Wetland-scale Habitat Determinants Influencing Least Bittern Use of Created Wetlands

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Abstract.—Southern Illinois mined lands were investigated to identify wetland-scale habitat parameters influencing the presence of a habitat limited species, the Least Bittern (*Ixobrychus exilis*). Total area (ha), open water area (ha), robust emergent (REM) area (ha), percent REM coverage, REM-open water edge length (m), edge:REM cover index and water depth parameters were measured at 35 wetlands (mean = 5.51 ha; range = 0.13-39.7 ha) to develop one- and two-regressor logistic regression models best explaining Least Bittern wetland use. Logistic regression models using open-water area or open-water area + edge index regressors ranked highest among candidate models, which distinguished our results from those obtained in previous studies. These data suggest that human-created basins supporting at least semi-permanently flooded robust emergent cover, ample expanses (>8 ha) of open water and high emergent edge lengths relative to flooded REM area may consistently meet breeding season requisites of Least Bitterns. Further work to validate or refine this profile of Least Bittern habitat may benefit efforts to enhance pre-existing wetland resources or create new ones. *Received 16 January 2008, accepted 20 July 2008.*

Key words.—Least Bittern, *Ixobrychus exilis*, habitat, habitat selection, mined land reclamation, area sensitivity.

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Alteration and destruction of emergent wetlands in the American Midwest is thought to have contributed to widespread marshbird population declines, especially in Illinois where less than 10% of pre-colonial wetlands remain (Graber *et al.* 1978; Dahl 1990; Suloway and Hubbell 1994; Herkert 1995). Once a common feature of the Illinois landscape, palustrine emergent wetlands in Illinois have declined to about 16.1% of the state's total wetland area (Suloway and Hubbell 1994). Among the taxonomically diverse suite of species using emergent wetlands, the Least Bittern (*Ixobrychus exilis*) is one of the most cryptic and poorly understood. Formerly an abundant breeder in Illinois, the Least Bittern is state-designated as Threatened (Nelson 1876; Endangered Species Protection Board 2007). Least Bittern population estimates suggesting declines or unacceptable levels of uncertainty prompted Gibbs and Melvin (1992) to list enhancement of existing wetland resources as one of the species' most crucial management needs. Yet the bittern's cryptic habits and relative lack of economic importance have generally caused it to be overlooked and seldom the subject of scientific research. Consequently, wetland management in support of Least Bittern conservation requires development of habitat criteria for the species across its range. A modest number of descriptive studies have characterized Least Bittern nesting microhabitat (Kent 1951; Weller 1961; Post 1998) and broad suites of habitat criteria at the wetland and landscape scale (Weller and Spatcher 1965; Frederick *et al.* 1990; Horstman *et al.* 1998). Quantitative investigations targeting specific vegetation, water level and other nest site habitat components (Reid 1989; Fredrickson 1996; DesGranges *et al.* 2006; Lor and Maleki 2006; Winstead and King 2006) tended to support and refine earlier research (Weller 1961), which in the Least Bittern's northern range, consistently indicated a positive affinity for persistently flooded, robust emergent vegetation (Weller 1961).

Tall, robust emergent marshes with stable water levels are common features of mine-affected lands in southern Illinois. Field studies in the region have documented consistent use of mined lands by Least Bitterns and other wetland-dependent wildlife (Klimstra and Thornburg 1982; O'Leary *et al.*1984; Perkins and Lawrence 1985; Pratt

1991; Horstman *et al.* 1998). As a result, southern Illinois mine lands represent a potential source of Least Bittern habitat in a region that is relatively marsh-poor (Horstman *et al.* 1998). Although ample evidence exists that Least Bitterns use managed or created wetlands (Frederick *et al* 1990; Horstman *et al.* 1998; Post 1998; DesGranges *et al.* 2006; Winstead and King 2006), conversion, enhancement, or creation of wetlands for this species require habitat criteria that will promote the most efficient allocation of limited conservation resources. Today, quantitative identification of habitat requisites associated with wetland size, structure, or distribution throughout the landscape represents a critical knowledge gap that few studies have adequately addressed (Brown and Dinsmore 1986; Gibbs and Melvin 1990; Fairbairn and Dinsmore 2001). Our primary objective was to identify wetland-scale habitat components most useful in predicting and promoting use of managed wetlands by Least Bitterns.

