PLANT ESTABLISHMENT AT THREE PONDS CREATED FOR GRAVEL EXTRACTION ALONG THE LOWER MAD RIVER, HUMBOLDT COUNTY, CALIFORNIA

by

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ABSTRACT

Three ponds were constructed in gravel bars along the lower Mad River in Humboldt County, California. They were excavated in the gravel bars to mitigate impacts on salmonid spawning habitat in the main channel and allow for the removal of gravel for commercial use. I mapped the vegetation in order to investigate its distribution, character, and the abundance of plant species around these ponds.

I gathered species abundance data while mapping patches of vegetation. Mapping recorded the vegetation assemblages as polygons and I analyzed their relations by using TWINSPAN. A moderate environmental gradient related to the existing vegetation was evident. There were eight vegetation types on the banks around two ponds on the Christie Bar. The Lower Christie pond had five types and had more well-developed emergent and submergent aquatic populations. The newer Upper Christie pond had two main types, with incidence of two others in a very small area. The third pond on the Blue Lake Bar was almost barren of vegetation and was not mapped for plant assemblages.

A thick blanket of fine sediment from the original construction sites was reserved prior to excavating the ponds. After the excavation was

completed, the sediments were spread on the banks of the Christie Bar ponds. The barren pond did not have this available. The blanket of fine sediment contributed to the vegetation development.

The maps illustrated a concentric pattern of vegetation groups around the ponds, showing the effects of water level changes. The pattern suggested the influence on the distribution of propagules and their survival. Seasonal patterns of precipitation providing moisture late in the spring probably also influenced plant germination and survival. Diversity in the distribution of plants was highest at the oldest pond.

The distribution of species around the ponds was evidence of the dominant effect the pond had over riverine influences. The species order from the TWINSPAN analysis paralleled their wetland indicator categories. Facultative upland species occurred along the outer banks bordering the excavation. Obligate species occurred predominantly at the shore. A transitional area of facultative species had a medial distribution.

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INTRODUCTION

The regulation of gravel mining was recently intensified along the lower Mad River in Humboldt County, near Blue Lake, California. The findings in an Environmental Impact Report evaluated impacts on the lower Mad and gravel mining was implicated as one practice that should be modified (Kondolf, 1993). As a result, an alternative method of gravel extraction was required as plans for sustainable operations were developed. The plans made by biologists, geomorphologists and others in collaboration with the mining companies and the county required that ponds be dug in gravel bars in order to avoid impacts on the main channel and interference with the seasonal processes and spawning habitat for anadromous fish, while still extracting gravel for commercial use. During a drought cycle, gravel deposits are less plentiful as a result of reduced winter flows. The ponds were a method to extract gravel under the limited conditions.

The excavations were designed to function as ponds. Standard contours, slopes, shapes and depths were dug according to applications that have worked well for other constructed wetlands (W. Trush, personal communication; Brooks, 1990). The ponds were to self-colonize and were designed to become refilled with gravel deposits after about a ten-year flood event (W. Trush, personal communication). One pond was three years old, and the others were one year old when they were sampled. Two years after this field work, the ponds were filled with gravel and fine sediment after repeated inundation by winter storms.

My study was initiated to provide information on the response of vegetation development after the construction of ponds in gravel bars along a riparian corridor. The documentation of the plant species, their abundance, and their local distribution would be a valuable aid in assessing pool location, design and construction.

The construction of ponds for sustainable gravel extraction along rivers was a new technique. Very little recorded information is available about the vegetation patterns along ponds under these circumstances. Also, very little information is available about vegetation along rivers (Nilsson et al., 1989), particularly in the temperate climates of the coastal northwest (Pabst and Spies, 1998).

Disturbance is common along rivers, and disturbance of the ponds by winter inundations was designed into their cycle of existence, and ultimately their demise. Disturbance is a factor influencing the mosaic pattern and plant species richness (Whittaker and Levin, 1977; Pabst and Spies, 1998).

Water depth, frequency, intensity and duration of flooding are forces affecting ponds (Pabst and Spies, 1998). Fluvial processes influencing plant growth were at work at the ponds just as they were elsewhere. Surface hydrology in the Mad River basin determines the variability of flows which directly influenced the ponds. During winter and spring storms, runoff from precipitation raised the height of the river and water flooded the gravel bars, submerging the ponds.

Water level factors affecting plant responses were outlined by the Biological Services Program (Teskey and Hinkley, 1977). These factors act in the constructed pond setting and in the naturally occurring riparian corridor:

1. Time of the year
2. Flood frequency
3. Flood duration
4. Water depth
5. Siltation
6. Temperature

Magnitude of a disturbance affects the distribution and abundance patterns of plants in the riparian corridor (Wisheu and Keddy, 1991; Bornette and Amoros, 1996; Nilsson et al, 1989; Whittaker and Levin, 1977), but predictability of the results of fluvial processes in the rapidly changing stream corridor is low (Kondolf, 1993). Niering (1990) stated: "Biotic change in wetlands is usually not directional and generally not predictable since fluctuating water levels, chance, and catastrophe are constantly interacting."

Bornette and Amoros (1996), concluded that frequency and intensity of fluvial disturbances affected the recovery and regeneration in an infrequently flooded channel and a frequently flooded channel along the Rhine. The channel experiencing higher intensity fluvial disturbances had low species richness. Areas in the least disturbed zones of the infrequently flooded channel also had fewer species. Zones within the channels that experienced intermediate levels of disturbance had greater species richness. Although species and their distributions were different in the two channels, they did not differ in overall species richness. Outcomes based on different sequences of influences and stochastic events result in widely variable plant responses (Willard and Hiller, 1990).

In this thesis I investigated the plant life growing along the banks and within three ponds constructed on gravel bars along the lower Mad River. The primary objective was to identify species and to map vegetation assemblages to describe and interpret their pattern. The maps provide a visual aid, based on the TWINSPAN analysis. The patchiness of the plant distribution around the ponds could be related to the processes influencing them (Frost et al., 1987).

METHODS

I mapped the vegetation in the summer and fall of 1995. Plant names conform with those in Hickman (1993). Plant species which were encountered only one time were not included in the analysis. Plants not identified were included when their incidence was frequent and it was felt they contributed to interpreting the vegetation structure.

Mapping was the chosen method to document the occurrence of plant assemblages at the ponds for a few reasons. A map is a visual tool which can be used by a wide variety of people (Hall, 1994). Relationships to the banks and orientation to the ponds could be easily recognized and evaluated. Vegetation patterns could be assessed by the planners to evaluate their designs. Maps would be valuable to recognize problems so that new designs could produce more desirable results.

Site description: Mad River Watershed

The Mad River watershed ranges in elevation from sea level to 6,000 feet, encompassing 497 square miles. The main channel heads at 2,900 feet. Table 1 compares watershed sizes with other rivers in Humboldt County (Rantz, 1964).

Table 1. Comparisons of watershed sizes for neighboring rivers and creeks in Humboldt County.

Watershed	Area in square miles
Eel River	3,625
Redwood Creek	282
Jacoby Creek	16
Mad River	497
Smith River	719
Klamath River	15,700

The mean annual precipitation (MAP) in the basin is 64 inches, based on a 60-year average. The MAP for the Blue Lake area from the isohedron map is 54 inches. Commonly, the area exhibits a coastal maritime climate. Typically 90% of the rains fall between October and April (NOAA, 1989).

The surface hydrology in the Mad River basin determines the variability of flows in the river that directly influence the ponds. A connection between the river and a pond is made when the river floods the gravel bars. A primary force affecting the vegetation pattern is fluvial hydrology (Pabst and Spies, 1998). When the river rises, the water level in each pond fluctuates.

The surface hydrology for northern California was summarized prior to the 1964 flood:

> The variability of runoff with time, reflecting the variability of precipitation from year to year, is also striking. Wet and dry periods lasting for several years are common, and during those periods average runoff departs widely from the long term mean. Northern California experienced a prolonged wet period from 1890 to 1916, followed by a dry period from 1917 to 1937. In the 22 years since 1937, there have been two wet periods and one dry period.... (Rantz, 1964).

During the winter and spring runoff, as the Mad River rises the waters flood the gravel bars so that the ponds eventually get flooded. Precipitation can also directly effect water levels, and sub-surface water flow within the gravel bar also influences the ponds.

Flooding can be a gentle inundation with only moderate water-level changes, or much more powerful submersion resulting in greater depths of inundation. These more forceful floods may create dramatic changes when the river forces a new channel into a pond, or removes a portion of a bank. Large depositions of gravel and fine sediment also occur at this time. Once flooding stops, water levels in the ponds fluctuate less. From the last flood of spring until the first inundation by next season's rains, the water levels gradually decline, usually reaching their lowest between mid-August and early September.

Site description: Ponds

I studied three ponds that were accessible and not disturbed by much vehicular traffic, or other major disturbances after construction. They were situated close to the town of Blue Lake, California. Two ponds were situated on the Christie Bar. The third pond was on the Blue Lake Bar, upstream from the other ponds. They are located on the Arcata North, Humboldt County, California quadrangle, at T.6N, R.1E section 24, S1/2 NE 1/4.

The Christie Bar ponds were constructed in different years (W. Trush, personal communication). One pond was three-years old pond when I sampled it. I called this the Lower Christie pond. The Upper Christie pond was sampled one year after it was created.

The construction on the Blue Lake Bar occurred in two phases. First a smaller pond was excavated, and then another small pond immediately adjacent to it was created the following year. The gravel separating the two ponds was removed, forming a single pond with a two-year old end and a one-year old end at the time the vegetation was mapped (W. Trush, personal communication).

The Lower Christie pond was a rectangle in shape, about 380 feet long and 50 feet wide at the shoreline. The banks at each end were gently sloping, dropping at the rate of one foot for each 10 feet of horizontal distance (1:10). In general, the slope steepened to 1:4 into the pond and then the floor of the pond dropped more abruptly to about 11 feet deep at its deepest place. The banks on the ends were broad, being between 50 and 65 feet wide. The side banks sloped down a little more steeply and were narrower than the ends, being about 25 to 30 feet wide. The study site measured about 500 feet in length overall, and was about 105 feet wide.

Water from this pond drained into the river at its downstream end year-round. Water appeared to enter the pond through seepage at the shoreline from the upstream end during summer. Other inflows may have occurred through the gravel. Most winter flooding occurred at the downstream end when the river would back up into the pond more gently at its mouth. Only a few of the highest winter flows entered the pond at the upstream end, however no new channels were created. Instead, the water flowed over the banks without removing them. No gravel deposits were observed, but fine sediments were deposited at this pond.

The Upper Christie pond was an irregular pear-shape. At the time of sampling the pond measured between about 55 feet and 170 feet wide by 280 feet long at the shoreline. The dimensions of the study site including the banks were about 208 feet by 390 feet. The banks were sloped similarly to the Lower Christie pond. The winter floods smoothed the banks after the initial excavation, but flooding was not all gentle and the river made two new channels into the upstream end of the pond. Cobble-sized (hand-sized) gravel was heavily deposited covering the upstream portion of the initial construction and creating a level bar with steep slopes into the pond. Fine sediments were deposited just offshore of these large gravel deposits, creating a shallow area in the pond.

These changes changed the shape of the pond from the original form. Slopes and depths were altered resulting in a more varied shape. The pond drained at its lower end only in early summer. Upstream seepage was not observed, but some through-flow in the gravel bar probably occurred, because the water-level at the pond remained at a low summer level corresponding to the water-level changes observed at Lower Christie Pond.

The pond farther upstream on the Blue Lake Bar was an elongated pear-shape. This pond was about 325 feet long and between about 55 feet and 117 feet wide at the shoreline. The overall length of the study site was about 415 feet. Overall width varied between 125 feet and 175 feet. Winter flooding created a new channel into this pond and deposited a large volume of cobble-sized gravel on the upstream end. Much fine sediment was left on the banks in some areas. All large tree-sized woody debris that had been placed in the pond during construction were removed, except for pieces placed vertically and buried on one end.

These physical changes played a part in determining the colonization, distribution and survival of the plants. The plant assemblages I mapped for my study in 1995 were influenced by these changes.

Mapping: Equipment and Techniques

The study site at each pond included the excavated banks and the pond itself. The boundaries were marked by placing bamboo wands at the shorelines, and wooden stakes at the perimeter of the excavation. Baselines were established on opposite sides of each pond. Each baseline was sited using a transit, and placing rebar at 100-foot intervals. They were backed up with other markers to protect from damage due to vandalism or flooding.

Transects were spaced along each baseline at 50-foot intervals and then extended across the pond to the opposite baseline. Mapping units were created along transects by spacing crosslines at 35-foot intervals between them, making 50-foot by 35-foot box-shaped mapping units (Figure 1). Some units were shorter if the distance at the end of a transect did not allow for a 35-foot interval.

Each transect was labeled with an indelible marker, either on the tape, or directly on a stake, or both. These markers weathered the field season, and most were present after the winter floods of 1995-1996. When an area was being mapped for vegetation, measuring tapes were strung tautly along the perimeter of the mapping unit.

Within each mapping unit, plant assemblages that were homogenous in species composition and structure were mapped as polygons. The polygons were mapped at 1:60 to depict a detailed scale of variation in the distribution. The chosen scaled depicted patches both large and small, and was easy to draw. A pattern of occurrence may be mapped homogeneously at one scale, or heterogenously at another (Hall, 1994). The maps depicted the scale of changes evident along the banks.

