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PIPELINE CORRIDORS THROUGH WETLANDS*

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ABSTRACT

This paper presents preliminary findings from six vegetational surveys of gas pipeline rights-of-way (ROW) through wetlands and quantifies the impacts of a 20-year-old pipeline ROW through a boreal forest wetland. Six sites of various ages were surveyed in ecosystems ranging from coastal marsh to forested wetland. At all sites except one, both the number and the percentage of wetland species on the ROW approximated or exceeded those in the adjacent natural area. The boreal forest study showed that (1) adjacent natural wetland areas were not altered in type; (2) water sheet flow restriction had been reversed by nature; (3) no nonnative plant species invaded the natural area; (4) three-quarters of the ROW area was a wetland, and (5) the ROW increased diversity.

RÉSUMÉ

Cette communication présente des résultats préliminaires de six études de la végétation sur les tracés de gazoduc (ROW) traversant des marécages et chiffre l'impact d'un tracé de gazoduc existant depuis 20 ans à travers un marécage de forêt boréale. Nous avons étudié six zones d'âges différents situées dans des écosystèmes allant d'un marécage littoral jusqu'à un marécage boisé. Dans toutes les zones sauf une, le nombre et la pourcentage d'espèces marécageuses sur le tracé égalaient ou dépassaient ceux des zones naturelles adjacentes. L'étude de la forêt boréale a montré que (1) la zone adjacente naturelle n'avait pas été changée; (2) la limitation de l'écoulement de la nappe d'eau a été corrigée naturellement; (3) aucune espèce végétale non-indigène n'a envahi la zone naturelle; (4) les trois quarts de la zone du tracé étaient marécageux et (5) la présence du tracé a augmenté la diversité.

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1. INTRODUCTION

Natural gas pipelines must traverse all types of terrain, including wetlands. Prior to the U.S. wetlands regulatory climate of the 1990s, the ROW corridors developed through these wetlands were most often welcomed, because they provided access to the public. With no-net-loss or more stringent policies being promulgated for wetland-related development activities, an evaluation of the historical impacts of pipeline ROWs through wetlands is needed to evaluate construction and reclamation methods, minimize permit delays, and evaluate future construction costs.

The Gas Research Institute (GRI) Corridors Program is evaluating the impacts of previous pipeline installations on wetlands. The data developed will provide a better understanding of the impact of past construction techniques and the type, degree, and duration of the impacts. This information will allow the industry to evaluate current construction practices and provide factual input to regulatory bodies.

A specific impact may be beneficial to some groups of plant and/or animal species and detrimental to others. In addition, some impacts may appear to be detrimental at first, but they may in fact improve conditions for other, more sensitive species or provide a greater diversity of species and habitat.

The initial questions to be addressed by the GRI Corridors Program are as follows:

1. Does the ROW alter the diversity of the adjacent wetland community? If so, how far do the impacts extend?

2. Does the ROW enhance species diversity of the wetland?

3. Are there ROW management practices that can enhance the ecotonal nature of ROWs in wetlands or limit detrimental impacts?

1.1 Objectives

The goal of the GRI Corridors Program is to document the historical impacts of pipelines on wetlands. Specific objectives are as follows:

- Document vegetative communities existing on ROWs and on adjacent natural areas.

- Evaluate similarities and differences between the plant communities on ROWs and on adjacent natural areas.

- Document changes to the topography, soils, and hydrology attributable to ROW construction.

- Survey avian communities on ROWs and on adjacent natural areas.

- Identify impacts caused by ROW construction on rare, threatened, endangered, or sensitive species.

The boreal forest wetland study conducted on a pipeline in Oconto County, Wisconsin, was the first in a series of studies of ROWs in particular types of wetlands.

2. DESCRIPTION OF STUDY AREAS

2.1 Site Descriptions

Two of the survey sites are located along a pipeline installed in 1970 in Oconto County, Wisconsin, about 60 miles northwest of Green Bay. Installation was by conventional methods that involved clearing a 65-ft ROW and using the slash to construct a corduroy road for moving equipment. Sampling was performed during July 1990. The natural vegetation of the first site was a scrub-shrub community (Cowardin 1979) dominated by meadow willow (*Salix petiolaris*), speckled alder (*Alnus rugosa*), autumn willow (*Salix serissima*), and bog birch (*Betula pumila*), with Emory's sedge (*Carex emori*) the most abundant plant in the herb layer. The second site was a forested wetland dominated by white cedar (*Thuja occidentalis)*, American larch (*Larix laricina*), and paper birch (*Betula papyrifera*), with speckled alder (*Alnus rugosa*) and red osier dogwood (*Cornus stolonifera*) abundant in the shrub layer.

A third survey site was located south of Watertown, New York, within a natural community dominated by shrubs and tree saplings. The area has a history of disturbance, including partial drainage and grazing, prior to pipeline installation in 1966. Sampling was carried out during June 1991. At the time of sampling, and apparently for some years previous, the entire site was encompassed by a low beaver dam that retained the water at a depth of 10 to 20 in., with occasional deeper channels. Dominant species in the shrub layer included pussy willow (*Salix discolor*), meadow willow (*Salix petiolaris*), and shrub-sized silver maple (*Acer saccharium*). An open sapling and tree layer consisted mostly of silver maple.

A fourth survey site was located in Gloucester County, New Jersey, about 10 miles south of Philadelphia, Pennsylvania, and 1/4 mile south of highway I-295. The ROW here contains three adjacent pipelines and crosses scrub-shrub and forested wetlands drained by Little Timber Creek into the Delaware River. At the time of sampling, July 1991, the 125-ft ROW had two distinct vegetational communities; the northern portion was recontoured following installation of the second pipeline in 1960, and the southern portion resulted from installation of the 1990 pipeline. Vegetation in the natural areas was dominated by shrubs and forbs. Dominant shrubs included shrub-sized red maple (*Acer rubrum*), common buttonbush (*Cephalanthus occidentalis*), and brook-side alder (*Alnus serrulata*). Dominant forbs included hairy swamp-loosestrife (*Decodon verticillatus*), arrow arum (*Peltandra arifolium*), halberd-leaf tearthumb (*Polygonum arifolium*), and spotted touch-me-not (*Impatiens capensis*).

