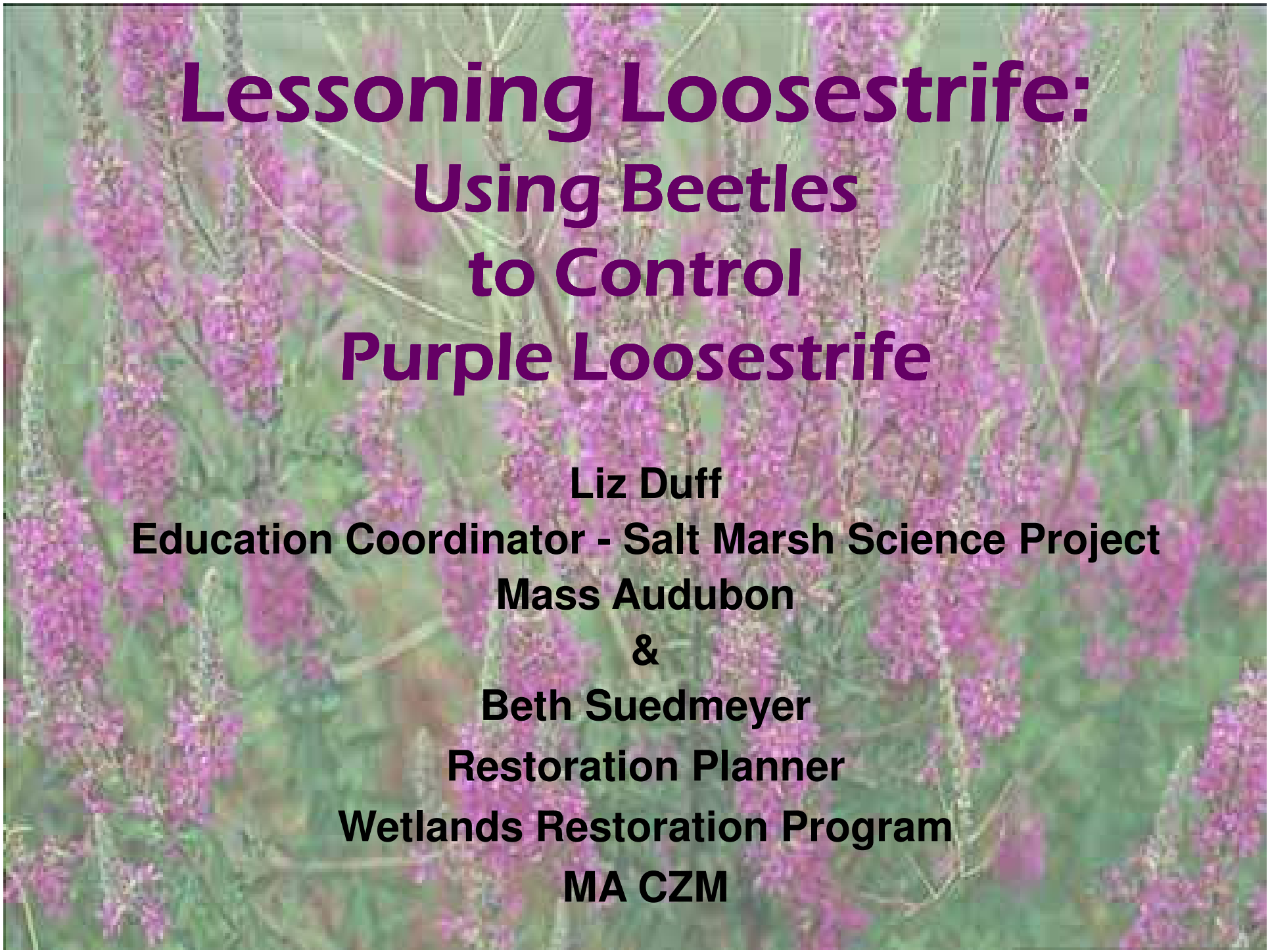

Lessoning Loosestrife:
Using Beetles to Control Purple Loosestrife

Liz Duff
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Mass Audubon
&
Beth Suedmeyer
Restoration Planner
Wetlands Restoration Program
MA CZM

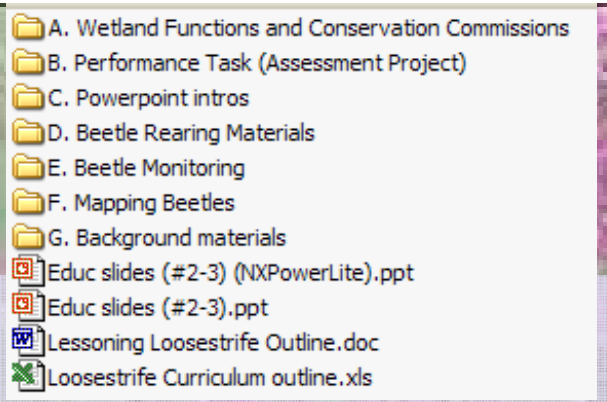
Lessoning Loosestrife Outline

Essential Understandings	Building Blocks (vocabulary)	Guiding Questions	Enabling Activities/Materials on Disk	Frameworks connections
Wetlands have important functions that humans protect	Wetland Wetland Protection Act, Wetland Functions Historical impacts to wetlands Threats to wetlands	What is a Wetland? What is the Wetland Protection Act? What are functions of wetlands that the WPA protects? Why do wetlands need protection? What threatens wetlands? What are historical impacts to wetlands? How do people protect wetlands?	Inquiry activity: Where does the wetland begin? Wetland Metaphors Wetland Observations Understanding the Wetlands Protection Act Conservation Commission Questions	Earth and Space 5 (Gr. 3-5) 1 (Gr. 6-8)
Invasive species are a threat to some of the wetland functions.	Invasive species	What threats to ecosystems do invasive species pose?	Performance Task Assessment Assignment. Loosestrife impact powerpoint, Loosestrife impact worksheet	Life Science 9,13 (Gr. 3-5), 17 (Gr. 6-8), 6.2 (H.S.)
Humans are working to protect and restore wetlands	Restoration Stewardship Biocontrol Galerucella Beetles	How can people help wetlands? How can we help?	Biocontrol of Purple Loosestrife Powerpoint, Loosestrife Life Cycle Powerpoint	Life Science 9 (Gr. 3-5), 17 (Gr. 6-8), 6.2 (H.S.)
Raising and releasing beetles is a way that students and teachers can contribute to wetland health.	Plant and beetle life cycles.	How can we help support wetland health?	Beetle rearing Checklists and Instructions, Beetle Rearing Guide, Beetle Life Cycle, How Many Beetles? Worksheet, Raising Beetles Powerpoint	Life Science 9, 10(Gr. 3-5), 13, 17 (Gr. 6-8), 6.2 (H.S.)
Monitoring wetlands is a way to check how successful restoration efforts have been.	Monitoring protocols Percent Cover Plant Parts Plant identification Plant and Beetle Life Cycles Data analysis	How can we study whether the beetles are having an impact?	Plant observation activity. Percent cover activity. Monitoring preparation. Monitoring Protocols.	Inquiry, Life Science 9 (Gr. 3-5), 13, 17 (Gr. 6-8), 6.2 (H.S.)
Mapping invasive species and beetle damage is a way to assess how widespread the problem is, and to begin to plan how to best approach the problem.	Mapping methods.	How can mapping loosestrife and beetle damage help to develop a plan for purple loosestrife control?	Mapping loosestrife and beetle damage.	Earth and Space 1 (Gr. 6-8)
Background Materials	Frameworks, Timelines, Safety, Vocabulary, Scientific Articles	How do we prepare for field trips? What have scientists learned already about purple loosestrife and biocontrol? How long does this take? What does that word mean? Additional resources?	CZM Protocols in detail, Frameworks connections, Research on Impact of Purple Loosestrife, Safety Checklist and Chaperone Letter, Suggested Resources, Vocabulary, Materials Cost List	

MA Educational Framework Connections

Frameworks connections	Grades 3-5	Grades 6-8	High School
Earth and Space	**5. Recognize and discuss the different properties of soil,** including color, texture (size of particles), the ability to retain water, and the ability to support the growth of plants.	1**. Recognize, interpret, and be able to create models of the earth's common physical features in various mapping representations**, including contour maps.	
Life Science	**13. Give examples of ways in which organisms interact** and have different functions within an ecosystem that enable the ecosystem to survive.	**Living things and their environment: 13.** Give examples of ways in which organisms interact and have different functions within an ecosystem that enable the ecosystem to survive.	**Central Concept: Ecology is the interaction among organisms and between organisms and their environment.**
Life Science	**7. Give examples of how changes in the environment (drought, cold) have caused some plants and animals to die or move to new locations (migration).**	**Changes in Ecosystems Over Time: 17** Identify ways in which ecosystems have changed throughout geologic time in response to physical conditions, interactions among organisms, and the actions of humans. Describe how changes may be catastrophes such as volccanic eruptions or ice storms.	**6.2 Analyze changes in population size and biodiversity** (speciation and extinction) that result from the following: natural causes, changes in climate, human activity, and the introduction of invasive, non-native species.
Life Science	**9. Recognize plant behaviors,** such as the way seedlings' stems grow toward light and their roots grow downward in response to gravity. Recognize that many plants and animals can survive harsh environments because of seasonal behaviors, e.g., in winter, some animals hibernate, and other animals migrate.		
Life Science	**10. Give examples of how organisms can cause changes in their environment** to ensure survival. Explain how some of these changes may affect the ecosystem		

Lessoning Loosestrife



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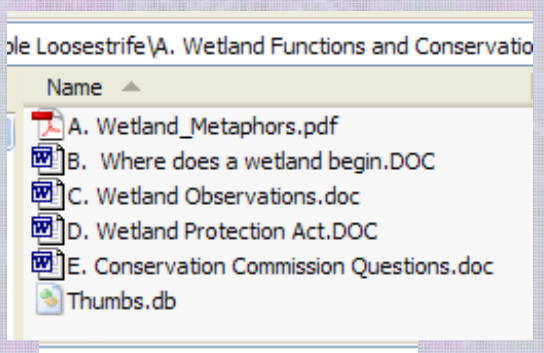