METHODS

Study Area

Coal mine-associated lands south of 38° N Latitude, which includes the Mt. Vernon Hill Country Section of the Southern Till Plain Division in southern Illinois (Schwegman 1973), comprised the study area. Relatively little topographic relief or gently rolling, agriculture-dominated terrain typifies the region. The focus of coal mining activity in Southern Illinois extends southeast from St. Clair County to Gallatin County (Fig. 1). Marshes established on mined lands in southern Illinois have fairly diverse origins. Some were designed as mitigation or restoration projects, with the specific intent of developing wildlife habitat and diverse macrophyte communities. Land subsidence associated with underground coal mining was an unintended source of wetland development. These wetlands typically developed diverse plant communities but are limited in area and distribution. The most abundant and widespread class of mined land wetland is associated with the construction of basins for the extraction, processing or storage of fine coal cleaning sediment. These basins were typically dominated by monotypic common reed (*Phragmites australis*) or cattail (*Typha* spp.) communities that developed after mining.

Study Site Selection

Initial site selection required the presence of robust emergent vegetation, at least seasonal flooding and mining origins. Development of a GIS incorporating mined land boundary and National Wetland Inventory (NWI) thematic layers allowed a random search for wetlands appearing to satisfy criteria for mining origins, cover type and hydrologic regime (Cowardin *et al.* 1979). This phase of the selection was validated using 1991-1996 black and white aerial imagery (≤1:12,000) followed by field visits. In many cases the NWI data and imagery failed to represent the current condition of mined-land wetlands, which were subject to a variety of shifting land uses and alterations (e.g., grazing, filling and adjacent industrial activity) considered incompatible with study objectives. When a candidate site was considered unsuitable, the nearest suitable replacement was used. Forty-one wetlands located in eight counties (Saline, Hamilton, Franklin, Williamson, Jackson, Perry, Randolph and St. Clair) met all criteria for inclusion in the study. At three locations, wetland complexes comprised of ≥two adjacent basins were considered single study sites; thus, our sample of 41 sites was collapsed to 35. All but one of these was located on private mined lands.

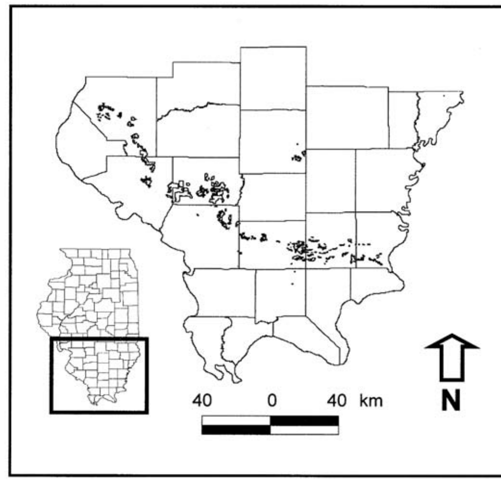

Figure 1. Distribution of mined lands in southern Illinois.

Least Bittern Surveys

Least Bitterns are among the most inconspicuous of marshbirds, a distinction that at least partially explains the lack of reliable population estimates for the species throughout most of their range. Call surveys conducted 15 May-23 June determined the presence of bitterns. A 15-minute point count divided equally among three phases was conducted at each survey station. Phases One and Three consisted of passive observation. Phase Two was a five-minute taped broadcast incorporating calls of the Least Bittern and four other target species: Pied-billed Grebe (*Podilymbus podiceps*), American Bittern (*Botaurus lentiginosus*), King Rail (*Rallus elegans*) and Common Moorhen (*Gallinula chloropus*). The broadcast phase consisted of one-minute vocalization periods for each species; each period included three ten–second calling bouts separated by three, ten-second silent periods. Alternate recordings featuring Least Bittern vocalizations at the beginning or end of the broadcast were used for each successive survey. Trained volunteers surveyed each study unit at least three times, a frequency that Gibbs and Melvin (1993) predicted would yield 90% probability of detecting Least Bitterns if they were present. At least one visit to each of the study units occurred during the Least Bittern's mid-May to early June peak calling period in southern Illinois (Horstman *et al.* 1994). Surveys were conducted during primarily calm, rain-free days.

