RED FOX ASSESSMENT

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NATURAL HISTORY

The average weight of a male red fox is about 12 lbs., females are slightly smaller. Red fox becomes sexually mature during their first year, usually at 10 to 11 months of age. They breed annually; the breeding season take place from December through March, with peak activity in late January. Young are born during March and early April. The average litter contains 5 pups (range 1-10). Both the male and female take part in raising the pups.

Family groups stay intact until mid September, when pups begin to disperse from their natal home range. Dispersal continues through the winter, however most of the dispersal takes place during mid September to early October with greatest dispersal distances occurring from October through December. Males generally disperse twice the distance of females, commonly moving 20-40 miles before settling in new territories. Quite often female offspring will remain close to, or share their mother's territories. Related females tolerate each other's presence, but territories of unrelated females are clearly defined and adhered to.

Home range sizes vary considerably for red fox. Factors affecting home range size include food abundance, degree of interspecific and intraspecific competition, type and diversity of habitat, and presence of natural and physical barriers. Two separate studies in Maine determined home range sizes for red fox . Major's (1983) study was conducted in marginal fox habitat in western Maine. He observed an average home range size of 12.4 Mi2. Sherburne and Matula's (1981) study in northern Maine observed an average home range size of 6 . I mi2 in higher quality fox habitat than that

found in the western Maine study. Home ranges of males clearly overlap those of at least 1 or more females. Red fox oftentimes travel much of their home range each night.

The red fox is omnivorous with seasonal variation in its diet. Small rodents and other small to mid-sized mammals are important foods that are consumed year round. Additional spring foods include grasses and forbs, and birds and bird eggs are also eaten. Fox rely heavily on a variety of fruits during the summer months, and insects are also consumed. Apples are utilized when they become available in the fall. Winter food consists almost entirely of animal matter. Small rodents are hunted when snow depth is limited and powdery surface conditions exist; frozen apples are also dug up at this time. When snow depths increase and surfaces crust over, snowshoe hare become the principle food item.

Red fox are known to live as long as 5 years in the wild. Leading causes of mortality include trapping, hunting, and road kills. Juveniles are approximately 1.2 times more vulnerable to hunting and trapping than adults, and are about 1.5 times more vulnerable to all forms of mortality. Highest mortality rates occur among juvenile males, which generally disperse earlier and further than juvenile females. occasionally, fox are preyed upon by bobcats or coyotes.

Rabies and sarcoptic mange are natural mortality factors which can substantially decrease local fox populations. Rabies is a disease that becomes almost 100% fatal once the symptoms appear. Sarcoptic mange is transmitted among fox by mites, and the communal denning behavior of red fox may be an important factor in the spread of mange. Mange is density dependent, and outbreaks usually occur when local fox

populations become too numerous for the amount of available habitat. Fox breed as juveniles, and populations can quickly rebound from large decreases in numbers attributed to either rabies or manage..

While the relationship between red fox and coyotes is not clearly understood, the recent increase in coyote numbers and distribution in Maine may have adverse affects on the State's red fox population. Coyotes have high reproductive and dispersal capabilities, a social organization allowing the use of large prey, and opportunistic feeding habits and habitat requirements. These characteristics may have permitted coyotes to displace red foxes from some areas through interference competition (Major 1983). Coyote ranges, which are 5 to 7 times larger than fox territories, may significantly limit the number of fox families in an area (Voigt and Earle 1983). Studies in Ontario and western Maine suggest that foxes avoid areas regularly used by coyotes, even though suitable habitat may exist in those areas (Voigt and Earle 1983, Major 1983). The Ontario study also noted that foxes avoided raising pups in areas where coyotes traditionally traveled and raised pups. However, because coyotes and red fox have been reported to coexist in various habitats despite competition between the 2 species (Sherburne and Matula 1981, Voigt and Earle 1983, Major 1983), additional research is needed to determine the impacts of coyotes on red fox populations.

HISTORY

Habitat Trends

Red fox can be found in a variety of cover types, but are closely associated with areas where crop land and fields are intermixed with adjacent wooded tracts. Logging and farming activities open the forest canopy and improve conditions for red fox. Increased cover type diversity improves food abundance and increases the types of food available. Farmland and pastures provide small rodents and mammals, grasses, forbs, and apple trees. Forest clearings supply a variety of fruits and small and mid-sized mammals. Hence, historical records of logging activity and farmland in the state can be used to assess past trends in fox habitat.

Agricultural practices intensified from the time of settlement until `880; at that time farmland comprised about 33% of the State. From 1880 to the early 1900's, many farms were abandoned and the land reverted back to forest (Day 1954). Since 1930, there has been a slow but steady decrease in farmland. Approximately 21% of Maine was farmland in 1950. By 1970, only 9% of the State was farmed, and today only 7% of Maine is classified as farmland (Census of Agriculture, Bureau of Census 1985).

Logging was one of the principal occupations of southern Maine residents during the colonial period. By the mid-1800's, logging had advanced north to the Penobscot River drainage, and by the late 1800's and early 1900's, logging had opened up the northern part of the State (Collidge 1963). As logging practices opened up the north woods, fox numbers increased to the point that they were considered "fairly common" (Blake 1926).

Beginning in the early 1900's, logging began to decline for a number of reasons: paper-making began to expand in other forested areas of the country, the Panama Canal opened up eastern markets to lumber from the Pacific Northwest, and coal use was expanded. Between 1912-1920, a spruce budworm outbreak killed much timber, and finally the Great Depression caused a dramatic collapse of production to levels about one-third of those experienced in 1910. By 1940, logging began to expand again, but harvest pressure was relatively light until the 1970's. Annual wood harvests have more than doubled between 1970 and 1985 (Chaisson 1985). In 1980, it was estimated that Maine contained 29,000 mi^2 of fox habitat.

