AN ABSTRACT OF THE THESIS OF

Maura B. Naughton for the degree of Master of Science in Wildlife Science presented on June 12, 1992.

Title: Relations between the distribution of Canada geese and the quantity and quality of forage at W. L. Finley National Wildlife Refuge, 1984 - 1987.

Abstract approved: Redacted for Privacy

Robert L. Jarvis

I studied the relation between the distribution of Canada geese (Branta canadensis) and the quantity and quality of forage at W. L. Finley National Wildlife Refuge during three winters, 1984-85 through 1986-87. The objectives of the study were: (1) determine the size and subspecies composition of the winter population at the refuge, (2) document the seasonal pattern of use of grass fields, (3) document the seasonal changes in the quantity and quality of forage in the fields and (4) determine the relation between use of fields by geese and the quantity and quality of forage in those fields. Forage quantity (height and cover) and quality (nitrogen and fiber) were measured in nine study fields of four forage types: annual ryegrass (Lolium multiflorum) perennial ryegrass (L. perenni), tall fescue (Festuca arundinacea) and pasture of grasses and forbs. Peak winter populations of 14,000 and 19,000 geese were counted during

1984-85 and 1985-86, respectively. The winter flock comprised seven subspecies of Canada geese, but the most numerous were dusky (*B. c. occidentalis*), Taverner's (*B. c. taverneri*) and cackling (*B. c. minima*) geese. Highest numbers of geese were present early and late in the season and low populations occurred during midwinter. Forage height and cover exhibited the same trends: height decreased from 47.4 ± 2.1 mm in November to a midwinter low of 21.2 ± 1.0 mm during January, then increased through the end of the season (75.0 ± 4.0 mm); grass cover declined from 29.0 ± 1.3% in November to 15.8 ± 1.1% in January and increased to 56.7 ± 1.9% in April. The number of geese using the refuge declined to a low midwinter level of 2750 in January 1986 during the period of lowest forage quantity. Prior to this movement off the refuge, geese shifted from annual and perennial ryegrass to fescue during December. Regression analysis revealed significant correlations during December and January between quantity of grass, and number and density of geese (P=0.01 and P=0.14, respectively). However, at the end of the season, there was a negative correlation between quantity of forage and the density of geese in March (P=0.09). In March, nitrogen and fiber were good predictors of the use of fields by geese. However, this correlation with quality of forage was not observed in 1986-87. I speculate that quality of forage was important only when geese were gaining weight prior to departure on spring migration. The high quality (crude protein = 13.75% -29.56%; ADF fiber = 17.5 - 23.4%)

of cultivated forage may have obviated the need for selectivity of food quality.

Relations between the distribution of Canada geese and the quantity and quality of forage at W. L. Finley National Wildlife Refuge, 1984 - 1987.

by

Maura B. Naughton

A THESIS

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RELATIONS BETWEEN THE DISTRIBUTION OF CANADA GEESE AND THE QUANTITY AND QUALITY OF FORAGE AT W. L. FINLEY NATIONAL WILDLIFE REFUGE, 1984 - 1987.

INTRODUCTION

Winter is a period of high stress for most animals, when low temperatures and short photoperiods of winter result in increased energy requirements for maintenance. For migratory birds, both gross energy intake and increased protein consumption influence survival (Nestler et al. 1944). Prior to migration, many species eat voraciously to accumulate energy stores in the form of fat (Owen 1980). It has been shown in some species that stores of protein are more important than fat reserves in regulation of timing of breeding and clutch size (Jones and Ward 1976).

Within a species, where all members feed on the same type of food, efficiency in the acquisition of food is of paramount concern (Pyke et al. 1977). High efficiency is generally the result of maximizing food energy intake per unit of effort (Royama 1970). An animal should seek an optimum balance between quantity of food consumed per unit of time and quality of the available food.

Canada geese (Branta canadensis) are one of the few bird species that obtain most of their diet by grazing (Delacour 1963). Because of its high fiber content, which is difficult for most animals to digest, grass is generally considered an inefficient form of energy. Canada geese are selective grazers, foraging on the growing tips of grasses, and during winter they rely on rapid through-put of large quantities of forage. Geese should be selective of where they choose to feed because of the variable quantity and quality of forage (Harwood 1977).

The physical condition of geese during migration and on the breeding grounds directly affects the survival of adults and productivity. Condition, as it is used here, means "the fitness of a bird to cope with its present and future needs" (Owen and Cook 1977). Just prior to spring migration, geese increase their energy reserves to meet the demands of migration and reproduction (Barry 1962, Hanson 1962, Ryder 1970, Raveling 1979, McLandress and Raveling 1981, Bromley 1985). Most geese acquire large lipid reserves on staging areas rather than on wintering grounds. Dusky Canada geese (*B. c. occidentalis*) apparently do not have staging areas and attain maximum lipid reserves on the wintering grounds just prior to departure on spring migration (Bromley 1985). For dusky geese, the Willamette Valley serves the function of both wintering and staging areas.

The exact migration route and breeding grounds of Taverner's geese (*B. c. taverneri*) wintering in the Willamette Valley is undocumented (Jarvis unpubl. rept.). Hence, the importance of the Willamette Valley as a staging area is unknown for this subspecies. Cackling Canada geese

(*B. c. minima*) stage during their migration to breeding areas on the Yukon Delta and peak weight gain probably occurs just prior to their final migration flight from a staging area somewhere between Cordova and the Yukon Delta (Raveling 1979). This study was designed to test the hypothesis that the distribution of Canada geese was related to the quantity and quality of forage. The objectives of this study were:

1. Determine the number, and subspecies composition of geese utilizing William L. Finley National Wildlife Refuge.
2. Determine the seasonal pattern of use of grass fields by geese.
3. Determine the seasonal changes in the quantity and quality of forage in selected fields.
4. Determine the relation between use of fields by geese and the quantity and quality of forage in those fields.

STUDY AREA

This study was conducted at William L. Finley National Wildlife Refuge (hereafter referred to as the refuge). This 2,155 hectare (5,325 acre) refuge is located in the Willamette Valley of Oregon, 12 miles south of Corvallis. The refuge was created in 1964 to provide winter habitat for dusky Canada geese. Approximately 2,000 acres were farmed each year of the study to provide winter forage for geese. In addition to the cultivated fields, upland pastures were grazed during the summer and burned in fall to provide additional goose forage areas. Three seasonal marshes and five ponds were important roost areas. Cabell Marsh, McFadden's Marsh and Brown Swamp were flooded by fall rains and retained water throughout the winter creating approximately 350 acres of marsh habitat. The remainder of the refuge was managed to provide a diversity of other habitats including mixed evergreen and deciduous upland forest, oak/ash riparian forests, brushlands, and wet prairie.

Private farmers, working under a cooperative agreement with the U. S. Fish and Wildlife Service cultivated grass during 1984-85 and 1986-87 for seed production. Refuge staff farmed the fields in 1985-86. The cooperative agreement provided green forage for the geese and a harvestable crop of grass seed. Over 80% of the cultivated acreage was planted to ryegrass, either annual (*Lolium multiflorum*) or perennial (*L. perenni*) (Table 1) (Figure 1). The other main grass crop

Table 1. Amount of crops available as forage for wintering geese, W. L. Finley NWR, Oregon, Fall 1984 through Spring 1987.

	1984/85 (ha)	1985/86 (ha)	1986/87 (ha)
Perennial Ryegrass	1098	1098	956
Annual Ryegrass	734	734	478
Tall Fescue	207	207	207
Winter Wheat	34	0	35
Corn	0	0	75
Pasture	320	320	320
TOTAL	2393	2359	2071

Figure 1. Map of the pastures and grasses cultivated at W. L. Finley NWR during the 1984-85 and 1985-86 seasons. The nine fields chosen for intensive study are numbered. Crops in these fields remained constant throughout the three years of the study.

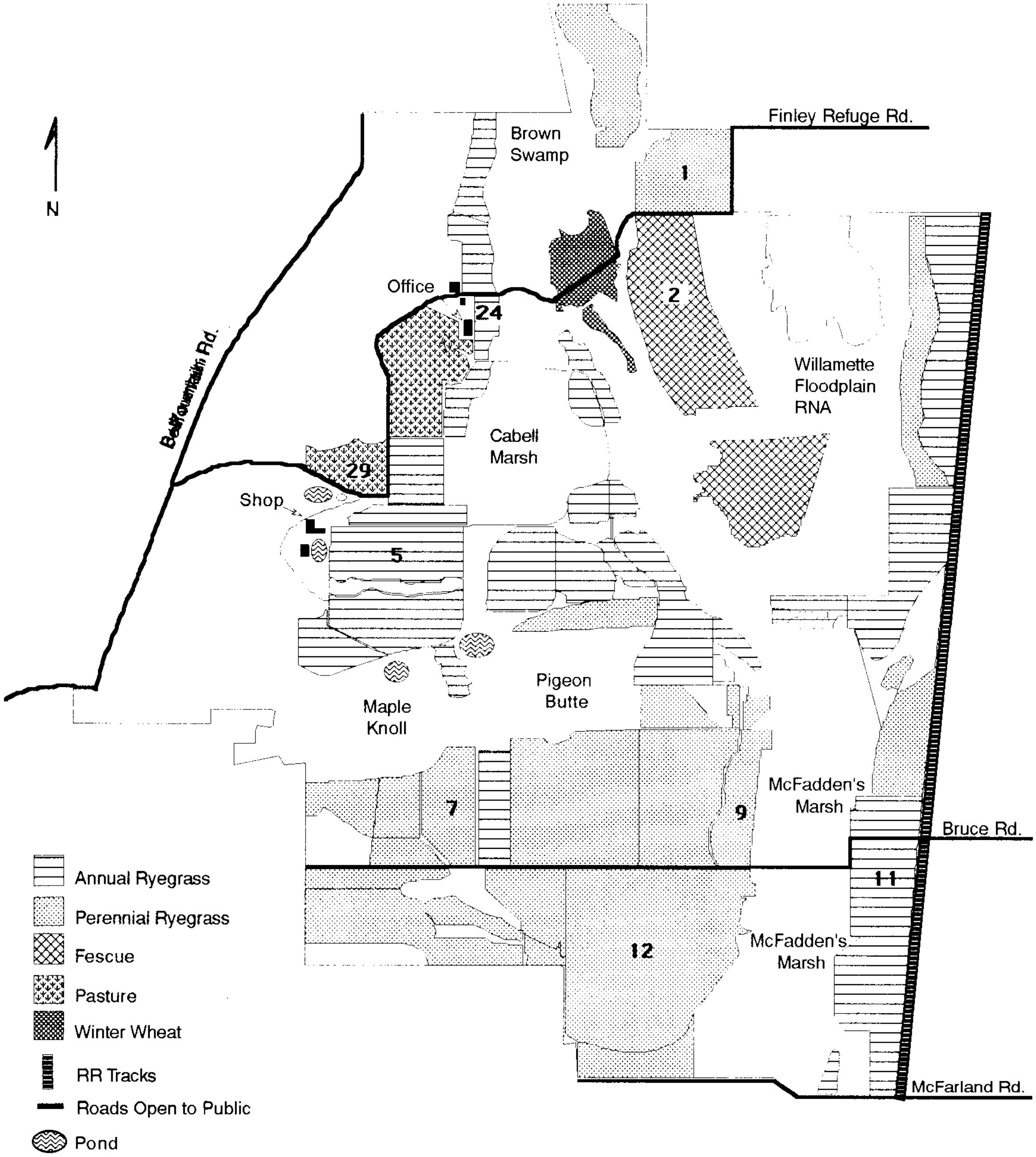

N
Finley Refuge Rd.
Brown
Swamp
1
Office
24
2
Willamette
Floodplain
RNA
Bellfountain Rd.
Cabell
Marsh
29
Shop
5
Pigeon
Butte
Maple
Knoll
7
9
McFadden's
Marsh
Bruce Rd.
11
12
McFadden's
Marsh
McFarland Rd.
Annual Ryegrass
Perennial Ryegrass
Fescue
Pasture
Winter Wheat
RR Tracks
Roads Open to Public
Pond

Figure 1.

was a perennial tall fescue, alta fescue (Festuca arundinacea). In addition to the grasses planted for seed production, two small fields of winter wheat (Triticum aestivum) were planted in 1984 and 1986 and one field of corn was planted in 1986. Management of the different crop fields is summarized in Figure 2.

Annual ryegrass fields were typically burned after harvest to remove the excess straw and then plowed and drilled with seed in September or October. Fertilizer was drilled into the soil with the seed. The annual grass was dependant on the early fall rains to germinate and it was not uncommon for these fields to contain little or no green grass when the geese first arrived on 12 October. The fields were fertilized with nitrogen, phosphorus and potassium in February or early March. The grass was cut and the seed harvested in June or July.

The fields of perennial ryegrass and tall fescue received similar treatments. After harvest the fields were typically burned to remove the excess straw. If the fields were not burned, the excess straw was baled and removed from the field. New growth usually appeared within weeks after burning. Farmers were required to mow the fields if grass was greater than 4 inches high on 15 October. The fields were fertilized with nitrogen, phosphorus and potassium in February or early March. The grass was cut and the seed harvested in June or July. Fields with perennial grasses were plowed and reseeded on a five to ten year cycle.

Figure 2. Annual cycle of manipulations to annual and perennial grass fields and pastures at W. L. Finley NWR, Oregon, 1984 - 1987.

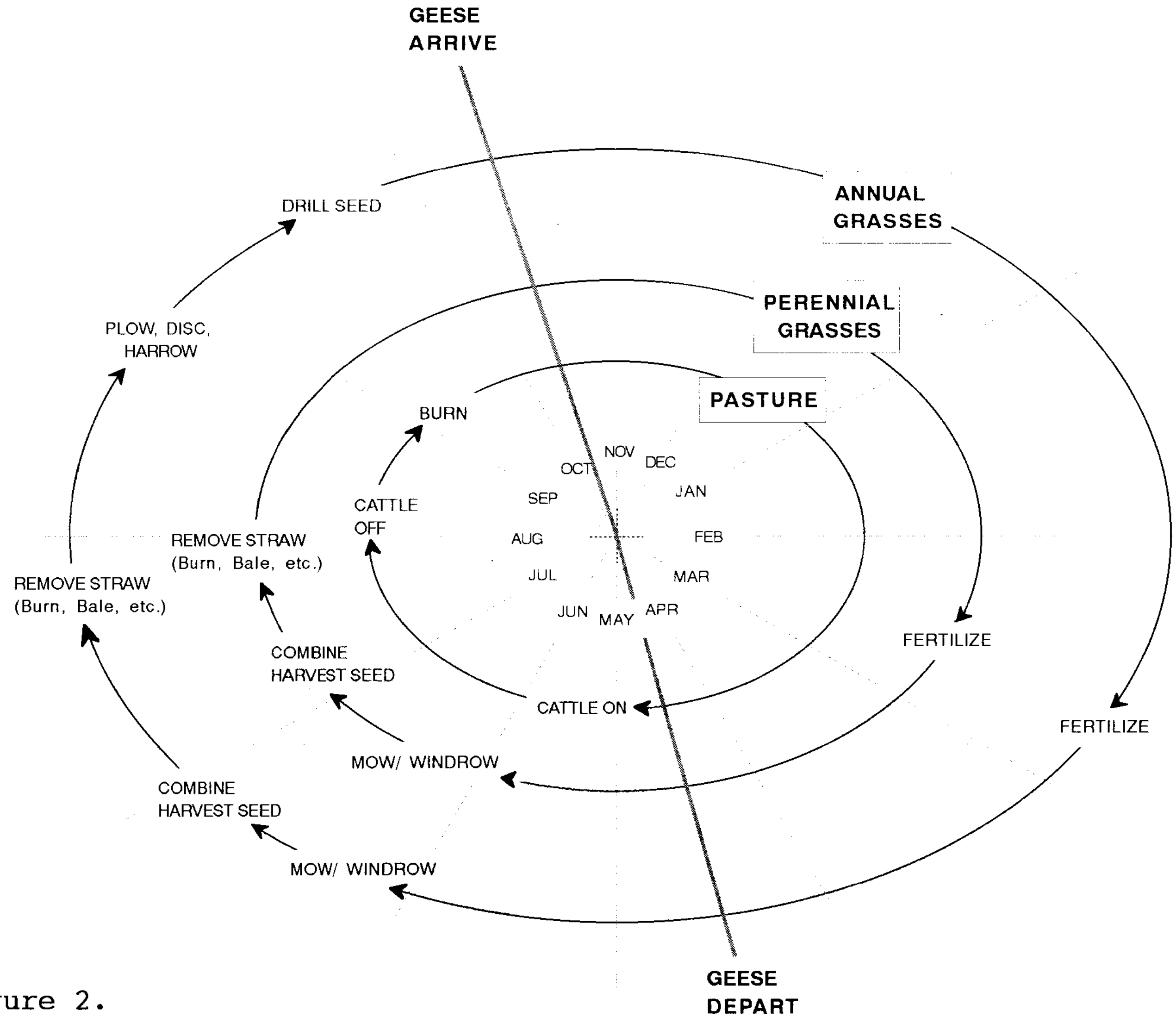

GEESE ARRIVE
ANNUAL GRASSES
PERENNIAL GRASSES
PASTURE
DRILL SEED
PLOW, DISC, HARROW
REMOVE STRAW (Burn, Bale, etc.)
COMBINE HARVEST SEED
MOW/ WINDROW
FERTILIZE
BURN
CATTLE OFF
REMOVE STRAW (Burn, Bale, etc.)
COMBINE HARVEST SEED
MOW/ WINDROW
FERTILIZE
CATTLE ON
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
GEESE DEPART

Figure 2.

