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# INTEGRATING RESEARCH AND MANAGEMENT TO CONSERVE WILDFOWL (*ANATIDAE*) AND WETLANDS IN THE MISSISSIPPI ALLUVIAL VALLEY, U.S.A.

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**KEY WORDS**: Wildfowl, *Anatidae*, population, evaluation, foraging habitat, habitat management, winter, Mississippi Alluvial Valley, North American Waterfowl Management Plan, U.S.A.

## ABSTRACT

*Efforts to conserve winter habitat for wildfowl,* Anatidae, *in the alluvial valley of the lower Mississippi River, U.S.A., are directed by the Lower Mississippi Valley (LMV) Joint Venture of the North American Waterfowl Management Plan (NAWMP). The Joint Venture is based on a biological framework developed through cooperative planning by wildfowl researchers and managers. Important elements of the framework include: (1) numeric population goals, (2) assumptions about potential limiting factors, (3) explicit relationships between wildfowl abundance and habitat characteristics, (4) numeric foraging habitat goals, and (5) criteria for evaluating success. The population goal of the Joint Venture for the Mississippi Alluvial Valley (MAV) is to enable 4.3 million ducks to survive winter and join continental breeding populations in spring. Currently, available data suggest that foraging habitat is the primary factor limiting duck populations in the MAV. To establish a goal for foraging habitat, we assumed the length of the wintering period is 110 days and calculated that a population of 4.3 million breeding ducks (plus 15% to account for winter mortality) would need 546 million duck-days of food in the preceding winter. Then, we used estimates of daily energy requirements, food densities, and food energy values to calculate the carrying capacity or number of duck-days of food available in the three primary foraging habitats in the MAV (flooded croplands, forested wetlands, and moist-soil wetlands). Thus, availability of foraging habitat can be used as a criterion for evaluating success of the Joint Venture if accurate inventories of foraging habitat can be conducted. Development of an explicit biological framework for the Joint Venture enabled wildfowl managers and researchers to establish specific objectives for management of foraging habitat and identify priority problems requiring further study.*

# I. INTRODUCTION

Efforts to develop a continental wildfowl management plan in North America began in the late 1970s. Important progress was made in 1986 when Canada and the United States signed the North American Waterfowl Management Plan (NAWMP) (CANADIAN WILDLIFE SERVICE and U.S. FISH AND WILDLIFE SERVICE, 1986), which became truly continental in scope when it was updated in 1994 and signed by Canada, the United States, and Mexico (CANADIAN WILDLIFE SERVICE *et al.*, 1994). Authors of the NAWMP intended that it provide a broad policy framework for conservation of 43 species of Anatidae and their habitats during the period 1986-2000 and beyond. The NAWMP recommended a hierarchical approach to implementation, with specific management activities designed and conducted by regional and local Joint Ventures comprising partnerships of governmental and non-governmental organisations. The NAWMP further recommended that habitat goals be based on numeric population goals and explicit relationships between wildfowl abundance and habitat characteristics, rather than on financial and political opportunities as had been done in the past.

The first priority of the NAWMP was to increase breeding success of dabbling ducks (*Anatini*) in midcontinent prairie nesting areas by improving habitat on 1,456,920 ha in Canada and 438,695 ha in the United States. Other goals included conservation and improved management of migration and winter habitat for mallard (*Anas platyrhynchos*), pintail (*A. acuta*), and American black duck (*A. rubripes*) in selected geographic areas. One such area is the Lower Mississippi River valley and adjacent Gulf of Mexico coastal region, where the NAWMP recommended protecting an additional 277,624 ha of migration and winter habitat.

For many years, research on the migration and winter ecology of North American wildfowl received less emphasis than studies of breeding biology because many researchers believed that population fluctuations were determined primarily by reproductive success (cf. ANDERSON and BATT, 1983). However, faced with continuing losses of winter habitat (e.g. GILMER *et al.*, 1982; REINECKE *et al.*, 1988) and a growing concern that events in winter could influence reproductive success (e.g. HEITMEYER and FREDRICKSON, 1981), North American researchers increased studies of wildfowl in winter. Data collected in important wintering areas, such as the coastal plain of Louisiana and Texas and the Central Valley of California, were synthesized and presented at conferences in Missouri in 1983 (ANDERSON and BATT, 1983), Texas in 1987 (WELLER, 1988), and Mississippi in 1989 (SMITH *et al.*, 1989). Thus, important research data were available to guide development of the habitat Joint Ventures that were organised to implement the NAWMP.

