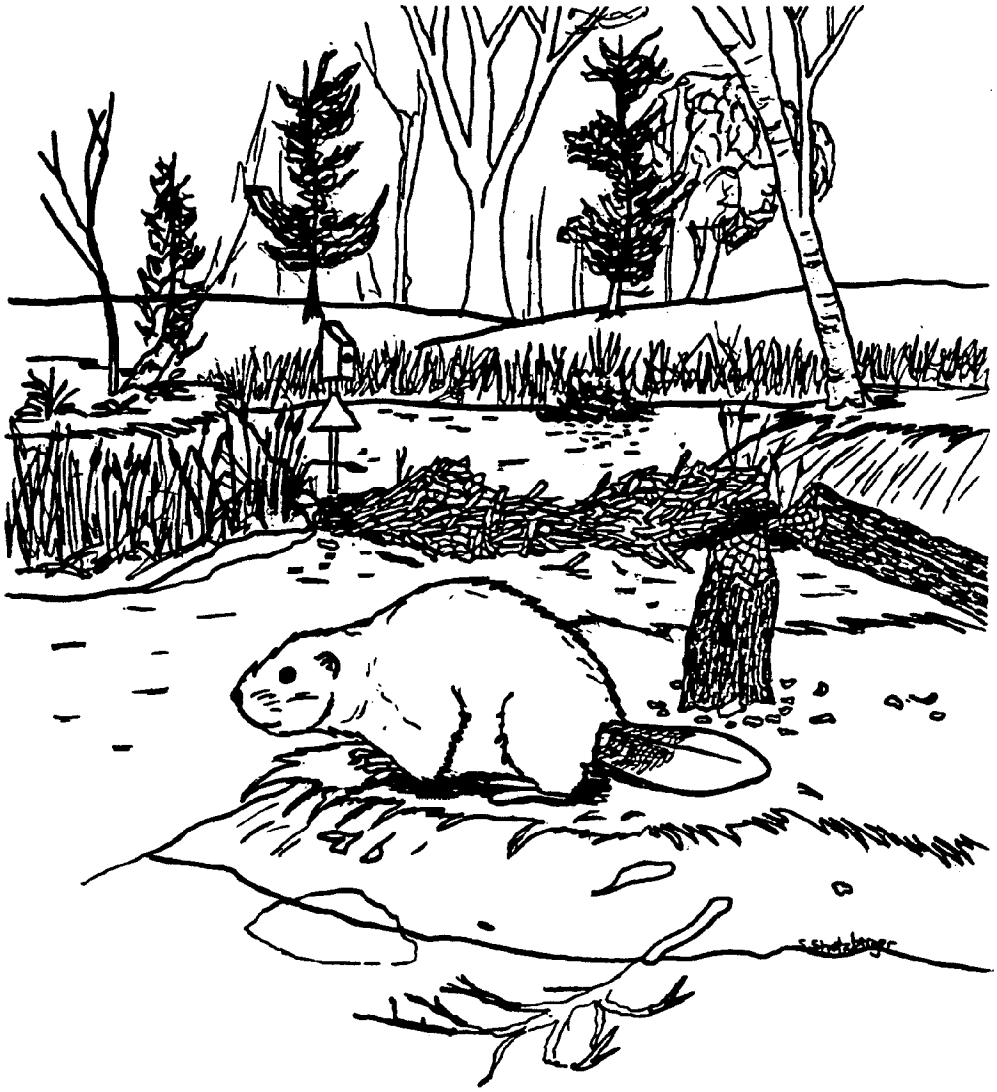
DELAWARE BEAVER MANAGEMENT PLAN

Delaware Division of Fish and Wildlife
Department of Natural Resources and Environmental Control

September, 1991



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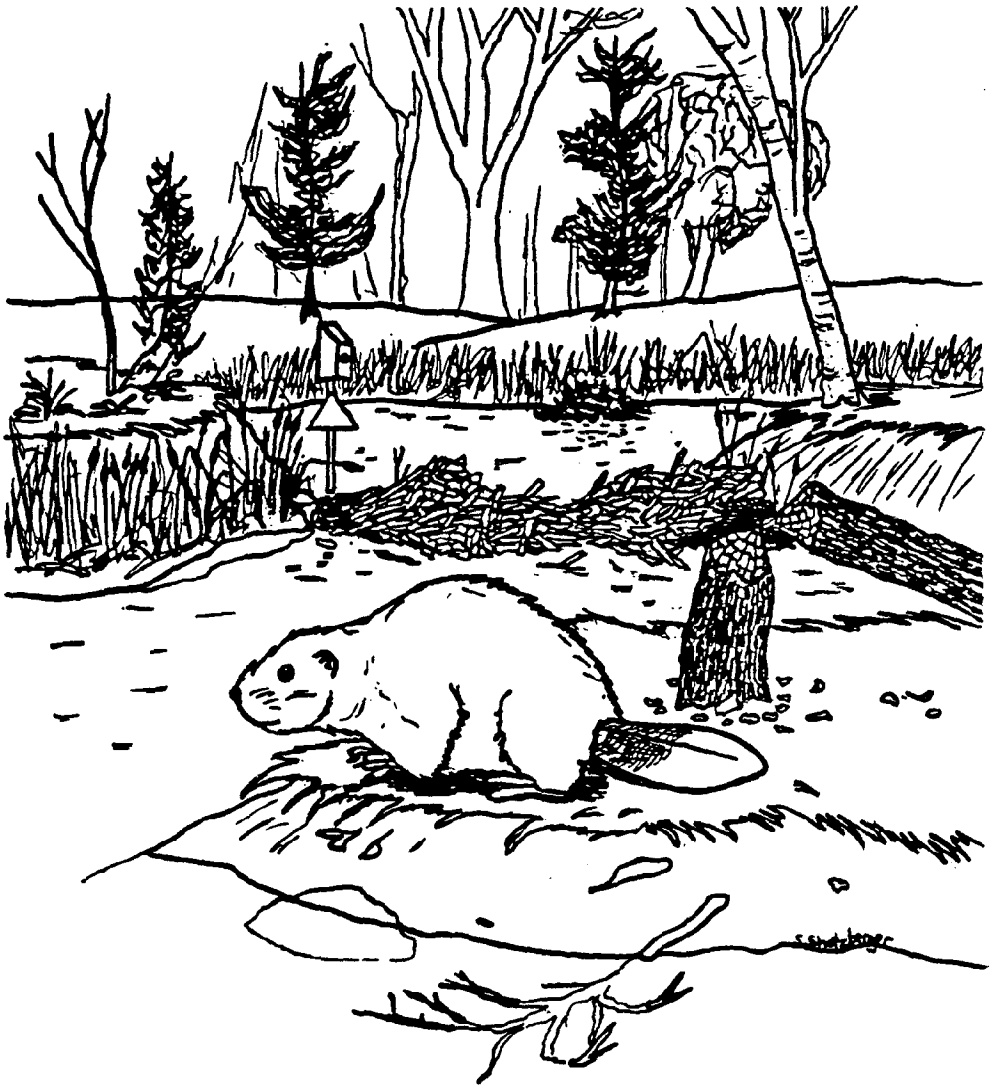

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EXECUTIVE SUMMARY

Following inter-agency and public review, the Delaware Division of Fish and Wildlife has developed a statewide Beaver Management Plan (BMP) designed to promote environmental benefits associated with beaver activities, and to contend with socio-economic problems that beavers may cause. The primary goal of the plan is to achieve and then maintain a maximum sustainable population of beavers and their associated wetland habitats throughout Delaware, located and managed in a manner compatible with other land uses and human activities. The BMP presents the Department of Natural Resources and Environmental Control's management perspective concerning beavers, and reviews beaver biology, ecology, and their historical and current population status in Delaware. Because of the critical environmental values and functions of Delaware's freshwater wetlands, and because the State has lost about one-half of its non-tidal wetlands acreage since colonial times, the beaver's role as a beneficial environmental agent becomes even more important in today's landscape. However, the beaver's substantial population expansion in Delaware during the past 20 years, coupled with the increasing development and urbanization of the State's rural areas, has increased beaver-caused socioeconomic problems, necessitating formulation and implementation of a BMP.

The environmental benefits of beaver are discussed in the BMP, which include: 1) enhancement, restoration or creation of quality fish and wildlife habitats for wetlands-dependent species; 2) increased biodiversity within the State's array of wetland types; 3) enhanced aesthetics and increased recreational opportunities; 4) floodwater control; and 5) improved water quality following reduction of dissolved nutrients and retention of particulate sediments that would have been transported downstream. Conversely, socioeconomic problems that are sometimes caused by beavers are also examined, focusing primarily on beaverdam-caused flooding problems, and on vegetation or timber damage or loss via cutting or girdling. These socioeconomic problems may affect residential, commercial or industrial development; agriculture; forestry; public health or safety; or transportation.

The BMP addresses factors to consider in determining if substantial beaver-caused socioeconomic problems are occurring, and identifies five categories of potential beaver problems: 1) private lands - urban/suburban/residential; 2) tax ditches and associated aglands; 3) public lands - conservation or recreational; 4) transportation - roads, highways, railways, airports; 5) private lands - rural (non-tax ditch). The BMP also examines response options that could be taken to contend with substantive beaver-caused problems. The response options include: 1) live-trapping and transfer of problem-beavers to carefully-selected release sites; 2) dispatch of problem-beavers, done by regulated contract trappers or other personnel;

3) implementation of a regulated trapping program open to the public; 4) installation of water control structures to manage maximum water levels at acceptable heights in beaverdam wetlands.

The preferred participation, roles and responsibilities of various government agencies and personnel in implementing a BMP are given in the plan. The potential types of costs in implementing a BMP, along with recommendations for cost-shared activities, are provided. A listing of management options to manage beaver-abandoned beaverdam wetlands is also given. Finally, the necessity for better public education and knowledge about beavers and their activities, needed for the public to become more tolerant of beavers and thus expand the beaver's environmental benefits, is discussed.

In order to implement the BMP, the following action-steps are recommended, dependent upon available resources:

1) In order to contend with excessive beaver densities and reduce nuisance problems, initiate a regulated, controlled trapping season open to the public. Only licensed trappers could participate, using prescribed methods in designated zones during specified seasons. The harvest goals would be conservatively set in order to avoid overharvesting, with the catch carefully monitored and analyzed.

2) Continue a regulated "contract" trapper program to address beaver problems that still remain or which cannot be handled via a public open season; remedies under the "contract" trapper program include dispatch or live-trap and relocation.

3) Designate Division of Fish and Wildlife biologists to:

   a. Design, implement, monitor and analyze controlled harvests by licensed trappers during zoned seasons open to the public;

   b. Make technical determinations and recommendations to landowners, on public and private lands, whether or not a beaver complaint is a substantive problem needing remedial action;

   c. Make technical determinations and recommendations to landowners, on public and private lands, of the preferred remedial actions to contend with individual substantive problems;

   d. In order to promote the distribution or recovery of beavers in suitable areas throughout Delaware which do not yet have a desired population density of beavers, continue a program which solicits,

evaluates and inventories potential relocation sites for problem-beavers caught elsewhere in Delaware;

e. Coordinate (or in some special cases supervise or perform) the live-trap and relocation program for problem-beavers;

f. Perform casual monitoring at release sites of the activities and colony success of trap-and-transferred beavers;

g. Help to coordinate (or in some special cases help to supervise or perform) the use of structural remedies;

h. Contribute to and help to maintain databanks, maps, inventories, and other records necessary to run a statewide beaver management program.

4) Using environmental criteria identified in the BMP, evaluate the environmental importance or quality of existing beaverdam wetlands throughout the State, done in order to help determine the level of funds or effort that might be allocated for treating substantive socioeconomic problems that may occur at specific sites; this assessment could be done in advance, or could be done on a case-by-case basis when (and if) substantive problems occur in association with existing beaverdam wetlands.

5) Perform long-term evaluations of the effectiveness and utility of various structural remedies (e.g. water level control devices) to contend with beaver-caused problems.

6) Develop cost-share programs for BMP activities that are desirable and suitable for the cost-share approach.

7) Prepare an informational brochure for distribution to landowners and the general public about beavers, their biology and ecology, their environmental benefits, their potential socioeconomic problems, the solutions or remedies to such problems, where and from whom to get further help, etc.

The target audiences for the Beaver Management Plan (in the form which follows) include the professional technical staff of the Division of Fish and Wildlife (who will have the primary responsibility for implementing the Plan), other technical staff associated with pertinent federal or state agencies charged with natural resource management or regulation, and technically-oriented policy-and-decision makers.

DELAWARE
BEAVER MANAGEMENT PLAN

I. Introduction

The Delaware Division of Fish and Wildlife, Department of Natural Resources and Environmental Control, is the agency responsible for the management of beavers (Castor canadensis) in Delaware. The Division of Fish and Wildlife is mandated by Section 8005, Title 29, of the Delaware Code to protect and conserve Delaware's wildlife resources. The Division's management philosophy to implement the provisions of this statute is given in Appendix 1. The goal for formulating a Beaver Management Plan is to provide guidelines and criteria for the management of beaver populations, on public and private lands, in Delaware. While this management plan is designed to be as comprehensive and flexible as possible, it should be considered a dynamic document subject to on-going review and could be modified as needed.

Beaver have not been harvested commercially in Delaware since colonial times due to diminished populations caused by over-trapping, which almost led to their extirpation from the state. In recent years however, beaver populations have rebounded and expanded into areas of the state where their activities are sometimes incompatible with primary land-use practices. As a result, there has been an increasing number of landowner complaints concerning beaver activities, including the flooding of agriculture lands, woodlands, personal property, and highways, plus timber damage and cutting of ornamental trees. At the same time, increased beaver activity has provided environmentally-beneficial effects including the creation of high quality wetlands habitat for a variety of wetland-dependent flora and fauna; removal of excess dissolved nutrients; particulate sediment and toxicant retention; floodwater detention; and enhanced aesthetic values and recreational opportunities. It is the Department's goal to promote these environmental benefits in a manner compatible with other land-use practices and goals.

II. General Policy and Plan Purpose

Beavers and their activities can provide substantial environmental benefits, in particular valuable fish and wildlife wetland habitats and improved water quality. It is the Department's policy to promote the establishment, expansion and recovery of beaver in Delaware in locations where unacceptable socioeconomic problems will not occur. The promotion of this policy will involve conflict assessment and resolution regarding beaver-induced environmental modifications and the socioeconomic interests of agriculture, forestry, highways and transportation, public health and safety, and industrial, commercial or

residential development. Determining and implementing conflict resolutions will also incur expenses to both public and private sectors. However, these resolvable concerns should not outweigh the environmental benefits that a managed beaver population could provide in Delaware, and thus the Department views the beaver as a beneficial environmental agent.

In order to promote a managed beaver population in Delaware, the Department has developed a "Beaver Management Plan" focused on three primary topics:

1. Promotion of the environmental benefits provided by beavers;

2. Evaluation procedures and guidelines for determining where and when beavers are causing unacceptable socio-economic impacts;

3. Action procedures and guidelines for determining and taking corrective measures to address unacceptable socioeconomic impacts.

The primary goal of the plan is: to achieve and then maintain a maximum sustainable population of beavers and their associated wetland habitats throughout Delaware, located and managed in a manner compatible with other land uses and human activities.

A statewide quantification of the maximum sustainable population goal is not yet possible, since we do not know the number of remaining unoccupied sites in the State where the habitat is suitable for beaver colonization and for which beaver activities will not create substantive socioeconomic problems. The Plan's intent is to eventually reestablish beaver colonies throughout all of Delaware's watercourses, wherever beaver find suitable habitats and where they do not cause substantive problems. When all such sites are eventually occupied, whether this maximum occupancy be on a local, regional or statewide basis, then beaver population growth beyond maximum levels of distribution and abundance (i.e. beyond maximum sustainable populations on local, regional or statewide bases) must be proactively curtailed. It is not necessary nor desirable that 100% of all potentially inhabitable sites must be colonized (on local, regional or statewide bases) before this curtailment begins, since it is desirable to maintain (or create) temporarily vacant areas which may eventually be colonized by future beaver generations.

III. Biology and Ecology

1) Description

The beaver (Castor canadensis) is a member of the order Rodentia and is the largest rodent in North America. An adult

beaver usually weighs between 35-70 pounds and can be almost four feet long. The beaver's coat consists of underfur and long guard hairs giving it a course appearance, and can vary in color from yellowish-brown to reddish to almost black. Two prominent characteristics of beaver are a paddlelike tail and large incisors which grow continuously. The beaver's skeleton is heavier than animals of similar size in order to withstand the stress of gnawing and cutting of hardwoods. The beaver is specialized for aquatic life, with its hind legs and feet, webbed toes and flattened tail all adapted for swimming. The nostrils are closeable, the ears have valves that can close, and skin flaps seal the mouth leaving the incisors exposed for carrying tree branches underwater.

2) Range and Habitat

Beaver can be found throughout most of North America from the Atlantic to the Pacific (including most of Alaska) and from Canada to Florida. It is believed that the beaver's historic range included all areas of North America that contained plants and water suitable for its winter survival. Typical habitats include rivers, impoundments, lakes, streams and tributaries that have adequate flow for damming to provide seasonably-stable water levels. Although beaver can occur in steep, rocky habitats, they prefer areas of relatively flat terrain.

Beaver habitat must contain all of the following: (1) a stable aquatic habitat which provides adequate water; (2) a channel gradient of less than 15%, with less than 6% ideal; and (3) quality food species present in sufficient quantity (Williams 1965).

3) Dens, Lodges, Dams and Other Structures

Beavers live in excavated bank dens, or build dome-shaped lodges constructed of limbs or branches from felled trees and saplings and then caulked with mud. A bank den or lodge has at least two entrances and may have four or more. Bank dens are often dug and inhabited when beavers first move into an area, occupied as they build their dams and lodges. Additional bank dens are often built to provide strategic locations where they can rest or take refuge. In some areas where water levels are already adequately deep and stable, or conversely where streams or rivers are shallow but subject to severe floods, dams are not built and beavers sometimes live their entire lives in bank dens. Beavers living in pond lodges occupy a dry chamber above waterline, which is created by cutting away brush or sticks in the chamber's ceiling and trampling the material under foot. Lodges can be constructed in the center of ponds as island houses, or are sometimes built along pond edges, usually overtop the den of a bank burrow which has been abandoned as water level rose. Lodges can rise up to 7 feet above pond bottom, and can be more than 14 feet in diameter.

The length and height of beaverdams, made from limbs, branches, stones, mud and other debris, depends on what is necessary to stop the flow of water and create a pond. Beavers are constantly working on either increasing the size of their dams or on maintaining or repairing what they've built. Beaver dams are designed to maintain water levels above lodge entrances and to provide open water for easy swimming, needed to expand and allow safe access to food sources. Beaverdams usually average less that 6 feet high, but in narrow, steep-sided vallyes have been found to be up to 15 feet high. Thickness of a dam's base is usually from 8-18 feet, while width at the top is from only a few inches up to 3 feet. The length of dams is very variable, ranging from only several feet long when blocking culverts, underpasses or narrow corridors, up to over 2000 feet long in some western meadow valleys. A single beaver colony may build one or more secondary dams within a few hundred feet of the primary dam, in downstream or upstream locations, relieving the main dam from excessive water pressures, and providing additional waterborne access to new feeding areas.

Beavers are also well known for excavating travel canals (inundated trails) connecting their dam-formed pools or to provide access to feeding sites. Another highly visible structure created by beavers is a food pile, composed of unpeeled limbs, branches and twigs, deposited near the lodge to provide a winter food supply.

4) Food Habits

Beaver will eat the leaves, twigs and bark of most species of trees and woody plants, but prefer species such as aspen, poplar or, in Delaware, red maple, cottonwood, willow, alder, sassafras, sweetgum, blackgum, dogwood, holly, oaks and even pine. An ideal food situation for woody vegetation would be a stand of preferred food trees (e.g. aspen, poplar, willow, cottonwood, alder) within 100 yards of a watercourse, having a size from 1-6 inches dbh with 40-60% canopy closure (Allen, 1982). Beaver also feed on herbaceous and aquatic plants, vines, roots, the fruit of woody plants, and sometimes even agricultural crops such as corn or soybeans. Aquatic vegetation such as arrowhead or duck potato (Sagittaria spp.), duckweed (Lemna spp.), pondweed (Potamogeton spp.), water weed (Elodea spp.), and water lilies (Nymphaea spp.) are preferred food when available. If present in adequate amounts, the roots and rhizomes of water lilies provide satisfactory winter foods, and may result in little cutting or caching of woody materials for winter sources. When one considers that beaver have even colonized irrigation ditches in the Great Basin Desert of Nevada, it is apparent that they are able to eat a wide variety of foods.

Most trees for food, shelter or dams are felled within 30 yards of the lodge; however, beaver will travel and cut choice foods up to 100-200 yards away. Beavers appear to prefer

herbaceous vegetation, when available, over woody vegetation during all seasons of the year (Jenkins 1981).

5) Wetlands Successional Cycles

When food supplies at a site become too scarce, or when beavers cannot raise their dams to create new waterborne access to new food sources, beavers will abandon the site. When this happens, deterioration of the dam eventually occurs and water levels drop, causing the beaverdam wetlands to go through a successional wetland series from permanently-inundated wetlands to seasonally-inundated wetlands to temporarily-inundated wetlands. This successional series, after several decades, may culminate in a wet meadow with a shallow central channel. As woody growth recolonizes the perimeter of the meadow and encroaches across the open meadow itself, food conditions may again become suitable for beaver to return to the site and construct a new dam, starting the wetlands successional cycle anew.

The wetlands successional cycle created by beaver activities forms a complex of wetlands types, with the wetland type at any specific site being a transitory stage, different than what existed a decade before and destined to be different ten years later. At any one time in a region where beavers have been established for several decades, there will be a mosaic of wetland types of different ages, forming a diversity of wetlands habitats. Thus, beavers and their activities are significant agents in promoting biodiversity, creating a series of ephemeral wetland habitats critical to the perpetuation of many endangered, threatened or rare plant and animal species. Active or abandoned beaverdam wetlands in Delaware are important quality components of the State's freshwater wetlands array, contributing to both the State's proposed Type I wetlands (unique biotic assemblages) and proposed Type II wetlands (moderately-wet to very-wet wetlands), plus restoring or expanding proposed Type III wetlands (marginally-wet wetlands) in peripheral areas.

6) Reproduction and Development

Beavers are monogamous and are believed to pair for life. They are sexually mature when they are 1-1/2 years old, but their first litter usually occurs at age three. Breeding usually occurs between January and March with a subsequent gestation period of about 100-110 days. Copulation takes place either in the water or in the lodge or bank den. Litter size varies with the age of the female and quality of habitat. A typical litter is three to four kits with a range from one to nine, and they are born fully-furred with eyes open. The female produces one litter per year, with the kits typically born in May, and the mother nurses the young for approximately 6-8 weeks. At birth a kit weighs about one pound, reaches 4 pounds when weaned, and grows to 15 pounds by the start of its first winter.

The young are usually displaced from the colony by the adults after approximately two years of age, in March following their second overwintering in the lodge or den, in advance of the arrival of the year's new litter. Thus, during mid-winter within most colonies, there's usually the two adult parents, a few yearlings (sub-adults) from the litter two years before, and a few older kits from the current year's litter. The displacement of offspring from the colony after two years of development causes the geographical expansion of the population, which sometimes leads to new socioeconomic problems as the dispersed young adults build new dams, mate and establish new colonies. While the dispersion of some young up to 150 miles from parental colonies has been documented, average emigration distances range from 5-10 stream miles. Another type of displacement, but which is voluntary in nature, is when the male parent leaves the lodge after the kits are born, staying out until the kits are fully weaned. During this time, the male takes up solitary residence in a bank den, but remains within the colony's habitat, working on dams, food piles, and the lodge.

7) Population Structure and Density

Based upon population data of trapped beavers from widespread areas across North America, and disregarding trapping biases, the mean percentages of kits (young-of-the-year), sub-adults (yearlings), and adults (two years and older) in an average beaver population is 30%, 23%, and 47%, respectively. Sex ratio in beavers is almost even, with total population averages from widespread areas yielding a male:female = 105:100.

Not surprisingly, reported population densities for beaver are widely variable, dependent upon habitat quality and harvest or mortality factors. Beavers are highly territorial, and will mark their territories with scent mounds. Beaver colony territories are distinct and non-overlapping, with usually no more than one colony per 0.5 miles of stream length. Densities are reported either as number of colonies per unit area or per length of stream. Examples of the former are as follows: colony densities in Algonquin Park, Ontario = 0.98-1.97 colonies per square mile; in the MacKenzie Delta, Northwest Territories = 1.01 colonies per square mile. Examples of the latter are: colonies along streams in New Brunswick = 0.14-0.22 colonies per stream mile; in Alaska = 0.56-0.77 colonies per stream mile. The typical densities of colonies in favorable habitat range from 1-2 per square mile. Densities greater than 1.98 colonies per stream mile are estimated to exceed saturation maximums in New York, while saturation is considered to occur in Alberta at only 0.64 colonies per stream mile, but saturation doesn't occur in Alabama until densities exceed 3.0 colonies per stream mile. The mean number of beavers per colony, based on survey data from 22 states and provinces, averages 5.2 animals per colony; an extreme number of animals per colony would be 12 individuals.

