

**The Federally-Endangered Delmarva Fox Squirrel (*Sciurus niger cinereus*):  
Recovery Planning, Habitat Conservation Planning, and Current Status**

**Dan Murphy**

**PUAF740**

**May 9, 2001**

**INTRODUCTION**

The Delmarva fox squirrel (DFS) (*Sciurus niger cinereus*), a unique fox squirrel subspecies, has been extirpated from much of its former range. The DFS was originally found throughout southeastern Pennsylvania, west central New Jersey, and the Delmarva peninsula, encompassing the State of Delaware and the eastern shore portions of Maryland and Virginia. By the middle 1960's, as a result primarily of habitat loss due to timber, agricultural, and residential development, it occupied only 10% of its former range (Taylor 1973) in four counties in Maryland (Kent, Queen Anne's, Talbot, and Dorchester; USFWS 1993). This led the U.S. Fish and Wildlife Service (FWS) to list the subspecies as "Endangered" on the Endangered Species list in 1967. Due to reintroduction efforts by the FWS and the Maryland Department of Natural Resources (DNR), the squirrel now inhabits all Maryland Counties on the Eastern Shore of Maryland and several sites in Pennsylvania, Delaware, and Virginia (USFWS 1999).

The major threat to the DFS continues to be loss of its preferred forest habitat due to timber, agriculture, and residential development activities (USFWS 1993). As a result of increasing population pressure, residential development is expected to play an increasing role in DFS habitat loss in the future unless effective conservation measures are established. From 1980 to 1990 the population on the Eastern Shore of Maryland and the State of Delaware increased by 14% and 13%, respectively (USFWS 1993). This trend is expected to continue. Between 1972 and 1986, up to 3.7% of the forests in

Delaware were cleared for agricultural, industrial, and housing purposes (Ferguson and Mayer 1974, Frieswyk and DiGiovanni 1989, MacKenzie 1989). In Maryland, up to 7% of the forest land on the Eastern Shore was lost to development between 1973 and 1990 (Frieswyk and DiGiovanni 1988, Maryland Office of Planning 1990). A similar trend was seen on Virginia's Eastern Shore.

Forest pest infestations could be potentially devastating to isolated DFS populations. For example, the population on the Chincoteague National Wildlife Refuge is thought to be particularly vulnerable to pest-related forest die-off because Chincoteague is an island that is isolated from the mainland, with little possibility of natural recruitment should the current population be lost. Other threats to the squirrel include: many predators, including domestic dogs and cats, eagles, hawks, foxes, raccoons, and great horned owls; mortality due to gray squirrel hunter misidentification; and being struck by automobiles (USFWS 1999a).

### **Natural History**

The DFS is a large, heavy bodied, very light-colored tree squirrel, with a very full, fluffy tail (USFWS 1993). From a distance, most individuals appear almost all white in color, however, the tail usually contains black and grayish streaks and bands. Squirrel abundance and density varies naturally from year to year depending on predation rate, food supply (especially foods suitable for winter storage), and disease occurrence (Nixon and Hansen 1987, Weigl et al. 1989). While no long-term population studies have been completed, the DFS is usually observed at low densities, suggesting that the removal of a few individuals could substantially impact a local population (USFWS 1993).

Delmarva fox squirrels are typically found in mature upland and bottomland forest stands of mature loblolly pine and oak, or mixed stands of pine, beech, and sweetgum (Dueser et al. 1988). Greatest preference appears to be for forests that contain a variety of nut and seed-bearing trees, have corn or soybean fields nearby, have open park-like understories, and contain older trees with hollows that are suitable for den sites (Taylor 1976, Dueser et al. 1988). Modern habitat preferences are markedly different from conditions in the old-growth hardwood forests historically exploited by the squirrels (USFWS 1993).

Like the gray squirrel with which they coexist, fox squirrels feed on mature green pine cones in late summer and mast, including acorns, hickory nuts, beech nuts, walnuts, and pine nuts (primarily from loblolly pines) in the fall (USFWS 1993). They bury nuts and seeds, many of which are relocated by odor and eaten at a later date. In the winter months, during poor mast years, the animals become weak and emaciated and mange becomes prevalent, resulting in high mortality (USFWS 1983). Spring and summer staples include tree buds, flowers, mushrooms, insects, fruit, and seeds (USFWS 1983). They have also been known to occasionally eat bird eggs and nestlings (USFWS 1983).