The pastures were comprised of a mixture of grasses and legumes. The most abundant components were annual and perennial fescues (*Festuca* spp.), annual bluegrasses (*Poa* spp.), annual and perennial ryegrass, subterranean clover (*Trifolium subterraneum*) and white clover (*Trifolium repens*). Pastures were grazed by 70 cow/calf pairs from late May through 1 August. These fields were then burned by refuge staff in September or October. Pastures were not fertilized during the course of this study and had not been plowed or reseeded since the refuge was created in 1964.

METHODS

This three year study was conducted from mid-October through mid-April of each year from 1984 to 1987. The study was conducted in two phases: (1) the entire refuge was surveyed to determine the number of geese, subspecies composition, and distribution (Objective 1); and (2) nine fields were selected for intensive study of forage characteristics and utilization by geese (Objectives 2 - 4).

A census of the entire refuge was conducted every 7 - 10 days, in 1984-85 and 1985-86 to determine the size and subspecies composition of the refuge flock (Objective 1). Surveys were conducted simultaneously by two observers. Geese were observed with 7 or 10 power binoculars, 20 - 60 power spotting scopes, and a 40 - 80 power Questar telescope. When possible, observations were made from a vehicle to minimize disturbance of the geese. Total number of geese, subspecies composition, location in the field, and behavior were recorded for each flock of geese encountered. Many dusky Canada geese were marked with plastic neck collars by Alaska Department of Fish and Game and cackling Canada geese were marked with yellow plastic neck collars by U. S. Fish and Wildlife Service. The identification codes of neck collars were recorded. Fields on private land adjacent to the refuge were also surveyed, but no attempt was made to locate all geese utilizing private fields off the refuge.

To document the seasonal changes and interfield differences in goose utilization and grass quantity and quality outlined in Objectives 2 and 3, nine fields were chosen for more intensive study (Table 2) (Figure 1). These fields included three annual ryegrass, four perennial ryegrass, one tall fescue, and one pasture of mixed grasses and forbs. Winter wheat was not included in this portion of the study because the two fields planted in winter wheat were very small, immediately adjacent the main road, and flooded for most of the winter.

When possible, the nine study fields were surveyed daily for geese in 1984-85 and 1985-86. In 1986-87 surveys were conducted 3-4 days/week. Surveys were distributed throughout all daylight hours. If geese were present, the number, subspecies composition, location in the field, and behavior of the geese were recorded. Behavior was noted to ensure that the field was used primarily for feeding and not roosting.

Quantity of grass was based on two measures: height and percent cover. Twice each month (November 1985 - April 1986) thirty 0.25 meter^2 plots were sampled in each of the nine fields. Plots were photographed to determine percent cover. A tripod mounted SLR camera was used to take vertical 35 mm slides of the plot. The slides were projected over a dot grid and percent cover of green grass was calculated. Height of the grass canopy within the plot was measured to the nearest 1.0 mm at the time photographs were taken. Thirty

Table 2. Crops cultivated in the nine intensively studied fields, W. L. Finley NWR, Oregon, 1984 - 1987.

Field Number	Crop	Size (ha)
5	Annual Ryegrass	25.9
11	Annual Ryegrass	18.6
24	Annual Ryegrass	2.0
1	Perennial Ryegrass	23.5
7	Perennial Ryegrass	18.6
9	Perennial Ryegrass	18.6
12	Perennial Ryegrass	105.7
2	Tall Fescue	50.2
29	Pasture	18.2

plots were photographed in each field according to a stratified random sampling scheme.

Quality of grass was based on nitrogen and fiber content. Each month (December 1985 - April 1986; October 1986 - March 1987), 5 grass samples were clipped in each of the nine study fields. Many of the early 1985-86 samples were accidentally destroyed and the December and January data sets are incomplete. Samples were washed and sorted to remove mud and dried stalks, then dried to a constant weight at 60°C (approximately 48-72 hours). Nitrogen and fiber were expressed as percent dry weight of the sample.

Nitrogen content was determined at the Plant Analysis Laboratory, Department of Horticulture, Oregon State University, by the macro-Kjeldahl technique. Crude protein was estimated by multiplying the nitrogen value by a conversion factor of 6.25 (Shenk and Barnes 1985). Fiber content was determined at the Forage Analytical Service Laboratory, Department of Agricultural Chemistry, Oregon State University, with an Acid Detergent Fiber (ADF) test (Goering and Van Soest 1970).

Statistical analyses were computed using the SAS statistical package for personal computers (Version 6). Differences over time and between fields were tested for significance using analysis of variance. If sample sizes were unequal, general linear model was used. If data did not meet the assumptions for parametric testing then a nonparametric Kruskall Wallis test was used. To further test for separation between the means a Student-Newman-Kuells Mean Separation test was calculated. A Students t-Test was used to test for differences between years. Significance was accepted at $P \leq 0.05$ or better level of significance. Multiple regression and correlation analyses of goose and grass data were conducted to test for a relation between goose distribution and grass characteristics. Significance levels for entry of data into the regression models were 0.15.

RESULTS

GEESE

Composition of Wintering Flock

The winter flock at the refuge was composed almost exclusively (>99%) of Canada geese. Small flocks of white-fronted geese (*Anser albifrons*), lesser snow geese (*Chen c. caerulescens*), and individual Ross' geese (*Anser rossii*), brant (*Branta bernicula*) and barnacle geese (*Branta leucopsis*) were observed each year. Six subspecies of Canada geese were recorded during this study: dusky, Taverner's, lesser (*B. c. parvipes*), cackling, western (*B. c. moffitti*), and Aleutian (*B. c. leucopareia*). Dusky, Taverner's and cackling geese were the most numerous accounting for over 99 percent of the geese observed.

In 1984-85, Taverner's geese were the most numerous subspecies accounting for over half the geese, dusky geese for slightly less than half and cackling geese for the remaining three percent (Figure 3). In 1985-86 the three subspecies were present in approximately equal proportions. Because of the difficulty distinguishing the different subspecies and the inexperience of observers at the start of this study, the number of cackling geese recorded in 1984-85 may be an under representation of the actual numbers present. However, information from collar sightings confirm an

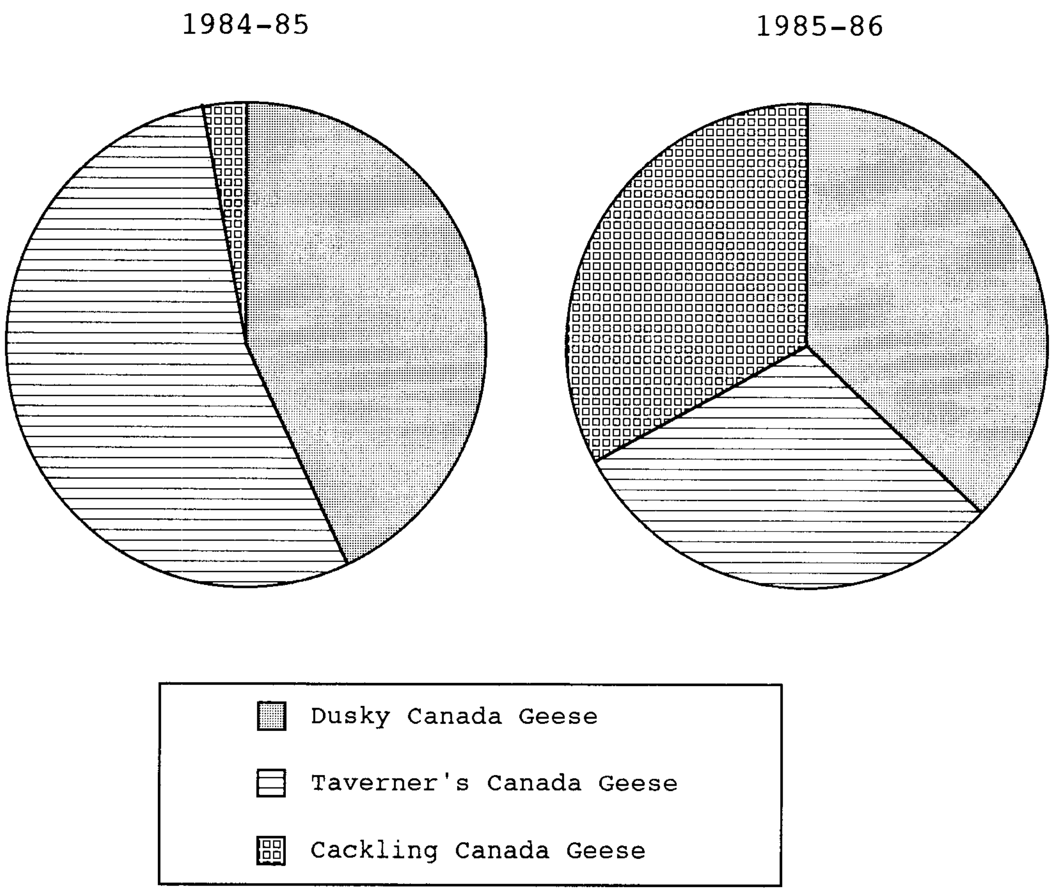


Figure 3. Subspecies composition of Canada geese wintering at W. L. Finley NWR, Oregon, 1984 - 1986.

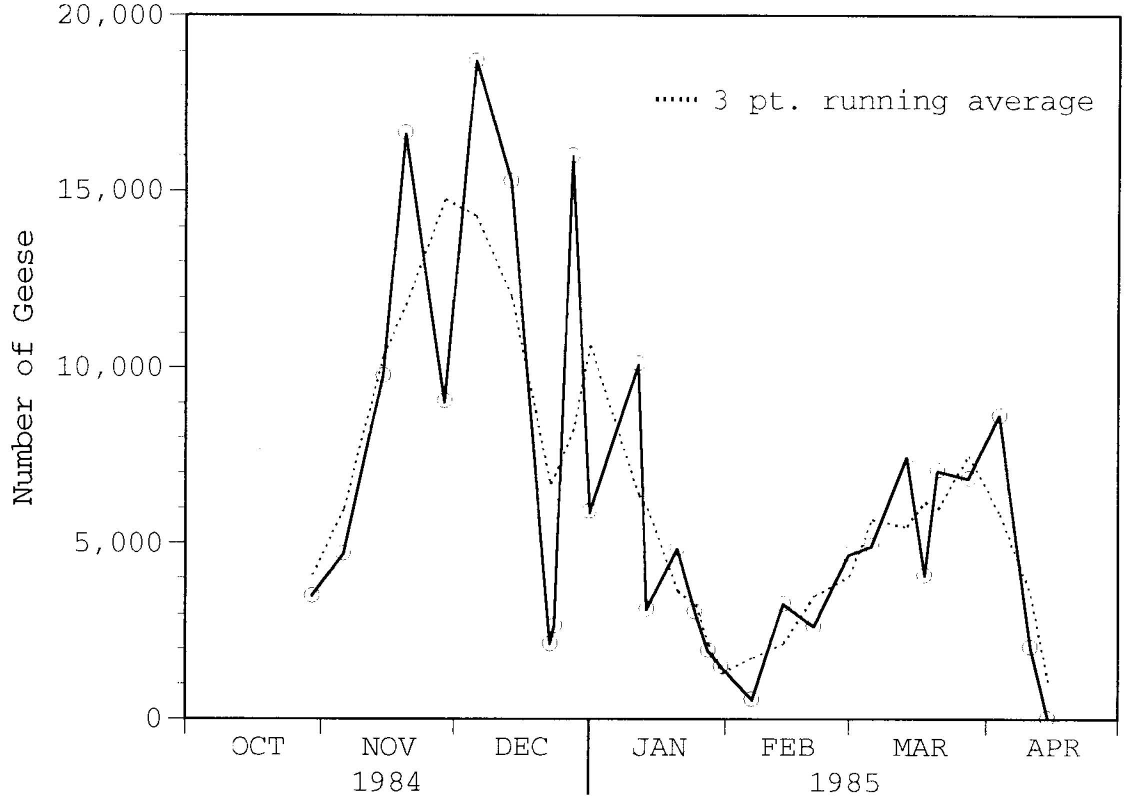
increase in the number of cackling geese between the two years.

Phenology and Magnitude

Wintering geese spent six months, from mid-October to mid-April, in the lower Willamette Valley. The first geese arrived at the refuge on 12 October 1985 and 1986, and were already present when observations began on 20 October 1984. The last wintering geese departed the refuge by 15 April each year, although small flocks of migrating geese occasionally landed on the refuge after this date. These flocks of migrating geese were most commonly cackling or white-fronted geese.

The number of geese counted during censuses varied greatly as geese moved on and off the refuge to feed (Figure 4). In both years, use of the refuge exhibited a bimodal pattern; the number of geese increased rapidly in November and December, declined in January, and increased again in February and March.

