The ethnoecology and reproductive ecology of bakeapple (*Rubus chamaemorus* L., Rosaceae) in southern Labrador

By

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ABSTRACT

Bakeapple (*Rubus chamaemorus* L.; Rosaceae) is a circumpolar herbaceous perennial typically found in peat bogs. Bakeapple fruits have served as a vital food resource for many northern peoples including those of the Subarctic and Arctic areas of North America. Although the reproductive ecology and habitat requirements of this plant have been studied extensively in Scandinavia, there has been scant research on bakeapple populations in Canada. Furthermore, there has been little documentation of its use or ethnoecology in many parts of Canada, especially in Newfoundland and Labrador.

For this research I worked in the predominantly Métis community of Charlottetown, Labrador, where there has been a long tradition of bakeapple use. My objectives were to: 1. Document traditional use and major changes in use of bakeapple by this community; 2. Determine the most important factors influencing fruit production in local bakeapple populations; and 3. Link community observations on the ecology of this species with previous research and ecological data from my study in the area.

To examine traditional use and knowledge of bakeapple in the community of Charlottetown, I conducted semi-directed in-depth interviews with knowledgeable bakeapple pickers in the community. Traditionally, bakeapple has been a vital component of the diet for this community. In recent years, a number of changes, including particularly the northern cod moratorium, have altered social practices surrounding bakeapple picking. Despite decreased reliance on wild foods by community members in general, this plant still remains a culturally important species.

To assess the main influences on fruit production for local bakeapple populations, I sampled on islands where community members routinely harvest bakeapples. I

measured various environmental variables and stages in bakeapple reproductive output. Environmental variables showed only weak relationships to flowering and fruit production. The most prominent influences on fruit production in these populations were due to the abundance and distribution of males and females in this dioecious species; female dominated sex ratios and long distances between male and female flowers resulted in decreased seed set.

To examine the ecology of bakeapple through a combination of local ecological knowledge and scientific knowledge, I documented observations made by community members pertaining to bakeapple ecology. Residents outlined three main habitat types in this area through semi-directive interviews associating various bakeapple densities and fruit sizes with each type; my ecological data confirmed some of these observations. Bakeapple development (e.g., “turned in” stage) and variations in the berry (e.g. in color and size) were also discussed. Information gained from the interviews pertaining to bakeapple population and habitat characteristics, such as black spots that periodically appear on the berries, could serve as starting points for future research on bakeapple populations.

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Leith Award, Melburn Award, Coasts Under Stress (through Nancy Turner and Barbara Neis) NSTP (Northern Scientific Training Program) and the Labrador Metis Nation.

Chapter 1: Introduction

For this project, I worked in the community of Charlottetown, in southeastern Labrador, to conduct a study on the ethnoecology and reproductive ecology of bakeapple (cloudberry, maltberry, salmonberry; *Rubus chamaemorus* L., Rosaceae). Bakeapple, a circumpolar perennial plant with edible fruits, has been a vital food resource for many groups living in northern areas but there has been little ethnobotanical research carried out in Labrador. Fruit production in this species is highly influenced by its unpredictable and extreme environment. However, there have been few studies on the reproductive ecology of bakeapple populations in Canada. I have attempted to link local ecological knowledge of Charlottetown residents with scientific knowledge to examine various ecological characteristics of bakeapple.

1.1 Local Ecological Knowledge

In this thesis, local ecological knowledge of community members in Charlottetown, Labrador was incorporated into a study of bakeapple populations. Experienced bakeapple pickers were selected for their in-depth knowledge of harvesting practises and ecological characteristics of this plant. This type of local expertise has been acquired through trial and error and passed on from generation to generation. Local ecological knowledge is based on continuous observation over a relatively short spatial scale and can be qualitative in nature (Fischer, 2000). Due to monetary and time constraints, such detailed data within a specific spatial area can be difficult to gather when conducting scientific research. Scientific knowledge is generally quantitative and involves sporadic observations over a larger spatial scale. The linking of local ecological knowledge and scientific knowledge can benefit our understanding of species and/or ecosystems in a particular environment.

Many studies have incorporated local (cumulative knowledge over a few generations) or traditional (longer time scale than local with belief systems incorporated into knowledge) ecological knowledge when conducting research on a particular species. For example, researchers have been able to address questions pertaining to population changes in Arctic Tundra caribou (*Rangifer tarandus*), potential influences of oil development on the ecology and biogeography of eider ducks (*Somateria mollissima*), fish behaviour and practises, the ecology of Beluga whales (*Delphinapterus leucas*), population changes in cod (*Gadus morhua*) and lumpfish (*Cyclopterus lumpus*), the potential decline of Ivory Gull (*Pagophila eburnea*) populations in Canada, ecological effects of salal (*Gaultheria shallon* Pursh.) harvesting, restoration of wapato (*Sagitarria latifolia* Willd.), and disturbance effects on yellow glacier lily (*Erythronium grandiflorum* Pursh.) (Cocksedge, 2003; Ferguson et al., 1997; Garibaldi, 2003; Loewen, 1998; Mallory et al., 2003; Mymrin, 1998; Nakashima, 1990; Neis et al., 1999). These studies all provided substantial contributions to the current body of knowledge on the biology of these species. Documentation of traditional or local ecological knowledge can be particularly helpful when working in areas that are very remote, in which the difficulty of access has often resulted in little scientific research being done.

There has been little research carried out on bakeapple ecology in Canada. In this work, I have attempted to link local ecological knowledge of Charlottetown residents with scientific knowledge to examine various ecological characteristics of bakeapple including: habitat type, developmental stages, animal consumption of fruits, variation in the berries (e.g. size, color), and major factors affecting fruit production.

1.2 Background on bakeapple

Rubus chamaemorus L. is a herbaceous perennial distributed in Arctic and Subarctic areas, in Northern Russia, Finland, Sweden, Norway, and across northern North America, extending south to latitude 50° N in Europe and 44° N in North America (Taylor, 1971; Figure 1.1). It has been found at elevations as high as 1770 m above sea level but generally occurs at low elevations (Resvoll, 1929). It is widespread in the boreal areas of Atlantic Canada.

Plants reach up to 20 cm in height with 1-3 palmately lobed basal leaves, and have a single unisexual terminal white flower with 5 petals and 5 sepals (Taylor, 1971; Figure 1.2). Stamen number varies between 25 and 120 and pistil number can vary between 3 and 40 (Gustafsson and Kortesharju, 1996). The aggregate fruits are orange to red, each comprised of 4-20 drupelets (Figure 1.3; Taylor, 1971). The species is dioecious; male flowers often open earlier and have larger petals than female flowers (Agren, 1987; Makinen and Oikarinen, 1974). Significantly, the male flowers produce nectar but the female flowers do not (Agren, 1987; Makinen and Oikarinen, 1974). *Rubus chamaemorus* is strictly entomophilous (insect-pollinated) and attracts generalist pollinators such as anthomyids, syrphids, empidid flies and bumblebees (Hippa and Koponen, 1981; Makinen and Oikarinen, 1974). Fruits are often dispersed by birds and mammals such as grouse, ptarmigan, ravens, foxes and bears (Rantala, 1976; Resvoll, 1929). Bakeapple is typically found in bog habitats and exhibits clonal growth (Figure 1.4).

Bakeapple berries have served as a vital food resource for many human communities living in Arctic and Subarctic areas (Andre and Fehr, 2001; Griffin, 2001; Hawkes, 1916; Heller, 1976; Jones, 1983; Kari, 1987; Kuhnlien and Turner, 1991;

Marles, 2000; McGee, 1961; Turner, 1995; Table 2.1). Many people, especially in the north, consider it their most important berry (Griffin, 2001; Jones, 1983; Eidlitz, 1969; Oswalt, 1957).

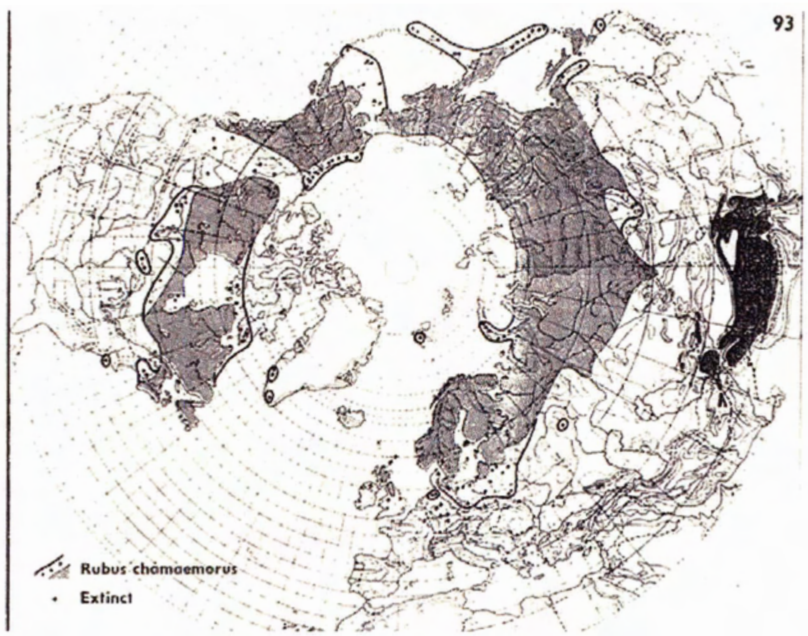

Figure 1.1 Global distribution of *Rubus chamaemorus* (Hultén, 1971)

Figure 1.2 *Rubus chamaemorus:* male flower in southeastern Labrador

Figure 1.3 *Rubus chamaemorus*, fruit, in southeastern Labrador

Figure 1.4 *Rubus chamaemorus*, typical bog (acidic wetland with accumulations of undecomposed peat) habitat in southeast Labrador.

1.3 Coasts Under Stress

My research on bakeapple in Labrador is part of a larger national interdisciplinary research program, Coasts Under Stress (CUS). This is a five-year project funded by Social Sciences and Humanities Research Council (SSHRC) and

Natural Science and Engineering Research Council (NSERC)(Rosemary Ommer, PI). The project includes researchers from a number of universities working with local communities on the East and West Coasts. The purpose of the project is to assess the impact of environmental and social restructuring on the health of the people, communities and environments.

There were five research arms in the Coasts Under Stress project. This research falls under the second research arm, which looks at combining traditional and local knowledge with scientific knowledge to better understand changes in social and environmental health with a view to help develop better strategies for future ecological recovery.

My project combines local ecological knowledge and scientific knowledge to assess changes in use of bakeapple by community members as well as environmental factors affecting fruit production. This is the first study to combine LEK and scientific knowledge to examine bakeapple use and fruit production, and provides a more comprehensive understanding by using both sources of knowledge.

1.4 Charlottetown, Labrador

This research was carried out in the community of Charlottetown, located on the southeastern coast of Labrador (Figure 1.4). Charlottetown is a relatively recent settlement, established in 1950. The original inhabitants were mainly comprised of people living in small communities within the White Bear Arm Region (e.g. Campbells Cove, Newtown). The town began as a core of about seven families and now has a population of approximately 350 people, many of whom are members of the Labrador Métis Nation (LMN). Members of the LMN have a mixture of Labrador Inuit and European ancestry.

Traditionally, people in this community relied on fish (salmon (*Salmo salar*), char (*Salvelinus alpinus*), cod (*Gadus morhua*), capelin (*Mallotus villosus*)), birds (partridges (*Lagopus* spp.), eider ducks (*Somateria mollissima*)), caribou (*Rangifer tarandus*) and rabbit (*Lepus* spp.) for meat sources. They also harvested berries (bakeapples (*Rubus chamaemorus*), redberries/partridgeberries (*Vaccinium vitis-idaea* L.; Ericaceae), squashberries (*Viburnum edule* Michx.; Caprifoliaceae), blueberries (*Vaccinium* spp.; Ericaceae), and "blackberries" (crowberries, *Empetrum nigrum* L.; Empetraceae)) extensively. The primary source of income for community members was based on cod fishing (prior to the cod fishing moratorium of 1992[1]), supplemented by trapping. After the cod moratorium, residents tried fishing other species such as scallops, and in 2001, a shrimp plant was established in the town. This plant employs over 100 people and is currently the primary economic support in the community. In 2002, a road was built, now connecting the communities of Mary's Harbour, Port Hope Simpson, Charlottetown and Cartwright, to Red Bay. Previous to this time, the people of Charlottetown relied solely on boat, plane or skidoo transportation to connect with other communities and places.

[1] The federal government put a moratorium on cod fishing in 1992 due to the devastatingly low cod stocks. This moratorium was still in effect in southeast Labrador in July 2004.

Figure 1.5 Location of study area, Charlottetown, Labrador

1.5 Thesis Objectives

My general objectives were to document ethnoecological knowledge and information on traditional use of bakeapple in a Métis community and to better understand the relationship of bakeapple population characteristics and sexual reproductive output to habitat characteristics.

Specifically, in terms of traditional use of this plant, I was interested in the history of use of bakeapple by community members and the cultural and economic importance of this berry to the community (Chapter 2). I recorded information concerning: 1. Social norms/practises associated with bakeapple picking such as who picked bakeapples, how they were picked and how knowledge about them was transferred; 2. Areas where bakeapples were picked and how community members negotiated these areas; 3. How bakeapples were processed, eaten and stored; and 4. Major changes in the use of bakeapples and possible economic, social or environmental factors that may be associated with these changes.

In terms of bakeapple reproductive ecology, I assessed various environmental factors to determine which had the greatest effect on reproductive output (Chapter 3). I measured: 1. Microhabitat characteristics (shelter, peat depth, moisture, pH, temperature); 2. Species composition and abundance; and 3. Factors specific to dioecious species, such as sex ratio and distance to nearest potential fertilising partner, to determine their relationship to vegetative (ramet density) and/or reproductive output (flowers:ramet, fruit set, seed set).

I combined both sources of knowledge to understand more fully the ecological characteristics of bakeapple populations (Chapter 4). During my interviews I also recorded information about: 1. Bakeapple habitat; 2. Animal consumption of bakeapple; 3. Bakeapple development; and 4. Major influences on fruit production. I compared these observations with the scientific literature on this species, and used my own data to confirm some observations made by community members.

In the conclusion, I summarise all of my findings, explore the potential benefits of linking scientific and local ecological knowledge, and discuss concerns of community members (Chapter 5).

Chapter 2 Traditional use of Bakeapple (*Rubus chamaemorus* L.): history of use, importance and major changes

2.1 Introduction

"…few berries stir them to such action and poetry as the bakeapple." (Omohundro, 1994)

Bakeapple also known as cloudberry, maltberry or salmonberry, has been a popular food source for many northern groups living in Subarctic and Arctic areas of North America (Table 2.1; Andre and Fehr, 2001; Griffin, 2001; Hawkes, 1916; Heller, 1976; Jones, 1983; Kari, 1987; Kuhnlien and Turner, 1991; Marles, 2000; McGee, 1961; Turner, 1995; see Table 2.2). Many groups consider it their most important berry (Griffin, 2001; Jones, 1983; Eidlitz, 1969; Oswalt, 1957). The Vitamin C (ascorbic acid) content of bakeapple berries is about 130 mg per 100 g of fresh fruit, more than twice that of oranges, with a Vitamin C content of 52 mg/100 g (Arnason et al., 1981; Kuhnlien and Turner, 1991). Throughout their range, bakeapples have likely provided essential amounts of this vital nutrient to people in northern communities where access to other fruit is limited. Traditionally, the berries were often gathered in birch-bark baskets and eaten fresh, mixed with oil and/or sugar or served in "Eskimo/Indian ice cream" (Eidlitz, 1969; Jones, 1983; Kari, 1987; Kuhnlein and Turner, 1991). This last dish, popular with many Aboriginal groups, was made by whipping warmed animal fat by hand into a foam and as it slowly cools, adding other foods such as berries, seal oil and meat to the mixture (Jones, 1983). Large quantities of bakeapples (as much as 30 gallons (132 L) per family) were often stored for the winter in seal pokes, wooden barrels or underground caches (Griffin, 2001; Jones, 1983; Kari, 1987; Kuhnlein and Turner, 1991; Omohundro, 1994).

The berries were stored in cold water or oil, with other berries (e.g. nagoonberries (*Rubus arcticus*), "blackberries" (*E. nigrum*)) or with edible greens such as sourdock leaves (*Rumex arcticus*)(Andre and Fehr, 2001; Jones, 1983; Russell, 1991; Turner, 1995).

Berries are the plant food type most frequently gathered by contemporary Aboriginal peoples and berry gathering is often a much anticipated event (Kuhnlein and Turner, 1991). For example, as of the 1980's, in Northwestern Alaska, groups of Inupiat women or whole families would go out annually and set up berry picking camps for days or weeks (Jones, 1983). Women and children were, and still are, typically the primary berry gatherers (Griffin, 2001; Jones, 1983; Kari, 1987; Russell, 1991) but men sometimes gather as well (Oswalt, 1957; Thornton, 1999). One of my objectives in this study was to document all aspects of traditional use of bakeapple including picking customs and areas, processing and storage. Because relatively little ethnobotanical research has been carried out with Aboriginal peoples in Eastern Canada, especially the Labrador Métis Nation, this Nation and the locality around Charlottetown was chosen for this project.

2.2 Methods

I used in-depth semi-directive interviews coupled with a mapping component to conduct this research. This approach involves a guided interview where the interviewee has an opportunity to answer questions but also to add other comments that they feel are relevant (Walker, 1985). I obtained written consent from all participants in the study after informing them of potential risks and benefits of the research. All interview protocols were approved by the University of Victoria Human Research Ethics Committee (see

Appendix 1 for Application for review, and sample letter of informed consent and interviewing schedule for this project).

I obtained contact information for potential participants from the office of the Labrador Métis Nation. Volunteer members of the Métis Nation distributed posters concerning my project in a number of towns throughout southeastern Labrador. From these volunteers, I obtained phone numbers of community members who had considerable bakeapple picking experience. In the end I selected Charlottetown as the focus for my research because it was a known centre for bakeapple picking and was home to the largest number of people who agreed to be interviewed.

Interviews were carried out between May and August 2004. I used a "snowball" sampling method to identify interviewees in the community. In this method initial contacts suggest additional potential interviewees (Walker, 1985). I first sought out the most experienced bakeapple pickers in the community from my original contacts in Charlottetown. I then asked these experienced pickers to provide names of other community members who would be appropriate to interview. I first contacted interviewees through a phone call and then a subsequent home visit, where I provided them with a leaflet describing the project. During these initial visits, I learned about a number of local words used concerning bakeapples and noted some of these for use in my subsequent interviews.

Interviews were conducted in community members' homes. Prior to the interview, each interviewee signed the consent form after reading or having it read to them. All interviewees also signed an additional form permitting me to photograph them and use photos of them in written work and presentations. Interviewees were given the choice of whether or not their interviews would be tape-recorded and I assured them that they were able to stop the recording or stop the interview at any time. Each interview consisted of approximately 100 questions (Appendix 1) and lasted between 45 minutes and 2 hours. Questions were focused on all aspects of bakeapple harvesting, including the social groups with whom interviewees tended to pick, specific areas picked, types of containers used, storage techniques, and how bakeapples were prepared and eaten. Locations of picking areas were identified by interviewees on topographical maps of coastal areas and islands near Charlottetown and many of these sites were used in my study of the reproductive ecology of bakeapples (Chapter 3).

Interviews were transcribed and data were compared by identifying major topical themes within the research to determine trends in interviewee statements using QSR N6 © (Vol 4.0, QSR International Pty Ltd). Maps were digitized into MapInfo © (MapInfo, New York) and composite tables and maps were created in this program. These tables were used to compare information provided by various pickers and to enable me to identify changes in bakeapple picking areas over time.

Each interviewee is identified by a number within the text in order to protect their anonymity, and any names in quotes have been changed. Results are presented as follows: general demographics of interviewees followed by all data involving aspects of bakeapple picking.

2.3 Results

2.3.1 Interviewee demographics

I interviewed 15 community members in total: six women and nine men. Interviewee age ranged from 30 to 73 years, but I interviewed a larger proportion of older pickers because of their greater experience (Figure 2.1).

Table 2.1 Age and gender of interviewees from Charlottetown Labrador.

Interviewee #	Gender	Age
1	M	73
2	M	73
3	F	71
4	F	66
5	M	42
6	M	56
7	M	59
8	F	70
9	M	66
10	F	37
11	F	36
12	M	69
13	M	50
14	F	64
15	M	41

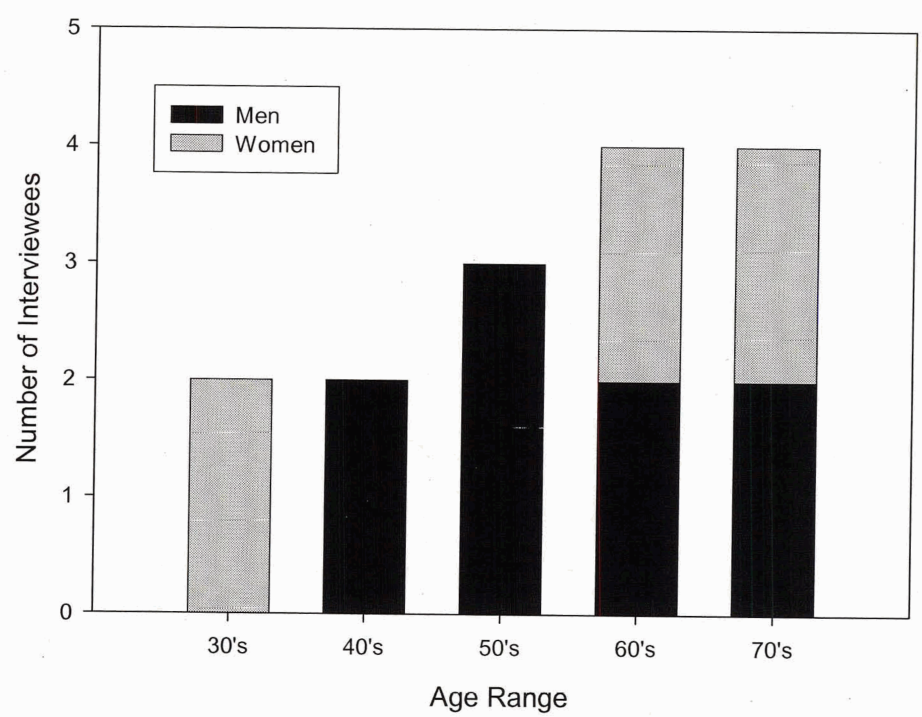

Figure 2.1 Age distributions for interviewees in Charlottetown bakeapple study

Of the interviewees, 80% (12/15) grew up in Charlottetown, or around St. Michael's Bay (map, Figure 1.2), while 20% (3/15) had moved in from other communities (Henley Harbour and Red Bay) (Figure 2.2). Prior to the cod-fishing moratorium of 1992, the majority of community members spent their summer months at fishing communities, where they would also have picked bakeapples. Sixty percent of interviewees (9/15) lived on Square Islands during the summer, and 20 % (3/15) lived on Triangle and Dead Islands, which are also in St. Michael's Bay (Figure 2.2). The remaining 20 % of interviewees (3/15) spent their summers in fishing communities farther north such as Styles Harbour and Penny's Harbour.

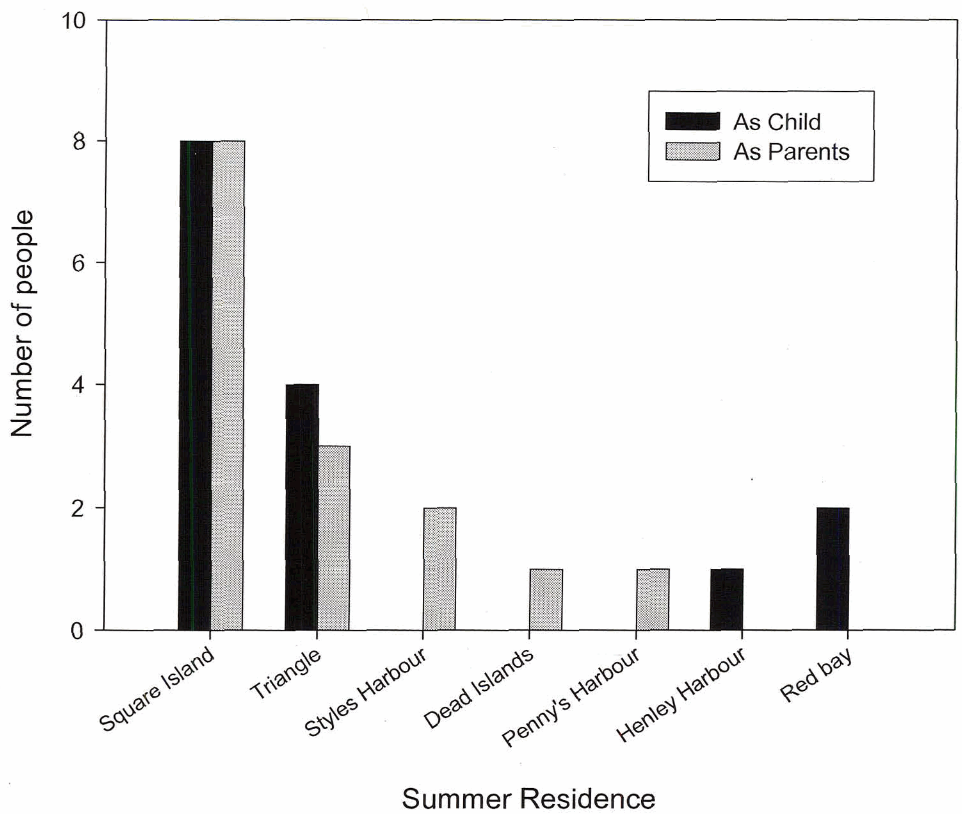

Figure 2.2 Places where bakeapple study interviewees lived and around which they picked bakeapples in the summer, as children and as parents.

All of those interviewed had over three generations of bakeapple picking experience in their family and had begun picking bakeapples at the age of 5-7. All interviewees had picked bakeapples continuously throughout their lives; picking was interrupted only by periods when they were living away from the community (e.g., at Goose Bay), if the women were "too pregnant," if there were small children who had to stay home (then the father went with older children), or for the men if they were still busy fishing (but then they would drop off their wives and children on an island to pick). Bakeapple picking experience of individual interviewees varied from 25 to 65 years.

2.3.2 Bakeapple picking

2.3.2.1 Picking

> Done my share of bakeapple picking...I was picking, picking, all last year, I go to sleep, and all I can see is bakeapples, bakeapples, bakeapples... My dear, you dream about it, you close your eyes, all you can see was bakeapples... that's what it is hey? I suppose, you know, you're so earnest about it, hey... and all you know, you pick pick, pick, pick, pick, you're probably there six or seven hours, bakeapple picking... then you go to bed at night and close your eyes and all you see is these bakeapples, bakeapples, everybody was saying, I mean the girls at home, even when I went with Jane Smith up there, she used to say the same thing, she said, 'Maid, all I can see is bakeapples when I close my eyes'... yeah. (Interviewee 3) [2]

> They're the hardest berry to pick, because you got the flies, and the heat and the flies... that's the worst about bakeapple picking is the flies... It's hard work bakeapple picking, really hard work, 'cause you got to go in the bogs, it's like, up and down with the old moss and that... (Interviewee 8)

> It's exciting, it's nothing that will start your adrenaline flowing like, coming up on a marsh and it's orange, yeah. Everyone gets real excited and starts picking... (Interviewee 11)

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[2] Quotes included often contain I = [interviewee], which reflects statements made by the interviewee and R = [reserarcher], which represents statements I made during the interview. Any quotes without these identifiers represent words of the interviewee. Numbers in brackets (e.g., (6)) denote the number of interviewees that made the referred statement. Any names mentioned are pseudonyms.

> Last time I took her with me, she gave up on me... me and she went down and it was a hot day, and the flies enough to eat the devil... and anyway, we get alongside the berries hey? Thick as they could stow all across the bog, Curlew Island, and I said we're going to go here, and she said, 'Boy,' she said 'You can pick them, I'm not picking them here, boy', I said 'Why?', 'Too many flies, too hot,' so I said 'Well I'm going to give it a try,' so I go on out berry picking and she lied down in the bog and she took her coat over her head and there she stayed, and she was there until I got my bucket full... that's true... wasn't it?... She was there until I got my bucket full… thousands of berries there that day... I never mind, I don't mind the flies, don't mind a few flies... Yeah she had a little nap anyway. (Interviewee 6)

Figure 2.3a Bakeapple picking in vicinity of Charlottetown, Labrador, August, 2004.

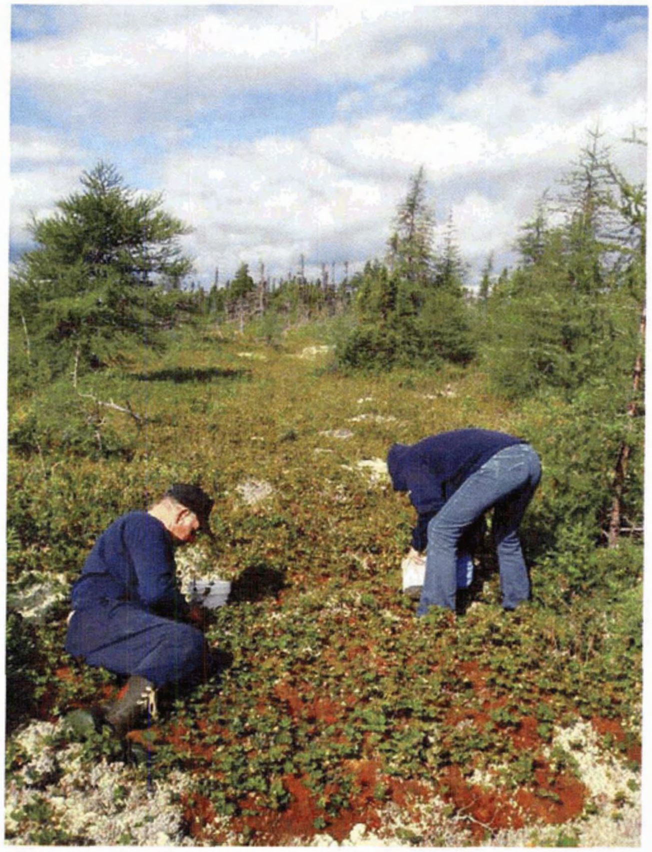


Figure 2.3b Bakeapple picking near Charlottetown, Labrador, August, 2004.

2.3.2.2 Timing of bakeapple harvest

Interviewees stated that bakeapple picking begins between the last week of July and the first week of August, and Interviewee 7 reported picking until September in some areas further north (near Isle of Ponds), in a "late" year. During the years before the cod moratorium when community members were living in their fishing communities in the summer, interviewees said bakeapple-picking time often coincided with an interval of decreased abundance of cod. Often the "fish would go slack" around the end of July and community members would stop harvesting cod with nets and switch to jigging for cod. When there was a day that was too windy for jigging, pickers said they would go bakeapple picking, and the wind helped keep away the flies. Even if the "fish were still on," (i.e., the cod were still being caught with nets) interviewees say that most people still managed to get out to pick berries. Interviewee 10 said:

> So they always took time out of their fishing, like, to pick berries, you know, they didn't fish when the berries were ripe, they always took that time off.
> R = Even if the fishing was good, they just...?
> I = Yeah, 'cause that was still part of, you know part of the food source as well, right?… And part of their livelihood, so they would still take time off to pick berries...'cause you didn't have a big time frame to pick them, you know, 'cause I mean from the time they're ripe to when they spoil is not very long, a week or two.

Pickers used a range of methods to determine when the bakeapples were ready to be picked. They talked about checking nearby plants to see how the bakeapples were developing when they were living in the fishing communities for the summer. In addition, interviewees said the weather was monitored and that certain indicators, like an early spring or a hot summer, would signal pickers to check the bakeapples earlier. Furthermore, pickers said if they were not able to check the bakeapples themselves, they could always hear through word of mouth. Nowadays, since fewer people are fishing and many are working at the shrimp plant, there are fewer people to relay that information. Nevertheless, pickers say they are still able to find out how the berries are ripening. Another important indicator to community members for the beginning of the bakeapple season is when the first boat returns with bakeapples. Interviewee 10 said:

> Where we live here in Charlottetown, and we have to go in the boat to get the bakeapples, we don't really get to see the bakeapples progress from one stage to another because, you hear word in town, that the bakeapples are ripe, and so you get in your boat and you head out, right? But sometimes we might, for different reasons, be out on an island earlier in the year and you will look around and see if there's bakeapple blossoms, and sometimes you'll try and predict, based on what you see, like, oh its going to be a good year for berries or, and sometimes you'll see the older people and you'd ask them, leading up to the time, 'Have you seen the bakeapples?' or 'When do you think they're going to be ripe?' And, most every year now, my husband will

> be at the store for something and then, he's usually the person out and about more than me, and he'll come home and say, 'Boy the bakeapples are ripe, you know, several boats were out today.' And that's your cue, like, okay, 'When's our first Saturday off?' 'cause you just cannot stay home on a day off, once the bakeapple season starts, you know, you gotta go, you gotta get them, you only got a short time.
> R = It seems like a frenzy once you hear about boats on the go.
> I = Yes, yeah, that's right, a little panic button.

Interviewee 3 reported that Sunday was the one day in the week when bakeapple picking was not acceptable in her family, and this prohibition appears to be adhered to by many religious community members.

2.3.2.2.1 Picking bakeapples before they are ripe

While most interviewees expressed the importance of waiting until the berries are soft before picking them, there are some inconsistencies in what people actually do. Most interviewees tend to pick between a few and many hard berries, and there are a number of reasons for this. Interviewee 7 explained that most people would often pick a bucketful of hard (less ripe) berries just at the beginning of the bakeapple season to make jam, since hard berries are better than soft ones for making jam. Interviewee 10 explained that she would determine if there were enough hard berries in a patch to allow for another round of picking (on a return trip), and if there were not, the hard berries would be picked with the soft ones. Interviewee 7 explained that it is very difficult to refrain from picking really large bakeapples, even if they are not ripe. Three interviewees said they pick a few hard ones when they are picking mostly soft ones, because the hard ones give the berry mix a better colour (red) for desserts. A few interviewees (2) said a few hard berries keep bakeapple pies from being soggy; sogginess can result from only using soft berries.

Interviewees disagreed somewhat concerning the time (whether past or present) when the frequency of picking unripe berries was highest. More pickers (5) claimed that unripe berries are picked more frequently now than in the past. Some suggested that since there are more people in the community, or, "on the go" now, pickers feel the need to harvest bakeapples earlier or else other community members will get to them first. Interviewee 10 remarked:

> So you just hook your thumb in, and with a little snap of the thumb, it [the berry] will pop out, and still leave the shuck [the calyx] there, so at that stage, we would pick them... but not when we had to shuck them....But in later years we have picked them when you shuck them, 'cause it's kind of getting to a point that if you want them, you kind of got to, unless it's an area where people don't usually travel to, you can wait it out until they're ripe enough to pick, but sometimes we have picked them... when we've had to shuck them, 'cause if you want them....
> R = Otherwise you come back and they would be gone?
> I = Yeah, yeah.

In addition, for people employed full time in town (e.g., in the shrimp plant), if their few days off are the only opportunity they have to go picking, they will pick the available berries whether they are ripe or not. Furthermore, since gas has become increasingly expensive and they have further to go than before the cod moratorium, people now feel they have to make their bakeapple-picking trip "worth it," and therefore feel pressured to pick bakeapples regardless of their ripeness.

A few interviewees (2) say that community members picked unripe bakeapples just as much or more in the past compared to now. Interviewee 7 said in response to the question, "Were you not supposed to pick them with the shucks on them?"

> We did one time, we done a lot of that one time. We don't do that now. You mostly tries to get them now without the shuck, hey?
> R = But when you were a kid?
> I = When we was young, we used to pick them with the shuck on them and didn't... you had soft ones and hard ones picked together, and that was a mang

> [mess] when you get back, hey?... 'Cause you had to separate them now and pick the shucks off of the hard ones, you know, and so... we don't do that now.
> R = So why'd you pick the hard and the soft... you just wanted all of them?
> I = That's what it seemed like; you was trying to get what you could get, I suppose, hey?

In his study on the Northern Peninsula in western Newfoundland, Omohundro (1994) also found that increased picking pressure on popular or convenient "meshes" has led to people picking unripe berries, which is an "unsatisfactory crop."

There are a few factors that discourage community members from picking hard berries. The main reason is the extra time required for cleaning unripe berries. Pickers say that such berries are more time consuming to process because the shuck (calyx) must be removed from the berry either during picking or back at home. Also, pickers mentioned that bakeapples harvested when unripe get "rubbery" after they are left to ripen and do not taste as good as bakeapples harvested when fully ripe. Furthermore, if the whole stalk is removed from the ground, which only happens if unripe berries are being picked, some pickers (4) believe it is not good for the bakeapple plants. Interviewee 15 said:

> I think if they be's picked so much, lot of people just picks them before they're ripe, and they take them stalk and all....I wonder if they grow back, hey?

The belief that unripe bakeapples contained a worm, which emerges as the berry ripens (see Chapter 4), could also have served as a deterrent to harvesting unripe berries.

2.3.2.3 Who picks bakeapples?

> One time, 'cause they didn't always take us, if they were going to do some serious bakeapple picking when we were just really young, and they only had a short time to get them and it was for food and things like that, the younger ones, maybe some of the older ones, someone in the family would stay home and watch the real little ones. And there was one particular time, when I desperately wanted to go, they said there's not enough room in the

> boat, and we're going farther away and a lot of walking and as they were pulling off from the wharf I was running to the dock and I ran over the wharf, 'cause I wanted to go bakeapple picking so bad, so that sort of messed up them getting started 'cause then it was getting me out, is she ok, so I got teased a lot about that when I, especially when I became a teenager and I wasn't always so willing to go, they'd say, 'My, where's the little girl that ran overboard 'cause she wanted to go so bad,' so that story stuck with me. (Interviewee 11)

When people were living in their fishing communities during the summer, the whole family would generally go out picking bakeapples. Interviewee 6 said:

> ...The way it was back then, when your parents went berry picking... everybody in the house went... and if you was that high and you could pick a berry then you helped pick'em, you know?

