



Hubbard Brook Research Foundation

Migratory Bird Math and Science Lessons



Black-throated Blue Warbler/Robert Royse

Lesson: Message in a Song

An important skill scientists must have is the ability to read and understand literature that describes research done by other scientists in their field. This lesson asks students to read a published account of bird research and tests their ability to grasp key components of that research. All science begins with questions—and not necessarily complicated questions—that, in some cases, high-school and middle-school students might pose. In the case of this article, Hubbard Brook researcher Nick Rodenhouse asks the question: How do birds choose a location for their nests? Rodenhouse’s experiment suggests that birds may respond more to social cues than habitat characteristics—an idea that challenges a widely held belief that habitat characteristics are the most important factor in nesting location choice. These results will likely prompt researchers to test the idea again, under similar circumstances, to determine that it is replicable, and therefore holds true, as well as to investigate if the idea applies widely to other species of birds.

The provided article demonstrates to students how a series of research questions or hypotheses are posed by scientists and how data are collected to support or reject these hypotheses. If students are successful at parsing out the hypotheses and experimental design of the study described in the article provided, they will not only have mastered reading comprehension for a science article, but also developed skills that will allow them to understand how science operates by building on previous work.

Summary	After the teacher poses an essential question and leads students through important contextual information, students read a published account of bird research and then answer questions that will test their reading comprehension and help develop their science process skills.
Subject areas	Biology, Environmental Science
Skill level	Advanced
Objectives	<ul style="list-style-type: none"> • List two factors important to birds as they select the location of territories. • Explain why this knowledge is useful to know. • State the hypothesis tested by the researcher in the article. • Describe the experimental design used to test the hypothesis. • Identify the control, independent and dependent variables in the study.
NH Science Framework Standards	S:SPS1:8:1.7, S:SPS1:11:1.1, S:SPS1:11:2.2, S:SPS1:8:5.1, S:SPS1:11:5.1, S:SPS3:11:1.2 S:LS2:8:1.1
Time	One 45-minute class period plus homework
Materials (per group)	<ul style="list-style-type: none"> • Introductory Slides.pdf • Student Reading: Tuned In • Student Handout: Message in a Song
Assessment	A student handout and answer key are included.

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Note to Teachers

Introduce lesson to students

Imagine that you are a male Black-throated Blue Warbler returning from your wintering ground. You have just traveled thousands of miles and you must decide where to land and choose a place to call home. You need to establish a territory and attract a female mate, with whom you will build a nest within this territory. Together, your goal is to produce baby birds that will survive to join the migration come fall, and for that you will need plenty of food as well as protection from predators. This is your one and only chance to get it right: where is the best place for you to settle down?

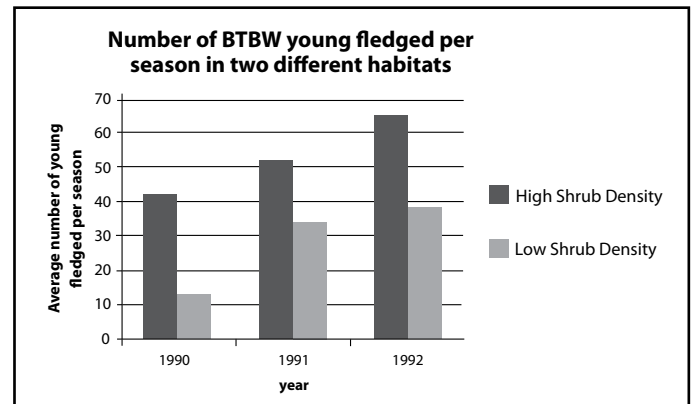
Each spring, in the forests of New England, birds make perhaps the most important decision of their lives: where to establish territories. According to Hubbard Brook (HB) researcher Dr. Nick Rodenhouse, “We’ve always wanted to know what cues they used to make that decision.”

1. Define what is meant by *territory*:

In terms of animal behavior, *territory* refers to an area that an animal of a particular species consistently defends against others of the same species, and occasionally other species of animals as well.

