EVALUATION OF A REPRODUCTIVE INDEX TO ESTIMATE DICKCISSEL REPRODUCTIVE SUCCESS

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Abstract: Intensive monitoring of bird nests to measure reproductive success is time-consuming and may influence the fate of nests. Reproductive indices that do not require searching for and visiting nests may be reasonable alternatives to nest monitoring if they provide results similar to nest-searching efforts. We evaluated the reproductive index of Vickery et al. (1992) for estimating reproductive success of the dickcissel (*Spiza americana*) in northeast Kansas, USA. We used nest searching and Vickery et al.'s (1992) reproductive index to compare reproductive success on 20 plots (200 × 200 m). Daily nest survival (DNS) rates averaged 0.911 (SE = 0.011, $n = 72$ nests), and brown-headed cowbirds (*Molothrus ater*) accounted for 21% of all nest failures. Surveyors underestimated reproductive index ranks when compared to nest-searching efforts and were inaccurate in their assignment of reproductive success. In particular, surveyors reported successful nests on 3 study plots that fledged no young, probably because young dickcissels moved onto plots after fledging from their natal territories. Our results indicate that the reproductive index of Vickery et al. (1992) may be inappropriate for wary species or those heavily parasitized by brood parasites. We suggest that before relying on the index alone, investigators should use pilot trials to determine whether results from this index are concordant with results from intensive nest-searching efforts for species of interest.

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Accurate estimation of the vital rates that structure animal populations is critical for sound management decisions, particularly for species of conservation concern (Beissinger and Westphal 1998). Accurate estimates of reproductive success for migratory birds are needed to make informed management decisions because populations are influenced strongly by events on the breeding grounds (Donovan et al. 1995*a,b*; Robinson et al. 1995; Sherry and Holmes 1995). However, finding and monitoring nests can be time-consuming, requires much effort, and may limit the scope of investigations. In addition, some species construct difficult-to-find cryptic nests, resulting in small sample sizes that can provide weak inference to the populations of interest. Moreover, found nests may misrepresent and inaccurately reflect reproductive success of the population. Disturbance by investigators during nest monitoring also can influence nest fates (Götmark 1992) and may lead to poor estimates of reproductive success. Poor estimates of reproductive success may in turn lead to inappropriate management decisions or misguided conservation efforts.

Indirect techniques to measure reproductive success may be reasonable alternatives to nest searching and monitoring because they circumvent some of the difficulties associated with intensive nest monitoring (Vickery et al. 1992, Dale et al. 1997). Because they rely on observations of breeding activity, indirect techniques require less effort per nest than typical nest-monitoring efforts, can be used on species that construct cryptic nests that are difficult to locate, and may have less impact on nest fate than traditional nest-searching techniques (Vickery et al. 1992, Dale et al. 1997). Despite their potential, it is unclear whether results obtained from indirect techniques provide similar estimates of reproductive success to those produced by nest-searching efforts. We evaluated the indirect technique (Index of Reproductive Success [IRS]) developed by Vickery et al. (1992) that uses spot-mapping and accumulated observations of reproductive behaviors to assess reproductive success. Since the use of indirect techniques has increased in recent years (e.g., Dale et al. 1997, Rangen et al. 2000,

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Christoferson and Morrison 2001), it is important that these methods be evaluated to understand under which circumstances they perform best.

Using a northeast Kansas dickcissel population, we evaluated the indirect technique of measuring reproductive success (IRS) developed by Vickery et al. (1992). The IRS uses spot-mapping and accumulated observations of reproductive behaviors to rank reproductive activity for each male territory over the course of the breeding season. To evaluate IRS, we compared estimates of reproductive success from this technique to those obtained from intensive nest searching and monitoring. We also examined whether polygynous mating by male dickcissels or heavy brood parasitism by brown-headed cowbirds, hereafter cowbirds, influenced the performance of the IRS. We reasoned a priori that using the IRS on a species with a polygynous mating system would lead to an underestimate of reproductive success. A researcher using the IRS would have to observe several females simultaneously on a single territory to accurately document the state of each nest. Thus, correctly classifying the reproductive status of several females on a single territory at a given time may be difficult, particularly for inexperienced observers. Likewise, cowbird parasitism may lead to inaccurate estimates of host production via the IRS. Ascertaining if a nest contains host offspring, cowbird offspring, or both is virtually impossible, unless the nest is observed directly. Finally, we examined the influence of observer experience on the accuracy of the IRS by using an experienced and an inexperienced surveyor to implement this technique.