Sometimes only one parent would go with the children. If the men were still busy netting for cod, the father would often drop off his wife and children on an island for the day or for a few hours to pick bakeapples. Other times, if a woman was far along in her pregnancy and/or if there were a few really young children around, she might stay with the younger children and the father would take some of the older ones to berry pick. Often it was not just one family that would go, but perhaps two to three families would go berry picking together. These were most often relatives, and sometimes friends from church or fishing partners. Interviewee 7 said,

> Different times, you know you get to go out where we was going, hey, there'd be a big crowd, a boatload... a number of boatloads.
> R = How many could fit in a boat?
> I = My maid, there's times I'd say there's fifteen or twenty of us, at certain times, big crowd.

Pickers say that now very few children go with their parents to pick bakeapples.

> R = So do you think their parents didn't take them out when they were kids like your parents took you?
> I = Oh they probably go with them, my dear, but, you know, they just,

> never had the interest, I calls them lazy, that's what I says... I says, you're hardly, you're too lazy, I says, to go and pick them, you shouldn't be allowed to eat them, when I brings them in... 'Oh my,' they says, 'Nan [grandma], Nan is old fashioned, Nan, listen to Nan, Nan is old fashioned,' I say, 'Well I'm old fashioned but that's the way it is.' (Interviewee 3)

In addition, the average number of people who go berry picking together has decreased. Pickers talk about going picking with two to five people, but never a "crowd" of ten to fifteen as described by interviewees in the past. Interviewee 11 noted that people who grew up in the community and moved away would often try to time their visit home during the bakeapple-picking season. This trend was also observed with "Main Brookers" (people living in Main Brook) in Newfoundland (Omohundro, 1994). Another new practice is that some male interviewees pick bakeapples alone; this began after the cod-fishing moratorium, when a few of these pickers (mostly retired fishermen) began picking bakeapples to sell.

2.3.2.4 Bakeapple areas

The places people went to pick bakeapples often depended on the location of their summer residence and on family ties. Interviewees described picking near, or "handy to," their summer fishing areas, when they were living there during the summer, especially before people began driving speedboats in the area, when they traveled by lower powered motorboats and rowboats (Figure 2.8a). Pickers found their berry picking areas primarily through their parents, uncles and aunts taking them when they were young. Interviewee 8, when asked how she knew where to go, said, "We knew handy about where, the old people would tell us." Pickers who had married into the community (2) said that in-laws initially took them out berry picking. A few pickers (3) found spots by noticing islands where other boats had landed to go bakeapple picking. Interviewee 13, who had married into the community, found some spots by looking on maps, and looking for flat areas on the islands. A few interviewees (2) discussed how their fathers or uncles discovered bakeapple spots while walking over the land to hunt and trap. If these men came across an area in the winter that they thought would be good for berry picking (sometimes described as 'a good "mashee" spot'), they would return to this area in bakeapple picking time to investigate.

Due to the unpredictable nature of bakeapple fruit yields, most pickers said it was important to check all bakeapple spots/islands every year because good bakeapple areas can vary from one year to the next. Also, interviewees described how people would often move further north (to Isle of Ponds, Black Tickle area) to get "their winter's bakeapples," when berries were quite scarce in St. Michaels Bay. When talking about searching for new picking places, Interviewee 11, said,

> We didn't, when I was with Nan, we just usually went to these places that she had in her mind but, Adam and I, during the years that bakeapples were scarce and stuff, we would do a little bit of looking around, I remember just a few summers ago, we went with another couple and we sort of thought, 'Now, today is a beautiful day, and we got time on our hands, let's go look for some new spots, there must be bakeapples somewhere,' and so we pretty much spent that day just hopping off different islands, looking around, but we didn't find too much.

Since the cod-fishing moratorium, all interviewees leave from Charlottetown to pick and some families have started to pick in different areas (Figure 2.8b). While, previously, families from each fishing community identified bakeapple areas near their community (Figure 2.8a), today interviewees generally visit more islands, and there has been a trend for those who fished from Community A (which had a much larger number of residents than Community B) to visit islands near Community B. Also, the most commonly visited and well known islands for bakeapples presently are those found on the direct route by water between Charlottetown and Community A.

2.3.2.4.1 Proprietorship

Only some (6) interviewees recognized bakeapple areas that were picked exclusively by specific people or families. A few others (2) only recognized one area as being left specifically for one person. The rest of the pickers stated that there is no "ownership" or "claiming" of bakeapple areas and the first person to go to an area in picking season can harvest the berries. Those interviewees who suggested that, years ago, there were certain areas identified with specific people, described spots named after these individuals (mostly men), which were often left for them to pick. These were named by the person who evidently first found the spot, picked a large amount of bakeapples there at one time, or was known to regularly pick in that area. Interviewee 1, when talking about a spot named after his father, said,

> …well I guess like someone like Louise's father, probably put the name, you know, 'cause it's where he picked them good one year, and so they called it Martin's spot...and that's the way that went...

Interviewee 10 said,

> It was, I think you knew where, one family kind of went to pick their berries, and you didn't go there, just out of respect,… everybody kind of had, it was like fishing or hunting, everybody kind of had their own areas. It was something, not an agreement as such, written or said, but it was just…yeah I guess 'respect' would probably be the word, you didn't invade on…like, it was boundaries that weren't said, or wasn't, but they were there, they existed.

Interviewee 7 said,

> You were out there one time, you probably be going to this place, but that was Uncle Bob's spot, somewhere else was Uncle Albert's spot, somewhere else was Uncle Martin Brown's spot, that's the way it was …more people now, they don't regard it the same, not now, everyone goes wherever he wants to go, certainly… But then they had their special, their certain spots, and they wouldn't go there, this other person, that was their spot, he go there, hey… that's the way it was, you never done with it.…Like on Brook Island, Alex and Ken was out there now, I been there too, years ago, but, on Brook island, in that cove, on this end, see? Just, up the Bay?... that was Uncle Albert's spot, they called that, we went there one time, we couldn't find no berries, so we went in there and we picked 11 gallons of berries, that was in Uncle Albert's spot, that was the first time anybody went there, like I said, except his own crowd.…

Two interviewees who grew up in Community A identified Bob Smith's spot on Eagle Island, Albert Smith's spot on Brook Island, and Martin Brown's spot near Whistler Point and on Eagle Island. In terms of the families who lived in Community B, two interviewees from this area pointed out that the brother of Interviewee 12 and his family picked in Blue Harbour and Interviewee 9's family picked on Hilly Island. Five pickers noted that Interviewee 12's family picked on Bear Island. These are all areas in close proximity to Community B. Interviewee 8 had an island named after her by her father, where she picked as a child and where the berries grew big, and her sister had an island named after her, because this is where she was known to pick her berries. Interviewee 9, when describing his bakeapple picking spots, said,

> Now we go up here, we go this way... we're right there, now that direction that's real good for bakeapples, my first cousin's area, he goes here, I will go that way... I'll come this way for bakeapples, or I will go, this, that's his area, he always went that way, so I never, invaded his territory, so that's how old people, they were really organized, you know? More than today.

Interviewee 11, when discussing the changes in where people pick, said,

> …You know designated places where different families went, and now through the years you get more outsiders moving in, like teachers and stuff and, they'll only know about the one or two nearby islands, so if they happen to be the good islands, that's where you'll get most of the people going.

One third of interviewees (5) were from one family, and all pickers from this family reported that no bakeapple areas were left unpicked for certain people, except one picker who recognized Interviewee 12's area.

Those pickers who did describe bakeapple areas that are identified with certain people, say that these spots are not recognized anymore. The only designated territory still acknowledged is Bear Island, which is left for Interviewee 12. His was one of the few families to live on and fish around this island. One picker mentioned that Interviewee 12 could get all his winter's bakeapples at this location. He also picks on other islands and sells his bakeapples. But for some (5) interviewees (two of which said that no one "owned" or "claimed" any bakeapple areas) it was important not to tread on "his" [Interviewee 12's] island. One of these pickers, who used to pick on this island, said that he no longer does so. Interviewee 8 said,

> No, we didn't go on [Bear] Island, 'cause that was [Interviewee 12], lived there, we wouldn't want to go and take his, you know.
> R = Okay, so [Bear] Island belonged to [Interviewee 12], did it...but there was…
> I = We sneak the bakeapples on Uncle Adrian's garden.
> R = 'Cause Uncle Adrian's garden is on [Bear] Island, is it?
> I = Uncle Adrian was on [Hilly Island], where he had his garden…he had big potatoes there, they said, he growed big potatoes on [Hilly Island], on his garden? And there'd be great big bakeapples growed there, and we'd sneak around and we'd go get some big bakeapples.
> R = Did you?... 'Cause he would still go there to pick?
> I = Yeah, oh yeah.

Interviewee 6 said that there were no designated territories for bakeapple picking but there were for redberry (partridgeberry, *Vaccinium vitis-idaea*).

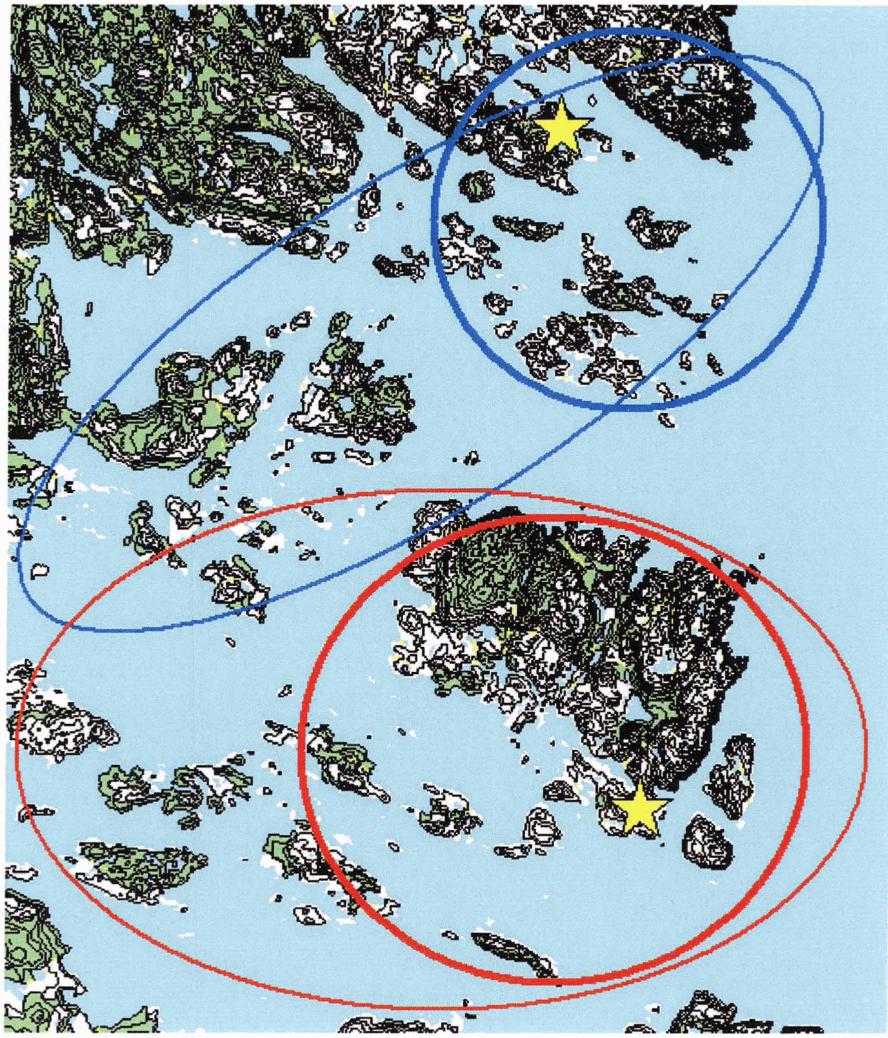


Figure 2.4a Bakeapple picking areas between 1940-1960, before cod-fishing moratorium: red = families fishing from Community A; blue = families fishing from Community B; light lines indicating range of islands visited, dark line indicating most commonly visited areas; locations of communities indicated by yellow stars.

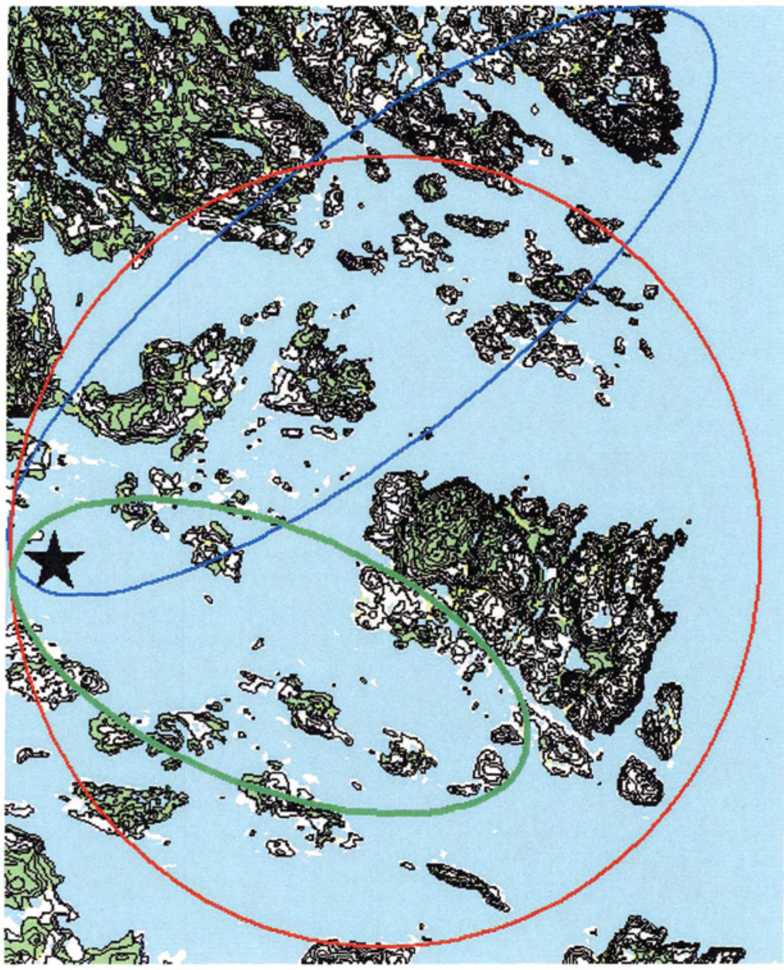


Figure 2.4b Bakeapple picking areas between 1990-2004, after the cod-fishing moratorium, when most people stayed in Charlottetown for the summer; red = families fishing from Community A; blue = families fishing from Community B; green = most commonly visited islands by community members, Charlottetown located west of black star

2.3.2.5 How bakeapples are picked

> ...Don't leave nothing in the berries...One time, my cousin was down with his wife from up on Cornerbrook?... and we went berry picking... and there was a lot of berries.... We got a lot of berries, we got a bucket full of berries each, we had some, a bag full.... And now he had more shucks then what he had berries.... So when I come back, see, we put our berries on the table and his wife Phyllis, she was looking at the, berries, hey?....At he's and mine, but she wouldn't say nothing, she just looking hey?.... And I said 'Phyllis', I said, 'if you can find a shuck.... in them berries I picked there... you can have what's there, take them all'.... And I keep me eye on her, and she was looking at the berries, by and by she reached over, she got a shuck out of her husband's berries, and she fooled around and she got the shuck in my berries and she said, 'I found

> a shuck,' I said, 'Yeah I seen ya, you found that in his bucket'... so she was gonna have the berries, eh? (Interviewee 6)

Most interviewees (11) did not describe a particular way to pick bakeapples but some (4) described the technique of giving the bakeapple a little twist to take it off the stalk when it is just starting to get soft. Some pickers (4) talked about the importance of not pulling the stalks out while picking, as this damages the bakeapple plant and could impede the next year's growth. Some interviewees (4) discussed the necessity of picking the bakeapples "clean," that is, not to get any shucks, pieces of dirt, flies, or twigs in your bucket. Interviewee 6 also discussed certain berries that are discoloured or have "spots" on them; these are avoided while picking bakeapples.

When bakeapples are picked before they are ripe, there are a few ways to "shuck" (remove the calyx) the berry. Some pickers use their thumb to snap the berry from the shuck. Some people use their teeth, which another Interviewee 11 did not find to be an acceptable practise. Some interviewees (3) talked about the importance of not trampling over the berries while picking. Interviewee 6 was upset in the summer of 2004 because he said people had trampled all over his main picking island and damaged it. Interviewee 10 described how she was taught not to "pick through" the bakeapples, which is only picking the very large bakeapples instead of picking all berries that are ripe. While I was picking with Interviewee 1, he was annoyed to find that areas we went to had been "picked through" by another picker.

2.3.2.6 Quantity gathered

> We couldn't get any fresh fruits [in winter], hey, no fresh fruits, so, I mean, you had to eat a lot of like bakeapple and partridgeberry [redberry] jam. (Interviewee 13)

For the older interviewees, wild berries have been the main source of fruit in their diets for most of the year. Pickers said their only opportunity to buy commercial fruit was in the fall after the fishing season, when families would buy their winter "staples." Both an initial lack of fruit products (e.g. jam, dried fruit) available and inadequate funds to purchase these products often prevented interviewees from acquiring other sources of fruit. This meant that wild berries were required in considerable quantities (Figure 2.9). The amount of bakeapples gathered each year depended primarily on three factors: the size of the family, the productivity of the bakeapples that year, and the time available to pick and process. Before freezers were introduced to the community (about 30 years ago), storage capacity would also limit the amount of bakeapples gathered.

Figure 2.5 Thirteen gallons of bakeapples gathered in "a good year" by a family of four, 2004.

All but one of the older pickers who had, on average, ten children in their families, had tried to gather approximately 20 gallons of bakeapples for their families for the winter. Interviewee 6 said "twenty gallons is not a lot of berries for a family for the winter". Only Interviewee 12 said his family just needed about five gallons of bakeapples for the winter. Most interviewees described "bad" years when only one to five gallons were collected. In the years when bakeapples were "plenty," some interviewees (3) were able to gather up to 30 gallons. If pickers were not able to collect the full quantity of bakeapples they required for the winter, they would pick more of the other species of berries available, especially redberries (*Vaccinium vitis-idaea*). Most interviewees said they would always gather about 20 to 25 gallons of redberries each year.

A number of changes have contributed to smaller quantities of bakeapples being gathered in recent years. For one, there is now a permanent store in the community, so that wild fruits are no longer the primary source of fruit. Secondly, pickers said that they have less time available to pick the quantity of bakeapples they would like. Finally, there are fewer people in each household. That said, pickers still collect more bakeapples than they can consume so they have some to give away or sell (discussed in Section 2.5). Currently, most pickers (those who are not picking to sell their berries) said they try to pick five to ten gallons of bakeapples for the year. Interviewee 12, who sells bakeapples, tries to get about 20 gallons each year, while Interviewee 2, who is the best known bakeapple picker in the area, picked 70 gallons last summer (2004).

Pickers tend to use their carrying container as an initial means to estimate quantity, and will later use a scale for a more reliable measure. The most typical containers currently used are plastic buckets, which, as noted previously, can be smaller ("gallon" size) or larger (five-gallon size). When picking, pickers will commonly attempt to “fill their bucket” before they return. Since bakeapples tend to “sink” as they are picked, depending on their ripeness, the actual amount in the bucket can vary. This is why pickers say it is much more difficult to fill your bucket with bakeapples than with redberries, which are more solid and hold their volume better. This characteristic of the bakeapple combined with changing definitions for a gallon (e.g. 8-10 lbs), has led to variable estimates of the number of gallons a person picks. Some interviewees mentioned that certain people in the community “claim” to collect more bakeapples than they actually had.

2.3.2.7 Containers

> W = this old boiler is left down on [Eagle] Island, down there now, where someone put him on a tree....up on the hill there, in a certain place, the old bucket, the old boiler was still there a few years, a couple of years ago
> R = someone left it behind?
> W = Gary Stein...left his boiler.
> I = Tom was stealing the berries out of his bucket and he got mad, I suppose, and he took the old bucket and he put it up on a stump, Tom must have had all the berries took I suppose.
> R = and so he just got mad and left?
> I = I guess that's what happened, I'm only just guessing that part.
> W = Yes, couldn't think why he left his bucket, hey?...I suppose all the berries was gone and....
> I = was old enamel boiler, old brown enamel boiler, it was...
> (Interviewees 1,8)

Older interviewees (in their 60’s and 70’s) described several types of containers for bakeapples that they used as children, and later as parents to carry bakeapples. Typical containers included: galvanized buckets that were used for carrying water (often holding 2.5 gallons), dinner “boilers”, which were larger cooking pots (~5 gallons), and enamel “dippers” (smaller pots used to dip water out of the water buckets) (Figure 2.10).

Interviewee 6 explained that you could not leave bakeapples in the aluminium buckets for too long, because it would turn them a dark color.

> My dear sometimes, your arms would be dragged off, hey, trying to lift old heavy buckets, hey... long distances, over good land, yeah… Now it seems like a gallon of bakeapples is like nothing now. (Interviewee 3)

Figure 2.6 Typical carrying container, dinner "boiler", before plastic buckets were introduced to the community

Interviewee 14, growing up in Red Bay, remembers carrying a ten-pound wooden butter tub for carrying bakeapples. Some interviewees (3) remember their moms washing out old paint cans to pick in. Old fruit tins or condensed milk cans were sometimes washed out for small children to pick bakeapples. Approximately 20-30 years ago, large plastic buckets were introduced to the community (as salt beef and herring buckets – 5-gallon size) and later smaller "gallon" buckets were introduced. Those pickers who walk long distances to get their bakeapples say they pick them in a bucket lined with a plastic bag. Once the bag is filled, they tie the top and put it in their "game bag" (backpack) and then place another bag in their picking bucket.

2.3.2.8 Eating bakeapples while picking

The majority of interviewees (12) reported rarely, if ever, eating bakeapples while picking them. Interviewee 4 explained that this is because bakeapples taste best directly from the plant and it was difficult to stop eating the bakeapples once you began. Older pickers stated that the purpose of gathering bakeapples was to "secure" food for the winter, so it was important not to eat them while picking. Most pickers say that they likely ate bakeapples while picking when they were younger, but would eat none or only a few while picking as an adult. Interviewee 3, who is in her late 60's, said, when talking about eating the berries while picking,

> Oh I dare say we did…yeah, probably did when we were children, if we got a chance to do it, we probably got a bat on the side of the head, if we was caught, eating them or knocking them off, hey? If they caught us.

It is primarily younger pickers (30's and 40's) who say they eat bakeapples while picking them. It is possible that these pickers did not experience the early years in the community when wild berries served as such a crucial food resource.

A number of strategies existed to prevent people from eating bakeapples while they were harvesting. Most interviewees who were parents maintained that they never told their children not to eat berries. However, one interviewee whose parent had said this remembers "not being allowed" to eat the berries. This suggests that the instruction of not eating bakeapples while picking must have been more subtle than explicit. Pickers seemed to use teasing to dissuade people from eating the berries. Interviewee 8, when talking about people who eat bakeapples while picking said, "Well there was some, but you laugh at them, see them eating their bakeapples when they're picking them." Inciting competition appears to have been an effective tool for one family in particular. An older picker from this family explained that he would not eat bakeapples because he wanted to fill his bucket the fastest. Even now, this picker and his siblings will try to pick more than others they go picking with. Another possible way to prevent pickers from consuming bakeapples was if an alternative food was available; a few pickers (2) talked about eating "blackberries" (*E. nigrum*) when they were out picking bakeapples. These are the only other berries that are ripe at the same time.

2.3.2.9 Other plants/berries

Bakeapple is the first berry to ripen out of all berries collected by community members. "Blackberries" ripen around the same time but are not gathered in nearly the same quantities as bakeapples and redberries (*V. vitis-idaea*); often they would be eaten on the spot or gathered in small quantities to make a pudding. Squashberries (*V. edule*) ripen next, followed by blueberries (various *Vaccinium* species, for e.g., *V. angustifolium*, *V. uliginosum*); all these species ripen in August. Finally, in the fall (September), redberries are ready to be picked. All pickers stated that no other berries or plants were gathered during bakeapple picking other than for snacking, partly because no other berries were ripe at this time (except the lesser valued "blackberries"). Some pickers also suggested that the focus on bakeapples was encouraged due to the very short period between when bakeapples are hard and when they become "faded" (overripe), requiring concentration on the one species. Interviewee 5 talked about watching the development of the other berries because this would help them know when the bakeapple would be ripe, since all the other berries are whitish before maturity. A number of (older) interviewees remembered gathering various plants for medicine, such as ground juniper (*Juniperus communis* L.; Cupressaceae), "Indian tea" leaves (*Rhododendron* (*Ledum) groenlandicum*

L.; Ericaceae), and twinflower (*Linnaea borealis* L.; Caprifoliaceae), but these were often only gathered when people became sick and also in the fall.

2.3.2.10 Traditions associated with bakeapple picking

> I = She'd take the knife, and she'd slice it [pork], like that? ... you know... She left the fat on them, the ol' fat part? And she slices all the pork like that, and take and cut a hole and put it on a stick, and she'd put it over the fire ... and she'd roast pork ... well my dear, that was ... when you was, when you roast it over the fire, you take all the salt and pickle went out of it ... burned out of it? ... And that was delicious ... put that on your bread now ... perfect ... always had pork.
> R = And you'd boil a kettle too, right?
> I = Boil a kettle... Oh that was, that was the fun....That was what, you know, we young fellers always liked, when we was going around, is... the boil-up, hey?...Was a lot of fun....Toast the bread and... probably now you might be lucky enough when you're out on the island berry pick'in... might come across a few gulls eggs, or ducks eggs, or something?....It was good that way... everything, everything tastes better when your outdoors...cooking up, on the rocks. (Interviewee 6)

All pickers identified the most important tradition involved with berry picking as the "boil-up". This, Interviewee 5 explained, is "how you get your lunch." The basic component was a fire and a kettle or container for boiling water to make tea (Figure 2.11). Favorite foods for the boil-up include: toasted bread, roasted dried capelin (small smelt fish), mussels, smoked salmon or trout, molasses bread and molasses buns. Roasted salt pork is one of the favourite types of food among older interviewees (3) but it is no longer eaten. Some interviewees (2) used to bring a piece of bread to put a few bakeapples on with some sugar. Some pickers (3) mentioned catching cod for the boil-up. Interviewee 10 said, "but we always would jig for a fish until we weren't allowed to do that... dad says that's hard, not to be able to jig for fish when we're out getting our bakeapples."

Figure 2.7 Boil-up after picking bakeapples, with mussels and water to make tea.

There were a few more traditions that were tied to bakeapple picking in the past. Some interviewees (4) remember going swimming in ponds on some islands while picking. If pickers were traveling north to get their bakeapples, it would often be a multiple day excursion, and the family would sleep on the boat or in canvas tents. Some people from Newfoundland ("Flowers Cove people") traveled by "canvas covered skiffs" to pick bakeapples in Labrador and "Conche" families would travel by longliner to Grey Islands to camp and pick bakeapples (Omohundro, 1994). A few pickers (2) remember their fathers getting a "meal" of ducks or shooting a seal while the others picked bakeapples.

Interviewees reported that more recently, they often do not have the time to have a "proper" boil-up with a fire and now have conveniences that allow them to get their lunch and "cup of tea" by other means. For example, they bring a thermos of hot water to make tea, or a soft drink instead, and bring items such as canned wieners, bottled rabbit, chips and candy bars for lunch. Interviewee 1 said,

> Probably, yeah, boils up less now, yeah, 'cause most times we have got a soft drink and, you're in a hurry getting all the berries you can, you don't stop very much.
> R = But why are you more in a hurry to get the berries now than you were then?
> I = Oh I don't know, I suppose there's more people around the islands, and, you know, come to a nice spot, and you, try to pick them up.

For some pickers, the "boil-up" and bakeapple picking have been separated into two events, where a family might take an afternoon to enjoy a boil up, but if they are "serious" about picking bakeapples, they will just bring a lunch. Interviewee 10 considered boiling up (lighting a fire) to be a "waste of time," given the large amount of time required to move among islands for picking bakeapples. She considered molasses bread as traditional berry-picking food that was necessary for bakeapple picking and would only have a boil-up when camping out for bakeapple picking. Interviewees who often picked alone (4) said they usually do not have a boil-up. Interviewee 2, when talking about boiling up, said, "Oh yes [I do], when I got someone with me, but when I'm by myself, I don't boil-up, because, I don't know, I just don't like eating very much by myself." Two interviewees that said they have more boil-ups more recently than they did when they were younger, but these were people who had married into this community.

2.3.2.11 Knowledge transmission

> But I think, mostly for me, the traditions for me was always the storytelling, like with every island there came a story, or something that happened, maybe a place where, you know, a boat ran ashore, or grandfather had a cabin there, or where they hunted, there always seemed to be a story to each island....It would be related to berry picking or, things that he, you know, or maybe they came across a bear during berry picking, or something that had happened with

> a whale or, just different stories, you know, that through his lifetime have, if they camped out, or where grandfather would set up tent and, just, just stories, every day stories, right? (Interviewee 10)

It was often in the act of bakeapple picking that local knowledge associated with this cultural practise was communicated from parents or older relatives to children. It was there that children learned about the history of the islands on which they were picking. This history would encompass both biological (e.g., history of fluctuations in bakeapple abundance) and social (e.g., past berry picking experiences on the islands) aspects pertaining to the land. They would learn all aspects ranging from the location of bakeapple picking areas and habitat characteristics, influences on bakeapple abundance, and techniques involved with picking. I experienced this personally, where interviewees would have difficulty explaining aspects of bakeapple picking in the interview, but once out bakeapple picking, had many stories to tell about these topics.

> R = Did your parents tell you any stories or anything about when they were picking bakeapples, when they were younger?
> I = Well, you know, you'd hear them talk about how thick they was certain years, and how much they picked on this marsh and on another one, you know, they'd tell you that, yeah… and you know, they was red right over it, and, the marsh as... where they grow thickest, hey? (Interviewee 7)

Interviewee 6, when discussing the berries his mother or uncle would teach him to avoid, said,

> While you was there, picking with them and they'd talk about the berry, this one here was blighted… and another one over there, with... queer spots on it and, you know? … And they'd always tell us, they'd show us, like the berry to pick, right? … don't pick'em if … they got old spots into them, right?….You see lots of berries, not, got all different, spots and that, and not only spots, but some of them got colours, eh?
> R = Colours?

> I = Different colours in them? ... Like old green colours? ...and like partly ripe, and so much old green on it and so much old stuff, so there's all kinds of little spots on berries...Bakeapples, when your picking them you got to make sure you watches for it, hey, you don't....
> R = And you don't want to get those ones?
> I = No, no ... We was always taught not to do that.

It appears that this knowledge is not being transmitted as efficiently between generations as it was in the past. Interviewee 13, who is in her 30's, discussed the difficulty she had finding new areas for picking bakeapples. She said:

> No, I think that's where having an older person with you, they certainly come in handy... I think they can just actually smell them, when they're going through in the boat, I swear they can, 'cause I know, with Uncle James, we go down through the run, and he's just like 'bakeapples there, bakeapples there' and like he can actually see them and everything.

2.3.3 Processing

> R = Did you have to do anything with them, after you picked them and brought them back, before you could eat them?
> I = Oh we'd leave it for mother to clean them all up, right?
> W = She'd do the work.
> I = Bottle them up or whatever.
> W = And now he leaves it for his wife.
> I = Yeah. (Interviewee 5)

For most interviewees, it was the mother's job to carry out all processing activities with the bakeapples after they were picked, sometimes with the assistance of the oldest female siblings. Most interviewees said it was important to clean the bakeapples after they were picked. Cleaning required removing twigs, shucks, flies, or black "pecks" (pieces of dirt or burned material if picking occurred in a burned area) from the berries. Some interviewees describe some berries picked so "clean," that it was not necessary to go through them afterwards. Interviewee 10 perceived the process of cleaning bakeapples as a way of taking pride in what you were doing. Any unripe bakeapples that were picked would be left in a plastic bag or bucket to ripen, either in the sun (2), or in the dark (2).

Two pickers commented that if hard and soft bakeapples were left together, the hard berries would ripen faster than if left to ripen alone.

2.3.4 Consuming bakeapples

Traditionally, the berries were often eaten raw in a dish with some sugar and sometimes cream, when available. Only interviewee 12 said that he never ate the bakeapples raw when he was growing up, and only ate them when they were boiled to make jam. Jam was commonly made (and often stored this way) and most pickers preferred to use hard berries for jam. Most people (9) remember having bakeapple drink as well, sometimes referred to as "berryockee" (Figure 2.12a). Some pickers (4) still drink bakeapple beverage today, but others (5) only drank it when they were young. Interviewee 15 had only observed his grandparents drinking it. Pickers say that bakeapple drink is made from a few spoonfuls of bakeapples in a cup combined with some sugar and hot water. Interviewee 8 also drank bakeapple drink cold, where the berries were mashed with water and sugar and the pulp was strained out. Interviewees describe both bakeapple crumble and bakeapple pie as very popular desserts in the past as well as in the present (Figure 2.12b). Only interviewee 13, who grew up outside the community, began eating bakeapple pies only in adulthood. This picker was the only person who grew up eating "upside down" cake (white cake with bakeapples and whipped cream in the cake). Now, interviewees state that cheesecake is the most popular form of dessert using bakeapples. I found bakeapple cheesecake being served at every community event I attended in the summer. Some pickers reported eating bakeapples in tarts, crepes, sundaes, or with custard, mixed with strawberry jelly, or combined with 7up.

Figure 2.8a Bakeapple drink made from hot water, sugar and bakeapples.

Figure 2.8b Bakeapple pie, a favourite bakeapple dessert both in the past and presently.

2.3.5 Storing

> But for the winter, there was times I suppose, my maid, they had a barrel of bakeapples, some of the older people like, old grandmother, and or mother, I'd say if she was trying, she might have had close to, she never had the barrel [full] probably, but she had had a lot of berries, but...like the older people, like I said, they had their barrel full, I'd hear them talk about it... 20 gallons, 25, something like that, hey? (Interviewee 7)

Interviewee 8 said that bakeapples were much more difficult to store, or "keep" than redberries, before freezers were introduced in the community. Traditionally, interviewees report storing bakeapples in glass (gallon-sized) jars that had a narrow opening, or in smaller glass bottles. Consequently, the quantity of berries a family could store depended on the number of bottles available in the household. Interviewee 3 said,

> Whatever you could get, I mean, everything you could find, every bottle and everything you could find, you'd have it filled up.....mostly it was just an old common ordinary bottle, put them in, everybody'd have so many, so many bottles each and have your name marked on them, hey...the youngsters.

The opening of the glass jar would be covered with a screw cap or cork, which would then be sealed with pitch (thick black material used to seal the seams of the boats) or wax. The glass containers were kept in the coolest areas of the house over the winter. Interviewees generally stored bakeapples without anything else added and the method of storage (i.e., raw vs cooked) seemed to be related to the picker's summer residence. Interviewees who fished at Community A stored their berries raw, while the interviewees who fished at Community B boiled their berries before storage. Some pickers (3) only discussed boiling for bakeapples that were not ripe, while others (8) talked about boiling bakeapples before storing them, likely in order to preserve them better.

Some (4) of the older pickers remember their parents using wooden barrels for bakeapple storage, either herring barrels (holding 20-25 gallons) or smaller molasses kegs (holding 6-15 gallons). Interviewee 3 said the molasses barrels were superior to the herring barrels because they were less leaky (they only had one small opening), which was an important factor when storing a juicy berry such as a bakeapple. Interviewee 8 said that her mother would put many different kinds of berries (e.g., bakeapples, redberries, "blackberries", squashberries) together into the molasses keg. She recalled her aunt adding some sugar and "scalding" the berries briefly before storing them. The opening would be sealed with a cork and some cloth. Interviewee 3 explained that these wooden containers could be stored outside for the winter and the bakeapples would freeze, whereas glass containers would break if stored outdoors. People living on Newfoundland's Northern Peninsula would sink wooden barrels filled with bakeapples into a bog, cover them with moss, and return by dog sled in the winter to retrieve them (Omohundro, 1994). Interviewee 14, who grew up in Red Bay, also remembers her mother using ceramic "crocks" (holds 2-5 gallons) sealed with wax to store bakeapples. These storage practises are no longer in use today.

Interviewees described how the bakeapples could get "worked" or "strong" if they were not sealed properly (likely the result of fermentation). Some pickers occasionally observed green mould in the barrels or jars and, when this happened, the upper layer was removed and the rest was eaten. Pickers explained that the bakeapples might then have a "stronger" taste, but they were never thrown away.

Around fifty years ago, canning jars were introduced to the area and this became the main storage container for bakeapples (and other berries and meat). The berries would either be boiled into jam, or simply scalded briefly, and put in the bottle to seal. Interviewee 3 used to make jam with many different berries mixed together. But Interviewee 8 did not like to mix bakeapples with other berries; she said, "But, I'm always too careful over my bakeapples, [it would] spoil them to put them with other berries." A recent trend in jam-making is use of 'freezer jam gelling powder', where bakeapples are mixed with the powder, left for a half hour, put in the freezer to set, and stored in the fridge until consumed. In the last thirty years, pickers have been storing their bakeapples in the freezer, and everybody agrees that the bakeapples taste much better (comparable to when first picked) and will last longer (for a few years) when stored in the freezer.

