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Assessing the Suitability of Windbreaks as Wildlife Habitat

1994 Pilot Plan

EMAP

Environmental Monitoring and
Assessment Program

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ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM

Agroecosystem Resource Group

Assessing the Suitability of Windbreaks as Wildlife Habitat - 1994 Pilot Plan

by

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Notice

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Executive Summary

The Environmental Monitoring and Assessment Program's (EMAP) Agroecosystems Resource Group is developing a program to monitor and evaluate the ecological condition of United States agricultural lands. We are evaluating agricultural lands from several perspectives: productivity; quality of air, water, and soil; and biodiversity. This pilot focuses on the potential biodiversity value of windbreaks in the Great Plains, and is designed to test the feasibility of applying the U.S. Fish and Wildlife's Bird Species Richness Index for windbreaks on a regional basis.

Windbreaks are an important non-crop element in the Great Plains, an extensive agricultural landscape. Although planted to protect fields, crops, livestock, and farmsteads from the prevailing winds, windbreaks also provide some of the scarce wooded habitat for birds and other wildlife. For example, less than 2% of Nebraska is covered by trees; and approximately 25% of that wooded cover is provided by windbreaks. Windbreaks may also have a negative impact on wildlife species that require large, uninterrupted areas of grassland habitat; this issue is not addressed by this research.

We are working in cooperation with the United States Department of Agriculture, National Agricultural Statistics Service (NASS). During June, 1994, NASS enumerators will collect information about the location of windbreaks in Nebraska. This information will be used to draw a probability sample of windbreaks. NASS enumerators will visit the sample windbreaks later in the year and collect the data needed to calculate the Bird Species Richness Index for windbreaks. The Index gives the number of different bird species expected in a windbreak and is based on four habitat characteristics of the windbreak. The habitat characteristics needed to calculate the Index are windbreak area, average height of the tallest row of trees in the windbreak, foliage height diversity, and snag density. An associated Wildlife Habitat Suitability Index can also be calculated from these data; this index reflects a windbreak's value as habitat for birds and small mammals, but has been subjected to less extensive testing.

We will produce a report documenting the results of this study, including: (a) estimated extent (number and area) of windbreaks in Nebraska, with 95% confidence; (b) estimated cumulative distribution of the Bird Species Richness Index of windbreaks in Nebraska, with 90% confidence intervals; and (c) estimated cumulative distribution of windbreak area in Nebraska, with 90% confidence.

We are also planning a follow-up visit to the sample windbreaks during the Spring, 1995, to survey the birds present and test the Bird Species Richness Index. As part of that study, we will also collect multi-scale remote sensing data for the study sites in an attempt to determine the spatial scales of habitat to which the bird community composition is most closely correlated. Details of these future efforts are not covered in this plan.

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Acknowledgements

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Thanks to Dan Fiscus (North Carolina State University) and Charles Harper (North Carolina State University) for their help in early field-testing the data collection procedure.

Jim Brandle, Lee Campbell (United States Department of Agriculture, Agricultural Research Service), Bruce Jones (United States Environmental Protection Agency), Michele Schoeneberger (United States Department of Agriculture Forest Service), Brian Schumacher (United States Environmental Protection Agency), and Llew Williams (United States Environmental Protection Agency) commented on an earlier version of this plan.

1. Introduction: Why Windbreaks?

The Environmental Monitoring and Assessment Program's (EMAP) Agroecosystems Resource Group is developing a program to monitor and evaluate the ecological condition of United States agricultural lands (Heck *et al.* 1991, 1993; Campbell *et al.* 1994). We are evaluating agricultural lands from several perspectives: productivity; quality of air, water, and soil; and biodiversity. This pilot focuses on the potential biodiversity value of windbreaks in the Great Plains, specifically bird diversity.

Agricultural lands - fields, pastures, and orchards - are managed to produce food and fiber for people. When land is converted from other cover to agricultural use, the landscape is changed. Changes in the amount and arrangement of different parts of the landscape - forests, grassland, fields, woodlots, windbreaks, and so forth - may affect populations of plants and animals that live there (*e.g.* Forman and Godron 1986). Windbreaks are an important non-crop element in the Great Plains, an extensive agricultural landscape. Although planted to protect fields, crops, livestock, and farmsteads from the prevailing winds, windbreaks also provide some of the little wooded habitat for birds and other wildlife. For example, less than 2% of Nebraska is covered by trees and approximately 25% of that wooded cover is provided by windbreaks (Table 1). Hunting, wildlife observation and hiking are all enriched by the diversity of life in windbreaks (Johnson *et al.* 1991).

Table 1: Estimated forest and windbreak cover in Nebraska.

Area of...	1982 (sq-km)	1987 (sq-km)
Forest[1]	2965.0	2946.4
Windbreaks[2]	935.3	909.5
Nebraska[1]	200504.6	200504.6

1. USDA Soil Conservation Service National Resources Inventory (USDA-SCS 1987, 1989).
2. Bruce Wight, personal communication, based on National Resources Inventory data. The "windbreak" and "forest" categories are mutually exclusive.

Much of the wooded habitat in the Great Plains is associated with riparian corridors. Windbreaks may serve as stepping stones between riparian areas, as well as for birds that migrate through the area each year. The EMAP Surface Waters Resource Group is developing techniques to monitor habitat and birds along riparian corridors (Larsen and Christie 1993). The EMAP Forest Resource Group is monitoring birds in forest cover (Martin *et al.* 1994). How these data will be integrated among resource groups is still unclear. Although the USDA Soil Conservation Service evaluates the condition of windbreaks with respect to soil erosion (through the National Resources Inventory), there is no current effort to monitor their condition for biological diversity. In this pilot, we will evaluate the extent and condition of windbreaks in Nebraska as they relate to biodiversity, particularly bird species diversity. In a later effort, we will survey the bird species present in the windbreaks.

Agriculture in the Great Plains has eliminated much of the grassland habitat that existed before the area was settled by Europeans. Some native grassland birds – such as meadowlarks, dickcissels, and greater prairie chickens – need large, unbroken areas of grass. Some of these birds have suffered declines, and windbreaks may provide habitat for other birds and mammals that prey on grassland birds. Thus, while windbreaks may help some wildlife species – those that depend on wooded habitat – they may be detrimental to others (*e.g.* Knopf 1992). This trade-off must be kept in mind when the overall condition and sustainability of biodiversity in the Great Plains is considered; it is not considered in this plan.

