HABITAT MANAGEMENT GUIDELINES FOR
WATERFOWL IN ONTARIO

for use in Timber Management

ONTARIO MINISTRY OF NATURAL RESOURCES

Prepared by J. Hickie

MNR # 51606
ISBN 0-7794-2355-0 (Internet)

March 1985

Table Of Contents Page

List of Figures **Page**

1.0 Preface

There is an increasing demand for forests that are managed for multiple uses rather than solely for wood products (Canada-Ontario Forest Resource Agreement 1984). It is also recognized that under certain circumstances timber operations can conflict with the maintenance of waterfowl habitat. Activities such as hunting, camping, and tourism require that there be viable populations of wildlife both for consumptive (hunting) and non-consumptive (bird-watching, photography etc.) uses. Waterfowl hunting alone contributes about fifty-five (55) million dollars per year to the Ontario economy (OMNR 1982). Forestry practices that enhance wildlife habitat are consistent with a multi-use forest policy. These guidelines are intended to assist forest managers, where it is required, in protecting and enhancing waterfowl habitat congruent with economical timber harvesting.

About twenty (20) species of waterfowl nest regularly in forested areas of Ontario and consequently the guidelines are general in nature. Waterfowl communities differ from place to place in the province and modification of local cutting plans will entail cooperation between foresters and wildlife biologists on a site specific basis.

2.0 Habitat Requirements of Waterfowl

The most important habitat requirement for waterfowl is access to shallow waters that produce high numbers of small aquatic invertebrates (Sugden 1973). These form a high-quality diet for egg-laying females and actively growing young. Most waterfowl that breed in Ontario nest within or close by marshes and other wetlands. However, the black duck will build nests on the forest floor several kilometres from water, whereas wood ducks, buffleheads, goldeneyes and the mergansers nest in cavities in large trees. Mergansers also require clear, unpolluted streams for raising their young.

2.1 Nesting Requirements

2.1.1 Nests in or near Wetlands

Canada geese, gadwall, mallard, blue-winged and green-winged teal, shoveller, and the lesser scaup nest on dry land close to wetlands, or in emergent vegetation. Most nests are within 100 metres of water in sedge or grass meadows, under wetland shrubs such as willow, or tall dense clumps of weeds. Red-breasted merganser nests on the ground under shrubs adjoining streams. Ring-necked ducks nest in stands of emergent vegetation on floating mats of vegetation (Bellrose 1976, Johnsgard 1978).

2.1.2 Upland Nesters

The black duck, wigeon and pintail may nest considerable distances from the nearest water. Nests may be found under dense shrub cover, in upland forests, or in emergent wetland vegetation - anywhere that good concealment can be found. However, the pintail will nest in very open areas, its nest being little more than a scrape in the ground (Bellrose 1976, Johnsgard 1978).

2.1.3 Cavity Nesters

Wood ducks, common goldeneyes, buffleheads, as well as common and hooded mergansers require large trees with cavities for their nests. Holes left by pileated woodpeckers or flickers are probably the best nest cavities, but holes resulting from heart rot or fallen branches may also be used. Trees with d.b.h. over thirty-eight (38) centimetres provide nest cavities for buffleheads and hooded mergansers while trees with a minimum d.b.h of fifty (50) centimetres are required for wood ducks, common goldeneye, and common merganser (Thomas 1979). Nest cavities are usually quite close to water. All these species will nest in man-made nest boxes. Unlike the other mergansers the red-breasted merganser will nest under shrubs and bushes close to streams and clear lakes in addition to using cavities or nest boxes. Female ducks in this group are highly site tenacious, returning year after year to nest in the area where they were raised (Erskine 1971, 1972, Bellrose 1976, Johnsgard 1978). They are also reluctant to move to other locations if unable to nest near their natal site. Extensive clear cuts in riparian zones could reduce populations for many years, even after suitable nesting habitat has recovered (Erskin 1972).

2.2 Feeding Requirements

2.2.1 Canada Goose

Canada geese graze primarily on grasses and sedges. Young goslings start to graze immediately after hatching, but will take small numbers of invertebrates opportunistically (Bellrose 1976, Johnsgard 1978, H. Lumsden, OMNR Maple, pers. comm.).

2.2.2 Ducks

All ducks require areas of water with high numbers of small aquatic invertebrates at shallow depths. Growing young, laying females, and moulting adults require a high protein diet of aquatic invertebrates (Bartonek and Hickey 1969 a,b, Krapu 1974, Patterson 1976, Reinecke and Owen 1980). Ducklings feed on small invertebrates at shallow depths during the first few weeks of life. After that time, some begin to incorporate more plant matter into the diet while others become able to forage at greater depths.

2.2.2 (a) Dabbling Ducks

Adult wigeon, gadwall, blue-winged and green-winged teal, mallard, pintail, shoveller, black and wood ducks feed on a variety of aquatic plants, seeds and aquatic invertebrates (Bellrose 1976, Johnsgard 1978). Beaver ponds and marshes with large amounts of emergent vegetation - water edge (semi-marsh, Voigts 1976, FIG. 1) are especially productive sources of invertebrates. Dabbling ducks tip up for their food and so are restricted to shallow areas. Some ducks that lay their eggs in upland areas or on unproductive ponds will often lead their broods on long overland journeys of several kilometres to reach productive areas (Patterson 1976, Brown and Parsons 1979, Ringelman and Longcore 1982).

2.2.2 (b) Diving Ducks

Adult ring-necked ducks feed predominantly on submerged vegetation whereas lesser scaup, buffleheads, and common goldeneyes feed almost exclusively on animal matter at depths up to eight (8) m. Young diving ducks rely heavily on small aquatic invertebrates at shallow depths, but unlike young dabbling ducks they will submerge to forage and can move to progressively deeper water with age (Bellrose 1976, Johnsgard 1978).

2.2.2 (c) Mergansers

The common, hooded, and red-breasted mergansers require clear, unpolluted, shallow streams for nesting and brood rearing, but beaver ponds may also be used (Beard 1953, Bellrose 1976, Johnsgard 1978, Brown and Parsons 1979). Adults are capable of diving to depths of ten (10) metres (Johnsgard 1978) for fish in clear lakes, but in their first few weeks, ducklings are limited to diving in depths less than one (1) metre for aquatic insects, tadpoles, small fish and snails.

3.0 Special Management Considerations

3.1 Fish

Fish are far more sensitive than waterfowl to disturbances of the aquatic environment. Waterfowl are able to move from one waterbody to another with relative ease if erosion or sedimentation causes reductions in invertebrate populations. Habitat management guidelines developed for the protection of fish habitat in most cases should provide more than adequate protection for waterfowl aquatic habitat.

3.2 Wetlands

Wetlands are "lands that are seasonally or permanently covered by shallow water ... (where) abundant water has caused the formation of hydric soils and has favoured the dominance of ... water tolerant plants (OMNR - CWS 1984). Marshes are dominated by emergent vegetation such as cattails (*Typha latifolia*), bulrushes (*Scirpus spp*.), arrowheads (*Sagittaria latifolia*) or shallow water submergents such as coontail (*Ceratophyllum demersum*), fragrant (white) water lily (*Nymphaea odorata*) and bladderwort (*Utricularia spp*.). Swamps are wooded wetlands containing water tolerant trees such as red maple (*Acer rubrum*), trembling aspen (*Populus tremuloides*), black spruce (*Picea mariana*), and tamarack (*Larix laricina*), or shrubs such as willow (*Salix spp*.), or speckled alder (*Alnus rugosa*). Bogs and fens are peatlands with less inflow and outflow than swamps and marshes tend to be isolated from other surface water, and are less productive than other wetlands. Ring-necked ducks will nest in bogs that have open water and suitable shrub cover such as leatherleaf (*Chamaedaphnae culyculata*), sweet gale (*Myrica gale*), or Labrador tea (*Ledum groenlandicum*). Wetlands may be discrete entities, or shallow bays on lakes or rivers. Emergent vegetation and wetland shrubs provide nesting cover for some ducks and cover for many other ducks and geese that rear their broods in wetlands. In addition to being hiding cover for ducklings, emergent vegetation provides a substrate upon which many invertebrates live (Krull 1970, Voigts 1976). Wetlands with a high proportion of edge between emergent vegetation and water (hemi-marsh, Voigts 1976) are particularly good waterfowl habitat. Submergent vegetation is also a substrate for invertebrates (Krull 1970), and may also provide food for adult ducks. Wetland areas as small as a half (0.5) hectare can provide good habitat for waterfowl if they produce enough invertebrates and contain sufficient cover (Dzubin 1969, Poston 1969, LaCaillade 1975, Patterson 1976).