Similar numbers of geese were present in both years although higher individual counts were recorded in 1984-85 than in 1985-86 (18,500 vs 14,500). The seasonal distribution of geese was also slightly different in the two years. In 1984-85, more geese were present in early winter than in early spring, whereas in 1985-86 the pattern was reversed; more geese were present in early spring than in



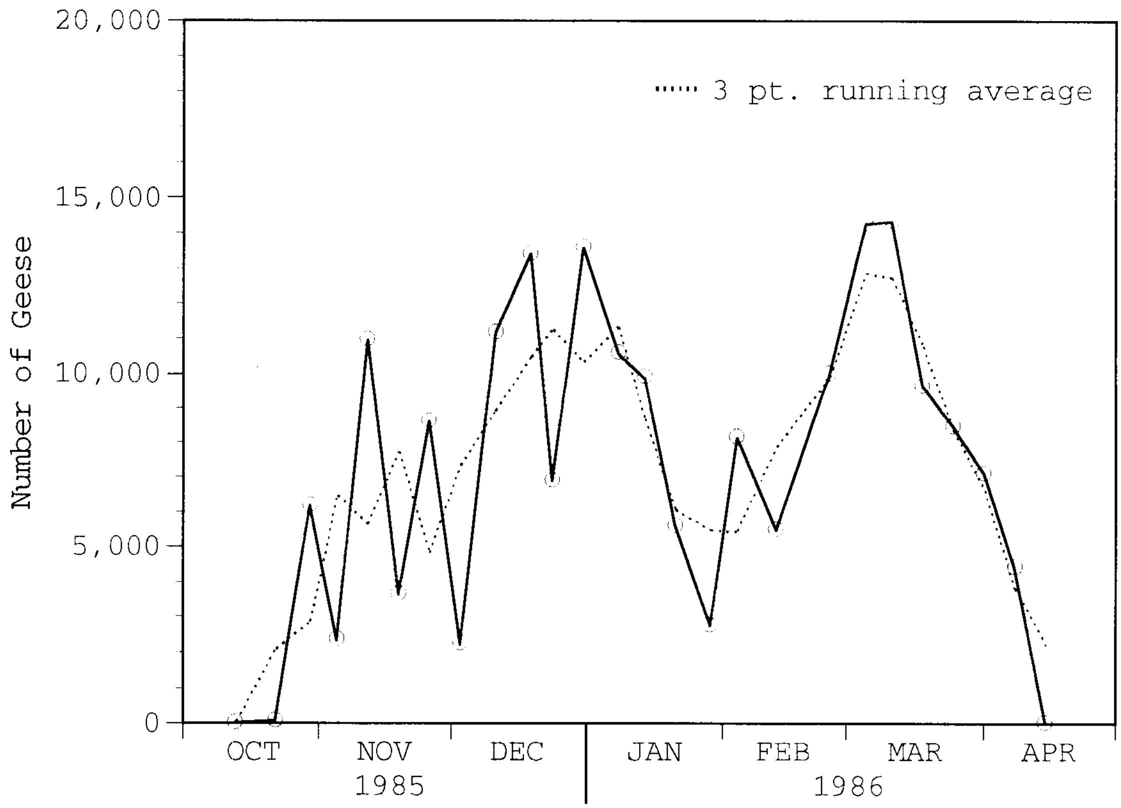


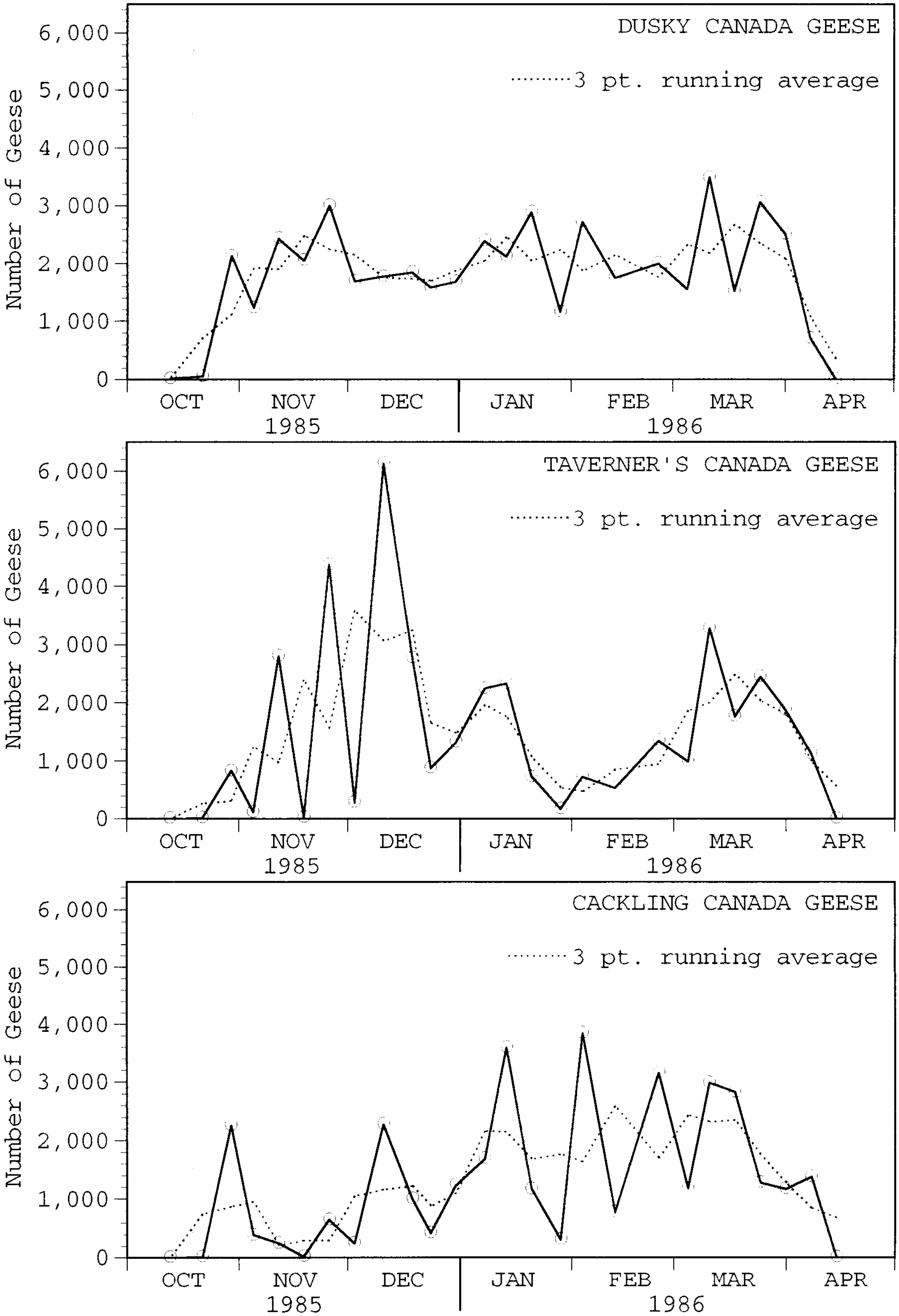
Figure 4. Total number of geese counted during weekly censuses, W. L. Finley NWR, Oregon, 1984-1985 and 1885-1986.

early winter. These changes were apparently due to changes in use of the refuge since aerial surveys of the entire Willamette Valley indicated no change in the size of the wintering flock (USFWS unpubl. data). Censuses were not conducted during 1986-87 but based on incidental observations, the refuge population was comparable to levels in the previous two seasons. There was no difference ($\underline{P}<0.05$) in the number of geese utilizing the refuge during the three years based on monthly aerial surveys (USFWS unpubl. data).

Seasonal trends in abundance were different for each of the three subspecies (Figure 5). Dusky geese first arrived in mid-October and numbers rapidly increased through the end of the month. The dusky population remained at a relatively constant level throughout the season until geese began migrating in early April. Taverner's geese also arrived in mid-October, but the number present on the refuge fluctuated greatly, especially in early winter (November - December). Peak numbers were present in early December. An obvious decline in use of the refuge by Taverner's geese occurred in mid-winter but then numbers increased again prior to migration. The number of cackling geese increased quickly after birds first arrived in mid-October. However, most of these geese were gone by the next census on 5 November, and numbers remained low until December and January when the population increased again and remained high through mid-March. Since the differences among the subspecies were

Figure 5. Number of dusky, Taverner's, and cackling Canada geese counted during censuses, W. L. Finley NWR, October 1985 - April 1986.

Figure 5.


DUSKY CANADA GEESE
3 pt. running average
Number of Geese
6,000
5,000
4,000
3,000
2,000
1,000
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
1985
1986
TAVERNER'S CANADA GEESE
3 pt. running average
Number of Geese
CACKLING CANADA GEESE
3 pt. running average
Number of Geese

relatively minor, all three subspecies were combined in the remaining analysis.

Use of the Study Fields

Nine fields with consistent histories of goose utilization were selected for study. Since use of the fields had been consistent, I judged that there was nothing inherently different about the fields that caused them to be either avoided or strongly preferred by geese. However, the fields were used significantly differently by geese ($P<0.01$) but the differences were confounded with time periods within the wintering season (Table 3 and Table 4). Overall, no pattern of differences was discernable.

Some seasonal differences became apparent when goose densities were segregated by forage type (Figure 6). Early in the 1985-86 season goose densities were relatively low and distributed among all four forage types. By late December, highest densities of geese were recorded in the fescue field. As the season progressed (late February) highest densities were found in the perennial ryegrass fields. Late in the season, just prior to migration, geese were seen in highest density on annual ryegrass. Geese fed on the pasture in low numbers early in the season but were rarely seen in this field after January.

Early season patterns in 1986-87 were similar; geese fed on all crops, however, they did not utilize the fescue as

Table 3. Seasonal differences in the number and density of Canada geese utilizing nine study fields, W. L. Finley NWR, Oregon, October 1985 - April 1986.

Time Period	N	Mean Number of Geese[1]	SNK[2]	Mean Density of Geese[1]	SNK[2]
Late February	124	307.7 ±79.7	A	14.7 ±4.2	A
Late December	121	292.2 ±53.8	A	9.1 ±1.6	A
Early March	138	275.5 ±54.5	A	13.1 ±2.8	A
Early November	194	264.0 ±52.3	A	10.6 ±2.3	A
Late March	101	259.7 ±49.5	A	12.7 ±2.6	A
Late January	100	225.9 ±46.1	A	6.5 ±1.4	A
Early April	213	200.5 ±40.1	A	8.9 ±1.9	A
Early December	80	183.7 ±44.9	A	5.3 ±1.2	A
Early February	118	157.0 ±35.7	A	4.6 ±1.2	A
Early January	141	149.4 ±38.1	A	4.8 ±1.2	A

[1] Mean ± standard error.
[2] Means with the same letter are not significantly different (Student-Newman-Keuls mean separation test, $\alpha<0.05$).

Table 4. Seasonal differences in the number and density of Canada geese utilizing nine study fields, W. L. Finley NWR, Oregon, October 1986 - April 1987.

Time Period	N	Mean Number of Geese[1]	SNK[2]	Mean Density of Geese[1] (geese/ha)	SNK[2]
December	88	487.1 ±128.2	A	10.5 ±2.6	A
January	129	286.3 ± 85.7	A	5.6 ±1.2	A
February	91	267.9 ± 61.7	A	10.1 ±2.7	A
March	107	192.4 ± 40.6	A	5.9 ±1.4	A
November	97	159.5 ± 51.7	A B	5.0 ±1.7	A B
April	36	136.9 ± 46.2	B	3.0 ±0.8	A B
October	54	8.1 ± 4.1	A	0.3 ±0.2	B

[1] Mean ± standard error.
[2] Means with the same letter are not significantly different (Student-Newman-Keuls mean separation test, $\alpha<0.05$).

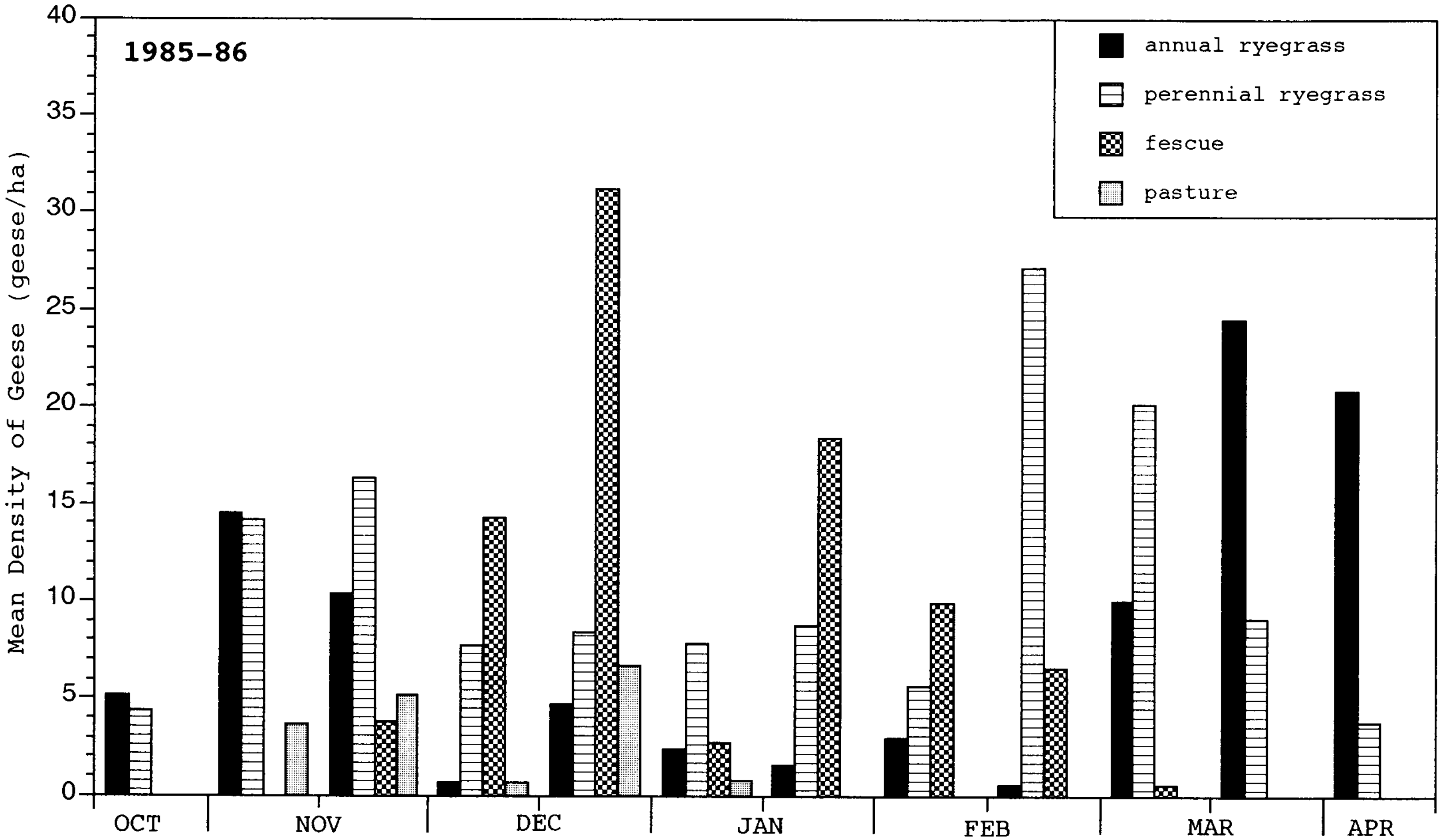


Figure 6. Seasonal goose density on four different crops, W. L. Finley NWR, October 1985 - April 1986.

heavily during the December/January period (Figure 7). During the last 2 weeks in December large flocks fed on the pasture but after 1 January geese were never recorded in this field again. Perennial ryegrass supported the highest densities of geese from January until the end of the season.

Overall during 1985-86, the highest number of geese were counted in the fescue and perennial ryegrass fields (Table 5). Flock sizes were significantly lower in annual ryegrass fields and the pasture. Annual ryegrass fields were smaller in size than the other fields and when the effect of field size was minimized by calculating the density of geese, there was no significant difference between ryegrass and fescue field use. Goose utilization of the pasture was significantly below utilization of other crops in all analyses. During 1986-87, perennial ryegrass had significantly larger flocks and higher densities than the other three crop types (Table 6).

FORAGE

Forage Height

Forage height was measured in 2700 plots, located in the nine study fields, between November 1985 and April 1986. Height was sampled twice each month, December through March, but only once during November because snow covered the ground for more than a week in late November.

