1999

Plant Phenology in Central Minnesota

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Figures

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I. Introduction

Definitions of phenology differ. One important aspect, as in The American Heritage College Dictionary (1993), is "the relationship between a periodic biological phenonenon and climatic conditions." This relationship is in the definition by Anderson (1972) who wrote, "Phenology is the visible response of an organism to a seasonally changing environment . . . . ."

The second definition in the dictionary is, "The scientific study of phenology." This would be comparable to Lieth (1970, 1971) who says, "Phenology is generally described as the art of observing life cycle phases or activities of plants and animals in their temporal occurrence throughout the year." None of these definitions happen to mention physical phenomena or their seasonal changes.

Organisms and the physical parts of ecosystems undergo seasonal changes whether studied by humans or not.

Phenology, a term introduced after the mid 1800's, whatever the definition, has long been an integral part of all nature observations. Primitive man was well aware of seasonal changes in both plants and animals. He regularly migrated seasonally to where the best food source was located. Food storage is an adaptation of humans and other mammals because some plants and animals are not always available.

There are innumerable natural phenomena in nature that are observed to correlate with the seasons. Climate is the cause of seasons. The seasons in turn affect both the physical and the living parts of ecosystems. The date that ice disappears from a lake in Minnesota would be one example of physical phenological data. The seasons have made necessary such adaptations as hibernation and migration and other seasonal changes in the life history and behavior throughout the year in plants and animals.

Seasons have influenced the course of organic evolution and of human culture.

The classic phenology paper by Leopold and Jones (1947) included both plant and animal phenology plus items in the physical environment. Some studies have stressed only vegetative growth of plants, or flowering period (Taylor 1969), or of bird nesting, or bird migration (Partch 1971,1972,1975). The present study deals primarily with plants and, although foliage is duly noted, the phenophases with the most records are floral. In a few species the vegetative phenophase is significant and is noted.

A. Sources of Data

The phenological data in this study were collected since 1949 when I began teaching at SCSU. Data were recorded on field trips with classes or while doing vegetation research in various plant communities, or from herbarium specimens* or from dated slides. With some exceptions, which are noted, the records are mostly from central Minnesota. All records used on the same date are from different locations or, if from the same location, then on different dates. All records, for each species, include date, phenophase and location.

The records have been obtained from several hundred locations. Some locations may have been visited only once. Some like the Cold Spring Heron Colony, the Waubun Prairie, the Partch Woods and others used for class field trips, or special research, were visited many times for many years.

B. Plant Life History and Phenophases

The typical annual life history of most flowering plants involves the following stages or phenophases which form, more or less, a continuum of vegetative and floral development:

1. An early vegetative or foliage stage. This stage does not precede flowering in some species. Some foliage may become colorful in fall. Germination may be considered as a part of this phenophase.
2. Development of floral buds.
3. In bloom. Easily recognized if colorful petals present. In grasses, conifers and in the catkin-bearing plants ripe pollen was recorded as in bloom.
4. Green fruit developing.
5. Seeds ripe.
6. Seeds and/or fruit may disperse or persist on the plant until spring.

The symbols used for the above phenophases in the field or on the charts or tables in this report are as follows:

X = green foliage present, frequently not recorded if floral phenophases were also present.
( ) = with floral buds.
O = in bloom, or with ripe pollen if without perianth.
# = green fruit developing, or green spores in ferns.
* = seeds (fruits) ripe, or spores ripe in ferns.
G = ripe seeds (fruits) gone or dispersed.

* Herbarium specimens are not 100% reliable because some plants can change in the plant press. A succulent may "go to seed" when pressed even though originally in bloom.

II. Methods

The complete record of observations for each species, from the file cards, was listed chronologically by month and day (not year). The example of Aster sericeus in Table 1 was chosen because the records would fit on one page. The records for some species would occupy eight or more pages. This seasonal chronology of field data contains the complete record for each species (date, phenophases and location) and is the basis for all subsequent tables, figures and discussion.

The list was then divided into four week intervals per month. (week I, 1-7; II 8-14; III 15-21; IV 22-end of month) The numbers of observations for each phenophase for each week were counted. These figures are the basis for the tables showing the number of Observations per Week per Phenophase. (O/W/P) Examples are shown in Tables 2 and 3 . Such tables for each species are in Supplement 1. This method of presenting the data is the first step in consolidating the records for one species in the form of a table. Such tables do not include location. Some tables exhibit a classic "stairstep" form illustrated by Geranium mac. where there is an orderly progression of phenophases through the season with each occupying a usually brief period of weeks before the next phenophase is recorded.

The above data have also been assembled into phenophase (linear) charts. These charts occupy less space per species than the O/W/P tables, which, in itself, is an important consideration when several hundred species are involved. An example is shown in Fig. 1. These charts display the "stairstep" aspect similar to their O/W/P source. Linear phenophase charts for each species are in Supplement 2, and illustrate a further consolidation of data.

Three other methods of presenting the data, in subsequent sections, or Supplements, are:

1. Ten groups of special seasonal phenophase patterns.
2. Categories based on life form such as trees, shrubs, grasses and forbs.
3. Spine diagrams of modal species. (see Section on Grasses and/or Supplement 3)

Examples of all these methods of presenting data are included to illustrate the range of possibilities.

A. Average vs. Median Date of Flowering

In many Tables, the species are arranged according to the seasonal sequence of average or median dates of flowering. The average or the median was calculated for all species with sufficient records. For species with low number of observations the average is easy to determine but, where dates are widely scattered, either average or median date is probably of doubtful accuracy. Where the flowering phenophase is compact and definite the average or the median is more accurate. With greater numbers of flowering observations, the median date is easiest to determine.

For comparison, both the average and the median were calculated for 269 species. The difference in the two ranged from the median being 17 days later than the average to being 11 days earlier than the average. These discrepancies occurred where records were noticably scattered. Twenty four of these (random?) species had equal dates for average and median.

Of the total 203 observations in which the median was later than average, the average difference was 5.1 days. There was an average of 3.3 days in the 42 observations in which the median date was earlier than the average. Combining all observations, including the "equal" 24, the overall difference averaged 3.6 days. For this reason, the average vs. the median (A/M) in most tables and discussions is not differentiated. (Fig. 2)

Table 1 The Seasonal Chronology of Field Data for

Aster sericeus

Week	Date	Phenophase	Location
II -	6-14-81	x	Esk
IV -	6-29-52	x	
I -	7-3-52	x	Tal.U
	7-6-51	x	Mor.1
II -	7-10-52	x	Tal.U
	7-10-62	x	App.W
	7-12-86	x	Clear
	7-13-54	x	Esk
III -	7-16-55	x	Tal.U
	7-21-52	x	Tal.U
	7-21-89	( )	Jacob
I -	8-2-86	O	Sher.7
	8-7-55	( )	Tal.U
II -	8-13-52	O	Tal.U
	8-14-80	O	Sher.17
III -	8-15-86	( )	Wtb.1
	8-18-89	x	Eng 1 seen
	8-20-75	( )	TNC.3
	8-21-55	O	Wtb.1
IV -	8-26-52	O	Tal
	8-27-87	O	Clear.E
	8-29-59	O#	TNC.1 or Brown
	8-30-51	O	Tal.U
I -	9-1-59	O	Tal.U
	9-6-50	O	Tal
	9-7-59	O	Norm.1 slide
II -	9-11-85	O	Sher.14b
	9-11-85	O	Sher.18
	9-13-58	O	Aug
	9-13-75	O	Ord
	9-13-75	O	TNC.3
	9-14-78	O	Wtb.1
III -	9-15-68	O	Aug.R
	9-15-74	O	Aug
	9-15-85	O	Clear
	9-18-76	O	TNC.2
	9-18-85	O	Sher.6
IV -	9-22-76	O	Wtb.6
	9-23-52	O	Tal.U
	9-23-78	O	Felt R in bloom
I -	10-1-65	O	Tal.U
	10-1-76	O	Wtb.1
	10-2-69	O	Aug
	10-4-49	O#	Tal
	10-7-76	O#	Wtb.1

Table 2 # of Observations/Week/Phenophase

Aster sericeus

Week		X	()	O	#	*
June	II	1				
	III					
	IV	1				
July	I	2				
	II	4				
	III	2	1			
	IV					
Aug	I		1	1		
	II			2		
	III	1	2	1		
	IV			4	1	
Sept	I			3		
	II			6		
	III			5		
	IV			3		
Oct	I			5	2	
	Sum	11	4	30	3	/37

9 wks
Median 9-13

Table 3 # of Observations/Week/Phenophase

Geranium maculatum

Week		X	( )	O	#	*	G
Apr	IV	5					
May	I	2					
	II	6	2	5			
	III	3	12	22			
	IV	1	14	64	4		
June	I		1	35	6		
	II			45	22		
	III		1	34	27	2	
	IV	1		15	20	5	
July	I			1	4	6	2
	II				1	7	3
	III			1		1	
	IV					1	
Aug	I	1				1	1
	II					1	1
	III	1					
	Sum	20	30	222	74	24	7

(10) weeks
A = 6-5
M = 6-4

Total 357

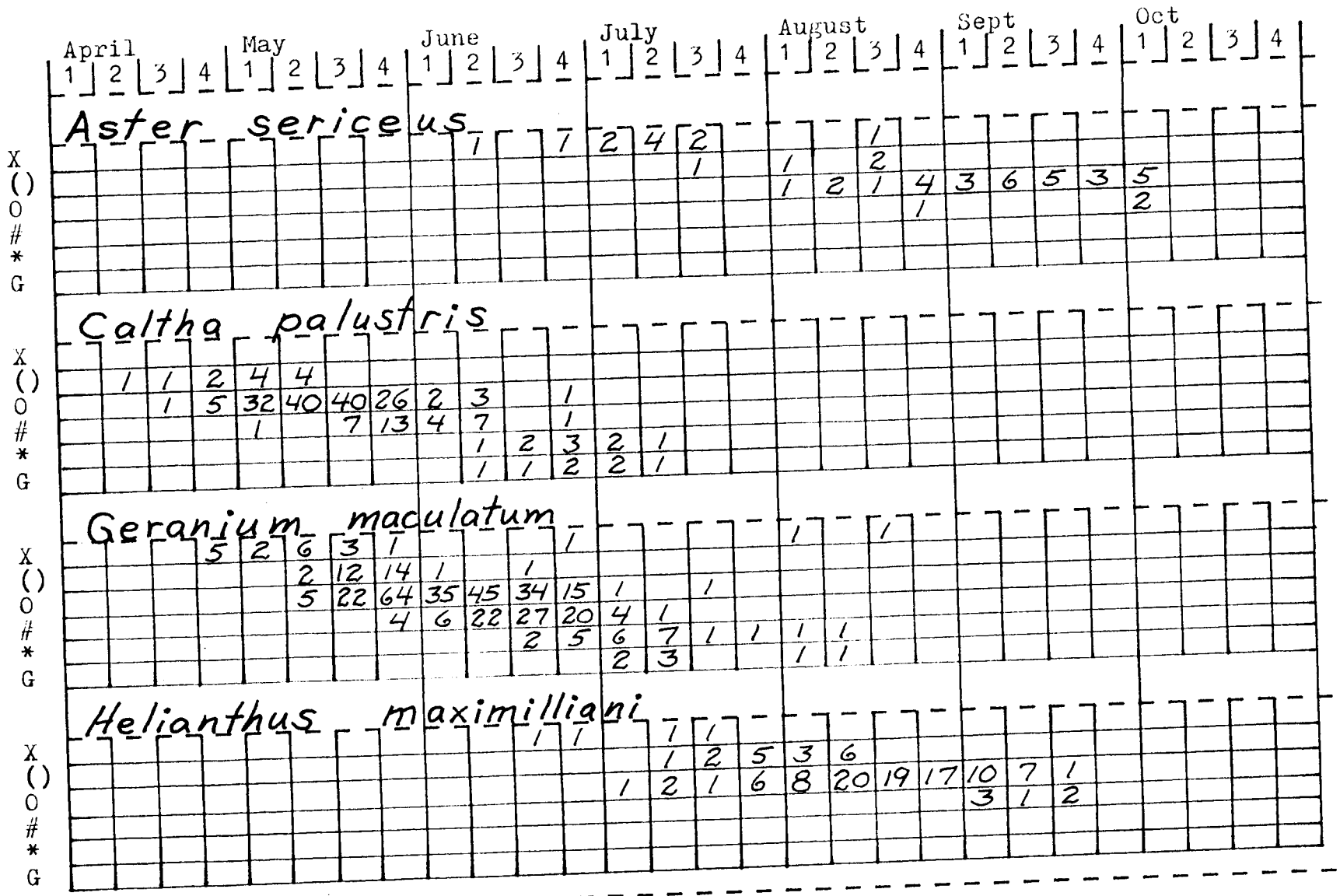

Fig. 1 Examples of Phenophase Charts

Fig. 2 shows the number of flowering starts (= first day of flowering for each species) and the number of A/M dates per week for all species. Flowering begins in March with the first observations of silver maple. After the peak of first flowering during the first week of May there is an irregular decline in number to the second week of September when Artemisia frig. was first observed in bloom.

