Bosque-Pérez, Nilsa A.; Force, Jo Ellen; Waits, Lisette P.; Eigenbrode, Sanford D.; Wulfhorst, J.D.; Cleary, Kate; Holbrook, Joseph D.; Galbraith, Sara M.; Bentley Brymer, Amanda L.; Rhoades, Paul; O'Rourke, Michael; Finegan, Bryan; Klos, P. Zion; Sibelet, Nicole. 2016. **A model for team-based interdisciplinary doctoral education.** In. *Science of Team Science (SciTS) Conference*, May 16-19, 2016 Phoenix, Arizona, USA.
University of Idaho, CATIE and CIRAD.

The IGERT Program is a National Science Foundation-funded initiative to foster interdisciplinary graduate education. The program develops innovative approaches to graduate education, catalyzes a cultural change in graduate education and is a collaborative model that transcends traditional disciplinary boundaries.

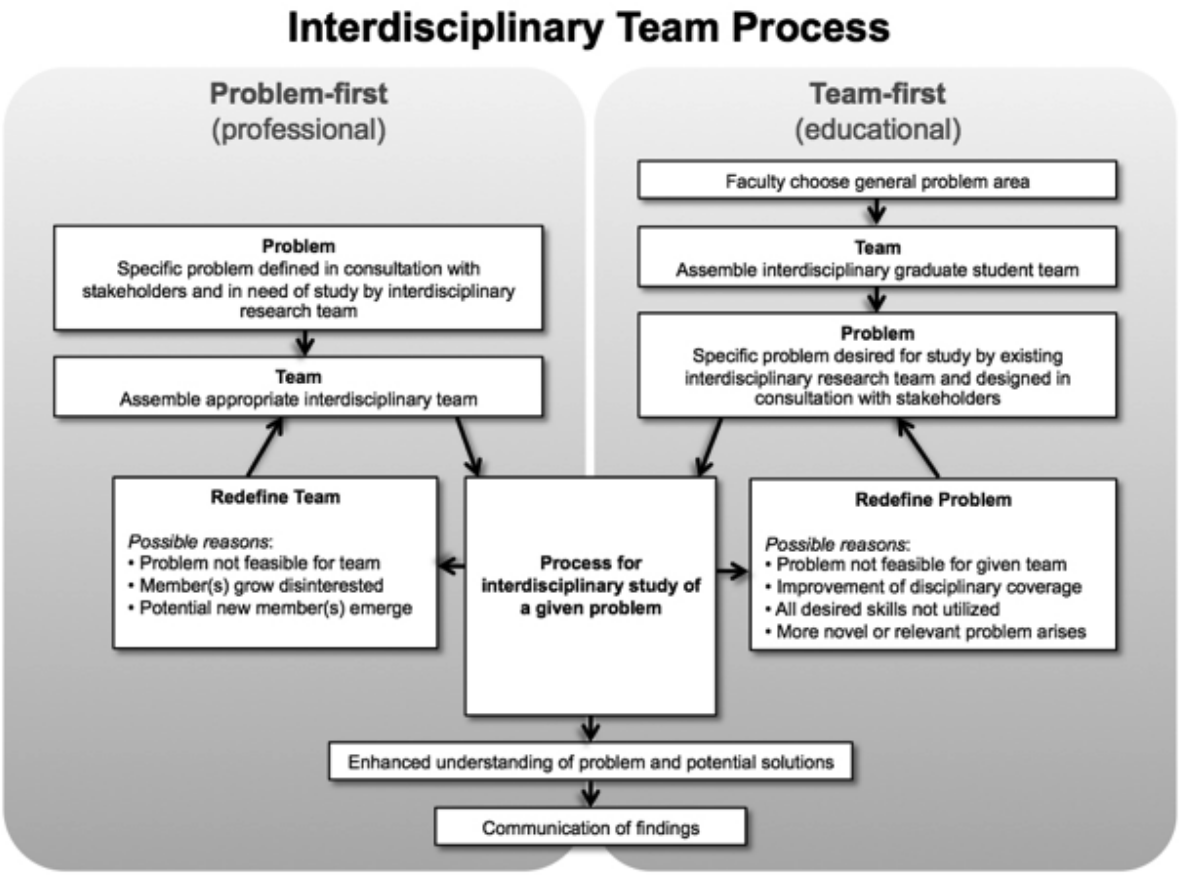
The University of Idaho and CATIE share the goal of environmental conservation and improved livelihoods. In 2001, the two institutes created a joint PhD program that addresses problems in coupled natural-human systems such as non-sustainable management practices, habitat destruction, climate-related changes, changes in policies and economic structure, human migration and impacts on livelihoods.

Since 2001 the program has had two interdisciplinary projects that have funded dozens of PhD students. The first project, from 2001 to 2008, entitled Ecosystem Management in Tropical and Temperate Regions: Integrating Education in Sustainable Production and Biodiversity conservation, focused on fragmented ecosystems in Costa Rica and Idaho and funded 18 PhD students. The second project, from 2009 to 2016, entitled Evaluating Resilience of Ecological and Social Systems in Changing Landscapes: A Doctoral Research and Education Program in Idaho and Costa Rica, focused on drivers of change, including climate change, and funded 22 PhD students.