This paper shows how research data were used to provide a biological framework for implementation and evaluation of a plan for conserving wildfowl habitat in the southcentral United States. Specific objectives were to: (1) describe the biological framework guiding the plan, (2) illustrate management implications resulting from the biological framework, and (3) indicate the extent to which officials implementing the plan have committed to biological evaluations.

# II. MATERIAL AND METHODS

## II.1. STUDY AREA

The Mississippi Alluvial Valley (MAV) comprises > 89,000 km$^2$ in seven states bordering the lower Mississippi River (Figure 1); it varies from 32 to 128 km wide and is > 800 km long. Topography of the MAV has been shaped by erosion and deposition of alluvial sediments from the Mississippi River and its tributaries. Elevations vary from near sea level in the south to 100 m in the north, and local relief rarely exceeds 5-10 m. Climate in the MAV is humid subtropical, with an average annual rainfall of 150 cm in the south and 115 cm in the north. Minimum daily temperatures in January average 13°C in the south and – 1°C in the north. Two wetlands in the MAV have been recognized as internationally significant under the Ramsar Convention; they are the Cache River-Lower White River region in Arkansas and Catahoula Lake in Louisiana.

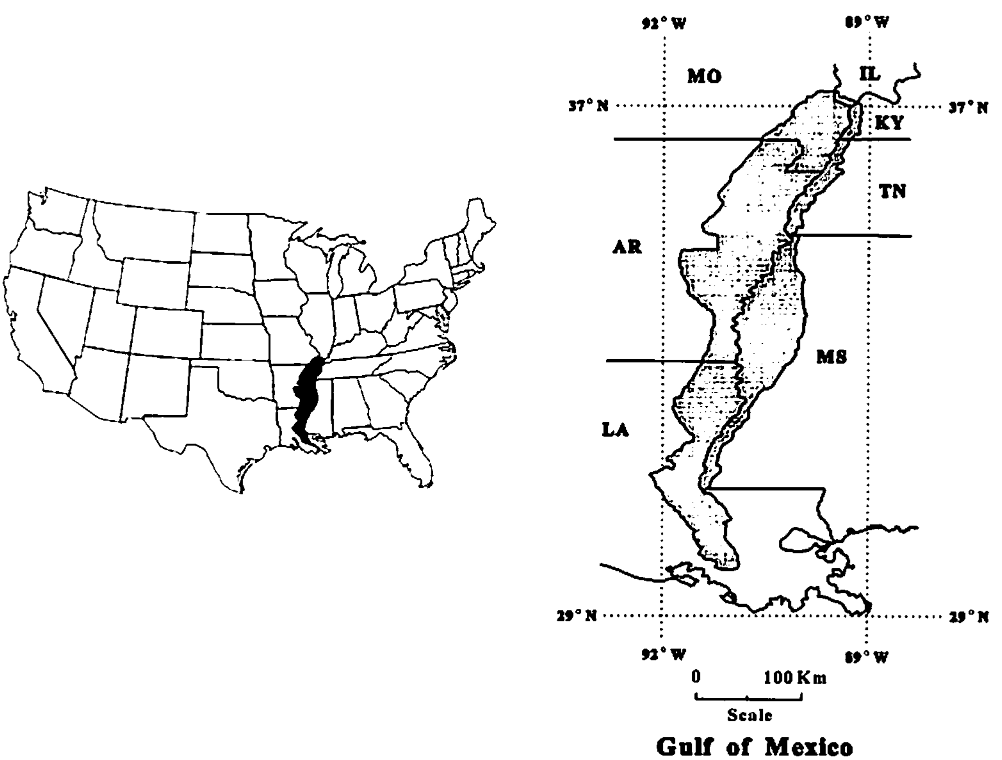


Figure 1: The Mississippi Alluvial Valley in the southcentral United States provides winter habitat for as many as 5 million waterfowl annually. Abbreviations for states are: AR (Arkansas), IL (Illinois), KY (Kentucky), LA (Louisiana), MO (Missouri), MS (Mississippi), and TN (Tennessee).

Figure 1 : La plaine alluviale du Mississippi située au centre du sud des Etats-Unis assure tous les ans des sites d'hivernage à pas moins de 5 millions d'oiseaux d'eau. Les abréviations des états sont : AR (Arkansas), IL (Illinois), KY (Kentucky), LA (Louisiane), MO (Missouri), MS (Mississippi) et TN (Tennessee).

