Interdepartmental Correspondence

October 16, 1998

To: Dr. Marsha L. Landolt
Dean and Vice Provost, the Graduate School

From: Dr. Jeffrey E. Richey
Professor, School of Oceanography

Re: PRISM Year 1 Progress Report

Please find attached the Year 1 Progress Report for the PRISM UIF project. This report is submitted on behalf of the College of Ocean and Fisheries Sciences, Arthur Nowell, Dean, representing the multi-College collaboration of PRISM.

THE PUGET SOUND REGIONAL SYNTHESIS MODEL (PRISM) UIF

http://www.prism.washington.edu

YEAR 1 PROGRESS REPORT

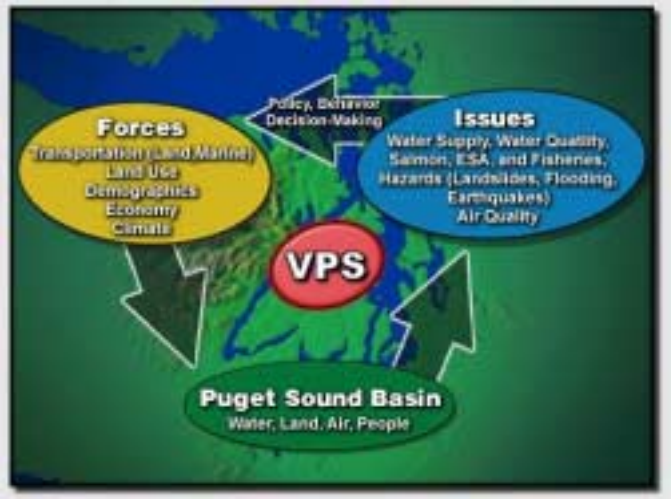
October 16, 1998

PRISM: in Principle and Practice

The central intellectual theme of PRISM is to describe and analyze the interactions of the human population with the natural environment of the Puget Sound Basin: *"What are the impacts of human population growth and environmental stressors and climate change on the structure and biological integrity of water resources in the Puget Sound Basin?"* Once these interactions have been identified, PRISM attempts to "capture" or model the dynamics in the form of a "Virtual Puget Sound" (VPS). The VPS then serves as the vehicle for education programs and can be applied to problem-solving of regional issues. It should be noted that creating a "virtual world" of this level of sophistication is a very complex technical (and sociological) challenge, and has been done in very few places worldwide (if anywhere).

Our intention with PRISM is two-fold:

- *To provide the engine for and to serve as the catalyst for finding solutions to important issues in the Puget Sound region. The mechanism for achieving this central role will be a sequence of linked education and research programs.*
- *To serve as a programmatic "role model" that serves to develop the organizational practices and educational-technology tools for cross-unit, interdisciplinary education programs. It is our goal that the PRISM model can be readily adapted by other departments or applied to other topics.*



The Year 1 progress of PRISM has involved work on two interdependent fronts. The first is defining the technical and logistical issues involved in developing the program itself. The second is establishing the protocols, or the "rules of the game," necessary to conduct major interdisciplinary, cross-unit, collaborative work at the UW. As is summarized in following sections, first year accomplishments included:

- *The Virtual Puget Sound "Version 1" was elaborated and made functional*
- *PRISM launched its overall Education Agenda, from Core Content to Innovative Technology*
- *PRISM established "working groups" across the University and with Regional Partners*
- *PRISM broadened its funding base (securing nearly $3 million in extramural funds)*
- *PRISM worked out an effective "management and business plan" for how to conduct such a project*

PRISM was conceived and is being executed to help the University of Washington and the region it serves meet the important challenges in what will be the increasingly crowded and competitive environment of the 21st Century. The societal effects caused by our growing population will push the limits of the Puget Sound region's ability to sustain the quality of life we have come to expect.

Solving the problems caused by regional growth calls for unprecedented cooperation between the regional educational and governmental institutions and the citizens of the region. The UW must be a key player in this process. It must find the means to transform itself from an institution focused on traditional, academic disciplines to one capable of supporting the multidisciplinary, multiunit research and teaching environments required to deal with today's complex topics. It must do this in the face of demand for increased access and increasingly crowded classrooms. These realities require that the university creates new and innovative education and research programs that incorporate educational advances made possible by information technology.