After the A/M curve peaks in the fourth week of May there is also a decrease to September but it is delayed compared to the number of flowering starts because of the many Composites that have an A/M in July and August.

Both curves are somewhat tri-modal and vaguely synchronized. Both curves could suggest a spring (vernal) peak, an early plus a late summer (estival) peak with an absence of any autumnal peak in A/M starting in September. However, many species continue in full bloom in September.

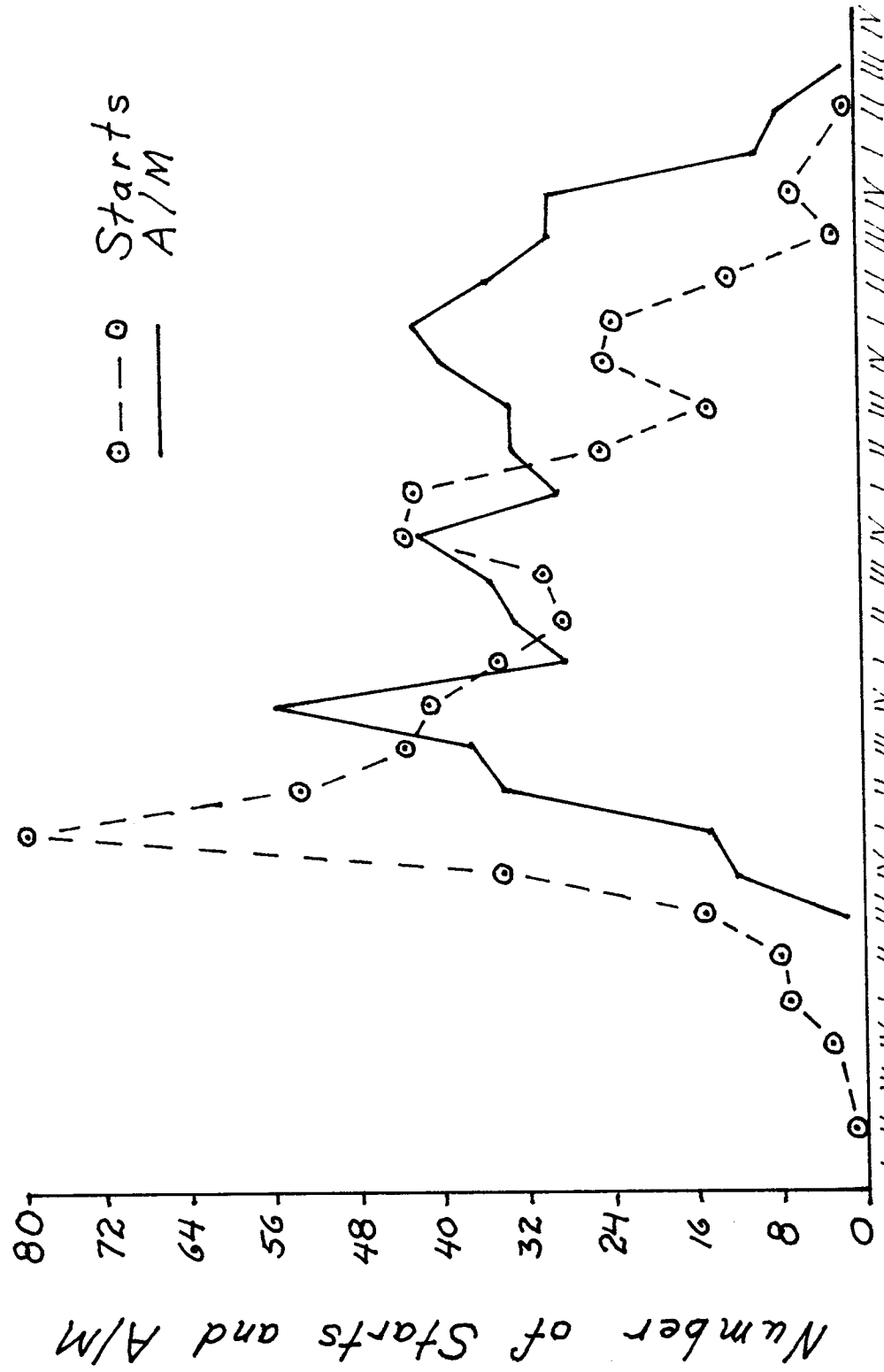

Fig. 2 Number of Flowering Starts and A/M Dates per Week

III. Groups of Distinctive or Special Seasonal Phenophase Patterns*

Ten more or less distinct groups, or phenophase patterns, may be recognized based on the relative importance or sequence of the phenophases. There is some overlap between the groups.

Group 1. Species with a Significant Vegetative Period.

Group 2. Species with most Observations in the Flowering Phenophase.

Group 3. Flowering Observations Scattered, and/or prolonged, at the End of the Main Blooming Season.

Group 4. Early Flowering Resumed in Late Summer and/or Fall.

Group 5. Long Period with Floral Buds before flowering begins.

Group 6. Long Period with Developing Green Fruits.

Group 7. Long Period with Ripe Fruit on Plant.

Group 8. Ripe Fruit Persisting to the following year.

Group 9. Multiple Phenophase Observations, as in Cruciferae.

Group 10. Variations in Length of Flowering Phenophase.

* some species may be in more than one group.

Group 1. Species with a Significant Vegetative Period.

In some species the period of vegetative growth, as separate from the floral phenophases, is significant. Table 4 contains some species with six or more weeks of vegetative growth before the onset of the floral phenophases. The average of those on this list is 9.4 weeks. This vegetative phenophase could no doubt be greatly extended with earlier observations. Many possible vegetative observations were not recorded; the vegetative phenophase was not always a priority. Few, if any, vegetative observations were recorded after a species started to bloom. If the species continued to have foliage after the flowering period, as with most shrubs, it was probably considered to be too normal to be recorded.

In some cases, the early-season vegetative stage may not have been identified. On the other hand, some seedling and/or early growth stages are easy to recognize. Impatiens, Echinocystis and Tilia seedlings with cotyledons are distinctive.

Most Aster and Solidago species are easy to recognize in the early vegetative stage. Many other Composites such as Helianthus, Eupatorium and Prenanthes seem to have a long vegetative stage before their typical late-blooming period. Only a few are species of dense forests. Solidago flex. is a noteworthy exception.

Some species may have some unique characteristic that identifies them in the early vegetative stage such as the characteristic palmate leaves of Coreopsis on prairies, the ciliated petioles of Lysimachia ciliata, the single early "lion's foot" leaf of Prenanthes alba or the large divided leaves of Rudbeckia laciniata in flood plains.

Two forest herbs, Hepatica and bloodroot, respond differently following the flowering period. Whereas the mostly persistent Hepatica leaves barely change size throughout the year, the bloodroot leaves become greatly enlarged following flowering and persist until the fall frost, New leaves of bloodroot tightly enfold the new spring floral stems.

Shrubs may have an extended period of foliage both before and after the typical flowering period. Wolfberry and meadow sweet are usually found in the open uplands or open lowlands respectively. The ripe fruits of smooth sumac may persist for months. The ripe fruits of elderberry may soon be eaten by birds. (see Group 7)

There is an advantage to being able to identify a species at any season. If a species can be recognized in the vegetative stage it is therefore available when making a survey (plant list) of a plant community at most any time during the growing season. With care, such observations can also be of value in quadrat or releve´ studies. Many important observations are still to be made of the vegetative phenophase.

Anderson (1972) has also suggested some possible subsurface vegetative aspects of plant life histories. In "the vegetative life cycle of Trientalis borealis shoot development and flowering are spring events, rhizome growth occurs in summer and tubers are formed in the summer and fall."

Table 4. Group 1. Early Separate Vegetative Phenophase

Species	A/M	6+ Veg. Weeks Before Bloom	# of Veg. Observations	
Allium tri.	7-04	10	81	
Pyrola asar.	7-04	9	11	
Circaea lutet.	7-13	6	7	
Coreopsis palm.	7-13	6	14	
Leonurus card.	7-14	7	4	
Verbascum thap.	7-15	11	9	
Lilium mich.	7-15	8	19	
Symphoricarpos occ.	7-17	7	4	
Aralia race.	7-18	(8)	22	
Spiraea alba	7-19	7	5	
Lysimachia ciliata	7-21	7	10	
Laportea canad.	7-27	12	9	
Veronicastrum virg.	7-29	7	14	
Arctium minus	7-30	9	4	
Oenothera bi.	8-4	11	4	
Artemisia absinth.	8-08	9	6	
Impatiens cap.	8-08	9	15	coty*
Echinosystis lob.	8-10	12	5	coty
Allium stellatum	8-11	10	5	
Amphicarpaea bract.	8-11	9	12	
Lespedeza cap.	8-11	8	11	
Solidago gig.	8-11	6	5	
Helianthus rig.	8-12	6	7	
Helianthus hirs.	8-18	6	2	
Solidago rigida	8-19	10	11	
Artemisia camp.	8-19	8	6	
Solidago spec.	8-20	10	4	
Rudbeckia lacin.	8-23	12	17	
Eupatorium rugosum	8-26	7	4	
Helenium autum.	8-26	7	4	
Aster macro.	8-27	9	16	
Prenanthes race.	8-27	8	1	
Aster novae-	8-29	8	4	
Gentiana andrew.	8-29	9	4	
Artemisia ludo.	9-05	14	14	
Prenanthes alba	9-05	13	20	
Solidago flex.	9-10	14	16	
Aster uroph.	9-11	10	4	
Aster sericeus	9-13	7	10	
Artemisia frig.	9-14	20	10	
Gentiana puber.	9-16	11	5	

* = cotyledons

Aver. 9.4

1A. The Phenology of *Allium tricoccum*

The phenology of Allium tricoccum (wild leek or woods onion) is unique in that the vegetative phenophase and the flowering phenophase rarely overlap in the same year. Table 5. shows the numbers of phenophase observations for each week of the growing season and illustrates a classic example of a stairstep sequence of phenophases. These same data are in the linear phenophase chart for this species.

The following field notes, not all from the same year or the same location, record the leaf lengths, the yellowing and disappearance of the leaves as well as the floral phenophases.

Some field notes for Allium tricoccum:

Apr	I	3" length of leaf
	II	4-5" "young leaves"
	III	4" 6"
	IV	3-6" 4-8" 6,8 and 10"
May	I	6-8" 8-10" "dry leaves" "old seed stem"
	II	6-8"
	III	
	IV	5 turning yellow
June	I	3 turning yellow "some leaves flat on ground"
	II	1 turning yellow
	III	4 turning yellow, some green, some no leaves and 4 records of flowering this week, one in the 1970's and three in the 1980's. (O)
	IV	2 turning yellow some "leaves gone" (O)
July	I	No leaves seen after this week

The two spatulate leaves begin to appear before the first week of April in central Minnesota. (Table 5) They grow longer and mature in April and May as indicated above. The leaves start to turn yellow in late May as the forest canopy closes in. They are mostly gone by the last week of June.

Meanwhile, in May, one erect floral stem per plant grows to about 6" (1.5 dm) and produces a bud (an umbel of buds). This phenophase may last for six weeks. Then in the third week of June after most Allium green leaves have disappeared, the plant begins to bloom. This phenophase continues for five weeks (maybe not in any one year) at which time the leaves are long since gone not to return until the next spring. This species is separated in a key (Gleason 1968) to species as "leaves absent at anthesis".

The previous year's dried floral stem may overwinter with the 3 ripe seeds per fruit intact. (3 seeds, round like Coccus bacteria = tricoccum)

Table 5. Number of Observations/Week/Phenophase

Allium tricoccum

Weeks		X	Y*	( )	O	#	*
Apr	I	4					
	II	4					
	III	7					
	IV	16					
May	I	24		1			1 old stem
	II	11					
	III	8		11			
	IV	6	5	12			
June	I		3	12			
	II	1	1	8			
	III	1	4	15	4		
	IV		2	11	1	1	
July	I			5	6		
	II			2	2	3	
	III				1	3	
	IV					2	
Aug	I					2	
	II					3	
	III						1 old
	IV					1	
Sept	I						1
	Sum	82	15	77	14	15	1
					Median 7-4		2 old
					Total floral		109

* Y = yellow leaves

1B. The Phenology of the Pasque Flower, *Pulsatilla nuttalliana*

The pasque flower, which is in bloom in central Minnesota by late March, is a classic example of early flowering. It is noted for appearing in early spring on open wind-swept prairie hillsides. The species is included in Group 1 because a vegetative phenophase persists long after the flowering period.

The flower emerges at the ground level, but is soon elevated by the elongating floral stem. As the peduncle elongates, the flower is raised to 2-3 dm or more exposing the sessile involucre-like leaves on the upper peduncle below the flower. (As in other Anemones before recent name change)

Green fruits may appear by the fourth week in April as flowering continues. (Table 6) By late May most flowers have produced numerous plumose fruits which are easily detached when ripe. These plumose styles may present a fuzzy aspect to the early spring prairie. Gilmore (1929 in 1987 reprint) wrote a book called Prairie Smoke which in this case refers to the pasque flower. One song of the pasque flower, translated out of the Dakota language, has one line that says, "I stand here, old and gray-headed."