2. Ask students: What are some variables that might affect the decision-making process that male warblers use when deciding where to establish their territories? *Brainstorm as a class.*

3. Show graph (graph is included in *Introductory Slides* in Support Materials): Many types of data have been collected on the Black-throated Blue Warbler at the Hubbard Brook Experimental Forest for over

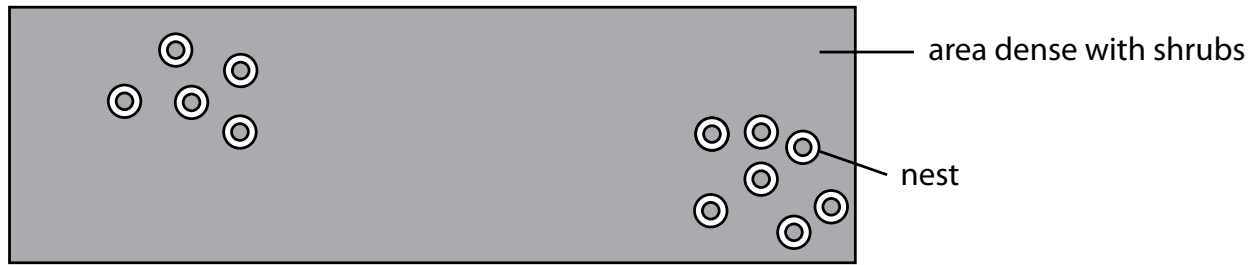


40 years. Above is a graph of some of these data. It compares habitats that contain a high density of shrubs with those that have a low density of shrubs and shows the average number of birds that *fledged* during a 3-year time period. A bird has *fledged* when it has developed the ability to leave the nest. Researchers use this important milestone to indicate that the bird’s parents successfully reproduced.

4. Ask students: According to this graph, in which habitat did Black-throated Blue Warblers fledge more young birds?

5. Ask students: Recall that researchers are trying to figure out what is important to a male warbler as it chooses a place to establish a nest. Develop a hypothesis to address this that is supported by the data in the graph above. Allow students to provide a few testable hypotheses.

6. Show diagram (diagram is included in *Introductory Slides* in Support Materials): For a long time researchers thought that density and other attributes of vegetation determined where nests were established. But then researchers at Hubbard Brook noticed that even in sections of forest with a high density of vegetation, the nests of these warblers were clustered in certain areas.



Why were the nests not spread evenly over the area? What else must go into the decision-making process warblers use when deciding where to establish nest sites? The following article from *The Boston Globe*, [“Tuned In: Evidence that black-throated warblers use the grapevine to pick nesting sites upends conventional wisdom,”](#) will tell this story.



Student Procedure

1. Your teacher will introduce this topic to you through a series of questions. Pay careful attention to the graph and image that you will be shown.
2. Read the *The Boston Globe* article by Billy Baker titled “Tuned in: Evidence that black-throated warblers use the grapevine to pick nesting sites upends conventional wisdom.”
3. Answer the questions on the Student Handout.



Student Reading

Tuned in: Evidence that black-throated warblers use the grapevine to pick nesting sites upends conventional wisdom

By Billy Baker, *Globe Correspondent* / July 21, 2008
Permission to reprint the article granted by the author.



NORTH WOODSTOCK, N.H. - It's just after 6 on a mid-July morning, and Nicholas Rodenhouse is doing what he does most every summer morning, trekking into the woods of the Hubbard Brook Experimental Forest to check on his beloved black-throated blue warblers.

As he makes his way through thick brush to a clearing, he stops for a moment to listen, hoping to hear a male singing. He's probably not the only one listening.

"Everybody sings early in the season," Rodenhouse explains, but mating season is wrapping up, and an important divide is starting to emerge. The males who have been unsuccessful in their procreation will soon stop singing, choosing silence over the blues. The proud papas, on the other hand, will continue belting out the tunes into August, broadcasting their success.

All around him, flitting stealthily between trees, Rodenhouse believes the young warblers born this year are listening, too. Over the next several weeks, they will eavesdrop on their elders, scouting several territories to make mental notes on who is singing and who is not.