Fixed survey stations at 100-200 m spacings provided complete coverage of robust emergent communities in each wetland unit. On wetlands with > one station, the order of stations visited was rotated with each survey date to minimize sampling biases. Observations at the first survey station of the morning usually commenced within one hour after official sunrise to facilitate visual identification of birds that flushed but did not respond vocally. Surveys continued as late as 11.30 h. All detections were documented from the time of arrival at the wetland edge until departure from the site.

Habitat Characterization and Resource-use Analysis

Area-associated variables included total wetland area (ha), open-water area (ha), robust emergent (REM) cover (ha) and REM percent cover. Total wetland area and REM area included only the portion of a study site subject to at least semi-permanent flooding, based on the well-documented importance of inundated conditions to Least Bitterns (Weller 1961; Weller and Spatcher 1965). Open water area included portions of wetlands supporting non-persistent emergent (e.g. *Nelumbo lutea*), floating-leaved (e.g., *Lemna* spp.) and submerged aquatic (e.g., *Chara* spp.) growth. Edge-related parameters were measured to the nearest 30 m (the finest level of resolution available). REM edge represented the length of emergent edge coinciding with readily distinguishable open water areas in aerial imagery. Edge index (EI) provided a measure of REM edge length relative to REM cover:

$$EI = \text{robust emergent edge (m)} / \sqrt{\text{robust emergent area (m}^2)}.$$

Digitized black and white aerial imagery (1996-1997) provided data for cover and edge variables. Imagery was ground-truthed during surveys and other field activities. Water depth for each wetland unit was calculated using the mean of five soundings obtained in representative habitat at the open water-REM vegetation interface.

Identification of resource-use patterns was based on comparisons of wetland characteristics for study sites with (occupied) and without (assumed unoccupied) associated Least Bittern detections. Prior to modeling, summary statistics for all parameters provided a coarse characterization of resource-use vs. availability by tallying the percentage of study sites that had median habitat parameter values greater than the median values for all sites. A Spearman rank correlation (alpha = 0.05) identified model parameter combinations with correlation coefficients ≥0.60, which suggested the risk of multicolinearity. Based on the correlation results, a suite of potential parameter combinations were used to develop one and two-regressor logistic regression models. Models were limited to a maximum of two regressors to avoid instability driven by a high proportion of explanatory variables to sampling units (study sites, in this case). Goodness-of-fit was based on Akaike's Information Criterion corrected for small sample size sizes (AIC_c) (Akaike 1974). The lowest AIC_c values among a set of candidate models were indicative of good model fit. All other things being equal, as the number of regressors in a model increases, so does the AIC_c value, the corollary being that parsimonious models are rewarded with lower values than those with similar explanatory value but more regressors. The difference between the lowest (optimal) AIC_c value and larger values from competing models provided an ΔAIC_c for each model, which was normalized to identify the relative likelihood of best fit for each model. Akaike weights (w_i) based on relative likelihoods allowed a quantification of relative model performance. Uncertainty regarding the fit of competing models with similar Akaike weights was resolved by using a confidence set analogous to a confidence interval, where candidate model weights falling within 10% of the largest weight should be considered as having similarly good fit.

RESULTS

Habitat Characterization

The distribution of study sites was skewed towards small wetlands (mean = 5.51 ha; range = 0.13-39.7 ha), which reflected region-wide conditions observed during our GIS site selection process. Nearly 60% of all wetlands were <3 ha (Fig. 2). Sites that were <1 ha, 1 < 2 ha, 2 < 3 ha, 3 < 4, and 4 < 5 ha represented 17%, 20%, 20%, 9%, and 9% of all wetlands, respectively. The REM component of wetland sites was also skewed towards the smaller end of the spectrum, with >50% of REM measurements at individual sites being <1ha (Fig. 2) and only three sites supporting >five ha of REM.

