

# Intertidal, Subtidal and Beach Ecosystems

The Lesson Plan and Nature-based activities  
were developed by Dr. Aspa D. Chatziefthimiou

Edited by Ruba Hinnawi



# Intertidal, Subtidal and Beach Ecosystems

## The Lesson Plan and Nature-based activities

November 2023

### Acknowledgment to the Earthna Center

Earthna, a Center for a Sustainable Future, is a Qatar Foundation center aimed to provide a holistic view of environmental, social, and economic prosperity as part of Qatar's ambition to enhance sustainability at the national and global levels. Earthna leverages Qatar Foundation's unique ecosystem of experts in research, academia, and innovation and collaborates with leading international institutions to enhance the depth and breadth of Qatar's sustainability efforts.

The vision of Earthna is to develop sustainable societies in arid and water-scarce environments. Its mission is to support sustainability by advocating evidence-based policy action, encouraging behavioral change in the community, and positioning Qatar as a leading voice for sustainability issues in arid and water-scarce environments.

For more information about Earthna and to stay updated on our latest initiatives, please visit [www.earthna.qa](http://www.earthna.qa)

## Report Team

### Dr. Aspa D. Chatziefthimiou

Doha, Qatar

### Ruba Hinnawi

Qatar Foundation, Earthna  
Doha, Qatar

## Editorial board

### Dr. Gonzalo Castro de la Mata

Qatar Foundation, Earthna  
Doha, Qatar

### Sebastien P. Turbot

Qatar Foundation, Earthna  
Doha, Qatar

### Dr. Alexandre Amato

Qatar Foundation, Earthna  
Doha, Qatar

### Nihal. Mohamed Al-Saleh

Qatar Foundation, Earthna  
Doha, Qatar

### Dr. Mona Matar Al-Kuwari

Qatar Foudation, Earthna  
Doha, Qatar

© Earthna 2023

P.O. Box: 5825, Doha, Qatar

Telephone: (+974) 4454 0242; internet: [www.earthna.qa](http://www.earthna.qa)

PI: EEF-2023-003



**Open Access.** This report is licensed under the terms of the Creative Commons Attribution-Noncommercial-No Derivatives 4.0 International License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits any noncommercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if you modified the licensed material. You do not have permission under this license to share adapted material derived from this report or parts of it.

The publisher, the authors, and the editors are safe to assume that the advice and information in this report are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained here in or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.



## Task 1: Before-you-begin

### Introduction

## Task 2: In-class Activities

### 6-9 Years

- Introduction
- Environmental Review
- Action Plan
- Resource

### 10-13 Years

- Introduction
- Environmental Review
- Action Plan
- Resource

### 14-17 Years

- Introduction
- Environmental Review
- Action Plan
- Resource

## Task 3: Nature-based Activities

### 6-9 Years

- Introduction
- Environmental Review
- Action Plan
- Resource

### 10-13 Years

- Introduction
- Environmental Review
- Action Plan
- Resource

### 14-17 Years

- Introduction
- Environmental Review
- Action Plan
- Resource



## Task 1

# Ecosystems: Intertidal, subtidal and beach Before-you-begin

# Task 1: Before-you-begin



**Surrounding the shorelines of the Gulf are subtidal, intertidal and beach ecosystems. Their physical appearance (how they seem in your eyes and how they feel in your hands) depends on the force and frequency of the tides, as well as on the kinds of particles that tides pick up and deposit in place. Intertidal are shallow ecosystems, between the high and low levels of the tide, which experience two daily cycles of wetting and drying (hydration/desiccation), the intense radiation of the sun, and extreme salinity caused by hot temperatures and seawater evaporation. Subtidal ecosystems are always flooded because they sit below the level of the tide, and together with beaches, found above the high tide level, they sandwich the intertidal on either side.**

As with the other ecosystems of the Gulf, where communities of organisms thrive despite extreme conditions, here too, one can find a colorful community with its own set of adaptations to the set of tidal extremes. A very successful behavioral adaptation to desiccation is burrowing (making holes/homes in the sediment/sand) in deeper, moister depths. Swimming crabs are masters in digging up burrows and pushing off sand with their claws, not only to make their home in, but to quickly hide themselves from lurking predators like herons.

