Initial Study: Exception to the California Ocean Plan for the Hopkins Marine Station Discharge into the Pacific Grove Area of Special Biological Significance.

Appendices

- Appendix A – 1979 Recon Survey SWRCB Species List
- Appendix B – PISCO Survey species lists
- Appendix C – ASBS Natural Water Quality Committee Summation of Findings
- Appendix D – Mussel Watch Bioaccumulation Data
- Appendix E – List of Species maintained at HMS
- Appendix F – Best Management Practices (BMPs)

Appendix A – 1979 Recon Survey SWRCB

http://www.swrcb.ca.gov/publications_forms/publications/general/docs/asbs_pacificgrove.pdf

Species Name	ASBS	Habitat	Survey Date
Abietinaria sp.	19	rocky subtidal	01-Apr-1979
Abietinaria sp.	19	sandy intertidal	01-Apr-1979
Acanthina spirata	19	sandy intertidal	01-Apr-1979
Acanthodoris hudsoni	19	sandy intertidal	01-Apr-1979
Acarnus erithacus	19	rocky subtidal	01-Apr-1979
Acarnus erithacus	19	sandy intertidal	01-Apr-1979
Aegires albopunctatus	19	sandy intertidal	01-Apr-1979
Aglaophenia sp.	19	rocky subtidal	01-Apr-1979
Aglaophenia sp.	19	sandy intertidal	01-Apr-1979
Ahnfeltia plicata	19	rocky intertidal	01-Apr-1979
Alaria marginata	19	rocky intertidal	01-Apr-1979
Alpheus dentipes	19	sandy intertidal	01-Apr-1979
Alpheus sp.	19	rocky subtidal	01-Apr-1979
Alpheus sp.	19	sandy intertidal	01-Apr-1979
Amphiodia occidentalis	19	sandy intertidal	01-Apr-1979
Amphissa versicolor	19	sandy intertidal	01-Apr-1979
Amplisiphonia pacifica	19	rocky intertidal	01-Apr-1979
Analipus japonicus	19	rocky intertidal	01-Apr-1979
Ancula pacifica	19	sandy intertidal	01-Apr-1979
Anisocladella pacifica	19	rocky intertidal	01-Apr-1979
Anisodoris nobilis	19	rocky subtidal	01-Apr-1979
Anisodoris nobilis	19	sandy intertidal	01-Apr-1979
Anthopleura artemisia	19	rocky subtidal	01-Apr-1979
Anthopleura elegantissima	19	rocky subtidal	01-Apr-1979
Anthopleura elegantissima	19	sandy intertidal	01-Apr-1979
Anthopleura xanthogrammica	19	rocky subtidal	01-Apr-1979
Anthopleura xanthogrammica	19	sandy intertidal	01-Apr-1979
Antithamnion defectum	19	rocky intertidal	01-Apr-1979
Antithamnion kylinii	19	rocky intertidal	01-Apr-1979
Antithamnionella glandulifera	19	rocky intertidal	01-Apr-1979
Antithamnionella pacifica uncinata	19	rocky intertidal	01-Apr-1979
Aplidium arenatum	19	sandy intertidal	01-Apr-1979
Aplidium californicum	19	sandy intertidal	01-Apr-1979
Aplidium solidum	19	sandy intertidal	01-Apr-1979
Aplidium sp.	19	rocky subtidal	01-Apr-1979
Aplysia californica	19	rocky subtidal	01-Apr-1979
Aplysilla glacialis	19	sandy intertidal	01-Apr-1979
Aplysilla polyraphis	19	sandy intertidal	01-Apr-1979
Archidistoma diaphanes	19	sandy intertidal	01-Apr-1979
Archidistoma molle	19	rocky subtidal	01-Apr-1979
Archidistoma psammion	19	rocky intertidal	01-Apr-1979
Archidistoma psammion	19	rocky subtidal	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Archidistoma psammion	19	sandy intertidal	01-Apr-1979
Archidistoma ritteri	19	sandy intertidal	01-Apr-1979
Archidoris montereyensis	19	rocky subtidal	01-Apr-1979
Archidoris odhneri	19	rocky subtidal	01-Apr-1979
Arthrocardia silvae	19	rocky intertidal	01-Apr-1979
Arthropoma cecili	19	sandy intertidal	01-Apr-1979
Ascidia ceratodes	19	rocky subtidal	01-Apr-1979
Astraea gibberosa	19	rocky subtidal	01-Apr-1979
Astrangia lajollaensis	19	rocky intertidal	01-Apr-1979
Astrangia lajollaensis	19	rocky subtidal	01-Apr-1979
Astrangia lajollaensis	19	rocky subtidal	01-Apr-1979
Astropecten verrilli	19	rocky subtidal	01-Apr-1979
Astylinifer arndti	19	sandy intertidal	01-Apr-1979
Axocielita originalis	19	rocky subtidal	01-Apr-1979
Axocielita originalis	19	rocky subtidal	01-Apr-1979
Axocielita originalis	19	sandy intertidal	01-Apr-1979
Balaenoptera acutorostrata	19	pelagic	01-Apr-1979
Balanophyllia elegans	19	rocky subtidal	01-Apr-1979
Balanophyllia elegans	19	sandy intertidal	01-Apr-1979
Balanus glandula	19	sandy intertidal	01-Apr-1979
Balanus nubilis	19	rocky subtidal	01-Apr-1979
Balanus sp.	19	rocky intertidal	01-Apr-1979
Balanus sp.	19	rocky subtidal	01-Apr-1979
Balanus sp.	19	rocky subtidal	01-Apr-1979
Bangia fusco-purpurea	19	rocky intertidal	01-Apr-1979
Barentsia ramosa	19	sandy intertidal	01-Apr-1979
Berthella californica	19	sandy intertidal	01-Apr-1979
Bittium interfossa	19	sandy intertidal	01-Apr-1979
Bittium sp.	19	sandy intertidal	01-Apr-1979
Blidingia minima minima	19	rocky intertidal	01-Apr-1979
Blinksia californica	19	rocky intertidal	01-Apr-1979
Boltenia villosa	19	rocky subtidal	01-Apr-1979
Bossiella californica var. californica	19	rocky intertidal	01-Apr-1979
Bossiella californica var. californica	19	sandy subtidal	01-Apr-1979
Bossiella chiloensis	19	rocky intertidal	01-Apr-1979
Bossiella chiloensis	19	sandy subtidal	01-Apr-1979
Bossiella orbigniana dichotoma	19	rocky intertidal	01-Apr-1979
Bossiella plumosa	19	rocky intertidal	01-Apr-1979
Bossiella sp.	19	rocky intertidal	01-Apr-1979
Botryocladia pseudodichotoma	19	rocky intertidal	01-Apr-1979
Botryocladia pseudodichotoma	19	rocky subtidal	01-Apr-1979
Botryoglossum farlowianum	19	rocky intertidal	01-Apr-1979
Botryoglossum farlowianum	19	rocky subtidal	01-Apr-1979
Botryoglossum farlowianum	19	rocky subtidal	01-Apr-1979
Brachyramphus marmoratus	19	pelagic	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Bryopsis corticulans	19	rocky intertidal	01-Apr-1979
Bugula sp.	19	rocky subtidal	01-Apr-1979
Cadlina flavomaculata	19	sandy intertidal	01-Apr-1979
Cadlina luteomarginata	19	rocky subtidal	01-Apr-1979
Cadlina luteomarginata	19	sandy intertidal	01-Apr-1979
Cadlina modesta	19	sandy intertidal	01-Apr-1979
Calliarthron cheilosporioides	19	rocky intertidal	01-Apr-1979
Calliarthron tuberculosum	19	rocky intertidal	01-Apr-1979
Calliostoma annulatum	19	rocky subtidal	01-Apr-1979
Calliostoma canaliculatum	19	rocky subtidal	01-Apr-1979
Calliostoma ligatum	19	rocky subtidal	01-Apr-1979
Calliostoma supragranosum	19	rocky subtidal	01-Apr-1979
Callistochiton crassicostatus	19	sandy intertidal	01-Apr-1979
Callithamnion pikeanum	19	rocky intertidal	01-Apr-1979
Callithamnion rupicolum	19	rocky intertidal	01-Apr-1979
Callithamnion sp.	19	rocky intertidal	01-Apr-1979
Callophyllis crenulata	19	rocky intertidal	01-Apr-1979
Callophyllis firma	19	rocky intertidal	01-Apr-1979
Callophyllis firma	19	sandy subtidal	01-Apr-1979
Callophyllis flabellulata	19	rocky subtidal	01-Apr-1979
Callophyllis linearis	19	rocky intertidal	01-Apr-1979
Callophyllis pinnata	19	rocky intertidal	01-Apr-1979
Callophyllis pinnata	19	sandy subtidal	01-Apr-1979
Callophyllis sp.	19	rocky subtidal	01-Apr-1979
Callophyllis violacea	19	rocky intertidal	01-Apr-1979
Callophyllis violacea	19	rocky subtidal	01-Apr-1979
Calycella syringa	19	sandy intertidal	01-Apr-1979
Campanularia sp.	19	rocky subtidal	01-Apr-1979
Campanularia sp.	19	sandy intertidal	01-Apr-1979
Cancer antennarius	19	sandy intertidal	01-Apr-1979
Cancer anthonyi	19	sandy intertidal	01-Apr-1979
Caulibugula ciliata	19	sandy intertidal	01-Apr-1979
Cebidicthys violaceus	19	sandy intertidal	01-Apr-1979
Celleporaria brunnea	19	rocky subtidal	01-Apr-1979
Centroceras clavulatum	19	rocky intertidal	01-Apr-1979
Ceramium gardneri	19	rocky intertidal	01-Apr-1979
Ceramium pacificum	19	rocky intertidal	01-Apr-1979
Ceratostoma foliatum	19	rocky subtidal	01-Apr-1979
Ceratostoma foliatum	19	sandy intertidal	01-Apr-1979
Cerorhinca monocerata	19	pelagic	01-Apr-1979
Chaetomorpha linum	19	rocky intertidal	01-Apr-1979
Chaetopleura gemma	19	sandy intertidal	01-Apr-1979
Chama pellucida	19	sandy intertidal	01-Apr-1979
Chelidonura inermis	19	sandy intertidal	01-Apr-1979
Chondria decipiens	19	rocky intertidal	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Chthamalus fissus	19	sandy intertidal	01-Apr-1979
Citharichthys stigmaeus	19	rocky subtidal	01-Apr-1979
Cladophora columbiana	19	rocky intertidal	01-Apr-1979
Cladophora graminea	19	rocky intertidal	01-Apr-1979
Cladophora sakaii	19	rocky intertidal	01-Apr-1979
Cladophora stimpsonii	19	rocky intertidal	01-Apr-1979
Clathriopsamma pseudonaphya	19	sandy intertidal	01-Apr-1979
Clathromorphum parcum	19	rocky intertidal	01-Apr-1979
Clavelina huntsmani	19	sandy intertidal	01-Apr-1979
Clavularia sp.	19	rocky subtidal	01-Apr-1979
Clinocottus analis	19	sandy intertidal	01-Apr-1979
Clinocottus recalvus	19	sandy intertidal	01-Apr-1979
Cliona celata	19	rocky subtidal	01-Apr-1979
Cliona celata californiana	19	sandy intertidal	01-Apr-1979
Cnemidocarpa finmarkiensis	19	rocky subtidal	01-Apr-1979
Codium fragile	19	rocky intertidal	01-Apr-1979
Codium setchellii	19	rocky intertidal	01-Apr-1979
Coeloseira compressa	19	rocky intertidal	01-Apr-1979
Coilodesme californica	19	rocky intertidal	01-Apr-1979
Coilodesme plana	19	rocky intertidal	01-Apr-1979
Collinsiella tuberculata	19	rocky intertidal	01-Apr-1979
Collisella digitalis	19	sandy intertidal	01-Apr-1979
Collisella limatula	19	sandy intertidal	01-Apr-1979
Collisella ochracea	19	sandy intertidal	01-Apr-1979
Collisella pelta	19	sandy intertidal	01-Apr-1979
Collisella scabra	19	sandy intertidal	01-Apr-1979
Colpomenia bullosa	19	rocky intertidal	01-Apr-1979
Colpomenia peregrina	19	rocky intertidal	01-Apr-1979
Compsonema intricatum	19	rocky intertidal	01-Apr-1979
Constantinea simplex	19	rocky intertidal	01-Apr-1979
Corallina officinalis var. chilensis	19	rocky intertidal	01-Apr-1979
Corallina vancouveriensis	19	rocky intertidal	01-Apr-1979
Corambe pacifica	19	sandy intertidal	01-Apr-1979
Coriophyllum expansum	19	rocky intertidal	01-Apr-1979
Corynactis californica	19	rocky intertidal	01-Apr-1979
Corynactis californica	19	rocky intertidal	01-Apr-1979
Corynactis californica	19	rocky subtidal	01-Apr-1979
Corynactis californica	19	rocky subtidal	01-Apr-1979
Corynactis californica	19	rocky subtidal	01-Apr-1979
Corynactis californica	19	sandy intertidal	01-Apr-1979
Coryphella trilineata	19	rocky subtidal	01-Apr-1979
Coryphella trilineata	19	sandy intertidal	01-Apr-1979
Costaria costata	19	rocky intertidal	01-Apr-1979
Costazia robertsonae	19	rocky intertidal	01-Apr-1979
Costazia robertsonae	19	rocky intertidal	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Costazia robertsonae	19	rocky subtidal	01-Apr-1979
Costazia robertsonae	19	rocky subtidal	01-Apr-1979
Crangon dentysis	19	sandy intertidal	01-Apr-1979
Crangon sp.	19	sandy intertidal	01-Apr-1979
Crisia sp.	19	rocky subtidal	01-Apr-1979
Cryptochiton stelleri	19	rocky subtidal	01-Apr-1979
Cryptochiton stelleri	19	rocky subtidal	01-Apr-1979
Cryptolithodes sitchensis	19	rocky subtidal	01-Apr-1979
Cryptolithodes sitchensis	19	sandy intertidal	01-Apr-1979
Cryptonemia ovalifolia	19	rocky intertidal	01-Apr-1979
Cryptopleura corallinara	19	rocky intertidal	01-Apr-1979
Cryptopleura lobulifera	19	rocky intertidal	01-Apr-1979
Cryptopleura violacea	19	rocky intertidal	01-Apr-1979
Cryptosiphonia woodii	19	rocky intertidal	01-Apr-1979
Cryptosula pallasiana	19	rocky intertidal	01-Apr-1979
Cryptosula pallasiana	19	rocky subtidal	01-Apr-1979
Cucumaria miniata	19	rocky subtidal	01-Apr-1979
Cucumaria piperata	19	rocky subtidal	01-Apr-1979
Cumagloia andersonii	19	rocky intertidal	01-Apr-1979
Cyanoplax dentiens	19	sandy intertidal	01-Apr-1979
Cyanoplax fackenthallae	19	sandy intertidal	01-Apr-1979
Cyanoplax hartwegii	19	sandy intertidal	01-Apr-1979
Cylindrocarpus rugosus	19	rocky intertidal	01-Apr-1979
Cystodytes lobatus	19	rocky subtidal	01-Apr-1979
Cystodytes lobatus	19	sandy intertidal	01-Apr-1979
Cystoseira osmundacea	19	rocky intertidal	01-Apr-1979
Cystoseira osmundacea	19	rocky subtidal	01-Apr-1979
Damalichthys vacca	19	rocky subtidal	01-Apr-1979
Delesseria decipiens	19	rocky intertidal	01-Apr-1979
Dendrochiton thamnoporus	19	sandy intertidal	01-Apr-1979
Dendronotus albus	19	sandy intertidal	01-Apr-1979
Dendronotus frondosus	19	sandy intertidal	01-Apr-1979
Dendronotus subramosus	19	sandy intertidal	01-Apr-1979
Derbesia marina	19	rocky intertidal	01-Apr-1979
Dermasterias imbricata	19	rocky subtidal	01-Apr-1979
Desmarestia latifrons	19	rocky intertidal	01-Apr-1979
Desmarestia ligulata	19	rocky subtidal	01-Apr-1979
Desmarestia ligulata	19	rocky subtidal	01-Apr-1979
Desmarestia ligulata var. ligulata	19	rocky intertidal	01-Apr-1979
Desmarestia tabacoides	19	rocky intertidal	01-Apr-1979
Desmarestia tabacoides	19	sandy subtidal	01-Apr-1979
Diadumene lighti	19	sandy intertidal	01-Apr-1979
Diaulula sandiegensis	19	rocky subtidal	01-Apr-1979
Diaulula sandiegensis	19	sandy intertidal	01-Apr-1979
Dictyoneuropsis reticulata	19	rocky intertidal	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Dictyoneuropsis reticulata	19	rocky subtidal	01-Apr-1979
Dictyoneurum californicum	19	rocky intertidal	01-Apr-1979
Dictyota binghamiae	19	rocky intertidal	01-Apr-1979
Dictyota binghamiae	19	sandy subtidal	01-Apr-1979
Didemnum carnulentum	19	rocky intertidal	01-Apr-1979
Didemnum carnulentum	19	rocky subtidal	01-Apr-1979
Didemnum carnulentum	19	sandy intertidal	01-Apr-1979
Dilsea californica	19	rocky intertidal	01-Apr-1979
Diodora aspera	19	rocky subtidal	01-Apr-1979
Diodora aspera	19	sandy intertidal	01-Apr-1979
Diomedea nigripes	19	pelagic	01-Apr-1979
Diopatra ornata	19	rocky intertidal	01-Apr-1979
Diopatra ornata	19	rocky subtidal	01-Apr-1979
Diplosoma macdonaldi	19	rocky subtidal	01-Apr-1979
Diplosoma macdonaldi	19	sandy intertidal	01-Apr-1979
Dirona albolineata	19	sandy intertidal	01-Apr-1979
Dirona picta	19	sandy intertidal	01-Apr-1979
Discodoris heathi	19	sandy intertidal	01-Apr-1979
Dodecaceria fewkesi	19	rocky intertidal	01-Apr-1979
Dodecaceria fewkesi	19	rocky subtidal	01-Apr-1979
Doriopsilla albopunctata	19	rocky subtidal	01-Apr-1979
Doriopsilla albopunctata	19	sandy intertidal	01-Apr-1979
Doto amyra	19	sandy intertidal	01-Apr-1979
Doto kya	19	sandy intertidal	01-Apr-1979
Dynamenella benedicti	19	sandy intertidal	01-Apr-1979
Dynamenella dilatata	19	sandy intertidal	01-Apr-1979
Dynamenella glabra	19	sandy intertidal	01-Apr-1979
Ectocarpus acutus acucus	19	rocky intertidal	01-Apr-1979
Ectocarpus corticulatus	19	rocky intertidal	01-Apr-1979
Ectocarpus parvus	19	rocky intertidal	01-Apr-1979
Egregia menziesii	19	rocky intertidal	01-Apr-1979
Eisenia arborea	19	rocky intertidal	01-Apr-1979
Embiotoca jacksoni	19	rocky subtidal	01-Apr-1979
Embiotoca lateralis	19	rocky subtidal	01-Apr-1979
Endocladia muricata	19	rocky intertidal	01-Apr-1979
Endophyton ramosum	19	rocky intertidal	01-Apr-1979
Enteromorpha flexuosa	19	rocky intertidal	01-Apr-1979
Enteromorpha prolifera	19	rocky intertidal	01-Apr-1979
Epiactis prolifera	19	rocky subtidal	01-Apr-1979
Epiactis prolifera	19	sandy intertidal	01-Apr-1979
Erato sp.	19	rocky subtidal	01-Apr-1979
Erato vitellina	19	sandy intertidal	01-Apr-1979
Erythrocladia irregularis	19	rocky intertidal	01-Apr-1979
Erythrocladia subintegra	19	rocky intertidal	01-Apr-1979
Erythrocystis saccata	19	rocky intertidal	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Erythrophyllum delesserioides	19	rocky intertidal	01-Apr-1979
Erythrophyllum delesserioides	19	sandy subtidal	01-Apr-1979
Erythrotrichia camea	19	rocky intertidal	01-Apr-1979
Erythrotrichia pulvinata	19	rocky intertidal	01-Apr-1979
Eschrictius gibbosus	19	pelagic	01-Apr-1979
Eubranchus rustyus	19	sandy intertidal	01-Apr-1979
Eucopella spp.	19	rocky subtidal	01-Apr-1979
Eucopella spp.	19	rocky subtidal	01-Apr-1979
Eudendrium californicum	19	sandy intertidal	01-Apr-1979
Eudistylia polymorpha	19	rocky subtidal	01-Apr-1979
Euherdmania claviformis	19	sandy intertidal	01-Apr-1979
Eupentacta quinquesemita	19	rocky subtidal	01-Apr-1979
Eurylepta aurantica	19	sandy intertidal	01-Apr-1979
Eurystomella bilabiata	19	rocky subtidal	01-Apr-1979
Eurystomella bilabiata	19	sandy intertidal	01-Apr-1979
Farlowia conferta	19	rocky intertidal	01-Apr-1979
Farlowia mollis	19	rocky intertidal	01-Apr-1979
Feldmannia acuminata	19	rocky intertidal	01-Apr-1979
Feldmannia chitonicola	19	rocky intertidal	01-Apr-1979
Feldmannia cylindrica	19	rocky intertidal	01-Apr-1979
Feldmannia rhizoidea	19	rocky intertidal	01-Apr-1979
Filicrisia franciscana	19	sandy intertidal	01-Apr-1979
Fissurella volcano	19	sandy intertidal	01-Apr-1979
Flabellinopsis iodinea	19	rocky subtidal	01-Apr-1979
Flabellinopsis iodinea	19	sandy intertidal	01-Apr-1979
Flustrellidra corniculata	19	rocky subtidal	01-Apr-1979
Freemania litoricola	19	sandy intertidal	01-Apr-1979
Fucus distichus	19	rocky intertidal	01-Apr-1979
Fulmarus glacialis	19	pelagic	01-Apr-1979
Garveia franciscana	19	sandy intertidal	01-Apr-1979
Gastroclonium coulteri	19	rocky intertidal	01-Apr-1979
Gelidium coulteri	19	rocky intertidal	01-Apr-1979
Gelidium purpurascens	19	rocky intertidal	01-Apr-1979
Gelidium pusillum	19	rocky intertidal	01-Apr-1979
Gelidium robustum	19	rocky intertidal	01-Apr-1979
Gelidium robustum	19	rocky subtidal	01-Apr-1979
Gibbonsia metzi	19	sandy intertidal	01-Apr-1979
Gibbonsia montereyensis	19	sandy intertidal	01-Apr-1979
Giffordia mitchelliae	19	rocky intertidal	01-Apr-1979
Giffordia saundersii	19	rocky intertidal	01-Apr-1979
Gigartina agardhii	19	rocky intertidal	01-Apr-1979
Gigartina canaliculata	19	rocky intertidal	01-Apr-1979
Gigartina corymbifera	19	rocky intertidal	01-Apr-1979
Gigartina corymbifera	19	rocky subtidal	01-Apr-1979
Gigartina exasperata	19	rocky intertidal	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Gigartina exasperata	19	rocky subtidal	01-Apr-1979
Gigartina exasperata	19	sandy subtidal	01-Apr-1979
Gigartina harveyana	19	rocky intertidal	01-Apr-1979
Gigartina harveyana	19	rocky subtidal	01-Apr-1979
Gigartina leptorhynchos	19	rocky intertidal	01-Apr-1979
Gigartina papillata	19	rocky intertidal	01-Apr-1979
Gigartina sp.	19	rocky intertidal	01-Apr-1979
Gigartina spinosa	19	rocky intertidal	01-Apr-1979
Gigartina volans	19	rocky intertidal	01-Apr-1979
Gloiosiphonia capillaris	19	rocky intertidal	01-Apr-1979
Gloiosiphonia verticillaris	19	rocky intertidal	01-Apr-1979
Golfingia hespera	19	sandy intertidal	01-Apr-1979
Golfingia margaritacea californiensis	19	sandy intertidal	01-Apr-1979
Golfingia procera	19	sandy intertidal	01-Apr-1979
Gomontia polyrhiza	19	rocky intertidal	01-Apr-1979
Gonimophyllum skottsbergii	19	rocky subtidal	01-Apr-1979
Gonimophyllum skottsbergii	19	rocky subtidal	01-Apr-1979
Goniotrichum alsidii	19	rocky intertidal	01-Apr-1979
Gonothyraea spp.	19	sandy intertidal	01-Apr-1979
Gracilaria robusta	19	rocky intertidal	01-Apr-1979
Gracilaria sjoestedii	19	rocky intertidal	01-Apr-1979
Grateloupia doryphora	19	rocky intertidal	01-Apr-1979
Grateloupia doryphora	19	rocky subtidal	01-Apr-1979
Grateloupia setchellii	19	rocky intertidal	01-Apr-1979
Gymnogongrus linearis	19	rocky intertidal	01-Apr-1979
Halecium sp.	19	sandy intertidal	01-Apr-1979
Haliclona permollis	19	sandy intertidal	01-Apr-1979
Haliotis rufescens	19	rocky subtidal	01-Apr-1979
Haliotis rufescens	19	sandy intertidal	01-Apr-1979
Haliotis walallensis	19	rocky subtidal	01-Apr-1979
Halosaccion glandiforme	19	rocky intertidal	01-Apr-1979
Halosydna brevisetosa	19	sandy intertidal	01-Apr-1979
Halymenia schizymenioides	19	rocky intertidal	01-Apr-1979
Hancockia californica	19	sandy intertidal	01-Apr-1979
Hapalogaster cavicauda	19	sandy intertidal	01-Apr-1979
Hapalospongidion gelatinosum	19	rocky intertidal	01-Apr-1979
Haplogloia andersonii	19	rocky intertidal	01-Apr-1979
Hecatonema primarium	19	rocky intertidal	01-Apr-1979
