

Annual Report

Submitted to:

United States Golf Association (USGA) and
National Fish and Wildlife Foundation (NFWF)

November 1, 2000

Project title: Enhancing Amphibian and Reptile Biodiversity
On Golf Courses through Use of Seasonal Wetlands

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Executive Summary

"Enhancing Amphibian and Reptile Biodiversity On Golf Courses through Use of Seasonal Wetlands"

In the second year of our study we continued sampling the amphibians and reptiles that use wetland habitats on golf courses in the Central Savannah River Area (CSRA) of South Carolina and Georgia. We compared these survey data from golf courses to species surveys at nearby (off-course) seasonal wetlands. In addition, two of the courses sampled have on-course seasonal wetlands, which allowed us to compare amphibian diversity on these courses to the other three courses that do not have seasonal wetlands.

We continued to make progress on the other objectives outlined in our proposal (i.e., literature compilation, unpublished database search, statistical model formulation, and educational products). Most of our efforts this past year were focused on field sampling, however. In the coming year 2-3 additional courses will be sampled.

Although sampling is not completed, some trends are evident from our data. An overall comparison of amphibian species numbers on golf courses relative to off-course seasonal wetlands reveals that fewer species inhabit the golf course landscape (14 species vs. 21 at comparison wetlands). The difference between the two landscapes results largely from the paucity of seasonal wetland amphibian species on golf courses; whereas 14 seasonal wetland species were captured at off-course wetlands, only five were found on golf courses. A similar pattern emerges from the data collected only on golf courses when comparing courses with and without seasonal wetlands.

Our data documented that most of the wetlands we sampled on golf courses harbored large populations of numerous fish species, and consequently these same wetlands contained very few amphibian species. A greater variety of amphibian species was found in both on-course and off-course seasonal wetlands, compared to permanent lakes and ponds.

In summary, our sampling of golf courses thus far indicates that: 1) permanent wetlands are far more numerous than seasonal wetlands on courses, 2) the permanent wetlands on courses harbor large numbers of fish species, 3) amphibian species that use seasonal wetlands are generally absent from golf courses, and 4) courses that have seasonal wetlands have different amphibian species present than those courses with only permanent wetlands. As we continue to sample and add new courses, it is likely that these trends will continue.

Annual Report

Project title: Enhancing Amphibian and Reptile Biodiversity On Golf Courses through Use of Seasonal Wetlands

Project background: We have completed 18 months of this 3-yr study.* Our objectives, as stated in the proposal and previous report, are:

- Compile pertinent literature that relates species habitat needs, especially of amphibians, to the management of wetland hydroperiods.
- Locate unpublished databases that describe natural hydroperiod variation in seasonal wetlands.
- Develop a statistical model to describe species abundance in relation to wetland hydroperiod.
- Sample select golf course wetlands and comparison off-course wetlands for amphibian and reptile diversity.
- Produce educational products that courses can use to inform their membership about the importance of wetland habitats.

Substantial progress was made on several of these objectives in the first year of the study, and these results were summarized in last year's report. Although we continued to work on all objectives this past year, most of our efforts were focused on field sampling. Below we briefly recap the progress on all objectives, and then detail the results of our sampling to date.

Research to date:

LITERATURE COMPILATION: During the first year we assembled more than 100 references from scientific journals that relate amphibian and reptile habitat use to wetland hydroperiod. We now have several hundred references, and continue to acquire more. The literature will enable us to take information about amphibians and wetland hydroperiods from a broad geographic area and distill the information into a useful summary for golf course architects and superintendents.

We also have started to dig into the "gray" literature on constructing seasonal wetlands. As stated previously, this "how to" information will be essential in any effort to build seasonal wetlands on golf courses.

SEASONAL WETLAND DATABASES: Our goal is to acquire the data necessary to describe how "natural" wetland hydroperiods vary in relation to rainfall patterns and wetland size. With an understanding of the relationship between wetland size and hydroperiod, we will be able to make suggestions for maintaining a hydroperiod continuum across a golf course landscape. Last year we located unpublished data for our region in the southeastern U.S. We have not located similar data for other regions.

