

**ACADIA NATIONAL PARK
PURPLE LOOSESTRIFE MANAGEMENT
PROGRAM
CORE MANUAL**

1992-1996

by
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NOTES ON THE REPORT:

In 1992, we decided to split the report into two sections, the core and the yearly summary. The core section contains the complete methodology for the purple loosestrife control program at Acadia National Park; it will not be revised unless there is a major change in the structure of the program. The yearly summary section contains data, observations, analysis, discussion, etc. This section will be revised every year we manage purple loosestrife.

This format allows the reader to have full information on the program without referencing the 1989 report for methodology and eliminates yearly editing and repetition. Alternatively, the reader who only wants the specific year's information no longer has to hunt through the whole report.

New references to the Literature Cited and Literature Reviewed section are in bold type the year they are added. They revert to regular type in subsequent years.

INTRODUCTION

Purple loosestrife (*Lythrum salicaria*) is an herbaceous perennial, introduced from Eurasia before 1814 (Louis-Marie, 1944). While its striking displays of color have made it a favorite of gardeners, its highly invasive nature has seriously impacted wetland communities throughout the United States. Fernald (1940) first noted that purple loosestrife was displacing native vegetation, which later caused concern that important wildlife food plants such as cattail (*Typha latifolia*) would decline (McKeon, 1959; Smith, 1959; Smith, 1964; Novak, 1968). Loosestrife encroachment has now been recognized as a cause for decline in wetland quality (Malecki and Rawinski, 1979; U.S. Fish and Wildlife Service, 1979; Rawinski and Malecki, 1984; Thompson et al, 1987).

Rawinski and Malecki (1984) have noted that serious ecological consequences appear to result from purple loosestrife invasion in marshes. In their study, loss of open water and mud flats reduced feeding areas for shorebirds and waterfowl. Muskrats and long-billed marsh wrens used cattail stands rather than loosestrife, although red-winged blackbirds appeared to prefer loosestrife for nesting sites.

While some native animals have been shown to benefit from loosestrife, these are primarily species with broad niches that can exist in a variety of communities. Animals that lose their habitat to loosestrife invasion are species with narrow niches that rely on cattails and other graminoid plants out-competed by loosestrife.

The National Park Service has been directed by Congress to maintain native functioning ecosystems. National Park Service Management Policies (1988) specifically address the issue of management of exotic species already present in the park:

"Management of populations of exotic plant and animal species, up to and including eradication, will be undertaken wherever such species threaten park resources or public health and when control is prudent and feasible."

As a result, a purple loosestrife management program was developed and implemented at Acadia National Park (ACAD) in 1988. Its primary components include:

- A. Surveying wetlands for the presence of purple loosestrife
- B. Quantitatively monitoring selected populations for treatment success
- C. Chemical suppression
- D. Public education
 - 1. Local media
 - 2. Park employees and visitors
 - 3. Local nursery owners and managers
- E. Annual literature review

The components of this program were incorporated into the park's Integrated Pest Management Plan (Connery, 1991) as a specific action plan (see Appendix A).

SUMMARY OF HISTORICAL MANAGEMENT AT ACADIA

The first record we have found of *Lythrum salicaria* on Mount Desert Island is in Wild Flowers of Mount Desert Island, a 1928 list of plants of Mount Desert Island (Wherry, 1928). However, populations remained at relatively low levels in a handful of wetlands since that time, perhaps due to a lack of disturbance coupled with heavy competition from native vegetation. Mechanical removal of beaver dams and lodges in the Bear Brook watershed in the late 1970's and early 1980's seems to have resulted in proliferation of purple loosestrife there.

In 1984, Biological Technician Norman Fletcher established six permanent, one square meter (1 m²) plots in the Bear Brook Pond watershed to monitor changes in the population of purple loosestrife. Unfortunately, the location of these plots was poorly documented and water levels changed due to beaver activity, submerging some plots. In 1987, only two plots could be relocated.

From 1984 to 1987, flowering stems in the Bear Brook and other watersheds were either pulled or cut, collected, and burned to prevent additional seed production.

