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Member of Qatar Foundation

Eco-Schools

Mangrove Forest Ecosystem

The Lesson Plan and Nature-based activities
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Photo Source: Raviv Cohen

Mangrove Ecosystem

The Lesson Plan and Nature-based activities

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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.

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Ecosystem: Mangrove Forest Before-you-begin

Task 1: Before-you-begin

Moving farther away from the open Gulf waters through the coral reefs and the seagrass beds, we land in mangrovial forests that line sheltered shores. This is yet another example of an ecosystem being named after the species that engineers it from scratch, the mangrove, which in its original Spanish "mangle" means swamp.

There are about 70 different species of mangroves in the tropics and sub-tropic climates, with the Indo-West Pacific having the most diverse assemblage (30-35 species), and the Arabian Gulf having the least diverse community of just two native species: *Rhizophora macrunata* and *Avicennia marina.* The last, is the only one that takes root on the shores of Qatar. *Avicennia marina,* the grey or white mangrove, is particularly equipped for life in very saline habitats and sediments that get quickly depleted of oxygen. Using its aerial roots that extend vertically out of the main root, it performs ultrafiltration of seawater, leaving the salt behind. The salt that makes it in is then excreted on the underside of its sclerophyllous (hard) leaves.

The aerial roots are called pneumatophores (lung carriers) because they bring in extra oxygen. In Al Khor and Al Thakira, we find two of the naturally occuring mangrovial forests. The rest, have been partially or fully afforested (planted by humans) in the 1980's, when it was recognized that mangroves could help protect from coastal erosion, flooding, and filter out pollution. These are what we call ecosystem services in ecology. After all these decades, the young planted seedlings have grown into lush forests that can be seen on satellite images.

Like coral reefs, and in more similar ways to seagrass beds because they are both ecosystems pioneered by plants, mangrove forests too act as refugia, feeding grounds and nurseries for a diverse array of aquatic organisms. It all starts when a seed grown on its mother plant gets released, a characteristic we call vivipary, an adaptation to the ever-changing coasts. After that, all the seedling needs is some sand or sediment to bind to and it starts extending its roots out horizontally, creating micro-habitats and niches for other organisms to settle around the root system, on the actual mangrove or amidst the forest area. Some common inhabitants of the forest include purple swimming crabs, hermit crabs, sea snails, barnacles, and a variety of fish. The mudskipper is regarded as one of the most impressive fish species, because it performs a ceremonial dance during mating season to attract females, by jumping up and off the ground with the wondrous agility of a decorated gymnast. Mangrove forests are also transient homes to marine birds visiting during their fall and spring migrations on the East Africa/West Asia Flyway. These include the vibrant flamingo, curlews, sandpipers, gulls, plovers, pied avocets and kingfishers. The tall tippy tops of the trees are nesting sites for herons and ospreys alike, while the Arabian honey bee, constructs elaborate honey combs hanging from the inner branches of the tree.

Photo Source: Shutterstock

Threats: Recreational activities that involve driving over or walking on seedlings and aerial roots, negatively affect the fitness of the mangrove trees as well as the forest's wildlife. coastline development is another threat since these trees are uprooted in the process and thus the habitat is lost to all the resident organisms. Mangrove trees are also nutritionally impacted when seaweeds like *Sargassum boveanum* get wrapped around and cover the photocenters of leaves, rendering them unable to carry out photosynthesis to produce organic molecules essential for their growth.

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Task 2

Eco-schools 6-9 Years

Introduction:

As with all forests, the coastal forests of mangroves buzz with activity and provide shelter to a biodiverse community of organisms. Mangrove species situate themselves along a gradient of salinity, depending on their adaptations to freshwater versus seawater, and in the Gulf we find two of the most salt-tolerant species. Mangrove ecosystem services contribute to human and environmental wellbeing as they sequester carbon, protect against coastal erosion, and provide livelihood and sustenance for the community in the form of timber, fisheries etc.

The lesson plan familiarizes the students with the mangrovial forest ecosystem, its micro-habitats and biodiversity.

The learning processes include exchanging of information on the topic, classroom interaction, and a presentation of the topic through art.

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 mangrove forest ecosystem, and list threats
- Explain how the mangroves engineer a whole ecosystem
- Illustrate the community of organisms in mangrove forests with an emphasis on those in Qatar
- Develop positive actions for the protection of mangrove forests

Time required/ Duration:

Classroom Session 1: 45 minutes
(20 minutes to explain how the mangrove trees create habitats for a large community of organisms; 20 minutes provided for students to label and color the mangrove inhabitants worksheet, 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:

Resources Required: "Before-you-begin":
Mangrove forest ecosystem
Key concepts: overview of the mangrove forest ecosystem with a focus on those found in the Arabian Gulf; mangrove species; biodiversity hotspots; nurseries; refugia; ecosystem services; threats.

Online Resources

www.enature.qa
Key concepts: marine species biodiversity in the Arabian Gulf

www.thebluecarboninitiative.org
Key concept: blue planet, blue carbon ecosystems, conservation

Photo Source: Aspa D. Chatziefthimiou

- 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 mangrove forests.

- Resource 1 (Mangrove Inhabitants Worksheet)
- Student stationary, pencils, colored markers, scissors
- Dedicated display board

Action Plan:

Action Plan 1

- Discuss with the students how the physical structure of the mangrove's root system helps create habitats for other organisms, in part because it stabilizes the coast in place.
- Screen Nature Conservancy's short film

https://www.youtube.com/watch?v=aoMrLYJOdA4&t=12s

so that students can visualize how mangroves dissipate wave action protecting the coasts.

