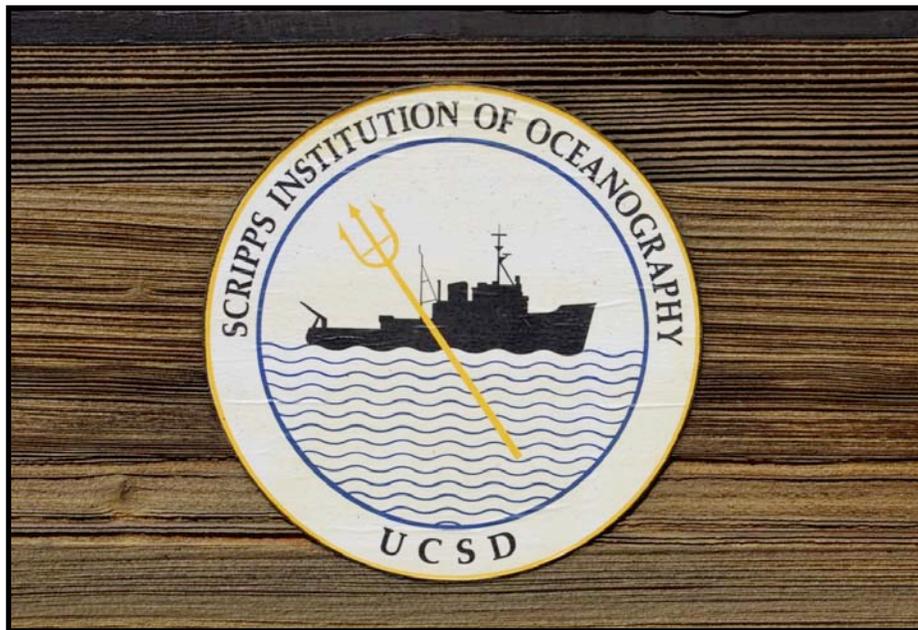


FULL REPORT



2009 EXTERNAL ASSESSMENT OF THE UCSD/SIO CMBC IGERT PROJECT: CONSERVATION OF MARINE BIODIVERSITY - UNDERSTANDING THREATS AND PROVIDING SOLUTIONS



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Table of Contents

Introduction	1
Project Generational Stages	2
Key Project Metrics	4
Project Strengths	9
Opportunities for Improvement	16
Recommendations	20
Conclusion	26
Bibliography	28
Appendix A: Student Demographic Matrix	30
Appendix B: “T Competency” Methods	34
Appendix C: Enabling Conditions	35
Appendix D: Project Evaluation Matrix	40
Appendix E: Glossary	41

Introduction

The purpose of this report is to offer external assessment and provide recommendations to improve overall effectiveness of interdisciplinary graduate training at Scripps Institution of Oceanography (SIO) as a part of the larger institutional structure of the University of California San Diego (UCSD) and University of California system. The external assessment is based on a single project funded in part by the National Science Foundation (NSF) and operated through the Center for Marine Biodiversity Conservation (CMBC). CMBC is one of 125 award sites nationwide that has received funding through the Integrative Graduate Education and Research Traineeship (IGERT) program. According to the NSF website: “The IGERT program has been developed to meet the challenges of educating U.S. Ph.D. scientists, engineers, and educators with the interdisciplinary backgrounds, deep knowledge in chosen disciplines, and technical, professional, and personal skills to become in their own careers the leaders and creative agents for change. The program is intended to catalyze a cultural change in graduate education, for students, faculty, and institutions, by establishing innovative new models for graduate education and training in a fertile environment for collaborative research that transcends traditional disciplinary boundaries. It is also intended to facilitate greater diversity in student participation and preparation, and to contribute to the development of a diverse, globally-engaged science and engineering workforce.” The project under review as the basis of this report is entitled: Conservation of Marine Biodiversity - Understanding Threats and Providing Solutions. Hereafter, the project will be referred to as CMBC IGERT or the project.

While the project has been ongoing since Fall of 2003, the external assessment presented in this document was initiated over two periods, Fall 2006 and Winter 2008-2009. This report is the second of two formative external assessments. The first was a mid-term assessment prepared for CMBC in January 2007. The focus of the first report was to provide a mid-term assessment and recommendations for project adjustments and mid-course corrections. The focus of this report is to sum up "lessons learned" from the current IGERT project in order to inform future interdisciplinary training at UCSD. The report is not intended to be a summative evaluation in order to prove a theory of institutional or programmatic change, rather the evaluation is intended to contribute to learning and adaptation to improve interdisciplinary graduate training, research and scholarship at SIO.



The report follows the American Evaluation Association standards and guidelines for systematic, competent, honest and respectful evaluation that is intended to be useful, accurate and conducted with due regard for the welfare of those involved in the evaluation. Primarily a formative mixed methods approach, the results provide insight into progress toward desired and unanticipated outcomes. The evaluation is utilization-based, acknowledging that the intended users are more likely to apply the findings if they both understand and feel ownership of the assessment process and findings (Patton 2002, Patton 2008, Wholey et al. 2004). Thus, the methods were subject to collaborative development and agreement by the CMBC Steering Committee to ensure maximum benefit for three primary intended user audiences: the CMBC PIs, staff and Steering Committee; UCSD/SIO Administrators; and The National Science Foundation (NSF).



This report does not review or make recommendations regarding the quality of the research, research methods, or level of competency of any student, faculty, administrator or partner. Instead, it is focused on the project's overall performance and relies on the data collected, and analysis and interpretation of those data, to tell the project's performance story. Based primarily on open-ended interviews, the report synthesizes a large set of information gathered between 2006-2009 through a total of 41 individual or small group interviews lasting between 1-2 hours. Interviews included IGERT Fellows and Associates (37), Faculty (29), PIs (2), Co-PIs (2), CMBC Staff (4) and UCSD/SIO Administrators (9). The evaluators also reviewed reports to NSF and other IGERT project-related reports and products. The data were collected, coded, analyzed and presented to sum up the results regarding project metrics, project strengths, opportunities for improvement, and considerations for sustaining interdisciplinary graduate research training at SIO. The report concludes with a set of specific recommendations and suggestions.

Project Generational Stages

From the perspective of the evaluators, the project has experienced two generational stages and is preparing to embark on a third. The first generation was marked by formation of the project by Principal Investigators Nancy Knowlton, Jeremy Jackson, Enric Sala, Richard Carson and Michael Tillman and a combination of factors: the strong and essential support championed by Lisa Shaffer and Sarah Mesnick; the commitment by then SIO Director Charlie Kennel for five years of funding (2 by NSF IGERT and 3 for the out years); strong involvement from the start by the highly regarded Economics Department at UCSD led by PI Richard Carson; strong participation from key faculty members Ted Groves, Jeff Vincent, and John Largier; involvement by other individuals, departments and partners such as NOAA's Dale Squires; the emergence of CMBC as a research center producing internationally relevant results and innovative communication strategies from Project PIs; and, overall administrative support of the IGERT most notably by Penny Dockry and Russ Chapman. With a research agenda focusing on conserving marine biodiversity, economic analysis was a central feature of the cross-discipline approach, as well as communication, anthropology, history and ethics. Successful outcomes from the first generation include: admission and training of the first four student cohorts (Co 03, 04, 05, 06); increased commitment and success with diversity recruitment; implementation and refinement of project elements including the defining Summer Course; design and teaching of IGERT Courses; requirement of an Internship experience; development of the UCSD/SIO Masters of Advanced Studies in Marine Biodiversity and Conservation (MAS Program); and, a growing list of cross-departmental intellectual products including refereed journal articles, dissertation chapters, team projects, presentations, and outreach events.

The first generation was marked by stages of development that included issue identification, project planning, formal approval from within UCSD and from NSF, project implementation, and concentrated reflection on project mechanics and improvements facilitated by an external project evaluation. The end of the first generation can be linked to the departure of three of the original PIs, Enric Sala, Nancy Knowlton and Michael Tillman in 2007. As described in the first external mid-term report on the project submitted to CMBC in January 2007, the first generation of the CMBC IGERT notably and significantly broke new



ground for interdisciplinary training at SIO. A faculty advisor not otherwise involved with the project and who has been at SIO for 30 years noted:

When Nancy Knowlton and Jeremy Jackson came (to SIO) about 10 years ago, it was a real step change in terms of the capacity of the institution to address just-emerging problems, the areas of conservation and human impacts on biology, in which (SIO) had no voice...up to that point.

In this first generation, the project benefitted from a few strong-willed, charismatic and visionary people who believed that complex problems facing ocean health, marine biodiversity, and societal interests require research that cuts across disciplinary lines. Even though SIO has a history of “problem-based” research in response to issues such as the collapse of the Pacific sardine fishery, the team that developed the IGERT vision was breaking new ground. After World War II, SIO developed an international reputation and internal culture of strong disciplinary divisions. Departmental “silos” and “stovepipes” are well known. In the first generation, rather than becoming an interdisciplinary program per se, the team realized that the strength of the IGERT project’s content and methods for interdisciplinary research must compliment the enduring commitment by SIO to disciplinary excellence in responding to emerging, complex societal problems. Project mechanics often conflicted with a varying degree of structure imposed by departmental and curricular groups. Involvement by faculty from other departments was growing but not to the degree anticipated by the project creators. Many agree the project was “rough around the edges” in its first generation documented in detail in the mid-term report, however, the project was very successful in both creating a sense of urgency for cross-departmental connectivity and collaboration, as well as attracting a large number of applicants resulting in high quality trainees, several of whom modeled the vision of the project through their research, scholarship and intellectual products.

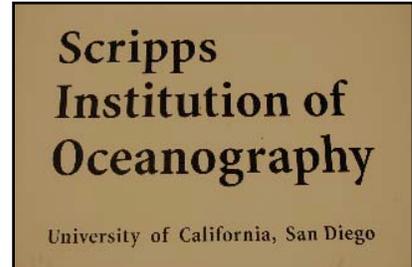
The beginning of the second generation of the project was marked by Dick Norris assuming the main role and responsibilities of the PI and reviving the IGERT Steering Committee to look at project mechanics in detail, recommitting to the core vision of interdisciplinary training and expanding outreach to other departments. Tony Haymet assumed the role as Director of SIO and Vice Chancellor of UCSD from departing Charlie Kennel and continued much needed practical support from the administration. In the second generation, Norris and his team expanded engagement by other faculty from SIO and UCSD, made adaptations to project elements such as the IGERT Forum course, continued the popular and effective Summer Course taught by Jeremy Jackson, improved the MAS program, produced another IGERT proposal, and led the process of admission and training of the final two cohorts (Co 07, 08). The conclusion of the second generation will be marked by the completion of the current round of IGERT funding and review, the decision already made to continue the 2009 Summer Course despite no guaranteed NSF support, and refining the vision of the interdisciplinary graduate training with or without NSF support. One faculty member noted:

IGERT... has united science at Scripps Institution of Oceanography with management at NOAA Southwest Fisheries, Economics Department (at UCSD), and the School of International Relations/Pacific Studies and history.