2. Approach and Objectives

We are working in cooperation with the United States Department of Agriculture, National Agricultural Statistics Service (NASS) to evaluate the potential biodiversity value of windbreaks. During the 1994 June Agricultural Area Survey, NASS enumerators will collect information about the location of windbreaks in Nebraska. This information will be used to draw a probability sample of windbreaks.

In July, 1994, NASS enumerators will visit the sample windbreaks and collect the data needed to calculate the U.S Fish and Wildlife's Bird Species Richness Index (BSRI) for windbreaks (Schroeder *et al.* 1992). The Index is the number of different bird species expected in a windbreak, based on correlations of the bird species present in windbreaks with four habitat characteristics: windbreak area, average height of the tallest row of trees in the windbreak, foliage height diversity, and snag density. Schroeder *et al.* (1992) developed the Bird Species Richness Index during a three-year study of 34 windbreaks in Kansas. By using the four windbreak characteristics they were able to explain a large portion of the variability in the bird species present in the windbreaks ($R^2 = 0.893$). An associated Wildlife Habitat Suitability Index can also be calculated from these data; this index reflects a windbreak's potential value as habitat for birds and small mammals, but has been subjected to less extensive testing (Schroeder 1986).

This pilot project is designed to test the feasibility of applying the U.S. Fish and Wildlife's Bird Species Richness Index for windbreaks on a regional basis. Specifically, we will:

(1) Determine if the data needed to calculate the BSRI can be collected successfully by NASS enumerators.

(2) Evaluate several components of variability in the data used to calculate the index:

(a) Among-team variability. If two teams of NASS enumerators measure the same windbreak, how variable are the results? We recognize that this includes same-team variability but will not attempt to disentangle it from among-team variability. Because of the long term nature of EMAP, among-team variability is the more likely source of problems.

(b) Measurement variability. Is the number of sampling stations within windbreaks sufficient? Can we use fewer without loss of information?

(c) Spatial variability. Are windbreaks in the same area more likely to be similar to one another than to windbreaks further away?

(3) Develop data processing and information management techniques to use data collected at each windbreak to calculate a BSRI for the windbreak.

(4) Develop statistical methods to use data collected at sample windbreaks to make regional estimates of the extent and BSRI of windbreaks.

(5) Develop and evaluate logistics and quality assurance procedures.

(6) Use this information to develop a sampling design suitable for monitoring windbreaks as wildlife habitat.

This work focuses on the biodiversity value of individual windbreaks, specifically for birds. The BSRI provides information about the condition of windbreak habitat; it does not provide information about the condition of bird populations and communities. Trends in the BSRI over time will indicate whether the condition of available windbreak habitat is improving, degrading, or remaining the same. Other information – from the ongoing Breeding Bird Survey (Robbins *et al.* 1986), future EMAP monitoring, or future efforts of the National Biological Survey – will be needed to track the condition of bird populations and communities.

3. Design

The EMAP Agroecosystems Resource Group is using the USDA National Agricultural Statistics Service's (NASS) June Agricultural Area Survey as the basis for sampling (Cotter and Nealon 1987; Campbell *et al.* 1994). In Nebraska, NASS defines seven strata based on land use in the surrounding area. The June Agricultural Area Survey is a stratified random sample of land areas, called segments, with sampling intensity based on the amount of agriculture in the surrounding area.

The June Agricultural Area Survey consists of five non-overlapping replicate-years, each covering the same geographic area (Nebraska, in this case). Each year the oldest replicate is removed from the Survey and a new replicate is added to the Survey and remains in the Survey for five years. Within each replicate and stratum, segments are numbered in a serpentine manner across the state. To sample windbreaks, NASS will draw a systematic sample of 60 windbreaks from a list, ordered by segment number, of all windbreaks identified for the newest replicate-year. Ordering by segment number within a single replicate-year ensures, as much as possible, uniform geographic coverage. If there are fewer than 60 total windbreaks in the newest replicate year, then the list will contain all windbreaks from the two newest replicate-years. If necessary, replicates will continue to be added to the list until there are at least 60 windbreaks in the list. Based on NASS's past experience in Nebraska, it is expected that our final sample will be about 20-30% percent smaller than planned due to non-response.

4. Logistics

4.1. Equipment Purchases

All necessary equipment will be assembled at the EMAP-Agroecosystems headquarters in Raleigh, NC. NASS has indicated that they will use 10 teams of enumerators to perform the windbreak sampling. We will purchase equipment to make up 11 kits - one for each team and a spare for the NASS Nebraska office. Equipment assembly will begin in late March, and all equipment will be at the NASS Nebraska office by 1 July 1994. A list of equipment is included in the Windbreak Data Collection Manual (USDA-NASS 1994).

4.2. Training

A training session will be hosted by NASS in Grand Island, Nebraska on 13 July 1994. George Hess (indicator lead) will lead the session; Brian Schumacher (Quality Assurance Officer) will also attend. Training will consist of a two-hour classroom session that will provide relevant background information and a detailed overview of the procedure. The classroom session will be followed by a 3-4 hour field session, during which techniques will be demonstrated at an actual windbreak.

4.3. Field Data Collection

Teams of two NASS enumerators will visit each of the windbreaks. At each windbreak, data will be collected to calculate four windbreak attributes. These four values are used to calculate the Bird Species Richness Index for the windbreak. Detailed data collection procedures are described in the Windbreak Data Collection Manual (USDA-NASS 1994).

A brief description of the data items that will be collected follows.

1) Windbreak area. The area covered by a windbreak is an important indicator of its ability to support biological diversity. Larger windbreaks provide more habitat. The enumerator will measure the length and width of the windbreak by calibrated pacing.

2) Average height of tallest row of trees in windbreak. Height is the third dimension of a windbreak — taller windbreaks provide more habitat. One enumerator will take several full-height photographs of the windbreak while another holds a standard of known height at the edge of the windbreak. These photographs will be used to determine the average height of the tallest row of trees in the windbreak.

3) Foliage height diversity. Different birds prefer different parts of the windbreak for nesting and foraging. Some like to nest on the ground, others in small trees and bushes, and others in the canopy. A windbreak with many different kinds of habitat can support a more diverse group of animals than one with only a few kinds of habitat. Foliage height diversity is a measure of the different kinds of habitat available in the vertical direction. At each sample point, the enumerator will use a marked 6-meter standard to determine if there is any vegetation at each of three levels: less than 1 meter (the ground vegetation), between 1 and 6 meters (mid-story), and above 6 meters (canopy).

