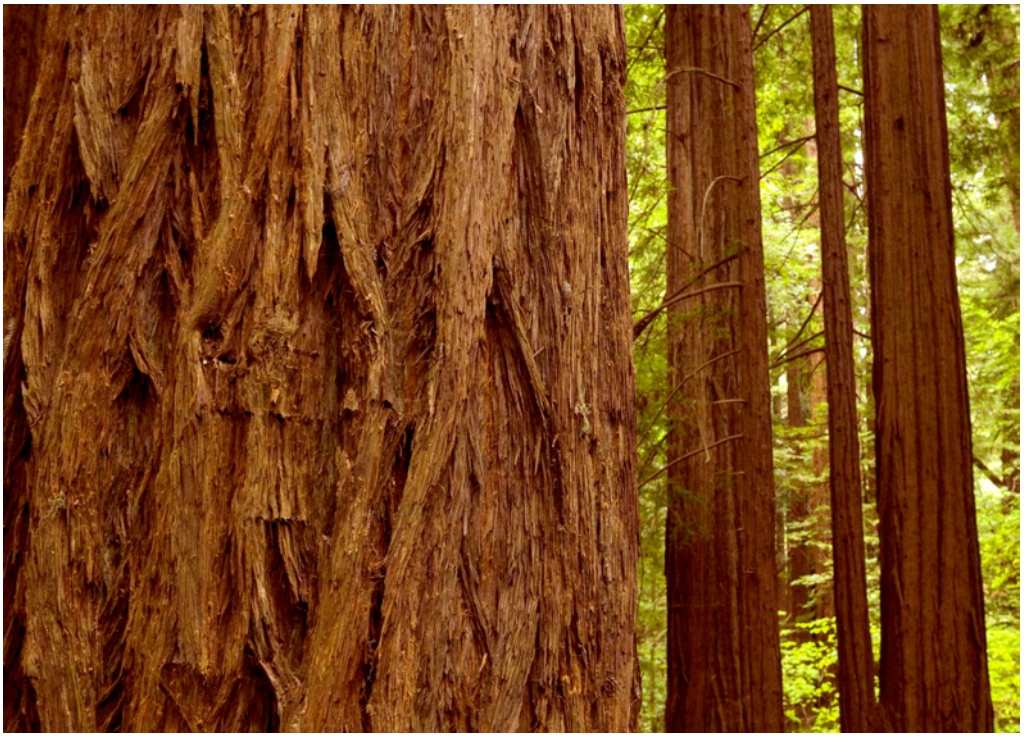
Center for Marine Biodiversity and Conservation IGERT Program at
Scripps Institution of Oceanography
University of California San Diego

Qualitative Analysis & Interpretation:
A Mid-Term Review



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Definition of Acronyms and Terms

ACRONYMS

SIO: **The Scripps Institution of Oceanography**

CMBC **Center for Marine Biodiversity and Conservation**

NSF: **The National Science Foundation**

IGERT: **Integrative Graduate Education and Research Traineeship Program**

UCSD: **University of California San Diego**

TERMS

IGERT Fellows/trainees/students: IGERT students who may receive up to two years of support from the CMBC IGERT program, plus teaching assistantships or graduate student researcher positions from their home department and other awards beyond the NSF sponsored grant.

IGERT Cohort: The entire group of IGERT fellows who are admitted and matriculate in the same year. A total of four cohorts have been admitted since the program started in 2003.

IGERT Associates: IGERT associates are UCSD graduate students in any of the related IGERT disciplines that participate in IGERT courses and other activities during the course of their graduate careers. IGERT Associates do not receive tuition or stipend support from the NSF IGERT program, but are eligible for NSF-IGERT funded internships and competitive awards for research support. As with IGERT fellows, they receive support from teaching assistantships or graduate student researcher positions from their home department and other awards (including NSF graduate fellowships). This program is not evaluated as part of this report, but students participate in IGERT courses.

MAS Students. Students enrolled in the Master of Advanced Studies in Marine Biodiversity and Conservation program established by CMBC, in cooperation with UCSD Division of Extended Studies and Public Programs. This program is not evaluated as part of this report, but students participate in IGERT courses.

IGERT Faculty: IGERT PIs, Co-PIs, faculty and mentors from:

- Scripps Institution of Oceanography (SIO) (including Birch Aquarium at Scripps)
- Other UCSD Departments e.g. Economics, Anthropology, Science Studies, Communication, Ethnic Studies, History, Biology, Political Science
- Graduate School of International Relations/Pacific Studies (IR/PS), UCSD
- Southwest Fisheries Science Center (SWFSC), NOAA
- San Diego Supercomputer Center (SDSC)

IGERT Steering Committee: CMBC IGERT activities are coordinated and planned by a 10-member Steering Committee (including the PI, co-PIs, other participants, and IGERT students). The Committee is responsible for determining student eligibility and recommending new candidates for the program, among other duties.

CBMC IGERT Staff and PIs: IGERT staff and Principle Investigators (PIs) who are also referred to as IGERT "core staff and faculty." This group includes staff of CMBC and PIs that manage financial and administrative aspects of the program.

IGERT Non-Academic Partners: A group of national and international partners outside academia including governmental agencies, intergovernmental agencies and non-governmental agencies. Examples include the NOAA Southwest Fisheries Science Center and World Wildlife Fund.

SIO Administration. CMBC is located at SIO and, as such, reports to the Director of Scripps Institution of Oceanography who is also UCSD Vice Chancellor for Marine Sciences, and Dean of the Graduate School of Marine Sciences. The SIO Graduate Department administers SIO IGERT student financial arrangements and affairs as per other SIO students.

SIO/UCSD Academic Centers. SIO has developed the concept of Academic Centers to meet the needs of students and researchers who are responding to the challenges of modern societies. These include the SIO Center for Marine Biodiversity and Conservation (CMBC), as well as Marine Genomics, Coastal Studies, Atmospheric Sciences, and Marine Biotechnology and Biomedicine.

Cross Disciplinary. *(See "Interdisciplinary")* For this evaluation the words are interchangeable.

Evaluators. Glenn G. Page of EcoLogix Group, Inc., Baltimore, MD and Page Nelson of Working InConcert, Berkeley, CA

Interdisciplinary. This term is rephrased from the NSF IGERT website (http://www.igert.org/): and refers to educational and research methods designed to train graduate students with competency in one's chosen discipline and foster breadth and depth in others. The program is designed to address the issues that surround most 'real life' problems since their solutions are multifaceted and complex. For example, policy decisions must be informed by science, societal values and economics in order to determine whether or not a solution is desirable or feasible.

Utilization-Focused Qualitative Evaluation. A research method designed to compile systematic data on the performance of a program, communicate the value of the program, and to identify opportunities for improvement.

Executive Summary

This report presents findings from a qualitative evaluation of the Center for Marine Biodiversity (CMBC) Integrative Graduate Education and Research Traineeships (IGERT) program at Scripps Institute of Oceanography (SIO) at University of California San Diego (UCSD) funded by the National Science Foundation (NSF). According to the NSF website for the IGERT program "*The Integrative Graduate Education and Research Traineeship (IGERT) program seeks to train PhD scientists and engineers with the interdisciplinary background and the technical, professional and personal skills needed to address the global questions of the future. Through the use of innovative curricula and internships, and by focusing on problem-centered training, these programs give their graduates the edge needed to become leaders in their chosen fields.*"[1]

The central purpose of this evaluation is to tell the performance story of the program by highlighting program success and identify program elements that may benefit from further attention ranging from modest tweaks to more holistic adjustments. To maximize its utility, the evaluation also attempts to identify and describe notable challenges encountered during the first three and a half years of the program by focusing on the patterns and processes involved in the larger interconnected systems. In this light, opportunities for program adjustments are suggested, as well as deeper investigation into enduring issues that may still need to be addressed. Where program successes are both evident and emerging, recommendations are included to support existing systems and interrelationships that seem to be generating positive near-term impacts that further cultivate an atmosphere that supports interdisciplinary education and research.

The evaluation of the CMBC/SIO IGERT program was conducted in the midst of the program's fourth year, in the fall of 2006 by Working in Concert, Inc. The methods for the qualitative evaluation are based on an analytical framework approach that explores both processes and near-term indicators of progress toward programmatic goals. [2] The evaluation focuses on three main program goals: interdisciplinary education of the IGERT trainees; cultivating an atmosphere at UCSD/SIO that fosters continued interdisciplinary education and research; and, increase in the participation of underrepresented groups, including women and minorities in the IGERT program. Nine questions were developed to investigate the processes that support these goals including indicators of progress and examples of near–term outcomes. For example, processes

[1] Information about the program can be found at the IGERT website at http://www.igert.org/

[2] Patton, M.Q., Qualitative Research & Evaluation Methods, 3rd Edition (Thousand Oaks: Sage Publications, 2002) Page 436-441.

highlighted in the report include the extensive development and implementation of the team-taught interdisciplinary Summer Course, extensive recruitment of minority applicants, trainee way-finding along their IGERT path, processes that affect program sustainability and PI "burnout", as well as processes that enhance faculty/partner involvement, and administrative support for IGERT.

Data include original IGERT proposal and attachments, transcriptions of informal conversational field interviews, three years of annual programmatic reports and surveys submitted by CMBC staff to NSF, IGERT program announcement and application forms, sample proposals and abstracts as examples of IGERT trainee work products, direct observation of two IGERT meetings (CMBC Advisory Committee Meeting, IGERT Faculty/Students Pot Luck), and other media sources such as websites, meeting minutes, videos, and PSAs (public service announcements) produced by the students during their IGERT program. Evaluators also reviewed and reference other IGERT program evaluations and "best practices" that are available via the NSF IGERT website[3] under "Idea Exchange" and from basic searches. One particular study provided significant insight into the comparison of IGERT versus non-IGERT programs. This report by Abt Associates entitled "Evaluation of the Initial Impacts of the National Science Foundation's Integrative Graduate Education and Research Traineeship Program" published in February 2006 was particularly useful and is referenced often in the document.

It is important to note that this evaluation **does not** include a review or make recommendations regarding the quality of the research, research methods, level of competency of any student, faculty, administrator or partner. Instead, it is focused on the program's overall performance and relies on the data collected, and analysis and interpretation of that data, to tell the performance story.

Interviews/Guiding Questions

Thirty-five stakeholders were interviewed in person including 17 IGERT Trainees, 1 IGERT Associates, 3 project PIs, 9 participating faculty, 2 external partners, and 3 administrators. Methodology for in-person interviews followed an informal, conversational approach centering around nine questions.

- What are the IGERT program's vision, mission, goals and objectives?
- What are the IGERT program mechanics, partners and institutional features developed to implement the program in order to achieve the vision?
- What are the barriers, risks and challenges to implementing the IGERT program vision, mission, goals, and objectives?
- How does the CMBC/IGERT team recruit and select the cohorts for the IGERT

[3] Website address: http://www.igert.org/ideaexchange.asp?sort=all

program?

- How does CMBC IGERT foster interdisciplinary research and learning?
- How does the IGERT program orient and guide individual students and cohort groups, track indicators of success and prepare cohorts for future careers and life-long learning?
- What is an example of an effective practice that has been developed from the IGERT program?
- What short-term outcomes are attributable to the IGERT program?
- How has the IGERT program represented change in the educational experience at SIO?

Field interviews typically lasted between one and two hours, often held in a group format with as many as four participants in each interview session. Following an introduction that included a brief explanation of the purpose of the evaluation, the interviews focused on using these nine questions to better understanding the process of interdisciplinary education of the trainees, the culture that supports interdisciplinary education and research at UCSD/SIO, and increase in the participation of underrepresented groups, including women and minorities in the IGERT program.

Questions were asked with these goals in mind and based on the richness of flow of information in response to a particular line of inquiry. Probes were used as cues to the interviewee to deepen the response. [4] In many cases, four or five questions combined with use of additional probes guided the majority of the interview. This unstructured approach was chosen because it allowed more flexibility during the inquiry process, facilitating a free flow of information and rapid response to situational elements and individual differences. The drawback to a less structured interview format is reduced statistical comparability of responses, yet in this case with limited time for field interviews, it allowed the evaluators to probe deeper for data relating to systematic patterns, processes and interrelationships.

While neither the timing nor the nature of the evaluation are ideal, being short-term and purely qualitative, a detailed evaluation methodology is included as part of this report that encourages an evaluation strategy that balances both quantitative methods with continued qualitative approaches to establish baseline conditions that can be tracked over the life of the program. Ongoing evaluation can also be achieved by the participants themselves throughout the program and if properly coordinated this approach can strengthen the program's learning opportunities. Therefore, suggestions are included for methods to track impacts and outcomes attributable to the IGERT program through performance measurement and outcome mapping. Central to this

[4] Patton, M.Q., Qualitative Research & Evaluation Methods, 3rd Edition (Thousand Oaks: Sage Publications, 2002) Page 372-379.

long-term evaluation strategy is active engagement by the trainees as participants in the evaluation process by establishing learning goals and anticipated outcome challenges and then tracking progress and performance along the way.

Findings from the evaluation indicate that overall, the CMBC IGERT program is achieving its intended goals for training doctoral students in an integrative education process, through a wide range of high-quality experiences such as the introductory summer course and team-based research projects, and culminating in internships and dissertations that are increasingly multidisciplinary. There was consensus from faculty and administrators who were interviewed that the IGERT program has broken new ground in each of these areas at CMBC/SIO and in doing so, the staff and PI's who developed and implemented the program took significant risks, invested great effort in making the program function at a high level, and faced daunting challenges all along the way.

Furthermore, the interdisciplinary nature of the IGERT program as well as innovations in the program's funding mechanics has received strong support from Dr. Tony Haymet, the recently appointed UCSD Vice Chancellor for Marine Sciences, Director of Scripps Institution of Oceanography and Dean of the Graduate School of Marine Sciences. Dr. Haymet has noted that the program has contributed to a more fertile atmosphere at SIO/UCSD for conducting interdisciplinary education and research and serves as a model for expanded efforts.

Finally, the program has excelled in dedicated outreach resulting in an increase participation of high quality IGERT trainees from underrepresented groups, including women and minorities. Of the combined list of graduates, trainees, and associates, (n=40), 55% are women and 12.5% minorities which is on target to be above the national average. According to the report by Abt associates: nationwide, women received 38 percent of all science and engineering Ph.D. degrees awarded in 2003, while underrepresented (American Indian/Alaskan Native, Black, Hispanic, Puerto Rican, Mexican American and Other Hispanic) minorities received 12 percent.[5] Two notable UCSD campus-wide diversity awards were presented to CMBC staff for their outstanding efforts in diversity recruitment. CMBC program staff, PIs, faculty, and administrators all conveyed a strong sense of pride in these near-term results for diversity recruitment.

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[5] Carney, Jennifer, Deepika Chawla, Autumn Wiley, Denise Young. Evaluation of the Initial Impacts of the National Science Foundation's Integrative Graduate Education and Research Traineeship Program. Prepared for the NSF Directorate for Education and Human Resources, Division of Research, Evaluation, and Communication. (Bethesda Maryland: Abt Associates, February 2006) Page 65-67.

Additional near-term positive outcomes resulting from the program's educational training include:

- An extremely popular summer course featuring immersion in applied issues spanning multiple disciplines that is team-taught and engages students in a diverse and applied set of experiences;
- Course work demanding deep knowledge in chosen disciplines while fostering and breadth and depth in other disciplines;
- Team-based research projects that focus on real-world problem solving and build experience in grant writing, project planning, budget management, research techniques, reporting and cost accounting;
- Unique internship experiences that expand skills, knowledge, and network of professional contacts;
- Cultivation of team-based, leadership and personal skills;
- Experience with development of communication tools such as Public Service Announcements as tools to expand communicating complex technical issues;
- A growing number of dissertations featuring interdisciplinary analysis; and,
- Greater career preparedness by providing trainees with an option for applied internship experiences

Interviewees also focused also on specific program elements that are still, as one PI put it, "rough around the edges." As such, the evaluation considers these "rougher" areas in detail, investigating the patterns and processes at work, including potential balancing and reinforcing aspects and delays. Ideas, thoughts and recommendations came readily for program improvements from students, staff, faculty and administrators and are included throughout the document. It is worth noting that even after extensive discussion of program shortfalls, interviewees demonstrated a common and strong enthusiasm and unwavering support of the IGERT program, further indicating a strong sense of investment and commitment for its success.

Common concerns voiced by IGERT fellows include:

- Quality of advisement is not consistent among faculty advisors;
- Way finding along the IGERT path is challenging for many;
- Gaining regular feedback on academic performance is not consistent;
- Limited feedback from many surveys administered to trainees;

- Several voiced a range of concerns regarding the processes in place to foster competency with strong depth of knowledge in a chosen major field – while also working in an interdisciplinary environment; and,
- Access to post-doctoral opportunities that align with interdisciplinary training.

