Commercial Value of Amphibians Produced From an Isolated Wetland

Author(s): Brett A. DeGregorio, John D. Willson, Michael E. Dorcas, and J. Whitfield Gibbons
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Notes and Discussion

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Abstract.—Despite the functional importance of isolated wetlands as supporters and sources of diverse assemblages of amphibians and reptiles, they lack federal protection and local protection is often insufficient to halt their destruction. A key step in guiding informed policy towards isolated wetlands is to understand their economic value. This study combines a year of intensive amphibian surveys within a wetland with the assignment of values to each of the captured species based upon their reported commercial values. The 392,605 amphibians comprising 17 species captured at this wetland in 1 y were valued at $3,605,848 (U.S. dollars). Juvenile amphibians produced in the wetland in a single year accounted for the 95% of the reported value ($3,413,821). This value far exceeds the value of other natural habitats evaluated with similar methods and exceeds by two orders of magnitude the value of this land had it been converted to agriculture. Although this study does not advocate amphibian harvest as an economic use for wetlands, it does highlight the value, diversity, and abundance of amphibians inhabiting these small, isolated, and often unprotected wetlands and provides a foundation for future research, management, mitigation, and policy.

Introduction

Isolated wetlands are critically important to the maintenance of biodiversity (Semlitsch and Bodie, 1998) and especially important in supporting large populations of amphibians (Gibbons *et al.*, 2006). Even very small wetlands can support surprisingly diverse herpetofaunal assemblages (*e.g.,* 27 species in 0.5 ha wetland; Semlitsch *et al.*, 1996) and annually produce remarkable amphibian biomass (*e.g.,* >1400 kg; Gibbons *et al.*, 2006). Additionally, these productive wetlands often occur in dense mosaics across the landscape (*e.g.,* 0.48/km^2 and 0.59/km^2; Semlitsch and Bodie, 1998) contributing to their importance in metapopulation connectivity (Willson and Hopkins, 2013) and transfer of biomass from aquatic to terrestrial ecosystems (Gibbons *et al.*, 2006).

Despite the ecological importance of isolated wetlands in the United States they receive little protection. No federal protection is provided to wetlands lacking a permanent surface-water connection to navigable waterways or a link to interstate commerce (Downing *et al.*, 2003). Protection at the local level varies considerably and currently two thirds of the United States do not provide protection for their isolated wetlands (Stetson, 2012). As a result isolated wetlands are rapidly vanishing (Richardson, 1983) as are the herpetofaunal communities reliant upon them (*e.g.,* Alford and Richards, 1999). In this study, we highlight the ecological value of these wetlands by assigning to them an economic value based on their amphibian production.

Valuation of a species, habitat, or ecosystem service is a difficult and often contentious task (*e.g.,* Loomis *et al.*, 2000) but may be a critical component of effective management and mitigation (Bauer *et al.*, 2010). Witczak and Dorcas (2009) recently proposed a method of valuing land based upon the commercial values of the inhabitant herpetofauna. While this, and any approach assigning economic value to wildlife has short-comings, we believe this represents an important starting point in contextualizing the value of land from an economic perspective. Our objective was to use the commercial value of amphibians to estimate the value of a single isolated wetland based on the number of amphibians it supports and produces annually.

Methods

Study site.—Ellenton Bay, located in South Carolina, U.S.A., is a semipermanent fishless freshwater wetland typical of Carolina bays (Sharitz, 2003). When completely full, Ellenton Bay measures 10 ha with a maximum water depth of approximately 2 m. For a more complete description of the wetland see Gibbons *et al.* (2006).

Amphibian surveys and valuation.—In Feb. 2003 we erected a terrestrial drift fence (1230 m long, 40 cm high, buried several cm into the soil) completely encircling Ellenton Bay. We placed 124 pitfall traps (19 L plastic buckets or 2.3 L coffee cans) and 40 wooden funnel traps in pairs on opposite sides of the fence, allowing captured individuals to be categorized as entering or exiting the bay. We placed

sponges in the bottom of pitfalls, providing moisture, cover, and a raft during times of inundation. We checked traps a minimum of once daily (0700–0900) from 3 Feb. 2003 to 31 Jan. 2004. We identified captured animals to species, categorized each as entering or exiting the wetland, and released them approximately 10–30 m away on the opposite side of the fence. Recently metamorphosed amphibians captured entering the wetland during peak emigrations were assumed to have been emigrants that had been captured and released earlier, rather than being immigrants from other wetlands; therefore, they were re-released on the outside of the fence and not included in capture totals. Because breeding amphibians enter and leave the wetland during a year, we subtracted the number of adults entering from the total number captured to determine total numbers of each species while reducing the risk of double-counting individuals.

