Turfgrass and Environmental Research Online

…Using Science to Benefit Golf

University of Georgia researchers at the Savannah River Ecology Laboratory show how seasonal wetlands can be used to increase biodiversity on golf courses.

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PURPOSE

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Seasonal Wetlands and Golf Courses

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SUMMARY

Innovative research by University of Georgia researchers at the Savannah River Ecology Laboratory demonstrates that seasonal wetlands can be used to increase the biodiversity on golf courses. Their findings and recommendations include:

- Seasonal wetlands enhance amphibian diversity on golf courses.
- Increased landscape diversity of wetlands equals higher diversity of amphibians.
- Education of the golf community on the value of seasonal wetlands is vital.
- Upland habitats of amphibian species must also be conserved.
- Some permanent wetlands can be converted suc-cessfully to seasonal wetlands.
- Seasonal wetlands should be incorporated into golf courses, either in "out of play" areas or as course hazards.

The golf course landscape may provide an ideal opportunity to combine golf course design objectives with conservation goals such as habitat protection and biodiversity enhancement. From a design standpoint, the incorporation of seasonal wetlands into a course layout has the potential to make a course more varied, aesthetically pleasing, and challenging. From a conservation standpoint, numerous isolated seasonal wetlands scattered across a habitat mosaic of forested and open areas on a course may create a biodiversity boon for amphibians and some reptiles.

Seasonal wetlands generally hold water for only part of the year. In the Southeast these wetlands usually fill with rains in late autumn and early winter, and often remain filled through early summer.

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Golf courses often have ample wetland habitats, but typically these are permanent lakes and ponds.

Seasonal wetlands represent ideal habitats for many species due to the absence of predatory fish. In fact, the presence of numerous seasonal wetlands very likely will enhance biodiversity of many taxa. In conjunction with permanent water hazards, seasonal wetlands of varied types will create a hydroperiod continuum across the landscape that will be used by a diverse array of species.

The value of seasonal wetlands

Seasonally flooded wetlands have an ecological value that is disproportionately large relative to the space they require and the time that water is present. In some coastal regions, they maintain water quality by controlling the seasonal movement and storage of rainfall (10). Seasonal wetlands provide essential habitat for a rich diversity of plant (9) and aquatic invertebrate species (19).

Additionally, many species of semi-aquatic reptiles and amphibians use small wetlands and surrounding uplands as linked habitats, both por-

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Carolina bays are one type of isolated seasonal wetland that is present on the southeastern Coastal Plain. Of the thousands of Carolina bays that once dotted the landscape in South Carolina, most have been severely altered and degraded. Fewer than 200 remain relatively intact.

tions of which are vital to the organisms' survival (2, 16). These isolated, ephemeral wetlands are an important refuge for wildlife species, particularly in agricultural landscapes where the wetlands are the last remaining unexploited habitat (18). If a goal of conservation efforts is to maintain or restore the ecological value of small wetlands, then greater knowledge of seasonal wetlands and their contribution to regional biodiversity is critical.

Wetland loss and golf courses possibilities

Wetland loss in the southeastern U.S. has been of concern for many years (5, 6). From the 1950s to the 1970s, the loss of wetlands in the Southeast was greater than any other region of the country, with a net annual loss of 386,000 acres per year (6). On the Coastal Plain of North Carolina, 51% of all wetland acreage had been lost by 1980 (11). This loss includes pocosins, a category of ephemeral wetlands, approximately 70% of which have been totally destroyed through development, partially altered, or scheduled for development (10).

In South Carolina, isolated freshwater wetlands account for over 22% of the total wetland acreage (20), yet alteration and destruction of these types of wetlands has also been severe. A recent survey of the status of Carolina bays on the Coastal Plain of South Carolina found that approximately 97% have been altered or severely impacted, and fewer than 200 bays of the original thousands remain "relatively unimpacted" (1). Seasonal wetlands are important from an ecological perspective because they retain surface water for only a portion of a year (12). The length of time that a wetland holds water, the hydroperiod, has an overriding influence on the range of species that can live and reproduce in or near the wetland, especially with regard to amphibians and other semi-aquatic taxa (21).