- Help the students understand that the position of each organism in the mangrovial forest depends on its food and sheltering requirements. For example, barnacles attach to the tree trunk, because they need a surface to attach to, from where they filter feed on seawater.
- Check out

https://bmrg.org.au/wp-content/uploads/2019/07/MarvellousMangoveAustralia_2_MangrovesAsHabitat.pdf

Action Plan Activity 1

- Provide students with the Mangrove Inhabitants Worksheet (Resource 1). Ask them to color and label the organisms on it.
- Ask the students to draw in some additional organisms that we find in the mangroves of Qatar.
- Ask the students whether the mangrove tree species depicted in the worksheet are the ones we find in Qatar, and if they are not, ask them to draw in the parts of the tree that are missing.

Action Plan 2

- Use The Blue Carbon Initiative

https://www.thebluecarboninitiative.org/

to explain to the students the concepts of the blue planet and blue carbon, and convey to them the importance of coastal areas in carbon sequestration and climate change.
Use Nature Conservancy's "Get involved / How to help"

https://www.nature.org/en-us/get-involved/how-to-help/

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

Action Plan Activity 2

- Ask the students to list one action they can take individually and as a school to help protect mangrove forests and their inhabitants.

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

4. Inform and Involve
Mangrove Inhabitants Worksheets should be displayed on the Eco-Schools bulletin board as part of inform and involve the school community.

Evaluation:
Conduct a review of the students' worksheets to determine their knowledge on mangrove forest biodiversity in general and for Qatar in particular.

Resource 1

Mangrove Inhabitants Worksheet

https://bmrg.org.au/wp-content/uploads/2019/07/MarvellousMangoveAustralia_2_MangrovesAsHabitat.pdf

Task 2

Eco-schools 10-13 Years

Introduction:

As with all forests, the coastal forests of mangroves buzz with activity and provide shelter to a biodiverse community of organisms. Mangrove species situate themselves along a gradient of salinity, depending on their adaptations to freshwater versus seawater. In the Gulf we find two of the most salt-tolerant species. Mangrove ecosystem services contribute to human and environmental wellbeing as they sequester carbon, protect against coastal erosion, and provide livelihood and sustenance for the community in the form of timber, fisheries etc.

The lesson plan familiarizes the students with the mangrovial forest ecosystem, its biodiversity, and its placement in relation to other ecosystems.

The learning processes include researching information pertaining to the topic, class interaction, cartography, creative writing, and communicating the topic in a "creative clues" game.

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 mangrove forest ecosystem, and list threats
- Explain the importance of ecosystem services of mangroves, and why they are used in afforestation
- Map mangroves forests, and explain where this ecosystem is located in the Arabian Gulf
- Develop "clues" game for mangrove forest organisms to raise awareness
- Develop positive actions for the protection of mangrove forests

Time required/ Duration:

Classroom Session 1: 45 minutes
(20 minutes for the mapping exercise and to brainstorm with the students on ecosystem engineering and services. 20 minutes provided to students to solve the clues on the Guess the Organism Worksheet and create their own clues for their favorite organisms, 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:

Resources Required: "Before-you-begin":
Mangrove forest ecosystem
Key concepts: overview of the mangrove forest ecosystem with a focus on those found in the Arabian Gulf; mangrove species; biodiversity hotspots; nurseries; refugia; ecosystem services; threats.


Photo Source: Aspa D. Chatziefthimiou

Online Resources

www.enature.qa
Key concepts: marine species biodiversity in the Arabian Gulf

link.springer.com
Al-Khayat et al 2021. Molluscan Diversity Influenced by Mangrove Habitat in the Khors of Qatar.

papers.ssrn.com
Al-Khayat and Balakrishnan 2014. Avicennia Marina Around Qatar: Tree, Seedling and Pneumatophore Densities in Natural and Planted Mangroves Using Remote Sensing.

- 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 mangrove forests.
- Resource 1 (Map of Qatar - Bathymetric)
- Resource 2 (Map of Qatar - Mangrove Forest Locations)
- Resource 3 (Guess the Organism Worksheet)
- Student notebooks, pencils, colored markers
- Dedicated display board

Action Plan:

Action Plan 1

- Use the available resources as a guide to brainstorm ideas to help students come to an understanding of why we call mangroves ecosystem engineers. What are some other organisms that we find in the Arabian Gulf that are ecosystem engineers? Do they engineer their ecosystem the same way?
- Provide students with the Bathymetric Map of Qatar (Resource 1).
- Show the map of natural and planted mangrove forests in Qatar (Resource 2). Ask the students to mark these location on their map. This will illustrate for the students that we find them in coastal shallow areas.
- Introduce students to the concept of ecosystem services
- Screen Nature Conservancy's short film

https://www.youtube.com/watch?v=aoMrLYJOdA4&t=12s

so that students can visualize how mangroves dissipate wave action protecting the coasts.

- Engage the students in coming up with some additional ecosystem services that mangroves provide. Assist the students to make the connection that mangroves were planted in the first place because of these ecosystem services.

Action Plan Activity 1

- Provide the students with the Guess the Organism Worksheet (Resource 3).
- Facilitate students to solve the clues given for each organism.
- Help students understand the connectivity of the Arabian Gulf ecosystems. Ask the students to name the other ecosystems.
- Facilitate students to create another 5 clues in the same style for their favorite mangrove forest organisms.

Action Plan:

Action Plan 2

- Use The Blue Carbon Initiative

https://www.thebluecarboninitiative.org/

to explain to the students the concepts of the blue planet and blue carbon, and impress in them the importance of coastal areas in carbon sequestration and climate change.