Fox squirrels are much slower moving and less agile than gray squirrels (Dozier and Hall 1944). When moving from tree to tree, rather than leaping from branch to branch as do gray squirrels, they descend to the ground. This activity may make them more susceptible to predation. The DFS is most active during the morning and early afternoon and exhibits reduced activity during periods of cold and inclement weather (USFWS 1993).

The home range for the DFS varies depending on habitat type (USFWS 1993) and can be as large as 30 hectares in agricultural areas (Flyger and Smith 1980) to as small as the 4.1 hectare ranges found in one coastal barrier island population (Larson 1990). Fox squirrels prefer to den in tree hollows, however, they will build leaf nests if necessary (Nixon and Hansen 1987, Allen 1952). Mating generally occurs in late winter and early spring, usually producing one to six young per nest (USFWS 1993). The squirrels are polygamous and the males take no part in raising the young. Food supply appears to be the most critical factor controlling reproductive success (Weigl et al. 1989).

### **ENDANGERED SPECIES ACT - OVERVIEW**

The Endangered Species Act (ESA) was promulgated in 1973 to provide a means of conserving endangered and threatened species and the habitats on which they depend, and provide a program for the conservation of threatened and endangered species. Responsibilities for enforcing the ESA fall to the Department of the Interior, represented by the FWS, and to a lesser extent, to the Department of Commerce (marine species). There are currently approximately 971 species listed as Federally endangered and 272 listed as threatened (www.fws.gov 2001). Once a species is listed on the ESA, it is protected under several sections of the act.

Section 7 of the ESA requires that all Federal agencies consult with the FWS prior to funding or carrying out any construction projects and other actions to determine whether those actions will jeopardize the continued existence of threatened or endangered species or their habitats. The Section 7 process concludes with the issuance of a biological opinion from the FWS stating whether the project will result in unnecessary

impacts to threatened or endangered species. According to Section 7, Federal government agencies must refrain from activities that negatively impact endangered species. If the FWS determines that this is to occur for any given project, the project must be modified or discontinued.

Section 9 of the ESA prohibits the “taking” of endangered animals. The taking prohibition only concerns endangered animals and not plants or threatened animals. It not only covers killing and capturing of animals but also indirect effects such as harassment and destruction to their habitats. The taking provision applies not only to Federal agencies, but also to state, local, and private entities. The way it was originally written, the takings provision had the potential to kill a construction project even if small inconsequential effects to an endangered species were expected. As a result, Congress amended Section 7 in 1982 to allow for takings that were incidental to Federal actions that otherwise satisfy Section 7 requirements. At the same time, a similar amendment was applied to Section 10 of the ESA to cover non-federal incidental takings due to projects that were otherwise lawful. Under Section 10 of the ESA the FWS can issue a permit for incidental take of an endangered species provided the following requirements are met: 1) the impacts must be minimized and mitigated to the maximum extent possible; 2) the taking must not reduce the prospects of survival and recovery of the affected species; and 3) the taking must be in accordance with a habitat conservation plan (HCP) that is adequately funded (Bean et al.1991).

Habitat Conservation Plans are submitted as part of the Section 10 permit application process and are expected to protect endangered species while still allowing some development. The intent of Congress in developing this process was to reduce

conflicts between listed species and developers and promote partnerships between private, local, state and Federal entities to protect and preserve endangered species and their habitats (USFWS 1995). A typical HCP includes plans to minimize take, provide for land acquisition for preservation, habitat restoration, and relocation of plants or animals potentially affected by the action (USFWS 1995). The HCP process has recently been employed as part of the Section 10 permitting process for activities occurring in Delmarva fox squirrel habitats.

### **Home Port – A Delmarva Fox Squirrel Habitat Conservation Planning Example**

Home Port is currently the only development resulting in take of DFS or their habitat with an approved HCP, resulting in the issuance of an incidental take permit under Section 10 of the ESA, allowing construction to occur. The project is located on Winchester Creek, in Grasonville, Queen Anne’s County, Maryland. The project design called for the construction of 16 homes on 56.6 acres of land that was approximately one-half forested and one-half agricultural field. Sightings of the DFS on the property were documented on several occasions in 1997 and 1998 (USFWS 1999b). In the spring of 1999, five individuals were trapped during a survey (Willey and Willey 1999).

