KEYSTONE PROJECTS: SERVICE-LEARNING PRACTICA IN WATERSHED STEWARDSHIP

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Sparked by Clean Water Act amendments focused on addressing impaired water quality from non-point sources, community-based approaches to protect and restore watersheds have proliferated nationally over the past decade. The policy shift is manifest in the Clean Water Action Plan promulgated by the U.S. Environmental Protection Agency and the Department of Agriculture giving added impetus to ". . . community-based watershed protection efforts at high priority areas, and providing communities with new resources to control polluted runoff" (U.S. Environmental Protection Agency, 1998). The toolkit of resources was to include collaborative watershed approaches involving public/private partnerships, technical knowledge, and accurate scientific information – all of which fall within the domain of educational institutions, particularly land grant universities having a strong community outreach and service tradition such as Penn State.

Pennsylvania has long been in the vanguard of proactive community watershed conservation and management. The nation's first watershed association was formed in 1948 in the Brandywine Valley near Philadelphia. Today, the number of such groups in the state is estimated at more than 150 and is growing fast. Start-up funds were awarded to organize 21 new watershed associations through the initial grant round of the recently enacted Pennsylvania Environmental Stewardship and Watershed Protection Act (Pennsylvania Department of Environmental Protection, 2000). Over five years, the lion's share of the $646 million grant program will be directed to watershed assessments, watershed restoration and protection plans, implementation of watershed plans, source water protection, watershed education and outreach, abatement of non-point source impairment from agriculture, on-lot sewage systems, and abandoned coal mine drainage. Significantly, funding of local, community-based efforts is given highest priority in the state program.

Pennsylvania has a deeply embedded local government tradition. Land use regulatory authority rests with over 1,800 townships and boroughs and many of these communities independently operate small water supply and municipal wastewater systems. Agriculture ranks as the leading economic activity followed closely by outdoor recreation and tourism geared to the state's rich cultural history and high quality "watershed-connected" environmental assets. These include premier trout streams, riverine Rail Trails and greenways, whitewater boating, and 2.5 million acres of state forest, parklands, and public hunting areas. A predominantly rural population holds strong attitudes favoring private property rights. A case can be made for a fundamental cultural predisposition in Pennsylvania toward community self-determination and voluntary stewardship, in contrast to centralized regional planning and management reinforced by an external command and control regulatory framework. The second author's experience with Ontario's mandated regional land use planning and the Conservation Authority implementation structure to achieve watershed management suggests that such a model would face serious challenges in Pennsylvania, unless modified to incorporate leading roles for municipalities, a wide range of stakeholders, and nonprofit environmental organizations.

ORIGINS OF THE GRADUATE WATERSHED STEWARDSHIP PROGRAM

Penn State faculty from the School of Forest Resources and the Department of Landscape Architecture have been engaged in watershed research and service projects for many years, often in collaboration with community groups. Dr. David DeWalle, Professor of Forest

Hydrology, has conducted research for two decades on acidic deposition impacts in the Laurel Hill region, aided by a watershed association in southwestern Pennsylvania. The Spring Creek watershed around the Penn State Campus and Centre Region is the location of watershed conservation and corridor planning work by a team of Landscape Architecture faculty in cooperation with the Clearwater Conservancy watershed organization, to cite just two examples. Professor Neil Korostoff, and members of the Spring Creek team, began informal conversations with DeWalle in the mid-1990s.

These faculty approached the Heinz Endowments of Pittsburgh in 1996 to discuss educational needs to train professionals in the burgeoning and changing watershed field. The Endowment had recently reoriented its environmental grant-making to support the increasingly ambitious water quality improvement projects being undertaken by established and emerging community watershed groups and was receptive to underwriting a planning and development process for the proposed new graduate studies program. The eight-month process involved a review of existing water resource curricula at U.S. and international universities, formation of a 26-member Advisory Committee from academe, federal and state government, business and industry, and the non-profit sector, and conducting three day-long Watershed Stewardship Forums across the state attended by 120 leaders and experts. The objectives were to examine the competencies required of future practitioners, assess employment potential, and to critique the conceptual and pedagogical design of the proposal.

The clear consensus verified the perceived need for scientifically-grounded, multidisciplinary team-oriented "real world" problem solving in a community context as the core premise of a curriculum relevant and responsive to present and future needs.[1] This experiential service-learning component was called a "Keystone Project" in the proposal submitted to the Heinz Endowments in the fall of 1997. It was symbolic of the structural anchor of a connected system and, geographically, for the state nickname of Pennsylvania where all student projects would be located.

Pedagogical Underpinnings

The need for the Watershed Stewardship option was supported by a growing body of literature on interdisciplinary in the academy. In fact, the timing of demand, funding mechanism and institutional will converged faultlessly with recent pedagogical scholarship to undergird the notion of the Center and the Keystone Project model. The needs assessment and scholarly pro-action also continued to drive curriculum design and the approach to interactive, community-based learning. The sequence of influences is worth tracing.

First, there was already a sporadic tradition of joint projects between faculty and students across the core units, as mentioned above. Pulled together by the gravity of similar stakes in watersheds and ecosystems, an informal teaching philosophy was developing through the 1980s and 90s based on direct experience of the benefits and challenges of multidisciplined teams. Institutional support for these endeavors has generally been on the rise since the environmental movement of the 1960s and 70s. Ian McHarg's seminal Design with Nature (1969) – with its exhortations to bring science, design and social concerns together into a substantive regional methodology – was soon followed by a small corps of Penn State University faculty eager to break scholarly barriers. Caroline Eckhardt's 1978 work on interdisciplinary administrative structures at Penn State helped create a framework for a handful of programs that would only come to fruition two decades later.