And when they return from their Caribbean migration in the spring, they will use this bit of "public information" to make perhaps the most important decision of their lives: where to build their nest. As any realtor will tell you, it's all about location; in the case of the birds, that location will have a huge impact on their mating success.

They will need a good food source—they love caterpillars—and good vegetation to support and shelter the small, fragile nests they will build a few feet off the ground. And they need to keep an eye out for predators—chipmunks and red squirrels are the bad guys in their story—that will menace their eggs and young.

"We've always wanted to know what cues they used to make that decision," Rodenhouse said, explaining the problem. "Was it vegetation? Food sources? Characteristics of the neighborhood? Was it something they could measure?"

And so Rodenhouse and his team tried to think like a warbler, to evaluate and measure each habitat. They counted caterpillars. They stopped silently for five minutes and counted any potential predators they saw.

They meticulously mapped the locations of all the nests, the number of eggs in them, the number of nestlings that hatched.

1 But a recent experiment at Hubbard Brook indicates that none of this matters to a young warbler looking for a good territory. Rodenhouse and some colleagues recently published a paper in the journal *Proceedings of the Royal Society: Biological Sciences* overturning the decades-old conventional wisdom that held vegetative structure as the chief basis for a bird's habitat choice.

3 Instead, they believe the “blues” choose where to live based on recommendations from their peers. Sound familiar?

4 In the experiment, researchers recorded the songs of the successful males, and then played those songs after the mating season in a variety of different habitats, including those they knew to be very bad for the warbler's needs, such as a clear-cut forest. The following spring, more than 80 percent of the poor habitats had warblers in them (while the control group of poor habitats, where the researchers hadn't played any music, had zero birds). Researchers had given out bad recommendations, and the birds bought it.

“I didn't think it would work,” Rodenhouse said of the experiment. “But by gum it did.”

“By gum,” like “by golly,” is pure Rodenhouse. He's 55, from a small town on the shore of Lake Michigan, and the apple-pie-and-ice-cream Midwestern-wholesomeness oozes from his every sentence, like when he places his hands on his hips and takes a deep breath through his nose and says that his job is to go out in the forest early in the morning and just stand there and listen to the world.

He doesn't have to say anything else for you to know that he thinks this is the greatest thing ever—though at the moment he has chosen to avoid mentioning the part of his job, as a biology professor at Wellesley College, that involves classrooms and grading papers.

The Hubbard Brook Experimental Forest, an 8,000-acre ecological laboratory in the White Mountain National Forest, is a home-away-from-home for Rodenhouse, who specializes in the population biology of migratory songbirds. He has been coming here since the early 1980s, when he did his Dartmouth PhD research on the black-throated blue warbler—a tiny bird that lends itself to population study because its low nests are easy to monitor. And he has been a permanent summer tenant every summer since 1996, awakened at 5 a.m. each day by the loons next to his cabin on Mirror Lake.

His is, he says, not a field that lends itself to the eureka moment; it's about gathering information daily. “Trust the data” is a mantra posted in the barn that serves as the hub for the 17 members of Rodenhouse's “bird crew.”

9 But this latest paper could be the closest thing to that eureka moment. If the birds choose their habitat chiefly on the recommendations of other birds, this could be a finding, Rodenhouse and others in the field say, with far-reaching implications, and represents particularly good news for birds' ability to adapt to a changing environment. By listening to their peers, the birds can avoid having to find out the hard way that a habitat has become unsuitable.

“One worry with climate change is that the old cues they use [to choose a habitat] might not work any more,” said Robert Askins, a biology professor at Connecticut College. “The structure of the vegetation changes, and what was good may not be anymore. If this

hypothesis is correct, this may not be such a serious problem because birds will find new habitats by finding other places birds have been successful. You won't need biological or organic evolution to occur; the population can respond through learning, and they can do that much more rapidly."

