WETLAND MANAGEMENT

Use of Contour Maps of Water Depths to Predict Flora and Fauna Abundance in Moist Soil Management

—Matthew C. Perry, Brian Bauman, Gregory A.Gough, and Edward J. R. Lohnes

INTRODUCTION

Wetland impoundments historically have been managed with seasonally adjusted water depths to mimic natural drying and flooding cycles and provide appropriate habitat and food for nesting and migratory waterfowl. Impoundments at Patuxent Research Refuge, Laurel, MD were created in the 1940-60s in response to continental wetland losses from agriculture and the drought of the 1930s and to provide suitable wetland sites for research (Perry et al. 1997). Since their creation, the impoundments have been managed to maintain the greatest biomass of plants (especially seeds) beneficial to migratory waterfowl. In years past, when floating-leaved plants (spatterdock, *Nuphar luteum*; waterlily, *Nymphaea odorata*; and watershield, *Brasenia schreberi*) covered more than 50 percent of the surface area, the impoundment was drained (a drawdown). Adverse effects of having too large a population of these plants include reduced light penetration, reduced submerged aquatic vegetation, overall reduction in plant diversity, and a reduced dissolved oxygen level, which has adverse effects on most other aquatic species. Drawdowns encourage beneficial moist soil plant growth and concentrate foods at depths that are within the foraging range of the targeted waterfowl (Fredrickson 1991). The impoundment drawdown procedure became known as moist soil management because of the large mud flats that were initially created. Plant populations historically have been the main focus of water level management within the impoundments.

There are, however, other factors that should be taken into consideration if wetland managers want to obtain and maintain the greatest biomass and biodiversity. Macroinvertebrates, an important, protein rich food source for migratory birds, are required by breeding female ducks, molting ducks, hatchlings, and shorebirds. Shorebirds feed on midge fly larvae (Chironomidae) found in sediment of shallow water areas during spring and fall migration in the mid-Atlantic area (Larsen 1996, Laskowski 1997). These invertebrates tend to thrive when water levels fluctuate on a yearly basis (Fredrickson and Reid 1988).

Currently, the decision to draw down an impoundment is based on results of past experience. In many cases this has become more an art than a science. Few data are available to support decisions on frequency, rate, or time of drawdown. The goal of this project was to develop a technique to quantitatively predict the area of moist soil that would be exposed as a result of a water drawdown of any magnitude and subsequently predict the abundance of flora and fauna. The use of this technique will allow managers to model their impoundments and predict amounts of food resources with various management strategies.

PROCEDURES

Precision lightweight global positioning systems (GPS) receivers (PLGR+96) were used to create maps of the topography of the bottom of the impoundments of Patuxent Research Refuge. Coordinates were taken at the intersection of a 25m x 25m grid system superimposed on each of the impoundments. At each point the depth was recorded with a meter stick or sounding line from a boat when impoundment was at full pool. Impoundments that already had been drawn down were measured by use of a surveyors' level and a height stick, using a full pool mark on the water control structure as a reference point. Noticeable changes in depths, between the 25 meter points, were recorded as they were observed. Depths and coordinates also were collected between islands, between any island and the perimeter of the impoundment, and around the perimeter of all of the islands where the slope became negligible. The coordinates from the GPS were then uploaded to a computer, along with data on the water depth at each intersection.

The completed data then were used to create point maps that were laid over aerial photographs of the impoundments to insure accuracy. Once the perimeter of the impoundment and islands were accurately digitized, the two maps were joined and a contour map was produced and overlaid with the appropriate aerial photographs. The use of aerial photographs can be avoided if the perimeter is accurately delineated with GPS readings, which does not occur if readings are only taken from the 25m x 25m grid points.

These completed contour maps will be available in the future on Patuxent Wildlife Research Center's home page (http://www.pwrc.usgs.gov) and can be generated for impoundments at other refuges. Refuge staff using other biological sampling data from the impoundments will then be able to predict flora