Population Trends

Red fox were considered common at the time of European settlement (Halpin 1984). By the 1800's, fox were well established in the agricultural areas of southern and western Maine, but were thought to be less abundant in the extensive spruce-fir forests covering the northern third of the State. However, as logging practices opened the north woods during the late 1800's and early 1900's, fox numbers increased to the point they were considered "fairly common" (Blake 1926).

Historically, red fox abundance and range have been estimated by examination of harvest records and trapper observations (Trapper Questionnaire and Fur Harvest Data, MDIFW). Red fox have inhabited, and continue to inhabit, virtually the entire State. Highest densities have historically occurred in Wildlife Management Unit's (WMU) 1, 4, 6, 7, and 8. Density estimates were considerably lower in the heavily

forested WMU's 2, 3, and 5. In 1980, Maine's preharvest red fox population was estimated at 14,500 animals (Planning for Maine's Inland Fish and Wildlife 1980).

Use and Demand Trends

Historically, red fox were regarded with mixed feelings. Farmers sought to limit fox numbers because of their tendency to prey on livestock. Also, fox played a ma]or role in the spread of both rabies and sarcoptic mange to other wild and domestic animals. During the early 1960's, a rabies outbreak spread through the State's fox population, and a poisoning campaign was initiated by the Maine Department of Inland Fisheries and Wildlife (MDIFW) in an effort to control the outbreak. Traditionally, however, trappers and hunters have pursued red fox because of the value of their fur.

Harvest Regulations

Management of red fox began in 1915 when a fall and winter trapping and hunting season was established. Poisoning was prohibited, and the practice of capturing fox by digging them out of their dens and hound training were regulated. From 1955 to 1975, trapping was restricted to a 3½ month hunting season with no closed season on hunting (Table 1). In 1976, the trapping season was reduced to 1½ months and a 3½ month hunting season was established. In 1978 and 1979, trapping season lengths were regulated by WMU, with all seasons falling between October 20 and November 25. The hunting season was also increased to about 4 months during this period. From 1980-82, trapping seasons were divided by the northern, western, and southern deer hunting zones, with all season dates falling between October 20 and

Table 1. Red fox management history in Maine.

Year	Estimated harvest[1]	Estimated effort	Estimated price[2]	Statutes and Regulations: Season Length: Trapping	Season Length: Hunting	Bag Limit	Remarks
1955	295	No records	.50	Nov 1-Feb 15	No closed season	No limit	
1956	193	"	.50	"	"	"	
1957	262	"	1.00	"	"	"	
1958	132	"	1.50	"	"	"	
1959	240	"	2.00	"	"	"	
1960	38	"	1.63	"	"	"	
1961	--	"	--	"	"	"	No questionnaire sent to trappers.
1962	97	"	2.34	"	"	"	
1963	212	"	2.38	"	"	"	
1964	136	"	2.38	"	"	"	
1965	230	"	4.15	"	"	"	
1966	391	"	4.70	"	"	"	
1967	223	"	4.74	"	"	"	
1968	228	"	7.30	"	"	"	
1969	544	"	7.83	"	"	"	
1970	1,036	"	9.03	"	"	"	
1971	1,695	"	9.64	"	"	"	
1972	2,295	"	16.35	"	"	"	Statutory provision repealed and replaced by regulation.
1973	5,685	"	32.50	"	"	"	
1974	6,408	"	26.30	"	"	"	
1975	6,863	"	39.30	"	"	"	
1976	4,948	1,795	55.20	Oct 20-Dec 1	Oct 20-Feb 1	"	Pelts must be tagged.
1977	6,531	3,717	50.10	"	"	"	
1978	5,466	3,537	62.55	WMU's 1-6 Oct 20-Nov 25 WMU's 7-8 Oct 25-Nov 15	Oct 20-Feb 15	"	
1979	6,220	4,313	65.11	WMU's 1-3, 5-6 Oct 20-Nov 25 WMU's 4,7 & 8 Oct 20-Nov 10	"	"	
1980	4,213	4,105	58.77	Northern and Western deer hunting zones Oct 20-Nov 30 Southern deer hunting zone Oct 28-Nov 30	Oct 20-Feb 14	"	
1981	5,097	4,453	56.71	"	Oct 20-Feb 15	"	
1982	5,660	4,118	37.56	"	Northern Zone Oct 20-Feb 15 Southern and Western Zones Oct 28-Feb 15	"	
1983	4,342	3,412	35.93	Northern Zone Oct 20-Dec 4 Southern Zone Oct 28-Dec 4	Northern Zone Oct 20-Feb 15 Southern Zone Oct 28-Feb 15	"	
1984	4,258	3,666	35.47	Northern Zone Oct 28-Dec 15 Southern Zone Oct 28-Dec 4	Oct 28-Feb 15	"	

[1] 1955-1975: Estimated harvest from trapper questionnaire (MDIFW).
1976-1984: Fur harvest data (MDIFW)

[2] 1955-1981: Estimated average pelt price from trapper questionnaire (MDIFW).
1982-1984: Average price from Maine fur buyer report.

November 30. In 1982, the hunting season on red fox was also divided by deer hunting zones, season dates ranged from October 20 to February 15. In 1983 and 84, trapping and hunting seasons were divided by a northern and southern zone, trapping season dates fell between October 20 and December 15, hunting season dates ranged from October 20 to February 15.

No bag limit has existed for red fox. Mandatory tagging of all fox pelts was initiated in 1976. Legal harvest methods have always included trapping, and hunting, including hunting with trained dogs.

Harvest Trends

Harvest records prior to 1976 are incomplete. Aldous and Mendall (1941) estimated the annual statewide harvest averaged 4,901 fox between 1928 and 1936, based on status reports of game in each warden district. From 1955 through 1975, the Department's Trapper Questionnaire indicated an average kill of 1,360 animals (Table 1). Since 1976, harvest figures have fluctuated between 4, 200 and 6,500 animals, with a 9-year average (1976 to 1984) of 5,193 fox.