2.3.6 Bakeapple picking in Red Bay (Labrador Straits area) vs Charlottetown

Two interviewees grew up in the Straits area, which is well known for its abundance of bakeapples. Interviews with them (and observations by other interviewees who have been to the Straits area for bakeapple picking) suggest there are a number of differences between the Straits and Charlottetown in terms of the bakeapples and practices associated with picking. For one, these interviewees say that Charlottetown, which is located farther north, is generally warmer than the Straits. Charlottetown's more inland climate results in earlier ripening times compared to the Straits. Also, interviewees have observed that the bakeapples from the Straits are redder (redder berries are more sought after than orange-colored berries). One picker suggested the different colour could be due to the higher occurrence of fog in the Straits area.

Pickers say that bakeapple picking is much easier in the Straits area than around Charlottetown owing to the higher abundance of bakeapples and relatively level (less hilly) habitat in the Straits area. It is more costly to pick bakeapples in Charlottetown, since bakeapples can only be accessed by boat whereas in the Straits bakeapple patches are located on the mainland and can be accessed by car (gas costs are higher with boats). This difference in the location of the bakeapples may have resulted in differences in social group formation for picking. Bakeapple patches located on islands and traveled to by boat necessitated that the whole family pick together, whereas having bakeapple patches more proximate to homes did not require that whole families go together. The interviewees (2) who grew up in the Straits area remember mostly picking bakeapples with just a sibling or some friends. Interviewee 14, from the Straits, also mentioned that it is easier for people to "claim" or identify with certain bakeapple areas in Charlottetown. In Red Bay, all the bakeapple areas are connected and continuous, while in Charlottetown, having bakeapple areas on islands allowed people to identify specific islands as "their" spots. Another difference between these areas pertains to the commodification of bakeapples. Bakeapples have been sold on a larger scale for a much longer time period in the Straits compared to Charlottetown. The two interviewees remember, when growing up in the Straits, selling bakeapples to buy clothes and exercise books for school. They also explained that bakeapples picked in the Straits are sold to stores, whereas in Charlottetown, the more recent trend towards selling bakeapples involves selling to individuals.

2.3.7 Exchange of bakeapples

> I mean we could be picking more but I was raised in a setting where we were really taught to never take more than you needed. My grandfather just instilled that in us, when we were fishing, when we were ice fishing in the spring, and whatever, he'd say 'never take more than you're going to eat,' because some people just fill their freezers and then it goes to the dump in the spring and, Pop always taught us the importance of thinking about the next generation that was coming, it's more than us here and now, so back, like, we were feeding there was probably eleven or twelve of us at home, and then Nan was the house where she was like the medicine… dispenser, all the nurses came through, all the pilots, we always had a lot of people staying with us, and I guess, and I often remember that, a lot of times when these people were going, like if they'd spent two or three days at our house and bakeapples seemed to be the delicacy of the day, and they really enjoyed it, she'd often give them, like you know, that was nice, that was a nice

> gesture on her part to, that would be something they can take away, oh here's a bottle of bakeapples and they'd be delighted. (Interviewee 11)

As mentioned previously, selling berries is relatively new to the community of Charlottetown. Interviewee 2 said, "but when we were here, we always picked them for our food, for wintertime, 'cause years ago you didn't sell it, it was only the last, probably about the last 20 years, we've been selling bakeapples, hey." Some members of the Smith family recall selling bottled bakeapples by the case (as well as smoked trout and salmon) to people on fishing boats, or trading bottles of bakeapples and redberries to the Grenfell Mission in exchange for winter clothes. Interviewee 8, who is 70 years old, traded bakeapples to the Grenfell Mission as a parent, and remembers her mother doing this when she was young. Interviewee 1 explained that he only sold enough bakeapples to pay for his gas. Some pickers said they would buy bakeapples if they were not able to pick enough while others said they would go without.

> I never sold a bakeapple in me life…never a berry in me life, not a berry... and I give away dozens and dozens of gallons, dozens, to people, never ever bothered, to charge them….I'm no worse off for it, I'm only gonna live till I die, just like everybody does... no more than that to it (Interviewee 6)

Most interviewees say they give away bakeapples. Interviewee 7 said, "we gives away a lot of berries, we gives away half we picks." Pickers will often give bakeapples to relatives who can't get out to pick their own, or visitors who are passing through town. Interviewees also describe situations where bakeapples are given to others who have given something to them or who did something nice for them, or as Christmas gifts.

> R = Who was that woman...the one that left before you had the chance to give her the berries, she had given you some meat...
> I = I want to give her something, I figures, bakeapples is what she likes… cause I give her a bag of bakeapples when she was here, last summer?…

> so they gets right proud of that, they loves bakeapples, the ones who can't get them.
> R = Yeah people seem to like them as gifts, hey?
> I = Yes, like gifts for Christmas, that's what I give some of the Miller's...they're right delighted if they had a bag of bakeapples....'cause where they're busy, they don't get to go out and get bakeapples? (Interviewee 8)

Interviewee 11, said, that she would often send bakeapples to her grandmother, who lived in Newfoundland, and her grandmother would then send her some raspberries. This exchange of bakeapples and raspberries or strawberries between people living in Labrador and those living in Newfoundland has been described by Omohundro (1994). Labrador berries (bakeapples) are thought to be "better than island berries" and strawberries/ raspberries do not grow in Labrador.

2.4 Discussion

2.4.1 Major changes

Charlottetown, despite being a relatively young community (54 years old), has undergone some very significant changes, in terms of its economy, technology and social practises. Many of these changes have influenced the customs surrounding bakeapple picking in the community. The closing of the cod-fishery (1992) and the establishment of the shrimp plant (2001) have been the most significant economic changes in this community in the past couple of decades and these changes have resulted in substantial social impacts as well. After the fishery closed, community members no longer moved "outside" to their summer fishing homes in the summer, which placed them relatively further away (than they were in the summer fishing homes) from the bakeapples during the picking season. This greater distance, and greater cost (in gas) to access bakeapple areas, makes it more expensive to check the ripeness of the berries, and has increased the pressure of making a bakeapple-picking trip "worth it". Also, the cod fishery allowed for all community members to be equally busy at the same type of work, but now community members have different levels of free time (e.g. between crab fishers, shrimp plant workers, and retired fishermen). Interviewee 1, when talking about the effects of the shrimp plant on bakeapple picking, explained,

> Well it has affected them a nice bit because now they haven't got much time, they got a job to get time off and when there's lots of crab and that, and shrimp coming in, they don't have much time, if they goes, they got to lose their day's pay to go and get berries and....So a lot of them is not getting a lot of the berries, and that's why me and Trevor and ones that's not retired, ones that's retired, we got more time when we can go out and get a good many berries, as long as our health is good hey?

The cod fishery also involved greater interaction between husbands and wives, because men would return home daily from fishing and women would help process the fish. In comparison, crab fishing requires fishermen to travel further and be away often for a week at a time. Even if both husband and wife are working at the shrimp plant, they may be working different shifts. This separation of the family in the workplace poses a challenge for families to make time to pick bakeapples together.

Certain aspects of work at the shrimp plant make it difficult to find the time to pick bakeapples. Interview 7 explained that at the shrimp plant, a person is "not your own boss" as they had been while harvesting cod, and therefore one can't simply decide to take a day to go berry picking as they had done in the past. Plant workers need to wait for a day off, and these are limited during the narrow bakeapple season. In contrast, bakeapple picking in the past coincided with the time when cod harvesting slowed down. Presently, interviewees say that the bakeapple-picking season coincides with the busiest time at the shrimp plant. With the decline in crab stocks, crab fishers are required to work longer hours to fill their quota. Some pickers also find that their physical fitness has changed as a result of the shrimp plant. Interviewee 7 and Interviewee 13 explained that shrimp plant jobs are far less physically active than the cod fishery work, and so some pickers find it more difficult (e.g., hard on their back) to engage in the physically demanding practice of bakeapple picking.

The closing of the cod fishery and opening of the shrimp plant have also influenced the demographics of bakeapple pickers. There has been a large shift from entire families and generally, everyone in the community going to pick, to retired fishers doing the majority of the picking (and searching for new spots), younger married people (in their thirties) picking in smaller amounts, and children almost never accompanying their parents to pick. All interviewees commented on the fact that the younger people (age twenty and under) are not interested in picking bakeapples. Some pickers suggest that there are too many other things for them to do and some say they are lazy and not forced to do it as pickers had been in the past. A few older pickers thought younger people might be forced to start picking to sell bakeapples when there aren't many job opportunities in the community.

> I = Yeah the younger, the crowd now, you won't get them to, the younger generation now, growing up here, teenagers, you could hardly pay them enough money to go berry picking.
> W = Well we've got a seventeen year old granddaughter, I don't know if she's....
> I = She don't want to go out there.
> W = She hasn't been berry picking since she was young.
> I = But back when we was younger, there was no such thing as saying no. 'Now we're going berry picking, we're all going,' that was it, away you went... but now if you said that now, said that to two or three young people here, and you said, 'Now we're going out berry picking,' they'd just get up and walk out through the door and go on home. (Interviewee 6)

Interviewee 1 when talking about adults who grew up in the community and moved away (e.g. his children), said, "When they comes home, they wants to go berry picking, they was used to it when they was younger." Despite the issues of time challenges and some households not picking bakeapples, pickers said there are still more people picking bakeapples in this community now than when it was first established. Pickers report that the town began with eight families and has now grown to about 50 or 60 families.

> ...But there are definitely more people berry picking, like ten years ago, or fifteen years ago, when we went berry picking, you'd see very few boats, and now when you go out, there's a boat on every island, kind of thing, so I guess the population is growing and, you know, more people do it as families and stuff, more time on their hands. (Interviewee 2)

Permanent year-round residence in Charlottetown has also influenced where people tend to go berry picking. Because most people feel limited by time and are concerned about the high cost of gas, they will try to find the "handy" spots to pick their bakeapples. While previously, "handy spots" would have been distributed among different fishing communities, they are now concentrated in the area around Charlottetown, and so there are a few islands that are known by most community members. Some pickers (4) who described bakeapple areas specific to people, feel that the younger generations, and people who moved into the community, do not adhere to the implicit bakeapple picking "boundaries" that shaped where families picked. Interviewee 10, when asked about people picking in other areas, said,

> ...Not the same older families wouldn't, but the younger people that was growing up, tend to not have... Whether they weren't familiar with where families picked, or didn't seem to, they didn't seem to have the same respect for the boundaries that people picked, they kind of went wherever they... They probably didn't have any, okay, say I pretty well know the

> bakeapple picking areas from year to year, they probably didn't know that but they went on every island and walked the island just to see where they were.... So that was the difference, they went wherever they wanted to go, where we just kind of still pick where we're used to going, we never really moved outside them islands.... So we never ever went any farther north and stuff to, but those other people, they were kind of growing, were coming on stream then, would go wherever they felt like going and, just come across them, I guess by chance, kind of thing, right?

Another issue related to areas specific to certain people is the degree of confidentiality surrounding bakeapple spots. A number of interviewees were concerned that I would share their particular bakeapple areas with the rest of the community. This suggests that bakeapple pickers in Charlottetown are secretive about their picking sites. On the other hand, in visits to community members during bakeapple picking time, I often heard news of which pickers traveled to different islands and how many gallons of bakeapples they picked. This information seems to be shared more freely than their concerns about secrecy suggest, but perhaps pickers only tell particular people in the community (friends) where they had been and perhaps knowledge sharing is seen as a form of reciprocity (it is their knowledge to share in return, perhaps for some reciprocal sharing down the road).

The areas people go to pick bakeapples have been strongly influenced by the changes in transportation for community members. Transportation to bakeapple picking spots has progressed from rowboats to motorboats and finally to speedboats. People can go farther than they used to go and in a much shorter time. Interviewee 11 described how they could now go bakeapple picking after supper, when previously, they would have to set aside a whole day for bakeapple picking.

There have been significant changes in both the carrying containers and methods of storing that have made bakeapple picking considerably more convenient. The switch in carrying containers from metal pots to plastic buckets has made carrying bakeapples far less laborious. Interestingly, while this transition has made berry picking physically easier, it has coincided with a trend towards avoidance of bakeapple areas that are more difficult to reach. Likely this could be related to the overall decreased physical activity of community members. The shift from bottle storage to freezers has considerably improved the taste of stored bakeapples, and allows for people to pick more bakeapples than in the past. It is possible that it has also facilitated the sale of bakeapples. The processing technique of leaving the unripe bakeapples out to ripen before storage likely developed with the introduction of the freezer, since hard bakeapples could ripen in the bottle but not in the freezer.

Another modern convenience, the establishment of permanent stores in town, has decreased the reliance of community members on wild foods, such as bakeapples. The existence of permanent stores has exposed the community to many new types of foods including alternative types of fruit. Also, with access to cash incomes from work and from Employment Insurance, community members can now afford to purchase these different foods. Interviewee 1, when describing the impacts of a "poor" year for bakeapples, said,

> It affected them more one time... because you'd, you depend on that for your winter's fruit and that? And, there was no place we could go, to buy anything? There was nere store in our bay and you'd have to go to, a day's drive on dog team, for to get to the store, and buy prunes or you'd buy apricots and raisins, and that kind of thing, and a lot of times we never had much of that because we was very poor off, very poor off.

Due to these changes, some of the older pickers say that bakeapples have decreased in importance in Charlottetown because if people do not get any bakeapples in the summer they "won't hurt for it" during the winter. However, they do acknowledge that community members are still extremely fond of bakeapples.

Interviewees didn't all agree on the significance of some of the changes in picking and the way these relate to their enjoyment of this work. The fond memories of pickers of going out with big crowds of relatives and friends and of having a big boil-up when they were younger, suggests that bakeapple picking was an important social and perhaps more leisurely activity in the past. People now go picking in smaller groups, sometimes even alone, and often are too busy to have a boil-up because they are pressured by a lack of time and increased pressure with other pickers. Conversely, Interviewee 11 felt that bakeapple picking was currently more enjoyable because people could go solely for the enjoyment of it, and there is no longer that pressure to "secure your berries" for the winter. The fact that children plan their visits home to the community around bakeapple season illustrates that this activity remains an enjoyable event for those who grew up picking bakeapples.

There are varying opinions about whether the abundance and distribution of bakeapple patches has changed over time. The responses by interviewees included: no difference in bakeapple abundance from when the interviewee picked as a child to now as an adult; more abundant berries now than ever; more abundant berries when the interviewee was young; and plentiful berries when the interviewee was a child and now as a grandparent, but low abundances when they were a parent. One factor that may influence people's ability to determine whether there have been substantial changes in bakeapple populations over their lifetime is difficulties they have assessing if an area has been picked or is just not fruiting that year. Interviewee 8 explained,

> The way it is with the bakeapples, if they're riped, someone can go and pick a big spot, and you wouldn't hardly know it.... that's, they just take them and you won't see?... Like, when they're all riped, you can pick them and go on, and then you're looking for them and there's none there? They can have them picked, like.
> R = So that could have been the case where you go and say there's no bakeapples here, maybe someone got there before you?
> I = Yes, maybe someone got them, when they're riped.

Another factor would be the highly variable use of certain islands for bakeapple picking by an individual over their lifetime. If a person began picking around Community B, for example, they likely would have personally experienced and heard stories only about bakeapple abundance in areas close to Community B. This person, now living in Charlottetown, is much more exposed to stories about more islands, but still to an extent will find out about islands depending on the identity of their friends and relatives. Those who fished farther north would likely have different perspectives on fluctuating abundance. For some interviewees who reported decreases in bakeapple abundances over time, a few (2) had mentioned that the areas had grown over with shrubs and should be burned.

2.4.2 Importance; Bakeapple as a Cultural Keystone

> Bakeapples and partridgeberries and salmon and trout and stuff, that's pretty much the community, it's a lot of it, those four or five things are really, really important, they're important in terms of diet in your home, and they're important in terms of, you know, all of the tradition and the stories and the things that come with it, passed down through, something I did as a kid, now I pass on that to my child and I show them and ... it's one of the ways you can still keep quality family time, berry picking, apart from the consumption side, just in a really busy life that seems to get busier every day, berry picking is just a nice way to still have everyone get away and go off to the island and enjoy the outdoors, get some food. (Interviewee 11)

Bakeapple appears to be an extremely important plant to this community. Interviewee 11 recalled a story about her grandmother, who raised her and was known to love picking bakeapples. One summer, when her grandmother was eight months pregnant, the bakeapples were ripe but her husband was too busy to take her out in his motorboat so she could go picking. She ended up taking their rowboat to the nearest island to pick bakeapples and ended up losing her baby. Interviewee 11 told me that her grandfather buried the child on the island that her grandmother had been picking bakeapples on that day. The lengths this woman went to to harvest her bakeapples points to how essential bakeapples were to the community members in the past.

Bakeapples may also have served a medicinal purpose for pickers who were alive during the years before the clinic was introduced to the community. Interviewee 3 said,

> Yeah, you use them as drinks … One time now people used to use it, like if someone was sick, make bakeapple drink.
> R = So sometimes you'd drink it to get better?
> I = Oh yes, yeah, I mean, help you, like hey?
> R = And would you get, would people feel better after they drank it?
> I = Well I guess so, something about it anyway, the older people, like hey?
> R = So the older people used to use it more for medicine than people now?
> I = Yes, I'd say, yeah, than we do now, 'cause now, we go to the clinic now, get a pill for anything, and everything, and no good in the end to have it.

Interviewee 9 said bakeapples are good for a bad stomach, that they won't "burn the stomach". He also said,

> A woman said to me one time, a nurse, years ago, she said you're a healthy crowd, I have seven sisters, I'm the only brother, 'cause we were a healthy family... we grew up with bakeapple drink... partridgeberry drink, because you couldn't run to the store and always buy pineapple drink, or orange drink… so we grew up with them days, you know, that was our foods to eat, and we was a healthy family.

While bakeapples are no longer necessary as one of the sole sources of fruit for the winter, they still hold high importance to the community. Interviewee 8 said, "I'd just sooner have bakeapples than I would meat, we loves them." Interviewee 1 said , "Oh we'd be lost if we never got our bakeapples … enjoys it … as cripple, as bad as my legs is, but

I loves berry picking, out in the fresh air, and like you get, doing something … enjoying it. " Other pickers described bakeapple as a "delicacy" and a "luxury". Interviewee 6 said, "…You missed it, when there was none, when the berry was scarce."

All interviewees identified redberry and bakeapple as the two "main berries" in the community. Interviewee 6 said, "It was a thing you'd always try to get, if you could get them, hey ... redberries and bakeapples, that was the two main berries, now you picked blueberries and a few blackberries for buns and puddings, but bakeapples and redberries, was the partridgeberries, that was the two main ones, yeah." Bakeapple was a more variable and unpredictable food source, whereas redberry was a much more abundant and dependable resource and thus could be consistently harvested in large quantities each year. When community members couldn't pick enough bakeapples, pickers said they often just harvested more redberries.

Interviewee 6 described the existence of redberry patches that were associated with different pickers/families. It would seem unnecessary to designate specific individual picking areas for a resource that is more abundant. Perhaps the greater dependence on this berry and the synchronised ripening time necessitated and allowed certain areas to be picked specifically by certain people. Since bakeapple patches are highly variable from year to year, and can be picked more than once in a season, this might have prevented the establishment of more permanent areas for people, permitting repeated visits by different people. Such a trend was found in a Teetl'it Gwichin community (Parlee et al., 2004). There were few access rules in this Gwichin community associated with bakeapple areas because fruit production is unpredictable. In contrast, the more densely distributed and "hearty" redberry had recognized property rights for certain families in different areas.

Another reason why redberries were considered a more essential part of the diet than bakeapples in the past was that bakeapples spoiled more easily over the winter. The introduction of the freezer solved the previous storage problems for bakeapple.

> Bakeapples now, a lot of people likes bakeapples, but partridgeberries is not so important in some ways, but the partridgeberries is more important to us, one time we never had a way to keep the bakeapples hey? Job to keep them? And now you can put them in the fridge, and that's all that's to it, them times we never had the, but a partridgeberry wouldn't spoil, put them in a flour barrel, sometimes, and keep them all winter. (Interviewee 8)

There now appears to be a shift in perception from redberry to bakeapple as the most important berry in the community. This appears to reflect the fact, in part, that the commercial opportunities for bakeapple sales are greater than for redberry. One gallon of bakeapples will sell for $40 dollars, and people have said they have sold a gallon for as much as $80 during years when bakeapples are very scarce.

> The reason I'd encourage my kids, because it's a good berry, one of the best berries in the world, the bakeapple, hey... and it is, if they got nothing else they can do, they can go off, and make a dollar for themselves, hey...picking berries, hey. (Interviewee 2)

One picker, however, did not support the idea of commercial bakeapple harvesting in the area.

> That's why, for the harvesting part of it, I don't agree with, because I think that all these, all these traditions that go with me, gives me ... I would want to be able to do that first, then just pick the berries and sell, like it's a lot more to it than that ... so and sometimes, we're always too eager to sell our things for money, then that loses the value of it. I wouldn't want that to happen at all; I enjoys being able to go and do that, and I would always want that to be there for my children if they choose to do that, because once things become an industry and a business, it just seems that, it's not available then for anybody to, same thing with the wood, you know....Once a business is made out of it, it's not available to the general public as it should be, so it's different....I guess you wouldn't have the same appreciation now, you might talk to somebody like you know, James' family that, it's different, than how I feel about it, but I guess it's just passed down from dad. (Interviewee 10)

Bakeapples are still an integral part of the culture in this community, and the way of explaining their importance varies among pickers based on their age. While some younger pickers, such as Interviewee 10, described bakeapple picking and consumption in terms of its importance to culture and identity, older pickers, like Interviewee 2, often described its importance more simply in the terms of "your living".

> It's a part of our culture and our traditions, and it's just become, like for me, for my own self, I don't just pick bakeapples as a form of having a berry. It's something of value to me, just the actual art of berry picking, the history that's attached to that island and, for me it's time with dad, like it's a time that I spend with him, just me and him....And I cherish those times, so I guess along with bakeapple comes all those other traditions that's attached to it that makes it of value to me, outside just the actual berry, even though, now the berry is precious, you know, but it's the other things that go along with it?...So it's not just one thing, and I don't know maybe, it seems like the younger generation, even in my generation, don't value it the same as I do, whether it wasn't passed down from their parents or some of them are probably people that have moved in here and, you know, don't really know the history beyond that. But for me, it's a part of my culture and it's a part of who I am, it's a part of who dad had, you know, it's a part of it that he has taught me, a part of that history, just kind of passed down, so it's meaningful....I always say that when I, the times that are important to me in my childhood and the memories that stand out are the memories of berry picking, with dad, you know, going from one island to another island or... so I, the unfortunate thing for me now, dad is getting older, and I can't imagine the day when he's not going to be there, like, it won't be the same, berry picking won't mean the same to me when he's gone....I know that, because it's something I share with him... like I can go berry picking with Wade, but it's not the same, it's not the same because, you know with all the little things... it doesn't mean the same, the islands don't mean to Wade what they did to dad, so... that's probably why it just means more to me. (Interviewee 10)

> Yeah, and it's something you should never give up, hey... give up picking berries, because it's a part of your living, it's something that's good to be at, it's out of doors, and for me, there's a really interest there. I just love berry picking, hey, just like fishing, when I was at the fishing, before the fishery closed, I just loved to be fishing hey, and it's our way of living, really, that's what we growed up doing, hey... (Interviewee 2)

Garibaldi and Turner (2004) introduced the term "cultural keystone species," which is a "metaphorical parallel" to ecological keystone species and was described as "culturally salient species that shape in a major way the cultural identity of a people, as reflected in the fundamental roles these species have in diet, materials, medicine and/or spiritual practices." They created an index with which to determine if a species serves as a cultural keystone for a group of people.

I applied the index of Garibaldi and Turner (2004) to evaluate bakeapple as a potential cultural keystone for the community of Charlottetown. The first point is the intensity (routinely harvested, quantities), type and multiplicity of uses for the plant. The routine yearly harvesting of bakeapple, in quantities up to 30 gallons, and the prominent role of this species in the winter diet, indicates the importance of this species. The next point concerns language, i.e. how the language incorporates names and specialized vocabulary relating to the species. Several local terms are used in reference to bakeapple, such as "shuck", "blighted", "turned in", and "mash", which will be described in Chapter 4. These describe different parts of the plant, developmental stages or habitat. Another aspect of the index is how ubiquitous the species is in the "collective cultural consciousness" and how frequently this plant is discussed by the group. From personal experience, I observed that, leading up to and right through the bakeapple picking season, bakeapples are discussed most frequently of any topic, within peoples homes and in the local shops. The stories told about the islands, the lessons taught to children about when to pick, about not eating while picking and about not wasting bakeapples, and the traditions like boil-ups combine to suggest bakeapple picking is an integral cultural practise.

The index also relates to how unique a position a species may have in a culture, and how difficult it would be to replace it with another native species. The unique position of bakeapple became evident when I questioned which berries might be considered "similar" to bakeapple and was given responses such as, "nothing like a bakeapple," and "bakeapple stands out pretty much on his self." While interviewees recalled being forced to "replace" bakeapples with redberries during poor years, most say that they were missed in these years. The unique taste and colour of bakeapples make it a resource that is difficult to replace.

The final indicator in the index is the extent to which the resource allows for trade with other groups. As already described, there were instances when people would give a gift of bakeapples to someone on the island who would then provide a gift of another type of berry, not found in Labrador, or a gift of caribou meat, for example. All of these points combine to suggest that bakeapple is definitely a cultural keystone for the community members of Charlottetown.

2.4.3 The future of bakeapple picking in Charlottetown

> Because the generations of those people now are coming to pass, like dad and Uncle James and them, they're, you know, they're getting up in age, so within ten years, probably most of those people are probably not going to be around, and how many of us in my generation, actually have something to tell, not a lot, which is you know, if we don't take advantage of those, knowledge of those people now, ten years down, we're not going to be, they're not going to be there to tell us. (Interviewee 10)

Most people interviewed did not have any concerns about the future of bakeapple picking in the community. Many feel that people will continue to pick bakeapples in the community as long as people are living here. One interviewee, however, did express some concern over the “tradition” of bakeapple picking dying out, due to the lack of interest by younger generations.

One aspect of bakeapple picking that will likely change is the purpose behind it. In the past, bakeapples were “part of your living”, a vital source of food for the winter months. Now, while the majority of people who pick bakeapples do so for consumption, there is a greater focus on picking bakeapples for the purpose of selling than there has been in the past in this community. This shift in focus could be accompanied by a decrease in the storytelling and cultural cohesion that often was a part of picking bakeapples. The whole custom of picking bakeapples with the family, and the teaching of the proper ways to pick and the stories associated with the land, might be lost with younger pickers focused on picking the berries to sell. As Interviewee 10 pointed out, even people in her generation (30’s) have far less of this knowledge than their elders. Whatever the underlying motivation, the modes of access or the social relationships involved, the importance of bakeapples, either in the practise of picking or the products consumed will continue to be integral to the culture of the Charlottetown community.

Table 2.2 List of names, uses and importance of *Rubus chamaemorus* among Indigenous peoples of North America

Group	Location	Bakeapple Name	Bakeapple importance	How used	Gathering	Processing
Cup'it (Inuit) (Griffin, 2001)	Nunivake Island, Alaska	*atsar atsakutag*	Most sought after berry on island	Eaten raw, frozen for winter use, mixed with other berries into *akutar*	By women/children in late summer/early fall	Stored in seal-pokes w/out being cooked, stored in rock-lined underground pits, lined with Rumex arcticus leaves, berries packed in, covered with more leaves, sod, then rocks
Huna Tlingit (Thornton, 1999)	Glacier Bay, Alaska	*néx̱ʼw*	Minor in relation to rest of berries	Fresh and stored? Not specified	Available in spring, men/women/ children all gathered	-----
Inupiat (Jones, 1983)	Alaska	*Aqpik, -piik, -piich*	Of all berries, most prized for being 1st to ripen, large, sweet, easy to pick and keep well; most significant source of Vit. C, and good source of roughage	Eaten fresh, with seal oil and sweetener after meal, as Eskimo ice cream, preserved with blackberries	Groups of women or whole families, berries picked individually by hand, gathered (and stored) in birch baskets or pokes (sacks made from animal (includes birds and fish) skin or wooden containers (now replaced by plastic and glass).	Folded into "fluffy" fat to make Eskimo ice cream; preserved in a seal poke or barrel, (keep best if mixed with something else) mixed with blackberries/ raw whole sourdock leaves/ nagoonberries/ firm cloudberries/ seal oil/blueberries and stored in lined (grass then coltsfoot, sourdock or ruhbarb) pits (covered again with leaves, grass, and birch bark) or sigluaq (small house dug part or all into the ground, covered with sod) for winter

Inuit (Anderson, 1939)	Northern Bering Sea and Arctic Regions of Alaska	*Akpik, epik*	"most widely distributed of Rosaceae berries"	Eaten fresh or preserved		Preserved in oil
Inuit (Shishmaref school, 1957)	Shishmaref, Alaska	*Ah-pick*	-----	-----	Gathered in dippers or pots, put into amouk (bag made of seal skin), then fill a seal poke, tie with string	Stored in a pit, 18 inches deep, with a little willow in it, "put in as many pokes as it will hold"
Inuit (Heller, 1976)	Barter Island, Shishmaref, Kotzebue, Noorvik, Nome, Lower Kuskokwim	*Akpik, Ahtchaigpiat*	"highly prized"	Eaten raw, with seal oil and sugar and preserved	Gathered in late August, early September, in seal poke, keg or barrel.	Large quantities stored by burying seal poke, keg or barrel in frozen tundra or in ice cellars – kept frozen until ready to use
Gwich'in (Andre and Fehr, 2001)	Inuvik, NWT	*naskal* Yellowberry	A favourite in the area	Eaten fresh, saved for special occasion or given as gift	---	Stored in birch bark baskets under the moss, where permafrost kept them from spoiling and in winter, from freezing too hard
Gwich'in (Holloway and Alexander, 1990)	Fort Yukon, Alaska		Limited use		Infrequently harvested	Processed into jam and jelly

Napaskiak Inuit (Oswalt, 1957)	Napaskiak, Alaska SW Alaska	*at'sut*	The berry most important to this group		Gathered by families, go by boat to open tundra country behind village, for 3 days	Stored in wooden barrels (?) over winter (in ice cellar)
Dena'ina (Kari, 1987)	Northern Athabaska	*nqutl'*	Highly favoured for its juicy fruit and gathered in quantity when available	Eaten fresh or preserved	Women in charge of gathering and processing all plant materials, in birch bark or wooden containers	Traditionally preserved in oil or lard (or will spoil). Presently commonly eaten raw or made into jam or "Indian ice cream". Traditionally stored in caches: platform cache, underground frame cache and pit cache
Alutiiq (Russell, 1991)	English Bay- Port Graham Alaska		Not plentiful but "relished"	Eaten raw, in Alutiiq ice cream, with seal oil, and preserved; shared given as gifts, occasionally traded	Women and children main gatherers (but sometimes berry gathering a family event), cleaned by hand, gathered in spruce bark containers, now in plastic containers, mid-July to mid-August	Traditionally eaten with seal oil and sugar, mixed with Alutiiq ice cream; preserved in seal oil, dried, preserved in water; stored in pit cache (in wooden kegs and seal stomachs, pit lined with spruce bark and grass) or platform cache (contained dried berries held in round spruce bark containers); recently, preserved by freezing, making into jams and jellies
Labrador Inuit (Hawkes, 1916)	Labrador		"chief" among the berries			
Montagnais (Clément, 1990)	Labrador	*Shakuteumin-ânakashî*	Gathered in great quantities			

Inuit (Young and Hall, 1969)	St. Lawrence Island	*Ahkahavazik*	Not available in large quantities, but relished when found	"some older Inuit claim that there is a good crop only once every 4 yrs"	Gathered by women and young girls	"say when the berries are exceptionally abundant, called yewewmattomililinggook,meaning "man with no clothes on"; b/c the berries colour the tundra flesh coloured"
Haida (Turner, 2004; 1995)		*k'aaxu ts^{1}alaangGa*, (Skidegate dialect), *k'a.àw ts^{1}alaangaa* (Massett dialect); *k'aawts^{1}aláang aa* (Alaska dialect); cloudberry, mars apples, maltberry	Eaten in large quantities, extremely popular			Stored in water or grease in tall boxes, barrels; now become rare since deer and cattle introduced on Haida Gwaii
Tsimshian (Turner and Thompson)	Hartley Bay	Golk	It is good luck to see them at Hartley Bay, up in the back where the lake is	ate them fresh, or made into jam called 'jam kolk'		

Chapter 3 Reproductive Ecology of *Rubus chamaemorus*

3.1 Introduction

Plants inhabiting northern climates encounter unpredictable weather conditions that pose challenges to successful growth and reproduction. Factors such as the short growing season, low temperatures and low nutrient availability all contribute to limiting reproduction (Groenendall, 1990). Many species persist through mechanisms, such as asexual reproduction, that can be more reliable than reproduction from seed in cold climates (Groenendall, 1990; Klimes et al., 1997). Habitat type will also have a large influence on reproductive success. Bog habitats, for example, subject plants to extreme abiotic conditions that include fluctuating water tables, low pH, low nutrient availability, and anoxic soil conditions (Haslam, 2003; Mitsch and Gosselink, 1993). Plants have adapted to this kind of environment through measures such as lower production, extensive root systems, asexual reproduction and long lifespans (Backeus, 1985; Mitsch and Gosselink, 1993).

Although asexual reproduction may be a more reliable form of reproduction in northern peatland environments, sexual reproduction is necessary to maintain genetic diversity of populations and to enable a species to colonise new areas by seeds. If single clones occupy large areas, reliance on asexual reproduction may limit sexual reproduction, by reducing seedling establishment opportunities and lowering the likelihood of successful cross-pollination (Lovett Doust and Lovett Doust, 1988a). Because weather and pollen quantity or quality are unpredictable in northern areas, plants may often produce an excess of flowers, to best take advantage of years when these conditions are favourable (Lovett Doust and Lovett Doust, 1988a; Wilson, 1983).

Dioecious plants are more influenced by highly variable pollen quantity and quality than species capable of self-fertilization. Although dioecy promotes genetic variability of offspring, successful reproduction requires that pollen be transferred between male and female flowers. The relative number of males and females in an area may influence how many pollinators are attracted because one of the main pollinator rewards, pollen, is only produced by males. In addition, the distance between male and female flowers influences how efficiently pollen is transferred.

Bakeapple (*Rubus chamaemorus*) is a dioecious species with a boreal circumpolar distribution (Figures 1.1-1.3). It is typically found in bogs and relies mainly on clonal growth for reproduction (Korpelainen, 1994). As described in the previous chapter, bakeapple has been a popular food source for many northern people in North America, and in parts of the Old World such as Scandinavia. Bakeapple populations show high variability in fruit production between habitats and from year to year (Makinen and Oikarinen, 1974). The importance of bakeapple as a food source necessitates that the factors that promote or decrease the high variability of fruit production in wild populations be understood. Also, study of this species can help elucidate the reproductive patterns of plants inhabiting extreme climates and with life history traits of clonal growth and dioecy. There has been considerable research on bakeapple populations in Scandinavia to assess potential for increasing natural yields and cultivating this species; however, there has been little focus on bakeapple populations in Canada. More study is required to compare bakeapple populations in the Old World to those in North America.

Sexual reproduction in *R. chamaemorus* is uncommon compared to asexual reproduction via underground rhizomes (Makinen and Oikarinen, 1974). Most bakeapple biomass (up to 94%) occurs in underground rhizomes and little is allocated to sexual reproduction (Dumas and Maillette, 1986). Seedlings are quite rare in natural populations because of highly variable fruit production (from year to year), low availability of seeds due to human consumption of the fruit, and a lack of suitable microsites for germination among the thick vegetation of bogs (Resvoll, 1929). *R. chamaemorus* seedlings from seeds sown onto bog with vegetation removed required seven years in the wild and four years in cultivation to attain sexual maturity after germination (Ostgard, 1964). Each genet (genetic individual or clone) may cover a large area (up to 9 m in length with lateral branches 1-8 m long) and can have many ramets (individual above-ground shoots). In this chapter I discuss bakeapple individuals at the level of the ramet.

A number of ecological factors affect the degree of successful sexual reproduction and fruiting in bakeapple. These include abiotic characteristics such as temperature, shelter, pH and soil moisture and biotic factors such as availability of pollinators and competition with neighbouring species. Factors specific to dioecious species, such as sex ratio and spatial segregation of male and female flowers, could play a large role in determining the degree of successful fruit reproduction. For sexual reproduction at the level of fruit/seed production, male reproductive success is dependent on successful pollen distribution whereas female reproductive success is limited by the abundance of resources to complete fruit and seed maturation (Agren, 1988a). All these factors could influence the levels of reproduction in bakeapple populations such as flowering (percentage of ramets) or fruit set (fruit:flower ratio).

Temperature

Sexual reproductive structures of *R. chamaemorus* are extremely sensitive to frost, which can be the most important factor inhibiting flowering and fruit development for this species (Agren, 1988a). While the winter buds are very cold tolerant, temperatures that fall below – 4 °C for males and – 2 °C for females during flower and fruit development can be lethal to flowers for bakeapple populations in Karelia, Russia (Yudina, 1993). Frost can injure flower buds, flowers, ovaries and green berries (Yudina, 1993). Temperature will also have an effect on the activity of pollinators. In one study the temperature threshold for bakeapple flower visitors in a study in Forest Lapland was +15 C (Hippa et al., 1981). Microhabitat temperature can be highly influenced by level of shelter from other plants, as described in the following section.

