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As many populations of neotropical migrant songbirds decline, wildlife managers pursue measures to help restore these populations to acceptable levels. One management option is the control of the brown-headed cowbird. The cowbird parasitizes the nest of over 200 species of songbirds. Combined with increasing habitat loss and fragmentation, cowbird parasitism may have detrimental effects on avian species that are already at risk. This manual provides a background on the concepts and mechanisms of controlling cowbirds. It provides guidance on how to evaluate the relationship between cowbirds and their hosts, determine whether a control program is needed, and administer a cowbird control program, and also defines management options.

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PREFACE

The Bureau of Reclamation's Technical Service Center (TSC) was created in 1995. The TSC, based in Denver, is an organization of about 41 different groups representing most of the technical disciplines required to support a modern water management agency with projects in 17 western states. The Ecological Planning and Assessment Group is part of the TSC. The group consists of aquatic and terrestrial biologists who conduct studies associated with habitat assessments for a variety of purposes including project compliance with the National Environmental Policy Act and Endangered Species Act.

The year the TSC was formed, the Ecological Planning and Assessment Group assisted the Bureau of Reclamation's Albuquerque Area Office in conducting presence/absence surveys for the endangered southwestern willow flycatcher on public lands along the Rio Grande in central New Mexico. That initial request for assistance has grown into a rather large effort including flycatcher surveys and nest monitoring, annual point count surveys for brown-headed cowbirds and other neotropical migrant songbirds, telemetry studies of female cowbirds, and habitat monitoring and restoration studies. This Technical Memorandum is the product of an important component of these studies—a cowbird trapping program we initiated in 1996 and continued through 2001. Biologists from the Ecological Planning and Assessment Group involved in flycatcher and cowbird studies include Darrel1 Ahlers, Eric Best, Deb Callahan, Dave Moore, Greg Reed, Juddson Sechrist, Rebecca Siegle, Rinda Tisdale-Hein, and Larry White.

We identified the need for a guidance manual due to limited information available on cowbird management when our trapping program was initiated. We gathered information from other workers throughout the southwestern United States to develop our own program. We trapped almost 5,000 cowbirds over a 6-year period in New Mexico and Arizona, and learned from our own experiences and from the experiences of other workers. Information that we found useful is included in this manual to assist others in their efforts to deal with cowbird issues. Our experiences have been obtained working along the Rio Grande and Colorado rivers. We have also included information from other sources in various locations. Readers should consider their own site-specific situations when using this manual.

We believe cowbird control programs—especially trapping—can address short-term resource management issues in specific situations. However, programs with the goal of recovering threatened or endangered neotropical migrant songbirds should focus on long-term habitat management whether it be acquisition, preservation, rehabilitation, or restoration. This manual addresses not only successful techniques for trapping cowbirds, but also the evaluation process that leads to a decision to initiate a cowbird control program, and how to determine its success. The evaluation process may also lead to the conclusion that cowbird trapping is not a realistic management activity.

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INTRODUCTION

Many neotropical migrant bird populations are declining (Audubon 2002). The U.S. Fish and Wildlife Service (Fish and Wildlife Service), Bureau of Reclamation, and other Federal and State agencies are concerned with declining populations of nesting neotropical migrants, and are actively pursuing management options that will improve habitat and restore bird populations to acceptable levels. One option is the control of brown-headed cowbird (*Molothrus ater*; hereafter cowbird) populations. Cowbirds are obligate brood parasites known to parasitize the nests of over 200 bird species (Friedmann and Kiff 1985, Lowther 1993). Combined with increasing rates of habitat loss and fragmentation, parasitism by the cowbird can pose serious threats to already declining avian species (Mayfield 1977, Brittingham and Temple 1983).

Female cowbirds lay their eggs in the nests of host species, allowing the host to incubate, hatch, and raise the young cowbirds until they fledge. Larger host species such as red-winged blackbirds (*Agelaius phoeniceus*) are capable of simultaneously raising both their own young as well as young cowbirds (Roskaft et al. 1990, Clotfelter and Yasukawa 1999a). However, this is often not the case for smaller host species. Generally, the larger cowbird chick outcompetes the smaller host chicks for food and will be the only chick to successfully fledge from the nest (Figure 1). Furthermore, each female cowbird is capable of laying dozens of eggs each breeding season (Scott and Ankney 1980, Lowther 1993), and the potential for adverse effects to host species can be significant.

Figure 1. A brown-headed cowbird chick in a southwestern willow flycatcher nest. Two dead flycatcher chicks are visible beneath the cowbird. Source: Bureau of Reclamation, Technical Service Center, Denver, Colorado.

The control of cowbird populations, especially the female component, has been a management option employed by the Bureau of Reclamation and other Federal agencies over the past several years. Cowbird removal has proven to be an effective tool for reducing brood parasitism and increasing nest success of neotropical migrants in some areas (Kelly and DeCapita 1982, Griffith and Griffith 2000, Hayden et al. 2000, Summers et al. 2000).

There are very few publications (see Fish and Wildlife Service 2002 and Rothstein et al. 2003) that provide guidance on how to evaluate the effectiveness of cowbird control programs or how to address the many related issues associated with such programs. This manual provides a background on the concepts and mechanisms of controlling the cowbird. It also provides techniques, with an emphasis on cowbird trapping, if cowbird control is selected as a tool for managing neotropical migrant bird populations. In meeting these objectives, the manual will provide guidance on how to evaluate the relationship between cowbirds and their hosts, determine whether a control program is needed, and administer a cowbird control program. Management options are also defined.

Parasitism as a Breeding Strategy

Brood parasitism is one of the rarest reproductive strategies known (Johnsgard 1997). One individual lays eggs into the nest of another individual, and lets the receiving bird incubate and rear the donor’s eggs and chicks instead of, or in addition to, its own.

Intraspecific brood parasitism occurs when an individual lays its eggs in the nest of another individual of the same species. About 162 species, or 1.8 percent of all bird species, exhibit intraspecific brood parasitism (Ortega 1998). This method may increase the reproductive potential of the donor individual, but usually has no effect on the overall reproductive success of the population or the species. This breeding strategy is relatively rare and is most common among waterfowl species, but is also exhibited by barn swallows (*Hirundo rustica*), European starlings (*Sturnus vulgaris*), and eastern bluebirds (*Sialia sialis*; Ortega 1998).

Interspecific brood parasitism occurs when the parasitizing individual lays its eggs in the nest of a bird of another species. This strategy may increase the reproductive potential of the donor bird, while having a minor effect on or significantly reducing the reproductive success of the “host.” Interspecific brood parasites may be facultative or obligate in habit. Facultative, or non-obligate, brood parasites are capable of building their own nest and rearing their own chicks, but may also deposit an egg in the nest of another bird. Facultative interspecific brood parasitism occurs in only a few species, especially waterfowl (Ortega 1998).

In contrast, obligate brood parasites do not construct their own nest, but rely on brood parasitism as their only opportunity for reproduction. Obligate brood parasitism is exhibited by about 91 bird species, or 1 percent of all bird species (Ortega 1998). These taxa include the black-headed duck (*Heteronetta atricapilla*; Family Anatidae), about 50 species of cuckoos (Family Cuculidae), the honeyguides (Family Indicatoridae), around 16 species of African finches (Families Ploceidae and Estrildidae), and 5 species of cowbirds (Family Emberizidae) (Johnsgard 1997).

Cowbirds are found only in the Americas and include six species (Ortega 1998). The bay-winged cowbird (*Molothrus badius*)—the one nonparasitic species—and the giant (*Scaphidura oryzivora*) and screaming (*M. rufoaxillaris*) cowbirds are found only in the Neotropics. The shiny cowbird (*M. bonariensis*) has expanded its range from South America and may now occur in southern Florida (Robinson et al. 1995). The bronzed cowbird (*M. aeneus)* inhabits the southern United States through Central America. The brown-headed cowbird is the only cowbird whose range is largely in North America and the only species that is currently causing concern to resource managers.

Brown-headed Cowbird

Historically, the cowbird primarily occupied grasslands of midcontinent North America in close association with bison, feeding on seeds and insects stirred up and associated with the mammals (Ortega 1998). During nesting season, the cowbird preferred regions where trees rose above the grasses and provided perching sites (Mayfield 1977). European settlement expanded habitat conditions for cowbirds (Mayfield 1965). Forests to the east of the plains were cleared, lands to the west were converted to rangeland, and trees were planted in prairies. Altered land use opened up short-grass feeding areas while creating more edge habitat and providing perching sites for cowbirds. Domestic livestock were introduced over broad areas. Livestock enhance feeding opportunities for cowbirds by reducing grass height and increasing food availability in the form of invertebrates, body parasites, insects, and seeds (Goguen and Mathews 1999). Widespread livestock grazing, agriculture, irrigation, and human development have probably all facilitated the range expansion of cowbirds (Rothstein 1994). As the cowbird expanded its range, it began to use new host populations. Most of these hosts had some defenses against cowbird parasitism, retained from historical parasitism experienced by their species during the 500,000 to 1 million years over which cowbirds have been in North America (Hosoi and Rothstein 2000). Some of the newly parasitized populations and/or species were simultaneously endangered by anthropogenic habitat loss, and it is these that are of concern to conservation biologists. New host populations probably led to increased reproductive success for cowbirds and likely contributed to its expansion into areas other than grasslands, even if these areas provided only marginally suitable habitat (Mayfield 1965).

Cowbirds are most common within the species historic range, from North Dakota to Oklahoma, including south central Canada (Robinson et al. 1995, Thompson et al. 2000), although their distribution is now nearly continent-wide (Figure 2). Although the cowbird's range has increased over time, recent trends show a decline in population. According to the Breeding Bird Survey (BBS), average cowbird numbers across North America decreased about 1 percent per year between 1966-1996 (Audubon 2002, Fish and Wildlife Service 2002). Cowbirds are, however, increasing in the northern Great Plains and Central Valley of California (Wiedenfeld 2000).

Many parasitic bird species specialize on one or a few host species, but cowbirds are generalists and will parasitize most co-occurring passerine species (Fish and Wildlife Service 2002). The cowbird has been cited as parasitizing 220 avian species and has been raised by

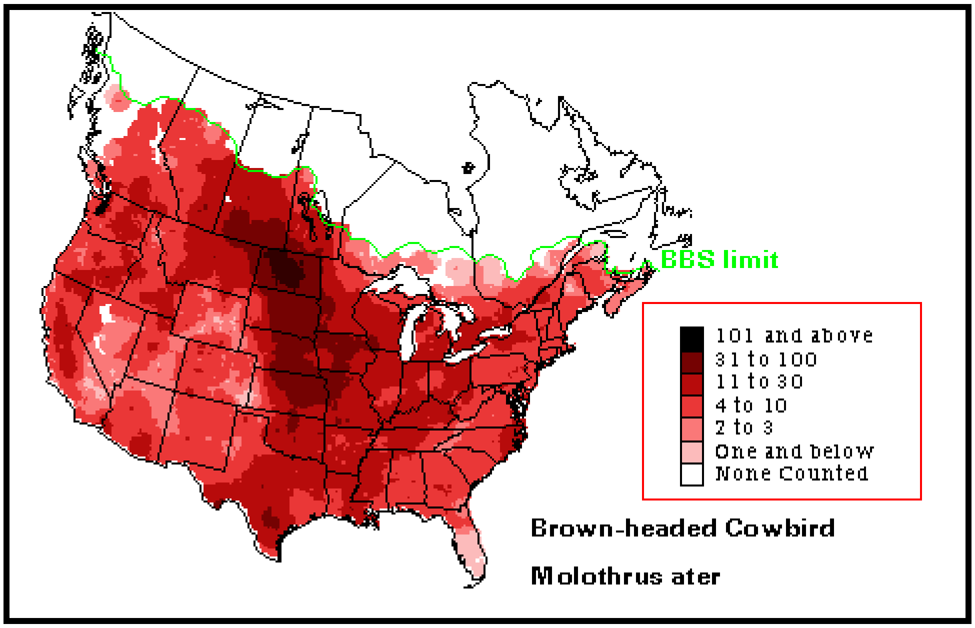

Figure 2. Mean number of cowbirds per Breeding Bird Survey route (1982-1996). Source: Sauer et al. 2003.

144 of these species (Friedmann and Kiff 1985, Lowther 1993). By foregoing parental care, cowbirds greatly increase their annual fecundity (Smith and Rothstein 2000). Female cowbirds are capable of laying up to 40 eggs each breeding season (Scott and Ankney 1980, Lowther 1993), although studies by Hahn et al. (1999) indicate effective cowbird fecundity to be closer to 2 to 8 eggs per female. Effective fecundity is defined as eggs that are accepted by hosts. The peak period of cowbird egg laying is in May, but in high elevation and northern areas, it generally occurs in June. Egg laying declines rapidly in early July and ends in most regions by mid-July (Robinson et al. 1995). Cowbirds apparently time their egg laying to coincide with egg laying of the host, secretively watching hosts build nests and estimating readiness for parasitism (Hann 1941). Female cowbirds lay their eggs in host nests about 10 to 25 minutes before sunrise (Scott 1991). Cowbird eggs laid too early have an increased chance of being rejected by some hosts, and eggs laid too late are unlikely to hatch (Robinson et al. 1995). A parasitized nest is shown in Figure 3.

The cowbird's parasitic nature frees it from the need for a single breeding and feeding area. Because they don't tend to their own young, they can be much more mobile than most passerine birds and choose host-rich breeding areas regardless of food availability (Rothstein et al. 1984, Thompson 1994, Robinson et al. 1995). Agricultural areas are so widespread in most of the country that adequate feeding habitat is typically not far away (Rothstein et al. 1984). Cowbirds commonly occupy short grass/edge habitats, where areas of short grass and bare ground provide foraging opportunities and trees provide perches for cowbirds to search for host nests (Ortega 1998). The amount of grassy area need not be extensive—enough grass is provided by lawns, berms, or forest gaps or meadows (Mayfield 1965). Cowbirds are highly adaptable and found in variable habitats including forest edges, riparian zones,

Figure 3. A parasitized vireo nest. Source: Bureau of Reclamation, Technical Service Center, Denver, Colorado.

thickets, prairies, fields, marshes, pastures, orchards, and suburban landscapes (Ortega 1998), where breeding and feeding areas are within commuting distance of each other. Radio tracking studies show that cowbirds may commute long distances of 6.7 kilometers (km) [4.1 miles (mi)] to over 11 km (6.8 mi) between morning breeding ranges and afternoon feeding sites (Rothstein et al. 1984, Thompson 1994, Curson et al. 2000, Goguen and Mathews 2001), though most appear to move less than 3.5 km (2.2 mi) a day (Thompson 1994, Curson et al. 2000, Goguen and Mathews 2001, Sechrist and Ahlers 2003).

Human activities provide many food resources for cowbirds. Cowbirds typically forage at livestock corrals where they feed on insects attracted by the mammals, and on hay and grain supplied for livestock. Cowbird abundance is strongly associated with proximity to agricultural areas (Stribley and Haufler 1999, Tewksbury et al. 1999, Young and Hutto 1999). Bird feeders, golf courses, and campgrounds also provide feeding opportunities.

Effects of Parasitism on Hosts

Cowbird parasitism can potentially have a detrimental effect on the reproductive success of host birds. Female cowbirds may eject host eggs (Friedmann 1963, Weatherhead 1989, Sealy 1992, Halterman et al. 1999), which results in lower clutch sizes. Also, cowbirds have a distinct reproductive advantage over many of their host species. The incubation period for cowbirds is generally about 9 to 11 days, which is as short or shorter than those of their hosts (Ortega 1998). Cowbird eggs have thick shells which can break host eggs either while being laid or by rolling into them (Blankespoor et al. 1982, Spaw and Rohwer 1987, Roskaft et al. 1990). Once hatched, cowbird nestlings double their mass within 24 hours (Norris 1947, Hatch 1983). The large, usually more advanced, cowbird often outcompetes host species' nestlings for food. Host species nearly always experience some reduction in reproductive output, and smaller hosts with longer incubation periods experience the greatest losses (Fish and Wildlife Service 2002). Finally, the time and effort spent raising a young cowbird may prevent hosts from renesting. This could negatively affect the reproductive success of the host if its own young do not survive in the parasitized nest (Rothstein 1990, Halterman et al. 1999).

Compounded with increasing rates of habitat loss and fragmentation, parasitism by the cowbird can ultimately threaten the persistence of some songbird species. Several species of flycatchers, vireos, warblers, tanagers, and grosbeaks are suffering decreases in productivity and population that can be at least partly attributed to cowbird parasitism (Brittingham and Temple 1983, Laymon 1987, Whitfield 1990, Halterman et al. 1999). Lorenzana and Sealy (1999) summarized several detailed studies on the effect of parasitism on host productivity and found that across all studies, the number of host young that are fledged per nest is significantly decreased by cowbird parasitism. Brood parasitism is particularly detrimental to rare species because the cowbird, being a generalist, does not depend on the rare species for reproductive success (Robinson et al. 1995). As a rare species declines, the number of cowbirds that could potentially parasitize remains relatively constant, being maintained by common host species.