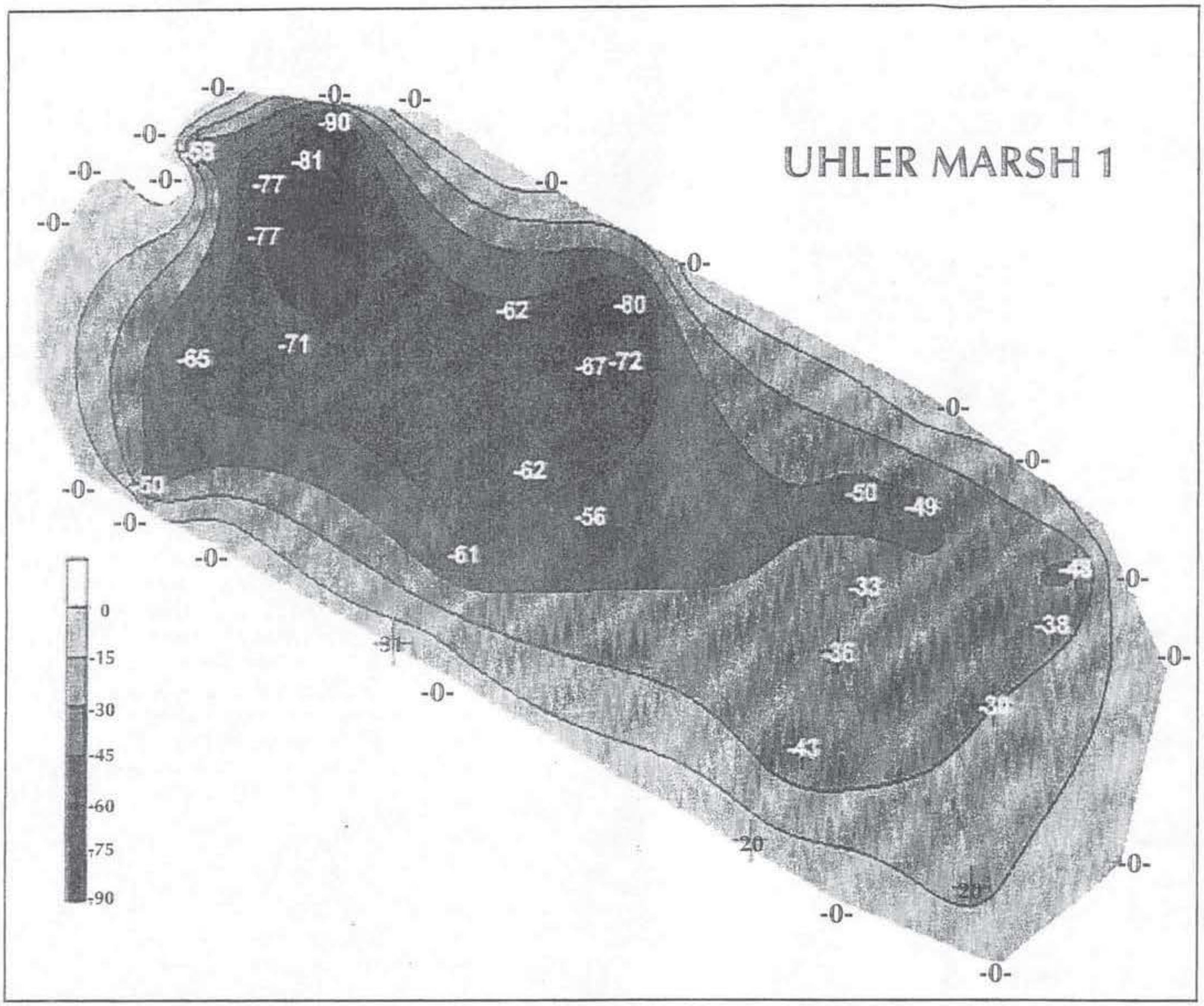


Figure 1. A contour map showing the depths (in cm) to bottom at Uhler Marsh 1 when filled to pool level.

and fauna based on management strategies for any impoundment in any year.

MANAGEMENT IMPLICATIONS

It is anticipated that contour maps of impoundments will be created in a similar manner for other selected National Wildlife Refuges and used in conjunction with data on flora and fauna availability. Selection of grid size for water depth readings should be based on the amount of relief of the impoundment and the desired precision. These maps, combined with the appropriate biological data, can aid managers in planning drawdowns to increase biodiversity and biomass of specific species. Contour maps allow the users to calculate the percentage of moist soil (or shallow water) exposed during a drawdown based on any given decrease in water level at the water control structure and predict the availability of flora and fauna. For example, a drawdown of Uhler Marsh 1 (Figure 1) of 15 cm (5.9 in) from a full pool would expose 3958 square meters (42.588 square feet) of mud (Surfer 1997). *Combined with* a database of the benthic biomass at various water depths and the life cycles of aquatic macroinvertebrates, managers can estimate the quantity of

Table 1. Area of moist soil exposed and midge fly larvae (chironomids) available based on various drawdown scenarios done during the spring, 1999 at Uhler Marsh 1, Patuxent Research Refuge, Laurel, MD.