Shelter

Shelter for bakeapple populations can be provided either by interspersed trees, such as black spruce (*Picea mariana*) swamps and dwarf shrub pine bogs (e.g *Rhododendron tomentosum* (*Ledum palustre*), *Calluna vulgaris, Empetrum nigrum* and *Pinus sylvestris*), or by forest margins. The effects of shelter can be complex depending on the nature of the shelter and local environment. Sheltered habitats provide a more stable microhabitat for understory bakeapple populations, serving as protection from wind and frost, and can sometimes be critical to successful fruit production (Makinen and Oikarinen, 1974).

The shelter helps buffer against large temperature fluctuations at the soil surface, which decreases the occurrence of frost in studies in Scandinavia and Russia (Agren, 1988a; Lohi, 1974). In addition, *R. chamaemorus* plants flower later in sheltered habitats than in open areas due to the cooler microclimate, which decreases the probability of plants being exposed to late frosts during their vulnerable stages (Yudina, 1993). Shelter also provides a good microclimate for insect pollinators (Makinen and Oikarinen, 1974). *R. chamaemorus* populations growing in sheltered habitats have been shown to have greater vegetative growth and more successful fruiting (more often and in greater numbers) (Lohi, 1974; Yudina, 1993). Additionally, the water economy is often better in sheltered habitats than open *Sphagnum* bogs due to decreased evaporation, which would be important during hot and dry summers (Lohi, 1974).

Water and pH

Rubus chamaemorus is mostly found on hummocks, which are located farther from the water table than hollows, and thus would be more affected than typical "hollow" species by fluctuations in the water table. Ideal hydrological conditions for *R. chamaemorus* seem to be moderately wet because populations tend to aggregate on well-drained hummocks within bogs, but Lohi (1974) states that drought can be a cause of fruit failure in this species during hot dry summers. High atmospheric humidity allows bakeapple to colonise environments with drier substrates, such as sandy coastal areas (Savory, 1981). Soil moisture has a strong effect on the pH, which is very important given the typically acidic conditions in peat bogs. Saebø (1970) found that decreased peat moisture (measured as g of dry matter per g of fresh peat) was correlated with a decreased pH, which is supported by the lower pH found on better drained hummocks compared to hollows in raised bogs. Lohi (1974) reports that the preferred pH for bakeapple is between 3.5 and 4.5 but this pH may reflect avoidance of competition rather than a physiological optimum. One micropropagation study on root tips of *R. chamaemorus* tested different pH levels of the media (between 3.5-5.6) and found 4.0 to be most effective for growth (Thiem, 2000).

Soil depth

Rubus chamaemorus is considered a deep-rooted plant relative to other bog plants and is often found growing on hummocks, which have a deeper soil layer over the water table (Nordbakken, 1996; Taylor, 1971). The maximum observed depth of bakeapple rhizomes is ~30 cm (Taylor, 1971). A study comparing underground dry mass of three bog species found that the underground biomass of *E. nigrum* and *Andromeda polifolia* was concentrated in the upper 0-15cm whereas *R. chamaemorus* had rhizomes, coarse roots (>0.5mm) and fine roots evenly distributed between 0 and 25 cm depth (Wallen, 1986). Resvoll (1929) states that this ability for underground growth to depths greater than competing species provides an advantage for bakeapple populations. Thus, decreased peat depths could potentially limit growth in bakeapples, especially in areas with high abundances of competing species, which could be manifested by lower above ground ramet densities.

Competition

Existing work (Savory, 1981; Makinen and Oikenaren, 1974) suggests that competition may be the most important factor determining the distribution and abundance of bakeapple populations. Savory (1981) suggested that bakeapple populations are found in bog habitats because these habitats have low competitive pressure and that environmental factors, such as moisture content, pH, and available nutrients only act indirectly on bakeapple populations by discouraging growth of competing species.

Competing species could negatively impact bakeapple populations through depletion of resources (e.g. nutrients, light) or interference in pollination. Growth of *R. chamaemorus* in a greenhouse study was considerably enhanced when all competing species (e.g., *E. nigrum*, *V. angustifolium* and several grasses) were removed (Savory, 1981). Ericaceous species, in particular, that are common on acidic soils, may limit pollination by "stealing" potential pollinators from bakeapples (Savory, 1981). They could also interfere with pollination if their pollen germinated on bakeapple pistils. Savory (1981) found germinating pollen of *Vaccinium* species on bakeapple stigmas, although it is difficult to determine if there was significant affect on fruit or seed set since these were not measured. Conversely, shrubs could have positive effects on bakeapple ramets, by facilitating attraction of pollinators in areas where there are low numbers of bakeapple flowers. It has not been established how specific associations between bakeapple and other bog species relate to bakeapple fruiting success. Associations between species could also be an indirect indicator of habitat variation and could merely reflect similar affinities for certain conditions, for example, well drained hummocks (vs. hollows).

Pollination

The necessity for out-cross pollination in dioecious species can contribute to pollen limitation of sexual reproduction. The effect of pollen limitation on successful fruiting in bakeapple is variable from year to year and among habitats (Agren, 1988b). Insufficient pollen transfer can be due to a skewed sex ratio, changes in composition and abundance of pollinators from year to year, within-season changes in pollinator abundance, or timing differences between either male and female flower maturity and/or flower maturity and pollinator abundance (Agren, 1988b; Lohi, 1974).

Sex ratio

The ratio of male to female plants within a population can affect the degree of successful sexual reproduction. One life history trait that has a large influence on local sex ratio is clonal growth. The reliance on this form of growth could produce a small number of large clones , predominantly of one gender, within a population, resulting in skewed sex ratios in patches and potential reductions in berry production (Korpelainen, 1994).

Makinen and Oikarinen (1974) estimated that a bakeapple population needs at least 10% males to provide adequate pollen for fertilization of the female plants. However, since they are the exclusive producers of nectar, a higher proportion of males may be required to attract pollinators. Male plants might be better competitors because their leaves appear to be more frost-resistant than those of female plants and because they have no further investment in sexual reproduction after flowering (Korpelainen, 1994; Makinen and Oikarinen, 1974). In a study in northern Sweden, the greater susceptibility to stressful conditions and the greater overall reproductive effort by female plants was shown to lead to higher mortality among female ramets (Agren, 1988b). As a result, wild bakeapple populations are often male biased, and the factor limiting fruit production is often an inadequate availability of female flowers relative to the abundance of pollen (Dumas and Maillette, 1986). The sex ratio can affect the relative importance of other factors to reproduction; Agren et al. (1986) found that pollen availability limited reproduction in female dominated bakeapple populations but it was not a limiting factor in populations with an equal sex ratio.

In addition to sex ratio, the spatial distribution of males and females within an area can also have an effect on fruit production (Agren, 1988a). Assuming that the foraging behaviour of the pollinator would be to move to nearby flowers, the farther away a female flower is from the nearest potential pollen donor (male flower), the lower the chance of successful pollination. However, this depends on the distribution of male and female plants in the area, the behaviour of the insect, and the synchrony of blooming within and among clones.

Flowering and fruiting

The production of flowers and fruits relative to a given density of *R. chamaemorus* ramets is highly variable. The ratios of flowers to ramets, fruits to flowers (fruit set) and fertilised ovules to total ovules (i.e., seed set, calculated only for flowers yielding fruit) within a population can provide an indication of which factors may be limiting fruit production. A low flower : ramet ratio could be due to high fruiting the prior year because Agren (1988b) found that female plants producing fruit have a decreased probability of producing flowers the following year. As a consequence of higher female reproductive effort, male ramets often have a higher frequency of flowering than female ramets (Agren, 1988b). However, female clones may produce more flowers than can yield fruit as a "bet-hedging" strategy, which would influence the flower : ramet ratio and other ratios (Agren, 1988b). This strategy may allow populations from frost prone habitats to take advantage of years when weather is favourable and allow populations in frost-sheltered populations to "selectively abort inferior offspring" or guard against variable effects of herbivory (Agren, 1988b). This strategy can result in low fruit set (Agren, 1988b). Seed set is determined in part by the efficiency of pollen flow and therefore by factors such as pollinator abundance, sex ratio and distance between males and females.

In my study of the reproductive ecology of *R. chamaemorus* in southeastern Labrador, my objectives were to determine how the various stages in bakeapple fruit production were related to the following factors: 1. Environmental conditions such as peat depth, shelter, temperature, soil moisture and soil pH; 2. Species composition; and 3. Sex ratio and distance to nearest potential fertilising partner. The stages of bakeapple fruit production examined were ramet density, flowers : ramet ratio, fruit set, and seed set.

3.2 Methods

The study area was located in St. Michael's Bay, east of Charlottetown, in southeastern Labrador (52°45' N, 56°00' W) (Figure 1.4). This area is characterised by extensive black spruce (*Picea mariana*) forests and peatlands (Glaser and Foster, 1983). Twenty-one sites were selected in the St. Michael's Bay area (Table 3.1), of which 18 were located on islands and three were on the mainland (Figure 3.2). These sites were identified by a local resident (73 years old) as areas where community members have harvested bakeapples; he provided rides to study areas over the course of the summer. Of these sites, I selected five for intensive study ("Intensive sites") based on general community knowledge of the islands and proximity to Charlottetown and Square Islands to study environmental and reproductive factors in depth. An extensive study ("Extensive sites") was carried out to ensure that the sites for the intensive study were representative of the area, in terms of environmental and bakeapple population characteristics.

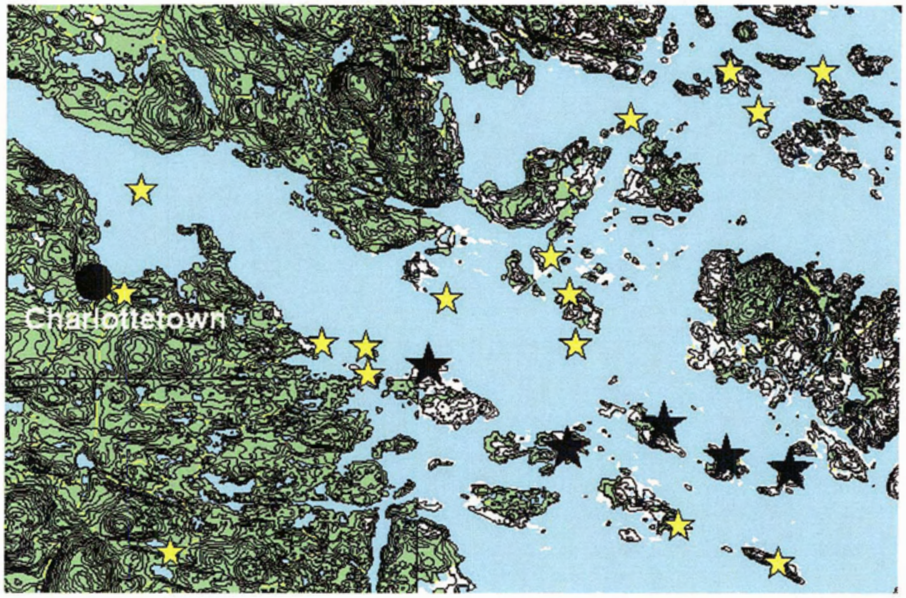


Figure 3.1 Map of site area: black circle indicates Charlottetown, yellow stars show Extensive sites, and black stars show Intensive sites.

Table 3.1 Location and site characteristics of sites chosen for study of reproductive ecology of *R. chamaemorus*; length and width were measured in the specified site area, often determined by surrounded shelter.

Site	Ordination Site Code	Latitude	Longitude	Elevation (m)	Length (m)	Width (m)
1	GOOS	52.79402	-56.1056	9	150	50
2	BURN	52.72999	-55.8601	23	146	50
3	CAPJK	52.75087	-56.0192	8	114	34
4	CRLW	52.73541	-55.9521	12	377	336
5	NRWS	52.74066	-55.9058	6	292	48
6	JNPR	52.75444	-55.9963	10	111	42
7	WLCV	52.75859	-56.0352	9	47	19
8	YELFX	52.71559	-55.8989	10	112	56
9	PNARM	52.70816	-56.0948	28	63	67
10	SCHNR	52.81999	-55.8487	5	157	56
11	SEAL	52.82001	-55.8838	15	253	72
12	WLPND	52.76833	-56.1129	30	43	36
13	MLMN	52.81093	-55.9203	11	65	47
14	WHTFX	52.76841	-55.944	9	113	52
15	WHTFSH	52.73296	-55.8823	14	81	43
16	LONG	52.7067	-55.8602	15	150	90
17	BKPL	52.81249	-55.8726	10	95	35
18	CRSFX	52.77888	-55.9489	12	118	116
19	LITJPR	52.75799	-56.0207	7	104	44
20	FLTNS	52.76914	-55.9905	8	122	64
21	GULL	52.75768	-55.9405	12	80	90

The five Intensive study sites were BN (Site 2 in Table 3.1), NW (Site 5), CW (Site 4), JP (Site 6) and CJ (Site 3). Site BN was located farthest from the coast, and proximate to fishing Community A (mentioned in Chapter 2). It is the best known island in St. Michael's Bay for bakeapple fruit production and some interviewees said it "never fails" to produce fruit. Site NW was completely exposed to the ocean, without any land or vegetation in between, and was the rockiest and driest of the sites. Site CJ was on the mainland, also proximate to the ocean, and was the closest site to Charlottetown (approximately 10 km). This site had been burned about six years ago due to lightning and had exposed soil in some areas.

Sampling Methods

At each Extensive site I laid out four 10 m transects. Along each transect I laid out five 1-m^2 sample quadrats, spaced 1 m apart, for a total of 20 quadrats per site. Transects were located to be as evenly spread out over the site as possible while also representing the apparent range of variation in the area (e.g., moisture, shelter, species composition). There was a minimum of 10 *R. chamaemorus* ramets per quadrat.

For the Intensive sites, five 10 m transects were set up permanently, each having 10 contiguous 1-m^2 quadrats, for a total of 50 quadrats per site. Transect locations were selected based on the same criteria as outlined for the Extensive sites. I put one transect in tall (greater than or equal to 15cm) vegetation, one transect in an area devoid of any shelter, and two transects that would each represent both forested and open areas for each site; the fifth transect was placed in an area that best represented the environmental variation (i.e., in terms of shelter, species composition and microtopography) of the local area.

For Extensive sites, I counted the total number of ramets and flowers in each quadrat between June 23 2004 and July 14 2004 during the flowering period. Peat depth was measured at a single point in each quadrat, near a bakeapple plant within the quadrat, to a maximum of 1 m. I made six estimates of shelter in each quadrat (defining shelter as any vegetation over 15 cm in height). The estimates included: highest shelter within the quadrat, average shelter height in the quadrat, shelter density (percentage of plot covered with plants >15 cm tall), proportion of the edge of the quadrat that comes into contact with vegetation at 45 degrees (%), distance to and height of the nearest shelter outside the plot.

I also recorded percentage cover of each plant species within each quadrat. Moss species were only identified to the genus level. Ryan (1978) and Meades and Brouillet (2000) were used to help identify plant species. For plants that could not be identified, voucher specimens were collected and were keyed out by Dr. Peter Scott at MUN. These specimens were deposited at the University of Victoria Herbarium.

For Intensive sites, I counted the number of ramets, male flowers, female flowers and fruits within each quadrat to obtain density. I randomly selected one female flower within each quadrat and measured the distance to the nearest male flower (potential fertilising partner), to a maximum of 900 cm. I randomly selected five unripe fruits, which were then weighed and the number of developed and undeveloped ovules counted. I measured peat depth, shelter variables, and species composition and abundance (%) within each quadrat, as outlined for extensive sites. I placed Ibuttons (Dallas Semiconductor Corp., Texas), temperature sensitive dataloggers, in all 50 quadrats of two Intensive sites. Ibuttons were placed in Ziploc bags and placed on the surface of the peat, near bakeapple ramets, and affixed with paper clips to the peat. They were set to record the temperature every hour from June 17th until August 22nd. I collected soil/peat samples from all intensive sites in July, within the same day. I took four samples, one from each quarter of a quadrat, at 10 cm depth. These were then mixed by hand, weighed and frozen for later drying.

Lab Methods

In the laboratory, the frozen soil/peat samples were dried at 70 degrees for 48 hours, and weighed promptly after removal from the drying oven. Soil moisture was calculated as dry weight/wet weight*100. The dried soil/peat samples were tested for pH using an Acumen digital pH 520 meter (Fisher Scientific). Equal volumes of soil/peat and distilled water were combined. The mixture was stirred periodically for a half hour, left to sit for another half hour and then measured for pH.

3.2.1 Data Analysis

Intensive sites were included in the analysis of extensive data. To give equivalent data from all sites, from each Intensive site one transect was randomly omitted and only odd numbered quadrats of each transect were included. For all peat depth measurements in all sites, values were converted to a scale of 1-6 (1 = 0-20 cm; 2 = 20-40 cm; 3 = 40-60 cm; 4 = 60-80 cm; 5 = 80-100 cm, 6 = >100 cm) to properly represent values exceeding 1 m. Three measurements were selected as the best estimates of shelter: density of shelter, average height of shelter, and proportion of shelter at 45 degrees. These three variables were converted to scales of 0-2 (0 = 0; 1 = 1-(26% density/ 31 cm height/ 36% at 45 degrees); 2 = >(26/31/36)), and then added together to form a shelter index (0-6); this index was created to adjust for the subjectivity of the measured variables.

I calculated fruit set in each quadrat as: # fruits/# female flowers per plot, and seed set as: # developed ovules/total # of ovules. The sex ratio value used in correlations is expressed as the proportion of female flowers (# female flowers/ # female flowers + # of male flowers) in each quadrat. Proportions expressed in summary tables for the sites are calculated as the proportion of female, male and nonflowering ramets out of the total number of ramets. The average weight per druplet was calculated as average berry weight/ average # fertilised carpels. Percentage cover of *R. chamaemorus* was not measured for the extensive sites, so these values were estimated using the regression equation from intensive data (ramet cover vs ramet density) to use in analysis of species composition. For the intensive sites, an Index of Cover per Ramet was calculated as: total ramet cover/ total ramet density within a quadrat.

The Ibuttons used in the intensive sites were removed and the data was downloaded. The data from the transect located in tall vegetation and the transect devoid of any shelter within each site were selected for analysis to study the relationships between shelter and temperature. Values for quadrats within each transect were averaged and time intervals of three hours were averaged to produce one value per transect every three hours. These values were plotted against time to determine any differences between sites and between sheltered and open quadrats.

Because many variables did not exhibit normal distributions, Spearman Rank correlations were performed on all variables in both extensive and intensive quadrats (Systat Version 9, 1998). An r-value of 0.400 was considered the cut-off value for significance, since 0.401 is the critical value in Spearman Rank Analysis for a significance level (α (2)) of 0.005, n = 48, vs. n = 50 for intensive sites. Extensive data were analysed with quadrats averaged within each transect (i.e., four means per site). For the Intensive data, each site was analysed separately, at the quadrat level. Reproductive variables with significant or notable patterns with sex ratio or distance to nearest male flower were further analysed using ANOVA. For sex ratio date, quadrats were separated into sex ratios (female proportions) of <50% and >50% to look at differences female dominated and non-female dominated quadrats. For the distance to nearest male flower, data was separated into distances between 1-10cm and >10cm. This was to look at affects of increased distance and achieve as equal sample sizes in each data set as possible.

Species cover values were converted to a modified Braun-Blanquet scale (Causton, 1988) and non-metric multidimensional scaling was performed on both intensive and extensive data (PC-ORD Version 4.25, 1999). Non-metric multidimensional scaling was chosen as the ordination method because this method is well suited for non-normal data sets, since it does not assume linear relationships between the variables. For both data sets, species with low frequency (presence in two plots or less) were omitted from the analysis. For the extensive data, quadrats were first averaged for each transect and then each transect was averaged within each site (i.e., one mean per site). For intensive data, analysis was carried out at the quadrat level, on each site separately. Ordinations were performed on habitat (environmental) data, plant reproductive variables, and the species cover data, using the Sorensen distance measure. Analysis was first run to determine the number of dimensions that would yield the least stress. Analysis was carried out with 400 maximum iterations, 40 runs with real data, 999 runs with randomized data and a stability criterion of 0.000010. Either the second or third dimension for each data set was selected because further dimensions only provided minimal reductions in stress. Each data set was reanalysed using these new dimensions. Final stress values ranged from 13 to 22 and final instability ranged from 0.00012 to 0.03488. Axes from the plot ordination were then used in correlations to determine relationships with other variables. Any variables with significant correlations with species axes were then plotted as vectors on ordination graphs. For sites with 3 dimensions, only two of the three possible graphs are included and the axes with the greatest correlations with other variables were selected.

3.3 Results

In total 39 species occurred in quadrats with *Rubus chamaemorus* in the Extensive sites. The most common species in the quadrats were *Empetrum nigrum* (occurring in 93% of quadrats), *Rhododendron (Ledum) groenlandicum* (88%), *Sphagnum* species (77%), *Cladonia* species (64.8%), *Vaccinium angustifolium* (72%), *Vaccinium oxycoccus* (68%), and *Drosera rotundifolia* (67%) (Table 3.2). Among the Intensive sites, Site JP had the highest means and Site NW had the lowest means for shelter, moisture and peat depth (Table 3.3.2).

The mean for ramet density of bakeapple in the Extensive sites was larger than for any of the Intensive sites, whereas flower:ramet ratios were similar (Table 3.3.1, 3.3.2). Site CJ had the highest mean for ramet density, which was most similar to the average density for the Extensive sites. Site CJ and Site NW both had low Cover per Ramet Index and flower:ramet ratio compared to the other sites, but both had the largest mean druplet weights. The proportion of non-flowering ramets was high in all sites, ranging from 63%-81%. Site JP, the only island with a higher proportion of female than male floral ramets, had the lowest means for fruit set and seed set. Site NW had the highest mean for fruit set and seed set. Site BN had the highest mean for total ovules per plant while Site CJ had the lowest. Site BN showed the greatest mean distance between male and female ramets while Site NW had the lowest mean distance.

Table 3.2 Species found in quadrats with *Rubus chamaemorus* and frequency of occurrence, defined as percentage of quadrats (out of 420) in which this species was present. Species codes for Ordination graphs are listed, unless the species was too rare to be included in analysis. Nomenclature for scientific names follows Meades et al.(2000).

Species	Species code	% quadrats (n=420)	. Species	Species code	% quadrats (/420)
Sphagnum spp	SphagSpp	76.9	*Coptis trifolia*	-	1.4
Polytrichum spp	PolytrSp	75	*Trientalis borealis*	-	0.7
Lycopodium annotinum	-	3.1	*Cornus Canadensis*	-	1.7
Cladonia spp	CladonSp	64.8	*Linnaea borealis*	-	0.7
Picea mariana	PicMaria	18.1	*Gaultheria hispidula*	GaulthHi	2.9
Larix laricina	LarixLar	17.9	*Diapensia lapponica*	-	2.1
Empetrum nigrum	EmpNigru	92.6	*Sibbaldiopsis tridentate*	-	0.2
Rhododendron groenlandicum	LedumGro	88.3	*Arctous alpina*	-	0.2
Rhododendron tomentosum	LedumPal	10	*Equisetum* spp	EquisetS	8.1
Vaccinium angustifolium	VaccAngu	71.7	*Myrica gale*	MyricaGa	13.6
Vaccinium uliginosum	VaccUlig	22.1	*Geocaulon lividum*	GeocauL	9.5
Vaccinium oxycoccus	VaccOxyc	68.3	*Chamerion angustifolium*	-	0.7
Drosera rotundifolia	DroserRo	67.4	*Carex rariflora* /*Carex pallescens*	CarexRar	22.9
Vaccinium vitis-idaea	VaccVitI	52.6	*Carex bigelowii*	-	0.2
Chamaedaphne calyculata	ChaemCal	39.5	*Carex trisperma*	CarexTri	6.4
Kalmia polifolia	KalmiaPo	58.1	*Trichophorum cespitosum*	ScirpusC	5.0
Kalmia angustifolia	-	3.6	*Carex microglochin*	CarexMic	2.6
Andromeda glaucophylla	AndroGla	4.5	*Eriophorum vaginatum*	-	1.7
Maianthemum trifolium	SmilaTri	35.7	*Eriophorum angustifolium*	-	0.4

Table 3.3.1 Summary statistics for variables in Extensive sites (n = 420)

Variable	N	Min.	Max.	Mean	Standard Error	Standard Deviation
Peat depth (cm)	420	13	>100	65.88	1.35	27.65
Shelter: Tallest (cm)	420	0	98.0	15.27	0.899	18.42
Shelter: Average Height (cm)	420	0	80.0	12.38	0.706	14.47
Shelter: Proportion 45 degrees (%)	420	0	100	19.94	1.39	28.52
Shelter: Density (cm)	420	0	95.0	13.83	1.09	22.23
Shelter: Distance Nearest (cm)	405	1.00	1500	148.43	14.1	283.7
Shelter: Ht Nearest (cm)	405	7.00	245.0	33.0	1.65	33.24
Ramet density (/m^2)	420	6.00	630	157.0	4.78	97.91
Flower: ramet	420	0.00	0.819	0.259	0.007	0.149

Table 3.3.2 Summary statistics for variables in Intensive sites (i.e., Sites BN, CJ, CW, JP, NW; n = 250)

Variable	BN	CJ	CW	JP	NW
	Mean +/- Std Error	Mean +/- Std Error	Mean +/- Std Error	Mean +/- Std Error	Mean +/- Std Error
Peat depth (cm)	61.1 +/- 4.74	58.3 +/- 3.99	60.7 +/- 3.94	69.9 +/- 3.42	45.8 +/- 2.70
Shelter: Tallest (cm)	17.5 +/- 3.3	21.6 +/- 3.63	18.1 +/- 2.77	25.9 +/- 2.16	4.58 +/- 1.48
Shelter: Average Height (cm)	12.6 +/- 2.45	16.5 +/- 2.49	14.1 +/- 2.02	20.0 +/- 1.50	3.54 +/- 1.11
Shelter: Proportion 45 degrees (%)	25.5 +/- 5.07	16.1 +/- 2.90	37.6 +/- 4.49	25.8 +/- 3.60	10.2 +/- 3.48
Shelter: Density (cm)	22.5 +/- 4.25	9.52 +/- 1.50	12.5 +/- 2.65	28.1 +/- 3.82	5.04 +/- 1.88
Shelter: Distance Nearest (cm)	219.6 +/- 31.6	44.5 +/- 9.37	185.4 +/- 44.7	40.2 +/- 5.03	322.7 +/- 34.2
Shelter: Height Nearest (cm)	51.9 +/- 5.66	27.9 +/- 3.41	34.3 +/- 2.73	34.6 +/- 4.03	69.5 +/- 12.5
Soil moisture (%)	88.2 +/- 0.33	89.2 +/- 0.37	88.8 +/- 0.242	88.3 +/- 0.28	84.3 +/- 0.424
PH	3.92 +/- 0.02	3.91 +/- 0.02	3.97 +/- 0.020	3.98 +/- 0.022	4.11 +/- 0.02
Ramet density (number/m^2)	132.3 +/- 9.75	153.2 +/- 11.5	119.5 +/- 7.68	129.8 +/- 8.67	130.7 +/- 8.48
Cover per ramet index (%)	0.261 +/- 0.03	0.15 +/- 0.01	0.227 +/- 0.014	0.220 +/- 0.02	0.159 +/- 0.011
Flower:ramet	0.285 +/- 0.02	0.19 +/- 0.02	0.236 +/- 0.017	0.239 +/- 0.015	0.371 +/- 0.016
Fruit set (#fruits/#female flowers)	0.779 +/- 0.03	0.71 +/- 0.06	0.775 +/- 0.038	0.615 +/- 0.037	0.887 +/- 0.033
Seed set (#fertilised ovules/total ovules)	0.699 +/- 0.03	0.73 +/- 0.03	0.709 +/- 0.023	0.497 +/- 0.034	0.734 +/- 0.028
Weight of berry (g)	0.49 +/- 0.03	0.60 +/- 0.05	0.466 +/- 0.023	0.288 +/- 0.020	0.615 +/- 0.045
Averaged druplet weight (g)	0.041 +/- 0.002	0.07 +/- 0.005	0.047 +/-0.002	0.027 +/- 0.002	0.053 +/- 0.004
Total ovules per flower	12.3 +/- 0.46	8.96 +/- 0.37	9.80 +/- 0.198	10.59 +/- 0.237	11.7 +/- 0.366
Sex ratio (female flwrs /female + male flwrs)	0.463 +/- 0.048	0.291 +/- 0.042	0.406 +/- 0.029	0.687 +/- 0.047	0.256 +/- 0.044
Female proportion (/total ramets)	0.122 +/- 0.01	0.06 +/- 0.009	0.084 +/- 0.007	0.158 +/- 0.015	0.074 +/- 0.013
Male proportion (/total ramets)	0.162 +/- 0.02	0.13 +/- 0.02	0.145 +/- 0.014	0.094 +/- 0.018	0.296 +/- 0.023
Nonfloral proportion (/total ramets)	0.716 +/- 0.02	0.81 +/- 0.02	0.771 +/- 0.017	0.748 +/- 0.018	0.630 +/- 0.016
Distance to nearest male flower (cm)	102.32 +/- 30.4	20.47 +/- 3.22	0.723 +/- 0.066	61.9 +/- 11.2	0.912 +/- 0.065

3.3.1 Environmental factors and habitat of bakeapple

In the Extensive sites, there were no significant relationships between any environmental and dependent variables (Table 3.4.1). At the Intensive sites BN and CW, temperatures recorded daily on Ibuttons differ considerably from those recorded at a weather station in Mary's Harbour (this was the closest weather station from the study area; approx 95 km). Ibuttons estimate much higher temperatures during the day (Figure 3.2.1); only day Ibutton temperatures (from 7:00am to 3:00pm) were included since only day temperatures were reported for the weather station. There were no observable differences in temperature between sheltered and open transects for either site (Figure 3.2.2).

Table 3.4.1 Spearman Rank Correlations for variables at Extensive Sites; **$p < 0.005$ ($r > 0.400$)**. Axis 1 and 2 represent ordination axes from Non-metric multidimensional scaling analysis of quadrat species composition.

Variable	Peat depth scale	Shelter Index	Ramet Density	Flower: ramet	Axis 1	Axis 2
Peat scale	1.00					
Shelter Index	0.348	1.00				
Ramet Density	0.173	-0.164	1.00			
Flower:ramet	-0.059	-0.319	0.301	1.00		
Ordination Axis 1	-0.378	**-0.638**	-0.048	0.106	1.00	
Ordination Axis 2	0.356	**0.674**	-0.124	-0.376	**-0.472**	1.00

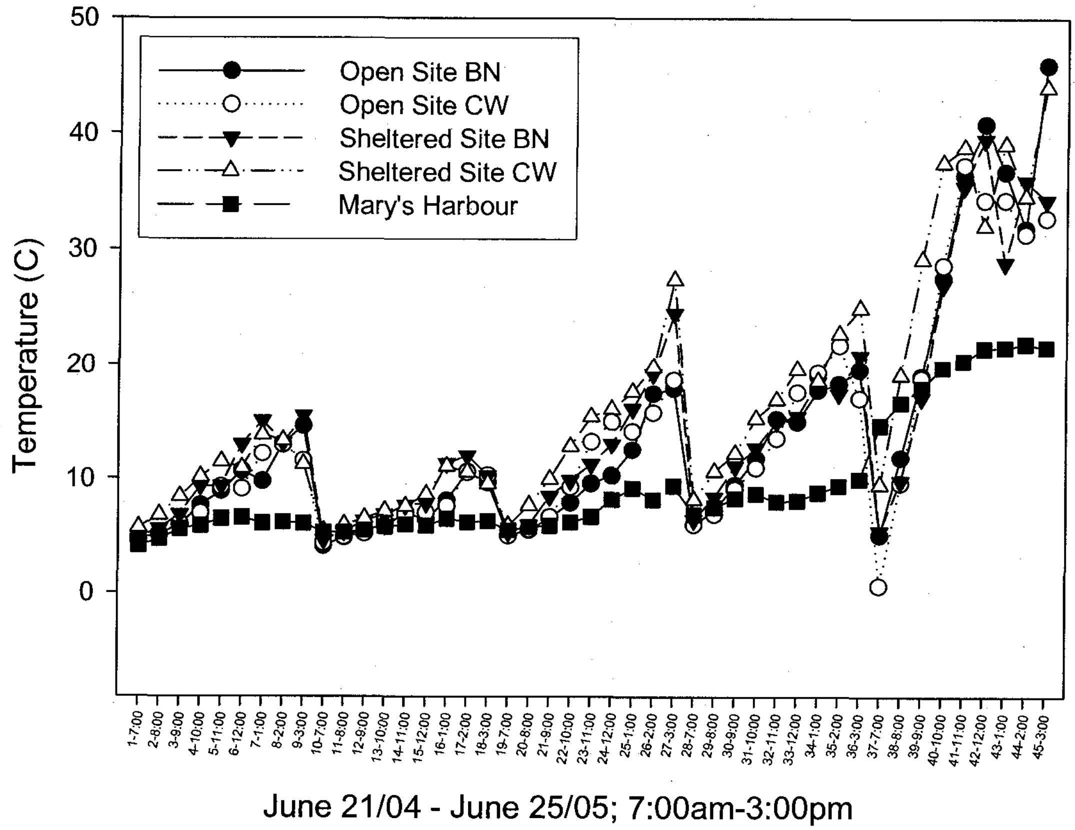


Figure 3.2.1 Ibutton temperature data for *R. chamaemorus* populations compared with temperatures from Mary's Harbour (National Climate and Information Archive) for 700am-300pm June 21-25, 2004.

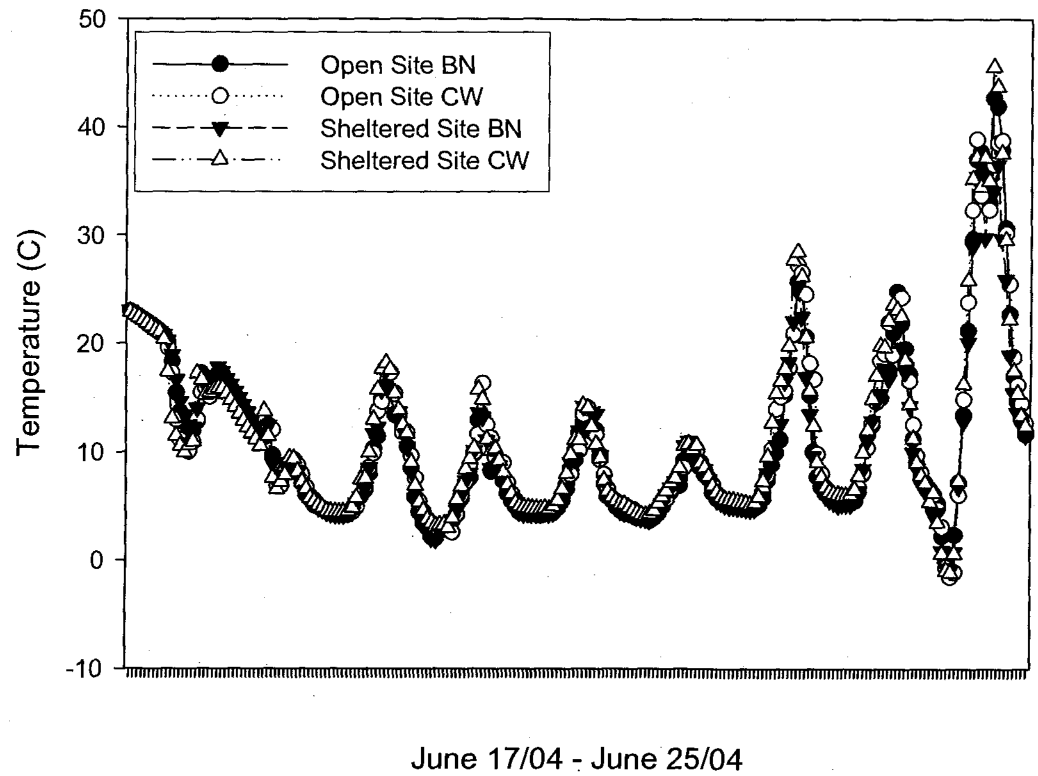


Figure 3.2.2 Ibutton temperature data for *R. chamaemorus* populations; ten quadrats averaged for each transect, hourly temperature averaged every 3 hours from June 17-July 7 2004.

Reproductive (dependent) variables showed significant correlations with environmental variables at all of the intensive sites, but the correlations differed among sites (Table 3.4.2). Cover per Ramet Index was positively correlated with Shelter Index for three sites and negatively correlated with soil moisture for one site. Ramet density was positively correlated with soil moisture for two sites and negatively correlated with Shelter Index for one site. Flower:ramet was correlated with Shelter Index, Peat Depth Scale, and pH for one site. Fruit set and soil moisture were positively correlated for one site, while average druplet weight and Shelter Index were negatively correlated for one site. Among environmental variables, there was a positive relationship between shelter index and pH for 1 site and between peat depth scale and both shelter index and soil moisture for one site (Appendix 3).

Table 3.4.2 Spearman Rank correlations for all five Intensive sites between environmental variables and dependent variables; **p < 0.005 (r > 0.400)**. Only correlations with significant relationships in at least one of the sites are listed. All correlations are presented in Appendix 2.

	BN	CJ	CW	JP	NW
Cover per Ramet Index					
Shelter Index	0.141	-0.007	**0.723**	**0.438**	**0.654**
Soil moisture	-0.145	**-0.660**	-0.341	-0.351	-0.287
Ramet density					
Shelter Index	**-0.424**	0.108	-0.286	-0.357	0.230
Soil moisture	-0.073	**0.562**	**0.417**	0.301	0.380
Flower:ramet					
Shelter Index	**0.534**	-0.069	-0.372	-0.277	-0.206
Peat depth scale	**0.400**	0.143	-0.077	-0.014	0.116
PH	**0.415**	0.182	0.373	-0.054	-0.183
Fruit set					
Soil moisture	**0.499**	-0.228	0.153	-0.076	0.071
Average druplet weight					
Shelter Index	0.249	0.233	-0.049	**-0.477**	-0.376

For quadrats at all Intensive sites combined, there was a significant relationship between Cover per Ramet Index and Shelter Index (r = 0.598; Figure 3.3; Appendix 3).