- Use Nature Conservancy's "Get involved / How to help"

https://www.nature.org/en-us/get-involved/how-to-help/

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

Action Plan Activity 2

- Ask the students to list one action they can take individually and as a school to help protect mangrove forests and their inhabitants.

3. Curriculum Linkages: Environmental Science, Ecology, Geography

4. Inform and Involve

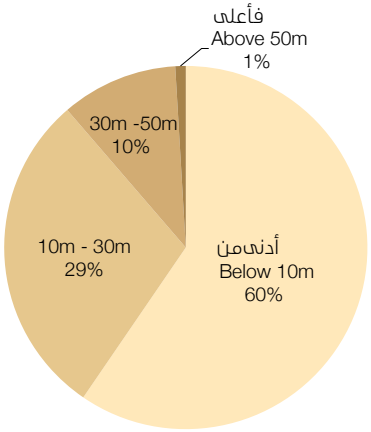
- Completed maps and un-filled Guess the Organism Worksheets should be displayed on the Eco-Schools bulletin board as part of inform and involve others in the school. A very entertaining option can be to create an Eco-Schools-wide competition using these clues.

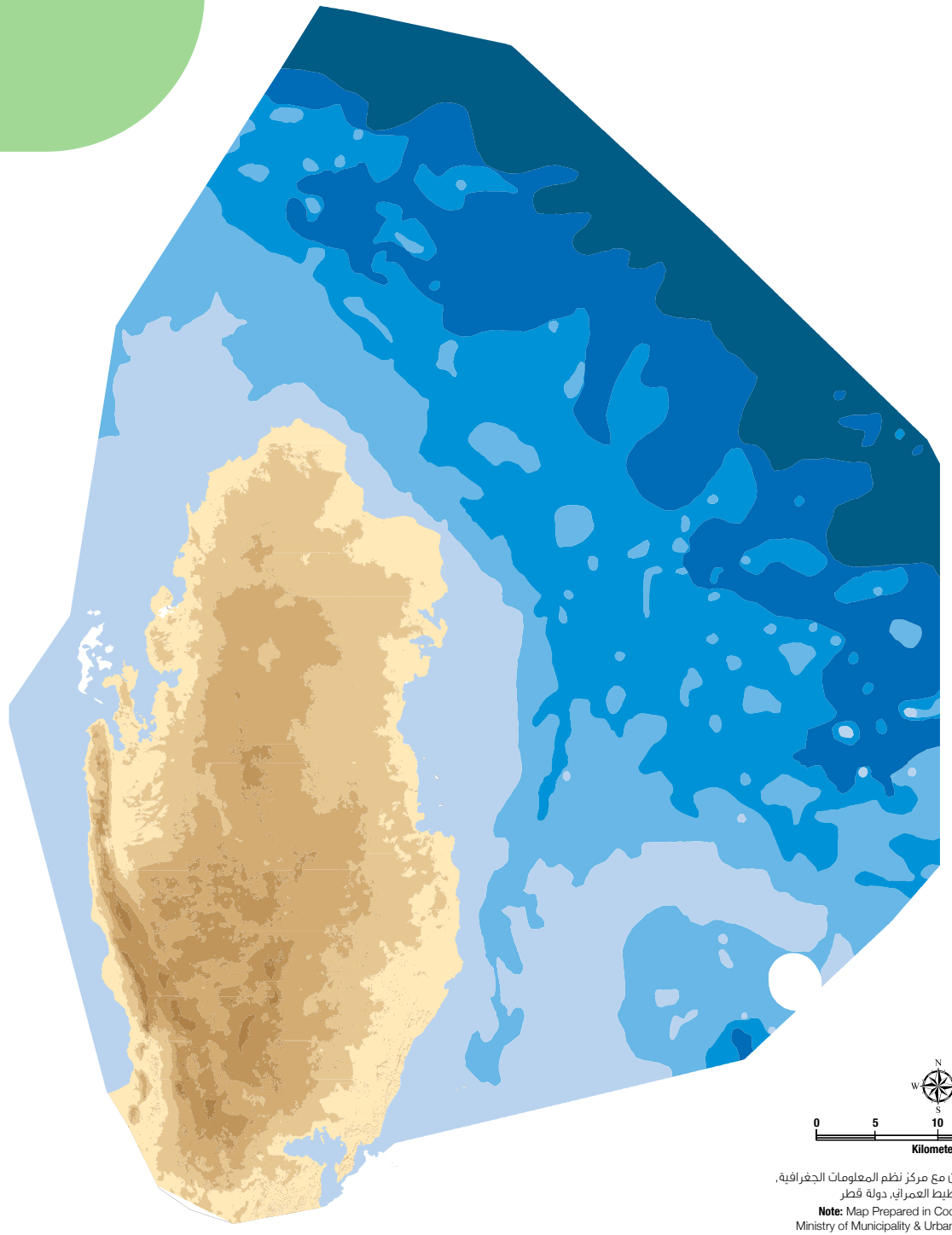
Evaluation:
Review their maps to determine whether students can correctly locate the mangrove forests on them. Display the clues on the board, and solve them with the students. Assess their knowledge based on the actual clues and their responses to the clues.

