YALE
PEABODY MUSEUM
of Natural History

Dear Teacher,

You are holding the latest draft copy of a new life science module that is being developed by the Peabody Fellows Program at Yale Peabody Museum. This version of the module includes suggestions from previous pilot teachers. Your own feedback will help us make this module more practical, accessible and manageable for students and teachers who will eventually be using it.

We decided to create a unit about vector-borne disease because it is a topic important to everyone in Connecticut. Our state plays a major role in the study of two well-known vector-borne diseases: 1) Lyme disease, named for the town of Lyme, Connecticut; and 2) West Nile virus, which first appeared in this country in 1999 and is being closely studied by the Connecticut Agricultural Experiment Station (CAES).

We also decided to follow the Event-Based Science (EBS) Instructional Model. In an EBS classroom, your students become the scientists, their work is a solution to a real problem, and you act as coach, guide, and advisor. On the following pages you will read more about EBS. The Peabody Fellows Program agrees with Dr. Russell Wright, who developed EBS, when he writes, "Knowledge cannot be transferred to your mind from the mind of your teacher, or from the pages of a textbook. Nor can knowledge occur in isolation from the other things you know about and have experienced in the real world. The EBS model is based on the idea that the best way to know something is to be actively engaged in it."

Because this module is not in its final form, you will see different types of pages – some newly created just for this module, some photocopied from other EBS modules. Again, it is <u>your</u> feedback that will pave the way for the final version over the next couple of years.

We want to thank the National Center for Research Resources of the National Institutes of Health for providing us with a Science Education Partnership Award to fund this project.

All of us at the Peabody Fellows Program at the Yale Peabody Museum thank you in advance for your participation. We look forward to hearing from you!

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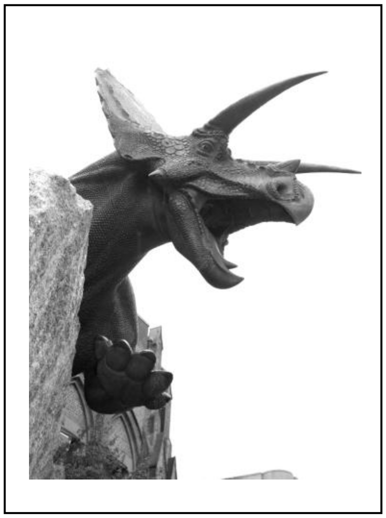
INTRODUCTION



During the time we have been testing this module, we have heard two questions from students:

1. Why would a museum care about vector-borne diseases?
2. Why should I care about this stuff?

Let's start with the first question…

Yale Peabody Museum, founded in 1866 in New Haven, Connecticut, is a special place. Its mission is to help understand and keep a record of the earth's history, including all of life and every human culture – a big task! How is such a task even possible? The museum does this by collecting, conserving and doing research on specimens from around the globe.

In 1908, Peabody's scientists – including biologists, geologists and anthropologists - would make observations, take measurements, and analyze their data. Their work might have included describing a new species or observing how a species evolved over millions of years. In 2008, Peabody's scientists would also observe, measure and analyze, but with some added twists. Today's scientists also include evolutionary biologists who might analyze genetic data that reveal how organisms that look very different are actually related. Or they'll discover the exact opposite - organisms that look related might not be genetically close at all. Museum scientists also work with Geographic Information System (GIS) experts. Together, they might observe rainfall patterns with GIS computer technology to predict how climate change might affect food crops. They can even map the exact spot where museum specimens were collected and figure out the environments in which they lived.

You might be surprised to find that this is the work of a museum. But let's take a look at our complete name: Yale Peabody Museum of Natural History. If you know the definition of **natural history** it is not surprising at all.

> **Natural history**: the scientific study and description of living things and natural objects, especially their origins, evolution, and relationships to one another.

Is there any part of this definition that helps you to understand why Yale Peabody Museum cares about vector-borne disease? Let's take a closer look…

"The scientific study and description of living things" sounds like the definition of a word you may already know: **biology**. The prefix, **bio-**, means "life or living" – think of words like biography (the story of someone's life), biohazard (a material that is dangerous to living things), and biofuel (fuel made from recently living materials, instead of fossil fuel from long dead material) The suffix -**ology** means "the scientific study of" – think of words like geology (the scientific study of the earth), entomology (the scientific study of insects), and ornithology (the scientific study of birds).

In an earlier paragraph, we mentioned an evolutionary biologist and the definition above includes the word **evolution**. What does this have to do with a vector-borne disease?

Evolution: In biology, any change over time in the genetic material of a population of organisms. There can be different degrees of evolution, from small changes in minor genes to major genetic changes that differentiate species. Evolution explains the diversity of all life on earth as a result of these genetic changes.

Hmm…we already know that natural history is the scientific study of living things. And now we know that evolution has to do with changes in genes in populations. We also know that evolution can result in the formation of new species. So, it makes sense that a natural history museum studies evolution, right? But, we still haven't figured out why the museum cares about vector-borne disease…or, have we?

Let's look at a few more important words.

As a middle or high school student in the 21st century, you have probably heard the word **ecology**. You may even know its definition.

Ecology: the scientific study of how living things interact with their environment, including the physical environment and other living things.

Maybe your teacher had you build a rainforest in the classroom. Your scout troop might have collected money to protect an endangered animal. Or, you did something as simple as play a food web game using a piece of string to show how some plants and animals are connected. All of these activities were to help you learn about an important part of ecology, **biodiversity**.

Biodiversity: the total range and variety of life-forms, including differences between gene pools, species, populations and entire ecosystems.

Did you know that this word didn't exist before 1986? That year the National Forum on BioDiversity was held in Washington, D.C. Scientists from all over the United States came together to discuss the importance of knowing as much as possible about *every living thing* – from genes to species to ecosystems to interactions with every other living thing. These scientists recognized that many plant and animal species are facing extinction. They also realized that we don't even know how many species there are! Current estimates put the number of plants, animals and microorganisms known to science at about 1.7 million. The truth is that most species have not yet been described and named. Many scientists think that the actual number of species on earth is anywhere from 10 to 80 million, but no one is sure. This means we are losing species that haven't even been described yet. Sadly, we may be losing more than just particular species.

Humans can build and use computers, create space shuttles and travel to the moon and invent ways to copy and change DNA molecules. But our bodies have evolved to follow the same biological rules as every other living thing on the planet. This can cause us problems, as you'll see when you learn about zoonotic diseases in this module. The same virus or bacterium can live in a bird, mouse, mosquito and human, causing illness and even death. People have always depended on biodiversity for medicines. There are parts of other living things that can treat or even cure diseases. One example is the rosy periwinkle, a plant from Madagascar. It contains chemicals that are used to treat a fatal childhood cancer. Thousands of children have been saved by this plant-based medicine. Another example concerns high blood pressure, a deadly condition of adults. The venom of a poisonous rain forest snake was used to make a powerful medicine that treats this illness. Today, we need new medicines to treat emerging diseases. We also need to be able to treat pathogens that have become resistant to the antibiotics we use now.

So, by now you have read a number of reasons why Yale Peabody Museum thinks biodiversity is important. But what about vector-borne disease? Although you will learn more about this type of disease in the module, let's take a quick look now.

A vector-borne disease has a complex story. First, there is the pathogen – a virus or bacterium that actually causes the illness. This pathogen must go through several steps before it can infect a person. It must find a non-human vertebrate host to live in– often a bird or a mammal. A host can carry the pathogen in its bloodstream without getting sick. This allows the pathogen to keep reproducing until it is picked up by a vector. The vector is a blood-sucking arthropod - often a mosquito, tick or flea. When the vector takes blood from an infected host, it picks up the pathogen, too.

But here's the thing (and here's a hint about why we have been talking about biodiversity): Every <u>specific</u> pathogen has <u>specific</u> vectors and <u>specific</u> hosts. For example, West Nile virus doesn't use <u>all</u> birds as its hosts. It only uses specific species, like robins, sparrows, and a few other song birds. When we say that "mosquitoes carry West Nile virus," we don't mean <u>all</u> mosquitoes. The virus is carried and transmitted by a few specific types of mosquitoes, mostly *Culex* species. In order to understand, treat and prevent this type of complicated disease, we must know <u>all</u> we can about <u>all</u> the species involved.

So, when we say that biodiversity matters, we mean that <u>each</u> species in this web of life matters. The truth is that we know so little about the role of biodiversity that we do not know how many species we can lose without putting the whole planet in danger.

Edward O. Wilson is a famous biologist who writes a lot about biodiversity. He said it best:

"If enough species are extinguished, will ecosystems collapse and will the extinction of all other species follow soon afterwards? The only answer anyone can give is: Possibly. By the time we find out, however, it might be too late. One planet, one experiment."

We at the Yale Peabody Museum hope that you might consider becoming a scientist in order to help us protect the future.

And, finally, here's the answer to the second question, why should you care? Because you <u>are</u> the future.