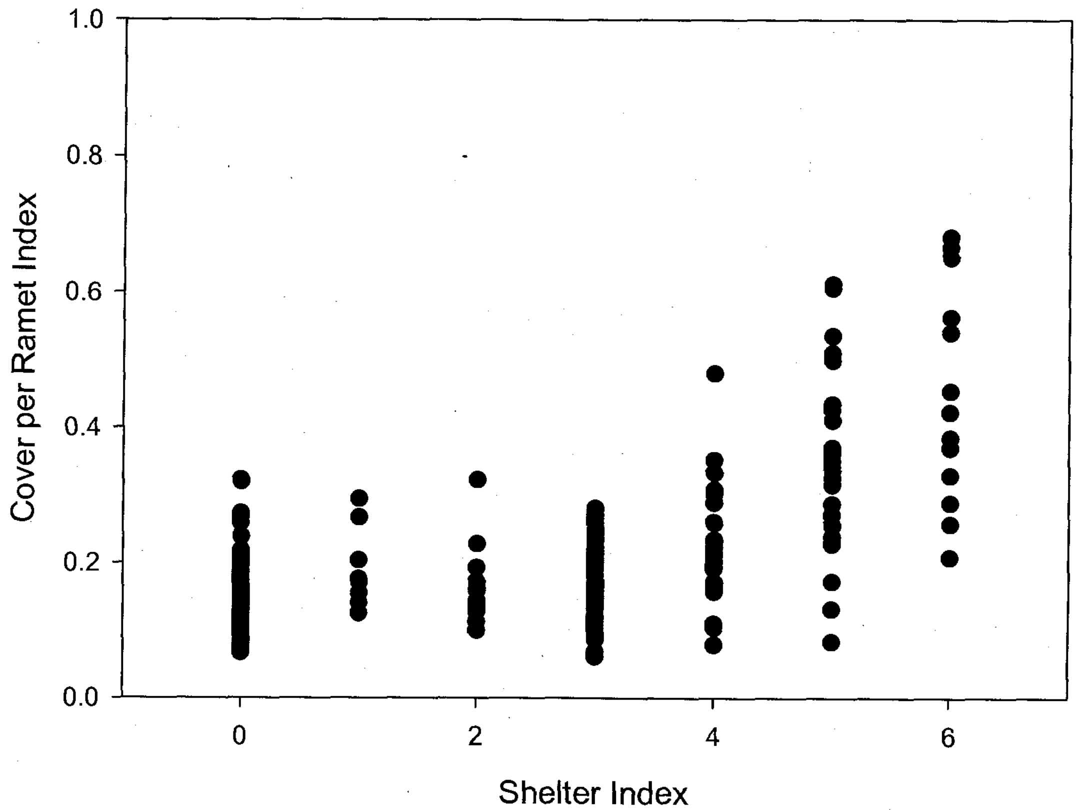
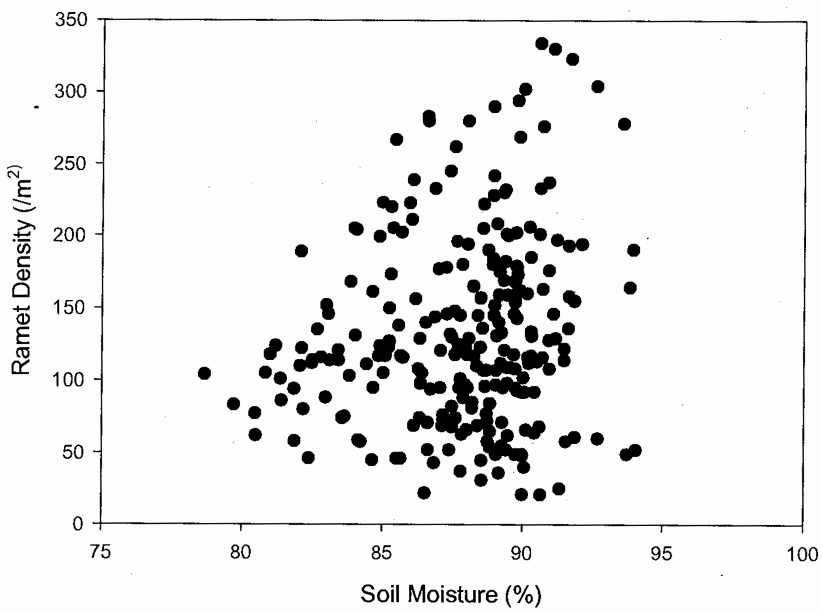


Figure 3.3 Bakeapple Cover per Ramet Index vs. Shelter Index (r = 0.598) in all Intensive quadrats (n = 250).

Soil moisture and ramet density were not significantly related for quadrats at intensive sites; however, there were no quadrats that had both low soil moisture and high ramet density (Figure 3.4a). There also were no significant relationships between flower:ramet ratio and soil moisture, but few quadrats had both low soil moisture and low flower:ramet ratio values (Figure 3.4b).

a)



b)

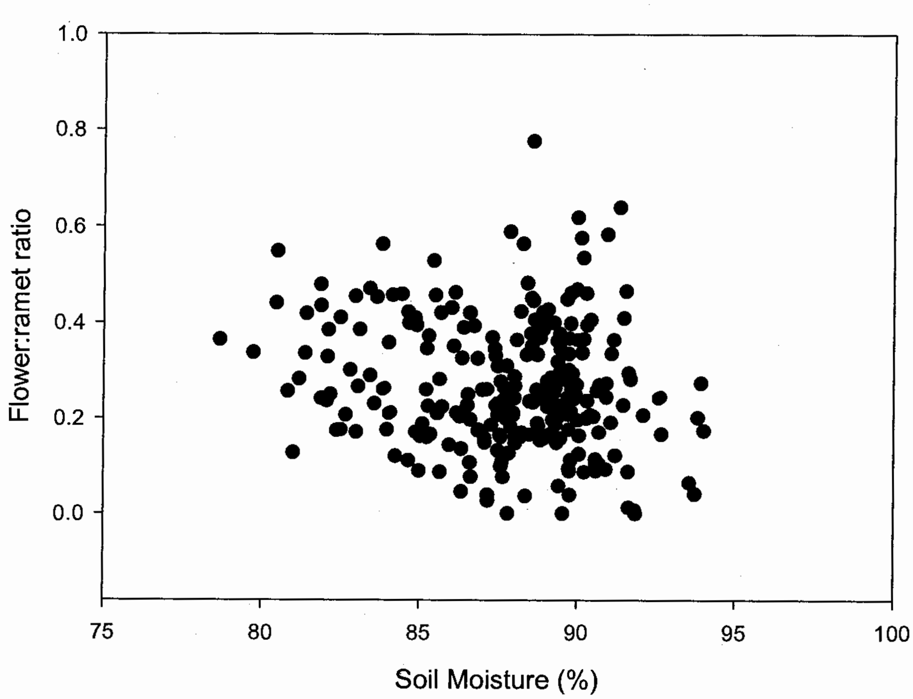


Figure 3.4 a) Bakeapple Ramet Density (not significant; $r = 0.181$) and b) Bakeapple Flower:ramet Ratio (not significant; $r = 0.036$) vs. Soil Moisture for all Intensive quadrats ($n = 250$).

3.3.2 Species Composition

For extensive sites, there were significant relationships between Shelter Index and both Axis 1 ($r = -0.638$) and Axis 2 ($r = 0.674$) of the ordination (Figure 3.51; Table 3.4.1). Axis were derived from species composition.

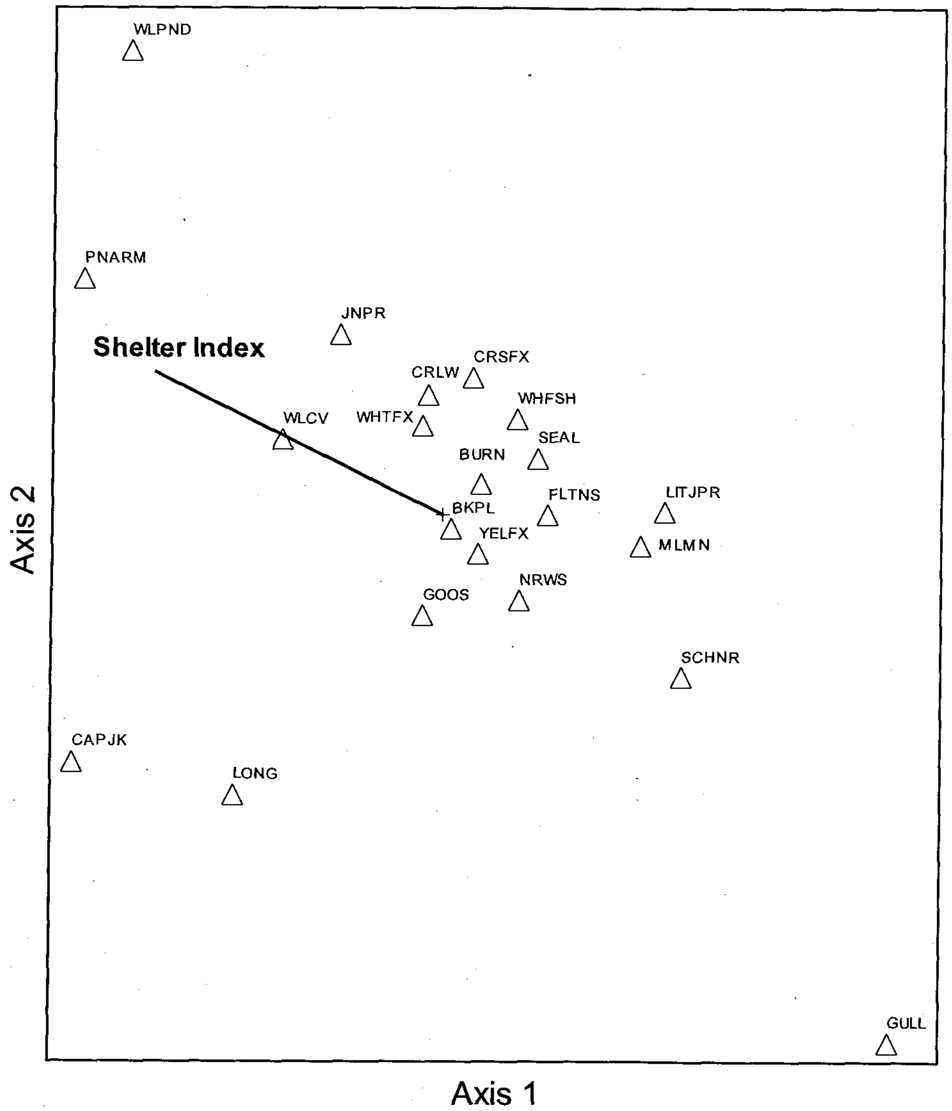


Figure 3.5.1 Non-metric multidimensional scaling ordination of 21 *Rubus chamaemorus* sites based on species composition. Site codes are indicated in Table 3.1. Two dimensions; final stress = 15.01491, final instability = 0.00012. Shelter was significantly correlated with ordination axes.

For Intensive sites, Axis 1 was correlated with Shelter Index for 4 sites, Peat Depth Scale for one site, pH for one site, ramet density for two sites, average druplet weight for two sites, Ramet Cover Index for one site, and seed set for one site (Figures 3.5.2-3.5.8; Table 3.4.3). Ordination Axis 2 was correlated with Shelter Index for three sites, Peat Depth Scale for three sites, soil moisture for one site, pH for one site, Cover per Ramet Index for two sites, ramet density for one site, flower:ramet for one site, seed set for one site, and Average Druplet Weight for one site. Ordination Axis 3 was correlated with Shelter Index, pH, and Cover per Ramet Index, each for one different site.

Table 3.4.3 Spearmans Rank Correlations for all five Intensive *Rubus chamaemorus* sites between ordination axes and both environmental and reproductive variables.

	BN	CJ	CW	JP	NW
Ordination axis 1					
Shelter Index	**-0.819**	**0.585**	0.007	**0.700**	**-0.781**
Peat depth scale	-0.267	-0.169	0.038	-0.112	**-0.413**
pH	**-0.507**	-0.298	0.323	0.398	0.383
Cover per Ramet Index	-0.064	-0.377	0.127	0.135	**-0.475**
Ramet density	0.361	**0.530**	**-0.514**	-0.031	0.008
Seed set	-0.288	0.031	-0.116	**0.453**	-0.019
Average druplet weight	-0.299	**0.440**	0.151	**-0.587**	0.151
Ordination axis 2					
Shelter Index	**0.819**	0.131	**0.800**	0.366	**0.564**
Peat depth scale	**0.495**	**-0.559**	-0.173	0.267	**0.406**
Soil moisture	0.238	-0.390	-0.110	**0.409**	0.061
pH	**0.437**	-0.019	0.074	0.139	-0.021
Cover per Ramet Index	0.243	0.221	**0.549**	0.004	**0.603**
Ramet density	-0.364	**-0.480**	-0.095	0.028	-0.210
Flower:ramet	**0.530**	0.155	-0.387	-0.105	-0.345
Seed set	0.343	-0.045	-0.169	0.002	**-0.409**
Average weight druplet	0.263	-0.303	0.053	-0.068	**-0.408**
Ordination axis 3					
Shelter Index	-	-	**-0.718**	-0.140	-0.366
PH	-	-	0.009	**-0.552**	0.247
Cover per Ramet Index	-	-	**-0.629**	-0.204	-0.059

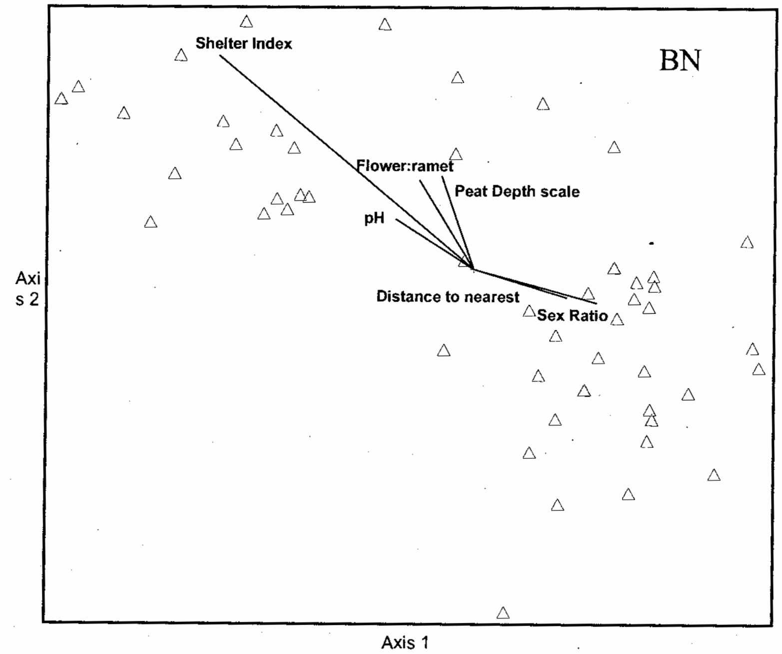


Figure 3.5.2 Non-metric multidimensional scaling ordination of 50 *Rubus chamaemorus* quadrats on Site BN based on species composition; Two dimensions, final stress = 15.01491, final instability = 0.00012. Environmental and reproductive variables significantly correlated to ordination axes were included.

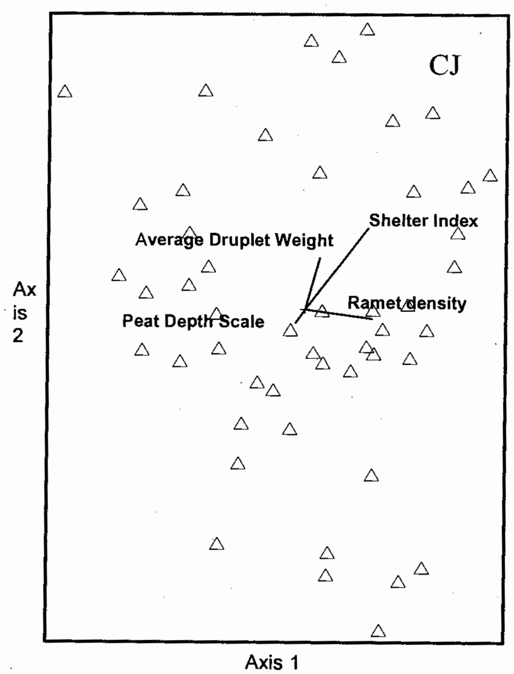


Figure 3.5.3 Non-metric multidimensional scaling ordination of 50 *Rubus chamaemorus* quadrats on Site CJ based on species composition; Two dimensions, final stress = 17.20449, final instability = 0.00797. Environmental and reproductive variables significantly correlated to ordination axes were included.

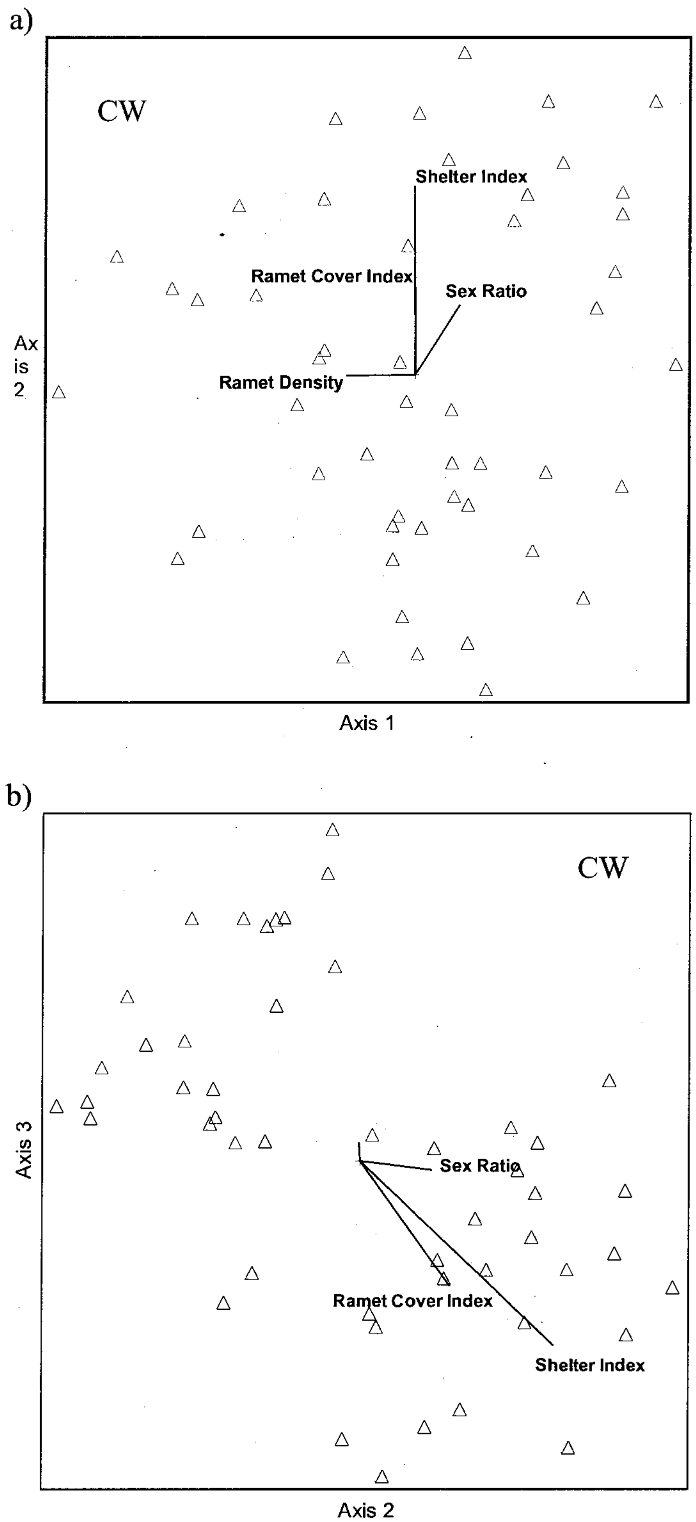
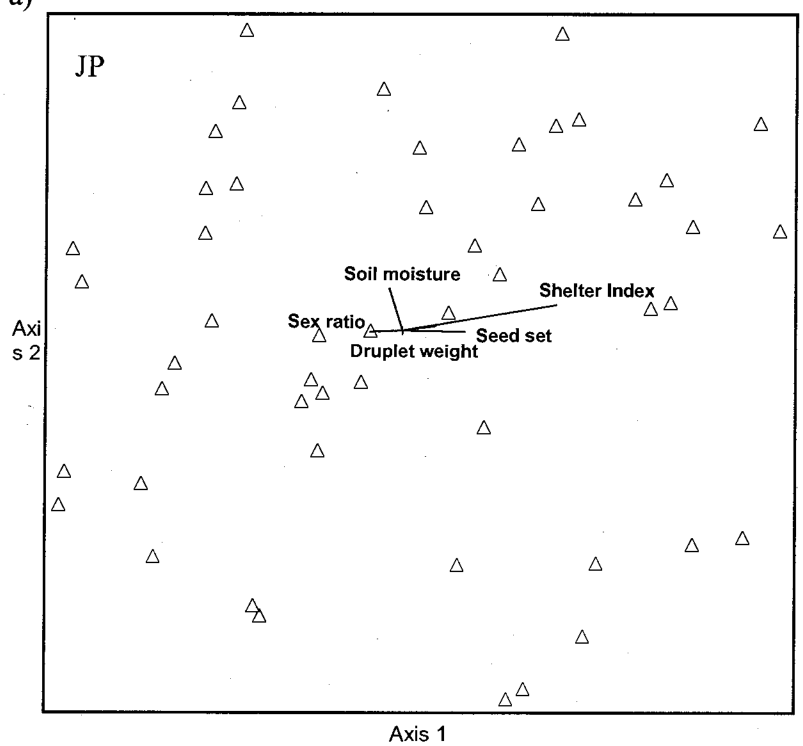


Figure 3.5.4 Non-metric multidimensional scaling ordination of 50 *Rubus chamaemorus* quadrats on Site CW based on species composition; 3 dimensions; a) axes 1 vs. 2, b) axes 2 vs. 3; final stress = 13.63997, final instability = 0.00552. Environmental and reproductive variables significantly correlated to ordination axes were included

a)



b)

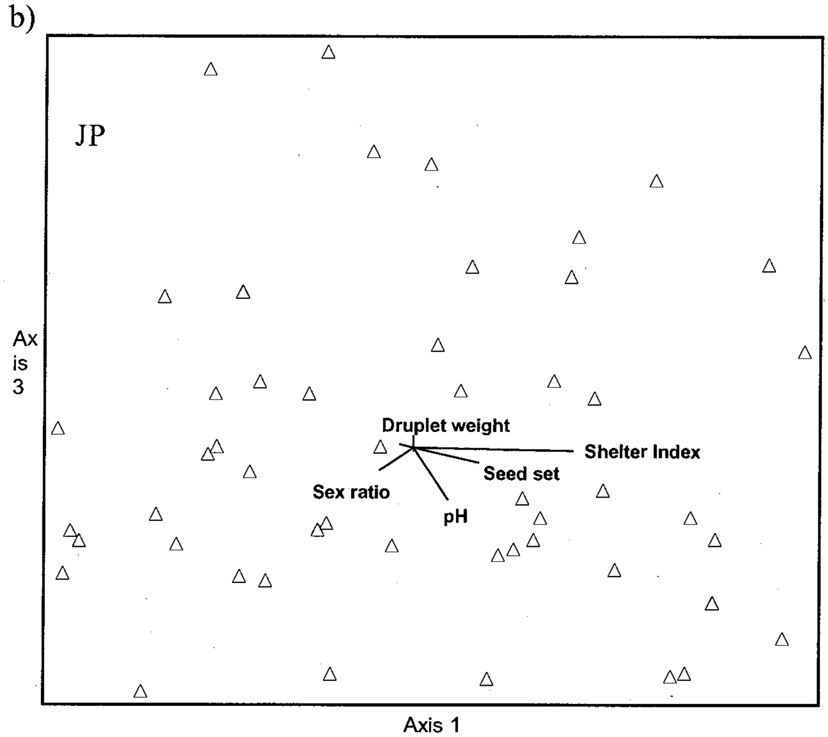


Figure 3.5.5 Non-metric multidimensional scaling ordination of 50 *Rubus chamaemorus* quadrats on Site JP based on species composition; 3 dimensions, a) axes 1 vs. 2, b) axes 1 vs. 3; final stress = 22.0065, final instability = 0.03488. Environmental and reproductive variables significantly correlated to ordination axes were included

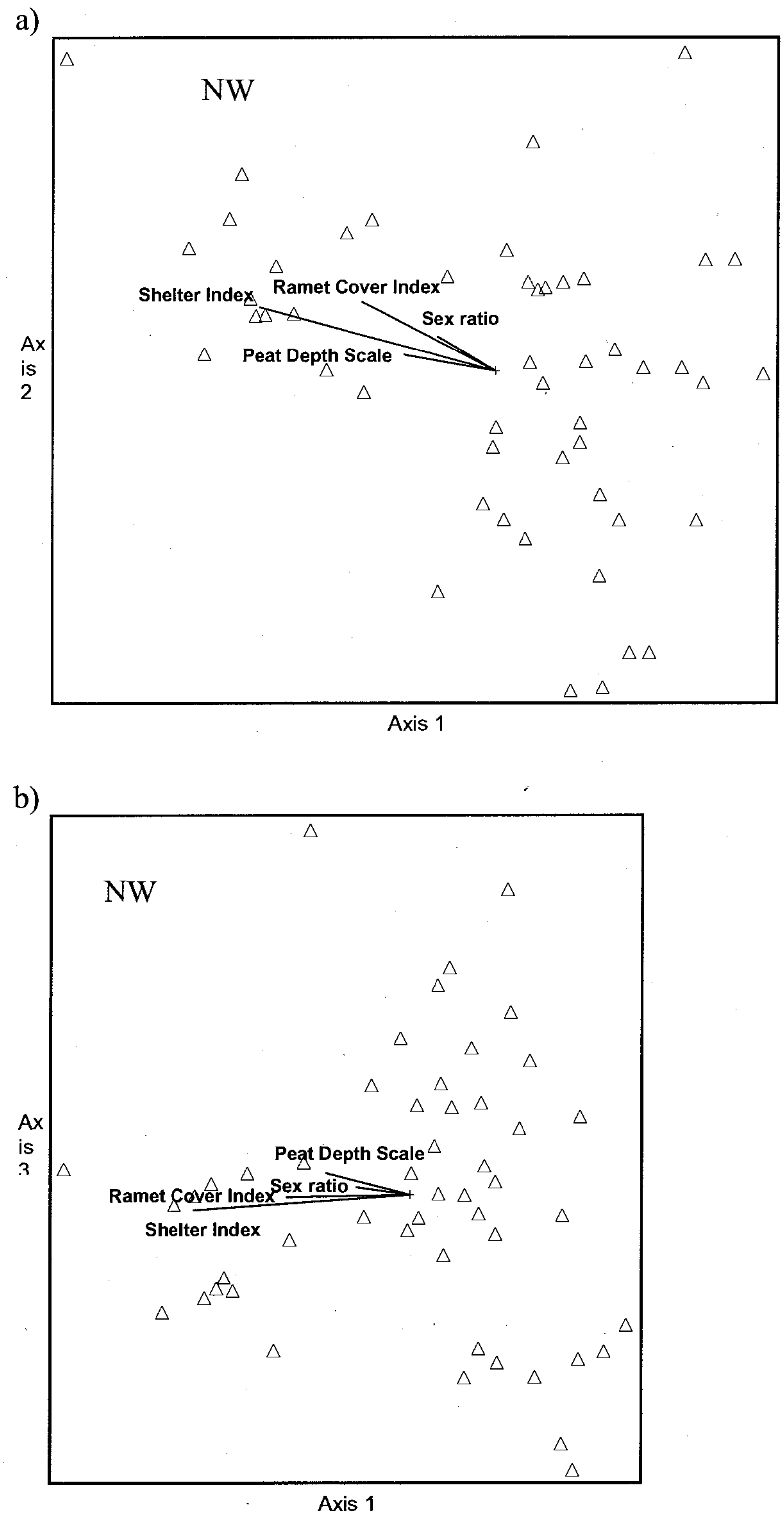


Figure 3.5.6 Non-metric multidimensional scaling ordination of 50 *Rubus chamaemorus* quadrats on Site NW based on species composition; 3 dimensions, a) axes 1 vs. 2, b) axes 1 vs. 3; final stress = 14.93659, final instability = 0.00394. Environmental and reproductive variables significantly correlated to ordination axes were included

For the ordination of species in the Extensive sites (Figure 3.5.7), *Rubus chamaemorus* was located in the left center of the ordination, closest to species such as *Empetrum nigrum*, *Rhododendron (Ledum) groenlandicum*, *Sphagnum* species and *Polytrichum* species. *Rhododendron tomentosum (Ledum palustre)*, *Andromeda glaucophylla* and *Trichophorum (Scirpus) cespitosum* were clustered together at one end of the second axis of the ordination, and *Geocaulon lividum*, *Carex trisperma*, *Carex microglochin*, *Gaultheria hispidula* and *Equisetum* species were clustered together at the opposite end. For Intensive sites, there were less defined aggregations of species (Figure 3.5.8). *Rubus chamaemorus* was located at the center of the ordination and near the same species it was near in the Extensive site ordination. Species on the periphery of the ordination include *Rhododendron lapponicum* (*Ledum palustre*) with *Vaccinium vitis-idaea*, *Equisetum* species, *Gaultheria hispidula* with *Carex microglochin*, and *Trichophorum (Scirpus) cespitosum* with *Andromeda glaucophylla* and *Eriophorum vaginatum (spissum)*; each of these species or group of species were located in different corners of the ordination.

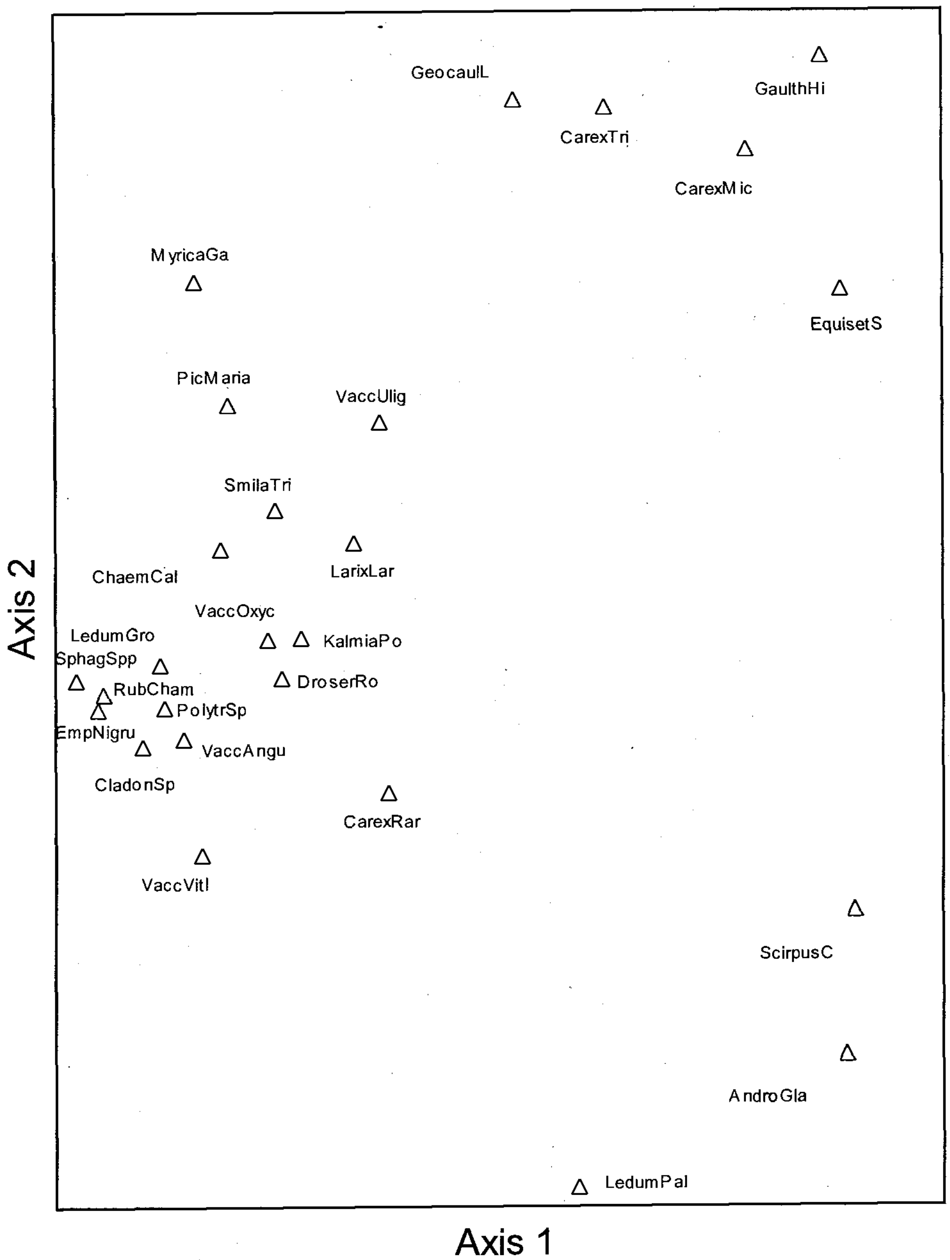


Figure 3.5.7 Non-metric multidimensional scaling ordination of all species found with *Rubus chamaemorus,* based on species cover in 420 quadrats from Extensive sites; Two dimensions, final stress = 11.72316, final instability = 0.00001. Species codes found in Table 3.2.

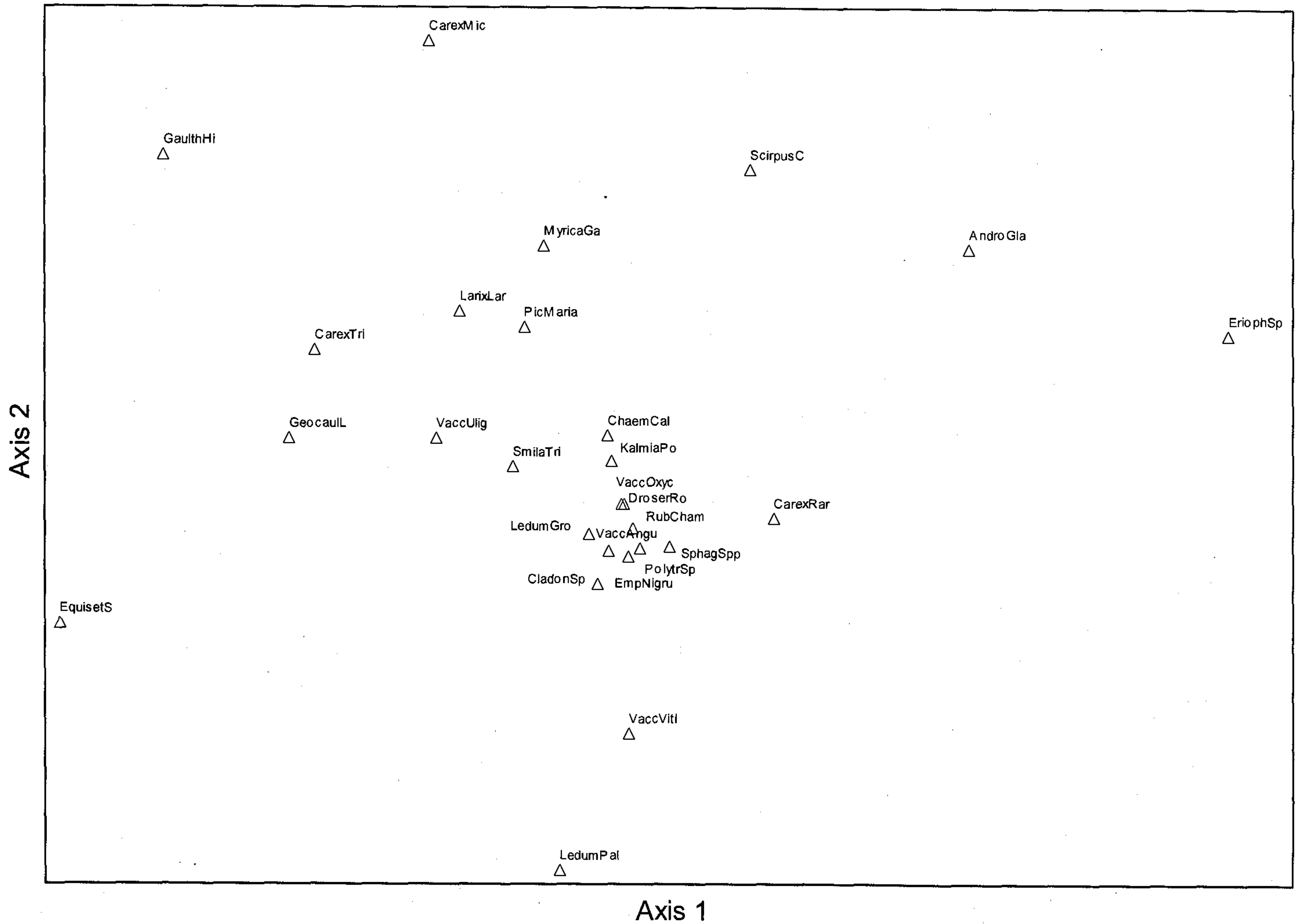


Figure 3.5.8 Non-metric multidimensional scaling ordination of all species found with *Rubus chamaemorus,* based on species cover in 250 quadrats from Intensive sites; 2 dimensions, final stress = 15.08684, final instability = 0.0001. Species codes found in Table 3.2.