Resource 1

Map of Qatar - Bathymetric

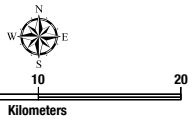
قطر: مساحة الأرض حسب مناطق المرتفعات
Qatar Land Area by Altitudinal Zones





Legend	مفتاح الخريطة
Bathymetry (in Metres)	البيثميتري (بالأمتار)
0 - 10	١٠ - ٠
10 - 20	٢٠ - ١٠
20 - 30	٣٠ - ٢٠
30 -50	٥٠ - ٣٠
50 +	+ ٥٠

Height (in Metres) Above Mean Sea Level	الارتفاع (بالأمتار) فوق متوسط مستوى سطح البحر
0 - 10	١٠ - ٠
10 - 30	٣٠ - ١٠
30 - 50	٥٠ - ٣٠
50 - 70	٧٠ - ٥٠
70 - 90	٩٠ - ٧٠
90 - 100	١٠٠ - ٩٠
100 +	+ ١٠٠



ملاحظة: أعدت الخريطة بالتعاون مع مركز نظم المعلومات الجغرافية، وزارة البلدية والتخطيط العمراني، دولة قطر

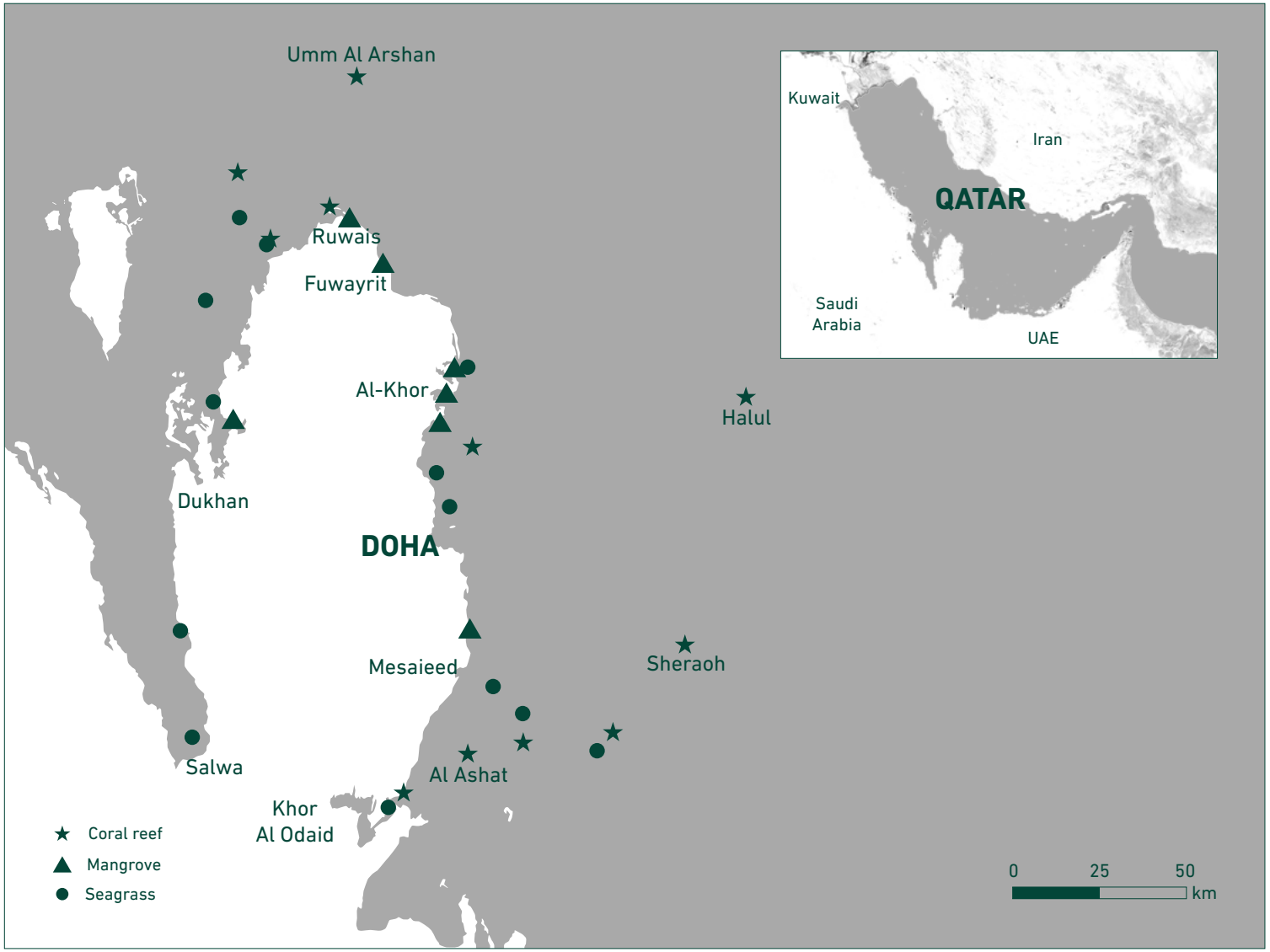
Note: Map Prepared in Coordination with CGIS, Ministry of Municipality & Urban Planning, State of Qatar

Resource 2

Map of Qatar - Mangrove Forest Locations

Location map of coastal marine ecosystems.

Al Khor and Al Thakira mangrove forests▲ are the only naturally occurring ones out of those depicted on the map. In Zekreet, Al Mafjar, Fuwairit and Semaisma, the mangroves have been planted. Other mangrove forests with significant stand, not depicted in the map and naturally occurring can be found all along the north western coast, and all along the entire east coastline. In Al Wakra the naturally occurring mangrove forest was transplanted to the northern area of the coastline as part of the offsetting of the Messaid Port development.



