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Waterfowl are a diverse group of birds that have widely divergent requirements for survival and recruitment. Whistling-ducks, geese, and swans (Anserinae) and ducks (Anatinae) have contrasting life history requirements.

Several goose populations have expanded greatly despite extensive continental wetland losses and degradation. Most expanding populations nest in arctic areas where modifications or disturbance of nesting habitats have been minimal. These grazers often find suitable migratory and wintering habitats in terrestrial or agricultural environments. In contrast, ducks are less terrestrial and populations are influenced more by wetland characteristics, such as quality, total area of wetland basins, and size and configuration of these basins. Because many dabbling ducks nest in upland habitats surrounding wetlands, recruitment of waterfowl is closely tied to both terrestrial and wetland communities. Their primary upland and wetland nesting habitats, as well as migratory and wintering habitats, have been severely degraded or lost to agriculture.

Management for waterfowl in North America is complicated further because each of over 40 species has unique requirements that are associated with different wetland types. Likewise, the requirements for a single species are best supplied from a variety of wetland types.

In recent years, the relations between migrating and wintering habitats have been identified for mallards and arctic-nesting geese. These cross-seasonal effects emphasize the importance of habitats at different latitudes and locations. Thus, effective management requires an appreciation of the general patterns of resource requirements in the annual cycle. Recognition of the adaptations of waterfowl to changing wetland systems provides opportunities for managers to meet the diverse needs of waterfowl.

The Annual Cycle

Waterfowl experience events during a year that necessitate energy and other nutritional requirements above the maintenance level (Fig. 1). These additional requirements, associated with processes such as migration, molt, and reproduction, are obtained from a variety of habitats. Other factors that influence wetland use include sex, dominance, pairing status, flocking, and stage in the life cycle. All these processes influence the resources needed as well as access to habitats where required resources are available.

The large body sizes and high mobility of waterfowl allow them to transfer the required nutrients or energy among widely separated wetlands. The general pattern of reproduction in waterfowl is unusually costly for females at the time of egg laying because eggs (and often clutches) are large. The large egg size of waterfowl requires rapid transfer of protein and lipid stores from the female to the developing egg. In the wood duck, daily costs of egg

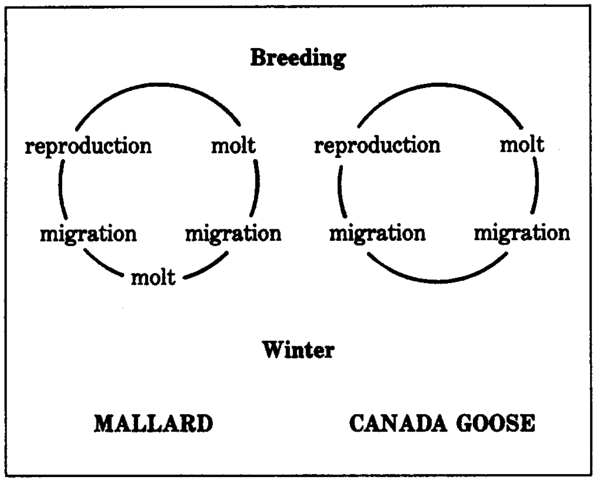


Figure 1. Major annual events in the life cycle of a mallard and a Canada goose.

Table 1. *Estimated energetic costs of some common waterfowl activities in relation to basal metabolic rate (BMR). Values represent averages from the literature.*

Activity	Estimated cost × BMR
Resting	1.3
Alert	1.5
Comfort movements	1.5
Oiling/preening	2.0
Courtship	2.0
Social interactions	3.2
Swimming	3.2
Diving	5.0
Flying	12.0–15.0
Egg laying	
Early follicular growth	16.7
Maximum during egg-laying	20+
Last egg	10.2

production are high and can exceed 210% of the basal metabolic rate (BMR) during peak demand. The daily protein requirements for egg laying are smaller than lipid requirements, but the females must meet these requirements by consuming invertebrates where they may be limiting. Parental investment after the time of hatch is small, however, compared to bird species that must brood and feed their offspring.