While interdisciplinary research was present at SIO since its inception, the long-held traditions of education at SIO/UCSD and administrative atmosphere was not well prepared for an interdisciplinary education program such as IGERT. Thus, the program staff created headway simply by the creation of CMBC and later with the IGERT program and developed many cross-discipline educational innovations such as the Summer Course and Masters Program. The team focused on both increasing the academic quality as well as the diversity of students and achieved both in a relatively short time. The program has made remarkable progress in the appreciation of importance of social sciences at SIO by building strong bridges to the upper campus of UCSD through strong participation by students and faculty from the economics department. More recently, the IGERT program features students in anthropology and communications,

CMBC IGERT was under a microscope from the start and therefore needed to do design and implement and tweak the basic program mechanics, so they chose to focus on the things that were most critical to the success of the program. In some cases, this meant delaying elements needing attention such as an on-going process for program evaluation, consistently assisting students in finding their way down their custom path of IGERT, cultivating thoughtful and open dialogue about the scale of change that was brought with interdisciplinary education and research, and tweaking curriculum to require certain fundamental interdisciplinary aspects such as ethics.

There are several examples of how the program is catalyzing a cultural change in graduate education at UCSD and SIO, for students, faculty, and the institution:

- A new Director of SIO who strongly supports the IGERT program and continued application of interdisciplinary education and research;
- Joint research projects that cross disciplines;
- New degree programs such as the Master of Advanced Studies in Marine Biodiversity and Conservation program established by CMBC, in cooperation with UCSD Division of Extended Studies and Public Programs;
- Faculty are teaching new courses that cross-traditional disciplinary boundaries; Several natural science faculty now incorporate social science subjects; Faculty are using new pedagogical approaches;

- Some faculty are using mock testimony and other techniques to give students training relevant to non-academic settings; Faculty are team-teaching courses across disciplines more often. All of our new IGERT courses are team taught across the natural and social sciences
- Faculty are sharing mentorship of students (other than membership on dissertation committees) across disciplines more often. This is now very common; Faculty are participating on multidisciplinary dissertation committees more often. The students are just now forming these committees but several planned dissertations will clearly have natural and social science faculty on the committees.

Staff and faculty are highly qualified and successful people who were creative in developing financial support for the program; they developed and leveraged critical partnerships to support IGERT; they provided a very clear values orientation toward current ocean conservation issues; they demonstrated flexibility; and, they took significant risks that challenged the core of education at Scripps Institution of Oceanography.

From a process perspective, CMBC/IGERT staff and PIs are developing key characteristics of a learning organization as demonstrated by their roundtable forums fostering an open dialogue such as student/faculty Pot Luck events, CMBC Steering Committee meetings, and planning sessions for the next IGERT proposal round. This commitment to learning will be important over the future of the CMBC/IGERT program, as attention is needed to refine the process and expand the interdisciplinary aspects. The atmosphere is now fertile – the seed has germinated – the work of care and feeding of the seedling is needed to grow into a tree to bear the many fruits of the IGERT goals and objectives.

A key concern is figuring out how to sustain the high level of contribution from the project PIs. One PI noted that sustainability was not about the finances, they have a good plan for that with a combination of elements, it has far more to do with avoiding burnout. Essential to this is maintaining current numbers of PIs by quickly replacing them when they depart the institution and finding the best people for academic appointments.

In just over three years of a five-year grant, the CMBC IGERT program has made significant progress in changing graduate research and education at SIO/UCSD. The number of IGERT faculty and advisors actively participating in the interdisciplinary program has expanded to over 40, with increases from many departments at UCSD and organizations such as NOAA SWFSC and San Diego Super Computer Center. The intensive summer course and group projects model an interdisciplinary approach to education and faculty continue to refine these program elements. Students report that

the teamwork and training has been valuable and preferable to a conventional, disciplinary PhD program, particularly in the exposure to contacts and networks beyond their chosen discipline.

In many ways the work has just begun. A change effort of this scale takes time and patience and all leading indicators point to profound success. All involved acknowledge "roughness around the edges" and all seem willing to devote thought, time and energy to improve performance. The motivation also can be found in the intellectual and moral imperative of working to solve the crisis of the loss of global marine biodiversity. Thus, the following list of recommendations is intended to summarize comments in the report and provide suggestions for improvements to the current program and the submission of the second round of IGERT funding.

PROGRAM MECHANICS

- Continue to develop strategies and review progress in expanding number of departments and core faculty to reduce burnout by a small number of highly committed individuals.

- Implement an ongoing evaluation program that cultivates continued learning and improvement in program mechanics and engages the trainees, associates and MAS students in establishing their learning goals and then tracking their progress, strategies and outcomes (see Evaluation Plan below).

- Support regular feedback between students and faculty on expectations and performance for interdisciplinary breadth and core depth in ones chosen discipline.

- Hire additional administrative support within CMBC to handle the anticipated increase in IGERT trainees, MAS students and associates.

- Continue Pot Luck events featuring reflection, peer mentoring and learning and program navigation tips. Local professional facilitation may be valuable to advance the dialogue, however it may be best if the facilitators are from outside the program

- During development of IGERT proposal, consult with department chairs and administration to identify financial support once IGERT ends.

- Continue to track and update diversity information initiated by the Mesnick report. Convene annual dialogue on the progress with diversity recruitment.

- IGERT trainees articulated a need for understanding the job market and how their training will make them competitive with someone who has core strength in a single discipline. This would pertain to work in non-academic environments and to others who are focused on remaining in the academic track.

- Provide stakeholders at all levels of IGERT with a common vocabulary and set of assumptions on what outcomes are important and what are not. This information may include common concepts, values, definitions, goals, and strategies.

Commitment to IGERT is expanded when all share a common understanding of where the program is headed, what success looks like (short and long term), what the barriers, risks, and challenges are, what needs to be done to move forward. At any given time, students, faculty and administrators associated with IGERT could be better equipped to field questions with a clearer understanding of these issues relating to the program's vision. Currently, some confusion and hesitation may impede effective expansion of the IGERT program and its core reason for being. Questions to consider:

- What values within the IGERT program are irreplaceable and fundamental?
- How does the IGERT approach differ from other programs at SIO/UCSD, and why is this important?
- What are the IGERT goals for a student in a particular semester, year, and five-years from now?
- Who has to do what for IGERT to achieve theses goals this semester, this year, next year, five years from now?

CURRICULUM

- Maintain the Summer Intensive course as it is considered one of the strengths of the program. Three students noted the room where many of the lectures took place enhanced migraines and should be changed if possible.
- Several students noted the strength of the summer intensive course then complained about the redundancy of the fall and spring IGERT required courses. An open discussion with the trainees may yield valuable suggestions. For example, during the interview a trainee suggested: *Make the 2nd year group project a requirement in the first year just after the summer session with the first two semesters. The students would work on:*

    1. *Developing the project*
    2. *Getting the proper team members*
    3. *Identifying the budget*
    4. *Getting the funding*
    5. *Plan for implementation*

  Year 2 is the time when the project is implemented and then evaluated and presented.

- Consider the educational preparation of the SIO IGERT students and the IGERT students from UCSD. On one hand, students from Economics complete all their coursework before applying for IGERT – this makes the IGERT experience "icing on the cake" as one economics student noted. On the other hand, students within SIO curricular groups must complete their coursework in parallel to the IGERT program creating a different experience. While this issue may not be able to be solved, it may benefit from open dialogue with members of each new cohort class.

- During new IGERT proposal development, ensure coordination of IGERT application requirements, degree requirements, and methods for tracking performance.

- Encourage faculty assistance with dissertation topics; particularly identification of questions that would benefit from an interdisciplinary perspective may aid trainees as they develop their dissertation topic. Promoting dissertation committees that are interdisciplinary would also be useful.

- Investigate practical alternatives to current faculty incentives for interdisciplinary teaching.

- One recurring issue that surfaced with students and faculty was the requirement for a technical paper. While there is no explicit requirement, several noted that a requirement for a technical paper would be welcomed.

- A final departure survey and interview could be a valuable tool for all trainees who either complete the program fully or depart prior to completion to gain final insight of the programs strengths, weaknesses and areas for improvement.

BUILDING CAPACITY: the following is a list of recommendations to continue to support the infrastructure and sustainability of the program:

- Identify sufficient resources for program administration – such as increasing FTE administrative support to assist CMBC staff with travel arrangements, scheduling, lecture and meeting room reservations etc. As the number of cohorts increase, a corresponding scale increase in administrative tasks falls upon the administrative staff. Effectiveness of IGERT mechanics directly relates to support staff and since CMBC has an extremely effective administrative staff, it is important to avoid burnout.

- Leverage the considerable experience gained in developing interdisciplinary coursework and teaching by documenting methods for developing new degrees such as MAS and certificates, as well as increased university support for interdisciplinary education in general. Identify how the CMBC IGERT program has helped develop new courses such as the summer course and integrative requirements for IGERT students as models for other programs.

- Continue to grow funding; as the CMBC staff and IGERT PI's have identified, growing a program endowment is the enduring challenge and one important path to sustainability.

- Identify methods to delegate program responsibilities currently held by IGERT PI's and empower other IGERT-interested faculty with SIO/CMBC affiliation and confidence that their input and participation is welcomed.

- Conduct a qualitative analysis of Master of Advanced Studies in Marine Biodiversity and Conservation (MAS). A formal review of the program would guide learning and improvement in both MAS and IGERT programs and to validate how it best fits with the vision, mission and goals of CMBC/SIO and UCSD.

- Continue to cultivate a meeting culture where passion, intensity and effective decision-making are valued – meetings as forums for asking difficult questions, challenging one another's ideas, ultimately arriving at decisions that people will

support. Cohesive teams tend to encourage all viewpoints and work towards consensus but may also accept non-consensus derived decisions when they trust a process of inclusion.

EVALUATION

Ongoing evaluation that is both qualitative and quantitative and started at the program's inception would be advisable. An evaluation plan may include a process for IGERT stakeholders to meet at the design stage to determine specific learning goals, activities, and near-term and long-term outcomes. A set of evaluation questions would be derived from this process to identify progress toward shared goals and identify challenges. Standard assessment practices such as surveys, interviews, focus groups as well as IGERT student assessments of their own progress are designed at the start of the program. These methods can be both simple and efficient strategies to review progress and assess IGERT program mechanics and activities.

"Outcome Mapping" is one methodology can be customized to systematically address each of these elements within the IGERT program and to document, learn from and report on achievements. This tool could serve well for the IGERT program to help create a process for planning, monitoring and evaluation of program outcomes and impacts.[6] The web link for the theory and practice can be found at: http://www.idrc.ca/en/ev-26586-201-1-DO_TOPIC.html.

This methodology relies on the use of journals that track the program benefits, costs, achievements, hurdles, barriers and opportunities. With a modest amount of effort and dedication to the process, this is achievable even with the limited time available by all involved with the IGERT program. With this methodology, it is also possible to track progress in teaching and mentoring skills, course development, teamwork, and learning that have occurred within the faculty. Application of these methods provides a closer look at the logical links between the coursework, experiences, exposures to current issues, and ultimate dissertation topics. The eventual post-doctoral jobs and long-term contributions to conservation and society are influenced by IGERT but not directly attributable to its effectiveness and therefore not a significant emphasis. By looking only at the logical links of what the IGERT program can influence, the program only assumes a contribution has been made – never attempting to claim attribution.

More quantitative approaches would focus on specific questions that would be established at the program design and may include such elements as tracking of increases in faculty and partner involvement, diversity recruitment followed by application and acceptance. The use of standardized survey questions could be applied

[6] Earl, Sarah et.al., Outcome Mapping: Building Learning and Reflection into development programs. (International Development Research Centre. Ottawa, ON Canada, 2007) P 11-29.

assuming the tool would generate a large enough sample size to produce a level of precision with adequate confidence intervals.

Additional questions to consider for the subsequent IGERT program proposals:

- From the perspective of students, faculty and staff, how does the program promote interdisciplinary learning?
- Does the IGERT program requirements fit well with the PhD requirements all IGERT trainees must complete?
- What are the benefits and costs of participating in the IGERT project – does the benefit outweigh the costs?
- How do students establish and track their learning goals as part of the IGERT program?
- What indicators exist that institutional culture supports interdisciplinary education and research?

The following table provides a draft for an on-going evaluation plan that would engage the trainees in the evaluation process, use an online tool such as "True Outcomes" to track progress and set times within the year to schedule in meetings and events to discuss performance.

Potential Evaluation Activities for a 2-Year Program Cycle (involving both internal & external evaluators at different times)

Schedule	*Activity*	*Participants*
IGERT Entry Summer 1	Benchmark Surveys	First-year students
	Set Learning Goals (interviews)	First-year students possibly some faculty
End of Summer 1	Course Evaluation Surveys	First-year students & faculty
	Interviews	Key program personnel
	Students reflect on learning goals	All students
	Evaluation results (dialogue)	All program participants
	Revise Learning Goals (assignment or interview)	All students
Mid-Fall & Spring 1/2	Ongoing postings to "blog" and/or "True Outcomes" site (i.e. online assessment sites)	All program participants
	Mid-semester Reflection (cohort)	Students & faculty
End of Fall & Spring 1/2	End of semester course evaluations (surveys, dialogue)	Students & faculty
End of Spring 1/2	IGERT annual survey/report	All participants

	Annual student & program evaluations	Students & faculty
Beginning Summer 2	Academic Year Experience Survey (may be a repeat of above)	Second-year students
Mid-Summer 2	Informal feedback by email, participant observation, etc.	All internship participants
	Online internship evaluation forms (as needed)	All participants
End of Summer 2	Internship Evaluation Surveys	All participants
	Interviews	Key program personnel
Post-Program	Annual update survey	All students, current and former
	Surveys/Interviews at degree attainment	All students and mentors as students graduate from doctoral programs
	Departure Survey/Interview	All students who leave fellowship program prematurely, at departure
	Surveys at intervals past exit	All student participants

Background

In 2002, the National Science Foundation's Integrative Graduate Education and Research Traineeship (IGERT) program awarded a five year grant to the Center for Marine Biodiversity and Conservation (CMBC) to develop "a new type of graduate education and training that will produce a generation of scientists conversant in the biological, social, economic, and political issues of marine conservation and equipped with technical competence in informatics and communication skills." The IGERT program activities are coordinated by CMBC at the Scripps Institution of Oceanography (SIO), a graduate department of the University of California San Diego (UCSD). Hereafter the program will be referred to as CMBC IGERT or simply the IGERT program. SIO is large and diverse, with curricular programs in marine biology, marine chemistry, earth sciences, physical oceanography and climate sciences and includes the Birch Aquarium at Scripps with strong public education and outreach programs. Staff and faculty operating at CMBC within SIO developed the IGERT program to train doctoral students in the field of marine biodiversity conservation since understanding the causes and testing solutions for conserving marine biodiversity requires the ability to work in teams and effectively communicate across disciplines.

Partnering in the program, as stated in the original IGERT proposal, are "economists and policy experts from UCSD's Economics Department and the Graduate School of International Relations and Pacific Studies (IR/PS); computer scientists from the San Diego Supercomputer Center (SDSC); and marine scientists and resource economists from the National Marine Fisheries Service, NOAA (NOAA Fisheries) Southwest Fisheries Science center (SWFSC). All participants are in residence on the SIO campus (SWFSC) or the main UCSD campus (Economics, IR/PS, SDSC)." The field of marine biodiversity conservation has an exceptionally broad base of stakeholders, extending beyond academia, government and policy circles to involve a growing global list of organizations including those from the non-profit, philanthropic, corporate, and public sectors.

In the fall of 2006, CBMC staff contracted the services of Working in Concert to prepare a rapid, cost-effective performance assessment of the IGERT program, mid-way through the fourth year of the program's five year life cycle. The evaluation is designed to be a practical, qualitative, utilization-based study of program process as well as providing insight into near-term positive outcomes and suggestions for improvement. Evaluation design follows standard social science research methodologies and professional standards for program evaluation. The fieldwork was conducted during two site visits to the Scripps Institution of Oceanography and campuses at UC San Diego in La Jolla California over a total of five days. Additional analysis of interview transcriptions, extensive written materials, and other data provided by the IGERT staff was conducted off-site between October 1 and December 21, 2006.

Evaluation Purpose and Methods

Purpose

This evaluation investigates the performance of the IGERT program, and intends to provide practical and useful information, highlight successful program elements that can be enhanced, and identify areas for program improvements. It is quite evident that this program is both complex and extremely successful. The evaluators attempt to identify the patterns; processes and interrelationships that contribute to the program's success and identify specific areas where changes may leverage further achievement of program goals and objectives. The evaluation is also intended to provide useful information to improve program competitiveness as the team prepares for a second IGERT proposal cycle. Thus, a major theme in this report is to provide a summary of the program results and also identify ways to improve program performance in light of the objectives developed by the National Science Foundation (NSF) for IGERT programs.