Host Susceptibility to Parasitism

There are two elements that are important in evaluating the susceptibility of a host species to parasitism—suitability and productivity (Bureau of Reclamation, unpub. data). Suitability refers to certain characteristics of the host that increase the likelihood for it to be parasitized. Within avian communities, it appears that some species are "selected" more frequently than others for parasitism by the cowbird (Mason 1980, May and Robinson 1985, Peer and Bollinger 1997). Productivity refers to the ability of a host to fledge young following a parasitism event and is dependent on the host's response to parasitism and fledgling results.

Suitability

Bureau of Reclamation (unpub. data) identified detectability, opportunity, and size as the primary factors that determine the suitability of a species to act as a cowbird host.

Detectability

The detectability of a host's nest is influenced by the type of nest, the local habitat used for breeding, and the degree of conspicuous behavior exhibited by the nesting pair.

Nest type.—Open-cup nests are the most common nest type parasitized by the cowbird, which tends to shy away from cavity nests and domed nests (Ortega 1998). In fact, 86 percent of all cavity-nesting passerines in North America are rarely or never parasitized (Friedmann 1929, 1963, 1966). Presumably, the preference in nest type is because cavity nests are less accessible, and it is more difficult to determine if the host is present than with open nests (Robinson et al. 1995). Bohning-Gaese et al. (1993) found that the group of bird species with low, open nests and high cowbird parasitism declined significantly from 1978 to 1987, suggesting that the type of nest a host uses may have a considerable effect on its susceptibility.

Habitat.—Riparian areas and forest edges support higher concentrations of cowbirds (Laymon 1987, O'Conner and Faaborg 1992, Hostetler 1994). Species that breed in these areas will therefore be the most frequently parasitized by the cowbird (Airola 1986, Gates and Giffen 1991). There is generally low cowbird parasitism in unfragmented forest and desert scrub habitats (Ortega 1998). Microhabitat may also be important. The structure of the vegetation appears to be a variable in parasitization. Brittingham and Temple (1996) found an association between parasitized nests and a more open canopy and subcanopy within deciduous woods. The open canopy apparently allows an unobstructed view for nest searching. Cowbirds use trees as perches to locate nests and observe host behavior (Norman and Robertson 1975, Freeman et al. 1990), and parasitization has been shown to increase with proximity to trees (Averill-Murray et al. 1999, Budnick et al. 2002). When tall trees or snags are located in more open habitats, they may provide a better perch for observing host activities than trees or snags in environments with a more closed tree canopy or with dense, interior vegetation (Robinson et al. 1995, Averill-Murray et al. 1999). High vegetation cover near the nest may provide concealment and reduce the likelihood of parasitism (Staab and Morrison 1999, Uyehara and Whitfield 2000, Budnik et al. 2002), although there are studies that found no association between nest concealment and parasitism (Buech 1982, Barber and Martin 1997, Powell and Steidl 2000).

Conspicuous behavior.—Due to the cowbird's practice of watching host species, birds that are very vocal and active may attract the attention of a female cowbird more than a nonactive host would. Conspicuous behavior increases the detectability of potential hosts, which in turn may increase the likelihood for their nests to be parasitized by the cowbird.

Opportunity

The opportunity provided to the cowbird for approaching the host nest affects the vulnerability of a host bird to being parasitized. Opportunity is provided based on the level of physical defense of their nest that the host exhibits. The host species may actively defend the nest by displaying aggression toward the female cowbird. Robertson and Norman (1976) found that bobolinks (*Dolichonyx oryzivorus*), red-winged blackbirds, and yellow warblers (*Dendroica petechia*) showed markedly aggressive behavior toward cowbird models. They also noted that all of the host species included in their study were more aggressive to cowbird models than to sparrow models, indicating that some hosts have the ability to discriminate between species. Other host species reported to interact aggressively with cowbirds include the American redstart (*Setophaga ruticilla*; Hickey 1940, Ficken 1961), song sparrow (*Melospiza melodia*; Nice 1943), robin (*Turdus migratorius*; Friedmann 1929), red-eyed vireo (*Vireo olivaceus*; Prescott 1947), and willow flycatcher (*Empidonax* *traillii*; Sogge, pers. comm. 2003). Birds may also indirectly defend their nests. When a host bird incubates the nest constantly, it prevents the cowbird from laying an egg in the nest but avoids physical confrontation. Gray catbirds (*Dumetella carolinensis*) appear to be more attentive to their nests during egg laying than more heavily parasitized northern cardinals (*Cardinalis cardinalis*; Scott 1977), and female catbirds have been observed calling their mates to guard the nest while they leave to forage (Slack 1976). Eastern kingbirds (*Tyrannus tyrannus*) display similar nest-guarding behavior (Neudorf and Sealy 1994). These two species are parasitized at relatively low rates, though they are also known to eject cowbird eggs from their nest, which could be more of a factor in contributing to the low parasitism rate than nest attentiveness (Ortega 1998). Birds that do not physically attack female cowbirds and are not vigilant in their incubation are more vulnerable to being parasitized.

Size

The size of the host bird also influences its likelihood to be parasitized. Smaller cowbird host species tend to be more heavily parasitized than the larger species (Mayfield 1977, Ortega 1998). Smaller hosts do not possess the physical stature to prevent parasitism by a larger female cowbird. The young of smaller species cannot compete with the larger cowbird chick for parental care, and do not typically survive. Hosts that generally fail to raise any of their own if a cowbird egg hatches include small species of flycatchers (Briskie and Sealy 1987, Whitfield and Sogge 1999), vireos, phoebes, warblers, and sparrows (Robinson et al. 1995). Medium- and large-sized hosts such as the song sparrow and red-winged and Brewers (*Euphagus cyanocephalus*) blackbirds usually experience no loss of their own young when raising a cowbird chick (Smith 1981, Weatherhead 1989, Roskaft et al. 1990). However, clutch sizes of parasitized nests of these species may be smaller due to egg removal by the cowbird (Robinson et al. 1995, Clotfelter and Yasukawa 1999a). Large thrashers (*Toxostoma* spp.) and common grackles (*Quiscalus quiscala*) appear to be the upper size limit of hosts that cowbirds will parasitize (Ortega 1998).

Other factors

Other factors that should also be considered in evaluating the likelihood of a species to receive cowbird eggs are breeding season and host density. The timing and length of the hosts' breeding season will have an effect on its vulnerability to parasitism. Birds that nest before and/or after the egg-laying period of the cowbird may escape high parasitism (Robinson et al. 1995, Ortega 1998). Hosts whose peak nesting period coincides with that of the cowbird may experience relatively high rates of parasitism (Brown 1994). In areas with shorter breeding seasons, such as in northerly climates and at higher elevations, there is a higher impact because there is less opportunity for hosts to renest after parasitism (Robinson et al. 1995). With a longer breeding season, not only does the host have the potential to avoid the egg-laying period of cowbirds, there is also more opportunity to renest.

Host density may also influence the occurrence of cowbird parasitism. Lower rates of parasitism have been found in dense red-winged blackbird colonies (Freeman et al.

1990, Clotfelter and Yasukawa 1999b, Carello and Snyder 2000). High nest density can facilitate group defense and increase vigilance and aggressiveness of the host (Robertson and Norman 1977). Colonies of one species can also provide indirect protection from parasitism to other species that are nesting nearby (Friedmann 1963). However, high host density also provides a larger number of nests for cowbirds to parasitize. With less aggressive and noncolonial host species, cowbird abundance has been positively correlated with host density (Lowther and Johnston 1977, Barber and Martin 1997, Tewksbury et al. 1999).

Productivity

Factors that affect the productivity of a host following a parasitism event are the host's response to parasitism and the results of post-parasitism fledging (Bureau of Reclamation, unpub. data).

Response to parasitism

Based on their response to parasitism, most host species can be categorized as either acceptor or rejecter species depending on their acceptance or rejection of the cowbird egg in their nest. Low acceptance rates have been linked to low parasitism rates (Ortega 1998). The rejection response requires the ability to discriminate between host and parasitic eggs and is exhibited by ejection of the cowbird egg from the nest, burial of the parasitized clutch, or nest abandonment (Ortega 1998). Parameters that are used in egg rejection responses include color, size, and maculation. There are only about 25 rejecter species in North America that respond to parasitism by selectively removing foreign eggs from their nest (Fish and Wildlife Service 2002). These include the cedar waxwing (*Bombycilla cedrorum*; Rothstein 1976), common grackle (Peer and Bollinger 1997), scissortail flycatcher (*Tyrannus forficatus*; Regosin 1994), eastern warbling vireo (*Vireo gilvus gilvus*; Sealy 1996), American robin, blue jay (*Cyanocitta cristata*), and gray catbird (Rothstein 1975, 1982) as well as species of kingbirds (Rothstein 1975, Hamas 1980, Sealy and Bazin 1995), thrashers (Finch 1982, Rothstein 1982, Haas and Haas 1998), and orioles (Rothstein 1977). Eggs are ejected from the nest either by removing the egg whole or by spiking the egg with the bill (Ortega 1998). Species that eject must be large enough to maneuver cowbird eggs and must also have bills that are large enough to grasp an egg (Ortega 1998, Freeman et al. 1990). For small-billed hosts, like the cedar waxwing, puncture ejection may be the only practical method of ejection, although the thick shells of cowbird eggs are relatively puncture resistant, making this a difficult strategy. Hosts may also bury the parasitized clutch by reconstructing a new nest floor over the eggs and starting a new clutch, a practice common among yellow warblers (Ortega 1998). Another defense is to completely abandon the parasitized nest and renest elsewhere (Robinson et al. 1995). Desertion provides the opportunity for a host to raise a successful clutch following parasitism, but may be costly due to the time involved in building another nest. There is also the potential for the second nest to be parasitized as well.

Results of post-parasitism fledging

Post-parasitism fledging results in one of three outcomes. One outcome is that only the host young is fledged because the host species is an unsuitable cowbird parent—usually due to a diet that is not suitable for cowbird chicks. Omnivorous cowbirds did not survive in nests of finches, which was attributed to a diet high in seeds (Middleton 1991, Mariani et al. 1993, Kozlovic et al. 1996). Alternatively, only the cowbird young may fledge because the larger, more developed cowbird chick often outcompetes the other nestlings for food, which leads to starvation of the host chicks. As discussed above, this most often is the result in nests of small-sized hosts. A third outcome is that both host and cowbird are fledged since some mid- to large-sized species are capable of rearing their own young alongside a cowbird chick. The outcome that results from a parasitized nest affects the reproductive success of the host. If the outcome leads to a decrease in productivity and if a host population is limited by recruitment of new individuals, then cowbirds are adversely impacting the host species.

COWBIRD MANAGEMENT

Control Measures

Efforts to protect locally threatened or endangered neotropical migrant bird species increasingly include cowbird management (Robinson et al. 1995, Eckrich et al. 1999, Whitfield et al. 1999, Winter and McKelvey 1999, DeCapita 2000, Griffith and Griffith 2000, Hayden et al. 2000, Rothstein and Cook 2000, Summers et al. 2000). Management strategies can range from improving habitat conditions that benefit rare birds and/or deter cowbirds to implementing control methods aimed at reducing cowbird numbers (Fish and Wildlife Service 2002). Control measures that involve cowbird removal may require Federal and/or State permits. If any of these methods are selected, local State agencies and Fish and Wildlife Service should be contacted for information on permitting requirements. Options in cowbird management are discussed below.

Habitat improvement

In situations where a cowbird control program is being considered, the need for management is typically associated with a loss of breeding habitat for the species of concern (Fish and Wildlife Service 2002). Declines in neotropical migrant songbirds are primarily due to degraded, modified, and/or fragmented habitat, which in turn makes these populations more vulnerable to parasitism by cowbirds (Rothstein and Cook 2000). Cowbird parasitism alone is not a major threat to healthy populations and is unlikely to endanger species when adequate habitat is available. Since habitat loss is probably the principal reason that species face endangerment, it is important to pursue efforts to augment habitat (Fish and Wildlife Service 2002). Therefore, habitat acquisition, improvement, and restoration are management strategies that should be implemented along with cowbird control measures (Ortega 1998, Whitfield and Sogge 1999, Fish and Wildlife Service 2002).

Certain characteristics of the vegetative structure can be beneficial in decreasing the vulnerability of host nests to parasitism. Dense vegetation at the nest level may help conceal nests and is often correlated with lower rates of parasitism (Staab and Morrison 1999, Uyehara and Whitfield 2000, Budnik et al. 2002). Consequently, measures that result in dense vegetation may help reduce parasitism. Management techniques that may achieve these qualities include planting seedlings where regeneration is not occurring, preventing overgrazing by livestock, and restricting areas from high recreation use (Staab and Morrison 1999). Increased waterflows may help to create denser riparian vegetation (Fish and Wildlife Service 2002). Removal of salt cedar (*Tamarix* spp.) may not be a practical technique unless dense, native vegetation is reestablished since salt cedar does provide suitable breeding habitat for many bird species (Averill-Murray et al. 1999). Staab and Morrison (1999) found lower parasitism rates in areas with large diameter cottonwoods that provided few perching sites. They also found less parasitism among nests that were located in shrubs and mid-sized trees than those located in small trees. They hypothesized that the small trees provided low perch sites and less concealment. This is consistent with the findings of Budnick et al. (2002). They determined that parasitization increased as the average height of trees in the area decreased, apparently because lower perches provided better vantage points for nest observation. Nevertheless, because cowbirds do use trees to observe host nest building, revegetation efforts focused on planting large trees without managing for a dense understory or subcanopy could be enhancing cowbird parasitism by providing perches with no cover (Averill-Murray et al. 1999). Using prescribed burns to alter vegetation may be another management technique for controlling parasitism of some species (Clotfelter et al. 1999). Both the rare Kirtland's warbler (*Dendroica kirtlandii*) and black-capped vireo (*Vireo atricapillus*) are dependent on fire for breeding habitat and therefore controlled burns would improve habitat conditions for these species.

The disadvantage to habitat improvement as an approach to cowbird population control is that it requires long-term strategy, taking many years to attain desired results. Habitat improvement is also a costly approach, which may be a limiting factor. Managers should always aim for increased amounts of quality habitat, but other actions may also be necessary when a population is imperiled.

Reducing human influences

Cowbirds are frequently associated with anthropogenic features such as livestock and agriculture; campgrounds; suburban areas with lawns, bird feeders, and golf courses; and internal and external edges created by development (Robinson et al. 1993, Ortega 1998, Fish and Wildlife Service 2002). Reducing these influences across the landscape will help to decrease the number of cowbirds in the area. One of the best management strategies for reducing these influences is to maintain large areas of contiguous habitat (Robinson et al. 1993). This can be achieved by consolidating ownership of the largest tracts when land is acquired. Agricultural or suburban developments that will fragment the land should be avoided. If warranted, livestock can be removed from the area or, at a minimum, a grazing rotation plan can be implemented that will relocate livestock during the host breeding season. Management should focus on eliminating feeding areas within large tracts by avoiding practices such as mowing roadsides and campgrounds, feeding birds with feed that is attractive to cowbirds such as millet or milo, establishing corrals or pack stations, and grazing. If these tactics are not feasible, feeding areas should be concentrated as much as possible.

Realistically, it is difficult to remove human influences over the landscape, and it is probably not possible to completely eliminate cowbirds using this approach. However, numbers of cowbirds can at least be reduced (Fish and Wildlife Service 2002). Cowbird abundance has been shown to decline with distances as short as 2 to 4 km (1.2 to 2.5 mi) from anthropogenic food sources (Tewksbury et al. 1999, Curson et al. 2000). If few feeding opportunities for cowbirds exist, parasitism may not be a problem even in areas where cowbirds are usually found, such as along edges and small openings (Robinson et al. 1993). Attempting to control cowbird populations by reducing human influences is time consuming and costly, especially when considering economic impacts to cattle and other interests (Fish and Wildlife Service 2002). Long-term planning must also be a factor in this approach since development must be curtailed if the method is going to be effective.

Fertility control

A nonlethal method of reducing or eliminating cowbird impacts on hosts could be to inhibit their reproductive capabilities (Fish and Wildlife Service 2002). Several existing compounds could be delivered via baited food and administered to large numbers of birds (Yoder et al. 1998). There are, however, various problems associated with the use of these compounds. The most promising compound, DiazaCon, prevents egg laying but must be administered continuously for 7 to 14 days. Currently, there is no feasible method of inhibiting breeding of large cowbird populations, but this approach merits additional research.

Egg removal/addling

Removing cowbird eggs from the host nest or addling them by shaking are other techniques used to limit cowbird impacts on hosts. These methods are cost effective and practical where small, remote populations of hosts and/or cowbirds exist (Kus 1999, Winter and McKelvey 1999, Fish and Wildlife Service 2002). Since nests do not require daily monitoring (Kus 1999, Winter and McKelvey 1999), these options are feasible in rugged or isolated areas that are difficult to access.

Addling may be preferable to removing eggs. Some host species may desert their nest if eggs are removed—they consider the cowbird egg part of their clutch (Fish and Wildlife Service 2002). However, if the host eggs have been ejected or damaged by the female cowbird, it is better for the host to desert and renest elsewhere increasing its chances for successful reproduction. In this case, removal of eggs is preferred to addling. Eggs can be removed using adhesive tape to minimize disturbance to host eggs (Kus 1999). Egg removal or addling is only practical where nests can be safely accessed. It may not be an option if nests are located too high in the tree or are placed in fragile vegetation (Fish and Wildlife Service 2002).

Egg removal or addling could potentially prevent a total loss in host productivity (Kus 1999). Another benefit is that these techniques do not affect non-target species. On the downside, however, they do not prevent impacts to the host eggs that may be caused by the female cowbird.