PRISM intends to be a long-term regional investment. While the funding base will evolve, the educational and research programs that PRISM has initiated do not have a specified "completion" date; they will be ongoing. At the core of the PRISM planning is the establishment of a "continuous" monitoring of Puget Sound, including real time measurements, long-term studies and long-term datasets. The UIF investment is not in creating a "snap-shot" of Puget Sound, but rather establishing the foundation (both technical and political) for remaining invested in our regional planning.

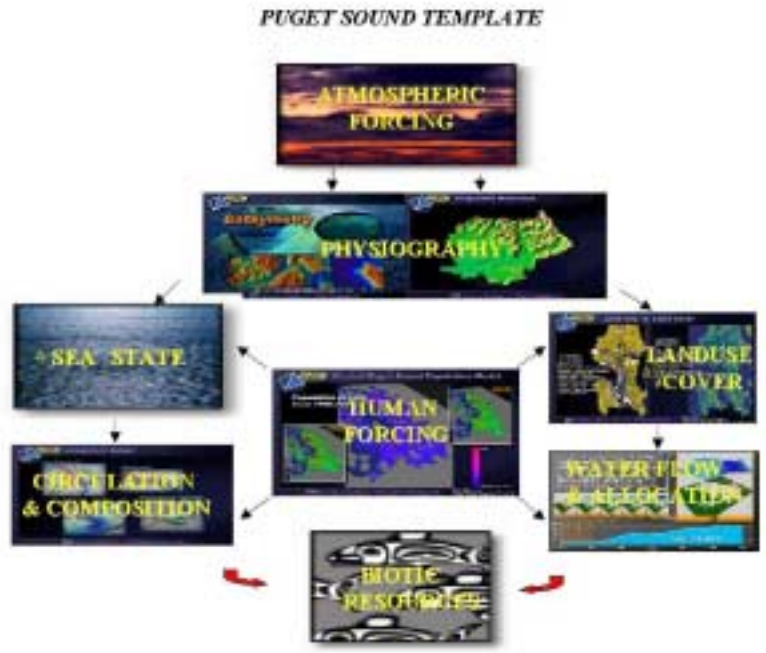
Significant progress on the linkages of Puget Sound research, education and outreach will constitute a transformation in how the UW does business, therefore PRISM's success is the UW's success.

YEAR 1 ACCOMPLISHMENTS

The Virtual Puget Sound "Version 1" was elaborated and made functional

For PRISM to have a significant regional impact, it must be focused on producing a highly comprehensive and interactive knowledge base of the Puget Sound Basin. This is the VPS. In Year 1, major effort went into defining what the VPS should be, for what purposes it must be developed and who would use it, how to build it (and how to most effectively use the UIF resources). The VPS is now defined as the combination of a "Puget Sound Template " and a "Visual Interface." The Template is the knowledge base, capturing information (from climate changes to demographics) as data layers in a digital format according to programmatically-defined rules of priority and documentation. To access and work with this highly-complex Template, PRISM is developing a series of software tools and graphical-user interfaces that, when combined, are referred to as the "Visual Interface."

<u>The Puget Sound Template</u>
The process of digitally representing the environment as a "Puget Sound Template," as a progression of knowledge layers, was launched in Year 1. The Template captures the multiplicity of time and space scales over which the Basin environment changes and which humans must respond to. The template incorporates spatial models of landscape and seascape attributes with a linked series of observations and computer models that analyze the flow of water within the environment.



- In Year 1, the meteorological processes that occur within our atmosphere are simulated by a "mesoscale atmospheric model," referred to as the MM5 (work lead by the Department of Atmospheric Sciences). The MM5 combines meteorological observations from both satellite and ground stations with weather predictions by National Weather Service models to create its own atmospheric simulations. The MM5 simulations predict the land and sea surface fields of rainfall, temperature, humidity, and winds. The Snoqualmie basin was used as a test region. In Year 2 the model is being set up for the whole basin.

