

The Masquerade Game

BY STEPHANIE TORO, JUAN ARMANDO SÁNCHEZ, AND MANU FORERO-SHELTON

RESOURCES FOR ACTIVITY

RESOURCE 1: BACKGROUND INFORMATION FOR STUDENTS

Highly Probable Events

Highly probable events from the natural history of *Simnia avena* and *Simnialena rufa* egg-cowries and *Pacifigorgia* spp (sea fans) occur in a regular and almost predictive manner, which are the main drivers of population dynamics at Malpelo Island (Colombian Pacific, TEP).

- High probable events are 43 cards of a 52-card deck.
- These events alter the number or position of cowries on the board, so helping to win the game but also to break down the uniformity that the players seek to win the game. Some cards require the player to throw two dice of different colors. One will represent the position on the x-axis (x-color dice) and y- axis (y-color dice) where the event will happen.

Events/Card Type	# of Cards	Description	Action During Game
Movement	16	Assumed that eventually cowries can move for no particular reason and look for another sea fan host.	Players move one cowry at every turn, and here they can move any of the cowries of their own color, which increases the chances for winning the game; move freely (one square, forward, back sideways, or diagonally).
Reproductive Aggregation	9	This is the major finding of this study: All types of egg-cowries color gather for reproduction and ovoposition into encapsulated eggs on the sea fan surface. As in other ovulids, both males and females exhibit gregarious behavior and gather on a single sea fan colony after copulating with multiple males briefly earlier (Nowlis 1993).	Throw the dice to determine the position; the closest cowries will congregate in that square. The number of cowries to participate is shown on the card. If a number of cowries are equidistant, the player may choose which to move. If all cowries are of the same color, the player with this color may keep the card for use in recruitment
Recruitment	9	Cowries develop on the encapsulated egg into an unknown planktonic phase (Bandel 1973). Afterwards, they settle on coral hosts.	The number of offspring is shown on the card. If the player has a reproduction card (they can play this to ensure all offspring are their color), the player will put cowries on that square and/or any adjacent square. If the number of cowries in any square is more than 6, any additional cowries die; but the order in which the cowries are placed on the squares is chosen by the player playing the card.
Predator	9	In the study area, there are two likely predators of cowries: the coral hawkfish (<i>Cirrhichthys oxycephalus</i>) and the Malpelo endemic twinspot triplefin <i>Lepidonectes bimaculatus</i> (Chasqui Velasco, Gil-Agudelo, and Nieto 2011). Since these 2 fishes are common, it is assumed that predation on cowries is occasional and, in response to camouflage, mismatches due to movements or reproductive aggregations.	The player moves the predator (from its previous position). The number of squares is shown on the card. The predator cannot move diagonally. In each square visited during the movement, it will eat any cowries whose color is not matched to the background coral's color.

Background Information for Students: Less Probable Events

Less probable events from the natural history of *Simnia avena* and *Simnialena rufa* egg-cowries and *Pacifigorgia* spp. (sea fans) at Malpelo Island (Colombian Pacific, TEP) are of the disturbance type, which are less frequent and have catastrophic results on the population.

- Less probable events are 9 cards of a 52-card deck.
- These movements, as in an intermediate disturbance scenario, will shake the fate of the game drastically. Moreover, these cards can delay the player that was close to winning and it introduces evenness between players. The player who gets this card must throw two dice of different colors to determine the position as above.

Events/Card Type	# of Cards	Description	Action During Game
Super Predator	2	The longnose hawkfish (<i>Oxycirrhites typus</i>) is a predator that also has a masquerade type background-matching mimicry for the same kind of sea fan (<i>Pacifigorgia</i>). It is closely associated to gorgonians and black corals (Béarez, Bujard, and Campoverde 2007). Its sharp and projecting mouth provides it with a lethal tool for picking up prey concealed on sea fans.	This predator eats even background matching cowries. The player chooses a corner of the square and all cowries in squares adjacent to this corner (up to 4 squares) are removed.
Invasive Species	3	The snowflake coral <i>Carijoa riisei</i> is an invasive octocoral, presumably from the Western Atlantic, which overgrows and kills sea fans at the Tropical Eastern Pacific-TEP (Sánchez and Ballesteros 2014). This is possible due to an associated sponge on the surface of the coral, which has cytotoxic effects on contact (Calcinai, Bavestrello, and Cerrano 2004).	At the chosen position, the invasive species will displace the cowries' coral host. All cowries on this square must move out of it and, the player who receives the card, decides which adjacent square to place each cowry in.
Fungal Disease	4	The fungal disease aspergillosis (<i>Aspegilus sydowi</i> and <i>A. flavus</i>) has been recently detected infecting sea fans in the Eastern Tropical Pacific (Barrero-Canosa, Dueñas, and Sánchez 2012). This disease could be related to warming seawater temperatures and land-borne pollution (Sánchez et al. 2014). It is responsible for most of mortality on sea fan hosts in Malpelo and other TEP Areas (Sánchez et al. 2012).	All cowries on this square die, so they are removed.

