

NATIONAL SCIENCE FOUNDATION
Panel Summary Review

Proposal:1232779

PI Name:Reed, Daniel

INSTITUTION: University of California-Santa Barbara
NSF PROGRAM: LONG TERM ECOLOGICAL RESEARCH
PROPOSAL TITLE: LTER: Land/Ocean Interactions and the Dynamics of Kelp Forest Ecosystems (SBC III)

PANEL SUMMARY:

Panel Summary

Results of Prior LTER Support:

Results have been excellent, with many publications in top journals. There have been substantial new findings about how kelp beds function and interact with other coastal habitats.

How have concerns from the last mid-term site review been addressed?

Concerns from the mid-term site review have been addressed sufficiently. The mid-term review suggested the data system be enhanced to include better "linking", and SBC has added this capability

Intellectual Merit:

This proposal focuses on land-sea interchange and effects of climate change, and nutrient availability in the coastal kelp forest ecosystem central California. The investigators have also examined the effects of storms on this ecosystem, and how the ecosystem changes in response to ENSO and PDO cycles. The long term data set, particularly with the inclusion of the 25-y Landsat record, provides a chance to examine effects of extreme storms on this system. The results of this LTER research are extremely important to the future of this coastal ecosystem and relevant to others as well.

One major finding of this group is that the kelp forest dynamics is radically different during warm phases of ENSO, with nutrient poor ocean conditions and large wave events. Previous studies focused on this period and considered those to be typical. The LTER study has shown that the kelp forest functions quite differently under more moderate conditions (e.g since 2000).

The proposal is effective at describing the importance of the above factors in ecosystem function, and it presents some of the long-term data that have been collected during the study to illustrate these points. The proposal incorporates field experimentation in several ways, including large scale experiments (on fishing, particularly in context of the Marine Preserves) as well as smaller scale more mechanistic experiments. This group has refined models of nutrient dynamics associated with kelp forests, finding that nitrate uptake dominates during some time periods, but that kelp use substantial amounts of other nitrogen sources, such as ammonia, at others. Proposed research on the movement of buoyant plumes through kelp forests, and their associated NPP, nutrients and particulates, is particularly important for this system.

The effective use of state of the art bio-physical models and development of new models for the kelp

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system is a particularly strong aspect of the proposal, which is also clearly integrated with the overall research effort. The authors have explored ecological and ecosystem models, as well as hydrodynamic and land-use change models as part of the project, and they discuss the utility of these models in the proposal. Ecosystem connectivity is a consistent theme of the proposal, and one that builds on past measurements and observations.

This proposal was improved by providing examples of data collected (figures) over the course of the project, although none of the core long-term data sets were provided in graphs. Diagrams were clear and informative, and most contained enough data to be useful to reviewers. 25 years of data from Landsat was very powerful. Storm effects, compared to historical ENSO patterns, provided a new paradigm.

The PI and Co-PIs have been very productive in publishing results of this research, along with many of the other participants. The number of publications associated with this LTER is impressive, and it has had a large impact on several fields of investigation. The investigators are well known in their fields of research, and are having a major impact on training new scientists in coastal ecology and related fields.

The watershed work is excellent, the modeling part especially. It may be important it in terms of future effects, or effects of other pollutants, even if it is not now a large nitrogen input to kelp beds. It was not clear if the contribution of land inputs to the kelp beds has been significant over time period of study (see weaknesses), but should be continued as these inputs may change in the future, relative to ocean inputs.

The proposal has compelling central ideas. The trophic dynamics theme helps organize planning for future studies and there is a strong link of models to questions of trophic dynamics. Theme 1 c, using new MPAS, was an excellent opportunity well used to examine fishing effects. The hypothesis that plankton might subsidize the filter feeders in the kelp forest (and presumably the imported nitrogen would be recycled and then available to the kelp) is novel and very interesting.

Weaknesses:

This study has not yet provided sound justification that land-based inputs of nutrients play a significant role in any aspect of kelp dynamics. There is some indication that these are small compared to oceanic inputs, of nitrogen for example. More quantitative nutrient budgets will be required to provide this justification, and these budget terms should have been developed at this point. Figure 9 diagrams this but it would have been helpful to have even preliminary numbers for this figure. If land inputs are insignificant to kelp dynamics, then continuation of the terrestrial and freshwater components of the study cannot be justified as a component of an LTER unless they can be linked quantitatively to ecological processes or biological communities. In part this depends on whether the focus of the LTER is "kelp forests", or "coastal ecosystems containing kelp forests". In the latter case, all components could remain even if inputs to kelp are minimal. Finally, are there other pollutants coming from the land that could affect components of the kelp forest community, such as pesticides or other toxics? Where are the sewage outfalls, and could the nutrient input from them be significant? Is groundwater an important source of nitrogen? Cessation of upwelling during the spring and early summer along WA and OR coasts has been observed in the last decade, and could also happen in CA. There might be times when nutrients from the land or waste water are more important than in recent years.

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The effect of runoff plumes from the land was not developed; if there are typical trajectories of these plumes, is there an effect on the patches of kelp that intersect these plumes? How well can these runoff plumes be tracked? If the freshwater layer is very thin, the glider may not be able to adequately detect the thin freshwater plume layer (glider data in the upper 3-5 meters is often compromised by the change in velocity of the glide and by maneuvering associated with surfacing for data transmission or preparation for diving).

While the question on the role of phytoplankton blooms in subsidizing kelp forest consumers is very exciting, the plan for measuring long-shore transport of phytoplankton adequate is not adequate as presented. This is a difficult problem; for example, one glider will not be sufficient for assessing both long- and cross-shelf transport (as evidenced in the high temporal variability in Fig. 12).