The dried fruits, with their long plumose styles, begin to blow off the 8-10" floral stem by the third week of June, long after the last flowers have disappeared.

The basal leaves are at first small and inconspicuous in May. As flowering and fruit production cease the leaves become long-petioled, large, deeply incised, characteristic and persistent until frost. They produce the food which is stored in the underground stem to be used for early flowering the following spring. The pasque flower, as a plant, does not disappear after the flowering period. Obviously, the plants that produce flowers before leaves are perennials.

Table 6 # of Observations/Week/Phenophase

Pulsatilla nuttalliana

Weeks		X	( )	O	#	*	G
Mar	IV		1	2			
Apr	I			2			
	II		1	7			
	III		2	11			
	IV		3	26	4		
May	I			19	6		
	II			13	12	2	
	III			9	18	2	
	IV	1		5	15	2	
June	I	2		1	4	2	
	II			1	1	3	
	III	1				2	2
	IV	3			1	2	2
July	I	1			1		
	II	2					
	III	2					
	IV	1					
Aug	II	1					
Sept	IV	1					
Oct	I	1					
		16	7	96	62	15	4
				Median Bloom 5-1	Total floral		184

Group 2. Species with most Observations in the Flowering Phenophase

There are some species which, for several practical reasons, are usually not noticed, or at least not recorded, unless in bloom. Some have easily recognized foliage such as the water lilies, various Potentillas or arrowhead, but the flowering phenophase was selectively recorded. Some species have very inconspicuous foliage, especially when imbedded in a community of associated plants, so that they are mostly overlooked unless in bloom. This applies to Sisyrinchium, Hypoxis, Spiranthes, Stellaria long. and Campanula rot. Frequently when such a species was seen in bloom then other phenophases of the same species were seen nearby and recorded. The rare records of ripe seeds on Erigeron glabellus, Viola sag. and Sisyrinchium were made when other nearby plants of the same species were in bloom.

Table 7 contains those species with 80% or more of the floral observations in the flowering phenophase. The average is 93%. The number of flowering observations for each species ranges from 8 for white water lily to 261 for Campanula rot. with an average of 38.

The median dates of flowering of the species in Table 7 are fairly evenly spaced from May to August. (in May 10 species, in June 11, in July 10 and in Aug 8) These species are modal in a wide range of habitats. Several are introduced species of disturbed areas. Some are aquatic or in wet lowlands. Others occur in a wide range of forest and grassland communities. The late blooming Spiranthes is difficult to see in the dense tall grassland. This group is not restricted to any one environmental preference.

In addition, not on Table 7, there were also several noteworthy vegetative observations. One was a record of prostrate yellow leaves on the ephemeral Dicentra cuc. during the first week of June. This plant would hardly be noticed after that. The two isolated records of leaves on the shrub Potentilla fruticosa merely illustrate the neglected opportunity for many more. A late recording of leaves on Viola sag., long after the flowering period, indicates that this species could also have been included with the late-foliage Group 1.

This is another group that depends somewhat on the preferences of the field observer.

Table 7. Group 2 Species with most Observations in the Flowering Phenophase

Species	# of bloom Observ.	Bloom % of Total	Weeks in Bloom	Median
Anemonella thal.	42	91	(8)	5-11
Calylophus serr.	94	94	14 + 1	7-24
Campanula apar.	30	97	9	8-2
Campanula rotund.	261	95	(22) + 1	7-21
Cardamine bulb.	28	97	8	5-30
Castilleja cocc.	43	100	10 + 2	6-12
Cerastium arvense*	107	90	8	5-28
Chamomilla suave.*	22	96	7 + 2	6-12
Chrysanthemum leuc.*	16	94	7 + 1	7-4
Corallorhiza trif.	10	83	(6)	5-23
Corydalis aurea	20	95	(9)	5-18
Cuscuta glom.	11	92	(6)	8-21
Dicentra cuc.	23	100	4	5-6
Erigeron glabellus	24	86	(10)	6-27
Euphorbia podperae*	12	80	(10) + 1	6-18
Glechoma heder.*	29	100	8	5-20
Hedyotis long.	51	89	(16) + 1	6-21
Hypoxis hirsuta	84	98	10	6-10
Lotus cornic.*	31	100	(16)	7-17
Lygodesmia juncea	11	85	(8)	8-4
Lythrum alatum	12	80	(9)	7-17
Lythrum salic.*	13	93	6	8-14
Nuphar luteum	21	100	6 + 1	6-14
Nymphaea tuber.	8	100	(5) + 1	7-6
Phlox divar.	28	90	7	5-26
Polygala sang.	15	94	(10)	8-20
Potentilla argentea*	81	96	(21) + 1	6-21
Potentilla frut.	11	92	(9) + 1	8-3
Potentilla simplex	43	98	(10)	6-19
Prunella vulgaris	16	100	(9)	7-29
Ranunculus flab.	9	90	5 + 1	6-1
Sagittaria sp.	12	92	(6) + 1	8-4
Sambucus canad.	12	92	6	7-8
Sisyrinchium sp.	144	87	(16)	5-31
Spiranthes sp.	14	82	(10)	8-29
Stellaria long.	47	94	8 + 1	6-13
Verbena bract.*	36	95	14 + 1	7-13
Vicia villosa*	17	100	(19)	7-8
Viola sagitt.	15	88	6	5-23
Average	38	93	10	

* Introduced

Group 3. Flowering Observations Scattered at the End of the Main Bloom Season.

This group, of minor importance and blending into Group 4, presents a lopsided distribution pattern with the number of observations tapering off at the end of the total flowering season. After more than four decades of observations there would logically be some very late or very early records.

The species in Table 8 are those with observation distribution patterns with four or more weeks below the average, scattered at the end of the main bloom period. Each species has its own average number of observations per week. And each species has its own number of weeks of below average observations. The average of all these latter is 7.6 weeks of below average observations. That is almost two months of what could be considered an atypical normal curve. Therefore the flowering period does not always end abruptly.

Table 8 Flowering Observations Scattered at the end of the main bloom season.

Species	Weeks of below Average number of observations at end	weeks of flowering
Amorpha canescens	5	12
Anemone canad.	7	(17)
Apocynum andros.	4	10
Berteroa incana	12	(25)
Campanula rotund.	10	(22)+1
Cornus stolon.	9	15
Crepis tect.	8	(7)+4
Erigeron strig.	7	16 +1
Melilotus alba	7	16 +2
Nepeta cataria	8	16sctd
Petalostemon can.	6	13 +1
Potentilla arguta	5	(16)
Ranunculus acris	11	(9)+2
Aver.	7.6	15.8

The species in Table 9, with flowering periods averaging 16.4 weeks, would naturally have a prolonged flowering period past the median date. These species have medians from mid May to Aug 1. After that there is not sufficient time for a prolonged flowering period.

Table 9 Group 3, Flowering Period Prolonged past Median

Species	A/M	# of Blooms	Total Floral	Total # of Weeks
1. Thalictrum dioicum	5-17	71	220	(8)
2. Taraxacum offic.	5-20	162	219	(23)+1
3. Lithospermum can.	5-31	215	280	14
4. Cornus stolon.	6-08	89	182	15
5. Ranunculus acris	6-17	20	21	(9)+2
6. Tradescantia bract.	6-20	133	151	13+2
7. Hedyotis long.	6-21	51	51	(16)+1
8. Oxalis stricta	6-25	78	95	(21)
9. Physalis virg.	6-26	80	128	(15)+1
10. Crepis tect.	6-28	30	34	(7)+4
11. Anemone canad.	6-30	137	210	(17)
12. Tragopogon dubius	6-30	80	163	19
13. Apocynum and.	7-06	70	82	10
14. Berteroa incana	7-09	138	161	(25)
15. Campanula rot.	7-21	261	276	(22)+1
16. Erigeron strig.	7-21	205	235	16+1
17. Nepeta cataria	7-21	25	30	(16sctd)
18. Petalostemon can.	7-28	137	210	13+1
19. Melilotus alba	8-01	178	212	16+1
	Aver	112.6	155.8	16.4
% of Total Floral		73%		

Group 4. Early Flowering Resumed in Late Summer and/or Fall.

Most species have consecutive weeks of observations in the flowering phenophase. Some may skip one-week intervals. Some may be separated by two or more weeks. The latter two may be due to limited observations.

In Group 4 the species skip longer intervals of non-flowering (or at least not observed) and after an early period of flowering reappear in bloom in the late summer and/or fall. In some species this may be due to day length. (Table 10)

The species that normally bloom late into Sept. or Oct. such as the Asters or Goldenrods are not in this group. Neither are Berteroa or Campanula rotund. that may have continuous flowering into Nov.

The November observations may be abnormal records from abnormal microhabitats. Some were located on the south sides of buildings or above University heating pipes.

In most cases in Table 10 there is a 4-week or more interval between the early and later records. Although dandelion does not strictly fit this criterion it is a well-known early and late bloomer. The consecutive flowering period as shown for Castilleja is from central Minn., the other records, for that species, are from farther north.

Table 10 Group 4. Early Flowering Resumed in Late Summer and/or Fall.*

Species	Apr I	May I	Jun I	Jul I	Aug I	Sep I	Oct I	Nov I
Arabis divar.	xxxxxxxxxx				x	x		
Caltha pal.	xxxxxxxx	x						x
Capsella bursa-	xx	xxxxxx		x			x	x
Castilleja cocc.			xxxxxxxxxx		x	xx		
Chamomilla suav.	xx	xxxxxxx						x
Circaea alpina			x	xxxxx		x		
Conyza canad.				xxxxxx			x	x
Crepis tect.			x	xxxxx	x	x x		x
Elymus hystrix				xxx		x		
Erysimum cheir.		x	xxxxxxxx	x				x
Hedyotis long.			xxxxxxxxxxxx		x x		xx	
Lactuca canad.				xx xx	x		x	x
Lechea stricta				x	xx		xx	
Leonurus card.				xxxxxxx	xx		xx x	x
Lepidium densifl.		x	xxxx	x			x	
Linnea borealis			xx	xxx			x	
Malva neglecta		x	xx	xxx	x		xx	x
Medicago lup.				xxxxxxxxxx			xx	x
Mirabilis nyct.				xxxxxxxx	x		x	
Oxalis violacea			xxxxxxxxx			x	xx	
Penstemon gracilis			xx	xxxxxxxxxx			x	
Potentilla recta				x	xxxxxxx		x	
Prunus pen.			xxxxxx		x			
Psoralea esc.				xxxxx		x		
Rorippa island.				x	x xxxx		x	
Saponaria off.					x xxxx		x	
Scrophularia lance.		x	xxxxxx				x	
Scutellaria leon.				x xxx		x		
Sonchus sp.					xxxxxxxxxxxxx			x
Taraxacum off.	xxxxxxxxxxxxxx				x	xxxxxxx		x x
Thlaspi arv.			x xxx xxx					x
Tradescantia bract.				xxxxxxxxxxxxx		x	x	
Vicia amer.				xxxxxxx		x	xx	
Viola cuc.		xxxxxxxx				x		
Viola ped.			xxxxxxx				x	

* Some of these species may also appear in Group 3 or 9.
x = flowering records in Table 10

In most cases there is a 4-week or more gap between early and later records.

Group 5. Long Period with Floral Buds before Flowering begins.

A typical sequence of phenophases would dictate that floral buds would precede blooming. This was recorded for less than 30% of those species on the master list. (Appendix A.) The data for most species show the floral bud stage being recorded at the same time or only one week earlier than the flowering phenophase. This is no doubt due to insufficient observations.

Of those 174 species that did show an earlier floral bud stage, i.e. earlier than the flowering stage, 75 or 43.1% showed one week of floral buds before the start of flowering. (Table 11) The species with four or more weeks of floral buds before flowering are listed.

There does not seem to be any unifying taxonomic, life form or ecological reason for the species on these lists. Most do have the A/M in July or August with two in September. Of the six with the A/M in May or June only one is not a shrub or woody vine. The Panax date, in parentheses, is based on only six flowering observations. The 7-week designation for the Rattlesnake Fern is based on the distinction between green and ripe spores.

Apparently a period of over three weeks of floral buds before before flowering is uncommon, at least early in the season. This is from many years of data. Such observations could cause the flowering phenophase to occupy the weeks otherwise occupied exclusively by the floral bud observations. The condition for any one year or one plant has not been determined.

Table 11. Group 5. Species with Various Numbers of Weeks with Floral Buds before Flowering.

Frequency of Prior Floral Bud Weeks

# of Weeks	# of Species	% of Total
1	75	43.1
2	48	27.6
3	29	16.7
4	10	5.7
5	9	5.2
6	1	0.6
7	2	1.1
	174	100

Species with 4 or more weeks of Floral Buds before Flowering.