Shooting

Shooting cowbirds is another control method that is effective in remote or rugged areas where daily visits are not practical (Stake et al. 2000, Fish and Wildlife Service 2002).

Shooting programs are generally conducted once a week during the breeding season in the morning hours along established circuits (Stutchbury 1997, Stake et al. 2000, Summers et al. 2000). Opportunistic shooting of cowbirds takes place at foraging areas throughout the year at Fort Hood, Texas (Summers et al. 2000). Cowbirds are attracted using tape playback of female chatter call. Once birds are shot, they should be located to confirm death and to euthanize any that were not killed.

This approach has been used successfully for disjunct host populations and as a supplement to trapping programs. Shooting reduced parasitism rates of black-capped vireos at Fort Hood, Texas (Stake et al. 2000, Summers et al. 2000) and of hooded warblers in Pennsylvania (Stutchbury 1997). Fledging success of vireos increased from 0 percent to 80 percent associated with shooting at Fort Hood, while the difference in the number of young fledged per nest was not significant between the cowbird removal sites and the control sites in the Pennsylvania study.

Shooting is less expensive than trapping, and it provides an alternative method where trapping is not practical. There are safety concerns with using this method, and it cannot be used near areas occupied by humans.

Trapping

Trapping is the predominant method used for cowbird population control. It is likely to be the most effective management tool in situations where immediate action is needed to protect declining rare neotropical migrant bird populations. Trapping efforts are typically highly successful in reducing local parasitism rates and can be a somewhat quick and easy cowbird control method (Fish and Wildlife Service 2002). Trapping, although it is not the least expensive of the control methods, is an attractive option because it is relatively cheap compared to habitat restoration (Rothstein and Cook 2000).

Trapping requires daily monitoring in order to supply fresh water and food for captured birds and to release non-target species. Therefore, it is important that the terrain be accessible by road. It is generally assumed that trapping programs will continue for many years and there are suggestions that some programs may be needed in perpetuity (Griffith and Griffith 2000). However, if the target host species has increased markedly since trapping began, then it may only need to be a temporary solution (Fish and Wildlife Service 2002). If trapping helps populations of rare species increase, there are more nests to disperse cowbird eggs among, and parasitism does not have such a large effect.

Although trapping is commonly employed to control cowbirds, there are drawbacks to this approach. A successful trapping program should be carried out until desired results are achieved or at least long enough to evaluate the program for effectiveness, and funding is not always guaranteed for the long term (Rothstein and Cook 2000). Management options other than trapping, such as habitat improvement and monitoring, may not be feasible if resources are directed toward the trapping program. Trapping has little effect on cowbird numbers year to year (DeCapita 2000, Griffith and Griffith 2000, Bureau of Reclamation 2001) so it must be conducted every year, as compared to habitat enhancement, which has effects for many years. Other issues include ethical and animal rights concerns involved in killing native cowbirds, especially if control has not been justified (Fish and Wildlife Service 2002). Species other than cowbirds are captured in the traps, which can have detrimental effects. Time in captivity is time spent away from the nest, and can lead to reproductive failure of non-target species. Another consideration is that cowbirds may become resistant to trapping over time (Fish and Wildlife Service 2002). Finally, trapping can be used as mitigation for land development and destruction of habitat (Rothstein and Cook 2000). This is a concern because the loss of habitat is most likely a permanent situation, whereas cowbird removal may not be. Trapping may not be necessary but may still be advocated by land developers and other private interests in order to meet mitigation obligations while pursuing planned developments (Fish and Wildlife Service 2002).

Case studies of control programs

Cowbird control is used in the management of four endangered taxa (Robinson et al. 1995): the Kirtland's warbler, the least Bell's vireo (*Vireo bellii pusillus*), the southwestern willow flycatcher, and the black-capped vireo. These control programs are discussed below. Note that in all of the case studies, the endangered species face restricted breeding ranges due to habitat destruction, fragmentation and/or fire suppression, which compounds problems with cowbird parasitism.

Kirtland's warbler

The Kirtland's warbler has always had a limited breeding range and population. The species nests in jack pine (*Pinus banksiana*) forests 6 to 24 years after fire (DeCapita 2000) in a small area in northern lower Michigan. Data indicate that parasitism increased during the 1960's, with a mean cowbird parasitism rate of 69 percent between 1966 and 1971 (Robinson et al. 1995). The warbler was almost extinct when cowbird trapping was initiated in 1972. Over the first 10 years of the cowbird control program, the parasitism rate dropped to an average of 3.4 percent (Kelly and DeCapita 1982), and reproductive success showed an increase also. Despite these achievements, the total number of Kirtland's warbler males remained relatively constant until 1989, ten years after the Mack Lake Burn wildfire (a small prescribed burn that went out of control) created a massive amount of new habitat (Rothstein and Cook 2000). Presumably, the rise in population size is in part due to this accidental expansion in habitat. Figure 4 shows the census of singing Kirtland's warbler from 1951 to 2003.

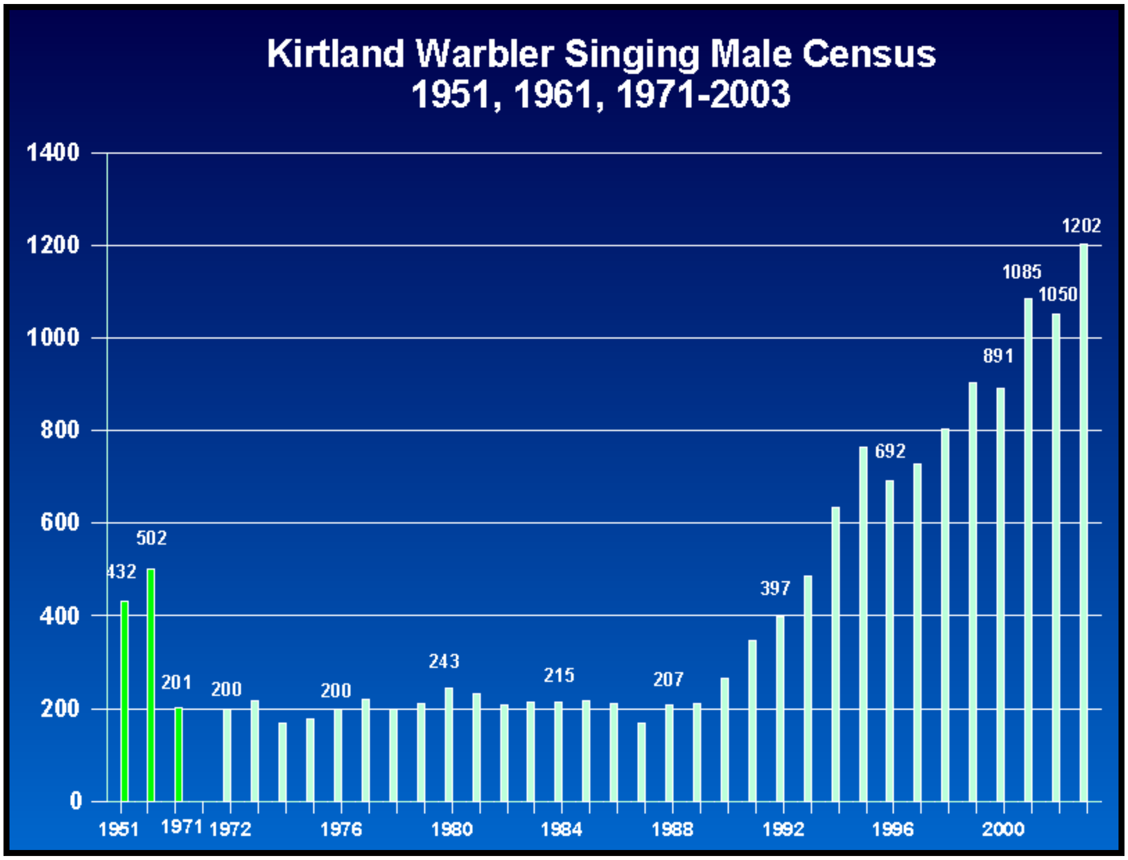

Figure 4. Census of singing male Kirtland's warbler, 1951-2003. Source: Fish and Wildlife Endangered Species webpage.

This trapping program is costly and would not be practical on a larger scale (DeCapita 2000). The number of traps has increased from 15 in 1972 to 67 in 1995. Although cowbirds have been removed for 24 years, the overall cowbird population has not decreased. Seal (1996) predicted that nest parasitism above 30 percent would lead to extinction of the Kirtland's warbler.

Least Bell's vireo

The least Bell's vireo is a riparian obligate that was once common in the Central Valley and southern coast of California (Robinson et al. 1995). Cowbirds invaded southern California around 1900 and began to spread into the valley. By the 1930's, vireo populations were declining. In the 1970's vireos were extirpated in the Central Valley, where 60 to 80 percent of the population once occurred (Franzreb 1989), and where 95 percent of riparian vegetation has been lost (Robinson et al. 1995). Parasitism was 50 percent in the remnant populations found along the southern coast. The present and historical range of the least Bell's vireo is shown in Figure 5. The least Bell's vireo is especially susceptible to parasitism because the species will generally only raise a cowbird and none of their own. Considering the extensive loss

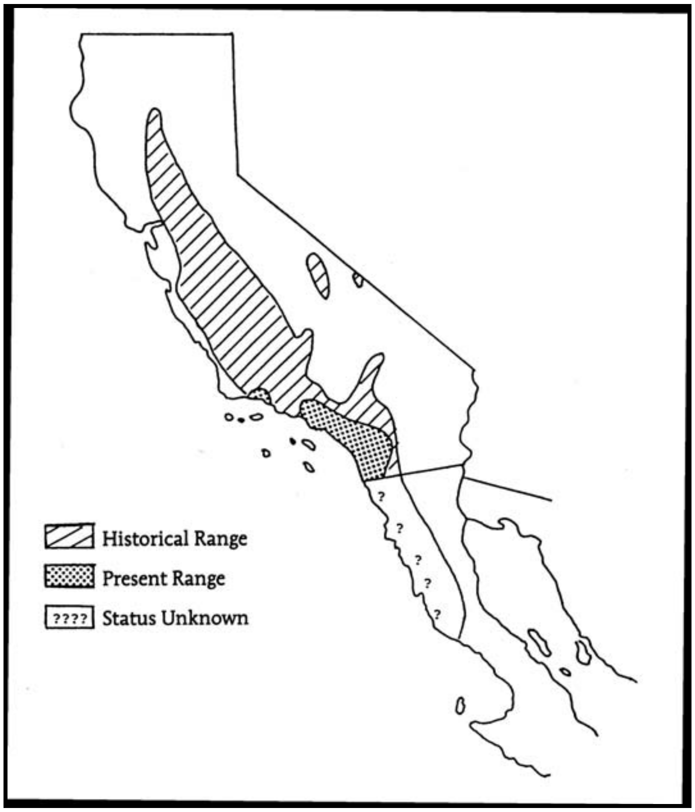

Figure 5. Historical and present range of the least Bell's vireo. Source: Franzreb 1989.

of habitat, cowbirds are not the primary reason for the decline in vireo populations, but under the current circumstances, parasitism might wipe out the remaining populations without management (Laymon 1987).

Cowbird control to protect the least Bell's vireo was initiated in the early 1980's at Camp Pendleton, which has the most extensive riparian habitat left in southern California (Griffith and Griffith 2000). The control program initially (1981-1990) focused on locating individual vireo nests with subsequent surveillance and removal of cowbird eggs and/or young from parasitized nests. While costly and labor intensive, this approach yielded almost instant results with vireo productivity increasing by 56 percent in 1982. Trapping began in 1983 and became the preferred method of cowbird control. It appears to be more effective in increasing productivity and can be conducted at less than 25 percent of the cost of nest surveillance. Since 1988, parasitism rates have dropped to below 1 percent (with only 2 cases of parasitism since 1990), and vireos have increased from 62 in 1983 to 902 in 1996 (Figure 6). The number of cowbirds trapped has not decreased over time, so it appears this program has had no cumulative effect on the larger population. Griffith and Griffith (2000) have concluded that cowbird control has been responsible for the

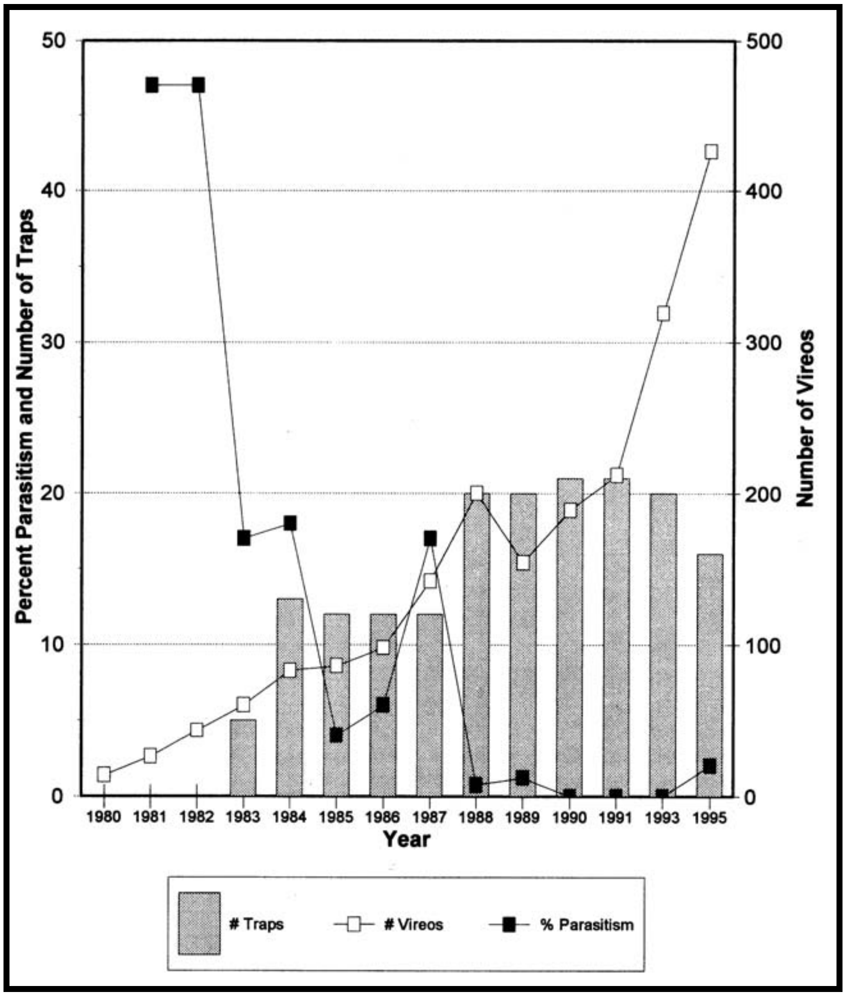

Figure 6. Number of vireos, percentage of parasitism of vireos, and number of cowbird traps at the Santa Margarita River, Camp Pendleton, 1980-1996. Source: Griffith and Griffith 2000.

increase in vireo numbers, and they believe the least Bell's vireo population at Camp Pendleton would not be endangered in the absence of cowbirds.

Other cowbird control programs in California include one in Prado Basin, which led to a large increase in the number of breeding vireos—from 19 in 1986 to 122 in 1993 (Robinson et al. 1995). Another trapping effort in the Cleveland National Forest could not prevent two of three least Bell's vireo populations from declining. Winter and McKelvey (1999) hypothesize that the low success is due to the remote and rugged location. The lack of road and trail access limited the number of traps that could be used and the choice of placement, and trapping was ineffective. They believe that nest surveillance and egg removal would be a better alternative for reducing the impacts of parasitism in this location. A trapping program on the Santa Clara River has only been provided enough funds to include trapping, not monitoring, so it is unknown if trapping has been effective here (Rothstein and Cook 2000).

Cowbird control has not been effective for northern populations of least Bell's vireo in Santa Barbara County (Robinson et al. 1995, Rothstein and Cook 2000) where populations have decreased. These isolated populations have experienced inbreeding and lack of immigration—both contributing factors to their decrease (Robinson et al. 1995). Parasitism was never above 15 to 20 percent and was probably therefore never a large impact to the vireo's productivity. These are important populations because they are closest to the Central Valley and could contribute to recolonization of the area (Rothstein and Cook 2000), one of the goals of the management program (Franzreb 1989). The primary goal is to establish a self-sustaining population of at least 4,000 pairs of vireos across its original range. This involves reestablishing riparian vegetation in the vireo's former range.

Southwestern willow flycatcher

The southwestern willow flycatcher nests along riparian corridors from southern California to west Texas. This species has experienced a decline (Robinson et al. 1995), likely attributed to a loss of 95 percent of riparian habitat within its range (Rothstein and Cook 2000). As with the least Bell's vireo, acceptance of a cowbird egg usually means failure of the flycatcher's brood. Most of the egg-laying season of the flycatcher overlaps that of the cowbird, which may help explain the drastic declines.