The vision of this program considers that interdisciplinary research is required to tackle complex problems and that a new generation of professionals must be educated in a holistic fashion that facilitates well-grounded knowledge, skills in interdisciplinary teamwork, skills in interdisciplinary communication, ability to address problem-based questions, ability to engage stakeholders, a strong philosophical understanding and an international perspective.

Some elements of this program's educational model include identification of integrated research questions combining team members' disciplines, coursework to review theoretical underpinnings of interdisciplinarity and to develop integrated research team proposals to address the questions, meetings, workshops and social events to enhance team cohesiveness, engagement with stakeholders and interdisciplinary team research that yields joint dissertation chapters and publications.

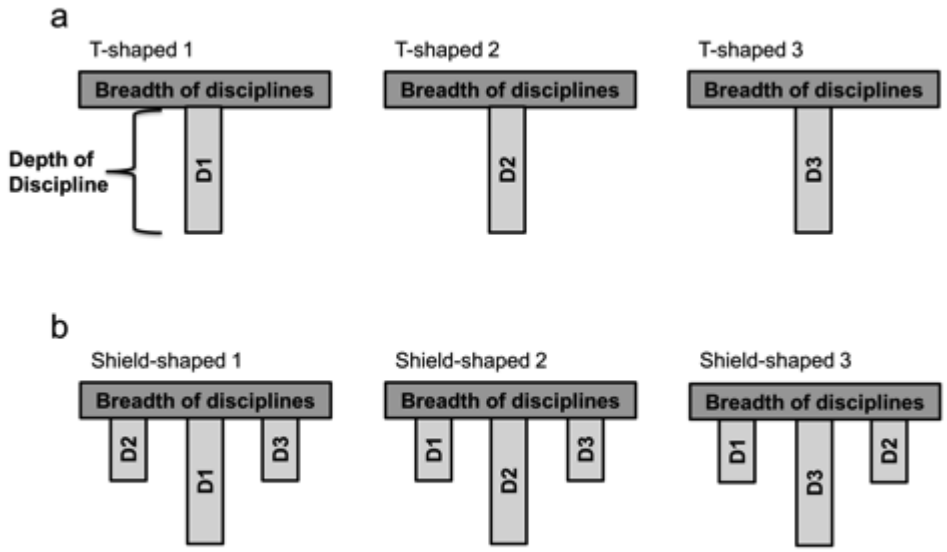
The following graphic illustrates the interdisciplinary team process.



The educational model consists of an interview process to select candidates and assemble research teams. Interviews were oral presentations by candidates highlighting their disciplinary and interdisciplinary expertise and interests. Following the four-day, on-campus interviews, faculty assembled teams and facilitated a team-building exercise that required candidates to work in teams over a two-day period on a hypothetical case study and culminated in team oral presentations. Upon selection, students completed disciplinary requirements and an interdisciplinary curriculum spanning biological, physical, and social sciences.

Students worked in teams to develop interdisciplinary research proposals and address related research questions. Students conducted joint field research and produced joint dissertation chapters and journal articles. Students interacted with other project teams to broaden understanding of principles, issues, and skills.

The following graphic shows examples of the T-shaped competency model and “shield-shaped” competency model.



Other components of the educational model include a summer immersion course, an interdisciplinary research methods course, seminar courses focusing on philosophical issues, resilience and ethics and the interdisciplinary component of the preliminary exams. The summer immersion course is a two-day retreat-style team-building exercise where students begin to explore disciplinary and interdisciplinary research questions and assess the tools they have to address them. Students visited potential research sites, attended presentations by stakeholders and met with stakeholders to identify researchable issues and gather ideas to help define the team’s research agenda. Students' regular interaction with stakeholders is imperative since research projects are tied to local communities and generate information for stakeholders and decision makers. The interdisciplinary research methods course enables students to develop conceptual models to help guide research, learn research methods and philosophical and theoretical underpinnings of other disciplines and develop interdisciplinary research proposals.