It is important to note that this evaluation **does not** include a review or make recommendations regarding the quality of the research, research methods, level of competency of any student, faculty, administrator or partner. Instead, it is focused on the program's overall performance and relies on the data collected, and analysis and interpretation of that data, to tell the performance story.

Methods: Data Collection and Analysis

Program evaluation remains more an art than a science – the planning of each evaluation effort requires difficult trade-off decisions to balance the feasibility and cost of alternative evaluation designs against the likely benefits of the resulting work in improving program performance and communicating the value of program activities.[7] There are few agreed upon prescriptive methods for qualitative data analysis in the sense of shared ground rules for drawing conclusions and verifying their rigor. Similarly, there are no formulas for determining significance, no perfect ways exist of replicating the analytical thought process, no tests can be applied for reliability and validity, no absolute rules exist. The mantra for qualitative evaluation is to do your best to collect the necessary data, conduct the analysis of the data thoughtfully, and communicate what the data reveal given the purpose of the study.[8] This utilization-focused qualitative evaluation is designed to be rapid, cost-effective and useful and capture the essence CMBC IGERT performance story.

Data used to address the evaluation questions were gathered primarily through direct field interviews with IGERT stakeholders as well as review of written materials such as NSF reports and surveys. Data include original IGERT proposal and attachments, transcriptions of informal conversational field interviews, three years of annual programmatic reports and surveys submitted by CMBC staff to NSF, IGERT program announcement and application forms, sample proposals and abstracts as examples of IGERT trainee work products, direct observation of two IGERT meetings (CMBC Advisory Committee Meeting, IGERT Faculty/Students Pot Luck both

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[7] Wholley, J. et. al., Handbook of Practical Program Evaluation (San Francisco: Jossey Bass, 2004) Pages 417-438

[8] Patton, M.Q., Qualitative Research & Evaluation Methods, 3rd Edition (Thousand Oaks: Sage Publications, 2002) Page 4-12.

in November 2006), and other media sources such as websites, meeting minutes, videos, and PSAs (public service announcements) produced by the students during their IGERT program. Evaluators also reviewed and reference other IGERT program evaluations and "best practices" that are available via the NSF IGERT website[9] under "*Idea Exchange*" and from basic searches. One particular study provided significant insight into the comparison of IGERT versus non-IGERT programs. This report by Abt Associates entitled "Evaluation of the Initial Impacts of the National Science Foundation's Integrative Graduate Education and Research Traineeship Program" written by Jennifer Carney, Deepika Chawla, Autumn Wiley, Denise Young and published in February 2006 was particularly useful and is referenced throughout this report. Stakeholder interviews were focused on IGERT students from the first four cohort years, CMBC staff, SIO and UCSD faculty, and SIO administration. Written material that was analyzed was generated by students, staff and faculty and includes reports and surveys submitted to NSF.

The qualitative evaluation is centered on questions pertaining mainly to the process for cultivating interdisciplinary breadth and core discipline depth for a diverse group of IGERT trainees and the processes that support cultural change by engaging more faculty and administrators in support of integrative education and research. Methods are based on an analytical framework approach[10] that organizes the questions and resultant data to investigate important processes in light of the goals articulated by CMBC staff and PIs as well as NSF for the IGERT program in general. Processes of interest include recruitment of minority applicants, socialization process and trainee way-finding along their customized IGERT path, processes that reduce PI "burnout", as well as processes that enhance faculty/partner involvement, administrative support for IGERT, decision-making and communication promoting a more fertile atmosphere for interdisciplinary education and research at CMBC/SIO.

It is worth noting that, in order to maximize the effectiveness of utilization-based assessment, evaluation planning should begin before the program does, during the design stage, and be implemented throughout the program life cycle to maximize learning and improvement. [11] Data quality can be both improved and more readily obtained if provision is made for data collection from the start of the program – through the collection of pre-program baseline conditions and prevailing attitudes. The evaluation team concludes each section of this report with a series of recommendations and urges the IGERT team to include a "learning cycle" approach to ongoing program monitoring and assessment with the goal of improving program content and process.

While neither the timing nor the nature of the evaluation are ideal, being both short term and purely qualitative, a detailed evaluation methodology is included as part of this report that encourages an evaluation strategy that balances both quantitative methods with continued qualitative approaches to establish baseline conditions that can be tracked over the life of the program, to strengthen the program's learning opportunities and track impacts and outcomes

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[9] Website address: http://www.igert.org/ideaexchange.asp?sort=all

[10] Patton, M.Q., Qualitative Research & Evaluation Methods, 3rd Edition (Thousand Oaks: Sage Publications, 2002) Page 436-441.

[11] Senge, P., ET. al., Schools that Learn, a Fifth Discipline Fieldbook for Educators, Parents, and Everyone Who Cares About Education (New York: Doubleday Dell Publishing Group Inc., 2000) P 19-24.

attributable to the IGERT program through performance measurement and outcome mapping. Central to the long-term evaluation strategy is active engagement by the trainees as participants in the evaluation process by establishing learning goals and anticipated outcome challenges and then tracking progress and performance along the way.

Questions & Responses

The evaluation focuses on three main program goals: interdisciplinary education of the IGERT trainees; culture change at UCSD/SIO that fosters continued interdisciplinary education and research; and, increase in the participation of underrepresented groups, including women and minorities in the IGERT program. Nine questions were developed to investigate the processes to support these goals and the near –term outcomes and indicators of success. The questions are broad in scope, and are interconnected. Not surprisingly, interview responses included program elements that are beyond the scope of this evaluation. For example, over the course of the interviews, a popular topic that was referenced often was the Master of Advanced Studies in Marine Biodiversity and Conservation program that was established by CMBC, in cooperation with UCSD Division of Extended Studies and Public Programs. While this program is included in the evaluation peripherally because it directly relates to the economic sustainability and the educational experience, a more comprehensive evaluation of that program is not part of this study. Furthermore, certain questions such as "how has education at SIO changed as a result of IGERT" are pertinent and related but require a scale of inquiry well beyond the scope of this evaluation.

The nine questions that form the core of the evaluation were developed with CMBC/SIO IGERT program staff and PI's. Several of the questions have been re-worded from NSF surveys and reports to align with the utilization-focused purpose of the evaluation. Quotes are attributed to certain stakeholder groups (i.e. students, faculty, PI's, administration) to provide perspective of the respondent yet the names are withheld. Data are from the transcribed field interviews conducted with the program stakeholders, IGERT project proposal to NSF, written responses to the NSF Annual Surveys, NSF Annual Reports, IGERT Advanced Student Surveys, IGERT letters of support from program partners, and other documents and data sources provided by the staff of CMBC.

The following are the questions used for the evaluation:

Question 1: What are the IGERT program's vision, mission, goals and objectives – why is this important?

Question 2: What are the IGERT program mechanics, partners and institutional features developed to implement the program in order to achieve the vision?

Question 3: What are the barriers, risks and challenges to implementing the IGERT program vision, mission, goals, and objectives?

Question 4: How does the CMBC/IGERT team recruit and select the cohorts for the

IGERT program?

Question 5: How does CMBC IGERT foster interdisciplinary research and learning?

Question 6: How does the IGERT program orient and guide individual students and cohort groups, track indicators of success and prepare cohorts for future careers and life-long learning?

Question 7: What is an example of an effective practice that has been developed from the IGERT program?

Question 8: What short-term outcomes are attributable to the IGERT program?

Question 9: How has the IGERT program represented change in the educational experience at SIO?

Question 1

Question 1: What are the IGERT program's vision, mission, goals and objectives?

"Marine Biodiversity: Understanding Threats and Providing Solutions" is a National Science Foundation (NSF) sponsored Ph.D. training program linking natural, social and informatic sciences. The following summary of the program is from the Announcement of IGERT Availability sent to potential IGERT students and provides a concise overview of the project's vision and context.

> *Effective marine conservation requires a novel interdisciplinary approach because of the complex physical and biological interactions affecting species in marine ecosystems, and between these ecosystems and human systems. In response to this need, we have designed a new type of graduate education and training program that will produce a generation of scientists conversant in the biological, social, economic, cultural and political issues of marine conservation and equipped with technical competence in informatics and communication skills. Our goal is to train professionals who not only can identify the problems, but who can also find practical solutions within ecological, social and economic constraints.*
>
> *Scripps Institution of Oceanography (SIO) is one of the oldest, largest and most important centers for ocean and earth science research, graduate training, and public service in the world. The Marine Biodiversity IGERT builds upon excellence in studies of global change and the marine environment at SIO with expertise from our partners in economics, political science, international relations, computer science, business and science communication to improve conservation of marine biodiversity in the world's most diverse and threatened eco-regions. Through research, training and global partnerships, the Center for Marine Biodiversity and Conservation mobilizes local capacity building and science-based management tools to achieve a sustainable future for the world's oceans.*

Interviewees described several success factors in the IGERT program's structure designed to achieve the vision. For example, the following observations were common: staff and faculty are highly qualified and successful people who were creative in developing financial support for the program; they developed and leveraged critical partnerships to support IGERT; they provided a very clear values orientation toward current ocean conservation issues; they demonstrated flexibility; and, they took significant risks that challenged the core of education at Scripps Institution of Oceanography.

As stated in the IGERT project summary, the vision for the program is to develop "a new type of graduate training whose centerpiece is a series of interdisciplinary, team-based, problem-solving experiences to foster analytical and communication skills with a global outlook." This pedagogy is designed specifically to answer dynamically complex problems starting with "identifying the magnitude and causes of environmental change" and using that knowledge base to understand "environmental and socioeconomic consequences of alternative policy responses". Furthermore, the program intends to broadly communicate the work: "This information must be conveyed effectively to policy-makers and the public."

When asked to describe the vision, mission goals, interviewees provided strikingly similar responses thus sharing a sense of purpose for the program and derive motivation from the vision. Many noted the unique nature of the program and how it is a highly unusual model at SIO/UCSD. For example, several trainees described the orientation and the emphasis of core competency in your chosen field, interdisciplinary breadth and a team-approach to teaching such as in the summer course and group research projects. During the interviews, the PIs noted these goals were intended to be explicit from the start of the program and that transforming the PhD experience from an individual to a team-based focus was an essential element in creating an interdisciplinary approach that permeates the program.

From the Trainees:

> *I didn't know what to expect, but once we had the orientation, I felt like I knew what they wanted me to do. I deeply support the vision of this program; that's why I came here.*
>
> *This program has exceeded my expectations beyond my wildest dreams. My life has been transformed and improved dramatically by my interactions and collaborations with ecologists.*
>
> *I think the IGERT program is very contrary to the SIO PhD program that expects you to be an expert in your field.*

From the student perspective, a paradox was revealed in their often spirited responses surrounding program mission and vision: All tend to share a common understanding of and commitment to the general purpose; yet many voice a lack of clarity on how the program's vision, mission and goals apply individually to their work and voice a common need for way-finding during the program's life and towards career opportunities beyond the life of the program. Several factors that repeatedly came up included advisement from major faculty and a need for guidance particularly after leaving the summer session, and several suggested a need for some sort of capstone interview and stronger career placement support upon completion of the doctoral program. These issues will be treated more fully in following sections of the evaluation.

Other faculty and administrators associated with IGERT communicated in the interviews a common understanding of the program's intent and generally agree on its overall value for the students and for the institution. In some cases, faculty more peripheral to the program noted concerns that were large enough to limit their involvement beyond basic compliance IGERT participation. This is in contrast to the strong commitment and shared vision described by PIs and faculty at SIO and UCSD upper campus. One faculty member from social sciences at UCSD articulated a sense that many of his colleagues have expressed interest to become more engaged in CMBC IGERT and a perceived barriers to engagement included a stronger sense of clarity of overall program objectives, inclusion in program recruitment, and basic logistics such as reserved parking for SIO events.

From an Administrator:

> *CMBC has gotten attention over 5 years – largely because of the NSF/IGERT – and commitment by Scripps - If IGERT hadn't happened CMBC would not have happened. Now they are capable of great things.*

PI's response to program purpose is that it is a bold vision and has demanded significant risk from all involved, and it will require a "village" of support from a wide

range of stakeholders. This grand vision was compared by one PI to the urgency of the grand vision articulated at SIO in years past of winning the cold war through undersea exploration, research and technology development. This new battlefront is in conserving global marine biodiversity and training leaders to address these problems not "*someone to replace me after I'm gone.*"

This call to action was clearly articulated by the recently appointed UCSD Vice Chancellor for Marine Sciences, Director of Scripps Institution of Oceanography and Dean of the Graduate School of Marine Sciences, Tony Haymet:

> *We're in the business of saving the world. IGERT is one of the main reasons I took the new job as SIO director. While (IGERT) training can be expensive, it is essential, and they (IGERT students) must be ready to answer the questions that society is asking. It's necessary to get up to that level quickly and build the scientific input into that as well as economic input.*

A reaction to the vision was voiced by a faculty member noting the desire to gain better clarity on the future submission of IGERT:

> *There's a real difference between saving diversity and understanding diversity. Both aspects were to be part of the program and included in the proposal, but this is not well integrated. The program focus is on conservation – the program application - rather than on the basic science on understanding diversity. Climate for example, that's getting further and further away from biology – maybe it's getting too broad. What is the actual focus? I'd like the chance to ask these questions.*

EVALUATORS' INTERPRETATION and RECOMMENDATIONS

"*A vision not consistent with values that people live by day to day will not only fail to inspire genuine enthusiasm, it will often inspire cynicism*"[12]

The vision of CMBC and the nature of marine biodiversity conservation as a crisis discipline seems a powerful motivator to many involved in the IGERT program. The need to "save the oceans" is a rallying cry that seems to inspire the trainees and other stakeholders of the IGERT program and possibly the future of SIO. This sense purpose may well hold high leverage in motivating faculty from other departments. As the program considers the future IGERT submission, CMBC has a unique opportunity to use the current IGERT experience to create a dialogue on the meaning of this vision and offer entry points from many stakeholders at UCSD/SIO and beyond. A deliberate process that communicates and strives to "share" the vision for the next five years of IGERT may help encourage participation and support of faculty, department chairs and administrators.

Several noted that CBMC has growing convening power by fostering dialogue and gaining the trust and commitment of many partners to develop innovative program elements. Disagreements and conflict exist throughout the academia and often present opportunities for addressing programmatic improvements. The introductory Summer Course that IGERT cohorts take at the start of their traineeship is a fine example of creating environments that relies on the strength of different viewpoints, ideas, and suggestions across disciplines. It seems to reinforce the fact that cohesive teams fight about issues and ideas not personalities – and when done fighting, they move on with no residual feelings. If disagreement does "cross the line", cohesive teams work to make

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[12] Peter M. Senge, The Fifth Discipline The Art and Practice of The learning Organization. (New York, Doubleday, 2006

things right, never walking away. [13] Commitment to the process of a shared vision for the future of IGERT is one step in building simple awareness of the core purpose and underlying values and may lead to greater stakeholder involvement and possibly cultivate greater commitment.

The evaluators suggest a process to develop a shared vision on the future of IGERT. The process would have five characteristics:

1. The process would need to be a safe forum for addressing basic philosophies such as interdisciplinary education vs. strength in core discipline as well as specific programmatic elements that have created tensions over current problems and concerns, some of which are expressed in this report. This should be woven into the long-term evaluation process

2. The process needs to be generative, providing participants with a place to talk about their hopes and desires for interdisciplinary and team-based training and overall program goals. This allows participants to recognize the source of each other's aspirations and generate momentum through differing perspectives around the needs of the IGERT program.

3. Provide students, faculty, and administrators who want to take action the ability to take specific steps on behalf of the program.

4. Over time, expand the group of IGERT stakeholders to dialogue on the fundamental concepts that drive the program. Constantly hold up the program's core values (and associated IGERT practices) to this wider audience allowing all to question assumptions and develop clarity on the IGERT purpose.

5. Describe the dynamic and interrelated environment within which the CMBC IGERT program operates and how each individual trainee has a slightly different system to operate in due to their major professor, curricular group, dissertation focus, dissertation committee, etc. Through the lens of a systems perspective, the nature of the path of each student and the IGERT program in general becomes explicit including the expectations, assessment procedures, and intended near-term outcomes. Thus, a common understanding, timeframe, language, urgency, and creativeness have emerged to lend additional focus to the IGERT program with the specific intent to ensure its long-term success.

[13] Lencioni, Patrick. The Five Dysfunctions of a Team: A Leadership Fable. (Jossey-Bass, San Francisco. 2002) P. 187-200.

Question 2

Question 2: What are the IGERT program mechanics, partners and institutional features developed to implement the program in order to achieve the vision?

