WILD HOG MANAGEMENT PROGRAM AT GREAT SMOKY MOUNTAINS NATIONAL PARK

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ABSTRACT: Over the last 30 years the wild hog population control program at Great Smoky Mountains National Park has experienced steady growth. The evolution has been relatively slow, and it was not until the latter part of the 1980s that sufficient funds were available to make a serious attempt at control measures. Over the years, the research program has focused on the biology of the wild hog; its reproductive rate; feeding and movement patterns; and its impact on the fauna, flora, and soils of the park. In addition, a major project was conducted to evaluate attractants and baits to increase the trapping success rate in the park. Finally, a population model has been developed to guide management as to the resources necessary to control the population at a satisfactory level. Based on lessons learned, the overall program is reviewed and recommendations are made for a more efficient and effective control program for the 1990s.

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PARK SETTING

The Southern Appalachian highlands are internationally known for their rich biological diversity. Great Smoky Mountains National Park (GSMNP) is located in a region that harbors a considerable number of endemic and disjunct plant species that date back to the tertiary forests (Braun 1950). GSMNP lies on the borders of eastern Tennessee and western North Carolina at lat. 84°30" and long. 35°35" at the southernmost extension of the Canadian zone in eastern North America. Within its 1,950 km^2 area are large tracts of virgin forest that Whittaker (1956) classified into the following 15 major forest types: cove, eastern hemlock, gray beech, red oak/pignut hickory, chestnut, chestnut/oak, chestnut/heath, red oak/chestnut, white oak/chestnut, Virginia pine, pitch pine/heath, table mountain pine/heath, grassy balds, red spruce, Fraser fir, and heath balds.

POLICY MANDATE

The National Park Service management policies direct the control or eradication of non-native animal species that have a negative impact on native ecosystems. The management objectives of GSMNP reflect national policy in the statement from the General Management Plan: "On the basis of research and experimentation, direct management measures will be taken to reduce as much as feasible the impact of European wild boar on the park, particularly in areas of special scientific value, fragility, or aesthetic appeal."

ORIGIN AND INVASION

The European wild hog (Sus scrofa) populations in western North Carolina and eastern Tennessee originated from an accidental escape of animals from a hunting enclosure 15 miles south of GSMNP at Hoopers Bald, North Carolina, in 1912 (Stegeman 1938). Captures of pen-reared animals from this population were subsequently transported to various places around the country, including Monterey County, California, in 1923 (Barrett 1977); Texas in the 1930s (Ramsey 1968); central Tennessee in 1971 (Conley 1977); West Virginia in 1975 (Decker 1978); and west Tennessee in 1979. Currently, wild pigs inhabit 13 National Park Service areas located in the States of Tennessee, North Carolina, Texas, Florida, South Carolina, Mississippi, Georgia, Hawaii, and the Virgin Islands.

The wild hogs have retained typical traits of long guard hairs, mid-dorsal mane of hair, split gray (brown hair) tips, fewer teats, agouti color, and longitudinally striped piglets (Springer 1977, Barrett 1978).

POPULATION, HOME RANGE AND ACTIVITY PATTERNS

In the 1960s, the population estimate was around 500 for the park, and Singer and Ackerman (1981) estimated population to be approximately 1,500 in the 1980 period. The European wild hog management plan (GSMNP 1982) cited between 1,000 and 2,000 animals. Because of the lack of access to the park's rough terrain and because of the habits and markings of the animal, it is not likely that a total population size for the park will ever be accurately estimated.

Apparently, the densest populations occur in the northern hardwood forests from April to July and around grassy areas at old homesites and managed protected areas in lower areas. Several authors have alluded to the summer migration of a large percentage of wild hogs up to the higher-elevation northern hardwood forests (Singer et al. 1979, Tipton and Otto 1979, Howe et al. 1981, Singer and Ackerman 1981).

In late summer, wild hogs begin their migration downslope; a move that is correlated with the drop of acorns, which is their principal food during this time (Conley et al. 1972, Scott and Pelton 1975, Tipton and Otto 1979). During fall and winter months, hogs prefer the warm xeric slopes of low elevations, with oak/pine and oak/pine overstories and heath understories (Tipton and Otto 1979).

Hog movements vary with time and food supply. In all seasons, wild hogs are more significantly active during crepuscular and nocturnal periods than they are during the day (Singer et al. 1979).