We consider the upcoming third generation critical to the success of interdisciplinary training at SIO. Looking forward, three trajectories are plausible: a reduction paradigm where external funding is not secured for further interdisciplinary training and programmatic emphasis is reduced; a maintenance paradigm where



interdisciplinary training is supported by a series of IGERT-type projects; and, a growth paradigm where both faculty and administration articulate and fully support interdisciplinary training as central to the vision, mission and future of graduate training at SIO. Whether or not NSF continues to support this effort, each of these three scenarios and their ramifications should be openly discussed. Given current opportunities such as the Multi-Campus Research Programs and Initiatives Proposal, emerging trends for use-inspired research, as well as the upcoming SIO Academic Review, the third generation is a defining time for SIO to determine political and programmatic will and define the appropriate level of investment for interdisciplinary graduate research, training and scholarship. Stanford University's recent announcement of a \$10 million endowment gift to the newly named Emmett Interdisciplinary Graduate Program in Environment and Resources (Emmett IPER) is a strong example of the level of external support available to such visionary programs.



This report presents a brief summary and lessons learned from the first two generations of the project including key project metrics, strengths, opportunities for improvement and evidence of adaptation and learning. The report concludes with a series of specific recommendations to foster the emerging culture of interdisciplinary research, training and scholarship at SIO. Information contained in this report is presented as a formative assessment for the project at this point in its generational stage. If a legacy of interdisciplinary graduate research, training and scholarship is to be created by current leaders, a series of adaptive measures are encouraged to promote the brand of UCSD/SIO and to build the university's capacity to study and address the emerging complex challenges facing societies and ecosystems.

Key Project Metrics

COHORT DEMOGRAPHICS

The project began in 2003, was awarded a no-cost extension in 2008 by NSF, and will conclude in September 2009. Several IGERT Fellows and IGERT Associates admitted into this project will continue to receive support via UCSD/SIO to complete their dissertations over the next few years. A total of 51 have been admitted into the IGERT project, 37 as IGERT Fellows and 14 as IGERT Associates. The sole distinction between the two is that Associates receive no stipends or fees from NSF funds. Otherwise, Associates have access to all of the same courses, training and support of the IGERT Project, including internships and funding from mini-grants. In this report, IGERT Fellows (Trainees) and Associates are collectively referred to as students. To date, 14 of 51 students have completed their dissertation defense (12 have officially graduated as of this report date). It is important to note that despite two high profile PIs departing the project, none of the 51 students admitted have left the project, nor have any been removed for academic reasons.

At the project's inception, there were 14 applicants for the first cohort (Co 03), 85 applicants for the second cohort (Co 04), 110 applicants for the third cohort (Co 05), 58 applicants for the fourth cohort (Co 06), 65



applicants for the fifth cohort (Co 07), and 60 applicants for the sixth and final cohort (Co 08). Many noted the consistently high quality of applicants throughout the six years. Typically, the applicant submits a full written application including an essay, and 10-15 candidates are then selected from the pool and invited to the SIO Spring Open House to present their academic background, research to date, and Ph.D. research aspirations. As noted in the mid-term report, several within the project noted that this process is uneven, potentially favoring those who already have strong communication skills and those who have already had a high degree of research opportunities unavailable to some applicants. Students report that the IGERT administrative team was both efficient and effective in providing follow-up information and logistical support that helped influence their decision to accept. Students also noted the positive experience of the applicant interview, (participation in the Open House, meeting with faculty, detailed interview), as this is a central feature of the strength of the recruitment process of the CMBC IGERT project.

Recruitment of diverse candidates has been a main focus for the project from the start and made stronger through efforts led by Sarah Mesnick, Russ Chapman and students including Serena Moseman and Elisa Maldonado. Reports by Sara Mesnick in December 2004 and May 2005 established a clear foundation for recruitment of underrepresented groups. Several issues were identified including improved tracking, increased student and faculty recruitment, increased awareness training, creation of feeder programs to Ph.D. programs at SIO, and links to UCSD “to encourage talented undergraduates to consider these fields and SIO as academic and career options.” As a result, the project has built relationships with undergraduate and graduate programs at other colleges and universities and at selected minority serving institutions such as Howard University, and University of Maryland, Eastern Shore. Staff with the IGERT project also met with the Meyerhoff Program, a nationally recognized program for high quality participants from underrepresented groups, located at the University of Maryland, Baltimore County, as a potential feeder program for the CMBC IGERT. However, Meyerhoff participants are typically focused on the biomedical field and therefore less interested in the marine conservation theme of the CMBC IGERT. There was consensus that there could be lessons learned from the Meyerhoff program directors regarding strategies and lessons learned for recruiting high potential students from programs that attract underrepresented groups in the Science Technology Engineering Mathematics (STEM) disciplines. Other programs such as SEEDS, (Strategies for Ecology Education, Diversity and Sustainability) a program of the Ecological Society of America, and the NSF-supported summer REU program (Research Experience for Undergraduates) are also opportunities that are being further explored.

A goal of the NSF IGERT program, clearly articulated by NSF, is to increase minority and female participation in STEM doctoral education. In spite of significant challenges associated with nationwide recruitment reported from this and other IGERT projects, the CMBC IGERT project has been successful in maintaining recruitment of women and minority students at levels exceeding national averages. In 2003, in a comparative study of 1100 Ph.D. Students (361 IGERT; 749 Non-IGERT) including 52 active IGERT projects across the country, 35% of the students were women and 9% came from minority groups underrepresented in STEM disciplines: Black, Native American, or Hispanic according to a report published in 2006 by Abt Associates (Carney et al. 2006). Including both IGERT Trainees and Associates, the CMBC



IGERT project successfully recruited women (57% of students over the course of the six year project) and minority students (25% of students over the course of the six year project) demonstrating the success of focused recruitment in becoming one of the leading IGERT projects in the nation.

Table 1 provides summary information regarding the project. A more detailed and comprehensive matrix for all six cohort years is presented in Appendix A.

Table 1: Cohort Demographics

CO-HORT YEAR	APPLIED	TOTAL ACCEPTED	GENDER	DIVER-SITY	SOCIAL SCIENCE	NATU-RAL SCIENCE	PH.D. COM-PLET E
2003	14	13 = 11 IGERT Trainees, 2 IGERT Associates	8 Females 5 Males	4 (2 Trainees, 2 Associates)	2	11	10
2004	85	9 = 6 IGERT Trainees, 3 IGERT Associates	5 Females 4 Males	1 Associate	2	7	3
2005	110	11 = 7 IGERT Trainees, 4 IGERT Associates	6 Females 5 Males	2 Associates	2	9	0
2006	58	6 = 5 IGERT Trainees, 1 IGERT Associates	3 Females 3 Males	1 Trainee	1	5	1
2007	65	7 = 6 IGERT Trainees, 1 IGERT Associates	4 Females 3 Males	3 (2 Trainee, 1 Associates)	1	6	0
2008	60	5 = 2 IGERT Trainees, 3 IGERT Associates	3 Females 2 Males	2 (1 Trainee, 1 Associates)	1	4	0



CO-HORT YEAR	APPLIED	TOTAL ACCEPTED	GENDER	DIVERSITY	SOCIAL SCIENCE	NATURAL SCIENCE	PH.D. COMPLETE
TOTAL	392 for 51 total positions	51 = 37 IGERT Trainees (73%), 14 IGERT Associates (27%)	29 Females (57%), 22 Males (43%)	13 (25%), (6 Trainees 16%, 7 Associates 50%)	9 (18%)	42 (82%)	14 (27%)

ADDITIONAL FUNDING

In the first two generations, the project leaders have been successful enough in securing private funds and developing entrepreneurial models such as the MAS program to create an IGERT Associates model and attract a larger suite of international applicants who may be excluded from funding under the NSF project requirements if they are non-US residents. In addition to citing the MAS program, our first report noted many other examples of such innovations associated with funding and considered essential to support interdisciplinary research in the long term. The total amount of private investment to date has been \$986,222 (not including extensive in-kind support from external partners: staff, advisors, lecturers), compared to the NSF allocation of \$3,448,945 over six years, representing a hard match of 28.6%. The MAS program has been such a successful model for both funding and attracting highly qualified applicants that it is a financial model likely to be replicated by other interdisciplinary programs using similar program elements, such as the Summer Course, to leverage a pool of funds from a fee-based one-year masters program. The interchange between IGERT and MAS students during the Summer Course was noted by many students as significant, fostering exchanges on real world vs. academic experiences, cultivating networking, and building an esprit de corps among a larger group of students who seek interdisciplinary training.



Table 2: Additional Funding Outside of NSF Grant

FUNDING FOR IGERT ASSOCIATES WHO ARE NON-NSF FUNDED		
UCSD Office of Graduate Studies	Diversity Awards	\$250,000
Private donors	Student Support	\$312,700
SIO	Diversity Outreach	\$6,000
Individual donor	Diversity outreach	\$3,000
The Betty and Gordon Moore Foundation	Student Support	\$96,000
Individual donor	Student Conference Participation	\$9,600
PADI	Research Grants	\$36,000
Private donors	Research Support	\$6,000
ADDITIONAL FUNDING FOR IGERT PROJECT		
CMBC	Entertainment costs	\$14,215
MAS	Entertainment costs	\$1,745
MAS	Teaching costs	\$249,382
CMBC	Guest lecturers	\$380
MAS	Guest lecturers	\$1,200
Total		\$986,222



RECENT AND PLANNED IGERT COURSE OFFERINGS:

IGERT FORUM Course: First offered in Fall 2008, this custom course for IGERT students meets bi-weekly to foster interdisciplinary collaboration and communication between IGERT students and faculty and is intended to foster a sense of community among the students beyond their own cohort. An additional stated goal is to provide regular feedback to the faculty on what is, and is not working with project mechanics.

SCIENCE, CONFLICT AND POLICY Course: Taught every other year by Naomi Oreskes, Professor of History and Adjunct Professor of Geosciences. The course examines the history of science in the context of social policy, attracting between 18-25 students as part of the IGERT course offerings.