We determined the values of herpetofauna (US$) by conducting searches of commercial values of species listed in peer reviewed literature (*e.g.,* Mitchell, 1995), pet trade companies (*e.g.,* Glades Herp Farms), and biological supply companies (*e.g.,* Carolina Biological Supply). When multiple values were found for a species, we used the highest value because the commercial value likely underestimates a species' true economic value (Gowdy, 1997). If unable to find a reported commercial value for a species we used the value of a closely related species. We used the same value for adults and juveniles of each species.

RESULTS

In 1 y of sampling we captured 392,605 individual amphibians comprising 23 species (Table 1). Individual commercial values of the amphibian species captured ranged from $0.50 (*Pseudacris nigrita*) to $29.99 (*Ambystoma tigrinum*). Abundances of individual species ranged from one (*Plethodon chlorobryonis* and *Pseudacris nigrita*) to 237,117 (*Lithobates sphenocephalus*). Individual species accounting for the greatest overall values were *L. sphenocephalus* ($2,371,171), *Anaxyrus terrestris* ($908,292) and *Ambystoma talpoideum* ($218,800). Values for five species (*Hyla femoralis, H. squirella, Pseudacris ornata, L. capito,* and *Ambystoma talpoideum*) could not be obtained due to their absence in the pet trade or biological supply industry. The market price ($5.50) for *Hyla cinerea* was used for the closely related and physically similar hylids. The price for *L. catesbeianus* ($25.00) was used for *L. capito* and that of *Pseudacris nigrita* was used for *P. ornata.* Finally, the price of *Ambystoma opacum* ($20.00) was used for *A. talpoideum.* The total commercial value of amphibians inhabiting the 10 ha Ellenton Bay was $3,605,848. The 17 species that bred in Ellenton Bay produced 370,015 juveniles valued at $3,413,821 (Table 1).

DISCUSSION

Isolated wetlands have long been recognized for their importance as wildlife habitat and providers of ecosystem services (Gibbs, 1993); however, no study has attempted to assign them an economic value based upon their faunal assemblages. We estimated the 392,605 individual amphibians comprising 17 species captured at Ellenton Bay during 1 y were worth $3,605,848 based solely on their commercial value. Although this value is an underestimate because it neglects the functional and aesthetic value of the animals, it highlights the importance and value of isolated wetlands and the diversity and abundance of amphibians they support and annually produce. Furthermore, this estimated value does not consider the amphibians that remain within the wetland year round or the multitude of other organisms reliant upon the wetland (plants, birds, reptiles etc). During the course of this study we captured 35 species of reptiles representing considerable commercial value. We did not include them in analyses as our sampling of reptiles associated with Ellenton Bay was incomplete compared to amphibians, which made predictable discrete migrations between upland and wetland habitats. Additionally, some species of reptile remain in the wetland year round, rendering our drift fence survey techniques inappropriate. Nonetheless, our estimated value for amphibians can be considered a minimum value of this unique and vulnerable habitat type. By assigning a commercial value to this imperiled ecosystem, we hope to promote more comprehensive local and federal protection of isolated wetlands; thereby, protecting the diverse and often unique flora and fauna associated with these habitats.

Draining of U.S. wetlands for agriculture is a leading cause of habitat loss; in fact, from 1887 to 1951, Ellenton Bay itself was drained and used as an agricultural field (Davis and Janecek, 1997). Under ideal

TABLE 1.—Abundance and estimated commercial values of all amphibians captured at Ellenton Bay, South Carolina, U.S.A, from 1 Feb. 2003 to 31 Jan. 2004. An asterisk denotes that the value of that species has not been established by the pet trade or biological supply industry and has been approximated from a closely related species (*see* Results)