RESOURCE 2: SYNTHESIS OF BACKGROUND INFORMATION AND RESEARCH FOR STUDENTS

Part 1: Predation

Identify the predators (including super predator)	Identify the prey
Why or how are the above the predators? Give 3 statements of evidence to justify your answer.	Why or how is the above the prey? Give 3 statements of evidence to justify your answer.
Describe the specific predator-prey relationships in this case study. Include the following: <ul style="list-style-type: none">• Adaptations of the predator that benefits them• Adaptations of the prey that benefits them• What happens when the predator and prey interact?• How the population of the predator and prey can change over time?	
How is the super predator different from the predator? Clearly identify each in your answer.	
GENERALIZE: Describe predator-prey relationships in general terms without referring to the specific organisms in this case study. Include how the populations may be affected over time and with changes the population numbers of either the prey or predator.	

Resource 2 continued on next page

Part 2: Reproduction and Recruitment

Describe the process of reproduction for this specific case study.	Describe the process of recruitment for this specific case study.
In this case study how is reproduction different from recruitment?	
GENERALIZE: Describe reproduction in general terms without referring to the specific organisms in this case study.	GENERALIZE: Describe recruitment for organisms in general terms without referring to the specific organisms in this case study.
GENERALIZE: How is reproduction different from recruitment in general terms without referring to the specific organisms in this case study?	

Part 3: Invasive Species

Identify the Native Species	Identify the Invasive Species
Why or how is the above the native species? Give 3 statements of evidence to justify your answer.	Why or how is the above the invasive species? Give 3 statements of evidence to justify your answer.
Describe the interaction between the native species and the invasive species in this case study. Which is the better competitor? Why? Include the traits that allow your choice to have a higher "fitness" (survive and reproduce)	
GENERALIZE: Describe in general terms what are native species and some example characteristics of them.	GENERALIZE: Describe in general terms what are native species and some example characteristics of them.
GENERALIZE: Why are invasive species an issue for native species? Explain in general terms not specifically for the organisms in this case study.	

Part 4: Disease

Identify the organism causing the disease	Identify the organism that suffers from the disease
Give 3 statements of evidence to justify your answer above.	Give 3 statements of evidence to justify your answer above.
How does the fungal disease impact the ecosystem on multiple levels? Describe all organisms impacted and explain how.	

RESOURCE 3: KEY FOR CARDS

(if using a regular card deck)

Type of Card	Description of Play	Example
<p>All face cards including aces (jacks, queens, kings, and aces of any suit)</p>	<p>Move one cowny one space</p>	<p>If any Queen is drawn, the team will move one cowny one space.</p>
<p>All numbered spades (spades 2-10)</p>	<p>The number on the card represents the number that the predator can move and eat all mismatched cownies in its path, which are then removed from the game board. A mismatch cowny is one that is not in its appropriate square.</p>	<p>For example, team A's cownies are considered matched if located in team A's squares. If they are located in team B's squares, then they are mismatched and eligible for predation. If a 5 of spades is drawn and the predator is moved 5 spaces to a square in which the egg cownies are not the same team as the square they are in, then they are removed.</p>
<p>All numbered hearts (hearts 2-10)</p>	<p>The number on the card will present the number of cownies that will be involved in the reproduction. Because the maximum number of cownies in a square is 6, any number hearts card pulled above 6 will still only have 6 cownies involved in the reproduction. The team that drew the card will roll the 2 dice. The combination will determine the location of the square on the board where reproduction is occurring. The closest cownies to that square will then be moved into that square. If any of the cownies being moved are the same color as the team who drew this card, then they keep the reproduction card for later play.</p>	<p>For example, team A's cownies are considered matched if located in team A's squares. If they are located in team B's squares, then they are mismatched and eligible for predation. If a 5 of spades is drawn and the predator is moved 5 spaces to a square in which the egg cownies are not the same team as the square they are in, then they are removed.</p>
<p>All number clubs (clubs 2-10)</p>	<p>The number on the card represents the number of cownies added to the board. The dice are roll again to determine the square using the 2 dice and the board's coordinate system. If more than 6 cownies are in the square, then the last cownies added to the square die and do not get added. This means you can only add up to 6 cownies total in the square. If the player has a reproduction card, the cownies placed in the square can be their own color. If the player does not have a reproduction card, the color of the cownies to be added, will be chosen at random.</p>	<p>For example, a team draws a 4 of clubs. They roll the dice and the square is row 2, column 3. There are already 3 cownies in that square. They do not have a reproductive card from previous play. They will then draw at random between the two colors of cownies and add 3 cownies, so that the square has a total of 6 to that specific square.</p>

Resource 3 continued on next page

Resource 3 continued

Type of Card	Description of Play	Example
9 and 10 of diamonds	9 and 10 of diamonds are used for the super predator. The dice is rolled to determine the position of the attack using the coordinate system of the board. The team that draws the super predator card then can determine which adjacent 4 squares the super predator will eat and remove all of the game pieces in those squares.	If any Queen is drawn, the team will move one cowry one space.
6, 7, and 8 of diamonds	6, 7, and 8 of diamonds are used as invasive species. The dice is rolled to determine the position on the board. All cowries in that square must be removed from that square into an adjacent square. The team that drew the card moves the cowries, regardless if they are their color of cowrie or not. If there are more than 6 cowries in all adjacent squares, the the most recent arrivals will die and be removed from the board.	A team draws a 6 of diamonds and then rolls a 1 and a 5. Any cowries in the square that is in the 1st row and the 5th column must be moved into other adjacent squares. The square contains 3 cowries that belong to their own team and 2 that belong to another team. They decide to move their 3 into an empty adjacent square. They move the 2 cowries belong to the other team into an adjacent square that already has 6 cowries and there the 2 new die and are removed from the game.
2, 3, 4, and 5 of diamonds	2, 3, 4 and 5 represent sea fan disease. The dice is rolled to determine the location on the board. All cowries in that square are removed.	A team draws a 2 of diamonds and rolls a 5 and 2. All the cowries located in the square in the 5th row, 2nd column are removed from the game.