4-Week prior List	A/M
Rhamnus cath.	(5-27)
Vitis riparia	6-12
Asclepias syr.	7-11
Chimaphila umbell.	7-12
Brachyeletrum erectum	7-26
Amphicarpaea bract.	8-11
Artemisia camp.	8-19
Solidgo speciosa	8-20
Prenanthes race.	8-27
Solidago flex.	9-10
5-Week prior List	
Sambucus pubens	5-14
Cornus rugosa	6-9
Viburnum rafin.	6-14
Panax quinq.	(6-18)
Apocynum cann.	7-8
Lespedeza cap.	8-13
Aster leavis	8-27
Aster macro.	8-27
6-Week prior List	
Allium tricoccum	7-4
7-Week prior List	
Botrychium virg.	7-8
Artemisia ludo.	9-5

Group 6. Long Period with Developing Green Fruits.

The number of weeks when developing green fruit can be observed is usually greater than other phenophases. Examples may best be seen on the linear phenophase charts. The following species have been recorded as having green fruit for a period of ten or more weeks, not necessarily all in the same year.

Trees

Carpinus carolin.	9+2	Ostrya virg.	(14)
Fraxinus pen.	(12)	Prunus virg.	10+1
		Quercus macro. sctd	(14)

Shrubs and woody vine

Alnus incana.	(16)sctd	Corylus amer.	(17)
Amelanchier hum.	(11)	Corylus corn.	(11)
Amorpha nana	10	Prunus pum.	10
Celastrus scand.	(15)sctd	Ribes cynos.	(13)
Cornus foem.	(11)	Sambucus pubens	10

Herbs

Anemone cyl.	11	Polygonatum pub.	(11)
Anemone virg.	(13)	Sanguinaria canad.	10
Arisaema tri.	13+1	Sanicula mariland.	(11)
Asclepias syr.	(13)	Smilacina stell.	15
Astragalus crass.	(11)	Smilax lasio.	(11)
Caulophyllum thal.	15	Thalictrum dasy.	11
Circaea lutet.	(11)	Trillium cern.	(11)
Coreopsis palm.	10	Uvularia grand.	11
Cryptotaenia can.	(11)+1	Uvularia sessil.	(13)+1
Maianthemum canad.	10	Viola pub.	(15)
Osmorhiza clay.	10+1	Zizia aptera	(15)
Panax quinq.	(12)	Zizia aurea	(13)
Polygonatum comm.	12+2		

Other tree species may be absent because of lack of observations. Sugar maple and basswood fruits usually develop out of reach. Over half of the herbaceous species, above, are found in local deciduous hardwood forests.

Group 7. Long Period with Ripe Fruit on Plant.

This phenophase shows great variation in observable length. Some ripe seeds and/or fruits, are soon eaten, stored or dispersed by birds and mammals. Some are blown away or shaken out of capsules by wind. Some are carried away as sticktights. Some persist on the plant until winter or, some, until the next spring. (Group 8) (In this section, ripe fruit = ripe seed = *)

Some species with moderate to long periods of ripe seeds found on plants, and the number of weeks. (see line designated as * on phenophase charts Supplement 2)

Acer spicatum	(9)	Oryzopsis race.	(7)
Actaea rubra	(13)	Osmorhiza clay.	(11)
Calamagrostis can.	(7)+1	Penstemon grac.	(7)
Cornus altern.	(11)	Phalaris arund.	(6)
Cornus stolon.	(12)	Phryma lepto.	(9)+2
Desmodium canad.	5	Rubus allegh.	(9)
Elymus hystrix	(11)	Rubus strig.	6
Geum canad.	12	Rumex crispus	(10)sctd
Mitella nuda	(6)	Stipa spartea	8
Oryzopsis asper.	6	Viburnum trilobum	3+4

Group 8. Ripe Fruit Persisting to the following year.

In most cases only a relatively small percentage of the ripe seeds persist on the plant to the following year. On many other species the empty fruits may persist on the plant such as on Ceanothus, Iris, Alnus catkin, Asclepias, Caltha, Celastrus, Catalpa, Glycyrrhiza and others.

Allium tricoccum	Osmorhiza clay.
Anemone cyl.	Osmunda cinn. (spores)
Caulophyllum thal.	Petalostemon purp.
Circaea lutet.	Phryma lepto.
Juniperus virg.	Rosa sp.
	Verbascum thap.

Group 9. Multiple Phenophase Observations, as in Cruciferae.

Because of the nature of the inflorescence, it would be extremely rare to find a mustard with only one phenophase present. Six genera of mustards (Cruciferae), with one observed species each, plus three other genera, in other plant families, are noted for displaying 2-4 phenophases at the same time on the same plant. The most common phenophase combination in the species shown in Table 12 is "O#" or "in bloom" with "green fruits". The most common combination with Lepidium is "#*" because they were most often first observed "past bloom". The flowers are inconspicuous and were easily overlooked.

The percent of multiple phenophase observations (of the total floral observations) for the mustards ranged from 24.3% to 36.8% (average 27.3%). Some tables or charts in the Supplements showing the weekly numbers of observations for each phenophase may appear to show this type of multiple observations but in most of these cases it is not one individual plant that is involved, or all recorded observations on the same date.

The percentage of multiple observations, of total observations, for Solanum pty. was 25.5%, for Polanisia 36% and for a limited sample of a cultivated garden flower, Cleome, it was 100%. When observed, the individual Cleome plants showed all four floral phenophases, ((O)#*). The "G" for "gone", or dispersed, was probably also applicable but was not always recorded in the early years.

Table 12 Comparative Multiple Phenophase Observations.

	Phenophase Combinations*							
Genus	(O)	(O)#	(O)#*	O#	O*	O#*	#*	#*G
Arabis	-	1	-	13	2	-	2	1
Capsella	-	5	5	11	-	-	-	-
Descurainia	2	2	-	7	-	1	-	-
Lepidium	-	2	1	-	-	1	14	1
Rorippa	2	1	-	4	-	-	-	-
Sisymbrium	-	-	-	-	2	3	-	-
Polanisia	-	-	-	11	-	1	1	-
Solanum	-	3	-	9	-	1	-	-
Cleome	-	-	2	-	-	-	-	-
Total	4	14	8	55	4	7	17	2

* see Plant Life History and Phenophases

Group 10. Variations in Length of Flowering Phenophase

Fig. 3A indicates that the length of time during which a species has been found in bloom, not in any one year, ranges from one to twenty five weeks. Those found in bloom for only one, two or three weeks have, perhaps, too few records to provide an accurate A/M. Some of the records totalling 2-4 weeks for one species are quite scattered through the season. (see spine Fig.4) Some species shown on the spine diagrams in Supplement 3 have many scattered observations. This is what makes the A/M less accurate. The number of species (87) with only one recorded week in bloom is 12.9% of the total number of species (676). Including species in bloom for two weeks the percent would be 21.2% of the total and including species in bloom for three weeks the figure would be 29% of the total. These may be the species with less accurate A/M dates.

Six is the modal number of weeks to be in bloom, omitting the unreliable one-week records. (Fig.3A) The frequency of occurrence curve then drops rapidly to the sharp break at eleven weeks after which the curve decreases more gradually. In other words many species have bloom periods of eleven or fewer weeks; far fewer have bloom period of twelve or more weeks. These latter 80 species are 11.8% of the total. (not significantly different than the percentage for the 87 species with single observations) The species that have been found in bloom during twelve or more weeks are in Table 13.

Of the first 10 species on the list, 7, or 70%, are introduced to the state. Of the first 25, over half are introduced. This is usually equivalent to "weedy" or at least "pioneer".

Another graph in Fig. 3B, to de-emphasize the smaller number of weeks in bloom, shows the results of multiplying the number of species by the number of weeks in bloom. This tends to show the importance of the number of species that bloom for a greater number of weeks. The mode is again six weeks in bloom.

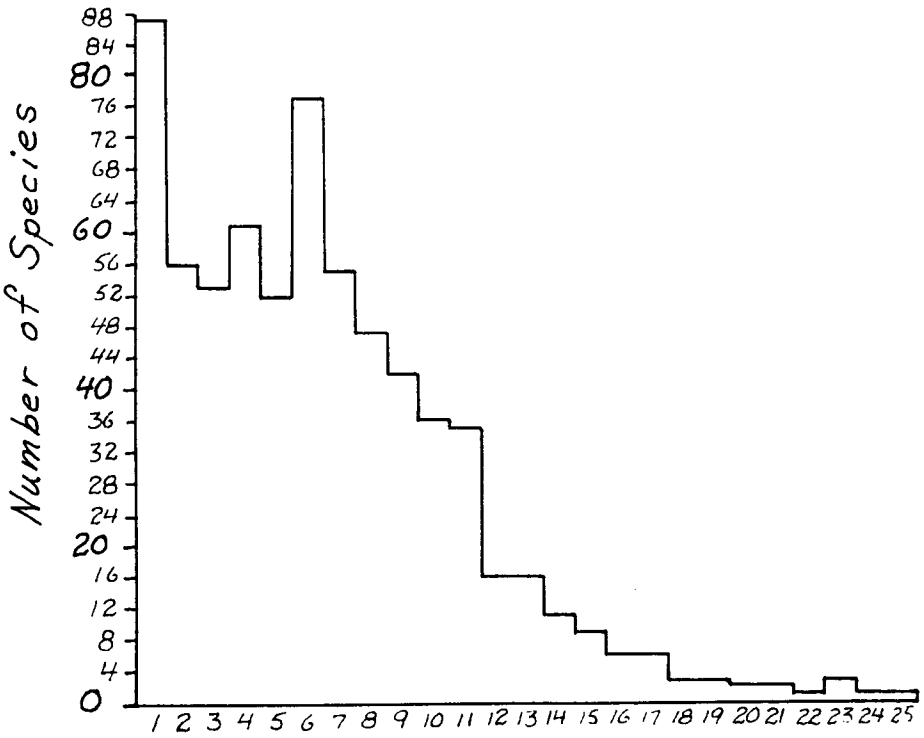

Fig. 3A Number of Weeks in Bloom

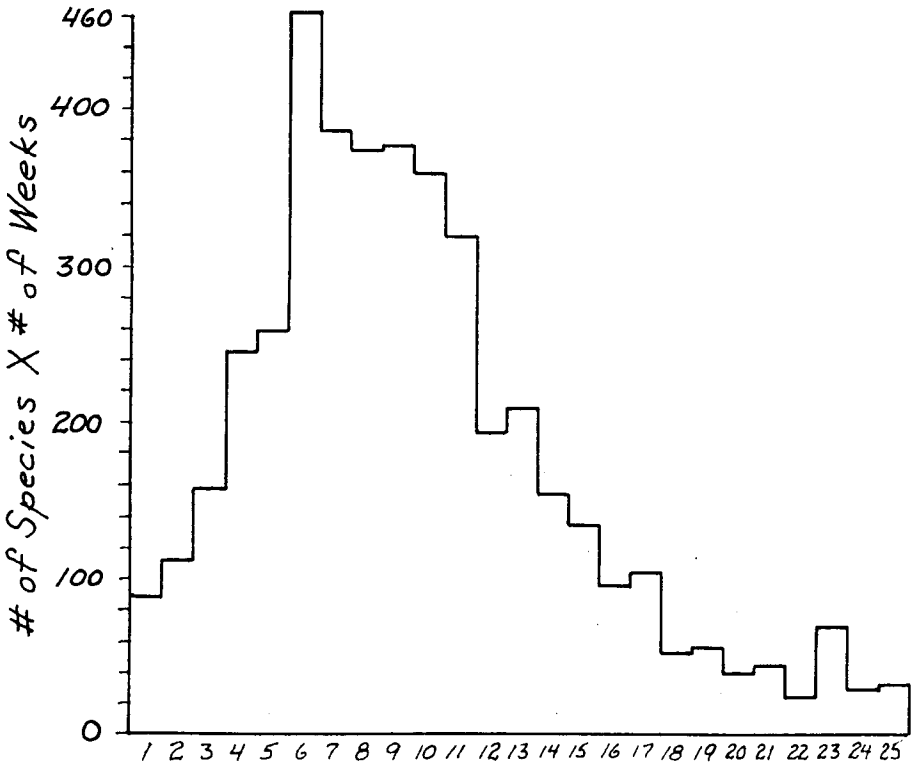

Fig. 3B Modified Duration of Bloom Period

Table 13 Group 10. Variations in Length of Flowering Phenophase. (Arranged according to the number of weeks found in bloom)

Weeks	
25	Berteroa incana*
24	Taraxacum off.*
23	Achillea mill.*
23	Campanula rotund.
23	Silene latif.*
22	Potentilla argentea*
21	Melilotus off.*
21	Oxalis stricta
20	Linaria vulg.*
20	Stellaria media
19	Rosa ark.
19	Tragopogon dubis*
19	Vicia villosa*
18	Melilotis alba*
18	Phlox pilosa
18	Trifolium pratense*
17	Agoseris glauca
17	Anemone canad.
17	Erigeron phil.
17	Erigeron strig.
17	Hedyotis long.
17	Sisymbrium altiss.*
16	Heterotheca villosa
16	Nepeta cat.*
16	Physalis virg.
16	Potentilla arguta
16	Rudbeckia hirta
16	Sisyrinchium
15	Brassica kaber*
15	Calylophus serr.
15	Cornus stolon.
15	Galium bor.
15	Helianthus petiol.
15	Lithospermum carol.
15	Silene vulgaris*
15	Tradescantia bract.
15	Verbena bract.
14	Erucastrum gall.
14	Heliopsis helianth.
14	Lathyrus pal.
14	Lithospermum can.
14	Oenothera bi.
14	Penstemon grac.
14	Petalostemon can.
14	Solanum pty.
14	Solidago nem.
14	Sonchus sp.*
14	Verbena stricta

Weeks	
13	Agastache foen.
13	Andropogon ger.
13	Aster eric.
13	Capsella bursa-*
13	Cirsium arv.*
13	Crepis tect.*
13	Galium asper.
13	Helianthemum bick.
13	Leonurus card.*
13	Linum sulc.
13	Mirabilis hirs.
13	Oxalis viol.
13	Polansia grav.
13	Ranunculus abort.
13	Solidago gig.
13	Solidago ptar.
13	Verbascum thap.
12	Allium stell.
12	Amorpha can.
12	Aquilegia can.
12	Arabis divar.
12	Asparagus off.
12	Castilleja cocc.
12	Cirsium flod.
12	Descurainia pinn.
12	Helenium aut.
12	Lechea stricta
12	Lobelia spicata
12	Lotus corn.*
12	Medicago lup.*
12	Petalostemon purp.
12	Psoralea esc.
12	Trifolium repens*

* Introduced

IV. The Phenology of Trees, Shrubs and Grasses

In this section it is life form that is used to separate, conveniently, the species for comparison. In each case a summary table of the species is provided. (Example Table 14)

Each table has four columns, plus the species list. Column 1 (A/M) is arranged according to the average and/or median date of flowering, from early to late. (see A/M in Methods) Those A/M dates in parentheses are less accurate because of four or fewer flowering observations. (Column 2)

Column 2, called "# of blooms", shows the total number of flowering observations recorded for that species over the years. The differences might indicate the commonness vs. rarity of the species in central Minnesota or could be the lack of observations in certain habitats.

