Capstone Experience Introduction

- Philosophy – experiential learning
- Course sequence & units:
  - Completing 2 units of 496, 498 and 499 **before** 495
  - Units from SFS or SEA
  - Flexibility
- Planning/How to get started
  - Know what you like and what we do
  - Take the initiative
- Creative Collaboration – 12:00-2:15, T/Th April 18 & 20th, 2017

University of San Diego®
COLLEGE OF ARTS AND SCIENCES
Environmental and Ocean Sciences

Research On Campus with Faculty

- Work with a faculty to develop a research project related to their research interests
- First step: learn about the research of faculty members in our department
- Second step: go talk to a faculty member that you are interested in doing research with
- The earlier you talk to faculty members the better, because we often have research students scheduled semesters in advance
- You can register for EOSC 496 to earn course credit for research conducted during the semester

SURE Program and Other Funded On-Campus Opportunities

- Some opportunities to be funded for research – usually during the summer
- SURE (Summer Undergraduate Research Experience)
  - Write a research proposal to conduct an independent research project with a faculty member over the summer
  - Due end of February each year
- McNair Scholars (email Ramiro Frausto: rfrausto@sandiego.edu)
- Other opportunities
  - NSF REU
  - Individual Faculty Grants

EOSC 496: Environmentally Focused Research Study Abroad Programs

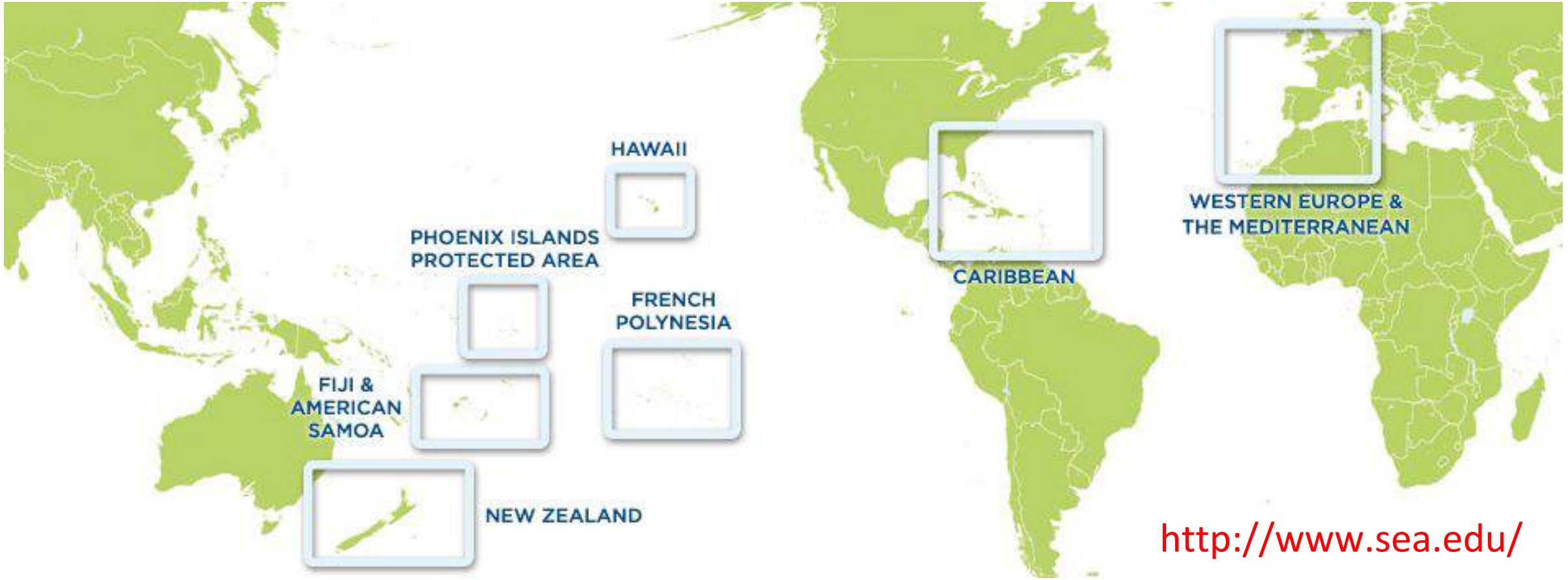
School for Field Studies (SFS):

- Rainforest Studies: **Australia & NZ**
- River Ecosystems & Envi. Ethics: **Cambodia**
- Sustainable Development: **Costa Rica**
- Himalayan Studies: **Bhutan**
- Biodiversity: **Peru**
- Wildlife Management: **Tanzania**
- Tropical Island Studies: **Panama**
- Marine Resource Studies: **Turks & Caicos Islands**

http://www.fieldstudies.org/programs

EOSC 496: Research through Environmentally Focused Research Study Abroad Programs

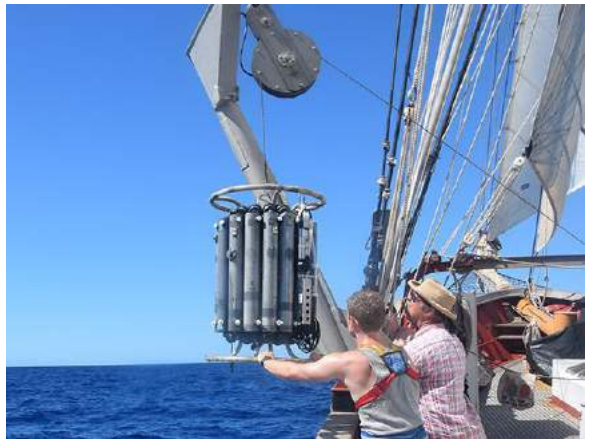
Sea Education Association (SEA):

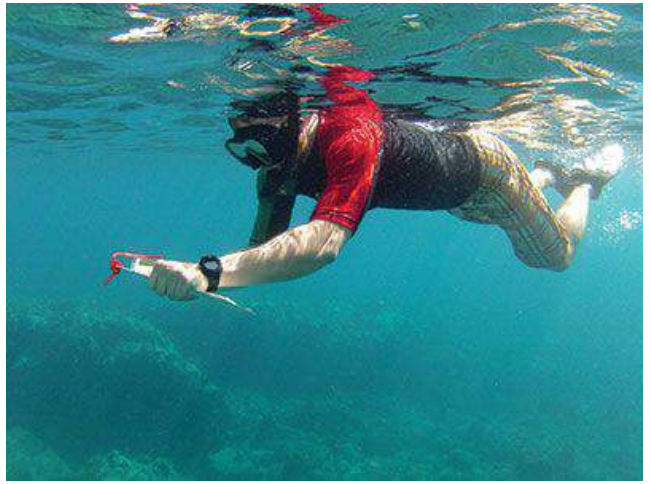


http://www.sea.edu/

EOSC 496: Research through Environmentally Focused Research Study Abroad Programs

Sea Education Association (SEA):





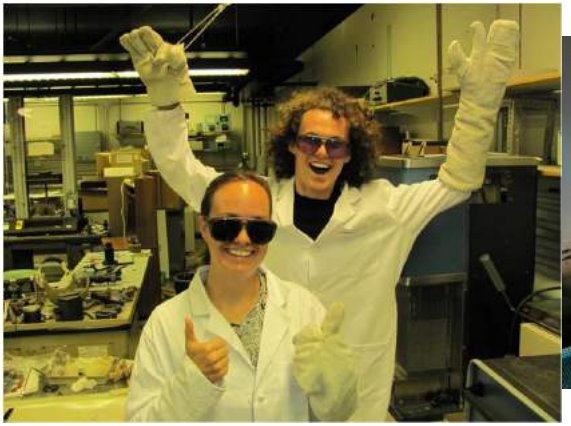
EOSC 496: Research through Environmentally Focused Research Study Abroad Programs

