



MAPPING A TERRAPIN TOWN

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Grade Level
7th Grade

Subject Area
Life Science, Environmental Science

VA SEA is a collaborative project between the Chesapeake Bay National Estuarine Research Reserve, the Virginia Institute of Marine Science's Marine Advisory Program, and Virginia Sea Grant. The VA SEA project is made possible through funding from the National Estuarine Research Reserve System Science Collaborative, which supports collaborative research that addresses coastal management problems important to the reserves. The Science Collaborative is funded by the National Oceanic and Atmospheric Administration and managed by the University of Michigan Water Center.



Title: Mapping a Terrapin Town

Focus: In small groups, students will explore diamondback terrapin habitat requirements, conservation, and how land use planning can affect their population.

Grade Level: Seventh Grade Life Science or scaled up for High School Environmental Science

VA Science Standards:

LS.1 The student will demonstrate an understanding of scientific reasoning by:

- Asking questions and defining problems
- Identifying, interpreting, and evaluating patterns in data
- Constructing and critiquing conclusions and explanations;
 - Construct explanations that include qualitative or quantitative relationships between variables
- Developing and using models
 - construct and use models and simulations to illustrate, predict, and/or explain observable and unobservable phenomena, life processes, or mechanisms

LS.8 The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic and change over time.

- organisms respond to daily, seasonal, and long-term changes;
- changes in the environment may increase or decrease population size; and
- large-scale changes such as eutrophication, climate changes, and catastrophic disturbances affect ecosystems.

LS.9 The student will investigate and understand that relationships exist between ecosystem dynamics and human activity.

- Changes in habitat can disturb populations;
- Disruptions in ecosystems can change species competition; and
- Variations in biotic and abiotic factors can change ecosystems.

Learning Objectives:

- ✓ Students will develop an understanding of the ecology and biology of Diamondback Terrapins as well as the issues facing terrapins and the conservation strategies employed to address them.
- ✓ Students will explore and identify the habitat requirements that healthy populations need to survive.
- ✓ Students will work collaboratively to utilize what they have been taught about terrapins by discussing and creating a conservation plan during a game that models a yearly population change in a developing community

Total length of time required for the lesson: 60-80 minutes total

**Game time will be variable depending on the length and depth of game instructions needed for your students*

Advance preparation of materials – 10 to 15 minutes

Setup – 5 minutes

Introduction (learning about terrapins and their conservation)– 10- 15 minutes

Explaining the rules- 5-6 minutes

Activity – 35- 45 minutes

Discussion/ wrap-up worksheet – 15 minutes

Breakdown and clean-up – 5 minutes

Key words, vocabulary, concepts:

- **Population:** the number of organisms of the same species that live in a particular geographic area at the same time.
- **Individual:** one organism of a single species
- **Keystone Species:** an organism that influences all other species living in an ecosystem, keeping it stable and functioning.
- **Minimum Viable Population:** the smallest number of individuals in a population capable of living within a habitat without threat of extinction from natural disasters, demographic, or genetic issues.
- **Land-use:** The human use of land for economic and cultural purposes
- **Ghost fishing:** abandoned fishing equipment which continues to catch organisms
- **Poaching:** the illegal removal of a managed species from its natural habitat
- **Conservation Plan:** a document that outlines how a site will be managed to decrease or avoid potential negative environmental impacts; can be specific to a population or community.

Background Information:

Diamondback Terrapin Ecology. *Malaclemys terrapin* is a brackish water turtle native to the eastern U.S. Terrapins can live up to 40 years in the wild and come in an array of colors and patterns, from dark gray and tightly speckled to pale with large black blotches.

Their range extends from coastal Massachusetts down the eastern coast, to the Gulf of Mexico and Texas. Terrapins are more closely related to freshwater turtles than sea turtles and are specially adapted to living in brackish water that is a mix of salty and fresh. In fact, they are the only brackish water turtle in the state of Virginia. They inhabit the tidal creeks and rivers of estuarine salt marshes where they feed on the invertebrates that live in this ecosystem. Animals such as periwinkle snails, ribbed mussels, fiddler crabs, and blue crabs are among their preferred diet.