Vertical movement is also used by photosynthetic cyanobacteria in microbial mats that most lushly line the intertidal and subtidal areas of Khor Al Adaid. This movement can only be perceived by time-lapse microscopy, where cyanobacterial filaments move in any each direction to find optimum light and oxygen levels, and to untrap themselves from sand particles brought on by the tide. Cyanobacteria also produce a dark pigment called scytonemin, similar to our sun-screen lotions, which helps protect them from the rays of the sun at low tide.

Gastropods (sea snails) of many species,

that feed on microbial mats as part of their diet, perform horizontal migration, which is again in sync with the tidal cycle. Every day they migrate towards the water as the tide moves away and toward the shore when the tide rises. This back and forth is cued by the wetting of the sediment, as well as by the acoustic shock and change in hydrostatic pressure caused by tides. Other organisms commonly found in the tidal ecosystems are damsel flies, hermit crabs, oysters, schools of fish, seabirds and sometimes even rays, baby sharks and sea snakes.

Plants that may be encountered there are mangroves, the succulents *Suaeda maritima* and *Arthrocnemum macrostachyum* among others, while pockets of seagrasses may also be observed.

Beaches are inhabited by burrowing ghost crabs, equipped with magnificent periscopic eyes that extend upward from their heads, as well as with sandhoppers, greater hoopoe larks, nightjars, sand geckos and others. Hawksbill turtles also visit sandy beaches to lay their eggs in the summer months. Mangroves may also be seen at the beach break, below desert hyacinths,

*Tamarix passerinides*, *Aeluropus lagopoides*, and the grass *Halopyrum mucronatum*, the latter three known for their ability to create phytogenic sand dunes by entrapping sand in their roots.



Photo Source: Shutterstock

**Threats:** Un-managed recreational activities that lead to plastic pollution and noise pollution, namely from jet skis and boats, pose a threat to the health of these ecosystems and to the organisms that they support. Vehicular movement across these ecosystems leads to plant and animal loss, while coastline development and climate change induced phenomena pose a threat due to habitat loss.



**Al-Maslamani et al. 2015.**

Baseline monitoring gastropods in the intertidal zone of Qatar - target species and bioindicators for hyper-thermic and hyper- saline conditions. International Journal of Research Studies in Biosciences. 3(12): 62-72.

**Al-Shirhan et al. 2022.**

Birds of the Middle East. A photographic guide. Bloomsbury Publishing: London.

**Butler JD, et al. 2020.**

A high-resolution remotely sensed benthic habitat map of the Qatari coastal zone. Marine Pollution Bulletin. 160: 111634.

**Foster JS, et al. 2009.**

Molecular and morphological characterization of cyanobacterial diversity in the stromatolites of Highborne Cay, Bahamas. The ISME Journal. 3: 573-587.





**Ghazanfar SA and Fisher M. 1988.**

Vegetation of the Arabian Peninsula. Springer Science+Business Media Dordrecht.

**Kohan A, et al. 2012.**

The Gastropod Fauna along the Bushehr Province  
Intertidal Zone of the Persian Gulf. Journal of the Persian Gulf. 3(9): 33-42.



Task 2

# Eco-schools 6-9 Years

# Introduction:



These are the ecosystems most affected by the tidal flood, ever changing them four times within one day. Life here exists on the surface and deep in the ground, an adaptation of avoidance to the combined extremes of solar radiation, heat, and cycles of desiccation/hydration. Birds, snails and crabs may be the most visible inhabitants, yet it is the almost imperceptible microbes that may be the most unique. The stromatolite structures they build, one layer at a time, are found in only two other places in the world: Shark Bay, Australia and Highbourne Cay in the Bahamas.

Currently astro-biologists, are looking for these microbial structures, when searching for signs of life on other planets.

The lesson plan familiarizes the students with the intertidal, subtidal and beach ecosystems, the inter-connections, behaviors and adaptations of their biodiversity.

The learning process includes exchanging of information on the topic, classroom interaction, brainstorming and role play.

**Age Group:** Eco-Schools 6-9 years

**Eco-Schools Steps:** Environmental Review, Action Plan, Curriculum Linkages, Inform and Involve, Monitoring and Evaluation



## Objectives:

Students will be able to:

- Describe the intertidal, subtidal and beach ecosystems, and list threats
- Search online for information on the biology and ecology of crabs
- Brainstorm ideas of why each crab has unique anatomical features and connect these adaptations to habitat
- Illustrate and impersonate animal behaviors for art and to raise awareness
- Develop positive actions for the protection of intertidal, subtidal and beach ecosystems

## Time required/ Duration:

**Classroom Session 1:** 45 minutes

(25 minutes to guide the students in conducting their online search, to facilitate them in answering the questions in their worksheet and to brainstorm on what makes each crab species unique, 15 minutes to help students with the role play, and 5 minutes to devise positive actions for ecosystem protection). (Multiple groups work simultaneously). It is left up to the facilitator's discretion to expand the timings as needed to allow students to better assimilate the information and to properly devise positive actions.