Hemigrapsus nudus	19	sandy intertidal	01-Apr-1979
Hemigrapsus oregonensis	19	sandy intertidal	01-Apr-1979
Henricia leviuscula	19	rocky subtidal	01-Apr-1979
Heptacarpus paludicola	19	sandy intertidal	01-Apr-1979
Hermissenda crassicornis	19	rocky subtidal	01-Apr-1979
Hermissenda crassicornis	19	sandy intertidal	01-Apr-1979
Herposiphonia plumula	19	rocky intertidal	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Herposiphonia verticillata	19	rocky intertidal	01-Apr-1979
Hesperophycus harveyanus	19	rocky intertidal	01-Apr-1979
Hexagrammos decagrammus	19	rocky subtidal	01-Apr-1979
Hildenbrandia dawsonii	19	rocky intertidal	01-Apr-1979
Hildenbrandia occidentalis	19	rocky intertidal	01-Apr-1979
Hildenbrandia prototypus	19	rocky intertidal	01-Apr-1979
Hinnites giganteus	19	rocky subtidal	01-Apr-1979
Hippodiplosia insculpta	19	rocky intertidal	01-Apr-1979
Hippodiplosia insculpta	19	rocky subtidal	01-Apr-1979
Hipponix sp.	19	rocky subtidal	01-Apr-1979
Hippothoa hyalina	19	rocky subtidal	01-Apr-1979
Hopkinsia rosacea	19	rocky subtidal	01-Apr-1979
Hopkinsia rosacea	19	sandy intertidal	01-Apr-1979
Hydractinia milleri	19	sandy intertidal	01-Apr-1979
Hydrolithon decipiens	19	rocky intertidal	01-Apr-1979
Hymenamphiastra cyanocrypta	19	rocky intertidal	01-Apr-1979
Hymenamphiastra cyanocrypta	19	rocky subtidal	01-Apr-1979
Hymenamphiastra cyanocrypta	19	sandy intertidal	01-Apr-1979
Hymenena flabelligera	19	rocky intertidal	01-Apr-1979
Hymenena multiloba	19	rocky intertidal	01-Apr-1979
Hypsurus caryi	19	rocky subtidal	01-Apr-1979
Idotea wasnesenskii	19	sandy intertidal	01-Apr-1979
Iridaea cordata	19	rocky intertidal	01-Apr-1979
Iridaea cordata splendens	19	rocky intertidal	01-Apr-1979
Iridaea cordata splendens	19	sandy subtidal	01-Apr-1979
Iridaea flaccida	19	rocky intertidal	01-Apr-1979
Iridaea heterocarpa	19	rocky intertidal	01-Apr-1979
Iridaea lineare	19	rocky intertidal	01-Apr-1979
Ischnochiton regularis	19	sandy intertidal	01-Apr-1979
Janczewskia gardneri	19	rocky intertidal	01-Apr-1979
Katharina tunicata	19	sandy intertidal	01-Apr-1979
Lagenipora sp.	19	rocky intertidal	01-Apr-1979
Lagenipora sp.	19	rocky subtidal	01-Apr-1979
Lagenorhynchus obliquidens	19	pelagic	01-Apr-1979
Laila cockerelli	19	rocky subtidal	01-Apr-1979
Laila cockerelli	19	sandy intertidal	01-Apr-1979
Lamellaria sp.	19	rocky subtidal	01-Apr-1979
Laminaria dentigera	19	rocky intertidal	01-Apr-1979
Laminaria dentigera	19	rocky subtidal	01-Apr-1979
Laminaria ephemera	19	rocky intertidal	01-Apr-1979
Larus philadelphia	19	pelagic	01-Apr-1979
Laurencia blinksii	19	rocky intertidal	01-Apr-1979
Laurencia crispa	19	rocky intertidal	01-Apr-1979
Laurencia pacifica	19	rocky intertidal	01-Apr-1979
Laurencia spectabilis	19	rocky intertidal	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Laurencia spectabilis	19	sandy subtidal	01-Apr-1979
Laurencia spectabilis spectabilis	19	rocky intertidal	01-Apr-1979
Leathesia difformis	19	rocky intertidal	01-Apr-1979
Leathesia nana	19	rocky intertidal	01-Apr-1979
Lepidozona mertensii	19	sandy intertidal	01-Apr-1979
Leptasterias hexactis	19	sandy intertidal	01-Apr-1979
Leptasterias sp.	19	rocky subtidal	01-Apr-1979
Leptosynapta sp.	19	sandy intertidal	01-Apr-1979
Lessoniopsis littoralis	19	rocky intertidal	01-Apr-1979
Leucandra heathi	19	rocky subtidal	01-Apr-1979
Leucilla nuttingi	19	rocky subtidal	01-Apr-1979
Leucilla nuttingi	19	sandy intertidal	01-Apr-1979
Leucosolenia eleanor	19	rocky subtidal	01-Apr-1979
Leucosolenia eleanor	19	sandy intertidal	01-Apr-1979
Ligia occidentalis	19	sandy intertidal	01-Apr-1979
Lissodendoryx firma	19	sandy intertidal	01-Apr-1979
Lithophyllum imitans	19	rocky intertidal	01-Apr-1979
Lithophyllum lichenare	19	rocky intertidal	01-Apr-1979
Lithothamnium aculciferum	19	rocky intertidal	01-Apr-1979
Lithothamnium aculciferum	19	sandy subtidal	01-Apr-1979
Lithothamnium californicum	19	rocky intertidal	01-Apr-1979
Lithothamnium crassiusculum	19	rocky intertidal	01-Apr-1979
Lithothamnium imitans	19	rocky intertidal	01-Apr-1979
Lithothamnium imitans	19	sandy subtidal	01-Apr-1979
Lithothamnium pacificum	19	rocky intertidal	01-Apr-1979
Lithothamnium phymatodeum	19	rocky intertidal	01-Apr-1979
Lithothamnium phymatodeum	19	sandy subtidal	01-Apr-1979
Lithothrix aspergillum	19	rocky intertidal	01-Apr-1979
Littorina planaxis	19	sandy intertidal	01-Apr-1979
Littorina scutulata	19	sandy intertidal	01-Apr-1979
Lobipes lobatus	19	pelagic	01-Apr-1979
Lophopanopeus bellus	19	sandy intertidal	01-Apr-1979
Lophopanopeus heathii	19	sandy intertidal	01-Apr-1979
Lottia gigantea	19	sandy intertidal	01-Apr-1979
Loxorhynchus crispatus	19	rocky subtidal	01-Apr-1979
Loxorhynchus crispatus	19	sandy intertidal	01-Apr-1979
Loxorhynchus grandis	19	rocky subtidal	01-Apr-1979
Lumbrineris sp.	19	sandy intertidal	01-Apr-1979
Lunda cirrhata	19	pelagic	01-Apr-1979
Macrocystis pyrifera	19	rocky intertidal	01-Apr-1979
Macrocystis pyrifera	19	rocky subtidal	01-Apr-1979
Megaptera novaeangliae	19	pelagic	01-Apr-1979
Megatebennus bimaculatus	19	rocky subtidal	01-Apr-1979
Megatebennus bimaculatus	19	sandy intertidal	01-Apr-1979
Megathura crenulata	19	rocky subtidal	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Melobesia marginata	19	rocky intertidal	01-Apr-1979
Melobesia mediocris	19	rocky intertidal	01-Apr-1979
Melobesia mediocris	19	sandy subtidal	01-Apr-1979
Membranella nitens	19	rocky intertidal	01-Apr-1979
Membranipora fusca	19	sandy intertidal	01-Apr-1979
Membranipora membranacea	19	sandy intertidal	01-Apr-1979
Membranipora sp.	19	rocky subtidal	01-Apr-1979
Membranoptera weeksiae	19	rocky intertidal	01-Apr-1979
Mesophyllum conchatum	19	rocky intertidal	01-Apr-1979
Mesophyllum conchatum	19	sandy subtidal	01-Apr-1979
Mesophyllum lamellatum	19	rocky intertidal	01-Apr-1979
Metandrocarpa taylori	19	rocky subtidal	01-Apr-1979
Metandrocarpa taylori	19	sandy intertidal	01-Apr-1979
Metridium exilis	19	sandy intertidal	01-Apr-1979
Metridium senile	19	rocky subtidal	01-Apr-1979
Microcladia borealis	19	rocky intertidal	01-Apr-1979
Microcladia californica	19	rocky intertidal	01-Apr-1979
Microcladia coulteri	19	rocky intertidal	01-Apr-1979
Microcladia coulteri	19	rocky subtidal	01-Apr-1979
Microcladia sp.	19	rocky intertidal	01-Apr-1979
Microporella ciliata	19	sandy intertidal	01-Apr-1979
Microporella cribrosa	19	sandy intertidal	01-Apr-1979
Mimulus foliatus	19	rocky subtidal	01-Apr-1979
Mimulus foliatus	19	sandy intertidal	01-Apr-1979
Mirounga angustirostris	19	pelagic	01-Apr-1979
Mitra idea	19	rocky subtidal	01-Apr-1979
Mola mola	19	rocky subtidal	01-Apr-1979
Monostroma zostericola	19	rocky intertidal	01-Apr-1979
Mopalia ciliata	19	sandy intertidal	01-Apr-1979
Mopalia hindsii	19	sandy intertidal	01-Apr-1979
Mopalia lignosa	19	sandy intertidal	01-Apr-1979
Mopalia muscosa	19	sandy intertidal	01-Apr-1979
Myrionema balticum	19	rocky intertidal	01-Apr-1979
Myrionema corunnae	19	rocky intertidal	01-Apr-1979
Myxicola infundibulum	19	rocky subtidal	01-Apr-1979
Myxicola infundibulum	19	rocky subtidal	01-Apr-1979
Nemalion helminthoides	19	rocky intertidal	01-Apr-1979
Neoagardhiella baileyi	19	rocky intertidal	01-Apr-1979
Neopolyporolithon reclinatum	19	rocky intertidal	01-Apr-1979
Neoptilota densa	19	rocky intertidal	01-Apr-1979
Neoptilota densa	19	rocky subtidal	01-Apr-1979
Neoptilota hypnoides	19	rocky intertidal	01-Apr-1979
Nereis sp.	19	sandy intertidal	01-Apr-1979
Nereocystis luetkeana	19	rocky intertidal	01-Apr-1979
Nienburgia andersoniana	19	rocky intertidal	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Nitophyllum hollenbergii	19	rocky intertidal	01-Apr-1979
Notoacmea insessa	19	sandy intertidal	01-Apr-1979
Notoacmea scutum	19	sandy intertidal	01-Apr-1979
Notoplana acticola	19	sandy intertidal	01-Apr-1979
Nucella emarginata	19	sandy intertidal	01-Apr-1979
Nuttalina californica	19	sandy intertidal	01-Apr-1979
Oceanodroma furcata	19	pelagic	01-Apr-1979
Oceanodroma homochroa	19	pelagic	01-Apr-1979
Oceanodroma leucorhoa	19	pelagic	01-Apr-1979
Ocenebra sp.	19	rocky subtidal	01-Apr-1979
Oligocottus rubellio	19	sandy intertidal	01-Apr-1979
Oligocottus snyderi	19	sandy intertidal	01-Apr-1979
Ophiopholis aculeata	19	sandy intertidal	01-Apr-1979
Ophioplocus esmarki	19	rocky subtidal	01-Apr-1979
Ophioplocus esmarki	19	sandy intertidal	01-Apr-1979
Ophiopteris papillosa	19	rocky subtidal	01-Apr-1979
Ophiopteris papillosa	19	sandy intertidal	01-Apr-1979
Ophiothrix spiculata	19	rocky subtidal	01-Apr-1979
Ophiothrix spiculata	19	sandy intertidal	01-Apr-1979
Ophlitaspongia pennata	19	sandy intertidal	01-Apr-1979
Orcinus orca	19	pelagic	01-Apr-1979
Orthasterias koehleri	19	rocky subtidal	01-Apr-1979
Oxyjulis californica	19	rocky subtidal	01-Apr-1979
Ozophora latifolia	19	rocky intertidal	01-Apr-1979
Pachycerianthus sp.	19	rocky subtidal	01-Apr-1979
Pachycheles rudis	19	sandy intertidal	01-Apr-1979
Pachycheles sp.	19	rocky subtidal	01-Apr-1979
Pachygrapsus crassipes	19	sandy intertidal	01-Apr-1979
Pagurus granosimanus	19	sandy intertidal	01-Apr-1979
Pagurus hemphilli	19	sandy intertidal	01-Apr-1979
Pagurus hirsutiusculus	19	sandy intertidal	01-Apr-1979
Pagurus samuelis	19	sandy intertidal	01-Apr-1979
Pagurus sp.	19	rocky subtidal	01-Apr-1979
Pandalus gurneyi	19	rocky subtidal	01-Apr-1979
Paracyathus stearnsi	19	rocky subtidal	01-Apr-1979
Patiria miniata	19	rocky subtidal	01-Apr-1979
Pelvetia fastigiata	19	rocky intertidal	01-Apr-1979
Pelvetiopsis limitata	19	rocky intertidal	01-Apr-1979
Percusaria dawsonii	19	rocky intertidal	01-Apr-1979
Perophora annectens	19	rocky subtidal	01-Apr-1979
Perophora annectens	19	sandy intertidal	01-Apr-1979
Petaloconchus montereyensis	19	rocky intertidal	01-Apr-1979
Petaloconchus montereyensis	19	rocky subtidal	01-Apr-1979
Petalonia fascia	19	rocky intertidal	01-Apr-1979
Petrocelis franciscana	19	rocky intertidal	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Petrolisthes cinctipes	19	sandy intertidal	01-Apr-1979
Peyssonellia hairii	19	rocky intertidal	01-Apr-1979
Peyssonellia meridionalis	19	rocky intertidal	01-Apr-1979
Phalaropus fulicarius	19	pelagic	01-Apr-1979
Phidiana pugnax	19	rocky subtidal	01-Apr-1979
Phidolopora pacifica	19	rocky subtidal	01-Apr-1979
Phocoena phocoena	19	pelagic	01-Apr-1979
Phragmatopoma californica	19	rocky intertidal	01-Apr-1979
Phragmatopoma californica	19	rocky subtidal	01-Apr-1979
Phycodrys profunda	19	rocky intertidal	01-Apr-1979
Phyllolithodes papillosus	19	rocky subtidal	01-Apr-1979
Phyllospadix scouleri	19	rocky intertidal	01-Apr-1979
Pikea californica	19	rocky intertidal	01-Apr-1979
Pinnixa occidentalis	19	sandy intertidal	01-Apr-1979
Pisaster brevispinus	19	rocky subtidal	01-Apr-1979
Pisaster giganteus	19	rocky subtidal	01-Apr-1979
Pisaster ochraceus	19	rocky subtidal	01-Apr-1979
Pisaster ochraceus	19	sandy intertidal	01-Apr-1979
Placiphorella velata	19	sandy intertidal	01-Apr-1979
Platythamnion pectinatum	19	rocky intertidal	01-Apr-1979
Platythamnion villosum	19	rocky intertidal	01-Apr-1979
Pleonosporium squarrosum	19	rocky intertidal	01-Apr-1979
Pleonosporium vancouverianum	19	rocky intertidal	01-Apr-1979
Plocamia igzo	19	sandy intertidal	01-Apr-1979
Plocamia karykina	19	sandy intertidal	01-Apr-1979
Plocamium cartilagineum	19	rocky intertidal	01-Apr-1979
Plocamium cartilagineum	19	rocky subtidal	01-Apr-1979
Plocamium violaceum	19	rocky intertidal	01-Apr-1979
Plumularia sp.	19	rocky subtidal	01-Apr-1979
Plumularia sp.	19	sandy intertidal	01-Apr-1979
Pogonophorella californica	19	rocky intertidal	01-Apr-1979
Polycera atra	19	sandy intertidal	01-Apr-1979
Polymastia pachymastia	19	rocky subtidal	01-Apr-1979
Polyneura latissima	19	rocky intertidal	01-Apr-1979
Polyneura latissima	19	sandy subtidal	01-Apr-1979
Polysiphonia hendryi gardneri	19	rocky intertidal	01-Apr-1979
Polysiphonia pacifica determinata	19	rocky intertidal	01-Apr-1979
Polysiphonia pacifica pacifica	19	rocky intertidal	01-Apr-1979
Polysiphonia paniculata	19	rocky intertidal	01-Apr-1979
Polysiphonia scopulorum villum	19	rocky intertidal	01-Apr-1979
Porphyra lanceolata	19	rocky intertidal	01-Apr-1979
Porphyra nereocystis	19	rocky intertidal	01-Apr-1979
Porphyra perforata	19	rocky intertidal	01-Apr-1979
Porphyra pulchra	19	rocky intertidal	01-Apr-1979
Porphyra schizophylla	19	rocky intertidal	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Porphyra smithii	19	rocky intertidal	01-Apr-1979
Porphyra sp.	19	rocky intertidal	01-Apr-1979
Porphyra thuretii	19	rocky intertidal	01-Apr-1979
Porphyrella gardneri	19	rocky intertidal	01-Apr-1979
Postelsia palmaeformis	19	rocky intertidal	01-Apr-1979
Prasiola meridionalis	19	rocky intertidal	01-Apr-1979
Prionitis australis	19	rocky intertidal	01-Apr-1979
Prionitis australis	19	rocky subtidal	01-Apr-1979
Prionitis lanceolata	19	rocky intertidal	01-Apr-1979
Prionitis lanceolata	19	rocky subtidal	01-Apr-1979
Prionitis linearis	19	rocky intertidal	01-Apr-1979
Prionitis lyallii	19	rocky intertidal	01-Apr-1979
Pseudolithophyllum neofarlowii	19	rocky intertidal	01-Apr-1979
Pseudomelatoma sp.	19	rocky subtidal	01-Apr-1979
Pseudopringsheimia apiculata	19	rocky intertidal	01-Apr-1979
Pseudulvella applanata	19	rocky intertidal	01-Apr-1979
Pterochondria woodii	19	rocky intertidal	01-Apr-1979
Pterochondria woodii	19	sandy subtidal	01-Apr-1979
Pterocladia media	19	rocky intertidal	01-Apr-1979
Pterosiphonia baileyi	19	rocky intertidal	01-Apr-1979
Pterosiphonia bipinnata	19	rocky intertidal	01-Apr-1979
Pterosiphonia dendroidea	19	rocky intertidal	01-Apr-1979
Ptilota filicina	19	rocky intertidal	01-Apr-1979
Ptilothamnionopsis lejolisea	19	rocky intertidal	01-Apr-1979
Ptychoramphus aleuticus	19	pelagic	01-Apr-1979
Puffinus bulleri	19	pelagic	01-Apr-1979
Puffinus creatopus	19	pelagic	01-Apr-1979
Puffinus griseus	19	pelagic	01-Apr-1979
Puffinus puffinus	19	pelagic	01-Apr-1979
Pugettia gracilis	19	sandy intertidal	01-Apr-1979
Pugettia producta	19	rocky subtidal	01-Apr-1979
Pugettia producta	19	sandy intertidal	01-Apr-1979
Pugettia richii	19	rocky subtidal	01-Apr-1979
Pugettia richii	19	sandy intertidal	01-Apr-1979
Punctaria hesperia	19	rocky intertidal	01-Apr-1979
Pycnoclavella stanleyi	19	rocky subtidal	01-Apr-1979
Pycnopodia helianthoides	19	rocky subtidal	01-Apr-1979
Pyura haustor	19	rocky subtidal	01-Apr-1979
Ralfsia pacifica	19	rocky intertidal	01-Apr-1979
Ralfsia sp.	19	rocky intertidal	01-Apr-1979
Reniera sp.	19	sandy intertidal	01-Apr-1979
Rhodochorton concrescens	19	rocky intertidal	01-Apr-1979
Rhodoglossum affine	19	rocky intertidal	01-Apr-1979
Rhodoglossum californicum	19	rocky intertidal	01-Apr-1979
Rhodoglossum roseum	19	rocky intertidal	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Rhodoptilum densum	19	rocky intertidal	01-Apr-1979
Rhodoptilum densum	19	sandy subtidal	01-Apr-1979
Rhodymenia californica	19	rocky subtidal	01-Apr-1979
Rhodymenia californica attenuata	19	rocky subtidal	01-Apr-1979
Rhodymenia californica californica	19	rocky intertidal	01-Apr-1979
Rhodymenia californica californica	19	rocky subtidal	01-Apr-1979
Rhodymenia californica californica	19	rocky subtidal	01-Apr-1979
Rhodymenia callophyllidoides	19	rocky intertidal	01-Apr-1979
Rhodymenia callophyllidoides	19	sandy subtidal	01-Apr-1979
Rhodymenia pacifica	19	rocky intertidal	01-Apr-1979
Rhodymenia pacifica	19	rocky subtidal	01-Apr-1979
Rissa tridactyla	19	pelagic	01-Apr-1979
Ritterella pulchra	19	sandy intertidal	01-Apr-1979
Ritterella rubra	19	rocky subtidal	01-Apr-1979
Rostanga pulchra	19	sandy intertidal	01-Apr-1979
Sabellaria sp.	19	rocky subtidal	01-Apr-1979
Salmacina tribranchiata	19	rocky subtidal	01-Apr-1979
Sargassum muticum	19	rocky intertidal	01-Apr-1979
Scagelia occidentale	19	rocky intertidal	01-Apr-1979
Schizymenia pacifica	19	rocky intertidal	01-Apr-1979
Schizymenia pacifica	19	sandy subtidal	01-Apr-1979
Scrupocellaria sp.	19	rocky subtidal	01-Apr-1979
Scyra acutifrons	19	rocky subtidal	01-Apr-1979
Scyra acutifrons	19	sandy intertidal	01-Apr-1979
Scytosiphon dotyi	19	rocky intertidal	01-Apr-1979
Scytosiphon lomentaria	19	rocky intertidal	01-Apr-1979
Sebastes atrovirens	19	rocky subtidal	01-Apr-1979
Sebastes mystinus	19	rocky subtidal	01-Apr-1979
Sebastes paucispinis	19	rocky subtidal	01-Apr-1979
Serpula sp.	19	rocky subtidal	01-Apr-1979
Serpulorbis squamigerus	19	rocky subtidal	01-Apr-1979
Serpulorbis squamigerus	19	sandy intertidal	01-Apr-1979
Serraticardia macmillanii	19	rocky intertidal	01-Apr-1979
Sertularella sp.	19	rocky subtidal	01-Apr-1979
Sertularella sp.	19	sandy intertidal	01-Apr-1979
Sertularella turgida	19	sandy intertidal	01-Apr-1979
Sertularia sp.	19	rocky subtidal	01-Apr-1979
Smithora naiadum	19	rocky intertidal	01-Apr-1979
Soranthera ulvoidea	19	rocky intertidal	01-Apr-1979
Sphacelaria didichotoma	19	rocky intertidal	01-Apr-1979
Spheciospongia confoederata	19	rocky subtidal	01-Apr-1979
Spheciospongia confoederata	19	sandy intertidal	01-Apr-1979
Spirontocaris prionota	19	sandy intertidal	01-Apr-1979
Spirorbis sp.	19	rocky subtidal	01-Apr-1979
Spirorbis sp.	19	sandy intertidal	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Spirorbis spp.	19	rocky subtidal	01-Apr-1979
Spongomorpha coalita	19	rocky intertidal	01-Apr-1979
Spongonema tomentosum	19	rocky intertidal	01-Apr-1979
Stelletta clarella	19	rocky subtidal	01-Apr-1979
Stenoplax heathiana	19	sandy intertidal	01-Apr-1979
Stercorarius parasiticus	19	pelagic	01-Apr-1979
Stercorarius pomarinus	19	pelagic	01-Apr-1979
Sterna hirundo	19	pelagic	01-Apr-1979
Stichopus californicus	19	rocky subtidal	01-Apr-1979
Streblonema myrionematoides	19	rocky intertidal	01-Apr-1979
Streblonema penetrale	19	rocky intertidal	01-Apr-1979
Streblonema porphyrae	19	rocky intertidal	01-Apr-1979
Strongylocentrotus franciscanus	19	rocky subtidal	01-Apr-1979
Strongylocentrotus purpuratus	19	rocky subtidal	01-Apr-1979
Styela montereyensis	19	rocky subtidal	01-Apr-1979
Styela montereyensis	19	sandy intertidal	01-Apr-1979
Styela truncata	19	rocky subtidal	01-Apr-1979
Stylochoplana gracilis	19	sandy intertidal	01-Apr-1979
Stylochus tripartitus	19	sandy intertidal	01-Apr-1979
Syncoryne eximia	19	sandy intertidal	01-Apr-1979
Synoicum parfustis	19	rocky subtidal	01-Apr-1979
Synoicum pellucidum	19	sandy intertidal	01-Apr-1979
Synthliboramphus antiquus	19	pelagic	01-Apr-1979
Tealia coriacea	19	rocky subtidal	01-Apr-1979
Tealia coriacea	19	sandy intertidal	01-Apr-1979
Tealia lofotensis	19	rocky subtidal	01-Apr-1979
Tealia sp.	19	rocky subtidal	01-Apr-1979
Tedania toxicalis	19	sandy intertidal	01-Apr-1979
Tedanione obscurata	19	sandy intertidal	01-Apr-1979
Tegula brunnea	19	rocky subtidal	01-Apr-1979
Tegula brunnea	19	sandy intertidal	01-Apr-1979
Tegula montereyi	19	rocky subtidal	01-Apr-1979
Tegula pulligo	19	rocky subtidal	01-Apr-1979
Tenarea ascripticia	19	rocky intertidal	01-Apr-1979
Tenarea dispar	19	rocky intertidal	01-Apr-1979
Tethya aurantia	19	rocky subtidal	01-Apr-1979
Tethya aurantia	19	sandy intertidal	01-Apr-1979
Tetilla arb	19	rocky subtidal	01-Apr-1979
Tetilla arb	19	sandy intertidal	01-Apr-1979
Thalamoporella sp.	19	rocky subtidal	01-Apr-1979
Thalasseus elegans	19	pelagic	01-Apr-1979
Thelepus crispus	19	rocky subtidal	01-Apr-1979
Themiste dyscritum	19	rocky subtidal	01-Apr-1979
Themiste dyscritum	19	sandy intertidal	01-Apr-1979
Themiste pyroides	19	sandy intertidal	01-Apr-1979