The first control program for this species began in 1993 along the South Fork of the Kern River, where the largest California population of willow flycatchers exists. At that time, parasitism rates were 50 to 55 percent (Whitfield 1990). Despite a decrease in parasitism and an increase in nest success associated with trapping (Whitfield et al. 1999), pairs declined from 34 in 1993 to 23 in 1999 and dropped to 12 in 2000 and 11 in 2001 (Fish and Wildlife Service 2002). Table 1 shows willow flycatcher data with and without trapping on the Kern River from 1989 to 1997. This population grew or remained stable in the 1980's without cowbird control. The declines may be due to recently high levels of flycatcher eggs that were not viable (Whitfield and Lynn 2001). Analyses indicate that parasitism in this area would need to be reduced from the current 11 to 19 percent to <10 percent for the flycatcher population to increase (Uyehara et al. 2000). Taking all of these variables into account, there are probably factors beside parasitism that are affecting the Kern River flycatcher.

Southwestern willow flycatchers at Camp Pendleton increased from 5 pairs in 1981 to 19 pairs in 1991 under the cowbird trapping program that was implemented to recover the Bell's vireo (Rothstein and Cook 2000, Whitfield 2000). However, as of 2000, there has been no marked increase in flycatchers despite this initial rise in numbers (Rothstein et al 2003).

Cowbirds were trapped in one of four river segments studied along the Middle Rio Grande in New Mexico from 1996 to 2001 (Bureau of Reclamation 2001). Differences in parasitism and nest success of all host species were minimal between the trapped and untrapped areas. Non-flycatcher host nests on the trapped site

Table 1. Breeding and demographic parameters for willow flycatchers along the South Fork Kern River, California (1989-1997). Source: Whitfield et al. 1999

Year	Number of pairs	Number of nests[c]	Predation rate (%)	Parasitism rate (%)	Mayfield nest success (%)	Total number young fledged	Number young fledged/female
1989[a]	44	34	33	50	24	25	1.04
1990	41	38	42	61	24	21	0.88
1991	31	45	35	78	17	25	1.14
Means	39	116[d]	37	63	23	24	1.04
1992[b]	27	36	14	69	32[e]	33	1.83
1993	34	33	37	38	33[e]	37	1.76
1994	34	32	47	16	39[e]	42	2.10
1995	34	32	34	19	43[e]	40	1.90
1996	29	29	28	11	61[e]	58	2.42
1997	38	51	57	20	30[e]	37	1.09
Means	34	178[d]	40	22	39	43	1.74

[a]Cowbird control was not implemented from 1989 to 1991.
[b]During 1992, cowbird trapping was not conducted but 30 female cowbirds were removed. Cowbirds were trapped from 1993 to 1997.
[c]In all years, nests for all pairs of willow flycatchers in the study area were not found.
[d]Total instead of mean.
[e]This rate reflects intervention by removing cowbird eggs and nestlings from flycatcher nests.

exhibited lower parasitism rates but similar productivity to host nests on untrapped sites. Parasitism of the southwestern willow flycatcher was 5 percent, and nest success 75 percent in 2001. The number of flycatcher territories increased from 10 to 25 during 5 years of the trapping period (1997-2001). The number of territories increased to 86 in the next 2 years in the absence of trapping (Ahlers, Bureau of Reclamation, unpub. data). Success of willow flycatchers is believed to be due to a population that became established in the area and experienced high nesting success concurrent with expanding high quality riparian habitat in the trapping area rather than to cowbird removal. This assumption is based on results showing that (1) flycatchers continued to increase significantly after trapping was discontinued, and (2) trapping had no effect on the productivity of other cowbird host species.

Trapping programs have also been implemented for the southwestern willow flycatcher in Arizona. There have been large increases in flycatcher populations at Lake Roosevelt and San Pedro River sites that have occurred during cowbird control (Rothstein et al 2003). There has also been an increase in habitat and in survey effort during this time, therefore it is hard to know the extent that cowbird control can be attributed to the increase in flycatcher numbers. At other sites in Arizona, populations have increased slightly with cowbird removal, and numbers have actually decreased at the Alpine/Greer site.

Although there have been increases in southwestern willow flycatchers with the use of cowbird control at some sites, there is no direct correlation between these increases and cowbird removal.

Black-capped vireo

The black-capped vireo formerly nested from south central Kansas through Texas and into Mexico (Robinson et al. 1995). Nesting habitat is in deciduous shrubs 3 to 25 years after disturbance. This species' habitat has been reduced due to fragmentation and fire suppression. Its range is now limited to an isolated population in Oklahoma, a core population in central Texas, and populations in northern Mexico of unknown size and range (Hayden et al. 2000). The black-capped vireo's breeding distribution is within the historical cowbird range, but the reduction in bison and the introduction of cattle have influenced cowbird distribution. Vireos are vulnerable to parasitism due to their small size, open-cupped nests, long incubation period (14 to 17 days) relative to cowbirds, and nesting habitat.

Trapping of brown-headed cowbirds, augmented with a shooting program, has been conducted on the Fort Hood Army Base in central Texas since 1988 in an effort to reduce parasitism on the black-capped vireo (Eckrich et al. 1999, Summers et al. 2000). Before cowbird removal was initiated, 90 percent of vireo nests monitored were parasitized (Hayden et al. 2000). A number of different trap designs have been used to capture cowbirds on Fort Hood, though managers favor the current standard, a wooden hybrid design. Trapping has been conducted year-round, and the number of traps in operation varies between years. In 2000, the parasitism rate for black-capped vireos was below 10 percent (Figure 7; Summers et al. 2000). Lower parasitism rates have lowered nest desertion by the vireos (Hayden et al. 2000). Nest success has also increased during the trapping period. Abundance of male vireos increased from 85 to 357 between 1987 and 1997 (Koloszar 1998), and as of 2003 the population of male vireos on Fort Hood was approximately 2000 (Kosteche et al. The Nature Conservancy of Texas, unpub. data). The increase in vireos is strongly correlated with the onset of cowbird control, and managers believe that cowbirds are the primary limiting factor for vireos, (Kosteche et al. The Nature Conservancy of Texas, unpub. data), but there are other factors to consider. For instance, the study area was smaller and fewer surveys were conducted when the program was begun, so the initial numbers of vireos is not certain (Kosteche, pers. comm. 2003). Hayden et al. (2000) suggest that vireo habitat availability, immigration and emigration, and adult and juvenile survival rates may have also influenced population size.

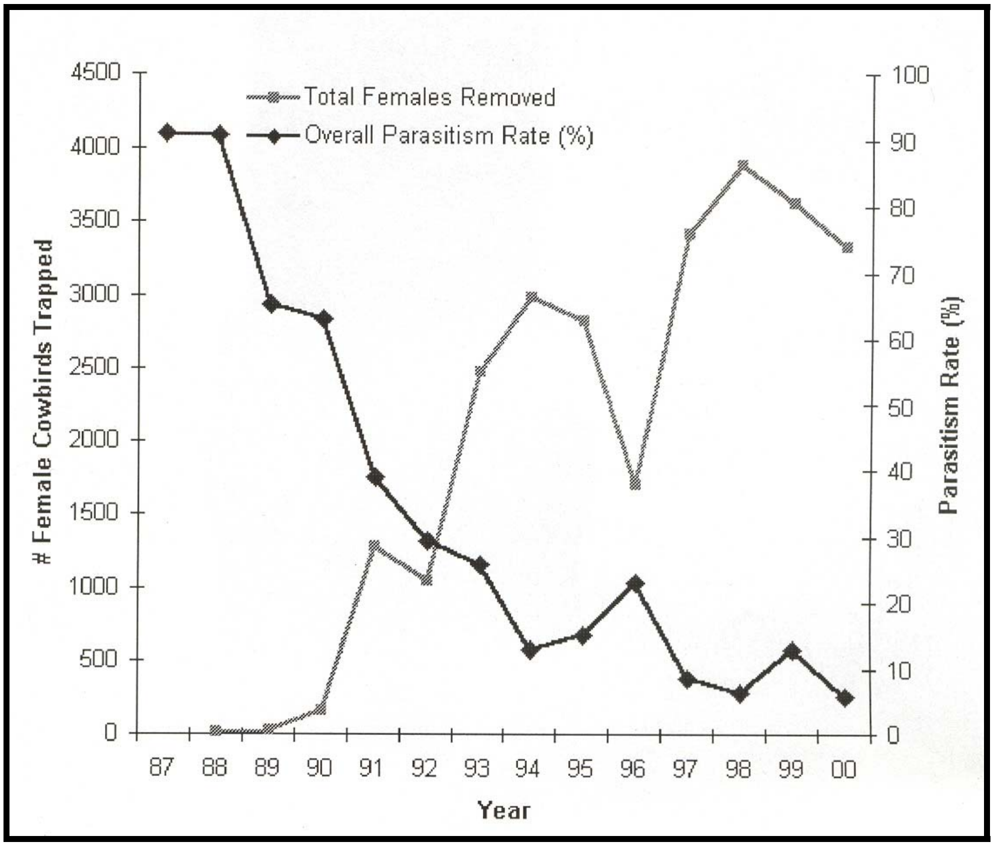

Figure 7. Number of female brown-headed cowbirds captured in traps during the black-capped vireo breeding season (March-June), and observed rate of cowbird parasitism on black-capped vireo broods, from 1987 to 2000, on Fort Hood, Texas. Source: Summers et al. 2000.

Effectiveness of control

Case studies demonstrate trapping can be highly effective at reducing the rate of parasitism on local populations of songbirds. This reduction in parasitism typically results in an increase in nest productivity per host female. Despite these positive trends in nest success, cowbird control programs have not always been successful at increasing the number of breeding adult hosts (Hall and Rothstein 1999, Rothstein and Cook 2000). Populations of the least Bell's vireo and the black-capped vireo have grown since trapping began, and in both cases control was probably a major factor. It is unclear how much these increases are due to other management actions, such as improved habitat (Hayden et al. 2000, Fish and Wildlife Service 2002, Rothstein, pers. comm. 2003). The Kirtland's warbler population did not increase until 18 years after trapping began, and only after expanded habitat became available (DeCapita 2000). Current cowbird trapping programs have not been directly related to an increase in southwestern willow flycatcher populations (Fish and Wildlife Service 2002). Although cowbird management may be instrumental in helping to sustain threatened and endangered species, it is important to recognize that the effectiveness of cowbird control on increasing host populations is still not clearly defined.

Pre-control Evaluation

Before initiating a control program, local conditions should be examined to determine to what extent, if any, cowbird management is necessary. Baseline data are collected to provide information on local populations of host species and cowbirds. It is also valuable to gather existing information on different cowbird control programs which will provide insight on circumstances that have led to control in other locations. Once adequate local data and existing literature are compiled, then informed decisions can be made regarding whether the species of concern is being impacted by parasitism and if cowbird control is needed. If control is selected as a management option, this information can be used to identify the objectives of the control program and to design a cowbird control plan.

Baseline monitoring

Ideally, no cowbird removal program should be initiated without adequate baseline data. Without baseline data to determine parameters such as pre-trapping cowbird and host abundance and distribution, parasitism rates, and nest success, there is no basis for comparing conditions that exist during trapping. It is impossible to get a valid measure of effectiveness. Recommended monitoring techniques are discussed below but for detailed methodology refer to Ralph et al. (1993).

Although any data collected will be valuable in making decisions about whether to implement cowbird control, the most important factor to focus on is the rate of parasitism on the host species. Because parasitism rates vary geographically and temporally, baseline data need to be collected for each population to determine necessary cowbird management. The degree of cowbird parasitism at one site cannot be predicted based on only 1 year's data, or by extrapolating from other sites (Whitfield and Sogge 1999). The Fish and Wildlife Service (2002) advises that baseline studies include at least 2 years of data collection, if not more, and that all populations with more than five nests be monitored. Baseline monitoring can be expensive but may save money in the long run if it shows that control is not necessary.

Point counts

Point counts may be conducted to assess the size and distribution of local host and cowbird populations. Although this type of information is important in characterizing local bird populations, it may not be the best method for identifying numbers of the target species. It also provides a rough estimate of parasitism intensity but does not provide data on the parasitism rate, which is determined through nest monitoring. Therefore, if funds are limited, managers may opt not to include point counts as a method for gathering baseline data.

Point counts are conducted along established routes five to eight times during the breeding season (Halterman et al. 1999, White and Best 1999, Bureau of Reclamation 2001). Neotropical migrant songbirds are the most vocal in the early morning hours; point counts conducted then will detect the greatest number, generally just before sunrise to 3 to 5 hours after sunrise. All birds seen or heard from a fixed point in 3- to

10-minute intervals are recorded and categorized as flyover, >50 meters (m) [164 feet (ft)], or < 50 m (164 ft) from the point. It is best to count all cowbird detections but record males and females separately (Rothstein et al. 2000). Females can be detected by the "rattle" call while males primarily give the other two cowbird calls (Robinson et al. 1993). Tape playback of the female chatter can be used for census training. Field workers use the tapes to attract cowbirds and become familiar with the vocalizations, which leads to a more accurate census (Rothstein et al. 2000). The mean number of cowbird detections per route will provide a measure of abundance. Cowbird frequency—the percentage of points at which cowbirds are encountered at least once—is an index of distribution and can aid in identifying areas of cowbird concentration (Halterman et al. 1999, Bureau of Reclamation 2001). Figure 8 is an example of mean and frequency point count results. Another option in collecting and analyzing point count data is Program DISTANCE (Buckland et al. 1993, Thomas et al. 1998). Program DISTANCE uses exact distance of birds from fixed points to estimate the density of birds (i.e., cowbirds and potential hosts) on each site. Lastly, the ratio of cowbird to host may be used as a crude indicator of parasitism intensity (Robinson et al. 1993). For example, a ratio of 0.05 to 0.10 female cowbird:host male corresponded with 60 to 80 percent parasitism in Illinois. In Arizona, White et al. (2002) noted higher parasitism rates in areas where the ratio of female cowbirds to host species was greater than 0.05.

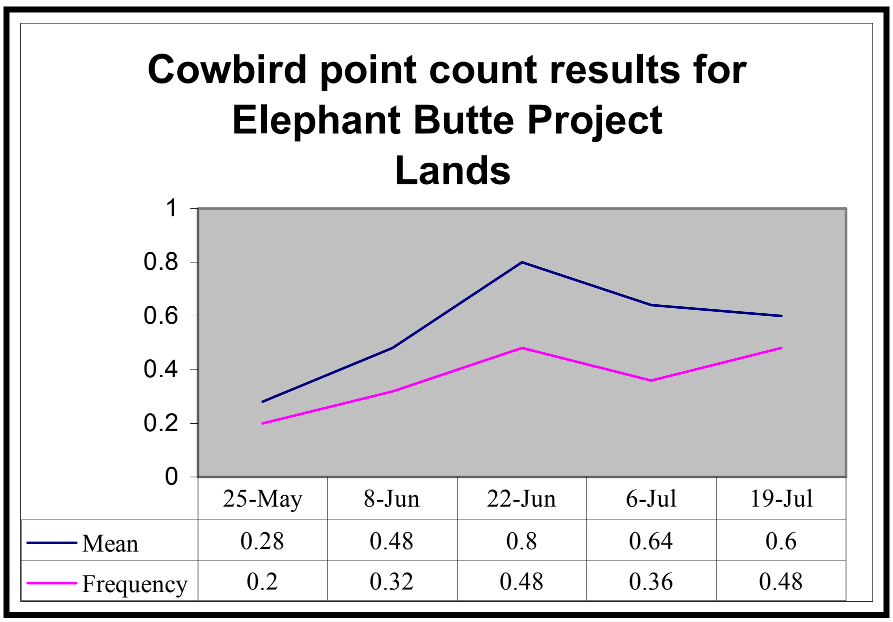

Figure 8. Cowbird point count mean and frequency results from May 25-July 19, 2001, on Elephant Butte Project Lands on the Middle Rio Grande. Source: Bureau of Reclamation 2001.

Nest monitoring

Nest monitoring is conducted to determine the rate of cowbird parasitism and the reproductive success of the host species—two key parameters in evaluating impacts of parasitism on host species at the population level (Fish and Wildlife Service 2002). The parasitism rate is the percentage of nests sampled that are parasitized by cowbirds. This is the most important parameter to identify. Reproductive success connotes host fledgling survival. Reproductive output is a measure of the productivity of the host. Smith et al. (2000) and Grzybowski and Pease (2000) recommend estimating reproductive output of the host using *seasonal* reproductive success as opposed to *nest* reproductive success. Measuring productivity by nest may inflate cowbird impact; nest failures caused by parasitism may not have a great impact on productivity as long as the host succeeds in producing young by renesting (Fish and Wildlife Service 2002). Unfortunately, measuring seasonal reproductive output may require more intensive methods such as color banding or radio telemetry, which increases labor requirements, time, and expenses. Nest reproductive success is therefore more commonly measured by monitoring individual nests. Sufficient reproductive success data exist for those species listed as threatened or endangered (Rothstein, pers. comm. 2003), so this type of information may not be a focus in baseline nest monitoring. As with any data collected, however, it does help to characterize the local population.

Intensive surveys following established protocols are conducted to locate nests of the species of concern (e.g., Sogge et al. 1997). Once nests are identified, nest monitoring protocols are used as guidance in monitoring the nests and collecting pertinent information (e.g., Rourke et al. 1999). Intensive nest monitoring provides data on the size, parasitism rates, and reproductive success of the local populations of the species of concern.