FOOD HABITS

Wild hogs are omnivorous and may eat fish, snakes, frogs, salamanders, crayfish, mussels, snails, small mammals, carrion, earthworms, immature and adult insects, and the eggs of young and ground nesting birds. Plants usually constitute the majority of the food items taken (Table 1). Much of the nourishment comes from the underground parts of the plants and from animals which inhabit the soil or leaf litter.

Table 1. Frequency of occurrence of food items identified in 128 European wild hog stomachs collected in great Smoky Mountains National Park, 1971-1973 (after Scott and Pelton 1975).

Items identified	Percent of frequency				
	Spring (30)[a]	Summer (14)	Fall (48)	Winter (36)	Total (128)
Plant matter					
Roots	26.7	64.3	79.2	75.0	64.1
Leaves and stems	86.7	71.4	54.2	55.6	64.1
Fruits and seeds	63.3	50.0	39.6	44.4	47.6
Total plants	100.0	100.0	100.0	100.0	100.0
Animal matter					
Invertebrates	30.0	64.3	52.1	72.2	52.3
Other	16.7	14.3	20.8	25.0	20.3
Miscellaneous					
Garbage	--	7.1	--	2.8	1.6
Other (gravel, debris)	10.0	--	4.2	2.8	4.7

[a]Number in parentheses represents number of stomachs examined. Data source–Scott and Pelton 1975. Seasonal food habits of the European wild hog in the Great Smoky Mountains National Park.

REPRODUCTIVE CHARACTERISTICS

The wild hog has an extremely high reproductive potential. It is perhaps the primary reason why the management situation of control of the species is so difficult. The single most important reason is that there is no distinct rutting season and hogs can and do breed year-round. Forty-one percent of the piglets are born between March and May in the park compared to 100 percent in the Soviet Union (Sludskii 1956, Singer 1981). The earliest age of sexual maturity for both sexes is 7 to 8 months. Sexual maturity is delayed in years of food scarcity (Duncan 1974). The number of piglets produced averaged 4.36 per litter. Production of two successful litters in 1 year was limited to 5 percent of the sows in the park. Although there were slightly fewer fetuses in the reproductive tracts, the litter size was slightly greater at GSMNP than other areas reviewed by Singer (1981).

Rates of increase. A population's observed rate of increase at a given time is determined by age specific survival, age specific fecundity, sex ratio, and age distribution (Caughley and Birch 1971). Hog populations vary tremendously from year to year in relation to food availability (Oloff 1951). In GSMNP, the wild hog population on an undisturbed study area of 11.6 square kilometers increased 46 percent after an abundant mast crop year and declined 4 percent after the following abundant mast crop year. This statistic alone suggests that population fluctuations in the park might be most directly related to mast productivity.

RESOURCE IMPACTS

The growing number of hogs not only competes for space and food with virtually all types of wildlife but also creates impacts on other resources.

Flora

Bratton et al. (1982), using vegetation survey plots from the western end of the park, found that rooting was present at all elevations but was concentrated in mesic sites except those having Rhododendron maximum understories.

Hog rooting in gray beech forests can reduce cover of herbaceous understory to less than 5 percent of its expected value (Bratton 1974a). Over 50 nonwoody species are known to be eaten, uprooted, or trampled. These disturbed species exhibit changes in population structure, including reduction in percentage of mature and flowering individuals. Changes in species composition favor plants with deep or poisonous roots (Bratton 1974a). It is also suspected that a fungus infecting the beech forests (Armellaria mellea) proliferates because of aeration of soil from rooting.

Hog exclosures have been established in the park to evaluate impacts of hog rooting on vegetation and the high elevation gray beech forests. Three sample locations have been identified for these exclosures, representing a range of hog activity over time and a history of rooting impact. Quadrants were established both inside and outside the exclosures to evaluate this effect change. Total herbaceous cover within the exclosures was approximately 70 percent while the range outside the exclosures was from 20 to 50 percent cover. Following hog rooting, total cover returned quickly to previous levels but the species composition was slow to return to preimpact levels. A few plants which were nonfood items increased once the area was protected.