Species Name	ASBS	Habitat	Survey Date
Tiffaniella snyderiae	19	rocky intertidal	01-Apr-1979
Tonicella lineata	19	rocky subtidal	01-Apr-1979
Tonicella lineata	19	sandy intertidal	01-Apr-1979
Tridemnum opacum	19	rocky intertidal	01-Apr-1979
Tridemnum opacum	19	rocky intertidal	01-Apr-1979
Tridemnum opacum	19	rocky subtidal	01-Apr-1979
Trinchesia abronia	19	sandy intertidal	01-Apr-1979
Trinchesia fulgens	19	sandy intertidal	01-Apr-1979
Trinchesia lagunae	19	rocky subtidal	01-Apr-1979
Trinchesia virens	19	sandy intertidal	01-Apr-1979
Triopha carpenteri	19	rocky subtidal	01-Apr-1979
Triopha carpenteri	19	sandy intertidal	01-Apr-1979
Triopha grandis	19	rocky subtidal	01-Apr-1979
Triopha grandis	19	sandy intertidal	01-Apr-1979
Triopha maculata	19	sandy intertidal	01-Apr-1979
Tritonia festiva	19	sandy intertidal	01-Apr-1979
Tubulanus polymorphus	19	rocky subtidal	01-Apr-1979
Tubulanus sexlineatus	19	rocky subtidal	01-Apr-1979
Tubularia marina	19	sandy intertidal	01-Apr-1979
Tubularia sp.	19	rocky subtidal	01-Apr-1979
Tubulipora sp.	19	rocky subtidal	01-Apr-1979
Ulothrix flacca	19	rocky intertidal	01-Apr-1979
Ulothrix pseudoflacca	19	rocky intertidal	01-Apr-1979
Ulva californica	19	rocky intertidal	01-Apr-1979
Ulva expansa	19	rocky intertidal	01-Apr-1979
Ulva lobata	19	rocky intertidal	01-Apr-1979
Ulva lobata	19	sandy subtidal	01-Apr-1979
Ulva sp.	19	rocky intertidal	01-Apr-1979
Ulva taeniata	19	rocky intertidal	01-Apr-1979
Uria aalge	19	pelagic	01-Apr-1979
Urospora penicilliformis	19	rocky intertidal	01-Apr-1979
Urospora wormskioldii	19	rocky intertidal	01-Apr-1979
Weeksia reticulata	19	rocky intertidal	01-Apr-1979
Weeksia reticulata	19	rocky subtidal	01-Apr-1979
Weeksia reticulata	19	sandy subtidal	01-Apr-1979
Xema sabini	19	pelagic	01-Apr-1979
Xestospongia vanilla	19	rocky subtidal	01-Apr-1979
Xestospongia vanilla	19	sandy intertidal	01-Apr-1979
Xiphister atropurpureus	19	sandy intertidal	01-Apr-1979
Xiphister mucosus	19	sandy intertidal	01-Apr-1979

Appendix B – PISCO Survey species lists

http://www.piscoweb.org/data/access-and-applications

Hopkins, Monterey County
January 18, 2003
Species list:

Abietinaria spp	Mastocarpus jardinii
Acanthinucella spp	Mastocarpus papillatus
Alia spp	Mazzaella affinis
Amphissa versicolor	Mazzaella leptorhynchos
Analipus japonicus	Mazzaella spp
Anthopleura elegantissima	Microcladia borealis
Anthopleura sola	Mopalia spp
Aplidium arenatum/propinquum	Mytilus californianus
Aplysina fistularis	Mytilus galloprovincialis/trossulus
Archidistoma psammion	Nucella emarginata/ostrina
Asterina miniata	Nuttallina spp
Balanus glandula	Ocenebra circumtexta
Bittium esrichtii	Ocenebra lurida
Blue green algae	Ophlitaspongia pennata
Bossiella spp	Osmundea spectabilis
Cadlina luteomarginata	Pachygrapsus crassipes
Calliarthron spp	Pagurus granosimanus
Calliostoma canaliculatum	Pagurus hirsutiusculus
Calliostoma ligatum	Pagurus samuelis
Callithamnion pikeanum	Petrocelis spp
Chondracanthus canaliculatus	Petrospongium rugosum
Chondracanthus spinosus	Phidiana hiltoni
Chthamalus spp	Phragmatopoma californica
Cladophora columbiana	Phyllospadix scouleri
Cladophora graminea	Phyllospadix torreyi
Corallina spp	Pisaster ochraceus
Cryptopleura/Hymenena spp	Plocamium violaceum
Distaplia occidentalis	Pollicipes polymerus
Egregia menziesii	Polysiphonia spp
Encrusting coralline	Porphyra spp
Endocladia muricata	Prionitis lanceolata
Epiactis prolifera	Pseudomelatoma torosa
Fissurella volcano	Pterosiphonia baileyi
Gastroclonium subarticulatum	Pugettia producta
Gelidium coulteri	Ralfsiaceae
Gelidium coulteri/pusillum	Rhodymenia californica
Gelidium robustum	Sculpin
Hildenbrandia/Peyssonnelia spp	Serpula vermicularis
Idotea spp	Serpulorbis squamigerus