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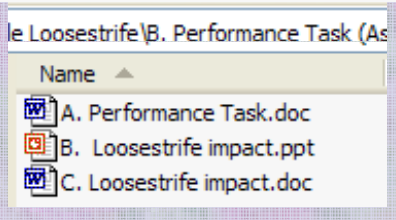

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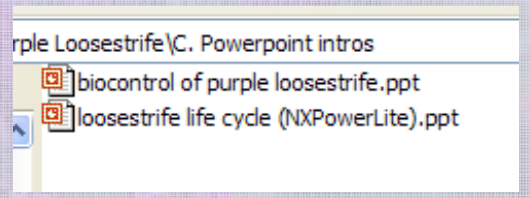

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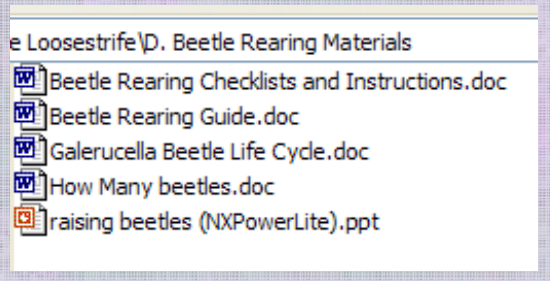

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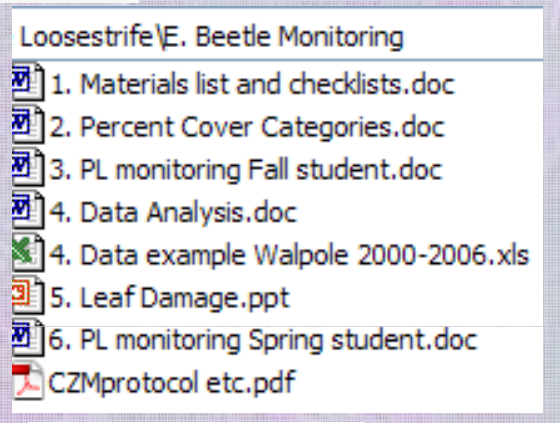

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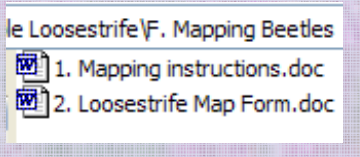

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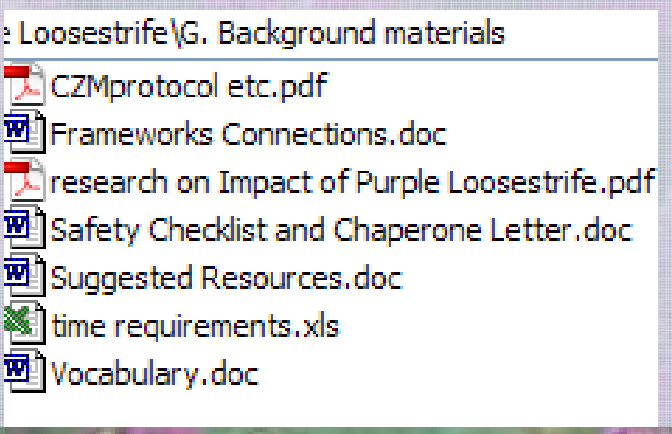


Pretty Purple Plague

Invasive Species Defined ~

Organisms not native to our region and its introduction is harmful to the environment, our health and/or our economy

The Invasive Species Threat

- In their native environment species are kept in check by natural controls, like predators and food supply. They are part of a balanced system.
- When a species is introduced into a new landscape, and it is able to survive and establish itself, the consequences for the environment can be devastating.

Consequences

- Invasive species globally are the second greatest threat to biodiversity
  - Have contributed directly to the decline of 42% of the threatened and endangered species in the United States.
- The annual cost to the US economy is estimated at $120 billion a year

Source- The Nature Conservancy

Examples of invasive aquatic invertebrates


Club tunicate

Zebra mussels

It’s here…

Add some of most fascinating abilities of pL

Original Pathways of introduction

- Early 1800s, introduction via ship ballast and raw wool
- Horticultural, honey production, and herbal uses

Means of distribution

- Wind and water
- Wildlife
- Human movements (Canals, Highways) and Disturbance

Ecological Impacts of Purple Loosestrife

- Reduction in plant biodiversity
- Degradation of wildlife habitat
- Alteration of wetland function

Blossey, B., L. C. Skinner, and J. Taylor. 2001. Impact and management of Purple loosestrife (*Lythrum salicaria*) in North America. Biodiversity and Conservation.

A unique solution—biological control!

- Specific to target and self-perpetuating
- Long-term control of purple loosestrife (but not eradication)
- Requires lower inputs (but possibly longer to realize effects)

Biological control (biocontrol) defined~
The use of natural enemies to reduce the damage caused by a pest population, such as an invasive plant.

Ultimate goal: Restore wetland habitat and function; give native species a competitive chance.

Meet the Beetles

Galerucella species

Is this safe?

- **USDA regulates the use of biocontrol organisms.**
- **Leaf-eating beetles, *Galerucella calmariensis* and *G. pusilla*, were approved for U.S. release in 1992 following a lengthy process that determined host-specificity (no negative impacts to other plants) and effectiveness of control.**
- **Research was conducted, primarily at Cornell University, and included:**
  - Quarantine
  - No-choice tests (in lab)
  - Initially tested on small scale field plots in the US,
  - Then long term monitoring of beetles was evaluated for establishment, spread, impact on the target species, and impact on nontarget species.

Study references for host specificity…

Kaufman L.N.; Landis D.A. (2000) *Host Specificity Testing of Galerucella calmariensis L. on Wild and Ornamental Plant Species.* Biological Control, Volume 18, Number 2, pp. 157-164(8).

Blossey, B., Schroeder, D., Hight, S.D., and Malecki, R.A. (1994) *Host specificity and environmental impact of two leaf beetles (Galerucella calmariensis and G. pusilla) for biological control of purple loosestrife (Lythrum salicaria).* Weed Sci., 42: 134-140.

Kok, L.T., McAvoy, T.J., Malecki, R.A., Hight, S.D., Drea, J.J., and Coulson, J.R. (1992) *Host specificity tests of Galerucella calmariensis (L.) and G. pusilla(Duft.), potential biological control agents of purple loosestrife, Lythrum salicaria L.* Bio. Control, 2: 282-290.

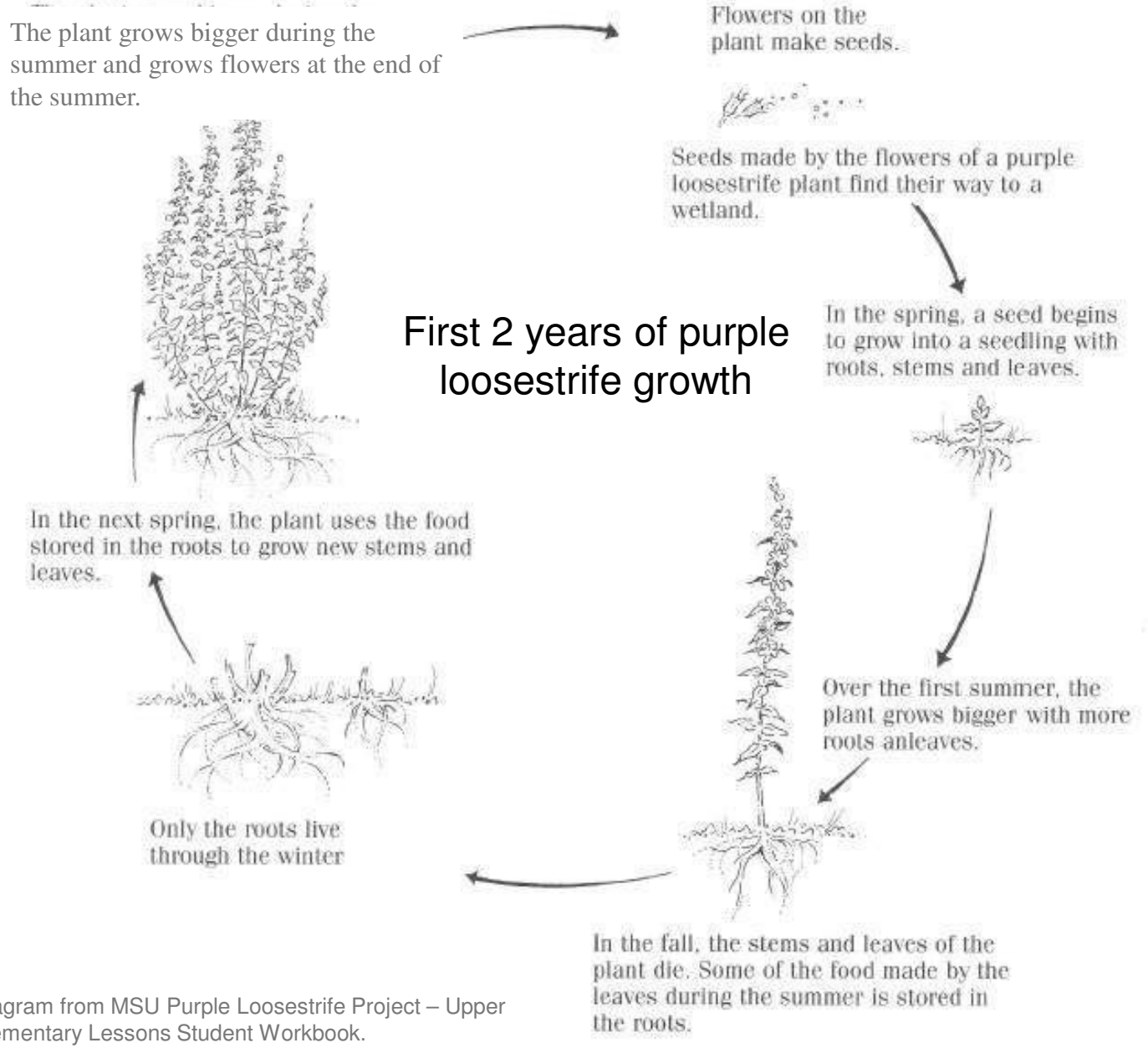
Malecki, R.A., Blossey, B., Hight, S.D., Schroeder, D., Kok, L.T., and Coulson, J.R. (1993) Biological control of purple loosestrife: a case for using insects as control agents, after rigorous screening, and for integrating release strategies with research. BioSci., 43: 680-686.