- The slowly-changing attributes (topography, river networks, bathymetry, shorelines, and soil and sediment properties) of the surface of the Puget Sound Basin constitutes its physiography. In Year 1, the focus was to start working towards a "seamless" physiography that would continuously represent the basin from mountaintop to sea floor in a geographic information system (work lead by the Department of Geological Sciences and the School of Oceanography, in close cooperation with the USGS and DNR).

- The changing aspects of land surface cover and use are the physical expression of how humans impact the environment. A significant development in Year 1 was initiating a systematic remote-sensing program. PRISM acquired two complete sets of 30m multi-spectral satellite remote-sensing images from LANDSAT of Puget Sound for the years of 1991 and 1998. This data will allow PRISM to produce the only current regional landcover inventory, which will be made available to the public. PRISM will also use the two images to create the only regional landcover change detection analysis where the methods are controlled, documented, and reproducible. These results will also be made available to the public in 1999. PRISM is partnering with NOAA's Coastal Change Analysis Program and King County to contribute to this important regional project. (Work was lead by Geological Sciences, Urban Planning, and Oceanography).

- Preliminary descriptions of sea state were provided not only by existing data bases (in cooperation with the Department of Ecology), but by dedicated cruises of the UW oceanography ships, the *Thompson* and the *Barnes*. Plans are being made to augment these measurements with a Friday Harbor Laboratory boat. Detailed plans been made for direct monitoring of the Puget Sound water column with moored instrument arrays that will be capable of "beaming" their measurements, via the cellular phone system, straight to the classroom. Groundwork was laid for the use of remote sensing of sea surface color using new generation SeaWIFS satellites.

- The water "from" the MM5 model is distributed across the land surface and down river channels according to the properties of the physiography and land cover through a model, the "DHVSM." The DHVSM model takes the predicted rainfall amounts from the MM5, distributes the rainwater over the landscape and predicts river flow resulting from the runoff. The water runoff predicted by the DHVSM model can be fed into to a water allocation model to analyze the impact of water flow on water resource management practices in our region. (Atmospheric Sciences and Civil Engineering led the work).

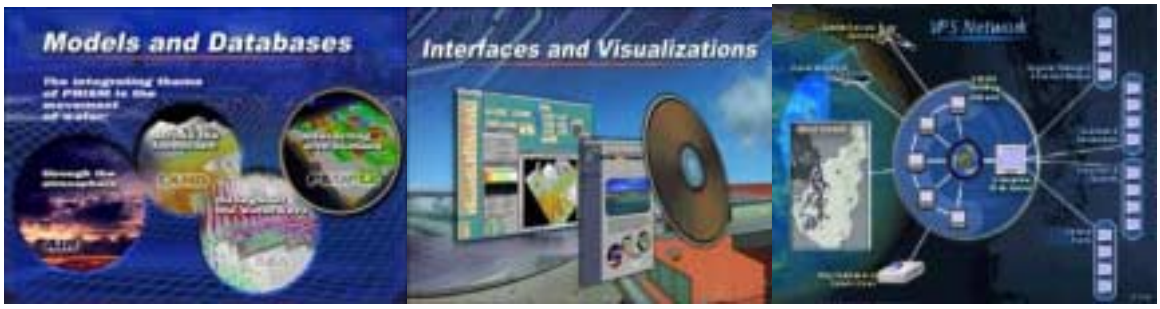
- After the water flows off the land and into the Sound, the "Princeton Ocean Model" (POM) is being used to model the circulation of water in the ocean basin (Oceanography). The model was run to simulate Puget Sound water circulation and stratification for a year, it has also successfully simulated the effects of tidal forcing and impacts of river flows into the basin. The POM is being improved upon by adding models for the biology and chemistry of the Sound so that it can be more accurate in describing and predicting the impact of water circulation changes on the ecosystem of Puget Sound.

- Incorporating the impact of human activities on the environment was the work of the "Human Dimension" team, in Urban Planning and Forestry. They addressed two aspects of particular interest to residents of Puget Sound: (a) the impacts of human action on the biophysical system, and (b) the socio-economic effects of environmental change in the Puget Sound. During the first year the team focused on four major activities: 1) development of a conceptual framework and modeling structure; 2) development of database and analysis; 3) building partnership with regional agencies; and 4) planning future steps for model implementation.