McInnes (1986) identified two locations with purple loosestrife within the park (Bear Brook and Visitor Center/Hulls Cove House wetland) and listed loosestrife as one of twelve exotic species of management concern. A more thorough survey for exotic plants was completed the following year and identified four additional sites within park boundaries (Compass Harbor, the south end of the Tarn, Breakneck Brook/Paradise Hill carriage road access beaver pond, pond south of Old Farm Road) infested by purple loosestrife (Smith, 1987).

Chemical control of purple loosestrife using glyphosate was initiated in 1988 in all infested park wetlands except the Tarn.

In 1989, seven permanent monitoring grids were set up to detect changes in purple loosestrife populations and a sampling protocol was established (Hazen and Anderson, 1990). Chemical control of loosestrife was begun at the Tarn in 1989, following sampling of the permanent monitoring grid set up there.

As of 1996, purple loosestrife is known to be present in thirteen areas within the park. All known locations of loosestrife from 1992 through 1996 are listed in Appendix B, including occurrences on private lands adjacent to park wetlands.

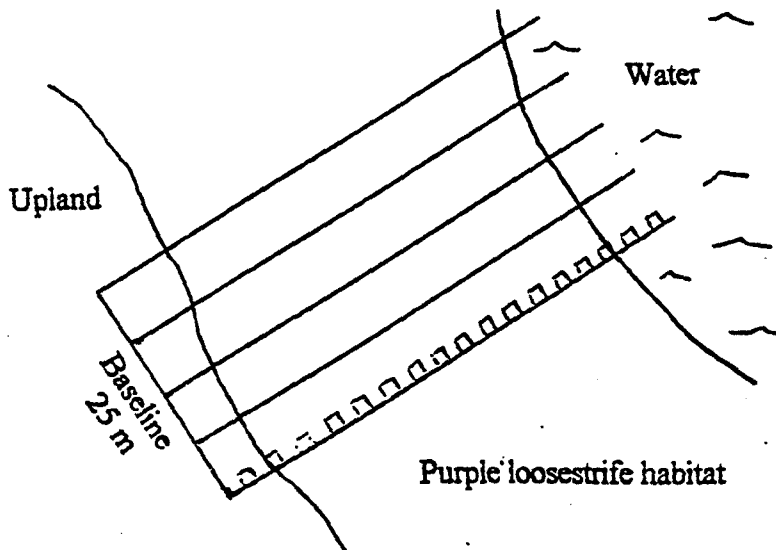
MONITORING EFFORT

Sampling Protocol

Each year we monitor the effectiveness of suppression treatments using seven permanent grids. A schematic of the seven grids is provided in Figure 1, and grid locations are described in Appendix C.

In 1989, seven permanent grids were set up to monitor population levels of purple loosestrife on a long term basis. None of these grids corresponded with survey plots set up by Norm Fletcher in 1984. Areas with the highest concentrations of loosestrife infestation were selected to establish these monitoring grids. Stratified random grids were then placed within the selected areas. Each grid consists of five transect lines along the stream, pond or lakes where loosestrife had been previously seen. Grid baselines were marked at both ends with 1-2 foot high pieces of white PVC pipe painted orange at the tops. Grid baselines run generally parallel with the edge of the wetland; the transect lines run perpendicular to the grid baseline, across the wetland, at a specified compass bearing, and are five meters apart. Transects run above and below suitable loosestrife habitat to allow for fluctuations in water levels. One-meter-square (1 m^2) survey plots are always placed on the left side of the transect line as one faces from the grid baseline toward the center of the wetland. Surveying begins at meter 1 (meter 0 being the one which begins at the grid baseline) and continues every other meter (see Figure 1).

Figure 1. Schematic of Permanent Survey Grids.



For a transect on a pond edge, the transect ends when the water becomes too deep to support purple loosestrife, generally 2-3 feet. A "w" is included in the field notes to indicate those plots which contain water either in puddles, or associated with lakes, ponds, or streams. For a transect across a stream, the transect ends when it reaches upland habitat which does not support loosestrife. The number of reproductive (flowering) and non-reproductive stems are counted in each 1 m² survey plot. Care is taken not to walk in the survey plots and trample the vegetation to be surveyed. Seedlings under 3 inches in height are not counted due to the difficulty of distinguishing purple loosestrife (*Lythrum salicaria*) seedlings from yellow loosestrife/swamp candles (*Lysimachia terrestris*).