Fauna

Singer et al. (1982) reported that red-back voles (Clethrionomys gapperi) and short-tailed shrews (Blarina brevicauda), that depend largely on leaf litter for habitat, were nearly eliminated from intensively rooted stands as their habitat was lost. Other species sampled which were more arboreal or subterranean seemed unaffected by hog activities. Two potentially threatened species which are in the diet of the hog include the red-cheeked salamander (Plethodon jordani), which is endemic to the park, and the Jones middle-tooth snail (Mesodon jonesianus). An estimated 80 percent reduction in microinvertebrates in the soil in some areas could be contributed to habitat destruction as well as direct predation. Siltation or contamination of streams in the vicinity of rooting or wallow areas have had unknown effects on the aquatic environment that could be detrimental to a native brook trout (Salvelinus fontinalis) (Ackerman et al. 1978, Howe et al. 1979). Wild hogs may compete for available food sources with other species such as deer (Odocoileus virginianus), wild turkeys (Meleagris gallopava), black bears (Ursus americanus), squirrels (Sciurus carolinensis, Sciurus niger, Tamiasciurus hudsonicus), and chipmunks (Tamias striatus). Matschke (1965) documented predation on nests of ruffed grouse (Bonasa umbelous) and wild turkey in highly populated areas of the Tellico Wildlife Management Area of Cherokee National Forest. Hogs may also have an impact on ground-nesting song birds (Wilcove 1983).

Soil

Soil erosion was accelerated with the incidence of rooting, along with leaching of calcium, potassium, zinc, copper, and magnesium from leaf litter and soil. Nitrate concentrations, however, were higher in soil water and stream water from rooted stands, suggesting alterations in ecosystem nitrogen transportation processes with a potential loss of nitrogen from

the soils. Rooting does not appear to increase the sediment load, apparently because of the high infiltration rate of loamy soils involved and because rooting decreased soil bulk density, therefore further promoting infiltration by rainfall (Singer 1982).

Disease

Wild hogs may serve as cause, with other wildlife and livestock, for infectious and parasitic diseases and may serve as reservoirs for diseases which can spread to domestic livestock, such as hog cholera, brucellosis, trichinosis, hoof and mouth disease, African swine fever, Giardia, and pseudorabies. A wild hog preserve in South Carolina has been quarantined for brucellosis and pseudorabies (Singer 1981). Blood from hogs removed from GSMNP is currently being tested for those two diseases.

CONTROL PROGRAM

Early History

The hog control program began in 1960 in reaction to significant hog rooting of Gregory Bald and Spence Field (Singer 1981). The very early attempts at hog removal in the 1960s were focused primarily on trapping and direct reduction by shooting, which remains the mainstay of the hog control program in the park today. The total number of hogs removed over the life of this 30-year program is 6,594 hogs, as depicted in Figure 1. Over 40 percent of these animals were taken during the course of the last 4 years. This is a result, in part, of a special grant to deal with the program provided by the NPS Natural Resource Preservation Program.

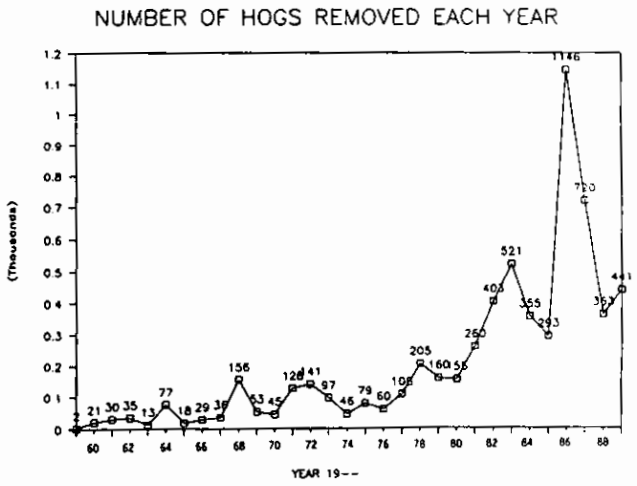

Figure 1. Number of hogs removed each year for a 30-year period, 1959-1989.

Setbacks

Although the control of the European wild hog and/or its mitigation impacts are well grounded in the legislative mandate and policy guidance for the National Park Service, the hog control program has had its share of controversy. In August 1977 a controversy evolved following a field test of the use of hunters and dogs for the purpose of killing wild hogs in the park. The handlers and dogs were not from this area, and hostility toward the program developed immediately and still continues today. In hindsight, the timing, choice of control, and personnel on the target area were all, unfortunately, ill-advised. As a result, a moratorium was established on further hunting in the park until a management plan was written and approved. Simultaneously, a cooperative agreement on hog management with the North Carolina Wildlife Resource Commission was signed.