The interviews revealed that the IGERT goal of transforming the PhD experience from an individual to a team focus and creating the interdisciplinary approach is based upon the following set of inputs: strong administrative support, strong support from department chairs and administration, a steady supply of external funding, and a cadre of partners to assist in multiple program elements. PIs noted that the development of many of these program elements has required dedication of significant time and effort, a need to constantly challenge existing practices at UCSD/SIO, and creative dedication to solving complex and often infuriating administrative and bureaucratic hurdles. A few key people are at the center of encouraging and maintaining the flow of inputs of administrative support, funding, and partnerships described below. Most of the interviews noted the "superhuman dedication" of the project PI's, CMBC staff and some key partners as essential to ensuring the smooth operation of the program. While celebrated, many also note this level of effort may not be sustainable and needs to be addressed in order to maintain and nourish this effort and the future IGERT program. One PI noted;

> *The more people become IGERT-ized the better, I'm less worried about the financial implications than the issue of sustainability. My biggest concern is the personnel – the sustainability of the program by the PI's.*

One aspect of this issue is replacing members of the faculty who are also PIs and have left SIO/UCSD for other professional pursuits. The administration has indicated strong willingness to replace these positions and maintain continuity in the program.

The following is a general description of the program mechanics to provide context for the responses and suggestions. According to the CMBC website, The Center for Marine Biodiversity and Conservation (CMBC) was established at the Scripps Institution of Oceanography (SIO) in May 2001 to meet the challenges of marine conservation.[14]

The goals include:

- **Investigation**: Assess the state of marine ecosystems now and in the past and develop predictive models for the future.
- **Education**: Train new marine biodiversity and conservation scientists in the United States and around the world.
- **Integration**: Develop novel interdisciplinary approaches linking the biological, physical, social and informatic sciences.
- **Communication**: Increase public understanding of scientific issues and provide sound scientific analyses to policy makers.
- **Application**: Design technically sophisticated, regionally appropriate strategies to prevent and reverse biodiversity collapse.

The Center for Marine Biodiversity and Conservation, in cooperation with UCSD

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[14] The website can be found at http://cmbc.ucsd.edu/

U C S D - S I O - C B M C - I G E R T

Division of Extended Studies and Public Programs has established a new program leading to a Master of Advanced Studies in Marine Biodiversity and Conservation. The program is designed to teach current and future professionals about marine ecosystems from the scientific, economic, and policy perspective, as well as to provide important cultural and communication skills needed to improve conservation of marine biodiversity in the world's most diverse and threatened ecoregions through development of local capacity and management tools.

Innovations associated with funding:

- IGERT Fellowships: Marine Biodiversity IGERT Fellows may receive up to five years of support (two years funded by NSF plus teaching assistantships or graduate student researcher positions from their home department and other awards). IGERT fellowships include a $30,000 annual stipend and up to $10,500 for tuition & fees. IGERT Fellows are placed in a fully funded summer internship program (typically after their first year) and are eligible for competitive awards for research support.
- Master of Advanced Studies in Marine Biodiversity and Conservation –Each student or their sponsoring organization is responsible for the tuition of $30,000 per year. Some of these funds are used to directly support the IGERT program and are intended to help develop financial sustainability for the program beyond NSF support.
- External donors providing support to bring international students into the program. The CMBC Website http://cmbc.ucsd.edu/about/donors.cfm lists over one hundred individuals and private foundations that support the interdisciplinary approach to its postgraduate and other programs. This is invaluable support and well cultivated – clearly a core element to program sustainability.
- Support from SIO/UCSD administration has been a strong indicator of the support of the program. Examples include directed support of the CMBC Executive Director in minority outreach and agreements to direct funds from the masters program described above to IGERT support.
- The development of a mini grant program (3k per year per student) for research topics.
- Internship support (9k per year per student) for internships designed to foster international, professional and research networking experiences.
- Innovations with Partners:
- Core UCSD Partners: Education and Public Outreach (SIO), Economics Dept, Graduate School of International Relations/Pacific Studies, Anthropology Dept, Science Studies, Communication, Ethnic Studies, History, Biology (Section of Ecology, Behavior and Evolution), Political Science
    - The impact of these partnerships throughout UCSD is significant. They catalyze a cultural change in graduate education by creating a fertile place for collaborative research beyond single disciplines.
- Core External Partners: NMFS Southwest Fisheries Science Center, World Wildlife Fund, San Diego Supercomputer Center, CEA-Crest, UMBC Meyerhoff Center, Blue Frontier
    - These partners help with teaching courses, guest lecturers, advise students, provide research facilities, diversity recruitment models,

communications support

- Some given lecture or adjunct professor status at SIO

- Project-based: CMBC contributed to the initial development of the Palmyra Atoll Research Consortium (PARC) that helped to form, operate, and manage a remote research facility on the island. This partnership includes SIO/UCSD, UC Santa Barbara, UC Irvine, Stanford, The Nature Conservancy, the American Museum of Natural History (NYC), The University of Hawaii, the California Academy of Sciences, and Victoria University in New Zealand.
- Extended partners that have provided assistance with program elements such as intern placement include Environmental Defense Fund, UN Development Programme, and Ocean Champions
- Other organizations such as Tijuana River National Estuary Research Reserve, Earthjustice, University of New Hampshire, Oceana, San Diego State University, Greenpeace, Blue Ocean Institute, Environmental Law Institute, SeaWeb, Shifting Baselines, New York Times and Los Angeles Times have provided support such as special lecturers.

EVALUATORS' INTERPRETATION and RECOMMENDATIONS:

The overall program structure and mechanics are well thought out and well implemented. The program would not be able to survive without a strong entrepreneurial and development spirit – manifested in the Master of Advanced Studies (MAS) in Marine Biodiversity and Conservation program, cultivation of external donors and foundations, and the mini-grants programs not funded by the IGERT program. Detailed analysis of these programs, particularly the MAS in Marine Biodiversity and Conservation is not part of the scope of this evaluation, yet is closely linked with both the financial and programmatic success of the IGERT program.

The following recommendations were synthesized from comments voiced during the interview process and are intended to help in the short t-term as well as in the continuation of the IGERT program:

1. **Maintain strong program administration support**

   Identify sufficient resources for program administration – such as increasing FTE administrative support to assist Penny Dockry with travel arrangements, scheduling, lecture and meeting room reservations etc. As the number of cohorts increase, a corresponding scale increase in administrative tasks falls upon the administrative staff. Effectiveness of IGERT mechanics directly relates to support staff and since CMBC has an extremely effective administrative staff, it is important to avoid burnout.

2. **Encourage more support from Department Chairs and Administration**

   Make explicit the benefits of IGERT in terms of the positive policy changes at SIO/UCSD for interdisciplinary coursework and teaching, revised degree requirements, new degrees such as MAS and certificates, as well as increased university support for interdisciplinary education in general. Identify how the CMBC IGERT program has helped develop new courses such as the summer course and integrative requirements for IGERT students.

3. **Continue to grow funding**

   As the CMBC staff and IGERT PI's have identified, growing a program

endowment is the enduring challenge and one important path to sustainability.

4. **Continue to build external partner support**

   Identify methods to delegate program responsibilities currently held by IGERT PI's and empower other IGERT-interested faculty with SIO/CMBC affiliation and confidence that their input and participation is welcomed.

5. **Conduct a qualitative analysis of the Master of Advanced Studies in Marine Biodiversity and Conservation**

   Based on the interviews, students, faculty and administrators identified important financial and programmatic benefits as well as costs associated with the Master of Advanced Studies in Marine Biodiversity and Conservation (MAS). A formal review of the program would guide learning and improvement in both MAS and IGERT programs and to validate how it best fits with the vision, mission and goals of the University.

6. **Continue to foster an open and effective meeting culture**

   Continue to cultivate a meeting culture where passion, intensity and effective decision-making are valued – meetings as forums for asking difficult questions, challenging one another's ideas, ultimately arriving at decisions that people will support. Cohesive teams tend to encourage all viewpoints and work towards consensus but may also accept non-consensus derived decisions when they trust a process of inclusion.

Question 3

Question 3: What are the barriers, risks and challenges to implementing the IGERT program vision, mission, goals, and objectives?

Interviews with students, staff, faculty and administrators identified a list of current challenges, most of which seem linked with the nature of change IGERT represents and long-held traditions at SIO/UCSD. Several noted that CBMC IGERT transcends predominant focus on strength in a single discipline and that the staff developed new administrative structures and degree programs, placed acute focus on team learning, expanding the diversity of the student body, and amplified methods of outreach to other internal departments and external partners.

When asked about the severity of the challenges, several reflected on the fact that the IGERT program was implemented very recently (since October 2003), and the challenges were linked to basic program mechanics that were "rough around the edges" and can be "fixed" and that these challenges "are to be expected." Frequently, students and faculty who focused largely on the program challenges ended their remarks with a reflection on remarkable success of the program.

As with any change effort, people on the periphery tend to have high expectations, expecting to see results, impacts and outcomes over a short period of time. Some of the faculty and even some trainees noted delays in realizing results particularly in regards to interdisciplinary competency, technical rigor of some of the student's work products, and the challenges with advisement and way finding along the IGERT path. The results

gap between expected and actual can drive negative assessments within the team and from others within the larger organization.[15] This was particularly evident during the interviews when trainees were comparing their experiences to their colleagues who were not in IGERT. One student expressed concerns that the program has projected elitism due to perceived inequity in fee structures, certain program mechanics, and negatively reinforcing communication. It is important to note that NSF requires a compensation level that is often much higher other doctoral students and that fee inequality is an issues for many if not all IGERTS.

> *There is already enough burden on being an IGERT student – where we're told we're the "Best of the Best" – I look around at all the other students at Scripps and I see the "Best of the Best" all over the place - we simply can't be "the Best of the Best of the Best." It hurts our program.*
>
> *The open house invitation process is not smooth – the curricular groups invite a certain number of people, IGERT invites people but it's often not coordinated. IGERT picks up the cost of the travel for the roughly twelve students; then four are chosen. The dinner party at the open house is an important event, but since all the IGERT students sit together, it has the look of elitism – there's no reason to do that here. We want to make sure that the IGERT symposium is not viewed as elitist.*

Understandably, in order to point to near term program success IGERT staff and PIs tend to refer to case studies of specific "shining stars" within the IGERT program to exemplify positive outcomes. Many of the students recognize this perceived special attention given to a few students who are IGERT "poster children" and while they understand the need to highlight positive examples, some have expressed concern over this method to communicate short-term results.

Faculty who were interviewed expressed concern with expectation and students expressed concerns with perceptions.

From Faculty:

> *The biggest challenge is to maximize the optimal reallocation of time within a day & achieve IGERT goals. Some students don't have a clear sense of expectations – there is insecurity on how they are doing*
>
> *The requirements for IGERT may be a hindrance to some of the faculty participating; there is a perception that they are too thin, the atmosphere at IGERT too casual; while there is a seminar series for the faculty to orient and update them on IGERT curriculum and coursework, few show up.*

From Students:

> *My concern is that IGERT participants are viewed in a certain way – professors from other disciplines have an attitude that the program is not well focused – that there's too much time away from their major discipline and dissertation, that the time may not benefit their thesis, and that there is a lack of rigor in the scientific method, and I think that's a valid concern.*
>
> *You're still getting surprised reactions when IGERT is doing something that is not horrible.*
>
> *I believe that the perception of the lack of science in IGERT is a problem, because if you*

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[15] Senge, Peter, A. Kleiner, C. Roberts, R. Ross, G. Roth, B. Smith. The Dance of Change: The Challenges to Sustaining Momentum in Learning Organizations (New York: Doubleday, 1999) Pgs. 281-291

are not seen as a pure scientist it can be a big problem, therefore I believe that the fact that publishing is not a requirement is a problem, I want something that will be benefiting to my CV. I think this should be a primary goal.

EVALUATORS' INTERPRETATION and RECOMMENDATIONS:

Long-held traditions are important, particularly in an environment of intense academic competition, elite scholars, and a long history of achievement at SIO/UCSD. As noted in the announcement for applications for the 2006-2007 academic years, "Scripps Institution of Oceanography (SIO) is one of the oldest, largest and most important centers for ocean and earth science research, graduate training, and public service in the world." Project PIs report significant personal and professional risk taken in the first few years to develop CMBC and the IGERT program. As IGERT came on line, the leadership team implemented several groundbreaking steps to support the program such as creating a Master of Advanced Studies in Marine Biodiversity and Conservation program established by CMBC, in cooperation with UCSD Division of Extended Studies and Public Programs. While not "new ground" per se, staff resources were dedicated to expand student diversity, to commit to team learning, to reach out to the upper campus at UCSD for potential education and research partnerships, to develop and perfect the summer intensive course, and to foster a sense of belonging.

The scale and pace of change that IGERT represents naturally draws interest and skepticism from those engaged from the periphery of the program, often applying well-established and traditional values. Pointing to delays and gaps in realizing near term goals can be useful – or damaging in this atmosphere of intense competitiveness. A negative feedback loop can occur if enough concern leads to questioning credibility of the transformation effort, which in turn can cause fewer people to commit to program goals and objectives, causing greater burden on the PI's to sustain the effort, extending concern among the students that they are not progressing along a certain path, and possibly contributing to reduced achievement of IGERT core goals and objectives. While there was not enough evidence to suggest this negative feedback loop is taking place, it is worth noting. One project PI noted the difficulty in cultivating patience in tune with the profound nature of change, while creating a fertile ground for interdisciplinary learning, and grow a climate of inclusiveness.

An administrator noted that it is important to remind each other not to judge the ultimate success of the effort based only on a few years of results even though some of the near-term program outputs have met some program goals. Developing new capabilities based on a vision that challenging long-held traditions requires regular practice, evaluation, reflection and new program design over the course of many years. It also is important to maintain sharp focus on the core values of interdisciplinary graduate training and creating a fertile environment at SIO/UCSD for educational change like this to occur. This may require sharing deep insight into how each other perceives interdisciplinary training and their own genuine aspirations for progress and development in light of their perceptions.

The old saying: "what we see depends upon what we are prepared to see" may have meaning here.[16] If patterns, processes and interrelationships are important to see along the path to interdisciplinary graduate education, a customized systems diagram

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[16] Senge, P., ET. Al., Schools that Learn, a Fifth Discipline Fieldbook for Educators, Parents, and Everyone Who Cares About Education (New York: Doubleday Dell Publishing Group Inc., 2000) P 289-303.

depicting the IGERT program may be a useful tool to both understand and test assumptions about circles of influence and to identify high leverage strategic choices, especially when individuals, teams, and organizations need to see beyond events and into the forces that shape change.

Best Practices from other IGERT Programs:

The following information is from Shekhar Bhansali, Principal Investigator for the Sensory Knowledge-based Interface Sciences (SKINS) IGERT at University of South Florida. The information was found on the NSF website under "Idea Exchange"

> *An educational highlight has been the requirement of having our students write a NSF style research proposal and later serve as members of a mock NSF review panel during the IGERT SKINS core course "Chemical and Biological Sensors & Micro-fabrication". For an entire day, IGERT trainees and associates have been required to critique the research proposals of their peers as if they were on an NSF panel. This has led to greater insight of the NSF peer review process, provided students with an ideal venue to develop writing and communication skills, and help students understand the importance of "selling" their ideas in the abstract and throughout the entire proposal.*

Question 4

Question 4: How does the CMBC/IGERT team recruit and select the cohorts for the IGERT program?

Strong emphasis on recruitment of exceptionally qualified students and expanding the diversity of the student body within the CMBC IGERT program clearly models the intent of the NSF. Recruitment and application process is central to the success of this aspect of the IGERT program. Four variables are given significant priority in the decision-making process: diversity recruitment, the oral presentation at the SIO March Open House and specific research interests relative to faculty within a specific curricular group to which the student is applying, and available funding. The selection committee balances and optimizes the variables inherent in each of these processes to select a cohort class.

The selection of cohorts is not specifically formulaic as described in the first year NSF survey response:

On a formula for weighing the various criteria:

> *We look at the student's background, experience and goals in relation to the goals of the IGERT project. In addition, we have personal interviews and require all candidates to make a brief presentation to faculty, staff and students. The student's commitment and dedication to this rigorous educational program is reflected in goals and experiences they discuss, and their communication skills can also be evaluated. In the final analysis we evaluate the entire cohort to determine that there is blend of experiences that would add value to the other members or the program through their participation.*

On the CMBC/IGERT Commitment to Diversity

> *Only when all individuals are able to bring their full, rich brilliance to bear on solving environmental problems will conservation be up to the great challenges that face us*

> *today. The future of the world's oceans requires trained experts who can connect with local populations and who will apply themselves to issues of global concern, the environment, biodiversity and sustainable resources. Our goal is to achieve a diversified Marine Biodiversity IGERT student body and we actively encourage students from underrepresented minority groups to apply.*[17]

Many have noted that the academic quality of the matriculated IGERT students continues to improve and serves as a benchmark of success for the IGERT Program.