A fifth survey site was located about four miles southeast of Logansport, Louisiana, within a forest wetland. The pipeline was installed in 1987 and had a 65-ft ROW. The canopy forest was dominated by sweet gum (*Liquidambar stryaciflua*), bald cypress (*Taxodium disticum*), and loblolly pine (*Pinus taeda*).

A sixth survey site was located about 60 miles SSW of New Orleans, near Ponte aux Chene. This site, within the coastal marsh, contains three pipelines installed between 1960 and 1980. Backfill over the pipelines was approximately the same elevation as adjacent natural areas. The dominant species present was saltmarsh cordgrass (*Spartina alterniflora*), with lesser amounts of saltmeadow cordgrass (*Spartina patens*) and seashore saltgrass (*Distichlis spicata*).

2.2 Oconto County, Wisconsin Sites

In Northeast Wisconsin, the pipeline traverses a number of areas that include boreal wetlands, from which the two study sites that would be classified as "Jurisdictional Wetlands" under Section 404 of the Clean Water Act were selected. Each site was a wetland extending at least 3,300 ft (1,000 m) along the ROW, at least 330 ft (100 m) wide, and at least 165 ft (50 m) on both sides of the ROW center. The locations of the two sites are shown in Figure 1, both located in Oconto County, Wisconsin, approximately 60 miles northwest of Green Bay. The Peshtigo Brook site is within the Peshtigo Brook State Wildlife Area, while the Airport Road site is in the Nicolet National Forest.

2.3 History and Management Practices

Constructed in 1970, the Wisconsin pipeline section on which the two study sites are located is approximately 182 miles (303 km) long, extending from Crystal Falls, Michigan, to Kewaskum, Wisconsin. The pipeline is 30 in (76.2 cm) in diameter, has a maximum pressure of 975 psi, and delivers as much as 700 million standard cubic feet of natural gas per day.

The pipeline was built using conventional methods of the time, which involved clearing the ROW, cutting a trench, laying the pipe, and backfilling. In wetland areas, such as the two study sites, a temporary road was constructed to allow men and equipment to operate on the very soft underlying peaty and sandy soils. Normal practice was to place trees and brush cut during clearing of the ROW on the working side of the ROW (perpendicular to the ROW center line) and cover them with locally available soils. At both study sites, the construction roads were placed on the west side of the ROW. After backfilling of the pipeline ditch, the surface was seeded. No specific data are available about seeding this site. As part of the permitting agreement with the U.S. Forest Service and the State of Wisconsin, the pipeline company was (and still is) required to provide unrestricted public access to the ROW.

It is normal maintenance practice, in the areas of the two sites, to mow the ROW every three to five years during the winter months. Because the land is in state and national forest, no herbicides are used. The width of the mowing is limited to the east half of the ROW at the Airport Road site because of requirements imposed by the U.S. Forest Service. The entire ROW width is mowed at the Peshtigo Brook site.

3. APPROACH AND METHODS

The primary objective of this study is to identify the impacts of pipeline construction 20 years after its installation through a boreal forest wetland. To accomplish this, it was necessary to develop methodologies for site reconnaissance, vegetation data collection, and data analysis.

The vegetation data were the main focus of the study because of the need to identify the type of plant community that develops on the ROW under normal management practices, the types of edges that develop at the interface between the ROW and the natural areas adjacent to it, and any changes that may have been brought about in the natural communities adjacent to the ROW due to the presence of the ROW. The data-analysis techniques employed were developed to separate the plant communities so that their uniqueness and commonality could be evaluated.

3.1 Site Stations

At each of the two sites, five stations were placed approximately 330 ft (100 m) apart, perpendicular to the ROW, with the first station randomly located. Each of the five stations was a transect 200 ft (60 m) long, with its center in the middle of the ROW.

3.2 Vegetational Data Collection

Vegetational data-collection areas were established at each station as shown in Figure 2. Each plant species observed was recorded, together with its abundance category (abundant, common, occasional, or rare), in each of the four habitats and two edges at each of the five site stations.

3.3 Average Wetland Values

The AWV is calculated by multiplying the wetland indicator category for each species by the factors specified in the Federal Manual (2) [e.g., obligate wetland (OBL) = 5] and dividing by the total number of species present. AWVs range from 1.0 to 5.0, with a value of 1.0 representing all OBL plants (wetlands) or an unquestionable wetland. The highest value, 5.0, signifies an unquestionable upland; 3.0 indicates the division between wetland and upland.

4. RESULTS AND DISCUSSION

4.1 Results

4.1.1 Six Sites

A comparison of both the actual numbers and the percentages of wetland species found on the ROWs and in adjacent natural areas reveals that at two sites, the Wisconsin scrub-shrub wetland and the Louisiana forested wetland, the ROWs had distinctly higher numbers of both total wetland species and OBL species. At a single site, the Wisconsin forested wetland, both total number and percentage of wetland species and the number and percentage of OBL wetland species were distinctly lower for the ROW than the natural areas. This site also had the highest number, 19, and the highest percentage, 27%, of facultative upland (FACU) and upland (UPL) species combined. Comparisons for the other three sites revealed little difference between the ROWs and adjacent natural areas in either numbers or percentages of wetland species. Of the 12 ROW habitats sampled, nine had 90% or greater wetland species. The two portions of the ROW at the Louisiana forested wetland site had 84% and 86% wetland species, compared with 87% and 78% wetland species in the adjacent natural areas on either side of the ROW. The Wisconsin forested wetland site was unusual in that the corduroy road used for pipeline installation was left intact to provide public access to the national forest it traverses. This site had the lowest percentage of wetland species (72%) of any habitat sampled and had the highest number of FACU and UPL species.