Plots can also be established to search for all nests of cowbird host species that occupy the same habitat as the target species. By including all host species and not just the species of concern, the sample size (i.e., number of nests) can be increased and leads to a more accurate prediction of parasitism rates in the area. It is especially helpful to monitor parasitism rates of all species when the target population is small. Parasitism rates do vary from species to species, so including all species will not provide an estimate of parasitism for the species of concern specifically, but still provides an indication of the local rates of cowbird parasitism. Data on parasitism rates of the target species should be recorded separately. Monitoring plots are first established and then plots are searched for nests of those species thought to exhibit suitable cowbird host characteristics (Halterman et al. 1999, Bureau of Reclamation 2001, but see Mayfield 1975 and Martin et al. 1997 for detailed methodology). During nest searching, pairs are observed and nest chronology identified. Indicators of nest chronology include defensive behavior, nest building, incubation, feeding of young, or the presence of fledglings. Once chronology is determined, nests are checked periodically, every 3 to 7 days, to determine success or failure of the brood. Data collected include location, nest substrate, nest height, dates on nest chronology, clutch size, parasitism, success, and productivity (Bureau of Reclamation 2001).

For examples of nest monitoring data forms used in the Breeding Biology Research and Monitoring Database (BBIRD) protocol and for nests of endangered species (i.e., southwestern willow flycatcher) see Appendix A. Parasitism is documented with the presence of at least one cowbird egg. A nest is considered successful if at least one host young is fledged. The number of fledglings that survive per nest determines nest productivity. Nest monitoring is conducted during the same period as point counts, plus an additional 1 to 2 months following, depending on how long birds continue nesting. Data on parasitism can be used to determine if parasitized nests are less successful than unparasitized nests (Halterman et al. 1999, Whitfield and Sogge 1999). Hatching success and fledging success of parasitized and unparasitized nests can also be compared (Whitfield and Sogge 1999). Sample sizes (i.e., number of nests) should always be included when reporting parasitism rates (Fish and Wildlife Service 2002). Parasitism based on small sample sizes may not be statistically valid when it comes to assessing overall impact. For example, a 100-percent parasitism rate means little if two of two nests are parasitized.

Unfortunately, the disturbance associated with nest monitoring, such as the physical presence of humans around the host adults and nestlings and scent trails left behind, creates a potential for impacting nest success. Protocols may be modified to make monitoring less intrusive, which may be especially important when managing endangered species. For example, the number of visits to the nest can be decreased. Also, mirrors should not be used to check nests with young that are 10 days old or more so as not to force fledge; these nests should instead be observed from a distance.

Evaluating the population level impacts of parasitism

A number of factors are involved in determining if a host population is threatened by parasitism and in need of cowbird management. These include the host population's current size, its recent population trend, its parasitism rate, the extent of losses due to cowbird parasitism, and the amount of suitable habitat (Fish and Wildlife Service 2002, Rothstein et al. 2003).

Baseline data will help estimate a population's current size and indicate if the population is small enough to warrant concern. When using data to examine population trends, patterns may result that indicate that parasitism is having at least some effect on host species numbers, such as a decline in host species that occurs concurrently with increasing parasitism (Whitfield and Sogge 1999). Using current population trends to assess impacts of cowbird parasitism illustrates the importance of collecting local data to determine impacts on a site-specific basis. For example, the southwestern willow flycatcher population at South Fork Kern declined despite cowbird control that reduced parasitism from 65 percent to 11 to 20 percent (Whitfield et al, 1999). This is consistent with analyses that indicate that the population cannot sustain itself if parasitism exceeds 10 percent (Uyehara et al. 2000). Alternatively, the Cliff-Gila southwestern willow flycatcher population in New Mexico appeared to increase even with parasitism rates ranging from 11 to 27 percent (Fish and Wildlife Service 2002).

Parasitism threshold levels (i.e., percentage of parasitized nests above which a species may be imperiled) have been estimated for a number of species. Tazik and Cornelius

(1993) estimated a 35-percent threshold level for the black-capped vireo population at Fort Hood, Texas. The Fish and Wildlife Service (2002) recommends a critical parasitism level of >20 to 30 percent for southwestern willow flycatchers, although analysis by Uyahara et al. (2000) indicates that the Kern River population of flycatchers cannot grow unless parasitism is about 10 percent or less. A 30-percent level of parasitism is commonly used as a threshold of concern for many species (Mayfield 1977, Laymon 1987), though Grzybowski and Pease (2000) surmise that a parasitism rate of 30 percent is probably much too low to be a meaningful indicator. When deciding upon local parasitism threshold levels it is helpful to consult recovery plans and other studies that have identified threshold levels for the species of concern, but ultimately parasitism thresholds should be established based on population trends in the area. As discussed above, similar cowbird parasitism rates can have different effects in different areas. Smith (1999) provides some guidance in determining site-specific threshold levels for target species, suggesting that cowbird management should be initiated when frequency of parasitism in a sample size of 30 or more nests gathered for 2 or more years consistently exceeds 60 percent. If one or more of the following factors applies, the threshold level should be 50 percent and possibly much lower depending on local conditions:

- The habitat is so poor that even unparasitized females are reproducing poorly
- The host species belongs to a particularly vulnerable taxon (e.g., vireos)
- The population of concern is spatially isolated and listed as threatened or endangered
- The host population is/has been in a prolonged state of decline
- There is frequent multiple parasitism

If any of the following factors apply, the threshold should be raised:

- There is a period early in the year when the host can breed outside of the cowbirds' breeding period
- There is a widespread distribution and generally healthy population of host species in most of its range so that local populations that are doing poorly may be rescued by immigration
- Host numbers are increasing in the absence of management actions.

Outside parameters may influence the parasitism levels that a species can withstand while still maintaining a positive growth rate (Robinson et al. 1993). For example, species with high nest predation, low abandonment of parasitized nests, long incubation periods, and short breeding season relative to the length of the nest cycle can tolerate only low parasitism rates. Conversely, species with low nest predation rates, high abandonment rates of parasitized nests, short incubation periods, and long nesting season might be able to tolerate high parasitism rates.

The impacts of parasitism on reproductive output can be measured by comparing parameters such as nest failure rate, hatching success, and fledging success of parasitized and unparasitized nests (Halterman et al. 1999, Sedgewick and Iko 1999, Whitfield and Sogge 1999). Statistical tests such as the Chi square test of homogeneity, the t-test for normally distributed data or the Mann-Whitney test for non-normal data are used to compare the reproductive success of parasitized versus unparasitized nests. If parasitized nests show significantly higher rates of nest failure and significantly lower rates of hatching and/or fledging success, parasitism is having a detrimental effect on reproductive output of the host population being studied.

When suitable habitat is lacking due to fragmentation or degradation, species are even more vulnerable to parasitism (Rothstein and Cook 2000). Parasitism probably reduces the likelihood of populations of rare species to recover once habitat is lost (Whitfield and Sogge 1999).

Bureau of Reclamation (unpub. data) has created a standardized technique that can be used to categorize species as having “high,” “medium,” “low,” or “non” suitability as cowbird hosts. Suitability values are input into a formula that also incorporates values for parasitism defense behavior and nest productivity to calculate an index. This index helps estimate the threat of parasitism for particular species and gives some insight into the necessity of cowbird control for a local area.

Determining if cowbirds are a problem

Determining if cowbird parasitism is having an impact at a population or species level is a significant challenge (Fish and Wildlife Service 2002). Even if parasitism is shown to limit a host species, managers have to decide if that limitation is a cause for concern. Parasitism is no less natural than any other limiting factor such as competition, predation, disease, or habitat. Managers should also consider whether cowbirds are the only problem or if local habitat conditions are so poor that host populations would be threatened even without parasitism (Rothstein and Cook 2000).

Management goals should be based on measurable population parameters that have established an association between cowbird parasitism and host productivity (Robinson et al. 1993). Cowbird control should be implemented only when baseline data show parasitism is a significant threat (Fish and Wildlife Service 2002). Keep in mind that a population subject to parasitism may be doing well even without cowbird management.

During the evaluation period, it is important to recognize that cowbirds are a native species, and nest parasitism is a natural phenomenon. Although cowbird parasitism may affect host productivity, it is not evident that it plays a major role in decreasing host breeding populations (Peterjohn et al. 2000, Weidenfeld 2000), except for a small number of endangered species.

Deciding if cowbird management is warranted

Once data have been collected and evaluated, managers must ask themselves if cowbird management is justified. Despite cowbird impacts to host species, cowbird control might not be the best management alternative. Host populations have increased after the initiation of cowbird control for only about half of the species for which control has been implemented (North American Cowbird Advisory Council 2002). Since there is not a straightforward correlation between increased productivity resulting from cowbird control and an increase in breeding populations, there are apparently factors other than reproductive output that are limiting host populations (North American Cowbird Advisory Council 2002). These limitations should be examined rather than relying exclusively on cowbird trapping to recover declining bird species. Another reason that cowbird control may not be the best management choice is that it can divert resources from other management actions that might better protect host populations such as habitat improvement, monitoring, or studying reproductive success and population dynamics of the species of concern (North American Cowbird Advisory Council 2002). It has been argued that cowbird control is a short-term solution that ignores the real problem of why species are at risk—habitat degradation (Audubon 2002).

When evaluating the need for a control program, managers should consider that abundance and distribution of neotropical migrants are dynamic, i.e., passerine species may be decreasing in one region and increasing in another (Rothstein and Cook 2000). Taking this into account, managers must recognize when populations are decreasing to dangerous levels, in which case management of cowbirds to help restore these populations may be warranted.

Before attempting a cowbird control program, managers should ask practical questions:

What is the root of the problem? Managers need to examine the reasons for decline in host populations and determine if parasitism is a major cause (Hall and Rothstein 1999). If parasitism is impacting declining species, can high rates of parasitism be traced to causes that can be controlled by means other than cowbird removal? Habitat loss may be a major reason for the endangerment of a species. If so, then habitat restoration, either instead of or in addition to cowbird control, may be a more appropriate management focus (Hall and Rothstein 1999). Also, consider if target host populations are viable in the absence of nest parasitism (Hayden et al. 2000). If a species has a number of populations, it may not be worthwhile to apply intensive control efforts for a very small population that has a low probability of persisting even with protection from cowbirds. If a population is imperiled even without parasitism, this may be an indication of poor habitat conditions (Rothstein and Cook 2000). Recognize that cowbird control is not a substitute for habitat restoration. Cowbird control should be considered a "stop-gap" measure to sustain an endangered population until root problems are successfully addressed (Audubon 2002).

Are resources available to continue control efforts indefinitely? (Hayden et al. 2000). Control efforts are generally long term, so managers should be sure that funding will be available in the long term (Hall and Rothstein 1999). Managers should also consider if the benefits of the program outweigh these inevitable long-term financial costs (Audubon 2002). Or will the money be better used for other management actions, such as improving habitat conditions or studying host populations? (Hall and Rothstein 1999).

Will monitoring be implemented to evaluate the effectiveness of control efforts, with the ultimate goal being a sustainable increase in the population size of target hosts? (Hayden et al. 2000). The cost of monitoring should be included when evaluating the availability of long-term funding. There have been cases in which funding is designated for trapping, but no funds remain to determine the effects of trapping on the target host population (Hall and Rothstein 1999). The ultimate goal of cowbird control is to realize an increase in target host species. If monitoring is not conducted, there is no basis for managers to determine if this objective has been met or to evaluate if cowbird control is an effective technique for attaining this goal.

Identifying the population to be protected

Managers should have a good understanding of general characteristics of the species of concern to determine its susceptibility to parasitism. Other information helpful in making management decisions includes the species' life history and current distribution and status. In addition to general knowledge about the species, detailed information about local populations—gathered during baseline evaluations—is essential in characterizing particular populations and predicting whether cowbird management is practical. Data pertaining to the species of concern that will help guide management decisions include numbers of individuals or pairs, population trends, parasitism rates, and nest success. This information will also help in deciding if protection should be provided for the species as a whole or just for certain populations.

Defining success criteria

When setting up a cowbird control program, the point at which control can be terminated should be determined before the effort is even begun. This involves establishing what conditions are expected to exist when the program goals are achieved. It also involves determining what criteria will be used to measure this success. For instance, goals might include a parasitism rate < *x* percent, fledging success > *y*, and/or a sustained increase in host populations for > *z* years. Fish and Wildlife Service (2002) recommends reviewing progress every 3 to 5 years to see if the program is effective and if goals have been met.

A permanent reduction in local numbers of cowbirds is likely not a realistic success criterion for a cowbird control program. All control programs to date (discussed above and below) have failed to reduce the number of cowbirds trapped per year after several years of control (e.g., trapping). Success criteria should focus on measures of the host(s) population and assume that cowbirds will always be a part of local avian communities. Along this line, it is also probably not realistic to aim for a complete elimination of parasitism, which may not be practical from a cost/benefit perspective. Managers might make the best use of funds by accepting a goal of < 5-percent parasitism since the cost of going from a parasitism rate of a few percent to 0 percent could be quite high (Rothstein, pers. comm. 2003).

Determining the level of control needed

Once the success standards of the program have been defined, then the method and intensity of control required to meet these objectives must be determined. Methods of control range from habitat improvement to cowbird removal, as described above. The intensity of the effort is defined by such factors as the size of the area that will be included, how long control will continue, or the location and number of traps to be used if trapping is selected as a method of control. Decisions about the level of control needed are based on local conditions and available resources. For example, location may influence the length of time a cowbird removal program must be carried out. When the traps are located within major migration routes, it is unlikely that trapping efforts will have significant effects on the overall cowbird population. This is demonstrated in many trapping programs where there is no decrease in the number of cowbirds trapped each year (DeCapita 2000, Griffith and Griffith 2000, Bureau of Reclamation 2001). In this situation, cowbird control may be required indefinitely, or at least until the target population is viable enough to sustain continual cowbird parasitism. If trapping is conducted in regions removed from major flyways, and there is not a constant influx of cowbirds into the area, trapping may impact the larger population. Another example of local conditions that may influence a control plan is in the case of a natural disturbance such as flooding or fire. Managers may choose to control cowbirds with the intent of enabling desirable species to breed successfully in the newly created environment. Trapping may continue while habitat conditions are developing and as rare species are moving in, though it may not be necessary to trap long term once the habitat and nesting species are established. Probably more than any other factor, the resources allocated to the project will dictate the level of control that can be realized. The security of future funding should be a consideration in choosing the type and extent of control.

Cowbird trapping may be relatively easy and effective, but managers should be flexible in employing alternative control methods and in designing plans suited to local areas. Managers might even consider leaving small populations and/or remote areas unprotected so those resources can be used toward other management actions (Hall and Rothstein 1999). Managers should also weigh the downside to cowbird control in neotropical migrant songbird management (e.g., cowbird control may be treated as a management option that replaces the need for other, possibly more effective, measures) against the benefits. Most control programs should include improving habitat conditions as one of the goals. Habitat restoration may not be a factor at sites where good habitat already exists or at sites that will eventually be lost to events such as reservoir drawdown, but in most cases it should be a consideration.

Trapping Protocol

If, after evaluating local conditions, a trapping program is selected as a management option, keep in mind that the goal of cowbird control is to benefit imperiled species, not to maximize the number of cowbirds killed (Fish and Wildlife Service 2002). It is important to follow good trapping protocol to keep impacts to species other than cowbirds at a minimum (e.g., adjust size of openings, visit daily so all non-targets are released quickly, experiment with placement of traps). When non-target bird species are in the trap, they are away from their nest, which can be more detrimental to the reproductive success of songbirds than parasitism. Being in captivity is also stressful for the birds. If large numbers of non-targets are captured, the control program should be reassessed to correct avoidable problems.

Timing

Griffith Wildlife Biology (1994) recommends activating traps at the start of the cowbird dispersal period (when cowbirds disperse from the winter flock into the host habitat) or 2 weeks before the first egg laying by the host. Traps are then deactivated when host nests are about 2 weeks past egg stage. Using this rule of thumb, managers can be assured that most of the cowbirds utilizing the area are captured, however these are not necessarily the cowbirds that pose a threat to the local populations of hosts. Most trapping programs find that the majority of cowbirds are caught in the first several weeks of the 2.5- to 4-month trapping periods (Rothstein and Cook 2000, Bureau of Reclamation 2001). These high numbers represent not only cowbirds that are establishing residency, but also those that are migrating through the area and therefore not all of these individuals are actually parasitizing the local host population. The number of cowbirds captured may again increase at the end of the breeding season when cowbirds are migrating to wintering grounds. Once a trapping program has been in place for a few years, data that have been collected during this time can be used to determine the resident period of cowbirds in the area (Figure 9). Bureau of Reclamation calculates the resident period as beginning when the weekly number of cowbirds captured drops by 50 percent and ending when the capture numbers again increase by 50 percent (Tisdale-Hein, pers. comm. 2002). Managers should consider limiting trapping to only this resident period to avoid capturing and euthanizing cowbirds that are not directly impacting local populations. An initial peak in numbers of cowbirds captured would still be expected since most residents are captured quickly, but by trapping during the resident period, managers can be confident that the majority of cowbirds captured in the traps will be the same birds that are parasitizing local hosts. Peak host nesting period can also be determined from local data and may be used as a factor in selecting the optimum time for trapping. If funds are scarce, once the trapping period has been identified using either host breeding season or cowbird resident period, managers might consider trapping only the first 2 to 4 weeks of this period when the most cowbirds will be captured.

