

Sabkha Ecosystem

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

Edited by Ruba Hinnawi

Sabkha Ecosystem

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

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

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

Ecosystem: Sabkha Before-you-begin

Task 1: Before-you-begin



The sabkha (plural - sabkhat) ecosystem usually creates an unmarked boundary separating the coastal marine environment, that it is a part of, from the terrestrial (land) environment. In some cases, we find sabkhat strewn amidst terrestrial ecosystems. We call these inland sabkhat, and in Qatar they are located in the west side of the country, from the tippy top of the Ras Brooq peninsula, all the way down to Umm Bab. Sabkha is, of course, an Arabic word, describing a salt or salt-encrusted flat, and since this ecosystem lines the coasts or inlands of many countries in drylands and hot deserts the world over, this term is used universally, not just in the Arabian Peninsula where its name was originated.

The morphology of the sabkha's surface (how it looks like) depends on the types and frequency of the waters that run through it, the particles and organisms that tidal-floods deposit on it, and on the atmospheric temperature. The highest salinity edge of the sabkha, usually receives subterranean (underground) seawater flow and low levels of rainwater. It is made out of sediment that, when one walks on it, feels like quick sinking sand. When water gets evaporated by the hot rays of the sun, white salt crystals are left behind, and only the hardiest microbes and no other organisms are able to survive. The Salt Lake in Utah, USA, has a similar look to our white sabkhat in Qatar and the Gulf.

In edges that only receive tiny amounts of rainwater, the sabkha is sandy, yellowish, and dry. The Gulf sand gecko may be the only reptile observed in the edges of sabkhat. Its swollen fingers and elongated spiny scales on the underside are thought to be direct adaptations to life in this

ecosystem. As we move towards areas that get tidal floods, the sabkha surface becomes darker and wavy but dry most of the time, and as we get close to the intertidal, the sabkha is lined with leathery-to-the-touch microbial mats. Seaweeds, phytoplankton, shrimp and other crustaceans are brought in by the tide, attracting many seabirds and migratory flamingos. This flamboyant bird is a filter feeder and gets its plumage coloration from the pigments of the shrimp and cyanobacteria it eats.

The community of the sabkha is notorious for its halophytes (plants growing in salt) like the succulents *Halocnemum strobilaceum*, *Halopeplis perfoliata*, and others, as well as for its sea lavender (*Limonium axillare*) and mangrove grass (*Aeluropus lagopoides*). Butterflies, ants, pseudoscorpions and spiders are some of the organisms that make up the insect community of the sabkha.



Photo Source: Shutterstock

Threats: Climate change induced phenomena pose a threat to the health of sabkha as an ecosystem and to the organisms that it supports. Destruction of this community of organisms by off-road driving and other un-managed recreational activities are major threats, as is coastline development.



Ahour MM.

2013. Sabkhas in Qatar Peninsula. Landscape and Geology. 1: 10-35.

Al-Shirhan et al. 2022.

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

Belnap J. 2002.

Biological Soil Crusts in the Arabian sabkha, in Sabkha Ecosystems: Volume I: The Arabian Peninsula and Adjacent Countries. Editors: H.-J. Barth, Benno Böer. Kluwer Academic Publishers. London.

Boer B and Al Hajiri S. 2002.

The coastal and sabkha flora of Qatar, in Sabkha Ecosystems: Volume I: The Arabian Peninsula and Adjacent Countries. Editors: H.-J. Barth, Benno Böer. Kluwer Academic Publishers. London.



Metallinou M et al, 2014.

Filling in the gap: two new records and an updated distribution map for the Gulf Sand gecko *Pseudoceramodactylus khobarensis* Haas, 1957. *Biodiversity Data Journal* 2: e4011.

Richer R. 2009.

Conservation in Qatar: impacts of increasing industrialization.
Center for International and Regional Studies, Georgetown University Publication.

A decorative graphic composed of several orange line-art shapes. At the top left, a curved line arches across the page. Below it, a line descends and then turns into a diagonal line pointing towards the top right. To the right of this is a large, empty circle. At the bottom right, there is a large, empty shape that resembles a stylized cup or a shield with a curved bottom edge.

Task 2

Eco-schools 6-9 Years

Introduction:



The sabkha is another ecosystem, in the coastal environment facing the same extremes as the inter-tidal. The sabkha, like the desert, is mistakenly believed to be barren, partly because the vegetation is not lush, and partly because most of the inhabitants lead a cryptic life or are camouflaged to blend in with the scenery, creating the illusion of life being absent. The trained eye can see the diverse organisms hosted in the sabkha and recognize the fragility of this ecosystem as it takes a long time to recover healthy functioning after a disturbance.