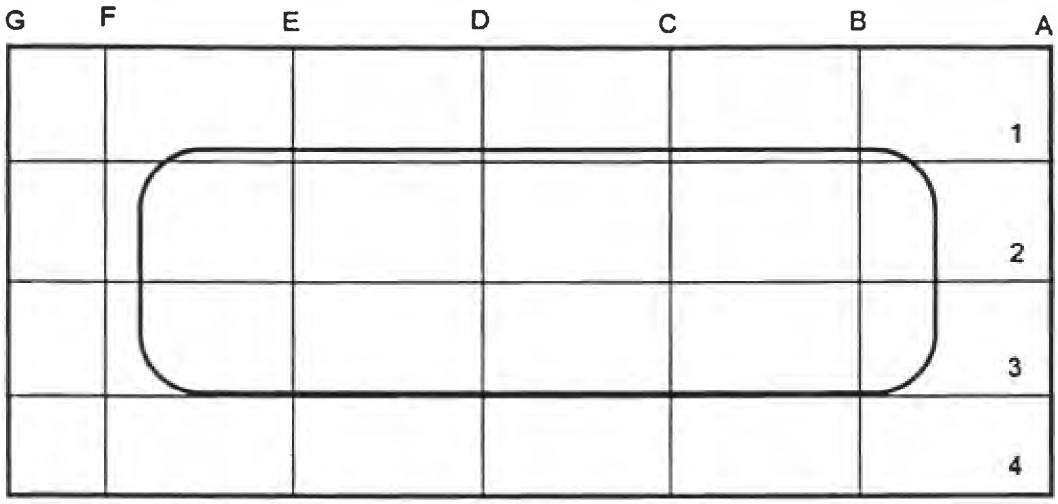


Figure 1. A diagram of how transects were laid out on a pond. Each whole mapping unit was fifty feet by thirty-five feet.

Mapmaking

In order to join the original map units into a complete map, they were traced by hand onto larger vellum pieces. Transect lines were not included in the final product. This information was then digitized into ARC/INFO. The original maps were reduced in size for convenience of presentation.

Mapping was done during the 1995 growing season. Vegetation mapping began in July and continued through mid-December, when the first large winter storm occurred. The bulk of the mapping occurred in August and September. August and September coincide with the peak cover of most species (Campbell and Franklin, 1979).

Polygons in Open Water

To view and assess the underwater plants from the boat was relatively easy due to the high clarity of the water. Plants were easily visible into the deepest areas of the ponds, prior to any rains. Accuracy of identification was aided by two tools. An underwater viewer was made by cutting out the bottom of a Rubbermaid dishpan and using a silicon sealant to adhere a Plexiglas window to the bottom. I could float and view submerged plantlife. Glare on the window was occasionally a problem, and a mask and snorkel helped. A three-tined gardening claw was fastened to a section of the fiberglass stadia rod with duct tape and insulating foam to retrieve plant material from the bottom when recognition from the boat was uncertain.

Visibility was eventually reduced to 5 or 6 feet in depth on the Upper Christie following a small storm and mapping the submergent plants had to be stopped here before it was completed. All the aquatic assemblages were mapped on the Lower Christie pond.

Mapping at the Blue Lake Bar did not occur as planned. Vegetation cover was less than 5%. The appearance was recorded on film. Some initial data was recorded pertaining to species presence.

Mapping: Defining a polygon, or vegetation patch

A census of the plant assemblages was made at the Upper and Lower Christie ponds. The objective of the mapping procedure was to identify homogenous patches of plants, document a patch as a polygon, and record the cover value for each plant species in the patch.

The definition of patch boundaries proved to be the single most challenging aspect of the mapping procedure. While others were more subtle, some boundaries were abrupt, with patches grading into one another. Deciding when a polygon was the same, a variant, or simply a different one was based on visible changes in the structure and homogeneity of a patch of vegetation. Repetition among polygons was evident during early surveying of the sites (Appendix C). Differences in plant structure were recognized to allow for a consistent method of obtaining data (Orloci and Pillar, 1991). Variations were delineated and described as subtypes, a methodology supported by Kuchler (1988).

For example, if polygon 100 consisted of 12 species, and one species covered 12% of the polygon in one instance, 5% in another and 20% in yet one more patch, that patch could still be polygon 100 if the overall homogeneity of the patch was consistent, and all species were present in each patch.

A polygon is typified by the species and a range of cover values. When the data for a polygon type like 100 was recorded, a range was recorded, such as *Juncus supiniformis*, 5-20% cover. A single average value for that species in that polygon type was entered for data analysis. Pabst and Spies (1998) used this approach in a study of species distributions and pattern occurrence along stream corridors in Oregon coastal watersheds.

Analysis

TWINSPAN (Hill, 1979) was used to help classify the polygons into vegetation types. Default cut levels were used: 0-2, >2-5, >5-10, >10-20, >20 percent cover. Other cut levels were tried, but they did not alter the TWINSPAN output or interpretation.

TWINSPAN uses a divisive method of classification that first creates a hierarchy of the polygons, grouping together polygons that most resemble each other in species composition. The classification is the result of an ordination using reciprocal averaging of the ranked cover values. Pseudospecies are created in TWINSPAN by using the ranked cover values. The quantitative cover values recorded as percent cover in the data are ranked according to cut levels. I used five cut levels. A species occurring in a polygon with 25% cover would create five pseudospecies in the analysis, one for each cut level, because the cover value exceeds or equals all the cut levels for the five ranks. In the event it occurs with only 10% cover in another polygon, three pseudospecies would be created within the analysis. Pseudospecies are a tool to allow the use of quantitative values within the analysis (Hill, 1979).

The primary division in the hierarchy divides the polygons into the two most strongly differentiated groups. Species are identified which prefer one side of a dichotomy or the other, and are called differential species. The preference is based on ecological differences among polygons. These species are used to refine the initial ordination.

Finally, an "indicator" ordination recognizes the preferential species, resulting in a table that is a two-way matrix of samples and species (Appendix D). Primarily, the distribution of species with their ranked cover values, determined by the selected cut-levels, is ordered according to the distribution of polygons based upon ecological differences (Hill, 1979).

RESULTS

Over 90 species were identified at the ponds (Appendix A) which produced the TWINSPAN table (Appendix D). This table presents results pertaining to the ordering of species, the distribution of their ranked cover values, and the ordering of polygons. First, I will look at the order of the species to support understanding of the results.

A simple table was made of wetland indicator categories for the plant species found around the ponds (Table 3). The table is based on the "Revision of The National List of Plant Species That Occur in Wetlands" (Reed, 1997). The categories result from the frequency of occurrence of a species in wetlands over their regional occurrence. Below are the categories and their descriptions:

1. Obligate Wetland (OBL). Occur almost always (estimated probability>99%) under natural conditions in wetlands.

2. Facultative Wetland (FACW). Usually occur in wetlands (estimated probability 67%-99%), but occasionally found in non-wetlands.

3. Facultative (FAC). Equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%).

4. Facultative Upland (FACU). Usually occur in non-wetlands (estimated probability 67%-99%), but occasionally found in wetlands (estimated probability 1%-33%).

Table 3. The species ordered according to TWINSPAN, and their wetland indicator categories.

Ordered Species	Wetland Indicator Category[a]	Ordered Species	Wetland Indicator Category[a]	Ordered Species	Wetland Indicator Category[a]
AnthOdor	FACU	PlanLanc	FAC-	PareVisc	FAC
BromCari	none	XantStru	FAC+	PolyInte	OBL
LinuBien	none	EpilBrac	UPL	RumeCris	FACW
LoliMult	FAC	RubuUrsi	FACW	CypeErag	FACW
PicrEchi	FAC	AlnuRubr	FACW	EuthOcci	OBL
TrifCamp	none	HypoGlab	none	LythHyss	FACW
AiraCary	FACU	SoncAspe	FAC	PolyMons	FACW+
BrizMino	FACU	BaccPilu	none	PoteAnse	FACW
BromHord	FACU-	MeliAlba	FACU	SaliExig	FACW
CynoEchi	none	ChenPumi	none	SaliLuci	OBL
DaucCaro	none	EchiMuri	FACW	MentPule	OBL
GaliApar	FACU	GnapPalu	FACW	PolyMari	OBL
VulpMyur	FACU	KickElat	none	VeroAmer	OBL
AnapMarg	none	PetrDubi	FACW	JuncBola	OBL
DipsFull	FACW-	PolyAmph	OBL	JuncPate	FAC
GaliDiva	FAC	SaliSitc	FACW+	AgroStol	FACW
HypePerf	none	CotuCoro	FACW	EquiArve	FACW
LeucVulg	FAC-	EquiHyem	FACW	JuncXiph	OBL
LoniInvo	FAC	HelePube	FACW	RoriNast	OBL
RumePulc	FAC+	PlanMajo	FAC	TrifFuca	FAC
AnagArve	FAC	ScirMicr	OBL	TyphLati	OBL
ArteDoug	FAC+	SileGall	none	VeroAnag	OBL
ErecMini	none	CentDavy	FAC+	RumeSali	OBL
HirsInca	UPL	GnapStram	FAC-	CallStag	OBL
LotuCorn	FAC	JuncBufo	FACW+	CharSp.	OBL

Table 3. The species ordered according to TWINSPAN, and their wetland indicator categories (continued).

Ordered Species	Wetland Indicator Category[a]
HippVulg	OBL
PotaFoli	OBL
SparEmer	OBL
UnknSubm	OBL
AlisPlan	OBL
JuncSupi	OBL
OenantSp.	OBL
PotaNata	OBL

[a] none = not all plants are categorized.

5. Obligate Upland (UPL). Occur in wetlands in another region, but occur almost always (estimated probability >99%) under natural conditions in non-wetlands in the region specified.

To clarify the nature of the descriptions further, the Revision states:

1. The wetland indicator categories should not be equated to degrees of wetness. Many Obligate Wetland species occur in permanently or semipermanently flooded wetlands, but a number also occur and some are restricted to wetlands that are only temporarily or seasonally flooded.

2. The Facultative Upland species include a diverse collection of plants that range from weedy species adapted to a number of environmentally stressful or disturbed sites (including wetlands) to species in which a portion of the gene pool (an ecotype) always occur in wetlands. Both the weedy and ecotype representatives of the facultative upland category occur in a variety of wetland habitats, ranging from the driest wetlands to semipermanently flooded wetlands.

My TWINSPAN table reflects an ecological gradient that is understood in terms of these wetland indicators (Appendix D). On the upper left side are the facultative or facultative upland species. The center of the table contains facultative and facultative wet plants, and the lower right portion of the table contains mostly the obligate species.

The diagonal array of species on the TWINSPAN table seems like a gradient based on moisture, but wetness is only part of the influence. The results are also tied to habitat distributions of the plants in reference to the setting at the pond. For instance, the twelve polygons in the upper left-hand corner of the table (the 'driest' portion) are dominated by *Melilotus alba* (FACU) and *Alnus rubra* (FACW), and contain abundant *Cyperus eragrostis* another FACW plant. The many other species present in this corner of the table are more uniformly abundant in other polygons next over on the table. These other polygons are more abundant with the FACU and FAC species and were drier sites at the ponds. Yet all of the polygons arranged in this corner of the table are similarly positioned around the pond, bordering the unexcavated areas and similarly distant from the shoreline. They are characterized by their spatial orientation in the landscape as well as their species composition and wetland characteristics. All of these sites are at the older, Lower Christie pond.

The maps depict the polygons in five main vegetation types and three subtypes around the two ponds (Figures 2, 3, and 4). The groups were created from the hierarchical division of 291 polygons indicated at the bottom of the table. The first level division in the hierarchy cut away two polygons which contained only the floating-leaved pondweed, *Potamogetan natans*. This type was atypical. The floating-leaved pondweed usually occurred with dense patches of the submergent leafy pondweed, *Potamogetan foliosus*. It grew at the base of the floating-leaved pondweed, most often mixed with the algae, *Chara*. Had more samples of these species