RESOURCE 4: ADDITIONAL QUESTIONS FOR GAME ANALYSIS

Predators, recruitment, and reproduction are each represented by a different suit 2-10, but super predators, invasive species, and fungal infections are only a portion of the diamond suit. Why the difference? Use specific examples from the science research to justify your answer.

Why is the predator moves different from the super predator in the game? How does this difference in the game relate to the research? Use specific examples from the research to justify your answer.

How is reproduction different than recruitment in the game? How does this difference in the game relate to the science research? Use specific examples from the science research to justify your answer.

How is the invasive species different from the fungal disease in the game? How does this difference in the game relate to the science research? Use specific examples from the science research to justify your answer.

What is natural selection? How does this game demonstrate natural selection? Use specific examples from the game to justify your answer.

RESOURCE 5: SIMULATION BOARD GAME DEBRIEF

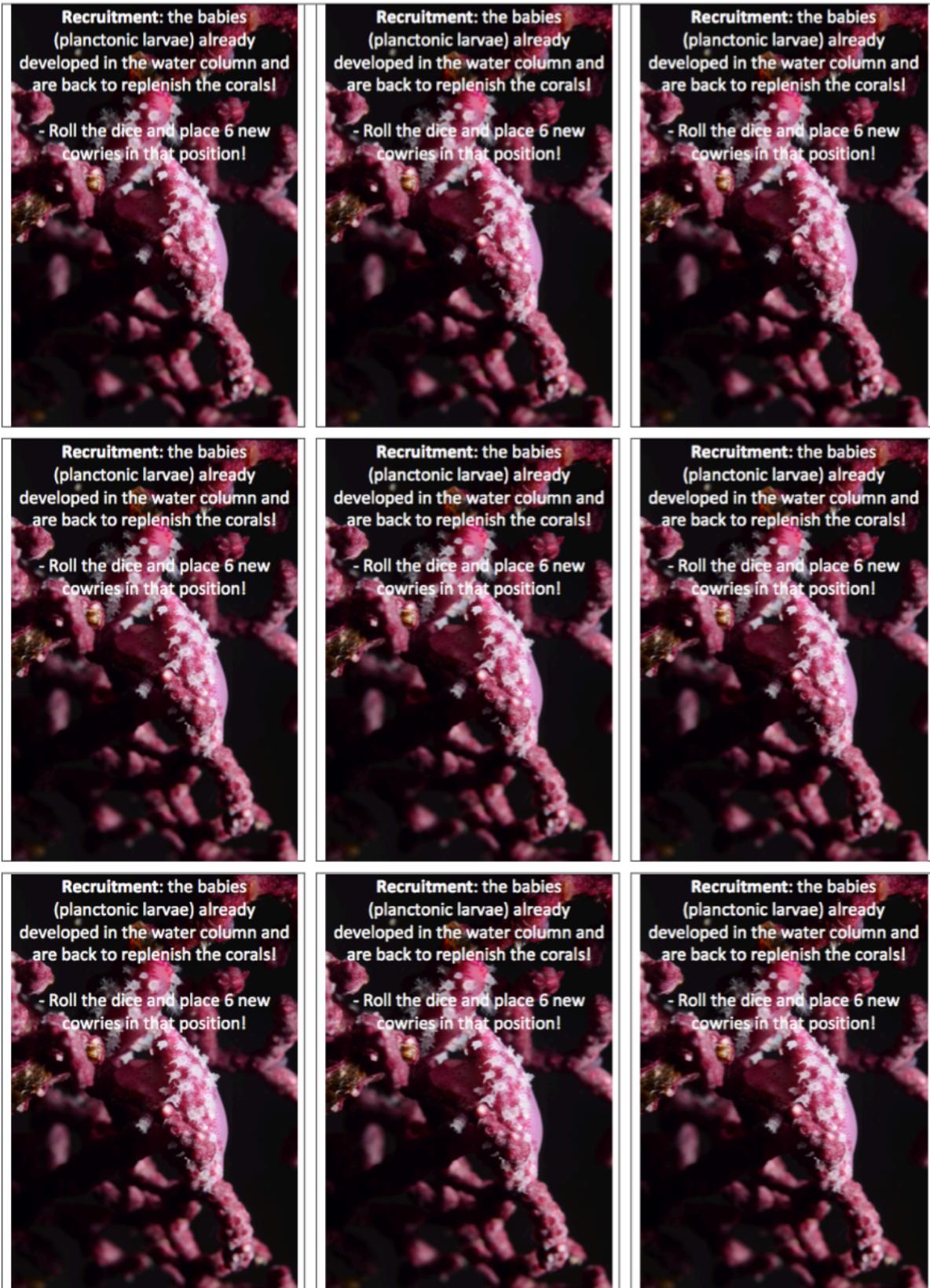
How did this simulation help your understanding of science concepts in this lesson?