Teacher Guide General Notes

1. *<u>PLEASE MAKE SURE YOU READ THIS GUIDE!</u> It contains pointers and information that you may have missed during training, as well as important tips based on feedback from other teachers. We also recommend reading the summary of the Event-Based Science Model to further help your understanding of this unique framework.*
2. *<u>It is important to make sure ALL Discovery File materials are covered!</u> The pre- and post-assessments will focus on specific content from the Files. Feel free to rewrite as you see fit, but please cover the Discovery File content. NOTE: There is one advanced supplemental File on the immune system that is only in this guide.*
3. *Please read the kit content sheets (immediately AFTER this section) carefully. We have tried to organize materials in a user-friendly way, as well as provide you with important information in the spreadsheets. When you are through with the kit, please follow instructions from your training site regarding what is consumable and what is to be returned.*
4. *Use of the additional kit materials (books, skulls, Mi-Scope digital scope, slides) has not been specifically written into lesson plans. Some teachers have found it useful to keep a resource area in the classroom for the duration of the module.*
5. *We encourage you to supplement the student materials with media sources, such as newspapers, magazines, websites. You will probably find timely articles as you teach. The students will also be carrying out their own research to complete the Task.*
6. *As you know, there are many websites that contain questionable or inaccurate information. In particular, there are many Lyme disease websites containing serious errors. We have included a list of trusted sites for the students, including a journal article in your packet that deals with misleading Lyme disease websites.*
7. *Locations of the six Connecticut plots, per latitude and longitude given in the Task:*

    #A – Cornwall #D - Hampton
    #B = Kent #E – Sharon
    #C – Stafford/Somers #F - Lakeville/Salisbury

8. *After the initial lesson, Operation Vector Find, the lessons are organized so that the Mosquito/West Nile virus activities are together, followed by the Tick/Lyme disease activities. We begin with Skeeter Farm to allow your students a couple of weeks to observe mosquito larval growth. As long as you complete all lessons as a single module over several weeks, you may change the order to better suit the needs of your classroom and district.*
9. *We encourage you to give your students enough time to complete the Task. This stage of cooperative learning among groups is a key factor in the success of an EBS unit. Final presentations may even be shared with other classes.*

Inventory for National Sites Kits 2009-10

SKEETER FARM					
YELLOW LABEL					
	# PER KIT (for 30 sudents)	**ITEM**	**WHERE TO FIND IT**	**RECOMMENDED PER LESSON**	**IMPORTANT: PLEASE NOTE!**
	1	growing chamber	wrapped separately	1 / teacher classroom	brittle/avoid heat
	1	mosquito FOOD	in yellow bag	1 / teacher classroom	**SEE TEACHER GUIDE**
	20 and 20	squares of netting/rubber bands	in yellow bag	2 and 2 / student group	reuse
	1	mosquito bits larvacide--**NOT FOOD!**	in yellow bag	1 / teacher classroom	mosquito bits larvacide--**NOT FOOD! SEE TEACHER GUIDE**
	5	well slides with cover-slips	in yellow bag	5/teacher classroom	
	30	pipettes	in yellow bag	1 /student	**SEE TEACHER GUIDE**
	1 20-pak	LG. 100X20mm Petri dishes	packed separately	2 / student group	wash carefully and reuse
	1	Vernier digital thermometer	in yellow bag	1 / teacher classroom	**FRAGILE**
	4	thermometers	in yellow bag	1 /student group	
	1	hand lens	in yellow bag	1 or 2/student group	
IN OSP BAG	3	china markers (3 colors)	in OSP blue bag #2	for marking petris	careful of over-active peelers!
	1	MiScope	separate box	1/teacher classroom	**FRAGILE**
SUPPLIED BY TRAINING SITE		MOSQUITO eggs	**not in kit**		**SEE TEACHER GUIDE**
HANDY IF YOU HAVE THEM	more	thermometers	**not in kit**	1 /student group	
	more	handlenses	**not in kit**	1 or 2/student group	
SEE SHOPPING LIST	several	household products as possible larvacides	**not in kit**	for student-designed experiments	**SEE TEACHER GUIDE**

Inventory for National Sites Kits 2009-10

MIX UP WITH OSP

BLUE LABEL

	# PER KIT (for 30 sudents)	ITEM	WHERE TO FIND IT	RECOMMENDED PER LESSON	IMPORTANT: PLEASE NOTE!
	1 dropper bottle	RED liquid water color	blue bag #1	15 ml per batch	secure top
	8	medicine-cup measures	blue bag #1	1/student group	wash and dry imediately after use
	3 doz.	2-oz.dropper-bottles	in blue bag #2	5-6 / student group	wash in hot soapy water imediately after use
	2 20-paks	small 15 X 60 mm Petri dishes	packed separately	5-6/ student group	
	1	***Ixodes dammini*** M&F whole mount	in blue bag #1	in cardboard slide pkg	**NOTE:**Carolina Biologic refuses to relabel the slide correctly as ***I.scapularis !***
	10	tick ID cards	with Ixodes slide in blue bag #1	1-2/student group	
IN BLUE OSP BAG	3	china markers (3 colors)	in blue bag #2	for marking petris and bottles	
SEE SHOPPING LIST		cornstarch	**not in kit**	see shopping list	in red bag or Teacher Guide
		vinegar	**not in kit**	see shopping list	in red bag or Teacher Guide
	1 pt.	skim milk	**not in kit**	25 ml / OspA solution	**MUST** be **skim** milk. SEE **shopping list** in TEACHER GUIDE
	several	household products as possible larvacides	**not in kit**	for student-designed experiments	
HAVE ON HAND	1	beaker and stirrer	**not in kit**	for preparing solutions	
	1 set	measuring spoons	**not in kit**	1/teacher	

Inventory for National Sites Kits 2009-10

SPICY INHIBITORS

RED LABEL

	# PER KIT (for 30 sudents)	ITEM	WHERE TO FIND IT	RECOMMENDED PER LESSON	IMPORTANT: PLEASE NOTE!
	1	**shopping list**	**in red bag and TEACHER GUIDE**	1/teacher	for local shopping
	20	alcohol wipes	in red bag	1 / student pair or group	
	20	sterile swabs	I red bag	20 / classroom	
	5	mini sample scoops	in red bag	1 set/classroom	
	1 vial	blank discs	in red bag	1 / teacher classroom	control discs (if using antibiotics)
	5	forceps	in red bag	5/classroom	to place control discs (if using antibiotics)
IN BLUE OSP BAG	3	china markers (3 colors)	in OSP blue bag #2	3 / teacher classroom	
SUPPLIED BY TRAINING SITE	1 20-pak	bottles EasyGel	**not in kit**	1 / student pair or group	**Keep frozen until ready to use. SEE TEACHER GUIDE**
	1 20-pak	treated Petri dishes for EasyGel	**not in kit**	1 / student pair or group	store at **room temperature**
	1 tube	E. coli nutrient broth	**not in kit**	1 sterile swabful / student group	do **NOT** refrigerate keep at **room temperature**
IF REQUIRED BY YOUR DISTRICT		disposable gloves	**not in kit**		
		goggles	**not in kit**		
SEE SHOPPING LIST		powdered garlic and spices	**not in kit**	small amounts	**SEE TEACHER GUIDE**

Inventory for National Sites Kits 2009-10

OPERATION VECTOR FIND

	# PER KIT (for 30 students)	ITEM	WHERE TO FIND IT	RECOMMENDED PER LESSON	IMPORTANT: PLEASE NOTE!
		PLOT map #7	in student guide	1 / student	
	10	clear 12"/30 cm rulers		1/ student or student pair	supplement with classroom supply on hand
HAVE ON HAND		clear 12"/30 cm rulers	**not in kit**	1/ student or student pair	

TRAVELING VIRUS I & II

GREEN LABEL

	# PER KIT (supplement if more than 30 students)	ITEM	WHERE TO FIND IT	RECOMMENDED PER LESSON	IMPORTANT: PLEASE NOTE!
	small bag	phenolphthalein	green bag	0.1g /class	keep separate
	small bag	sodium carbonate	green bag	1.0 g / class	keep separate
	60	pipettes	green bag	1 / student (I); 1 / "mosquito" (II)	**SEE TEACHER GUIDE**
	60	3 oz. Cups	green bag	1 / student (I); 1 / student (II)	***See note below**
SEE SHOPPING LIST	1 pt (500 ml)	95%, 200 proof ethanol	**not in kit**	200 ml / TOTAL(I and II)	**SEE TEACHER GUIDE** caution **flammable!** read label

***NOTE: Paper cups with sodium carbonate solution will leak when sitting too long!**

Inventory for National Sites Kits 2009-10

SKULL BOX

	# PER KIT	ITEM	WHERE TO FIND IT	RECOMMENDED PER LESSON	IMPORTANT: PLEASE NOTE!
	1	deer skull	in box	1/classroom teacher	fragile
	1	mouse skull	in small magnifier box	1/classroom teacher	fragile

BOOK BAG

	# PER KIT	ITEM	WHERE TO FIND IT	RECOMMENDED PER LESSON	IMPORTANT: PLEASE NOTE!
	1 set of 6 books	Hidden Life Series	book bag	1/classroom teacher	paperbacks
	1	Achoo!	book bag	1/classroom teacher	paperback
	1	Bill Nye's Big Book of Germs	book bag	1/classroom teacher	hardback
	1	Human Wildlife	book bag	1/classroom teacher	paperback
	1	Killing Germs; Saving Lives	book bag	1/classroom teacher	hardback
	1	Deadly Invaders	book bag	1/classroom teacher	hardback
	1	Mosquito Bite	book bag	1/classroom teacher	paperback

The Task
Vector-Borne Diseases

Something's "bugging" Connecticut! Two diseases spread by **vectors** have been getting a lot of public attention. One is **Lyme disease**, which is transmitted by ticks. The other is **West Nile virus,** transmitted by mosquitoes.

The **pathogens** that cause these diseases are spread by the bites of certain ticks and mosquitoes. Blood-sucking mosquitoes and ticks are most active during warmer weather. More contact with these **arthropods** means more chances of being infected. **Public health** officials are working harder on prevention.

A wealthy donor has given six plots of land across Connecticut and she wants her gift used for public recreation. The problem is that these places are hot zones for vector-borne diseases. Many ticks and mosquitoes in Connecticut carry Lyme disease and West Nile virus.

Your class has been divided into project teams. Your team has been hired by the state. Your task is to design a recreation area in one of these plots of land. The design must help keep people from getting vector-borne diseases.

Your project will have two parts:

Part I

Design a recreation plan for your area that will <u>reduce public risk</u> of getting local vector-borne diseases. The plan must also <u>protect the environment</u>.

This site **<u>must</u>** have **<u>all</u>** of the following:

- Education Center
- Campsite
- Walking and nature trails

The site also **<u>must</u>** have **<u>one</u>** of the following:

- Playground
  OR
- Playing fields for sports

Teacher Notes

You may wish to have your students keep a vocabulary list of unknown words. Most new vocabulary words, in boldface type, are defined as part of the Discovery Files.