# Environmental Review:

Photo Source: Raviv Cohen

## Resources Required: “Before-you-begin”: Intertidal, subtidal, and beach ecosystems.

Key concepts: overview of the Intertidal, subtidal, and beach ecosystems with a focus on those found in the Arabian Gulf; physical formation; biodiversity; animal behavior; salinity; adaptations; threats.

### Online Resources



- Brainstorm with the students, ideas on why this ecosystem is important, how and which human activities threaten the health of this ecosystem, and what we can do to help protect intertidal, subtidal, and beach ecosystems.

- Resource 1 (Crab Crab Profile Worksheet)
- Resource 2 (Crab Sketch Sheet)
- Student notebooks, pencils, and colored markers
- Dedicated display board

# Action Plan:



## Action Plan 1

- Screen the Cape Cod National Seashore “The Intertidal Zone” short film
- Discuss with the students the ways in which crabs fit in to the overall community of organisms in this ecosystem, what are some threats that these organisms and the coasts are facing.
- Brainstorm with the students why each crab has distinct features, what is the advantage of such uniqueness? Explain that these features allow them to occupy different habitats within the ecosystem and take advantage of different resources.

## Action Plan Activity 1

- Divide the student into groups of 3-5 members, according to the crab species they want to research on and impersonate, out of the choices in Question 1 of Worksheet 1 (Resource 1).
- Guide the students in navigating their online search to answer the questions in Worksheet 1.
- Facilitate the sharing of each group’s results, while creating a whiteboard on the whiteboard. The students can take a photograph of the whiteboard for their records, or it can be taken and later distributed by the facilitator.

## Action Plan Activity 2

- Have the students play the crab theater. Students can show and tell different crab behaviors: walking, digging, feeding, taking cover etc. Students may also assume each a role of the overall community that crabs belong to, and impersonate a plant, or a predator, or another co-existing species.
- At the facilitator’s discretion and time budget management, the students can be asked to draw their crab of choice or all of them using the Crab Sketch Sheet (Resource 2), as a group or individually.

# Action Plan:



## Action Plan 2

- Use Victorian Fisheries Authority's "50 Ways to Care for Our Coast"

to showcase and provide ideas to the students of the possible positive actions they can take individually and as a school to protect intertidal, subtidal, and beach ecosystems.

## Action Plan Activity 2

- Ask the students to list one action they can take individually and as a school to help protect intertidal, subtidal, and beach ecosystems and their inhabitants in Qatar.

**3. Curriculum Linkages:** Environmental Science, Ecology, Art&Craft

### 4. Inform and Involve

- Student sketches should be displayed on the Eco-Schools bulletin board to inform and involve the whole school community.

### Evaluation:

Evaluate the students' understanding of crab biology, adaptations, and behavior during the role play.



## Crab Profile Worksheet

Instructions: You have won the lottery to become a crab for a day. Please answer the questions below for your favorite crab and share your results with the class.

1. Which would you like to be out of the following ones we find in Qatar? a. Blue / swimming crab b. Violet crab c. Ghost crab	2. What color(s) are you?
3. Where are your eyes located on your body?	4. How does your pincher look like?
5. How do you walk?	6. Where do you build your home?
7. How do you build your home?	8. What other animals and plants do you see around you?
9. Who is your predator?	10. What do you do during high tide? Is it different from what you do during low tide?



## Crab Sketch Sheet

**Name(s) of student(s) in the team:**

**Instructions:** use the space below to draw your favorite crab, or all of them!





Task 2

# Eco-schools 10-13 Years

# Introduction:



These are the ecosystems most affected by the tidal flood, ever changing them four times within one day. Life here exists on the surface and deep in the ground, an adaptation of avoidance to the combined extremes of solar radiation, heat, and cycles of desiccation/hydration. Birds, snails and crabs may be the most visible inhabitants, yet it is the almost imperceptible microbes that may be the most unique. The stromatolite structures they build, one layer at a time, are found in only two other places in the world: Shark Bay, Australia and Highbourne Cay in the Bahamas. Currently astro-biologists, are looking for these microbial structures, when

searching for signs of life on other planets.