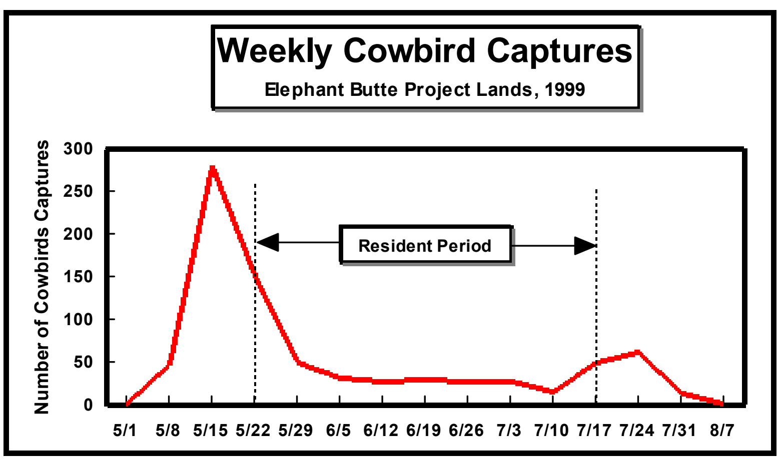

Figure 9. Weekly adult cowbird captures on the Middle Rio Grande River during the 1999 trapping season, with resident period identified. Source: Ahlers and Tisdale-Hein 2000.

Placement of traps

There are several opinions on optimum location for placing cowbird traps. The daily movement of cowbirds from riparian and woodland edge breeding areas to pastures or grassland feeding areas is an important factor in locating traps. Placement of traps between these areas can be effective (Robinson et al. 1993, Averill 1996). A common strategy for placing traps is to select sites where cowbirds are known to occur, namely within foraging areas (Robinson et al. 1993, Griffith Wildlife Biology 1994, Summers et al. 2000), often where livestock occur. More birds can be caught at feeding areas (Eckrich et al. 1999, Rothstein and Cook 2000), but these may not be the same birds that are parasitizing nests of the population of concern. Therefore, it may be most effective to locate traps in or adjacent to host breeding habitat because this removes those cowbirds that are parasitizing the target host species. Traps located in openings adjacent to the breeding areas are more effective than those in dense vegetation (Collins et al. 1989, Averill 1996) and also avoids drawing cowbirds into nesting areas due to singing decoys (White and Best 1999). Cowbirds travel up or down defined corridors, such as valleys and river canyons, or across saddles, so traps placed at entrances or in saddles may also be effective (Robinson et al. 1993, Griffith Wildlife Biology 1994).

As a control program progresses, managers should rely on past experience and place traps based on effectiveness of locations in previous years. Geographic Information Systems (GIS) can be a useful tool for placing traps in breeding areas by using map layers to identify optimum habitat for host target species. Figure 10 is an example of a GIS map along the Rio Grande where vegetation types were used to locate traps adjacent to host breeding areas and in natural openings. Another tool, the Individual Cowbird Behavior Model (ICBM), was designed to assist in identifying optimal locations for trap placement at Fort Hood, Texas, by simulating daily movement of the cowbirds (Trame et al. 1998).

Relocating traps at regular intervals (e.g., every 2 to 3 weeks) can be effective (Ahlers, Bureau of Reclamation, unpub. data). Capture records for individual traps indicate that numbers of captured females decline with time at any specific location (Ahlers and Tisdale 1999). When traps are moved to a new location, capture rates for females initially increase and then decline with the capture pattern mimicking the original site (Figure 11). At least on the Rio Grande, this capture pattern may be related to relatively small daily and seasonal home ranges of female cowbirds (Sechrist and Ahlers 2003). An individual trap likely services several female home ranges. Once the females occupying these home ranges are removed, these home ranges may not be reoccupied for some time during the remainder of the breeding season. Moving the trap exposes a new group of female cowbirds to potential capture whose home ranges overlap the new trap site. Local telemetry studies can aid in relocating traps by tracking daily movements of cowbirds in the area, and can provide an estimate of how far to move traps [generally about 0.4 to 0.8 km (0.25 to 0.5 mi)] to target other groups. Relocating traps should not occur if consistency in long-term capture data is more important than the number of cowbirds captured. Moving traps can complicate the management and interpretation of capture data from individual traps. If this is the case, managers may choose to saturate the area with traps to achieve the same effect, however, it will be more costly. Traps

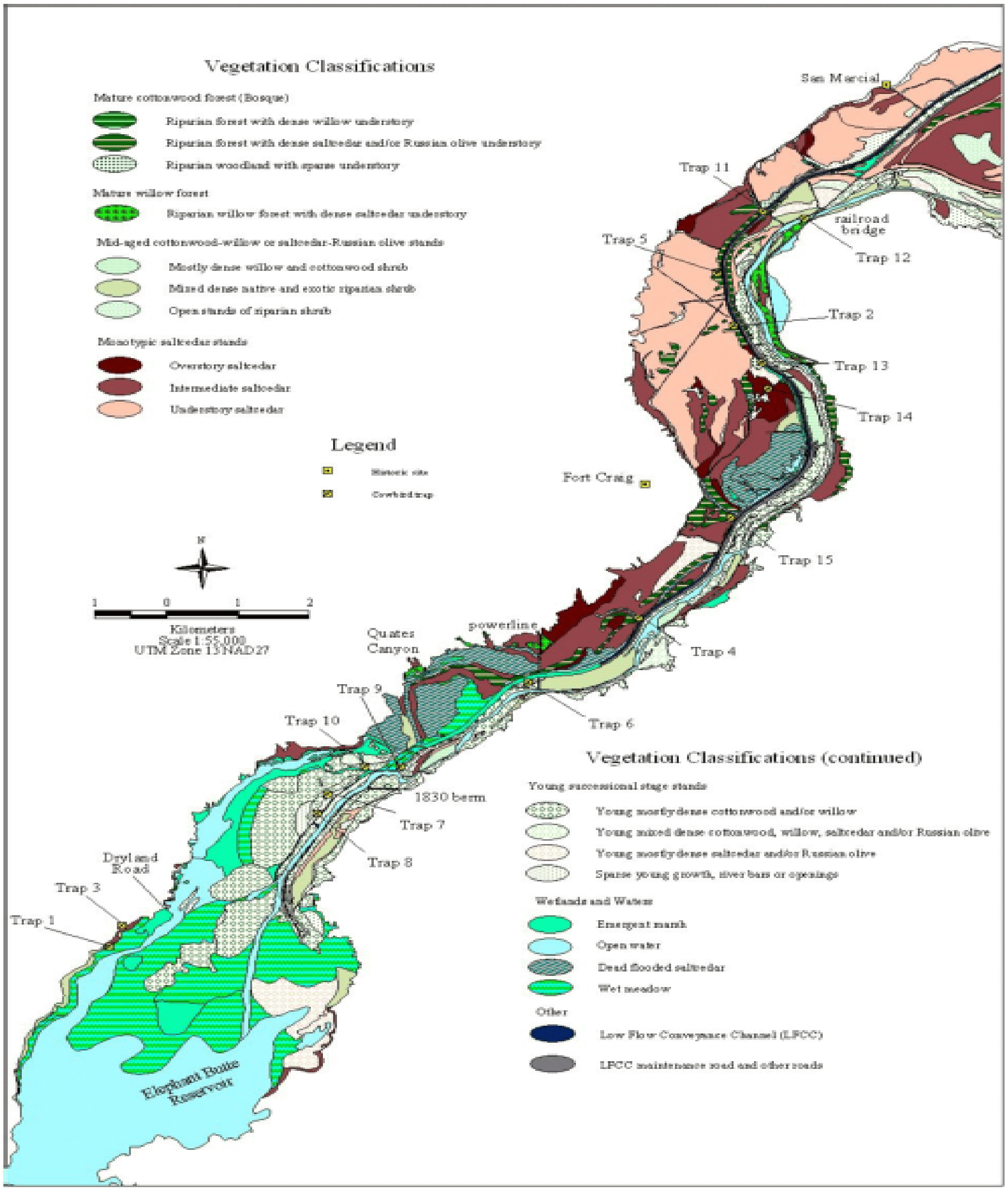

Figure 10. Vegetation classification map is used to locate cowbird traps along the Middle Rio Grande in 2000. Source: Bureau of Reclamation, Technical Service Center, Denver, Colorado.

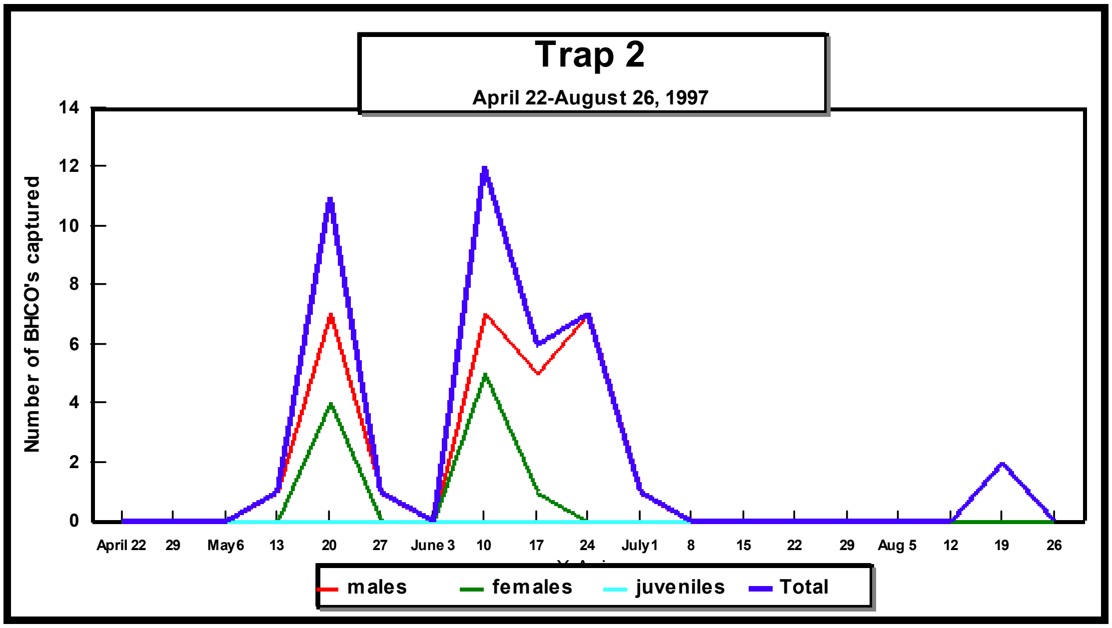

Figure 11. Weekly adult cowbird captures at one trap on the Middle Rio Grand River showing a spike in capture rates during the week of June 10, immediately following trap relocation. Source: Bureau of Reclamation, Technical Service Center, Denver, Colorado.

should only be relocated to sites where target hosts are at risk, keeping in mind that the goal is to protect host species, not maximize the number of cowbirds trapped.

Regardless of where traps end up on the landscape, the site they occupy should be in a clearing away from heavy brush. Traps should be placed on level ground to prevent gaps through which predators can enter and cowbirds escape. Placing a trap under perch sites, like tree limbs or powerlines, may make the trap more easily seen by roosting cowbirds. Trap locations should also be in areas that are easily accessible by vehicles.

Trap designs

There are a variety of trap designs, ranging from portable traps with dimensions of 2.4 by 1.2 by 1.2 m (8 by 4 by 4 ft; Figure 12) to much larger traps up to 5 by 5 by 2 m (16.4 by 16.4 by 6.6 ft) in size (Figure 13). A number of trap styles exists, as is demonstrated in Table 2, which shows the various traps that have been used in the Fort Hood cowbird trapping program. Plans for constructing a wood cowbird trap—based on the Australian crow trap design (see Figure 14)—are provided in Appendix B. Larger traps are highly effective for capturing cowbirds, although they are cumbersome and difficult to transport. Bureau of Reclamation found a portable design to be favorable since it is much easier to construct, disassemble, and transport. Photographs and dimensions of this trap design are included in Appendix C. Another option is to construct a mobile version on a trailer bed to ease in assembly and transport (Robinson et al. 1993). This version, however, requires more storage space and only one trap can be transported at a time.

Figure 12. Portable cowbird trap used on the Middle Rio Grande. Source: Bureau of Reclamation 2001.

Figure 13. Large cowbird trap used for the Kirtland's warbler recovery program. Source: Fish and Wildlife Endangered Species webpage.

Table 2. Number, dimensions, and construction of cowbird traps used on and adjacent to Fort Hood, Texas, from October 1999 to September 2000. Source: Summers et al. 2000.

Trap type	*n*	Trap dimensions l x w x h (m)	Slot dimensions l x w x *n* slots centimeter (cm)	Frame material	Mesh size (cm), shape
Australian crow	2	2.4 x 1.9 x 1.8	61.0 x 4.4 x 3	wood	2.5, hexagonal
Hybrid	12	2.4 x 1.9 x 2.2	92.0 x 3.1 x 2	wood	1.3, square
Hybrid - USDA	1	2.4 x 1.9 x 2.2	33.0 x 3.1 x 3	steel	1.3, square
JCMT	1	1.2 x 1.2 x 1.8	61.0 x 3.1 x 2	wood	2.5, hexagonal
Mega	10	5.0 x 5.0 x 2.4	96.0 x 3.5 x 2	wood	2.5, hexagonal 2.5, square
USFWS	11	2.4 x 1.9 x 1.8	53.0 x 3.1 x 2	wood	2.5, hexagonal

Figure 14. The design of this cowbird trap used on the Middle Rio Grande is based on the Australian crow trap. Source: Bureau of Reclamation 2001.

Cowbirds enter the traps through an opening generally located on the flat top or within a funnel-shaped top of the trap. This opening is a slot 2.9 cm (1-1/8 in) to 3.5 cm (1-2/5 in) in width. Anything larger usually leads to a higher number of cowbirds escaping and/or a higher number of non-targets captured. Cowbirds are attracted by other cowbirds and by bait in the trap and enter by folding their wings against their bodies and dropping into the traps. Escape is difficult because birds cannot fly through the openings. The size of the slot may need to be adjusted if high numbers of cowbirds are escaping or high numbers of non-targets are being captured.

Panels are constructed with 2- by 2-ft boards using bolts with butterfly nuts. Metal braces or PVC tubing can also be used which generally weather better over the long term (Robinson et al. 1993). Traps are enclosed using 1- by 1-in chicken wire, 0.5-in hardware cloth, or 1-in welded wire mesh. The welded wire mesh comes in heavy sheets and can be harder to work with than the other two materials, which come in lighter weight rolls. There are, however, benefits to the mesh (Tisdale-Hein, pers. comm. 2002). The square openings may convey a sense of unconfined space to the birds but are small enough that birds cannot escape and wide enough for birds to poke their head out without harming themselves. The hardware cloth can wound birds as they repeatedly thrust themselves against it in an attempt to escape. Only the beak fits through the openings and the face suffers injury. When buying materials, be aware that chicken wire sold as 1 by 1 in is sometimes actually 1 by 1-1/2 in, and cowbirds can escape through this larger size (Robinson et al. 1993). Shade must be provided or birds may become heat stressed. If surrounding vegetation does not provide adequate cover, shade is most easily created by covering one corner with an opaque material such as plywood on the sides and top of the trap. Green nylon mesh installed on the west facing side will also provide shade for captured birds (Griffith Wildlife Biology 1994).

When assembling the trap, provide perches for the decoys and non-target species. Do not place perches near the opening, as cowbirds could use them to escape. Floors are not built into the traps so that ground material provides a foraging area where bait is poured (Griffith Wildlife Biology 1994), although screening may be installed on the floor to protect birds and the trap from burrowing mammals (Rothstein, pers. comm. 2003). Traps should be labeled with a number for data collection purposes. It may also be useful to include a sign identifying ownership and purpose of the trap.

Daily servicing

Traps should be visited daily to supply fresh water and food and to release non-target species. Water is provided in a water guzzler. Fresh seed should be supplied inside the trap each day, leaving a small amount on the slot board to attract cowbirds. Cowbirds will be attracted to a variety of seed types; the challenge is to find a seed type that is attractive to cowbirds, yet not so attractive to non-target bird species. White millet was found to be preferable bait for the Rio Grande trapping program (Bureau of Reclamation 2001). The cowbird control program conducted at Fort Hood successfully used milo for bait seed to attract cowbirds (Summers et al. 2000). Do not use a mix that includes sunflower seeds because it will attract high numbers of non-target species (Griffith

Wildlife Biology 1994). Species other than cowbirds should be recorded and released immediately.

Some cowbirds will be left in the trap to act as decoys. Cowbirds are highly social (Rothstein et al. 1986) and are attracted to the live birds inside. At least one cowbird of each sex should remain in the trap since individuals of both sexes are attracted to vocalizations of the other sex (Rothstein et al. 1987). There are differing recommendations as to the number and gender ratio of decoys. The number of decoys used should be proportional to the size of the trap. The Fort Hood program uses 10 to 15 decoys and up to 50 in their largest trap (Summers et al. 2000). Anywhere from one to five male birds and three to five female birds are left in the portable sized traps on the Rio Grande control program (Bureau of Reclamation 2001). Robinson et al. (1993) recommend using at least two females with ratios favoring females. Griffith Wildlife Biology (1994) suggests a decoy ratio of 2:3 (m:f). When newly captured females are used as decoys, one wing should be clipped to deter escape. This entails cutting seven to eight primary feathers, just below the secondaries. On daily visits, any cowbirds in excess of the desired decoy number should be removed from the traps. Decoys that remain in the trap too long may change their behavior by showing anxiety, which may deter other cowbirds (Robinson et al. 1993). Based on this theory, managers should remain attentive to changes in behavior and replace decoys if circumstances warrant.