In addition, wetlands are a very important habitat for many other wildlife species (Weller 1978) as well as helping to charge water tables, maintaining summer flows in small streams and purifying water that flows through the system (Stearns 1978).

Due to their importance to waterfowl and many other wildlife species, wetland areas can be considered to be "critical habitat". Wetlands that are connected to other wetlands, lakes, or ponds by intervening surface water are particularly important habitat. Small wetlands that are not connected but are about a kilometre (1) or less apart should be treated together rather than singly since many ducks use several waterbodies during the course of a breeding season (Dzubin 1969, Patterson 1976, Ringelman and Longcore 1982). Wetlands that are overgrown with emergents are not used by waterfowl, but may be important hydrologically or useful to other wildlife. An evaluation system developed for Ontario wetlands south of the precambrian shield can provide managers throughout the province with useful insights for rating wetlands valuable for waterfowl production (OMNR-CWS 1984).

3.3 Ponds

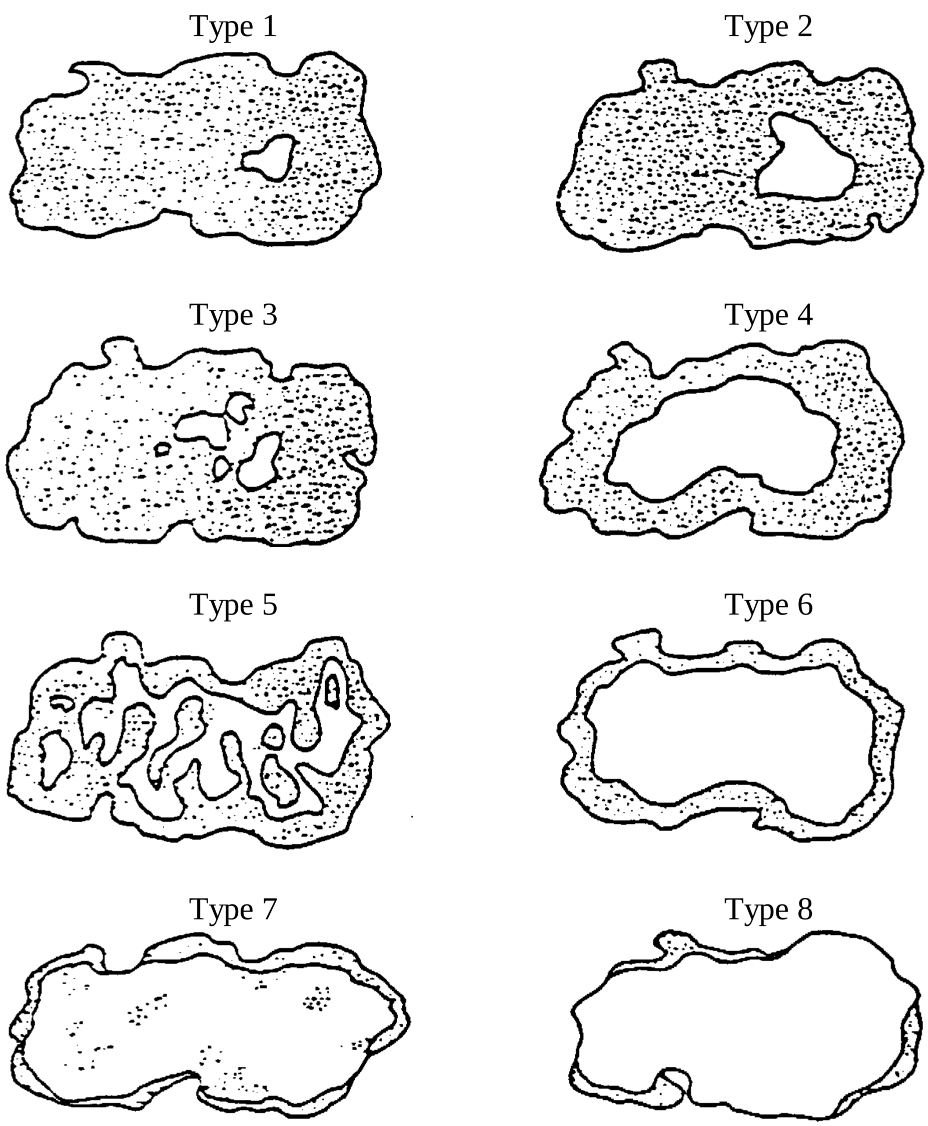
The "Marsh" wetland type includes areas of open, permanent, shallow water, (OMNR-CWS 1984). Such ponds as small as a half (0.5) hectare and shallower than three (3) metres deep can provide important habitat for waterfowl (Dzubin 1969, Poston 1969, LaCaillade 1975, Patterson 1976), if emergent vegetation is present around the perimeter and/or as patches in the pond (FIG 1). High proportions of edge between emergents and open water provides more cover and feeding sites for ducklings. Ponds that are in close proximity or connected to other water bodies are the most valuable as waterfowl habitat. Ponds that are, for the most part, deeper than three (3) metres, and with little emergent vegetation, are not suitable for brood rearing, but may be used by some ducks as staging areas when broods are being led overland from nesting areas to productive brood rearing areas.

3.4 Beaver Ponds

Beaver ponds are an especially important waterfowl habitat in Ontario, especially on the Canadian Shield where naturally occurring wetlands and ponds may be considerably less productive than those on the carbonate soils of Southern Ontario or the clay belt region of North-Central Ontario (Krull 1970, Collins 1972, Golet and Larson 1974, Brown and Parsons 1979, Ringleman and Longcore 1982, Patterson 1976). In the first three or four (3-4) years of their existence beaver ponds are extremely productive sources of small invertebrates - the prime requisite for brood rearing in ducks (Ringelman and Longcore 1982). After the first few years beaver ponds tend to become less productive and duck use decreases. Beaver have a strong preference for woody stemmed deciduous vegetation with d.b.h. of two and a half (2.5) to fifteen point two (15.2) cm as winter food (Allen 1982). Making openings in mature canopy close to waters edge will encourage the regeneration of willow, alder, and aspen, all important beaver food species. Herbaceous plants in regenerating areas also provide important summer forage for beaver, and cover for upland nesting ducks. Beaver ponds are the preferred habitat of black ducks. Mallards, blue-winged teal, ring-necked ducks, hooded mergansers, and common mergansers also use beaver ponds. Beaver show a preference for dam-building along small watercourses with gradients less than six percent (6%) and with suitable food sources within thirty (30) m of the water (Allen 1982). Creating open areas from one to four (1-4) ha. in such areas will encourage regeneration of beaver forage as well as nesting habitat for upland ducks (AFC 1972).