In April of 1978 the moratorium was lifted, and direct reduction was again used in concert with the nonhalted trapping procedures. During this time, four additional part-time people were allocated to the hog control program of the park. With this additional staff support, the number of hogs removed in the period from 1978 to 1983 surpassed the total number removed in the previous 19 years. In the summer of 1978 and subsequent summers, control emphasis was placed on high-elevation beech gaps and along northern hardwood forested ridgetops in the park. Although direct reduction has been carried out on the North Carolina side of the park, it has never been fully supported by the North Carolina Wildlife Resources Commission and has been low key.

In the summer of 1981 a second flare-up of hog controversy began with the publication of an article in the Wall Street Journal which described government hog hunting in the park. As the political temperature rose, the park was once more placed under a moratorium on the killing of hogs. However, this moratorium was in effect only in the State of North Carolina. Several stipulations were place on the moratorium. Animals could be shot if they directly threatened an endangered species or if they were in the Cataloochee area, which at that time was the last remaining hog-free area in the park. Other than that, they were not to be taken by shooting. The trade-off was the formation of a North Carolina volunteer action group to trap hogs in the park. They were permitted, under the joint supervision of park personnel and the North Carolina Wildlife Resource Commission, to trap and remove as many hogs as possible. Resource support in the form of traps, bait, and sometimes boats was provided by the park. Animals were transported to acceptable release sites in national forests in the State of North Carolina. A core group of 10 to 12 individuals maintains traps in the Hazel Creek portion of the park. The volunteer program has successfully diffused much of the hostility toward the park regarding the hog issue. It has more than quadrupled the manpower that the park has had to devote to the program. However, the project has had several drawbacks, including sporadic trapping efforts, the capture and release of nontarget species, less effective baiting techniques and trapping efforts, trapping restricted to areas of easy access, and the potential for illegal activity.

Trapping Techniques

Early trapping success rates were relatively low in the park, ranging from .0062 to .0328 captures per night (Duncan 1972). Traps are generally placed in areas of relatively easy access due to the problems of transportation. This means that they tend to be placed in areas of open grassland along road edges and in agricultural districts such as Cades Cove. There has been an evolution in the design of the traps and currently they are fabricated by students of the Job Corps at Oconaluftee.

Shooting Techniques

Several weapons have proven effective in the shooting activities. The .44 magnum or the .357 magnum is the preferred sidearm. Most rangers carry the .38, which does

not seem to be as effective. The 12-gauge shotgun with .00 buck is preferred as the long gun. The .243 or larger caliber is effective in open areas for night hunting, and artificial light source directly fixed to the gun has proven effective. Table 2 summarizes the number of hogs removed per year from the park over the last 4 years. Shooting is the more effective method in terms of expenditure of man-hours. In 1980, 6.6 man-hours per hog were used for shooting as opposed to 9.4 man-hours per hog for trapping.

Table 2. Hog removals-1986-1989, Great Smoky Mountains National Park.

Mgt. Unit	Total[a] + (percent of total)	Male	Female	Pigs[b]	Juv[c]	Adult[d]
			1986			
BKY	285 (26).	93	160	23	136	115
CAC	72 (6.5)	40	43	13	44	27
CAT	3 (.3)	0	1	0	2	1
COS	6 (.5)	3	3	0	1	5
DCK	345 (31)	153	185	30	167	143
LRR	67 (6)	30	36	14	17	36
OCO	53 (5)	21	26	0	9	37
TWM	269 (24)	114	147	31	150	80
			1987			
BKY	294 (41)	124	135	17	50	223
CAC	35 (5)	19	12	6	15	14
CAT	0	-	-	-	-	-
COS	30 (4)	14	15	7	8	10
DCK	159 (22)	68	84	46	32	76
LRR	40 (6)	22	15	9	10	21
OCO	32 (5)	18	14	3	7	22
TWM	123 (17)	54	65	13	29	81
			1988			
BKY	97 (27)	35	56	10	14	73
CAC	30 (8)	13	11	1	8	21
CAT	5 (1)	1	4	0	3	2
COS	8 (2)	5	2	0	3	5
DCK	55 (15)	24	29	0	4	50
LRR	29 (8)	13	16	4	6	19
OCO	41 (11)	19	21	0	4	37
TWM	96 (27)	27	67	21	10	65
			1989			
BKY	54 (12)	23	30	4	21	29
CAC	45 (10)	15	30	1	31	13
CAT	1 (2)	1	0	0	1	0
COS	37 (7)	14	17	0	22	10
DCK	70 (16)	36	34	16	26	28
LRR	45 (10)	17	28	8	23	14
OCO	28 (6)	8	19	7	3	18
TWM	166 (38)	78	86	16	95	52