Penn State faculties in natural science and design disciplines have more recently been influenced by scholars directly focused on curricular integration. Higher education visionary Ernest Boyer writes, "To be truly educated means going beyond the isolated facts, putting learning in larger contexts and, above all, it means discovering the connectedness of things" (1997). Noted ecological thinker David Orr echoes this: "Disconnectedness in the form of excessive specialization is fatal to comprehension because it removes knowledge from its larger context. Collection of data supercedes understanding of connecting patterns which is, I believe, the essence of wisdom" (1992 p. 101). A series of papers in *Water Resources Update* was also instrumental in establishing a "collaborationist" perspective at Penn State.[2]

The 1998 Shire Conference, sponsored by the University of Oregon, attracted landscape architecture, ecology and water resource science faculty from institutions across the continent to focus on questions of integration of science and environmental planning and design. In his keynote address, aquatic ecologist James Karr (1998) acknowledged that "landscape architects make decisions each day that can worsen the damage to Earth's living systems, or they can act to minimize that damage. They can be important in restoring the connections." Karr then broadened the perspective: "*Interdisciplinary* means a combination of knowledge and methods or paradigms; interdisciplinary teams construct an original synthesis that would probably not emerge from a collection of

multidisciplinary sub-components. The most important attribute of all members of a truly interdisciplinary team is a recognition that no individual and no discipline is smart or broad enough to understand all the dimensions of the complex ecological issues faced by modern society."

These trends and events are only a few of many that preceded and inspired the pedagogy of the Center toward a genuine form of interdisciplinary collaboration based on mutual respect and full engagement, a blending of science and design and planning methodologies, and a commitment to community service through which watershed learning is activated. As evident in the retrospective that follows, the Keystone Project's pedagogy parallels a small but growing number of integrated programs which are "precariously positioned between 'real-world' utilitarian and traditional liberal education . . . reflect[ing] the principle that knowledge and application be intimately linked" (Tamminga et al. 2000, p.5).

Center for Watershed Stewardship: From Concept to Reality

The Howard Heinz Endowment awarded a $1.8 million, five year startup grant to Penn State early in 1998 to establish the Center for Watershed Stewardship (CWS) and a graduate option initially within two academic units: Landscape Architecture and the School of Forest Resources. The University match included extensive renovation of a 4,000 square foot storefront facility adjoining the campus. Facilities of CWS include a GIS (ArcView)/computing lab, map center and library, work stations for research assistants and second year ("Keystone") students, classroom, conference room, and offices for faculty and administrative support staff. A national search produced faculty appointments of Kerry Wedel, a watershed planning manager from the Kansas State Water Office, and the first author who came to the new program from an executive director post with a non-profit watershed association in southwest Pennsylvania. An Executive Committee of faculty, unit leaders, and nonacademic representation drawn from participants on the Watershed Stewardship forums and Curriculum Advisory panel was formed early in the start-up phase to select Keystone Projects, among other responsibilities.

Curriculum and Students

The Watershed Stewardship curriculum is not a separate graduate degree but rather a two-year, 19 or 22 credit Option, depending on the department, offered primarily at the Masters degree level. The post-professional Master of Landscape Architecture is the terminal degree in the discipline. Forest Resources and Wildlife and Fisheries Science students may pursue a Master of Science degree (requiring independent research and thesis), a Master of Forest Resources professional degree (emphasizing applied resource management), a Master of Agriculture degree intended to develop professional skills in the communication of technical knowledge, or a PhD (an advanced research degree).

In the first year, emphasis is placed on enhancing the knowledge base through coursework and field exercises (Figure 1) designed to provide depth and breadth to a student's undergraduate education, and in some cases, to related work experience. Students are required to take one breadth course from each of the following four categories, totaling 12 credit hours: Water Resources Sciences; Social Science, Public Policy, or Economics; Humanities; and Communications and Design. Landscape Architecture students are exempted from the latter category due to the content of other studio courses, but they must fulfill additional special topics credits related to the Keystone Project. Two seminars dealing broadly with watershed management and planning round out the first two semesters.

Most students entering the Watershed Stewardship Option have come from undergraduate backgrounds in landscape architecture, environmental science, biology, or forestry. The CWS enrolled its first five students in the Fall of 1998. Growth in enrollment to eleven students entering Fall 1999 and fourteen entering Fall 2000 has greatly diversified the disciplinary range by adding graduates from fisheries management, wildlife biology, geography, architecture, geology, horticulture, law, social science, and regional planning curricula. Expansion of the Option to intercollege graduate degree programs in Ecology and in Environmental Pollution Control (beginning in 2000) and to prospective departments such as Agricultural Economics and Rural Sociology will further broaden the disciplinary competencies and training student teams will bring to their Keystone Project experience.

THE "MAIDEN" KEYSTONE PROJECT

Selection Process and Criteria

About nine months prior to the scheduled beginning of the inaugural project, a letter was sent to all known Pennsylvania watershed associations, conservancies, coalitions and "umbrella" environmental groups, sixty-six county Conservation Districts, Cooperative Extension offices, and selected state agencies. Letters of interest

were invited from prospective community-based sponsors to undertake a two-semester watershed assessment and management planning project with five students, two faculty CWS directors, and three faculty fellows beginning in August 1999. The twenty-five responses received exceeded expectations in terms of sheer numbers, the variety of sponsoring entities, and complexity and scope of case problems proposed for study (Table 1). Since only one project would be carried out, screening and selection criteria were required to make the choice.

The primary criteria used to evaluate proposals addressed the following areas:

> Local commitment to comprehensive watershed planning focused on multiple issues.
>
> Match of case problem tasks to student team backgrounds and relevance to individual graduate education goals.
>
> Sponsor capacity to plan and implement, measured by extent of collaboration with partner agencies and participation of key local stakeholders such as township government officials.
>
> Sponsor organizational resources including full-time staff, GIS database, volunteer logistical and technical assistance and availability of scientific data.
>
> Timeliness of planning process and opportunity for substantive student involvement in a wide range of planning activities.