History in MA

- Released at two national wildlife refuges (Parker River and Great Meadows) began releasing *Galerucella* beetles in1996/98.
- MA Wetland Restoration Program (WRP) coordinated first release in 2000 at a Walpole site.
- Since then WRP has coordinated releases at 26 other sites.
- Total beetles released since 2000—approximately 300,000.

WRP Purple Loosestrife Biocontrol Sites

What's happening in the wetland



First 2 years of purple loosestrife growth

Diagram from MSU Purple Loosestrife Project – Upper Elementary Lessons Student Workbook.

New Mapping initiative

Purple Loosestrife Beetle

(*Galerucella* spp.)

Identification Card

Purple Loosestrife Biocontrol in Massachusetts

Surveillance of purple loosestrife infested wetlands outside of beetle release sites is an important component of biocontrol project monitoring. WRP requests that individuals who spend time in wetlands report observations of *Galerucella* beetles and/or evidence of *Galerucella* feeding on purple loosestrife.

For more information on the Purple Loosestrife Biocontrol Project or to submit observations, contact -

Beth Suedmeyer
Massachusetts Office of Coastal Zone Management
Wetlands Restoration Program (WRP)
251 Causeway St., Suite 800
Boston, Massachusetts 02114
phone: 617-626-4921 • fax: 617-626-1240
beth.suedmeyer@state.ma.us
www.mass.gov/czm/wrp/projects_pages/loosestrife.htm

Examine Purple Loosestrife Stands and report observations (beetle presence and damage).

Purple Loosestrife Beetle

(*Galerucella* spp.)

Identification

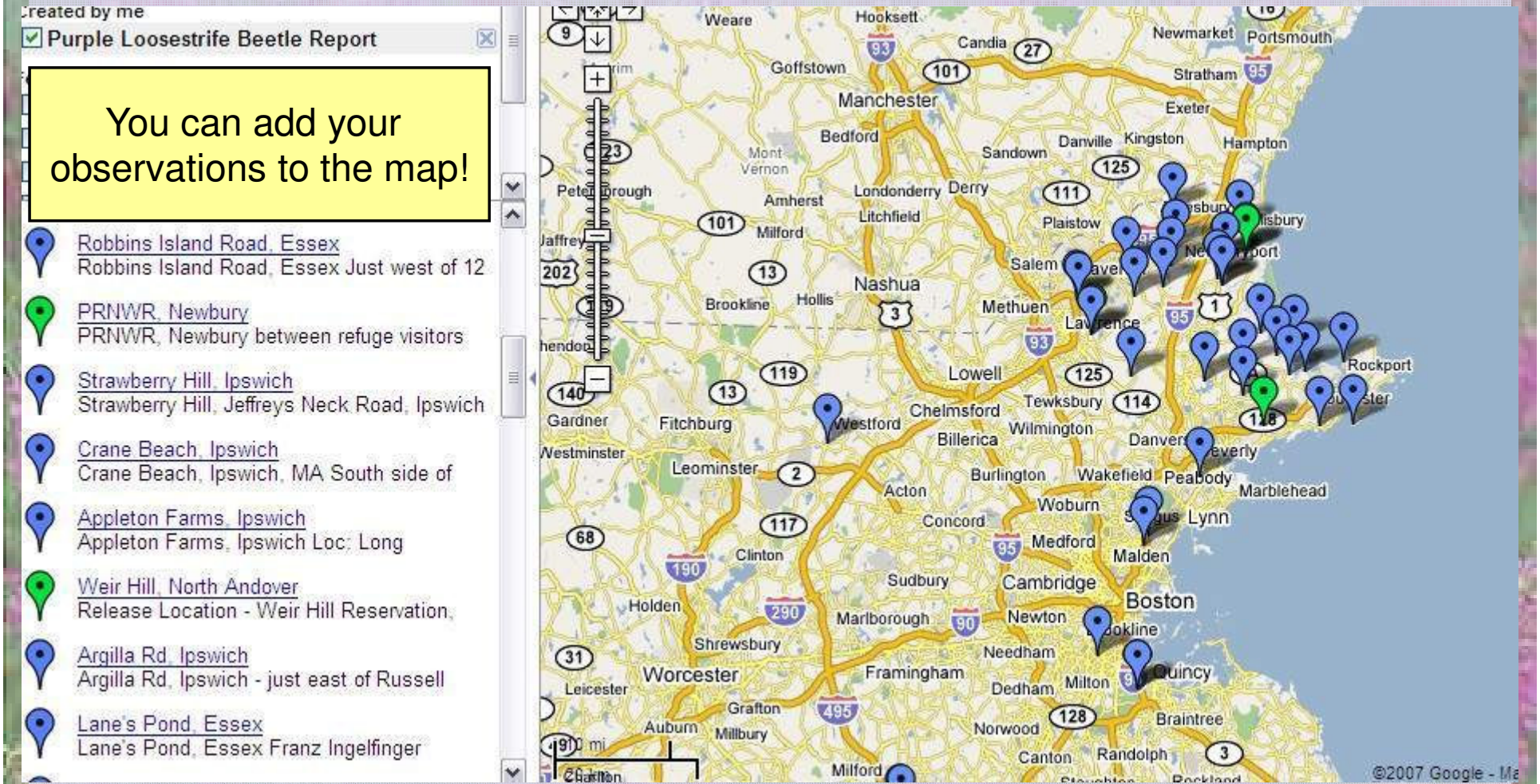
Please help WRP monitor beetle progress!

Let us know if you see the beetles or beetle evidence shown below. *Galerucella* spp. beetles are biocontrol agents released to feed specifically on the invasive wetland plant, Purple Loosestrife.

From left to right: *Galerucella* spp. eggs, larvae, and adults (3-5 mm long and half as wide). Adult and larval feeding patterns can be distinguished from each other. Adult feeding leaves a bullet-hole like pattern with the leaf tissue completely penetrated. Larval feeding does not penetrate the entire leaf; a thin layer of leaf tissue remains visible. Larva prefer to feed on the newest leaves/shoot tips.

Photo credits - www.forestryimages.org: Linda Wilson, University of Idaho; Agriculture and Agri-Food Canada Archives; Bernd Blossey, Cornell University; John D. Byrd, Mississippi State University (cover)

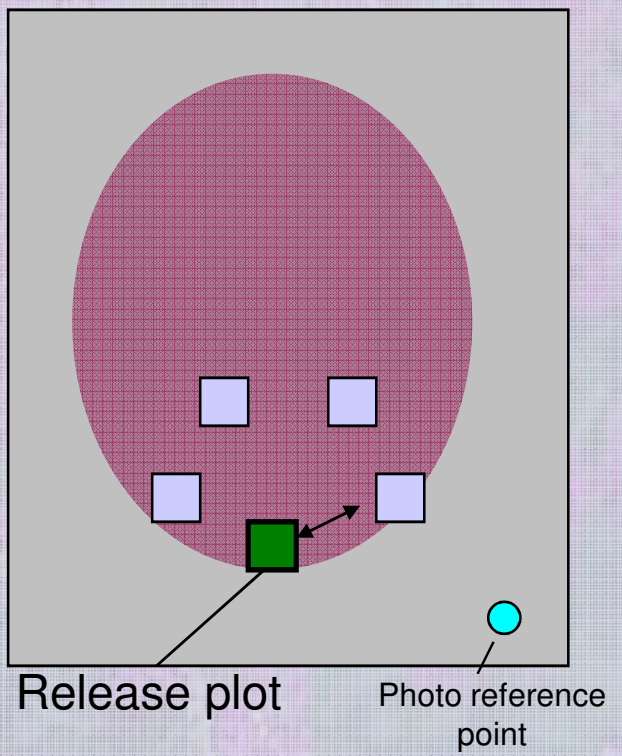
Reporting Observations via Google Maps



Beetles have dispersed as far as 10 miles from release sites.

Monitoring

- Standard methodology used across the U.S.
- Monitoring plots are 1x1 m quadrats, marked with wood stakes or PVC pipe.
- Monitor twice each year for at least three years.
- Document changes at site (and of each plot) with photos



Monitoring methods

Spring Monitoring includes:

- Visual assessment of the abundance of *Galerucella* eggs, larvae, and adults,
- Estimation of damage to purple loosestrife plants,
- Estimation of percent cover and count of stems of loosestrife and cattails.

Fall Monitoring includes:

- Estimation of percent cover and count of stems of loosestrife and cattails.
- Height of five tallest loosestrife and Cattails stems,
- Measurements of infloresences and flowers.
- Qualitative and quantitative observations of other insect and plant species.

Why monitor?

Looking at the data over time helps us to see if there are any trends -- Are the purple loosestrife plants responding to the introduction of the beetles?

Hypothesis: Purple loosestrife will be reduced by the introduction of the *Galerucella* beetles.

Does the field collected data support this hypothesis?

The data collected allows us to look at this reduction in more than one way.