4) Snag density. Snags are dead but standing trees and branches. They provide yet another important type of habitat - homes for birds that build their nests by hollowing out dead trees. Enumerators will count all snags in the windbreak so that a number of snags per unit area can be calculated.

4.4. Data Collection Schedule

NASS enumerators will carry out all field work for the 60 windbreaks in the sample. Field work will be performed on 16, 18, 19, 20 July and 1-5 August. Sampling activities will be coordinated by the NASS state office. NASS enumerators are responsible for transportation to and from field sites, locating sample windbreaks, completing all measurements, mailing completed data sheets to the NASS state office, and shipping exposed film to the EMAP-Agroecosystems headquarters via Federal Express.

Any field work not completed by 5 August will be completed in the autumn of 1994. The only problem we anticipate is failure to obtain the photographs needed to measure the height of the windbreaks. The sampling period is fairly late in the growing season, and some crops (e.g., corn) may already be taller than the enumerators, making it impossible to obtain photographs. In this case, the enumerator will make a note and photographs will be obtained in a re-visit after harvest.

5. Quality Assurance

5.1. Training

Ten teams of NASS enumerators will be trained by George Hess (indicator lead) immediately before the field measurement period (see Logistics). Brian Schumacher (Quality Assurance Officer) will attend the training session.

5.2. Audits

George Hess and Brian Schumacher will perform field audits on approximately 5% of the sampled windbreaks. They will confirm that data collection is being completed in accordance with the instructions in the "Windbreak Data Collection Manual" (USDA-NASS 1994).

5.3. Repeat Measures

During the enumerator training session multiple teams of enumerators will measure the same windbreak. Field training will take place in an area in which five windbreaks are in close proximity. Two teams will measure each windbreak simultaneously in a round-robin fashion. Then teams will be shifted around and the process of two teams measuring each windbreak simultaneously will be repeated. This will be done three times, so that each of the five windbreaks will be measured by six teams; this provides 25 degrees of freedom for estimating among team variability.

5.4. Data Consistency

Data consistency checks have been built into the data collection procedure (USDA-NASS 1994).

5.5. Measurement Variability

The variability of width, height, and foliage height diversity within windbreaks will be measured during data analysis.

Width. Windbreak width is measured at multiple points in the windbreak (USDA-NASS 1994). Variability will be determined from these measures.

Height. Windbreak height is measured from photographs. One-fifth of the photographs will be re-measured by the same observer so that we can calculate same-observer variability. If more than one person is used for these analyses, we will also measure among-observer variability.

Foliage height diversity. Foliage height diversity is measured at multiple points in the windbreak (USDA-NASS 1994). Variability will be determined from these measures.

5.6. Sensitivity Analysis

Using the data collected during the survey we will perform a sensitivity analysis to determine the effect error in each of the Index components has on the BSRI values.

6. Data Analysis and Reporting

The EMAP Agroecosystems Resource Group is responsible for all data analysis and reporting.

6.1. For each windbreak

Various characteristics of each windbreak are combined into a single value to calculate Bird Species Richness Index (Figure 1) (Schroeder *et al.* 1992). Many individual data items will be combined to arrive at a *raw value* for each of four windbreak characteristics:

(1) Area

(2) Average height of tallest row of trees

(3) Foliage height diversity

(4) Snag density

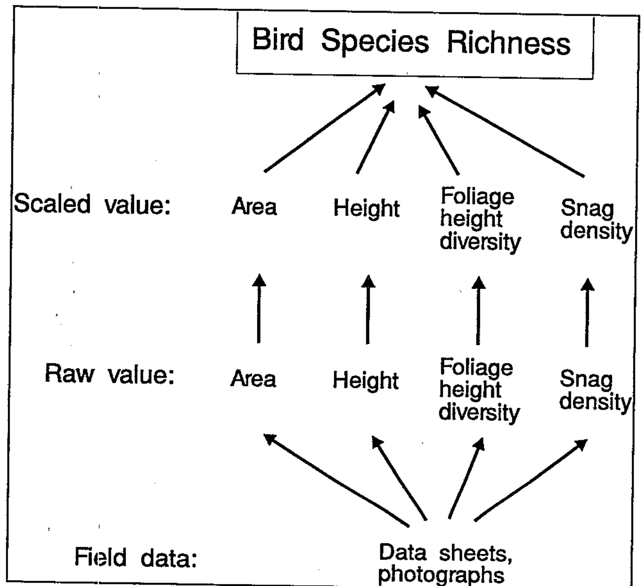


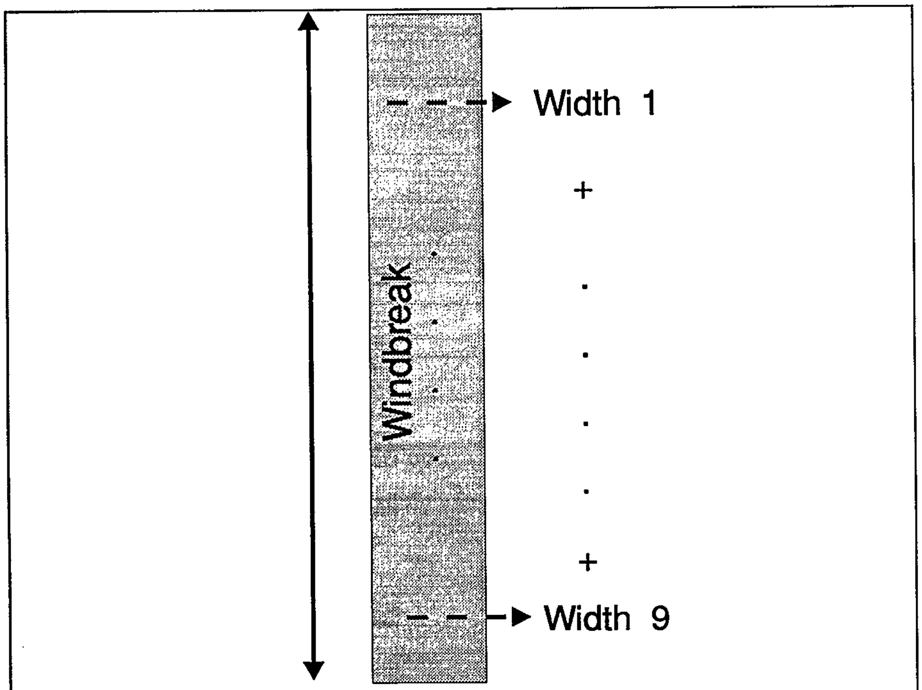
Figure 1: Overview of calculations needed to derive Bird Species Richness Index from field data.