4.1.2 Peshtigo Brook Site

General Ecology. In general, the west half of the ROW, which includes the roadway, was slightly higher in elevation than the adjacent natural areas. The east portion of the ROW, which includes the pipeline, was generally lower in elevation than the west portion or adjacent natural area and had standing water at most locations. A composite cross section of the Peshtigo Brook site based on average conditions at the five stations is shown in Figure 3.

Of the 96 species observed at the Peshtigo Brook site, 64 occurred in natural areas and 73 occurred on the ROW. Nineteen plant species were found only in the natural areas. Of the 64 natural area species, 53 were observed in the east and 42 in the west. Thirty-one species were common to both natural areas; 22 species were observed in the east natural area but not in the west natural area; and 11 species were observed in the west natural area but not in the east natural area.

Twenty-seven species occurred only on the ROW and adjacent edges, with 15 of these found only on the west half of the ROW. Many of the species (46 of 64) found in natural areas were able to sustain a foothold on or reinvade the ROW. All species found in natural areas were native. Of 27 species unique to the ROW, seven were introduced* species.

Table 1 summarizes plant-species data by habitat and plant type association according to the Federal Manual's Wetlands Plant Classification System. Of 64 species occurring within natural area transects east and west of the ROW, 29 were obligate (OBL) wetland species, 19 facultative upland (FACU) species (4). Of 27 species collected only on the ROW, 14 were OBL, six FACW, three FAC, three FACU, and one a UPL species.

The AWVs for the Peshtigo Brook site are listed in Table 2. These AWV values support the observation that the east ROW portion is wetter than the west ROW portion and that both portions support hydrophytic vegetation. Also, the plants in the west portion of the ROW tend to be associated with dryer habitats.

Eight-four percent of the site's OBL plants were represented in the ROW, and the east and west ROW portions each had 76%, all higher than the natural area. Thirty-one percent of the site's OBL plants were found exclusively on the ROW. Both the natural area and the ROW contained 67% of the UPL species represented. The ROW contained more wetland plant species than did the adjacent natural areas.

4.1.3 Airport Road Site

General Ecology. The pipeline was buried in the east half of the ROW; the west half consisted of a well-elevated corduroy road. The roadway bed consisted of exposed sand with scattered grasses and forbs, while shoulders were occupied by scrubs and trees. The east half of the ROW was much lower than either the road or the adjacent forest. This east portion of the ROW was either vegetated by thick stands of grasses and sedges or had open shallow water. Whether covered by shallow water or vegetation, the soil on the east half of the ROW was best described as fluid organic soil. At two locations south of the site, surface water was observed flowing from west to east through gaps that had been washed through the pipeline roadway.

The natural area east of the ROW was a dense boreal forest with a sparse shrub and herb understory, except in gaps formed by wind-throw or tree death and near the ROW edge. The soil surface was extremely irregular, with hummocks 0.7-1.7 ft (0.2-0.5 m) high and standing water between the hummocks. The peat depth was greater than 3 ft (1 m). The forest east of the ROW was

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*As used here, "introduced" means not native to the U.S. (most by European). Some species, such as quackgrass (*Aqropyron repens*) and dandelion (*Taraxacum officionale*), grew from "escaped" seeds. Others were probably seeded.

generally in good health except near the edge, where there was clearly some wind damage.

Both sides of the ROW appeared to have been similar at one time with respect to the plant community, peaty soil, and hummocks. During July 1990, most large trees in the natural area west of the ROW were dead or dying, and the natural community west of the ROW was dominated by thick shrubs and herbs growing on hummocks. Figure 4 shows a general representation of the Airport Road site based on conditions at the five stations.

Of 108 species observed at the Airport Road site, 82 occurred in natural areas, and 58 of the 82 were common to both the ROW and the natural areas. Of the remaining 26 species, 25 were found only on the ROW, or on the ROW and adjacent edges, and one species was found only in the ROW's east edge. The ROW contained a total of 83 plant species.

In the natural area, 55 of the 82 species occurred in both east and west natural areas. Fourteen species occurred in the east natural area but not in the west; 13 species occurred in the west natural area but not in the east. The natural area had 24 unique species, with seven of these found only on the east portion and five only on the west portion.

Twenty-two of the 25 species found only on the ROW, or on the ROW and adjacent edges, were present only on the west half of the ROW. One species was recorded only on the east half of the ROW. The relatively large number of species unique to the west half of the ROW is probably related to its use as a roadway, with higher elevation and areas of greater disturbance.

Of 82 plant species found in the two natural areas, 58 were able to reinvade the ROW. All species found in natural areas were native to that area, while of 25 species unique to the ROW, five were introduced European species.

Table 3 shows the relationships of the Airport Road site species classified according to wetlands plant habitat groupings in and between the four site habitats.

AWVs for each Airport Road habitat are listed in Table 2. The slightly higher AWVs for the east natural area at this site compared with the Peshtigo Brook site are related to the presence of many elevated hummocks in this type of forest. The hummocks provide sites for species requiring better drainage. The traveled portion of the ROW (west half) at this site was significantly higher in elevation than both areas and the ditch (east portion) of the ROW.

As expected from the AWVs, the natural area has a higher percentage of the OBL plants (88%) than the ROW (73%), and the west half of the ROW has only 46%. The natural area has only 11% of the UPL species, while the ROW has 100% of the UPL species present. The percentages for the unique species clearly show the upland nature of the west half of the ROW, where 89% of the site's UPL species are present, while none of the exclusive species in the natural area are UPL.

4.2 Discussion

4.2.1 Six Sites

The vegetational communities on the ROWs at all six sites were composed predominantly of wetland species, as were the adjacent natural communities. At two sites, the vegetational community on the ROW contained more wetland species, particularly more obligate wetland species, than did the vegetational communities in the adjacent natural areas. Total numbers of species on the ROWs were also similar to total numbers of species found in the adjacent natural areas, although many species were different and (at all sites but one) woody strata were absent.