Terrapins play an important role in estuarine ecosystems for several reasons. In some areas, they are a keystone species, an organism that keeps an ecosystem stable and effect all other species living there. This is because of their role in predating periwinkle snails and other animals

that damage saltmarsh cordgrass (Silliman and Bertness, 2002). Without terrapins these places are prone to large areas of mudflats where there should be saltmarsh. In the state of Virginia, they also play an important role in the dispersal of eel grass seeds in the southern Chesapeake Bay (VA Department of Wildlife Resources, 2022).

Threats to Terrapins. Unfortunately, terrapin populations are in decline. The International Union for the Conservation of Nature IUCN red list rating lists the species as ‘*vulnerable*’ (IUNC; Roosenburg et al., 2019) and in the Virginia Wildlife Action Plan they are a ‘*Species of Greatest Conservation Need-Tier 2a.*’ There are several major threats to terrapins including habitat loss, illegal harvest for the pet trade or food, road mortality, nest predation, and drowning in abandoned fishing gear.

Poaching. Terrapins have a long and messy history with humans. In the mid-1800s along the Mid-Atlantic coastal region, terrapins were nearly over-harvested to extinction for food. As their population declined, terrapin meat grew out of culinary fashion and eventually, states began to manage terrapin populations. It is currently illegal to harvest terrapins in the state of Virginia, though harvesting laws vary by state. Despite this, poaching still occurs for both food and the pet trade.

Habitat loss. Terrapins rely on salt marshes and barrier islands. Unfortunately, these habitats along their range are heavily interspersed with human development and expansion. Increasing use of tidal waterways for both commercial and recreational purposes can also pose a threat to the species.

Ghost fishing. Fishing gear that are abandoned or lost in waterways continue to catch marine creatures even when no one is actively fishing. Blue crab pots pose a particular issue for terrapins. Crabs that are caught in abandoned pots can act as an unintentional bait for terrapins. Although these turtles can hold their breath for a long time, if pots are lost under the water, it is likely that terrapins trapped inside will drown. This issue disproportionately affects young male terrapins that are smaller than females and can more easily fit into the crab pot openings.

Nest Predation. Barrier islands and sand dunes are valuable nest sites for diamondback terrapins. Female terrapins can lay 3 clutches of egg during a nesting season and need to lay their eggs above the high tide line to ensure that their nests do not become flooded with water. In these sandy areas, nests can be dug up by racoons or coyotes, and hatchlings can be eaten by crows and shore birds.

Road Mortality. During their nesting season in the late spring and summer months, female terrapins are on the move trying to reach nest sites. Once they leave the water, they are likely to be hit by vehicles as they attempt to cross road ways. If they are able to make it to nest site to lay eggs, then hatchling terrapins may be vulnerable to being hit as they migrate back to water. If hatchling do not make it across the road, they may become stranded or be washed down storm drains where they can die from chemical exposure or lack of food.

Terrapin Conservation Efforts. Despite the various threats to the species, many scientist and wildlife managers are working towards conserving their population. Many states have laws that prevent terrapins from being harvested commercially or recreationally. Scientists will monitor populations and nest sites. Other conservation efforts include:

- Placing **predator exclusion** cages over known terrapin nests to prevent predation
- Lining roadways with **road barrier tubing** that prevent terrapins from crossing during nesting season
- Creating **animal crossing areas** over roadways where wildlife can safely pass
- Distributing **Turtle Exclusion Devices (TEDs)** to blue crab watermen to prevent terrapins from entering pots.
- And **head starting programs** allow for terrapin eggs to be hatched and raised by humans for a period of time until they are large enough to be released into the wild

These efforts can be implemented alongside research, monitoring, habitat conservation, and wildlife policy to manage terrapin populations.