It is up to you whether or not to distribute the plot maps at this point. You may wish to show them to the students so they can have an idea of what these "donated plots" look like. Since the first activity, Operation Vector Find has a similar map, it might make sense to let them see that map first.

Part I of the Task lists the specific items to be created by the team. What is key in the Task is that EVERYTHING the students put into the Recreation Site must incorporate the idea of minimizing exposure to arthropod vectors of disease. It is also important for students to understand something about the environmental impact of their actions.

Make sure that students are clear about what components the park MUST have and which ones they may choose.

The Education Center is there to provide an outlet for some of the materials the students will be creating. The Campsite and Trails are to force the students to think about park visitors' exposure to mosquitoes and ticks. Discuss these components one by one, if only to reinforce the fact that students are not yet prepared to complete the Task.

Review the Site Permit questions (Part II) that ask students to not only plan the park, but to be able to explain how and why they made the choices they did.

Part II

Complete the “Public Recreation Site Permit” from the CDC Division of Vector- Borne Infectious Diseases on pages 3-6. Your permit will include all of the information about the park you are designing.

The permit will ask team members to explain:

1. How your plan changes the environment (what did you remove or add?).
2. How your design reduces exposure to ticks and mosquitoes.
3. Why you think the plan helps reduce the risk of getting Lyme disease and West Nile virus.
4. How you have protected the environment by not using toxic pesticides.

The plot locations are below. Find the closest towns on this website: http://www.mapquest.com/maps/latlong.adp

Plot	Latitude	Longitude
A	41.84°	-73.32°
B	41.72°	-73.47°
C	42.03°	-72.33°
D	41.78°	-72.05°
E	41.87°	-73.48°
F	41.97°	-73.44°

The Roles

Your team will be made up of specialists. Each person will do research needed to complete this project. You and your team members will each give a list to your teacher with your top role choices (1st choice, 2nd choice, and so on). Before you pick a role, carefully read what each role must do. It is important that you make sure you are willing to meet the responsibilities of your role. Your teammates will be counting on you. And all the people who use the public recreation areas will too!

The Recreation Site Permit was created to help students keep track of the required components as well as the rationale for doing each one. Each section of the Permit asks for data that are specifically tailored to each student role. The Project Manager supervises the permit. In some cases students are asked to complete the Permit directly by checking off a box or filling in a section.

The details in the Site Permit reflect that this module was created in Connecticut, but feel free to refocus the Task to your local situation.

Your students can do an exercise in latitude and longitude using the chart to the left that lists data for six areas. The Site Permit asks for coordinates and the town in Connecticut where the plot is located, but this is optional. We have provided you with colorful maps that show the rate of Lyme disease in every Connecticut town, as well as a list of the same data.

As you know your students best, you may assign roles, or allow them to choose a role. You are encouraged to have a detailed discussion about the responsibilities of each role, to minimize chances of a student complaining that they didn’t know what their role entailed.

Some teachers choose not to assign student roles until all lesson activities are completed. This helps eliminate the “it’s not my job so I don’t have to pay attention” reaction from students. Teachers who do this find that assigning groups without roles works just fine.

On the other hand, the roles are perfect for the jigsaw technique! Some teachers who have assigned roles from the beginning were able to have “role meetings” where all Epidemiologists

Landscape Architect will:

1. With your team, decide the location of the Education Center, Campsite, Walking and nature trails, and Playground or Sports area. Make sure these areas are not placed where people would be most likely to come in contact with mosquitoes or ticks. Draw and label a site plan showing all areas of your new public recreation site. You must use the plot you chose (or was given to you). **All group members will work on this with you.**
2. Create a report and a *PowerPoint*® presentation showing three to five deer-resistant plants you will plant in the park. This information will be needed for Part III of the Site Permit.
3. Write a report about how deer will be managed in the park. You will use this report for the Site Permit.

Epidemiologist will:

1. Make a poster or a brochure for the Education Center that will teach people about signs, symptoms, and prevention of West Nile virus (WNV)
2. Design an experiment to show how some plants can control bacteria. This will be used in the Education Center.
3. Write a report on pesticides that can control mosquitoes in the park without harming people or the environment. This information will be needed for Part IV of the Site Permit.

Entomologist will:

1. Make a poster for the Education Center to teach people in the park about *Ixodes* ticks and signs, symptoms, and prevention of Lyme disease.

(or Park Rangers or Landscape Architects, etc.) would sit and discuss their findings and then bring that back to their groups. We encourage you to try it – read the enclosed section from www.Jigsaw.org on page 13.

The Landscape Architect is asked for a PowerPoint® presentation but any type of presentation is acceptable. If your school is equipped for this, however, we encourage your students to become familiar with this medium. The goal here is not for your students to learn unpronounceable Latin names of plants, but for them to be aware of deer management methods that may not be harmful to the environment.

The Site Permit includes deer hunting as a possible method of population control. This may foster a lively debate among your students – not a bad thing in science class! If you have the time, you might even hold a debate among students of differing opinions as a realistic example of what scientists do in "real life."

The Epidemiologist is asked to create an experiment that will demonstrate to the Education Center visitors in the park how some plant materials can control bacteria. Students are expected to know that Lyme disease is caused by a bacterium. This is directly related to the Spicy Inhibitors activity on page 82.

Remind team members that posters and brochures should contain all the information that will inform the public about either the assigned diseases and/or the vectors that transmit them.

2. Write a report about the vector monitoring programs in the area. Decide if you need to create a monitoring program for the park. This information will be needed for Part V of the Site Permit.
3. Help Landscape Architect by marking the site plan to show the most likely habitat areas for ticks and mosquitoes.

Park Ranger will:

1. Design a simple test for animals in the park that are hosts for Lyme disease. This test will show whether a host is carrying Lyme disease. This information will be used for Part VI of the Site Permit.
2. Help Landscape Architect by marking the site plan to show the most likely habitat areas for Lyme disease and WNV host animal populations.
3. Make a game about mosquitoes and WNV for the Education Center.

Project Manager will:

1. Keep a Daily Progress Report. Make a log book or scrapbook of team efforts. (This will not be part of the final presentation. You will use this to make sure all team members are on task.)
2. Keep track of the Site Permit for the team. You will sign off on every section to make sure the permit is completed properly.
3. Make a poster for the Education Center showing the mosquito life cycle.
4. Help Landscape Architect with mapping and labeling of the site plan.

The Entomologist can find information regarding vector monitoring in Connecticut at the URL listed in the Site Permit, Part V. Your own state's programs can be found at:
http://www.cdc.gov/ncidod/dvbid/westnile/city_states.htm

The Lyme disease test to be created by the Park Ranger may use the same principles of "clumping" found in the Mix Up With OSP activity. It is expected that students will know that white-footed mice and white-tailed deer are Lyme disease hosts eligible for testing. Students are not expected to accurately describe either capturing the animals or obtaining blood samples from them.

The job of Project Manager may be reserved for a student whose academic skills are not as developed. Many teachers have found that such a student can rise to the occasion and be successful and seriously keep the other students on task. Your packet has a Project Manager Daily form (there is also a copy enclosed in this Teacher Guide on page 16). Please copy this to allow the Project Manager to fill one out after each class session.

Please remember that even though EBS asks you to be a resource rather than a lecturer, your guidance during classroom work and discussions is crucial. Keep sheets of brown craft paper handy to record topics, comments, questions and observations. Your students will find it interesting to see how much they have learned by the end of the module.

Jigsaw in 10 Easy Steps
(Taken from www.jigsaw.org)

The jigsaw classroom is very simple to use. If you're a teacher, just follow these steps:

1. Divide students into 5- or 6-person jigsaw groups. The groups should be diverse in terms of gender, ethnicity, race, and ability.

2. Appoint one student from each group as the leader. Initially, this person should be the most mature student in the group.

3. Divide the day's lesson into 5-6 segments. For example, if you want history students to learn about Eleanor Roosevelt, you might divide a short biography of her into stand-alone segments on: (1) Her childhood, (2) Her family life with Franklin and their children, (3) Her life after Franklin contracted polio, (4) Her work in the White House as First Lady, and (5) Her life and work after Franklin's death.

4. Assign each student to learn one segment, making sure students have direct access only to their own segment.

5. Give students time to read over their segment at least twice and become familiar with it. There is no need for them to memorize it.

6. Form temporary "expert groups" by having one student from each jigsaw group join other students assigned to the same segment. Give students in these expert groups time to discuss the main points of their segment and to rehearse the presentations they will make to their jigsaw group.

7. Bring the students back into their jigsaw groups.

8. Ask each student to present her or his segment to the group. Encourage others in the group to ask questions for clarification.

9. Float from group to group, observing the process. If any group is having trouble (e.g., a member is dominating or disruptive), make an appropriate intervention. Eventually, it's best for the group leader to handle this task. Leaders can be trained by whispering an instruction on how to intervene, until the leader gets the hang of it.

10. At the end of the session, give a quiz on the material so that students quickly come to realize that these sessions are not just fun and games but really count.

Tips on Implementation

Compared with traditional teaching methods, the jigsaw classroom has several advantages:

* ***Most teachers find jigsaw easy to learn***
* ***Most teachers enjoy working with it***
* ***It can be used with other teaching strategies***
* ***It works even if only used for an hour per day***

** It is free for the taking*

Too good to be true? Well, yes and no. It would be misleading to suggest that the jigsaw sessions always go smoothly. Occasionally, a dominant student will talk too much or try to control the group. How can we prevent that? Some students are poor readers or slow thinkers and have trouble creating a good report for their group. How can we help them? At the other end of the talent continuum, some students are so gifted that they get bored working with slower students. Is the jigsaw technique effective with them? In some cases, students may never have experienced cooperative learning before. Will the jigsaw technique work with older students who have been trained to compete with one another? All of these problems are real but not fatal.