The lesson plan familiarizes the students with the intertidal, subtidal and beach ecosystems, how they were created, and the inter-connections, behaviors and adaptations of their biodiversity.

The learning process includes researching information pertaining to the topic, class interaction, brainstorming, and communicating the topic in artform.

**Age Group:** Eco-Schools 10-13 Years

**Eco-Schools Steps:** Environmental Review, Action Plan, Curriculum Linkages, Inform and Involve, Monitoring and Evaluation



## Objectives:

Students will be able to:

- Describe the intertidal, subtidal and beach ecosystems, and list threats
- Explain how dunes are created
- Brainstorm on ideas of adaptations to life in the sand
- Illustrate the community of organisms in habitats of the dune ecosystem as a means of raising awareness

## Time required/ Duration:

**Classroom Session 1:** 45 minutes

[5 minutes to screen the film, 10 minutes to introduce the students to the ecology of this habitat, and brainstorm on adaptations and threats, 25 minutes to facilitate students' drawing, and 5 minutes to devise positive actions for ecosystem protection]. It is left up to the facilitator's discretion to expand the timings as needed to allow students to better assimilate the information and to properly devise positive actions.

# Environmental Review:

Photo Source: Raviv Cohen

## Resources Required: “Before-you-begin”: Intertidal, subtidal, and beach ecosystems.

Key concepts: overview of the intertidal, subtidal, and beach ecosystems with a focus on those found in the Arabian Gulf; physical formation; biodiversity; animal behavior; salinity; adaptations; threats.

- Online source at the discretion of the facilitator, showcasing how dunes are formed and the organisms that inhabit the beach dune habitat.

## Online Resources

- Brainstorm with students ideas on why this ecosystem is important, how and which human activities threaten the health of this ecosystem, and what we can do to help protect intertidal, subtidal, and beach ecosystems.
- Resource 1 (Dune Ecology and Threats Sketch Sheet)
- Student notebooks, pencils, and colored markers
- Dedicated display board



# Action Plan:



## Action Plan 1

- Screen the film from the choices above, showcasing how marine dunes are created through physical forces of water, wind, etc.
- Explain to the students how plants also help the development of dunes by trapping sand in their roots. Sometimes these are called “phytogenic mounds”.
- Introduce the students to the plant and animal communities we find in Qatar in the beach ecosystem and around dunes.
- Brainstorm with the students on ideas of adaptations to life in the sand, like burrowing, nocturnal behavior, etc.
- Screen CARO’s film “Sand Dune: how we can damage them”

to showcase the threats that this ecosystem is faced with.

## Action Plan 2

- Use Victorian Fisheries Authority’s “50 Ways to Care for Our Coast”

to showcase and provide ideas to the students of the possible positive actions they can take individually and as a school to protect intertidal, subtidal, and beach ecosystems.

## Action Plan Activity 1

- Provide the students with the Dune Ecology and Threats Sketch Sheet (Resource 1).
- Ask the students to draw a variety of organisms inhabiting this ecosystem, representing flora, fauna, and microbes, at the specific habitat we would find them. For example, the ghost crab burrowing on the beach, etc.
- Ask the students to draw in some of the threats in their sketch.
- Facilitate the students with building/ drawing the community of their choice, as well as the threats faced.

## Action Plan Activity 2

- Ask the students to list one action they can take individually and as a school to help protect intertidal, subtidal, and beach ecosystems and their inhabitants in Qatar.

**3. Curriculum Linkages:** Environmental Science, Ecology, Art&Craft

### 4. Inform and Involve

- Student drawings should be displayed on the Eco-Schools bulletin board to inform and involve the whole school community.

### Evaluation:

Conduct a pop quiz to assess students’ understanding on the forces that help dunes develop. Review the students Sketch Sheets to determine their level of understanding when it comes to dune community and habitat utilization.



## Dune Ecology and Threats Sketch Sheet

**Name of student:**

**Instructions:** use the space below to draw a variety of organisms inhabiting this ecosystem, representing flora, fauna, and microbes, at the specific habitat we would find them. Please include some of the threats that these organisms and their habitats experience.