Four grids are located around Beaver Dam Pond south of the Park Loop Road. Two additional grids have been established along Bear Brook north of the Park Loop Road and south of Schooner Head Road. One grid was established across the wetland south of the Tarn; this grid was chosen because it was in an area known to have purple loosestrife, but which had not received prior herbicidal treatment. For a more complete description of the transects see Appendix C.

Transect Monitoring Results

Yearly stem counts are entered onto the computer for analysis. We have decided the most effective means of analyzing and summarizing the data is using bar graphs of stem counts.

Other Wetland Areas Surveyed

Visual inspections are made at other wetland areas in addition to areas chemically treated, to ensure that new infestations do not go undetected. It is important to locate infestations early when populations are small, and thus more easily managed. Currently, there is no systematic inspection cycle for the wetlands on Mount Desert Island. Wetlands on the Schoodic and Isle au Haut portions of the park have never been formally surveyed. Inspections ideally are made on foot for the best coverage. Where this is impossible, we have sometimes used binoculars to look for flowers during the flowering period. For some areas, such as the south end of Seal Cove Pond, a canoe is the best means to inspect pond edges. While recognizing the difficulty of traversing some of the habitat, a good-faith effort should be made to cover the area as thoroughly as possible.

SUPPRESSION EFFORT

While developing a management strategy we considered treating some areas and leaving other populations untreated as an experimental control, and monitoring both. However, botanists we consulted (C. Greene, T. Rawinski, pers. comm.) strongly recommended that control in all watersheds be initiated as soon as possible. They felt that the invasive nature of purple loosestrife has already been well documented in nearby areas. Based on these recommendations and our literature review, we set the threshold for treatments as the presence of one purple loosestrife plant.

Preparation

As required by NPS management policies, approval from the Northeast Regional Office, Washington Office, and U.S. Department of Agriculture is obtained for the use of glyphosate herbicide and surfactant prior to application. Each year we request permission from the Jackson Laboratory to conduct control measures on the property they own adjacent to Bear Brook. Permission has been granted every year since 1989.

All personnel involved in field work are given training in the history of the project, rationale for control, identification of purple loosestrife, safety and health issues related to the chemicals used, and proper operation of pressure sprayers, prior to initiating survey and suppression efforts. The suppression program must be supervised by a Maine Master Pesticide Applicator. A Maine Master Pesticide Applicator or a Maine Certified Pesticide Applicator must be on site during all herbicide applications.

A solution of 1% RODEO herbicide (Monsanto Co., St. Louis, MO 63167) and 1/2% aquatic surfactant (Arborchem Products Co., Fort Washington, PA 19034) is mixed in 2 gallon capacity pressure sprayers [2 ½ T RODEO and 1 ¼ T surfactant were mixed per gallon of water]. Sprayers are cleaned and inspected before being filled or re-filled with herbicide. We use only plastic tank sprayers because RODEO reacts with metal other than stainless steel. All sprayers should be tested using plain water prior to each day's spraying. An effort should be made to only mix the amount of herbicide necessary for each day's planned spraying.

Spraying Technique

To allow time for the transport of herbicide from leaf surface to plant tissue, no spraying is done if precipitation or heavy fog is expected within 24 hours. Also, to minimize spray drift and further protect non-target plants, no spraying is done when local wind speed exceeds 10 MPH.

RODEO is most effective when applied while loosestrife plants are flowering, when the plant is allocating the maximum amount of energy into growth and have not yet begun to senesce. The optimal spraying period usually begins in mid to late July, as plants begin to flower.

Sprayers are carried in backpacks, and the RODEO mixture is carefully applied to individual loosestrife plants until leaves are wet but not dripping. By carefully adjusting the nozzle spray pattern and by physically isolating individual loosestrife plants as much as possible, nearby non-target plants can be protected. Complete coverage of treatment areas is ensured by dividing large areas into smaller, easily demarcated units and by using flagging to mark spray lines. Flagging is removed from spray areas as soon as spraying is completed. If more than one person is present, generally all parties walk abreast and then turn as a unit at the end of the transect. When time allows, the effectiveness of the spraying should be checked two weeks after herbicide application; in cases where spraying is not effective, or in cases where plants are missed, areas should be re-sprayed. Re-spraying is also indicated if rain occurs within 24 hours of spraying.