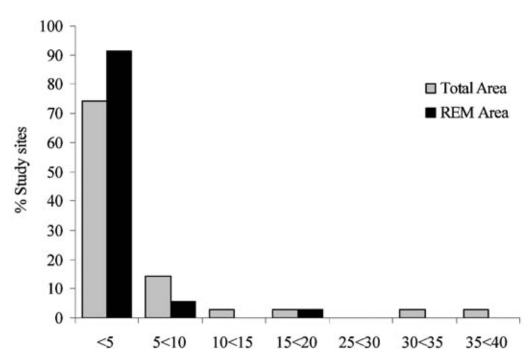

Figure 2. Distribution of mined land wetlands assigned to area (ha) classes based on total area and robust emergent (REM) area values. *n* = 35 wetlands surveyed for Least Bitterns in southern Illinois.

Persistent emergent vegetation consisted of common reed and cattail. Common reed was present on 29 (82.9%) of the 35 sites and was the dominant (>50% coverage) species on eleven occupied (84.6%) and 16 unoccupied (72.7%) sites (Fig. 3). The total area of common reed on individual study sites ranged from 0.04-18.77 ha (mean = 1.68 ha, SD = 3.43 ha). Cattail was present on 13 (37.1%) of the 35 sites and cattail area ranged from 0.02-1.65 ha (mean = 0.48 ha, SD = 0.12 ha). The small size of cattail patches relative to common reed hindered our ability to adequately test if a floristic preference (i.e. common reed vs. cattail) was a component of bittern resource selection.

For most habitat parameters (e.g. total area, open water area, REM area, REM edge length, and edge index), occupied sites had larger means and medians than did unoccupied sites (Table 1). For these parameters, the relatively large proportion of occupied sites with median values greater than medians for all sites combined was notable. The relative lack of sites supporting conditions leading to these large median values suggested a disproportionate use of resources by Least Bitterns, given availability (Fig. 4). Exceptions to this pattern included REM %, which for occupied sites, had markedly lower values than would be inferred by availability. For water depths at the REM-open water interface, there were no apparent differences between occupied and unoccupied sites.

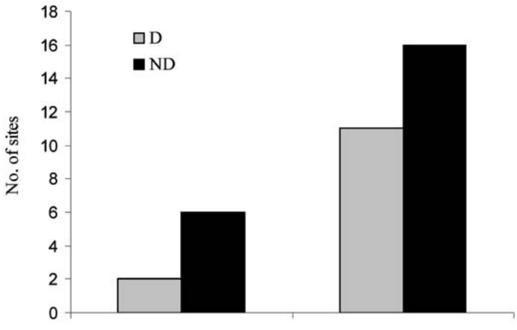

Figure 3. Distribution of southern Illinois mined-land wetland study sites dominated by cattail or common reed. Sites are divided into those with (D) and without (ND) associated Least Bittern detections.

Resource-use Model

Strong correlations between some habitat parameter combinations precluded their use in logistic regression models. For instance, total area was highly correlated with open water (Rs 0.9643, $P = 0.000$), REM area (Rs 0.7849, $P = 0.000$) and REM edge (Rs 0.7204, $P = 0.000$). Consequently, two-regressor models incorporated no more than one of these four variables each. The resulting six one-regressor and five two-regressor models were ranked according to Akaike weights, w_i (Table 2). The model with open water area as its single regressor ranked highest among the candidate models ($w_i = 0.1966$). With a w_i of 0.1778, the open water area + edge index model was included in the confidence set (0.1769 - 0.1966) and therefore considered to provide model fit at least as good as open water area. Wetlands with 4-5 ha of open water could be expected to yield a 0.5 probability of Least Bittern use. Increasing open water area to about 8.0 ha could be expected to yield a ≥0.9 probability of use.