4.2.2 Peshtigo Brook Site

The wetlands adjacent to the Peshtigo Brook site are described as shrub-carr by Curtis (2). According to the Classification of Wetlands and Deep Water Habitats of the United States (3), they would be classified as scrub-shrub (PSS1/EM3), which signifies a wet ground community dominated by tall shrubs, a community intermediate between a meadow and a forest. The 96 plant species found at the Peshtigo Brook site represent a conservative estimate, since many of the spring flora had completed their annual cycle and were no longer present; in addition, the mid-July collection undoubtedly missed some fall-blooming species.

The primary difference observed in vegetation within the ROW compared with that in the natural areas is the addition of species not found in the natural areas. Of these, only one is considered an upland species (4), although there was a slight shift to upland and facultative upland species (as shown in Figure 5, which shows the species types for both the ROW and natural areas for both sites). This may also reflect the fact that species that invade disturbed areas are typically generalists. The percent distribution of plant species for both Wisconsin pipeline sites, based on presence or absence only, is shown in Figure 6.

The important point is that at the Peshtigo Brook site most of the ROW plant species were native species common in the natural area, while none of the nonnative species found on the ROW were found in the natural wetlands adjacent to the ROW. There was no evidence of the new species having invaded the natural areas beyond the 3-6 ft (1-2 m) edge.

The relatively open shallow pools on the east side of the ROW were a feature not normal for adjacent boreal wetlands. These pools are very important to several of the bird species observed, notably the sandhill crane.

At the Peshtigo Brook site, the ROW remains a wetland despite the major disturbance 20 years ago, as well as continual use by offroad vehicles and the regular maintenance crews.

4.2.3 Airport Road Site

At the airport Road site, the forest adjacent to the ROW was dominated by white cedar *(Thiya occidentalis)*, paper birch *(Betula papyrifera)*, larch *(Larix larcina)*, and red maple *(Acer rubrum)* mixture, of which white cedar was the leading dominant. Natural areas were underlain by deep peat [>1 m (3 ft) in depth], with standing water between hummocks. The corduroy road along the west side of the ROW did not appear to be a wetland. However, there was a higher proportion of upland species associated with the ROW at this site relative to the Peshtigo Brook site (Figure 5), all of which were on the corduroy road. The east portion of the ROW has a low AWV (1.56) due to the fact that this area contained standing water at most of the stations and lacked the hummocks needed by many wetland species of the adjacent natural areas.

The natural areas and the ROW at the Airport Road site contained about the same number of unique species (Figure 6). The natural area's plant species were all part of the native wetland flora. Most of the species found in the ROW were also native wetland flora that had survived or reinvaded, as shown in Figure 5. Included in this reinvasion was the showy ladyslipper *(Cypripedium reginae)*, which was found growing along the edge between the corduroy road and the ditch portion of the ROW (approximate ROW center line). This is a sensitive species, and its reinvasion is indicative of the establishment of the ROW as a natural-type wetland. Five introduced species occurred on the ROW, but none were observed to be invading the adjacent natural wetlands from the ROW.

The elevated roadway of the ROW at the Airport Road site has clearly had an impact on the natural area to the west (Figure 5). In the past, the roadway has acted as a low dam across this very flat terrain, increasing flooding stress to the ecosystem. No data are available to determine the degree of increased flooding, but 0.8-1.5 ft (0.25-0.5 m) of additional flooding seems likely. Most of the white cedar trees were dead, although they were still standing. The natural area west of the ROW could be described, in July 1990, as scrub-shrub alder thicket. During the past 20 years, water on the west side of the road has either flowed over the top of the road or washed the fine sands from beneath the road, creating several drainage channels in the road. This appears to have reduced the depth and duration of flooding west of the road as time went on. The occurrence of young larch, paper birch, and white cedars in the natural area west of the road indicates that the white cedar forest is in the process of recovery.

The accessibility of the native forest (probably second growth) to wind due to the open nature of the ROW has produced a large number of lodged and wind-thrown trees along the forest edge east of the ROW (Figure 4). The showy ladyslipper, found occasionally in the forest, was more abundant and more robust and had fruit along the ROW edge. No showy ladyslipper plants were found in the natural area west of the ROW, despite the more open nature of the land. The new habitats and edges created by the ROW have increased plant diversity by 23%.

5. CONCLUSIONS

Specific conclusions concerning the two Wisconsin pipeline sites based on the July 1990 site visits are stated below. Many of these apply to the other four sites; the one conclusion from the additional four sites worth noting at this time is that with proper handling and placement of the wetland soils, the ROW will revegetate itself with site-specific species.

Impact of Construction. The construction methods used in 1970 to build the pipeline resulted in the following:

- An elevated, sand-covered roadway on the west half of the Airport Road site, which caused a temporary interruption of water sheet flow at the site;
- A lowering of the east side of the ROW at both sites, providing sections of open water;
- An opening in the forest cover, necessary for the sandhill crane and various water birds, and edges along both sides of the ROW, conducive to the growth of showy ladyslippers;
- Introduction of European species via seeding operations; and
- Creation of habitat for deer and other wildlife.

Impacts of Maintenance. Maintenance of the ROW appears to have had the following results:

- Arrested the ROW in an emergent vegetative stage of wetland development, except for the west half of the Airport Road site;
- Maintained the edges between ROW and natural area;
- Allowed introduced species to persist on the ROW; and
- Provided habitat for wildlife.

Impacts on Plant Communities. At the Peshtigo Brook site, there appears to have been no impact or only a minimal impact on the natural-area plant community on either side of the ROW. At the Airport Road site, the major impact on natural-area plant communities east of the ROW seems to have been increased windfall of white cedar near the ROW edge. West of the ROW at the Airport Road site, the natural-area plant community appears to have been set back to an earlier stage of successional development due to the higher water levels likely to have existed there. None of the introduced plant species on the ROW appeared to have invaded the natural areas.

