FIELD-FEEDING ECOLOGY OF WATERFOWL

WINTERING ON THE SOUTHERN HIGH

PLAINS OF TEXAS

by

GUY A. BALDASSARRE, B.S., M.S

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AESTRACT

The ecology of field-feeding dabbling ducks wintering on the Southern High Plains of Texas was studied on a 50 km2 study area in Castro County, from September-March 1979-82. Ducks relied primarily on waste corn that averaged 364 j^ 12 kg/ha/field. Fields harvested at 14-21^ moisture lost more than twice the corn as fields harvested at 22-36^ moisture. Therefore, moisture content of corn at harvest provided a useful measure to predict initial waste. Waste cornfields underwent a vari'ety of agricultural treatments that affected the abundance and availability of waste corn to waterfowl. Burning stubble maximized abundance and availability, whereas deep plowing reduced abundance by 975o. Disking and grazing reduced abundance by 77^ and 84-%, respectively. However, landowners tended to graze cattle on fields where initial waste was high and thus substantial amounts of waste corn remained when grazing was terminated. Manual salvage by migrant workers removed 58% of initial corn waste.

Field-feeding waterfowl conducted 2 flights daily to cornfields near playa lakes where the birds concentrated. The average morning flight was initiated 52 j^ 1.5 min before sunrise and terminated in 23 _+ 1 .4 min. The average evening flight began 25 j^ 2.0 min after sunset and terminated in 37 j^ 4.2 min with duration increasing as the season progressed.

Dabbling ducks fed longer and participated more in evening as compared to concurrent daily morning flights. Minimum temperatures were correlated negatively with duration of evening flights, but not

morning flights. There was no correlation between the amount of waste corn in, or the condition of, a field selected by feeding ducks with duration or initiation of feeding flights. However, the amount of corn present was correlated negatively with duration of the evening flight. Snowfall was positively correlated with duration of evening flights, but not morning flights.

Feeding flocks selected fields based on an abundance/availability hierarchy, apparently attempting to minimize foraging time. Eurned fields were preferred most when available, followed by disked fields, especially those containing >60 kg waste corn/ha. Field-feeding is an adaption to widespread agriculture, but also is a learned response to changes in wetland habitats.

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CHAPTER I

INTRODUCTION

The Southern High Plains of Texas contain 20,000-30,000 playa lakes that are the terminal drainage basins for more than 78,000 km2 of agricultural land (Huddleston and Ward 1969). knnually, these basins collect 2-3-million ac-ft of runoff water and constitute a maximum area of 136,295 ha. Most playas fill during the rainy seasons in May-June and September-October, but 90^ of the water is lost through evaporation, leaving many playas dry during other times of the year.

These unstable playas are the second-most important winter waterfowl habitat (exceeded only by the Gulf Coast) in the Central Flyway, and in years of adequate rainfall may support winter populations exceeding 1 million ducks (Euller 1964). However, waterfowl on the High Plains largely are an unexploited hunting resource (Funk et al. 1971). Indeed, the High Plains is characterized by a specific wintering population, lower duck stamp sales, and higher waterfowl survival rates when compared to the remainder of the Central Flyway. Therefore, the High Plains have been organized into the special High Plains Mallard Management Unit (HPMMU) that is regulated by a greater bag limit and longer season than other portions of the Central Flyway. Grieb et al. (1971) provided summary data justifying establishment of the HPMMU and provided results from the first experimental hunting season.

The establishment of the HPMMU has provided an attractive opportunity for developing a lease system by local landowners that may substantially suppleraent agricultural incomes and thereby encourage winter habitat development for waterfowl populations.

However, the aquifer that supplies most of the ground water for irrigation in this semi-arid region (the Ogallala Aquifer) is being depleted rapidly as pumping rates exceed recharge capabilities (Wyatt et al. 1976). Indeed, in 1977 water was pumped from some 71,400 wells (New 1977). Subsequently, with a declining groundwater supply, recent research and management efforts have concentrated on modification of playa lakes to increase availability of this water for irrigation (Huddleston and Ward 1969). More than 3,000 playas were pumped for irrigation water in 1977 (New 1977), and Eolen et al. (1979) estimated that no less than 85^ of the larger playas on the Southern High Plains of Texas have experienced some type of modification.

Rollo and Eolen (1969) suggested that playa modification adversely affected wintering waterfowl by destroying native vegetation and feeding sites in shallow water. Consequently, as playa modification is accelerated, a major research effort is needed to document the response by wintering waterfowl.

Recent work on the Southern High Plains of Texas has shown that corn is an important component of the diet of wintering waterfowl (Moore 1980). However, the actual field-feeding ecology of wintering waterfowl in the area is unknown. Further, the nutritional properties

'-•-• ---- z:.tlve watefowl foods in playa lakes largely are unknown. This study was initiated to (l) determine the dynamics of waste corn as a food resource for wintering waterfowl, (2) determine the field-feeding ecology of waterfowl wintering on the Southern High Plains of Texas, and (3) determine the nutritional properties of waste corn and native foods used by wintering waterfowl.

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CHåPTER II

DYNAMICS OF WASTE CORN AS WATERFOWL FOOD ON THE SOUTHERN HIGH PLAINS OF TEXAS

Abstract

Waste corn abundance, availability, and nutritional quality as a food source for raigrating and wintering waterfowl were investigated on the Southern High Plains of Texas from September-March, 1979-82. Waste cora underwent a variety of agricultural treatments following harvest from burning, which did not affect abundance and maxiraized availability, to deep plowing that reduced initial waste by 97^. Farmers lost 3.7 _^ 0.3^ of a potential crop with an initial field waste of 364 ^ 12 kg/ha (N=202). Disking reraoved 77^ of initial waste but increased availability by removing litter and shattering cobs. Fields that were burned or disked once received the most field-feeding use. Moisture content of corn at harvest was inversely correlated (r=-0.70) with total waste. Cornfields harvested at 14-21^ moisture lost 554 + 14 kg/ha, more than twice that of fields harvested at 22-32^. Initial corn loss (kg/ha) can be approximated by the equation Total Waste=1544 kg/ha-54 kg/ha X (percent harvest moisture). Nutritional quality of corn did not change as the season progressed. However, corn was nutritionally incomplete, particularly in protein, calcium, and amino acids, when compared to natural waterfowl foods in the area. Management suggestions to increase waste corn abundance and availability on migrating and wintering waterfowl areas include discouragement of fall plowing, curtailment of hand salvage, and burning of litter.

Introduction

Corn remaining in fields after harvest by mechanical combines (waste corn) has long been recognized as an important food source for migrating and wintering waterfowl (Eellrose 1976). Indeed, Martin et al. (1951 p. 464) rated corn as "one of the leading wildlife foods of this country". Recognizing this fact, managers often cultivate corn as a waterfowl food. For example, the National Wildlife Refuge systera anually plants some 66,000 ha of agricultural crops (U.S.F.W.S. 1976) and in the Mississippi Valley more than 30,000 ha of agricultural land are managed for waterfowl (Arthur 1968). However, there are virtually no data concerning the manageraent of waste corn (on refuges or private land) as a waterfowl food. This is especially iraportant as abundance and availability of waste corn becorae dynamic when subjected to various agricultural treatraents such as disking, plowing, and grazing.

Waterfowl characteristically feed on waste corn and norraally are not associated with daraage to the unharvested crop (Eellrose 1976). However, wildlife-related research with corn has focused largely on aspects of nongarae bird, particularly blackbird (lcteridae), daraage to sprouting or unharvested corn (Stone et al. 1972, Stone and Mott 1973, Dolbeer 1980). A.gronomic investigations have addressed factors associated with harvest losses (Jugenheimer 1976), but no data are at hand relative to abundance and availability of corn waste in response to agricultural treatraents. Further, changes in nutritional quality of waste corn during raigrating and wintering periods are unknown.