OCEAN LAW AND POLICY Course: A course taught by Kathryn Mengerick, Staff Attorney and Director of the Ocean Program for the Environmental Law Institute, who teaches the course every other year, alternating with the Science, Conflict and Policy course taught by Oreskes described above.

GLOBAL CHANGE, MARINE ECOSYSTEMS AND SOCIETY Course: Taught by Dick Norris (Winter 2009)

GLOBAL ISSUES IN SEA TURTLE CONSERVATION AND POTENTIAL POLICY SOLUTIONS Course (Planned Fall 2009): To be team taught by Sarah Mesnick, Dale Squires, Lisa Ballance.

PROFESSIONAL SURVIVAL Course (Planned Fall 2010): Research leadership, working in teams and getting your message out. To be team-taught by Dick Norris, Charlie Kennel, and faculty from Rady School of Management.

Project Strengths

POSITIONED FOR SUCCESS

The CMBC IGERT is in the right place at the right time, highly suited to the pursuit of conserving marine biodiversity in the context of massive global, regional and local changes, an issue of increasing economic, social and ecological importance. Several of UCSD/SIO administrators acknowledged the growing need to focus attention on such global crises and respond to the national trend toward interdisciplinary graduate training by fostering this capacity at SIO:

The IGERT program has helped with interdisciplinary recruitment at SIO... a lot of prospective students are more interested in, for example, policy-related things. We've recently expanded to include a Ph.D. MBA program with Rady School of Business on UCSD campus... so there has definitely been a movement in the fields of oceanography and climate science, etc ... to find ways to reach beyond the lab and get involved with the community.... The initial impetus of the IGERT program to involve policy and economics, etc... to see the larger picture... contributes to that.

There was impressive awareness and conceptual support of the project on the part of key campus administrators. UCSD's seventh Chancellor Marye Anne Fox has been a strong champion of interdisciplinary initiatives as noted by an SIO staff member:



I know that (interdisciplinary education and research) was a vision of Chancellor Fox when she took over. The current success of this program, the impact of all the IGERTs on campus, and Chancellor Fox's vision... (all) play into the advancement of interdisciplinary education and training at UCSD.

The Director of SIO Tony Haymet has played a central role in procuring additional funding for IGERT students by supporting the excellent work and contributions of the SIO Development Office and the Office of Graduate Studies (OGS).

A concrete example of the university's support of interdisciplinary collaboration, and CMBC IGERT's positioning to take advantage of that support, is UCSD's "Interdisciplinary Collaboratories Fellowships" program, funded by the Office of Graduate Education. CMBC has quickly leveraged its existing network of faculty, students and external partners to procure one of the first of these one-year fellowships, sixty thousand dollars of funding for four students to conduct collaborative research in the Gulf of California with faculty members and external partners, and CMBC faculty will be submitting an additional proposal to UCSD in March of 2009.

Dr. Haymet's focus on attracting the best and brightest students, committing to a total of 5 years of support for IGERT students, and growing young faculty is consistent and complimentary with the administration's more implicit commitment to interdisciplinary training. Upon arriving at SIO in 2006, Dr. Haymet noted that simply having an IGERT on campus "continues to change the culture of interdisciplinary research at Scripps" an important target under his leadership. If interdisciplinary training aligns with SIO vision for the future of graduate training at SIO, more explicit commitments to this type of training are needed such as public and direct communication to all faculty noting this commitment and continuing support from the SIO Development Office in order to carry on the vital private fundraising needed to maintain this program as well as to support international students. Acknowledging the need to both balance faculty age structure and increase diversity of SIO Faculty, Dr. Haymet has the opportunity to foster a lasting legacy in support of interdisciplinary training through hiring and promotion decisions, updated policies for tenure review, and via specific budget decisions. Future proposals to NSF and other funding sources would benefit greatly from a descriptive list of explicit forms of support for interdisciplinary graduate training from the lead UCSD/SIO administrators.



Several of those interviewed have noted that the IGERT project has been a shock to the more traditional SIO system of disciplinary training, yet the perseverance of the PIs/C0-PIs, the support by Charlie Kennel (first generation) and Tony Haymet (second generation), and evolution of more diplomatic outreach throughout SIO and UCSD on behalf of the IGERT mission have made substantial cultural inroads. The project is well situated to inform other similar interdisciplinary efforts and expand its own reach but must remain as collaborative as possible, focusing on "problem-based" issues such as climate change and its impact on marine biodiversity while encouraging crosscutting research on less applied topics that furthers scientific inquiry.



INSTITUTIONAL CAPACITY AND INCIPIENT COMMITMENT

Rather than being led from within a curricular group, the IGERT project is operated out of the multidisciplinary Center for Marine Biodiversity Conservation (CMBC). The CMBC platform provides multiple benefits including strong interdisciplinary and applied research, a nationally recognized and award winning research faculty, a growing and diverse network of collaborators, and an emerging track record of success in obtaining external grant funding. The PIs that led the first generation of the project (Knowlton, Jackson, Sala, Carson and Tillman) along with Lisa Shaffer, Sarah Mesnick, Penny Dockry, and Russ Chapman were essential in establishing both the CMBC reputation as well as the IGERT identity within the Center and across campus. Extremely visionary and energetic, this leadership team built strong and formal relationships with staff from UCSD's Economics Department and Graduate School of International Relations and Pacific Studies (IR/PS), NOAA's Southwest Fisheries Science Center (SWFSC), National Marine Fisheries Service (NMFS), and San Diego Supercomputer Center (SDSC). In the project's second generation, current PI Dick Norris has extended this list of partnerships with a new brand of energy and enthusiasm, reaching out to involve more faculty, departments and partners. The project also benefits from strong involvement from other outside academic partners such as Universidad Autonoma de Baja California Sur, Mexico (UABC Sur) and the Smithsonian Tropical Research Institute (STRI), as well as federal programs such as NOAA's National Marine Sanctuary Program, and international conservation non-governmental organizations (NGOs).

Under Norris's leadership, CMBC continues to foster a culture of cross-departmental and cross-disciplinary collaboration, innovation and commitment to applied research, training and scholarship. CMBC staff, particularly Penny Dockry who serves as the IGERT Administrative Manager, serve critical support functions to the CMBC IGERT, assisting the PI with multiple aspects of project administration and logistics. This level of staff support furthers a team dynamic and can serve to reduce overload and PI burnout that has been a main concern with this and other IGERT projects as detailed in the mid-term report. However, it is essential to note that the project is operated with a high degree of risk by assigning only one person as the project administrator. This situation greatly increases the chance of administrative collapse should there be no trained or capable support to take over in case of emergency.

FACULTY AND STUDENT QUALITY AND COMMITMENT

The project began with strong faculty at its core and has attracted a bright and diverse group of student candidates expected to participate in a wide range of activities and successfully complete the IGERT project course work on route to their Ph.D. dissertation and defense. Students apply to the project with strong commitment to these goals for several reasons. Common themes among cohorts include the following: rich tradition of SIO providing high quality depth of training in one's chosen discipline as well the perceived benefits of interaction with a robust network of partners; the applied nature of the work; training available in communication, ethics and policy as complimentary to their applied research; and, the quality of the faculty across other disciplines. Students repeatedly noted relationships with specific faculty members as key factors



for why they chose to attend this particular IGERT, commonly citing hopes and experience of cultivating linkages between marine and social sciences in their research.

There was strong consensus among the students from the natural sciences that the interdisciplinary nature of CMBC and the strong involvement of the Economics Department and other UCSD social science departments were key factors in their decision to apply for the CMBC IGERT.

The interdisciplinary feature and feel of the program is (what) attracted me most to SIO and has been far and away the most valuable (element) to me... I've learned a huge amount that I wouldn't have been able to learn in most Ph.D. programs... (and been able) to tap into upper campus faculty that most of the students here at SIO don't even know about.

In the first stages of the project, some faculty from SIO and social science departments and curricular groups at UCSD were early and enthusiastic adopters and implementers of the IGERT philosophy, building bridges between campuses and disciplines where few existed. Their continued and increasing commitment to maintaining and strengthening those bridges, as well as balanced student guidance and mentoring, has been a critical factor in student and project success.

My advisor, who is not directly involved in the IGERT program, is willing to let me do these outside projects. He does the right amount of pushing me in both directions (within and without my discipline).

The growing number of intellectual products enumerated in reports to NSF is a strong indicator of continued and growing faculty engagement in interdisciplinary training. A student who has been described by faculty and students alike as an exemplar of the IGERT philosophy and potential noted:

Before IGERT it was harder to (work on) more than one research topic... Without a couple of professors (from outside my discipline) taking me seriously and (without) their commitment, I wouldn't be able to do this interdisciplinary work.

Faculty spoke of being inspired by the mission of the IGERT project and the quality of students to increase their own level of commitment to interdisciplinary training. These interactions have influenced decisions by faculty to remain with the project longer-term. For example, a senior economics faculty member decided to postpone his retirement because of a shared enthusiasm for the work he was conducting with his IGERT students. Another SIO faculty noted his shift in thinking and actions due to IGERT:

IGERT has created a different social dynamic than we had before (at SIO)... people from different fields talking and interacting in ways that we didn't before... cuts across all the fields that the program has been involved in... very positive... In fact I now have a collaborative project with some people in Communications, which I wouldn't have done... I would have been hard pressed to even find the person... so IGERT has broadened my interactions.

Annual reports submitted by CMBC to NSF from 2004-2008 have also highlighted and quantified numerous IGERT student efforts and accomplishments in the areas of research, outreach, publishing and presenting. As described in the 2008 Annual Report to NSF:

During a summer internship with the Nature Conservancy, IGERT Associate Ayana Johnson increased her understanding of the ways in which protected areas can be managed in light of climate change and learned how non-profit organizations use science to promote their policy goals. She prepared three policy papers for publication. The first is on the need for a triage approach, the second is on the appropriate use of resilience, and the third is more generally about protected areas and climate change. Upon completion of the internship, the lead scientist asked, "When do you finish your PhD? Do you want a job with TNC anywhere in the world?" The future for this scholar is bright thanks to the encouragement from project advisors



and our partnership with The Nature Conservancy.

A faculty member provided this comment:

(A student who) is an example of the success of the program came in with a really hard science background, ... and this year he's doing an MBA program up at the Rady School of Management... (He) is a really interesting case of someone... with an unusual set of interests and a lot of skills that have developed really well... and the ability to do a... quite different type of project than what we think as a traditional Scripps purely science project. Who knows what his long-term trajectory will be, but I think it's going to be good.

