USE OF RECLAIMED MINE LAND BY DISTURBANCE-ORIENTED AVIAN SPECIES: IMPLICATIONS FOR CONSERVATION AND MANAGEMENT[1]

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Abstract. Human disturbed landscapes such as those in early stages of mine reclamation provide habitat for disturbance-oriented species. Disturbance-oriented birds that are uncommon or absent from the surrounding region may be concentrated at large-scale human disturbed sites such as surface mines. Implications for conservation and management of such species are important considerations, given the possibility one or more of those species may be federally protected. Recent expansion of the breeding range of Interior Least Terns (*Sterna antillarum athalassos*), a federally endangered species, in Texas has many implications for management on private lands. Interior Least Terns first nested on reclaimed mine spoil at Big Brown Mine in East-Central Texas in 1997. Management objectives for reclamation planning were subsequently established to provide suitable nesting and foraging habitat for terns while seeking to reduce the risk of interference with mining activities at Big Brown Mine. Since 1997, an average of 29 nests per year have occurred on artificial sites created for tern nesting, with average annual nest success 49%, hatching success 47%, and fledging success 46%. Average annual reproductive success (fledglings per female) is 0.40. We discuss colonization of reclaimed mine land by disturbance-oriented avian species and present research on the nesting and foraging ecology of Interior Least Terns in Texas as a case study. Implications for conservation and management of disturbance-oriented birds in reclamation are discussed.

Additional Key Words: Interior Least Tern, avian colonization of reclaimed mine lands.

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Introduction

Some avian species have evolved reproductive strategies allowing them to nest in naturally disturbed sites such as beaches and gravel bars (Grover and Knopf 1982, Thompson and Slack 1982, Gochfeld 1983, Thompson et al. 1997), or disturbed grasslands (Castrale 1982, Petersen & Best 1987). These sites are erosional deposits formed/maintained by wave action, flooding, and wind, or in the case of grasslands, fire. More recently, such disturbance-oriented species have begun to utilize human disturbed sites (Whitmore 1980, Hunter et al. 2001, this study). The first human disturbed sites used were likely spoil islands deposited during channelization of coastal waters and some rivers (Fisk 1975, Thompson et al.1997), and grazed pastureland (Castrale 1982, Petersen & Best 1987). As development has proceeded into coastal areas, ~~and~~ flooding has been controlled in many major tributaries, and agricultural practices change, such species have been forced to seek other similar sites in which to nest. Species, such as the Interior Least Tern (*Sterna antillarum athalassos*), now nest frequently in human created sites such as parking lots (Thompson et al. 1997), Harrier jet pads (Altman and Gano 1984), gravel roof tops (Fisk 1975), and disturbed landscapes created during construction and mineral mining (Thompson et al.1997). Other avian species that are adapted to open landscapes with little vegetation and bare ground also utilize disturbed sites such as those created during the beginning phases of surface mine reclamation (Hunter et al. 2001). In many cases, such species are scarce or uncommon in the natural landscape of the region in question, while large aggregations of the species may be found at such disturbed sites. Disturbed areas provide refugia for ~~such~~ these species and often shift avian community structure in the region.

The Horned Lark (*Eremophila alpestris*) occupies open landscapes such as shortgrass prairie, cropland, and exposed lakeshores (Castrale 1982, AOU 1998). Horned Larks serve as an example of species which colonize human disturbances in the landscape. Horned Larks are uncommon in most of the Post Oak Savannah region of East-Central Texas (TOS 1995), with little suitable habitat available for the species' ecological requirements (Castrale 1982). In the reclaimed portion of Big Brown Mine, Fairfield, Freestone County, Texas, Horned Larks are one of the most abundant species in the avian community, while they are largely absent from the surrounding areas with native habitat (Table 1). The Dickcissel (*Spiza americana*) nests in

native grasslands in North America and is present in low numbers in the Post Oak Savannah of Texas, nesting in scattered, small grasslands in the region (TOS 1995, AOU 1998). Dickcissels are one of the most abundant birds on reclaimed land at Big Brown Mine, taking advantage of recently reclaimed areas in early successional stages (Table 1). Reclamation provides suitable nesting habitat and refugia for several disturbance-oriented bird species that are otherwise absent from the natural landscape (Table 1). Such occurrences of avian colonization have been previously documented on reclaimed mines (Whitmore 1979, 1980).

Table 1. Common avian species nesting and/or wintering on reclaimed portions of Big Brown Mine, Freestone County, Texas.