STUDY AREA

Trials were conducted on Fort Riley Military Installation, a 40,273-ha training area of the U.S. Army located in Clay, Geary, and Riley counties in the Flint Hills of northeast Kansas (39°15'N, 96°50'W). The Flint Hills region encompasses over 1.6 million ha extending over much of eastern Kansas from near the Kansas–Nebraska border south into northeast Oklahoma and contains the largest remaining areas of unplowed tall grass prairie in North America (Knapp and Seastedt 1998). The region has hot summers and cold, dry winters; mean monthly temperatures range from a low of –2.7 °C in January to a high of 26.6 °C in July. Annual precipitation averages 83.5 cm with 75% of precipitation occurring during the growing season (Hayden 1998). Grasslands comprise 32,200 ha (approx 80%) of Fort Riley and are dominated by big bluestem (*Andropogon geradii*), Indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), and smooth brome (*Bromus inermis*). Other annual grasses and forbs also occur at low abundances on the installation, and small numbers of smooth sumac (*Rhus glabra*) and rough-leaved dogwood (*Cornus drummondii*) are found within the grassland matrix. Military training on Fort Riley includes field maneuvers, combat vehicle operations, mortar and artillery fire, small arms fire, and aircraft flights. Mowing, prescribed burning, and wildfires resulting from training activities create a mosaic of age classes in grassland habitats.

METHODS

Study Species

The dickcissel is a common breeding species in the Flint Hills region, typically nesting in forbs and bunchgrasses in early-successional and prairie habitats. Dickcissels are single-brooded and have a polygynous mating system, although social monogamy may occur in less preferred habitats (Zimmerman 1982). Male dickcissels may be mated with up to 5 females at 1 time, yet they provide no parental care (Zimmerman 1966, 1982). Although they begin nesting later in the season than most other grassland birds in the Flint Hills, dickcissels experience high rates of cowbird parasitism in this area (Zimmerman 1983). We selected the dickcissel to examine the performance of the IRS because this species is the most abundant songbird breeding on Fort Riley (Althoff et al., Kansas Cooperative Fish and Wildlife Research Unit, U.S. Geological Survey, unpublished data), and its nests are relatively easy to find and monitor compared to other grassland-nesting species. In addition, we selected this species because it allowed us to examine the influence of a socially polygynous mating system and heavy cowbird parasitism on the performance of the IRS.

The Index of Reproductive Success

We selected the IRS for this investigation because it relies on observations of breeding activity to estimate reproductive success on the territories of breeding birds (Vickery et al. 1992). The IRS uses spot-mapping and accumulated observations of stage-specific reproductive behaviors to track reproductive activities on male territories over the course of the breeding season. After study plots are established, a surveyor visits each plot for a prescribed amount of time, systematically traverses each plot at a steady rate, and maps the location of all individuals while noting behaviors indicative of reproductive activity (e.g., carrying of nest material, feeding young). Plots are visited over the course of the breeding season so that the complete breeding cycle is covered. At the end of the breeding season, territory maps are compiled and reproductive index ranks are assigned to each territory based on behavioral observations and indirect evidence of breeding activity.

We established 20 plots in early June 2001, with 10 plots clustered in each of 2 areas (1,320 and 1,910 ha) >10 km apart. Plots were 200 × 200 m (4 ha), >300 m apart, and were established in contiguous grassland areas at least 100 m from natural (e.g., woodland) and anthropogenic (e.g., roads) edges because dickcissels appear to avoid nesting near habitat edges (McCoy et al. 1999). Plots were selected if they met the above criteria and if male dickcissels were observed exhibiting territorial behavior on plots during early June. To facilitate orientation on the plots, 1 orange pin flag with a large black circle was placed in the center of the plot with 8 additional orange flags placed at 100-m intervals around the perimeter of the plot. Ten plots (5 from each of the 2 areas) were randomly assigned to each of 2 surveyors.