Are there changes in Purple Loosestrife's-

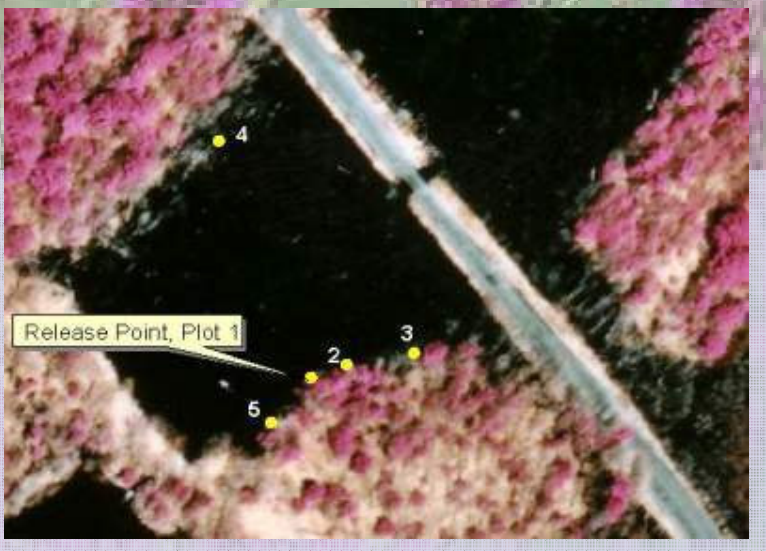
- **Stem height?**
- **Space that it is taking up (percent cover)?**
- **Seed production?**

We also expect to see changes in other plants growing alongside the purple loosestrife.

HANDS ON
Demonstration of Monitoring Methods

Results Walpole Site

- Three releases
- (1st in 2000, total 30,000 beetles)

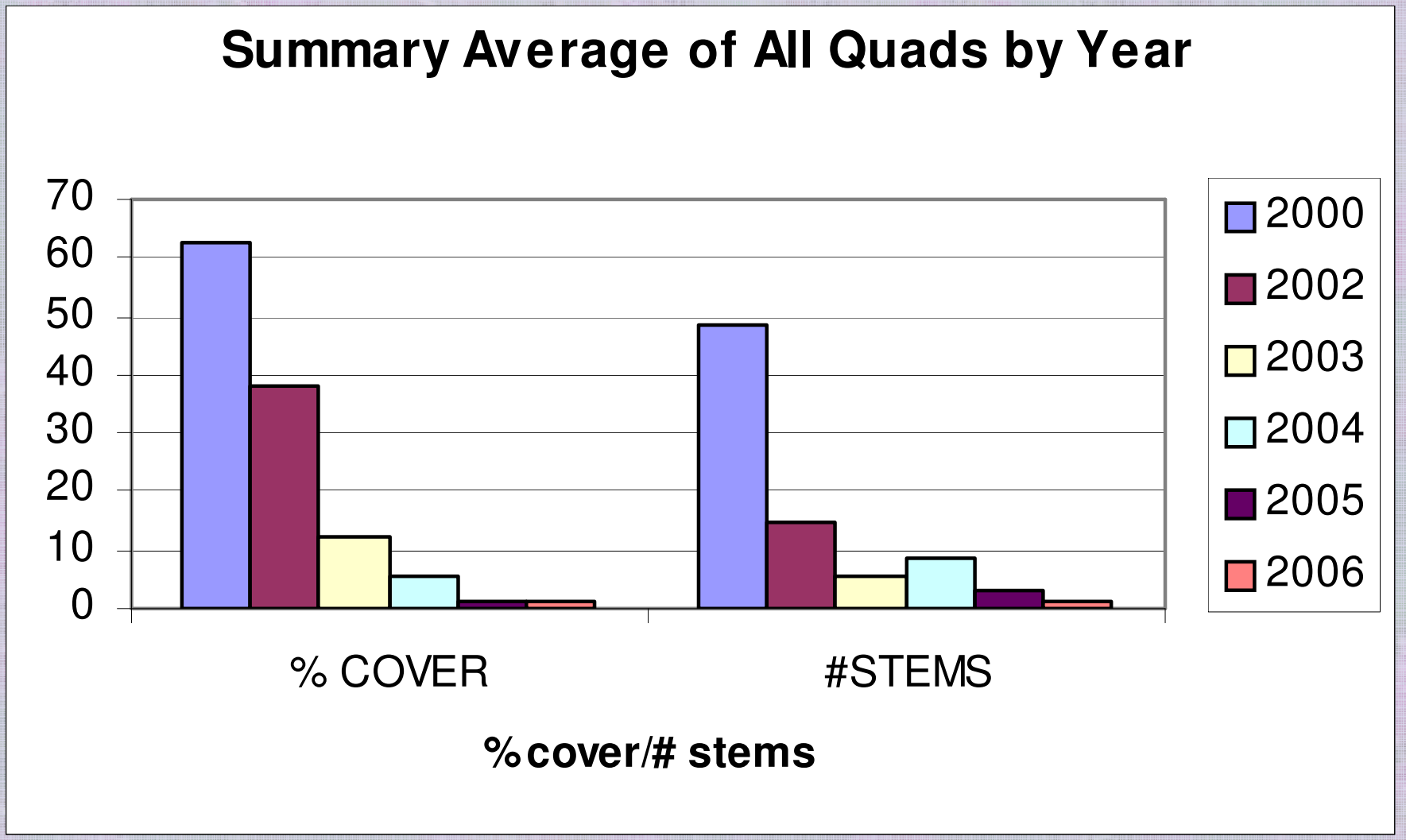


- Photo documentation of quadrats

Quadrat #2, 2002

Quadrat #2, 2004

Monitoring Data for Walpole Site

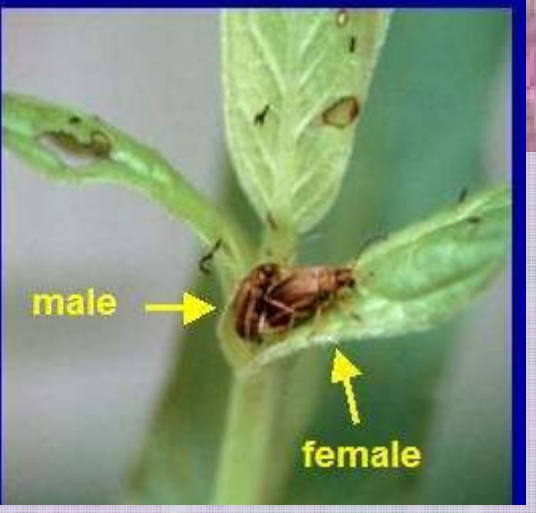


Releases happened in 2000, 2001, 2002. Five plots monitored. No data collected for 2001.

Beetle Rearing

Remove the growing tips of plants when they are 12 inches tall to encourage healthy, dense vegetation.

Galerucella Beetle Mating Pair



Galerucella egg cluster on a purple loosestrife leaf.

Release and Damage

Galerucella larvae on purple loosestrife shoot tips.

New *Galerucella* adults ready to be released.

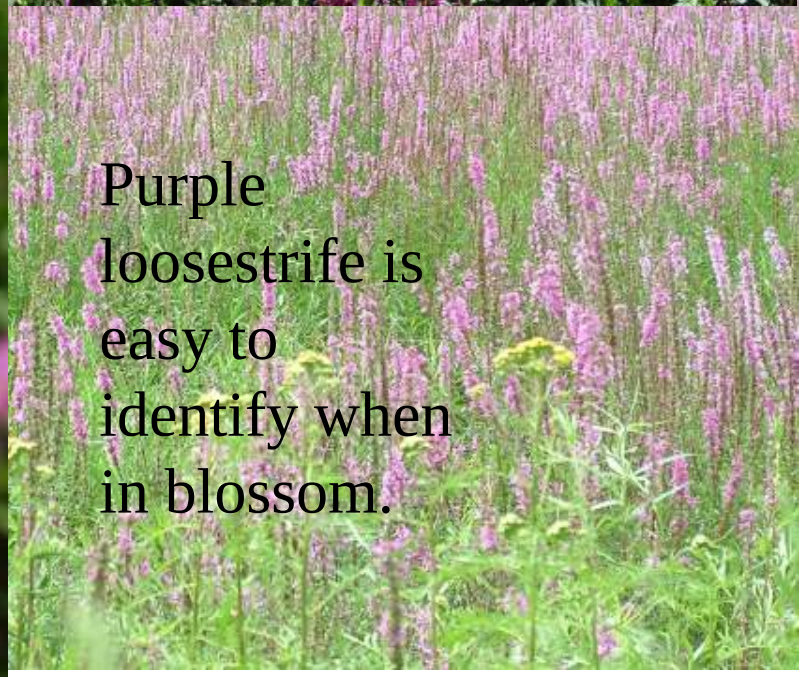
Adult beetles begin feeding on new leaves, mate, and lay eggs.