The 2004-2008 annual reports to NSF provide a great amount of detail and insight into the quantity, type and distribution of intellectual products generated by both IGERT students and faculty. As an example, the following table enumerates select accomplishments from the 2008 annual report i.e. from just one year of the project.

Table 3: Select Accomplishments

SELECT ACCOMPLISHMENTS (2007-2008)	STUDENTS	FACULTY
Outreach Activities	25	32
Journal Articles in Refereed Publications	23	42
Journal Articles in Non-Refereed Publications	2	2
Books		3
Book Chapters	1	10
Conference Presentations	7	7
Conference Publications	3	6

CURRICULUM AND PEDAGOGY

A keystone to the success of the project, as reported by both students and faculty, has been the Summer Course. There was unanimous agreement that this course exposed the students to a wide range of different disciplinary perspectives, applied research techniques, and the opportunity to think across disciplinary lines to discuss current and potential problems and the role of research, policy, ethics and communication in





addressing these problems. As noted earlier, the Summer Course includes the MAS students, providing a strong collaborative experience for IGERT students with generally mid-career, high-potential professionals from the MAS program. There was universal agreement that the wide range of disciplines and ‘real-world’ experiences provided the students with an interdisciplinary lens that set an ideal tone for their Ph.D. training. Several of the students noted that the Summer Course opened their eyes and minds to disciplines, applications and situations they had not fully considered before. The course provides a range of ideas for potential internships, an important aspect of the project described briefly below and at length in the mid-term report. Weekly evaluations are administered to the students, providing current feedback for adjustments to improve the experience, many of which were woven into mid-course and annual project adjustments. The dynamic and well-planned Summer Course, taught primarily by Jeremy Jackson with support from a long list of partners, is considered a keystone experience in the project’s interdisciplinary training process. If/when Jackson concludes his leadership of the Summer Course, considerable effort should be placed on securing new leaders to insure continuity of the high quality and diversity of this course. At the sunset of current NSF funds, the decision to continue the Summer Course demonstrates strong commitment to interdisciplinary research and training and also presents the opportunity to institutionalize the course, expand its reach, and use it as a foundation to lead the third generation of the initiative.

Another key project element has been the IGERT internship experience that has presented students with opportunities to work with individuals from a wide range of fields and focus on real-world problem solving. Students and faculty alike have spoken of “mind and career changing effects” associated with this experience, and students report that the cultivation of team-based communication and leadership skills through these internships has been an invaluable part of their Ph.D. training, particularly in the exposure to contacts and networks beyond their discipline.

As a clear indicator of adaptation and mid-project adjustments, Norris’s addition of the student-led IGERT Forum course, added in Fall 2008, has multiple apparent benefits. It furthers an esprit de corps initiated in the Summer Course for entering IGERT cohorts, something that has been noteworthy for students of previous cohorts. Students and participating faculty note that the Forum fosters communication and collaboration between cohorts throughout their graduate training. Students have taken advantage of this bi-weekly Forum to present their research plans and objectives in an informal atmosphere and gain valuable feedback from other IGERT faculty and students. Students value feedback both on their research as well as presentation skills, something that was noted by earlier cohorts as missing. A few students from previous cohorts who have “graduated” from IGERT and chose to attend the Forum noted that this opportunity provides them with an important way to stay in touch with their own and other cohorts and keep abreast of what others are doing. A strategy to consider as SIO decides whether to



grow a larger epistemic community devoted to interdisciplinary learning, is to possibly institutionalize such a forum so both faculty and students can share struggles and success. Students who are formally registered in the Forum are excited about it and convey a desire to be more involved with its design and implementation, presenting an ideal opportunity to hand over specific administrative aspects and content.

The evaluators found numerous other examples of the project's adaptiveness in response to student, faculty, administration and partner feedback. Examples have ranged from developing core courses that are more relevant to students' interest and needs (and bringing in more diverse faculty to teach them), to improved student advisement, to embracing modern communication techniques to reach more diverse audiences. We found that the current IGERT administrative team is highly committed to broadening the reach of the project and bringing in a still wider range of faculty and institutional interests to improve the quality of their students' education and training.

INFLUENCING CULTURAL CHANGE

Overall I've found the (IGERT) program to be extraordinarily worthwhile... For the longest time, before CMBC, applied biology and conservation biologies were really terms that weren't used at Scripps for fear that your science wouldn't be respected... Professors didn't have any particular conservation ethic... That has really changed dramatically and changed the students we've attracted... We're now attracting and training the students who will be the leaders in the field in the future.
(Faculty)

Our first report noted several examples of how the project is catalyzing a cultural change in graduate education at UCSD and SIO - for students, faculty and institutions. In recent interviews, SIO and UCSD faculty and administrators repeatedly emphasized the role that the CMBC IGERT project has played in fostering an atmosphere and culture of interdisciplinary research and education at SIO and UCSD. The project's efforts in this arena have been very complementary to the cultural change espoused by UCSD Chancellor Fox and SIO Director Haymet. This emerging cultural change is evident in the creation of other university programs such as UCSD's Center for Environmental Economics and the new Environmental Sustainability Initiative that was created by two early IGERT supporters, Charlie Kennel and Lisa Shaffer. Besides broadening and deepening the interactions between SIO and UCSD, the IGERT project has also leveraged existing external partnerships e.g. with NOAA Southwest Fisheries Science Center:

CMBC/IGERT has been very good for NOAA SWFSC because our scientific research has focused on management and conservation questions by definition... implicit in everything we do... So IGERT and CMBC have really helped firm up the marriage between SW Center and SIO... From my perspective, the influx of graduate students (because of IGERT) into SW Center has been a huge benefit... something I'd like to see continue and grow.

On another front the MAS program is a prime example of how entrepreneurial thinking and implementation can continue to support an IGERT project in a post-NSF supported era. Other examples of the project's development of alternate sources of funding, and thus the potential of long-term stability, include philanthropic funding for IGERT Associates, including international students, and other IGERT project activities (see Table 2 "Additional Funding Outside of NSF Grant").

IGERT has showcased SIO's work in the interdisciplinary... shows that we're not just single-topic focused... (and) helps people understand they have other options of study... This has become a shift across SIO... for example, we don't admit to one individual curriculum group anymore... we admit to programs that are umbrella groups to the curriculum... so there's



cooperation among admissions rather than competing against each other to try to get a student... and students see they have more choice... They don't have to pigeon hole themselves into one area.

Opportunities for Improvement

INTERDISCIPLINARY EDUCATION AND TRAINING

Conserving marine biodiversity is a theme that requires multiple perspectives across disciplines, strong integration and analysis of results, and regular attention to the basic concept of interdisciplinary training, research and scholarship. Likewise, all agree that strong disciplinary scholarship is essential and must continue to be emphasized in the development of dissertation research. These are not competing philosophies. Rather, maintaining disciplinary strength and building the capacity for cross-disciplinary research excellence are complementary if there is a collective aspiration to build this capacity. As disciplines become more divided, a sub-optimization of research potential can occur as departments compete for resources such as high potential students, partners, funders, etc. Instead of expanding the dialogue surrounding this inherent challenge in interdisciplinary collaboration, the IGERT project has led more by example. While proven effective in the short-run, the IGERT project in particular and the initiative to increase a culture of interdisciplinary training at SIO/UCSD in general may benefit from more effort in exploring the dimensions of interdisciplinary collaboration with fellow faculty and administrators. In the third generation, capacity is needed to “see together” the future of interdisciplinary training at SIO as well as to define specific roles and responsibilities, challenge unstated assumptions, and make explicit the values shared by both faculty and administration for crosscutting, collaborative research. Since the issue of cross-departmental collaboration challenges long held cultural norms, conflicting perspectives should be encouraged and can be extremely productive if they are welcomed via well-facilitated processes.

Students frequently remarked on the tension and struggles of finding their way within an existing culture that values strong disciplinary training often to the exclusion of outside distractions and does not boast a long history of research in applied conservation. The pioneering aspect felt by earlier cohorts was understandably stronger than more recent cohorts, yet there was uniform urgency to provide additional structure for the students' training. For example, adding an interdisciplinary aspect to dissertation research and including a chapter that is outside of their discipline is a goal many share, yet find it a significant challenge and suggest stronger preparation and training earlier in the project specifically for this outcome.

Several faculty and students felt that practical experience was an important pre-condition to the IGERT experience rather than entering the project directly from undergraduate or graduate school. Tracking the students with and without practical experience and their degree of success in their research would be useful in order to develop a metric for programmatic success.

PROJECT GUIDANCE AND STRUCTURE

Students report relatively positive understanding of the general IGERT project expectations, yet many describe challenges in finding their way along that track. Several referred to the “walls” as being “nonexistent” and the interdisciplinary nature of the project as being “disorienting.” Given a culture at SIO



that encourages students to work independently in selecting their dissertation topic and path towards graduation (an environment that several faculty described as a positive feature of SIO), the role of a student's faculty advisors seems to be a key determinant for success. Students who describe highly functional exchanges with faculty mentor(s) early in the project describe fewer problems along the way. Ideally, advisor(s) and students work to "get on the same page" regarding disciplinary and interdisciplinary requirements and objectives, including an implementation timeline and clear definition of success. IGERT students would also benefit from better coordination between project leadership and faculty advisors to ensure that students are continuing to meet regularly with advisors and key milestones are being reached.

Across the cohorts, the students note a need for a shared language that defines certain aspects of interdisciplinary training as well as a method to articulate their aspirations for crosscutting research. When introduced to the use of a "T Competency" model, students felt this might be useful. The original concept of "T Competency" was developed by Stanford University Professor Richard Zare and described in the Chronicle of Higher Education (<http://tinyurl.com/352qq6>). The vertical of the "T" represents disciplinary knowledge; and for a traditional Ph.D. candidate, this vertical part of the "T" would be narrow and deep. The horizontal of the "T" represents knowledge across disciplines that the CMBC IGERT project intends to develop. A simple method is being tested at the University of Rhode Island and University of Maryland Baltimore County IGERT projects to help students describe aspirations and track progress on their own path of interdisciplinary training. Several CMBC IGERT students noted the lack of a shared language that offers clarity and distinction between multi- and interdisciplinary training to guide them in research pursuits and opportunities for internships, post-doctoral fellowships, etc. Many students noted the lack of a "road map" to help describe and plan research goals, developmental training and overall learning goals. While these tensions are inherent to graduate training in general, students within IGERT projects are expected to foster interdisciplinary capacity within a culture noted for disciplinary divisions. Students are seeking a common language to define and guide their own path with strong faculty advisement.