Permanent lakes and ponds are at one end of a hydroperiod continuum and most water hazards on golf courses can be categorized as "permanent." Lakes and ponds are usually inhabited by a few common non-native fish species (e.g., largemouth bass, bluegill), and, as a result, a limited number of amphibian species except bullfrogs. In general, most amphibian species are preyed upon heavily by fish (and bullfrogs) and do not fare well in permanent waters (7, 15, 4). Most "pond-breeding" amphibian species actually require seasonal wetlands for breeding and for completing the larval stage of their life cycles.

Redbreast Sunfish

Largemouth Bass

Most wetlands on golf courses were permanent ponds or lakes. A few small creeks were present, also. These habitats supported large populations of fish.

The historic availability of seasonal wetlands probably accounts, at least in part, for the exceptionally high amphibian and reptile biodiversity of the southeastern U.S. Throughout the region, seasonal wetlands are used by large numbers of amphibian species: 16 species in a 0.16-ha Florida pond (3), over 20 species in each of numerous wetlands in South Carolina (14, 17), 19 species in each of two Tennessee ponds (13), and over 15 species of just frogs and toads in a single Texas pond (22).

Thus, while increasingly recognized as the most valuable wetland habitat type for maintaining amphibian diversity in the Southeast, seasonal wetlands continue to rapidly disappear and remain unprotected by most wetlands regulations (1). A concerted effort by golf courses to preserve and even create new seasonal wetlands has the potential for great conservation value.

The goals of the study

In general, the goals of this research were to examine how amphibians use the variety of wetlands found on golf course landscapes, and compare them to amphibian use of off-course seasonal wetlands. This was accomplished through a combination of sampling on five courses and in 10 off-course wetlands, surveying the literature, and analyzing prior data on seasonal wetlands. Based on the results, recommendations were developed for enhancing biodiversity on golf courses by increasing the spatial distribution and abundance of seasonal wetlands as part of a golf course landscape.

Bullfrog

The amphibians associated with permanent waters on golf courses were generally those known to be tolerant of fish.

Marbled Salamander

Mole Salamander

Ornate Chorus Frog

Narrowmouth Toad

Seasonal wetlands provided breeding sites for amphibian species not captured in permanent lakes, such as marbled and mole salamander species, chorus frogs, and narrowmouth toads.

Main players...frogs, toads, and salamanders

Approximately 40 species of amphibians occur in the Central Savannah Regional Area (CSRA), and many of them use seasonal wetlands for breeding and larval development. Individual species vary in the times of year during which they breed. Some species, particularly some salamanders, breed in the autumn, followed by other species that breed in winter, spring, and summer. We sampled wetlands on and off golf courses throughout the year to account for species differences in breeding chronology. Wetlands were sampled approximately every two months. Each sample period consisted of four days and three nights of trapping with small-meshed minnow traps, supplemented by dip-netting, hoop-net trapping, hand collecting, and visual observations (7).

Sampling in off-course seasonal wetlands began in April, 1999. Golf course wetland sampling at five courses was added in late summer of

Seasonal wetlands could be constructed in "out of play" wooded areas on golf courses.

1999. We compared the diversity and abundance of amphibians in permanent aquatic habitats to that of seasonal wetlands, both among courses and between courses and the off-course wetlands.

Sampling confirmed a well-known trend in amphibian ecology: wetlands that harbor fish populations are generally not suitable for a diversity of amphibian species. In the permanent lakes and ponds on CSRA golf courses we have found three primarily amphibian species: bullfrog (*Rana catesbeiana*), green frog (*Rana clamitans*), and southern toad (*Bufo terrestris*). All lakes and ponds contain numerous predatory fish species, including species of sunfish (*Lepomis spp.*), largemouth bass (*Micropterus salmoides*), redfin pickerel (*Esox americanus*), mosquitofish (*Gambusia affinis*), and lake chub (*Couesius plumbeus*). Additional amphibian species were found in stream and marsh areas on some courses, including the lesser siren (*Siren intermedia*), dwarf waterdog (*Necturus punctatus*), southern leopard frog (*Rana utricularia*), and mud salamander (*Pseudotriton montanus*).