Acknowledgements

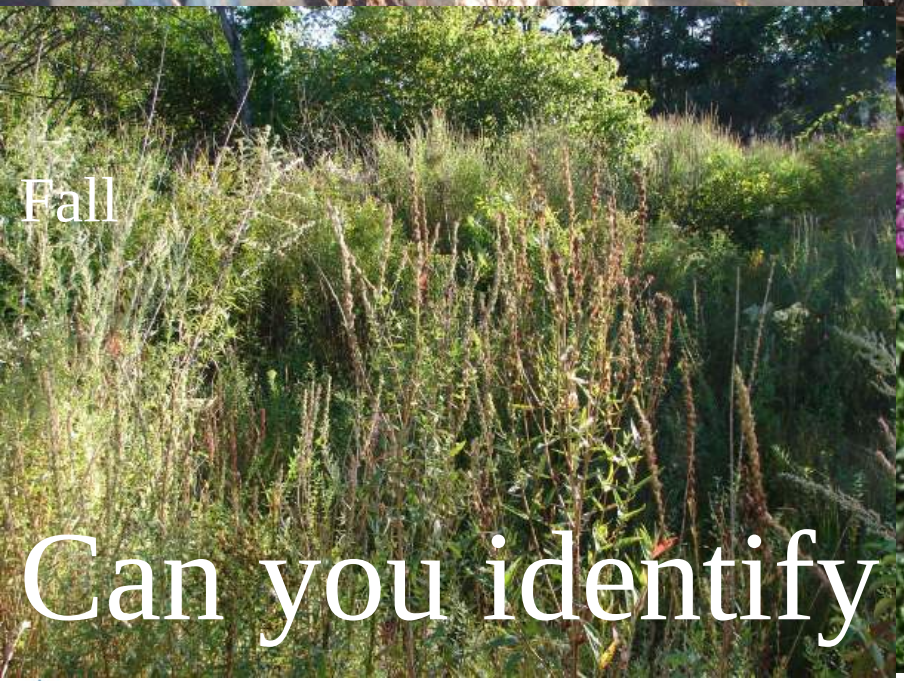
- Partners for Fish and Wildlife Program USFWS
- Coastal Americas Foundation
- Corporate Wetlands Restoration Partnership
- EPA 5-star Restoration Program & grant team
- Site coordinators and volunteers

Image and slide use

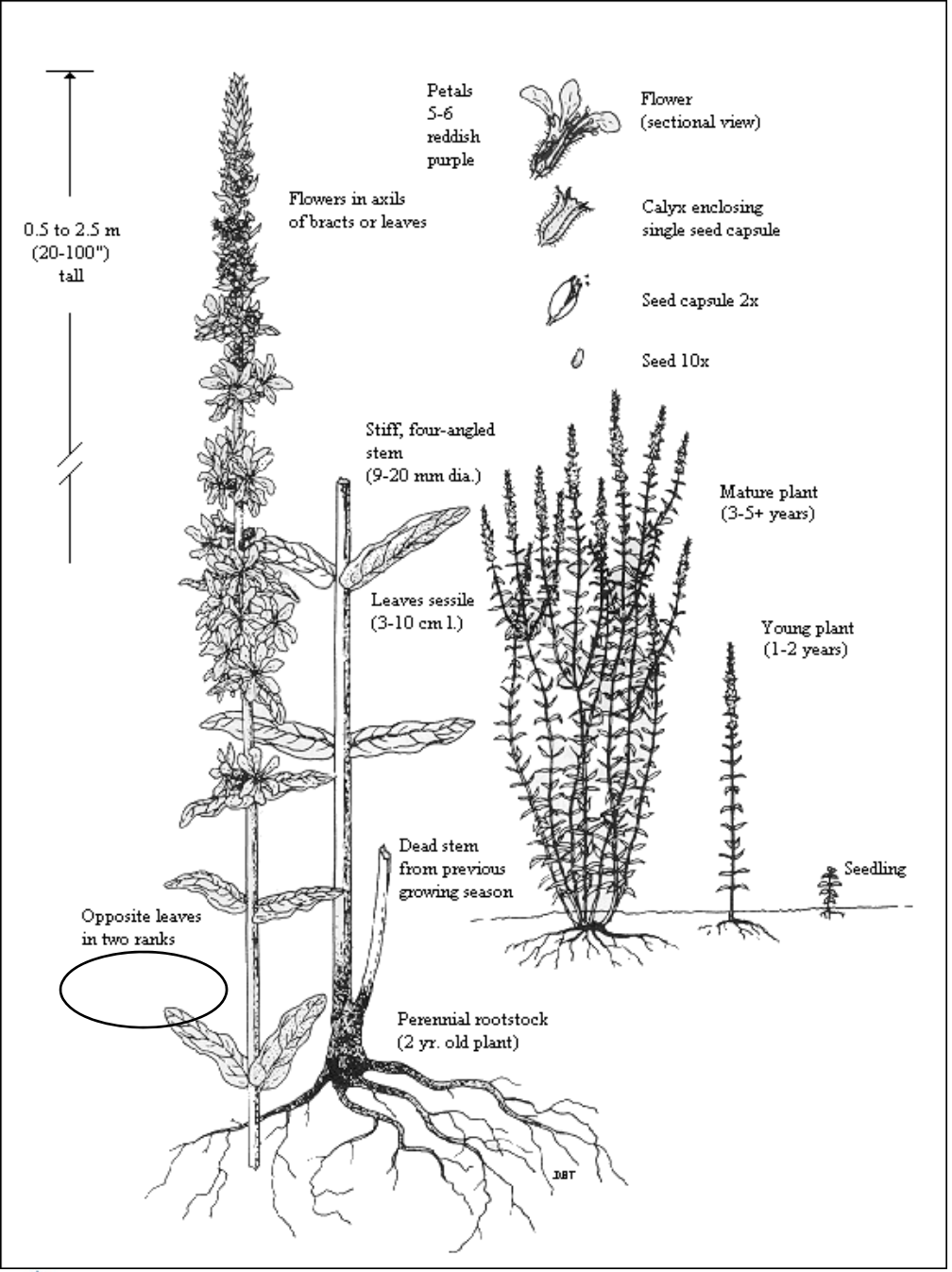
- Donna Ellis – CT Beetle Farmer Program
- MSU Purple Loosestrife Project

