Public Hearing (4/20/11)
ASBS Hopkins Marine Station
Deadline: 3/14/11 by 12 noon

HOPKINS MARINE STATION
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11 March 2011

Ms. Jeanine Townsend
Clerk to the Board
State Water Resources Control Board
1001 I Street, 24th Floor
Sacramento, CA 95814

Dear Ms. Townsend and Members of the Board:

This letter is written in response to materials included in two State Water Resources Control Board documents, received by us on the 21st of January 2011, related to a requested "*Exception to the California Ocean Plan for the Hopkins Marine Station Discharge into the Pacific Grove Area of Special Biological Significance.*" Several points of logic and fact contained in these two documents, the "*Initial Study*" (IS) and the "*Draft Mitigated Negative Declaration*" (DMND) merit close, critical consideration, as the Board works with us to develop a rational plan for maintaining the water quality and ecological health of the ASBS that adjoins our Marine Station.

Below, we present our response in three sections. We first provide some background information about the Hopkins Marine Station (hereafter, the "Station"), to give the Board a sense of our mission and contribution to marine science and the Station's historical marine conservation work supporting the entire Monterey Bay, including the ASBS. Next, we present several general points that deal with the fundamental logic and scientific validity of certain of the key issues associated with the monitoring efforts presented in the "Draft Mitigated Negative Declaration". Lastly, in *Appendix I* attached to this letter, we focus on some of the specific details related to monitoring included in the IS and DMND, where we identified errors in fact and questionable recommendations for monitoring efforts. The questions we raise about certain elements of the proposed monitoring program comprise a number of issues that include basic scientific validity of certain monitoring efforts as well as cost-to-benefit ratios for this work.

I. Background information: Hopkins Marine Station.

As described briefly in the IS document and in much more detail in the exception request we provided to the Board in August of 2006 (attached to this letter as *Appendix II*), Hopkins Marine Station is a unit of Stanford University and is the oldest marine laboratory on the West Coast (established in 1892 and located at our present site on China (Cabrillo) Point since 1917). The Station has been a leader in marine research in a wide variety of disciplines, and we have always maintained a strong emphasis on conservation and careful use of the marine resources present at our protected site. Stanford was supportive of the establishment of a marine reserve (initially named the Hopkins Marine Life Reserve) in 1931. During its history, the Station has supported a broad range of marine biological studies in the Reserve, resulting in the publication of more than 600 papers in the peer-reviewed literature. Our academic program includes a suite of undergraduate and graduate-level classes that have trained several generations of marine scientists, many of whom have gone on to occupy important academic positions around the world and to serve in governmental and non-governmental organizations dedicated to study of marine science and conservation of marine resources.

Thus, it is clear that maintaining the healthy condition of our local ASBS is of paramount importance to the Station—our scientific livelihood depends on this. Our historical record in conservation illustrates how seriously we have taken this charge in the past and the analyses provided in our August 2006 request for an exception (*Appendix II*) illustrate how seriously and proactively we continue to work in this conservation effort. In close cooperation with the State and Regional Water Boards, we will continue in our strong efforts to protect the ASBS through evolution of an effective monitoring effort. However, to do so we must create a plan that is scientifically valid and realistic in scope and cost, such that unnecessary expenditure of effort and funds is eliminated, so as not to impact the positive activities we can perform in conserving this habitat. We hope that the issues raised below will help enable the Board to work with us in a effective and expeditious manner to devise a plan that will achieve this mutually desired outcome.

II. General points concerning the fundamental logic and scientific validity of elements of the DMND.

A. **The logic of requiring the Hopkins Marine Station to initiate a separate monitoring program for storm water.** We remain perplexed by the requirement stated in the DMND that Hopkins Marine Station develop a storm water monitoring program that is separate from the program to be developed by the City of Pacific Grove, within whose boundaries the Station is located. Here is the basis of our concern. The Station's 11 acres of land represent 0.6 percent of the total land area of the City of Pacific Grove and only 0.3 percent of the impermeable area of the City. We questioned the Board staff as to why a separate storm water monitoring program was required for the Station, in view of the miniscule fraction of the total (or impermeable) surface area of the City we represented. We were told that a separate storm water plan was needed because the Station also discharged sea water into the ASBS. Were we to close down our flow-through seawater system, thereby eliminating discharge of seawater back into Monterey Bay, we would not be required to develop a separate storm water management program. Frankly, we are mystified at the "logic" involved here.

We view a separate storm water management plan for the Station as unnecessary and feel that the costs entailed in this effort would be an indefensible financial burden. We, of course, will work with the City on their storm water program and assist them in any way we can. Through easement agreements signed with the City, we host storm water discharge lines for the City, through which the vast majority of the storm water entering the ASBS flows (see information in *Appendix I* on this point). We do not believe that monitoring these flows of water that originate outside of the boundaries of the Station should be a burden that we must bear in any significant measure.

Note that the Station has made several pro-active changes to our storm water and sea water systems, including re-plumbing these systems to cleanly separate all discharges of storm water and sea water. These changes enable unambiguous monitoring of flows and permit distinct sampling of sea water and storm water for water quality monitoring efforts. However, the question remains as to why the Station cannot be included with the storm water management efforts of the City, of which our 11 acres represent by a very tiny fraction of total run-off area.

Can the Board defend the logic of the recommendations found in the DMND concerning a separate storm water monitoring program for the Station?

B. The scientific validity of monitoring 'reference' and 'discharge' sites. Here, several compellingly strong arguments can be raised that undermine the logic of attempting to detect effects of discharge (storm water or sea water) on local rocky intertidal sites. I briefly summarize the shortcomings of this section of the DMND in an effort to demonstrate to the Board that the proposed monitoring is scientifically invalid and thus should not be included as part of the exception requirements.

(a) *Identifying valid 'reference' and 'discharge' sites.* Key to the success of this proposed monitoring effort is the need to identify essentially identical sites (topography, wave action, current flow, ecosystem composition, etc.), so that "apples to apples" comparisons can be made between a site of water discharge and a site where no discharge pipes are found. This exercise is a straightforward 'thought experiment,' but a nightmare in reality. The coastline of the local Pacific Grove ASBS is extremely heterogeneous, and finding two sites that are virtually identical in all relevant characteristics is not possible. We have consulted with a number of marine ecologists who are familiar with the ASBS and they all concur that a meaningful comparison of 'reference' and 'discharge' sites is impossible for this and other reasons, as we show below.

(b) *Statistical invalidity of the proposed comparison of one 'discharge' and one 'reference' site.* Even if a pair of sites ('discharge' and 'reference') could be identified, the resulting comparisons could not have statistical validity. One would need several 'discharge' and 'control' sites to have an adequate sample size ("N" value, in statistical jargon) to allow a valid comparison to be conducted (to avoid what statisticians term a "type 2 error"). No scientifically valid study can be done with sample sizes of one each for the control and experimental groups under investigation. This fundamental logic completely undermines this element in the monitoring program. And, because multiple 'reference' and 'discharge' sites cannot be identified, there is no way to overcome this statistical issue.

(c) *Forces unrelated to seawater or storm water discharge are the primary drivers of water quality and ecosystem status.* There are numerous factors, biological, oceanographic and climatological, that are the major drivers of water quality and ecosystem status. Here, I list but few of these factors, in an effort to show how detecting, for example, the effects of our sea water discharge could not possibly be accomplished due to enormous variation in natural events, which create a high level of 'background noise' for any such analyses. These events include, but are not limited to:

(i) <u>Marine mammal populations</u>. Currently, there are more than 300 harbor seals using China Point as their terrestrial home—their haul-out site. In preparing our exception request, we estimated the annual output of fecal material into the ASBS due to these large, metabolically active animals. The number exceeded the "waste" output in our discharged sea water ("waste" representing the production of at most tens of kg of local animals brought into the lab from China Point, where they would have produced the same amount of "waste" *in situ* in any case) by more than a million-fold. On-going analyses of the microbial flora in sea water in the ASBS and adjoining near-shore waters show that a huge spike in bacterial counts is found at the seal haul-out areas, which lie a few hundred meters away from the sea- and storm-water discharge pipes. Thus, we see no possible way of teasing-out the effects of our miniscule "waste" stream (of materials that otherwise would have been released *in situ* regardless) from the effects of the marine mammals. The hundreds of sea birds, including a rapidly rising population of non-migratory Canada geese, that live on China Point also add to this background noise in bacterial/organic content of the waters.

(ii) El Niño-Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), climate change and shifting upwelling events. These major oceanographic processes are well-documented to cause large shifts in species composition in marine ecosystems. The shifting current patterns that accompany ENSO and PDO processes affect transport of adults and larvae, leading to changes in species composition in coastal ecosystems. The changes in water temperature that occur during El Niño and PDO events likewise affect the composition of ecosystems. And, in addition to the relatively short-term changes due to ENSO and PDO events there is a continuing effect on marine ecosystems from climate change. The increased upwelling of low pH, low oxygen waters being observed in the Monterey Bay likewise could have measurable effects on local ecosystem composition. The background changes in flora and fauna that occur as a result of these four factors, which would likely have differential impacts at different sites and on different species, would also almost certainly swamp-out any effects due to sea water and storm water discharge at 'reference' and 'discharge' sites.

Closely related to these oceanographic and climatic issues is the fact that the Monterey Bay is a zone where the biogeographic ranges of northern-occurring and southern-occurring species commonly overlap. For many northern species, the southernmost extent of their ranges is moving to higher latitudes, as are the northern limits of the ranges of southern-occurring species. These on-going, quite rapid (decadal scale) and reversible (due to ENSO and PDO influences) biogeographic shifts further complicate any monitoring efforts designed to test for effects of water discharge on ecosystem composition and health.

III. Errors, Corrections and Comments Regarding Draft Initial Study

A number of problems involving omissions or errors of fact and mis-interpretations of data were identified in the Initial Study document. These issues are summarized and discussed in *Appendix I.*

To sum up our comments on the IS and DMND, I will begin by emphasizing that we are in full accord with most of the recommendations contained in the DMND, including those that mandate a Seawater System that meets all legal standards, a Storm Water Management Plan that addresses issues of storm water runoff and dry weather flows, and a Waterfront Management Plan that prevents any pollution due to shore-based activities. These are all issues that we have taken seriously throughout our history and have been pro-active in dealing with. Clearly, it is in the Station's very best interest—scientifically and morally—to do all that we possibly can to protect the local ASBS. It is, in effect, "where we earn our living" and where we plan to continue research for decades to come. Throughout our 119 year history, we have been very conscientious in protecting China Point and the surrounding waters of Monterey Bay. We worked closely with the State to establish, in 1931, the ASBS surrounding the Station and we have worked hard to sustain this ecosystem's health, e.g., by closely monitoring all collecting and research activities, so as to minimize impacts and maximize the generation of scientifically valid studies. To this end, we have used best management practices (BMPs) of several types, including a mandate that no non-native species can be kept in our flow-through seawater system, the elimination of all dry-weather runoff, and the requirement for cleaning of aquaria with use of only fresh seawater and 'elbow grease,' but no cleaning chemicals. These and other BMPs are detailed in our exception request attached as *Appendix II.*

Our past and on-going efforts to maintain the quality of the environment of our ASBS indicate clearly that our criticisms of shortcomings found in the IS and DMND must not be taken as any indication of unwillingness on our part to do all that is reasonable and feasible to protect our ASBS. The significant problems we found in the Monitoring sections of the DMND reflect activities that are neither scientifically valid nor reasonable in terms of cost-to-benefit analysis. A mandate to carry out these inappropriate monitoring efforts could be counter-productive. Thus, the large sums of funds and the time and energy the staff would need to commit to these invalid efforts would represent an indefensible waste of finite financial and human resources and, ironically, might reduce the level of positive activities we could afford to perform related to maintaining the status of the ASBS ecosystem that we and the Board are concerned to protect.

Thanking you for your consideration, I remain,

Sincerely,

George N. Somero
David and Lucile Packard Professor of Marine Science
Associate Director—Hopkins Marine Station of Stanford University

APPENDIX I. Errors, Corrections and Comments Regarding Draft Initial Study

A number of omissions or misstatement of facts and other misconceptions are in the current draft Initial Study. This appendix provides a statement of each issue, where in the document it is identified, and provides recommended language to correct any factual misstatement or representations.

p.1 – Introduction

One major issue is missing from the introductory paragraphs. The bulk of the stormwater discharged either from pipes owned by the City of Pacific Grove or pipes owned by Hopkins Marine Stations (HMS) is urban runoff from the City. In fact, the discharge from five locations is made up exclusively of water from Pacific Grove. Table 1 in section 7.3 accurately reflects this fact, but the reader does not see this table until p. 18 of the document. (See below for additional comments about table 1.) Accordingly, Stanford recommends that the Board insert the following text after the words "China Point since 1918" in the first paragraph of the introductory section

"HMS is bordered along the entire length of its southwest side by the City of Pacific Grove. Urban runoff from Pacific Grove contains all the pollutants normally present in urban runoff, which materially impacts the quality of stormwater discharged from the HMS facility."

p. 15 – Agassiz Building Discharge

There is not one but two discharges from this building. Accordingly, Stanford recommends that the following text replace the first sentence on p.15.

"PCG246 discharges 100% seawater from the tanks in the Agassiz and DeNault buildings; PCG247 discharges stormwater originating from roof drains on the Agassiz building. PCG246 previously discharged a mixture of seawater and stormwater, but the stormwater was redirected to PCG247 as part of a building remodel in 2006."

The sentence "This pipe corresponds to SCCWRP outfall PCG247" becomes redundant with this suggested text, so should be struck.