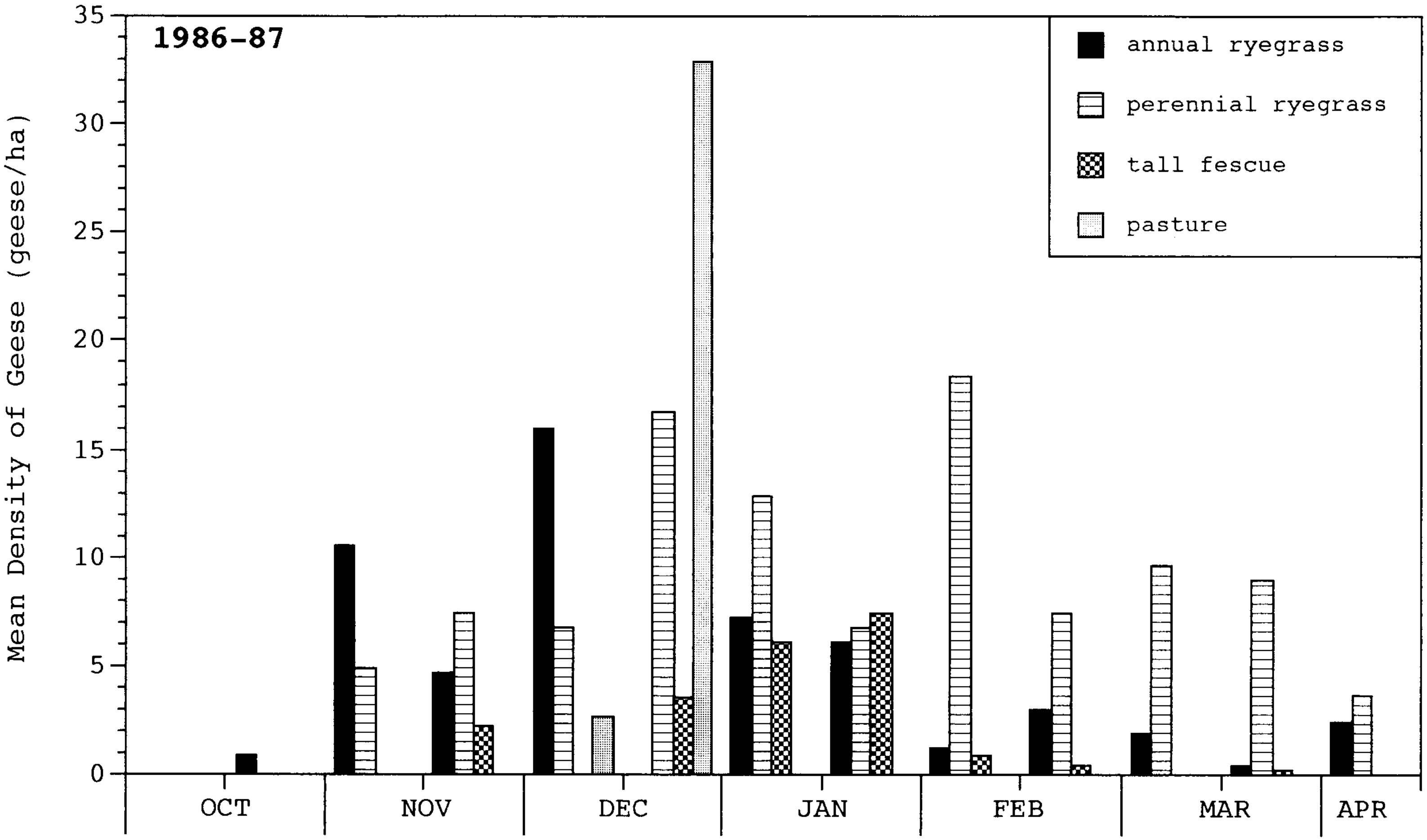


Figure 7. Seasonal goose density on four different crops at W. L. Finley NWR, October 1986 - April 1987.

Table 5. Mean number and density of Canada geese utilizing different crops in nine study fields, W. L. Finley NWR, Oregon, October 1985 - April 1986.

Crop	N	Mean Number of Geese[1]	SNK[2]	Mean Density of Geese[1] (geese/ha)	SNK[2]
Tall Fescue	132	353.5 ±55.9	A	7.0 ±1.1	A
Perennial Ryegrass	619	293.9 ±28.4	A	11.6 ±1.3	A
Annual Ryegrass	434	177.3 ±22.9	B	9.1 ±1.2	A
Pasture	145	27.1 ±11.7	C	1.5 ±0.6	B

[1] Mean ± standard error.
[2] Means with the same letter are not significantly different (Student-Newman-Keuls mean separation test, $\alpha<0.05$).

Table 6. Mean number and density of Canada geese utilizing different crops in nine study fields, W. L. Finley NWR, Oregon, October 1986 - April 1987.

Crop	N	Mean Number of Geese[1]	SNK[2]	Mean Density of Geese[1] (geese/ha)	SNK[2]
Perennial Ryegrass	273	414.9 ±61.6	A	8.6 ±1.2	A
Annual Ryegrass	197	119.9 ±27.0	B	5.9 ±1.4	B
Tall Fescue	66	93.0 ±38.8	B	1.9 ±0.8	B
Pasture	66	39.2 ±25.7	B	2.2 ±1.4	B

[1] Mean ± standard error.
[2] Means with the same letter are not significantly different (Student-Newman-Keuls mean separation test, $\alpha<0.05$).

The mean grass height per field ranged from 12 mm (Field 5; annual ryegrass; late January) to 222 mm (Field 2; tall fescue; early April). In general, annual and perennial ryegrass and the pasture were low in stature and fescue was significantly taller ($\underline{P}<0.001$, Figure 8). However, there were exceptions and the height of grass in the fields was affected by both season and the amount of goose use.

Two perennial ryegrass fields, Fields 9 and 12, which sustained heavy grazing pressure through the season, were short in stature and did not differ significantly from the annual ryegrasses and the pasture (Table 7). The other two perennial ryegrass fields, Fields 1 and 7, received intermediate and low grazing pressure, respectively, and were significantly taller than all grasses except fescue. Field 11, the annual ryegrass field which sustained the heaviest grazing pressure of the three annual ryegrass fields had significantly shorter grass than all other fields ($\underline{P}<0.05$).

Grass height varied significantly between seasons ($\underline{P}<0.001$, Table 8). Grass was tallest in early spring, just prior to departure of geese (Late March/early April) and shortest in mid-winter (December/January). Grass was intermediate in height early in the season. Average grass height for all fields combined ranged from a high of 75 mm in April to a low of 21 mm in early January.

The seasonal height profile differed slightly for each of the different crops and for each of the different fields (Figure 9). Annual ryegrass, which was planted in September

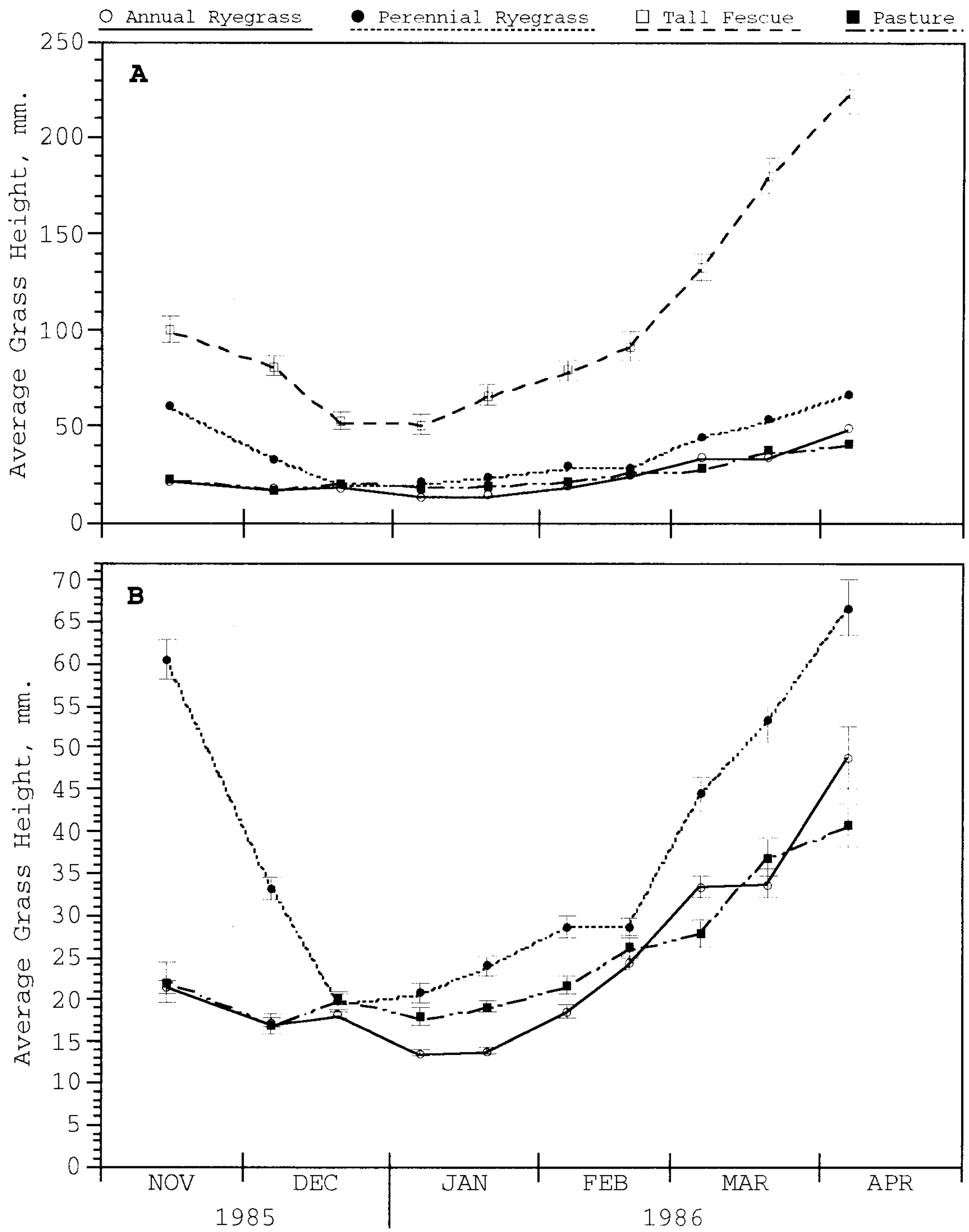


Figure 8. (A) Seasonal trends in mean forage height of four different crops, W. L. Finley NWR, 1985-86.
(B) Fescue has been deleted from the graph and the scale changed so that differences among the remaining crops can be distinguished.
Error bars reflect ± standard error.

Table 7. Mean grass height in nine different fields, W. L. Finley NWR, Oregon, November 1985 - April 1986.

Crop	Field Number	N	Mean Grass[1] Height (mm)	SNK[2]
Tall Fescue	2	300	105.0 ±3.8	A
Perennial Ryegrass	1	300	52.9 ±1.8	B
Perennial Ryegrass	7	300	45.5 ±1.7	C
Perennial Ryegrass	9	300	28.8 ±1.0	D
Annual Ryegrass	5	300	28.6 ±1.2	D
Annual Ryegrass	24	300	25.6 ±1.1	D E
Pasture	29	300	24.8 ±0.7	D E
Perennial Ryegrass	12	300	24.2 ±0.6	D E
Annual Ryegrass	11	300	18.3 ±0.5	F

[1] Mean ± standard error.
[2] Means with the same letter are not significantly different (Student-Newman-Keuls mean separation test, $\alpha<0.05$).

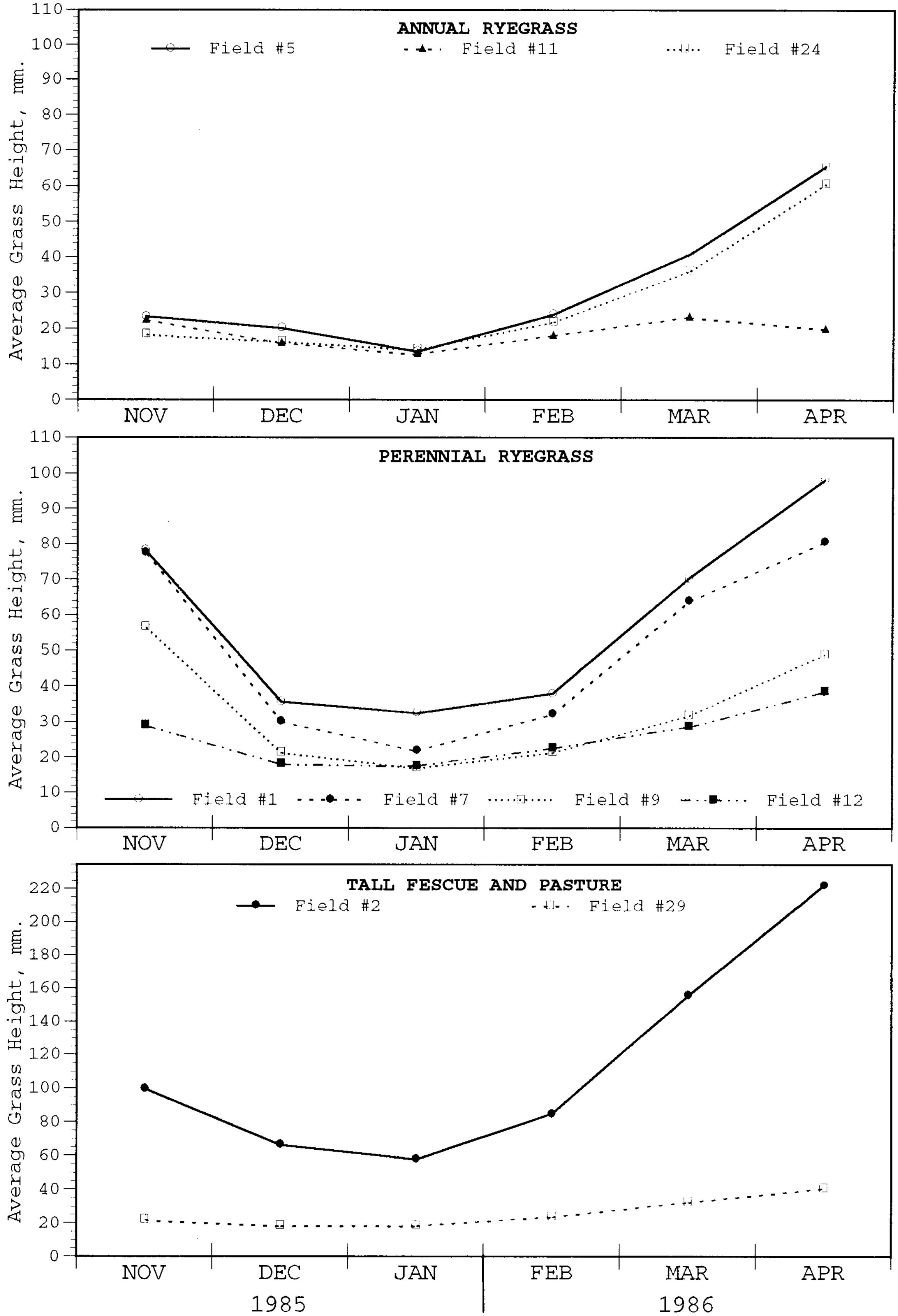
Table 8. Mean grass height, W. L. Finley NWR, Oregon, November 1985 - April 1986.

Time Period	N	Mean Grass Height (mm)[1]	SNK[2]
Early April	270	75.0 ±4.0	A
Late March	270	58.8 ±3.1	B
Early March	270	48.5 ±2.2	B
Early November	270	47.4 ±2.1	C
Late February	270	33.7 ±1.6	D
Early December	270	31.2 ±1.4	E
Early February	270	29.9 ±1.4	E
Late January	270	24.5 ±1.1	F
Late December	270	22.7 ±0.9	F
Early January	270	21.2 ±1.0	G

[1] Mean ± standard error.
[2] Means with the same letter are not significantly different (Student-Newman-Keuls mean separation test, $\alpha<0.05$).

Figure 9. Seasonal trends in mean forage height in nine study fields, W. L. Finley NWR, November 1985 - April 1986.

FIGURE 9.


ANNUAL RYEGRASS
Field #5
Field #11
Field #24
Average Grass Height, mm.
0
10
20
30
40
50
60
70
80
90
100
110
NOV
DEC
JAN
FEB
MAR
APR
PERENNIAL RYEGRASS
Field #1
Field #7
Field #9
Field #12
Average Grass Height, mm.
TALL FESCUE AND PASTURE
Field #2
Field #29
Average Grass Height, mm.
0
20
40
60
80
100
120
140
160
180
200
220
NOV
DEC
JAN
FEB
MAR
APR
1985
1986

and October, was low in stature from November through early February (12 - 23 mm) and then increased slowly until the end of the season (20 - 65 mm). By April, grass was approximately three times higher than in November. Grass height in Field 11 differed from the other two annual ryegrass fields by remaining fairly constant throughout the season (13 - 23 mm).

Perennial ryegrass was taller than annual ryegrass when first measured in November (29 - 78 mm), but decreased rapidly and by late December the height of perennial ryegrass was comparable to that of annual ryegrass (20 mm and 18 mm, respectively). Grass height began increasing in February and continued to increase through the end of the season. Grass height in April was comparable to that in November (67 mm and 60 mm respectively). Although Field 12 followed the same general trend as the other perennial ryegrass fields, the grass height in both November and April was significantly lower.