Species	Nesting	Wintering
Eastern Meadowlark (*Sturnella magna*)	Likely	Yes
Horned Lark (*Eremophila alpestris*)	Yes	Yes
Dickcissel (*Spiza americana*)	Yes	No
Killdeer (*Charadrius vociferus*)	Yes	Yes
Interior Least Tern (*Sterna antillarum athalassos*)	Yes	No

Interior Least Terns are colonial, ground-nesting waterbirds that feed on fish and crustaceans. Interior Least Terns nested historically on gravel and sand bars in rivers and other major tributaries. Gravel and sand bars are deposited during spring flooding, while existing gravel/sand bars are scoured during flooding, creating bare islands of sand and gravel where the birds nest. Control of flooding and natural flows has eliminated many natural sites by reduction in size and vegetational encroachment, leading to listing of the interior population as an endangered species (USFWS 1985,1990). In response to the lack of suitable nesting sites, Interior Least Terns have nested in alternative sites including gravel roof tops, spoil islands, and reclaimed mine spoil (Fisk 1975). Recent expansion of the species in Texas (Kasner, unpub. data) has facilitated the species' expansion into human disturbed areas, including the reclaimed land of Big Brown Mine. The implications of this expansion for conservation and management are paramount for environmental personnel and land managers, and serve as an example of the potential for a suite of disturbance-dependent species benefiting directly from reclaimed landscapes. We present the results of research on the nesting ecology of Interior Least Terns at

artificially created sites and the associated implications for managing this and other species on reclaimed surface mine lands.

Methods

Study Area

Big Brown Mine is a surface coal mine in Freestone county near the city of Fairfield in the Post Oak Savannah region of east-central Texas. Topography of the area is characterized as gently rolling. Mining has been continuous at Big Brown for 28 years with approximately 5,328 ha reclaimed prior to 2002. Land use designations of reclaimed land include wetlands, improved pasture, commercial timber, and wildlife habitat.

Methods

We studied Interior Least Terns during the spring and summer of 2000 and 2001 at Big Brown Mine. In 2000, two tern nest sites were developed to encourage nesting in areas conducive to mining activities. In 2001, three sites were developed. In both years, created nest areas were fenced with electric fencing to deter predators, and vegetation was eliminated mechanically and controlled with herbicides. Decoys were placed in each area to attract terns. Concrete blocks and wood debris were placed to provide escape cover, shade, and perch sites for adults and chicks. Colonies on the reclaimed portion of the mine were monitored for nest success, and the physical characteristics of each colony site were measured to determine the overall characteristics of sites chosen by Interior Least Terns. Number of adult terns was counted upon arrival in the spring. Each colony was visited weekly to count number of adults, nests, eggs, chicks, and fledglings and to determine the fate of each nest. Soils were sampled from each site and analyzed for color and percent composition of sand, silt, and clay. A series of 75 m line intercept transects stratified randomly at 5 m intervals were used to sample the vegetation at each site. Principal Components Analysis (a variable reduction procedure) was used to describe variation among Interior Least Tern colonies each year, and ANOVA was used to investigate differences among sites (SPSS 1999). Nine sediment ponds were stocked at three levels of fish density (3 replicates, 3 levels of treatment each) to test whether terns forage in ponds with higher fish densities and if nest sites may be chosen based on prey abundance in nearby sediment ponds. Experimental ponds were monitored by observing ponds for 1-2 hours

on a rotating schedule from May-August to determine frequency of visits by Least Terns. Kruskal Wallis Test was used to test for differences in pond use.

Results and Discussion

Interior Least Terns first nested on reclaimed mine spoil at Big Brown Mine in east-central Texas in 1997, and have nested successfully at the mine every year since (Table 2). In 1997, a management plan was written with management objectives to provide suitable nesting and foraging habitat for terns while seeking to reduce the risk of interference with mining activities (Tanner and Hart 1997). The plan included creating nesting areas as described above in methods. Prepared Least Tern nesting areas were designated as such in the mine's bond release program. Nesting terns from 1997-1999 used these areas.

Table 2. Summary nesting data for Interior Least Terns from 1997-1999 at Big Brown Mine.

	1997	1998	1999
Adults	40	44	32
Tot. Nests	25	28	35
Tot. Eggs	45	69	76
Est. Chicks Hatched	35	44	19
Fledglings	15	14	15

Terns nested with limited success in 2000, with primary losses of eggs and chicks attributed to depredation by coyotes (*Canis latrans*) and other meso-mammals or rainfall (Table 3). Terns were more successful in 2001, with less pressure from predators and limited rainfall during the peak of nesting (Table 3). Only one pair of terns utilized one of two prepared nesting areas in 2000, and none of three areas in 2001, causing nest losses to predators due to absence of protective fencing and proximity of colonies to predator corridors (Table 3).

Table 3. Summary nesting data for Interior Least Terns from 2000-2001 at Big Brown Mine.

	2000	2001
Adults	25	20
Tot. Nests	27	12
Tot. Eggs	60	27
Depredated	24 (10 nests)	7 (3 nests)
Abandoned	21 (10 nests)	8 (4 nests)
Chicks Hatched	12	11
Depredated	?	3 (3 nests)
Fledglings	2	7

Nesting in 2000 occurred in a newly developed wetland (WCV) still in the early stages of reclamation ~~at the time~~. The development created a large area of freshly disturbed sandy soils with a water source very nearby. All but four tern nests were located in WCV, while three of the remaining nests were on a limestone gravel bed deposited during construction of a coal unloading facility (UNL). Only one pair nested in a prepared nesting area several miles from WCV. The pair subsequently abandoned the nest due to egg-sticking after a major rainfall event.