The raw value for each of these characteristics is then scaled from 0-1, where 0 is the poorest condition and 1 is the best condition, (Schroeder *et al.* 1992), and the 4 *scaled values* combined to yield the Bird Species Richness Index. The calculations are described below.

6.1.1. Area

Input Data. Length of windbreak (paces); width of windbreak (paces) at 4 or 9 sample stations along the windbreak.

Calculations. The calculations are detailed in Figure 2.



Length (paces)
x meters/pace
Length (meters)

Sum / 9 = Average Width (pace)
x meters/pace
Average Width (meters)

Raw value:

$$\frac{\text{Length (m)} \times \text{Average Width (m)}}{10{,}000\ \text{m}^2/\text{ha}} = \text{Area (ha)}$$

Scaled value:

$$\text{Minimum of } \left(1\ ,\ \frac{17.4 \times \text{Area}^{0.359}}{42} \right)$$

Figure 2: Calculating raw and scaled values for windbreak area.

6.1.2. Average height of tallest row of trees

Input data. Photographs of the windbreak at 4 or 9 sample stations along the windbreak. Measurement of the height of the range pole (or a section of it) in the photograph and the height of the tree in the photograph.

Obtaining height measures. Each photograph will contain a calibrated range pole . The height of the tallest tree directly behind the range pole can be calculated as follows (Figure 3).

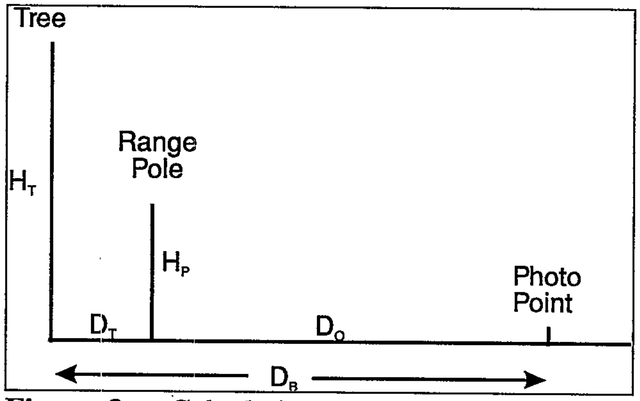


Figure 3: Calculating tree heights from photographs.

The height of the calibrated range pole (H_P) in the photograph is related to the actual distance between the photo point and the range pole (D_O). This relationship can be determined by photographing the range pole at various distances, measuring the range pole on the photographs, and performing a regression with a quadratic model (this is a wide angle lens, so the relation is not linear). The relationship is

$$D_O = aH_P^2 + bH_P + c$$

where *a, b,* and *c* are constants determined by the regression. Since film processing procedures are standardized, the relationship between the actual size of an object at a given distance from the camera and its size in the photograph is constant. This relationship (i.e., values for *a, b,* and *c*) will be determined in advance at EMAP-Agroecosystem headquarters.

The distance between the range pole and the base of the tree (D_T) is assumed to be half the width of the windbreak, which is known from field measures. The distance between the photo point and the base of the tree, D_B, is $D_O + D_T$. Given this distance, the scale height of the range pole at distance D_B can be calculated by solving

$$D_B = ah^2 + bh + c$$

for h. The height of the tree can be measured in the photograph and the actual height of the tree can be calculated as:

$$\frac{Actual\ Height\ of\ Tree}{Photo\ Height\ of\ Tree} = \frac{Actual\ Height\ of\ Pole}{Scale\ Height\ of\ Pole\ (h)}$$

Calculation of average height. The calculations are detailed in Figure 4 (based on Schroeder *et al.* 1992).