As a result of the presence of DFS and their habitat on the property, the FWS concluded in a 1999 Biological Opinion (BO;USFWS 1999b) that incidental take would occur, resulting from adverse effects caused by human disturbances due to the proximity of the houses to DFS forested habitat and the construction of roads in the vicinity of DFS habitat. The impacts associated with the development were expected to take the form of increased harassment and predation by pets and feral animals; increased physical barriers

to dispersal and mobility; direct impacts from human presence, such as disruptions caused by noise and the application of lawn chemicals; vehicular strikes; and habitat loss and degradation resulting in loss of potential future habitat, increasing foraging time and reducing sheltering opportunities, and resulting in increased mortality.

In order to address these concerns, the developer completed an HCP designed to minimize and mitigate the effects of the development on the DFS. The HCP was provided to the FWS as a necessary component of the Section 10 incidental take permit application (Winchester Creek Limited Partnership 1998). The measures outlined in the HCP to minimize the effects of the development on the DFS included: 1) instituting a public awareness program for contractors and homeowners; 2) instituting a maximum speed limit of 15 mph for contractors and homeowners; 3) installation of DFS road signs and stop signs at strategic locations to minimize vehicle strikes; 4) instituting deed restrictions on each lot to minimize disturbance of forested habitat; 5) instituting regulations concerning the control of domestic pets; 6) a contact person would be identified to advise contractors and homeowners on DFS issues and coordinate with the FWS; 7) erect fencing to limit disturbance to forested habitats during both construction and occupancy; 8) relocate DFS found in the construction area; 9) reporting dead or injured DFS to the FWS; 10) prohibiting dumping of trash, lighting of fires, and discharge of firearms during construction; 11) granting right of access to the property to the FWS; 12) consent to the installation of speed bumps; 13) prohibiting small game hunting on the property. Most importantly, except for a 9.6-acre early successional area, no construction occurred on forested portions of the property. In order to mitigate for

disturbances resulting in taking, the developer proposed to restore 4.5 acres on the site and purchase the development rights to 31 acres of offsite habitat for DFS.

Based on the conservation measures outlined in the HCP, the FWS BO (USFWS 1999b) concluded that the issuance of an incidental take permit for the project was not likely to jeopardize the continued existence of the DFS. With the implementation of the conservation measures, the FWS predicted that there would be limited disturbance by pets, low impacts on mobility, low incidence of vehicle strikes, permanent protection of enough habitat to replace that which would be lost due to construction. A total of 9.6 acres would be lost. However, conservation measures outlined in the HCP would result in the permanent preservation of over 66 acres of habitat. An incidental take permit was issued and the project was constructed in 2000.

### **Recovery Plans**

An important component of the ESA in achieving the recovery of an endangered species is the recovery planning process. The purpose of recovery plans is to develop plans of action for the eventual recovery and delisting of an endangered species. The ESA requires that recovery plans be developed for all listed species. Recovery plans have yet to be developed for many listed species, however, there is a plan in place for the recovery of the DFS.

Recovery strategies for endangered species can range from management of populations to preserving and restoring their habitats (Meffe and Carroll 1994). Management strategies rely on the protection afforded by the endangered species act and other laws or measures such as translocations. Preservation strategies target specific

habitats (e.g. forested habitats) for preservation to protect the species of interest as well as other resident plants and animals that contribute to the ecological health of the habitat (Meffe and Carroll 1994). Due to the increasing fragmentation and degradation of the habitats upon which many species rely, the habitat conservation and preservation approach is being applied with greater frequency (Harris 1984, Wilson 1988, Shaffer 1996).

### **DELMARVA FOX SQUIRREL RECOVERY PLAN**

The stated objective of the DFS recovery plan is to delist the DFS by increasing its population and protecting its habitat to enable it to persist as a viable self-sustaining part of its ecosystem (USFWS 1993). The overall recovery strategy calls for protection of existing populations, translocation of squirrels to suitable protected sites within the historical range, and habitat management and protection (USFWS 1983). If successful, these efforts are expected to assure habitat availability in the long-term for the maintenance of both natural and introduced populations and result in the expansion of current populations throughout the historic range of the DFS.