- Changes in biological resources (including salmon) are a consequence of changes in the physical environment. Work went into defining how these processes would be linked, specifically in the case of the salmon being affected by the pending ESA classifications (Fisheries, Forest Resources, NMFS).

The Visual Interface

A major focus in Year 1 was the development of a "Visual Interface." This work was led by a team from COFS, APL, the HITL, Computer Sciences and Engineering, UW Digital Library, and Oceanography. The Virtual Puget Sound is "brought to life" by wrapping the Puget Sound Template with the Visual Interface, creating a user-friendly, interactive virtual environment. The VPS can then be made available via the web to many different types of users. Interface development focused on the needs of users who want to interact with the Template and will include World Wed Web-based tools to access data base structures, create interactive visualizations and extract customized information from the models and data.



The computer requirements of constructing the Puget Sound Template and interfaces make it accessible to a wide variety of users are so great as to constitute significant challenges in information technology. The challenge for the VPS is to efficiently store and analyze data from multiple data sources in meta-data referenced mass storage and knowledge bases. These data are collected for widely-varying purposes on hugely disparate time and space scales; they also have extremely variable precision and accuracy.

Visualization of the data and model output is required for users to better understand the scope of the information available from the models. To facilitate delivery, the visualization products are distributed via web-based delivery mechanisms.

Related technical activities conducted in Year 1 included:

- Metadata: PRISM helped organize and hold the first campus-wide workshop on metadata, held in the Department of Geography "Collaboratory." At this workshop, PRISM became committed to working with the UW Libraries and participating with a metadata node hosted at UW. PRISM, in cooperation with the Digital Librarian, has agreed to standardize on the *Spatial Metadata Management System* software for maintaining the PRISM metadata.

- Database management: A core element of the PRISM project is the data that constitutes the Puget Sound Template. The Template will be housed on platforms and in formats that are easily accessed by a variety of end-users. The data layers that have been completed are now maintained in an index relational database management system that will be served to web-based clients through the developing technologies associated with SDE (Spatial Data Engineering) and Distributed Internet Collaboration.

- Data query: PRISM has entered into a partnership with software engineers at Mathsoft Corporation and will provide a test-bed for a prototype software package that enables desktop data queries of very large (>4 gigabytes) visual data sets.

- Extensive visualization work led to the production of a series of images and animations that were instrumental in "selling" PRISM across the region.

- Web sites with enhanced communication capabilities were set up, including an in-house experimental site for testing.

- *PRISM launched its overall Education Agenda, from Core Content to Innovative Technology*

The UW faces a series of challenges in undergraduate and graduate education, and in reaching out to the K-12 educational community in the Puget Sound region. The key "link" between all these challenges is that the development and use of the VPS as an integral part of the K-20 educational resources in regional educational institutions. Because PRISM is dealing with a "real-life" set of issues and problems, it is important that it works with "real people" to help find solutions. While PRISM cannot do anything about class size, it can develop innovative means of structuring and delivering content. As an interactive tool, VPS can provide a platform for experiential learning about our Puget Sound environment. It is a high-priority goal for PRISM to involve undergraduates directly in both the technical development of and classroom use of VPS. By providing integrated content, PRISM will provide a means for the university to effectively address instructional issues involved in interdisciplinary and cross-departmental teaching.

The critical Year 1 objective for the Education Working Group (all participating Units, led by the College of Education) was to design the set of guiding principles for how the PRISM education agenda would be executed. Briefly:

- Through the VPS, PRISM intends to provide all departments with a resource to teach skills and inquiry disciplines by allowing everyone to "look" at the same data. Instead of instructing with training data molded to fit the unique problem set, departments can create new courses and curriculum around a complex, but integrated and shared data base that becomes richer each day.

- Instead of the one-professor-to-one-research-question approach, PRISM is offering the opportunity for students and faculty to use a team-based approach to problem-solving. Instead of producing research findings that must be integrated and synthesized by the decision-maker, PRISM provides a model for education and research where the integration and synthesis of information is the product.