Column 3 is the total of all floral phenophase observations, i.e. excluding the vegetative phenophase. The percentage of flowering observations to total floral varies because in some species the green fruit or seeds ripe phenophases are more easily noticed.

Column 4 indicates the total number of weeks during which the species was observed in bloom. This is not necessarily in any one year. And certainly not on any one individual plant. A number without parentheses signifies consecutive weeks of observations. A number in parentheses indicates that the number of weeks includes a gap of (usually only) one week in the data. Rarely two or more one-week blank intervals occurred. It is believed that if sampling had been adequate, these single-week blanks would provide data. In the case of a "+1", this signifies one blank interval of two or more weeks. If these intermittant intervals become excessive, then the designation of the flowering period would be "scattered". The actual weeks during which any species was observed in bloom is shown on the O/W/P Tables (Supplement 1), on the linear phenophase charts (Supplement 2) and on the "spine" figures. (Supplement 3) The latter does not show the numbers of observations per week. Most of the forb observations are contained in the three supplements.

A graph which plots the number of weeks in bloom with the number of flowering observations, for native trees, shows a definite correlation. This was also found with the Compositae in Supplement 3. (Fig. 33) Perhaps all groups would show the same relationship.

A. The Phenology of Trees

As seen in Table 14, most central Minnesota trees bloom early, i.e. between mid April and mid May. Many of these are catkin-bearing. Some are Gymnosperms. Two noteworthy exceptions to this early blooming are Mt. maple, modal in the Boreal Forest, and basswood which is usually expected to be in bloom on the Fourth of July.

The number of flowering observations, as previously mentioned, probably reflects the abundance of certain tree species in central Minnesota. Some floral phenophases may be easily observed but of quite different duration. Whereas box elder samaras cling to the tree for months, the ripe fruits of Amer. elm are shed immediately at which time they accumulate in city gutters and may soon germinate. (less so now after the introduction of the Dutch Elm Disease)

Perhaps because of insufficient seasonal length of flowering observations, the average number of weeks to be in bloom is only 4.8. For most trees that may be sufficient.

B. The Phenology of Shrubs

More shrub phenology observations were recorded than those for trees. This may be in part because there are more shrub species or it may also be simply that shrubs are shorter and more easily seen. The median dates in Table 15 cover a 15 week period from 4-18 to 8-3, and, with more June and July dates, a wider seasonal spread than with trees: 4 in April, 17 in May, 13 in June, 9 in July and 1 in August. Although one median occurs in August, several shrubs continue to bloom to the last of August and into September. (see linear phenophase charts in Supplement 2)

The average of 29 observations per shrub species in the flowering phenophase is more than for trees. The high number of observations for some species may reflect local abundance and/or the type of plant community most frequently visited.

Rose sp. was observed in bloom during 19 weeks, red osier 15 weeks and lead plant 12 weeks, otherwise the average of 5.6 weeks for when a shrub is in bloom is some higher than for trees.

Shrubs, in general, help to provide a seasonal continuity of flowers, and therefore food, for insects and perhaps hummingbirds. The seasonal availability of most species is limited.

Table 14. Summary of Phenological Data for Native Trees

Species	1 A/M	2 # of Blooms	3 Total Floral	4 # of Weeks
1. Acer saccharinum	4-17	42	115	(11)
2. Populus tremuloides	4-26	40	140	(8)+1
3. Ulmus americana	4-26	50	178	7
4. Ulums rubra	(4-26)	4	21	2
5. Populus deltoides	4-27	15	55	5
6. Juniperus virginiana	4-28	20	40	6
7. Fraxinus pennsylvanica	4-29	12	52	6
8. Acer rubrum	4-30	29	43	7
9. Acer negundo	5-03	96	220	6
10. Populus grandidentata	5-05	8	23	4
11, Betula papyrifera	5-07	17	33	5
12. Larix laricina	(5-07)	4	19	4
13. Picea glauca	(5-07)	2	3	2
14. Celtis occidentalis	5-08	13	24	6
15. Salix nigra	(5-09)	3	6	2+1
16. Acer saccharum	5-11	32	46	6
17. Betula alleghaniensis	(5-12)	3	7	3
18. Prunus serotina	5-12	5	19	(4)
19. Ostrya virginiana	5-13	18	75	5
20. Prunus americana	5-13	46	61	5
21. Prunus pensylvanica	5-15	28	47	6+1
22. Carpinus caroliniana	(5-16)	3	23	2
23. Quercus ellipsoidalis	5-17	11	42	3
24. Juglans cinerea	5-17	5	24	4
25. Quercus macrocarpa	5-18	15	134	4
26. Pinus banksiana	5-20	19	54	(7)
27. Prunus virginiana	5-21	45	129	5
28. Quercus rubra	(5-22)	2	5	1
29. Crataegus punctata	5-24	12	20	4
30. Pinus resinosa	6-02	9	26	(4)+1
31. Acer spicatum	(6-08)	3	15	(4)
32. Quercus alba	(6-18)	1	6	1
33. Tilia americana	7-10	45	89	6
		Aver. 19.9	54.4	4.8
		% of Total Floral 36.6%		

Table 15. Summary of Phenological Data for Native Shrubs

Species	A/M	# of Blooms	Total Floral	# of Weeks
1. Alnus incana	4-18	12	32	4
2. Taxus sp.	(4-23)	3	8	2
3. Corylus amer.	4-24	38	114	8
4. Salix humilis	4-30	20	63	5
5. Dirca palustris	5-01	79	143	7
6. Zanthoxylum amer.	5-11	37	69	5
7. Amelanchier laevis	5-12	13	17	4
8. Amelanchier hum.	5-13	57	117	6
9. Ribes cynos.	5-13	39	99	5
10. Ribes triste	5-13	27	37	5
11. Sambucus pubens	5-14	98	355	6
12. Rhamnus alnifolia	(5-16)	4	6	2
13. Ribes miss.	5-18	13	21	4
14. Salix exigua	5-18	6	10	(8)
15. Vaccinium angust.	5-18	19	39	(6)
16. Prunus pumila	5-19	28	73	5
17. Ribes amer.	5-20	80	108	5
18. Betula gland.	(5-23)	2	17	2
19. Arctostaphylos uva-	(5-27)	1	5	1
20. Rhamnus cath.	5-27	5	20	2
21. Viburnum lent.	5-29	13	39	3
22. Lonicera dioica	5-30	9	20	(5)
23. Hudsonia toment.	(6-02)	2	2	1+1
24. Cornus altern.	6-03	37	123	7
25. Euonymus atro.	6-03	15	40	6+1
26. Viburnum tri.	6-03	6	17	(3)
27. Staphylea tri.	6-05	5	15	2
28. Cornus stolon.	6-08	89	182	15
29. Cornus rugosa	6-09	6	16	(4)
30. Rhus radicans	6-10	21	51	(7)
31. Viburnum rafin.	6-14	5	27	4
32. Rubus allegh.	6-14	24	44	5
33. Rubus strig.	6-14	15	40	5
34. Amorpha frut.	6-16	11	23	6
35. Cornus foemina	6-22	26	63	7
36. Elaegnus comm.	(6-23)	1	2	1
37. Diervilla lon.	6-25	32	59	6+2
38. Amorpha nana	6-27	18	69	8
39. Rosa ark.	7-02	146	209	(19)
40. Rhus typhina	(7-04)	3	4	3
41. Rhus glabra	7-08	10	31	4+1
42. Sambucus canad.	7-08	12	13	6
43. Ilex vert.	(7-10)	1	2	1
44. Ceanothus amer.	7-15	26	47	(8)
45. Symphoricarpos occ.	7-17	68	96	10

(cont'd)

Table 15 (cont'd)

Species	A/M	# of Blooms	Total Floral	# of Weeks
46. Spiraea alba	7-19	79	112	9
47. Amorpha can.	7-25	145	266	12
48. Spiraea tomentosa	(7-26)	3	7	(3)
49. Potentilla frut.	8-03	11	12	(9)+1
	Aver.	29.0	60.9	5.6
	% of Total Floral	47.6%		

Table 16. Summary of Phenological Data for Introduced Shrubs

Species	A/M	# of Blooms	Total Floral	# of Weeks
1. Forsythia suspensa	4-30	11	13	6
2. Ribes odorata	(5-10)	2	2	3
3. Syringa vulgaris	5-19	40	62	7
4. Caragana arbor.	5-20	19	27	5
5. Lonicera tatarica	5-23	23	56	6
6. Spiraea vanhouttei	5-23	16	19	6
7. Cotoneaster sp.	(5-26)	2	2	1
8. Weigela florida	6-11	5	6	3
9. Philadelphus coron.	6-18	9	12	6
10.Physocarpus opulif.	(7-29)	1	2	1
	Aver	12.8	19.1	4.4
	% of Total Floral	67.0%		

Table 17. Summary of Phenological Data for Introduced Trees

Species	A/M	# of Blooms	Total Floral	# of Weeks
1. Ulmus pumila	4-24	10	31	(7)
2. Acer platanoides	5-08	6	12	(5)
3. Betula alba	5-08	4	17	(5)
4. Picea pungens	(5-15)	4	4	4
5. Pyrus sp.	5-16	17	27	4
6. Aesculus glabra	5-17	5	11	(5)
7. Sorbus sp.	5-21	8	13	(5)
8. Robinia hispida	6-06	12	12	6
9. Robinia pseudo-	6-06	23	31	5
10.Acer ginnala	(6-18)	1	9	1
11.Catalpa speciosa	6-23	20	26	4+2
	Aver	10.0	17.5	4.8
	% of Total Floral	57 %		

C. The Phenology of Grasses

Grasses were considered "in bloom" if stamens were exserted. In a few cases styles were obvious.

The higher number of flowering observations for prairie species discloses the type of plant community frequently visited. (Table 18) The higher numbers for Phalaris and Spartina indicate that wet prairies were well represented, more so than dry prairies with such typical species as Stipa, Schizachyrium or Bouteloua. This could be another artifact of selective observation.

Also well represented were several species of the hardwood forest in central Minnesota: Oryzopsis asper., Schizachne purp. and Elymus hystrix. The first two are common in the Partch Woods, with median bloom in May, the latter, with median bloom date in July, is also common in the Cold Spring Heron Colony.

Most grasses on Table 18 have the median time of bloom in July and August. The median dates for the Introduced grasses in Table 19 is June and July. Indian grass was observed in bloom during 10 weeks but the lack of observations for some species may make the average for weeks in bloom less accurate.

The native grasses in Table 18 have been put on the "spine diagram" in Fig. 4 as an example of the many such figures in Supplement 3. (modified from Heinrich 1976)

The "spine" is the line that connects all the average or median dates of bloom (A/M) for the 24 species on the list. The earliest A/M date, May 8, is number 1 at the bottom of the spine, progressing to number 24.

The horizontal lines, or points in parentheses, indicate the weeks when flowering was recorded. Five species, of insufficient observation, were recorded in bloom only during one week each, so therefore were on the spine. Note that the number of weeks in bloom for species 19, big bluestem, would be (13)+1.

Three forest species are first on the list. Other forest species have their A/M dates in July. Most of the prairie species have their A/M dates in July and August.

