.20	0.80	6.50	-20.00
		3	1	5	0.15	94.94	3.11	2.00	5.11	2.19	0.97	5.80	0.90	6.40	
				Mean	14.72	73.88	9.01	2.46	11.47	1.44	1.97	8.37	1.03	7.67	
		1	3	2	0.45	87.24	0.60	11.71	12.31	2.52	1.76	5.40	0.90	6.00	
		2	3	4	0.47	92.71	4.37	0.85	5.22	2.77	0.59	7.10	1.00	7.10	-22.10
		3	3	6	0.07	87.69	2.55	8.29	10.84	2.57	1.95	8.30	1.00	8.30	
				Mean	0.33	89.21	2.51	6.95	9.46	2.62	1.43	6.93	0.97	7.13	

[1]Depth Transects 1 = 6-20 m, 3 = < 3 m
[2]Silt and clay.
[3]Some mean and sorting values were not calculated because all relevant percentiles could not be obtained from the cumulative curve.

Appendix Table H-2. Continued.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Silt %	Clay %	Mud[2] %	Mz[3] Mean	δ[3] Sort	O C mg g^{-1}	N mg g^{-1}	OC/N	$\delta^{13}C$
Short Arm	Oiled	1	3	31	0.00	2.49	22.85	74.66	97.51	12.47	5.52	44.80	5.20	8.60	
(Bay of		2	3	32	0.00	26.55	34.13	39.31	73.44			80.30	5.60	14.30	-20.30
Isles)		3	3	33	0.00	21.77	20.60	57.63	78.23			132.10	10.90	12.10	
Site(35)				**Mean**	0.00	16.94	25.86	57.20	83.06	12.47	5.52	85.73	7.23	11.67	
Mallard Bay	Control	1	1	19	0.00	82.30	11.36	6.34	17.70	4.09	1.26	85.50	9.20	9.30	
Site (34)		2	1	20	51.98	26.44	14.55	7.03	21.58	-1.46	5.57	43.80	5.30	8.30	-19.80
		3	1	21	0.00	45.64	35.29	19.07	56.36	4.26	1.29	53.70	6.20	8.70	
				Mean	17.33	51.46	20.40	10.81	31.88	2.30	2.71	61.00	6.90	8.77	
		1	3	22	0.00	62.40	20.25	17.35	37.60	6.54	1.43	102.00	10.60	9.60	
		2	3	23	0.00	57.94	24.38	17.68	42.06	3.64	1.52	68.40	6.60	10.30	-18.70
		3	3	24	4.34	43.73	30.81	21.12	51.93	3.93	1.88	68.40	6.60	10.40	
				Mean	1.45	54.69	25.15	18.72	43.86	4.70	1.61	79.60	7.93	10.10	

[1]Depth Transects 1 = 6-20 m, 3 = < 3 m
[2]Silt and clay.
[3]Some mean and sorting values were not calculated because all relevant percentiles could not be obtained from the cumulative curve.

Appendix Table H-3. Granulometric composition of surficial sediments from *Zostera* (eelgrass) habitats in western Prince William Sound, Alaska, Summer 1993.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Mud %
Bay of Isles Site (13)	Oiled	1	1	S19	9.91	32.69	57.40
		2	1	S20	0.55	43.34	56.11
		3	1	S21	0.26	45.76	53.98
				Mean	3.57	40.60	55.83
		1	3	S22	1.56	46.28	52.16
		2	3	S23	0.55	52.32	47.13
		3	3	S24	1.11	35.97	62.92
				Mean	1.07	44.86	54.07
Drier Bay Site (14)	Control	1	1	S25	0.36	75.40	24.24
		2	1	S26	0.09	59.65	40.26
		3	1	S27	18.62	45.06	36.32
				Mean	6.36	60.04	33.61
		1	3	S28	0.59	54.89	44.52
		2	3	S29	0.00	45.28	54.72
		3	3	S30	0.00	8.38	91.62
				Mean	0.20	36.18	63.62

[1]Depth Transects 1 = 6-20 m, 3 = < 3 m

Appendix Table H-3. Continued.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Mud %
Herring Bay Site (16)	Oiled	1	1	S13	29.50	60.97	9.53
		2	1	S14	12.02	64.78	23.20
		3	1	S15	2.34	94.35	3.31
				Mean	14.62	73.37	12.01
		1	3	S16	18.91	74.78	6.31
		2	3	S17	99.23	0.16	0.61
		3	3	S18	60.60	37.57	1.83
				Mean	59.58	37.50	2.92
Lower Herring Bay Site (15)	Control	1	1	S31	74.85	11.03	14.12
		2	1	S32	92.95	1.25	5.80
		3	1	S33	82.41	10.61	6.98
				Mean	83.40	7.63	8.97
		1	3	S34	2.79	10.27	86.94
		2	3	S35	2.21	34.67	63.12
		3	3	S36	1.39	17.22	81.39
				Mean	2.13	20.22	77.15

[1]Depth Transects 1 = 6-20 m, 3 = < 3 m

Appendix Table H-3. Continued.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Mud %
Sleepy Bay Site (17)	Oiled	1	1	S1	0.19	86.01	13.80
		2	1	S2	0.54	84.28	15.18
		3	1	S3	1.35	88.38	10.27
				Mean	0.69	86.22	13.08
		1	3	S4	0.40	94.39	5.21
		2	3	S5	0.17	98.35	1.48
		3	3	S6	1.65	96.42	1.93
				Mean	0.74	96.39	2.87
Moose Lips Bay Site (18)	Control	1	1	S7	0.43	65.38	34.19
		2	1	S8	0.04	65.80	34.16
		3	1	S9	0.15	64.94	34.91
				Mean	0.21	65.37	34.91
		1	3	S10	0.00	96.71	3.29
		2	3	S11	0.00	94.66	5.34
		3	3	S12	0.13	96.45	3.42
				Mean	0.04	95.94	4.12

[1]Depth Transects 1 = 6-20 m, 3 = < 3 m

Appendix Table H-4. Granulometric composition of surficial sediments from *Zostera* (eelgrass) habitats in western Prince William Sound, Alaska, Summer 1995.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Mud %
Bay of Isles Site (13)	Oiled	1	1	S13	0.00	5.80	94.20
		2	1	S14	11.40	6.30	82.30
		3	1	S15	0.00	26.50	73.50
				Mean	3.80	12.87	83.33
		1	3	S16	1.40	33.00	65.60
		2	3	S17	5.50	56.70	37.80
		3	3	S18	9.70	32.20	58.10
				Mean	5.53	40.63	53.83
Drier Bay Site (14)	Control	1	1	S19	0.00	46.40	53.60
		2	1	S20	0.40	53.30	46.30
		3	1	S21	0.00	59.80	40.20
				Mean	0.13	53.17	46.70
		1	3	S22	1.00	48.70	50.30
		2	3	S23	0.00	34.30	65.70
		3	3	S24	0.00	57.30	42.70
				Mean	0.33	46.77	52.90

[1]Depth Transects 1 = 6-20 m, 3 = < 3 m

Appendix Table H-4. Continued.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Mud %
Herring Bay Site (16)	Oiled	1	1	S31	25.20	59.00	15.80
		2	1	S32	40.90	54.10	5.00
		3	1	S33	29.60	64.70	5.70
				Mean	31.90	59.27	8.83
		1	3	S34	65.30	26.50	8.20
		2	3	S35	47.50	50.10	2.40
		3	3	S36	16.20	72.90	10.90
				Mean	43.00	49.83	7.17
Lower Herring Bay Site (15)	Control	1	1	S25	91.00	2.80	6.20
		2	1	S26	11.10	78.70	10.20
		3	1	S27	80.40	11.90	7.70
				Mean	60.83	31.13	8.00
		1	3	S28	10.60	61.20	28.20
		2	3	S29	50.30	40.20	9.50
		3	3	S30	1.90	26.70	71.40
				Mean	20.93	42.70	36.37

[1]Depth Transects 1 = 6-20 m, 3 = < 3 m

Appendix Table H-4. Continued.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Mud %
Sleepy Bay Site (17)	Oiled	1	1	S7	1.50	94.30	4.20
		2	1	S8	2.90	95.20	1.90
		3	1	S9	0.40	96.80	2.80
				Mean	1.60	95.43	2.97
		1	3	S10	0.70	79.60	19.70
		2	3	S11	0.00	92.50	7.50
		3	3	S12	0.00	89.80	10.20
				Mean	0.23	87.30	12.47
Moose Lips Bay Site (18)	Control	1	1	S1	0.20	62.90	36.90
		2	1	S2	0.00	53.80	46.20
		3	1	S3	0.00	47.60	52.40
				Mean	0.07	54.77	45.17
		1	3	S4	0.70	91.40	7.90
		2	3	S5	0.00	88.40	11.60
		3	3	S6	0.00	87.10	12.90
				Mean	0.23	88.97	10.80

[1]Depth Transects 1 = 6-20 m, 3 = < 3 m

Appendix Table H-4. Continued.

Site (#)	Site Oiling Status	Sta.	Depth[1] Trans.	Sample #	Gravel %	Sand %	Mud %
Clammy Bay Site (25)	Oiled	1	1	S43	0.00	90.80	9.20
		2	1	S44	0.00	96.60	3.40
		3	1	S45	0.00	94.20	5.80
				Mean	0.00	93.87	6.13
		1	3	S46	2.00	95.90	2.10
		2	3	S47	0.40	97.50	2.10
		3	3	S48	0.00	97.50	2.50
				Mean	0.80	96.97	2.23
Puffin Bay Site (26)	Control	1	1	S37	0.20	86.30	13.50
		2	1	S38	3.20	86.00	10.80
		3	1	S39	22.60	67.50	9.90
				Mean	8.67	79.93	11.40
		1	3	S40	0.20	78.70	21.10
		2	3	S41	0.10	89.50	10.40
		3	3	S42	7.00	85.10	7.90
				Mean	2.43	84.43	13.13

[1]Depth Transects 1 = 6-20 m, 3 = < 3 m

Appendix H-5. Means, standard errors, and results of one-way and two-way randomization ANOVAs for percent mud and sand.

PERCENT MUD
Depth Stratum = 6 to 20 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN %MUD	SE % MUD	N STATIONS
1990	13	O	Percent Mud	93.6333	3.6485	3
1990	14	C	Percent Mud	30.5333	1.6438	3
1990	16	O	Percent Mud	21.6000	9.2200	3
1990	15	C	Percent Mud	29.3000	15.1967	3
1990	17	O	Percent Mud	11.2733	2.8704	3
1990	18	C	Percent Mud	45.3367	6.8816	3
1991	13	O	Percent Mud	81.1233	6.9572	3
1991	14	C	Percent Mud	31.1033	6.0019	3
1991	16	O	Percent Mud	11.8867	2.2628	3
1991	15	C	Percent Mud	15.0300	10.8902	3
1991	17	O	Percent Mud	6.6433	1.0173	3
1991	18	C	Percent Mud	20.0533	10.1112	3
1993	13	O	Percent Mud	55.8300	0.9971	3
1993	14	C	Percent Mud	33.6067	4.8195	3
1993	16	O	Percent Mud	12.0133	5.8745	3
1993	15	C	Percent Mud	8.9667	2.5991	3
1993	17	O	Percent Mud	13.0833	1.4620	3
1993	18	C	Percent Mud	34.4200	0.2452	3
1995	13	O	Percent Mud	83.3333	5.9979	3
1995	14	C	Percent Mud	46.7000	3.8734	3
1995	16	O	Percent Mud	8.8333	3.4892	3
1995	15	C	Percent Mud	8.0333	1.1667	3
1995	17	O	Percent Mud	2.9667	0.6692	3
1995	18	C	Percent Mud	45.1667	4.5042	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MUD	SEMUD	N SITES
1990	O	Percent Mud	42.1689	25.9043	3
1990	C	Percent Mud	35.0567	5.1523	3
1991	O	Percent Mud	33.2178	24.0006	3
1991	C	Percent Mud	22.0622	4.7474	3
1993	O	Percent Mud	26.9756	14.4305	3
1993	C	Percent Mud	25.6644	8.3522	3
1995	O	Percent Mud	31.7111	25.8666	3
1995	C	Percent Mud	33.3000	12.6411	3

One-way randomized within blocks

YEAR	P for oil code
1990	0.63
1991	0.37
1993	0.86
1995	0.87

Two-way randomized within blocks

P values for:

Interaction	Oilcode	Year
0.797	0.351	0.22

PERCENT MUD
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN %MUD	SE % MUD	N STATIONS
1990	13	O	Percent Mud	98.2267	0.7367	3
1990	14	C	Percent Mud	86.1300	4.9898	3
1990	16	O	Percent Mud	19.0200	6.1194	3
1990	15	C	Percent Mud	87.6133	4.3948	3
1990	17	O	Percent Mud	6.6500	3.6116	3
1990	18	C	Percent Mud	12.4667	2.1028	3
1991	13	O	Percent Mud	68.7233	1.3317	3
1991	14	C	Percent Mud	42.0033	9.8102	3
1991	16	O	Percent Mud	12.2633	4.1761	3
1991	15	C	Percent Mud	37.7033	20.0044	3
1991	17	O	Percent Mud	5.7667	2.5721	3
1991	18	C	Percent Mud	7.1600	.	3
1993	13	O	Percent Mud	54.0700	4.6571	3
1993	14	C	Percent Mud	63.6200	14.3063	3
1993	16	O	Percent Mud	2.9167	1.7328	3
1993	15	C	Percent Mud	77.1500	7.1956	3
1993	17	O	Percent Mud	2.8733	1.1755	3
1993	18	C	Percent Mud	4.0167	0.6627	3
1995	13	O	Percent Mud	53.8333	8.3039	3
1995	14	C	Percent Mud	52.9000	6.7656	3
1995	16	O	Percent Mud	7.1667	2.5075	3
1995	15	C	Percent Mud	36.3667	18.3296	3
1995	17	O	Percent Mud	12.4667	3.6997	3
1995	18	C	Percent Mud	10.8000	1.4978	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MUD	SEMUD	N SITES
1990	O	Percent Mud	41.2989	28.6870	3
1990	C	Percent Mud	62.0700	24.8054	3
1991	O	Percent Mud	28.9178	19.9909	3
1991	C	Percent Mud	28.9556	10.9682	3
1993	O	Percent Mud	19.9533	17.0583	3
1993	C	Percent Mud	48.2622	22.4649	3
1995	O	Percent Mud	24.4889	14.7518	3
1995	C	Percent Mud	33.3556	12.2461	3

One-way randomized within blocks

YEAR	P for oil code
1990	0.20
1991	0.98
1993	0.09
1995	0.33

Two-way randomized within blocks

P values for:

Interaction	Oilcode	Year
0.286	0.015	0.013

PERCENT SAND
Depth Stratum = 6 to 20 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN %MUD	SE % MUD	N STATIONS
1990	13	O	Percent Sand	6.3700	3.6471	3
1990	14	C	Percent Sand	56.5133	11.3234	3
1990	16	O	Percent Sand	61.4450	14.7950	3
1990	15	C	Percent Sand	34.1967	4.3572	3
1990	17	O	Percent Sand	88.7300	2.8717	3
1990	18	C	Percent Sand	54.6633	6.8816	3
1991	13	O	Percent Sand	18.8467	6.9831	3
1991	14	C	Percent Sand	53.1367	8.5337	3
1991	16	O	Percent Sand	50.3500	5.6270	3
1991	15	C	Percent Sand	19.1100	14.4429	3
1991	17	O	Percent Sand	92.8033	1.1942	3
1991	18	C	Percent Sand	51.6933	18.2733	3
1993	13	O	Percent Sand	40.5967	4.0146	3
1993	14	C	Percent Sand	60.0367	8.7605	3
1993	16	O	Percent Sand	73.3667	10.5492	3
1993	15	C	Percent Sand	7.6300	3.1923	3
1993	17	O	Percent Sand	86.2233	1.1884	3
1993	18	C	Percent Sand	65.3733	0.2483	3
1995	13	O	Percent Sand	12.8667	6.8182	3
1995	14	C	Percent Sand	53.1667	3.8688	3
1995	16	O	Percent Sand	59.2667	3.0629	3
1995	15	C	Percent Sand	31.1333	23.9280	3
1995	17	O	Percent Sand	95.4333	0.7311	3
1995	18	C	Percent Sand	54.7667	4.4431	3

Means by year and category

YEAR	OILCODE	TAXANAME	SAND	SESAND	N SITES
1990	O	Percent Sand	52.1817	24.2222	3
1990	C	Percent Sand	48.4578	7.1505	3
1991	O	Percent Sand	54.0000	21.4273	3
1991	C	Percent Sand	41.3133	11.1095	3
1993	O	Percent Sand	66.7289	13.5830	3
1993	C	Percent Sand	44.3467	18.4229	3
1995	O	Percent Sand	55.8556	23.8959	3
1995	C	Percent Sand	46.3556	7.6251	3

One-way randomized within blocks

YEAR	P for oil code
1990	0.90
1991	0.38
1993	0.13
1995	0.52

Two-way randomized within blocks

P values for:

Interaction	Oilcode	Year
0.677	0.034	0.787

PERCENT SAND
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN %MUD	SE % MUD	N STATIONS
1990	13	O	Percent Sand	1.7800	0.7350	3
1990	14	C	Percent Sand	12.7867	4.4632	3
1990	16	O	Percent Sand	71.9900	7.7718	3
1990	15	C	Percent Sand	7.3400	1.7612	3
1990	17	O	Percent Sand	93.0500	3.6679	3
1990	18	C	Percent Sand	77.7500	9.1346	3
1991	13	O	Percent Sand	31.2767	1.3317	3
1991	14	C	Percent Sand	56.2767	10.0173	3
1991	16	O	Percent Sand	57.7767	13.5569	3
1991	15	C	Percent Sand	31.0300	7.3772	3
1991	17	O	Percent Sand	94.0400	2.7651	3
1991	18	C	Percent Sand	92.8400	.	3
1993	13	O	Percent Sand	44.8567	4.7732	3
1993	14	C	Percent Sand	36.1833	14.1758	3
1993	16	O	Percent Sand	37.5033	21.5410	3
1993	15	C	Percent Sand	20.7200	7.2578	3
1993	17	O	Percent Sand	96.3867	1.1433	3
1993	18	C	Percent Sand	95.9400	0.6444	3
1995	13	O	Percent Sand	40.6333	8.0367	3
1995	14	C	Percent Sand	46.7667	6.7095	3
1995	16	O	Percent Sand	49.8333	13.3952	3
1995	15	C	Percent Sand	42.7000	10.0374	3
1995	17	O	Percent Sand	87.3000	3.9281	3
1995	18	C	Percent Sand	88.9667	1.2732	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	SAND	SESAND	N SITES
1990	O	Percent Sand	55.6067	27.5914	3
1990	C	Percent Sand	32.6256	22.6169	3
1991	O	Percent Sand	61.0311	18.1911	3
1991	C	Percent Sand	60.0489	17.9424	3
1993	O	Percent Sand	59.5822	18.5242	3
1993	C	Percent Sand	50.9478	22.9347	3
1995	O	Percent Sand	59.2556	14.2715	3
1995	C	Percent Sand	59.4778	14.7911	3

One-way randomized within blocks

YEAR	P for oil code
1990	0.12
1991	0.94
1993	0.34
1995	0.97

Two-way randomized within blocks

P values for:

Interaction	Oilcode	Year
0.263	0.103	0.073

Appendix H-6. Summary of sediment grain size analyses in eelgrass habitats.

● = greater at oiled sites
○ = greater at control sites
X = significant difference exists

●●●, ○○○, XXX = $P \leq 0.01$
●●, ○○, XX = $0.01 < P \leq 0.05$
●, ○, X = $0.05 < P \leq 0.1$
– = $P > 0.1$

	1-Way Test				2 - Way Test		
	1990	1991	1993	1995	Oilcode	Year	Interaction
Deep (6-20 m)							
Percent Mud	–	–	–	–	–	–	–
Percent Sand	–	–	–	–	●●	–	–
Eelgrass Bed (< 3 m)							
Percent Mud	–	–	○	–	○○	XX	–
Percent Sand	–	–	–	–	–	X	–

Appendix I.

Concentrations of polynuclear aromatic hydrocarbon (PAH) analytes in sediments from subtidal eelgrass sites in Prince William Sound, 1990.

Appendix I-1. Concentrations of polynuclear aromatic hydrocarbon (PAH) analytes in sediments from subtidal eelgrass habitat sites in Prince William Sound, 1990. TPAH = total PAH-perylene. Zero values indicate that the concentration of the analyte was below MDL. Numbers are in bold where the PAH composition pattern matched weathered EVO.

SITE	Bay of Isles	Bay of Isles	Bay of Isles	Bay of Isles	Bay of Isles	Drier Bay	Drier Bay
SITE (#)	13	13	13	13	13	14	14
DEPTH	6-20 m	6-20 m	< 3 m	< 3 m	< 3 m	6-20 m	6-20 m
TREATMENT	Oiled	Oiled	Oiled	Oiled	Oiled	Control	Control
COLLECTED	04-Jul-90	05-Jul-90	05-Jul-90	05-Jul-90	05-Jul-90	06-Jul-90	06-Jul-90
ID #	190201	190202	190206	190207	190208	190210	190211
PAH's (ng/g dry wt)							
Naph	20.38	16.80	31.70	21.27	31.97	11.98	5.95
C1naph	39.33	32.50	50.60	21.42	38.10	19.46	10.00
C2naph	44.89	62.90	26.00	84.11	122.65	23.99	9.75
C3naph	67.15	146.80	59.10	208.06	422.93	38.68	16.34
C4naph	158.28	1089.10	311.20	294.08	614.16	40.12	104.45
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorene	0.00	0.00	28.90	0.00	0.00	0.00	0.00
C1fluor	34.44	235.30	140.70	99.98	157.91	14.08	25.06
C2fluor	450.70	2353.40	2180.10	374.22	672.57	47.89	237.33
C3fluor	1116.61	4062.10	3664.80	639.73	1172.29	85.31	369.72
Dithio	13.76	69.70	65.20	57.13	99.65	9.43	9.92
C1dithio	178.36	721.90	830.70	258.53	460.43	37.05	102.60
C2dithio	562.14	1882.40	1942.00	488.33	881.42	64.77	216.74
C3dithio	445.51	1253.50	1386.60	514.99	852.14	62.70	151.30
Phenanth	78.73	414.80	341.90	162.67	247.40	26.75	51.20
C1phenan	718.31	2873.00	2850.10	546.26	908.17	82.27	328.31
C2phenan	1383.24	4469.40	4007.40	869.54	1588.51	121.91	526.36
C3phenan	801.40	2182.20	2456.60	601.49	1190.37	86.54	232.78
C4phenan	313.55	903.00	1535.20	324.87	679.74	42.76	110.24
Anthra	0.00	79.00	61.70	0.00	0.00	0.00	0.00
Fluorant	33.54	67.20	72.30	69.67	125.79	12.07	14.89
Pyrene	103.24	307.00	275.90	510.55	875.75	76.81	40.90
C1fluora	121.59	383.80	300.90	708.45	1544.73	118.37	37.63
Benanth	0.00	0.00	0.00	0.00	0.00	0.00	3.70
Chrysene	14.74	16.50	9.00	54.12	61.85	8.14	3.60
C1chrys	17.82	20.70	0.00	97.92	118.02	14.05	3.10
C2chrys	38.42	29.70	0.00	119.66	96.36	8.41	0.00
C3chrys	15.56	11.50	0.00	97.76	46.01	2.85	0.00
C4chrys	9.02	14.00	0.00	25.87	24.20	0.00	0.00
Benzobfl	13.01	0.00	0.00	0.00	0.00	0.00	0.00
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benapy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Perylene	193.09	128.50	74.80	71.89	0.00	38.83	0.00
Indeno	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dibenz	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	7.90	5.60	4.40	11.11	0.00	3.36	1.90
TPAH	6801.62	23703.80	22633.00	**7261.79**	**13033.12**	**1059.75**	2613.77
Mean		15252.71		14309.30			1836.76
SE		8451.09		4482.93			777.01
CV %		78.36		54.26			59.8

Appendix I-1. Continued.

SITE	Drier Bay	Drier Bay	Drier Bay	Herring Bay	Herring Bay	Herring Bay	Herring Bay
SITE (#)	14	14	14	16	16	16	16
DEPTH	< 3 m	< 3 m	< 3 m	6-20 m	6-20 m	6-20 m	< 3 m
TREATMENT	Control	Control	Control	Oiled	Oiled	Oiled	Oiled
COLLECTED	07-Jul-90	07-Jul-90	07-Jul-90	15-Jul-90	15-Jul-90	15-Jul-90	16-Jul-90
ID #	190215	190216	190217	190245	190247	190249	190251
PAH's (ng/g dry wt)							
Naph	6.79	11.03	14.11	7.46	2.91	3.31	1.26
C1naph	12.13	21.63	23.43	5.36	2.06	2.33	0.92
C2naph	14.75	40.07	32.06	3.65	0.00	0.00	0.00
C3naph	21.17	64.21	44.03	2.39	0.00	0.00	4.85
C4naph	99.85	99.30	28.04	0.00	0.00	0.00	8.42
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1fluor	24.11	0.00	0.00	0.00	0.00	0.00	0.00
C2fluor	175.18	197.35	40.36	8.63	0.00	0.00	8.66
C3fluor	221.33	371.99	28.47	9.93	0.00	8.12	19.16
Dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1dithio	62.48	82.60	18.90	0.00	0.00	0.00	3.49
C2dithio	117.18	179.57	16.84	0.00	0.00	0.00	21.16
C3dithio	66.42	111.68	17.36	0.00	0.00	0.00	36.31
Phenanth	46.37	42.66	23.51	5.39	2.24	2.43	3.49
C1phenan	221.38	317.73	44.72	10.10	0.89	0.79	9.08
C2phenan	260.69	430.57	44.37	11.66	7.27	0.00	32.10
C3phenan	92.34	117.52	21.55	0.00	0.00	0.00	41.48
C4phenan	31.67	35.26	23.00	0.00	0.00	0.00	34.28
Anthra	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	10.13	12.68	8.55	2.82	2.78	1.42	4.78
Pyrene	20.68	30.07	0.00	4.43	3.38	3.62	6.58
C1fluora	13.84	18.09	17.87	0.00	0.00	0.00	14.73
Benanth	0.00	0.00	0.00	0.00	0.00	0.00	2.67
Chrysene	4.43	5.88	6.33	4.97	3.04	1.95	17.70
C1chrys	6.97	8.44	6.93	0.00	0.00	0.00	17.47
C2chrys	9.77	23.28	17.87	0.00	0.00	0.00	24.48
C3chrys	0.00	0.00	0.00	0.00	0.00	0.00	14.85
C4chrys	0.00	0.00	0.00	0.00	0.00	0.00	4.41
Benzobfl	0.00	0.00	0.00	2.07	0.00	0.00	7.30
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	0.00	0.00	0.00	3.18	0.00	0.00	5.69
Benapy	0.00	0.00	0.00	1.56	0.00	0.00	2.60
Perylene	133.47	72.04	55.66	29.15	8.41	7.74	4.31
Indeno	0.00	0.00	0.00	0.00	0.00	0.00	2.18
Dibenz	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	4.34	5.06	4.87	2.67	0.90	0.59	2.20
TPAH	1544.00	2226.67	**483.17**	86.27	25.47	24.56	**352.30**
Mean		1417.95			45.43		
SE		507.24			20.42		
CV %		61.96			77.85		

Appendix I-1. Continued.

SITE	Herring Bay	Herring Bay	L. Herring B.	L. Herring B.	L. Herring B.	L. Herring B.	L. Herring B.
SITE (#)	16	16	15	15	15	15	15
DEPTH	< 3 m	< 3 m	6-20 m	6-20 m	< 3 m	< 3 m	< 3 m
TREATMENT	Oiled	Oiled	Control	Control	Control	Control	Control
COLLECTED	16-Jul-90	16-Jul-90	13-Jul-90	13-Jul-90	14-Jul-90	14-Jul-90	14-Jul-90
ID #	190252	190253	190237	190238	190242	190243	190244
PAH's (ng/g dry wt)							
Naph	0.74	4.62	16.86	1.57	0.00	6.03	7.36
C1naph	0.00	7.20	27.54	2.22	3.19	11.84	11.57
C2naph	0.00	0.00	33.50	2.58	10.31	18.01	0.00
C3naph	0.00	15.30	52.54	5.68	19.69	27.02	19.32
C4naph	3.59	0.00	75.99	18.64	23.77	30.00	27.63
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1fluor	0.00	0.00	23.56	4.19	0.00	10.64	0.00
C2fluor	3.09	14.29	84.34	56.37	28.19	24.82	21.51
C3fluor	3.59	25.53	135.39	122.32	31.46	23.47	38.36
Dithio	0.00	0.00	11.59	0.00	0.00	0.00	0.00
C1dithio	5.17	0.00	49.14	20.83	16.61	14.82	16.23
C2dithio	6.75	18.12	95.51	59.34	23.92	16.59	21.45
C3dithio	3.48	31.16	77.05	50.00	15.23	8.58	14.55
Phenanth	1.59	43.56	37.92	9.70	12.31	14.40	13.25
C1phenan	8.07	20.86	114.97	76.29	32.11	29.29	28.98
C2phenan	7.71	30.53	168.25	160.72	36.34	28.58	30.05
C3phenan	8.94	37.34	113.64	82.00	19.46	12.27	19.10
C4phenan	1.38	34.73	52.22	191.75	0.00	5.25	0.00
Anthra	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	1.18	59.11	14.36	2.97	2.19	2.62	3.20
Pyrene	0.00	33.89	97.95	11.68	16.31	0.00	0.00
C1fluora	3.69	18.14	142.67	6.35	19.46	9.64	10.45
Benanth	2.91	0.00	0.00	0.00	0.00	0.00	0.00
Chrysene	3.04	25.30	6.12	0.00	0.00	2.41	0.00
C1chrys	6.68	24.29	910.87	0.83	0.00	0.00	0.00
C2chrys	4.57	42.01	581.22	2.33	0.00	0.00	0.00
C3chrys	2.30	23.14	0.00	0.00	0.00	0.00	0.00
C4chrys	0.00	14.31	0.00	0.00	0.00	0.00	0.00
Benzobfl	0.00	8.54	0.00	3.44	0.00	0.00	0.00
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benapy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Perylene	0.00	0.00	106.41	9.47	0.00	32.48	35.16
Indeno	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dibenz	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	0.00	2.51	1.70	0.00	0.00	0.00	0.00
TPAH	**78.47**	**534.48**	**2924.90**	891.80	310.55	296.28	283.01
Mean	321.75			1908.35		296.61	
SE	132.52			1016.55		7.95	
CV %	71.34			75.33		4.64	

Appendix I-1. Continued.

SITE	Sleepy Bay	Sleepy Bay	Sleepy Bay	Sleepy Bay	Sleepy Bay	Moose Lips B.	Moose Lips B.
SITE (#)	17	17	17	17	17	18	18
DEPTH	6-20 m	6-20 m	< 3 m	< 3 m	< 3 m	6-20 m	6-20 m
TREATMENT	Oiled	Oiled	Oiled	Oiled	Oiled	Control	Control
COLLECTED	08-Jul-90	08-Jul-90	08-Jul-90	08-Jul-90	08-Jul-90	11-Jul-90	11-Jul-90
ID #	190219	190220	190224	190225	190226	190228	190229
PAH's (ng/g dry wt)							
Naph	4.44	2.19	1.37	1.30	1.66	3.86	2.74
C1naph	5.12	3.24	2.56	1.08	2.06	6.93	3.62
C2naph	7.34	3.60	2.66	0.00	3.18	7.27	3.68
C3naph	15.58	4.77	5.36	3.03	4.29	9.37	4.69
C4naph	41.07	7.13	20.47	3.75	3.92	5.05	3.35
Biphenyl	0.00	0.00	0.00	0.00	0.00	2.76	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorene	3.08	0.00	0.00	0.00	0.00	4.42	2.92
C1fluor	5.76	0.00	2.85	0.00	0.00	4.04	3.74
C2fluor	33.91	4.48	22.47	4.28	2.94	0.00	4.60
C3fluor	80.59	10.61	41.50	8.12	7.55	0.00	5.02
Dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1dithio	9.14	3.54	6.45	2.07	2.32	0.00	2.04
C2dithio	33.08	5.71	32.40	5.12	4.76	0.00	2.83
C3dithio	61.54	4.26	67.50	6.90	6.16	0.00	2.71
Phenanth	13.26	10.99	5.52	3.48	4.10	10.65	8.11
C1phenan	17.92	12.82	15.43	5.50	5.20	8.61	9.94
C2phenan	52.40	12.95	56.19	8.85	9.10	4.73	7.09
C3phenan	87.53	8.89	82.45	8.34	7.14	2.68	4.96
C4phenan	135.06	14.96	85.06	7.96	8.18	2.11	1.98
Anthra	6.46	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	27.88	31.10	7.01	3.08	4.40	1.25	1.13
Pyrene	23.96	25.71	6.90	3.39	3.49	4.51	4.98
C1fluora	96.40	18.80	26.43	4.86	3.99	4.37	5.30
Benanth	40.26	3.28	8.17	0.00	1.66	0.00	0.00
Chrysene	92.08	15.66	20.29	3.10	3.60	3.00	2.24
C1chrys	113.33	11.74	39.43	5.57	5.86	2.68	1.90
C2chrys	166.43	18.80	65.26	9.06	11.01	1.99	1.92
C3chrys	107.73	11.83	36.90	6.49	6.60	0.00	0.00
C4chrys	49.54	6.06	13.68	3.24	3.39	0.00	0.00
Benzobfl	29.48	6.00	4.39	0.00	0.00	5.05	3.62
Benzokfl	22.09	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	44.43	5.73	8.67	0.00	0.00	2.78	0.00
Benapy	17.63	1.93	1.59	0.00	0.00	0.00	0.00
Perylene	22.92	0.00	6.52	0.00	0.00	16.74	11.75
Indeno	9.93	0.00	0.00	0.00	0.00	0.00	0.00
Dibenz	5.07	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	14.73	2.13	2.77	0.69	0.57	6.12	4.06
TPAH	1474.25	268.91	691.73	109.26	117.13	104.23	99.17
Mean		871.58		306.04			101.70
SE		602.67		192.86			2.53
CV %		97.79		109.15			3.52

Appendix I-1. Continued.

SITE	Moose Lips B.	Moose Lips B.	Moose Lips B.
SITE (#)	18	18	18
DEPTH	< 3 m	< 3 m	< 3 m
TREATMENT	Control	Control	Control
COLLECTED	12-Jul-90	12-Jul-90	12-Jul-90
ID #	190233	190234	190235
PAH's (ng/g dry wt)			
Naph	2.96	2.48	13.60
C1naph	3.59	3.61	6.67
C2naph	4.24	3.58	4.64
C3naph	5.58	5.85	8.74
C4naph	5.24	4.54	8.96
Biphenyl	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00
Fluorene	3.46	2.73	2.96
C1fluor	3.84	3.49	4.72
C2fluor	5.37	7.17	9.39
C3fluor	5.22	8.02	10.58
Dithio	0.00	0.00	0.00
C1dithio	2.26	3.73	6.49
C2dithio	3.35	5.60	9.34
C3dithio	0.00	4.08	5.16
Phenanth	8.57	8.33	10.51
C1phenan	8.16	11.81	14.89
C2phenan	5.02	9.46	13.21
C3phenan	2.78	4.06	6.20
C4phenan	0.00	2.18	3.07
Anthra	0.00	0.00	0.00
Fluorant	1.11	1.30	1.66
Pyrene	4.33	5.99	8.80
C1fluora	3.37	5.91	9.05
Benanth	0.00	0.00	0.00
Chrysene	2.31	1.75	1.97
C1chrys	1.45	1.18	1.67
C2chrys	1.46	0.78	1.29
C3chrys	0.00	0.00	0.00
C4chrys	0.00	0.00	0.00
Benzobfl	2.75	2.52	2.77
Benzokfl	0.00	0.00	0.00
Benepy	0.00	0.00	0.00
Benapy	0.00	0.00	0.00
Perylene	8.42	6.02	6.87
Indeno	0.00	0.00	0.00
Dibenz	0.00	0.00	0.00
Benzop	3.77	3.06	3.22
TPAH	90.19	113.21	169.56
Mean		124.32	
SE		23.58	
CV %		32.85	

Appendix I-2. Concentrations of polynuclear aromatic hydrocarbon (PAH) analytes in sediments from subtidal eelgrass habitat sites in Prince William Sound, 1991. TPAH = total PAH-perylene. Zero values indicate that the concentration of the analyte was below MDL. Numbers are in bold where the PAH composition pattern matched weathered EVO.

SITE	Bay of Isles	Bay of Isles	Bay of Isles	Bay of Isles	Bay of Isles	Bay of Isles	Drier Bay
SITE #	13	13	13	13	13	13	14
DEPTH	6-20 m	6-20 m	6-20 m	< 3 m	< 3 m	< 3 m	6-20 m
TREATMENT	Oiled	Oiled	Oiled	Oiled	Oiled	Oiled	Control
COLLECTED	16-Jul-91	16-Jul-91	16-Jul-91	16-Jul-91	16-Jul-91	16-Jul-91	14-Jul-91
ID #	209909	209910	209911	209912	209913	209914	209817
PAH's (ng/g dry wt)							
Naph	9.50	5.53	7.33	8.31	8.59	8.29	3.91
C1naph	32.96	15.03	24.73	38.51	25.98	15.72	4.59
C2naph	105.84	23.05	52.86	81.76	65.87	18.72	5.27
C3naph	148.42	28.70	57.04	119.52	72.54	31.02	6.37
C4naph	146.16	34.17	42.67	117.52	39.66	48.88	6.60
Biphenyl	6.23	0.00	5.33	7.25	5.42	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorene	7.80	5.34	7.33	14.56	6.16	0.00	0.00
C1fluor	18.62	9.63	11.64	40.94	10.90	15.30	2.72
C2fluor	62.39	24.04	28.79	73.76	24.35	40.94	7.11
C3fluor	126.79	36.65	38.55	72.07	39.26	35.38	4.87
Dithio	7.17	4.53	4.55	20.00	4.86	0.00	0.00
C1dithio	38.49	14.04	12.79	39.63	11.92	19.06	2.52
C2dithio	134.77	36.84	29.46	59.88	33.78	29.83	3.40
C3dithio	192.82	55.72	26.61	49.38	30.05	18.20	2.15
Phenanth	21.89	16.65	18.79	40.44	14.69	19.14	5.89
C1phenan	74.34	36.15	42.01	84.20	35.48	47.86	12.46
C2phenan	155.09	51.31	53.04	89.64	51.13	41.53	10.65
C3phenan	190.50	60.07	42.67	66.13	46.10	28.12	5.67
C4phenan	154.40	49.51	25.03	41.82	25.93	18.63	4.19
Anthra	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	10.69	9.13	9.64	11.56	6.27	11.45	2.63
Pyrene	15.41	8.51	13.33	13.75	10.45	10.68	0.00
C1fluora	43.46	19.57	15.03	17.88	10.39	12.14	3.51
Benanth	11.95	5.22	5.64	6.13	3.67	0.00	1.47
Chrysene	34.84	17.95	9.94	11.75	5.93	7.86	1.84
C1chrys	60.69	28.95	14.73	15.63	9.83	9.74	2.58
C2chrys	90.06	47.09	22.61	20.25	13.62	15.47	3.48
C3chrys	40.88	16.46	7.82	10.31	5.71	10.08	1.30
C4chrys	17.36	6.83	2.91	5.31	0.96	2.22	0.00
Benzobfl	11.63	10.19	8.06	7.69	5.20	6.24	2.32
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	15.03	10.68	5.82	6.19	4.01	0.00	0.00
Benapy	4.72	3.35	2.73	3.56	0.00	0.00	1.90
Perylene	222.63	313.83	172.39	291.48	172.65	123.32	27.59
Indeno	3.96	4.10	3.45	2.63	2.54	0.00	0.00
Dibenz	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	10.63	7.21	6.30	5.81	4.80	7.26	2.29
TPAH	**2005.49**	**702.20**	**659.23**	**1203.77**	**636.05**	**529.76**	**111.69**
Mean		1122.31			789.86		
SE		441.77			209.22		
CV %		68.18			45.88		

Appendix I-2. Continued.

SITE	Drier Bay	Drier Bay	Drier Bay	Drier Bay	Drier Bay	Herring Bay	Herring Bay
SITE #	14	14	14	14	14	16	16
DEPTH	6-20 m	6-20 m	< 3 m	< 3 m	< 3 m	6-20 m	6-20 m
TREATMENT	Control	Control	Control	Control	Control	Oiled	Oiled
COLLECTED	14-Jul-91	14-Jul-91	14-Jul-91	14-Jul-91	14-Jul-91	18-Jul-91	18-Jul-91
ID #	209818	209819	209822	209823	209824	210001	210002
PAH's (ng/g dry wt)							
Naph	3.94	3.62	10.49	12.01	6.58	1.89	0.66
C1naph	4.04	3.19	29.87	14.09	33.34	7.41	0.00
C2naph	6.19	3.87	96.95	19.30	220.51	26.61	0.00
C3naph	8.44	6.40	104.73	25.62	282.79	36.87	2.75
C4naph	12.67	9.20	44.93	42.42	206.61	23.12	4.25
Biphenyl	0.00	0.00	7.64	0.00	8.36	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorene	0.00	0.00	8.40	0.00	8.36	0.00	0.00
C1fluor	4.53	2.58	9.45	10.35	22.05	4.27	0.00
C2fluor	12.74	8.33	22.29	41.10	62.29	10.30	3.26
C3fluor	11.01	5.39	38.89	32.98	121.02	17.64	3.27
Dithio	0.00	0.00	3.75	0.00	8.78	0.00	0.00
C1dithio	4.79	3.12	9.86	13.61	31.25	4.33	0.00
C2dithio	6.35	3.04	27.78	13.47	92.28	12.70	2.09
C3dithio	5.47	2.13	32.09	0.00	69.60	14.94	2.31
Phenanth	9.43	5.48	14.38	25.62	24.87	4.52	1.49
C1phenan	18.94	11.43	31.53	49.57	75.87	11.70	3.64
C2phenan	13.81	7.39	48.82	38.88	119.03	18.72	2.80
C3phenan	9.25	4.90	47.30	15.14	82.25	14.84	2.21
C4phenan	5.75	2.90	40.07	12.57	51.63	9.97	1.89
Anthra	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	4.77	2.01	4.31	9.79	6.79	2.05	0.46
Pyrene	5.10	0.00	15.63	11.25	20.27	4.05	0.00
C1fluora	5.00	2.71	10.00	12.29	15.15	3.82	0.84
Benanth	2.12	0.00	0.00	5.55	0.00	0.00	0.00
Chrysene	2.95	1.33	3.26	6.73	6.06	2.73	0.00
C1chrys	3.52	1.86	4.03	8.19	8.15	3.99	0.73
C2chrys	6.81	3.31	7.36	17.50	11.18	6.06	1.09
C3chrys	2.51	1.45	2.50	0.00	2.72	2.56	0.72
C4chrys	0.00	0.00	0.00	0.00	0.00	1.16	0.79
Benzobfl	3.00	0.00	0.00	8.89	0.00	0.00	0.00
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benapy	2.59	1.18	2.36	6.18	0.00	0.00	0.00
Perylene	25.75	11.16	30.84	63.74	41.38	19.50	0.00
Indeno	2.07	0.00	0.00	0.00	0.00	0.00	0.00
Dibenz	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	2.93	1.74	2.71	7.64	4.49	2.68	0.50
TPAH	180.72	98.56	681.38	460.74	1602.28	248.93	35.75
Mean	130.32			914.80			120.52
SE	25.48			349.59			65.29
CV %	33.87			66.19			93.83

Appendix I-2. Continued.