- When we speak of interdisciplinary research and education we are not talking about grouping together investigators with similar interests from various departments, but rather building teams of students and faculty that approach problem-solving from various directions. Evidence of this approach can be found in work in progress by the interdisciplinary team developing the "coupled model" which drives the Virtual Puget Sound. This group is synthesizing three different approaches to modeling the allocation of water resources using a hydrologist, a civil engineer, and a public water policy planner.

To meet these mandates, PRISM has pursued its education agenda during the past year on a number of fronts. Several courses now use PRISM resources; more courses using PRISM in their content are planned. The Education Working Group meets regularly to promote PRISM activities in University and K-12 education

Of particular note:

- Students in OCEAN 485 used PRISM materials as the basis for web pages designed to inform the layperson about a number of issues facing Puget Sound.

- PRISM co-sponsored, with the Department of Civil Engineering, the Spring 1998 quarter CEWA 520 Seminar Series. This series of lectures addressed the growing challenges of meeting the water needs and demands of the region in the coming century.

- The Education Working Group is collaborating with the Program on the Environment (POE) on the development of its curriculum. The intention is that PRISM materials will be used as the focus for "themes" in the new 200-level courses POE is developing.

- PRISM has established a working group to develop and sponsor campus-wide courses on GIS and remote sensing. A number of departments require their students to master these skills, and are not able to meet the increasing demand for the existing courses.

- PRISM provided money to fund the development of a curriculum unit on sewage treatment for Grade 8. Middle school students will use the water circulation model from VPS to study dispersal of sewage outfall by tidal currents and will write a report to King County Metro recommending a site for the new sewage treatment plant. This activity is also to be used in a science education course for pre-service teachers in the College of Education.

- The long-range PRISM intention of using "new technology" for teaching received a major boost, with the award of a major grant from the NSF for *Learning about complex environmental processes in immersive and non-immersive virtual environments* (below).

Specific courses to be given in Year 2 were organized:

- A new interdisciplinary course, "*The Puget Sound Basin and Salmon; Developing a Scientific Basis of Understanding*", will be offered in the Winter quarter, 1999. This course was developed as part of PRISM's response to the Federal decision to consider listing the Chinook Salmon as an endangered species.

- PRISM materials will be used in Urban Planning 200, an introductory course for Urban Planning majors, during the Fall quarter 1998. The focus of this course is on how decisions that urban planners make are influenced by water.

- In addition to courses which will be "using" PRISM data in the classroom, we are planing two course design to involve students in building the data set itself. The Winter Quarter course, Introduction to Remote Sensing (URBDP 467, cross listed in Urban Design and Planning, Geology, Forestry, and Oceanography, will be producing the remotely-sensed classified landcover data set. We plan on offering a Spring Quarter course related to "spatial analysis in watershed modeling"; again a course designed to extend the PRISM dataset to derived data layers for future research.

- P*RISM was successful in establishing "working groups" across the University and with Regional Partners;*

The issues that PRISM is addressing are very complex and cover much of the spectrum of the research and education mission of the UW. To deal with the logistics of mobilizing participants, a series of Working Groups was set up, where the subject of each group was a particular (cross-department) theme or area; the composite of which covers the PRISM "portfolio." But, while the extensive cross-departmental UW involvement is essential, it is not sufficient. PRISM requires the involvement of external Partners. Not only does UW expertise "not cover everything," if the Region is to accept and utilize what PRISM generates, it must also be at the table as Stakeholders vested in the process. PRISM established a "Partnership and Outreach" effort to ensure the long-term viability of PRISM through the development and maintenance of robust partnerships throughout the Puget Sound Basin. Partnerships are predicated on collaborative relationships within the working groups; outreach is predicated on providing PRISM technical knowledge, information and skills to a wider-ranging audience.

PRISM's visualization capabilities are a critical component for Partnerships and Outreach efforts. The communication of complex information about resources, inter-relationships and resource conflict presents challenges that can be addressed by presenting the information visually. PRISM visualizations are a powerful tool for presenting complex interactions, such as ecosystem function. By representing information in a visual format, it is also possible to reach a public increasingly accustomed to receiving information in a visual format. A number of potential program partners have discussed ways in which they would like to utilize PRISM's visualization capabilities.