Please note: PCG246 was sampled and analyzed once before the remodeling, and once after on 3/22/05 and 8/31/06. The Copper and Zinc levels were substantially reduced in the 8/31/06 sample; all metals were well below the most stringent Ocean Plan limits, the six month median. For this reason, Stanford recommends that no monitoring be required at this discharge location.

p. 17, Section 7.2 – Storm Water Discharges

The text explaining the number and types of stormwater discharge outfalls in paragraph #3 is incorrect. Accordingly, Stanford recommends that the first three sentences of the third paragraph be modified to read:

"There are ten stormwater discharge outfalls on HMS property. Five discharge points are made up entirely of urban runoff from the City of Pacific Grove, two of which are non-point sources. Three of the ten discharges are a mixture of Pacific Grove urban runoff mixed with a very small amount of stormwater generated from rainfall on HMS property. The remaining two discharges are primarily stormwater generated from rainfall on HMS property."

It should be noted that the two HMS pipes are smaller than the smallest of the city pipes crossing HMS (4"& 9" vs. 10"-36" respectively) and well below the 18" required sampling size.

p. 18, Section 7.3, Table 1 "Hopkins Marine Station SCWRP 2003 Discharge Points and Status 2010

The Agassiz building has only one storm drain discharge, and it is properly noted as PCG247. Drain discharge PCG248 does not exist. PCG259 has been removed as part of the TRCC backwash project and no longer exists.

"Sheet Runoff" is a mischaracterization of the water resulting from the "Dive gear/boat rinse area". Boats and dive gear are rinsed near the Boatworks to prevent corrosion, but they are only rinsed with tap water. No soaps or solvents are used and the quantity of water used is limited. It tends to pool on the grass, not run straight into the ocean as implied. There is nothing on the boats or dive gear that did not come out of the ocean. No lead paints or other toxic materials are used to paint or protect this equipment. Therefore, the nature of the runoff is identical to runoff from adjacent sidewalks and grassy areas. **As such, we recommend that no "Corrective Action" is needed.**

"PCG unid" is properly characterized as seawater outfall from the Loeb building. This discharge was sampled and analyzed on 6/15/06 and 8/31/06. All results were substantially below OP limits. Toxicity testing on samples collected on 6/15/06 and 9/10/07showed no toxicity to aquatic species. **Accordingly, we recommend that no "Corrective Action" is needed.**

One discharge is missing from the table. It does not have a PCG# as it was not noted during the SCCWRP survey. It is a 10" concrete pipe that discharges onto the beach adjacent to the Boatworks Building. The water discharged at this location is a mixture of PG urban runoff that enters the HMS property at the foot of Dewey Street, flows under the fence through an open swale, and enters a storm drain which is also fed by runoff from the grassy swale area behind the Boatworks Building. This discharge was tested for chemical constituents at two locations: the PG urban runoff at the HMS fence line, and at the discharge location. The data submitted to the board demonstrated that the discharge contained significantly lower levels of OP metals and PAHs at the discharge point, compared to levels found in the water as it entered the HMS property. **Accordingly we recommend that while the City of Pacific Grove may need to monitor or take other actions, no corrective action by Hopkins is needed.**

The existing table is very confusing to the reader and it is difficult to extract meaning from it. Stanford proposes that rather than organizing the table by PCG#, which is somewhat arbitrary, that the table be organized so that it clearly conveys the status and ownership of each discharge location as follows:

Status	Responsible Party	Number of Discharge Points	SCCWRP ID	Description	Action Needed by HMS
Existing	Stanford Hopkins	1	PCG246	Seawater Outfall Agassiz	No
Existing	Stanford Hopkins	1	PCG247	Storm water from Agassiz Roof	Yes
Existing	Stanford Hopkins	1	PCG250	Stormwater from Parking lot/roof drain	Yes
Existing	Stanford Hopkins	1	PCG254	Seawater Outfall Boatworks	Yes
Existing	Stanford Hopkins	1	Sheet Runoff	Dive gear/boat rinse area	No
Existing	Stanford Hopkins	1	PCG Unidentified	Seawater outfall Loeb Bldg	No

Existing	Pacific Grove is primary, HMS contributes small amount	1	PCG Unidentified	Stormwater discharged on Boatworks Beach. Pipe co-mingles City and Hopkins	No
Existing	Pacific Grove is primary, HMS contributes small amount	1	PCG257	Pipe co-mingles City and Hopkins	Yes, in conjunction with primary responsible party
Existing	Pacific Grove is primary, HMS contributes small amount	1	PCG258	Pipe co-mingles City and Hopkins	Yes, in conjunction with primary responsible party
Existing	City of Pacific Grove	5	PCG237-241	Drains Urban runoff on Stanford property	No
Existing	Monterey Bay Aquarium	2	PCG260,261	Located on Aquarium Property	No
Removed/capped	Stanford Hopkins	1	PCG242	Pipe	No
Out of service	Stanford Hopkins	1	PCG243	Old Pump House	No
Removed/capped	Stanford Hopkins	1	PCG244	Seawater holding tank overflow	No
Removed/capped	Stanford Hopkins	1	PCG245	Pipe	No
Removed	Stanford Hopkins	1	PCG248	Old seawater drain from Denault	No
Removed/capped	Stanford Hopkins	1	PCG249	Strom drain Denault/ E Shop	No
Removed/capped	Stanford Hopkins	3	PCG251,252,253	Pipe	No
Removed/capped	Stanford Hopkins	1	PCG255	Pipe	No
Removed/capped	Stanford Hopkins	1	PCG256	Pipe	No
Removed	Stanford Hopkins	1	PCG259	TRCC backflush outfall	No
Removed/capped	Stanford	1	PCG262	Drains TRCC	No

	Hopkins				

p. 31 "General Considerations for Toxicity Testing"; paragraph beginning with "Use of pass/fail tests"

Stanford acknowledges that a pass/ fail test may not be recommended by the Board. However, we take exception with the inference that the results of testing performed on Stanford's samples may "not accurately reflect...response to toxicity endpoints." A reader might conclude from these statements that toxicity test results presented by Stanford to the Board are less than conclusive. In fact, if a test organism shows no negative response to an undiluted sample, it stands to reason that the test organism would also show no negative response to a diluted sample. It is a useful practice in aquatic toxicity testing to first run a "screen" against undiluted sample, and then conduct a dilution series only if the test is failed. Stanford suggests that the final paragraph in this section be replaced by the following:

"Use of pass/fail tests consisting of undiluted effluent is a common method to screen samples for toxicity prior to conducting a full dilution series, but is not recommended by EPA. A dilution series protocol was not followed for either the acute or chronic bioassays and the test organisms were exposed to 100% concentration. Accordingly, the test results (Table 6) may be overly conservative, and not adequately reflect organism response to toxicity endpoints."

Pp 32-33 "Seawater Chemical and Physical Constituents"

Stanford agrees that the chemical and toxicity data as reported in the tables on p.32 are accurate, but does not agree with the characterization on p. 33 that the discharge from the aquaria is a "waste".

The copper and zinc detected in the Agassiz sample collected on 3/22/05 were due to the cross connection with roof drain water. Once the roof drain was separated, and the Agassiz aquaria re-sampled on 9/1/06, all metals were below Ocean Plan Limits. The Description for the sample collected from Site #2, Agassiz on 3/22/05 should be "**Seawater and Roof Drain Mix, 3/22/05**". In addition, the data for "Site #12 TRCC" should be annotated as follows: **"TRCC discharge was redirected back to MBA system, and no longer directly enters the ASBS.**"

The Ocean Plan does not have a numerical standard for nitrate-nitrogen, and comparing the level found in the two samples to a "pilot study" reference is not appropriate. The OP does have a non-numerical standard for nutrients of: "Nutrient materials shall not cause objectionable aquatic growths or degrade indigenous biota." Based on the receiving water appearance and toxicity data, the Hopkins discharge appears to meet this standard. Additionally, the USEPA has set the drinking water standard for nitrate-n at 10 mg/L (10,000 ug/l). Several Regional Boards have developed TMDLs for nitrate-nitrogen also at 10 mg/L. One study referenced by Region 2 in development of a nitrate-n TMDL suggests a limit of 2 mg/L for sensitive aquatic organisms. See "Carmargo, Chemosphere 58 (2005) pp 1255-1267." The HMS data are well below these standards. In addition, any nitrate present in HMS discharges is dwarfed by the nitrate levels in the receiving waters due to the native seals and birds that are abundant on China Point (please refer to APPENDIX II). Stanford suggests that the first paragraph on page 33 be replaced by the following:

"In terms of the water quality objectives, all seawater discharge samples met all Ocean Plan standards after HMS took corrective actions regarding cross connections. The Agassiz sample collected on 3/22/05 exceeded standards for copper, but after removing cross connection with roof drains, the subsequent sample, collected on 9/1/06, met all discharge standards. The discharge from the TRCC backflush exceeded copper standards on 6/15/06 prior to rerouting to the Monterey Bay Aquarium (MBA). This discharge now goes through the MBA treatment system prior to discharge at MBA. Receiving water samples met all Ocean Plan Objectives.

In terms of nitrate nitrogen levels applicable to aquaria discharge, the Ocean Plan has established the following non-numeric standard. "Nutrient materials shall not cause objectionable aquatic growths or degrade indigenous biota." While measured levels of 80 ug/L at the Loeb Aquaria were higher than recent statewide pilot study reference results, these results are not an Ocean Plan objective. Therefore it is not clear if these measured levels would violate the non-numerical standard. Measured levels of 870 ug/L at the TRCC have been addressed by rerouting the discharge to the MBA treatment system"

<u>p.33 "Storm Water Toxicity Results"</u>

The paragraph describing the giant kelp chronic toxicity tests accurately reflects the results obtained by the testing lab regarding germination in the PGAF, HTRC, PGSW and PGWB samples. Stanford would like to point out, however, that there is considerable scientific debate regarding the reliability of these specific species tests. In fact, the State Board's own "Natural Water Quality Committee" has noted in their September 2010 "Technical Report", that these tests are "of particular concern" regarding potential positive results.

In addition, stormwater collected at PGAF is exclusively urban runoff from Pacific Grove, not primarily HMS as noted. The PGAF location is the open grate immediately adjacent to the fence at the property line of Pacific Grove., and contains runoff from Ocean View Blvd as shown on the map provided by Stanford. (Figure 2, p.18). Accordingly, Stanford requests that the second sentence in the fourth paragraph under "Storm Water Toxicity Tests" be replaced by"

"The PGAF storm water sample, which is exclusively runoff from the City of Pacific Grove, was acutely toxic to mysids (TUa = 1.17), but the other storm drain samples...were not acutely toxic"

<u>p. 34; Table 9 "HMS Stormwater Runoff Chronic Toxicity Analysis, 2006"</u>

This table is confusing as it includes results from two distinct types of stormwater, but does not distinguish them

HGAZ (PCG250) is runoff made up primarily of rainwater which falls on the HMS parking lot with some contribution from Pacific Grove.

HTRC was collected from a storm drain grate up-gradient of PCG258 and previously contained TRCC back flush waters as well as rainwater from around the TRCC building. At the time this sample was collected, no TRCC back flush was occurring, and sheet runoff from Pacific Grove was mixed with the TRCC runoff. The TRCC back flush was subsequently removed from this discharge location and plumbed to the Monterey Bay Aquarium treatment system.

PGWB, PGAF and PGSW are exclusively urban runoff from the City of Pacific Grove.

Accordingly, Stanford recommends that Table 9 be reformatted as below to properly describe the source of the stormwater represented by the toxicity testing results. .

Water body Description	Site Description	Toxicity Test Type	Mysids	Kelp	Fish
HMS Parking Lot runoff; some contribution from Pacific Grove	HGAZ	Chronic	Survival 1.0 TUc; 90% mean survival; Growth 1.0 TUc; 0.19 mg mean biomass	Germ. > 1.0 TUc; 95.6 mean % germination; Growth 1.0 TUc; germ	Survival 1.0 TUc; 90% mean survival; Growth 1.0 TUc; 0.66 mg mean biomass

				tube length 13.5 um	
Storm Water from TRCC building; No TRCC backflush. Some contribution from Pacific Grove.	HTRC	Chronic	Survival 1.0 TUc; 100% mean survival; Growth > 1.0 TUc; 0.15 mg mean biomass	Germ. > 1.0 TUc; 93 mean % germination; Growth 1.0 TUc; germ tube length 14.6 um	Survival 1.0 TUc; 95% mean survival; Growth 1.0 TUc; 0.63 mg mean biomass
Pacific Grove Urban Runoff	PGWB	Chronic	Survival 1.0 TUc; 95% mean survival; Growth > 1.0 TUc; 0.17 mg mean biomass	Germ. > 1.0 TUc; 87 mean % germination; Growth 1.0 TUc; germ tube length 15.2 um	Survival 1.0 TUc; 95% mean survival; Growth 1.0 TUc; 0.69 mg mean biomass
Pacific Grove Urban Runoff	PGAF	Chronic	Survival 1.0 TUc; 90% mean survival; Growth > 1.0 TUc; 0.12 mg mean biomass	Germ. > 1.0 TUc; 89.6 mean % germination; Growth 1.0 TUc; germ tube length 14.1 um	Survival 1.0 TUc; 97.5% mean survival; Growth 1.0 TUc; 0.73 mg mean biomass
Pacific Grove Urban Runoff	PGSW	Chronic	Survival 1.0 TUc; 92.5% mean survival; Growth > 1.0 TUc; 0.2 mg mean biomass	Germ. > 1.0 TUc; 93.2 mean % germination; Growth 1.0 TUc; germ tube length 14.5 um	Survival 1.0 TUc; 95% mean survival; Growth 1.0 TUc; 0.68 mg mean biomass

p. 34; Table 10 "Metals and Ammonia-Storm Drain Discharge Water"

PG numbers have been incorrectly assigned to several samples. The results shown for PCG241 are actually for PCG238. (This sample location was named PGWB by HMS during the sampling.) The results shown for PCG249 are actually for PCG250. (This sample location was named HGAZ by HMS during the 3/22/05 sampling.) It was re-sampled on 3/6/06 but those results are not shown in this table. The results shown for PCG256 are actually for a location without a PCG number. (This sample location was named HBBW by HMS during the sampling.) The results shown for PCG259 are actually for a location without a PCG number. (This sample location was named PGAF by HMS during the sampling.) It is important to note that this last sample

(PGAF) location is not a discharge location, but a sample of Urban Runoff from PG entering the HMS property behind the Fisher Building.