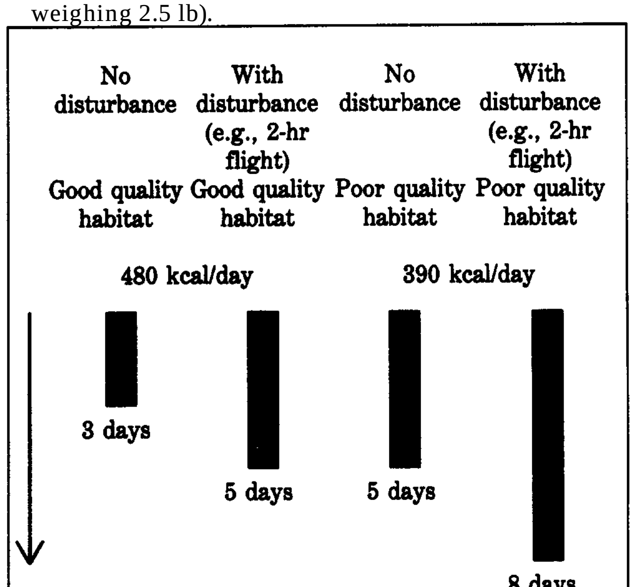
Flight is energetically expensive and is usually estimated at 12–15 × BMR (Table 1). For example, a mallard weighing 2.5 lb would require 3 days of foraging to replenish fat reserves following an 8-hour flight if caloric intake were 480 kcal/day (Fig. 2). However, if food availability were only equivalent to 390 kcal/day, then the mallard would need 5 days to replenish these reserves. If mallards must fly to reach food, the time required to replenish lost reserves is even longer (Fig.2). These time differences indicate the importance of well-managed areas and the need to protect waterfowl from disturbances.

The requirements for molt are poorly known or little studied, but recent information suggests the total cost of winter molt in female mallards is nearly equivalent to the energetic cost of egg laying and incubation. Not only is the loss of feathers involved, but there are thermoregulatory and foraging constraints during molt that are difficult to monitor in the field.

Waterfowl Reproductive Strategies

Each waterfowl species has a unique reproductive strategy. These strategies range from those of arctic-nesting geese, which transport large fat reserves to breeding habitats, to those of common eiders, which acquire all necessary reserves for reproduction on the breeding grounds (Fig. 3). The locations from which arctic-nesting geese acquire the different components for breeding have not been completely identified, but evidence indicates that most, if not all, of the lipid and protein resources are transported from migratory and wintering habi-

Figure 2. Time required to replenish endogenous fat reserves following and 8-hr migratory move (for a duck weighing 2.5 lb).



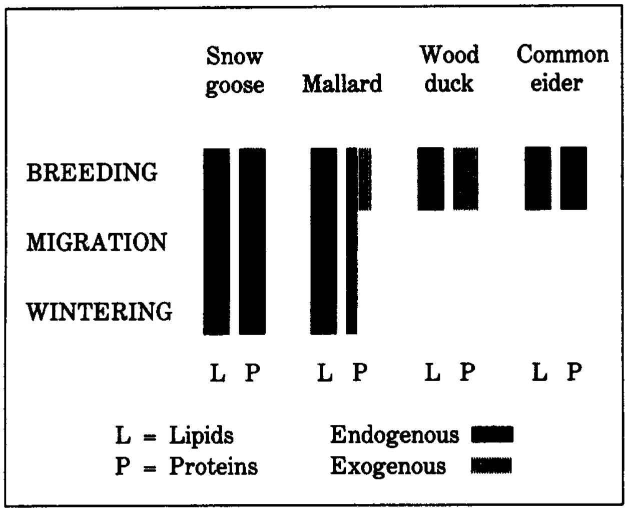


Figure 3. Reproductive strategies of four waterfowl species in relation to time in the annual cycle when the lipids and proteins for breeding are required.

tats as body reserves. Environmental conditions in different seasons and on widely separated habitats may have an important influence on the success of sequential activities in the annual cycle of these arctic-nesting geese.

Mallard breeding strategies are differ from strategies of snow geese. Most of the lipid reserves and as much as half of the protein required for reproduction in mallards are transported to the breeding grounds as body reserves. Wood ducks differ from mallards and geese because they acquire lipid and protein reserves for reproduction primarily from breeding habitats. Lipid reserves are acquired from breeding habitats before laying begins, but protein requirements are obtained solely from daily foraging. Common eiders are like wood ducks in that they acquire reserves for egg laying on the breeding grounds. But, unlike wood ducks, they acquire protein and lipid reserves for breeding and store them as reserves before laying begins.