Table 18. Summary of Phenological Data for Native Grasses

Species	A/M	# of Blooms	Total Floral	# of Weeks
1. Oryzopsis asper.	5-08	49	142	6
2. Schizachne purp.	5-18	17	39	3
3. Milium effusum	(6-05)	3	14	2
4. Koeleria micrantha	6-19	11	44	4
5. Calamagrostis can.	(6-20)	1	17	1
6. Stipa spartea	6-22	7	184	4
7. Phalaris arund.	6-23	19	41	8
8. Agropyron trachy.	(7-07)	1	29	1
9. Bromus latiglumis	(7-08)	4	10	3
10. Agrostis stolon.	(7-15)	3	16	3
11. Bromus kalmii	(7-15)	1	18	1
12. Elymus hystrix	7-17	13	60	3+1
13. Elymus canad.	7-18	8	40	(6)
14. Brachyeletrum erect.	(7-26)	3	14	(3)+1
15. Oryzopsis race.	(7-31)	1	22	1
16. Panicum virg.	8-01	18	44	6
17. Spartina pect.	8-04	36	38	7+1
18. Calamovilfa long.	8-04	6	11	3+1
19. Andropogon ger.	8-06	78	122	(13)+1
20. Bouteloua curt.	8-07	14	27	7
21. Sorghastrum nut.	8-11	66	87	(10)
22. Sporobolus het.	(8-11)	2	16	(3)
23. Schizachyrium scop.	8-14	9	27	(6)
24. Bouteloua grac.	8-24	7	10	8+1

Table 19. Summary of Phenological Data for Introduced Grasses

Species	A/M	# of Blooms	Total Floral	# of Weeks
1. Poa pratense*	6-14	11	48	(7)+1
2. Bromus inermis*	6-19	11	18	(5)+1
3. Hordeum jubatum*	(6-22)	1	17	1
4. Poa compressa*	6-25	5	13	(4)
5. Agropyron repens*	7-01	22	41	4+2
6. Phleum pratense*	7-06	6	17	4+2
7. Setaria vert.*	(7-10)	1	1	1
	Aver	8.1	22.1	4.6
	% of Total Floral	36.8%		

Table 20. Species with Late Separate Vegetative Phenophase

Species	A/M	# veg Weeks after Bloom	# of veg Observations
1. Salix humilis	4-30	15	3
2. Pulsatilla nutt.	5-01	9	13
3. Hepatica amer.	5-02	9	6
4. Sanguinaria canad.	5-04	13	6
5. Antennaria sp.	5-17	13	4
6. Fragaria virg.	5-25	6	2
7. Lathyrus ven.	6-18	6	2
	Aver	10.1	5.1

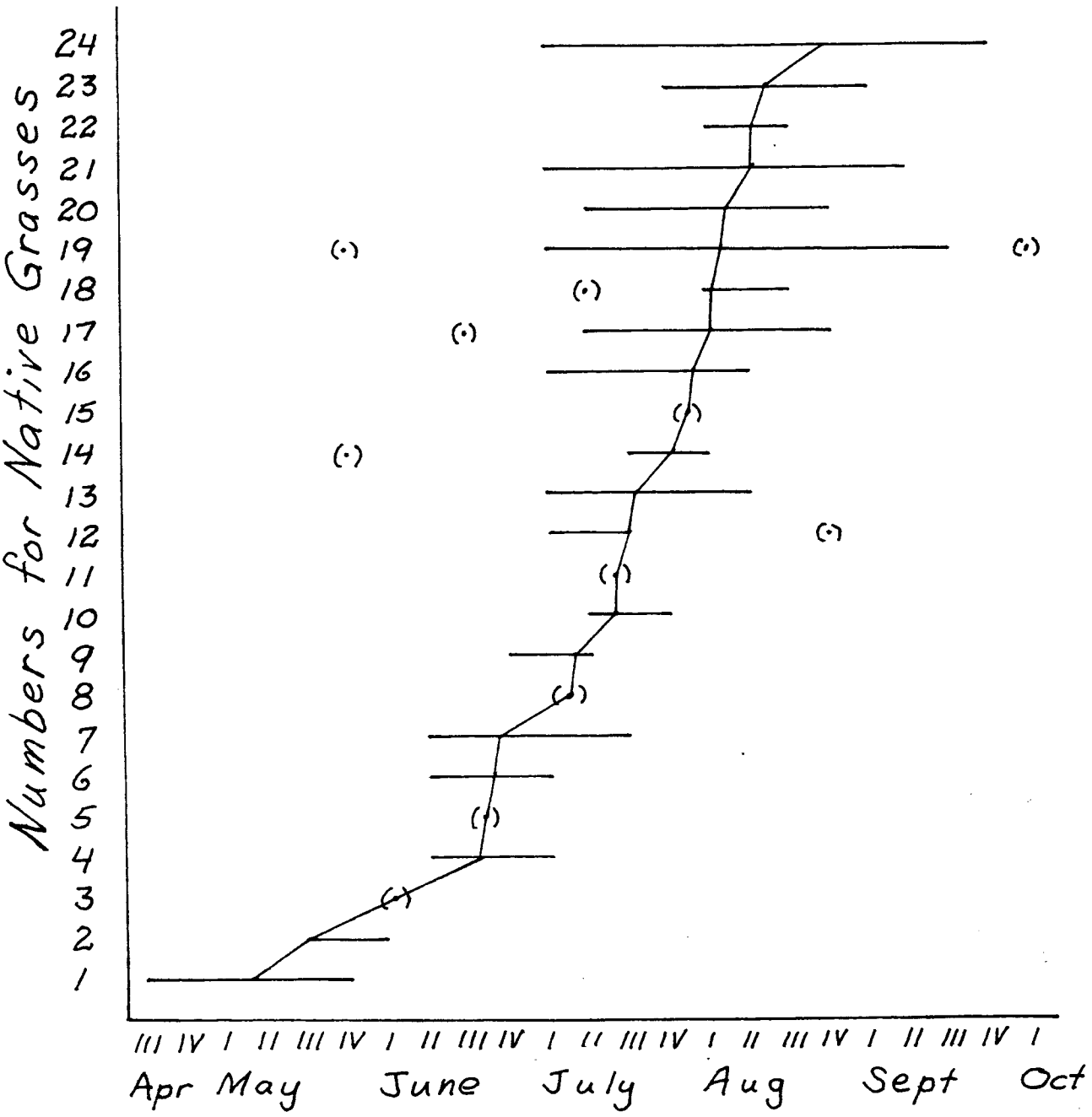

Fig. 4 Spine Diagram for Native Grasses

Appendix A. Plants with Flowering Phenology Data

Species	# of Blooms*	Total Floral	# of Weeks	Aver/Med
Acer ginnala*	1	9	1	(6-18)
Acer negundo	96	220	6	5-3
Acer platanoides*	6	12	(5)	5-8
Acer rubrum	29	43	7	4-30
Acer saccharinum	42	115	(11)	4-17
Acer saccharum	32	46	6	5-11
Acer spicatum	3	15	(4)	6-8
Achillea millefolium*	216	281	(22)+1	7-16
Actaea rubra	39	122	4+2	5-24
Aesculus glabra*	5	11	(5)	5-17
Agalinis tenuifolia	11	17	(8)	8-17
Agastache foeniculum	91	108	13	8-4
Agoseris glauca	38	68	(16)+1	7-3
Agrimonia gryposepala	23	54	7	7-30
Agropyron repens*	22	41	4+2	7-1
Agropyron trachycaulum	1	29	1	(7-7)
Agrostis stolonifera	3	16	3	(7-15)
Alisma triviale	4	17	(6)	(8-5)
Allium canadense	2	4	1	(6-18)
Allium stellatum	150	236	12	8-11
Allium tricoccum	14	110	5	7-4
Alnus incana	12	32	4	4-18
Amaranthus retroflexus*	1	6	1	(8-26)
Ambrosia artemisiifolia	10	37	4	8-18
Ambrosia coronopifolia	8	20	1	8-23
Ambrosia trifida	1	7	1	(7-28)
Amelanchier humilis	57	117	6	5-13
Amelanchier laevis	13	17	4	5-12
Amorpha canescens	145	266	12	7-25
Amorpha fruticosa	11	23	6	6-16
Amorpha nana	18	69	8	6-27
Amphicarpaea bracteata	22	32	5	8-11
Anaphalis margaritacea	3	4	sctd	(7-15)
Andromeda glaucophylla	2	2	1	(5-24)
Andropogon gerardii	78	122	(13)	8-6
Androsace occidentalis	11	27	(6)	5-11
Anemone canadensis	137	210	(17)	6-30
Anemone caroliniana	5	5	3	5-20
Anemone cylindrica	36	173	6+1	6-29
Anemone quinquefolia	225	284	7	5-14
Anemone virginiana	16	62	4	7-2
Anemonella thalictroides	42	46	(8)	5-11
Antennaria neodioica	43	86	(9)	5-17
Aplectrum hyemale	4	5	(4)	(6-21)
Apocynum androsaemifolium	70	82	10	7-6
Apocynum cannabinum	60	92	10	7-8
Aquilegia canadensis	179	296	12	5-30
Arabis spp.	46	74	10+2	5-26

* Number of Flowering Observations

Species	# of Blooms	Total Floral	# of Weeks	Aver/Med
Aralia nudicaulis	56	136	(8)	5-30
Aralia racemosa	13	84	(4)+1	7-18
Arctium minus*	3	12	(3)+1	(7-30)
Arctostaphylos uva-ursi	1	5	1	(5-27)
Arenaria lateriflora	115	123	(10)	5-31
Arisaema triphyllum	108	203	6	5-19
Artemisia absinthium*	4	6	3	(8-8)
Artemisia campestris	9	46	4	8-19
Artemisia frigida	4	7	3	(9-14)
Artemisia ludoviciana	8	45	5	9-5
Artemisia serrata	2	7	1+1	(9-3)
Asarum canadense	56	104	6+1	5-11
Asclepias exaltata	7	14	1+1	6-28
Asclepias incarnata	64	114	(9)	7-18
Asclepias ovalifolia	46	93	8+1	6-26
Asclepias speciosa	41	67	(10)	7-28
Asclepias syriaca	83	169	9	7-11
Asclepias tuberosa	50	75	11	7-17
Asclepias verticillata	16	22	(8)	8-6
Asclepias viridiflora	7	11	(4)	6-30
Asparagus officinalis*	21	46	(10)+2	6-16
Aster ciliolatus	24	26	(10)+1	9-9
Aster ericoides	115	157	(13)	8-30
Aster laevis	59	94	(10)	8-27
Aster lanceolatus	78	91	9	9-2
Aster lateriflorus	27	38	8	9-4
Aster macrophyllus	37	62	11	8-27
Aster novae-angliae	39	54	(10)	8-29
Aster oolentangiensis	48	64	9	9-8
Aster puniceus	4	5	(3)+1	(8-25)
Aster sericeus	30	37	9	9-13
Aster umbellatus	57	74	9	8-16
Aster urophyllus	55	58	(9)	9-11
Astragalus agrestis	18	23	(9)	6-15
Astragalus canadensis	56	117	8+1	7-29
Astragalus crassicarpus	12	40	(6)	5-22
Barbarea vulgaris*	12	13	4	5-23
Berteroa incana*	138	161	(25)	7-9
Betula alba*	4	17	(5)	(5-8)
Betula alleghaniensis	3	7	3	(5-12)
Betula glandulifera	2	17	2	(5-23)
Betula papyrifera	17	33	5	5-7
Bidens spp.	15	23	(8)	9-7
Bouteloua curtipendula	14	27	7	8-7
Bouteloua gracilis	7	10	(8)	8-24
Brachyelytrum erectum	3	14	(3)+1	(7-26)
Brassica kaber*	45	55	14+1	7-8
Bromus inermis*	11	18	(5)+1	6-19
Bromus kalmii	1	18	1	(7-15)
Bromus latiglumis	4	10	3	(7-8)