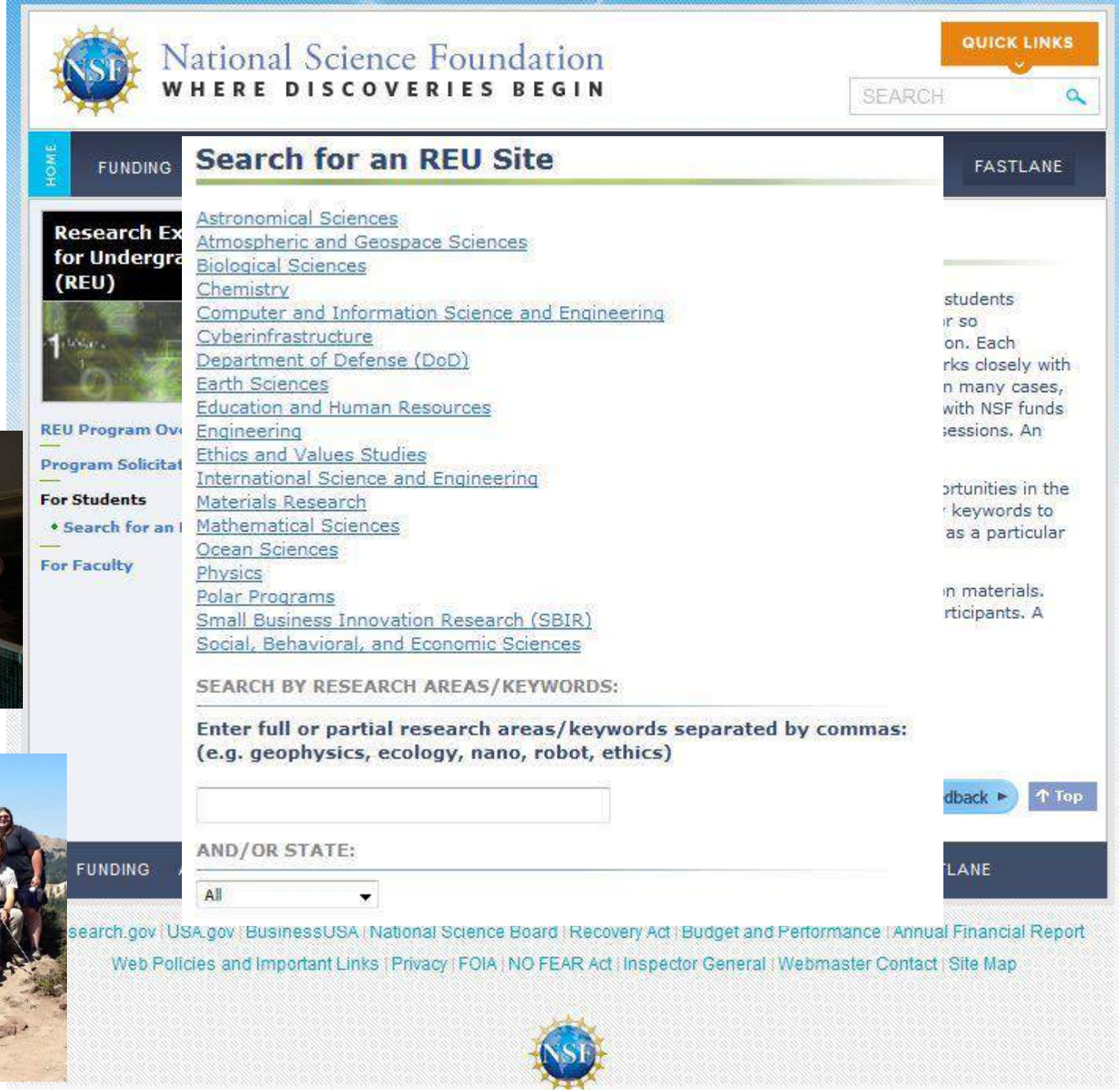
SEA RESEARCH THEMES:

- **Climate Change**
- **Cultural Sustainability**
- **Environmental Sustainability Policy**
- **Field Oceanography**
- **Marine Biodiversity**
- **Ocean Plastics and Marine Pollution**
- **Invasive species**
- **Island tourism impacts**
- **Land-use change and conservation**

Research Experiences for Undergraduates (REUs)

- https://www.nsf.gov/crssprgm/reu/
- National and International Sites





Internship (EOSC 498)
PURPOSE

1. To gain practical work experience in your field of study

2. To apply classroom knowledge to authentic work situations

3. To help focus your career goals

4. To establish contacts with professionals outside of USD

Internship (EOSC 498) Examples

PRIVATE COMPANIES

- Environmental consulting firms
- Environmental law firms
- Environmental laboratories

SCIENTIFIC RESEARCH ORGANIZATIONS

- Southwest Fisheries Science Center, National Marine Fisheries Service
- Hubbs-Sea World Research Institute
- Center for the Reproduction of Endangered Species (CRES), SD Zoo
- Space and Naval Warfare Systems Command (SPAWAR)
- Tijuana River National Estuarine Reserve
- Scripps Institution of Oceanography

EDUCATION

- Ocean Discovery Institute
- Sea Camp
- Local K-12 Schools
- Environmental camps

MUSEUMS AND PARKS

- Stephen Birch Aquarium Museum
- City of San Diego Parks and Recreation Department
- Torrey Pines State Reserve
- County of San Diego, Department of Parks and Recreation
- Tecolote Canyon Natural Park
- Cabrillo National Monument
- San Diego Natural History Museum

NONPROFIT AND POLITICAL ORGANIZATIONS

- USD Office of Sustainability
- USD Electronic Recycling
- Green Restaurant Association
- Think Green Live Clean Friends of Famosa Slough
- San Diego Coastkeeper
- The Student Conservation Association (SCA)
- Congressional Offices
- California Wolf Center

EOSC 498 Requirements

- **SET UP INTERNSHIP WITH EOSC INTERNSHIP COORDINATOR (Dr. Gray) BEFORE YOU START YOUR INTERNSHIP!**
- Work at an internship site for at least 45/hours per unit
- Attend internship class (4X per semester)
- Journals
- Biographies
- Resume & cover letter
- Presentation of a poster at Creative Collaborations

University of San Diego and the Career Development Center's Summer Internship Award

SUBMISSION DEADLINE: April 1st, 2017

The Summer Internship Award supports current University of San Diego undergraduate students as they pursue internships that advance their interest in exploring career options. Students granted this award are eligible to receive up to
$3000 that will be dispersed in three payments.

Zero Waste Intern for the Office of Sustainability

Erin Sommer BA in Environmental Studies
Intern Supervisor: Paula Morreale Intern Faculty Advisor: Sara Gray

University of San Diego

Organization and Mission

- The Office of Sustainability **was formed in Fall 2009**, proposed by President Mary Lyons to make our campus more green and eco-friendly
- The Office's goal is to seek out retrofits and initiatives to implement that **will help USD become one of the most sustainable campuses in the country**
- The Office of Sustainability is designated to plan and implement sustainable practices across campus as well as apply innovative applications to improve sustainability
- **The organization educates USD and the local community** regarding various ways to be sustainable in your everyday life
- They also run the **compost and garden** area behind Missions Crossroads, **complete office and home energy assessments**, as well as moderates the **Be Blue Go Green Team on campus** & started the **E-waste facility**

Zero Waste Intern

- Sticker design for paper towel dispensers at USD to help increase knowledge of consumption waste and to remind people to be more sustainable

- BYOT sign (on left) for Mission's gym, to reduce single use paper towel waste
- Zero Waste DYI signs (below & on right) to inform people what waste can be recycled & composed

My Job

- Expand and market Zero Waste events
- Created a Zero Waste marketing flyer
- Educate and sort waste at Zero Waste events
- Create DYI kits and signs for Zero Waste events
- Coordinate "Trash Talker" volunteers
- Initiate pre-consumer composting at SLP and Mission's Café
- Initiate recyclable to-go boxes for SLP dinners
- Initiate making undergraduate student teacher evaluations electronic
- Created sticker for paper towel dispensers to be displayed at Founder's Hall, Mission's gym, JCP, Sports Center and Manchester

Education & Animal Care Internship at the California Wolf Center

Tobias Nickel
Environmental & Ocean Sciences
University of San Diego

What is the California Wolf Center?

The California Wolf Center is a statewide non-profit organization headquartered in Julian dedicated to the recovery of wolves in the wildlands they once roamed. The California Wolf Center envisions a landscape where wolves thrive in healthy ecosystems and wolves and people successfully coexist.

The California Wolf Center accomplishes its mission through:

- **Conservation:** Partnering with stakeholders to implement proactive solutions that enable wolves and people to successfully share the landscape and leading the way in endangered species recovery programs.
- **Education:** Increasing awareness and understanding of wolves through engaging educational programs and public outreach.
- **Research:** Studying wolves' biology, behavior and history in California.

Wolves as Engineers of Biodiversity

Wolves are a *keystone species*, which means that they play a critical role in maintaining the structure of the ecological community affecting many other animal and plant species. The role that a keystone species plays in its ecosystem is analogous to the role of a "keystone" in an arch. If you remove the keystone, the entire arch collapses. Similarly, an ecosystem may experience a dramatic and often devastating shift if a keystone species is removed.