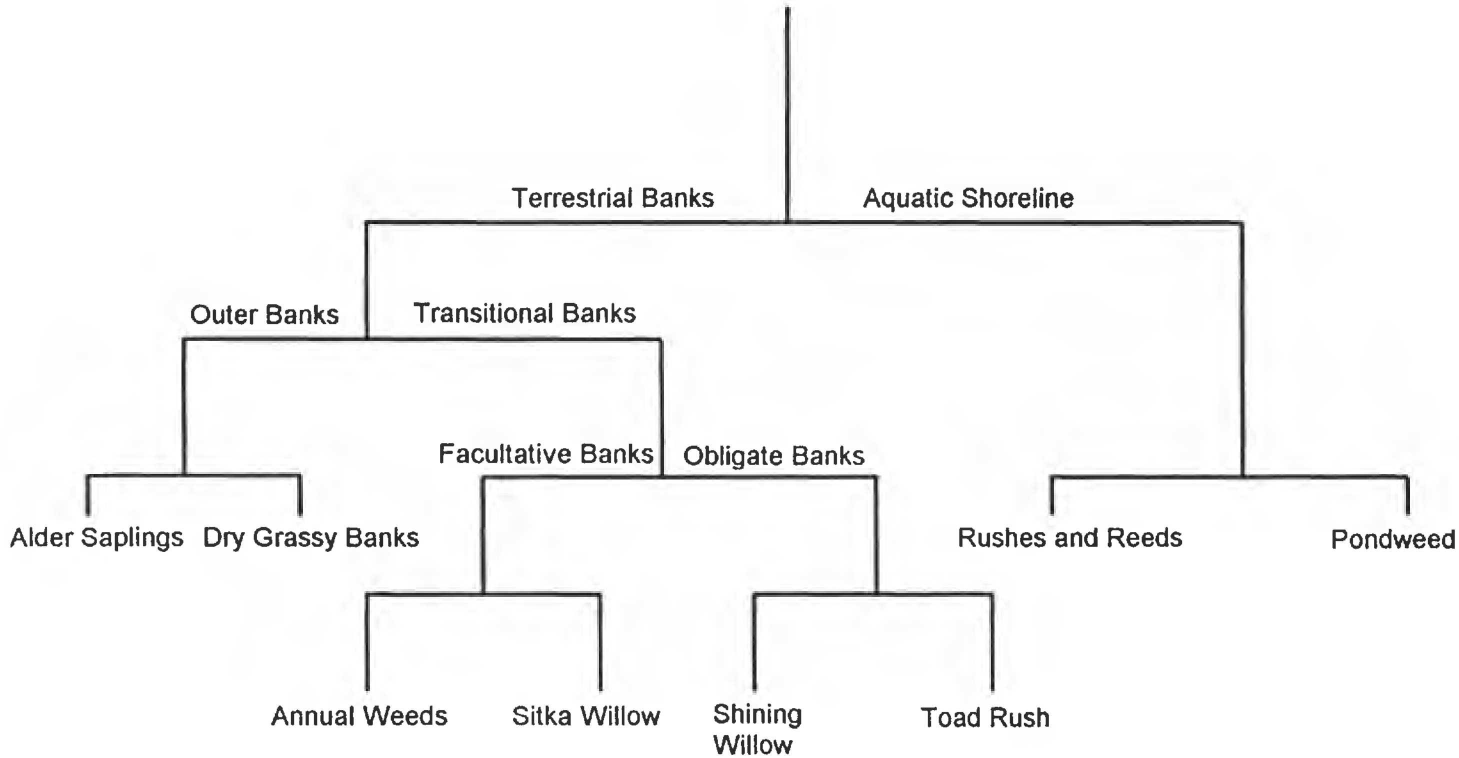
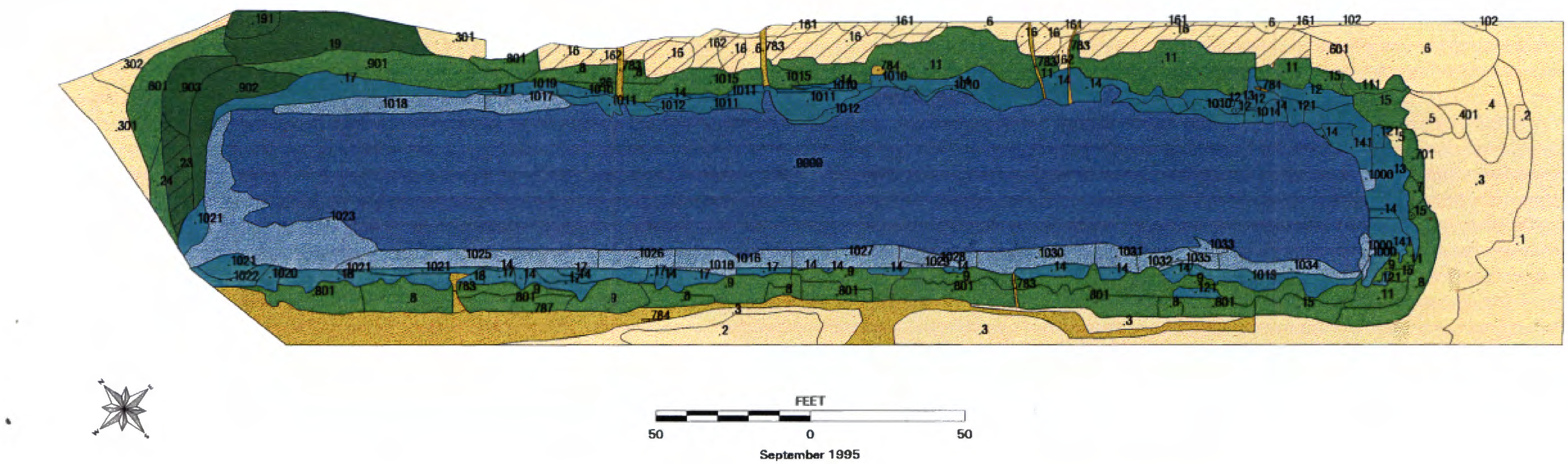


Figure 2. The interpretation of hierarchical divisions of vegetation types of the TWINSPAN table (Appendix D) in relation to environmental conditions and species composition.



Lower Christie Pond Group Types

Terrestrial Banks

- Dry Grassy Banks (1-6,102,301,302,401,601)*
- Alder Saplings (16,161,162)
- Sitka Willow (19,191,902,903)
- Annual Weeds (23)
- Shining Willow (7-9,11,15,24,26,111,701,801,901,1015)

Aquatic Shoreline

- Rushes and Reeds (12-14,17,18,121,141,171,1010-1014,1019-1022)
- Pondweed (1000,1016-1018,1023,1025-1035)
- Beaver Runs (783), Trails (787) and Woody Debris (784)
- Water (9999)

* The numbers displayed are coded vegetative assemblages associated with the polygon within which the number occurs

Figure 3. Map of vegetation types on Lower Christie Pond.

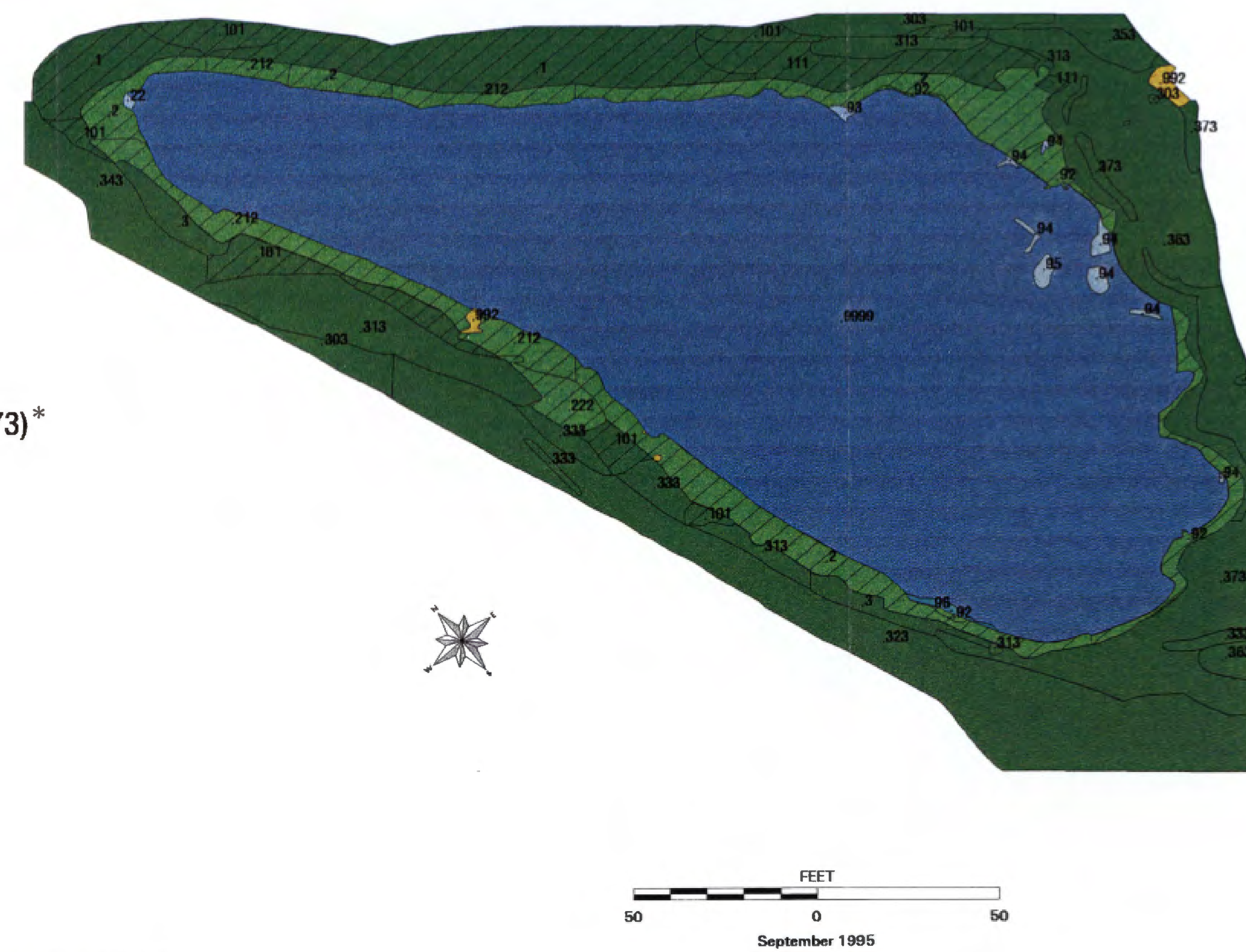
Upper Christie Pond Group Types

Terrestrial Banks

- Dry Grassy Banks (none)
- Alder Saplings (none)
- Sitka Willow (3,303,313,323,333,343,353,363,373)*
- Annual Weeds (1,101,111)
- Toad Rush (2,92,212,222)

Aquatic Shoreline

- Rushes and Reeds (96)
- Pondweed (22,93-95)
- Woody Debris (992)
- Water (9999)



* The numbers displayed are coded vegetative assemblages associated with the polygon within which the number occurs

Figure 4. Map of vegetation types on Upper Christie Pond.

been included, the two polygons would have been grouped with other polygons containing aquatic species.

The pondweeds and the *Chara* grew in both the shallower waters amongst shoreline aquatic plants or centrally in the deepest part of the pond, but they never occurred onshore. Other plants associated with them did, however, appear on the banks. Had more samples with the pondweeds been included, the group may or may not have divided initially from the others as the primary division in the table suggests with the two lone polygons.

The Aquatic Shoreline was made of two types. The shoreline areas which remain underwater as water-levels recede seasonally are the Pondweed type depicted in the map in light blue. The type occurs along the shorelines in water zero to 4 feet deep. Pondweed is separated from the shoreline that emerges over time. The emergent polygons are grouped into the Rushes and Reeds type which is mapped in an aqua-green color. The type is limited to shallower water sites, 0-2 inches deep with emergent plants.

Twenty species form the Pondweed type that occurred at Upper Christie pond and Lower Christie pond. The Rushes and Reeds type involves 33 species, 22 of which are obligate species. Fifty other species occur around the ponds, but very few of these are present in these two types. The 33 species forming the Aquatic Shoreline group, however, occur in many other places around the pond.

The second group to break off is the 49 polygons that are driest and/or most distant from the shoreline. Most of the FACU and FAC species occur here. They all occur on the Lower Christie pond which was three years old and form the Outer Banks type depicted in yellow on the map. Thirty-two species are grouped together here by TWINSPAN. Twenty of these species made almost no other appearances elsewhere on the ponds.

From within the Outer Banks type, two subgroups were formed. Twelve polygons comprise the Alder Saplings subtype located on the northeast side of the older pond. They were dominated by *Alnus rubra* and a mix of *Melilotus alba* and other more upland species, and *Cyperus eragrostis* beneath and alongside the *Alnus.*

Thirty-seven other polygons from the Outer Banks type comprise the Grassy Banks subtype, with less *Alnus* and little or no *Cyperus*. Most of these polygons are from the upstream end and along the northwest side of the lower pond. They are mostly contiguous with the unexcavated area surrounding the pond.

A large central group of 158 polygons remains, forming the Transitional Banks type. These samples are positioned transitionally in the table and at the ponds. *Melilotus alba* is prominent in many of the polygons from the central group.

The large central group divided almost equally into two types. These two are the Facultative Banks type with 78 polygons to the left of the division and the Obligate Banks type formed from the 80 plots to the right. The Facultative type formed from polygons from the newer Upper Christie pond, with a few exceptions from the older Lower pond. These plots had sparse cover and a weedier composition than other types.

The Facultative type was subdivided into the Annual Weeds type dominated by *Hirschfeldia incana* and *Melilotus alba* and the Sitka Willow type populated by more *Salix sitchensis* and *Salix lucida ssp. lasiandra.* These two subtypes occupy a similar position around the ponds, in bands midway between the outer plant assemblages and the inside assemblages closer to the shoreline. A few more obligate plant types occur in these areas.

The Obligate Banks type contains 80 polygons mostly from the lower pond with a contingent of 30 polygons grouped together from the newer pond. This mixture of species has larger cover values than the facultative group, and most of the species are from the lower half of the table. These polygons were more abundant in the obligate species and less weedy than the facultative group.

The Obligate type was subdivided between the Upper and Lower Chrisite ponds. The obligate species are in greater abundance in all the Lower pond polygons than the 30 Upper pond ones included here. *Mentha pulegium* and *Salix lucida* are more abundant, forming the Shining Willow type on the Lower pond. The upper pond sites form the Toadrush type, dominated by native *Juncus bufonius* but otherwise sparsely populated.

The third pond at the Blue Lake Bar was not mapped. There was less than 5% plant cover overall. Plant cover on the two-year old end had been removed by winter flows, with very little colonization at the new end.

Notes On Aquatic Plant Species

Juncus supiniformis is a species classified 'UNCOMMON' in the Jepson Manual (1993). The abundance and distribution of this plant on the Lower Christie pond was plentiful. There was even a very small population at the pond on the Blue Lake Bar. This *Juncus* occurred usually in mats along the shoreline, emerging from water as deep as two feet or more and also thrived onshore. Once stranded as the water level went down, the plant flowered, matured and then fruited. Once established it seems to grow rapidly. The mouth was bare in February (at the downstream end of the pond) prior to the third growing season. The largest mats grew in that location later that summer. These were in shallow water and onshore. Several other smaller patches also occurred on this end of the pond. They occurred in smaller patches in deeper water, between about 20 and 30 inches deep.

Deep Water Aquatic Plants

After three years, the Lower Christie pond grew an underwater jungle. Species were mapped at between 80% and 100% cover in water from about 2.5' to 12' deep. Plants such as *Alisma plantago-aquatica* grew about seven feet tall from the bottom of the pond to the surface in some areas. *Potamogetan natans,* another emergent species, grew in a large dense patch in one area of the pond where it was over 11 feet deep. There were also *Hippurus vulgarus*, *Veronica*, *Rorippa*, and *Callitriche stagnalis*, and an unidentified vascular submergent aquatic in nearshore water up to about 4' deep. The remainder of the deeper water was blanketed in large patches of the narrow-leafed submergent aquatic, *Potamogetan foliosus*, and *Chara.* These plants thickly co-mingled with each other, or with the *P. natans.* They also appeared in scattered smaller patches independently, usually in water 2'-5' deep, between the nearshore aquatic patches and the more thickly spread mixture of plants in deeper areas. An unidentified submergent narrow-leafed plant also occasionally appeared at these intermediate depths.

After only one year the newer pond had several small populations of *Potamogetan natans*, *P. foliosus*, and possibly two species of freshwater algae, *Chara canescens* and *Chara braunii*, scattered throughout the pond. The *Characeae* have been shown to be colonizers in reconstructed systems (Wade, 1990).