Lacuna spp	Silvetia compressa
Lepidochitona dentiens	Spirobranchus spinosus
Lepidochitona hartwegii	Spirorbis spp
Leptasterias spp	Strongylocentrotus purpuratus
Littorina keenae	Tegula brunnea
Littorina plena/scutulata	Tegula funebralis
Lottia austrodigitalis/digitalis	Tetraclita rubescens
Lottia limatula	Tonicella lineata
Lottia paradigitalis/strigatella	Ulva spp
Lottia pelta	
Lottia scabra/conus	
Lottia scutum	

Hopkins, Monterey County December 1-2, 2006 Species list:	
Abietinaria spp	Lottia pelta
Acanthinucella spp	Lottia scabra/conus
Acmaea mitra	Lottia scutum
Alia spp	Mastocarpus jardinii
Amphissa versicolor	Mastocarpus papillatus
Analipus japonicus	Mazzaella affinis
Anthopleura elegantissima	Mazzaella leptorhynchos
Anthopleura sola	Mazzaella spp
Anthopleura xanthogrammica	Membranipora spp
Aplidium californicum/solidum	Microcladia borealis
Asterina miniata	Mopalia spp
Balanus glandula	Mytilus californianus
Bittium eschrichtii	Mytilus galloprovincialis/trossulus
Blue green algae	Nucella emarginata/ostrina
Bossiella spp	Nuttallina spp
Bugula neritina	Ocenebra circumtexta
Calliarthron spp	Ocenebra interfossa
Calliostoma canaliculatum	Ophlitaspongia pennata
Calliostoma ligatum	Osmundea sinicola
Callithamnion pikeanum	Osmundea spectabilis
Centroceras/Ceramium/Corallophila spp	Pachycheles spp
Chondracanthus canaliculatus	Pachygrapsus crassipes
Chondracanthus spinosus	Pagurus granosimanus
Chthamalus spp	Pagurus hirsutiusculus
Cirolana spp	Pagurus samuelis
Cladophora columbiana	Pelvetiopsis spp
Cladophora graminea	Petrocelis spp
Corallina spp	Petrospongium rugosum
Cryptochiton stelleri	Phidiana hiltoni
Cryptopleura/Hymenena spp	Phragmatopoma californica
Diatoms	Phyllospadix scouleri

Egregia menziesii	Phyllospadix torreyi
Encrusting coralline	Pisaster ochraceus
Endocladia muricata	Plocamium pacificum
Epitonium tinctum	Pollicipes polymerus
Fissurella volcano	Porphyra spp
Gastroclonium subarticulatum	Prionitis lanceolata
Gelidium coulteri	Pterosiphonia baileyi
Gelidium pusillum	Pterosiphonia dendroidea/pennata
Henricia spp	Pugettia producta
Hildenbrandia/Peyssonnelia spp	Ralfsiaceae
Lacuna spp	Sarcodiotheca gaudichaudii
Laurencia pacifica/masonii	Serpulorbis squamigerus
Lepidochitona dentiens	Sertularella turgida
Lepidochitona hartwegii	Silvetia compressa
Lepidozona spp	Spirorbis spp
Leptasterias spp	Strongylocentrotus purpuratus
Littorina keenae	Tegula brunnea
Littorina plena/scutulata	Tegula funebralis
Lottia austrodigitalis/digitalis	Tetraclita rubescens
Lottia limatula	Tonicella lineata/lokii
Lottia ochracea	Ulva spp
Lottia paradigitalis/strigatella	

Source: PISCO 2003, 2006

Appendix C – ASBS Natural Water Quality Committee Summation of Findings

Status of California's Marine Water Quality Protected Areas
Kenneth Schiff, Brenda Luk and Dominic Gregorio
Technical Report 631 - September 2010

Status of California's Marine Water Quality Protected Areas

Kenneth Schiff
Brenda Luk
Dominic Gregorio

Southern California Coastal Water Research Project

Technical Report 631 - September 2010

Status of California's Marine Water Quality Protected Areas

Kenneth Schiff[1], Brenda Luk[1] and Dominic Gregorio[2]

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Technical Report 629

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ABSTRACT

California has designated 34 different marine water quality protected areas, termed Areas of Special Biological Significance (ASBS), which extend across roughly 500 miles (32%) of state shoreline. Recent surveys observed over 1,600 outfalls into ASBS, most of which are storm drains potentially discharging nonpoint sources of pollutants. The goal of this study was to assess the extent and magnitude of water quality impacts in California's ASBS following storm events. A stratified probabilistic design was used for sampling receiving water shorelines near (discharge) and far (non-discharge) from storm drain outfalls. In all, more than 98 target analytes were measured from 33 sites immediately prior to (pre-storm) and immediately following (post-storm) wet weather. In general, reasonably good water quality exists in California's ASBS following storm events. Many of the target analytes measured did not exceed the State of California's Ocean Plan water quality standards (WQS) and toxicity, using an endemic test species, was rare. The post-storm concentrations of most constituents in discharge and non-discharge strata of ASBS were similar. Likewise, the average concentration increase across all target analytes from pre- to post-storm was less than 3-fold in the discharge stratum. The three potentially problematic parameters identified were total PAH, chromium, and copper. Total chromium did not exceed state WQS such as the instantaneous maximum and daily maximum, but did exceed the six-month median WQS in an estimated 50% of the state's ASBS shoreline-miles. Total PAH exceeded the 30-day average WQS in an estimated 87% of the state's ASBS shoreline-miles. Copper exceeded WQS less extensively (7% of ASBS shoreline-miles), but exclusively in the discharge stratum and for dissolved as well as total copper concentrations. The relatively good water quality on a statewide basis was not evenly distributed. In southern California, whose shoreline is under much more intense development than elsewhere in the state, almost twice as many target analytes exceeded WQS as in central or northern California.

INTRODUCTION

By their proximity, oceans adjacent to coastal land development are continually subjected to pollutant inputs. In the United States, approximately 53% of the population lives in counties bordering the coast, but comprises only 17% of the land area (Culliton *et al*. 1998). This has led to habitat alteration (Boesch *et al*.2001), eutrophication (Bricker *et al*.1999), contaminated sediments (USEPA 2005), and accumulation of toxics in tissues of marine organisms (O'Connor 1998).

One conservation strategy used to safeguard the marine environment is the establishment of protected areas where portions of the coast are set aside for limited use. Marine protected areas exist for some of the most ecologically sensitive areas around the world including Australia's Great Barrier Reef, Fiji, the Galapagos Islands, and others. Many marine protected areas also exist within the United States including California, Hawaii, and Florida (NOAA 2008). Virtually all of these marine protected areas, however, were established based upon natural resource needs and not exclusively water quality issues. Almost in unanimity, the aforementioned marine protected areas initially have fisheries-based goals that limit recreational and/or commercial fishing. Water quality goals, if addressed, were not the primary motivation for the establishment of the marine protected area.

Unlike most other coastal conservation strategies, the State of California established 34 marine protected areas in 1974-75 specifically for the protection of water quality (SWRCB 2005). Although they are called areas of special biological significance (ASBS), not all of these marine water quality protected areas also limit harvesting (i.e., fishing). Twenty-five of the ASBS occur on the mainland of California comprising 499 shoreline miles and 32% of the state coastline (Figure 1). The primacy of water quality protection is indicated within state policy whereby all "discharge of waste is prohibited" and "natural water quality must be maintained" in these ASBS (SWRCB 2005).

The State of California has done a remarkable job limiting point source discharges in ASBS. Less than 10 point source discharges exist statewide, and these are almost entirely discharges from marine aquaria and/or flow through seawater systems associated with research academic institutions. However, little attention has been placed on non-point source discharges, which are much more numerous. Over 1,600 outfalls have been identified along ASBS shoreline (SCCWRP 2003). The vast majority of these outfalls were storm drains that could potentially discharge urban and agricultural runoff from upstream development. Large portions of this upstream development did not exist when the ASBS were originally established in the mid-1970's.

The objective of this study was to assess the extent and magnitude of water quality impacts in ASBS following storm events. Further, the magnitude and extent of impact in ASBS was compared between areas near stormwater discharges and areas distant from discharges to determine the potential of storm drain outfalls to cause the observed impacts in water quality. Ultimately, the goal was to determine if significant water quality impacts existed within ASBS, with the results guiding managers on the need and direction of potential future intervention.

METHODS

This study utilized a probabilistic-based design to estimate the shoreline-miles or percent of total shoreline-miles with observed impacts to water quality. Probabilistic designs, wherein sample sites are selected randomly, enable unbiased estimates of extent (Stevens 1997). For the current study design, the sampling frame consisted of all mainland ASBS shoreline, divided into two groups: 1) areas near direct discharges defined as less than 500m from a pipe, drain, or other surface discharge greater than 18 inches diameter; and 2) non-discharge areas defined as more than 500 m distant from direct discharges. The 500 m cutoff was selected based on nearshore modeling studies by Jenkins and Wasyl (2007). All sites were collected from shoreline receiving water. No effluent samples were collected as part of this study. All sites were sampled for only a single storm event between February and April 2009.

A total of 33 sites were selected for sampling. Twenty-one sites were from the discharge stratum and 12 sites were from the non-discharge stratum (Table 1). At each site, samples were collected immediately prior to (<48 hours), then immediately following (<24 hours), significant storm events. Sampling criteria included: 1) all post-storm samples must be collected as soon after the storm event as possible (nearly all were collected less than six hours following cessation of rainfall); 2) at discharge sites, stormwater flows must reach the ocean; and 3) all ocean receiving water samples must be collected by hand from the shore (no boats). These criteria helped ensure that the focus was on receiving waters, that recent stormwater inputs had occurred, and examining the area closest to shore where potentially the least mixing occurs.

All water samples were analyzed for 98 parameters: 1) general constituents including total suspended solids (TSS), dissolved organic carbon (DOC), and salinity; 2) nutrients including nitrate (NO3-N), nitrite (NO2-N), ammonia (NH3-N), total nitrogen (TN), total phosphorus (TP), and ortho-phophate (PO4-P); 3) dissolved and total trace metals (As, Cd, Cr, Cu, Ni, Pb, Ag, Se, Zn); 3) chlorinated hydrocarbons including total PCB (sum of congeners 18, 28, 37, 44, 49, 52, 66, 70, 74, 77, 81, 87, 99, 101, 105, 110, 114, 118, 119, 123, 126, 128, 138, 149, 151, 153, 156, 157, 158, 167, 168, 169, 170, 177, 180, 183, 187, 189, 194, 201, 206) and total DDT (sum of o,p'- and p,p'-DDT, DDE, and DDD); 4) total polycyclic aromatic hydrocarbons (28 PAH); and 5) short-term chronic toxicity using an early life stage of an endemic species. All sample analysis followed standard methods and/or EPA approved procedures (APHA 2006). Trace metals were prepared for analysis using ammonium pyrrolidine dithiocarbamate (APDC), a chelation method that concentrates trace metals and removes matrix interferences (USEPA 1996). Fertilization success of the purple sea urchin, *Strongylocentrotus purpuratus*, was used for toxicity testing (USEPA 1995).

The project focused on performance-based measures of quality assurance. In general, laboratory data quality was quite good: no laboratory blank samples greater than the method detection limit; 96% success meeting data quality objectives (DQOs) for precision using laboratory duplicates; 91 % success meeting DQOs for accuracy using spiked samples. The lowest accuracy success rate was for cadmium (12 of 15 batches) and zinc (8 of 16 batches) where the requirement of 75-125% recovery from seawater was not met. This was due, in part, to the APDC chelation method that has lower affinities for extracting cadmium and zinc.

Data Analysis

Based on the study design, two data analysis approaches were utilized to compare spatial (discharge vs. non-discharge strata) and temporal (pre-storm vs. post-storm) relationships. The first approach examined the magnitude of changes in space and time. To do this, area-weighted geometric means were calculated for total ASBS shoreline and for each stratum and time period using a ratio estimator approach following Thompson (1992):

$$m = \frac{\sum_{i=1}^{n} (p_i * w_i)}{\sum_{i=1}^{n} w_i},$$

Where:
m = Log_{10} of the area-weighted mean concentration for population j.
p_i = Log_{10} of the parameter value (e.g., concentration) at station i.
w_i = Area weight for station i.
n = Number of stations in population j.

The standard error of the mean is calculated using the following equation where the 95% confidence intervals about the mean were calculated as 1.96 times the standard error.

$$\text{Standard error (SE)} = \sqrt{\frac{\sum_{i=1}^{n} ((p_i - m) * w_i)^2}{\left(\sum_{i=1}^{n} w_i\right)^2}},$$

where:
m = Log_{10} of the area-weighted mean concentration for population j.
p_i = Log_{10} of the parameter value (e.g., concentration) at station i.
w_i = Area weight for station i.
n = Number of stations in population j.

All concentrations below detection limits were treated as zero. Area-weighted geometric means and confidence interval were back-transformed for tables and graphs.

The second data analysis approach focused on estimating the areal extent of impact. To accomplish this, area weights for each sample that exceeded State of California water quality standards (WQS) were summed and divided by the total area-weight for the stratum and time period of interest. The WQS are defined in Table B of the California Ocean Plan (SWRCB 2005). Four WQS exist including six-month median, 30-day average, daily maximum, and instantaneous maximum thresholds.

RESULTS

The post-storm concentrations of most constituents in discharge and non-discharge strata of ASBS were similar (Table 2). Except for DOC and dissolved copper, there was no statistical difference in area-weighted geomean concentrations between post-storm discharge and non-discharge strata. In the case of post-storm copper geomean concentrations, the discharge stratum was greater than the non-discharge stratum. The case was reversed for DOC; the non-discharge was greater than the discharge stratum. Although not statistically different, the area-weighted geometric mean concentration in the discharge stratum was greater for 14 of the remaining 24 parameters compared to the post-storm non-discharge stratum. Post-storm concentrations of chlorinated hydrocarbons, such as total DDT and total PCB, were uniformly non-detectable in both strata.

On average, the increase in concentration across all target analytes from pre- to post-storm samples was less than 3-fold in the discharge stratum (Table 2; Figure 2). In fact, none of the target analyte concentrations were significantly greater post-storm compared to pre-storm. Average concentrations for 12 of the 25 target analyte actually decreased from pre- to post-storm in the discharge stratum. Of the remaining 13 target analytes, the most substantial concentration increases were for dissolved iron (26-fold) and DOC (15-fold).

In general, exceedence of WQS such as instantaneous maxima, daily maxima, and six-month medians, were infrequent for ammonia and trace metals following storm events (Table 3). None of the target analytes collected post-storm exceeded WQS based on instantaneous maxima. Only a single target analyte collected post-storm exceeded the WQS based on the daily maximum. This analyte, total chromium, exceeded 2% of the post-storm shoreline-miles across all ASBS. Ten of 18 parameters collected post-storm exceeded the WQS based on six-month median objectives. Three parameters were dissolved metals (cadmium, copper, and nickel); none of these dissolved metals exceeded the six-month median in more than 2% of the ASBS shoreline-miles. Seven of the parameters exceeding the six-month median were for total metals. The parameter that exceeded the six-month median WQS most frequently (50% of ASBS shoreline-miles) was total chromium. Total nickel exceeded the six-month median WQS second most frequently (15% of ASBS shoreline-miles). Total arsenic, cadmium, copper, lead and zinc exceeded six-month median WQS between 2 and 7% of the ASBS shoreline-miles.

In contrast to ammonia and trace metals, exceedence of state WQS for trace organic parameters was much more frequent (Table 4). Of the six target organic analytes collected post-storm, only total PAH exceeded the 30-day average WQS. However, total PAH exceeded the 30-day average WQS an estimated 87% of the ASBS shoreline-miles. Other trace organic parameters including total DDTs, total PCBs, chlordane, and dieldrin did not exceed the 30-day average WQS.

Except for total chromium and total nickel, there was no dramatic difference in the extent of post-storm WQS exceedences between discharge and non-discharge strata (Tables 3 and 4). The difference in exceedence of the six-month median WQS following storm events was nearly two-fold for total chromium (35% of shoreline-miles for the non-discharge stratum compared to 61% of shoreline-miles for the discharge stratum) and a factor of eight for total nickel (3% of

shoreline-miles for the non-discharge stratum compared to 24% of shoreline-miles for the discharge stratum).

Contrary to expectations, there was little change in the extent of WQS exceedences from pre- to post-storm in the discharge stratum (Tables 3 and 4). For example, the percent of shoreline-miles that exceeded WQS for chromium and total PAH changed by less than 10% (Figure 3). On the other hand, there were substantial changes in the extent of WQS exceedence from pre- to post-storm in the non-discharge stratum, particularly for these same two target analytes. The extent of shoreline-miles approximately doubled pre- to post-storm for total chromium and total PAH. In fact, the extent of post-storm WQS exceedences of total PAH in the non-discharge stratum looked very much like the extent in the discharge stratum (89% vs. 86% of shoreline-miles, respectively).

Exceedences of the WQS occurred most frequently in southern California compared to northern or central California (Figure 4). The Irvine Coast ASBS in southern California had the greatest number of target analytes (six) sampled post-storm that exceeded WQS and had concentrations that increased from pre- to post-storm. The Robert Badham ASBS followed with four target analytes sampled post-storm that exceeded WQS. No ASBS in Central and Northern California exceeded these same criteria by more than three target analytes. Only a single ASBS in southern California (San Diego-Scripps ASBS) had no exceedences of the WQS for any analyte. There were six ASBS in Central and Northern California that had no analytes exceeding the WQS.

The occurrence of toxicity in post-discharge samples from ASBS was rare. Roughly 3% of the shoreline miles observed post-storm toxicity. This was relatively evenly split between non-discharge and discharge strata.

DISCUSSION

Based on the results from this study, generally good water quality exists in California's ASBS following storm events. Most target analytes measured did not exceed the State of California's WQS and, for the majority of analytes that did exceed the WQS, the relative extent of impact was small (< 7% of ASBS shoreline-miles). All of the target analytes that exceeded WQS have natural as well as anthropogenic sources (e.g., trace metals), but synthetic pesticides (e.g., total DDTs, total PCBs, chlordane and dieldrin) never exceeded WQS and were rarely detected. Additionally, toxicity using an endemic species (sea urchin fertilization test) was infrequent indicating unmeasured analytes were likely not problematic. Finally, average receiving water concentrations of most common stormwater constituents (i.e., lead, zinc, etc.) were statistically similar between the discharge and non-discharge stratum, and average concentrations measured pre-storm were statistically similar to post-storm concentrations in discharge stratum. The lack of demonstrative impact following storm events is an important finding because the greatest perceived risk to ASBS water quality is from stormwater runoff generated by urban, agricultural, and other nonpoint source activities.

While the summary of post-storm water quality in ASBS can be described as good, there were three parameters that stand out as potentially problematic. These include total PAH, chromium, and copper. Total PAH is a known stormwater contaminant from studies not only in California (Stein *et al*.2006), but around the United States (Hoffman *et al*.1984). Total PAH concentrations in ASBS were generally low, never exceeding 186 ng/L. Unlike all the other analytes that indicated impairment, the WQS for PAH is based on risk to human health through bioaccumulation in seafood. Hence, the total PAH WQS may be marginally applicable for the protection of marine aquatic life. Interestingly, the frequency of WQS exceedence for total PAH was similar between pre- and post-storm in the discharge stratum so non-storm sources may be at play. Other potential sources could be numerous including dry weather runoff (Stein *et al*. 2006), atmospheric deposition (Sabin *et al*.2009), or natural seeps (Leifer *et al*.2006). Clearly, future work on source attribution of total PAH and its potential for biological effects, should be evaluated.

