Science Advisory Board Review of Annis Water Resources Institute

Grand Valley State University

March 11-12, 2014

FINAL REPORT

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Introduction and General Observations

At the invitation of the Director of the Annis Water Resources Institute, Dr. Al Steinman, the Science Advisory Board (SAB) conducted a review of the Institute on March 11-12, 2014. The most recent review was conducted on March 9-10, 2011. The 2014 review included an assessment of the Institute's research program, academic program, outreach / education program, and administration. The SAB would like to thank Dr. Steinman for the invitation to review AWRI's programs. While the primary purpose of the review is to provide an assessment of AWRI's programs and to offer direction as to how the Institute may most effectively fulfill its mission, the review also provides an opportunity for learning and intellectual exchange between AWRI and the various universities represented by the SAB. It was obvious that all faculty and staff see the review as a valuable exercise, and the SAB appreciates the efforts that were made to provide a thorough, in-depth review of activities at AWRI over the past three years.

AWRI is a unique educational and research facility. It is the only educational institution on the eastern shores of Lake Michigan dedicated to the study of aquatic ecosystems and issues related to water supply and water-related technology. Within Grand Valley State University, AWRI is a major player in the graduate program, providing a facility that is well equipped for the training of MS students in aquatic science and technology. Considering the increasing importance of water as an economic resource, and the challenge of aquatic ecosystem stewardship in the face of a growing number of threats and stressors, the research and education provided through AWRI makes a significant contribution to the maintenance of healthy ecosystems and economies within the state of Michigan.

During the current review, the SAB was pleased to observe that virtually all of the significant issues that were raised during the previous review have been addressed, and significant progress has been made in the development of AWRI's research program. Noteworthy achievements include an extensive evaluation of strategies to make the outreach / education programs accessible to the disabled, increased activity in the Information Services Center (ISC), completed construction of a new field station, and an increase in collaborative research. Fluctuations have occurred in the funding of individual researchers, which is normal for a research institution that relies primarily on external funding for research support. In general, AWRI researchers have remained reasonably well funded, with expansion into some new funding sources, and the overall publication rate remains good. Some challenges remain related to graduate student education, which are due primarily to the relatively small size of the student body and the limited number of teaching staff. Recommendations regarding these challenges are highlighted below, along with a more detailed assessment of the research program, the education / outreach program, and AWRI administration.

In previous reviews, the SAB has provided detailed comments on the performance of individual faculty and staff at AWRI. Most of these comments focused on teaching and research activities. The format of the current review is somewhat different in that the SAB, along with the Director,

agreed that it would be more useful to provide a review of the AWRI research and learning programs as a whole, with comments on individual performance where necessary.

Research Program

Research activities at AWRI cover a broad array of topics within the general field of aquatic sciences, including biogeochemistry, human and ecosystem health, technology, ecology, modeling, molecular biology / genomics, and conservation. In 2012, AWRI hired an additional faculty member, Dr. Kevin Strychar, who strengthens AWRI's capacity within the field of aquatic biology and ecology.

Two of the key measures of research productivity are peer-reviewed publications and external funding. AWRI continues to perform well in these areas. For the institute as a whole, peer-reviewed publications number approximately 30 per year, which is reasonably good for a research faculty size of 8 (plus the ISC). The trend in total number of peer-reviewed publications has steadily increased from ~17 in 2010 to ~30 in 2013, with approximately half of these having AWRI faculty or students as first author.

Funding has also been reasonably good over the past three years. Based on the CV's of the 8 research faculty, total external funding levels have fallen within the range of $500,000 to $1,500,000 per year, which averages out to approximately $63,000 to $188,000 per PI per year. This is reasonably good, considering that these 8 PIs include the Director and a Biology Department professor with a heavy teaching load. With a few exceptions, funding is reasonably well distributed among the faculty. One exception is the area of modeling. In its previous review, the SAB pointed out that Dr. McNair's modeling skills may be useful in integrating different research disciplines within AWRI. It appears that several scientists at AWRI are indeed benefitting through collaboration with Dr. McNair. However, in addition to being used as a service for researchers, the modeling program should be further developed as an entity in its own right, and Dr. McNair should pursue funding opportunities to develop a strong modeling program, in addition to providing support for other scientists. Likewise, while the environmental chemistry program led by Dr. Rediske has contributed to an impressive number of funded research projects and publications, efforts should be made to play a stronger leading role in the development of research projects and publication of results, as recommended in the previous review.