3.3.3 Reproductive variables

Average ramet density for extensive sites was 157 +/- 4.78 /m^2 while for intensive sites it was 133+/- 4.18 /m^2 (Table 3.3.1, 3.3.2). Average total ovules per flower for Intensive sites was 10 +/- 0.17, ranging among plots from 5 to 22 ovules. Fruit set was on average 0.75 +/- 0.02, ranging from 0 -1.00 and seed set was 0.66, ranging between 0.11 - 1.00. There was no relationship between ramet density and flower:ramet for the extensive sites (Table 3.3.1). Cover per Ramet Index was negatively correlated with ramet density for four sites (Table 3.4.4). Fruit set was positively correlated with seed set and average druplet weight, each in one site.

Table 3.4.4 Spearmans Rank correlations for Intensive sites among dependent variables; >0.400 considered significant. Only correlations with significant relationships in at least one of the sites are listed.

	BN	CJ	CW	JP	NW
Cover per Ramet Index					
Ramet density	**-0.660**	**-0.782**	**-0.577**	**-0.835**	-0.361
Fruit set					
Seed set	0.145	0.343	0.048	**0.586**	-0.204
Average druplet weight	0.209	0.130	-0.263	-0.274	**0.410**

3.3.4 Sex Ratio and Distance to nearest potential fertilising partner

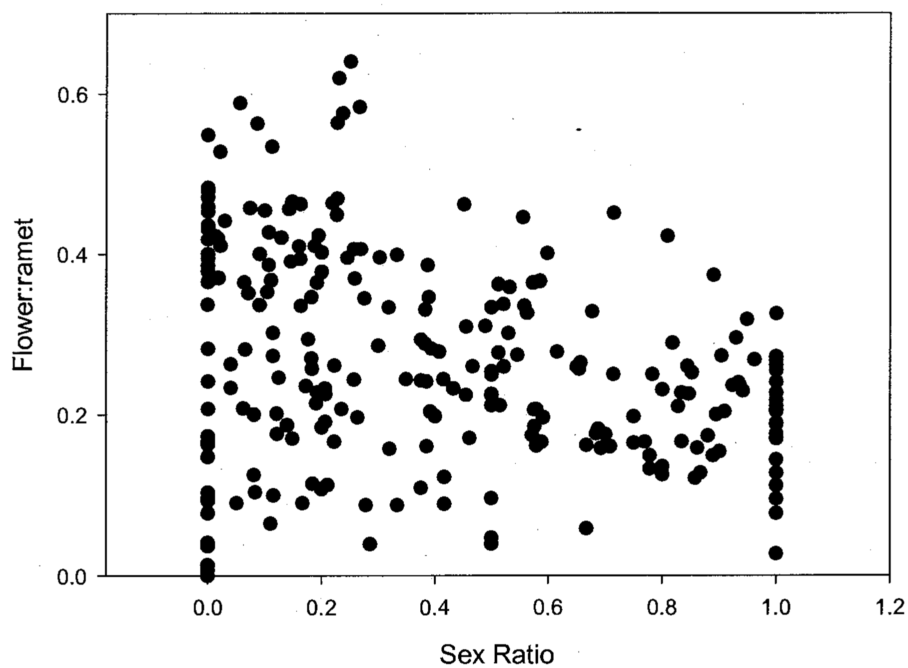
The sex ratio means were male biased for four sites and female biased for one site (Table 3.3.2). Sex ratio was significantly correlated with one Ordination axis for four sites, Shelter Index for three sites, soil moisture for two sites, Peat Depth Scale in one site, Cover per Ramet Index for one site, flower:ramet for one site, fruit set for one site, seed set for three sites and average druplet weight for three sites (Table 3.4.5). The distance to nearest male flower was correlated with pH in two sites, Shelter Index in one site, flower:ramet for one site, seed set for two sites, and average druplet weight for two sites.

Table 3.4.5 Spearman Rank correlations for Intensive sites between sex ratio and distance to nearest male flower and dependent variables; >0.400 considered significant. Only variables with significant relationships in at least one of the sites are listed.

	BN	CJ	CW	JP	NW
Sex Ratio					
Shelter Index	**-0.442**	0.356	**0.505**	-0.122	**0.522**
Peat Depth Scale	-0.085	**-0.446**	-0.181	0.224	0.228
Soil Moisture	-0.343	**-0.487**	**-0.420**	-0.133	-0.057
Ordination axis 1	**0.636**	0.263	0.392	**-0.431**	-0.339
Ordination axis 2	-0.367	0.246	**0.510**	0.094	**0.638**
Ramet area	0.156	0.386	0.398	0.317	**0.458**
Flower:ramet	-0.141	-0.347	**-0.443**	-0.325	**-0.617**
Fruit set	-0.206	0.026	-0.148	**-0.554**	-0.109
Seed set	**-0.588**	-0.397	-0.039	**-0.665**	**-0.483**
Average druplet weight	**-0.587**	**0.438**	0.292	0.301	**-0.467**
Distance to nearest male					
Shelter Index	**-0.401**	0.223	0.111	0.001	0.165
PH	**-0.453**	-0.038	-0.219	-0.056	**-0.427**
Flower:ramet	-0.302	-0.242	**0.580**	-0.301	0.052
Seed set	0.145	-0.284	**0.566**	**-0.595**	0.147
Average druplet weight	0.209	0.192	**0.425**	0.236	**-0.439**

For all quadrats in the Intensive sites combined, there was a significant negative relationship between sex ratio (female proportion) with the following variables: flower:ramet ($r = -0.450$), seed set ($r = -0.518$), and average druplet weight ($r = -0.471$)(Figure 3.6). When quadrats were separated into categories of female proportions below and above 50 % of flowering ramets, there was a significant difference between the two groups for all three variables (ANOVA). Female dominated quadrats had lower flower:ramet (0.230 vs. 0.290; $F = 12.26$, $p = 0.001$), seed set (0.567 vs. 0.743; $F = 41.58$, $p = 0.000$), and average druplet weight (0.038 vs. 0.051; $F = 18.06$, $p = 0.00$).

a)



b)

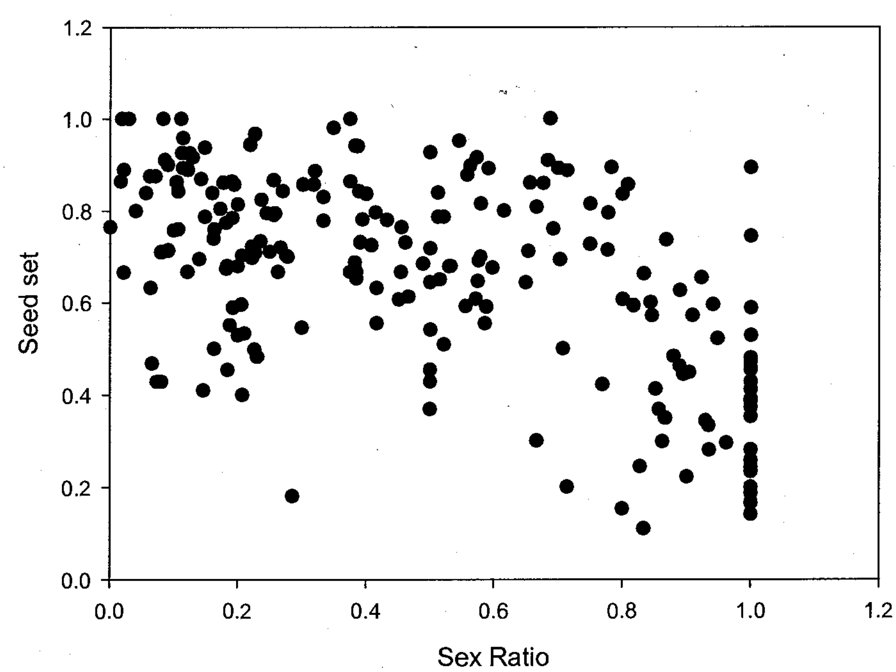


Figure 3.6 a) Flower:ramet ($r = -0.450$) and b) Seed Set ($r = -0.518$) vs. Sex Ratio (proportion of female flowers; (♀/(♀+♂) floral ramets) for all Intensive quadrats ($n = 250$).

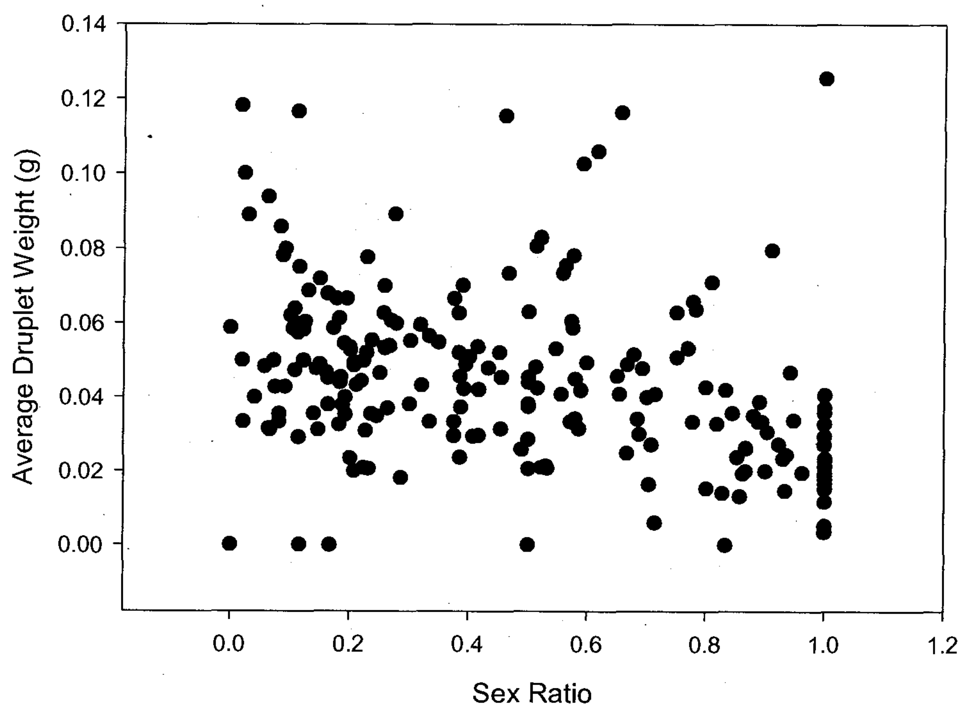


Figure 3.6 c) Average Druplet Weight vs. Sex Ratio (♀/(♀+♂) floral ramets) (r = -0.471) for all Intensive quadrats (n = 250).

There were no significant relationships between distance to nearest fertilizing partner and other variables but there was an observed pattern with seed set (Figure 3.7). When quadrats were separated into categories of distances between 1 - 10 cm (n = 118) and 10 – 900 cm (n = 96), and an ANOVA was run, there was a significant difference between these two groups. Quadrats with greater distance between females and males had significantly lower seed set (0.580 vs. 0.730; $F = 28.030$, $p = 0.000$).

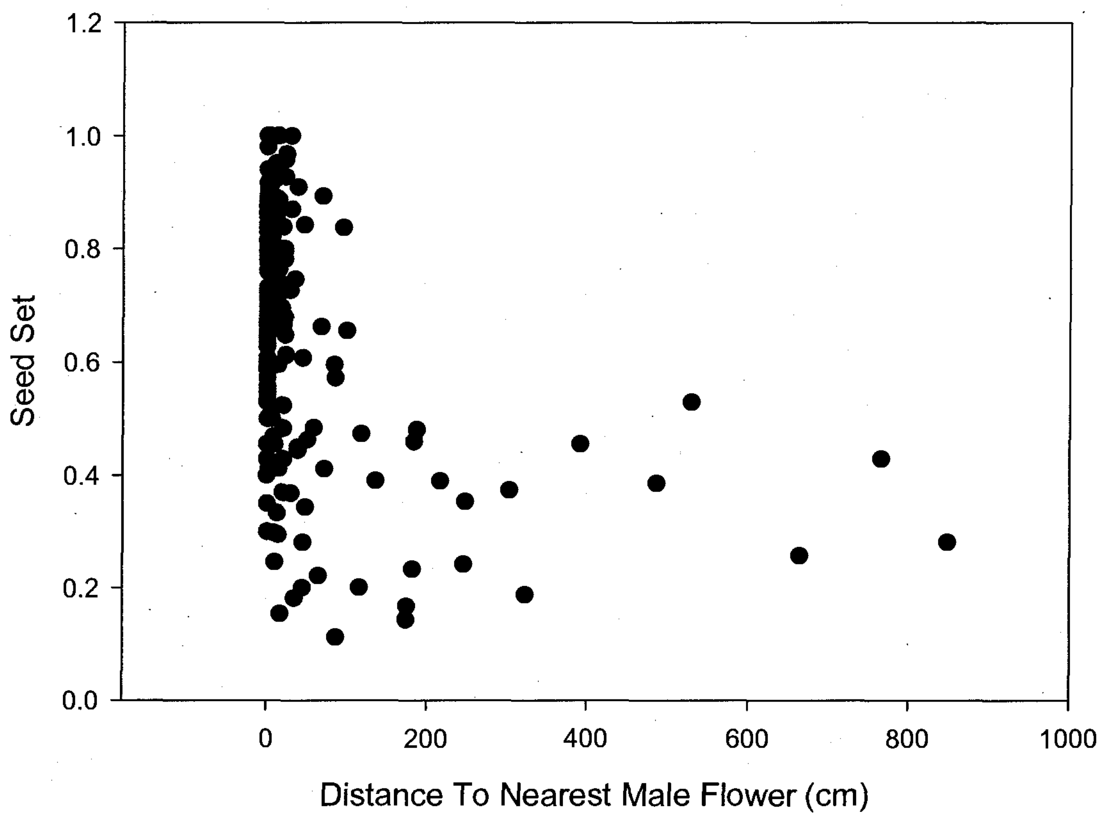


Figure 3.7 Distance to nearest male bakeapple flower vs. Seed Set (r = -0.291) for all Intensive quadrats (n = 250).

3.4 Discussion

3.4.1 Environmental factors

The results suggest that shelter (at least as measured here) did not have a prominent effect on fruit production under the particularly mild weather conditions during the study (summer 2004). There were no late frosts or extreme weather conditions such as heavy rains during the flowering and fruiting period of bakeapples, which is likely why there were few strong relationships between the shelter variables and flower:ramet, fruit set or seed set. Beneficial effects of shelter such as temperature buffering (Yudina, 1993), improved pollinator microclimate (Makinen and Oikarinen, 1974), or better water economy (Lohi, 1974) would most likely be observed during summers with particularly cold or dry weather conditions.

The positive relationship between the Cover per Ramet Index and Shelter Index is consistent with a previous study that found bigger leaves in sheltered areas compared to open sites (Lohi, 1974). The larger leaves are attributed to the combination of increased competition for light in sheltered habitats and increased protection from sun and wind (Lohi, 1974). Agren (1988b) found that during years devoid of frost, bakeapple populations in open areas in northern Sweden (64°N, 18°E) had much higher fruit set than sheltered ramets, which remain stable in fruit set from year to year (but this study area is located 12° further north). However, Yudina (1993) observed that bakeapple plants fruit "more often" and "more intensely" in forested areas compared to open areas. The lack of a significant relationship between fruit set and Shelter Index, during what appears to be a "favourable year," suggests that neither of these relationships exist in the populations I studied. Agren (1989) found that bakeapples produce larger seeds in shaded habitats than in open areas. However, I found no consistent relationships between shelter and either average berry weight or average druplet weight in this study. Only Site BN showed a significant relationship between shelter index and berry weight, which was positive. However, druplet weight may not be strongly correlated with seed size.

Some shelter measurements served as better estimates than others. The least useful measures were the distance to and height of the nearest shelter, since they did not effectively characterize the overall extent of shelter present outside of the quadrat. One value could have represented a single shrub/tree or a large number of trees, which could have very different influences on bakeapple reproductive stages. The average height and tallest shelter estimates yielded similar values and relationships with reproductive variables, as did the proportion at 45° and shelter density/cover measures.

The lack of any evident relationships between peat depth and the various stages of reproduction in bakeapple suggests that ramet growth or reproduction is not limited by shallow peat depths. Peat depth measurements do not reflect the depth of the rhizomes and roots nor the distance between the rhizomes/roots and the water table, which could potentially show stronger relationships with reproductive variables. Bakeapple rhizomes have been found from 12 to 25 cm above the water table (Nordbakken, 1996) and underground biomass was evenly distributed to a depth of 25 cm (Wallen, 1986). Only six percent of quadrats in the Intensive sites and three percent of quadrats in the Extensive sites had peat depths less than 25 cm, indicating that bakeapple ramets in this area would only infrequently experience any peat depth constraints. There were no observable relationships of either pH or moisture with reproductive stages in bakeapple, likely due to the fairly narrow range of values among and within the sites sampled. The pH values (3.5 - 4.5, average = 4.0) fell within the range of values reported in previous studies (Lohi, 1974; Thiem, 2000). Percentage moisture of soils in bakeapple habitats has not been quantified previously, so comparisons are not possible.

My temperature measurements indicate much higher daytime values than recorded at the closest weather station. However, the daytime temperatures were likely overestimated due to irradiation of metal Ibuttons, because in open bogs it was difficult to place the Ibuttons out of direct exposure to the sun. Another confounding factor is that the Ziploc bags the Ibuttons were stored in were punctured when paper clips were used to secure the bag to the ground. This resulted in some condensation accumulating in the bag, which would also have an effect on the recorded temperatures. There were no observable low temperature differences between sheltered and open quadrats, which likely would have been observed only during summers with more extreme climatic conditions. However, there appeared to be many days with temperatures that were lower than +15 C, a temperature that Hippa et al. (1981) found to be the lower threshold of most insect visitors. Thus temperatures could have influenced pollinator activity.

3.4.2 Species composition

In Europe, *Rubus chamaemorus* is commonly found in co-dominance with *Calluna vulgaris* (common heather), *Eriophorum vaginatum* (sheathed cottonsedge, cottongrass) and *Empetrum nigrum* (crowberry or "blackberry") (Taylor, 1971). Species commonly found in habitats with bakeapple populations in Newfoundland and Labrador were *Sphagnum* species (especially *S. fuscum,* which tends to form hummocks), other moss species (*Polytrichum* spp., *Racomitrium* spp.), *Cladonia* (lichen) species, sedges and their relatives (*Carex* spp., *Eriophorum angustifolium)*, grasses (Gramineae or Poaceae) species (on drier areas), bulrush (*Scirpus, Schoenoplectus* species), common juniper (*Juniperus communis*), sweet gale (*Myrica gale*), crowberry or "blackberry" (*Empetrum nigrum*) (the most frequent associate of bakeapple in these areas), and ericaceous shrubs (Savory, 1981). Common ericaceous species were *Kalmia angustifolia* (sheep laurel), *Rhododendron* (*Ledum) groenlandicum* (Labrador tea), *Vaccinium augustifolium* (low bush blueberry), *Vaccinium uliginosum* (bog blueberry), and *Vaccinium oxycoccus* (bog cranberry). Some sites in Savory's study (1981) were located in the Labrador Straits area, approximately 160 km south of my study area. Generally, species composition in my study area was similar to that of other bakeapple habitats in Newfoundland and Labrador.

Similar to previous studies, the most common plants that I found in bakeapple sites were *Empetrum nigrum, Rhododendron groenlandicum, Chamaedaphne calyculata*, *Sphagnum* spp. and *Cladonia* spp. In general, species composition was fairly uniform across all sites. A few additional species were noted in the Extensive study, but these were largely removed for the ordination because their frequency was so low. The most consistent relationship observed between species ordination axes and other variables was with the Shelter Index. This suggests that species are separated along a gradient from sheltered areas (e.g. *Gaultheria hispidula*, *Linnaea borealis*) to open areas (*Drosera rotundifolia, Vaccinium oxycoccus*). Resvoll (1929) commented that bakeapples might have rhizomes deep in the ground because of the lack of roots or rhizomes of competing species (e.g., *Empetrum nigrum, Vaccinium uliginosum*) at these depths. There were no significant correlations between species competition, peat depth and bakeapple reproductive variables to suggest that at shallow peat depths bakeapple reproduction was limited by competition.

3.4.3 Fruit set

Over-initiation of flowers in bakeapple populations (i.e., the production of more flowers than can develop into fruits on a yearly basis) could be an adaptation to highly variable climatic conditions, allowing plants to take advantage of favourable years (Agren, 1988a; Lovett Doust and Lovett Doust, 1988a). Ramets in habitats that are protected from detrimental climatic conditions can use the over-initiation of flowers to selectively abort genetically inferior offspring or buffer effects of sporadic herbivore damage (Agren, 1988a, Lovett Doust and Lovett Doust, 1988a). Resource requirements for such high fruit production during “favourable” years often cannot be sustained annually (Agren, 1988). If that was the case in this study, fruit set should have been relatively high compared to other studies due to the mild climatic conditions during the study summer. The average fruit set found in the intensive sites was 74%, comparable to fruit set reported from Northern Sweden and Finland (72.5-75.6%; Agren, 1989), and was intermediate between values reported in two studies conducted in Quebec (57% and 94%) (Dumas and Maillette, 1987; Pelletier et al., 2001). Pelletier et al. (2001) attributed the high fruit sets that they observed to the mild weather conditions (no frost), which would have provided good microclimates for pollinators. The values I found are also similar to average fruit set of 0.724 obtained from a summary of dioecious species (Sutherland, 1986). Some bakeapple populations with vigorous vegetative production have lost the ability to reproduce sexually (i.e., ramets do not produce functional sex organs) (Makinen and Oikarinen, 1974). This does not appear to be to case for the study populations, given the high fruit and seed set values that I found.

3.4.4 Sex ratio

Sex ratios have been found to be male biased in a number of dioecious species (Allen and Antos, 1993; Lloyd and Webb, 1977; Melampy and Howe, 1977; Willson, 1983; but see Crawford and Balfour, 1983; Niesenbaum, 1992). Male biased sex ratios could result from various factors, including differential mortality and clonal growth. Male bakeapple plants have been found to be more frost resistant and less affected by defoliation than female ramets of fruit producing female plants (Agren, 1987; Makinen and Oikarinen, 1974), which would likely result in lower mortality of male ramets and genets. Fruit producing female ramets have been shown to have higher mortality than male plants and nonfruiting female plants (Agren, 1988a). Individual bakeapple rhizomes can reach lengths of 9 meters and can have lateral branches 1-8 m long; thus one clone can cover a considerable area (Lohi, 1974). Agren (1988b) found that male ramets began rhizome growth earlier in a season than fruiting females, and that male rhizomes were more dense and thicker than female rhizomes. However, it has not been conclusively determined if differential clonal growth leads to a greater production of male ramets and thus also contributes to a male-biased ramet sex ratio.

Differences between males and females in the proportion of ramets flowering could also yield a sex ratio bias, which can be termed an apparent bias because it may not represent the primary sex ratio, i.e. the actual ratio of male to female plants (Allen and Antos, 1993; Lloyd and Webb, 1977, Lovett Doust and Lovett Doust., 1988a). Male bakeapples have been shown to have a higher reproductive effort than females at the time of flowering, and this is reflected in the higher proportion of floral ramets (Agren, 1988b; Lloyd and Webb, 1977). Because the sex of non-flowering ramets cannot be determined except by their rhizome connections apart from manually following each rhizome, there is no way to know exactly how the floral sex ratios compare to the ramet sex ratios and to determine the exact proportion of male and female ramets flowering. However, greater flower:ramet ratios in male dominated plots suggest that males have a higher flowering propensity than the females. Higher flowering frequency of males than of females has been found in other studies of *Rubus chamaemorus* and for other dioecious species (Agren, 1988; Lloyd and Webb, 1977). Although males have a higher reproductive effort during flowering, if both flowering and fruiting are taken into account, female bakeapples allocate far more to reproduction than males (Agren, 1987; Korpelainen, 1994) as has been shown for other species (Abe, 2002; Allen and Antos 1988; Lovett Doust and Lovett Doust, 1988a). Considerable resources can be directed towards the demanding process of fruit production in females, which can inhibit future growth and reproduction. Fruit producing female ramets of bakeapple have been shown to have a lower probability of flowering the following year (Agren, 1988a; Resvoll, 1929).

In this study, the significant relationships of reproductive variables to both sex ratio and distance to nearest fertilising partner, both within sites and among all sites collectively, suggests that these are the most important factors causing variation in reproductive output in these populations. The significant relationships of sex ratio to seed set found in this study were not observed in other studies on different species (Barrett and Thomson, 1982; Bullock and Bawa, 1981). In bakeapple populations in Scandanavia, Agren et al. (1986) did not find relationships between sex ratio and seed set, but did detect limitations on seed set using hand-pollination experiments. The more pronounced negative relationship of sex ratio (proportion of female flowers) to seed set as compared to fruit set suggests that the skewed sex ratio limited the number of repeat visits to the same female flower necessary to increase the number of fertilised ovules rather than in initial visits of pollinators to female flowers (where we would have seen effects on fruit set). This could possibly be due to the lack of an adequate proportion of males in an area of female clones to attract pollinators because females provide no "rewards" to the pollinator. This effect is also suggested by the negative relationship between distance to nearest male flower and seed set. Kay et al. (1984) found that the increased spatial separation of males and females had significant negative effects on seed set. Female flowers in close proximity to males are more likely to attract the insects by deceit, and are more likely to access the pollen carried on the pollinator's body (Agren et al., 1986).

Some studies have found that male and female plants are spatially segregated along a resource gradient. While some suggest this observed segregation is a selective force for the evolution of dioecy as it reduces competition between the sexes, the available evidence does not rule out differential mortality of males and females resulting from different reproductive ecologies (Beirzchudek and Eckert, 1988; Lovett Doust and Lovett Doust, 1988a; Nicotra, 1998; Wilson, 1983). Male and female plants show different relationships with a number of environmental variables, both temporally and spatially, such as light availability, soil phosphorous, soil moisture, salinity and pH (Bertiller et al., 2003; Bowker, 2000; Cox, 1981; Freeman et al., 1976; Niesenbaum, 1992; Onyekwelu and Harper, 1979; Salzman, 1985; but see Barrett and Thomson, 1982; Vasiliauskas, 1992; Quinn, 1991). Some studies indicate that female bakeapple clones are more abundant in more moist habitats relative to drier areas (Agren, 1987; Dumas and Maillette, 1987). In the present study, the inconsistent relationship between sex ratio and shelter (positive in two sites, negative in two sites) and lack of relationships found between sex ratio and other environmental variables suggest that there was no spatial segregation of male and female plants along the environmental gradients measured (e.g., soil moisture, pH or peat depth gradients).

Generally, my results reflect the complexity of influences determining successful fruit production in *Rubus chamaemorus* populations. The climatic variables, abiotic characteristics, and bakeapple population characteristics all interact to affect fruit production and the most prominent factors will vary on a yearly basis. During the study summer, the climatic conditions, which normally show considerable influence on bakeapple fruit production, were extremely mild. This resulted in bakeapple population characteristics, such as sex ratio, having the most prominent influence on fruit production. These factors are also indirect measures of other variables, such as pollination efficiency, which in turn are influenced by the climatic conditions. Thus a comprehensive perspective on bakeapple fruit production must assess all of these variables.

3.5 Conclusions

Although, shelter (as measured in this study) did not seem to have a prominent relationship with measures of bakeapple reproduction in my study, the mild climatic conditions of summer 2004 may not have revealed the prominent relationships found with these variables in previous studies. Peat depth does not appear to be a limiting factor in bakeapple growth and reproduction at the study sites, which is reasonable given the considerable soil depths found in peat bogs. Nor did either soil moisture or pH have any strong relationships to bakeapple growth and reproduction, likely due to the narrow ranges of these variables in bog habitats.

The bakeapple populations I studied had, on average, male biased ramet sex ratios. This is common among dioecious species, and a greater propensity for flowering by males than by females contributed, in part, to this bias. Sex ratio and distance to nearest male flower influence reproduction at the level of seed set, with female biased sex ratios and large distances between male and female flowers decreasing seed set. There do not appear to be any specific microhabitat differences between males and females in these populations. The biased sex ratios suggest that a predominance of vegetative reproduction has resulted in large clone sizes in this area, which have lead to limitations on sexual reproduction. However, given the high fruit set measured, it appears that the reliance on the more stable strategy of asexual reproduction does not trade off with the ability to produce abundant fruit during favorable years in this unpredictable environment and thus the potential for seedling establishment and maintenance of genetic diversity.

Chapter 4. Bakeapple (*Rubus chamaemorus*), a Cultural Keystone: Linking local and scientific knowledge to improve understanding of fruit production

4.1 Introduction

Local people who have resided in a particular area over many generations, have lived in close contact with their environment, making observations and decisions that are continually adaptive to the natural surroundings they depend upon. Their cumulative knowledge, although on a restricted spatial scale, is often on a long temporal scale of many generations (Berkes, 1999; Fischer, 2000). This knowledge can be combined with scientific studies to develop a more complete understanding of ecological systems or of a particular species and its ecology. There are a number of examples of studies that have incorporated both sources of knowledge to provide a more comprehensive perspective on a species or ecosystem (Chaffey, 2003; Ferguson et al., 1997; Garibaldi, 2003; Mallory et al., 2003; Murray et al., 2005; Mymrin et al., 1998; Neis et al., 1999). In this chapter, I link local knowledge with scientific knowledge for a more complete understanding of a culturally and ecologically important species, bakeapple (*Rubus chamaemorus* L.).

The people living in Charlottetown, Labrador relied extensively on local wild foods before a number of changes, such as permanent stores, establishment of roads and improved economic conditions decreased this reliance. Of these wild foods, berries comprised the majority of plant resources used by community members and bakeapple was one of the most important berries gathered for the winter. A circumpolar species, bakeapple has been identified as an important food resource for many northern groups (Andre and Fehr, 2001; Griffin, 2001; Hawkes, 1916; Heller, 1976; Jones, 1983; Kari, 1987; Kuhnlein and Turner, 1991; Marles et al., 2000; McGee, 1961; Turner, 1995; see

Chapter 2; Table 2.1). Although there has been considerable documentation of the importance of the bakeapple as a food source in northern communities, there has been little research about certain aspects of its use, including local ecological understanding of bakeapple habitat characteristics and factors affecting fruit production. Based on the expectation that the accumulated knowledge of local peoples about bakeapple ecology and phenology can provide valuable information about the conditions favouring sexual reproduction and fruiting in this species, my objectives for this chapter were threefold: 1. To document local knowledge concerning the ecology of bakeapple, including habitat and factors influencing reproduction; 2. To interpret these observations in relation to the scientific literature and my own data collected on bakeapple populations in the area; and, 3. To highlight specific local observations that can serve as a starting point for future research. To this end, I interviewed experienced bakeapple pickers from Charlottetown, Labrador to document traditional use of bakeapple in this community (Chapter 2) and also studied ecological variables in local populations of bakeapple to determine major influences on fruit production (Chapter 3).

4.2 Methods

I used in-depth semi-directive interviews with experienced bakeapple pickers from Charlottetown, Labrador, to conduct this research. Protocols for the interviews are described in Chapter 2. Questions for this aspect of my research were focused on traditional ecological knowledge of bakeapple ecology and reproduction, including environmental factors influencing bakeapple productivity and different types of bakeapple habitat (see Appendix 1). In all, 15 individuals were interviewed; the numbers cited in the Results section (4.3) indicate the number of people giving a particular response in proportion to the total number interviewed. Interview findings were linked with data obtained during my ecological field study on local bakeapple populations. Quadrats from five (Intensive) sites were divided into three different habitat categories based on interviewee observations and ANOVA's were performed to determine if there were any significant differences in various environmental variables and bakeapple reproductive output between habitat categories.

4.3 Results and Discussion

4.3.1 Bakeapple name, similar berries/plants

The name "Bakeapple" appears to be the only name used locally in Newfoundland and Labrador to refer to *Rubus chamaemorus*. This contrasts with "redberry" (*Vaccinium vitis-idaea* L.), which is also called by the common name of "partridgeberry" among community members in Charlottetown and elsewhere. None of the interviewees knew the origin of the term "bakeapple." When asked if there were any plants similar to bakeapple, all pickers asserted that no local plants are anything like bakeapple. When interviewees compared bakeapples to other berries, some interviewees articulated differences in terms of how they were picked (1), appearance of the berry (2), importance to the community (2), and their habitat (1). It does not appear that bakeapple pickers in Charlottetown rely on any general classification system to compare bakeapples with other plants and berries, except that they classify them as "berries".

4.3.2.1 Bakeapple habitat

Most interviewees had difficulty explaining or describing bakeapple habitat (one interviewee commented that it would have been easier if we were out in bakeapple areas) but in general they described three main habitat types where bakeapples are found. The first and most common is a bog, or "mash," as it is locally termed (Figure 4.1.1). Some pickers (5) identified a mash as similar to a marsh. Some interviewees (4) said a mash is similar to a bog, others (3) said it is drier than a bog and one said it is wetter than a bog. People described a bog as a wet, flat area that is fairly open with red/brown/yellow mossy ground. The second kind of bakeapple habitat interviewees identified was an area sheltered by shrubs and trees (Figure 4.1.2). Most interviewees describing this habitat often were referring to shrubs and trees on the periphery of the mashes, but some (6) said they found bakeapples in forested areas sheltered among trees. The third type of habitat described by some pickers (5) was what Interviewee 1 referred to as "barren ground" (the other interviewees generally referred to it as a drier area) (Figure 4.1.3). Interviewees described this type of area as open and flat, similar to a mash but drier and more rocky. Interviewees said that barren ground is characterised by more "caribou moss" (*Cladonia* spp.) and "blackberry" (crowberry; *Empetrum nigrum*) bushes compared to the predominant cover of moss (*Sphagnum* spp.) found in a mash. Interviewee 1 explained that the barren ground was "hard" to walk on, compared to the bog, where you are "going up and down" when you walk across it (reflecting the spongy nature of the peat in the bogs). Pickers also noted that bakeapples in both sheltered and barren areas are more "scattered" (i.e. lower density) whereas bakeapples found on mashes tend to be "thick" (i.e. higher density).

Interviewees reported few plants found in areas with bakeapples but Indian tea leaves (*Rhododendron (Ledum) groenlandicum*)(1), marshberries (bog cranberries; *Vaccinium oxycoccus*)(1) and "blackberry" bushes (*Empetrum nigrum*)(1) were mentioned as being associated with bakeapple. Three pickers noted that bakeapples tend to grow well near ponds and along brooks. Other descriptions of bakeapple habitat by pickers include: in small valleys higher up on an island, in gulches, on the sides of banks, and at the foot of hills, where Interviewee 9 said, "the water dribbles down and the ground isn't as dry."

Interviewee 6 had noticed that bakeapples are found in specific areas within the bogs.

> ...Well the best bakeapple spots that I know of, in this bay, is... like, you've got the bog, right? ...On the big bogs there, you need a big bog too, but now, in that bog, there's, what I calls, little places that are a bit higher than the bog? ...all over? Like almost like little islands it is, all over....I've seen the berries growed, that's the thickest place I ever seen them grow....They grow so thick as ever they could stow, on those little places... Now some years hey? Not every year but some years... and, that's a good picking, if you can find that, that's good berry ground, that's the best I've ever seen.
> R = But is it always pretty wet areas that you find them in?
> I = It's a wet area, but it's really wet down there, but it's not so wet a little higher... But what it is, you're still getting the dampness from the bog, right? Up through here, but just those places, like two or three times bigger than, and they're just peppered.... (Interviewee 6)

Figure 4.1.1 Bakeapple habitat: "mash" or bog

Figure 4.1.2 Bakeapple habitat: sheltered among the trees

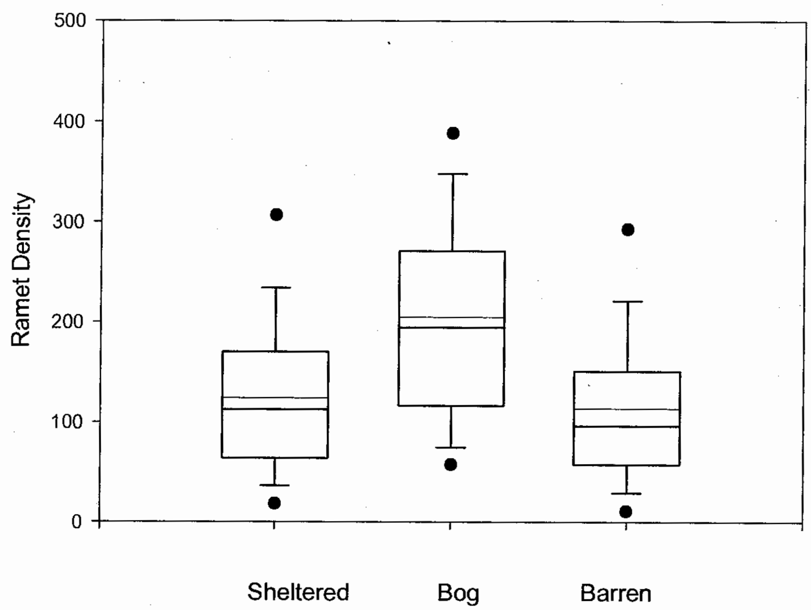
Figure 4.1.3 Bakeapple habitat: barren ground

4.3.2.2 Habitat type and fruit density/size: comparison between local observations and ecological data

The three main habitat types for bakeapples described by interviewees were said to have different bakeapple plant densities and fruit sizes. I used data collected at local sites to evaluate these observations. I used the shelter index and species composition values to separate quadrats in my extensive and intensive sites into the bog, sheltered and barren habitat types identified by the pickers interviewed. Quadrats with shelter index values (ranging 1-6) over 4 were placed into the sheltered habitat type. The remaining quadrats were divided based on species composition. Those quadrats that had *Sphagnum* species values (ranging 1-6) greater than 4 were classified as bog habitat type, and any of these categories were excluded from my analysis. While it would have been best to have interviewees themselves identify actual areas as bogs or barrens, these classifications provide a starting point for examining the potential basis for these observations. A number of variables were compared between these habitat types, such as ramet density for both extensive and intensive sites, and also average berry weight, average druplet weight, and soil moisture for intensive sites (see Chapter 3).