Users

Red fox hunting became a popular sport during the late 1800's, when fox hunting and hound-breeding clubs were organized in Brunswick and Buckfield (Anon. 1894, Anon. 1897, Goodwin 1898). Good fox hunting was found near almost any of the interior villages in the State, and fox hunters numbered in the hundreds (Goodwin 1898). During the late 1800's and early 1900's, fox farming was a growing business in

Maine. However, the market for longhair fur began to decline after 1929, and fox farms quickly went out of business.

From 1955 to 1976, estimates of trapping effort came from trapping license sales and the Department's Trapper Questionnaire, and estimates of hunting effort were obtained from the Department's Hunter Questionnaire. Estimates of total hunting and trapping effort have resulted from tagging records since 1976, when the Department initiated mandatory tagging of red fox (Table 2).

Hunters take a small percentage of fox annually. Most of these are taken incidentally by hunters pursuing deer and snowshoe hare; few hunters pursue fox with trained dogs in Maine. Fur harvest data, collected from 1976 to the present, suggest that hunter effort has fluctuated annually from a low of 335 successful fox hunters in 1976 to a high of 1,582 successful hunters in 1981 (Table 2).

Trappers have accounted for the majority of red fox harvested annually. Trapper effort has fluctuated from year to year since 1976, and a steady decrease has occurred since 1982 (Table 2). Very few nonresidents trap fox in the State; less than 20 individuals have purchased trapping licenses annually since 1970.

Past Management Goals

The management goal in the 1975 species assessment was to increase the use and abundance of red fox above present levels. The management objective was to maintain harvests of 7,500 fox annually by 10,000 hunters and trappers. This management objective was not reached in the 5-year period to 1980. Fox population levels required to meet this objective would be approaching the maximum capacity of

Table 2. Red fox harvest and effort, 1976 to 1984.[1]

Year	Hunting harvest	Hunting[2] effort	Trapping harvest	Trapping[3] effort
1976	240	335	4,644	1,428
1977	368	1,212	6,046	2,505
1978	291	1,142	5,072	2,322
1979	285	1,421	5,830	2,831
1980	235	1,299	3,876	2,722
1981	325	1,582	4,680	2,807
1982	252	1,391	5,285	2,663
1983	129	923	4,043	2,377
1984	239	1,245	3,953	2,356

[1]Total hunter and trapper harvest, and total hunter and trapper effort are not equal to totals recorded in Table 1. Harvest and effort results from 1976 through 1980 include gray fox.

[2]Hunting effort equals the number of hunters who tagged at least 1 upland furbearer.

[3]Trapping effort equals the number of trappers who tagged at least 1 upland furbearer.

the State's fox habitat. Establishment and maintenance of a population at this level would require intensive management, including resource monitoring and control over local harvest levels in order to maintain harvests at desired levels.

Since 1980, the Department's red fox management goal has been to maintain statewide harvests and abundance at levels experienced from 1975 to 1977. The management objectives have been to harvest 5,700 fox annually; to adequately distribute the take among WMU'S; to provide for greater use in WMU's with surplus fox; and to decrease harvests in WMU's experiencing excessive demand. The allowable harvest was substantially higher than the objective harvest.

Statewide harvests did not exceed the objective harvests since 1979 (Table 3), but the estimated allowable harvests for WMU's 1 and 8 were exceeded during this period. The kill averaged 927 and 995 in WMU's 1 and 8 respectively; their allowable harvests were estimated to be 817 and 857 respectively. Average harvests for the remainder of the State (WMU's 2-7) were considerably below allowable harvest goals.

The Department's major accomplishment, with respect to the management of red fox, was to require mandatory tagging of all fox pelts from 1976 to the present. Previously, harvests were estimated through the Department's Trapper Questionnaire, which was randomly distributed to trappers at the close of the season. While the mandatory tagging system has provided the Department with more accurate harvest data, little else has been done to directly manage red fox.

The 1975 species assessment addressed the need for research on red fox in the State. Beginning in the mid-1970's, research studies were initiated in eastern, western, and northern Maine. Important information obtained from these studies included

Table 3. Comparison of statewide harvest and species plan objective harvest of red fox, 1975 to 1984.

Year	Objective harvest	Harvest	Deviation (%)
1975	7,500	6,863	- 8.5
1976	"	4,948	- 34.0
1977	"	6,531	- 13.0
1978	"	5,466	- 27.0
1979	"	6,220	- 17.1
1980	"	4,213	- 43.8
1981	5,700	5,097	- 10.5
1982	"	5,660	- 0.7
1983	"	4,342	- 23.8
1984	"	4,258	- 25.3

density estimates, home range size, types of habitat utilized, principle activity of foxes in each habitat type, and the relationships of habitat use patterns between competing species.

HABITAT ASSESSMENT

Statewide

Status

Optimum habitat for red fox consists of a mixture of wooded and non-wooded tracts of land with adjacent waterways. Favored non-wooded habitat consists mainly of active and idle agricultural lands. Forested and agricultural lands by themselves are capable of supporting red fox; however, their value is less than optimal.

There are an estimated 29,938 mi2 of red fox habitat in Maine (Table 4). Fox habitat can be separated into 3 levels of suitability: optimum, medium, and marginal, as defined in the HSI and in Table 4 of this assessment. Quantity of habitat was calculated for each level of suitability, and these 3 totals were added to produce the total amount of fox habitat in the State. Seven percent of the State's fox habitat was classified as optimum habitat, 8% of the habitat was considered medium in suitability for fox, and the remaining 85% of the State's fox habitat was considered marginal in suitability for fox (Table 4).

Changes

The 1980 species assessment estimated that Maine contained about 29,000 mi2 of red fox habitat, but the calculations and assumptions used in determining this amount of fox habitat were not explained. over half of the habitat was considered less than optimum, and agricultural land accounted for only 6% of the available habitat.