SITE	Herring Bay	Herring Bay	Herring Bay	Herring Bay	L. Herring B.	L. Herring B.	L. Herring B.
SITE #	16	16	16	16	15	15	15
DEPTH	6-20 m	< 3 m	< 3 m	< 3 m	6-20 m	6-20 m	< 3 m
TREATMENT	Oiled	Oiled	Oiled	Oiled	Control	Control	Control
COLLECTED	18-Jul-91	18-Jul-91	18-Jul-91	18-Jul-91	23-Jul-91	23-Jul-91	24-Jul-91
ID #	210003	210004	210005	210006	210010	210011	210012
PAH's (ng/g dry wt)							
Naph	1.09	1.76	0.88	0.82	0.00	11.17	0.85
C1naph	2.25	3.48	1.90	0.89	0.00	8.76	0.00
C2naph	3.83	10.88	6.20	5.40	0.00	11.28	0.00
C3naph	6.44	19.45	10.16	9.91	0.00	15.11	0.00
C4naph	11.12	16.61	6.84	8.21	0.00	10.46	0.00
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1fluor	0.00	2.89	0.00	0.00	0.00	0.00	0.00
C2fluor	4.75	8.10	3.04	6.47	0.00	10.07	0.00
C3fluor	4.94	15.71	5.59	11.22	0.00	23.60	0.00
Dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1dithio	0.00	2.64	0.00	2.92	0.00	0.00	0.00
C2dithio	3.59	11.57	3.62	9.46	5.25	20.04	3.11
C3dithio	3.99	17.72	5.05	11.17	0.00	20.26	3.53
Phenanth	2.18	2.11	1.32	2.08	0.00	6.84	0.75
C1phenan	4.96	5.61	2.76	6.58	2.95	9.47	1.36
C2phenan	5.32	12.82	5.33	13.55	4.77	15.28	2.89
C3phenan	5.64	16.44	6.01	13.12	3.26	11.28	1.80
C4phenan	3.16	18.16	6.09	9.87	0.00	6.35	0.00
Anthra	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	1.06	1.63	0.72	0.91	0.00	3.45	0.00
Pyrene	0.00	3.49	0.00	0.00	0.00	0.00	0.00
C1fluora	1.76	4.81	1.22	3.05	0.00	2.74	0.00
Benanth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chrysene	2.09	4.50	1.13	1.77	0.00	0.00	0.00
C1chrys	2.45	7.05	2.21	3.21	0.00	0.00	0.00
C2chrys	3.03	9.41	3.46	4.71	0.00	3.18	0.00
C3chrys	1.72	5.50	1.72	2.57	0.00	0.00	0.00
C4chrys	0.00	1.30	0.00	1.51	0.00	0.00	0.00
Benzobfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benapy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Perylene	7.66	3.91	0.00	0.00	0.00	61.49	0.00
Indeno	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dibenz	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	1.52	1.40	0.59	0.54	0.00	0.00	0.00
TPAH	76.89	**205.04**	75.84	**129.94**	16.23	**189.34**	14.29
Mean			136.94			102.79	
SE			37.46			86.55	
CV %			47.38			119.09	

Appendix I-2. Continued.

SITE	L. Herring B.	L. Herring B.	Sleepy Bay	Sleepy Bay	Sleepy Bay	Sleepy Bay	Sleepy Bay
SITE #	15	15	17	17	17	17	17
DEPTH	< 3 m	< 3 m	6-20 m	6-20 m	6-20 m	< 3 m	< 3 m
TREATMENT	Control	Control	Oiled	Oiled	Oiled	Oiled	Oiled
COLLECTED	24-Jul-91	24-Jul-91	25-Jul-91	25-Jul-91	25-Jul-91	25-Jul-91	25-Jul-91
ID #	210013	210014	210017	210018	210019	210020	210021
PAH's (ng/g dry wt)							
Naph	2.75	1.23	2.06	2.49	1.64	1.76	1.65
C1naph	0.00	0.00	3.08	2.30	1.27	1.42	0.96
C2naph	0.00	0.00	3.95	2.70	2.67	3.38	0.00
C3naph	0.00	0.00	5.97	3.17	3.78	4.90	2.86
C4naph	0.00	0.00	4.06	4.15	5.09	7.44	2.74
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1fluor	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2fluor	0.00	0.00	4.81	3.16	2.75	8.18	2.64
C3fluor	11.16	3.69	12.00	5.40	7.79	19.24	5.70
Dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1dithio	15.44	0.00	2.95	0.00	2.08	4.52	0.00
C2dithio	51.07	0.00	9.52	5.47	6.17	20.48	5.95
C3dithio	47.70	0.00	12.93	8.65	7.39	40.06	7.49
Phenanth	1.99	0.00	4.02	4.81	3.17	3.23	1.97
C1phenan	4.89	1.20	6.19	4.49	4.68	6.45	2.98
C2phenan	9.94	1.46	8.59	5.70	8.02	16.55	5.80
C3phenan	6.88	1.31	9.76	7.74	7.57	30.29	6.07
C4phenan	5.20	0.87	14.87	8.02	7.15	31.65	4.86
Anthra	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	0.00	0.00	5.10	5.88	5.55	3.56	2.19
Pyrene	0.00	0.00	5.13	5.13	4.42	3.48	0.00
C1fluora	0.00	0.00	12.22	5.90	3.91	9.07	1.94
Benanth	0.00	0.00	2.37	2.40	0.00	3.84	0.00
Chrysene	0.00	0.00	26.34	9.03	6.50	14.98	2.60
C1chrys	0.00	0.00	37.16	11.57	76.38	26.89	3.20
C2chrys	0.00	0.00	52.80	15.68	93.47	40.87	3.75
C3chrys	0.00	0.00	46.95	15.48	67.43	34.65	2.98
C4chrys	0.00	0.00	11.31	3.20	87.33	7.61	0.78
Benzobfl	0.00	0.00	6.23	2.66	0.00	0.00	0.00
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	0.00	0.00	17.46	5.96	3.87	9.84	0.00
Benapy	0.00	0.00	3.24	2.47	0.00	1.85	0.00
Perylene	0.00	0.00	13.36	3.32	0.00	6.00	0.00
Indeno	0.00	0.00	1.71	0.00	0.00	0.00	0.00
Dibenz	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	0.00	0.00	5.92	2.61	1.42	3.69	0.52
TPAH	157.02	9.76	338.70	156.22	421.50	359.88	69.63
Mean	60.36			305.47			174.04
SE	48.35			78.36			93.16
CV %	138.75			44.43			92.71

Appendix I-2. Continued.

SITE	Sleepy Bay	Moose Lips B.	Moose Lips B.	Moose Lips B.	Moose Lips B.	Moose Lips B.	Moose Lips B.
SITE #	17	18	18	18	18	18	18
DEPTH	< 3 m	6-20 m	6-20 m	6-20 m	< 3 m	< 3 m	< 3 m
TREATMENT	Oiled	Control	Control	Control	Control	Control	Control
COLLECTED	25-Jul-91	28-Jul-91	28-Jul-91	28-Jul-91	28-Jul-91	28-Jul-91	28-Jul-91
ID #	210022	210101	210102	210103	210104	210105	210106
PAH's (ng/g dry wt)							
Naph	2.07	2.86	4.08	4.87	3.18	2.66	2.56
C1naph	1.18	4.24	5.48	6.01	2.49	3.22	2.08
C2naph	0.00	4.29	4.15	5.64	0.00	2.59	0.00
C3naph	3.24	4.39	4.23	5.50	0.00	3.54	0.00
C4naph	3.84	3.87	0.00	5.04	0.00	0.00	0.00
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorene	0.00	2.44	4.43	4.60	0.00	2.73	0.00
C1fluor	0.00	3.05	4.49	5.02	0.00	3.06	3.47
C2fluor	3.45	4.69	6.26	6.18	4.26	3.32	2.72
C3fluor	5.98	6.79	7.79	9.38	5.81	4.41	4.21
Dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1dithio	2.34	2.37	2.51	3.15	0.00	0.00	0.00
C2dithio	7.82	5.80	5.98	7.51	5.07	3.85	4.20
C3dithio	9.97	5.50	6.67	6.74	5.26	4.14	4.50
Phenanth	3.54	6.89	9.38	8.66	5.87	5.75	4.50
C1phenan	3.86	6.95	9.21	9.71	5.77	3.86	4.47
C2phenan	6.53	5.64	6.64	7.14	5.03	2.51	3.32
C3phenan	7.77	4.34	4.72	5.60	4.13	1.62	2.05
C4phenan	6.72	2.32	2.90	3.22	1.75	1.41	1.19
Anthra	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	4.12	1.01	1.44	1.45	0.88	1.45	0.67
Pyrene	0.00	0.00	4.66	4.67	0.00	3.30	0.00
C1fluora	2.85	2.78	3.75	4.45	2.28	2.54	1.58
Benanth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chrysene	2.42	1.86	2.52	2.52	1.53	1.49	1.08
C1chrys	4.29	1.59	1.84	2.08	1.03	0.86	0.75
C2chrys	4.83	2.07	1.51	2.12	0.79	0.74	0.73
C3chrys	3.90	0.94	0.00	0.82	0.00	0.00	0.00
C4chrys	1.12	1.26	0.87	1.12	0.00	0.00	0.00
Benzobfl	0.00	2.79	4.88	4.41	2.88	2.76	1.99
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	0.00	0.00	2.92	0.00	0.00	0.00	0.00
Benapy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Perylene	0.00	6.92	17.52	17.63	6.42	7.03	4.02
Indeno	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dibenz	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	0.77	3.52	6.39	6.67	4.00	3.97	2.39
TPAH	92.61	94.25	119.70	134.28	62.01	65.78	48.46
Mean			116.08			58.75	
SE			11.70			5.26	
CV %			17.45			15.5	

Appendix I-3. Concentrations of polynuclear aromatic hydrocarbon (PAH) analytes in sediments from subtidal eelgrass habitat sites in Prince William Sound, 1993. TPAH = total PAH-perylene. Zero values indicate that the concentration of the analyte was below MDL. Numbers are in bold where the PAH composition pattern matched weathered EVO.

SITE	Bay of Isles	Bay of Isles	Bay of Isles	Bay of Isles	Bay of Isles	Bay of Isles	Drier Bay
SITE #	13	13	13	13	13	13	14
DEPTH	6-20 m	6-20 m	6-20 m	< 3 m	< 3 m	< 3 m	6-20 m
TREATMENT	Oiled	Oiled	Oiled	Oiled	Oiled	Oiled	Control
COLLECTED	21-Jul-93	21-Jul-93	21-Jul-93	21-Jul-93	21-Jul-93	21-Jul-93	23-Jul-93
ID #	401719	401720	401721	401722	401723	401724	401725
PAH's (ng/g dry wt)							
Naph	0.00	0.00	0.00	94.44	10.25	10.61	0.00
C1naph	0.00	0.00	11.68	35.38	0.00	4.23	0.00
C2naph	0.00	0.00	28.11	16.28	10.80	0.00	0.00
C3naph	13.72	13.09	25.93	14.91	11.80	6.07	2.75
C4naph	5.19	5.03	16.43	13.94	17.26	4.77	1.01
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorene	0.00	0.00	0.00	11.50	0.00	0.00	0.00
C1fluor	0.00	0.00	7.55	9.16	0.00	0.00	0.00
C2fluor	6.90	9.48	47.42	25.15	13.92	0.00	2.34
C3fluor	0.00	0.00	76.38	15.40	15.37	0.00	0.00
Dithio	0.00	0.00	4.91	0.00	0.00	0.00	0.00
C1dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2dithio	8.83	9.82	63.77	12.96	22.83	0.00	0.00
C3dithio	16.91	26.17	181.26	27.39	52.12	8.23	0.00
Phenanth	9.12	9.65	26.63	18.42	0.00	0.00	1.68
C1phenan	20.48	20.81	52.94	28.56	29.18	12.00	4.10
C2phenan	20.92	22.40	123.41	43.96	65.59	16.99	0.00
C3phenan	28.26	34.98	287.54	52.05	107.02	22.30	0.00
C4phenan	11.57	16.95	105.03	17.15	35.97	0.00	0.00
Anthra	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	6.83	6.80	17.05	75.14	19.38	10.53	1.25
Pyrene	5.79	6.21	17.99	42.01	15.93	8.00	1.07
C1fluora	3.93	8.81	27.02	12.96	9.35	0.00	0.00
Benanth	1.93	2.01	6.23	9.94	2.90	2.92	0.59
Chrysene	9.94	25.92	59.33	26.32	25.84	0.00	0.00
C1chrys	0.00	0.00	13.31	0.00	0.00	0.00	0.00
C2chrys	0.00	22.40	60.34	16.37	14.70	0.00	0.00
C3chrys	0.00	0.00	21.33	0.00	0.00	0.00	0.00
C4chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzobfl	8.90	11.74	28.26	23.20	17.82	11.77	2.28
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	8.53	19.46	32.78	19.30	18.04	9.54	1.47
Benapy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Perylene	193.77	120.80	205.16	59.36	148.23	71.59	10.50
Indeno	0.00	0.00	0.00	0.00	0.00	0.00	0.73
Dibenz	0.00	0.00	3.11	0.00	0.00	0.00	0.00
Benzop	5.42	7.55	16.82	9.06	8.24	5.08	1.72
TPAH	193.17	**279.28**	**1362.56**	**670.95**	**524.31**	133.04	20.99
Mean		611.67			442.77		
SE		376.27			160.54		
CV %		106.55			62.80		

Appendix I-3. Continued.

SITE	Drier Bay	Drier Bay	Drier Bay	Drier Bay	Drier Bay	Herring Bay	Herring Bay
SITE #	14	14	14	14	14	16	16
DEPTH	6-20 m	6-20 m	< 3 m	< 3 m	< 3 m	6-20 m	6-20 m
TREATMENT	Control	Control	Control	Control	Control	Oiled	Oiled
COLLECTED	23-Jul-93	23-Jul-93	23-Jul-93	23-Jul-93	23-Jul-93	16-Jul-93	16-Jul-93
ID #	401726	401727	401728	401729	401730	401713	401714
PAH's (ng/g dry wt)							
Naph	0.00	0.00	0.00	4.58	9.03	0.00	0.00
C1naph	7.78	3.69	7.51	4.35	0.00	4.43	0.00
C2naph	7.36	12.57	15.01	9.46	0.00	7.00	0.00
C3naph	8.85	44.51	12.69	7.35	0.00	8.71	2.39
C4naph	3.60	54.82	0.00	0.00	0.00	3.16	0.83
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	2.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorene	3.44	0.00	0.00	0.00	0.00	0.00	0.00
C1fluor	2.80	0.00	0.00	0.00	0.00	5.81	0.00
C2fluor	6.08	4.67	0.00	0.00	0.00	5.65	0.00
C3fluor	2.43	0.00	0.00	0.00	0.00	2.97	0.00
Dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2dithio	0.00	0.00	0.00	0.00	0.00	2.19	0.00
C3dithio	0.00	0.00	0.00	0.00	0.00	4.87	1.60
Phenanth	7.44	7.70	12.69	6.41	0.00	21.63	1.17
C1phenan	9.76	12.57	14.06	11.58	0.00	11.30	4.09
C2phenan	4.50	9.96	0.00	0.00	0.00	6.76	3.08
C3phenan	0.00	6.58	0.00	0.00	0.00	9.06	3.31
C4phenan	0.00	0.00	0.00	0.00	0.00	6.68	0.00
Anthra	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	2.77	4.39	5.81	3.88	0.00	2.65	1.49
Pyrene	2.83	4.28	5.60	3.82	0.00	2.35	1.15
C1fluora	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benanth	1.28	2.58	3.28	1.82	0.00	0.46	0.96
Chrysene	0.00	0.00	0.00	0.00	0.00	7.35	2.45
C1chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2chrys	0.00	0.00	0.00	0.00	0.00	3.84	0.00
C3chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C4chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzobfl	4.40	5.02	8.56	7.17	0.00	3.41	3.86
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	3.12	3.59	7.29	5.35	0.00	3.87	2.92
Benapy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Perylene	25.67	28.84	54.76	65.47	45.39	5.52	14.77
Indeno	1.28	0.00	0.00	0.00	0.00	0.00	0.00
Dibenz	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	2.88	3.66	5.50	4.00	0.00	2.41	1.95
TPAH	84.60	180.59	98.00	69.77	9.03	126.56	31.25
Mean	95.39			58.93			87.41
SE	46.39			26.25			28.80
CV %	84.23			77.14			57.06

Appendix I-3. Continued.

SITE	Herring Bay	Herring Bay	Herring Bay	Herring Bay	L. Herring B.	L. Herring B.	L. Herring B.
SITE #	16	16	16	16	15	15	15
DEPTH	6-20 m	< 3 m	< 3 m	< 3 m	6-20 m	6-20 m	6-20 m
TREATMENT	Oiled	Oiled	Oiled	Oiled	Control	Control	Control
COLLECTED	16-Jul-93	16-Jul-93	16-Jul-93	16-Jul-93	24-Jul-93	24-Jul-93	24-Jul-93
ID #	401715	401716	401717	401718	401731	401732	401733
PAH's (ng/g dry wt)							
Naph	2.66	1.15	0.00	7.51	0.00	0.00	0.71
C1naph	14.68	0.00	0.00	0.00	0.00	0.00	0.00
C2naph	20.33	0.00	0.00	0.00	0.00	0.00	0.00
C3naph	34.90	0.97	0.00	0.00	0.00	0.00	0.56
C4naph	14.24	0.00	0.00	0.00	0.00	0.00	0.00
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1fluor	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2fluor	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C3fluor	0.00	2.78	0.00	0.00	0.00	0.00	0.00
Dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2dithio	0.00	2.99	2.61	0.00	0.00	0.00	0.00
C3dithio	0.00	7.54	5.41	0.00	0.00	0.00	0.00
Phenanth	2.09	0.00	0.00	0.00	0.00	0.00	0.00
C1phenan	4.70	2.68	0.00	0.00	0.00	0.00	0.00
C2phenan	3.72	5.47	6.02	0.00	0.00	0.00	0.00
C3phenan	2.60	11.83	13.41	0.00	0.00	0.00	0.00
C4phenan	0.00	4.57	4.97	0.00	0.00	0.00	0.00
Anthra	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	0.73	1.69	1.59	0.00	0.00	0.00	0.00
Pyrene	0.00	1.62	0.00	0.00	0.00	0.00	0.00
C1fluora	0.00	0.97	0.00	0.00	0.00	0.00	0.00
Benanth	0.68	0.87	0.00	0.00	0.00	0.00	0.00
Chrysene	0.00	5.42	4.84	0.00	0.00	0.00	0.00
C1chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2chrys	0.00	4.05	0.00	0.00	0.00	0.00	0.00
C3chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C4chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzobfl	1.15	4.12	2.74	0.00	0.00	0.00	0.00
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	1.20	3.91	3.64	0.00	0.00	0.00	0.00
Benapy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Perylene	2.32	3.16	2.26	0.00	0.00	9.46	3.22
Indeno	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dibenz	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	0.75	1.65	2.38	0.00	0.00	0.00	0.00
TPAH	104.43	64.28	47.61	7.51	0.00	0.00	1.27
Mean			39.80			0.42	
SE			16.85			0.42	
CV %			73.32			173.20	

Appendix I-3. Continued.

SITE	L. Herring B.	L. Herring B.	L. Herring B.	Sleepy Bay	Sleepy Bay	Sleepy Bay	Sleepy Bay
SITE #	15	15	15	17	17	17	17
DEPTH	< 3 m	< 3 m	< 3 m	6-20 m	6-20 m	6-20 m	< 3 m
TREATMENT	Control	Control	Control	Oiled	Oiled	Oiled	Oiled
COLLECTED	24-Jul-93	24-Jul-93	24-Jul-93	13-Jul-93	13-Jul-93	13-Jul-93	14-Jul-93
ID #	401734	401735	401736	401701	401702	401703	401704
PAH's (ng/g dry wt)							
Naph	29.86	11.61	0.00	0.00	0.00	0.00	0.00
C1naph	13.37	13.21	0.00	0.00	0.00	1.99	0.93
C2naph	0.00	28.81	0.00	0.00	0.00	4.48	1.86
C3naph	11.36	11.61	0.00	1.69	4.49	4.53	1.52
C4naph	0.00	0.00	0.00	1.04	1.87	1.58	0.00
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1fluor	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2fluor	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C3fluor	0.00	0.00	0.00	2.21	0.00	0.00	0.00
Dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2dithio	0.00	0.00	0.00	0.00	1.11	0.00	0.00
C3dithio	0.00	0.00	0.00	5.29	6.74	3.08	0.81
Phenanth	0.00	0.00	0.00	1.47	2.56	3.47	1.49
C1phenan	0.00	0.00	0.00	3.00	6.04	4.35	0.00
C2phenan	0.00	0.00	0.00	3.29	5.42	3.12	0.00
C3phenan	0.00	0.00	0.00	4.45	5.76	5.18	0.00
C4phenan	0.00	0.00	0.00	4.55	5.68	4.07	0.00
Anthra	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	0.00	0.00	0.00	2.04	9.14	3.34	1.15
Pyrene	0.00	0.00	0.00	1.67	10.81	2.76	0.90
C1fluora	0.00	0.00	0.00	2.72	3.76	3.38	0.00
Benanth	0.00	0.00	0.00	1.43	8.35	2.00	0.26
Chrysene	0.00	0.00	0.00	8.21	22.79	7.57	2.25
C1chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2chrys	0.00	0.00	0.00	11.74	10.45	8.28	2.37
C3chrys	0.00	0.00	0.00	5.88	5.37	3.49	0.00
C4chrys	0.00	0.00	0.00	4.96	4.99	0.00	0.00
Benzobfl	0.00	0.00	0.00	4.21	20.69	6.91	1.22
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	0.00	0.00	0.00	9.84	14.49	8.24	2.59
Benapy	0.00	0.00	0.00	0.00	8.66	3.25	0.00
Perylene	0.00	41.22	8.23	3.47	4.89	6.64	0.00
Indeno	0.00	0.00	0.00	1.37	4.51	1.42	0.00
Dibenz	0.00	0.00	0.00	1.18	1.91	0.96	0.00
Benzop	14.47	0.00	0.00	4.88	7.89	3.55	1.30
TPAH	69.06	65.24	0.00	87.12	173.48	91.00	18.65
Mean		44.77			117.20		
SE		22.41			28.16		
CV %		86.71			41.62		

Appendix I-3. Continued.

SITE	Sleepy Bay	Sleepy Bay	Moose Lips B.	Moose Lips B.	Moose Lips B.	Moose Lips B.	Moose Lips B.
SITE #	17	17	18	18	18	18	18
DEPTH	< 3 m	< 3 m	6-20 m	6-20 m	6-20 m	< 3 m	< 3 m
TREATMENT	Oiled	Oiled	Control	Control	Control	Control	Control
COLLECTED	14-Jul-93	14-Jul-93	15-Jul-93	15-Jul-93	15-Jul-93	15-Jul-93	15-Jul-93
ID #	401705	401706	401707	401708	401709	401710	401711
PAH's (ng/g dry wt)							
Naph	2.79	1.68	0.00	0.00	0.00	6.95	3.30
C1naph	0.79	0.00	0.00	2.68	6.34	3.32	2.41
C2naph	0.00	0.00	2.44	2.62	7.32	1.57	0.00
C3naph	0.00	0.00	3.59	3.25	5.52	0.92	0.00
C4naph	0.00	0.00	1.70	1.27	1.62	0.00	0.00
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorene	0.00	0.00	3.38	6.89	5.55	5.79	4.54
C1fluor	0.00	0.00	2.18	4.00	3.04	3.20	1.51
C2fluor	0.00	0.00	2.81	3.91	2.85	2.07	0.00
C3fluor	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dithio	0.00	0.00	0.00	0.00	0.93	0.00	0.00
C1dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C3dithio	0.75	0.00	0.00	0.00	0.00	0.00	0.00
Phenanth	0.00	0.00	8.69	12.26	14.40	8.74	7.96
C1phenan	0.00	0.00	9.97	10.27	11.42	4.83	2.84
C2phenan	0.00	0.00	4.14	3.19	2.85	0.00	0.00
C3phenan	0.00	0.00	2.96	0.00	0.00	0.00	0.00
C4phenan	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anthra	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	0.72	0.00	1.20	1.21	1.42	0.83	0.00
Pyrene	0.00	0.00	2.77	3.62	4.19	2.58	2.24
C1fluora	0.00	0.00	0.00	1.01	0.85	0.00	0.00
Benanth	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chrysene	0.00	0.00	0.00	2.77	2.96	2.18	2.60
C1chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C3chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C4chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzobfl	0.00	0.00	4.01	5.37	6.43	4.18	4.61
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	1.56	1.93	2.90	3.74	4.27	3.14	3.22
Benapy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Perylene	0.00	0.00	5.75	7.74	8.91	3.73	4.07
Indeno	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dibenz	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	1.20	1.28	4.07	6.89	7.68	4.85	4.24
TPAH	7.81	4.89	56.81	74.95	89.64	55.15	39.47
Mean	10.45			73.80			41.79
SE	4.19			9.49			7.14
CV %	69.38			22.28			29.59

Appendix I-3. Continued.

SITE	Moose Lips B.
SITE #	18
DEPTH	< 3 m
TREATMENT	Control
COLLECTED	15-Jul-93
ID #	401712
PAH's (ng/g dry wt)	
Naph	4.13
C1naph	2.19
C2naph	0.00
C3naph	0.00
C4naph	0.00
Biphenyl	0.00
Acenthy	0.00
Acenthe	0.00
Fluorene	3.98
C1fluor	1.75
C2fluor	0.00
C3fluor	0.00
Dithio	0.00
C1dithio	0.00
C2dithio	0.00
C3dithio	0.00
Phenanth	6.92
C1phenan	0.00
C2phenan	0.00
C3phenan	0.00
C4phenan	0.00
Anthra	0.00
Fluorant	0.00
Pyrene	1.79
C1fluora	0.00
Benanth	0.00
Chrysene	2.22
C1chrys	0.00
C2chrys	0.00
C3chrys	0.00
C4chrys	0.00
Benzobfl	2.82
Benzokfl	0.00
Benepy	2.08
Benapy	0.00
Perylene	2.76
Indeno	0.00
Dibenz	0.00
Benzop	2.87
TPAH	30.75
Mean	
SE	
CV %	

Appendix I-4. Concentrations of polynuclear aromatic hydrocarbon (PAH) analytes in sediments from subtidal eelgrass habitat sites in Prince William Sound, 1995. TPAH = total PAH-perylene. Zero values indicate that the concentration of the analyte was below MDL. Numbers are in bold where the PAH composition pattern matched weathered EVO.

SITE	Bay of Isles	Bay of Isles	Bay of Isles	Bay of Isles	Bay of Isles	Bay of Isles	Drier Bay
SITE #	13	13	13	13	13	13	14
DEPTH	6-20 m	6-20 m	6-20 m	< 3 m	< 3 m	< 3 m	6-20 m
TREATMENT	Oiled	Oiled	Oiled	Oiled	Oiled	Oiled	Control
COLLECTED	13-Jul-95	13-Jul-95	13-Jul-95	15-Jul-95	15-Jul-95	15-Jul-95	17-Jul-95
ID #	605813	605814	605815	605816	605817	605818	605819
PAH's (ng/g dry wt)							
Naph	0.00	0.00	0.00	0.00	0.00	3.39	3.63
C1naph	30.33	11.18	11.87	0.00	8.81	3.23	12.27
C2naph	46.39	29.41	25.59	11.27	21.93	9.03	16.59
C3naph	41.07	29.12	23.65	26.29	22.59	7.91	19.21
C4naph	23.80	15.66	14.45	23.12	13.71	2.61	9.36
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	10.40	0.00	0.00
Fluorene	0.00	0.00	0.00	0.00	8.94	0.00	4.40
C1fluor	10.04	9.71	0.00	7.07	0.00	0.00	5.17
C2fluor	16.27	10.07	0.00	14.14	0.00	0.00	5.61
C3fluor	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dithio	0.00	4.63	0.00	5.52	0.00	0.00	0.00
C1dithio	0.00	0.00	0.00	7.29	0.00	0.00	0.00
C2dithio	5.12	0.00	0.00	18.41	0.00	3.06	0.00
C3dithio	6.23	4.71	0.00	30.41	5.30	2.24	0.00
Phenanth	27.71	17.72	11.38	13.26	8.35	7.33	15.66
C1phenan	33.13	20.74	12.43	37.41	11.86	12.38	12.07
C2phenan	23.60	17.21	0.00	52.58	13.12	7.91	6.94
C3phenan	15.36	0.00	0.00	70.62	9.47	6.17	0.00
C4phenan	0.00	0.00	0.00	28.87	0.00	0.00	0.00
Anthra	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	9.54	17.13	5.89	13.03	17.56	13.74	5.25
Pyrene	8.33	20.07	5.25	13.18	11.00	9.52	5.17
C1fluora	8.03	8.68	5.17	19.74	7.29	8.82	3.11
Benanth	9.94	10.59	0.00	9.06	9.47	9.23	5.00
Chrysene	14.06	0.00	0.00	29.90	0.00	16.81	0.00
C1chrys	16.97	0.00	0.00	37.63	0.00	6.62	0.00
C2chrys	0.00	0.00	0.00	41.24	0.00	0.00	0.00
C3chrys	0.00	0.00	0.00	22.24	0.00	0.00	0.00
C4chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzobfl	18.27	15.37	9.44	24.37	13.05	15.44	8.39
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	15.56	10.29	9.36	20.99	8.48	9.40	5.89
Benapy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Perylene	105.83	134.27	45.93	142.12	585.56	60.36	57.79
Indeno	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dibenz	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	0.00	0.00	0.00	4.20	0.00	0.00	0.00
TPAH	379.75	252.29	134.48	**581.84**	201.33	154.84	143.72
Mean		255.51			312.67		
SE		70.82			135.25		
CV%		48.01			74.92		

Appendix I-4. Continued.

SITE	Drier Bay	Drier Bay	Drier Bay	Drier Bay	Drier Bay	Herring Bay	Herring Bay
SITE #	14	14	14	14	14	16	16
DEPTH	6-20 m	6-20 m	< 3 m	< 3 m	< 3 m	6-20 m	6-20 m
TREATMENT	Control	Control	Control	Control	Control	Oiled	Oiled
COLLECTED	17-Jul-95	17-Jul-95	17-Jul-95	17-Jul-95	17-Jul-95	20-Jul-95	20-Jul-95
ID #	605820	605821	605822	605823	605824	605831	605832
PAH's (ng/g dry wt)							
Naph	0.00	0.00	8.64	7.07	10.42	0.00	1.16
C1naph	0.00	0.00	8.15	19.13	23.66	0.00	0.00
C2naph	0.00	0.00	17.09	26.10	28.61	0.00	0.00
C3naph	2.69	4.12	15.56	22.18	25.06	0.94	0.00
C4naph	1.53	2.68	0.00	9.36	9.98	0.85	0.00
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	6.36	0.00	0.00
Fluorene	0.00	0.00	0.00	4.99	0.00	0.00	0.00
C1fluor	0.00	0.00	0.00	7.43	8.58	0.00	0.00
C2fluor	0.00	0.00	0.00	6.87	8.06	0.00	0.00
C3fluor	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C3dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phenanth	2.15	2.92	9.74	13.28	15.30	0.00	0.00
C1phenan	3.34	4.70	14.15	24.52	29.64	0.00	0.00
C2phenan	3.21	3.81	0.00	16.28	19.00	0.00	0.00
C3phenan	0.00	0.00	0.00	8.24	0.00	0.00	0.00
C4phenan	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anthra	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	0.00	1.55	3.12	6.51	7.98	0.00	0.00
Pyrene	1.31	1.51	0.00	6.71	7.84	0.00	0.00
C1fluora	1.61	1.82	0.00	6.61	6.80	0.82	0.00
Benanth	1.79	1.97	0.00	2.95	3.99	0.00	0.00
Chrysene	0.00	0.00	0.00	9.56	0.00	0.00	0.00
C1chrys	0.00	0.00	0.00	7.22	0.00	0.00	0.00
C2chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C3chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C4chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzobfl	2.20	3.30	7.17	9.51	9.98	1.21	1.15
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	0.00	2.52	0.00	5.75	6.73	0.00	0.84
Benapy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Perylene	24.20	22.21	53.67	181.30	143.34	5.28	4.94
Indeno	0.00	0.00	0.00	1.78	0.00	0.00	0.00
Dibenz	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	0.00	2.19	0.00	4.27	0.00	0.00	0.00
TPAH	19.83	33.09	83.62	226.32	227.99	3.82	3.15
Mean	65.55			179.31			34.35
SE	39.27			47.85			30.87
CV%	103.78			46.22			155.64

Appendix I-4. Continued.

SITE	Herring Bay	Herring Bay	Herring Bay	Herring Bay	L. Herring B.	L. Herring B.	L. Herring B.
SITE #	16	16	16	16	15	15	15
DEPTH	6-20 m	< 3 m	< 3 m	< 3 m	6-20 m	6-20 m	6-20 m
TREATMENT	Oiled	Oiled	Oiled	Oiled	Control	Control	Control
COLLECTED	20-Jul-95	20-Jul-95	20-Jul-95	20-Jul-95	19-Jul-95	19-Jul-95	19-Jul-95
ID #	605833	605834	605835	605836	605825	605826	605827
PAH's (ng/g dry wt)							
Naph	2.60	0.00	0.00	1.13	0.00	5.28	0.00
C1naph	5.13	0.00	0.00	0.00	0.00	13.80	0.00
C2naph	5.38	0.00	0.00	0.00	0.00	29.81	0.00
C3naph	4.09	0.74	0.00	0.00	0.00	42.42	1.02
C4naph	2.15	0.00	0.00	0.00	0.00	19.55	0.82
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	0.00	3.43	0.00
Fluorene	1.32	0.00	0.00	0.00	0.00	6.94	0.00
C1fluor	2.12	0.00	0.00	0.00	0.00	7.29	0.00
C2fluor	1.90	0.00	0.00	0.00	0.00	15.18	0.00
C3fluor	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dithio	0.00	0.00	0.00	0.00	0.00	3.15	0.00
C1dithio	0.00	0.00	0.00	0.00	0.00	4.42	0.00
C2dithio	0.00	1.90	0.00	0.00	0.00	5.44	0.00
C3dithio	0.76	5.22	0.73	0.00	0.00	2.21	0.00
Phenanth	6.47	0.00	0.00	0.00	0.00	37.14	0.00
C1phenan	7.35	0.00	0.00	0.00	0.00	37.41	0.00
C2phenan	4.42	4.26	0.00	0.00	0.00	21.37	0.00
C3phenan	2.64	9.36	0.00	0.00	0.00	5.60	0.00
C4phenan	2.11	2.62	0.00	0.00	0.00	8.63	0.00
Anthra	2.42	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	1.67	2.07	0.00	1.07	0.00	7.41	0.00
Pyrene	1.32	1.41	0.00	0.00	0.00	8.63	0.00
C1fluora	3.76	1.94	0.00	0.00	0.00	3.78	0.00
Benanth	3.59	0.67	0.00	1.03	0.00	7.25	0.00
Chrysene	14.93	4.02	0.00	0.00	0.00	20.30	0.00
C1chrys	3.58	4.84	0.00	0.00	0.00	10.96	0.00
C2chrys	0.00	5.22	0.00	0.00	0.00	0.00	0.00
C3chrys	0.00	2.22	0.00	0.00	0.00	0.00	0.00
C4chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzobfl	3.55	1.55	0.00	1.77	0.00	12.06	0.75
Benzokfl	2.40	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	3.58	2.19	1.51	1.86	0.00	10.49	0.00
Benapy	3.57	0.00	0.00	0.00	0.00	0.00	0.00
Perylene	11.57	2.69	1.16	2.38	3.55	77.79	18.87
Indeno	1.32	0.00	0.00	0.00	0.00	0.00	0.00
Dibenz	0.54	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	1.42	0.00	0.00	0.00	0.00	0.00	0.00
TPAH	96.09	50.23	2.24	6.86	0.00	349.95	2.59
Mean			19.78			117.51	
SE			15.28			116.22	
CV%			133.87			171.30	

Appendix I-4. Continued.

SITE	L. Herring B.	L. Herring B.	L. Herring B.	Sleepy Bay	Sleepy Bay	Sleepy Bay	Sleepy Bay
SITE #	15	15	15	17	17	17	17
DEPTH	< 3 m	< 3 m	< 3 m	6-20 m	6-20 m	6-20 m	< 3 m
TREATMENT	Control	Control	Control	Oiled	Oiled	Oiled	Oiled
COLLECTED	19-Jul-95	19-Jul-95	19-Jul-95	09-Jul-95	09-Jul-95	09-Jul-95	09-Jul-95
ID #	605828	605829	605830	605807	605808	605809	605810
PAH's (ng/g dry wt)							
Naph	2.28	0.92	0.00	1.98	0.00	0.00	0.00
C1naph	0.00	1.35	0.00	10.58	0.00	1.99	0.00
C2naph	0.00	1.59	0.00	38.43	0.00	4.42	0.00
C3naph	0.00	1.26	6.88	65.65	3.30	4.25	1.11
C4naph	0.00	0.00	8.67	43.19	2.87	2.75	1.57
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	3.32	0.00	0.00	0.00
Fluorene	0.00	0.00	0.00	6.22	0.00	0.00	0.00
C1fluor	0.00	0.00	0.00	11.78	0.00	0.00	0.00
C2fluor	0.00	0.00	0.00	22.36	0.00	0.00	0.00
C3fluor	0.00	0.00	0.00	7.77	0.00	0.00	0.00
Dithio	0.00	0.00	0.00	8.34	0.00	0.00	0.00
C1dithio	0.00	0.00	0.00	13.23	0.00	0.00	0.00
C2dithio	0.00	0.00	0.00	20.20	1.05	0.00	1.04
C3dithio	0.00	0.00	0.00	49.79	5.01	2.31	1.90
Phenanth	0.00	0.91	0.00	27.12	1.15	2.81	0.00
C1phenan	0.00	0.00	0.00	35.18	2.14	2.36	0.00
C2phenan	0.00	0.00	0.00	44.82	4.47	2.78	3.10
C3phenan	0.00	0.00	0.00	39.36	4.86	3.09	4.06
C4phenan	0.00	0.00	0.00	23.21	3.72	0.00	0.00
Anthra	0.00	0.00	0.00	5.02	0.00	0.00	0.00
Fluorant	0.00	0.00	0.00	7.04	1.31	1.71	0.72
Pyrene	0.00	0.00	0.00	8.35	1.19	1.44	0.00
C1fluora	0.00	0.00	0.00	25.06	3.03	1.99	1.43
Benanth	0.00	0.00	4.43	12.97	1.68	2.19	0.61
Chrysene	0.00	0.00	0.00	56.63	6.87	4.70	2.67
C1chrys	0.00	0.00	0.00	61.85	11.07	7.97	4.35
C2chrys	0.00	0.00	0.00	55.12	15.02	11.62	6.27
C3chrys	0.00	0.00	0.00	65.93	16.97	9.68	5.52
C4chrys	0.00	0.00	0.00	17.71	6.47	3.72	0.00
Benzobfl	0.00	0.00	0.00	48.38	5.29	4.10	1.88
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	0.00	0.00	0.00	36.14	9.96	6.93	3.85
Benapy	0.00	0.00	0.00	24.77	2.11	0.00	0.00
Perylene	9.66	2.39	63.83	11.77	1.77	0.00	0.00
Indeno	0.00	0.00	0.00	8.76	1.24	0.00	0.00
Dibenz	0.00	0.00	0.00	2.16	0.52	0.00	0.00
Benzop	0.00	0.00	0.00	19.19	5.62	3.52	2.08
TPAH	2.28	6.03	19.98	**927.61**	116.92	86.33	42.16
Mean		9.43			376.95		
SE		5.38			275.47		
CV%		98.91			126.57		

Appendix I-4. Continued.

SITE	Sleepy Bay	Sleepy Bay	Moose Lips B.	Moose Lips B.	Moose Lips B.	Moose Lips B.	Moose Lips B.
SITE #	17	17	18	18	18	18	18
DEPTH	< 3 m	< 3 m	6-20 m	6-20 m	6-20 m	< 3 m	< 3 m
TREATMENT	Oiled	Oiled	Control	Control	Control	Control	Control
COLLECTED	09-Jul-95	09-Jul-95	07-Jul-95	07-Jul-95	07-Jul-95	08-Jul-95	08-Jul-95
ID #	605811	605812	605801	605802	605803	605804	605805
PAH's (ng/g dry wt)							
Naph	1.12	0.00	4.82	0.00	3.75	0.00	10.31
C1naph	0.00	0.00	12.35	1.57	9.86	0.00	10.99
C2naph	0.00	0.00	14.65	3.41	13.71	0.00	7.37
C3naph	0.00	0.00	10.75	4.10	9.21	0.00	3.86
C4naph	0.00	0.89	5.07	2.52	5.10	0.00	0.00
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	5.61
Acenthy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenthe	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorene	0.00	0.00	8.15	4.85	8.88	1.82	3.98
C1fluor	0.00	0.00	6.26	3.77	6.41	1.19	3.31
C2fluor	0.00	0.00	5.03	2.72	4.51	0.00	2.27
C3fluor	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dithio	0.00	0.00	1.16	0.95	1.28	0.00	0.95
C1dithio	0.00	0.00	0.00	0.00	0.85	0.00	0.00
C2dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C3dithio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phenanth	1.17	1.06	19.27	12.38	21.71	4.58	17.94
C1phenan	0.00	0.00	12.37	9.38	11.55	2.35	10.73
C2phenan	0.00	0.00	3.06	4.84	5.03	0.00	2.32
C3phenan	0.00	0.00	0.00	2.25	0.00	0.00	0.00
C4phenan	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anthra	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorant	0.00	0.76	1.29	0.92	2.04	0.00	1.16
Pyrene	0.00	0.00	3.03	4.28	5.08	1.17	2.43
C1fluora	0.00	0.00	2.54	4.11	3.78	1.25	1.47
Benanth	0.00	0.00	1.08	1.85	1.66	0.58	0.00
Chrysene	0.00	0.00	3.74	5.29	4.48	0.00	4.30
C1chrys	0.00	0.00	3.08	3.61	3.70	0.00	0.00
C2chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C3chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C4chrys	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzobfl	0.00	0.00	7.90	8.21	9.58	2.84	4.04
Benzokfl	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benepy	0.00	0.00	5.88	5.33	6.07	2.21	2.02
Benapy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Perylene	0.00	0.00	9.10	9.80	12.70	2.72	3.96
Indeno	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dibenz	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzop	0.00	0.00	0.00	6.25	0.00	2.39	0.00
TPAH	2.29	2.71	131.48	92.59	138.24	20.38	95.06
Mean	15.72			120.77			59.81
SE	13.22			14.22			21.66
CV%	145.67			20.40			62.73

Appendix I-4. Continued.

SITE	Moose Lips B.
SITE #	18
DEPTH	< 3 m
TREATMENT	Control
COLLECTED	08-Jul-95
ID #	605806
PAH's (ng/g dry wt)	
Naph	2.40
C1naph	6.46
C2naph	8.55
C3naph	4.86
C4naph	1.97
Biphenyl	0.00
Acenthy	0.00
Acenthe	0.00
Fluorene	5.30
C1fluor	2.99
C2fluor	2.37
C3fluor	0.00
Dithio	0.71
C1dithio	0.00
C2dithio	0.00
C3dithio	0.00
Phenanth	11.70
C1phenan	4.88
C2phenan	0.00
C3phenan	0.00
C4phenan	0.00
Anthra	0.00
Fluorant	0.85
Pyrene	2.17
C1fluora	1.50
Benanth	0.59
Chrysene	0.00
C1chrys	0.00
C2chrys	0.00
C3chrys	0.00
C4chrys	0.00
Benzobfl	3.96
Benzokfl	0.00
Benepy	2.72
Benapy	0.00
Perylene	3.97
Indeno	0.00
Dibenz	0.00
Benzop	0.00
TPAH	63.98

Appendix J.