There were significant differences among ramet densities in the different habitats for extensive sites ($F = 36.502$, $p = 0.00$; Figure 4.2.1a) but not for intensive sites ($F = 0.829$; $p>0.05$; Figure 4.2.1b). Significant differences in soil moisture occurred among habitat types; barren areas were the driest ($F = 43.201$, $p = 0.00$; Figure 4.2.2a). Berry weight ($F = 8.024$, $p = 0.00$; Figure 4.2.2b) and druplet weight ($F = 4.37$, $p < 0.02$; Figure 4.2.3) were significantly different among habitat types, with barren areas having the highest means for both variables (i.e., having the largest berries).

a)



b)

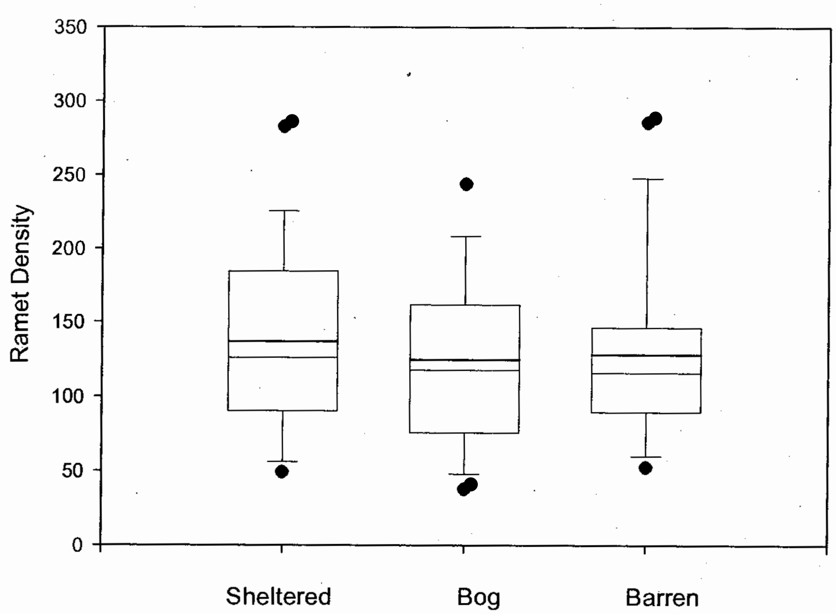
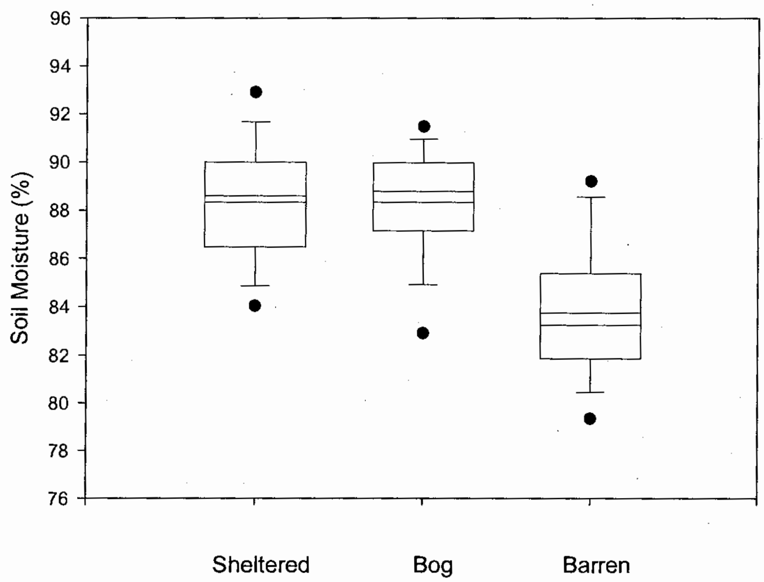


Figure 4.2.1 Average ramet density (floral and nonfloral) for the three different habitat types identified by interviewees for a) Extensive quadrats [sheltered (n=107), bog (n=151), barren (n=77) (F=36.502, p=0.00)] and b) Intensive quadrats [sheltered (n = 73), bog (n = 107), barren (n = 31) (F = 0.829; p>0.05)]. Center lines on box plot indicate mean and median while dots indicate the 5^{th} and 95^{th} percentile.

a)



b)

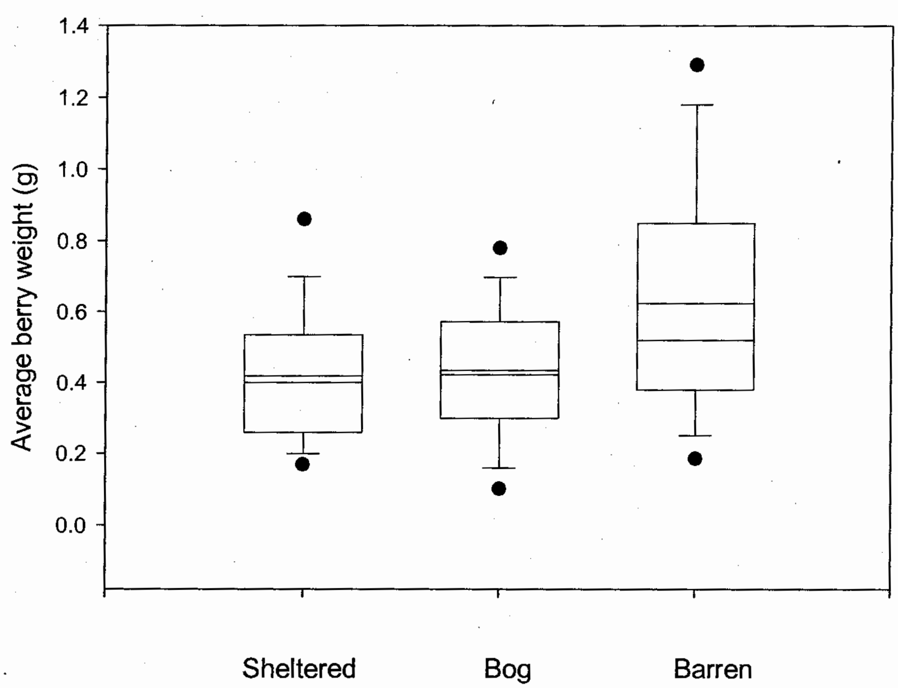


Figure 4.2.2 a) Soil Moisture ($F = 43.201$, $p = 0.00$) and b) Average berry weight ($F = 8.024$, $p = 0.00$) in Intensive sites for the three different habitat types identified by interviewees [sheltered ($n = 73$), bog ($n = 107$), barren ($n = 31$)]. Center lines on box plot indicate mean and median while dots indicate the 5^{th} and 95^{th} percentile.

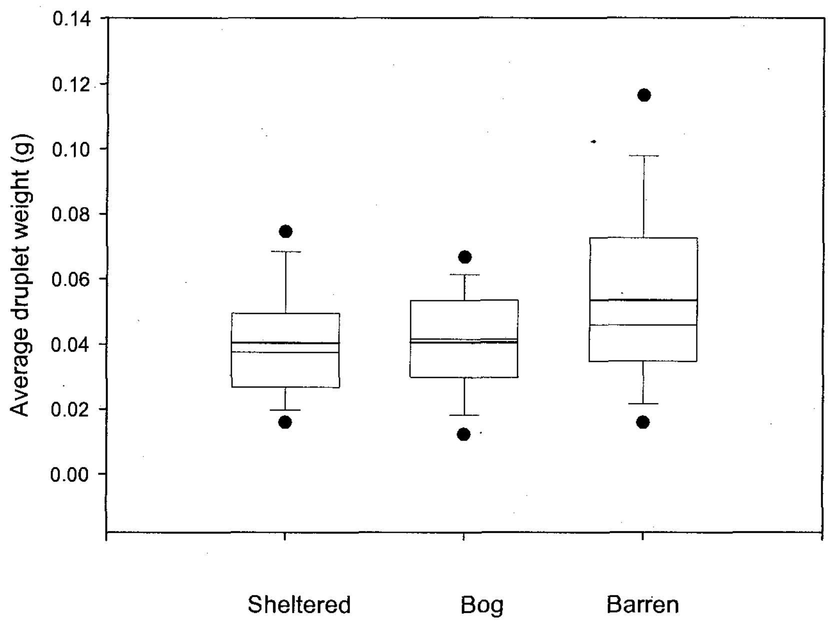


Figure 4.2.3 Average druplet weight ($F = 4.37$, $p < 0.02$) in Intensive sites for the three different habitat types identified by interviewees [sheltered (n = 73), bog (n = 107), barren (n = 31). Center lines on box plot indicate mean and median while dots indicate the 5th and 95th percentile.

Although there are some discrepancies between my data and local observations (e.g. I did not find differences between sheltered and bog quadrats for intensive variables in my ecological survey), generally, these results do support observations made by local residents of differences between open bog habitats and open "barren" habitats: namely, that barren areas have larger berries and lower ramet densities and are drier than bog habitats. These specific observations concerning characteristics of these habitat "types" have not been recorded in the scientific literature. Resvoll (1929) had discussed bakeapples being found in "dry" habitats that were sometimes dominated by lichens, but did not quantitatively report the bakeapples in terms of ramet density and fruit size relative to plants growing on bogs. These observed relationships between fruit size and shelter may explain why, in Chapter 3, I did not find a positive relationship between berry weight and shelter, which had been found in previous studies on bakeapple. Both bog and barren habitat types would have been considered open, non-sheltered areas (i.e. little vegetation > 15cm, as I defined in my study) and therefore be expected to have smaller berries relative to sheltered areas, but these open habitat types have different berry sizes relative to each other.

4.3.3 Growth and development of bakeapple

Interviewees characterised the growth and development of bakeapple over the summer in terms of several stages, often using local words. Some pickers (6) identified the "stalk" or the "tree" stage, based on observations of emerging shoots at the end of May and beginning of June. Those who did not mention the "stalk" or "tree" (9) recognized the white blossom, which appears in mid-June, as the first major developmental stage. Community members did not recognise the dioecious nature of this species and simply accepted that some flowers did not produce fruit. All interviewees recognised the "turned in" stage, during which the "shuck" (calyx or sepals of the plant) engulfs the developing berry, presumably to protect it as it starts to enlarge within (Figure 4.3).

among the remaining quadrats, those with *Cladonia* species values (ranging 1-6) greater than 2 were classified as barren habitat type. Quadrats that did not fit into

Figure 4.3 Bakeapple plant at the "turned in" stage, during which the shuck (calyx) is wrapped around the developing berry.

Two pickers explained that the shuck was a separate part of the plant, distinct from the blossom, and three said that the blossom "turned into" the shuck. Most did not explain the origin of the shuck. Interviewees described the "turned in" stage as particularly lengthy (around 3 weeks). As the berry grows, it starts to push out of the shuck at the top. Two interviewees described the initial color of the berry as "green," while all interviewees observed the berry changing from red - when the fruit expands and becomes exposed from the shuck - to orange. This is the ripe stage, in which the shuck has reflexed away from the berry, and the berry becomes soft, ready to be picked (Figure 1.2). The berries remain at this stage for a very short time (less than a week) and then become what interviewees referred to as "faded" or "fadee," which means the berry turns a pale, or greyish color. Most people interviewed would not pick bakeapples at this stage. Some interviewees (3) refer to this final state as "blighted." However, the word "blighted" also has another meaning; other interviewees (7) used it to refer to a bakeapple that "doesn't come to anything" (i.e., the berry is damaged, spoiled or does not mature). Some interviewees described a situation in which the shuck extends up around the berry but nothing grows inside (2), or in which the fruit that does develop dries up prematurely (1). The kinds of weather that can "blight" the bakeapples include hard wind (2), a lot of heat (1), and lightning (2). Most pickers interviewed (10) used the word "blighted" in one context or the other; two people had heard of the term but did not use it themselves and two others had never heard of it. Interestingly, of these four pickers who didn't use the word, three were among the youngest, between 35 and 41 years old and one had grown up outside the community.

4.3.3.1 Ripening time

All interviewees reported that bakeapples do not ripen all at once. For example, one bakeapple patch can be harvested up to three times over the course of a summer. Interviewees highlighted this as a difference from redberries (*Vaccinium vitis-idaea*), which ripen all together and can be harvested all at one picking. Interviewee 13 remarked,

> But like a partridgeberry [redberry], usually, one's ripe, they're all ripe, hey....But bakeapple, you know, might take two or three weeks, that you can keep going back to the same place and pick them.

Another factor identified by interviewees as influencing bakeapple ripening time is their proximity to the coast. Bakeapples occurring "inside," near Charlottetown, will ripen one to two weeks earlier than bakeapples on islands "outside," near the coast (e.g., Square Islands which is about 23 km from Charlottetown). Interviewees also commented that habitat type influences ripening time; ripening occurs more quickly for bakeapples growing in open habitats or on exposed hills and less quickly for bakeapples surrounded by shrubs or trees or growing in sheltered valleys or gulches. Interviewees also referred to a warm spring and hot summer weather as strong determinants of more rapid bakeapple ripening.

4.3.3.2 Influences on fruit production

All pickers identified the weather as the main factor influencing fruit production of bakeapple, and most prominently at the sensitive blossom stage. Interviewees described different kinds of damaging weather, including lightning and thunder (10), hard rain (9), frost (5), and hard wind (4). These weather conditions can potentially destroy the majority of blossoms in an area and thereby prevent berries from forming (Figure 4.5). The destruction of the blossom may not actually destroy the ability of the plant to produce fruit, but the lack of visible blossom could severely impede pollination, and would limit fruit production in this way.

Figure 4.4 Bakeapple plant with some petals removed, likely due to poor weather conditions.

Some pickers (3), however, observed that if a late frost or hard rain destroyed all the developed blossoms, some bakeapples might still fruit. Interviewee 7 remarked,

> ...Like in Hawkes Bay, you know, there's a little old marsh there, right in the door, almost....That'd be right white with blossoms, we was down there last year now....He come out, they was thick as could be, everything was white there, we got the hard rain that night, and the next morning there was hardly anything left, and I thought, wouldn't be nothing, but there was a good many berries in places after....But still see, that can happen once, might be another lot come out now yet, 'cause, they don't all come out one time. But then if you gets it again, you know, you mightn't get many berries the second time, but they don't all come out the one time, I'm telling you that now, 'cause, I knows that, they comes out different times, some is a bit later....

If these kinds of weather conditions have occurred, some (6) interviewees said that bakeapples will only be found in among the shrubs and trees (i.e., sheltered areas) and two remarked that they might also be found on the "lund" side (the lee side that is not hit by the wind) of the islands. Dry weather (4) is also said to be detrimental for developing fruit, and can result in the bakeapples "not coming to berries"; most dry weather effects were described to occur during the blossom stage but sometimes people (2) observed this happening after the fruits had turned in.

Interviewee 1, when describing how different kinds of weather conditions affect bakeapples, said,

> The sun dries them up and the wind blows them away and the rain knocks them off too… That sort of thing, if you got, the weather got to be sort of normal, hey, and nice normal weather, and showers of light rain and that sort of a thing, helps them to grow… And if you don't get the rain, it dries up, burns….

Some interviewee's (2) said that once the bakeapple reached the "turned in" stage, it was unaffected by the weather, while others (2) said it could still be affected by some adverse weather conditions, such as frost. Favorable weather conditions outlined by some pickers include an abundance of snow in the winter (2) and a balance of rain/fog/dampness (4) and warm weather (2) once the bakeapple has turned in. Interviewee 3 said the rain "brings the shucks away from the berry."

Other studies have reported similar relationships between bakeapple fruit production and weather. Many studies describe the sensitivity of bakeapple flowers to poor weather conditions such as frost (Makinen and Oikinaren, 1973; Resvoll, 1929; Taylor, 1971), but some also stated that other plant stages, such as buds, ovaries, green berries (Yudina, 1993) and large unripe berries (Resvoll, 1929) are also susceptible to damage by frost. Teetl'it Gwich'in elders had also noted that bakeapple is highly susceptible to poor weather conditions such as late frost or cold temperatures in the spring, hot weather, or drought in the summer (Parlee et al., 2004).

Most of the scientific literature highlights late frosts as the principal cause of mortality in bakeapple flowers (Agren, 1988a, Makinen and Oikarinen, 1974; Resvoll,

1929) while community members in Charlottetown seemed to emphasize hard rain and wind as the principal weather conditions that damage bakeapples. Resvoll (1929), however, also described developing fruits being destroyed by heavy rain or hail. There has been little documentation concerning the effects of lightning on the berries. Pickers from Newfoundland say lightning arrests the flower's development and turns the fruit white (Omohundro, 1994). Interviewee perceptions of the harmfulness of lightning may arise from the effects of accompanying intense storms (i.e., heavy rain and wind) rather than the direct effects of lightning.

4.3.3.3 Variation in berries

> ...There's always those small ones seems like every year, through the bigger ones, but the last year, was a lot of big ones....That's what people said, you know....I think they was right too, but there's certain places now, there's mostly big berries grows there, whatever does it too, in certain places (Interviewee 7)

Interviewees report that the size of bakeapple fruits can vary considerably among patches and years as well as within a patch in a given year. However, all pickers reported that there were larger berries in the sheltered areas relative to those found in the exposed mashes and some pickers (3) found larger berries on barren areas as well. Both sheltered habitats and barren areas were reported by pickers to have larger berries and lower densities of bakeapple plants than bog areas. Pickers also note that larger berries are also found at the bottom of hills and within depressions, or "valleys" on high elevation areas. Interviewees also discussed differences in the colour of the bakeapples, which can vary from pale orange to red. Interviewee 2 observed redder berries on more dry areas. Interviewee 7 noted that the larger bakeapples tend to have a paler colour. Interviewees generally preferred the redder berries (see Chapter 2).

A few interviewees (3) described black spots that sometimes appear on the berries, which they avoid while picking (Figure 4.6). These pickers stated that the number of berries affected by these spots will vary from year to year and that the affected berries are more prominent on certain islands. Interviewee 6 stated that Site CW (see Chapter 3) berries were most affected by this condition, and that some years he has found whole patches of bakeapples "ruined" by black spots. Two pickers attributed the black "pecks" to lightning, while another said they were caused by frost. Interviewee 7, when talking about the black spots, said,

> ....And you got to have some wet weather, seems like, to do berries good anyway, if you get the dry weather, and thunder and lightning, you gets a lot of that then and that, sometimes you'll see black spots on the berries... and they figures that's where they got struck with the lightning, that's what they say, hey... See a lot of that, some years....
> R = Do you pick the ones with the black spots?
> I = No, you try to get rid of them, not to pick them at all, if you can help it, hey?

Figure 4.5 Bakeapple fruit with black spots, attributed by a few pickers to weather events such as lightning and frost.

The fact that these black spots do not occur on particular plants consistently suggests that they are likely not a genetic trait. However, the observation that the spots are "worse" on specific islands or in particular areas suggests that there are certain localised environmental or biotic factors influencing this occurrence or potentially a genetic trait that is stimulated by variable environmental factors. These spots on the berries have not been described in previous studies on bakeapple and warrant further study to explore the causes and implications of this occurrence.

There are other local observations that could serve as the basis for future studies on bakeapple populations, such as the variations in the colour of the berries, which can vary from pale yellow to deep red in different areas. Another interesting observation was made by one interviewee, who commented that this year (2004) there were a lot of bakeapples that had the blossoms (petals) dried and stuck to the berry. He had discussed this with another resident and they both had agreed that this phenomenon was more prevalent this year than others. Both of these initial observations combined with the extensive knowledge of the area by local residents could inform further study to determine potential explanations for these observations; this could provide novel information on fruit production in wild bakeapple populations.

4.3.4.1 Animal consumption of bakeapples

Pickers identified a number of animals that consume bakeapples but the most common species identified were bears (4) and gulls (6). Other animals mentioned (each by a different picker) include: partridges, geese, crows, foxes, and groundhogs. All interviewees explained that animals do not eat the entire berry but rather, will "suck the juice" out of the bakeapple, and leave the rest (Figure 4.7). Interviewee 2 described a specific area where he thinks a small rodent eats the bakeapples, and he described how the animal often takes the largest berries. Interviewee 10 explained that on a particular Island where there is a resident bear, the people are always trying to pick the bakeapples on that island before the bear gets to them but he always beats them. Interviewee 9, when explaining how bears eat the bakeapples, said,

> You take a bear, he will fatten up over the summer, knowing he got seven months to sleep in the winter, and they'll live from that, usually, a lot of that is bakeapples....He'll get some fish from the river, but, not a lot... But mainly, he will just fatten himself up on bakeapples... and different types of berries, mostly bakeapples....That's his best food....You go to a nice spot of bakeapples, I showed you the other day, right?....We went around that whole bog area... where the bear been eating them... correct?.....You saw that yourself, right?
> R = You said he walks in a line, right?
> I = Yes, and then he might walk a straight line right across through, but if you go out through to that bog, out through Salt Pond, the bear was eating all around the edge of the bog, and that meant if he saw somebody, or something come, you know, he could jump, one jump and he's in the woods, he's sheltered....

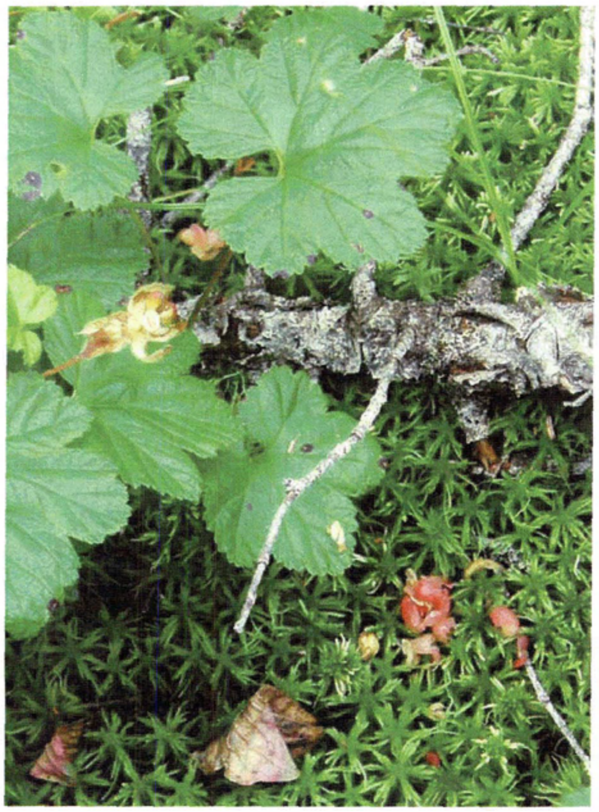


Figure 4.6 Evidence of animal consumption of bakeapples; fruit is partially consumed with remains of fruit left on moss.

Other studies report birds (Norway sea-birds, ravens, thrushes, red grouse, ptarmigan, grey lag goose), foxes and bears as the main consumers of bakeapples in other areas of the world (Resvoll, 1929). In fact, Resvoll (1929) attributed the high distribution of bakeapple populations between islands or above elevations where it normally grows in Norway to seed dispersal by frugivorous sea birds. Concerning the description by one interviewee of a small rodent eating bakeapples, Agren (1988a) also found evidence of bakeapple consumption by voles but they targeted primarily the ramets and developing buds rather than the fruits. Pickers observed that animal consumers often leave behind parts of the bakeapple fruits. This is interesting from both botanical and animal behaviour perspectives. Animals leaving some remains of the berry behind, may influence the seed dispersal of bakeapple. Some seeds would be transported and disseminated by the animal, and others would remain near the parent plant potentially to germinate in situ. Further study is required to determine why animals would not consume the entire berry and if and why some only "suck the juice" out of them.

4.3.4.2 Flies and worms

A few pickers (3) talked about the importance of flies for pollinating the flower during its blossom development stage. However, it may be that this aspect of bakeapple ecology was not understood traditionally. The source of this knowledge appears to have been an interviewee who had learned about bakeapple pollination from a visiting biologist; other interviewees who mentioned insect pollination during interviews were siblings of this picker. Another reference to insects during the interviews pertained to worms in the bakeapple fruits. Interviewee 12 stated there is a worm in the bakeapple prior to ripening, and it comes out once the bakeapple is soft.

4.3.5 Management of berry patches

All interviewees reported that there were no techniques employed locally to enhance growth or fruit production in the bakeapple. Some interviewees (4) did say, however, that burning bakeapple patches would be useful. Some pickers (4) stated burning was good for partridgeberries (redberries) but not for bakeapples; other pickers (3) said it would be beneficial to burn. Interviewee 12 saw the potential benefits in burning but was concerned about the fire spreading to other islands and summer houses. Interviewee 2, when talking about burning, said,

> Yeah, well a burned area is really good for berries, after three years? It's really good, 'cause in that burned spot down there, now that's where we're getting the blueberries at… There's a lot of blueberries, grows there, before that you, I don't know, probably, you wouldn't get a cupful there, and now there's just gallons on top of gallons you can pick there, hey?
> R = And it's good for bakeapples too?
> I = Yeah it's good for bakeapples, certain area, really good for bakeapples, I goes there every year, all I hope is no one comes there, cause I gets the big berries, hey?...'cause it's a new area.
> R = Has anyone burned it on purpose, any other bakeapple spot?
> I = No, no, it caught with the lightning.

The interviewees who advocate burning say this would help bakeapples (and other berries) grow better by clearing the land of shrubs and caribou moss that proliferate on the islands over time and inhibit bakeapple growth. A few islands were burned purposely in the past (16 and 50 years ago) to promote partridgeberry growth but burning as a method of habitat management seems to be discouraged in the community. Interviewee 8 suggested this is likely due to the concern over the risk of damaging homes, including summerhouses; this fear appears to have influenced people's perspective on this strategy. Burning has been found in some studies to be beneficial for bakeapples. Burned bakeapple areas showed increases in above ground matter yield (shoots, leaves) and "enhanced" fruit production (Taylor and Marks, 1970).

4.3.6 Bakeapple pickers as an influence on fruit production

4.3.6.1 Pulling out bakeapple stalks, trampling berry grounds

There were a few observations made by interviewees regarding the potential influence of the pickers themselves on the bakeapple populations. One relates to the potential harm associated with pickers pulling the stalks from the ground while picking. This was a concern of some interviewees (discussed in Chapter 2) because they felt that it was damaging to the bakeapples and that the plant would possibly not return the following year. While these concerns may primarily reflect a local effort to prevent people from harvesting bakeapples before they are ripe, there, there could in fact be biological effects from pulling up the stalks. Bakeapple rhizomes have been found at varying depths, from 0-30 cm (Taylor, 1971; Wallen, 1986). The overwintering bud begins to develop on the rhizome during "midsummer," and these will grow in the following spring into the next year's shoot (Taylor, 1971). If harvesters were to pick unripe berries and pull out the stalks while this bud was developing, they could potentially harm the bud and prevent it from growing. They could possibly also damage the rhizome supporting the ramet, but the likelihood of damage would depend on the depth of the rhizome; damage would be more likely the closer the rhizome is to the surface of the bog.

A few of the older interviewees expressed displeasure over berry grounds being "trampled" by other pickers. This frustration was tied both to the trampling of fruits that could potentially have been harvested that season, and to instances where just the plants had been trampled. One person viewed this as being very disrespectful to the bakeapples. It is difficult to determine if such trampling is harmful to future ramet or fruit production or if it is primarily a cultural perspective of one's relationship with the plant. Both trampling and pulling of stalks could influence the genet overall; by destroying the ability of the plant leaf to photosynthesize before the plant senesces for the winter, this potential energy is no longer available, either for vegetative growth (which occurs after fruit production) or cycling back within the genet/rhizome.

A few interviewees also mentioned one particular area in town that used to produce bakeapples but where the potential for the area to produce fruit had been destroyed due to considerable use by ATVs (all-terrain vehicles). Interviewee 3 commented that his friends from the Straits area were concerned about ATV use on bakeapple patches in their area. ATV's became popular in the late 1980's in Newfoundland and Labrador and now that machines are used as transportation to and from picking grounds, some pickers say they crush the beds and are responsible for an observed decline in berry yields (Omohundro, 1994).

4.3.6.2 Areas in which bakeapples are picked or not picked

While interviewees themselves did not discuss this, their patterns of bakeapple use, in terms of the areas they pick or do not pick, would certainly have an influence on bakeapple patches. In certain areas that are picked extensively, the number of fruits available for dispersal and eventual recruitment of new plants would be diminished. Picking could potentially influence the genetic composition of bakeapple populations, whereas areas less commonly visited might retain higher genetic variation than areas where the rate of recruitment has been decreased. Those bakeapple areas that are more commonly visited and harvested would then rely mainly on vegetative reproduction. However, existing research has established that the majority of bakeapple biomass (94%) is allocated to vegetative reproduction (Dumas and Maillette, 1987) and that bakeapple seedlings are rarely found in the wild (Resvoll, 1929). Consequently, due to the potentially low occurrence of seedling germination in bakeapple populations, the actual extent to which bakeapple picking patterns influence recruitment in this species remains uncertain.

4.4 Conclusion

In summary, combining local ecological knowledge and scientific knowledge about bakeapples has provided a more complete understanding of bakeapple fruiting in this area and has provided novel observations worthy of further research. Community members' descriptions of variable densities, fruit sizes and ecological characteristics associated with certain habitat types have been tentatively supported by quantitative data collected in the local area. Their observations about specific weather conditions and the sensitivity of the blossom stage in relation to fruit development are largely supported by the scientific literature, but have introduced more information that could lead to further study, such as potential factors correlated with lightning that would affect bakeapple fruits and the relative sensitivity of the blossom stage vs the "turned in" stage in terms of fruit set.

Local observations and descriptions of bakeapple use patterns in the Charlottetown area have illustrated how humans can modify and influence bakeapple populations, both positively and negatively. They also have provided unique information on animal consumption of bakeapple fruits, such as the particular way in which bakeapples are consumed by some animals. Finally, there are a few observations about variations in berry qualities, such as black spots and variation in color that warrant further study. The observations of these black spots, particularly, provide an interesting foundation for future research to determine the genetic and environmental factors responsible for this phenomenon. Local ecological knowledge and scientific knowledge have provided both complementary and varying perspectives on influences on sexual reproduction and fruit development in this species. This information can be used in enhancing fruit production in wild populations, which would benefit local peoples who still rely on this resource. Furthermore, these observations can also aid in understanding the biology of this species as a representative dioecious, clonal, circumpolar flowering plant.

Chapter 5. Conclusions

5.1 Summary

Bakeapple (*Rubus chamaemorus* L.) inhabits areas with unpredictable and extreme weather and habitat conditions, which poses many challenges to reproduction. Fruit production in this species is of interest from both social and ecological perspectives. Peoples inhabiting the circumpolar areas where bakeapple is found often rely on a predominantly meat-based diet, and this berry has served as a vital source of Vitamin C for many of these groups. Since the plant has adapted to the unpredictable environmental conditions of northern peatlands through a reliance on clonal growth, it is of interest to determine how much sexual reproduction is maintained in this dioecious species.

In southeastern Labrador, the area of my study, bakeapple populations are found on coastal islands proximal to Charlottetown, and residents traditionally relied on these berries for subsistence. Although Charlottetown is a recently established community, there have been some major changes in this area since its establishment, primarily the imposition of the cod-fishing moratorium and the establishment of a shrimp processing plant, which have influenced how people use their berry resources. Changes that have resulted from the moratorium include families/pickers being located further from bakeapples at picking time, decreased available time for families to harvest bakeapples together, and better economic conditions for community members (see Chapter 2), enabling them to access marketed fruit more readily. The areas where people pick bakeapples are becoming less defined by the communities from which they fished. This is likely facilitated by the availability of faster transportation, allowing for further travel, and year-round residence in Charlottetown, necessitating that everyone travels from this location to pick bakeapples.

Bakeapple can be considered a cultural keystone species for the people of Charlottetown, with indicators of its importance including the language and diverse vocabulary associated with bakeapple picking, the large quantities harvested, its use as a trade and gift item and the dominance of bakeapple as a discussion topic during bakeapple picking time. Whereas previously bakeapples served as a vital component of diet, they now serve only a supplementary role, being picked more out of tradition, enjoyment of the taste of the berries and in response to increasing commercial interest in these berries rather than out of dietary necessity. While there has been a prominent shift in the reason why residents pick bakeapples, these berries remain an important part of this community. It is unknown, however, what affect the lack of interest by younger community members in bakeapple picking, as noted by the interviewees, will have on the future of bakeapple picking in this community. The community members who enjoy bakeapple picking are individuals who grew up with this activity. Youth who have not been so intensively exposed to picking bakeapples may not wish to pick them as adults or teach their own children how to do it.

Many community members commented that during the study (summer 2004) they had not seen such plentiful bakeapples in their area (and all over the southeast coast of Labrador) in 10-30 years. During the study, the weather conditions were quite mild, which allowed bakeapple populations to take advantage of this “favourable” year with high fruit production in all areas. The mild summer weather likely explained why there were no relationships observed in my study between temperature or shelter measurements and bakeapple reproduction (Chapter 3). Peat depth, soil moisture and pH likewise did not show strong correlations with any reproductive variables measured, perhaps because these characteristics varied over a relatively narrow range in these peat bogs.

In addition to the relationship between environmental variables and reproductive stages in bakeapple, I also investigated relationships among factors specific to dioecious species and their reproductive stages. Populations, on average, had male biased ramet sex ratios, which is common among dioecious species. A greater propensity for flowering by males than by females contributed to this bias. Sex ratio and distance between male and female flowers had the strongest influence on reproduction (female biased sex ratios and distances of >10 cm between male and female flowers both tending to decrease seed set). There do not appear to be any specific environmental microhabitat differences between males and females in these populations. The biased sex ratios within sample quadrats suggest that vegetative growth has resulted in large clone sizes in the study area, which have led to possible limitations on sexual reproduction. However, the high fruit set (0.75) suggests that these populations can still take advantage of favourable years, such as occurred last summer (2004), through high fruit production.

I was able to learn that last summer was an exceptional year for bakeapple fruiting in southeastern Labrador through the recording of local ecological knowledge of bakeapple by Charlottetown community members. Community members' reliance on this berry as a food resource has resulted in particular observations about local bakeapple populations, which have been passed down from generation to generation. The previous studies addressing traditional use of bakeapple provide little information concerning local observations on the ecology of this plant and major influences on the fruit production. My interviews revealed insightful local observations on the phenological development of bakeapple over the summer, notably at the most sensitive blossom stage and later at the less vulnerable "turned in" stage. Most developmental changes in bakeapple were described in terms of the "shuck" (calyx), as it protected the developing berry and then signaled that the berry was ripe by reflexing completely away from the fruit. Community members also described three different types of bakeapple habitats, which were termed bog or "mash", sheltered and barren. They associated different ramet densities and fruit sizes with these different habitats and these were generally supported by the ecological data I collected on local populations. Their observations introduce new information regarding densities and fruit sizes associated with bakeapple in different habitats, most notably, the variable patterns found in bogs and barrens, which are both open habitats but distinctive in other ecological parameters. I also explored how community residents themselves could be influencing local bakeapple populations through means such as their selection or avoidance of certain plants/ramets or pulling the stalks out when picking the berries.

5.2 Linking of LEK and scientific knowledge

My study aimed to document both local ecological knowledge (LEK) and scientific ecological knowledge relating to bakeapple. A number of other studies have integrated local or traditional ecological knowledge with scientific knowledge for study of a species or ecosystem in order to gain a more comprehensive perspective (Chaffey, 2003; Ferguson et al., 1997; Garibaldi, 2003; Mallory et al., 2003; Mymrin et al., 1998; Neis et al., 1999). These studies contend that, although there are sources of bias and discrepancies between the two sources of knowledge, overall, it is beneficial to incorporate both when conducting a study aimed at better understanding a species and its requirements. Local residents and users of a resource can provide detailed information about it over a restricted spatial scale but a long time interval. This long-term cumulative information can effectively complement the quantitative but short-term data gathered in scientific research. It is important, however, that local observations be interpreted within the cultural context of the community. Charlottetown residents observed changes in bakeapple populations over the years they and their forerunners had been picking them. Although their knowledge may be focused on the particular bakeapple populations in the area where they picked, the information they do provide is often very detailed and perceptive.

There were some sources of potential biases from the interviewees that were outlined in Chapter 2, such as factors such as the summer fishing community, social relations, and areas visited in their lifetime, which would have influenced interviewee comments. Such biases are somewhat inevitable. Some perceptions could have been clarified by conducting group interviews after the individual interviews had taken place. Spending longer times with the residents and pickers in bakeapple picking areas, and participating more fully in several seasons of picking and processing bakeapples, would very likely have yielded clearer, more accurate, and more complete local knowledge and perspectives. Using a tape recorder to record interviews may also have constrained people's responses during interviews, since some felt uncomfortable being taped. Nevertheless a total of 36 hours of interviews with 15 experienced and knowledgeable pickers provided my study with insights and valuable information.