[illegible] x^ated dynaraics of waste corn abundance, availability, and nutritional quality on the Southern High Plains of Texas.

Study *krea* and Methods

Waste corn was sampled for 3 years during waterfowl raigrating and wintering seasons (Septeraber-March, 1979-82) in southeastern Castro County, which is centrally located on the Southern High Plains of Texas. Bolen et al. (1979) described the iraportance of the High Plains and associated playa lakes as raigrating and wintering habitat for waterfowl in the Central Flyway. The iramediate study area comprised 50 km2 of farraland north of Hart, Texas, of which about 45^ was planted in corn during each season. Overall, about 80^ of the 233,280 ha county area is cultivated; nearly 55,000 ha (24^) was planted in corn during 1979-82 (County Statistics 1980, 1981, 1982). Cotton, wheat, and sorghum coraprised the majority of additional crop acreage.

Freshly harvested fields were selected randomly within the study area. Sample plots were located randoraly (lO/field in 1979-80 and 5/field in 1980-81, 1981-82) with 1-2 plots placed in the center, NE, NW, SE, and SW quarters of each field. Each plot was a rectangular 8.13 X 0.50 ra (0.001 ac) within an 8.13 X 4.98 ra (0.01 ac) plot. At each plot location the number of rows per combine pass (usually 6) was determined. However, waste corn is not evenly distributed within a pass as more losses of ears occured on outside rows (1 or 6) while Vís-rnpl lnn«fas a-ría rrínr^entrated over rows 3-4 where shredded waste is discharged by the combine. Therefore, I selected row 1 or 6 as the plot corner, thus standardizing the number and type of rows included per plot which reduced within field sampling error. Corn rows were planted about 100 cra apart, thus each plot encorapassed 9 rows and 8 intervals. Identical plot dimensions and location procedures were used to re-sample fields following agricultural treatraents. However, relocating plot corners on rows 1 or 6 was not possible in disked, plowed, or bedded fields.

Kernels (single or <10 kernels/cob) were collected from the 0.001 ac plot whereas ears or pieces of ears (≥ 10 kernels/cob) were taken frora the 0.01 ac plot. Only corn visible on the ground was collected and only cobs completely covered with kernels were tallied as ears. Total waste per plot equalled ear waste + kernel waste. Samples were cleaned, ears were shelled, and a 50 g coraposite frora each field was oven dried for 48 hr at 50-55 C to obtain the oven dried weights reported here.

Data for percent corn raoisture at harvest, yield, variety of corn, field size, combine type, and row orientation were provided by farmers for most fields that were sampled. Factors affecting waste corn abundance were tested using 1-way ANOVA whereas differences between agricultural treatments were compared with paired t-tests (Steel and Torrie 1980).

Changes in nutritional quality of corn from Septeraber-March 1980-81 were measured by proximate analysis on a composite sample taken from xu„______m ^A^T^r, '^"-ing early fall, mid-winter, and late winter.

respectively (A.O.A.C. 1975). Nitrogen-free extract (NFE) was determined by subtraction. Natural plant foods most comraonly used by watefowl also were analyzed for nutrient (proxiraate analysis), raineral, and element content (k.O.k.C. 1975). Percentage data were analyzed using a randomized block design and ANOVA of the ranked data (iraan and Davenport 1980).

Results and Discussion

Factors Affecting Initial Corn Losses

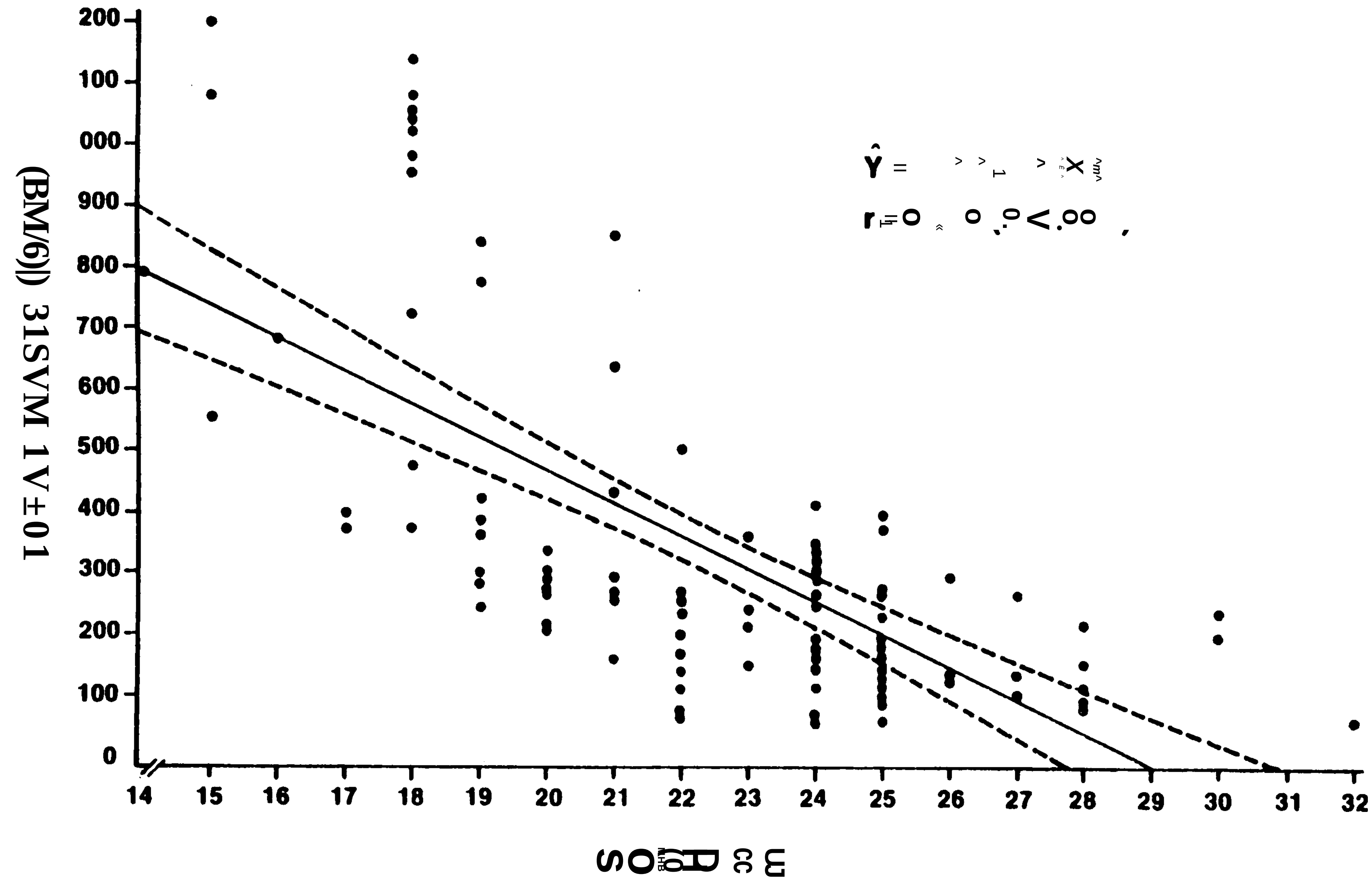
Moisture content of corn at harvest was the only factor tested that affected (P <0.001) total waste. Harvest date (days after 1 Septeraber), yield, variety, corabine type or row orientation did not influence (P>0.05) the amounts of corn left as waste. Fields harvested at 14-21^ moisture lost more than twice the corn than did those harvested at 22-26^ or 27-32^ raoisture (Table l).