The height of grass in the pasture displayed a pattern similar to annual ryegrass. The initial stature was low (22 mm) and remained low until late January when the height gradually increased until April. Average height in April (41 mm) was approximately twice as high as in November.

Fescue was consistently taller than the other grasses in each of the sampling periods. Grass height declined between November (100 mm) and mid-January (50 mm) and increased from late January through April (222 mm). Fescue was approximately twice as high in April as in November.

Grass Cover

Percent cover of green grass was measured in 1,609 plots between November 1985 and April 1986. The percent cover ranged from 0 - 100% in individual plots and monthly means for the fields ranged from 4% (Field 12; perennial ryegrass; February) to 82% (Field 5; annual ryegrass; April).

Significant differences existed between fields (Table 9) and between crops (Table 10); however, the trends were quite different from those documented for grass height. Fescue, the tallest grass, was intermediate in percent cover, and was not significantly different from the fields of annual ryegrass. Perennial ryegrass, which was generally taller in stature than pasture and annual ryegrass, was significantly lower in percent cover than all other fields ($\underline{P}<0.01$). The highest percent cover was recorded in the pasture.

Seasonal trends in the percent green cover were very similar to trends in height of grass. Grass cover was highest late in the season and lowest in mid-winter (Table 11). The mean grass cover was 57% in April, compared to 16% in January. All four crop types exhibited the same general trend (Figure 10).

There were slight differences between crops and fields (Figure 11). Early in the season, the newly planted annual

Table 9. Mean percent cover of green forage in nine study fields, W. L. Finley NWR, Oregon, November 1985 - April 1986.

Crop	Field Number	N	Percent Cover[1]	SNK[2]
Pasture	29	179	55.3 ±1.4	A
Annual Ryegrass	5	180	42.5 ±2.2	B
Annual Ryegrass	11	180	35.7 ±1.8	C
Tall Fescue	2	179	35.5 ±2.0	C
Annual Ryegrass	24	177	33.2 ±2.0	C D
Perennial Ryegrass	1	180	29.3 ±1.8	D
Perennial Ryegrass	9	180	25.3 ±1.7	E
Perennial Ryegrass	7	174	19.4 ±1.4	F
Perennial Ryegrass	12	180	6.4 ±0.7	G

[1] Mean ± standard error.
[2] Means with the same letter are not significantly different (Student-Newman-Keuls mean separation test, $\alpha<0.05$).

Table 10. Mean percent cover of green forage in four crop types, W. L. Finley NWR, Oregon, November 1985 - April 1986.

Crop	N	% Green Cover[1]	SNK[2]
Pasture	179	55.3 ±1.4	A
Annual Ryegrass	537	37.2 ±1.2	B
Tall Fescue	179	35.5 ±2.0	B
Perennial Ryegrass	714	20.1 ±0.8	C

[1] Mean ± standard error.
[2] Means with the same letter are not significantly different (Student-Newman-Keuls mean separation test, $\alpha<0.05$).

Table 11. Monthly means of the percent cover of green forage, W. L. Finley, NWR, Oregon, November 1985 - April 1986.

Month	N	Percent Cover[1]	SNK[2]
April	267	56.7 ±1.9	A
March	270	37.9 ±1.5	B
November	268	29.0 ±1.3	C
February	270	27.2 ±1.3	C
December	264	22.0 ±1.1	D
January	270	15.8 ±1.1	E

[1] Mean ± standard error.
[2] Means with the same letter are not significantly different (Student-Newman-Keuls mean separation test, $\alpha<0.05$).

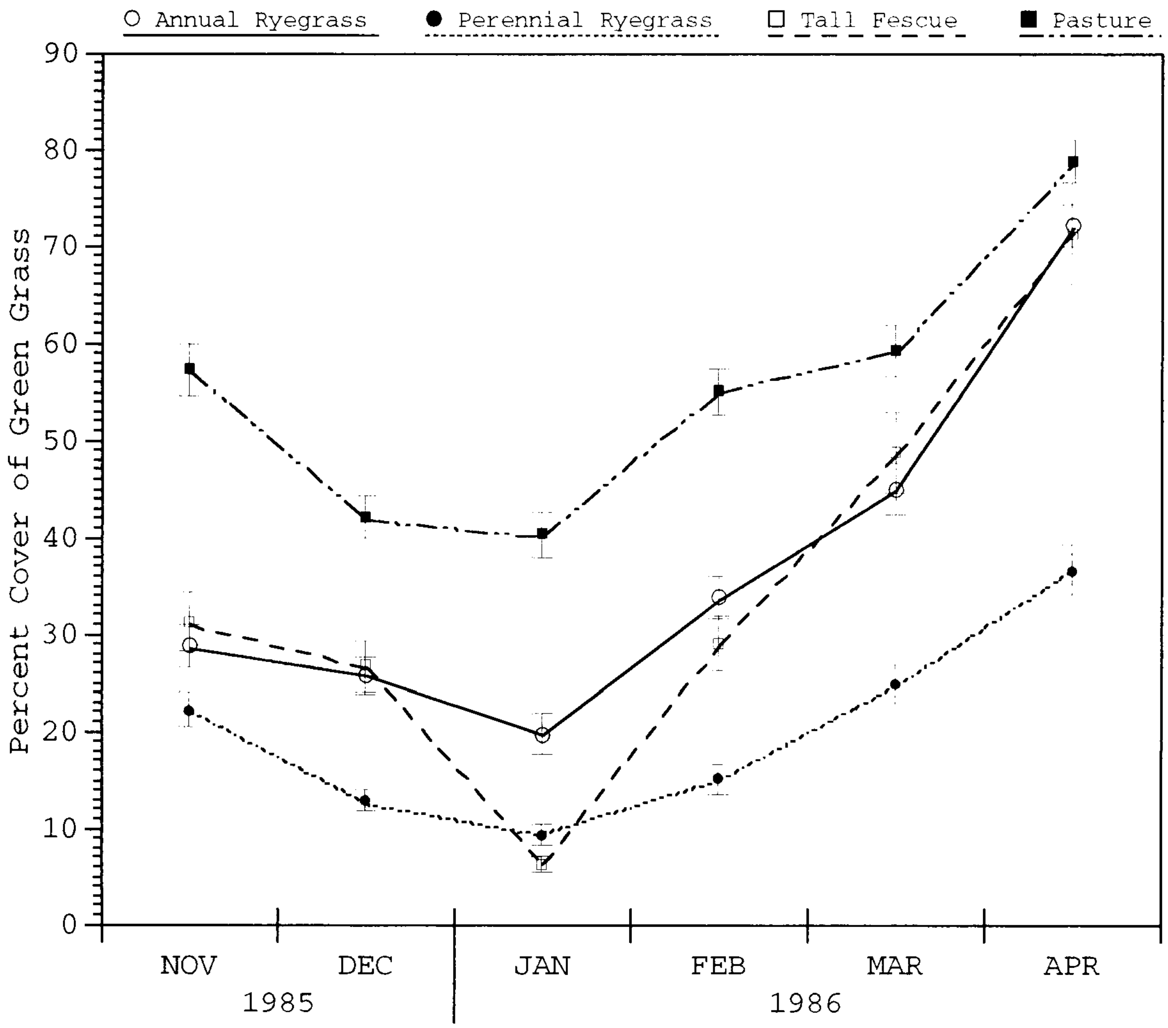
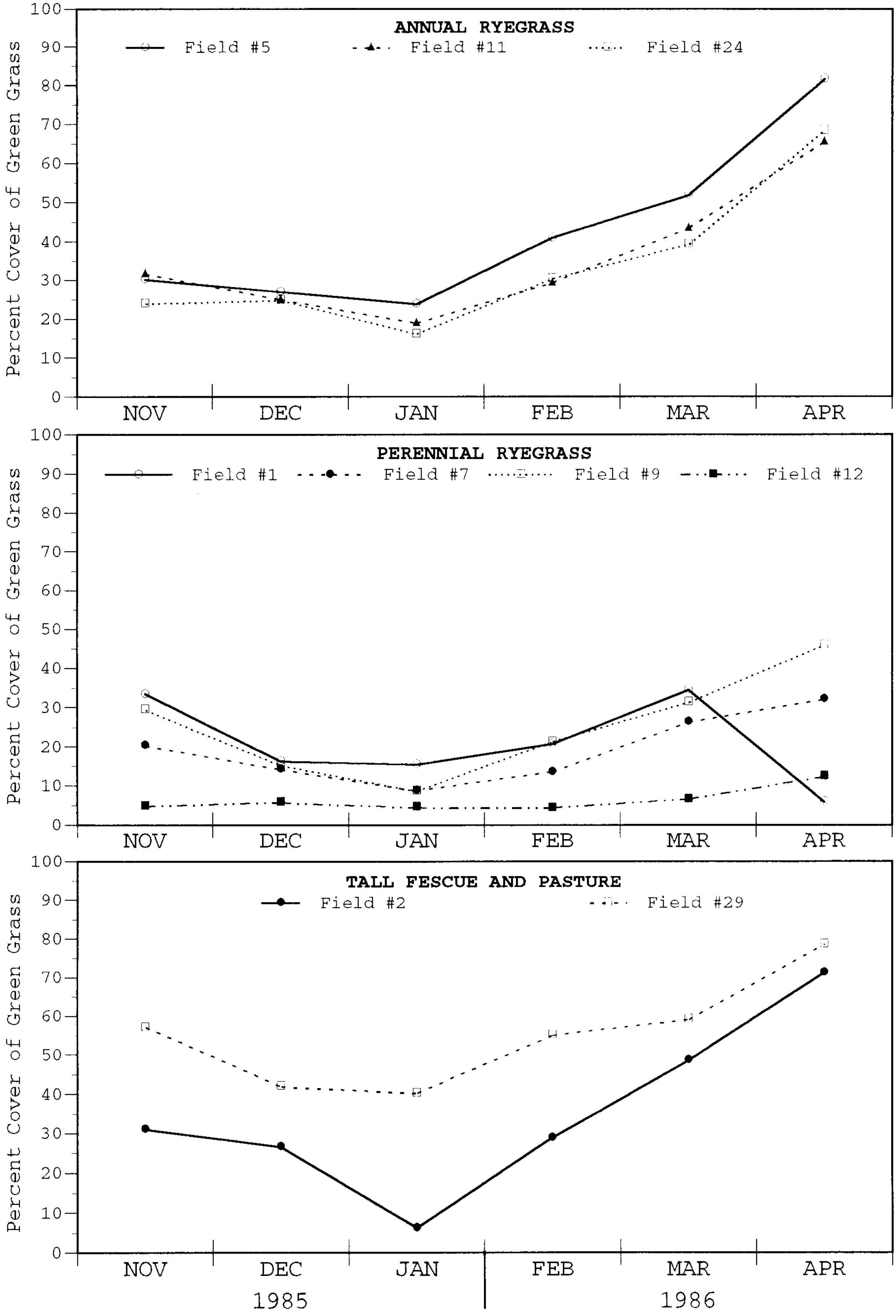


Figure 10. Seasonal trends in mean percent cover of green forage of four different crops, W. L. Finley NWR, 1985-86.
Error bars reflect ± standard error.

Figure 11. Seasonal trends in mean percent cover of green forage in nine study fields, W. L. Finley NWR, November 1985 - April 1986.

FIGURE 11.


ANNUAL RYEGRASS
Field #5
Field #11
Field #24
PERENNIAL RYEGRASS
Field #1
Field #7
Field #9
Field #12
TALL FESCUE AND PASTURE
Field #2
Field #29
Percent Cover of Green Grass
0
10
20
30
40
50
60
70
80
90
100
NOV
DEC
JAN
FEB
MAR
APR
1985
1986

ryegrass fields were sparsely covered (28.6%). Grass cover decreased slightly during the winter and was lowest in January (19.6%) but then increased in February and continued to increase through the remainder of the season. Grass cover in April (71.9%) was more than double November values. All fields of annual ryegrass behaved similarly.

The initial grass cover in fields of perennial ryegrass was also low (22.0%) and decreased as the winter progressed. January levels in perennial ryegrass fields (9.3%) were lower than those recorded in annual ryegrass fields (19.6%). Cover began to increase in February and the increase continued through the end of the season. Grass cover in perennial ryegrass fields was approximately 50% higher in April than in November.

Field 12 had significantly less cover than the other perennial ryegrass fields (Figure 11). Over the entire season, green cover averaged only 6.4%. Although values in April were double those measured in November and three times greater than values measured in December and January, at 12% they were lower than most midwinter values for the other perennial ryegrass fields.

Fescue and the pasture exhibited the same general trend of declining cover from November through January, followed by an increase in cover from February through the end of the season.

Nitrogen Content

Grass samples from the nine study fields were analyzed for nitrogen content. A total of 166 samples were collected during 1985-86 and 269 samples were collected during 1986-87. Nitrogen content was not significantly different between years ($\underline{P}<0.05$).

In 1985-86, nitrogen content ranged from 2.41% (Field 5; annual ryegrass; April) to 6.32% (Field 11; annual ryegrass; March) (Table 12). Data were not collected from all fields during December and January, thus only samples collected during February, March and April were analyzed. Grass clipped in March, after fertilization, was significantly higher in nitrogen than grass clipped in the other months. There was no significant difference between February and April (Figure 12).

In February 1986, wheat grain was spread on a unused road to provide supplemental feed for the geese. Nineteen samples of this grain collected in February and March, contained an average of 2.02% nitrogen, which was significantly lower than in all averages for grass samples ($\underline{P}<0.05$).

Nitrogen content of grass samples collected during 1986-87 ranged from 1.91% to 5.95% and field averages ranged from 2.20% to 5.78% (Table 13). The low values were from Field 5, annual ryegrass, clipped in late March and the high values were from grass clipped in the pasture (Field 29) during November.

Table 12. Monthly averages of percent nitrogen in nine intensively studied fields, W. L. Finley NWR, Oregon, December 1985 - April 1986.

Crop	Field Number	DEC	JAN	FEB	MAR	APR
Annual Ryegrass	5		4.22[1] ±0.09 (5)	4.54 ±0.16 (5)	5.04 ±0.09 (6)	2.41 ±0.13 (5)
Annual Ryegrass	11			5.19 ±0.42 (5)	6.32 ±0.10 (6)	2.70 ±0.10 (5)
Annual Ryegrass	24			4.94 ±0.13 (5)	4.49 ±0.12 (5)	2.76 ±0.20 (4)
Perennial Ryegrass	1	4.08 ±0.03 (5)	3.62 ±0.04 (5)	5.50 ±0.06 (5)	4.95 ±0.28 (5)	4.89 ±0.10 (5)
Perennial Ryegrass	7			4.80 ±0.17 (5)	5.13 ±0.07 (5)	3.63 ±0.12 (5)
Perennial Ryegrass	9	4.06 ±0.13 (5)		5.38 ±0.15 (4)	4.92 ±0.13 (6)	4.30 ±0.09 (5)
Perennial Ryegrass	12			4.92 ±0.14 (5)	5.10 ±0.03 (5)	3.97 ±0.25 (5)
Tall Fescue	2	2.87 ±0.12 (5)		3.29 ±0.03 (7)	4.30 ±0.08 (5)	3.24 ±0.12 (5)
Pasture	29	4.15 ±0.16 (5)		3.51 ±0.17 (3)	4.52 ±0.19 (5)	3.46 ±0.22 (5)

[1] Mean ± standard error (sample size).