Table 4. Current (1985) levels of habitat suitability.

Wildlife Management Unit	Total area (mi^2)	Square miles of optimum habitat[1]	(%)	Square miles of medium habitat[2]	(%)	Square miles of marginal habitat[3]	Total red fox habitat
1	3,216	461	(15%)	46	(1%)	2,614	3,121
2	8,397	168	(2%)	241	(3%)	7,528	7,937
3	4,234	59	(2%)	156	(4%)	3,692	3,907
4	5,726	578	(11%)	133	(2%)	4,726	5,437
5	2,949	118	(4%)	322	(12%)	2,235	2,675
6	2,610	276	(11%)	634	(26%)	1,533	2,443
7	2,113	225	(12%)	345	(18%)	1,331	1,901
8	2,825	347	(14%)	373	(15%)	1,797	2,517
Statewide	32,070	2,232	(7%)	2,250	(8%)	25,456	29,938

[1]Optimum habitat is forest with an understory which contains ≥ 20,000 stem cover units/acre and pertinent forest and agricultural edge types and some amount of suitable shallow fresh marsh habitat and a pertinent amount of tidal shoreline and all agricultural land.

[2]Medium suitability habitat is forest with an understory which contains ≥ 20,000 stem cover units/acre and pertinent forest edge types accompanied by some amount of suitable shallow fresh marsh.

[3]Marginal suitability habitat is the remainder of all forest types not included in optimum or medium habitat minus urban land.

Current red fox habitat is estimated at about 30,000 mi2. This estimate is approximately 1,000 mi^2 higher than the 1980 estimate. The 1985 estimate was based upon 9 habitat types thought to be most important to red fox for food, cover, and reproduction. Data obtained from the 1980 forest resurvey was calculated to determine the amount per mi^2 for each habitat type. Totals for each habitat type were added together to estimate the amount of red fox habitat in the State.

Because projections of 1985 habitat quality in the 1980 assessment were very general, no comparisons could be made with present habitat conditions.

Projections

Future changes in forest and agricultural acreage, human populations and development, and cutting practices are difficult to predict. However, some general assumptions can be made concerning future habitat conditions if present trends in these areas continue.

Fuelwood harvests are projected to increase by about 5% in the 5 year period to 1990 (Chaisson 1985). Harvests will primarily be in the form of clear-cuts which will create about 1,300 mi^2 of optimum fox habitat. The increase in cutting is assumed to occur in marginal fox habitat, decreasing the amount of marginal habitat by about 1,300 mi2. The amount of medium fox habitat is not projected to change from the present estimate.

Wildlife Management Units

Status

Maine's red fox habitat consists of 29,938 mi^2 (Table 4). WMU's 2, 4, and 3 collectively contain over half (58%) of the available habitat in the State followed in order by WMU's 1, 5, 8, 6, and 7. WMU's 4 and 1 collectively contain almost half (47%) of the State's optimum red fox habitat, followed in order by WMU's 8, 6, 7, 2, 5, and 3.

Changes

The 1980 species assessment estimated the amou t of fox habitat at 28,996 mi^2, with WMU's 2, 3, and 4 containing 61% of the available habitat. Similar estimates were obtained for WMU's 2, 3, and 4 in the 1985 species assessment. These WMU's were estimated to contain 58% of the current fox habitat in the State. Total red fox habitat estimates made in the 1980 species assessment are substantially different from 1985 estimates in all WMU's except WMU 5. However, different methods were used to estimate the 1980 and 1985 figures. significant differences in fox habitat occurred in WMU's 1 (+842 mi^2), 2 (-842 mi^2), 3 (+259 mi^2), 4 (+200 mi^2), 6 (+99 mi^2), 7 (-528 mi^2), and 8 (+308 mi^2). The 1980 species assessment did not project future habitat abundance to 1985 on a WMU basis.

The 1980 species update addressed habitat quality as the average density of red fox per unit of habitat. Density estimates were applied on a WKU level for all sawtimber, poletimber and seedling-sapling forest types, and for suitable marsh habitat and all agricultural lands. WMU's 8, 6, 4, and 1 were estimated to contain the highest amount of suitable red fox habitat. The 1985 species assessment separated fox habitat

into 3 levels of suitability: optimum, medium, and marginal as defined in Table 4 of this assessment. WMU's 4, 8, 1, and 6 contained the highest amounts of optimum fox habitat. WMU's 1, 8, and 7 contained the largest percentage of optimum fox habitat per WMU (Table 4). The 1980 assessment did not project any change in habitat quality for the 5-year period to 1985.

Projections

The amount of red fox habitat is not expected to change in any of the WMU's between 1985 and 1990 (Table 5). The amount of optimum fox habitat is projected to increase in all WMU'S, with largest increases expected in WMU's 2 and 4 (Table 5).

Table 5. Projected (1990) levels of habitat suitability.

Wildlife Management Unit	Total area (mi^2)	Square miles of optimum habitat[1] (%)	Square miles of medium habitat[2] (%)	Square miles of marginal habitat[3]	Total red fox habitat
1	3,216	592 (17%)	46 (2%)	2,483	3,121
2	8,397	544 (16%)	241 (3%)	7,152	7,937
3	4,234	244 (7%)	156 (4%)	3,507	3,907
4	5,726	814 (23%)	133 (3%)	4,490	5,437
5	2,949	230 (7%)	322 (13%)	2,123	2,675
6	2,610	353 (10%)	634 (27%)	1,456	2,443
7	2,113	292 (8%)	345 (19%)	1,264	1,901
8	2,825	437 (12%)	373 (15%)	1,707	2,517
Statewide	32,070	3,505 (12%)	2,250 (8%)	24,182	29,938

[1]Optimum habitat is forest with an understory which contains ≥ 20,000 stem cover units/acre and pertinent forest and agricultural edge types and some amount of suitable shallow fresh marsh habitat and a pertinent amount of tidal shoreline and all agricultural land.