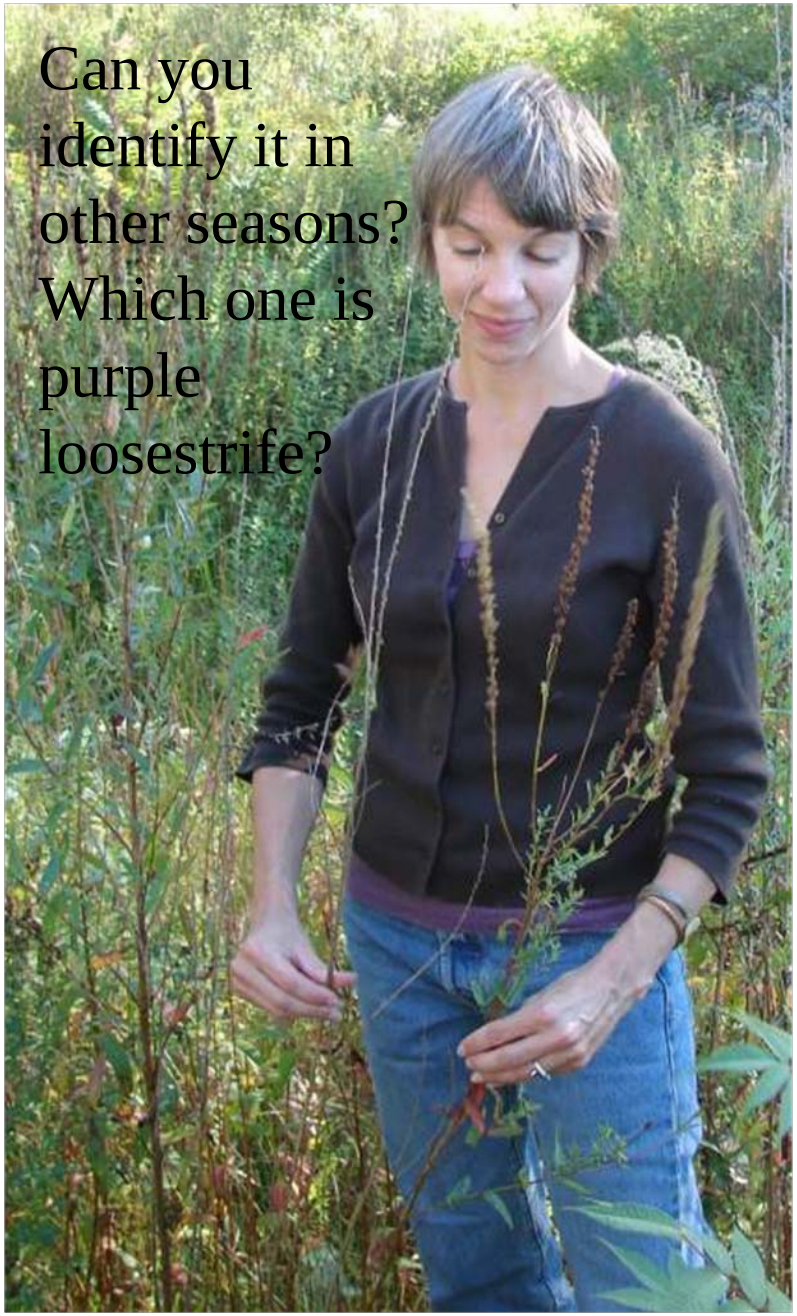


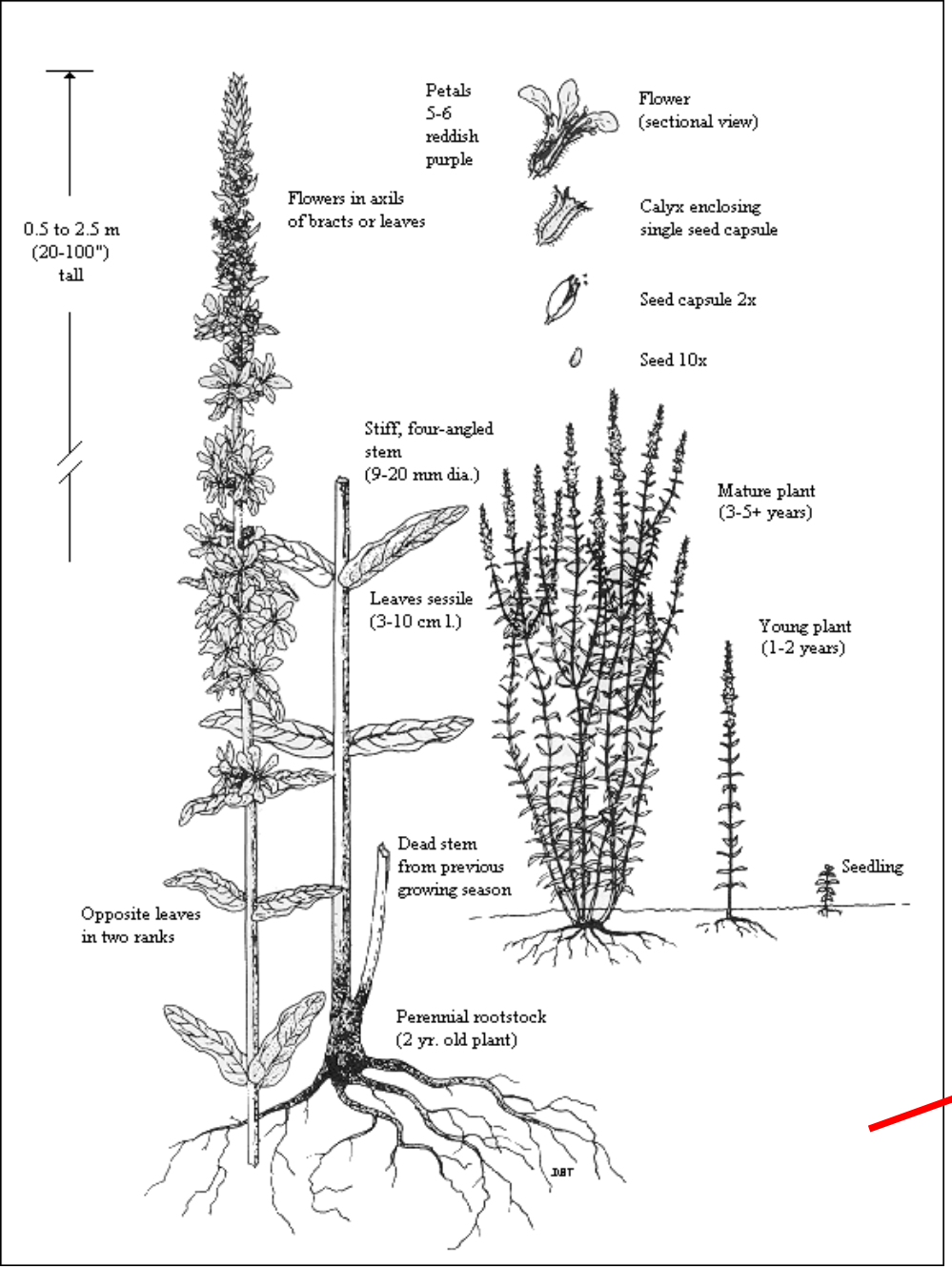
Purple loosestrife is easy to identify when in blossom.



Can you identify it in other seasons?


0.5 to 2.5 m
(20-100")
tall
Petals
5-6
reddish
purple
Flower
(sectional view)
Flowers in axils
of bracts or leaves
Calyx enclosing
single seed capsule
Seed capsule 2x
Seed 10x
Stiff, four-angled
stem
(9-20 mm dia.)
Mature plant
(3-5+ years)
Leaves sessile
(3-10 cm l.)
Young plant
(1-2 years)
Dead stem
from previous
growing season
Seedling
Opposite leaves
in two ranks
Perennial rootstock
(2 yr. old plant)
DBT


Can you identify it in other seasons? Which one is purple loosestrife?


Petals
5-6
reddish
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Flowers in axils
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Calyx enclosing
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0.5 to 2.5 m
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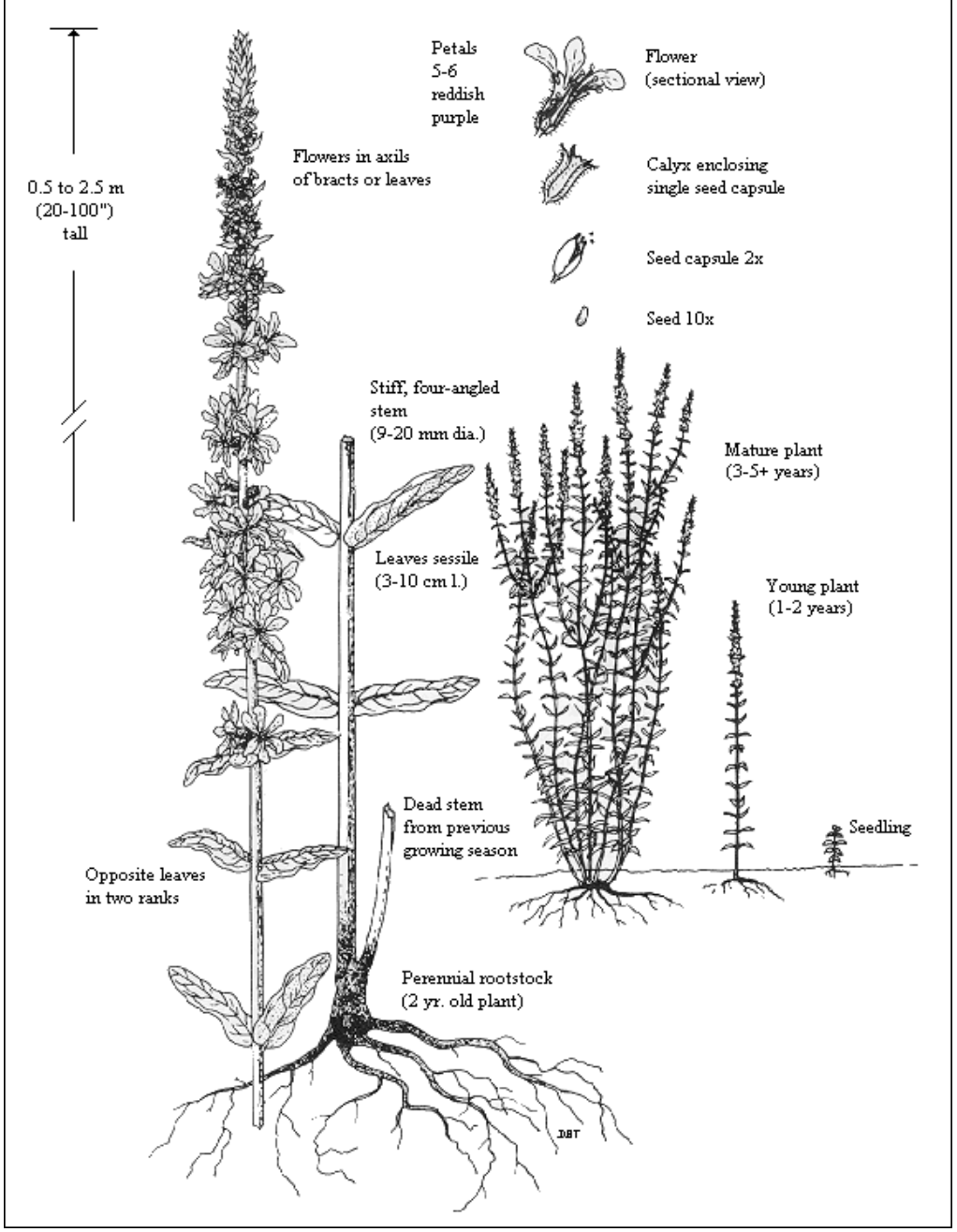
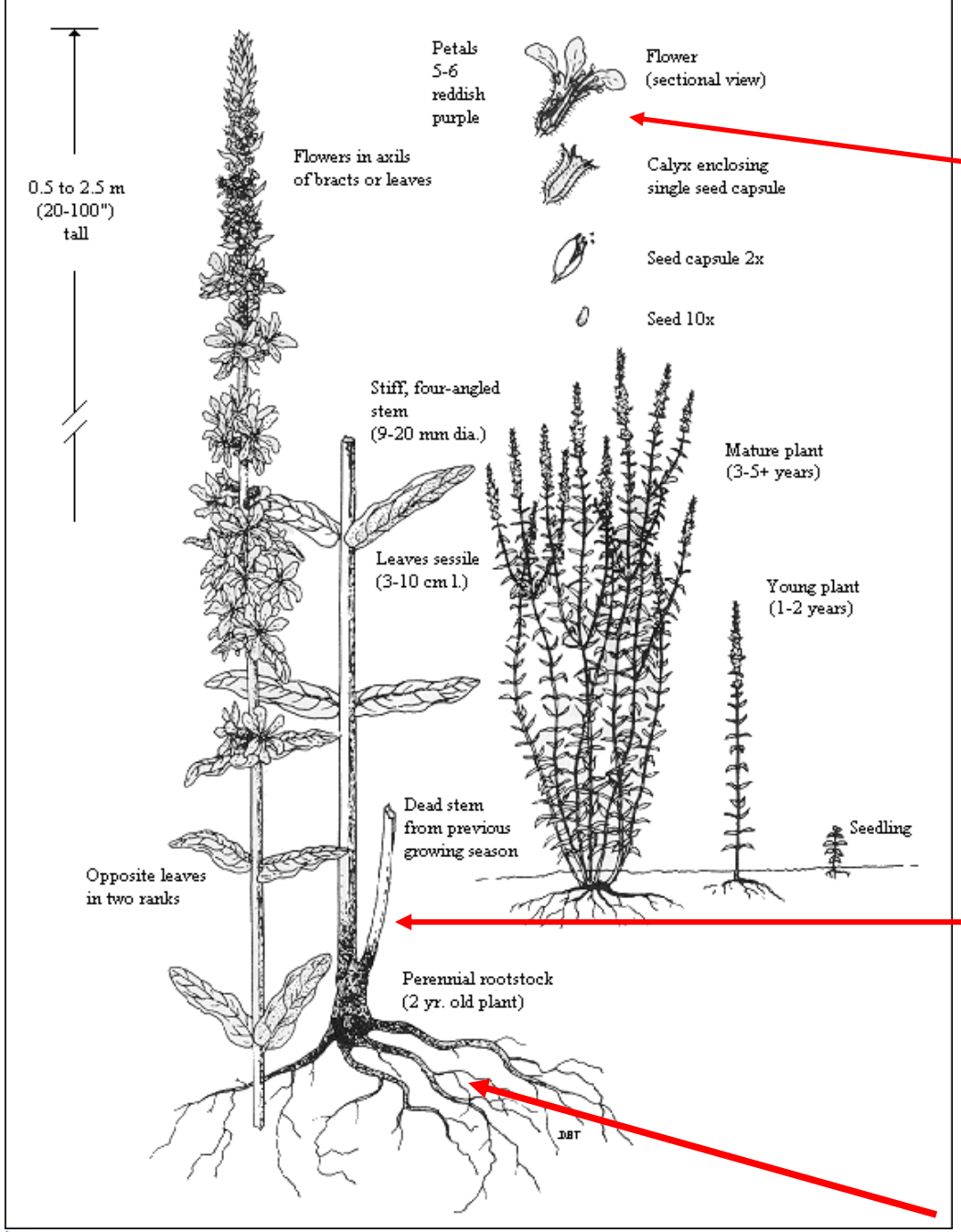


What part of the plant produces the seed?