Accordingly, Stanford requests that Table 10 be reformatted as below,w hich is accurate with the data.

Constituent (ug/L)	PCG238	PCG250 3/22/05	PCG250 3/22/05	PCG250 3/6/06	PCG Unid (a)	PCG Unid (a)	PCG257	PCG258	PCG Unid (b)
Arsenic	0.95	1.33	1.32	1.39	1.68	1.76	1.17	23.9	29.9
Cadmium	0.3	<0.1	<0.1	ND	ND	ND	0.3	ND	ND
Chromium	1.23	13.4	12.4	0.4	0.47	0.46	1.49	0.22	0.18
Copper	45.2	36.2	36.2	13.1	11	11	19.1	7.52	7.65
Lead	18.1	15.3	15.3	1.33	4.69	4.63	31.5	3.53	2.12
Mercury	ND	0.7	0.72	0.021	0.0149	0.0172	0.0155	ND	ND
Nickel	2.44	2.68	2.63	0.82	0.93	0.92	1.65	0.34	0.39
Selenium	ND	0.94	0.55	ND	ND	0.5	ND	ND	ND
Silver	ND	<0.1	<0.1	ND	ND	ND	ND	ND	ND
Zinc	201	102	102	33.4	59.9	59.4	129	115	94
Ammonia	<0.01	0.06			10		20	300	470

p.35 "Storm Water Chemical Constituents"

In addition to the misidentified PCG numbers, the first paragraph on p.34 contains discussion of three distinctly different types of samples without clearly differentiating them. PCG238 (misidentified as 241) is made up exclusively urban runoff from the City of Pacific Grove. It contains the highest concentrations of copper, lead and zinc among all samples collected. PCG 250 is comprised of runoff from the HMS parking lot and landscaped areas. This discharge was sampled twice on 3/22/05 and 3/2/06 with varying results PCG Unid (a) (misidentified as PCG256) contains discharge from the grassy swale area behind the Boatworks building with a very significant contribution from urban runoff. The results from the urban run-on that mixes with the grassy swale landscape area stormwater is not shown on this table. (No PCG # denoted PGSW by HMS) Levels of all OP metals found in this run-on sample exceeded the eventual discharge levels found at PCG Unid (a). PCG257 is primarily PG urban runoff with a very small contribution from the downspouts at the Fisher building. PCG258 contains primarily urban runoff from PG with a minor contribution from HMS. PCG Unid (b) (misidentified as PCG259) is a sample of urban runoff as it enters the HMS property as discussed above. Accordingly, Stanford requests that this paragraph be replaced with the following.

"Discharges of HMS stormwater and urban runoff discharged from or entering the HMS property contained levels of selected Ocean Plan chemical constituents exceeding the six month median objective for copper, zinc and lead. Urban runoff from the City of Pacific Grove contained the highest levels of these constituents, exceeding the instantaneous maximum for copper and zinc (PCG 238).

Results for urban runoff entering the HMS property exceeded the six month objective for Arsenic, Copper, Lead and Zinc at one location (PCG Unid(b)), and exceeded the six month median objective for Copper and Zinc at the second location (PCG257). In addition, results for lead exceeded the instantaneous maximum at PCG257.
Results for urban runoff mixed with stormwater from HMS landscaped areas and the open swale (PCG Unid(a)) exceeded the six month median for copper, lead and zinc. However, as noted above, samples collected at the fence line representing urban runoff prior to flowing through the open swale and mixing with HMS stormwater (PCG257) had significantly higher levels of these constituents. Results for urban runoff mixed with a very small amount of stormwater from HMS landscaped areas (PCG258) exceeded the six month median for arsenic, copper and zinc.

Results for runoff from the HMS parking lot and landscaped areas (PCG250) exceeded the six month median objective for chromium, lead, and zinc and the instantaneous maximum for copper in the first round of sampling. During follow-up sampling in 2006 all these were substantially reduced with no analytes exceeding the instantaneous maximum and only copper and zinc exceeding the six month median.

APPENDIX II.

LETTER TO MR. ROGER BRIGGS, DATED 24 AUGUST 2006, REQUESTING AN EXCEPTION TO ALLOW CONTINUED DISCHARGE OF SEA WATER AND STORM WATER INTO THE ASBS ADJOINING THE HOPKINS MARINE STATION OF STANFORD UNIVERSITY

HOPKINS MARINE STATION
STANFORD UNIVERSITY

OCEANVIEW BLVD.
PACIFIC GROVE, CA 93950-3094

TEL: 831 655-6243
FAX: 831 375-0793

24 August 2006

Mr. Roger W. Briggs
Executive Officer
California Regional Water Quality Control Board
Central Coast Region
895 Aerovista Place, Suite 101
San Luis Obispo, CA 93401-7906

Dear Mr. Briggs:

This letter is the response of Stanford University's Hopkins Marine Station to the letter from your office dated 15 February 2006 (Appendix 1), requesting information about our discharge of seawater and storm water into the Hopkins State Marine Reserve (HSMR), an Area of Special Biological Significance (ASBS).

At the outset, we wish to emphasize Stanford University's commitment to protecting the Hopkins State Marine Reserve, a responsibility that we have taken with the greatest seriousness since the original Hopkins Marine Life Refuge was established in 1931, a State action that was done in large part to support research done at the Station. We worked successfully in 1984 to have the State improve protection of the Refuge, and we continue to work with the State in overseeing the management of this valued resource.

To foster conservation of the Reserve's biota, we are scrupulous in preventing any anthropogenic contamination of its waters through our seawater discharges, which are minor in volume and contain no anthropogenic contaminants. The small amounts of natural metabolic end-products released in aquarium water by the animals and plants we hold are clearly not an anthropogenic waste. It is inconceivable that these dilute and naturally occurring metabolic end-products could have any effects on the ecosystem of the HSMR.

As to our storm water discharge into the ASBS, we emphasize that we are prepared to comply with any programs initiated by the City of Pacific Grove to address storm water discharge under its municipal storm water permit. Hopkins Marine Station is not an industrial discharger. We represent less than 0.6% of the total land area of Pacific Grove and our topographically level and largely undeveloped land allows much of the rainwater falling on our property to percolate into the soil. Therefore, our contribution to the total ASBS storm water outflow from the City is minor. Like other non-industrial contributors to the municipal discharge, we anticipate being regulated under the City of Pacific Grove's municipal storm water permit, not under a separate permit issued to Hopkins Marine Station.

You asked us to consider *"whether wastes are discharged into the ASBS by either storm water or the seawater system at Hopkins Marine Station."* Based on the available scientific evidence, as well as legal opinion provided by Stanford counsel, we conclude that our seawater discharge contains no anthropogenic wastes. Our one-pass system is simple: seawater in, seawater out. The Hopkins aquaria house a small population (approximately 44 – 100 pounds) of native species for scientific study, primarily sea urchins, mussels, squid, and snails.[1] We do not add chemicals to the seawater or use any to clean the tanks. Our seawater discharge contains no antibiotics, exotic species, metals or pathogens. Therefore, we are confident that our intake and discharge of seawater involves no anthropogenic waste and has no adverse impact on the HSMR ASBS.

In preparing our response to your 15 February 2006 letter, we have sought advice from State and Regional Water Board staff concerning how best to improve our seawater and storm water management practices. This advice has been extremely helpful to us in making physical improvements to the systems for managing these discharges. We have also cooperated closely with The Monterey Bay Aquarium (hereafter, the MBA) to develop joint strategies for effective management of seawater and storm water discharge. As detailed later in our response, several important changes already have been made or will be completed within the next few months. These changes include: (i) re-engineering to create full separation of seawater and storm water discharges, (ii) return of the Tuna Research and Conservation Center (TRCC) filter back-flush water to the MBA for treatment in their system that purifies water from aquaria holding exotic species, (iii) re-engineering of the seawater supply system to eliminate all overflow from the seawater storage tanks, (iv) complete survey of pipes identified in the State's survey and removal or capping of non-functional pipes, and (v) improvement in best management practices for storm water discharge.

[1]A few research projects occasionally involve work with non-native (exotic) species. These always are held in small-volume, re-circulating aquaria separate from our flow-through seawater system. Water from tanks holding non-native species also is discharged into the sanitary sewer to avoid introduction of exotics into the HSMR ASBS.

Following are our responses to the 17 questions you posed in your letter. In cases where a significant number of data are involved in addressing an issue, appendices have been included to provide this information. We also document the modifications to our seawater and storm water systems that have been made pro-actively since receipt of the February letter. Additional modifications to be made within the next eight to ten months are also described. These modifications are, we feel, significant advances in eliminating potential problems in discharge into the HSMR ASBS.

1. The discharger's name, address, and contact information. The Hopkins Marine Station (hereafter referred to as "the Station") is a unit of Stanford University organized within the Department of Biological Sciences in the School of Humanities and Sciences. The Station was founded in 1892, at the time that the University itself was established. We are the oldest marine station on the United States Pacific Coast and have been at our present location on China Point since 1918. The Station has 9 tenure-track faculty, 20-30 full-time Ph.D. students, and a support staff of ten. We offer undergraduate courses in marine science in the winter, spring, and summer terms. Undergraduate enrollments range between approximately twelve and thirty per term. Detailed descriptions of our research and teaching programs are found on our Web site: http://hopkins.stanford.edu.

As Director of the Station, I will serve as contact person for any correspondence with staff of the Regional and State Water Boards. My e-mail address is: somero@stanford.edu. My office phone and facsimile numbers are: 831-655-6243 and 375-0793, respectively. The Station's mailing address is 120 Oceanview Boulevard, Pacific Grove, CA 93940-3094.

2. **The daily discharge volume of seawater from the system.**

The discharge rate of seawater is normally about 85-100 gallons per minute (gpm), resulting in a **daily discharge volume of approximately 122,400 – 144,000 gallons**. Below, we provide data on the design, operation, and on-going re-engineering of our seawater system, to better define the flow parameters and the amounts of water discharged at the sites of release into the ASBS.

Figure 1 is a diagram of the Station's seawater system. Our seawater is supplied by the Monterey Bay Aquarium, at a current maximal rate of approximately 135 gpm. The actual rate of supply is normally 100 gpm or less. Seawater is sand-filtered at the MBA and then pumped to 3 storage tanks, from which our aquaria are supplied by gravity feed. The seawater supply system is currently being re-engineered so that seawater will be pumped into the tanks strictly on the basis of need. The overflow of excess seawater from the tanks therefore will be eliminated (pipe **PCG244** in the State's "*Discharge Locations @ Hopkins*" survey map, dated 4 January 2005 will cease to be a discharge site. See Appendix 2). The removal of this discharge will decrease the Station's seawater use by as much as ~70,000 gallons daily, based on the disparity between the current maximal rate of supply by the MBA and our periods of minimal requirements for seawater.