Reintroduction of Wolves in Yellowstone National Park

The Yellowstone ecosystem before and after the reintroduction of wolves in the park.

Where did all the wolves go?

Wolves used to be native to virtually all parts of North America. There are several factors that led to their demise including:

- **Population growth:** Unlike coyotes, wolves do not adapt well to urban development and as people moved west, wolves lost their natural habitat.
- **Human-wildlife conflict:** As much of wolves' natural prey was killed off (e.g. the bison), wolves began to go after secondary prey… livestock. This led to systematic hunting and the Anti-Predator Campaigns of the early 1900's, in which wolves were nearly extirpated in the lower 48 states.

Historic ranges of wolves

Current ranges of wolves

The areas in gray are where the North American gray wolves lived, the blue indicates the former territory of the Mexican grey wolves and the red is where the Red wolves historically lived.

My Role as an Intern

- Leading educational presentations and tours about wolf ecology and conservation
- Carrying out routine animal care for twenty-four resident grey wolves
- Assisting fundraising efforts, processing donations and non-profit administration tasks

What skills did I learn?

- Public speaking: Conveying complex information to diverse audiences in a way that is engaging and understandable
- Animal care: Learning how to care after and behave around large carnivores
- Ecology: Increased understanding of ecological principles, conservation practices, wildlife organizations, species survival plans, captive breeding programs, recovery of endangered species, human-wildlife conflicts, coexistence strategies and environmental policy
- Non-profit administration: Insights into management and operations of a 501(c)(3) non-profit organization

How has this experience affected my career choice?

My positive experience at the California Wolf Center has strengthened my desire to pursue a career in conservation, environmental advocacy and/or natural resource management. I find this to be a very rewarding field and want to place my talents in the service of the natural world.

Watershed Trash Assessments

By Rachel Stroud

Internship Summary

Watersheds provide over $450 billion in ecosystem services, such as provision of food, materials for manufactured goods, tourism, water for drinking, agriculture and manufacturing, and habitat for birds and wildlife including many species of concern (1,2). Plastic debris contaminates watersheds by breaking down into smaller pieces that are easily ingested and transported downstream, and that more efficiently bind with other contaminants in the environment (3,4). The provision of ecosystem services depends on the watersheds remaining clean and healthy. To find solutions to pollution, we need to better understand the source and behavior of pollutants in our watersheds.

I, therefore, helped with a project that examined the sources, pathways and fates of plastics in an urban watershed, the Chollas Creek subwatershed which runs through mid-city San Diego. We investigated the sources of plastics using trash transect surveys; the pathways by tracking the movement of tagged plastic bags, and the fate by analyzing fish guts for plastics.

Advisor: Theresa S. Talley, California Sea Grant, Scripps Institution of Oceanography, UCSD

Collaborators

Ocean Discovery Institute: L. Goodwin, R. Mothokakobo, D. Virden, G. Morales, M. Santos, D. Barajas, K. Kieu

San Diego Bay Debris Working Group: Christiana Boerger (U.S. Navy); Ted VonBitner, Terra Miller Cassman, Cara Simonsen (AMEC Consulting)

USD: C. Heller, T. Miller, R.Whalen

Responsibilities

I helped to collect and categorize trash from four canyons, track pathway plastic bags along Chollas Creek subwatershed, and determine the fate of plastics in fish from San Diego Bay.

Trash Transects

- Trash along 30 m transects was enumerated and classified by plastic number and human use to lend insight into consumer sources as well as entry location into waterways.
- Volumes of major trash categories were taken.

Plastic Bag Tracking

- Set out 10 labeled biodegradable plastic bags at the head of Swan Canyon and near the I-805 overpass on Chollas Creek.
- Each bag contained a TrackR® device to aid in relocation, bags were tracked after each major rain event.

Fates

- Dissected three species of fish from San Diego Bay.
- Looked for plastic in guts

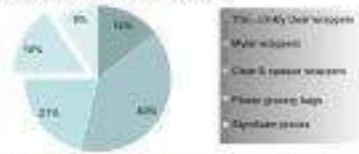
Rachel recording tagged bag locations along Chollas Creek.

Literature Cited

1. Nature 2005
2. WRI 2014
3. Rochman 2013. Environmental Science & Technology 47: 2439-2440
4. Rochman et al. 2015. Scientific Reports 5: 3263 DOI: 10.1038/srep03263

Impacts of research and my internship

Source



- 16% of common plastic packaging items are single-use plastic bags revealing how common these are in San Diego's watersheds

Possibilities why so many plastic bags are pollution watersheds

- Near by residential areas not properly disposing trash
- Wind blowing trash
- Storm drains depositing excess plastics bags

Pathway

- All plastic bags remained entangled in vegetation and/or trapped in pools after a 0.25" rain event.
- All plastic bags remained entangled in Swan Cyn, and 2 of 6 were found in Chollas Creek after a 0.75" rain event.

Reasons for not finding some plastic bags

- Entanglement in canyon vegetation or buried out of site and begin to breakdown
- Animals removing plastic bags
- Washed downstream during large rain events

Trash reduction strategies

- More community trash pick-ups
- Lobbying for stricter pollution prevention laws, such as a plastic bag ban
- Encourage use of reuseable bags

Tagged plastic bag along Chollas Creek

Fate

Types of fish	Total no. fish	No. plastics in guts	% plastics
Spotted sand bass	13	2	15
California halibut	7	0	0
Round stingray	37	12	12

- Micro plastics were found in 2 of the 3 fish species sampled
- Plastic originating on land eventually ends up in San Diego Bay
- Animals ingest parts of the plastic bags

Spotted sand bass and round sting ray- both species had microplastics in their guts

The results of these efforts will educate the public about the need for an adjustment in how watersheds are managed in urban areas.

Preparing to become a leader in science and conservation

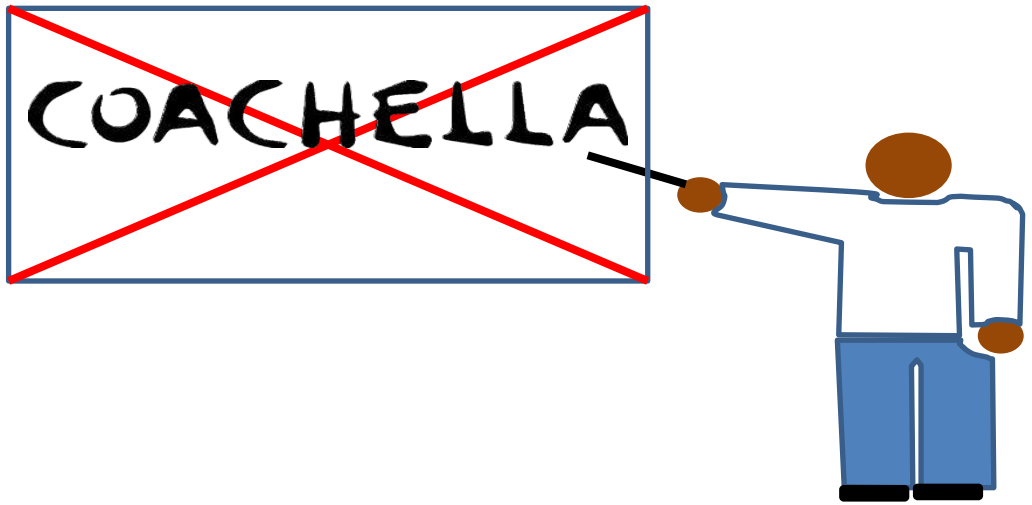
Helping with this project allowed me to see first hand the extent that San Diego's watersheds are polluted. As San Diego's population increases, watershed pollution rates will increase if nothing is done. There will be substantial consequences that will influence not only marine life but human life. It is crucial to educate people and start implementing more regulations to help reduce watershed pollution. I learned that without communication between organizations studies on the impacts of pollution in watersheds would not be possible. Every organization contributes to the study and the application of the results. Interning this semester has made me interested in environmental law. I potentially see myself in the future practicing environmental law and helping implement stricter pollution prevention laws.

Senior Seminar (EOSC 495)

What is senior seminar?