Unlike total PAH, the WQS for chromium is based on the predicted marine life toxicity of its most harmful state, hexavalent chromium. While total chromium is the accepted surrogate for hexavalent chromium in most regulatory applications, no analysis was done in this study to evaluate the relative contribution of hexavalent chromium. Since toxicity was infrequently observed, one can hypothesize that hexavalent chromium was often below the WQS. However, the disparity in the extent of total chromium exceeding WQS between the discharge stratum and non-discharge stratum was sizeable (61% vs. 35% of ASBS shoreline-miles, respectively). Therefore, total chromium in stormwater discharges likely has some influence on ASBS receiving water concentrations. Adding to the concern, total chromium is a commonly found analyte in urban stormwater discharges, with industrial land uses having amongst the greatest concentrations in southern California (Tiefenthaler *et al*.2008). Chromium is also a naturally occurring component of serpentine rock in many coastal California locations (Caillaud *et al*. 2009). Because of the issues associated with natural versus anthropogenic sources of chromium, surveys focused on chromium and the relationship between total and hexavalent chromium at problematic ASBS may be warranted.

Copper was the final target analyte of concern. The concern was generated by four factors that individually aren't alarming, but collectively may indicate stormwater influences. First, total copper exceeded WQS, although not extensively (7% of ASBS shoreline-miles). However, the extent of impact occurred exclusively in the discharge stratum while the non-discharge stratum was free of copper WQS exceedences. Second, the copper WQS exceedence in the discharge stratum occurred post-storm, but was absent in pre-storm samples. Third, the WQS exceedence occurred not just for total copper, but also for dissolved copper. Fourth, the average dissolved copper concentration was significantly greater post-storm than pre-storm. The third and fourth factors are relevant to stormwater inputs because dissolved copper is more bio-available, and an inherently greater toxicological risk to marine life, compared to total copper (Arnold *et al*.2005). Moreover, copper is consistently observed in stormwater discharges (Tiefenthaler 2008). Further, copper has been identified as the primary toxicant of concern for failed toxicity tests using the sea urchin fertilization test in near coastal water influenced by stormwater runoff (Bay *et al*.2003)

The larger concern for total PAH and total chromium may actually be in the non-discharge stratum. It was in the non-discharge stratum that WQS exceedences rose dramatically from pre- to post-storm. While average concentrations did not dramatically increase, they were very near the state's WQS and the extent of ASBS shoreline-miles exceeding WQS doubled or tripled. In fact, the extent of WQS exceedence in non-discharge areas post-storm looked very similar to the extent observed in the discharge stratum. This study design element was intentional; we wanted to see if discharges either inside or outside of ASBS may impact non-discharge shoreline. The influence of distant sources, at least for these two target analytes, was obvious.

An alternative hypothesis is that applying long-term WQS to short-term events, like storm events, are not appropriate in the nearshore zone. California has several short-term thresholds including instantaneous maximum, daily maximum, and additional long-term thresholds such as the 30-day average (for trace organics) or six-month median (for ammonia and trace metals). However, it is standard regulatory practice to use even single samples to evaluate the long-term thresholds when additional data are not available. In the case of this study, even the most problematic target analytes (total PAH and total chromium, both of which have both natural and anthropogenic sources) did not exceed the short-term thresholds. It was application of the long-term thresholds, whose benchmark concentrations are much lower, when WQS exceedences became problematic. For this reason, a more appropriate measure might be "natural water quality" as designated in state policy. Natural water quality, while attractive, has its own set of technical and political challenges. Since no statewide data exists from natural (e.g., reference) sites, additional data collection would be necessary.

Finally, the notably good water quality on a statewide basis was not evenly distributed throughout the state. Some ASBS exceeded WQS standards at a much greater frequency and these regions should likely receive further attention. For example, sites in southern California fared worse than their northern or central California counterparts. This may be due, in part, to the intense urbanization of the southern region. More than 20 million people live in southern California and coastal development pressure is intense (Ackerman and Schiff 2003). In the survey of storm drain discharges to ASBS, over 46% occurred in southern California. In fact, so

much development occurs in southern California coastal watersheds, that the non-discharge stratum (defined as >500m from drain discharges 18 inches and greater), did not exist in southern California.

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Figure 1. Map of California's Water Quality Protected Areas termed "Areas of Special Biological Significance".

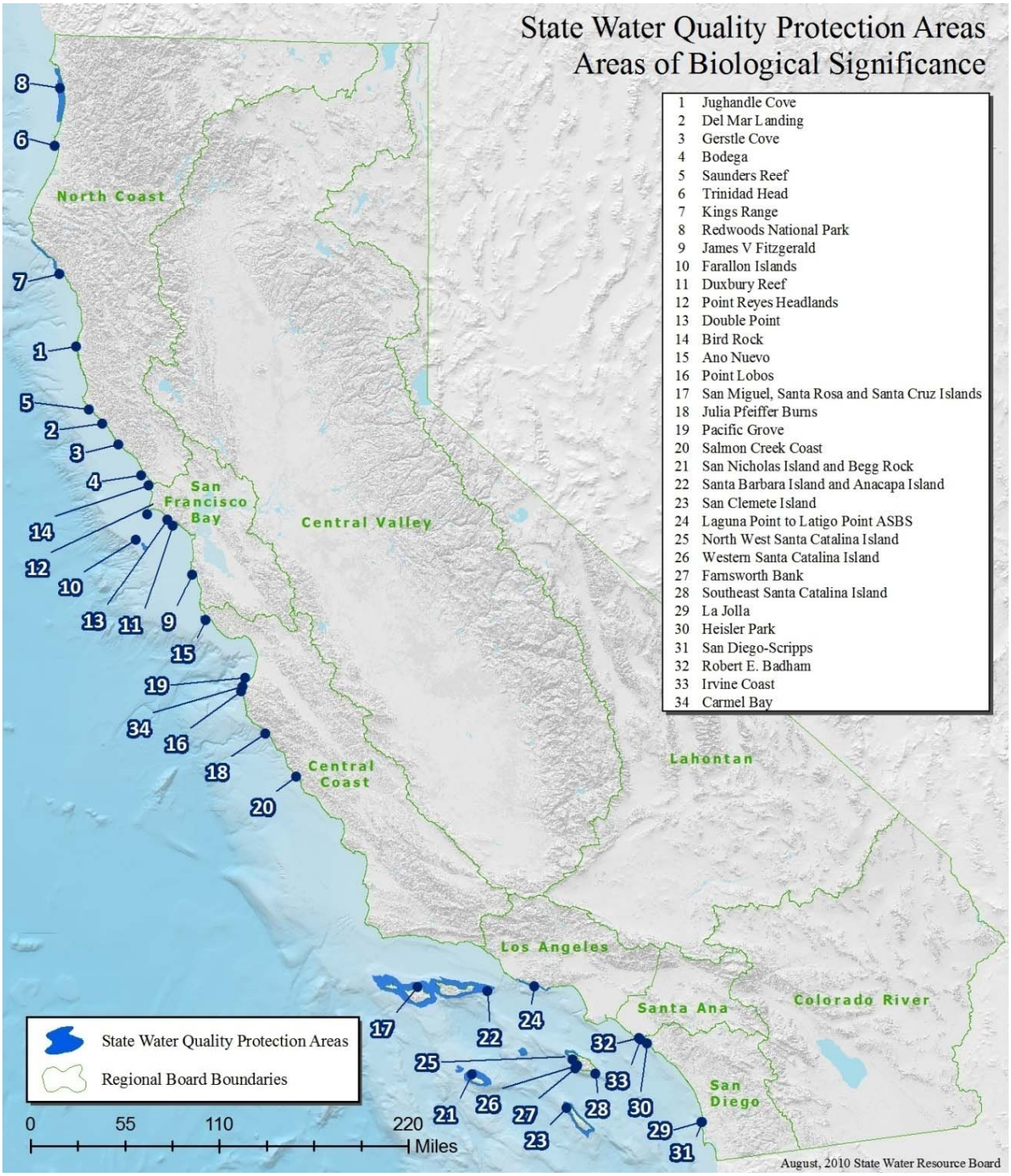


Figure 2. Relative increase of target analyte concentrations in Areas of Special Biological Significance (ASBS) collected <48 hours prior to a storm (pre-) compared to concentrations collected <24 hours following a storm (post-). Unity indicates pre- and post-storm concentrations were the same. Values greater than 1 indicate a post-storm increase in concentration.

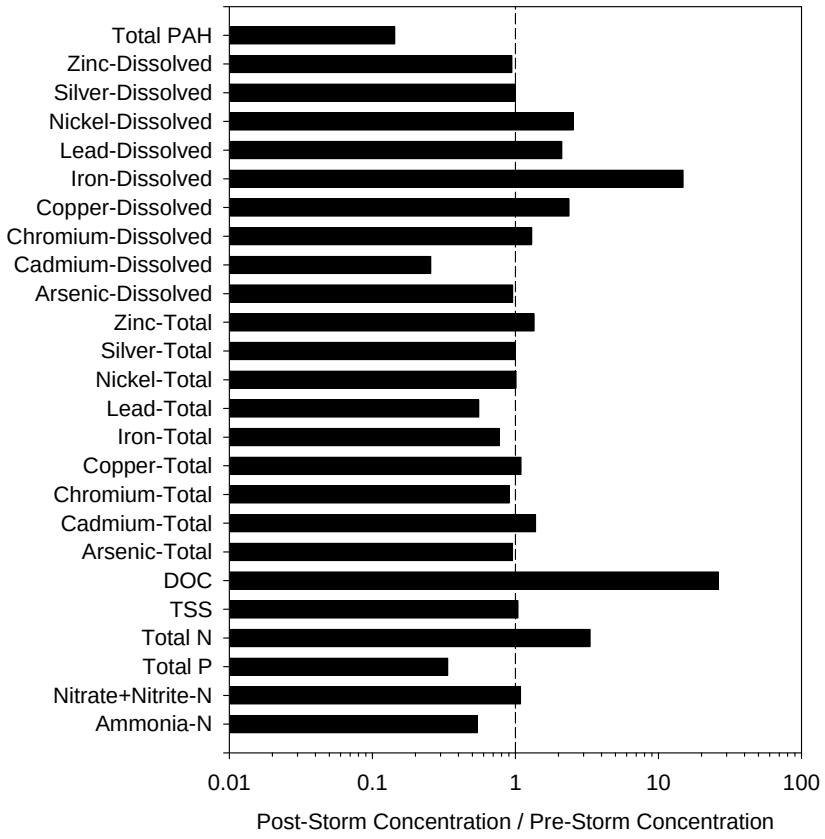


Figure 3. Comparison of the percent shoreline-miles that exceeded State of California 30-day water quality standards for total chromium and total PAH from pre- and post-storm samples in discharge and non-discharge strata.

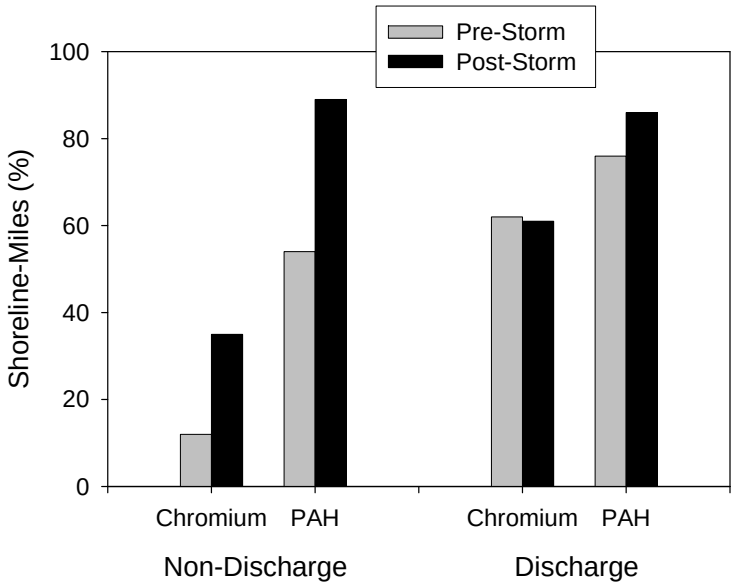


Figure 4. Number of parameters (out of 25) that exceeded State Water Quality Standards (6 month median for ammonia and trace metals, 30-day average for trace organics, SWRCB 2005), and had post-storm concentrations greater than pre-storm concentrations, in each of the sampled Areas of Special Biological Significance (ASBS). Data are presented for both the discharge and non-discharge strata. 0 = no parameters exceeded water quality standard (WQS). nd = no data.

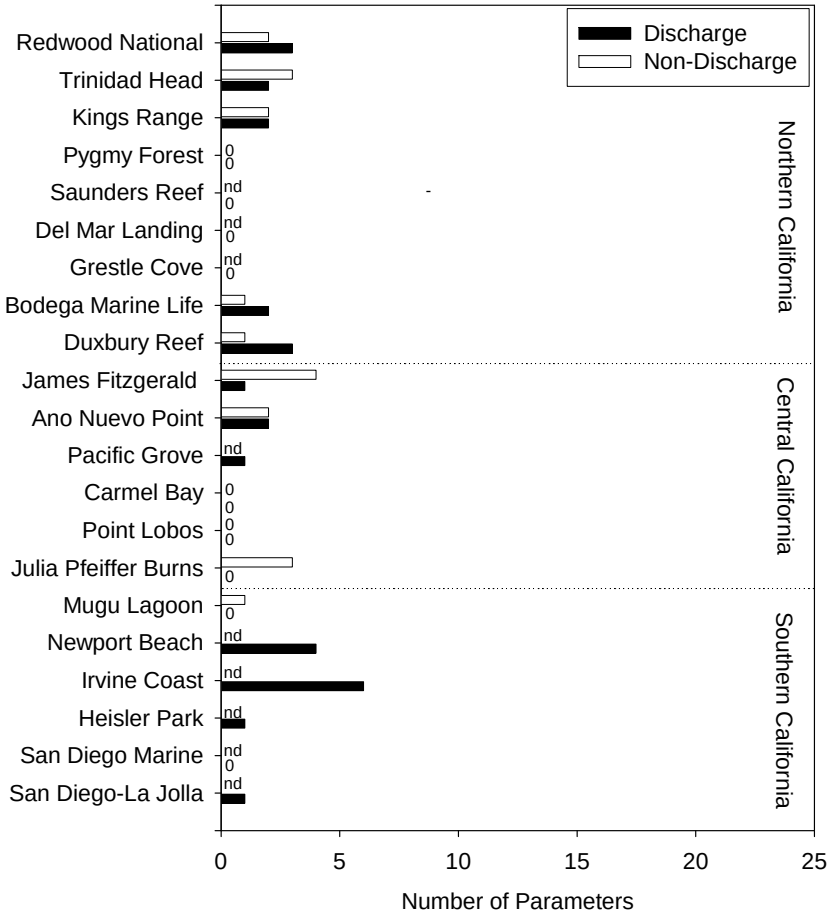


Table 1. List of sample sites.

Stratum	SiteID	Longitude	Latitude	ASBS No.	Location
Non-Discharge	N018	-124.0858	41.3196	7	Redwood National and State Parks ASBS
Discharge	D055	-124.0941	41.2799	7	Redwood National and State Parks ASBS
Discharge	D027	-124.1486	41.0608	5	Kelp Beds at Trinidad Head ASBS
Non-Discharge	N043	-124.1441	41.0573	5	Kelp Beds at Trinidad Head ASBS
Non-Discharge	N243	-124.0796	40.0584	6	Kings Range National Conservation Area ASBS
Discharge	D119	-124.0798	40.0388	6	Kings Range National Conservation Area ASBS
Non-Discharge	N035	-123.8216	39.3808	1	Pygmy Forest Ecological Staircase ASBS
Discharge	D037	-123.8188	39.3764	1	Pygmy Forest Ecological Staircase ASBS
Discharge	D050	-123.6487	38.8519	5	Kelp Beds at Saunders Reef ASBS
Discharge	D042	-123.5116	38.7408	2	Del Mar Landing Ecological Reserve ASBS
Discharge	D043	-123.3315	38.5663	3	Grestle Cove ASBS
Non-Discharge	N038	-123.0742	38.3190	4	Bodega Marine Life Refuge ASBS
Discharge	D046	-123.0704	38.3171	4	Bodega Marine Life Refuge ASBS
Non-Discharge	N051	-122.7192	37.9017	10	Duxbury Reef Reserve and Extension ASBS
Discharge	D067	-122.7111	37.8972	10	Duxbury Reef Reserve and Extension ASBS
Discharge	D058	-122.4986	37.5011	8	James V. Fitzgerald Marine Reserve ASBS
Non-Discharge	N042	-122.4958	37.4956	8	James V. Fitzgerald Marine Reserve ASBS
Discharge	D001	-122.3381	37.1361	15	Ano Nuevo Point and Island ASBS
Non-Discharge	N064	-122.3042	37.1153	15	Ano Nuevo Point and Island ASBS
Discharge	D035	-121.9135	36.6230	19	Pacific Grove Marine Gardens Fish Refuge and Hopkins Marine Life Refuge ASBS
Discharge	D220	-121.9316	36.5396	34	Carmel Bay ASBS
Non-Discharge	N055	-121.9298	36.5232	34	Carmel Bay ASBS
Non-Discharge	N002	-121.9528	36.5183	16	Point Lobos Ecological Reserve ASBS
Discharge	D030	-121.9439	36.5128	16	Point Lobos Ecological Reserve ASBS
Discharge	D031	-121.6973	36.1754	18	Julia Pfieffer Burns Underwater Park ASBS
Non-Discharge	N022	-121.6960	36.1743	18	Julia Pfieffer Burns Underwater Park ASBS
Discharge	D016	-118.8727	34.0373	24	Mugu Lagoon to Latigo Point ASBS
Non-Discharge	N006	-118.8076	34.0008	24	Mugu Lagoon to Latigo Point ASBS
Discharge	NWPT	-117.8675	33.5887	32	Newport Beach Marine Life Refuge ASBS
Discharge	D087	-117.8480	33.5774	33	Irvine Coast Marine Life Refuge ASBS
Discharge	D076	-117.7897	33.5428	30	Heisler Park Ecological Reserve ASBS
Discharge	D080	-117.2535	32.8693	31	San Diego Marine Life Refuge ASBS
Discharge	D074	-117.2637	32.8498	29	San Diego-La Jolla Ecological Reserve ASBS
22					Total No. Sites in Discharge Stratum
11					Total No. Sites in NonDischarge Stratum
33					Total No. Sites

Table 2. Area weighted geomean concentrations (±95% confidence intervals) for receiving water strata near (discharge) and far (nondischarge) from outfalls in areas of special biological significance <48 hours before (pre-storm) and <24 hours following (post-storm) wet weather events. "–" indicates no detectable quantities.