The concepts and applications of cross-departmental research are well developed in the Summer Course, yet the implementation of such research and training after this course seems to be largely dependent on the individual student and their faculty advisor. The IGERT Forum is a strong step in this direction, as are the group problem solving exercises in the second year that are part of the Integrated Research Projects, yet more effort should be placed on engaging others after these exercises are concluded. Student driven and product oriented reading groups, seminar series, and other approaches that have worked well here and in other IGERT projects should be considered to foster collaboration, build common language and increase awareness of other disciplines.

Orientation prior to the Summer Course is a critical time in the students' training, and many offered suggestions for ways to improve the early orientation including clear definition of policies and procedures and available resources from other departments at SIO and UCSD, and within the UC network.

Several of the students remarked on the positive nature of developing a strong esprit de corps among the cohort during the Summer Course and how that spirit diminished over time. Several noted that the shared



office space made available to all during the Summer Course led to greater interaction among the cohort and provided a series of unintended benefits such as positive team development and impromptu shared learning opportunities. This opportunity to co-locate desk space after the Summer Course is not offered, and understandably, many seek to locate their office space within their home department. However, those who have taken advantage of the opportunity to co-locate with their fellow cohorts described it as an ideal way to facilitate team learning and foster improved team dynamics within the cohort, as well as form a collegial community, and tended to display more excitement about the project.

In general, the students were very clear in their strong desire to participate more meaningfully in design of interdisciplinary project elements. Few knew when and specifically how they could help PIs and CMBC staff foster the culture of interdisciplinary training outside of their own research agenda and had little sense of ways to help over the course of their graduate training. Even though students envisioned continued interaction with each other throughout their careers, they did not feel a particularly strong sense of ownership and empowerment in contributing to the overall health and function of the project. Increasing student investment in the project and ownership of the initiative to foster interdisciplinary training is encouraged.

SUSTAINING INTERDISCIPLINARY EDUCATION AND RESEARCH

Sustaining interdisciplinary education requires balance between supporting the rigor of disciplinary research while emphasizing research that cuts across disciplines. There was agreement that both basic and applied interdisciplinary types of research are expected to become more important elements of the research portfolio in the future as societal and ecological crises mount. To foster this emerging culture, clear, explicit and continued communication is needed to define the value and complementarity of both rigorous disciplinary as well as interdisciplinary graduate education and research. When in doubt, over communicate the value of crosscutting research!

As noted earlier, integration of the IGERT interdisciplinary course work with the traditional structures of existing curricular groups was difficult across multiple departments. The UCSD Economic Department requires IGERT applicants from the department to complete graduate course work prior to starting the IGERT curriculum so as to encourage focus on the interdisciplinary nature of the IGERT opportunity and not interfere with disciplinary structures. One economics student called the IGERT experience “icing on the cake” of his Ph.D. experience, a capstone for an already strong disciplinary background. The Marine Biology curricular group at SIO is structured in such a way as to allow for more flexible graduate training for participating IGERT students but still requires a strong parallel course load. The traditional and less flexible core requirements of some curricular groups such as Biological Oceanography (BO) presented a significant challenge and potential disincentives to attend events such as the IGERT Forum for participating IGERT students. Over time, with continued communication between IGERT and the BO curricular group in this case, changes have occurred to maintain integrity of the disciplinary training while allowing participating IGERT students increased flexibility. This shift to removing barriers by providing some flexibility in departmental requirements is considered a significant cultural change and should be encouraged.



In response to the greater need to work across disciplines, faculty were uniformly positive on the value of crosscutting research, yet cited few institutional incentives. Key administrators described the emerging value of cross-departmental collaboration nationwide and the desire to be among the leaders, however, the evaluators found little evidence of direct explicit support for faculty who pursue cross-disciplinary research. Hiring, promotion, budget and tenure decisions are each ideal opportunities to communicate this level of overt support and to become a leading edge institution in this arena. A faculty advisor not otherwise involved in IGERT noted that the “Director (of Scripps) needs to make a pretty focused effort bringing in fresh new faculty who’s interests are aligned with doing (interdisciplinary research), I don’t think Scripps has done that yet.”

Tenure decisions are heavily weighted toward publications record, and being a contributing author on a crosscutting paper may not provide favorable review during tenure decisions. An administrator at SIO noted,

This is really one of the major issues for doing science these days... Do you stay in a trajectory where you are the corresponding author on most of these papers, or do you work with these large (interdisciplinary) teams... maybe the result is that you get more papers, but do you really get more papers where you’re a lead author or a corresponding author.... and it also makes it more difficult in evaluating peoples’ files, because we need to have a clearer accounting of just what the contributions are for a lot of these products, because they can involve so many different groups.

With few explicit incentives, gaining commitment from other faculty to participate in IGERT has proved challenging. It is important to note that there are strong partners from other disciplines, and some key individuals early on were true “connectors” and “boundary spanners” who believed in the effort and made cross-collaboration real. However, several noted the relatively small number of committed partners from other departments, expecting to see more interest and enthusiasm. It is unclear why this recruitment has been so difficult if research interests align. Perhaps risk of alienation from their home departments, diluted or weakened research as a result of being more engaged with other departments, and young faculty being perceived as renegades if they engage in cross-departmental collaboration to the exclusion of their own disciplinary activities are contributing factors. Other barriers to engagement may include lack of formal invitation, a perceived “club-like” atmosphere of the IGERT, lack of clarity regarding roles and responsibilities for interested faculty, and inclusion in student recruitment and curricular design. Something as simple as not providing free parking at SIO for IGERT events was noted by one faculty as a barrier. Creative methods of affiliation are necessary; one faculty external to IGERT noted the following:

If IGERT is going to ask for time from collaborating faculty, they need to find a way for the outside faculty to be affiliated and how and what they should be telling their departments and how faculty affiliated with IGERT represents itself to the Department and University. If I had a way to be involved and given affiliation, that would be key.



Recommendations

The following are recommendations for the primary intended users of this external assessment, specifically: CMBC IGERT Project administration and staff, UCSD/SIO Administration, and the National Science Foundation:

RECOMMENDATIONS TO CMBC

I. PROJECT GUIDANCE AND STRUCTURE

RECOMMENDATION: Add Structural Elements

While flexibility is essential and should be expanded, adding some additional structural elements to the project is encouraged. For example, a policies and procedures document given to entering students would be an important first step to providing project vision, mission, and goals as well as administrative details. Such a handbook is an ideal location for a glossary that would define a set of common terms associated with the project. Before the Summer Course, consider the use of a simple exercise such as “T Competency” to allow the students to describe their current, intended and aspirational goals for interdisciplinary training. A description of this instrument is presented in Appendix B of the full report and presents a language and methodology for articulating a student’s individual goals for interdisciplinary training.

A statement by Lisa Levin describes a need and a solution:

One thing we really haven’t done is to get the IGERT advisors together in any formal setting to discuss the kind of questions that we’re addressing now...and because, at least at Scripps, some of them aren’t actually in the inner circle, the Steering Committee for IGERT, they don’t come to any of the meetings. They don’t have the same sense of what success is or what the manifestations are of the interdisciplinary modes... Maybe that’s something we can think about doing... at the beginning of every year, when there’s a new cohort of students... bringing together the advisors and the students to have a discussion about the overall goals of the program.

Other examples of structural improvements to the project might include:

- Better integration of IGERT curriculum with SIO and upper campus structure and curriculum e.g. engaging more, and more diverse, graduate students from upper campus; more flexibility in SIO curriculum group requirements.
- Identifying ways to increase collaborations among different student groups e.g. between MAS and IGERT students.
- Career path guidance e.g. bringing back IGERT alumni to share their experiences; meet with UCSD Career Center to define shared goals and opportunities to collaborate.

RECOMMENDATION: Shadow Dissertation Committee

A suggestion to foster greater faculty involvement in the project and encourage interdisciplinary thinking is to require incoming students to develop a shadow dissertation committee - a cross-discipline group selected by the student to “guide” their work towards a dissertation topic over the first few years. The students would be encouraged to assemble a group that mirrors their multi-departmental interests. A typical group might consist of another IGERT student, junior/senior faculty, and project partners to provide insight and guidance



on the trajectory of the student's training. This concept has been implemented for an IGERT program at Arizona State University and has been considered successful by program leaders (Contact: Dr. Nancy Grimm at the Stream and Urban Ecosystems Lab in Tempe, Arizona). At the University of Maine, students in the interdisciplinary Ph.D. (IPHD) program develop an interdisciplinary graduate committee and negotiate the program of study and their support with participating faculty members.

This process might include a checklist of elements that the student must consider - including specific courses related to a particular trajectory, experiences, internship options and ways to support cross-disciplinary research. A trajectory could be defined and mapped as part of this exercise and include outcomes as defined by the student's aspiration for "T Competency". This committee could also be instrumental in offering career path guidance to students.

RECOMMENDATION: Continue the Summer Course

Successful programs have successful kick off experiences that set expectations and provide a shared sense of purpose. The students have overwhelmingly regarded the Summer Course as the defining experience for their interdisciplinary training at SIO. If interdisciplinary training is prioritized as part of a strategic direction for the institution, the Summer Course should be institutionalized as a core program in a strategic manner. The course could become a globally significant opportunity for collaboration and integration on topics relating to marine conservation. Design, instruction and evaluation in a post-Jackson era are important considerations. Maintaining the quality of the training, the diversity of the topics and the nature of the dialogue are considered paramount to success. Maintaining the high level of instruction will be essential.

RECOMMENDATION: Further Empower Students; Foster Ownership and Engagement

Students cared deeply about the quality and quantity of their personal training, while articulating a high interest and concern for interdisciplinary training. Few students have a clear understanding of how they can best contribute to IGERT specifically and interdisciplinary training in general. As a result, the students conveyed a low sense of ownership in the overall success of the project beyond their own training. The project could empower students in their own training and foster stronger ownership in the larger effort through the following:

- List the many ways a student could contribute to the initiative of fostering cross departmental collaboration during the lifetime of their graduate careers such as helping with recruitment, IGERT Forum, representation on the Steering Committee, engagement of other faculty, fundraising, assisting with the case statement, and effectively communicating the value of the project. Certain incentives could be tied to activities such as additional funding for travel associated with research activities.
- Offer students more overall ownership and control over certain aspects of the project such as design of IGERT courses and specifically the design and execution of the IGERT Forum: from organizing the speakers, to promoting the event, to engaging other faculty, so students are more invested in the success of the project.



