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ABSTRACT: In recent years, wildlife agencies in California have concluded that predators are limiting factors to the recovery of several endangered species, namely the San Joaquin kit fox (Vulpes macrotis mutica), California least tern (Sterna antillarum browni). and desert tortoise (Xerobates agassizii). As a result, separate control programs for the protection of these species have been undertaken by U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Animal Damage Control (ADC) in cooperation with State and Federal agencies. Aspects of control activities of avian and/or mammalian predators of each project are discussed.

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INTRODUCTION

Predator control is most often applied to protect agriculture, property, or human health and safety. However, it is occasionally employed to benefit sensitive, threatened, or endangered species (Shake and Mattsson 1975, Paulin 1986). Recently, wildlife agencies have concluded that predation is one of the limiting factors to the recovery of several endangered species and that reducing predation is necessary and proper. Consequently, ADC entered into active predator control programs for the protection of endangered species. This presentation will review the efforts as they relate to the San Joaquin kit fox, California least tern and desert tortoise.

SAN JOAQUIN KIT FOX

Introduction

The San Joaquin kit fox is native to the sparsely vegetated region of the southern San Joaquin Valley, much of which has been converted to agricultural use. A large block of essential habitat containing a significant population of San Joaquin kit fox remains at the Elk Hills Naval Petroleum Reserve in western Kern County. This 150-square mile oilfield is managed by the U.S. Department of Energy (DOE) and consists of two parts: NPR #l-a 70-square mile unit that is entirely fenced and supervised by DOE, and NPR #2-a 80-square mile unit that has uncontrolled boundaries and is primarily leased to private oil companies. As a result of a comprehensive San Joaquin kit fox enhancement and protection program sponsored by DOE, research revealed that many radio-collared fox were being killed by coyotes (Canis latrans). Of the 155 San Joaquin kit fox for which a cause of death could be determined, 119 (77%) were killed by coyotes (Berry et al. 1987). Scent-station surveys also revealed a significant decrease in trappable San Joaquin kit fox and an concomitant increase in coyotes on NPR #1 (Harris 1986).

Methods

In response to this, in 1985 DOE entered into a cooperative agreement with ADC to control coyotes on NPR #1, which DOE funded entirely at a cost of $5,000. Control activities were scheduled for April through June to coincide with the San Joaquin kit fox whelping season, when foxes are particularly vulnerable. Coyote control efforts included trapping, shooting, and denning by an ADC employee already placed in Kern County. This action received a favorable opinion in a Section 7 Consultation by the Fish and Wildlife Service Endangered Species Office.

This seasonal approach was repeated in this general manner in 1986, 1987, and 1988 on NPR #1. In late 1988, it was decided that this limited seasonal approach was not providing sufficient San Joaquin kit fox protection, and an expanded program of coyote control was initiated. The expanded program now included NPR #2 plus a buffer zone around NPR #1 and 2. Aerial gunning was now added as a technique and a full-time ADC position was created to conduct this expanded control effort.

Results

Table 1 summarizes the coyote control program conducted for the San Joaquin kit fox.

Table 1. Summary of coyote control for the protection of the San Joaquin kit fox at the Elk Hills Naval Petroleum Reserve, 1985-89.

Year	Cost	Areas of Work	Methods[a]	Coyotes Removed
FY85	$ 5,000	NPR #1	T,S,D	40
FY86	5,000	NPR #1	T,S,D	64
FY87	5,000	NPR #1	T,S,D	16
FY88	10,000	NPR #1	T,S,D	67
FY89	70,000	NPR #1,2 & buffer	T,S,D,AG	289

[a]T=trapping, S=shooting, D=denning, AG=aerial gunning

Although research is not conclusive, there are some indications that the coyote control is having some benefit. It appears that the San Joaquin kit fox population is stabilizing. Coyote populations on NPR #1 are declining, although the interpretation of this decline is confounded by a declining lagomorph population (Scrivner and Harris 1986).