10 John Faaborg, a professor of avian ecology at the University of Missouri, thinks the finding could throw a wrench into the entire idea of wildlife management—in a good way. "With management, you try to provide the appropriate habitat. But sometimes you do this and the birds don't come." Using recordings of the post-breeding songs could be a good way to draw birds into unused suitable habitats, Faaborg said, though the generality of this finding may be limited, because not all species of songbird sing after breeding.

The idea of social cues being the deciding factor in habitat choice is "fascinatingly simple," according to Matt Betts, an assistant professor of forest science at Oregon State who was the lead author on the paper. And it has clear parallels to human behavior, where Internet review sites such as Yelp.com are having an increasingly powerful influence on what people decide to do and buy.

"I use the metaphor of choosing a coffee shop when you're new in a town," Betts said. "Are you going to go to the one with nobody in it, or the one that's hustley and bustley?"

Rodenhouse is excited by the hypothesis, but in his reserved way. There's only one sure-fire way to get him going, and as he walks down a trail he's been down a thousand times, it happens. Just a few feet to his right, he spots a knee-high nest in a patch of yellow birch saplings. He checks his maps, and it isn't listed.

"We may have just found a new nest," he said. On his face is the look of a guy who thinks he's got the greatest job in the world, by gum.

Fact sheet: Dr. Nick Rodenhouse

Hometown: South Haven, Mich.; lives in Sherborn.

Education: Studied biology at Hope College in Michigan before being drafted in 1972. He went to the Army's Defense Language Institute and studied Hungarian before returning to Hope to finish his degree in 1977. Got his master's degree in animal ecology from Iowa State in 1981, and did his first study of black-throated blue warblers at Hubbard Brook to earn his PhD from Dartmouth in 1986.

Family: Wife, Marianne Moore, is a limnologist and an associate professor at Wellesley College. Their honeymoon was six weeks on a zooplankton expedition in the Australian outback.

Hobbies: Rodenhouse enjoys woodworking because he says he's too cheap to pay for furniture, and is currently hooked on restoring classic stereo speakers. He and his wife are also returning the land around their house - which was lawn when they bought it - back to its natural state.



Student Handout

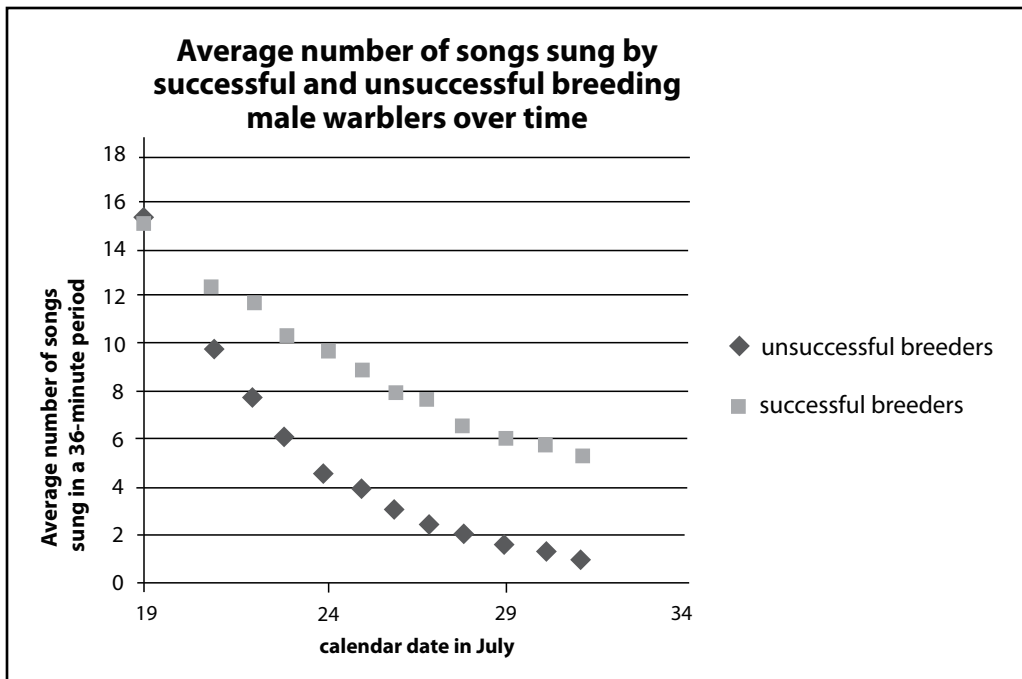
Message in a Song

Name _____

The following questions are based on the article “Tuned In.” The numbers given in the margin of the article pertain to questions 1, 3, 4, 9, and 10 below. Use the numbers as a guide to help you answer those questions.