In mid-June, immediately prior to commencement of field work, we conducted a 4-hr training session to visit all study plots, train surveyors (1 experienced, 1 inexperienced) in the use of the IRS, and discuss life-history attributes of the dickcissel that aid in determining reproductive stage (e.g., only females provision nestlings). The experienced surveyor had experience with nest searching and behavioral observations of breeding birds but lacked experience with dickcissels. In contrast, the inexperienced surveyor had limited experience with breeding birds and had never searched for bird nests.

Surveys were conducted on each study plot once/week from 18 June–20 July 2001. Surveyors selected a new starting corner with each successive survey and spent approximately 40 min traversing each plot. We decided a priori to survey plots at approximately twice the rate of Vickery et al. (1992) because only female dickcissels provide parental care, and observations must focus on females to accurately determine the stage of a given nest. Doubling the observation period for the care-providing parent of a uniparental care species should, theoretically, provide a similar detection probability for observing reproductive behaviors exhibited by both members of a species with biparental care. Thus, we assumed that female dickcissels exhibiting reproductive behaviors (e.g., procuring food, provisioning young) were detected at a rate similar to that of an individual that provides biparental care. Because our survey effort (9.5 min/ha) on each visit was approximately twice that of Vickery et al. (1992), we elected to conduct 7 surveys, or half the number of surveys they considered to be a minimum for assessing reproductive success for 3 grassland sparrow species. Our sampling was limited, however, to 5 surveys because dickcissel nesting on plots ended earlier than historical records indicated (Zimmerman 1983).

Surveyors using the IRS made 4 passes/plot, approximately 50 m apart, walked at a steady pace while observing dickcissels, and spot-mapped their behaviors following the guidelines of the International Bird Census Committee (1970). Surveyors were instructed to avoid searching for nests, but to note the location of any nest they came across in the course of fieldwork. Because of logistical constraints, the inexperienced observer surveyed all 20 plots during the third week of the study.

To establish a baseline of breeding success on study plots, an experienced nest searcher, who had prior experience working with dickcissels, spot-mapped and nest-searched all study plots (17 Jun–21 Jul 2001), searching each plot approximately once every 4–6 days. Spot-mapping was conducted using the protocol developed by the International Bird Census Committee (1970) and the consecutive flush technique (Wiens 1969). Nest searching was conducted following the guidelines suggested by Martin and Geupel (1993) and consisted largely of using behavioral observations of adults to locate nests. Each plot was also rope-dragged twice with 3 observers, none of whom implemented the IRS, during the second week (25–30 Jun) and the fifth week (16–19 Jul) to ensure that as many active nests as possible were located. Nests were checked once every 4 days, except in limited instances when military training prevented access to study plots.

After the breeding season ended, surveyors determined the reproductive index rank of each territorial male present ≥3 weeks following Vickery et al. (1992). Territories were assigned a rank of 1 if they harbored a territorial male ≥3 weeks; a 2 if they harbored a territorial male ≥3 weeks accompanied by a female; a 3 if they harbored a female engaged in nest building, laying, or incubating; a 4 if they harbored nestlings; or a 5 if they harbored fledglings. For analysis, we summed territory ranks separately over the subset of plots surveyed by the experienced observer (n = 10 plots) and the inexperienced observer (n = 10

Table 1. Daily nest survival (DNS) rates and overall survival for egg stage, nestling stage, and entire nest period for 72 dickcissel nests found on Fort Riley Military Installation (n = 20 plots), Kansas, USA, during the 2001 breeding season.

Stage	n_{failed}	Exposure days	DNS (SE)[a]	Overall survival
Egg	38	323.5	0.883 (0.018)	0.153[b]
Nestling	9	190.5	0.953 (0.015)	0.647[c]
Overall	47	514.0	0.909 (0.013)	0.099[d]

[a] Daily nest survival calculated following Mayfield (1975) and Johnson (1979).
[b] Calculated for 15-day period (3 days laying + 12 days incubation).
[c] Calculated for 9-day nestling period.
[d] Calculated for 24-day period (3 days laying + 12 days incubation + 9 days nestling).

plots). On the same subset of plots, we compared the distribution of rank frequencies based on the IRS technique to the distribution of rank frequencies based on intensive nest searching. In addition, surveyors reported the number of territorial males, successful nests, and nests that produced dickcissel young on each plot.

For nest data analysis, we followed Zimmerman (1982) and assumed that dickcissels spent, on average, 2 days nest building, 3 days laying, 12 days incubating, and 9 days brooding young. Daily nest survival was calculated following Mayfield (1975) and Johnson (1979).