Total waste (kg of waste corn/ha) was inversely correlated (r=-0.70, P <0.001) with harvest moisture (Fig. 1), and can be predicted (kg/ha) by the equation Total Waste=1544 kg/ha-54 kg/ha X (percent harvest moisture). Corn combined more efficiently at low raoistures and kernel waste was reduced (< 10^ of total waste), but the total loss increased greatly as dry ears became susceptible to dropping because of high winds or combine raovements. Shove (1970) recommended combining begin at 27-28^ moisture, which appears reasonable because farmers lost an additional 54+5 kg/ha corn per]% decrease in moisture when corn was dried in the field (Fig. l), rpimor>yo+--ir'flnTj- ^ar'n Maste occurred at 29^ moisture, but there is

Table 1. Mean (1 SE) amounts of waste corn relative to corn moisture at harvest.

Corn Moisture	N	Total Waste (kg/ha)
14-21	52	554 ± 14^
22-26	54	214 í 13^
27-32	24	183 í 20^

Means with the sa-me letter are not significantly different ($P > 0.05$), LSD test, Steel and Torrie (1980).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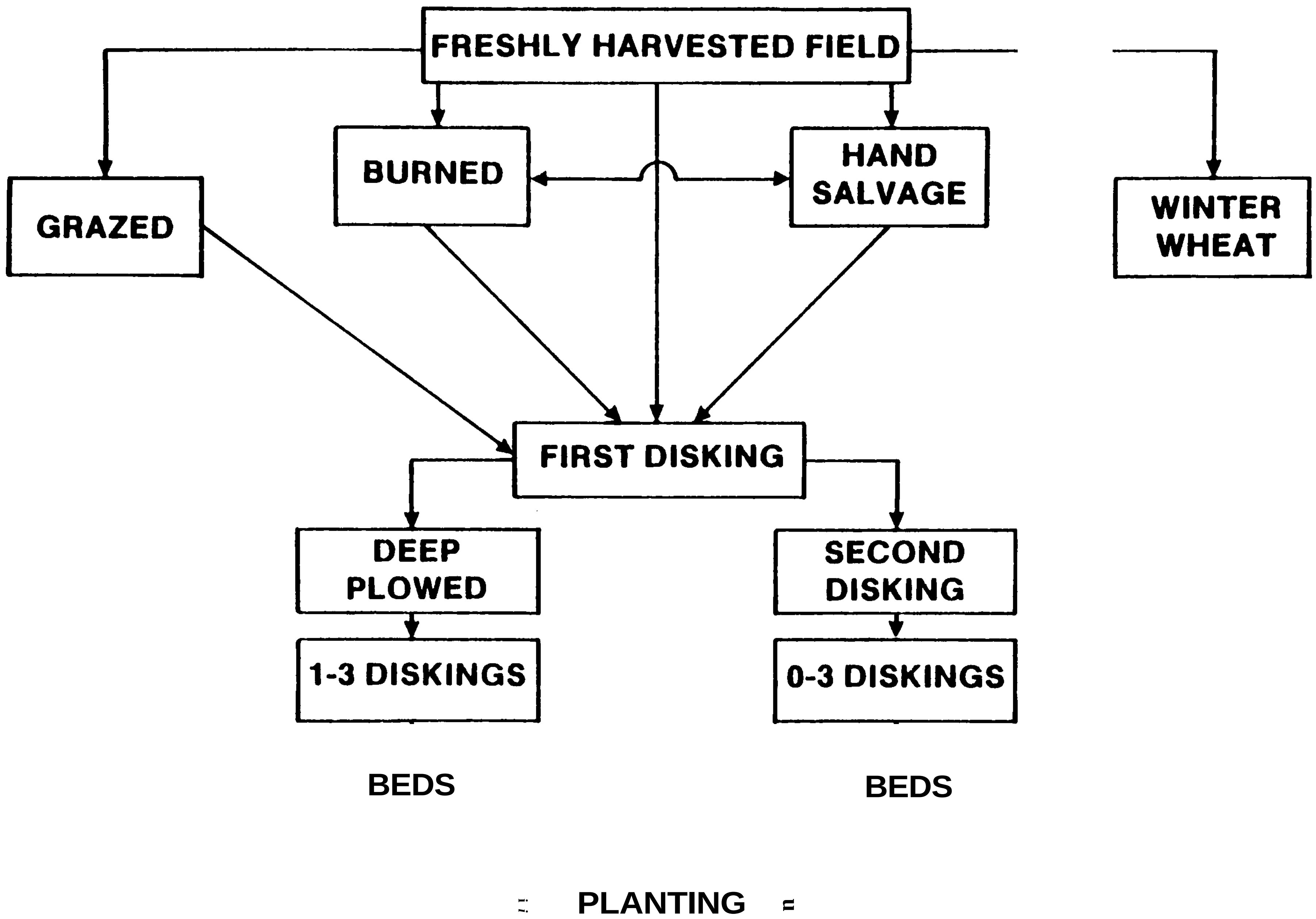
inherent high variability associated with sampling cornfields. Indeed, 43^ of a large variance occurred between fields.

Other factors can influence losses of corn including combine operation, insects, and disease (Jugenheimer 1976). However, these factors would be difficult for wildlife managers to measure under field conditions. Harvest moisture is obtained easily from farmers or elevator operators and, when used in the equation (Fig. 1), can provide a precise estimate of initial corn losses. Thus, percent moisture at harvest offers a useful tool upon which to base management decisions, modelling considerations, or surveys involving waste corn resources.

Farmers lost 3.7 ^ 0.3% (N=81) of a potential crop with only 6 fields losing more than 10^. Average loss in fields sampled over 3 seasons was 364 ji 23 kg/ha (N=202) of which 70^ was ear waste and 30^ was kernel waste. Pickard (1955) reported an average loss of 6% whereas estimates by Jugenheimer (1976) ranged from 2-15^. The rate of loss associated with corn harvest along the Platte River, Nebraska, averaged 6-7^ (U.S.F.W.S. 1981).

Factors Affecting Waste Corn Abundance and /Vvailability

k freshly harvested cornfield undergoes a variety of agricultural treatments before re-planting, each affecting waste corn abundance and availability (Fig. 2). Burning had no impact on abundance but increased availability by removing most stalk and leaf litter. In ___4.^«4. „„4.„„„ -1--^ + ing of winter wheat required complete tillage of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[illegible]

a field and rendered corn unavailable to waterfowl.

Grazing by cattle, sheep, or hogs is a common agricultural practice in harvested cornfields. Cornfields in the study area were grazed by cattle, which reduced total waste by 84^ and the number of ears/ha by 98^ (Table 2). However, farmers tended to graze cattle on fields where waste was most abundant. Thus, when grazing was completed, substantial waste corn (73 ;^ 30 kg/ha) remained for waterfowl because of its high initial abundance (Table 2).

Hand salvage of waste corn by resident or migrant laborers also was a common practice. However, impact on corn abundance was difficult to measure as salvage patterns usually were random; thus, re-sampling results often were too varied to accurately measure this impact. Fields sampled where salvage operations were more systematic showed that laborers removed 58^ of the available waste corn (Table 2).

Currently, hand salvage has a negligible impact on waste corn resources because of the extensive acreage planted. However, as ground water diminishes on the Southern High Plains of Texas, farmers will greatly reduce acreages of corn and other irrigated crops (Wyatt et al. 1976). Therefore, if resident/migrant laborer populations remain high, salvage operations may become concentrated on fewer acres and substantially reduce the availability of waste corn to waterfowl.

The majority of freshly harvested fiel(3s undergo an initial disking that breaks up rows and soil to depths <20 cm. (Fig, 2). First [illegible] jaste by 77^ and the number of ears/ha by 79^

Table 2. Changes in waste corn abundance (mean í SE) following various agricultural treatrraents of freshly harvested fields on the Southern High Plains of Texas .