Discussion

This project presented several problems that needed to be solved in order to be a success. First, trapping had to completely exclude foxes. Although the Section 7 Consultation provides for incidental take of San Joaquin kit fox, this would be counter-productive. It was determined that San Joaquin kit fox could be excluded from steel 3N Victor steel traps with reliable tension devices. Two tension devices were initially used in tandem-the underpan Stanley tape and a notched pan-and-dog-and set at 4 to 5 pounds' trip weight. Eventually, the standard 3N Victor tension device available from the Pocatello Supply Depot was adopted. The trip weight was regularly checked in the field to guarantee consistency. This system, along with selective placement of traps, was completely successful in excluding San Joaquin kit fox. In the 5 years of this project, in over 4,000 trap nights, no San Joaquin kit fox has been trapped despite many visits.

Secondly, there were some potential public relations problems to consider because NPR #1 and 2 are exposed to a considerable number of people. Prior to the onset of control activities in 1985, DOE announced the program via press release. Only the slightest response was received. In the actual performance of trapping, public notice and interference have been largely avoided with the selective and discreet use of traps and by checking traps early every morning.

CALIFORNIA LEAST TERN

Introduction

The California least tern is a seasonal resident of California, especially southern California, where it traditionally nests in colonies on the coastal dunes and beaches. While much of its preferred nesting habitat has been lost to development, about 30 colonies remain, most of which are controlled by public agencies. The colonies that remain consist of relatively few individuals, which deprive a colony of its defense mechanism-mobbing. Thus avian and mammalian predation has been recognized by observers as a severely limiting factor to the terns' recovery (Burr 1988, Massey 1988, U.S. Fish and Wildlife 1988). Early tern protection included fencing and occasional trapping and proved ineffective (Larry Salata, Naval Air Station North Island, pers. comm.; Mike Silbernagel U.S. Fish and Wildlife Service, pers. comm.).

Methods

Then in 1988, the U.S. Navy, the U.S. Marine Corps, and the U.S. Fish and Wildlife Service entered into separate cooperative agreements with ADC to provide control of avian and mammalian predators at eight different colony sites. Four sites were located in San Diego County, three in Orange County and one in Alameda County. Control efforts were timed to precede and coincide with tern nesting activities, i.e., April through August. In 1989, a colony in Los Angeles County was added as well as another site in San Diego County. All work was funded entirely by the respective requesting agency.

Because the tern colonies and their attendant predator problems differ so much, predator control methods at each site varied accordingly. At some sites, control efforts were directed towards a single predator. At other sites, a broadly focused program was required. A summary of activities for the protection of California least tern is provided in Table 2.

Table 2. Summary of predator control projects for the protection of California least tern by USDA-APHIS-ADC, 1988-1989.

Tern site, (county[a])	Year	Significant[b] depredating species	Methods[c]
Alameda NAS, (AL)	89	HC	CT
Terminal Island,(LA)	89	CR	1339
Seal Beach NWR,(OR)	88-9	RF	ST
Bolsa Chica,(OR)	88-9	RF	ST
Huntington Beach,(OR)	88	RF	ST
Santa Margarita,(SD)	88-9	C,K,S,RV,GS H,CR,R	ST,SH,RT,GC 1339,CT,CB
North Island NAS,(SD)	88-9	HC,K,S,RV RD,BO	CT,SH,1339, RT
Naval Training Ctr., (SD)	88-9	HC,K,S,RV	CT,SH,RT,ST
Naval Amphibious Base, (SD)	88-9	HC,K,S,GS RV,SK	CT,SH,RT
Lindberg Field (SD)	89	HC,K,S	CT,RT

[a]Counties: AL=Alameda; LA=Los Angeles; OR=Orange; SD=San Diego

[b]Predators: HC=house cat (Felis catus); CR=crow (Corvus brachyrhynchos): RF=red fox, non-native (Vulpes); C=coyote (Canis latrans); K=kestrel (Falco sparverius); S=loggerhead shrike (Lanius ludovicianus); RV=raven (Corvus corax); GS=ground squirrel (Spermophilus beechyii); H=harrier (Cirvus cyaneus); RD=rock dove (Columba livia); BO=burrowing owl (Speotvto cunicularia); R=raccoon (Procvon lotor); SK=striped skunk (Mephitis)