Prior to human settlement, the MAV was a complex of waterways and forested wetlands subject to floods that varied in timing, depth, duration, and frequency. Flood control projects and agricultural development have gradually altered hydrology and land use in the MAV. Currently, about 20% of the land is forested and 65% is used for agriculture (D.J. TWEDT, National Biological Service, unpubl. data). Important crops grown in the region include cotton (*Gossypium hirsutum*), soybeans (*Glycine max*), rice (*Oryza sativa*), grain sorghum (or broomcorn, *Sorghum bicolor*), wheat (*Triticum aestivum*), sugarcane (*Saccharum officinarum*), and corn (or maize, *Zea mays*).

Habitats used by migrating and wintering wildfowl in the MAV typically include forested wetlands and flooded croplands. Species that are abundant during winter include several dabbling ducks (especially mallard) and diving ducks (*Aythyini;* especially lesser scaup [*Aythya affinis*]), wood duck (*Aix sponsa*), ruddy duck (*Oxyura jamaicensis*), Canada geese (*Branta canadensis*), snow geese (*Anser caerulescens*), and white-fronted geese (*A. albifrons*) (REINECKE *et al.*, 1989). The wood duck is the only species that is abundant in the MAV during the spring-summer breeding season.

## II.2. METHODS

### Population Goals

Swan and goose populations associated with the MAV are stable or increasing (REINECKE *et al.*, 1989), and their habitat needs are addressed in individual species management plans. Given the favourable status of these species, the management board of the Lower Mississippi Valley (LMV) Joint Venture decided that the primary goal for wildfowl populations in the MAV was to help the NAWMP attain the continental population goal of 62 million breeding ducks. Specifically, the Joint Venture management board decided that the percentage of continental breeding populations derived from wintering areas in the MAV should equal the average percentage of ducks counted in the MAV during annual winter surveys of the 48 contiguous states, 1970-1979.

We used three sources of information to calculate the resulting duck population goals for the MAV. The first was the NAWMP continental population goal, defined as the average abundance of breeding ducks in North America by species during 1970-79 (Table 1 in CANADIAN WILDLIFE SERVICE *et al.*, 1994). The second source of information was an index to the winter distribution of ducks among states. For this, we used the number of ducks of each species counted in each state during annual mid-winter waterfowl inventories, January 1970-79 (available on computer disk from U.S. Fish and Wildlife Service, Office of Migratory Bird Management, Laurel, MD USA 20708). The third source of information was an index to the winter distribution of ducks within states. For this, we used estimates of the average annual harvest of ducks by species and county, 1970-79 (cf. CARNEY *et al.*, 1983). Six steps were needed to calculate duck population goals for the MAV.

*Step 1*

First, we restricted the analysis to seven species of dabbling ducks and

## TABLE I

**Continental goals (bird numbers) for populations of selected species of dabbling ducks (*Anatini*), diving ducks (*Aythyini*) and wood ducks (*Aix sponsa*) are from the North American Waterfowl Management Plan and reflect the average abundance of ducks during 1970-79 (cf. Table 1 in CANADIAN WILDLIFE SERVICE *et al.*, 1994). Species included in the table are those that are abundant in the Mississippi Alluvial Valley during winter (REINECKE *et al.*, 1989).**

## TABLEAU I

**Les objectifs quantitatifs (nombre d'oiseaux) concernant les populations continentales reproductrices de canards de surface (*Anatini*), de canards plongeurs (*Aythyini*) et de canards huppés (*Aix sponsa*) sont ceux définis par le Plan de Gestion des Oiseaux d'Eau Nord-Américains. Ils représentent les effectifs moyens des canards entre 1970 et 1979 (voir tableau 1 dans CANADIAN WILDLIFE SERVICE *et al.*, 1994). Les espèces mentionnées dans ce tableau sont celles hivernant en très grand nombre dans la plaine alluviale du Mississippi (REINECKE *et al.*, 1989).**

| Species | Breeding population goal |
|---|---|
| Dabbling ducks (*Anatini*) | |
| Mallard (*Anas platyrhynchos*) | 11,000,000 |
| Pintail (*A. acuta*) | 7,000,000 |
| American black duck (*A. rubripes*) | 1,400,000 |
| Gadwall (*A. strepera*) | 2,000,000 |
| American wigeon (*A. americana*) | 3,500,000 |
| Green-winged teal (*A. crecca*) | 3,000,000 |
| Northern shoveler (*A. clypeata*) | 2,000,000 |
| SUBTOTAL | 29,900,000 |
| Diving ducks (*Aythyini*) | |
| Redhead (*Aythya americana*) | 900,000 |
| Canvasback (*A. valisineria*) | 600,000 |
| Scaup (*A. affinis* and *A. marila*) | 8,000,000 |
| Ring-necked duck (*A. collaris*) | 1,000,000 |
| Ruddy duck (*Oxyura jamaicensis*) | 700,000 |
| SUBTOTAL | 11,200,000 |
| Wood duck (*Aix sponsa*) | 3,000,000 |
| TOTAL | 44,100,000 |

five species of diving ducks (including ruddy duck) that are abundant in the MAV during winter (Table I) (REINECKE *et al.*, 1989). We calculated population goals separately for these two groups of species and hereafter refer to them collectively as "dabbling ducks" and "diving ducks".