DISCUSSION

Least Bittern Wetland-scale Habitat Requisites

Analysis—Presence-absence data, such as those used in our analysis, are potentially limited by a number of factors. Detectability of target organisms is principal among these, especially when observations are influenced by cryptic behavior or morphology, low densities or spatial-temporal fluctuations in detectability (MacKenzie 2005; Vojta 2005). Our call survey protocol was designed to preclude these limitations by taking advantage of the peak detectability period, using proven playback survey methods, and a survey frequency that facilitated accurate designation of wetland status (i.e. occupied or unoccupied). Compared to relative abundance, presence-absence data also have the potential to dramatically limit the amount of information obtained by surveys, such as how incremental changes in habitat parameter values can influence target organism densities.

Table 1. Habitat parameter values from southern Illinois mined-land wetland sites with (D) and without (ND) Least Bittern detections.

Variables	Range	Mean	Median	Std Dev
Total Area (ha)				
D	1.76-39.17	10.94	5.79	11.76
ND	0.13-9.67	2.30	1.80	2.01
Open Water (ha)				
D	1.1-22.3	7.40	5.00	7.10
ND	0.00-7.7	1.40	1.00	1.70
REM[a] Area (ha)				
D	0.7-18.8	3.60	1.20	5.20
ND	0.1-2.4	0.90	0.50	0.60
REM[a]% Cover				
D	13-48	30	29	12
ND	10-98	42	41	20
REM[a] Edge (m)				
D	390-6,420	1,546.15	990	1647.57
ND	30-1,650	561.82	390	438.29
Edge Index				
D	2.1-8.2	4.80	5.20	1.86
ND	0.5-7.6	3.50	3.40	1.99
Water Depth				
D	8.10-85.30	38.40	34.10	21.92
ND	15.3-72.5	37.15	34.95	15.67

[a]REM = robust emergent vegetation.

However, we did not consider this pitfall relevant to our work because except for the largest two study wetlands, call surveys and nest searches suggested that occupied sites did not harbor >one or two pairs of bitterns.

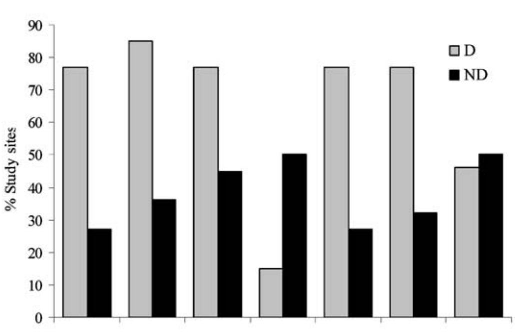

Figure 4. Resource-use versus availability, as indicated by the percentage wetland study sites with (D) and without (ND) Least Bittern detections that had median habitat parameter[a] values greater than the median values for all sites. [a]Parameters are: total area (ha), open water area (ha), robust emergent (REM) area (ha), REM %, REM edge length (m), edge index and water depth (cm) at the REM-open water interface.

Wetland Size—Research conducted over forty years ago provided a fundamental understanding of Least Bittern habitat as it relates to vegetation structure, hydrology and temporal shifts in wetland community dominance (Weller 1961; Weller and Spatcher 1965). A principal habitat criterion described by these authors was the presence of robust emergent vegetation (including residual material from the previous year) that provides a nesting substrate elevated above water and remains flooded throughout the nesting season (Weller 1961; Weller and Spatcher 1965). Few quantitative studies have refined this model of Least Bittern habitat, particularly where determinants of habitat use at the wetland scale are concerned. Among these, Brown and Dinsmore (1986) indicated that Iowa Least Bitterns were sensitive to wetland size, reporting that 92% of bitterns in their study used wetlands >five ha.

Table 2. Ranking of logistic regression models based on Least Bittern resources-use patterns observed in southern Illinois mined land wetlands.