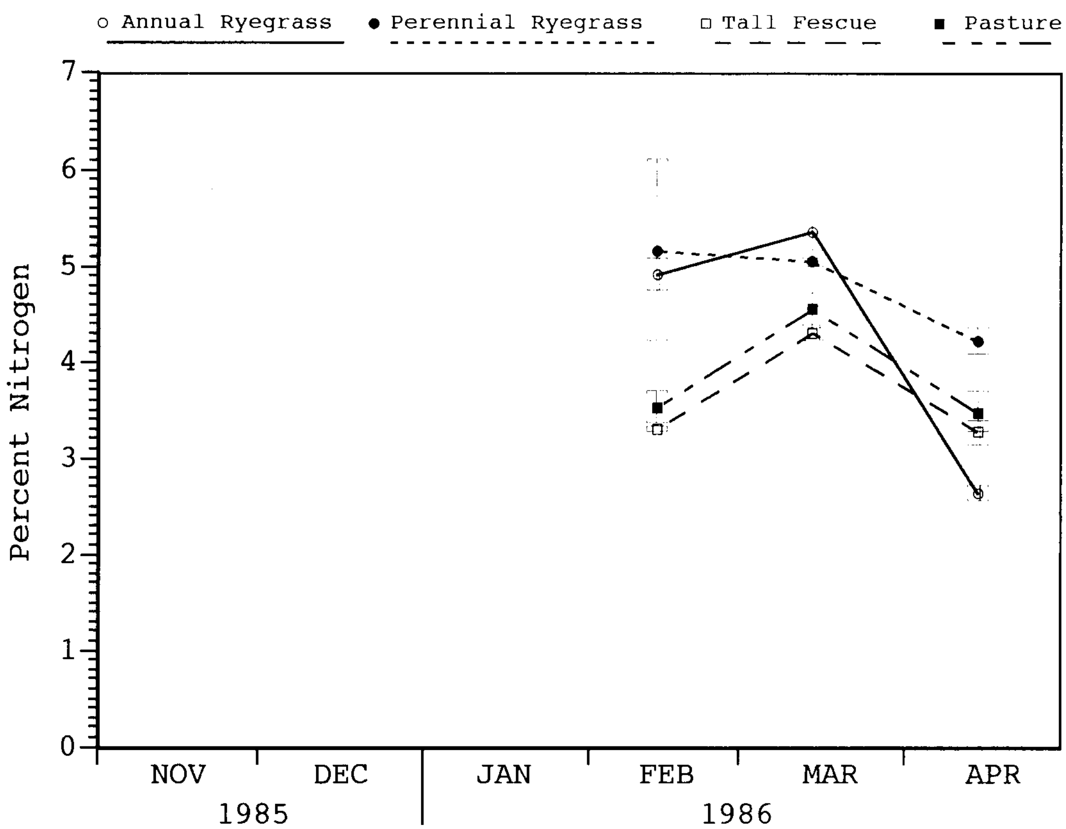


Figure 12. Mean percent nitrogen of four different crops, W. L. Finley NWR, February 1986 - April 1986.

Table 13. Monthly averages of percent nitrogen in nine intensively studied fields, W. L. Finley NWR, Oregon, October 1986 - March 1987.

Crop	Field Number	OCT	NOV	DEC	JAN	FEB	MAR
Annual Ryegrass	5	4.67[1] ±0.09	3.80 ±0.06	3.44 ±0.20	2.90 ±0.14	2.93 ±0.28	2.20 ±0.08
Annual Ryegrass	11	3.95 ±0.16	3.70 ±0.05	3.36 ±0.32	2.42 ±0.10	2.34 ±0.11	2.52 ±0.14
Annual Ryegrass	24	4.94 ±0.07	3.52 ±0.10	3.33 ±0.12	2.65 ±0.11	4.21 ±0.16	2.96 ±0.18
Perennial Ryegrass	1	3.33 ±0.08	4.54 ±0.29	4.31 ±0.20	4.29 ±0.06	5.06 ±0.11	4.73 ±0.21
Perennial Ryegrass	7	3.05 ±0.04	4.43 ±0.06	4.31 ±0.02	3.79 ±0.05	5.22 ±0.08	3.28 ±0.13
Perennial Ryegrass	9	3.51 ±0.09	3.54 ±0.53	3.86 ±0.32	4.15 ±0.36	5.12 ±0.14	3.70 ±0.09
Perennial Ryegrass	12	4.10 ±0.11	4.90 ±0.06	3.76 ±0.26	4.45 ±0.06	5.39 ±0.04	4.50 ±0.04
Alta Fescue	2	2.95 ±0.06	5.50 ±0.08	4.45 ±0.12	4.22 ±0.15	4.58 ±0.11	4.54 ±0.10
Pasture	29	4.94 ±0.13	5.78 ±0.06	4.13 ±0.21	4.84 ±0.39	4.71 ±0.12	3.60 ±0.04

[1] Mean ± standard error; sample size = 5 for each mean except Fld.24/Nov, sample size = 4.

There were significant seasonal differences in the nitrogen content of grass collected in 1986-87 ($\underline{P}$<0.01) (Table 14). Grass was highest in nitrogen during November and February (4.40%) and lowest in March (3.56%). With the exception of annual ryegrass, all fields increased in nitrogen content between October and November and either remained constant or began a slow decline until the end of the season. Nitrogen content increased sharply in many fields in February after fertilization (Figure 14).

The seasonal pattern of percent nitrogen in annual ryegrass differed from that in other crops. Nitrogen levels were fairly high in October (3.95 - 4.94%) but declined steadily from October through January (2.42 - 2.90%). January levels of nitrogen in annual ryegrass were significantly lower than January levels in all other fields. There was a slight increase in February although most of this was attributable to fertilization of one field (Field 24, Figure 14).

In October the pasture had the highest nitrogen content, followed by annual ryegrass, perennial ryegrass and fescue. By the end of the season, however, this order was nearly reversed. Alta fescue had the highest nitrogen content, followed by perennial ryegrass, the pasture and annual ryegrass.

Overall, the pasture had the highest nitrogen content (4.67%) but the level was not significantly different from that in perennial ryegrass in Field 12 (4.52%) (Table 15).

Table 14. Monthly averages of percent nitrogen in grass samples collected, W. L. Finley NWR, Oregon, October 1986 - March 1987.

Month	N	Mean Nitrogen %[1]	SNK[2]
November	44	4.40 ±0.13	A
February	45	4.40 ±0.16	A
October	45	3.94 ±0.12	B
December	45	3.89 ±0.09	B
January	45	3.75 ±0.14	B C
March	45	3.56 ±0.13	C

[1] Dry weight basis; mean ± standard error.

[2] Means with the same letter are not significantly different (Student-Newman-Keuls mean separation test, $\alpha<0.05$).

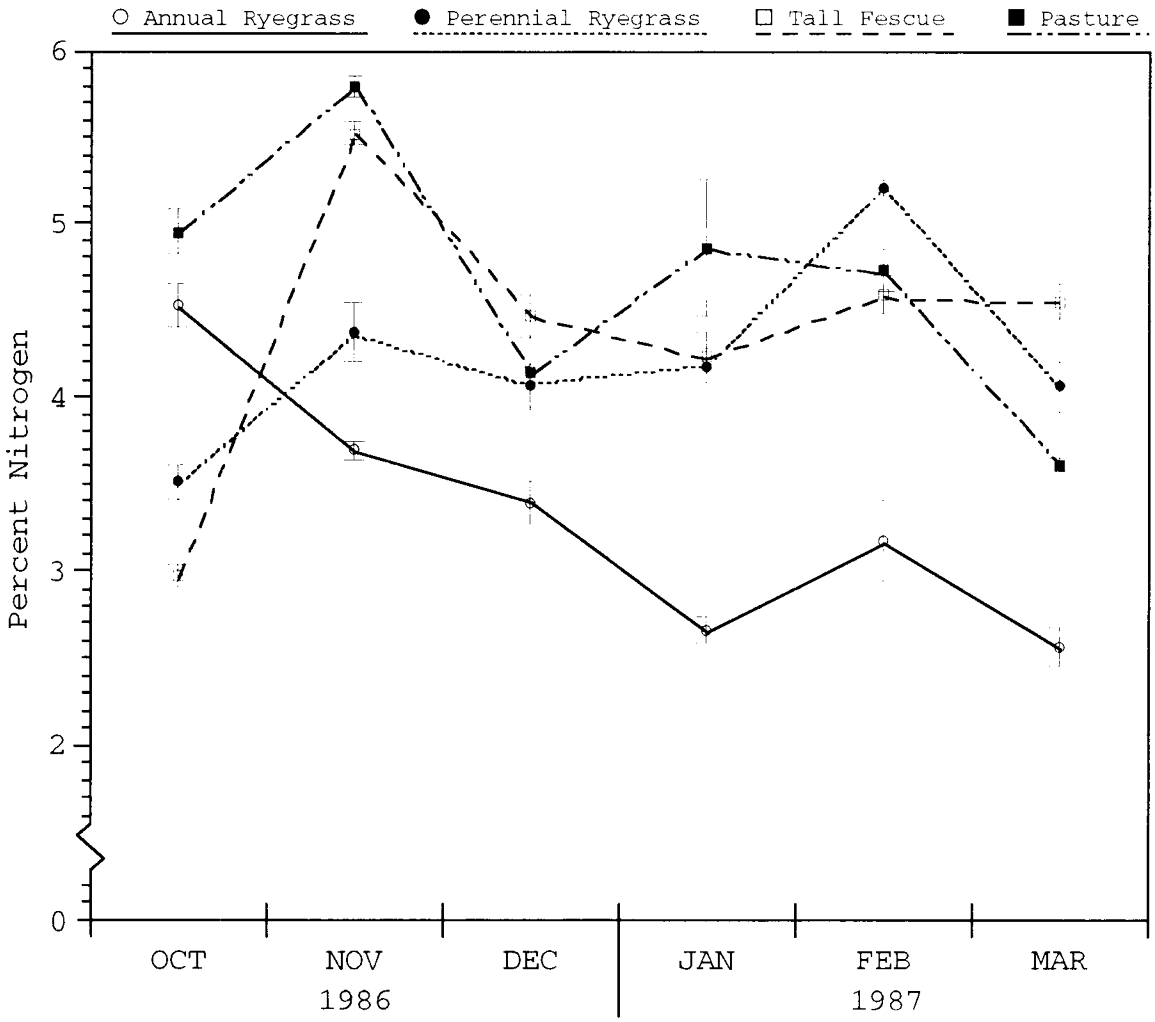


Figure 13. Seasonal trends in mean percent nitrogen of four different crops, W. L. Finley NWR, 1986-87. Error bars reflect ± standard error.

Figure 14. Seasonal trends in mean percent nitrogen in nine study fields, W. L. Finley NWR, Oregon, October 1986 - March 1987.

FIGURE 14.

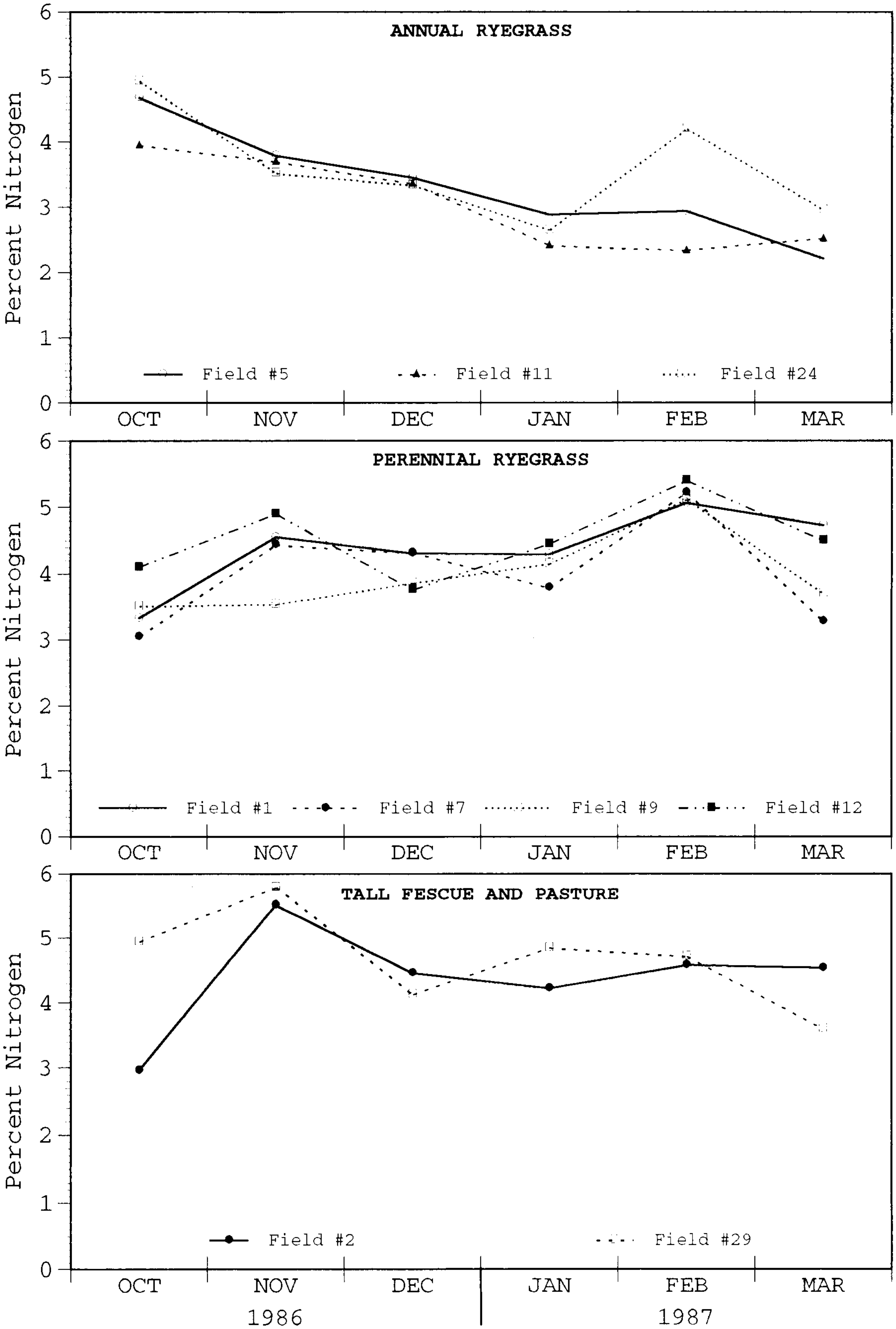

ANNUAL RYEGRASS
Percent Nitrogen
0
1
2
3
4
5
6
Field #5
Field #11
Field #24
OCT
NOV
DEC
JAN
FEB
MAR
PERENNIAL RYEGRASS
Field #1
Field #7
Field #9
Field #12
TALL FESCUE AND PASTURE
Field #2
Field #29
1986
1987

Table 15. Nitrogen content of grass samples collected in nine different fields, W. L. Finley NWR, Oregon, October 1986 - March 1987.

Crop	Field Number	N	Mean Nitrogen%[1]	SNK[2]
Pasture	29	30	4.67 ±0.15	A
Perennial Ryegrass	12	30	4.52 ±0.11	A B
Perennial Ryegrass	1	30	4.38 ±0.11	B
Tall Fescue	2	30	4.38 ±0.15	B
Perennial Ryegrass	7	30	4.02 ±0.14	C
Perennial Ryegrass	9	30	3.98 ±0.15	C
Annual Ryegrass	24	29	3.61 ±0.16	D
Annual Ryegrass	5	30	3.33 ±0.16	E
Annual Ryegrass	11	30	3.05 ±0.14	F

[1] Dry weight basis; mean ± standard error.
[2] Means with the same letter are not significantly different (Student-Newman-Keuls mean separation test, $\alpha<0.05$).

Perennial ryegrass and alta fescue did not contain significantly different levels of nitrogen, but had significantly more nitrogen than all annual ryegrass fields.

Fiber Content

A total of 162 grass samples from 1985-86 and 269 samples from 1986-87 were analyzed for fiber. Grass collected in 1985-86 contained significantly higher amounts of fiber than grass collected in 1986-87 (23.44 versus 20.05 %ADF, $\underline{P}<0.05$).

In 1985-86 percent ADF ranged from 18.09% (Field 11, annual ryegrass, February) to 26.81% (Field 9, perennial ryegrass, March) (Table 16). There were no significant seasonal differences in the fiber content of grass collected during different months. There were significant differences between crops; fescue contained the highest fiber followed by perennial ryegrass, annual ryegrass and pasture. There was no significant difference between the fiber content of annual ryegrass and pasture (Figure 15).

In 1986-87 samples ranged from 13 - 28% ADF while field means ranged from 14.75 - 27.39%. The low value was from a field of annual ryegrass (Field 11) in October and the high value was from perennial ryegrass (Field 12) in November (Table 17). There were significant seasonal differences in the fiber content of grass collected in 1986-87. Fiber was significantly lowest in October, January and February

Table 16. Monthly averages of percent Acid Detergent Fiber (%ADF) in nine intensively studied fields, W. L. Finley NWR, Oregon, December 1985 - April 1986.