The Problem of the Dominant Student

Many jigsaw teachers find it useful to appoint one of the students to be the discussion leader for each session, on a rotating basis. It is the leader's job to call on students in a fair manner and try to spread participation evenly. In addition, students quickly realize that the group runs more effectively if each student is allowed to present her or his material before question and comments are taken. Thus, the self interest of the group eventually reduces the problem of dominance.

The Problem of the Slow Student

Teachers must make sure that students with poor study skills do not present an inferior report to the jigsaw group. If this were to happen, the jigsaw experience might backfire (the situation would be akin to the untalented baseball player dropping a routine fly ball with the bases loaded, earning the wrath of teammates). To deal with this problem, the jigsaw technique relies on "expert" groups. Before presenting a report to their jigsaw groups, each student enters an expert group consisting of other students who have prepared a report on the same topic. In the expert group, students have a chance to discuss their report and modify it based on the suggestions of other members of their expert group. This system works very well. In the early stages, teachers may want to monitor the expert groups carefully, just to make sure that each student ends with an accurate report to bring to her or his jigsaw group. Most teachers find that once the expert groups get the hang of it, close monitoring becomes unnecessary.

The Problem of Bright Students Becoming Bored

Boredom can be a problem in any classroom, regardless of the learning technique being used. Research suggests, however, that there is less boredom in jigsaw classrooms than in traditional classrooms. Youngsters in jigsaw classes report liking school better, and this is true for the bright students as well as the slower students. After all, being in the position of a teacher can be an exciting change of pace for all students. If bright students are encouraged to develop the mind set of "teacher," the learning experience can be transformed from a boring task into an exciting challenge. Not only does such a challenge produce psychological benefits, but the learning is frequently more thorough.

The Problem of Students Who Have Been Trained to Compete

Research suggests that jigsaw has its strongest effect if introduced in elementary school. When children have been exposed to jigsaw in their early years, little more than a "booster shot" (one hour per day) of jigsaw in middle school and high school is required to maintain the benefits of cooperative learning. But what if jigsaw has not been used in elementary school? Admittedly, it is an uphill battle to introduce cooperative learning to 16-year olds who have never before experienced it. Old habits are not easy to break. But they can be broken, and it is never too late to begin. Experience has shown that although it generally takes a bit longer, most high school students participating in jigsaw for the first time display a remarkable ability to benefit from the cooperative structure.

In Conclusion

Some teachers may feel that they have already tried a cooperative learning approach because they have occasionally placed their students in small groups, instructing them to cooperate. Yet cooperative learning requires more than seating youngsters around a table and telling them to share, work together, and be nice to one another. Such loose, unstructured situations do not contain the crucial elements and safeguards that make the jigsaw and other structured cooperative strategies work so well.

The chart below lists all lessons and Discovery Files. Discovery Files are marked X if they are assigned within the lesson and marked (X) if they can be useful. You might want to use the Jigsaw technique when assigning Discovery Files to be read in class.

Lesson	Discovery Files *(pages in Teacher Guide)*	Tick/ Lyme	Mosquito/ WNV
Task	Pathogens Cause Disease, *p.17* What is Vector-Borne Disease?, *p.19* Zoonoses, *p.20* Evolving Alone…and Together, *p.23*	X X X X	X X X X
Operation Vector Find	Oh, Deer!, *p.30*	X	
Skeeter Farm Parts I & II	Mosquito Life Cycle, *p.44* Anatomy of a Bite, *p.52* Bacteria Join the Fight, *p.54* West Nile Virus, *p.55*		X X X X
Traveling Viruses Parts I & II	Bacteria and Viruses, *p.62* Can I Catch It?, *p.63*	(X) (X)	X X
Mix Up With OSP	Tick Life Cycle, *p. 72* Bad Bulls' Eye, *p. 75* Vaccines, *p. 76* Immune System, *p. 77*	X X X X	 (X) (X)
Spicy Inhibitors	Sterile Technique, *p. 86* Antibiotics, *p. 89* Bacteria Fight Back, *p. 90* Human linical Trials, *p. 91*	X X X (X)	 (X)

Project Manager Report

Date___________________ Project Day # ________

	Is working on	needs	has finished
Landscape Architect			
Epidemiologist			
Entomologist			
Park Ranger			

Ideas to consider:

Questions:

Supervisor Comments:

Discovery File
Pathogens Cause Disease

If someone asks you what causes disease, most of you will probably say pathogens. And by pathogens you mean microorganisms—tiny living things so small we can't see them. As obvious as it seems to us, the idea that pathogens cause disease was very controversial when it was first proposed.

> Microorganisms were first observed in 1673 by Anton van Leeuwenhoek (a Dutch scientist who lived from 1632 to 1723).

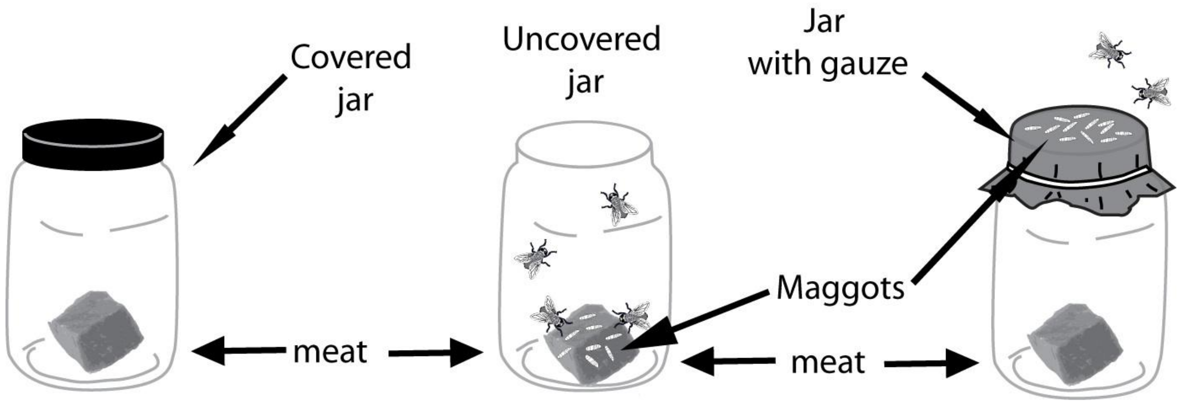
The old idea was that diseases – and some larger living things like insect larvae - just appear. Their sudden appearance was called *spontaneous generation*. Some people thought that invisible particles might cause some diseases. But it wasn't until microorganisms were discovered that the relationship between pathogens and disease was taken seriously.

In 1668, an Italian doctor named Francesco Redi proved that spontaneous generation does not happen. He wondered why maggots (fly larvae) appear on meat as it rots. So, Redi did an experiment. He placed pieces of meat in jars. Half of the jars were left open to the air. The rest were tightly covered. What do you think happened?

Not everyone believed he had proved that spontaneous generation was wrong. They were convinced that air was needed for the spontaneous generation to take place. He repeated the experiment with one change. This time he divided his jars into three groups. The first group was tightly covered, the second group was left open to the air, and the third group was covered with some gauze.

> Francesco Redi is often credited with being the first scientist to do a controlled experiment. What do you know about the steps in a controlled experiment?

After a few days, Redi again saw that maggots were crawling over the meat in the open jar. The jar covered with gauze also had maggots. But its maggots were on the surface of the gauze. How do you think he explained this?



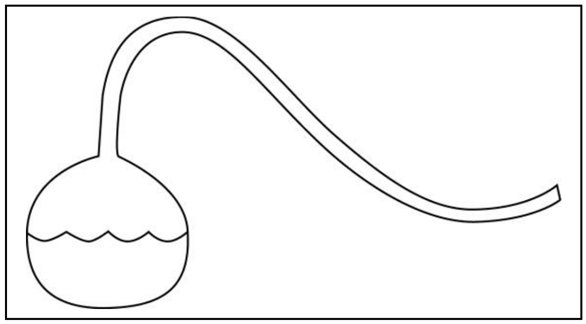
Another Italian scientist, Agostino Bassi, stated the pathogen theory of disease for the first time. In 1835 Bassi was studying the strange deaths of silkworms. Bassi blamed the deaths of the silkworms on a contagious, living agent that he could see as a powdery substance. The powder particles were tiny spores of a fungus. Bassi said that these tiny *pathogens* were killing the silkworms.

Many people thought that cholera was caused by bad air. This was an old belief- like thinking that air helped maggots to appear on meat.

John Snow contributed to the pathogen theory when he traced the source of the 1854 cholera outbreak in part of London. Snow found that drinking water was the source of the disease. The cholera only struck families who got their water from the Broad Street pump. And this pump was at the center of the cholera outbreak.

Between 1860 and 1864, a French chemist named Louis Pasteur again disproved spontaneous generation. Pasteur knew that when freshly boiled broths were left to stand in the open air they would spoil. So he did something different. He exposed broth to air but he used filters to stop all dust particles from entering the broth. The broth did not spoil.

Pasteur also found that he could prevent spoilage of the broth without a filter. As long as the air had to travel through a long and twisted tube that did not allow dust particles to enter, nothing grew in the broths. Pasteur concluded that any living organisms that grew in broth came from outside. They entered on dust, rather than coming from the broth itself.



A German doctor named Robert Koch was the first to actually state rules for the Germ Theory of Disease. Koch's Postulates (say **pos**-too-lets) were first used in 1875 to demonstrate that anthrax was caused by a bacterium. His postulates are still used today to help determine whether a particular germ causes a newly discovered disease.

Koch's Postulates:

1. The germ must be found in all people suffering from the disease, but not in healthy people.
2. The germ must be isolated from a sick person and grown in pure culture.
3. The germs from that culture should cause the disease when introduced into a healthy person.
4. The same germ must be found in the person who is made sick by the cultured germ.

Discovery File
What Is a Vector-Borne Disease?