[2]Medium suitability habitat is forest with an understory which contains ≥ 20,000 stem cover units/acre and pertinent forest edge types accompanied by some amount of suitable shallow fresh marsh.

[3]Marginal suitability habitat is the remainder of all forest types not included in optimum or medium habitat minus urban land.

POPULATION ASSESSMENT - CARRYING CAPACITY

Statewide

Status

The statewide maximum supportable preharvest population estimate for red fox is 121,134 (Table 6). This estimate was arrived at by applying a density estimate to each of the 3 levels of habitat suitability (optimum = 13/mi2, medium = 7/mi2, and marginal = 3/mi2) and multiplying this estimate by the amount of habitat in each suitability level. The estimated numbers of fox within each habitat suitability level were added together to give a maximum supportable population estimate for each WMU. WMU estimates were added together to give the statewide estimate.

The statewide maximum supportable preharvest density estimate for red fox is 4.05/mi2 of fox habitat (Table 6). This figure was arrived at by dividing the maximum supportable preharvest population estimate by the total amount of red fox habitat.

Changes

The 1980 species plan update did not address carrying capacity; therefore, no comparisons may be made with the present maximum supportable population estimate.

Projections

The projected 1990 statewide maximum supportable preharvest population estimate for red fox is 133,874 (Table 6). The increase (10%) from the 1985 estimate

Table 6. Current (1985) and projected (1990) maximum supportable red fox population by WMU.

Wildlife Management Unit	1985 maximum supportable population	Red fox density/mi^2 of habitat	1990 projected maximum supportable population	Red fox density/mi^2 of habitat
1	14,157	4.54	15,467	4.96
2	26,455	3.33	30,215	3.80
3	12,935	3.31	14,785	3.78
4	22,623	4.16	24,983	4.59
5	10,493	3.92	11,613	4.34
6	12,625	5.17	13,395	5.48
7	9,333	4.91	10,003	5.26
8	12,513	4.97	13,413	5.33
Statewide	121,134	4.05	133,874	4.47

is due to a 5% increase in cutting practices (Chaisson 1985) which will increase the amount of optimum red fox habitat in the State.

The projected statewide maximum supportable preharvest density estimate for red fox is 4.47/mi2 of fox habitat (Table 6). This estimate is an increase of 0.42/mi2 of fox habitat from the 1985 density estimate.

Wildlife Management Units

Status

Estimated maximum supportable preharvest populations are highest in WMU 2, followed by WMU's 4, 1, and 3 (Table 6). Maximum supportable preharvest density estimates are highest in WMU's 6, 8, and 7, in decreasing order (Table 6).

Changes

Carrying capacity was not addressed at the WMU level in the 1980 species assessment update; therefore, no comparisons may be made with present carrying capacity estimates.

Projections

Maximum supportable preharvest population estimates for red fox will increase from present estimates in all WMU'S. The largest increases will occur in WMU's 2, 4, and 3 (Table 6), with increases ranging from 6-14% over 1985 estimates. Reasons for the increase were addressed previously at the statewide level.

Density estimates will increase slightly from present levels in all WMU's (Table 6), with largest increases occurring in WMU's 2, 3, and 4.

POPULATION ASSESSMENT - CURRENT ESTIMATED POPULATION

Statewide

Status

The current statewide preharvest red fox population is estimated at 74,162 (Table 7). This estimate was calculated on a WMU basis using the ratio of red fox to coyote harvested during the 1984-85 season. At a ratio of 1 red fox to 1 coyote harvested, red fox were assumed to be at 50% of their maximum supportable population. As the harvest ratio of red fox to coyote-increased, current fox populations were considered to be closer to their maximum supportable population; likewise, as the harvest ratio of red fox to coyote decreased, current fox populations were assumed to be further from their maximum supportable population.

Several studies have indicated that red fox densities may decline as coyote numbers increase in an area. Red fox numbers are assumed to decrease as coyotes displace red fox from traditional habitat through interspecific competition. Coyotes have a more pronounced affect on red fox in heavily forested areas; however, red fox can be found living closer to towns and cities. Therefore, it is felt that coyotes may displace red fox more readily in the "big woods" portions of northern, eastern, and western Maine than in the heavily populated southern portion of the State.

Changes

The 1980 species plan update estimated the preharvest red fox population at 14,512; this estimate is about 59,700 lower than the current (1985) preharvest red fox

Table 7. Current (1985) and projected (1990) red fox population estimates by WMU.

Wildlife Management Unit	1985 estimated population	Red fox density/mi^2 of habitat	1990 estimated population	Red fox density/mi^2 of habitat
1	9,910	3.18	10,802	3.46
2	11,905	1.50	13,572	1.71
3	6,468	1.66	7,374	1.89
4	15,836	2.91	17,420	3.20
5	5,771	2.16	6,409	2.40
6	6,944	2.84	7,361	3.01
7	6,066	3.19	6,491	3.41
8	11,262	4.47	12,050	4.79
Statewide	74,162	2.48	81,479	2.72

population figure. The 1980 species update estimated the preharvest red fox population by multiplying the area (mi^2) of fox habitat by the average density of fox per unit of habitat. Density estimates were applied on a WMU level for all sawtimber, poletimber, and seedling-sapling forest types; suitable marsh habitat; and all agricultural lands. The 1985 estimate was calculated by examining red fox to coyote harvest ratios for the 1984-85 season.

The 1980 species plan projected no change in the estimated preharvest red fox population by 1982, but this projection was based on limited data.

Projections

An accurate projection of the 1990 red fox population is extremely difficult, because no data is available on the population's recruitment rates and sex and age structure. In addition, future red fox to coyote harvest ratios are nearly impossible to predict. Therefore, the following projections should be viewed cautiously.