Parameter	Units	Nondischarge				Discharge			
		Pre-storm		Post-storm		Pre-storm		Post-storm	
		Geomean	(±) 95% CI	Geomean	(±) 95% CI	Geomean	(±) 95% CI	Geomean	(±) 95% CI
Ammonia-N	mg/L	0.001	0.002	0.004	0.008	0.017	0.031	0.009	0.009
Nitrate+Nitrite-N	mg/L	0.13	0.10	0.14	0.10	0.11	0.07	0.12	0.0559
Total P	mg/L	0.41	0.24	0.19	0.09	0.21	0.20	0.07	0.03
Total N	mg/L	0.76	1.22	0.82	1.03	0.37	0.56	1.25	1.44
TSS	mg/L	95.7	145.3	78.5	52.3	91.7	69.2	95.5	75.4
DOC	mg/L	--	--	--	--	0.03	0.06	0.89	1.03
Arsenic-Total	ug/L	1.69	0.35	1.72	0.30	1.96	0.42	1.87	0.40
Cadmium-Total	ug/L	0.05	0.02	0.05	0.02	0.08	0.02	0.11	0.10
Chromium-Total	ug/L	1.61	0.49	2.17	0.74	2.85	1.48	2.59	0.96
Copper-Total	ug/L	0.99	0.32	1.43	0.70	1.09	0.37	1.19	0.43
Iron-Total	ug/L	761	539	1301	1098	1288	919	994	474
Lead-Total	ug/L	0.71	0.82	0.60	0.49	0.89	0.61	0.50	0.13
Nickel-Total	ug/L	2.07	0.84	2.91	0.88	2.87	1.28	2.90	0.95
Silver-Total	ug/L	0.002	0.004	--	--	0.007	0.010	--	--
Zinc-Total	ug/L	1.91	1.76	1.10	1.20	3.39	0.91	4.59	2.86
Arsenic-Dissolved	ug/L	1.43	0.07	1.32	0.16	1.35	0.07	1.29	0.13
Cadmium-Dissolved	ug/L	0.02	0.02	0.03	0.02	0.20	0.27	0.05	0.03
Chromium-Dissolved	ug/L	0.18	0.02	0.18	0.04	0.16	0.01	0.21	0.02
Copper-Dissolved	ug/L	0.17	0.03	0.21	0.05	0.23	0.10	0.54	0.24
Iron-Dissolved	ug/L	0.07	0.12	0.15	0.21	0.36	0.24	5.33	4.90
Lead-Dissolved	ug/L	0.002	0.003	0.003	0.003	0.009	0.006	0.018	0.019
Nickel-Dissolved	ug/L	0.39	0.13	0.47	0.27	0.37	0.15	0.93	0.65
Silver-Dissolved	ug/L	--	--	--	--	--	--	--	--
Zinc-Dissolved	ug/L	0.24	0.34	0.26	0.33	1.53	1.63	1.44	1.84
Total PAH	ug/L	0.020	0.017	0.038	0.033	0.106	0.117	0.015	0.005

Table 3. Percent of shoreline-miles exceeding daily maximum of six-month median water quality standards (WQS) in receiving water either near outfalls (discharge), far from outfalls (nondischarge), or combined (statewide) in areas of special biological significance <48 hours before (pre-storm) and <24 hours following (post-storm) wet weather events.

Parameter	Units	Shoreline-Miles (%) Exceeding Daily Maximum WQS						
		WQS	Pre-Storm			Post-Storm		
			Statewide	Discharge	Non-Discharge	Statewide	Discharge	Non-Discharge
Ammonia-N	mg/L	2.4	--	--	--	--	--	--
Arsenic-Dissolved	ug/L	32	--	--	--	--	--	--
Cadmium-Dissolved	ug/L	4	--	--	--	--	--	--
Chromium-Dissolved	ug/L	8	--	--	--	--	--	--
Copper-Dissolved	ug/L	12	--	--	--	--	--	--
Lead-Dissolved	ug/L	8	--	--	--	--	--	--
Nickel-Dissolved	ug/L	20	--	--	--	--	--	--
Silver-Dissolved	ug/L	2.8	--	--	--	--	--	--
Zinc-Dissolved	ug/L	80	--	--	--	--	--	--
Arsenic-Total	ug/L	32	--	--	--	--	--	--
Cadmium-Total	ug/L	4	--	--	--	--	--	--
Chromium-Total	ug/L	8	--	--	--	2	3	--
Copper-Total	ug/L	12	--	--	--	--	--	--
Lead-Total	ug/L	8	--	--	--	--	--	--
Nickel-Total	ug/L	20	--	--	--	--	--	--
Silver-Total	ug/L	2.8	--	--	--	--	--	--
Zinc-Total	ug/L	80	--	--	--	--	--	--

Table 3. Continued

Parameter	Units	WQS	Shoreline-Miles (%) Exceeding 6-Month Median WQS					
			Pre-Storm			Post-Storm		
			Statewide	Discharge	Non-Discharge	Statewide	Discharge	Non-Discharge
Ammonia-N	mg/L	0.6	--	--	--	--	--	--
Arsenic-Dissolved	ug/L	8	--	--	--	--	--	--
Cadmium-Dissolved	ug/L	1	--	--	--	< 1	< 1	--
Chromium-Dissolved	ug/L	2	--	--	--	--	--	--
Copper-Dissolved	ug/L	3	--	--	--	< 1	< 1	--
Lead-Dissolved	ug/L	2	--	--	--	--	--	--
Nickel-Dissolved	ug/L	5	--	--	--	2	3	--
Silver-Dissolved	ug/L	0.7	--	--	--	--	--	--
Zinc-Dissolved	ug/L	20	--	--	--	--	--	--
Arsenic-Total	ug/L	8	--	--	--	2	3	--
Cadmium-Total	ug/L	1	--	--	--	2	4	--
Chromium-Total	ug/L	2	41	62	12	50	61	35
Copper-Total	ug/L	3	--	--	--	7	5	10
Lead-Total	ug/L	2	11	6	18	5	--	11
Nickel-Total	ug/L	5	3	6	--	15	24	3
Silver-Total	ug/L	0.7	--	--	--	--	--	--
Zinc-Total	ug/L	20	--	--	--	4	7	--

Table 4. Percent of shoreline-miles exceeding 30-day average water quality standards (WQS) in receiving water either near outfalls (discharge), far from outfalls (nondischarge), or combined (statewide) in areas of special biological significance <48 hours before (pre-storm) and <24 hours following (post-storm) wet weather events.

Parameter	Units	Shoreline-Miles (%) Exceeding 30-Day Average WQS						
		WQS	Pre-Storm			Post-Storm		
			Statewide	Discharge	Non-Discharge	Statewide	Discharge	Non-Discharge
Fluoranthene	ng/L	150	--	--	--	--	--	--
Chlordane	ng/L	0.023	--	--	--	--	--	--
DDT	ng/L	0.17	< 1	1	--	--	--	--
Dieldrin	ng/L	0.04	--	--	--	--	--	--
PAHs	ng/L	8.8	66	76	54	87	86	89
PCBs	ng/L	0.019	--	--	--	--	--	--

Appendix D – Mussel Watch Bioaccumulation Data

Summary for Pacific Grove Lovers Point (PGLP)

At PGLP, according to the latest data (2007-2009):
Arsenic concentration (11.6 µg/dry g) is higher than state wide median (9.43 µg/dry g), and lower than statewide 85th percentile (13.28 µg/dry g);
Lead concentration (7.03 µg/dry g) is higher than state wide median (1.36 µg/dry g) and statewide 85th percentile (2.246 µg/dry g) concentration;
Cadmium concentration (12.8 µg/dry g) is higher than statewide median (5.01 µg/dry g) and statewide 85th percentile (7.498 µg/dry g) concentration;
Nickel concentration (2.52 µg/dry g) is higher than state wide median (2.18 µg/dry g), and lower than statewide 85th percentile (4.662 µg/dry g);
Zinc concentration (189 µg/dry g) is higher than statewide median (138 µg/dry g) and statewide 85th percentile (187.8 µg/dry g) concentration;
Mercury concentration (0.0941 µg/dry g) is higher than statewide median (0.074 µg/dry g), and lower than statewide 85th percentile (0.224 µg/dry g).
The other analyzed metals and total PAH concentrations are lower than both statewide median concentration and state wide 85th percentile concentrations.

Between 1985 and 2010, 18 constituents (Total Butyltins, Total Chlordanes, Total DDTs, Total Dieldrins, Total PAHs, Total PCBs, Zinc, Selenium, Tin, Ag, Al, As, Cd, Cr, Cu, Hg, Ni and Pb) were analyzed in Pacific Grove Lovers Point.

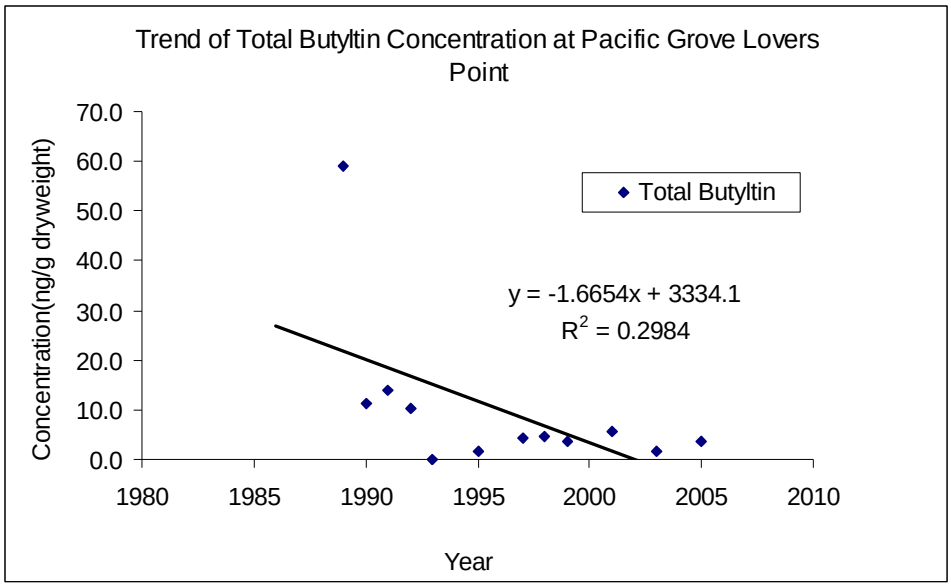
The following table provides the results for the test for a significant correlation coefficient. Highlighted values have statistically significant trends. Arsenic and Tin shows a significant decrease according to historic data (1986 – 2009). Cadmium shows a significant increase. Most of constituents (11 out of 18) show downward trends.

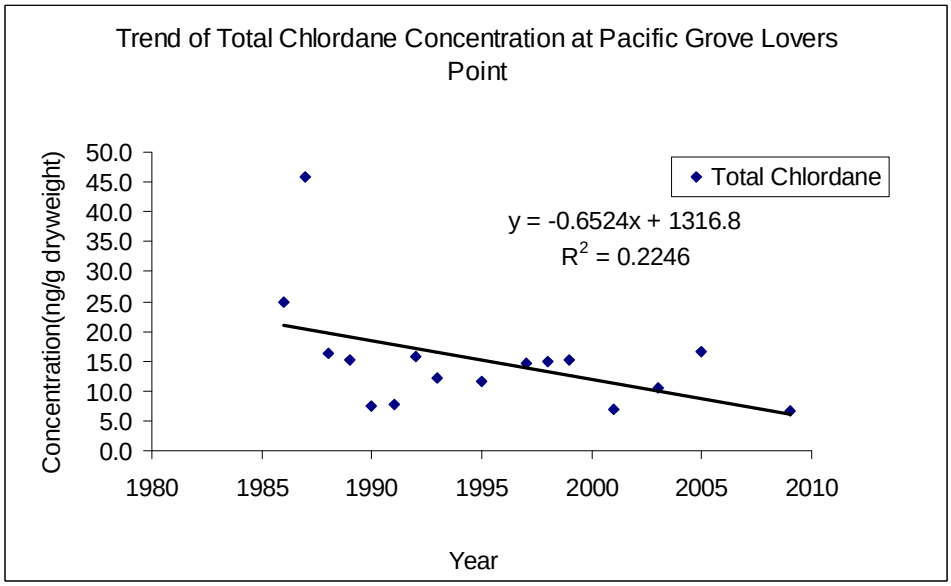
Table 1: Pearson Product-Moment Correlation Coefficient analysis for historical trend data(1986-2009). Highlighted constituents have significant trends.

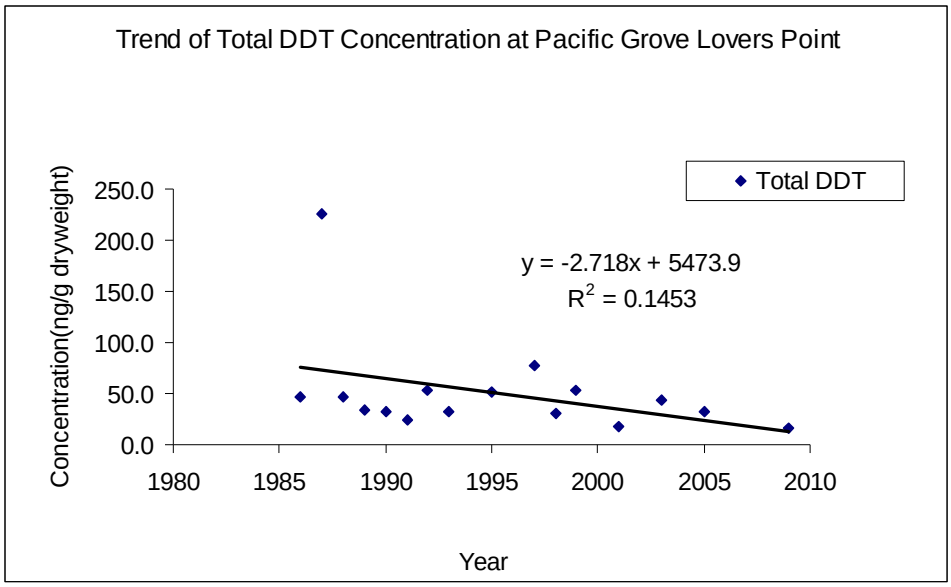
	Pacific Grove Lovers Point				
Year	Number of data	R^2	R*	Critical value of the Pearson Product-Moment Correlation Coefficient (0.05)	b**
Total Butlytins	12	0.298	0.546	0.576	-1.67
Total Chlordane	16	0.225	0.474	0.497	-0.65
Total DDT	16	0.145	0.381	0.497	-2.72
Total Dieldrin	16	0.126	0.355	0.497	-0.395
Total PAHs	13	0.068	0.26	0.553	1.27
Total PCBs	13	0.015	0.124	0.553	-0.21
ZN	16	0.01	0.098	0.497	-0.42
Ag	12	0.022	0.147	0.576	0.007
AS	16	0.362	0.602	0.497	-0.24
CD	15	0.269	0.518	0.514	0.27
CR	16	0.171	0.413	0.497	0.04
CU	16	0.077	0.278	0.497	0.078
HG	16	0.053	0.231	0.497	0.0015
NI	16	0.145	0.381	0.497	0.0334
PB	16	0.053	0.23	0.497	-0.09
SB	6	0.879	0.937	0.811	-0.157
SE	16	0.021	0.146	0.497	-0.01
SI	6	0.141	0.375	0.811	-72.06

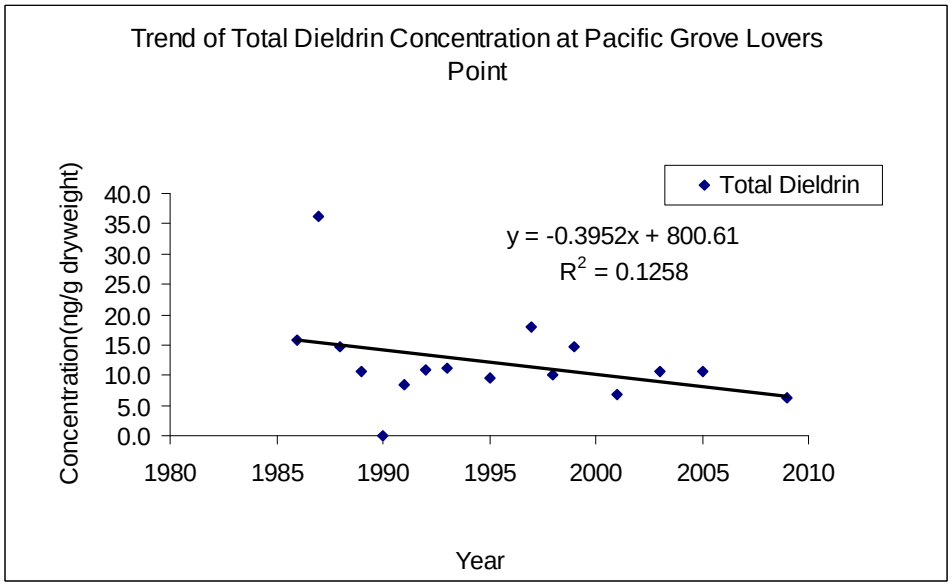
R-Correlation coefficient; **b- slope of the linear model

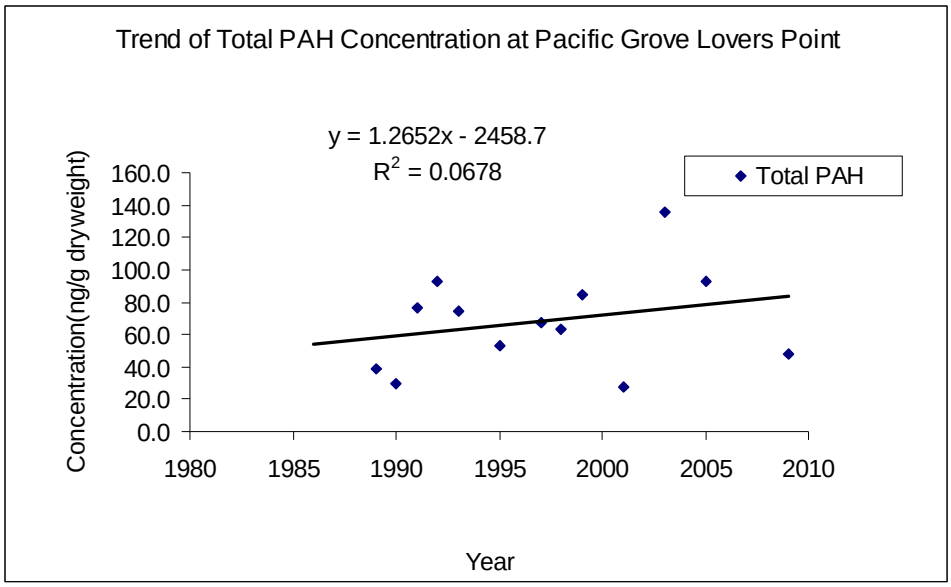
Graphs for mussel watch tissue concentrations over time are provided below.

