PRIMARY PRODUCTIVITY AND SPECIES COMPOSITION OF A RECONSTRUCTED WETLAND IN EASTERN KENTUCKY

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ABSTRACT OF THESIS

PRIMARY PRODUCTIVITY AND SPECIES COMPOSTION OF A RECONSTRUCTED WETLAND IN EASTERN KENTUCKY

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Primary productivity and vegetative species composition was determined for a reconstructed wetland from April, 1990 to March, 1991. This study was done to aid in evaluation of restoration status of this wetland, by comparing field data to literature data for the same parameters. Above-ground herbaceous biomass was harvested monthly over the study period using a 0.25 m^2 quadrat. Plant samples were identified, and dry weight was determined. Woody biomass was calculated from measurements of diameter at breast height, using regression equations. The wetland remained inundated with water for ten of the twelve months studied. Species composition was found to vary with the hydrologic parameter of the sampling area. Obligate and facultative wetland plants (*Decodon verticillatus*, *Iris virginica*, *Juncus* spp., and *Carex* spp.) dominated the majority of the wetland. Total above ground production was 551.2 g m^{-2} and total net primary productivity was 2.7 g m^{-2} d^{-1}. This study indicated that this restored wetland was peforming the functions of a wetland ecosystem. Some problems in reconstruction of wetland hydrology were found. Productivity values were low compared to literature values for similar wetland communities.

Accepted by:

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Howard J. Sitser

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CHAPTER I

INTRODUCTION

Currently, many wetlands are being constructed. Man-made wetlands are being designed to function as, or replace, natural systems. It is essential that constructed wetlands function properly to assure the survival of wetland biota. Unfortunately, there is a paucity of ecological studies comparing the functions of man-made and natural wetland systems. Most of the studies concerning constructed wetlands have involved design and engineering processes (Wolf *et al.*, 1986).

Wetlands are being constructed for different reasons: some to provide habitat for waterfowl; however, others are being created or restored as a result of mitigation. Mitigation is becoming common; the development of shopping malls, and required parking areas, in wetland areas, being a major reason for these projects.

Comparisons between constructed and natural wetland systems can be made by studying components essential to the functioning of the entire wetland system. Two components, primary productivity and species diversity, are factors that can be used to estimate the health of an ecosystem. Measurements of primary productivity are further useful for making comparisons between systems, and are easily converted to values that allow the measurement of ecosystem energetics.

I propose to study the primary productivity and vegetative species composition in a restored wetland, then compare productivity and composition with values, cited in the literature, for "natural" wetland systems. Because obligate wetland species are dependent upon particular hydrologies, measurements will be made for hydrologic parameters (rainfall, water level and hydroperiod) to determine if the hydrologic forcing functions are adequate to maintain a shallow water, semipermanently flooded environment.

CHAPTER II

LITERATURE REVIEW

Wetland Restoration

The processes required for the restoration of wetlands represent a new technology. Data concerning the functioning of restored wetlands is sparse. Although Wolf *et al.* (1986) published an annotated bibliography with 304 reports enumerating works associated with wetland restoration and creation, the majority of the annotated articles pertain to engineering processes that are necessary for wetland restoration or creation; they do not explain the results of the restoration projects.

In the past, wetlands were created mostly for waterfowl management. Now wetlands are built for the functions of sewage treatment (Shijun and Jinsong, 1989), and improvement of water quality (Fennessy and Mitsch, 1989).

Presently, new wetlands are being developed because federal laws require that wetlands damaged by development be restored, or be replaced, by the creation of compensatory systems. Mitigation is a process utilized by developers to avoid, or offset, the payment of fines imposed for damages to natural systems (Salveson, 1990).

Specific problems may be inherent in the mitigation process: 1) the quality of the restored or created wetland may be less than the original wetland; 2) the restored or created wetland may have ecological structures and functions different from those of the original wetland (Salveson, 1990). Weller (1981) earlier identified the degree of success in reconstruction as a problem in wetland restoration. Existing classification methods are sufficient to determine the status of an area as a wetland or a non-wetland, but there is a paucity of data concerning how a restored wetland should function, or what kind of natural succession will proceed in a restored wetland (Salveson, 1990).

Wetland restoration, or reconstruction, is a process of reclaiming a drained or drowned former wetland. Restoration is more easily effected than wetland creation; creation requires the change of a dry, upland area into a wetland. In the processes of restoring a former wetland area, many of the required components for wetland development are present. For example, seeds of wetland plants are in the seed bank awaiting conditions required for germination; soils are usually capable of retaining water. In wetland creation, new soils or impermeable liners (clay or plastic) must be imported to the area to assure water retention; aquatic macrophyte seeds must be sown (Salveson, 1990).

Sinigrope *et al.* (1990) reported dramatic results from a study completed in a restored tidal salt marsh in New England; a marsh that had been impounded for thirty-two years for use as waterfowl habitat. Tidal flushing was restored by removing barriers to ocean access. Changes in vegetative structure were recorded for ten years following restoration. *Typha augustifolia* dominated during the impoundment period (prior to restoration). Ten years after restoration *Typha* cover had decreased from 76% to 16%. The salt marsh plant *Spartina alterinflora* increased from <1% to 45% cover. The change occurred because of increases in salinity levels which allowed the more salt tolerant *Spartina alterinflora* to dominate (Sinigrope *et al*, 1990). Usually, salinity levels do not play a role in plant competition, or exclusion, in freshwater systems, but a marked vegetative change resulting from restoration processes is important to all studies involving wetland restoration (Salvesen, 1990).

Since wetlands are protected by federal laws, wetland delineation has become important for those who enforce laws, as well as for those who attempt to bypass laws. Federal delineation previously followed the guidelines established by Cowardin *et al* (1979). The classification system was hierarchical according to system and subsystem type. The classification system was used much the same as a taxonomic key, but it was used to identify a wetland, rather than a plant or animal. Five categories were established for the identification of wetlands by Cowardin *et al* (1979): 1) areas with hydrophytes and hydric soils; 2) areas without hydrophytes, but with hydric soils; 3) areas with hydrophytes, but with nonhydric soils; 4) areas without soils, but with hydrophytes; and 5) areas that are wetland, without hydric soils or hydrophytes (Cowardin *et al*, 1979). A more recent manual, The Federal Interagency Committee for Wetland Delineation (1989), is presently used for identification and delineation of wetlands. The manual employs a simpler and more comprehensive definition for wetlands: In the manual (The Federal Interagency Committee for Wetland Delineation, 1989) wetlands have three essential characteristics: 1) wetlands normally have, or are capable of supporting, hydrophytic vegetation; 2) wetlands have hydric soils, and 3) wetlands have a unique hydrology. These characteristics are not only important to wetland regulation, but may also be used to assess the status of wetlands restored for mitigation purposes.

Species Composition

The importance of vegetative species composition is illustrated by the use of composition as an aid in detemining wetland status (Cowardin et. al., 1979). The rationale for this resides in the fact that species composition changes in response to flooded conditions (Millar, 1973).

Species composition and primary productivity are influenced by hydrology; hydrology usually being a secondary factor. Continuous water cover can force sediments to become anaerobic; this, in turn, affects the type of vegetation that can grow and the amount of primary productivity (Lyon *et al.*, 1986). Elevation and substrate differences resulting from hydrologic changes can influence spatial heterogeneity, which can influence species composition (Gosselink and Turner,1978). Water levels can affect the availability of oxygen for root systems of plants; thus, oxygen availability affects productivity. Under anoxic conditions, soil redox potential falls and roots of plants convert to anaerobic respiration. Fermentation pathways, used under anaerobic conditions, do not yield as much energy and can affect plant growth (Mendelssohn *et al.,* 1981). Under extreme reducing conditions in soils, aerenchyma production occurs; this aids in providing oxygen to the roots. Even aerenchyma production is not enough to allow for complete aerobic respiration under extreme reducing conditions (Burdick and Mendelssohn, 1990).

Water levels can also affect the availability of both dissolved nutrients, and nutrients bound to particulate matter; such events can affect species composition indirectly. Continuous standing water can make the substrate anoxic, and release nutrients bound to the sediments. High water velocity can be the cause of high sediment input into the wetland (Gosselink and Turner, 1978).

Some wetland plants are more capable of tolerating flooded conditions than others. For example, wetland plant distribution follows the cyclic hydrologic regime in oxbow lakes: under flooded conditions, submerged communities dominate. As the oxbow begins to fill with sediments, water level decreases, and emergent macrophytes become dominant. This drying process produces a sedge meadow community and, eventually, a willow-poplar dominated forest (van der Valk and Bliss, 1970).

Often, water level changes do not result in a change in macrophyte species composition, but affects abundance. Kadlec (1962) found that stable flooding prohibited growth of herbaceous macrophytes; only woody species being capable of tolerating such hydrology. When water levels were lowered, species composition did not change; however, the abundance of macrophytes increased (Kadlec, 1962).

Many studies have been made to determine types changes in vegetation proportionate to increases or decreases in water levels (Millar, 1973; Kadlec, 1962). Research completed in a waterfowl impoundment showed that at least 2 years of controlled water levels (depending on wetland size) were necessary to change species composition (Millar, 1973).

Freshwater species structure studies have been done mostly in waterfowl impoundments; these studies are difficult to correlate with restored swamp studies, because they are usually made in prairie pothole regions which have a distinct cycle of vegetative and hydrologic changes (Van der Valk and Davis, 1978).

Macrophyte distribution and productivity may also be affected by differing types of sediments. Sediment types, and nitrogen and phosphorous availability, often limit the growth of aquatic macrophytes (Mitsch and Gosselink, 1986). Barko and Smart (1978) found that different sediment types influenced the distribution and growth of some macrophytes by changing soil heterogeneity. Biomass was highest on fine-textured sediments, such as silty clay; lowest on sand (Barko and Smart, 1978).

It has also been suggested that the accumulation of decomposing litter affects plant growth in wetland communities (Bertness, 1988).

For example, Bertness (1988), in a sudy of a New England salt marsh, found that accumulating peat had a negative affect on both plant growth and production. Sites with small amounts of peat had less available nutrients and higher salinities than sites with large amounts of peat. However, sites with smaller amounts of peat sustained higher growth rates than those sites with larger amounts of peat (Bertness, 1988).

In a literature review of wetland vegetative dynamics, A.G. van der Valk (1987) listed ten generalizations that were important in studying vegetation in wetlands. Several of his generalizations are pertinent to this study:

(1) Aquatic plants have the ability to undergo clonal growth allowing them to spread over large areas rapidly.

(2) Water depth changes are correlated with changes in wetland community structure.

(3) Herbaceous wetland macrophytes change their population structure from year to year following environmental changes.

(4) Water depth and nutrients will effect growth rates of perennial wetland macrophytes.

The ability of wetland plants to grow and spread rapidly, via the formation of rhizomes and tubers, will facilitate the succession from upland plant species to facultative and obligate wetland plant species after restoration. Increasing water depth (by damning the outflows) should change community structure by encouraging the growth of aquatic macrophytes. Year to year changes should be recognizable as the result of changes in habitats resulting from increased water levels. Changes in hydrology could also cause changes in nutrient availability by lowering redox potential. Lower redox potential may cause nutrients bound in the sediments to be released; thus further changing wetland community structure (Gambrell and Patrick, 1978).

Wetland Productivity

Net Primary Productivity (NPP) is the rate of biomass production per unit time. NPP is the amount of food material directly available to the next trophic level (Brower *et al.*, 1989).

Net Primary Productivity in wetland systems has been computed to be the highest for any ecosystem studied (Neiring and Warren, 1977). The way in which wetland system components interact to influence primary productivity is not completely understood, because many diverse factors influence productivity. The lack of understanding is further complicated by the fact that different techniques are used to measure primary productivity. These problems make the comparison of systems difficult (Gosselink and Turner, 1978).

NPP has been examined in various wetlands characterized by different vegetative communities (Table 1). Comparisons have revealed relationships between NPP and community structure. For example, Bulrush and Sedge (*Scirpus* sp and *Carex* sp.) dominated wetlands tend to have high productivity levels in freshwater systems. In a Bulrush-

Table 1. Peak biomass of various herbaceous wetlands. Meadow and old-field community for comparison to wetland community production

Dominant species	g/m2	author
Carex sp.	852	Bernard, 1974
C. lacustris	1037	Bernard & McDonald, 1973
Scirpus-Equisetum	845	Auclair et al, 1976
Brasenia-Nymphaea	195	Schalles & Shure, 1989
Typha latifolia	1527	Penfound, 1956
C. acutiformis	550	Verhoeven et al, 1988
Poa-Aristida(old-field)	340	Weigert & Evans,1964
submerged community	200	van der Valk & Bliss, 1971
floating community	210	van der Valk & Bliss, 1971
emergent community	465	van der Valk & Bliss, 1971
meadow community	325	van der Valk & Bliss, 1971

Horsetail (*Scirpus* sp. and *Equisetum* sp.) wetland, NPP was found to be 914 g m^{-2} yr^{-1} (Auclair *et al*, 1976). In a marsh dominated by the sedge *C. lacustris*, NPP was 857 g m^{-2} yr^{-1} (Bernard & McDonald, 1973).

Of all freshwater wetland systems, productivity values are highest for swamps. Again, community structure is related to NPP. For example, NPP of 1574 g m^{-2} yr^{-1} was determined for a bottomland hardwood forest, and NPP of 1140 g m^{-2} yr^{-1} was computed for a Cypress-Water Tupelo (*Taxodium* sp. and *Nyssa* sp.,) dominated swamp by Conner and Day (1976).

Leaf Litter

Leaf litter is a measurement of how much organic matter, nutrients, and decomposing material produced by woody plants is reentering a system; it is also an indirect measurement of productivity for woody plant species. Leaf litter also adds to the amount of decomposing material on the floor of the wetland; it returns bound N and P to a wetland system, and it makes these nutrients available to other plant species (Wylie, 1987).

Leaf litter has been studied in different types of swamps. Day (1984) measured leaf litter fall for four types of communities in the Great Dismal Swamp: Cypress communities were found to have litter fall of 1.8 g m^{-2} d^{-1}; Cedar 2.0 g m^{-2} d^{-1}; Maple-Gum 1.8 g m^{-2} d^{-1}; and mixed hardwood 1.7 g m^{-2} d^{-1}. Conner and Day (1976) found that leaf litter in bottomland hardwood was 1.6 g $m^{-2} d^{-1}$, and in Cypress-Water Tupelo leaf litter was 1.7 g $m^{-2} d^{-1}$. These values demonstrate the significant amount of organic material that enters a swamp ecosystem as leaf litter.

Hydrology and Productivity

The importance of water level and hydrologic fluctuations to productivity has been described by Brinson *et al.* (1981) in forested wetlands. It was found that swamps with rapidly flowing water had greater productivity than swamps with slowly flowing water; both had greater productivity values than swamps with stillwater (Brinson *et al.*, 1981). A large amount of evidence has been presented to support the findings of Brinson *et. al* (1981). Mitsch (1988) showed that a pulsing system had higher productivity then a permanently flooded system. A relationship between the amount of fluctuation in water level and plant growth did exist (Mitsch, 1988). In a study of bottomland hardwood swamps in western Kentucky, primary productivity was determined for different water regimes. Areas with intermittent flooding were found to have the highest productivity, while swamps with continuous standing water, not influenced by flooding events, had the lowest productivity (Taylor, 1986). The author suggested that intermittent flooding may not only aid in importing nutrients, but may also aid in exporting detrital material and in oxygenating the root zone. Taylor (1986) further found that structural complexity may have an affect on productivity. The most complex, and least complex, swamps had the highest productivity, while swamps with intermediate complexity had lower productivity (Taylor, 1986). The author suggested that primary productivity was related to the adaptations made by plants to hydrologic conditions; an excellent example being the fact that cypress trees outcompeted bottomland hardwoods in permanently flooded areas, because of the ability of cypress trees to withstand the conditions of long periods of exposure to standing water (Taylor, 1986).

In macrophyte dominated systems, correlations have been found between hydrology and productivity (Gosselink and Turner, 1978; Mitsch, 1988). Van der Valk and Bliss (1971) summarized standing crop data for submerged, floating leafed, and emergent wetland communities (Table 1). Highest productivity was recorded in the emergent community; the lowest in communities dominated by submerged macrophytes. In a wetland with continuous standing water, Schalles and Shure (1989) recorded a NPP of 140.4 g m^{-2} yr^{-1}. The low NPP (for a freshwater wetland) can be directly attributed to stagnant, standing water and its affects on low nutrient input and anoxic root conditions (Schalles & Shure, 1989).

Water levels can have other affects on wetland macrophytes. For example, growth and seed production have been shown to yield different results when measured for different water levels; macrophytes in deeper waters have greater seed production and less vegetative growth than macrophytes associated with shallower waters (Lieffers and Shay, 1981). Further, different water depths may allow for some wetland plants to out-compete others in a particular area by causing competitive exclusion (Grace and Wetzel, 1981). For example, paleoecological studies suggest deeper water (>75cm) allows for growth of both floating macrophytes and plankton, while shallower water has a larger amount of emergent macrophytes (Reeder, 1990).

Hydrology affects primary productivity as a secondary factor. The direct influence hydrology has on nutrient level, sediment heterogeneity, litter accumulation, soil nutrients, and species composition is well known. These factors affect the primary productivity of a wetland system.

CHAPTER III

METHODS

Site Description

The Rowan County Sphagnum Swamp (RCSS) is a reconstructed wetland located in the Licking River valley of western Rowan County, Kentucky (Figure 1). The reconstruction of the RCSS was part of The Glimcher Company's mitigation to compensate for the building of a shopping mall on a wetland in Ashland, Kentucky. The RCSS was a former bottomland hardwood wetland (located within the former floodplain of the Licking River) that had been ditched for agricultural uses. Reconstruction of the RCSS was completed in October, 1989; a dam was built at the outflow and seedlings were planted.