One unit class on how to make a professional presentation in your field of study

Meets every Friday 2:30-4:30 for one semester in your senior year



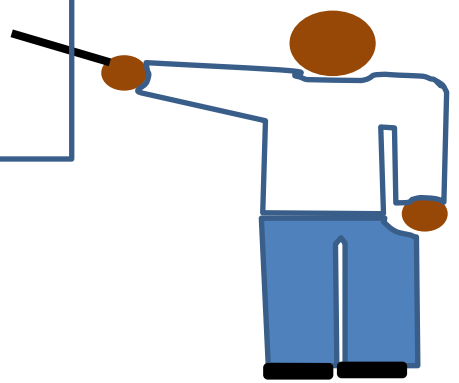
Senior Seminar (EOSC 495)

Step 1: Take 2 UNITS of

EOSC 496 (Research)

EOSC 498 (Internship)

Senior Seminar Poster Session



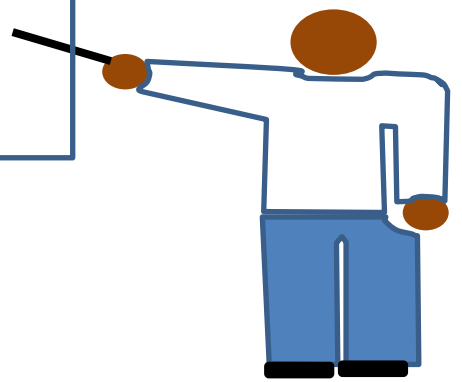
Senior Seminar (EOSC 495)

What if your research flopped or your internship didn't allow you to collect any data that you can present?

Expand on a laboratory/field project that you started in another class

- EOSC 301W (Research Applications), EOSC 473 (Climatology)…
- School for Field Studies (SFS), Sea Education Association (SEA)…
- Conduct a thorough literature review and synthesize your own thoughts on an approved topic

Not as easy as it sounds!

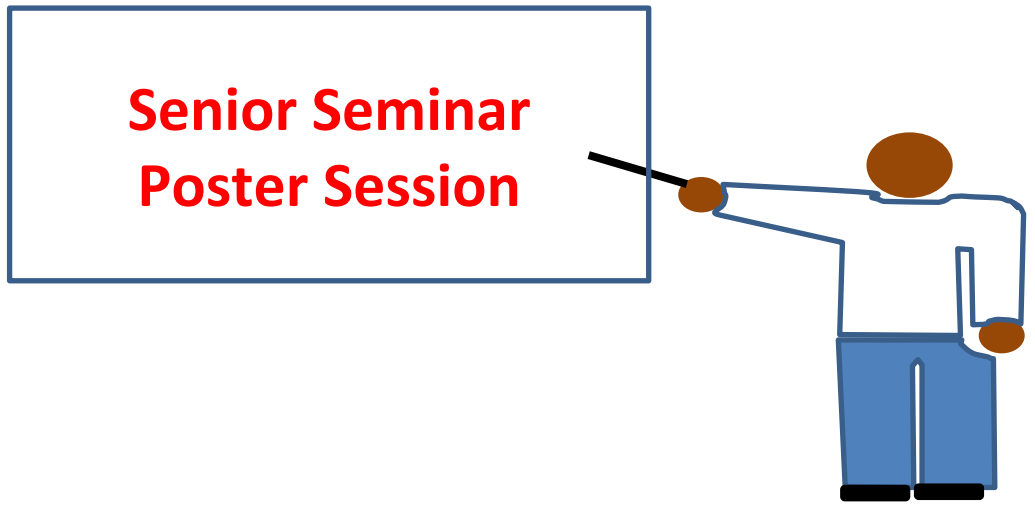


Senior Seminar (EOSC 495)

What should you complete before you enroll in Senior Seminar?

- Completed data analysis (Graphs & Statistics)
- Literature Review
- Conclusion and Interpretation

(these are completed as part of your research or internship units)



Senior Seminar (EOSC 495)

What you will present

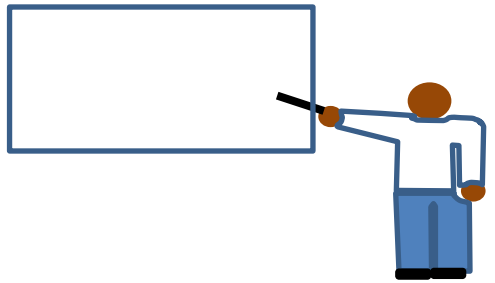
(1) What your question or problem was

(2) Why it was important to answer it

(3) Your results and interpretation

(4) How your topic relates to published literature on the topic

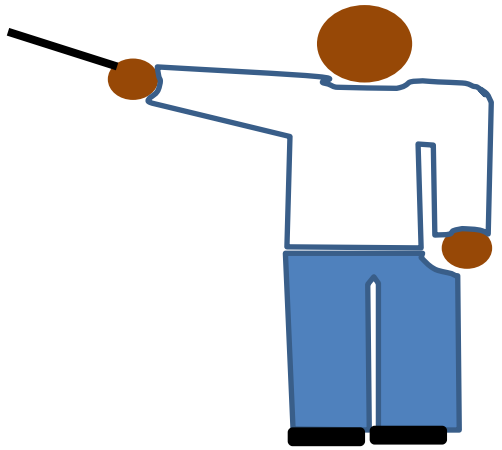
(5) How your topic relates to your major pathway.



Senior Seminar (EOSC 495)

Examples of Presentations

- School for Field Studies
- Literature Review
- Research at UCSD
- Research at USD
- SEA
- Internship
- Research at SDSU



Colonizing the Amazon:

Causes and Consequences of Andean Settlement in the Community of Pillcopata in Southeastern Peru

Rani Kumar, Environmental and Ocean Sciences Department, University of San Diego

Background

After Brazil, Peru has the largest extension of Amazonian forest (around 75 million ha). Since the 1960s, the government has sponsored many settlement programs to encourage the transformation of the forest territories into agricultural land (Smith et al. 2006). While policies have begun to shift, the Amazonian frontier in Peru remains a place of dynamic social change with many environmental concerns.

Timeline of Government Interventions in the Amazon

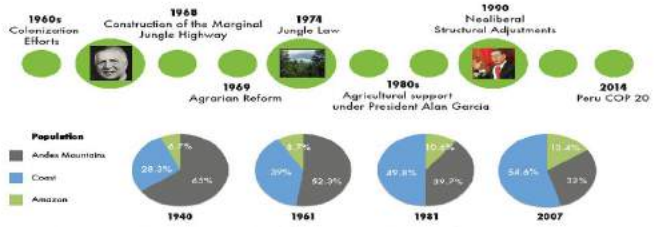


Figure 1. Change in population distribution in Peru from 1940-2007. The amount of people living in the Amazon increased by 6.7% over that time period. Source: Peruvian National Institute of Statistics and Information Technology (INEI).

Deforestation and biodiversity loss as a result of migration into the Amazon is a global environmental concern. Despite these increasing problems, little attention has been paid to the motivations and experiences of Peruvian *colonos* who have settled the southeastern Amazon.

Objectives

- Establish a historical timeline for the community of Pillcopata
- Document personal narratives of Andean migrants
- Understand Andean colonization patterns in order to guide local conservation efforts

Study Area: Pillcopata

- Capital of the Kosñipata District in the Department of Cusco
- In the Upper Amazon near Manu National Park
- Population approximately 2,800

Figure 2. A map of Peru marking the location of Pillcopata with an inset photograph taken from a viewpoint overlooking the community.

Methods

Purposive Sampling

- Two weeks of field interviews
- 21 individuals and three public institutions

Semistructured Interviews

- Demographics (e.g. age, place of birth etc.)
- Migratory experience (e.g. why did you move here, how did you find work?)
- Discussed emotional experience of the transition, adjustment to the Amazonian environment, and changes they observed since migrating to the area.

Results

Demographics

- Age range 27-90 years old
- Majority had migrated from neighboring Sierra regions (Figure 3).
- Average period of residence: 30 years

Figure 3. Most common places from which respondents had migrated. Map source: Colegio de Ingenieros del Perú.

Motivations for Migrating

- Lack of economic opportunities in home regions
- Logging, agriculture, and commercial vending employment options
- Family connections, especially for women

Historical Timeline of Pillcopata

Key Themes from Interviews

Postive Transition to the Amazon

- Some challenges: mosquitoes, biting flies, heat, and intense sun
- However, most interviewees focused on the positive aspects of arriving to the rainforest:

Vine en busca de la libertad.
I came in search of liberty.

Me ha llamado esta selva.
This jungle called to me.

La Amazonia es maravillosa, misteriosa, te invita vivir.
The Amazon is marvelous, mysterious, it invites you to live.