Potamogetan has been shown to withstand greater force of flows than other more delicate emergent species (Newall, 1995). Populations of durable *Sparganium emersum* had appeared, and of course *Typha latifolia*. They were widely scattered in patches. The aquatic plants continued to flourish through the end of summer and early September.

These aquatic plant assemblages were not included in my analysis. Initially this choice was made because comparable mapping at both ponds on the Christie Bar was not completed. The newer Upper pond became turbid after a small storm so that visibility was impossible below about 5' deep. The more vegetated Lower pond had been mapped by this time. It did not become turbid until the water-level of the river itself rose and inundated the pond. In retrospect, it seems for the purposes of interpreting these maps and the character of the ponds, these criticisms are minor, and their inclusion may have fleshed out the analysis of the pond data better.

DISCUSSION

This was a local scale study. The purpose was to describe the vegetation patterns around three ponds. Two accomplishments of the TWINSPAN analysis were the ordering of the species, and the ordering of polygons. The formation of vegetation types from the polygons using TWINSPAN (Appendix D) was successful. The maps (Figures 3 and 4) are particularly useful in illustrating the assemblages as a patchwork of vegetation types in relation to the ponds which formed an interpretable pattern.

The TWINSPAN table displays a fairly even gradient in the distribution of species over polygons. The plant assemblages grade into one another gradually. The moderate environmental gradient is evident in the way that most species occur almost everywhere, though varying in distribution and abundance.

When ordered plant species were labeled with their appropriate wetland indicator categories, a trend of species associated with habitats was almost always clear. It illustrated a moderate, but strong environmental gradient between the plants growing in the pond, along the shoreline, and with those furthest from the water at the edge of the excavation.

The trends in the distribution of species at the ponds are comparable to those of other works in the stream corridors in the Pacific Northwest (Gecy and Wilson, 1990; Pabst and Spies, 1998). I expected the results in my study to be comparable to these studies because the substrates around the ponds were made from the local gravel and sediments in common with the rest of the riparian wetland areas around the river. Gecy's study (1990) pertained to colonization after debris flows. The excavation and subsequent winter floods affecting the banks possibly parallel the impact of a debris flow. The other papers pertained to the colonization and distribution of comparable species in the riparian corridor (Pabst and Spies, 1998; Bornette and Amoros, 1996; Campbell and Franklin, 1979; Nilsson et al., 1989).

In the riparian corridor, a complex of intense influences is at work. Pabst and Spies (1998) found that distinctions were obscured and variable along streams but that "the vegetation is ordered along a complex environmental gradient running from streamside to lower hillslopes." The distribution of species at the ponds was more diffuse in some areas and more distinct in others. Based on the hierarchy of vegetation types resulting from the analysis and maps, the strongest distinction is between vegetation types of aquatic plants and those of terrestrial plants. The emergent species are concentrated at the shoreline and within the water. The sharpest influence is at the water's edge, and going down into the deeper water where the submergent species appeared.

Many emergent species can be found almost anywhere on the banks. The primary division between the Shoreline and Banks groups developed at the waters' edge. The submergent aquatic species began to occur in the water at the shoreline and grew nowhere on the Banks. The emergent species also grew in greatest abundance here.

The Outer Banks type (Figure 2), composed of the dry Grassy Banks and Alder Saplings subtypes, borders the unexcavated area surrounding the Lower Christie pond. The subtypes are almost as distinct from the other assemblages as the aquatic plants. There were species occurring here that appeared almost nowhere else around the ponds. They are driest and most distant from the pond. The orientation to the adjacent habitat is clear. Gecy and Wilson (1990) concluded that "the composition of the adjacent undisturbed vegetation can also influence revegetation patterns after debris flows." Though the surrounding area was not sampled as a part of my study, the species recorded in the Outer Banks type were also observed in the surrounding area.

Although the seasonal influences of the river impact the ponds dramatically, at some point the influence of the ponds asserts itself. Most noticeably, the maps depict the concentric orientation of the groups around the ponds. The river rearranges things, and water level changes affect the plants, but the summer growing season is stable and pondlife flourished.

An aspect of construction also affected the establishment of vegetation types and influenced the ponds over time. When the ponds were constructed on the Christie Bar, a thick blanket of the fine surface sediments from the construction site was set aside. It was spread over the banks after the excavation was completed. This technique in constructed wetlands encourages plant colonization. The propagules persist in the original sediments (Jensen and Platts, 1990). Abundant plant cover was evident at these two ponds.

Pictures taken by the miners on the Christie Bar after the first growing season on the Lower Christie pond showed the banks blanketed in *Polypogon* (R. McLaughlin, personal communication). *Alnus rubra* colonized the northeast bank and so did *Cyperus eragrostis*. *Salix*, *Typha*, *Daucus* and *Melilotus* were also present. After three growing seasons, the Lower Christie pond was no longer blanketed with a homogeneous distribution of species. It had more of a mosaic appearance.

In 1995, the newer Upper Christie pond did not develop the grassy area that was present at the older Lower pond. There is no Outer Banks type here. The Upper Christie pond began with *Salix*, *Cyperus*, and *Hirschfeldia*. It was thick with the *Salix*, which occurred in bands. *Cyperus*, and *Hirschfeldia* appeared in large patches and bands at the older Lower Christie pond during its second growing season in 1994. *Salix* appeared as individuals or in very small clumps at that time. They established themselves in large homogenous bands around the pond at the same time as the Upper Christie pond in 1995. The two ponds got a somewhat different start and then presented similar populations of some species in the same growing season.

In contrast, almost nothing established on the new end of the pond on the Blue Lake Bar after one growing season. The two-year old end of this pond lost plant cover it had from the previous year. *Salix* and *Typha* were scoured out when flooded during the winter. The ubiquitous nature of durable colonizers was somehow not successful in this case. An original thick blanket of fine sediments was not present at the new end of the pond on the Blue Lake Bar. It did not seem to be available onsite during construction. Sediment did get thickly deposited after the winter storms in some areas around the pond. Propagules may not be present in newly deposited sediments in contrast to sediments deposited earlier. How long any deposits remain in place before being transported elsewhere is a good question. Each year changes take place.

Salix did germinate and sprout in abundance here, but their propagules were airborne and recently deposited, judging by the way they were blanketed evenly where they did occur. The *Salix* did not thrive growing knee-high and taller like they did at the more productive ponds on the Christie Bar ponds. In the fall, the banks at the Blue Lake Bar looked more like the others did in May or June. Along one bank hundreds of sprouts grew to between one and five inches tall. In another area they remained less than one inch tall, and most of them died as the area dried out.

The Transitional Banks type on the Christie Bar ponds varied in abundance of plant cover and the wetland characteristics of the species. There was a greater abundance of obligate species at the Lower Christie pond, but scant cover of primarily facultative species at the Upper Christie pond. The overriding influence seems to be the division between the obligate and facultative groups. This fact is mirrored in the species order originally mentioned in this section. This result seems to be one associated with the passage of time (Bornette and Amoros, 1996), in conjunction with hydrology, which is the driving force in wetlands (Pabst and Spies, 1998).

Different Inundation Patterns

Gecy and Wilson (1990) mention that given different starts, the long-term effects can result in different outcomes, even within otherwise similar areas. The different inundation patterns at each pond were described in the site description of the methods section. If *Salix* or *Typha* heavily establish in one pond, that can limit what else can colonize the area. In terms of overall populations, individualistic tendencies may also result in different outcomes (Pabst and Spies, 1998).

The different magnitude of forces of inundation result in differences in what is deposited, and turbulence would determine what is scoured (Dunne and Leopold, 1978). The Lower Christie pond was mildly inundated by the force of the river from the upstream end. It experienced gentler inundations which brought fine sediments, but no gravel deposits and no noticeable scour (forceful removal). As time passed, more obligate species appeared at the Lower Christie pond. The gentler winter inundation pattern in conjunction with the relatively steady water levels occurring over summer supported the colonization of the aquatic species. Their populations increased over time, despite deep and lengthy wintertime submersion. This result corresponds to Bornette and Amoros' (1996) study of frequently and infrequently flooded channels along the Rhine. The zone within the frequently flooded channel that received less intense flooding than other zones due to its physical dimensions and orientation favored sedimentation and resulted in the greater plant species diversity. The intensity of the forces were moderated, supporting more changes than less disturbed areas of the infrequently flooded channel, but not damaging the zone as much as areas receiving higher intensity flows. In contrast, the less disturbed sites on the infrequently disturbed channel had fewer species over a ten-year period. However the two channels measured alike in terms of overall species diversity and richness, even though the species and their distributions were different.

The Upper Christie pond experienced more intense fluvial processes. New side channels going into the pond were formed when the river swept over the gravel bar. Large gravel deposits resulted when the water level dropped, changing the shape of the pond at the upstream end.

The barren pond on the Blue Lake Bar experienced similar inundation forces as the Upper Christie pond. The flooding smoothed and shaped the banks of both the newly constructed ponds. The cobble-sized depositions which reduced the area of the ponds were similar, indicating the similarity in forces at work. The cobbles at the Blue Lake pond were slightly larger in comparison, though, indicating a larger force carried them to that site. That it should be so different in plant cover was a little surprising. Some vulnerability to damage existed at this site, but it was unclear whether fluvial disturbance was the primary cause or whether it was the lack of the initial blanket of onsite sediments favoring revegetation.

Seasonality and Water Level Changes

One influence water levels had at the pond was determining seed dispersal on the banks. The airborne distribution of *Salix* seeds was influenced by water levels. Timing and seasonality had some effects on the distribution and survivorship. When the wind blew the seeds onto the ponds, the water level would have to be down off the banks if the seedlings were going to find mineral soil and blanket an area. A narrow line of seedlings might indicate the seeds were deposited on the water then blown to shore, sprouting at the waterline. This was not observed in the *Salix*, but may have occurred with some *Typha* on the Blue Lake Bar.

Wind lapping the water at the shoreline may also influence seed dispersal. The downwind end of Upper and Lower Christie ponds appeared to have the most diverse-looking areas. Many species were interspersed, rather than there being large mats or bands of one or two species. The diversity at Upper Christie pond was offshore where sedimentation created a large shallow area at the downwind end beneath the massive gravel banks.

If the plants germinated too far from a water source, they would not survive. Survival might also have been affected by how late the rain showers came after the water level dropped. Heavy rains came as late as May and supported seedling survival.

Niering (1990) emphasized that fluctuating levels of impact from siltation, timing, flood frequency, duration and depth were the norm in wetlands. He placed particular emphasis on the effects of seasonal water level changes. Fluctuation may also be due to mild or extreme disturbances that were naturally occurring or man-induced. He concluded that a natural or created wetland sustains many disturbances of varying intensity and constancy which may or may not result in changes in vegetation structure or composition, but that it was imperative that a system should be designed and constructed so that the organisms and the wetland as a whole can persist when facing all the influences that it can expect to meet.

Had the ponds survived a few more years, it would have been interesting to see how they changed. The more newly constructed ponds would probably have high plant cover if the river was not overpowering them. The attractive Lower Christie pond was testimony to the success of the site where inundation was mild by comparison to the other more heavily inundated sites. The success of the aquatic species at the Lower Christie pond was surprising and impressive with approximately 90% plant cover. Colonization by aquatic species at the Upper Christie pond was also successful and impressive. Had the pond not been destroyed by subsequent flooding, an aquatic jungle would probably have flourished there.

Destruction of the Ponds

Cutting away of the mouth at the Lower Christie site and heavier upstream inundation brought on its eventual demise. Dramatic cutting of the bank supporting the mouth had occurred previously, but the outlet had remained intact. Eventually, approximately one-third the length of the pond was removed. The final demise may have occurred suddenly, because almost none of the aquatic plants remained, or the jungle of plants may have been swept out if a more intense flow came in from the upstream end. Burial by fine sediments may have occurred. Without the mouth to retain the water, the water level within the remainder of the pond was lowered so much that banks which had been previously inundated during the stable summertime were now exposed and barren. The few remaining plants were stranded farther from the shoreline. *Baccharis pilularis* seedlings persisted. Mature *Baccharis* was common in the surrounding area.

Large scour holes were left on the pond site at the Blue Lake Bar after the winter of 1996-97. The size of the pond was very reduced. The Upper Christie pond was completely buried in gravel. These physical changes were all expected, though not so soon after the construction (W. Trush, personal communication).

CONCLUSIONS

The original interest in the vegetation was to identify and describe the species and their abundance. Of further interest was to investigate the patchiness of different types of vegetation. The mapping procedure identified possible species assemblages, and my analysis allowed me to classify the types using a TWINSPAN table. The completed maps illustrate the results as interpretable vegetation patterns.

Whittaker and Levin (1977) stated that the complexity of the mosaic of vegetation is increased by the combination of biological and non-biological factors. The complexity of the vegetation mosaic increased over time at Lower Christie pond. In some areas along the banks this year's growth thinly overlain the previous year's plants. Vague boundaries of the previous year's growth were interspersed within the newer plant populations. Each assemblage seemed patchy in its own right.

The effects of flooding would have to do with a plant's ability to withstand inundation, sedimentation, scouring, and relocation. The species stratified themselves according to their defined wetland categories. Some occur everywhere, some only further from the pond and adjacent to the drier unexcavated areas, and some only with other obligate species within the pond.

The most surprising result was the collection of aquatic plant species within the ponds. Since these were constructed ponds, and freshwater ponds are uncommon near the coast, it was somewhat remarkable to see them thriving with aquatics. The source of propagules is of interest.

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APPENDIX A

Table 2. Plant species recorded at ponds on the Christie Bar.

PLANT SPECIES	TWINSPAN CODE NAMES
AQUATIC SPECIES	
ALISMATACEAE	
Alisma plantago-aquatica	AlisPlan
CALLITRICHACEAE	
Callitriche stagnalis	CallStag
CYPERACEAE	
Scirpus microcarpus	ScirMicr
Cyperus eragrostis	CypeErag
HIPPURIDACEAE	
Hippurus vulgaris	HippVulg
JUNCACEAE	
Juncus bufonius var. occidentalis	JuncBufo
J. supiniformis	JuncSupi
J. patens	JuncPate
J. bolanderi	JuncBola
J. xiphoides	JuncXiph
POTAMOGETONACEAE	
Potamogeton natans	PotaNata
P. foliosus var. foliosus	PotaFoli
TYPHACEAE	
Sparganium emersum ssp. emersum	SparEmer
Typha latifolia	TyphLati

Table 2. Plant species recorded at ponds on the Christie Bar (continued).