Model regressors	AIC_c	AIC_c $Delta_i$	AIC_c $Delta_i$ relative likelihood	Akaike Weights[a] $_{wi}$
Open Water	30.93	0.00	1.000	0.1966*
Open Water + Edge Index	31.13	0.20	0.904	0.1778*
Total Area	31.28	0.35	0.838	0.1648
Total Area - REM%	31.72	0.79	0.675	0.1328
Total Area + Edge Index	31.75	0.82	0.665	0.1308
Open Water - REM%	32.05	1.12	0.572	0.1126
REM Edge	37.23	6.30	0.043	0.0084
REM Area	37.35	6.42	0.040	0.0079
REM ARea + Edge Index	37.42	6.49	0.039	0.0077
-%REM	41.94	11.01	0.004	0.0008
Edge Index	42.58	11.65	0.003	0.0006

[a]Akaike weights falling within the confidence set (0.1966-[0.1966 × 0.10]) are signified by an asterisk.

In the present study, total wetland area ranked relatively high among the competing model variables, but scored insufficiently for inclusion in the confidence set (Table 2). Our interpretation is not that wetland size is completely irrelevant, but rather, in the absence of more detailed wetland cover-type and configuration data, total size alone failed to provide sufficient information to explain why bitterns used some wetlands and not others.

Emergent Vegetation—Gibbs and Melvin (1990) and Fairbairn and Dinsmore (2001) reported that Least Bittern wetland use was positively correlated with the amount and relative proportion of emergent vegetation area, respectively. Our findings did not concur with either characterization; the reasons may be more related to study design approaches than Least Bittern biology and behavior at different sites. In recognition of known Least Bittern affinities for flooded REM, Gibbs and Melvin (1990) made a specific effort to target this condition in their investigations, as did we. However, their analyses were based on use of repeated univariate tests that may have been less able to characterize contributions of key habitat variables as adeptly as our multivariate procedure. The discrepancy between our results and those of Fairbairn and Dinsmore (2001) may be more related to their habitat characterization methodologies, which were apparently not developed specifically in the context of known Least Bittern ecological requirements. In their multispecies avian habitat research, these authors (Fairbairn and Dinsmore 2001) did not apparently require flooding throughout the nesting and brood-rearing seasons as a requisite condition of the emergent vegetation they mapped for Least Bittern habitat use analyses. The positive correlation between % emergent vegetation and bitterns that they reported is therefore difficult to interpret because the condition of the vegetation may not have been consistent with bittern use and could have confounded subsequent analyses.

Open Water—Our results were also distinct from previous research by demonstrating that once requisite minimum Least Bittern habitat criteria (flooded robust emergent vegetation) were satisfied, open water area (ha) was the highest scoring predictor of bittern use. The influence of large, persistently flooded areas of open water observed in this study may be related to several factors. First, although periodic substrate exposure benefits some avian taxa by increasing wetland productivity (Kadlec 1962; Fredrickson and Reid 1988), it is unlikely that community turnover resulting from frequent drought or drawdown would be advantageous to a habitat specialist such as the Least Bittern, especially in habitat-limited regions such as the Midwestern U.S. In fact, several researchers (Murchison 1893; Nolan 1952; Weller 1961, DesGranges *et al.* 2006) have demonstrated or suggested that low water conditions can trigger Least Bittern population declines.

Secondly, large bodies of open water may signal the availability of diverse aquatic prey communities throughout the breeding and brood-rearing season. Under these conditions, important fish (Howell 1932; Weller and Spatcher 1965) and macroinvertebrate prey (Howell 1932; Merritt and Cummins 1996; Moore's observations) are more likely to be present. It is also likely that nest sites and territories situated in and adjacent to relatively permanent water bodies are less accessible to some terrestrial, mammalian predators (Giroux 1981). Consequently, these conditions may benefit Least Bitterns during the vulnerable seasonal phase that starts with nest initiation and continues throughout the flightless juvenile period.