Public Education

A memo is sent to park staff in all visitor contact stations to inform them about the purple loosestrife suppression program, and to assist them in answering visitor's questions about our activities (see N50 files in the Resource Management office). In addition, Resource Management includes purple loosestrife information in seasonal training programs.

As stated in the Integrated Pest Management Plan, the park's goal is to provide information to local nurseries and greenhouses to educate them about purple loosestrife and discourage them from selling it.

Reporting

The total amount of herbicide use is reported to the NPS Northeast Regional Office and to the Maine State Board of Pesticide Control at the end of each year.

MANAGEMENT RECOMMENDATIONS

The Park places a high priority on maintaining undisturbed wetlands. The use of heavy equipment in wet areas is avoided whenever possible, even during beaver control efforts.

The broadcast use of broad spectrum herbicides is avoided.

As noted in the Integrated Pest Management Plan, successful purple loosestrife management involves addressing populations adjacent to the Park on private property. Park resource managers should work with abutting landowners and local nurseries to reduce infestation sources from nearby lands.

An integrated approach of loosestrife management will be most effective. However, until tests of biological control agents can be completed, and both risks and costs evaluated, biological control is not a viable control strategy. Because loosestrife can rapidly spread and is difficult to control, early detection is a priority when instituting control measures (Thompson et al, 1987).

New low cost monitoring techniques may be available with the cooperation of U.S. Agricultural Stabilization and Conservation Services (ASCS). Balogh and Bookhout (1989) had success in monitoring large areas for loosestrife invasion by using true-color aerial photographs. These photographs are usually taken in July or August which coincides with the bloom period of loosestrife. However, this technique may not be effective at Acadia now that the number of mature flowering plants seems to be reduced.

As of 1997, sale of purple loosestrife has been banned in fourteen states. Park managers should contact State and other land management agencies (The Nature Conservancy, Audubon, etc.) to discuss this possibility for Maine.

Park personnel need to be careful to find and spray all loosestrife plants. It is important to not make assumptions regarding "appropriate loosestrife habitat". The loosestrife population at the Halls Cove House/Visitor Center wetland was overlooked in 1989 because it was in an alder stand and the investigators did not think purple loosestrife would grow there. Also, in the Bear Brook watershed, we found many young plants in the woods west of the stream (behind Morrill Park and Jackson Lab) where we might have assumed that it would not grow due to shading. If pockets of loosestrife remain untreated they may eventually be a seed source to the wetland, further hampering control efforts.

Care should be taken to wash footwear when moving from one wetland to another to prevent spreading seeds from wetlands with loosestrife to uninfested wetlands.

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APPENDIX A
PURPLE LOOSESTRIFE ACTION PLAN FROM ACADIA'S
INTEGRATED PEST MANAGEMENT PLAN (1991)

SPECIES: Purple loosestrife (*Lythrum salicaria* L.)

IDENTIFICATION:

A showy non-native perennial introduced from Europe, with striking rose or magenta colored floral spikelets which bloom from mid-July through the end of August. Flowers are 1/2 - 3/4" wide, with 5 or 6 petals. The lance-shaped leaves clasp the stem, and grow in pairs or sometimes in whorls of 3. Found in swamps or wet meadows, ditches, beaver ponds. Similar native plants which may be easily confused with purple loosestrife, especially in immature form, include swamp candles (*Lysimachia terrestris*) and many species of goldenrods (*Solidago* spp.).

DESCRIPTION OF PEST AND POTENTIAL FOR DAMAGE:

A highly invasive alien plant which colonizes disturbed wet environments, purple loosestrife displaces indigenous wetland vegetation, including rare species and species which are of great value to wildlife. In other parts of the Northeast, it has virtually wiped out native wetland communities by establishing mono-specific stands. Once established, it is extremely difficult to eliminate. If loosestrife becomes well established in the park and many years of seed production have occurred, the opportunity to attempt local eradication has probably been lost (Thompson 1987), and the native community may well be irretrievable. *Lythrum salicaria* was noted on a list of plants of Mount Desert Island in 1928 (Wherry 1928). However, populations remained at relatively low levels in a handful of wetlands since that time, perhaps due to a lack of disturbance coupled with heavy competition from native vegetation. Mechanical removal of beaver dams and lodges in the Bear Brook watershed in the late 1970's and early 1980's seems to have resulted in proliferation of purple loosestrife there.