Depths of Water Removed in CM (IN)	Moist Soil Exposed M^2 (Ft^2) [% of Total][1]	Chironomids No. (% of Total)[1]
15 (5.9)	3958 (42,588) [15]	2,018,580 (21)
30 (11.8)	9089 (97,798) [35]	4,532,770 (85)
45 (17.7)	16063 (172,838) [62]	8,159,250 (85)
60 (23.6)	20570 (221,332) [79]	9,083,185 (95)
75 (29.5)	25038 (269,409) [97]	9,529,985 (100)
90 (35.4)	25861 (278,264) [100]	9,550,560 (100)

[1]Areas of moist soil exposed and chironomids available represent cumulative totals as increased amounts of water are removed. Total chironomids were based on concurrent sampling that determined densities of approximately 50 to 550 per square meter.

macroinvertebrates within the impoundment for any stage of drawdown (Table 1). In this example, 85% of the midge fly larvae (chironomids) were available to shore birds when 50% of the water in the impoundment was drawn down 45cm (17.7 in) exposing 62% of the bottom. These same calculations also can be conducted for plant populations. The scheduling of drawdown can target a desirable species or multiple species depending on the life cycle data available.

Managers also could manage impoundments to control or eliminate undesirable species in the same manner. The on-site evaluation needed for non-cyclic drawdowns (Knighton and Verry 1983) could be done using aerial photographs of the impoundment in question to determine exact coverages of undesirable plants. These photographs can be combined with the contour maps to determine the amount of flooding or draining needed to regulate their abundance to an acceptable or optimum level. By creating a database of the species that inhabit or use the impoundments, their breeding schedule, feeding habitats, and preferred resting areas, a manager can directly control the diversity and population to efficiently manage for any species. Research is presently underway that will further refine impoundment management on a regional basis, by analyzing data from many refuges to manage more effectively for migrating birds. ❀

REFERENCES

Fredrickson, L. H. 1991. Strategies for water level manipulations in moist-soil systems. Fish and Wildlife Leaflet 13.4.6. Waterfowl Management Handbook. U. S. Fish and Wildlife Service, Washington, D. C.

Fredrickson, L. H., and F. A. Reid. 1988. Invertebrate response to wetland management. Fish and Wildlife Leaflet 13.3.1. Waterfowl Management Handbook. U. S. Fish and Wildlife Service, Washington, D. C.

Knighton., M. D, and E. S. Verry. 1983. How to evaluate water impoundments sites for wildlife. U. S. Dept. of Agric., Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota.

Larsen, A. C., 1996. Marsh management at Prime Hook NWR: seeking a definition of "marsh quality" for intensively managed wetland impoundments in terms of chironomid production and management. Unpub. Report. U. S. Fish and Wildlife Serv., Milton, DE. 15 pp.

Laskowski, H. 1997. Management of important aquatic invertebrates at National Wildlife Refuges. Region 5 Biological Newsletter 7:2-6.

Perry, M. C., P. Kangas, and H. H. Obrecht, III. 1997. Creating and managing wetland impoundments to provide habitat for aquatic birds. Second Society of International Limnologists International Congress of Limnology and Aquatic Birds: Monitoring, Modeling, and Management. Merida, Yucatan, Mexico. 22 pp.

Surfer -WIN32. 1997 Surface mapping system, Version 6.04. Golden Software, Inc. Golden CO.

ABOUT THE AUTHORS

Matthew C. Perry

Matthew C. Perry was born in Rhode Island. He received his BS from the University of Rhode Island in 1963, MS from Virginia Polytechnic Institute in 1970, and PhD at University of Maryland in 1985. Matt's research deals with habitat management dealing with impoundment wetlands, powerline rights-of-way, compost amendments to soil, and buffer zones in agriculture fields. Matt also recently initiated a study of sea ducks in Chesapeake Bay.

Patuxent Wildlife Research Center
11410 American Holly Drive
Laurel, Maryland 20708 USA
phone: (301)-497-5622
fax: (301)-497-5624
e-mail: Matt_Perry@USGS.GOV

Brian S. Bauman

Brian S. Bauman attended the University of Maryland and graduated with a BS in Natural Resource Management in 1996. He spent three years working on a variety of issues at Patuxent Wildlife Research Center in Laurel, Maryland. The focus of his work was on wetland ecology and he conducted field studies dealing with wetland vegetation, small mammals, amphibians, aquatic macroinvertebrates, and water chemistry. He is currently employed at Oregon's Department of Transportation working as an Environmental Program Coordinator.