Crop	Field Number	DEC	JAN	FEB	MAR	APR
Annual Ryegrass	5		25.63[1] ±0.76 (5)	22.11 ±0.41 (5)	20.29 ±0.56 (6)	19.98 ±0.09 (5)
Annual Ryegrass	11			18.09 ±0.48 (5)	20.32 ±0.27 (6)	21.63 ±1.54 (5)
Annual Ryegrass	24			22.21 ±0.66 (5)	22.62 ±1.12 (5)	23.12 ±0.36 (4)
Perennial Ryegrass	1	19.09 ±0.23 (5)	21.68 ±0.41 (3)	23.19 ±0.35 (5)	20.84 ±0.53 (5)	23.74 ±0.26 (5)
Perennial Ryegrass	7			22.03 ±0.25 (5)	22.51 ±0.60 (5)	21.39 ±0.19 (5)
Perennial Ryegrass	9	25.88 ±0.54 (5)		25.64 ±0.97 (4)	26.81 ±0.93 (6)	25.18 ±1.35 (5)
Perennial Ryegrass	12			24.51 ±1.56 (5)	22.50 ±0.16 (5)	23.68 ±0.39 (5)
Tall Fescue	2	22.48 ±0.18 (5)		23.42 ±0.58 (7)	24.26 ±0.34 (5)	25.41 ±0.19 (5)
Pasture	29	20.16 ±1.24 (5)		21.29 - (1)	18.84 ±0.37 (5)	21.78 ±0.66 (5)

[1] Mean ± standard error (sample size).

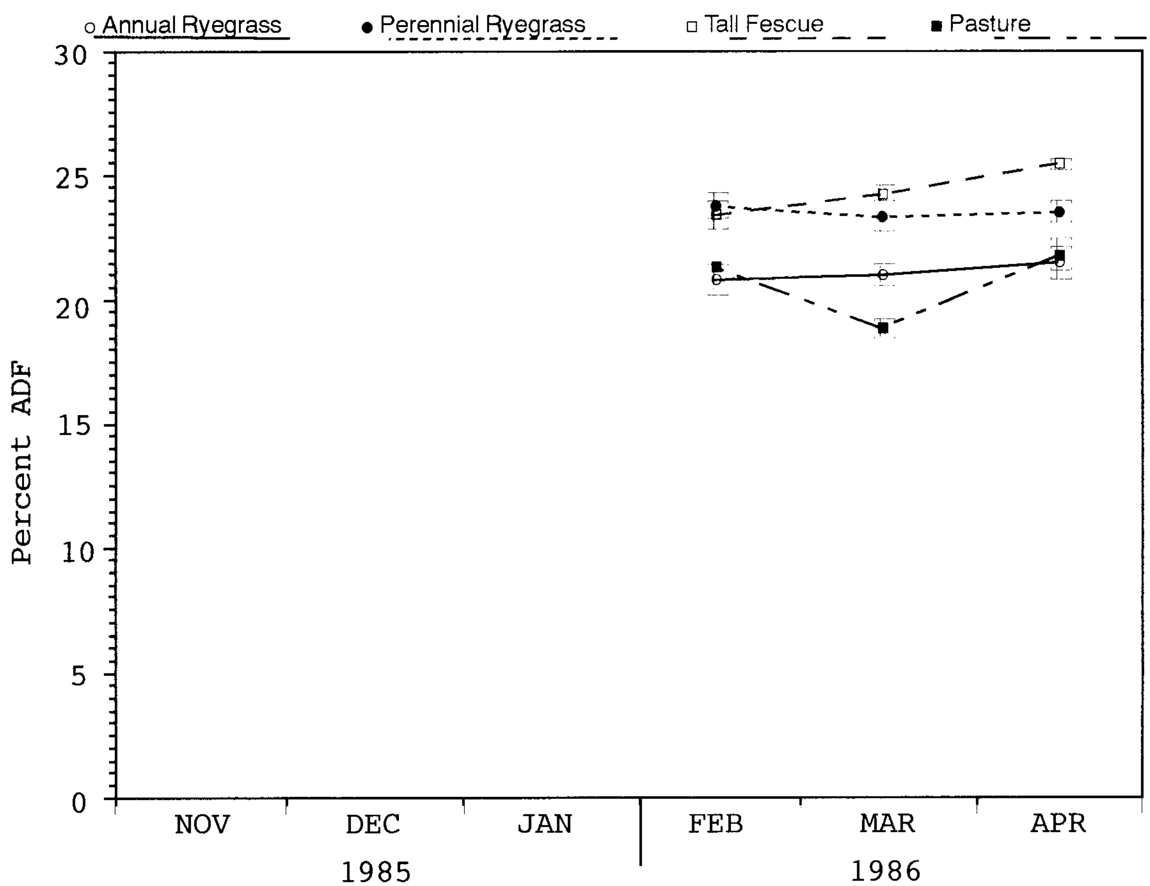


Figure 15. Mean fiber content of four different crops,
W. L. Finley NWR, February 1985 - April 1986.

Table 17. Monthly averages of acid detergent fiber (%ADF) in grass from nine intensively studied fields, W. L. Finley NWR, Oregon, October 1986 - March 1987.

Crop	Field Number	OCT	NOV	DEC	JAN	FEB	MAR
Annual Ryegrass	5	15.98	18.78	16.76	14.94	17.74	18.48
		±0.04	±0.44	±0.24	±0.22	±0.53	±0.29
Annual Ryegrass	11	14.75	22.09	18.45	16.98	17.13	21.47
		±0.31	±0.40	±0.58	±0.84	±0.42	±0.65
Annual Ryegrass	24	16.35	20.69	18.14	16.08	17.63	20.19
		±0.30	±0.28	±0.46	±0.21	±0.52	±0.52
Perennial Ryegrass	1	22.49	23.75	23.12	20.67	18.76	21.64
		±0.30	±0.39	±0.32	±0.41	±0.68	±0.32
Perennial Ryegrass	7	19.32	25.55	20.31	20.25	21.66	19.64
		±0.60	±0.31	±0.46	±0.18	±0.22	±0.35
Perennial Ryegrass	9	17.71	19.67	19.56	21.23	19.65	20.38
		±0.40	±0.64	±1.32	±0.49	±0.33	±0.30
Perennial Ryegrass	12	18.72	23.14	27.39	21.98	21.02	21.36
		±0.30	±0.51	±4.59	±0.99	±0.22	±0.41
Alta Fescue	2	27.17	23.64	20.37	20.89	19.40	23.44
		±0.92	±1.22	±0.41	±0.36	±0.35	±0.37
Pasture	29	18.92	20.26	19.68	17.78	19.43	20.31
		±0.45	±0.22	±0.37	±0.29	±0.33	±0.31

[1] Mean ± standard error; sample size = 5 for each mean except Fld. 24/Nov, sample size = 4.

(Table 18) and significantly highest in November. The seasonal pattern for each of the different crops was slightly different (Figure 16).

Annual ryegrass, initially low in fiber content (15.69%) increased sharply in November (20.51%) and then declined steadily through January (16.00%). Fiber content began to increase in February and continued to increase until the end of the season. End of season values were slightly higher than early season values (20.04%). All fields exhibited a similar pattern (Figure 17).

Fiber content was more variable among the four fields of perennial ryegrass than among the three fields of annual ryegrass (Figure 17). Fiber content of perennial ryegrass was moderately high in October (19.56%), increased during November (23.03%), and then decreased in January (21.03%) and remained relatively constant through the remainder of the season. Two fields (7 and 12) had sharp increases early in the season followed by sharp declines. The early season increase in the other two fields (1 and 9) was more gradual. Fiber values for the four perennial fields were less variable at the end of the season and were comparable in magnitude to values measured early in the season.

At the start of the season, fescue had the highest fiber content (27.17%) of any crop type. Fiber levels decreased steadily through the winter (19.40%, February) and then increased at the end of the season. Values in March (23.44%) were significantly lower than values in October.

Table 18. Fiber content of grass samples collected, W. L. Finley NWR, Oregon, October 1986 - March 1987.

Month	N	Fiber[1] (% ADF)	SNK[2]
November	44	21.98 ±0.37	A
March	45	20.77 ±0.24	B
December	45	20.42 ±0.67	B
February	45	19.16 ±0.25	C
October	45	19.05 ±0.56	C
January	45	18.98 ±0.40	C

[1] Percent Acid Detergent Fiber on dry weight basis; mean ± standard error.
[2] Means with the same letter are not significantly different (Student-Newman-Keuls mean separation test, $\alpha<0.05$).

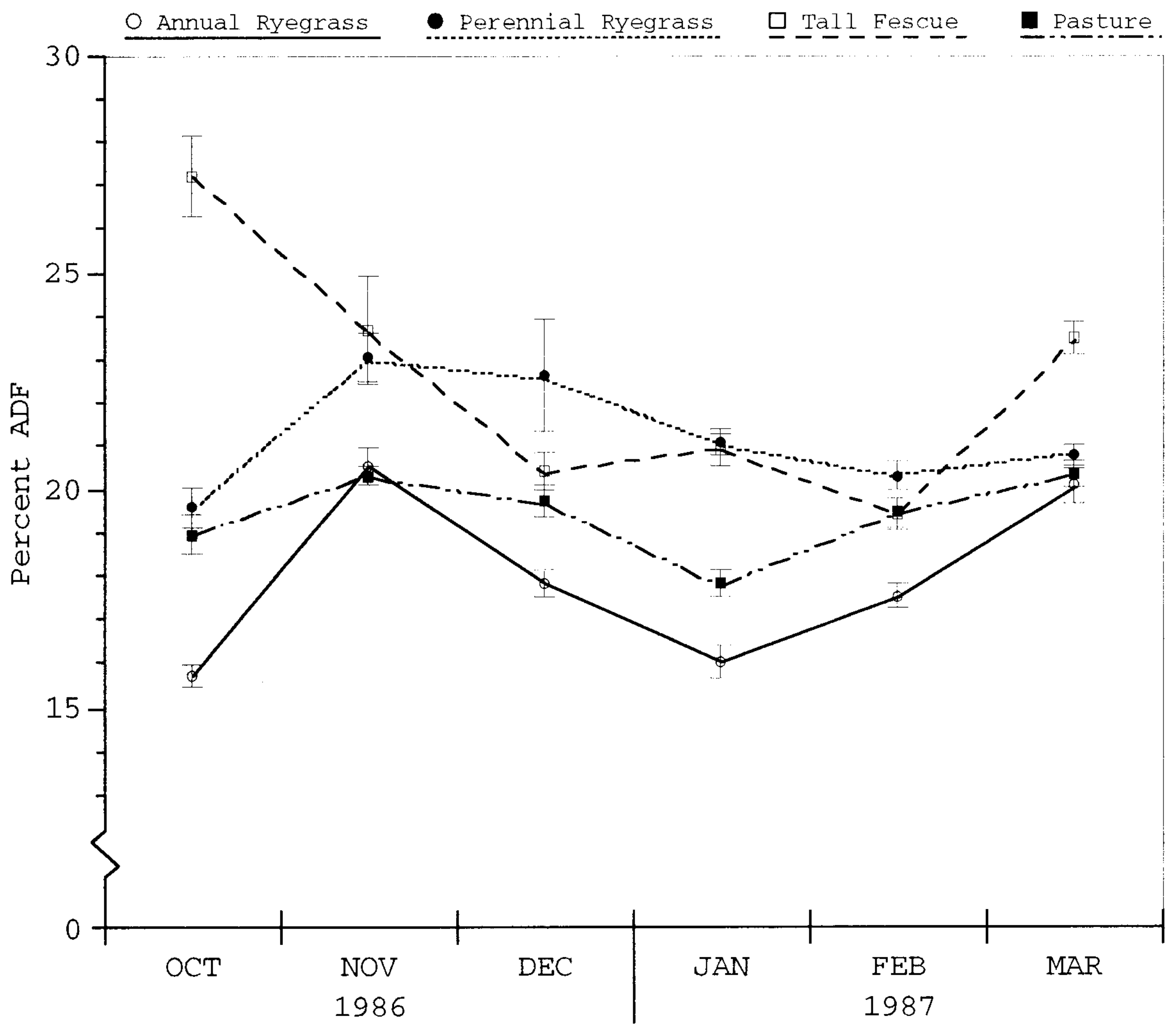
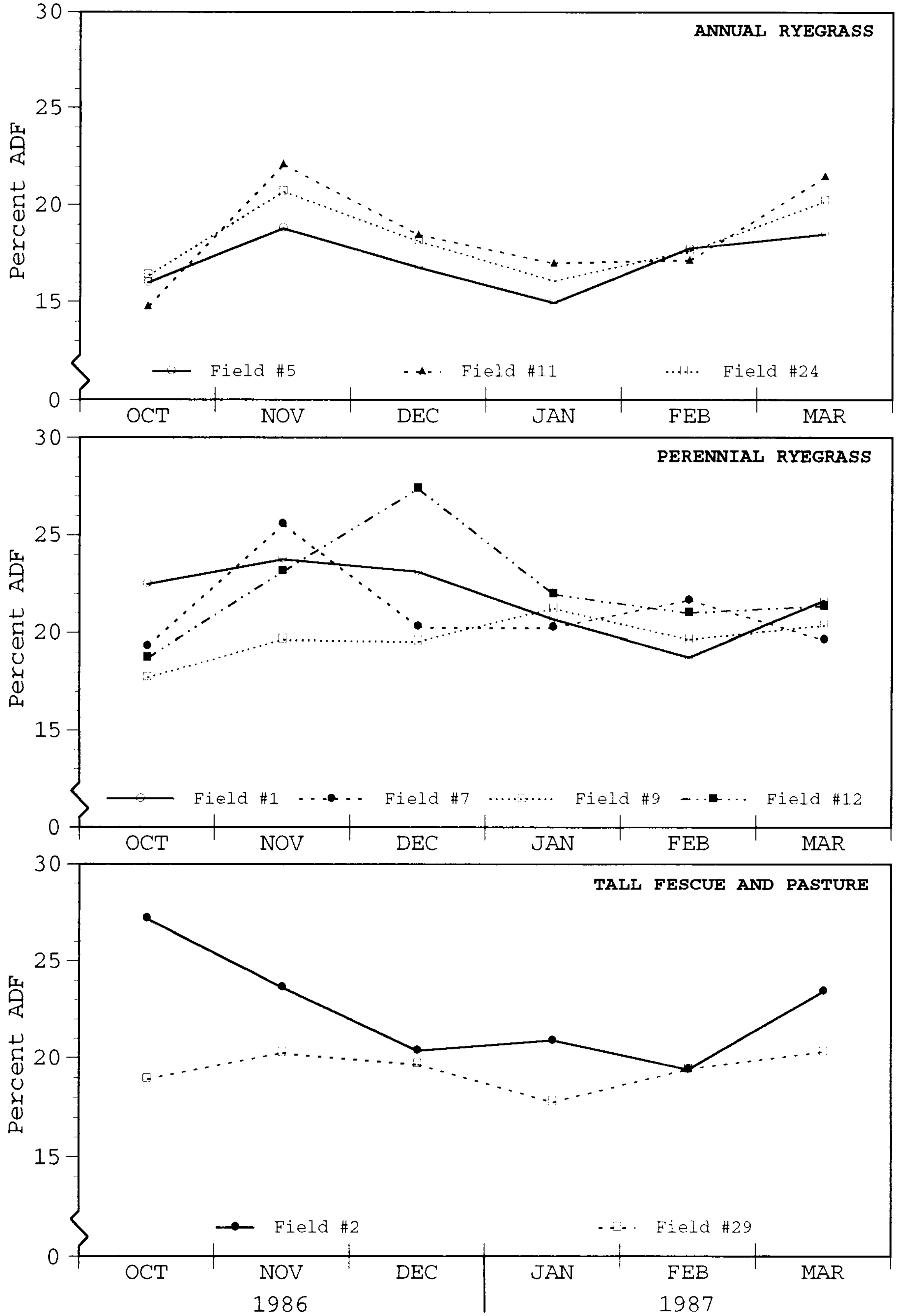


Figure 16. Seasonal trends in mean fiber content of four different crops, W. L. Finley NWR, 1986-87. Error bars reflect ± standard error.