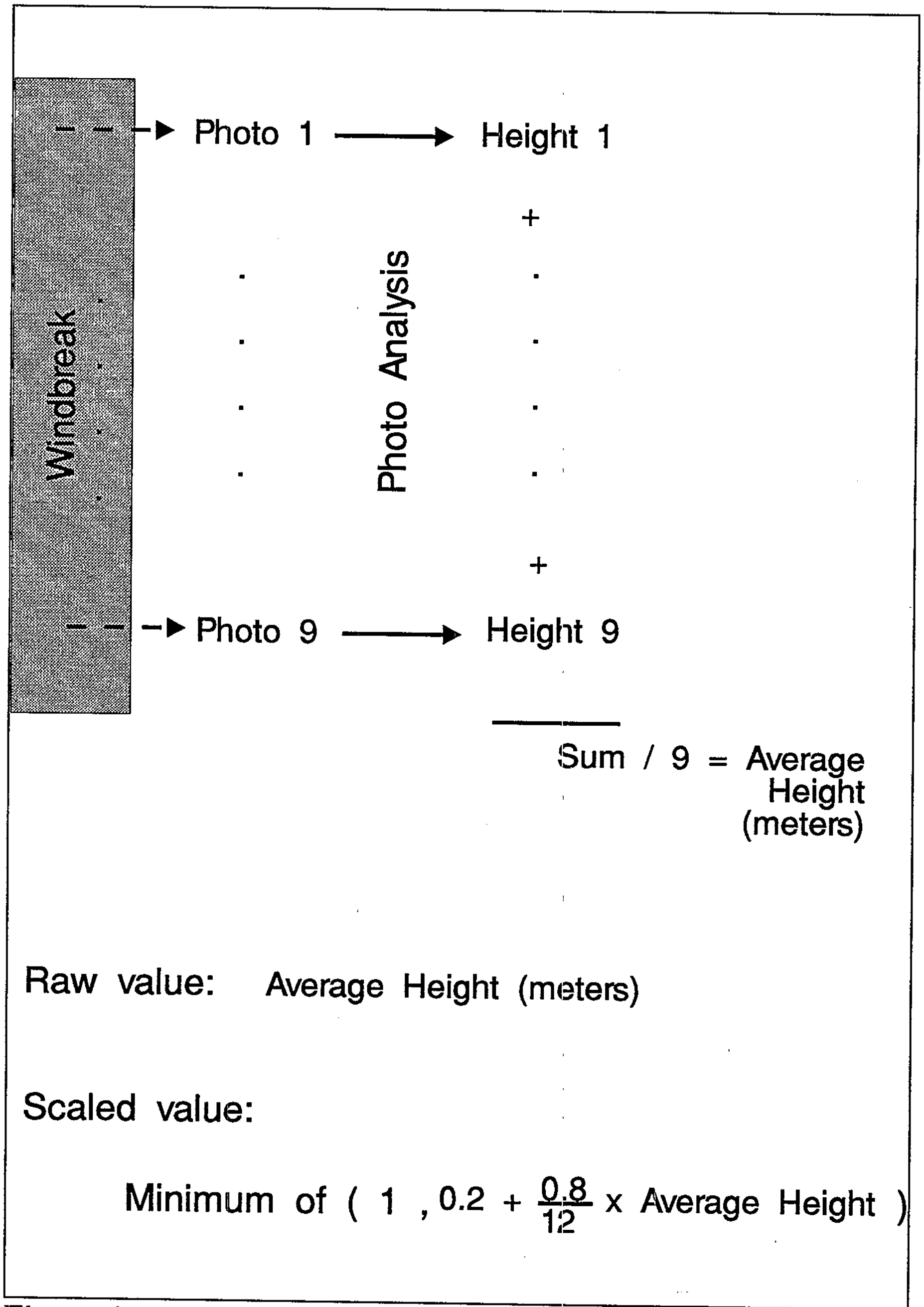
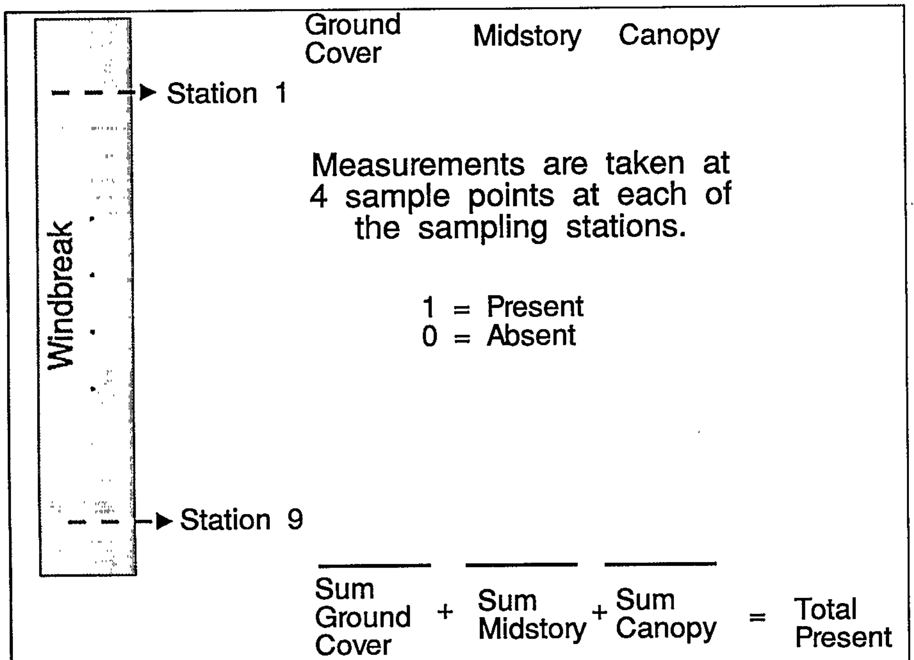


Figure 4: Calculating raw and scaled values for average height of tallest row of trees.

6.1.3. Foliage height diversity

Input data. Presence or absence of vegetation in each of 3 vertical layers at each of 4 sample points at each of 4 or 9 sampling stations.

Calculations. Calculations are detailed in Figure 5 (Phil Cook, personal communication; Schroeder *et al.* 1992).



Raw value: FHD =

$$\frac{1.0}{\left(\frac{\text{Sum Ground}}{\text{Total}}\right)^2 + \left(\frac{\text{Sum Midstory}}{\text{Total}}\right)^2 + \left(\frac{\text{Sum Canopy}}{\text{Total}}\right)^2}$$

Scaled value:

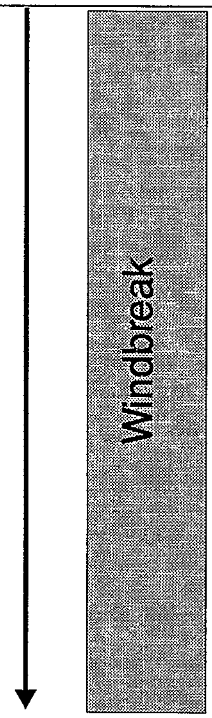
$$\text{Minimum of } (1,\ 0.2 + 0.26666 \times \text{FHD})$$

Figure 5: Calculating raw and scaled values of foliage height diversity.

6.1.4. Snag density

Input data. A count of all snags in the windbreak and windbreak area.

Calculations. Calculations are detailed in Figure 6 (based on Schroeder *et al.* 1992).



$$\frac{\text{Number of Snags in Windbreak}}{\text{Windbreak Area (ha)}} = \text{Snag Density (snags/ha)}$$

Raw value: Snag Density

Scaled value:

Minimum of (1 , 0.5 + 0.02273 x Snag Density)

Figure 6: Calculating raw and scaled values of snag density.

6.1.5. Calculating the Bird Species Richness Index

The scaled values are combined to calculate the Bird Species Richness Index for the windbreak (Figure 7) (Schroeder *et al.* 1992).

$$\text{Habitat Suitability Index (HSI)} = \text{Scaled Area} \times \frac{\text{Scaled FHD} + \text{Scaled Height} + \text{Scaled Snag Density}}{3}$$

$$\text{Bird Species Richness Index} = 5.34 + 41.1 \times \text{HSI}$$

Figure 7: Calculating Bird Species Richness Index from scaled values of windbreak attributes.