Many of the current research and management challenges related to aquatic ecosystems require interdisciplinary collaboration. Since the previous review, it appears that AWRI has strengthened internal collaboration among researchers, resulting in a number of high quality publications and reports. Particular assets within AWRI that facilitate internal collaboration include modeling capacity, a multi-sensor observing system in Muskegon Lake, and the climate change / genomics skills that Dr. Strychar brings. Based on funding proposals submitted in the

past two years, it appears that efforts are being made to continue building collaborative research programs. The SAB was also pleased to note that some AWRI scientists are progressing from narrowly focused, parochial science to broader, fundamental issues. Of note are Dr. Ruetz's attempts to place his ecological research within the context of meta-community theory, Dr. McNair's exploration of methods for quantifying lake metabolism, and the work of Dr. Thum and Dr. McNair to model population genetics of invasive species.

During the present review, some faculty raised questions about how AWRI might be able to pursue research collaboration outside of the Institute. This is a somewhat organic process that will proceed as the reputation of the Institute and its faculty continues to grow, but there are several ways to facilitate this goal: 1) Enhance interaction with other research universities by bringing in guest speakers, e.g. through the existing seminar series; 2) Maximize exposure of AWRI scientists and direct contact with other scientists through attendance of professional conferences and publication in high quality journals; 3) Directly contact other researchers whose work is related to AWRI's research programs. This can be particularly useful when responding to funding opportunities that require skills not strongly represented within AWRI, including hydrology, physical limnology, plankton ecology, and policy / economics. To some extent, AWRI is already doing all of the above. To maximize the potential for developing collaborative relationships through these actions, it may be helpful for individual AWRI scientists to put their research into a broad context. For example, to determine the implications of specific research findings for broader questions, such as ecosystem functioning or policy implications, scientists may identify other skill sets that are needed, and target those skill sets when inviting guest speakers.

AWRI, under the lead of Dr. Biddanda, has established an automated monitoring system on Muskegon Lake. This is a valuable resource for research, as well as monitoring and outreach. At the same time, it can be challenging to maintain consistent support for the operation and maintenance of such a system. Wherever appropriate, this system should be used as an integral component of research programs. This will provide leverage in research proposals, along with a funding mechanism through which continuing system operation can be supported.

AWRI is well set up as a research / training facility for graduate students, and the inclusion of graduate students in virtually all of the institute's research programs is highly commended.

Education / Outreach Program

The Education and Outreach (E&O) program at AWRI is directed by Dr. Janet Vail, who is assisted by 6 seasonal instructors (generally retired teachers) and a host of other volunteers and AWRI staff. The additional funding support from the GLRI has been put to good use. We hope there is more support like this because the Education and Outreach program is key to AWRI's mission and a strong node in the Great Lakes education network.

As in the past, E&O efforts can be broadly classified into (1) local and extended vessel cruises for educational activities, (2) formal classroom teaching to GVSU undergraduates, (3) sponsorship and organization of regional conferences, (4) teacher continuing education programs, and (5) career fairs and state- and federally-funded demonstration projects. Each of these programs remains strong, and participation continues to grow, especially in the Annis Educational Foundation Classroom.

The E&O program is very active and well integrated into the overall fabric of AWRI. In previous reviews, we suggested that Dr. Vail work more with the AWRI faculty to incorporate recent research into her program, and the response to that recommendation continues to grow. For example, we noted that there are new efforts to connect the Muskegon Lake Observational Buoy with educational activities. Overall, the E&O program is well integrated into local, regional, and state environmental activities that focus on water, especially Lake Michigan, and is impressively active in state curriculum development and certification. Dr. Vail is also highly involved in professional service at the community, regional, and state levels, with clear benefits to AWRI and GVSU.