Some diseases cannot pass directly from person to person. The pathogen that causes the disease must be picked up and carried to a new host. These are called vector-borne diseases.

A **host** is an organism in which a virus or bacteria lives. The host provides food and shelter and is infected with the disease.

Most vector-borne diseases (like Lyme disease) live in an animal called the **intermediate host.** They wait there, growing and multiplying in number until another animal, called a ***vector***, picks them up and carries them to us.

Some vector-borne diseases (like malaria) can be picked up from one person and given to another person. In both cases, vectors carry the **pathogens** without getting sick themselves.

Pathogens are organisms that cause disease.

Most vectors are arthropods—insects and arachnids. When arthropods bite or sting us they **directly** affect our health. When they act as vectors, they **indirectly** affect our health.

Over 85% of all known animal species are invertebrate animals called **arthropods**.

The best arthropod vectors are bloodsuckers, like ticks (arachnids) and mosquitoes (insects).

There is even a special word to describe **ar**thropod-**bo**rne viruses: **arbo**viruses.

But not every mosquito or tick carries a pathogen. When mosquitoes and ticks first hatch they are not yet infected. Only after they bite a host animal do mosquitoes and ticks become pathogen carriers.

Several things must be in place before any vector-borne disease can thrive in a human population:

1. enough vectors and intermediate hosts;
2. enough of the disease-causing pathogens;
3. pathogens that work well with the vectors and the human or animal host;
4. the proper conditions (especially temperature and humidity); and
5. poor health and low immunity of the human population.

Intermediate hosts have other names. They are sometimes called **reservoir hosts** or **amplifying hosts.**

1. They are called **reservoir hosts** because a reservoir is a place where something is stored.

2. They are called **amplifying hosts** because the number of pathogens grows larger while living there.

The last animal in the chain of hosts is sometimes called the **dead-end host**, because the pathogen stops spreading at that point.

This list gives us some clues about how we can protect ourselves. Read about this in other Discovery Files.

Discovery File
Zoonoses

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Zoonoses are not what you think they are. They are not the funny animal noses you see at the zoo. And if you didn't see the word but heard it pronounced, you might not think of a zoo at all. *Zoonoses* is pronounced zoh-uh-**no**-sees.

Zoonoses are a special group of diseases—also called zoonotic (say zoh-uh-**not**-ic) diseases.

They are caused by pathogens (pathogens) that are passed from animals to humans. Zoonoses can come from wild animals, farm animals, pets, or even animal products.

Both bacteria and viruses cause zoonotic diseases. Humans are infected by these diseases in different ways. Some infections result from direct contact, some from indirect contact, and some are vector-borne.

Zoonoses have been known for thousands of years. The Bible mentions plague, which is a bacterial zoonosis (the singular form of zoonoses) that is transmitted to humans by fleas from the mice and rats that are their hosts. Some zoonoses—yellow fever and rabies—are well known today. But many others are less well known. And some probably haven't even been discovered yet.

Some of our greatest concerns about human diseases are zoonoses. Scientists are especially worried about the ones we don't know about yet.

For example, before 1982 no one knew about AIDS. It began as a zoonosis in chimpanzees, but when it adapted to human-to-human transmission it became a real problem.

A **pandemic** is a disease outbreak that affects a large geographical area and a large portion of the population.

In 1918, a bird flu virus moved from a deadly zoonosis to a human-to-human serial killer. This flu pandemic of 1918-1919 killed between 20 and 40 million people around the world. It has been called the most devastating epidemic in history.

Here are some other examples of zoonoses:

- Lyme disease: a bacterial disease transmitted by the bite of an infected tick
- Ebola: a viral disease spread by infected blood, tissues, secretions, or excretions
- Hantaviral disease: a viral disease contracted by breathing air contaminated with the infected waste from rodents

- Leptospirosis (say lep-to-spy-**row**-sis): a bacterial disease usually transmitted to humans through contact with urine from infected animals
- Brucellosis (say brew-sell-**oh**-sis): a bacterial disease contracted by drinking unpasteurized milk
- Cat-scratch disease: a bacterial disease passed to humans by bites or licks from infected cats

There are some zoonoses that we thought were under control. Guess what, we were wrong!

Some of them are back. And new zoonotic diseases have appeared, too. This happened due to the following reasons:

1. changes in the environment that have affected the spread of animal host species and vectors;
2. growing human populations which led to increased contact between humans and infected animals;
3. changes in food processing and consumer eating habits;
4. increased human travel and increased trade in animals and animal products;
5. decreased monitoring and control of some of the major zoonoses; and
6. changing global climate that has allowed the spread of both arthropod vectors and the vertebrate hosts in which some zoonoses live.

Sometimes, zoonoses that seem to be new diseases have actually been around for a long time. For example, hantaviruses are transmitted by rodents such as deer mice. They cause the disease known as *hantavirus pulmonary syndrome*. This disease has likely been around for decades, if not centuries, but human cases were first reported in 1993.

Many zoonoses can be treated with **antibiotics**, but there are few medicines that can be used to treat viral zoonoses.

Antibiotics are substances that kill or inhibit the growth of bacteria.

Vaccines are available for a small number of zoonoses, such as Japanese encephalitis and yellow fever. Antimalarial drugs are recommended for travelers to malaria hot zones.

Vaccines are preparations of antigens used to produce active immunity to a disease, to prevent or lessen the effects of infection.

How can you reduce the risk of catching a vector-borne zoonosis?

- Avoid areas infested by arthropods.
- Use insect repellents.
- Wear clothing that exposes as little skin as possible.
- Do not drink untreated water or unpasteurized milk.

What can your town or community do?

- Reduce the risk of zoonotic diseases by decreasing the number of rodents and other hosts.
- Clean and disinfect areas containing animal waste that may be contaminated.

Is my risk the same as your risk?

Some people have a greater risk for contracting zoonoses. If you have a job working with animals—veterinarian, farmer, and slaughterhouse worker—you have a high risk! Outdoor recreational activities—hiking, hunting, and camping—also put people at greater risk.

Knowledge is your best defense against contracting zoonoses. Be aware of the zoonoses in your environment and the times of year of greatest risk for contracting them.

Good luck!

Discovery File
Evolving Alone…and Evolving Together

All living things are suited to their environments. But this did not happen because the organisms *wanted* to live in a certain place or in a certain way. What we see is the result of millions of years of **evolution** (For more about evolution, please read "A Message from Our Sponsor" at the front of this book). In this process, there are changes in the genetic information of a population over time. All living things store genetic information in their DNA. Each change in DNA is called a **mutation**.

> A group of organisms belonging to the same species that live in the same place at the same time is called a **population**.

A mutation is a mistake that changes the information in the genetic material of a single organism in a population. This may not cause the organism a problem. Or it can cause damage or even death.

Here's a helpful way to think about this. Imagine that you are trying to copy this poem on your computer: "*Roses are red, violets are blue, sugar is sweet and so are you.*" But while you are typing, you change the first letter to an "n" by mistake. Now the poem reads, "*Noses are red, violets are blue…*" It's silly, but you can still read it and it's still a poem.

But what happens if you are typing the poem and all your fingers are on the wrong keys? You might end up typing something like this: "*Tpwrd str trf, bop;ryd str n;it…"* This is not a readable message at all! In the same way, a DNA mutation can cause a big problem or no problem at all.

Every once in a while, a mutation makes a change that helps an organism survive in its environment. When the environment changes, some members of a population may survive and reproduce better than others. Over a number of generations this results in organisms that are better adapted to the environment. We call this **adaptation**.

Adaptations help an organism "fit" its environment. Have you ever heard the phrase "survival of the fittest?" In biology, being fit doesn't have anything to do with working out or following a healthy diet. It means that the organisms that survive are the ones that are better adapted to the environment. Generally, better fit organisms will reproduce more offspring than less fit organisms.

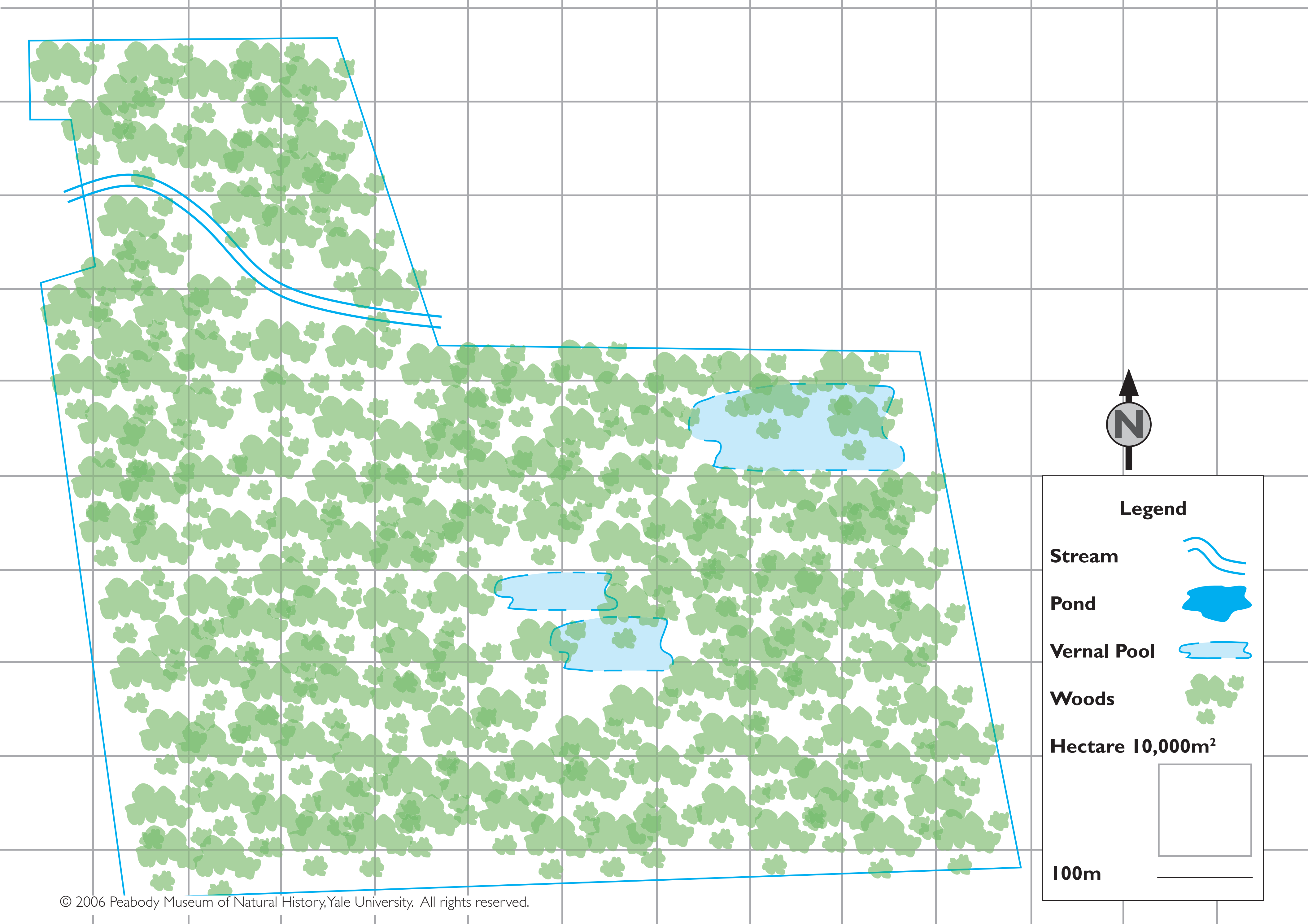
Other species in a community are part of the environment, too. Sometimes, changes in one species can lead to evolutionary changes in the other species it interacts with. The term **coevolution** is used when two (or more) species affect each other's evolution.