Map source:
Burt et al. 2017. Improving Management of Future Coastal Development in Qatar Through Ecosystem-based Management Approaches.

https://doi.org/10.1016/j.ocecoaman.2017.08.006

Resource 3

Guess the Organism Worksheet

1. I am the _____

- **I eat** insects, small fish and shrimp
- **Fun facts:** I don't have a tongue to catch prey with, so the smart creature I am, I suck in water which I expel to flood my prey and then I engulf it. Yummy! I live in water pools and when it is mating time, I jump up and down in an elaborate dance to attract females.

2. I am the _____

- **I eat** carbon dioxide and I use sunlight energy to make photosynthate sugars
- **Fun facts:** I am an ecosystem engineer, providing shelter and food for many other organisms around me.
  I can survive very salty waters because my leaves can excrete the salt that I bring in.
  I can survive anoxic sediments because my roots have pneumatophore extensions that help bring more oxygen in for me.

3. I am the _____

- **I eat** everything including phytoplankton, seaweed and dead fish, squid and crabs
- **Fun facts:** I am an omnivore and a scavenger. I am not a true crab, and although I live inside a snail's shell to protect my soft under-body, I cannot build that shell. When I get bigger I am constantly on the look out for a larger empty shell to inhabit.

4. I am the _____

- **I eat** everything in the water column including fish, shrimp and microbes
- **Fun facts:** I am a filter-feeder. I siphon seawater and filter it through my bill.
  My lower beak is larger than my upper beak. To swallow, sometimes, I turn my head upside down.
  I get my flamboyant color from the carotenoid pigments of my prey.

5. I am the _____

- **I eat** fish, shrimp, mudskippers, crabs
- **Fun facts:** I like to stand still in wait for prey, sometimes on one leg.
  My beak is long and so are my legs and wingspan.
  I make my nest on the top of tall trees in mangrove forests and elsewhere.

KEY

1. Mudskipper

2. Mangrove tree

3. Hermit crab

4. Flamingo

5. Indian Reef Heron

Task 2

Eco-schools 14-17 Years

Introduction:

As with all forests, the coastal forests of mangroves buzz with activity and provide shelter to a biodiverse community of organisms. Mangrove species situate themselves along a gradient of salinity, depending on their adaptations to freshwater versus seawater, and in the Gulf we find two of the most salt-tolerant species. Mangrove ecosystem services contribute to human and environmental wellbeing as they sequester carbon, protect against coastal erosion, and provide livelihood and sustenance for the community in the form of timber, fisheries, etc.

The lesson plan familiarizes the students with the mangrovial forest ecosystem, its biodiversity, how this ecosystem is engineered, and how succession looks like in satellite imagery.

The learning process includes researching information pertaining to the topic, class interaction, technology, brainstorming, and communicating the topic by producing a time-lapse video.

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 mangrove forest ecosystem and list threats
- Explain mangrove anatomical structures and adaptations to the extremes of the Arabian Gulf
- Navigate the program Google Earth Pro, and monitor environmental / land use change through satellite images
- Record a time-lapse video to include in a presentation about threats to mangroves and raise awareness
- Develop positive actions for the protection of mangrove forests

Time required/ Duration:

Classroom Session 1: 45 minutes
(20 minutes to discuss with the students the characteristics of mangroves and their forests, including distribution and adaptations, 20 minutes to brainstorm with students ideas on how mangroves are threatened and track these threats using time-lapsed satellite imagery, 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: Shutterstock

Resources Required: "Before-you-begin":
Mangrove forest ecosystem
Key concepts: overview of the mangrove forest ecosystem with a focus on those found in the Arabian Gulf; mangrove species; biodiversity hotspots; nurseries; refugia; ecosystem services; threats.

Online Resources

earthobservatory.nasa.gov
Key concepts: mangrove distribution; habitat loss; threats; mapping

www.enature.qa
Key concepts: marine species biodiversity in the Arabian Gulf

www.youtube.com
Key concepts: mangrove ecosystem services; threats

link.springer.com
Al-Khayat et al 2021. Molluscan Diversity Influenced by Mangrove Habitat in the Khors of Qatar.

papers.ssrn.com
Al-Khayat and Balakrishnan 2014. Avicennia Marina Around Qatar: Tree, Seedling and Pneumatophore Densities in Natural and Planted Mangroves Using Remote Sensing.

- 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 mangrove forests.
- Recording device for videography, such as a cell phone
- Dedicated display board

Action Plan:

Action Plan 1

- Provide the students with a general overview of the mangrove as a tree, the number of species that exist in the world and in Qatar, and their distribution.
- Visit the Earth Observatory

https://earthobservatory.nasa.gov/images/47427/mapping-mangroves-by-satellite

to show the students the exact distribution of mangroves.
- Help students understand that the extreme conditions of the Arabian Gulf select the hardiest of mangrove species.
- Discuss with the students some of the adaptations that mangrove trees have to life in high salinity, in ever-changing coastlines, and to anoxia.
- Discuss with the students the concepts of the ecosystem engineers and ecosystem services provided by the mangrove forests.
- Screen Nature Conservancy's short film

https://www.youtube.com/watch?v=aoMrLYJOdA4&t=12s

so that students can visualize how mangroves dissipate wave action protecting the coasts.
- Brainstorm with the students ideas of the threats that are faced by mangrove forests and the community of organisms they support the world over.
- Visit the Earth Observatory

https://earthobservatory.nasa.gov/images/147142/mapping-the-roots-of-mangrove-loss

to show students the areas of the globe where mangrove forests are being lost, and the root causes of that loss.

Action Plan Activity 1

- Facilitate the students in monitoring the succession of a mangrove forest in Qatar using the "Time-lapse" or "Historical Imagery" tool on Google Earth Pro. Help them pick one coastal zone, the forest at Lat. 25.680933° Lon. 51.564036°, for example, and have them start from the earliest satellite imagery available to the present time.
- Guide the discussion using the following questions:

  How does the landscape change through time?