Robust Emergent Cover-Open Water Edge—Higher values of our edge index variable were associated with the presence of Least Bitterns. Gibbs and Melvin (1990) also reported that increased littoral zone length was associated with Least Bittern use. Robust emergent growth where Least Bitterns were detected was most often represented by narrow bands of flooded vegetation that encircled open water areas and continued upslope into the moist soil zone. Most of these wetlands were comparable to Stewart and Kantrud's (1971) Cover Type 3, although several had highly irregular emergent edge contours and/or many islets more similar to Cover Type 2. The value of the open water-emergent edge is likely related to a variety of factors such as increased densities of macroinvertebrates and fish that benefit from conditions where ample light penetration, protective structure, persistent flooding and freedom to maneuver confer fitness advantages (Zimmerman *et al.* 1984; Merritt and Cummins 1996; Lampert and Sommer 1997). Least Bittern prey availability may also be enhanced if decreased stem densities (Reid 1989) facilitate more efficient prey acquisition by visually orienting predators such as the Least Bittern. Consequently, although Least Bitterns have been reported to use wetland interiors during the breeding season (Weller 1961) birds may favor use of the edge when cover conditions are dense with few openings. Therefore, edge may provide advantages to both prey and Least Bitterns that would not be available in denser, interior areas. Reportedly, edge use can lead to increased avian mortality through predation (Faaborg *et al.* 1995). If present, elevated predation rates went unnoticed in the present study, despite consistent observations of bittern nests within several meters of the open water edge. Overall, where the edge represents most of the usable habitat in a wetland, such as when dense cover or low water conditions prevail, our data indicate that higher edge index values or edge length imply higher quality Least Bittern habitat.

Management Implications

Despite the apparent success of regulatory mechanisms intended to reduce the destruction of high quality waterbird habitat, the abatement of wetland loss alone is unlikely to promote recovery of waterbird populations that have already experienced marked declines due to breeding ground alteration or destruction. In habitat-limited regions such as the midwestern United States, the key to growth and resilience of imperiled waterbird populations may be the construction of new wetlands and the enhancement of existing basins. The largest concentrations of emergent wetlands and wetland-dependent birds in Illinois occur in the northeastern region of the state (Paine and Stricker 1998). Based on the criteria developed in this study, a GIS assessment using NWI mapping revealed that southern Illinois contains roughly 1,200 ha of potential Least Bittern habitat. The contribution of mined land wetlands to this total may be as high as 10-20% (120-240 ha).

Once the persistently flooded robust emergent vegetation (REM) criterion was satisfied, our findings indicated that Least Bittern wetland use was most influenced by the amount of open water available and secondarily by the length of the REM-open water interface relative to REM area (ha). These variables efficiently address the need for key habitat elements such as adequate amounts of flooded substrate for nesting, feeding and other life requisites. Additionally, they serve as proxies for less easily evaluated wetland conditions that are undoubtedly important to Least Bitterns, such as prey community diversity, density and availability. These conditions, which commonly prevail where littoral zones are associated with large deep water systems and low gradient lotic environments, may provide core habitat for Least Bitterns, especially during drought conditions.

The profile of Least Bittern habitat determinants provided by our research consisted of: 1) large basins supporting at least one to four ha of semi-permanent to permanently flooded robust emergent cover, 2) ample expanses (>eight ha) of open water (which by our definition can include aquatic bed and emergent vegetative communities not consistent with Least Bittern use), and 3) relatively high flooded REM edge lengths relative to flooded REM emergent cover. This parsimonious model of habitat-use cannot account for all the variance in Least Bittern resource selection, especially if other less well-understood factors, including those operating at the landscape level, are important. Nevertheless, the criteria in this study appear to represent easily assessed benchmarks for prioritizing conservation efforts intent on habitat acquisition, enhancement and the development of new wetlands for Least Bitterns and sympatric waterbird species of management interest. Additional management attention may also be required to facilitate the resilience of Least Bittern populations on wetlands thought to meet habitat criteria. Predation-associated bittern mortality (Fredrickson 1996), muskrat (*Ondatra zibethicus*) herbivory (Weller and Spatcher 1965) and water level fluctuations (Weller 1961; author's observations) are just a few factors that can dramatically suppress bittern nesting success and carrying capacity. Where feasible, regular monitoring of wetland conditions can facilitate opportunities for prompt and effective management intervention benefiting Least Bittern conservation efforts.

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