The initial DFS recovery plan was drafted in 1979. Up to 1993, when the second revision was finalized, the main thrust in the recovery process had been in translocating squirrels to protected areas within their historic range. Other early goals including increased public awareness and habitat management were only partially implemented (USFWS 1993). The translocation plan called for re-populating the squirrel into its historic range to reduce the probability of chance extinction due to one catastrophic event, restoring diversity, and expanding the involvement of other locales and entities in

the process. Translocations were considered successful when the new population was still established and increased in size after 5 years. Through 1990, 264 squirrels were translocated to 11 sites in Maryland, 2 in Virginia, 2 in Delaware, and 1 in Pennsylvania (USFWS 1993). An average of 17 squirrels were released at each site. Post-release monitoring revealed that 15 (6%) of the squirrels died following release, mostly due to predation. As of 1993, 10 of the 16 translocations were deemed successful (USFWS 1993). The remaining six either failed or the outcome was undetermined.

Based on studies performed on the translocated populations and several experimental populations, researchers made the following observations/recommendations concerning DFS translocations: 1) translocations must not remove so many individuals from the source population that inbreeding occurs; 2) at least 30 individuals should be transferred to each translocation site to insure a viable breeding population (Moncrief and Dueser 1991); 3) squirrels should be collected from several source populations for each translocation to insure genetic diversity in the new site; 4) translocation sites should be a far enough distance away so that translocated squirrels cannot return to the source site; and 5) better record keeping must be maintained to adequately track translocations over time and make adjustments to the program (USFWS 1993).

Since the early 1990's, no new translocation sites have been created (Ratnaswamy pers. comm.). There is some concern that removing squirrels from existing populations to establish new ones will result in reductions in genetic diversity in the existing populations. If a large-scale translocation program is to be resumed, further study of the genetic and demographic status of existing populations will be required. In the

meantime, the DNR has been supplementing existing populations periodically with small translocations of a few individuals.

According to the 1993 Recovery Plan, major future activities were to center around protecting habitat for both natural and translocated populations. Much of the habitat currently occupied by the squirrels is on privately owned land (USFWS 1999). One of the major challenges for individuals responsible for developing recovery plans for endangered species is that, in many cases, large portions of the species' required habitat is on private lands (Ratnaswamy et al. 2001). In one study of endangered vertebrate species in Washington, Cassidy and Crue (2000) found that 79% were found to at least partially occupy private lands. Such is the case with the DFS on the Delmarva Peninsula. This contributed to the DFS originally being given priority for the development of a recovery plan (USFWS 1993). Recent decisions by regulatory agencies concerning the management of endangered species on private lands have resulted in disagreements, litigation, and the perception that endangered species regulations present an undue burden for private landowners (Ratnaswamy et al. 2001).

The plan concludes that preservation of the DFS will require region-wide land use planning and management by using regulatory measures and cooperating with county planning boards, private landowners, farmers, and the timber industry. Preservation of both occupied and unoccupied potential habitat would be emphasized. Education and public information programs were to be strengthened to provide greater awareness of the DFS and the need to preserve its habitat. Specific attention would be given to training private landowners and managers in forest management practices that benefit or at least do not adversely impact the squirrel. More study would be undertaken to better

understand habitat requirements, population status and distribution, genetic variation, dispersal rates and other life history factors, the knowledge of which are important to improve recovery efforts (USFWS 1993). In addition, monitoring of ongoing recovery efforts and population characteristics at natural and translocation sites would be continued and expanded. To that end, six benchmark monitoring sites were established within the squirrel's remaining natural range in Maryland and one translocation site at Chincoteague NWR in Virginia. Since 1993, due to lack of funding and staffing, only Chincoteague has been regularly monitored (Ratnaswamy pers. comm.).

For species that are currently listed as endangered, there are two categories of recovery possible. They can be reclassified from endangered to threatened, which means they are likely to become endangered but are not currently classified as such. An endangered species that is reclassified to "threatened" is considered to be no longer under the threat of extinction and hence, on the road to recovery. The second category is called "delisting." When an endangered species is delisted, it is considered to be no longer endangered or threatened and is removed from the endangered species list.