Open Water Types

White areas indicate open water (including floating and submerged plants). Stippled areas indicate emergents, shrubs and trees.



Different distributions and proportions of cover that might be found on wetlands or ponds. Type 5 is the best for waterfowl production -- cover and open water are distributed in a ratio of about one to one (1:1), but there is far more edge than any other type. Types four, six, and seven 4, 6,7) also provide waterfowl habitat. Adapted from Golet 1976 for an Evaluation System for Wetlands of Ontario 1984.

3.5 Riparian Forest and Woodpeckers

Mature forest close to water, especially those with a large deciduous component, are critical habitat for cavity nesting ducks (Gilmer et al. 1978). Vacated holes of northern flickers (*Colaptes auratus*) and pileated woodpeckers (*Dryocopus pileatus*) are the most important nest sites available to cavity nesting ducks. Pileated woodpeckers nest in areas of mature mixed or deciduous forest with territory sizes ranging from seventy (70) to 200 hectares. The nests are usually within fifty (50) m of water in snags over eight (8) metres high with a d.b.h. of at least fifty (50) cm (Conner et al. 1975, Conner and Adkisson 1977, Thomas 1979, McClelland et al. 1975, Conner and Adkisson 1977, Thomas 1979, McClelland et al. 1979). Snags should be left behind in cut over areas as future woodpecker nest sites. Unmarketable trees greater than thirty-five (35) cm d.b.h. (minimum size for flickers, Thomas 1979) should not be thinned, but girdled and left standing as snags. Snags do not compete with surrounding live trees for light or nutrients. Deciduous snags, such as aspen, are preferred since their centers rot before their exteriors. This allows woodpeckers to excavate a large nest cavity in soft wood while retaining a strong outer shell (Conner et al. 1976). Managing riparian forest for pileated woodpecker nesting requirements should provide adequate habitat for flickers as well as cavity nesting ducks.

3.6 Openings

Cutting should not be totally prohibited in riparian zones. Openings in riparian zones can provide important habitat for upland nesting ducks (AFC 1972), beaver (Allen 1982), and deer (Thomas et al. 1979 a,c, OMNR 1984), as well as providing regeneration of hardwoods for woodpeckers and cavity nesting ducks. Wood ducks usually build nests in trees that are within 100 metres of openings in mature riparian forests. Gilmer et al. (1978) suggest an old-growth timber management plan that creates one to four (1-4) hectare openings (see Appendix II). The rotation age of blocks is such that trees in a block are harvested ten (10) years after aspen in the blocks have reached a d.b.h. of fifty (50) cm. The aspen provide habitat for woodpeckers and cavity nesting ducks for about ten (10) years and are then harvested before degenerating beyond economic usefulness. In order to encourage the regeneration of aspen and other hardwoods, broad leaf herbicides, scarification, and conifer planting should be curtailed in riparian cuts.

3.7 Erosion and Sedimentation

Erosion and sedimentation caused by logging can result in scour of stream beds (Hall and Lantz 1969), reduce aquatic invertebrate populations (Culp and Davies 1983), and foul fish spawning beds (Hall and Lantz 1969). Cutting trees causes a negligible amount of erosion, but soil disturbing activities such as road building, skidding, landings, and scarification are the major causes of erosion associated with logging (Packer 1967). Road crossings in riparian areas are a major source of eroded solids washed into streams (Packer 1967).

4.0 General Cutting Considerations

Riparian zones surrounding wetlands, ponds, streams, rivers, and lakes are used by more wildlife species than any other habitat type (Thomas et al. 1979 a). When cutting in riparian zones, special care must be taken to curtail erosion and maintain bank stability. Logging practices outside a riparian zone may also have an influence on water quality. Patch cutting of small blocks within a watershed has less effect on water quality than clear cutting (Hall and Lantz 1983). Group selection cutting for thinning results in less erosion than individual selection due, perhaps, to the reduced number of skidding trails used (Haupt 1960). Group selection thinning also produces small openings and edge that are important to wildlife (Thomas et al. 1976 b). Natural regeneration of riparian areas should be encouraged. Replanting of conifers within riparian zones should be allowed only for enhancement of wildlife habitat. Where planting is allowed, scarification and planting should follow cutting as soon as possible. This restricts any erosion to one period rather than having several episodes of erosion.

Any waterfowl management scheme applied to riparian zones should be based on maintaining an uneven-aged, old-growth reserve with some openings. This acts to prevent erosion from surrounding clear cuts, as well as providing important wildlife habitat. The width of riparian zone reserves is largely determined by slope (see guidelines). McClelland et al. (1979) recommended that about ten percent (10%) of each management area should be maintained as an old-growth component. The ten percent (10%) reserve should contain both riparian and upland areas, with some blocks of twenty to forty (20-40) hectares to provide habitat for pileated woodpeckers.

5.0 Recommended Cutting Guidelines

5.1 Cutting in riparian zones surrounding wetlands, lakes, rivers, streams and ponds, that have been determined as important for waterfowl, should not take place during waterfowl nesting season. Nesting season will vary throughout the province and the restricted timing of cuts must be determined by District Biologists.

5.2 Where cutting is allowed in riparian zones, patch cuts, strip cuts, or group selection cuts should be employed. Cutting in riparian zones should not occur if the area upslope has been cut and has not yet recovered enough to resist erosion.

5.3 Where cutting is allowed in riparian zones leave all snags, and leave some large mature trees for future snags. Leave all unmarketable trees greater than thirty-eight (38) cm d.b.h. in place if possible. Rather than thinning unwanted trees, they can be girdled and left in place as snags (Thomas 1979).

5.4 Cut-over areas in riparian zones should be allowed to regenerate naturally.

Scarification and other erosion inducing regeneration activities should be restricted in riparian zones. No cutting of adjacent areas should be permitted until the cut block has regenerated sufficiently to act as an erosion barrier.

5.5 The width of any riparian zone can be determined according to the following table (adapted from Trimble and Sartz 1957). The widths suggested in the table should be modified for local soil and ground cover conditions.

SLOPE %	SLOPE ANGLE (^{o})	WIDTH OF ZONE
0 - 30	0 - 17	50 metres
31 - 45	18 - 24	70 metres
46 - 60	25 - 31	90 metres

All riparian zones should be measured from the high water mark. The widths specified here apply to each side of a stream. The zones specified here are intended to provide adequate erosion protection and allow nesting habitat for cavity nesters.

5.6 Avoid road building in riparian zones. Where road building is necessary for stream crossings, erosion should be minimized.

5.7 Landings should not be built within riparian zones.

References

Allen, AW. 198. *Habitat suitability models: beaver*. U.S. Dept. Int., Fish Wildl. Serv. FWS/OBS-82/10.30 20p.

AFC. 1972. *Techniques handbook of the waterfowl habitat development and management committee*. Atlantic Flyway Council, Bolton Mass. 218 p.

Bartonek, J.C. and J.J. Hickey. 1969a. *Food habits of canvasbacks, redheads, and lesser scaup in Manitoba*. Condor 71: 280-290.

Bartonek, J.C. and J.J. Hickey. 1986b. *Selective feeding by juvenile diving ducks in summer*. Auk 86: 443-457.

Beard, E.B. 1953. *The importance of beaver in waterfowl management at the Seney National Wildlife Refuge*. J. Wildl. Manage. 17: 398-436.

Bellrose, F.C. 1976. *Ducks, geese and swans of North America*. Stackpole Books, Harrisburg, Pa. 540 p.

Brown, M.R. and G.R. Parsons. 1979. *Waterfowl production on beaver flowages in a part of northern New York*. N.Y. Fish and Game Journal 26: 142-153.

Canada - Ontario Forest Resource Development Agreement. 1984.