PLANT SPECIES	TWINSPAN CODE NAMES
TERRESTRIAL SPECIES	
BETULACEAE	
Alnus rubra	AlnuRubr
CAPRIFOLIACEAE	
Lonicera involucrata var. ledebouri	LoniInvo
CARYOPHYLLACEAE	
Petrohagia dubia	PetrDubi
Silene gallica	SileGall
CHENOPODIACEAE	
Chenopodium pumilio	ChenPumi
Atriplex spp.	*
COMPOSITAE	
Anaphalis margaritiacea	AnapMarg
Artemesia douglasiana	ArteDoug
Baccharis pilularis	BaccPilu
Chamaemelum nobile	ChamNobi
Cotula coronopufolia	CotuCoro
Erechtites minima	ErecMini
Euthemia occidentalis	EuthOcci
Gnaphalium palustre	GnapPalu
G. stramineum	GnapStra
Helenium puberulum	HelePube
Hemizonia congesta ssp. calyculata	*
Hemizonia congesta ssp. clevelandii	*
Hypochaeris glabra	HypoGlab
Leucanthemum vulgare	LeucVulg
Picris echioides	PicrEchi
Sonchus asper ssp. asper	SoncAspe
Xanthium strumarium	XantStru

Table 2. Plant species recorded at ponds on the Christie Bar (continued).

PLANT SPECIES	TWINSPAN CODE NAMES
TERRESTRIAL SPECIES	
CRUCIFERAE	
Hirschfeldia incana	HirsInca
Raphanus raphanistrum	*
Rorippa nasturtium-aquaticum	RoriNast
DIPSACACEAE	
Dipsacus fullonum	DipsFull
EQUISETACEAE	
Equisetum hyemale ssp. affine	EquiHyem
E. arvense	EquiArve
GENTIANACEAE	
Centaurium davyi	CentDavy
HYPERICACEAE	
Hypericum perforatum	HypePerf
LAMIACEAE	
Mentha pulegium	MentPule
Prunella vulgaris	PrunVulg
LEGUMINOSAE	
Cytisus monspessulanus	*
Lathyrus tingitanus	*
Lotus corniculatus	LotuCorn
Medicago polymorpha	*
Melilotus alba	MeliAlba
Trifolium dubium	*
T. campestre	TrifCamp
T. fucatum	TrifFuca
Vicia disperma	*
V. tetrasperma	*
LILIACEAE	
Brodiaea elegans ssp. elegans	*

Table 2. Plant species recorded at ponds on the Christie Bar (continued).

PLANT SPECIES	TWINSPAN CODE NAMES
TERRESTRIAL SPECIES	
LINACEAE	
Linum bienna	LinuBien
LYTHRACEAE	
Lythrum hyssopifolium	LythHyss
ONAGRACEAE	
Epilobium brachycarpum	EpilBrac
PLANTAGINACEAE	
Plantago lanceolata	PlanLanc
P. major	PlanMajo
POACEAE	
Agrostis stolonifera	AgroStol
Aira caryophyllea	AiraCary
Briza minor	BrizMino
Bromus carinatus var. carinatus	BromCari
Bromus hordeaceus	BromHord
Cynosurus echinatus	CynoEchi
Echinochloa muricata	EchiMuri
Koeleria phleoides	*
Lolium multiflorum	LoliMult
Polypogon interruptus	PolyInte
P. maritimus	PolyInte
P. monspeliensis	PolyMons
Vulpia myuros	VulpMyur
POLYGONACEAE	
Polygonum amphibium var. emersum	PolyAmph
Rumex crispus	RumeCris
R. pulcher	RumePulc
R. salicifolius var. transitorius	RumeSali

Table 2. Plant species recorded at ponds on the Christie Bar (continued).

PLANT SPECIES	TWINSPAN CODE NAMES
TERRESTRIAL SPECIES	
PRIMULACEAE	
Anagallis arvensis	AnagArve
RANUNCULACEAE	*
Ranunculus spp.	
ROSACEAE	
Oemleria cerastiformis	*
Potentilla anserina	PoteAnse
Rubus ursinus	RubuUrsi
RUBIACEAE	
Galium aparine	GaliApar
G. divaricatum	GaliDiva
G. parisiense	*
SALICACEAE	
Populus balsamifera ssp. *trichocarpa*	*
Salix exigua	SaliExig
S. lucida ssp. lasiandra	SaliLuci
S. sitchensis	SaliSitc
S. lasiolepis	SaliLasi
SCROPHULARIACEAE	
Kickxia elatine	KickElat
Mimulus cardinalis	*
Parentucellia viscosa	PareVisc
Veronica americana	VeroAmer
V. anagallis-aquatica	VeroAnag
UMBELLIFERAE	
Oenanthe spp.	OenantSp
Torilis arvensis	*
Daucus carota	DaucCaro

*Plants occurring only once were not included in the study.

APPENDIX B

Table 4. Polygons listed in vegetation types and labeled as shown on the maps. [a]

Vegetation Types and Associated Polygons				
Dry Grassy Banks	Sitka Willow	Shining Willow	Rushes and Reeds	Pondweed
L1	L19	L1015	L1010	L1000
L102	L191	L11	L1011	L1016
L2	L192	L111	L1012	L1017
L3	L902	L15	L1013	L1018
L301	L903	L24	L1014	L1023
L302	Annual Weeds	L26	L1019	L1025
L4	U1	L7	L1020	L1026
L401	U101	L701	L1021	L1027
L5	U111	L8	L1022	L1028
L6	U3	L801	L12	L1029
L601	U303	L9	L121	L1030
Alder Saplings	U313	L901	L13	L1031
L16	U323	Toad Rush	L14	L1032
L161	U333	U2	L141	L1033
L162	U353	U212	L17	L1034
	U363	U222	L171	L1035
	U373	U92	L18	
			L20	U22
	L23		L22	U94
				U95
			U96	

[a]The letter portion within each label represents which pond each plant assemblage occurs in, shown as a polygon on the map. An 'L2', for example, indicates polygon 2 at Lower Christie pond, and 'U2', a different polygon 2 at Upper Christie pond. Species assemblages are described in table 5, appendix C.

APPENDIX C

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions.*

Lower Christie Pond Polygon Descriptions

Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
1	AiraCary	25.0	102	AiraCary	10.0	2	AiraCary	10.0
	AnagArve	0.9		AnagArve	0.9		AnagArve	0.9
	BrizMino	15.0		BrizMino	5.0		BrizMino	5.0
	BromHord	5.0		BromHord	2.0		BromHord	2.0
	CynoEchi	15.0		CynoEchi	5.0		CynoEchi	5.0
	DaucCaro	3.0		DaucCaro	3.0		DaucCaro	1.5
	DipsFull	0.9		EpilBrac	1.0		EpilBrac	0.1
	EpilBrac	1.0		GaliApar	2.0		GaliApar	2.0
	GaliApar	5.0		GaliDiva	2.0		GaliDiva	2.0
	GaliDiva	10.0		HirsInca	5.0		HirsInca	2.5
	HirsInca	5.0		HypoGlab	2.0		HypoGlab	0.9
	HypoGlab	2.0		LinuBien	5.0		JuncBufo	0.9
	LinuBien	10.0		LoliMult	5.0		LinuBien	5.0
	LoliMult	15.0		MeliAlba	50.0		LoliMult	5.0
	PareVisc	5.0		PareVisc	5.0		PareVisc	2.5
	PlanLanc	2.0		PlanLanc	2.0		PlanLanc	0.9
	PolyInte	5.0		PolyInte	2.0		PolyInte	2.0
	RubuUrsi	2.0		RumeCris	0.9		RumeCris	0.9
	RumeCris	0.9		RumeSali	0.9		RumeSali	0.9
	RumeSali	0.9		TrifCamp	10.0		TrifCamp	2.0
	TrifCamp	10.0		VulpMyur	10.0		VulpMyur	10.0
	VulpMyur	20.0						

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

Lower Christie Pond Polygon Descriptions

Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
3	AnagArve	0.9	301	AnthOdor	5.0	302	AnthOdor	0.9
	AnthOdor	5.0		BromCari	5.0		BromCari	0.9
	BaccPilu	0.9		BromHord	2.0		BromHord	0.9
	BromCari	5.0		CynoEchi	2.0		CynoEchi	0.9
	BromHord	2.0		HirsInca	5.0		HirsInca	1.0
	CynoEchi	2.0		HypoGlab	1.0		HypoGlab	0.9
	CypeErag	0.9		LeucVulg	10.0		LeucVulg	1.0
	DaucCaro	1.4		LinuBien	2.0		LinuBien	1.0
	EpilBrac	0.1		LoliMult	5.0		LoliMult	0.9
	HelePube	0.1		LotuCorn	1.0		LotuCorn	0.9
	HirsInca	2.4		PareVisc	2.5		PareVisc	1.0
	HypoGlab	0.9		PicrEchi	1.0		PicrEchi	0.9
	JuncBola	0.9		PlanLanc	5.0		PlanLanc	0.9
	JuncBufo	0.9		PolyInte	2.0		PolyInte	0.9
	LinuBien	4.8		RumeCris	5.0		RumeCris	0.9
	LoliMult	5.0		TrifCamp	1.0		TrifCamp	0.9
	LotuCorn	0.9		VeroAnag	0.9		VeroAnag	0.9
	PareVisc	2.4		XantStru	0.9		XantStru	0.9
	PlanLanc	0.9						
	PolyInte	2.0						
	RumeCris	0.9						
	RumeSali	0.9						
	TrifCamp	2.0						

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

Lower Christie Pond Polygon Descriptions								
Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
4	AiraCary	5.0	401	AiraCary	2.0	401(cont.)	TrifCamp	2.0
	AnagArve	0.9		AnagArve	0.9		VulpMyur	2.0
	BaccPilu	0.9		ArteDoug	0.9		XantStru	0.9
	BrizMino	3.0		BaccPilu	0.9			
	BromHord	2.0		BrizMino	1.0			
	CentDavy	0.9		BromHord	2.0			
	CynoEchi	2.0		CentDavy	0.9			
	DaucCaro	1.5		CynoEchi	2.0			
	EpilBrac	0.1		DaucCaro	1.5			
	GaliApar	0.9		DipsFull	0.9			
	GaliDiva	0.9		EpilBrac	0.1			
	HirsInca	2.5		EuthOcci	0.9			
	HypoGlab	0.9		GaliApar	0.9			
	JuncBola	0.9		GaliDiva	0.9			
	JuncBufo	0.9		HirsInca	2.5			
	LinuBien	3.0		HypoGlab	0.9			
	LoliMult	3.0		JuncBola	0.9			
	LotuCorn	0.9		JuncPate	0.9			
	MeliAlba	10.0		LeucVulg	0.9			
	PareVisc	2.5		LinuBien	3.0			
	PlanLanc	0.9		LoliMult	3.0			
	PolyInte	2.0		LotuCorn	0.9			
	RumeCris	3.0		MeliAlba	10.0			
	RumeSali	2.0		PareVisc	2.5			
	TrifCamp	2.0		PlanLanc	0.9			
	VulpMyur	5.0		PolyInte	2.0			
	XantStru	0.9		RumeCris	3.0			
				RumeSali	2.0			

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

			Lower Christie Pond Polygon Descriptions					
Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
5	AiraCary	2.0	5 (cont.)	MentPule	0.9	6 (cont.)	HypePerf	0.9
	AlnuRubr	5.0		PareVisc	2.5		HypoGlab	0.9
	AnagArve	0.9		PlanLanc	0.9		JuncBola	0.9
	ArteDoug	0.9		PolyInte	2.0		JuncSupi	2.0
	BaccPilu	0.9		RumeCris	3.0		LeucVulg	0.9
	BrizMino	1.0		RumeSali	2.0		LinuBien	3.0
	BromHord	2.0		SaliLuci	0.1		LoliMult	3.0
	CentDavy	0.9		SaliSitc	0.9		LotuCorn	0.9
	CynoEchi	2.0		TrifCamp	2.0		MeliAlba	90.0
	CypeErag	0.9		VulpMyur	2.0		PareVisc	2.5
	DaucCaro	1.5		XantStru	0.9		PlanLanc	0.9
	DipsFull	0.9					PolyInte	2.0
	EpilBrac	0.1	6	AiraCary	2.0		RumeCris	3.0
	EquiArve	4.0		AlnuRubr	5.0		RumeSali	2.0
	EuthOcci	0.9		AnagArve	0.9		TrifCamp	2.0
	GaliApar	0.9		ArteDoug	0.9		VulpMyur	2.0
	GaliDiva	0.9		BaccPilu	0.9		XantStru	0.9
	HirsInca	2.5		BrizMino	1.0			
	HypePerf	0.9		BromHord	2.0			
	HypoGlab	0.9		CentDavy	0.9			
	JuncBola	5.0		CynoEchi	2.0			
	JuncBufo	4.0		DaucCaro	1.5			
	JuncSupi	2.0		DipsFull	0.9			
	LeucVulg	0.9		EpilBrac	0.1			
	LinuBien	3.0		EuthOcci	0.9			
	LoliMult	3.0		GaliApar	0.9			
	LotuCorn	0.9		GaliDiva	0.9			
	MeliAlba	10.0		HirsInca	2.5			