The 12 hectare swamp consists of 2.5 hectares of forested area, and 9.5 hectares of various open marsh communities. The wetland is bounded on the south and west by open fields (still used for pasture land), and on the north by a gravel access road. To the east is a paved road, Kentucky State Route 1722. The majority of the surface inflow to the RCSS passes through tile beneath S.R. 1722 or from surface flow across the road. A natural gas pipeline is situated east-west beneath the open marsh portion of the wetland. The 0.31 km^2 watershed consists of forested hillsides, pasture land, and roadway. As part of the

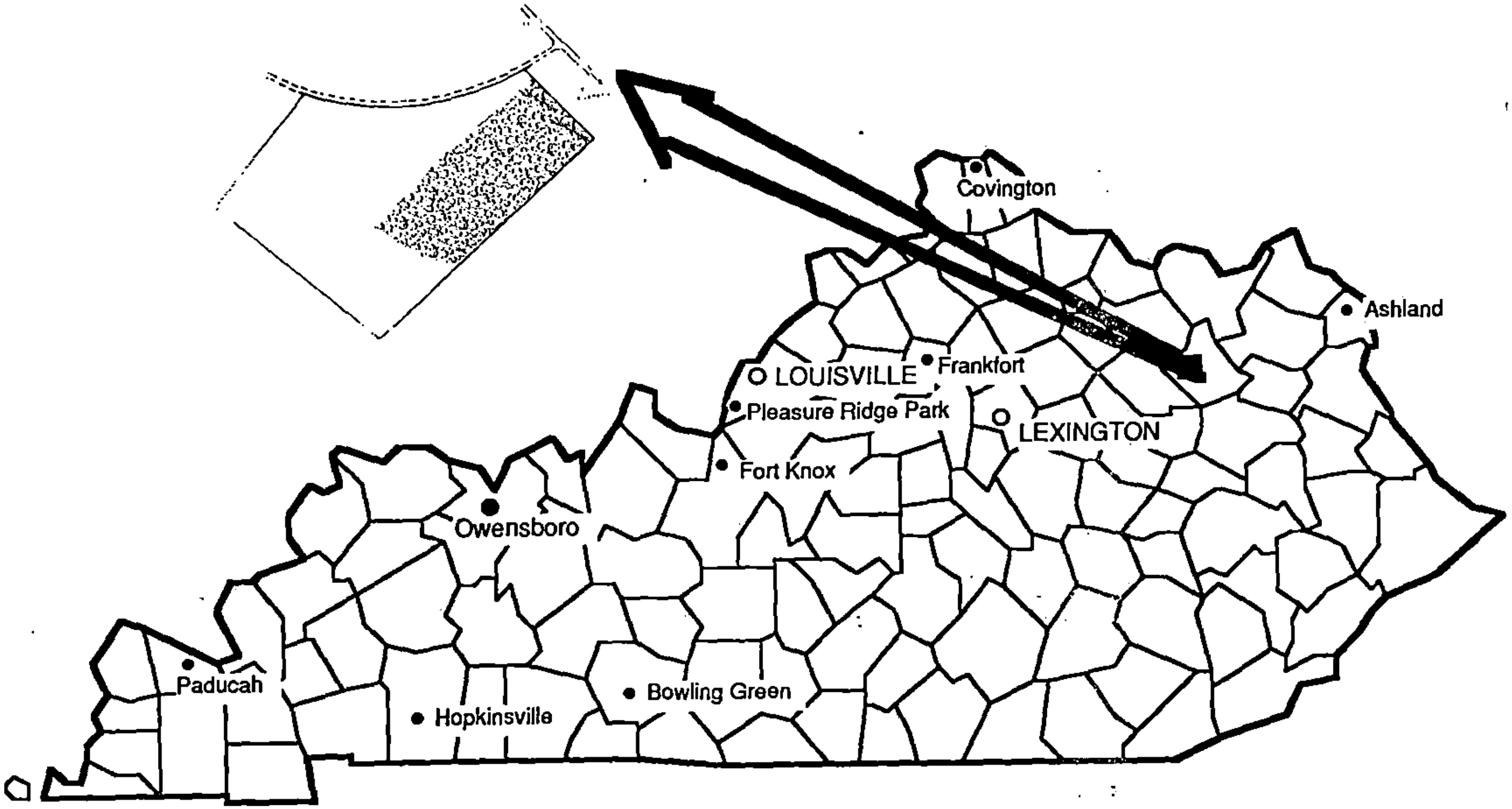

Figure 1, Location of Rowan County Sphagnum Swamp, Rowan County, KY.

reconstruction of this wetland, ponds have been created to aid in water retention. Five ponds are located in the wetland; three shallow (average depth=0.25m) ponds are located near the outflow (created as part of the reconstruction); two deeper (average depth=2-3m) ponds, are located within the wooded area (created prior to reconstruction). Hydrologic data was collected from the northern deeper pond (Figure 3).

Several different wetland types were found within the non-forested area: pond-edge communities existed along the ponds; however, open marsh was dominant throughout most of the RCSS area. The wooded swamp with intermittent areas of standing water constituted another community. These different community types were interspersed throughout the RCSS area; making it a complex of interacting communities.

Collection and Analysis of Data

Above-ground herbaceous vegetation was sampled monthly by harvesting 0.25 m^2 quadrats (Vollenweider, 1972). To select sampling sites, a map of the RCSS was covered with a grid, and each block was given a number. Sites were chosen using a random numbers chart. Sites were sampled continuously until three consecutive sites added no new species to the species total. Eight sites were randomly located within the wooded area, and nine sites were located within the open marsh (Figure 2). Each study site covered an area of approximately 100m^2.

Duplicate samples were taken at each site. Quadrats were randomly thrown within each site area, and macrophytes were harvested at ground level and placed in labeled bags for transport to the laboratory.

Quadrat size was determined by comparing harvest weights of several quadrats of differing sizes. For convenience, and to limit vegetation destruction, the quadrat of smallest size that produced a representative sample was used. To determine the smallest area, three different quadrat sizes, 1m^2, 0.25m^2, and 0.0625m^2 were used to harvest samples. It was found that the quadrat of 0.25m^2 was the smallest quadrat to produce a yield comparable to that of the 1m^2 quadrat. Samples were harvested monthly throughout the study period (April, 1990 - March 1991).

Samples were transported to the laboratory at Morehead State University where they were taxonomically identified using the keys by Strausburgh and Core (1979); Beal and Thieret (1986); Fassett (1969); Hotchkiss (1972); and Knobel (1980).

Plants were air dried and dry weight was determined, after samples in labeled jars were dried at 105°C for 48-72h (Vollenweider, 1972). Samples from five representative sites were ashed at 550°C in a muffle furnace, to determine the percentage of organic matter (Newbould, 1967).

Macrophyte species composition and average biomass were compared for each site. Net Primary Productivity was also analyzed for each site.

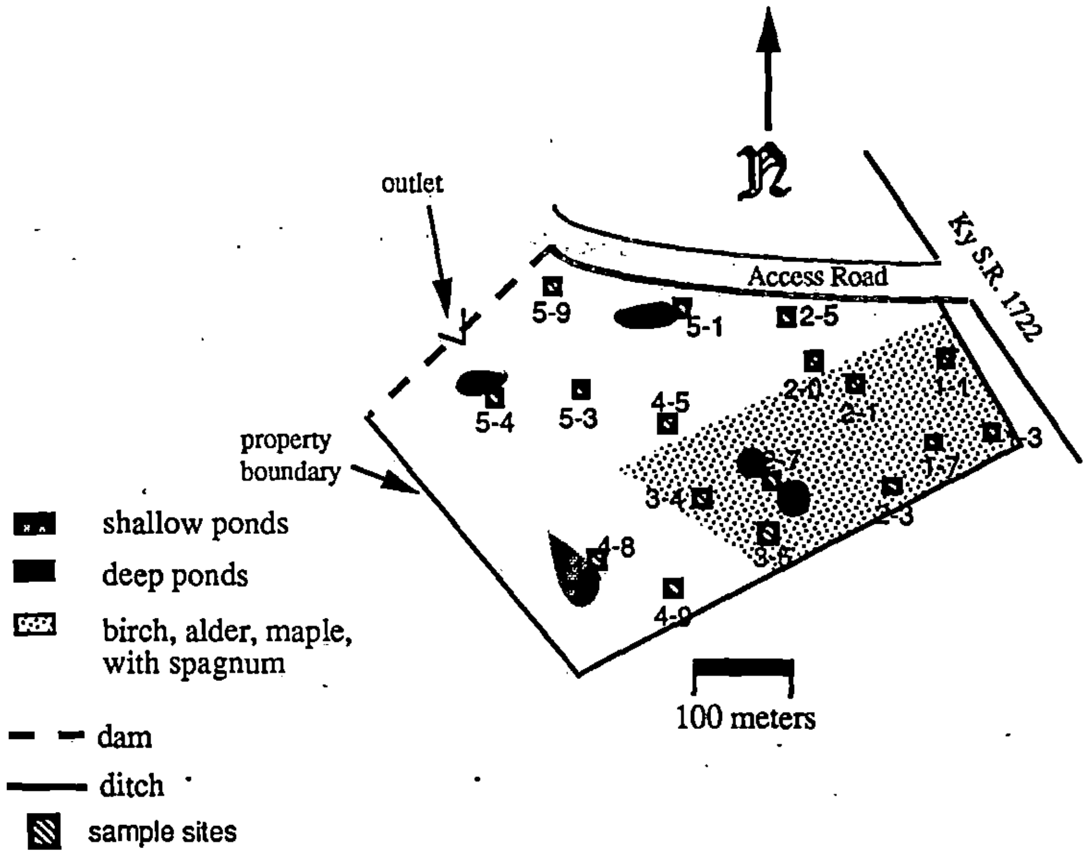

Figure 2, Location of sampling sites for herbaceous vegetation

Peak standing crop was considered to be the sample month with the highest average biomass. NPP was determined by dividing the change in biomass between months by number of days in that month. Annual NPP was computed for changes in biomass through the growing season.

Woody Productivity and Composition

Woody biomass and production were estimated by two methods: 1) calculating biomass from diameter at breast height (DBH) measurements; and 2) collecting litter-fall. Twenty $25m^2$ quadrats were alternately located on a 100m transect plotted within the wooded portion of the RCSS (Brower *et al*, 1989), see Figure 3. Diameter at breast height was measured for all trees >2.5cm DBH, and each tree was identified to species level using Petrides (1972) key. Biomass was calculated using the regression equation from Dable and Day (1977):

$$\log_{10} \text{dry weight(kg)} = A + B \log_{10} \text{dbh}$$

(explanation for coefficients can be found in Table 2).

This equation permits the calculation of standing stock of leaves, branches, and stems of woody plant species. Biomass was compared within tree species to determine species specific biomass.

Annual productivity of woody plants was determined by studying tree rings. Since it was not possible to harvest trees for tree-ring study,

Table 2: Regression coefficients for estimation of above ground biomass of trees >2.5 cm DBH using the equation $\log_{10}$ dry weight (kg) = A + B $\log_{10}$ DBH (cm). From Dabel and Day, (1977)

plant component	A	B	r
leaves	-2.1381	2.1516	0.90
branches	-1.4297	2.1880	0.90
stem	-1.0665	2.4064	0.90

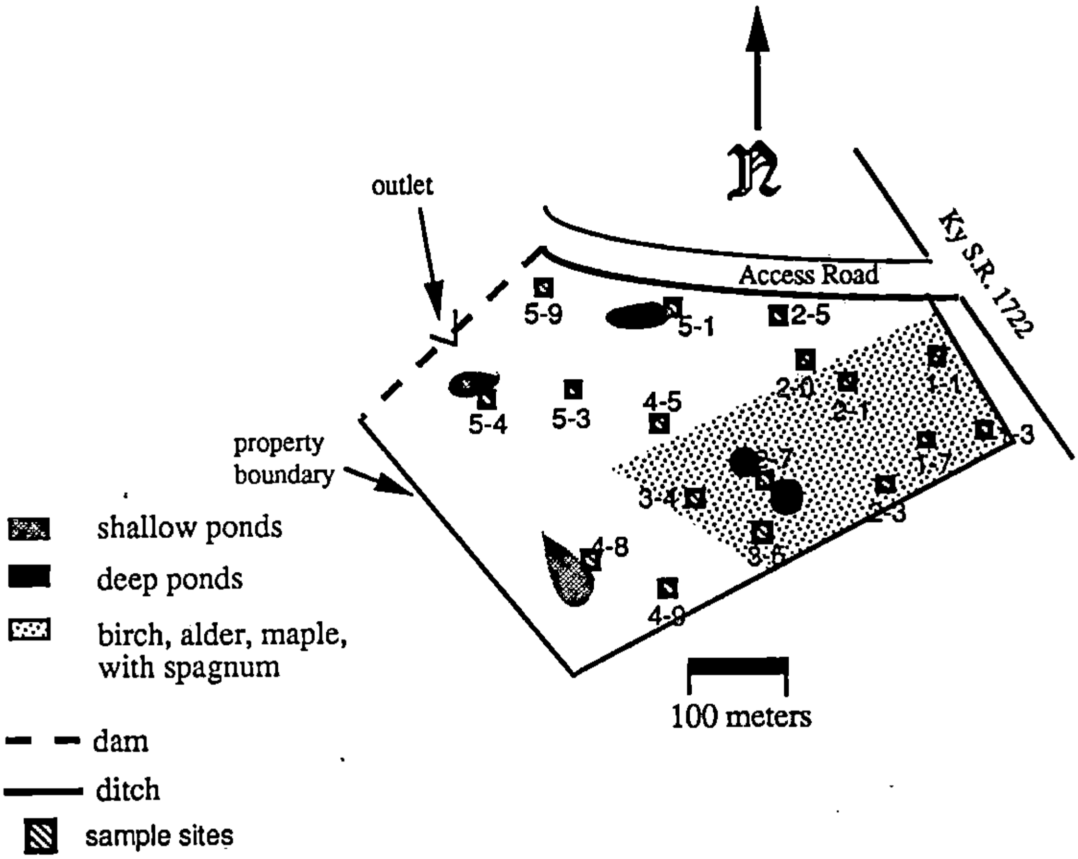

Figure 2, Location of sampling sites for herbaceous vegetation two trees selected randomly from each quadrat were cored. The cores were glued to a board, and sanded with 300 to 400 grit sandpaper. The cores were analyzed by using a disecting microscope, with an ocular micrometer, to measure annual growth ring size. The tree-ring analysis was also used to assist in determining the historical affects of hydrology, especially the hydrology of the Licking River water levels prior to flood control effected by the U.S. Army Corps of Engineers' dam at Cave Run Lake.

Leaf litter was collected from September 20 to January 31. Four, 0.25m^2 leaf litter traps were randomly located within the wooded area (Figure 3). Leaf litter was collected monthly, and transported to the laboratory where it was dried and weighed (using the same methods previously described for above-ground herbaceous biomass analysis).

Climatic data

Hydrologic data were collected using a Stevens type F continuous water level recorder. The recorder was located in an area of standing water within the RCSS (Figure 3). A staff gauge was also placed in this site to obtain monthly readings for calibrating the water level recorder. Sunlight data were collected daily by a Qualimetrics mechanical pyranograph located on the roof of Lappin Hall at Morehead State University (approximately 13km from the RCSS).

Daily precipitation, river level, and air temperature were obtained from data collected at the U.S. Army Corps of Engineers Project Office at Cave Run Lake (located approximately 5km from the RCSS). Evaporation data were measured with a USGS approved evaporation pan by the U.S. Army Corps of Engineers at Buckhorn Lake in Eastern Kentucky. Readings of evaporation via the pan method can be converted to estimates of evapotranspiration by multipling evaporation rates by the value 0.77 (Chow, 1967).

Statistical Analysis

Data from insolation, air temperature, water level, and biomass were analyzed statistically. This was done using a Macintosh SE computer with the program Statview SE + Graphics.

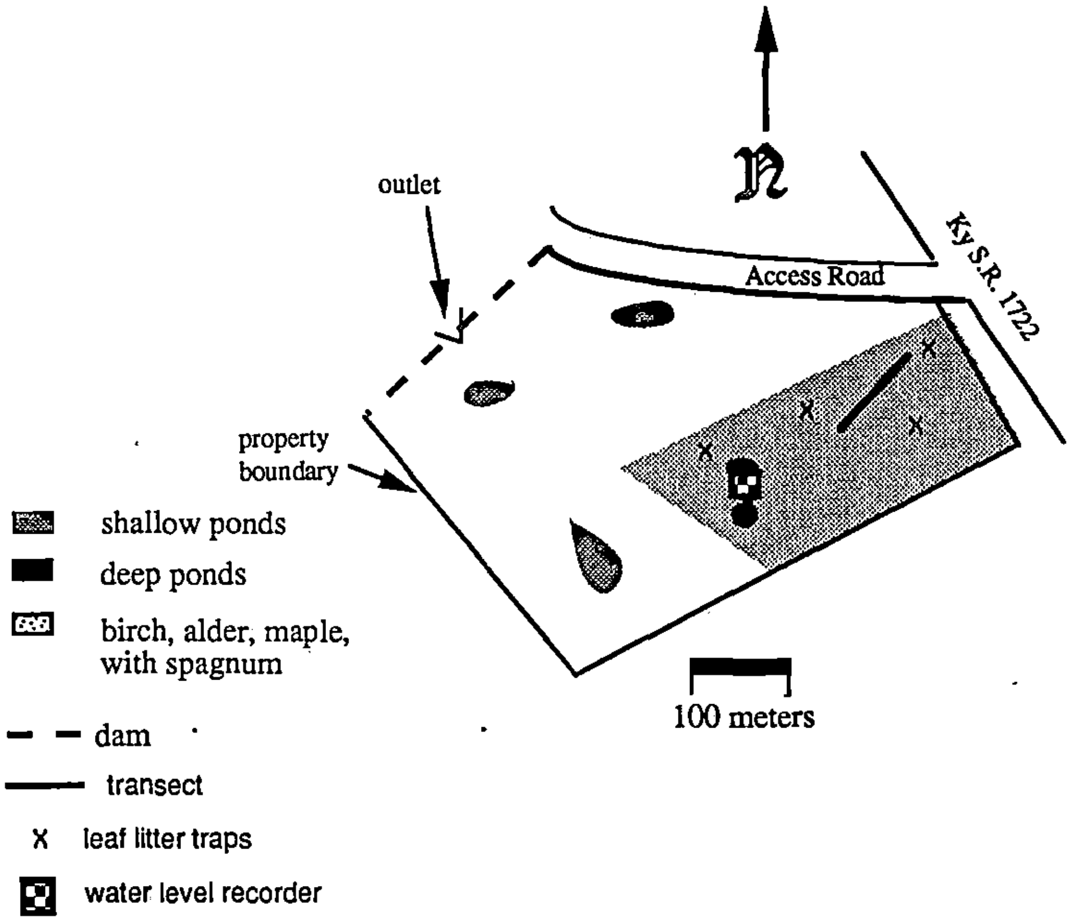

Figure 3, Location of leaf litter traps, transect for woody biomass sampling and water level recorder

Chapter IV

RESULTS

Hydrology and Climate

The RCSS maintained water levels greater than 20cm for the greater part of the study period. The hydroperiod (Figure 4) reveals many storm events, emphasizing the short water retention time of the wetland. Retention time, after a storm event, was approximately 36h. Between early August and early October, the entire wetland, with the exception of three ponds, was dry. However, during the summer dry period, the soil of many areas, such as the forest and pond edges, remained moist.