Nesting in 2001 occurred in a new wetland developed during the spring of 2001 (WB6), creating conditions similar to those at WCV in another area of the mine. Only one nest occurred elsewhere in 2001, when a pair initiated nesting near an auxiliary coal pit several miles from WB6 after being forced off nearby Trinity River by floodwaters. The nest was subsequently depredated.

Interior Least Tern colonies in 2000 and 2001 occurred in areas of fresh disturbance, with sites characteristic of newly leveled spoil in the earliest stages of succession prior to land use designation. A variety of forb and grass species typical of new reclaim were sparsely distributed in the colonies (Table 4), with large expanses of bare ground and water nearby.

Table 4. Plant species in Interior Least Tern Colonies from 2000-2001 at Big Brown Mine.

Yellow Nutsedge (*Cyperus*)	Green Sprangletop
Crabgrass (*Digitaria*)	Red lovegrass
Carpetweed (*Mollugo*)	Knot-root bristle grass
Goatweed (*Croton*)	Jungle rice (*Echinochloa*)
Tumble Pigweed (*Amaranthus*)	Spotted Spurge (*Euphorbia*)
Millet	Rattlepod (*Sesbania*)
Johnson grass	Ragweed
Bermuda	

Principal Components Analysis for colonies in 2000 and 2001 revealed that colony site variation was largely due to percent forbs, grasses, and bare ground, and soil composition. Analysis of variance confirmed this. In general, colony sites in 2000-2001 varied in soil composition as well as in the percent vegetational coverage. However, in both years, the sites where terns nested were very similar in percent forbs, grasses, and bare ground. Those sites where terns nested were generally higher in sand content and percent bare ground, with the exception of UNL, which was gravel. Sandy soils or gravel are preferred due to decreased risk of "egg-sticking" during rainfall events (Thompson and Slack 1982, Thompson et al. 1997), while such sites may secondarily be preferred due to the effects of soil composition on plant growth, allowing more bare ground in sandy soils or gravel. Differences in grass species among sites are due to introduction of seeds from plantings and mulching along with naturally occurring colonists during early reclamation prior to land use designation.

Availability of prey does not seem to influence nest site selection in Least Terns. Least Terns will travel several miles to foraging sites (Thompson et al. 1997, Kasner, personal obs.). In 2000, the nearest pond in WCV had no fish. The presence of water near the colony seems important only as a loafing site for adults and a water source for young. Furthermore, preliminary analysis of foraging data from an experiment manipulating fish densities on Big Brown indicates that Interior Least Terns do not select foraging ponds based on fish density, with Kruskal Wallis Test among ponds of different experimental fish densities not significant ($P>0.05$) for number of visiting or foraging terns. The use of foraging ponds by Least Terns is affected by other factors and will not be discussed further here.

While it is apparent that disturbed sites such as surface coal mines are important as potential nest sites for Interior Least Terns, the exact mechanisms behind site selection remain unclear. While some of the mechanisms for site selection by Least Terns are made clear by this study at a local scale, sites may be chosen based on some landscape level factors beyond the scope of the scale of our study. At a small scale, nest sites can be quantified, but nest site selection almost certainly is effected at a larger landscape scale as well. At a larger scale, settlement patterns may be determined by very different cues (Wiens et al. 1987). Further research is needed to better understand site selection by Interior Least Terns at broader scales.

Conclusions

Disturbed sites such as Big Brown Mine are important to a variety of avian species, and reclamation can be done in such a way as to benefit many of them. Reclamation practices have changed in select areas at Big Brown Mine in an attempt to effectively manage Interior Least Terns. New management practices include the construction of designated nest areas and leaving selected areas unplanted the first year after leveling to provide areas that are attractive to Least Terns away from mining and other reclamation activities. Other avian species that benefit from similar disturbances or from grasslands created during the early successional stages of reclaimed land can be successfully managed as well. Cover species can be planted that enhance the suitability of grassland habitats (e.g. structural diversity, vegetation density) for grassland birds such as the Dickcissel and Horned Lark. Ideally, an effective management plan can be incorporated into reclamation designs that will benefit a suite of species along a temporal and spatial gradient. Early successional species such as the Least Tern and Horned Lark, mid-succesional (grassland) species such as the Dickcissel, and even shrub and woodland dependent species in more advanced successional stages may all benefit from the same landscape as succession progresses through time, given the proper reclamation and land management practices. Managing for disturbance is important to the conservation of many disturbance-oriented species (Hunter et al. 2001), and the implications for conservation and management of these species are important considerations. A number of such species utilize reclaimed habitats, and the possibility exists one or more of those species may be federally protected, threatened, or endangered (e.g. Interior Least Tern). Land managers can be proactive in preventing such status

for species that are currently of conservation concern by implementing strategies that enhance the suitability of reclaimed habitats to their benefit.

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