* funding for this project was not received until May 1, 1999

STATISTICAL MODEL: Our goal is to develop a general model that relates amphibian species richness (number of species) to wetland hydroperiod. As reported last year, one of the project's principal investigators (Dr. Joel Snodgrass) developed such a model for seasonal wetlands in our region. His observations, that amphibian numbers increase from "short" hydroperiod wetlands to "intermediate" hydroperiod wetlands, and then decrease in "long" hydroperiod wetlands, are consistent with our survey results to date. Additional data from golf courses and comparison wetlands will enable us to fine-tune our final model.

SAMPLING WETLANDS:

GOLF COURSE PARTICIPANTS: To date we have sampled five courses in the CSRA of South Carolina and Georgia. In addition to the courses identified in last year's report (Houndslake Country Club, Cedar Creek Golf Club, North Augusta River Course, Jones Creek Country Club), we added Pine Ridge Country Club in Edgefield, SC. Pine Ridge has a variety of on-course wetland habitats, including one wooded seasonal wetland, a beaver pond, several large lakes, and a creek.

COMPARISON WETLANDS: The 12 comparison wetlands we sampled are located in Aiken and Barnwell Counties on the Savannah River Site (SRS) in South Carolina, and are generally within 30 miles of the golf courses we sample. The comparison wetlands cover a broad range of hydroperiod variation (i.e., very temporary ponds to nearly permanent) and landscape position (e.g., upland sandhills versus river floodplain). Ten of the comparison wetlands have a substantial herpetofaunal database from previous years of research.

SAMPLING METHODS: Sampling involves setting small ("minnow") and large ("turtle") hoop traps in all microhabitats of a wetland for four days/three nights. Captured animals are identified, and some are collected for species verification. When appropriate, each wetland is hand sampled using time-constrained dip-net sampling. Because different species breed in wetlands at different times, and also because animals are more trappable at some life stages than others, sampling at each wetland is conducted four times annually, beginning in December and continuing at approximate 2-mo intervals.

ANALYSES: At the end of our study we will compare diversity and abundance data from permanent golf course wetlands to data from seasonal course wetlands. We will also contrast overall species diversity between comparison wetlands and golf course wetlands.

EDUCATIONAL PRODUCTS: We developed two educational products for courses and their members last year; by December 2000 we will have a handout specific to each course. These handouts will contain a list of species found at each course, as well as information on the importance of seasonal wetlands.

Results from field surveys through September 1, 2000:

Two of the golf courses (Houndslake and Cedar Creek) we are sampling have no seasonal wetlands (only permanent lakes or ponds); two courses (River Course and Pine Ridge) have a seasonal wetland in addition to permanent waters; one course (Jones Creek) has permanent ponds and a large creek, plus a single low-lying area that could be converted to a seasonal wetland with little effort. The permanent wetlands on all courses

contain numerous predatory fish species. Lists of species from all courses are presented in Appendix 1.

Although our sampling is not completed, some trends are evident from the data gathered thus far (Table 1). First, an overall comparison of amphibian species numbers on golf courses relative to off-course seasonal wetlands reveals that fewer species inhabit the golf course landscape (15 species vs. 21 at comparison wetlands; Table 1). The difference between the two landscapes results largely from the paucity of seasonal wetland amphibian species on golf courses; whereas 14 seasonal wetland species were captured at off-course wetlands, only six were found on golf courses.

A similar pattern emerges from the data collected only on golf courses (Table 1). The courses with a seasonal wetland, Pine Ridge and the River Course, had numerous individuals of three pond-breeding salamander species [the marbled salamander, (*Ambystoma opacum*) and the spotted salamander (*Ambystoma maculatum*) at Pine Ridge, and the spotted salamander and the red-spotted newt (*Notophthalmus viridescens*) at the River Course]. Our sampling revealed eggs, larvae, and adults of these species, which likely indicate viable populations on both courses. Two of these salamander species were not found on the courses without seasonal wetlands. In addition, the River Course seasonal wetland produced numerous young narrow-mouthed toads (*Gastrophryne carolinensis*), a species that is only successful in very temporary fish-free ponds.