Following are the recovery criteria that were identified in the most recent revision of the DFS recovery plan (USFWS 1993). The DFS can be reclassified to threatened when its ecological requirements and distribution are adequately understood, permitting effective management; based on five years of data, benchmark populations are determined to be stable or expanding; and ten translocated populations become successfully established. Delisting will occur when five additional colonies are established outside the current natural range; monitoring results show that translocated colonies have successfully persisted throughout the recovery period; mechanisms are in

place for the long-term preservation of enough DFS habitat to enable the preservation of the species; mechanisms are in place to ensure the protection of new populations, allow for expansion, and provide conservation corridors to allow for gene flow between populations.

### **Current Status**

Since publishing the most recent edition of the recovery plan in 1993, few systematic surveys have been conducted to understand the population status of the species outside the original benchmark sites (Ratnaswamy et al. 2001). This is in part due to the difficulties encountered in attempting to monitor and trap individuals on private lands. As a result, the current knowledge of DFS population status and distribution is primarily based on opportunistic sightings by state and Federal biologists (Ratnaswamy et al. 2001). Since most sightings are opportunistic, rather than resulting from a rigorous monitoring strategy, the data are considered to represent “occurrences” rather than “distributions” of the DFS. When sighted, the occurrence of the squirrels is recorded on a Geographic Information Systems (GIS) data base.

Recent observations suggest that the greatest DFS concentrations occur in Queen Anne’s, Talbot, and Dorchester Counties in Maryland (Ratnaswamy et al. 2001). There are distinct differences in land use and potential threats to the DFS in the different counties. In Dorchester, 36% of the land is forested and 5% of the land is currently developed. Queen Anne’s and Talbot Counties are 26% and 24% forested, respectively, with 8% and 12% of the land developed. Three quarters of the DFS sightings have occurred in Dorchester County and almost all of the major forested areas in Dorchester

support populations of the squirrel (Ratnaswamy et al. 2001). The squirrel is widely distributed throughout Talbot and located primarily in the southern portion of Queen Anne's County. While conversion of forestland for residential development is occurring in all three counties, it is happening at a much greater rate in Talbot and Queen Anne's Counties, where there is already less forested habitat. Populations of DFS in Queen Anne's County occur primarily near towns and highways where most development is occurring (Ratnaswamy et al. 2001).

As noted earlier, timber harvesting has been identified as a significant threat to the DFS. However, recent observations suggest that some harvesting can occur in DFS habitat without significant effects to the species. The FWS (C. Keller, unpublished data) has observed that the DFS has persisted in Dorchester County for the past twenty years, even though greater than 3000 acres of forest have been harvested annually. It should be noted that considerable portions of Dorchester remain forested. Large-scale timber extractions could have different consequences in counties such as Queen Anne's and Talbot, with less forested habitat.

In the three county area, 87% of the DFS population occurs on private lands (Ratnaswamy et al. 2001). While public lands can serve as core refuge areas for the population, recovery of the species will depend on the management of both public and private lands. Conservation of the DFS on private lands is being attempted through 1) land protection, 2) regulatory mechanisms, and 3) encouraging landowner stewardship (Ratnaswamy et al. 2001). Currently, through a combination of conservation easements negotiated with private landowners and collaboration with private land trusts, 8,930

acres of habitat on private lands has been protected in the three-county area (Ratnaswamy et al. 2001).

Certain Federal, State and local regulations have been employed to assist with limiting impacts of development on DFS habitat. Non-tidal wetland protection under Section 404 of the Clean Water Act has resulted in the protection of some habitat. Habitat Conservation Planning under the Federal Endangered Species Act is beginning to play an important role in minimizing the impacts of development. The State of Maryland endangered species law requires State permitting agencies to include endangered species conservation measures in development permit conditions (Therres 1998). The Chesapeake Bay Critical Areas Program requires habitat protection for endangered species be considered for development and timber harvesting projects occurring within 1000 feet of the Chesapeake Bay and its tidal tributaries (Therres 1988). The program requires that plans for development or timber harvest be approved by the State prior to initiation. In the case of the DFS, habitat management measures outlined in the Recovery Plan (USFWS 1993) are applied to the plans. Currently, county governments consider DFS in the master planning process to varying degrees. Increased coordination between counties and State and Federal regulatory agencies has been identified as a future need to enable better preservation of DFS habitat (Ratnaswamy et al. 2001).

