Experimental Ponds for Aquatic Ecological Research

Project Leaders: TJ DeWitt, FI Gelwick, KO Winemiller, WH Neill, LA Fitzgerald, DL Roelke, SE Davis

Lead Contact: Thomas DeWitt, Texas A&M University Wildlife and Fisheries Sciences Department, (979) 458-1684. tdewitt@tamu.edu

Project Need—This is a facilities improvement request for the Aquatic Ecology Group at Texas A&M University. In the last 6 years Texas A&M has hired 6 of its 9 core faculty involved in experimental aquatic ecology. Now that a critical mass of aquatic ecologists exists we are making a serious effort to build our group facilities. Often, replicated mesocosms are needed to do experiments under a controlled setting, to complement our work in large natural systems where replication of experiments is infeasible or less preferred than mesocosm work.

Toward improving our facilities for aquatic ecology experimentation we seek funds to renovate and expand a series of existing ponds on the Riverside Campus of Texas A&M University. We understand the mission of the funds to which we are applying is research, we also point out below the complementary benefits of the proposed project for education in the research arena. Our overall goal is to develop a complete series of facilities that range in scale from small mesocosm facilities on main campus, to larger scale facilities (Artificial Streams and Ponds) just off campus. The collective facilities will serve both research and education missions involving the water resources of Texas.

Description—

History: Ten ponds were dug for the aquaculture program immediately before it moved off TAMU's Riverside Campus (roughly 8 years ago). Due to reduction in the aquaculture faculty and lack of communication between this group and the few experimental ecologists at the time, the ponds were not used or maintained. Recently, DeWitt discovered the existence of these ponds. The ponds would be extremely useful for experimental studies of aquatic ecosystems, because they are replicated and larger in scale than laboratory aquaria. For example, DeWitt often conducts his mesocosm work in 200 gallon aquaria or in 300 gallon troughs, but these ponds are roughly 30,000 gallons in size (12' by 24' surface area with a 4' depth). Thus for experiments infeasible to do in aquaria the ponds are a very elegant step up. These ponds, being both larger and more naturalistic, will improve the quality of all of our aquatic experiments.

Seven (arguably eight) of the ponds are suitable now for many types of experiment. Two need work to remove cattails, one must be deepened to match the others, and we would like to add two more to bring the number to 12. The ponds are in a natural clay area and hold water without liners. The pond site is plumbed with water and electricity. The Riverside Campus is enclosed in a security fence with gated access, and is patrolled regularly by campus police. Drs. Gelwick and DeWitt have extensive experience building aquatic mesocosms and would direct the renovation.

Intended uses: The facility will provide for nutrient and chemical studies, behavioral and functional ecology experiments, and community ecological and evolutionary studies. The taxa studied will likely include attached and pelagic algae, aquatic vascular plants, invertebrate grazers and predators (snails, insects, crustaceans), larval amphibians, fish and turtles.

Use in education: The ponds likely will be used in eight courses and may be used in others if scheduling permits. The first three projects listed below already have been conducted in WFSC

courses, but stand to be improved by use of the proposed new facility. The other listings are prospective projects that could use the streams to further enhance training in our aquatics program.

1. Evolutionary Ecology (WFSC 689; Fitzgerald)
"*Natural selection and predator impacts on prey with multiple predators*". Details of this project are available in the handout from last year's course (available upon request). To summarize, students measure natural selection on prey traits (behavior, morphology) when exposed to either of two predators, or when exposed to both predators simultaneously. Selection coefficients and predator impacts on prey numbers are compared with control (no predator) treatments and examined for basic and emergent predator effects.

2. Animal Ecology (WFSC 403; Gelwick)
"*Experimental foodweb manipulations and aquatic community ecology*". This experiment demonstrates the effects of top-down (predation) and bottom-up (nutrients) factors on aquatic food-web structure and ecosystem functions (primary and secondary production). Students run experiments to examine interactions among aquatic taxa (fish, snails, crayfish, tadpoles) at different levels of the foodweb. The experiment has been run in local streams. However, the ponds offer virtually complete control over environmental factors, and the number of ponds would allow us to examine several specific experimental questions each semester.

3. Animal Ecology (WFSC 403; Gelwick)
"*Experiments on population size and structure in a freshwater invertebrate*". Using freshwater snails reared under varied predator treatments, students examine growth, reproductive effort, and antipredator behavior. Data generated become the basis for a paper on the controls for population size and structure. This experiment has been run in the past in 55-liter aquaria borrowed from Dr. DeWitt.

4. Animal Ecology (WFSC 403; Gelwick)
"*Structuring principles in aquatic communities*". The ponds can be used to demonstrate influences of predators and habitat structure on foraging behavior and habitat use by fish and aquatic invertebrates. For example, mosquitofish in the absence of large piscivorous fishes (e.g. bluegill, green sunfish, bass) use the open water habitat but restrict activity to pond edges under predation risk.