Place-based Identity

- Sense of adventure and 'wild-west' frontier
- Strong connection to Andean homelands including language, traditional dress, and *chacra* holdings
- Cultural exchange and intermarriage with local Wachiperi and Machiguenga communities
- Resentment of outsiders and foreign conservation groups
- Many no longer feel like migrants

La ley de la selva no es tan fuerte.
The law of the jungle is not that strong.

Todos tenemos nuestras chacras en la sierra.
We all still have our fields in the mountains.

Ya no soy colono, con tantos años soy de aquí.
I am no longer a colonizer, with so many years, now I am from here.

Conclusions

- National policy and the establishment of Pillcopata appear to coincide.
- Andean migrants have deep connections to the Amazonian environment.
- Because of this connection to the Amazon, future conservation efforts can likely create more sustainable and impactful projects in Pillcopata through community support and participation (Brooks et al. 2012).

Figure 4. (Left) Andean migrant coca farmers share their agricultural knowledge with student researchers from the School for Field Studies (SFS). (Right) Students from SFS Peru present their final research projects to students from the Technological Institute of Pillcopata and other community members.

References and Acknowledgments

I would like to thank all the respondents and the community of Pillcopata for their time, enthusiasm, and for being open to sharing their stories. Many thanks to my advisor Dr. Lisa DePaoli, the SFS and Villa Carmen Staff, as well as ACCA. Also, thanks to Professor Eric Cathcart and Dr. Steven Searcy for their support.

Brooks, J et al. (2012). How national context, project design, and local community characteristics influence success in community-based conservation projects. PNAS, 109 (52): 21265–21270.
Smith, J. et al. (2006). Why policy reforms fail to improve logging practices: The role of governance and norms in Peru. Forest Policy and Economics, 8:458–469.

Settlement of Barnacle Larvae Within the Southern California Rocky Intertidal

By: Diana Fontaine
Dr. Nathalie Reyns, Department of Environmental and Ocean Sciences
University of San Diego

Introduction

- Barnacles are model organisms for understanding how larval transport processes influence adult abundances (1)
- Barnacles, like many marine organisms, have a two part life cycle. Adults release pelagic larvae (nauplii) that develop offshore and transform into cyprids which travel back to shore, settle on a hard substrate, metamorphose into juveniles, and develop into adults (Fig. 1)

Figure 1. Barnacle Life Cycle (2)

- Studies have previously found that internal waves, observed through sudden increases in water temperature are important phenomena for barnacle larval transport (3,4). In addition, increasing wave height during storms may transport larvae onshore.
- **Objective**: observe how changes in settlement are related to water temperature and wave height
- **Hypothesis:** settlement is positively related to water temperature in the spring/summer and to wave height in the fall/winter

Methods

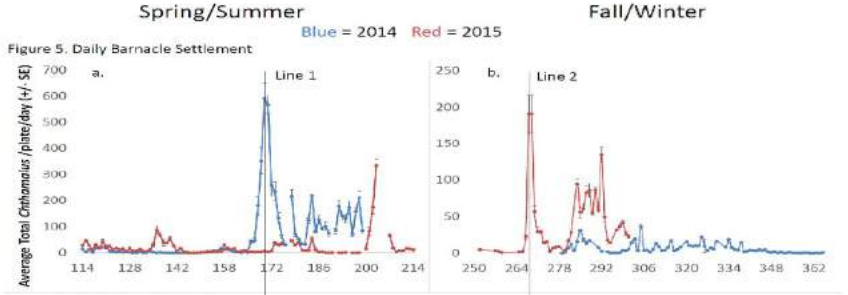
- Deployed PVC settlement plates at Bird Rock on 12 rocks throughout the rocky intertidal
- Collected plates daily during low tide and brought back to the lab to examine under microscope
- Identified and counted the number of cyprids and metamorphs
- Obtained temperature data (Fig. 6) from temperature logger deployed 2 m under water in intertidal

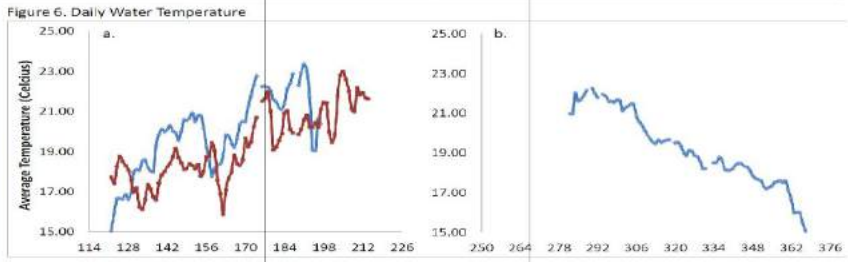

Figure 2. Field Site

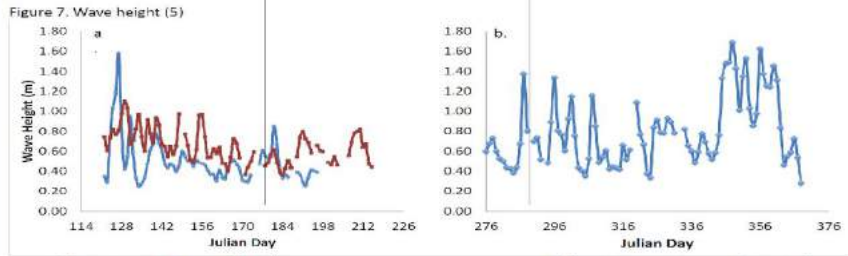

Figure 3. PVC Plate on Rock


Figure 4. Plate Under Microscope

Results







Julian Day 114 = April 24th

Julian Day 276 = October 3rd

Seasons	Average Daily Settlement	Average Daily Temperature (°C)	Average Daily Wave Height (m)
Spring 2014	69.01	19.93	0.50
Fall 2014	6.2	19.26	0.79
Spring 2015	22.19	19.33	0.65
Fall 2015	41.78	N/A	N/A

Figure 8. Settlement and Abiotic Data across four sampling seasons.
N/A denotes data still being collected and processed.

Discussion

- Barnacle settlement varied seasonally, and annually:
  - Relatively high settlement in spring/summer compared to fall/winter months (both years) may reflect the reproductive timing of *Chthamalus sp.*
  - Relatively high settlement in fall/winter 2015 compared to fall/winter 2014 may relate to changing oceanographic conditions due to a developing El-Niño
- There was **no correlation** between settlement and temperature or wave height (p-values > 0.05) but trends indicate that:
  - Settlement peaks corresponded to relatively high temperatures (Line 1) and low wave height (Lines 1 & 2)
- Other studies have observed larger barnacle settlement throughout entire sampling period (3)
  - Could be due to differences among sites
- **Future Studies** will examine the currents and oceanographic conditions of the Bird Rock region to identify the mechanisms that may transport larval barnacles to the intertidal. Rapid (over several minutes) changes in water temperature may generate fronts that transport larvae, so relatively fine-scale temperature changes may be better correlated with settlement than daily average temperature.

Acknowledgements & References

I would like to thank Dr. Nathalie Reyns for her continued support, Dr. Jesús Pineda, Anthony Basilio, and Kate Hargenrader. Funding was made possible by the National Science Foundation. Thank you Dr. Searcy and Prof. Cathcart for your support throughout senior seminar.

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Landfill Redevelopment: An Assessment of Phased Approaches

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Environmental and Ocean Sciences Department

University of San Diego

Introduction

This study looked at how phasing was being implemented during closed landfill redevelopment projects. Many communities are exploring options to repurpose closed landfill sites. This oftentimes includes achieving more efficient site utilization by establishing recreational areas.

- Phased development can reduce problems by adding amenities over time as the site changes and settles.
- **Phasing should add the least impacting amenities first then add the more impacting amenities to the site.**
- Phasing in this way results in greater site success rates.
- Phased development gives developers additional time to obtain proper funding.

***Figure 1**: Recreational area at North Wake Landfill Park.*

Methods

- One small and one large landfill redevelopment project were chosen for the comparison.
- A clear timeline of the amenities added during each phase was found, providing a basis for comparison.
- The two redevelopment examples were compared to phasing in accordance with site changes and settlement.

***Figure 2**: The evolution of the landfill sites over time.*

Results

Fresh Kills Landfill New York, New York	North Wake Landfill Raleigh, North Carolina
2,200+ acres	260 acres
Phased due to its extreme size	Phased for financial reasons
Phased in 3 stages (30 years)	Phased in 4 stages

Fresh Kills:

- Phase 1: Eleven miles of bikeways and pedestrian paths, soccer fields, and park entrances, signage, lighting, and parking.
- Phase 2: Extension of paths and trails, increase in natural setting open to the public, and structures for nonprofit and commercial ventures.
- Phase 3: Expand landscaping, enhance wildlife and habitat areas, and ensure that all park areas and programs are built out and active.