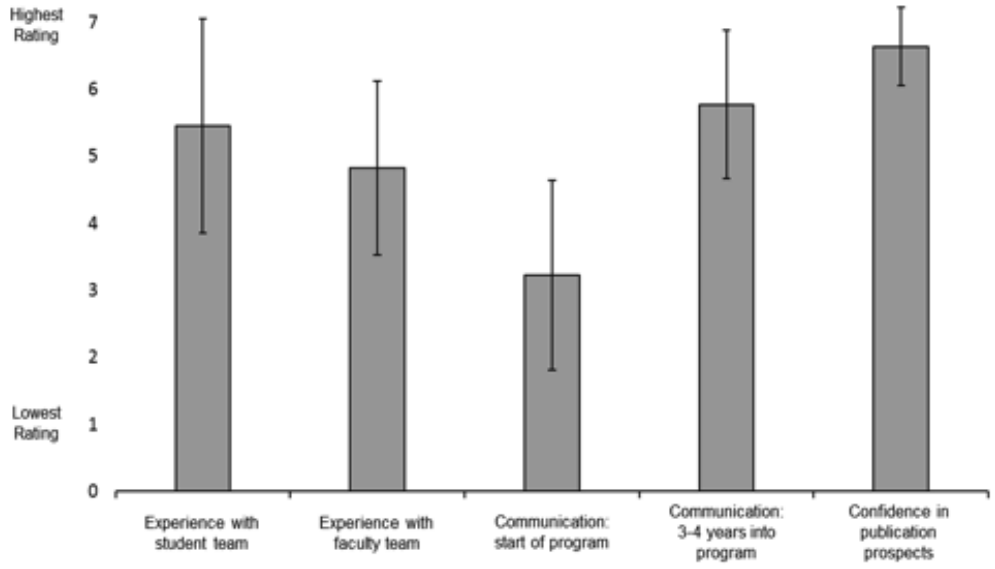
Annual meetings were held and alternated between Idaho and Costa Rica. At these meetings students presented results of disciplinary and interdisciplinary research. Additionally, such meetings provided participating students and faculty the chance to interact via workshops, team meetings, field visits and social events.

In order to ensure that teams were effective there was a faculty team leader for each team, there were regular team meetings of students and faculty, joint presentations at professional meetings and development of joint grant proposals. To promote interdisciplinarity, students were required

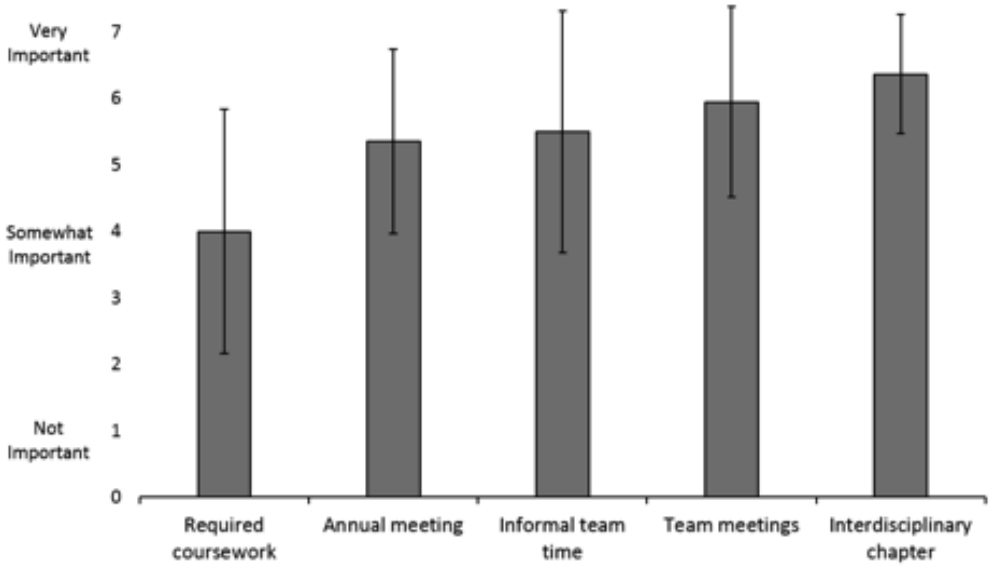
to collaborate throughout their tenure in the program. Furthermore students received close mentoring and support from multiple faculty.

There were three interdisciplinary teams in Idaho and three in Costa Rica. In Idaho, the Northern Rockies team engaged in evaluation and advancement of climate change communication, the Sagebrush team developed a framework for the assessment of social-ecological impacts within public lands, and the Palouse team did an evaluation of ecosystem services from prairie remnants. In Costa Rica, the Sarapiquí-San Juan-La Selva team evaluated effects of agricultural intensification on social-ecological systems, the Hojancha-Nicoya team assessed ecosystem services from ecological, economic, and social perspectives, and the Turrialba team examined matching scales of drinking water provisioning and management.

The following graphic shows average ratings of students' experiences with the educational model.



The following graphic shows student assessment of the importance of components of the educational model for their development as interdisciplinary scientists.



Regarding students' academic and professional outcomes, retention rates were 90% and 96% for the first and second project, respectively. Nine (50%) first-project graduates are now in academia; others are with international or state agencies and NGOs. Nineteen second-project students have graduated and three of them are now in academia. Graduates assert that the interdisciplinary experience and professional development opportunities provided were instrumental in securing and being successful in their current positions. Many are engaged in interdisciplinary research and education projects.

Also notable are the publication and presentation outcomes. The first project produced 10 interdisciplinary and over 35 disciplinary publications. The second project has produced 7 interdisciplinary and 12 disciplinary publications thus far. The first project made 100 disciplinary and 30 interdisciplinary presentations. The second project made over 90 disciplinary and more than 70 interdisciplinary presentations and over 60 presentations to stakeholders.