From an Administrator:

> *You're not going to get in unless you know why you want to be here. The students need to articulate a bigger vision.*

The application process follows the standard SIO procedures, yet has subtle nuances that have been identified as potential concerns. While more students are applying for IGERT, several of the faculty remarked that they encourage their students to apply to IGERT simply for the access to larger graduate stipends. Students, faculty and CMBC/IGERT staff had strong reaction to the presentation process, whereby students under final consideration of acceptance to the program are asked to make a formal presentation at the SIO Open House during March of each year. According to one PI, the content and delivery during the presentation is an important factor the application process, since they are also looking for articulate communicators who are able to integrate interdisciplinary thinking in their presentation.

From a PI:

> *We use the presentation model because we want to jump-start the program when they are at Scripps from the point when they are accepted. The application has to go through Scripps – then to a department – then to a curricular group – if a faculty person knows the students that helps a great deal – then CMBC sits down and goes through the applicants. A subset of applicants is invited to give a presentation during the SIO Open House. At this point we have the most special students and they either make it or break it – everything is pretty well open. This is a group that should catapult to the top leveraging their experiences with an expanded network and through good internships.*

From Students:

> *It used to be students who wanted to learn about corals and marine protected areas – that was the big draw – now with an expanded interdisciplinary program they are getting many students with different desires– the real question is: "who will advise them?" and "who has the money to keep them going?" and "are they people that IGERT likes?" In some cases there were students nobody wanted to advise yet they selected them anyway.*
>
> *The open house was intense with the presentations – they knew that they invited more people than they would take – since the PI's were chosen first – it was a double edged sword – you needed to know exactly what you wanted to do and then present your interdisciplinary thinking.*

From Faculty:

> *It's a good pool of students – they all gave really good presentations – that seems to be the big criteria.*

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[17] *More information on the large number of UCSD diversity programs and additional fellowships can be found at http://diversity.ucsd.edu and http://ogsr.ucsd.edu/fellowships/sd_fellowship/index.htm .*

We could work together to recruit IGERT students as I am very active in my department and I would be happy to attend if they ever wanted to send someone to an IGERT faculty meeting. This department is very interested in these interdisciplinary issues. I don't know exactly what they are looking for – what are they actually looking for? I think IGERT should recruit students beyond economics - there should be more strength in political science – sociology – literature – philosophy – ethics – religion.

On Diversity Recruitment

"IGERT projects have had a clear impact on the ability of participating programs to recruit in the perception of faculty, more and better academically qualified individuals…The IGERT program has recruited minorities and women in science and engineering programs at rates equal to national averages. While IGERT projects have shown success in their recruitment efforts, the goal of the IGERT program is to be a leader in increasing diversity, and this challenge will continue to be a major focus of the program. The continued recruitment efforts of individual IGERT projects may in the future further increase the diversity of students enrolling in IGERT projects in these areas."[18]

Excerpt from Evaluation of IGERT National Program

CMBC IGERT has been an outstanding model and demonstrated an effective practice for increasing participation of traditionally under-represented groups. In a May 2005 report on the topic, Sarah Mesnick, a former academic administrator at SIO now at SWFSC, compiled a description the programs goals, methods and near-term results achieved by CMBC from October 2003 (start of the program) to May 2005. The report includes a description of the team at CMBC working on recruitment, relevant national diversity statistics, review of current and proposed activities and strategies, and specific "recommendations to increase diversity participation in marine biodiversity and conservation at SIO."[19] The quality and depth of the report reflects the quality and depth of the program and its commitment to this task. The following segments from the report identify positive trends at SIO directly as a result of IGERT recruitment efforts:

Among the original IGERT faculty participants there are six women, two Native Americans…and three are foreign born.

The (CMBC IGERT) applicants from under-represented groups increased from 3.7% in 2004 to 8.0% in 2005. The 2004-2005 IGERT cohort from SIO consisted of 3 white and 1 Chinese/American; all were women. In the coming 2005-2006 academic year, the incoming cohort consists of 4 white students, 1 African-American and 1 Native American, evenly split between males and females.

CMBC encourages and financially supports the participation of the Academic Administrator and graduate students at grad fairs, professional conferences.

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[18] Carney, Jennifer, Deepika Chawla, Autumn Wiley, Denise Young. Evaluation of the Initial Impacts of the National Science Foundation's Integrative Graduate Education and Research Traineeship Program. Prepared for the NSF Directorate for Education and Human Resources, Division of Research, Evaluation, and Communication. (Bethesda Maryland: Abt Associates, February 2006) Executive Summary, Page ix.

[19] Mesnick, Sarah. Efforts to Increase Participation of Traditionally Under-represented Groups in Marine Biodiversity and Conservation. An Internal Report to the Center of Marine Biodiversity and Conservation. (La Jolla, CA: Scripps Institute of Oceanography, May 2005) Pgs. 1-8

> *We are also working to facilitate research and/or sabbatical visits at SIO of professors from traditionally underrepresented groups, which should develop into both an effective student and faculty recruitment tool.*

Significantly, in university-wide recognition, Sarah Mesnick received the Chancellor's award for Diversity in 2005 and Russ Chapman won the award for their diversity recruitment efforts in 2006.

Activities described in detail in the report include: web presence, IGERT brochure, recruitment PowerPoint presentation, formation of the "Diversity Group", recruitment packages for faculty and students, diversity partnerships, professional meetings, visits to Minority Serving Institutions, methods to develop a good working relationship with Office of Graduate Studies and Research (OGSR) – UCSD, graduate fairs, internships, and course participation of diversity students, professional collaboration with diversity faculty, and diversity participation in CMBC activities. The report evaluates these activities and provides specific recommendations including leadership by example, continuing to assess numbers and trends in diversity recruitment, needs for increasing awareness training, teaching to a broader audience, promoting partners such as the Birch Aquarium, and developing transition programs for incoming students to UCSD to be led by graduate students and targeting special cases faced by minority students.

A Diversity Award has been created that provides funding specifically for students from underrepresented communities. Once matriculated, they become part of the IGERT cohort and have all the same benefits as students funded under the NSF program. Unfortunately, funding for the Diversity Award must pass through an administrative process through the Office of Graduate Studies and Research (OGSR).[20] Several staff/PIs noted they have lost prime candidates since the delay from OGSR has resulted in an offer letter arrives well after other letters of award from other institutions.

Another innovation was described during the interviews to improve diversity recruitment. This quote from CMBC/IGERT Staff member:

> *Through experience with our IGERT application process, we have come to recognize that successful applicants distinguish themselves through their research experiences. Yet many students do not have access to these same opportunities or the financial freedom with which to participate. We call the years after graduation and before graduate school the "transition years". Students exposed to exciting research opportunities during this time are more likely to apply to graduate school – and their applications are more likely to be competitive. Thus, with support from the local donors, SIO, and the Southwest Fisheries Science Center, we hosted an informal summer internship program for 5 "transition" diversity students last year. (2006) This is a program that we believe fills a crucial gap for future IGERT applicants.*

A significant amount of effort is focused on the recruitment of candidates from underrepresented groups. The current strategy is a good one that is multi-pronged and focuses on strong presence at events such as SACNAS – the Society for the Advancement of Chicanos & Native American Symposium – and enrolling other IGERT students and associates to assist in the marketing process. By attending the right events, the thought is that more diverse students apply, therefore you go to more events and hopefully more students apply. While this reinforcing loop seems to be working, the staff acknowledges there are a very small number of qualified students who fit the

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[20] Website found at: http://www-ogsr.ucsd.edu/

strongly held model of SIO extraordinariness - yet the program intends to find them.

By enlisting the IGERT students and associates in the actual marketing of the program, an expanded pattern of engagement has multiple positive effects. For example, one associate provided important insight into first generation doctoral students and indicated it gave her meaningful involvement in a program that she was only tangentially involved in.

> *(At SIO) here is a cultural divide, a class divide, a gender divide. CBMC helps give students a sense of belonging – it's the only entity to really put forth a tangible effort – this is not true with other faculty – there is not much support within the graduate department. There is a lack of support in general and I am grateful for the attention given by CBMC to students of diversity. The atmosphere is friendly among the leaders of CBMC – however there needs to be transcendence beyond the program – setting conditions to go beyond the CBMC relationship.*
>
> *This (diversity) is important as it provides different perspectives - there is a real northern perspective at SIO and there needs to be more representation from developing countries.*

From Faculty:

> *IGERT is one of the only entities doing diversity recruitment at SIO, it is an adaptive model being led by administration staff, not faculty; they are leading the institution. Recently two diversity awards were given at UCSD – one on diversity at CMBC to Sarah Mesnick and the other to a person working on technical web issues, both to administrative staff. What is odd is that there was simply no faculty doing this level of work on increasing diversity – so they had to give it to administrative folks.*
>
> *CMBC's Executive Director and IGERT graduate students participate bi-annually in the California Forum and in 2005 attended the NSF-funded HBCU-UP (Historically Black Colleges and Universities Undergraduate Program) National Research Conference in Baltimore. We are expanding our participation in the annual SACNAS (Society for the Advancement of Chicanos and Native Americans in Science) conference: hosting a symposium (co-hosted with CSU-LA, NOAA and SIO) and roundtable, and offering competitive awards for undergraduate and graduate presentations.*

From CMBC Staff:

> *To recruit diverse students we have been getting some matching funds…for 2 additional students...We really like the Meyerhoff model at UMBC.*
>
> *The interdisciplinary CMBC IGERT project continues to attract a larger percentage of the PhD graduate students applications to Scripps, and clearly the attractiveness of the project is helping us bring in highly qualified students, including those who are significantly enhancing the diversity of the graduate program at Scripps Institution of Oceanography. With no shortage of applications, our recruitment strategies are almost entirely focused on students from traditionally under-represented groups.*
>
> *Our program begins the 2006-07 academic year with six new IGERT fellows, one of whom is a Native Pacific Islander. We are delighted with our success in attracting outstanding, diverse students, but we are not relying solely on the allure of the program. Our goal over the past two and a half years has been to continue to enhance our website (which highlights the multi-cultural aspects of the program) and to broaden our professional network to encompass students and faculty from traditionally underrepresented groups and minority serving institutions (MSI). We build upon strong support for diversity recruitment by the Director's office at SIO, the UC San Diego Office of Graduate Studies and Research (OGSR), and the national IGERT*

recruiting office, sharing resources and costs.

As in years past, we have supported IGERT and SIO graduate students to hold events for undergraduates at professional society meetings, such as AAAS and ASLO. This year, at the Ocean Science Meeting in Hawaii, 4 SIO graduate students also presented highlights of our IGERT recruitment efforts during a special double session on increasing participation of minority students in marine science. IGERT PI, Nancy Knowlton also participated at the ASLO meeting in a session on interdisciplinary education.

We deepened our relationship with the NSF-funded CEA-CREST program at Cal State University-Los Angeles: two IGERT members are on the CEA-CREST board, we exchange visits of students and faculty, and Jeremy Jackson (an IGERT co-PI) was the keynote speaker at the annual CEA-CREST meeting. We strengthened ties with Cal State University-San Diego and with Cal State University-Fullerton (for whom we provided a strong letter of support for CSU-Fullerton's proposal for an NSF-funded CREST program). CMBC's Academic Administrator taught a weeklong course at the Ocean Studies Institute (a consortium of CSU-campuses in southern California) and CMBC's Executive Director visited again with the students of the Meyerhoff Fellowship Program at the University of Maryland Baltimore County campus. These long-term and personal relationships with administrators, faculty and students at MSI's are important as we now have one admit (from San Diego State) and at least two additional juniors who are likely to apply to IGERT when they graduate. All of these students attended CMBC events in their undergraduate years and applied or participated in SIO summer internships.

EVALUATORS' INTERPRETATION and RECOMMENDATIONS:

Recruitment is an area where CMBC IGERT staff and core faculty have achieved significant progress toward achieving the vision for an outstanding and diverse IGERT student body. The number of people contributing to this effort has grown since IGERT's inception, as well as the recognition and awards for the key staff involved, ultimately the recruitment of the best and diverse cohort group is a shared responsibility beyond IGERT staff and core faculty as clearly stated in Sarah Mesnick's outstanding diversity report of May 2005. From this document, and potential annual updates of this document, an expanded set of stakeholders is well positioned to further refine the recruitment strategy and aid implementation. It may also be useful to make explicit to a wider audience on a regular basis the purpose and intended outcomes of a more diverse program and how a recruitment-for-diversity strategy has or has not worked, thus providing lessons learned to other interested parties associated with SIO/UCSD and other IGERT programs. Clearly this is a best practice.

In their book *Teaching Diversity: Listening to the Soul, Speaking from the Heart*, Gallos and Ramsey address the complexity of expanding diversity:[21]

> *Institutional, structural and systemic issues are very difficult for members of dominant groups to understand. Systems are most often designed by dominant group members to meet their own needs. It is then difficult to see the ways in which our institutions and structures systematically exclude others who are not 'like us.' It is hard to see and question what we have always taken for granted and painful to confront personal complicity in maintaining the status quo. Privilege enables us to remain unaware of*

[21] Gallos, J.V., Ramsey, V.J., Teaching Diversity: Listening to the Soul, Speaking from the Heart (San Francisco: Jossey-Bass, 1997)

institutional and social forces and their impact.

To maintain strength in recruitment, it may be valuable to identify exactly how minority students are involved in decision-making within the CBMC structure and show colleagues how IGERT has built diversity into information and incentive systems and strengthened career opportunities.[22]

As is very clear from the May 2005 Mesnick report, promoting diversity comes down to understanding target communities and persistence. CMBC IGERT has taken this seriously and built in day-to-day tactics and overarching strategies. As this effort continues to be successful, the concept outlined in the report that focuses on "Transition to the PhD Program" may be an essential additional effort needed to foster internal mentoring programs to help new cohorts learn the ropes at SIO/UCSD. This type of training can be part of the initial orientation and be reinforced through student-to-student mentoring. True diversity will be reflected in faculty, administration, and boards who are also composed of underrepresented groups. The program could also identify situations where purchasing through minority vendors is emphasized and encouraged as well as the benefits and costs associated with the products and services.

Diversity recruitment is related to the level of involvement by staff and students and the high-involvement strategy currently underway at CMBC/SIO has been working well. With continued success comes the need for providing assistance to matriculated students of diversity along the IGERT path. An explicit and comprehensive strategy as articulated by Sarah Mesnick underscores the basic steps needed to positively reinforce this strong commitment to diversity recruitment.

Best Practices from other IGERT Programs:

The following information is from Steven Strogatz, Principal Investigator for the Nonlinear Systems IGERT at Cornell University. The information was found on the NSF website under "Idea Exchange"

> *In our original budget, we requested funds to support a visiting minority or woman scholar for one semester. This has turned out to be amazingly useful in every respect. The scholars have been excellent mentors for our students, collaborating with them, and guiding them on their projects, also helping to find them summer internships. Because they are relatively unburdened (compared to our regular faculty who are overcommitted), they can help with research questions, with running seminars, organizing social events, etc. On top of that, they are role models for our students (e.g., we have very few women faculty, yet 30% of our students are female). We have been so successful with this part of the program that we now have two scholars per year, thanks to additional funding from Cornell's Vice Provost for Minority Affairs, Bob Harris. This is money well spent!*

[22] Bolman, L.G., Deal, T.E., Reframing Organizations: Artistry, Choice and Leadership (San Francisco: Jossey-Bass, 2003)

Question 5

Question 5: How does CMBC IGERT foster interdisciplinary research and learning?

One CMBC IGERT PI's described the guiding philosophy and basic program elements designed to foster interdisciplinary research and learning:

> *The IGERT project is designed to provide trainees with a solid understanding of the basics of and complex interactions between natural and social sciences. In order to train future leaders in marine conservation, our IGERT students are trained to be competent in one discipline and conversant in a number of them so that they can establish meaningful and effective interdisciplinary collaborations with others. SIO students work alongside social science (e.g., economics, anthropology) Ph.D. students to learn how to have an impact on critical issues in a complex world.*

Two important aspects highlighted in this section are: clarity on the concept of interdisciplinary research and learning, and program elements designed to enhance depth or strength in a single discipline as well as breadth of knowledge in multiple disciplines.