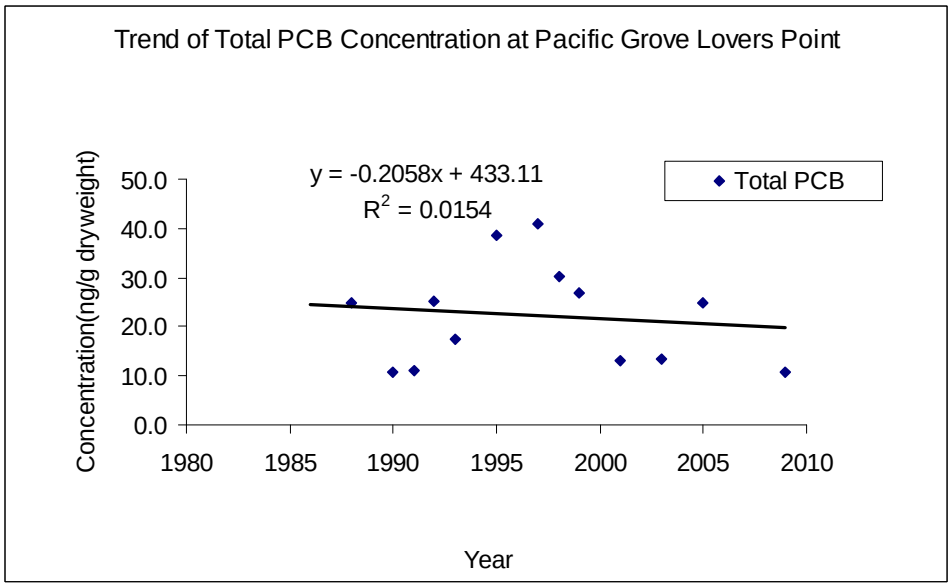

Trend of Total Butyltin Concentration at Pacific Grove Lovers Point
Concentration(ng/g dryweight)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1980
1985
1990
1995
2000
2005
2010
Year
Total Butyltin
y = -1.6654x + 3334.1
R2 = 0.2984

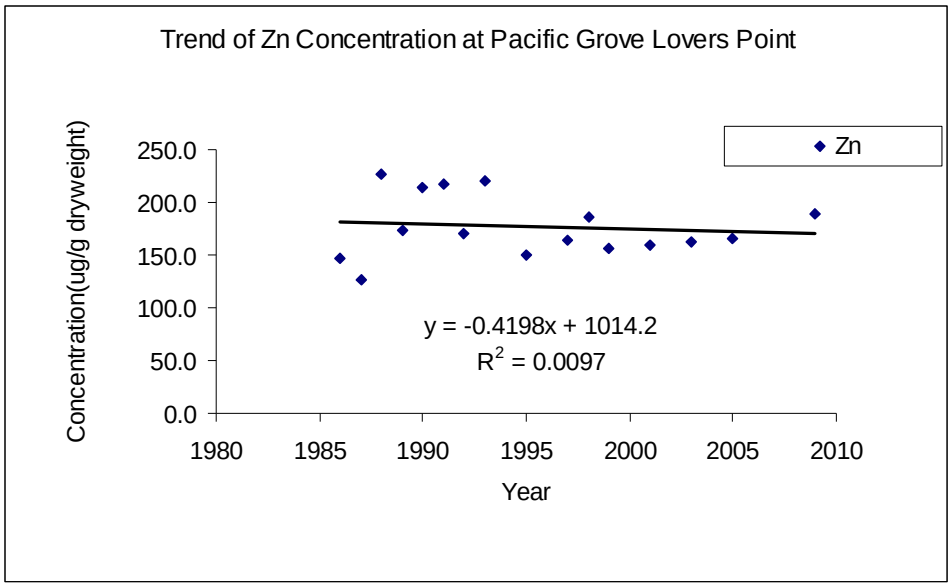

Trend of Total Chlordane Concentration at Pacific Grove Lovers Point
Concentration(ng/g dryweight)
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1980
1985
1990
1995
2000
2005
2010
Year
Total Chlordane
y = -0.6524x + 1316.8
R2 = 0.2246

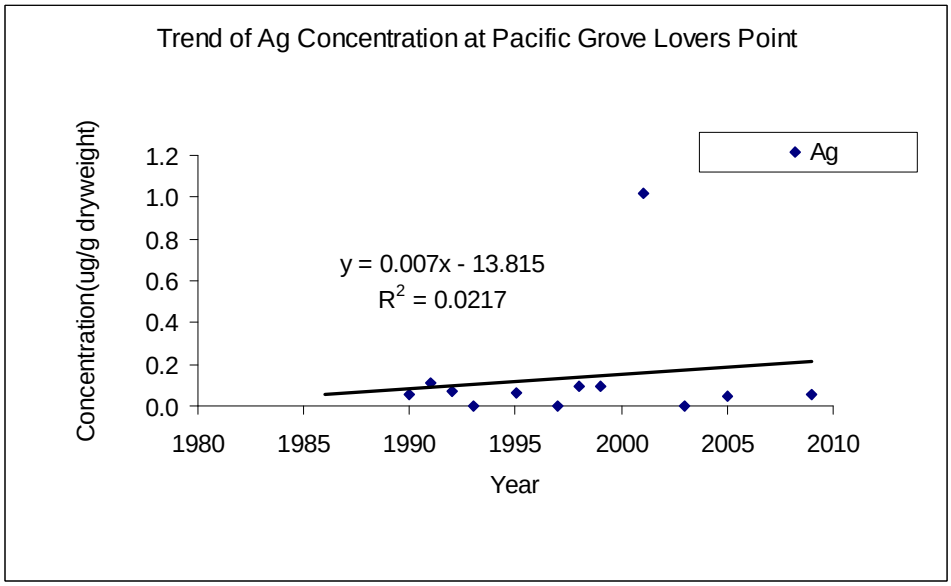

Trend of Total DDT Concentration at Pacific Grove Lovers Point
Total DDT
y = -2.718x + 5473.9
R2 = 0.1453
Concentration(ng/g dryweight)
250.0
200.0
150.0
100.0
50.0
0.0
1980
1985
1990
1995
2000
2005
2010
Year

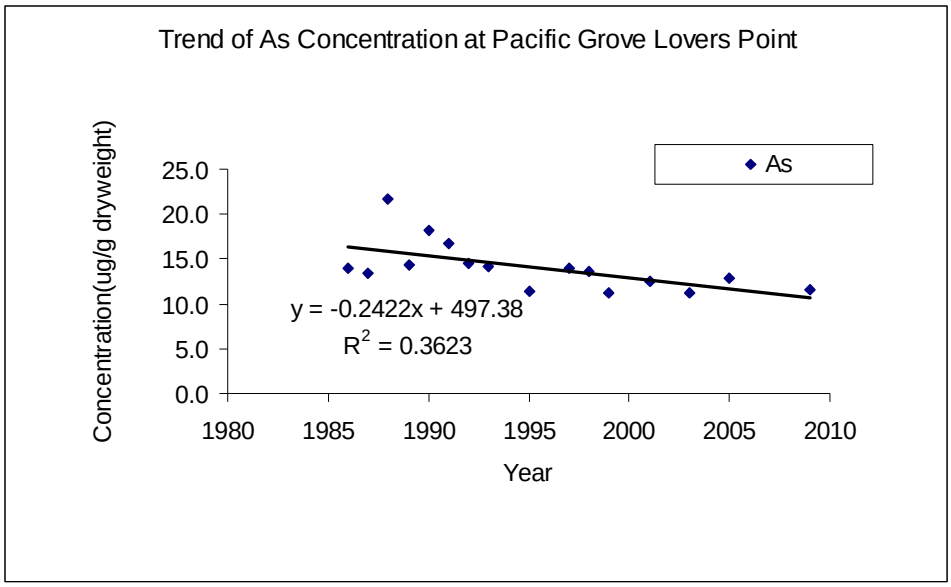

Trend of Total Dieldrin Concentration at Pacific Grove Lovers Point
Total Dieldrin
y = -0.3952x + 800.61
R2 = 0.1258
Concentration(ng/g dryweight)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1980
1985
1990
1995
2000
2005
2010
Year

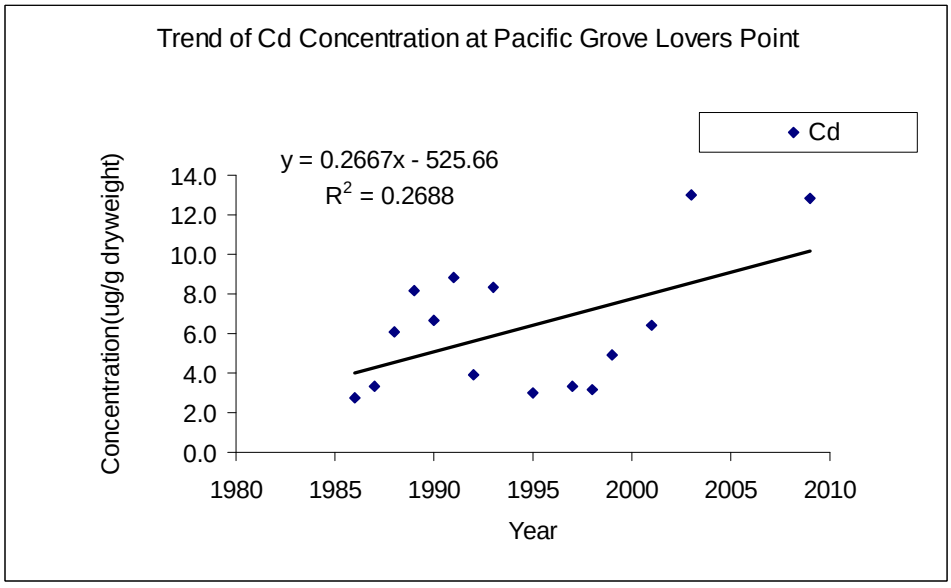

Trend of Total PAH Concentration at Pacific Grove Lovers Point
y = 1.2652x - 2458.7
R2 = 0.0678
Total PAH
Concentration(ng/g dryweight)
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1980
1985
1990
1995
2000
2005
2010
Year

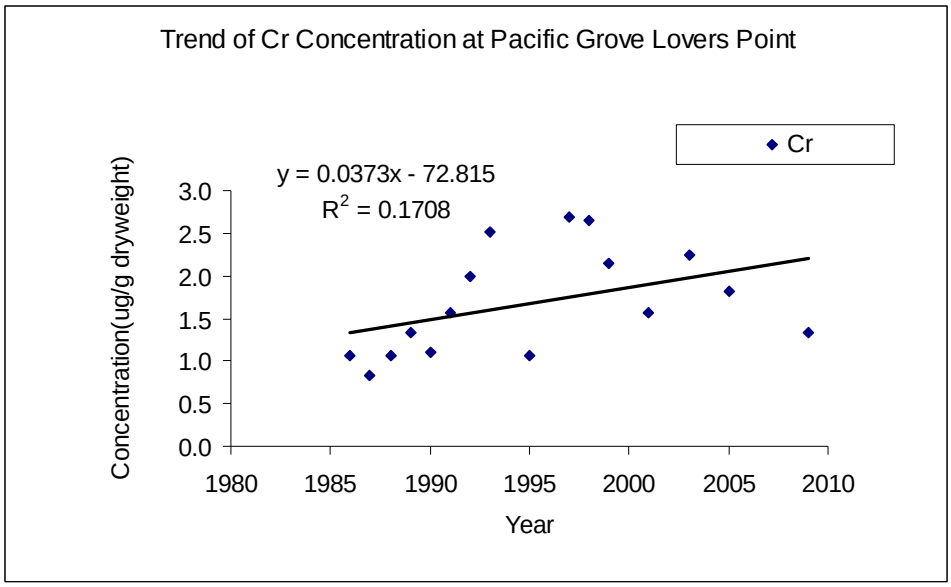

Trend of Total PCB Concentration at Pacific Grove Lovers Point
y = -0.2058x + 433.11
R2 = 0.0154
Total PCB
Concentration(ng/g dryweight)
50.0
40.0
30.0
20.0
10.0
0.0
1980
1985
1990
1995
2000
2005
2010
Year

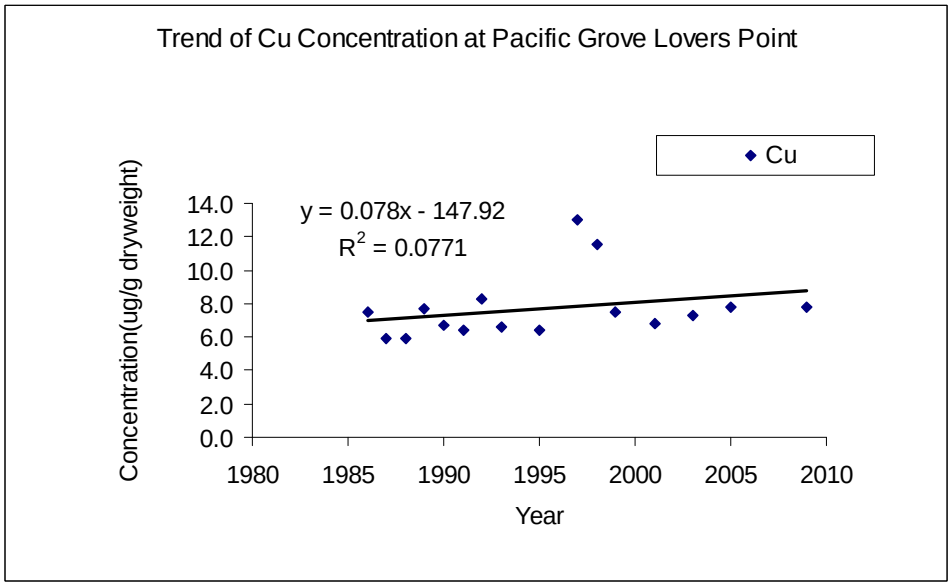

Trend of Zn Concentration at Pacific Grove Lovers Point
Concentration(ug/g dryweight)
250.0
200.0
150.0
100.0
50.0
0.0
1980
1985
1990
1995
2000
2005
2010
Year
Zn
y = -0.4198x + 1014.2
R2 = 0.0097

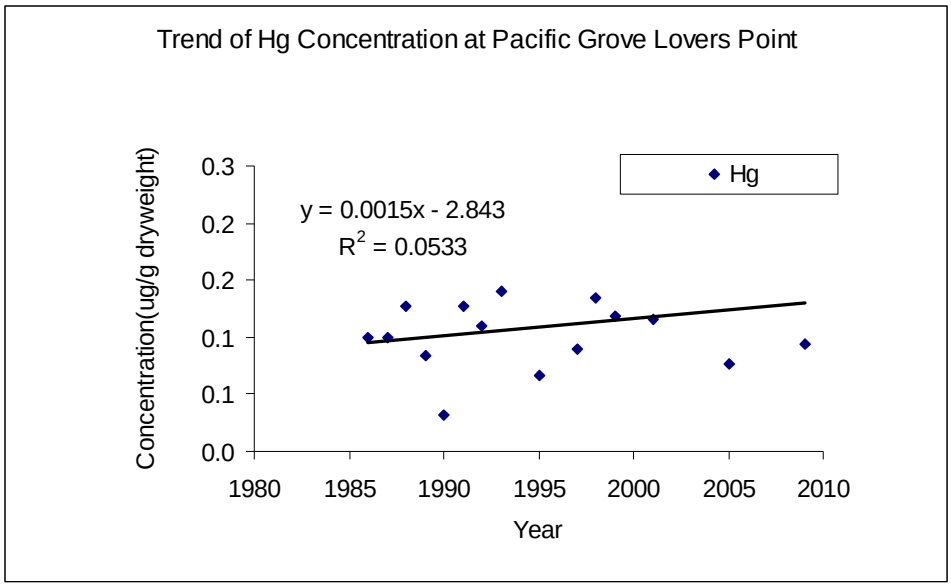

Trend of Ag Concentration at Pacific Grove Lovers Point
Concentration(ug/g dryweight)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1980
1985
1990
1995
2000
2005
2010
Year
Ag
y = 0.007x - 13.815
R2 = 0.0217

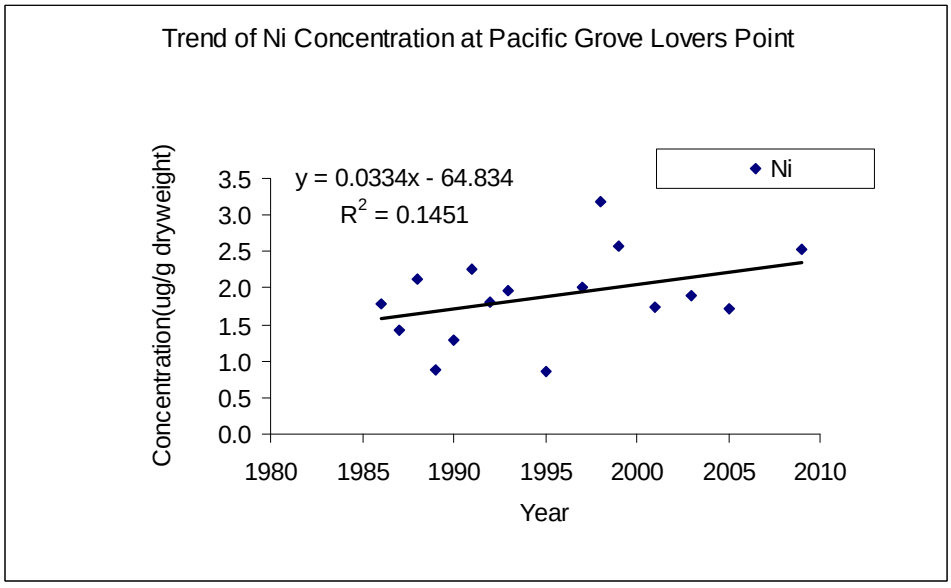

Trend of As Concentration at Pacific Grove Lovers Point
Concentration(ug/g dryweight)
25.0
20.0
15.0
10.0
5.0
0.0
1980
1985
1990
1995
2000
2005
2010
Year
As
y = -0.2422x + 497.38
R2 = 0.3623

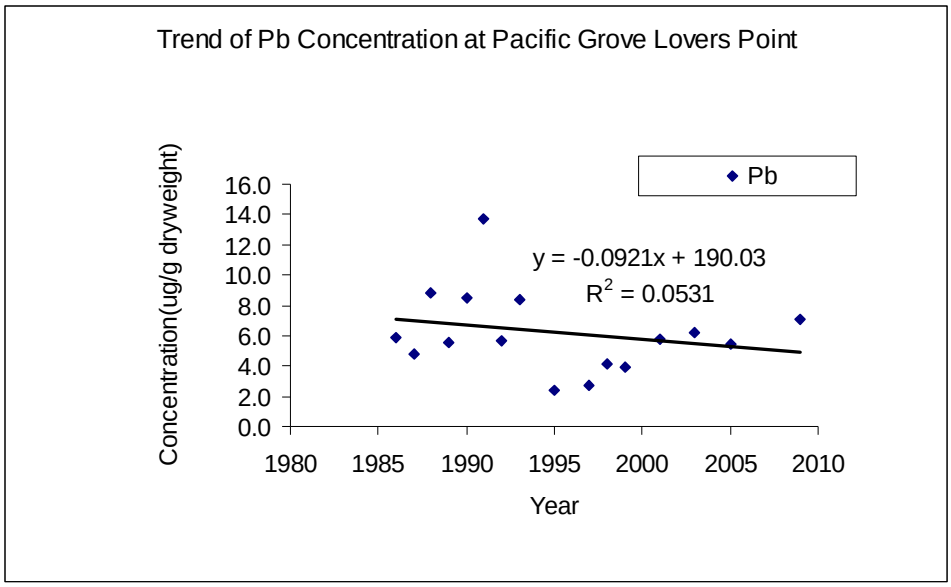

Trend of Cd Concentration at Pacific Grove Lovers Point
Concentration(ug/g dryweight)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1980
1985
1990
1995
2000
2005
2010
Year
Cd
y = 0.2667x - 525.66
R2 = 0.2688