The lesson plan familiarizes the students with the sabkha ecosystem, and its biodiversity through the ecology and adaptations of the Gulf sand gecko.

The learning process includes exchanging of information on the topic, classroom interaction, visualization, and presenting this topic in artform.

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 sabkha ecosystem, and list threats
- Visualize the sabkha using their senses
- Explain the biology, ecology and adaptations of the Gulf sand gecko in the context of the sabkha
- Illustrate these and raise awareness

Time required/ Duration:

Classroom Session 1: 45 minutes

(5 minutes to screen the film, 10 minutes for the experiencing the sabkha with their senses, 25 minutes to discuss and show the Gulf sand gecko appearance and adaptations, and to facilitate the students' drawings of these, 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”:

Sabkha ecosystem

Key concepts: overview of the sabkha ecosystem with a focus on those found in the Arabian Gulf; formation of sabkha; biodiversity; nurseries; 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 sabkhat.
- Resource 1 (Gulf Sand Gecko Sketch Sheet)
- Student stationary, pencils, colored markers
- Dedicated display board

Action Plan:



Action Plan 1

- Screen the California Academy of Sciences “Life on the Salt Flats”
- Encourage students to understand the sabkha environmental conditions with their senses. Help them to visualize the colors. How does the students’ skin feel when it is dry and salty? etc.
- Use the Gulf sand gecko as a protagonist to introduce the students to the sabkha community of organisms, the threats they are faced by the community and the habitat.
- Display on the board the pictures in the online resource for the Gulf sand gecko in Qatar, to depict to the students how this lizard looks like, pointing to their anatomical adaptations. Encourage the students to visualize sabkha life through the eyes of the Gulf sand gecko.

Action Plan 2

- Use Salt Marsh Guide’s “What can you do”

to showcase and provide ideas to the students of the possible positive actions they can take individually and as a school to protect sabkhat.

Action Plan Activity 1

- Provide the students with Gulf Sand Gecko Sketch Sheet (Resource 1).
- Facilitate the students to draw the Gulf sand gecko in its natural environment. The students can draw and label the organisms the lizards eat, where they shelter, some of their predators etc.
- Facilitate the students to draw this lizard’s anatomical adaptations in close up view.

Action Plan Activity 2

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

3. Curriculum Linkages: Environmental Science, Ecology, Biology, Arts & Crafts

4. Inform and Involve

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

Evaluation:

Review the student sketches to assess their knowledge on the Gulf sand gecko’s biology, ecology and trophic interactions in the context of the sabkha. Evaluate their understanding of habitat-relevant adaptations.



Gulf Sand Gecko Sketch Sheet

Name of student

Instructions: use the space below to draw the Gulf Sand Gecko in its natural environment. Draw and label the organisms the lizards eat, where they shelter, some of their predators etc. With the help of your facilitator, draw this lizard's anatomical adaptations in close up view.

A decorative graphic composed of several orange line-art shapes. It includes a large curved line at the top left, a circle on the right side, and a shield-like shape at the bottom right.

Task 2

Eco-schools 10-13 Years

Introduction:



The sabkha is another ecosystem, in the coastal environment facing the same extremes as the inter-tidal. The sabkha, like the desert, is mistakenly believed to be barren, partly because the vegetation is not lush, and partly because most of the inhabitants lead a cryptic life or are camouflaged to blend in with the scenery, creating the illusion of life being absent. The trained eye can see the diverse organisms hosted in the sabkha and recognize the fragility of this ecosystem as it takes a long time to recover healthy functioning after a disturbance.

The lesson plan familiarizes the students with the sabkha ecosystem, its biodiversity, its extreme conditions and fragility, and ways to protect it.

The learning process includes researching information pertaining to the topic, class interaction, group work, creative writing, communicating the topic in a creative manner through the camping trip itinerary and protection guidelines.

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 sabkha ecosystem, and list threats
- Explain the process of seawater evaporation
- Describe the community and the extreme conditions in the sabkha
- Develop an itinerary and guidelines for the protection of nature
- Encourage exposure to nature and raise awareness

Time required/ Duration:

Classroom Session 1: 45 minutes

(5 minutes to screen the film, 5 minutes to explain to the students the gradients and evaporation, 5 minutes to encourage the students to take the sabkha virtual tour, 25 minutes to facilitate the students to come up with itineraries and guidelines for their camping trip, 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”:

Sabkha ecosystem

Key concepts: overview of the sabkha ecosystem with a focus on those found in the Arabian Gulf; formation of sabkha; biodiversity; nurseries; salinity; adaptations; threats.