How does the simulation game model the following science concepts?

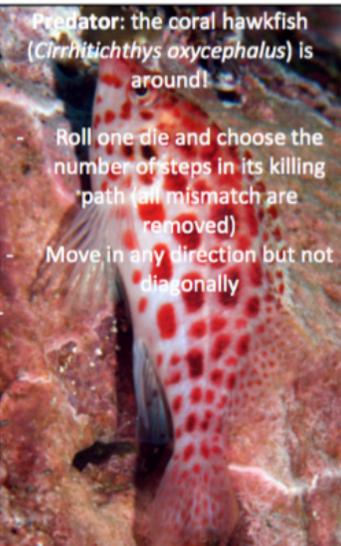
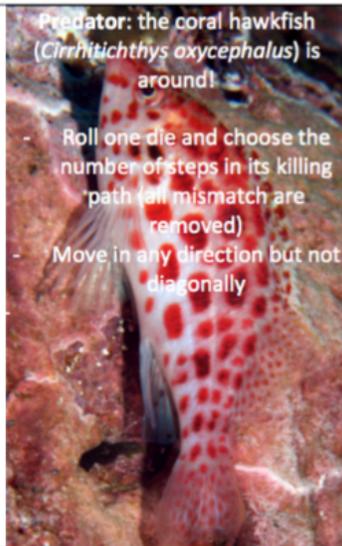
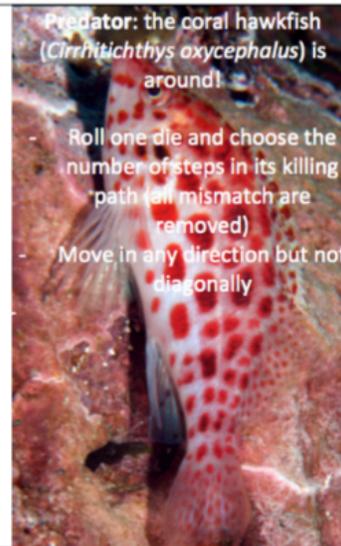
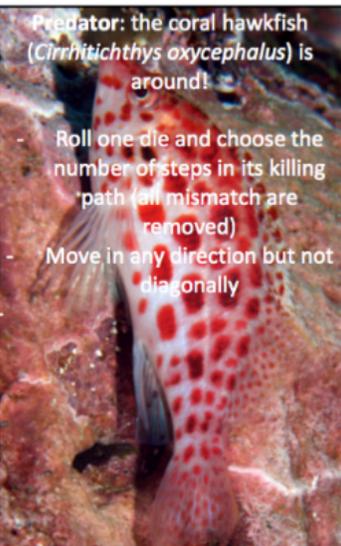
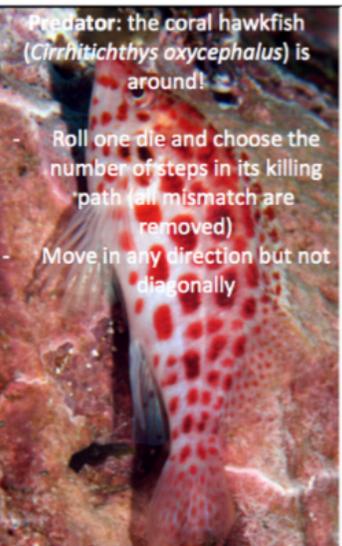
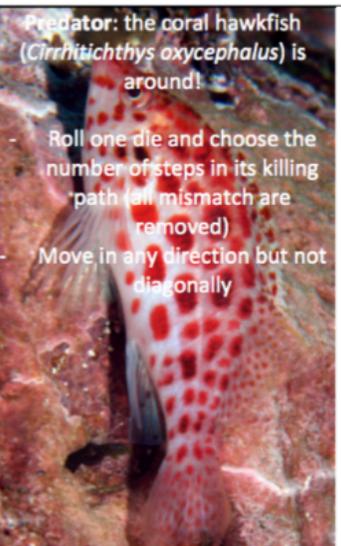
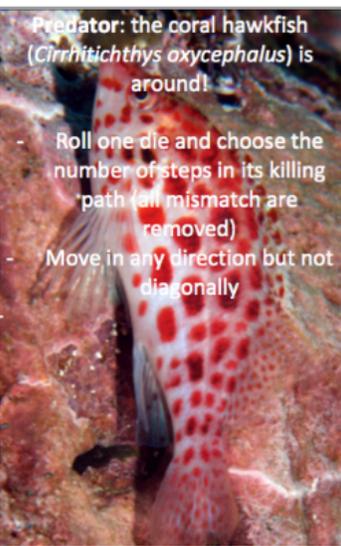
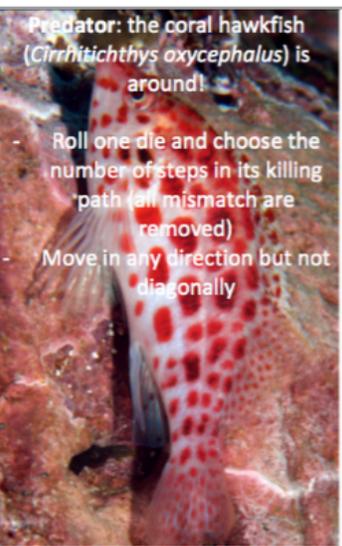
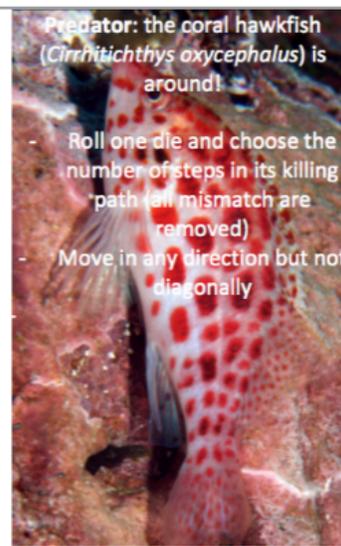
Models and simulations are used to represent but are not perfect examples. How does the simulation game NOT model the following science concepts?