Through follow-up site visits, meetings and conference calls with sponsors, CWS faculty developed a short list of five leading candidates using an unweighted rating scale of 1-10 for the above criteria. The students who would be participating in the project were briefed on the full list of candidates, reviewed the short list ratings and provided input on the rating scores and evaluations from their perspectives. By consensus, the student team endorsed the faculty first choice of Maiden Creek watershed proposed by the Berks County Conservancy (BCC). In April 1999 the CWS Executive Committee formally approved the recommended Keystone Project watershed, completing a four-month solicitation, evaluation, and selection process. It should be noted that financial considerations had no bearing on the candidate evaluations. The work is performed gratis as a student educational project. Reimbursement of direct expenses for travel, printing of a project report for the sponsor's use, etc. is requested only if designated funds are on hand at the local sponsoring entity to specifically support a watershed management planning project performed in the context of service-learning. Otherwise, costs are absorbed by the CWS.

Study Watershed Setting

Maiden Creek is a 216 square mile watershed draining to the Schuylkill River in the Delaware River Basin located in Berks and Lehigh Counties approximately 50 miles northwest of Philadelphia (Figure 2). Lake Ontelaunee, meaning "maiden" in the Delaware Indian language, impounds the stream just upstream from the mouth to export municipal water supply for 125,000 residents of the City of Reading and its suburbs located outside the watershed. The reservoir is a eutrophic water body designated on the Section 303(d) Report by the Pennsylvania Department of Environmental Protection as "impaired" by nutrients and sedimentation that has reduced water storage capacity by an estimated 25 percent since construction in the 1930s. Agriculture is the dominant land use at 58 percent of the watershed area and is intensively practiced by Old Order Mennonite, Amish, and "English" farmers for dairy animals, row crops and forage, vegetable produce, orchards, nurseries, and mushrooms, the region's most important specialty cash crop. A population of about 40,000 people resides in 21 municipal jurisdictions within the Maiden Creek watershed. Land development and population growth is greatest in the prime farmland and karst geology region of the watershed's southern third between Reading and Kutztown, the watershed's largest community.

Project Scope - Phase 1: Watershed Assessment

The Maiden Creek project was conducted in two phases: Phase 1, Watershed Assessment, generally coinciding with the Fall 1999 semester and; Phase 2, Key Issues, Goals, and Management Alternatives, to conclude at the end of the Spring 2000 semester with delivery of a watershed stewardship report document and public presentation by the student team (Figure 3).

The assessment involved an inventory and characterization of selected water, land, and biological resource conditions; and cultural features utilizing existing data, published reports, and personal interviews with regulatory, management, planning, and service agency staff. A source water assessment of Lake Ontelaunee conducted by The Cadmus Group consulting firm in 1998 and a 1994 Diagnostic Study of the reservoir by F.X. Browne for the Reading Water Authority were primary sources of information. Several special topic

analyses and some primary data collection in the field were also conducted by the students:

Development of a GIS database clipped to 13 subwatersheds for targeting sources of water quality impairment.

DRASTIC groundwater pollution vulnerability model (a Penn State model).

Nonpoint source pollution assessment by three methods and comparison of results:

> Unit Area Loading (Environmental Resources Research Institute at Penn State; Generalized Watershed Loading Function (developed at Cornell University);
> EPA-STORET regression analysis;
> Riparian forested buffer condition of four subwatersheds from digital orthophotography satellite imagery.
>
> Field utilization of Stream Visual Assessment Protocol (a NRCS assessment protocol).
> Biotic Index Value (Izaac Walton League "Save Our Streams") calculations for subwatersheds from macroinvertebrate data.
> Municipal ordinance review of existing water resource protection criteria, guidelines and standards.

Two deliverable products were slated during the assessment phase. First, a midterm status presentation was made by students to the Maiden Creek Steering Committee assembled by BCC to function in advisory and oversight roles. The committee was composed mainly of representatives from municipal, county, state, and federal agencies and commissions. Second, an essentially complete draft report of assessment findings was due by commencement of Phase 2 in mid-January, 2000.

Project Scope - Phase 2: Key Issues, Goals and Management Alternatives

Moving into the second semester, there was a sense among students and faculty that additional direct dialogue with citizen stakeholders would be extremely useful in understanding the issues and resource concerns of the community, drawing upon local knowledge to complete the assessment, and beginning to set goals and frame management approaches and strategies. A "Public Issues Forum" was organized by the student team in mid-March at the Berks County Ag Center. The students facilitated focus group input by about 30 participants on important community values attached to the watershed and the problems and opportunities to be addressed in a watershed plan. A prioritization voting process (Figure 4) distilled 36 issues brought forward into priority concerns, broadly stated as follows:

> Impaired water quality in Lake Ontelaunee and streams and threats to groundwater from nonpoint source pollution of various kinds.
>
> Impacts of growth/urbanization on prime agricultural land, rural character, environmentally sensitive areas, natural habitats, and overall ecological integrity and continuity.
>
> Watershed awareness and cooperation.

Next, students drafted goal statements and preliminary management approaches responsive to the issues in preparation for a Watershed Planning Workshop held at CWS two weeks after the Public Issues Forum. A contingent of community representatives and invited Penn State faculty critiqued the emerging management plan and brainstormed other potential strategies. Participating faculty were drawn from agronomy, forest hydrology, rural sociology, civil engineering, landscape architecture, ecology and water resources extension departments, and included three CWS Faculty Fellows supported on stipends to provide specialized expertise on specific aspects of the Maiden Creek Keystone Project. Dr. William E. Sharpe, Water Quality Coordinator for the College of Agricultural Sciences, Barry Evans, GIS Research Coordinator at the Environmental Resources Research Institute, and the second author served as Fellows for all or part of the project.

Outcomes of the Maiden Creek Keystone Project

Two primary outcomes had been promised to BCC by the end of the semester and delivery came down to the final days. A two hour public presentation was made by the students to an audience of over 100 people in conjunction with Kutztown University's "Earth Day" activities, followed a week later by delivery of the final 114-page bound report document and digital file. Most of the report was devoted to assessment findings in text, data tables, and 24 GIS-based graphics and appendices containing the special topics analyses, Public Issue Forum and Planning Workshop documentation, and other information (Center for Watershed Stewardship 2000).