The plant communities on the ROW at both sites appear to have developed differently than those in the natural areas. At the Peshtigo Brook site and on the east half of the Airport Road site, except for areas of deeper water, these communities have developed into emergent stages of a boreal wetland vegetation. On the west half of the Airport Road site, they have developed into a mixture of successional stages of upland communities. Plant diversity at the Airport Road and Peshtigo Brook sites has been increased by 28% and 23%, respectively, compared with adjacent natural communities.

6. REFERENCES

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TABLE 1 Plant Types by Habitats, Peshtigo Brook Site

Plant Species	Habitat Location	Species Classification					Sum of All Species
		OBL	FACW	FAC	FACU	UPL	
All	Natural Area	29	19	8	6	2	64
	West N.A.[a]	21	11	6	2	2	42
	East N.A.	26	18	4	5	0	53
	ROW	38	20	8	6	2	74
	West ROW	34	19	7	5	2	67
	East ROW	34	11	4	1	1	51
Exclusive to Habitat	Natural Area	5	5	3	5	1	19
	West. N.A.	1	1	2	1	1	6
	East N.A.	3	2	1	4	0	10
	ROW	14	6	3	3	1	27
	West ROW	3	5	3	3	1	15
	East ROW	1	0	0	0	0	1
	Edge	2	0	0	1	0	3
	West Edge	1	0	0	0	0	1
	East Edge	1	0	0	1	0	2

[a]N.A. = Natural Area.

TABLE 2 Average Wetland Values (AWVs) by Habitat

Plant Species	Habitat Location	Peshtigo Brook Site AWV	Airport Road Site AWV
All	Natural Area	1.95	1.93
	West N.A.[a]	1.88	1.76
	East N.A.	1.77	2.01
	ROW	1.84	2.33
	West ROW	1.84	2.55
	East ROW	1.51	1.56
Exclusive to Habitat	Natural Area	2.58	2.01
	West N.A.	3.0	1.40
	East N.A.	2.6	3.00
	ROW	1.93	3.36
	West ROW	2.6	3.41
	East ROW	1.0	1.00

[a]N.A. = Natural Area.

TABLE 3 Plant Types by Habitats, Airport Road Site

Plant Species	Habitat Location	Species Classification					Sum of All Species
		OBL	FACW	FAC	FACU	UPL	
All	Natural Area	36	25	13	7	1	82
	West N.A.[a]	32	23	10	3	0	68
	East N.A.	28	20	12	7	1	68
	ROW	30	23	10	10	9	82
	West ROW	19	21	10	10	9	69
	East ROW	23	9	1	3	0	36
Exclusive to Habitat	Natural Area	10	5	7	2	0	24
	West. N.A.	4	0	1	0	0	5
	East N.A.	0	2	3	2	0	7
	ROW	4	4	4	5	8	25
	West ROW	3	4	4	3	8	22
	East ROW	1	0	0	0	0	1
	Edge	1	0	0	0	0	1
	West Edge	0	0	0	0	0	0
	East Edge	1	0	0	0	0	1

[a]N.A. = Natural Area.