- Consider appointing or electing a “senior fellow” who is charged with leadership of all IGERT cohorts including student affairs and certain administrative and programmatic aspects of the project, reducing both PI and CMBC staff workload and increasing student involvement and ownership.
- Provide mechanisms for students to define their aspirational goals and conduct periodic self-assessments of progress toward their desired level of interdisciplinary academic development. A method is provided in Appendix B of the full report that is being used at two IGERT projects where students describe their current and desired “breadth” and “depth” as part of a “T Competency” exercise, and then track their path toward their goals using a method of graduated progress markers. This is one way of fostering systematic and safe mechanisms for student reflection and feedback on their own path, in addition to programmed opportunities such as the IGERT Forum.

RECOMMENDATION: Build Evaluation Capacity

The same principles of systematic inquiry that guide scientific investigation are also used to improve program mechanics and effectiveness. If the most convincing evidence that interdisciplinary learning has occurred are outcomes such as students’ publication records, composition of dissertation committees, faculty involvement, internship experience, and subsequent career paths, then dialogue on ways to measure these goals is important. Building evaluation capacity to increase learning on program effectiveness, and committing to regular adaptation is important. Often, just talking about ways to evaluate a target outcome contributes in unintended ways to fostering group dialogue between and among students, faculty and administrators, increasing the quality of the commitment surrounding aspirations and goals.

Engaging external evaluators is valuable but is not essential if high capacity exists within the core team for evaluative thinking. Engaging peer faculty from other institutions on an annual or biannual basis, who are also growing interdisciplinary training programs, is another way of gaining valuable reflection and learning. Whatever the methods, a focused, detailed and clear evaluation strategy is essential and must be implemented at the design stage of a program to maximize effectiveness. Late mid-term and end-term evaluation does little to course correct along the way. When woven into program design, evaluative thinking will shape purpose, goals, sequence and prioritization of actions, refining indicators of success to increase learning and adaptation. A simple annual calendar that sets evaluation activities should include all internal and external assessment activities and periodic external peer review and be made available to all stakeholders. Regularly communicating success metrics, convening reflection dialogues, and sharing lessons learned builds capacity for program evaluation.

A simple tool is presented in Appendix C of the full report to allow CMBC to assess the enabling conditions for the development of proposals for further interdisciplinary research and education. This rubric allows for a program to assess the quality and degree to which goals, commitment, capacity and constituencies are present to develop an effective program. While the rubric includes a numerical ranking, the value of the exercise is in the comments made that lead to the generation of this numerical ranking. Summing up these comments into an action plan can help sequence and prioritize actions to improve proposal development.



II. SUSTAINING INTERDISCIPLINARY EDUCATION AND RESEARCH AT SIO

RECOMMENDATION: Success metrics

The role evaluation plays in deepening the understanding and value of interdisciplinary research is just emerging. NSF values and encourages project evaluation and offers guidance but understands that all project efforts are unique to their context and benefit most from their own development of evaluation capacity. The CMBC and SIO initiative to increase interdisciplinary research will benefit from development of an explicit set of near, mid-term and long-term success metrics. Agreement on specific goals and definition of success is an important first step. Traditional linear logic modeling for some aspects of the project such as student development is encouraged as appropriate (see Appendix C), however, systems and “Outcome Mapping” are more appropriate and a better match for modeling the complexity inherent in interdisciplinary research. Framing metrics in time-bound (near term, mid-term and long term) and measurable dimensions is useful. Some examples include:

- Research breakthroughs, development of new academic programs and new disciplines - examples of transformations that are not possible from research within disciplines.
- Effects on industry, public policy, and political will.
- Quality of collaborative structures and dynamics as well as connectivity among participants (See Gajda and Koliba, 2007).
- Broadening participation from faculty and students from underrepresented groups in STEM disciplines.
- Broader engagement with students, faculty and administrators across SIO and UCSD.
- Explicit types of support from SIO and UCSD administration.

RECOMMENDATION: Build case statement “Why Multi-disciplinary Research and Teaching is Important to UCSD/SIO”

A simple team-led process could produce a case statement that would add value for the development of the program and aid in recruitment and outreach, as well as helping to foster an emerging interdisciplinary culture at SIO/UCSD. This case statement could be adapted for different audiences such as existing faculty, students and administrators, faculty and students being recruited, and potential external partners and donors. As positive results of the IGERT project and other multidisciplinary collaborations continue to accumulate, capture the information in a well laid out glossy publication/brochure/poster etc. that provides basic results and case examples that underscore the value of interdisciplinary training. Make explicit in the case statement why cross-departmental collaboration is important to CMBC and graduate research experiences in the STEM disciplines. Recruit colleagues in UCSD’s Economics Department who can assist with methods to assign value for UCSD/SIO of the CMBC IGERT project and similar collaborations. Clear, explicit and consistent communication of key facts, outputs, outcomes and emerging impacts of cross-departmental collaboration is needed to define the value and complementarity of both rigorous disciplinary as well as interdisciplinary graduate education and research. When in doubt, over communicate the value of crosscutting research!



RECOMMENDATION: Students Engage Faculty

Consider a project element whereby each IGERT student (Trainee and Associate) invites a faculty member not directly associated with the IGERT Project to the IGERT Forum to interact with project participants. If practical, the students could also encourage the faculty member to foster immersion into the invited faculty member's field via extracurricular activities such as a field trip, tour of their lab facilities, running a discussion seminar, providing a mini lecture on a technique or a method, or discussing/critiquing key journal papers in the field. This activity could be led by a group of IGERT students, or single students wanting to broaden the field of participation. Encourage creativity!

RECOMMENDATIONS TO SIO/UCSD

RECOMMENDATION: Increase Institutional Commitment

Graduate training programs around the country are reorganizing structures to accommodate and enhance research that crosses disciplines in response to the urgency to address complex social, economic and ecological issues as well as to attract the best and brightest applicants. Stanford University's recent announcement of a \$10 million endowment gift to the newly named Emmett Interdisciplinary Graduate Program in Environment and Resources (Emmett IPER) is one example in a growing list of programs valued by institutional administrators and donors. The IPER is an ongoing interdisciplinary program (not tied to NSF IGERT funding) that features a detailed framework for coursework, year-by-year advising and milestones, minimum breadth requirements (culture and institutions, economic and policy analysis, engineering and technology, and natural sciences) as well as requirements of mastery in two distinct fields of inquiry. The program was recently approved (Spring 2008) and endowed (Winter 2009).

Another unique approach is the "ACCESS" program at the University of California-Los Angeles, where students are admitted to graduate study in a given interdisciplinary field and receive funding pledged by participating departments before they have even selected their particular degree program. They go on a rotation and then select the department and research group they will eventually join. Michigan State, University of Minnesota and University of Idaho each have a "Matrix" program of interdisciplinary programs across multiple departments enabling collaboration and interaction.

Further funding for interdisciplinary programs at UCSD/SIO, including NSF renewal, will benefit from greater and more explicit institutional commitment and entrepreneurial planning. The following are some suggestions to consider if there is desire to institutionalize interdisciplinary research as a core function of UCSD/SIO:

- Establish faculty incentives for conducting interdisciplinary work. Make explicit in a public statement the degree to which the administration values crosscutting research and encourages shared faculty appointments, team-taught courses, publishing outside of the home discipline, chapters in dissertations that cross disciplinary lines, jointly authored dissertation chapters and diverse thesis committee compositions.



- Make explicit, through public statements as well as specific actions related to hiring, promotions, tenure and budget allocation, the value that the UCSD/SIO Administration places on cross-departmental collaboration.
- Use ongoing announcements of new policies for tenure, promotion decisions and new faculty hires to underscore the value the institution holds for collaboration across disciplines and as opportunities for outreach, public relations and branding of UCSD/SIO as a destination for collaborative research.
- Identify the disincentives such as structures and policies that place disciplinary research in conflict with cross-departmental collaboration. For example, NSF has identified that teaching overloads and lack of release time for faculty is a barrier faced by many programs. One step would be to discuss ways to encourage cross-departmental collaborations by providing release time in recognition of time required to do proposed research. If SIO/UCSD has proposed this for cross-campus initiatives such as the Sustainability Solutions Institute, identify if there are similar mechanisms that can work to promote further cross-departmental collaborations. These issues are being addressed by Oregon State University (Debbie Delmore: 541-737-8390) and being proposed by other programs including Boston University and University of Maryland.
- Provide mentoring and training of junior and senior faculty in certain skill sets considered essential for success in interdisciplinary research. Skill sets could include effective communication and a shared language to describe basic interdisciplinary goals, identifying external funding sources, how to negotiate release time, how to most effectively team teach courses and co-author papers, networking with other faculty outside of home departments, how to recruit more interdisciplinary students, and how to reduce tension within departments when cross collaboration is underway.
- Reward successful interdisciplinary initiatives by allocating space and additional faculty FTEs when available to support ongoing initiatives and grow larger multidisciplinary research groups such as the Multicampus Research Programs and Initiatives Proposal developed in February 2009. The value of interdisciplinary training should be made explicit including building capacity. If faculty workloads are shared across departments or units, a simple formal agreement such as a Memorandum of Understanding could be a useful tool to define consensus.
- Put more faculty FTEs into positions that would foster larger multidisciplinary groups. Currently, each department hires relatively independently of other departments or divisions. Even the recent slate of “Environmental FTEs” eventually all went to individual departments without any promise that efforts would be made to hire people who might interact with other departments or would build cross-disciplinary teams.

RECOMMENDATION: Recruit and Empower Dynamic Champions

As was true at the start of the first generation of the CMBC IGERT, a growing number of visionary, energetic and charismatic champions are needed. The project cannot rely solely on the current set of allies if it intends to grow in scope and scale. SIO and UCSD can help recruit and cultivate such champions by hiring faculty who care about promoting diversity and working at the interface between fields to promote multi-disciplinary research and education. Pressure is needed from UCSD administration at all levels to avoid



narrow disciplinarian hires. Some evidence of candidates' engagement outside their core field should be a requirement for being hired at SIO and UCSD, particularly in a time of limited resources when there should be a premium placed on being able to work collaboratively.

RECOMMENDATIONS TO NSF

RECOMMENDATION: Provide Lessons Learned

The staff at NSF has a rich and compelling set of case histories to share with the IGERT sites and have convened several events to sum up and develop lessons learned. While there are several items that are universal, many are context-specific. A lessons learned process that can be customized to the specific issues and context that face institutions that are considering renewal and/or continuation of interdisciplinary research and education will help advance interdisciplinary training.