The aquarium systems receiving seawater from the storage tanks are located in the following buildings: the *Aquaria* (an outdoor roofed facility located between the Loeb and Agassiz Buildings), the *Blinks Building*, the *Agassiz Building*, the *DeNault Family Research Building*, and the *Monterey Boat Works Building.*

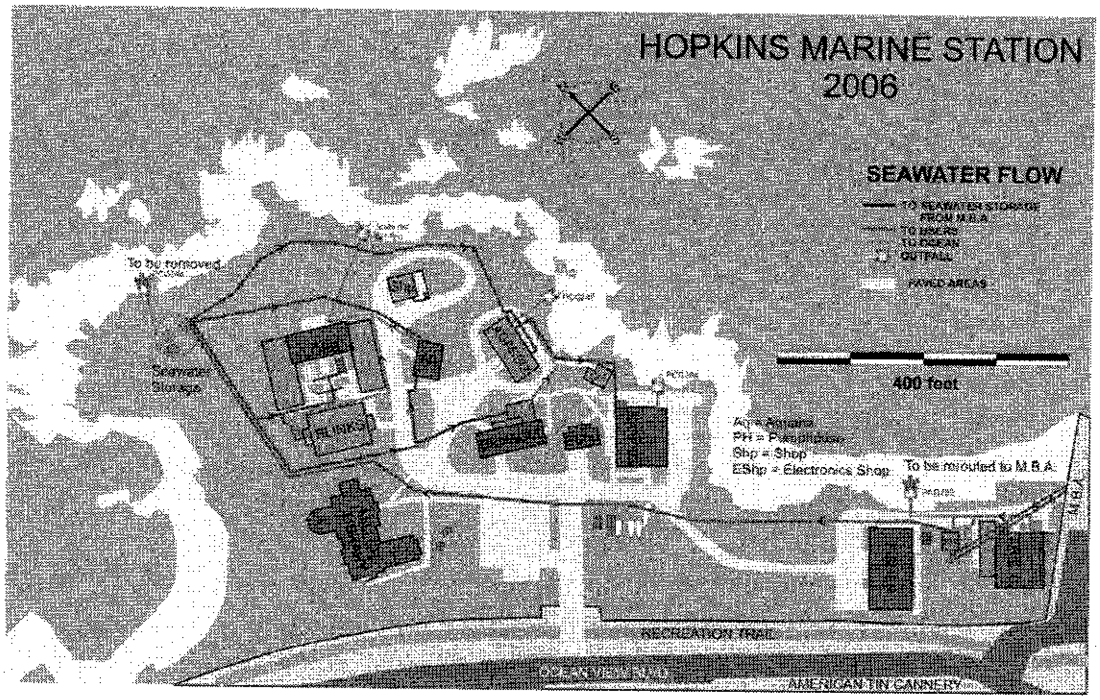
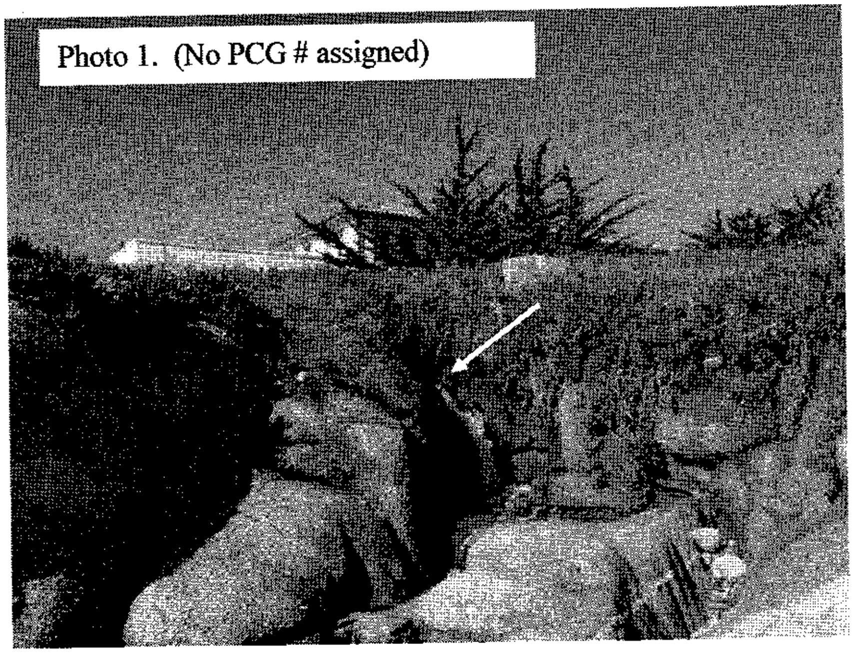


Figure 1. *Sea water supply and discharge systems and locations of aquarium facilities at the Hopkins Marine Station.* [A larger version of this figure is included at the end of this report.]

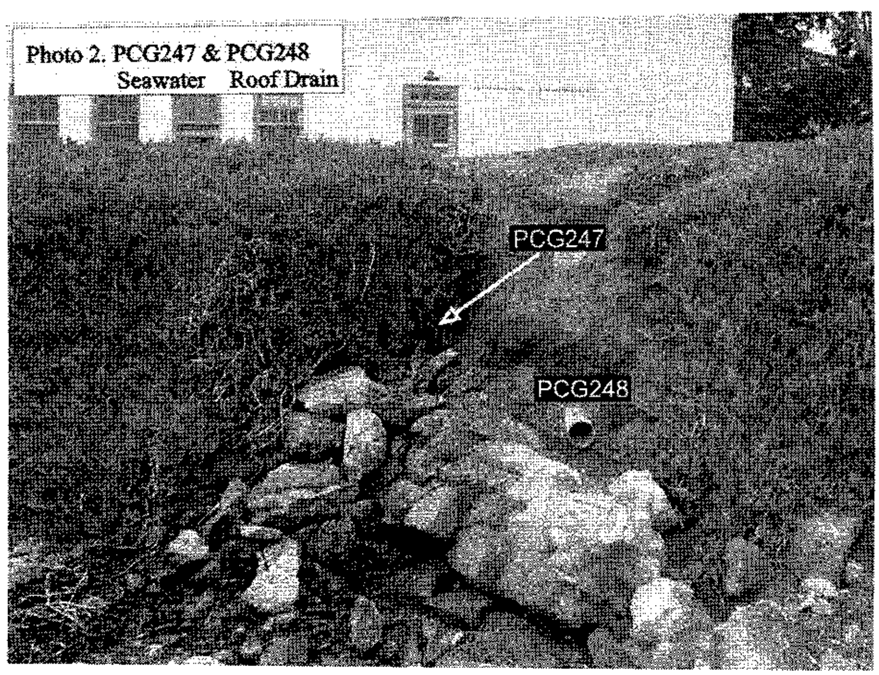
Seawater from these 5 aquarium systems is discharged at three outfalls, as shown on Figure 1. These 3 discharge sites are the only permanent outfalls that will remain in operation at the Station after mid-2007. Two other seawater discharge sites, one at the Tuna Research and Conservation Center (filter back-flush water) and one from two small tanks near the pump house (PH), will cease to discharge seawater into the ASBS within the next several months.

Permanent Outfalls.

(1) A single 6" pipe discharges water from the Blinks Building and the outdoor Aquaria facility at a point on the cliff face above the rocky intertidal zone around Bird Rock (the "Hewatt site" (see responses to questions 12 b and 15, below). Approximately 60% of our seawater discharge occurs at this site. This pipe was missed in the survey conducted by the State and thus has no PCG number. This outlet is shown in photo 1.



(2) A single 4" pipe discharges water from the DeNault Building and Agassiz Building near the base of the cliff face above Agassiz beach. Approximately 30% of our seawater discharge occurs at this site. This pipe corresponds to outfall **PCG247** on the State's survey map. Photo #2 shows this outfall site. The color evident on the rocks is due to algae that are able to grow in the splash zone created by this outfall (see response to question 12b).



(3) A small (3" diameter) pipe discharges seawater from the outdoor tanks located at the east side of the Monterey Boat Works Building onto a field of granite boulders above the upper reach of Agassiz beach. This outflow pipe is denoted as **PCG254** on the State survey map and is shown in the two photos below. This is the smallest of our aquarium facilities and is used primarily to hold specimens for teaching. It is usually in operation only during winter, spring and summer terms. Outflow from this pipe accounts for only ~10% of our total seawater discharge.

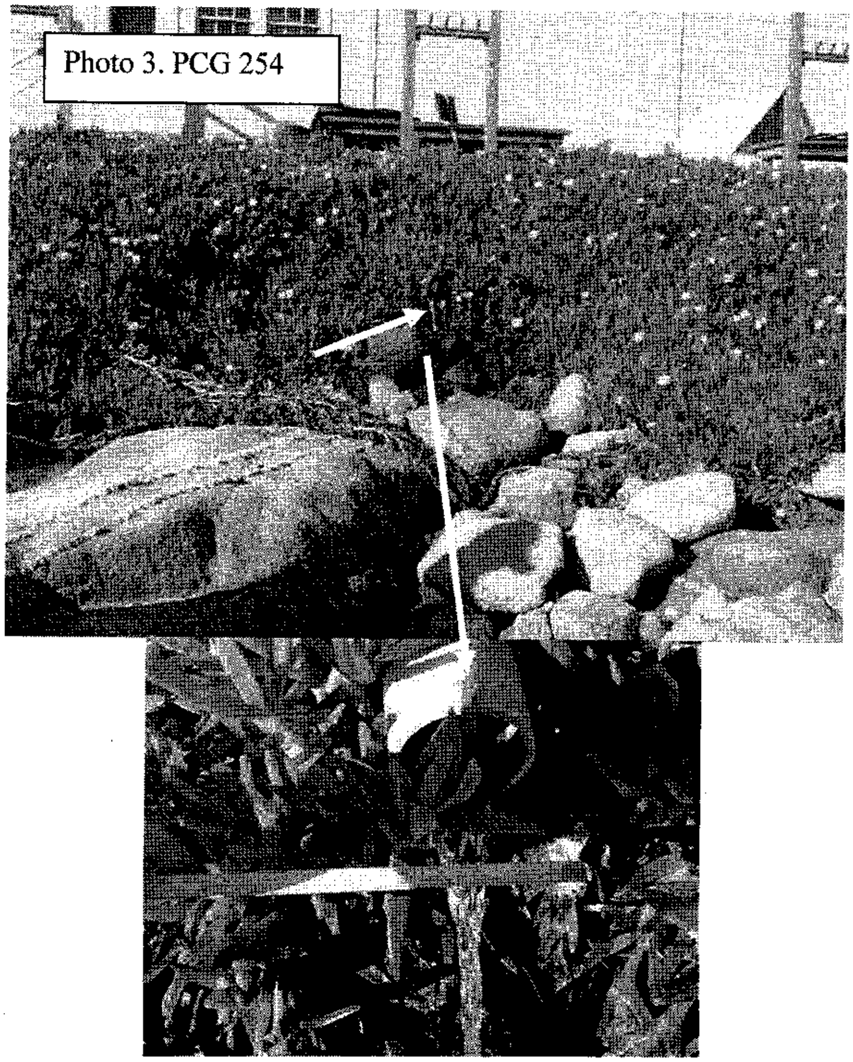


Photo 3. PCG 254

<u>Seawater outfalls to be eliminated</u>.

One additional permanent aquarium facility is located on Stanford University property, the Tuna Research and Conservation Center (Fig. 1). This facility is operated jointly by the Station and the MBA. The TRCC receives its seawater directly from the

MBA's system and all seawater from the aquaria is returned to the MBA for discharge through its seawater system, at a site outside of the HSMR ASBS. However, currently there is one form of discharge from the TRCC into the ASBS: back-flush water from the filtration system used to condition the water for the TRCC's large aquaria where tuna are held. Discharge volume of a full back-flush is approximately 11,000 gallons. Currently, back-flush water is discharged into the ASBS through pipe **PCG259**. However, the system handling filter back-flush is in the process of being re-engineered, so that all back-flush water will be returned to The MBA. There, it will be treated along with the seawater leaving MBA aquaria in which non-native ("exotic") species are held. Re-engineering will entail installation of two 5,500 gallon storage tanks, to hold the back-flush water before it is injected into their treatment system. The design of the system is completed, funding by the MBA is approved, and the project should be completed within six-eight months. **Thus, by mid-2007 the TRCC will cease to discharge any water into the Hopkins ASBS.**

Two temporary aquaria are currently located adjacent to the seawater pumping facility ("Pump House" in Fig. 1). They discharge into a site just to the east of the Fisher Building (pipe PCG259 on the State's survey map). **These two temporary tanks are being removed within the next few months, in concert with the re-engineering of the back-flush return system at the TRCC.**

3. The amount of aquatic animals harvested or produced in the aquarium per year.

We hold only field-collected animals and do not propagate any species in our aquarium facilities. Most animals are invertebrates, primarily sea urchins, mussels, squid, and snails, which represent over 90% of the mass of specimens held at the Station. The total mass of animals held in our aquaria at any one time varies between approximately **20 – 50 kg** (44 – 110 pounds), with quantities depending on teaching and research activities and seasonal availability of specimens. Based on the rates at which specimens are used, I estimate that our annual use of animals for research and teaching is no greater than **150 kg** (330 pounds). Most of the animals we use in our programs are small, weighing less than a few grams in many cases. Many of the animals we use in our teaching are returned to the ocean after use.

4. The amount of food fed to the animals in the aquarium during the month of maximum feeding.

We provide our animals approximately **51 kg** (112.2 pounds) of food during the months of maximal feeding, which typically are during the winter and spring quarters when our teaching program is most active. [Note: because the Tuna Research and Conservation Center seawater system is being re-engineered to remove any discharge into the ABSB, we do not include TRCC feeding in this analysis (see point 2, above). The response of the MBA to their 15 February 2006 letter from your office will address feeding of specimens at the TRCC.]

Invertebrates. Approximately **50 kg** (110 pounds) of food, maximum, are fed to invertebrates each month. Most of this food comprises local species of marine algae.

Echinoderms and snails are fed locally collected macroalgae, usually *Macrocystis pyrifera* or *Egregia* sp. Uneaten algae are removed from the tanks and discarded in the trash. Some species of snails are fed carcasses of market squid. Mussels are often maintained for only short periods (a few days to a week) and these specimens generally are not fed. When feeding of mussels occurs, a suspension of local unicellular marine algae is the food used. I estimate that no more than 5 liters of algal suspension containing approximately 1-5 grams of algae per liter are used in any given month. One laboratory occasionally maintains populations of locally captured squid (*Loligo opalescens*) in the DeNault aquarium (total mass of squid approximately 10 kg/year). The squid are fed goldfish (APLAC approved protocol). In summary, the total mass of food given to the invertebrates held in our tanks is no more than approximately 50 kg/month. Most of this food is naturally occurring marine algae collected in Monterey Bay.

Fish. No more than approximately **1 kg** (2.2 pounds) of food per month is given to the fish held at the Station. Two diets are used. One is a premium quality commercial fish food that contains no unnatural additives (e.g., antibiotics). The total amount of food given is approximately 0.5 kg (1.1 pounds) per month. A second diet is dried squid, given at a rate of approximately 0.5 kg per month. Fish are fed to satiation, and all uneaten food is removed from the tanks and disposed off in the trash.