Now It's Your Turn! How would you modify the game to improve or add more features that would make it more representative of this case study in nature?

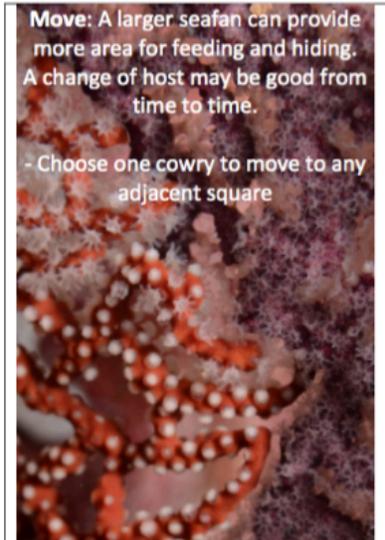
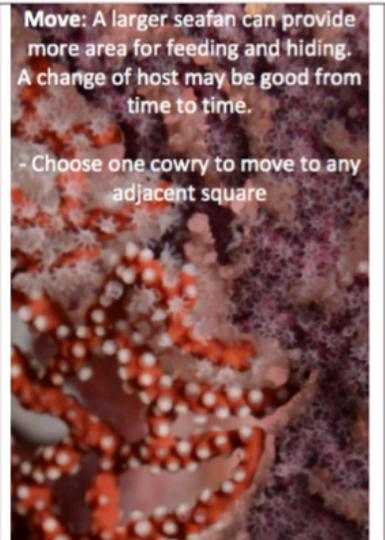
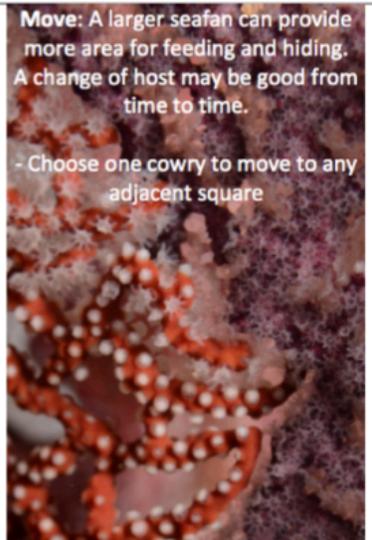
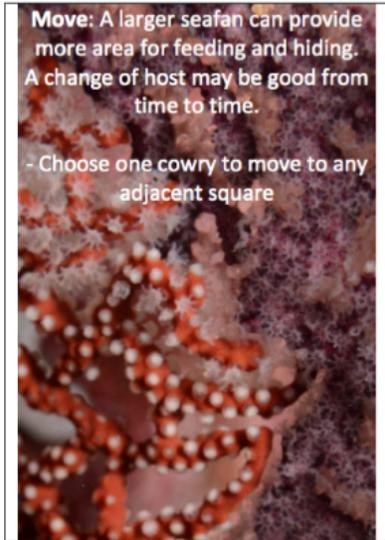
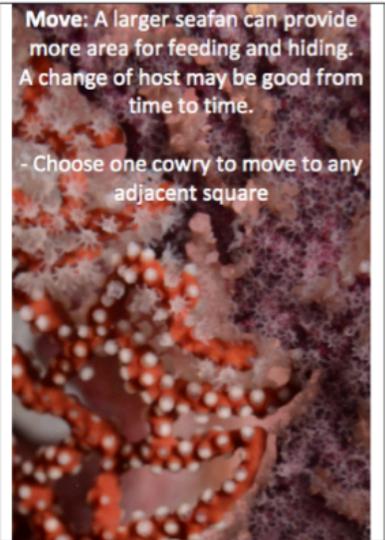
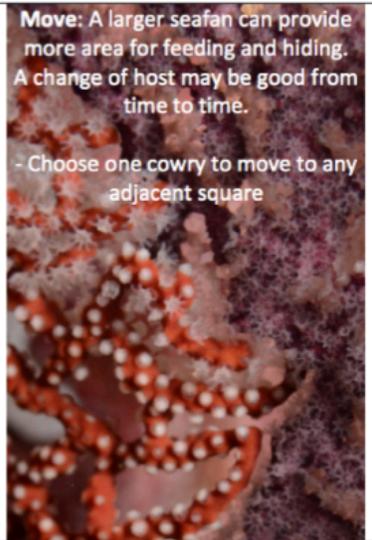
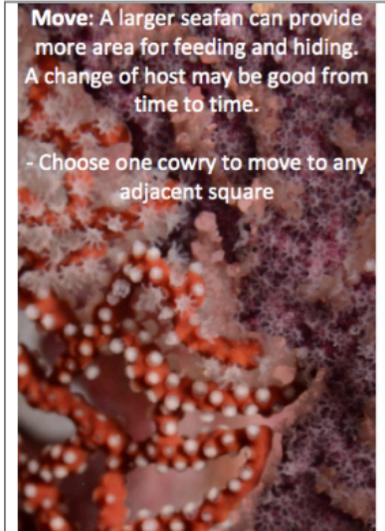
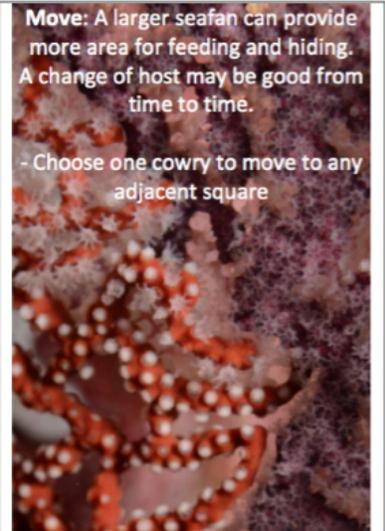
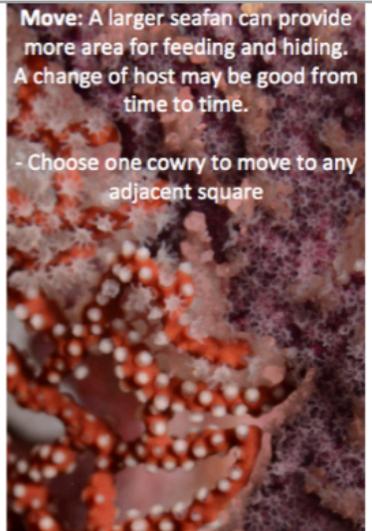
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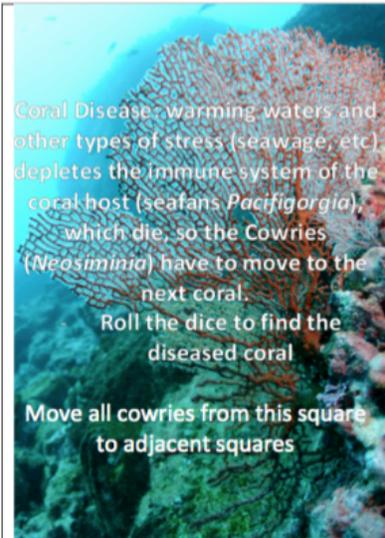