Treatments		Total Waste (kg/ha)	Ear Waste (kg/ha)	Kemal Waste (kg/ha)	No. ears/ha
Fresh to first disking (N = 68)	Fresh	275+26	206Í24	69Í5	619Í75
		(-77)**^^	(-71)**	(-93)**	(-79)**
	Disked Once	63Í7	59Í7	5Í0.5	133Í19
Disked once to disked twice (N = 19)	Disked Once	64+20	60±19	3.5Í1	91Í36
		(-36)NS	(-38)NS	(+30)NS	(-45)NS
	Disked Twice	41±8	37Í7	5±1	50Í14
Fresh to grazed (N = 11)	Fresh	466+142	409Í141	57±8	1209Í408
		(-84)*	(-97)*	(+7)NS	(-98)*
	Grazed	73+30	11±4	61±30	26Í7
Fresh to hand salvage (N = 6)	Fresh	787+108	738±111	50Í9	2123Í299
		(-58)**	(-61)**	(-6)NS	(-64)**
	Hand Salvage	333Í93	286±82	47±14	760Í221
Fresh to deep plow (N = 5)	Fresh	238±58	178Í60	61Í11	547Í208
		(-97)*	(-97)*	(-99)*	(-99)*
	Deep Plow	6±2	5±2	0.8Í0.4	4±4
Fresh to end of season. All treatments (N = 70)	Fresh	289±6	221Í29	73Í6	660±90
		(-92)**	(-94)**	(-96)**	(-98)**
	End Season	22±5	14Í3	3Í0.5	16Í5

v{   * ^

P < 0.05; P <1 0.001; NS = no significant difference between means.

Number in parentheses is % change.

(Table 2). However, disking increased availability of remaining corn by reducing stalk and leaf litter and shattering ears into smaller pieces, which facilitated use by waterfowl. Indeed, disked fields, particularly those with >60 kg waste corn/ha, were preferred by field-feeding waterfowl. There were no differences (P >0.05) in corn abundance between the first or second disking operations (Table 2).

Burned fields maximized waste corn abundance and availability more than any other agricultural treatment. Litter in freshly harvested fields is extensive and thus decreases the availability of waste corn; such fields are rarely used by field-feeding waterfowl. Burning often removed all harvest litter but did not destroy corn except for a negligible amount of kernel waste. Burned fields were often disked within 1-4 days but, when they remained available, they were most preferred by field-feeding waterfowl.

Deep plowing reduced the abundance of waste corn more than any other agricultural treatment (Table 2). Deep plowing involves a tillage practice that turns soil over from depths of 30-45 cm (Fig. 2). However, this practice was uncommon because it requires more time and energy than conventional disking and it is not necessary each year. Freshly harvested fields that were disked once and then deep plowed lost 97^ of total waste, a reduction whereby only 6 jj^ 2 kg/ha remained in a field (Table 2).

Following a second disking, fields may undergo numerous disking-type activities involving a variety of farm equipment that does not . „ T T „ 4- -• T T '0,-il b^low 20 cm. It was difficult to distinguish treatments following second disking, thus they seldom were sampled. However, in fields where data were obtained additional diskings rarely reduced abundance below the effect of a first or second disking. /^dditional diskings broke available corn into smaller pieces and, coupled with the overturn of soil, the net change of visible corn on the surface was minimal. Generally, I would estimate that agricultural treatments beyond the first or second diskings, if not involving deep plowing, reduced abundance by 75-90^ from levels in freshly harvested fields.

Waste cornfields had undergone numerous agricultural treatments and/or waterfowl use by late February-March. Fields sampled in late February-March lost 92^ of their initial waste, leaving 22+5 kg/ha (Table 2). However, by the end of the season, there were always several fields retaining > 60 kg/ha. Thus, although reduced in number, fields with abundant corn resources still were available to waterfowl. Cornfields were not sampled at the end of the 1979-80 season, but there were no differences (P >0.05) in the amounts of waste corn available at the end of the 1980-81 season as compared to 1981-82.

Nutritional /Vspects of Waste Corn

There were no changes (P >0.05) in nutritional quality of waste corn as the season progressed (Table 3)» Corn was highest in carbohydrate value but lower in protein content and most elements and minerals (especially calcium) when compared to natural foods (Table 4). Indeed, the average content of natural foods was 37^ higher in ís tjil;.^' 9.7 tiraes more calcium than corn (Table 4).

Table 3. Proximate analysis of waste corn sampled during the vTÍnter waterfowl season of 1980-81 on the Southern High Plains of Texas.

Period	N	Protein	Fat	NFE	Fiber	Ash
Fall (Sept.-Oct.)	10	10.5	3.5	82.1	2.4	1.5
Mid-winter (Dec.-Jan.)	10	10.5	3.7	81.3	2.4	1.9
Late-winter (Feb.-Mar.)	10	10.8	3.5	81.5	2.4	1.8

Means within the same column are not significantly different ($P > .05$).

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Further, protein in corn is deficient in amino acids, notably lysine, tryptophan, and methionine which are essential for body maintenance of all higher animals (Schaible 1970, Sturkie 1976). The calcium deficiency of corn is severe because vertebrates require calcium for formation and maintenance of skeletal structures, blood clotting, and normal heart functions (National Research Council 1977).

Overall, natural foods are nutritionally more complete than corn. Reinecke and Owen (1980) noted the high protein content of invertebrate foods in general and Sugden (1973) stated that midge (Chironomidae) larvae provided the most complete range of amino acids for developing ducklings. iVlthough normally participating in 2 field-feeding flights daily, waterfowl in the study area also spent considerable time foraging for plant and invertebrate foods, perhaps offsetting nutritional deficiences associated with a corn diet.

Conclusions and Management Recommendations

Waste corn becomes a dynamic waterfowl food source in response to agricultural treatments. Managers can determine initial harvest losses using the equation in Fig. 1 and determine subsequent losses from agricultural treatments from data in Table 2.

Management decisions relative to waste corn will depend on local considerations, including acreages of waste corn available and the sizes of bird populations present, but managers should attempt to maximize corn availability throughout the migrating and wintering

: l'_le maximizes the availability of corn, thus greatly decreasing waterfowl foraging time yet ultimately insuring the greatest use of initial waste. Fall plowing should be discouraged, particularly when plowing depths exceed 30-45 cm. This will enhance the availability of food, particularly in regions were corn is planted in low acreages. Hand salvage also should be discouraged in this situation.

Grazing is an acceptable management practice, particularly on private lands. Landowners graze cattle in fields where initial losses are heavy and termination of grazing still leaves corn abundant. Further, grazing delays fall plowing and cattle can increase the availability of corn during snowfalls by trampling litter and snow. Jorde (I98I) found that mallards (ånas platyrhynchos) preferred grazed cornfields during periods of snowfall.

Approximate estimates of corn consumption and expectations about waterfowl utilization (i.e., use days) should be determined in the management process. For example, in the study area, waterfowl made 2 field-feeding flights daily, usually to fields disked once (63 ;^ 7 kg/ha, Table 2). I found that mallards and green-winged teal {_k. crecca) consumed up to 100 g and 40 g respectively, per flight. Therefore, a 100-ha field that is disked once could provide 31,500 mallard or 78,750 green-winged teal-use days.

Waste corn never should be considered a substitute for, but rather a supplement to, natural foods. Migration/winter waterfowl management programs must provide abundant natural foo(3s to offset the nutritional ....•-•--- ^^ith corn. However, the high energy content of corn cannot be ignored, and efficient management of this resource by the public and private sector should be an integral part of the continental waterfowl management program.