Collins J.M. 1974. *The relative abundance of ducks breeding in southern Ontario in 1951 and 1971*. p. 33-39. **In**: H. Boyd (ed.) *Canadian Wildlife Service waterfowl studies in eastern Canada 1967-73*. Can. Wildl. Serv. Rept. Series No. 29, Dept. of the Environment, Ottawa. 106 p.

Conner, R.N. and C.S. Adkisson. 1977. *Principal component analysis of woodpecker nesting habitat*. Wilson Bull. 89: 122-129.

Conner, R.N., O.K. Miller and C.S. Adkisson. 1976. *Woodpecker dependence on trees infected by fungal heart rots*. Wilson Bull. 88: 575-581.

Conner, R.N., R.G. Hooper, H.S. Crawford, and H.S. Mosby. 1975. *Woodpecker nesting habitat in cut and uncut woodlands in Virginia*. J. Wildl. Mange. 39: 144-150.

Cowardin, L.M., V. Carter, F.C. Goblet, and E.T. LaRoe. 1979. *Classification of wetlands and deepwater habitats of the United States*. U.S. Fish and Wildl. Serv. U.S. Dept. of the Interior, Washington. 103 p.

Dennis, D.G. 1974. *Waterfowl observations during the nesting season in precambrian and clay belt areas of north-central Ontario*. p. 53-56 **In**: H. Boyd (ed.) *Canadian Wildlife Service waterfowl studies in eastern Canada 1967-73*. Can. Wildl. Serv. Rept. Series No. 29. Dept. of the Environment, Ottawa. 106 p.

Dzubin, A. 1969. *Comments on carrying capacity of small ponds for ducks and possible effects of density on mallard production*, p. 138-160. **In**: *Saskatoon Wetlands Seminar*. Can. Wildl. Serv. Rept. Ser. 6. Dept. of Indian Affairs and Northern Development, Ottawa. 262 p.

Erskine, A.J. 1971. *Buffleheads*. Can. Wildl. Serv. Monograph Series No. 4, Dept. of the Environment, Ottawa. 241 p.

Erskine, A.J. 1972. *Populations, movements, and seasonal distribution of mergansers in northern Cape Breton Island*. Can. Wildl. Serv. Rept. Series No. 17. Dept. of the Environment, Ottawa. 36 p.

Gilmer, D.S., I.J. Ball, L.J. Cowardin, J.E. Mathisen, and J.H. Reichman. *Natural cavities used by wood ducks in north-central Minnesota*. J. Wildl. Manage. 42: 288-298.

Golet, F.C. and J.S. Larson. 1974. *Classification of freshwater wetlands in the glaciated northeast*. Resource Publication No. 116. Bureau of Sport Fisheries and Wildlife. U.S. Dept. of the Interior, Washington, D.C. 56 p.

Haupt, H.F. 1960. *Variation of aerial disturbance produced by harvesting methods in ponderosa pine*. J. Forestry 58: 634-639.

Johnsgard, P.A. 1978. *Ducks, geese, and swans of the world*. University of Nebraska Press, Lincoln. 404 p.

Krapu, G.L. 1974. *Feeding ecology of pintail hens during reproduction*. Auk 91: 278-290.

Krull, J.N. 1970. *Aquatic plant-macroinvertebrates associations and waterfowl*. J. Wildl. Manage. 34: 707-718.

LaCaillade, H.C. 1975. *Waterfowl and their management in New Hampshire*. Survey Rept. No. 11. New Hampshire Fish and Game Dept. 126 p.

OMNR. 1982. *Economic impact of wildlife expenditures in Ontario: a summary report*. Wildlife Branch, Ontario Ministry of Natural Resources and Econometric Research Ltd.

OMNR. 1984. *Guidelines for deer habitat management in Ontario*. Wildl. Branch, Ontario Ministry of Natural Resources. Draft Memo. 24 p.

OMNR-CWS. 1984. *An evaluation system for wetlands of Ontario south of the precambrian shield*. 2nd ed. Ontario Ministry of Natural Resources and Canadian Wildlife Service. Toronto, Ontario. 169 p.

Packer, P.E. 1967. *Forest treatment effects on water quality*. p. 687-699 **In**: W.E. Sopper and H.W. Lull (eds.). *Forest Hydrology*. Pergamon Press.

Patterson, J.H. 1976. *The role of environmental heterogeneity in the regulation of duck populations*. J. Wildl. Mange. 40: 22-32.

Poston, H.J. 1969. *Relationship between the shoveller and its breeding habitat at Strathmore, Alberta*. p. 132-137.

Reinecke, K.R. and R.B. Owen. 1980. *Food use and nutrition of black ducks nesting in Maine*. J. Wildl. Manage. 44: 549-558.

Ringelman, J.K. and J.R. Longcore. 1982. *Movements and wetland selection by brood-rearing black ducks*. J. Wildl. Manage. 46: 615-621.

Sugden, L.G. 1973. *Feeding ecology of pintail, gadwall, American widgeon and lesser scaup ducklings in Alberta*. Can. Wildl. Serv. Rept. Ser. No. 24. Dept. of Environment, Ottawa. 43 p.

Stearns, F. 1978. *Management potential: summary and recommendations*. p. 357-363 **In**: R.E. Good, D.F. Wingham and R.L. Simpson (eds.). *Freshwater wetlands: ecological processes and management potentia*l. Academic Press, New York. 378 p.

J.W. Thomas (ed.). 1979. *Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington*. Agriculture Handbook No. 553. U.S. Dept. of Agriculture Forest Service, Washington, D.C. 512 p.

Thomas, J.W., C. Mawer and J.E. Rodiek, 1979a. *Riparian zones*. P. 40-47 **In**: J.W. Thomas (ed.). *Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington*. Agriculture handbook No. 553. U.S. Dept. of Agriculture Forest Service, Washington, D.C. 512 p.

Thomas, J.W., C. Mawer and J.E. Rodiek. 1979b. *Edges*. p. 48-59 **In**: J.W. Thomas (ed.). *Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington*. Agriculture Handbook No. 553 U.S. Dept. of Agriculture Forest Service, Washington, D.C. 512 p.

Thomas, J.W., H. Black Jr., R.J. Scherzinger and R.J. Pederson. 1979c. *Deer and elk*. p. 104-127 **In**: J.W. Thomas (ed.). *Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington*. Agriculture Handbook No. 553. U.S. Dept. of Agriculture Forest Service, Washington, D.C. 512 p.

Trimble, G.R. and R.S. Sartz. 1957. *How far from a stream should a logging road be located*. J. Forestry 55: 339-341.

Voigts, D.K. 1976. *Aquatic invertebrate abundance in relation to changing marsh vegetation*. Am. Midl. Nat. 95: 313-322.

Weller, M.W. 1978. *Management of freshwater marshes for wildlife*. p. 267-284 **In**: R.E. Good, D.F. Wingham and R.L. Simpson (eds.). *Freshwater wetlands: ecological processes and management potential*. Academic Press, New York. 378 p.