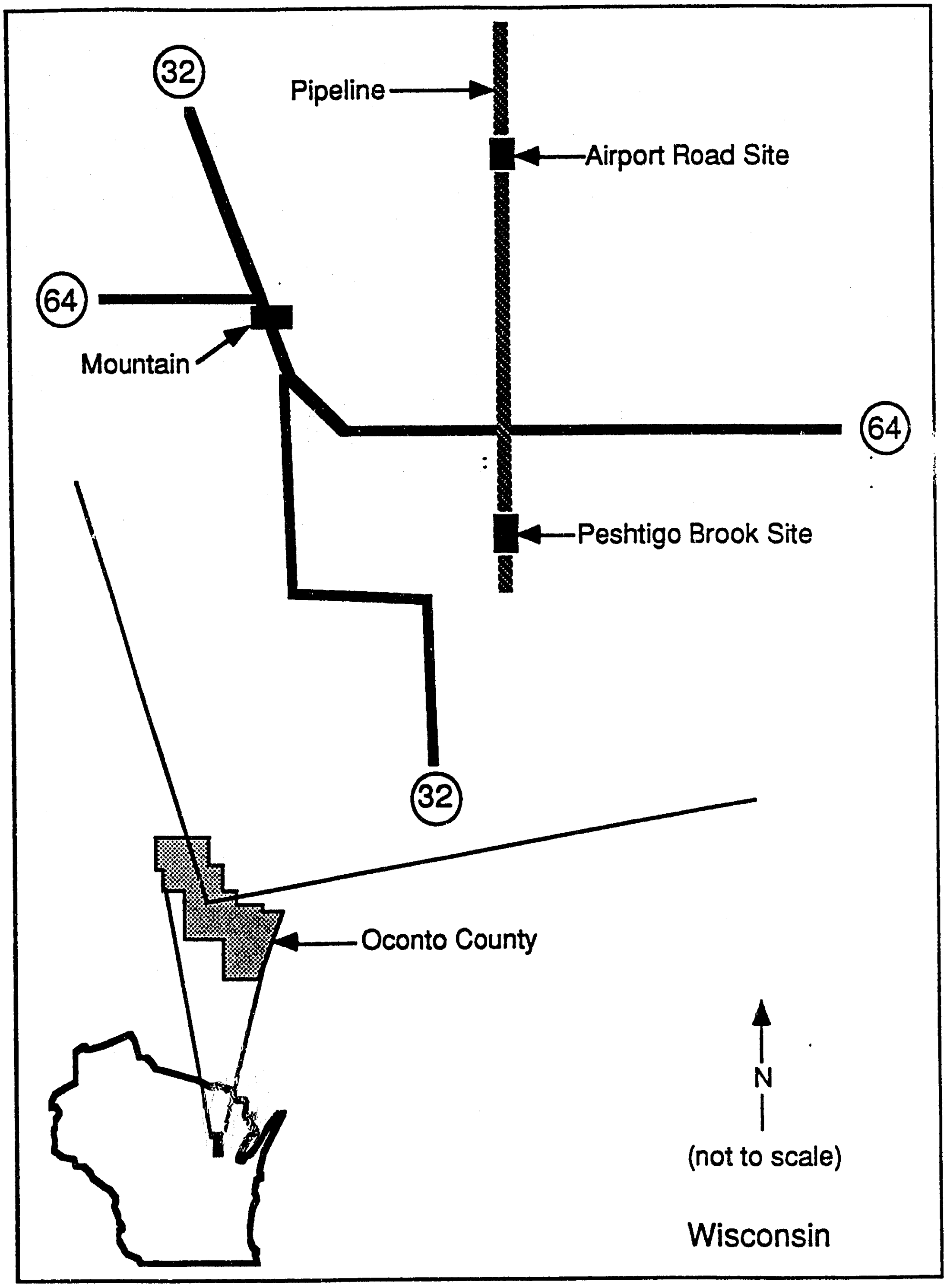

FIGURE 1 Research Sites in Oconto County, Wisconsin

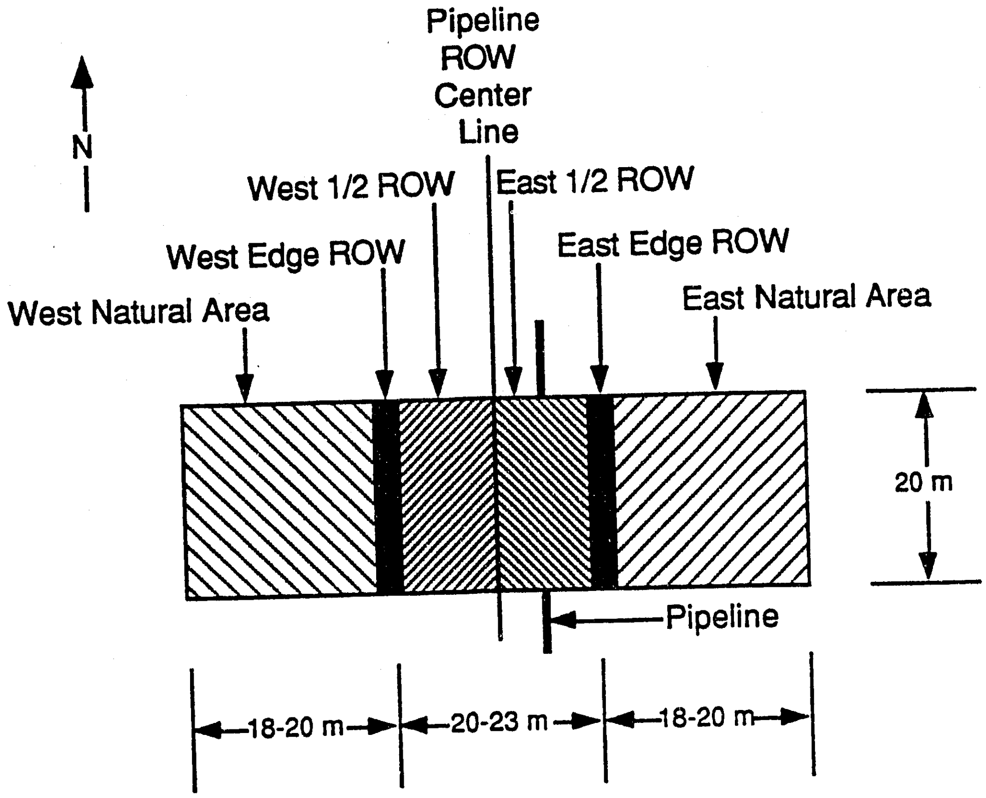

FIGURE 2 Right-of-Way Vegetational Data Collection Areas for Wisconsin Sites

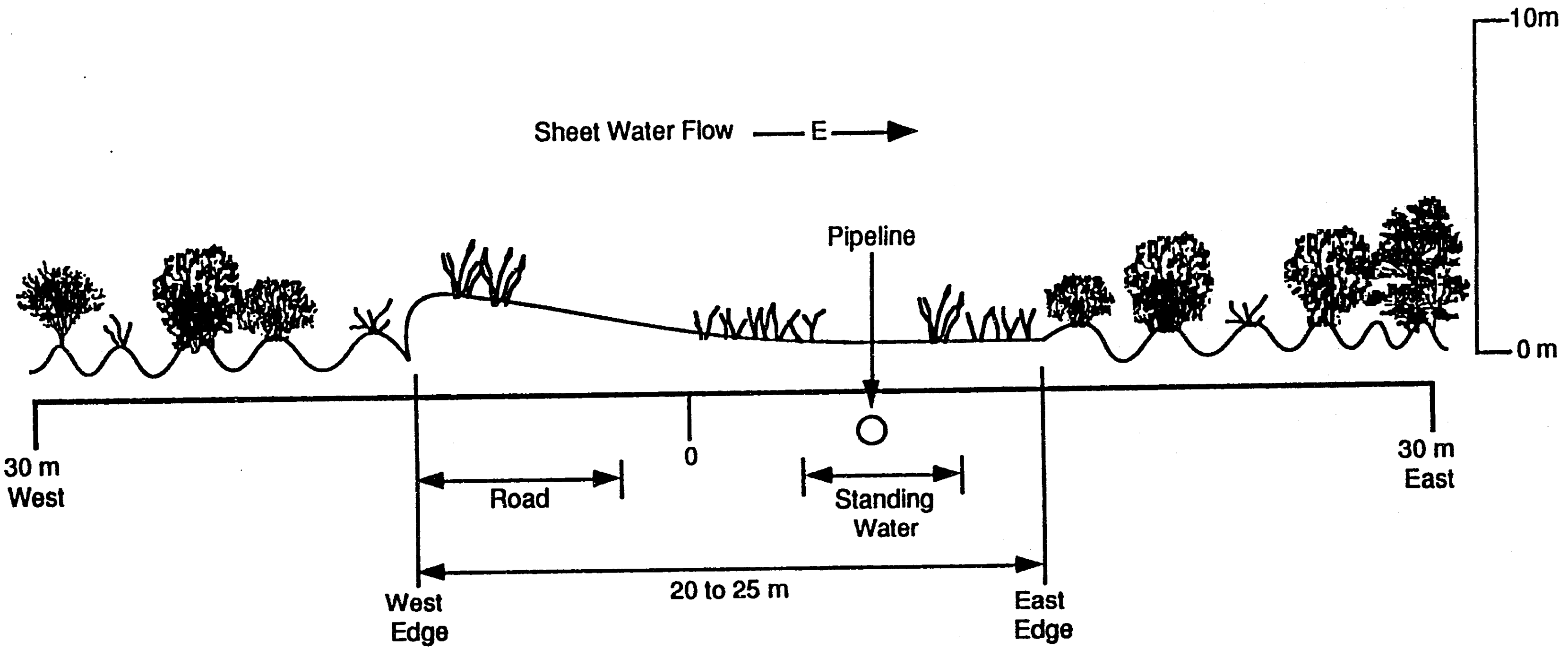