Sediment denitrification in kelp forest may be a missing piece. DOM released from kelp is nitrogen poor; bacteria utilizing N-poor DOM will need to supplement organic nitrogen with inorganic nitrogen, and will compete with kelp for ammonium and nitrate.

The objectives of the manipulation experiment of kelp removal, to mimic wave disturbance by clearing annually, were not clear. What is the question? Are the plots big enough?

Another important component of climate change is CO₂ in the atmosphere, and in the water where it has already caused substantial changes in pCO₂, pH (acidification) and in the saturation state of calcium carbonate in seawater, which is a major determinant of organismal calcification. Inorganic carbon sources also affect photosynthesis of aquatic macrophytes, but this proposal does not discuss the potential effects of pCO₂ or acidification of the seawater. There are many factors that could cause pH and pCO₂ to vary widely in these habitats and the proposal should address this topic and recent research in more detail. The potential importance of acidification as an ecosystem level climate change driver should be considered in any analysis of coastal community change. Gretchen Hoffman and Pete Raimond are both also on OMEGAs project, but this connection was not described. Lisa Levin has a funded program working on pH in kelp beds to south of this region and could be a collaborator.

This proposal should address monitoring of pH, pCO₂, total alkalinity and/or total DIC as components of a coastal LTER. The basic data will be collected as part of that effort and pH is noted as an added component although it should be made clear that the frequency of sampling is appropriate for a system that may vary widely even over tidal cycles and over upwelling events. The effects of changing pCO₂ on vegetation and on calcifiers should also be discussed, even if experiments are not part of the current project. Given a consistent sampling program for inorganic carbon sampling, it should be possible to attract other research groups to conduct experiments on ocean acidification effects in this system. The proposal mentions "cross-site pH sensor arrays" but does not give details of location or who is deploying these.

Larval drift and settlement is part of the project but did not get much discussion. Are there hot spots for settlement? What has come from the long-term data set on larval recruitment? It would be nice to see results of this study graphically.

Temporal and spatial variation in land use, as opposed to land cover, could be incorporated to better model watershed effects on kelp forest ecosystems (Theme 2b). This is a logical extension of the

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proposed work, as changes in land use in large part drive changes in land cover. The SBC website boasts of the myriad of land use jurisdictions contained on the site, including parkland, military, residential, commercial, and coastal conservancies. It appears the Santa Barbara County Assessor's has the required sales and land use data to undertake this analysis, which is warranted if what is happening on the land is indeed affecting the kelp forests.

Collaboration with other LTERs was not described, and results from other coastal LTERs did not factor into the proposal. Nutrient fluxes, sea level rise and eutrophication are examples factors addressed cross-site. This project is inclusive of lots of local people but not those from other kelp systems. They should compare their kelp forest to others and interact more with researchers in other kelp-dominated systems; similar to their extension of Landsat analysis to other regions along west coast. Given they focus on a kelp system and thus have limited potential for cross-site comparisons, we recommend they pursue collaborative work with similar systems outside of the LTER. There were comments that they should justify that their findings are general, and this would be one way to do this.

Broader Impacts:

Strengths:

This proposal describes a substantial number of outreach activities that involve the LTER site. It is often difficult to tell how significant each activity is in terms of numbers of participants or total effect. However, this proposal describes a number of K-12 programs where students have opportunities to visit the site, use site data, and be directly involved in scientific investigations (e.g. through the REU programs). Many of these students are from under-represented groups. There is strong involvement with undergraduate and graduate education through several universities. There is also significant interaction with nonprofit and citizen groups that can make use of the data and findings.

Weaknesses:

Engage more stakeholders. There are lots here. This is not a strong component of the proposal as it stands.

Information management and technology:

Strengths:

The SBC IMS and website (<http://sbc.lternet.edu>) currently meet or exceed the standards of the current version LTER Network's Review Criteria for LTER Information Management Systems and Guidelines for LTER Web Site Design and Content. SBC's information management system is featured in the proposal Project Summary as being key to facilitating their research. The recognition of the importance of good data management practices is evidenced in the overall quality of their information management system.

The SBC IM system has made significant improvements in the previous funding cycle, most notably in the

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metadata database. The detailed lists of suggested improvements described in the mid-term review have been addressed and it is clear that SBC respected these recommendations and made use of the information to improve the Web site. The only suggestion from the mid-term review not addressed was the suggestion to provide data in other formats in addition to plain ASCII. This reviewer agrees with the SBC decision not to devote resources to creating NetCDF files at this time. ASCII is a much more logical format choice for in situ observational data. The GIS shape files might prove useful for inter-comparison and should be considered if resources can be made available to add this capability.

The data are easy to locate and access and information management appears to be very well integrated into the research program with training offered in best practices for data management. The metadata database improvements have been effectively leveraged to provide data-driven enhancements to the data access systems. The IM staff members are mindful of new technologies and preparing their content to take advantage of opportunities as they are identified. The system supports the research by providing project PIs with full access to all data, while restricting access to select data sets for limited periods of time if required.

Site management :

Strengths: Very effective and well organized.

Weaknesses:.. None identified

Additional Comments or Areas of Special Concern: None

Synthesis and Recommendation:

This is an excellent proposal and a very strong and productive program, that is addressing important issues in coastal ecology. The research has resulted in better models and new paradigms for how kelp forests function. The linkage of land and ocean is being explored further, and may lead to new directions for the LTER.

The panel's advice to NSF is: Renewal

This summary was read by the assigned panelists and they concurred that the summary accurately reflects the panel discussion.

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PANEL RECOMMENDATION: Renew

PANEL RECOMMENDATION KEY:

DNR:Do Not Renew, P:Renew on Probation, R:Renew