Genus	Species	Value ($USD)	Source	Number of individuals	Percent metamorphs	Total value ($USD)
Anurans						
Acris	*gryllus*	1.50	CO	579	10	869
Anaxyrus	*terrestris*	7.00	RC	129,756	91	908,292
Gastrophryne	*carolinensis*	3.00	GHF	3861	7	11,583
Hyla	*chrysoscelis*	15.00	RC	9	33	135
Hyla	*cinerea*	5.50	CBS	51	27	281
Hyla	*femoralis*	5.50*	CBS	3	0	17
Hyla	*gratiosa*	20.00	RC	579	65	11,580
Hyla	*squirella*	5.50*	CBS	30	46	165
Pseudacris	*crucifer*	3.00	CO	2461	86	7383
Pseudacris	*nigrita*	0.50	MI	1	0	0.5
Pseudacris	*ornata*	0.50*	MI	3574	91	1787
Lithobates	*capito*	25.00*	CBS	3	0	75
Lithobates	*catesbeianus*	25.00	CBS	431	12	10,775
Lithobates	*clamitans*	7.00	CO	516	67	3612
Lithobates	*palustris*	3.00	CO	4	0	12
Lithobates	*sphenocephalus*	10.00	RC	237,117	99	2,371,170
Scaphiopus	*holbrookii*	13.99	RC	1206	29	16,872
Salamanders						0
Ambystoma	*opacum*	20.00	ML	144	65	2880
Ambystoma	*talpoideum*	20.00*	ML	10,940	79	218,800
Ambystoma	*tigrinum*	29.99	RC	1315	91	39,437
Eurycea	*quadridigitata*	2.50	RC	18	11	45
Notophthalmus	*viridescens*	10.00	GHF	6	0	60
Plethodon	*chlorobryonis*	19.00	RC	1	0	19
Total					$3,413,821	$3,605,848

[a] Sources: CBS: Carolina Biological Supply. http://www.carolina.com; CO: (Collins, 1993); GHF: Glades Herp Farms. http://www.gherp.com; MI: (Mitchell, 1995); ML: Mark Lucas. http://www.markmlucas.com; RC: Reptiles N Critters. http://www.reptilesncritters.com

[b] Values for five species (*Hyla femoralis, H. squirella, Pseudacris ornata, Lithobates capito*, and *Ambystoma talpoideum*) could not be obtained. The market price for *Hyla cinerea* was used for the closely related and physically similar hylids. The price for *L. catesbeianus* was used for *L. capito* and that of *Pseudacris nigrita* was used for *P. ornata*. Finally, the price of *Ambystoma opacum* was used for *A. talpoideum*

conditions and in a favorable market, corn produced in a field the size of Ellenton Bay (10 ha) could gross approximately $24,710 (assuming a price of $1000/acre) before offsetting costs of seed, fuel, machinery, taxes, and labor (http://www.hayandforage.com). By our estimate the value of Ellenton Bay ($360,085/ha) exceeds that of agriculture by two orders of magnitude. In placing a value on Ellenton Bay based on the commercial value of its amphibian inhabitants it is important to note 95% of the value is derived from the large number of juveniles emerging and dispersing from the wetland each year. Not only is there a very valuable standing crop of adult amphibians but it produces over $3 million worth of juvenile amphibians each year which either disperse across the landscape or return to breed at Ellenton Bay. Although our aim is not to advocate the commercial harvest of amphibians, the large number of juveniles produced each year indicates isolated wetlands can produce commercial value in perpetuity.

It should be noted high wetland productivity is reliant upon the quality of the adjacent upland habitat (Gibbons, 2003). Semlitsch and Bodie (2003) suggest some amphibians require up to 290 m of terrestrial habitat adjacent to wetlands during nonbreeding periods. Modifying our calculations to include the 10 ha wetland and a 300 m terrestrial buffer reduces the estimated value to $56,341/ha. However, this estimation does not take into account the numerous herpetofauna associated with the upland habitat and not recorded within our wetland surveys, which would increase the estimated value. Witzak & Dorcas (2009) used these same methods to estimate a value of $93,029/ha for the herpetofauna inhabiting upland forested habitat in North Carolina.

The valuation of wildlife and natural systems is a complex and contentious endeavor. Market-forces are often insufficient in reflecting the true social and ecological value of natural resources (reviewed in Freeman, 2003). It is beyond the scope of this study to comprehensively estimate the entire value of wetlands, nor is our aim to advocate commercial harvest of amphibians. Rather, the simplicity of this approach provides a minimum value of one isolated wetland and its amphibian inhabitants. An association of wetlands with significant monetary sums may assist in altering perceptions that they are unimportant and unworthy of protection. The application of this method can provide a preliminary step in understanding the importance and value of wetlands to avoid further habitat loss and guide thoughtful and effective land use policy.

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LITERATURE CITED

ALFORD, R. A. AND S. J. RICHARDS. 1999. Global amphibian declines: a problem in applied ecology. *Annu. Rev. Ecol. System.*, **30**:133–165.

BAUER, D. M., P. W. C. PATON, AND S. K. SWALLOW. 2010. Are wetland regulations cost effective for species conservation: a case study of amphibian metapopulations. *Ecol. Appl.*, **20**:798–815.

CAROLINA BIOLOGICAL SUPPLIES. http://www.carolina.com

COLLINS, J. T. 1993. Retail prices of Kansas amphibians and reptiles. Report to the Kansas Department of Wildlife and Parks, Pratt, Kansas.