*Step 2*

The second step was to calculate a series of proportions (one for each state and species group) relating the number of dabbling ducks or diving ducks counted during winter surveys in each MAV state to the total number of dabbling ducks or diving ducks counted in the 48 contiguous states. We computed these proportions as

$$p_{state} = \frac{\sum_{year=1}^{10} \sum_{species=1}^{5\ or\ 7} N_{year,\ species}}{\sum_{state=1}^{48} \sum_{year=1}^{10} \sum_{species=1}^{5\ or\ 7} N_{state,\ year,\ species}} \qquad (1)$$

where $N_{year,species}$ represented the number of ducks of a given species counted in a given year and $N_{state,year,species}$ represented the number of ducks of a given species counted in a given state and year.

*Step 3*

The third step was to calculate proportions (one for each state and species group) relating the number of dabbling ducks or diving ducks killed by hunters in the MAV counties of each state to the total number of dabbling ducks or diving ducks killed throughout the state. We computed these proportions as

$$p_{MAV_{state}} = \frac{\sum_{county=1}^{No.\ in\ MAV} \sum_{species=1}^{5\ or\ 7} N_{county,\ species}}{\sum_{county=1}^{No.\ in\ state} \sum_{species=1}^{5\ or\ 7} N_{county,\ species}} \qquad (2)$$

where $N_{county,species}$ represented the average number of ducks of a given species killed by hunters in a given county of an MAV state during 1970-79.

*Step 4*

The fourth step was to calculate population goals for dabbling ducks and diving ducks for each state as

$$Goal_{state} = p_{state} * p_{MAV_{state}} * Goal_{continental} \qquad (3)$$

where $P_{state}$ is the proportion of ducks in each species group counted during winter inventories in each state (Eq. 1), $p_{MAVstate}$ is the proportion of ducks in each species group killed by hunters in the MAV portion of each state (Eq. 2), and $Goal_{continental}$ is the corresponding continental population goal from Table I.

*Step 5*

Next, we calculated state population goals for the wood duck, *Aix sponsa*. Goals for wood ducks were determined differently than goals for the other species, because wood ducks are difficult to observe in their forested wetland habitats and thus are not counted accurately in most surveys. We calculated population goals for wood ducks as indirect population estimates (cf. BOWERS and MARTIN, 1975) by dividing the average number of wood ducks killed by hunters in each MAV state (CARNEY *et al.*, 1983) by an estimated harvest rate of 0.10. The harvest rate was determined by dividing the average recovery rate for ringed wood ducks (0.033) (BELLROSE, 1994:449) by the average reporting rate for duck rings (0.33) (NICHOLS *et al.*, 1995), where recovery rate is defined as the probability that a ringed wood duck is killed by a hunter and reported to the ringing centre, and reporting rate is the probability that a hunter will report to the ringing centre a ring from a wood duck that was killed (cf. NICHOLS, 1991).

*Step 6*

The final step in determining population goals for the MAV was to calculate goals for all ducks as a sum of the goals for dabbling ducks, diving ducks, and wood ducks.

### Food Requirements and Foraging Habitats

We calculated winter food requirements corresponding to the Joint Venture population goals in two steps. First, we increased the population goals for breeding ducks by 15% to account for winter mortality (cf. REINECKE *et al.*, 1987). Then, we multiplied the adjusted population goals by 110, the average number of days ducks are present in the MAV during winter (i.e., early November through late February), to express population food requirements as duck-days of food.

To assess the ability of selected foraging habitats to satisfy population food requirements, we used estimates of the energy requirements of ducks and of the density and metabolisable energy value of available foods. To simplify calculation of energy requirements, we assumed that mallard are representative of duck species using the MAV, and that the average daily energy requirement of a mallard in winter is 292 kcal (1,223 kJ) (PRINCE, 1979). We also assumed that there is a food density of 50 kg/ha below which it is not profitable for ducks to continue feeding (cf. REINECKE *et al.*, 1989; BEEKMAN *et al.*, 1991). For additional details regarding sources of data used to estimate food densities and energy values, readers are referred to reviews by REINECKE *et al.* (1989) and LOESCH *et al.* (1994).