8) Mortality

Beaver have a normal life expectancy of about 10 years in the wild, although captive animals may live to 21. Numerous predators affect the beaver throughout its range. In wilderness areas these include man, coyotes, bobcats, wolves, bears and wolverine. In Delaware, the major predator on adult beavers is man, but both feral and domestic dogs may also kill adults. Young kits may be killed by river otter or mink. In addition, there can be territorial conflicts between beaver and otter. Tularemia, a bacterial disease, has caused mortality and decimation of beaver populations in the Rocky Mountain and northern states, but is not common in beavers in the southeast. Giardiasis, a protozoan parasite, is carried by beavers but does not appear to severely affect them; however, excretion of this parasite by infected beavers appears to have contaminated water bodies over a wide geographical range (e.g. Maine, Texas), and may lead to outbreaks of the disease in humans who drink untreated surface water. In some regions, snow melt and heavy spring rains can cause flooding, which may destroy lodges and drown beavers under the ice. Starvation, particularly in northern high latitudes near the range edge, can be a mortality factor.

IV. Status and Trends of Beaver in Delaware

1) Historical Distribution of Beaver in North America, the mid-Atlantic, and Delaware

Beaver were essential providers of fur, food and other important products in early settlement days. Beavers ranged over all of boreal and temperate North America, as long as there was acceptable habitat. Before European settlement of North America, the total continental beaver population was estimated to be 60-400 million individuals. It is probable that almost all streams or creeks on the Delmarva Peninsula during pre-colonial times were staircase-series of beaverdam-regulated flowages. However, intensive trapping by early settlers reduced their populations to alarmingly low levels. Extensive removal of beavers in North America began in the early 1600's. For example, 10,000 beaver per year were estimated to be harvested in Massachusetts and Connecticut during the 1620's, and 80,000 beaver per year were estimated to be taken from the Hudson River valley and western New York during the 1630's. Beaver were probably almost extirpated in Delaware by the mid-1800's. The current population of beavers in North America is estimated to be between 6-12 million individuals. Gregg (1948) summarized the national situation when he stated that "the ground swell of conservation consciousness brought attention to the beaver as a vanishing species, and due to widespread interest, stringent or total protection was provided by law almost everywhere in the United States by World War I."

An indication of the widespread distribution and historical abundance of beaver in Delaware can be gleaned by examining the placenames for Delaware's streams, creeks and other geographical features. In New Castle County, there are two streams named Beaver Branch, plus a Beaver Creek; Beaver Valley is an area near Wilmington. Kent County has three streams named Beaverdam Branch, plus two Beaverdam Ditches and one Beaver Gut Ditch. Sussex County has three streams named Beaverdam Branch, plus one Beaver Dam Run, a Beaverdam Creek, and a Beaverdam Ditch. One may also find in Sussex County a Beaverdam Bridge, a Beaverdam Cemetary, and an area called Beaver Dam Heights.

An illustration of how rapidly beaver can repopulate an area or region, when they are protected and allowed to occupy the suitable habitats that remain, is provided in Pennsylvania, where beavers were essentially extirpated by the early 1900's. Between 1917 and 1920, 28 pairs of beavers were imported from the upper Great Lakes region by the Pennsylvania Game Commission and released in suitable habitats. By 1930, over 1500 known colonies were documented in 49 Pennsylvania counties. During the first trapping season in Pennsylvania in 1934, 6400 beavers were taken (Hilfiker, 1991).

In 1935, the Delaware Board of Game and Fish Commissioners purchased three pair of beaver from Maine in an attempt to restore beaver in Delaware, and released one pair in each Delaware county (New Castle, Kent and Sussex). By 1943, it was estimated that these initial releases had increased to a total of 24 individuals. Additional beaver have also since moved into Delaware from Maryland, where populations were not historically reduced to the very low levels which occurred in Delaware.

The Division of Fish and Wildlife's Wildlife Section started to respond, as a non-mandated public service, to beaver-problem complaints in the early 1970's. In 1972, the Wildlife Section heard only one public complaint, and received four public complaints in 1973; throughout the remainder of the 1970's, beaver complaints remained at similar low levels per year. When complaints were addressed by the Wildlife Section during the 1970's, the typical response was to live-trap problem-beavers and transfer them for release in Maryland, or to dispatch problem-beavers on-site. The Division's Enforcement Section started to respond to beaver complaints in the early 1980's, when problems started becoming more numerous. Simultaneous with the 1980 decision to transfer responsibility for handling problem-beavers to the Enforcement Section, the Division made a policy decision to live-trap and transfer for in-state release (at suitable sites) as many of the problem-beavers as practical, done in order to promote the environmental benefits of beaver activities in Delaware. Concomitant with this decision was a realization that the Division would also have to be as responsive as practical to public complaints about beaver nuisances, whether the problems be real or only perceived.

Beaver populations in Delaware greatly increased and expanded throughout the 1980's, and have now reached a level of nuisance taxing the capability of the Division's staff and resources to provide satisfactory responses. In 1990, the Division's enforcement officers spent 550 man-hours attending to beaver problems in New Castle County and northern Kent County. Also in 1990, Division enforcement officers spent at least 150 man-hours attending to 28 problem-beavers in southern Kent County and Sussex County, which was time withdrawn from their enforcement duties and responsibilities. The necessity for this level of response effort not only reflects an increase in beaver numbers, but also the rapid development and urbanization of formerly rural areas in Delaware, creating more beaver-human conflicts.

2) Current Status of Beaver in Delaware

Beaver are currently protected in Delaware by state statute, and have been protected by law since the late 1920's. By Section 701, Chapter 7, Title 7 of the Delaware Code (see Appendix 2), beavers are considered game animals and thus protected. Limited trapping of beavers, from December 15 through March 15, done only under a special permit issued by the Division of Fish and Wildlife, may be done by landowners (or their agents) who have beaver problems or damage on their property. Each landowner's name (and any contracted trapper) must be listed on the permit, and all beavers caught must be presented to the Division for pelt tagging. At other times of the year, problem-beavers may still be trapped under a special animal damage control permit, applicable to many species, which is also issued by the Division of Fish and Wildlife. Additionally, as an ad hoc service function to citizens complaining about beaver nuisance problems, Division of Fish and Wildlife enforcement officers (or their agents) have also trapped and removed problem-beavers.

3) Current Distribution and Population of Beaver in Delaware

An initial survey was conducted in 1990 in order to determine the locations of existing dams and lodges in Delaware (see Figures 1-4 for beaverdam sites). There are at least 126 active beaverdams in Delaware, yielding an estimated total statewide population of 750-1500 beavers. This number is based on the premise that each "beaverdam wetland" has at least one colony, although each designated site may have more than one dam in close proximity to the main dam. Using an average value of 5.2 beavers per colony yields 655 beavers in the known 126 sites. An extra 95 beaver were added to the total to bring the minimum estimation to 750 beavers statewide, to account for overlooked or unknown colonies, particularly in Sussex County (the extra 95 beaver would represent an additional 18 colonies). The minimum estimation was then doubled to yield a maximum statewide estimation, based primarily on subjective knowledge that "bank beavers" are also a substantial component of Delaware's population, but how substantial is truly a

Figures 1-4

Locations of Beaverdams in Delaware, 1991

Figure 1	Statewide Locations	(126 sites)
Figure 2	New Castle County	(33 sites)
Figure 3	Kent County	(71 sites)
Figure 4	Sussex County	(22 sites) *

* The number of beaverdams in Sussex County, particularly in the western and southern portions, is probably an underestimation, since these areas are relatively remote and the frequency of beaver-complaints is low.

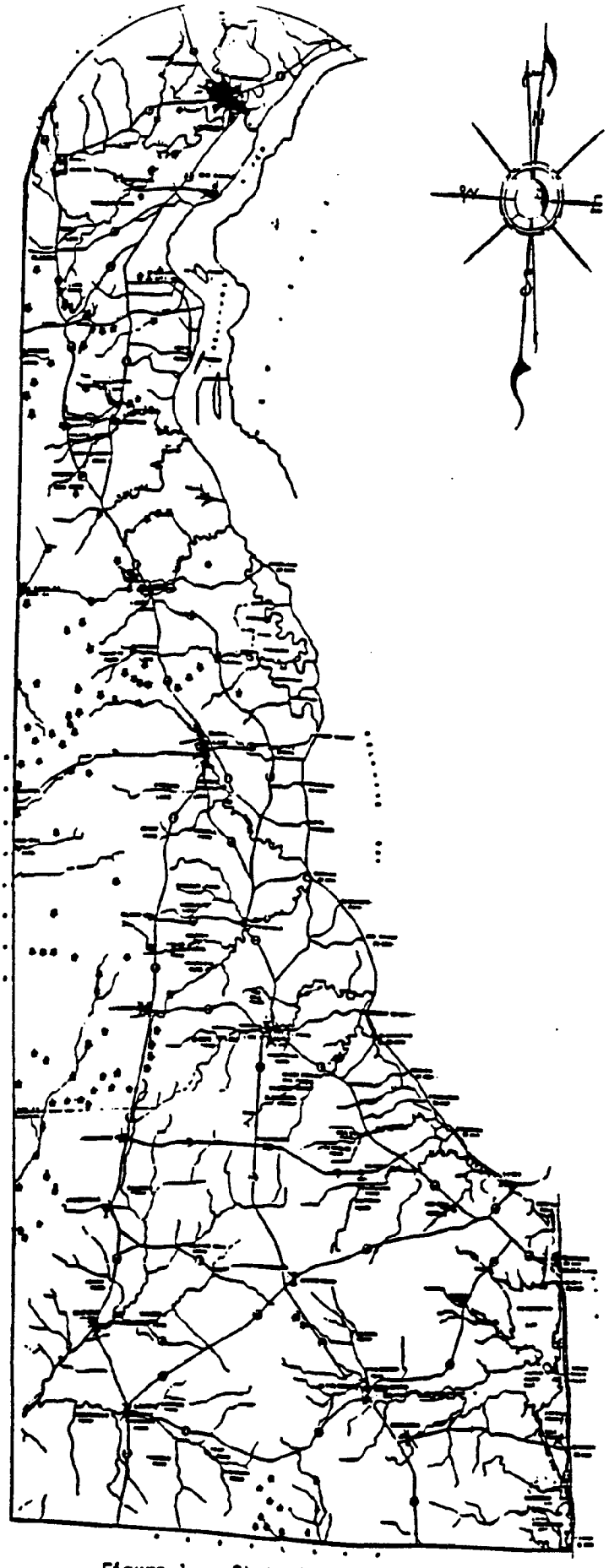

Figure 1. Statewide Locations

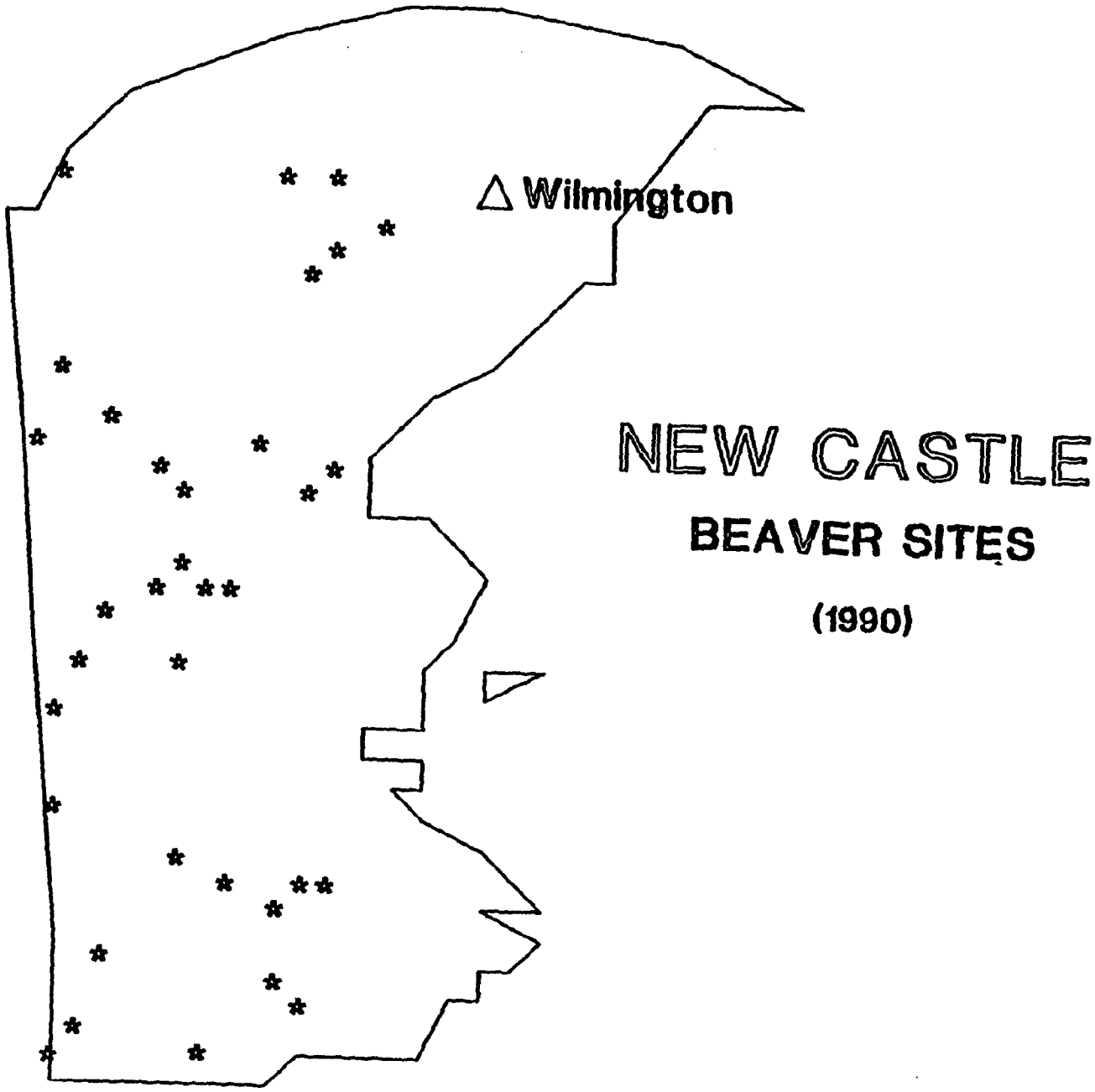

Figure 2

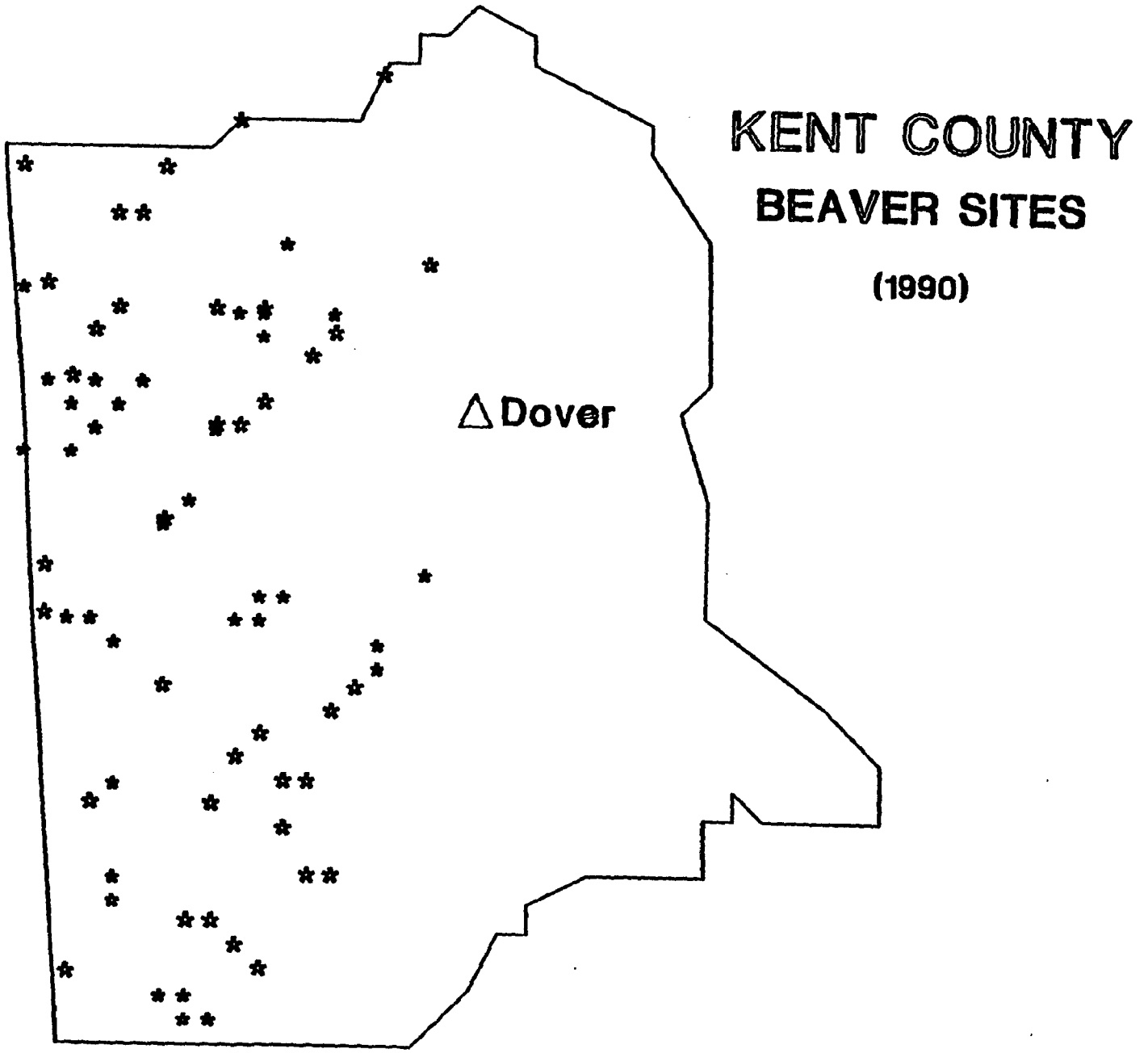

Figure 3

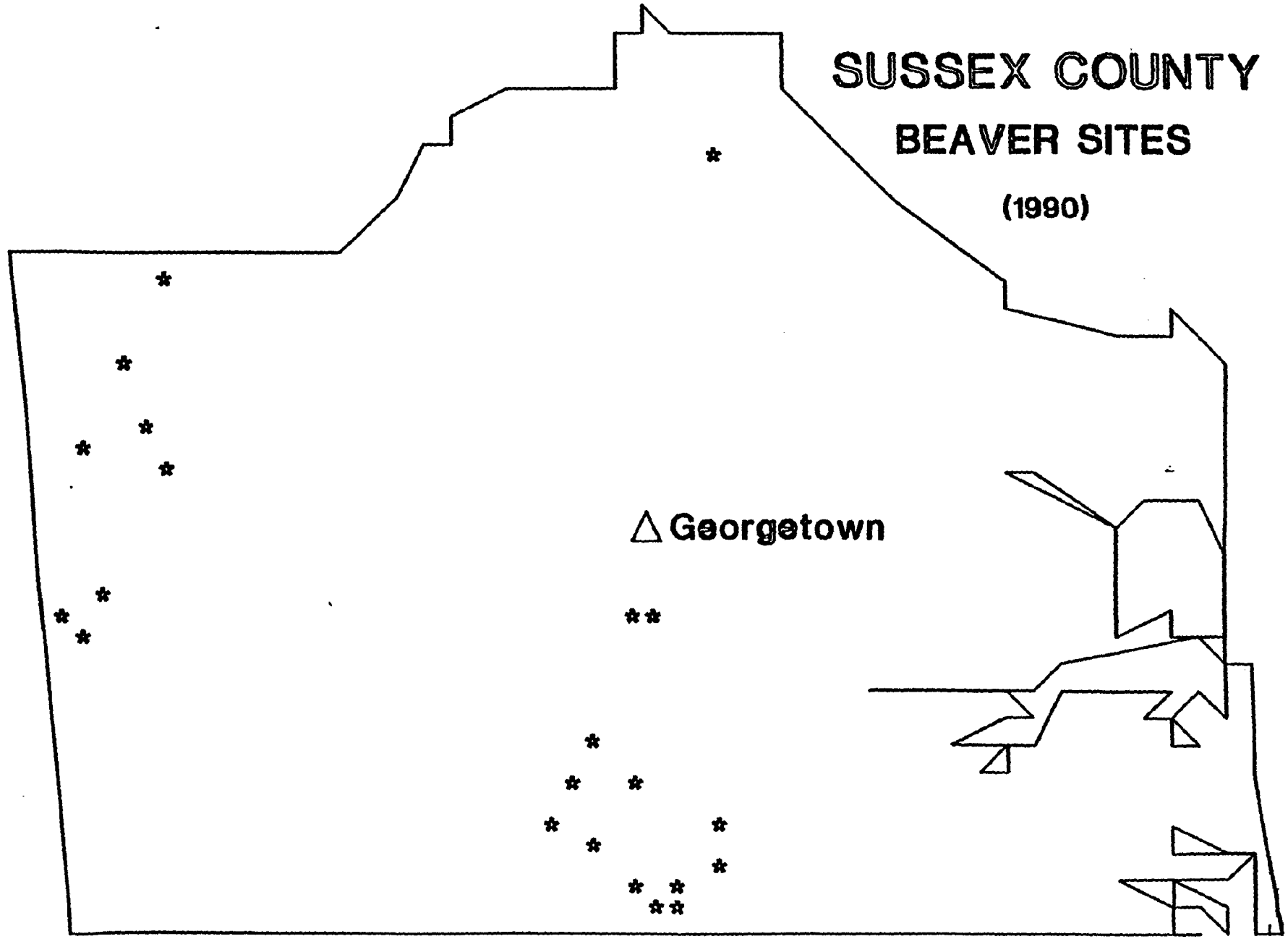

Figure 4

guesstimate. Beaver activities control the hydrological regimes on at least a few thousand acres of Delaware's remaining 130,000-150,000 acres of non-tidal wetlands. Survey data will be updated periodically in order to document changes in trends and distributions throughout the state. The frequency and methods for survey updating will be developed later.

4) Future Population Growth of Beavers in Delaware

The population expansion of beavers in Delaware has been substantial throughout the 1980's. However, the amount of suitable sites for future population expansion has undoubtedly declined since the early 1980's, although potential sites still exist, particularly in rural areas of Sussex County and southern or eastern Kent County. Potential suitable sites for future colonization (or release) are discussed in more detail in Section VIII-1A and 1B.

Because of the population expansion throughout the 1980's, it is probable that the rate of population growth is now slowing as more and more suitable sites have been occupied. However, the total number of beavers will continue to grow for the foreseeable future, creating more socioeconomic conflicts caused by a still burgeoning total population and dwindling suitable habitats. Adults living in the habitats where beavers do not cause socio-economic problems will continue to produce offspring, which may cause problems following the offspring's emigration from parental colonies.

A quantified estimation of future beaver populations in Delaware is somewhat difficult to predict, but if we make several assumptions, estimations can be generated based on projections of past trends. Prior to the rapid expansion of beavers in Delaware during the 1980's, a liberal estimation of the number of active beaver colonies in the state during the late 1970's would be 20. Thus, for the 11-year period from 1980 through 1990, the number of beaver colonies would have increased by 106 (to today's estimate of 126 colonies statewide), an average increase of 9.6 colonies per year. However, this average rate of increase is misleading, since what we really need to know is the realized rate of increase (r) per year, because accelerated population growth is an exponential function. A yearly population increase of about 16.7% (r=0.167) from 1980 through 1990 would increase the number of colonies from 20 to 126 during this period.

Making the assumption that the annual rate of future increase will be an exponential function with r = 0.167 (which assumes that future reproduction and mortality rates will not change from the past, that the availability of suitable habitat for future colonization will be the same as in the past, and that our past management policies and practices will continue), then some projections of future beaver populations in Delaware can be made. Using an average colony size of 5.2 beavers per colony, beavers in Delaware could increase from a very conservative

estimate of 655 animals (126 colonies) in 1990 to: 775 animals (149 colonies) in 1991; 915 animals (176 colonies) in 1992; 1508 animals (290 colonies) by 1995; and 3479 animals (669 colonies) by 2000. It is quite probable that the limited carrying capacity of suitable habitats in modern Delaware will never permit such an expansion, but as the modern carrying capacity is approached (whatever it may be), we can only expect that beaver-human conflicts and associated socioeconomic problems will continue to increase.

An interesting estimation to make, based upon available density estimates from remaining wild areas in the East, is that Delaware's approximate 1892 square miles of non-tidal lands could have supported over 10,000 beavers in pre-colonial times. Today's beaver population, which has rebounded since the early 1980's, probably represents less than 10% of the State's historic abundance.

The most effective control for an overly abundant beaver population, and often the only practical control, is a trapping (dispatch) program. Experience in other regions suggests that an annual harvest of one-third of the estimated population can maintain beaver populations or even allow a slow increase in high quality habitats (Denny, 1952). Various methods to achieve this harvest goal, while avoiding overharvesting, include trapping about 1.5 beavers per colony per year, or trapping each colony more intensively but on a 2-3 year rotational cycle, or on completely trapping-out some colonies for a 4-5 year period while allowing others to remain undisturbed.