RECOMMENDATION: Provide Regular Feedback to Project

In response to annual reports, direct feedback from NSF to the project could be valuable if feedback is directed at program improvements and on how SIO/UCSD administration could continue to shape change regarding interdisciplinary training and advance the interdisciplinary model. Also, simple use of technologies to upload outstanding products from the project locations would greatly facilitate transfer of information on outputs and near-term outcomes.

RECOMMENDATION: Increase Dissemination of Best Practices

Information on Best Practices from other IGERT programs is available on the NSF website and through a matrix inquiry format to customize specific project aspects, however more context specific dissemination of Best Practices to the project sites would be useful, including information on project evaluation and continuation of projects following the termination of NSF support.

Conclusion

The CMBC IGERT project is a successful and highly functional training program for interdisciplinary graduate research that attracts quality candidates, has made significant progress with intellectual achievement and diversity recruitment, and is helping to develop a culture for interdisciplinary research at SIO. Students report that cross-disciplinary IGERT training provides them with a strong platform to further develop their aspirations for breadth across disciplines and depth within their chosen discipline. The project has been in place for six academic years and has reached a point that is ideal for reflection and self-assessment. CMBC IGERT has concluded two generations and is now embarking on a third that is focused on the continued building of a culture of interdisciplinary research, scholarship and training at UCSD/SIO.

Before embarking on this third generation of interdisciplinary research and education, leaders from faculty and administration have an opportunity to reflect on progress to date and define a shared purpose. In general, the same metrics used to evaluate disciplinary research and education (quality of students,



publications, funding, student outcomes) can be used to evaluate interdisciplinary programs, but the capacity to build evaluative thinking needs to be developed further. If the administration views interdisciplinary research and education as part of the academic mission, then hiring, promotion and tenure guidelines need to be adjusted to include contributions to interdisciplinary research and education.

Faculty should discuss methods to increase student ownership of project design and engagement in the process of interdisciplinary training to reach individual and project goals while creating more structure associated with attainment of those goals. Many outstanding curricular elements and products from the first two generations of the project such as the Summer Course must be retained and institutionalized. The third generation should not be marked by whether or not NSF decides to fund a second round of IGERT. This generation should instead be defined by the quality of conversation and aspiration needed to lead interdisciplinary graduate research training to a level complementary to the world-class strength that SIO currently has in disciplinary education. If the ultimate criteria for success of the six-year IGERT project are what results are created, then tracking student outcomes is one useful metric. However, the long-term and lasting impacts of the IGERT project will be determined by the enthusiasm and willingness of all stakeholders to come together, challenge assumptions, and define a clear path forward including strategies for increasing minority recruitment process, increasing funding and support of interdisciplinary programs, and expanding the reach of the project to other departments and faculty within the UCSD/SIO system.



Pioneers in Interdisciplinary Research

While opinions differ, Wolfe (1981) suggests that the first interdisciplinary, mission-oriented project began in 1830 when federal funding was made available to the Franklin Institute for research into the cause of steam boiler explosions. Klein (1990) argues that the Lewis and Clark exploration of the Upper Missouri River in 1803 was really the first true interdisciplinary program. In both cases, the research was problem or mission oriented; it was instrumental in purpose. As noted by Lowhan and Schilla (2008), "perhaps what is most remarkable about the long history of interdisciplinary research in the United States is that, despite considerable funding, support with nearly religious fervor, and much practice, interdisciplinary research and education often fell short of genuine integration and the results were stymied 'by disciplinary chauvinism and the psychological, social, and epistemological problems of working across disciplines' (Klein 1990; 35)."



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Appendix A: Student Demographic Matrix

* = IGERT Associates

COHORT ENTER DATE	NAME	GENDER /DIVERSITY	MA-JOR/ADVISOR	PH.D. AND YEAR	YEARS TO PH.D.	POSITIONS POST PH.D.
2003	Corringhan	M	Carson	No		
2003	Glaser	F	Checkley	Yes, 2009	6	(Graduation pending) Postdoc SIO
2003	McClenachan	F	Jackson	No		
2003	Walsh	F	Knowlton	No		
2003	Kline	M	Knowlton	Yes, 2005	2	Postdoc Australia
2003	Sepulveda	M (yes)	Graham	Yes, 2005	2	Scientist Pflieger Institute of Environmental research
2003	Blankenship	F (yes)	Levin	Yes, 2005	2	Teacher Palomar College
2003	Smith	M	Jackson	Yes, 2007	4	Engineer, Dudek Environmental Consulting
2003	Whitcraft	F	Levin	Yes, 2007	4	Postdoc, San Francisco Bay National Estuary
2003	Damon	F	Carson	Yes, 2007	4	Faculty, University of Washington School of Public Affairs
2003	Gruenthal	F	Burton	Yes, 2007	4	Postdoc Hubbs SeaWorld



COHORT ENTER DATE	NAME	GENDER /DIVERSITY	MAJOR/ADVISOR	PH.D. AND YEAR	YEARS TO PH.D.	POSITIONS POST PH.D.
2003*	Paredes	M (yes)	Sala	Yes, 2009	6	(Graduation pending) Scientists Environmental Defense Oceans project
2003*	Moseman	F (yes)	Levin	Yes, 2008	4	Postdoc Woods Hole Oceanographic Institution
2004	Cramer	F	Jackson	No		
2004	Hanson	F	Leichter	No		
2004	Marhaver	F	Jackson	No		
2004	Roth	F	Knowlton/Sala/Jackson	No		
2004	O'Hara	M	Groves	Yes, 2007	3	Chicago Climate Exchange
2004	Murray	M	Carson	Yes, 2007	3	Faculty University of South Carolina Joint appointment (business/environment)
2004*	Hull	F	Ohman/Norris	No		
2004*	Aburto	M (yes)	Sala	No		
2004*	Erisman	M	Hastings	Yes, 2008	4	Postdoc SIO
2005	Anderson	M	Sugihara	No		
2005	Forrest	M	Norris	No		



COHORT ENTER DATE	NAME	GENDER /DIVERSITY	MAJOR/ADVISOR	PH.D. AND YEAR	YEARS TO PH.D.	POSITIONS POST PH.D.
2005	Johnson	F	Lisa Cartright	No		
2005	McKenna	F	Hildebrand	No		
2005	Neal	M	Norris, Jackson	No		
2005	Vardi	F	Knowlton/Jackson/Leichter	No		
2005	Westcott	M	Joel Robbins	No		
2005*	Hatch	M (yes)	Dayton	No		
2005*	Johnson	F (yes)	Sala	No		
2005*	Konotchick	F	Leichter	No		
2005*	Omand	F	Franks	No		
2006	Cie	M (yes)	Leichter/Dayton	No		
2006	Cook	M	Levin	No		
2006	Garren	F	Azam	No		
2006	Gilbert	M	Groves	No		
2006	Goldstein	F	Leichter	No		
2006*	Newman	F	Jackson/Sala	Yes, 2007	1	Research Associate, Blue Oceans Institute
2007	Asch	F	Checkley	No		



COHORT ENTER DATE	NAME	GENDER /DIVERSITY	MA-JOR/ADVISOR	PH.D. AND YEAR	YEARS TO PH.D.	POSITIONS POST PH.D.
2007	Galland	M	Hastings	No		
2007	Hartmann	M (yes)	Norris, Jackson	No		
2007	Knowles	M	David Lake	No		
2007	Leonard-Pingel	F	Jackson	No		
2007	Nosal	F (yes)	Graham	No		
2007*	Whitty	F (yes)	Balance Barlow	No		
2008	Flemming	F	Jay Barlow	No		
2008	Rosero	M (yes)	Michael Cole	No		
2008*	Navarro	M (yes)	Lisa Levin	No		
2008*	Martin	F	Balance, Sugihara	No		
2008*	Kelly	F	Smith, Rouse, Jackson	No		



Appendix B: “T Competency” Methods

A simple qualitative metric called “T Competency” was developed by a team at the University of Rhode Island Coastal Institute IGERT Project (CIIP) in partnership with External Evaluators to establish a shared language and measure aspirations for student interdisciplinary training. The vertical element of the “T” represents depth in a particular discipline, and the horizontal of the “T” represents breadth across multiple disciplines. The model is based upon the belief that balance between breadth and depth is ultimately a student’s personal choice with inherent opportunity costs and potential benefits. The methods are intended to illuminate these tradeoffs that the IGERT student will encounter, while providing an opportunity to define one’s aspirations for both disciplinary and multidisciplinary skill development within the time frame of the IGERT project, the completion of their Ph.D., and in their careers ahead.

The model is a conceptual one, made of blocks. The students are told they have 20 blocks to invest in making a T. If the students put all 20 on top of each other in the vertical, the model will reflect an extreme disciplinary competence and no multidisciplinary skills. Examples are used to illustrate the point, describing a person who is the best in their field but remains very focused in their chosen discipline and does not work out of their narrow zone of brilliance. Conversely, if one puts all 20 blocks on the horizontal plane of the T, the model would suggest incredible breadth, but no real depth in any single discipline. Examples are similarly provided of people who can speak intelligently on a wide variety of issues, but their knowledge is comparatively superficial.

The IGERT project recognizes that the balance between the horizontal and vertical domains of the T, between breadth and depth, is a personal choice. Some students might feel they do not have 20 blocks to allocate at the moment, since they are presently developing new personal knowledge in one or another dimension of the T. This is acceptable within this model, and the student is allowed to assign some number of blocks as unallocated at the present. Each student must, however, assign all 20 blocks in a future goal allocation, since he or she will likely function at a high level of competency in the future, 5-10 years post Ph.D. The T Competency assessment instrument is being applied to all incoming cohorts at the start of the IGERT project as well as those who have completed the project as a pre/post test. The model is administered alongside another methodology referred to as “graduated progress markers” as a means for tracking specific intended and unintended changes in behavior of individuals involved in the project.

By combining the T competency instrument with the progress markers, the student defines his/her intended outcome for the IGERT project and then has a structure to apply his/her defined aspirations and track progress toward these aspirations through journaling during the two-year IGERT curriculum. The external assessment includes entry, mid point and exit interviews with each student to collect the data. These data are analyzed and presented as part of the external assessment report and discussed with the PI, co-PIs, and staff for reflection and learning.