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

Lower Christie Pond Polygon Descriptions

Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
601	AiraCary	10.0	601	RumeCris	3.0	7	VeroAnag	0.9
	AlnuRubr	5.0	(cont.)	RumeSali	2.0	(cont.)	VulpMyur	1.0
	AnagArve	0.9		TrifCamp	2.0			
	ArteDoug	0.9		VulpMyur	10.0	701	AgroStol	2.0
	BaccPilu	0.9		XantStru	0.9		AiraCary	1.0
	BrizMino	5.0					BrizMino	1.0
	BromHord	2.0	7	AgroStol	5.0		BromHord	1.0
	CentDavy	0.9		AiraCary	1.0		CynoEchi	1.0
	CynoEchi	5.0		BrizMino	1.0		CypeErag	0.9
	DaucCaro	1.5		BromHord	1.0		GaliApar	0.9
	DipsFull	0.9		CynoEchi	1.0		GaliDiva	0.9
	EpilBrac	0.1		CypeErag	2.0		JuncBufo	0.9
	EuthOcci	0.9		GaliApar	0.9		LinuBien	1.3
	GaliApar	2.0		GaliDiva	0.9		LoliMult	0.9
	GaliDiva	2.0		JuncBufo	0.9		MentPule	50.0
	HirsInca	2.5		LinuBien	2.0		PareVisc	0.9
	HypePerf	0.9		LoliMult	2.0		PolyInte	1.0
	HypoGlab	0.9		MeliAlba	0.9		PoteAnse	0.9
	JuncBola	0.9		MentPule	85.0		RumeCris	0.9
	JuncSupi	2.0		PareVisc	0.9		RumeSali	5.0
	LeucVulg	0.9		PolyInte	1.0		SaliExig	0.9
	LinuBien	5.0		PoteAnse	0.9		SaliLuci	2.0
	LoliMult	5.0		RumeCris	0.9		SaliSitc	0.9
	LotuCorn	0.9		RumeSali	5.0		VeroAmer	2.0
	MeliAlba	50.0		SaliExig	0.9		VeroAnag	0.9
	PareVisc	2.5		SaliLuci	5.0		VulpMyur	1.0
	PlanLanc	0.9		SaliSitc	0.9			
	PolyInte	2.0		VeroAmer	5.0			

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

			Lower Christie Pond Polygon Descriptions					
Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
8	AgroStol	7.6	801	AgroStol	18.0	9	AgroStol	10.0
	CentDavy	0.9		CentDavy	0.9		AlnuRubr	0.9
	CypeErag	0.9		CypeErag	5.0		CypeErag	5.0
	EquiArve	0.9		EpilBrac	0.9		EquiArve	0.9
	HelePube	0.1		EuthOcci	0.9		JuncBola	15.0
	LythHyss	0.9		JuncBola	2.0		JuncSupi	5.0
	MeliAlba	76.9		JuncSupi	3.0		LythHyss	0.9
	MentPule	4.9		LoliMult	2.0		MeliAlba	5.0
	PareVisc	5.0		LotuCorn	3.0		MentPule	3.5
	PlanMajo	0.9		MeliAlba	20.0		PareVisc	10.0
	PoteAnse	0.9		MentPule	4.0		RumeCris	0.9
	RumeCris	2.4		PareVisc	4.0		RumeSali	2.0
	RumeSali	2.4		PlanMajo	0.9		SaliExig	2.0
	SaliExig	0.9		PolyInte	2.0		SaliLuci	5.0
	SaliLuci	4.9		PolyMari	0.9		SaliSitc	0.9
	SaliSitc	0.9		PolyMons	2.0		TyphLati	0.1
				PoteAnse	1.0		VeroAmer	0.9
				RumeCris	5.0		VeroAnag	0.9
				RumeSali	5.0			
				SaliLuci	35.0			
				SaliSitc	1.0			
				VeroAmer	2.0			
				VeroAnag	2.0			

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

Lower Christie Pond Polygon Descriptions

Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
901	AgroStol	8.0	902	ChenPumi	1.0	903	ChenPumi	1.0
	AlnuRubr	1.0		CypeErag	1.0		EpilBrac	0.9
	ArteDoug	0.9		EpilBrac	0.9		EquiArve	40.0
	ChenPumi	0.9		EquiArve	5.0		GnapPalu	0.9
	CotuCoro	1.0		GnapPalu	0.9		HirsInca	1.0
	CypeErag	2.7		HirsInca	1.0		HypoGlab	0.9
	EquiArve	1.6		HypoGlab	0.9		SaliExig	0.9
	ErecMini	0.9		JuncSupi	1.0		SaliLuci	1.0
	JuncBola	8.3		PolyMons	1.0			
	JuncBufo	3.6		SaliExig	0.9			
	JuncSupi	4.0		SaliLuci	1.0			
	LythHyss	0.9						
	MeliAlba	2.7						
	MentPule	1.9						
	PareVisc	5.3						
	RumeCris	0.9						
	RumeSali	1.0						
	SaliExig	1.0						
	SaliLuci	2.7						
	SaliSitc	0.9						
	TyphLati	0.1						
	VeroAmer	0.9						
	VeroAnag	0.9						

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

Lower Christie Pond Polygon Descriptions								
Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
11	AlnuRubr	0.9	111	PareVisc	0.9	121	AgroStol	5.0
	CentDavy	0.9	(cont.)	PolyInte	0.9		AlisPlan	0.9
	CypeErag	90.0		RumeCris	0.1		AlnuRubr	0.9
	EpilBrac	0.9		RumeSali	0.9		CypeErag	25.0
	EquiArve	5.0		SaliLuci	5.0		EquiArve	5.0
	EuthOcci	2.0		SaliSitc	0.9		JuncBola	5.0
	HelePube	0.1		ScirMicr	0.9		JuncPate	0.9
	JuncBola	5.0		VeroAmer	0.9		JuncSupi	0.9
	LeucVulg	0.9					JuncXiph	0.9
	PareVisc	0.9	12	AgroStol	5.0		LythHyss	0.9
	PolyInte	0.9		AlisPlan	0.9		MentPule	4.0
	RumeCris	0.1		CypeErag	85.0		PareVisc	0.9
	RumeSali	0.9		EquiArve	5.0		PolyInte	2.0
	SaliLuci	5.0		JuncBola	5.0		RumeCris	0.9
	SaliSitc	0.9		JuncPate	0.9		RumeSali	10.0
	ScirMicr	0.9		JuncSupi	0.9		SaliExig	0.9
	VeroAmer	0.9		JuncXiph	0.9		SaliLuci	0.9
				MentPule	4.0		TyphLati	0.9
111	AlnuRubr	0.9		PareVisc	0.9		VeroAmer	70.0
	CentDavy	0.9		PolyInte	2.0		OenantSp	5.0
	CypeErag	70.0		SaliExig	0.9			
	EpilBrac	0.9		SaliLuci	0.9			
	EquiArve	5.0		TyphLati	5.0			
	EuthOcci	2.0		VeroAmer	2.0			
	HelePube	0.1						
	JuncBola	5.0						
	LeucVulg	0.9						

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

			Lower Christie Pond Polygon Descriptions					
Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
13	AgroStol	50.0	14	AgroStol	5.0	15	AgroStol	10.0
	AlisPlan	5.0		AlisPlan	2.0		AlnuRubr	0.9
	AlnuRubr	0.9		EquiArve	5.0		CentDavy	0.9
	CypeErag	5.0		JuncBola	5.0		CypeErag	10.0
	EquiArve	10.0		JuncSupi	95.0		EquiArve	5.0
	EuthOcci	2.5		MentPule	2.0		EquiHyem	1.0
	JuncBola	5.4		PolyInte	0.9		JuncBola	15.0
	JuncSupi	30.0		RumeSali	5.0		JuncPate	0.9
	JuncXiph	2.0		VeroAnag	0.9		JuncSupi	5.0
	LythHyss	0.9		OenantSp	2.0		LythHyss	1.0
	MeliAlba	2.0					MeliAlba	15.4
	MentPule	0.9	141	AgroStol	4.8		MentPule	10.0
	PareVisc	0.9		AlisPlan	2.0		PareVisc	4.0
	PolyInte	0.9		CypeErag	4.8		PoteAnse	5.0
	PoteAnse	0.9		EquiArve	4.8		RumeCris	0.9
	RumeCris	2.9		JuncBola	9.5		RumeSali	10.0
	RumeSali	2.0		JuncSupi	75.0		SaliLuci	10.0
	SaliExig	2.0		MentPule	9.5		SaliSitc	5.0
	SaliLuci	2.5		PolyInte	0.9		SoncAspe	0.9
	SaliSitc	0.9		RumeSali	4.8		TyphLati	5.0
	SparEmer	0.1		VeroAnag	0.9		VeroAmer	5.0
	VeroAmer	3.0		OenantSp	2.0		VeroAnag	1.0
	VeroAnag	2.0					OenantSp	0.9
	OenantSp	10.0						

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

Lower Christie Pond Polygon Descriptions								
Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
16	AiraCary	2.0	161	AiraCary	0.9	162	AiraCary	1.2
	AlnuRubr	95.0		AlnuRubr	20.0		AnapMarg	0.1
	AnapMarg	0.1		BrizMino	0.9		BrizMino	0.9
	BrizMino	0.9		BromHord	0.9		BromHord	1.2
	BromHord	2.0		CynoEchi	0.9		CentDavy	1.0
	CentDavy	1.0		CypeErag	30.0		CynoEchi	1.2
	CynoEchi	2.0		EpilBrac	0.9		CypeErag	10.0
	CypeErag	10.0		ErecMini	2.0		DaucCaro	2.0
	DaucCaro	2.0		GaliApar	0.9		DipsFull	0.9
	DipsFull	0.9		GaliDiva	5.0		EpilBrac	2.0
	EpilBrac	2.0		GnapPalu	0.9		ErecMini	5.0
	ErecMini	2.0		HypePerf	0.9		GaliApar	0.9
	GaliApar	0.9		LeucVulg	2.0		GaliDiva	4.2
	GaliDiva	5.0		LinuBien	0.9		HirsInca	15.0
	HirsInca	5.0		LoliMult	0.9		HypePerf	0.9
	HypePerf	0.9		MeliAlba	50.0		LeucVulg	2.0
	LeucVulg	2.0		PareVisc	0.9		LinuBien	1.4
	LinuBien	3.0		PolyInte	2.0		LoliMult	1.4
	LoliMult	3.0		RumeCris	0.9		LoniInvo	0.9
	LoniInvo	0.9		RumeSali	2.0		MeliAlba	10.0
	MeliAlba	5.0		VulpMyur	0.9		MentPule	2.0
	MentPule	2.0					PareVisc	1.0
	PareVisc	1.0					PolyInte	2.0
	PolyInte	2.0					RubuUrsi	1.0
	RubuUrsi	1.0					RumePulc	0.9
	RumePulc	0.9					RumeSali	0.9
	RumeSali	0.9					SoncAspe	0.9
	SoncAspe	0.9					VulpMyur	1.2
	VulpMyur	2.0						

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

Lower Christie Pond Polygon Descriptions

Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
17	AlisPlan	0.9	171	AlisPlan	0.9	18	AgroStol	3.0
	EquiArve	10.0		EpilBrac	1.0		AlisPlan	0.9
	HypoGlab	0.9		EquiArve	10.0		CentDavy	2.0
	JuncBola	3.0		HypoGlab	0.9		CypeErag	4.0
	JuncSupi	30.0		JuncBola	3.0		EpilBrac	0.9
	MentPule	5.0		JuncBufo	5.0		JuncBola	3.0
	PareVisc	5.0		JuncSupi	30.0		JuncSupi	55.0
	PolyMari	3.0		MentPule	5.0		JuncXiph	2.0
	PolyMons	5.0		PareVisc	5.0		LythHyss	0.9
	RumeCris	3.0		PolyMari	3.0		PareVisc	0.9
	RumeSali	1.0		PolyMons	5.0		PolyInte	0.9
	SaliLuci	0.9		RumeCris	3.0		PolyMons	3.0
	SaliSitc	0.9		RumeSali	1.0		RoriNast	8.0
	TyphLati	0.1		SaliLuci	0.9		SaliExig	0.9
	VeroAnag	8.0		SaliSitc	0.9		SaliLuci	0.9
				TrifFuca	0.1		SaliSitc	0.9
				TyphLati	0.1		VeroAnag	3.0
				VeroAnag	8.0			

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

				Lower Christie Pond Polygon Descriptions				
Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
19	AgroStol	0.9	191	AgroStol	0.9	20	MentPule	60.0
	AlnuRubr	1.0		AlnuRubr	1.0		PolyInte	0.9
	BaccPilu	1.0		BaccPilu	1.0		PolyMons	0.9
	CentDavy	0.9		CentDavy	0.9		VeroAnag	2.0
	CypeErag	1.0		CypeErag	20.0			
	DaucCaro	1.0		DaucCaro	1.0	22	CentDavy	0.9
	EpilBrac	0.9		EpilBrac	0.9		ErecMini	0.9
	EquiArve	0.9		EquiArve	0.9		GnapStra	0.9
	ErecMini	0.9		ErecMini	0.9		JuncBola	2.0
	EuthOcci	10.0		EuthOcci	10.0		PareVisc	2.0
	GnapPalu	0.9		GnapPalu	0.9		PolyMons	0.9
	HirsInca	3.0		HirsInca	3.0		RumeCris	0.9
	HypoGlab	1.0		HypoGlab	1.0		VeroAmer	2.0
	JuncBufo	0.9		JuncBufo	0.9		VeroAnag	50.0
	JuncPate	0.9		JuncPate	0.9			
	LeucVulg	0.9		LeucVulg	0.9	23	ChenPumi	1.0
	LinuBien	0.9		LinuBien	0.9		CypeErag	5.0
	LotuCorn	0.9		LotuCorn	0.9		GnapPalu	1.0
	MeliAlba	0.9		MeliAlba	0.9		HirsInca	1.0
	MentPule	0.9		MentPule	0.9		LythHyss	0.9
	RumeCris	3.0		RumeCris	3.0		MeliAlba	10.0
	RumeSali	2.0		RumeSali	2.0		PolyMari	3.0
				SaliLuci	1.0		TrifFuca	1.0
				VeroAnag	0.1			