Online Resources



- Brainstorm with students ideas on why this ecosystem is important, how and which human activities threaten the health of this ecosystem, as well as what we can do to help protect sabkhat.
- Resource 1 (Camping Trip Itinerary and Guiding Questions Worksheet)
- Student notebooks, pencils, and colored markers
- Dedicated display board

Action Plan:



Action Plan 1

- Screen the California Academy of Sciences “Life on the Salt Flats”
- Explain to the students this ecosystem’s gradient of salinity, from the terrestrial edge all the way to the coast, and how seawater evaporates leaving salt behind.
- Encourage the students to take a virtual tour with their imagination around the sabkha environment. Ask the students to describe the extreme conditions and the organisms they see there.
- Help students understand the threats of this fragile ecosystems.

Action Plan Activity 1

- Provide the student with the Camping Trip Itinerary and Guidelines Worksheet (Resource 1)
- Ask the students to divide themselves into teams, each to develop their own camping trip’s itinerary and dos and don’ts.
- Give the students the following instruction for this activity:
Your parents announce a camping trip near a sabkha, and they assign you the organizer of the trip - based on what you know about this ecosystem, its fragility, and the organisms that live there, where would you take them? How would you prepare for the trip?
- Facilitate the students to come up with the itineraries and guidelines.

Action Plan:



Action Plan 2

Use Salt Marsh Guide's "What can you do"

to showcase and provide ideas to the students of the possible positive actions they can take individually and as a school to protect sabkhat.

Action Plan Activity 2

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

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

4. Inform and Involve

- Student camping trip itinerary and guidelines should be displayed on the Eco-Schools bulletin board to inform and involve, and to encourage nature exposure and nature protection.

Evaluation:

Review the Worksheets to assess whether the students were able to apply their knowledge of the sabkha ecosystem to organize their camping trip. Evaluate their understanding of nature protection and the practical steps involved.

Resource 1



Camping Trip Itinerary and Guiding Questions Worksheet

Some questions to help guide the students:

- **How will you decide on the final destination?**
(Hint: where do we find sabkhat in Qatar?).
- **How would you prepare for the camping trip?**
(Hint: freshwater and shade are limited in the sabkha).
- **Considering the fragility of the sabkha, where would you pitch your tent? “**
- **What steps will you take to protect the ecosystem and your family from the extremes of the sabkha?**
- **What information and stories will you share with your family about the ecology of this ecosystem and the life of organisms there?**

A decorative graphic composed of several orange line-art shapes. At the top left, a curved line arches across the page. Below it, a large circle is positioned to the right of the main text. At the bottom right, there is a large, open-bottom shape that resembles a stylized 'U' or a partial circle. The entire graphic is rendered in a consistent orange color.

Task 2

Eco-schools 14-17 Years

Introduction:



The sabkha is another ecosystem, in the coastal environment facing the same extremes as the inter-tidal. The sabkha, like the desert, is mistakenly believed to be barren, partly because the vegetation is not lush, and partly because most of the inhabitants lead a cryptic life or are camouflaged to blend in with the scenery, creating the illusion of life being absent. The trained eye can see the diverse organisms hosted in the sabkha and recognize the fragility of this ecosystem as it takes a long time to recover healthy functioning after a disturbance.

The lesson plan familiarizes the students with the sabkha ecosystem, its biodiversity, microbial mats, and ways to make environmental awareness campaigns more compelling.

The learning process includes researching information pertaining to the topic, class interaction, brainstorming, creative writing, communicating the topic in short stories.

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 sabkha ecosystem, and list threats
- Describe the community of organisms in the sabkha
- Explain what are microbial mats and stromatolites
- Develop a storyline for a day in the life of their favorite sabkha organism to create awareness
- Develop positive actions for the protection of the sabkha ecosystem

Time required/ Duration:

Classroom Session 1: 45 minutes

[5 minutes to visualize with the student the sabkha inhabitants, 5 minutes to screen the "Specimen Spotlight" film on mats, 30 minutes to help the students come up with storylines and to facilitate the students' writing, 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”:

Sabkha ecosystem

Key concepts: overview of the sabkha ecosystem with a focus on those found in the Arabian Gulf; formation of sabkha; biodiversity; nurseries; 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, as well as what we can do to help protect sabkhat

- Resource 1 (Microbial marine mats and stromatolites description)
- Resource 2 (Story Sheet)

Action Plan:



Action Plan 1

- Using the resources available, help the students to visualize the physical habitat and the organisms in the sabkha ecosystem, including the microbial mats (Resource 1).
- Screen the Harvard Museum of Natural History's film "Specimen Spotlight"

to showcase to the students how the different layers of the mat look like.