FIGURE 3 General Cross-Sectional View of the Peshtigo Brook Site

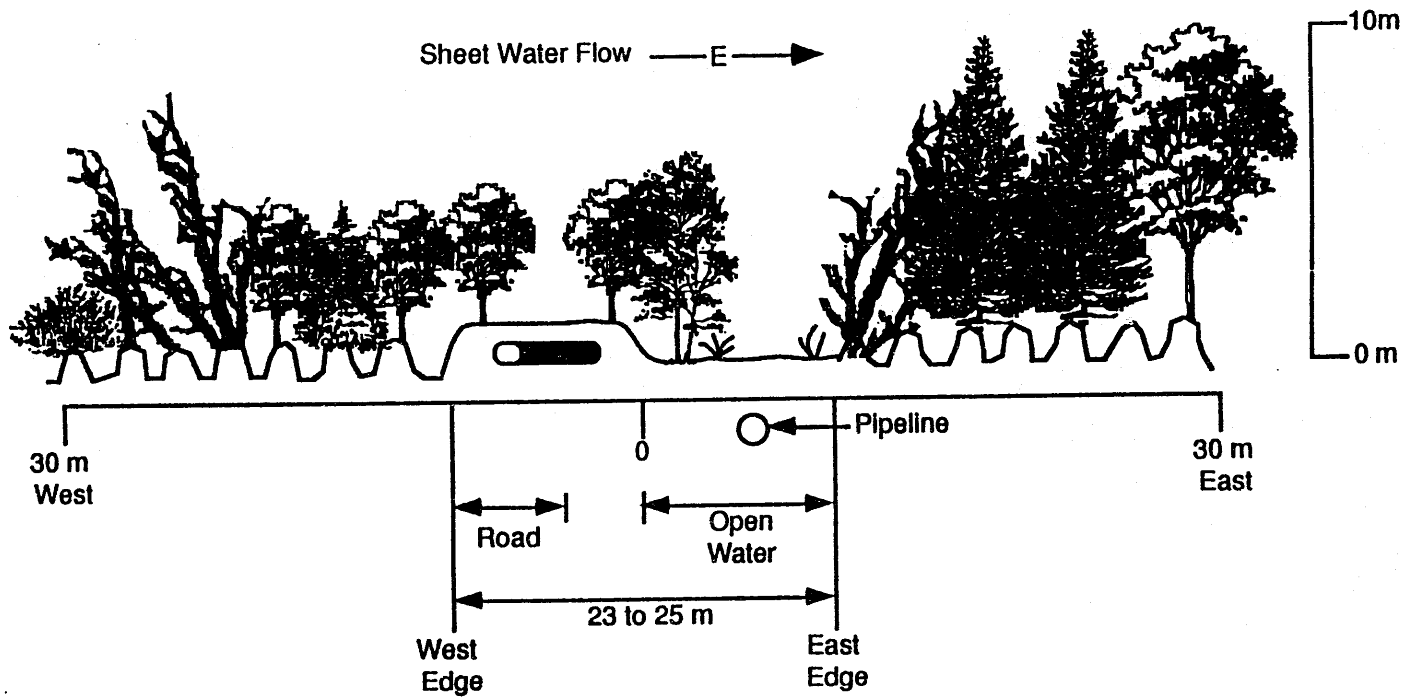

FIGURE 4 General Cross-Sectional View of the Airport Road Site

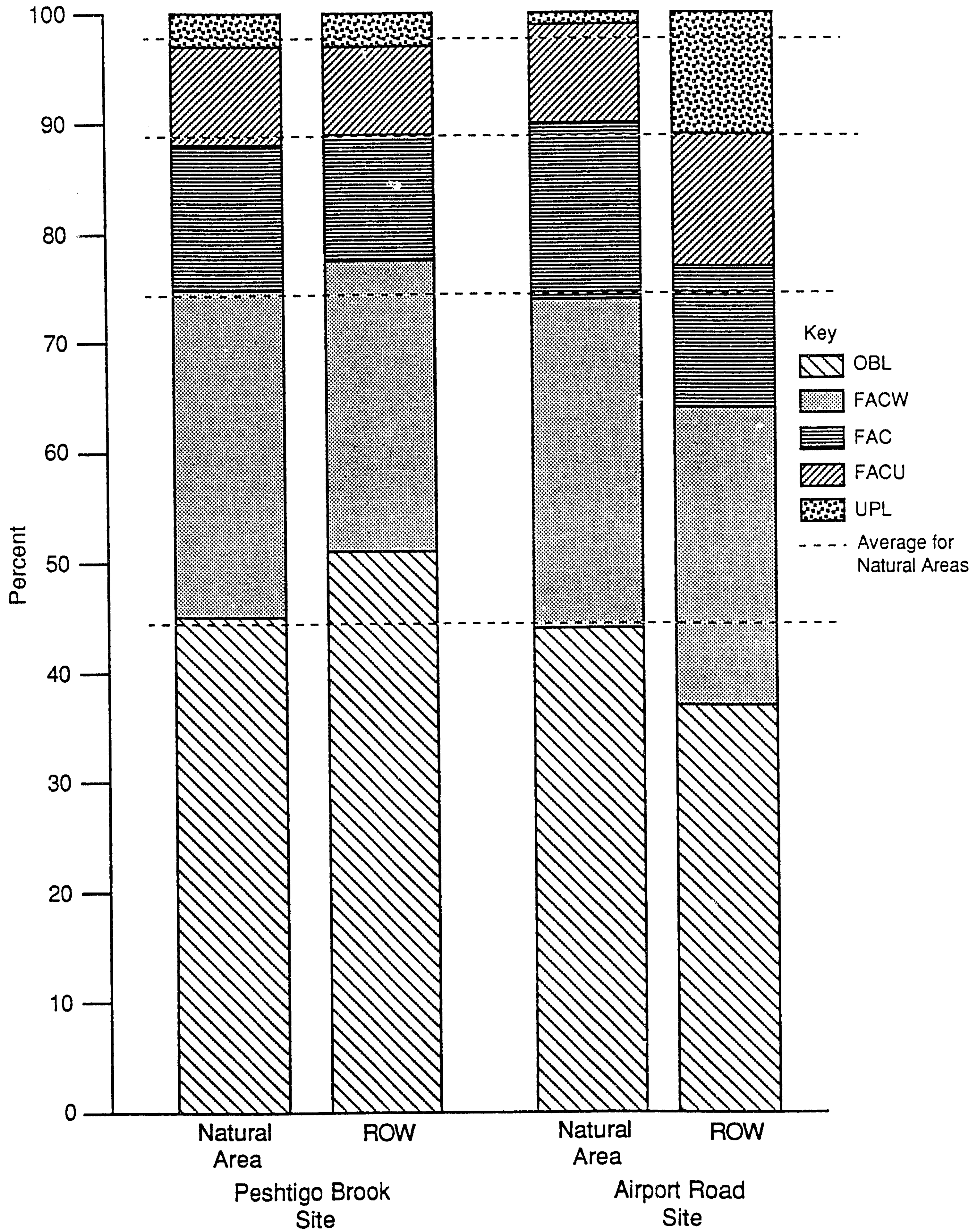