An "Issues and Management Options" section framed around seven key issues and goal statements was the core of the report. In all, 53 strategies were developed with as

many as 12 specific options aimed at impaired water quality in Lake Ontelaunee and streams. Potential lead community organizations and funding sources were identified. The resource management strategies were fairly straightforward; e.g., "Target agricultural best management practices (e.g. streambank fencing to exclude cattle) to subwatersheds of highest estimated loading (of a related pollution source)." However, it became increasingly evident that human, political, and cultural dimensions and the need for a truly community-based watershed initiative would ultimately determine if the resource management actions being recommended would be implemented.

With emphatic encouragement by BCC and its agency partners, the stewardship plan focused heavily on strategies and model organizational frameworks (Figure 5) to build community capacity as a cornerstone of integrated watershed stewardship. Prominent among those strategies were recommendations to form a watershed association and utilize available PA Watershed Protection Act funding to hire at least part time staff dedicated to raising watershed awareness and opening lines of communication with stakeholders and disparate interests. Outreach efforts to engage culturally distinct Mennonite farmers and the Reading-based Latino community in their respective communities (and language via multilingual educational materials) through a marketing cooperative, schools and other institutions were among a variety of recommended steps.

Measuring Success-Did the Keystone Service-Learning Project Provide *Service?*

While there was an undeniably significant degree of learning accomplished (see Measuring Success-Program Evaluation, below), did the practicum live up to the *service* part of the formula? Did it make a *difference* in the Maiden Creek Watershed, consistent with Penn State's outreach mission? These questions test the underlying presumption that, in Pennsylvania at least, service-learning is superior to the conventional purely academic and entirely campus-based professional curriculum. The logic is direct and unavoidable: if there is a strong learning-by-doing reality in the Center's pedagogy, then the interactions between the study team and the watershed stakeholders must have some effect, whether good or bad.

By all accounts, the project had very positive impacts during the process, particularly on student-led presentations and workshops held in-situ. More recently, there are clear indications that several of its key recommendations are taking on life in the watershed. CWS remains in regular contact with Joseph E. Hoffman, BCC's Director of Environmental Management, who served as the local sponsor's project coordinator and participated as a key informant during the External Review of CWS conducted in July 2000. At this writing, implementation actions taken and spin-off benefits include the following (Hoffman, personal communications):

> Initial meetings held to form a watershed association, expected to become a reality in the Fall of 2000. Staff time allocated by Berks County Conservation District to support organizational development, educational programs, and administrative functions. Prioritization of water quality assessment/Total Maximum Daily Loading (TMDL) determinations for the watershed by PA Department of Environmental Protection.
>
> Proposed establishment of "watershed overlay district" by several townships incorporating consistent water resource protection criteria in municipal ordinances and plans.
>
> Student-produced graphics and data utilized in meetings and presentations with community stakeholders, government agencies, and potential funding sources.
>
> Final report used as template for other watershed planning projects underway or anticipated by the BCC.

As events unfold over time in Maiden Creek, the CWS will be monitoring and documenting the effectiveness of the project through Research Assistant assignments. A retrospective "state-of-the-watershed" seminar presentation to the next student cohort by Joseph Hoffman and key community partners is planned for Spring 2001, and possibly on a periodic basis in the future.

Measuring Success-Program Evaluation

The Heinz Endowment proposal provided for formal internal and external reviews of the graduate program at the mid-point of the start-up phase. In July 2000, a four-member team of university faculty and a professional practitioner in the disciplines of landscape architecture, natural resources management, environmental policy, and hydrology from Syracuse University, University of New Hampshire, Cornell University, and American Water Resources Association, respectively, visited CWS. Over two days, the team reviewed course syllabi, instructional

materials, student assignments and products and interviewed faculty, students, administrators and others involved in the program.

With reference to the Maiden Creek Keystone experience, the review team report commended " . . the success of the interdisciplinary approach and (we) are impressed by its incorporation of a strong service-learning environment." Also favorably reviewed were the participatory decisionmaking model and its value to ". . . learning team building and collaboration skills so essential to interdisciplinary problem solving." A constructive critique offered was to more clearly define and develop the competencies (e.g. GIS, field data acquisition, group process, community collaboration, conflict resolution) required of students before plunging into their Keystone Project ". . . baptism by fire" (Review Team Report 2000).

LESSONS LEARNED

Bridge Academic Cultures

Anyone who has spent any time on a major university campus will have been subjected to the mantra of "interdisciplinarity" as an antidote to perceived over-specialization and scholarly isolation. Yet the Keystone Project and the entire CWS curriculum were compelled – because of the nature of watersheds and their human inhabitants – to bypass the rhetoric and adopt its own peculiar working brand of cross-disciplinary training.

The effect of this necessary working arrangement was to overlap in a single setting two quite distinct academic cultures. The deductive and rational tradition of forestry and water resources science confronted the somewhat more inductive and holistic tendencies of planning and design. This initially expressed itself as two methodological impulses through the watershed assessment phase, the one linear and reductionist, the other a more freewheeling blend of qualitative and quantitative inquiries. These differences became apparent early on in the Keystone Project as students and faculty alike strived to adapt to fresh approaches to building knowledge. Consistent with the core pedagogic goals of the program, science and design students alike were engaged in watershed investigations that spanned the range from purely quantitative to experiential.[3] The Project's integrated methodology and professional training focus ensured a surprisingly steep learning curve that was not driven by standard research protocols and hypothesis-testing.

Individual student work habits and styles of interaction also needed time for reconciliation. The Center's open studio environment was designed to facilitate faculty-to-student and peer-to-peer interaction, as well as accommodate frequent guests. This required acclimatization on the part of several students who were more comfortable acting independently in the laboratory or lecture hall. The studio culture of deferring intensive production until the "off hours" also took its toll on the students who were accustomed to more regular work hours.