5) Examples of Beaverdam Wetlands Habitat in Delaware

Habitat evaluation surveys were conducted at 3 selected beaver colonies in Delaware during 1990 (Appendices 3-5). Data collected included information on vegetative cover, fish and wildlife species present, dimensions of dam, number of lodges or bank dens, depth of water upstream and downstream of the dam, and approximate age of the dam (assessed via contacts with landowners or field staff, or by presence of fresh cuttings). Information collected will help determine positive and negative aspects of beaver activities at the selected sites, will also be valuable in assessing other existing sites, and will also be useful for determining desirable features of future release sites as beaver complaints and concerns are addressed. The criteria for determining a beaver nuisance site vs. a non-problem area were initially examined at these 3 sites. In some cases an area impacted by beaver causes problems that are unacceptable to the landowner, and corrective actions need to be taken. Each of the 3 sites was evaluated to determine whether it is a problem site or not, based upon complaints received, flooding potential, and on-site and adjacent land-use practices.

Site #1 - Garrisons Lake

The first site that was evaluated is above Garrisons Lake (Kent County) (Appendix 3). A pair of Maine beavers were introduced into this area in 1935 (Bonwill and Owens 1939). They were released into the Willis Branch which flows into Garrisons Lake. This site was selected for habitat evaluation because it probably represents a site having no apparent socioeconomic problems caused by beaver activity.

Site #2 - Paradise Alley

The second site chosen for evaluation is located south of the town of Felton (Kent County) on Paradise Alley Road (Appendix 4). This area has some beaver-caused problems, including flooding of private property where the landowner perceives a loss of commercial timber, cutting of ornamental trees, and the potential "undermining" of a train trestle. A water control pipe was installed through the dam to attempt to maintain a constant desirable water level; however, beaver effectively plugged the pipe, causing it to fail. (This led to a conclusion that further research needs to be done on different types of beaverdam water control pipes - see structural remedies, Section VIII-3).

Site #3 - Massey's Pond

The third site for evaluation is currently having no apparent adverse impacts due to beaver activity. The location of the site is in a existing millpond called Massey's Pond (Kent County) (Appendix 5). Beaver have built a lodge and are using the pond, but they do not appear to be building any dams.

V. Environmental and Socioeconomic Benefits of Beavers and Beaverdam Wetlands

Beaver activities provide many environmental benefits, with particular emphasis on fish and wildlife habitat, recreation and aesthetics, flood control, and water quality. In terms of improving the quality and quantity of Delaware's freshwater wetlands, there is probably no more cost effective agent to enhance, restore or create wetlands environs than the beaver. A beaver management program, which promotes beaver colonization where socioeconomically feasible, can probably do as much as man's efforts (if not more) to improve Delaware's freshwater wetlands, achieved at a fraction of the cost. Reestablishment of the historical distribution and abundance of beaver in Delaware, done wherever socioeconomically feasible, would be a very desirable habitat management goal and tool.

1) Quality Fish and Wildlife Wetlands Habitat

Beavers are adept at modifying their environment to suit their needs. Beaver activity also enhances, restores or creates

wetlands habitat valuable for a diversity of wetland-dependent flora and fauna. Many species of waterbirds, such as grebes, wood ducks, black ducks, mallards, teals, coots, gallinules, kingfishers, herons, egrets, bitterns, and rails, benefit from beaverdam wetlands, using these wetlands for breeding, nesting, brood rearing, feeding, or migratory resting. Other birds such as woodpeckers, swallows, woodcock, snipe, red-winged blackbirds, and several species of warblers and sparrows find beaverdam wetlands to be suitable nesting or feeding habitats. Fishes in Delaware such as minnows, shiners, chubs, bullheads, madtoms, darters, and sunfishes are associated with the deeper pools of beaverdam wetlands. Aquatic invertebrates such as snails, mussels, clams, crayfishes, and immature and adult forms of numerous aquatic insect species can be abundant in the shallow waters of Delaware's beaverdam wetlands. Many species of frogs, toads, salamanders, water snakes, and aquatic turtles are provided with quality habitat in Delaware by beaver activities. In addition to beavers, other Delaware mammals frequently found in beaverdam wetlands include muskrats, mink, raccoon, and river otter. Beaverdam wetlands may also support rare and endangered species of plants and animals (see discussion of wetlands successional cycles in Section III-5).

Beaver in many cases convert marginally-wet wetlands with temporary or short-seasonal hydrologic regimes into more functionally valuable, wetter habitats having extended or permanent surface inundation. Quite often timber of low commercial value is converted by beaver-caused inundation into dead standing timber important to species such as woodpeckers and nesting wood ducks, hooded mergansers, tree swallows, bluebirds, screech owls, kestrels, and other cavity nesters using abandoned woodpecker holes. However, trees of commercial value are sometimes also killed by beaver-caused inundations, so the creation of quality habitat for cavity-nesting birds may sometimes involve undesirable socioeconomic costs. For example, swamp white oak (Quercus bicolor) trees may be killed by long-term flooding; this species has a very high commercial value for domestic veneers and cooperage, and is also sought by Europeans and Asians as a substitute for true white oak (Quercus alba) (T.A. Kaden, pers. comm.).

An in-depth example of the importance of beaverdam wetlands for quality wildlife habitat is provided by the black duck (Anas rubripes), which is a species of special concern in Delaware and within the Atlantic Coast Joint Venture of the North American Waterfowl Management Plan. Beaver ponds are preferred habitats for black ducks throughout their range, and account for a major portion of black ducks produced in eastern Canada and New England. For example, beaver ponds in New Brunswick are estimated to produce 9,000-11,000 black duck broods annually (each brood typically has 8-10 ducklings). Although beaver ponds in the Northeast are now much more numerous than in the mid-Atlantic region and represent a major portion of the available breeding habitat, such habitat type use to be found throughout

the black duck's breeding range, which extends southward to northeastern North Carolina. The loss of beaverdam wetlands in the mid-Atlantic has undoubtedly played a role in the black duck's population decline.

The importance of beaverdam wetlands as black duck breeding habitat varies with age of the ponds. Generally, the most productive breeding sites for black ducks are on active beaver ponds less than 3 years old. It may be that older beaver ponds, as in older man-made impoundments, provide fewer invertebrates and other foods important to breeding waterfowl and their broods. Thus, establishing new sites and reactivating drained or old ponds, courtesy of new beaver activity, could significantly increase black duck breeding habitat. Black ducks have been observed in Delaware's beaverdam wetlands, but the black duck's current frequency and intensity of use of this habitat type has not been quantified in Delaware.

2) Recreation and Aesthetics

Beaverdam wetlands provide interesting areas for nature study, photography, and other forms of outdoor recreation in aesthetically-pleasing surroundings, as well as new or increased opportunities for hunting, fishing or trapping.

3) Flood Control

Beaverdams, and the wetlands that they create, slow downstream water movement and allow for a more controlled release of floodwaters. This reduces erosion of stream beds, decreases downstream flooding, and allows dammed water to be absorbed by the soil, raising groundwater levels. Higher groundwater levels may stimulate crop growth in some soils, especially where beaver are active in tax ditches near agricultural fields. Beaver ponds may also serve as a limited source of water for irrigation activities. However, the current role of beaverdam wetlands in Delaware for flood control and water supply has not been quantified.

4) Water Quality Effects - Dissolved Nutrients and Particulate Sediments

Beaver ponds serve as settling basins for waterborne particulates and as filters for removing dissolved nutrients (e.g. run-off from agricultural fields). Emergent and submergent aquatic vegetation in beaver-created wetlands can substantially remove excess dissolved nutrients from ponded water. Dennis Whigman of the Smithsonian Institution recently compiled an unpublished review of the impacts of shallow freshwater impoundments on water quality. In Whigman's review, he cites studies of beaver-influenced systems published by Robert Naiman and colleagues from 1984-1987. Their research focused on ecosystem processes, community structure, and carbon dynamics (including production of invertebrates and fishes) in beaverdam

wetlands.

The main conclusions of the Naiman et al. studies in beaverdam wetlands were as follows:

a. Low-order streams (Strahler orders 1-5) have a low processing efficiency, high storage capacity, and high export of carbon. The low order streams act as important organic carbon sources for consumers in downstream areas.

b. Microbial production was relatively constant across all stream orders indicating that available carbon was relatively constant in different stream orders.

c. Most of the carbon that is transported is in the form of dissolved organic carbon.

d. The presence of beaver impoundments resulted in greater amounts of dissolved organic carbon export per unit area.

e. Beaver impoundments result in an increase in stream stability, retention capacity, and processing efficiency of drainage systems.

The findings of Naiman et al. indicate that beaverdam wetlands, in comparison to streams and adjacent riparian habitats that are not dammed and flooded, function differently. In net terms of overall water quality, downstream water having passed through a beaverdam wetlands has a more desirable composition than downstream water which has not traversed beaverdam environs. The amount of sediment retained within beaverdam wetlands can be very substantial, amounting in volume to 350-500 times the volume of wood in the dam. For example, a small beaverdam consisting of 10 cubic yards of wood can retain (throughout the life of the site as an active beaver colony) up to 5000 cubic yards of sediment, preventing this potential sediment load from running downstream to ponds, lakes or open estuaries.

Beaver activities also substantially change the total amounts of carbon inputs, carbon standing stocks, and carbon outputs. Beaverdam wetlands are more efficient for retaining and processing organic carbon; little material, relative to the amount received, is transported downstream. The standing stock of carbon in an undammed wetlands may turnover (i.e. be replaced or passed through the system) up to 7 times faster than in a beaverdam wetlands. Conversely, the standing stock of carbon in a beaverdam wetlands may be up to 20 times greater than an undammed wetlands, providing a large reserve of carbon and other nutrients needed for ecosystem stability. This nutrient pool is manifested in an increase in the total density and biomass of aquatic invertebrates in beaverdam wetlands. While there are species shifts of aquatic invertebrates in beaverdam wetlands from predominantly shredders and scrapers (in undammed streams)

to collectors and predators (in beaver ponds), the total number of species stays similar, and both organism density and biomass per unit area increases 2-5 times in beaverdam habitats.

Finally, beaverdam wetlands help to reduce the downstream transport of dissolved nutrients, helping to reduce eutrophication problems in receiving waters when dissolved nutrients become excessive. For example, increases in flooded land caused by beaverdam blockage increase the lateral extent of anaerobic surficial layers, which helps to reduce (via denitrification to atmospheric nitrogen) nitrate and nitrite loads flowing into beaverdam wetlands, reducing downstream transport of these dissolved nitrogen forms. Increases occur in available soil nitrogen as a result of flooding, but this is primarily in the form of ammonia, which is absorbed by rooted macrophytes or anaerobic microorganisms, or may be immobilized onto negatively charged soil particles, or may diffuse into the thin, upper aerobic soil layer, where it might be nitrified and then rapidly exposed to denitrification in a nearby anaerobic zone, or it might be volatilized directly to the atmosphere.

5) Summary of Attributes

The following synopsis of beaver activities and their environmental benefits is quoted from Hilfiker (1991):

> "The beaver is a remarkable animal. No creature except man surpasses him in his ability to change his environment to suit his special needs. He builds dams, maintains ponds, clears roadways, digs canals, and conducts extensive logging and lumbering operations. These things he does in order to survive, but the dams he builds spread out flood waters, slow them down, and reduce their capacity to do damage downstream. The ponds store water against times of scarcity and act as settling basins for silt carried downstream during periods of high water. The clearings around the ponds let in light and create edge conditions. Wherever beavers build their ponds, a vast variety of living things are attracted to them as iron filings are drawn to a magnet."

VI. Socioeconomic/Environmental Problems Caused by Beavers

1) Flooding Problems

Beaver activity may cause serious flooding in low-lying areas, particularly in areas with minimal lateral relief. This can result in residential, commercial or industrial property damage; damage to roads, railways or airports; loss of agricultural crop production; and loss of commercial timber stands.

In the State of Delaware, many agricultural problems are related to poor drainage or flooding. The tax ditches which border many agricultural fields are designed to drain wet areas to improve the capability for cultivation. Beavers sometimes build their dams in these ditches, causing water to back up, flooding the fields. The damming of these ditches also interferes with normal water flow, causing slow drainage, which can result in reduced crop production. The Delaware Forestry Section (Delaware Department of Agriculture) also has concerns about commercial timber loss due to beaver-induced flooding and tree girdling. Beaver activities may also result in damming-up highway culverts and railroad right-of-ways, or the flooding of residential yards and homes. Overall, flooding is probably the primary problem related to beaver activities.

The areas flooded by beaver can sometimes create breeding habitat for nuisance and potentially health-hazardous mosquitoes. However, in most cases mosquito production problems may actually be reduced, since the alternately wet-dry habitats required for egg-deposition and larval maturation of many pestiferous, temporary-pool breeding mosquitoes (e.g. Aedes spp.) may be usurped by beaver-caused permanent inundation. Mosquito species that will breed in permanent standing water (e.g. Culex spp.; Anopheles spp.) typically do not fly as far as temporary-pool breeding mosquitoes when in search of blood meals, and the larval populations of permanent-water breeding species are often kept in check by larvivorous fishes resident in beaver ponds.

Many rare or endangered plant species may be sensitive to excessive inundation, and hence killed by prolonged flooding of an area. Ironically, many of Delaware's rare or endangered wetlands plant species are now found in wetlands that were formerly created or occupied by beaver, and these areas are now in later successional stages following beaver abandonment (or removal). The long-term perpetuation of certain rare or endangered species in Delaware may depend upon wetlands successional cycles, and the beaver may be a primary agent for triggering or controlling these cycles.

2) Other Damages to Property

Beaver use woody and herbaceous vegetation for food and as building materials. These activities can result in the loss of commercial timber through cutting or girdling, the destruction of ornamental or fruit trees, and even depuration of agricultural crops adjacent to beaver wetlands. In addition, beaver may damage ditch banks and culverts through burrowing, and in some instances farm equipment has fallen into beaver bank-tunnels or ditch-bank dens.

VII. Determination if Substantive Beaver-Caused Socioeconomic Problems are Occurring

1) Types and locations of potential problems and factors to consider and evaluate.

A. Private Lands in Urban or Suburban Areas.

In urban or suburban areas, beaver damage often involves the girdling or cutting of ornamental trees and shrubs. Their burrowing under roads or walkways may cause collapse. Beaver-induced flooding can cause damage to lawns or gardens, basements or foundations, and roadside ditches or driveway culverts. Beaver activities can interfere with the functioning of septic fields or cesspools, and can inhibit stormwater management facilities. However, many flooding "problems" in urban or suburban areas are often more cosmetic than truly damaging, in that many people do not like the conversion of lawns to standing "swamp" water. Additionally, flooding damage is often limited only to minor structures located in the floodplain, which could be moved with relatively little trouble (e.g., woodpiles, dog houses or kennels, small sheds, etc.). Nevertheless, the willingness of property owners to accept even minor new pools of standing water on their property may not meet with widespread acceptance. Possible concerns with potential cutting of ornamental trees or other valuable vegetation, in relation to either existing beaver colonies or proposed introduced colonies, may be addressed by educating landowners about damage prevention methods. Such methods may include enclosing the bottom three feet of valuable individual trees with heavy wire mesh, hardware cloth, or galvanized metal. Commercial deer repellents may deter beavers, with diluted repellent (1:50) painted on the first few lower feet of a tree trunk. Exclusion fencing of small critical areas such as driveway culverts, storm drains, or small ponds may prevent damage.

B. Tax Ditches

The agricultural tax ditch system in Delaware is used to drain water off agricultural fields within a 24-hour period in order to prevent crop damage. Tax ditches also help prevent flooding of highways and road structures, and provide drainage relief for residential properties. Tax ditches are independent units of government established by the courts, and are supervised by tax ditch associations and tax ditch managers.

Beaverdams built in tax ditches can cause surface flooding of agricultural cropland or commercial timber adjacent or lateral to beaverdam wetlands. Upstream drainage may also be inhibited, creating similar problems for agriculture or forestry in the upstream watershed. Even if surface flooding does not occur, excessive subsurface wetness may be caused by tax ditch blockage, lowering crop production lateral to ditches (although higher water tables in ditches may enhance crop production during

droughts or late summer). Tax ditch blockage by beavers may also impair the operation of water control structures within the ditches. Finally, beaver activities may affect ditch-edge access of vehicles or heavy machinery necessary for crop production or ditch maintenance and repair.

C. Public Lands - Conservation or Recreation Areas

The promotion of beaver-created wetland habitat on public conservation or recreation lands is, in a relative sense, easier to accomplish than on other types of lands. However, beaver activities on public lands may still create problems needing remedial action. For example, on Bombay Hook National Wildlife Refuge, beavers have occasionally plugged water control structures needed to manage water levels for waterbird habitats within impoundments, with blockage usually occurring in the "drawdown" phase of impoundment management. The impacts of flooding on species or habitat management plans, including species of special concern and rare or endangered species, should be considered; many wetlands species will benefit from enhanced hydroperiods, while others may not. Flooding impacts may also have unacceptable effects on recreational access or use of the land (for both consumptive and non-consumptive recreational activities). Beaver activities and their effects on tax ditches crossing public lands must also be considered, in terms of needed ditch functions on both public and private lands, and in consideration of the tax ditches' adverse environmental impacts to public lands (for which beavers may serve as remedial agents).

D. Highways, Railways, Airports

The frequency, duration and depth of beaver-induced floodings on road surfaces, railways, runways, and other transportation corridors must be considered, particularly in regard to the extent of threat to public safety. Beaver activities can also cause unacceptable impacts to transportation structures such as clogging of culverts, burrowing into embankments or causeways, or roadbed undermining due to saturated conditions and erosion.

E. Private Land in Rural Areas (Non-tax ditch)

Many of the beaver-caused problems potentially occurring on private urban or suburban lands (see Section VII-1a) may also occur on private lands in rural areas. Additionally, flooding damage or unacceptable cutting or girdling of vegetation may affect agricultural crops or commercial timber.

2) Prioritization of Concerns if Two or More Types of Problems are Occurring at One Site

In Section VII-1 above, 5 classes of potential beaver problems are described: a) private lands in urban or suburban areas; b) tax ditches and the aglands or other lands influenced

by tax ditch drainage; c) public lands-conservation or recreation areas; d) highways, railways, airports; e) private lands in rural areas (non tax-ditch). It is not unusual for a beaver-caused problem to involve aspects of two or more problem classes. For example, a beaverdam may have been constructed on a State Wildlife Area (SWA) in a tax ditch which has a natural tributary upstream of the SWA on private lands, and this natural tributary flows under a public road. Beaverdam flooding on the SWA may be creating desirable wildlife habitat on the SWA and improving downstream water quality, but at the same time the elevated water may: 1) occasionally block access to a SWA maintenance road; 2) create poor drainage in 3 acres of upstream cropland; 3) cause minor road floodings of the public road when rainfall exceeds 2" in 24 hours; and 4) occasionally cause inundation of the lower end of a dog kennel on private land.

In order to provide some guidance for how to prioritize concerns when evaluating whether or not substantial beaver-caused problems exist, which may also help in selection of remedial actions, the following recommendation is made for beaver-problems involving two or more classes of problems. We recommend that the following sequence of concerns be recognized in evaluating beaver-induced problems, ranked in priority from higher concern (#1) to lower concern (#4):

1) Highways, railways, airports
2) Tax ditches and the aglands or other lands influenced by tax ditch drainage
3) Private lands, whether they be urban/suburban or non-tax ditch rural
4) Public lands - conservation or recreational

This prioritization does not suggest the neglect of any problem that may be occurring in a lower priority class when two or more problem types simultaneously occur, but it does provide some guidance to decision-makers whenever prioritization of problems may be necessary to make an action decision. Also note that this recommended sequence does not set priorities for determining how to balance the positive environmental aspects of beavers with their potential socioeconomic problems. The recommended prioritization merely applies to ranking concerns for when beaver-induced impacts are determined, on a site-specific basis, to be substantive problems.

3) Integration of Factors to Make a Decision if Substantial Problems are Occurring and if Remedial Action is Warranted

Section VII-1 identifies 5 classes of potential socioeconomic problems that beavers may cause, and Section VII-2 recommends a prioritization of the class concerns for when substantive problems are recognized or identified. Unfortunately, no simple "cookbook" formulae exist to determine if and when substantive socioeconomic problems occur to an extent where remedial action must be taken. Nor are there simple

procedures to follow to weigh positive environmental benefits of beavers against problems that they might be causing. Each suspect beaver-problem will have to be evaluated on a site-specific, case-by-case basis, since each location's setting and circumstances will be unique. The most critical tool in determining if a substantive problem really exists will be the balanced judgment of a trained ecological professional, knowledgeable about both environmental values and socioeconomic realities.

In almost all cases, it would be environmentally desirable from the standpoint of quality wildlife habitat or good water quality to let beavers remain in an area and go about their business of being beavers. However, the potential socioeconomic problems discussed in Section VII-1 may frequently override the environmental desirability of retaining beavers at certain locations. It will be important in the decision process to recognize truly substantive problems and to reject cosmetic or superficial complaints. Clearly, part of the assessment process must involve estimation of economic or acreage losses that beavers may be causing residential areas, agriculture or silviculture. Estimation of economic costs would also be involved for the maintenance, repair or modification of transportation structures if problem-beavers are allowed to remain. Sometimes the availability of a suitable remedial action (see Section VIII) can quickly and easily turn a beaver-problem into a non-problem (while still maintaining the beaver's environmental benefits), but in other cases the beavers may have to be removed because the available remedial actions are too costly or impractical. Finally, one must assess the attitudes of the local people about the presence of beavers, for both the beaver's good and bad attributes, because the sentiments and biases of landowners, neighbors, community associations, tax ditch managers and others will be crucial to the long-term success of whatever recommendations and decisions are made. Public education about beavers and their attributes will be needed to counter incorrect perspectives or unwarranted biases. Since the Division of Fish and Wildlife does not have the authority on private lands (nor on many public lands) to mandate management either for beaver habitat protection or for taking remedial actions, the success of a beaver management program must depend upon mutual understanding and cooperation amongst public agencies and the private sector.

VIII. Remedial Response Options if a Substantive Beaver-caused Socioeconomic Problem is Occurring

1. Live-trapping and transfer of problem-beavers.

A. Identification of Potential Release Sites for Live-Trapped and Transferred Beaver

The identification of potential release sites for live-trapped and transferred beavers involves several environmental

considerations. Each potential release area will require evaluations of site-specific criteria. A potential release site should be reviewed in terms of the support necessary to maintain a male-and-female pair of transferred adult beavers, plus up to two generations of their offspring (i.e. kits and yearlings) simultaneously occupying the site. Additionally, because of both innate social behaviors and habitat needs, one should not be surprised if some (or many) relocated beavers extensively wander away from their release sites; one should also expect that mortality will be high during these extensive movements or wanderings.

Criteria for release site selection should include:

1. Acceptance by landowners in the potential floodplain;

2. Suitable on-site habitat capable of supporting beavers, with attention to hydrological potential and food supply; release sites with extensive forested areas adjacent to waterways will provide longer-lived colony locations than sites where the forested cover is only a narrow corridor along the watercourse;

3. The release site's potential wetlands edge (i.e. the predicted edge of standing water in a beaverdam wetland) should be assessed in terms of proximity to agricultural fields and vertical relief between wetlands bottom and agricultural field edge; based upon the predicted height of water in a beaverdam wetland (e.g. 5-feet above bottom), estimate extent of lateral and upstream flooding in relation to adjacent croplands; eliminate potential release sites having moderate to high probabilities of creating cropland flooding problems;

4. Evaluate current land-use patterns and the associated reliance on tax ditch systems to determine if beaver-caused flooding in an area would be compatible with existing land uses, causing only minimal negative impacts;

5. Evaluate potential flooding of highways and roads, culverts, residential structures and property, etc.;

6. Consider proximity to ornamental vegetation, tree farms, nurseries, etc. that may be damaged by beaver cuttings; for concerns with potential vegetation cutting damage in residential areas, landowners should be educated about possible damage prevention measures (see Section VII-1A).

7. Determine if a potential release site (or the potentially flooded area) has been identified as a habitat of special concern, in that it contains rare or endangered plant or animal species or constitutes a

unique biotic association; beavers moving into such areas may cause hydrological alterations detrimental (in intermediate ecological timeframes) to extant flora or fauna; while such impacts would probably not call for remedial actions for beavers "naturally" colonizing a site (i.e. moving-in unassisted by man), the purposeful release or reestablishment by man of beavers in such valued areas may not be currently desirable, particularly if alternative release sites having equally attractive features for beavers are available; however, it must be kept in mind that when beavers have become fully reestablished in Delaware (i.e. when they occupy all naturally available sites not causing substantive socioeconomic problems), the beavers' final decision to occupy (or reoccupy) a site will depend solely on suitable topography, hydrology and vegetation as perceived by the beavers, not on man-made classifications of extant biota;

8. Consider the need for beaver sterilization prior to release to prevent potentially undesirable colonizations to adjacent but unintended areas.

Generally Desirable Release Sites:

1. Compatible public lands (e.g. state wildlife areas, state parks, state forests, national wildlife refuges);

2. Private lands having suitable environmental features, where landowners are cooperative and socioeconomic problems will be minimal, both for the actual release site and within the surrounding vicinity in event of beaver moving off-site.

B. Potential release sites in Delaware

The Division of Fish and Wildlife maintains updated maps of potential release sites for problem-beavers, and keeps an inventory of sites where beavers have been released. The Division is made aware of potential sites by private landowners, Division field staff, and other sources. As of July 1991, the Division of Fish and Wildlife has identified 17 potential release areas in Delaware for problem-beavers, with 8 areas on state-owned lands and 9 areas on private land. Each potential release area could accommodate from 4-12 transferred beavers depending upon an area's specific characteristics; statewide, these 17 areas could potentially accommodate an estimated total of 110 transferred beavers.

