November 25, 2002

California Coastal Environmental Quality Initiative
UC Marine Council
Office of the President
1111 Franklin Street
Oakland, California 94607-5200

To the UC Marine Council:

This is the final report for proposal 01T CEQI 06 1081: Evaluating the Relative Importance of Coastal Habitat Types as Productive Nursery Grounds for the California Halibut. During the past 15 months, I have been able to build a foundation for my thesis research, and based upon the work completed thus far I will qualify for Ph.D. candidacy on December 3rd of this year.

During the first year of my research, I have focused on specimen collection, and development of protocols for analyzing trace element concentrations in seawater and fish otoliths as a means of tracking fish and thereby determining the relative importance of various nursery habitat types as nursery grounds for the halibut. To date, I have collected otoliths from over 400 juvenile and adult halibut specimens taken from estuarine, lagoon, bay, semi-protected cove and open coast sites ranging from Mugu Lagoon, California to San Quintin Bay, Baja California. Also, quarterly (at 15 sites along San Diego County) and weekly (at 2 sites within the county) surface water samples have been collected during this period (160 samples total).

Scripps Institution of Oceanography purchased a Fennigan Element 2 Inductively Coupled Plasma Mass Spectrometer (ICPMS), as well as a 213 nm Laser Ablation (LA) unit in the spring of 2001. I have developed protocols for preparing and analyzing seawater and otolith samples with solution-based ICPMS. Using this approach, I have been able to document site-specific trace element "fingerprints" (Figure 1). These signals will be used as environmental tags to infer the juvenile habitats occupied by adult fish. Also, I have developed methods for sectioning, polishing, cleaning and analyzing otoliths using LA ICPMS (Figure 2). This methodology (in concert with site-specific "fingerprints") will allow me to infer the nursery habitat occupied by individual adult fish by analyzing the portion of their otolith laid down during the juvenile period for characteristic "fingerprints".

Additional work has included construction of a Geographic Information System (GIS) database that will be used to evaluate if the availability of various nursery habitat types interacts with juvenile halibut densities to regulate recruitment. As of now, I have collected data concerning coastal bathymetry, kelp forest cover, submerged aquatic

vegetation, and marsh cover, as well as aerial photographs of coastal estuaries, lagoons and bays (Figure 3). These data will be coalesced in the GIS with data of halibut densities taken from the literature as well as my own field surveys to develop inferences regarding the quantity and quality of alternative nursery habitats.

I have also been able to construct a stage-based demographic matrix model that will be employed to evaluate the population fitness consequences of utilizing various nursery habitat types during the juvenile period (Figure 4). I have parameterized the model with halibut-specific fecundity and stage duration information and finfish-specific mortality rates to produce a representative stable (lambda = 1) halibut population. In the future, growth and mortality data from each of the possible nursery habitat types will be introduced into the model in order to evaluate the population-level consequences of halibut reliance upon particular nursery grounds.

I have explored the feasibility of surveying halibut stocks for genetic structure using allozymes. This has involved screening loci for multiple alleles and developing proper gel electrophoresis and scoring techniques. My preliminary analysis indicates that the XDH locus has a large number of alleles that may be useful in discriminating among stocks, and EST-5, LDH-2, MDH-2, PGM-1 and PGM-2 are loci that may also prove useful in testing for genetic structure.

Two appendices are included with this report. Appendix 1 lists my accomplishments during the funding period. Appendix 2 is a detailed explanation of expenditures.

Yours most gratefully,

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Appendix 1: Accomplishments

1. Collection of +400 juvenile, sub-adult and adult halibut that will be used to: (1) estimate halibut densities within various nursery habitats, (2) retroactively track the nursery habitat occupied by halibut using a trace element approach, (3) obtain habitat-specific growth and mortality rates, and (4) survey halibut populations for stock structure.

2. Collection of quarterly and weekly water samples used evaluate if site-specific trace element fingerprints exist.

3. Outplanting of field cages in protected embayment and open coast sites. These cages will house juvenile halibut that will be used as a means of validating the trace element approach for retroactive tracking of halibut.

4. Development of protocols for solution and laser ablation ICPMS analysis of seawater and otolith samples.

5. Creation of a GIS database used to assess the importance of nursery habitat quality and quantity in regulating halibut recruitment.

6. Development of a demographic model for evaluating the population fitness consequences of alternative nursery habitat usage options.

7. Testing loci for multiple alleles. Those demonstrating heterozygosity can now be used to survey halibut stocks for genetic structure using allozyme electrophoresis.

8. Restoration of a 17' Boston Whaler that has proved invaluable in fieldwork associated with this project.