PROBLEM AREAS IN THE PARK:

The most significant populations of purple loosestrife include:

- A. Park Loop Road, Beaver Dam Pond, Bear Brook - Scattered individual plants growing around the perimeter of pond. The most extensive population of loosestrife found in the park is on the north of road in and around numerous beaver ponds and canals.
- B. Hulls Cove House Wetland - Sparsely distributed individual plants in the main section of the wetland. A large, previously hidden stand was discovered among alders on the southern margin of this wetland in 1990.
- C. Compass Harbor Trail - There is a scattered population of about 30 plants adjacent to the shore.

D. The Tarn - Scattered plants on the south end of the pond. Due to the extensive wetlands downstream, this population is especially dangerous.

Very small populations have been reported in other park areas. More detailed descriptions of infested sites and treatments are available in the Purple Loosestrife Control Annual Reports (Willey 1988; Hazen 1990).

MONITORING AND ACTION LEVELS:

Known locations of loosestrife plants will be inspected early in July when flowers first break into bloom. When blooms become obvious, other park wetlands will be inspected visually for purple loosestrife invasion. Because staffing limitations restrict the number of wetlands which can be monitored each year, a priority system will be established based on the following criteria:

1. previously infected areas or wetlands in proximity to other infected wetlands
2. proximity to roads or other sources of infection such as *Lythrum salicaria* used ornamentally in gardens
3. areas which have not been previously inspected
4. areas which have been inspected previously and were not infected

Care must be given to prevent seed transfer on boots or clothing by monitors who go from wetlands harboring loosestrife to unaffected areas. Footwear must be cleaned of all mud or debris and inspected before moving from one area to another. Areas which are monitored and treated will be mapped on a USGS topographic map "Acadia National Park and Vicinity" each year. The park should strive to incorporate purple loosestrife control information into the Geographic Information System (GIS) as quickly as possible.

In addition to visual surveys, treatment success will be monitored using permanent grids of one square meter quadrats established in wetlands where loosestrife was present in 1989.

Methodology, detailed in the 1989-90 purple loosestrife annual report, must remain consistent from year to year. Total stem counts of plants over 3 inches in height for each quadrat will be tabulated, and the results analyzed statistically.

Loosestrife is very difficult to eliminate once it becomes established, therefore, every effort will be made to eradicate it whenever populations are identified. The presence of even one loosestrife plant will be the threshold where eradication efforts are initiated.

PREVENTATIVE TECHNIQUES:

Purple loosestrife does not successfully invade natural plant communities, but responds to disturbance. Clearly, the most successful management method is to prevent the initial invasion of loosestrife by maintaining the integrity of natural wetlands. Any form of disturbance or

stress to the native plant community should be avoided. This includes mechanical disturbance, such as the removal of beaver dams for managing beaver damage by the use of heavy equipment. Purple loosestrife has the ability to regenerate from adventitious buds growing from crushed stems whereas many of its native associates do not (Thompson 1987). Water drawdowns should not occur after April or before August.

TREATMENT ALTERNATIVES:

A. No treatment - The no treatment alternative would result in continued spread of this alien species, with associated displacement of native vegetation and loss of the wetland ecosystem. Adoption of this alternative would result in the Congressional mandate to preserve naturally functioning native systems not to be met.

B. Mechanical - Plants may be partially managed by cutting or pulling.

Pulling - Small plants can be pulled using great care to remove the entire root system. It is much more difficult to pull large, mature plants because the root system is often very extensive.

Cutting - Cutting the flowering heads is most effective when done in the late summer (Malecki & Rawinski 1985). A 54% reduction in shoots was reported when cutting was performed in late August, compared to 34% when cut in early August.

Cut or pulled plants must be removed from the site and destroyed, because they will form adventitious shoots if left lying on moist, unvegetated soil. However, it should be noted that cutting is not a permanent solution for elimination of loosestrife (Malecki & Rawinski 1985). Cutting and pulling did not result in lower populations of plants at Acadia in 1987. In fact, some populations receiving this treatment actually increased in size (Willey 1988).