Appendix I Waterfowl Species Nesting in Forested Areas of Ontario

Canada Goose ....*Branta canadensis*

Mallard...*Anas platyrynchos*

Black Duck..*Anas rubripes*

Pintail ....*Anas acuta*

Green-winged Teal ....*Anas crecca*

Blue-winged Teal..*Anas discors*

Northern Shoveller ....*Anas clypeata*

American Widgeon ....*Anas americana*

Gadwall...*Anas strepera*

Wood Duck...*Aix sponsa*

Lesser Scaup ....*Aythya affinis*

Ring-necked Duck ....*Aythya collaris*

Bufflehead ....*Bucephala albeola*

Common Goldeneye ....*Bucephala clangula*

Hooded Merganser ....*Lophodytes cucullatus*

Red-breasted Merganser ....*Mergus serrator*

Common Merganser ....*Mergus merganser*

Appendix II Natural Cavities Used by Wood Ducks in North-Central Minnesota[1]

David S. Gilmer, Department of Ecology and Behavioural Biology, University of Minnesota, St. Paul 55108[2]

I.J. Ball, Department of Entomology, Fisheries and Wildlife, University of Minnesota, St. Paul 55108[3]

Lewis M. Cowardin, U.S. Fish and Wildlife Service. Northern Prairie Wildlife Research Center, Jamestown, North Dakota 58401

John E. Mathisen, U.S. Forest Service, Chippewa National Forest, Cass Lake, Minnesota 56633

John H. Riechmann, Department of Ecology and Behavioral Biology, University of Minnesota, St. Paul 55108[4]

Abstract

Radio telemetry was used to locate thirty-one (31) wood duck (*Aix sponsa*) nest cavity sites in sixteen (16) forest stands. Stands were of two (2) types: (1) mature ($\bar{x}$ = 107 years) northern hardwoods (ten [10] nest sites), and (2) mature ($\bar{X}$ = 68 years) quaking aspen (*Populus tremuloides*) (twenty-one [21] nest sites). Aspen was the most important cavity-producing tree used by wood ducks and accounted for fifty-seven percent (57%) of twenty-eight (28) cavities inspected. In stands used by wood ducks, the average density of suitable cavities was about four (4) per hectare. Trees containing nests were closer to water areas ($P < 0.05$) and the nearest forest canopy openings ($P < 0.01$) than was a random sample of trees from the same stands. A significant (< 0.005) relationship existed between the orientation of the cavity entrance and the nearest canopy opening. Potential wood duck cavities usually were clustered within a stand rather than randomly distributed. Selection of trees by woodpeckers for nest hole construction probably influenced the availability of cavities used by wood ducks. A plan for managing forests to benefit wood ducks and other wildlife dependent on old-growth timer is discussed.

J. Wildf. Manage. 42(2):288-298

---

[1] This research was supported by the U.S. Fish and Wildlife Service, University of Minnesota, National Institute of Health Training Grant T01-GM-01779, and the U.S. Energy Research and Development Administration (C00-1332-126).
[2] Present address: U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, Jamestown, North Dakota 58401
[3] Present address: Department of Zoology, Washington State University, Pullman 99163
[4] Present address: R.R. #1, Valmeyer, Illinois 62295

McCabe (1966) and Aultfather (1966) pointed out the lack of information needed to guide foresters in multiple-use programs beneficial to wood ducks. There is little information on the use of natural cavities by wood ducks, particularly in the northern forested regions of the Lake States. Increases in wood duck populations in certain areas have been attributed to nest boxes (Bellrose et al. 1964, Grice and Rogers 1965), but, in some forested areas, large scale nest box programs may not be practical. Furthermore, timber resources that can provide a sustained source of cavity sites may be available.

The primary objectives of this paper are to describe: (1) the home range of wood duck hens in relation to the nest site, (2) features of the habitat used by the nesting pair and characteristics of the forest stands containing cavity trees, (3) characteristics of the cavity tree and its immediate surroundings, and (4) guidelines for foresters managing northern forests to consider in formulating multiple use programs that would benefit wood ducks and other cavity-dwelling wildlife-species.

We thank H.A. Doty for critically reviewing the manuscript and W.A. Aultfather and G.W. Gullion for providing suggestions in manuscript preparation. E. Johnson provided assistance in photo interpretation and in the description of forest site conditions. T.S. Klodfelter and R. S. Stott assisted with data collection. We were assisted in statistical analyses by D.H. Johnson and in computer processing by D.A. Davenport. Telemetry equipment was constructed and maintained by the engineering staff, Cedar Creek Bioelectronics Lab, University of Minnesota.

J. Wildf. Manage. 42(2):1978

Study Area

The eighty-eight km square (88-km^2) area was in the northwest portion of the Chippewa National Forest, Beltrami County, about nineteen (19) km east of Bemidji, Minnesota. Approximately fifty percent (50%) of the lands within the National Forest boundary are under Federal control and management. Surface waters in the form of lakes, streams, and various wetland types make up about fifty percent (50%) of the area managed by the Forest Service (Mathisen 1966, unpublished data U.S. Forest Service, Cass Lake, Minnesota). Mean density of nonpermanent wetlands (Cowardin and Johnson 1973) was nine point eight square km (9.8 km^2) (Gilmer et al. 1975). Composition of forest lands under Federal control are: hardwood forests (sixty-five percent [65%]), coniferous forests (thirty-three percent [33%]), brush and open areas (two percent [2%]).

Based on a 1974 inventory (unpublished U.S. Forest Service report, Cass Lake, Minnesota) aspen (mostly quaking aspen) was the most important timber type and accounted for thirty-eight percent (38%) of the forest land area. Northern hardwoods including sugar maple (*Acer saccharum*), American basswood (*Tilia americana*) and American elm (*Ulmus americana*) covered eleven percent (11%) of the area. The remainder of the forest lands consisted of coniferous stands (thirty-three percent [33%]) and other hardwoods (eighteen percent [18%]). A detailed description of the pattern of lakes, wetlands, and forests found in the study area was given by Gilmer (1971). Primary industries in the area are pulpwood logging and summer resorts.

Methods

During the breeding seasons of 1968-71, wood duck hens were captured by various techniques and marked with radios (Ball 1971, 1973, Gilmer 1971). Tracking instrumented hens to their nesting cavities enabled us to obtain a sample of thirty-one (31) nesting sites that was unbiased by search techniques. During the tracking period, locations of each hen were determined approximately twice (2) a day. When a cavity tree was found, its exact position was recorded. During subsequent visits, the tree was climbed and the cavity inspected. For each tree and cavity we measured d.b.h. (diameter at breast height), tree and cavity height, cavity type, orientation of opening and tree age. At three (3) sites (ten percent [10%]), only the approximate location of the cavity tree could be determined. A professional forester inspected most sites to appraise site index (the height of a tree at or projected to a specified age) and crown closure. Stands containing each cavity tree were defined on vertical colour and colour infrared aerial photography (enlarged scale = 1:7,920) taken in the spring of 1971. Locations of water areas and other canopy openings nearest the nest site also were determined from photography. Openings in the forest canopy were defined as roadways and trails, or other clearings that were at least point one (0.1) ha in size. Tree ages were determined from increment borings.

Sample trees were chosen within four (4) stands containing thirteen (13) wood duck cavity trees by establishing random points in each stand marked on aerial photographs. These points were located on the ground and a plot with a twenty (20) m radius (0.126 ha) was established about each one. We recorded species, d.b.h., and the number and type of potential wood duck cavities contained for all trees greater than twenty-eight (28) cm d.b.h. within the plots. A potential cavity was defined as one with an entrance approximately ten (10) cm or larger in diameter. These same measurements were recorded for a total of eleven (11) plots centered about wood duck cavity trees in four (4) stands. If a tree contained two (2) or more cavities, each cavity was tallied.

Statistical analyses for any measurements (e.g., basal area, trees/ha, cavities/tree, distance to nearest water and canopy opening) were based on the null hypothesis that random plot and cavity plot measurements within a stand are from the same distribution. Under H_o , if we also assume normality,

$$\bar{X}_c - \bar{X}_r \sim N[0, (\frac{1}{m} + \frac{1}{n})\sigma^2]$$

where $\bar{X}_c$ = the mean measurements for plots centered on nest tree, m = the number of measurements for plots centered on nest trees, $\bar{X}_c$ = the mean measurements for plots centered on random points, n = the number of measurements for plots centered on random points, and σ^2 = true variance of the distribution for measurements from plots centered on random points.