The transfer and release of beaver in a relocation area should consider the number of potential suitable sites in an area which could be occupied by beaver pairs. As much as practical, a live trap-and-relocate program should consider territorial needs and behavior of beavers, release of male-and-female pairs,

population age structure, and other social factors important to colony success. Sexing of beavers can be done in the field (via presence or absence of baculum), but to make such observations requires an immobilization device. The best candidate animals for relocation and successful establishment of new colonies, in terms of staying on-site at the release areas, are pregnant females, with the best times for transportation from February through April. Releasing too many beavers in a relocation area, or stocking beaver groups having inappropriate sex ratios or age structures, should be avoided as much as possible.

We believe that the potential release sites identified to date may represent a substantial fraction of the ultimate number of potential release sites in the state, so it will become increasingly harder to find future release sites for transferred beaver. Because of the flat topography that exists throughout most of Delaware, beaver activities can cause water to back-up over extensive areas. While in many ways this helps to promote positive environmental aspects of beaver activities, it may also increase potential socioeconomic problems, thus lowering the number of options for potential release sites. In order to help insure the successful establishment of transferred beavers, potential release sites will not be publicized. New potential release sites or cooperative landowners will be both sought and welcomed.

Using Delaware's two National Wildlife Refuges (Bombay Hook and Prime Hook) as potential release sites for problem-beavers might be possible in certain instances, but these outlets are not as attractive as one might assume. The U.S. Fish and Wildlife Service has a policy not to introduce animals of any kind on a federal refuge without extensive tests of individual animals to rule out transmission of disease to extant wildlife populations. Such a precautionary policy has both its advantages and disadvanatges--in terms of procedures and paperwork needed to release transferred beavers on the federal refuges, the bureaucratic hurdles may be too great to achieve expeditious, economical releases, particularly if alternative release sites exist.

The alternative of shipping Delaware's problem-beavers for relocation out-of-state is not viable, since most other states also now have substantial populations (and their own problems). In a recent telephone survey conducted by the Delaware Division of Soil and Water Conservation, all 50 states and several Canadian provinces were attempted to be contacted to see if they would accept live-trapped Delaware beavers. The phone survey was able to contact authoritative personnel in 31 states and the province of Quebec. Out of the authoritative contacts that were made, only the state of Idaho was willing to accept Delaware beavers; Idaho said they could accept 25-50 beavers on a one-time basis, if Delaware was willing to provide the appropriate transport care and pay for their shipping. We probably would not have considered out-of-state transport of

problem-beavers prior to filling all suitable and desirable relocation sites in Delaware. However, the phone survey does indicate that once Delaware's release site are exhausted, the option of out-of-state relocations has very limited potential.

C. Methods of Live Trapping

When beavers are to be removed from an area, the site where the colony is living should be examined carefully before setting traps. It is important to look for dams, lodges, bank burrows, travel canals, and food plots. It is also important to remember that each trap must be placed to get the quickest result. There are basically two types of traps that can be legally used for trapping beaver in Delaware. There are traps that kill the animal (e.g. leg-hold traps in a drowning set), and there are traps that will restrain a live animal until the trapper returns (e.g. Bailey or Hancock live-traps or cable snares).

Live-traps are used to capture beavers alive so that they can be removed from an area. The most common live-trap is the Bailey trap. The animal steps onto a trigger pan, and the Bailey trap closes around the animal like a suitcase. The other live-trap used in Delaware is the Hancock trap. It is similar to the Bailey except that only one side of the trap closes while the other side remains in place. The Hancock trap was designed for use on steep banks and is easier to use than the Bailey type. Both of these types of live-traps are fairly expensive, costing a few hundred dollars per trap.

Another method of live trapping beavers is to use a cable snare. Cable snares can be effective, practical, time-saving devices for beaver capture (T.S. Hardisky, pers. comm.). There are several advantages to using cable snares: good trapping efficiency; lightweight and inexpensive ($1.00 per snare); cannot injure trapper or unsuspecting traveler and will not kill captured beavers; risk of non-target capture is low, and non-target catches can be released; low susceptibility to theft or rust. Disadvantages include: heavy tie-down required; cannot be reused after capture; first-time users require instruction in their use and types of sets.

D. Methods of Transfer

Once a beaver has been live-trapped, the trap and captured animal should be carried to an unobstructed area so that the beaver can be more easily transferred from the trap to a transport cage. Transport cages were designed and built by Division of Fish and Wildlife staff to aid in transporting trapped beavers to release sites. The transport cage was designed so that when transferring a beaver from a trap to a cage, the beaver does not need to be handled, and the transfer can be accomplished by one person if required. This also helps the trapper, so that he may re-set his traps immediately if needed, and not have to use the traps themselves as the transport

containers. It must be kept in mind that live-trap and transfer operations involve some stress on the animals, and that nervous reactions may result in gnawing on transport cages, sometimes resulting in chipped or broken teeth. Occasional mortality should also be expected.

Once a beaver is in the transport cage, it is taken by vehicle to the release site. Data are collected and recorded at the release site on a beaver-release data sheet (Appendix 6). Tagging the beaver with a metal ear tag is the last step prior to release. The beaver is taken out of the cage with a noose-pole, and a numbered tag is fastened to the ear (National Band & Tag Co., Jiffy Style 893, size 3). Beavers may also be marked with tail tags (cattle ear tags can be used). Tail tags are not as susceptible to loss as are ear tags, since the tail consists of thick cartilage (not highly vascularized) under scaly skin.

E. Potential Need and Procedures for Reproductive Control of Transferred Beavers

At some potential release sites, the fear of beavers reproducing and having their progeny move off-site to cause unforeseen problems may be great enough that sterilization of live-trapped and transferred animals might be considered prior to their release. The most acceptable methods for induced sterility include male vasectomy and female oviducal ligation. Testicular or ovicular castration is not recommended because of associated behavioral problems. However, because of the expense involved in doing any surgical procedures, with the need for veterinary operative and post-operative care, it is doubtful that surgically-induced sterility will have much practical use. Additionally, effective chemosterilants are not available for beavers. It is more probable that if progeny expansion is a major concern at a release site, and if the problems that might be associated with progeny movement could not be handled by other methods, then the release site would probably be delisted as a release location. If release sites are used where the potential for future beaver problems is more than minimal, then the need for extra post-release monitoring and increased responsiveness to complaints should be recognized.

F. Long-Term Monitoring of Transferred Beavers

Problem-beavers transferred and released at designated release sites are tagged to allow their future study. Periodic inspections should be done, probably by wildlife biologists, at and near the release sites to see if the beavers are successfully colonizing the site, to determine what types of activities the beavers are doing, and to see if beavers are causing any unforeseen problems on-site or off-site.

2. Dispatch of Problem-Beavers

When potential release sites for problem-beavers have been

exhausted, or when manpower, monetary or logistical considerations do not permit a live-trap and transfer operation, it may be necessary to dispatch problem-beavers. It is probable that the killing of problem-beavers will become a more common solution to beaver problems in Delaware as the options for release sites become scarcer; if no release sites are available for problem-beavers, then dispatch becomes the only solution when structural remedies (see Section VIII-3) are impossible or impractical.

Dispatch of beaver can be effectively achieved using a leg-hold trap in a drowning set, where a slide device or angle of the trap-set prevents reemergence of the captured animal. The potential for capturing non-target species in leg-hold traps is low, as long as care is given to making the proper aquatic sets. Cable snares can also be used for trapping beaver, and any non-target species which may be caught can usually be released unharmed from a cable snare set. Beavers live-trapped in a cable snare could then be dispatched by legally-approved methods. Leg snares could also be used, but these spring-activated snares are difficult and time-consuming to use for aquatic drowning sets. Beavers can also be trapped in a live-trap such as the Bailey or Hancock, and then dispatched upon retrieval. Killer or conibear traps of sufficiently large size for beaver capture (e.g. #220 or #330) are illegal to use in Delaware. Any permitted trapping of problem-beaver should be done in a humane fashion as discretely as possible.

Potential personnel who might participate in beaver trapping and dispatch include Division wildlife biologists or enforcement officers, private contract trappers authorized by the Division, private landowners, or private trappers seasonally participating in a regulated trapping program open to the public.

3. Regulated Trapping Program Open to the Public

Beaver-nuisance problems may become too widespread or intensive in Delaware to be satisfactorily handled by the Division of Fish and Wildlife, whether done by Division-contracted trappers or by staff enforcement officers or wildlife biologists. Funding availability may limit the effectiveness of using contracted agents to control beavers, even if the costs of trapping and dispatch are cost-shared under certain conditions. For example, trapping and dispatching 100 problem-beavers per year at a contract cost of $50 per beaver would cost $5000 per annum. Also, time and availability of even contracted agents may not be adequate to contend with nuisance problems if they become too numerous.

In order to contend with beaver problems that may become too numerous or widespread to be satisfactorily handled on a case-by-case basis, the Division does have, as a readily available option, the remedy of a regulated trapping program open to the general public, which could be used to manage overly abundant

beaver populations. The creation of a beaver trapping program open to the public, if needed or desirable, would be done via the Division's regulatory authority and procedures.

Any statewide open trapping season for beavers would be developed having an annual total statewide harvest goal in mind (e.g. 150 beaver per year), with the goal achieved via control of season lengths, harvest limits per trapper, numbers of participating trappers, gear restrictions, etc. (or various combinations of these limitations). The types of traps and trapping methods to be used in a regulated trapping season open to the public would be the same as discussed in Section VIII-2. As with any type of open season trapping, traps could not be set for beavers without prior permission of the landowner. Beaver harvest could be monitored via a tagging or registration system.

The use of a regulated trapping program open to the public is probably one of the most cost-effective methods for controlling undesirably high beaver numbers (in terms of statewide population densities). Additionally, such a program offers the public new sources of food and fur, plus new recreational opportunities. However, public trapping does not have the level of precision that other approaches offer for contending with specific beaver-caused problems, nor for safeguarding the continuance of beaver activities at desirable sites. There is potential that problem-beavers might be underharvested and thus not cure certain site-specific problems, while beavers at non-problem locations, where they're environmentally beneficial, might be overharvested. Thus, total statewide harvest goals might be achieved, but specific nuisance problems might not be eliminated, while environmentally-desirable activities might be unwantedly terminated.

Nevertheless, an open trapping season would allow private landowners to take care of their own beaver problems without having to get a special permit from the Division (which would be needed during the closed seasons). Additionally, in areas where beavers are not causing socioeconomic problems, but are subject to density reductions via an open trapping season, new vacancies would be created for release (during closed seasons) of problem-beavers that could be live-trapped and transferred. Since the economic demand for beaver fur or meat is now very low, it would not be too surprising if much of the harvest during an open season focused on problem-beavers.

In the event of undesirable underharvesting or over-harvesting of beavers in more localized areas, refinements to a statewide open season could be made by dividing the State into several geographical zones, each zone potentially having different open season lengths, total harvest goals, individual limits per zone, etc. Depending upon the demand for participating in a beaver trapping program, exclusive trapping rights might have to be delineated for areas within the zones and awarded to individuals on a lottery basis, or the total number of

participants within a zone might have to be restricted, perhaps again using lottery selection. Such fine-tuning of wildlife harvests are familiar undertakings for the Division.

An additional refinement to a public open trapping season might be the creation of a "hot spot" program for landowners having extensive beaver damage problems on their property. Such landowners would enroll in the program and allow public beaver trapping on their land only; the names and addresses of all cooperating landowners would be available to interested trappers. The number of trappers permitted on lands in a "hot spot" program would be determined by the landowner in consultation with Division of Fish and Wildlife biologists, and all trapping procedures would still have to adhere to the public season dates, bag limits, prescribed methods, etc.

In event of a beaver population expanding beyond the State's resource availability to control it, perhaps a combination of a Division-regulated trapping program open to the public to contend with statewide or regional density problems, plus a Division-authorized contract trapper program to contend with site-specific problems, would yield the most responsive, cost-effective approach.

An overview of how nearby states (Maryland, New Jersey, Pennsylvania, New York, Virginia, West Virginia, North Carolina and Massachusetts) handle open trapping seasons for beaver and respond to nuisance problems is given in Appendix 8.

4. Structural Remedies to Resolve Flooding Problems Caused by Beavers

Many types of structural remedies have been tried to resolve socioeconomic problems that may be associated with excessive flooding or high water levels in beaverdam wetlands. In situations where beavers must be removed (by trap-and-transfer or dispatch) and then the flooding problem eliminated, the complete remedy must also involve the structural removal or breaking-up of the beaverdam, accomplished by hand, heavy machinery or explosives. While it is prohibited in Delaware to damage the nest, den or lair of a game animal, the alteration of a beaverdam (whether an active colony is present or not) is not prohibited. In many cases, however, it is possible to control water levels with water control structures where beaver ponds are desired, allowing the beaver to remain. These water control structures are designed to lower and maintain desired water levels in existing beaverdam wetlands. An example of a beaverdam water control pipe is given in Figure 5, and was installed in a beaverdam located on a State Wildlife Area during the spring of 1991. It is important that the water intake end of a beaver pipe be submerged deeply enough that all running water noise, and even surface whirlpools or swirls, be eliminated, since beavers will go to great lengths to attempt to block any running water that

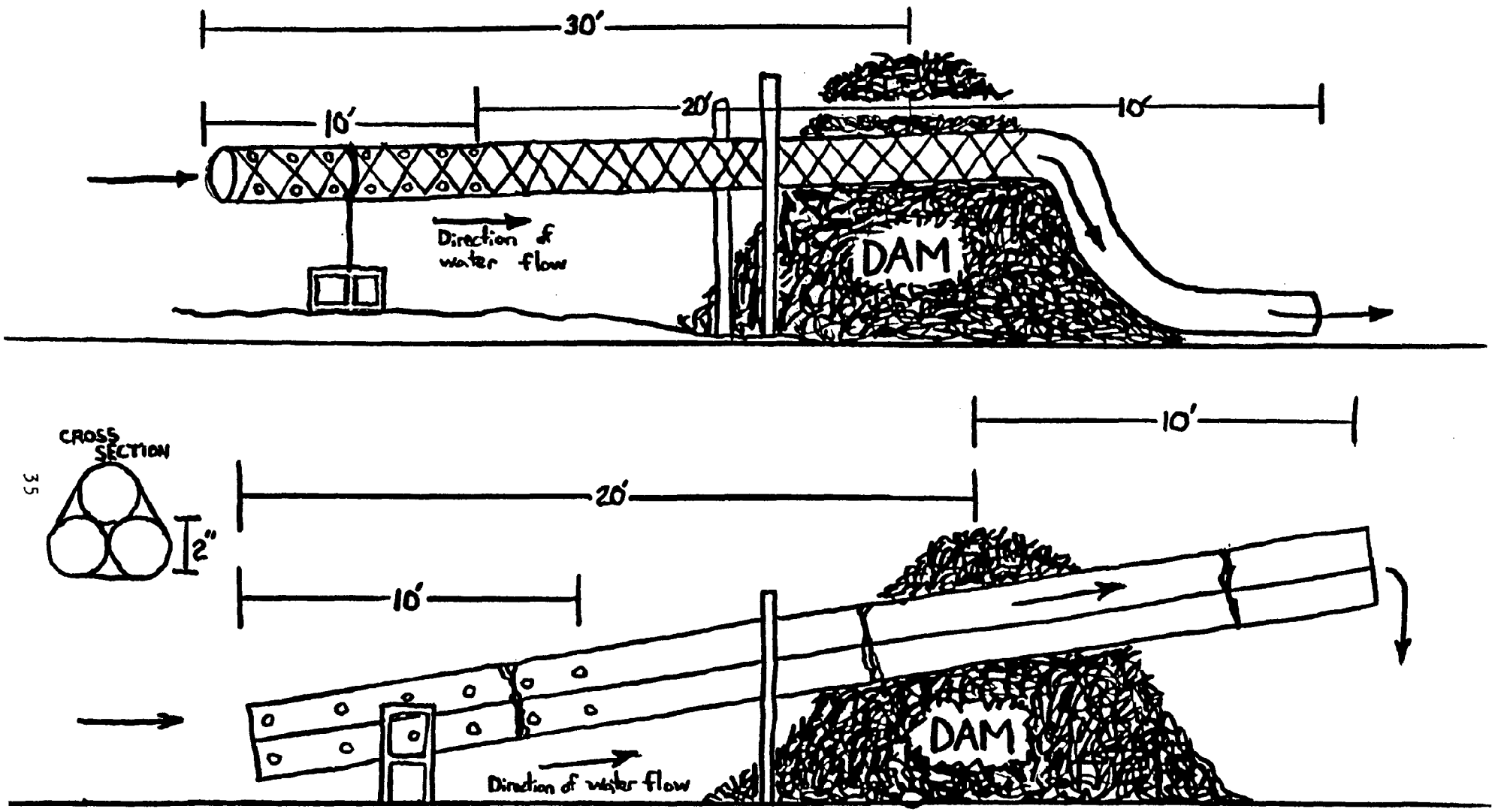

Figure 5 Examples of beaver-flow through pipes using corrugated flexible sewer pipe and PVC pipe

they can detect. Initial observations indicated the structure was functioning as desired, but before substantial monitoring could be done, the system was vandalized.

Most beaverdam water control structures consist of flow-through pipes of various diameters and configurations that are designed and installed to stop dammed water from rising above a desired level during times of normal runoff. Thus, no matter how high beavers may attempt to build a dam, the water level during normal runoff periods will not be able to be maintained by beavers above a human-determined level. Beaverdam water control structures are not designed to control water levels during spates (short-lived, sporadic, rainfall-induced flooding events). Water level control during spates is determined by the height of spillways that beavers may have built into a dam, or by the actual top of the dam itself, with the entire surface of the dam top serving as a spillway. Each beaver site will vary, so the design and installation of beaverdam water control structures must be site-specific.

There are several considerations that need to be examined before choosing and installing beaverdam water control structures. First, the socioeconomic acceptance of installing the structure must be a paramount consideration. The diameter and number of flow-through pipes to effectively handle the water volumes in inundated areas during routine or base flows (in order to maintain desired levels) must be calculated prior to installation. The design of the structures should be as "beaverproof" as possible, in that it should be very difficult for beavers to block the water intake or outflow devices of the structures. The structures should also blend visually with their surroundings, and not be excessively visible to invite vandalism. The installation costs for long-term maintenance and repair must also be considered, as well as designation of the agencies or personnel responsible for these activities.

5. Choosing a Remedial Response for a Substantive Beaver-Caused Problem

As with determining if a substantive beaver-caused problem exists in the first place (see Section VII-3), there are no simple "cookbook" formulae for determining the type of remedy to use to address substantive problems. While a purpose of a possible regulated trapping season open to the public is to help reduce beaver regional population densities to levels in which nuisance problems become more managable, substantive nuisance problems will still occur that must be addressed on a case-by-case basis. The selection of a remedy for substantive problems must be evaluated on a site-specific basis. The live-trap and transfer option may be the most preferred, but is heavily dependent upon staff availability and coordination on short notice, plus the availability of suitable release sites. Structural remedies whose implementation would allow beavers to remain on-site and not cause socioeconomic problems are sometimes

too costly to be practical, or from an engineering standpoint may be impossible, or from the standpoint of commitment to long-term maintenance and repair may be impractical. Dispatch of problem-beavers is the quickest and least expensive remedy, but this option eliminates the positive environmental benefits of active beaverdam wetlands, and in some cases may cause adverse human reactions or social problems.

6. Criteria for Evaluating the Environmental Quality or Importance of Existing Beaverdam Wetlands.

The expense and effort associated with various remedial options varies widely, ranging from relatively inexpensive on-site dispatch done by landowners or contract trappers, to more expensive live-trap and transfer operations, to more costly installation and maintenance of structural remedies. The factor of cost effectiveness should also be built into an evaluative process for determining how to deal with substantive beaver-caused problems, since resource management funds are limited and must be wisely spent. It makes practical sense that in deciding how to spend limited funds for wisely managing beaver populations, we should not invest heavily in remedial actions (for substantive problems) in existing beaverdam wetlands where the environmental values or benefits of a given wetland are relatively lower than in another beaverdam wetland having greater environmental values and benefits. Conversely, when given limited funds for beaver management, we might spend our resources for the more costly structural remedies (to maintain existing beaverdam wetlands) for only those wetlands having higher environmental values and benefits.

In order to help evaluate the level of environmental values and benefits of existing beaverdam wetlands, the following factors should be considered for existing beaverdam wetlands:

A. What is the expected longevity of the beaverdam wetland (e.g. number of years) before one would predict that the colony will have to abandon the site? At current water levels, how much longer might it be expected that herbaceous or woody vegetation will remain adequate to meet the colony's needs? Can water levels be raised in the future by the beavers (in order to provide access to new food sources) without causing substantive socioeconomic problems? If water levels can be raised, how many more years of colony occupancy might be predicted?

B. What are the known or suspected site-specific values of the existing beaverdam wetland for wildlife habitat? Is there knowledge or evidence that the site is valuable for waterfowl production, feeding or resting, or that it's valuable habitat for other waterbirds or passerine species? Does it have abundant or diverse populations of fishes, amphibians or reptiles? Are muskrat lodges evident, or is there evidence of raccoon or otter use? Are endangered, threatened or rare species present?

C. Does the existing beaverdam wetland appear to be located at a site where it would be providing substantial water quality benefits, in terms of sediment retention or dissolved nutrient filtration? For example, beaverdam wetlands immediately upstream from the headwaters of millponds, or those that receive upland runoff fron extensive cropland acreage, or those that receive urban runoff from watersheds lacking good stormwater management controls, all have the potential to be important landscape features for maintaining or improving water quality.

D. The size (acreage) of a beaverdam wetland should be considered. In general, the larger the area affected by beaverdam inundation, the more valuable the site, since greater amounts of environmental benefits would be associated with larger sites (in comparison to smaller sites).

E. Will future water supply to the existing beaverdam wetland be adequate to meet the colony's needs? If not, then beaver will abandon the site. If it's known that man's future plans for water supplies at a site will unavoidably cause excessive water extraction or diversion at expense of the colony's water needs, then the site's potential longevity will be compromised.

IX. <u>Identification of Types of Action Costs Associated with Implementing a Beaver Management Plan</u>.

1) Cost of determining or resolving if a substantive beaver-caused problem is occurring and warrants remedy.

2) Cost of determining the type of remedy to use to resolve a substantive beaver-caused problem.

3) Implementing the remedies
   a) Live trap/transfer

      . Trapping costs
      . Transportation costs
      . Pre-release and release procedural costs
      . Long-term monitoring costs

   b) Dispatch

      . Trapping costs
      . Disposal costs

   c) Structural Measures

      . Costs of determining the type of structure to use
      . Engineering design costs
      . Structural material costs
      . Installation costs
      . Regulatory permit costs (if needed)
      . Long-term maintenance and repair costs

X. Preferred Participation and Responsibilities of Agencies and Personnel in a Beaver Management Plan

The Division of Fish and Wildlife is recommending the following participatory roles of agencies and personnel in implementing the Beaver Management Plan. We have recommended the participation of agencies or personnel in context of 5 classes of beaver-caused problems and 7 types of management decisions or actions:

Types of Beaver-caused Problems:

1) Private urban/suburban residential
2) Tax ditches and the aglands or other lands influenced by tax ditch drainage
3) Public lands-conservation or recreation
4) Highways, railways, airports
5) Rural private lands (non-tax ditch)

Types of Management Decisions or Actions:

1) Who has final authority to determine if there is a substantive beaver-caused problem?
2) Who finally determines the desirable action to be taken if a substantive problem exists?
3) Who implements action if the remedy is to live-trap and transfer?
4) Who monitors long-term for transplanted beaver?
5) Who implements action if the remedy is dispatch?
6) Who implements action if the remedy is a structural solution?
7) Who manages long-term for maintenance and repair of structural remedies?

In order to help delineate who takes what action based on the types of problem that may be occurring, we have identified 13 categories of potential plan participants:

1) Division of Fish and Wildlife (DNREC) biologist
2) Division of Fish and Wildlife (DNREC) enforcement officer
3) Division of Fish and Wildlife (DNREC) biologist, whose activities are cost-shared with the landowner
4) Division of Fish and Wildlife (DNREC) enforcement officer, whose activities are cost-shared with the landowner
5) Landowner or designated lessee
6) Tax ditch manager
7) Other State of Delaware employees (e.g., Division of Soil and Water Conservation field technicians; Division of Water Resources wetlands staff; Division of Parks and Recreation naturalists; State Foresters; Division of Highways engineers; etc.)

8) U.S. Soil Conservation Service engineer, biologist or field technician
9) Conservation District engineer or field technician (New Castle Conservation District; Kent Conservation District; or Sussex Conservation District)
10) Contract trapper authorized under permit from the Division of Fish and Wildlife
11) Contract trapper authorized under permit from the Division of Fish and Wildlife, whose activities are cost-shared with the landowner
12) Private engineer or contractor working at the landowner's expense
13) No action - no personnel

The recommended participation of these agencies or personnel, in context of the type and location of beaver-caused problems, is given in matrix format in Table 1. For most of the individual management decisions and actions in Table 1, more than a single party is indicated, reflecting the complexity and diversity of affected parties in making and taking management actions. Table 1 also provides a recommended hierarchy for decision-making and action-taking, indicating which agency or personnel has the final responsibility when two (or more) parties want to make the same final decisions or perform the same management actions. However, no matter who is recommended to take final responsibility for a management decision or action, the advisory input of all interested parties must be seriously considered.