Materials & Supplies:

For the teacher or game facilitator:

- One event table (printed and laminated)
- One six-sided die

Each group gets:

- One Terrapin Town gameboard sheet (can be laminated and reused)
- 5 different brightly colored markers (if gameboards are laminated these should be wet-erase)
- 10 tokens per group (these can be beads, chips, or any similar small objects)
- 5 ghost pot squares and 3 nest cover squares per group (can be laminated and reused)
- Deck of 22 development cards (can be laminated and reused)

Each Student gets:

- One student worksheet
- One spending actions sheet (can be laminated for future classes)

Procedure:

Suggestion: depending on students understanding of the concepts in the game (human impacts, ecosystem disturbances, etc.) from prior years, you may want to spend some time simply introducing these concepts and reviewing the vocabulary in the lesson before the start of the game. When they come up again during the PowerPoint, direct students to make connections to these words.

Teacher Preparation: Print one of each student handout per group. The development cards should also be printed and cut so that that there is one set of 22 cards per group. If possible, this deck should be printed in color, however, it is not necessary to play the game.

Set up. Make sure that all materials are printed and divided amongst the groups. If you choose to laminate materials, do so. This activity will work best with students in groups of 2 or 3.

Part 1: Introduction to Terrapin Conservation PowerPoint

Begin the PowerPoint presentation that accompanies this lesson.

- See slides for specific notes with suggested dialog and discussion
- To segway into the game, ask students:
 - Can humans and wildlife live together in the same habitat?

Part 2: Map a Terrapin Town Game

Have the students break up into groups of 2 or 3. Each group should start the game with 5 tokens (this is their spending budget), a deck of 22 development cards, and a game board. The habitat on each gameboard supports a population of 100 terrapins (4 terrapins per marsh square).

The teacher should start the game with an event table (see the attached game sheets) and a six-sided die.

Set the stage: Tell students that “a beautiful and scenic coastal town is being built along the river. However, this location is prime habitat for diamondback terrapins. You are part of a team of terrapin experts and future community members in charge of advising the development of the new town. You were told that there is a population of 100 terrapins that live here. Since this species is threatened you are tasked with making sure that the town is terrapin friendly while also being functional for the future residents. You are given a budget of 5 tokens to spend on terrapin conservation strategies that can help mitigate any conservation issues from development.”

Goal: Have the largest viable population of terrapins at the end of the game while also having an appealing town that people will want to move to.

Step 1: On the gameboard map, have the students use a pencil to mark each square that is an ideal nest habitat for terrapins in an N. These should be sand squares adjacent to marsh or water. These are their starting nests. At the end of each round **successful clutches will result in 1 new adult terrapin.**

Also, have students calculate the maximum population that they can have based on how many marsh squares they have. This is $4 \times (\text{number of marsh squares}) = \text{maximum population}$. They should all have a max population of 100 at the start.

Note that the maximum population in the context of the game means that 1 marsh square habitat can only support 4 terrapins. All animals have habitat requirements like access to enough food or space. A habitat of 1 marsh square means that 4 terrapins can live there comfortably without having to compete for resources. The maximum population will probably change through the game. For example, there are 25 marsh squares on the board. The maximum population for 25 marsh squares is 100 terrapins. If a group builds on a marsh square, then there is less habitat and less resources. Now the maximum terrapin population that the ecosystem can support will go from 100 to 96. There is also a **minimum viable population**, which in conservation, is defined as the smallest number of individuals in a population without threat of extinction from natural disasters or genetic issues. So, if a student group

somehow has a population of 4, there is no longer a viable population as their population has crashed. So, 8 terrapins is the minimum viable population.

In the game, students will go through 5 rounds of building up the community and implementing terrapin conservation strategies. In each round, an event (rolled on the event table) will occur that may cause students to lose individual terrapins from their population or terrapins' nests. Their conservation spending may offset some of this. After each round, students will calculate the number of nest sites they have (sand squares next to marsh and water), the maximum population (marsh squares X 4), how many terrapins were lost (from the event), how terrapins were gained (1 X each nest site) and their total population (total population from last round - terrapins lost + terrapins gained).