The steps used to calculate potential carrying capacity of foraging habitats in duck-days of food were: (1) subtract 50 kg/ha from the density of available foods; (2) multiply the resulting food density times the concentration of metabolisable energy (kcal/g); and (3) divide by the daily energy requirement (292 kcal). Using these methods, we calculated average duck-days of food available (or carrying capacity) for the three most important foraging habitats in the MAV: forested wetlands, flooded croplands, and seasonally flooded herbaceous wetlands (hereafter referred to as moist-soil wetlands, cf. FREDRICKSON and TAYLOR, 1982).

# III. RESULTS

## III.1. POPULATION GOALS

The overall population goal for the MAV is to contribute 4.3 million ducks to continental breeding populations (Table II). This total represents 9.8% of the population goal of 44.1 million for species that are abundant in the MAV (Table I) and 6.9% of the continental population goal of 62 million breeding ducks. Population goals for ducks were greatest in Arkansas, Louisiana, and Mississippi, the states with the largest land areas in the MAV.

**TABLE II**

**Duck population goals for states in the Mississippi Alluvial Valley. Values represent the number of ducks that are expected to join continental breeding populations in spring and were calculated using equations 1-3 (see text).**

**TABLEAU II**

**Objectifs quantitatifs pour les populations de canards de surface, plongeurs et huppés hivernant dans les états situés dans la plaine alluviale du Mississippi. Les valeurs indiquées représentent les effectifs de canards qui, au printemps, devraient rejoindre les populations reproductrices continentales. Ces effectifs ont été calculés à l'aide des équations 1-3 (voir texte).**

| State | Dabbling ducks[a] (*Anatini*) | Diving ducks[a] (*Aythyini*) | Wood duck (*Aix sponsa*) | TOTAL |
|---|---|---|---|---|
| Arkansas | 1,474,189 | 78,401 | 322,290 | 1,874,880 |
| Illinois | 3,005 | 0 | 10,890 | 13,895 |
| Kentucky | 12,662 | 194 | 6,710 | 19,566 |
| Louisiana | 637,907 | 332,965 | 395,860 | 1,366,732 |
| Mississippi | 435,151 | 44,414 | 179,230 | 658,796 |
| Missouri | 65,817 | 3,664 | 26,020 | 95,501 |
| Tennessee | 236,884 | 15,066 | 35,500 | 287,450 |
| Total | 2,865,615 | 474,703 | 976,500 | 4,316,818 |

[a] Includes species listed in Table I.
[a] Comprend les espèces mentionnées au Tableau I.

The MAV population goal for dabbling ducks is 9.6% of the continental goal of 29.9 million for species that are abundant in the MAV (Tables I and II) and 8.0% of the continental goal of 35.9 million for all dabbling ducks. For diving ducks, MAV population goals represent 4.2% of the continental goal of 11.2 million for species that are abundant in the MAV and 3.4% of the continental goal of 13.7 million for all diving ducks. The MAV population goal for wood ducks is 32.6% of the continental goal of 3.0 million.

## III.2. FOOD REQUIREMENTS AND FORAGING HABITATS

Because estimates of food requirements are directly proportional to population goals, the states of Arkansas, Louisiana, and Mississippi together will be responsible for providing approximately 90% of the foraging habitat needed in the MAV (Table III). Overall, 546 million duck-days of food will be needed to achieve population goals.

Available data indicate that moist-soil wetlands have the greatest average food densities and potential duck-days of food per hectare (Table IV). Waste grain from harvested rice, corn, and grain sorghum fields provide intermediate numbers of duck-days, whereas soybean fields provide relatively few duck-days. Forested wetlands provide low numbers of duck-days of food, but foraging value increases with the percentage of oak (*Quercus* spp.) trees in the respective forest stands (Table IV).

## TABLE III

**Number (in thousands) of duck-days of food needed to satisfy population goals for states in the Mississippi Alluvial Valley (see Table II and text).**

## TABLEAU III

**Nombre (en milliers) de jours de gagnage-canards nécessaires pour atteindre les objectifs quantitatifs fixés pour les populations de canards de surface, plongeurs et huppés hivernant dans les états situés dans la plaine alluviale du Mississippi (voir TABLEAU II et texte).**

| State | Dabbling ducks[a] (*Anatini*) | Diving ducks[a] (*Aythyini*) | Wood duck (*Aix sponsa*) | TOTAL |
|---|---|---|---|---|
| Arkansas | 186,485 | 9,918 | 40,770 | 237,172 |
| Illinois | 380 | 0 | 1,378 | 1,758 |
| Kentucky | 1,602 | 25 | 849 | 2,475 |
| Louisiana | 80,695 | 42,120 | 50,076 | 172,892 |
| Mississippi | 8,326 | 463 | 3,292 | 12,081 |
| Missouri | 55,047 | 5,618 | 22,673 | 83,338 |
| Tennessee | 29,966 | 1,906 | 4,491 | 36,362 |
| Total | 362,500 | 60,050 | 123,527 | 546,078 |

[a] Includes species listed in Table I.
[a] Comprend les espèces mentionnées au Tableau I.