Means, standard errors, and results on one-way and two-way randomization ANOVAs for TPAH and Chrysene concentrations (ng g^{-1}).

Appendix J. Means, standards errors, and results on one-way and two-way randomization ANOVAS for TPAH and Chrysene concentrations (Ng g^{-1}).

TPAHs - PERYLENE
Depth Stratum = 6 to 20 M

Means by year and site

TRANSECT	YEAR	PAIR	OILCODE	SITNUM	SITNAME	MEAN TPAH	SE	N	CV	STD
1	90	1	Oiled	13	Bay of Isles	15252.71	8451.09	2	78.358	11951.65
1	90	1	Control	14	Drier Bay	1836.76	777.01	2	59.826	1098.86
1	90	2	Oiled	16	Herring Bay	45.43	20.42	3	77.847	35.37
1	90	2	Control	15	L. Herring B	1908.35	1016.55	2	75.333	1437.62
1	90	3	Oiled	17	Sleepy Bay	871.58	602.67	2	97.788	852.30
1	90	3	Control	18	Moose Lips B	101.70	2.53	2	3.518	3.58
1	91	1	Oiled	13	Bay of Isles	1122.31	441.77	3	68.178	765.16
1	91	1	Control	14	Drier Bay	130.32	25.48	3	33.866	44.14
1	91	2	Oiled	16	Herring Bay	120.52	65.29	3	93.832	113.09
1	91	2	Control	15	L. Herring B	102.79	86.56	2	119.091	122.41
1	91	3	Oiled	17	Sleepy Bay	305.47	78.36	3	44.431	135.73
1	91	3	Control	18	Moose Lips B	116.08	11.70	3	17.454	20.26
1	93	1	Oiled	13	Bay of Isles	611.67	376.27	3	106.547	651.71
1	93	1	Control	14	Drier Bay	95.39	46.39	3	84.226	80.35
1	93	2	Oiled	16	Herring Bay	87.41	28.80	3	57.064	49.88
1	93	2	Control	15	L. Herring B	0.42	0.42	3	173.205	0.73
1	93	3	Oiled	17	Sleepy Bay	117.20	28.16	3	41.620	48.78
1	93	3	Control	18	Moose Lips B	73.80	9.49	3	22.283	16.45
1	95	1	Oiled	13	Bay of Isles	255.51	70.82	3	48.009	122.67
1	95	1	Control	14	Drier Bay	65.55	39.27	3	103.779	68.02
1	95	2	Oiled	16	Herring Bay	34.35	30.87	3	155.637	53.47
1	95	2	Control	15	L. Herring B	117.51	116.22	3	171.300	201.30
1	95	3	Oiled	17	Sleepy Bay	376.95	275.47	3	126.575	477.13
1	95	3	Control	18	Moose Lips B	120.77	14.22	3	20.400	24

Means by year and oiling category

TRANSECT	YEAR	OILCODE	MEAN TPAH	SE	N	CV	STD
1	90	Oiled	5389.91	4937.16	3	158.656	8551.42
1	90	Control	1282.27	590.65	3	79.783	1023.03
1	91	Oiled	516.10	307.77	3	103.288	533.07
1	91	Control	116.40	7.95	3	11.832	13.77
1	93	Oiled	272.09	170.01	3	108.219	294.46
1	93	Control	56.54	28.74	3	88.050	49.78
1	95	Oiled	222.27	100.29	3	78.148	173.70
1	95	Control	101.28	17.89	3	30.595	30.99

One-way Randomized within blocks

YEAR	P for oil code
1990	0.02
1991	0.08
1993	<0.01
1995	0.24

Two-way Randomized within blocks

P values for:

Interaction	Oilcode	Year
0.003	0.014	0.000

TPAHs - PERYLENE
Depth Stratum < 3 M

Means by year and site

TRANSECT	YEAR	PAIR	OILCODE	SITNUM	SITNAME	MEAN TPAH	SE	N	CV	STD
3	90	1	Oiled	13	Bay of Isles	14309.30	4482.93	3	54.263	7764.66
3	90	1	Control	14	Drier Bay	1417.95	507.24	3	61.960	878.56
3	90	2	Oiled	16	Herring Bay	321.75	132.52	3	71.340	229.53
3	90	2	Control	15	L. Herring B	296.61	7.95	3	4.643	13.77
3	90	3	Oiled	17	Sleepy Bay	306.04	192.86	3	109.149	334.04
3	90	3	Control	18	Moose Lips B	124.32	23.58	3	32.846	40.83
3	91	1	Oiled	13	Bay of Isles	789.86	209.22	3	45.878	362.37
3	91	1	Control	14	Drier Bay	914.80	349.59	3	66.190	605.51
3	91	2	Oiled	16	Herring Bay	136.94	37.46	3	47.381	64.88
3	91	2	Control	15	L. Herring B	60.36	48.35	3	138.748	83.74
3	91	3	Oiled	17	Sleepy Bay	174.04	93.16	3	92.710	161.35
3	91	3	Control	18	Moose Lips B	58.75	5.26	3	15.504	9.11
3	93	1	Oiled	13	Bay of Isles	442.77	160.54	3	62.803	278.07
3	93	1	Control	14	Drier Bay	58.93	26.25	3	77.145	45.46
3	93	2	Oiled	16	Herring Bay	39.80	16.85	3	73.316	29.18
3	93	2	Control	15	L. Herring B	44.77	22.41	3	86.708	38.82
3	93	3	Oiled	17	Sleepy Bay	10.45	4.19	3	69.377	7.25
3	93	3	Control	18	Moose Lips B	41.79	7.14	3	29.587	12.36
3	95	1	Oiled	13	Bay of Isles	312.67	135.25	3	74.924	234.26
3	95	1	Control	14	Drier Bay	179.31	47.85	3	46.218	82.87
3	95	2	Oiled	16	Herring Bay	19.78	15.28	3	133.867	26.47
3	95	2	Control	15	L. Herring B	9.43	5.38	3	98.907	9.33
3	95	3	Oiled	17	Sleepy Bay	15.72	13.22	3	145.666	22.90
3	95	3	Control	18	Moose Lips B	59.81	21.66	3	62.726	37.51

Means by year and oiling category

TRANSECT	YEAR	OILCODE	MEAN TPAH	SE	N	CV	STD
3	90	Oiled	4979.03	4665.14	3	162.286	8080.26
3	90	Control	612.96	405.55	3	114.598	702.44
3	91	Oiled	366.95	211.73	3	99.939	366.72
3	91	Control	344.64	285.08	3	143.275	493.78
3	93	Oiled	164.34	139.47	3	146.996	241.57
3	93	Control	48.50	5.29	3	18.888	9.16
3	95	Oiled	116.06	98.31	3	146.727	170.29
3	95	Control	82.85	50.38	3	105.315	87.25

One-way Randomized within blocks

YEAR	P for oil code
1990	0.02
1991	0.07
1993	<0.01
1995	0.23

Two-way Randomized within blocks

P values for:

Interaction	Oilcode	Year
0.004	0.018	0.000

TPAHs - CHRYSENE
Depth Stratum = 6 to 20 M

Means by year and site

TRANSECT	YEAR	PAIR	OILCODE	SITNUM	SITNAME	CHRYSENE	SE	N	CV	STD
1	90	1	Oiled	13	Bay of Isles	15.6200	0.8800	2	7.967	1.2445
1	90	1	Control	14	Drier Bay	5.8700	2.2700	2	54.689	3.2103
1	90	2	Oiled	16	Herring Bay	3.3200	0.8830	3	46.065	1.5293
1	90	2	Control	15	L.Herring Bay	3.0600	3.0600	2	141.421	4.3275
1	90	3	Oiled	17	Sleepy Bay	53.8700	38.2100	2	100.310	54.0371
1	90	3	Control	18	Moose Lips Bay	2.6200	0.3800	2	20.511	0.5374
1	91	1	Oiled	13	Bay of Isles	20.9100	7.3388	3	60.790	12.7112
1	91	1	Control	14	Drier Bay	5.5467	0.5732	3	17.901	0.9929
1	91	2	Oiled	16	Herring Bay	1.6067	0.8243	3	88.863	1.4277
1	91	2	Control	15	L.Herring Bay	0.0000	0.0000	2	.	0.0000
1	91	3	Oiled	17	Sleepy Bay	13.9567	6.2346	3	77.373	10.7986
1	91	3	Control	18	Moose Lips Bay	2.3000	0.2200	3	16.567	0.3811
1	93	1	Oiled	13	Bay of Isles	31.7300	14.5506	3	79.428	25.2024
1	93	1	Control	14	Drier Bay	5.3500	1.0627	3	34.406	1.8407
1	93	2	Oiled	16	Herring Bay	3.2667	2.1607	3	114.564	3.7424
1	93	2	Control	15	L.Herring Bay	0.0000	0.0000	3	.	0.0000
1	93	3	Oiled	17	Sleepy Bay	12.8567	4.9701	3	66.957	8.6085
1	93	3	Control	18	Moose Lips Bay	1.9100	0.9566	3	86.745	1.6568
1	95	1	Oiled	13	Bay of Isles	4.6867	4.6867	3	173.205	8.1175
1	95	1	Control	14	Drier Bay	0.0000	0.0000	3	.	0.0000
1	95	2	Oiled	16	Herring Bay	4.9767	4.9767	3	173.205	8.6198
1	95	2	Control	15	L.Herring Bay	6.7667	6.7667	3	173.205	11.7202
1	95	3	Oiled	17	Sleepy Bay	22.7333	16.9599	3	129.217	29.3754
1	95	3	Control	18	Moose Lips Bay	4.5033	0.4476	3	17.215	0.7753

Means by year and oiling category

TRANSECT	YEAR	OILCODE	CHRYSENE	SE	N	CV	STD
1	90	Oiled	24.2700	15.2200	3	108.619	26.3618
1	90	Control	3.8500	1.0180	3	45.796	1.7632
1	91	Oiled	12.1578	5.6445	3	80.414	9.7766
1	91	Control	2.6156	1.6089	3	106.546	2.7868
1	93	Oiled	15.9511	8.3611	3	90.789	14.4818
1	93	Control	2.4200	1.5653	3	112.034	2.7112
1	95	Oiled	10.7989	5.9678	3	95.719	10.3365
1	95	Control	3.7567	1.9887	3	91.692	3.4446
3	90	Oiled	22.0000	9.9978	3	78.712	17.3167

One-way Randomized within blocks

YEAR	P for oil code
1990	<0.01
1991	<0.01
1993	<0.01
1995	0.16

Two-way Randomized within blocks

P values for:

Interaction	Oilcode	Year
0.134	0.000	0.148

TPAHs - CHRYSENE
Depth Stratum < 3 M

Means by year and site

TRANSECT	YEAR	PAIR	OILCODE	SITNUM	SITNAME	CHRYSENE	SE	N	CV	STD
3	90	1	Oiled	13	Bay of Isles	41.6567	16.4801	3	68.523	28.5444
3	90	1	Control	14	Drier Bay	1.8667	1.1193	3	103.854	1.9386
3	90	2	Oiled	16	Herring Bay	15.3467	6.5328	3	73.730	11.3151
3	90	2	Control	15	L.Herring Bay	0.8033	0.8033	3	173.205	1.3914
3	90	3	Oiled	17	Sleepy Bay	8.9967	5.6485	3	108.746	9.7835
3	90	3	Control	18	Moose Lips Bay	2.0100	0.1629	3	14.037	0.2821
3	91	1	Oiled	13	Bay of Isles	8.5133	1.7116	3	34.822	2.9645
3	91	1	Control	14	Drier Bay	2.0400	0.4782	3	40.604	0.8283
3	91	2	Oiled	16	Herring Bay	2.4667	1.0333	3	72.558	1.7898
3	91	2	Control	15	L.Herring Bay	0.0000	0.0000	3	.	0.0000
3	91	3	Oiled	17	Sleepy Bay	6.6667	4.1570	3	108.002	7.2001
3	91	3	Control	18	Moose Lips Bay	1.3667	0.1438	3	18.224	0.2491
3	93	1	Oiled	13	Bay of Isles	17.3867	8.6944	3	86.614	15.0592
3	93	1	Control	14	Drier Bay	0.0000	0.0000	3	.	0.0000
3	93	2	Oiled	16	Herring Bay	3.4200	1.7182	3	87.017	2.9760
3	93	2	Control	15	L.Herring Bay	0.0000	0.0000	3	.	0.0000
3	93	3	Oiled	17	Sleepy Bay	0.7500	0.7500	3	173.205	1.2990
3	93	3	Control	18	Moose Lips Bay	2.3333	0.1338	3	9.934	0.2318
3	95	1	Oiled	13	Bay of Isles	15.5700	8.6536	3	96.265	14.9885
3	95	1	Control	14	Drier Bay	3.1867	3.1867	3	173.205	5.5195
3	95	2	Oiled	16	Herring Bay	1.3400	1.3400	3	173.205	2.3209
3	95	2	Control	15	L.Herring Bay	0.0000	0.0000	3	.	0.0000
3	95	3	Oiled	17	Sleepy Bay	0.8900	0.8900	3	173.205	1.5415
3	95	3	Control	18	Moose Lips Bay	1.4333	1.4333	3	173.205	2.4826

Means by year and oiling category

TRANSECT	YEAR	OILCODE	CHRYSENE	SE	N	CV	STD
3	90	Oiled	22.0000	9.9978	3	78.712	17.3167
3	90	Control	1.5600	0.3806	3	42.256	0.6592
3	91	Oiled	5.8822	1.7890	3	52.679	3.0987
3	91	Control	1.1356	0.6001	3	91.537	1.0395
3	93	Oiled	7.1856	5.1585	3	124.343	8.9347
3	93	Control	0.7778	0.7778	3	173.205	1.3472
3	95	Oiled	5.9333	4.8201	3	140.707	8.3486
3	95	Control	1.5400	0.9215	3	103.637	1.5960

One-way Randomized within blocks

YEAR	P for oil code
1990	<0.01
1991	<0.01
1993	<0.01
1995	0.18

Two-way Randomized within blocks

P values for:

Interaction	Oilcode	Year
0.129	<0.01	0.148

Appendix K.

Mean densities of eelgrass turions (No m^2) and flowers, and results of randomization ANOVAs.

Appendix K. Mean densities of eelgrass turions (No m^{-2}) and flowers, and results of randomization ANOVAs.

Means by year and site

YEAR	SITNUM	OILCODE	MEAN	SE	N STATIONS
1990	13	O	110.000	2.0000	3
1990	14	C	172.667	32.2714	3
1990	16	O	197.667	31.9235	3
1990	15	C	279.000	61.9785	3
1990	17	O	140.333	8.1921	3
1990	18	C	119.333	15.8570	3
1991	13	O	137.333	27.4853	3
1991	14	C	141.333	18.6577	3
1991	16	O	183.667	29.3844	3
1991	15	C	229.000	15.5027	3
1991	17	O	112.667	6.7412	3
1991	18	C	173.333	19.2296	3
1993	13	O	146.667	13.2958	3
1993	14	C	123.333	29.1681	3
1993	16	O	121.000	3.5119	3
1993	15	C	243.667	44.2882	3
1993	17	O	161.000	5.0332	3
1993	18	C	150.667	36.6803	3
1995	13	O	157.333	31.4660	3
1995	14	C	113.333	25.7250	3
1995	16	O	141.000	14.4684	3
1995	15	C	119.333	10.1050	3
1995	17	O	158.667	23.1325	3
1995	18	C	80.667	21.1686	3

Means By year and oiling category

YEAR	OILCODE	MEAN	SE	N SITES
1990	O	149.333	25.7042	3
1990	C	190.333	46.9306	3
1991	O	144.556	20.8116	3
1991	C	181.222	25.6127	3
1993	O	142.889	11.7005	3
1993	C	172.556	36.4206	3
1995	O	152.333	5.6797	3
1995	C	104.444	12.0144	3

One-way randomized within blocks

YEAR	P for oil code
1990	0.23
1991	0.05
1993	0.33
1995	0.03

Two-way randomized within blocks

Interaction	Oilcode	Year
0.052	0.265	0.122

Density of Flowering Turions (No./Sq. m)

Means by year and site

YEAR	SITNUM	OILCODE	MEAN	SE	N STATIONS
1990	13	O	6.3333	1.45297	3
1990	14	C	9.0000	5.68624	3
1990	16	O	0.0000	0.00000	3
1990	15	C	13.0000	2.88675	3
1990	17	O	2.6667	0.88192	3
1990	18	C	4.3333	2.96273	3
1991	13	O	1.5000	0.48572	3
1991	14	C	1.1222	0.31348	3
1991	16	O	1.1111	0.29586	3
1991	15	C	4.4000	0.27756	3
1991	17	O	2.9667	0.52104	3
1991	18	C	1.6778	0.10599	3
1993	13	O	4.4222	1.41190	3
1993	14	C	2.8778	0.57553	3
1993	16	O	0.6222	0.22305	3
1993	15	C	4.8889	2.57008	3
1993	17	O	0.6000	0.43504	3
1993	18	C	5.9222	2.76783	3
1995	13	O	0.7111	0.27307	3
1995	14	C	0.6556	0.18987	3
1995	16	O	0.6667	0.10000	3
1995	15	C	1.0556	0.02222	3
1995	17	O	1.4889	0.23280	3
1995	18	C	1.0111	0.60746	3

Means by year and oiling category

YEAR	OILCODE	MEAN	SE	N SITES
1990	O	3.00000	1.83586	3
1990	C	8.77778	2.50432	3
1991	O	1.85926	0.56497	3
1991	C	2.40000	1.01278	3
1993	O	1.88148	1.27039	3
1993	C	4.56296	0.89384	3
1995	O	0.95556	0.26698	3
1995	C	0.90741	0.12658	3

One-way randomized within blocks

YEAR	P for oil code
1990	0.35
1991	0.48
1993	0.12
1995	0.83

Two-way randomized within blocks

P values for:

Interaction	Oilcode	Year
0.128	0.016	0.002

Appendix L.

Benthic invertebrate genera and species within higher taxa from shallow subtidal eelgrass sites in Western Prince William Sound, 1990.

Appendix L. Benthic invertebrate genera and species within higher taxa from shallow subtidal eelgrass sites in western Prince William Sound, 1990, 1991, 1993, and 1995.

Taxon	Code	Common Name
RHYNCHOCOELA	430000	Ribbon Worms
LINEIDAE	430302	Ribbon Worms
Cerebratulus sp.	430302020000	"
POLYCHAETA	500100	Polychaetes
POLYNOIDAE	500102	"
Eunoe sp.	500102050000	"
Eunoe oerstedi	500102050500	"
Harmothoe sp.	500102080000	"
Harmothoe extenuata	500102080300	"
Harmothoe imbricata	500102080600	"
POLYODONTIDAE	500104	"
Peisidice aspera	500104010100	"
SIGALIONIDAE	500106	"
Pholoe minuta	500106010100	"
CHRYSOPETALIDAE	500108	"
Paleanotus sp.	500108010000	"
PHYLLODOCIDAE	500113	"
Anaitides sp.	500113010000	"
Anaitides groenlandica	500113010200	"
Eteone sp.	500113020000	"
Eteone longa	500113020500	"
Eulalia sp.	500113030000	"
Notophyllum sp.	500113040000	"
HESIONIDAE	500121	"
Gyptis brevipalpa	500121010200	"
Micropodarke sp.	500121080000	"
Micropodarke dubia	500121080100	"
SYLLIDAE	500123	"
Autolytus sp.	500123010000	"
Syllis sp.	500123030000	"
Typosyllis sp.	500123050000	"
Typosyllis alternata	500123050100	"
Typosyllis armillaris	500123050200	"
Exogone sp.	500123070000	"
Sphaerosyllis sp.	500123080000	Polychaetes
Sphaerosyllis erinaceus	500123080100	"
Odontosyllis sp.	500123130000	"
NEREIDAE	500124	"
Nereis sp.	500124040000	"
Platynereis bicanaliculata	500124050100	"
Micronereis sp.	500124070000	"
NEPHTYIDAE	500125	"
Nephtys sp.	500125010000	"
Nephtys ciliata	500125010200	"
Nephtys caeca	500125010300	"
Nephtys cornuta	500125010400	"
Nephtys ferruginea	500125011100	"
Aglaophamus rubella	500125030200	"
SPHAERODORIIDAE	500126	"
Sphaerodorum sp.	500126010000	"
Sphaerodorum papillifer	500126010200	"
Sphaerodoropsis sp.	500126020000	"
Sphaerodoropsis minuta	500126020100	"
Sphaerodoropsis sphaerulifer	500126020200	"
GLYCERIDAE	500127	"
Glycera sp.	500127010000	"
Glycera capitata	500127010100	"
Hemipodus borealis	500127020100	"
GONIADIDAE	500128	"
Glycinde sp.	500128010000	"
Glycinde picta	500128010100	"
Glycinde armigera	500128010300	"
Goniada sp.	500128020000	"
Goniada maculata	500128020200	"
ONUPHIDAE	500129	"
Onuphis sp.	500129010000	"
Onuphis conchylega	500129010100	"
Onuphis iridescens	500129010300	"

Appendix L. Continued.

Taxon	Code	Common Name
LUMBRINERIDAE	500131	Polychaetes
Lumbrineris sp.	500131010000	"
Lumbrineris luti	500131010900	"
DORVILLEIDAE	500136	"
Dorvillea sp.	500136010000	"
Dorvillea pseudorubrovittata	500136010100	"
Protodorvillea gracilis	500136020100	"
Dorvillea rudolphi	500136050400	"
ORBINIIDAE	500140	"
Leitoscoloplos sp.	500140010000	"
Leitoscoloplos pugettensis	500140010700	"
Naineris sp.	500140020000	"
Naineris uncinata	500140020400	"
Scoloplos sp.	500140030000	"
Scoloplos armiger	500140030100	"
Scoloplos acmeceps	500140031100	"
PARAONIDAE	500141	"
Aricidea sp.	500141020000	"
Aricidea lopezi	500141021500	"
Aricidea ramosa	500141021800	"
Cirrophorus lyra	500141060300	"
SPIONIDAE	500143	"
Laonice sp.	500143020000	"
Laonice cirrata	500143020100	"
Polydora sp.	500143040000	"
Polydora socialis	500143040200	"
Prionospio sp.	500143050000	"
Prionospio cirrifera	500143050200	"
Prionospio steenstrupi	500143050600	"
Spio sp.	500143070000	"
Spio filicornis	500143070100	"
Spio cirrifera	500143070300	"
Spiophanes sp.	500143100000	"
Spiophanes bombyx	500143100100	"

Taxon	Code	Common Name
Spiophanes berkeleyorum	500143100400	Polychaetes
Malacoceros sp.	500143120000	"
Malacoceros glutaeus	500143120100	"
Rhynchospio glutaeus	500143120100	"
Pygospio sp.	500143130000	"
Pygospio elegans	500143130200	"
Scolelepis sp.	500143200000	"
Scolelepis squamata	500143200100	"
MAGELONIDAE	500144	"
Magelona sp.	500144010000	"
Magelona longicornis	500144010500	"
Magelona sacculata	500144011600	"
Magelona berkeleyi	500144012300	"
CHAETOPTERIDAE	500149	"
Mesochaetopterus taylori	500149040100	"
CIRRATULIDAE	500150	"
Tharyx sp.	500150030000	"
Tharyx secundus	500150030900	"
Chaetozone sp.	500150040000	"
Chaetozone setosa	500150040100	"
Dodecaceria sp.	500150050000	"
ACROCIRRIDAE	500151	"
Acrocirrus sp.	500151010000	"
FLABELLIGERIDAE	500154	"
Flabelligera affinis	500154020200	"
Pherusa sp.	500154030000	"
Pherusa plumosa	500154030200	"
SCALIBREGMIDAE	500157	"
Scalibregma inflatum	500157010100	"
OPHELIIDAE	500158	"
Ophelina sp.	500158010000	"
Ophelina acuminata	500158010100	"
Armandia brevis	500158020200	"
Ophelia limacina	500158030100	"

Appendix L. Continued.

Taxon	Code	Common Name
Travisia sp.	500158040000	Polychaetes
Travisia forbesi	500158040200	"
CAPITELLIDAE	500160	"
Capitella sp.	500160010000	"
Capitella capitata	500160010100	"
Heteromastus sp.	500160020000	"
Notomastus sp.	500160030000	"
Mediomastus sp.	500160040000	"
Decamastus sp.	500160050000	"
Decamastus gracilis	500160050100	"
Barantolla sp.	500160060000	"
Barantolla americana	500160060100	"
ARENICOLIDAE	500162	"
MALDANIDAE	500163	"
Petaloproctus tenuis	500163070100	"
Praxillella praetermissa	500163090200	"
Praxillella affinis	500163090300	"
OWENIIDAE	500164	"
Owenia fusiformis	500164010200	"
Myriochele oculata	500164020200	"
SABELLARIDAE	500165	"
Idanthyrsus sp.	500165010000	"
Idanthyrsus ornamentatus	500165010100	"
Idanthyrsus armatus	500165010200	"
AMPHICTENIDAE	500166	"
Cistenides sp.	500166020000	"
Cistenides granulata	500166020200	"
Pectinaria sp.	500166030000	"
Pectinaria californiensis	500166030400	"
AMPHARETIDAE	500167	"
Ampharete sp.	500167020000	"
Ampharete acutifrons	500167020800	"
Ampharete finmarchica	500167021400	"
Lysippe labiata	500167040100	"

Taxon	Code	Common Name
Melinna cristata	500167050100	Polychaetes
Melinna elisabethae	500167050300	"
Asabellides sp.	500167080000	"
Asabellides sibirica	500167080100	"
Asabellides lineata	500167080400	"
Neosabellides sp.	500167240000	"
TEREBELLIDAE	500168	"
Nicolea sp.	500168060000	"
Pista sp.	500168070000	"
Pista cristata	500168070100	"
Polycirrus sp.	500168080000	"
Laphania sp.	500168150000	"
Laphania boecki	500168150100	"
Streblosoma sp.	500168250000	"
TRICHOBRANCHIDAE	500169	"
Terebellides stroemii	500169010100	"
Trichobranchus glacialis	500169020100	"
SABELLIDAE	500170	"
Chone sp.	500170010000	"
Chone magna	500170010600	"
Euchone sp.	500170020000	"
Euchone analis	500170020100	"
Euchone hancocki	500170020900	"
Oriopsis sp.	500170200000	"
SERPULIDAE	500173	"
Pseudochitinopoma occidentalis	500173010100	"
Crucigera sp.	500173020000	"
Crucigera irregularis	500173020100	"
Crucigera zygophora	500173020200	"
SPIRORBIDAE	500178	"
POLYGORDIIDAE	500205	"
Polygordius sp.	500205010000	"
GASTROPODA	510000	
ARCHAEOGASTROPODA	510200	Limpets

Appendix L. Continued.

Taxon	Code	Common Name
FISSURELLIDAE	510204	Snails
Puncturella sp.	510204020000	"
LOTTIDAE	510205	"
Acmaea mitra	510205010300	"
Lottia sp.	510205020000	"
Lottia ochracea	510205020300	"
Lottia ochra	510205040200	"
LEPETIDAE	510207	"
Cryptobranchia sp.	510207010000	"
Cryptobranchia concentrica	510207010100	"
Cryptobranchia alba	510207010200	"
TROCHIDAE	510210	"
Margarites sp.	510210030000	"
Margarites pupillus	510210030800	"
Margarites beringensis	510210031600	"
LACUNIDAE	510309	"
Lacuna sp.	510309030000	"
Lacuna vincta	510309030500	"
LITTORINIDAE	510310	Periwinkle
Littorina scutulata	510310010400	"
RISSOIDAE	510320	Snails
Alvinia sp.	510320010000	"
Alvinia compacta	510320010600	"
Cingula sp.	510320030000	"
CAECIDAE	510336	Caecum
Fartulum sp.	510336010000	"
Fartulum occidentale	510336010100	"
Micranellum sp.	510336020000	"
Micranellum crebricinctum	510336020200	"
CERITHIIDAE	510346	Snails
Bittium sp.	510346010000	"
EULIMDAE	510353	"
Melanella columbiana	510353010100	"
Eulima sp.	510353030000	"

Taxon	Code	Common Name
TRICHOTROPIDAE	510362	Snails
Trichotropis sp.	510362020000	"
Trichotropis bicarinata	510362020100	"
Trichotropis insignis	510362020200	"
Trichotropis borealis	510362020300	"
Trichotropis cancellata	510362020400	"
CALYPTRAEIDAE	510364	"
Crepidula sp.	510364020000	"
Crepidula grandis	510364020200	"
Crepidula dorsata	510364021100	"
LAMELLARIIDAE	510366	"
Velutina sp.	510366040000	"
Velutina velutina	510366040100	"
NATICIDAE	510376	"
Natica sp.	510376020000	"
Natica clausa	510376020100	"
Polinices sp.	510376040000	"
MURICIDAE	510501	"
Trophonopsis tenuisculptus	510501041600	"
COLUMBELLIDAE	510503	"
Alia gausapata	510503020400	"
NASSARIIDAE	510508	"
Nassarius sp.	510508010000	"
Nassarius mendicus	510508010100	"
OLIVIDAE	510510	"
Olivella sp.	510510010000	"
Olivella baetica	510510010200	"
MARGINELLIDAE	510515	"
Granulina margaritula	510515010100	"
TURRIDAE	510602	"
Oenopota sp.	510602040000	"
Kurtziella plumbea	510602110700	"
Taranis strongi	510602350100	"
PYRAMIDELLIDAE	510801	"

Appendix L. Continued.

Taxon	Code	Common Name
Odostomia sp.	510801010000	Snails
Turbonilla sp.	510801020000	"
CEPHALASPIDEA	511000	Bubble Shells
CYLICHNIDAE	511004	"
Cylichnella culcitella	511004010100	"
Cylichnella harpa	511004010200	"
Cylichna sp.	511004020000	"
Cylichna attonsa	511004021400	"
Cylichnella harpa	511004040000	"
Cylichnella sp.	511004040000	"
Cylichnella culcitella	511004040100	"
PHILINIDAE	511005	Paperbubble
GASTROPTERIDAE	511007	Batwing Seaslug
Gastropteron pacificum	511007010100	"
DIAPHANIDAE	511009	Paperbubble
Diaphana sp.	511009010000	"
Diaphana minuta	511009010100	"
ATYIDAE	511012	Glassy-bubble
Haminoea sp.	511012010000	"
Haminoea vesicula	511012010100	"
SACOGLOSSA	512300	Nudibranchs
STILIGERIDAE	512306	
Hermaea vancouverensis	512306010300	"
NUDIBRANCHIA	512700	"
DORIDACEA	512800	"
DORIDIDAE	513003	"
ONCHIDORIDIDAE	513105	"
CORAMBIDAE	513107	"
Doridella steinbergae	513107020400	"
TETHYIDAE	513408	"
Melibe leonina	513408010100	"
OPISTOBRANCHIA	518100	"
POLYPLACOPHORA	530000	Chitons
LEPTOCHITONIDAE	530201	"
Leptochiton sp.	530201010000	Chitons
Leptochiton alveolus	530201010600	"
ISCHNOCHITONIDAE	530302	"
Ischnochiton sp.	530302030000	"
Ischnochiton interstinctus	530302030300	"
Tonicella sp.	530302060000	"
Tonicella insignis	530302060100	"
Tonicella lineata	530302060200	"
Tonicella rubra	530302060400	"
Stenosemus albus	530302090200	"
MOPALIIDAE	530307	"
Mopalia sp.	530307040000	"
Mopalia laevior	530307040600	"
BIVALVIA	550000	Bivalves
NUCULIDAE	550202	Nutclam
Nucula sp.	550202020000	"
Nucula tenuis	550202020100	"
NUCULANIDAE	550204	Clams
Nuculana sp.	550204020000	"
Nuculana minuta	550204020200	"
Nuculana fossa	550204020300	"
Yoldia sp.	550204050000	"
Yoldia amygdalea	550204050100	"
Yoldia scissurata	550204050400	"
Yoldia seminuda	550204050500	"
GLYCYMERIIDAE	550606	"
Glycymeris sp.	550606010000	"
Glycymeris subobsoleta	550606010100	"
Glycymeris septentrionalis	550606010400	"
MYTILIDAE	550701	Mussels
Mytilus sp.	550701010000	"
Mytilus edulis	550701010100	"
Mytilus trossulus	550701010100	"
Crenella sp.	550701020000	"

Appendix L. Continued.

Taxon	Code	Common Name
Crenella decussata	550701020100	Mussels
Musculus sp.	550701040000	"
Musculus niger	550701040100	"
Musculus corrugatus	550701040300	"
Musculus vernicosus	550701040500	"
Musculus seminudus	550701040800	"
Modiolus modiolus	550701060100	"
PECTINIDAE	550905	Scallops
Chlamys sp.	550905010000	"
Chlamys sp. A	550905010000	"
Chlamys sp. B	550905010000	"
Chlamys rubida	550905010200	"
ANOMIIDAE	550909	Jingles
Pododesmus macrochisma	550909010100	"
LUCINIDAE	551501	Clams
Lucina tenuisculpta	551501010100	"
Lucinoma annulatum	551501020100	"
THYASIRIDAE	551502	"
Adontorhina sp.	551502010000	"
Axinopsida sp.	551502020000	"
Thyasira sp.	551502030000	"
Thyasira flexuosa	551502030100	"
Thyasira cygnus	551502030400	"
Thyasira gouldii	551502032500	"
UNGULINIDAE	551505	"
Diplodonta sp.	551505010000	"
Diplodonta impolita	551505011300	"
KELLIDAE	551508	"
Pseudopythina compressa	551508020100	"
MONTACUTIDAE	551510	"
Mysella sp.	551510010000	"
Mysella tumida	551510010200	"
TURTONIIDAE	551514	"
Turtonia sp.	551514010000	"

Taxon	Code	Common Name
Turtonia minuta	551514010100	Clams
ASTARTIDAE	551519	"
Astarte sp.	551519010000	"
Astarte borealis	551519010100	"
Astarte montagui	551519010300	"
Astarte esquimalti	551519010800	"
CARDIIDAE	551522	Cockles
Clinocardium sp.	551522010000	"
Clinocardium ciliatum	551522010100	"
Clinocardium nuttallii	551522010200	"
Clinocardium fucanum	551522010300	"
Clinocardium californiense	551522010400	"
Serripes groenlandicus	551522020100	"
MACTRIDAE	551525	Clams
Spisula polynyma	551525100100	"
TELLINIDAE	551531	"
Macoma sp.	551531010000	"
Macoma calcarea	551531010100	"
Macoma elimata	551531010200	"
Macoma brota	551531010300	"
Macoma obliqua	551531010600	"
Macoma expansa	551531011300	"
Macoma inquinata	551531011500	"
Tellina sp.	551531020000	"
Tellina carpenteri	551531020300	"
VENERIDAE	551547	"
Transennella sp.	551547010000	"
Transennella tantilla	551547010100	"
Saxidomus gigantea	551547020100	Butter clam
Compsomyax sp.	551547030000	Clams
Psephidia sp.	551547050000	"
Psephidiam sp.	551547050000	"
Psephidia lordi	551547050100	"
Humilaria kennerlyi	551547060100	"

Appendix L. Continued.

Taxon	Code	Common Name
Protothaca staminea	551547070100	Littleneck clam
MYIDAE	551701	Clams
Mya sp.	551701020000	"
Mya truncata	551701020300	"
HIATELLIDAE	551706	"
Hiatella arctica	551706020100	"
LYONSIIDAE	552005	"
Lyonsia sp.	552005020000	"
Lyonsia bracteata	552005020100	"
THRACIIDAE	552008	"
Thracia sp.	552008020000	"
Thracia myopsis	552008020200	"
CUSPIDARIDAE	552010	"
Cardiomya sp.	552010010000	"
Cardiomya pectinata	552010010100	"
Cardiomya planetica	552010010200	"
DENTALIIDAE	560001	Tuskshells
Dentalium sp.	560001010000	"
Dentalium dalli	560001010100	"
PYCNOGONIDA	600000	Sea Spiders
CRUSTACEA	610000	Crustaceans
BALANOMORPHA	613400	Barnacles
CHTHAMALIDAE	613401	"
Chthamalus dalli	613401010100	"
BALANIDAE	613402	"
Balanus sp.	613402010000	"
Semibalanus balanoides	613402010100	"
Balanus crenatus	613402010400	"
CUMACEA	615400	Cumaceans
LAMPROPIDAE	615401	"
Lamprops sp.	615401010000	"
Lamprops quadriplicata	615401010500	"
Lamprops sarsi	615401010600	"
LEUCONIDAE	615404	"

Taxon	Code	Common Name
Leucon sp.	615404010000	Cumaceans
Eudorella sp.	615404020000	"
Eudorella emarginata	615404020100	"
Eudorella pacifica	615404020200	"
Eudorellopsis sp.	615404030000	"
Eudorellopsis derzhavini	615404030200	"
Eudorellopsis biplicata	615404030300	"
Eudorellopsis deformis	615404030400	"
DIASTYLIDAE	615405	"
Diastylis sp.	615405010000	"
Diastylis alaskensis	615405010100	"
Diastylis bidentata	615405010300	"
Diastylis koreana	615405011200	"
Leptostylis sp.	615405040000	"
NANNASTACIDAE	615408	"
Cumella sp.	615408010000	"
BODOTRIIDAE	615409	"
Vaunthompsonia pacifica	615409040100	"
ISOPODA	615800	Isopods
GNATHIIDAE	615901	"
Gnathia tridens	615901010900	"
ANTHURIDEA	616000	"
SPHAEROMATIDAE	616102	"
Gnorimosphaeroma oregonensis	616102030100	"
LIMNORIDAE	616105	"
Limnoria lignorum	616105010100	"
IDOTEIDAE	616202	"
Idotea sp.	616202030000	"
Pentidotea sp.	616202080000	"
MUNNIDAE	616312	"
Munna sp.	616312010000	"
Munna ubiquita	616312010300	"
Pleurogonium sp.	616312020000	"
AMPHIPODA	616900	Amphipods

Appendix L. Continued.

Taxon	Code	Common Name
ACANTHONOTOZOMATIDAE	616901	Amphipods
Odius sp.	616901020000	"
Odius carinatus	616901020100	"
AMPELISCIDAE	616902	"
Ampelisca sp.	616902010000	"
Ampelisca macrocephala	616902010100	"
Ampelisca birulai	616902010200	"
Ampelisca pugetica	616902011400	"
Ampelisca brevisimulata	616902012500	"
Ampelisca careyi	616902013500	"
AMPHITHOIDAE	616904	"
Ampithoe sp.	616904010000	"
AORIDAE	616906	"
Aoroides sp.	616906020000	"
Aoroides columbiae	616906020200	"
ATYLIDAE	616909	"
Atylus collingi	616909010500	"
CALLIOPIIDAE	616912	"
Halirages bungei	616912040100	"
COROPHIDAE	616915	"
Corophium sp.	616915020000	"
DEXAMINIDAE	616917	"
Guernea sp.	616917020000	"
EUSIRIDAE	616920	"
Pontogeneia sp.	616920120000	"
GAMMARIDAE	616921	"
Anisogammarus pugettensis	616921010600	"
Melita sp.	616921100000	"
Melita dentata	616921100300	"
HAUSTORIIDAE	616922	"
Eohaustorius sp.	616922010000	"
HYALELLIDAE	616923	"
Najna sp.	616923030000	"
ISAEIDAE	616926	"
Photis sp.	616926020000	Amphipods
Protomedeia sp.	616926030000	"
ISCHYROCERIDAE	616927	"
Ischyrocerus sp.	616927020000	"
LYSIANASSIDAE	616934	"
Anonyx sp.	616934030000	"
Hippomedon sp.	616934140000	"
Lepidepecreum sp.	616934210000	"
Onisimus sp.	616934270000	"
Orchomene sp.	616934290000	"
Orchomene pacifica	616934290300	"
OEDOCEROTIDAE	616937	"
Aceroides sp.	616937020000	"
Bathymedon sp.	616937050000	"
Monoculodes sp.	616937080000	"
Synchelidium sp.	616937140000	"
Synchelidium rectipalmum	616937140300	"
PHOXOCEPHALIDAE	616942	"
Phoxocephalus homilis	616942070100	"
Paraphoxus sp.	616942090000	"
Paraphoxus similis	616942093000	"
PLEUSTIDAE	616943	"
Pleustes sp.	616943040000	"
Pleustes cataphractus	616943040200	"
PODOCERIDAE	616944	"
STENOTHOIDAE	616948	"
Metopelloides erythrophthalmus	616948040800	"
SYNOPIIDAE	616950	"
Tiron sp.	616950050000	"
Tiron biocellata	616950050300	"
CAPRELLIDAE	617100	Caprellids
DECAPODA	617500	
PLEOCYEMATA	617800	Shrimps
CARIDEA	617900	"

Appendix L. Continued.

Taxon	Code	Common Name
HIPPOLYTIDAE	617916	Shrimps
Spirontocaris sp.	617916020000	"
Spirontocaris lamellicornis	617916020200	"
Spirontocaris ochotensis	617916020600	"
Lebbeus sp.	617916030000	"
Eualus sp.	617916040000	"
Eualus fabricii	617916040400	"
Heptacarpus sp.	617916050000	"
Heptacarpus brevirostris	617916051000	"
PANDALIDAE	617918	"
Pandalus sp.	617918010000	"
Pandalus tridens	617918010401	"
Pandalus hypsinotus	617918010600	"
CRANGONIDAE	617922	"
Crangon sp.	617922010000	"
Crangon alaskensis	617922010200	"
Mesocrangon munitella	617922011500	"
Sclerocrangon boreas	617922020100	"
Rhynocrangon alata	617922020200	"
Sclerocrangon boreas	617922020200	"
Argis sp.	617922030000	"
Argis lar	617922030100	"
Rhynocrangon sp.	617922110000	"
PAGURIDAE	618306	Hermit Crabs
Pagurus sp.	618306020000	"
Pagurus hirsutiusculus	618306021300	"
Elassochirus tenuimanus	618306030100	"
BRACHYURA	618400	True Crabs
MAJIDAE	618701	"
Oregonia gracilis	618701010100	"
Pugettia gracilis	618701050300	"
ATELECYCLIDAE	618802	"
Telmessus cheiragonus	618802010100	Helmet Crab
CANCRIDAE	618803	Cancer Crabs
Cancer productus	618803010100	"
Cancer oregonensis	618803010600	"

Taxon	Code	Common Name
SIPUNCULA	720000	Peanut Worms
SIPUNCULIDAE	720001	"
PRIAPULIDA	740000	
PHORONIDA	770000	
BRACHIOPODA	800000	Lamp Shells
CANCELLOTHYRIDIDAE	800507	"
Terebratulina unguicula	800507010100	"
ASTEROIDEA	810400	Sea Stars
SOLASTERIDAE	811301	"
Crossaster papposus	811301010300	"
ASTERIIDAE	811703	"
Evasterias troschelii	811703030200	"
Leptasterias sp.	811703040000	"
Pycnopodia helianthoides	811703120100	"
OPHIUROIDEA	812000	Brittle Stars
AMPHIURIDAE	812903	Brittle Stars
Amphiodia sp.	812903010000	"
Amphipholis squamata	812903020200	"
ECHINOIDEA	813600	
STRONGYLOCENTROTIDAE	814903	Sea Urchins
Strongylocentrotus droebachiensi	814903020100	"
ECHINARACHNIIDAE	815502	Sand Dollars
Echinarachnius parma	815502010100	"
HOLOTHUROIDEA	817000	Sea Cucumbers
CUCUMARIIDAE	817206	"
Eupentacta sp.	817206020000	"
Eupentacta pseudoquinquesemita	817206020100	"
Pentamera sp.	817206030000	"
Pentamera populifer	817206030500	"
SYNAPTIDAE	817801	"
Leptosynapta sp.	817801020000	"
Leptosynapta clarki	817801020300	"
UROCHORDATA	840000	Tunicates
ASCIDIACEA	840100	"
PYURIDAE	840602	"
Boltenia echinata	840602020200	"

Appendix M.