Step 2: Play the game

Each round consists of the following consecutive steps:

1. **Development Action:** Draw 4 development cards and plan out where they should go on the map. Make sure students discuss where to build.
 - a. Note that the development cards have colored block shapes on them. Students should use their markers or colored pencils to add these to their map. During the game, students can (and will) color over the habitat squares on the board. Like in Tetris, shapes can be turned to fit in whatever way they wish, as long as the blocks in the shape match what is on the card.
2. **Spending Action:** spend tokens on conservation (see table in the handout section)
3. **An Event Occurs:** Roll the die. Whatever number it lands on corresponds with the event number on the Event Table. Students then add the event to their maps.
 - a. The ghost pots event is continuous. If that event is rolled, have students place a ghost pot square in one of their water spaces. They stay there collecting terrapins until removed.
 - b. The habitat loss event will cause students to lose nest sites. They can use the nest cover squares to place over the lost site if they choose the restoration action during one of their spending rounds.
4. **Estimate and record the terrapin population change:** This will take into account:
 - a. what they lost during the Event phase
 - b. what their conservation spending saved
 - c. if they built on any marsh or nest site squares during the development phase and
 - d. the individuals that hatched from the remaining nests and survived.

In short, they are looking for their current terrapin population, their maximum population, and how many nest sites. There is a table to record this on their gameboard.

5. Collect 2 tokens for the start of the new round.

There are a total 5 rounds. At the end of the game students will calculate their final terrapin population and maximum population to see how well their town did. While this game is not intended to be a competition between groups, final populations can be compared across groups to see which was the most successful.

Part 3: Discussion and Worksheet

Have each group share their finished town with the class. Ask them what conservation efforts worked well in their town and what issues they faced. Once all groups have shared, have the students take a few minutes to answer questions on their student worksheet. If you run out of time, this can easily be a take-home reflection assignment.

Extension Activity:

In their groups, have students create a conservation plan for their towns from the game. The plan should be based on the population results from the last round of the game and include recommended steps to help increase the population or keep it at a stable level.

Assessment:

Students will be assessed based on their team's discussion of the mapping activity and their answers to the student worksheet. In their team discussions look for an understanding of the problems from the power point (habitat loss, ghost fishing, etc.) and that most are human cause. Also listen for solutions using the conservation strategies from the game.

If you would like a further assessment, have the students write a paragraph using the Claims Evidence Reasoning (CER) framework. The first sentence should be a claim as to what the best conservation method is for conserving terrapins. Have the student support this by using evidence from the game to identify why it is the most effective. Then they should back that up with reasoning.

Terrapin Town Student Worksheet

Name: _____

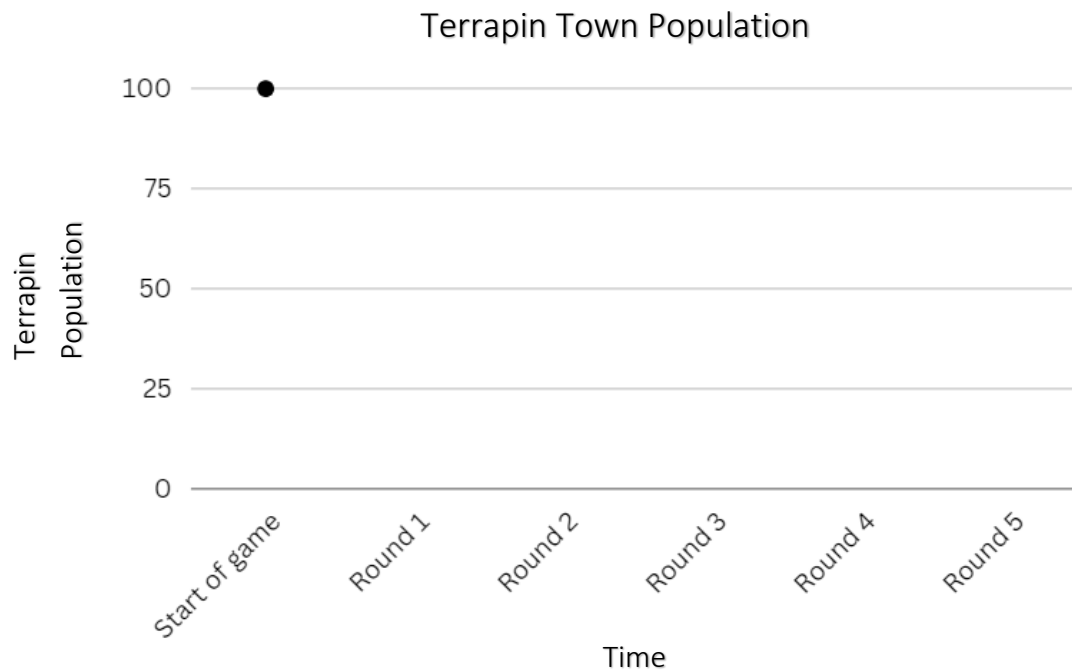
Fill out the table as you play the game. You will need this to complete the rest of the worksheet.