DAVIS, C. E. AND L. L. JANECEK. 1997. Area no. 1: field 3-412/Ellenton Bay, Department of Energy Research Set-Aside Areas of the Savannah River Site. SRS National Environmental Research Park Program U.S. Department of Energy, Aiken, South Carolina.

DOWNING, D. M., C. WINER, AND L. D. WOOD. 2003. Navigating through Clean Water Act jurisdiction: a legal review. *Wetlands*, **23**:475–493.

FREEMAN, A. M. 2003. The measurement of environmental and resource values: theory and methods. RFF Press, Washington, U.S.A.

GENERAL EXOTICS REPTILES DEALERS. http://www.generalexotics.com

GLADES HERP FARMS. http://www.gherp.com/lists.htm

GIBBONS, J. W. 2003. Terrestrial habitat: a vital component for herpetofauna of isolated wetlands. *Wetlands*, **23**:630–635.

———, C. T. WINNE, D. E. SCOTT, J. D. WILLSON, X. GLAUDAS, K. M. ANDREWS, B. D. TODD, L. A. FEDEWA, L. WILKINSON, R. N. TSALIAGOS, S. J. HARPER, J. L. GREENE, T. D. TUBERVILLE, B. S. METTS, M. E. DORCAS, J. P. NESTOR, C. A. YOUNG, T. AKRE, R. N. REED, K. A. UHLMANN, J. NORMAN, D. A. CROSHAW, C. HAGEN, AND B. B. ROTHERMEL. 2006. Remarkable amphibian biomass and abundance in an isolated wetland: implications for wetland conservation. *Conserv. Biol.*, **20**:1457–1465.

GIBBS, J. P. 1993. Importance of small wetlands for the persistence of local populations of wetland-associated animals. *Wetlands*, **13**:25–31.

GOWDY, J. M. 1997. The value of biodiversity: markets, society, and ecosystems. *Land Econ.*, **73**:24–41.

LOOMIS, J. B., P. KENT, L. STRANGE, K. FAUSCH, AND A. COVICH. 2000. Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey. *Conf. Eea. C.*, **33**:103–117.

MARK LUCAS HERPETOLOGY. http://www.markmlucas.com

MITCHELL, J. C. 1995. Amphibians and Reptiles of Sugarland Run, Fairfax, and Loudoun Counties, Virginia: estimated Numbers and Commercial Value. *Catesbeiana*, **15**:15–22.

REPTILES N CRITTERS. http://www.reptilesncritters.com

RICHARDSON, C. J. 1983. Pocosins: vanishing wastelands or valuable wetlands? *BioScience*, **33**:626–633.

SEMLITSCH, R. D., D. E. SCOTT, J. H. K. PECHMANN, AND J. W. GIBBONS. 1996. Structure and dynamics of an amphibian community: evidence from a 16 year study of a natural wetland, p. 265–286. *In:* M. L. Cody and J. A. Smallwood (eds.). Long-term studies of vertebrate communities. Academic Press, San Diego, U.S.A.

——— AND J. R. BODIE. 1998. Are small, isolated wetlands expendable? *Conserv. Biol.*, **12**:1129–1133.

SHARITZ, R. R. 2003. Carolina bay wetlands: unique habitats of the southeastern United States. *Wetlands*, **23**:550–562.

STETSON, L. 2012. Wetland program plans: a strategic tool for states and tribes. *Wetland News*, **2012**:1–7.

WITCZAK, L. R. AND M. E. DORCAS. 2009. What are frogs and snakes worth? the economic value of reptiles and amphibians inhabiting the Charlotte-Metropolitan Area of North Carolina. *J. North Carolina Acad. Sci.*, **125**:131–137.

WILLSON, J. D. AND W. A. HOPKINS. 2013. Evaluating the effects of anthropogenic stressors on source-sink dynamics in pond-breeding amphibians. *Conserv. Biol.*, **27**:595–604.

BRETT A. DEGREGORIO[1], JOHN D. WILLSON, MICHAEL E. DORCAS, AND J. WHITFIELD GIBBONS, Savannah River Ecology Lab, University of Georgia, Drawer E, Aiken, SC 2980, MICHAEL E. DORCAS, Department of Biology, Davidson College, Davidson, NC 28035. *Submitted 20 February 2013; Accepted 21 November 2013.*

[1] Corresponding author present address: Department of Natural Resources and Environmental Sciences, University of Illinois, Urbana, 61801; Telephone: (260) 416-4242; e-mail: bdegrego@illinois.edu