A frame of reference concerning discharge of feces and urine. If one assumes that assimilation of ingested food by the fish we maintain is in the range of 85% (a typical value for marine fish) and that all of the algal material fed to the invertebrates is ingested (much is not, and the uneaten material is removed from the tanks), then the ~50 kg of food given to fish and invertebrates during the month of maximal feeding would lead to fecal material and nitrogenous products totaling approximately 7.5 kg/month, or approximately 0.25 kg/day (0.55 pounds/day). Because a large fraction of the macroalgal food is uneaten, this is a considerable over-estimate of actual release of organic material into the ASBS.

The relative impact of this discharge of material into the ASBS should be analyzed in the context of other naturally occurring feces and urine production in the HSMR ASBS. Notably, the resident population of harbor seals in the HSMR exceeds 300 and continues to rise (personal communication from Ms. Terry Nicholson, the MBA, who has monitored the HSMR harbor seal population for over a decade). A 100 kg harbor seal will produce approximately 0.26 kg (0.6 pounds) of fecal matter per day and release approximately 1.2 liters of urine (Dr. Daniel Costa, University of California, Santa Cruz, personal communication). ***Thus, metabolic end-products from a <u>single</u> harbor seal equal or exceed the amount of feces and urine produced by all of the animals we hold in our aquaria.*** Sea otters are common in the HSMR, and have a higher metabolic turnover than seals. In addition, hundreds of sea birds and Canada geese live on the rocks and shores of the HSMR. An adult Canada goose defecates approximately 2.2 kg of feces daily. There are about two dozen Canada geese resident at the Station and hundreds more in the other shoreline area bordering the ASBS in Pacific Grove. The amount of feces and other wastes produced by the resident populations of these endothermic (warm-blooded) mammals and birds exceeds, by many orders of magnitude, any amount of material ("waste") discharged from the ectothermic (cold-blooded) animals and algae held in our aquarium systems. And, of course, for every native mussel, snail or fish held in our tanks, thousands of individuals of the same species are found naturally in the HSMR ASBS.

In view of these data and the facts that we add no chemicals to our discharged seawater and hold no exotic species in our flow-through aquaria, **it is scientifically invalid to conclude that our aquarium systems represent an environmentally relevant *"discharge of waste into the ASBS"*.** The extremely small amount of fecal material and nitrogenous end-products in our seawater discharge thus is not a form of anthropogenic pollution, but rather the result of natural metabolic processes that occur at vastly higher levels in the ASBS itself.

5. A list of species cultured at the facility.

Appendix 3 is a full list of species held ("cultured") in aquarium systems at the Hopkins Marine Station. With one exception (the pallid sea urchin, which will be held for only a few more months), all species are native to the Central California coast. Non-native species, when present, are always held in small re-circulating seawater tanks that have no connection to the seawater discharge lines shown in Figure 1. Waste water from the tanks holding non-native species is discharged into the sanitary sewage system, not into the ASBS.

6. Controls employed to eliminate potential discharge of parasites.

Because the large majority of the specimens held in our facilities are species native to the Central California coast, introduction of exotic parasites into the ASBS from the seawater discharged at our three outfalls is not a problem. Non-native (exotic) species are held in re-circulating aquaria that are not connected to the seawater discharge systems. The water from aquaria holding non-native species is routed to the sanitary sewer system, where it goes to the Publicly Owned Treatment Works (POTW) and receives primary and secondary treatment.

7. Information on all chemicals added to the facility seawater system or to marine life food used at the facility.

No chemicals are added to the Station's seawater systems or to food given to our animals. To maintain the integrity of the research and protect the animals held in the aquaria, only seawater and nylon brushes are used to clean the aquaria themselves.

8. A diagram or sketch that gives the general flow and location of intake and discharge points of the Hopkins Marine Station seawater system.

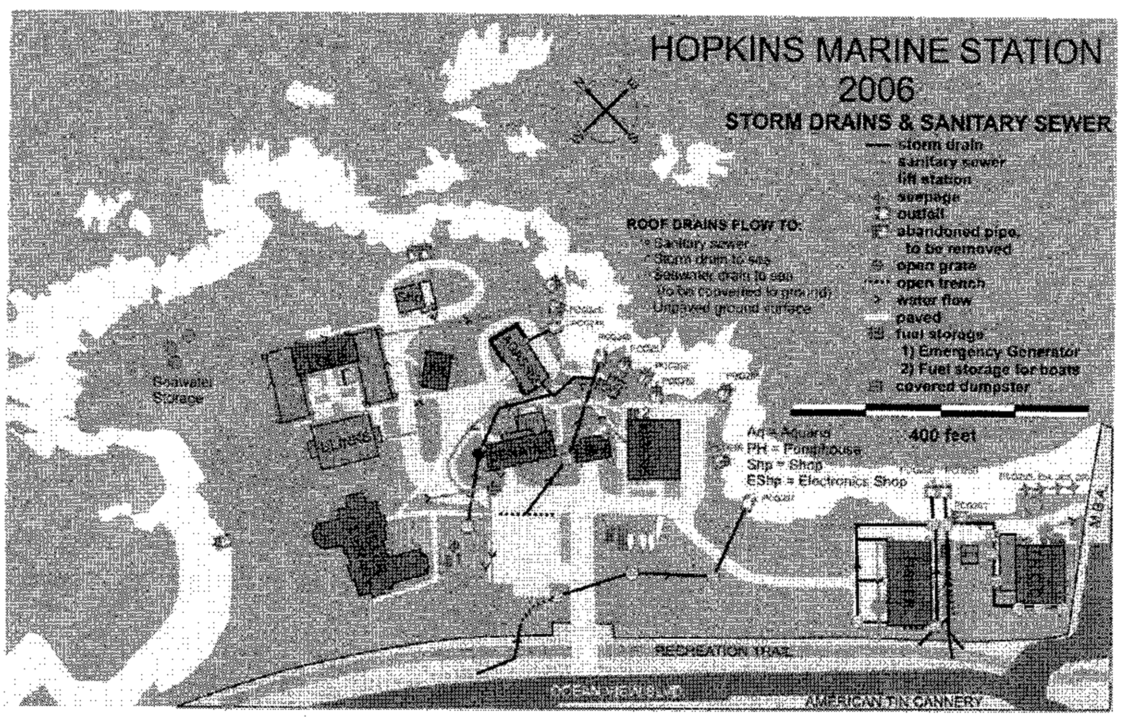
See Figure 1. Please refer to Appendix 2 for details on the Station's seawater systems and the changes being made to reduce discharge volume.

9. A characterization of your facility in terms of percent impervious surfaces, and a map of surface drainage of storm water runoff, including areas of sheet runoff, and locations of any structural Best Management Practices (BMP) employed...

Figure 2 shows the complete storm water and sanitary drainage systems at the Station as well as fuel storage and dumpster sites.

Hopkins Marine Station is built upon 11 acres of oceanfront land. The bedrock is primarily granite and soil coverage is quite shallow in most areas. The property has 28% impervious area (research building footprints, associated parking lots, and paved foot paths). The remaining 72% of the land is natural and provides a recharge area for rainfall.

Figure 2 also indicates structural BMPs and protected fuel and waste storage areas. The Station has a diesel-fueled emergency generator with a double-walled fuel storage tank. A metal shed houses small quantities of double-contained fuel canisters used for the out-board motor for small research boats. Covered dumpsters in a fenced, cement-floored area are used to hold waste and recyclables for weekly pick-up. No run-off from this area into the ASBS occurs. Pesticides and herbicides are not applied at the Station except for the application of boric acid around the Loeb building to control ants. There are no loading docks or outside vehicle or equipment service areas at the Station.



<u>Figure 2</u>. Storm drain and sanitary sewer systems at the Hopkins Marine Station. [A larger version of this figure is included at the end of this report.]

10. Compliance history for drainages into the ASBS, including any spills, or upset events that resulting in the discharge of toxic or otherwise prohibited substances.

No spills, upset events or discharges of toxic chemicals have occurred at the Station.

11. Documentation showing that the public interest will be served by granting the exception.

Our ability to sustain our programs in education and research depends absolutely on the continued operation of our seawater and aquarium systems. Since our founding in 1892, the Station has been one of the world's leading centers for training marine scientists and conducting a wide range of experiments on marine plants and animals. Our contributions to the public interest can be measured in several ways.

First, the basic knowledge that we generate in our research has been exceedingly important in informing public policy in the arena of marine conservation. A number of our faculty (Professors Block, Micheli, and Palumbi) are contributing to the science of how marine reserves should be structured and managed. This applied science stems directly from the understandings that have been gained through the basic marine biological research done at the Station. For example, Dr. Palumbi's group has characterized the patterns of genetic variation that exist within a species, and these data are of major importance in designing reserve systems that allow retention of genetic diversity, on which the potential for adaptive change is based.

Second, the Station's educational programs make major contributions to training of marine scientists and enlightening the public about important issues in marine science. Our educational programs range from field trips by K-12 students to mentoring of Ph.D. students and postdoctoral scholars. With the increased concern about the health of the oceans, our educational programs are exemplary in advancing the generation and dissemination of critical knowledge about marine life and the threats it faces from anthropogenic changes.

Third, the faculty, students and staff of the Station continue to be effective stewards of our ASBS. Since its establishment in 1931, the Hopkins Marine Life Refuge (recently renamed the Hopkins State Marine Reserve) has been carefully managed by Hopkins personnel. We assist the California Department of Fish and Game (CDF&G) in supervising use of the ASBS. We report to CDF&G violators of the regulations in force in the HSMR. We maintain and service, at no cost to the State, the large buoys that mark the periphery of the HSMR. Thus, we are an active partner with the State of California in protecting this resource. Many of our scientists use the local ecosystem in their research, so we have a strong vested interest in maintaining the HSMR ecosystem in as near to a pristine state as possible.

Fourth, our on-going studies since the founding of the reserve in 1931 have produced unique ecological baseline data showing how the fauna at China Point has changed over time, in concert with global climate change (see responses to queries 12b and 15, below). Most major reviews of the biological consequences of climate change cite these data. Our ability to continue this important monitoring effort depends on keeping all anthropogenic effects to our ASBS at a minimum.

Thus, in concert with State agencies and environmental groups, we at the Station are strong advocates of protecting our ASBS in the most effective ways possible. To achieve this, we require continuing operation of a seawater system that can support our studies of the biota found in the HSMR.

Our abilities to monitor and protect our ASBS also depend importantly on financial resources. In that context, it is relevant to point out that the costs of monitoring are high and, for this reason, only monitoring that is scientifically justifiable should be mandated. In responding to the Water Boards' requests outlined in your February 15, 2006 letter, $17,905 has been spent to date doing water analyses. Another $5,000 has been spent to buy the MARINe/PISCO data set discussed under questions 12b and 15. These costs do not include staff-related expenses involved in responding to the February 2006 letter. These sums far exceed our annual teaching budget and these costs thus have had a significant impact on our ability to support our courses and our intramural research programs. Because our funds for research and teaching are limited, monitoring efforts need to be designed in a scientifically valid and cost-effective manner.

12. Please describe any monitoring that has been done and/or that is presently employed at the facility, including:

a. Assessment of all available historical data on discharge volume, chemical and physical constituents, toxicity, and indicator bacteria in the waste seawater and desalination brine effluent.

Summary

Historical sampling of seawater discharge revealed no detectable levels for nearly all Ocean Plan constituents, and levels below Table B instantaneous limits for the remainder, except for three Phthalates. The latter were introduced into the sample by the plastic tubing used for sample collection. Aquatic toxicity testing showed no toxicity to any of the species tested.

Sampling and Analysis

Figure 3 shows the 13 sampling sites used for monitoring ocean water chemistry. The locations include sites for sampling seawater and storm water discharge, receiving water, seawater supply, and storm water run-on to the Hopkins property from the City of Pacific Grove. The Station has no desalination facility (the 15 February 2006 letter errs on this point) and therefore we discharge no brine effluent.

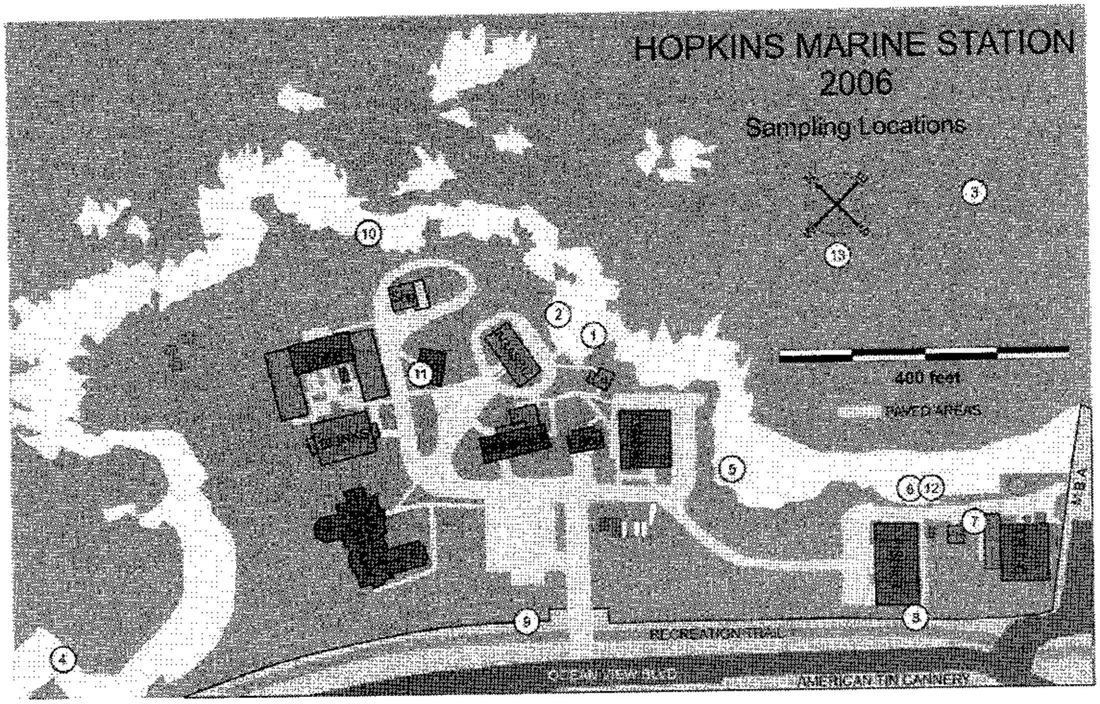


Figure 3. Collection sites for water samples (see text for details). [A larger version of this figure is provided at the end of this report.]