The sample variance of the random plots is distributed proportional to a chi-square; i.e.,

$$(n-1)s^2 \sim \sigma^2\chi^2_{n-1}$$

and $\bar{X}_c - \bar{X}_r$ and s^2 are independent.

Thus, $(\bar{X}_c - \bar{X}_r)\left(\frac{n+m}{nm}\right)^{-1/2} \sim N(0, \sigma^2)$

and $Z = (\bar{X}_c - \bar{X}_r)\left[S\left(\frac{n+m}{nm}\right)^{1/2}\right]^{-1} \sim t_{n-1}$

because Z is the ratio of a normal, variate and the root of an independent chi-square variate, divided by its degrees of freedom (e.g., Wilks 1962:184). Let $P = \Pr\ (Z \geq \sim t_{n-1})$ be the significance level of the obtained t. For a series of K stands, let P_i be the obtained significance level of the i^{th} stand. Then let

$$P_{total} = -2\sum_{i=1}^{k} \ln P_i$$

and $P_{total} \sim \chi^2_{2k}$ (Kendall and Stuart 1966:40), which can be used in a test combining all stands. Statistical analysis of the orientation of cavity entrances was accomplished according to Batschelet's (1972:65) modified Rayleigh Test (V Test).

Results

Home Range of Wood Duck Hens

To obtain a better understanding of the relationship between the cavity site and the home range of breeding wood ducks, we examined the movement patterns of thirty-one (31) radio-marked hens, ten (10) of which were instrumented one to thirty-three (1-33) days prior to nest initiation and provided movement data during the pre-nest period. Distribution of distances from nesting cavities when hens were not at the nest were similar for prenesting and nesting periods; therefore, these periods were combined (Fig. 1). Roughly fifty percent (50%) locations were within a half (0.5) km of the nest and seventy percent (70%) were within one (1.0) km.

Habitat Features Around the Cavity Site

We examined habitat within a half (0.5) km radius (seventy-eight [78] ha) of each of thirty-one (31) nest cavities. Permanent water (Cowardin and Johnson 1973) that served as brood-rearing areas (Ball 1971) was present within a half (0.5) km of twenty-one (21) nests (sixty-eight percent [68%]) but exceeded one (1.0) km for eight (8) nests (twenty-six percent [26%]); within a half (0.5) km radius of the nest cavity nonpermanent water areas ranged from three to forty-seven (3-47) discrete wetlands per km^2. The percentage of the area in forest or other upland cover varied from thirty-eight and a half to ninety-nine point seven (38.5-99.7). The balance of the area was composed of permanent and nonpermanent water.

Forest stands used by nesting wood ducks were of two (2) upland types, unmanaged mature northern hardwood forests (three [3] stands) and mature aspen (thirteen [13] stands). The northern hardwood stands accounted for approximately one third (1/3) (ten [10] nest sites) of the wood duck cavities used by marked hens. The estimated ages of those stands ranged from 100 to 120 years although some trees may have been much older.

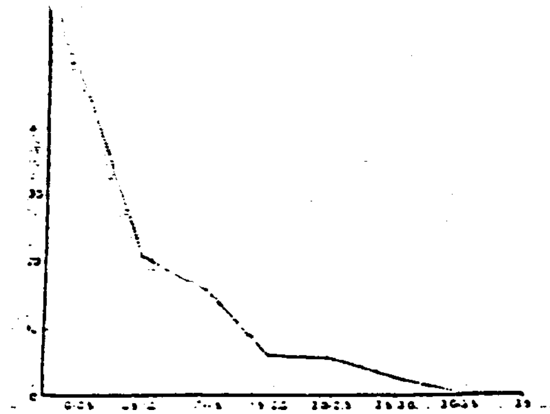


Figure 1 Distribution of locations determined during the prenesting, laying, and incubating periods

Distribution of locations determined during the prenesting, laying, and incubating periods for thirty-one (31) radio-equipped wood duck hens as distances from their nests. Distance was determined for each location beyond a fifty (50) m radius of the cavity site.

Estimated crown closures ranged from fifty to eighty percent (50-80%) ($\bar{x}$ = 63%). Stand size ranged to two to four (2-4) ha ($\bar{x}$ = 25 ha).

About two thirds (2/3) (twenty-one [21] nest sites) of the wood duck cavities were found in stands of mature aspen (sixty to more than seventy-five [60-75+] years old) which usually overtopped surrounding northern hardwoods (fifty to sixty [50-60] years old). We examined thirteen (13) aspen stands and estimated crown closures to range from twenty to seventy percent (20-70%) ($\bar{x}$ = 48%). Stand sizes varied from one to fifty-four (1-54) ha ($\bar{x}$ = 19 ha). One third of the aspen stands were less than eight (8) ha and were situated in inaccessible locations that could not be logged efficiently. In such situations small stands of aspen had been disregarded and allowed to grow well beyond their normal rotation age (forty-five [45] years). Many of these trees had contained cavities for more than five (5) years and could be expected to provide a source of cavities for another ten (10) or more years. The crowns of some aspen had broken off leaving a dead stub but continued to serve as useful cavity sites. Other stands had been logged within the past twenty (20) years, but unmerchantable aspen was left standing and supplied the cavities used by the instrumented wood ducks.

Relatively fertile glacial soils and adequate moisture conditions enabled trees to attain sizes required for cavity development. Based on our examination of four (4) stands, we determined that large diameter trees (d.b.h. > 51 cm) produced potential wood duck cavities at a rate of point forty-nine (0.49) cavities per tree, nearly five (5) times the rate (point one [0.10]) observed in smaller trees (twenty-eight to fifty-one [28-51] cm).

Table 1: Relationship between tree species and cavities found in mature northern hardwood and aspen stands used as nesting sites by wood ducks.

	No. Trees in Sample	% Trees with Cavities	No. Cavities Observed	Cavity Trees per ha
Northern hardwood: [a]				
Sugar Maple	91	37.4	43	7.1
American basswood	133	15.0	32	4.2
American elm	11	63.6	11	1.5
Red and white oak [b]	152	0.3	4	0.8
Others [c]	85	9.4	8	1.7
Total	472	20.8	98	15.3
Aspen: [d]				
Quaking aspen	53	20.7	15	11.0
Other [e]	28	0.0	0	0
Total	81	18.5	15	11.0

[a] Sample included thirty-seven (37) plots (twenty-nine (29) random and eight [8] cavities) in three (3) stands
[b] (*Quercus rubra* and *Q alba*)
[c] Quaking aspen, paper birch (*Betula papyrifera*), and ash (*Fraxinus* spp)
[d] Sample included eight (8) plots (five [5] random and three [3] cavities) in one (1) stand
[e] Jack oak (*Quercus ellipsoidalis*), white pine (Pinus strobus), red pine (*Pinus resinosa*), paper birch and ash

Table 2: Characteristics of trees and cavities used as nest sites by wood ducks, 1968-71.

		Average Tree Characteristics					
Species	No. of nests	Minimum age (years)	d.b.h. (cm)	Tree height (m)	Cavity height* (m)	Cavity depth** (cm)	Trees dead (%)
Quaking aspen	16	68	47	21	9	55	12
American elm	6	112	42	19	9	67	17
Sugar maple	5	102	50	22	9	94	0
American basswood	1		58	15	11	158	100

*In trees with more than one (1) possible cavity entrance, the lowest entrance was used.
**Cavity depth measurements were obtained for nests in eleven (11) aspen, three (3) elm, two (2) maple and one (1) basswood.