***Figure 3**: Phasing at Fresh Kills Landfill. Colored areas show the parts that will be completed by the end of the phase.*

North Wake:

- Phase 1: Elementary school, a community recreation complex, and athletic fields.
- Phase 2: Shelter, pathways, and vegetation.
- Phase 3: Recreational areas for kids and canines.
- Phase 4: Vehicular and pedestrian roads, pathways, landscaping, playgrounds, and a few structures.

Conclusions

- The two examples did not fully implement phasing in accordance with site changes and settlement.
  - A reverse order of phasing would have allowed for the site to change and settle more before adding the most impactful amenities to the site.
- Developers are not fully benefitting from phasing.
  - They are not considering how the site will change and settle over time, which could save a lot of time, effort, and money.

Future Considerations

- To allow for site changes and settlement, future landfill redevelopment projects should complete the least impacting phases first and leave structures and other significant impacts to the site for the last phase.
- Phasing due to the size of the site and for financial reasons can still be achieved when phasing in accordance with landfill site changes and settlement over time.
  - By saving the largest and most impactful additions until the end of the project, even more time is given to find funding.

***Figure 4**: A more ideal progression of phasing.*

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Using Rainwater Catchment to Promote Sustainability at USD

Spencer Dunlap
Dr. Suzanne Walther, Environmental and Ocean Sciences
Dr. Julia Cantzler, Sociology

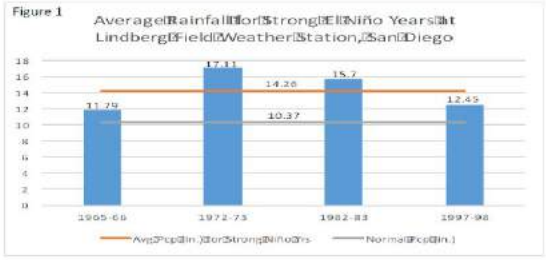
Introduction

California is in a state of drought emergency, and USD should be doing it all it can to conserve water. *What's Your 20?*, a water conservation group founded by Sterling Fearing, Hailey Gordon, Angela Hessenius and myself, urges USD students to reduce their personal water consumption by 20% this academic year. As an institution, USD is headed in the right direction, as we have reduced our water consumption by nearly 40% over the past 15 years.

Background

- When it rains in San Diego, water runs off buildings and overland into storm drains, eventually ending up in the Pacific Ocean, and picking up trash and other contaminants on the way. As part of the EPA's 2015 Campus RainWorks Challenge, *What's Your 20?* is collaborating with the USD Gardening Club, the Changemaker Hub, and several faculty members, to install rain barrels at various locations around campus. By installing rain barrels, we will capture water that would normally run off, and recycle that water to reduce our dependence on water from drought-stressed resources, as 80% of San Diego's water is imported from reserves in Northern California and the Colorado River.
- In collaboration with the USD gardening club, *What's Your 20?* is installing a 500 gallon rain barrel next to the community garden behind Missions Crossroads on November 19th, 2015. This barrel is a demonstration, or *proof of concept*, that we intend to apply to the Shiley Center for Science and Technology (SCST).

Figure 1



Methods

- I performed a literature review, focusing on strategies employed by the Office of Sustainability at the College of Charleston in Charleston, SC, to determine the effectiveness of rainwater catchment techniques, as well as barriers to sustainable initiatives on college campuses. I found that a primary barrier to sustainability projects is lack of economic incentive.
- Additionally, I looked at literature concerning the value of Green Infrastructure, focusing specifically on storm water diversion infrastructure. I discovered that the system-wide energy cost to treat and distribute 1 million gallons of storm water in California is 12,700 kWh, or 8.6 tons of CO_2. Using water catchment techniques, such as rain barrels, decreases the amount of water needing municipal treatment, thus saving energy and cutting CO_2 emissions.
- I used rainfall data to predict the amount of runoff that is generated at SCST during rainfall events. Average normal annual rainfall at Lindbergh Field, the closest weather station to USD, is 10.37 inches (figure 1). However, average annual precipitation during strong El Niño years is 14.26 inches. This information is relevant, because San Diego is predicted to experience a strong El Niño event for 2015-16, based on current sea surface temperature anomaly data.
- I used Google Earth to estimate the surface area of the SCST roof that drains into the proposed rain barrel locations (see figures 2 and 3). This surface area was cross-checked using a blueprint of the SCST roof, as well as a visual survey of the SCST building and roof space.

Results

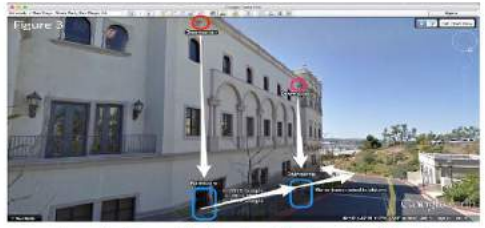
- The section of roof space (figure 2) that drains into the downspouts pictured in figure 3 has a surface area of 2,800 ft². For each inch of rain that falls, approximately 1,680 gallons of runoff is produced here.

Rainwater Catchment Rule of Thumb: 1,000ft² of roof space captures 600 gallons of water for every 1 inch of rain.

Figure 2

- If USD receives 14 inches of rain during the 2015-16 El Niño year (see figure 1), we could capture and store approximately 23,520 gallons of water using two rain barrels at this location (figure 3).

Figure 3



- The grassy area shown in figure 4 below is an ideal location for a below-ground cistern, as water naturally flows down gradient from the SCST rain barrels to this location. Also, water could easily be accessed at this location, and transported to other areas around campus via a water truck.

Figure 4

Rainwater Catchment Back-of-the-Envelope Economics:

- Cost of two 500 gallon rain barrels is $1,000 → cost of 5,000 gallon cistern is $7,000 → total cost of installing rain barrel-cistern system at SCST is $8,000.
- Cost of municipal water is less than a penny per gallon → we would need to capture well over a million gallons of water to see a return on investment.

Conclusion

- USD is a truly beautiful college campus, consistently ranked one of the top campuses in the country in terms of aesthetics, but unfortunately this beauty comes at a price, as water demands for irrigation are very high. Furthermore, students at USD seem to lack awareness of the severity of the California drought, and have little knowledge of where their water comes from, or how far it travels.
- My rainwater catchment proposal takes action to reduce storm water runoff and recycle rainwater to remediate the drought. Also, this is an ideal year to install rain barrels on campus, as scientists are anticipating a strong El Niño event.

Future Implications

- Eventually, USD could install a cistern (figure 4) behind the SCST building that would store water from the building, and capture storm water that drains downhill next to the building (figure 3). Although storm water is non-potable, it could be filtered and used to support a terraced drip-irrigation community garden on the hill immediately below the proposed cistern location (figure 5), further contributing to USD's mission to become a more sustainable campus by using recycled water to produce food.

Figure 5

- The rain barrel-cistern-community garden proposal pictured above has the potential to bring students from various academic backgrounds together for collaboration. This proposal requires educating students about water catchment, storm water diversion, water quality monitoring, agriculture, gardening, and composting.
- USD has a responsibility to educate its students, and although there may not be an immediate economic return on investing in water catchment, there will certainly be an educational one. This educational return is exponential, as water catchment has further implications for interdisciplinary collaboration and sustainability.

Acknowledgements & References

Special thanks to *What's Your 20?*, the USD Gardening Club, the Changemaker Hub, Dr. Walther, Dr. Cantzler, Dr. Yin, Dr. Searcy, Professor Cathcart, Keith Macdonald, and Rodolfo Cuellar.

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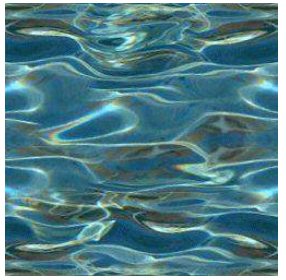
Interested in being a TA?

- **EOSC490:** Undergrad. Lab Assistant
- 1 unit of credit, P/F
- See liz: Office SCST250 or ebaker@sandiego.edu
- Bring ADD/DROP form to Dr. Gray for signature <u>after</u> talking to liz.



Fall 2017 Lower Division Labs

EOSC104 Natural Disasters:

- Wed. 9:05-11:55
- Thurs. 9:15-12:05
- Thurs. 2:30-5:20 (precep.)