  Does the extent of the forest increase or decrease?

  What are some of the factors that lead to the decrease in cover?

  How does that affect ecosystems services and biodiversity?

- Facilitate students to record the time-lapse of different mangrove forests in Qatar, and to create a short presentation with the threats.

Action Plan:

Action Plan 2

- Use The Blue Carbon Initiative

https://www.thebluecarboninitiative.org/

to explain to the students the concepts of the blue planet and blue carbon, and convey to them the importance of coastal areas in the carbon sequestration process as well as in climate change.

- Use Nature Conservancy's "Get involved / How to help"

https://www.nature.org/en-us/get-involved/how-to-help/

to showcase and provide ideas to the students about the possible positive actions they can take individually and as a school to protect mangrove forests.

Action Plan Activity 2

- Ask the students to list one action they can take individually and as a school to help protect mangrove forests and their inhabitants.

3. Curriculum Linkages: Environmental Science, Ecology, Technology, Geography

4. Inform and Involve
Student time-lapse videos and short presentations can be showcased on Ocean Day and on the Eco-Schools bulletin board to inform and involve the whole school community.

Evaluation:
Evaluate the technological abilities of the students. Review their videos to determine how well they synthesized information on the mangrove forest ecosystem and its threats, and their level of creativity.

Task 3

Nature-based Activities 6-9 Years

6-9 Years

The activities are designed to enhance students' understanding of the unique characteristics of the mangrove forest, its biodiversity and the threats it faces, through nature immersion and a hands-on learning experience. Students will be exposed to nature in their own "backyard" and will learn how to respect it. Students will develop practical skills for nature exploration, field work, nature protection and conservation. Students will be able to articulate the inner-workings of this ecosystem, and to transfer this knowledge to their peers, family and community.

Time required/ Duration:

Field Session 1: 5 hours
(2 hours to travel to/from the field location, 2 hours and 20 minutes for the activities, 40 minutes for lunch, supervised downtime, and a restorative action such as a clean-up of the area). It is left up to the facilitator's discretion to expand the timings as needed.

Resources Required:

"Before-you-begin": Mangrove forest ecosystem
Lesson Plan: Mangrove forest

Online Resources:

http://www.enature.qa/

for Qatari flora and fauna (including birds) identification (an App is also available)

Best Practices:

- **Risk Assessment:** the chosen location has been risk assessed and meets the following safety criteria - it can be safely accessed by school bus, it is distant from anthropogenic activities such as construction and vehicular traffic, and is near to hospitals.
  In the absence of a professional tour guide, it is highly advisable that faculty pay a site visit prior to the school field trip, to get acquainted with the surroundings, and identify and mitigate risks that may have arisen in the time since the location was first risk assessed. The weather forecast should be monitored to avoid rain, hot temperatures and/or sand storms during the field trip, and the marine forecast should be checked to avoid above"knee-height" tide levels (0.5-0.7 meters). Weather and tidal forecasts can be accessed through Q Weather App or Qatar Metereology Department or other smartphone applications suchas Windfinder. Tidal forecast can also be accessed on your bowser

  https://qweather.gov.qa/CAA/Tide.aspx

  by selecting or tapping on the specific location where the nature activities are to take place.

- **Personal Safety:** Field excursions can be very demanding in terms of energy expenditure, especially in extreme climates like the Arabian Gulf, where there is a risk of heat exhaustion. It is imperative that faculty and students carry with them all items listed under "Field preparedness"; that the airconditioned school bus is always near in case a participant needs reprieve from the heat or to be transferred to the emergency room.

6-9 Years

A well-stocked First Aid Kit is essential as well.

- **Nature Protection:** The goal of the field trip is to instill in the students a deep founded respect for nature, in addition to enhancing students understanding of this ecosystem. It should be conveyed to the students that the best explorers preserve nature, by always walking on existing trails; by never stepping on plants and mangrove aerial roots (pneumatophores); by never destroying burrows; by never driving over fragile sabkha; and by never bashing pristine sand dunes.
  Wildlife distress in our presence, thus the students should be guided in keeping their distance and learn to marvel wildlife from afar. A golden rule of explorers is to leave nature in the same or in a better state than when they first arrived. Use the moto "pick up your trash, keep nature clean".

- Field preparedness: hat, sunscreen, water (2 liters per person), swimsuit, wet shoes or sandals or old sneakers, towels, change of clothes, second pair of shoes.

- First Aid Kit (check RedCross.org for directions on how to stock a First Aid Kit)

- Field equipment: permanent markers or stickers for the bingo; a device to take photographs

- Resource 1 (Location map)

- Resource 2
  (Bingo Card - Mangrove Forest Markers - preferably laminated)

Activity:

Field Session 1:

1. Title of the Activity: Bingo with mangrove forest markers

- Provide students with the Bingo Card - Mangrove Forest Markers (Resource 2) and the permanent markers or stickers.
- Take a tour around the mangroves with the students.
- Draw information from the available resources to discuss with the students the special characteristics of the mangrove forest and the organisms that inhabit this ecosystem.
- Connect the knowledge they gained in class to what they see in the natural setting.
- Have them fill in their bingo card. Every time they discover a new organism, make a stop to ask the students about the unique characteristics of the specific organism.
- Encourage the students to identify and include in their bingo cards additional organisms, and signs of disturbance.
- Sit in a circle with the students and discuss their findings. Guide the students in connecting their individual observations to make up the whole community of the mangrove forest.
- Reinforce the concept of mangrove forests being refugia, feeding grounds and nurseries of these organisms.