[a]The total may not equal the sum of the parameters because of unknowns.
[b]Animals weighing 15 lbs or less.
[c]Animals weighing more than 15 but less than 60 lbs.
[d]Animals weighing 60 lbs or more.

Hog Bait Study

In an attempt to increase trapping success, a study was conducted in GSMNP to determine if there was a bait that hogs significantly preferred over all others. The study found that, overall, hogs significantly preferred fermented corn mash over other baits. Several olfactory attractants were also tested and generally there were no significant preferences (Wathen et al. 1988).

Current Control Activities

A review of the control program over the last four years is very instructive in assessing the potential for the park managers to control the population of hogs and to evaluate the overall effectiveness of the techniques of control that have evolved over the 30-year history of the program. The distribution of the successive removal varies by year but, by and large, the greatest success lies in the area labeled BKY (backcountry) along the Appalachian Trail, where hogs are shot; and the areas labeled TWM (Twenty Mile), which borders Fontana Lake, and DCK (Deep Creek,) near Deep Creek campground, where hogs are trapped (Table 2). In those areas where trapping is the primary removal method (DCK, TWM), generally there are more juveniles removed than adults. Where hunting is the primary method (BKY), there are usually more adults taken.

There was a steady increase in the time it took to remove hogs (Table 3). A steady decline in the success rate of kill per-hours-hunted would indicate that the population was in fact being significantly reduced. A study by Bishir et al. (n.d.), North Carolina State University, suggested a method to estimate a population based on catch effort. They have developed a population estimator for hogs in GSMNP based on the number of hogs shot and the time it takes hunters to find the hogs. Table 3 indicates clearly that the number of man-hours required to remove one hog increased from 1986 to 1988. According to Bishir's hypothesis, this would indicate a reduction in the population. He suggests that the estimates are probably low.

Table 3. Hog removals by shooting and trapping from high elevations (BKY).

Pigs shot			Pigs trapped			Hours/pig shot		
1986	1987	1988	1986	1987	1988	1986	1987	1988
244	172	83	47	115	12	5.5	9.68	21.1

Just how effective have the extraordinary efforts in the park been to control this population of hogs? Have the taxpayers gotten their money's worth from the over-$1 million public investment in this program over the last 4 years? Unfortunately, we cannot provide a precise answer to this question. Certainly, in the high-elevation forests the population seems to be in a marked decline, but what about elsewhere in the park? Fifty percent or more of the population must be removed to truly reduce the size of the population. This is probably being accomplished for the population of hogs in the park that utilize the high-elevation

forests along the Appalachian Trail in the western portion of the park. Beyond that, the relative impact on the total population is unknown. Fortunately, the knowledge gained over the last 4 years on how to go about controlling these animals and the additional insight gained from the research over this period of time has now put us into a position to establish a program to very directly and precisely answer that very fundamental question.

MONITORING

Devising a means to monitor the hog population in the park has been extremely difficult. Possibly the only effective sign that one can utilize in the park is rooting. During the summer of 1983, trail and cross-country transects were run in two watersheds of the park to try to get a perspective on the overall distribution of rooting throughout watersheds. Trails and cross-country routes were treated as 20-meter-wide belt transects. Results of the study tend to confirm the perspective that during early to mid-summer the hog rooting is more intensive in the high elevations and is concentrated along trails, ridgelines, and grassy areas. The results will be used in designing a parkwide and/or management unit monitoring program for hog rooting which will be utilized to evaluate the effectiveness of the overall hog control program. The hog-rooting transects will be utilized in conjunction with the existing system of hog exclosures to monitor long-term adverse impacts of hog activity as well.

HOG POPULATION MODEL

As management techniques become more sophisticated, research needs become more and more specific. Currently, the research has focused on the development of a computerized hog population model. Ultimately, the model should predict the minimum number of hogs that need to be killed in certain management areas in order to keep the population under control.