The leaf cutter ant from Central America is a part of a cool coevolution story. These ants collect pieces of leaves that are poisonous to them. In fact, the ants can't eat most of the leaves that grow in the rain forest. What do the ants do with these leaves? They feed them to a fungus that they grow in little underground "farms." What happens then? The fungus uses the leaves to make food for the ants! The ants and the fungus have coevolved over time. Their relationship is so close that neither the ants nor the fungus can survive without the other.

Vector-borne pathogens and their vectors and hosts have coevolved, too. This is one reason that getting rid of these diseases can be so tricky.

Peabody Fellows Program

Plot #1



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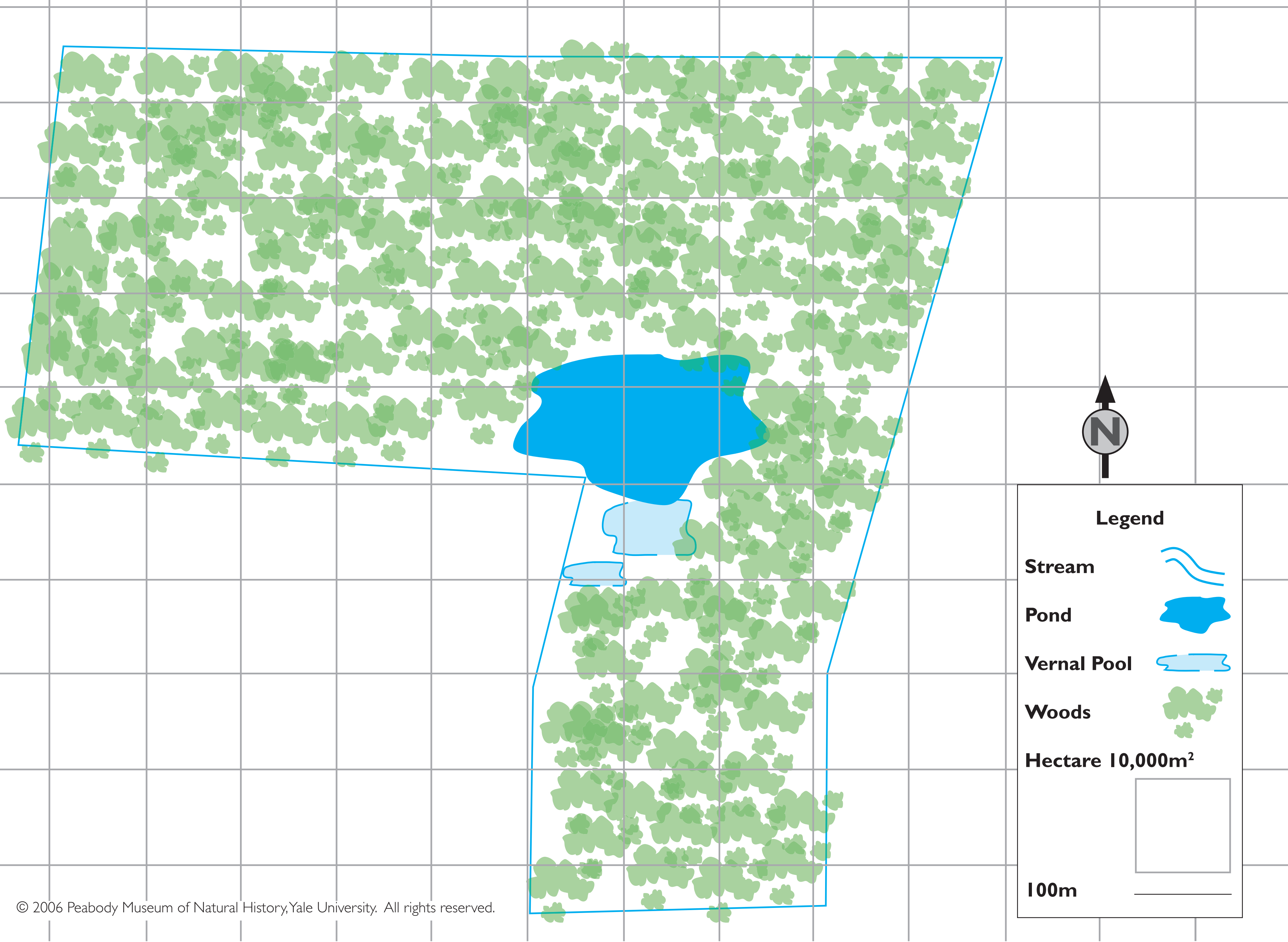
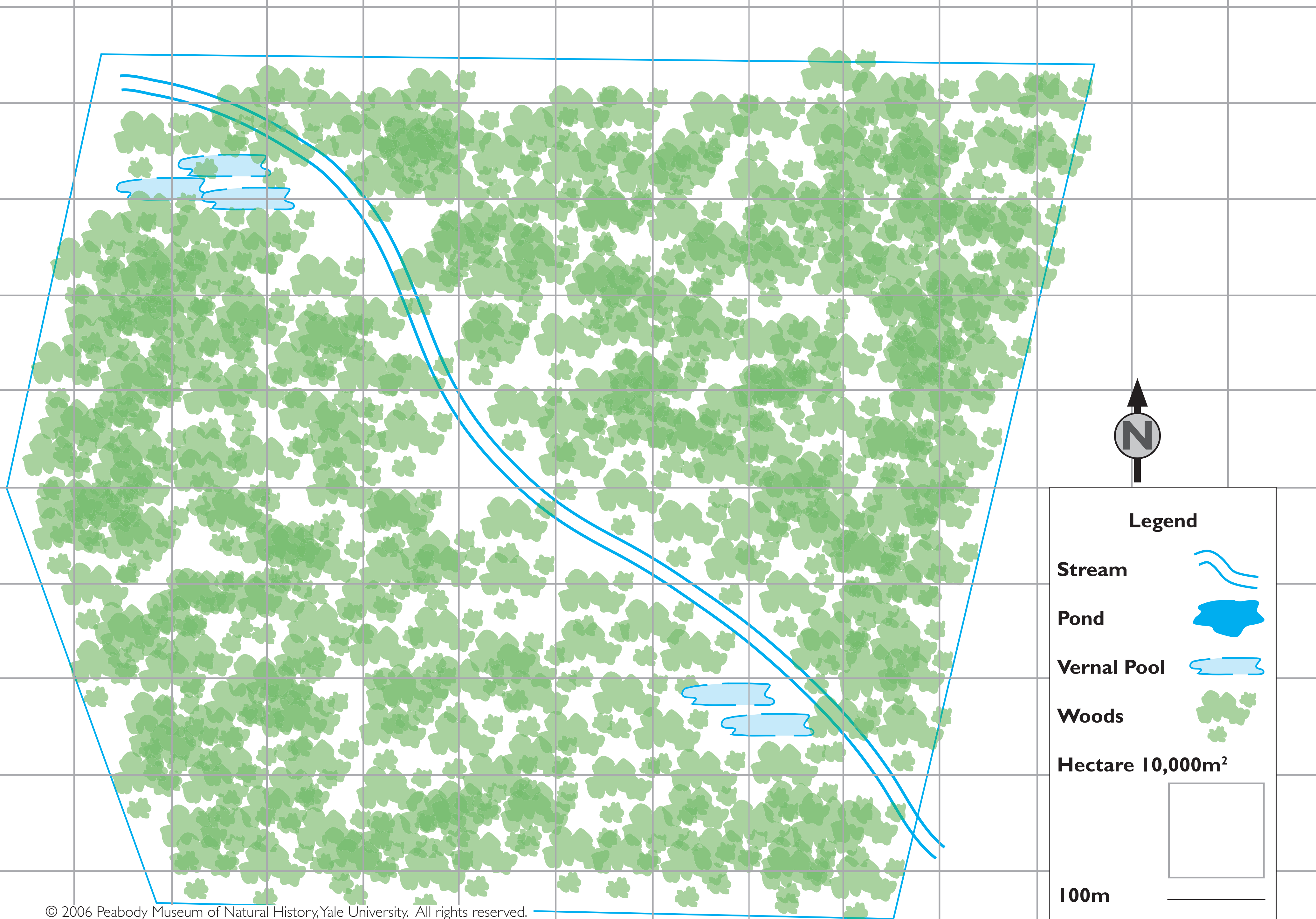
Plot #2