RESULTS

Seventy-three nests were found on study plots through nest-searching efforts. One nest was removed from survival analyses because it was clearly influenced by research activities. Mean DNS rate was 0.911 (SE = 0.011), and the probability that a nest would survive until fledging (24 days) was P= 0.099 (Table 1). Approximately 65% (47/72) of the nests failed, and predation accounted for 70% of failed nests. Other reasons for nest failure included desertion attributed to cowbird parasitism (21%), destruction by military vehicles (6%), and desertion attributed to observer influence (2%).

Social polygyny was limited on study plots; a maximum of 14% of males attended to >1 breeding female on its territory at a time. Of 63 territorial males, only 4 were determined to be polygynous (3 males with 2 mates, 1 male with 3 mates), whereas 5 were suspected of polygyny (all 5 with 1–2 mates each). Cowbirds parasitized 85% of nests, laying a mean of 3.0 eggs/parasitized nest (SE = 0.21, range = 1–7). Daily nest-survival rates of parasitized nests were similar to those of unparasitized nests (Table 2). Of 67 nests with known fates, 20 nests fledged 55 young, of which 30 (55%) were cowbirds and 25 (45%) were dickcissels. The mean number of young fledged from parasitized nests (0.86 dickcissel and cowbird young fledged/nest, n = 57 nests) was greater than unparasitized nests (0.60 dickcissel young fledged/nest, n = 10 nests). In parasitized nests, dickcissel production averaged 0.33 dickcissel young fledged/nest, approximately half the production of unparasitized nests.

Surveyors underestimated the final reproductive index rank of most territories regardless of experience (Fig. 1). However, the proportions of territories considered successful (those with a rank of 5) by IRS surveyors were similar to the proportions determined by nest searching. Although this suggests that the IRS provided accurate estimates of reproductive success, true concordance must be examined on a territory-by-territory basis to determine whether surveyors classified successful territories correctly. Unfortu-

Table 2. Parasitism intensity, daily nest survival (DNS), number of dickcissel (DICK) young produced, and number of brown-headed cowbird (BHCO) young produced for 72 dickcissel nests found on Fort Riley Military Installation (n = 20 plots), Kansas, USA, during the 2001 breeding season.

No. BHCO eggs	n_{total}	n_{failed}	Exposure days[a]	DNS (SE)[b]	n_{known}[c]	No. DICK	No. BHCO
0	11	7	74.0	0.905 (0.034)	10	6	—
1	11	6	61.5	0.902 (0.038)	8	5	1
2	18	13	102.5	0.873 (0.033)	17	4	7
3–4	20	15	128.5	0.883 (0.028)	20	5	8
5–7	12	6	147.5	0.959 (0.016)	12	5	14
At least 1	61	40	440.0	0.909 (0.014)	57	19	30

[a] Includes laying, incubating, and nestling periods.
[b] Daily nest survival calculated following Mayfield (1975) and Johnson (1979).
[c] Number of nests with known fates. Sample sizes are lower from the pool of nests used to estimated daily nest survival because monitoring terminated at 5 nests before nest failed or fledged young.