Stanford University conducted two rounds of seawater sampling and analysis from several locations at the Hopkins Marine Station. The first round, denoted "preliminary sampling," was collected on 22 March 2005, prior to issuance of the February 2006 request for information. The second round of samples was collected in response to the 15 February 2006 letter on three dates during the rainy season in 2006. (Summary Data Tables are attached as Appendix 4A. Comprehensive Laboratory Reports for both chemical and aquatic toxicity testing are contained in Appendices 4B and 5B, respectively. These voluminous files are packaged in separate envelopes.)

As discussed more thoroughly in our response to query 2, the estimated daily discharge volume of seawater is currently approximately 122,400 – 144,000 gallons. Also discussed in response to query 2 is the plan for removal of overflow discharge from the seawater holding tanks, thereby reducing the facility's daily discharge by approximately 50%.

Preliminary sampling. On 22 March 2005, Stanford collected one seawater discharge sample. As Stanford had not yet received a letter requesting sampling or guidance regarding sampling protocols or required analysis, we elected to analyze the samples for all 90 analytes listed in Tables A and B. This analytical suite is far more extensive than that requested by the Board in the 15 February 2006 letter. The seawater sample was collected from a discharge point located on Agassiz beach, denoted as sample location #2 (SWRCB survey map location #PCG247), which previously served as the overflow drainage for aquaria tanks located in the Agassiz building. The sample was collected during a period of no rainfall to eliminate any storm water dilution from roof drains on the Agassiz building. (Note: during the Agassiz building remodel in 2005-2006, roof discharge was separated from the seawater discharge for the building and now is discharged entirely through PCG248.)

The seawater sample contained no detectable amounts of Ocean Plan Volatile Organics, Chlorinated Phenolics, Non-Chlorinated Phenolics, Organo-Tins, Poly-Aromatic Hydrocarbons, Poly Chlorinated Biphenyls or Chlorinated Pesticides. All results for Ocean Plan Metals, Ocean Plan General Chemistry, and Radiochemistry were well below the Ocean Plan Instantaneous Maximum limits.

The seawater sample contained no detectable amounts of Base/Neutral extractable Organics except for three Ocean Plan Phthalates, which we believe were due to the sample collection equipment. Due to safety considerations of sample access location and to facilitate sample collection, these samples were collected using approximately two to three feet of 1-inch diameter clear flexible plastic tubing newly obtained from a nearby hardware store. Flexible plastic tubing is known to contain significant amounts of Phthalate plasticizers, as it is very pliable, and this was not considered before applying it to the sample collection. Therefore, we report this sample result, but consider the probability the sample was tainted from the new plastic tubing used in the collection process.

Both Chronic and Acute Aquatic Toxicity testing was performed using three different species on a combined sample of aquaria discharge (seawater) and Agassiz roof drain water (storm water). **The sample evidenced no toxicity to any of the species.**

b. Data on the status and description of marine life in the ASBS, and on the natural background of the ASBS.

Four sets of studies provide survey data on marine life found in the HSMR ASBS: **(i)** the doctoral thesis work of Willis Hewatt conducted in the early 1930s, at the time the HSMR was established (Hewatt, 1934); **(ii)** surveys by Barry *et al.* (1995) and Sagarin *et al.* (1999) that were conducted in the early to mid-1990s at the same site used by Hewatt, which I refer to as the "Hewatt Site" in recognition of his pioneering work; **(iii)** a survey of the ASBS commissioned by the State Water Resources Control Board and published in 1979; and **(iv)** on-going surveys by marine biologists at the University of California-Santa Cruz involved in the **P**artnership for the **I**nterdisciplinary **S**tudy of **C**oastal **O**ceans (PISCO) research program. These data are being compiled and integrated into the MARINe (Multi-Agency Rocky Intertidal Network) data base.

Appendix 6 provides copies of two primary publications in which extensive, quantitative survey data are presented (Barry *et al.* (1995) and Sagarin *et al.* (1999). The 1979 survey conducted by the State should be available at your office. The UCSC researchers have indicated that they plan to have their report completed within the next couple of weeks. Upon receipt of their data, we will conduct our analysis and forward this to the Water Boards as part of Stanford's response. In our meeting with State and Regional Water Board staff on Monday August 14, 2006, we were told that the MARINe/PISCO data could be provided as an addendum to this response letter after the analysis of these data is completed. We anticipate submitting this addendum no later than mid-November 2006. [Note: The information found in these surveys is also relevant to query #15, and it is in this context that I will provide an overview of relevant conclusions concerning the status of life in the "*discharge*" site in the HSMR ASBS.]

The three published surveys of the biota of the HSMR ASBS all support a conclusion that is relevant to the analysis of possible discharge effects: **the HSMR ASBS is a dynamic ecosystem in which spatial and temporal variation in species composition and in abundance of organisms is prevalent**. This biological variation in space and time is a consequence of a number of factors, notably climate change and oceanographic variables like El Niño/Southern Oscillation (EÑSO) events and the Pacific Decadal Oscillation (PDO). Changing ecological interactions that result from shifts in species composition also may lead to large faunal and floral changes over time and space. An illustration of this type of effect is the cropping of abalone and sea urchins by sea otters, which reappeared in the HSMR ASBS in 1963, Exploding populations of marine mammals, following the signing into law of the federal Marine Mammal Protection Act, also contribute importantly to the water chemistry (e.g., nutrient levels) and ecological interactions of coastal ecosystems like the HSMR. This background variation may make it difficult, if not impossible, to tease out any effects of seawater and storm water discharge into the HSMR ASBS, especially when disparate "discharge" and "comparison" sites are used.

Below, I review the study commissioned by the State and completed in 1979. This study provides relevant information on the "natural background" of the HSMR ASBS and illustrates well the spatial variability in the biota in this ASBS. I address temporal variability in my comments in response to query 15.

State of California Water Quality Monitoring Report No. 79-11 (*"California Marine Waters Areas of Special Biological Significance Reconnaissance Survey Report: Pacific Grove Marine Gardens and Hopkins Marine Life Refuge."* California State Water Resources Control Board, Division of Planning and Research Surveillance and Monitoring Section (May 1979).

This survey was conducted to provide baseline ("natural background") information about the substrates (e.g., sand *versus* rock cover), current patterns, and biota of the Pacific Grove Marine Gardens and Hopkins Marine Life Refuge ASBS. Six line transects, evenly spaced throughout the ASBS, were conducted in subtidal habitats. Several intertidal sites were examined as well. The Report contains extensive descriptions of the topography of the habitats and their flora and fauna. Diverse species assemblages were noted at the different sites. These differences in faunal and floral composition likely are a consequence of topographical and oceanographic features of the different habitats. For example, the ratio of sand-covered to rock-covered surfaces had a clear influence on species composition. Intensities of current flow and wave action affected the biota as well. Time-dependent changes were noted during the survey. For example, the abundance of the kelp *Macrocystis pyrifera* at several sites decreased markedly after an October storm. Populations of the sunfish *Mola mola* plummeted during the survey.

The Report discusses the role of Hopkins Marine Station in the establishment and use of the ASBS. On page 70 of the Report, the authors state that, *"Scientific use of this* *reserve served as the main reason for designating it an ASBS."* Discharge of seawater is discussed on page 77: *"The Agassiz beach discharges are largely absorbed by the coarse grain sand beach before they reach the water. The other two discharges are to areas above the intertidal zone; the only observable effect is the creation of a small artificial "splash" zone on the granite rocks, with appropriate algae and invertebrate populations."* These are the three permanent seawater discharge sites discussed above and shown in photographs 1 - 3.

In agreement with the conclusions of this 1979 Report, we believe that none of the seawater discharge sites at the Station creates any potential for environmental change, other than the establishment of a slight increase in available habitat in the "splash" regions, which could be viewed as a positive effect. And, as stated above, the spatial and temporal variability documented in this report emphasizes the difficulty of selecting meaningful "discharge" and "comparison/control" sites for analyzing the effects of seawater and storm water discharge (see query #15). As discussed in my response under query 15, *time series study of a single discharge site may provide more meaningful data for analyzing potential effects of water discharge than concurrent studies of spatially separate sites that are intrinsically not comparable for reasons of topography, current pattern, intensity of wave exposure, and species composition.*

13. A description of current treatment processes, pollution controls, and/or BMPs currently used or planned, including structural BMPs to control storm water runoff (with a schedule for implementation).

Appendix 7 describes in detail many of the best management practices (BMPs) now employed or soon to be initiated at the Hopkins Marine Station. These BMPs comprise the University-wide policies of Stanford and additional BMPs that reflect the unique characteristics of Hopkins Marine Station. The bulleted statements below provide an overview of current and future BMPs at the Station.

Current BMPs

- The separation of seawater and storm water (no commingling): *complete August 2006*
- All campus staff are trained immediately upon Facility arrival and annually thereafter for proper chemical handling and disposal and proper storm water best management practices. *Annual*
- Catch basins are labeled appropriately and cleaned out annually. *Annual*
- No pesticides or herbicides are used on property. *Current practice*
- Minimal outdoor hazardous materials (emergency generator fuel storage, small fuel containers for boats): Containers are properly labeled; locked storage; secondarily contained; inspected regularly; absorbent materials are kept on hand. *Current practice*
- Small boat fueling area is covered; regularly inspected and requires spill response training before use. *Current practice.*

- All dumpsters and recycling containers are leak-proof, have lids that are kept closed, sited on concrete surfaces located distant from storm drains, emptied weekly and inspected regularly. *Current practice.*

<u>Planned BMPs</u>

- Gradual conversion of paved walkways and parking lot to permeable pavement. *To be completed as surfaces require replacement.*
- Install moisture sensor irrigation controls to prevent over-watering of landscaping. *Expected completion 2007.*
- Replace lawn with native plantings to reduce water use, potential herbicide/pesticide use, and irrigation over-watering. Project underway: area around Miller Library and Monterey Boat Works Building completed (2005). *Expected full completion 2008.*
- Formalize current swale on property to treat storm water run-off from the City of Pacific Grove's recreation trail onto Station property: re-direct water to large field to allow percolation into soil. *Expected completion 2008.*

14. An analysis of alternatives to discharge and their impacts if implemented.

<u>Seawater discharge</u>. If we were required to cease discharging seawater into the ASBS we would face significant reductions in our research and educational programs. None of the available options discussed below are realistic alternatives to the continued discharge of one-pass seawater.

1. *Constructing a closed, recirculating seawater system.* This would be an extremely costly and, in our view, scientifically unjustified alternative to maintaining our current flow-through, one-pass seawater system. We use small (approximately 100 liter) recirculating aquaria to maintain exotic species and to conduct acclimation experiments. To expand this expensive technology throughout our aquarium systems cannot be justified on the basis of putative "waste discharges" into the ASBS. Furthermore, converting to a closed, recirculating system begs an important question: Where will this seawater be discharged when it has become too contaminated for continued use? Municipal sewer systems cannot accept sizeable amounts of seawater. The small amounts we currently add to the local sewer system fall below these limits; full conversion to recirculation would create a disposal problem whose solution is not evident. Another argument against a recirculating system is that many species are highly sensitive to water quality and are healthier in a one-pass, flow-through system. Converting to recirculation could therefore reduce the types of investigation and teaching we perform and adversely impact the marine research programs.

2. *Move the seawater discharge site to a location outside of the ASBS.* This alternative to continued discharge into the ASBS would be very expensive and represent a cost to benefit ratio that is highly unfavorable. The small amount of feces, urine and

uneaten food released into the ASBS is, as demonstrated earlier (point #4), trivial relative to naturally occurring production of these same materials. Collecting all of our seawater into a single pipe and pumping this water to a site that is legally defined as being "far enough" away from the ASBS to no longer represent discharge into the ASBS is problematic for another reason: there is no clear guideline as to how far away from the ASBS is "far enough." Thus, this option does not make scientific, legal, or economic sense.

3. *Eliminating seawater use at the Station.* This would eliminate >90% of our research and severely impact our teaching. It would effectively shut down the work at the Hopkins Marine Station and thus cannot be considered as a viable option.

Storm water discharge. Hopkins has fully separate storm water and seawater discharges; there is no commingling. Hopkins has established its BMPs for the small amount of storm water generated from impervious areas at our 11 acre site. The Station has no industrial activities and does not have its own NPDES storm water permit. By far the greatest amount of storm water discharge occurring on Station property is water collected off-Station in the City of Pacific Grove and discharged through municipal storm water pipes that outfall into the HSMR ASBS. It is not within the purview of Stanford University to redirect this off-Station storm water to an alternative site that is adequately distant from the ASBS. Moreover, there is currently no legal definition of what this distance might be. Neither can the University direct the City of Pacific Grove to remove the existing storm water discharge pipes that we currently host for the City. Any re-direction of Hopkins' storm water would be part of a larger municipal program under the City of Pacific Grove's municipal storm water permit.