Finally, there was a period of acculturation that took place as the study team entered the "synthetic" phase of production of the watershed management plan. The process of plan making (e.g. goal-setting, issues identification, the formulation of alternatives, and a holistic package of recommendations) was foreign for students with a background in experimental science. These students seemed to be unnerved by the first few sessions of interactive brainstorming and debating of watershed interventions. Conversely, design students needed periodic reminding by their science peers to formulate defensible interventions that were based on analytical findings. But with some coaching from faculty, these initial incongruencies soon evolved into complementary group strengths that served to heighten the rigor and creativity of developing watershed solutions.

Resolve Inequitable Inter-Unit Expectations

One unanticipated issue that periodically surfaced through the course of the first Keystone Project had to do with the range of academic commitments brought to the table by individual students. Each academic unit buying into the option retains the prerogative to tailor the option to its broader departmental goals. Thus, the CWS curriculum varies slightly between units, as do specific expectations for the practicum.

Graduate faculty in Landscape Architecture, more attuned to professional practice, saw the practicum as nearly equal to the standard terminal MLA project. Faculty in the School of Forest Resources, on the other hand, perceived the practicum as a rather robust two-semester course, and asserted their expectation of a separate graduate thesis or paper. The reasons for this are quite involved, but suffice to say that two of the five students on the inaugural Keystone team were in the position of working simultaneously on the watershed

practicum *and* funded thesis research for faculty advisors external to the Center. On more than a few occasions the uncomfortable position of attempting to "serve two masters" was debated during team planning sessions. The unwieldy situation provided a strong lesson in curriculum design: achieve curricular parity between the various majors opting into the program. This notion was also reaffirmed in the Review Team report discussed earlier.

Focus on the Essentials / Make Space to Explore

Despite the best efforts of faculty and students to anticipate the range of watershed assessment topics and the necessary time to address them satisfactorily, we nevertheless were confronted with the proverbial "too much to do and too little time to do it." We learned soon enough, however, to frequently reassess study priorities, often adjusting the agenda to refocus on watershed topics and issues that were most important to Maiden Creek. The students came to tolerate the mild frustration of having to resist the urge to dig too deeply on a sub-topic with which they were adept, instead playing the more essential role of watershed generalist. Staying true to the pedagogic objective of gaining experience in a fairly broad range of real-world watershed topics and issues was a constant challenge. Thus, as noted above, substantive topics such as the impairment of surface and groundwater quality took priority over other potentially intriguing leads.

But sometimes the team simply felt the need for fun and exploration. The last thing faculty wanted was to quash curiosity and spontaneity. For example, the entire team got into the act of aquatic macroinvertebrate collection and bank-side identifications. One student – a fisheries biologist – served as *de-facto* field mentor for her peers. This soon-entrenched habit of making some room for slightly impetuous field activities and tangential studio discussions actually deepened our collective understanding of the watershed, and reinforced our growing appreciation for the places and people of the Maiden Creek basin. The Project's disciplined-yet-flexible approach helped achieve basic watershed training objectives while making room for individual strengths and interests. As importantly, it solidified our belief in the concrete and intangible merits of collaborative watershed study and peer learning.

Anticipate and Overcome the Data Glut *(or, Life Beyond Analysis)*

As alluded to above, there were times during the watershed assessment phase where students were nearly overwhelmed with the amount of data that quickly became available. The many PASDA data layers, online Census Bureau statistics, professional reports, a long wish-list of potential field activities – all threatened to shift the experience from one of inspired learning to one of endurance. Although several students found a certain analgesic comfort in processing data, it soon became apparent that the end was nowhere in sight. The specter of "analysis paralysis" threatened to reach new heights on the first Keystone Project, particularly for those students targeted for GIS duty. Moreover, each week added to the assessment phase cut directly into time allotted for preparation of the watershed stewardship plan.

This is where the guidance of both faculty and sponsors became crucial. A series of intensive project management sessions that reemphasized project goals resulted in consensus on what information was important and what could be discounted. This recovered a semblance of balance in the process, putting the emphasis back on learning, and confirming that a fully comprehensive watershed study was neither necessary to meet CWS program objectives, nor expected on the part of the sponsor. Nevertheless, the second phase of work was curtailed by several weeks to make room for the extended watershed assessment. In retrospect, the arena of interaction with stakeholders in the watershed was most short-shrifted. Adjustments to the curriculum will ensure that all students are facile with GIS and able to share equally in this essential but time-consuming activity. Most importantly, the second Keystone Project will ensure that stakeholder interaction is an inviolable item on the practicum's agenda.

Embrace Adaptive Practicum Management

Under the gaze of sponsors, stakeholders across the Commonwealth, and academic units in two Colleges there was ample motivation to make the Keystone Project run rigorously and smoothly. Faculty deliberations about their role arose almost daily, since it quickly became apparent that a single teaching style would not be effective for all students. More profoundly, faculty struggled with the challenge of dual accountability built into the practicum. On the one hand there were external obligations to conduct a watershed assessment process in Maiden Creek and deliver a stewardship plan. On the other was the mission to train watershed professionals, and whenever possible, promote graduate-level inquiry and learning-for-learning's sake. Although an increasingly common theme in university-based service-learning, the challenges in this case were compounded by the level of

funding involved, the Project's inaugural status at the Commonwealth level, and the quite unique interdisciplinary issues discussed above. Key questions included:

> When do we serve as scholarly mentors, and when do we step in as project managers?
> When do we use the prod of academic performance evaluation? Should we allow the students to make mistakes or miss minor deadlines as lessons-to-be-gained?

Later in the process, students began to mesh as a team and take control of project management duties. But the synthesis phase raised another basic question of "readiness." Armed with an extensive but still nascent understanding of the watershed, were students ready to be assertive and creative in prioritizing short- and long-range solutions?