Species	# of Blooms	Total Floral	# of Weeks	Aver/Med
Calamagrostis canadensis	1	17	1	(6-20)
Calamovilfa longifolia	6	11	3+1	8-4
Calla palustris	5	6	4+1	6-9
Calopogon tuberosa	3	3	(3)+1	(7-13)
Caltha palustris	151	212	(10)	5-14
Calylophus serrulata	94	100	14+1	7-25
Campanula aparinoides	30	31	9	8-2
Campanula rapunculoides*	14	16	6	7-19
Campanula rotundifolia	261	276	(22)+1	7-21
Capsella bursa-pastoris*	32	70	(9)+4	6-22
Caragana arborescens*	19	27	5	5-20
Cardamine bulbosa	28	29	8	5-30
Cardamine pensylvanica	33	46	6	5-26
Carduus nutans*	4	10	3+1	(8-31)
Carex pensylvanica	94	128	7	5-4
Carex rosea	1	19	1	(5-11)
Carpinus caroliniana	3	23	2	(5-16)
Castilleja coccinea	43	43	10+2	6-12
Catalpa speciosa*	20	26	4+2	6-23
Caulophyllum thalictroides	125	342	6	5-15
Ceanothus americanus	26	47	(8)	7-15
Celastrus scandens	8	22	3+1	6-10
Celtis occidentalis	13	24	6	5-8
Centaurea biebersteinii*	5	7	1	8-8
Cerastium arvense*	107	119	8	5-28
Chamaedaphne calyculata	4	7	(3)	(5-20)
Chamomilla suaveolens*	22	23	7+2	6-12
Chelone glabra	8	13	(4)+1	8-20
Chenopodium album*	7	22	sctd	7-12
Chimaphila umbellata	11	27	4	7-12
Chrysanthemum leucanth.*	16	17	7	7-4
Cicuta bulbifera	12	19	(8)	8-12
Cicuta maculata	76	130	8+2	7-18
Circaea alpina	15	24	(7)+1	7-5
Circaea lutetiana	54	120	8	7-13
Cirsium arvense*	85	139	13	8-4
Cirsium flodmani	90	122	12	8-10
Cirsium hillii	6	10	3	7-25
Cirsium muticum	21	35	(11)	8-18
Cirsium vulgare*	5	6	(4)+1	8-21
Claytonia virginica	6	6	4	5-14
Clematis virginiana	2	5	(3)	(7-27)
Cleome spinosa*	1	4	1	(9-22)
Clintonia borealis	5	26	2	6-6
Collomia linearis*	3	3	(3)+1	(6-21)
Comandra umbellata	91	153	9	6-3
Convallaria majalis*	16	22	(9)	5-8
Convolvulus arvensis*	7	7	(5)+2	7-8
Convolvulus sepium	7	7	6	7-23

Species	# of Blooms	Total Floral	# of Weeks	Aver/Med
Conyza canadensis	12	46	6+2	8-7
Coptis groenlandica	1	2	1	(5-29)
Corallorhiza trifida	10	12	(6)	5-23
Coreopsis palmata	59	107	6	7-13
Cornus alternifolia	37	123	7	6-3
Cornus canadensis	8	19	(7)	6-8
Cornus foemina	26	63	7	6-22
Cornus rugosa	6	16	(4)	6-9
Cornus stolonifera	89	182	15	6-8
Corydalis aurea	20	21	(9)	5-18
Coryadlis sempervirens	21	29	4+4+1	5-26
Corylus americana	38	114	8	4-24
Crataegus punctata	12	20	4	5-24
Crepis runcinata	21	25	8	7-20
Crepis tectorum*	30	34	(7)+4	6-28
Cryptotaenia canadensis	78	144	7	6-21
Cuscuta glomerata	11	12	(6)	8-21
Cynoglossum officinale*	3	4	3	(6-10)
Cypripedium acaule	8	12	5	6-13
Cypripedium calceolus	37	53	8	6-3
Cypripedium candidum	19	23	(6)	6-9
Cypripedium reginae	4	7	(3)	(6-24)
Delphinium virescens	92	153	(10)+1	7-6
Dentaria laciniata	5	7	2	5-5
Descurainia pinnata*	34	48	(12)	6-2
Desmodium canadense	32	59	6	7-31
Desmodium glutinosum	33	86	(8)	7-16
Dianthus armeria*	2	3	1+1	(sctd)
Dicentra cucullaria	23	23	4	5-5
Dicentra spectabilis*	10	13	(5)	5-19
Diervilla lonicera	32	59	6+2	6-25
Dirca palustris	79	143	7	5-1
Draba spp.	16	27	7+2	5-13+Nov
Dracocephalum parviflorum	4	4	2	(6-30)
Drosera intermedia	2	2	2	8-7
Dulichium arundinaceum	2	2	1	(8-10)
Echinacea angustifolium	12	21	6	7-17
Echinocystis lobata	15	19	5	8-10
Echium vulgare*	3	3	2	(6-23)
Elaeagnus commutata	1	2	1	(6-23)
Eleocharis sp.	2	3	1	(5-6)
Ellisia nyctelea	3	5	2	(6-5)
Elymus canadensis	8	40	(6)	7-18
Elymus hystrix	13	60	3+1	7-17
Epigaea repens	3	3	1	(5-29)
Epilobium angustifolium	26	45	10+1	7-28
Epilobium glandulosum	15	36	(7)	8-12
Epilobium leptophyllum	13	30	(8)	8-14

Species	# of Blooms	Total Floral	# of Weeks	Aver/Med
Erigeron glabellus	24	28	(10)	6-27
Erigeron philadelphicus	126	157	(17)	6-20
Erigeron strigosus	205	235	16+1	7-21
Erucastrum gallicum*	64	81	(14)	8-9
Erysimum cheiranthoides*	21	30	8+2	6-27
Erythronium albidum	14	17	3	5-8
Euonymus atropurpureus	15	40	6+1	6-3
Eupatorium maculatum	38	56	7	8-15
Eupatorium perfoliatum	35	55	7	8-10
Eupatorium rugosum	55	83	11	8-26
Euphorbia corollata	4	4	1+1+1	(7-25)
Euphorbia cyparissias*	3	4	(4)	(5-22)
Euphorbia podperae*	12	15	(10)+1	6-18
Euthamia graminifolia	112	164	11	8-16
Festuca obtusa	2	14	1	(7-15)
Festuca ovina*	1	8	1	(6-14)
Forsythia suspensa*	11	13	6	4-30
Fragaria virginiana	187	206	(11)	5-25
Fraxinus pennsylvanica	12	52	6	4-29
Galearis spectabilis	37	66	5	5-27
Galeopsis tetrahit*	2	3	2	(7-23)
Galinsoga quadriradiata*	8	8	4+1	7-29
Galium aparine	79	152	8	5-29
Galium asprellum	15	25	(12)+1	8-8
Galium boreale	173	235	15	6-27
Galium triflorum	8	44	(6)	6-25
Gautheria procumbens	1	5	1	(8-12)
Gentiana andrewsii	48	61	6	8-29
Gentiana puberulenta	32	41	7	9-16
Gentianopsis crinita	19	25	(8)	9-6
Geranium bicknellii	5	12	(3)&2	6-24
Geranium maculatum	222	357	(10)	6-4
Geum aleppicum	38	62	(10)	7-7
Geum canadense	62	132	9	6-28
Geum rivale	10	15	4	5-30
Geum triflorum	44	134	6+1	5-19
Glecoma hederacea*	29	29	8	5-20
Glycyrrhiza lepidota	19	56	(9)	7-17
Gnaphalium obtusifolium	3	5	3+1	(7-10)
Goodyera sp.	3	6	2+1	(7-28)
Grindelia squarrosa	10	15	(8)	8-20
Gypsophila muralis*	5	6	4+1	7-2
Hackelia deflexa	7	19	3	7-14
Hedeoma hispida	24	41	5+1	6-26
Hedyotis longifolia	51	57	(16)+1	6-21
Helenium autumnale	61	84	(12)	8-26
Helianthemum bicknellii	38	50	(13)	7-8
Helianthus annuus*	2	2	2	(8-27)
Helianthus gig/gross	86	106	(11)	8-19

Species	# of Blooms	Total Floral	# of Weeks	Aver/Med
Helianthus hirsutus	53	68	10	8-18
Helianthus maximiliani	92	115	11	8-18
Helianthus petiolaris	38	40	15	8-3
Helianthus rigidus	137	207	11	8-12
Helianthus tuberosa	4	5	4	(9-7)
Heliopsis helianthoides	103	120	(14)	7-22
Hepatica acutiloba	2	4	(3)	(5-12)
Hepatica americana	96	150	8	5-2
Heracleum lanatum	4	7	1+1	(7-4)
Heterotheca villosa	67	79	(15)+1	8-1
Heuchera richardsonii	87	171	11	6-16
Hieracium kalmii	48	65	(10)+1	8-16
Hierochloa odorata	10	22	(4)	5-22
Hordeum jubatum*	1	17	1	(6-22)
Hudsonia tomentosa	2	2	1+1	(6-2)
Hydrophyllum appendiculatum	1	1	1	(6-7)
Hydrophyllum virginianum	75	147	(9)	6-1
Hypericum pyramidatum	12	21	7	7-21
Hypoxis hirsuta	84	86	10	6-10
Impatiens capensis	55	69	10	8-8
Iris versicolor	47	63	(10)	6-21
Isopyrum biternatum	37	61	7	5-14
Juglans cinerea	5	24	4	5-17
Juncus balticus	1	7	1	(6-26)
Juncus nodosus	2	9	2	(7-8)
Juniperus virginiana	20	40	6	4-28
Kalmia polifolia	3	4	1+1+1	(8-3)
Koeleria macrantha	11	44	4	6-19
Krigia biflora	28	35	6+1	6-26
Kuhnia eupatorioides	2	8	2	(8-5)
Lactuca canadensis	11	37	(7)+2	7-26
Lactuca pulchella	29	37	7	8-6
Lactuca serriola*	4	16	3	(8-15)
Laportea canadensis	20	23	(9)	7-27
Lappula squarrosa*	21	31	(10)+1	6-27
Larix laricina	4	19	4	(5-7)
Lathyrus japonicus	2	5	1+1	(8-23)
Lathyrus ochroleucus	41	48	8	6-3
Lathyrus palustris	32	38	(14sctd)	6-17
Lathyrus venosus	47	57	7	6-18
Lechea stricta	5	11	(12sctd)	8-7
Ledum groenlandicum	4	13	(4)	(6-6)
Leonurus cardiaca*	31	47	(10)+3	7-14
Lepidium densiflorum	9	76	(6)+2	6-16
Lespedeza capitata	9	32	(5)	8-13
Liatris aspera	110	201	8+1	8-19
Liatris ligulistylis	22	44	8	8-20
Liatris punctata	39	79	(11)	8-14
Liatris pycnostachya	79	149	9	8-9

Species	# of Blooms	Total Floral	# of Weeks	Aver/Med
Lilium michiganense	29	52	7+1	7-15
Lilium philadelphicum	43	76	5+1	7-12
Linaria vulgaris*	88	97	(20)	8-6
Linnaea borealis	11	14	(6)	7-3
Linum sulcatum	24	41	(13)	8-5
Lithospermum canescens	215	280	14	5-31
Lithospermum caroliniense	87	106	(15)	6-24
Lithospermum incisum	41	51	4	5-24
Lithospermum latifolium	3	14	2+1	(5-23)
Lobelia inflata	4	7	(4)	(8-6)
Lobelia kalmii	6	7	(6)	8-12
Lobelia siphilitica	13	15	(7)+1	9-5
Lobelia spicata	130	143	12	7-30
Lonicera dioica	9	20	(5)	5-30
Lonicera tatarica*	23	56	6	5-23
Lotus corniculatus*	31	31	(16)	7-17
Lupinus perennis	12	25	6+1	6-11
Luzula acuminata	8	27	(5)	5-8
Lycopus spp.	47	55	7	8-6
Lygodesmia juncea	11	13	(8)+1	8-4
Lysimachia ciliata	27	33	(6)	7-21
Lysimachia quadriflora	15	18	4	7-31
Lysimachia terrestris	6	9	4+1	7-7
Lysimachia thysiflora	17	23	5	6-17
Lythrum alatum	12	15	(9)	7-17
Lythrum salicaria*	13	14	6	8-14
Maianthemum canadense	89	233	7	6-9
Malva neglecta*	20	31	(10)sctd	6-16
Medicago lupulina*	37	54	10+2	6-23
Medicago sativa*	13	13	7+2	7-8
Melampyrum lineare	3	6	3	(8-4)
Melilotus alba*	178	212	16+2	8-1
Melilotus officinalis*	139	154	(21)	7-17
Menispermum canadense	3	6	1+1+1	(6-8)
Mentha arvensis	25	30	(9)	8-6
Mertensia virginica (*)	20	28	5+1north	5-12
Milium effusum	3	14	2	(6-5)
Mimulus ringens	10	16	5+1	7-20
Mirabilis hirsuta	17	33	(13)	8-27
Mirabilis linearis	6	10	(5)+3	7-25
Mirabilis nyctaginea	32	52	(10)+1	6-21
Mitella diphylla	17	30	4	5-25
Mitella nuda	11	18	(5)	5-26
Mollugo verticillata*	7	12	3+1	8-6
Monarda fistulosa	116	154	(11)	8-4
Monotropa uniflora	7	16	(4)+2	8-12
Muhlenbergia racemosa	3	4	3	(8-19)
Myosotis laxa	5	8	2+2	6-21