According to Chaisson (1985), timber harvesting will increase by 5% between 1985 and 1990. The increase in cutting will increase the projected (1990) statewide maximum supportable preharvest red fox population by 10%. Therefore, it is assumed that the actual statewide preharvest red fox population will also increase by 10% during the same 5-year period (Table 7).

Wildlife Management Units

Status

Current estimated preharvest red fox population levels are highest in WMU's 4, 2, and 8. About 74% of the current estimated fox population occurs in these 3 WMU's (Table 7). Current preharvest fox population levels are lowest in WMU's 1, 6, 3, 7, and 5.

Changes

Preharvest population levels calculated for the 1980 species update were highest in WMU's 4 and 2 and lowest in WMU 5. Current (1985) population levels are also highest in WMU's 4 and 2 and lowest in WMU 5. Current fox population estimates are considerably higher than 1980 estimates for all WMU'S, due to differences in methods used to estimate fox numbers. The 1980 species update projected no changes in population levels through 1982, but these projections were based on limited data.

Projections

By 1990, preharvest fox populations are expected to increase from present estimates in all WMU's (Table 7). Increases ranging from 6-14% are expected, equal to projected increases in maximum supportable preharvest populations. Largest increases are projected in WMU's 2, 4, and 3.

POPULATION ASSESSMENT - RELATIONSHIP OF CURRENT ESTIMATED POPULATION TO MAXIMUM SUPPORTABLE POPULATION

Maine's preharvest red fox population is estimated at 74,162. This figure is 61% of the maximum supportable preharvest population estimate. The current population level in WMU 8 is considered to be 90% of its maximum supportable population, followed in descending order by WMU's 1 and 4 (70%), 7 (65%), 5 and 6 (55%), 3 (50%), and 2 (45%).

Interspecific competition with coyotes may be responsible for keeping red fox numbers below the carrying capacity of the habitat. Most of the heavily forested portions of the State are considered marginal fox habitat, but these areas do contain some optimum fox habitat in the form of clear-cuts and forest edges created by logging roads. However, coyotes are most often found in these heavily forested areas, and research conducted in Maine (Sherburne and Matula 1981, Major 1983) and Ontario (Voigt and Earle 1983) suggest that coyotes may displace red fox from traditional habitat. Coyote home ranges are substantially larger than fox home ranges, and may limit the number of fox families in an area. Fox may avoid raising pups in areas traditionally inhabited by coyotes (Voigt and Earle 1983), and coyotes have been known to occasionally prey on red fox.

USE AND DEMAND ASSESSMENT - HARVEST

Statewide

Status

Fox harvests have varied from 4,258 to 5,660 since 1981, with an average harvest of 4,839. Fluctuating harvest levels are a reflection of a variety of factors including effort, pelt price, weather, season starting dates, disease, competition with other hunters and trappers, and production and survival of young. The 1981-84 average harvest, effort and success rates by WMU are presented in Table 8.

Changes

Prior to the 1980 season, gray fox were included with red fox in the harvest summaries. Therefore, no comparisons can be made between the recent (1981-84) 4-year average, and the previous (1977-80) 4-year average.

Projections

Given current harvest trends, no significant change is expected in the 4-year (1986-90) average statewide harvest (Table 9). This figure should be viewed with caution, because annual harvest figures are largely affected by pelt price and weather, which are extremely difficult to predict. An outbreak of either rabies or sarcoptic mange within the fox population could also substantially reduce harvest size.

Table 8. 1981-84 average red fox harvest, effort and success rates.

Wildlife Management Unit	Allowable harvest[1]	Harvest	estimated number of users	Successful users	Percent successful	Users/mi² occupied habitat
1	4,955	942	368	184	50	0.12
2	5,953	209	305	89	29	0.04
3	3,234	233	234	82	35	0.06
4	7,918	1,304	1,156	407	35	0.21
5	2,886	299	271	105	39	0.10
6	3,472	411	378	130	34	0.15
7	3,033	408	590	163	28	0.31
8	5,631	1,033	606	274	45	0.24
Statewide	37,082	4,839	3,912[2]	1,433[3]		

[1]The allowable harvest equals 50% of the current (1985) preharvest red fox population.

[2]The term "users" includes both hunters and trappers. The statewide estimate of number of users is more than the sum of the WMU's. The difference is due to sampling error.

[3]Successful users are successful harvesters of red fox. The statewide estimate for successful users is more than the sum of the WMU's. The difference is due to sampling error.

Table 9. 1986-1990 average red fox harvest, effort and success rates.

Wildlife Management Unit	Allowable harvest[1]	Harvest[2]	Estimated number of users[3]	Successful users[4]	Percent successful	Users/mi^2 occupied habitat
1	5,401	919	352	186	53	0.12
2	6,786	194	313	86	27	0.04
3	3,687	242	235	86	37	0.06
4	8,710	1,307	1,174	401	34	0.22
5	3,205	290	274	100	36	0.11
6	3,681	387	391	129	33	0.16
7	3,246	387	587	158	27	0.32
8	6,025	1,016	587	272	46	0.24
Statewide	40,740	4,742	3,913	1,418		

[1]Allowable harvest equals 50% of the projected (1990) preharvest red fox population.

[2]WMU harvest, effort, and success is based on the average percent of statewide red fox harvests 1981-84.

[3]The term "users" includes both hunters and trappers.

[4]Successful users are successful harvesters of red fox.

Wildlife Management Units

Status

Recent 4-year (1981-84) average harvests have been highest in WMU's 4, 8, and 1 (Table 8). These WMU's have accounted for about 68% of the average statewide harvest for that period. Allowable harvests have not been exceeded in any WMU.

Changes

No comparisons can be made with the recent 4-year (1981-84) average harvests at the wr4U level. Prior to 1980, gray fox were included with red fox in the harvest summaries.

Projections

No significant changes are expected in the projected (1986-90) average harvest from present estimates for any WMU (Table 9).