Population at start of game: 100

Maximum Population (MP) at start of game:

	Nests	MVP	Terrapins Lost	Terrapins Gained	Total Number of Terrapins
Round 1					
Round 2					
Round 3					
Round 4					
Round 5					

Use the data from the game to graph the terrapin population over time.



Answer the following:

1. Identify the independent and dependent variables.

2. Looking at your graph, describe what happened to the terrapin population in your community. Did your terrapin population increase or decrease over time? Why?

3. How many terrapins were in your population at the end of the game? Based on your map, what are some of the biggest threats facing terrapins in your community? Why?

4. What was your maximum population of terrapins at the end of the game? Why do you think that the amount of marsh habitat at a site could determine how many terrapins can live there?

5. What are the habitat requirements of the diamondback terrapin? Keeping this in mind, if you were a conservation manager, what regulations would you recommend that the town enact to conserve this species? (ex. would you suggest making any actions illegal or restrict where people could build?)

Terrapin Town Student Worksheet

(Teacher's guide)

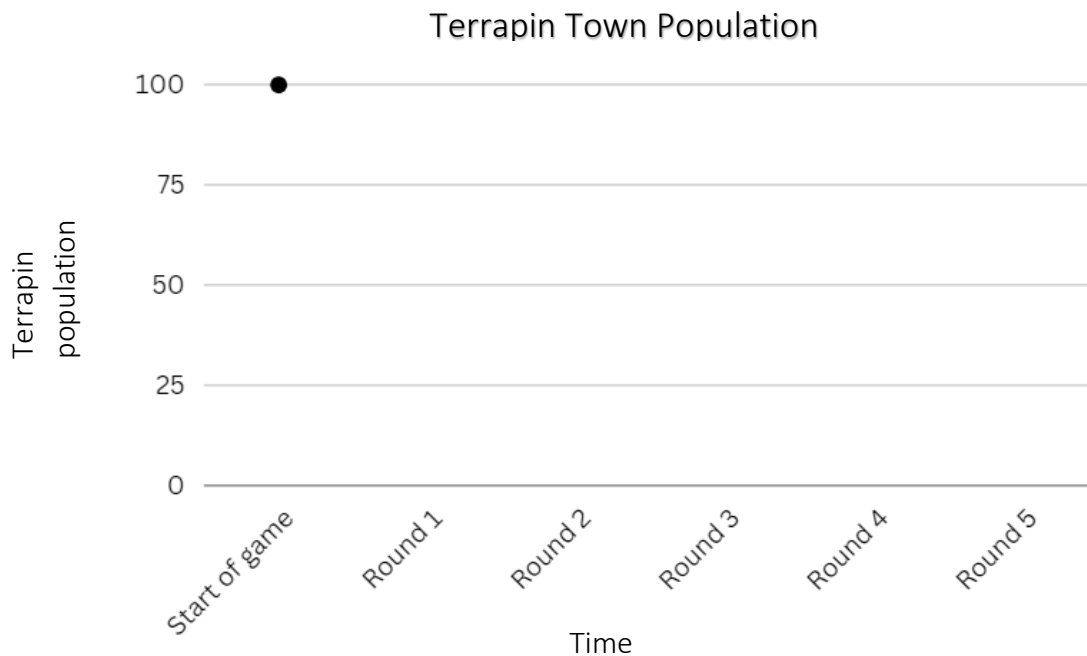
Name: _____

Fill out the table as you play the game. You will need this to complete the rest of the worksheet.