The concept of interdisciplinary graduate education varies even to those who administer IGERT programs as identified in a recent NSF national study of IGERT program. The evaluators from Abt Associates described "*the wide range of activities in which IGERT participants engage, which might include:*

- *Education pursued by an individual in multiple disciplines, where each discipline is taught by educators situated in single disciplines but the disciplines are not necessarily related to each other;*
- *Education involving issues that can only be studied by integrating parts of existing disciplines into a new discipline; or*
- *Education involving issues that require individuals to have substantial knowledge of multiple disciplines.* "

The authors of the Abt report measured the variations in interpretations of "interdisciplinary" across many programs:

> *IGERT programs have adopted different interpretations of what it means to organize education around an interdisciplinary theme. One fifth of the PIs (22 percent) expect their students to become experts in more than one field. More report that students in their projects will have a mastery of one field and be able to work with scientists in other fields (63 percent) and/or that they are educating students who know and can use the techniques of multiple disciplines (59 percent).* "[23]

Since CMBC IGERT's inception in October 2003, the students have been thrust into an academic world where strength in a single discipline is, as one SIO faculty put it: "*the irreducible core of doctoral competency*." According to the students interviewed, their ability to deal with this pervasive climate has been largely self-directed and depends

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[23] Carney, Jennifer, Deepika Chawla, Autumn Wiley, Denise Young. *Evaluation of the Initial Impacts of the National Science Foundation's Integrative graduate Education and Research Traineeship Program*. Prepared for the NSF Directorate for Education and Human Resources, Division of Research, Evaluation, and Communication. Abt Associates, Bethesda Maryland, February 2006.

largely on the student's perseverance and how they see themselves in the SIO/UCSD system. For example, some seem motivated to "*break new ground*" as one student said, and others are less prepared to face tradition head on and "*figure out how to fit in this place*." Some come with a clear focus on their discipline and research topic and others use the opportunity afforded by being an IGERT trainee to sample multiple disciplines and identify one that fits them best. Some students focus their training on core competency in two disciplines and develop research topics accordingly. As a result, we found a similar range of activities into which the students might engage. We found spirited discussion on what interdisciplinary means as well as the value of being interdisciplinary from the perspective of the individual, the cohort group, and from other faculty members.

A metaphor that has been used effectively at the University of Rhode Island Coastal Institute's IGERT Project regarding interdisciplinary training is the concept of T-Competency. Strength in one's discipline is described as the vertical portion of the "T." While the horizontal cap of the "T" can be described as the basic level of competency in other disciplines – a breadth of understanding, which includes both an appreciation for and ability to communicate with practitioners in the other disciplines.

The metaphor of T-Competency as a way of communicating the issue of depth versus breadth was presented to several of the students during interviews and several went on to describe the shape of their own "T" and in some cases compared their shape to the shape of others. These descriptions ranged from '*I think I have a short trunk and fat top'* to '*I have a really wide base and just a thin coating over the top*.' One student mentioned another who they thought had a "*double trunk"* – indicating core competency in two disciplines "*and very short top beyond that."* While the responses ranged in description, this use of the T-competency seemed to provide a language that was easily understood and could be discussed openly.

When used to prompt some faculty on the topic, one had this reaction supporting the traditional notion of core strength in one's discipline,

> *Make sure the trunk is strong (referring to T-competency). What are we training people for anyway? The very best ones are good at many things anyway. Where are they going to be regarded as experts?*

The following are additional responses from several different IGERT stakeholders on their thoughts about interdisciplinary training showing the broad range of interpretations as well as benefits and costs of interdisciplinary education:

From students:

> *The individual goals for interdisciplinary were vague and not clear – I think this was intentional – but it is not great structure for me. Thinking the big thoughts is good, and the summer course is great, because it's emotionally charged; otherwise the curriculum is predisposed to writing a dissertation that may or may not be interdisciplinary.*
>
> *Are we generalists or collaborative specialists? (The project) should determine this, and then tell us what to do. Everyone agrees that each student needs to create their own program, but they all seemed to want to give general guidance and more structure to the offerings and examples of what other students did in order to lead us down a path.*
>
> *For the social sciences, IGERT is the icing on the cake, it is an extra little connection to the hard sciences, but we are economists.*
>
> *Anthropologists need their own data, and biology is used to facilitate the fieldwork. They (program PI's) are still in the process of linking the biology to the anthropology in the way they linked economics to marine science*

There should be more legal, political science and policy, ecological philosophy, ethics, social psychology, engineering. What's the point of IGERT if we don't hear from these different fields – students who are interested are doing it on their own. More structure is needed, but it's important not to shoehorn in different perspectives.

I know most of the people in IGERT are from the marine Biology fields, and we have few contacts with the other departments.

They say the program is interdisciplinary, but that is really false marketing as the program severely lacks anything substantive on Policy and Politics. I spend between 75-100% of my time on hard science. The only other discipline that is offered is economics.

We focus on Saving the Oceans first, then and only then add the human element. CBMC is not interested in the human element as a fundamental question/problem, thus needing real diversity from all of the other disciplines.

The generalist path is very hard and not supported at SIO.

The program does not do a lot of human oriented training, there is very basic work on social sciences, really only in economics – there is good faculty in economics and good faculty at Scripps involved but not much more beyond that.

From Administrators:

One of the keys for (IGERT) was to bring in economics – and law – but the law aspect and policy aspect was not fully developed.

The funds that started Scripps came from money that was given to the institution to study the sardine collapse – that was an inherently cross discipline issue that they worked on and developed into CAL/COFI (California Cooperative Oceanic Fisheries Investigations) now a partnership with NMFS/NOAA, CDFG (California Department of Fish and game) and IOD/SIO.

From Faculty:

The program frames economic and ecological issues to force a dialogue on sustainability of human dominated ecosystems.

(My student) has really thrived in IGERT. It has made him such a well-rounded scholar; he has greatly improved his ability to articulate, and increased his willingness to face the challenges of biology. I would be happy to send more students like him if we had them.

Most people fear that an interdisciplinary curriculum will water down – dilute – the overall SIO experience. I would agree with that.

The biggest concern is having adequate faculty depth to be able to deal with the level of inquiry coming from recent IGERT cohorts. There's only one political science guy on faculty…I don't know why there isn't a stronger political science department, you get faculty by getting the students, how do you get a student to apply?

The environmental/social science linkage is not deep other than environmental economics. This is not just a CMBC problem but an SIO problem as well.

The model for the IGERT student should be one that is very grounded – firmly rooted in a particular discipline – this seems to be particularly true for the ones who are biologists. When you graduate with a PhD from Scripps – it means something – when it's a PhD from Scripps in IGERT, it's not exactly clear what that field is. It requires depth. There are core requirements already – there is a bit of tension that we're stretching the IGERT kids too thin.

EVALUATORS' INTERPRETATION and RECOMMENDATIONS:

The concept of interdisciplinary training is clearly a significant issue to all stakeholders, particularly the issue of perceived depth in one discipline versus depth in one discipline and breadth in others.

Many of the concerns that were noted during the interviews had some connection with the perceived value of interdisciplinary training as it applied to the student's own discipline and career. Given that there are several students who have progressed along very different paths of interdisciplinary training within CMBC IGERT, the practice of getting together for pot luck type events and roundtable discussions may be a very important practice to aid in learning and clarity. Encouraging students to use a metaphor like T-competency may help clarify exactly what is intended by interdisciplinary study. Tools to help faculty advisors understand the program elements such as a "cheat sheet" may also prove useful. At the end of the document, an evaluation strategy is suggested that engages the students in the development of their learning goals and tools to help them track progress along the way. This clarity may be a valuable tool upon entry, during mid-course assessments and upon departure from the IGERT program as a final assessment.

In Howard Gardner's book *The Disciplined Mind*[24] he puts forth the argument that in a culture devoted to fostering competency in a single discipline, being part of a new program that requires participants to be competent in a range of disciplines of knowledge – science, social science, the arts, ethics, mathematics - requires a great deal of effort and sustained, counterintuitive, and compassionate study and practice. The persistence and dedication by CMBC staff to advance the integration of interdisciplinary into the SIO/UCSD culture has been essential to the success of CBMC IGERT and fostering change at SIO and UCSD.

It may be valuable to use other methods of discussing interdisciplinary training beyond "T-Competency". Identifying differences in multidisciplinary versus interdisciplinary may be valuable as a tool to create a common language for incoming cohorts to allow students to describe their goals for interdisciplinary graduate education. This can lead to the establishment of intended outcome challenges with performance markers along the way to track progress. This could take the form of a simple set of self described aspects of their competency such what they would like, would expect, and would love to see in regard to their ability to demonstrate the vision of the CMBC IGERT of a "*solid understanding of the basics of and complex interactions between natural and social sciences*."

In regards to the other stakeholders of the CBMC IGERT, it may be valuable to convene an annual dialogue on interdisciplinary research and learning. It may not be enough to simply highlight examples of IGERT students to other IGERT students. There may be value in having open discourse with key faculty, department chairs and administrators on the topic of T-competency and exploring the continuum of perspectives and views held on the subject. Such an open forum held at the onset of a cohort year would give the new IGERT students an opportunity to examine other views and better understand the tradition of strength in a core discipline at SIO/UCSD. As one faculty member said, "*the program frames economic and ecological issues to force a dialogue on sustainability of human dominated ecosystems.*" A potential segue to that dialogue would be the value and practice of interdisciplinary training at CMBC/SIO/UCSD.

Interestingly, from a national program-wide perspective, perceived depth in one's discipline is similar in IGERT and non-IGERT students according to the recent NSF

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[24] Gardner, H. *The Disciplined Mind: What All Students Should Understand*. New York: Simon & Schuster, 1999.

IGERT nationwide program evaluation conducted by Abt Associates: [25]

> *Interested stakeholders have sometimes wondered if participation in IGERT interdisciplinary graduate education decreases students' depth of knowledge in their chosen doctoral field, but students in IGERT programs do not perceive such a problem. Equal numbers of IGERT and non-IGERT students agree with the statement that they are able to study their home field in as much depth as they would like (84 versus 82 percent respectively), and that their program has well prepared them to know their own discipline in depth (80 versus 81 percent).*
>
> *It is possible that this observed equality of responses is due to IGERT students having different expectations of the level of depth they want to have in their chosen field compared to non-IGERT students, and that the level of depth achieved by IGERT students is actually lower than that achieved by non-IGERT students. Faculty data, however, do not indicate this to be the case. Only 21 percent of the PIs surveyed agreed with the statement "IGERT students loose some content expertise by spending time working across disciplines"*

Best Practices from other IGERT Programs:

The following information is from Gordon Bradley, Principal Investigator for the Urban Ecology IGERT at University of Washington. The information was found on the NSF website under "Idea Exchange"

> *One of our best practices is the involvement of a professional educational innovator. This experienced facilitator and group coach helps faculty and students work better together as an interdisciplinary team. She helps get the most work out of our limited time together and teaches us techniques to improve collaboration. Her work produced a handbook of collaboration and facilitation skills that our students now regularly use. Because our education innovation involves intensive group work, we must study, discuss, and understand group dynamics. Neither faculty nor students are trained in this important life skill. Involving a professional innovator has allowed us to manage group dynamics and learn important tools for academic and everyday life.*

Question 6

Question 6: How does the IGERT program orient and guide individual students and cohort groups, track indicators of success and prepare cohorts for future careers and life-long learning?

The program goal to develop a new type of graduate training is articulated to IGERT students from the application stage, during the Program Open House where prospective students are invited to make presentations, and at the three-day program orientation that occurs at the start of the intensive Summer Course. The following section is from the CMBC IGERT proposal to NSF and clearly outlines the intended path:

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[25] Carney, Jennifer, Deepika Chawla, Autumn Wiley, Denise Young. *Evaluation of the Initial Impacts of the National Science Foundation's Integrative graduate Education and Research Traineeship Program*. Prepared for the NSF Directorate for Education and Human Resources, Division of Research, Evaluation, and Communication. Abt Associates, Bethesda Maryland, February 2006.

Training will begin with an intensive summer program in the natural and social sciences relevant to marine conservation, so that the students with diverse backgrounds build on a common intellectual framework from the start. During the first year, students will participate in structured interdisciplinary learning experiences, beginning with case studies and then proceeding to work in interdisciplinary teams on problems with real-world application. In the summer following the first academic year, students will participate in an internship (national or international, governmental or NGO) relevant to their developing research interests. In the second year, students with related interests (e.g. coral reefs, pelagic ecosystems) will work together to develop interdisciplinary research topics targeted at important threats to marine ecosystems. The Ph.D. projects of these students will immerse them in team-based, problem-solving, interdisciplinary research, guided by experts from different disciplines and institutions. These experiences will be supplemented by workshops designed to expose them to new skills and settings. Our goal is to not only train professionals who can identify the problems, but who can also find practical solutions within ecological, social, and economic constraints. In other words, we need a conservation biology that resembles medicine, where diagnosis is followed by attempts to find a cure for the disease.

The following IGERT course information is also presented to prospective students in the application materials:

Introduction to Marine Biodiversity and Conservation	Summer 1 (full time, 9 weeks)
Marine Science, Economics and Policy Interdisciplinary Team-based Problem Solving	First & second academic years; three quarter core course featuring case studies
Coursework Requirements	See requirements of departmental or curricular group listing, specialized courses per student needs
Committee Requirements	Years 1 and 2 three faculty members plus one member outside academia. Years 3-5 five faculty members plus one member outside of academia
Dissertation Requirements	Dissertation whose topic matches the goals of the IGERT proposal
Summer Internship	Summer 2 (with the potential to evolve into a longer-term association)
Collaborative Research Project	Second year; interdisciplinary teams of graduate students
Ethics, Communication Skills and Career Workshops	Offered every year (1/2 to 1 day each)
IGERT mini-grant application	Second academic year
Non-traditional publications/materials	Part of dissertation
Distinguished Seminar Series	Quarterly
Teaching requirements	One IGERT related course

Note: Particulars of requirements are tailored to individual fellows in consultation with their major professor and dissertation committee.

The current practices for guidance and assessment along the IGERT path include the following basic structure for each student. However, specific guidance, course requirements and assessments are tailored to individual fellows in consultation with their major professor and dissertation committee:

- 3-day Orientation at beginning of Intensive Summer Course
- Intensive Summer Course student evaluations. These surveys are given to the students from the faculty to assess the effectiveness of the summer program but do not include extensive cross-feedback or formal follow up with the students; during interviews, the program faculty noted that the students' evaluations have contributed significantly to important adjustments to the Intensive Summer Course.
- Guidance or help with way-finding can occur after the Summer Course and during the first year; yet from the interviews with the students, it seems largely dependent on the relationship of the student with their major advisor and other IGERT faculty.
- Formal mid-year or end-of-year evaluations of IGERT trainees or cohorts are not a formal practice within the IGERT program, yet may occur on a one-to-one basis between students and major professors and with other IGERT PI's and CMBC staff if requested.
- Students report being involved with many IGERT program surveys – some on specific courses, some on CMBC IGERT program elements, and some administered by people affiliated with NSF on effectiveness of the national program. In general, students understand and are willing to participate in these surveys. They report limited feedback from their involvement.
- Student projects such as PSAs, mini-grants, internship reports, and reports on team-based interdisciplinary research topics are assessed and evaluated by faculty and other project partners, and the results are provided directly to students and teams.
- IGERT student participation in workshops and special training programs in ethics, communication skills, and career planning workshops are not generally assessed unless there is a real-time feedback process woven into the workshop or training course. Students are often asked to complete a survey assessment of the program.
- Students are expected to develop a dissertation committee for their Ph.D. research and that committee is generally composed of six faculty members with one member required to be outside of the student's curricular group. This structure is true for all SIO Ph.D. committees, not simply IGERT.

Students report a positive and strong awareness of the general IGERT track as provided to them during the initial three-day orientation. At the same time the students describe the complexity of the SIO/UCSD system and related confusion as to how the IGERT track fits into the interactions with the different curricular groups on both campuses.

> *Orientation is great combined with the summer course – then everyone takes off in their own direction; any guidance depends on individuals and their advisors. The "challenge" might be stated as creating a system for 'guidance and tracking' of students to ensure their, and the program's success.*

During the interviews, several students articulated a desire for more advisement and way finding along their IGERT path. Many described being 'lost' and suffering from lack of access to one's advisor. Two described a growing concern regarding how their

IGERT training would affect their doctoral research. While the sense of being lost is not uncommon for doctoral students and likely an essential step in the process of preparing for one's career, some of the students described losing hold of the IGERT mission along the way and attributed this to weak advisement and way-finding. Conversely, some students were very clear that way-finding and advisement would be welcomed, but there was value in the strong sense of discovery of oneself through the existing process - realizing that through the program they were developing an ability to see something in their own behavior that was invisible to them before.

From Students:

> *There should be a road map – since there is no real sense of when you should get an advisor. There should be a road map with lots of opportunity to stray from the traditional path – IGERT is not explicit on deadlines –- I would like to know what the consequences are when deadlines are not met and when I take certain turns off the map.*
>
> *People have no idea what I'm doing – but I think it's OK for people not to understand what you are doing. He (referring to another IGERT student) got involved early with his professor since his discipline is pretty quantitative; mine is not. There needs to be more emphasis on getting together – keeping people connected.*
>
> *We need more advising, the IGERT students are intelligent, adventuresome, and inquisitive; the IGERT program is not.*

Students and faculty also noted an uneven set of conditions for IGERT students belonging to different curricular groups. For example, several students and faculty mention the differences in the requirements of an IGERT student if you are in the physical oceanography curricular group versus the biological oceanography curricular group. As noted in one of the annual reports of the IGERT program submitted to NSF: *the principal disciplines available to applicants are marine biology and economic and environmental policy. Cohorts can earn degrees from any of eight curricular groups at SIO and any graduate program at UCSD.* A subtle but important distinction emerges, as students from an SIO curricular group must enter the IGERT project during their first year and students from other disciplines at UCSD may only enter the IGERT program after completing graduate course work required by their program. Many students and faculty note this fact as a positive for students from disciplines such as Economics or Anthropology, but several consider it a significant challenge for those accepted to SIO curricular groups such as Biological Oceanography which allows a modest reduction in standard course work.