Resource 6 continued

 <p>Predator: the coral hawkfish (<i>Cirrhitichthys oxycephalus</i>) is around!</p> <ul style="list-style-type: none">- Roll one die and choose the number of steps in its killing path (all mismatch are removed)- Move in any direction but not diagonally	 <p>Predator: the coral hawkfish (<i>Cirrhitichthys oxycephalus</i>) is around!</p> <ul style="list-style-type: none">- Roll one die and choose the number of steps in its killing path (all mismatch are removed)- Move in any direction but not diagonally	 <p>Predator: the coral hawkfish (<i>Cirrhitichthys oxycephalus</i>) is around!</p> <ul style="list-style-type: none">- Roll one die and choose the number of steps in its killing path (all mismatch are removed)- Move in any direction but not diagonally
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Resource 6 continued

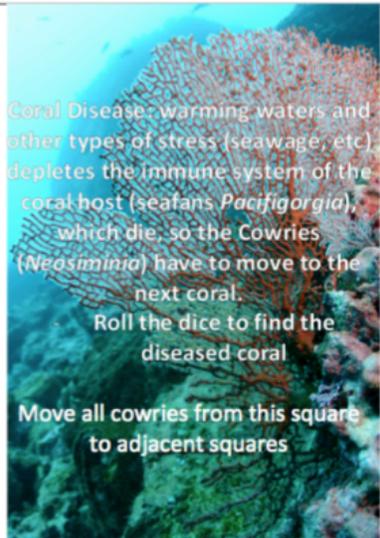
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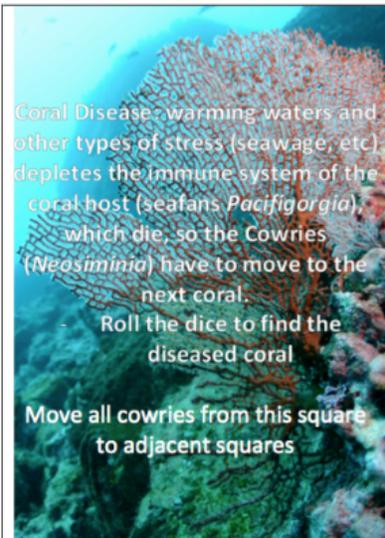
Coral Disease: warming waters and other types of stress (seawage, etc) depletes the immune system of the coral host (seafans *Pacifigorgia*), which die, so the Cowries (*Neosimonia*) have to move to the next coral.
Roll the dice to find the diseased coral
Move all cowries from this square to adjacent squares