Population at start of game: 100 Maximum Viable Population (MVP) at start of game:

	Nests	MVP	Terrapins Lost	Terrapins Gained	Total Number of Terrapins
Round 1					
Round 2					
Round 3					
Round 4					
Round 5					

Use the data from the game to graph the terrapin population over time.



Answer the following:

1. Identify the independent and dependent variables.

Independent variable: time

Dependent variable: terrapin population

2. Looking at your graph, describe what happened to the terrapin population in your community. Did your terrapin population increase or decrease over time? Why?

Look to see if the student's interpretation of their data matches their graph. They can describe "events" that occurred during the game to explain drops or conservation efforts to describe increases. Ultimately, students should conclude that increasing development makes it difficult for populations to thrive because of habitat loss.

3. How many terrapins were in your population at the end of the game? Based on your map, what are some of the biggest threats facing terrapins in your community? Why? What do you think were most effective conservation strategies you could fund?

This answer depends on what happened in the student's game. Depending on the state, the largest threats to terrapins are road mortality, poaching, and ghost fishing. Though the student may be able to argue a different threat.

Again, students can make arguments based on what they saw in game. Looking at the conservation efforts, the more permanent structures, like an animal crossing area, are some of the most beneficial. Also having a conservation center is effective because it's a designated organization that work towards conservation.

4. What was your maximum population of terrapins at the end of the game? Why do you think that the amount of marsh habitat at a site could determine how many terrapins can live there?

Marsh habitat is where terrapins hunt for food and is the place where their preferred prey species live. Without marsh habitat, the terrapins would not be nearly as successful hunt and gaining energy.

5. What are the habitat requirements of the diamondback terrapin? Keeping this in mind, if you were a conservation manager, what regulations would you recommend that the town enact to conserve this species? (ex. would you suggest making any actions illegal or restrict where people could build?)

Habitat requirements: Marsh with available food, sandy areas free from disturbances for nesting, and brackish water.

Students should come up with answers like: restrict the harvest of terrapins from the wild, preserve nesting habitat, restrict public access to beaches during nesting season, or require that watermen remove crab pots from the water when not in use or place TEDs on pots.

References:

Roosenburg, W.M., Baker, P.J., Burke, R., Dorcas, M.E. & Wood, R.C. 2019. *Malaclemys terrapin*. The IUCN Red List of Threatened Species. <https://www.iucnredlist.org/species/12695/507698>

Silliman, B. R. and M. D. Bertness. 2002. A trophic cascade regulates salt marsh primary production. *Proceedings of the National Academy of Science* 99 (16): 10500-10505.

Virginia DWR. August 25, 2022. Northern Diamondback Terrapin.

<https://dwr.virginia.gov/wildlife/information/northern-diamond-backed-terrapin/>

Resources and Further Reading:

Badger, Curtis. Sept 1, 2021. From Delicacy to Decline: A Tale of the Diamond-Backed Terrapin. *Virginia Wildlife Magazine*. <https://dwr.virginia.gov/blog/from-delicacy-to-decline-a-tale-of-the-diamond-backed-terrapin/>

Kleopfer, J.D. and Sevin, Jennifer. May 3, 2021. Shell Game. *Virginia Wildlife Magazine*. <https://dwr.virginia.gov/blog/shell-game/>

The Wetlands Institute. Sep 13, 2015. 25 Years of Terrapin Conservation. <https://wetlandsinstitute.org/25-years-terrapin-conservation-research/>

Virginia Herpetological Society. 2022. Northern Diamondback Terrapin. https://virginiaherpetologicalsociety.com/reptiles/turtles/northern-diamond-back-terrapin/northern_diamond-backed_terrapin.php

Recent Examples of Conservation Projects:

The Largest Wildlife Crossing Area being built in California (2022):