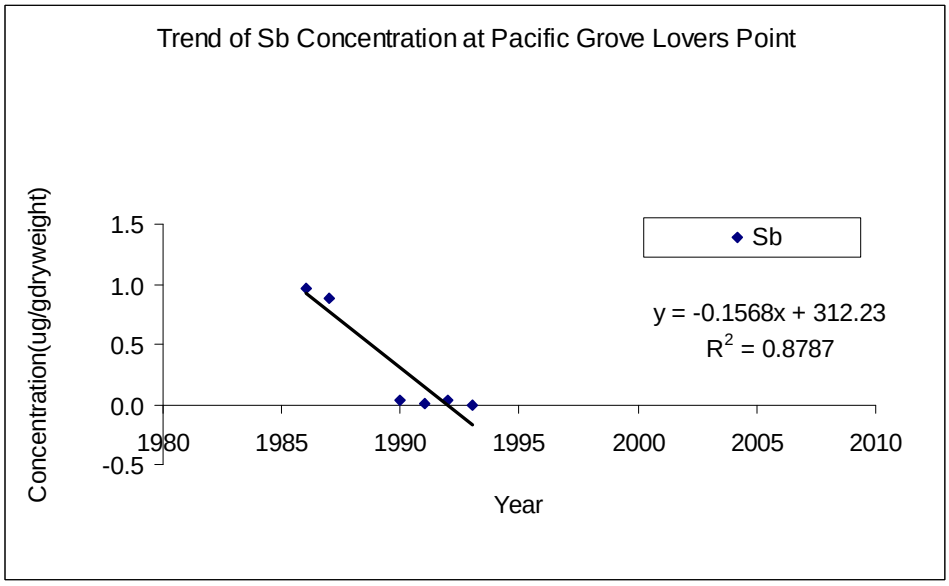

Trend of Cr Concentration at Pacific Grove Lovers Point
Cr
y = 0.0373x - 72.815
R2 = 0.1708
Concentration(ug/g dryweight)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1980
1985
1990
1995
2000
2005
2010
Year

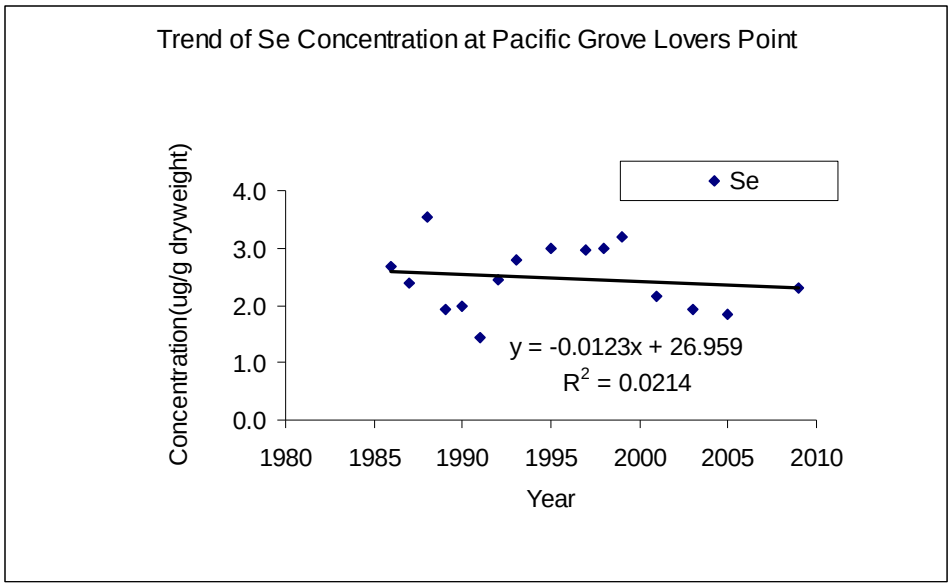

Trend of Cu Concentration at Pacific Grove Lovers Point
Cu
y = 0.078x - 147.92
R2 = 0.0771
Concentration(ug/g dryweight)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1980
1985
1990
1995
2000
2005
2010
Year

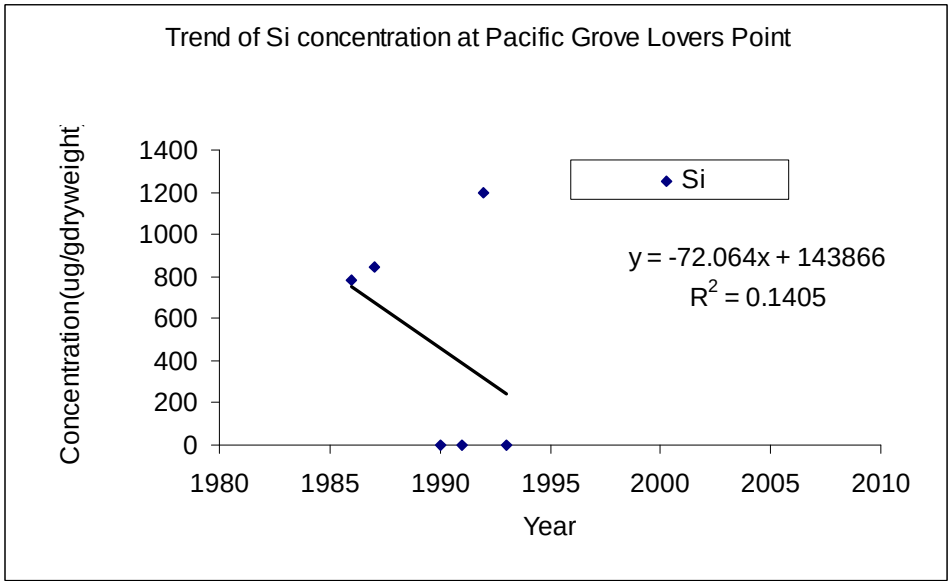

Trend of Hg Concentration at Pacific Grove Lovers Point
Concentration(ug/g dryweight)
0.3
0.2
0.2
0.1
0.1
0.0
y = 0.0015x - 2.843
R2 = 0.0533
Hg
1980
1985
1990
1995
2000
2005
2010
Year


Trend of Ni Concentration at Pacific Grove Lovers Point
Concentration(ug/g dryweight)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
y = 0.0334x - 64.834
R2 = 0.1451
Ni
1980
1985
1990
1995
2000
2005
2010
Year


Trend of Pb Concentration at Pacific Grove Lovers Point
Concentration(ug/g dryweight)
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1980
1985
1990
1995
2000
2005
2010
Year
Pb
y = -0.0921x + 190.03
R2 = 0.0531


Trend of Sb Concentration at Pacific Grove Lovers Point
Concentration(ug/gdryweight)
1.5
1.0
0.5
0.0
-0.5
1980
1985
1990
1995
2000
2005
2010
Year
Sb
y = -0.1568x + 312.23
R2 = 0.8787


Trend of Se Concentration at Pacific Grove Lovers Point
Concentration(ug/g dryweight)
4.0
3.0
2.0
1.0
0.0
1980
1985
1990
1995
2000
2005
2010
Year
Se
y = -0.0123x + 26.959
R2 = 0.0214


Trend of Si concentration at Pacific Grove Lovers Point
Concentration(ug/gdryweight
1400
1200
1000
800
600
400
200
0
1980
1985
1990
1995
2000
2005
2010
Year
Si
y = -72.064x + 143866
R2 = 0.1405

Appendix E – List of Species Maintained at HMS

Appendix 3. List of species maintained for teaching and research in the aquarium facilities of the Hopkins Marine Station. The set of species held at any one time varies considerably because during winter and spring terms a wide array of marine invertebrates and macroalgae are maintained for our courses. Approximately 90% of the invertebrate species listed below are used only in teaching contexts.

Native species.

Marine invertebrates:

PORIFERA	
Class Calcarea:	*Leucilla nuttingi*
Class Demospongiae:	*Tethya, Polymastia, Acarnus erithacus, Leucandra heathi, Haliclona,*
CNIDARIA	
Class Hydrozoa:	*Tubularia marina, Eudendrium* spp., *Polyorchis penicillatus, P.haplus; Hydractinia* *Obelia* spp., *Aglaophenia* spp., *Plumularia, Orthopixis* sp., *Abietinaria* spp., *Sertularia, Sertularella, Eutonina indicans* *Velella velella*
Class Scyphozoa	*Aurelia aurita , Phacellophora camtschatica*
Class Anthozoa	*Epiactis prolifera, Anthopleura elegantissima, Urticina lofotensis, Metridium senile* *Corynactis californica* *Balanophyllia, Astrangia, Paracyathus* *Pachycerianthus fimbriatus* *Stylatula, Virgularia,*
CTENOPHORA	*Pleurobrachia, Beroë*
PLATYHELMINTHES	
Class Turbellaria	*Notoplana acticola*, misc. spp.
ECHINODERMATA	
Class Asteroidea	*Luidia, Astropecten armatus, Patiria miniata, Henricia, Dermasterias imbricata, Pisaster giganteus, P. ochraceus, Leptasterias hexactis, L. pusilla, Orthasterias koehleri*
Class Ophiuroidea	*Ophiothrix, Ophiopterus papillosa, Ophioplocus esmarki, Amphiura arsystata, Ophiopholis bakeri*
Class Echinoidea	*Strongylocentrotus purpuratus, Strongylocentrotus droebachiensis, Dendraster excentricus, Lytechinus pictus*
Class Holothuroidea	*Eupentacta, Pachythione, Cucumaria* spp., *Pseudocnus lubricus, Pentamera, Cucumaria piperata* et. al., *Leptosynapta, Parastichopus californica, P. parvimensis, Dendraster excentricus*
CHORDATA, SUBPHYLUM UROCHORDATA	
Class Ascidiacea	*Ciona intestinalis, C. savagnyi, Ascidia, Styela, Boltenia Clavelina, Perophora, Pycnoclavella stanleyi* *Diplosoma, Synoicum, Polyclinum, Aplidium,Botryllus schlosseri.*
ECTOPROCTA	
Class Stenolaemata	*Crisia, Heteropora, Lichenipora, Diaperoecia*

Class Gymnolaemata	*Pherusella brevituba, Bowerbankia, Membranipora, Buglula neritina, B. californica, Scrupocellaria, Cellaria mandibulata, Celleporaria brunnea, Phidolopora, Hippodiplosia, Costazia, Hippothoa hyalina,*
PHYLUM MOLLUSCA,	
Class Gastropoda	*Lottia gigantea, L. pelta, L. limatula, L. digitalis, L.scutum, Fissurella, Diodora, Megatabennus, Megathura crenulata, Tegula funebralis, T. brunnea, T. montereyi, Calliostoma ligatum, C. annulatum, C. canaliculatum, Crepidula adunca, Crepipatella lingulata, Littorina keenae, L. scutulata*, vermetids, *Polinices lewisi, Nucella emarginata, Ceratostoma, Pteropurpura, Acanthina, Olivella biplicata,Kellettia kelletii, Cancellaria cooperi, Nassarius mendicus, Nassarius fossatus, Ocenebra circumtexta, Rictaxis*), *Navanax inermis, Hermissenda crassicornis, Flabellina (=Coryphella) trilineata, Discodoris, Cadlina, Doriopsilla, Anisodoris, Archidoris, Triopha catalinae, Baptodoris Trimusculus reticulatus; Helminthoglypta, Conus californicus*
Class Bivalvia	*Mytilus californianus, M. galloprovincialis, M. trossulus, Protothaca, Clinocardium, Hinnites,*
Class Cephalopoda	Loligo opalescens
Class Polyplacophora	*Mopalia* spp., *Lepidochitona (Cyanoplax), Nuttalina, Katherina, Cryptochiton, Tonicella lineata, T. undocaerulea, T. lokii, T. venusta, Stenoplax*
PHYLUM ANNELIDA	
Class Polychaeta	*Aphrodita Pygospio Orbinia johnsoni, Glycera, Hemipodus borealis, Arabella, Lumbrineris zonata, Nephtys californiensis, Pherusa papillata , Axiothella , Amphiduros, Paraeurythoe, Nereis grubei, Platynereis, Halosydna, Arctonoë, Antinoella anoculata, Dorvillea moniloceras, Anaitides mediapapillosa ; Notophyllum imbricatum, Eunice antenata, Diopatra ornata, Chone mollis, Myxicola infundibulum, Megaloma splendida, Serpula vermicularis ,Thelepus crispus, Owenia fusiformis, Phragmatopoma californica, Sabellaria cementarium, Cirriformia, Dodecaceria fewkesi Phyllochaetopterus, Chaetopterus variopedatus, Spiochaetopterus*
PHYLUM SIPUNCULA	*Phascolosoma*
PHYLUM ECHIURA	*Urechis caupo*
PHYLUM ARTHROPODA	
Subph Chelicerifformes, Class Chelicerata	
Subcl. Pycnogonida	unident species
Subph. Crustacea	
Class Maxillipoda	
Subclass Copepoda	*Tigriopus californica*
Subcl Thecostraca, Infracl. Cirripedia	*Balanus, Lepus*
Class Malacostraca	
Subcl Eumalacostraca	
Superorder Peracarida	
Order Isopoda	*Cirolana, Idothea, Ligia*
Order Amphipoda	*Orchestia, Orchestoidea*
Superorder Eucardia	
Order Decapoda	

Suborder Brachyura	*Cancer, Lophopanopeus, Pachygrapsus, Hemigrapsus, Pugettia producta, Scyra acutifrons, Loxorhynchus crispatus*
Suborder Caridea	*Pandalas, Alpheus, Heptacarpus*
Suborder Anomura	*Pagurus samuelis, P. hemphilli, P. armatus ,Paguristes* spp., *Petrolisthes cinctipes, Pachycheles rudis, P. pubescens, Isocheles, Cryptolithoides sitchensis, Emerita analoga*

Fish

long-jaw mudsucker (*Gillichthys mirabilis*),
black-eyed goby (*Coryphopterus nicholsii*)
monkey-face eel *(Cebidichthys violacens)*
black prickleback *(Xiphister atropurpureus)*
rock prickleback *(Xiphister mucosus)*
wooly sculpin *(Clinocottus analis)*
sand dabs *(Citharichthys sordidus)*

Non-native species: held in closed, recirculating tanks only [this species will cease to be held at Hopkins by the end of 2006]

PHYLUM ECHINODERMATA	*Echinometra* sp. (pallid sea urchin)

Appendix F – Best Management Practices (BMPs)

POTENTIAL POLLUTANT SOURCES AND CORRESPONDING BEST MANAGEMENT PRACTICES				
BMP #	AREA	POLLUTANT SOURCE	POLLUTANT	BEST MANAGEMENT PRACTICE
1	**All Hopkins Campus**	Dumpsters	Leaks	Dumpsters are inspected regularly and leaks are reported to the garbage company for repair.
2			Garbage	Dumpsters are located away from storm drains.
3			Garbage	Dumpster lids are kept closed at all times.
4		Chemical Deliveries	Hazardous Materials	All deliveries are made to indoor locations, either the front office or directly to the lab space. All chemicals are ordered in the smallest quantities necessary and are delivered in DOT approved packaging.
5		Any Pollutant Source		Staff are trained in storm water BMPs on an annual basis.
6		Any Pollutant Source	Hazardous Materials	All campus staff are trained immediately upon Hopkins arrival and annually thereafter for proper chemical handling and disposal.
7		Any Pollutant Source		All Facility storm drains are labeled with "NO DUMPING FLOWS TO OCEAN" signs.
8		Roof Runoff		Several building on the Hopkins campus have disconnected down spouts to allow for roof runoff infiltration into the surrounding area.
	There are no current construction projects on the Hopkins Campus.			
9	**Construction Areas**	Construction Materials Loading, Unloading, and Access Areas.	Paints, sprays, grease, oil, etc.	Cover storage areas with plastic tarp and use sand bags to hold in place.
10		Vehicle and Equipment storage	Oil and Grease, Coolants	Drip Pans should be used under equipment, Absorbent material should be kept on hand.
11		Project Grading	Sediment	Straw waddles, earth dikes, silt fences, gravel at construction entrances, street cleaning of nearby streets, cover catch basins.
12		Saw-Cutting	Concrete	Protect all storm drains, use minimal water, follow directly behind saw and vacuum up slurry. Sweep up dried residue and dispose of all waste properly.
13		Waste Storage Areas	Misc.	Earthen berms, covered dumpsters, sand bags.
14				Filter fabric on storm drains.
15		Erosion Areas	Sediment	Use straw waddles, filter fabric, earth dikes, silt fences, or replant area.
16				Cover local catch basins.
	Hopkins Marine Station has minimal need for grounds maintenance. The only pesticide currently in use is Boric Acid to control ants.			
17	**Grounds Maintenance**	Lawn clippings and debris	Lawn clippings and debris	Cut grass is redistributed as mulch.
18		Fertilizers, pesticides	Fertilizers, pesticides	Pruning and other yard waste is recycled into compost.
19				If Chemicals are needed: All chemicals will be stored indoors.
20				Pesticides or fertilizers are not normally used, if needed they will not be used during the rainy season.
21				If needed, apply fertilizers and pesticides sparingly.
22				Label instructions are followed.
23		Over-Irrigation	Non-storm water	The irrigation system is regularly inspected to ensure proper functioning.

POTENTIAL POLLUTANT SOURCES AND CORRESPONDING BEST MANAGEMENT PRACTICES

BMP #	AREA	POLLUTANT SOURCE	POLLUTANT	BEST MANAGEMENT PRACTICE
	Hazardous Materials for research purposes are stored inside buildings.			
24	**Hazardous Material Storage**	Cabinets	Paints, Solvents, Gasoline, Oil, etc.	Containers are labeled appropriately.
25				Containers and cabinets are inspected regularly for leaks.
26		Outdoor storage areas		Cabinets and gated areas are kept locked at all times.
27				Hazardous materials stored outdoors are held in secondary containment or are enclosed.
28				Hazardous material handling areas are inspected and kept orderly in order to prevent spills.
29				Absorbent materials are readily available.
30	**Parking Lots**	Automobiles	Grease/Oil	Parking Lots are swept regularly.
31		Trees	Leaves	Clean out Catch basins at least once per year and as needed.
32				Cleanup of paved areas is accomplished by sweeping the areas rather than by hosing.
33	**Boat Equipment Fueling**	Spills/Leaks		Fueling area is covered
34				Spill materials are kept on site at all times.
35				Fueling area is inspected regularly for spills/leaks.
36				Employees are trained on proper fueling, cleanup and spill response methods annually.
	Future BMPs			
37				Put in permeable pavement in parking lot and walkways as they are due for replacement.
38				Formalize current swale on property to treat storm water runoff from the parking lot by 2006.
39				Install cisterns or dry-well feature to capture and retain storm water runoff from the roofs of site buildings as building renovations are due.
40				Replace lawn at facility with native plantings. Expected completion 2008. This BMP will reduce the possibility of irrigation runoff and the potential use of herbicides/pesticides.
41				Install moisture sensor irrigation controls to prevent over-watering of landscaping. Complete by 2007.