On Bombay Hook or Prime Hook National Wildlife Refuges, which are owned and managed by the U. S. Fish and Wildlife Service, the management of beavers and their habitats will be the responsibility of federal refuge personnel. Management activities should conform to the Service's refuge management plans; beaver trapping or other forms of harvest or capture will be subject to all pertinent State laws and regulations. When beavers living on the federal refuges cause substantive socioeconomic problems off the refuges, the evaluation and resolution of problems will be a cooperative undertaking involving both federal refuge personnel and State wildlife biologists.

Cost-share programs between service agencies and the parties affected by substantive beaver-caused problems are recommended to be developed for the following activities:

a. Determination if a substantive problem really exists and for selecting a remedial course of action.

b. For live-trap/transfer or dispatch remedies.

c. For design, materials and installation of structural remedies.

BEAVER MANAGEMENT PLAN PARTICIPATION

Table 1. Determination of Responsible Parties for Management Decisions and Actions

TYPE OF BEAVER PROBLEM	Who determines if there is a problem?	Who determines the needed action to take?	Who implements action if it's live-trap and transfer?	Who monitors long-term for transplanted beaver?	Who implements action if it's dispatch?	Who implements action if it's structural?	Who manages long-term for structural maintenance and repair?
I. Private Urban Suburban Residential	1/5/9/7	1/9/7/5	11/10/4/3/2/1	1/13	11/10/4/3/5	9/12/8/3/5	9/3/12/5
II. Tax Ditch & Associated Aglands	1/6/5/9/7/8	1/6/5/9/7	11/10/4/3/2/1	1/13	11/10/4/3/6/5	7/9/8/6/5	9/6/7/8/5
III. Conservation or Recreational Public Lands	1/5/7/9	1/7/5/9	10/2/1	1/13	10/2/1	1/7/9/8/12	1/7/9/12
IV. Highways Railroads Airports	7/1/9/8	1/7/9	11/10/4/3/2/1	1/13	11/10/4/3/2/1	7/9/8/12/5	7/9/12/5
V. Rural Private Land (Non-Tax Ditch)	1/5/9/7/8	1/9/7/5	11/10/4/3/2/1	1/13	11/10/4/3/5	9/12/8/3/5	9/3/12/5

KEY

1. F & W Biologist
2. F & W Enforcement Officer
3. F & W Biologist/Cost Share with Landowner
4. F & W Enforcement Officer/Cost Share with Landowner
5. Landowner/Lessee
6. Tax Ditch Manager
7. Other State Employee (e.g. Hwy: Forestry: Soil & Water: Parks & Rec: Wetlands)
8. U.S. Soil Conservation Service
9. Conservation Districts
10. Authorized Contract Trapper at DFW Expense
11. Authorized Contract Trapper/Cost Share with Landowner or Agency
12. Private Contractor/Engineer at Landowner's Expense
13. No Action

RESPONSIBILITY HIERARCHY

A/B/C/etc.

A = FINAL AUTHORITY
B = 1st ADVISORY INPUT
C = 2nd ADVSORY INPUT
etc.

PROBLEM PRIORITIZATION

(For when 2 or more types of beaver problems are occuring at one site)

IV > II > I = V > III

d. For long-term maintenance and repair of structural remedies.

For some activities, the development of a cost-share approach may require legislative action, while for other activities cost-shared approaches may be implemented by regulatory or other programmatic means. Some services that are now performed gratis by public agencies to assist private landowners, and which are not legislatively mandated to be performed, may be suitable candidates for future cost-share agreements. The experience and expertise of Delaware's three Conservation Districts in establishing cost-share programs would be invaluable to address beaver-caused problems.

XI. Listing of Management Options to Manage Beaver-Abandoned Beaverdam Wetlands.

1. No action alternative--let unmanaged succession occur.

2. Destroy beaverdams to accelerate return to low water levels and channelized flow.

3. Maintain higher, desired water levels by replacing beaverdams with low-level earthen levees, and manage water heights with water control structures.

XII. Public Education and Beavers

A major effort in implementing a Beaver Management Plan is to educate the public about the beneficial environmental attributes of beavers and their activities. With the current emphasis on protecting and conserving freshwater wetlands at the national, state and local levels, it is important to promote public understanding about the high environmental values and important functions of beaverdam wetlands. An ultimate goal is to make the public more tolerant of the presence of beavers. A reduced or condensed version of this plan should be prepared, targeted for distribution (on an as-needed basis) to landowners, the general public, and to non-technical agency personnel, decision-and-policy makers, and elected government officials. Outreach efforts such as newspaper and magazine articles, and presentations to organized groups, are needed to convey the message. Through education, the public can become proponents of beavers and the habitat that they provide, helping to promote and protect the overall wetlands resource.

XIII. Proposed Immediate Action-Steps to Implement the Plan

The following 7 actions are proposed to be initiated as soon as possible in order to start to implement the Plan. Of course, these proposed actions are subject to potential unforeseen limitations of staff, time, funds, etc. The following are not

listed in any order of priorities; we should try to simultaneously move forward with all 7 actions.

1) In order to lessen beaver nuisance complaints, particularly in areas or regions where beaver densities have become intolerably excessive, the Division of Fish and Wildlife will institute a regulated, controlled beaver trapping season open to the public. In order to avoid overharvesting beavers, the initial harvest goals will be conservatively set, with participation limited only to licensed trappers using prescribed methods during established seasons in specific zones. The harvest will be carefully monitored as it occurs, with a requirement that all pelts be tagged within a limited time period after capture.

Because of the currently low monetary value of beaver pelts (about $6 per Delaware pelt), and the hard work that beaver trapping involves, it remains to be seen if the level of trapper participation in Delaware (during a zoned open season) will be sufficient to satisfactorily reduce excessive beaver densities and their nuisance problems. The first few years of having an open season would be an evaluative period to see if the nuisance problems can be reduced to a more tolerable level.

2) Establish/identify a dependable source of Division of Fish and Wildlife funding (e.g. $5,000 per year) to pay for contract trapping of problem-beavers. Such efforts will be needed to contend with beaver nuisance problems (via dispatch or live-trap and transfer) which may newly arise during the closed season; or which were not (or would not be) satisfactorily eliminated during a zoned open season; or for which no landowner wants or is able to undertake proper corrective action; or in cases where no "responsible" landowner can be identified.

3) In order to best implement the technical aspects of the Plan's recommendations for dealing with regional problem densities or site-specific problem colonies, and for promoting the environmental benefits of beaver activities, designate which Division of Fish and Wildlife biologist(s) will have the responsibilities for the following actions, and provide (or seek) adequate funds or other support necessary for satisfactory performance:

a) Design, implement, monitor and analyze controlled harvests by the public during zoned open seasons. Enforcement needs during open seasons will be handled by Division EO's.

b) Make technical determinations, on public or private lands on a statewide basis, and in consultation with appropriate parties, whether or not a beaver complaint is a substantive problem needing remedial action. Because of the environmental benefits provided by beavers, site-specific technical evaluation is warranted before

deciding that a beaver complaint received from a landowner (or other party) is substantive and needs remedy.

c) Make technical determinations and recommendations, on public or private lands on a statewide basis, and in consultation with appropriate parties, about the best type of remedial action to be taken when action is needed. Because of the environmental benefits provided by beavers, case-specific technical evaluation is warranted when selecting a remedial option, to see if it is desirable and practical to take structural corrective actions which will still allow the beavers to remain, or to see if the situation presents an opportunity to help establish or expand beaver populations at desired and suitable locations elsewhere (i.e. live-trap and transfer); if neither approach is desirable, practical or available for a substantive problem, then dispatch remedies must be recommended.

d) In order to further promote the distribution or recovery of beavers in Delaware in areas or regions of the State where desired sustainable populations have not yet been achieved, and where the environmental benefits of beavers have not yet been optimally realized, continue a program which solicits, evaluates and inventories potential release sites for the potential relocation of problem-beavers caught elsewhere.

e) Coordinate (or in some special cases supervise or perform) tagging of transferred beavers and gathering of other technical data at the release sites.

f) Perform <u>casual</u> monitoring at the release sites of the population and activities of trap-and-transferred beavers; if new research funds could be found, it may be desirable to undertake a more intensive study of beaver responses and activities at a few selected release sites.

g) Help to coordinate (or in some special cases help to supervise or perform) the planning, design or installation of structural remedies.

h) Contribute to and help to maintain, at a centralized Division location, any maps, inventories and detailed records about existing beaverdam sites and their populations, trap-and-transferred beavers and their release sites, candidate release sites, etc.

4) Using the environmental criteria developed in the Plan, attempt to determine and classify the environmental "quality" or "importance" of each existing beaverdam wetland in the State. This could be of value in determining, on a case-by-case basis, how much effort or resources should be put into structural or

monetary compensation remedies for contending with a substantive socioeconomic problem caused by a beaverdam wetland. If a specific beaverdam wetland causing a substantive problem is determined to be of relatively lower value, then less expensive dispatch or trap-and-transfer remedies might be used, whereas a relatively higher value beaverdam wetland causing a substantive problem might warrant the greater expense of structural remedies.

A precautionary note about the advanced application of this "quality" or "importance" criteria is that we're dealing with at least 126 potential evaluation sites statewide, which would require field (ground) and often aerial assessments, a logistically cost and labor intensive undertaking. The proposed evaluation as an advance undertaking might not be worth the effort, since we do not anticipate that all 126 existing sites will eventually lead to socioeconomic problems (most probably won't). It might be wisest and most cost effective to apply the "quality" or "importance" criteria only on an "as needed" basis, in response to having to evaluate (in terms of cost effectiveness) what to do about individual sites when (and if) they become problematic.

5) Perform longer-term evaluations (e.g. over several months) of the effectiveness and durability of various water control devices (i.e. "beaver baffles" or "beaver pipes") for preventing excessive water heights in beaverdam wetlands during longer-term period of baseflow. We may also want to design and evaluate various water control structures intended to reduce maximum water heights in beaverdam wetlands during shorter-term storm flows or spates. For devices or structures that are proven to be satisfactory, or which have a high probability of success, we should install a few as demonstration projects on the properties of cooperative private landowners.

6) Working with the Division of Soil and Water Conservation and the Conservation Districts, establish cost-share programs for those Plan activities which the Department and Districts both agree are desirable and suitable for the cost-share approach.

7) Prepare and make available for public distribution a 4-6 page information pamphlet about beavers and their activities. This is primarily intended to be a hand-out for landowners or people having beaver problems, focusing on beaver biology and ecology, their environmental benefits, their socioeconomic problems, remedies that are possible to alleviate problems, how and from whom to get further information or help, etc.

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XV. Appendices (Contents)

1. Delaware Division of Fish and Wildlife Management Philosophy (Appendix 1)

2. Title 7, Chapter 7, Section 701--Regulations and Prohibitions Concerning Game and Fish (Appendix 2)

3. Descriptions of selected beaverdam-wetlands habitats in Delaware.

   a. Garrisons Lake (Appendix 3)

   b. Paradise Alley (Appendix 4)

   c. Masseys Pond (Appendix 5)

4. Beaver-Release Data Sheet (Appendix 6)

5. List of Agencies/Organizations who have reviewed the Delaware Beaver Management Plan (Appendix 7)

6. An Overview of Beaver Trapping Seasons and Control Programs in Nearby States (Appendix 8)

7. Written Comments About the Plan Received from Other State Agencies, Federal Agencies, Private Environmental Groups, or the Public; Public Meeting (Appendix 9)

8. Active Participants in the Development of Delaware's Beaver Management Plan - plan research and preparation, technical advice and consultation, or plan review and comments (Appendix 10).

Appendix 1

Delaware Division of Fish and Wildlife Management Philosophy

The Delaware Division of Fish and Wildlife was formed to protect and conserve Delaware's wildlife resources (Section 8005 of Title 29). To fulfill this objective, management principles were formed to serve as a conceptual basis for Statewide and Regional Wildlife Management Plans. It is our goal to perpetuate the natural diversity of indigenous plant and animal communities, and when possible to restore viable populations of extirpated species. We recognize that man is an integral component of the ecosystem and has a significant impact on plant and animal communities. It is this ability, to determine the fate of our natural resources, that encumbers upon us the role of stewards. The Division will assume this responsibility by applying sound management practices based on the best available biological data.

The Division's first responsibility is to Delaware's wildlife resources. All species have an intrinsic value and we must strive to develop and apply the necessary knowledge to assure their survival through responsible habitat management. We will encourage, manage for and support the wise use of our wildlife resources as long as their viability is not jeopardized. Good quality habitat is essential for wildlife survival. A dynamic balance exists between plant and animal communities; changes to either may upset this relationship causing repercussions throughout the ecosystem. A community with great diversity of plants and animals is more stable and therefore more desirable. Our approach will be to manage ecosystems, to maximize plant and animal diversity and thus increase stability.

Our second responsibility is to manage our wildlife resources for recreational enjoyment, economic benefit and scientific instruction. We are committed to the concept of multiple use management of our natural resources provided the activity does not harm the resource or infringe upon the rights of others. Conserving our wildlife resources to provide both consumptive and nonconsumptive use requires careful planning and the application of prudent management policies.

The following concepts form the basis of our decision-making philosophy used to meet the responsibilities with which we are charged:

Philosophical Tenants for Managing Delaware's Wildlife Resources

1. We are committed to managing ecosystems. We will recommend no action that threatens the viability of any species or population because this would effect the stability of the whole system. Exotic and pest species will not be given equal

consideration with native species. Their relationship to the ecosystem will be evaluated for adverse effects on native wildlife populations and human and health safety.

2. We will manage wildlife species as viable, self supporting and free ranging populations. Consideration will be given to all species in order to maintain diversity and therefore stability and to maximize the variety of human experience.

3. Restoring native extirpated species is a desirable objective provided their reintroduction does not adversely effect human health and safety.

4. Land acquisition is desirable and necessary to preserve ecosystem diversity and recreational opportunities. However, the lands purchased will represent a complete ecological community without privately owned inholdings or represent an expansion of an existing Wildlife Area.

5. We will consider both consumptive and nonconsumptive uses in our planning processes and oppose competitive uses that are detrimental to wildlife populations or habitats. Competitive land uses are those that effect the welfare of wildlife because they alter or destroy wildlife habitat, even though the users may have no conscious intent to preempt wildlife habitat per se (e.g. timber harvesting, mining, ditching, human and agricultural waste disposal, and the spread of urban areas). Note: Timber harvesting and some other economically-driven land alterations may often be compatible with, or even enhancing to, wildlife populations and their habitats, if these activities follow Best Management Practices (BMP's) which satisfactorily consider and address wildlife concerns.

6. Population and habitat manipulations are acceptable management tools provided the viability of a species or the integrity of an ecosystem is not threatened.

7. We recognize hunting and trapping as legitimate management tools and recreational pursuits. We will strive to meet the demands for hunting and trapping as long as species viability is not jeopardized.

8. We recognize that some competitive land uses are desirable to human well being; we will mitigate for uses beyond our control and try to educate competitive users of the trade-offs.

9. Fulfilling our goals requires public support. We will attempt to educate people to wildlife benefits and instill a sense of responsibility towards the resource.

10. We recognize that most wildlife habitat is privately owned. We will develop a landowner wildlife habitat assistance program and strive to encourage landowners to expand hunting access to their property.

APPENDIX 2

TITLE 7

CHAPTER 7. REGULATIONS AND PROHIBITIONS CONCERNING GAME AND FISH

Subchapter I. General Provisions

S 701. Game Animals.

The following shall be considered game animals: Mink, snapping turtle, raccoon, opossum, gray squirrel, otter, muskrat, red fox, hare, rabbit, frog, deer, and beaver. The Bryant fox-squirrel, otherwise known as the "Sciurus niger branti," shall be protected wildlife.

REGULATION 17. SEASONS.

Section 1. Protected Wildlife.

It shall be unlawful to hunt, sell, ship or possess any species of protected wildlife except as permitted by law.

Section 2. Beaver.

There shall be no season during which beaver may be hunted, possessed, shipped or sold, except landowners or their agents may trap, possess and sell beavers causing damage on their property with a valid permit from the Division.

Appendix 3

Garrisons Lake

Observed: 8/24/90

Observers: Terri Fabean
Roger J. Wolfe
Randall V. Cole

The site is located at the headwaters of Garrisons Lake (Kent County) approximately 20 feet upstream of the train trestle culvert. The dam is 51 feet across and 1.5-2 feet in height. This colony appears to have been abandoned, the dam having been there approximately 5 to 10 years (Tom Whittendale and Cathy Martin, pers. comm.). The dam is partially intact with a steady flow of water coming through open sections. The water is 4-1/2 feet deep above the dam and 2-1/2 feet deep below. Signs of previous beaver activity include tree girdling and cutting, but there appears to be no beaver activity at this time. Forest composition on the south lateral side of the impoundment is 85% beech, while forest composition on the north lateral side is a diverse mixture of northern red oak, willow oak, maples and black gum. Sixty-five percent of the flooded surface area is vegetated (vegetation species listed below), while thirty-five percent of the impounded surface is open water. Numerous dead snags are present through the pond. The depth of the channel within the impounded area is approximately 4.5-6 feet, while the depth of water in vegetated areas is 1-2 feet.

Vegetation Observed

Smartweed (Polygonacea)
Spatterdock (*Nuphar luteum*)
Duckweed (Lemnaceae)
Cardinal-flower (*Lobelia cardinalis*)
Arrow Arum (*Peltandra virginica*)
Cattail (*Typha latifolia*)
Primrose willow (Primulaceae)
Water willow (*Decodon verticillatus*)

Birds

Green-backed heron (*Butorides striatus*)
Woodduck (*Aix sponsa*)
Snowy egret (*Egretta thula*)
Double-Crested Cormorant (*Phalacrocorax auritus*)
Kingfisher (*Megaceryle alcyon*)
Great Blue Heron (*Ardea herodias*)
Red-Shouldered Hawk (*Buteo lineatus*)

Trees

Red maple (Acer rubrum)
Willow Oak (Quercus phellos)
Black gum (Nyssa sylvatica)
Beech (Fagus grandifolia)
Northern red oak (Quercus rubrum)
Magnolia (Magnolia virginiana)
Blackjack oak (Quercus velutina)

Appendix 4

Paradise Alley

Surveyed: 8/28/90

Observers: Terri Fabean
Randall V. Cole

This dam is located off Paradise Alley Road (Kent County), 1/2 mile south of the railroad tracks, in a large culvert under a train trestle. The dam is intact with a steady flow of water coming through the middle. The dam is 31 feet across and 4-4.5 feet in height. The water above the dam is 4-4.5 feet deep in the channel, tapering to shallow depths at the edges. Directly below the dam is a pool of water 2-5 feet in depth, shallowing-out downstream to a small channel.

Signs of previous beaver activity include tree girdling and cutting. A beaver lodge is located upstream of the dam in the center of the impounded area. The lodge was built on an overturned tree. There appears to be no fresh sign of beaver activity at this time, but beaver scat specimens were found.

Forest composition lateral to and along the margin of the impounded area consisted of a mixture of species including: red maple (Acer rubrum), willow oak (Quercus phellos), river birch (Betula nigra), sweet gum (Liquidambar stryaciflua), black cherry (Prunus serotina), black gum (Nyssa sylvatica), and blackjack oak (Quercus marilandica). Approximately 45% of the pond center is vegetated with a variety of species including: duckweed, water willow, buttonbush, sweet pepperbush, and lizard tail. Coontail was also present as a submergent. The amount of open pond water was 35%, and about 20% of the ponded area has dead snags. Waterbirds present included kingfisher, great blue heron, and wood duck. Frogs, toads, and a five-line skink were also present at the time of survey.

Appendix 5

Masseys Pond

Observed: 8/30/90

Observers: Terri Fabean
Roger J. Wolfe
Shawn Shotzberger

There is no present dam at this Kent County site, but beaver appear to be using the pond for food sources and living area. Two lodges were located upstream of the pond. One is on the bank of Jim Short's property, which is on the pond's south side in the lower headwaters. The other lodge is approximately 25m upstream on the same side, but at a location narrowed into a stream.

Forest composition along the pond edges consists of red maple, northern red oak, willow oak, black willow, speckled alder (Alnus rugosa), tulip poplar (Liriodendron tulipifera), and black oak. The pond surface consisted of open water with no emergent vegetation. The pond headwaters were 75% vegetated, with 25% open water having a 4-5 feet deep channel. Vegetation consisted of an abundant amount of water willow, with a mixture of spatterdock (Nuphar luteum), arrow head (Sagittaria latifolia), jewelweed (Impatiens capensis), smartweed (Polygonum punctatum), pickerelweed (Pontedria cordata), cardinal flower (Lobelia cardinalis), and buttonbush (Cephalanthus occidentalis). Dead snags were present in the stream section of the pond. The area upstream appeared to be flooded at one time, but the water level was down at the time of survey. There were previous signs of beaver activity such as tree girdling and cutting.

Appendix 6

BEAVER RELEASE DATA SHEET

TAG NO._____

STREAM AND LOCATION WHERE TRAPPED:_____

_____

TRAPPER:_____

DATE TRAPPED:_____

STREAM AND LOCATION WHERE RELOCATED:_____

_____

DATE RELEASED:_____

AGE:_____

SEX:_____

WEIGHT:_____

NOTES:

Appendix 7

List of Agencies/Organizations Who Have Reviewed the Delaware Beaver Management Plan

Delaware Division of Fish and Wildlife (DNREC)
- Wildlife Section
- Enforcement Section
- Mosquito Control Section
- Fisheries Section

Advisory Council on Fish and Game

Delaware Division of Soil and Water Conservation (DNREC)
- Drainage Section
- Conservation District Operations
- Delaware Coastal Management Program

Delaware Division of Water Resources (DNREC)
- Wetlands and Aquatic Protection Branch
- Watershed Assessment Branch

Delaware Division of Parks and Recreation (DNREC)
- Technical Services Section
- Delaware Natural Heritage Inventory

Delaware Department of Agriculture
- Forestry Section
- Aglands Preservation Section

Delaware Department of Transportation
- Division of Highways

New Castle Conservation District

Kent Conservation District

Sussex Conservation District

U.S. Soil Conservation Service (Dover)

U.S. Agricultural Stabilization and Conservation Service (Dover)

U.S. Fish and Wildlife Service
- Bombay Hook NWR
- Prime Hook NWR

Appendix 8

OVERVIEW OF BEAVER TRAPPING SEASONS AND CONTROL PROGRAMS IN NEARBY STATES

MARYLAND

As of now, the Wildlife Administration responds to beaver complaint calls. Their methods are:

1. The sites are reviewed and technical advice is offered to the landowner.
2. Trapping beaver on a landowner's property is postponed (if possible) until the trapping season is open.
3. If a landowner does not want to personally take care of a problem, he can call a licensed trapper to take care of the matter (at a fee).
4. Staff will often remove beaver themselves (District biologists or other staff).

Open Trapping Season

January 1 - March 15	Bag Limit = 5-15 per year depending on county

PENNSYLVANIA

If a landowner has a beaver problem, he can take care of the problem himself without a permit.

If a landowner does not want to personally take care of a problem, he can call a damage control officer.

In the northeastern part of the state, beaver harvest was approximately 400 animals (60% done by landowners).

Open Trapping Seasons

1st Season (Recreation)	December 15 - January 15
2nd Season (Fur)	March 1 - March 23

The annual bag limit is different throughout the state. It ranges from 6 to 40 per year depending on geographic location.

If the harvest goal is met during the first trapping season, then the second season will be closed.

NEW JERSEY

Beaver trapping season is concurrent with otter season.

Open Trapping Season

February only - by lottery system
Very limited season; 60-70 permits available statewide (annual limit 3 beaver, 1 otter).

1990 statewide harvest: 140 - 160 beaver

Research Unit - sets up season and bag limit

Wildlife Control Unit responds to complaints
(1990 = 160 complaints)

1. Gives advice (e.g. fencing around trees; beaver pipes)
2. May install structural control devices
3. Live-traps and relocates about 10 to 20 beavers per year

Site-specific permits are issued to landowners who have problem-beavers on their land and who did not get a statewide permit. These special permits are only issued for February.

In times past, area managers would survey their areas for any beaver sites, done once per year for three days.

NEW YORK

Numerous man-hours by state personnel are spent responding to complaint calls.

1. Technical advice
2. If landowners are willing to install beaver pipes, the staff will show the landowner how to do it.
3. A permit will be issued to the landowner if he wants to remove the beaver.

Open Trapping Season - Split Season
(Example from Region 9)

December 14	- January 26	- No limit
March 7	- March 22	- No limit

*Season lengths and bag limits can vary by region.

MASSACHUSETTS

The Wildlife Section will respond to a beaver complaint call. They have a four-step process when responding to a call.

1. Site visit
   Nature of complaint
   Public health
   Public safety
2. May install beaver pipes.
   A site-by-site evaluation will be done before installing a pipe; history of complaint, food source, size of wetland that will be created, etc. Pipes will be utilized for wetland enhancement purposes.
3. If a landowner does not want to personally take care of a problem, the Division has a list of trappers to which they may refer.
4. Any landowner who has damage to his property caused by wildlife (e.g. deer, beaver, etc., except for non-game species) can kill the animal under permit issued by the Division. Problem animals so killed must be buried or turned into the state.

A data card is also issued with landowner permits or trapper licenses. The card is used to collect information on how many beaver were taken and the type of damage prompting their removal.