As in the past, a particularly impressive aspect of the E&O program is the K-12 educational program for school children in the tri-city area, which is conducted in the AWRI classrooms and on-board the AWRI vessels. AWRI and the E&O program continue to offer high-quality and frequent educational opportunities. They continue to maintain between 5,000 and 6,000 participants per year participating in roughly 250 events per year. These activities are enormously important for AWRI, GVSU, the local community, and the state of Michigan. This level of outreach is the envy of larger, better known schools.

The SAB is particularly appreciative of the thorough and innovative response to our request to consider a broader interpretation of access and attention to disabled learners. Their vessel- and classroom-based report on Inclusive Strategies for AWRI Outreach and Education Programs surpassed our expectations. We appreciate the difficulty in making major capital investments in upgrading the vessel operations to be more accommodating, but note that while they are fully in compliance with Coast Guard guidelines and regulations, they are taking steps in both the near term and long term to increase opportunities for those with physical disabilities. The approaches to awareness training and in classroom adjustments are important, and it is heartening to see AWRI going beyond “accommodation” and designing programs FOR those with disabilities. Kudos to Dr. Vail and Captain Fiore!

Graduate program

The SAB was pleased to note that the AWRI Master's program continued to improve during the period 2011-2014, with a core group of dedicated and articulate students who expressed a strong sense of solidarity and mission, and faculty who are genuinely engaged in the mentoring and development of the students. The SAB met with a group of graduate students and discussed a number of issues, including curriculum, academic and intellectual environment, integration into the academic ladder, and financial support and benefits. At several junctures, the SAB also solicited the views of the director and the faculty of AWRI on the graduate program, particularly on the issue of future directions of the graduate program.

A. Curriculum

The core curriculum for the graduate students continues to develop but several challenges remain. These can be broken down into (1) curriculum, (2) credit requirements, and (3) logistics. First, the students noted that academic course availability continues to be challenging because of a limited number of relevant courses suitable for them, and the under-enrollment (<10 students) that periodically shuts down desired courses. Second, the students expressed a desire to complete all formal course requirements in their first year of study, thereby freeing their second year to focus on research to allow a realistic finishing time of ~2.5 years. With 18 formal course credits (~6 courses) and the somewhat unpredictable availability of courses noted above, this goal is challenging. It may be worthwhile to consider a reduction to 15 credits (one less formal course). Third, some students feel challenged to travel back and forth from AWRI to the main campus in Allendale. The director may wish to work with the GVSU administration to provide a van to make a campus run once per day around main class hours during the academic year. Alternatively, it might be possible for courses that have a majority of AWRI students to be taught in Muskegon, with other students traveling the opposite way.

B. Academic and Intellectual Environment

The students are generally pleased with the level and rigor of academic mentoring that they receive at AWRI, and appreciate the strong focus on water science that links the faculty and the program. However, we again heard the desire of students to be more integrated intellectually with students and faculty from other units at Grand Valley State University. Students voiced a desire to interact with graduate students in disciplines outside of aquatic biology. The SAB realizes that other relevant departments at GVSU (e.g., Chemistry, Geology, Environmental Engineering, Mathematics) do not currently have graduate programs However, it may be possible to encourage additional student exchanges (e.g., joint workshops, symposia, etc.) with other state institutions that host strong graduate programs (e.g., MSU, UM). In addition, Master's students could be encouraged to include faculty from other institutions on their advisory committees, as appropriate. This might connect students with other laboratories that host Ph.D. students and perhaps launch collaborations. Finally, undergraduate internships at

AWRI might be considered, as these would provide valuable learning opportunities for undergraduate students in other GVSU departments, promote interaction between AWRI students and other departments, and provide informal opportunities for AWRI graduate students to gain experience in teaching and training.