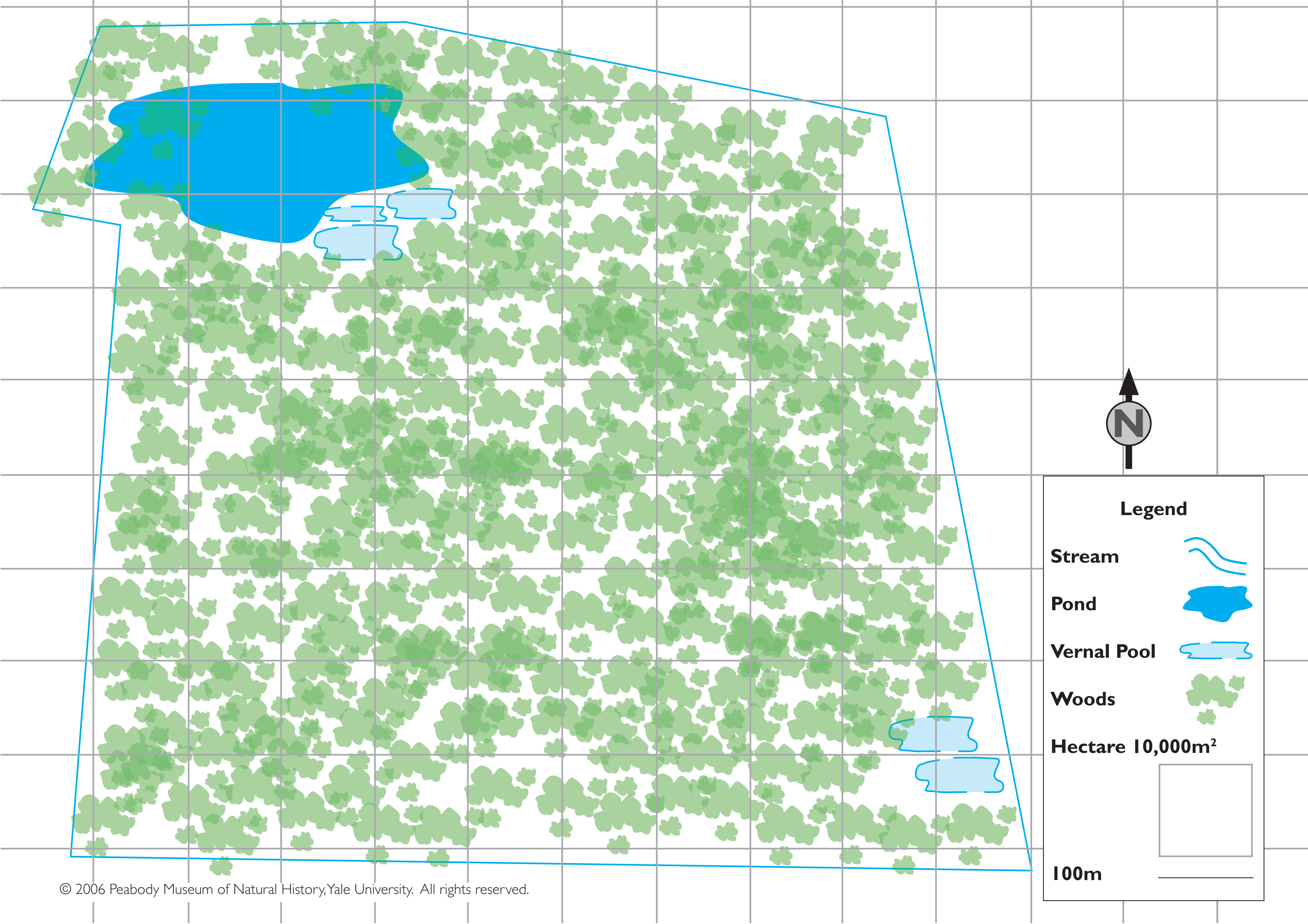
Peabody Fellows Program

Plot #3



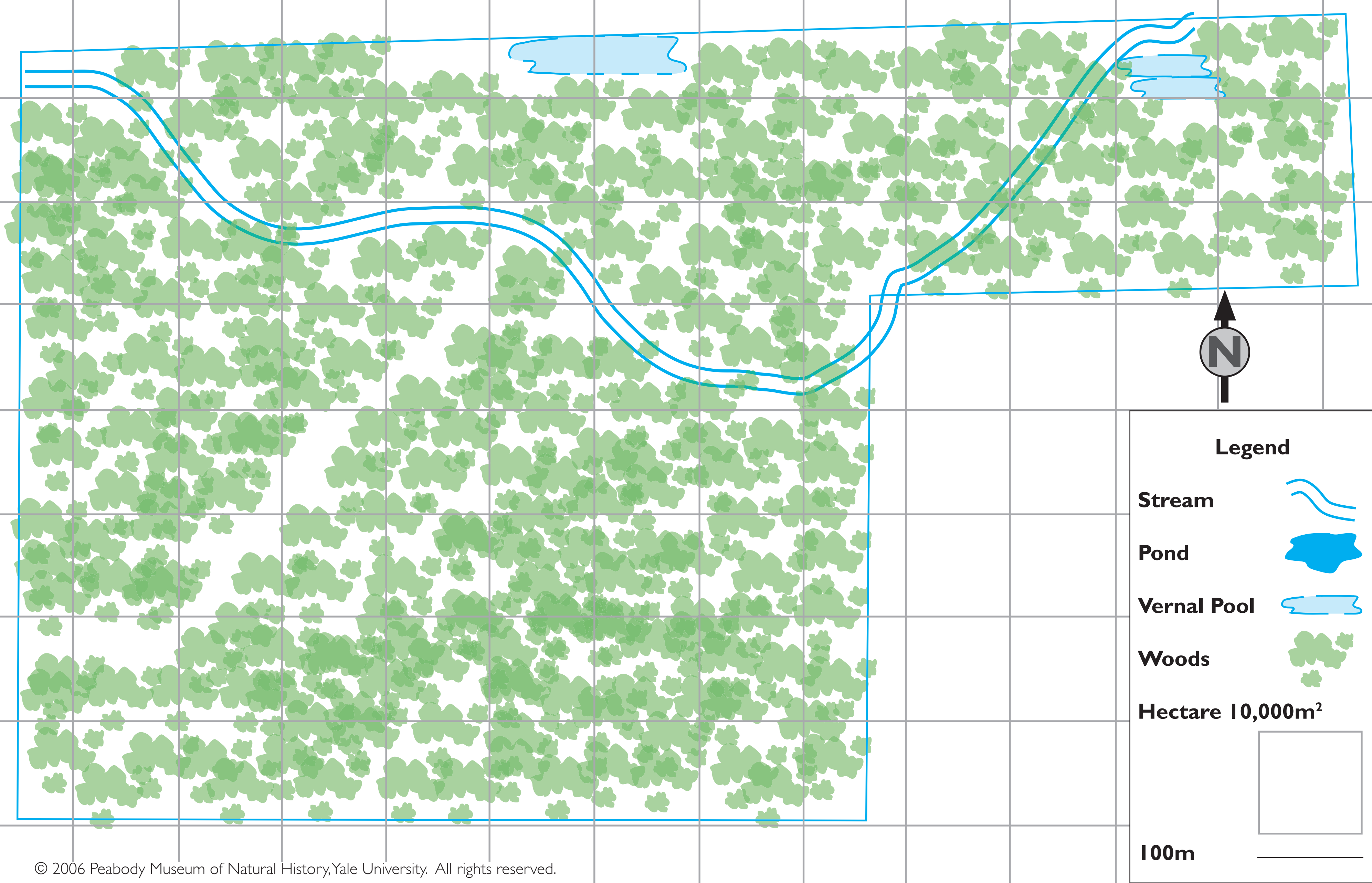
Peabody Fellows Program

Plot #4

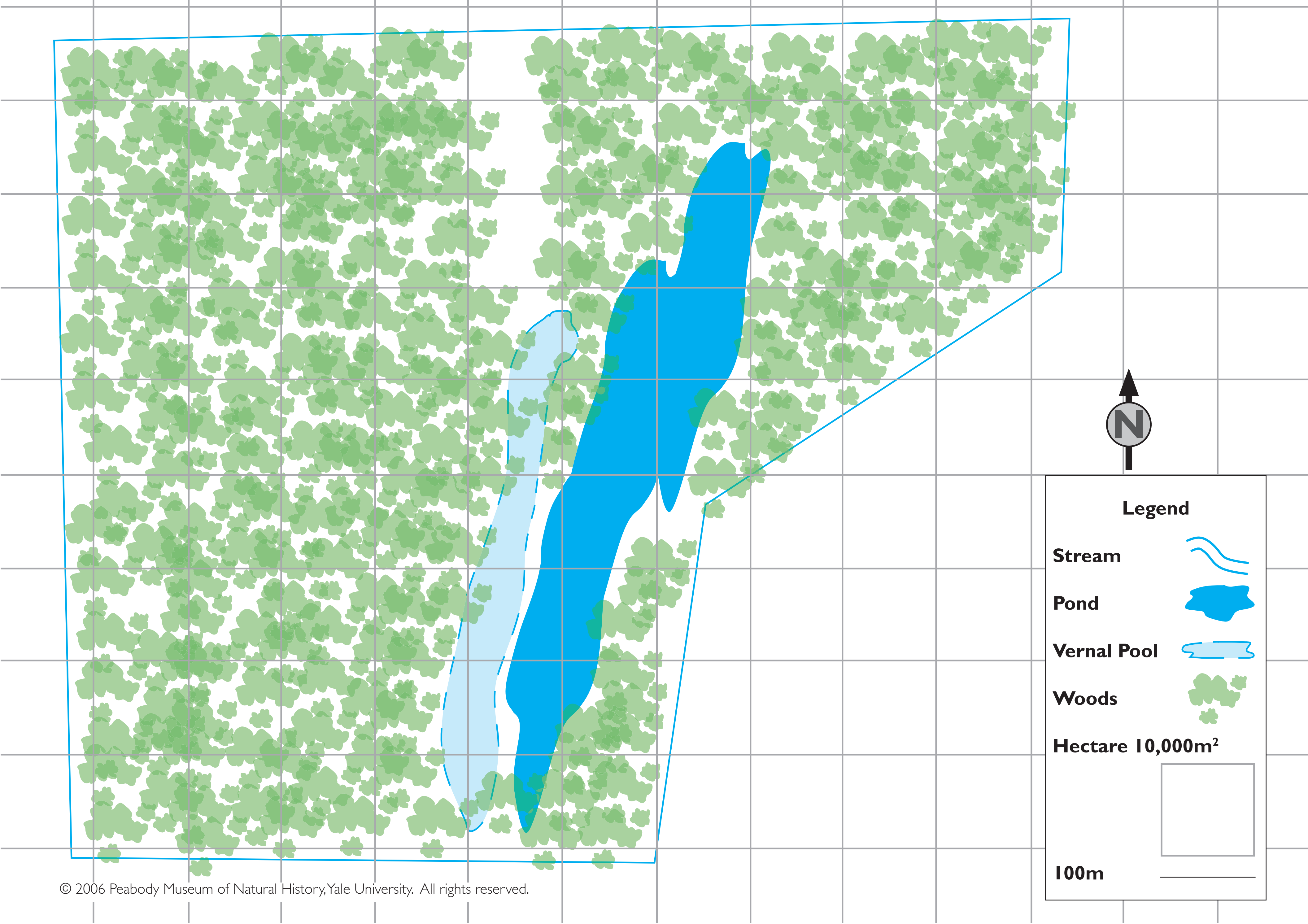


Peabody Fellows Program

Plot #5



Plot #6



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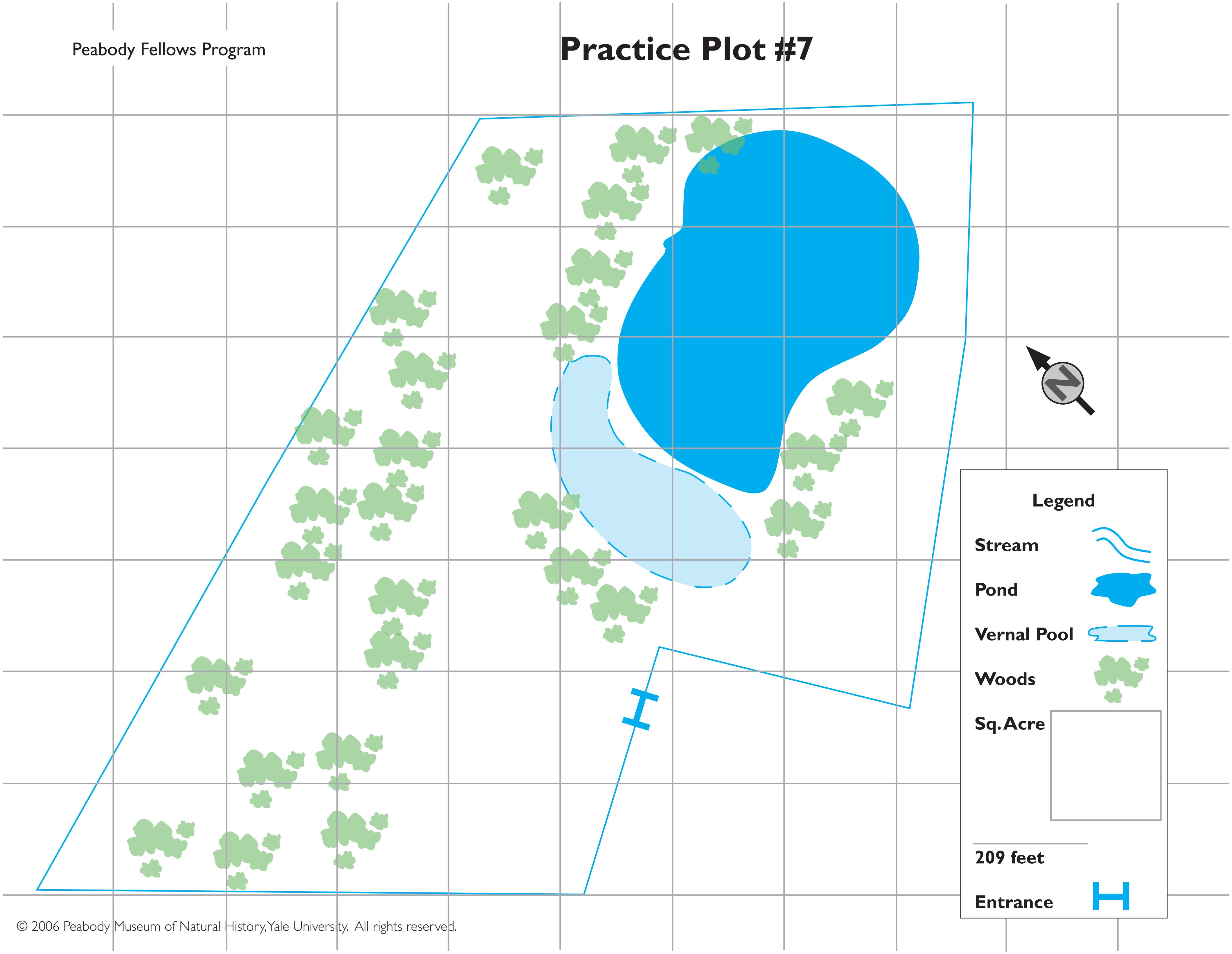
Practice Plot #7



PEABODY FELLOWS PROGRAM
STUDENT PRE-TEST **Student Name:________________________**

PART I. FILL IN THE BLANKS

Word Bank for questions #1 - 3:

predator vector antibody pathogen host habitat

1. A ____________ is an animal that can transmit a disease from one animal to another.
2. A ____________ is an animal whose body provides food and shelter for another organism.
3. A ____________ is an organism that causes a disease.

Word Bank for questions #4 - 6:

bacterium mosquito tick virus deer human

4. Name one reservoir host for Lyme disease: ______________________

5. The pathogen for Lyme disease is a ______________________.

6. What is the vector for West Nile virus? ______________________

PART II. SELECT ONE ANSWER FOR THE FOLLOWING QUESTIONS:

7. In which season do you have the GREATEST risk of getting West Nile virus?
   - a. spring
   - b. winter
   - c. fall
   - d. summer

8. Ticks are arachnids and mosquitoes are insects, but they are both arthropods. Which answer BEST describes how they are different?
   - a. different number of body segments
   - b. different number of legs
   - c. different number of both body segments and legs
   - d. different number of antennae

9. When is it most likely that mosquitoes will transmit West Nile and that ticks will transmit Lyme disease?

a. As soon as they bite
b. Mosquitoes as soon as they bite; ticks, 1-2 hours after they bite
c. Mosquitoes, 1-2 hours after they bite; ticks, 12-24 hours after they bite
d. Mosquitoes as soon as they bite; ticks, 36-48 hours after they bite

10. Which stage of the tick life cycle is most dangerous to humans?

a. egg
b. larva
c. nymph
d. adult

11. What can speed up the development of mosquitoes?

a. higher temperatures
b. cooler temperatures
c. more water
d. more shade

12. What do Lyme disease and West Nile virus have in common?