An understanding of the range of strategies and the timing of these needs enables wetland managers at different latitudes to produce the desired resources in a timely manner.

Relation Among Habitat Variables and Waterfowl Use

Waterfowl managers have long recognized the relation among habitat structure, water depth, and water use by waterfowl. The stage in the annual cycle and the associated behavioral adaptations of waterfowl determine which resources managers must provide.

Table 2. *Water depths and vegetative characteristics at foraging sites of some North American waterfowl.*

Species	Water depth	Vegetative structure
Small Canada geese	dry, mudflat	Short herbaceous
Large Canada geese	dry, mudflat <10 inches	Short herbaceous, rank seed-producing annuals
Northern pintail	<10 inches	Open water with short, sparse vegetation
Mallard	<10 inches	Small openings, tolerate robust vegetation
Ring-necked duck	>10 inches	Scattered, robust emergents
Lesser scaup	>10 inches	Open water, scattered submergents

Appropriate water depths should be available for effective waterfowl management. Shallow water is essential for dabblers because the optimum foraging depth is 2–10 in. (Table 2). Although diving ducks can exploit deeper water, there is little justification to provide deep waters when they can reach food resources in shallow water. Such strategies decrease costs associated with pumping or supplying water for waterfowl.

Waterfowl have various tolerances for the height and density of vegetation. Sea ducks and divers are adapted to large bodies of open water. Mallards, wood ducks, and blue-winged teal readily use habitats with dense vegetation; northern pintails prefer shallow, open habitats where visibility is good and vegetation sparse.

Little information is available on how waterfowl make decisions relating to where they feed and which foods they select. Nevertheless, geese are known for their ability to select forage of high nutritional content. Complex habitat and nutritional requirements, in conjunction with recent losses and degradations of wetland habitats, require managers to consider a wide array of factors when attempting to optimize use by waterfowl (Table 3).

When conflicting factors are apparent, advanced planning is essential to optimize and maintain desired use of habitats. Such conflicts are apparent to managers facing difficult decisions because the site may provide habitats for breeding, migratory, and wintering waterfowl. Determining a

Table 3. *Important considerations to ensure optimum use of wetland complexes by waterfowl.*

1) **Life cycle event**
   - Molt
   - Reproduction
   - Migration
2) **Behavioral activities**
   - Roosting
   - Social behavior
   - Foraging
3) **Habitat structure**
4) **Water depth/regimes**
5) **Food quality/type**
6) **Wetland complex**
7) **Disease**
8) **Habitat degradations**
   - Habitat losses
   - Habitat perturbations
     - Toxicants
     - Turbidity
     - Modified hydrology
     - Modified structure
9) **Disturbance**
   - Hunting
   - Other recreation
     - Fishing
     - Water skiing
     - Bird watching
   - Aircraft—military and commercial
   - Research/management
   - Industrial/commercial

reasonable balance of the resources required to meet seasonal requirements of all populations of waterfowl using a specific refuge undoubtedly is more challenging than determining the species of plants needed to provide food and cover.

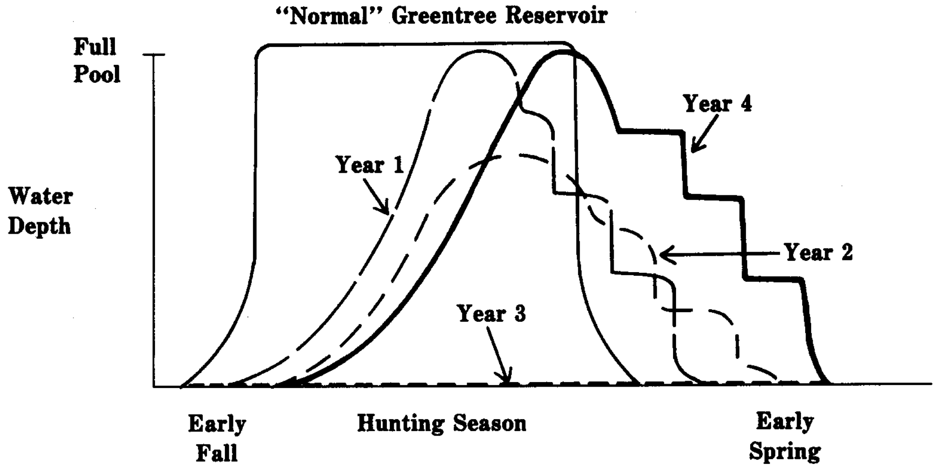
Resource Availability and Exploitation by Waterfowl