Average annual temperature at the RCSS during the study period was 13.1°C, with a high temperature of 36.1°C on August 29, 1990 and a low temperature of -16.1°C on February 16 and 17, 1991 (Table 2). Annual precipitation during the study period was 152.4cm, with a high of 27.8cm during the month of December, and a low of 6.6cm in January (Table 3).

Water level at RCSS varied spatially. Man-made ponds, trenches, and low areas, greatly influenced the total wetland hydrology. For example, higher ground, located in the open marsh area, was never covered with water even though the damming of the outflows was meant to increase water level throughout the RCSS. Each site had a unique hydrology, but,

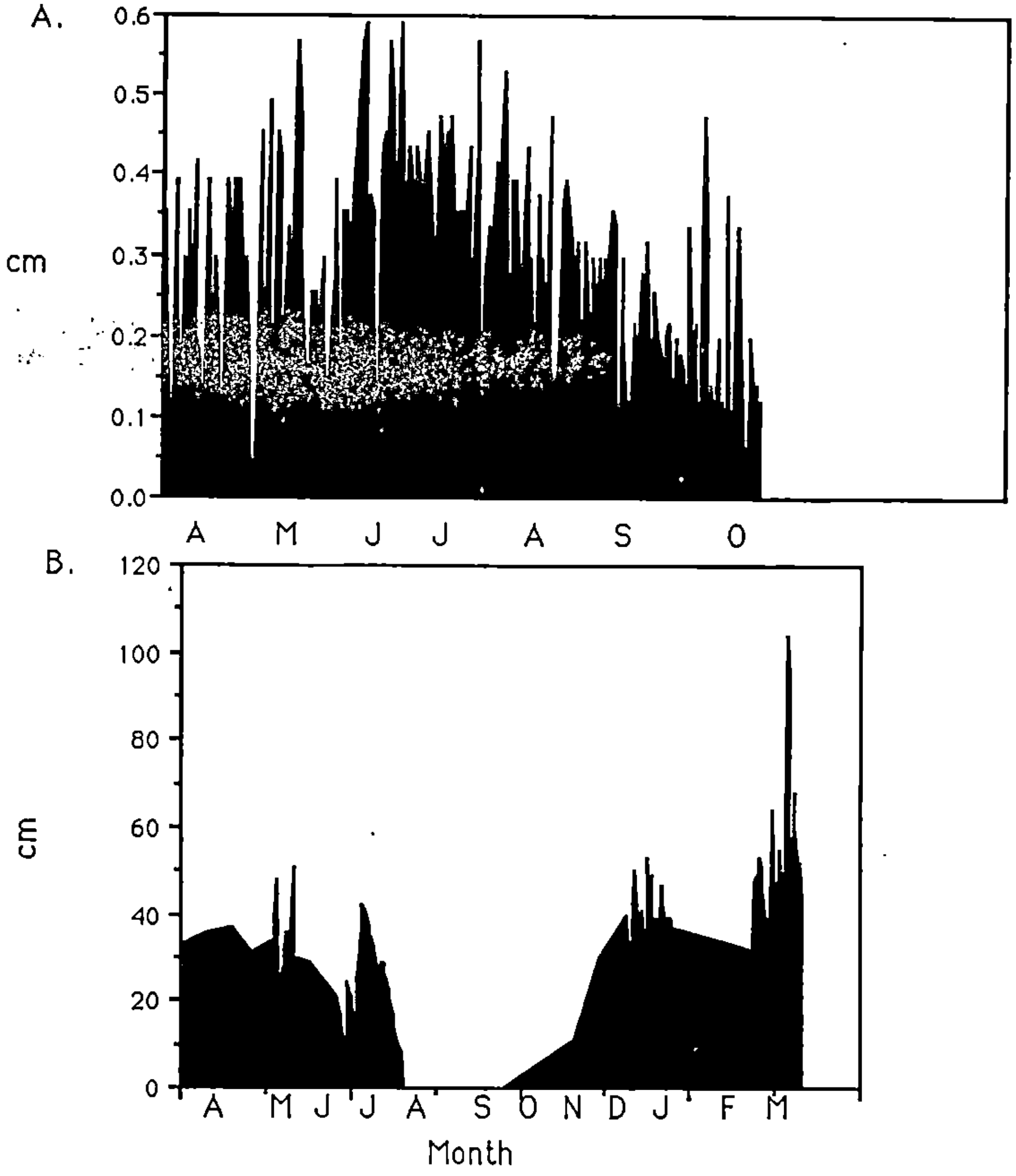

Figure 4, Evapotranspiration (A) and water level (B) at the RCSS for study period

Table 3, Average monthly maximum and minimum temperatures (°C) for the 1990-1991 study period. Data from U. S. Army Corps of Engineers, Cave Run Lake

month	average max	average min
April	19.2	3.8
May	22.8	10.3
June	28.6	15.5
July	31.1	16.6
August	29.3	16.4
September	27.1	13.4
October	20.5	6.1
November	17.7	2.0
December	11.2	-1.5
January	5.7	-4.4
February	9.0	-2.7
March	14.9	1.3

Table 4, Average monthly precipitation(cm) for the past 17 years for the RCSS and average monthly precipitation(cm) over the study period. Data from U. S. Army Corps of Engineers, Cave Run Lake

month	17 y average	1990-91 average
April	9.5	9.8
May	11.7	19.8
June	10.7	11.3
July	14.9	15.5
August	10.4	10.1
September	8.8	7.6
October	9.3	10.7
November	9.5	7.3
December	11.0	27.8
January	8.6	6.6
February	8.0	8.9
March	9.2	17.2
season total:	121.4	152.4

for convenience of the study, sites can be classified according to similar characteristics. Sites 5-1, 5-4 and 4-8 were all pond edge sampling areas; their water level were influenced by that of the ponds near them. Sites 1-1, 1-3, 1-7, 2-3 and 3-4 were all wet, wooded areas and were characterized by intermittent standing water with continuously wet soils. Site 2-7 was near the water level recorder, between the two deepest ponds. The water level of site 2-7 more closely followed the events of the hydroperiod, being under standing water for all but the driest periods of the study. Sites 2-1 and 3-5 were located in open clearings within the wooded portion of the wetland. These sites were usually under standing water, but did become dry intermittently. Sites 2-0, 5-9 and 4-9 were rarely (to never) under standing water, but often had moist soils. These areas were less "wetland-like", and more "upland-like" then the rest of the sites. Sites 2-5, 4-5 and 5-3 were open marsh areas that intermittently had standing water, but did become dry during the dry period.

The Rowan County Road Department dug ditches, from the swamp to areas across the access road, to alleviate flooding. Water was lost from the swamp via ditching, thus, increasing the outflows from the RCSS.

Herbaceous Biomass and Productivity

Changes in biomass during the sampling period (Figure 5) show that peak biomass occurred in September. The biomass peak was little different from the standing crop of the previous sample collected in August. This low rate of productivity for this time period is illustrated in Figure 6. Very little productivity occurred after peak biomass was reached. Peak productivity was 2.2 g $m^{-2} d^{-1}$ in April, and overall productivity for the growing season was 1.0 g $m^{-2} d^{-1}$. The ecological efficiency for the growing season for the RCSS was 0.1%. After the first frost, which occurred on 20 October, 1990, plant die off began, and negative production levels were observed. The lowest standing crop for this study (7.6 g m^{-2}) was recorded in November; occurring after two months of negative production. Increases and decreases in biomass were related to the number of days with frosting events per month (r^2=.75), (Figure 7), insolation (r^2=.613), (Figure 8) and increases and decreases in biomass were negatively correlated with wetland water level (r=-.761), (Figure 9). When water level was low, biomass was highest; when water level was high, biomass was lowest.

As plants began to sprout, in January and February, they were constantly subjected to frost. The response to frost was observable in samples taken in the winter. Plants were green close to the base of the new sprouts, but the upper portion was brown as a result of frost action. Samples collected when temperatures were below 0^{o} C were often brown from frosting. The longer the duration of freezing, the greater the browning affect. For example, biomass results for 28 February, 1991 were higher (19.6 g m^{-2}) than results for 30 March, 1991 (9 g m^{-2}). when

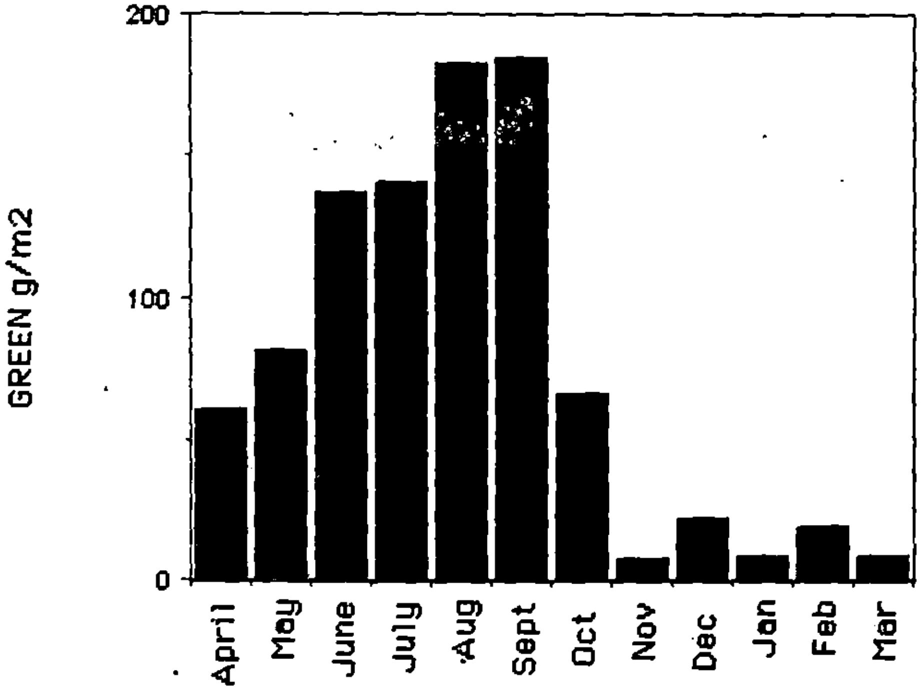

Figure 5, Average total biomass for each sample day (g m^{-2})

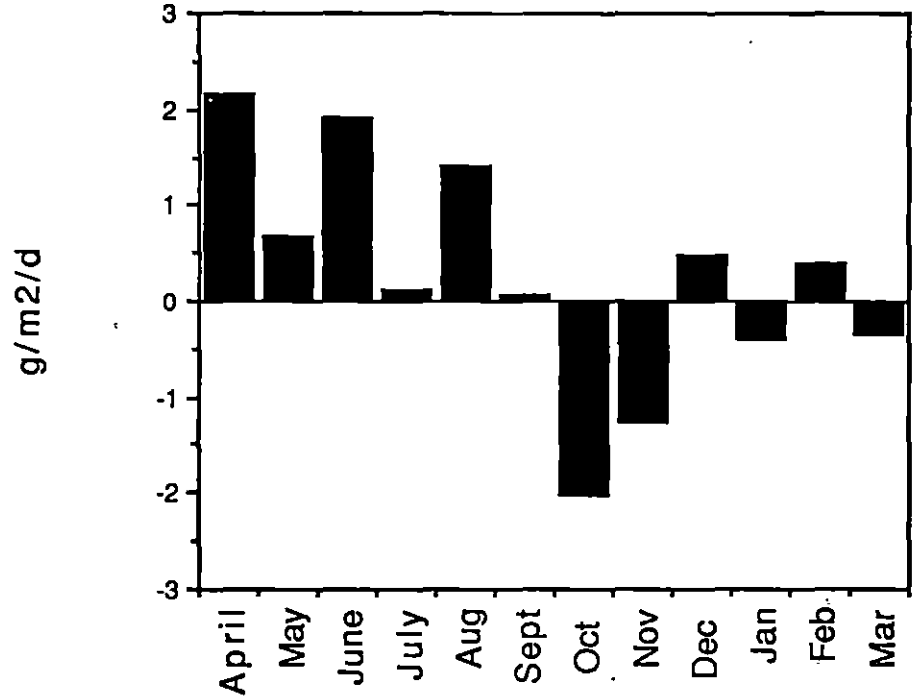

Figure 6, Net Primary Productivity of the RCSS by study day from April, 1990 to March, 1991 the March sample was collected, the ground was snow-covered, and the air temperature had been below freezing for the preceding two days.

Analysis of changes in biomass, for each site throughout the study period showed site variation in both time of peak biomass and plant dominance. Different sites supported different plant types, and had different times of the year for peak biomass. Figures 10 through 14 show the biomass of sites characterized by dominant plant species during the time period of the study. When peak biomass occurred at a site early in the season (such as May, June, July), the dominant plant species was sedge and bulrush (*Carex* spp. or *Scirpus* spp.). When peak biomass for a site occurred in late summer (August and September), the dominant plants were grasses, rushes and spikerush (Poaceae, *Juncus* spp., and *Eleocharis* spp.). Site 2-0 produced the highest standing crop, reaching 745.0 g m^{-2} in August. High standing crops tended to be dominated by grasses, especially redtop (*Triodia flava*), and rush species (*Juncus* spp.). *Juncus effusus* was the most common plant in the RCSS; it was present in 56% of the samples collected. Other common plants in the RCSS were: *Iris virginica* present in 26% of the samples collected; *Eleocharis tenuis* in 22% of the samples; and *Carex crinita* in 13% of the samples. The sites with the lowest production (Figure 10) had peak biomass below 100 g m^{-2}. These sites all had two factors in common. They were located within the wooded portion of the swamp; and they were dominated by sedge (*Carex* spp.). These sites were also similar hydrologically, having wet soils but very little standing water.

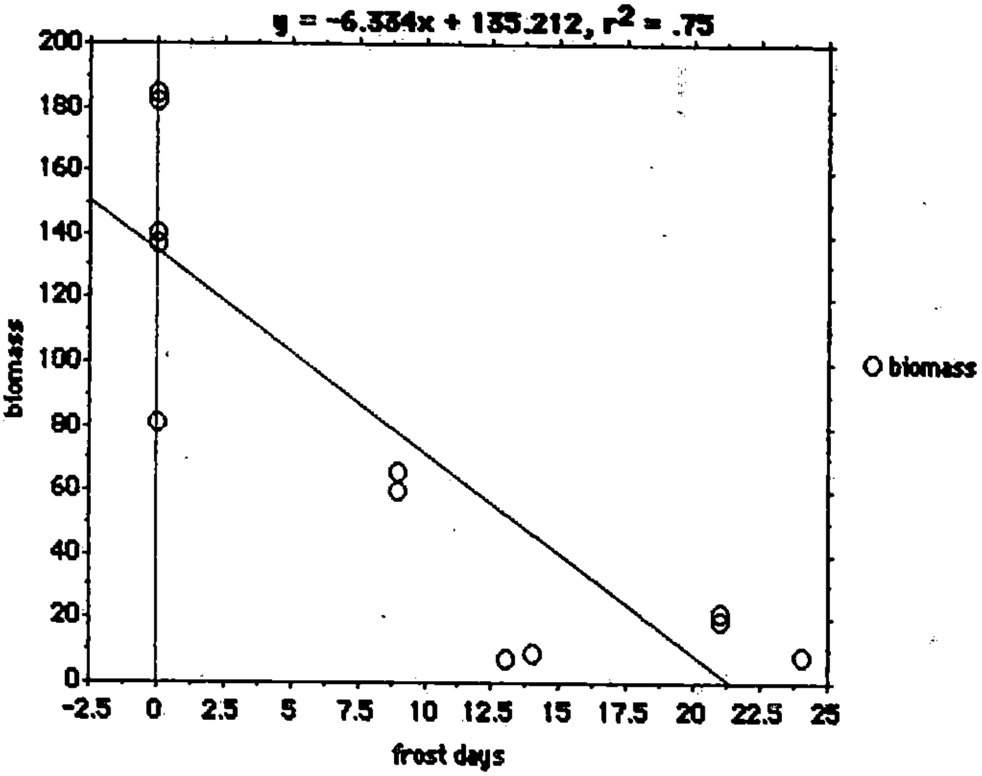

Figure 7, Regression analysis showing the relations between number of days below freezing each month and biomass for that month