Working with a local community to record local ecological knowledge provided a good opportunity for reciprocal knowledge sharing. Community members did not know about the dioecious nature of the plant, so while they shared all their knowledge about bakeapple populations, I was able to share some information with them. Local knowledge is valuable not only for the way in which it can add to scientific knowledge of a species, but also in that it represents a different way of interpreting the biology of a species and human beings' relationship with it.

5.3 Concerns of community members

There were some concerns that surfaced a few months after I arrived. One concern was that after I conducted my study, residents might need to buy permits to pick their bakeapples in the area. This concern likely arose out of the fact that the residents had seen many "researchers" come into their town to ask questions about a resource (e.g., salmon) and after this, they were then required to buy permits to use this resource and were restricted in the times and amount they could harvest. One resident expressed discontent over the way some previous research has been done in their town, where someone has come into the community, asked a select few people questions and then left, while most residents didn't know what this research was about. Some residents were concerned that I would potentially share their bakeapple picking areas in my thesis or community report, thus giving outsiders or local residents access to "their" spots. These concerns highlight the importance of carrying out respectful research in which participants are told that they have control over how their information is used, and ensuring that the whole community is made aware of projects carried out.

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Appendix 1

Consent Form
UNIVERSITY OF VICTORIA
OFFICE OF THE VICE-PRESIDENT, RESEARCH
HUMAN RESEARCH ETHICS COMMITTEE

Participant Consent Form

The ethnobotany and ecology of *Rubus chamaemorus* (bakeapple) in southern Labrador

You are being invited to participate in a study entitled "**The ethnobotany and ecology of Rubus chamaemorus (bakeapple) in southern Labrador**" that is being conducted by Amanda Karst. Amanda Karst is a graduate student in the Department of Biology at the University of Victoria and you may contact her if you have further questions by email <alk@uvic.ca>; or phone (250) 472-4694 (work).
As a graduate student, I , Amanda Karst, am required to conduct research as part of the requirements for a biology degree. It is being conducted under the supervision of Dr. Nancy Turner (School of Environmental Studies) and Dr. Gerry Allen (Department of Biology), both at the University of Victoria. You may contact Dr. Nancy Turner at (250) 721-6124 or <nturner@uvic.ca>, Dr. Gerry Allen at (250) 472-7110 or gallen@uvic.ca, and Dr. Barbara Neis at (709) 777-8249 or <bneis@mun.ca>.

This research is funded by a post graduate scholarship from the Natural Sciences and Engineering Research Council of Canada that was awarded to Amanda Karst for her graduate studies. <will add NSTP and MEC funding if I am awarded the grants>

The objective of this research is to determine the importance of the bakeapple to your community and gather traditional knowledge about this plant. I will conduct an ecological study on wild bakeapple populations to determine ideal habitat conditions for the highest berry yield. I plan to integrate traditional knowledge about the bakeapple into this ecological study.

This research is important because it will provide recognition for the historical and traditional use of the bakeapple by your community. This research could be applied to local management of bakeapple populations for traditional and possibly small-scale commercial harvesting.

You are being asked to participate in this study because you are a plant and/or cultural specialist in your community[3]. If you agree to voluntarily participate in this research, your participation will include a one-to-one interview that will be one to two hours in length at a location in your community or at your home. If you are willing, additional interviews may be requested. The number, length and location of interviews are up to you, and other family or community members may be present if you choose. **The interviewer may wish to audio and/or video record the interviews. If this is the case, you will be asked for consent before recording begins. This recording will not be necessary for the interviews and if you wish the interviews can proceed without being audio or video recorded. At any time you may ask for the audio or video recorder to be turned off.** If given consent you may also be observed and photographed while harvesting bakeapple, if you are willing.

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[3] Alternate reason: You were referred to me by a member of your community, or a member of the Town Council.

Participation in this study may cause some inconvenience to you, as the time you take to participate in interviews may infringe on time usually spent fulfilling other duties and responsibilities.

There are some potential risks to you by participating in this research. You may be concerned about providing information about the whereabouts of your personal bakeapple harvesting area. All information concerning locations of bakeapple patches will remain confidential; I would only set up plots in these areas with permission, and I would not return to these areas if not given consent to do so.

The potential benefits of your participation in this research include financial compensation for your time, having your knowledge recorded, and recognition for your knowledge.
As a way to compensate you for any inconvenience related to your participation, you will be given payment of $25.00 per interview. It is important for you to know that it is unethical to provide undue compensation or inducements to research participants and, if you agree to be a participant in this study, this form of compensation to you must not be coercive. If you would not otherwise choose to participate if the compensation was not offered, then you should decline.

Your participation in this research must be completely voluntary. If you do decide to participate, you may withdraw at any time without any consequences or any explanation. If you do withdraw from the study your data will be used in the study analysis ONLY if you agree.

To make sure that you continue to consent to participate in this research, we will discuss your participation on each occasion that we request an interview and you will be given full opportunity to withdraw from the study, without question.

This research may be used in a commercial situation. Possibly it will eventually inform small-scale commercial harvesting but this would be at the discretion of your community.

Your anonymity will be **partially** protected if you request it. **If you request to remain anonymous, in all written notes you will only be identified by a fictitious name or by coded initials. As well, any identifying information will be removed from the outcomes of the study. In all interviews any personal information will be considered confidential, and no personal information will be recorded or reported without your specific permission.**

The data from this study may be used in the future by being incorporated into ongoing ethnobotanical studies, but only with permission of the participants or their families.

Data from this study will be destroyed ONLY if you request it.

The interviews will be transcribed and you will be given the opportunity to review them and delete or edit any parts that you would not, in retrospect, wish to share with others. It is anticipated that the results of this study will be shared with others in one or more of the following ways: directly with you; in my thesis, in published articles; in presentations at scholarly meetings; or in community-based booklets or other resources that can be distributed to interested individuals and groups in the area. Also, the Labrador Straits Development Corporation is planning to build a Natural Heritage Center in Labrador and I could possibly display the results of this study (perhaps in poster form) in this center if the participants give permission for me to do so.

If given permission, I would like to take photographs of participants, possibly engaged in activities such as bakeapple gathering, processing and management. You will also have an opportunity to look at photos taken of you to decide if you want them to be used or not.

In addition to being able to contact the researcher and the supervisors at the above phone numbers, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Associate Vice-President, Research at the University of Victoria (250-472-4362).

Your signature below indicates that you understand the above conditions of participation in this study and that you have had the opportunity to have your questions answered by the researchers.

Name of Participant		*Signature*		*Date*

A copy of this consent will be left with you, and a copy will be taken by the researcher.

UNIVERSITY OF VICTORIA
OFFICE OF THE VICE-PRESIDENT, RESEARCH
HUMAN RESEARCH ETHICS COMMITTEE

Participant Consent Form

The ethnobotany and ecology of *Rubus chamaemorus* (bakeapple) in southern Labrador

You are being invited to participate in a study entitled "**The ethnobotany and ecology of Rubus chamaemorus (bakeapple) in southern Labrador**" that is being conducted by Amanda Karst. Amanda Karst is a graduate student in the Department of Biology at the University of Victoria and you may contact her if you have further questions by email <alk@uvic.ca>; or phone (250) 472-4694 (work).
As a graduate student, I , Amanda Karst, am required to conduct research as part of the requirements for a biology degree. It is being conducted under the supervision of Dr. Nancy Turner (School of Environmental Studies) and Dr. Gerry Allen (Department of Biology), both at the University of Victoria. You may contact Dr. Nancy Turner at (250) 721-6124 or <nturner@uvic.ca>, Dr. Gerry Allen at (250) 472-7110 or gallen@uvic.ca, and Dr. Barbara Neis at (709) 777-8249 or <bneis@mun.ca>.

This research is funded by a post graduate scholarship from the Natural Sciences and Engineering Research Council of Canada that was awarded to Amanda Karst for her graduate studies.

The objective of this research is to determine the importance of the bakeapple to your community and gather traditional knowledge about this plant. I will conduct an ecological study on wild bakeapple populations to determine ideal habitat conditions for the highest berry yield. I plan to integrate traditional knowledge about the bakeapple into this ecological study.

In the course of this research I would like to take pictures of you, possibly engaged in activities such as bakeapple gathering, processing and management. It is anticipated that the results of this study will be shared with others in one or more of the following ways: directly with you; in my thesis, in published articles; in presentations at scholarly meetings; or in community-based booklets or other resources that can be distributed to interested individuals and groups in the area. Also, the Labrador Straits Development Corp is planning to build a Natural Heritage Center in Labrador and I could display the results of this study (perhaps in poster form) in this center if the participants give permission for me to do so.

If I am given permission to take photographs of you, I will provide you a copy of the photographs. If I would like to include them in my thesis, published articles, presentations or posters, I will review each photograph with you, and obtain permission to use them. You can let me know if there are any ways you do not want photographs of you displayed.

In addition to being able to contact the researcher and the supervisors at the above phone numbers, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Associate Vice-President, Research at the University of Victoria (250-472-4362).

Your signature below indicates that you understand the above conditions of participation in this study and that you have had the opportunity to have your questions answered by the researchers.

Name of Participant		*Signature*		*Date*

A copy of this consent will be left with you, and a copy will be taken by the researcher.

Archival Deposit/Access Form

Name_______________

Project: Traditional use and reproductive ecology of *Rubus chamaemorus* (bakeapple) in Southeastern Labrador.
Amanda Karst, University of Victoria, Masters Candidate

As a member of the Labrador Metis Nation, I give permission for the original tapes and maps from my interviews to be deposited with the LMN at the completion of the project.

Access to the deposited interview materials should be:

a) at the discretion of the organizational representative with responsibility for these materials
b) only with my written permission
c) only after ________years from the date of this interview

Signed

____

Appendix 2

List of Questions for Interviewees
Interview Schedule

Basic Demographics
For this first part of the interview, we will ask some general background questions regarding age, background in picking bakeapples, education, etc.

1) Age ___________

2) Gender M _____ F _____

3) Community where born? _____________________________

4) Where currently living? _____________________________

5) Father's occupation _________________________

6) Mother's occupation ______________________________

7) Marital Status single, married, divorced, common law, widowed (circle) other _____________

8) Occupation _______________________________

9) Spouse's occupation _________________________

10) Did your spouse also pick bakeapples?

11) Number of children _____________

12) Do any of your children pick bakeapples right now/ do they like to/do some enjoy it more than others? Yes ________ No ________ If yes, how many? ________

13) Would you/ are you encouraging any of your children to pick bakeapples Yes ______ No _______

14) Your education level < Grade 8 Grades 9-11 Graduated High School (circle)

2. Bakeapple picking experience Start tape recording here.

In the next part of the interview, we will ask you some questions about your experience with picking bakeapples—where you have picked, for how long, etc. and about who you have picked with.

15.) How many generations has your family been picking bakeapples? 1 2 3 >3 generations (circle)

16.) Always based in this community? Yes _____ No ______ If no, explain: ____

17.) Age when you started picking bakeapples ______

18.) General areas where you have picked bakeapples in your lifetime? ________________

19.) Any gaps in bakeapple picking Yes ______ No _____ If yes, when?___________ how long? __________

20.) Last season picked ________

21.) Total years picking __________

22.) Who did you pick with when you started? __________________

23.) Who taught you how/where to pick? _________________

Interview Schedule

* Is there any other local names for this plant besides bakeapple? What does this name mean/how did this name come to be?
* Are there any "relatives"/plants considered "similar" to the bakeapple?
* Describe bakeapple in the spring when the snow goes. Describe how it changes over the spring, summer, fall. Do these different stages have different names? What does "turned in", "shucks", "mash", "blighted" mean?

Starting when you first starting picking bakeapples (when you were young)
* What is your first memory of bakeapples?
* Who did the picking (age, gender)? Any rules about gathering?
* When did gathering happen (time of year), how do you know when? Any rules about when gathering could happen?
* Where did you pick? (near fishing areas, where parents gathered)? Did different families pick in certain areas? (I heard that in those times, people respected each others traplines, was this the same with bakeapple patches?). Any rules about where you gather?
*Did your areas change from year to year? Lets say the area you always went wasn't very good, and you went to another would this place always be the same, or would it depend on the weather etc?
* How do you pick them, was there any way your parents showed you how to pick them? What did you put them in when you picked (container)? Rules? Did you eat the berries when you were picking them?
* Did you (or your parents/grandparents) pick any other berries/plants, animals (birds, fish) at the same time as you were bakeapple picking?
* Did you have any other traditions while out picking bakeapples?
*How much would you gather, on average? Whats the smallest and greatest amount your family picked when you were young?
* Once they were all picked, what did do with them/did you have to do anything with them before you could eat them or store them? How did you eat the berries? Eaten raw, cooked, combined with anything? Dishes?
* How did you store it for the winter?
* During the years that bakeapples were not plentiful, how did that affect people (health)? Was there always enough to last for the winter?
* Did your parents/grandparents tell you anything about picking bakeapples when they were younger?

Now think of when you picked bakeapples around the time when you were a parent:
* Who did the picking then (spouse, kids, parents)? Any rules about who picked? How young were your children when you started to take them out picking?
* When did gathering happen (time of year), Did you check the bakeapples the same way you did when you were a kid to see if they were ripe (go look, touch)? Any new rules about when you could pick or notice any differences about when people would pick (more people picking when shucks still on)?
* Did you pick in the same areas you picked as a kid (near fishing areas)?

* Did your areas change from year to year? Did you gather in any new areas (besides where your parents gathered)? Where are these areas? Any rules about where you picked?
* Did you still gather them the same way you did when you were younger? The same kinds of containers? Rules? Did you eat the berries when you were picking them?
* Did you gather any other plants or animals, etc. at the same time as you were bakeapple picking?
* How much would you gather, on average? Whats the smallest and greatest amount your family picked?
* What did you do with the berries once they were picked? Did you eat them in any new ways?
* How was it stored?
* During the years that bakeapples were not plentiful, how did that affect people (health)? Did you pick the same amount of bakeapples as when you were young? Was there always enough to last for the winter?

* How do you know where to find bakeapples? If you went to new spots other than where your parents went, how did you find the good spots to go to? Just looked around/look for anything in particular (in the landscape)?
* Do you notice anything in the areas where you find really good bakeapples or areas where they're not as good? Describe, water, other plants (trees vs shrubs, caribou moss, grass), flat/hilly land
* Do the good and bad spots stay the same, or change a lot? Any pattern?
* What kinds of places do you go look if theres been a hard rain?
* What kinds of things affect how good the berries will be that year
* When was a "good" year for bakeapple/ "bad" year? What do you think was the cause?

Now think of when you picked bakeapples now that you are a grandparent:
* Does everyone still go out to pick bakeapples? (age, gender)? Any gender or age that tends to be out picking more often? Any rules about who picks?
* Does bakeapple picking still happen around the same time of year? Is it more difficult to check to see when the bakeapples are ready when you aren't living out on the islands anymore? Any other way to know if they are ripe (from here in town?) Any changes in when people pick bakeapples (more people taking unripe berries)?
* Do you still pick in the same areas as before? (if not, where are the new places/islands) Have you noticed any changes in where everyone else picks? Do your areas change from year to year? Are there any places with good bakeapples that you won't go to? (if so, why)
* Do you still pick them in the same way as when you were younger? In the same types of containers? Rules? Did you eat the berries when you were picking them?
* Do you gather any other plants or animals, etc. at the same time as you pick bakeapples?
* How much would you gather, on average? Whats the smallest and greatest amount you've picked lately?
* Do you do anything different with the berries once they are picked? Did you eat them in any new ways?
* How do you store bakeapples for the winter?

* Do you think if families did not get any bakeapples for the winter, that it would affect people in the same as it did when you were younger?

* Is there anything done to help bakeapple plants produce more berries?
* Do you burn over bakeapple patches?

* Are there any stories/myths/songs about the bakeapple?
* Is bakeapple an important plant to you/your community? Why?
* Do you think bakeapple was more important to the community when you were young than now?
* Is the bakeapple used for anything else besides food?
* What do you think are the biggest changes in the use of bakeapple between you and your grandparents/parents, grandchildren/children
  - how many bakeapples you find, how they are picked and eaten, how much people enjoy bakeapple picking?
* Why do you think these changes happened?

Appendix 3

Table 3.1 Summary statistics for environmental and reproductive variables measured at five Intensive *R. chamaemorus* sites

Site	Variable	N	Minimum	Maximum	Mean	Standard Error	Standard Deviation
BN	Peat depth (cm)	50	14	101	61.1	4.74	33.49
	Shelter: Tallest (cm)	50	0	87	17.5	3.3	23.34
	Shelter: Average Height (cm)	50	0	80	12.62	2.45	17.30
	Shelter: Proportion 45 degrees (%)	50	0	95	25.5	5.07	35.88
	Shelter: Density (cm)	50	0	90	22.5	4.25	30.07
	Shelter: Distance Nearest (cm)	50	1	615	219.6	31.56	223.12
	Shelter: Height Nearest (cm)	50	15	182	51.98	5.66	40.08
	Soil moisture (%)	50	82.2	93.8	88.2	0.330	2.33
	PH	50	3.68	4.17	3.92	0.015	0.107
	Ramet density	50	21	302	132.3	9.75	68.97
	Leaf area (%)	50	0.086	1.19	0.261	0.030	0.215
	Flower: ramet	50	0.095	0.619	0.285	0.018	0.124
	Fruit set	48	0	1	0.779	0.034	0.239
	Seed set	46	0.258	1	0.699	0.030	0.206
	Weight of berry	46	0.06	0.98	0.49	0.03	0.21
	Average druplet weight	46	0.005	0.086	0.041	0.002	0.016
	Total ovules	46	5	21.5	12.3	0.46	3.11
	Female proportion (/total ramets)	50	0.00	0.323	0.122	0.012	0.086
	Male proportion (/total ramets)	50	0.00	0.476	0.162	0.018	0.130
	Nonfloral proportion (/total ramets)	50	0.381	0.905	0.716	0.018	0.124
	Distance to nearest	48	1	848	102.32	30.35	210.28

Table 3.1 continued

Site	Variable	N	Minimum	Maximum	Mean	Standard Error	Standard Deviation
CJ	Peat depth (cm)	50	15	101	58.32	3.99	28.22
	Shelter: Tallest (cm)	50	0	137	21.6	3.63	25.70
	Shelter: Average Height (cm)	50	0	90	16.46	2.49	17.63
	Shelter: Proportion 45 degrees (%)	50	0	80	16.10	2.897	21.49
	Shelter: Density (cm)	50	0	35	9.52	1.50	10.64
	Shelter: Distance Nearest (cm)	50	1	270	44.52	9.37	66.25
	Shelter: Ht Nearest (cm)	50	15	165	27.98	3.41	24.08
	Soil moisture (%)	49	83	94	89.16	0.368	2.57
	PH	49	3.6	4.45	3.91	0.019	0.135
	Ramet density	50	45	334	153.18	11.49	81.26
	Leaf area (%)	50	0.061	0.385	0.152	0.010	0.071
	Flower: ramet	50	0	0.466	0.192	0.018	0.127
	Fruit set	39	0	1	0.713	0.055	0.343
	Seed set	35	0.182	1	0.725	0.032	0.191
	Weight of berry	35	0.130	1.18	0.598	0.045	0.267
	Average druplet weight	35	0.013	0.126	0.067	0.005	0.028
	Total ovules	35	5	17	8.96	0.365	2.16
	Female proportion (/total ramets)	50	0.00	0.216	0.058	0.009	0.060
	Male proportion (/total ramets)	50	0.00	0.397	0.134	0.016	0.113
	Nonfloral proportion (/total ramets)	50	0.534	1.00	0.808	0.018	0.127
	Distance to nearest	38	3	85	20.47	3.22	19.84

Table 3.1 continued

Site	Variable	N	Minimum	Maximum	Mean	Standard Error	Standard Deviation
CW	Peat depth (cm)	50	21	101	60.70	3.94	27.85
	Shelter: Tallest (cm)	50	0	91.0	18.1	2.77	19.6
	Shelter: Average Height (cm)	50	0	54	14.1	2.02	14.3
	Shelter: Proportion 45 degrees (%)	50	0	90	37.6	4.49	31.8
	Shelter: Density (cm)	50	0	75	12.5	2.65	18.7
	Shelter: Distance Nearest (cm)	50	1	986	185.4	44.65	315.8
	Shelter: Ht Nearest (cm)	50	2	103	34.3	2.73	19.3
	Soil moisture (%)	50	85	91.6	88.8	0.242	1.71
	pH	48	3.74	4.28	3.97	0.020	0.139
	Ramet density	50	37	294	119.5	7.68	54.3
	Leaf area (%)	50	0.089	0.541	0.227	0.014	0.099
	Flower: ramet	50	0	0.583	0.236	0.017	0.120
	Fruit set	48	0	1	0.775	0.038	0.263
	Seed set	47	0.300	1.00	0.709	0.023	0.155
	Weight of berry	47	0.100	0.780	0.466	0.023	0.158
	Average druplet weight	47	0.012	0.083	0.047	0.002	0.014
	Total ovules	47	7	14.2	9.80	0.198	1.36
	Female proportion (/total ramets)	50	0.00	0.197	0.084	0.007	0.050
	Male proportion (/total ramets)	50	0.00	0.407	0.145	0.014	0.099
	Nonfloral proportion (/total ramets)	50	0.444	1.00	0.771	0.017	0.118
	Distance to nearest	47	0	1	0.723	0.066	0.452

Table 3.1 continued

Site	Variable	N	Minimum	Maximum	Mean	Standard Error	Standard Deviation
JP	Peat depth (cm)	50	17	101	69.90	3.42	24.21
	Shelter: Tallest (cm)	50	0	61	25.90	2.16	15.24
	Shelter: Average Height (cm)	50	0	48	20.04	1.50	10.63
	Shelter: Proportion 45 degrees (%)	50	0	90	25.8	3.60	25.38
	Shelter: Density (cm)	50	0	90	28.1	3.82	26.99
	Shelter: Distance Nearest (cm)	50	5	207	40.20	5.03	35.58
	Shelter: Ht Nearest (cm)	50	12	180	34.64	4.03	28.53
	Soil moisture (%)	50	82.1	93.9	88.32	0.28	1.98
	pH	49	3.65	4.44	3.98	0.022	0.155
	Ramet density	50	22	323	129.84	8.67	61.24
	Leaf area (%)	50	0.86	0.68	0.22	0.02	0.11
	Flower: ramet	50	0.027	0.589	0.239	0.015	0.104
	Fruit set	49	0.154	1.00	0.615	0.037	0.260
	Seed set	49	0.111	1.00	0.497	0.034	0.240
	Weight of berry	49	0	0.640	0.288	0.020	0.139
	Average druplet weight	49	0	0.064	0.027	0.002	0.012
	Total ovules	49	7.6	14.8	10.59	0.237	1.66
	Female proportion	50	0.00	0.673	0.158	0.015	0.108
	Male proportion	50	0.00	0.556	0.094	0.018	0.130
	Nonfloral proportion	50	0.224	0.973	0.748	0.018	0.128
	Distance to nearest	49	2	323	61.88	11.19	78.31

Table 3.1 continued

Site	Variable	N	Minimum	Maximum	Mean	Standard Error	Standard Deviation
NW	Peat depth (cm)	50	24.0	101.0	45.8	2.70	19.1
	Shelter: Tallest (cm)	50	0	43	4.58	1.48	10.5
	Shelter: Average Height (cm)	50	0	30	3.54	1.11	7.84
	Shelter: Proportion 45 degrees (%)	50	0	85	10.2	3.48	24.6
	Shelter: Density (cm)	50	0	60	5.04	1.88	13.3
	Shelter: Distance Nearest (cm)	50	2	846	322.7	34.2	241.5
	Shelter: Ht Nearest (cm)	50	15	240	69.5	12.5	88.1
	Soil moisture (%)	50	78.7	91.3	84.3	0.424	3.00
	pH	50	3.89	4.45	4.11	0.02	0.143
	Ramet density	50	25	290	130.7	8.48	59.9
	Leaf area (%)	50	0.066	0.351	0.159	0.011	0.081
	Flower: ramet	50	0.127	0.640	0.371	0.016	0.111
	Fruit set	34	0.333	1	0.887	0.033	0.192
	Seed set	34	0.350	1.00	0.734	0.028	0.162
	Weight of berry	34	0.240	1.30	0.615	0.045	0.260
	Average druplet weight	34	0.020	0.118	0.053	0.004	0.022
	Total ovules	34	8.00	16.5	11.7	0.366	2.13
	Female proportion (/total ramets)	50	0.00	0.342	0.074	0.013	0.090
	Male proportion (/total ramets)	50	0.017	0.548	0.296	0.023	0.163
	Nonfloral proportion (/total ramets)	50	0.360	0.873	0.630	0.016	0.113
	Distance to nearest	34	0	2	0.912	0.065	0.379

Table 3.1 continued

Site	Variable	N	Minimum	Maximum	Mean	Standard Error	Standard Deviation
All sites	Peat depth (cm)	250	14	101	59.15	1.76	27.88
	Shelter: Tallest (cm)	250	0	137	17.53	1.31	20.76
	Shelter: Average Height (cm)	250	0	90	13.35	0.95	15.00
	Shelter: Proportion 45 degrees (%)	250	0	95	21.04	1.82	28.73
	Shelter: Density (cm)	250	0	90	15.53	1.44	22.81
	Shelter: Distance Nearest (cm)	250	1	986	162.48	14.66	231.78
	Shelter: Ht Nearest (cm)	250	2	240	43.67	3.11	49.22
	Soil moisture (%)	249	78.7	94	87.76	0.19	2.93
	PH	246	3.6	4.45	3.98	0.01	0.15
	Ramet density	250	21	334	133.10	4.18	66.20
	Leaf area	250	0.06	1.19	0.204	0.01	0.13
	Flower: ramet	250	0	0.640	0.265	0.01	0.13
	Fruit set	218	0	1	0.746	0.02	0.28
	Seed set	211	0.11	1	0.664	0.015	0.22
	Weight of berry	211	0	1.3	0.476	0.016	0.235
	Average druplet weight	211	0	0.126	0.045	0.002	0.023
	Total ovules	211	5	21.5	10.70	0.17	2.45
	Female proportion	250	0	0.673	0.099	0.089	0.006
	Male proportion	250	0	0.556	0.166	0.145	0.009
	Nonfloral proportion	250	0.224	1.00	0.734	0.135	0.009
	Distance to nearest	218	0	848	40.68	7.68	112.81

Table 3.2.1 Spearmans Rank Correlations for Intensive Site BN; >.400 considered significant.

	Depth Scale	Shelter Index	Soil Moisture	pH	Ramet density	Leaf area	Flower : ramet
Depth Scale	1.00						
Shelter Index	0.318	1.00					
Soil Moisture	0.146	0.106	1.00				
PH	0.188	**0.488**	0.350	1.00			
Ramet density	-0.082	**-0.424**	-0.073	-0.096	1.00		
Leaf area	0.017	0.141	-0.145	0.014	**-0.660**	1.00	
Flower: Ramet	**0.400**	**0.534**	0.090	**0.415**	-0.237	0.138	1.00
Sex ratio (% female)	-0.085	**-0.442**	-0.343	-0.304	0.326	0.156	-0.141
Distance to nearest male flower	-0.291	**-0.401**	-0.332	**-0.453**	0.016	0.292	-0.302
Fruit set	0.394	-0.109	**0.499**	0.285	-0.116	0.071	0.069
Seed set	0.268	0.235	0.327	0.269	-0.317	-0.123	0.258
Average droplet weight	0.229	0.249	0.361	0.253	-0.052	-0.320	-0.111
Ordination Axis 1	-0.267	**-0.819**	-0.206	**-0.507**	0.361	-0.064	**-0.410**
Ordination Axis 2	**0.495**	**0.819**	0.238	**0.437**	-0.364	0.243	**0.530**

Table 3.2.1 continued.

	Sex ratio (% female/ total flowers)	Distance to nearest male flower	Fruit set	Seed set	Average droplet weight	Axis 1	Axis 2
Depth Scale							
Shelter Index							
Soil Moisture							
PH							
Ramet density							
Leaf area							
Flower: Ramet							
Sex ratio (% female)	1.00						
Distance to nearest male flower	**0.591**	1.00					
Fruit set	-0.146	-0.206	1.00				
Seed set	**-0.588**	**-0.460**	0.145	1.00			
Average droplet weight	**-0.587**	**-0.423**	0.209	**0.778**	1.00		
Ordination Axis 1	**0.636**	**0.657**	-0.162	-0.288	-0.299	1.00	
Ordination Axis 2	-0.367	**-0.459**	0.199	0. 343	0.263	**-0.674**	1.00

Table 3.2.2 Spearmans Rank Correlations for Intensive Site CJ; >.400 considered significant.

Variable	Depth Scale	Shelter Index	Soil Moisture	pH	Ramet density	Leaf area	Flower : ramet
Depth Scale	1.00						
Shelter Index	-0.364	1.00					
Soil Moisture	0.159	-0.071	1.00				
pH	0.150	-0.233	-0.011	1.00			
Ramet density	0.167	0.108	**0.562**	-0.069	1.00		
Leaf area	-0.045	-0.007	**-0.660**	0.027	**-0.782**	1.00	
Flower: ramet	0.143	-0.069	-0.017	0.182	-0.382	0.354	1.00
Sex ratio (% female)	**-0.446**	0.356	**-0.487**	0.021	-0.202	0.386	-0.347
Distance to nearest male flower	-0.262	0.223	-0.365	-0.038	-0.389	0.310	-0.242
Fruit set	0.185	0.224	-0.228	0.182	-0.150	0.147	0.267
Seed set	0.227	0.063	0.174	0.194	-0.106	-0.187	0.293
Average droplet weight	0.197	0.233	-0.213	-0.081	0.144	0.130	-0.323
Ordination Axis 1	-0.169	**0.585**	0.208	-0.298	**0.530**	-0.377	-0.358
Ordination Axis 2	**-0.559**	0.131	-0.390	-0.019	**-0.480**	0.221	0.155

Table 3.2.2 continued.

Variable	Sex ratio (% female /total flowers)	Distance to nearest male flower	Fruit set	Seed set	Average droplet weight	Axis 1	Axis 2
Depth Scale							
Shelter Index							
Soil Moisture							
pH							
Ramet density							
Leaf area							
Flower:ramet							
Sex ratio (% female)	1.00						
Distance to nearest male flower	**0.572**	1.00					
Fruit set	0.026	-0.046	1.00				
Seed set	-0.397	-0.284	0.343	1.00			
Average droplet weight	**0.438**	0.192	0.130	-0.128	1.00		
Ordination Axis 1	0.263	0.049	-0.004	0.031	**0.440**	1.00	
Ordination Axis 2	0.246	0.258	0.074	-0.045	-0.303	-0.095	1.00

Table 3.2.3. Spearmans Rank Correlations for Intensive Site CW; >.400 considered significant.

Variable	Depth Scale	Shelter Index	Soil Moisture	pH	Ramet density	Leaf area	Flower: ramet
Depth Scale	1.00						
Shelter Index	-0.160	1.00					
Soil Moisture	-0.064	-0.330	1.00				
PH	0.015	0.005	0.017	1.00			
Ramet density	0.057	-0.286	**0.417**	-0.027	1.00		
Leaf area	-0.039	**0.723**	-0.341	0.029	**-0.577**	1.00	
Flower: Ramet	-0.077	-0.372	0.329	-0.373	0.194	-0.182	1.00
Sex ratio (% female)	-0.181	**0.505**	**-0.420**	0.172	-0.387	0.398	**-0.443**
Distance to nearest male flower	-0.134	0.111	-0.106	-0.219	0.112	0.097	**0.580**
Fruit set	-0.107	0.177	0.153	0.266	-0.013	-0.027	-0.207
Seed set	-0.101	-0.113	-0.062	-0.189	-0.023	-0.177	0.298
Average droplet weight	-0.147	-0.049	-0.100	0.028	-0.076	0.068	0.295
Ordination Axis 1	0.038	0.007	-0.132	0.323	**-0.514**	0.127	-0.281
Ordination Axis 2	-0.173	**0.800**	-0.110	0.074	-0.095	**0.549**	-0.387
Ordination Axis 3	-0.037	**-0.718**	0.022	0.009	0.277	**-0.629**	0.140

Table 3.2.3 continued.

Variable	Sex ratio (% female /total flowers)	Distance to nearest male flower	Fruit set	Seed set	Average droplet weight	Axis 1	Axis 2	Axis 3
Depth Scale								
Shelter Index								
Soil Moisture								
pH								
Ramet density								
Leaf area								
Flower: ramet								
Sex ratio (% female)	1.00							
Distance to nearest male flower	0.064	1.00						
Fruit set	-0.148	-0.167	1.00					
Seed set	-0.039	**0.566**	0.023	1.00				
Average droplet weight	0.292	**0.425**	-0.263	0.048	1.00			
Ordination Axis 1	0.392	-0.182	0.034	-0.116	0.151	1.00		
Ordination Axis 2	**0.510**	0.109	0.203	-0.169	0.053	0.118	1.00	
Ordination Axis 3	-0.252	-0.141	-0.183	0.129	-0.100	-0.117	**-0.568**	1.00

Table 3.2.4. Spearmans Rank Correlations for Intensive Site JP; >.400 considered significant.

Variable	Depth Scale	Shelter Index	Soil Moisture	pH	Ramet density	Leaf area	Flower: ramet
Depth Scale	1.00						
Shelter Index	-0.027	1.00					
Soil Moisture	0.124	-0.132	1.00				
pH	-0.023	0.365	-0.053	1.00			
Ramet density	-0.096	-0.357	0.301	0.055	1.00		
Leaf area	-0.013	**0.438**	-0.351	0.139	**-0.835**	1.00	
Flower: Ramet	-0.014	-0.277	0.162	-0.054	0.231	-0.336	1.00
Sex ratio (% female)	0.224	-0.122	-0.133	-0.099	-0.304	0.317	-0.325
Distance to nearest male flower	0.212	0.001	-0.089	-0.056	-0.370	0.341	-0.301
Fruit set	-0.133	0.135	-0.076	0.102	0.057	-0.035	0.296
Seed set	-0.225	0.180	0.072	0.216	0.293	-0.144	0.255
Average droplet weight	0.264	**-0.477**	0.176	-0.299	-0.023	-0.169	0.102
Ordination Axis 1	-0.112	**0.700**	-0.179	0.398	-0.031	0.135	-0.020
Ordination Axis 2	0.267	0.366	**0.409**	0.139	0.028	0.004	-0.105
Ordination Axis 3	0.213	-0.140	0.104	**-0.552**	-0.016	-0.204	0.162

Table 3.2.4 continued.

Variable	Sex ratio (% female)	Distance to nearest male flower	Fruit set	Seed set	Average druplet weight	Axis 1	Axis 2	Axis 3
Depth Scale								
Shelter Index								
Soil Moisture								
pH								
Ramet density								
Leaf area								
Flower: Ramet								
Sex ratio (% female)	1.00							
Distance to nearest male flower	**0.836**	1.00						
Fruit set	**-0.554**	-0.437	1.00					
Seed set	**-0.665**	**-0.595**	**0.586**	1.00				
Average druplet weight	0.301	0.236	-0.274	**-0.414**	1.00			
Ordination Axis 1	**-0.431**	-0.364	0.339	**0.453**	**-0.587**	1.00		
Ordination Axis 2	0.094	0.145	-0.265	0.002	-0.068	0.102	1.00	
Ordination Axis 3	-0.007	-0.011	-0.097	-0.093	0.234	-0.033	0.053	1.00

Table 3.2.5 Spearmans Rank Correlations for Intensive Site NW; >.400 considered significant.

Variable	Depth Scale	Shelter Index	Soil Moisture	pH	Ramet density	Leaf area	Flower: ramet
Depth Scale	1.00						
Shelter Index	**0.489**	1.00					
Soil Moisture	**0.501**	-0.015	1.00				
PH	-0.067	-0.458	0.235	1.00			
Ramet density	0.183	0.230	0.380	0.045	1.00		
Leaf area	0.280	**0.654**	-0.287	-0.399	-0.361	1.00	
Flower: Ramet	0.116	-0.206	0.310	-0.183	-0.191	-0.088	1.00
Sex ratio (% female)	0.228	**0.522**	-0.057	0.160	0.100	**0.458**	**-0.617**
Distance to nearest male flower	0.115	0.165	-0.049	**-0.427**	-0.080	0.179	0.052
Fruit set	0.204	-0.107	0.071	-0.161	**-0.465**	0.364	0.280
Seed set	-0.024	-0.065	-0.098	-0.157	0.137	-0.256	0.335
Average droplet weight	-0.036	-0.376	-0.107	-0.216	-0.192	-0.193	0.376
Ordination Axis 1	**-0.413**	**-0.781**	0.032	0.383	0.006	**-0.475**	0.115
Ordination Axis 2	**0.406**	**0.564**	0.061	-0.021	-0.210	**0.603**	-0.345
Ordination Axis 3	0.252	-0.366	0.221	0.247	-0.333	-0.059	0.041

Table 3.2.5 continued.

	Sex ratio (% female /total flowers)	Distance to nearest male flower	Fruit set	Seed set	Average droplet weight	Axis 1	Axis 2	Axis 3
Depth Scale								
Shelter Index								
Soil Moisture								
PH								
Ramet density								
Leaf area								
Flower: Ramet								
Sex ratio (% female)	1.00							
Distance to nearest male flower	-0.065	1.00						
Fruit set	-0.109	0.302	1.00					
Seed set	**-0.483**	0.147	-0.204	1.00				
Average droplet weight	**-0.467**	**-0.439**	**0.410**	0.171	1.00			
Ordination Axis 1	-0.339	-0.286	0.083	-0.019	0.151	1.00		
Ordination Axis 2	**0.638**	0.072	0.170	**-0.409**	**-0.408**	**-0.558**	1.00	
Ordination Axis 3	-0.042	0.109	0.398	0.222	0.230	0.051	0.138	1.00