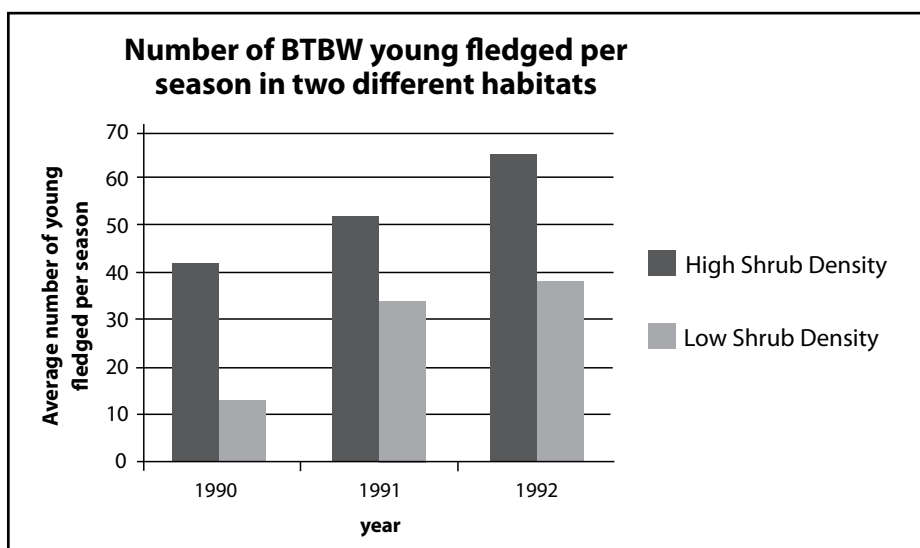
1. As a warbler flies around a forest searching for a breeding territory, it finds some areas that it considers to be high quality habitat and other areas that it thinks are poor quality habitat. How do these birds identify the difference? According to the article, “Rodenhouse and his team tried to think like a warbler, to evaluate and measure each habitat.” List at least two variables that they measured to identify habitat quality.

2. As scientists continued to study the location of warbler territories they realized that habitat quality didn’t fully explain where the birds chose to build nests, because nests were not evenly distributed throughout the high quality habitat. In fact, they tended to be clumped near one another, which suggested that something else was helping birds choose nest sites. Since singing is a major way birds communicate, the researchers looked at singing data and observed something very interesting, displayed in the graph below:



Who sang more frequently: Black-throated Blue Warbler males who were unsuccessful at breeding or those who were successful?

3. Recall the graph your teacher showed you before you read the article. It shows that Black-throated Blue Warblers are more successful at producing young in areas with greater shrub density. However, according to the article, it appears that it is not the density of shrubs that influences the decision a Black-throated Blue Warbler makes about where to establish his territory. Instead, what is more important in this decision-making process?



4. Let's take a step back to figure out how researchers designed an experiment to help them learn about how warblers choose territory sites. Why was it important for researchers to play "songs after the mating season in a *variety of different habitats*, including those they knew to be very bad for the warbler's needs?" (Hint: why didn't they simply play songs in good quality habitats?)

5. Consider this hypothesis:

If male warblers (who are searching for a good place to establish a territory) are attracted by songs sung by males of the same species (who have been successful at breeding), then more territories will be found in areas where male songs are played than in areas where no male songs are played.

A. If this hypothesis is true, what should result in each of the following situations?

Fill in each blank box with either "Males establish territories" or "Males do not establish territories."