[c]Methods: CT=cage trap; 1339=DRC-1339; ST=steel trap; SH=shooting; RT=raptor trap; GC=gas cartridges; CB=conibear trap

Results

Since the initiation of predator control by ADC for the protection of the California least tern, tern reproduction in those sites has generally improved. However, it is not true for every colony nor is it clear how much of that credit is due to predator control. Some sites with predator control have had little or no reproduction, while unprotected sites have had significant reproduction. Analysis is complicated by increased efforts to exclude the public and predators and the unpredictable nature of terns as they select a colony. However, there is general agreement among tern biologists and observers that predator control as conducted by ADC is having some positive contributions to recent tern nesting success (Carlson 1988, Massey 1988).

Discussion

There were several problems presented by these projects that needed to be solved in order to provide effective control. The first concern was an internal one of staffing. In the first year of the project, it was decided to use existing, experienced ADC personnel instead of hiring new employees due to the seasonal nature and extreme sensitivity of these projects. Because in most cases there were no experienced ADC personnel available near these projects, personnel from elsewhere was used. This increased travel and per diem costs considerably, not to mention personal sacrifices made by the employees. In 1989 the project was developed in San Diego County to provide for two full-time ADC employees assigned to California least tern protection.

The second challenge involved developing a more effective response to predation by raptors, particularly kestrels and shrikes. Because shooting is not possible at several of the colonies, effective trapping was necessary. Raptor traps such as Balchatri, Channing, and noose harnesses were used with some success but many individual raptors are not drawn to these traps. Therefore, efforts were made to develop alternatives and an adaptation of a pole trap was made and found to be quite effective. It involved affixing a small (1-in.) elevated perch to the pan of a #0 Victor single long-spring trap. The trap was mounted on a 5-foot section of 5/8-inch aluminum conduit with a wire for the trap to slide to the ground when it was sprung. The pole assembly was built to be easily portable.

The projects have evolved as unusual predatory observations are made. Ants (Formicidae sp.), when in sufficient numbers, are known to be predators of California least tern nestlings; therefore control efforts include ant control on two San Diego sites. Rock doves were strongly implicated in tern egg destruction on one site in 1988. Likewise, great blue herons (Andea herodias) were observed in one tern colony apparently chasing tern chicks and thus were considered target animals at that site. A harrier was shot while inside a colony, and upon examination revealed that it had consumed three California least tern embryos from the eggs. And, in probably the most complicating development, peregrine falcons (Falco peregrines)–an endangered species themselves-were observed frequenting the area of several tern colonies and are suspected of preying on adult California least tern in 1989. No peregrines were removed but their presence caused some disruption of other raptor control efforts. Contingency plans are being developed by an interagency team to respond to predation of California least tern by peregrines.

Finally, predator control for California least tern has not proceeded without litigation. A local animal rights group sued the U.S. Government to halt the removal of a non-native red fox from a site in Orange County. The suit challenges the Environmental Assessment written by the U.S. Fish and Wildlife Service and is as yet unresolved. The predator control efforts are not enjoined while the suit moves to conclusion.

DESERT TORTOISE

Introduction

Populations of the desert tortoise in California have declined precipitously in recent years. Contributing to this has been habitat loss, disease, vandalism and predation by an increasing population of ravens. Ravens have increased as much as 15-fold in the last 20 years as the result of increased human influence in the desert. Ravens prey upon juvenile tortoises, i.e., up to age 7 years–by penetrating the shell or by decapitation. There are numerous reports that some ravens have fed extensively on tortoises, e.g., up to 200 tortoise shells have been discovered at several raven roosts or nest sites. Predation by ravens is so severe that some age classes of tortoises have practically disappeared in certain areas (Bureau of Land Management et al. 1989).