Facts:

* Nuisance complaints - approximately 180 per year.
* There are 351 towns in the state, and one-third of the towns have had beaver complaints concerning road inundation, blockage of road culverts causing flooding, etc. Between $200,000 and $300,000 has been spent on actions taken to correct these problems.
* In the 1950's and again in the late 1980's, beaver were relocated throughout the state; it was a "quick fix" but the solution may have long-term negative results. The relocation of beaver was done to reestablish the statewide beaver population.

Open Trapping Season - (Best Management Practice)

November 15 to last day in February

After January 15, the conibear #220 and #330 traps are prohibited, and leg-hold traps only can be used.

75% of the trappers use conibear #220 or #330 traps, and they must be used as underwater sets. Leg-hold traps may also be used with a drowning set.

Value of beaver - Pelt value currently low at $16

Castor glands: $90-100 per pound in Canadian auction
$45- 50 per pound at local auction

VIRGINIA

1990 - 593 killed statewide (beaver complaints)

If a landowner has a beaver problem, a control permit can be issued out-of-season.

A game warden will review the complaint; if he feels there is a problem, he will issue the landowner a permit. Depending on the problem, the warden will set the number of beavers to be taken.

Open Trapping Season

December 1 - February 29 - No bag limit

When fur prices are up, the beaver population goes down; when the fur prices are down, the population goes up.

WEST VIRGINIA

County Conservation Officer will respond to beaver complaint calls.

1. He will give technical advice to the landowner.

2. If the landowner still wants the beaver to be removed, the officer will issue a special trapping permit.

Open Trapping Season

November 2 - February 29 Bag limit = 25 daily or 25 per season

1984-85 : 523 harvested statewide
1987-88 : 1064 harvested statewide
1989-90 : 962 harvested statewide

NORTH CAROLINA

Any landowner who has damage to his property caused by wildlife (e.g. deer, beaver), except for non-game species, can shoot the nuisance animal without permit. Problem animals so killed must be buried or turned into the state.

If a nuisance animal is to be trapped from an area, a permit has to be issued by a wildlife officer or biologist.

Open Trapping Seasons
Three Regions

Western: November 7 - February 12 (no limit)
Coastal: December 15 - February 28
Piedmont: December 1 - February 20

Appendix 9

Written Comments About the Plan Received from Other State Agencies, Federal Agencies, Private Environmental Groups, or the Public; Public Meeting and meetings with the Advisory Council on Fish and Game. All entires in Appendix 9 are in chronological order, based upon sequential dates of distribution, receipt, or occurrence.

DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

DIVISION OF FISH AND WILDLIFE

M E M O R A N D U M

TO : Dave Small

FROM : Bill Meredith Bill

SUBJECT: Announcement for upcoming editions of the DNREC Register

DATE : May 23, 1991

Please include the following information in the upcoming editions of the DNREC Register:

PUBLIC MEETING - BEAVER MANAGEMENT PLAN

AUGUST 15, 1991 - 7:30 P.M. - DNREC AUDITORIUM

To receive and review public comments about the proposed statewide Beaver Management Plan, designed to promote environmental benefits associated with beaver activities and to contend with socioeconomic problems that beavers may cause.

Further information:
Contact Division of Fish and Wildlife, 739-4782.

DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

DIVISION OF FISH AND WILDLIFE

M E M O R A N D U M

TO : Distribution List (DFW Personnel Only - See Below)

FROM : Bill Meredith Bill

SUBJECT: Review of draft Beaver Management Plan

DATE : May 31, 1991

Enclosed is a draft copy of the Beaver Management Plan for your review and any written comments that you'd like to provide. You can write your comments either directly on the draft text or on separate paper. We need to have any written comments given to either Terri Fabean or me by no later than June 14, 1991. If we don't hear from you by the end of this two-week period, we must assume that you'll be offering no suggestions or recommendations, and that the draft plan is satisfactory to you.

An external agency review of the plan will be done from late June through mid-July (see list on next page for preliminary indication of external agencies who'll be asked to review the plan.) We will hold a public meeting in mid-August for citizen review and to receive public comments. According to our DCMP grant, the plan must be "finalized" by the end of September. Thank you for your cooperation and assistance.

DFW Distribution List

Bill Wagner
Lloyd Alexander
Bill Whitman
Greg Moore
Ken Reynolds
Tom Whittendale
Randy Cole
Charlie Lesser
Rod Harmic
Rick Burritt
Jim Reynolds
Chet Stachecki
Bill Meredith
Roger Wolfe
Terri Fabean

Proposed External Agency Review

Drainage Section, DSWC/DNREC
Conservation District Operations (E&S/NPS), DSWC/DNREC
Delaware Coastal Management Program, DSWC/DNREC
Wetlands and Aquatic Protection Branch, DWR/DNREC
Watershed Assessment Branch (includes Stormwater Management Program), DWR/DNREC
Technical Services Section, DPR/DNREC
Delaware Natural Heritage Inventory, DPR/DNREC
Delaware Division of Highways, DOT
Delaware Forestry Section, DOA
Aglands Preservation Section, DOA
New Castle Conservation District
Kent Conservation District
Sussex Conservation District
U.S. Soil Conservation Service (Dover)
U.S. Agricultural Stabilization and Conservation Service (Dover)
Bombay Hook NWR (USFWS)
Prime Hook NWR (USFWS)

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
DIVISION OF FISH AND WILDLIFE
89 KINGS HIGHWAY
P.O. BOX 1401
DOVER, DELAWARE 19903

OFFICE OF THE
DIRECTOR

June 21, 1991

Name

Address

Dear _____:

Enclosed is a draft copy of a proposed statewide Beaver Management Plan. The draft plan was prepared by the Delaware Division of Fish and Wildlife. The plan's development is being supported by a one-year grant from the Delaware Coastal Management Plan. The purpose of the plan is to promote environmental benefits associated with beaver activities, and to contend with socioeconomic problems that beavers may cause.

We are soliciting your review and any written comments that you'd like to provide. We need to receive any written comments from you by no later than July 15, 1991. If we don't hear from you by the end of this three-week period, we must assume that you'll be offering no suggestions or recommendations, and that the draft plan is satisfactory to you. If you have any questions, please call either Terri Fabean or me at 739-4782 (Little Creek Biological Field Office).

Further modification of the draft plan may come following further internal review by the Division of Fish and Wildlife, from comments provided by the Advisory Council on Fish and Game or from other state and federal agencies (see distribution list below), or from the general public following a public meeting planned for August 15.

Thank you for your cooperation and assistance.

Sincerely,

William H. Meredith
Fish and Wildlife Program Manager

WHM:jea

cc: William C. Wagner, II
H. Lloyd Alexander
Rodney L. Harmic
Chester J. Stachecki, Jr.
William R. Whitman
E. Greg Moore
Kenneth M. Reynolds

Distribution List:
Advisory Council on Fish and Game
Drainage Section, DSW/DNREC
Conservation District Operations, DSWC/DNREC
Delaware Coastal Management Program, DSWC/DNREC
Wetlands and Aquatic Protection Branch, DWR/DNREC
Watershed Assessment Branch, DWR/DNREC
Technical Services Section, DPR/DNREC
Delaware Natural Heritage Inventory, DPR/DNREC
Delaware Division of Highways, DOT
Delaware Forestry Section, DOA
Aglands Preservation Section, DOA
New Castle Conservation District
Kent Conservation District
Sussex Conservation District
U.S. Soil Conservation District
U.S. Agricultural Stabilization & Conservation Service (Dover)
Bombay Hook NWR (USFWS)
Prime Hook NWR (USFWS)

July 5, 1991

Mr. William H. Meredith
Div. of Fish & Wildlife Program Manager
DNREC
89 Kings Highway
P.O. Box 1401
Dover, DE 19903

Dear Bill:

I just finish reading the proposed statewide Beaver Management Plan. I must admit that I have always felt sad that we americans almost brought the beaver to extinction.

I have asked Lloyd Simmons, Manager at Redden State Forest and Mike Brown, Manager at Blackbird State Forest to also review the draft since they have dealt directly with beaver on the State Forest.

In addition I cannot recall at any time when our foresters working with the private forest landowner has ever reported a detrimental beaver problem. So I can only conclude that if the beaver has caused a timber management problem, the private landowner has not made it one of his concerns.

I would like to present a couple of points for your consideration. First, page 18: "**Quite often timber of low commercial value**". Swamp white oak has a very high commercial value in domestic veneers and cooperage. Also, it is sought out by Europeans and Asians as a substitute to true white oak (**Quercus alba**). Second, page 42: "**We have identified 13 categories of potential plan participants**:" I do not see forestry as a participant in your listing or matrix. I think you need someone to speak for the trees that the beaver are eating and using for housing. Third, page 52: "**Planning processes and oppose competitive uses**"...

"Competitive land uses.. (e.g. timber harvesting, etc." The statement, "no conscious intent", I assume includes man and beaver. Oppose competitive uses (e.g. timber harvesting). I suggest oppose harvesting that is detrimental to the residual forest stand and beaver habitat, but support harvesting that incorporate Forestry Best Management Practices for to co-benefits of timber and beaver.

One additional note, the Forestry Section has a federally funded program titled **"Stewardship Incentive Program"**. This is a cost-share for forest landowners to perform a conservation activities, the development of wildlife habitat is one of those programs. Jim Wilber form you wildlife staff is a member of the stewardship committee. I would contact him for what he is doing and how you could use these funds to help landowners in there timber/wildlife practices.

Thanks for the opportunity.

Sincerely,

Timothy A. Kaden
Forester Supervisor

TAK/d

cc: Roland Derrickson, Acting Forestry Administrator

United States Department of the Interior
FISH AND WILDLIFE SERVICE
BOMBAY HOOK NATIONAL WILDLIFE REFUGE
R.D. #1, BOX 147
SMYRNA, DELAWARE 19977

July 8, 1991

Dr. William H. Meredith
Fish & Wildlife Program Manager
Delaware Division of Fish & Wildlife
P.O. Box 1401
Dover, Delaware 19903

Dear Bill:

Thank you for the opportunity to review the draft copy of the Beaver Management Plan. It was very comprehensive and well done. I only have two minor comments:

1. Page 24: Our greatest problem (Public Lands - Conservation/Recreation Area) with beavers is their habit of plugging water control structures when we are actively trying to manage habitat for waterfowl, usually in the "drawdown" phase of impoundment management. You may wish to address this.

2. Page 29: Even though national wildlife refuges could be potential release sites in certain instances; the policy is not to introduce animals of any kind on a refuge without extensive tests to rule out transmission of disease to extant wildlife populations. There would be more paperwork "hoops" to jump through than release sites on other public or private lands.

Again, I appreciate the opportunity to review the plan. Biologist Frank Smith of my staff also reviewed the document.

Sincerely,

Paul D. Daly
Refuge Manager
Bombay Hook/Prime Hook Refuges

PDD/sms

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION
89 KINGS HIGHWAY
P.O. BOX 1401
DOVER, DELAWARE 19903

OFFICE OF THE DIRECTOR

TELEPHONE: (302) 739 - 4411

July 15, 1991

To: Bill Meredith, Fish and Wildlife

Fr: Kevin Donnelly, District Operations

Re: Beaver Management Plan

Overall, I am impressed with the breadth and depth of the plan. It is well organized and well written. My comments should be considered to reflect the views of the New Castle and Kent districts. Sussex district indicated that they were working with Dick Smith to ensure coordination with a key component of their operation.

One of the first questions that comes to my mind when reading this report is "Who is our audience?". Was this written for the scientific community, key decision makers or the general public? Will it be used as the technical reference for future policies or is it part of the department's initial policy for beaver management? The answers to these questions will determine the final content and format of this plan.

If it is written for decision makers or general consumption then we need to simplify the language, shorten the paragraphs and sentences and make it more visual. I would hope the I&E section has software such as Right Writer that can analyze a document and offer suggestions for improving readability.

In terms of format, perhaps it should be reorganized to clarify what issues need decisions, where more study is needed and where we are relatively certain of our position?. I would suggest that our target audience dictates whether or not the first section of the report addresses biology or the roles and responsibilities of the agencies charged with implementing such a plan.

To make the document more user friendly I would like to see an Executive Summary, approximately 1-1.5 pages long, that succinctly spells out the who, what, why, where and how much of the draft plan. This summary should be included as part of the plan and be able to stand alone if necessary. The section entitled General Policy and Plan Purpose is a good start. We know from past

experiences that our elected decision makers are not likely to read this entire document. The summary should provide them with the most important information within your plan.

I hope that we can improve the graphics, especially Figures 1-4. Our GIS section and their computers should be able to assist in this effort even with the limitations of budget and copier technology. Our society thrives on the visual display of information; we need to capitalize on this fact if we can.

I like to now concentrate on some specific concerns. The first one centers around Table 1. The last sentence in paragraph 1 on page 43 reads "... the advisory input of all interested parties must be seriously considered." The matrix on page 44 fails to communicate this commitment to coordination. A matrix, by design, displays discrete boundaries of responsibility. This is not the message that you want to convey.

Specifically, I am concerned that the districts, who are identified as the primary implementers of structural activities, along with the primary or partial responsibility for the long term maintenance and repair of many structures possibly effected by beaver, are not, at least at this point, displayed as part of the team responsible for determining either the problem or the corrective action. In most cases the authority to determine the problem and the action never includes a representative from the group charged with the implementation of the action.

We need to go beyond the matrix and develop a table or figure that illustrates the level of coordination the authors of the plan describe on page 43. Without this extra step, it may be perceived that the plan contains a flaw in it's approach for assessing a problem and devising a mutually agreeable solution.

The districts can provide help in implementing the recommendation of developing a cost-share program(s) to assist in managing the states beaver population. All three districts have many years experience in cost-share programs and their experience will prove very valuable no matter what form this cost-share program takes. You must understand that such a program, under our current allocation, must compete for funds targeted towards our current water quality priorities.

Other changes that you may wish to consider include:

pg 21 - Change Delaware Forestry Section to "DOA - Forestry Section"

pg 26 - Should the tax ditch category be expanded to include the lands drained by them?. I am concerned with not specifically mentioning ag land in this prioritization. Farmers are going to want to know where they place on this list.

pg 26 - For consistency sake this list and the one describing beaver problems on page 42 should be the same. I mention it because rural private land is listed last on page 42 and this may raise a flag in the agricultural community.

pg 29 - Criteria #3 - Where did the 20 yards and 5 feet come from? I'm sure the ag community will want to know. Perhaps it should be stated in a less definitive manner until the plan has undergone public review. (Bill, I'll work on this.)

pg 33 - Websters' not withstanding, "dispatch", in my opinion is a weasel word that government uses too often. Let's say what we mean and use words that people understand. How about changing the word "dispatch" to "annihilate" or "exterminate"?

Finally, shouldn't the table of contents contain a separate list of figures and tables?

Bill, this is a real strong effort for first review draft. Let me know where and how I can help this effort and I'll do all I can. I'm sure the districts feel the same way.

cc: John Hughes
Andy Manus
Dick Smith
Larry Irelan/Andy Burger
Art Malinowski/Ernie Zimmerman
Beth Horsey/Cashar Evans
Fred Mott

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
DIVISION OF WATER RESOURCES
89 KINGS HIGHWAY, P.O. BOX 1401
DOVER, DELAWARE 19903

SURFACEWATER MANAGEMENT SECTION
WATERSHED ASSESSMENT BRANCH
POLLUTION CONTROL BRANCH
FACILITY SUPPORT BRANCH
WETLANDS & AQUATIC PROTECTION BRANCH

(302) 739-5726
(302) 739-4590
(302) 739-5731
(302) 739-5081
(302) 739-4691

MEMORANDUM

TO: Bill Meredith

THRU: Bill Moyer

FROM: Dave Saveikis

SUBJECT: Draft Beaver Management Plan

DATE: July 15, 1991

The Wetlands and Aquatic Protection Branch (WAPB) has completed review of the Division of Fish and Wildlife's draft Beaver Management Plan. We welcome the opportunity to provide our input on draft plans such as these which affect wetland and subaqueous land resources and would like to continue to be involved in providing input in your Division's wetland and aquatic management policies and programs, preferably as early as possible in the process involving such efforts. Early collaboration in such efforts can only lead to better, more implementable programs.

Regarding the draft Beaver Management Plan, the WAPB supports the objectives of the plan and recognizes the benefits and challenges of management of beaver compatible with other ecological and social considerations.

We have several substantive comments regarding the draft plan to include:

1) Include in Section VIII 1.A. under potential beaver release site criteria to be considered, language addressing extant site characteristics relative to rare or endangered plant or animal species and unique aquatic and wetland community types. This would insure that otherwise beneficial beaver induced hydrological and ecological alterations do not conflict with other sensitive resources (e.g. extended hydroperiod causing unacceptable damage to Atlantic white cedar communities). Addition of such language would be consistent with other textual sections addressing this issue found on pages 22 and 24 of the plan.

Delaware's good nature depends on you!

2) Criteria considering potential agriculture conflicts at potential beaver release sites (Section VIII 1.A.3.) may not adequately address, through the proposed 20 yard isolation between potential wetland edge and cropland, agriculture conflicts since the "potential wetlands edge" may be difficult to predict due to the uncertainty of the ultimate elevation of any beaver damns, the variable success of beaver flow-through pipes at managing water levels, and the relatively flat topography of many sites.

3) We request that the Wetlands and Aquatic Protection Branch play an active advisory role for those situations affecting wetlands or subaqueous lands in assisting in management decisions as outlined in Section X numbers 1 (determination of a problem) and 2 (determination of desirable action) for all five listed types of beaver-caused problems.

Management of beaver impacts on wetlands and subaqueous lands is but one opportunity available enabling our two agencies to work proactively toward achievement of wise management of our aquatic habitat resources. We anticipate this potential and look forward to you response. Please feel free to call us if you should have any questions regarding our comments.

DES/ca

cc: Jerry Esposito
Bob Zimmerman
Tony Pratt

DES9159

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
DIVISION OF PARKS & RECREATION
89 KINGS HIGHWAY
P.O. BOX 1401
DOVER, DELAWARE 19903

7 August 1991

M E M O R A N D U M

TO: William Meredith, Terri Fabean

FROM: Leslie D. Trew, Keith Clancy, David Rothstein, Delaware Natural Heritage Inventory

SUBJECT: Comments on the Draft Beaver Management Plan by the Division of Fish and Wildlife

CC: William Wagner, Chazz Salkin, Susan Laporte

We have reviewed the Delaware Beaver Management Plan drafted by the Division of Fish and Wildlife and would like to provide our comments on this plan.

The staff of the Delaware Natural Heritage Inventory would prefer that no extrinsic manipulative techniques be employed to manage the beaver. A hands-off policy would be the ideal situation. However, we are aware that there have been numerous complaints recently regarding the beaver and its activities and that in certain instances an active role of management is warranted in order to alleviate hardships created by beaver activities. In an ideal world the beaver and humans could live together harmoniously.

It was mentioned, although briefly, in the management plan of instituting an educational program to emphasize the environmental importance of beavers and their activities. We strongly believe that education can be an important tool in alleviating some problems associated with beavers by making the public more aware of the value of the beaver and more tolerant of its activities. The recent boom in housing developments throughout much of Delaware adjacent to, and in some cases in, wetlands has undoutedly resulted in many recent beaver complaints from the public. We encourage the Division of Fish and Wildlife to pursue a beaver education program vigorously as part of their overall beaver management strategy.

Specific Heritage concerns about the beaver plan:

Potential Relocation Sites/Transplanting Beavers

Relocation sites must be chosen with extreme care and long-term monitoring of these sites should be enacted to ensure that transplanted beavers remain on site. Translocation of nuisance beavers is recommended only in situations where suitable habitat is available. Proposed sites should be thoroughly surveyed for rare species as well as unique natural communities. While the influence of a beaver population in a habitat may be beneficial to some species (e.g. waterfowl, herons and allies), it may not be for others. Translocation of beavers will certainly alter the habitat (assuming they remain in their new home) and could adversely affect insect, herpetile, and bird populations. Plant species are most vulnerable to these changes. We would like to have the opportunity to review potential release sites for presence/absence of rare species. Flooding of a site by beaver damming could destroy populations of rare plants or similarly have negative impacts on a unique or otherwise pristine (i.e. in a relative sense) natural community. For example, a site in Connecticut containing 15 rare plant species was severely impacted by beaver activities (Connecticut Natural Heritage Program). Likewise, a lake in New York which was dammed resulted in the loss of the federally endangered orchid, Isotria medeoloides, in the wooded areas surrounding the lake (The Nature Conservancy, New York Chapter). We would like to avoid the need to relocate beavers a second time in the event that the beaver's new home contained rare species or unique natural communities that would be impacted by the animal's activities.

The problem of habitat alteration also exists in extant beaver ponds. Removal of a population would result in water flow augmentation, a change in water quality, and the alteration of the habitat. Before a beaver is relocated, it must be known which other species and natural communities will be affected, and how will they be affected.

Translocation is a popular method in beaver management, but one which often results in unforeseen consequences. Transplanted beaver have been known to range widely from their new dwellings. Research has documented movements from 5-200 miles from the release site (see Hibbard, E.A. 1958. Movement of beavers transplanted in North Dakota. J. Wildlife Managem. 22:209-211). Will frequent monitoring occur in order to determine if the transplanted beaver are remaining in their new homes.
How will relocation sites be chosen, particularly those potential sites that are on private land, to ensure that the beavers will not be causing problems to the public in the future? Long-term monitoring should be implemented to track breeding success and any dispersal events from the site.

A beaver colony is more appropriately described as a "family unit" since beavers exhibit a high degree of fidelity. Beavers often mate for life and the family frequently consists of from 4-6

individuals that may represent several generations. Site fidelity is a factor in familial interrelations. A good understanding of the sub-population at the site is necessary. The potential for disruption of the breeding cycle as well as the family unit is apparent. Another important consideration in translocating beavers is the fact that the process is labor-intensive and frequently the adults need to be anesthetized prior to relocation (Seal, U.S. and T.J. Kreeger. 1987. Chemical immobilization of furbearers. Pages 191-215, in M. Novak, ed. Wild furbearer management and conservation in North America. Ontario Ministry of Natural Resources).

As you are aware much of the beaver's habitat has been destroyed by human activities. Each year more of this habitat is being encroached upon. It is difficult for the beaver to go about the job of being a beaver. Perhaps the Division of Fish and Wildlife or DNREC could become actively involved in the review process for development projects to help these projects avoid impacting beaver habitats (such as building far enough away from wetland habitats to avoid any flooding problems caused by beaver dams).

Structural Alteration of Lodges

Structural alteration of the lodge is a good alternative that should be pursued; although it may require funds above those needed for relocation dependant on the method employed. Monitoring will be necessary. Another consideration is that methods utilized will be experimental and will need to be fine-tuned from site-to-site. Readjustment of the water levels will allow the beavers to remain in the area, as well as placate the complainant. If possible methods to alter water levels should be attempted before beaver relocation. As the beaver plays an integral role in the ecosystem, water flow alteration should be conducted with the habitat in mind.

Remedial Response Options if a Substantive Beaver-related Socioeconomic Problem is Occurring

While a study of beaver lodge locations has been conducted, there is little information available regarding site/statewide populations. An extensive population/breeding ecology survey should be undertaken prior to the implementation of the proposed management practices. Estimation of numbers of individuals in each family is time consuming and probably impractical. A knowledge of breeding success, dispersal rates and distances and sex ratio for Delaware's beavers is important if a population is to be minimally disrupted.

Translocation of individuals and structural alteration of dams are the most viable options presented in the plan. While acceptable, these measures should only be used as a last resort. There are a variety of control methods which were not discussed in the plan, which should be initially explored at each site which are outlined below. Any alternative selected should be implemented on a site-by-site basis, following thorough

examination of the beaver population, including a comprehensive biological inventory of proposed release and existing sites. The sterilization, dispatching and public trapping of beavers are extreme management measures, and for reasons to be discussed, are not recommended.

Alternative Control Measures

Individual trees may be protected by enclosing the bottom 1 m with heavy wire mesh, hardware cloth, or galvanized metal. Volunteers from the Nevada Humane Society wrapped 1200 cottonwood trees to prevent beaver-related damage.

Commercial deer repellents may deter beavers, but may have an unpleasant odor (de Almedia, M.H. et al. 1979. Nuisance furbearer damage control in urban and suburban areas. Wild furbearer management and conservation in North America. Ontario Ministry of Natural Resources). Beavers may avoid trees painted with diluted repellent (1:50) for three years or more. Experiments regarding the effectiveness of this method show a learned intolerance of an area to which repellent has been applied.

A short-term solution may include artificial feeding. Placing food in an acceptable den area has proven to be a successful alternative, allowing one dam to be dismantled, while another one is created in an appropriate area. The reliability of this method is unknown.

Artificial scent mounds are effective in deterring transient beaver from using existing but uninhabited lodges (Muller-Schwarze, D. n.d. Canadian Beaver at Acadia National Park. National Park Service Cooperative Research Unit). Castor secretion is natural and is released as a territorial marking. So effective is this method, that sometimes even resident beaver are affected (Svendson, G.E. and W.D. Huntsman. 1988. A field bioassay of beaver castoreum and some of its components. Am. Midl. Nat. 120:144-9.)

Exclusion fencing of small critical areas such as culverts, drains, and small ponds or lakes may prevent damage (Miller, J.E. 1983. Beavers. Prevention and control of wildlife damage. University of Nebraska).

Electrified barriers can be highly successful in controlling beaver flooding at sites where the activity of beavers is otherwise acceptable. These systems work best in areas with little public exposure as vandalism may be a problem (Muller and Schwarze, n.d. On a study of the behavioral and population ecology of the Canadian beaver at Acadia National Park. National Park Service Cooperative Research Unit, SUNY, Syracuse, NY. 86 pp).