Some students appear to think that all committee members must be Biology faculty, although members outside of Biology are clearly permissible; this opportunity should be reiterated by PIs to the students. Finally, some PIs also noted a limited "vibrancy" to the graduate program, which may be linked to its relatively small size and limited exposure to other graduate students and disciplines as noted above. The SAB notes that the quality of students appears to be high and believes that they can be nurtured into strong scholars with high aspirations. Exposure to labs with Ph.D. students may encourage them to consider entering such programs after their M.S.

C. Vertical Integration of Research and Mentoring

The Master's students spoke about desiring a more effective integration into the mentoring structure of the academic environment, from undergraduates to PI. The students appreciate the presence of undergraduate students in the research laboratories of AWRI faculty, but do not always take advantage of mentoring opportunities or perhaps are not always encouraged to do so. This might be a goal for their second year in the program when they have a better sense of their own research project. In addition, AWRI should work to expose the students to Ph.D. candidates and postdoctorates so that they might see themselves in those roles someday. It might be useful to invite senior Ph.D. students from other local institutions (e.g., UM, MSU, CMU, ND) to Friday eco-lunches to present their research and also speak about their own programs. This would dually benefit both AWRI students and also the Ph.D. candidate with a formal speaking invitation. AWRI might also look into the feasibility of inviting Ph.D. students from other Michigan institutions to spend a semester or summer at AWRI conducting research or thesis-writing. In addition, the students felt that the low number of postdoctorates at AWRI was somewhat constraining in terms of senior role models. We heard the comment that "Every lab should have a post-doc". While this is certainly limited by external funding, perhaps this could be a fund-raising goal for AWRI to secure additional endowed postdoctoral positions.

D. Financial Support and Health Benefits

In general, the students appear to be largely satisfied with the level of financial support (i.e., stipend) provided by GVSU, although the unevenness of the stipend (i.e., weighted towards the summer) continues to provide budgeting challenges to the students. The federal Healthcare Act has provided students under the age of 26 the option of continuing their coverage under their parents' policy, but those students over 26 still lack adequate health insurance options through the university and are left with finding their own health coverage. We continue to strongly recommend that GVSU rectify this issue with at least partially subsidized student health coverage.

E. Graduate Program Options

The issue of a Ph.D. program in aquatic biology was raised briefly during discussions with the director, who indicated that there is little enthusiasm for this idea in the upper administration of GVSU. The SAB agrees that a Ph.D. program is not a realistic possibility at this time, due to the same reasons detailed in the 2011 SAB Report. As before, AWRI should focus on producing strong M.S. students who can be matriculated into Ph.D. programs elsewhere or can directly enter the workforce. The continuance of a formal Master's thesis, as opposed to a "project" (which was discussed briefly), is key to this strong program.

One idea that was floated by the SAB during discussions with the director was that of a "professional" master's program. Many institutions (e.g., UM) have a growing number of professional master's programs in the sciences, in which an intensive course of study is developed for students seeking the master's degree either for educational enhancement or for diversifying employment opportunities. These programs are normally tuition-charging and non-stipend bearing, thus having the capacity to generate considerable revenue. They are typically of finite duration to the degree (e.g., 12-15 months), course intensive, and include a capstone project or literature-based thesis. AWRI might want to consider such an option in the future as long as it does not detract from the current successful M.S. program.

Service

A. Information Services Center (ISC)

The ISC continues to serve Western Michigan communities by providing mapping and spatial analyses. The ISC was undergoing a funding hiatus at the time of the previous SAB visit, but has since received two grants with multiple years of funding: the Upper Muskegon River Watershed Management Plan and the Muskegon River Watershed Assembly GLRI Project. Urban Tree Canopy Assessment Atlases recently prepared by Rod Denning for the Cities of Zeeland and Holland were also well received, and have generated interest in similar assessments elsewhere. The ISC's publication rates remain very low, and there were no refereed publications reported since the last SAB review.

John Koches indicated he has 2 years of graduate student support from GVSU, and he is looking for a Biology student to participate in the LGROW project. There may be opportunities for graduate students to get involved in, or at least benefit from, ISC projects. This is especially true for grad students who are more oriented to a Professional Science-style M.S. program.