USE AND DEMAND ASSESSMENT - TYPES OF USERS

Statewide

Status

Trappers represent the largest group using Maine's red fox resource. Over the past 4 years (1981-1984), they have accounted for approximately 93% of the annual harvest, with an average success rate for fox trappers of 37%. Hunters account for the remaining 7% of the harvest. Some hunters take fox by predator calling or hunting with dogs, and the remainder are taken incidentally while pursuing snowshoe hare, upland birds, and deer.

Demand for red fox has fluctuated annually since 1981, ranging from 3,412 to 4,453 hunters and trappers. Average pelt price has steadily declined from $56.71 in 1981 to $35.47 in 1984. In spite of fluctuating pelt prices and harvests, it appears that red fox supply continues to outweigh demand throughout the State.

Many factors affect use opportunity for fox trappers. Relatively short trapping seasons (designed to maintain population levels of other furbearers), increased competition, unfavorable trapping conditions (freezing temperatures and snow), and conflicts with deer, bird and hare hunters all limit use opportunity for fox trappers. Additional problems faced by fox trappers include: trap theft, posted land and an anti-trap movement (primarily in the southern portions of the State), amount of optimum fox habitat, an expanding coyote population which may be displacing red fox from traditional habitat, and access to remote areas of the State.

Changes

No major changes in types of users has occurred in the 5-year period to 1985. No significant change in effort and success rates have occurred between the recent (1981-84) 4-year average, and the previous (1977-80) 4-year average.

Factors affecting use opportunity have shifted in emphasis since 1980. Trapping season lengths have increased by an average of 1 week, but competition with deer hunters may have cancelled out any advantage the additional week would have given to trappers. Between 1980-84, the number of trapping days before the start of the firearm deer season declined steadily, and trappers had less time to trap before they had to compete with deer hunters. The presence of large groups of hunters in the woods may have changed the behavior of fox, and affected success rates for trappers. Trap theft large group trappers.

Trap theft, and the destruction of animals in traps by both hunters and unethical trappers has also become a problem. Trapping seasons were extended after the close of the deer season between 1980-84. However, unfavorable weather conditions (snow and freezing temperatures) during this period made it more difficult to trap fox, and many trappers did not take advantage of this additional opportunity to trap for fox.

There has been a growing concern in recent years that coyotes are displacing red fox from traditional habitat, therefore decreasing the opportunity to trap fox. The slow but steady decline of optimum fox habitat in the form of agricultural lands also limits use opportunity. Finally, an increase in posted land and anti-trap sentiment has been observed, particularly in the southern portions of the State.

Projections

Trappers are expected to be the primary group using the red fox resource through 1990. Predator calling, which is gaining in popularity, may increase the number of hunters utilizing the fox resource but the extent of this increase is difficult to measure.

Projected statewide effort and success rates were determined by taking the average percent of the statewide totals per WNU for the period 1981-84 (Table 9). WMU. estimates were then added together to give the statewide calculations, averaqe (1986-90) effort and success rates are not expected to significantly differ from present (1981-84) averages. However, increases in pelt prices could increase effort and success rates for trappers. Predator calling could also increase effort and success rates for fox hunters.

Effort and success rates can be affected by use opportunity, which is in turn affected by several factors, of including: local competition between trappers; amount posted land; anti-trap sentiment; conflicts between trapped and deer, bird and hare hunters; and timing of pelt primeness. Projected increased timber harvest may increase use opportunity by increasing road access in fox habitat.

Increases in fox numbers could also increase use opportunity. Changes in fox and coyote numbers will affect use opportunity, and fox numbers may be affected by disease. The Department's antlerless deer permit system, proposed for 1986, may increase conflicts between trappers and deer hunters in areas where a large number of permits are issued.

Because of the complex relationships between these factors, and their unpredictable nature, it is impossible to accurately project effort, success rates, and use opportunity through 1990, and the figures presented in Table 9 should be viewed cautiously.

Wildlife Management Units

Status

Trappers are the primary users of the red fox resource in all WMU'S. Demand for red fox is greatest in WMU's 4, followed by Units 8, and 7 (Table 8). However, success rates are highest in WMU's 1 and 8 (Table 8).

Changes. User groups have not changed since the 1980 species assessment; trappers continue to represent the largest group utilizing the red fox resource. Current (1981-84) average effort and success rates on a WMU basis do not differ significantly from the previous (1977-80) 4-year average.

Factors affecting use opportunity have shifted in emphasis in the recent (1981-84) 4-year period from those in the 1977-80 period. Many of these changes are difficult to measure on a WMU basis, but some general comments can be directed at particular WMU'S.

The increased number of trapping days beyond the close of the deer season may have had little affect on use opportunity in WMU's 1-3, and the northern portions of WMU's 4

and 5. Snow and freezing temperatures generally occur earlier in those areas, and limit opportunity to trap fox. Increasing coyote numbers may have further decreased use opportunity in heavily forested WMU's 2, 3, and 5, because coyotes are believed to displace red fox from traditional habitat. Finally, use opportunity may have decreased in WMU's 7 and 8 due to increases in posted land and anti-trap sentiment.

Projections

User groups are not expected to change from those presently utilizing the red fox resource; trappers should continue to be the largest group utilizing the fox resources in all WMU's. Effort and success rates should not change significantly from present (1981-84) averages in any WMU.

Projecting use opportunity is extremely difficult on a WMU basis, due to reasons discussed at the statewide level. Therefore, use opportunity is assumed to have no impact on 1990 effort and success rates within WMU's (Table 9).

SUMMARY AND CONCLUSIONS

Red fox become sexually mature at 10-11 months. They breed annually, and breeding season takes place from December through March. Young are born during March and early April, with litters averaging 5 pups. Both the male and female take part in raising the pups. Pups begin to disperse in mid-September, and dispersal continues through December. Home range sizes vary considerably, and are affected by the abundance of food, degree of interspecific and intraspecific competition, type and diversity of habitat, and the presence of natural and physical barriers.