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CHAPTER III

FIELD-FEEDING ECOLOGY OF WATERFOWL WINTERING ON THE SOUTHERN HIGH PLAINS OF TEXAS

Abstract

The ecology of field-feeding dabbling ducks wintering on the Southern High Plains of Texas was investigated on a 50 km2 study area in Castro County from September-March, 1980-82. Ducks participated in 2 feeding flights/day to waste cornfields occupying about 45^ of the study area and providing numerous combinations of waste corn abundance and availability. The average morning flight was initiated 52 + 1.5 min before sunrise and terminated in 23 +1.4 min. The average evening flight began 25 +2.0 min after sunset and ended in 37 + 4.2 min with duration increasing as the season progressed. Eirds fed longer and participated more in the evening versus morning flight. Minimum temperatures were correlated negatively with duration of evening flights, but not morning flights. There was no correlation between the amount of waste corn in or the condition of a field selected by feeding ducks. However, the amount of corn present was correlated negatively with duration of the evening flight. Snowfall was positively correlated with duration of evening flights, but not morning flights. Feeding flocks selected fields based on an abundance/availability hierarchy, apparently attempting to minimize foraging time. Eurned fields were preferred most when available, followed by disked fields, especially those containing >60 kg waste corn/ha. Field-feeding is an adaption to widespread agriculture, but also may be a learned response to changes in wetland habitats.

Management recommendations for increasing use of waste corn by postbreeding waterfowl include burning and disking corn stubble.

Introduction

Field-feeding by waterfowl is a widely documented occurrence (Eellrose 1976). However, most studies have focused on aspects of crop depredation by aggregations of postbreeding waterfowl on the Canadian prairies prior to fall migration (Bossenmaier and Marshall 1958, Sugden 1976). Hence, there is a paucity of information relative to the field-feeding ecology of waterfowl away from northern breeding areas.

Indeed, Fredrickson and Drobney (1979) emphasized the urgent need to gather information on the ecology of postbreeding waterfowl. These data are particularly lacking from winter quarters where waterfowl may spend 8-9 months of their annual cycle, but where crop depredation is usually not a problem because waterfowl feed on agricultural waste following harvest (Eellrose 1976).

Reinecke (1981) correctly identified the need to determine the functional roles of habitats for wintering waterfowl. However, the impact of agriculture in meeting the requirements of wintering waterfowl is not well understood. Consequently, this study was initiated to determine the temporal and spatial aspects of field-feeding by dabbling ducks on the Southern High Plains of Texas, with emphasis on the timing and duration of feeding flights, and factors affecting field selection.

This study was conducted on privately-owned farmland in Castro County, Texas, where I sincerely thank farmers for access privileges to their properties. I especially acknowledge L. and L. Lee, T. and W. Hill, J.D. Myrick and family, J.R. Davis and family, D. Erown, A. McLain, Mr. and Mrs. E. Davis, Mr. and Mrs. H.H. Buchanan, F.A.. Smith, P. Upshaw, W.T. King, and E. Bennett. E. Quinlan, G. Huber, C. Lunn, and R. Whyte assisted in all phases of the field work. This study was supported by the USDA Forest Service, Rocky Mountain Forest and Range Experiment Station through the Great Plains Wildlife Research Laboratory, the Caesar Kleberg Foundation for Wildlife Conservation, and the Department of Range and Wildlife Management at Texas Tech University.

Study Area

The semi-arid Southern High Plains of the Texas Panhandle contain 20,000-30,000 playa lakes that are the terminal drainage basins for more than 78,000 km2 of agricultural land (Huddleston and Ward 1969). This region is among the most intensively cultivated in North åmerica with cotton and cereal grains, largely corn, wheat, and sorghum, comprising the majority of crop acreage. It is this combination of playa lakes situated within the agricultural regime that provides the second-most important winter habitat for wintering waterfowl in the Central Flway. Indeed, in years of adequate rainfall the playas may support winter populations exceeding 1 million ducks (Euller 1964). The most abundant wintering species are the pintail (*Anas acuta*), mallard (*k*, platyrhynchos), green-winged teal (A.. crecca), and wigeon

Corn has become an important food for these wintering populations, comprising some 93^ by volume of the winter diet in a sample of 243 ducks (Moore 1980). Bolen and Guthery (1982) provided a summary of the general relationships between playa lakes, agriculture, and wintering waterfowl on the Southern High Plains of Texas.

The study area was located centrally on the Southern High Plains of Texas, in southeastern Castro County. A. 50 km2 area of farmland immediately northeast and northwest of the town of Hart comprised the specific study site; about 45^ of this area was planted in corn from 1979-82. This area also contained 4 permanent playas of 10-15 ha in size, insuring a large population of wintering waterfowl during each season of the study.

Overall, about 80^ of Castro County is cultivated, with corn (24^) the dominant crop planted from 1979-82 (County Statistics 1980-82). The county also contains 607 playa basins totalling about 6,400 ha (Schwiesow 1965, Grubb and Parks 1968).

Methods

kll freshly harvested cornfields within the study area were sampled randomly during the 1980-81 and 1981-82 wintering seasons to determine the abundance of waste corn potentially available to waterfowl. Cornfields were re-sampled to measure changes in corn abundance following the agricultural treatments of disking, plowing, grazing, and use by field-feeding ducks. Detailed sampling methods and the

]r ísi/âcrxeMiTCMral treatment on waste corn abundance and availability are described in Chapter II.

Field-feeding flights were observed from 1 October-15 March during both seasons. The timing of morning and evening flights was recorded as the time of flight initiation from a playa (10^ of flock), time most birds departed (75-90^ of flock), and the time the last birds departed (10^ of flock), which in most cases closely corresponded to timing of arrival and departure from feeding fields. Flight duration represented the time spent in cornfields. The flight interval was the time from initiation or arrival to last departure. Differences in timing and duration between years were compared using a t-test (Steel and Torrie 1980). Relationships between timing and duration of feeding flights with ecological variables (abundance and availability of waste corn, maximura and minimum daily temperatures, snowfall, flock size, and timing and duration of flights) were analyzed using Spearman correlation coefficients (Conover 1980). Differences between years in harvest chronology of cornfields and distribution of waste corn were tested using chi-square analysis (Conover 1980).

The percent of available waste cornfields was categorized within each season as freshly harvested or burned fields with > or < 700 kg of corn/ha, grazed, or disked with > or < 60 kg of corn/ha. Cornfields planted in winter wheat or undergoing manual salvage were grouped as 'other'. The percent of field use was determined by calculating the number of flight-days occurring within each category of available cornfields. Flight-days/field equalled the average number of ducks observed/field X the number of days the field was used V o ^i j „i,4.„/^„„ F-'Vcld preference was measured using the formula (percent use - percent available)/(percent use + percent available) as presented by Ivlev (1961). This index yields values from -1 (avoidance) to +1 (preference) with a value of zero equivalent to no preference.

Results

A.bundance of Waste Corn Resources

Corn harvest was initiated by 1 September and terminated by 14 October during both seasons. There was no difference (P >0.05) in harvest chronology between years. The harvest was about 70^ completed between 15-30 September and 90^ completed by 1 October.

Corn was planted in 78 fields covering 40.5^ and 45.6^ of the study area during the 1980-81 and 1981-82 seasons, respectively. Total corn waste/field was not different (P >0.05) between seasons, averaging 358 ± 38 kg/ha in 1980-81 and 329 1 33 kg/ha in 1981-82. Additionally, during 1981-82, another 20.2^ of the study area was planted in corn harvested for silage in late August and early September. These fields were re-planted in winter wheat by the first week of October.