Means, standard errors, and results of one-way and two-way randomization ANOVAs for diversity data.

Appendix M. Means, standard errors, and results of one-way and two-way randomization ANOVAs for diversity data. HPRIME = H prime diversity, HSE = H prime standard error, TOTCNT = total abundance, TOTCNTSE = total abundance, Standard error, TOTWT Biomass (gm 0.1 m^{-2}), TOTWTSE biomass standard error, SR = species richness, SRSE = Species richness standard error.

INFAUNA
Depth Stratum = 6 to 20 m

Means for diversity by site and year

YEAR	OILCODE	SITENUM	HPRIME	HSE	TOTCNT	TOTCNTSE	TOTWT	TOTWTSE	SR	SRSE
1990	O	13	0.86160	0.03598	240.00	41.329	1.0287	0.39976	1.77411	0.02296
1990	C	14	2.18142	0.18485	578.00	20.386	6.8009	2.31687	3.61656	0.07156
1990	O	16	2.86766	0.34393	558.68	116.056	7.5070	3.29459	6.71996	1.25144
1990	C	15	2.85645	0.06282	401.67	134.279	2.9195	1.40108	6.48789	0.40184
1990	O	17	2.70559	0.15415	618.01	82.557	10.1348	3.99902	7.86113	1.29606
1990	C	18	2.22716	0.14795	986.04	142.035	9.9918	3.52637	3.86289	0.40590
1991	O	13	1.25659	0.67044	364.34	73.546	2.4836	1.60253	2.26755	0.98722
1991	C	14	2.18351	0.12022	1200.50	68.997	21.7729	6.48429	4.75563	0.32444
1991	O	16	3.29736	0.01513	1066.50	64.496	6.9835	0.93232	7.65726	0.22905
1991	C	15	2.99070	0.09188	776.05	295.068	2.6544	0.71438	6.62159	0.51117
1991	O	17	2.52532	0.22933	1444.82	389.804	9.0381	2.64887	6.12963	0.51321
1991	C	18	2.43545	0.30140	1578.00	136.980	17.4230	3.89443	6.15005	1.09246
1993	O	13	2.24472	0.10620	447.17	60.071	2.0526	0.42314	3.77558	0.45629
1993	C	14	2.14895	0.16067	2498.44	913.128	18.7269	2.51957	4.37790	0.23053
1993	O	16	2.82084	0.32447	1392.01	406.600	12.2053	6.04844	6.81046	1.26788
1993	C	15	2.76346	0.08315	1028.71	22.003	8.1943	0.79830	7.35067	0.78778
1993	O	17	2.68800	0.13590	1214.67	150.773	7.8980	0.67481	6.68417	0.15660
1993	C	18	2.40678	0.16026	1210.83	64.688	13.9571	3.17967	6.48773	0.34522
1995	O	13	1.90220	0.60809	570.86	197.510	5.9564	2.64622	4.09641	0.77459
1995	C	14	2.57843	0.23134	1455.16	383.862	16.5411	6.11234	4.79166	0.48987
1995	O	16	3.07119	0.20077	686.18	160.662	4.4989	1.00167	7.36177	1.11672
1995	C	15	2.73177	0.18565	653.83	472.802	7.4607	4.12639	7.43834	1.61941
1995	O	17	2.58242	0.04248	1868.89	528.346	12.9017	4.21797	7.18889	0.59378
1995	C	18	2.63994	0.06762	954.17	139.171	8.1072	2.32859	7.65697	0.18078

Means for diversity by oiling category and year

YEAR	OILCODE	HPRIME	HSE	TOTCNT	TOTCNTSE	TOTWT	TOTWTSE	SR	SRSE
1990	O	2.14495	0.64338	472.23	117.371	6.2235	2.70592	5.45173	1.86809
1990	C	2.42167	0.21779	655.24	173.058	6.5707	2.04483	4.65578	0.91881
1991	O	2.35976	0.59491	958.55	316.544	6.1684	1.93552	5.35148	1.60379
1991	C	2.53655	0.23844	1184.85	231.634	13.9501	5.78576	5.84242	0.56018
1993	O	2.58452	0.17418	1017.95	289.946	7.3853	2.94202	5.75674	0.99125
1993	C	2.43973	0.17816	1579.33	462.554	13.6261	3.04500	6.07210	0.88297
1995	O	2.51860	0.33896	1041.98	414.795	7.7857	2.59240	6.21569	1.06081
1995	C	2.65005	0.04455	1021.05	233.729	10.7030	2.92503	6.62899	0.92083

Results of two-way randomization tests

Variable	Oilcode	Year	Interaction
H prime diversity	0.041	0.241	0.711
Total abundance	0.078	0.038	0.998
Total biomass	0.283	0.575	0.736
Species richness	0.591	0.912	0.618

Results of one-way randomization tests

Variable	1990	1991	1993	1995
H prime diversity	0.047	0.784	0.823	0.262
Total abundance	0.303	0.335	0.227	0.987
Total biomass	0.875	0.679	0.259	0.477
Species richness	0.332	0.923	0.488	0.902

EPIFAUNA
Depth Stratum = 6 to 20 m

Means for diversity by site and year

YEAR	OILCODE	SITENUM	HPRIME	HSE	TOTCNT	TOTCNTSE	TOTWT	TOTWTSE	SR	SRSE
1990	O	13	0.00000	0.00000	3.667	2.186	0.0254	0.02332	1.44270	1.44270
1990	C	14	0.15652	0.15652	21.500	18.000	0.0348	0.00972	1.07915	0.28091
1990	O	16	1.69018	0.39040	137.388	28.743	0.9676	0.31815	2.09419	0.43164
1990	C	15	0.92140	0.15279	80.500	15.332	0.3455	0.14003	2.73050	0.73494
1990	O	17	0.50075	0.30978	150.382	38.623	1.1721	0.88008	0.93242	0.12883
1990	C	18	0.22920	0.22920	20.977	14.979	0.0969	0.07918	0.16984	0.16984
1991	O	13	0.23105	0.23105	2.782	0.850	0.0142	0.00921	3.56194	1.98547
1991	C	14	0.85769	0.13273	12.277	5.008	0.0269	0.01683	1.31417	0.24021
1991	O	16	1.80441	0.07808	190.000	46.490	1.4907	0.56672	2.25192	0.09184
1991	C	15	0.99360	0.40125	235.403	178.524	1.0718	0.52759	2.21954	0.51977
1991	O	17	1.10092	0.17930	175.278	37.861	3.0025	1.04574	1.49936	0.31795
1991	C	18	1.05655	0.43177	134.500	87.910	6.9233	6.51981	1.37293	0.80248
1993	O	13	1.24552	0.08398	14.108	1.061	0.0144	0.00472	1.64055	0.11105
1993	C	14	0.92196	0.22281	16.888	3.111	0.0349	0.01955	1.35182	0.33200
1993	O	16	1.51277	0.35360	182.668	67.025	2.1520	0.72252	2.13450	0.42730
1993	C	15	2.03733	0.16974	112.062	37.766	3.2404	0.35615	3.62782	0.20190
1993	O	17	0.16574	0.02398	522.000	109.038	4.9183	3.70266	0.63363	0.14190
1993	C	18	0.50737	0.30040	19.500	17.500	0.1805	0.16847	3.57773	2.19305
1995	O	13	0.80957	0.20250	36.187	30.576	0.0256	0.01303	0.81494	0.21614
1995	C	14	0.29027	0.29027	51.333	47.333	0.2410	0.23900	0.54446	0.54446
1995	O	16	1.72050	0.24839	185.310	66.331	8.1840	6.67150	2.03789	0.47266
1995	C	15	1.10440	0.04205	56.000	25.105	0.9761	0.33919	1.87870	0.61069
1995	O	17	0.26867	0.12815	936.000	194.577	13.3658	3.68215	0.63080	0.10921
1995	C	18	1.62236	0.06590	8.500	2.309	0.1199	0.06021	2.83450	0.27431

Means for diversity by oiling category and year

YEAR	OILCODE	HPRIME	HSE	TOTCNT	TOTCNTSE	TOTWT	TOTWTSE	SR	SRSE
1990	O	0.73031	0.50123	97.146	46.890	0.72171	0.35311	1.48977	0.33620
1990	C	0.43571	0.24375	40.992	19.754	0.15903	0.09494	1.32650	0.74947
1991	O	1.04546	0.45504	122.687	60.103	1.50246	0.86266	2.43774	0.60262
1991	C	0.96928	0.05868	127.393	64.509	2.67397	2.14595	1.63555	0.29249
1993	O	0.97467	0.41176	239.592	149.353	2.36157	1.41952	1.46956	0.44162
1993	C	1.15555	0.45685	49.483	31.298	1.15193	1.04507	2.85246	0.75046
1995	O	0.93291	0.42362	385.832	278.432	7.19179	3.88281	1.16121	0.44155
1995	C	1.00568	0.38770	38.611	15.116	0.44567	0.26750	1.75255	0.66408

Results of two-way randomization tests

Variable	Oilcode	Year	Interaction
H prime diversity	0.915	0.058	0.569
Total abundance	0.002	0.228	0.044
Total biomass	0.065	0.169	0.022
Species richness	0.452	0.279	0.081

Results of one-way randomization Tests

Variable	1990	1991	1993	1995
H prime diversity	0.189	0.817	0.379	0.753
Total abundance	0.060	0.922	0.083	0.028
Total biomass	0.025	0.913	0.608	0.039
Species richness	0.768	0.369	0.047	0.235

INFAUNA
Depth Stratum = < 3 m

Means for diversity by site and year

YEAR	OILCODE	SITENUM	HPRIME	HSE	TOTCNT	TOTCNTSE	TOTWT	TOTWTSE	SR	SRSE
1990	O	13	1.54884	0.30981	416.36	117.98	0.5217	0.1486	2.55336	0.46901
1990	C	14	2.28553	0.11845	122.24	34.68	0.8562	0.7367	3.18530	0.61639
1990	O	16	2.32475	0.11887	871.83	220.08	3.9746	2.4356	4.14451	0.48683
1990	C	15	1.65555	0.14679	233.78	41.20	0.5546	0.2604	2.07795	0.19898
1990	O	17	2.23094	0.10745	1803.27	180.29	16.2132	0.3548	4.71298	0.32835
1990	C	18	2.42073	0.27078	1133.67	380.13	7.6245	4.4455	4.49241	0.89357
1991	O	13	1.97313	0.10134	1790.00	742.39	1.9481	0.8267	2.87980	0.38015
1991	C	14	2.28410	0.12628	962.10	69.84	5.2509	1.6143	3.79207	0.38851
1991	O	16	2.41480	0.20192	1534.94	139.17	4.7160	0.3551	5.10343	0.82815
1991	C	15	2.31719	0.08370	1013.78	84.98	1.6097	0.4054	3.32174	0.40944
1991	O	17	2.17199	0.13524	1935.18	522.04	7.9873	2.2406	5.32759	0.68989
1991	C	18	2.35538	0.17123	3313.08	1275.01	16.1371	7.1521	5.34225	0.34567
1993	O	13	2.49389	0.15494	898.66	426.82	2.3520	0.8925	4.74821	0.56361
1993	C	14	2.12793	0.19938	1179.55	340.52	2.2188	0.7734	3.34968	0.46168
1993	O	16	2.30175	0.11076	2610.67	192.59	7.4320	4.0170	4.28782	0.33891
1993	C	15	2.36733	0.06403	666.93	151.95	1.5190	0.3215	3.62263	0.36994
1993	O	17	2.41693	0.04992	1641.78	626.84	29.2166	23.0996	5.15181	0.24003
1993	C	18	2.21772	0.15372	620.48	55.51	6.5632	2.1327	3.75023	0.49886
1995	O	13	2.09278	0.28192	1155.87	500.16	4.5171	1.1782	3.89931	0.58070
1995	C	14	2.20898	0.03215	531.40	89.56	1.9253	0.7384	3.90265	0.26451
1995	O	16	2.62029	0.05856	1201.05	192.30	4.9762	2.6309	4.52673	0.15752
1995	C	15	2.30884	0.03126	540.80	47.58	1.1057	0.3324	4.23087	0.44444
1995	O	17	2.36735	0.13058	2095.56	743.94	7.7489	1.2806	5.42913	0.16257
1995	C	18	2.69033	0.08549	864.30	161.24	5.2326	1.2382	7.13316	0.19986

Means for Diversity by oilng category and year

YEAR	OILCODE	HPRIME	HSE	TOTCNT	TOTCNTSE	TOTWT	TOTWTSE	SR	SRSE
1990	O	2.03484	0.24451	1030.49	408.149	6.9032	4.76054	3.80362	0.64631
1990	C	2.12060	0.23578	496.56	320.175	3.0118	2.30801	3.25189	0.69779
1991	O	2.18664	0.12771	1753.37	116.982	4.8838	1.74538	4.43694	0.78126
1991	C	2.31889	0.02060	1762.99	775.189	7.6659	4.36408	4.15202	0.61041
1993	O	2.40419	0.05583	1717.04	495.645	13.0002	8.23975	4.72928	0.24959
1993	C	2.23766	0.06982	822.32	179.119	3.4337	1.57775	3.57418	0.11814
1995	O	2.36014	0.15232	1484.16	305.979	5.7474	1.00949	4.61839	0.44399
1995	C	2.40272	0.14667	645.50	109.433	2.7546	1.26143	5.08889	1.02651

Results of two-way randomization tests

Variable	Oilcode	Year	Interaction
H prime diversity	0.608	0.102	0.353
Total abundance	0.001	0.992	0.358
Total biomass	0.086	0.937	0.846
Species ricness	0.181	0.058	0.052

Results of one-way randomization tests

Variable	1990	1991	1993	1995
H prime diversity	0.623	0.116	0.065	0.511
Total abundance	0.201	0.509	0.028	0.038
Total biomass	0.213	0.252	0.205	0.240
Species richness	0.946	0.079	0.022	0.081

EPIFAUNA
Depth Stratum = < 3 m

Means for diversity by site and year

YEAR	OILCODE	SITENUM	HPRIME	HSE	TOTCNT	TOTCNTSE	TOTWT	TOTWTSE	SR	SRSE
1990	O	13	0.23717	0.14628	291.45	125.189	0.03135	0.00720	0.63513	0.38275
1990	C	14	0.64397	0.04919	77.49	7.779	0.04858	0.02911	0.69726	0.23671
1990	O	16	0.82123	0.13793	739.33	116.859	1.99300	0.77906	1.21873	0.18859
1990	C	15	0.26321	0.15070	202.67	35.511	0.58613	0.25862	0.87179	0.19720
1990	O	17	0.95717	0.12485	773.72	292.741	3.12113	0.40290	1.18567	0.07557
1990	C	18	0.61780	0.11571	294.67	134.865	0.34667	0.09271	0.92184	0.35129
1991	O	13	0.55724	0.15486	239.56	124.656	0.07568	0.03344	0.57007	0.08070
1991	C	14	0.81628	0.09906	152.80	60.896	0.06207	0.02507	0.94752	0.09635
1991	O	16	0.87262	0.09222	1077.61	387.631	3.30678	1.15401	1.14288	0.23724
1991	C	15	0.56617	0.14101	481.78	117.067	0.66758	0.55793	0.76468	0.15298
1991	O	17	0.84671	0.03213	1272.14	218.23	4.8065	0.74283	0.79418	0.07910
1991	C	18	0.66640	0.06037	759.18	123.02	2.7728	0.91810	1.11406	0.11443
1993	O	13	0.68729	0.15133	379.70	88.23	0.5855	0.32455	1.00928	0.12821
1993	C	14	1.06795	0.29369	264.89	72.45	0.4307	0.19610	1.57807	0.54700
1993	O	16	1.00803	0.04570	3566.67	955.59	12.6907	4.11422	1.07908	0.19312
1993	C	15	0.99793	0.08751	125.51	12.47	0.0975	0.05070	1.31808	0.20160
1993	O	17	0.88788	0.03150	2423.11	644.82	2.9730	0.88277	1.08246	0.03322
1993	C	18	0.54940	0.16796	413.60	168.64	8.8797	2.47205	1.28682	0.18706
1995	O	13	0.88261	0.20985	157.48	140.82	1.7341	1.22169	0.80912	0.10742
1995	C	14	0.79520	0.08069	172.24	11.11	1.2693	1.07348	1.10888	0.35857
1995	O	16	0.91933	0.06101	1677.78	285.54	3.4900	0.73671	1.03597	0.03514
1995	C	15	0.20768	0.08107	2762.30	1050.26	2.8149	2.53084	0.80335	0.14123
1995	O	17	1.39299	0.16959	471.56	128.11	1.1145	0.38923	1.26597	0.08136
1995	C	18	1.04996	0.16509	109.60	30.82	0.3486	0.08556	1.76899	0.28698

Means for diversity by oiling category and year

YEAR	OILCODE	HPRIME	HSE	TOTCNT	TOTCNTSE	TOTWT	TOTWTSE	SR	SRSE
1990	O	0.67186	0.22086	601.50	155.345	1.71516	0.90270	1.01318	0.18926
1990	C	0.50833	0.12279	191.61	62.936	0.32713	0.15548	0.83029	0.06807
1991	O	0.75885	0.10109	863.10	316.789	2.72964	1.39581	0.83571	0.16665
1991	C	0.68295	0.07267	464.59	175.258	1.16748	0.82147	0.94209	0.10089
1993	O	0.86107	0.09356	2123.16	932.143	5.41639	3.70186	1.05694	0.02385
1993	C	0.87176	0.16244	268.00	83.179	3.13596	2.87347	1.39432	0.09231
1995	O	1.06498	0.16435	768.94	463.375	2.11284	0.71143	1.03702	0.13188
1995	C	0.68428	0.24939	1014.71	873.980	1.47761	0.71952	1.22707	0.28495

Results of two-way randomization tests

Variable	Oilcode	Year	Interaction
H prime diversity	0.061	0.052	0.352
Total abundance	0.004	0.078	0.010
Total biomass	0.048	0.012	0.918
Species richness	0.294	0.064	0.373

Results of one-way randomization tests

Variable	1990	1991	1993	1995
H prime diversity	0.366	0.502	0.965	0.034
Total abundance	0.010	0.034	0.006	0.684
Total biomass	0.030	0.057	0.514	0.539
Species richness	0.311	0.532	0.078	0.324

Appendix N.

Means (No 0.1 m^{-2}), standard errors and results of randomization ANOVAs for densities of higher order taxanomic groupings.

Appendix N. Means (No 0.1 m^{-2}), standard errors and results of randomization ANOVAS for densities of higher order taxanomic groupings.

Taxa = Infaunal AMPHIPODA
Depth Stratum = 6 to 20 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	AMPHIPODA	0.1667	0.1667	3
1990	14	C	AMPHIPODA	4.0000	4.0000	3
1990	16	O	AMPHIPODA	29.7783	12.7036	3
1990	15	C	AMPHIPODA	63.6667	6.0850	3
1990	17	O	AMPHIPODA	32.0483	9.5612	3
1990	18	C	AMPHIPODA	90.7533	22.0309	3
1991	13	O	AMPHIPODA	1.6517	1.6517	3
1991	14	C	AMPHIPODA	9.1100	5.1973	3
1991	16	O	AMPHIPODA	56.0000	12.0000	3
1991	15	C	AMPHIPODA	36.8333	11.9734	3
1991	17	O	AMPHIPODA	62.4417	19.5187	3
1991	18	C	AMPHIPODA	114.6667	23.5891	3
1993	13	O	AMPHIPODA	3.7217	0.5477	3
1993	14	C	AMPHIPODA	2.0000	1.1547	3
1993	16	O	AMPHIPODA	70.2250	26.8251	3
1993	15	C	AMPHIPODA	14.4300	2.8081	3
1993	17	O	AMPHIPODA	118.6667	27.5520	3
1993	18	C	AMPHIPODA	66.5000	3.7859	3
1995	13	O	AMPHIPODA	4.9633	3.5329	3
1995	14	C	AMPHIPODA	22.3100	17.5161	3
1995	16	O	AMPHIPODA	41.5900	19.6810	3
1995	15	C	AMPHIPODA	29.0000	15.9478	3
1995	17	O	AMPHIPODA	137.7783	38.5806	3
1995	18	C	AMPHIPODA	254.6667	48.9356	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	AMPHIPODA	20.6644	10.2698	3
1990	C	AMPHIPODA	52.8067	25.6254	3
1991	O	AMPHIPODA	40.0311	19.2796	3
1991	C	AMPHIPODA	53.5367	31.5954	3
1993	O	AMPHIPODA	64.2044	33.3180	3
1993	C	AMPHIPODA	27.6433	19.7569	3
1995	O	AMPHIPODA	61.4439	39.6047	3
1995	C	AMPHIPODA	101.9922	76.3616	3

One-way randomization within blocks with % mud as covariate

Year	P for Oilcode
1990	0.21
1991	0.81
1993	0.20
1995	0.99

Two-way randomization within blocks with % mud as covariate

P values for:

Interaction	Oilcode	Year
0.103	0.976	0.964

Taxa = Infaunal AMPHIPODA
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	AMPHIPODA	11.7917	1.3392	3
1990	14	C	AMPHIPODA	9.6917	2.5624	3
1990	16	O	AMPHIPODA	32.8333	4.6934	3
1990	15	C	AMPHIPODA	2.6667	2.6667	3
1990	17	O	AMPHIPODA	30.4450	15.7822	3
1990	18	C	AMPHIPODA	232.0000	9.8658	3
1991	13	O	AMPHIPODA	6.6667	5.6960	3
1991	14	C	AMPHIPODA	6.4000	4.5490	3
1991	16	O	AMPHIPODA	64.6667	5.6960	3
1991	15	C	AMPHIPODA	67.1100	18.2539	3
1991	17	O	AMPHIPODA	40.3033	6.0653	3
1991	18	C	AMPHIPODA	604.7317	63.1581	3
1993	13	O	AMPHIPODA	36.3017	4.1013	3
1993	14	C	AMPHIPODA	36.4433	19.3259	3
1993	16	O	AMPHIPODA	85.3333	15.3768	3
1993	15	C	AMPHIPODA	56.5317	33.1120	3
1993	17	O	AMPHIPODA	227.3333	110.2018	3
1993	18	C	AMPHIPODA	195.8550	50.0087	3
1995	13	O	AMPHIPODA	20.4450	8.0165	3
1995	14	C	AMPHIPODA	24.0883	13.3863	3
1995	16	O	AMPHIPODA	56.8867	11.5810	3
1995	15	C	AMPHIPODA	26.9333	6.7620	3
1995	17	O	AMPHIPODA	125.7783	11.2171	3
1995	18	C	AMPHIPODA	348.5333	57.3091	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	AMPHIPODA	25.0233	6.6517	3
1990	C	AMPHIPODA	81.4528	75.3009	3
1991	O	AMPHIPODA	37.2122	16.8143	3
1991	C	AMPHIPODA	226.0806	190.1350	3
1993	O	AMPHIPODA	116.3228	57.2816	3
1993	C	AMPHIPODA	96.2767	50.1257	3
1995	O	AMPHIPODA	67.7033	30.8843	3
1995	C	AMPHIPODA	133.1850	107.6773	3

One-way randomization within blocks with % mud as covariate

Year	P for Oilcode
1990	0.00
1991	0.15
1993	0.57
1995	0.18

Two-way Randomized within blocks with % mud as covariate

P values for:

Interaction	Oilcode	Year
0.264	0.015	0.811

Taxa = Infaunal POLYCHAETA
Depth Stratum = 6 to 20 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	POLYCHAETA	195.3333	30.8036	3
1990	14	C	POLYCHAETA	295.8333	91.4040	3
1990	16	O	POLYCHAETA	238.4500	34.8203	3
1990	15	C	POLYCHAETA	195.1667	73.7848	3
1990	17	O	POLYCHAETA	354.6483	30.0177	3
1990	18	C	POLYCHAETA	401.2417	47.6990	3
1991	13	O	POLYCHAETA	244.9633	51.7004	3
1991	14	C	POLYCHAETA	396.7767	134.4407	3
1991	16	O	POLYCHAETA	496.0000	11.5470	3
1991	15	C	POLYCHAETA	463.2617	259.2559	3
1991	17	O	POLYCHAETA	1075.7167	349.8706	3
1991	18	C	POLYCHAETA	909.1667	278.5897	3
1993	13	O	POLYCHAETA	243.9983	24.4425	3
1993	14	C	POLYCHAETA	1615.7767	782.0291	3
1993	16	O	POLYCHAETA	924.4450	234.0256	3
1993	15	C	POLYCHAETA	669.0900	36.7881	3
1993	17	O	POLYCHAETA	895.3333	126.0282	3
1993	18	C	POLYCHAETA	504.3333	83.5216	3
1995	13	O	POLYCHAETA	299.3000	48.4884	3
1995	14	C	POLYCHAETA	539.5550	35.8295	3
1995	16	O	POLYCHAETA	330.1067	95.2903	3
1995	15	C	POLYCHAETA	304.8333	229.9925	3
1995	17	O	POLYCHAETA	1447.1133	435.6168	3
1995	18	C	POLYCHAETA	201.6667	23.3119	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	POLYCHAETA	262.8106	47.5759	3
1990	C	POLYCHAETA	297.4139	59.4940	3
1991	O	POLYCHAETA	605.5600	245.9948	3
1991	C	POLYCHAETA	589.7350	160.8649	3
1993	O	POLYCHAETA	687.9256	222.1226	3
1993	C	POLYCHAETA	929.7333	346.3032	3
1995	O	POLYCHAETA	692.1733	377.5747	3
1995	C	POLYCHAETA	348.6850	99.9739	3

One-way randomization within blocks with % mud as covariate

Year	P for Oilcode
1990	0.14
1991	0.29
1993	0.12
1995	0.92

Two-way Randomized within blocks with % mud as covariate

P values for:

Interaction	Oilcode	Year
0.979	0.074	0.053

Taxa = Infaunal POLYCHAETA
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	POLYCHAETA	56.4033	20.7996	3
1990	14	C	POLYCHAETA	53.9117	21.5737	3
1990	16	O	POLYCHAETA	413.0000	115.2345	3
1990	15	C	POLYCHAETA	109.1100	32.0793	3
1990	17	O	POLYCHAETA	1039.8850	97.1399	3
1990	18	C	POLYCHAETA	435.8333	233.9359	3
1991	13	O	POLYCHAETA	247.3267	98.2831	3
1991	14	C	POLYCHAETA	605.4000	97.0049	3
1991	16	O	POLYCHAETA	729.6050	156.1959	3
1991	15	C	POLYCHAETA	652.0017	36.2966	3
1991	17	O	POLYCHAETA	1335.6800	385.7723	3
1991	18	C	POLYCHAETA	1686.6483	760.2494	3
1993	13	O	POLYCHAETA	288.2367	159.9426	3
1993	14	C	POLYCHAETA	923.7767	224.1466	3
1993	16	O	POLYCHAETA	1016.0000	75.0822	3
1993	15	C	POLYCHAETA	324.9767	70.0390	3
1993	17	O	POLYCHAETA	1127.1117	461.5283	3
1993	18	C	POLYCHAETA	174.7667	24.4060	3
1995	13	O	POLYCHAETA	150.8250	32.5905	3
1995	14	C	POLYCHAETA	228.9733	43.5853	3
1995	16	O	POLYCHAETA	408.8850	40.8029	3
1995	15	C	POLYCHAETA	184.0000	35.6905	3
1995	17	O	POLYCHAETA	1391.1150	663.5414	3
1995	18	C	POLYCHAETA	162.5667	48.8705	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	POLYCHAETA	503.0961	287.4584	3
1990	C	POLYCHAETA	199.6183	119.1775	3
1991	O	POLYCHAETA	770.8706	314.8573	3
1991	C	POLYCHAETA	981.3500	352.9057	3
1993	O	POLYCHAETA	810.4494	263.0691	3
1993	C	POLYCHAETA	474.5067	228.7819	3
1995	O	POLYCHAETA	650.2750	377.8367	3
1995	C	POLYCHAETA	191.8467	19.5673	3

One-way randomization within blocks with % mud as covariate

Year	P for Oilcode
1990	0.11
1991	0.31
1993	0.01
1995	0.03

Two-way Randomized within blocks with % mud as covariate

P values for:

Interaction	Oilcode	Year
0.728	0	0.704

Taxa = Infaunal GASTROPODA
Depth Stratum = 6 to 20 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	GASTROPODA	18.6667	3.0322	3
1990	14	C	GASTROPODA	24.6667	17.9010	3
1990	16	O	GASTROPODA	108.8883	9.5636	3
1990	15	C	GASTROPODA	51.6667	19.4772	3
1990	17	O	GASTROPODA	91.8367	48.3220	3
1990	18	C	GASTROPODA	17.2433	11.2565	3
1991	13	O	GASTROPODA	58.2717	50.6745	3
1991	14	C	GASTROPODA	69.3333	20.9550	3
1991	16	O	GASTROPODA	346.0000	47.2864	3
1991	15	C	GASTROPODA	106.0350	39.3793	3
1991	17	O	GASTROPODA	109.1100	37.5876	3
1991	18	C	GASTROPODA	60.6667	48.8854	3
1993	13	O	GASTROPODA	44.5550	13.6087	3
1993	14	C	GASTROPODA	25.7767	6.6380	3
1993	16	O	GASTROPODA	114.6667	42.1004	3
1993	15	C	GASTROPODA	49.4067	20.9407	3
1993	17	O	GASTROPODA	67.3333	14.3450	3
1993	18	C	GASTROPODA	37.8333	12.6040	3
1995	13	O	GASTROPODA	97.7067	57.5591	3
1995	14	C	GASTROPODA	31.6433	3.1184	3
1995	16	O	GASTROPODA	153.0217	37.3379	3
1995	15	C	GASTROPODA	10.3333	1.9221	3
1995	17	O	GASTROPODA	64.4450	15.5543	3
1995	18	C	GASTROPODA	19.3333	7.6721	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	GASTROPODA	73.1306	27.6732	3
1990	C	GASTROPODA	31.1922	10.4591	3
1991	O	GASTROPODA	171.1272	88.6595	3
1991	C	GASTROPODA	78.6783	13.9053	3
1993	O	GASTROPODA	75.5183	20.6491	3
1993	C	GASTROPODA	37.6722	6.8219	3
1995	O	GASTROPODA	105.0578	25.8327	3
1995	C	GASTROPODA	20.4367	6.1764	3

One-way randomization within blocks with % mud as covariate

Year	P for Oilcode
1990	0.10
1991	0.22
1993	0.28
1995	0.06

Two-way randomization within blocks with % mud as covariate

P values for:

Interaction	Oilcode	Year
0.976	0	0.01

Taxa = Infaunal GASTROPODA
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	GASTROPODA	121.9633	25.0760	3
1990	14	C	GASTROPODA	27.7133	5.9338	3
1990	16	O	GASTROPODA	262.3333	97.1465	3
1990	15	C	GASTROPODA	96.4450	5.5550	3
1990	17	O	GASTROPODA	531.7750	77.7293	3
1990	18	C	GASTROPODA	194.0000	84.0714	3
1991	13	O	GASTROPODA	622.4450	267.3166	3
1991	14	C	GASTROPODA	225.8667	9.0784	3
1991	16	O	GASTROPODA	414.2217	155.8282	3
1991	15	C	GASTROPODA	172.0000	16.1658	3
1991	17	O	GASTROPODA	357.6850	91.8962	3
1991	18	C	GASTROPODA	632.8917	236.6636	3
1993	13	O	GASTROPODA	268.0000	90.0074	3
1993	14	C	GASTROPODA	127.3317	91.1068	3
1993	16	O	GASTROPODA	388.0000	103.7176	3
1993	15	C	GASTROPODA	155.5550	37.0902	3
1993	17	O	GASTROPODA	131.7783	51.3812	3
1993	18	C	GASTROPODA	51.2550	6.9326	3
1995	13	O	GASTROPODA	216.5933	85.5810	3
1995	14	C	GASTROPODA	154.7533	23.7223	3
1995	16	O	GASTROPODA	489.3317	125.8629	3
1995	15	C	GASTROPODA	253.0667	29.0813	3
1995	17	O	GASTROPODA	393.7767	64.8515	3
1995	18	C	GASTROPODA	124.3333	32.9575	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	GASTROPODA	305.3572	120.2424	3
1990	C	GASTROPODA	106.0528	48.2426	3
1991	O	GASTROPODA	464.7839	80.5023	3
1991	C	GASTROPODA	343.5861	145.4862	3
1993	O	GASTROPODA	262.5928	74.0142	3
1993	C	GASTROPODA	111.3806	31.1472	3
1995	O	GASTROPODA	366.5672	79.8996	3
1995	C	GASTROPODA	177.3844	38.8467	3

One-way randomization within blocks with % mud as covariate

Year	P for Oilcode
1990	0.11
1991	0.59
1993	0.10
1995	0.03

Two-way randomization within blocks with % mud as covariate

P values for:

Interaction	Oilcode	Year
0.757	0	0.198

Taxa = Infaunal BIVALVIA
Depth Stratum = 6 to 20 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	BIVALVIA	23.1667	12.0842	3
1990	14	C	BIVALVIA	245.8333	105.9970	3
1990	16	O	BIVALVIA	147.2800	99.2395	3
1990	15	C	BIVALVIA	69.3333	42.0618	3
1990	17	O	BIVALVIA	91.6917	26.7323	3
1990	18	C	BIVALVIA	465.1567	199.6643	3
1991	13	O	BIVALVIA	52.5333	49.7405	3
1991	14	C	BIVALVIA	713.9433	139.4243	3
1991	16	O	BIVALVIA	63.6667	13.3458	3
1991	15	C	BIVALVIA	78.7350	55.9871	3
1991	17	O	BIVALVIA	104.8883	25.5933	3
1991	18	C	BIVALVIA	444.8333	156.0118	3
1993	13	O	BIVALVIA	111.0017	42.0973	3
1993	14	C	BIVALVIA	814.4467	142.8162	3
1993	16	O	BIVALVIA	198.6700	112.5994	3
1993	15	C	BIVALVIA	231.5417	11.3112	3
1993	17	O	BIVALVIA	77.3333	5.8119	3
1993	18	C	BIVALVIA	577.3333	118.2005	3
1995	13	O	BIVALVIA	140.8150	80.2533	3
1995	14	C	BIVALVIA	817.0317	414.9488	3
1995	16	O	BIVALVIA	78.2883	27.9725	3
1995	15	C	BIVALVIA	246.0000	200.6006	3
1995	17	O	BIVALVIA	132.4450	30.4669	3
1995	18	C	BIVALVIA	434.6667	82.6410	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	BIVALVIA	87.3794	35.8933	3
1990	C	BIVALVIA	260.1078	114.4870	3
1991	O	BIVALVIA	73.6961	15.9238	3
1991	C	BIVALVIA	412.5039	184.0800	3
1993	O	BIVALVIA	129.0017	36.1647	3
1993	C	BIVALVIA	541.1072	169.2422	3
1995	O	BIVALVIA	117.1828	19.5967	3
1995	C	BIVALVIA	499.2328	167.9741	3

One-way randomization within blocks with % mud as covariate

Year	P for Oilcode
1990	0.97
1991	0.72
1993	0.92
1995	0.24

Two-way randomization within blocks with % mud as covariate

P values for:

Interaction	Oilcode	Year
0.387	0.723	0.267

Taxa = Infaunal BIVALVIA
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	BIVALVIA	219.7283	107.4112	3
1990	14	C	BIVALVIA	29.4900	8.6649	3
1990	16	O	BIVALVIA	137.5000	10.4203	3
1990	15	C	BIVALVIA	24.6667	7.7843	3
1990	17	O	BIVALVIA	163.8333	98.4921	3
1990	18	C	BIVALVIA	253.6667	59.4988	3
1991	13	O	BIVALVIA	903.1117	386.9998	3
1991	14	C	BIVALVIA	96.9667	20.6107	3
1991	16	O	BIVALVIA	291.3333	71.9660	3
1991	15	C	BIVALVIA	100.8883	34.7038	3
1991	17	O	BIVALVIA	154.2067	108.2049	3
1991	18	C	BIVALVIA	290.1600	196.7732	3
1993	13	O	BIVALVIA	207.6350	149.5895	3
1993	14	C	BIVALVIA	58.6667	7.0553	3
1993	16	O	BIVALVIA	1073.3333	184.6992	3
1993	15	C	BIVALVIA	118.4000	55.4571	3
1993	17	O	BIVALVIA	63.5550	40.3127	3
1993	18	C	BIVALVIA	180.7217	61.9704	3
1995	13	O	BIVALVIA	712.5950	463.1635	3
1995	14	C	BIVALVIA	104.0333	18.6811	3
1995	16	O	BIVALVIA	207.2767	31.4186	3
1995	15	C	BIVALVIA	62.9333	3.8736	3
1995	17	O	BIVALVIA	78.2217	38.4314	3
1995	18	C	BIVALVIA	132.2667	29.2704	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	BIVALVIA	173.6872	24.2432	3
1990	C	BIVALVIA	102.6078	75.5423	3
1991	O	BIVALVIA	449.5506	230.2095	3
1991	C	BIVALVIA	162.6717	63.7542	3
1993	O	BIVALVIA	448.1744	315.3345	3
1993	C	BIVALVIA	119.2628	35.2369	3
1995	O	BIVALVIA	332.6978	193.5676	3
1995	C	BIVALVIA	99.7444	20.1294	3

One-way randomization within blocks with % mud as covariate

Year	P for Oilcode
1990	0.35
1991	0.81
1993	0.92
1995	0.41

Two-way randomization within blocks with % mud as covariate

P values for:

Interaction	Oilcode	Year
0.289	0.705	0.124

Taxa = Infaunal OTHER CRUSTACEA
Depth Stratum = 6 to 20 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	OTHER CRUSTACEA	2.8333	2.8333	3
1990	14	C	OTHER CRUSTACEA	4.6667	4.6667	3
1990	16	O	OTHER CRUSTACEA	20.6133	12.9499	3
1990	15	C	OTHER CRUSTACEA	20.5000	4.0104	3
1990	17	O	OTHER CRUSTACEA	41.9050	13.2884	3
1990	18	C	OTHER CRUSTACEA	5.8667	2.2683	3
1991	13	O	OTHER CRUSTACEA	6.0317	4.1938	3
1991	14	C	OTHER CRUSTACEA	6.6667	2.6667	3
1991	16	O	OTHER CRUSTACEA	50.0000	5.2915	3
1991	15	C	OTHER CRUSTACEA	53.8167	5.3292	3
1991	17	O	OTHER CRUSTACEA	12.8883	8.8883	3
1991	18	C	OTHER CRUSTACEA	32.6667	17.7514	3
1993	13	O	OTHER CRUSTACEA	43.3883	11.7590	3
1993	14	C	OTHER CRUSTACEA	22.2217	5.1260	3
1993	16	O	OTHER CRUSTACEA	14.6667	5.3333	3
1993	15	C	OTHER CRUSTACEA	24.7850	11.4483	3
1993	17	O	OTHER CRUSTACEA	24.6667	6.3596	3
1993	18	C	OTHER CRUSTACEA	12.6667	3.9193	3
1995	13	O	OTHER CRUSTACEA	4.6300	2.4654	3
1995	14	C	OTHER CRUSTACEA	26.7550	7.3839	3
1995	16	O	OTHER CRUSTACEA	17.9700	7.1297	3
1995	15	C	OTHER CRUSTACEA	42.0000	15.0028	3
1995	17	O	OTHER CRUSTACEA	49.7783	23.6045	3
1995	18	C	OTHER CRUSTACEA	31.5000	5.2520	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	OTHER CRUSTACEA	21.7839	11.2942	3
1990	C	OTHER CRUSTACEA	10.3444	5.0896	3
1991	O	OTHER CRUSTACEA	22.9733	13.6575	3
1991	C	OTHER CRUSTACEA	31.0500	13.6350	3
1993	O	OTHER CRUSTACEA	27.5739	8.4177	3
1993	C	OTHER CRUSTACEA	19.8911	3.6872	3
1995	O	OTHER CRUSTACEA	24.1261	13.3917	3
1995	C	OTHER CRUSTACEA	33.4183	4.5042	3

One-way randomization within blocks with % mud as covariate

Year	P for Oilcode
1990	0.14
1991	0.67
1993	0.17
1995	0.36

Two-way randomization within blocks with % mud as covariate

P values for:

Interaction	Oilcode	Year
0.372	0.861	0.496

Taxa = Infaunal OTHER CRUSTACEA
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	OTHER CRUSTACEA	6.4767	2.7666	3
1990	14	C	OTHER CRUSTACEA	1.2700	1.2700	3
1990	16	O	OTHER CRUSTACEA	16.6667	7.6884	3
1990	15	C	OTHER CRUSTACEA	0.0000	0.0000	3
1990	17	O	OTHER CRUSTACEA	25.3333	11.6809	3
1990	18	C	OTHER CRUSTACEA	12.0000	6.1101	3
1991	13	O	OTHER CRUSTACEA	10.4450	3.8559	3
1991	14	C	OTHER CRUSTACEA	18.9333	9.6922	3
1991	16	O	OTHER CRUSTACEA	22.8883	8.5580	3
1991	15	C	OTHER CRUSTACEA	11.1117	2.4744	3
1991	17	O	OTHER CRUSTACEA	6.7150	4.6733	3
1991	18	C	OTHER CRUSTACEA	87.7150	25.2916	3
1993	13	O	OTHER CRUSTACEA	54.6667	30.6014	3
1993	14	C	OTHER CRUSTACEA	16.4450	6.1629	3
1993	16	O	OTHER CRUSTACEA	24.0000	6.1101	3
1993	15	C	OTHER CRUSTACEA	10.1333	2.6303	3
1993	17	O	OTHER CRUSTACEA	69.1117	23.5393	3
1993	18	C	OTHER CRUSTACEA	9.0550	1.0550	3
1995	13	O	OTHER CRUSTACEA	39.2600	38.1477	3
1995	14	C	OTHER CRUSTACEA	12.0883	2.3111	3
1995	16	O	OTHER CRUSTACEA	16.4450	0.4450	3
1995	15	C	OTHER CRUSTACEA	4.2667	0.5333	3
1995	17	O	OTHER CRUSTACEA	56.4450	15.0914	3
1995	18	C	OTHER CRUSTACEA	88.3000	44.0468	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	OTHER CRUSTACEA	16.1589	5.4494	3
1990	C	OTHER CRUSTACEA	4.4233	3.8060	3
1991	O	OTHER CRUSTACEA	13.3494	4.8895	3
1991	C	OTHER CRUSTACEA	39.2533	24.3358	3
1993	O	OTHER CRUSTACEA	49.2594	13.3003	3
1993	C	OTHER CRUSTACEA	11.8778	2.3047	3
1995	O	OTHER CRUSTACEA	37.3833	11.5851	3
1995	C	OTHER CRUSTACEA	34.8850	26.8028	3

One-way randomization within blocks with % mud as covariate

Year	P for Oilcode
1990	0.39
1991	0.60
1993	0.02
1995	0.49

Two-way randomization within blocks with % mud as covariate

P values for:

Interaction	Oilcode	Year
0.086	0.579	0.315

Taxa = Infaunal ECHINODERMATA
Depth Stratum = 6 to 20 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	ECHINODERMATA	0.0000	0.0000	3
1990	14	C	ECHINODERMATA	0.1667	0.1667	3
1990	16	O	ECHINODERMATA	13.3333	4.8074	3
1990	15	C	ECHINODERMATA	4.3333	2.2423	3
1990	17	O	ECHINODERMATA	0.7150	0.3599	3
1990	18	C	ECHINODERMATA	3.1117	3.1117	3
1991	13	O	ECHINODERMATA	0.8883	0.8883	3
1991	14	C	ECHINODERMATA	2.6667	1.3333	3
1991	16	O	ECHINODERMATA	46.6667	18.6667	3
1991	15	C	ECHINODERMATA	21.5300	5.7926	3
1991	17	O	ECHINODERMATA	9.1117	6.3524	3
1991	18	C	ECHINODERMATA	8.6667	4.3716	3
1993	13	O	ECHINODERMATA	0.5000	0.5000	3
1993	14	C	ECHINODERMATA	12.0000	2.3094	3
1993	16	O	ECHINODERMATA	33.7783	18.5606	3
1993	15	C	ECHINODERMATA	30.6500	11.9957	3
1993	17	O	ECHINODERMATA	4.0000	2.3094	3
1993	18	C	ECHINODERMATA	4.6667	0.9280	3
1995	13	O	ECHINODERMATA	14.2233	7.2768	3
1995	14	C	ECHINODERMATA	5.3333	3.5277	3
1995	16	O	ECHINODERMATA	42.9833	11.7190	3
1995	15	C	ECHINODERMATA	13.1667	4.0449	3
1995	17	O	ECHINODERMATA	3.1117	1.6029	3
1995	18	C	ECHINODERMATA	4.0000	0.7638	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	ECHINODERMATA	4.6828	4.3302	3
1990	C	ECHINODERMATA	2.5372	1.2366	3
1991	O	ECHINODERMATA	18.8889	14.0903	3
1991	C	ECHINODERMATA	10.9544	5.5642	3
1993	O	ECHINODERMATA	12.7594	10.5579	3
1993	C	ECHINODERMATA	15.7722	7.7342	3
1995	O	ECHINODERMATA	20.1061	11.8799	3
1995	C	ECHINODERMATA	7.5000	2.8594	3

One-way randomization within blocks with % mud as covariate

Year	P for Oilcode
1990	0.28
1991	0.60
1993	0.53
1995	0.09

Two-way randomization within blocks with % mud as covariate

P values for:

Interaction	Oilcode	Year
0.87	0.106	0.227

Taxa = Infaunal ECHINODERMATA
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	ECHINODERMATA	0.0000	0.0000	3
1990	14	C	ECHINODERMATA	0.0000	0.0000	3
1990	16	O	ECHINODERMATA	2.6667	1.3333	3
1990	15	C	ECHINODERMATA	0.0000	0.0000	3
1990	17	O	ECHINODERMATA	0.6667	0.6667	3
1990	18	C	ECHINODERMATA	4.6667	2.4037	3
1991	13	O	ECHINODERMATA	0.0000	0.0000	3
1991	14	C	ECHINODERMATA	2.6667	1.3333	3
1991	16	O	ECHINODERMATA	4.0000	4.0000	3
1991	15	C	ECHINODERMATA	1.3333	1.3333	3
1991	17	O	ECHINODERMATA	1.0483	0.5794	3
1991	18	C	ECHINODERMATA	5.4933	3.9286	3
1993	13	O	ECHINODERMATA	40.6667	39.6709	3
1993	14	C	ECHINODERMATA	9.1117	7.2048	3
1993	16	O	ECHINODERMATA	4.0000	0.0000	3
1993	15	C	ECHINODERMATA	0.0000	0.0000	3
1993	17	O	ECHINODERMATA	1.7783	1.1758	3
1993	18	C	ECHINODERMATA	7.0883	2.5186	3
1995	13	O	ECHINODERMATA	7.5550	7.5550	3
1995	14	C	ECHINODERMATA	0.8883	0.8883	3
1995	16	O	ECHINODERMATA	10.2217	8.9224	3
1995	15	C	ECHINODERMATA	9.0667	3.0052	3
1995	17	O	ECHINODERMATA	1.3333	1.3333	3
1995	18	C	ECHINODERMATA	3.8000	1.4107	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	ECHINODERMATA	1.1111	0.8012	3
1990	C	ECHINODERMATA	1.5556	1.5556	3
1991	O	ECHINODERMATA	1.6828	1.1975	3
1991	C	ECHINODERMATA	3.1644	1.2264	3
1993	O	ECHINODERMATA	15.4817	12.6088	3
1993	C	ECHINODERMATA	5.4000	2.7625	3
1995	O	ECHINODERMATA	6.3700	2.6334	3
1995	C	ECHINODERMATA	4.5850	2.3933	3

One-way randomization within blocks with % mud as covariate

Year	P for Oilcode
1990	0.33
1991	0.51
1993	0.95
1995	0.52

Two-way randomization within blocks with % mud as covariate

P values for:

Interaction	Oilcode	Year
0.708	0.492	0.752

Taxa = Epifaunal AMPHIPODA
Depth Stratum = 6 to 20 M
X

Means by Year and Site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	AMPHIPODA	0.0000	0.0000	3
1990	14	C	AMPHIPODA	0.0000	0.0000	3
1990	16	O	AMPHIPODA	16.8883	3.8750	3
1990	15	C	AMPHIPODA	24.0000	23.0018	3
1990	17	O	AMPHIPODA	0.0000	0.0000	3
1990	18	C	AMPHIPODA	0.0000	0.0000	3
1991	13	O	AMPHIPODA	0.0000	0.0000	3
1991	14	C	AMPHIPODA	7.1100	4.7038	3
1991	16	O	AMPHIPODA	20.0000	4.6188	3
1991	15	C	AMPHIPODA	6.6983	2.9025	3
1991	17	O	AMPHIPODA	47.3333	27.1866	3
1991	18	C	AMPHIPODA	27.3333	24.3402	3
1993	13	O	AMPHIPODA	3.5550	1.9368	3
1993	14	C	AMPHIPODA	8.8883	4.5103	3
1993	16	O	AMPHIPODA	33.3333	14.1107	3
1993	15	C	AMPHIPODA	5.8050	4.0311	3
1993	17	O	AMPHIPODA	4.0000	2.3094	3
1993	18	C	AMPHIPODA	0.1667	0.1667	3
1995	13	O	AMPHIPODA	11.8883	11.3920	3
1995	14	C	AMPHIPODA	1.3333	1.3333	3
1995	16	O	AMPHIPODA	6.9217	4.1296	3
1995	15	C	AMPHIPODA	0.3333	0.3333	3
1995	17	O	AMPHIPODA	10.2233	4.9487	3
1995	18	C	AMPHIPODA	1.5000	0.2887	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	AMPHIPODA	5.6294	5.6294	3
1990	C	AMPHIPODA	8.0000	8.0000	3
1991	O	AMPHIPODA	22.4444	13.7185	3
1991	C	AMPHIPODA	13.7139	6.8108	3
1993	O	AMPHIPODA	13.6294	9.8528	3
1993	C	AMPHIPODA	4.9533	2.5535	3
1995	O	AMPHIPODA	9.6778	1.4595	3
1995	C	AMPHIPODA	1.0556	0.3643	3

One-way randomization within blocks

Year	P for Oilcode
1990	0.85
1991	0.39
1993	0.24
1995	0.03

Two-way randomization within blocks

P values for:

Interaction	Oilcode	Year
0.756	0.21	0.184

Taxa = Epifaunal AMPHIPODA
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	AMPHIPODA	0.3817	0.3817	3
1990	14	C	AMPHIPODA	26.9917	9.2942	3
1990	16	O	AMPHIPODA	152.0000	44.0606	3
1990	15	C	AMPHIPODA	9.3333	5.3333	3
1990	17	O	AMPHIPODA	4.4450	1.2375	3
1990	18	C	AMPHIPODA	246.6667	120.4676	3
1991	13	O	AMPHIPODA	0.0000	0.0000	3
1991	14	C	AMPHIPODA	47.4667	19.6846	3
1991	16	O	AMPHIPODA	258.0000	108.4866	3
1991	15	C	AMPHIPODA	93.3333	45.8597	3
1991	17	O	AMPHIPODA	97.5000	38.3438	3
1991	18	C	AMPHIPODA	558.9200	107.1130	3
1993	13	O	AMPHIPODA	35.8183	10.4115	3
1993	14	C	AMPHIPODA	84.6667	24.1697	3
1993	16	O	AMPHIPODA	574.6667	102.4847	3
1993	15	C	AMPHIPODA	64.2667	6.9257	3
1993	17	O	AMPHIPODA	1322.4450	433.2084	3
1993	18	C	AMPHIPODA	366.8667	148.8501	3
1995	13	O	AMPHIPODA	19.8517	19.4084	3
1995	14	C	AMPHIPODA	61.0667	12.4523	3
1995	16	O	AMPHIPODA	105.7783	9.1190	3
1995	15	C	AMPHIPODA	83.7333	15.8683	3
1995	17	O	AMPHIPODA	153.7783	43.9347	3
1995	18	C	AMPHIPODA	84.3000	30.6663	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	AMPHIPODA	52.2756	49.8760	3
1990	C	AMPHIPODA	94.3306	76.3384	3
1991	O	AMPHIPODA	118.5000	75.2147	3
1991	C	AMPHIPODA	233.2400	163.3774	3
1993	O	AMPHIPODA	644.3100	373.0459	3
1993	C	AMPHIPODA	171.9333	97.6444	3
1995	O	AMPHIPODA	93.1361	39.1746	3
1995	C	AMPHIPODA	76.3667	7.6517	3

One-way randomization within blocks

Year	P for Oilcode
1990	0.54
1991	0.29
1993	0.04
1995	0.49

Two-way randomization within blocks

P values for:

Interaction	Oilcode	Year
.002	0.296	0.000

Taxa = Epifaunal POLYCHAETA
Depth Stratum = 6 to 20 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	POLYCHAETA	0.6667	0.6667	3
1990	14	C	POLYCHAETA	11.1667	11.1667	3
1990	16	O	POLYCHAETA	72.8883	29.6787	3
1990	15	C	POLYCHAETA	41.8333	23.7071	3
1990	17	O	POLYCHAETA	6.8333	3.3706	3
1990	18	C	POLYCHAETA	9.3333	9.3333	3
1991	13	O	POLYCHAETA	0.0000	0.0000	3
1991	14	C	POLYCHAETA	1.6667	1.2019	3
1991	16	O	POLYCHAETA	74.6667	23.1325	3
1991	15	C	POLYCHAETA	192.7467	171.2184	3
1991	17	O	POLYCHAETA	9.3333	3.5277	3
1991	18	C	POLYCHAETA	39.5000	37.5178	3
1993	13	O	POLYCHAETA	0.0000	0.0000	3
1993	14	C	POLYCHAETA	3.1117	1.6029	3
1993	16	O	POLYCHAETA	109.3333	71.3427	3
1993	15	C	POLYCHAETA	61.6417	31.6733	3
1993	17	O	POLYCHAETA	8.6667	2.9059	3
1993	18	C	POLYCHAETA	11.0000	10.5040	3
1995	13	O	POLYCHAETA	0.0000	0.0000	3
1995	14	C	POLYCHAETA	29.7783	27.8023	3
1995	16	O	POLYCHAETA	100.2533	45.6673	3
1995	15	C	POLYCHAETA	38.8333	19.3484	3
1995	17	O	POLYCHAETA	6.6667	6.6667	3
1995	18	C	POLYCHAETA	0.3333	0.3333	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	POLYCHAETA	26.7961	23.1148	3
1990	C	POLYCHAETA	20.7778	10.5411	3
1991	O	POLYCHAETA	28.0000	23.4884	3
1991	C	POLYCHAETA	77.9711	58.4178	3
1993	O	POLYCHAETA	39.3333	35.0893	3
1993	C	POLYCHAETA	25.2511	18.3372	3
1995	O	POLYCHAETA	35.6400	32.3639	3
1995	C	POLYCHAETA	22.9817	11.6219	3

One-way randomization within blocks

Year	P for Oilcode
1990	0.74
1991	0.47
1993	0.73
1995	0.55

Two-way randomization within blocks

P values for:

Interaction	Oilcode	Year
0.484	0.845	0.688

Taxa = Epifaunal POLYCHAETA
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	POLYCHAETA	284.6233	126.4776	3
1990	14	C	POLYCHAETA	49.7850	4.6859	3
1990	16	O	POLYCHAETA	396.0000	91.2433	3
1990	15	C	POLYCHAETA	188.2217	27.5211	3
1990	17	O	POLYCHAETA	430.6667	183.9577	3
1990	18	C	POLYCHAETA	2.6667	2.6667	3
1991	13	O	POLYCHAETA	196.8900	112.1847	3
1991	14	C	POLYCHAETA	95.7333	53.8449	3
1991	16	O	POLYCHAETA	291.7783	94.9242	3
1991	15	C	POLYCHAETA	376.4450	76.7119	3
1991	17	O	POLYCHAETA	382.3817	163.8531	3
1991	18	C	POLYCHAETA	0.0000	0.0000	3
1993	13	O	POLYCHAETA	256.0600	116.1019	3
1993	14	C	POLYCHAETA	164.4450	65.8325	3
1993	16	O	POLYCHAETA	981.3333	415.8611	3
1993	15	C	POLYCHAETA	49.1550	14.2243	3
1993	17	O	POLYCHAETA	948.4450	176.1516	3
1993	18	C	POLYCHAETA	0.5333	0.5333	3
1995	13	O	POLYCHAETA	59.8517	59.8517	3
1995	14	C	POLYCHAETA	106.4433	5.5416	3
1995	16	O	POLYCHAETA	764.8883	360.4472	3
1995	15	C	POLYCHAETA	2668.0000	1045.8158	3
1995	17	O	POLYCHAETA	39.5567	12.5149	3
1995	18	C	POLYCHAETA	0.7667	0.4333	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	POLYCHAETA	370.4300	44.0550	3
1990	C	POLYCHAETA	80.2244	55.6854	3
1991	O	POLYCHAETA	290.3500	53.5516	3
1991	C	POLYCHAETA	157.3928	112.9589	3
1993	O	POLYCHAETA	728.6128	236.4671	3
1993	C	POLYCHAETA	71.3778	48.6043	3
1995	O	POLYCHAETA	288.0989	238.4667	3
1995	C	POLYCHAETA	925.0700	871.9988	3

One-way randomization within blocks

Year	P for Oilcode
1990	0.00
1991	0.20
1993	0.00
1995	0.19

Two-way randomization within blocks

P values for:

Interaction	Oilcode	Year
.006	0.522	0.29

Taxa = Epifaunal GASTROPODA
Depth Stratum = 6 to 20 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	GASTROPODA	0.3333	0.3333	3
1990	14	C	GASTROPODA	0.0000	0.0000	3
1990	16	O	GASTROPODA	3.5550	2.3519	3
1990	15	C	GASTROPODA	3.3333	2.4037	3
1990	17	O	GASTROPODA	0.1667	0.1667	3
1990	18	C	GASTROPODA	0.0000	0.0000	3
1991	13	O	GASTROPODA	1.0667	1.0667	3
1991	14	C	GASTROPODA	0.6667	0.6667	3
1991	16	O	GASTROPODA	26.6667	17.0229	3
1991	15	C	GASTROPODA	13.6217	6.1395	3
1991	17	O	GASTROPODA	6.0000	3.0551	3
1991	18	C	GASTROPODA	25.3333	25.3333	3
1993	13	O	GASTROPODA	1.2217	0.7773	3
1993	14	C	GASTROPODA	0.0000	0.0000	3
1993	16	O	GASTROPODA	11.5567	7.9017	3
1993	15	C	GASTROPODA	18.7900	4.4610	3
1993	17	O	GASTROPODA	0.0000	0.0000	3
1993	18	C	GASTROPODA	0.0000	0.0000	3
1995	13	O	GASTROPODA	19.5567	14.8942	3
1995	14	C	GASTROPODA	0.0000	0.0000	3
1995	16	O	GASTROPODA	5.1450	2.0600	3
1995	15	C	GASTROPODA	5.8333	3.6324	3
1995	17	O	GASTROPODA	0.0000	0.0000	3
1995	18	C	GASTROPODA	0.3333	0.3333	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	GASTROPODA	1.3517	1.1027	3
1990	C	GASTROPODA	1.1111	1.1111	3
1991	O	GASTROPODA	11.2444	7.8415	3
1991	C	GASTROPODA	13.2072	7.1237	3
1993	O	GASTROPODA	4.2594	3.6656	3
1993	C	GASTROPODA	6.2633	6.2633	3
1995	O	GASTROPODA	8.2339	5.8530	3
1995	C	GASTROPODA	2.0556	1.8913	3

One-way randomization within blocks

Year	P for Oilcode
1990	0.50
1991	0.82
1993	0.59
1995	0.32

Two-way randomization within blocks

P values for:

Interaction	Oilcode	Year
0.811	0.882	0.057

Taxa = Epifaunal GASTROPODA
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	GASTROPODA	4.2483	0.9478	3
1990	14	C	GASTROPODA	0.0000	0.0000	3
1990	16	O	GASTROPODA	0.3333	0.3333	3
1990	15	C	GASTROPODA	2.2217	2.2217	3
1990	17	O	GASTROPODA	16.6667	5.4569	3
1990	18	C	GASTROPODA	3.3333	3.3333	3
1991	13	O	GASTROPODA	5.1117	2.8889	3
1991	14	C	GASTROPODA	0.5333	0.5333	3
1991	16	O	GASTROPODA	10.2217	3.9508	3
1991	15	C	GASTROPODA	3.5550	0.4450	3
1991	17	O	GASTROPODA	2.2217	2.2217	3
1991	18	C	GASTROPODA	2.1033	0.5854	3
1993	13	O	GASTROPODA	4.0000	3.0551	3
1993	14	C	GASTROPODA	2.6667	0.6667	3
1993	16	O	GASTROPODA	30.6667	9.3333	3
1993	15	C	GASTROPODA	5.6883	1.5807	3
1993	17	O	GASTROPODA	8.0000	2.3094	3
1993	18	C	GASTROPODA	2.0000	2.0000	3
1995	13	O	GASTROPODA	3.7050	3.7050	3
1995	14	C	GASTROPODA	1.2000	0.6110	3
1995	16	O	GASTROPODA	11.5550	6.9425	3
1995	15	C	GASTROPODA	7.7333	4.9817	3
1995	17	O	GASTROPODA	9.3333	2.6667	3
1995	18	C	GASTROPODA	5.1667	5.1667	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	GASTROPODA	7.0828	4.9234	3
1990	C	GASTROPODA	1.8517	0.9799	3
1991	O	GASTROPODA	5.8517	2.3389	3
1991	C	GASTROPODA	2.0639	0.8725	3
1993	O	GASTROPODA	14.2222	8.3029	3
1993	C	GASTROPODA	3.4517	1.1348	3
1995	O	GASTROPODA	8.1978	2.3361	3
1995	C	GASTROPODA	4.7000	1.9004	3

One-way randomization within blocks

Year	P for Oilcode
1990	0.14
1991	0.08
1993	0.02
1995	0.31

Two-way randomization within blocks

P values for:

Interaction	Oilcode	Year
0.505	.001	0.268

Taxa = Epifaunal BIVALVIA
Depth Stratum = 6 to 20 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	BIVALVIA	0.0000	0.0000	3
1990	14	C	BIVALVIA	1.8333	1.8333	3
1990	16	O	BIVALVIA	15.5550	3.7971	3
1990	15	C	BIVALVIA	2.5000	1.7559	3
1990	17	O	BIVALVIA	133.7383	48.1263	3
1990	18	C	BIVALVIA	4.0883	2.8612	3
1991	13	O	BIVALVIA	1.3333	1.3333	3
1991	14	C	BIVALVIA	0.0000	0.0000	3
1991	16	O	BIVALVIA	13.3333	2.6667	3
1991	15	C	BIVALVIA	8.3567	4.1784	3
1991	17	O	BIVALVIA	101.2783	22.8763	3
1991	18	C	BIVALVIA	0.6667	0.6667	3
1993	13	O	BIVALVIA	5.0550	1.7651	3
1993	14	C	BIVALVIA	1.3333	1.3333	3
1993	16	O	BIVALVIA	3.5550	0.4450	3
1993	15	C	BIVALVIA	0.1667	0.1667	3
1993	17	O	BIVALVIA	505.3333	104.8258	3
1993	18	C	BIVALVIA	1.3333	1.3333	3
1995	13	O	BIVALVIA	3.1117	3.1117	3
1995	14	C	BIVALVIA	0.8883	0.8883	3
1995	16	O	BIVALVIA	12.2517	8.7256	3
1995	15	C	BIVALVIA	0.3333	0.3333	3
1995	17	O	BIVALVIA	853.3317	136.7168	3
1995	18	C	BIVALVIA	1.5000	0.7638	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	BIVALVIA	49.7644	42.2264	3
1990	C	BIVALVIA	2.8072	0.6688	3
1991	O	BIVALVIA	38.6483	31.5060	3
1991	C	BIVALVIA	3.0078	2.6814	3
1993	O	BIVALVIA	171.3144	167.0100	3
1993	C	BIVALVIA	0.9444	0.3889	3
1995	O	BIVALVIA	289.5650	281.8957	3
1995	C	BIVALVIA	0.9072	0.3369	3

One-way randomization within blocks

Year	P for Oilcode
1990	0.02
1991	0.03
1993	0.00
1995	0.02

Two-way randomization within blocks

P values for:

Interaction	Oilcode	Year
0.124	0.000	0.163

Taxa = Epifaunal BIVALVIA
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	BIVALVIA	1.1433	1.1433	3
1990	14	C	BIVALVIA	0.1667	0.1667	3
1990	16	O	BIVALVIA	178.1667	166.2308	3
1990	15	C	BIVALVIA	0.6667	0.6667	3
1990	17	O	BIVALVIA	309.2767	112.8444	3
1990	18	C	BIVALVIA	38.0000	20.2320	3
1991	13	O	BIVALVIA	37.5550	13.2906	3
1991	14	C	BIVALVIA	6.4000	3.4871	3
1991	16	O	BIVALVIA	515.1117	444.5248	3
1991	15	C	BIVALVIA	5.7783	5.7783	3
1991	17	O	BIVALVIA	789.3167	118.2945	3
1991	18	C	BIVALVIA	189.5867	25.2126	3
1993	13	O	BIVALVIA	82.4850	49.6302	3
1993	14	C	BIVALVIA	5.3333	0.7693	3
1993	16	O	BIVALVIA	1968.0000	451.7699	3
1993	15	C	BIVALVIA	4.4450	1.9368	3
1993	17	O	BIVALVIA	136.6667	57.3450	3
1993	18	C	BIVALVIA	39.3117	25.5119	3
1995	13	O	BIVALVIA	73.1850	63.8752	3
1995	14	C	BIVALVIA	0.1667	0.1667	3
1995	16	O	BIVALVIA	778.6667	71.4174	3
1995	15	C	BIVALVIA	1.6000	0.0000	3
1995	17	O	BIVALVIA	169.3350	43.4706	3
1995	18	C	BIVALVIA	8.9667	4.8254	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	BIVALVIA	162.8622	89.2790	3
1990	C	BIVALVIA	12.9444	12.5286	3
1991	O	BIVALVIA	447.3278	219.6455	3
1991	C	BIVALVIA	67.2550	61.1661	3
1993	O	BIVALVIA	729.0506	619.6721	3
1993	C	BIVALVIA	16.3633	11.4770	3
1995	O	BIVALVIA	340.3956	220.8864	3
1995	C	BIVALVIA	3.5778	2.7260	3

One-way randomization within blocks

Year	P for Oilcode
1990	0.00
1991	0.00
1993	0.00
1995	0.00

Two-way randomization within blocks

P values for:

Interaction	Oilcode	Year
0.300	0.000	0.281

Taxa = Epifaunal Other CRUSTACEA
Depth Stratum = 6 to 20 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	OTHER CRUSTACEA	2.6667	2.6667	3
1990	14	C	OTHER CRUSTACEA	1.3333	1.0929	3
1990	16	O	OTHER CRUSTACEA	12.9450	2.7493	3
1990	15	C	OTHER CRUSTACEA	5.3333	1.4530	3
1990	17	O	OTHER CRUSTACEA	0.1667	0.1667	3
1990	18	C	OTHER CRUSTACEA	7.5550	7.5550	3
1991	13	O	OTHER CRUSTACEA	0.3817	0.3817	3
1991	14	C	OTHER CRUSTACEA	1.5000	1.5000	3
1991	16	O	OTHER CRUSTACEA	2.6667	1.3333	3
1991	15	C	OTHER CRUSTACEA	0.5000	0.5000	3
1991	17	O	OTHER CRUSTACEA	0.6667	0.6667	3
1991	18	C	OTHER CRUSTACEA	34.3333	28.5443	3
1993	13	O	OTHER CRUSTACEA	4.2767	1.5036	3
1993	14	C	OTHER CRUSTACEA	3.5550	0.4450	3
1993	16	O	OTHER CRUSTACEA	9.3333	5.3333	3
1993	15	C	OTHER CRUSTACEA	4.4767	2.3581	3
1993	17	O	OTHER CRUSTACEA	0.0000	0.0000	3
1993	18	C	OTHER CRUSTACEA	0.5000	0.2887	3
1995	13	O	OTHER CRUSTACEA	1.6300	1.2125	3
1995	14	C	OTHER CRUSTACEA	0.8883	0.8883	3
1995	16	O	OTHER CRUSTACEA	29.8167	12.5078	3
1995	15	C	OTHER CRUSTACEA	0.3333	0.3333	3
1995	17	O	OTHER CRUSTACEA	0.0000	0.0000	3
1995	18	C	OTHER CRUSTACEA	3.3333	1.5899	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	OTHER CRUSTACEA	5.2594	3.9100	3
1990	C	OTHER CRUSTACEA	4.7406	1.8203	3
1991	O	OTHER CRUSTACEA	1.2383	0.7189	3
1991	C	OTHER CRUSTACEA	12.1111	11.1149	3
1993	O	OTHER CRUSTACEA	4.5367	2.6974	3
1993	C	OTHER CRUSTACEA	2.8439	1.2018	3
1995	O	OTHER CRUSTACEA	10.4822	9.6787	3
1995	C	OTHER CRUSTACEA	1.5183	0.9215	3

One-way randomization within blocks

Year	P for Oilcode
1990	0.89
1991	0.28
1993	0.55
1995	0.23

Two-way randomization within blocks

P values for:

Interaction	Oilcode	Year
0.094	0.98	0.978

Taxa = Epifaunal Other CRUSTACEA
Depth Stratum 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	OTHER CRUSTACEA	0.0000	0.0000	3
1990	14	C	OTHER CRUSTACEA	0.5483	0.3314	3
1990	16	O	OTHER CRUSTACEA	4.8333	4.0859	3
1990	15	C	OTHER CRUSTACEA	2.2217	2.2217	3
1990	17	O	OTHER CRUSTACEA	5.3333	4.3716	3
1990	18	C	OTHER CRUSTACEA	4.0000	2.3094	3
1991	13	O	OTHER CRUSTACEA	0.0000	0.0000	3
1991	14	C	OTHER CRUSTACEA	0.0000	0.0000	3
1991	16	O	OTHER CRUSTACEA	0.5000	0.2887	3
1991	15	C	OTHER CRUSTACEA	0.0000	0.0000	3
1991	17	O	OTHER CRUSTACEA	0.0000	0.0000	3
1991	18	C	OTHER CRUSTACEA	4.4767	0.7792	3
1993	13	O	OTHER CRUSTACEA	0.6667	0.6667	3
1993	14	C	OTHER CRUSTACEA	2.6667	1.3333	3
1993	16	O	OTHER CRUSTACEA	9.3333	7.4237	3
1993	15	C	OTHER CRUSTACEA	0.0000	0.0000	3
1993	17	O	OTHER CRUSTACEA	4.8900	0.8900	3
1993	18	C	OTHER CRUSTACEA	3.5550	2.3519	3
1995	13	O	OTHER CRUSTACEA	0.8900	0.5138	3
1995	14	C	OTHER CRUSTACEA	2.3000	1.1590	3
1995	16	O	OTHER CRUSTACEA	5.3333	1.3333	3
1995	15	C	OTHER CRUSTACEA	0.1667	0.1667	3
1995	17	O	OTHER CRUSTACEA	0.0000	0.0000	3
1995	18	C	OTHER CRUSTACEA	6.4333	4.4427	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	OTHER CRUSTACEA	3.3889	1.7006	3
1990	C	OTHER CRUSTACEA	2.2567	0.9966	3
1991	O	OTHER CRUSTACEA	0.1667	0.1667	3
1991	C	OTHER CRUSTACEA	1.4922	1.4922	3
1993	O	OTHER CRUSTACEA	4.9633	2.5021	3
1993	C	OTHER CRUSTACEA	2.0739	1.0682	3
1995	O	OTHER CRUSTACEA	2.0744	1.6496	3
1995	C	OTHER CRUSTACEA	2.9667	1.8395	3

One-way randomization within

Year	P for Oilcode
1990	0.54
1991	0.18
1993	0.40
1995	0.73

Two-way randomization within blocks

P values for:

Interaction	Oilcode	Year
0.395	0.678	0.28

Taxa = Epifaunal ECHINODERMATA
Depth Stratum = 6 to 20 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	ECHINODERMATA	0.0000	0.0000	3
1990	14	C	ECHINODERMATA	0.0000	0.0000	3
1990	16	O	ECHINODERMATA	1.7783	1.1758	3
1990	15	C	ECHINODERMATA	0.6667	0.6667	3
1990	17	O	ECHINODERMATA	1.3333	1.3333	3
1990	18	C	ECHINODERMATA	0.0000	0.0000	3
1991	13	O	ECHINODERMATA	0.0000	0.0000	3
1991	14	C	ECHINODERMATA	0.0000	0.0000	3
1991	16	O	ECHINODERMATA	1.3333	1.3333	3
1991	15	C	ECHINODERMATA	0.1667	0.1667	3
1991	17	O	ECHINODERMATA	2.0000	1.1547	3
1991	18	C	ECHINODERMATA	0.0000	0.0000	3
1993	13	O	ECHINODERMATA	0.0000	0.0000	3
1993	14	C	ECHINODERMATA	0.0000	0.0000	3
1993	16	O	ECHINODERMATA	0.0000	0.0000	3
1993	15	C	ECHINODERMATA	0.8333	0.6009	3
1993	17	O	ECHINODERMATA	0.0000	0.0000	3
1993	18	C	ECHINODERMATA	0.0000	0.0000	3
1995	13	O	ECHINODERMATA	0.0000	0.0000	3
1995	14	C	ECHINODERMATA	1.3333	1.3333	3
1995	16	O	ECHINODERMATA	0.0000	0.0000	3
1995	15	C	ECHINODERMATA	1.8333	1.3642	3
1995	17	O	ECHINODERMATA	1.3333	1.3333	3
1995	18	C	ECHINODERMATA	0.0000	0.0000	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	ECHINODERMATA	1.0372	0.5343	3
1990	C	ECHINODERMATA	0.2222	0.2222	3
1991	O	ECHINODERMATA	1.1111	0.5879	3
1991	C	ECHINODERMATA	0.0556	0.0556	3
1993	O	ECHINODERMATA	0.0000	0.0000	3
1993	C	ECHINODERMATA	0.2778	0.2778	3
1995	O	ECHINODERMATA	0.4444	0.4444	3
1995	C	ECHINODERMATA	1.0556	0.5472	3

One-way randomization within blocks with % mud as covariate

Year	P for Oilcode
1990	0.22
1991	0.15
1993	0.00
1995	0.23

Two-way randomization within blocks with % mud as covariate

P values for:

Interaction	Oilcode	Year
0.101	0.438	0.465

Taxa = Epifaunal ECHINODERMATA
Depth Stratum = < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	ECHINODERMATA	0.6667	0.6667	3
1990	14	C	ECHINODERMATA	0.0000	0.0000	3
1990	16	O	ECHINODERMATA	4.0000	0.0000	3
1990	15	C	ECHINODERMATA	0.0000	0.0000	3
1990	17	O	ECHINODERMATA	7.3333	2.9059	3
1990	18	C	ECHINODERMATA	0.0000	0.0000	3
1991	13	O	ECHINODERMATA	0.0000	0.0000	3
1991	14	C	ECHINODERMATA	0.0000	0.0000	3
1991	16	O	ECHINODERMATA	0.6667	0.6667	3
1991	15	C	ECHINODERMATA	0.0000	0.0000	3
1991	17	O	ECHINODERMATA	0.7150	0.3599	3
1991	18	C	ECHINODERMATA	0.0000	0.0000	3
1993	13	O	ECHINODERMATA	0.0000	0.0000	3
1993	14	C	ECHINODERMATA	2.6667	2.6667	3
1993	16	O	ECHINODERMATA	2.6667	2.6667	3
1993	15	C	ECHINODERMATA	0.0000	0.0000	3
1993	17	O	ECHINODERMATA	2.6667	2.6667	3
1993	18	C	ECHINODERMATA	0.0000	0.0000	3
1995	13	O	ECHINODERMATA	0.0000	0.0000	3
1995	14	C	ECHINODERMATA	1.0667	0.5333	3
1995	16	O	ECHINODERMATA	10.2217	2.9148	3
1995	15	C	ECHINODERMATA	0.0000	0.0000	3
1995	17	O	ECHINODERMATA	9.3333	5.8119	3
1995	18	C	ECHINODERMATA	0.1667	0.1667	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	ECHINODERMATA	4.0000	1.9245	3
1990	C	ECHINODERMATA	0.0000	0.0000	3
1991	O	ECHINODERMATA	0.4606	0.2307	3
1991	C	ECHINODERMATA	0.0000	0.0000	3
1993	O	ECHINODERMATA	1.7778	0.8889	3
1993	C	ECHINODERMATA	0.8889	0.8889	3
1995	O	ECHINODERMATA	6.5183	3.2692	3
1995	C	ECHINODERMATA	0.4111	0.3313	3

One-way randomization within blocks with % mud as covariate

Year	P for Oilcode
1990	0.00
1991	0.00
1993	0.62
1995	0.05

Two-way randomization within blocks with % mud as covariate

P values for:

Interaction	Oilcode	Year
0.081	0	0.067

Appendix O.

Means (No. 0.1 m^2) standard errors and results of randomization ANOVAs for feeding group data.

Appendix O. Means (No 0.1 m^{-2}) standard errors and results of randomization ANOVAs for feeding group data. SDF = surface deposit feeders, SSDF = surface deposit feeders, PS = predator/scavengers, Herb = Herbirores, and SF = suspension feeders.

Depth Stratum = 6 to 20 M

1990 to 1995 Site Means

YEAR	SITNUM	OILCODE	SDFMEAN	SSDFMEAN	PSMEAN	HERBMEAN	SFMEAN	SDFSE	SSDFSE	PSSE	HERBSE	SFSE	NSTATNS
1990	13	O	6.625	6.81	204.572	6.313	24.90	1.870	1.289	27.429	1.4045	9.958	3
1990	14	C	138.387	146.93	78.403	24.112	221.60	2.003	67.019	15.425	4.0494	88.316	3
1990	16	O	187.470	80.79	133.915	58.355	252.80	54.000	33.001	14.191	12.0408	63.057	3
1990	15	C	139.487	78.53	136.647	35.785	108.70	29.133	43.836	60.482	5.0168	12.266	3
1990	17	O	200.373	77.47	158.902	28.195	315.78	9.496	17.723	54.374	8.8702	34.435	3
1990	18	C	357.413	196.91	73.912	7.173	387.25	33.199	27.979	4.287	1.9786	105.499	3
1991	13	O	23.617	62.37	231.243	7.472	47.19	21.736	29.629	13.994	0.2412	42.253	3
1991	14	C	481.040	68.33	78.450	45.023	552.43	49.132	17.035	15.789	18.3596	75.102	3
1991	16	O	288.857	103.54	310.092	191.188	385.42	37.685	8.697	40.497	37.7020	39.486	3
1991	15	C	257.715	85.30	314.345	88.400	276.00	107.572	61.420	125.128	37.3602	161.578	3
1991	17	O	507.933	227.79	277.545	76.983	545.79	151.853	67.959	74.368	21.7893	134.850	3
1991	18	C	316.220	693.23	178.458	65.950	476.73	46.798	245.972	57.134	48.2908	118.984	3
1993	13	O	63.600	121.53	188.977	25.615	68.80	2.671	27.347	20.944	10.0498	13.887	3
1993	14	C	446.899	1178.43	141.803	43.112	722.21	154.008	576.584	40.359	24.6592	150.115	3
1993	16	O	393.300	276.45	359.065	74.457	493.67	151.568	124.027	108.692	15.1499	230.699	3
1993	15	C	271.568	309.93	233.778	37.550	299.94	25.884	26.730	42.171	5.8179	24.881	3
1993	17	O	465.433	189.76	206.138	53.280	841.32	65.282	66.442	6.969	18.6682	124.064	3
1993	18	C	261.132	232.38	107.197	7.695	616.55	43.478	96.201	10.968	3.9025	109.616	3
1995	13	O	84.857	13.89	316.040	58.972	138.30	42.261	6.639	86.817	45.5523	83.332	3
1995	14	C	366.933	158.92	169.890	30.127	775.42	92.313	19.343	18.211	4.6416	278.055	3
1995	16	O	221.505	79.73	219.893	47.255	311.12	62.264	42.815	53.231	8.5508	92.877	3
1995	15	C	161.415	29.69	207.902	21.227	293.10	97.779	21.763	148.812	1.9743	187.061	3
1995	17	O	689.835	122.92	318.688	128.987	1560.24	167.861	3.727	99.866	52.2882	387.556	3
1995	18	C	421.493	41.14	138.052	8.775	341.74	58.678	2.806	20.672	1.6569	59.003	3

1990 to 1995 Means by Oilcode and Year

YEAR	OILCODE	SDFMEAN	SSDFMEAN	PSMEAN	HERBMEAN	SFMEAN	SDFSE	SSDFSE	PSSE	HERBSE	SFSE	NSITES
1990	C	211.762	140.793	96.321	22.3567	239.182	72.826	34.311	20.2047	8.3060	80.889	3
1990	O	131.489	55.023	165.796	30.9544	197.826	62.543	24.125	20.6861	15.0864	88.356	3
1991	C	351.658	282.285	190.418	66.4578	435.053	66.859	205.531	68.3591	12.5243	82.474	3
1991	O	273.487	131.229	272.960	91.8811	326.132	140.037	49.720	22.8767	53.5550	146.955	3
1993	C	326.529	573.581	160.926	29.4522	546.231	60.255	303.254	37.7712	10.9964	126.868	3
1993	O	307.446	195.913	251.393	51.1172	467.926	123.689	44.826	54.0633	14.1408	223.379	3
1995	C	316.614	76.583	171.948	20.0428	470.085	79.182	41.299	20.1902	6.1921	153.312	3
1995	O	332.066	72.179	284.874	78.4044	669.887	183.182	31.701	32.4993	25.5163	447.965	3

Two-way randomization tests

Dependent variable	ANCOVA covariate	transect code	fraction exceeding base SS for interact.	fraction exceeding base SS for oilcode	fraction exceeding base SS for year	fraction exceeding base SS for pair	number of randomization tests
sdf	mud	1	0.969	0.027	0.028	0.879	1000
ssdf	mud	1	0.878	0.830	0.231	0.847	1000
ps	mud	1	0.999	0.082	0.306	0.705	1000
herb	mud	1	0.794	0.085	0.008	0.093	1000
sf	mud	1	0.795	0.098	0.083	0.735	1000

One-way randomization tests

Dependent variable	1990	1991	1993	1995
sdf				
ssdf				
ps				
herb				
sf				

1990 to 1995 Site Means

YEAR	SITENUM	OILCODE	SDFMEAN	SSDFMEAN	PSMEAN	HERBMEAN	SFMEAN	SDFSE	SSDFSE	PSSE	HERBSE	SFSE	NSTATNS
1990	13	O	52.265	38.82	108.410	35.192	476.27	9.731	12.813	13.100	6.536	236.128	3
1990	14	C	18.650	28.34	56.405	17.595	83.35	2.199	13.882	16.385	2.194	11.149	3
1990	16	O	182.953	225.18	375.055	151.120	687.34	56.958	14.854	87.960	46.099	94.634	3
1990	15	C	36.303	38.76	129.823	32.538	210.73	5.651	16.711	24.177	3.994	33.930	3
1990	17	O	547.610	329.87	334.050	192.363	1185.00	58.332	51.713	31.818	33.914	325.851	3
1990	18	C	425.868	228.25	306.523	129.452	344.91	101.342	111.236	39.788	24.419	97.986	3
1991	13	O	376.222	264.15	254.807	342.662	790.70	143.467	110.314	73.737	196.282	346.548	3
1991	14	C	83.380	253.77	451.770	132.195	208.80	6.680	135.669	50.392	18.660	60.407	3
1991	16	O	242.192	525.74	501.840	248.477	1111.41	28.760	119.516	129.481	54.790	525.139	3
1991	15	C	177.475	191.91	438.495	158.023	535.39	24.359	39.518	61.843	37.825	85.884	3
1991	17	O	452.055	707.80	258.690	122.883	1674.62	132.551	354.780	63.634	35.607	335.515	3
1991	18	C	854.688	1336.14	748.385	462.130	652.14	226.685	607.582	37.163	143.034	168.995	3
1993	13	O	115.319	154.378	328.59	111.855	536.01	36.668	75.235	166.593	48.422	202.60	3
1993	14	C	145.582	363.172	497.97	124.913	306.54	58.118	53.951	199.058	32.643	53.16	3
1993	16	O	394.600	722.975	833.74	309.752	2263.06	46.573	168.847	150.847	43.634	938.07	3
1993	15	C	116.960	90.552	298.51	97.492	210.08	22.046	14.263	56.433	17.998	53.24	3
1993	17	O	303.828	668.072	1005.95	353.785	1747.72	110.976	209.862	328.591	117.143	527.14	3
1993	18	C	277.305	132.012	294.32	101.190	233.94	43.696	18.951	66.038	37.685	45.31	3
1995	13	O	191.077	38.368	242.33	88.805	721.55	128.860	8.868	27.671	26.661	306.65	3
1995	14	C	58.717	12.488	288.31	111.387	242.04	18.490	6.221	41.468	18.836	27.81	3
1995	16	O	237.483	94.793	517.44	243.882	1798.24	41.397	14.636	59.345	59.576	311.04	3
1995	15	C	48.552	5.253	295.46	199.573	2760.45	2.969	1.267	41.269	25.399	1045.31	3
1995	17	O	523.940	257.485	413.48	169.757	1214.10	43.711	89.613	80.089	21.339	657.52	3
1995	18	C	441.288	34.078	249.19	65.707	132.55	77.970	8.277	57.591	12.956	13.70	3

1990 to 1995 Means by Oilcode and Depth

YEAR	OILCODE	SDFMEAN	SSDFMEAN	PSMEAN	HERBMEAN	SFMEAN	SDFSE	SSDFSE	PSSE	HERBSE	SFSE	NSITES
1990	C	160.274	98.448	164.251	59.862	213.00	132.895	64.968	74.227	35.061	75.514	3
1990	O	260.943	197.954	272.505	126.225	782.87	148.215	85.115	82.897	47.048	210.093	3
1991	C	371.848	593.940	546.217	250.783	465.44	242.944	371.529	101.157	105.936	132.675	3
1991	O	356.823	499.227	338.446	238.007	1192.24	61.354	128.756	81.705	63.660	258.346	3
1993	C	179.949	195.245	363.598	107.865	250.19	49.374	84.812	67.197	8.591	29.005	3
1993	O	271.249	515.142	722.762	258.464	1515.60	82.251	181.077	203.258	74.398	511.888	3
1995	C	182.852	17.273	277.651	125.556	1045.01	129.251	8.658	14.380	39.288	858.303	3
1995	O	317.500	130.216	391.085	167.481	1244.63	104.086	65.686	80.203	44.781	311.188	3

Two-way randomization tests

Dependent variable	ANCOVA covariate	transect code	fraction exceeding base SS for interact.	fraction exceeding base SS for oilcode	fraction exceeding base SS for year	fraction exceeding base SS for pair	number of randomization tests
sdf	mud	3	0.747	0.059	0.478	0.045	1000
ssdf	mud	3	0.408	0.033	0.059	0.06	1000
ps	mud	3	0.050	0.046	0.418	0.998	1000
herb	mud	3	0.191	0.020	0.626	0.924	1000
sf	mud	3	0.463	0.031	0.508	0.734	1000

One-way randomization tests

Dependent variable	1990	1991	1993	1995
sdf				
ssdf				
ps				
herb				
sf				

Appendix P.