The golf courses without seasonal wetlands generally had fewer amphibian species. Although two amphibian species typical of seasonal wetlands were captured at Houndslake (where we did not find any seasonal wetlands), the two species [the leopard frog (*Rana utricularia*) and the red-spotted newt (*Notophthalmus viridescens*)] were represented by a total of four individual adults. Eggs and larvae of these species were not found, and it is unlikely that populations are present and maintained by wetlands on the course. The single seasonal wetland species found at Jones Creek was the leopard frog. No adults were captured, but numerous egg masses were discovered in a low-lying depression after a heavy rainfall. It is likely that this small area could be converted to a true fish-free seasonal wetland with little effort. No seasonal wetland species were found at Cedar Creek, as there are no on-course seasonal wetlands; however, the creek and associated marsh habitats supported three species of salamanders: three-lined salamanders (*Eurycea longicauda guttolineata*), dwarf waterdogs (*Necturus punctatus*), and lesser sirens (*Siren intermedia*).

The data illustrate that most of the wetlands we sampled on golf courses harbored large populations of numerous fish species, and consequently these same wetlands contained very few amphibian species. A greater variety of amphibian species was found in both on-course and off-course seasonal wetlands, compared to permanent lakes and ponds.

Table 1—Summary of amphibian and fish species captures on golf courses and in off-course seasonal wetlands. Numbers in each cell are the total number of species located at each site for the respective categories and the total number of individuals (in parentheses). Letters in parentheses denote the type of wetlands found on the golf courses—P indicates that only “permanent” wetlands such as lakes, ponds, creeks, or marshes are present; S indicates that the course has a seasonal wetland in addition to the typical permanent wetlands. The off-course wetlands category is the combined data from 12 seasonal wetlands that vary in the length of time they hold water.

Species	Hounds-lake (P)	Cedar Creek (P)	Jones Creek (P)	Pine Ridge (S)	River Course (S)	Golf Course Totals	Off-course wetlands
<u>Amphibians</u>							
Seasonal wetland breeders	2 (4)	0 (0)	1 (5 egg masses)	3 (54)	4 (84)	6 (142)	14 (3,291)
Permanent Pond Breeders	3 (772)	3 (9)	3 (686)	3 (271)	3 (61)	3 (1,799)	3 (481)
Creek/Marsh Breeders	0 (0)	3 (25)	2 (4)	0 (0)	3 (5)	6 (34)	4 (15)
Total	5 (776)	6 (34)	6 (690)	6 (325)	9 (131)	15 (1,956)	21 (3,787)
<u>Fish</u>	7 (3,929)	8 (205)	11 (1,909)	14 (1,996)	13 (1,997)	18 (10,036)	11 (909)

Research Outline for 2000-2001:

SAMPLING WETLANDS: We will continue sampling golf course and non-course wetlands. Two to three more courses are being added for the coming year, with the goal of having at least one more course that has seasonal wetlands. Our new courses will be picked by December 1, 2000, so that sampling can begin by December 15, 2000. Golf course wetlands and comparison wetlands will be sampled in December, February, April, June, and August.

At the two courses that have an on-course seasonal wetland (Pine Ridge and the River Course) we have installed short (100-200 m) drift fences with pitfall traps. The drift fence technique is used to capture adult animals moving into and out of a breeding site, as well as juveniles that are leaving the wetland. The technique involves erecting a barrier between the wetland (where the animals breed) and the upland habitat (where the animals live in the non-breeding season). As animals move to or from the wetland, they encounter the barrier, travel along it, and fall into traps dug into the ground. When the fence is in operation it is checked daily; during non-census periods the traps are closed. Data acquired from the drift fences will give us a better idea of the species breeding in the wetlands, the type of adjacent terrestrial habitat they use, and their direction of travel from the wetlands.

OTHER OBJECTIVES: We will continue to compile the literature database in an EndNote® format, and categorize the references by the USGA geographic region. Our database search and statistical model objectives are largely completed, but we will fine-tune the model based on additional data acquired during the next year. Other than continued sampling, our primary efforts will focus on the educational products we have started. Based on suggestions from course superintendents, we will revise our handout that describes the project to include course-specific species lists. We completed a brochure on the importance of seasonal wetlands to amphibians, and it will be distributed to courses this winter. The final educational product, an interactive CD of use to golf course managers, is scheduled for the third year of this project.