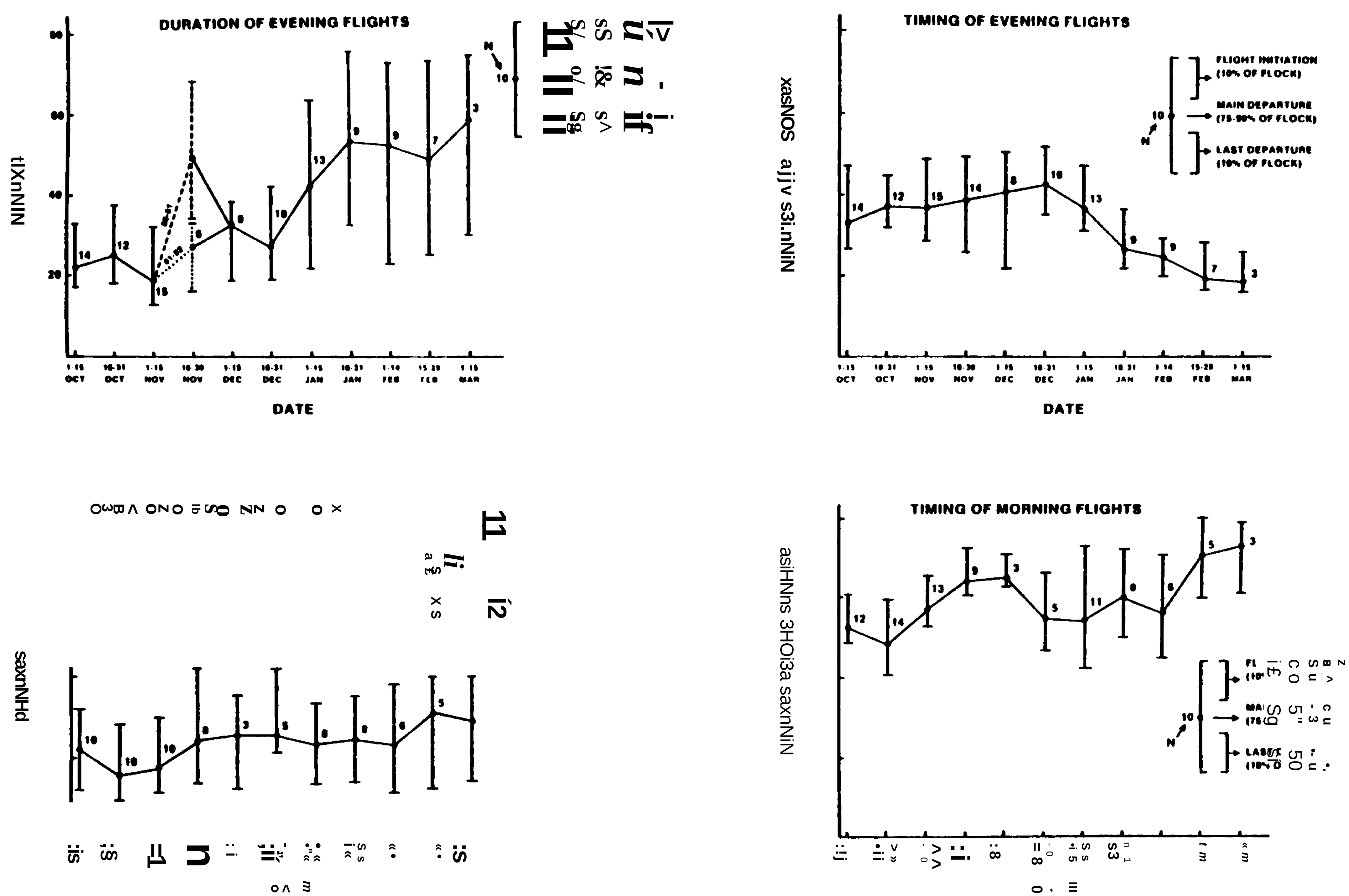
The amount of waste corn/field varied from <100 kg/ha to >700 kg/ha. However, there was no difference (P >0.05) between seasons in the distribution of field wastes (Table 5).

Timing and Duration of Field Feeding Flights

Waterfowl normally participated in 2 field-feeding flights daily (before sunrise and after sunset). Flocks nearly always represented interspecific aggregations of pintails, green-winged teal, wigeon, and mallards. Pintails and green-winged teal were most abundant during both seasons, comprising about 50-75^ of most feeding flocks. Distances flown from playa lakes to cornfields rarely exceeded 5 km, with the longest flight observed being 15 km. It was assumed that flocks foraging in fields outside the study area were not selecting different types of fields than those within the study area, but were foraging within a larger cruising radius. Indeed, this was the case on the 20 occasions when these flocks were followed outside the study area.

There were no differences (P >0.05) in the timing of departure (excepting initiation of morning flights in November) or duration of morning flights between the same months of different seasons. The November difference was only 5 min, therefore timing and duration data for the same months in different seasons were combined (Fig. 3). The seasonal average for initiating morning flights was 52 j|^ 1 .5 min before sunrise, with most birds (75-90^) departing at 44 :|: 1 .6 min before sunrise. The entire flock departed in a 10-15 min interval, which tended to increase as the season progressed. The last birds in an average morning flight returned 16.5 1 1•1 °iin before sunrise with no flights, except during snowfall, terminating after sunrise. The seasonal average for the duration of morning feeding flights by most

The average interval of flight duration (23 +


DURATION OF EVENING FLIGHTS
TIMING OF EVENING FLIGHTS
FLIGHT INITIATION (10% OF FLOCK)
MAIN DEPARTURE (75-90% OF FLOCK)
LAST DEPARTURE (10% OF FLOCK)
TIMING OF MORNING FLIGHTS
DATE
1-15 OCT
16-31 OCT
1-15 NOV
16-30 NOV
1-15 DEC
16-31 DEC
1-15 JAN
16-31 JAN
1-14 FEB
15-28 FEB
1-15 MAR

1.2 min) was relatively constant throughout the season (Fig. 3).

There were no differences ($P > 0.05$) between the same months of different seasons in the timing of departure or duration of evening flights (except duration in November), therefore, these data also were combined (Fig. 3). The seasonal average for departure of most birds was 25 jj^ 2.0 min after sunset. Flocks departed in a 10-15 min interval, which decreased as the season progressed. Most birds returned to playa lakes 52 _+ 2.8 min after sunset.

The seasonal average for duration of evening flights by most birds was 37 _^ 4.2 min. However, duration from October-January averaged 27 _+ 2.1 min, which was shorter ($P < 0.05$) than duration from January-March (53 '● 2.6 min). Further, the interval of duration increased greatly as the season progressed, averaging 19 + 0.6 min from October-January and 46 + 1.4 min from January-March. The increased flight duration in late November of the 1980-81 season reflects the occurrence of 2 snowstorms of about 15 cm accumulation.

Factors Affecting Timing and Duration of Field-Feeding Flights

The minimura temperature 1 day before a feeding flight was correlated negatively ($P < 0.05$) with initiation of morning flights, but minimum temperatures were not correlated ($P > 0.05$) with initiation of evening flights (Table 6). Snowfall was correlated negatively ($P < 0.05$) with initiation of evening flights but not morning flights. Although cloud cover was not measured directly, evening flights were -; n-i-t-T a-f-dH ahon-h 10-11^ min earlier during corapletely overcast

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rho
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conditions. The abundance of waste corn in various categories was not correlated with initiation of evening flights, but was correlated (P <0.05) with initiation of the morning flight (Table 6).

The percentage of freshly harvested cornfields was negatively correlated with duration of the morning flight and positively correlated with the evening flight (Table 7). There was no correlation between the amount of waste corn in, or the condition of, a field selected by a feeding flock and initiation of flights. Flock size was positively correlated (P <0.08) with initiation of morning flights but correlated negatively (P <0.01) with initiation of evening flights.

Minimum temperatures were not correlated (P >0.05) with duration of morning flights but were correlated negatively (P <0.001) with duration of evening flights (Table 7). Snowfall was correlated positively (P <0.001) with duration of evening flights but not morning flights. Condition of a cornfield selected was not correlated with duration of morning or evening flights, but the amount of corn present was correlated negatively (P <0.01) with duration of the evening flight (Table 7). Flock size was correlated positively (P <0.05) with duration of the morning and evening (P <0.01) flights.