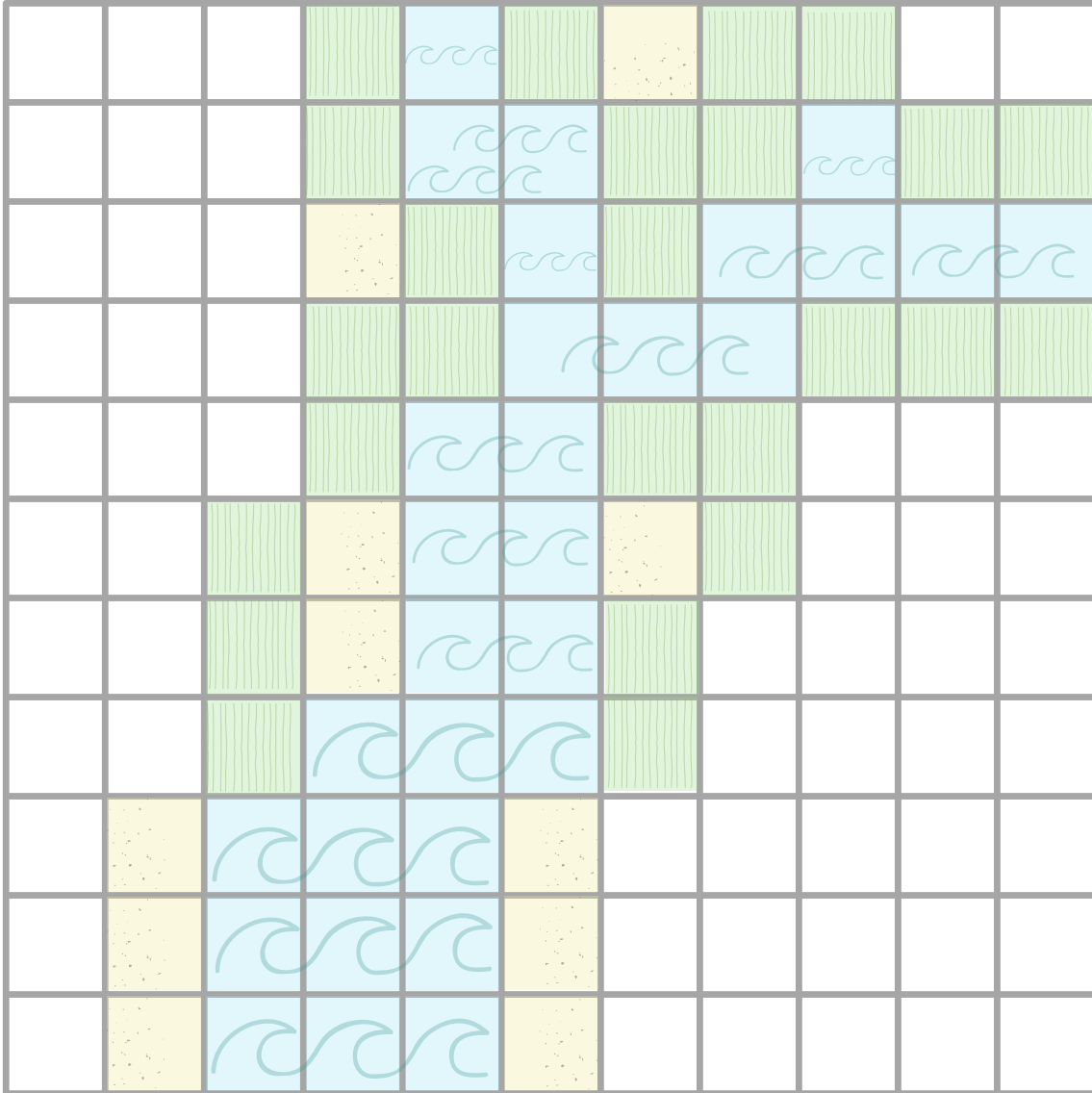
<https://www.cnn.com/2022/04/23/us/california-wildlife-crossing-scen-trnd/index.html>

Mapping a Terrapin Town

Group Members:

Town name:

 Marsh
  Water
  Sand



Terrapin population at start: 100

Maximum Population (MP) at the start:

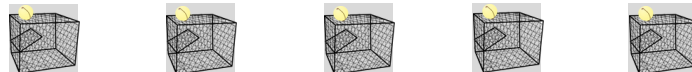
	Nests	MP	Terrapins lost	Terrapins gained	Total terrapins
Round 1					
Round 2					
Round 3					
Round 4					
Round 5					

Event Table			
1	Poaching	Terrapins were harvested from the marsh and sold as pets.	-35 terrapins
2	Storm Drain	A storm came through and washed baby terrapins down the storm drain.	-3 nest
3	Predation	Predators, such as raccoons or coyotes, dug up terrapin nests and ate the eggs.	-4 nest
4	Ghost Pots	Place 2 ghost pot icons in the water. They will remain there until removed.	-10 terrapins (per pot per round they're on the board)
5	Habitat Loss	A landowner has accidentally built on a nest site.	-1 nest square (color this in as a house)
6	Road Mortality	Female terrapins were stuck by cars while trying to cross roadways.	-7 per road adjacent to marsh, water, or beach

Nest cover Squares:



Ghost Pot Squares:



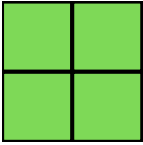
Spending Actions

You can spend tokens on the following **Conservation Efforts**:


Solution	Cost	Description
Road Barrier	1 token	protects 5 terrapins per road per round
Turtle Crossing	2 tokens	protects 5 terrapins permanently per road
Turtle Exclusion Devices (TED)	1 token	decreases mortality by 5 per ghost pot (hold onto this for when it's useful)
Protect and Monitor a nest	1 token	prevent a predator from digging up 3 nests.
Head Start Program	3 tokens	successfully add 4 more turtles to the population
Restoration	1 token	restore a nest or marsh square that had been destroyed by a habitat loss event
Research Conservation Center	4 tokens; 2 squares	building this allows you to add one of the terrapin conservation efforts listed above after the Event has taken place. You can do this once per round this is on your map. You may only build one.
Conservation Officer	3 tokens	stop a poaching Event or remove a ghost pot
Protect a Habitat	1 token	protected an undisturbed nest or marsh square permanently

Development Cards

Park




Road



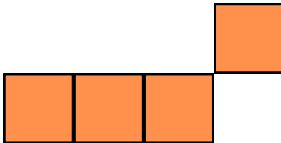
**must be placed next to a building or another road*

Road



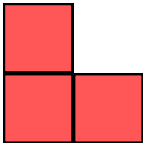
**must be placed next to a building or another road*

Road

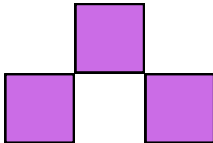


**must be placed next to a building or another road*

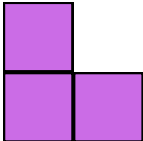
Housing



Shopping Center




Marina




**must be placed with 1 square in a water space*

Public Beach




**must be placed on sand*

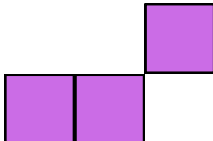
Grocery Store



Housing




Shopping Center




Development Cards


Grocery Store



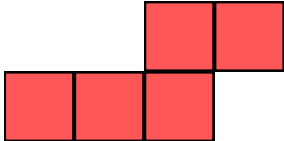
City Hall




Library



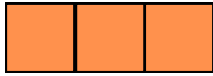
Housing



School



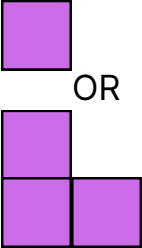
Bridge



**must go over water*

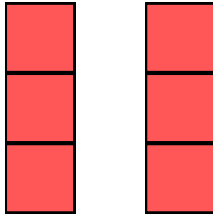
Hospital

OR

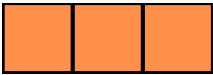


and gain a token at the end of the round

Housing

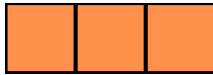


Road



**must be placed next to a building or another road*

Road



**must be placed next to a building or another road*

Housing