Figure 17. Seasonal trends in mean fiber content (%ADF) in nine study fields, W. L. Finley NWR, Oregon, November 1985 - April 1986.

FIGURE 17.


ANNUAL RYEGRASS
Percent ADF
30
25
20
15
0
Field #5
Field #11
Field #24
OCT
NOV
DEC
JAN
FEB
MAR
PERENNIAL RYEGRASS
Field #1
Field #7
Field #9
Field #12
TALL FESCUE AND PASTURE
Field #2
Field #29
1986
1987

Seasonal changes in the fiber content of the pasture samples were slight. Fiber content was initially moderate (18.92%) and increased slightly in November (20.26%). Values decreased to 17.78% in January and then increased through the end of the season (20.31%, March).

Overall, fescue had the highest fiber content followed by perennial ryegrass and the pasture (Table 19). Annual ryegrass had the lowest fiber content. Although differences between crop types were significant ($\underline{P}<0.01$), all fields of a specific crop type were not statistically distinct from fields of other crop types (Table 20). Field 2 (tall fescue) was not significantly different from two perennial ryegrass (Fields 1 and 12). Fiber content of the pasture was lower than the mean for perennial ryegrass but not significantly different from values measured in perennial ryegrass Field 9. The three annual ryegrass fields were significantly lowest

CORRELATION ANALYSIS

Stepwise regression and correlation analyses of use of fields by geese in 1985-86 with the characteristics of forage in those fields revealed few meaningful patterns. None of the forage variables met the 0.15 significance level set for inclusion of the variables into the regression model (Table 21).

When analyzed separately by type of crop, several patterns did emerge (Table 22). In annual ryegrass there was

Table 19. Fiber content of grass collected from four different crop types, W. L. Finley NWR, Oregon, October 1986 - March 1987.

Crop	N	Fiber[1] (% ADF)	SNK[2]
Annual Ryegrass	89	17.89 ±0.24	A
Pasture	30	19.40 ±0.20	B
Perennial Ryegrass	120	21.21 ±0.28	C
Tall Fescue	30	22.49 ±0.55	D

[1] Percent Acid Detergent Fiber on dry weight basis; mean ± standard error.

[2] Means with the same letter are not significantly different (Student-Newman-Keuls mean separation test, $\alpha<0.05$).

Table 20. Fiber content of grass samples collected in nine different fields, W. L. Finley NWR, Oregon, October 1986 - March 1987.

Crop	Field Number	N	Fiber[1] (% ADF)	SNK[2]
Tall Fescue	2	30	22.49 ±0.55	A
Perennial Ryegrass	12	30	22.27 ±0.87	A
Perennial Ryegrass	1	30	21.74 ±0.35	A B
Perennial Ryegrass	7	30	21.12 ±0.42	B
Perennial Ryegrass	9	30	19.70 ±0.32	C
Pasture	29	30	19.40 ±0.20	C
Annual Ryegrass	11	30	18.48 ±0.52	D
Annual Ryegrass	24	29	18.01 ±0.36	D
Annual Ryegrass	5	30	17.11 ±0.29	E

[1] Percent Acid Detergent Fiber on dry weight basis; mean ± standard error.
[2] Means with the same letter are not significantly different (Student-Newman-Keuls mean separation test, $\alpha<0.05$).

Table 21. Correlation coefficients of geese and forage characteristics measured at W. L. Finley NWR, Oregon, 1985 - 1986

	Number of geese/field	Density of geese/field	Frequency of occurrance
All Fields			
% Nitrogen	0.07	0.15	0.07
% ADF	0.09	0.12	0.04
Forage Height	-0.05	-0.10	-0.18
% Green Cover	-0.03	0.10	-0.29
Annual Ryegrass			
% Nitrogen	0.24	0.21	-0.01
% ADF	0.26	0.20	-0.09
Forage Height	0.27	0.14	-0.18
% Green Cover	0.61	0.51	0.13
Perennial Ryegrass			
% Nitrogen	-0.01	0.13	0.14
% ADF	0.02	0.17	0.18
Forage Height	-0.34	-0.19	-0.68
% Green Cover	0.14	0.36	-0.16
Tall Fescue			
% Nitrogen	-0.21	-0.21	-0.26
% ADF	-0.29	-0.29	-0.46
Forage Height	-0.68	-0.68	-0.76
% Green Cover	-0.54	-0.54	-0.68
Pasture			
% Nitrogen	-0.06	-0.06	-0.26
% ADF	-0.12	-0.12	-0.32
Forage Height	-0.13	-0.13	-0.18
% Green Cover	0.04	0.04	-0.01

Table 22. Summary statistics of stepwise regression analysis of frequency of occurrence and mean density of geese per field with nitrogen, fiber, canopy height, and percent cover of the green forage, W. L. Finley NWR, 1985 - 1986.

		Density of geese				Frequency of occurrence		
		Partial R^2	Model R^2	Prob.>F		Partial R^2	Model R^2	Prob.>F
All fields			NS[1]				NS	
Annual ryegrass								
	% Cover	0.26	0.26	0.03			NS	
	Height	0.32	0.58	0.004				
Perennial ryegrass								
	% Cover	0.13	0.13	0.09	% ADF	0.06	0.52	0.11
	Height	0.18	0.31	0.03	Height	0.46	0.46	0.0003
Tall fescue								
	Height	0.46	0.46	0.14	Height	0.58	0.58	0.08
Pasture			NS				NS	

[1]Not Significant

a positive correlation between mean goose density and the height and percent cover of green forage ($\underline{P}$=0.004). Together these two measures of grass quantity accounted for 58% of the variability in density of geese. Grass height and percent cover were also significantly correlated with goose density in perennial ryegrass (R^2=0.31, $\underline{P}$=0.03), but the correlation was negative: high densities of geese were associated with short and sparse perennial ryegrass. Height of grass was the only variable significantly correlated with goose density in the fescue field (R^2=0.46, $\underline{P}$=0.14); again the correlation was negative. In the pasture, none of the forage variables were significantly correlated with density of geese.

Results were similar for regressions of flock size and frequency of occurrence of geese with forage characters in each of the crop types (Table 22). However, in annual ryegrass fields, no forage variables were significantly correlated with frequency of occurrence of geese. Additionally, grass height and percent fiber of perennial ryegrass were significantly related to frequency of occurrence of geese but the contribution of fiber to the model was small (partial R^2=0.06, $\underline{P}$=0.11). Excepting this one instance, nitrogen and fiber were not significant components of any of the regression models conducted over time.

When examined by month, regression analysis revealed significant correlations between quantity of grass in December and January, and quality of grass in February and March (Table 23). During December, height of grass alone

Table 23. Monthly summary statistics of stepwise regression analysis of frequency of occurrence and mean density of geese per field with nitrogen, fiber, canopy height, and percent cover of the green forage, W. L. Finley NWR, 1985 - 1986.

		Density of geese				Frequency of occurrence		
		Partial R^2	Model R^2	Prob.>F		Partial R^2	Model R^2	Prob.>F
November			NS				NS	
December	Height		0.63	0.01			NS	
January	Cover		0.28	0.14			NS	
February	% ADF		0.30	0.12			NS	
March	% N	0.30	0.30	0.13	% N	0.44	0.44	0.05
	% ADF	0.32	0.62	0.07	% ADF	0.24	0.69	0.07
	% Cover	0.17	0.79	0.11				
	Height	0.12	0.90	0.09				
April			NS				NS	

accounted for 80% of the variability in the number of geese and 63% in the density of geese (R^2=0.80, $\underline{P}$=0.001 and R^2=0.63, $\underline{P}$=0.01, respectively). Height and cover were both important components of the model exploring the relation between forage and the number of geese in January (R^2=0.73, $\underline{P}$=0.07), but only cover remained significant when density of geese was analyzed (R^2=0.28, $\underline{P}$=0.14). A relatively weak correlation existed between fiber and the number and density of geese observed during February (R^2=0.41, $\underline{P}$=0.06 and R^2=0.30, $\underline{P}$=0.12, respectively). In March, nitrogen and fiber together explained over 62% of the variability in density of geese and frequency of occurrence of geese(R^2=0.62, $\underline{P}$=0.07 and R^2=0.69, $\underline{P}$=0.07, respectively). Cover and height of forage combined with nitrogen and fiber to explain 90% of the variability in density of geese (R^2=0.90, $\underline{P}$=0.09) in March.

In 1986-87, the only forage characters measured were percent nitrogen and percent fiber. As in 1985-86, correlation coefficients were low and as often negative as positive (Table 24). Fiber content was positively correlated with density and frequency of occurrence of geese but the relations were weak (R^2=0.05, $\underline{P}$=0.10 and R^2=0.04, $\underline{P}$=0.13, respectively). When analyzed by individual crop type, nitrogen was positively correlated with frequency of occurrence of geese and fiber was positively correlated with density of geese in perennial ryegrass (Table 25), but the models accounted for little variability (R^2=0.21, $\underline{P}$=0.02 and

Table 24. Correlation coefficients of geese and forage characteristics measured at W. L. Finley NWR, Oregon, October 1986 - March 1987.

	Number of geese/field	Density of geese/field	Frequency of occurrance
All Fields			
% Nitrogen	0.19	-0.09	0.20
% ADF	0.31	0.23	0.21
Annual Ryegrass			
% Nitrogen	-0.12	-0.01	-0.13
% ADF	-0.04	0.22	0.07
Perennial Ryegrass			
% Nitrogen	0.26	-0.06	0.46
% ADF	0.40	0.41	0.21
Tall Fescue			
% Nitrogen	0.22	-0.03	-0.02
% ADF	-0.36	-0.52	-0.52
Pasture			
% Nitrogen	0.73	-0.29	-0.08
% ADF	0.45	0.19	0.32

Table 25. Summary statistics of stepwise regression analysis of frequency of occurrence and mean density of geese per field with nitrogen and fiber content of the green forage, W. L. Finley NWR, 1986 - 1987.

		Density of geese			Frequency of occurrence	
		R^2	Prob.>F		R^2	Prob.>F
All fields	%ADF	0.05	0.10	%ADF	0.04	0.13
Annual ryegrass		NS			NS	
Perennial ryegrass	%ADF	0.17	0.05	%N	0.21	0.02
Tall fescue		NS			NS	
Pasture		NS			NS	

R^2=0.17, P=0.05, respectively). No significant correlations occurred in the other crop types.

Analysis of data by monthly periods did not indicate the same trends with nitrogen documented in 1985-86. A weak negative correlation with fiber existed in October (R^2=0.30, P=0.12) and a stronger,positive correlation with fiber was documented in December and January (R^2=0.65, P=0.009 and R^2=0.55, P=0.02, respectively). As grass grows taller the fiber content increases.

DISCUSSION

The winter flock at the refuge was a diverse assemblage of Canada goose subspecies. Of the seven different subspecies identified, Taverner's, dusky and cackling geese were the most numerous. The presence of a large wintering population of cackling geese was unexpected. Cackling geese were known to migrate through Oregon during fall (Chapman et al. 1969) enroute to their traditional wintering grounds in California, but few remained in the Willamette Valley during winter. As recently as 1975-78, dusky and Taverner's geese constituted 97% of the overwintering flock (Simpson and Jarvis, 1979). During the winter of 1985-86 approximately 33% of the geese identified to subspecies in this study were cackling geese. The cause of the increase in numbers of cackling geese in the wintering flock are unknown, but a new tradition has apparently evolved (Cornely et al. In press, Jarvis and Bromley In press).

Annual population peaks of 14,000 - 19,000 geese were counted on the refuge during the first two years of this study. Goose populations on the refuge exhibited a bimodal distribution. Geese were more abundant early and late in the season and least abundant during mid-winter (January and February). Although geese were only counted on the refuge, I presumed most geese not on the refuge were feeding on private farm land during midwinter. Most private farm land used by geese was planted to grass crops.

Quantity of forage in the study fields displayed a pattern similar to the distribution of geese: low in mid-winter and moderate to high early and late in the winter. Heavy grazing on the refuge fields in early winter appeared to have reduced the quantity of forage and in response geese seemingly moved off the refuge to seek forage. In late February, when forage on refuge fields began increasing in quantity, geese began foraging on the refuge in increasing number.

Although forage quantity was greatly reduced by December, geese first shifted to lightly used fields on the refuge, and only moved off the refuge after hunting ended in early January. Hunting on the private lands surrounding the refuge apparently inhibited movement of geese away from the safety of the refuge. Restriction of movements of geese to and around refuges and sanctuaries by hunting has been frequently reported (Craighead and Stockstad 1956, Koerner et al. 1974, Zicus 1981, Anderson and Joyner 1985, Frederick 1987, Harvey 1987).

When geese arrived in October of 1985, highest densities were recorded on annual and perennial ryegrass. By December, grass quantities were reduced to minimum levels and the geese began using the fescue field. By December grass height in the ryegrass fields averaged only 26 mm compared to 81 mm in the fescue field. After large flocks of geese began feeding on the fescue in early December the height decreased to

52 mm. From late February through the end of the season the highest densities of geese were again recorded on the annual and perennial ryegrass fields. Nitrogen content of annual and perennial ryegrass were significantly higher than for fescue during this period and warmer temperatures resulted in increased grass height and cover.

The patterns of goose distribution were different in 1986-87 and the association between geese and quality of forage were weak or nonexistent. Geese utilized annual ryegrass fields when they first arrived and they continued to use annual ryegrass through early December. Nitrogen content of annual ryegrass was high in October but declined steadily after that. In late December, large flocks of geese fed on the pasture. This area had received very little use in 1985-86 and it was used only in December 1986. Nitrogen content of the pasture forage peaked at 5.79% in late November and declined to 4.13% by December. During January the density of geese on annual ryegrass, perennial ryegrass and fescue were approximately equal. It was during mid-winter that goose use of fescue had peaked in 1985-86. Climate conditions were extremely mild in 1986-87 and the height and cover in ryegrass seemed to remain fairly high, but measurements of quantity were not taken in 1986-87. Perhaps there was sufficient quantity of the two ryegrasses so that geese continued to feed on these grasses. From February through the end of the year, the highest densities of geese were recorded on the perennial ryegrass fields.

There was no increase in usage of annual ryegrass fields as had been observed in 1985-86.

These patterns of usage of fields seem to suggest that geese were responding to the quantity and quality of forage as it changed over the winter. During the middle of the winter when temperatures were at a minimum, quantity of grass was an important determinant of where geese fed. But late in the season, the quality of the forage became more important. In addition to wintering, the Willamette Valley functions as a staging area for dusky geese prior to a rapid spring migration to their breeding grounds (Bromley 1985). Hence, in late winter when geese were building lipid stores prior to migration and breeding (Bromley 1985), they fed in fields containing forage with the highest protein content. Several researchers have documented selection by geese for forage high in nitrogen (Owen 1971, 1975, 1980, Ydenberg and Prins 1981, Smith et al 1986) especially during the spring. Usually these studies documented the switch from a grain diet low in nitrogen to one of green forage high in nitrogen. At Finley NWR, where grains were not available, geese switched from the green forage that was most abundant to the green forage with the highest nitrogen.

The weak statistical correlations in 1986-87 indicate that factors other than forage may have a major influence on use of fields by feeding geese. Perhaps factors related to security and tradition may be important influences on usage of fields by foraging geese, especially when food is abundant and of high quality. Significant differences in the nitrogen and fiber existed among fields and crops, however, overall the quality of all grasses was high. Estimated crude protein of these grasses ranged from 14 - 36% during the winter with an overall average of 24%.

I conclude that the quality of forage on Finley NWR was adequate for maintenance nutrition of geese during the winter and for acquisition of energy stores prior to spring migration. However, geese reduced the quantity of forage on the refuge and once hunting ceased, they began utilizing the nearby untapped food resources on private farm land. Whether forage on the refuge is insufficient for the geese by mid-winter or merely less attractive compared to the abundant forage on private farm land is unknown. Additionally, the response of geese to quantity, and perhaps quality of forage, is strongly influenced by weather disturbance and security.

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