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

Lower Christie Pond Polygon Descriptions

Polygon	Species	% Cover
24	CypeErag	10.0
	EquiArve	0.9
	JuncBufo	5.0
	JuncSupi	1.0
	LythHyss	0.9
	MeliAlba	30.0
	PareVisc	0.9
	PolyMari	1.0
	SileGall	0.4
	TyphLati	30.0
	VeroAnag	0.9
26	AlnuRubr	20.0
	CentDavy	3.0
	CypeErag	1.0
	EquiHyem	25.0
	EuthOcci	20.0
	JuncBola	20.0
	LeucVulg	3.0
	PareVisc	1.0
	PoteAnse	3.0
	SaliSitc	3.0
1000	AlisPlan	30.0
	CallStag	5.0
	RoriNast	5.0
	SaliExig	0.9
	SaliLuci	5.0
1000 (cont.)	SoncAspe	0.1
	SparEmer	30.0
	TyphLati	5.0
1010	AgroStol	4.0
	AlisPlan	13.0
	CallStag	2.0
	EquiArve	10.0
	EuthOcci	1.0
	JuncBola	2.0
	JuncSupi	15.0
	PareVisc	1.0
	RumeSali	1.0
	SaliLuci	0.9
	SparEmer	2.0
	VeroAnag	2.0
	OenantSp	5.0
1011	AgroStol	4.0
	AlisPlan	30.0
	CallStag	2.0
	EquiArve	10.0
	EuthOcci	1.0
	JuncBola	2.0
	JuncSupi	15.0
	PareVisc	1.0
	RumeSali	1.0
	SaliLuci	0.9
1011 (cont.)	SparEmer	2.0
	VeroAnag	2.0
	OenantSp	5.0
1012	AlisPlan	10.0
	EquiArve	4.0
	EuthOcci	1.0
	JuncBola	8.0
	JuncSupi	40.0
	PolyMons	2.0
	PoteAnse	1.0
	RumeSali	1.0
	TyphLati	30.0
	VeroAnag	0.9

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

Lower Christie Pond Polygon Descriptions

Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
1013	AgroStol	3.0	1015	AlnuRubr	8.0	1017	CallStag	5.0
	AlisPlan	0.9		CentDavy	1.0		JuncSupi	20.0
	CallStag	0.9		CypeErag	5.3		SparEmer	75.0
	CypeErag	2.0		EquiArve	2.0		TyphLati	10.0
	JuncBola	2.0		GnapStra	0.9		VeroAnag	1.0
	JuncBufo	0.9		JuncBola	30.0		OenantSp	0.9
	JuncSupi	2.0		JuncSupi	5.0			
	MeliAlba	0.9		JuncXiph	2.0	1018	AlisPlan	1.0
	MentPule	2.0		LythHyss	0.9		CallStag	0.9
	PareVisc	3.0		MeliAlba	3.0		JuncSupi	15.0
	PolyInte	0.9		MentPule	6.0		PolyMons	0.9
	RumeCris	2.0		PareVisc	5.0		TyphLati	20.0
	RumeSali	5.0		PolyMons	2.0		VeroAnag	3.0
	SaliLuci	8.0		PoteAnse	8.0			
	TyphLati	70.0		SaliLuci	0.9	1019	AlisPlan	20.0
	VeroAnag	3.0		TyphLati	35.0		CentDavy	1.0
				VeroAmer	0.9		JuncBola	1.0
1014	AgroStol	2.0		VeroAnag	1.0		JuncBufo	3.0
	AlisPlan	1.0		OenantSp	3.0		MentPule	2.0
	EquiArve	10.0					PareVisc	2.0
	JuncBola	2.0	1016	AlisPlan	1.0		PolyInte	1.0
	JuncSupi	2.0		CallStag	1.0		SparEmer	2.0
	RumeSali	4.0		EquiArve	1.0		VeroAnag	25.0
	SparEmer	1.0		JuncSupi	20.0		OenantSp	1.0
	TyphLati	65.0		UnknSubm	5.0			
	OenantSp	10.0						

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

Lower Christie Pond Polygon Descriptions

Polygon	Species	% Cover
1020	MentPule	60.0
	PolyInte	0.9
	PolyMons	0.9
	VeroAnag	2.0
1021	AgroStol	2.0
	CentDavy	0.9
	JuncBola	1.0
	JuncSupi	98.0
	MeliAlba	0.9
	MentPule	0.9
	PolyMons	0.9
	RoriNast	1.0
	RumeSali	5.0
	TyphLati	2.0
	VeroAmer	2.0
	VeroAnag	2.0
1022	CentDavy	0.9
	ErecMini	0.9
	GnapStra	0.9
	JuncBola	2.0
	PareVisc	2.0
	PolyMons	0.9
	RumeCris	0.9
	VeroAmer	2.0
	VeroAnag	50.0
1023	AlisPlan	5.0

Polygon	Species	% Cover
	CallStag	1.0
	JuncSupi	65.0
	PolyMons	1.0
	RoriNast	2.0
	TyphLati	5.0
1025	AlisPlan	1.0
	CallStag	4.0
	HippVulg	0.9
	JuncSupi	20.0
	TyphLati	1.0
	UnknSubm	15.0
1026	AlisPlan	1.0
	CallStag	4.0
	JuncSupi	20.0
	RoriNast	15.0
	TyphLati	1.0
	UnknSubm	1.0
1027	AgroStol	2.0
	AlisPlan	1.0
	CallStag	17.0
	JuncSupi	20.0
	PotaFoli	1.0
	TyphLati	2.0
	UnknSubm	1.0
1028	AgroStol	5.0
	CallStag	40.0

Polygon	Species	% Cover
	CharSp.	5.0
	JuncSupi	10.0
	SparEmer	10.0
	TyphLati	1.0
	UnknSubm	20.0
1029	SparEmer	100.0
1030	AgroStol	1.0
	AlisPlan	1.0
	CallStag	15.0
	CharSp.	15.0
	JuncSupi	1.0
	PotaFoli	30.0
	PotaNata	1.0
	SparEmer	1.0
	TyphLati	1.0
	UnknSubm	20.0
1031	CallStag	0.9
	JuncSupi	8.0
	PoteAnse	0.9
	SparEmer	60.0
	UnknSubm	0.9

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

			Lower Christie Pond Polygon Descriptions					
Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
1032	CallStag	0.9						
	JuncSupi	2.0						
	PoteAnse	0.9						
	SparEmer	95.0						
	UnknSubm	0.9						
1033	PotaNata	100.0						
1034	AgroStol	0.9						
	TyphLati	83.0						
1035	JuncSupi	15.0						
	SparEmer	5.0						

End of Lower Christie Pond descriptions. Upper Christie Pond continues on next page.

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

Upper Christie Pond Polygon Descriptions								
Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
1	AlnuRubr	0.9	101	AlnuRubr	0.9	111	AlnuRubr	0.9
	BaccPilu	0.9		BaccPilu	0.9		BaccPilu	0.9
	CentDavy	0.9		CentDavy	0.9		CentDavy	0.9
	CypeErag	3.5		CypeErag	1.7		CypeErag	22.5
	EpilBrac	0.9		EpilBrac	0.9		EpilBrac	0.9
	EuthOcci	0.9		EuthOcci	0.9		EuthOcci	0.9
	GnapPalu	0.9		GnapPalu	0.9		GnapPalu	0.9
	GnapStra	0.9		GnapStra	0.9		GnapStra	0.9
	HirsInca	0.9		HirsInca	0.9		HirsInca	0.9
	HypoGlab	0.9		HypoGlab	0.9		HypoGlab	0.9
	JuncBola	7.5		JuncBola	1.0		JuncBola	2.0
	JuncBufo	7.5		JuncBufo	1.7		JuncBufo	20.0
	JuncXiph	1.0		JuncXiph	0.9		JuncXiph	1.0
	MeliAlba	0.9		MeliAlba	0.9		MeliAlba	0.9
	PlanLanc	0.9		PlanLanc	0.9		PlanLanc	0.9
	PolyMons	0.9		PolyMons	0.9		PolyMons	0.9
	SaliLuci	12.5		SaliLuci	5.0		SaliLuci	5.0
	SaliSitc	87.5		SaliSitc	35.0		SaliSitc	20.0
	VeroAmer	0.9		VeroAmer	0.9		VeroAmer	0.9
	VeroAnag	0.9		VeroAnag	0.9		VeroAnag	0.9

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

Upper Christie Pond Polygon Descriptions

Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
2	AgroStol	3.5	212	AgroStol	5.0	222	AlnuRubr	0.9
	BaccPilu	0.1		AlnuRubr	0.9		BaccPilu	0.1
	CallStag	0.9		BaccPilu	0.1		CallStag	0.9
	EpilBrac	0.9		CallStag	0.9		CentDavy	0.9
	EquiArve	1.0		CentDavy	0.9		CypeErag	5.0
	EuthOcci	0.9		EpilBrac	0.9		EpilBrac	0.9
	JuncBola	12.5		EquiArve	25.0		EquiArve	60.0
	JuncBufo	32.5		EuthOcci	0.9		EuthOcci	0.9
	LythHyss	0.9		JuncBola	3.0		JuncBola	0.9
	MentPule	0.9		JuncBufo	23.3		JuncBufo	0.9
	PareVisc	0.9		LythHyss	0.9		JuncXiph	0.9
	PolyAmph	0.1		MentPule	0.9		LythHyss	0.9
	PolyMons	3.0		PareVisc	0.9		MeliAlba	3.8
	RoriNast	1.0		PolyAmph	0.1		MentPule	0.9
	RubuUrsi	0.1		PolyInte	0.9		PareVisc	0.9
	SaliExig	0.1		PolyMons	3.0		PolyAmph	0.1
	SaliLuci	1.0		RoriNast	1.0		PolyInte	0.9
	SaliSitc	0.8		RubuUrsi	0.1		PolyMons	0.9
	TyphLati	0.9		SaliExig	0.9		RoriNast	1.0
	VeroAmer	0.9		SaliLuci	0.9		RubuUrsi	0.1
	VeroAnag	0.9		SaliSitc	0.9		SaliExig	0.9
				TyphLati	0.9		SaliLuci	17.5
				VeroAmer	0.9		SaliSitc	0.9
				VeroAnag	0.9		TyphLati	0.9
							VeroAmer	0.9
							VeroAnag	0.9

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

Upper Christie Pond Polygon Descriptions

Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
3	AnagArve	0.9	303	AgroStol	2.0	313	AnagArve	0.9
	CentDavy	0.9		AnagArve	0.9		CentDavy	0.9
	ChenPumi	1.5		BaccPilu	0.9		ChenPumi	1.5
	CypeErag	0.9		BromHord	2.0		CypeErag	7.5
	EpilBrac	0.9		CentDavy	0.9		EpilBrac	0.9
	ErecMini	0.9		ChenPumi	0.9		ErecMini	0.9
	EuthOcci	1.0		CypeErag	5.0		EuthOcci	1.0
	GnapPalu	0.9		EchiMuri	0.9		GnapPalu	0.9
	HirsInca	3.5		EpilBrac	0.9		HirsInca	0.9
	JuncBufo	0.9		EquiArve	0.9		JuncBufo	0.9
	MeliAlba	70.0		ErecMini	0.9		MeliAlba	60.0
	PlanLanc	1.0		EuthOcci	0.9		PlanLanc	1.0
	PolyMons	2.5		GnapPalu	0.9		PolyMons	2.5
	SaliLuci	3.0		GnapStra	0.9		SaliLuci	3.0
	SaliSitc	0.9		HirsInca	0.9		SaliSitc	10.0
	SoncAspe	0.9		JuncBufo	2.0		SoncAspe	0.9
	XantStru	0.9		MeliAlba	0.9		XantStru	0.9
				MentPule	0.9			
				PlanLanc	4.0			
				PlanMajo	0.9			
				PolyMons	3.5			
				SaliLuci	0.9			
				SaliSitc	7.5			
				SoncAspe	0.9			
				XantStru	1.0			

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

Upper Christie Pond Polygon Descriptions								
Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
323	AgroStol	0.9	333	AnagArve	0.9	343	AgroStol	2.0
	ChenPumi	0.9		CentDavy	0.9		AnagArve	1.0
	EquiArve	0.9		ChenPumi	0.9		BaccPilu	0.9
	ErecMini	0.9		CypeErag	3.0		BromHord	2.0
	GnapStra	0.9		EpilBrac	0.9		CentDavy	0.9
	HirsInca	0.9		ErecMini	0.9		ChenPumi	0.9
	MeliAlba	7.5		EuthOcci	1.0		CypeErag	0.9
	PareVisc	0.9		GnapPalu	0.9		EchiMuri	0.9
	PetrDubi	0.9		HirsInca	0.9		EpilBrac	0.9
	PlanLanc	0.9		JuncBufo	0.9		EquiArve	0.9
	PolyMari	0.9		MeliAlba	20.8		ErecMini	0.9
	RumeCris	0.9		PlanLanc	1.0		EuthOcci	0.9
	XantStru	0.9		PolyMons	0.9		GnapPalu	0.9
				SaliLuci	2.0		GnapStra	0.9
				SaliSitc	3.0		HirsInca	0.9
				SoncAspe	0.9		JuncBufo	0.9
				XantStru	0.9		MeliAlba	0.9
							MentPule	1.0
							PlanLanc	4.0
							PolyMons	3.5
							SaliLuci	1.5
							SaliSitc	0.9
							SoncAspe	0.9
							XantStru	1.0

Table 5. Species assemblages. These are the polygons and their descriptions. The lower 3-year old pond descriptions are first, followed by the newer upper pond descriptions (continued).*

Upper Christie Pond Polygon Descriptions								
Polygon	Species	% Cover	Polygon	Species	% Cover	Polygon	Species	% Cover
353	AiraCary	0.9	373	AnagArve	0.9	92	CypeErag	6.2
	BaccPilu	0.9		ArteDoug	0.9		EpilBrac	0.9
	BromHord	0.9		BrizMino	0.9		JuncBufo	12.5
	CentDavy	0.9		ChenPumi	0.9		JuncSupi	0.1
	ChenPumi	2.0		CypeErag	0.9		LythHyss	1.8
	CypeErag	5.0		EpilBrac	0.9		MentPule	0.9
	DaucCaro	0.9		HirsInca	6.0		PolyMons	15.4
	HirsInca	15.0		LythHyss	0.9		RoriNast	5.0
	JuncBufo	0.9		MeliAlba	40.0		SaliExig	0.9
	LoliMult	1.0		PlanLanc	0.9		SaliLuci	0.9
	MeliAlba	17.5		PolyAmph	0.9		SaliSitc	0.9
	PlanLanc	0.9		PolyMons	0.9		TyphLati	2.5
	PolyAmph	0.9		SaliSitc	0.9		VeroAmer	0.9
	PolyMons	3.0						
						94	PolyMons	1.0
363	HirsInca	1.0					TyphLati	19.0
	KickElat	0.1						
	MeliAlba	1.0				95	PotaNata	95.0
						96	AgroStol	2.0
							CharSp.	0.9
							PolyMons	10.0
						22	SparEmer	100.0

* Polygons are labelled by the numerical part of their label only. The text portion of the original labels, eg. Aa101, tells which transect and which mapping unit. The numerical portion refers to the vegetation description. All labels '101' have the same description if on the same pond, regardless of where they occur on that pond.