Other tasks involved in daily visits include inspecting the trap and repairing any damage or replacing perches, shade cloth, signs, etc. Data such as the species, sex, and number of birds captured are recorded in a daily log. Daily servicing generally ranges from 3 to 45 minutes a day per trap. For planning purposes, managers should allow an average of 45 minutes per trap per week, not including travel time (Griffith Wildlife Biology 1999).

Euthanasia

Some program managers suggest euthanizing only female cowbirds (Kennard 1978, Stutchbury, 1997, Summers et al. 2000), which makes sense from an ethical perspective. However, Ortega (1998) suggests that euthanizing only females would leave a more unbalanced sex ratio, and we do not yet adequately understand how this might affect the cowbird's mating system, territoriality, and fecundity. Until more information is available on the effects of removing only female cowbirds, managers must decide for themselves which approach is appropriate for their program.

The method that is chosen to euthanize cowbirds must be humane, fast, and certain. Euthanasia techniques should result in rapid unconsciousness followed by cardiac or respiratory arrest and ultimate loss of brain function (Andrews et al. 1993). There should be minimal stress and anxiety experienced by the animal prior to unconsciousness. Birds should be euthanized at the site of each trap rather than collecting a number of birds from different locations to be euthanized in a single session, even though this may be an easier approach. Euthanizing at each trap will avoid stressing cowbirds by confining them to a small space with a number of other birds while driving from site to site. Acceptable agents and methods of euthanasia for birds according to veterinary ethics (Andrews et al.

1993) are listed below. Some of these methods may not be practical in the field. Managers may want to consult local authorities for preferred methods of euthanization.

- *Inhalant anesthetics*

Inhalant agents that can be used to euthanize birds are, in order of preference, halothane, enflurane, isoflurane, methoxyflurane, and ether, with or without nitrous oxide (N_20).

- *Carbon monoxide (CO)*

Three methods for generating CO have been used in mass euthanasia: (1) chemical interaction of sodium formate and sulfuric acid, (2) exhaust fumes from idling gasoline internal combustion engines, and (3) commercially compressed CO in cylinders. The American Veterinary Medical Association's only recommended source is compressed CO in cylinders.

- *Carbon dioxide (CO_2)*

Dry ice can be used as a source of CO_2 (Texas Parks and Wildlife n.d.), though compressed CO_2 gas in cylinders is preferable to dry ice because the inflow to the chamber can be regulated. CO_2 generated by other methods is unacceptable.

- *Barbiturate*

Sodium pentobarbital is the most widely used barbiturate for euthanizing animals, although any that are potent, long acting, stable in solution, and inexpensive fit the criteria for use.

- *Nitrogen (N2) or Argon (Ar)*

Although these agents are effective, other methods are preferable because N_2 or Ar can be distressful to animals preceding unconsciousness.

- *Cervical dislocation*

Cervical dislocation is practical when there are only small numbers of cowbirds to be killed.

- *Decapitation*

Decapitation is generally used when chemically uncontaminated tissues and body fluids are needed for scientific research.

Cowbirds that are trapped and killed in a control program may serve a useful purpose in other scientific studies. For example, specimens might be a source of blood or tissue samples used in studies tracking West Nile virus or in reproductive research. Managers undertaking cowbird control should consider collaborating with other researchers who could use the specimens in their investigations.

Monitoring the Effectiveness of Trapping

Once a cowbird removal program is implemented, it is necessary to keep records to know if trapping has been successful. Otherwise, long-term effects are hard to judge. Managers should monitor changes in host and cowbird populations across time and space (DeGroot et al. 1999). Pre- and post-trapping data on rates of parasitism and number of breeding hosts will be compared to evaluate the effectiveness of the control program in achieving its goals and whether cowbird control is still necessary. Analysis of complete nesting data, including success and productivity, is also valuable but not as important. Because the consequences of parasitism are commonly understood, especially for listed species, if funds are limited evaluation should focus on parasitism rates and breeding host numbers (Rothstein, pers. comm. 2003). Use statistical comparison tests such as the Chi square test, the t-test for normally distributed data, or the Mann-Whitney test for data that are not normally distributed to evaluate trapped and untrapped areas (see Zar 1999). Fish and Wildlife Service (2002) recommends conducting a nest monitoring program for at least 3 to 5 years following a control program and at several intervals after that.

When evaluating the results of a control program, managers should consider variables outside of cowbird removal that may be affecting success or failure of the program. For example, habitat quality may influence changes in a host species' local population size during the monitoring period. If data collected indicate an effect from cowbird trapping, managers should consider whether there are factors other than control, i.e., habitat, that are contributing to a change in conditions. As discussed in the case studies above, Bureau of Reclamation (2001) found that the southwestern willow flycatcher population grew and parasitism rates remained the same after the trapping program on the Middle Rio Grande was discontinued. The primary flycatcher sites also had expanding, high quality riparian habitat. It was surmised that habitat, not cowbird trapping, was the largest factor contributing to an increasing willow flycatcher population. After cowbird control began, the Kirtland's warbler population did not increase for about 15 years and did so only after an expanse of suitable habitat opened up for the species. These examples illustrate the importance of weighing all factors while evaluating trapping data.

Number of cowbirds and non-target species trapped

Data from daily trap logs is used to determine the number of birds captured during the season. Calculate the number of cowbirds (by gender) and non-target species caught for each day the trap is operating.

These data can be used to test for a relationship between the number of female cowbirds removed from the population during the breeding season and the incidence of parasitism of nests (Eckrich et al. 1999, Summers et al. 2000). Data also provide information on the ratio of cowbirds to non-target species captured. Low ratios may indicate that trapping techniques need to be altered to decrease the number of non-target species trapped.

Point counts

Guidelines for conducting point counts are outlined in the baseline data section above. Compare results from post-control to those from pre-control to determine if there has been a significant change in the abundance and/or distribution of cowbirds and host species. If funds are limited, point counts need not be conducted. Although this method provides important information, the most valuable measure is if there has been a reduction in parasitism rates with a subsequent increase in host breeding numbers, which is measured through nest monitoring.

Nest monitoring

Guidelines for nest monitoring are outlined in the baseline data section above. Comparing pre- and post- trapping data tests the effectiveness of cowbird control on parasitism rates and nest success.

Effects of trapping on host species populations

Effects of cowbird removal on parasitism rates and fledgling success will be evident in a relatively quick time period, but it may take years to notice positive results, if any, on host populations. The ultimate measure of success in any cowbird control program is an increase in host breeding populations. Another important measure of success in the short term is stopping the decline of a rare species.

When evaluating your cowbird control program, always remember that if continued human intervention is responsible for the existence of a rare species, that species cannot be considered recovered (Rothstein and Cook 2000). Although cowbird control may be carried out for a number of years, it should be considered a stopgap measure (60 FR 10694). Therefore, there must be suitable habitat and land management practices that will sustain the species in the long term.

RECOMMENDATIONS

The process for evaluating and designing a cowbird control program is summarized below.

Pre-Control Evaluation

Gather baseline data

- Collect data for each population
- Include nest monitoring to determine the rate of cowbird parasitism and the reproductive success of the host species as a method of data collection; point counts may also be used to assess the size and distribution of local host and cowbird populations if funding permits
- Use baseline data for local populations of host species to measure the effectiveness of the program

- Compile at least 2 years of data before initiating cowbird control and include all populations with more than five nests
- Consult accounts of other cowbird control programs

Evaluate local conditions

- Use factors such as the host population's current size, its recent population trend, its parasitism rate, the extent of losses due to cowbird parasitism, and the amount of suitable habitat to estimate impacts
- Establish a parasitism threshold level for local population based on existing studies and more importantly on local conditions such as population trends
- Compare nest success of parasitized and unparasitized nests to estimate the effects on reproductive output

Examine the need for cowbird management

- Recognize that cowbirds are a native species and that nest parasitism is a natural phenomenon
- Evaluate whether a parasitized population is doing well even without cowbird management
- Consider that cowbird control might not be the best management option—increased host populations have occurred in only about half of the species it has been used to protect, and it can divert resources from other, potentially better, management actions
- Examine the reasons for declines in host populations and determine if parasitism is a major cause
- Implement control only when an association between cowbird parasitism and host productivity has been determined
- Evaluate if populations are decreasing to dangerous levels, which may justify cowbird management
- Ascertain that funding will be available in the long term
- Include monitoring in the cost of control
- Decide if cowbird control will be used as a management tool

Define objectives of a successful cowbird control program

- Identify and characterize the target population
- Establish goals of a successfully achieved program
- Determine what criteria will be used to measure this success
- Decide the method and intensity of control that will be required to meet objectives
- Base decisions on local conditions and available resources
- Be flexible in employing alternative control methods and in designing plans suited to local areas
- Include improving habitat conditions as one of the goals

Trapping Protocol

Timing

- Begin program by activating traps about 2 weeks before the first egg laying by the host and deactivating when host nests are about 2 weeks past egg stage to ensure capture of most cowbirds utilizing the area
- Calculate the cowbirds' resident period and peak host nesting period in the area when enough data has been collected
- Adjust timing of trapping to include only the resident period to avoid capturing cowbirds that are not directly impacting local populations
- Consider trapping only the first 2 to 4 weeks of the trapping period when the most cowbirds will be captured if funds are scarce, identifying trapping dates using either host breeding season or cowbird resident period

Placement

- Locate effective sites for traps: between feeding and breeding areas, adjacent to host breeding areas, in saddles, and along defined corridors such as valleys, canyons, streams, abandoned roads or berms, but consider trapping at foraging sites if it is most effective for your local situation
- Use tools such as GIS or radio telemetry to help place traps on the landscape
- Relocate traps often to increase capture rates unless monitoring design dictates consistency and only if some target hosts remain unprotected
- Place traps in clearings away from heavy brush, on level ground to avoid gaps, and under perch sites, like tree limbs or powerlines, to make the trap more easily seen by roosting cowbirds
- Locate in areas that are easily accessible by vehicles

Designs

- Research trap designs used in other programs to determine which one will best fit your needs—a variety of trap styles and sizes exist
- Refer to plans for the Australian crow trap design provided in Appendix B and plans for a portable trap design provided in Appendix C
- Construct traps—most often built with a wood or metal frame enclosed with wire mesh
- Provide entrance for cowbirds to the trap through a slot 2.9 cm (1-1/8 in) to 3.5 cm (1-2/5 in) in width
- Adjust the slot as needed to keep cowbirds from escaping and non-target species from entering the traps
- Provide perches within the trap that are not near the opening
- Provide shade
- Leave native ground material for the trap floor to serve as a foraging area where bait is poured or install screening on the floor to provide protection from burrowing mammals

- Label traps for data collection purposes

Daily servicing

- Visit traps daily to supply fresh water and food and to release non-target species
- Select bait seed; white millet will probably be the best choice; don't use bird feed that includes sunflower seeds because it will attract non-target species
- Leave some male and female cowbirds in the traps to act as decoys to attract other cowbirds
- Inspect traps and repair any damage
- Record data including the species, sex, and number of birds captured

Euthanasia

- Choose method to euthanize cowbirds; must be humane, fast and certain
- Use agents and methods of euthanasia acceptable for birds according to veterinary ethics: certain inhalant agents, carbon monoxide, carbon dioxide, barbiturate, nitrogen or argon, cervical dislocation, and decapitation
- Consider collaborating with other researchers and providing cowbird specimens for scientific studies

Monitoring the Effectiveness of Trapping

Collect post-trapping data

- Compile trapping records to determine the number of birds captured during the season
- Use nest monitoring methods to gather data on parasitism rates, nest success and host breeding numbers
- Conduct point counts to gather information on cowbird and host abundance and distribution if funding permits

Data analysis

- Use statistical analysis to compare pre- and post- trapping data to evaluate the effectiveness of the control program and whether cowbird control is still necessary
- Determine if goals have been met, i.e., if there has been a reduction in parasitism rates and/or an increase in host breeding numbers
- Decide if trapping is an effective method for meeting objectives and if the program should continue
- Remember the ultimate measure of success in any cowbird control effort is a sustainable increase in host breeding populations

CONCLUSION

Cowbird control programs, especially trapping programs, can be effective short-term management activities to address site-specific issues. When considering a cowbird control program, it is important to recognize that cowbirds and their hosts have been components of natural systems long before European development of North America began. Many of the issues surrounding cowbirds and their hosts are the result of human activities. Cowbird control programs should address these issues as much as is feasible. If control programs are initiated, they should be well planned, have a measurable goal, and be terminated when predetermined goals are attained.

This manual includes trapping techniques that have been effective in our own control programs. We are not currently trapping cowbirds, but continue to collect cowbird abundance data, host abundance and parasitism rates, and host nest success and productivity data. We found that our trapping efforts may have reduced the rate of parasitism on host species' nests, but did not increase productivity. In addition, the population of southwestern willow flycatchers has expanded from a few nests to almost 100 nests during the 9 years we have been involved with flycatchers and cowbirds. Potential flycatcher nesting habitat has also expanded dramatically during the years since we began trapping cowbirds. Some or all of these events may or may not be related.

We will continue to monitor the avian communities on study sites along the Rio Grande. If, at some future time, data indicate that cowbird control is warranted, we will resume trapping with a goal of increasing host nests' productivity. Based on past experience, if we were to reinstate a cowbird trapping program our approach would include:

- trapping only during the cowbirds' resident period
- using small, portable traps exclusively
- relocating traps often to ensure that all targeted hosts are protected from parasitism
- euthanizing only female cowbirds

Not every manager will agree that the techniques we recommend are best nor will every technique be appropriate for all locations or situations. Be flexible in developing a program that is specific to conditions in your area.

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APPENDIX A

Nest monitoring data forms

NID:	Nest ID:	Species:	Plot:

Station:	Dir. Stn.>Nst.: o	Dist. Stn.>Nst.: m	Owner:	Order:

Obs.:	Attempt:	Year:		Obs.:		Date:	Sex:
Location Description:				TL:	BL:	TR:	BR:
				Notes:			
				Obs.:		Date:	Sex:
				TL:	BL:	TR:	BR:
				Notes:			

			Srch. Meth.	Time (min)	# Parent visits	Search rad (m)	Nest Fate	Su re	Pr ob
Substr 1:	Nst. Ht.(m):	# Srch. tries:							
Substr. 2:	Substr. Ht (m):						Success /Fail		
Conceal 1:	Dist. from stem (cm):						# Fledged		
Conceal 2:	Dist. from fol. edge (cm):						Predated ?		
	Orient: o						Deserted ?		
Fail Cause: human weather cowbird predation other:							# CB Fledged		

NID:				Nest ID:				Species:								Plot:
Mo.	Day	Time	Min @ Nest	Obs-erver	Stage	Nest cont. seen	# Egg	# Yng.	Elu sive	Adult Loc.	Adult activity	Min age yng.	Max Age yng.	# CB egg	# CB Yng.	COMMENTS

Figure A-1. Data forms used for the BBIRD nest monitoring method. Source: Martin et al. 1997.

Willow Flycatcher Nest Record Form (2002)

AGFD site no.:______ Site name:_________(See maps in report for nest locations) Nest no.:____

IMS Nest no.:

1) How was nest located:_________ (Location codes: **PB**= parent behavior, **F**= flush, **NBC**= non-behavior cue, **SS**= systematic search, **L**= luck, **PY**= from previous yrs nest, **YB**= young behavior, **O**= other)

2) Nest Height:____________m 3) Nest Substrate:____________(eg. TASP=tamarisk, SAGO=Gooding willow, POFR=cottonwood, SAEX=Coyote willow)

Bird 1: Color band combination:__________N/A__________ Band Number:__________Female
Bird 2: Color band combination:__________N/A__________ Band Number:__________Male

Willow Flycatcher

Trans dates	BD	(T/F)
		Found
		First egg
		Clutch completion
		Hatching
		Fledged or Failed

Willow Flycatcher

No.	Complete? (T/F)	
		Eggs
		Nestlings
		Fledglings (Presumed)
		Fledglings (Confirmed)

Cowbird

Trans dates	BD	(T/F)
		First egg
		Hatching
		Fledged

Cowbird

No.	Complete? (T/F)	
		Eggs
		Nestlings
		Fledglings

Outcome (Record code & describe):__:____

Outcome codes: **UN**= unknown; **FY**= fledged young, with at least one young seen leaving or in the vicinity of nest; **FP**= fledged young, as determined by parents behaving as if dependent fledgling(s) nearby; **FU**= suspected fledging of at least one young; **FC**= fledged at least one host young with cowbird parasitism; **FD**= Nest depredated, the confirmed fledging of at least one young; **PO**= predation observed; **PE**= probable predation, nest empty and intact. Fledging of young unlikely; **PD**= predation, damage to nest structure; **PC**= probable predation by cowbird; **AB**= nest abandoned prior to egg(s) being laid; **DE**= deserted with egg(s) or young; **AC**= nest abandoned due to cowbird, cowbird egg(s) found in nest that was absent on previous nest check; **CO**= failure due to cowbird, host attempted to raise cowbird young. No host young were fledged from the nest; **WE**= failure due to weather; **HA**= failure due to human activities; **IN**= failure, entire clutch infertile; **OT**= other.