By understanding how waterfowl use resources managers are able to attract and hold waterfowl on managed habitats. Monocultures should be avoided, whether natural plant communities (such as large expanses of dense cattail) or agricultural crops. Manipulation of soil and water to produce habitat structure or foods essential as life requisites may be a necessary part of refuge management. Production of these requisites does not assure that waterfowl will use the resources.

Foods are only accessible if (1) appropriate water depths are maintained during critical time periods, (2) habitats are protected from disturbance, and (3) habitats that provide protein and energy are close to one another. Disturbance is particularly damaging, because it affects access to and acquisition of requirements throughout the annual cycle (Table 2, Fig. 2). The subtle effects of bird watchers, researchers, and refuge activities during critical biological events may be as detrimental to waterfowl populations as hunting or other water-related recreational activities (boating, etc.). At certain locations, predators or activities associated with barge traffic, oil exploration, or other industrial or military operations are detrimental.

Identification of the proportions of each wetland type within refuge boundaries, and the potential for management within each wetland type, is essential. Wetlands on private or other public property within 10 miles of the refuge boundary should also be used to estimate resources within the foraging range of most waterfowl. As wetlands are lost on areas surrounding refuges, managers will be able to identify special values or needs for certain habitat types on refuges. For example, producing only row crops on refuge lands in extensive areas of agriculture may be less valuable than supplying natural vegetation and associated invertebrates to complement these high-energy agricultural foods. Furthermore, the presence of toxicants or disease may preclude use of some wetlands.

An important part of management is identification of wetlands that are productive and unmodified. These wetlands should be protected in their natural state rather than changed by development. Where man-made or modified wetlands are managed, manipulations that emulate natural wetland complexes and water regimes provide diverse habitats for a variety of waterbirds. Well-timed, gradual changes in water level are effective approaches that provide good conditions for producing foods and desirable foraging depths for game and nongame birds. In fall, many southern habitats are dry, but having pools full before waterfowl arrive and maintaining pools at capacity until after their departure may reduce access to many resources by waterfowl. By providing changing water depths in greentree reservoirs or elsewhere, managers can enhance cost-effectiveness by assuring that resources produced are also used effectively. For example, a management scenario for modifying the time and pattern of fall flooding in a greentree reservoir or a moist-soil impoundment might include four or more approaches to flooding (Figs. 4 and 5).



Rationale

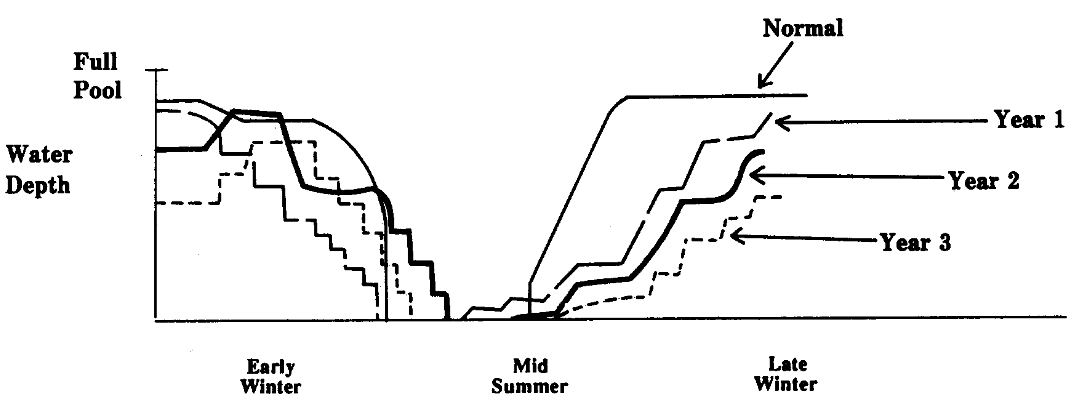
Year 1 - Gradual flooding to provide access to food resources on a continuing basis throughout the hunting season. Gradual drawdowns commence before the end of the waterfowl season.