Year 1 of this effort has focused on analyzing ways in which PRISM can address the information needs of the program constituents. The process has involved identifying strategic partners, critical issues, and relevant products, all in the context of the continuous development of PRISM's technical capabilities and organizational structure. A Partnerships and Outreach Working Group was formed, and a Partnerships Specialist was recruited and hired (with matched funds) to manage PRISM's partnership development and outreach efforts.

The project is now at a point where it is possible to go back to those entities whose interests and needs best match current PRISM capabilities. For example, strong ties are being forged with the King County Department of Natural Resources (direct involvement in treatment plant siting, combined sewer overflow, and endangered species issues), Department of Ecology (implications for development of South Sound), Department of Natural Resources and USGS (database development), Puget Sound Water Quality Action Team (regional development), and the National Marine Fisheries Service (endangered species).

An active Outreach agenda was launched:

- Communication of PRISM project plans and goals was done through a series of departmental seminars, invited presentations at a variety of external audiences, including local governments, Federal and State agencies, non-governmental organizations and business interests;

- Data acquisition/leveraging and the initiation of cooperative relationships with Odyssey (a maritime museum) and the Seattle Aquarium, both important local public education institutions interested in utilizing PRISM;

- Formal presentations at the Puget Sound Research Conference and the upcoming Marine Technology Society (with papers published in proceedings);

- Positive public relations presence has been maintained through news articles (*Seattle Times*, *University Week*, and *PERSpectives (*the Newsletter of the Pacific Estuarine Research Society),

- Development of a full color brochure, and the broad dissemination of a flyer promoting PRISM;

- Sponsored Fish 497U;

- Strategic outreach coordination with UW Development; discussions about the potential for joint funding of PRISM and external partners are pending.

These activities will be augmented in Year 2 by:

- Establishment of creative and productive partnerships, particularly with local governments and conservation districts in underserved rural communities (Whatcom, Jefferson, Mason Counties);

- Collaboration with UW Office of Educational Partnerships at both the Higher Education and K-12 levels to provide broader access to PRISM;

- Reaching a broad audience of professionals, decision makers, and interested citizens through PRISM-sponsored courses and presentations;

- Finalizing a strategy, based in part on relationships with the Governors Council on Natural Resources Education & Outreach Committee, the National Marine Educators Association, and the Governors Council on Environmental Education, to address natural resource education at the K-12 level;

- Development of a communication plan with media and public relations elements;

- Continued proposal preparation for external funds.

- *PRISM was very successful in broadening its funding base (securing nearly $3 million in extramural funds)*

The agenda being adopted by PRISM is very broad and ambitious—it is also very expensive. PRISM had essentially two choices. It could have scaled its approach strictly to the UIF resources available to it, and said, "enough." Or it could scale its approach to attempt to achieve the full magnitude of the challenges and opportunities presented to it. PRISM has chosen the latter, and has successfully sought to broaden the funding base through research grants and regional partnerships. Using the UIF resources as the seed funding to leverage proposals, PRISM principals have been very successful at writing proposals and receiving grants, so far totaling nearly $3 million (with additional proposals totaling nearly $4 million still in review):

Learning about complex environmental processes in immersive and non-immersive virtual environments. (W. Winn, P.I .). NSF. $1,138,905, 1998-2001.

Integrating Salmon Habitat Restoration and Flood Hazard Initiatives: Societal/Biophysical Estimators for the Cedar River and Implications for Regional Rivers. (R. Wissmar, P.I.). NSF/EPA $749,991, 2/1/99 to 1/31/02

CISNet In Situ and Remote Monitoring of Productivity and Nutrient Cycles in Puget Sound. (S. Emerson, A. Devol, M.J. Perry, J. Newton, P.I.s) EPA/NASA, $909,064,. 10/1/98 - 9/30/2001.

Geobrowse: An Integrated Environment for Satellite Image Retrieval and Mining. (K. Schmitt, P.I.). NASA-funded Small Business initiative proposal with MathSoft, Inc. $100,000 1998-1999.

PRISM Outreach and Partnerships (A. Copping, P.I). NOAA, $85,000, 1998-99.