Mean densities (No. 0.1 m^{-2}) of infauna and epifauna from samples collected with a diver-operated suction dredge.

Appendix P. Mean densities (No.100 m^{-2}) of infauna and epifauna from samples collected with a diver operated suction dredge.

Taxa = AMPHARETIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	AMPHARETIDAE	0.0000	0.0000	3
1990	14	C	AMPHARETIDAE	6.6667	2.6667	3
1990	16	O	AMPHARETIDAE	3.5567	2.3516	3
1990	15	C	AMPHARETIDAE	10.0000	6.0622	3
1990	17	O	AMPHARETIDAE	1.6667	1.6667	3
1990	18	C	AMPHARETIDAE	0.0000	0.0000	3
1991	13	O	AMPHARETIDAE	10.1567	10.1567	3
1991	14	C	AMPHARETIDAE	40.6117	24.3826	3
1991	16	O	AMPHARETIDAE	11.3333	1.7638	3
1991	15	C	AMPHARETIDAE	86.2317	70.9105	3
1991	17	O	AMPHARETIDAE	0.8883	0.8883	3
1991	18	C	AMPHARETIDAE	9.3333	5.8119	3
1993	13	O	AMPHARETIDAE	22.3883	6.8264	3
1993	14	C	AMPHARETIDAE	5.3333	3.5277	3
1993	16	O	AMPHARETIDAE	18.2217	6.2217	3
1993	15	C	AMPHARETIDAE	48.9783	12.1395	3
1993	17	O	AMPHARETIDAE	53.3333	5.8119	3
1993	18	C	AMPHARETIDAE	12.0000	1.3229	3
1995	13	O	AMPHARETIDAE	45.1100	34.7780	3
1995	14	C	AMPHARETIDAE	12.9783	4.1607	3
1995	16	O	AMPHARETIDAE	52.6350	32.3201	3
1995	15	C	AMPHARETIDAE	7.6667	6.1734	3
1995	17	O	AMPHARETIDAE	59.1117	15.4029	3
1995	18	C	AMPHARETIDAE	30.5000	12.8970	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	AMPHARETIDAE	1.7411	1.0274	3
1990	C	AMPHARETIDAE	5.5556	2.9397	3
1991	O	AMPHARETIDAE	7.4594	3.3031	3
1991	C	AMPHARETIDAE	45.3922	22.3270	3
1993	O	AMPHARETIDAE	31.3144	11.0750	3
1993	C	AMPHARETIDAE	22.1039	13.5743	3
1995	O	AMPHARETIDAE	52.2856	4.0457	3
1995	C	AMPHARETIDAE	17.0483	6.8984	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.089
1991	0.911
1993	0.130
1995	0.345

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.246	0.577	0.147

Taxa = AMPHICTENIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	AMPHICTENIDAE	0.0000	0.0000	3
1990	14	C	AMPHICTENIDAE	14.0000	11.1355	3
1990	16	O	AMPHICTENIDAE	8.8883	3.8750	3
1990	15	C	AMPHICTENIDAE	6.3333	4.0961	3
1990	17	O	AMPHICTENIDAE	17.9050	2.9937	3
1990	18	C	AMPHICTENIDAE	18.0450	9.2325	3
1991	13	O	AMPHICTENIDAE	6.2217	6.2217	3
1991	14	C	AMPHICTENIDAE	21.5550	0.8008	3
1991	16	O	AMPHICTENIDAE	6.0000	3.0551	3
1991	15	C	AMPHICTENIDAE	7.7150	7.1501	3
1991	17	O	AMPHICTENIDAE	81.3333	55.3454	3
1991	18	C	AMPHICTENIDAE	32.0000	4.6188	3
1993	13	O	AMPHICTENIDAE	18.1667	11.2080	3
1993	14	C	AMPHICTENIDAE	15.7783	6.1138	3
1993	16	O	AMPHICTENIDAE	32.8900	19.0170	3
1993	15	C	AMPHICTENIDAE	13.7133	3.8108	3
1993	17	O	AMPHICTENIDAE	34.6667	10.9138	3
1993	18	C	AMPHICTENIDAE	37.8333	27.3470	3
1995	13	O	AMPHICTENIDAE	1.6300	1.2125	3
1995	14	C	AMPHICTENIDAE	26.0450	15.9756	3
1995	16	O	AMPHICTENIDAE	2.6033	1.4856	3
1995	15	C	AMPHICTENIDAE	1.8333	1.0929	3
1995	17	O	AMPHICTENIDAE	36.0000	6.8431	3
1995	18	C	AMPHICTENIDAE	2.1667	0.3333	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	AMPHICTENIDAE	8.9311	5.1688	3
1990	C	AMPHICTENIDAE	12.7928	3.4343	3
1991	O	AMPHICTENIDAE	31.1850	25.0742	3
1991	C	AMPHICTENIDAE	20.4233	7.0333	3
1993	O	AMPHICTENIDAE	28.5744	5.2291	3
1993	C	AMPHICTENIDAE	22.4417	7.7189	3
1995	O	AMPHICTENIDAE	13.4111	11.2979	3
1995	C	AMPHICTENIDAE	10.0150	8.0156	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.014
1991	0.707
1993	0.309
1995	0.105

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.964	0.146	0.494

Taxa = CAPITELLIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	CAPITELLIDAE	0.0000	0.0000	3
1990	14	C	CAPITELLIDAE	17.3333	11.3920	3
1990	16	O	CAPITELLIDAE	12.4450	2.3519	3
1990	15	C	CAPITELLIDAE	8.0000	4.0104	3
1990	17	O	CAPITELLIDAE	7.0483	0.9517	3
1990	18	C	CAPITELLIDAE	5.9550	0.9896	3
1991	13	O	CAPITELLIDAE	5.1550	3.8991	3
1991	14	C	CAPITELLIDAE	6.8883	1.7356	3
1991	16	O	CAPITELLIDAE	54.6667	5.8119	3
1991	15	C	CAPITELLIDAE	6.8900	2.1876	3
1991	17	O	CAPITELLIDAE	13.3333	7.4237	3
1991	18	C	CAPITELLIDAE	96.8333	84.8333	3
1993	13	O	CAPITELLIDAE	0.0000	0.0000	3
1993	14	C	CAPITELLIDAE	84.6667	59.6695	3
1993	16	O	CAPITELLIDAE	62.6667	15.7198	3
1993	15	C	CAPITELLIDAE	35.2700	14.7449	3
1993	17	O	CAPITELLIDAE	63.3333	39.4011	3
1993	18	C	CAPITELLIDAE	13.5000	7.7621	3
1995	13	O	CAPITELLIDAE	3.1117	3.1117	3
1995	14	C	CAPITELLIDAE	38.3117	13.7792	3
1995	16	O	CAPITELLIDAE	32.1267	10.7163	3
1995	15	C	CAPITELLIDAE	14.5000	12.7508	3
1995	17	O	CAPITELLIDAE	20.8900	11.1638	3
1995	18	C	CAPITELLIDAE	3.6667	0.1667	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	CAPITELLIDAE	6.4978	3.6031	3
1990	C	CAPITELLIDAE	10.4294	3.5021	3
1991	O	CAPITELLIDAE	24.3850	15.3238	3
1991	C	CAPITELLIDAE	36.8706	29.9814	3
1993	O	CAPITELLIDAE	42.0000	21.0009	3
1993	C	CAPITELLIDAE	44.4789	21.0537	3
1995	O	CAPITELLIDAE	18.7094	8.4466	3
1995	C	CAPITELLIDAE	18.8261	10.2324	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.267
1991	0.406
1993	0.069
1995	0.338

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.195	0.821	0.137

Taxa = LUMBRINERIDAE
DEPTH STRATUM = 6 to 20 M

Means by Year and Site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	LUMBRINERIDAE	0.1667	0.1667	3
1990	14	C	LUMBRINERIDAE	42.8333	19.3139	3
1990	16	O	LUMBRINERIDAE	13.6667	7.0257	3
1990	15	C	LUMBRINERIDAE	4.8333	1.7401	3
1990	17	O	LUMBRINERIDAE	0.7150	0.3599	3
1990	18	C	LUMBRINERIDAE	2.4883	1.3885	3
1991	13	O	LUMBRINERIDAE	0.0000	0.0000	3
1991	14	C	LUMBRINERIDAE	5.7783	1.1758	3
1991	16	O	LUMBRINERIDAE	23.3333	4.0552	3
1991	15	C	LUMBRINERIDAE	14.2883	6.8637	3
1991	17	O	LUMBRINERIDAE	0.0000	0.0000	3
1991	18	C	LUMBRINERIDAE	4.6667	0.6667	3
1993	13	O	LUMBRINERIDAE	0.1667	0.1667	3
1993	14	C	LUMBRINERIDAE	21.5550	12.6739	3
1993	16	O	LUMBRINERIDAE	14.2217	14.2217	3
1993	15	C	LUMBRINERIDAE	16.3017	7.1896	3
1993	17	O	LUMBRINERIDAE	7.3333	2.4037	3
1993	18	C	LUMBRINERIDAE	11.0000	3.0139	3
1995	13	O	LUMBRINERIDAE	0.0000	0.0000	3
1995	14	C	LUMBRINERIDAE	25.8667	13.9816	3
1995	16	O	LUMBRINERIDAE	14.0967	5.1787	3
1995	15	C	LUMBRINERIDAE	21.3333	8.5163	3
1995	17	O	LUMBRINERIDAE	1.7783	1.1758	3
1995	18	C	LUMBRINERIDAE	6.3333	0.6009	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	LUMBRINERIDAE	4.8494	4.4115	3
1990	C	LUMBRINERIDAE	16.7183	13.0750	3
1991	O	LUMBRINERIDAE	7.7778	7.7778	3
1991	C	LUMBRINERIDAE	8.2444	3.0389	3
1993	O	LUMBRINERIDAE	7.2406	4.0576	3
1993	C	LUMBRINERIDAE	16.2856	3.0470	3
1995	O	LUMBRINERIDAE	5.2917	4.4323	3
1995	C	LUMBRINERIDAE	17.8444	5.9025	3

One-way randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.35
1991	0.86
1993	0.18
1995	0.09

Two-way randomized within blocks with %mud as covariate

Interaction	Oilcode	Year
0.417	0.907	0.632

Taxa = MALDANIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	MALDANIDAE	0.0000	0.0000	3
1990	14	C	MALDANIDAE	11.5000	7.1122	3
1990	16	O	MALDANIDAE	7.1117	3.6381	3
1990	15	C	MALDANIDAE	0.0000	0.0000	3
1990	17	O	MALDANIDAE	10.1900	6.9447	3
1990	18	C	MALDANIDAE	0.0000	0.0000	3
1991	13	O	MALDANIDAE	0.0000	0.0000	3
1991	14	C	MALDANIDAE	3.3333	2.4037	3
1991	16	O	MALDANIDAE	13.3333	5.3333	3
1991	15	C	MALDANIDAE	11.1750	9.4135	3
1991	17	O	MALDANIDAE	35.7783	6.3044	3
1991	18	C	MALDANIDAE	4.0000	2.3094	3
1993	13	O	MALDANIDAE	0.0000	0.0000	3
1993	14	C	MALDANIDAE	41.1117	12.0138	3
1993	16	O	MALDANIDAE	6.2217	3.2045	3
1993	15	C	MALDANIDAE	9.4950	1.7803	3
1993	17	O	MALDANIDAE	17.3333	7.4237	3
1993	18	C	MALDANIDAE	1.8333	1.3642	3
1995	13	O	MALDANIDAE	0.0000	0.0000	3
1995	14	C	MALDANIDAE	46.1333	21.6707	3
1995	16	O	MALDANIDAE	28.0000	26.8656	3
1995	15	C	MALDANIDAE	1.0000	1.0000	3
1995	17	O	MALDANIDAE	39.1100	7.5550	3
1995	18	C	MALDANIDAE	1.6667	1.0138	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	MALDANIDAE	5.7672	3.0174	3
1990	C	MALDANIDAE	3.8333	3.8333	3
1991	O	MALDANIDAE	16.3706	10.4394	3
1991	C	MALDANIDAE	6.1694	2.5102	3
1993	O	MALDANIDAE	7.8517	5.0696	3
1993	C	MALDANIDAE	17.4800	12.0211	3
1995	O	MALDANIDAE	22.3700	11.6357	3
1995	C	MALDANIDAE	16.2667	14.9346	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.153
1991	0.090
1993	0.952
1995	0.363

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.617	0.010	0.652

Taxa = NEPHTYIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	NEPHTYIDAE	188.0000	30.3150	3
1990	14	C	NEPHTYIDAE	0.0000	0.0000	3
1990	16	O	NEPHTYIDAE	0.0000	0.0000	3
1990	15	C	NEPHTYIDAE	2.8333	1.4240	3
1990	17	O	NEPHTYIDAE	2.0000	1.1547	3
1990	18	C	NEPHTYIDAE	2.6667	1.3333	3
1991	13	O	NEPHTYIDAE	168.2933	69.1111	3
1991	14	C	NEPHTYIDAE	2.6667	1.3333	3
1991	16	O	NEPHTYIDAE	0.0000	0.0000	3
1991	15	C	NEPHTYIDAE	2.6033	1.3028	3
1991	17	O	NEPHTYIDAE	0.8333	0.6009	3
1991	18	C	NEPHTYIDAE	4.8333	1.7401	3
1993	13	O	NEPHTYIDAE	139.8333	17.5697	3
1993	14	C	NEPHTYIDAE	0.6667	0.6667	3
1993	16	O	NEPHTYIDAE	0.0000	0.0000	3
1993	15	C	NEPHTYIDAE	0.0000	0.0000	3
1993	17	O	NEPHTYIDAE	4.6667	3.7118	3
1993	18	C	NEPHTYIDAE	6.6667	1.0138	3
1995	13	O	NEPHTYIDAE	97.5933	59.1320	3
1995	14	C	NEPHTYIDAE	10.6667	5.3333	3
1995	16	O	NEPHTYIDAE	2.0967	2.0967	3
1995	15	C	NEPHTYIDAE	0.0000	0.0000	3
1995	17	O	NEPHTYIDAE	4.0000	3.3547	3
1995	18	C	NEPHTYIDAE	0.8333	0.1667	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	NEPHTYIDAE	63.3333	62.3360	3
1990	C	NEPHTYIDAE	1.8333	0.9179	3
1991	O	NEPHTYIDAE	56.3756	55.9594	3
1991	C	NEPHTYIDAE	3.3678	0.7330	3
1993	O	NEPHTYIDAE	48.1667	45.8531	3
1993	C	NEPHTYIDAE	2.4444	2.1199	3
1995	O	NEPHTYIDAE	34.5633	31.5198	3
1995	C	NEPHTYIDAE	3.8333	3.4251	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.410
1991	0.591
1993	0.319
1995	0.908

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.947	0.091	0.967

Taxa = OPHELIIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	OPHELIIDAE	4.0000	0.0000	3
1990	14	C	OPHELIIDAE	68.1667	37.3010	3
1990	16	O	OPHELIIDAE	36.0000	34.0196	3
1990	15	C	OPHELIIDAE	36.6667	14.8052	3
1990	17	O	OPHELIIDAE	32.0483	8.9344	3
1990	18	C	OPHELIIDAE	116.8883	36.9611	3
1991	13	O	OPHELIIDAE	47.1367	22.9110	3
1991	14	C	OPHELIIDAE	8.8883	5.5692	3
1991	16	O	OPHELIIDAE	8.0000	8.0000	3
1991	15	C	OPHELIIDAE	18.3517	13.2153	3
1991	17	O	OPHELIIDAE	84.4433	50.5635	3
1991	18	C	OPHELIIDAE	505.5000	252.3574	3
1993	13	O	OPHELIIDAE	49.1117	11.9407	3
1993	14	C	OPHELIIDAE	997.1117	503.8182	3
1993	16	O	OPHELIIDAE	153.3333	108.3533	3
1993	15	C	OPHELIIDAE	233.7517	15.9099	3
1993	17	O	OPHELIIDAE	64.0000	38.5746	3
1993	18	C	OPHELIIDAE	114.8333	57.1987	3
1995	13	O	OPHELIIDAE	0.2967	0.2967	3
1995	14	C	OPHELIIDAE	7.5550	5.6737	3
1995	16	O	OPHELIIDAE	1.3333	1.3333	3
1995	15	C	OPHELIIDAE	0.0000	0.0000	3
1995	17	O	OPHELIIDAE	4.4467	0.4442	3
1995	18	C	OPHELIIDAE	1.3333	0.4410	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	OPHELIIDAE	24.0161	10.0729	3
1990	C	OPHELIIDAE	73.9072	23.3352	3
1991	O	OPHELIIDAE	46.5267	22.0694	3
1991	C	OPHELIIDAE	177.5800	163.9828	3
1993	O	OPHELIIDAE	88.8150	32.5442	3
1993	C	OPHELIIDAE	448.5656	276.4130	3
1995	O	OPHELIIDAE	2.0256	1.2470	3
1995	C	OPHELIIDAE	2.9628	2.3281	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.716
1991	0.257
1993	0.693
1995	0.011

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.883	0.769	0.228

Taxa = ORBINIIDAE
Depth Stratum = 6 to 20 M

YEAR	SITE NUMBER	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	ORBINIIDAE	0.0000	0.0000	3
1990	14	C	ORBINIIDAE	5.3333	2.6667	3
1990	16	O	ORBINIIDAE	8.1683	4.4752	3
1990	15	C	ORBINIIDAE	0.6667	0.6667	3
1990	17	O	ORBINIIDAE	1.5000	1.2583	3
1990	18	C	ORBINIIDAE	41.5983	13.3243	3
1991	13	O	ORBINIIDAE	0.0000	0.0000	3
1991	14	C	ORBINIIDAE	8.0000	4.0000	3
1991	16	O	ORBINIIDAE	7.3333	4.0552	3
1991	15	C	ORBINIIDAE	3.8417	1.2942	3
1991	17	O	ORBINIIDAE	3.3333	2.4037	3
1991	18	C	ORBINIIDAE	26.1667	1.1667	3
1993	13	O	ORBINIIDAE	0.0000	0.0000	3
1993	14	C	ORBINIIDAE	22.0000	5.0332	3
1993	16	O	ORBINIIDAE	8.0017	6.1096	3
1993	15	C	ORBINIIDAE	5.9917	1.4629	3
1993	17	O	ORBINIIDAE	2.6667	2.6667	3
1993	18	C	ORBINIIDAE	41.3333	3.0596	3
1995	13	O	ORBINIIDAE	0.0000	0.0000	3
1995	14	C	ORBINIIDAE	21.6883	7.6836	3
1995	16	O	ORBINIIDAE	5.5883	2.8029	3
1995	15	C	ORBINIIDAE	7.5000	6.2915	3
1995	17	O	ORBINIIDAE	4.8883	2.4744	3
1995	18	C	ORBINIIDAE	24.6667	0.1667	3

Means by year and oiling categoy

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	ORBINIIDAE	3.2228	2.5104	3
1990	C	ORBINIIDAE	15.8661	12.9364	3
1991	O	ORBINIIDAE	3.5556	2.1199	3
1991	C	ORBINIIDAE	12.6694	6.8545	3
1993	O	ORBINIIDAE	3.5561	2.3523	3
1993	C	ORBINIIDAE	23.1083	10.2173	3
1995	O	ORBINIIDAE	3.4922	1.7578	3
1995	C	ORBINIIDAE	17.9517	5.2961	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.02
1991	0.07
1993	0.02
1995	0.02

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.93	0.51	0.73

Taxa = SABELLIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	SABELLIDAE	0.0000	0.0000	3
1990	14	C	SABELLIDAE	2.6667	2.6667	3
1990	16	O	SABELLIDAE	6.2217	1.1758	3
1990	15	C	SABELLIDAE	0.0000	0.0000	3
1990	17	O	SABELLIDAE	2.2633	1.0105	3
1990	18	C	SABELLIDAE	2.2217	2.2217	3
1991	13	O	SABELLIDAE	0.0000	0.0000	3
1991	14	C	SABELLIDAE	3.3333	1.7638	3
1991	16	O	SABELLIDAE	34.6667	14.1107	3
1991	15	C	SABELLIDAE	1.3333	1.3333	3
1991	17	O	SABELLIDAE	41.3333	41.3333	3
1991	18	C	SABELLIDAE	1.3333	1.3333	3
1993	13	O	SABELLIDAE	0.0000	0.0000	3
1993	14	C	SABELLIDAE	6.0000	3.4641	3
1993	16	O	SABELLIDAE	18.6667	10.4137	3
1993	15	C	SABELLIDAE	10.3167	3.1124	3
1993	17	O	SABELLIDAE	30.0000	23.0651	3
1993	18	C	SABELLIDAE	9.8333	2.1667	3
1995	13	O	SABELLIDAE	0.0000	0.0000	3
1995	14	C	SABELLIDAE	2.2217	2.2217	3
1995	16	O	SABELLIDAE	10.6667	1.3733	3
1995	15	C	SABELLIDAE	0.0000	0.0000	3
1995	17	O	SABELLIDAE	218.2200	130.1713	3
1995	18	C	SABELLIDAE	5.8333	2.5874	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	SABELLIDAE	2.8283	1.8181	3
1990	C	SABELLIDAE	1.6294	0.8248	3
1991	O	SABELLIDAE	25.3333	12.8120	3
1991	C	SABELLIDAE	2.0000	0.6667	3
1993	O	SABELLIDAE	16.2222	8.7461	3
1993	C	SABELLIDAE	8.7167	1.3655	3
1995	O	SABELLIDAE	76.2956	71.0290	3
1995	C	SABELLIDAE	2.6850	1.6998	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.032
1991	0.227
1993	0.748
1995	0.938

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.786	0.499	0.672

Taxa = SIGALIONIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	SIGALIONIDAE	0.0000	0.0000	3
1990	14	C	SIGALIONIDAE	4.6667	0.6667	3
1990	16	O	SIGALIONIDAE	6.6667	3.5277	3
1990	15	C	SIGALIONIDAE	21.6667	20.1687	3
1990	17	O	SIGALIONIDAE	0.3333	0.3333	3
1990	18	C	SIGALIONIDAE	0.0000	0.0000	3
1991	13	O	SIGALIONIDAE	0.0000	0.0000	3
1991	14	C	SIGALIONIDAE	0.8883	0.8883	3
1991	16	O	SIGALIONIDAE	56.666	14.2517	3
1991	15	C	SIGALIONIDAE	121.3767	65.2342	3
1991	17	O	SIGALIONIDAE	1.3333	1.3333	3
1991	18	C	SIGALIONIDAE	12.6667	10.7290	3
1993	13	O	SIGALIONIDAE	0.00	0.0000	3
1993	14	C	SIGALIONIDAE	13.5550	7.6434	3
1993	16	O	SIGALIONIDAE	84.0000	42.3950	3
1993	15	C	SIGALIONIDAE	78.1900	24.9543	3
1993	17	O	SIGALIONIDAE	0.0000	0.0000	3
1993	18	C	SIGALIONIDAE	6.0000	0.5774	3
1995	13	O	SIGALIONIDAE	93.7783	79.5628	3
1995	14	C	SIGALIONIDAE	21.8667	11.4667	3
1995	16	O	SIGALIONIDAE	36.8250	19.9052	3
1995	15	C	SIGALIONIDAE	131.8333	112.2105	3
1995	17	O	SIGALIONIDAE	4.4450	2.3519	3
1995	18	C	SIGALIONIDAE	1.3333	0.3333	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	SIGALIONIDAE	2.3333	2.1688	3
1990	C	SIGALIONIDAE	8.7778	6.5837	3
1991	O	SIGALIONIDAE	19.3333	18.6706	3
1991	C	SIGALIONIDAE	44.9772	38.3507	3
1993	O	SIGALIONIDAE	28.0000	28.0000	3
1993	C	SIGALIONIDAE	32.5817	22.9082	3
1995	O	SIGALIONIDAE	45.0161	26.1115	3
1995	C	SIGALIONIDAE	51.6778	40.5137	3

One-way Randomized with blocks with %mud as covariate

YEAR	P oil code
1990	0.000
1991	0.811
1993	1.000
1995	0.511

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.573	0.602	0.389

Taxa = SPIONIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	SPIONIDAE	0.0000	0.0000	3
1990	14	C	SPIONIDAE	77.1667	23.0585	3
1990	16	O	SPIONIDAE	62.8350	36.6961	3
1990	15	C	SPIONIDAE	36.8333	11.5698	3
1990	17	O	SPIONIDAE	177.4767	28.7040	3
1990	18	C	SPIONIDAE	144.3550	50.7299	3
1991	13	O	SPIONIDAE	2.1583	2.1583	3
1991	14	C	SPIONIDAE	247.9433	109.3836	3
1991	16	O	SPIONIDAE	78.0000	27.3008	3
1991	15	C	SPIONIDAE	37.7283	10.6377	3
1991	17	O	SPIONIDAE	542.2217	201.6145	3
1991	18	C	SPIONIDAE	81.1667	31.3692	3
1993	13	O	SPIONIDAE	11.7767	5.8915	3
1993	14	C	SPIONIDAE	272.6650	121.2414	3
1993	16	O	SPIONIDAE	312.4433	162.7229	3
1993	15	C	SPIONIDAE	123.4967	40.3546	3
1993	17	O	SPIONIDAE	423.3333	102.2046	3
1993	18	C	SPIONIDAE	202.3333	62.3139	3
1995	13	O	SPIONIDAE	11.1133	5.5699	3
1995	14	C	SPIONIDAE	226.8450	11.8021	3
1995	16	O	SPIONIDAE	42.2883	29.7151	3
1995	15	C	SPIONIDAE	81.8333	63.0875	3
1995	17	O	SPIONIDAE	582.2200	124.8899	3
1995	18	C	SPIONIDAE	48.5000	1.5000	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	SPIONIDAE	80.1039	51.9556	3
1990	C	SPIONIDAE	86.1183	31.3599	3
1991	O	SPIONIDAE	207.4600	168.8066	3
1991	C	SPIONIDAE	122.2794	64.0710	3
1993	O	SPIONIDAE	249.1844	122.9444	3
1993	C	SPIONIDAE	199.4983	43.0845	3
1995	O	SPIONIDAE	211.8739	185.3916	3
1995	C	SPIONIDAE	119.0594	54.7451	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.730
1991	0.080
1993	0.174
1995	1.000

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.794	0.020	0.130

Taxa = SYLLIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	SYLLIDAE	0.0000	0.0000	3
1990	14	C	SYLLIDAE	8.6667	5.6960	3
1990	16	O	SYLLIDAE	8.4450	1.9368	3
1990	15	C	SYLLIDAE	4.6667	4.6667	3
1990	17	O	SYLLIDAE	66.8333	19.1841	3
1990	18	C	SYLLIDAE	1.3333	1.3333	3
1991	13	O	SYLLIDAE	0.8883	0.8883	3
1991	14	C	SYLLIDAE	4.0000	2.3094	3
1991	16	O	SYLLIDAE	30.6667	14.6667	3
1991	15	C	SYLLIDAE	13.6517	11.2653	3
1991	17	O	SYLLIDAE	206.8883	63.7518	3
1991	18	C	SYLLIDAE	19.1667	9.2391	3
1993	13	O	SYLLIDAE	0.0000	0.0000	3
1993	14	C	SYLLIDAE	86.8883	76.6837	3
1993	16	O	SYLLIDAE	79.1117	44.7696	3
1993	15	C	SYLLIDAE	13.8600	1.8262	3
1993	17	O	SYLLIDAE	125.3333	38.1109	3
1993	18	C	SYLLIDAE	4.0000	2.0817	3
1995	13	O	SYLLIDAE	1.7767	0.8883	3
1995	14	C	SYLLIDAE	33.6000	12.4964	3
1995	16	O	SYLLIDAE	16.7633	10.2231	3
1995	15	C	SYLLIDAE	5.5000	5.2520	3
1995	17	O	SYLLIDAE	371.1117	154.6755	3
1995	18	C	SYLLIDAE	16.5000	4.0723	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	SYLLIDAE	25.0928	21.0122	3
1990	C	SYLLIDAE	4.8889	2.1199	3
1991	O	SYLLIDAE	79.4811	64.2810	3
1991	C	SYLLIDAE	12.2728	4.4322	3
1993	O	SYLLIDAE	68.1483	36.5935	3
1993	C	SYLLIDAE	34.9161	26.1415	3
1995	O	SYLLIDAE	129.8839	120.6915	3
1995	C	SYLLIDAE	18.5333	8.1752	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.179
1991	0.098
1993	0.051
1995	0.984

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.891	0.039	0.621

Taxa = LUCINIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	LUCINIDAE	0.0000	0.0000	3
1990	14	C	LUCINIDAE	58.6667	45.3921	3
1990	16	O	LUCINIDAE	132.4450	100.3999	3
1990	15	C	LUCINIDAE	7.5000	5.8381	3
1990	17	O	LUCINIDAE	10.7150	4.4007	3
1990	18	C	LUCINIDAE	88.8000	45.7891	3
1991	13	O	LUCINIDAE	5.7150	5.7150	3
1991	14	C	LUCINIDAE	407.5550	95.0711	3
1991	16	O	LUCINIDAE	33.3333	17.4865	3
1991	15	C	LUCINIDAE	12.1933	5.9853	3
1991	17	O	LUCINIDAE	14.2217	5.1253	3
1991	18	C	LUCINIDAE	90.0000	24.0278	3
1993	13	O	LUCINIDAE	15.5550	15.5550	3
1993	14	C	LUCINIDAE	429.1117	131.2986	3
1993	16	O	LUCINIDAE	126.6667	77.7117	3
1993	15	C	LUCINIDAE	162.4633	19.3904	3
1993	17	O	LUCINIDAE	29.3333	12.7192	3
1993	18	C	LUCINIDAE	108.1667	43.8941	3
1995	13	O	LUCINIDAE	13.9267	11.7743	3
1995	14	C	LUCINIDAE	286.4883	208.2347	3
1995	16	O	LUCINIDAE	57.0783	27.9718	3
1995	15	C	LUCINIDAE	64.6667	46.4806	3
1995	17	O	LUCINIDAE	28.4450	18.7675	3
1995	18	C	LUCINIDAE	25.3333	17.3357	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	LUCINIDAE	47.7200	42.4753	3
1990	C	LUCINIDAE	51.6556	23.7297	3
1991	O	LUCINIDAE	17.7567	8.1663	3
1991	C	LUCINIDAE	169.9161	120.9237	3
1993	O	LUCINIDAE	57.1850	34.9678	3
1993	C	LUCINIDAE	233.2472	99.1786	3
1995	O	LUCINIDAE	33.1500	12.6770	3
1995	C	LUCINIDAE	125.4961	81.2930	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.775
1991	0.648
1993	0.700
1995	0.409

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.229	0.674	0.039

Taxa = MONTACUTIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	MONTACUTIDAE	13.0000	10.0167	3
1990	14	C	MONTACUTIDAE	17.3333	9.3333	3
1990	16	O	MONTACUTIDAE	4.0000	2.3094	3
1990	15	C	MONTACUTIDAE	0.0000	0.0000	3
1990	17	O	MONTACUTIDAE	24.2850	3.7137	3
1990	18	C	MONTACUTIDAE	4.4450	4.4450	3
1991	13	O	MONTACUTIDAE	21.4600	20.1422	3
1991	14	C	MONTACUTIDAE	53.1117	18.0953	3
1991	16	O	MONTACUTIDAE	0.6667	0.6667	3
1991	15	C	MONTACUTIDAE	0.0000	0.0000	3
1991	17	O	MONTACUTIDAE	22.2217	3.9508	3
1991	18	C	MONTACUTIDAE	12.0000	6.9282	3
1993	13	O	MONTACUTIDAE	2.6117	1.5411	3
1993	14	C	MONTACUTIDAE	178.4450	23.1458	3
1993	16	O	MONTACUTIDAE	32.0000	19.7315	3
1993	15	C	MONTACUTIDAE	10.6283	5.3996	3
1993	17	O	MONTACUTIDAE	12.6667	7.8599	3
1993	18	C	MONTACUTIDAE	8.0000	3.7528	3
1995	13	O	MONTACUTIDAE	76.4450	51.0710	3
1995	14	C	MONTACUTIDAE	83.2883	45.9816	3
1995	16	O	MONTACUTIDAE	5.6500	2.3493	3
1995	15	C	MONTACUTIDAE	4.0000	4.0000	3
1995	17	O	MONTACUTIDAE	33.3333	1.5401	3
1995	18	C	MONTACUTIDAE	6.8333	4.1466	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	MONTACUTIDAE	13.7617	5.8681	3
1990	C	MONTACUTIDAE	7.2594	5.1978	3
1991	O	MONTACUTIDAE	14.7828	7.0615	3
1991	C	MONTACUTIDAE	21.7039	16.0814	3
1993	O	MONTACUTIDAE	15.7594	8.6235	3
1993	C	MONTACUTIDAE	65.6911	56.3820	3
1995	O	MONTACUTIDAE	38.4761	20.5979	3
1995	C	MONTACUTIDAE	31.3739	25.9701	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.200
1991	0.689
1993	0.227
1995	0.443

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.261	0.016	0.189

Taxa = TELLINIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	TELLINIDAE	0.0000	0.0000	3
1990	14	C	TELLINIDAE	4.8333	3.6553	3
1990	16	O	TELLINIDAE	0.0000	0.0000	3
1990	15	C	TELLINIDAE	0.0000	0.0000	3
1990	17	O	TELLINIDAE	17.6433	4.2801	3
1990	18	C	TELLINIDAE	238.6683	103.3162	3
1991	13	O	TELLINIDAE	1.5233	1.5233	3
1991	14	C	TELLINIDAE	122.3883	27.6951	3
1991	16	O	TELLINIDAE	5.3333	1.3333	3
1991	15	C	TELLINIDAE	0.0000	0.0000	3
1991	17	O	TELLINIDAE	8.4450	6.5476	3
1991	18	C	TELLINIDAE	91.3333	27.8648	3
1993	13	O	TELLINIDAE	9.1117	0.5880	3
1993	14	C	TELLINIDAE	47.7783	20.1998	3
1993	16	O	TELLINIDAE	2.6667	1.3333	3
1993	15	C	TELLINIDAE	0.7000	0.4726	3
1993	17	O	TELLINIDAE	4.0000	2.3094	3
1993	18	C	TELLINIDAE	43.5000	7.7513	3
1995	13	O	TELLINIDAE	0.4450	0.4450	3
1995	14	C	TELLINIDAE	63.7900	23.0595	3
1995	16	O	TELLINIDAE	2.0967	0.9517	3
1995	15	C	TELLINIDAE	6.8333	6.5849	3
1995	17	O	TELLINIDAE	9.3333	7.4237	3
1995	18	C	TELLINIDAE	256.1667	45.0854	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	TELLINIDAE	5.8811	5.8811	3
1990	C	TELLINIDAE	81.1672	78.7629	3
1991	O	TELLINIDAE	5.1006	2.0015	3
1991	C	TELLINIDAE	71.2406	36.7311	3
1993	O	TELLINIDAE	5.2594	1.9642	3
1993	C	TELLINIDAE	30.6594	15.0305	3
1995	O	TELLINIDAE	3.9583	2.7295	3
1995	C	TELLINIDAE	108.9300	75.4321	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.570
1991	0.729
1993	0.643
1995	0.781

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.587	0.482	0.580

Taxa = THYASIRIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	THYASIRIDAE	4.3333	3.8442	3
1990	14	C	THYASIRIDAE	84.0000	84.0000	3
1990	16	O	THYASIRIDAE	0.8883	0.8883	3
1990	15	C	THYASIRIDAE	6.5000	5.2994	3
1990	17	O	THYASIRIDAE	6.1667	3.4681	3
1990	18	C	THYASIRIDAE	102.9333	62.8231	3
1991	13	O	THYASIRIDAE	12.1900	12.1900	3
1991	14	C	THYASIRIDAE	65.7783	31.7146	3
1991	16	O	THYASIRIDAE	0.0000	0.0000	3
1991	15	C	THYASIRIDAE	0.8900	0.8900	3
1991	17	O	THYASIRIDAE	1.3333	1.3333	3
1991	18	C	THYASIRIDAE	206.6667	156.0570	3
1993	13	O	THYASIRIDAE	0.8883	0.8883	3
1993	14	C	THYASIRIDAE	120.0000	47.7214	3
1993	16	O	THYASIRIDAE	1.7783	1.1758	3
1993	15	C	THYASIRIDAE	26.3033	14.0225	3
1993	17	O	THYASIRIDAE	8.0000	4.0000	3
1993	18	C	THYASIRIDAE	384.6667	75.5327	3
1995	13	O	THYASIRIDAE	32.6283	16.8796	3
1995	14	C	THYASIRIDAE	312.0883	152.2331	3
1995	16	O	THYASIRIDAE	3.7450	2.5322	3
1995	15	C	THYASIRIDAE	162.8333	141.0686	3
1995	17	O	THYASIRIDAE	5.7783	2.9148	3
1995	18	C	THYASIRIDAE	120.0000	33.7651	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	THYASIRIDAE	3.7961	1.5472	3
1990	C	THYASIRIDAE	64.4778	29.4996	3
1991	O	THYASIRIDAE	4.5078	3.8603	3
1991	C	THYASIRIDAE	91.1117	60.7381	3
1993	O	THYASIRIDAE	3.5556	2.2370	3
1993	C	THYASIRIDAE	176.9900	107.3033	3
1995	O	THYASIRIDAE	14.0506	9.3074	3
1995	C	THYASIRIDAE	198.3072	58.2188	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.627
1991	0.565
1993	0.514
1995	0.156

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.408	0.050	0.449

Taxa = CAECIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	CAECIDAE	0.0000	0.0000	3
1990	14	C	CAECIDAE	0.0000	0.0000	3
1990	16	O	CAECIDAE	35.1117	18.0594	3
1990	15	C	CAECIDAE	0.3333	0.3333	3
1990	17	O	CAECIDAE	0.0000	0.0000	3
1990	18	C	CAECIDAE	0.0000	0.0000	3
1991	13	O	CAECIDAE	0.0000	0.0000	3
1991	14	C	CAECIDAE	0.0000	0.0000	3
1991	16	O	CAECIDAE	149.3333	30.7535	3
1991	15	C	CAECIDAE	1.1433	1.1433	3
1991	17	O	CAECIDAE	0.0000	0.0000	3
1991	18	C	CAECIDAE	0.0000	0.0000	3
1993	13	O	CAECIDAE	0.0000	0.0000	3
1993	14	C	CAECIDAE	0.0000	0.0000	3
1993	16	O	CAECIDAE	46.6667	20.1770	3
1993	15	C	CAECIDAE	10.8767	5.4763	3
1993	17	O	CAECIDAE	1.3333	1.3333	3
1993	18	C	CAECIDAE	0.0000	0.0000	3
1995	13	O	CAECIDAE	0.0000	0.0000	3
1995	14	C	CAECIDAE	0.0000	0.0000	3
1995	16	O	CAECIDAE	104.0000	25.0636	3
1995	15	C	CAECIDAE	0.0000	0.0000	3
1995	17	O	CAECIDAE	0.0000	0.0000	3
1995	18	C	CAECIDAE	0.0000	0.0000	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	CAECIDAE	11.7039	11.7039	3
1990	C	CAECIDAE	0.1111	0.1111	3
1991	O	CAECIDAE	49.7778	49.7778	3
1991	C	CAECIDAE	0.3811	0.3811	3
1993	O	CAECIDAE	16.0000	15.3382	3
1993	C	CAECIDAE	3.6256	3.6256	3
1995	O	CAECIDAE	34.6667	34.6667	3
1995	C	CAECIDAE	0.0000	0.0000	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.239
1991	0.251
1993	0.058
1995	0.000

Two-way Randomized within blocks with %mud as covariates

P values for:

Interaction	Oilcode	Year
0.797	0.000	0.423

Taxa = OLIVIDAE
DEPTH STRATUM = 6 to 20 M

Means by Year and Site

YEAR	SITNUM	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	OLIVIDAE	0.0000	0.0000	3
1990	14	C	OLIVIDAE	0.0000	0.0000	3
1990	16	O	OLIVIDAE	0.0000	0.0000	3
1990	15	C	OLIVIDAE	0.0000	0.0000	3
1990	17	O	OLIVIDAE	61.0950	44.5959	3
1990	18	C	OLIVIDAE	0.8883	0.8883	3
1991	13	O	OLIVIDAE	0.0000	0.0000	3
1991	14	C	OLIVIDAE	0.0000	0.0000	3
1991	16	O	OLIVIDAE	0.0000	0.0000	3
1991	15	C	OLIVIDAE	0.0000	0.0000	3
1991	17	O	OLIVIDAE	72.2217	28.5200	3
1991	18	C	OLIVIDAE	3.3333	3.3333	3
1993	13	O	OLIVIDAE	0.0000	0.0000	3
1993	14	C	OLIVIDAE	0.6667	0.6667	3
1993	16	O	OLIVIDAE	1.3333	1.3333	3
1993	15	C	OLIVIDAE	0.0000	0.0000	3
1993	17	O	OLIVIDAE	30.0000	5.2915	3
1993	18	C	OLIVIDAE	30.3333	13.1032	3
1995	13	O	OLIVIDAE	0.0000	0.0000	3
1995	14	C	OLIVIDAE	0.5333	0.5333	3
1995	16	O	OLIVIDAE	0.3817	0.3817	3
1995	15	C	OLIVIDAE	0.0000	0.0000	3
1995	17	O	OLIVIDAE	30.2217	10.8143	3
1995	18	C	OLIVIDAE	12.3333	6.6416	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	OLIVIDAE	20.3650	20.3650	3
1990	C	OLIVIDAE	0.2961	0.2961	3
1991	O	OLIVIDAE	24.0739	24.0739	3
1991	C	OLIVIDAE	1.1111	1.1111	3
1993	O	OLIVIDAE	10.4444	9.7854	3
1993	C	OLIVIDAE	10.3333	10.0019	3
1995	O	OLIVIDAE	10.2011	10.0109	3
1995	C	OLIVIDAE	4.2889	4.0252	3

One-Way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.10
1991	0.11
1993	0.93
1995	0.32