Faculty roles, in fact, spanned the full spectrum. There were more than a few instances where faculty decided to bring their experience to bear to ensure success and pro-action rather than setbacks and reaction. But there were also intensely productive periods where team dynamics took a positive life of its own; faculty was then quick to ease to the sidelines. Public and stakeholder sessions, in particular, evolved as venues in which the student team could demonstrate their new knowledge, build communication skills, and execute a carefully choreographed sequence of activities.

Vital to the resolution of these questions was a sympathetic and flexible client. Our Berks County Conservancy sponsors not only understood the need to balance service-learning objectives with product obligations, but in fact were often the first to emphasize student team perspectives and field forays that served primarily educational ends. Time and again, the extraordinary level of institutional good-will between Penn State University and organizations and agencies in the Commonwealth surmounted the hurdles (real and perceived) that arose during the course of the first Keystone Project.

Summary of Lessons Learned

In retrospect, the Keystone Project's mild growing pains were most effectively addressed through a commitment to achieving academic and professional balance and adhering to first principles. Keystone Project instructors and fellows have in a relatively short time achieved a seasoned perspective on adaptive management of interdisciplinary watershed stewardship training. They have also been able to exchange skills and tactics in dealing with the inevitable idiosyncrasies of student teams. Through it all, students and faculty alike have witnessed first hand the great potential for collaborative learning and creative problem-solving inherent in the CWS model.

We are learning to accept the challenges of conducting professional watershed training in an academic context; to know when to let learning (including its minor setbacks) take place, and when to intervene in favor of obligations to the external sponsor. Watersheds of any scale are incredibly complex ecosystems, infused with human values and shortcomings. We now know the determination and focus required to conduct assessments that are marked by rigor, efficiency, selectivity, and relevance. But we also know that the investment is a wise one, a gateway to the vibrant and creative application of new knowledge to priority watershed issues and opportunities.

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ENDNOTES

1. Denise Fort discusses the enlightening nature of service-learning for students: "Decision-making in communities over water often is rancorous, passionate, and rowdy. Our students go forth into fora where neither experts, not those who hold political power can expect deference to their opinions based on their titles" (1998, p.26). The Keystone Project is beginning to corroborate this assertion.

2. Articles by John Burt, James Heaney, and Robert Wayland (Issue Number 93) were especially useful.

3 Jaroslav Pelikan echoed our convictions when he wrote, "Anyone who cares simultaneously about the environment and about the university has the capacity to meet a crisis that is not only ecological and technological, but ultimately educational and moral," (1992, pp. 20-21).