2. Inform and Involve

- The bingo cards, and before-and-after photographs of students' restoration actions should be displayed on the Eco-Schools bulletin board as a way to inform and involve the school community.
- Students may also be encouraged to write and post on the Eco-Schools bulletin board a reflection of their experience in nature, or how disturbance affects biodiversity as well as the ways that we can help protect nature.

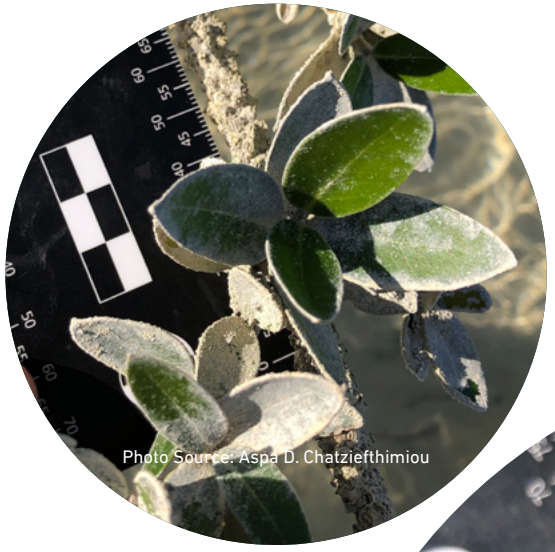
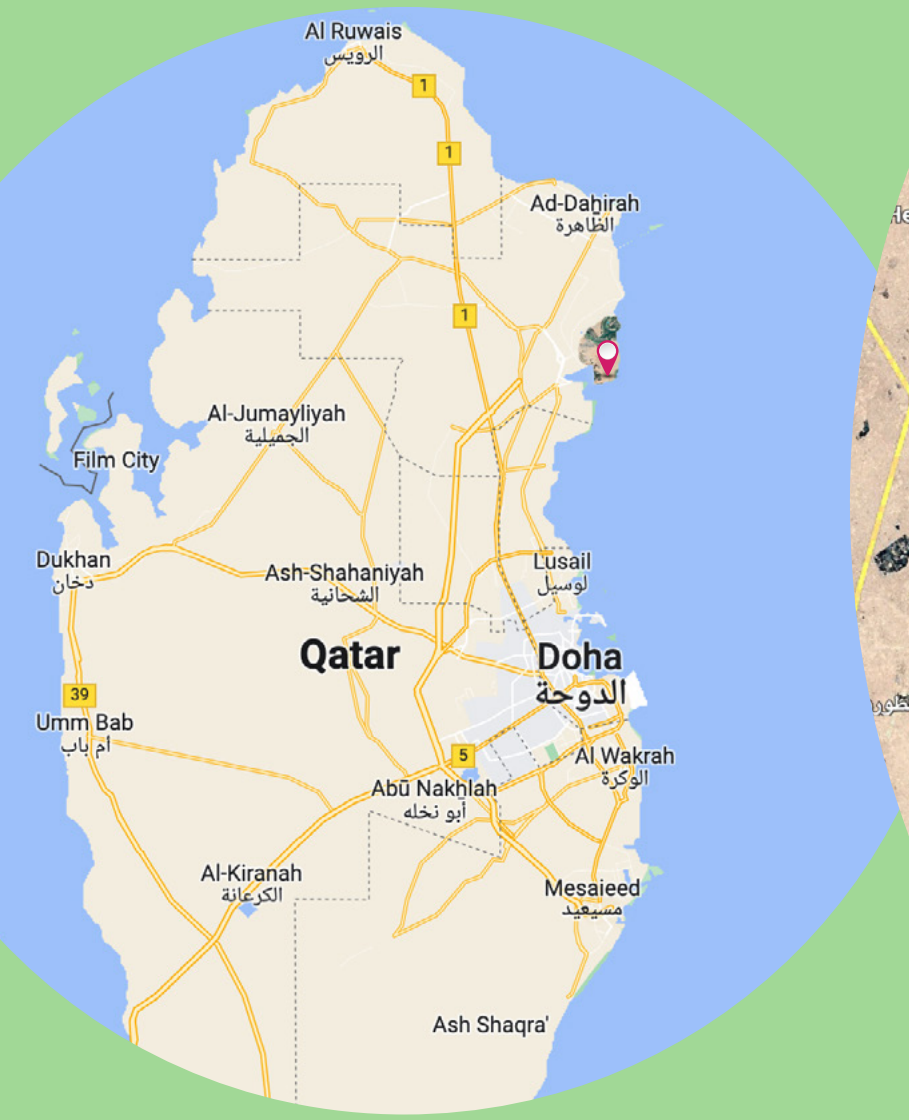
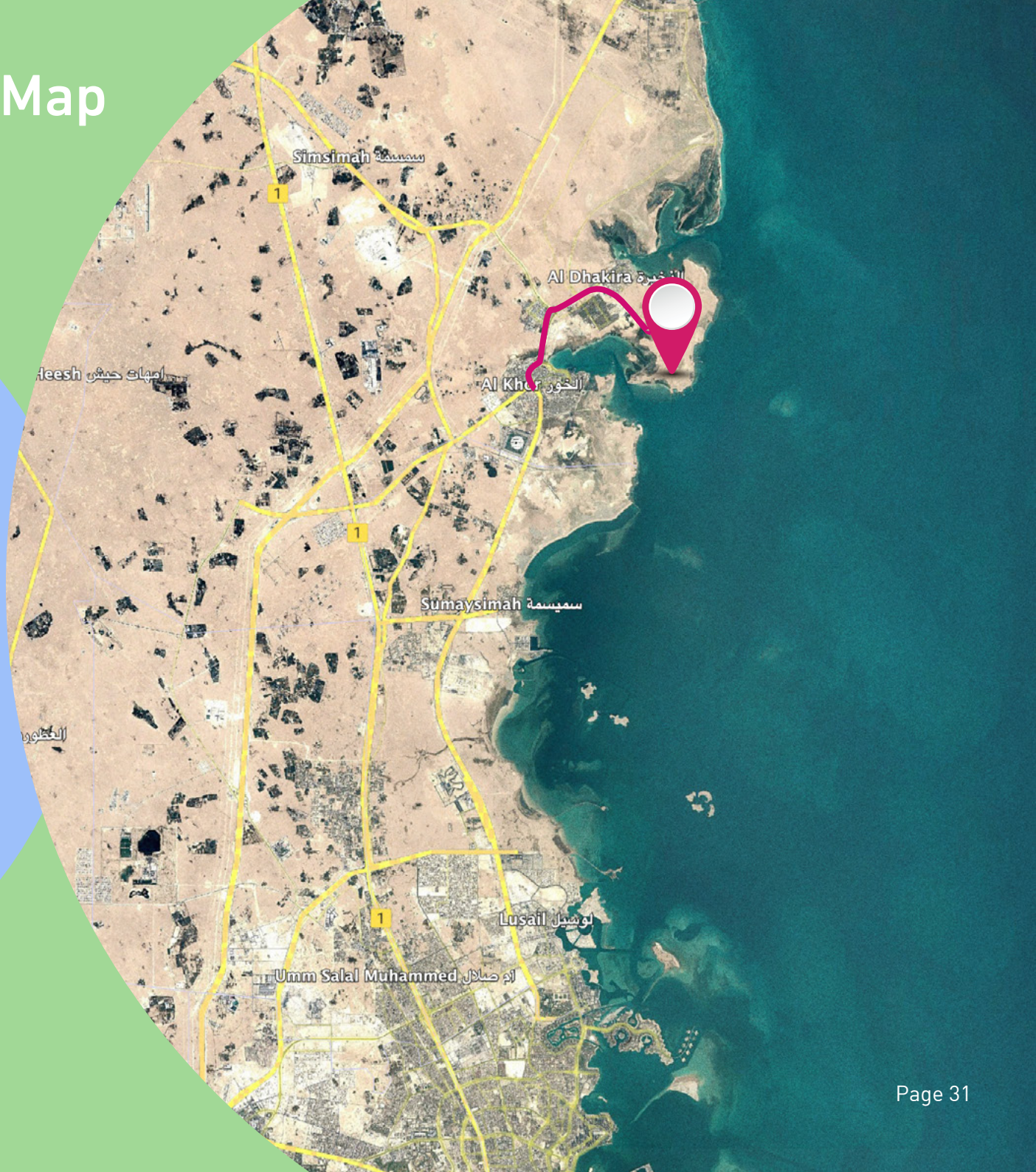