Implications of Results:

Our sampling of golf courses thus far indicates that: 1) permanent wetlands are far more numerous than seasonal wetlands on courses, 2) the permanent wetlands on courses harbor large numbers of fish species, 3) amphibian species that use seasonal wetlands are generally absent from golf courses, and 4) courses that have seasonal wetlands have different amphibian species present than those courses with only permanent wetlands. As we continue to sample and add new courses, it is likely that these trends will continue.

If the amphibian (and some reptile) species that use seasonal wetlands are missing from the golf course landscape, then our results indicate that this habitat type should be incorporated into course design. We believe that even slight modifications to "out of play" areas on courses might make a big difference to the variety of species that the golf course landscape supports. Because local courses appear to be very supportive of our efforts, we may be able to experiment with such modifications on a small scale to assess their effectiveness.

We also believe that education will play a large role in the golf community's acceptance of changes to course appearance. While it is true that seasonal wetlands do not look like permanent ponds and lakes, such wetlands are nonetheless aesthetically appealing. As the public is told of the value of such habitat to wildlife, these wetlands may be even more attractive. One result we expect is that, as people are informed of the value of seasonal wetlands, golfers will be pleased to have such habitats as part of their home course.

**Appendix I—
Species List for Golf Courses
(from sampling through 1 September, 2000)**

I. Jones Creek Country Club

Amphibians

Southern Dusky Salamander (*Desmognathus auriculatus*)
Eastern Mud Salamander (*Pseudotriton montanus*)
Southern Toad (*Bufo terrestris*)**
Bullfrog (*Rana catesbeiana*)
Bronze Frog (*R. clamitans*)
Southern Leopard Frog (*R. utricularia*)*

Reptiles

Common Snapping Turtle (*Chelydra serpentina*)
Stinkpot (*Sternotherus odoratus*)
Yellow-bellied Turtle (*Trachemys scripta*)
Painted Turtle (*Chrysemys picta*)
Banded Water Snake (*Nerodia fasciata*)

Fish

Lake Chub (*Couesius plumbeus*)
Creek Chub (*Semotilus atromaculatus*)
Dusky Shiner (*Notropis cummingsae*)
Yellowfin Shiner (*Notropis lutipinnis*)
Lake Chubsucker (*Erimyzon sucetta*)
Yellow Bullhead Catfish (*Ameiurus natalis*)
Mosquitofish (*Gambusia affinis*)
Sunfish (*Lepomis* sp.)
Warmouth (*Lepomis gulosus*)
Bluegill (*Lepomis macrochirus*)
Mud sunfish (*Acantharcus pomotis*)

II. Houndslake Country Club

Amphibians

Red-spotted Newt (*Notophthalmus viridescens*)*
Southern Toad (*Bufo terrestris*)**
Bullfrog (*Rana catesbeiana*)
Bronze Frog (*R. clamitans*)
Southern Leopard Frog (*R. utricularia*)*

Reptiles

Common Snapping Turtle (*Chelydra serpentina*)
Stinkpot (*Sternotherus odoratus*)
Yellow-bellied Turtle (*Trachemys scripta*)
Painted Turtle (*Chrysemys picta*)
Banded Water Snake (*Nerodia fasciata*)
Eastern Garter Snake (*Thamnophis sirtalis*)

Fish

Grass Carp (*Ctenopharyngodon idella*)
Lake Chub (*Couesius plumbeus*)
Yellowfin Shiner (*Notropis lutipinnis*)
Mosquitofish (*Gambusia affinis*)
Sunfish (*Lepomis* sp.)
Largemouth Bass (*Micropterus salmoides*)
Warmouth (*Lepomis gulosus*)

III. Cedar Creek Golf Club

Amphibians

Three-lined Salamander (*Eurycea longicauda guttolineata*)
Dwarf Waterdog (*Necturus punctatus*)
Lesser Siren (*Siren intermedia*)
Southern Toad (*Bufo terrestris*)**
Bullfrog (*Rana catesbeiana*)
Bronze Frog (*R. clamitans*)

Reptiles

Banded Water Snake (*Nerodia fasciata*)
Eastern Cottonmouth (*Agkistrodon piscivorus*)