Year 2 - Gradual flooding but water levels never reach full pool. Gradual drawdown extending into spring.

Year 3 - No flooding.

Year 4 - Similar to Year 1, but full pool not reached until end of hunting season. Gradual drawdown extending well into spring.

Figure 4. Suggested flooding regimes for southern greentree reservoirs.



Rationale

Normal - Typical midsummer drawdown to establish moist-soil vegetation. Fall and winter flooding for waterfowl.

Year 1 - Gradual drawdown to optimize use by late spring migrants. Gradual reflooding for rails and waders.

Year 2 - Gradual drawdown lasting into midsummer to optimize use by late spring, migrant waterfowl, shorebirds, and waders. Gradual reflooding in fall to optimize use of seed resources.

Year 3 - Increasing water depths in spring to make food resources available. Gradual drawdown by late spring, followed by gradual reflooding in fall to shallow depths.

Figure 5. Suggested flooding regimes for seasonally flooded wetlands of the Midwest.

By recognizing the importance of natural wetland complexes throughout the annual cycles of waterfowl, managers can provide waterfowl with required resources.

Suggested Reading

Ankney, C.D., and C.D. MacInnes. 1978. Nutrient reserves and reproductive performance of female lesser snow geese. Auk 95:459–471.

Drobney, R.D. 1980. Reproductive bioenergetics of wood ducks. Auk 97:480–490.

Drobney, R.D., and L.H. Fredrickson. 1985. Protein acquisition: a possible proximate factor limiting clutch size in wood ducks. Wildfowl 36:122–128.

Fredrickson, L.H. and R.D. Drobney. 1979. Habitat utilization by postbreeding waterfowl. Pages 119–129 *in* T.A. Bookhout, ed. Waterfowl and wetlands: an integrated review. Proc. 1977 Symp., North Cent. Sect., The Wildl. Soc., Madison, Wis. 147 pp.

Fredrickson, L.H. and M.E. Heitmeyer. 1988. Waterfowl use of forested wetlands in the southeastern United States—an overview. Pages 307–323 *in* M.W. Weller, ed. Waterfowl in winter—a symposium and workshop. University of Minnesota Press, Minneapolis.

Fredrickson, L.H., and T.S. Taylor. 1982. Management of seasonally flooded impoundments for wildlife. U.S. Fish and Wildl. Serv., Resour. Publ. 148. 29 pp.

Heitmeyer, M.E., and L.H. Fredrickson. 1981. Do wetland conditions in the Mississippi Delta hardwoods influence mallard recruitment? Trans. N. Am. Wildl. and Nat. Resour. Conf. 46:44–57.

Krapu, G.L. 1979. Nutrition of female dabbling ducks during reproduction. Pages 59–70 *in* T.A. Bookhout, ed. Waterfowl and wetlands: an integrated review. Proc. 1977 Symp., North Cent. Sect., The Wildl. Soc., Madison, Wis. 147 pp.

Owen, R.B., Jr., and K.J. Reinecke. 1979. Bioenergetics of breeding dabbling ducks. Pages 71–99 *in* T.A. Bookhout, ed., Waterfowl and wetlands: an integrated review. Proc. 1977 Symp., North Cent. Sect., The Wildl. Soc., Madison, Wis. 147 pp.

Weller, M.W. 1975. Migratory waterfowl: a hemispheric perspective. Publicaciones Biologicas Instituto de Investigaciones Cientificas U.A.N.L. 1:89–130.

White, D.H., and D. James. 1978. Differential use of freshwater environments by wintering waterfowl of coastal Texas. Wilson Bull. 90:99–111.

Appendix. Common and Scientific Names of Animals Named in Text.

Wood duck	*Aix sponsa*
Northern pintail	*Anas acuta*
Blue-winged teal	*Anas discors*
Mallard	*Anas platyrhynchos*
Lesser scaup	*Aythya affinis*
Ring-necked duck	*Aythya collaris*
Canada goose	*Branta canadensis*
Snow goose	*Chen caerulescens*
Common eider	*Somateria mollissima*

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