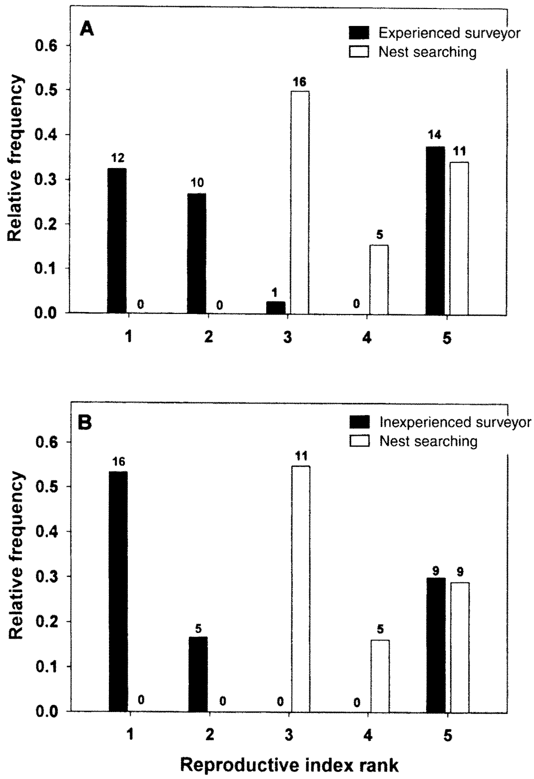

Fig. 1. Distribution of reproductive index ranks of dickcissel territories as determined by surveyors using an Index of Reproductive Success (IRS) and as determined by nest searching data during the 2001 breeding season on Fort Riley Military Installation in Kansas, USA. (A) Reproductive index rank distribution of dickcissel territories as determined by an experienced surveyor using the IRS and as determined by nest searching data on the same subset of plots (*n* = 10 plots). (B) Reproductive index rank distribution of dickcissel territories as determined by an inexperienced surveyor using the IRS and as determined by nest searching data on the same subset of plots (*n* = 10 plots). Number of territories within each rank class is reported above vertical bars. Relative frequency is calculated as the number of territories within each reproductive index rank divided by the total number of territories. Only males observed on plots for ≥3 weeks were considered territorial.

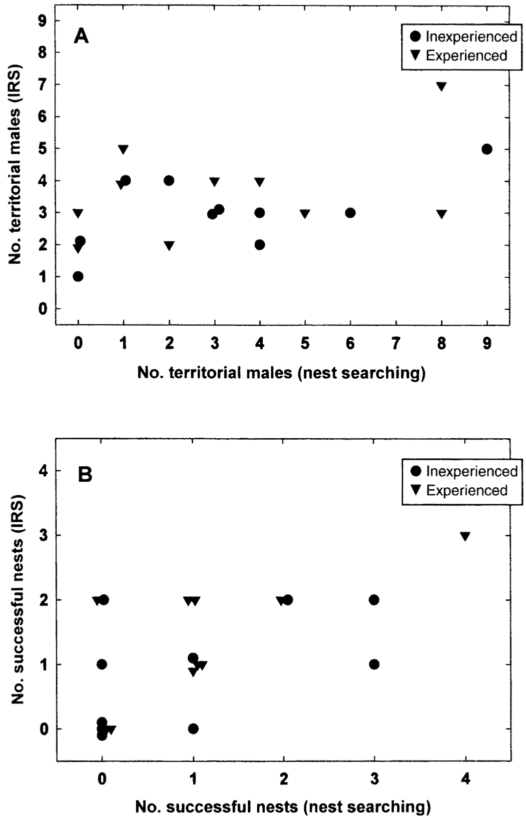

Fig. 2. Comparison between the number of dickcissel territories per plot and the number of successful nests per plot as determined by surveyors using an Index of Reproductive Success (IRS) on Fort Riley Military Installation in Kansas, USA, during the 2001 breeding season. (A) Number of dickcissel territories on 20 plots recorded through nest searching efforts compared to the number of dickcissel territories recorded by an experienced surveyor (solid triangles) and an inexperienced surveyor (solid circles) using the IRS. (B) Number of successful dickcissel nests found on 20 plots through nest searching efforts compared to the number of dickcissel nests perceived to be successful on the same plots by the experienced surveyor (solid triangles) and the inexperienced surveyor (solid circles) using the IRS. Note that data points occupying the same coordinates are jittered slightly to clarify their location among all data points.

nately, the number of territorial males recorded per plot differed markedly between the IRS and nest-searching techniques and precluded direct comparisons of individual territories (Fig. 2A).

An alternative approach to determine whether surveyors correctly classified territories entailed comparing the number of successful nests estimated on each plot by IRS surveyors with the results from nest searching. No meaningful relationship was observed between the number of successful nests per plot from nest searching and the number of successful nests per plot reported by IRS surveyors (Fig. 2B), indicating that the IRS provided an inaccurate estimate of dickcissel reproductive success. Neither surveyor could determine the proportion of cowbird fledglings in successful nests.

An average of 294 (SD = 122.8) min were spent on each plot searching for nests by behavioral cues. In addition, an average of 382 (SD = 96.2) min were spent on each plot using rope-dragging techniques to find nests. Surveyors spent an average of 190 (SD = 9.0) min using the IRS on each plot.