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.603	0.249	0.986

Taxa = RISSOIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	RISSOIDAE	2.1667	1.6915	3
1990	14	C	RISSOIDAE	0.0000	0.0000	3
1990	16	O	RISSOIDAE	22.2217	6.2227	3
1990	15	C	RISSOIDAE	11.5000	6.5000	3
1990	17	O	RISSOIDAE	0.0000	0.0000	3
1990	18	C	RISSOIDAE	0.8883	0.8883	3
1991	13	O	RISSOIDAE	4.8883	1.1761	3
1991	14	C	RISSOIDAE	31.3333	15.9304	3
1991	16	O	RISSOIDAE	97.3333	18.6667	3
1991	15	C	RISSOIDAE	51.9367	37.9383	3
1991	17	O	RISSOIDAE	0.0000	0.0000	3
1991	18	C	RISSOIDAE	19.3333	19.3333	3
1993	13	O	RISSOIDAE	19.0000	8.7369	3
1993	14	C	RISSOIDAE	2.0000	1.1547	3
1993	16	O	RISSOIDAE	12.8883	6.1749	3
1993	15	C	RISSOIDAE	1.6000	1.6000	3
1993	17	O	RISSOIDAE	0.0000	0.0000	3
1993	18	C	RISSOIDAE	0.0000	0.0000	3
1995	13	O	RISSOIDAE	4.7783	2.6971	3
1995	14	C	RISSOIDAE	3.5550	3.5550	3
1995	16	O	RISSOIDAE	1.2700	1.2700	3
1995	15	C	RISSOIDAE	0.8333	0.6009	3
1995	17	O	RISSOIDAE	0.0000	0.0000	3
1995	18	C	RISSOIDAE	0.1667	0.1667	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	RISSOIDAE	8.1294	7.0738	3
1990	C	RISSOIDAE	4.1294	3.6942	3
1991	O	RISSOIDAE	34.0739	31.6612	3
1991	C	RISSOIDAE	34.2011	9.5204	3
1993	O	RISSOIDAE	10.6294	5.5999	3
1993	C	RISSOIDAE	1.2000	0.6110	3
1995	O	RISSOIDAE	2.0161	1.4289	3
1995	C	RISSOIDAE	1.5183	1.0364	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.392
1991	0.712
1993	0.414
1995	0.335

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.799	0.680	0.000

Taxa = OEDICEROTIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	OEDICEROTIDAE	0.0000	0.0000	3
1990	14	C	OEDICEROTIDAE	1.3333	1.3333	3
1990	16	O	OEDICEROTIDAE	4.8883	0.8883	3
1990	15	C	OEDICEROTIDAE	6.0000	0.5774	3
1990	17	O	OEDICEROTIDAE	14.9050	5.0197	3
1990	18	C	OEDICEROTIDAE	0.0000	0.0000	3
1991	13	O	OEDICEROTIDAE	0.0000	0.0000	3
1991	14	C	OEDICEROTIDAE	0.0000	0.0000	3
1991	16	O	OEDICEROTIDAE	14.6667	3.5277	3
1991	15	C	OEDICEROTIDAE	4.0667	1.1566	3
1991	17	O	OEDICEROTIDAE	16.8883	11.4261	3
1991	18	C	OEDICEROTIDAE	4.6667	2.9059	3
1993	13	O	OEDICEROTIDAE	0.0000	0.0000	3
1993	14	C	OEDICEROTIDAE	0.0000	0.0000	3
1993	16	O	OEDICEROTIDAE	25.7783	17.1152	3
1993	15	C	OEDICEROTIDAE	0.8883	0.8883	3
1993	17	O	OEDICEROTIDAE	55.3333	7.3333	3
1993	18	C	OEDICEROTIDAE	0.3333	0.1667	3
1995	13	O	OEDICEROTIDAE	0.0000	0.0000	3
1995	14	C	OEDICEROTIDAE	2.7550	1.6172	3
1995	16	O	OEDICEROTIDAE	7.2400	2.1968	3
1995	15	C	OEDICEROTIDAE	1.5000	0.7638	3
1995	17	O	OEDICEROTIDAE	60.8900	13.7990	3
1995	18	C	OEDICEROTIDAE	4.6667	2.1667	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	OEDICEROTIDAE	6.5978	4.3868	3
1990	C	OEDICEROTIDAE	2.4444	1.8190	3
1991	O	OEDICEROTIDAE	10.5183	5.2981	3
1991	C	OEDICEROTIDAE	2.9111	1.4658	3
1993	O	OEDICEROTIDAE	27.0372	15.9858	3
1993	C	OEDICEROTIDAE	0.4072	0.2591	3
1995	O	OEDICEROTIDAE	22.7100	19.2041	3
1995	C	OEDICEROTIDAE	2.9739	0.9207	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.501
1991	0.286
1993	0.223
1995	0.649

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.393	0.042	0.382

Taxa = ISAEIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	ISAEIDAE	0.0000	0.0000	3
1990	14	C	ISAEIDAE	0.0000	0.0000	3
1990	16	O	ISAEIDAE	0.0000	0.0000	3
1990	15	C	ISAEIDAE	0.0000	0.0000	3
1990	17	O	ISAEIDAE	1.3333	1.3333	3
1990	18	C	ISAEIDAE	33.6883	13.5850	3
1991	13	O	ISAEIDAE	1.2700	1.2700	3
1991	14	C	ISAEIDAE	0.0000	0.0000	3
1991	16	O	ISAEIDAE	6.0000	3.0551	3
1991	15	C	ISAEIDAE	4.6667	2.9059	3
1991	17	O	ISAEIDAE	0.0000	0.0000	3
1991	18	C	ISAEIDAE	60.0000	32.3316	3
1993	13	O	ISAEIDAE	2.2217	1.1758	3
1993	14	C	ISAEIDAE	0.0000	0.0000	3
1993	16	O	ISAEIDAE	0.0000	0.0000	3
1993	15	C	ISAEIDAE	0.1667	0.1667	3
1993	17	O	ISAEIDAE	13.3333	7.0553	3
1993	18	C	ISAEIDAE	12.3333	4.3237	3
1995	13	O	ISAEIDAE	1.5183	0.5742	3
1995	14	C	ISAEIDAE	0.0000	0.0000	3
1995	16	O	ISAEIDAE	1.5233	1.5233	3
1995	15	C	ISAEIDAE	0.3333	0.3333	3
1995	17	O	ISAEIDAE	14.2217	7.2757	3
1995	18	C	ISAEIDAE	126.6667	19.8165	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	ISAEIDAE	0.4444	0.4444	3
1990	C	ISAEIDAE	11.2294	11.2294	3
1991	O	ISAEIDAE	2.4233	1.8255	3
1991	C	ISAEIDAE	21.5556	19.2694	3
1993	O	ISAEIDAE	5.1850	4.1243	3
1993	C	ISAEIDAE	4.1667	4.0836	3
1995	O	ISAEIDAE	5.7544	4.2336	3
1995	C	ISAEIDAE	42.3333	42.1668	3

One-Way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.689
1991	0.322
1993	0.894
1995	0.736

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.760	0.053	0.978

Taxa = PHOXOCEPHALIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	PHOXOCEPHALIDAE	0.0000	0.0000	3
1990	14	C	PHOXOCEPHALIDAE	0.0000	0.0000	3
1990	16	O	PHOXOCEPHALIDAE	6.2217	2.9148	3
1990	15	C	PHOXOCEPHALIDAE	37.0000	2.3629	3
1990	17	O	PHOXOCEPHALIDAE	4.5950	1.7383	3
1990	18	C	PHOXOCEPHALIDAE	16.8883	9.5636	3
1991	13	O	PHOXOCEPHALIDAE	0.0000	0.0000	3
1991	14	C	PHOXOCEPHALIDAE	0.0000	0.0000	3
1991	16	O	PHOXOCEPHALIDAE	3.3333	1.7638	3
1991	15	C	PHOXOCEPHALIDAE	8.4467	5.9788	3
1991	17	O	PHOXOCEPHALIDAE	4.2217	1.3512	3
1991	18	C	PHOXOCEPHALIDAE	10.6667	3.5277	3
1993	13	O	PHOXOCEPHALIDAE	0.0000	0.0000	3
1993	14	C	PHOXOCEPHALIDAE	0.0000	0.0000	3
1993	16	O	PHOXOCEPHALIDAE	1.7783	1.1758	3
1993	15	C	PHOXOCEPHALIDAE	2.5667	1.0588	3
1993	17	O	PHOXOCEPHALIDAE	0.0000	0.0000	3
1993	18	C	PHOXOCEPHALIDAE	43.3333	10.0844	3
1995	13	O	PHOXOCEPHALIDAE	0.0000	0.0000	3
1995	14	C	PHOXOCEPHALIDAE	0.0000	0.0000	3
1995	16	O	PHOXOCEPHALIDAE	2.5417	1.9967	3
1995	15	C	PHOXOCEPHALIDAE	2.5000	2.5000	3
1995	17	O	PHOXOCEPHALIDAE	9.3333	1.3333	3
1995	18	C	PHOXOCEPHALIDAE	80.8333	18.4985	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	PHOXOCEPHALIDAE	3.6056	1.8629	3
1990	C	PHOXOCEPHALIDAE	17.9628	10.6945	3
1991	O	PHOXOCEPHALIDAE	2.5183	1.2850	3
1991	C	PHOXOCEPHALIDAE	6.3711	3.2494	3
1993	O	PHOXOCEPHALIDAE	0.5928	0.5928	3
1993	C	PHOXOCEPHALIDAE	15.3000	14.0362	3
1995	O	PHOXOCEPHALIDAE	3.9583	2.7859	3
1995	C	PHOXOCEPHALIDAE	27.7778	26.5376	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.031
1991	0.000
1993	0.569
1995	0.470

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	YEAR
0.082	0.013	0.043

Taxa = OPHIUROIDEA
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	OPHIUROIDEA	0.0000	0.0000	3
1990	14	C	OPHIUROIDEA	0.1667	0.1667	3
1990	16	O	OPHIUROIDEA	13.3333	4.8074	3
1990	15	C	OPHIUROIDEA	4.3333	2.2423	3
1990	17	O	OPHIUROIDEA	0.0000	0.0000	3
1990	18	C	OPHIUROIDEA	3.1117	3.1117	3
1991	13	O	OPHIUROIDEA	0.8883	0.8883	3
1991	14	C	OPHIUROIDEA	2.6667	1.3333	3
1991	16	O	OPHIUROIDEA	46.6667	18.6667	3
1991	15	C	OPHIUROIDEA	20.1967	6.9310	3
1991	17	O	OPHIUROIDEA	7.1117	7.1117	3
1991	18	C	OPHIUROIDEA	8.6667	4.3716	3
1993	13	O	OPHIUROIDEA	0.5000	0.5000	3
1993	14	C	OPHIUROIDEA	12.0000	2.3094	3
1993	16	O	OPHIUROIDEA	33.3333	18.5233	3
1993	15	C	OPHIUROIDEA	29.9833	12.2596	3
1993	17	O	OPHIUROIDEA	4.0000	2.3094	3
1993	18	C	OPHIUROIDEA	4.6667	0.9280	3
1995	13	O	OPHIUROIDEA	12.8900	6.9862	3
1995	14	C	OPHIUROIDEA	5.3333	3.5277	3
1995	16	O	OPHIUROIDEA	42.9833	11.7190	3
1995	15	C	OPHIUROIDEA	12.8333	4.0449	3
1995	17	O	OPHIUROIDEA	3.1117	1.6029	3
1995	18	C	OPHIUROIDEA	4.0000	0.7638	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	OPHIUROIDEA	4.4444	4.4444	3
1990	C	OPHIUROIDEA	2.5372	1.2366	3
1991	O	OPHIUROIDEA	18.2222	14.3352	3
1991	C	OPHIUROIDEA	10.5100	5.1437	3
1993	O	OPHIUROIDEA	12.6111	10.4103	3
1993	C	OPHIUROIDEA	15.5500	7.5208	3
1995	O	OPHIUROIDEA	19.6617	11.9976	3
1995	C	OPHIUROIDEA	7.3889	2.7493	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.320
1991	0.648
1993	0.552
1995	0.078

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.859	0.104	0.269

Taxa = SPIRORBIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	SPIRORBIDAE	0.6667	0.6667	3
1990	14	C	SPIRORBIDAE	11.1667	11.1667	3
1990	16	O	SPIRORBIDAE	70.6667	31.8608	3
1990	15	C	SPIRORBIDAE	41.6667	23.7282	3
1990	17	O	SPIRORBIDAE	4.1667	2.1667	3
1990	18	C	SPIRORBIDAE	9.3333	9.3333	3
1991	13	O	SPIRORBIDAE	0.0000	0.0000	3
1991	14	C	SPIRORBIDAE	1.6667	1.2019	3
1991	16	O	SPIRORBIDAE	72.6667	23.7861	3
1991	15	C	SPIRORBIDAE	192.7467	171.2184	3
1991	17	O	SPIRORBIDAE	5.3333	1.3333	3
1991	18	C	SPIRORBIDAE	25.0000	23.0290	3
1993	13	O	SPIRORBIDAE	0.0000	0.0000	3
1993	14	C	SPIRORBIDAE	3.1117	1.6029	3
1993	16	O	SPIRORBIDAE	80.0000	50.1199	3
1993	15	C	SPIRORBIDAE	49.6067	28.9696	3
1993	17	O	SPIRORBIDAE	7.3333	3.3333	3
1993	18	C	SPIRORBIDAE	11.0000	10.5040	3
1995	13	O	SPIRORBIDAE	0.0000	0.0000	3
1995	14	C	SPIRORBIDAE	29.7783	27.8023	3
1995	16	O	SPIRORBIDAE	68.3167	31.1267	3
1995	15	C	SPIRORBIDAE	37.8333	19.3139	3
1995	17	O	SPIRORBIDAE	6.6667	6.6667	3
1995	18	C	SPIRORBIDAE	0.1667	0.1667	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	SPIRORBIDAE	25.1667	22.7724	3
1990	C	SPIRORBIDAE	20.7222	10.4856	3
1991	O	SPIRORBIDAE	26.0000	23.3841	3
1991	C	SPIRORBIDAE	73.1378	60.1826	3
1993	O	SPIRORBIDAE	29.1111	25.5324	3
1993	C	SPIRORBIDAE	21.2394	14.3652	3
1995	O	SPIRORBIDAE	24.9944	21.7464	3
1995	C	SPIRORBIDAE	22.5928	11.4516	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.76
1991	0.53
1993	0.71
1995	0.82

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.651	0.776	0.649

Taxa = MYTILIDAE
Depth Stratum = 6 TO 20 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	MYTILIDAE	0.0000	0.0000	3
1990	14	C	MYTILIDAE	1.8333	1.8333	3
1990	16	O	MYTILIDAE	12.8883	3.6381	3
1990	15	C	MYTILIDAE	2.0000	2.0000	3
1990	17	O	MYTILIDAE	113.7383	48.1263	3
1990	18	C	MYTILIDAE	4.0883	2.8612	3
1991	13	O	MYTILIDAE	1.3333	1.3333	3
1991	14	C	MYTILIDAE	0.0000	0.0000	3
1991	16	O	MYTILIDAE	7.3333	1.7638	3
1991	15	C	MYTILIDAE	0.0000	0.0000	3
1991	17	O	MYTILIDAE	101.2783	22.8763	3
1991	18	C	MYTILIDAE	0.6667	0.6667	3
1993	13	O	MYTILIDAE	5.0550	1.7651	3
1993	14	C	MYTILIDAE	1.3333	1.3333	3
1993	16	O	MYTILIDAE	2.2217	1.1758	3
1993	15	C	MYTILIDAE	0.0000	0.0000	3
1993	17	O	MYTILIDAE	505.3333	104.8258	3
1993	18	C	MYTILIDAE	1.3333	1.3333	3
1995	13	O	MYTILIDAE	3.1117	3.1117	3
1995	14	C	MYTILIDAE	0.8883	0.8883	3
1995	16	O	MYTILIDAE	10.9183	7.4429	3
1995	15	C	MYTILIDAE	0.0000	0.0000	3
1995	17	O	MYTILIDAE	853.3317	136.7168	3
1995	18	C	MYTILIDAE	1.5000	0.7638	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	MYTILIDAE	48.8756	42.5942	3
1990	C	MYTILIDAE	2.6406	0.7255	3
1991	O	MYTILIDAE	36.6483	32.3614	3
1991	C	MYTILIDAE	0.2222	0.2222	3
1993	O	MYTILIDAE	170.8700	167.2337	3
1993	C	MYTILIDAE	0.8889	0.4444	3
1995	O	MYTILIDAE	289.1206	282.1146	3
1995	C	MYTILIDAE	0.7961	0.4355	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.02
1991	<0.01
1993	<0.01
1995	0.02

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.117	0.000	0.154

Taxa = AMPHICTENIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	AMPHICTENIDAE	5.0483	2.6094	3
1990	14	C	AMPHICTENIDAE	1.9050	1.9050	3
1990	16	O	AMPHICTENIDAE	31.3333	5.4569	3
1990	15	C	AMPHICTENIDAE	0.0000	0.0000	3
1990	17	O	AMPHICTENIDAE	83.3333	36.5574	3
1990	18	C	AMPHICTENIDAE	40.6667	19.4708	3
1991	13	O	AMPHICTENIDAE	18.2217	14.8942	3
1991	14	C	AMPHICTENIDAE	18.6667	5.8119	3
1991	16	O	AMPHICTENIDAE	22.8883	12.5565	3
1991	15	C	AMPHICTENIDAE	2.6667	2.6667	3
1991	17	O	AMPHICTENIDAE	52.3017	12.8156	3
1991	18	C	AMPHICTENIDAE	78.2767	32.3852	3
1993	13	O	AMPHICTENIDAE	14.1200	13.1327	3
1993	14	C	AMPHICTENIDAE	8.4450	6.5476	3
1993	16	O	AMPHICTENIDAE	16.0000	10.5830	3
1993	15	C	AMPHICTENIDAE	20.2667	9.0077	3
1993	17	O	AMPHICTENIDAE	38.4433	22.1863	3
1993	18	C	AMPHICTENIDAE	1.6000	1.6000	3
1995	13	O	AMPHICTENIDAE	4.0017	2.6790	3
1995	14	C	AMPHICTENIDAE	6.7550	5.9729	3
1995	16	O	AMPHICTENIDAE	46.6667	8.7433	3
1995	15	C	AMPHICTENIDAE	1.6000	1.6000	3
1995	17	O	AMPHICTENIDAE	155.1117	69.5435	3
1995	18	C	AMPHICTENIDAE	1.3000	0.5686	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	AMPHICTENIDAE	39.9050	23.0017	3
1990	C	AMPHICTENIDAE	14.1906	13.2495	3
1991	O	AMPHICTENIDAE	31.1372	10.6676	3
1991	C	AMPHICTENIDAE	33.2033	23.0051	3
1993	O	AMPHICTENIDAE	22.8544	7.8133	3
1993	C	AMPHICTENIDAE	10.1039	5.4521	3
1995	O	AMPHICTENIDAE	68.5933	44.9783	3
1995	C	AMPHICTENIDAE	3.2183	1.7705	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.301
1991	0.157
1993	0.132
1995	0.004

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.220	0.000	0.357

Taxa = CAPITELLIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	CAPITELLIDAE	2.9333	1.4847	3
1990	14	C	CAPITELLIDAE	2.8733	1.2855	3
1990	16	O	CAPITELLIDAE	49.8333	16.0009	3
1990	15	C	CAPITELLIDAE	32.0000	13.6137	3
1990	17	O	CAPITELLIDAE	45.5550	13.2903	3
1990	18	C	CAPITELLIDAE	24.0000	18.3303	3
1991	13	O	CAPITELLIDAE	7.3333	4.3716	3
1991	14	C	CAPITELLIDAE	200.7000	132.0872	3
1991	16	O	CAPITELLIDAE	29.3333	6.6667	3
1991	15	C	CAPITELLIDAE	5.3333	3.5277	3
1991	17	O	CAPITELLIDAE	26.0167	15.6677	3
1991	18	C	CAPITELLIDAE	34.6983	28.0475	3
1993	13	O	CAPITELLIDAE	15.5750	10.5576	3
1993	14	C	CAPITELLIDAE	57.1117	35.8809	3
1993	16	O	CAPITELLIDAE	36.0000	12.2202	3
1993	15	C	CAPITELLIDAE	11.0217	4.2448	3
1993	17	O	CAPITELLIDAE	32.2217	13.8265	3
1993	18	C	CAPITELLIDAE	3.7333	2.0827	3
1995	13	O	CAPITELLIDAE	13.9267	1.8212	3
1995	14	C	CAPITELLIDAE	1.0667	0.5333	3
1995	16	O	CAPITELLIDAE	32.4433	6.5460	3
1995	15	C	CAPITELLIDAE	1.0667	0.5333	3
1995	17	O	CAPITELLIDAE	39.1117	12.8883	3
1995	18	C	CAPITELLIDAE	12.9000	6.7855	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	CAPITELLIDAE	32.7739	14.9713	3
1990	C	CAPITELLIDAE	19.6244	8.6881	3
1991	O	CAPITELLIDAE	20.8944	6.8478	3
1991	C	CAPITELLIDAE	80.2439	60.8217	3
1993	O	CAPITELLIDAE	27.9322	6.2741	3
1993	C	CAPITELLIDAE	23.9556	16.7110	3
1995	O	CAPITELLIDAE	28.4939	7.5337	3
1995	C	CAPITELLIDAE	5.0111	3.9444	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.574
1991	0.915
1993	0.110
1995	0.068

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.180	0.919	0.235

Taxa = NEREIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	NEREIDAE	0.5333	0.5333	3
1990	14	C	NEREIDAE	0.3817	0.3817	3
1990	16	O	NEREIDAE	11.0000	3.7859	3
1990	15	C	NEREIDAE	1.5550	1.5550	3
1990	17	O	NEREIDAE	42.4450	11.1638	3
1990	18	C	NEREIDAE	4.0000	2.3094	3
1991	13	O	NEREIDAE	2.6667	2.6667	3
1991	14	C	NEREIDAE	5.3333	2.6667	3
1991	16	O	NEREIDAE	30.2217	11.5295	3
1991	15	C	NEREIDAE	8.4433	0.4433	3
1991	17	O	NEREIDAE	25.8100	9.5932	3
1991	18	C	NEREIDAE	8.3650	3.7246	3
1993	13	O	NEREIDAE	0.6667	0.6667	3
1993	14	C	NEREIDAE	3.1117	3.1117	3
1993	16	O	NEREIDAE	73.3333	13.5319	3
1993	15	C	NEREIDAE	6.4000	1.9666	3
1993	17	O	NEREIDAE	48.0000	22.7450	3
1993	18	C	NEREIDAE	10.0767	2.2661	3
1995	13	O	NEREIDAE	4.4450	4.4450	3
1995	14	C	NEREIDAE	17.6450	5.8553	3
1995	16	O	NEREIDAE	32.8883	9.5636	3
1995	15	C	NEREIDAE	2.4000	1.2220	3
1995	17	O	NEREIDAE	40.8900	9.2804	3
1995	18	C	NEREIDAE	20.6667	11.7556	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	NEREIDAE	17.9928	12.5939	3
1990	C	NEREIDAE	1.9789	1.0658	3
1991	O	NEREIDAE	19.5661	8.5452	3
1991	C	NEREIDAE	7.3806	1.0239	3
1993	O	NEREIDAE	40.6667	21.2951	3
1993	C	NEREIDAE	6.5294	2.0117	3
1995	O	NEREIDAE	26.0744	11.0587	3
1995	C	NEREIDAE	13.5706	5.6530	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.025
1991	0.131
1993	0.023
1995	0.065

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.528	0.000	0.517

Taxa = OPHELIIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	OPHELIIDAE	13.5817	10.2156	3
1990	14	C	OPHELIIDAE	21.0550	10.8521	3
1990	16	O	OPHELIIDAE	102.0000	6.0000	3
1990	15	C	OPHELIIDAE	2.2217	2.2217	3
1990	17	O	OPHELIIDAE	194.2217	12.3312	3
1990	18	C	OPHELIIDAE	112.0000	59.7327	3
1991	13	O	OPHELIIDAE	145.3317	67.6282	3
1991	14	C	OPHELIIDAE	24.0000	0.0000	3
1991	16	O	OPHELIIDAE	413.7217	111.7408	3
1991	15	C	OPHELIIDAE	172.4450	38.2295	3
1991	17	O	OPHELIIDAE	616.1200	326.3347	3
1991	18	C	OPHELIIDAE	1159.2050	521.7365	3
1993	13	O	OPHELIIDAE	69.0917	38.6272	3
1993	14	C	OPHELIIDAE	246.6667	54.1774	3
1993	16	O	OPHELIIDAE	501.3333	115.2466	3
1993	15	C	OPHELIIDAE	44.8900	8.4785	3
1993	17	O	OPHELIIDAE	576.8900	186.8200	3
1993	18	C	OPHELIIDAE	102.8117	12.3812	3
1995	13	O	OPHELIIDAE	7.7033	5.8191	3
1995	14	C	OPHELIIDAE	1.9550	0.3550	3
1995	16	O	OPHELIIDAE	3.5550	2.3519	3
1995	15	C	OPHELIIDAE	0.5333	0.5333	3
1995	17	O	OPHELIIDAE	35.1117	10.6199	3
1995	18	C	OPHELIIDAE	0.4333	0.4333	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	OPHELIIDAE	103.2678	52.1501	3
1990	C	OPHELIIDAE	45.0922	33.8928	3
1991	O	OPHELIIDAE	391.7244	136.3492	3
1991	C	OPHELIIDAE	451.8833	356.2475	3
1993	O	OPHELIIDAE	382.4383	158.1843	3
1993	C	OPHELIIDAE	131.4561	59.9829	3
1995	O	OPHELIIDAE	15.4567	9.9002	3
1995	C	OPHELIIDAE	0.9739	0.4914	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.197
1991	0.735
1993	0.009
1995	0.129

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.488	0.057	0.030

Taxa = POLYNOIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	POLYNOIDAE	25.8100	6.0972	3
1990	14	C	POLYNOIDAE	14.4517	3.3259	3
1990	16	O	POLYNOIDAE	37.8333	5.1667	3
1990	15	C	POLYNOIDAE	37.1117	7.9105	3
1990	17	O	POLYNOIDAE	11.5550	3.2282	3
1990	18	C	POLYNOIDAE	3.3333	1.7638	3
1991	13	O	POLYNOIDAE	17.7767	9.0627	3
1991	14	C	POLYNOIDAE	227.2000	17.5454	3
1991	16	O	POLYNOIDAE	31.3333	16.3435	3
1991	15	C	POLYNOIDAE	93.7783	24.0292	3
1991	17	O	POLYNOIDAE	1.3817	0.8741	3
1991	18	C	POLYNOIDAE	17.4283	8.4485	3
1993	13	O	POLYNOIDAE	22.5450	14.7813	3
1993	14	C	POLYNOIDAE	103.5567	44.9550	3
1993	16	O	POLYNOIDAE	58.6667	7.4237	3
1993	15	C	POLYNOIDAE	68.0883	14.8360	3
1993	17	O	POLYNOIDAE	4.6667	2.4037	3
1993	18	C	POLYNOIDAE	0.0000	0.0000	3
1995	13	O	POLYNOIDAE	22.0750	6.3072	3
1995	14	C	POLYNOIDAE	108.4450	18.2225	3
1995	16	O	POLYNOIDAE	82.6667	10.6667	3
1995	15	C	POLYNOIDAE	51.2000	12.4279	3
1995	17	O	POLYNOIDAE	15.1117	4.7035	3
1995	18	C	POLYNOIDAE	6.8333	3.1667	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	POLYNOIDAE	25.0661	7.5950	3
1990	C	POLYNOIDAE	18.2989	9.9389	3
1991	O	POLYNOIDAE	16.8306	8.6592	3
1991	C	POLYNOIDAE	112.8022	61.2984	3
1993	O	POLYNOIDAE	28.6261	15.8822	3
1993	C	POLYNOIDAE	57.2150	30.3846	3
1995	O	POLYNOIDAE	39.9511	21.4522	3
1995	C	POLYNOIDAE	55.4928	29.4112	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.445
1991	0.691
1993	0.056
1995	0.114

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.430	0.442	0.169

Taxa = SABELLIDAE
Depth Stratum <3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	SABELLIDAE	0.0000	0.0000	3
1990	14	C	SABELLIDAE	0.0000	0.0000	3
1990	16	O	SABELLIDAE	0.0000	0.0000	3
1990	15	C	SABELLIDAE	0.0000	0.0000	3
1990	17	O	SABELLIDAE	37.1117	30.4539	3
1990	18	C	SABELLIDAE	0.6667	0.6667	3
1991	13	O	SABELLIDAE	0.0000	0.0000	3
1991	14	C	SABELLIDAE	0.5333	0.5333	3
1991	16	O	SABELLIDAE	0.6667	0.6667	3
1991	15	C	SABELLIDAE	0.0000	0.0000	3
1991	17	O	SABELLIDAE	130.5250	124.7479	3
1991	18	C	SABELLIDAE	0.0000	0.0000	3
1993	13	O	SABELLIDAE	0.0000	0.0000	3
1993	14	C	SABELLIDAE	0.0000	0.0000	3
1993	16	O	SABELLIDAE	0.0000	0.0000	3
1993	15	C	SABELLIDAE	0.0000	0.0000	3
1993	17	O	SABELLIDAE	176.0000	174.0038	3
1993	18	C	SABELLIDAE	0.0000	0.0000	3
1995	13	O	SABELLIDAE	0.0000	0.0000	3
1995	14	C	SABELLIDAE	0.0000	0.0000	3
1995	16	O	SABELLIDAE	0.0000	0.0000	3
1995	15	C	SABELLIDAE	0.0000	0.0000	3
1995	17	O	SABELLIDAE	584.8883	525.8164	3
1995	18	C	SABELLIDAE	0.0000	0.0000	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	SABELLIDAE	12.3706	12.3706	3
1990	C	SABELLIDAE	0.2222	0.2222	3
1991	O	SABELLIDAE	43.7306	43.3976	3
1991	C	SABELLIDAE	0.1778	0.1778	3
1993	O	SABELLIDAE	58.6667	58.6667	3
1993	C	SABELLIDAE	0.0000	0.0000	3
1995	O	SABELLIDAE	194.9628	194.9628	3
1995	C	SABELLIDAE	0.0000	0.0000	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.069
1991	0.552
1993	0.227
1995	0.158

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.892	0.045	0.794

Taxa = SIGALIONIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	SIGALIONIDAE	0.0000	0.0000	3
1990	14	C	SIGALIONIDAE	0.3817	0.3817	3
1990	16	O	SIGALIONIDAE	18.3333	3.4801	3
1990	15	C	SIGALIONIDAE	1.3333	1.3333	3
1990	17	O	SIGALIONIDAE	5.5550	3.4926	3
1990	18	C	SIGALIONIDAE	3.3333	3.3333	3
1991	13	O	SIGALIONIDAE	8.8883	3.5767	3
1991	14	C	SIGALIONIDAE	0.0000	0.0000	3
1991	16	O	SIGALIONIDAE	52.6667	8.3533	3
1991	15	C	SIGALIONIDAE	19.1117	5.8796	3
1991	17	O	SIGALIONIDAE	3.0000	2.5166	3
1991	18	C	SIGALIONIDAE	7.1117	7.1117	3
1993	13	O	SIGALIONIDAE	88.6667	86.6744	3
1993	14	C	SIGALIONIDAE	16.0000	16.0000	3
1993	16	O	SIGALIONIDAE	98.6667	28.6899	3
1993	15	C	SIGALIONIDAE	26.4000	7.8926	3
1993	17	O	SIGALIONIDAE	0.0000	0.0000	3
1993	18	C	SIGALIONIDAE	0.0000	0.0000	3
1995	13	O	SIGALIONIDAE	71.5567	11.8348	3
1995	14	C	SIGALIONIDAE	3.0217	0.9408	3
1995	16	O	SIGALIONIDAE	117.3333	15.7198	3
1995	15	C	SIGALIONIDAE	113.6000	19.5523	3
1995	17	O	SIGALIONIDAE	10.2217	3.9508	3
1995	18	C	SIGALIONIDAE	1.2000	0.6110	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	SIGALIONIDAE	7.9628	5.4276	3
1990	C	SIGALIONIDAE	1.6828	0.8698	3
1991	O	SIGALIONIDAE	21.5183	15.6667	3
1991	C	SIGALIONIDAE	8.7411	5.5769	3
1993	O	SIGALIONIDAE	62.4444	31.3554	3
1993	C	SIGALIONIDAE	14.1333	7.6780	3
1995	O	SIGALIONIDAE	66.3706	31.0290	3
1995	C	SIGALIONIDAE	39.2739	37.1668	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.832
1991	0.181
1993	0.434
1995	0.278

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.443	0.699	0.099

Taxa = SPIONIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	SPIONIDAE	0.3817	0.3817	3
1990	14	C	SPIONIDAE	2.1583	2.1583	3
1990	16	O	SPIONIDAE	13.3333	1.3333	3
1990	15	C	SPIONIDAE	0.8883	0.8883	3
1990	17	O	SPIONIDAE	554.0000	62.0000	3
1990	18	C	SPIONIDAE	190.6667	106.2659	3
1991	13	O	SPIONIDAE	6.2217	3.4712	3
1991	14	C	SPIONIDAE	27.2000	9.9385	3
1991	16	O	SPIONIDAE	31.5550	21.8316	3
1991	15	C	SPIONIDAE	20.0000	2.3094	3
1991	17	O	SPIONIDAE	426.3967	217.1490	3
1991	18	C	SPIONIDAE	217.9683	112.7633	3
1993	13	O	SPIONIDAE	8.0000	4.6188	3
1993	14	C	SPIONIDAE	20.4433	13.7973	3
1993	16	O	SPIONIDAE	20.0000	10.0664	3
1993	15	C	SPIONIDAE	7.1983	0.7992	3
1993	17	O	SPIONIDAE	149.7783	61.1118	3
1993	18	C	SPIONIDAE	12.2450	3.5799	3
1995	13	O	SPIONIDAE	5.9283	1.1556	3
1995	14	C	SPIONIDAE	8.3100	0.9737	3
1995	16	O	SPIONIDAE	8.8883	4.7035	3
1995	15	C	SPIONIDAE	1.0667	1.0667	3
1995	17	O	SPIONIDAE	397.3350	60.9391	3
1995	18	C	SPIONIDAE	27.1333	10.2665	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	SPIONIDAE	189.2383	182.4192	3
1990	C	SPIONIDAE	64.5711	63.0488	3
1991	O	SPIONIDAE	154.7244	136.0328	3
1991	C	SPIONIDAE	88.3894	64.8228	3
1993	O	SPIONIDAE	59.2594	45.3918	3
1993	C	SPIONIDAE	13.2956	3.8594	3
1995	O	SPIONIDAE	137.3839	129.9784	3
1995	C	SPIONIDAE	12.1700	7.7684	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.016
1991	0.443
1993	0.006
1995	0.014

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.976	.0002	0.258

Taxa = SYLLIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	SYLLIDAE	0.5333	0.5333	3
1990	14	C	SYLLIDAE	2.8333	1.4240	3
1990	16	O	SYLLIDAE	125.8333	97.4818	3
1990	15	C	SYLLIDAE	15.3333	6.3596	3
1990	17	O	SYLLIDAE	6.0000	6.0000	3
1990	18	C	SYLLIDAE	10.6667	5.8119	3
1991	13	O	SYLLIDAE	2.2217	1.1758	3
1991	14	C	SYLLIDAE	56.8000	23.7902	3
1991	16	O	SYLLIDAE	57.5550	15.2521	3
1991	15	C	SYLLIDAE	237.7783	52.5747	3
1991	17	O	SYLLIDAE	4.0483	2.0471	3
1991	18	C	SYLLIDAE	19.3650	7.9768	3
1993	13	O	SYLLIDAE	5.1500	2.4609	3
1993	14	C	SYLLIDAE	130.6667	67.1650	3
1993	16	O	SYLLIDAE	121.3333	27.9364	3
1993	15	C	SYLLIDAE	101.8667	32.6075	3
1993	17	O	SYLLIDAE	2.6667	2.6667	3
1993	18	C	SYLLIDAE	0.0000	0.0000	3
1995	13	O	SYLLIDAE	1.6300	1.6300	3
1995	14	C	SYLLIDAE	67.5550	22.6369	3
1995	16	O	SYLLIDAE	26.6667	8.7433	3
1995	15	C	SYLLIDAE	4.2667	1.3333	3
1995	17	O	SYLLIDAE	16.0000	8.0000	3
1995	18	C	SYLLIDAE	2.7667	1.2667	3

Means by year and oiling strategy

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	SYLLIDAE	44.1222	40.8860	3
1990	C	SYLLIDAE	9.6111	3.6468	3
1991	O	SYLLIDAE	21.2750	18.1477	3
1991	C	SYLLIDAE	104.6478	67.4368	3
1993	O	SYLLIDAE	43.0500	39.1482	3
1993	C	SYLLIDAE	77.5111	39.6373	3
1995	O	SYLLIDAE	14.7656	7.2538	3
1995	C	SYLLIDAE	24.8628	21.3505	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.855
1991	0.436
1993	0.111
1995	0.022

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.870	0.427	0.665

Taxa = MONTACUTIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	MONTACUTIDAE	170.8567	128.6140	3
1990	14	C	MONTACUTIDAE	21.2617	4.4602	3
1990	16	O	MONTACUTIDAE	13.1667	3.3706	3
1990	15	C	MONTACUTIDAE	13.3333	13.3333	3
1990	17	O	MONTACUTIDAE	26.6667	21.6744	3
1990	18	C	MONTACUTIDAE	22.6667	20.6989	3
1991	13	O	MONTACUTIDAE	287.3333	145.8806	3
1991	14	C	MONTACUTIDAE	53.0667	10.8353	3
1991	16	O	MONTACUTIDAE	142.0000	82.0000	3
1991	15	C	MONTACUTIDAE	61.7783	41.2423	3
1991	17	O	MONTACUTIDAE	35.7300	25.1822	3
1991	18	C	MONTACUTIDAE	38.0000	37.0045	3
1993	13	O	MONTACUTIDAE	114.6067	75.5760	3
1993	14	C	MONTACUTIDAE	35.3333	13.0024	3
1993	16	O	MONTACUTIDAE	618.666	140.7093	3
1993	15	C	MONTACUTIDAE	94.7550	52.7888	3
1993	17	O	MONTACUTIDAE	14.0000	14.0000	3
1993	18	C	MONTACUTIDAE	0.0000	0.0000	3
1995	13	O	MONTACUTIDAE	439.5550	224.7245	3
1995	14	C	MONTACUTIDAE	96.4000	18.0796	3
1995	16	O	MONTACUTIDAE	190.6667	23.2475	3
1995	15	C	MONTACUTIDAE	46.9333	5.0877	3
1995	17	O	MONTACUTIDAE	4.0000	4.0000	3
1995	18	C	MONTACUTIDAE	4.2667	1.1348	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	MONTACUTIDAE	70.2300	50.4640	3
1990	C	MONTACUTIDAE	19.0872	2.9054	3
1991	O	MONTACUTIDAE	155.0211	72.9228	3
1991	C	MONTACUTIDAE	50.9483	6.9454	3
1993	O	MONTACUTIDAE	249.0911	187.0561	3
1993	C	MONTACUTIDAE	43.3628	27.6465	3
1995	O	MONTACUTIDAE	211.4072	126.1608	3
1995	C	MONTACUTIDAE	49.2000	26.6207	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.960
1991	0.641
1993	0.586
1995	0.140

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.183	0.302	0.336

Taxa = TELLINIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	TELLINIDAE	0.0000	0.0000	3
1990	14	C	TELLINIDAE	0.0000	0.0000	3
1990	16	O	TELLINIDAE	4.3333	1.1667	3
1990	15	C	TELLINIDAE	0.0000	0.0000	3
1990	17	O	TELLINIDAE	44.0000	31.8957	3
1990	18	C	TELLINIDAE	108.0000	20.2320	3
1991	13	O	TELLINIDAE	8.8883	4.7507	3
1991	14	C	TELLINIDAE	5.5000	3.4034	3
1991	16	O	TELLINIDAE	7.5550	2.7040	3
1991	15	C	TELLINIDAE	0.0000	0.0000	3
1991	17	O	TELLINIDAE	50.7933	36.9454	3
1991	18	C	TELLINIDAE	123.8100	54.4199	3
1993	13	O	TELLINIDAE	0.2417	0.2417	3
1993	14	C	TELLINIDAE	0.0000	0.0000	3
1993	16	O	TELLINIDAE	5.3333	3.5277	3
1993	15	C	TELLINIDAE	0.9783	0.4951	3
1993	17	O	TELLINIDAE	28.8883	20.2845	3
1993	18	C	TELLINIDAE	179.6667	62.4082	3
1995	13	O	TELLINIDAE	3.8533	2.3280	3
1995	14	C	TELLINIDAE	1.0550	0.8178	3
1995	16	O	TELLINIDAE	3.5550	2.3519	3
1995	15	C	TELLINIDAE	2.4000	1.6653	3
1995	17	O	TELLINIDAE	10.2217	5.1260	3
1995	18	C	TELLINIDAE	116.4000	26.4791	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	TELLINIDAE	16.1111	14.0004	3
1990	C	TELLINIDAE	36.0000	36.0000	3
1991	O	TELLINIDAE	22.4122	14.1958	3
1991	C	TELLINIDAE	43.1033	40.3846	3
1993	O	TELLINIDAE	11.4878	8.8236	3
1993	C	TELLINIDAE	60.2150	59.7265	3
1995	O	TELLINIDAE	5.8767	2.1742	3
1995	C	TELLINIDAE	39.9517	38.2261	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.176
1991	0.934
1993	0.054
1995	0.063

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.293	0.000	0.367

Taxa = TURTONIIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	TURTONIIDAE	0.0000	0.0000	3
1990	14	C	TURTONIIDAE	0.0000	0.0000	3
1990	16	O	TURTONIIDAE	0.0000	0.0000	3
1990	15	C	TURTONIIDAE	0.0000	0.0000	3
1990	17	O	TURTONIIDAE	0.0000	0.0000	3
1990	18	C	TURTONIIDAE	0.0000	0.0000	3
1991	13	O	TURTONIIDAE	329.1117	144.9972	3
1991	14	C	TURTONIIDAE	0.0000	0.0000	3
1991	16	O	TURTONIIDAE	0.6667	0.6667	3
1991	15	C	TURTONIIDAE	0.8883	0.8883	3
1991	17	O	TURTONIIDAE	0.0000	0.0000	3
1991	18	C	TURTONIIDAE	0.0000	0.0000	3
1993	13	O	TURTONIIDAE	12.9083	12.5476	3
1993	14	C	TURTONIIDAE	0.0000	0.0000	3
1993	16	O	TURTONIIDAE	0.0000	0.0000	3
1993	15	C	TURTONIIDAE	0.0000	0.0000	3
1993	17	O	TURTONIIDAE	0.0000	0.0000	3
1993	18	C	TURTONIIDAE	0.0000	0.0000	3
1995	13	O	TURTONIIDAE	223.4083	218.3043	3
1995	14	C	TURTONIIDAE	0.0000	0.0000	3
1995	16	O	TURTONIIDAE	0.0000	0.0000	3
1995	15	C	TURTONIIDAE	1.6000	0.9238	3
1995	17	O	TURTONIIDAE	0.0000	0.0000	3
1995	18	C	TURTONIIDAE	0.0000	0.0000	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	TURTONIIDAE	0.0000	0.0000	3
1990	C	TURTONIIDAE	0.0000	0.0000	3
1991	O	TURTONIIDAE	109.9261	109.5929	3
1991	C	TURTONIIDAE	0.2961	0.2961	3
1993	O	TURTONIIDAE	4.3028	4.3028	3
1993	C	TURTONIIDAE	0.0000	0.0000	3
1995	O	TURTONIIDAE	74.4694	74.4694	3
1995	C	TURTONIIDAE	0.5333	0.5333	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	N/A
1991	0.351
1993	0.887
1995	0.298