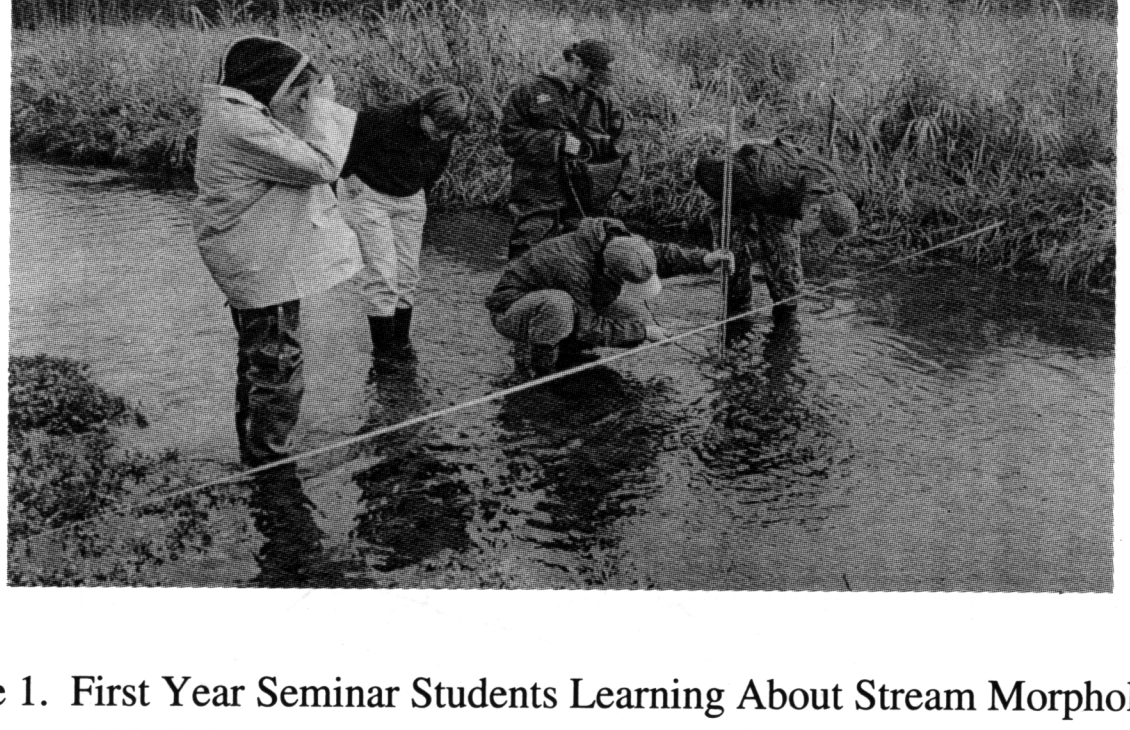

Figure 1. First Year Seminar Students Learning About Stream Morphology

Source: Center for Watershed Stewardship

Source: Center for Watershed Stewardship

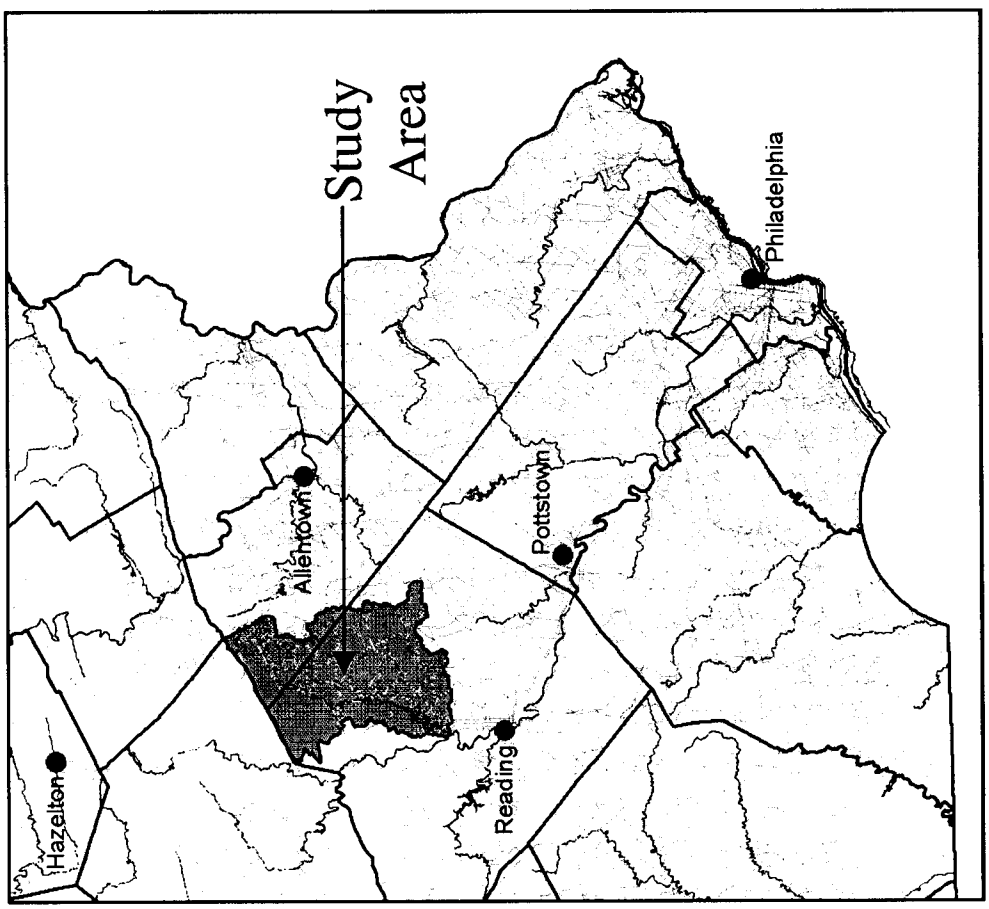

Figure 2. Maiden Creek Watershed Study Area

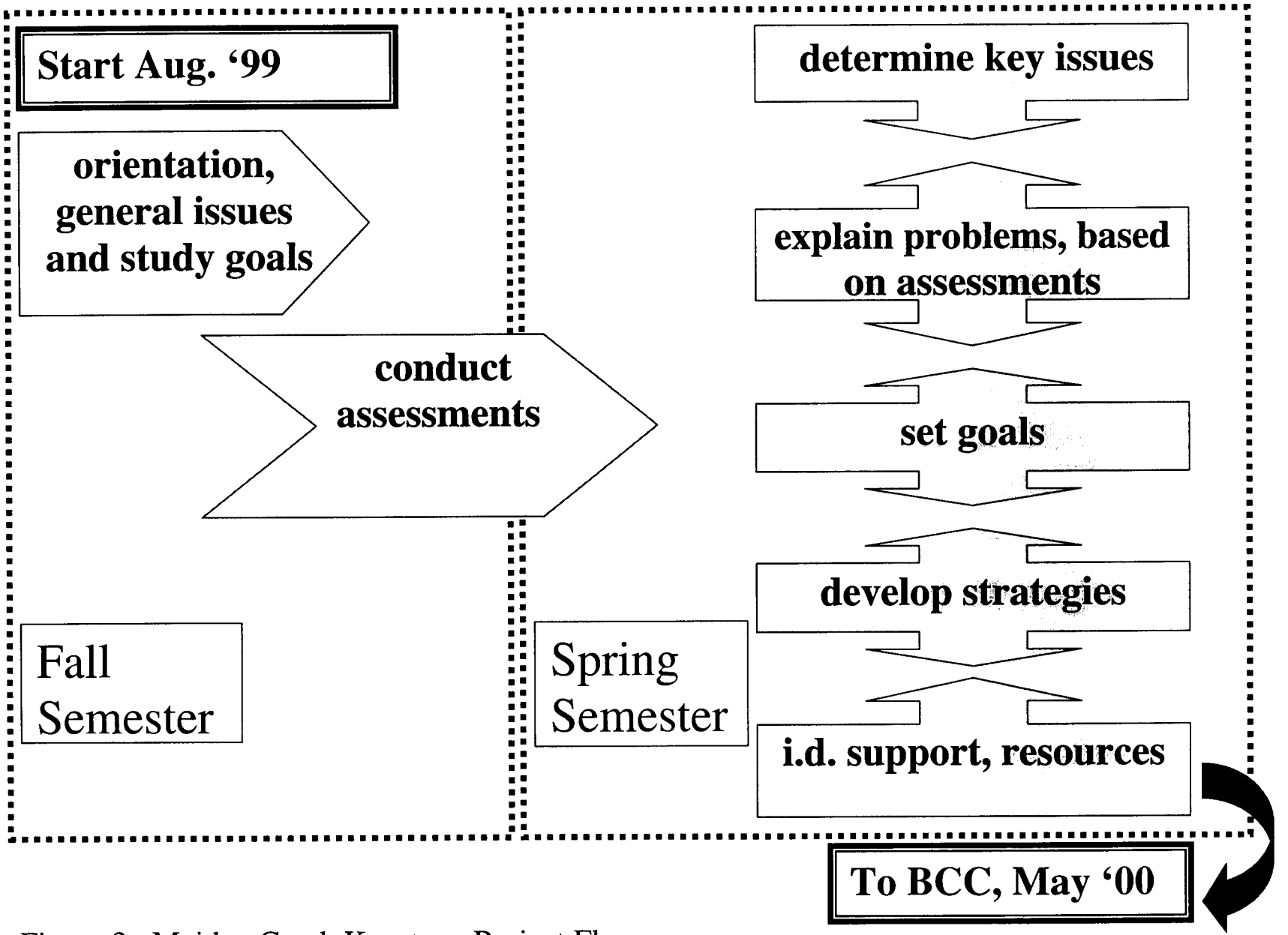

Figure 3. Maiden Creek Keystone Project Flow

Source: Center for Watershed Stewardship

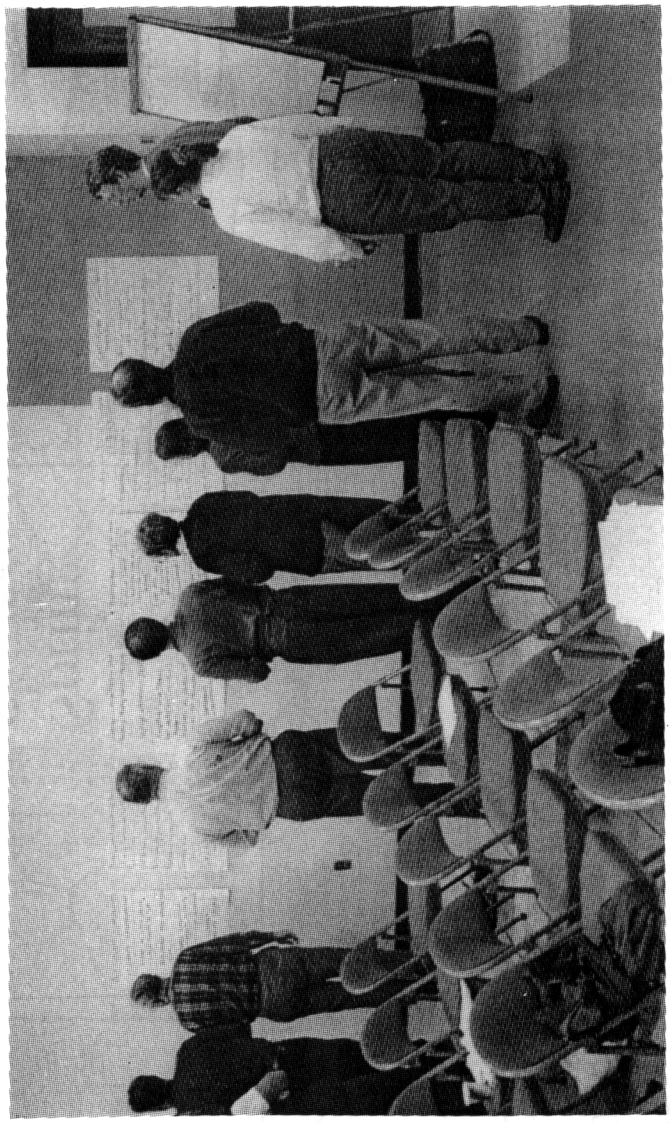

Figure 4. Stakeholder Prioritization of Issues, Public Issues Forum

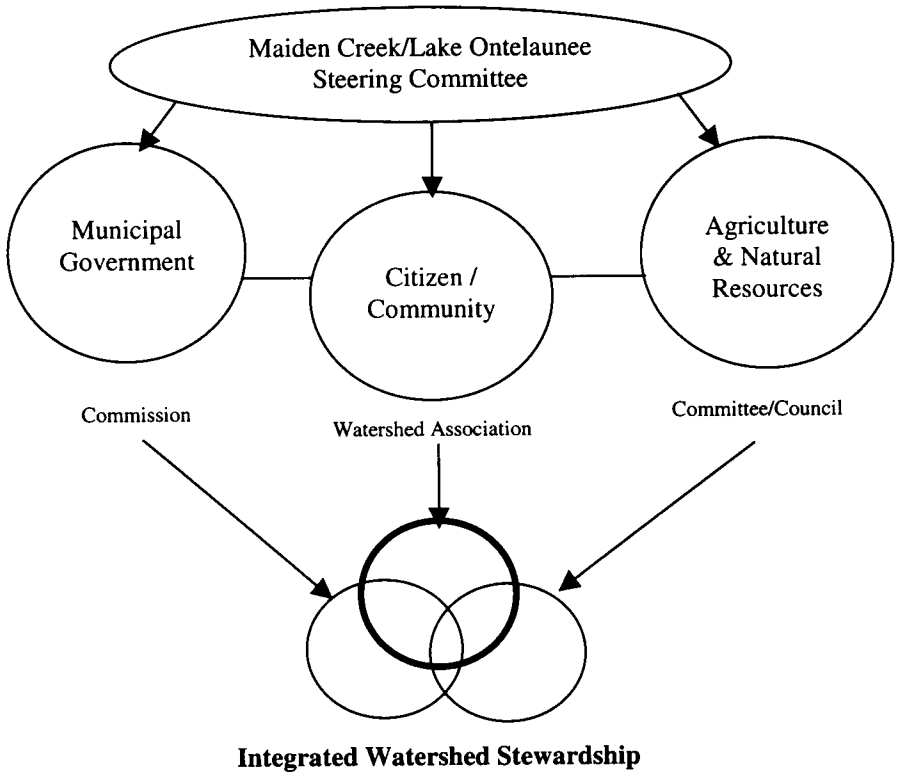

Figure 5. Proposed Maiden Creek Organizational Model

Table 1. Watershed Stewardship Issues and Topics

• Abandoned mine drainage	• Point source discharges
• Flooding	• Combined sewer overflows
• Agricultural runoff	• On-lot septic malfunctions
• Groundwater pollution	• Riparian buffers
• Stormwater management	• Urban sprawl
• Natural area restoration	• Source water protection
• Nitrates in drinking water	• Low flow water availability
• Fluvial geomorphology	• Forest harvest impacts
• Active mining	• Gas/oil drilling
• Environmental justice	• Fisheries management