CONTROL STRATEGY FOR THE FUTURE

Stable Funding

The hog control program in the park has emerged over a 30-year period. At no time have there been any specific monies designated from the base funding for resource management activities in the park for hog controls per se. Hog control duties in the early years were incorporated into the work assignments of park personnel and the limits of available resources restricted the activities significantly. This funding level has been used to demonstrate that park personnel can make a difference. All the progress made can be quickly lost if pressure is taken off the population for as short a time as 2 years under favorable mast crop and weather conditions. Base funding for the program is the most important issue that needs to be resolved before the National Park Service can systematically commit the kind of resources necessary to control this population for the long term. With stable funding will come an opportunity to stabilize personnel positions dedicated to the control program. This would provide the potential for collaboration on long-term research projects which are needed to find better, more cost-effective solutions to the problem. Benefits from long-term research designed to develop species specific biological controls would also benefit other parks that have feral pig populations. The potential benefit might be control of the population at a much lower cost. This dimension cannot be even contemplated without a commitment of long-term funding to the program.

Staff Requirements

With base funding, a full-time administrator-- hopefully a research wildlife biologist--would be hired to run this program. Along with this leader, there is a need for at least three people dedicated to a control program to work year-round as permanent biological or wildlife technicians stationed at strategic ranger stations in the park. Finally, there needs to be a large crew of 15 to 20 seasonal staff people who would be available to focus on intensive control activities when the hogs are concentrated in late spring and early summer in the high-elevation or hardwood forests, and in the winter months when food is most scarce in the lower-elevation deciduous forests and grassland areas.

Hog Removal Efficiency

A key element to increase the success of both trapping and shooting is to know where the hogs are and how to get in position to either trap or shoot them quickly. There needs to be a wider distribution of trained personnel responsible for hog removal throughout the park. The current program represents a recurrent pattern for removal where we know there is an abundance of hogs but, because of lack of research, has ignored parts of the park completely, allowing populations to increase in those areas.

Strategic Planning for Management

For a variety of reasons, such as inaccessibility and lack of sufficient personnel, some areas of the park have never been actively worked to remove hogs. The park needs to expand current management areas and establish specific management units for controlling these animals, such as suggested in Figure 2. Next, there need to be goals set for these management units as to the amount of acceptable damage from the hogs and the size of the population that is acceptable for the season of the year in which they are concentrated in that management unit. Finally, possibly portions of the park should be fenced to reduce the influx of hogs from outlying areas.

Research Agenda

If the control program is to become more refined and efficient in the removal of animals, research will need to be used as a tool to evaluate the effectiveness of the increased productivity of the program and to access means to increase that efficiency. For instance, we know that hogs tend to range on high-elevation ridgetops during late spring and early summer but we really do not fully understand how that is triggered in relation to temperature, moisture, and the phenology of their primary food source-plants. Very little is known about their mid-elevation behavior. It is very important to try to identify this information as well.

Additionally, research may be required to aid in establishing a correlation between weather conditions and juveniles for reproductive potential in more specific habitats and fall mast crop. Once base funding has been established, a long-term strategy for research that would provide key information needed for a more sophisticated program could be developed.

Possibly the most important research agenda should be the long-term investment in the development of species-specific biological controls of hogs and not likely to affect domestic hog populations outside the park. The potential options are numerous and the pay-offs are potentially enormous in the more efficient protection of the park's

resources and potential saving of valuable resources we now need to commit to the control program due to lack of any other viable control options.

Adequate Monitoring

In order to maintain an adequate monitoring program of the adverse impacts of the hogs in the park, the hog exclosure system that has been established will be maintained, and it will be recommended that vegetation inside and outside the exclosures will be monitored every 3 years. The monitoring can be staggered so that in any one year, the vegetation from three to four exclosures would be monitored.

In addition, there needs to be maintained a series of transects that are monitored for hog rooting annually during the height of the season when the hogs are most likely to be in the vicinity of the transect. A third component for monitoring would include the usage of Bishir's (n.d.) catch-effort estimator. Verification of the accuracy of his estimator would be a valuable addition to the management program.

Data Management

For each management unit there needs to be a strategy to systematically collect data to evaluate the success of the removal program and the success of the monitoring program, pinpointing the major location and severity of impacts, and verifying management unit specific population models.