6.2. Regional estimates

Once a Bird Species Richness Index is available for each of the sampled windbreaks, these values are used to generate regional estimates of windbreak condition. Cumulative distribution functions (CDFs) will be estimated for the Bird Species Richness Index (BSRI) and for each of the four raw values which go into the BSRI. An estimated CDF for these measures will give the estimated proportion of Nebraska windbreaks that have values of the measure less than or equal to any specified value (*e.g.*, the proportion of windbreaks with a BSRI of 14 or less). A CDF will also be estimated for the number of windbreaks per unit area, where unit area is defined as the average size of NASS segments. This CDF will make use of windbreak counts from the complete June Agricultural Area Survey. Approximate 90% pointwise confidence bands will be computed for each CDF to indicate the precision of the estimated CDF.

In addition to the CDFs, extent estimates will be made for the number of windbreaks in Nebraska using the complete June Agricultural Area Survey, and for the total area of windbreaks in Nebraska using the subsample from the June Agricultural Area Survey. Approximate 95% confidence intervals will be included with the estimates of extent.

NASS samples different strata with different intensities and, therefore, windbreaks from different strata have different inclusion probabilities (Cotter and Nealon 1987). Estimates of regional CDFs will be constructed using procedures described in Lesser and Overton (1994), which allow for varying inclusion probabilities and are unbiased.

6.3. Spatial Variability

We will perform analyses to determine if the condition of windbreaks is spatially autocorrelated to answer the question "Are windbreaks in the same area more similar to one another than they are to distant windbreaks?". We will divide Nebraska into several geographic regions and determine the spatial variability of windbreaks within and among regions.

6.4. National Resources Inventory Data

The USDA Soil Conservation Service has data on the length and area of thousands of windbreaks collected through their National Resources Inventory (USDA-SCS 1987, 1989). We would like to use these data to get a better measure of spatial variability and to improve our regional estimates of windbreak condition. Our regional estimate can be improved using these data if we find that the other components of the Bird Species Richness Index are closely correlated with windbreak area, and if we assume that this correlation holds for all windbreaks in Nebraska. Under these assumptions, we could use windbreak area to estimate the Bird Species Richness Index of all windbreaks in the National Resources Inventory. We have been in contact with the Soil Conservation Service and should be able to obtain these data for analysis (Bruce Wight, personal communication).

6.5. Pilot Report

We will produce a report documenting the results of this study, including:

(a) Estimated extent (number and area) of windbreaks in Nebraska, with 95% confidence.

(b) Estimated cumulative distribution of the Bird Species Richness Index of windbreaks in Nebraska (*e.g.*, percent of windbreaks expected to contain *S* or fewer species of bird), with 90% confidence intervals.

(c) Estimated cumulative distribution of the four raw values that comprise the BSRI, with 90% confidence.

(d) Estimated cumulative distribution of the number of windbreaks per unit area, with 90% confidence.

(e) Results of variability studies.

7. Information Management

Information management for this pilot is summarized in Figure 8.

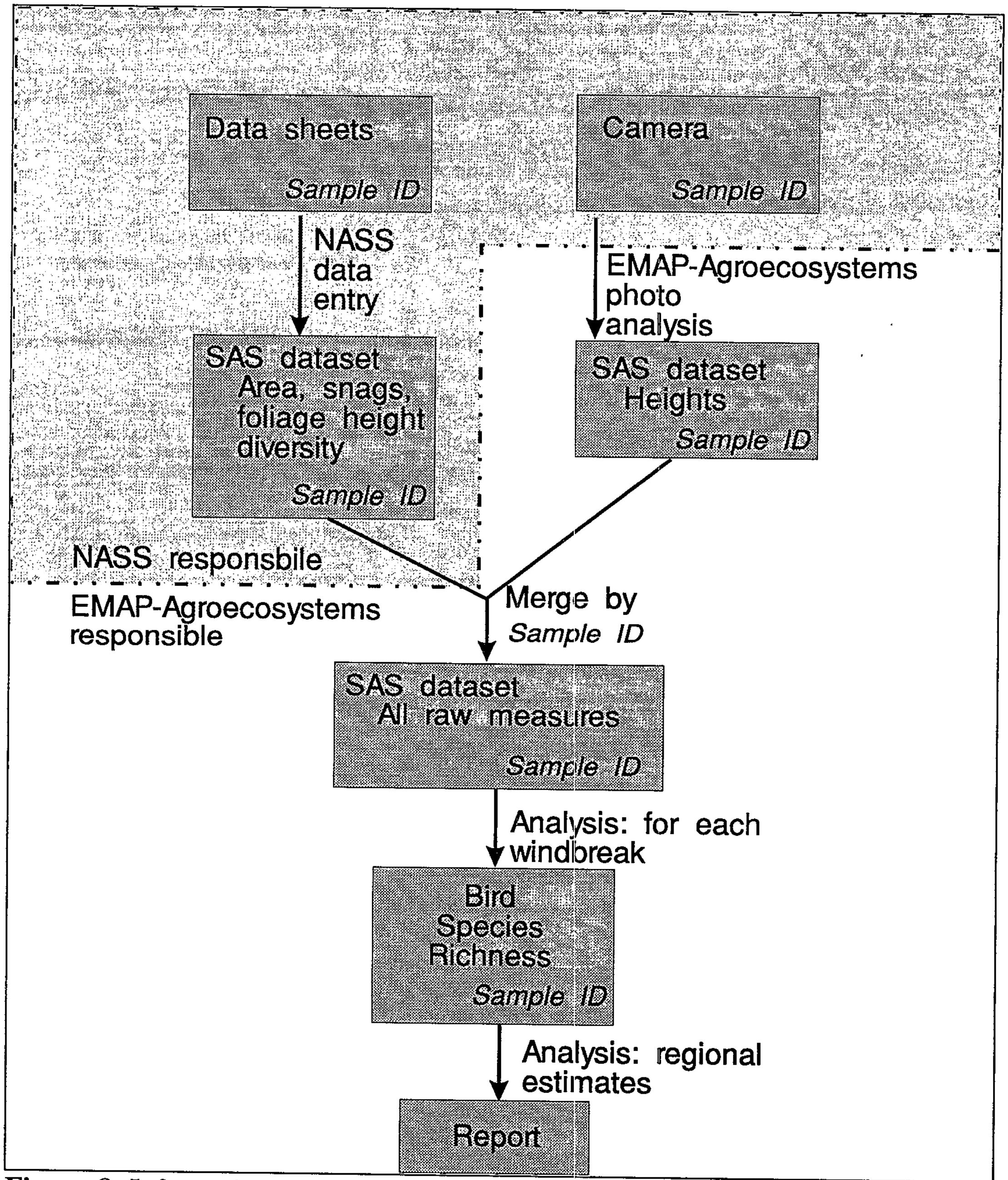


Figure 8: Information management for windbreak data.