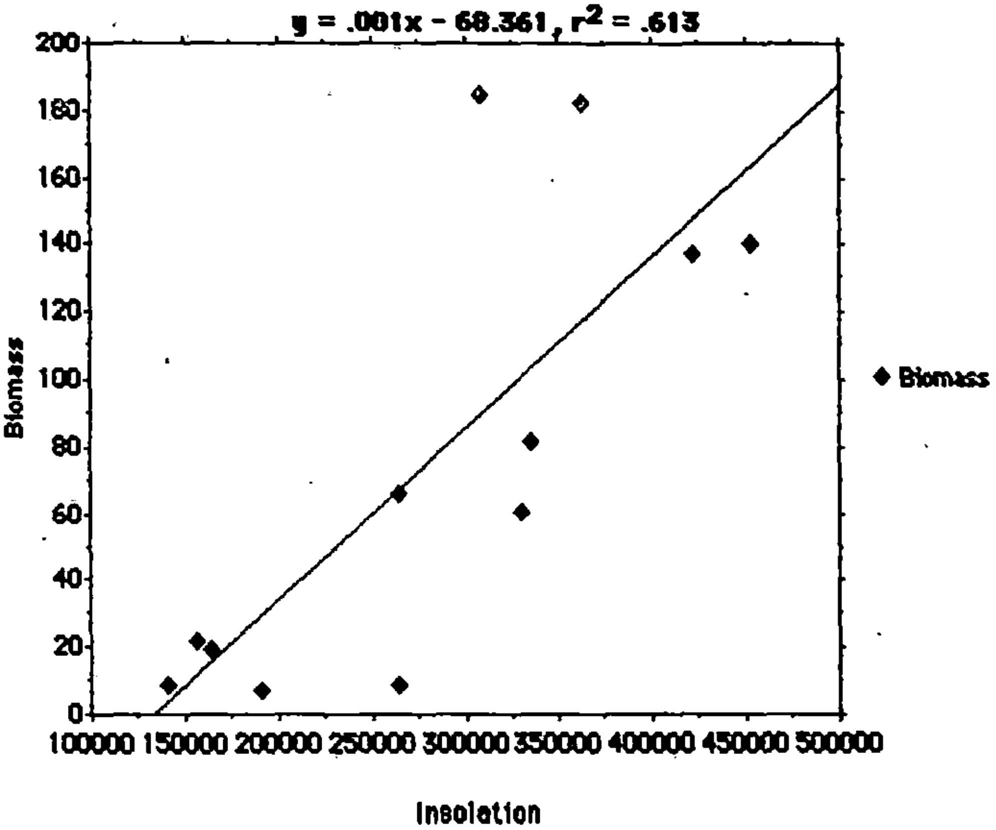

Figure 8, Regression analysis showing the relationship between insolation and biomass

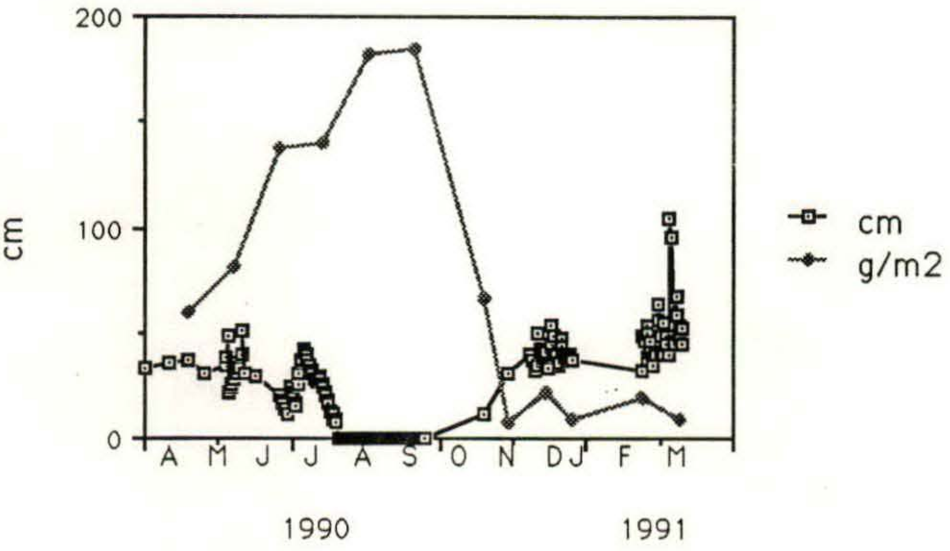

Figure 9, Comparison of biomass and water levels at the RCSS during the study period. Correlation (r= -.761) shows an inverse relationship

Generally, wetland plants were the most common species collected. However, meadow and field plants dominated in high, dry areas. Plants such as Tall Ironweed (*Vernonia altissima*), Joe-Pye Weed (*Eupatorium fistulosum*), and Redtop (*Triodia flava*) dominated in dryer areas; these plants also produced a greater biomass than those in the areas dominated by obligate wetland plants (Figure 12).

NPP was analyzed for each site from the beginning of the growing season to peak biomass (Figure 15). Site 2-0 had the highest NPP of any site. This site was dominated by *Juncus effusus* and *Eleocharis tenuis* in the winter and spring, but was dominated by grasses, particularly *Triodia flava*, during late summer. The rapid growth and increased production of *Triodia flava* made it the most productive plant in the wetland.

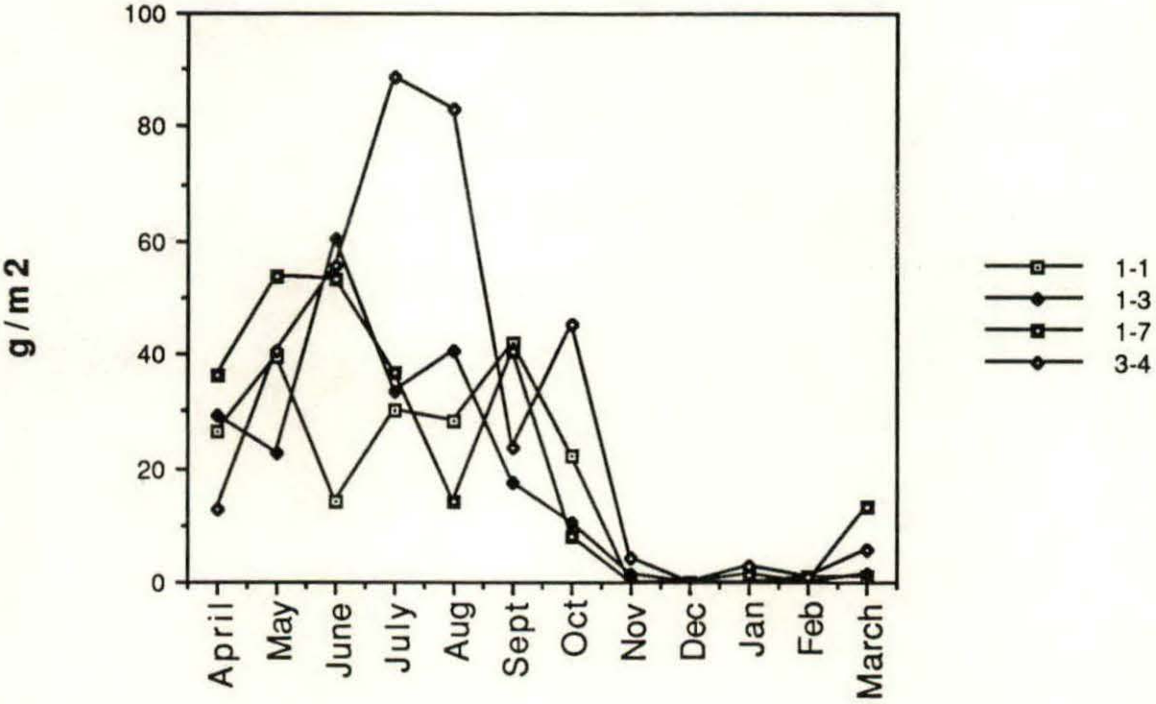

Figure 10, Biomass for wooded sites dominated by sedge (*Carex* spp.)

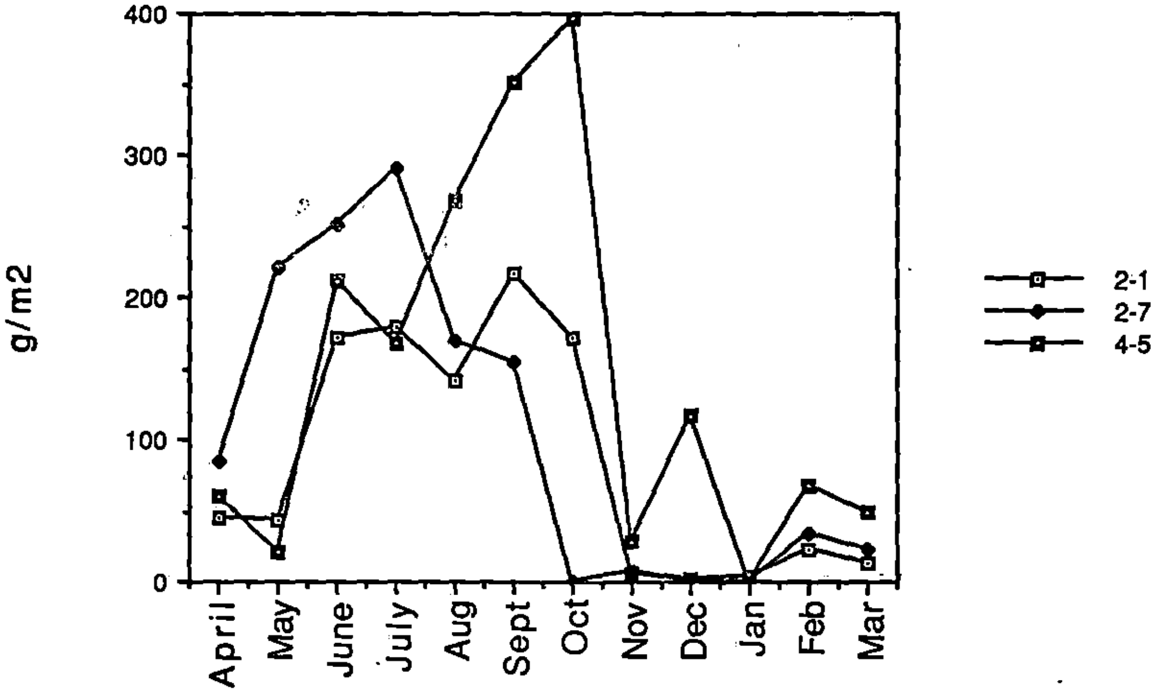

Figure 11, Biomass for sites with intermittent standing water dominated by *Juncus* spp., *Scirpus atrovirens* and *Iris virginica*

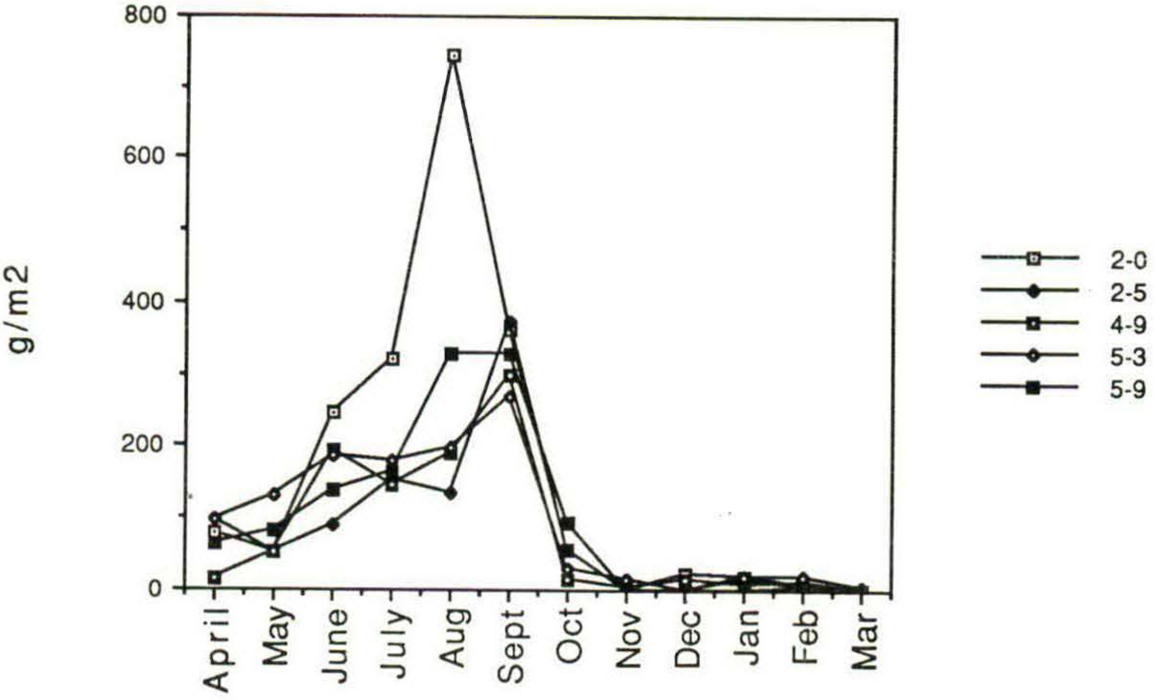

Figure 12, Biomass for sites dominated by grasses (Poaceae)

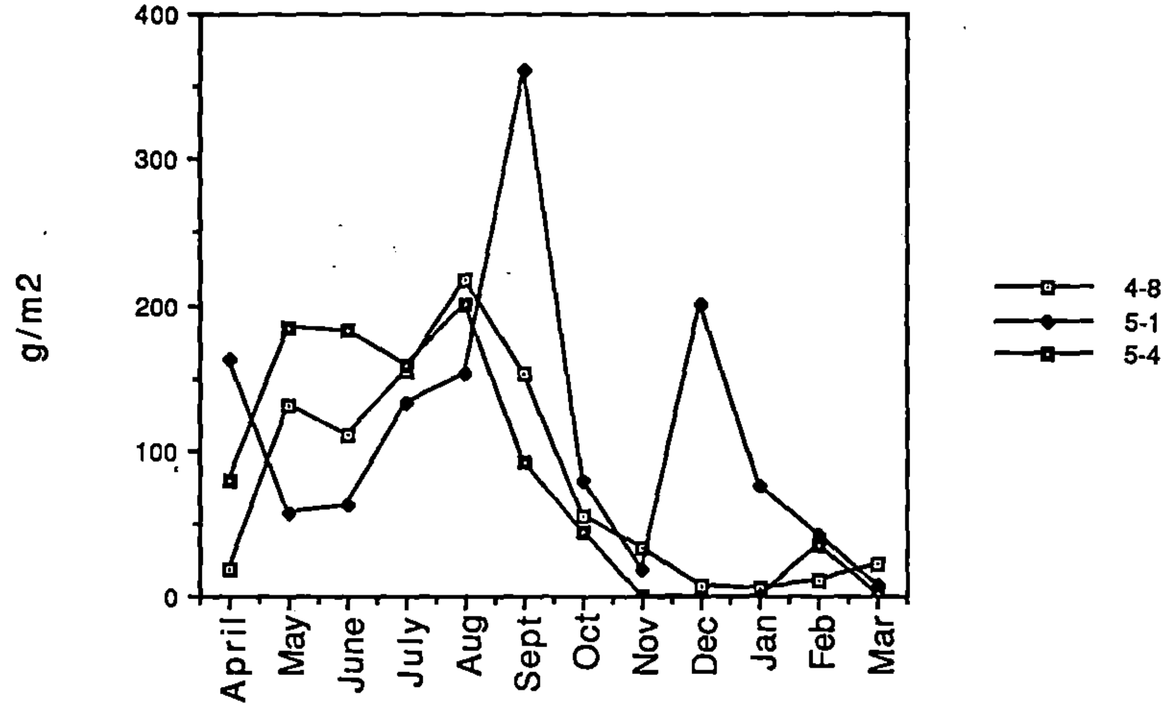

Figure 13, Biomass for pond-edge sites dominated by *Juncus* spp. and *Eleocharis* spp.

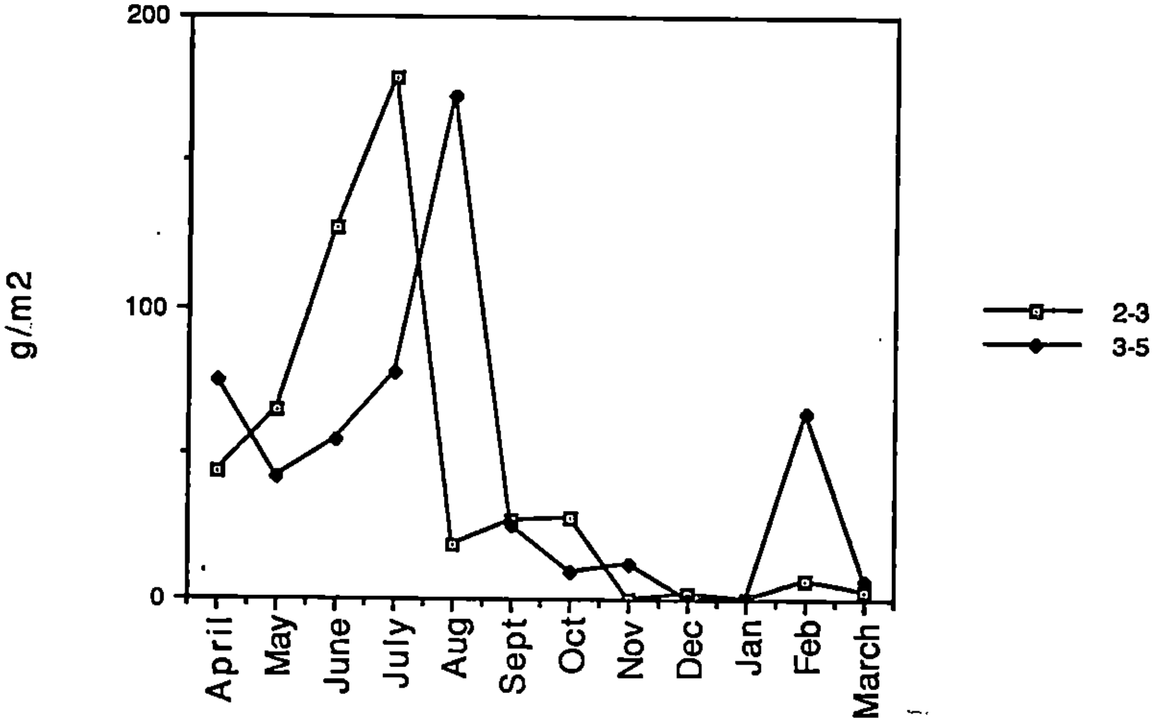

Figure 14, Biomass for wooded sites dominated by grasses (Poaceae) and sedges (*Carex* spp.)