DISCUSSION

The IRS had poor concordance with results obtained from intensive nest monitoring and typically underestimated the reproductive index rank of territories, regardless of surveyor experience. Against our predictions, polygyny did not appear to influence the level of reproductive activity reported by surveyors using the IRS because most males attended a single breeding female. That surveyors had limited occasions to keep track of multiple females on a single territory suggests that other factors led to an underestimate of reproductive activity using the IRS.

One explanation for the underestimation of reproductive index ranks is related to a combination of the uniparental care by dickcissels, the furtive behavior of female dickcissels, and the survey methods of the IRS. Male dickcissels do not provide parental care to young, so observations must focus on female dickcissel behavior to identify the stage of the nesting cycle. If a female is not observed with nest material, food, or fecal sacs, it is difficult for a surveyor to determine the reproductive stage of her nest. Although a minimum of 73 active nests were on study plots, both surveyors reported limited observations of female dickcissels carrying nesting material, food, or fecal sacs in >63 hr of observation, which probably contributed to an underestimation of reproductive activity. Moreover, female dickcissels were wary in the presence of researchers. An observer sitting low in vegetation observed female dickcissels carrying food or nesting material more often than did a conspicuous observer walking on plots (Rivers personal observation). Thus, surveyors walking on plots had fewer opportunities to observe stage-specific female behaviors (e.g., food carrying), which likely led to the poor concordance of the IRS with nest-searching data. We recommend that researchers using the IRS on the dickcissel or other wary species record behavioral observations at fixed locations (e.g., plot center). This will allow adults to acclimate to their presence and exhibit behaviors specific to reproductive stages.

An alternative explanation for the lack of concordance with the results of nest searching is based on the number of surveys conducted on each plot. Vickery et al. (1992) concluded that a minimum of 14 surveys were required for assessing reproductive success of sparrows in New England where plots were surveyed at a mean rate of 5.2 min/ha. Given the uniparental care of the dickcissel, we decided a priori that a survey effort of approximately 10 min/ha would be adequate for assessing reproductive activity. Data from this study substantiated an increase in survey length because the mean number of active nests/ha was >3 times and the mean number of nests per territorial male on our plots was >2 times those on the study area of Vickery et al. (1992).

Assuming that our search rate was reasonable, it is unclear whether increasing the number of surveys conducted would increase the concordance with the results of nest-searching efforts. We suspect that additional surveys would not have increased the concordance of the IRS with nest searching because they would have been conducted in the middle of the breeding season during periods of high activity. We found that surveyors had difficulty classifying plots during the peak of breeding activity and only increased their accuracy as the activity level on plots decreased. This was evidenced by the observation that all females recorded by surveyors carrying nest material, food, or fecal sacs were recorded on plots with ≤3 concurrently active nests. This pattern was opposite of what we expected: more active nests on a plot should have resulted in more observations of females with nest material, food, or fecal sacs. This suggests that surveyors had difficulty classifying reproductive activity level when many adults were present. Coupled with the observation that females were wary in the presence of observers, we believe that additional surveys during high-activity periods probably would not have improved the resolution of the IRS. Nevertheless, it is unknown whether additional surveys may have led to better concordance with the results of nest-searching techniques.

Additional surveys are undertaken at additional costs, and the benefits gained by any additional surveys must be weighed against the additional costs incurred by those surveys. We conducted 5 surveys/plot requiring only 28% of the time needed to search for and monitor nests, saving an average of 8.1 hr/plot. If we had increased the number of surveys on each plot to 14, as suggested by Vickery et al. (1992), the effort required to conduct these surveys would be 79% of that required for nest searching. Our savings would be reduced to only 2.4 hr/plot. Thus, for dickcissels in northeast Kansas, conducting 14 surveys would not be economical because little time would be saved over that required for nest searching. Moreover, relying on the IRS alone will preclude acquisition of site-specific data on brood parasitism and daily nest survival, 2 rates important in understanding factors that limit populations (Sherry and Holmes 1995, Beissinger and Westphal 1998). In some situations (e.g., endangered species), a savings in effort may not be the primary consideration of using the IRS. However, many researchers are likely to choose the IRS over traditional nest-searching techniques to obtain similar data at a reduced effort (Vickery et al. 1992, Dale et al. 1997). It is unknown whether the effort required for nest searching in this study represents other species. It is clear, however, that if the IRS is chosen as a time-saving technique, the effort required for IRS surveys must be carefully weighed against the effort required to search for and monitor nests. In addition, study objectives must determine whether the data provided by the IRS are suitable or whether additional data that can only be gathered by nest searching are required.