NASS will be responsible for tracking information in the field and collecting all completed data sheets at their state office in Lincoln, Nebraska. NASS will provide a SAS dataset containing the values for all measurements made on each windbreak, with the exception of average height. Each windbreak will have a unique sample identification number.

Windbreak height measures will be obtained from photographs taken at the site. A label containing the sample identification number will be affixed to each camera. The sample identification number will also be photographed as the first and last frame on each roll of film. Recyclable cameras will be returned directly to EMAP-Agroecosystems' headquarters in Raleigh, NC for processing and analysis. After heights are obtained by analyzing the photographs, height measures will be merged with the other data by sample identification number.

8. Future Efforts

Schroeder *et al. (1992)* developed the BSRI on 34 windbreaks in Kansas, and speculated that it will provide reliable estimates over most of the Great Plains region. In the spring of 1995, trained ornithologists will revisit the windbreaks sampled during July, 1994 and determine the species of birds present. This will provide a test of the BSRI for our study region.

This Pilot focuses on the potential biodiversity value of individual windbreaks, specifically for birds. The Bird Species Richness Index does not account for surrounding landscape features. Further efforts at multiple scales are needed to understand how windbreaks and other types of habitat influence regional biodiversity (*e.g.*, the effect of wooded habitat on grassland birds and other grassland wildlife; the effect of nearby wooded habitat on the biodiversity value of an individual windbreak). Planning is underway to expand our 1995 bird survey to include a larger area around the windbreak, and to correlate these data with remotely sensed land cover data at multiple scales and with U.S. Fish & Wildlife Service Breeding Bird Survey data (Robbins *et al.* 1986). This work will help us identify appropriate monitoring scales for birds and their habitat, and ways in which to integrate our results with those of other programs.

9. Definitions

Windbreak: One or more rows of trees and shrubs planted either along the edges of fields and pastures, within fields and pastures, or near farmstead buildings and feedlots, designed to protect the field, pasture, building, or feedlot from the wind.

Minimum height: None. Since windbreaks may be planted as young trees and grow over time, there is no minimum height (Jim Brandle, Bruce Wight, personal communication).

Minimum length for windbreaks protecting fields or pastures: 300 feet.
Field windbreaks should be at least 10 times their mature height of 30 to 50 feet (Jim Brandle, personal communication).

Minimum length for windbreaks protecting buildings or feedlots: None.

Gaps may occur in a windbreak. Although poor windbreaks do a poor job of providing wind protection, they are still windbreaks and we want to include them in our sample . Excellent windbreaks consist of a stand of trees and shrubs that are continuous from end to end and which present an almost unbroken barrier to wind. Gaps in a windbreak reduce their effectiveness. Poor windbreaks lack continuity and consist of sparse, open stands of trees and shrubs in scattered clumps or as individuals (Read 1958). Small gaps of 15-50 feet are caused by failure of three to eight consecutive trees; large gaps may extend for up to several hundred feet.

Separating windbreaks. Windbreaks are designed to provide protection from the wind. The decision to mark off a separate windbreak is related to windbreak function rather than to the occurrence of gaps in the windbreak. However, changes in direction and some gaps may indicate that an otherwise continuous row of trees should be defined as two windbreaks (see Figures 9 and 10 and further definitions below).

Count each segment of an otherwise continuous row of trees and shrubs that is broken by a road – paved or otherwise – that creates a 60 foot or larger gap as a separate windbreak (e.g., Figure 9, Windbreaks 3 & 5). Section roads – which run through approximately 60 foot right-of-ways – are considered to separate an otherwise continuous row of trees into two windbreaks (Jim Brandle, Bruce Wight, personal communication). We extend this concept to all roads. A 60 foot or larger gap *without* a road does not separate a windbreak into two.

Count each segment of a field or pasture windbreak that changes direction as a separate windbreak (e.g., Figure 9 Windbreaks 2 & 3, 4 & 5). The Soil Conservation Service considers a change in direction as a new windbreak for field windbreaks (USDA-SCS 1991). For example, a windbreak on the western edge of a field blocks winds blowing from the west; a windbreak on the northern edge of a field blocks winds blowing from the north. Since these are two different functions, the windbreaks are considered to be separate.

Count all windbreaks around farmstead buildings or feedlots as a single windbreak, regardless of changes in direction (e.g., Figure 9 Windbreak 6). This is consistent with the Soil Conservation Service definition (USDA-SCS 1991). The function of the windbreak is to protect the farmstead buildings or feedlot.