a. Both cause nausea and vomiting.
b. Both can be passed to another person by a cough or sneeze.
c. Both are zoonoses that spread to humans.
d. Both can be prevented by careful hand-washing.

13. Which one of the following statements is NOT true?

a. Antibiotics can only kill certain bacteria.
b. Antibiotics can be made from plants.
c. Antibiotics can kill viruses.
d. Antibiotics can stop certain bacteria from growing.

14. Which statement BEST describes how bacteria develop resistance to antibiotics?

a. Bacteria can mutate quickly and no longer be killed by antibiotics that used to kill them.
b. Resistant bacteria survive when people start to feel better and stop taking their antibiotics.
c. Using too many antibiotics at the same time can cause allergic reactions in some people.
d. Bacteria can mutate quickly and develop new diseases that are unknown.

15. The adaptive or acquired immune system attacks:

a. viruses but not bacteria
b. bacteria but not viruses
c. both viruses and bacteria
d. only red blood cells

16. Antibody activity is triggered by:
    a. antigens
    b. inflammation
    c. red blood cells
    d. increase in body temperature

17. You can diagnose Lyme disease with a blood test. The Lyme test can show that:
    a. the patient has symptoms of fever, a bull's-eye rash and body aches.
    b. the patient has been bitten by a tick within a two-week period.
    c. the patient has an active virus and too many white blood cells.
    d. the patient has developed antibodies which react to an antigen for the disease.

18. How have people learned to control harmful bacteria without antibiotics?
    a. By growing vegetables near a stream
    b. By using garlic and other spices on food
    c. By planting rice and beans together
    d. By burning incense to keep away mosquitoes

19. Growing bacteria successfully in the lab requires:
    a. A Petri dish and a disease vector
    b. A culture medium and an alcohol swab
    c. A culture medium and a warm environment
    d. A disease vector and a warm pathogen

PEABODY FELLOWS STUDENT TEST

ANSWER KEY

1. vector
2. host
3. pathogen
4. deer
5. bacterium
6. mosquito
7. D
8. C
9. D
10. C
11. A
12. C
13. C
14. B
15. C
16. A
17. D
18. B
19. C