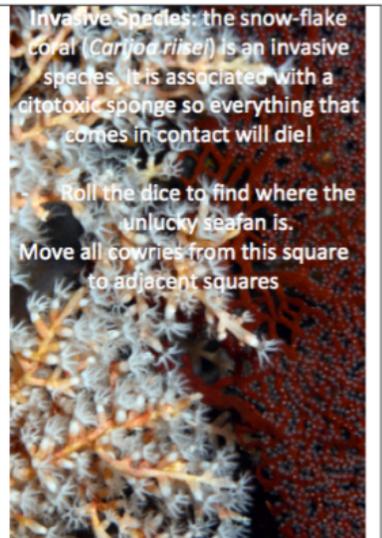
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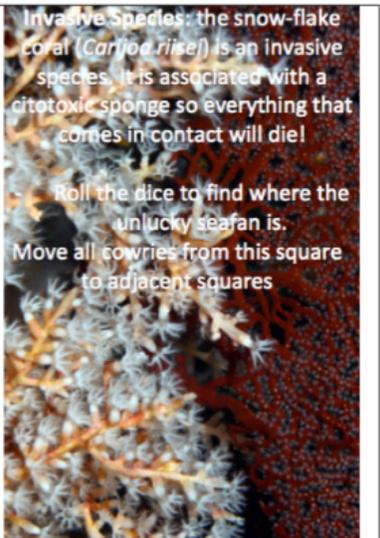
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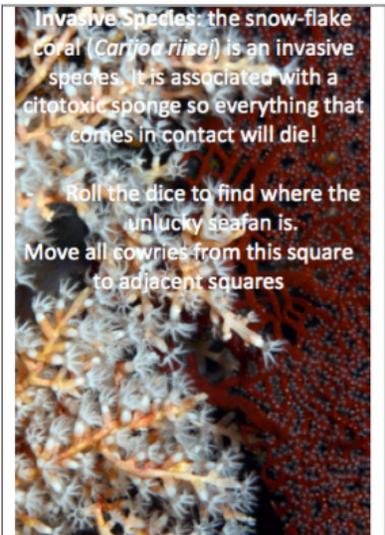
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Invasive Species: the snow-flake Coral (*Carloia riisei*) is an invasive species. It is associated with a cytotoxic sponge so everything that comes in contact will die!
Roll the dice to find where the unlucky seafan is.
Move all cowries from this square to adjacent squares



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The Masquerade game: To play the game we need two kinds of colored cowry-like pieces (e.g., beans and chickpeas, see image above), and two different toy-like pieces for two kinds of predators. Players choose a side (a seafan populations of specific color) and are given the same amount of "cowries" (6) to start with. The game begins with each player drawing cowries randomly (with no control over which color) and ends when only one color remains (the winner) or when one seafan has been completely colonized by the cowries of matching color.

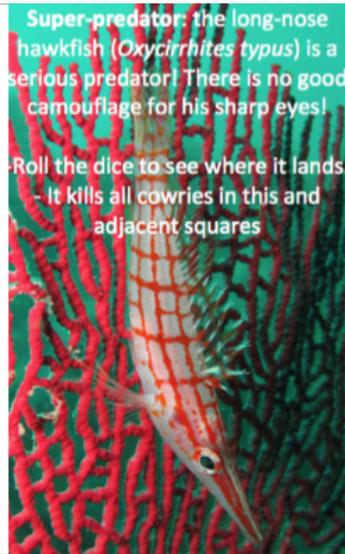
Events cards & dice: The cards are used to assign events in the population as well as dice to specify the location if required (each dice for x or y axis of the board), except in the case of the predators, which had a physical presence on the board (the predator can not move diagonally).

The goal of the game is for each player to fill each and all of the squares of their color (Color 1 or color2) with at least one cowry of the color of their squares. There can be no more than six cowries in one particular square. Enjoy!

Resource 6 continued

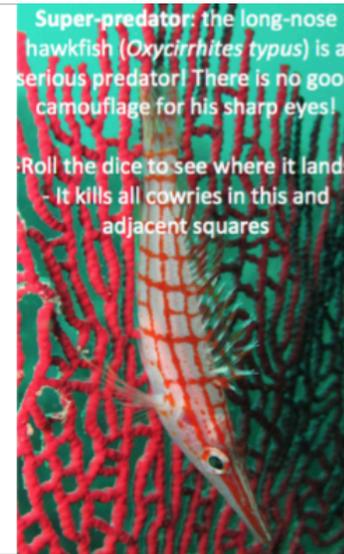
Super-predator: the long-nose hawkfish (*Oxycirrhites typus*) is a serious predator! There is no good camouflage for his sharp eyes!