In the northern hardwood stands sugar maple produced the greatest number of cavity trees (seven point one [7.1]) per ha (Table 1). The combined density for all northern hardwood species was fifteen point three (15.3) cavity trees per ha. Mature aspen stands produced eleven (11.0) cavity trees per ha. Average cavity density in stands used by nesting wood ducks was fourteen (14) cavity trees per ha or approximately twenty (20) cavities per ha (some trees had two (2) or more cavities). We believe that the stands selected by nesting wood ducks represented some of the best nesting habitat (highest cavity densities) present in the study area.

About 680 ha (seven point seven percent [7.7%]) of the study area were covered by forest stands that were of the type and size class that could produce potential wood duck nest cavities. Wood ducks were not found nesting in stands of coniferous species and in hardwood forests other than northern hardwood. After inspecting fifty-two (52) cavities with entrances large enough for wood duck use in Iowa, Dreis and Hendrickson (1952) reported that twenty-one percent (21%) were suitable nest sites. Based on this criterion, a conservative estimate of the density of usable cavities in stands that we examined would be approximately four (4) cavities per hectare.

Table 3: Forest characteristics within a twenty (20) metre radius of eleven (11) wood duck cavity sites and thirty-four (34) random sites located in four (4) different stands.

	Basal Area (m^2 ha)		Trees/ha (>28 cm d.b.h.)		Cavities/Trees	
	Cavity Sites	Random Sites	Cavity Sites	Random Sites	Cavity Sites	Random Sites
Mean	14.2	12.5	96	99	0.3	0.1
Maximum	20.1	24.8	127	175	0.7	0.8
Minimum	5.9	2.3	40	32	0.1	0.0

Characteristics of Cavity Sites

Quaking aspen contained fifty-seven percent (57%) of the twenty-eight (28) nest cavities that were occupied by instrumented hens (Table 2). According to site index (SI) curves based on the height (in feet) of the tree at or projected to fifty (50) years (Brinkman and Roe 1975:14), cavity bearing aspen were found on fair to excellent sites (SI > 65). These trees were approximately seventy (70) years old and probably sprouted following the fires that occurred after large scale cutting of pine stands near the turn of the century (Shirley 1936). In decreasing order of importance, American elm, sugar maple, and basswood accounted for the balance (forty-three percent [43%]) of nest sites.

No trees with a d.b.h. of less than twenty-eight (28) cm contained a cavity used by instrumented wood ducks. The shortest tree containing a cavity was a fourteen (14) m aspen stub. Cavity entrances were not less than four (4) m above the ground and fifty-four percent (54%) of the holes were at least nine (9) m above ground. The deepest cavity that we checked contained a successful nest 158 cm below the entrance. All types of cavity entrances were used: bucket type

-- top entrance (thirty-one percent [31%]), side entrance (fifty-eight percent [58%]), and combination (eleven percent [11%]).

Distances from nesting cavities to nearest water ranged from zero (0) to 350 m ($\bar{x}$ =eighty [80]m), whereas distances to the nearest canopy opening (other than water) varied from zero (0) to 200 m ($\bar{x}$ =thirty-five [35]m). To test the hypothesis that cavity sites were randomly situated within stands relative to the nearest water and to other canopy openings, we compared distances obtained for cavity trees to measurements obtained for trees (cavity and non-cavity) in randomly selected plots. Four (4) different stands that included thirty-four (34) random plots and thirteen (13) wood duck cavity trees were examined in this manner. Results of the tests suggested that cavities selected by wood ducks were closer to water ($P<0.05$) and the nearest canopy openings ($P<0.01$) than were random trees.

Orientation of the cavity entrance used by wood ducks in relation to nearby openings in the forest canopy was examined. In this analysis we excluded twelve (12) cavity sites including those with top entrances (six [6]), side entrances surrounded by a clearing (two [2]), or when the entrance was not confirmed in a tree with several possible entrances (four [4]). The difference in degrees of bearing between the direction of the cavity entrance and the direction to the nearest forest canopy opening was determined for sixteen (16) nests. We detected a significant ($P<0.005$) relationship between the orientation of the cavity entrance and the nearest forest opening. Nearest openings were within ninety degrees (90^{o}) (right or left) of the cavity entrance in all but two (2) nests (Fig. 2). One of these was adjacent to a small pond (nearest opening) with the cavity entrance oriented 145 degrees from the pond but directly facing a logging trail approximately thirty (30) m away. The other cavity was situated in an elm that was taller than the surrounding canopy and was the highest cavity (fifteen [15] m) observed in the study. We detected no tendency for cavities used by wood ducks to face any particular compass direction ($P>0.10$).

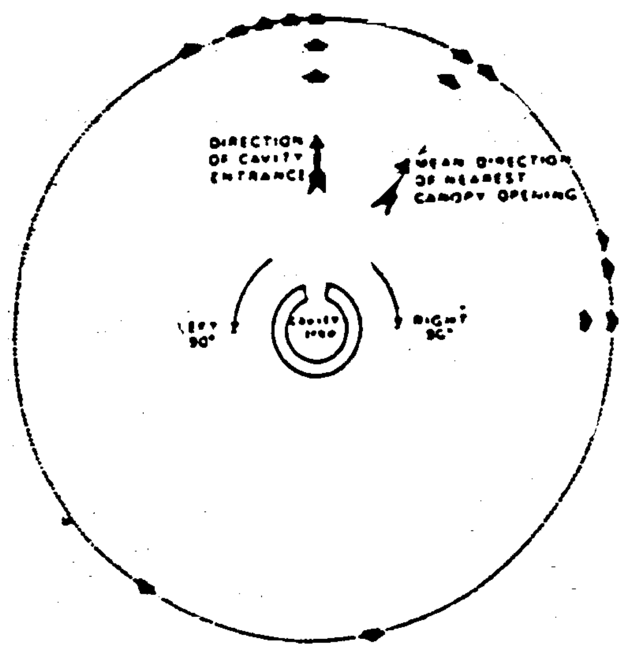


Figure 2 Direction of the nearest forest canopy opening relative to the entrances of 16 wood duck cavities.

When plots centered at known nest-cavity trees were compared to random plots within the same stand, no significant differences in either basal area or trees per ha were detected (P>0.10, Table 3). However, nest cavity plots contained significantly more cavities per tree (even though the cavity used by the radio-marked bird was excluded) than did random plots ($\bar{x}$ =0.3 vs. $\bar{x}$ = 0.1,P<0.01). Thus, potential cavity sites tended to be clumped within stands and nests occurred in the high cavity density portions of stands.

Table 4: Densities of natural cavities in timber stands used by wood ducks.

Location	Cavities Per Ha		Habitat Type	Reference
	Total Observed	Suitable for use by wood ducks		
New Brunswick	11.5	5.5	river flood plains [a]	Prince (1968)
Minnesota	21	4.2 [b]	mature northern hardwoods	This study
New York		3.9	elm-ash-maple [c]	Haramis (1975)
Minnesota		1.0	Northern hardwoods	Nage (1969)
Illinois		0.5	black oak woodlots [d]	Bellrose et al. (1964)
Missouri	5.4	0.3	elm-ash-maple [e]	Weier (1966)
Mississippi		0.6	bottomland [e]	Strange et al. (1971)
Iowa	0.5	0.1	bottomland	Dries and Hendrickson (1952)

[a] Virgin stand of silver maple (Acer saccharinum) and American elm.
[b] Conservatively estimated as twenty percent (20%) of total cavities observed.
[c] American elm, red ash (Frazimus pennysylvanica) red maple (Acer rubrum)
[d] Quercus Volutina
[e] Predominately willow (Salix nigra)

Discussion

Mot hen activity was within a one (1.0) km radius of the nest, suggesting that a land unit of about three (3.0) km^2 may be representative of the area used by pairs in the study area. Similarity between the distances travelled from the nest site by hens both before and after nest initiation suggested that wood duck pairs established home ranges in the vicinity of the nest site before the nest was initiated. Homing instincts and desirable features of the habitat (i.e., mature timber, suitable wetlands) may have encouraged pairs to remain in specific locations even though a nest was not initiated until late in the season.