We used only 2 surveyors to evaluate the IRS, and neither surveyor had prior experience working with dickcissels. Ideally, a comprehensive evaluation of the influence of surveyor experience on the results from the IRS would include more surveyors with a range of experiences. The disparate levels of experience of our 2 surveyors, however, probably represent the ends of a continuum of experience held by most surveyors. If surveyors had prior experience with dickcissels, better concordance between the results of the IRS and nest searching may have been achieved.

Our results contrast those of Vickery et al. (1992), who found the IRS to be comprehensive and time-efficient for use with grassland sparrows in Maine. Although it was a conservative measure of dickcissel breeding activity, 2 situations arose on our sites where the IRS misdirected conclusions from individual study plots. The first situation occurred when a study plot was known to contain a successful nest that was not recorded by surveyors using the IRS. This error only occurred once, however, and led to a more conservative estimate of breeding success. A more serious situation occurred when no successful nests were found on a study plot through nest-searching efforts, yet surveyors using the IRS reported 1–2 successful nests on the same plot. In contrast to the first error (missing a successful nest that is present), the second error has more important consequences because it reports breeding success when success has not occurred. The second error occurred on 15% of plots and was not restricted to either surveyor. The possibility exists that a limited number of nesting attempts went unrecorded. However, it is unlikely that our intensive nest-searching efforts missed the only successful nest(s) on plots, suggesting that these errors were due instead to errors made by surveyors using the IRS. Given that our plots were part of larger, contiguous grasslands and that fledgling dickcissels often move from natal territories shortly after fledging (Rivers personal observation), it is plausible that recent fledglings immigrated onto study plots from adjacent areas and were mistaken for young fledged from nests assumed to be on study plots. Vickery et al. (1992) rarely observed marked fledglings move into adjacent territories after leaving the nest (P. D. Vickery, Massachusetts Audubon Society, personal communication). The movement of fledglings may influence estimates of reproductive success for investigations that place study plots in large, contiguous habitats and should be considered when placing study plots or assigning young to purportedly successful territories.

Vickery et al. (1992) did not encounter cowbird parasitism on his sites in Maine, and concluded that the IRS was appropriate to estimate sparrow young production. However, most nests in our study contained cowbird eggs, and many were parasitized more than once (Table 2). To estimate accurately the production of host young produced in heavily parasitized species using the IRS, surveyors must distinguish between the number of host young and the number of cowbird young. Unfortunately, surveyors observed few fledglings on study plots, and neither surveyor could determine the proportion of dickcissel young raised from successful nests. It was virtually impossible for surveyors using the IRS to determine the number of host young produced in parasitized nests on our study sites, a scenario likely to be true for other species. One way to circumvent this problem is to use historical cowbird parasitism data to estimate host production in parasitized nests. This approach may avoid the problem of estimating host production under heavy cowbird parasitism. However it requires several years of site-specific data and limits the IRS to sites that have been studied using typical nest-searching techniques.

MANAGEMENT IMPLICATIONS

Although Vickery et al. (1992) used the IRS successfully on sparrows in New England, we found that it poorly estimated dickcissel reproductive success in northeast Kansas. Our results suggest that the IRS is inappropriate for our study system, but changes may make the technique more appropriate. Additional surveys (>5) may improve the resolution of this index, but the time commitment necessary for more surveys must be weighed carefully against the amount of effort required to search for and monitor nests and study objectives. Conducting observations at fixed locations may also result in better estimation of reproductive success for the dickcissels we studied. This may be more practical than nest searching, given the effort needed to find and monitor a large sample of nests. However, heavy cowbird parasitism is a major hurdle to overcome for this technique. Whether historical levels of brood parasitism can be successfully used to estimate the number of host young produced in parasitized nests is unclear.

We suggest that before using the IRS—or similar techniques—to document reproductive success, researchers first conduct pilot trials. These trials should determine whether reproductive success estimates are concordant with results from intensive nest searching and examine the extent of local cowbird parasitism on focal species. If it provides similar estimates of reproductive success as nest searching and brood parasitism rates are sufficiently low (e.g., <10%), then IRS use may be warranted. Using a comparative approach will strengthen the results of studies using the IRS and will provide additional opportunities to evaluate the performance of this technique under different conditions.

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