Fish

Pirate Perch (*Aphredoderus sayanus*)
Redfin Pickerel (*Esox americanus*)
Dusky Shiner (*Notropis cummingsae*)
Madtom catfish (*Noturus* sp.)
Mosquitofish (*Gambusia affinis*)
Sunfish (*Lepomis* sp.)
Mud sunfish (*Acantharcus pomotis*)
Blackbanded sunfish (*Enneacanthus chaetodon*)

IV. Pine Ridge Country Club

Amphibians

Marbled Salamander (*Ambystoma opacum*)*
Spotted Salamander (*A. maculatum*)*
Southern Toad (*Bufo terrestris*)**
Bullfrog (*Rana catesbeiana*)
Bronze Frog (*R. clamitans*)
Southern Leopard Frog (*R. utricularia*)*

Reptiles

Common Snapping Turtle (*Chelydra serpentina*)
Stinkpot (*Sternotherus odoratus*)
Eastern Mud Turtle (*Kinosternon subrubrum*)
Yellow-bellied Turtle (*Trachemys scripta*)
Painted Turtle (*Chrysemys picta*)
Eastern Box Turtle (*Terrapene carolina*)
Florida Cooter (*Pseudemys concinna*)

Five-lined Skink (*Eumeces fasciatus*)
Banded Water Snake (*Nerodia fasciata*)
Black Rat Snake (*Elaphe obsoleta*)

Fish

Pirate Perch (*Aphredoderus sayanus*)
Eastern Mudminnow (*Umbra*)
Redfin Pickerel (*Esox americanus*)
Grass Carp (*Ctenopharyngodon idella*)
Lake Chub (*Couesius plumbeus*)
Dusky Shiner (*Notropis cummingsae*)
Yellowfin Shiner (*Notropis lutipinnis*)
Creek Chubsucker (*Erimyzon oblongus*)
Mosquitofish (*Gambusia affinis*)
Sunfish (*Lepomis* sp.)
Largemouth Bass (*Micropterus salmoides*)
Warmouth (*Lepomis gulosus*)
Bluegill (*Lepomis macrochirus*)
Spotted sunfish

V. River Course Golf Club

Amphibians

Greater Siren (*Siren lacertina*)
Spotted Salamander (*A. maculatum*)*
Red-spotted Newt (*Notophthalmus viridescens*)*
Southern Dusky Salamander (*Desmognathus auriculatus*)
Eastern Mud Salamander (*Pseudotriton montanus*)
Southern Toad (*Bufo terrestris*)**
Spring Peeper (*Pseudacris crucifer*)**
Narrow-mouthed toad (*Gastrophryne carolinensis*)*
Bullfrog (*Rana catesbeiana*)
Bronze Frog (*R. clamitans*)

Reptiles

Common Snapping Turtle (*Chelydra serpentina*)
Stinkpot (*Sternotherus odoratus*)
Yellow-bellied Turtle (*Trachemys scripta*)
Florida Cooter (*Pseudemys concinna*)
Painted Turtle (*Chrysemys picta*)
Eastern Box Turtle (*Terrapene carolina*)
Banded Water Snake (*Nerodia fasciata*)
Southern Black Racer (*Coluber constrictor*)
Black Rat Snake (*Elaphe obsoleta*)

Fish

Eastern Mudminnow (*Umbra pygmaea*)
Redfin Pickerel (*Esox americanus*)
Grass Carp (*Ctenopharyngodon idella*)
Creek Chub (*Semotilus atromaculatus*)

Dusky Shiner (*Notropis cummingsae*)
Yellowfin Shiner (*Notropis lutipinnis*)
Creek Chubsucker (*Erimyzon oblongus*)
Yellow Bullhead Catfish (*Ameiurus natalis*)
Mosquitofish (*Gambusia affinis*)
Sunfish (*Lepomis* sp.)
Largemouth Bass (*Micropterus salmoides*)
Warmouth (*Lepomis gulosus*)
Mud sunfish (*Acantharcus pomotis*)

* Obligate seasonal wetland species

** Sometimes breeds in permanent ponds, but usually breeds in seasonal wetlands