EOSC110 Intro. to Geoscience:

- Mon. 2:30-5:20
- Fri.. 2:30-5:20

EOSC220 Intro. to Atmosphere and Ocean Science:

- Mon. 2:30-5:20
- Fri. 2:30-5:20

EOSC121 Life in the Oceans:

- Thurs. 9:15-12:05
- Fri. 9:05-11:55

EOSC123 Organisms and Ecosystems :

- Wed. 2:30-5:20
- Thurs. 2:30-5:20 (precep.)
- Fri. 2:30-5:20

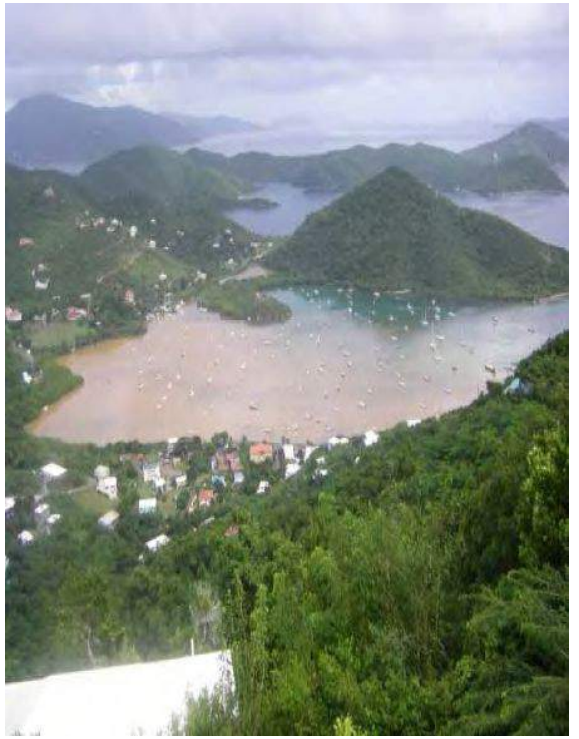
Michel Boudrias

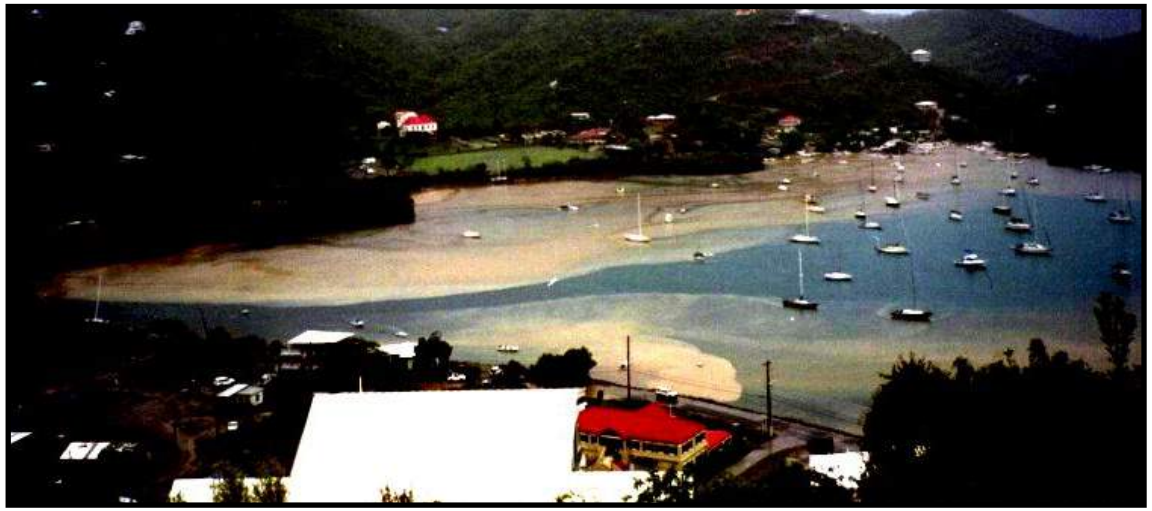
- I have three areas of research: functional morphology & locomotion of crustaceans, marine pollution impacts on beaches, and climate change education for leaders
- Are the ecosystems in the back of the bay affected by storm drain pollution?
- Benthic cores for macro and meiofauna analysis
- Water sampling for nutrient analysis
- Sediment samples (cores or hand samples) for grain size distribution

Sarah Gray

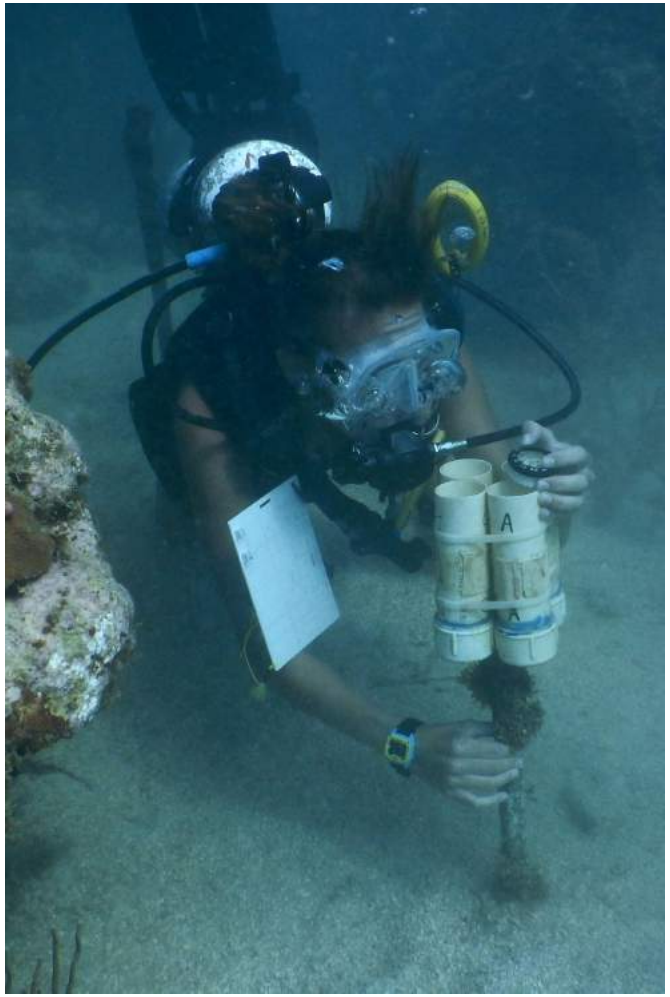
Research: Marine sedimentology; anthropogenic impacts in coastal systems (coral reefs)

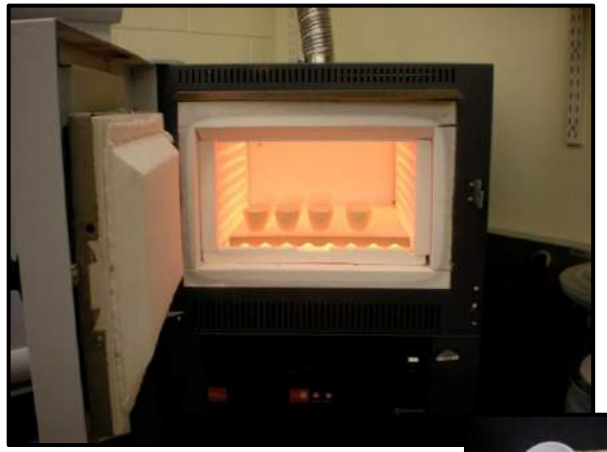
Current project: How watershed development (mostly unpaved roads affects sedimentation on coral reefs in the US Virgin Islands





Field and lab methods





Ron Kaufmann

- Responses of organisms, populations and communities to environmental variation across a range of spatial & temporal scales
- How do plankton community abundance & composition across Mission Bay vary in relation to changing environmental conditions on scales of hours to years?
- Plankton sampling (towed nets)
- Hydrographic profiling (multimeter, CTD)
- Plankton enumeration, identification (light microscope)

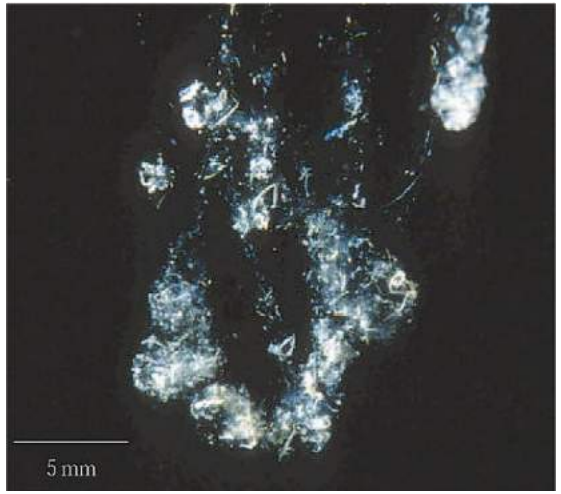
Beth O’Shea

- Dr. O’Shea is an environmental geochemist specializing in the investigation of metal contaminants in sediments, soil, and water.