The seasonal wetlands that we sampled off golf courses had greater numbers of amphibian species than permanent golf-course wetlands. Off-course seasonal wetlands generally had two to three additional salamander species, and two to five additional frog and toad species. On the two courses that have seasonal wetlands (Edgefield, SC, and North Augusta, SC), we found some of this region's pond-breeding species in our sampling of the on-course seasonal wetlands, but we did not find these species in the on-course permanent lakes. Species at the permanent golf-course wetlands were the "expected" species, i.e., those known to be tolerant of fish and to inhabit long hydroperiod wetlands, such as bullfrogs and southern toads. At the on-course seasonal wetlands we picked up several species generally associated with shorter hydroperiod wetlands and a lack of fish, including marbled salamanders, spotted salamanders, and narrowmouth toads. At the comparison sites we found many species not captured on any golf course, including mole salamanders, ornate chorus frogs, spadefoot toads, and gopher frogs.

Implications of results

Most golf course water hazards had a lower diversity of amphibians than comparison seasonal wetlands (i.e., similar sized, natural wetlands with variable hydroperiods). Consequently, we predict that incorporating more seasonal wetlands into the design of golf courses will increase the biodiversity of amphibians and other semi-aquatic animals. This idea cannot be tested until seasonal wetland habitats are implemented in golf course designs, and the amphibian populations are monitored. However, our extensive sampling of seasonal wetlands indicates that if the wetland itself is "intact," and if there is suitable adjacent terrestrial habitat, then it is likely that amphibians and other wetland species will thrive. One unknown, of course, is whether effects from chemical use on golf courses will be any different in a variable hydroperiod habitat, as compared to permanent waters.

The creation of true seasonal wetlands "from scratch" is largely an unknown art/science. Although there is abundant information on techniques for restoring previously degraded wetlands, little research has been conducted to *create* a wetland with a variable hydroperiod that mimics a natural seasonal wetland. Given the need for

SPECIES * obligate seasonal wetlands species ** species that use both seasonal and permanent water sources	Comparison Wetlands	Golf Course Wetlands	Courses with seasonal wetlands	Courses with permanent water only
Acris gryllus (northern cricket frog)**	41	2	2	0
Ambystoma maculatum (spotted salamander)**	6	405	405	0
A. opacum (marbled salamander)*	129	54	54	0
A. talpoideum (mole salamander)*	2188	0	0	0
A. tigrinum (eastern tiger salamander)*	10	0	0	0
Amphiuma means (two-toed amphiuma)	1	0	0	0
Bufo terrestris (southern toad)**	352	2014	251	1763
Desmognathus auriculatus (southern dusky salamander)	0	7	5	2
Eurycea cirrigera (southern two-lined salamander)	0	1	1	0
E. longicauda guttolineata (three-lined salamander)	0	1	0	1
E. quadridigitata (dwarf salamander)*	2	0	0	0
Gastrophryne carolinensis (eastern narrow-mouthed toad)*	709	53	53	0
Hyla cinerea (green treefrog)**	74	3	3	0
H. femoralis (pine woods treefrog)*	6	0	0	0
H. gratiosa (barking treefrog)*	1	0	0	0
H. squirella (squirrel treefrog)*	20	0	0	0
Necturus punctatus (dwarf waterdog)	0	1	0	1
Notophthalmus viridescens (red-spotted newt)**	209	21	20	1
Plethodon glutinosus (slimy salamander)	18	2	2	0
Pseudacris crucifer (northern spring peeper)**	179	1	1	0
P. nigrita (southern chorus frog)*	150	0	0	0
P. ornata (ornate chorus frog)*	174	0	0	0
Pseudotriton montanus (eastern mud salamander)	2	3	1	2
Rana capito (Carolina gopher frog)*	10	0	0	0
R. catesbeianna (bullfrog)	9	502	239	263
R. clamitans (bronze frog)	275	998	309	689
R. utricularia (southern leopard frog)*	817	18	5	13
Scaphiopus holbrooki (eastern spadefoot toad)*	320	0	0	0
Siren intermedia (lesser siren)	6	9	0	9
S. lacertina (greater siren)	9	9	8	1
Total species 30	**26**	**19**	**16**	**11**

and benefit of such wetlands on a golf course landscape, studies that determine the best methods for constructing these habitats are essential.

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