Oregon Department of Transportation
Eugene, Oregon 97401
phone: (503)-986-2652
e-mail: Brian.S.Bauman@odot.state.or.us

Gregory A. Gough

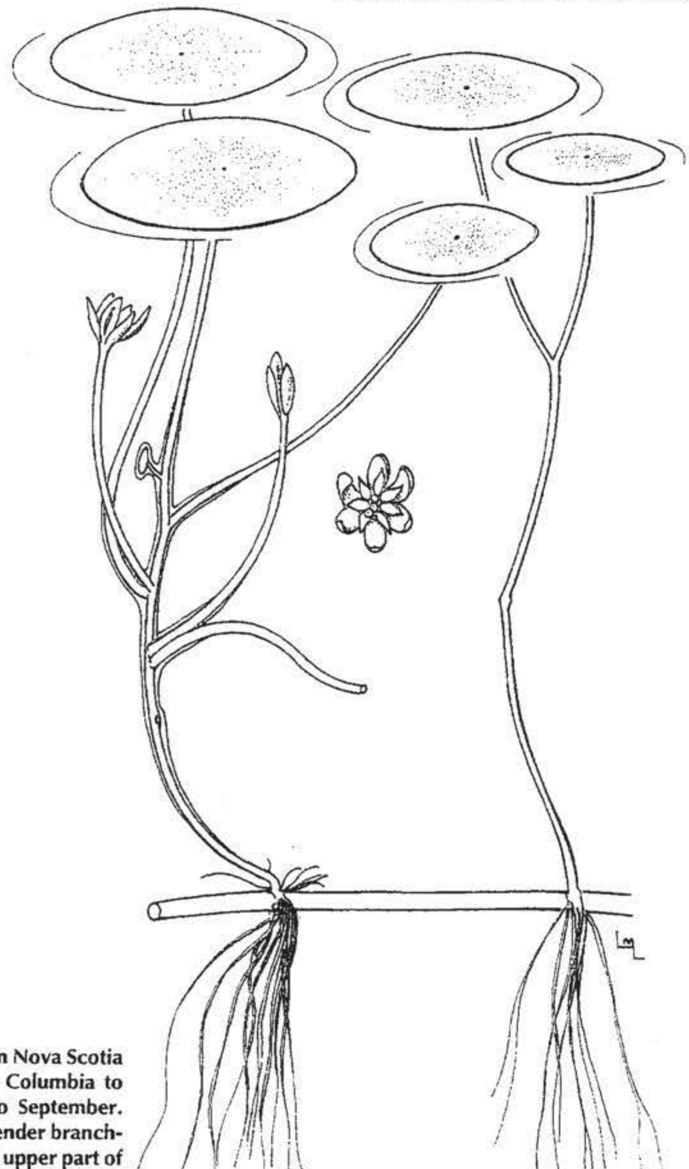
Gregory A. Gough is originally from Bethesda, Maryland and graduated from the University of Maryland, College Park in 1988 with a BS degree in Biology. Greg has worked at the Patuxent Wildlife Research Center since 1992 dividing his work between field research (bird and vegetation surveys) and computer analysis (data manipulation, analysis and presentation).

Patuxent Wildlife Research Center
11410 American Holly Drive
Laurel, Maryland 20708 USA
phone: (301)-497-5626
fax: 301-497-5624
e-mail: Gregory_Gough@USGS.Gov

Edward J. R. Lohnes

Edward J. R. Lohnes was born in Kings Lynn, Norfolk, in the United Kingdom. He received his Bachelor of Science degree in Coastal Zone and Marine Environment Studies at Pembrokeshire College, University of Glamorgan, Wales, in the summer of 1999. Since the mid 1990s he has worked during the summer at Abbotsbury Swannery, Dorset, and has been responsible for helping to compile a large database dealing with a mute swan breeding colony. Edward recently was in Maryland in an intern position at Patuxent Wildlife Research Center, where he conducted field and computer studies dealing with wetlands and wildlife, and hopes to return to the States at the end of the summer to continue his position there.

Edward. J .R. Lohnes,
Haytor, Portland Court,
Lyme Regis, Dorset.
U.K. DT7 3ND.
phone: 01297 443666
e-mail: Edward_Lohnes@Hotmail.com



water shield
Brasenia schreberi

This perenial freshwater floating aquatic herb is found from Nova Scotia to Minnesota south to Florida and Texas, and S. British Columbia to Oregon on lakes, ponds and quiet streams from June to September. Submerged underground creeping rhizomes give rise to slender branching stems with alternate, floating peltate leaves toward the upper part of the stem. Small, purple flowers are solitary with three to four sepals and petals. (see reference 3 and 7 on page 37)