According to the students, the relationship between the IGERT program and their major professor as well as other faculty is a strong determinant regarding success in the program. The students note that if their major professor is welcomed into the program and that person also identifies and supports the IGERT model, the major professors have much more interest in advisement and assessment of interdisciplinary capacity and success in movement along the IGERT path.

According to faculty, barriers to engagement by additional UCSD faculty in IGERT include stronger and more formal affiliation to CMBC, stronger sense of clarity of overall program objectives, inclusion in program recruitment, and basic logistics such as reserved parking for SIO events.

From Faculty:

> *It's personally fulfilling to be connected to CMBC-SIO; it helps.*
>
> *If we are to be involved – we need to be involved from the beginning.*
>
> *If IGERT/CMBC 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 w/ IGERT represents itself to the department/university.

If I had a way to be involved and given affiliation, that would be key

There are things they tend to invite you to, but there is a physical distance involved; the events are all down there (at SIO), they should give us methods on where to park. You currently feel as though you can be as included as you want to be.

From Students:

None of the PI's work together on specific research projects – it's better to have a student come in and fill in a gap between the two PI's – students need an example of how PI's can work together - where there are situations where an econ and oceanography professor are collaborating on a current issue, use this as a case study.

Regarding preparation for diverse careers, both academic and nonacademic, the IGERT program has emphasized the internship experience as an important element. The team research project in the second year also creates ideal conditions for students to work with individuals from a wide range of fields.

Many of the students note that a significant benefit is the variety of professionals they encounter along the way. The interviews indicate that some students enter with a very clear idea of what they intend to do and IGERT helps refine that, others "have no clue" and expect the IGERT experience to assist them in career path-finding. Furthermore, students speak of a tradition of education at SIO to train future professors or researchers with world-class strength in a single discipline. The IGERT program intends to broaden this trajectory and grow leaders with a "global outlook".

Our consortia arrangement with the World Wildlife Fund provides an NGO perspective on marine biodiversity and conservation. WWF annual involvement in our summer course introduces our trainees to various activities and challenges the NGO's face around the world.

We have frequent guest speakers from government agencies including NOAA Fisheries, Federal and State Parks, Inter American Tropical Tuna Commission and California Department of Fish and Game.

One administrator felt the jobs that would be available to IGERT graduates were at a higher level than those available to students with strength in a single discipline. When students were asked about this, some agreed, perhaps hoping that to be true, while others conveyed the opposite experience. We heard that they felt under-prepared and under-qualified compared to some of their colleagues who had strength in their discipline, and they felt there was little to no assistance in finding the top-level job opportunities. In general, all students would welcome more career placement assistance.

From a student:

We're supposed to find the doors … as you become more interdisciplinary … there are fewer doors open and some doors that were open seemed to close when you broaden your focus; I haven't seen this "other" level of job opportunities.

To address these needs, the IGERT students are made aware of a number of programs. The UCSD Center for Teaching Development provides training sessions in various areas for all graduate students including:

- *Professional Roles and Responsibilities*
- *How to Find a Position as a Post-doc*
- *Instructional Technology 2 part mini-course*
- *Grant Writing for the Sciences*
- *Publishing Workshop*
- *Grant Writing for Humanities and Social Sciences*
- *Leading Science Sections*
- *Academic Honesty*

IGERT students participate in a funded internship at another academic institution, governmental or non-governmental organization, or in industry. The program is flexible in timing, duration and location of these internships. In most cases, these research internships will develop naturally from existing collaborations between CMBC faculty and advisors and those at host institutions. The potential for the program is that many of these internships may evolve into longer associations. The purpose of the internships is described in the IGERT application:

> *The motivation behind these internships is several-fold. First, time spent at a different institution can provide students with a unique opportunity to experience a new intellectual environment. Even when students are working on a continuation of the same project, they will have the chance to interact with people who will offer new perspectives. Second, many of these internships will be available at institutions that offer expertise complementary to that available at SIO. Thus, students will have the opportunity for training in a broader array of areas relevant to Marine Biodiversity and Conservation than would be possible at any single institution. Third, these internships will provide perspectives on career opportunities and may help establish valuable professional contacts. Research internships in industry will provide professional training, experience with diverse and exposure to non-academic career options.*

The range of examples in the following list of student research and internships around the globe indicate the global reach and depth of the IGERT program. This material is from an annual NSF report of the program.

> *Our location near the Mexican border and our small but effective cohort of IGERT Associates from that county has provided opportunities to work with Mexican students from Universidad Autónoma de Baja California Sur and government officials. Two separate IGERT mini-grants supported the IGERT cohort's work at Revillagigedo Archipelago Biosphere Reserve, Mexico.*
>
> *(One IGERT Fellow) challenged the language barrier and seasonal presence of scientists on Mo'orea in French Polynesia with her IGERT supported international internship. Working with a Tahitian non-profit association and the local community, developed an outreach infrastructure to build into the NSF Long Term Ecological Research (LTER) program site on the island. The effort was crucial to the integration of LTER research into local education programs and the community.*
>
> *(One IGERT fellow) is participating in a conservation initiative with the government of Vanuatu. He is working with ni-Vanuatu fieldworkers to collect traditional environmental knowledge on the island of Gaua. The goal is to provide the Vanuatu Cultural Center with the necessary preliminary data to form a basis for establishing conservation policy. This is part of a larger Vanuatu government program funded by the United National Development Programme to implement a community-based biodiversity management on three islands, Santo, Tanna, and Gaua.*
>
> *(One IGERT Fellow) interned in Belize, designing and administering surveys to fishing cooperatives and other user groups to manage the trade-off between immediate human needs and the capacity of ecosystems to provide life-sustaining good and services. This*

research complement a World Wildlife Fund (WWF) program "Reducing Threats from Agriculture and Aquaculture in the Mesoamerican Reef. The data gathered during his internship was also an important contribution to IGERT Fellow, Sheila Walsh's IGERT mini-grant "The Long-term Cost of Land Development on Coral Reef Health and Ecosystem Services in Belize".

EVALUATORS' INTERPRETATION AND RECOMMENDATIONS:

The IGERT program features multiple traditional educational assessment tools that are effectively used to monitor and evaluate students' success in the program regarding their academic progress. There are far fewer processes in place to assess the structure, organizational practices, mechanics, strategies, and progress made by the students to achieve change in their interdisciplinary training.

Orientation is done extremely well from the start of the program. Students get a sense of the intent and spirit of the program during the intensive summer course. Afterwards, when the students enter their respective programs – they are exposed to a much larger system into which they must perform and compete. Each curricular group has its own set of unique circumstances, and some have progress markers along the way such as tests and research experiences they must pass before moving on. These systems are also dynamic, subject to multiple variables such as time availability, financial resources, effective communication, flexibility, etc. Due to these variables, both positive and negative feedback loops can occur that can both support a student along an IGERT path and possibly limit progress along a path.

An effective tool to systematically address each of these elements within a program is called "Outcome Mapping" and was developed by the International Development Research Centre (IDRC) in Ottawa, Canada to document, learn from and report on achievements. This methodology is based on extensive theory and practice of evaluation of programs and was developed to track the winding path toward real outcomes and impacts of programs. It is designed to assist in understanding results of a program while recognizing that contributions by others beyond the program are essential to achieving the kind of sustainable, large-scale improvements in human and ecological well being towards which IGERT is working.[26] The evaluators currently use this methodology at the University of Rhode Island's Coastal Institute IGERT Project (CIIP).

Another tool is to draw a systems-type diagram to graphically portray the spheres of influence, the variables, the progress markers along the way, potential reinforcing and balancing feedback loops and delays. As the systems become better understood, the student can adjust their own systems model. Students who are comfortable at this can assist the incoming IGERT students as they develop and customize their own systems model. While a systems model does not take the place of advice from a faculty member, it may assist with way finding.

Finally, as a capstone experience to the IGERT program, the Evaluators suggest an exit interview process. The exit interview would be an opportunity for each IGERT student to assemble a team of their choosing as they leave the program and discuss with them all aspects of their training as well as ideas for next steps. It would also provide an opportunity for "360-degree" assessments, add value to the program, and provide support and suggestions for the IGERT graduate as they enter the next phase of their

[26] Earl, Sarah et.al., Outcome Mapping: Building Learning and Reflection into development programs. International Development Research Centre. Ottawa, ON Canada, 2007.

leadership. At this point there may be some identified ways for graduates to be ambassadors for IGERT recruitment and promotion.

Through the exit interview, the students could assess their own abilities to navigate through the program and the value of certain program elements including:

- Usefulness of the interdisciplinary courses
- The strength of one's faculty advisor:
    - Level of engagement in IGERT
    - Understanding of what interdisciplinary means
    - Availability
    - Investment in job placement after IGERT
    - Networks and partnerships they open up to students
    - Ability to provide feedback that reinforces IGERT core values
- The students own ability to navigate through the UCSD/SIO world
- The students ability to deal with criticism and skepticism associated with the program
- The students core disciplinary strength
- Expectations and interrelationships with the curricular group
- Students support network including peers, family and colleagues outside of IGERT who "support" them

Best Practices from other IGERT Programs:

The following information is from Daniel Voytas, Principal Investigator for the Computational Molecular Biology IGERT at Iowa State University. The information was found on the NSF website under "Idea Exchange"

> *One challenge faced by our IGERT program is the inherent difficulty in tracking student progress, particularly because our trainees are scattered across 14 departments in four different colleges. To aid this task, we created a database into which we put milestones such as Thesis committee meetings, qualifying examinations, presentations at symposia, and publications. Students fill out an annual activity survey to provide the data for the input. This is followed by a face-to-face meeting with each student by the IGERT PI and program assistant. Because of the number of students involved, the interviews require significant time and effort. Nonetheless, this exercise has proven very valuable, and we view these interviews as one of our 'best practices.' The interviews provide an opportunity to advise students regarding program requirements, and also uncover problems not revealed by the surveys. For example, we learn about difficulties with major professors, financial concerns and personal problems faced by the students. This creates an important connection between the program management and the students. The interviews also make it possible to head off problems before they become unmanageable.*

Question 7

Question 7: What is an example of an effective practice that has been developed from the IGERT program?

By the very nature of the cross discipline approach, the IGERT Program staff and PIs have developed a series of program elements that are new at UCSD/SIO. Innovation has been at the heart of the program, starting with the creation of CMBC, introducing a summer course, developing a masters program and associated revenue generation to support CMBC and IGERT, greatly expanding diversity in recruitment and enrollment of IGERT Fellows, focused outreach and collaboration with many departments at UCSD, cross-departmental research, and greater outreach to academic and non-academic partners.

Other program elements in support of the vision of cross-discipline training include a focused three-day program orientation to interdisciplinary thinking as part of the summer course, a first year course series that focuses on case studies of real world problems and features multiple disciplinary perspectives, a group research project, mini grant opportunities, internships, and program enrichments such as seminar series, conference presentations, and field trips. Along the way, the program intends for the IGERT students to refine their research focus and encourages but does not require cross-disciplinary dissertation topics. The students must develop a faculty committee to support that research, and complete the research and dissertation as the capstone to the doctoral program.

In this section, the intensive summer course is featured as a best practice as well as examples of short-term outcomes and successes associated with the program. Diversity recruitment is considered by all involved a best practice and is treated in detail earlier in this evaluation, as are other program elements.

SUMMER COURSES

From one PI:

> *For the summer program called Introduction to Marine Biodiversity and Conservation, the team has developed a combination of two courses (SIO295 & SIO295L) that are both required. They provide lectures on ecological, economic, social and legal issues related to marine biodiversity and case studies on socioeconomic and legal issues along with lab work on major biological taxa, field trips on biodiversity in situ, computer labs for informatic tools. Due to the expense of lab work and field trips, SIO 295L is open only to IGERT and Masters students. The Lecture/Discussion course, SIO 295, is open to all students.*

Almost all of the students conveyed strong emotion and deep connection to both interdisciplinary thinking and team-based training gained during the summer intensive course at the beginning of their IGERT experience. According to the students, the summer course was both innovative and a "headliner" for the program; "a great kickoff."

From Students:

> *We were exposed to different disciplines out in the field co-mingling, synthesizing, more*

problem solving lectures; however many one-way lectures, rather than problem sets; he learned more from field work than from any aspect of his training. Field trips are key. Too much of the other courses don't take into account different perspectives – the summer work is not replicated in the other courses, he thinks the one or two field trips are insufficient. He really liked the "willingness to pay" field trip where they interviewed folks. He thinks the students are considered already pre-disposed to interdisciplinary by the presentation process.

First summer of IGERT – all IGERT cohorts and masters students are together in a small setting – you really get to spend quality time with your IGERT team & major professor – tackling real world problems – talking through ideas. This is a situation worth creating again however – people tend to go off after the summer session – there should be more programming similar to that experience – across the cohorts – instead they are left with only their crew who are doing similar research. The PhD and masters students are basically divided – the PhD students felt sorry for the masters students "they paid so much money and they have to live in little trailers – we never see them"

There needs to be better follow up on the work we were doing in the summer course I gave several specific suggestions for follow up courses with related case studies and multi-disciplinary perspectives.

Great way to meet professors, many ideas going around, but you end up taking courses in all of these things and there is way too much overlap. The fall/winter IGERT classes are bad – after the summer session they are ready to go – they have the general overview. Keep the summer course but make the fall/winter IGERT courses solutions oriented – make it practical and structured as a working group. The momentum is high after the summer; keep it going.

The summer course plus three electives was overkill after the summer course. "We get the point." We don't need to keep talking about MPAs – once you get the concepts you should be allowed to move on.

The summer class was held on Hubbs 4500 and it was a bad room, the chairs are terrible, it was way too dark, it was migraine inducing, there were three others who would get migraines as a result of the class. However, I liked the discussions.

The MSEP – the interdisciplinary seminar in fall/spring is variable in quality – it really depends on who is teaching it. For me it was redundant to the summer course.

From Faculty:

On the science and policy courses after the summer session: there is up & down – I think there should be more follow-up to the type of work conducted in the summer session – more informal seminars.

EVALUATORS' INTERPRETATION and RECOMMENDATIONS:

The summer course is clearly a best practice, well done and sets the stage for the IGERT program at the beginning. There is a great opportunity to keep building on momentum and good reviews and "institutionalize" so as not to be dependent on current PIs. The work associated with the summer course has required significant effort by the faculty, and may be progressing towards a heavy maintenance stage where other faculty or possibly staff or students could assume leadership roles in the process of organizing the events.

A few students referenced basic logistics including confinement to dark classroom, three students mentioned that the room was migraine inducing, too many PowerPoint

presentations. While impossible to please everyone, some of these issues could be resolved with student input and problem solving to address the basic logistics.

Many students note that the course was so strong that subsequent courses in the first two semesters were letdowns. Specific suggestions for follow up courses included focus on related case studies and expanding the multi-disciplinary perspectives. Others felt that experience was enough for the interdisciplinary experience and strength in ones field was necessary afterwards.

A Student Suggestion: *Make the 2nd year project a requirement in the first year just after the summer session with the first two semesters:*

1. *Developing the project*
2. *Getting the proper team members*
3. *Identifying the budget*
4. *Getting the funding*
5. *Plan for implementation*

Year 2 is the time when the project is implemented and then evaluated and presented.

Question 8

Question 8: What near-term outcomes are attributable to the IGERT program?

Many of the people interviewed identified positive outcomes associated with faculty and the students. The IGERT PI's and staff in the 2005 annual survey to NSF identified the following list of indicators of growing faculty engagement in interdisciplinary training:

- *Faculty increased their participation in non-home-discipline meetings, conferences, and similar activities. We routinely have faculty from various departments in our planning meetings and international conferences.*
- *Faculty are teaching new courses that cross-traditional disciplinary boundaries.*
- *Several natural science faculty now incorporate social science subjects.*
- *Faculty are using new pedagogical approaches.*
- *Some faculty are using mock testimony and other techniques to give students training relevant to non-academic settings*
- *Faculty are team-teaching courses across disciplines more often. All of our new IGERT courses are team taught across the natural and social sciences*
- *Faculty are sharing mentorship of students (other than membership on dissertation committees) across disciplines more often. This is now very common.*
- *Faculty are participating on multidisciplinary dissertation committees more often. The students are just now forming these committees but several planned dissertations will clearly have natural and social science faculty on the committees.*
- *Faculty are team-teaching courses across disciplines more often.*

It is safe to say CMBC IGERT has created a more fertile atmosphere for such engagements and may be an important pre-condition for expanding faculty comfort level in seeking cross discipline collaboration.