Field-Feeding Preference

Field-feeding waterfowl selected fields based on availability rather than abundance of waste corn during both seasons (Table 8).

grazed fields usually were avoided during

Var...

Flock size

17.

31.1 1.0

21.8

12.9 0.0 -1.0

12.9

1980-81 because these fields contained extensive litter that decreased the availability of corn (Fig. 4). Exceptions occurred during 1-15 October when only a small percentage of burned or disked fields were available and again in November when snowfall covered more preferred fields. During periods of snow accumulation, the ridges of planting beds were windswept clear and small amounts of corn became available. Thus, these fields received use while corn in disked fields remained snow covered and unused.

Feeding flocks always preferred burned fields when they were available, regardless of the amount of waste corn present (Table 8). Burning maximized abundance and availability of waste corn by removing harvest litter (Fig. 4). Disked fields, especially those containing >60 kg waste corn/ha, where always used by waterfowl when available. Disking increased availability by removing some litter (Fig. 4); disking decreased the initial abundance of corn by about *11%,* Most fields were disked during January-February, but waterfowl preferred fields of >60 kg waste corn/ha and avoided fields of <60 kg/ha. Disked fields with <20 kg waste corn/ha never were selected by field-feeding waterfowl in 1980-80 or 1981-82.

The silage fields available to field-feeding waterfowl during the 1980-81 season were used extensively before their conversion to winter wheat. This was particularly true during late /^ugust and September when these fields received extensive use by migrating blue-winged teal (Anas discors) and early-arriving pintails. These fields were not sampled to determine the abundance of waste corn, but were estimated

~ ^.,^.Vha. However, silage fields received use in

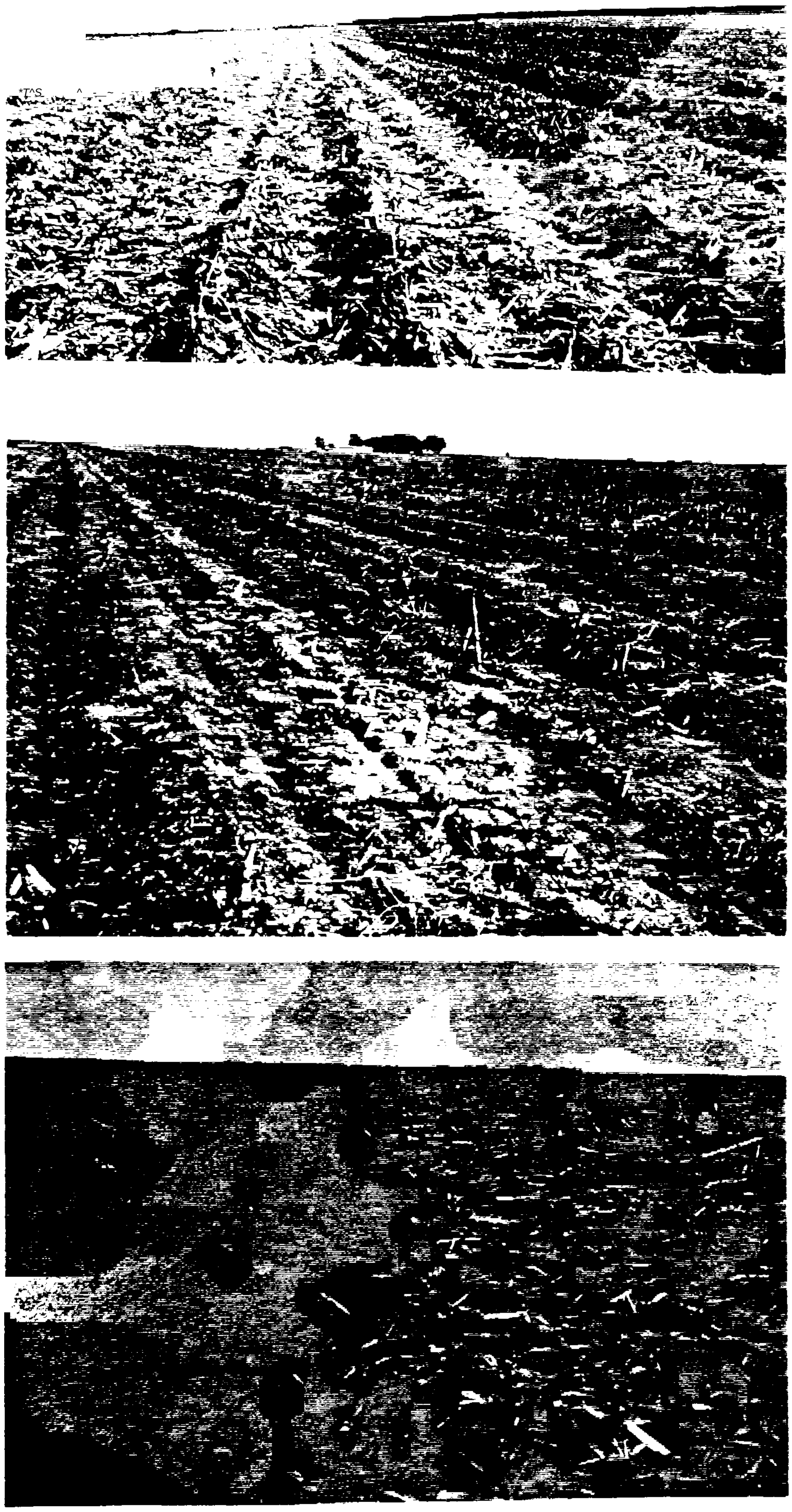

Figure 4. Changes in the availability of waste corn on the Southern High Plains of Texas following the agricultural treatments of harvesting (top), burning (middle), and disking (bottom) Field-feeding waterfowl preferred burned and disked fields.

late summer because normal harvest of corn had not yet begun in earnest and silage fields do not contain harvest litter that decreases attractiveness to waterfowl.

Field preferences could not be determined from 1-15 October during the 1981-82 season because waterfowl populations in the study area were <1,000 birds and could not be followed reliably to fields (Table 8). Overall, preference patterns were similar to those of 1980-81, except that freshly harvested and grazed fields were avoided throughout the 1981-82 season because there was no substantial snowfall and waste corn was more available elsewhere (e.g., burned and disked fields). When available, burned fields were preferred most, followed by disked fields with >60 kg waste corn/ha. Feeding flocks usually avoided or did not prefer disked fields with <60 kg waste corn/ha, especially during January-February when most fields had been disked.

Of 14 disked fields sampled following their use by waterfowl, an initial average of 74 kg waste corn/ha was reduced to 15 kg/ha (80^) before the birds selected a new field.

Field-Feeding Eehavior

Waterfowl participated in morning and evening flights except during periods when fields were covered by snow. Daytime feeding flights were observed only at this time with birds constantly moving from playa lakes to fields. These daytime flights involved pintails, ___J_____IT____J but rarely green-winged teal, that remained resting on playas in tightly packed flocks. Not all of the larger species participated in daytime flights. However, all birds, including green-winged teal, engaged in the normal morning and evening flights. Also, ducks participating in daytime flights often did not select the best available fields. Indeed, on 3 occassions mixed flocks of >2,500 birds were observed landing in plowed cotton fields.

During normal morning and evening flights, the flocks landed on fields in densely packed groups and then spread over the field by walking. Although nighttime observation was difficult, even with night vision equipment, birds appeared to spend most time searching for, or ingesting, food.

Not all birds participated in the normal field-feeding flights. It was not possible to gather data constantly on this aspect of field-feeding ecology, thus results reported here are largely qualitative, but some distinctive trends were apparent. There always were more non-participants in morning versus concurrent daily evening flights with non-participants usually comprising 5-20^ of the birds on a playa but at times exceeding 5Qf%. The percentage of non-participants decreased as the season progressed and was virtually zero, especially during evening flights, when temperatures were below -7 C.