Do you think Purple loosestrife grows taller every year, or dies back and grows up again?

What part of the plant continues living in the winter?



What part of the plant produces the seed?

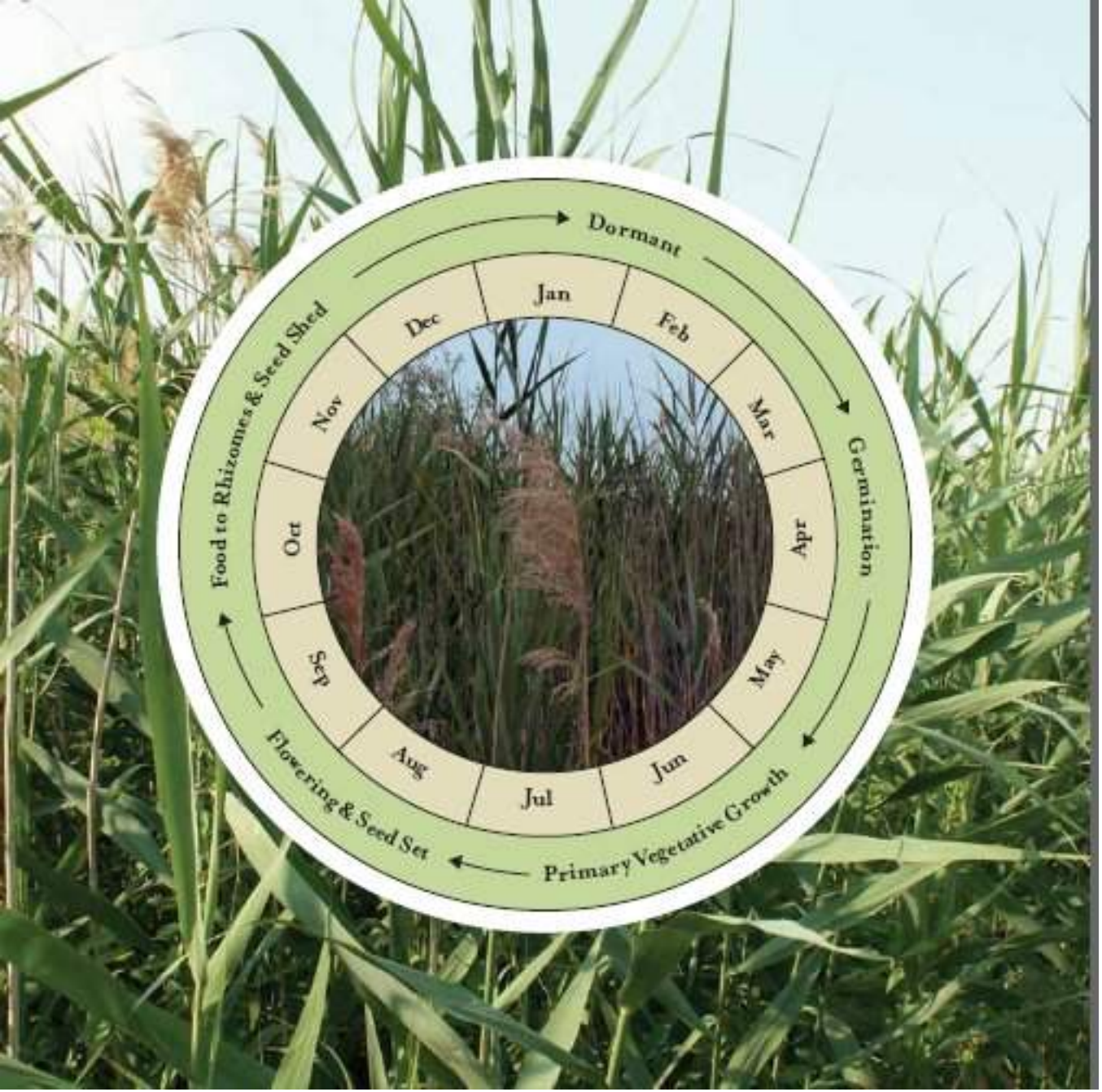
The job of flowers is to produce seeds.

Does Purple loosestrife grow taller every year like a bush, or die back and grows up again from the roots ?

Dies back. Plant grows up from stored energy in roots.

What part of the plant continues living in the winter?

The roots.



This is life cycle model for *Phragmites*, another invasive plant.

Challenge: Observe purple loosestrife through the year and create a life cycle timeline for purple loosestrife

Winter

Old dead stalks remain

Fall: Flowers go to seed.

New Growth. Seeds sprout & grow.

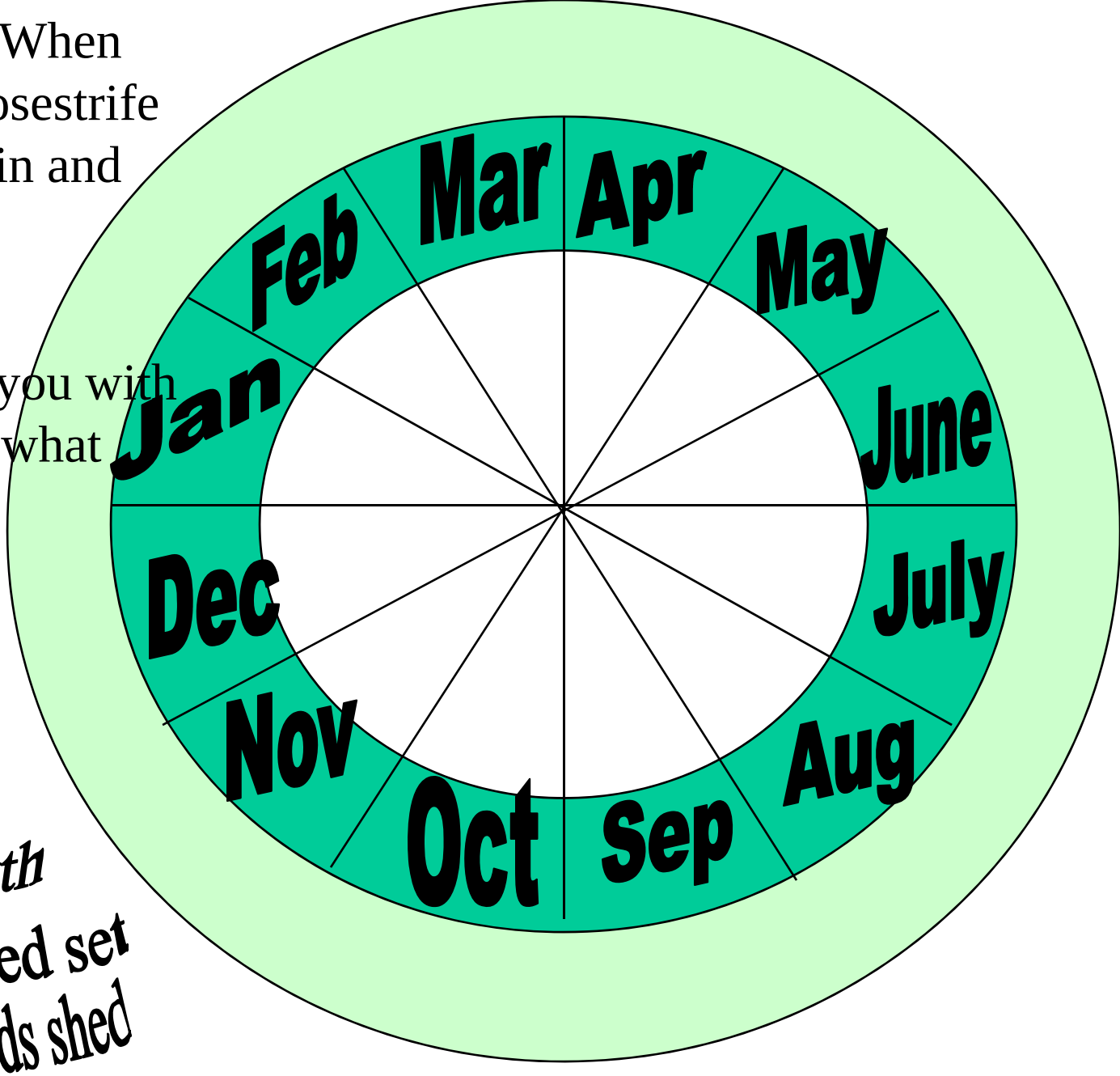
Spring

Summer,

Flowers bloom

Make a prediction: When does your purple loosestrife growing season begin and end in your town?