Availability of winter food supply is the most important factor affecting beaver distribution and abundance. Hence, it is theoretically possible to affect beaver population through

manipulations of the vegetation (Hill, E.P. 1982; Slough and Sadleir, 1977). In general, activities which favor young woody deciduous growth will favor the beaver. Other management practices may hinder the success of beaver at a site. This option may not be advantageous in Delaware due to the beavers' opportunistic feeding habits.

Beaver damage to roads and culverts may be prevented by anticipating the likelihood of beaver activity and properly designing the road or stream crossing. Relocating roads or edifices may be more complicated, and would have to be coordinated with DELDOT. The study of beaver distribution should be substantive enough to make recommendations to city, county and state planners. People actively involved with beaver management should regularly attend planning and development meetings.

Sterilization, Dispatching and Public Trapping Season

These methods should be avoided if possible. As mentioned, sterilization is costly, and also requires the resources for live trapping. Pre- and post-operative care are required as well. This method is not suggested as its effects on the population are irreversible and its effectiveness in population control is questioned.

Dispatching of problem beavers is not recommended for a variety of reasons. As discussed earlier, the stability of the population is dependent upon monogamy, a 3-year maturity cycle and familial relations. The dispatching of one or more individuals may have unanticipated affects on a "family". Likewise, the beaver is an integral facet of its environment. The elimination of the beaver from its habitat may have a resounding impact on numerous species.

At this point in time, a public trapping season is premature. Without a firm knowledge of statewide abundance, one cannot effectively regulate trapping. Determining the appropriate number of beavers for a particular area or management unit can be a difficult and often subjective decision. Your example of having a statewide harvest of 300 beavers per year would deplete the current state population by 40%, assuming a total of 750 beavers. A harvest of one-third of the population has been suggested by researchers, with the stipulation that season length and localities be varied (Hill, 1982; Novak, 1987b; Ermer, E.M. 1988. Manageing beaver in New York. The conservationist. State of New York.)

Despite the difficulty that is sometimes encountered in totally removing beavers from an area, their confined ecological limits and low reproductive rate, together with the ease with which they may be trapped, make beaver vulnerable to overharvest. Avoiding beaver problems through regulated harvest recently has become more difficult because low pelt prices in some areas discourage many trappers.

The possibility of capturing non-target species is high. Raptors and herons are most susceptible, but many other species have been caught in leghold traps.

The estimate of 750-1500 individuals is wide-ranging. It may not represent a stable population. A regulated season would have dramatic impacts on habitat, and non-target species. As mentioned in your plan, this method is imprecise. A skewed sex ratio may result from large-scale trapping and unpredictable population fluctuations should be anticipated. Likewise, a regulated season may not effectively put an end to the problem beaver(s). Alternative means which operate on a site-by-site basis are preferred.

p
All management techniques should be geared to nuisance beavers; those which occur in already developed areas. Anticipation and proper planning for new developments should eliminate much of the problems associated with beavers. They do not become pests until humans encroach on their breeding grounds.

We appreciate the opportunity to comment on the Beaver Management Plan and we hope that you will give serious consideration to the concerns addressed above by the Delaware Natural Heritage Inventory.

DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL

DIVISION OF FISH & WILDLIFE

M E M O R A N D U M

TO: Bill Wagner, Lloyd Alexander, Bill Whitman, Greg Moore, Ken Reynolds, Rod Harmic, Rick Burritt, Chet Stachecki

FROM: Bill Meredith, Terri Fabean
Bill Terri

SUBJECT: Proposed Immediate Action-Steps to Implement the Beaver Management Plan

DATE: August 14, 1991

The latest draft of the Beaver Management Plan distributed to you (August, 1991) had a blank Section XIII: "Proposed Immediate Action-Steps to Implement the Plan". Based upon written comments received to date about the Plan, and on three recent meetings in which we received Division and Department input, we've prepared the draft text for Section XIII (see enclosed). The recently received input was primarily informed opinions about varied topics, and sometimes revealed differences of opinion amongst the contributors, or sometimes did not mesh with technical facts in the Plan; however, most input offered was decipherable and will strengthen the Plan. We've done the best that we could in devising 8 proposed action steps, and believe that all of these recommendations are consistent with the Plan's content and with what we've heard from you. However, since we also know that suggesting anything to do about beavers always seems to elicit counterpoints, we won't be too surprised if you'll differ with some of the proposed actions.

What we now need is for you to edit the attached, both conceptually and for "wordsmithing." We need to have this Section finalized, along with any policy or organizational decisions that may have to be made, by no later than August 30th. The Plan's final version must be completed and printed by late September. If we don't hear from you by August 30th, we must assume that the 8 proposed action steps are satisfactory to you and, as such, they'll appear in the final plan. Where policy or organizational decisions have to be made, we request that such be made by the appropriate authorities and be conveyed to us in a clear, timely manner. If you can take the time, you may want to give us some verbal feedback (for matters over which you have pressing concerns) before tomorrow night's public meeting, which would help us to give a stronger presentation and avoid making mistakes.

Thanks for your cooperation and assistance.

WHM:jea

PUBLIC MEETINGS

I. Attendance at Public Meeting on August 15, 1991 (DNREC Building, Dover, DE) for plan presentation and question-and-answer period; public was given until September 6, 1991 to provide any written comments which individuals or organizations wished to submit.

Carl Hughes, Delaware City, DE
Fred M. Goldsborough, Smyrna, DE
Mary J. Stachecki, Harrington, DE
John Stevenson, Townsend, DE
J. D. Metzger, Wilmington, DE
D. Scherger, Dover, DE
Robert Piacinski, Dover, DE
Mr. R. A. Raley, Lewes, DE
Mrs. R. A. Raley, Lewes, DE
Bud Holland, Townsend, DE (New Castle Trappers Assoc.)
E. D. Buper, Dover, DE
Leslie G. Porter, Wilmington, DE (Delaware Action for Animals)

William C. Wagner II, DFW/DNREC
H. Lloyd Alexander, DFW/DNREC
Chester J. Stachecki, Jr., DFW/DNREC
Jim Reynolds, DFW/DNREC
Paynter Lynch, DFW/DNREC
Dick Nutter, DFW/DNREC
Randall V. Cole, DFW/DNREC
Roger J. Wolfe, DFW/DNREC

Terri Fabean, DFW/DNREC
William H. Meredith, DFW/DNREC

II. Meetings with the Advisory Council on Fish and Game; short presentations and question-and-answer periods:

1) June 4, 1991 - Short overview and distribution of draft plan.

2) August 27, 1991 - Plan overview and slide presentation on beaver biology/ecology.

Friends of Animals

August 15, 1991

Dept. of Natural Resources
and Environmental Control

Att.: Terri Fabean, Div. of
Fish and Wildlife.

Dear Ms. Fabean:

As I indicated in our telephone conversation this morning, Friends of Animals, Inc. is anxious to assist any individual, organization, governmental body or agency in their effort to eliminate or mitigate the problems associated with the expanding beaver population in your state. Obviously, we are committed to the exclusive implementation of non-lethal measures.

Please consider us to a resource at your disposal in regard to the above matter.

Sincerely,

Steve Ruggeri
Wildlife Policy Dir.

Priscilla Feral, President

☐ NATIONAL HEADQUARTERS:
Post Office Box 1244
Norwalk, Connecticut 06856
(203) 656-5223
Telecopier: (203) 853-0102

☐ CORPORATE OFFICE:
11 West 60th Street #801
New York, New York 10023
(212) 247-8120
Telecopier: (212) 582-4482

NEW ENGLAND OFFICE:
342 Broadway, First Floor
Newport, Rhode Island 02840
(401) 847-3337
Telecopier: (401) 846-4520

Mid-Atlantic Regional Office
Bartley Square
270 Route 206
Flanders, New Jersey 07836
(201) 927-5611

FAX NUMBER--(201) 927-5617

OUTGOING--------

FACSIMILE TRANSMISSION

TO: BILL MERIDETH DATE: AUGUST 15, 1991

FROM: BOB REDER RE: BEAVER DAMAGE & CONTROL

THIS MESSAGE CONSISTS OF THIS PAGE PLUS 9 PAGES FOLLOWING.

SPECIAL INSTRUCTIONS OR COMMENTS:

National Headquarters:

The Humane Society
of the United States
2100 L Street, NW
Washington, DC 20037

The Humane Society of the United States
Mid-Atlantic Regional Office
Barkley Square
270 Route 206
Flanders, NJ 07836
(201) 927-5611

August 15, 1991

Mr. William Merideth
Delaware Fish and Wildlife
Dover, Delaware

FAX Transmitted 8/15/91

Re: Proposed Beaver Management Controls
HSUS-MARO Case # 91-271

Dear Mr. Merideth,

It is our understanding that your agency is considering methods to control damage caused by wild beavers and that a discussion of that issue will be held this evening in Dover.

If it were not for the late notice, The Humane Society of the United States (HSUS) would have had a representative in attendance. We regret that we can not physically be there but do hope that the view points and suggestions contained within this letter may be shared by your Agency as well as all those in attendance.

We also understand that there are three proposed methods on your agenda, which are;

1. By killing the animals
2. To trap and transfer
3. Compensation to the effected property owners

HSUS POSITION

1. Killing the Animals
   The Humane Society of the United States (HSUS) representing almost 5,000 members and constituents within the state of Delaware and most of all on behalf of the animals, intensely opposes the killing of the beavers. Even where the killing of beavers is legal, it will not prevent the problem from reoccurring. If the habitat remains the same, new animals will move in some time in the future.

continued

2. Trap and Transfer
   Live trapping would seem an acceptable alternative to killing, however, splitting of the family groups usually ends in the death of most of the beaver family. Where legal, beavers can be live trapped but because of their strength and large teeth special, expensive cages must be used and it requires a knowledgeable person to set them. If the trap is set incorrectly the animal could be drowned or killed by the closing mechanism. This alternative, like killing will not provide long term relief if the habitat remains the same.

3. Compensation
   This is not an animal protection issue, however we realize that if damages are compensated for by the State, the immediate pressure to eliminate the animals will be relieved, for now, and may alleviate the need to destroy or transfer the animals.

Our recommended solution lies in removing from the existing habitat those things that attract and maintain the beavers in the concerned area.

We have attached to this letter a copy of HSUS Shelter Sense, April 1987 article, entitled, "Busy Beavers Can Be Persuaded to Leave Home". Within this article are numerous suggested solutions to alter the environment to cause the beavers to move elsewhere, naturally.

The Humane Society of the United States would strongly urge that your agency consider this alternative to killing and we would be happy to have you speak directly to our Wildlife Director and expert, Dr. John Grandy, who can be reached at our Washington DC Headquarters, 202-452-1100. Of course this office which represents Delaware will continue to offer any assistance possible to reach an amiable solution.

continued

Thank you for the opportunity to share our views and ideas with your Agency and on behalf of the animals, I remain

Sincerely,

Bob Reder
Field Investigator

cc: Dr. John Grandy

Wilmington News Journal

Jill Church, Delaware Action for Animals

Volume 10
Number 3
April/May 1987

Shelter Sense™

For the people who care about community animal control

INSIDE:

- Ridding Beavers Humanely
- Dog Attacks, Owner in Prison
- Pet Food Discounts

Dog Bites: How Protected Is Your Community?

by Debbie Reed

Your community may be the next to be involved in a severe dog bite incident. In the past 12 months, 14 people have been killed nationwide as a result of dog attacks. Now is the time to review your community's animal ordinance so that your organization will be prepared *before* facing such a tragedy.

Some communities have passed unenforceable vicious dog ordinances. Many laws are not based on knowledge about animal behavior, animal welfare, and animal bites. Since today's citizens are more apprehensive about their safety and the security of their belongings, it is common for a person to own a guard dog in addition to or in place of a gun. But many laws place the burden of punishment on an offending animal, when, in fact, it is an irresponsible owner who usually is the direct or indirect cause of a dog's severe bite.

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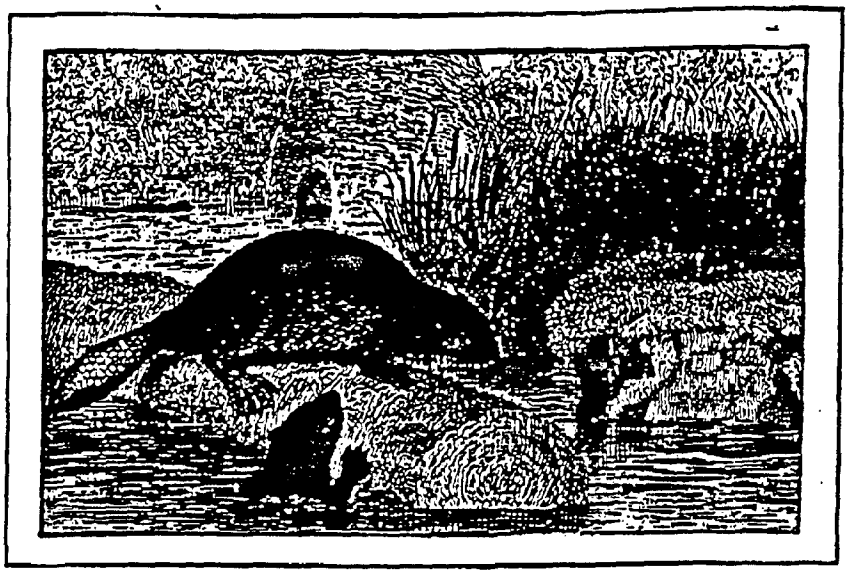

Busy Beavers *Can* Be Persuaded To Leave Home!

The second article in a series about humane solutions to wildlife problems that began with the March 1987 issue.

Beavers' legendary capacity for hard work has endeared them to some people, but their industrious activity can cause bad will when they move into urban or suburban neighborhoods. Fortunately, many people prefer to solve such conflicts without killing them. It *is* possible to evict beavers or to find ways to live peacefully with them without causing them harm. Further, the humane approach to beaver control is usually the most practical.

Beavers will live wherever there is sufficient food and water and quickly will make themselves at home in ponds, lakes, and streams. In streams, they busy themselves with building a dam to create a more desirable environment, which results in trapped water that may flood crop lands, pastures, or lawns. Beavers cut down ornamental trees for food or dam construction materials. They also may eat twigs and bark, leaving the damaged trees to die. Some landowners may not enjoy watching their carefully landscaped yards being redesigned by beavers.

No repellents, toxicants, or fumigants are registered for use in controlling beavers. A landowner with a beaver problem may resort to shooting or trapping the offending beavers because he or she knows of no other practical solution. This simplistic approach includes several drawbacks: The taking of beavers is strictly regulated in most states; may only be done legally at certain times, using specified techniques; and usually requires a permit. Even where killing beavers is legal, it will not prevent other beavers from moving in and restarting the problem. Such drastic measures fail to acknowledge the aesthetic value of beavers as fascinating and complex animals, nor do they recognize beavers' important role in our cultural and natural heritage.

Continued on next page

There are effective, nonlethal techniques for controlling nuisance beavers, and these can be best understood by first understanding beaver biology.

The beaver (*Castor canadensis*) is the largest North American rodent. It is monogamous and remains faithful to its mate. Females produce one litter per year, usually between March and June. A typical litter contains three or four kits. Young beavers are able to reproduce by the age of 18 months. A beaver colony commonly contains eight to 13 animals, including an adult pair, kits from the previous spring, and yearlings. Two-year-old beavers leave in search of unoccupied territories to colonize. Dispersing beavers may travel many miles in search of new homes.

The two most important requirements for good beaver habitat are plentiful food and deep water. The largest portion of their diet includes tree bark and twigs, and beavers prefer trees such as aspen, cottenwood, poplar, willow, and members of the birch family. They also require deep water in order to build their lodges with underwater entrances and to provide a refuge from disturbances. This is why they build dams in shallow streams. In deeper bodies of water, they may forego the hard work of building a dam.

Once beavers populate a watershed, stream system, or other wetland area, they periodically will re-invade land from which they have been eliminated by trapping or shooting. Recolonization is likely, as long as the site continues to offer a hospitable environment. A landowner who relies on firearms or traps should anticipate an influx of beavers to his or her property.

Armed with the knowledge of what attracts beavers, a landowner may make the area less attractive to them by "thinking like a beaver." Ask "Why would beavers want to live here?" Then devise ways to make food and/or deep water unavailable to them. Of course, it would be unreasonable to cut down all trees and to drain wetlands, but there are other practical, relatively simple solutions.

One solution is to exclude animals from the land. This approach is practical only for small areas such as ponds, around which a barrier can be created with a metal fence.

Where a conventional fence is not practical or desirable, it may be possible to repel beavers with an electrified suspension fence, which depends upon a high-voltage, low-amperage energy source such as an automobile battery. A single wire, suspended approximately 1 foot off the ground, is connected to a power unit that transmits a pulsating electric charge. When a beaver touches the wire, it receives a mild shock but is otherwise unharmed. After several encounters with this type of fence, a beaver will be conditioned to avoid that location. The equipment needed to construct an electrified fence can be purchased from a farm supply store.

Electrified fences are less expensive to build than conventional fences, but they require more maintenance. Some systems can fail in extremely dry conditions because an animal's feet may not be sufficiently grounded. Another problem is that broken insulators or wet, heavy weeds and grass can short the electric current,

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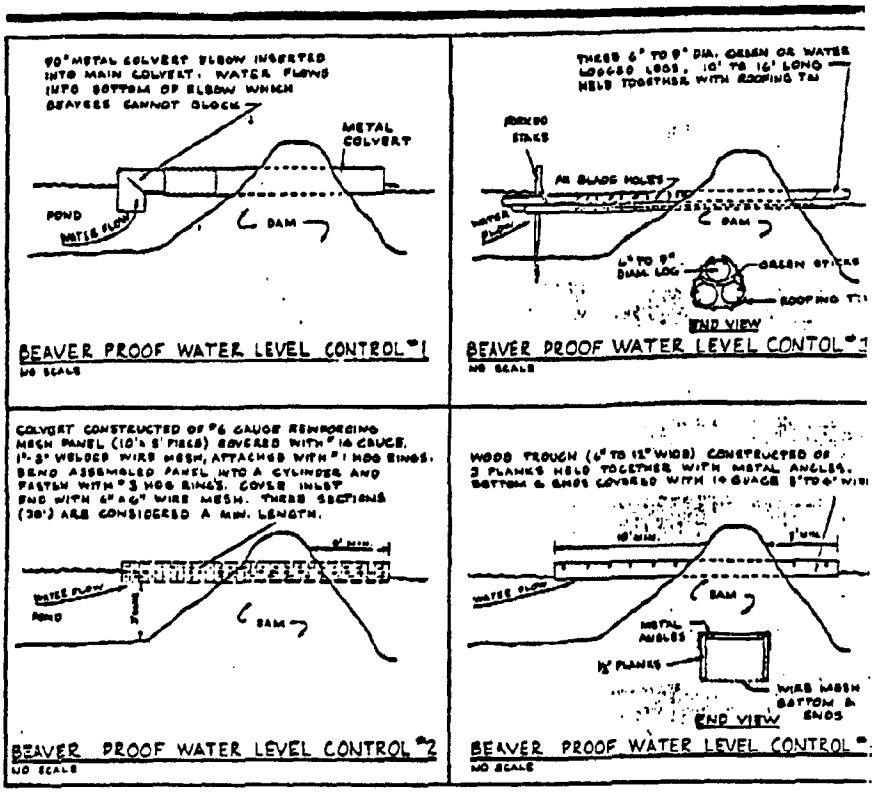

preventing it from flowing through the fence, thereby eliminating its effectiveness.

Physical barriers can be used to shield ornamental trees. Each tree can be wrapped in a band of hardware cloth or wire mesh that extends approximately 3-1/2 feet above the ground. Recommended mesh sizes vary from one-quarter inch to 1 inch. If the trees are in an area that is occasionally flooded, the cloth should extend at least 2 feet above the high-water mark.

A diluted solution of creosote, available at most local garden centers, has been found to reduce damage by gnawing beavers when sprayed or painted on tree trunks. A landowner also can use a homemade concoction to make trees or crops distasteful to beavers. A favorite formula consists of 1 tablespoon of hot pepper sauce in a gallon of water which contains an additive that promotes retention (such as Wilt-Pruf or Vapor-Gard). The disadvantage of such a preparation is that it must periodically be reapplied.

When planting trees near waterways frequented by beavers, avoid their preferred food trees, listed above.

It is futile to destroy a beaver dam. Beavers will begin rebuilding one as soon as the landowner departs. It is possible, however, to modify a beaver dam by placing a specially constructed pipe through it so that the animals are unable to stem the flow of

Continued on next page

water. This device regulates the water level and prevents beaver from expanding the size of a pond or impeding the flow of a stream.

The pipe must stick out beyond the actual dam construction, particularly on the upstream side of the pond. A 10-foot to 40-foot pipe will be required for most dams. A pipe that is 8 inche to 12 inches in diameter usually is adequate. Pipe size depends on the average volume of water flowing in the stream. Several smaller diameter pipes may be substituted for one larger pipe. Either galvanized, plastic, or aluminum irrigation pipe can be used. A pipe also can be built with concrete reinforcing mesh panels and welded wire mesh, or it can be fashioned from sheets o metal, with the bottom side made of wire mesh. The pipe should b placed at the same depth as the water level desired by the landowner. Steel posts can be used to secure the pipe in position.

The pipe should prevent beavers from obstructing the flow of wate or, at least, should limit flooding to a tolerable depth. In man cases, beavers will find the shallow site unsuitable and will loo for a more favorable spot for their colony.

To prevent beavers from plugging the upstream opening in the pipe it should be fitted with a protective cover known as a "beaver baffler." One design for a baffler is a cone-shaped wire guard. The base of the cone is anchored flat against the pipe. If properly fitted, this system looks like an arrow. Beavers will attempt to dam the guard using twigs. They even may scoop mud from the bottom of the pond and push it against the guard. The shape of the guard should prevent beavers from placing materials flush against the mouth of the pipe. Although the beavers may be partially successful in their efforts to block the pipe, enough water usually will continue to flow to maintain the desired water level. The animals soon will tire of their losing battle to bloc the flow of water and will move.

A second type of baffler also is designed for use on the mouth of the pipe. It consists of an elbow bent downward at a 90-degree angle and approximately one foot under the water surface. Beaver cannot block the vertical intake opening of the elbow.

In Canada, biologists have improved on this concept. Before placing the pipe through the beaver dam, they drill 1-inch holes, approximately 10 inches apart, along its entire length. Some biologists contend that it is necessary only to drill along the first 10 feet of pipe on the upstream side of the dam. The water flowing through the holes seems to confuse beavers, which cannot determine how or where to stop the flow of water. They often try to plug the holes and ignore the mouth of the pipe. Once a pipe has been properly installed, a periodic inspection will ensure that the water is flowing properly.

Habitat alteration is a technique of beaver control that often is overlooked. On many streams and ponds, beavers can be encouraged to relocate simply by removing food trees -- particularly young willow and cottonwood trees -- and dam construction materials from the water's edge. Beavers are limited in their ability to haul

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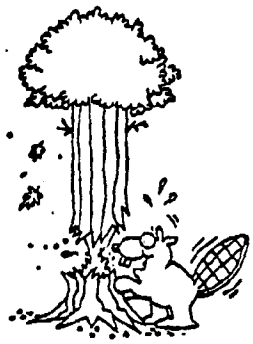

building materials across land. In the absence of a ready supply of food or construction materials, they are unlikely to colonize a stream or pond.

Some landowners insist on removing beavers. In such circumstances, beavers can be captured alive and unharmed in cage traps (check first with state wildlife officials for legal restrictions). Because a beaver's powerful muscles and sharp teeth can destroy a standard cage trap, several manufacturers have designed special beaver traps that resemble a giant purse with chain sides. This type of trap is expensive, costing approximately $150, and it takes skill to properly and safely set. If the trap is placed in too deep water, the animal may drown, and if the trap is positioned incorrectly, the trap jaws may kill the animal. Contact a district game warden or county extension agent for professional help in using cage traps to catch beavers.

When re-landscaping an area damaged by beavers, careful selection of ornamental trees can prevent a recurrence of the problem. Evergreens such as pine, firs, and spruce generally are safe from assault. Because these trees are fast growing, they quickly restore landscape that has been damaged by beaver activity.

The control of any wildlife species is as much an art as a science. Success in controlling beavers ultimately is related to the skills and inventiveness of individuals. Tolerance for this industrious, often beneficial animal can make life easier for all concerned. Nevertheless, if an occasional beaver problem must be solved, the techniques outlined here offer the best hope for a practical, permanent, and humane solution. ●

This column is about you —*the Academy graduate!* If you've received a promotion, helped to achieve local or state animal legislation, improved your community's animal-control program, or had an interesting work-related experience, write to *Shelter Sense*, The HSUS, 2100 L St. N.W., Washington, DC 20037. Include a telephone number, please.

After Art Evans graduated from The Humane Society of the United States' Animal Control Academy in 1982, he was promoted to director of Greene County Animal Control. Since then, Evans has overseen a number of improvements in the facility's operations.

Previously chief of the animal-control department, located at 641 Dayton-Xenia Road, Xenia, OH 45385, Evans has used the skills and knowledge he gained at the Academy to increase the income of his self-supporting agency to $220,000 a year from $80,000, increase the three-person staff to eight full-time employees, and establish new programs such as cruelty investigation, cat control, pet therapy, obedience training, and fund raising. His organization is the first in the state with authority to impound nuisance or injured cats. The agency runs two shelters in Greene County: one in Fairborn, one in Xenia. It also picks up and redeems stray dogs in Clinton County.