B. Other Community Service

Several AWRI faculty (Rediske, Biddanda, McNair) have been involved in a service project to provide clean drinking water to people in developing nations, specifically Haiti and Ghana. This

collaboration involves a local industry that manufactures injection molded plastic housings for Hydraid BioSand filters, as well as a local middle school teacher funded by a NSF Target Inquiry grant. This is a great example of scientific collaboration that also aids the needy.

All of the AWRI faculty work with state or local entities charged with advancing aquatic science and protecting natural resources. A few examples include Biddanda's service on the Michigan Space Grant Consortium Executive Board, service by Ruetz and Rediske on the Muskegon Lake Watershed Partnership, Rediske's work with the Michigan Department of Environmental Quality, Luttenton and Ruetz' work with the Michigan Department of Natural Resources, and Strychar serving as a local expert as PADI Open Water Scuba Instructor. Koches serves the community as Chair of the Lower Grand River Organization of Watersheds (LGROW), Chair of the West Michigan Community Sustainability Partners, and Co-chair of the Muskegon Area Sustainability Coalition. Community service provided by Steinman and Vail is too extensive to list (more information about Vail's contributions is provided above in the Education/Outreach section).

The AWRI faculty are also involved in local educational service. Two examples are Science Olympiad and Super STAT-urday, in which several AWRI faculty volunteered their time to stimulate youth interest in science.

C. Academic Service

AWRI faculty perform substantial service to the University through participation on various committees. The AWRI faculty provide service to their professions by sitting on proposal review panels, reviewing journal manuscripts, and participating on editorial review boards.

In short, the service provided by AWRI faculty has benefitted GVSU, NGOs, local and state government entities, scientific professional societies, and even developing countries. These accomplishments are even more impressive given that they are done on top of the considerable research and teaching programs that each of the PIs maintains.

Facilities

A. Infrastructure

Few issues regarding general infrastructure were raised, other than identifying funds to continue operation of "Bopi's Buoy." This buoy-based observatory in Muskegon Lake measures multiple meteorological and water column parameters, providing real-time access to the data over a web interface. The buoy was purchased and installed under a 3-year grant from the US-EPA Great Lakes Restoration Initiative (GLRI), and its utility for education and research (both at AWRI and by external researchers) has become apparent through its widespread use by universities,

colleges, K-12th grade schools, and the general public. A clear need exists to continue its operation beyond the 3-year life of the initial GLRI grant.

B. Vessels and Vehicles

Captain Tony Fiore provided a comprehensive report about vessel operations and maintenance. The Angus and the Jackson are critical to the lake education and outreach programs, as well as serving many research needs. The credentials of the pilots and deckhands are impressive, and their willingness to return year-after-year is a benefit to the fleet and a credit to its operation.

The 5-year vessel maintenance schedule is well-conceived, and the needs are clear. Some of the changes to be made were required by recent Coast Guard mandates for life safety equipment. Maintenance costs are economical due to the use of deckhands to perform tasks such as stripping/prepping/painting the boats.

Captain Fiore also described the status and upkeep of trucks and small boats (jon boats, pontoon boat) used in research, and planned modifications to accommodate new research needs (e.g., buoy servicing). He is developing specifications for a new vessel capable of going out short distances on Lake Michigan that can be used for research purposes. The efficient operation of the vessel program and its close collaboration with the AWRI faculty has been fundamental to the success of many research projects.

Captain Fiore has not reported at all SAB meetings, but speaking as a landlubber (CAJ), I am always impressed with his integral role in accommodating the scientific and educational needs of the AWRI operation.