The simple fact that CMBC existed before IGERT as an entity on the campus of SIO/UCSD is a significant near-term outcome. The organizational structure within the SIO/UCSD campus spotlights the subject matter of conserving marine biodiversity, a highly interdisciplinary and applied field. It is safe to say, that as a result of IGERT, CMBC has become a well-known entity on campus.

From a staff member:

> *It is important to note however, that even without IGERT, CMBC would likely still exist as a sponsor of meetings, seminars, etc. But IGERT funds provided the student body mass and administrative support to really make a difference.*

As one administrator noted:

> *CMBC/IGERT has been a single focal point for non SIO professionals, faculty, researchers and grad students to address marine issues and climate; (UCSD faculty and students) never used to talk with SIO, we have been an isolated institution; social science students are now far more interested and involved in these areas.*

At the highest level of administration at SIO/UCSD, there seems to be very strong support of the broader context of IGERT with respect to quality of the students, academic quality of the program as well as funding and incentive structures. The new Director of SIO/UCSD Tony Haymet noted the following during the interview:

> *IGERT is one of the reasons why I took the new job as SIO director – things like the summer course and the masters program – these all have beneficial effects on society. There is a great potential here for science to influence policy. I want to take what they're doing at CMBC and apply it to 3 or 4 different areas here – applying the same kind of cross-discipline programming.*

One notable near-term outcome has been the creation of a new Masters of Advanced Studies degree in Marine Biodiversity Conservation (MAS). Since this was the first masters program approved by the university on the SIO campus, this new program represents significant change. The program was designed to both support the IGERT program financially, as students in the MAS program pay an annual tuition of $30,000, and designed to provide positive interactions as the students from the MAS program and IGERT take the summer course together. A condition for acceptance into the MAS program is to have had three years or more in the professional world, preferably in a field related to marine conservation. While not a formal requirement, the program was designed for students to have institutional sponsors who would pay the tuition for the one-year program. While the benefits and costs, program mechanics and associated issues are beyond the scope of this evaluation, it is important to note four aspects of the program that are summarized here from the student, faculty and administration interviews:

- The IGERT staff and core faculty developed this program in line with the strong vision, mission goals of IGERT, and therefore the success of both programs are interrelated and equal emphasis and effort needs to be addressed towards program assessments and improvements.
- The MAS program represents a clever entrepreneurial effort to support the IGERT program providing a potential for one aspect of financial sustainability after NSF funding ends. This new financial structure challenged traditional administrative arrangements and required significant effort to simply create the mechanisms for the program to work. Due to the significant effort of the IGERT staff and PIs, and the support of the new Director of SIO/UCSD, a positive administrative arrangement has been agreed upon in late 2006 and the financial benefit from the program will continue. This is a significant short-term outcome

and model for change within SIO/UCSD.

- During the interviews, IGERT students and faculty expressed an understanding of the program purpose yet many identified significant challenges associated with the mechanics. It may be in the best interest of IGERT and CMBC to provide a forum for feedback and potential solutions.
- The MAS program was hugely expensive in time and energy, not to speak of funds; it takes a great deal to sustain such an enterprise.

Other structural elements of the program that are considered as important pre-conditions for short-term outcomes include the following:

- Mini-grant program: students develop a formal research proposal include a detailed budget in order to secure a small grant for their research. The $3,000 ceiling is used to assist students with travel and logistics and the model has been used to secure additional funds to support the research activities. Some students use this funding for an individual research effort; others have combined it as a joint research experience as part of the IGERT 2nd year curriculum.
- International internships: this program intends to expose IGERT students to a variety of non-academic settings during the second summer. This program provides up to $9,000 of travel and logistics support and would not be possible without NSF support of IGERT. Most, but not all, students take advantage of this opportunity to broaden their horizons. In principal, all students are supposed to do this but not all internships are international. In addition, the ten students from the first cohort were exceptions to this requirement. It is required for all other IGERT funded students and is an option for those IGERT associates who are US Citizens.
- Collaborative research: two students have used the structure of the IGERT program to conduct research in collaboration with other UCSD IGERT programs. One example is a partnership with the IGERT in Computer Vision where a student is developing methods for analyzing underwater images.

The commitment to international work is directly connected to the program's vision and goals of creating global change agents and has lead to a growing familiarity with different cultural perspectives and the ability to work with scientists and other collaborators from different cultures.

The fact that they exist as part of the IGERT structure allows students a variety of integrative applied experiences. These experiences have strong potential to grow networks of colleagues, develop skill sets, and lead to the development of specific work products such as articles that appear in refereed publications, conference presentations, conference publications, posters, etc. Another important product has been the strong focus on students developing public service announcements (PSAs). These are non-traditional products for PhD and Masters training and demand a team of students to communicate in a language that is both highly creative and understood by the general public. It is notable that some of these products have been used in direct advocacy campaigns. The website www.shiftingbaselines.org is an ideal example of communicating conservation of marine biodiversity that was developed by one of the IGERT PI's. Competency in both traditional and non-traditional methods of communication build strong capacity for communicating results and inspiring action to target audiences and is a necessary enabling condition for integrative short-term outcomes.

When asked about positive outcomes associated with the students, there were many examples during the interview process:

From Faculty:

IGERT trainees in general are more creative, outgoing and have excellent public speaking skills. They are more interested in solving real-world problems and building interdisciplinary collaborations to achieve their goals. Although these qualities are not required for success in research, we found that IGERT trainees are more likely to establish lasting relationships with visiting faculty and collaborators that will impact their long-term research goals.

The final payoff may not be immediate regarding the student's careers…but now they're developing an understanding and mindset that will prepare them well for the future.

Our success in all areas is attributed primarily to the selection of cohorts whose motivation, interests and disciplines work well to create the teamwork and multidisciplinary environment for which the program strives.

In addition, the course work developed by the IGERT program focuses on team projects and presentations to a variety of audiences. We have specific communication coursework during our summer course. This intensive course includes traditional communication methods provided in an Aldo Leopold workshop format, non-traditional communication methods such as writing for a web site, and Internet blogs, preparation of public service announcements and film media. Four PSAs were produced in two days time by four teams in this year's summer class.

Workshops are created and provided to give trainees added experience when a need is identified. We have had two such workshops in GIS technology. The IGERT program established a joint teaching/research lab to provide hands-on research using state of the art PCR equipment and computer programs to analyze data.

UCSD Office of Graduate Studies and Research provide ethics training on a regular basis for all graduate students. This period they included: Ethics and Survival Skills: Successful Publication, Teaching and Research Ethics.

IGERT has rejuvenated me. If I hadn't been doing this I don't know what I'd be doing. The biggest success is seeing the quality of the IGERT kids improve each year. They become colleagues, there is a contrast between the typical SIO student and the IGERT student, with luck they will leave us in the dust.

Not only are students getting interdisciplinary exposure, but faculty are able to also talk with students regarding interdisciplinary topics. This program has identified need for interdisciplinary training and the need for someone in the middle who understands the domain, we're producing students that no one else is producing.

EVALUATORS' INTERPRETATION and RECOMMENDATIONS:

The range of program elements described appears to create a mosaic of meaningful experiences for the IGERT student. These program opportunities are structured to fit together to extend one's competency and skill set, in a way where no one factor is primary. Since the graduate dissertation is the program capstone, and is the primary output it may be valuable to both learn how the many program elements contribute to the dissertation process.

It may be that the value of these diverse program elements bears fruit further downstream for IGERT students. [27] As such, participation in a novel interdisciplinary

[27] Smutylo, Terry. *Crouching Impact, Hidden Attribution: Overcoming Threats to Learning in Development Programs*. Block Island Workshop on Across Portfolio Learning. May 2001

program may have few outcomes, impacts and changes that can be predicted with any level of certainty. Moreover, changes that do occur are highly specific to particular individuals in particular circumstances. The patterns of change within the individual experience is of great interest in order to look at the whole program and make mid course adjustments[28].

Question 9

Question 9: How has the IGERT program represented change in the educational experience at SIO?

A central goal of the CMBC IGERT project is to change the educational experience at UCSD and SIO. Since October 2003, when this IGERT program started, the CMBC /IGERT program staff and PIs have developed a number of program elements that represent interdisciplinary change at UCSD/SIO, and many have been discussed previously in this report. This section explores how the IGERT program elements influence institutional culture, policies, and structures.

The recent national study of IGERT programs commissioned by NSF and prepared by Abt Associates reveal important insight into these issues on a national scale.[29]

> *Administrators indicated that support for interdisciplinary graduate education at research universities is substantial and growing, and in general IGERT projects are situated at universities that support interdisciplinary graduate education in a variety of ways. Most IGERT department chairs report that their university supports inter/multidisciplinary graduate education (81 percent) and that over the last five years their university's support for inter/multidisciplinary graduate education has increased (75 percent).*
>
> *In general, university support for interdisciplinary **research** is stronger than that for interdisciplinary **education** at IGERT institutions. For example, twice as many IGERT department chairs report that their department supports cross-departmental faculty research collaboration (78 percent) compared to cross-departmental faculty team teaching (44 percent). IGERT faculty members also perceive much higher support for interdisciplinary research activities: 72 percent report their department chair values and rewards inter/multidisciplinary research and collaboration, while only 32 percent believe that interdisciplinary teaching is rewarded in the tenure/promotion process at their university.*

At SIO/UCSD, there are some concrete examples of support of the mission of the IGERT program by the Administration of SIO/UCSD. For example, directed financial support has been identified for the director of CMBC to expand the diversity recruitment initiative. Policies allowing new education programs at the masters level (MAS program) and creating policy to allow large portion of those funds to support the

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[28] Patton, M.Q., Qualitative Evaluation and Research Methods. 3rd Edition. (Thousand Oaks, CA Sage Publications, 2002) p. 525

[29] Carney, Jennifer, Deepika Chawla, Autumn Wiley, Denise Young. *Evaluation of the Initial Impacts of the National Science Foundation's Integrative graduate Education and Research Traineeship Program*. Prepared for the NSF Directorate for Education and Human Resources, Division of Research, Evaluation, and Communication. Abt Associates, Bethesda Maryland, February 2006. p. 51

development of the IGERT program is a significant indicator of administrative support.

Other indicators beyond IGERT and CMBC are the development of the UCSD's Environment and Sustainability Initiative (ESI) established in 2005 *"as a catalyst for change, providing the intellectual infrastructure to effectively tackle big problems and generate concrete green solutions for business and governments, both locally and globally. The ESI also promotes environmental multidisciplinary research, education, service, and learning across the campus, and corporate and public sector partnerships. In addition, the UCSD campus is committed to environmentally sustainable practices in all campus operations, from use of alternative transportation and energy to green building and design practices."*[30]

While the ESI initiative may have occurred without the IGERT program, its genesis came out of CMBC IGERT. It also provides another important access point to conservation that is not directly linked to IGERT.

The incoming Director of SIO Dr. Tony Haymet has been explicit with his strong support of IGERT interdisciplinary training:

> *IGERT is the greatest thing going, they provide good support for first year students and throughout the program. They will be the next generation of leaders. They intend to create situations for the students so they are comfortable in situations other than Scripps. Science is key, they need to be excellent scientists, but they are also training them to be comfortable talking to policy leaders, to speak-teach-communicate to business and government, right up to the policy interface.*

IGERT core staff and PIs indicate that these important educational policy changes at SIO/CMBC directed support for interdisciplinary research. They acknowledge this scale of change over a relatively short period:

> *The administration does not like to do things differently, CMBC is willing to take the flack, this is a forward thinking program, getting more time under our belt is enormous.*
>
> *Scripps won the cold war in the ocean, half of all Navy money from ONR (Office of Naval Research) research went to Scripps, this money drove the entire program. Now that the cold war is over we need to reinvent ourselves. IGERT is a way to address the global issues we face, new SIO Director Tony Haymet says we are in the business of saving the world, and if that's the case we need to figure out the best way to do that. IGERT and CMBC directly address this.*
>
> *The students are no longer tied to single professors work and their grants, IGERT helps students create their own way. While they are still tied into specific faculty members they are much more able to expand their horizons with IGERT and create their own focus for their dissertation.*

IGERT students who were interviewed report a feeling of positive institutional change. It is clear to many that the IGERT program and the experience at SIO/UCSD has had a deeply-felt personal impact as well as creating a common awareness that it will require more work than a traditional disciplinary Ph.D. program, and they have accepted the role.

From Faculty:

> *All IGERT Fellows are required to serve as a teaching assistant in one IGERT class. Many of the Fellows have taken advantage of opportunities to provide lectures in undergraduate classes. One outstanding IGERT Fellow… has developed an entire course outline for our Marine Science Economics and Policy class that will involve faculty from*

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[30] From the website: http://scrippsnews.ucsd.edu/article_detail.cfm?article_num=738

all the participating departments.

Our trainees have responded to public inquiries on many issues and most recently on a local issue: the dilemma of harbor seals at the "children's pool" in La Jolla and increased fishing pressure on shark populations.

The seal issue is an excellent application – local, applied, interdisciplinary. This project requires thoughtful solutions as a result of shifted baselines, a great point for dialogue with the public - full of conflict.

EVALUATORS' INTERPRETATION and RECOMENDATION:

Policy changes are often in the wake of culture changes. For example, in order to encourage interdisciplinary research, some institutions with IGERT programs report having tenure review teams that are themselves interdisciplinary and would potentially foster interdisciplinary research. This suggestion came out of the national study of the IGERT programs by NSF[31]:

It poses a fundamental question on how to establish the criterion for evaluating work that has no established standards while maintaining the highest expectation of quality. As one IGERT administrator explains, "it works like this: many traditional scientific disciplines, when looking at promotion/tenure, are looking at evidence that (faculty members) have initiated creative work. When (work has a) single author, it's easy to see. When there are ten authors (on a paper), on a subject that crosses disciplinary boundaries, it's harder to see."

If the administration wants to foster interdisciplinary work, they may need to provide clear incentives and recognition of promotion, tenure, and merit rewards for those who follow that path. At SIO/UCSD, many report a change in culture that supports interdisciplinary research and education, yet reinforcing policy changes are needed that both reward and encourage faculty interested in continued interdisciplinary collaborations. Joint faculty appointments may be another way to do collaborate beyond a core discipline. Collaborations between SIO and the Economics Department are a positive standard that could be expanded to other departments. Courtesy appointments and more formal affiliations with SIO were suggested several times by interested Faculty during interviews.

Since the inception of the IGERT program, CMBC/IGERT staff and core faculty have prioritized recruitment of underrepresented students. This effort has resulted in many positive outcomes and accomplishments reflected both in awards received by CBMC/IGERT staff and more importantly in the number of IGERT students from underrepresented groups. This commitment to diversity is reinforced through targeted recruitment strategies, modeling and learning from existing programs, and SIO administration dedicating resources to allow key CMBC/IGERT staff to focus part of their time specifically on diversity recruitment. An anecdote that may be a positive indicator of change from the public's awareness of the opportunities at SIO/UCSD comes from the Executive Director of CMBC:

Parents of two different high school students called me to inquire as to how best prepare their children for applying and being accepted to CMBC/IGERT. One was a local, from San Diego and the other was from Mexico.

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[31] Carney, Jennifer, Deepika Chawla, Autumn Wiley, Denise Young. *Evaluation of the Initial Impacts of the National Science Foundation's Integrative graduate Education and Research Traineeship Program*. Prepared for the NSF Directorate for Education and Human Resources, Division of Research, Evaluation, and Communication. Abt Associates, Bethesda Maryland, February 2006. p. 56

Peter Senge, in his book *Schools that Learn* expands this idea by reinforcing the idea of interdisciplinary training with the concept of values as students move along their path[32]:

> *This (Interdisciplinary training) has profound implications for our educational system. Education and the media are the two primary institutions that transmit values, norms, and expectations to people on a large scale. Everything that schools do is based on (often implicit) assumptions about the future ten to fifty years ahead, and about the people who will shape, and take part in, that future. The skills and sensibilities, the attitudes and qualities you plant as an educator today, are all seeds. They can lead to greater competitiveness and exploitation, or they can lead to qualities that would help people contribute to a world where you feel good about your great-grandchildren living. That is the context for asking what difference our respective theories can make not just to schools in particular and learning in general, but to the prospects of a sustainable culture.*

In this light, the CMBC IGERT represents profound change in education at SIO/UCSD.

[32] Senge, P.M., et. Al., *Schools That Learn: A Fifth Discipline Fieldbook for Educators, Parents, and Everyone Who Cares About Education.* New York: Doubleday, 2000