Task 2

# Eco-schools 14-17 Years

# Introduction:



These are the ecosystems most affected by the tidal flood, ever changing them four times within one day. Life here exists on the surface and deep in the ground, an adaptation of avoidance to the combined extremes of solar radiation, heat, and cycles of desiccation/hydration. Birds, snails and crabs may be the most visible inhabitants, yet it is the almost imperceptible microbes that may be the most unique. The stromatolite structures they build, one layer at a time, are found in only two other places in the world: Shark Bay, Australia and Highbourne Cay in the Bahamas. Currently astro-biologists, are looking for these microbial structures, when

searching for signs of life on other planets.

The lesson plan familiarizes the students with the intertidal, subtidal and beach ecosystems, their biodiversity, the biology and conservation status of the hawksbill sea turtle, as well as education as a part of conservation.

The learning process includes researching information pertaining to the topic, class interaction, group work, brainstorming, communicating and amplifying conservation through social media campaigns.

**Age Group:** Eco-Schools 14-17 Years

**Eco-Schools Steps:** Environmental Review, Action Plan, Curriculum Linkages, Inform and Involve, Monitoring and Evaluation



## Objectives:

Students will be able to:

- Describe the intertidal, subtidal, and beach ecosystems, and list threats
- Explain why education is a major component of sound conservation
- Identify conservation programs for sea turtles
- Make associations between organisms and different ecosystems in the Arabian Gulf and the world
- Conceptualize and develop social media campaigns to raise awareness

## Time required/ Duration:

**Classroom Session 1:** 45 minutes

(5 minutes to screen the film, 35 minutes to brainstorm ideas for social media campaign development and species-habitat pairs, and 5 minutes to devise positive actions for ecosystem protection). It is left up to the facilitator's discretion to expand the timings as needed to allow students to better assimilate the information and to properly devise positive actions.

# Environmental Review:

Photo Source: Raviv Cohen

## Resources Required: “Before-you-begin”: Intertidal, subtidal, and beach ecosystems.

Key concepts: overview of the intertidal, subtidal, and beach ecosystems with a focus on those found in the Arabian Gulf; physical formation; biodiversity; animal behavior; salinity; adaptations; threats.

### Online Resources



- Brainstorm with the students ideas on why this ecosystem is important, how and which human activities threaten the health of this ecosystem, and what we can do to help protect intertidal, subtidal, and beach ecosystems.
- Student stationary, pencils, colored markers
- Dedicated display board



# Action Plan:



## Action Plan 1

- Use the available resources to showcase to the students the physical and ecological (including flora and fauna) attributes of the intertidal, subtidal, and beach ecosystems in Qatar.
- Screen the IUCN Red List film

to familiarize students with IUCN's work on species and nature conservation.

- Help students understand that education is always a big part of any conservation program for a given species and its habitat.
- Visit the IUCN Hawksbill turtle page

to showcase to the students the types of information compiled for this species.

- Visit

to make the students aware of the local conservation effort for the hawksbill turtle.

## Action Plan Activity 1

- Ask the students to divide themselves into teams, each to conceptualize and develop content for "Conserve by Making People Aware" social media campaigns (2-3 posts per species), focusing on one species-habitat pair we find in intertidal, subtidal, and beach ecosystems in the Arabian Gulf. For example, the hawksbill turtle and the beach, or the intertidal and the heron, etc.
- Brainstorm with the students ideas of the topics to be covered. Topics can include predators and prey; migrations through ecosystems: nesting and feeding grounds; threats and conservation status; conservation actions in place and conservation needs.
- Use the IUCN Red List to extract information needed to develop the content.

# Action Plan:



## Action Plan 2

- Use Victorian Fisheries Authority's "50 Ways to Care for Our Coast"

to showcase and provide ideas to the students of the possible positive actions they can take individually and as a school to protect intertidal, subtidal, and beach ecosystems.

## Action Plan Activity 2

- Ask the students to list one action they can take individually and as a school to help protect intertidal, subtidal, and beach ecosystems and their inhabitants in Qatar.

**3. Curriculum Linkages:** Environmental Science, Ecology, Writing

### 4. Inform and Involve

- The posts and media campaign should go live on Eco-Schools' social media accounts and be displayed on the Eco-Schools bulletin board to inform and involve others in the school community and beyond.

### Evaluation:

Review the posts for the social media campaign to assess their knowledge of this ecosystem. Evaluate the effectiveness of the information presented and how compelling their writing is.