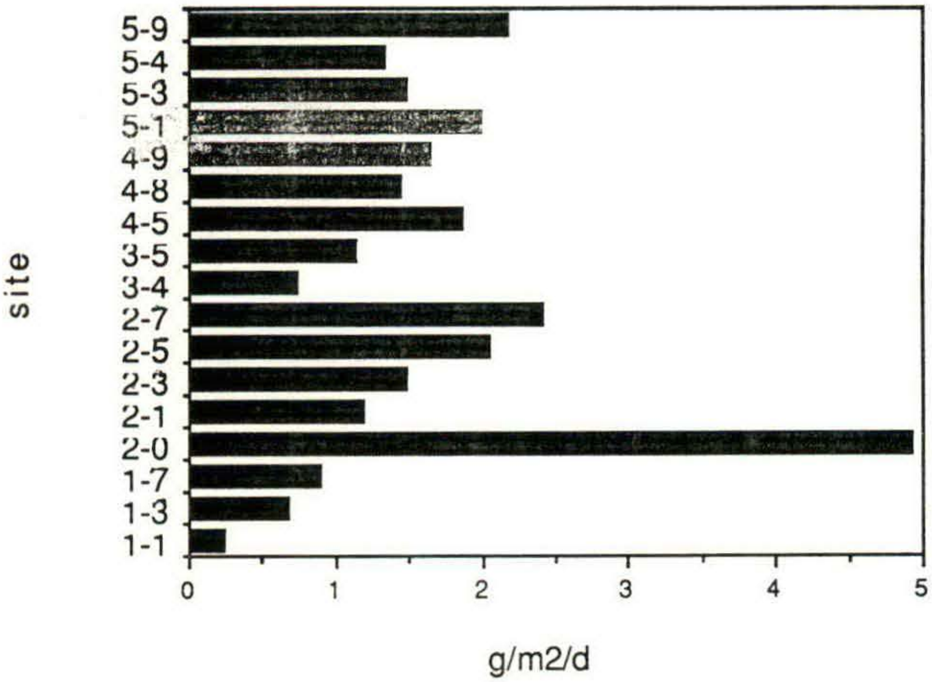

Figure 15, Net Primary Productivity for each site, calculated from beginning of growing season to peak biomass

Woody Biomass and Leaf Litter

Total annual woody biomass for the RCSS was 135.43 kg m^{-2} dry weight (Table 22). Eighty-one percent of the total biomass was composed of river birch (*Betula nigra*), making it the largest standing crop of any plant species in the RCSS. Only thirty-five percent of the tree species sampled were river birch; the total biomass percentage for river birch indicated that the size of birch trees was larger than any other tree species sampled.

Leaf litter averaged 2.6 g m^{-2} d^{-1} over a leaf-fall period of 132 days (September 20 - January 31). These data do not provide a complete annual litter value, but do provide an estimate for leaf litter during the fall season. Total leaf production for the season was 366.8 g m^{-2}.

Of those trees cored, the oldest tree was approximately 31 years of age. No correlation between tree ring sizes for different trees was found. There was no particular ring year that had similar growth rates among the trees that had been cored.

Total Production

Above ground production for the RCSS was 551.2 g m^{-2} at peak biomass. This value includes both herbaceous and woody vegetation. Total NPP for the RCSS was 2.7 g m^{-2} d^{-1}, from the beginning of the growing season to peak biomass.

Table 5. Estimated standing crop of woody plants in the RCSS (kg/m^2 dry weight)

Tree species	leaf biomass	wood biomass	total biomass
Betula nigra	2.74	106.51	109.25
Nyssa sylvatica	0.30	9.83	10.13
Liquidambar styraciflua	0.20	7.09	7.29
Acer rubrum	0.14	5.20	5.34
Quercus palustris	0.07	2.30	2.37
Alnus serrulata	0.01	0.31	0.32
all species	3.48	131.95	135.43

CHAPTER V

DISCUSSION

Hydrologic Problems

For two months (August and September) during this study, the RCSS was dry. Several explanations may be presented to explain this dry state: 1) It may be a natural cyclic event for bottomland wetlands in eastern Kentucky to become dry during late summer (Allen Risk, personal communication). There is lack of information concerning wetlands for this region, and specifically, for wetlands in this type of landscape. 2) Another alternative explanation resides in the possibility that the amount of precipitation recieved in this area during summer, coupled with the rarity of late summer flooding events, could be a cause for the depletion of water in the RCSS. Wetlands on alluvial floodplains often respond in such a manner; having high water levels during spring floods and low water levels during late summer (Mitsch and Gosselink, 1986). Evapotranspiration levels should be highest during early summer, when both air temperature and primary productivity are higher. Therefore, evapotranspiration would not be a major factor determining water loss for late summer. 3) The hydrology of the wetland could have been affected by ground water loss through the gas pipeline located below the surface of the wetland. If precipitation levels did not exceed the groundwater loss from the pipeline or other outflows, the wetland could become dry. Preliminary models, simulated for the RCSS, suggest that the levels of the Licking River may affect groundwater outflow, causing increased water loss during periods of low water levels in the river. 4) It may be impossible for the wetland hydrology to be restored properly. The erosion of the dam and ditching of the access road have contributed to increased surface outflow. The wetland may not be able to cope with this great loss of water, especially during late summer. Groundwater outflow for this type of wetland may be greater than that expected from design. The steeply sloping landscape of the watershed insured that a short water retention time for storm events will occur.

The most probable of the possible explanations is that the wetland is acting as a natural system, even with the engineering faults that characterize the project. Short retention times for storm events, shallow water cover for 10 of 12 months, and severe flooding after storms are characteristics similar to those that would be expected in a bottomland hardwood wetland. Repair and maintenance of the dam would aid in water retention after storm events, but it is unlikely that repair and maintenance would keep the wetland flooded year round. Flooding events from the Licking River do not reach this wetland, as they did prior to the construction of the dam at Cave Run Lake. The factors make it improbable that this system will ever fully mature into a bottomland hardwood forest.

Species Composition

The majority of the wetland was dominated by obligate or facultative wetland plants. These plants (such as *Iris virginica* and *Decodon verticillatus*), can only compete in wetland areas. The areas in which these plants can grow must have water cover for most of the year; they must also compete best in hydric soils produced by the anoxic conditions in continuous standing water. In the absence of basic requirements, these plants would not out-compete grasses and upland species in the RCSS.

Specific areas of the wetland were not inundated with water during the year, or dominated by wetland plants. These areas, specifically in the open marsh, added to the complexity of the system. It is unlikely that the plants from these areas will spread to areas with higher water levels, because they are not adapted to compensate for stresses imposed on plants by the presence of continuous water cover. Many of these plants, such as redtop (*Triodia flava*), would not be able to compete in wetter areas. Plants that grew in the dryer areas had the highest productivity in the RCSS. Redtop (*Triodia flava*), and other plants are capable of high productivity rates during the short dry periods in this wetland. So long as this wetland continues to have dry periods, the dominance of upland plants in the dryer areas is beneficial. Plants in the dryer areas do not interfere with the growth and expansion of obligate wetland plants, such as swamp loosestrife (*Decodon verticillatus*), Bulrush (*Scirpus atrovirens*), Lizard's Tail (*Saururus cenuus*), and Iris

(*Iris virginica*). From a management perspective, the plants that dominate the dryer areas may add to the quality and diversity of the RCSS by creating several different habitats; an advantage over a single habitat which produces a wetland characterized by a monoculture.

The criteria required for wetland definition were met in this study. The RCSS had water cover for the majority of the year; the RCSS was dominated by aqutic macrophytes; and hydric soils had to be present, because of the continuous standing water and the ability for obligate wetland plants to survive.

Productivity

Primary productivity and peak biomass for the RCSS were comparitively lower than values established for similar natural systems. Since the RCSS is a restored wetland, productivity levels may not be as high as those in established wetlands. Few studies have been made concerning primary productivity in restored wetlands; therfore, the level of production recorded in the RCSS, may be within the expected range for a two year old system.

It has been shown in this study that certain plants, such as *Triodia flava*, are more productive than others. Understanding the physical factors that control species diversity allows one to predict productivity. For example, in the RCSS, areas that were wooded and subjected to intermittent flooding, will be characterized by herbaceous domination (example; *Carex sp.*), and woody domination by (example; *Betula nigra*). The inverse relationship between water level and biomass may be a secondary factor in the control of productivity.

Early peak herbaceous biomss was a result of maximum growth for those plants in wooded areas maximizing sunlight before they become shaded by leaf growth from the trees above. However, production may still be limited by water stress. When water stress is alleviated, herbaceous vegetation reached maximum biomass. Such a response may be typical in a wetland like the RCSS. It is also possible that plants which do not have the highest productivity are not obligate wetland plants, and are subject to water stress and competition by those plants more able to survive under these conditions.

Bottomland hardwood forests may require floodwater input from creeks and rivers to maintain high productivity levels. For example, Taylor (1986) showed that bottomland hardwoods of western Kentucky, with intermittent flooding from rivers, had the highest productivity rates studied in western Kentucky. Similar responses may also be true for wetlands in eastern Kentucky.

Betula nigra dominated the biomass of the RCSS. The characteristics of quick growth and large size for *B. nigra* indicated that the swamp was acting as a bottomland hardwood forest. The larger size of *B. nigra* could be the result of its ability to withstand long periods of water cover, and out-compete, and outgrow, other tree species that may be slightly inhibited by water stress. It should also be noted that river birch is a common tree along aluvial flood plains in eastern Kentucky; it may be adapted for the nutrient load and soil types in this kind of wetland. Such an adaptation would permit *B. nigra* to out-compete other tree species.

Results of low herbaceous NPP and high leaf litter suggested that much of the swamp's production and biomass resided within the trees. The herbaceous vegetation may not have been capable of producing biomass because of stresses such as water cover, low pH, and low nutrient availability. The trees, particularly *B. nigra* may have been more adapted to the type of wetland characterized by the RCSS; therfore, the species was capable of producing a higher biomass.

CHAPTER VI

CONCLUSION AND SUGGESTIONS

Wetland restoration, resulting from mitigation, has become a common method employed by developers to bypass the problems imposed by laws that govern the legal use of protected land. New wetlands will be created as restoration becomes more prevalent. Questions concerning the quality of restored wetlands must be answered to validate reconstruction projects; to answer some questions pertinent to reconstruction has been the purpose of this study.

Based upon criteria established for the legal definition of a wetland, the RCSS is recognized as a wetland. The wetland was inundated with water for most of the study period, thus meeting the hydrology component of the definition. The RCSS is generally dominated by obligate, or facultative, wetland plants, meeting the hydrophyte criteria of the definition. The third definitional component, hydric soils, must have been present in the RCSS in order to support hydrophytic vegetation, and wetland hydrology. All the criteria for wetlands were met by conditions present in the RCSS.

Primary productivity for the RCSS was relatively low. Comparative studies of reconstructed wetlands and natural systems would aid in determining the progress of restorative processes in the RCSS site. Primary productivity may not be low for a wetland which has been restored for only two years. More studies for restored freshwater wetlands similar to the RCSS would be of great value in restoration design; studies could also aid in understanding the processes involved in natural wetland formation and succession.

Results from analysis of tree cores, showed the variation that existed in water levels throughout the forested area of the wetland. Variation in water levels caused growth to be different for each tree; according to the length and amount of inundation in the area that it was growing. This variation in water level was common throughout the RCSS.

Hydrology must be the primary concern when attempts are made to restore a wetland. Hydrology is the one physical parameter that most influences the vegetation structure of a wetland; the influence of hydrology was evident in this study. Water loss was a problem for the RCSS. The dam should be rebuilt with materials that are less affected by processes of erosion. Keeping this wetland flooded for longer periods of time may allow invading wetland plants to become established and outcompete proliferating upland species.

Wetlands will continue to be restored in the future. Many natural systems will be destroyed, and replaced by restored wetlands. More studies need to be made on reconstructed systems, before it can be determined that reconstructed systems can replace natural systems. The loss of a natural wetland system is devastating; if the promised restoration project is anything but totally correct and complete, structurally and functionally, the loss is catastrophic.

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Appendix A. Harvest weights and energy conversions

Date	Plot	g/.25m2	g/m2	104 sub	550 aft	930M	kcal/m2	av g/m2	av kc/m2
28-Apr-90	1.1.1		29.2				131.4	26.4	118.8
	1.1.2		23.6				106.2		
	1.3.1		42.4				190.8	29.4	132.3
	1.3.2		16.4				73.8		
	1.7.1		62.4				280.8	36.2	162.9
	1.7.2		10.0				45		
	2.0.1		24.0				108	76.8	345.6
	2.0.2		129.6				583.2		
	2.1.1		6.8				30.6	46	207
	2.1.2		85.2				383.4		
	2.3.1		22.8				102.6	43.2	194.4
	2.3.2		63.6				286.2		
	2.5.1		107.2				482.4	98	441
	2.5.2		88.8				399.6		
	2.7.1		88.8				399.6	85	382.5
	2.7.2		81.2				365.4		
	3.4.1		17.6				79.2	12.6	56.7
	3.4.2		7.6				34.2		
	3.5.1		116.0				522	74.6	335.7
	3.5.2		33.2				149.4		
	4.5.1		10.8				48.6	60.4	271.8
	4.5.2		110.0				495		
	4.8.1		28.0				126	18	81
	4.8.2		8.0				36		
	4.9.1		7.2				32.4	16.4	73.8
	4.9.2		25.6				115.2		
	5.1.1		134.0				603	162.2	729.9
	5.1.2		190.4				856.8		
	5.3.1		50.8				228.6	98.6	443.7
	5.3.2		146.4				658.8		
	5.4.1		54.8				246.6	79	355.5
	5.4.2		103.2				464.4		
	5.9.1		4.8				21.6	62.4	280.8
	5.9.2		120.0				540		
Average			60.3				271.4	60.3	271.4

Appendix A. Harvest weights and energy conversions

Date	Plot	g/.25m2	g/m2	104 sub	550 aft	%OM	kcal/m2	av g/m2	av kc/m2
31-May-90	1.1.1		49.6				223.2	39.4	177.3
	1.1.2		29.2				131.4		
	1.3.1		31.6	1.48	0.25	83.1	142.2	22.8	102.6
	1.3.2		14.0				63		
	1.7.1		24.4				109.8	54	243
	1.7.2		83.6				376.2		
	2.0.1		183.6	1.22	0.19	84.4	826.2	152.8	687.6
	2.0.2		122.0				549		
	2.1.1		68.0				306	43.6	196.2
	2.1.2		19.2				86.4		
	2.3.1		82.0				369	64.4	289.8
	2.3.2		46.8				210.6		
	2.5.1		43.2				194.4	53	238.5
	2.5.2		62.8				282.6		
	2.7.1		175.6				790.2	220.4	991.8
	2.7.2		265.2				1193.4		
	3.4.1		46.0	0.94	0.08	91.5	207	40.6	182.7
	3.4.2		35.2				158.4		
	3.5.1		46.8				210.6	41.6	187.2
	3.5.2		36.4				163.8		
	4.5.1		16.4				73.8	20.4	91.8
	4.5.2		24.4				109.8		
	4.8.1		95.2				428.4	131.6	592.2
	4.8.2		168.0				756		
	4.9.1		85.6				385.2	51.4	231.3
	4.9.2		17.2				77.4		
	5.1.1		36.0	1.44	0.27	81.3	162	57	256.5
	5.1.2		78.0				351		
	5.3.1		90.0				405	130.2	585.9
	5.3.2		170.4				766.8		
	5.4.1		221.2	1.96	0.29	85.2	995.4	184	828
	5.4.2		146.8				660.6		
	5.9.1		128.8				579.6	80.4	361.8
	5.9.2		32.0				144		
Average			81.6	1.4	0.2	85.1	367.3	81.6	367.3

Appendix A. Harvest weights and energy conversions

Date	Plot	g/.25m2	g/m2	104 sub	550 aft	930M	kcal/m2	av g/m2	av kc/m2
29-Jun-90	1.1.1		20.8				93.6	14.2	63.9
	1.1.2		7.6				34.2		
	1.3.1		24.0	2.06	0.26	87.4	108	60.6	272.7
	1.3.2		97.2				437.4		
	1.7.1		91.2				410.4	53.4	240.3
	1.7.2		15.6				70.2		
	2.0.1		259.6				1168.2	248.4	1117.8
	2.0.2		237.2	2.41	0.15	93.8	1067.4		
	2.1.1		234.4				1054.8	171	769.5
	2.1.2		107.6				484.2		
	2.3.1		94.8				426.6	127.4	573.3
	2.3.2		160.0				720		
	2.5.1		105.6				475.2	88.4	397.8
	2.5.2		71.2				320.4		
	2.7.1		171.2				770.4	250.4	1126.8
	2.7.2		329.6				1483.2		
	3.4.1		64.0	1.86	0.22	88.2	288	55.8	251.1
	3.4.2		47.6				214.2		
	3.5.1		67.2				302.4	54.4	244.8
	3.5.2		41.6				187.2		
	4.5.1		277.2				1247.4	211.6	952.2
	4.5.2		146.0				657		
	4.8.1		158.0				711	110.6	497.7
	4.8.2		63.2				284.4		
	4.9.1		207.6				934.2	195.6	880.2
	4.9.2		183.6				826.2		
	5.1.1		50.8	2.02	0.2	90.1	228.6	62.4	280.8
	5.1.2		74.0				333		
	5.3.1		199.6				898.2	187	841.5
	5.3.2		174.4				784.8		
	5.4.1		132.4	1.89	0.23	87.8	595.8	182.2	819.9
	5.4.2		232.0				1044		
	5.9.1		129.6				583.2	137.2	617.4
	5.9.2		144.8				651.6		
Average			133.3	2.0	0.2	89.5	600.1	137.3	617.7

