**ACTIVITY: Modelling marine stressors and tipping points**

**Activity idea**

In this activity, students research and identify marine stressors and play a game, similar to Jenga, to simulate how small changes and stressors can lead to an ecosystem tipping point.

By the end of this activity, students should be able to:

* use online resources to locate information about marine stressors
* provide simple explanations about how the stressors affect marine ecosystems
* create and play a game to model stressors and tipping points
* discuss how this game accurately (or inaccurately) represents a marine tipping point model
* discuss if/how marine tipping points can be reversed.

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**Background information for teachers**

New Zealand’s coastal ecosystems are the most multivalued, multiused and contested ecosystems in the country. As New Zealanders, we demand a lot from marine environments. At the moment, New Zealand is managing its marine resources at limits set by a single stressor in isolation such as sediment loading. We need to think about how we manage the ecosystem as a whole.

A tipping point is the point when a number of changes or incidents become significant enough to cause a large change in the way an ecosystem functions. This change is often rapid and results in the ecosystem becoming one of reduced value.

This activity encourages students to research and identify marine and coastal stressors that can potentially lead to a tipping point. Students use this knowledge to construct and play a game, similar to Jenga. Individual blocks represent individual stressors. Students continue to stress the ‘block ecosystem’ until it reaches a tipping point and collapses.

Tipping points are not always negative. Steps can be taken to rehabilitate ecosystems. New Zealand examples include the work to revive [toheroa](https://www.sciencelearn.org.nz/resources/1048-reviving-toheroa) in Northland and [mussels](https://www.sciencelearn.org.nz/videos/730-revive-our-gulf) in the Hauraki Gulf. These are ongoing, decades-long processes. It is better to effectively manage marine environments to avoid a tipping point than to reverse one.

***Materials required***

Use a Jenga game set if you have one available. Alternatives to Jenga blocks are Cuisenaire rods, building blocks or dominoes. Each block or rod must be the same size.

If you want to make a purpose-built game set, consider purchasing 3 m of 18 x 18 mm pine trim, cut to 6 cm lengths. This is enough to make 30 blocks at a minimal cost. Using your own blocks allows students to label the blocks with the individual stressors.

If desired, use removable stickers to number the ends of the blocks. The numbers correspond to stressors from the students’ lists or from the numbered stressors in the student instructions and can be removed after the activity.

Another option is to provide a hat or ice cream container from which students draw a stressor before removing a block.

**Teacher instructions**

1. Introduce the activity with the images [Kelp](https://www.sciencelearn.org.nz/images/1477-kelp) (a pristine habitat) and [Red tide](https://www.sciencelearn.org.nz/images/391-red-tide) (a coastal habitat affected by an algal bloom).
2. Discuss the concept of environmental stressors with references to the two images. Are there stressors we may be unable to see? How could we find out?
3. Have students use these suggested resources to find out about and list marine stressors:

* [Dynamic seas](https://www.sciencelearn.org.nz/resources/2581-dynamic-seas) – article
* [Ecosystem tipping points and stressors](https://www.sciencelearn.org.nz/resources/2579-ecosystem-tipping-points-and-stressors) – article
* [Investigating marine and coastal tipping points](https://www.sciencelearn.org.nz/resources/2580-investigating-marine-and-coastal-tipping-points) – article
* [Human impacts on marine environments](https://www.sciencelearn.org.nz/resources/144-human-impacts-on-marine-environments) – article
* [Human impacts on estuaries](https://www.sciencelearn.org.nz/resources/1231-human-impact-on-estuaries) – article
* [Estuaries and farmland run-off](https://www.sciencelearn.org.nz/resources/138-estuaries-and-farmland-run-off) – article
* [Oceans of rubbish](https://www.sciencelearn.org.nz/resources/2074-oceans-of-rubbish) – article
* [Pollution from Rena](https://www.sciencelearn.org.nz/resources/1138-pollution-from-rena) – article
* [Revive Our Gulf](https://www.sciencelearn.org.nz/videos/730-revive-our-gulf) – video
* [Reviving toheroa](https://www.sciencelearn.org.nz/resources/1048-reviving-toheroa) – article

1. Decide/discuss whether students will label the blocks with words/stressors or corresponding numbers. If you do not want to risk defacing the blocks, students can draw a stressor out of a container and read it out loud as they pull a block from the tower.
2. Play the game.
3. Discuss how the game acts as a model for marine tipping points. (A succession of stressors can lead to a quick ecosystem change.)
4. Discuss how the game may be inaccurate as a model. For example, in the game, the stressors all have equal weighting. In real life, some stressors may have more dire consequences than others.
5. After playing the game once or twice, extend student thinking by asking which stressors might have more significant impacts. For example, removing too many mussels may lead to reduced water quality/clarity, which then can lead to loss of plant life, which then leads to loss of animal biodiversity and so on. Students can rank the stressors and set up the game with highly ranked stressors at the bottom of the ecosystem tower.
6. Tipping points are not always negative. Brainstorm positive actions that may help to tip the ecosystem back to one that is more valuable, for example, the work of Revive Our Gulf to restore mussel beds, councils upgrading sewerage systems, reducing intensified farming, restoring wetlands and so on.