CONCLUSION

Stable funding, adequate staff, program efficiency, a research agenda, data management, and adequate monitoring are the essentials of a complete hog control program. A merging of those elements into a single functional strategic plan will provide the insight necessary to maintain a highly efficient and well-justified hog control program. The preliminary analysis of the current management program indicates that the methods and efforts of removal are at least somewhat successful. An attempt to confirm the achievements of the hog program must be expanded, and additional factors must be used to validate the working objectives. Bishir (n.d.) reported a definite increase in the time it takes hunters to find and kill hogs, indicating a reduction in the population. This is one indicator of a successful program.

The Great Smoky Mountains National Park management is at a crossroads. One path will lead to continuation of the program that has evolved in the 1980s, which is the result of an extraordinary effort by dedicated staff to remove, in an opportunistic way, animals from known concentrated populations in the park when resources are available and can be assembled to do so. The availability of the resources is highly unpredictable. The presence of the animals is relatively unpredictable, and some of the key driving environmental conditions, such as weather conditions and mast crop on productivity, are unpredictable as well. The bywords are essentially "catch-as-catch-can."

A second direction would be to stop for a moment and take stock of the program through the 1980s and develop a very deliberate strategic plan for a long-term operation of the program with specifically stated goals by management unit, not only in terms of size of population but also the level and nature of damage that is to be tolerated from the animals. This plan should incorporate all the components mentioned in this paper, demonstrating a balance between control activities using current technologies along with an investment in the future through research for improving on those technologies. Once the strategic plan is developed, then the responsibility lies with park management to go up through the ranks in the National Park Service to sell the critical need to establish base funding for this program over the long term. The seasonal rangers and biological technicians have shown a tremendous amount of power of will and tenacity in removal of these thousands of animals in the park over the last 30 years. Now it is time for park managers to show that same tenacity and level of effort in the field of Park Service bureaucracy and bring home the biggest prize of all--a guaranteed long-term funding capability to be dedicated to the park's number one resident natural resource problem.

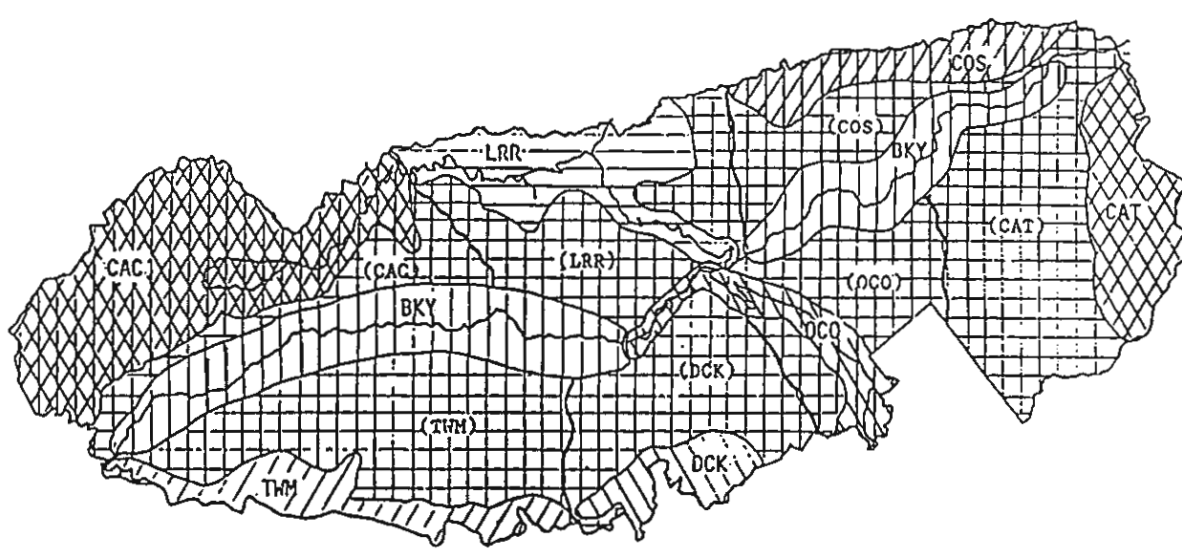

Figure 2. Great Smoky Mountains National Park. Current management areas of concentrated hog removal (designated by large capital letters) and proposed extensions (designated by smaller letters and parentheses).

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