Species	# of Blooms	Total Floral	# of Weeks	Aver/Med
Myosurus minimus	2	5	1	(5-28)
Nepeta cataria*	25	30	(16sctd)	7-21
Nuphar luteum	21	21	6+1	6-14
Nymphaea tuberosa	8	8	(5)+1	7-6
Oenothera biennis	117	194	14	8-4
Oenothera nuttallii	4	5	2+1	(7-27)
Onosmodium molle	3	12	2	(7-4)
Opuntia spp.	5	7	4	6-29
Oryzopsis asperifolia	49	142	6	5-8
Oryzopsis racemosa	1	22	1	(7-31)
Osmorhiza claytoni	61	172	5	6-3
Osmorhiza longistylis	36	74	5	6-2
Ostrya virginiana	18	75	5	5-13
Oxalis stricta	78	95	(21)	6-25
Oxalis violacea	86	94	9+(4)	5-27
Oxytropis lambertii	3	3	3	(6-4)
Panax quinquefolium	6	61	3*	6-18
Panicum spp.	4	21	2+1	(6-27)
Panicum virgatum	18	44	6	8-1
Parnassia sp.	21	27	8+1	8-24
Parthenocissus inserta	3	14	2	(5-30)
Pedicularis canadensis	55	89	7	6-2
Pedicularis lanceolata	39	62	6	8-21
Penstemon gracilis	85	104	(13)+1	6-26
Penstemon grandiflorus	23	49	5	6-12
Penthorum sedoides	12	18	4+2	8-2
Petalostemon candidum	137	210	13+1	7-28
Petalostemon purpureum	175	272	12	8-4
Petalostemon villosum	10	14	3+1	8-3
Phalaris arundinacea	19	41	(8)	6-23
Philadelphus coronarius*	9	12	(6)	6-18
Phleum pratense*	6	17	4+2	7-6
Phlox divaricata	28	31	7	5-26
Phlox pilosa	149	182	18	7-2
Phryma leptostachya	66	154	10	7-15
Physalis heterophylla	30	62	9+1	7-3
Physalis virginiana	80	128	(15)+1	6-26
Physostegia virginiana	13	17	4+1	8-9
Picea glauca	2	3	2	(5-7)
Picea pungens*	4	4	4	(5-15)
Pilea pumila	4	11	2	(8-8)
Pinus banksiana	19	54	(7)	5-20
Pinus resinosa	9	26	(4)+1	6-2
Plantago major*	11	23	6	7-10
Plantago patagonica*	14	19	7	6-23
Platanthera hyperborea	25	48	(11)	6-2
Platanthera psycodes	11	15	(6)	8-1

* Total Panax observations over 21 weeks

Species	# of Blooms	Total Floral	# of Weeks	Aver/Med
Poa compressa*	5	13	(4)	6-25
Poa pratensis	11	48	(7)+1	6-14
Podophyllum peltatum	13	25	4	5-27
Pogonia ophioglossoides	2	3	1+1	(7-11)
Polanisia dodecandra	19	36	(13)	8-6
Polygala paucifolia	3	3	(3)	(5-31)
Polygala sanguinea	15	16	(10)	8-20
Polygala senega	33	47	7+1	6-11
Polygala verticillata	4	8	1+1+1	(8-23)
Polygonatum commutatum	46	199	6	6-20
Polygonatum pubescens	32	129	5	5-27
Polygonum amphibium	4	6	(4)	(8-10)
Polygonum aviculare*	7	7	3+2	9-12
Polygonum coccineum	9	11	(5)+1	8-6
Polygonum sagittatum	12	22	5+1	8-11
Polygonum scandens	8	22	4+2	7-3
Pontederia cordata	2	2	2	(8-5)
Populus deltoides	15	55	5	4-27
Populus grandidentata	8	23	4	5-5
Populus tremuloides	40	140	(8)+1	4-26
Portulaca olerecea*	3	6	(4)	(7-23)
Potentilla anserina	11	11	5+2	6-27
Potentilla argentea*	81	84	(21)+1	6-21
Potentilla arguta	134	199	(16)	7-2
Potentilla fruticosa	11	12	(9)+1	8-3
Potentilla norvegica	43	55	(9)+1	7-9
Potentilla palustris	5	7	(5)+1	7-8
Potentilla pensylvanica	3	4	(3)	(7-13)
Potentilla recta*	24	35	(9)+1	7-1
Potentilla simplex	43	44	(10)	6-19
Potentilla tridentata	5	5	sctd	(7-23)
Prenanthes alba	15	26	6	9-5
Prenanthes racemosa	54	123	7	8-27
Prunella vulgaris*	16	16	(9)	7-29
Prunus americana	46	61	5	5-13
Prunus pensylvanica	28	47	6+1	5-15
Prunus pumila	28	73	5	5-19
Prunus serotina	5	19	(4)	5-12
Prunus virginiana	45	129	5	5-21
Psoralea argophylla	84	97	(12)	8-6
Psoralea esculenta	18	53	5+1	6-23
Pulsatilla nuttalliana	96	184	11	5-1
Pycnanthemum virginianum	101	144	(11)	8-6
Pyrola asarifolia	45	77	7	7-4
Pyrola secunda	7	28	3	7-3
Pyrus ioensis ? or *	17	27	4	5-16

Species	# of Blooms	Total Floral	# of Weeks	Aver/Med
Quercus alba	1	6	1	(6-18)
Quercus ellipsoidalis	11	42	3	5-17
Quercus macrocarpa	15	134	4	5-18
Quercus rubra	2	5	1	(5-22)
Ranunculus abortivus	163	269	(13)	5-19
Ranunculus acris*	20	21	(9)+2	6-17
Ranunculus cymbalaria	3	3	sctd	(7-13)
Ranunculus fascicularis	53	66	6	5-11
Ranunculus flabellaris	9	10	5+1	6-1
Ranunculus hispidus	16	19	(5)+2	5-31
Ranunculus longirostris	2	2	(3)	(6-20)
Ranunculus pensylvanicus	10	19	(7)+2	6-20
Ranunculus recurvatus	14	37	3	5-30
Ranunculus rhomboideus	47	60	7	5-3
Ranumculus scleratus	4	8	2+2	(6-15)
Ratibida columnifera	2	2	2	(7-22)
Ratibida pinnata	8	13	6	7-24
Rhamnus alnifolia	4	6	2	(5-16)
Rhamnus cathartica	5	20	2	5-27
Rhus glabra	10	31	4+1	7-8
Rhus radicans	21	51	(7)	6-10
Rhus typhina	3	4	3	(7-4)
Ribes americanum	80	108	5	5-20
Ribes cynosbati	39	99	5	5-13
Ribes missouriense	13	21	4	5-18
Ribes odoratum*	2	2	(3)	(5-10)
Ribes triste	27	37	5	5-13
Robinia hispida*	12	12	6	6-6
Robinia pseudo-acacia*	23	31	5	6-6
Rorippa islandica	9	19	(6)+2	7-9
Rosa arkansana	146	209	(19)	7-2
Rubus allegheniensis	24	44	5	6-14
Rubus pubescens	30	40	6	5-22
Rubus strigosus	15	40	5	6-14
Rudbeckia hirta	210	259	15+1	7-25
Rudbeckia laciniata	27	40	7	8-23
Rumex acetosella*	29	38	8	6-22
Rumex crispus*	5	28	(4)+2	6-18
Sagittaria latifolia	12	13	(6)+1	8-4
Salix exigua	6	10	(8)	5-18
Salix humilis	20	63	5	4-30
Salix nigra	3	6	2+1	(5-9)
Sambucus canadensis	12	13	6	7-8
Sambucus pubens	98	355	6	5-14
Sanguinaria canadensis	154	329	7	5-4
Sanicula marilandica	76	138	7	6-16
Saponaria officinalis*	11	14	(6)+1	7-24
Sarracenia purpurea	4	4	2+2	(7-23)

Species	# of Blooms	Total Floral	# of Weeks	Aver/Med
Saxifraga pensylvanica	32	78	6	6-1
Schizachne purpurascens	17	39	3	5-18
Schizachyrium scoparium	9	27	(6)	8-14
Scrophularia lanceolata	53	128	6+2	6-19
Scutellaria galericulata	19	26	(7)+1	7-21
Scutellaria lateriflora	7	15	2	8-2
Scutellaria leonardi	9	25	(5)+1	6-17
Senecio aureus	43	49	8	6-12
Senecio congestus	5	9	4	6-9
Senecio spp.	58	87	7	6-12
Silene antirrhina	3	32	(4)	(6-13)
Silene latifolia	49	57	(20)+3	6-14
Silene vulgaris*	25	44	(15)	7-9
Silphium laciniatum	3	4	(4)	(8-23)
Silphium perfoliatum	2	5	2	(8-14)
Silphium terebinthinaceum	3	3	2	(8-27)
Sisymbrium altissimum*	52	76	17	7-6
Sisyrinchium sp.	144	166	(16)	5-31
Sium suave	12	20	(8)	8-11
Smilacina racemosa	53	193	6	6-7
Smilacina stellata	125	267	7	5-25
Smilacina trifolia	3	8	3	(5-28)
Smilax ecirrata	11	39	3	5-27
Smilax hispida	1	2	1	(6-12)
Smilax lasioneura	55	152	7+1	5-25
Solanum ptycanthum	28	51	13+1	8-8
Solidago canadensis	118	174	11	8-19
Solidago flexicaulis	40	62	9	9-10
Solidago gigantea	102	143	(13)	8-11
Solidago hispida	5	6	2+2	8-22
Solidago missouriensis	71	118	(11)	7-28
Solidago nemoralis	98	171	(14)	8-27
Solidago ptarmicoides	79	102	(13)	8-11
Solidago riddellii	14	36	6	8-29
Solidago rigida	124	224	(10)	8-19
Solidago speciosa	51	128	10	8-20
Sonchus sp.*	108	142	13+1Nov	8-10
Sorbus sp. (*)	8	13	(5)	5-21
Sorghastrum nutans	66	87	(10)	8-11
Spartina pectinata	36	38	(9)+1	8-4
Spiraea alba	79	112	9	7-19
Spiraea tomentosa	3	7	(3)	(7-26)
Spiraea vanhouttei*	16	19	6	5-23
Spiranthes sp.	14	17	(10)	8-29
Sporobolus heterolepis	2	16	(3)	(8-11)
Stachys palustris	70	88	11	7-27
Staphylea trifolia	5	15	2	6-5

Species	# of Blooms	Total Floral	# of Weeks	Aver/Med
Stellaria longifolia	47	50	8+1	6-10
Stellaria media*	10	10	(20sctd)	6-27
Stipa spartea	7	184	4	6-22
Streptopus roseus	17	63	4+1	5-27
Symphoricarpos occident.	68	96	10	7-17
Syringa vulgaris*	40	62	7	5-19
Talinum parviflorum	11	36	(7)	7-4
Tanacetum vulgare*	6	6	(3)+2	8-15
Taraxacum officinale*	162	219	(23)+1	5-20
Taxus sp.* cult	3	8	2	(4-23)
Thalictrum dasycarpum	75	232	8+1	6-30
Thalictrum dioicum	71	220	(8)	5-17
Thlaspi arvense*	16	39	(9)+1	5-23
Tilia americana	45	89	6	7-10
Tofieldia glutinosa	2	3	2	(7-7)
Tradescantia bracteata	133	151	13+2	6-20
Tragopogon dubius*	81	163	(19)	6-30
Trientalis borealis	27	42	(8)	5-28
Trifolium arvense*	4	8	(8)	(7-24)
Trifolium pratense*	59	67	(18)	7-16
Trifolium repens*	55	59	(11)+1	6-28
Trillium cernuum	145	292	9	5-23
Trillium grandiflorum	31	38	(7)	5-21
Triosteum perfoliatum	5	30	5	6-6
Typha latifolia	5	8	3	6-27
Ulmus americana	50	178	7	4-26
Ulmus pumila*	10	31	(7)	4-24
Ulmus rubra	4	21	2	(4-26)
Urtica dioica	8	16	4	7-16
Utricularia cornuta	1	1	1	(8-18)
Utricularia vulgaris	6	6	2+2	7-10
Uvularia grandiflora	205	325	7	5-14
Uvularia sessilifolia	87	124	5	5-14
Vaccinium angustifolium	19	39	(6)	5-18
Verbascum thapsus*	54	90	13	7-26
Verbena bracteata*	36	38	14+1	7-13
Verbena hastata	73	87	10	7-28
Verbena stricta	68	82	(14)	7-18
Verbena urticifolia	15	37	(8)	8-5
Vernonia fasciculata	12	17	(4)	8-8
Veronica peregrina	9	12	(6)	5-24
Veronicastrum virginicum	145	218	10	7-29
Viburnum lentago	13	39	3	5-29
Viburnum rafinesquianum	5	27	4	6-14
Viburnum trilobum	6	17	(3)	6-3
Vicia americana	45	53	7+2	6-12
Vicia villosa*	17	17	(19sctd)	7-8

Species	# of Blooms	Total Floral	# of Weeks	Aver/Med
Viola canadensis	22	22	(8)+1	5-18
Viola conspersa	46	48	6	5-14
Viola cucullata	186	186	8+1	5-22
Viola macloskeyi	26	27	5	5-14
Viola pedatifida	111	115	7+1	5-24
Viola pubescens	288	384	(7)	5-27
Viola sagittata	15	17	6	5-23
Vitis riparia	5	29	3	6-12
Weigela florida*	5	6	3	6-11
Zanthoxylum americanum	37	69	5	5-11
Zigadenus elegans	51	111	9	7-10
Zizia aptera	59	139	(10)	6-10
Zizia aurea	102	218	7	6-11

* Introduced Species

There are native species of Pyrus, Sorbus, Taxus and Tilia in Minnesota but probably those in central Minnesota, especially St. Cloud street trees, were introduced.

Species names from Ownbey and Morley 1991