In addition to finding a nest cavity, wood ducks must have wetlands suitable for breeding pairs and brood rearing if they are to breed successfully. Spatial relationships between these three (3) habitat components are of considerable management importance. The amount of wetland habitat within a half (0.5) km radius of each nest varied considerably. Some nests occurred where wetland densities were as low as three (3.0) ponds/km^2, comprising less than point three percent (0.3%) of the landscape. These conditions are close to the lowest wetland densities in the study area, though it is not clear whether wood ducks nested there out of preference, or because sites with good water distribution and adequate nearby nesting cavities were lacking.

Wood duck hens led their broods overland for up to three point nine (3.9) km to brood rearing areas (Ball 1973). Because duckling mortality may be directly related to amount of overland travel (Ball et al. 1975), we concur with Grice and Rogers (1965:18) and McGilvery (1968:8) that pairs should be encouraged to nest within point eight (0.8) km of brood water. The fact that a number of hens nested each year in stands which seemed to lack quality pair and brood habitat may indicate that the distribution of nesting cavities was less than optimal.

Wood duck nest cavities usually were oriented toward the nearest clearing or water area. However, we do not know whether most available cavities had this orientation, or if wood ducks actually selected for these holes (or discovered them more readily). Woodpecker site preferences may be an important factor in the location and orientation of potential cavities. In British Columbia, Erskine (1971:64,65) noted that the height of cavities selected by buffleheads (Bucephala albeola) and the orientation of the entrance were more the result of the requirements of common flickers (Colaptes auratus) which produced the cavity than the duck.

Northern forests have received increased attention as wood duck habitat in recent years. The cavity-producing potential of these forests was demonstrated by Prince's (1968) study of timber along the St. John river in New Brunswick, Nagel's (1969) survey of natural tree cavities in upland hardwood stands on Tamarack NWR in west-central Minnesota, and a study of green-timber impoundments at Montezuma NWR in New York (Haramis 1975). Forests in more southerly regions have produced relatively low cavity densities (Table 4).

Generally, aspen has been disregarded as a cavity producing species because it is short-lived and does not grow to large size except under very favourable conditions (Hansen 1966:66). The life expectancy of aspen is short compared to that of many other species. Nevertheless, a tree containing a suitable wood duck cavity at age sixty (60) would probably remain suitable for at least ten (10) years; this may exceed the life expectancy of a wood duck box (except plastic and metal structures). Decay in aspen in northern regions sets in at a later age than in those trees growing at the southern limit of its range. According to Graham et al. (1963:147) "pathological rotation age" (age beyond which trees will have no monetary value) for aspen in northern Ontario is eighty (80) years. Poplar (Populus spp.) were the major cavity site for buffleheads breeding in British Columbia but few cavities in these trees lasted more than ten (10) years (Erskin 1971:69).

In spite of the relatively short cavity-producing life of aspen, this species has tremendous potential as a source of nest sites for wood ducks and other cavity-dwelling wildlife in the northern regions of the Lake States. Wood duck production estimates in northcentral Minnesota indicated an upward trend beginning in the mid-1950’s (unpublished reports, U.S. Fish and Wildlife Service, Minneapolis). This apparent population increase occurred at the time large areas of aspen were beginning to reach maturity, having sprouted after the logging era of the 1900’s (Shirley 1936). These trees potentially were capable of producing many cavities and may have contributed to the wood duck population increase (Gilmer 1971).

Northern hardwood species have the potential for producing high cavity densities but the time required to develop suitable wood duck cavities in this timber type may be on the order of 100 years vs. about fifty (50) for aspen.

Management Implications

To optimize the commercial utilization of timber, stands usually are harvested at an age preceding the onset of decay. Under that system of management, the old-growth element in the forest generally is lacking, and wildlife species requiring cavities for nesting and protection are absent or scarce. In forested areas (private as well as publicly owned) where cavity nesting wildlife is considered an important product of the forest, silvicultual prescriptions must accommodate those species associated with the old-growth condition.

Through careful planning and coordination, old-growth aspen and other timber types can be perpetuated to insure a supply of cavities for wood ducks and other wildlife. A management program may be developed using the following guidelines.

(1) Identify and map all aspen and northern hardwood stands within point eight (0.8) km of water areas containing emergent vegetation judged to be suitable for wood duck brood cover (see McGilvrey 1968:9, Ball 1973:31). Aspen stands situated on sites capable of optimum growth (i.e., site index >70) have the greatest potential for producing tree sizes suitable for wood duck use.

(2) Within the areas outlined in (1), draw a border 100 m wide around all water areas, roads, and logging trails, and other openings in the forest canopy having a minimum size of about one (1.0) ha. The stands within this area represent prime wood duck habitat and should be considered for old-growth timber management.

(3) Stands designated in (2) are divided into blocks for appropriate management. These blocks should be as small as possible, preferably less than four (4.0) ha. In blocks containing aspen, regeneration timber harvests should be scheduled to occur after economic rotation age (forty-five [45] years) but before decay renders the stand uneconomical for minimum commercial utilization (i.e., old-growth rotation age is about eighty [80]+ years). Harvest cycles will vary by site and age-class distribution of existing stands. Selected cavity trees and stubs should be left standing, provided they do not interfere with stand regeneration. For northern hardwood, old growth rotation exceeds 150 years and regeneration will occur in an unmanaged stand. In

northern hardwood types, silvicultural prescriptions should favour uneven-aged management to insure a continuous component of older age-class trees.

(4) If openings are not present in large, otherwise suitable areas they can be created and maintained as management procedure (Mathisen 1972). Impoundments created by beaver (Castor canadensis) may increase the utilization of certain timber habitat by wood ducks (Cringan 1971, Kirby 1973) but beaver also may destroy aspen potentially valuable for wood duck use. Increasing beaver populations therefore should be considered carefully as a wood duck management tool. Man-made impoundments may serve as suitable alternatives for improving the distribution of wetlands.

(5) Assessment of the effectiveness of the management plan can be accomplished by inspection to determine cavity densities. Randomly selected cavity trees can be inspected periodically to determine wood duck utilization.

Several authors (Bellrose et al. 1964, Grice and Rogers 1965, Doty and Kruse 1972) have demonstrated the value of nest boxes for establishing and maintaining populations of wood ducks. The relative merits of creating artificial nesting cavities for wood ducks and other wildlife usually is judged on the basis of both cost effectiveness and aesthetics. On the Chippewa National Forest, construction costs were approximately $10.00 per box (based on construction of 5,000 boxes) and maintenance checks ran about $2.50 per box per year. In areas where natural cavities are sparse or absent, placement of artificial sites may be the only alternative to establishing or increasing a population of cavity nesters. Nesting boxes provide “instant” nest sites, but decades may pass before a stand of timber reaches the cavity-producing age. The average life expectancy of a box was estimated at about ten (10) years.

Retaining old-growth timber for the purpose of producing cavities is ecologically sound; however, there are additional factors that must be considered. The timber volume lost from reserving these stands could be substantial, and in the intolerant types, such as aspen, silvicultural treatments necessary to perpetuate the stand would require management cost. High nest predation rates in natural cavities may justify the use of nest boxes (Bellrose et al. 1964).