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.792	0.959	0.434

Taxa = LACUNIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	LACUNIDAE	0.0000	0.0000	3
1990	14	C	LACUNIDAE	0.0000	0.0000	3
1990	16	O	LACUNIDAE	5.5000	5.5000	3
1990	15	C	LACUNIDAE	0.0000	0.0000	3
1990	17	O	LACUNIDAE	344.2217	154.3500	3
1990	18	C	LACUNIDAE	130.0000	27.0062	3
1991	13	O	LACUNIDAE	0.0000	0.0000	3
1991	14	C	LACUNIDAE	0.0000	0.0000	3
1991	16	O	LACUNIDAE	36.0000	36.0000	3
1991	15	C	LACUNIDAE	1.3333	1.3333	3
1991	17	O	LACUNIDAE	228.0483	92.1720	3
1991	18	C	LACUNIDAE	253.8733	91.2194	3
1993	13	O	LACUNIDAE	1.3333	1.3333	3
1993	14	C	LACUNIDAE	0.0000	0.0000	3
1993	16	O	LACUNIDAE	25.3333	13.1318	3
1993	15	C	LACUNIDAE	0.0000	0.0000	3
1993	17	O	LACUNIDAE	41.3333	19.3678	3
1993	18	C	LACUNIDAE	24.0667	4.4126	3
1995	13	O	LACUNIDAE	14.2217	10.4793	3
1995	14	C	LACUNIDAE	0.0000	0.0000	3
1995	16	O	LACUNIDAE	272.8883	53.0061	3
1995	15	C	LACUNIDAE	34.9333	2.5438	3
1995	17	O	LACUNIDAE	312.4433	85.2292	3
1995	18	C	LACUNIDAE	82.8667	19.8251	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	LACUNIDAE	116.5739	113.8350	3
1990	C	LACUNIDAE	43.3333	43.3333	3
1991	O	LACUNIDAE	88.0161	70.7832	3
1991	C	LACUNIDAE	85.0689	84.4031	3
1993	O	LACUNIDAE	22.6667	11.6237	3
1993	C	LACUNIDAE	8.0222	8.0222	3
1995	O	LACUNIDAE	199.8511	93.5145	3
1995	C	LACUNIDAE	39.2667	24.0195	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.258
1991	0.868
1993	0.353
1995	0.032

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.303	0.034	0.081

Taxa = RISSOIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	RISSOIDAE	0.0000	0.0000	3
1990	14	C	RISSOIDAE	2.3883	1.3064	3
1990	16	O	RISSOIDAE	3.1667	3.1667	3
1990	15	C	RISSOIDAE	0.0000	0.0000	3
1990	17	O	RISSOIDAE	29.5550	27.2558	3
1990	18	C	RISSOIDAE	4.0000	3.0551	3
1991	13	O	RISSOIDAE	233.3333	162.6574	3
1991	14	C	RISSOIDAE	24.8000	4.6876	3
1991	16	O	RISSOIDAE	59.3333	51.5407	3
1991	15	C	RISSOIDAE	5.3333	5.3333	3
1991	17	O	RISSOIDAE	2.0000	2.0000	3
1991	18	C	RISSOIDAE	180.4450	151.4388	3
1993	13	O	RISSOIDAE	38.6667	38.6667	3
1993	14	C	RISSOIDAE	0.0000	0.0000	3
1993	16	O	RISSOIDAE	0.0000	0.0000	3
1993	15	C	RISSOIDAE	0.0000	0.0000	3
1993	17	O	RISSOIDAE	0.0000	0.0000	3
1993	18	C	RISSOIDAE	0.0000	0.0000	3
1995	13	O	RISSOIDAE	29.3333	14.1324	3
1995	14	C	RISSOIDAE	6.0450	3.8995	3
1995	16	O	RISSOIDAE	39.5550	17.3902	3
1995	15	C	RISSOIDAE	107.4667	12.4992	3
1995	17	O	RISSOIDAE	1.3333	1.3333	3
1995	18	C	RISSOIDAE	2.1667	1.1667	3

Means by year and category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	RISSOIDAE	10.9072	9.3686	3
1990	C	RISSOIDAE	2.1294	1.1619	3
1991	O	RISSOIDAE	98.2222	69.5534	3
1991	C	RISSOIDAE	70.1928	55.4118	3
1993	O	RISSOIDAE	12.8889	12.8889	3
1993	C	RISSOIDAE	0.0000	0.0000	3
1995	O	RISSOIDAE	23.4072	11.4246	3
1995	C	RISSOIDAE	38.5594	34.4718	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.215
1991	0.800
1993	0.906
1995	0.258

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.990	0.810	0.654

Taxa = TROCHIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	TROCHIDAE	0.0000	0.0000	3
1990	14	C	TROCHIDAE	0.0075	0.0039	3
1990	16	O	TROCHIDAE	0.0000	0.0000	3
1990	15	C	TROCHIDAE	0.0000	0.0000	3
1990	17	O	TROCHIDAE	0.0000	0.0000	3
1990	18	C	TROCHIDAE	0.0000	0.0000	3
1991	13	O	TROCHIDAE	0.0493	0.0493	3
1991	14	C	TROCHIDAE	0.2117	0.0760	3
1991	16	O	TROCHIDAE	0.0227	0.0093	3
1991	15	C	TROCHIDAE	0.0427	0.0427	3
1991	17	O	TROCHIDAE	0.0015	0.0008	3
1991	18	C	TROCHIDAE	0.0000	0.0000	3
1993	13	O	TROCHIDAE	0.1368	0.0724	3
1993	14	C	TROCHIDAE	0.0213	0.0213	3
1993	16	O	TROCHIDAE	0.0307	0.0081	3
1993	15	C	TROCHIDAE	0.0059	0.0059	3
1993	17	O	TROCHIDAE	0.0040	0.0040	3
1993	18	C	TROCHIDAE	0.0000	0.0000	3
1995	13	O	TROCHIDAE	0.0307	0.0307	3
1995	14	C	TROCHIDAE	0.2759	0.0616	3
1995	16	O	TROCHIDAE	0.1089	0.0528	3
1995	15	C	TROCHIDAE	0.3269	0.1111	3
1995	17	O	TROCHIDAE	0.0000	0.0000	3
1995	18	C	TROCHIDAE	0.0012	0.0012	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	TROCHIDAE	0.0000	0.0000	3
1990	C	TROCHIDAE	0.0025	0.0025	3
1991	O	TROCHIDAE	0.0245	0.0138	3
1991	C	TROCHIDAE	0.0848	0.0647	3
1993	O	TROCHIDAE	0.0572	0.0406	3
1993	C	TROCHIDAE	0.0091	0.0064	3
1995	O	TROCHIDAE	0.0465	0.0324	3
1995	C	TROCHIDAE	0.2013	0.1012	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.352
1991	0.030
1993	0.606
1995	0.734

Two-way Randomized within blocks with %mud as covariate

P values are:

Interaction	Oilcode	Year
0.622	0.748	0.154

Taxa = COROPHIIDAE
Depth Stratum < 3 M

YEAR	SITE NUMBER	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	COROPHIIDAE	3.8667	1.2719	3
1990	14	C	COROPHIIDAE	2.4767	1.2492	3
1990	16	O	COROPHIIDAE	13.8333	5.1667	3
1990	15	C	COROPHIIDAE	0.6667	0.6667	3
1990	17	O	COROPHIIDAE	0.0000	0.0000	3
1990	18	C	COROPHIIDAE	4.0000	2.3094	3
1991	13	O	COROPHIIDAE	2.6667	1.7638	3
1991	14	C	COROPHIIDAE	5.8667	4.0354	3
1991	16	O	COROPHIIDAE	24.0000	12.2202	3
1991	15	C	COROPHIIDAE	57.3333	17.0229	3
1991	17	O	COROPHIIDAE	0.0000	0.0000	3
1991	18	C	COROPHIIDAE	14.0000	7.0238	3
1993	13	O	COROPHIIDAE	31.5750	2.9435	3
1993	14	C	COROPHIIDAE	18.6667	16.7066	3
1993	16	O	COROPHIIDAE	17.3333	1.3333	3
1993	15	C	COROPHIIDAE	32.4433	14.5319	3
1993	17	O	COROPHIIDAE	26.8883	12.7682	3
1993	18	C	COROPHIIDAE	0.0000	0.0000	3
1995	13	O	COROPHIIDAE	5.3333	5.3333	3
1995	14	C	COROPHIIDAE	18.0450	11.0230	3
1995	16	O	COROPHIIDAE	17.3333	2.6667	3
1995	15	C	COROPHIIDAE	14.1333	2.1828	3
1995	17	O	COROPHIIDAE	28.4450	8.0120	3
1995	18	C	COROPHIIDAE	1.0333	0.7965	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	COROPHIIDAE	5.9000	4.1207	3
1990	C	COROPHIIDAE	2.3811	0.9634	3
1991	O	COROPHIIDAE	8.8889	7.5947	3
1991	C	COROPHIIDAE	25.7333	15.9735	3
1993	O	COROPHIIDAE	25.2656	4.1905	3
1993	C	COROPHIIDAE	17.0367	9.4010	3
1995	O	COROPHIIDAE	17.0372	6.6734	3
1995	C	COROPHIIDAE	11.0706	5.1441	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.30
1991	0.06
1993	0.43
1995	0.40

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.33	0.09	0.79

Taxa = ISCHYROCERIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	ISCHYROCERIDAE	3.7150	1.4087	3
1990	14	C	ISCHYROCERIDAE	2.6033	0.8247	3
1990	16	O	ISCHYROCERIDAE	8.0000	6.1101	3
1990	15	C	ISCHYROCERIDAE	1.3333	1.3333	3
1990	17	O	ISCHYROCERIDAE	11.1117	2.5630	3
1990	18	C	ISCHYROCERIDAE	23.3333	14.3450	3
1991	13	O	ISCHYROCERIDAE	1.3333	1.3333	3
1991	14	C	ISCHYROCERIDAE	0.0000	0.0000	3
1991	16	O	ISCHYROCERIDAE	8.2217	1.8989	3
1991	15	C	ISCHYROCERIDAE	3.5550	1.9368	3
1991	17	O	ISCHYROCERIDAE	18.4933	2.8703	3
1991	18	C	ISCHYROCERIDAE	216.5717	28.5316	3
1993	13	O	ISCHYROCERIDAE	0.0000	0.0000	3
1993	14	C	ISCHYROCERIDAE	2.2217	1.1758	3
1993	16	O	ISCHYROCERIDAE	18.6667	8.1104	3
1993	15	C	ISCHYROCERIDAE	0.5333	0.5333	3
1993	17	O	ISCHYROCERIDAE	117.5550	63.4965	3
1993	18	C	ISCHYROCERIDAE	26.1117	9.0924	3
1995	13	O	ISCHYROCERIDAE	1.7783	1.7783	3
1995	14	C	ISCHYROCERIDAE	0.0000	0.0000	3
1995	16	O	ISCHYROCERIDAE	4.0000	2.3094	3
1995	15	C	ISCHYROCERIDAE	0.0000	0.0000	3
1995	17	O	ISCHYROCERIDAE	9.3333	9.3333	3
1995	18	C	ISCHYROCERIDAE	38.0000	7.9739	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	ISCHYROCERIDAE	7.6089	2.1442	3
1990	C	ISCHYROCERIDAE	9.0900	7.1311	3
1991	O	ISCHYROCERIDAE	9.3494	4.9857	3
1991	C	ISCHYROCERIDAE	73.3756	71.6054	3
1993	O	ISCHYROCERIDAE	45.4072	36.4741	3
1993	C	ISCHYROCERIDAE	9.6222	8.2591	3
1995	O	ISCHYROCERIDAE	5.0372	2.2418	3
1995	C	ISCHYROCERIDAE	12.6667	12.6667	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.607
1991	0.147
1993	0.126
1995	0.225

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.034	0.646	0.209

Taxa = ISAEIDAE
Depth Stratum = < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	ISAEIDAE	0.0000	0.0000	3
1990	14	C	ISAEIDAE	3.2783	1.6568	3
1990	16	O	ISAEIDAE	1.3333	1.3333	3
1990	15	C	ISAEIDAE	0.0000	0.0000	3
1990	17	O	ISAEIDAE	0.0000	0.0000	3
1990	18	C	ISAEIDAE	68.6667	32.5849	3
1991	13	O	ISAEIDAE	0.0000	0.0000	3
1991	14	C	ISAEIDAE	0.0000	0.0000	3
1991	16	O	ISAEIDAE	0.0000	0.0000	3
1991	15	C	ISAEIDAE	0.0000	0.0000	3
1991	17	O	ISAEIDAE	1.3333	1.3333	3
1991	18	C	ISAEIDAE	192.5400	77.3515	3
1993	13	O	ISAEIDAE	0.9083	0.5846	3
1993	14	C	ISAEIDAE	1.3333	1.3333	3
1993	16	O	ISAEIDAE	4.0000	2.3094	3
1993	15	C	ISAEIDAE	0.8883	0.8883	3
1993	17	O	ISAEIDAE	0.0000	0.0000	3
1993	18	C	ISAEIDAE	63.2433	32.1371	3
1995	13	O	ISAEIDAE	0.0000	0.0000	3
1995	14	C	ISAEIDAE	3.2000	2.4440	3
1995	16	O	ISAEIDAE	10.2217	5.1253	3
1995	15	C	ISAEIDAE	1.8667	1.8667	3
1995	17	O	ISAEIDAE	19.5550	11.5556	3
1995	18	C	ISAEIDAE	98.4333	31.0439	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	ISAEIDAE	0.4444	0.4444	3
1990	C	ISAEIDAE	23.9817	22.3625	3
1991	O	ISAEIDAE	0.4444	0.4444	3
1991	C	ISAEIDAE	64.1800	64.1800	3
1993	O	ISAEIDAE	1.6361	1.2107	3
1993	C	ISAEIDAE	21.8217	20.7112	3
1995	O	ISAEIDAE	9.9256	5.6470	3
1995	C	ISAEIDAE	34.5000	31.9690	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.067
1991	0.033
1993	0.040
1995	0.191

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.871	0.000	0.539

Taxa = PHOXOCEPHALIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXA NAME	MEAN	SE	N STATIONS
1990	13	O	PHOXOCEPHALIDAE	0.0000	0.0000	3
1990	14	C	PHOXOCEPHALIDAE	0.0000	0.0000	3
1990	16	O	PHOXOCEPHALIDAE	0.0000	0.0000	3
1990	15	C	PHOXOCEPHALIDAE	0.0000	0.0000	3
1990	17	O	PHOXOCEPHALIDAE	0.6667	0.6667	3
1990	18	C	PHOXOCEPHALIDAE	112.6667	34.8393	3
1991	13	O	PHOXOCEPHALIDAE	0.0000	0.0000	3
1991	14	C	PHOXOCEPHALIDAE	0.0000	0.0000	3
1991	16	O	PHOXOCEPHALIDAE	0.0000	0.0000	3
1991	15	C	PHOXOCEPHALIDAE	0.0000	0.0000	3
1991	17	O	PHOXOCEPHALIDAE	7.4283	1.8367	3
1991	18	C	PHOXOCEPHALIDAE	129.7783	17.7278	3
1993	13	O	PHOXOCEPHALIDAE	0.0000	0.0000	3
1993	14	C	PHOXOCEPHALIDAE	0.0000	0.0000	3
1993	16	O	PHOXOCEPHALIDAE	0.0000	0.0000	3
1993	15	C	PHOXOCEPHALIDAE	0.0000	0.0000	3
1993	17	O	PHOXOCEPHALIDAE	20.6667	10.9747	3
1993	18	C	PHOXOCEPHALIDAE	98.2000	20.4981	3
1995	13	O	PHOXOCEPHALIDAE	0.0000	0.0000	3
1995	14	C	PHOXOCEPHALIDAE	0.0000	0.0000	3
1995	16	O	PHOXOCEPHALIDAE	0.0000	0.0000	3
1995	15	C	PHOXOCEPHALIDAE	0.0000	0.0000	3
1995	17	O	PHOXOCEPHALIDAE	25.3333	13.5319	3
1995	18	C	PHOXOCEPHALIDAE	173.0667	40.2296	3

Means by year and oiling category

YEAR	OILCODE	TAXA NAME	MEAN	SE	N SITES
1990	O	PHOXOCEPHALIDAE	0.2222	0.2222	3
1990	C	PHOXOCEPHALIDAE	37.5556	37.5556	3
1991	O	PHOXOCEPHALIDAE	2.4761	2.4761	3
1991	C	PHOXOCEPHALIDAE	43.2594	43.2594	3
1993	O	PHOXOCEPHALIDAE	6.8889	6.8889	3
1993	C	PHOXOCEPHALIDAE	32.7333	32.7333	3
1995	O	PHOXOCEPHALIDAE	8.4444	8.4444	3
1995	C	PHOXOCEPHALIDAE	57.6889	57.6889	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.0004
1991	0.0029
1993	0.0037
1995	0.0051

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.873	0.000	0.823

Taxa = SPIRORBIDAE
Depth Stratum < 3 M

YEAR	SITE NUMBER	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	SPIRORBIDAE	284.6233	126.4776	3
1990	14	C	SPIRORBIDAE	49.7850	4.6859	3
1990	16	O	SPIRORBIDAE	396.0000	91.2433	3
1990	15	C	SPIRORBIDAE	188.2217	27.5211	3
1990	17	O	SPIRORBIDAE	430.6667	183.9577	3
1990	18	C	SPIRORBIDAE	2.6667	2.6667	3
1991	13	O	SPIRORBIDAE	196.8900	112.1847	3
1991	14	C	SPIRORBIDAE	95.7333	53.8449	3
1991	16	O	SPIRORBIDAE	291.7783	94.9242	3
1991	15	C	SPIRORBIDAE	376.4450	76.7119	3
1991	17	O	SPIRORBIDAE	382.3817	163.8531	3
1991	18	C	SPIRORBIDAE	0.0000	0.0000	3
1993	13	O	SPIRORBIDAE	256.0600	116.1019	3
1993	14	C	SPIRORBIDAE	161.3333	67.0257	3
1993	16	O	SPIRORBIDAE	981.3333	415.8611	3
1993	15	C	SPIRORBIDAE	49.1550	14.2243	3
1993	17	O	SPIRORBIDAE	948.4450	176.1516	3
1993	18	C	SPIRORBIDAE	0.5333	0.5333	3
1995	13	O	SPIRORBIDAE	59.8517	59.8517	3
1995	14	C	SPIRORBIDAE	106.4433	5.5416	3
1995	16	O	SPIRORBIDAE	764.8883	360.4472	3
1995	15	C	SPIRORBIDAE	2668.0000	1045.8158	3
1995	17	O	SPIRORBIDAE	39.5567	12.5149	3
1995	18	C	SPIRORBIDAE	0.7667	0.4333	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	SPIRORBIDAE	370.4300	44.0550	3
1990	C	SPIRORBIDAE	80.2244	55.6854	3
1991	O	SPIRORBIDAE	290.3500	53.5516	3
1991	C	SPIRORBIDAE	157.3928	112.9589	3
1993	O	SPIRORBIDAE	728.6128	236.4671	3
1993	C	SPIRORBIDAE	70.3406	47.6123	3
1995	O	SPIRORBIDAE	288.0989	238.4667	3
1995	C	SPIRORBIDAE	925.0700	871.9988	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	<0.01
1991	0.21
1993	<0.01
1995	0.18

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
<0.01	0.52	0.30

Taxa = MYTILIDAE
Depth Stratum < 3 M)

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	MYTILIDAE	1.1433	1.1433	3
1990	14	C	MYTILIDAE	0.1667	0.1667	3
1990	16	O	MYTILIDAE	178.1667	166.2308	3
1990	15	C	MYTILIDAE	0.6667	0.6667	3
1990	17	O	MYTILIDAE	309.2767	112.8444	3
1990	18	C	MYTILIDAE	38.0000	20.2320	3
1991	13	O	MYTILIDAE	37.5550	13.2906	3
1991	14	C	MYTILIDAE	5.8667	3.4667	3
1991	16	O	MYTILIDAE	514.4450	443.8583	3
1991	15	C	MYTILIDAE	5.7783	5.7783	3
1991	17	O	MYTILIDAE	789.3167	118.2945	3
1991	18	C	MYTILIDAE	189.5867	25.2126	3
1993	13	O	MYTILIDAE	82.4850	49.6302	3
1993	14	C	MYTILIDAE	5.3333	0.7693	3
1993	16	O	MYTILIDAE	1968.0000	451.7699	3
1993	15	C	MYTILIDAE	4.4450	1.9368	3
1993	17	O	MYTILIDAE	136.6667	57.3450	3
1993	18	C	MYTILIDAE	39.3117	25.5119	3
1995	13	O	MYTILIDAE	70.5183	61.2097	3
1995	14	C	MYTILIDAE	0.0000	0.0000	3
1995	16	O	MYTILIDAE	778.6667	71.4174	3
1995	15	C	MYTILIDAE	1.6000	0.0000	3
1995	17	O	MYTILIDAE	169.3350	43.4706	3
1995	18	C	MYTILIDAE	8.9667	4.8254	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	MYTILIDAE	162.8622	89.2790	3
1990	C	MYTILIDAE	12.9444	12.5286	3
1991	O	MYTILIDAE	447.1056	219.6113	3
1991	C	MYTILIDAE	67.0772	61.2547	3
1993	O	MYTILIDAE	729.0506	619.6721	3
1993	C	MYTILIDAE	16.3633	11.4770	3
1995	O	MYTILIDAE	339.5067	221.4252	3
1995	C	MYTILIDAE	3.5222	2.7611	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	<0.01
1991	<0.01
1993	<0.01
1995	<0.01

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.32	<0.01	0.27

Taxa = CAPRELLIDAE
Depth Stratum < 3 M

Means by year and site

YEAR	SITE NUMBER	OILCODE	TAXANAME	MEAN	SE	N STATIONS
1990	13	O	CAPRELLIDAE	0.3817	0.3817	3
1990	14	C	CAPRELLIDAE	26.9917	9.2942	3
1990	16	O	CAPRELLIDAE	152.0000	44.0606	3
1990	15	C	CAPRELLIDAE	9.3333	5.3333	3
1990	17	O	CAPRELLIDAE	4.4450	1.2375	3
1990	18	C	CAPRELLIDAE	246.6667	120.4676	3
1991	13	O	CAPRELLIDAE	0.0000	0.0000	3
1991	14	C	CAPRELLIDAE	47.4667	19.6846	3
1991	16	O	CAPRELLIDAE	257.3333	109.1380	3
1991	15	C	CAPRELLIDAE	93.3333	45.8597	3
1991	17	O	CAPRELLIDAE	65.0883	38.1228	3
1991	18	C	CAPRELLIDAE	557.6500	107.8342	3
1993	13	O	CAPRELLIDAE	35.8183	10.4115	3
1993	14	C	CAPRELLIDAE	83.7783	24.9810	3
1993	16	O	CAPRELLIDAE	574.6667	102.4847	3
1993	15	C	CAPRELLIDAE	64.2667	6.9257	3
1993	17	O	CAPRELLIDAE	1316.6667	430.6218	3
1993	18	C	CAPRELLIDAE	362.6450	149.8171	3
1995	13	O	CAPRELLIDAE	19.8517	19.4084	3
1995	14	C	CAPRELLIDAE	60.5333	12.8900	3
1995	16	O	CAPRELLIDAE	105.7783	9.1190	3
1995	15	C	CAPRELLIDAE	83.2000	15.6154	3
1995	17	O	CAPRELLIDAE	141.7783	45.0535	3
1995	18	C	CAPRELLIDAE	78.5333	27.8989	3

Means by year and oiling category

YEAR	OILCODE	TAXANAME	MEAN	SE	N SITES
1990	O	CAPRELLIDAE	52.2756	49.8760	3
1990	C	CAPRELLIDAE	94.3306	76.3384	3
1991	O	CAPRELLIDAE	107.4739	77.2496	3
1991	C	CAPRELLIDAE	232.8167	162.9555	3
1993	O	CAPRELLIDAE	642.3839	371.2961	3
1993	C	CAPRELLIDAE	170.2300	96.3722	3
1995	O	CAPRELLIDAE	89.1361	36.1674	3
1995	C	CAPRELLIDAE	74.0889	6.9104	3

One-way Randomized within blocks with %mud as covariate

YEAR	P for oil code
1990	0.55
1991	0.27
1993	0.04
1995	0.54

Two-way Randomized within blocks with %mud as covariate

P values for:

Interaction	Oilcode	Year
0.003	0.306	<0.01

Appendix Q.

Mean densities of *Musculus* (No. per turion) on eelgrass turions and results of randomization ANOVAs.

Appendix Q. Mean densities of *Musculus* (No.per turion)on eelgrass turions and results of randomization ANOVAs.

Mean Densities of Musculus spp. on eelgrass blades
Depth Stratum < 3 M

Means by year and site

VARNAME	YEAR	SITNUM	OILCODE	CLPL	SE	N STATIONS
Musculus Density per Turion	1991	13	O	3.643	2.858	3
Musculus Density per Turion	1991	14	C	0.100	0.053	3
Musculus Density per Turion	1991	16	O	124.362	108.049	3
Musculus Density per Turion	1991	15	C	0.042	0.042	3
Musculus Density per Turion	1991	17	O	139.833	24.123	3
Musculus Density per Turion	1991	18	C	0.811	0.264	3
Musculus Density per Turion	1993	13	O	2.883	1.394	3
Musculus Density per Turion	1993	14	C	0.033	0.017	3
Musculus Density per Turion	1993	16	O	185.533	18.945	3
Musculus Density per Turion	1993	15	C	0.000	0.000	3
Musculus Density per Turion	1993	17	O	3.333	1.210	3
Musculus Density per Turion	1993	18	C	0.250	0.076	3
Musculus Density per Turion	1995	13	O	1.300	1.250	3
Musculus Density per Turion	1995	14	C	0.067	0.067	3
Musculus Density per Turion	1995	16	O	68.000	19.079	3
Musculus Density per Turion	1995	15	C	0.000	0.000	3
Musculus Density per Turion	1995	17	O	7.217	1.539	3
Musculus Density per Turion	1995	18	C	0.550	0.208	3

Means by year and oiling category

VARNAME	YEAR	OILCODE	MEAN	SE	N SITES
Musculus Density per Turion	1991	O	89.28	43.05	3
Musculus Density per Turion	1991	C	0.32	0.25	3
Musculus Density per Turion	1993	O	63.92	60.81	3
Musculus Density per Turion	1993	C	0.09	0.08	3
Musculus Density per Turion	1995	O	25.51	21.32	3
Musculus Density per Turion	1995	C	0.21	0.17	3

One-way randomized within blocks

YEAR	P for oil code
1991	0.009
1993	0.000
1995	0.003

Two-way randomized within blocks

P values for:

Interaction	Oilcode	Year
0.000	0.000	0.388

Appendix R.

Mean densities (No. 100 m^{-2}) of large benthic invertebrates and results of randomization ANOVAs.

Appendix R. Mean densities (No.100 m^{-2}) of large benthic invertebrates and results of randomization ANOVAs.

Pycnopodia helianthoides - juveniles
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXA	MEAN	SE	N STATIONS
1990	13	O	Pycnopodia Juv./100m2	2.78	2.003	3
1990	14	C	Pycnopodia Juv./100m2	5.56	2.778	3
1990	16	O	Pycnopodia Juv./100m2	1.67	0.962	3
1990	15	C	Pycnopodia Juv./100m2	0.00	0.000	3
1990	17	O	Pycnopodia Juv./100m2	2.22	1.470	3
1990	18	C	Pycnopodia Juv./100m2	0.00	0.000	3
1991	13	O	Pycnopodia Juv./100m2	26.67	12.019	3
1991	14	C	Pycnopodia Juv./100m2	36.11	11.954	3
1991	16	O	Pycnopodia Juv./100m2	32.22	19.868	3
1991	15	C	Pycnopodia Juv./100m2	25.56	3.379	3
1991	17	O	Pycnopodia Juv./100m2	19.44	13.687	3
1991	18	C	Pycnopodia Juv./100m2	52.22	7.222	3
1993	13	O	Pycnopodia Juv./100m2	423.33	373.333	3
1993	14	C	Pycnopodia Juv./100m2	130.00	41.141	3
1993	16	O	Pycnopodia Juv./100m2	0.00	0.000	3
1993	15	C	Pycnopodia Juv./100m2	135.56	115.700	3
1993	17	O	Pycnopodia Juv./100m2	5.56	1.111	3
1993	18	C	Pycnopodia Juv./100m2	10.00	3.849	3
1995	13	O	Pycnopodia Juv./100m2	24.44	24.444	3
1995	14	C	Pycnopodia Juv./100m2	82.22	9.095	3
1995	16	O	Pycnopodia Juv./100m2	8.89	2.940	3
1995	15	C	Pycnopodia Juv./100m2	10.00	6.939	3
1995	17	O	Pycnopodia Juv./100m2	12.22	4.006	3
1995	18	C	Pycnopodia Juv./100m2	4.44	1.111	3

Means by year and oiling category

YEAR	DEPTH	OILCODE	TAXA	MEAN	SE	N SITES
1990	Shallow-Bed	C	Pycnopodia Juv./100m2	1.85	1.852	3
1990	Shallow-Bed	O	Pycnopodia Juv./100m2	2.22	0.321	3
1991	Shallow-Bed	C	Pycnopodia Juv./100m2	37.96	7.753	3
1991	Shallow-Bed	O	Pycnopodia Juv./100m2	26.11	3.699	3
1993	Shallow-Bed	C	Pycnopodia Juv./100m2	91.85	40.957	3
1993	Shallow-Bed	O	Pycnopodia Juv./100m2	142.96	140.194	3
1995	Shallow-Bed	C	Pycnopodia Juv./100m2	32.22	25.051	3
1995	Shallow-Bed	O	Pycnopodia Juv./100m2	15.19	4.729	3

One-way randomized within blocks

YEAR	P for oil code
1990	0.78
1991	0.58
1993	0.99
1995	0.29

Two-way randomized within blocks

P values for:

Interaction	Oilcode	Year
0.000	0.000	0.000

Pycnopodia helianthoides - adults
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXA	MEAN	SE	N STATIONS
1990	13	O	Pycnopodia adults/100m2	1.67	0.962	3
1990	14	C	Pycnopodia adults/100m2	4.44	2.222	3
1990	16	O	Pycnopodia adults/100m2	1.67	0.000	3
1990	15	C	Pycnopodia adults/100m2	1.67	0.962	3
1990	17	O	Pycnopodia adults/100m2	2.78	2.003	3
1990	18	C	Pycnopodia adults/100m2	6.67	2.546	3
1991	13	O	Pycnopodia adults/100m2	3.33	1.925	3
1991	14	C	Pycnopodia adults/100m2	8.33	3.333	3
1991	16	O	Pycnopodia adults/100m2	4.44	1.470	3
1991	15	C	Pycnopodia adults/100m2	3.89	1.111	3
1991	17	O	Pycnopodia adults/100m2	2.22	1.470	3
1991	18	C	Pycnopodia adults/100m2	6.11	2.778	3
1993	13	O	Pycnopodia adults/100m2	17.22	1.470	3
1993	14	C	Pycnopodia adults/100m2	2.78	1.470	3
1993	16	O	Pycnopodia adults/100m2	0.56	0.556	3
1993	15	C	Pycnopodia adults/100m2	2.22	0.556	3
1993	17	O	Pycnopodia adults/100m2	3.33	0.000	3
1993	18	C	Pycnopodia adults/100m2	2.22	1.111	3
1995	13	O	Pycnopodia adults/100m2	7.22	7.222	3
1995	14	C	Pycnopodia adults/100m2	1.11	0.556	3
1995	16	O	Pycnopodia adults/100m2	4.44	1.470	3
1995	15	C	Pycnopodia adults/100m2	2.22	1.470	3
1995	17	O	Pycnopodia adults/100m2	13.33	6.009	3
1995	18	C	Pycnopodia adults/100m2	3.89	1.470	3

Means by year and oiling category

YEAR	DEPTH	OILCODE	TAXA	MEAN	SE	N SITES
1990	Shallow-Bed	C	Pycnopodia adults/100m2	4.26	1.446	3
1990	Shallow-Bed	O	Pycnopodia adults/100m2	2.04	0.370	3
1991	Shallow-Bed	C	Pycnopodia adults/100m2	6.11	1.283	3
1991	Shallow-Bed	O	Pycnopodia adults/100m2	3.33	0.642	3
1993	Shallow-Bed	C	Pycnopodia adults/100m2	2.41	0.185	3
1993	Shallow-Bed	O	Pycnopodia adults/100m2	7.04	5.155	3
1995	Shallow-Bed	C	Pycnopodia adults/100m2	2.41	0.807	3
1995	Shallow-Bed	O	Pycnopodia adults/100m2	8.33	2.625	3

One-way randomized within blocks

YEAR	P for oil code
1990	0.38
1991	0.22
1993	0.15
1995	0.09

Two-way randomized within blocks

Interaction	Oilcode	Year
0.007	0.273	0.626

Telmessus cheriagonus
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXA	MEAN	SE	N STATIONS
1990	13	O	Telmessus/100m2	0.00	0.000	3
1990	14	C	Telmessus/100m2	0.56	0.556	3
1990	16	O	Telmessus/100m2	1.11	0.556	3
1990	15	C	Telmessus/100m2	5.00	1.667	3
1990	17	O	Telmessus/100m2	0.56	0.556	3
1990	18	C	Telmessus/100m2	3.89	2.422	3
1991	13	O	Telmessus/100m2	2.78	0.556	3
1991	14	C	Telmessus/100m2	2.78	2.003	3
1991	16	O	Telmessus/100m2	1.11	0.556	3
1991	15	C	Telmessus/100m2	3.89	1.111	3
1991	17	O	Telmessus/100m2	0.56	0.556	3
1991	18	C	Telmessus/100m2	0.56	0.556	3
1993	13	O	Telmessus/100m2	0.00	0.000	3
1993	14	C	Telmessus/100m2	0.00	0.000	3
1993	16	O	Telmessus/100m2	0.56	0.556	3
1993	15	C	Telmessus/100m2	1.67	0.000	3
1993	17	O	Telmessus/100m2	0.00	0.000	3
1993	18	C	Telmessus/100m2	0.00	0.000	3
1995	13	O	Telmessus/100m2	0.00	0.000	3
1995	14	C	Telmessus/100m2	0.56	0.556	3
1995	16	O	Telmessus/100m2	0.00	0.000	3
1995	15	C	Telmessus/100m2	0.56	0.556	3
1995	17	O	Telmessus/100m2	0.56	0.556	3
1995	18	C	Telmessus/100m2	0.56	0.556	3

Means by year and oiling category

YEAR	DEPTH	OILCODE	TAXA	MEAN	SE	N SITES
1990	Shallow-Bed	C	Telmessus/100m2	3.15	1.335	3
1990	Shallow-Bed	O	Telmessus/100m2	0.56	0.321	3
1991	Shallow-Bed	C	Telmessus/100m2	2.41	0.980	3
1991	Shallow-Bed	O	Telmessus/100m2	1.48	0.668	3
1993	Shallow-Bed	C	Telmessus/100m2	0.56	0.556	3
1993	Shallow-Bed	O	Telmessus/100m2	0.19	0.185	3
1995	Shallow-Bed	C	Telmessus/100m2	0.56	0.000	3
1995	Shallow-Bed	O	Telmessus/100m2	0.19	0.185	3

One-way randomized within blocks

YEAR	P for oil code
1990	0.01
1991	0.32
1993	<0.01
1995	0.08

Two-way randomized within blocks

P values for:

Interaction	Oilcode	Year
0.244	0.016.	0.001

Dermasterias imbricata
Depth Stratum < 3 M

Means by year and site

YEAR	SITNUM	OILCODE	TAXA	MEAN	SE	N STATIONS
1990	13	O	Dermasterias/100m2	0.56	0.556	3
1990	14	C	Dermasterias/100m2	1.11	0.556	3
1990	16	O	Dermasterias/100m2	0.56	0.556	3
1990	15	C	Dermasterias/100m2	5.56	1.470	3
1990	17	O	Dermasterias/100m2	1.67	0.962	3
1990	18	C	Dermasterias/100m2	0.56	0.556	3
1991	13	O	Dermasterias/100m2	2.78	2.003	3
1991	14	C	Dermasterias/100m2	8.33	3.333	3
1991	16	O	Dermasterias/100m2	1.11	0.556	3
1991	15	C	Dermasterias/100m2	10.00	3.849	3
1991	17	O	Dermasterias/100m2	1.67	0.962	3
1991	18	C	Dermasterias/100m2	0.00	0.000	3
1993	13	O	Dermasterias/100m2	2.78	2.003	3
1993	14	C	Dermasterias/100m2	7.78	4.339	3
1993	16	O	Dermasterias/100m2	0.00	0.000	3
1993	15	C	Dermasterias/100m2	6.67	4.194	3
1993	17	O	Dermasterias/100m2	2.22	1.470	3
1993	18	C	Dermasterias/100m2	0.00	0.000	3
1995	13	O	Dermasterias/100m2	0.56	0.556	3
1995	14	C	Dermasterias/100m2	6.67	5.853	3
1995	16	O	Dermasterias/100m2	0.00	0.000	3
1995	15	C	Dermasterias/100m2	0.00	0.000	3
1995	17	O	Dermasterias/100m2	2.22	2.222	3
1995	18	C	Dermasterias/100m2	0.56	0.556	3

Means by year and oiling category

YEAR	DEPTH	OILCODE	TAXA	MEAN	SE	N SITES
1990	Shallow-Bed	C	Dermasterias/100m2	2.41	1.582	3
1990	Shallow-Bed	O	Dermasterias/100m2	0.93	0.370	3
1991	Shallow-Bed	C	Dermasterias/100m2	6.11	3.093	3
1991	Shallow-Bed	O	Dermasterias/100m2	1.85	0.490	3
1993	Shallow-Bed	C	Dermasterias/100m2	4.81	2.429	3
1993	Shallow-Bed	O	Dermasterias/100m2	1.67	0.849	3
1995	Shallow-Bed	C	Dermasterias/100m2	2.41	2.136	3
1995	Shallow-Bed	O	Dermasterias/100m2	0.93	0.668	3

One-way randomized within blocks

YEAR	P for oil code
1990	0.17
1991	0.09
1993	0.19
1995	0.52

Two-way randomized within blocks

P values for:

Interaction	Oilcode	Year
0.674	0.004	0.257

Appendix S.

Mean densities (No. 100 m^2) of cod and results of randomization ANOVAs.

Density of Juvenile Cod (Gaddidae, excluding pollock)
Depth stratum < 3 M

Means by year and site

TRANSECT	YEAR	GROUP	STAGE	SITNUM	OILCODE	MEAN	SE	N STATIONS
3	1990	Gadidae without Pollock	J	13	O	5.00	0.00	3
3	1990	Gadidae without Pollock	J	14	C	2.78	2.00	3
3	1990	Gadidae without Pollock	J	16	O	137.78	57.91	3
3	1990	Gadidae without Pollock	J	15	C	11.67	0.96	3
3	1990	Gadidae without Pollock	J	17	O	161.11	88.24	3
3	1990	Gadidae without Pollock	J	18	C	13.33	5.09	3
3	1991	Gadidae without Pollock	J	13	O	4.44	3.64	3
3	1991	Gadidae without Pollock	J	14	C	6.67	5.00	3
3	1991	Gadidae without Pollock	J	16	O	108.89	33.23	3
3	1991	Gadidae without Pollock	J	15	C	1.11	1.11	3
3	1991	Gadidae without Pollock	J	17	O	775.56	254.33	3
3	1991	Gadidae without Pollock	J	18	C	0.00	0.00	3
3	1993	Gadidae without Pollock	J	13	O	22.22	18.99	3
3	1993	Gadidae without Pollock	J	14	C	10.00	10.00	3
3	1993	Gadidae without Pollock	J	16	O	91.11	36.12	3
3	1993	Gadidae without Pollock	J	15	C	6.67	3.33	3
3	1993	Gadidae without Pollock	J	17	O	92.22	16.81	3
3	1993	Gadidae without Pollock	J	18	C	7.78	2.22	3
3	1995	Gadidae without Pollock	J	13	O	4.44	2.22	3
3	1995	Gadidae without Pollock	J	14	C	51.11	27.03	3
3	1995	Gadidae without Pollock	J	16	O	1.11	1.11	3
3	1995	Gadidae without Pollock	J	15	C	17.78	11.76	3
3	1995	Gadidae without Pollock	J	17	O	653.33	513.69	3
3	1995	Gadidae without Pollock	J	18	C	141.11	137.79	3

Means by year and oiling category

TRANSECT	YEAR	GROUP	STAGE	OILCODE	MEAN	SE	N SITES
3	1990	Gadidae without Pollock	J	O	101.30	48.62	3
3	1990	Gadidae without Pollock	J	C	9.26	3.28	3
3	1991	Gadidae without Pollock	J	O	296.30	241.52	3
3	1991	Gadidae without Pollock	J	C	2.59	2.06	3
3	1993	Gadidae without Pollock	J	O	68.52	23.15	3
3	1993	Gadidae without Pollock	J	C	8.15	0.98	3
3	1995	Gadidae without Pollock	J	O	219.63	216.85	3
3	1995	Gadidae without Pollock	J	C	70.00	36.83	3

One-way randomized within blocks

YEAR	P for oil code
1990	0.004
1991	0.025
1993	0.020
1995	0.710

Two-way randomized within blocks

P value for:

Interaction	Oilcode	Year
0.589	0.000	0.023

Density of Juvenile Cod (Gaddidae, excluding pollock)
Depth stratum < 3 M

Means by year and site

TRANSECT	YEAR	GROUP	STAGE	SITNUM	OILCODE	MEAN	SE	N STATIONS
3	1990	Gadidae without Pollock	J	13	O	5.00	0.00	3
3	1990	Gadidae without Pollock	J	14	C	2.78	2.00	3
3	1990	Gadidae without Pollock	J	16	O	137.78	57.91	3
3	1990	Gadidae without Pollock	J	15	C	11.67	0.96	3
3	1990	Gadidae without Pollock	J	17	O	161.11	88.24	3
3	1990	Gadidae without Pollock	J	18	C	13.33	5.09	3
3	1991	Gadidae without Pollock	J	13	O	4.44	3.64	3
3	1991	Gadidae without Pollock	J	14	C	6.67	5.00	3
3	1991	Gadidae without Pollock	J	16	O	108.89	33.23	3
3	1991	Gadidae without Pollock	J	15	C	1.11	1.11	3
3	1991	Gadidae without Pollock	J	17	O	775.56	254.33	3
3	1991	Gadidae without Pollock	J	18	C	0.00	0.00	3
3	1993	Gadidae without Pollock	J	13	O	22.22	18.99	3
3	1993	Gadidae without Pollock	J	14	C	10.00	10.00	3
3	1993	Gadidae without Pollock	J	16	O	91.11	36.12	3
3	1993	Gadidae without Pollock	J	15	C	6.67	3.33	3
3	1993	Gadidae without Pollock	J	17	O	92.22	16.81	3
3	1993	Gadidae without Pollock	J	18	C	7.78	2.22	3
3	1995	Gadidae without Pollock	J	13	O	4.44	2.22	3
3	1995	Gadidae without Pollock	J	14	C	51.11	27.03	3
3	1995	Gadidae without Pollock	J	16	O	1.11	1.11	3
3	1995	Gadidae without Pollock	J	15	C	17.78	11.76	3
3	1995	Gadidae without Pollock	J	17	O	653.33	513.69	3
3	1995	Gadidae without Pollock	J	18	C	141.11	137.79	3

Means by year and oiling category

TRANSECT	YEAR	GROUP	STAGE	OILCODE	MEAN	SE	N SITES
3	1990	Gadidae without Pollock	J	O	101.30	48.62	3
3	1990	Gadidae without Pollock	J	C	9.26	3.28	3
3	1991	Gadidae without Pollock	J	O	296.30	241.52	3
3	1991	Gadidae without Pollock	J	C	2.59	2.06	3
3	1993	Gadidae without Pollock	J	O	68.52	23.15	3
3	1993	Gadidae without Pollock	J	C	8.15	0.98	3
3	1995	Gadidae without Pollock	J	O	219.63	216.85	3
3	1995	Gadidae without Pollock	J	C	70.00	36.83	3

One-way randomized within blocks

YEAR	P for oil code
1990	0.004
1991	0.025
1993	0.020
1995	0.710

Two-way randomized within blocks

P value for:

Interaction	Oilcode	Year
0.589	0.000	0.023