Since most squirrels occur on private lands, stewardship by private land owners is considered to be the most important of the three main conservation measures employed to preserve DFS habitat (Ratnaswamy et al. 2001). Timber extraction can lead to substantial financial gains to a private landowner, resulting in incentives to keep land in forest and use sound management practices, rather than converting to agriculture or

residential development. Sound management of forestland for timber, such as selective cutting rather than clearcutting, can also result in benefits to the squirrel by leaving a certain amount of habitat following extraction.

Due to the increasing level of residential development in DFS territory, the FWS and other recovery team member regulatory agencies have been expending large portions of staff time reviewing and responding to Section 7 and Section 10 permit applications and associated HCPs at the expense of the recovery planning process (Ratnaswamy pers. comm.). As a result, many of the recovery goals have yet to be fully addressed. For example, after eight years, there is still not enough available information to determine whether the DFS can be considered for downlisting or delisting. In addition, there is some consensus among recovery team members that the recovery criteria are too vague and may need to be refined. Making matters even more difficult, the recovery process for the DFS is not currently funded.

### **CONCLUSION AND RECOMENDATIONS**

Many of the ambitious goals outlined in the 1993 DFS Recovery Plan have yet to be realized. This is primarily due to the limited funding and staffing of the natural resource agencies, whose efforts are consumed by responding to specific development projects rather than long-term strategic planning and monitoring. This can be remedied in several ways; the most obvious is to increase funding. Another way to increase the output of the recovery team is to include additional personnel who could potentially come from outside government. Included in this group could be developers and private landowners, important stakeholders in the issues surrounding the squirrel who currently

(in many cases) are adversaries to the recovery process. Bringing developers and landowners into the process would serve two purposes: it would bring in more people to do the work and assist in the decision making process and it would foster a relationship of conversation rather than the current confrontational atmosphere (Mann and Plummer 1995).

It will be important to find some way to monitor translocated and naturally established populations to determine whether future translocations are needed; whether translocations result in reductions in the genetic viability of source populations; and when the DFS has recovered sufficiently to be considered for downlisting or delisting. Due to the lack of monitoring, the population status of the DFS is unclear at this time. It is improbable that staffing and funding of resource agencies will be increased to the levels necessary to effectively carry out monitoring activities as outlined in the Recovery Plan. As a result, it will be necessary to find other means, such as enlisting the services of volunteers, to complete this important part of the plan. Moreover, since most of the squirrels occur on private lands, the cooperation of private landowners will be vitally important if monitoring is to successfully determine the status of DFS populations.

At this time, county planning boards consider DFS in master planning to various degrees. Better coordination between county planning boards and between county planning boards and State and Federal agencies is needed to more effectively manage DFS habitats on a regional scale. Plans to increase public awareness, a major component of the Recovery Plan, have yet to fully take fruition. More efforts must be made to educate landowners and the public at large as to the habitat requirements and status of the squirrel. Greater public awareness could pay dividends in the form of added pressure on

elected officials to conserve DFS habitats. Since the major portion of DFS habitat occurs on private lands, sound habitat stewardship by private landowners is ultimately the most important requirement for the recovery of the squirrel.

Efforts must be made to remove the burden of protecting the squirrel from individual landowners to the public at large. As the system currently works, landowners bear the full brunt of the cost of maintaining this endangered species through a permitting process that ultimately decreases the value of the land by increasing the cost of development or eliminating the development potential altogether. This creates an atmosphere where rather than assisting with the recovery of the squirrel, private landowners are uncooperative from fear that they will suffer financial losses if the squirrel is found on their property. In their 1995 critical review of the Endangered Species Act, Mann and Plummer recommended the establishment of a “National Trust” that would cover the cost of preserving endangered species on private lands by buying the lands outright or compensating landowners for putting development restrictions on their property through tax incentives or monetary rewards. The trust would be established by congress and managed by an advisory board consisting of biologists, social scientists, economists, philosophers, and political scientists, whose mandate would be to establish biological priorities and weigh the economic, moral, and social implications of each case. Mann and Plummer also recommended that the definition of “take” exclude harm to habitat. This should improve the relationship with private landowners, who would no longer have cause for fearing financial ruin if endangered species were found on their property. According to Mann and Plummer, the availability of the Trust Fund to

compensate landowners who protect habitat should offset any losses resulting from loosening restrictions on development.