C. Biological - Efforts are currently underway by the Department of Agriculture to test three promising European insect control agents. Host specificity will be included as an important aspect of their study (personal communication with G. Johnston, NPS-Washington). Currently, there are no known natural predators with control potential in the United States. Biological control alternatives appear to be at least several years away.

D. Chemical - Herbicide treatment studies using glyphosate have been very successful, though careful attention should be given to growth stage and timing. Although varying rates of application does not result in significantly different control, time of application does (Malecki and Rawinski 1985). Previous studies (Monsanto Company 1975; Kline and Selleck 1978) indicated that treatment in the later stages of development is most effective and that timing affects the

extent of loosestrife reinfestation. Glyphosate is biodegradable and quickly inactivated upon exposure to moist soils (Sprankle 1975; Sprankle et al. 1975). It is considered to be a low hazard to fish and wildlife (Batt et al. 1980). Despite the promise of early investigations of the use of glyphosate, Rawinski (1982) cautioned against its widespread use without adequate knowledge of the effects of this relatively new chemical on marsh ecosystems. See-2,4-D@ is currently being used for purple loosestrife control at Voyageurs National Park in Minnesota (Benedict & Grim 1989). While this herbicide is more selective, it has not been extensively tested in the East as has glyphosate. Should purple loosestrife populations at Acadia become resistant to Rodeo@, it would be beneficial to switch to See-2,4-D@ or another broadleaf herbicide approved for aquatic sites.

PREFERRED TREATMENT STRATEGIES:

Due to the highly detrimental nature of this invasive plant, every effort should be made to assure complete and continuous suppression of all identified populations as soon as possible. A chemical control program is the only effective method of protecting native wetlands at this time. Current populations must be held in check until more effective chemicals or biological control agents have been adequately tested and are approved for use.

However, chemical suppression alone will not maintain native wetland systems free of purple loosestrife. Chemical suppression must be integrated with:

- public education to inform visitors, neighbors and employees of the impacts of uncontrolled purple loosestrife invasion and the park's management program
- cooperation with local nursery owners to reduce or eliminate the use of *Lythrum salicaria* ornamentally
- cooperation with state officials and other land management agencies (The Nature Conservancy Audubon, etc.) to share information on loosestrife suppression and work toward noxious plant legislation
- education, and where appropriate, cooperative control agreements with local landowners to reduce or eliminate the risk of invasion from adjacent lands
- continued literature review of scientific information on the ecology, biology, and management of *Lythrum salicaria*
- support of scientific research on purple loosestrife or the possible effects of herbicide contamination on soils, native plants, or water by private and public organizations and agencies.

Park field staff within all divisions will be alerted to look for purple loosestrife during their daily activities and will be given a guide to assist in *Lythrum salicaria*

identification. Quantitative monitoring in permanent plots will be completed as necessary to monitor population levels and treatment effectiveness.

Prior to herbicide treatment, approval must be obtained from the Department of Agriculture, National Park Service, and the Maine Board of Pesticide Control. Newly infested wetlands which have not been previously checked will be inspected for the presence of rare and endangered plants before chemical treatment begins. Staff of visitor contact stations will be notified when management actions begin, so that they may answer visitor questions and educate the public about the park's purple loosestrife suppression program. In order to implement chemical management techniques at least one and preferably two staff members in the Division of Natural Resources will maintain pesticide applicator certification in the aquatic category. In addition, safety briefings will be held before treatment is initiated each summer for all personnel involved in purple loosestrife management. Treatment actions, including amounts of herbicide application, and level of success will be documented in writing and yearly use logs will be submitted to the North Atlantic Regional Office and the Maine Board of Pesticide Control.

Herbicide will be applied by hand sprayer and care will be taken to minimize application to non-target plants. Treatment will be made only when ground wind speeds are low enough to prevent pesticide drift to non-target plants. Treated areas will be checked to assess treatment success and detect reinfestations. Other wetlands will be monitored visually to detect new populations so that they may be treated as soon as possible.