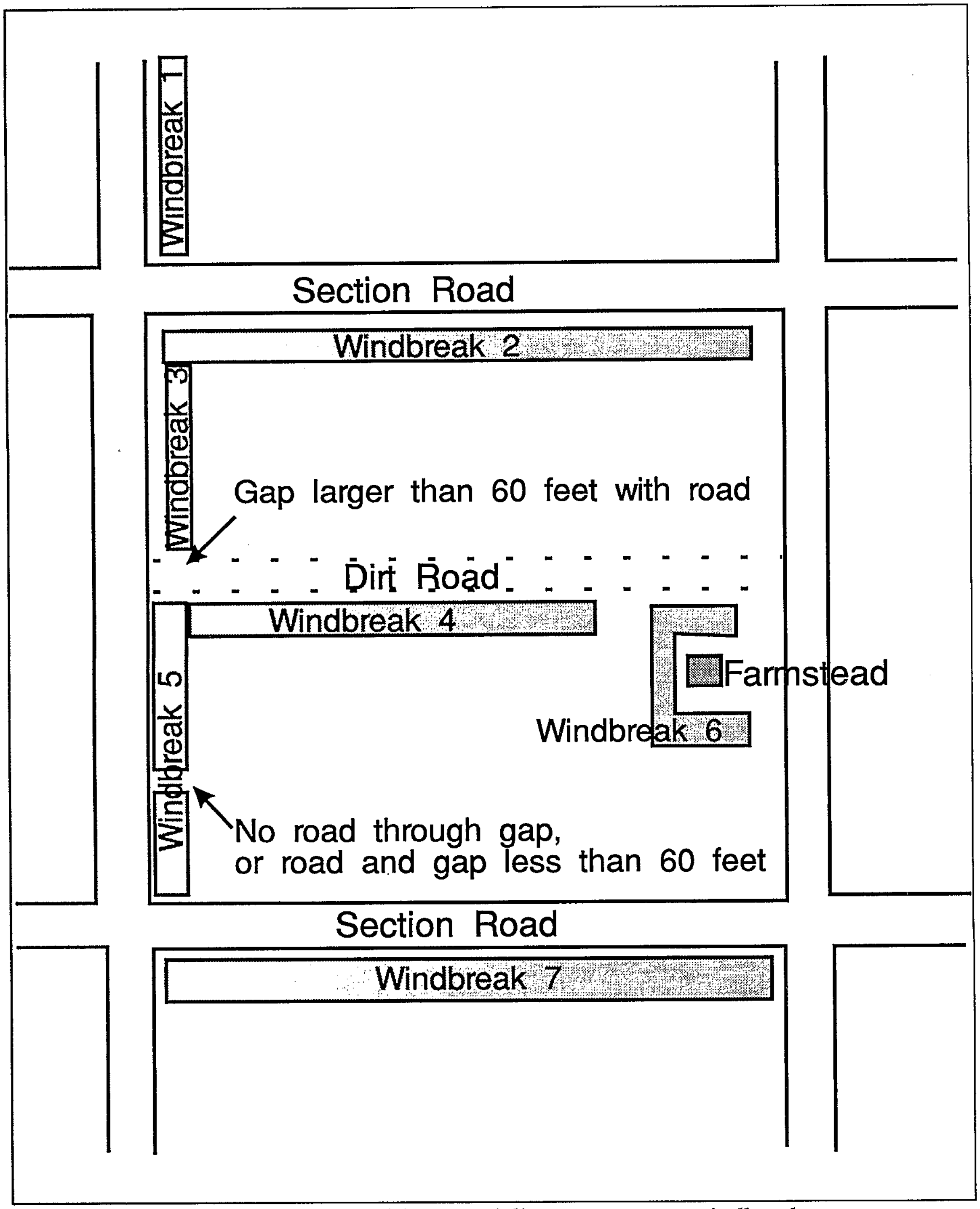


Figure 9: Examples of when and how to delineate separate windbreaks.

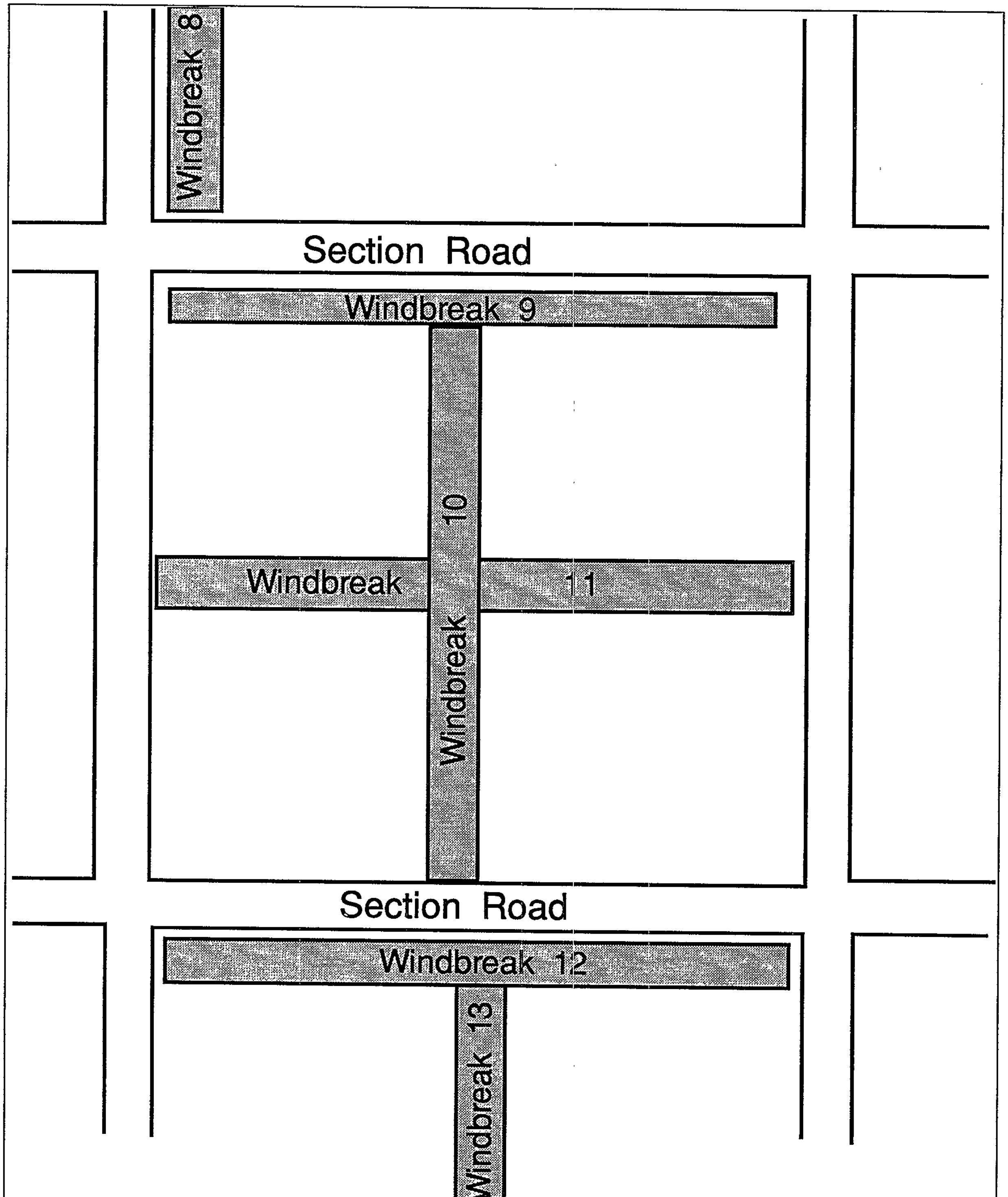


Figure 10: Examples of when and how to delineate separate windbreaks.

Dead tree: A tree with less than half the branches living (bearing foliage).

Live tree: A tree with more than half the branches living (bearing foliage).

Snag: A snag is a dead tree > 8" in diameter at breast height, or a live tree with one or more dead branches > 8" diameter.

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