- Help the students to realize that these are very special structures that are found in a few selected places in the world, Qatar being one of them, and that most people are not aware of them.

Action Plan Activity 1

- Help students choose one of their favorite inhabitants of the sabkha ecosystem, and describe a day in the life of this organism. Choices can be the Gulf sand gecko, a snail, the microbial mat, etc.
- Brainstorm with the students on coming up with storylines that would be the most compelling, so that they can reach maximum effectiveness in raising awareness and making readers understand how unique this ecosystem is.
- Provide the students with Story Sheet (Resource 2)
- Facilitate the students in writing their story.

Action Plan:



Action Plan 2

- Use Salt Marsh Guide's "What can you do"

to showcase and provide ideas to the students of the possible positive actions they can take individually and as a school to protect sabkhat.

Action Plan Activity 2

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

3. Curriculum Linkages: Environmental Science, Ecology, Writing

4. Inform and Involve

- The stories should be displayed on the Eco-Schools bulletin board as part of inform and involve others in the school community.

Evaluation:

Review the students' stories to determine their level of understanding of the sabkha ecosystem and its inhabitants. Evaluate their creativity in story-telling and their writing skills.



Microbial marine mats and stromatolites description (Copyright: Aspa D. Chatziefthimiou)

Common name: Microbial marine mat

Classification: Phyla – Cyanobacteria, Proteobacteria, Bacteroidetes, Verrucomicrobia, Planctomycetes, Ochrophyta, Dinoflagellata and others.

Size: Microbial mats can be as thin as 1 mm and may be developed and well-defined up to a depth of 20 cm. An individual polygonal plate may be up to 1.6 m in diameter.

Habitat: Microbial marine mats inhabit marine neritic habitats, including sabkha, inter-tidal and sub-tidal zones.

Distribution: Marine mats are found circumglobally, lining shallow marine waters, and are visible especially in areas of low disturbance.

Conservation status: Not applicable

Description: Microbial marine mats are found lining shallow marine water, in all coastlines. Their appearance varies based on the available material of the local substrata, and their size is dependent on the levels of disturbance e.g., less disturbed sites have larger and better developed mats. The age of microbial mats is also dependent on the degree of disturbance on a particular site, and it is thought that well developed mats in secondary succession can be older than hundreds of years. Microbial marine mats are a vibrant community of a variety of microbial partners including photosynthetic bacteria and chemosynthetic bacteria, archaea, diatoms and dinoflagellates. Marine worms have also been observed inside microbial mats. The positioning of the partners in the mat is determined mainly by their ability to carry out photosynthesis

in the presence or absence of oxygen, and based on their metabolic demands in the sulfur/oxygen gradient.

The leathery-felt surface of the microbial mat is developed through the entrapment of sediment particles by filamentous cyanobacteria, which are pioneer species and the only bacteria known to perform photosynthesis in the presence of oxygen. Other anoxygenic photosynthetic bacteria form layers below, and farther below them are found bacteria and archaea that reduce sulfate in anoxia. In a cross section, this layering looks like multicolored thin stacks of French crepes, due to the pigmentation of the photosynthesizers and the black bottom layer of the sulfate reducers.

Sometimes, microbial mats form active stromatolites, which microbiologists call living fossils. Geologists use the term “stromatolite”, only for cemented or fossilized marine microbial mats. In Qatar, both forms are found in the coast, while fossilized stromatolite mounds are found in terrestrial areas, and serve as evidence to a previously wetter/flooded Arabian Peninsula. Other places in the world that stromatolites have been recorded include the Shark Bay in Australia and Highbourne Cay in the Bahamas among others. Threats to microbial mats include their sinking and destruction from vehicular action in coastlines, habitat destruction as well as loss of coastline due to climate change.

Resource 1



Sources:

Stal LJ et al. 1985 Structure and development of a benthic marine microbial mat.

Brauchli M et al. 2016. The importance of microbial mats for dolomite formation in the Dohat Faishakh sabkha, Qatar.

Al Thani et al. 2014. Community structure and activity of a highly dynamic and nutrient-limited hypersaline microbial mat in Um Alhool Sabkha, Qatar.



Story Sheet

Names of students in the team:

Instructions: use the space below to describe a day in the life of your favorite inhabitant in the sabkha ecosystem.