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APPENDIX B

KNOWN CURRENT AND PAST LOCATIONS OF PURPLE LOOSESTRIFE

LOCATIONS WHERE PURPLE LOOSESTRIFE IS CURRENTLY FOUND:

-WITHIN PARK BOUNDARIES (13):

- Bear Brook Pond (Beaver Dam Pond)
- Bear Brook Drainage below pond
- Compass Harbor
- Old Farm Road - small pond, south side of road
- The Tarn, south end only
- Between Visitor Center and Hulls Cove House
- Behind Visitor Center storage building, off access road
- Breakneck Brook/Paradise Hill carriage road access beaver pond
- Kent Field wetland
- Blackwoods/COA Dump access road
- West side of gravel pit on Schooner Head B Road
- Thorndike Field (easement)
- Route 198, just south of Parkman Mountain parking lot

-OUTSIDE PARK BOUNDARIES (8):

- Bear Brook Drainage
- Old Farm Road pond
- Drainage ditch or small stream southwest of Rt. 3,
across from the northernmost COA entrance, between the Bar
Harbor Motel and the Acadia Motel
- Across from the Bluenose Ferry terminal, west side of Rt. 3
- Hamilton Pond area, and east side of Rt. 3
- Hulls Cove shore, at Park Entrance Motel
- South of Ocean Drive Dairy Bar, ditch on the west side of Rt. 3
- Drainage north of Old Farm Road along Rt. 3, west of Compass Harbor

LOCATIONS WHERE PURPLE LOOSESTRIFE GROWTH HAS CEASED (2):

- Beaver impoundment east of where culvert crosses east
to west under Duck Brook Road (New Eagle Lake
Road)
- Beaver impoundment on Witch Hole Pond outflow, within
and adjacent to carriage road loop (northeast section)

APPENDIX C

DESCRIPTIONS OF MONITORING GRID LOCATIONS

- GRID 1: Located on the northeast side of the Bear Brook Beaver Pond, southeast of the main dam near the Park Loop Road, near a clump of three oaks. Transects run at a bearing of 226.5 degrees true north (246 degrees magnetic) from the grid baseline. The oaks were cut by beaver in 1990, but have re-sprouted.
- GRID 2: Located about halfway along the east side of the Bear Brook Beaver Pond, steeper gradient than Grid 1. Transects run at a bearing of 254.5 degrees true north (274 degrees magnetic) from the grid baseline.
- GRID 3: Located on the south side of the Bear Brook Beaver Pond, beginning just north of trees in thick alder and grasses/sedges, across the pond from and behind the western-most beaver lodge. Transect 1 begins near the base of hemlock tree with grid to left--bearing from beginning of transect 1 to the beginning of transect 5 is 302.5 degrees true north. Transect 5 begins near the base of the largest diameter snag in the vicinity, just east of a very large, deep beaver canal--bearing from the beginning of transect 5 to culvert at road is 10.5 degrees true north. Transects run at a bearing of 12.5 degrees true north (32 degrees magnetic) from the grid baseline.
- GRID 4: Located to the west of the Bear Brook Beaver Pond north of the northernmost feeder stream that has been dammed by beaver. From the Park Loop Rd. intersection with Bear Brook Picnic Area entrance, looking along the road toward the dam, there are stones on the right shoulder. After the last stone is a culvert. From the culvert, transect 5 is at a bearing of 149.5 true north (169 degrees magnetic), within sight. Transects run at a bearing of 96.5 degrees true north (116 degrees magnetic) from the grid baseline.
- GRID 5: Located on the east of the wetland south of and adjacent to the Tarn, west of Route 3, approximately 15 feet from the iron guard rail, 22 posts north of the south end. Transects run at a bearing of 264.5 degrees true north (284 degrees magnetic) from the grid baseline.
- GRID 6: Located north of the Park Loop Road on the Bear Brook outlet stream, west of the stream, high and dry near stone ledge, north of the stone walkway which crosses the footpath. Transect 2 runs along a small dam. Transects run at a bearing of 100.5 degrees true north (120 degrees magnetic) from the grid baseline.
- GRID 7: Located north of the Park Loop Road on the Bear Brook outlet stream, east of the stream, downstream from Grid 6, below a major dam where the stream makes an almost 90 degree turn to the east. Transects run at a bearing of 320.5 degrees true north (340 degrees magnetic) from the grid baseline.