Appendix A. Harvest weights and energy conversions

Date	Plot	g/.25m2	g/m2	104 sub	550 aft	%OM	kcal/m2	av g/m2	av kc/m2
31-Jul-90	1.1.1		46.0				207	30.2	135.9
	1.1.2		14.4				64.8		
	1.3.1		22.8	0.66	0.18	72.7	102.6	33.6	151.2
	1.3.2		44.4				199.8		
	1.7.1		31.6				142.2	36.8	165.6
	1.7.2		42.0				189		
	2.0.1		340.8	1.53	0.41	73.2	1533.6	323	1453.5
	2.0.2		305.2				1373.4		
	2.1.1		251.6				1132.2	179	805.5
	2.1.2		106.4				478.8		
	2.3.1		27.6				124.2	80.2	360.9
	2.3.2		132.8				597.6		
	2.5.1		111.2				500.4	151.8	683.1
	2.5.2		192.4				865.8		
	2.7.1		314.0				1413	290	1305
	2.7.2		266.0				1197		
	3.4.1		105.2	1.47	0.27	81.6	473.4	88.8	399.6
	3.4.2		72.4				325.8		
	3.5.1		107.2				482.4	77.6	349.2
	3.5.2		48.0				216		
	4.5.1		32.8				147.6	167.8	755.1
	4.5.2		302.8				1362.6		
	4.8.1		76.0				342	154.4	694.8
	4.8.2		232.8				1047.6		
	4.9.1		135.6				610.2	145.4	654.3
	4.9.2		155.2				698.4		
	5.1.1		152.8	0.88	0.16	81.8	687.6	132	594
	5.1.2		111.2				500.4		
	5.3.1		206.0				927	178.6	803.7
	5.3.2		151.2				680.4		
	5.4.1		137.2	1.19	0.39	67.2	617.4	158.6	713.7
	5.4.2		180.0				810		
	5.9.1		185.2				833.4	163.4	735.3
	5.9.2		141.6				637.2		
Average			140.7	1.1	0.3	75.3	633.0	140.7	633.0

Appendix A. Harvest weights and energy conversions

Date	Plot	g/.25m2	g/m2	104 sub	550 aft	%OM	kcal/m2	av g/m2	av kc/m2
8/30/90									
	1.1.1		15.2				68.4	28.2	126.9
	1.1.2		41.2				185.4		
	1.3.1		41.8	2.77	0.47	83	188.1	40.5	182.25
	1.3.2		39.2				176.4		
	1.7.1		8.0				36	14	63
	1.7.2		20.0				90		
	2.0.1		736.2	2.25	0.5	77.8	3312.9	744.95	3352.28
	2.0.2		753.7				3391.7		
	2.1.1		164.8				741.6	141.8	638.1
	2.1.2		118.8				534.6		
	2.3.1		16.2				72.9	17.95	80.775
	2.3.2		19.7				88.65		
	2.5.1		82.4				370.8	133.2	599.4
	2.5.2		184.0				828		
	2.7.1		233.2				1049.4	170.4	766.8
	2.7.2		107.6				484.2		
	3.4.1		76.9	1.61	0.26	84	346.05	83.15	374.175
	3.4.2		89.4				402.3		
	3.5.1		125.2				563.4	172.2	774.9
	3.5.2		219.2				986.4		
	4.5.1		305.6				1375.2	267	1201.5
	4.5.2		228.4				1027.8		
	4.8.1		175.6				790.2	218.4	982.8
	4.8.2		261.2				1175.4		
	4.9.1		152.1				684.45	190.15	855.675
	4.9.2		228.2				1026.9		
	5.1.1		152.4	1.92	0.29	85	685.8	153.8	692.1
	5.1.2		155.2				698.4		
	5.3.1		183.2				824.4	198.8	894.6
	5.3.2		214.4				964.8		
	5.4.1		185.0				832.5	201.35	906.075
	5.4.2		217.7				979.65		
	5.9.1		287.2				1292.4	327.8	1475.1
	5.9.2		368.4				1657.8		
Average			182.6	2.1	0.4	82.4	821.6	182.6	821.6

Appendix A. Harvest weights and energy conversions

Date	Plot	g/.25m2	g/m2	104 sub	550 aft	%OM	kcal/m2	av g/m2	av kc/m2
9/30/90									
	1.1.1		17.6				79.2	42	189
	1.1.2		66.4				298.8		
	1.3.1		14.8	0.69	0.08	88	66.6	17.6	79.2
	1.3.2		20.4				91.8		
	1.7.1		78.0				351	40.6	182.7
	1.7.2		3.2				14.4		
	2.0.1		389.6	3	0.3	90	1753.2	364.4	1639.8
	2.0.2		339.2				1526.4		
	2.1.1		60.0				270	217	976.5
	2.1.2		374.0				1683		
	2.3.1		48.0				216	26.6	119.7
	2.3.2		5.2				23.4		
	2.5.1		394.8				1776.6	372.2	1674.9
	2.5.2		349.6				1573.2		
	2.7.1		12.8				57.6	154.6	695.7
	2.7.2		296.4				1333.8		
	3.4.1		26.4	1.3	0.2	85	118.8	23.4	105.3
	3.4.2		20.4				91.8		
	3.5.1		6.4				28.8	24.6	110.7
	3.5.2		42.8				192.6		
	4.5.1		183.6				826.2	350.2	1575.9
	4.5.2		516.8				2325.6		
	4.8.1		147.2				662.4	152.2	684.9
	4.8.2		157.2				707.4		
	4.9.1		348.0				1566	300.4	1351.8
	4.9.2		252.8				1137.6		
	5.1.1		250.0	2.06	0.17	92	1125	361	1624.5
	5.1.2		472.0				2124		
	5.3.1		273.2				1229.4	268.8	1209.6
	5.3.2		264.4				1189.8		
	5.4.1		115.6	1.11	0.09	92	520.2	91.8	413.1
	5.4.2		68.0				306		
	5.9.1		337.2				1517.4	327.4	1473.3
	5.9.2		317.6				1429.2		
Average			184.4	1.6	0.2	89.3	829.8	184.4	829.8

Appendix A. Harvest weights and energy conversions

Date	Plot	g/.25m2	g/m2	104 sub	550 aft	%OM	kcal/m2	av g/m2	av kc/m2
10/29/90									
	1.1.1		44.0				198	22	99
	1.1.2		0.0				0		
	1.3.1		0.0				0	10.2	45.9
	1.3.2		20.4				91.8		
	1.7.1		3.6				16.2	8.2	36.9
	1.7.2		12.8				57.6		
	2.0.1		110.4	1.07	0.09	92	496.8	56.8	255.6
	2.0.2		3.2				14.4		
	2.1.1		321.2				1445.4	171	769.5
	2.1.2		20.8				93.6		
	2.3.1		17.6				79.2	28	126
	2.3.2		38.4				172.8		
	2.5.1		107.2				482.4	57.8	260.1
	2.5.2		8.4				37.8		
	2.7.1		0.0				0	0.4	1.8
	2.7.2		0.8				3.6		
	3.4.1		88.0				396	45.4	204.3
	3.4.2		2.8				12.6		
	3.5.1		11.6				52.2	9.6	43.2
	3.5.2		7.6				34.2		
	4.5.1		596.4				2683.8	396.8	1785.6
	4.5.2		197.2				887.4		
	4.8.1		14.8				66.6	55.6	250.2
	4.8.2		96.4				433.8		
	4.9.1		8.8				39.6	15.2	68.4
	4.9.2		21.6				97.2		
	5.1.1		123.6	1.66	0.13	92	556.2	79	355.5
	5.1.2		34.4				154.8		
	5.3.1		36.8				165.6	29.8	134.1
	5.3.2		22.8				102.6		
	5.4.1		45.6	0.78	0.05	94	205.2	43.6	196.2
	5.4.2		41.6				187.2		
	5.9.1		84.8				381.6	94	423
	5.9.2		103.2				464.4		
average			66.1	1.2	0.1	92.4	297.4	66.1	297.4

Appendix A. Harvest weights and energy conversions

Date	Plot	g/.25m2	g/m2	104 sub	550 aft	%OM	kcal/m2	av g/m2	av kc/m2
11/30/90	1.1.1		0.0				0	0	0
	1.1.2		0.0				0		
	1.3.1		0.0				0	1.4	6.3
	1.3.2		2.8				12.6		
	1.7.1		0.0				0	0	0
	1.7.2		0.0				0		
	2.0.1		0.0				0	0	0
	2.0.2		0.0				0		
	2.1.1		4.4				19.8	4.8	21.6
	2.1.2		5.2				23.4		
	2.3.1		0.0				0	0	0
	2.3.2		0.0				0		
	2.5.1		0.0				0	0	0
	2.5.2		0.0				0		
	2.7.1		9.2				41.4	7.6	34.2
	2.7.2		6.0				27		
	3.4.1		8.4	0.91	0.05	95	37.8	4.4	19.8
	3.4.2		0.4				1.8		
	3.5.1		17.2				77.4	12.4	55.8
	3.5.2		7.6				34.2		
	4.5.1		55.2				248.4	27.6	124.2
	4.5.2		0.0				0		
	4.8.1		0.0				0	33.6	151.2
	4.8.2		67.2				302.4		
	4.9.1		0.0				0	4.2	18.9
	4.9.2		8.4				37.8		
	5.1.1		7.2	1.31	0.11	92	32.4	19	85.5
	5.1.2		30.8				138.6		
	5.3.1		0.0				0	14	63
	5.3.2		28.0				126		
	5.4.1		0.0				0	0	0
	5.4.2		0.0				0		
	5.9.1		0.0				0	0	0
	5.9.2		0.0				0		
average			7.6	1.1	0.1	93.1	34.1	7.6	34.1

Appendix A. Harvest weights and energy conversions

Date	Plot	g/.25m2	g/m2	104 sub	550 aft	%OM	kcal/m2	av g/m2	av kc/m2
12/29/90									
	1.1.1		0.0				0	0	0
	1.1.2		0.0				0		
	1.3.1		0.0				0	0	0
	1.3.2		0.0				0		
	1.7.1		0.0				0	0	0
	1.7.2		0.0				0		
	2.0.1		18.4				82.8	22	99
	2.0.2		25.6				115.2		
	2.1.1		4.4				19.8	2.2	9.9
	2.1.2		0.0				0		
	2.3.1		2.4				10.8	1.8	8.1
	2.3.2		1.2				5.4		
	2.5.1		0.0				0	0	0
	2.5.2		0.0				0		
	2.7.1		1.6				7.2	0.8	3.6
	2.7.2		0.0				0		
	3.4.1		0.0				0	0	0
	3.4.2		0.0				0		
	3.5.1		0.0				0	0	0
	3.5.2		0.0				0		
	4.5.1		0.0				0	117.8	530.1
	4.5.2		235.6				1060.2		
	4.8.1		0.0				0	7.4	33.3
	4.8.2		14.8				66.6		
	4.9.1		0.0				0	16	72
	4.9.2		32.0				144		
	5.1.1		24.8	1.41	0.09	94	111.6	200.8	903.6
	5.1.2		376.8				1695.6		
	5.3.1		0.0				0	0	0
	5.3.2		0.0				0		
	5.4.1		0.0				0	0	0
	5.4.2		0.0				0		
	5.9.1		0.0				0	0	0
	5.9.2		0.0				0		
average			21.7				97.6	21.7	97.6

Appendix A. Harvest weights and energy conversions

Date	Plot	g/.25m2	g/m2	104 sub	550 aft	%OM	kcal/m2	av g/m2	av kc/m2
1/31/91	1.1.1		0.0				0	0	0
	1.1.2		0.0				0		
	1.3.1		0.0				0	0	0
	1.3.2		0.0				0		
	1.7.1		2.4				10.8	1.2	5.4
	1.7.2		0.0				0		
	2.0.1		0.0				0	19	85.5
	2.0.2		38.0				171		
	2.1.1		7.6				34.2	3.8	17.1
	2.1.2		0.0				0		
	2.3.1		0.0				0	0	0
	2.3.2		0.0				0		
	2.5.1		26.4				118.8	13.2	59.4
	2.5.2		0.0				0		
	2.7.1		0.0				0	0	0
	2.7.2		0.0				0		
	3.4.1		5.2				23.4	2.6	11.7
	3.4.2		0.0				0		
	3.5.1		0.0				0	0	0
	3.5.2		0.0				0		
	4.5.1		0.0				0	0	0
	4.5.2		0.0				0		
	4.8.1		11.2				50.4	5.6	25.2
	4.8.2		0.0				0		
	4.9.1		14.0				63	7	31.5
	4.9.2		0.0				0		
	5.1.1		65.2	1.26	0.07	94	293.4	75	337.5
	5.1.2		84.8				381.6		
	5.3.1		34.8				156.6	17.4	78.3
	5.3.2		0.0				0		
	5.4.1		1.6				7.2	0.8	3.6
	5.4.2		0.0				0		
	5.9.1		2.0				9	1	4.5
	5.9.2		0.0				0		
average			8.6				38.8	8.6	38.8

Appendix A. Harvest weights and energy conversions

Date	Plot	g/.25m2	g/m2	104 sub	550 aft	%OM	kcal/m2	av g/m2	av kc/m2
2/28/91	1.1.1		2.0				9	1	4.5
	1.1.2		0.0				0		
	1.3.1		0.0				0	0	0
	1.3.2		0.0				0		
	1.7.1		0.4				1.8	0.2	0.9
	1.7.2		0.0				0		
	2.0.1		14.0				63	7.2	32.4
	2.0.2		0.4				1.8		
	2.1.1		6.4				28.8	22	99
	2.1.2		37.6				169.2		
	2.3.1		4.4				19.8	6.2	27.9
	2.3.2		8.0				36		
	2.5.1		10.0				45	5	22.5
	2.5.2		0.0				0		
	2.7.1		62.0				279	34.4	154.8
	2.7.2		6.8				30.6		
	3.4.1		1.6				7.2	0.8	3.6
	3.4.2		0.0				0		
	3.5.1		17.2				77.4	64	288
	3.5.2		110.8				498.6		
	4.5.1		135.2				608.4	68.8	309.6
	4.5.2		2.4				10.8		
	4.8.1		23.6				106.2	11.8	53.1
	4.8.2		0.0				0		
	4.9.1		22.8				102.6	11.4	51.3
	4.9.2		0.0				0		
	5.1.1		39.6				178.2	41.6	187.2
	5.1.2		43.6				196.2		
	5.3.1		40.0				180	20	90
	5.3.2		0.0				0		
	5.4.1		48.0				216	34.4	154.8
	5.4.2		20.8				93.6		
	5.9.1		8.2				36.9	4.1	18.45
	5.9.2		0.0				0		
average			19.6				88.1	19.6	88.1

Appendix A. Harvest weights and energy conversions

Date	Plot	g/.25m2	g/m2	104 sub	550 aft	930M	kcal/m2	av g/m2	av kc/m2
3/30/91	1.1.1	0.5	2.0				9	1	4.5
	1.1.2	0	0.0				0		
	1.3.1	0	0.0				0	1.2	5.4
	1.3.2	0.6	2.4				10.8		
	1.7.1	6.6	26.4				118.8	13.2	59.4
	1.7.2	0	0.0				0		
	2.0.1	0	0.0				0	0	0
	2.0.2	0	0.0				0		
	2.1.1	0	0.0				0	13	58.5
	2.1.2	6.5	26.0				117		
	2.3.1	0	0.0				0	2.8	12.6
	2.3.2	1.4	5.6				25.2		
	2.5.1	0	0.0				0	2.6	11.7
	2.5.2	1.3	5.2				23.4		
	2.7.1	9.5	38.0				171	23.2	104.4
	2.7.2	2.1	8.4				37.8		
	3.4.1	2.9	11.6				52.2	5.8	26.1
	3.4.2	0	0.0				0		
	3.5.1	3.3	13.2				59.4	6.6	29.7
	3.5.2	0	0.0				0		
	4.5.1	11.3	45.2				203.4	48.8	219.6
	4.5.2	13.1	52.4				235.8		
	4.8.1	9.2	36.8				165.6	23	103.5
	4.8.2	2.3	9.2				41.4		
	4.9.1	0	0.0				0	0	0
	4.9.2	0	0.0				0		
	5.1.1	3.3	13.2				59.4	6.6	29.7
	5.1.2	0	0.0				0		
	5.3.1	1.8	7.2				32.4	3.6	16.2
	5.3.2	0	0.0				0		
	5.4.1	0.8	3.2				14.4	1.6	7.2
	5.4.2	0	0.0				0		
	5.9.1	0	0.0				0	0	0
	5.9.2	0	0.0				0		
average			9.0				40.5	9.0	40.5

Appendix A. Harvest weights and energy conversions

BROWN WT.