Read background information to help you with this. Observe to see what happens.



dormant

germination

vegetation *growth*

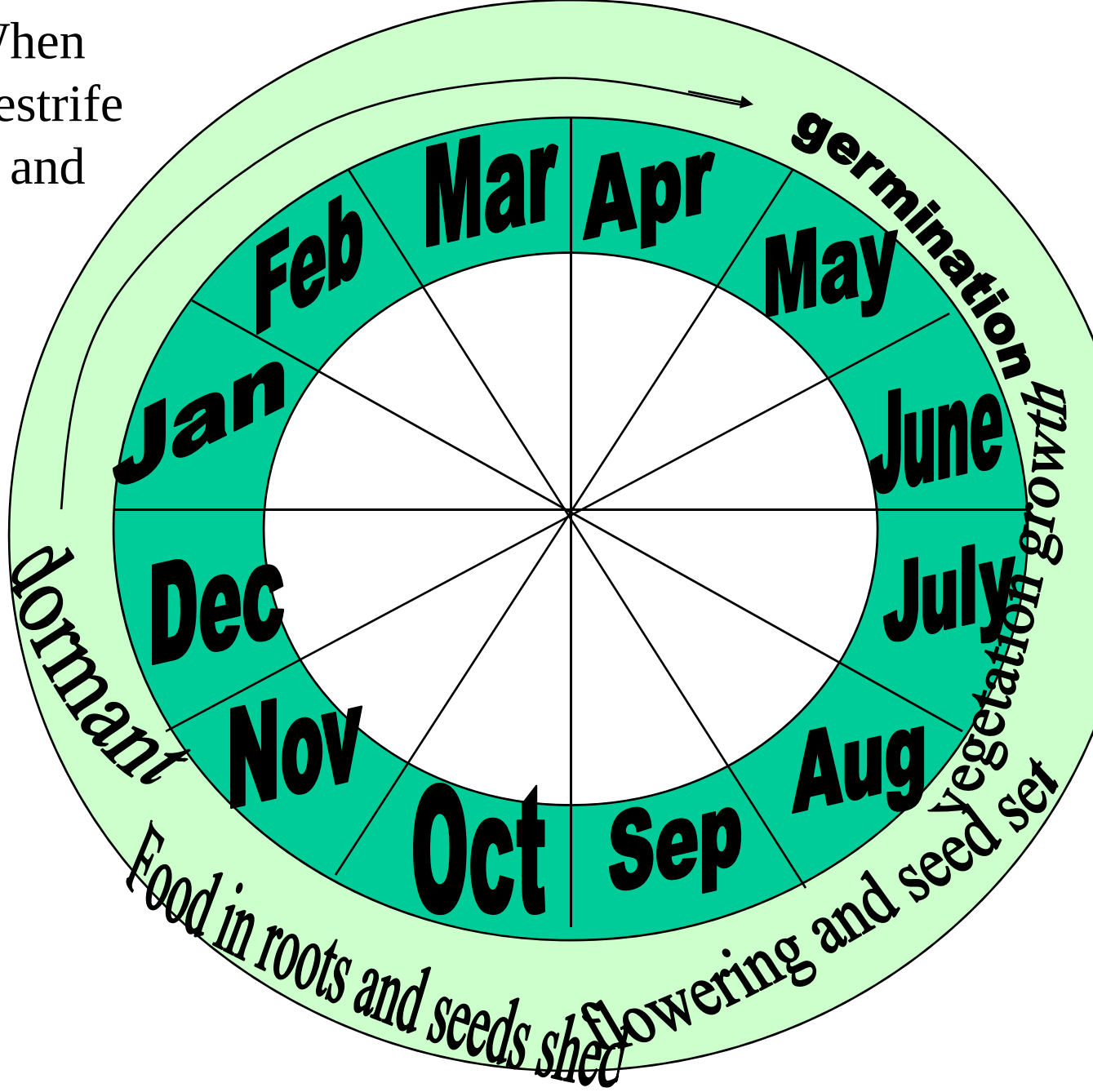
flowering and seed set

Food in roots and seeds shed

Make a prediction: When does your purple loosestrife growing season begin and end in your town?

Observe to see what happens.

Here's a guess. Does your prediction look like this?




Winter
New Growth.
Seeds sprout and
Spring
Old de
ain
Jan
Feb
Mar
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bserve to see what really happens at your
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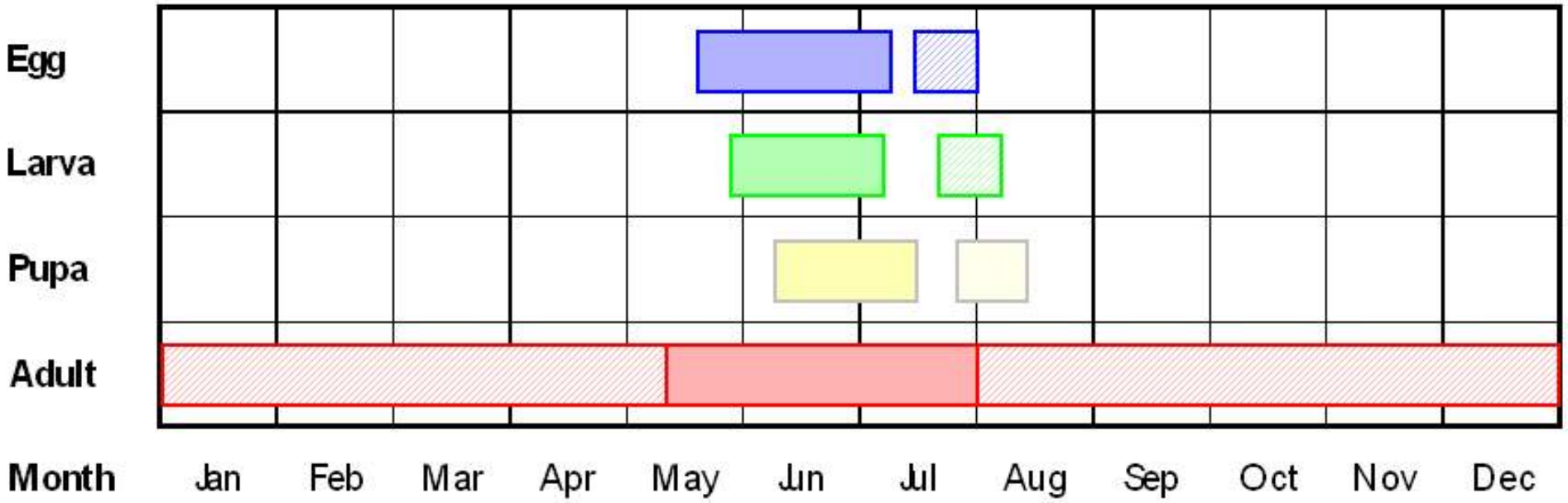
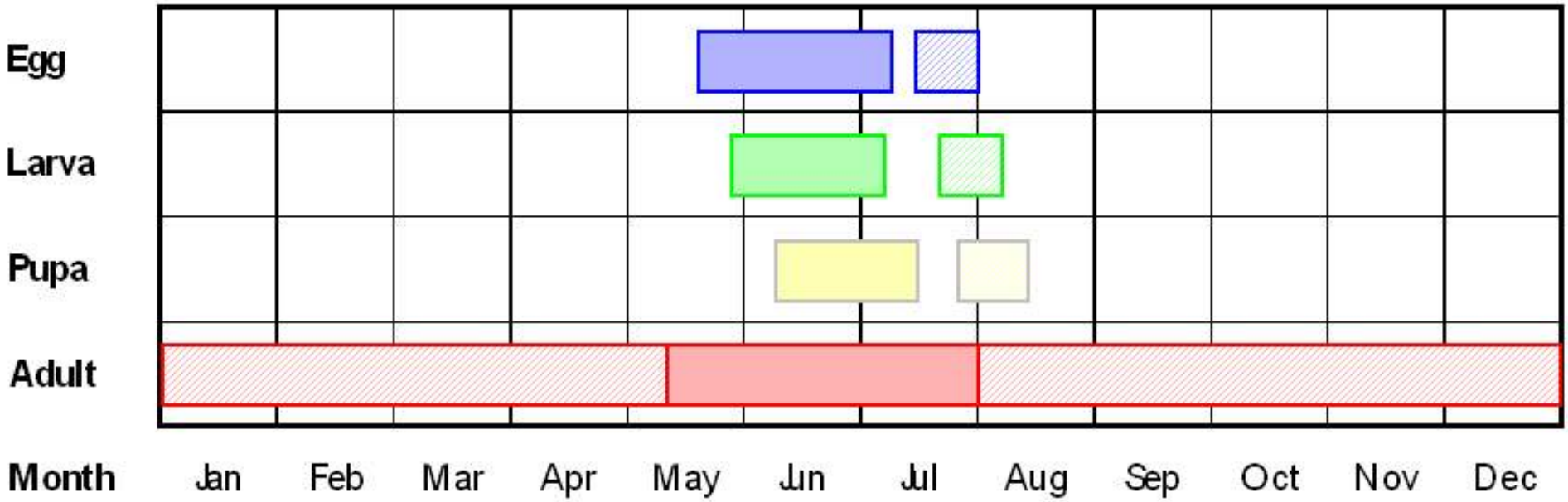


Figure 3. Lifecycle of *Galerucella calmariensis* and *G. pusilla*. Solid colored bars represent the length of activity for each of the life stages. Short patterned bars for the upper three stages represent potential second generation activity.

	May				June				July
weeks	1	2	3	4	5	6	7	8	9
Fast	Egg	Egg	Larva	Larva	Pupa	Pupa	Adults		
Slow	Egg	Egg	Egg	Larva	Larva	Larva	Pupa	Pupa	Adults
		Be sure to feed adults! Release or they will die!							



Compare the life cycle of the *Galerucella* beetles and the purple loosestrife. Why do you think this plant is a good match for the beetles?

	May				June				July
weeks	1	2	3	4	5	6	7	8	9
Fast	Egg	Egg	Larva	Larva	Pupa	Pupa	Adults		
Slow	Egg	Egg	Egg	Larva	Larva	Larva	Pupa	Pupa	Adults