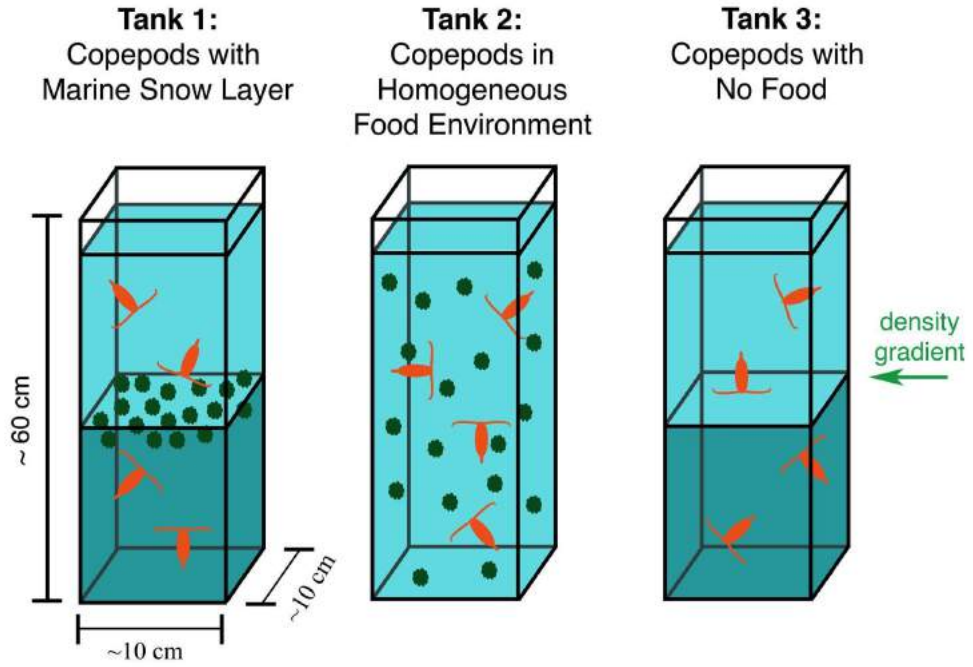
Jennifer Prairie

- Research interests include biological and physical interactions in planktonic ecosystems on the scale of individual organisms; currently looking at bio-physical factors affecting marine snow aggregates

- Use laboratory experiments to investigate properties of marine snow aggregates and copepod foraging behavior



Marine Snow (courtesy of Kiørboe 2001)

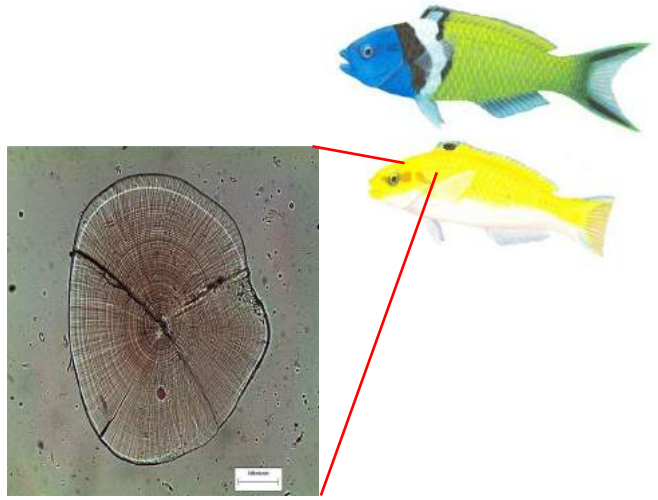


Copepod Foraging Experiments

Nathalie Reyns

- research interests: understanding the biophysical factors that impact larval dispersal; invasive species in Mission Bay
- Which biophysical factors allow larvae retained within/advected out of Mission Bay? Which invasive invertebrates persist within Mission Bay?
- Plankton nets and pump systems; measuring currents with ADCPs, CTD casts; ecological sampling with quadrats and along transects

Steven Searcy



- Early life history of marine fishes and invertebrates
- Establish a long term data set monitoring fish populations and their habitat in Mission Bay
- Trawls
- Light traps
- Standard Monitoring Unit for Recruitment of Fishes (SMURFs)

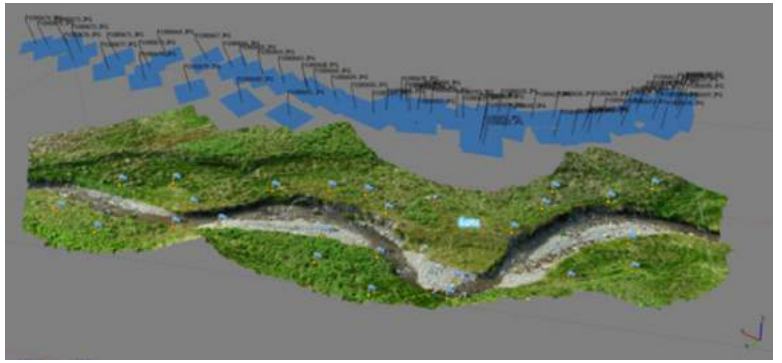
Drew M. Talley

- I am interested in issues of habitat connectivity within and between Mission Bay ecosystems.

- How does the presence of wetlands affect habitat use by mobile fauna?

- Benthic cores; Seining/Trawling; stable isotope analysis

Suzanne Walther



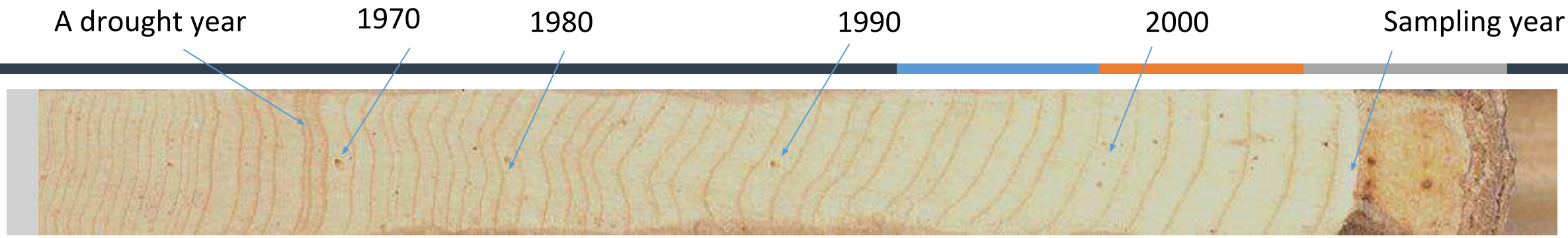
- Research focus: studying the role of natural disturbances and human land use in shaping river system dynamics (aka fluvial geomorphology)

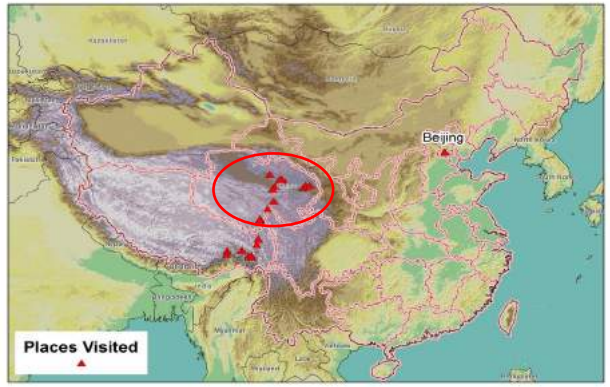
- How much sediment is accumulating in Tijuana Estuary and at what rate? How has El Niño influenced Tecolote canyon erosion and stability?

- High resolution GPS & imagery data collection (using a quadcopter); Sediment sampling; Remote sensing & GIS; Modeling

Project on mapping flash flooding impacts in Capitol Reef National Park

Zhi-Yong Yin





Research interest: terrestrial hydrological systems' responses to climatic variations.

Recent projects:

- Using tree ring data to reconstruct past climate in the eastern Tibetan Plateau.
- Changes of the Asian monsoon system during geological times through modeling.
- Applications of GIS and remote sensing