The following data put our storm water discharge relative to that from the entire City of Pacific Grove into perspective. The total surface area of the City of Pacific Grove is 1,830 acres (79,714,800 square feet). Our 11 acres (479,160 square feet) represent **0.6%** of the surface area of the City at large. We thus receive less than one percent of the total rainfall of the City of Pacific Grove. Moreover, whereas the city is largely built-up and has minimal permeable area, most of our acreage (approximately 72%) is covered by natural vegetation or lawn. Thus, a relatively small fraction of rainfall on the Station's 11 acres is likely to end up as storm water runoff, relative to the City of Pacific Grove at large.

15. At a minimum, submit a quantitative description of representative marine life at the ASBS near the discharges and at a similar location away from the discharges.

Choice of designated "discharge" site. Because the Hewatt Transect site (Fig. 4) on China Point lies immediately seaward of our highest volume seawater discharge pipe and is approximately 400 feet from the only storm water discharge sites that contains run-off entirely from Hopkins property (Fig. 2), State and Regional Water Board staff, at our meeting on 14 August 2006, recommended that we employ this site as our "***discharge***" site. We agree with this recommendation, especially because survey data from this site allow a quantitative time-series analysis of the site's biota over a period of 65 years. These data are found in the following documents: Hewatt, W.G. (1934). *Ecological*

Studies on Selected Marine Intertidal Communities of Monterey Bay, Ph.D. dissertation, Stanford University; Barry, J.P., C.H. Baxter, R.D. Sagarin and S.E. Gilman (1995). Climate-related, long-term faunal changes in a California rocky intertidal community. *Science* 267: 672-675; and Sagarin, R.D., J.P. Barry, S.E. Gilman and C.H. Baxter (1999). Climate-related changes in an intertidal community over short and long time scales. *Ecological Monographs* 69: 465-490. Copies of the Barry *et al.* (1995) and Sagarin *et al.* (1999) papers are found in Appendix 6.

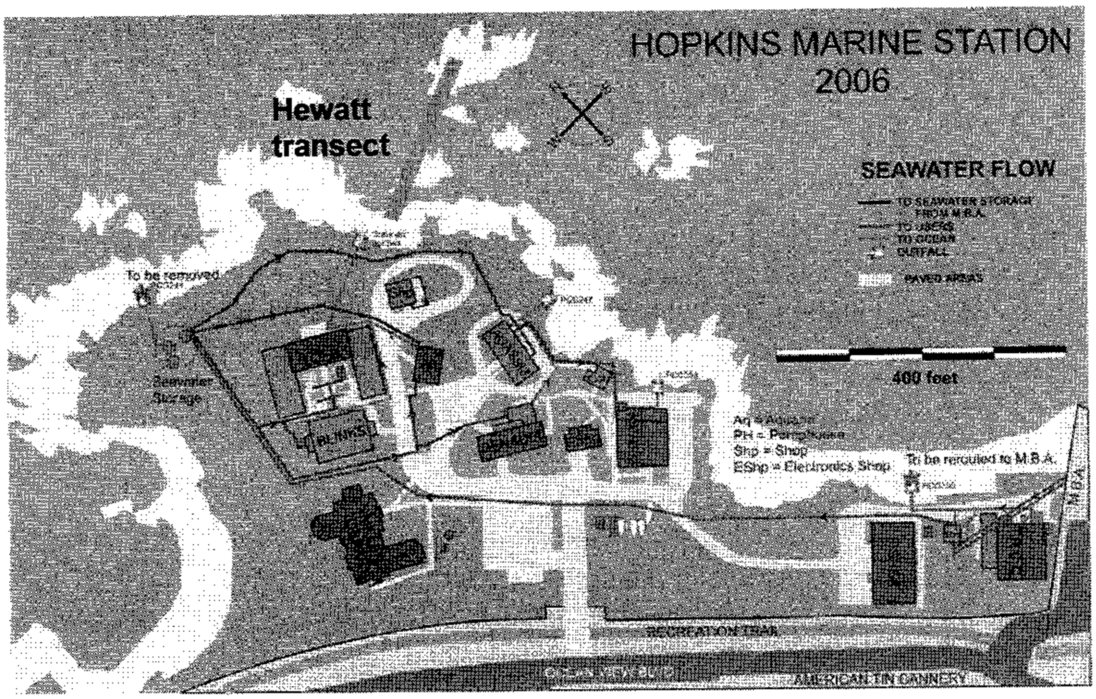


Figure 4. Location of the Hewatt Transect site ("Hewatt site") on China Point.

<u>*Choice of designated "comparison" site.*</u> The MARINe/PISCO intertidal site is approximately 1200 feet to the west of the Hewatt site, and therefore is well away from any discharges that might influence the Hewatt site. Water Board staff recommended on 14 August 2006 that we use the MARINe/PISCO site as a "***comparison***" site. As indicated above, the scientists at UCSC who are conducting the MARINe/PISCO studies will be providing us with their survey data in early September. We will provide these data and their analysis as an addendum to this letter within several weeks.

At this time, I will focus the analysis strictly on the temporal patterns observed in the Hewatt site—our *discharge site*—studies. **The principal conclusion reached by Sagarin *et al.* in their quantitative analysis is that the substantial change in species composition and abundance observed at this site over the period between 1931-1933 and 1991-1996 is most likely a consequence of climate change—warmer water—and not a reflection of any direct anthropogenic influences such as discharge** (see page

481 of their monograph). A detailed, cause-effect interpretation of the data found in their publications is given at the beginning of Appendix 6.

16. Measurements of representative samples from waste seawater outfalls.

Summary.

Results from Regional Board mandated chemical analysis and toxicology testing of seawater samples showed that Hopkins seawater discharge contains no harmful materials and thus does not represent the introduction of waste into the ASBS.

These results also demonstrate that the receiving water in the vicinity of Hopkins Marine Station is in excellent health as measured by Ocean Plan metals, general chemistry, and toxicity to marine species.

Sampling and Analysis

On 15 June 2006, Stanford collected and analyzed discharge samples in accordance with the Regional Board request for information as enumerated in the 15 February 2006 letter. The seawater supply sample was analyzed for Ocean Plan metals. Figure 3 shows sampling locations. Summary Data Tables are attached as Appendix 4A. Full Laboratory reports for both Chemistry and Aquatic Toxicity testing are contained in Appendices 4B and 5B, respectively. These large files are supplied in separate envelopes.

All sampling results were well below Table B Ocean Plan Instantaneous limits for all seawater discharge samples. (Location 10, not on the State survey map; and Location 12, (SWRCB #PCG259). Bacteriological testing results were also well below Ocean Plan limits.

Results of toxicology testing showed no toxicity in any samples with respect to kelp germination or growth, mysid growth, or fish survival or growth. There was slight reduction in mysid survival in the sample from location #12.

Receiving water sample results (Location 13) were also well below Table C numeric limits for specifically listed metals (Arsenic, Copper, Mercury, Silver, and Zinc). General chemistry results (Ammonia-N, Nitrate-N, pH, salinity, settleable solids, and turbidity) were below applicable Table B and Table C limits. Bacteriological testing results were well below Ocean Plan limits except for fecal coliforms.

The fecal coliform is, we believe, a reflection of the large populations of marine mammals and birds in the ASBS and bordering shoreline region (see above calculations in query 4 response about fecal output by harbor seals, sea otters, and birds).

17. An assessment of discharge volume, chemical and physical constituents, toxicity, and indicator bacteria in the storm water runoff and in the ambient marine water of the ASBS during a rain event.

Summary

Urban storm water runoff from the City of Pacific Grove significantly contributes to storm water discharges located at the Hopkins facility. Rough estimates as explained in section 14 indicate that Hopkins Marine Station surface constitutes less than 0.6 percent of the total surface area of Pacific Grove runoff. At sampling location #4, the discharge is exclusively water from Pacific Grove runoff as the outfall has no Hopkins input. This sample contained the highest measured levels of Ocean Plan constituents of all samples collected. At another discharge location, sample location #5, the data support a finding that the effect of Hopkins flow as it mixes with urban runoff is to reduce both the contaminant load and the aquatic toxicity of the final discharge. The contaminant load is less at the actual discharge point than the levels entering Hopkins from Pacific Grove, based on comparative sampling of the two points. Based on these sampling results, one could argue that Hopkins contribution is not only negligible, but lowers the contaminant level of Pacific Grove's contribution.

Each of the Pacific Grove contributory run-on sample locations (Sampling locations # 8 and 9) and the Pacific Grove discharge location (Sampling location # 4) evidenced toxicity to aquatic species. Hopkins discharge locations (Sampling locations #1 and #7) demonstrated no ecologically significant toxicity in all tests.

Given the fact that the storm water discharges at this location contain principally runoff from the City of Pacific Grove, we reiterate our position that Hopkins Marine Station storm water discharge should be part of the Pacific Grove MSW4 permit.

Sampling and Analysis

Preliminary sampling of storm water was conducted on 22 March 2005, prior to receiving guidelines for sampling and analysis from the Board. Two samples were collected from a discharge location denoted as Location #1 on the map (Figure 3) (SWRCB discharge # PCG249). One sample was collected at 10:20 AM, during initial rainfall, which was quite light, and the second sample was collected at 11:36 AM during a period of heavy rainfall. Since light rainfall is not representative of typical discharge conditions and does not meet the condition specified in the February 2006 letter for 0.1 inch rain, the data for that sample are included in the laboratory reports given in Appendices 4B and 5B, but not further discussed here.

The 11:36 AM storm water sample contained no detectable amounts of Ocean Plan Volatile Organics, Chlorinated Phenolics, Non-Chlorinated Phenolics, Organo-Tins, Poly Chlorinated Biphenyls or Chlorinated Pesticides. Also, Ocean Plan General Chemistry and Radiochemistry levels were all well below all Ocean Plan limits.

The storm water sample collected at 11:36 AM contained detectable levels of 8 Ocean Plan Metals, with all, except for Copper, at levels below the Instantaneous Maximum limit. Copper was detected at 36.2 mg/l; the Ocean Plan Instantaneous Limit is 30.0 mg/l. However, subsequent sampling of this outfall conducted on 6 March, 2006 which was based on the directive in the February2006 letter, resulted in Copper levels well within the instantaneous maximum limits (see below).

The storm water sample contained no detectable amounts of Base/Neutral extractable Organics except for four Ocean Plan Phthalates that were detected at levels ranging from 0.3 to 1.3 ppb. Total Ocean Plan Poly-Aromatic Hydrocarbons (PAHs) were measured at 1.664 ppb. Neither of these results can be compared to Ocean Plan limits as these results are for instantaneous grab samples, not 30 day averages. Subsequent sampling in March 2006 showed significant decline in PAHs (see below).

In accordance with the 15 February 2006 letter, Stanford collected and analyzed four storm water discharge samples (Locations 1-PCG249, 5-PCG257, 6-PCG258 and 7-PCG259) and two receiving water samples (Locations 3 and 13). For purposes of comparison, Stanford also collected and analyzed storm water run-on samples at two locations representing flows solely from the City of Pacific Grove where it merges into the storm water system located on the Hopkins property. (Location 8, contributes to PCG258; and Location 9, contributes to PCG257.) Stanford also collected and analyzed one municipal storm water discharge sample located on Hopkins property (Location 4, PCG#241) for the City of Pacific Grove. Analysis and testing were conducted as requested in the February 2006 letter. Summary Data Tables are attached as Appendix 5. Full Laboratory reports for both Chemistry and Aquatic Toxicity testing are contained in Appendices 4B and 5B, respectively.

Ocean Plan Metals were measured at levels substantially below the Instantaneous Maximum limit in all Hopkins discharge samples except for Copper in sample location #7. Copper was detected at 69.2 μg/l, the Instantaneous Maximum limit is 30 μg/l.

Ocean Plan Total Poly-Aromatic Hydrocarbons were measured at levels ranging from 0.03 to 0.08 μg/l in Hopkins samples, and 0.03 to 0.61 μg/l in Pacific Grove urban watershed contributory run-on and runoff samples. It is important to note that the Ocean Plan contains no Instantaneous Maximum limit for PAHs. These results are for grab samples that represent a single point in time, and cannot be compared to Ocean Plan limits, which are based on 30-day averages.

Ammonia-Nitrogen and Oil and Grease levels were well below Ocean Plan limits in all Hopkins samples.

Bacteriological results measured at all locations exceeded all Ocean Plan limits except fecal coliforms at Hopkins Sampling location #1. However, when Hopkins discharge locations are compared to the associated Pacific Grove contributory urban runoff location, bacterial loading is somewhat reduced. The lowest results were measured at Sample location #1, which represents discharge from Hopkins property only, with no influence from Pacific Grove urban watershed runoff. This supports the conclusions that fecal coliform is from the resident marine mammals and birds in the area and there is no measurable contribution from the Marine Station storm water discharge.

Both Chronic and Acute Aquatic Toxicity testing was performed using three different species on two Hopkins storm water discharges, two Pacific Grove contributory run-on locations (Sampling locations # 8 and 9), and one Pacific Grove only discharge location (Sampling location # 4). Hopkins Sample location #1 evidenced no toxicity to any of the species. Hopkins Sample location #7 evidenced none or no ecologically significant toxicity to Kelp, no acute toxicity to Mysid, no chronic toxicity to Mysid survival, and no toxicity to Fish. The sample did evidence chronic toxicity to Mysid growth. As noted above, each of the Pacific Grove contributory run-on sample locations and the Pacific Grove only discharge location evidenced toxicity in three, one and two of the seven tests, respectively.

Conclusions.