## TABLE IV

**Carrying capacity, expressed as duck-days/ha of available food, for selected foraging habitats in the Mississippi Alluvial Valley.**

## TABLEAU IV

**Capacité d'accueil de certains habitats de gagnage (zones légèrement humides, cultures – riz, graine de soja, graine de sorgho, maïs –, zones humides boisées de chênes rouges) situés dans la plaine alluviale du Mississippi, exprimée en jours de disponibilité alimentaire-canards/ha, et densités des aliments (kg/ha) (glands, grains et graines cultivées, autres graines, invertébrés).**

| Foraging habitat | Food density (kg/ha) | | | | Carrying capacity (duck-days/ha) |
|---|---|---|---|---|---|
| | Acorns | Grain | Other seeds | Invertebrates | |
| Moist-soil wetlands | | | 450.0 | | 3,425 |
| Harvested croplands | | | | | |
| Rice | | 180 | 25.0 | | 1,858 |
| Soybeans | | 60 | 25.0 | | 300 |
| Grain sorghum | | 200 | 25.0 | | 2,098 |
| Corn | | 250 | | | 2,397 |
| Forested wetlands | | | | | |
| 30% red oaks[a] | 27 | | 22.5 | 13.7 | 154 |
| 50% red oaks[a] | 44 | | 22.5 | 13.7 | 366 |
| 70% red oaks[a] | 62 | | 22.5 | 13.7 | 579 |
| 90% red oaks[a] | 80 | | 22.5 | 13.7 | 792 |

[a] Includes willow oak (*Quercus phellos*), pin oak (*Q. palustris*), Nuttall oak (*Q. nuttallii*), water oak (*Q. nigra*), cherrybark oak (*Q. falcata* var. *pagodifolia*), and Shumard oak (*Q. shumardii*).
[a] Comprend le chêne à feuille de saule, *Quercus phellos*; le chêne des marais, *Q. palustris*; *Q. nuttallii*; le chêne aquatique, *Q. nigra*; *Q. falcata* var. *pagodifolia*; et *Q. shumardii*.

# IV. DISCUSSION

The biological framework developed by researchers and managers to guide the LMV Joint Venture can be thought of as a model depicting the structure and function of an important wildfowl wintering area. Like other models (cf. WALTERS, 1986), the value of this one depends on the extent to which it: (1) represents the system under study, (2) provides insights regarding management actions and research needs, and (3) is testable.

Available data indicate foraging habitat is the primary factor limiting duck populations in the MAV. Evidence supporting food limitation is that, during winters with greater availability of foraging habitat, more mallard are attracted to the MAV (NICHOLS *et al.*, 1983), and body masses and seasonal survival rates of mallard increase (DELNICKI and REINECKE, 1986; REINECKE *et al.*, 1987). Further, there is little evidence that disease, predation, environmental contaminants, or other risk factors are important determinants of duck population dynamics in the MAV (REINECKE *et al.*, 1989).

Available data also support the contention that moist-soil wetlands, flooded croplands, and forested wetlands are the primary foraging habitats of ducks in the MAV. Studies in Missouri, Mississippi, Arkansas, Tennessee, and Louisiana (reviewed by REINECKE *et al.*, 1989) showed that, although the importance of individual foods varied from site to site and among years, most of the foods of ducks were obtained from these three foraging habitats in all years.

The biological framework guiding the LMV Joint Venture has also encouraged researchers and managers to think about waterfowl ecology in new ways. For example, discussions about the importance of the three primary foraging habitats led to the conclusion that each habitat should be further characterized as occurring on public or private land and as subject to managed or natural hydrology. Thus, the amount of food available from all foraging habitats in the MAV can be expressed as

$$Duck\text{-}days_{total} = \sum_{ownership=1}^{2} \sum_{hydrology=1}^{2} \sum_{habitat=1}^{3} Duck\text{-}days_{ownership,\ hydrology,\ habitat} \qquad (4)$$

where the total number of duck-days of food is a sum comprising two categories of land ownership (public *vs* private), two hydrologic regimes (managed *vs* natural), and three foraging habitats. Representing the value of foraging habitats in this manner provides a criterion for determining the success of Joint Venture habitat management programs. That is, the Joint Venture goal for development of foraging habitat will be satisfied when the total duck-days of food calculated from the preceding summation equals or exceeds the goal in Table III.