Methods

As a result, in 1989 the Bureau of Land Management entered into a cooperative agreement with ADC to conduct a pilot program of raven control. The purpose of the program was to reduce raven populations by the use of poison 3-chloro-p-toluidine hydrochloride (DRC-1339) and shooting in selected areas where raven predation on tortoises was considered severe. Additionally, the methodology to safely and effectively deliver the toxicant DRC-1339 to ravens on a large scale was to be developed and tested. Use of DRC-1339 was authorized by 24c registration SLN #CA890013. Two areas were designated as control sites: the Desert Tortoise Natural Area (DTNA) near Mojave, and the Marine Corps Air Ground Combat Center (MCAGCC) near Twenty-Nine Palms.

One milliliter of 10% solution of DRC-1339 was injected into hard-boiled chicken eggs. The baited eggs were presented on elevated (4 ft x 6 ft) platforms (16 in x 16 in) after ravens had accepted untreated hard-boiled chicken eggs. A maximum of two eggs was placed at each platform. The baited eggs were placed with varying degrees of monitoring and in some cases the eggs were removed at night.

Results

Acceptance of prebaited eggs at the platforms was almost immediate and complete in May 1989. Likewise was the acceptance of baited eggs. No nontarget animals were observed at the platforms at any time. No ravens were observed removing eggs from the platforms nor were egg fragments found beneath the platforms.

At MCAGCC landfill, 75 baited eggs were consumed in 6 days. Extensive searches in the vicinity of the landfill yielded 78 dead ravens, particularly at water sources. Although no necropsies of the carcasses were performed, it is presumed that they died as a result of DRC-1339 poisoning. In addition, 18 ravens were shot, although it is quite likely that they had consumed baited eggs too. As a result of control efforts, a population of 125 ravens was reduced to approximately 10.

At DTNA, 10 baited eggs were consumed in 2 days, but control efforts were halted by a restraining order obtained by the Humane Society of the United States against the Bureau of Land Management. No pre-control or post-control estimations of ravens were made but anecdotal information suggests that raven activity in the areas was reduced (Ted Rado, Bureau of Land Management, pers. comm.). No dead ravens were located.

It appears that raven control as conducted in this pilot program was quite effective in reducing raven populations. It also appears that the methodology of delivering DRC-1339 to ravens presents very minimal risks to nontarget animals and the environment.

Discussion

The first challenge of this pilot project was to develop a method of delivery of DRC-1339 treated eggs that was

selective and as effective as possible. An elevated platform was necessary to provide a means of leaving treated eggs in the field overnight without being available to such mammalian scavengers as coyotes or kit fox (V. macrotis). Whether or not ravens would feed on a platform was unknown. The first test was unable to induce ravens to feed on eggs at platforms. Later tests proved to be successful, possibly because sand was added to the platforms and baited with food refuse and carrion.

Because ravens are known to cache eggs, it was necessary to prevent this to minimize hazards to nontarget animals. After a field test of several devices, it was recognized that eggs could be secured to the platform with wire (approximately 18GA), which practically eliminates caching and yet remains acceptable to ravens.

The second challenge presented by this project was a logistical one of obtaining a reliable and sizable supply of hard-boiled eggs to two work sites in the California desert nearly 150 miles apart. Because ADC had no personnel in the California desert, it was necessary to rely on several Marine Corps mess halls to boil eggs in quantity. This proved quite acceptable for our purposes.

CONCLUSION

At this point, it appears that predator control as conducted by ADC in these projects has had some positive benefit for the endangered species mentioned here. It is unclear how much because in all projects predator control was one part of a comprehensive recovery program. In no instance, however, has it been demonstrated or suggested that predator control as conducted by ADC in the projects has been detrimental to the endangered species.

Finally, it should be recognized that ADC has received benefits for its participation in these projects. It has provided a funding source of approximately $200,000, although not without significantly increased duties and sacrifices by existing employees in most cases. But more importantly, it has allowed ADC to expand its influence and demonstrate its professionalism into new areas and to people not traditionally receptive to predator control.

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