5. Fisheries Management (WFSC 410; Gelwick)
"*Environmental controls on fish production and ecology*". Students can run experiments to test the effects of competitors, predators, habitat structure (cobbles, aquatic weeds) and environmental conditions (light, temperature), on survival, body size, and growth rates of fishes. Such activities are vital for training in fisheries management because students can gain experience in research design and methodology, and generate real data to practice statistical analysis and both written and oral communication of results.

6. Biology of Fishes (WFSC 417; Neill)
"*Ecophysiology of fish production*". This activity is at the conceptual interface between those planned in WFSC 414 and WFSC 410. An existing ecophysiological model will be used to "translate" measured values of environmental variables such as temperature, dissolved oxygen concentration, pH, conductivity, and forage availability (WFSC 414) into simulated fish survival, distribution and growth, for comparison with observed values (WFSC 410).

7. Physiological Ecology of Vertebrates (WFSC 616; Neill)
"*Physiological Mechanisms in Ecology of Aquatic Vertebrates*". Individual class-research projects, on topics like fish metabolism vs. environmental factors, poikilothermy in fish and semi-aquatic turtles.

8. Limnology (WFSC 414; Roelke)
"*Competition between Attached and Pelagic Algae in Multiple Nutrient Environments*". These ponds would be perfect for quick experiments not even feasible in the field. A likely course use would be to cross nutrient and UV treatments to examine the effects of nutrients on attached and pelagic alga, and examine the effects on attached algae of removing pelagic algae with the UV.

9. Lower Foodweb Dynamics of Aquatic Systems (WFSC 614 / OCNG 629; Roelke)
"*Algal community structure*." Will conduct projects similar to those in WFSC414, but with greater emphasis on experiments addressing the mechanisms structuring algal communities. For example, suspended solids can be precipitated or clays can be added in suspension and later removed. Light quantity can be changed or grazers added to understand their roles in agal community structure.

10. Behavioral Ecology (WFSC 622; DeWitt)
"Chemically mediated antipredator behavior". I plan to use the ponds to demonstrate chemically mediated antipredator behavior in a variety of organisms, including snails, odonates (dragonfly or damselfly larvae) and fish. Behaviors observed will be burial, hiding, and crawlout behavior of snails, activity reduction and changes in perch use by odonates, and activity reduction and altered habitat use by fish. DeWitt has worked extensively on these topics and used similar exercises in Animal Behavior courses at Boston University.

Note on Existing Aquatic Class Projects.—Aquatic class projects in the past have often been conducted in Dr. DeWitt's large (180 gallon) aquaria at his indoor facility at Riverside. While this mode will continue to some extent, it creates problems of conflict between DeWitt's research program and the teaching programs of several faculty. Local water bodies are unpredictable and often are too distant to feasibly continue their use in courses. Thus, the pond facility is needed to reduce or eliminate a variety of conflicts and problems, while also maximizing quality of course projects.

Use in research: Drs. DeWitt, Gelwick, Fitzgerald, Winemiller, Neill, Roelke and Davis, as well as graduate and undergraduate researchers plan to use these ponds for research projects. This facility will promote collaboration between faculty and increase the integrative nature of our research. Increasing group cohesion through shared core facilities is a major goal of this effort to establish a pond facility. Ultimately, my hope is that the facility and the integration it achieves can help launch more integrated projects of significant value to understanding aquatic ecology and to specific goals in Texas and national waterways.

TJ DeWitt: *Natural selection and ecological genetics of freshwater organisms.*

- Plans to conduct experiments on evolution, developmental plasticity and community ecology primarily with two systems: (1) snails, sunfish, crayfish and (2) mosquitofish, sunfish, odonates.

FI Gelwick: *Community ecology of freshwater systems (producers, consumers and predators).*

- Plans to conduct experiments on species interactions, especially those producing spatial and temporal patterning in structure and ecosystem functioning in aquatic communities.

KO Winemiller: *Food web dynamics of fish communities; functional ecology of fish*.

- Plans to perform community structuring experiments with varied introduction regimes of several local fish species.

LA Fitzgerald: *Functional morphology of herpetofauna.*

- Plans to conduct experiments on the functional morphology and life history traits of amphibian larvae, especially as it relates to predation ecology (e.g. with turtles as the major predators).

WH Neill: *Physiological ecology of fishes and nutrient processes in natural aquatic systems.*

- Plans to conduct experiments on the physiological effects of variation in temperature and dissolved oxygen on fish in 'seminatural' systems.

DL Roelke: *Nutrient processes in lakes, rivers and ocean environments.*

- Plans to conduct nutrient pulsing experiments to complement related work that is ongoing in local riverine and bay systems.

SE Davis: *Food web dynamics of fish communities; functional ecology of fish*.

- Plans to perform nutrient addition and transport experiments, to involve aquatic macrophytes and emergent plants.

Expected Outcomes—We hope TWRI agrees this facility would be a boon for training and for integrative research between TAMU's aquatic ecology faculty. These ponds figure big into our future plans for training, group and individual proposals. We plan to continue expanding our facilities by writing maintenance and expansion requests (e.g. shade structures, aerators) for these facilities into our individual and group grants. Thus we will continue to leverage funds TWRI can provide to support our initial efforts. The value of this facility is potentially immense, as the PIs build from this base over the years to come.