In the case of the DFS, this strategy with some modifications could be translated to the local/regional level. One of the major unrealized goals of the recovery plan was to better educate private landowners and the public at large concerning the habitat needs and other issues surrounding the continued existence of the squirrel. An initial public information campaign could be carried out in Delaware, Maryland, Virginia, and Pennsylvania at relatively little cost by placing ads in newspapers and placing public information announcements on local radio stations. The campaign should be timed to coincide with statewide elections. A voting referendum would then be placed on the statewide ballots to set aside funds to establish a land trust to preserve DFS habitat on the Delmarva Peninsula and Pennsylvania by compensating private landowners for giving up the development rights for their land. The land trust could be peopled with individuals with backgrounds such as those described by Mann and Plummer, who would be responsible for managing the trust and prioritizing land parcels for preservation. Members of the DFS land trust could also function as members of the recovery team, improving the capabilities of that group with the addition of more informed personnel.

It is important for the referendum to be statewide within each state, because all citizens of the each state, regardless of whether the squirrel resides in their county, should bear the cost of preserving the squirrel. It is important for society as whole to pay for the preservation of endangered species. Just as the cost should not be born by individual landowners, it should also not be shouldered only by the residents of certain counties where the squirrel resides. There is always the chance that the referendum would fail. In

that case, there may not be much hope for the squirrel, as society apparently has other priorities. Those interested in preserving the squirrel would have to find other means of establishing a trust, perhaps by resorting to referendums only in counties where the squirrel resides or by soliciting private funds.

Several important accomplishments have been made. The fact that resource agencies working with local land trusts and private landowners have been able to preserve almost 9000 acres of DFS habitat on Delmarva is a step in the right direction. Due to ever increasing development pressure, this needs to continue and be expanded through the establishment of a DFS land trust by referendum or other measures. The Homeport HCP is a good example of coordination between government agencies and a developer under the Endangered Species Act, leading to solutions that allow building to occur while limiting destruction of habitat and resulting in benefits to an endangered species through preservation of additional habitat. If the Homeport experience is any indicator, the future of development and the DFS habitat preservation on Delmarva need not be in conflicting directions.

## **REFERENCES:**

Allen, J.M. 1952. Gray and fox squirrel management in Indiana. Indiana Department of Conservation of Conservation, P-R Bulletin 1.

Bean, M.J., S.G. Fitzgerald, and M.A. O'Connell. 1991. Reconciling Conflicts Under the Endangered Species Act: The Habitat Conservation Experience. World Wildlife Fund, Washington, D.C. 109 pp.

Cassidy, K.M. and C.E. 2000. The role of private and public lands in at-risk vertebrates in Washington State. Wildlife Society Bulletin 28(4):1060-1076.

Dozier, H.L. and H.E. Hall. 1944. Observations of the Bryant fox squirrel. *Sciurus niger bryanti* Bailey. Maryland Conservation 21:2-7.

Dueser, R.D., J.L. Dooley, Jr., and G.J. Taylor. 1988. Habitat structure, forest composition, and landscape dimensions as components of habitat suitability for the Delmarva fox squirrel. In: Management of Amphibians, Reptiles and Small Mammals in North America. R.C. Szaro, K.E. Severson, and D.R. Patton, eds. U.S. Forest Service Technical Report RM-166.

Ferguson, R.H. and C.E. Mayer. 1974. The timber resources of Delaware. USDA Forest Service Resource Bulletin NE-32, Northeast Forest Experiment Station, Upper Darby, Pa.

Flyger, V. and D.A. Smith. 1980. A comparison of Delmarva fox squirrel and gray squirrel habitat and home ranges. Transactions of the Northeast Section of Wildlife Societies 37:19-22.

Frieswyk, T.S. and D.M. DiGiovanni. 1989. Forest statistics for Delaware-1972 and 1986. USDA Forest Service Resource Bulletin NE-109. Northeastern Forest Experiment Station, Broomall, Pa.

Frieswyk, T.S. and D.M. DiGiovanni. 1988. Forest statistics for Maryland-1972 and 1986. USDA Forest Service Resource Bulletin NE-107. Northeastern Forest Experiment Station, Broomall, Pa.

Harris, L.D. 1984. The fragmented forest: island biogeography theory and the preservation of biotic diversity. University of Chicago Press, Chicago, Illinois. 211 pp.