Appendix D. Table 6. TWINSPAN table displaying the cover value distribution of ordered species and polygons.

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                                                                              Polygons*

              11   11      111         1       111111112222222222222222211112222222222222222222222222222221111111111111122222222222222                    1111111111111111111        1111111222222222222222222222221222222222111111111          111111111      11111111 111222  1111   11    11 2
             388913368913  12 12024     11133481 1225780245588811334455777788897899001123334445555566667777788896677894668889900001122223334411112334445557778900012233344555556889222567991123990000111122222334456694556788623344677772233334444555666677789012245567755799900122167646668884413458890366780966
     Species 612853540742189421633345673457863632255384440605969165637024716901889895800250140124834591356825716723719342343401460212373787806783495784674569056775667856127895160078108451295572357134745689493962822596938721428246899190123123402312351297623011359578971238907891097080040989044590067061681

  7 AnthOdor ----------------------------------333333333333331---------------------------------------------------------------------------------------------------------------------------------------------------------- 000000
 11 BromCari ----------------------------------333333333333331---------------------------------------------------------------------------------------------------------------------------------------------------------- 000000
 44 LinuBien 111112222222444433333322222223222333333333322321--------------------------------------11111------------------22---1-21--------1---------------------------------------------------------------------------- 000000
 45 LoliMult 111112222222444433333322222223222333333333333331-------------------------1------1-----------------------------21---1-21----2-2-12-----2-2-2--2-222------------------------------------------------------ 000000
 53 PicrEchi ------------------------------------------1--11-------------------------------------------------------------------------------------------------------------------------------------------------------- 000000
 75 TrifCamp -----------44442242222222222222222222222222-2211-------------------------------------------------------------------------------------------------------------------------------------------------------- 000000
  2 AiraCary 111112222222555544444432223222422----------------------------------------1------1-----------------------------11---1-11--------1---------------------------------------------------------------------------- 000001
 10 BrizMino 11111111111114444333333211121113111----------------------------------------11--1--11-11-11--------------------11-----1----------------------------------------------------------------------------------- 000001
 12 BromHord 1111122222222333322222222222222222222222222222221------------------22-------2--2-1--2---1-----------------------11---1-11--------1---------------------------------------------------------------------------- 000001
 18 CynoEchi 11111222222224444333333222222232222222222222222221-------------------------------------------------------------11---1-11--------1---------------------------------------------------------------------------- 000001
 20 DaucCaro --2222222222222211211111111111111111111111111-11-------------------------1------1------------11111-------------------------------------------------------------------------------------------------------- 000001
 28 GaliApar 1111111111113333222222111111112111-------------------------------------------------------------------------------11-----1----------------------------------------------------------------------------------- 000001
 81 VulpMyur 111112222222555544444432223222422-------------------------------------------------------------------------------11---1-11--------1---------------------------------------------------------------------------- 000001
  6 AnapMarg --1111111111------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------ 00001
 21 DipsFull --11111111111-11-------111-1111111------------------------------------------------------------------------------------------------------------------------------------------------------------------------ 00001
 29 GaliDiva 33333333333334444222222111111112111-------------------------------------------------------------------------------11-----1----------------------------------------------------------------------------------- 00001
 35 HypePerf 111111111111------------11--111111------------------------------------------------------------------------------------------------------------------------------------------------------------------------ 00001
 43 LeucVulg 222222222222-----------111-1111111----------4--41-----------------------------------------11111---------------------------------------------111111-1-1-2-------------------------------------------------------- 00001
 46 LoniInvo --1111111111------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------ 00001
 66 RumePulc --1111111111------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------ 00001
  5 AnagArve ------------111111111111111111111111111111111-11---------------111111111111111-111111-11111111------------------------------------------------------------------------------------------------------------ 000100
  8 ArteDoug ----------------------111-1111111------------------------------------------11--1--11-11-11--------------------------------------------1---1---------------------------------------------------------------- 000100
 26 ErecMini 223333222222-------------------------------------111111--1-----1---111111111111111---11-1-----1----1----11111----------------------------------------1---1--------------------------------1--1--------------------- 000100
 34 HirsInca --44443333333333223222222222222222222222222223223111111111111111111211111111111211433113243313313311111122222111111111111111111------------------------------------------------------------------------- 000100
 47 LotuCorn ------------------111111111111111111111111111----------------------------------------11111------------------------------2-2--2-----2-2-2--2-222------------------------------------------------------------ 000100
 54 PlanLanc -----------222211211111111111111111111111131131111111--1------1---12211111111211211112111111111111-------11111111111111111-------------------------------------------------------------------------------- 000100
 83 XantStru ----------------------111111111111--------------1-11111111--1------1---111111111111111---11-1--1--1------------------------------------------------------------------------------------------------------------ 000100
 23 EpilBrac 1122222222222111111111111111111111111111111111-11------------------11111111111111-111111-11111111111111111111-11111111111111111-------------1-1--1------1-1-1--1--111111111-1-1--111111111111111111111111-1111111---1-11------------------1--1-------- 000101
 64 RubuUrsi --11111111112-22--------------------------------------------------------------------------------------------------------------------------------11111111111111111111111------------------------------------------ 000101
  4 AlnuRubr 55----555555-----------33---333333-----------------------------------------------11111-1111111111111111111111----1--1--1--1--1--1--1--1--1--1--1---111111313135----111111--1-1---------------------------11-11---11---1--1--1---------------------- 00011
 36 HypoGlab -----------222211211111111111111111111111111111---------------------------------------------------11111111111111111111111111111----------------------------------------------------------1-1111-------------------------------------------- 00011
 73 SoncAspe --1111111111------------------------------------------------------------111111111111111---11-1--1--1-------------------------1-----1-1-1-----------------------------------------------------------------------------------------------11----------------- 00011
  9 BaccPilu ----------------------111111111111111111111-11-----------------11-------1--1-1--1---1------------1111141111111111111111111------------------------------------------------1111111111111111111111111------------------------------------------------------------ 00100
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 16 ChenPumi ----------------------------------------------------111111--1------1-111111111111111111211111121111111111111111---------------------------------------------------------------------1---------------------------------------------------------------------------- 001010
 22 EchiMuri -------------------------------------------------------------------11---------1--1---1------------------------------------------------------------------------------------------------------------------------------------------------------------------------------ 001010
 30 GnapPalu 11--------------------------------------------------------------------11111111111111111---11--1---1--1--1111111111-1111111111111111--------------------------------------------------------------------------------------------------------------------------------------- 001010
 42 KickElat -----------------------------------------------------------11-11111-1-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------- 001010
 52 PetrDubi ----------------------------------------------------111111--1-----1-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------- 001010
 56 PolyAmph ---------------------------------------------------------------------------------111--1-111-11-11-----------------------------------------------111111111111111111111111--------------------------------------------------------------------------------------------- 001010
 70 SaliSitc -----------------------1----1--1--------------------------------------113444242434134-113411-11411211------------5555555555555555531113131311111111111111111111111111111111111111-1-1-2111111111111111111111111-1111111-1-1111----11--1---1-------1--------------------1--1-------------------- 001010
 17 CotuCoro --------------------------------------------------------------------------------------------------------------------------------------------1----1------------------------------------------------------------------------------------------------------------------------------------------- 001011
 25 EquiHyem -----------------------------------------------------------------------------------------------------------1---1-1--1-------------------------------------5-------------------------------------------------------------------------------------------------------------------------- 001011
 32 HelePube ---------------------------------1--------------------------------------------------------------------11------1-1--------11-1---------------111111-1-1------------------------------------------------------------------------------------------------------------------------------ 001011
 55 PlanMajo -----------------------------------------------------------1--------1--1--1------------------------------11------1-11-1--1-11-11-1-1-11-111-------------------------------------------------------------------------------------------------------------------------------------- 001011
 71 ScirMicr ----------------------------------------------------------------------------------------------------------------------------------------111111-1-1------------------------------------------------------------------------------------------------------------------------------ 001011
 72 SileGall ---------------------------------------------------------------------------------------------------------------------------------------------------------------------1---------------------------------------------------------------------------------------------------------- 001011
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 31 GnapStra ----------------------------------------------------111111--1-----1-----11----------1--1--1---1----------------------1111111111111111---------------------------------------------------------1-1------------------------------------------------------------------------------------ 0011
 38 JuncBufo -------------11-1111-2-1-2--2---111111111-11---------------------------112111111121211--21-11--1--1------------11111-3131113131325125525-11---1-11--------------------3---3---1--------------555555555115551555555534444444--23-33-------------------------1-----1---------------------------- 0011
 51 PareVisc 1111111111113333223222222222222222222222222111111--1------1------------------------------------------------------------211332121123432424124334323242332422221111131313111111111111111111111111111------------323333-2-211111--11--21-11-21---------1--11-111-11-11------------------ 0100
 57 PolyInte 2222222222222333322222222222222222222222222221-------------------------------------------------------------------11---1-11-------2-2-12------2-2-2--2-222111111-1-1-------111111--1-1---------------------1--1-1-1122111121111211211111111-1--1----------------------------------------------- 0100
 65 RumeCris 11---------1111111111122222222222221111111111131131111111--1------1---------------------------------22222---------------111221111121231311312213131312311333111111-1-1-------------------------------2-2222-1-122-12--12---21--2-21------------------------------------------------------------ 0100
 19 CypeErag 554444444444-----------1---1---1--11-1111111-11--------------------33113333232333133311331131312111-1---11515-2121121225125254211414241413133313311313233321332333555555353531----------33---3-3-------4222244-----------33553-353-325353-25---------2--2--2------------------------------------- 01010
 27 EuthOcci ----------------------111-1111111------------------------------------11111111111111---11-1--1--1---1-----44444-111111111111111111----------------1-1-1------1-1-1--1--111222222-2-2-51111111111111111111111--------------22--2---2----2----------------1-11111111----------------------------- 01010
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 68 SaliExig --------------------------------------------------------------------------------------------111111-------------1111-1-11-121-2-21-21121-1-2-11-21-------------1111111111111111111111-1111111------------22112--12---1-12--1--------1--1--------------11------------------------------- 01010
 69 SaliLuci -----------------1---1---1---------------------------------21122222222212212---12-2---2--2--111111------14-4---4-433--3333432334243243335353253333352535225325553333313131-11111111144141414111111-1111111-1-1111----22112--12--31-12-31---------1--1-1---11-111-11-11-----33------------------------ 01010
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 58 PolyMari ----------------------------------------------------111111--1-----1--22----------------------------------------------------------------------------------------------2-2222------------------------------------------------------------------------------------------------------------ 01011
 78 VeroAmer --------------------------------------------------------------------------------------------------111111111111111111332--323323-1-2121221--1-212121-211222111111111111111111111111111111111111111-1111111---------2-222252--52---5-22--5--------2-22----------------------------- 01011
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 39 JuncPate -----------------1---1-----------------------------------------------------------------------11111-----------------------1-1-1--------------------------------------------------------------------11---1---1-----1-1---1-------------------------------------------------------------- 011000
  1 AgroStol ----------------------------------------------------111111--1-----1----22-------2--2---2-----------11111-----------------432334243243434444244334344444344424444-------------33-3--------2--------------2----------55353335332333532333333333232222222222-22-22---1-------------3123---------------------- 011001
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 63 RoriNast ---------------------------------------------------------------------------------------------------------------------------------1--1----1-1--1--1-111------------------------------------------------------1---1111111111111111---33------------------------------13123----------422-------33--4--------------- 011001
 76 TrifFuca -------------------------------------------------------------11----------------------------------------------------------------------------------------------------------------------------------------1--11---------------------------------------------------------------------------------------- 011001
 77 TyphLati ------------------------------------------------------------------------------------------------------------3---3-3--3-1--1-1--1--1-1-1-1-11-----------5-5-5-11111111111111111111111152222222-1-1111------31---1---51-3--51----------2-22---5--5--5--133555544433-11111214---------------- 011001
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 13 CallStag --------------------------------------------------------------------------------------------------------------------------------------------------------11111111111111111111111-------------------------------1----1-----------------1---2-222-22-22211-111---3312225445311-1------------------ 01110
 15 CharSp.  ------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------1-------------------------------------------------------------------------34-3------------------- 01110
 33 HippVulg -----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------1------------------------ 01110
 60 PotaFoli ---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------51------------- 01110
 74 SparEmer ---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------2----------11--1---1----------1-----------21222-22-22---------55-----41-45553555-------------------- 01110
 80 UnknSubm -------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------34145515-11-1----------------- 01110
  3 AlisPlan ------------------------------------------------------------------------------------------------------------------------------------------------------------------------151111---33113221322112132112222222222-1--141445445445133-111---551111-11----------------------------------------- 01111
 40 JuncSupi -----------------22---222222------------------------------------------------------------1-1----------------------------3----3-3--3-3-2323-23---3-232323-232222-------3-3-3-------------------11111111-5-5555----5511555155521515521555555555555554244454454455-444------5555415453243-------------- 01111
 82 OenantSp ------------------------------------------------------------------------------------------------------------1----1-1--1-------------------------2-2-2---------------------------------1---------44-34223422-32-42-3222222222------34333-33-33--------------------------1-------------------------- 01111
 61 PotaNata ------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------1---------55              1

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* Key to polygons and vegetation types in appendix B. Polygon descriptions with species and cover values in appendix C.