Further consideration of the model led participants in the Joint Venture to conclude that, in addition to satisfying the overall goal for food resources, it was important to establish constraints on certain sources of foraging habitat. For example, a decision was made to explicitly define the role of public wildlife areas. Because states participating in the Joint Venture had different philosophies, they selected values ranging from 20-95% for the percentage of foraging habitat to be provided on public lands (C.R. LOESCH, U.S. Fish and Wildlife Service, unpubl. data). Overall, the aggregate goal of the Joint Venture is to provide approximately 30% of the foraging habitat needed by ducks on public lands.

Another constraint adopted by participants in the Joint Venture was to establish a minimum percentage of foraging habitat that will be available at sites with managed hydrology. These foraging habitats represent a "safety net" of food that will be available in unfavourable years, when winter precipitation and associated natural flooding are limited. The goal selected by the Joint Venture was to provide 75% of foraging habitat at sites with managed hydrology. Thus, use of an explicit model has encouraged land managers to define numeric goals for several categories of foraging habitat and has provided objective criteria for measuring progress toward those goals.

The hypothesis regarding the role of foraging habitat also suggested opportunities for further contributions by researchers. One important challenge is to design reliable methods to conduct inventories of foraging habitat. This realisation motivated a study investigating the use of aerial sample surveys (cf. REINECKE *et al.*, 1992) to estimate the area of foraging habitat with managed hydrology on private land. Preliminary results (W.B. UIHLEIN, Mississippi State University, unpubl. data) suggest that approximately 150,000 ha of potential foraging habitat, mostly harvested croplands, are flooded by private landowners each winter to attract waterfowl. Researchers also are studying the feasibility of using satellite imagery of the MAV to determine the extent of foraging habitats subject to natural flooding.

Another challenge is to test the assumption that food is the most important factor limiting duck populations in the MAV. To do this, researchers need to design studies of food depletion, foraging behaviour, and the effects of variation in food resources on the abundance and distribution of ducks. The hypothesis of food limitation predicts most food resources should be depleted in winters of average precipitation, and depletion of food should be accompanied by interpretable patterns of behaviour among foraging ducks. Studies of the use of food resources by common cranes (*Grus grus*) wintering at Gallocanta, Spain (ALONSO *et al.*, 1994) provide a good model for this kind of work.

Perhaps the most important benefit of developing a biological framework for the Joint Venture has been the recognition by researchers and managers that the resulting model is a working hypothesis that needs further evaluation. This realisation resulted in preparation of an evaluation plan identifying critical assumptions and data needs, and defining roles for researchers and managers in obtaining the necessary information (LOESCH *et al.*, 1994).

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# UTILISATIONS CONCOMITANTES DE LA RECHERCHE ET DE LA GESTION POUR LA CONSERVATION DES *ANATIDAE* ET DES ZONES HUMIDES DANS LA PLAINE ALLUVIALE DU MISSISSIPPI, U.S.A.

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**MOTS-CLÉS :** Anatidé, *Anatidae*, population, évaluation, habitat de gagnage, gestion de l'habitat, hiver, plaine alluviale du Mississippi, Plan de Gestion des Oiseaux d'Eau Nord-Américains, Etats-Unis.