Roll the dice to see where it lands.
- It kills all cowries in this and adjacent squares



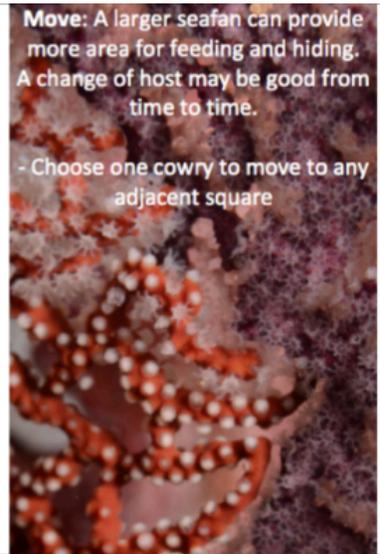
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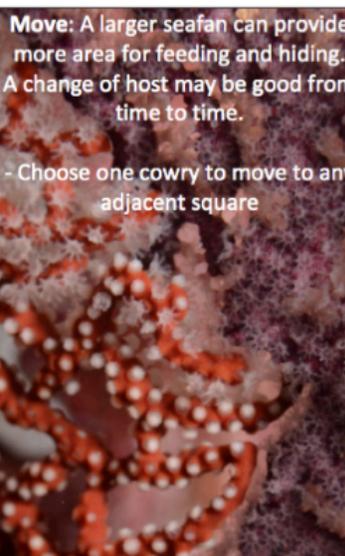
Move: A larger seafan can provide more area for feeding and hiding. A change of host may be good from time to time.

- Choose one cowry to move to any adjacent square



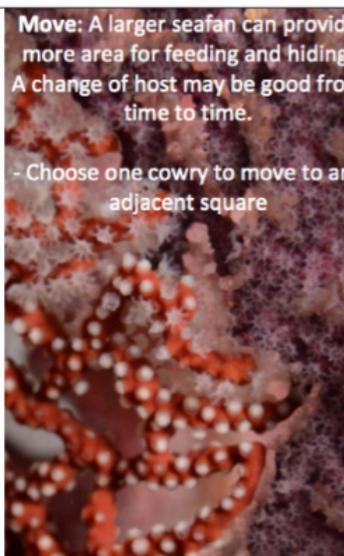
Move: A larger seafan can provide more area for feeding and hiding. A change of host may be good from time to time.

- Choose one cowry to move to any adjacent square



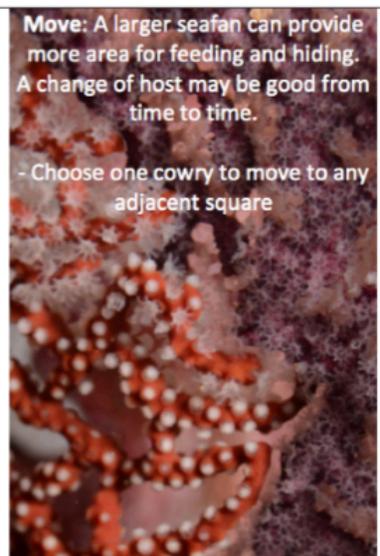
Move: A larger seafan can provide more area for feeding and hiding. A change of host may be good from time to time.

- Choose one cowry to move to any adjacent square



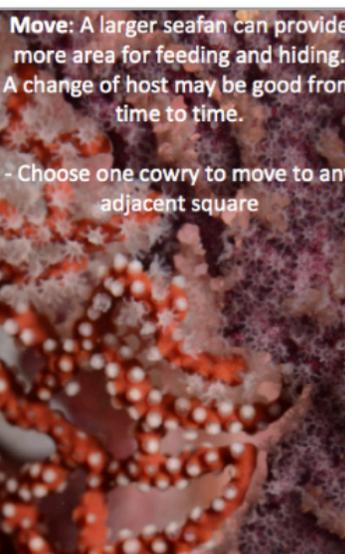
Move: A larger seafan can provide more area for feeding and hiding. A change of host may be good from time to time.

- Choose one cowry to move to any adjacent square



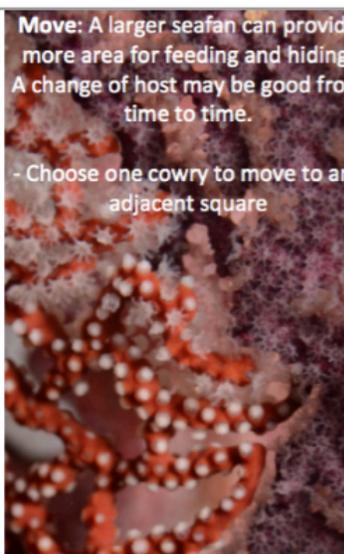
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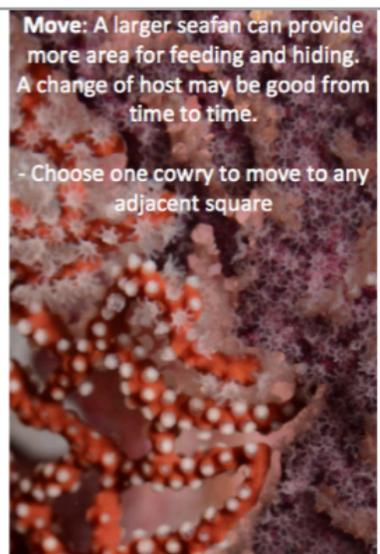
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Move: A larger seafan can provide more area for feeding and hiding. A change of host may be good from time to time.

- Choose one cowry to move to any adjacent square



RESOURCE 7: STUDENT OBSERVATION SHEET

Type of Play	Impact on Population Numbers	Impact on Distribution	Other Observations
Movement			
Predation			
Super predation			
Reproduction			
Recruitment			
Invasive Species			
Sea Fan Disease			
General Observations			