Date	Plot	g/.25m2	g/m2	104 sub 550 aft 930M	kcal/m2	av g/m2	av kc/m2
10/29/90	1.1.1	0	0.0		0	0	0
	1.1.2	0	0.0		0		
	1.3.1	2	8.0		36	4	18
	1.3.2	0	0.0		0		
	1.7.1	0	0.0		0	0	0
	1.7.2	0	0.0		0		
	2.0.1	40.7	162.8		732.6	219.4	987.3
	2.0.2	69	276.0		1242		
	2.1.1	39.5	158.0		711	95.8	431.1
	2.1.2	8.4	33.6		151.2		
	2.3.1	0	0.0		0	0	0
	2.3.2	0	0.0		0		
	2.5.1	2.7	10.8		48.6	120	540
	2.5.2	57.3	229.2		1031.4		
	2.7.1	0	0.0		0	23.8	107.1
	2.7.2	11.9	47.6		214.2		
	3.4.1	0	0.0		0	0	0
	3.4.2	0	0.0		0		
	3.5.1	5.3	21.2		95.4	10.6	47.7
	3.5.2	0	0.0		0		
	4.5.1	0	0.0		0	54.6	245.7
	4.5.2	27.3	109.2		491.4		
	4.8.1	37.3	149.2		671.4	122.8	552.6
	4.8.2	24.1	96.4		433.8		
	4.9.1	0	0.0		0	53	238.5
	4.9.2	26.5	106.0		477		
	5.1.1	0	0.0		0	67.8	305.1
	5.1.2	33.9	135.6		610.2		
	5.3.1	16.1	64.4		289.8	102.8	462.6
	5.3.2	35.3	141.2		635.4		
	5.4.1	19.7	78.8		354.6	55	247.5
	5.4.2	7.8	31.2		140.4		
	5.9.1	30.8	123.2		554.4	95.6	430.2
	5.9.2	17	68.0		306		
average			60.3		271.4	60.3	271.4

Appendix A. Harvest weights and energy conversions

Date	Plot	g/.25m2	g/m2	104 sub	550 aft	%OM	kcal/m2	av g/m2	av kc/m2
BROWN									
11/30/90	1.1.1	1.5	6.0				27	3	13.5
	1.1.2	0	0.0				0		
	1.3.1	0	0.0				0	0	0
	1.3.2	0	0.0				0		
	1.7.1	0.3	1.2				5.4	5.8	26.1
	1.7.2	2.6	10.4				46.8		
	2.0.1	68.9	275.6				1240.2	298.2	1341.9
	2.0.2	80.2	320.8				1443.6		
	2.1.1	35.3	141.2				635.4	112.8	507.6
	2.1.2	21.1	84.4				379.8		
	2.3.1	2.3	9.2				41.4	12.6	56.7
	2.3.2	4	16.0				72		
	2.5.1	60.6	242.4				1090.8	283.2	1274.4
	2.5.2	81	324.0				1458		
	2.7.1	0	0.0				0	0	0
	2.7.2	0	0.0				0		
	3.4.1	6.7	26.8				120.6	24	108
	3.4.2	5.3	21.2				95.4		
	3.5.1	17.1	68.4				307.8	59	265.5
	3.5.2	12.4	49.6				223.2		
	4.5.1	24.3	97.2				437.4	153	688.5
	4.5.2	52.2	208.8				939.6		
	4.8.1	16.3	65.2				293.4	129.4	582.3
	4.8.2	48.4	193.6				871.2		
	4.9.1	46.5	186.0				837	183	823.5
	4.9.2	45	180.0				810		
	5.1.1	18.6	74.4				334.8	90	405
	5.1.2	26.4	105.6				475.2		
	5.3.1	8.1	32.4				145.8	67.4	303.3
	5.3.2	25.6	102.4				460.8		
	5.4.1	26.5	106.0				477	77	346.5
	5.4.2	12	48.0				216		
	5.9.1	46.2	184.8				831.6	198.4	892.8
	5.9.2	53	212.0				954		
average			99.8				449.2	99.8	449.2

Appendix B. Insolation data

DATE	P.U	CM	KCAL	KCAL (m2)
5/1/90	23	2.3	1.08	10810
5/2/90	23	2.3	1.08	10810
5/3/90	23	2.3	1.08	10810
5/4/90	23	2.3	1.08	10810
5/5/90	23	2.3	1.08	10810
5/6/90	23	2.3	1.08	10810
5/7/90	23	2.3	1.08	10810
5/8/90	21	2.1	0.99	9870
5/9/90	26	2.6	1.22	12220
5/10/90	27	2.7	1.27	12690
5/11/90	43	4.3	2.02	20210
5/12/90	8	0.8	0.38	3760
5/13/90	21	2.1	0.99	9870
5/14/90	33	3.3	1.55	15510
5/15/90	16	1.6	0.75	7520
5/16/90	21	2.1	0.99	9870
5/17/90	34	3.4	1.6	15980
5/18/90	41	4.1	1.93	19270
5/19/90	23	2.3	1.08	10810
5/20/90	15	1.5	0.71	7050
5/21/90	20	2	0.94	9400
5/22/90	4	0.4	0.19	1880
5/23/90	24	2.4	1.13	11280
5/24/90	30	3	1.41	14100
5/25/90	15	1.5	0.71	7050
5/26/90	6	0.6	0.28	2820
5/27/90	21	2.1	0.99	9870
5/28/90	6	0.6	0.28	2820
5/29/90	24	2.4	1.13	11280
5/30/90	30	3	1.41	14100
5/31/90	42	4.2	1.97	19740
Avg May	23	2.3	1.08	10794.84
Sum May	712	71	33.5	334640
6/1/90	20	2	0.94	9400
6/2/90	20	2	0.94	9400
6/3/90	30	3	1.41	14100
6/4/90	28	2.8	1.32	13160
6/5/90	26	2.6	1.22	12220
6/6/90	32	3.2	1.5	15040
6/7/90	31	3.1	1.46	14570

Appendix B. Insolation data

DATE	P.U	CM	KCAL	KCAL (m2)
6/8/90	33	3.3	1.55	15510
6/9/90	33	3.3	1.55	15510
6/10/90	40	4	1.88	18800
6/11/90	35	3.5	1.65	16450
6/12/90	30	3	1.41	14100
6/13/90	30	3	1.41	14100
6/14/90	30	3	1.41	14100
6/15/90	30	3	1.41	14100
6/16/90	30	3	1.41	14100
6/17/90	30	3	1.41	14100
6/18/90	30	3	1.41	14100
6/19/90	30	3	1.41	14100
6/20/90	31	3.1	1.46	14570
6/21/90	18	1.8	0.85	8460
6/22/90	32	3.2	1.5	15040
6/23/90	15	1.5	0.71	7050
6/24/90	26	2.6	1.22	12220
6/25/90	30	3	1.41	14100
6/26/90	46	4.6	2.16	21620
6/27/90	33	3.3	1.55	15510
6/28/90	34	3.4	1.6	15980
6/29/90	36	3.6	1.69	16920
6/30/90	28	2.8	1.32	13160
AVG June	30	3	1.41	14053
Sum June	897	90	42.2	421590
7/1/90	31	3.1	1.46	14570
7/2/90	31	3.1	1.46	14570
7/3/90	38	3.8	1.79	17860
7/4/90	32	3.2	1.5	15040
7/5/90	35	3.5	1.65	16450
7/6/90	30	3	1.41	14100
7/7/90	36	3.6	1.69	16920
7/8/90	42	4.2	1.97	19740
7/9/90	41	4.1	1.93	19270
7/10/90	38	3.8	1.79	17860
7/11/90	32	3.2	1.5	15040
7/12/90	30	3	1.41	14100
7/13/90	13	1.3	0.61	6110
7/14/90	12	1.2	0.56	5640
7/15/90	14	1.4	0.66	6580

Appendix B. Insolation data

DATE	P.U	CM	KCAL	KCAL (m2)
7/16/90	33	3.3	1.55	15510
7/17/90	43	4.3	2.02	20210
7/18/90	34	3.4	1.6	15980
7/19/90	40	4	1.88	18800
7/20/90	36	3.6	1.69	16920
7/21/90	34	3.4	1.6	15980
7/22/90	25	2.5	1.18	11750
7/23/90	22	2.2	1.03	10340
7/24/90	16	1.6	0.75	7520
7/25/90	30	3	1.41	14100
7/26/90	39	3.9	1.83	18330
7/27/90	33	3.3	1.55	15510
7/28/90	32	3.2	1.5	15040
7/29/90	33	3.3	1.55	15510
7/30/90	35	3.5	1.65	16450
7/31/90	23	2.3	1.08	10810
AVG JULY	31	3.1	1.46	14600.3226
SUM JULY	963	96	45.3	452610
8/1/90	30	3	1.41	14100
8/2/90	31	3.1	1.46	14570
8/3/90	30	3	1.41	14100
8/4/90	35	3.5	1.65	16450
8/5/90	27	2.7	1.27	12690
8/6/90	7	0.7	0.33	3290
8/7/90	25	2.5	1.18	11750
8/8/90	36	3.6	1.69	16920
8/9/90	32	3.2	1.5	15040
8/10/90	26	2.6	1.22	12220
8/11/90	15	1.5	0.71	7050
8/12/90	32	3.2	1.5	15040
8/13/90	34	3.4	1.6	15980
8/14/90	14	1.4	0.66	6580
8/15/90	30	3	1.41	14100
8/16/90	18	1.8	0.85	8460
8/17/90	23	2.3	1.08	10810
8/18/90	21	2.1	0.99	9870
8/19/90	28	2.8	1.32	13160
8/20/90	27	2.7	1.27	12690
8/21/90	27	2.7	1.27	12690
8/22/90	25	2.5	1.18	11750

Appendix B. Insolation data

DATE	P.U	CM	KCAL	KCAL (m2)
8/23/90	3	0.3	0.14	1410
8/24/90	14	1.4	0.66	6580
8/25/90	24	2.4	1.13	11280
8/26/90	26	2.6	1.22	12220
8/27/90	32	3.2	1.5	15040
8/28/90	33	3.3	1.55	15510
8/29/90	30	3	1.41	14100
8/30/90	14	1.4	0.66	6580
8/31/90	24	2.4	1.13	11280
AVG AUG	25	2.5	1.17	11719.6774
SUM AUG	773	77	36.3	363310
9/1/90	28	2.8	1.32	13160
9/2/90	23	2.3	1.08	10810
9/3/90	28	2.8	1.32	13160
9/4/90	30	3	1.41	14100
9/5/90	38	3.8	1.79	17860
9/6/90	26	2.6	1.22	12220
9/7/90	31	3.1	1.46	14570
9/8/90	25	2.5	1.18	11750
9/9/90	10	1	0.47	4700
9/10/90	21	2.1	0.99	9870
9/11/90	16	1.6	0.75	7520
9/12/90	20	2	0.94	9400
9/13/90	12	1.2	0.56	5640
9/14/90	15	1.5	0.71	7050
9/15/90	13	1.3	0.61	6110
9/16/90	31	3.1	1.46	14570
9/17/90	25	2.5	1.18	11750
9/18/90	31	3.1	1.46	14570
9/19/90	10	1	0.47	4700
9/20/90	6	0.6	0.28	2820
9/21/90	15	1.5	0.71	7050
9/22/90	13	1.3	0.61	6110
9/23/90	24	2.4	1.13	11280
9/24/90	11	1.1	0.52	5170
9/25/90	30	3	1.41	14100
9/26/90	23	2.3	1.08	10810
9/27/90	26	2.6	1.22	12220
9/28/90	17	1.7	0.8	7990
9/29/90	36	3.6	1.69	16920

Appendix B. Insolation data

DATE	P.U	CM	KCAL	KCAL (m2)
9/30/90	24	2.4	1.13	11280
AVG SEPT	22	2.2	1.03	10308.6667
SUM SEPT	658	66	30.9	309260
10/1/90	20	2	0.94	9400
10/2/90	30	3	1.41	14100
10/3/90	19	1.9	0.89	8930
10/4/90	20	2	0.94	9400
10/5/90	26	2.6	1.22	12220
10/6/90	20	2	0.94	9400
10/7/90	22	2.2	1.03	10340
10/8/90	6	0.6	0.28	2820
10/9/90	21	2.1	0.99	9870
10/10/90	18	1.8	0.85	8460
10/11/90	5	0.5	0.24	2350
10/12/90	7	0.7	0.33	3290
10/13/90	6	0.6	0.28	2820
10/14/90	9	0.9	0.42	4230
10/15/90	23	2.3	1.08	10810
10/16/90	25	2.5	1.18	11750
10/17/90	24	2.4	1.13	11280
10/18/90	20	2	0.94	9400
10/19/90	4	0.4	0.19	1880
10/20/90	31	3.1	1.46	14570
10/21/90	23	2.3	1.08	10810
10/22/90	21	2.1	0.99	9870
10/23/90	2	0.2	0.09	940
10/24/90	18	1.8	0.85	8460
10/25/90	18	1.8	0.85	8460
10/26/90	4	0.4	0.19	1880
10/27/90	29	2.9	1.36	13630
10/28/90	32	3.2	1.5	15040
10/29/90	21	2.1	0.99	9870
10/30/90	20	2	0.94	9400
10/31/90	20	2	0.94	9400
AVG OCT	18	1.8	0.86	8550.96774
SUM OCT	564	56	26.5	265080
11/1/90	23	2.3	1.08	10810
11/2/90	12	1.2	0.56	5640
11/3/90	12	1.2	0.56	5640
11/4/90	12	1.2	0.56	5640

Appendix B. Insolation data

DATE	P.U	CM	KCAL	KCAL (m2)
11/5/90	12	1.2	0.56	5640
11/6/90	12	1.2	0.56	5640
11/7/90	13	1.3	0.61	6110
11/8/90	9	0.9	0.42	4230
11/9/90	7	0.7	0.33	3290
11/10/90	6	0.6	0.28	2820
11/11/90	17	1.7	0.8	7990
11/12/90	17	1.7	0.8	7990
11/13/90	16	1.6	0.75	7520
11/14/90	20	2	0.94	9400
11/15/90	20	2	0.94	9400
11/16/90	14	1.4	0.66	6580
11/17/90	16	1.6	0.75	7520
11/18/90	12	1.2	0.56	5640
11/19/90	10	1	0.47	4700
11/20/90	12	1.2	0.56	5640
11/21/90	9	0.9	0.42	4230
11/22/90	7	0.7	0.33	3290
11/23/90	17	1.7	0.8	7990
11/24/90	14	1.4	0.66	6580
11/25/90	13	1.3	0.61	6110
11/26/90	14	1.4	0.66	6580
11/27/90	11	1.1	0.52	5170
11/28/90	9	0.9	0.42	4230
11/29/90	21	2.1	0.99	9870
11/30/90	19	1.9	0.89	8930
AVG NOV	14	1.4	0.64	6360.66667
SUM NOV	406	41	19.1	190820
12/1/90	4	0.4	0.19	1880
12/2/90	4	0.4	0.19	1880
12/3/90	10	1	0.47	4700
12/4/90	18	1.8	0.85	8460
12/5/90	14	1.4	0.66	6580
12/6/90	10	1	0.47	4700
12/7/90	16	1.6	0.75	7520
12/8/90	17	1.7	0.8	7990
12/9/90	16	1.6	0.75	7520
12/10/90	15	1.5	0.71	7050
12/11/90	10	1	0.47	4700
12/12/90	10	1	0.47	4700

Appendix B. Insolation data

DATE	P.U	CM	KCAL	KCAL (m2)
12/13/90	10	1	0.47	4700
12/14/90	10	1	0.47	4700
12/15/90	10	1	0.47	4700
12/16/90	10	1	0.47	4700
12/17/90	10	1	0.47	4700
12/18/90	10	1	0.47	4700
12/19/90	10	1	0.47	4700
12/20/90	10	1	0.47	4700
12/21/90	10	1	0.47	4700
12/22/90	10	1	0.47	4700
12/23/90	10	1	0.47	4700
12/24/90	10	1	0.47	4700
12/25/90	10	1	0.47	4700
12/26/90	10	1	0.47	4700
12/27/90	10	1	0.47	4700
12/28/90	10	1	0.47	4700
12/29/90	10	1	0.47	4700
12/30/90	10	1	0.47	4700
12/31/90	10	1	0.47	4700
AVG DEC	11	1.1	0.51	5063.87097
SUM DEC	334	33	15.7	156980
1/1/91	10	1	0.47	4700
1/2/91	10	1	0.47	4700
1/3/91	10	1	0.47	4700
1/4/91	10	1	0.47	4700
1/5/91	10	1	0.47	4700
1/6/91	10	1	0.47	4700
1/7/91	10	1	0.47	4700
1/8/91	10	1	0.47	4700
1/9/91	10	1	0.47	4700
1/10/91	10	1	0.47	4700
1/11/91	10	1	0.47	4700
1/12/91	10	1	0.47	4700
1/13/91	10	1	0.47	4700
1/14/91	10	1	0.47	4700
1/15/91	10	1	0.47	4700
1/16/91	6	0.6	0.28	2820
1/17/91	3	0.3	0.14	1410
1/18/91	8	0.8	0.38	3760
1/19/91	10	1	0.47	4700

Appendix B. Insolation data

DATE	P.U	CM	KCAL	KCAL (m2)
1/20/91	5	0.5	0.24	2350
1/21/91	7	0.7	0.33	3290
1/22/91	8	0.8	0.38	3760
1/23/91	14	1.4	0.66	6580
1/24/91	11	1.1	0.52	5170
1/25/91	19	1.9	0.89	8930
1/26/91	9	0.9	0.42	4230
1/27/91	3	0.3	0.14	1410
1/28/91	6	0.6	0.28	2820
1/29/91	4	0.4	0.19	1880
1/30/91	19	1.9	0.89	8930
1/31/91	18	1.8	0.85	8460
AVG JAN	9.7	1	0.45	4548.3871
SUM JAN	300	30	14.1	141000
2/1/91	16	1.6	0.75	7520
2/2/91	14	1.4	0.66	6580
2/3/91	20	2	0.94	9400
2/4/91	10	1	0.47	4700
2/5/91	6	0.6	0.28	2820
2/6/91	9	0.9	0.42	4230
2/7/91	5	0.5	0.24	2350
2/8/91	6	0.6	0.28	2820
2/9/91	14	1.4	0.66	6580
2/10/91	10	1	0.47	4700
2/11/91	16	1.6	0.75	7520
2/12/91	20	2	0.94	9400
2/13/91	3	0.3	0.14	1410
2/14/91	5	0.5	0.24	2350
2/15/91	11	1.1	0.52	5170
2/16/91	20	2	0.94	9400
2/17/91	6	0.6	0.28	2820
2/18/91	10	1	0.47	4700
2/19/91	5	0.5	0.24	2350
2/20/91	12	1.2	0.56	5640
2/21/91	17	1.7	0.8	7990
2/22/91	21	2.1	0.99	9870
2/23/91	25	2.5	1.18	11750
2/24/91	17	1.7	0.8	7990
2/25/91	6	0.6	0.28	2820
2/26/91	7	0.7	0.33	3290