**RÉSUMÉ**

*Les efforts actuels de conservation des zones d'hivernage pour les anatidés,* Anatidae, *dans la plaine alluviale du Mississippi inférieur (« Lower Mississippi Valley – LMV »), aux Etats-Unis, sont dirigés par « Joint Venture », un programme élaboré dans le cadre du Plan de Gestion des Oiseaux d'Eau Nord-Américain (« North American Waterfowl Management Plan – NAWMP »). Le programme « Joint Venture » est basé sur un concept biologique, élaboré en commun par les chercheurs et gestionnaires des oiseaux d'eau. Les éléments importants de ce plan comprennent : (1) des objectifs quantitatifs pour les populations, (2) une évaluation des facteurs limitants potentiels, (3) la mise en évidence des relations entre l'abondance des populations d'anatidés et les caractéristiques de l'habitat, (4) des objectifs quantitatifs pour les habitats de gagnage et (5) des critères d'évaluation de la réussite du programme. L'objectif quantitatif pour les populations de la plaine alluviale du Mississippi (MAV), défini par le programme « Joint Venture », est de permettre à 4,3 millions de canards de survivre à l'hiver pour pouvoir rejoindre les populations reproductrices continentales au printemps. Selon les données dont nous disposons actuellement, l'habitat de gagnage est probablement le facteur primaire limitant les populations de canards hivernant dans la plaine alluviale du Mississippi. Pour définir la quantité d'habitat nécessaire, nous nous sommes basés sur une période d'hivernage de 110 jours et nous avons calculé qu'une population de 4,3 millions de canards reproducteurs (plus 15 % pour tenir compte de la mortalité hivernale) aurait eu besoin, l'hiver précédent, de 546 millions de jours de gagnage. Ensuite, nous avons estimé les besoins énergétiques journaliers, les potentialités trophiques des milieux et les valeurs énergétiques des aliments pour calculer la capacité d'accueil, ou le nombre de jours de gagnage-canards disponibles par rapport à la capacité alimentaire des trois principaux habitats de gagnage de la plaine alluviale du Mississippi (zones agricoles inondées, zones humides boisées et zones légèrement humides). La disponibilité des habitats de gagnage pourrait ainsi être utilisée comme critère d'évaluation de la réussite du programme « Joint Venture ». Ce critère, toutefois, ne peut pas être appliqué sans un inventaire exact des zones de gagnage. Le développement d'un concept biologique pour le programme « Joint Venture » a permis aux gestionnaires et chercheurs d'établir des objectifs appropriés pour la gestion des habitats de gagnage et d'identifier les problèmes importants qui devraient être étudiés en profondeur.*

# INTEGRIERTE FORSCHUNG UND INTEGRIERTES MANAGEMENT ZUR ERHALTUNG DER ENTENVÖGEL (*ANATIDAE*) UND FEUCHTGEBIETE IN DER MISSISSIPPI-AUE, USA

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**SCHLÜSSELWÖRTER :** Entenvogel, *Anatidae*, Population, Evaluation, Nahrungshabitat, Habitatmanagement, Winter, Mississippi-Aue, North American Waterfowl Management Plan, USA.

**ZUSAMMENFASSUNG**

*Die Erhaltungsbemühungen der Winterhabitate der Entenvögel (*Anatidae*) in der Mississippi-Aue, USA, werden von dem Gemeinsamen Programm « Lower Mississippi Valley » (LMV) des « North Amercian Waterfowl Management Plan » (NAWMP) geleitet. Dieses gemeinsame Programm (Joint Venture) beruht auf einem biologischen Konzept, das gemeinsam von Entenvogel-Forschern und -Managern ausgearbeitet wurde. In diesen Rahmen fallen folgende wichtige Punkte : (1) quantitative Definition der Populationsziele, (2) Klärung potentieller limitierender Faktoren, (3) Ermittlung expliziter Beziehungen zwischen Entenvogel-Abundanz und Habitateigenschaften, (4) quantitative Zielsetzung von Nahrungshabitaten und (5) Kriterien zur Evaluation des Erfolges des « Joint Venture »-Plans. Dieses gemeinsame Programm für das Mississippi Alluvial Valley (MAV) hat sich zum Ziel gesetzt, daß hier 4,3 Millionen Entenvögel den Winter überleben und im Frühling die kontinentalen Brutpopulationen erreichen sollen. In der Tat geht aus dem derzeitig vorliegenden Datenmaterial hervor, daß das Angebot an Nahrungshabitaten der bedeutendste limitierende Faktor für die Entenvogelpopulationen im MVA darstellt. Für die quantitativen Zielsetzungen hinsichtlich dieser Nahrungshabitate haben wir unseren Studien eine Winterperiode von 110 Tagen zu Grunde gelegt und errechnet, daß eine Brutpopulation von 4,3 Millionen (plus Wintersterblichkeitsrate von 15 %) 546 Millionen Enten-Tage Nahrung im vorhergehenden Winter benötigt hätte. Dann schätzten wir den täglichen Energiebedarf, das Nahrungsangebot der Habitate und den Energiewert der Nahrung, um die Tragfähigkeit oder die Anzahl der Entenvogel-Tage im Vergleich zu dem Nahrungsangebot in den drei wichtigsten Nahrungshabitaten des MAV (überflutete Kulturen, bestockte Feuchtgebiete und Gebiete mit leicht feuchtem Boden) zu bestimmen. Somit kann das Angebot an Nahrungshabitaten als Kriterium für den Erfolg des « Joint-Venture »-Plans angesehen werden, aber nur dann, wenn genaue Nahrungshabitatinventare durchgeführt werden können. Die Entwicklung eines expliziten biologischen Konzepts für das « Joint Venture » erlaubte es den Managern und Forschern, spezifische Ziele zum Management von Nahrungshabitaten festzulegen und die prioritären, weitere Forschung benötigenden Probleme zu identifizieren.*