	Songs played	No songs played
Poor quality habitat		
Good habitat		

B. If this hypothesis is false, what should result in each of the following situations?

	Songs played	No songs played
Poor quality habitat		
Good habitat		

6. What was the control in the experiment?

7. What was the independent variable?

8. What was the dependent variable?

9. In biological terms, an adaptation is something that allows an organism to survive and successfully reproduce. The ability to adapt is critical for organisms trying to cope with changing environments.

a. List three ways that climate change could alter the life of the Black-throated Blue Warbler.

b. Explain how the research finding described in the article might help warblers adapt to life in a changed climate.

10. How might this knowledge—that young males choose to nest in areas where they have heard experienced males singing songs the year before—be used by land managers and people concerned with bird conservation?

Answer Key

Message in a Song

1. As a warbler flies around a forest searching for a breeding territory, it finds some areas that it considers to be high quality habitat and other areas that it thinks are poor quality habitat. How do these birds identify the difference? According to the article, “Rodenhouse and his team tried to think like a warbler, to evaluate and measure each habitat.” List at least two variables that they measured to identify habitat quality.

Caterpillars, predators, nests, nestlings

2. Who sang more frequently: males who were unsuccessful at breeding or those who were successful?

Those who were successful sang more frequently.

3. Recall the graph your teacher showed you before you read the article. It shows that warblers are more successful at producing young in areas with greater shrub density. However, according to the article, it appears that it is **not** the density of shrubs that influences the decision a warbler makes about where to establish his territory. Instead, what is more important in this decision-making process?

The songs that male warblers hear other males sing after they have successfully raised young birds into fledglings.

4. Let’s take a step back to figure out how researchers designed an experiment to help them learn about how warblers choose territory sites. Why was it important for researchers to play “songs after the mating season in a variety of different habitats, including those they knew to be very bad for the warbler’s needs?” (Hint: why didn’t they simply play songs in good quality habitats?)

If researchers had played songs in good quality habitats only and if birds then established territories in these habitats, researchers would not know whether it was the song or the quality of the habitat that influences the birds’ decisions. By playing songs in both good and poor quality habitats and then observing the number of territories established in each during the following breeding season, researchers could see whether the songs had anything to do with the birds’ decisions.

5. Consider this hypothesis:

If male warblers (who are searching for a good place to establish a territory) are attracted by songs sung by males (who have been successful at breeding), then more territories will be found in areas where male songs are played than in areas where no male songs are played.

A. If this hypothesis is true, what should result in each of the following situations? Fill in each blank box with either “Males establish territories” or “Males do not establish territories.”

	Songs played	No songs played
Poor quality habitat	Males establish territories	Males do not establish territories
Good habitat	Males establish territories	Males do not establish territories

B. If this hypothesis is false, what should result in each of the following situations?

	Songs played	No songs played
Poor quality habitat	No difference in numbers of territories established among poor habitats	
Good habitat	No difference in numbers of territories established among good habitats	

6. What was the control in the experiment?

Habitat quality (both good and poor quality)

7. What was the independent variable?

Frequency of song; or song (or no song)

8. What was the dependent variable?

Territories established by male birds

9. In biological terms, an adaptation is something that allows an organism to survive and successfully reproduce. The ability to adapt is critical for organisms trying to cope with changing environments.

a. List three ways that climate change could alter the life of the BTBW.

Answers will vary. Changes to climate (temperatures, rainfall, snowpack) can affect things like distribution of tree species and other vegetation, which in turn can affect things like availability of food and nest sites as well as abundance of predators. Students may describe possible benefits as well as drawbacks (i.e.: birds will have more time to mate and raise young).

b. Explain how the research finding described in the article might help warblers adapt to life in a changed climate.

If climate change affects the types of vegetation in an area, what was once good habitat may no longer be of the same quality. But if birds find new habitats by going to places where others have been successful, they will be able to find suitable habitat more quickly than they would if they had to go through the trial-and-error of trying out a new place without this information.

10. How might this knowledge—that young males choose to nest in areas where they have heard experienced males singing songs the year before—be used by land managers and people concerned with bird conservation?

People could use playback (recordings of post-breeding songs) to attract birds to areas that have been restored and are now suitable for birds.