"The key word is 'professional,'" said Evans. "At the Academy, I became aware of the fact that I am not alone in the problems I face, that solutions are available. I gained new pride and a sense of organization through my training at the Academy that allows me to overcome the negatives in my work and accent the positive." ●

August 26, 1991

Ms. Terri Fabean
Division of Fish and Wildlife
Delaware Department of Natural Resources and Environmental Control
Post Office Box 1401
Dover, Delaware 19903

Dear Ms. Fabean:

A friend aware of my long-standing interest in beavers sent me a copy of the August 15th *Delaware State News* article on your statewide beaver management plan. I'm writing to alert you to the existence of an organization devoted to protecting beavers and finding creative ways for these wonderful animals to live in harmony with man. The Beaver Defenders, based at the Unexpected Wildlife Refuge in Newfield, New Jersey, can provide you with extensive information about beavers and their contribution to the environment and suggestions for ways to resolve conflicts between beavers and man. You can join for $10, which entitles you to receive a quarterly newsletter filled with beaver facts, lore and letters from people who live near lodges/dams. Contact:

Hope Sawyer Buyukmihci
The Beaver Defenders
Unexpected Wildlife Refuge, Inc.
Post Office Box 765
Newfield, New Jersey 08344
(609) 697-3541

Recent editions of the newsletter mentioned the following resources you might find useful:

- Experiments reveal that the chemical repellent Ro-pel will sometimes discourage beavers from eating trees. For more information, contact:
  B.J. Hilliker
  Young Street
  East Hampton, CT 06424

- A booklet entitled "Living with Beavers" by Dr. Tom Eveland is available from the Alliance for Animals' Beaver Project. Contact:
  Alliance for Animals - Beaver Project
  111 King Street - #26
  Madison, Wisconsin 53703

- A device known as a Beaver Baffle prevents them from damming up culverts. This inexpensive gadget resembles a cylindrical chicken wire cap which fits over the end of the pipe. Contact the Beaver Defenders for more information.

PLEASE PLEASE PLEASE reconsider using underwater traps as an element of your Beaver Management Plan. Drowning is a slow and horrible death for any animal, especially one with the capacity to hold its breath underwater for half an hour or more. Beavers can and do use their strong teeth to gnaw off their paws. Death may follow from loss of blood, starvation, etc. Traps are cruel and inhumane. The Beaver Defenders can tell you more, and may be able to put you in touch with Delaware residents (and/or people from other states) who would welcome a beaver colony on their land (people write to them asking to be put in touch with organizations which relocate beavers).

Although the Beaver Defenders does not advocate moving beavers to zoos, I have found that they make wonderful exhibits. A successful beaver exhibit captivates both children and adults, and leads to greater appreciation of their contribution to the environment. The Minneapolis-St.Paul Zoo has an excellent beaver facility. If you cannot find homes for all of the beavers you relocate, you might wish to send them to area zoos - it's better than death! Since beavers learn many of their skills from their parents, zoos are a reasonable alternative for injured animals and youths separated from their colonies who are less able to cope in the wild. You should also contact such groups as The Nature Conservancy to find homes for "problem" beavers.

As I'm sure you know, beavers are remarkable, trusting, intelligent animals who maintain strong family structures. Since they remain at their lodges until they are two years old, learning skills and contributing to lodge and dam maintenance, food gathering, and caring for younger animals, the impact of killing any single beaver, especially a parent, has terrible ramifications for the entire colony. Could you please send me a copy of your Beaver Management Plan? Thank you very much.

Sincerely,

Elaine Van S. Carmichael
1411 Prince Street
Alexandria, Virginia 22314

Home: (703) 549-3912
Work: (703) 893-1560

cc: Hope Sawyer Buyukmihci, The Beaver Defenders

THE BEAVER DEFENDERS
Membership Application

NAME _____

ADDRESS _____

_____

Membership-subscription $10.00 per year. Please make checks payable to Unexpected Wildlife Refuge. Contributions tax deductible. Amounts in excess of actual membership will be considered a donation unless otherwise specified.

EDUCATIONAL MATERIALS AVAILABLE FROM THE BEAVER DEFENDERS
(Proceeds to the Refuge. Postage extra. Please estimate.)

BEST OF THE BEAVER DEFENDERS. Selected articles, essays and poems, illustrated with sketches, from the first 15 years of The Beaver Defenders. 175 pages. $10.00.

BEAVERSPRITE. By Dorothy Richards with HSB. 1977. Heart of the Lakes Publishing Co., Interlaken, NY. Story of Beaversprite, a sanctuary for beavers and other wildlife. Recounts Richards' more than 40 years of close association with beavers. $12.00.

IN BEAVER WORLD. By Enos A. Mills. First published in 1913. Republished in 1989 by University of Nebraska Press, Lincoln, NE. A beaver classic. Paperback, $10.00.

LILY POND, FOUR YEARS WITH A FAMILY OF BEAVERS. By Hope Ryden. William Morrow & Co., NY. 1989. Close obervations and experiences with beavers in a state park. $17.95.

PLAY, THE TRAPPER. 10¢.

WHAT BEAVERS DO FOR OUR WATERWAYS. 10¢.

YOU AND THE BEAVER and GOLDEN RULES OF CONSERVATION. Two leaflets @ 10¢ ea.

THE STORY OF CHOPPER. 20¢.

IN MEMORIAM (Chopper). 10¢.

TWO BEAVER SONGS. 50¢ ea.

TRAPPED BEAVER POSTER. 50¢.

SAVE THE ANIMALS: 101 EASY THINGS YOU CAN DO. By Ingrid Newkirk. Warner Books, NY. 1990. Paperback, $6.00 postpaid.

"BEAVERS TURN WILDERNESS . . . INTO HAPPINESS."

COMMONWEALTH OF PENNSYLVANIA

PENNSYLVANIA GAME COMMISSION

2001 ELMERTON AVENUE
HARRISBURG, PA 17110-9797

ADMINISTRATIVE BUREAUS:

ADMINISTRATION	787-5670
AUTOMOTIVE AND PROCUREMENT DIVISION	787-6594
LICENSE DIVISION	787-2084
PERSONNEL DIVISION	787-7836
WILDLIFE MANAGEMENT	787-5529
INFORMATION & EDUCATION	787-6286
LAW ENFORCEMENT	787-5740
LAND MANAGEMENT	787-6818
REAL ESTATE DIVISION	787-6568
MANAGEMENT INFORMATION SYSTEMS	787-4076

DATE: August 29, 1991

SUBJECT: Delaware Beaver Management Plan

TO: William Meredith
Terri Fabean

FROM: Thomas S. Hardisky, Chief
Wildlife Data Base Division
Bureau of Land Management

Tom

Enclosed are my comments on your draft Beaver Management Plan as well as some material which you may find useful. This document is one of the most thorough and well-prepared plans I have seen on beavers. You've done an excellent job!

Please contact me if I can assist you further (717-787-1570).

Comments on Beaver Management Plan
Tom Hardisky
29 August 1991

Ref: p. 24

Relocated beavers will wander and attempt to return to their original colony. Expect *extensive* movements. With the exception of pregnant females, I believe that few transplanted beavers will remain in the general vicinity of the release site. Beavers are highly social and if scent mounds possessing unfamiliar odors exist at the release site, transplanted beavers will leave the area regardless of the sex or age of the relocated beavers. Mortality would also be high during these random movements.

Relocation of pregnant females is an excellent way to establish beaver colonies in new areas. Transplanted females in their latter term of pregnancy generally will not move extensively and will seek shelter in preparation for birthing. Parturition dates vary but adult females captured from February-April would be good candidates for relocation.

Personally, I would relocate a nuisance beaver as a last resort. Unless a beaver colony is highly desirable in an area presently void of beavers, the time, expense, and limited success of beaver relocation outweighs its usefulness and practicality. Only where public attention is drawn to a specific site would I attempt to relocate a beaver. Dispatch and disposal (burying) of the nuisance beaver on-site should be a viable (if not preferred) alternative. The decision to relocate or dispatch the beaver should be flexible. Occasionally, circumstances warrant immediate dispatch (for safety reasons).

Accurate sex and age information on removed beavers is extremely important. Sexing beavers externally can only be accomplished by determining the presence or absence of the baculum. This will require immobilization of the beaver or some type of "squeeze" cage.

The stress associated with capture, immobilization, and transport will trigger nervous reactions such as gnawing on the metal cage. Chipped and broken teeth are common. Occasional mortality should be expected.

***

Ref: p. 25

The leg snares, mentioned under Methods of Live Trapping, would result in very limited trapping success. These spring-activated snares are generally used for terrestrial animal capture and would be difficult and time-consuming to set in aquatic habitats.

The use of cable snares for live capture of beavers should be considered. Trappers in the eastern U.S. are unfamiliar with snares and lack confidence in their performance. However, cable snares have many advantages over other live-capture methods.

Advantages of Using Snares:

- Cost, $1.00 each
- Lightweight
- Cannot injure trapper or unsuspecting traveler
- Do not kill beavers
- Risk of non-target catch is low
- Non-target catches may be released
- Low susceptibility to trap theft
- Low susceptibility to rusting

Disadvantages of Snares:

- Heavy tie-down is required
- Cannot be reused after capture
- First-time users usually require instruction

Snares are practical, time-saving devices, especially in remote areas. Since there is virtually no limit on the number of snares which may be set, beaver problem areas may be heavily trapped resulting in faster, more efficient beaver control.

As you probably know, I'm sold on snares. I used snares in Mississippi, Florida, and Tennessee for bobcats, black bears, and beavers and prefer them over steel traps and live traps. My trapping efficiency using snares was 11% (77 captures/707 trapnights). Trapping success will vary by season with the best trapping period falling between November and May. I did not routinely use No. 4 steel traps (underspring or longspring) due to the time involved in preparing a drowning set. I have also had little success using this type of trap. If you are interested in a snaring demonstration for your trappers/employees, let me know.

•••

Ref: p. 26

Since ear tags are susceptible to loss especially on beavers, you may wish to mark beavers with tail tags. Cattle ear tags work well for this purpose. The tail is not very vascular and consists of thick cartilage under the scaly skin surface.

•••

Unless telemetry is used, monitoring transplanted beavers will be extremely difficult. Telemetry is very costly and would be difficult to justify in this situation. If telemetry is used, I would recommend a surgically-implanted transmitter rather than a collar-mounted transmitter. An on-site inspection, as you have suggested, is probably sufficient. However, an extensive search may be needed to find evidence of beaver activity.

•••

Ref: p. 28

You may wish to implement a "hot spot" program for regulated beaver harvest. Landowners experiencing beaver damage would enroll in the program and allow public beaver trapping on their land only. Names and addresses of all cooperating landowners would be available to any interested trapper. The landowner would be responsible for regulating the number of trappers permitted on his land. This "hot spot"

program would focus trapper effort on specific beaver problem areas. Disadvantages of this program include law enforcement difficulties and the lack of access to neighboring landowners who do not permit beaver trapping.

•••

Ref: p. 29

The intake portion of water control devices in beaver dams must be *deeply* submerged to prevent blockage by beavers. One very important behavior universally exhibited by beavers is their dam-building response to the sound of running water. This behavior is thought to be innate (instinctive). Beavers will attempt to plug water leakage on the upstream side of a dam, and even small whirlpools and swirls on the surface of the water will stimulate the dam-building response. Water control structures or pipes must be positioned such that the water intake is well below the water surface and does not create noticeable water currents. Multiple water control devices should be installed to drain large water courses rather than installing 1 large drain. Beavers generally will not attempt to block the water flowing out of the pipe on the downstream side of the dam. The pipe need not extend several feet past the dam (see enclosed illustration).

•••

Complete elimination of a beaver colony through trapping is unlikely. The best way to alleviate a severe beaver problem is to heavily trap the area until you have no trapping success for several days. At this point, begin to slowly lower the water level by breaking part of the dam each day. If beavers still exist in the area, they will attempt to repair the dam and trapping should continue. If the dam is not repaired, continue to drain the beaver pond to the desired water level and install a drainage device to maintain this level if beavers return. Unrepaired dam breaks and lack of trapping success usually means that the remaining members of the beaver colony have temporarily moved out of the area or that you have temporarily trapped out all the beavers in the area.

Beaver ponds consisting of new dams (< 1 yr. old) and bank dens (no lodges) are characteristic of a 2-year-old pair of beavers who dispersed to a new area. Trapping can effectively eliminate this pair and the associated beaver problem. Colonies with older dams and lodges generally support more beavers in different age classes. Trapping in these areas controls population growth, but unless the dams are destroyed, complete elimination through trapping is unlikely. Without sufficient water depth, beavers will leave the area and seek more suitable habitat.

DELAWARE TRAPPERS ASSOCIATION

New Castle County Chapter

August 29, 1991

Dear Ms. Terri Fabean,

Delaware Trapper Association respectfully request a limited trapping season be implemented on beaver.

The season and method of catch could be closely regulated by DNREC A system of tagging captured beavers similar to otter would be useful in monitoring.

When considering beaver trapping in Delaware, the problem of restrictive use of foothold traps must be addressed! The leasing of state owned live traps may be a viable solution. The costs of such traps makes them prohibitive.

We look forward to working with the Division on this most important project. The beaver, landowners, Department of Natural Resources and Environmental Control and the Delaware Trappers Association, will most certainly benefit from this season.

Respectfully,

Bud Holland

BH/psb

"Committed to Conservation and Education"

Ms. Terri Fabean
Division of Fish and Wildlife
Delaware Department of Natural Resources and Environmental Control
Post Office Box 1401
Dover, Delaware 19903

August 29, 1991

Dear Ms. Fabean:

When I wrote you about The Beaver Defenders a few days ago, I should have mentioned another organization dedicated to ensuring that beavers and man can live together in harmony. Leave it to the Beavers, a New Hampshire-based organization, installs beaver baffles, pipes and dam diversions, facilitates beaver relocations, and operates a sterilization program to enable beavers to remain in the wild at levels the area can support. Contact:

Leave it to the Beavers
Post Office Box 40
Plainfield, New Hampshire 03781

The booklet entitled "Living with Beavers" by Dr. Thomas E. Eveland, which I recommended, is also available for one dollar from:

The Fund for Animals, Inc.
850 Sligo Avenue
Silver Spring, Maryland 20910
(301) 585-2591

Incidently, the rangers at Acadia National Park on Mt. Dessert Island in Maine have used pipes with great success. I've enclosed a photocopy of a page from a recent Beaver Defenders newsletter which includes an excerpt from "Living with Beavers" and a description of Leave it to the Beavers' efforts. I hope the information I've provided has been helpful and encourage you to continue identifying creative solutions to beaver management issues which do not involve traps and other methods of killing. Thank you for your efforts to help beavers.

Sincerely,

Elaine Van S. Carmichael
1411 Prince Street
Alexandria, Virginia 22314
Home: (703) 549-3912
Work: (703) 893-1560

cc: Hope Sawyer Buyukmihci, The Beaver Defenders

When Beavers and People Collide

by Dr. Thomas E. Eveland,
The Fund For Animals

We do have the technology to either correct or prevent most of the problems created when beavers and people collide. It is simply a matter of understanding the beaver, the problem, and the methods used to change a bad situation into a good one. When this knowledge is applied, the outcome can be very rewarding.

To site a case in point, let's take a brief look at Gatineau Park, a large lake-strewn area encompassing over 80,000 acres in Quebec with a high population of beavers.

Gatineau had a serious beaver problem which began in the early 1960's. Road flooding and drain pipe blockage were common and accounted for approximately 60 percent of all beaver related complaints. And for nearly 20 years the park managers tried to correct these problems through dam breaking and trapping.

In 1981, the park hired a contractor to deal with the unsolved beaver complaints. Realizing that the quick-fix method was not solving the problems over the long-run, they wanted to try new and innovative techniques. First, they began experimenting with various pipes through the dams themselves to regulate the water levels. Later, they experimented with other techniques at road culverts. When all was said and done, their success was amazing. From 1980 to 1985 they recorded an increase of 15 percent in the park's beaver population. Yet with the installation of the experimental devices, the number of flooding problems was reduced by more than 75 percent.

In 1980, only 5 percent of the entire park was under long-term management. By 1989, over 80 percent of the park was being managed for long-term problem prevention. At one site in the early 1980's more than 80 interactions were recorded for a single year. Yet, only one year later, after the installation of a drain and without removal of the beavers, the interactions had dropped to only four or five. Rather than call this a form of wildlife management, the park's employees deemed it "natural resource management", a more appropriate namesake. Besides producing an almost total reduction in beaver-related problems, the park's attempt at natural resource management produced other results.

For example, with no controls on the park's beavers, the estimated total population that would be reached in the near future caused some concerns. The final outcome, however, was quite different than expected. The park's beavers stabilized at only 60 percent of the estimated figure. Apparently this self regulation was caused by the following:

- an apparent decrease in the female reproduction rate when population density increases.
- the increased mortality rate of the species during dry spells.
- the use of lower quality sites which also reduces the species reproduction rates.

So, with a progressive program of beaver problem control utilizing modern technology and the philosophy of natural resource management combined with the self-regulating abilities of the beaver itself, Gatineau Park's conflicts between beaver and man have been reduced to near zero.

(Excerpted with permission from "Living with Beavers", a highly recommended paper on ways of solving problems. It is available for $1.00 from The Fund for Animals, Inc., Suite LL2, 850 Sligo Ave., Silver Spring, MD 20910)

NEW HAMPSHIRE HELPS BEAVERS:

by Steve Hackman

Leave it to the Beavers is a newly formed group of people who would like to see beaver living harmoniously among us. Granted permission by the New Hampshire Fish and Game Department to start a beaver sterilization program in New Hampshire, this small group is seeking your assistance. Of prime importance right now is the need for relocation sites for those beaver which must be removed. In other instances, beaver could remain if beaver bafflers or beaver pipes, or dam diversions were used. In some circumstances, the beaver could remain, provided numbers were kept at a level suitable for the site.

If you have a few acres with a brook or stream, a low marshy area with lots of alder and poplar, you have the perfect spot for a lovely beaver pond. We hope you will consider including one in your natural landscape. You will be rewarded many times over. Not only do beaver ponds have a special mystery, but they do much for the ecosystem, enriching the waterways and enhancing their surroundings to benfit birds and other wildlife. If you feel your land is capable of suporting only one pair of beavers, an older pair of beaver, already sterilized, could be relocated to your property....

A beaver pond could be a beautiful part of nature woven into your landscape.

(*Editor's note*: this new nonprofit group is funded solely by donations. Organizers plan to use 98% of contributions for veterinarian fees for sterilizations. For more information contact Leave it to the Beavers, P.O. Box 40, Plainfield, NH 03781.

*** HANDWRITTEN LETTER SUBMITTED BY JAMES D. METZGER, WILMINGTON, DEL.

9/3/91

Comments on Delaware Beaver Management Plan, proposed August 1991.

After attending the public meeting in Dover on Aug. 15, 1991, and reading through the draft of the proposed Plan, I have the following comments to make:

A) Of the five options given for managing the beaver, the best option would be to have an open, regulated season. It appears to me that all the other options would quickly exceed the manpower and funds allocated to them and not really solve the problem based on your projected population increases.

B) Page 1, Item I, 3rd sentence.
I believe "in Delaware" is redundant, since this Plan is specifically designed for Delaware.

C) Page 8, Item IV, Section 3)
This section states that the "survey data will be updated periodically..." but there are no specifics given as to how often or by what method. Both these factors are critical for how reliable the data are. For example look at the USFWS and the duck surveys. Even

after collecting data on the 215 and Canada for years. these data are not sufficient to justify the current reasons — according to the Courts. So they are now having to start a whole new data base.

d) Page 14, Section Permit, Introduction.
This presents an interesting scenario
Once a new beaver dam is discovered evaluating it for the benefits vs risks (problems) needs to be done immediately to prevent conflicts with other Wetlands policies. If it is determined that the dam could become a problem, steps should be taken then before they develop. Otherwise I could envision the following: a landowner allows a beaver to establish a dam that eventually causes some problems. The colony is removed and the dam is left to deteriorate. What happens under the various Wetland Protection laws when the dam gives way and the land is no longer a wetland. Does the landowner become liable for wetland destruction? In the current legal atmosphere I don't think this is too far out an idea especially after reading about other prosecution under these laws.

E) Page 27, Item VIII, Section 2

The second paragraph mentions the killing of the trapped beaver with a .22 caliber pistol. I was under the impression that pistols were illegal for taking of game animals. Would this be an exception?

F) Page 29, Item VIII, Section 4.

The introductory paragraph mentions destroying the beaver dam. Again I was under the impression that it was against Delaware law to willfully destroy a game animal's den, lair or home. Does this mean that the dam doesn't come under this classification?

That ends my comments.

I think the proposed plan was well put-together and very well done. I just hope that action will be taken on this plan, so that some form of management is in place by 1992 since it looks like the problem could rapidly get out of hand.

Sincerely,
J D McIntyre

Appendix 10

Active Participants in the Development of Delaware's Beaver Management Plan - plan research and preparation; technical advice and consultation; or plan review and written comment.

Terri Fabean, DFW/DNREC - Fish and Wildlife Scientist (plan's primary biologist, DCMP grant)

William H. Meredith, DFW/DNREC - Fish and Wildlife Program Manager (DCMP task leader/liaison for Beaver Plan)

William C. Wagner II, DFW/DNREC - Division Director

H. Lloyd Alexander, DFW/DNREC - Program Administrator, Wildlife Section
William R. Whitman, DFW/DNREC - Fish and Wildlife Scientist (Beaver Committee chairman), Wildlife Section
E. Greg Moore, DFW/DNREC - Fish and Wildlife Program Manager, Wildlife Section
Kenneth M. Reynolds, DFW/DNREC - Fish and Wildlife Program Manager, Wildlife Section
Thomas W. Whittendale, DFW/DNREC - Fish and Wildlife Scientist, Wildlife Section
Randall V. Cole, DFW/DNREC - Fish and Wildlife Scientist, Wildlife Section
Wayne C. Lehman, DFW/DNREC - Fish and Wildlife Scientist, Wildlife Section (regional wildlife biologist)
William L. Jones, DFW/DNREC - Fish and Wildlife Scientist, Wildlife Section (regional wildlife biologist)
Robert D. Gano, DFW/DNREC - Fish and Wildlife Scientist, Wildlife Section (regional wildlife biologist)
Stein H. Innvaer, DFW/DNREC - Fish and Wildlife Scientist, Wildlife Section (regional wildlife biologist)

Major Rodney L. Harmic, DFW/DNREC - Enforcement Administrator, Enforcement Section
Captain Roderick H. Burritt, DFW/DNREC - Fish and Wildlife Agent (staff captain), Enforcement Section
Cpl. James C. Reynolds, DFW/DNREC - Fish and Wildlife Agent, Enforcement Section
Cpl. Paynter A. Lynch, DFW/DNREC - Fish and Wildlife Agent (retired), Enforcement Section
Richard L. Nutter, DFW/DNREC - Deputy Fish and Wildlife Agent, Enforcement Section

Chester J. Stachecki, Jr., DFW/DNREC - Program Administrator, Mosquito Control Section
Roger J. Wolfe, DFW/DNREC - Fish and Wildlife Scientist, Mosquito Control Section

Edwin H. Clark II, DNREC - Secretary of the Delaware Department of Natural Resources and Environmental Control

Andrew T. Manus, DSWC/DNREC - Deputy Division Director
Anthony P. Pratt, DSWC/DNREC - Program Administrator, Delaware Coastal Management Program
Kevin C. Donnelly, DSWC/DNREC - Program Administrator, Conservation Districts Operations
Richard T. Smith, DSWC/DNREC - Program Administrator, Drainage Section

William Moyer, DWR/DNREC - Environmental Program Manager, Wetlands and Aquatic Protection Branch
David E. Saveikis, DWR/DNREC - Environmental Scientist, Wetlands and Aquatic Protection Branch

Ron Vickers, DPR/DNREC - Office of Nature Preserves/Natural Areas, Technical Services Section
Leslie D. Trew, DPR/DNREC - Delaware Natural Heritage Inventory, Technical Services Section
Keith Clancy, DPR/DNREC - Delaware Natural Heritage Inventory, Technical Services Section
David Rothstein, DPR/DNREC - Delaware Natural Heritage Inventory, Technical Services Section

David S. Small, I&E/DNREC - Chief, DNREC Information and Education
Michael B. Mahaffie, I&E/DNREC - Public Information Officer

Timothy A. Kaden, FS/DOA - Forester Supervisor, Forestry Section, Delaware Department of Agriculture

Paul D. Daly, USFWS - Refuge Manager, Bombay Hook/Prime Hook National Wildlife Refuges

Thomas S. Hardisky, Chief, Wildlife Data Base Division, Pennsylvania Game Commission

Steve Ruggeri, Wildlife Policy Director, Friends of Animals, Inc., Norwalk, CT
Bob Reder, Field Investigator, The Humane Society of the United States, Flanders, NJ
Elaine Van S. Carmichael, The Beaver Defenders, Alexandria, VA

Bud Holland, President, New Castle County Trappers Assoc. (Delaware Trappers Association), Townsend, DE
James D. Metzger, Wilmington, DE

Jessie E. Anglin, DFW/DNREC - Word Processing Technician (all typing of plan)