/ p/

Discussion

Field-Feeding Ecology

Field-feeding behavior provides several insights toward understanding the ecology of postbreeding waterfowl. Firstly, participation in 2 flights daily appears the general rule (Bellrose 1944 1976, Hochbaum 1944, Bossenmaier and Marshall 1958, Winner 1959). Morning flights are initiated about sunrise whereas the second flight begins in late afternoon or evening. Moming flights may begin earlier in Texas because waterfowl wintering at more northerly latitudes may need to feed sooner in response to cold nighttime temperatures. However, it is difficult to explain why evening flights always began after sunset. Tamasier (1976) noted a similar departure time for pintails and green-winged teal wintering in Louisiana. Perhaps changes in departure times reflect a need to increase overall foraging time in response to fluctuations in the availability of food resources associated with agricultural habitats.

The evening flight was more important than the morning flight to waterfowl wintering on the Southern High Plains of Texas. The evening flight always was longer and contained fewer or no non-participants compared to concurrent morning flights, indicating that birds consumed'^ more food in preparation for cold nighttime temperatures. 1 Kendeigh et al. (1977) stated that energy defecits in birds are greatest at night thus, if waterfowl consume more corn during evening flights, they increase the probability of surviving the night with a positive energy balance. ' Indeed, overnight storage of food in the crop can augment lipid storage in birds (Calder and King 1974). klso, the progressive increase in the interval of the evening flight's duration suggests that birds will remain in fields until sufficient food is obtained rather than follow the majority of the flock back to roosting playas, which is a behavior they could afford energetically during warmer temperatues earlier in the season. Further, birds spent more time in fields during evening flights in response to cold weather, whereas temperature did not influence duration of morning flights. However, low temperatures caused earlier initiation of morning flights, presumably because food in the crop would be used faster than on warmer nights. Eossenmaier and Marshall (1958) found that hunger influenced punctuality of morning flights.

Feeding flocks may use the evening flight as the primary time to locate new fields. Earlier initiation times coincided with intensified plowing of corn stubble that reduced the number of fields where corn was abundant and available; yet birds always located the 'best' fields. Early departure may have been necessary to increase searching time. General observations indicated that shifts in field use occurred during evening flights with foraging flocks returning to the same field on the following morning. During snowfalls corn became less available and the existing pattern of field use was broken. However, non-participation by green-winged teal in these daytime flights represents an interesting strategy for a small-bodied bird and may warrant further study.

Field-Feeding Preference

Habitat selection occurs when animals exhibit a choice among available habitats rather then ocuppylng them differentially in response to extrinsic factors such as predation and corapetition (Wiens 1976, 1977). Extrinsic factors were not considered to influence the choice of fields thus, data presented here may provide a true measure of habitat selection for waterfowl wintering in an agricultural regime.

Lack (1954) has propossed that abundance and availability of food is the major natural factor regulating the population size of most bird species. If so, general theory would predict that rainimization of foraging time would become a strong selective pressure. This was reflected by field-feeding waterfowl that preferred cornfields where foraging time was minimized because of increased availability of waste corn.

However, the interaction between abundance and availability of food is complex. *k* highly abundant food source may require no raore foraging time than a less abundant, albeit highly available source. Field-feeding waterfowl selected fields based on an abundance/availability hierarchy, thus when fields with highly available waste corn (i.e., burned or disked fields) are lacking, flocks prefer freshly harvested fields with the most abundant corn (i.e., >700 kg/ha). However, when fields with more available corn are present, birds prefer those where corn is most abundant (e.g., disked >60 kg/ha over disked <60 kg/ha).

The Occurrence of Field-Feeding

Field-feeding by waterfowl is an adaptation to widespread and intensive agriculture, a hypothesis advanced by Bossenmaier and Marshall (1958). However, and more importantly, field-feeding behavior may also reflect a learned response to changes in wetland habitats. Historically, field-feeding on the Canadian prairies was documented in the early 1880's. Geese probably field-fed following the first grain harvests in that area, but field-feeding by puddle ducks was uncommon until the 1920's. Intense problems of crop depredation began in the 1930's and were not well established until the 1940's; these flights reportedly involved only mallards and pintails (Bossenmaier and Marshall 1958).

Noticeably, field-feeding by puddle ducks began and accelerated coincident to the period of greatest wetland losses in North /Uaerica. The extent and distribution of these losses is documented in the literature and need not be repeated here. However, this period (1930-1950's) coincides with numerous reports of crop depredation problems throughout North America and involved adaptable species such as mallards, pintails, and to a lesser extent, wigeon (Kalmbach 1935, Horn 1949, Biehn 1951, Colls 1951). Losses of wetlands max.have forced dabbling ducks into a learned response of exploiting agricultural crops because wetland habitats no longer provided abundant, available, and nutritionally complete food resources for large postbreeding populations.

This study has now documented extensive field-feeding behavior in

1 i_ •n ,jich as green-winged, blue-winged, and probably

cinnamon teal (Anas cyanoptera). These species, especially the green-winged teal, usually prefer to feed on mudflats or in shallow marshes (Bellrose 1976). However, widespread playa lake modification and competition for water resources on the Southern High Plains of Texas (Bolen and Guthery 1982) may limit the availability of preferred feeding sites and force teal to field-feed. Late summer irrigation of corn and early fall watering of wheat reduces water volumes in playa basins, which, if not replenished by September-October rains, renders productive littoral zones dry and unavailable to waterfowl. Indeed, during September-October, 1980, the area received only 6.0 cm of rainfall, with blue-winged and green-winged teal beginning field-feeding flights upon their arrival to the area (late August). However, in September-October, 1981, 17.7 cm of rainfall occurred and extensive field-feeding did not occur until October.

If an abundant and available source of natural foods always was present in playa lakes there would be an advantage for dabbling ducks to feed there and forego field-feeding, because birds would obtain a diet nutritionally more complete than corn. Also, birds would not engage in energetically costly flights to stubble fields and foraging time may be reduced because moist-soil vegetation can produce more than 1500 kg of seed/ha, which is greater than the amount of waste corn available in most freshly harvested and all disked cornfields (Fredrickson pers. cornm.)* However, field-feeding may reflect a learned response whereby dabbling ducks begin to field-feed whenever this activity minimizes foraging time over that in natural wetlands. Bossenmaier and Marshall (1958) noted that waterfowl in Manitoba fed [illegible] -/en when waste grainfields were available.

Therefore, field-feeding by dabbling ducks maybe a learned response to decreased abundance of food in natural wetlands and reflective of overall degredation and/or losses of wetland habitats.

Management Recommendations

Waterfowl managers should attempt to maximize the use of waste corn resources by postbreeding waterfowl. The theoretical goal in refuge situations should be to have all waste corn consumed by waterfowl. Eurning stubble maximizes availability and ultimately assures the greatest use of corn by minimizing foraging time, which should increase use-days on a particular field. A.lso, burning stubble does not destroy the ridges of planting beds, thus during snowstorms they may be windswept clean, which would make some corn available. Further, because birds prefer burned fields, this practice could hold birds on refuges or influence flock movements, which may be important to lure birds from contaminated crops, zones of excessive hunting pressure, or to alleviate crop depredation elsewhere. Also, a patchwork of burning within an extensive corn regime may distribute birds more evenly and increase hunting and/or viewing opportunities, and assure a constant, readily available food resource.

Disking should be discouraged because, although increasing availability of waste corn, it substantially reduces initial abundance and becomes unavailable during snowfall. However, disking may be acceptable on private lands if fall plowing, particularly deep plowing, is not extensive. Grazing is an acceptable practice on :" ": ielays fall plowing and substantial amounts of corn remains when grazing terminates. Also, cattle trample litter and break-up snowfall, which can increase the availability of corn to waterfowl.

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