Red fox are found in a variety of habitats, but are more closely associated with areas containing cropland and fields intermixed with adjacent wooded tracts. Fox were considered common at the time of European settlement. By the 1800's, fox were abundant in the agricultural areas of southern and western Maine, and as logging practices opened the north woods during the late 1800's and early 1900's, fox became fairly common in northern Maine. Historically, red fox have been viewed with mixed feelings; they were considered a threat to farm livestock, and a danger because of their role in the spreading of rabies and sarcoptic mange. However, many Maine residents consider the red fox to be a valuable animal and trap and bunt them for their pelts.

Maine contains about 30,000 mi2 of fox habitat; optimum fox habitat consists of about 2,200 mi2 (7%), while marginal fox habitat is estimated at about 25,300 mi2 (85%). Fox habitat quality is estimated to increase about 5% by 1990, with this increase occurring from conversion of marginal habitat to optimum fox habitat.

The current maximum supportable preharvest red fox population is estimated at about 121,134. The 1985 preharvest population is estimated at 74,162, or about 61% of the maximum supportable preharvest population estimate. Both the maximum supportable and current preharvest populations are projected to increase by 1990. Increased cutting practices will create additional optimum fox habitat primarily in the form of clear-cuts.

Red fox harvests have varied from 4,258 to 5,660 in the period 1981-84, averaging 4 839 (Table 10). WMU's 4 yields the highest harvest followe'd by WMU's 8 and 1. Projected (1986-90) average harvests are not expected to differ significantly from current (1981-84) average harvests.

Trappers traditionally account for 90-95% of the annual harvest; intentional fox hunters, and bird, hare, and deer hunters account for the remainder of the kill. Hunting harvests are fairly stable, with about 200-300 red fox taken annually by this method. Trapping harvests have fluctuated considerably, but averaged 4,490 in the 4-year period 1981-84. Projected (1986-90) average harvests are not expected to differ significantly from the present (1981-84) 4-year period.

Estimates of effort and success rates for the recent (1981-84) 4-year period are similar to averages experienced in the 4-year period 1977-80. Projected (1986-90) effort and success rates are expected to be similar to current (1981-84) averages.

Factors affecting use opportunity include: relatively short trapping seasons (designed to maintain preharvest population levels of other furbearers), conflicts with deer, bird, and hare hunters, trap theft, and destruction of animals in traps. Additional

Table 10. Past, present and projected future red fox harvests (actual, allowable and objective) and users (total and successful).

	Harvest			Users	
Year	Actual	Maximum allowable	Objective	Total	Successful
1976	4,948	7,200	7,500	1,795	1,172
1977	6,531	7,200	7,500	3,717	1,493
1978	5,466	7,200	7,500	3,537	1,470
1979	6,220	7,200	7,500	4,313	1,723
1980	4,213	7,200	7,500	4,105	1,448
1981	5,097	7,200	5,700	4,453	1,621
1982	5,660	7,200	5,700	4,118	1,575
1983	4,342	7,200	5,700	3,412	1,269
1984	4,258	7,200	5,700	3,666	1,267
1990	2,813			2,639	789

problems include posted land and anti-trap sentiment (primarily in the southern portions of the State), amount of fox habitat, an expanding coyote population which may be displacing fox from traditional habitat, and road access, particularly to remote portions of the State. These factors also affect effort and success rates and are difficult to measure. However, these factors should be considered when developing management plans for red fox.

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RED FOX MANAGEMENT GOAL AND OBJECTIVES
1985-1990

GOAL: Allow the red fox population to fluctuate naturally in all WMU's.

OBJECTIVES:

Abundance: Monitor the red fox population but allow fox densities to fluctuate naturally in all WMU's through 1990.

Harvest: Maintain current user opportunity (season length and timing) through 1990.

Capability of Habitat: Red fox habitat throughout Maine is capable of supporting fox densities which fluctuate naturally.

Feasibility: This goal can be accomplished as current regulations and use of red fox do not significantly affect red fox densities.

Desirability: This goal may be desirable to hunters and trappers because use opportunity will not be restricted; supply greatly outweights demand.

Possible Consequences: Red fox densities may reach carrying capacity if they are allowed to fluctuate naturally. If local fox populations do reach carrying capacity, transmittable diseases including sarcoptic mange and rabies may occur and cause substantial declines in fox numbers. An outbreak of rabies in fox could result in public demand for a Departmental control program, which would be costly.

Summary of Working Group Conserns

RED FOX

Habitat

1. Clearcutting in Jackman area may be causing an increase in foxes.

Populations

1. Red fox populations have declined in WMU's 5 and 6 since mange struck and coyotes moved in.

2. Coyotes take over fox dens and kill foxes.

Harvest

1. Foxes could be harvested in the winter but pelts are low value.

2. Deer hunters interfere with trapping. Would like to change deer season to provide more opportunity.

Red Fox Problems and Strategies in Order or Priority

Problem 1: Decreasing accessibility of private lands to trapping.

- **Strategy 1:** Develop a system to monitor the amount of land being lost to public access by WMU.
- **Strategy 2:** Implement programs to maintain access to private lands.
- **Strategy 3:** Acquire public access rights to land where necessary.

Problem 2: Restrictions on trapping opportunity implemented for other species (i.e., fisher, marten, bobcat) on the opportunity to harvest foxes.

- **Strategy 1:** Develop selective methods for harvesting foxes.
- **Strategy 2:** Implement selective methods to offset loss of trapping opportunity when it occurs.

Problem 3: Lack of information on the size of red fox populations throughout the State.

- **Strategy 1:** Develop and implement a system to monitor red fox populations on a WMU basis.

Problem 4: Opposition to consumptive use of red fox by non-consumptive users.

- **Strategy 1**: Develop programs to minimize the conflicts and concerns of non-consumptive users and maintain use opportunity.