By developing working partnerships with regional agencies, PRISM effectively leverages the expertise and resources of the respective agency. In the process, the critical partnerships are established. In Year 1, partnerships with governmental agencies were established. In Year 2, PRISM is starting to work with private enterprise. Negotiations are under way with SUN computer to establish a UW Sun Technology base. Funds were obtained from NASA through a software company for specific software development.

- *PRISM worked out an effective "management and business plan" for how to conduct such a project.*

As a non-departmental organization, PRISM has a very complex logistic and administrative charge—learn how to operate in a transparent fashion across multiple units of the UW. An overall structure was worked out for how best to do this. Briefly (organization plan available upon request), the goals and direction for PRISM are set by the PRISM Executive Committee and the Project Leader in consultation with the Advisory Structure. The PRISM Advisory Structure is an organization of committees and working groups composed of UW participants and outside partners that report to the PRISM Project Leader. The PRISM Advisory Structure provides planning and advice on achieving PRISM goals and objectives, Virtual Puget Sound (VPS) development, proposal funding, and operating procedures.

PRISM began operations in late September 1997 with the first Planning Committee meeting on September 19, 1997.During Autumn quarter, PRISM budget development was done by Jeffrey Richey, the Project Leader, in consultation with the Steering Committee. An Action Plan and Budget for Biennium 1 were submitted to the UIF committee in February 1998.

Because of the October 1997 start for PRISM operations, Year 1 expenditures were below those budgeted for the Year 1 period in the Action Plan. The Year 2 Budget submitted in February 1998 was updated in July 1998 to reflect the revised amounts available after accounting for all actual expenditures in Year 1.

The PRISM budget for Year 2 has been revised to allocate the funds remaining from the total PRISM Biennium budget ($900K). Budget details are available upon request.

PROBLEMS ENCOUNTERED

PRISM confronts a series of challenges which "push the envelope" on technical development and cross-cultural collaborations (between individuals, between departments, between institutions). We believe that these are eminently solvable, and that we have made a very strong start. Perhaps the biggest problem is that the highly-motivated and capable individuals who need to be leading this project are already so over-committed that their available time is very sparse.

A second significant issue has been the lack of resources for the computer hardware across the units of the UW which can take full advantage of what the VPS offers.

NEAR-TERM PROJECTED ACTIVITIES

In keeping with our original work plan, Year 2 is a transition year from collecting and building a data and model structure for the Virtual Puget Sound (VPS) into a "proof of concept". Year 2 will see the first continuous simulation runs of the physical ecosystem model liked to real-time atmospheric, river flow and sound circulation forecasts. The human dimension models will complete initial urban growth simulations and the regions only basin-wide remotely sensed landcover change analysis will near completion. The datasets will be used in course work, the models argued in dissertations, and simulations used in applied research.

But most importantly Year 2 is about making to transition from coupling the data, models, and resources that we knew we had to do; to finding and incorporating solutions to that which, up till now, has not been done. This is the point where the mechanisms we have in place to support classroom, thesis, and internship education will begin to pay off. This is the point at which the partnerships we have begun outside the university will translate into active participants in the program. This is when solutions from an interdisciplinary team will mean the most.

What will Year 2 need:

- People: We will need to increase the number of skilled, trained, and inquisitive students and continue a "team-approach" by our lead scientists. We must recruit and support undergraduate and graduate student participation.

- Computers: We will not realize the full potential of VPS using our current computer resources. We will see computational limitation within year two requiring either shifting our emphasis away from full basin-wide modeling to sub-basin projects, or choosing to aggregate our data to coarser time and space scales.

- Time: The first year "fast-track" was possible because of incredible diversity of scientist and intellectual capital at the UW. Year 2 will be the point at which the data collection, models, and interfaces will either fall short or fail to anticipate all of the complexity of and the science questions we confront. Year 2 will find our weaknesses; we will need time, and a team approach, to devise solutions.

- Liaisons: As we make the transition from a data centric "tooling-up" program to a "user centric" investigative tool we will need to strengthen our coordination with governmental, tribal, and legislative agendas. Towards the end of year two we should have in place mechanisms and opportunities for the university administration to facilitate more in-depth and long-term liaisons with our collaborators.