Appendix C: Enabling Conditions

The table below is presented as a tool to assess the degree to which the enabling conditions are in place for the development of an interdisciplinary project, program or initiative. The markers serve as the basis for an internal exercise to consider progress, whether adjustments in the design and strategies of a program are called for and to help identify priorities for the next stage of work. The framework is based upon an Orders of Outcome framework (Olsen, 2003; UNEP/GPA, 2006) that was designed to specify progress assessment, purpose and objectives, and the way findings will be used for integrated coastal zone management.

Ideally, the program would refine both the set of key questions and the description associated with each ranking criteria to match context and increase the utility of the effort. A time series notation is included to track progress over a certain period encouraging assessment at multiple times. While the ranking is important, far more learning is accomplished by notations that describe why a ranking was chosen and specific sources of evidence. This process is best carried out by the entire group involved with developing the proposal, project or initiative.

KEY QUESTIONS	RANKING (0-3)				TIME	
	0	1	2	3	1	2
<i>Unambiguous Goals (3 Indicators)</i>						
<i>Have research issues been identified and prioritized?</i>	no action to date	broad issues identified by project team; some stakeholder involvement	specific issues identified with stakeholders; prioritization underway	issues have been identified and prioritized with stakeholders		
<i>Do the program's goals define desired interdisciplinary research, training and scholarship outcomes?</i>	no goals defined	goals are being negotiated with faculty and administration but have not been formalized	desired long-term goals address interdisciplinary goals but are not directly outcome oriented	goals define desired and specific interdisciplinary outcomes as goals for research, training and scholarship		



KEY QUESTIONS	RANKING (0-3)				TIME	
	0	1	2	3	1	2
<i>Are such program goals detailed through time bound and quantitative targets (how much, by when)?</i>	no targets defined	targets for interdisciplinary research training and scholarship are expressed in non-quantitative or time bound terms	targets specify either a target date for specific accomplishments for interdisciplinary accomplishment or a quantitative measure, but not both	targets have been defined in quantitative and time bound terms (how much, by when)		
<i>Constituencies (4 Indicators)</i>						
<i>Have specific constituencies involved in the program's interdisciplinary research been identified as partners: faculty, administrators, external partners?</i>	a detailed list of partners has not been developed	a list of partners is forming but it does not include specific details	with a few important exceptions, the partners have been identified but have not been provided their specific roles and responsibilities	relevant partners (faculty, administration and external partners) have been identified, and have been provided explicit set of roles and responsibilities		
<i>Does the UCSD/SIO administration understand and support its goals, strategies and targets for interdisciplinary research?</i>	key UCSD/SIO administrators are unaware of the program	key administrators are aware of program's goals and targets but the degree of support varies	with a few important exceptions, key UCSD/SIO administrators understand and support the program	key UCSD/SIO administrators understand and support program goals and targets and actively support them		
<i>Is there support for the program from within the key departments and specific faculty involved in the program?</i>	there is little awareness of the program within the key departments, target faculty	awareness is incipient for both target departments and target faculty but support is unclear	support is building up due to outreach efforts, but some departments and key faculty have not pledged support	wide public support for the program is evident from the departments and faculty targeted for the program		



KEY QUESTIONS	RANKING (0-3)				TIME	
	0	1	2	3	1	2
<i>Do the external partners that will assist in implementing the interdisciplinary program understand and support its agenda?</i>	there is little awareness of the program from target external partners	while pertinent external partners are aware of the program their degree of support is unclear	with few exceptions pertinent external partners understand and support the program and have publicly endorsed it	the interdisciplinary program is recognized by external partners as important and strongly supported by them		
<i>Formal Commitment (3 Indicators)</i>						
<i>Have the program's pedagogy and curricular plan of action been formally approved by the appropriate level of administration?</i>	formal approval process has not been initiated	there is a tacit approval for the program by the administration	policies and actions are being negotiated with approving authorities but formal approval has not occurred	the interdisciplinary plan of action, pedagogy and curricular plan have been obtained by the Chancellors office, providing formal approval for implementation		
<i>Has the target external funding partners (public and private) provided the program with the authorities and support it needs to implement long-term plan of action?</i>	no clear support has been identified from public or private funding partners	acknowledgement of the importance of the program by some funding partners has occurred but no formal approval or commitment for long term support	some commitments negotiated between some of the target funding partners for short term support	formal commitment (grant award, MOU, decree, or decision) ceements funding support, legitimacy and long term support of program by external funding partners		



KEY QUESTIONS	RANKING (0-3)				TIME	
	0	1	2	3	1	2
<i>Have sufficient financial resources been committed by the UCSD/SIO administration to match external support and implement the program over the long term?</i>	no financial resources committed by SIO/UCSD administration for implementation of plan of action	some pledges and commitments from UCSD/SIO administration, but significant funding gap remains	adequate short term funding (3-5 years) secured as match to external funding partner for implementation but no long term commitment has been made by UCSD/SIO administration	sufficient commitment of matching financial resources in place to fully implement program over long term		
<i>Institutional Capacity (4 Indicators)</i>						
<i>Does the program possess the human and intellectual resources to implement its plan of action?</i>	no personnel have been assigned responsibility for program implementation	staffing for program implementation is building but inadequate, gaps remain in both teaching and administrative support	staffing is adequate in either faculty or administrative support but not in both	sufficient human and intellectual resources are in place regarding faculty and administrative support to fully implement the program		
<i>Have the faculty members who will be responsible for program implementation demonstrated their capacity to implement the plan of action?</i>	institutional and intellectual capacity necessary to implement program is not present	institutional and intellectual capacity to implement program is marginal	in some key curricular areas capacity is adequate but there are important weaknesses in others	sufficient institutional and intellectual capacity is present from multiple faculty members who have responsibilities for implementing program		



KEY QUESTIONS	RANKING (0-3)					TIME	
	0	1	2	3	1	2	
<i>Have the PI and staff responsible for program implementation demonstrated the ability to practice utilization-based evaluation and learning?</i>	no evidence of evaluation capacity applied to the program	evaluation capacity is incipient and is being expressed as minor adjustments to operational and programmatic procedures	internal and external evaluation capacity is increasing, staff engage in periodic assessments, program elements are adjusted based on learning	program as a whole relies on strong evaluation capacity to foster its ability to learn and adapt, modifying important program elements and building a culture of program reflection			
<i>Does the program empower students to assume a large role in planning and decision making for program?</i>	power and responsibility are concentrated at one level	program provides for some responsibility and initiative at various levels	decision making and responsibility is decentralized but there are significant coordination issues	program successfully integrates top-down and bottom-up initiative; it is structured as a decentralized system without sacrificing efficiency			



Appendix D: Project Evaluation Matrix

A draft schedule for evaluation is presented here as one type of approach to project assessment.

SCHEDULE	ACTIVITY	PARTICIPANTS
At Entry - Before Start of Summer Course	Entry Interview	First Year Trainees/Associates
	“T Competency”, learning goals and progress markers	First Year Trainees/Associates
	Discussion of overall goals and objectives	First Year Trainees/Associates and Advisors
End of Summer Course	Course evaluation reflection	First Year Trainees/Associates
	Journal entries	First Year Trainees/Associates
Spring (end of year 1)	Reflection exercise	First Year Trainees/Associates and PI & Co/PIs (advisors invited)
	Journal entries	First Year Trainees/Associates
	Revise learning goals	First Year Trainees/Associates
Fall Year 2	Journal entries	First Year Trainees/Associates
	External Assessment Committee	All Trainees/Associates and PI & Co/PIs (advisors invited)
End of Year 2	Reflection exercise	First Year Trainees/Associates and PI & Co/PIs (advisors invited)
	Journal entries	First Year Trainees/Associates
	Exit Interview	First Year Trainees/Associates



Appendix E: Glossary

The following is a glossary for words used in the report and the start of a shared language that could be part of a policy and procedures document.

A) Cohort

A group of CMBC IGERT students who matriculated into the project in the same year.

B) CMBC

Center for Marine Biodiversity Conservation.

C) IGERT Evaluation

An external assessment of the overall effectiveness of the CMBC IGERT project.

D) IGERT Steering Committee

The team of people who review and guide the CMBC IGERT Project.

E) IGERT Project Coordinator

Person who ensures the day-to-day administration of the CMBC IGERT project.

F) IGERT Project Director

Person who oversees the mission, direction and overall management of the CMBC IGERT project.

G) IGERT Orientation

Scheduled meeting(s) at the beginning of the IGERT experience where the policies, procedures, mission and overall administration of the CMBC IGERT project is discussed with incoming and existing IGERT students.

H) IGERT Associate

Ph.D. student who is currently funded or was funded at one time by the CMBC IGERT program (but not by NSF).

I) IGERT Fellow or Trainee

Ph.D. student who is currently funded or was funded at one time by NSF via the CMBC IGERT program.

J) Interdisciplinary

IGERT students' graduate education and training provided by the CMBC IGERT project utilizes and integrates the knowledge, skills and expertise of faculty and students from various disciplines.

K) Impact

The social, economic, civic and/or environmental consequences of the project. Impacts tend to be longer-term and so may be equated with goals. Impacts may be positive, negative, and/or neutral: intended or unintended.

L) Logic Model

Graphic representation of a program showing the intended relationships between investments and results.

M) Measure

Either quantitative or qualitative information that expresses the phenomenon under study. In the past, the term measure or measurement carried a quantitative implication of precision and, in the field of education, was synonymous with testing and instrumentation. Today, the term measure is used broadly to include both quantitative and qualitative information.

N) Mentor

Faculty member who guides the IGERT student in their pursuit to obtain a Ph.D. degree.

O) Multidisciplinary

IGERT student graduate education and training provided by the CMBC IGERT project draws on knowledge and expertise from multiple disciplines

P) Outcomes

Results or changes from the project such as changes in knowledge, awareness, skills, attitudes, opinions, aspirations, motivation, behavior, practice, decision-making, policies, social action, condition, or status. Outcomes may be intended and/or unintended: positive and negative. Outcomes fall along a continuum from immediate (initial; short-term) to intermediate (medium-term) to final outcomes (long-term), often synonymous with impact.

Q) Output

The activities, products, and participation generated through the investment of resources. Goods and services delivered.



R) Out-year funding

IGERT students are funded for five years of their Ph.D. two with IGERT project funds. After these two years, IGERT students may be funded from sources such as research assistantships, teaching assistantships or fellowship programs, referred to as out-year funding.

S) Performance Measurement

The ongoing monitoring and reporting of accomplishments, particularly progress towards pre-established goals.