C. Field Station

The successful completion of the Robert B. Annis Field Station is a crowning achievement of the Institute, and a tribute to Dr. Steinman's fund-raising ability. The new facility provides three research laboratories, aquatic mesocosms, faculty and graduate student offices, a conference room, and equipment storage. It provided laboratory space to accommodate the new faculty hire (Kevin Strycher) an essential part of a competitive start-up package. Both Dr. Steinman and Captain Fiore helped guide the design and construction of the building. The new facilities are a huge improvement over the previous warehouse that was used, and have greatly enhanced the research infrastructure at AWRI. For example, the mesocosms were in full use at the time of the SAB visit. Some aspects of the planned field station design had to be abandoned due to cost issues, but the resulting facility remains a credit to AWRI.

Administration

AWRI continues to be run efficiently and effectively under Dr. Steinman's leadership. As a result, the scientific, education, technical, and student staff are productive both individually and collectively. We have a small number of recommendations to consider:

1. PI's should be required to include vessel operation costs in their proposal budgets. This is standard practice at most institutions and can go a long way in underwriting vessel operations, maintenance, and upgrades.

2. We recommend a reduction in the level of indirect funds returned to the faculty. The rate is much higher than what is provided in most other institutions, and retaining a higher proportion of indirect funds for the Institute centrally can help build a fund to enhance collaboration across the faculty, increase technical and student support where needed, and seed innovation and new directions that can help shape the overall AWRI direction.

Summary

Major strengths of AWRI include:

1. A strong, well-designed outreach and education program.
2. Good integration of students into faculty research programs.
3. Good external funding and a good average publication rate.
4. Good internal collaboration among faculty, resulting in multi-disciplinary research.
5. Excellent community service of faculty through collaboration with state and local agencies.
6. The Robert B. Annis Field Station, which significantly augments AWRI's research capacity, and will facilitate collaboration with visiting scientists.

Weaknesses:

1. In some research areas, AWRI functions more as a service to other researchers, rather than a leader.
2. Integration of programs across AWRI can still be enhanced, such as modeling and geospatial analysis that can be more effectively incorporated into grant proposals.
3. Graduate students are somewhat insulated from other GVSU departments.
4. Students would benefit from more exposure to Ph.D.s and postdocs.

Major challenges and opportunities:

- Continue to conduct applied research that addresses local and regional issues while also contributing to fundamental advances in the aquatic sciences.

Develop an academic program in which the balance between student learning needs and course offerings is optimized.

Recommended short term actions:

1. Develop mechanisms for students from other GVSU departments to conduct work at AWRI, e.g. through undergraduate internships.
2. Give increased consideration to inclusion of non-AWRI faculty in graduate student committees.
3. Consider reducing credit requirement to 15, to make it easier for students to complete all credit requirements in 1st year. Alternatively, revise the curriculum so that students can take all desired courses in their first year. This may require faculty to develop courses (possibly in collaboration with other departments) that appeal to a broader cross-section of students, rather than specialty courses that cater to a small number of students.
4. Explore ways to provide health insurance options for students 26 and older.
5. Have faculty members write individual self-assessment reviews annually.
6. Include vessel costs in grant proposals.
7. Revise the allocation of indirect funds so that a smaller proportion is directed to faculty and a larger proportion is directed to AWRI administration.

Recommended long term actions:

1. Expand research collaboration with other universities.
2. Continue to support various research programs with modeling expertise, while also developing specific, self-supporting modeling initiatives. For example, AWRI's collaborative work with multiple management agencies may benefit from the development of decision-support software, which could integrate both AWRI's Information Services Center (ISC) expertise and modeling expertise.
3. Consider feasibility of a professional master's program. The ISC seems like an ideal platform for this type of program, but other specialties within AWRI, such as environmental chemistry, are also amenable to such a program.

The stated mission of AWRI is to integrate research, education, and outreach to enhance and preserve freshwater resources. The growth that the Institute has achieved since it became an academic unit five years ago has been well aligned with this mission; its research program has grown, it has a world class education / outreach program that focuses on the aquatic resources of Michigan, and its research and education programs are oriented around specific challenges related to aquatic resource management. In the opinion of the Science Advisory Board, AWRI is

successfully achieving it mission, and based on the current trajectory of its research and education programs we expect that AWRI will continue to fill a unique educational and research niche within the state of Michigan.