I trust that our responses to your 17 queries provide the data and analyses you require. To recapitulate the two major conclusions from the analysis provided herein, we view our sea water discharge as not adding any waste to the HSMR ASBS and we believe that the storm water discharge we contribute should be managed jointly with the broader municipality, the City of Pacific Grove, of which we represent a minor fraction. We look forward to the opportunity to discuss our findings and concerns with State and Regional Water Board representatives. In the meantime, please feel free to contact me if you have any questions about the contents of this response to your 15 February 2006 letter.

Sincerely,

G. N. Somero

George N. Somero
David and Lucile Packard Professor of Marine Science
Director—Hopkins Marine Station of Stanford University

Appendix 1. Letter from California Regional Water Quality Control Board, dated 15 February 2006.

Appendix 2. Pro-active improvements to the physical plant, to address concerns about discharge.

A. Separation of seawater and storm water discharges.

1. Re-plumbing of the Agassiz Building during the 2006 remodel, to eliminate any commingling of seawater and storm water. [Completed in March 2006]

2. Separation of seawater discharge from roof drainage in Aquarium building. Covers installed to prevent storm water from entering sea water drains. Storm water from roof drains will be directed to flat area near the Aquarium building. [To be Completed in September 2006]

3. Fluorescent dye tracing of flows through seawater discharge pipes, showing no mixing of sea water and fresh water flows. [Completed July 2006]

B. Elimination of discharge of filter back-flush water from the Tuna Research and Conservation Center (TRCC). This is the only organically-rich seawater currently being discharged into the ASBS. The Monterey Bay Aquarium is re-engineering its seawater purification system to accommodate return to the MBA of all back-flush water. [To be completed in the first half of 2007.]

C. Elimination of two seawater discharges.

1. Storage tanks for fresh water. Regulation of seawater supply to be engineered, so supply is on an "as-needed" basis, thus eliminating the need for the overflow outlet. [Work in progress; to be completed in September-October 2006.]

2. Temporary tanks near the pump house. Tanks to be removed by the end of 2006.

D. Survey of pipes for dry-season discharge and removal of non-functional pipes. The majority of the pipes noted on the State's survey map were shown by us to be non-functional. No dry weather flow was found in any of these pipes. All pipes found to be non-functional are being removed or capped. Photo-documentation of this work is being done and an up-dated pipe survey map is now available. [Work in progress; to be completed by the end of 2006]

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,Polym astia, Acarnus erithacus,Le ucandra heathi, Haliclona,*

CNIDARIA

Class Hydrozoa:	*Tubularia marina,Eudendrium* spp., *Polyorchis penicillatus, P.haplus; Hydractinia* *Obelia* spp., *Aglaophenia* spp., *Plumularia,Or thopixis* sp., *Abietinaria* spp., *Sertularia, Sertularella,Eutonina i ndicans* *Velella velella*
Class Scyphozoa	*Aurelia aurita , Phacellophora camtschatica*
Class Anthozoa	*Epiactis prolifera,Anthopleura eleg antissima, Uriticina lofotensis, Metridium senile* *Corynactis californica* *Balanophyllia, Astrangia,Parac yathus* *Pachycerianthus fimbriatus* *Stylatula, Virgularia,*

CTENOPHORA	*Pleurobrachia, Beroë*

PLATYHELMINTHES

Class Turbellaria	*Notoplana acticola*, misc. spp.

ECHINODERMATA

Class Asteroidea	*Luidia,As tropecten armatus,Pati ria miniata,Henri cia, Dermasterias imbricata, Pisaster giganteus,P. ochraceus, Leptasterias hexactis,L. pusilla, Orthasterias koehleri*
Class Ophiuroidea	*Ophiothrix,Ophiopter us papillosa, Ophioplocus esmarki, Amphiura arsystata, Ophiopholis bakeri*
Class Echinoidea	*Strongylocentrotus purpuratus, Strongylocentrotus droebachiensis, Dendraster excentricus, Lytechinus pictus*
Class Holothuroidea	*Eupentacta, Pachythione,Cuc umaria* spp., *Pseudocnus lubricus,Pentam era, Cucumaria piperata* et. al., *Leptosynapta, Parastichopus californica, P. parvimensis, Dendraster excentricus*

CHORDATA, SUBPHYLUM UROCHORDATA

Class Ascidiacea	*Ciona intestinalis, C. savagnyi,As cidia, Styela, Bolt enia Clavelina, Perophora,Py cnoclavella stanleyi* *Diplosoma, Synoicum,Poly clinum,Aplidium ,Botryllus schlosseri.*

ECTOPROCTA

Class Stenolaemata	*Crisia,Heteropora , Lichenipora,Di aperoecia*

Class Gymnolaemata	*Pherusella brevituba, Bowerbankia, Membranipora,Bug lula neritina, B. californica,Scr upocellaria, Cellaria mandibulata, Celleporaria brunnea, Phidolopora,Hippod iplosia, Costazia, Hippothoa hyalina,*
PHYLUM MOLLUSCA, Class Gastropoda	*Lottia gigantea, L. pelta,L. l imatula, L. digitalis, L.scutum, Fissurella,Di odora,Megatabe nnus, Megathura crenulata, Tegula funebralis, T. brunnea,T. m ontereyi,Call iostoma ligatum, C. annulatum, C. canaliculatum, Crepidula adunca, Crepipatella lingulata,Lit torina keenae, L. scutulata,* vermetids, *Polinices lewisi,Nuc ella emarginata, Ceratostoma, Pteropurpura,Ac anthina,Ol ivella biplicata,Kellettia kelletii, Cancellaria cooperi,Nas sarius mendicus,Nas sarius fossatus, Ocenebra circumtexta, Rictaxis), Navanax inermis, Hermissenda crassicornis,Flabelli na (=Coryphella) trileata, Discodoris, Cadlina,Doriops illa,Anis odoris, Archidoris, Triopha catalinae, Baptodoris Trimusculus reticulatus; Helminthoglypta, Conus californicus*
Class Bivalvia	*Mytilus californianus, M. galloprovincialis,M. trossulus, Protothaca,Clinoc ardium, Hinnites,*
Class Cephalopoda	Loligo opalescens
Class Polyplacophora	*Mopalia* spp., *Lepidochitona (Cyanoplax), Nuttalina, Katherina, Cryptochiton,Ton icella lineata,T. undocaerulea,T. l okii, T. venusta,Sten oplax*
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,Antinoell a anoculata, Dorvillea moniloceras, Anaitides mediapapillosa ; Notophyllum imbricatum, Eunice antenata, Diopatra ornata, Chone mollis,My xicola infundibulum,Megalom a splendida, Serpula vermicularis ,Thelepus crispus, Owenia fusiformis, Phragmatopoma californica, Sabell aria cementarium, Cirriformia, Dodecaceria fewkesi Phyllochaetopterus, Chaetopterus variopedatus, Spiochaetopterus*
PHYLUM SIPUNCULA	*Phascolosoma*
PHYLUM ECHIURA	*Urechis caupo*
PHYLUM ARTHROPODA	
Subph Cheliceriformes, Class Chelicerata	
Subcl. Pycnogonida	unident species
Subph. Crustacea	
Class Maxillipoda	
Subclass Copepoda	*Tigriopus californica*
Subcl Thecostraca, Infracl. Cirripedia	*Balanus,Le pus*
Class Malacostraca	
Subcl Eumalacostraca	
Superorder Peracarida	
Order Isopoda	*Cirolana,Idothea, Ligia*
Order Amphipoda	*Orchestia,Or chestoidea*
Superorder Eucardia	
Order Decapoda	

Suborder Brachyura	*Cancer, Lophopanopeus, Pachygrapsus,Hem igrapsus, Pugettia producta, Scyra acutifrons,Lox orhynchus crispatus*
Suborder Caridea	*Pandalas,Alph eus, Heptacarpus*
Suborder Anomura	*Pagurus samuelis,P. hem philli,P. armatus ,Paguristes* spp., *Petrolisthes cinctipes,Pac hycheles 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)

<u>Appendix 4.</u> A. Water chemistry data: <u>Summary sheets</u>. Samples identified by *sampling site* and *sampling date* (See text and Figure 3).
[Original laboratory data sheets are provided in a separate ring-binder labeled: Appendix 4-**B**.]

<u>Appendix 5.</u> Water toxicity analyses: Summary sheets. Samples identified by *sampling site* and *sampling date* (See text and Figure 3).

[Original laboratory data sheets are provided in a separate ring-binder labeled: Appendix 5-**B**.]

Appendix 6. Quantitative studies by Barry *et al.* (1995) and Sagarin *et al.* (1999) at the designated "discharge" site (the Hewatt site).

Summary of biological survey data:

The surveys published in the Barry *et al.* (1995) and Sagarin *et al.* (1999) papers exploited the brass markers set into the granite substrate on China Point by Hewatt in the early 1930s. Thus, the surveys done in the early- to mid-1990s were carried out at the exact sites examined by Hewatt some six decades earlier. The appended publications by Barry *et al.* (1995) and Sagarin *et al.* (1999) provide species lists of the intertidal animals present at the Hewatt site at the time of the initial and subsequent surveys. Hewatt identified 64,742 specimens in his survey; Barry and colleagues identified 125,590. (Much of the difference in numbers reflects the large number of *Chthamalus* sp. barnacles included only in the later study.) Densities of organisms are given as well, allowing a quantitative description of the site's fauna and a comparison of faunal change over the 60+ year period between the surveys.

For 62 species of invertebrates enough data were gathered to allow statistical analysis of changes in abundance over time. For 46 of these 62 species, significant changes in abundance were observed (see Table 2 of Sagarin *et al.*, 1999). *Overall, 24 species increased in abundance and 22 decreased. Thus, over the six decades between the two surveys, there is no indication that an overall decrease in species' abundances occurred at the Hewatt site. Likewise, the data in the surveys provide no suggestion of a loss in total number of species at the site (Sagarin et al., 1999).*

To determine what causal mechanisms might explain the shifts in abundance of the 46 species that showed changes, Barry, Sagarin and colleagues considered several hypotheses, including natural and anthropogenic changes in habitat conditions, short-term population variations, life history characteristics, and the biogeographic ranges of species. A 3-year study (1993-1996) by Sagarin *et al.* (1999) showed that short-term variation in biota at the Hewatt site was minor and could not account for the types of effects seen over the six-decade period. Possible effects of anthropogenic discharge, notably from the Hovden Cannery, the current site of the Monterey Bay Aquarium, were excluded as well (see page 481 of Sagarin *et al.* 1999). Only one factor was found to be relevant as a causal mechanism: changes in water temperature during the period between the surveys. This conclusion was supported by analyzing the species in the context of their biogeographic ranges. The species that showed changes in abundance could be grouped into three sets: "Southern" species" were those with a northern biogeographic limit of Cape Mendocino. "Northern" species were those with distribution ranges that extended no further south than Point Conception. "Cosmopolitan" species had ranges that extended beyond both Cape Mendocino and Point Conception. For "Southern" species, increased abundances were found in 10 of 11 cases. In contrast, "Northern" species decreased in abundance in 5 of 7 cases. "Cosmopolitan" species showed no consistent change: 12 increased in abundance whereas 16 decreased.

Based on their results and the available data on water temperatures at the Hewatt site [Note: an essentially continuous (=daily) water temperature data set exists for China

Point, beginning around 1920.] Barry *et al.* (1995) and Sagarin *et al.* (1999) conjecture that the observed shifts in faunal abundances are a reflection of the effects of climate change. Waters at China Point increased in average temperature by 0.79°C between the early 1930s and mid-1990s. Perhaps more significantly, summer temperatures were 1.94°C higher in the 1990s relative to the 1930s. Support for a role of temperature in causing the observed shifts in faunal abundance is provided by a number of physiological studies conducted with some of the same species analyzed in these surveys. Widespread temperature-adaptive physiological differences have been found between "Northern" and "Southern" species (Stillman, 2000; Tomanek and Sanford, 2004; Harley *et al.* 2006). The more heat tolerant "Southern" species show higher thermal tolerance for such physiological processes as heart function, protein biosynthesis and enzymatic catalysis. Thus, it seems fair to conclude that, whereas anthropogenic influences have affected the faunal composition on China Point, these influences have been *indirect*, e.g., through production of greenhouse gases, rather than direct impacts related to research and teaching activities by scientists at the Station.

Because Hewatt did not survey macroalgae, less is known about this important group of intertidal and subtidal species than about the fauna. However, Barry *et al.* (1995) and Sagarin *et al.* (1999) emphasize that algal cover is likely to have an important influence on creating available shelter and food for animals, especially invertebrates. One factor that could influence algal abundance and, therefore, animal abundance, is the amount of nutrients, e.g., fixed nitrogenous compounds, that are added to the water. In this regard, marine mammals loom as important contributors to the status of the China Point ecosystem. The enormous amount of nitrogenous waste produced by the large and growing population of harbor seals at China Point could be having a large (potentially positive) impact on algal growth and animal abundance (see comment made in conjunction with point #4, above).

In summary, studies that were done at the Hewatt site over a period exceeding six decades show the benefits of doing time-series analysis at a single site. Substantial changes in species' abundances were observed, but the data provide no evidence that these changes are a result of discharge of seawater or storm water. Rather, biogeographic evidence and physiological data support the hypothesis that climate change may be the most important driver of these shifts in species abundance. The "natural background" of the ASBS is in flux, and we would anticipate that the suite of background environmental changes, which include temperature (due to EÑSO and PDO events as well as climate change) and nutrients (e.g., as generated by rising populations of mammals and birds and as affected by EÑSO and PDO processes) will continue to drive shifts in this ecosystem.

<u>Literature cited.</u>

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<u>Appendix 7</u>. Best management practices: storm water run-off.