Keller, C. E. Unpublished data. USFWS biologist. Annapolis, MD.

Mackenzie, J. 1989. Land use transitions in Delaware, 1974-1984. Department of Food and Resource Economics, University of Delaware, Newark, DE.

- Mann, C.C. and M.L. Plummer. 1995. Noah's Choice: The Future of Endangered Species. Alfred A. Knopf, New York, 302 pp.
- Maryland Office of Planning. 1990. Maryland's land 1973-1990, a changing resource. Baltimore, MD.
- Moncrief, N.D. and R.D. Dueser. 1991. Genetic variation within and among populations of Delmarva Fox Squirrels (*Sciurus niger cinereus*). Final Report submitted to the U.S. Fish and Wildlife Service, Newton Corner, Mass.
- Meffe, C.K. and C.R. Carroll. 1994. Principles of conservation biology. Sinauer Associates, Inc., Sunderland, Mass. 600 pp.
- Nixon, C.M. and L.P. Hansen. 1987. Managing forests to maintain populations of gray and fox squirrels. Illinois Dept. of Conservation Technical Bulletin 5.
- Ratnaswamy, M. 2001. Personal communication with USFWS endangered species biologist.
- Ratnaswamy, M., C.E. Keller, and G.D. Therres. 2001. Private lands and endangered species: lessons from the Delmarva fox squirrel in the Chesapeake Bay Watershed. Unpublished. Submitted for publication to the Society for Conservation Biology.
- Shaffer, M. 1996. The promise of Gap Analysis for understanding biodiversity. Pages 3-5 in Gap Analysis – a landscape approach to biodiversity planning. J.M. Scott, T.H. Tear, and F.W. Davis, eds. American Society for Photogrammetry and Remote Sensing, Bethesda, MD.
- Taylor, G.J. 1976. Range determination and habitat description of the Delmarva fox squirrel in Maryland. M.S. Thesis, University of Maryland, College Park.
- Taylor, G.J. 1973. Present status and habitat survey of the Delmarva fox squirrel (*Sciurus niger cinereus*) with a discussion of reasons for its decline. Proceedings of the 25<sup>th</sup> Annual Conference of the Southeastern Association of Game and Fish Commissioners 27:278-289.
- Therres, G.D. 1998. Maryland's endangered species law as a tool for biodiversity conservation. In Conservation of biological diversity: a key to restoration of the Chesapeake Bay ecosystem and beyond, G.D. Therres ed. Maryland DNR, Annapolis.
- USFWS. 1999a. Delmarva Peninsula Fox Squirrel. Fact Sheet. U.S. Fish and Wildlife Service. April 1999. 2 pp. (Available at [www.fws.gov](http://www.fws.gov)).
- USFWS. 1999b. Biological Opinion: Application for incidental take permit/habitat conservation plan submitted by Winchester Creek Limited Partnership for the Home Port

on Winchester Creek Housing Development. U.S. Fish and Wildlife Service, Annapolis, MD. 19pp.

USFWS. 1995. Fact Sheet. Habitat Conservation Planning. U.S. Fish and Wildlife Service.

USFWS. 1993. Delmarva Fox Squirrel (*Sciurus niger cinereus*) Recovery Plan, Second Revision. Hadley, Mass. 104 pp.

USFWS. 1983. Delmarva Fox Squirrel Recovery Plan, First Revision. Newton Corner, Mass. 49 pp.

Weigl, P.D. M.A. Steele, L.J. Sherman, J.C. Ha, and T.S. Sharpe. 1989. The ecology of the fox squirrel (*Sciurus niger*) in North Carolina: implications for survival in the southeast. Bulletin of the Tall Timbers Research Station. 93 pp.

Willey, R.J. and A.G. Willey. 1999. Delmarva Fox Squirrel Survey for Home Port Development on Winchester Creek, Maryland, Spring 1999. Three-Square Wildlife Services, Cambridge, MD.

Wilson, E.O. 1988. The current state of biological diversity. Pages 3-18 in Biodiversity, E.O. Wilson and F.M. Peters eds. National Academy Press, Washington, D.C.

Winchester Creek Limited Partnership. 1998. Home Port on Winchester Creek Housing Development. Home Port Habitat Conservation Plan. October 1998. Winchester Creek Limited Partnership, Chester, MD. 70 pp.