Appendix B. Insolation data

DATE	P.U	CM	KCAL	KCAL (m2)
2/27/91	18	1.8	0.85	8460
2/28/91	20	2	0.94	9400
AVG FEB	12	1.2	0.59	5858.21429
SUM FEB	349	35	16.4	164030
3/1/91	14	1.4	0.66	6580
3/2/91	19	1.9	0.89	8930
3/3/91	4	0.4	0.19	1880
3/4/91	10	1	0.47	4700
3/5/91	21	2.1	0.99	9870
3/6/91	8	0.8	0.38	3760
3/7/91	19	1.9	0.89	8930
3/8/91	23	2.3	1.08	10810
3/9/91	17	1.7	0.8	7990
3/10/91	14	1.4	0.66	6580
3/11/91	20	2	0.94	9400
3/12/91	7	0.7	0.33	3290
3/13/91	17	1.7	0.8	7990
3/14/91	20	2	0.94	9400
3/15/91	12	1.2	0.56	5640
3/16/91	30	3	1.41	14100
3/17/91	21	2.1	0.99	9870
3/18/91	8	0.8	0.38	3760
3/19/91	10	1	0.47	4700
3/20/91	24	2.4	1.13	11280
3/21/91	21	2.1	0.99	9870
3/22/91	17	1.7	0.8	7990
3/23/91	34	3.4	1.6	15980
3/24/91	30	3	1.41	14100
3/25/91	31	3.1	1.46	14570
3/26/91	12	1.2	0.56	5640
3/27/91	25	2.5	1.18	11750
3/28/91	14	1.4	0.66	6580
3/29/91	32	3.2	1.5	15040
3/30/91	10	1	0.47	4700
3/31/91	18	1.8	0.85	8460
AVG MAR	18	1.8	0.85	8520.64516
SUM MAR	562	56	26.4	264140
4/1/91	4	0.4	0.19	1880

Appendix C. Tree biomass data for RCSS

site	species	leaves (kg)	branches (kg)	stem (kg)
A-1	*Q. palustris*	4.57	26.3	114.82
	Q. palustris	2.82	15.85	67.61
	B. nigra	21.38	125.89	645.65
	Q. palustris	1.51	8.51	33.88
	B. nigra	46.77	275.42	1548.82
	Q. palustris	10.23	58.88	281.84
A-2	*B. nigra*	23.99	138.04	724.44
	Q. palustris	0.48	2.63	9.33
	B. nigra	28.84	169.82	912.01
	Q. palustris	3.24	18.2	77.62
	B. nigra	26.3	154.88	812.83
	Q. palustris	0.14	0.79	2.4
A-3	*B. nigra*	50.12	302	1698.24
	L. styraciflua	2.45	13.8	57.54
	B. nigra	31.62	186.21	1000
	N. sylvatica	5.13	28.84	131.83
	L. styraciflua	10.23	58.88	281.84
	L. styraciflua	22.39	131.83	691.83
	Q. palustris	0.35	1.86	6.46
A-4	*B. nigra*	60.26	354.81	2041.74
	N. sylvatica	0.48	2.63	9.33
A-5	*N. sylvatica*	6.17	35.48	162.18
	B. nigra	91.2	537.03	3235.94
	Q. palustris	0.35	1.86	6.46
	B. nigra	40.74	239.88	1318.26
	L. styraciflua	1.02	5.75	21.88
	L. styraciflua	1.51	8.51	33.88
	L. styraciflua	3.24	18.2	77.62
	L. styraciflua	6.76	38.9	177.83
	L. styraciflua	2.82	15.85	67.61
A-6	*B. nigra*	45.71	269.15	1513.56
	N. sylvatica	1.82	10.23	40.74
	A. rubrum	8.71	50.12	239.88
	B. nigra	81.28	489.78	2884.03
	B. nigra	79.43	467.74	2818.38
	N. sylvatica	1.51	8.51	33.88
A-7	*N. sylvatica*	16.22	95.5	478.63
	N. sylvatica	1.82	10.23	40.74
	N. sylvatica	22.39	131.83	691.83
	N. sylvatica	10.23	58.88	281.84

Appendix C. Tree biomass data for RCSS

site	species	leaves (kg)	branches (kg)	stem (kg)
	Q. palustris	0.63	3.55	12.88
	B. nigra	72.44	426.58	2511.89
	N. sylvatica	2.14	12.02	48.98
	B. nigra	53.7	323.6	1819.7
	B. nigra	50.12	302	1698.24
	Q. palustris	11.75	67.61	331.13
A-8	*N. sylvatica*	7.41	42.66	199.53
	J. virginiana	9.55	54.95	263.03
	N. sylvatica	4.57	26.3	114.82
	B. nigra	17.38	100	512.86
	A. serrulata	0.05	0.28	0.78
	A. serrulata	0.08	0.41	1.2
A-9	*C. caroliniana*	0.08	0.41	1.2
	N. sylvatica	0.35	1.86	6.46
	B. nigra	0.05	0.28	0.78
	L. styraciflua	0.08	0.41	1.2
	L. styraciflua	0.05	0.28	0.78
	N. sylvatica	0.19	1	3.24
	N. sylvatica	0.09	0.48	1.41
	B. nigra	0.19	1	3.24
	A. serrulata	0.72	3.98	14.79
	B. nigra	12.59	72.44	363.08
	L. styraciflua	0.08	0.41	1.2
	L. styraciflua	0.08	0.41	1.2
A-10	*B. nigra*	38.02	223.87	1230.27
	A. serrulata	0.25	1.38	4.57
	A. serrulata	0.07	0.35	1.02
	L. styraciflua	0.11	0.58	1.74
	B. nigra	0.19	1	3.24
	A. serrulata	0.11	0.58	1.74
	A. serrulata	0.19	1	3.24
	A. serrulata	0.23	1.26	4.17
	B. nigra	2.82	15.85	67.61
	B. nigra	2.45	13.8	57.54
A-11	*L. styraciflua*	40.74	239.88	1318.26
	A. serrulata	0.76	4.27	15.49
	A. serrulata	0.14	0.78	2.4
	L. styraciflua	0.05	0.28	0.78
	L. styraciflua	0.08	0.41	1.2
	L. styraciflua	0.05	0.28	0.78

Appendix C. Tree biomass data for RCSS

site	species	leaves (kg)	branches (kg)	stem (kg)
	B. nigra	104.71	630.96	3890.45
A-12	*B. nigra*	1.82	10.23	40.74
	B. nigra	5.37	30.9	138.04
	B. nigra	30.9	181.97	977.24
	B. nigra	10.23	58.88	281.84
	A. rubrum	2.45	13.8	57.54
	A. rubrum	0.11	0.58	1.74
	A. serrulata	0.28	1.55	5.25
	L. styraciflua	1.02	5.75	21.88
	A. serrulata	1.02	5.75	21.88
	A. serrulata	0.83	4.57	16.98
A-13	*B. nigra*	1.38	7.76	30.9
	N. sylvatica	9.77	56.23	269.15
	B. nigra	34.67	204.17	1096.48
	A. serrulata	0.25	25.12	4.57
	A. rubrum	0.23	1.26	4.17
	A. rubrum	1.38	7.76	30.9
A-14	*A. rubrum*	0.05	0.28	0.78
	A. rubrum	0.08	0.41	1.2
	A. rubrum	0.08	0.41	1.2
	A. rubrum	0.35	1.86	6.46
	A. rubrum	0.08	0.41	1.2
	N. sylvatica	0.72	3.98	14.79
	B. nigra	19.5	112.2	575.44
	B. nigra	10.96	63.1	309.03
	B. nigra	0.69	3.8	14.13
	A. rubrum	0.08	0.41	1.2
	A. rubrum	0.14	0.78	2.4
	A. rubrum	0.48	2.63	9.33
	A. rubrum	0.48	2.63	9.33
	B. nigra	5.13	28.84	131.83
	N. sylvatica	0.14	0.78	2.4
	N. sylvatica	0.63	3.55	12.88
	A. rubrum	4.57	26.3	114.82
	N. sylvatica	0.35	1.86	6.46
A-15	*A. rubrum*	0.08	0.41	1.2
	L. styraciflua	5.89	33.88	154.88
	N. sylvatica	1.51	8.51	33.88
	N. sylvatica	1.51	8.51	33.88
	A. serrulata	0.23	1.26	4.17

Appendix C. Tree biomass data for RCSS

site	species	leaves (kg)	branches (kg)	stem (kg)
	A. rubrum	0.14	0.78	2.4
A-16	*N. sylvatica*	3.24	18.2	77.62
	B. nigra	8.13	46.77	218.78
	B. nigra	0.63	3.55	12.88
	B. nigra	5.62	32.36	144.54
	N. sylvatica	8.71	50.12	239.88
	B. nigra	0.35	1.86	6.46
A-17	*B. nigra*	10.23	58.88	281.84
	B. nigra	18.2	107.15	549.54
	B. nigra	83.18	501.19	2951.21
	N. sylvatica	6.17	35.48	162.81
	N. sylvatica	3.63	20.89	89.13
	A. rubrum	0.05	0.28	0.78
A-18	*N. sylvatica*	2.45	13.8	57.54
	N. sylvatica	7.41	42.66	199.53
	N. sylvatica	4.57	26.3	114.82
	N. sylvatica	3.63	20.89	89.13
	N. sylvatica	0.35	1.86	6.46
	N. sylvatica	3.63	20.89	89.13
	N. sylvatica	1.02	5.75	21.88
	N. sylvatica	1.51	8.51	33.88
	N. sylvatica	4.07	23.44	102.33
	N. sylvatica	1.51	8.51	33.88
	N. sylvatica	2.45	13.8	57.54
	B. nigra	5.13	28.84	131.83
	B. nigra	3.24	18.2	77.62
A-19	*B. nigra*	2.14	12.02	48.98
	B. nigra	14.45	83.18	416.87
	B. nigra	2.45	13.8	57.54
	B. nigra	1.82	10.23	40.74
	B. nigra	1.51	8.51	33.88
	B. nigra	17.38	100	512.86
	N. sylvatica	0.72	3.98	14.79
	L. styraciflua	1.02	5.75	21.88
A-20	*B. nigra*	10.96	63.1	309.03
	A. rubrum	50.12	302	1698.24
	B. nigra	3.24	18.2	77.62
	L. styraciflua	0.07	0.35	1.02
	N. sylvatica	0.23	1.26	4.17
	B. nigra	0.48	2.63	9.33

Appendix C. Tree biomass data for RCSS

site	species	leaves (kg)	branches (kg)	stem (kg)	total kg/m2
	B. nigra	0.63	3.55	12.88	
	B. nigra	9.55	54.95	263.03	
	B. nigra	2.14	12.02	48.98	
	B. nigra	43.65	257.04	1445.44	
	L. styraciflua	1.02	5.75	21.88	
	N. sylvatica	1.26	7.08	27.54	
	B. nigra	21.38	125.89	645.65	
	sum	1742.48	10274.27	55701.3	
	kg/m2	3.48496	20.54854	111.403	
	B. nigra	2.74	16.16	90.35	109.25
	N. sylvatica	0.30	1.75	8.08	10.13
	L. styraciflua	0.20	1.17	5.92	7.29
	A. rubrum	0.14	0.83	4.37	5.34
	Q. palustris	0.07	0.41	1.89	2.37
	A. serrulata	0.01	0.11	0.20	0.32

Appendix D. Plant species found in RCSS

- Pteriodophyta
  - Polypodiaceae
    - *Lorinseria areolata*
    - *Onoclea sensibilis*
- Pinophyta
  - Cupressaceae
    - *Juniperus virginiana*
- Magnoliophyta
  - Aceraceae
    - *Acer rubrum*
  - Alismataceae
    - *Sagittaria latifolia*
  - Anacardiaceae
    - *Rhus radicans*
  - Apiaceae
    - *Sium suave*
  - Araceae
    - *Peltandra virginica*
  - Asclepiadaceae
    - *Asclepias incarnata*
  - Asteraceae
    - *Bidens aristosa*
    - *Eupatorium fistulosum*
    - *Vernonia altissima*
  - Balsaminaceae
    - *Impatiens capensis*
  - Betulaceae
    - *Alnus serrulata*
    - *Betula nigra*
  - Cyperaceae
    - *Carex crinita*
    - *Carex lupulina*
    - *Carex lurida*
    - *Carex projecta*
    - *Carex scoparia*
    - *Carex squarrosa*
    - *Carex swanii*
    - *Carex tribuloides*
    - *Carex vulpinoidea*
    - *Carex spp.*

Appendix D. Plant species found in RCSS

- *Cladium mariscoides*
- *Cyperus strigosus*
- *Eleocharis ovata*
- *Eleocharis tenuis*
- *Scirpus atrovirens*

Fagaceae
- *Quercus palustris*

Hamamelidaceae
- *Liquidambar styraciflua*

Iridaceae
- *Iris virginica*

Juncaceae
- *Juncus acuminatus*
- *Juncus brachycarpus*
- *Juncus canadensis*
- *Juncus coriaceus*
- *Juncus effusus*
- *Juncus marginatus*
- *Juncus subcaudatus*
- *Juncus tenuis*
- *Juncus spp.*

Lamiaceae
- *Mentha sp.*

Lythraceae
- *Decodon verticillatus*

Nyssaceae
- *Nyssa sylvatica*

Poaceae
- *Digitaria filiformis*
- *Echinochloa crusgalli*
- *Festuca octoflora*
- *Glyceria acutifolia*
- *Glyceria septentrionalis*
- *Panicum anceps*
- *Panicum clandestinum*
- *Panicum dichotomiflorum*
- *Panicum dichotomum*
- *Panicum implicatum*
- *Panicum spp.*
- *Paspalum circulare*
- *Setaria glauca*
- *Setaria viridis*

Appendix D. Plant species found in RCSS

Triodia flava

Poaceae

Polygonaceae

Polygonum punctatum

Rumex acetosella

Rumex obtusifolius

Rosaceae

Fragaria virginiana

Rubiaceae

Cephalanthus occidentalis

Galium tinctorium

Saxifragaceae

Hydrangea arborescens

Saururaceae

Saururus cernuus

Typhaceae

Sparganium americanum

Violaceae

Viola sp.

A Guide for Resumé Writing

10 Suggestions and 1 Requirement for Effective Resumé Preparation.

SUGGESTIONS

1. There is no universal resumé format. There are only guidelines you should follow and the resumé sample shown is intended for that purpose.
2. Present your job objective in a manner that relates to the company you are applying to and to the job description.
3. Final hiring decisions are rarely based upon resumés alone; however they should be a concise, factual and positive listing of your education, employment history and accomplishments.
4. Test your resumé for relevancy. The information included in your resumé should either support your job or career objective directly or support your character in general. If you don't have a definite purpose for including something, leave it out.
5. Be conscious of the continuity of your history. The reader will be looking for reasons to eliminate as many resumés as possible. A gap of unaccountable time is often reason enough for a resumé to hit the circular file.
6. Weigh your choice of words. Select strong action verbs, concrete nouns and positive modifiers for emphasis (see below). Use concise phrasing rather than complete sentences.
7. Try your resumé out on someone who knows you and will be objective in their opinion.
8. Keep a separate list of references, and make them available only upon request.
9. Always send a cover letter on matching paper with specific reference to the company's need and your qualifications for the job. A personal letter is always best so make an effort to get the individual's name and title who will be making the hiring decision.
10. Remember your resumé is only a door opener. A personal interview is what you want.

REQUIREMENT

11. Submit your resumé on a paper the reader will remember. The Southworth Mill has been producing papers for business since 1839 and our Parchment Deed 100% cotton fiber substance 24 (lb.) is the best we produce. The colors white and ivory are always correct and faddish colors should be avoided.

ACTION VERBS

accelerated
accomplished
achieved
adapted
administered
analyzed
approved
coordinated
conceived
conducted
completed
controlled
created
delegated
developed

demonstrated
designed
directed
effected
eliminated
established
evaluated
expanded
expedited
facilitated
found
generated
increased
influenced
implemented

initiated
instructed
interpreted
improved
launched
led
lectured
maintained
managed
mastered
motivated
operated
originated
organized
participated

performed
planned
pinpointed
programmed
proposed
proved
provided
proficient in
recommended
reduced
reinforced
reorganized
revamped
revised
reviewed

scheduled
simplified
set up
solved
structured
streamlined
supervised
supported
taught
trained
translated
utilized
won

CONCRETE NOUNS AND POSITIVE MODIFIERS

ability
actively
capacity

competent
competence
consistent

effectiveness
pertinent
proficient

qualified
resourceful
substantially

technical
versatile
vigorous

ADDITIONAL RESOURCES ON WRITING RESUMÉS

Resumé Writing, by Burdette E. Bostwick.

Where Do I Go From Here With My Life, by John P. Crystal and Richard N. Bolles. New York: John Wiley & Sons, 1976.

Professional Resumé/Job Search Guide, by Harold W. Dickhut and Marvel J. Davis. Chicago: Management Counselors, Inc. 1975.

The Perfect Resumé, by Tom Jackson. New York: Anchor Books, 1981.

Who's Hiring Who, by Richard Lathrop, Berkeley CA.: Ten Speed Press, 1977.

Southworth Company West Springfield, Massachusetts 01090

BARBARA R. JENSEN
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SUMMARY OF EXPERIENCE: Eleven years with office products manufacturer, during which I moved from assistant in the customer service department to assistant to the Vice-President of Sales. Contributed to the expansion of the company and increased profits, with sales volumes rising steadily by 30% in the last 5 years.

OBJECTIVE: To direct sales program for a manufacturer of office products marketed to commercial office supply dealers. Seek company in need of an aggressive sales manager to improve sales performances, a firm that is willing to embark on an original and innovative path to broaden market share.

EDUCATION: University of Massachusetts, Amherst, Massachusetts.
B. S. in Business Administration, 1977.
Special emphasis on marketing, statistics, English, speech and psychology. Played varsity softball. President of Glee Club. Expenses partially covered through scholarships and summer jobs.

EXPERIENCE: MENCOLITE PEN COMPANY, Albany, New York

1980 to Present Sales Executive/Assistant to the Vice-President of Sales.
In charge of handling sales seminars for national dealer and wholesaler sales force. Assist the Vice-President of Sales in the supervision of the sales management team, develop sales strategies and identify new sales opportunities. My position requires creative sales and marketing ability. I travel about 30% of the time.

1977 to 1980 Began in customer service department after graduating from college. Helped revise and improve shipping department.

Promoted to telemarketing department in 1978. Was responsible for the introduction of monthly dealer sales promotions nationwide. This program surpassed the target goal by 45%.

ACTIVITIES: President, Albany Sales Executives Forum; Organist, First Congregational Church.

INTERESTS: Enjoy oil painting, reading scientific journals.

REFERENCES: Furnished upon request.