Mayfield Success

(WIFL) Period	# Exposure days	Success
Egg Laying		
Incubation		
Nestling		

Mayfield success codes: **S**= successful; **D**= depredated; **U**= status unknown/nest occupied- fate unknown; **M**= mortality other that predation; **A**= abandoned with host egg(s) or young; **Z**= abandoned, no (zero) eggs laid.

WIFL Nest Monitoring Log

Date	Time	Obs	Mon Type	Stage	Adult pres.	# WF Egg	# CB Egg	# WF Nstl	# CB Nstl	#WF Fldg	Age Yng	Comments

Figure A-2. Willow flycatcher nest record form. Source: Arizona Game and Fish Department 2002.

WILLOW FLYCATCHER NEST SITE DATA FORM

(Do not approach an active nest or nest tree without obtaining appropriate state and federal permits)

AGFD site number:_____________ Site name:____________________ Nest #:____________

Biologist(s) name:____ Phone:____________

Nest substrate spp:____

Tree Health:________ (Codes: **L**= live, **PD-NL**= partly dead, nest in live portion, **PD-ND**= partly dead, nest in dead portion, **D**= dead)

Substrate Ht (m):____

Nest Ht (m):____

Canopy Ht (m):____

Distance to foliage edge (m):____

Distance to water when the nest was first found:____m, when the nest was last active:____m

Water type:____

DBH:___________________________Circle one: cm in

Number support branches:____

UTM coordinates or file name (if available):____

Comments:____

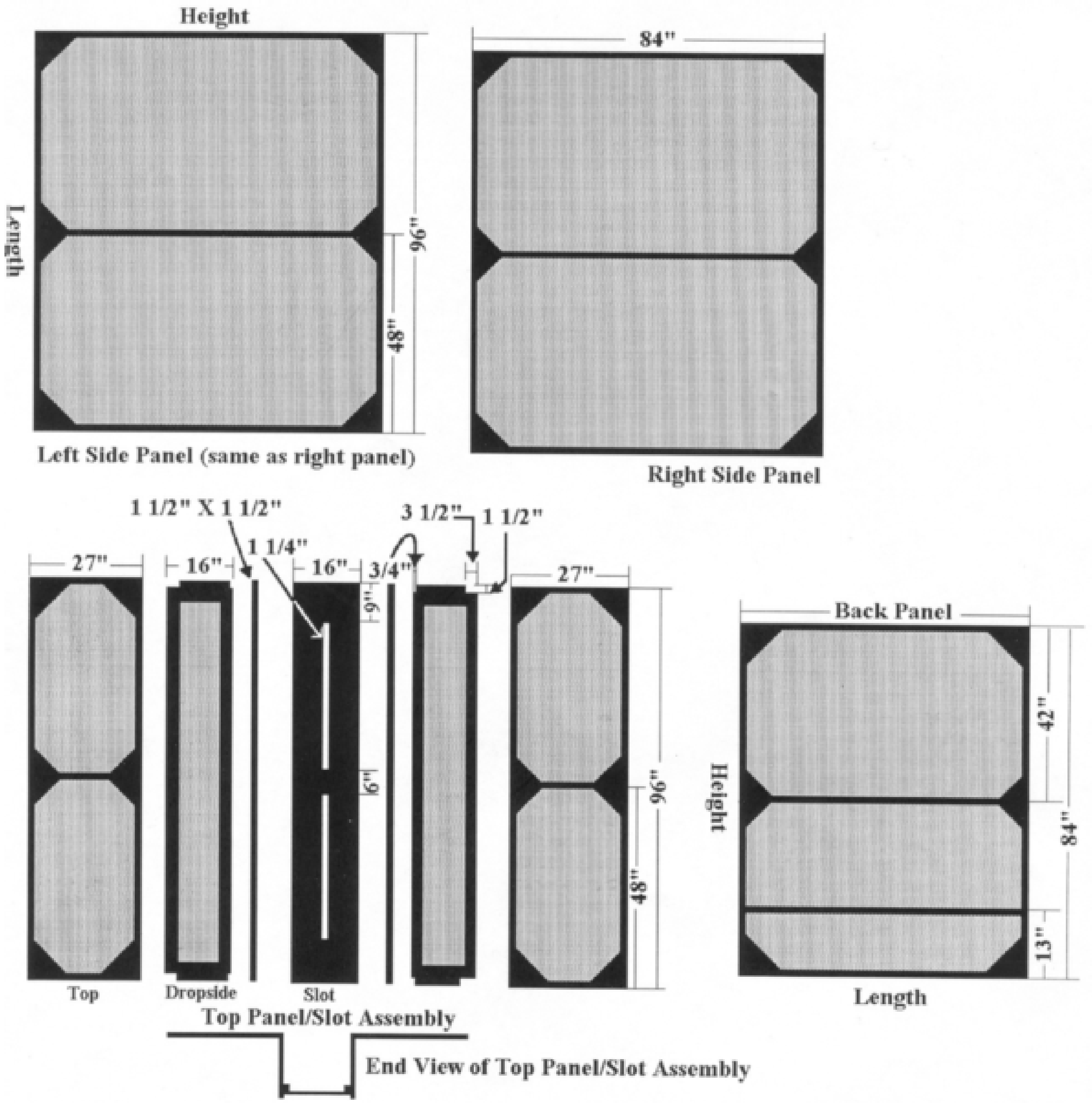
Figure A-3. Willow flycatcher nest site data form. Source: Arizona Game and Fish Department 2002.

APPENDIX B

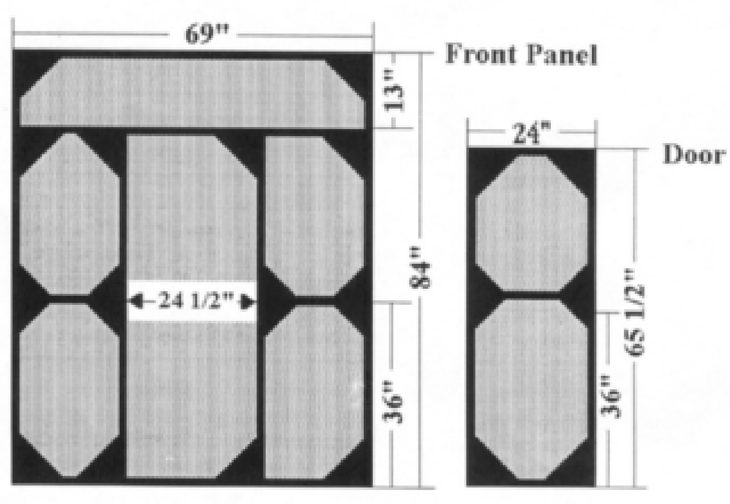
Texas Parks and Wildlife
Cowbird trap design

Materials list for 6x8 wood cowbird trap

Number	Description	Comments
16	2x4x8 (treated)	Rip 2x4 into 2x2
2	Sheets ½" CDX plywood	1 sheet is for slot assembly, 1 sheet is to cut up for gussets
64 linear ft.	½" mesh hailscreen	Bought in 100 ft. rolls
1 pair	Tight pin hinges (3")	Door hinges
1	Screen door handle	Outside of door
1	Galvanized hasp (4 ½")	Use with padlock for security
1	Screen door latch	Used on inside of door
14	10"x12" shelf brackets	Used to square panels (2 per panel)
125 (approx.)	1" drywall screws	Field assembly of slot assembly, attaching shelf brackets to panels
50 (approx.)	3" galvanized deck screws	Field assembly (panel to panel)
300 (approx.)	1 ½" pneumatic staples	Used to attach gussets
600 (approx.)	1" pneumatic staples	Used to attach screen to panels
300 (approx.)	½" staples	Used to attach screen to slot assembly



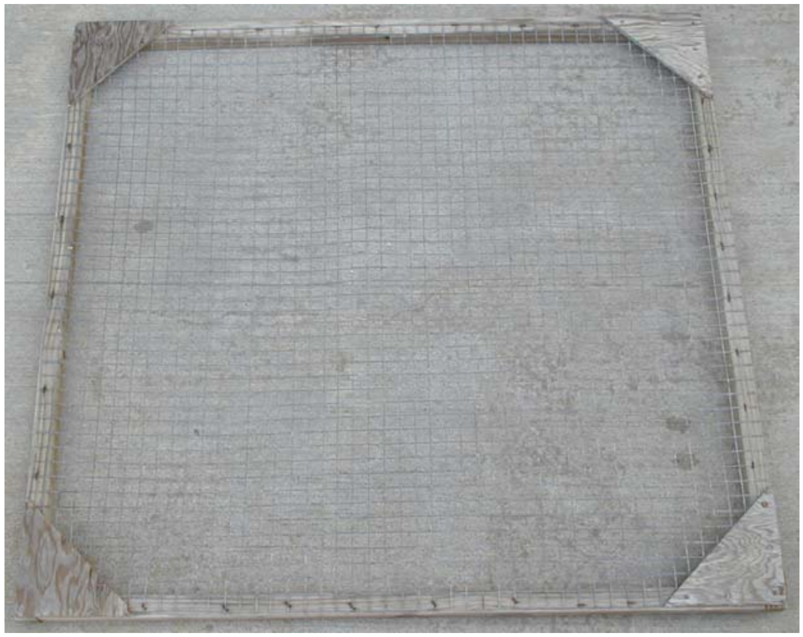
Cowbird Trap Plans



APPENDIX C

Bureau of Reclamation
Portable cowbird trap design

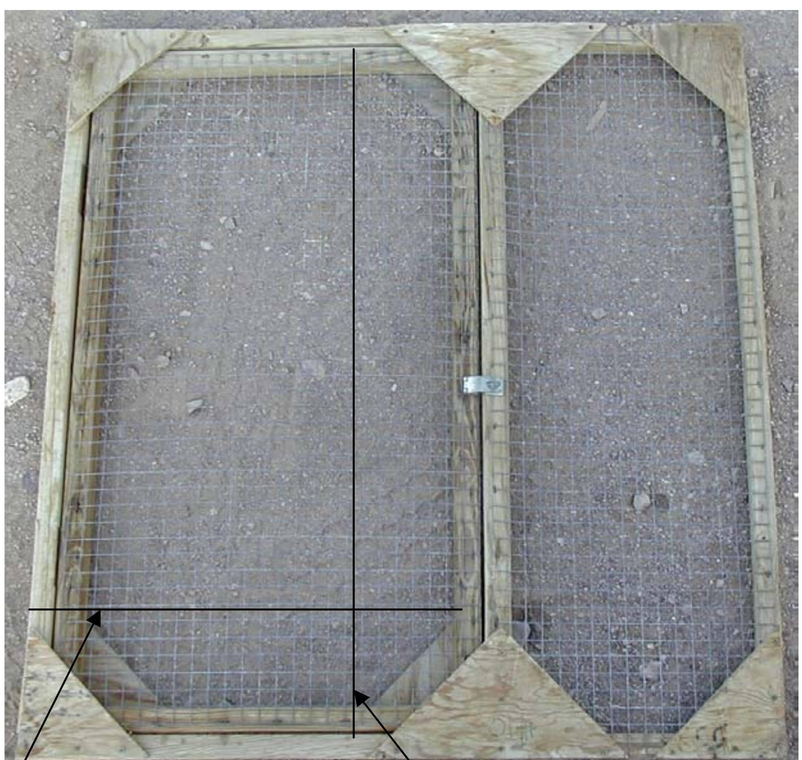
Back panel



4’

3’ 9-3/8”

Front panel with door



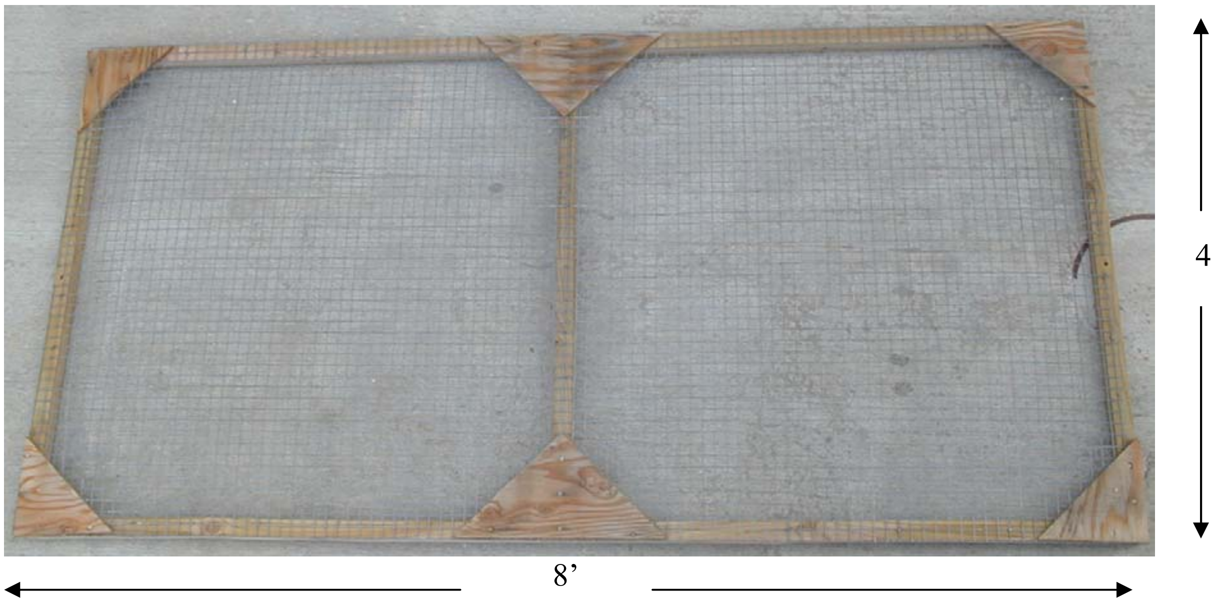
4’

Door width = 1’ 11-5/8”

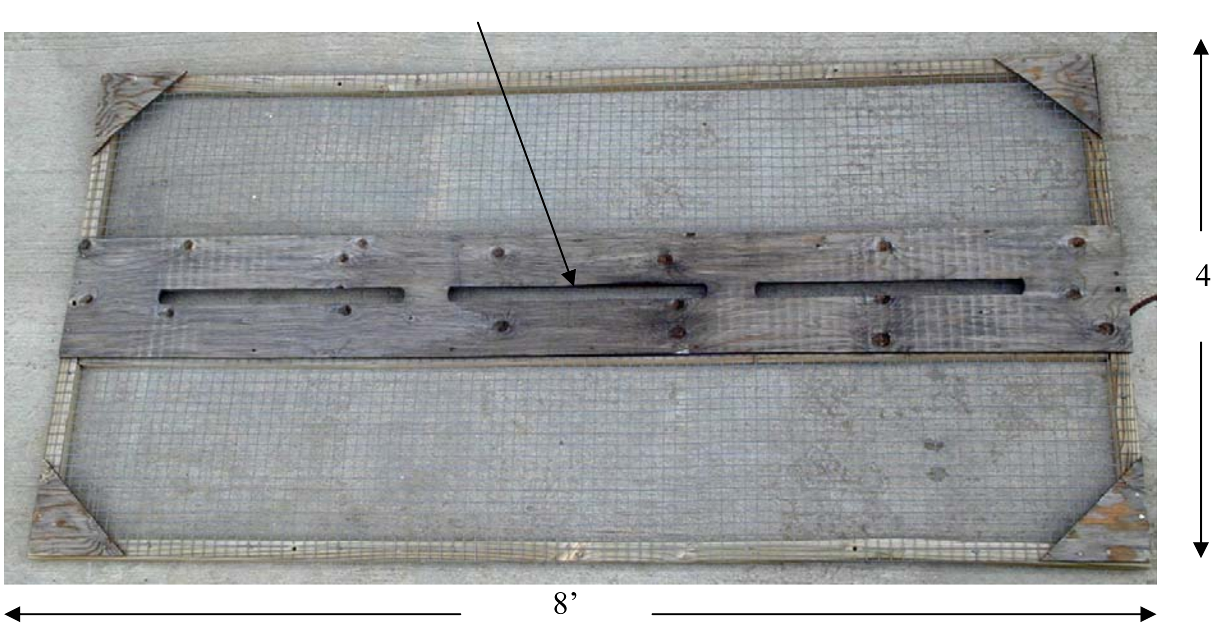
Door height = 3’ 8-½”

3’ 9-1/8”

Side panel (x2)



Top panel



Materials list for 4’x4’x8’ bottomless cowbird trap

Quantity	Description	Comments
1	4’x4’x8’ sheet 1/2” CDX plywood	Ripped to 18” for slotted top Cut three slots 1 3/8” x 24” Cut triangular corner braces to hold panels square
14	2”x2”x8’ treated (can be ripped from 2”x4”x8’)	Cut to appropriate size for side, top, front, back, and door
32 linear ft	4’ welded 1”x1” steel wire	Purchased in 100’ rolls; cut to size
1 pair	Pin hinge	Door hinge
1	Galvanized hasp	Used to secure door closed
250 (approx.)	Small 5/8” wire staples	Used to secure slotted top and corner braces to frame
125 (approx.)	1 1/4" deck screws	Used to secure slotted top and corner braces to frame
10	5/16” x 4 ½” carriage bolts and wingnuts	Used to connect sides, top, front, and back panels to complete trap