NOTE: If the alternative or home-made blocks don’t stack or slide easily, alter the game rules. Students can stack the blocks, one by one, until the tower becomes unstable and topples over.

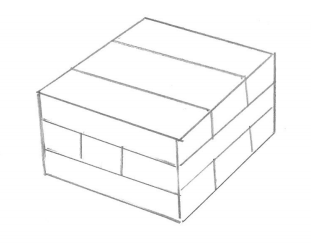
**Student instructions**

***Listing marine stressors***

This is a list of things we think stress the marine environment. (When you are finished, check your stressors with those listed on the following page. Are there some you missed out? Are there some we forgot to add?)

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|  |

***Creating and playing the game***

* + - 1. Choose the number of blocks you want to use. The game is most effective with between 15–30 blocks. The ecosystem tower works best if you build it in multiples of 3 blocks.
      2. Decide whether you will use stressors from your own list or those listed on the following page.
      3. If you use your own stressors, add corresponding numbers.
      4. Decide whether you will label the blocks with words, corresponding numbers or draw stressors from a hat.
      5. Label the blocks with words, numbered stickers or cut up the stressors and put them in a hat or other container.
      6. Set up the game. Lay 3 blocks side by side. Add a layer of three blocks, perpendicular to the blocks underneath. Continue to layer the blocks.
      7. One person removes one of the blocks from the tower. Touch only the block. Try not to use your other hand to steady the ecosystem tower.
      8. Read out the information on the label, corresponding number or stressor drawn from the hat.
      9. Discuss how this stresses the marine environment and whether anyone in the group has experienced the stressor or knows of it happening in New Zealand.
      10. Place the block on top of the tower.
      11. Take turns removing a block and discussing the stressor until the ecosystem tower collapses.

**Marine stressors**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **1**  Ocean acidification affects how shellfish grow and develop | **2**  Offshore marine accidents cause oil spills and other types of contamination | **3**  Taking too many pipi (or other shellfish) from an area depletes stocks | **4**  Excess nutrients lead to algal blooms, making it unsafe to swim | **5**  Removal of mangroves to enhance sea views affects coastal habitats and ecosystem services |
| **6**  Warming water temperature due to climate change encourages algal growth | **7**  Plastics fragment but do not biodegrade so quantities in the seas are growing | **8**  Agricultural run-off carries nutrients like nitrogen from the land to the sea | **9**  Sediments from land clearance cloud the water, reducing light for photosynthesis | **10**  Draining estuaries for urban or agricultural purposes reduces coastal habitats |
| **11**  Sea level rise can impact estuary and coastal habitats | **12**  Fish stocks are reduced due to overfishing | **13**  Sewage mixes with stormwater and drains out to the sea | **14**  Sediments from slips increase water turbidity | **15**  Overharvesting of mussels means less food for snapper |
| **16**  Melting ice shelves dilute seawater with freshwater and alter habitat conditions | **17**  Intensive aquaculture reduces natural habitats and adds extra nutrients | **18**  Horticultural run-off carries nutrients like phosphorus from the land to the sea | **19**  Agricultural intensification leads to increased nutrient run-off to waterways and estuaries | **20**  Removing crayfish allows kina to overgraze kelp beds |
| **21**  Dredging to deepen a harbour increases turbidity | **22**  Bottom trawling fishing disturbs the seafloor and can destroy habitat | **23**  Sediments and nutrients wash into an estuary, triggering mangrove growth | **24**  Phytoplankton blooms die and deplete oxygen supplies for marine species | **25**  Introduced marine species lead to a loss of native marine biodiversity |
| **26**  Trawling catches targeted and non-targeted fish species | **27**  Heavy metals and other wastes enter marine food webs, affecting kaimoana | **28**  Extracting sand for construction of roads, making concrete or for export affects habitats | **29**  Bridges, stopbanks and other structures isolate or restrict the movement of coastal animals | **30**  Dams for irrigation or electricity generation affect amounts of freshwater entering estuarine habitats |