FIGURE 5 Plant Classification for the Two Wisconsin Sites

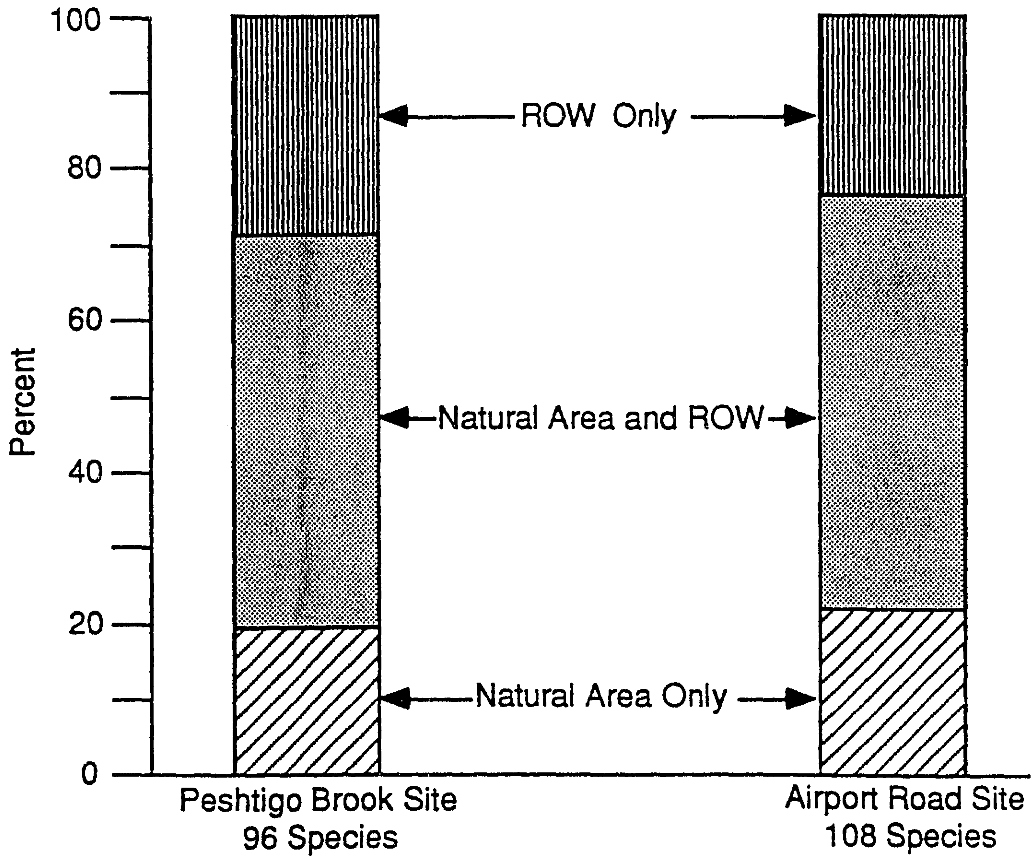

FIGURE 6 Distribution of Plant Species at the Peshtigo Brook and Airport Road Sites Based on Presence or Absence Only

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