Photo Source: Aspa D. Chatziefthimiou


Photo Source: Aspa D. Chatziefthimiou

Resource 1: Location Map





Google Earth

Task 3
Mangrove Forest

6-9 Years

Location: Ras Matbakh

Coordinates:

25°40'54.2"N

51°34'21.0"E

Task 3
Mangrove Forest

6-9 Years

Location: Ras Matbakh

Coordinates:

25°40'54.2"N

51°34'21.0"E

Google Earth

Resource 2

Bingo Card - Mangrove Forest Markers

Names of students in the team:

 Desert hyacinth	 Sea lavender	 Mangrove tree	 Seaweed
Flamingo 	Heron 	 Barnacles	Plover 
Sea snails 	Hermit crab 	Blue crab 	Seagrass 
 Pneumatophores	 Burrow	 Humans	Disturbance - fill in (it can be trash or tire tracks or destroyed plants etc.)

Photo sources: Aspa D. Chatzieftimiou, Phil Cullen, Creative Commons Open Access.

Task 3

Nature-based Activities 10-13 Years

10-13 Years

The activities are designed to enhance students' understanding of the unique characteristics of the mangrove forest, its biodiversity and the threats it faces, through nature immersion and hands-on experience. Students will be exposed to nature in their own "backyard", and will learn how to respect it. Students will develop practical skills for nature exploration, field work, nature protection and conservation. Students will be able to articulate the inner-workings of this ecosystem, and to transfer this knowledge to their peers, family, and community.

Time required/ Duration:

Field Session 1: 5 hours
(2 hours to travel to/from the field location, 2 hours and 20 minutes for the activities, 40 minutes for lunch, supervised downtime, and a restorative action such as a clean-up of the area). It is left up to the facilitator's discretion to expand the timings as needed.

Resources Required:

"Before-you-begin": Mangrove forest ecosystem
Lesson Plan: Mangrove forest

Online Resources:

https://spia.princeton.edu/news/forest-soundscapes-monitor-conservation-efforts-inexpensively-effectively

for background on bioaccoustics research.

http://www.enature.qa/

for Qatari flora and fauna (including birds) identification (an App is also available).

https://www.inaturalist.org/projects/q-birds

for photographic records of birds in Qatar, bird identification, and to share bird observations with the community.

https://www.kuwaitbirds.org/

for bird identification (an App is also available).

https://www.inaturalist.org/

to identify, map and share species observations with the community (Please note that you will need to create a free account to access features of this app).

https://merlin.allaboutbirds.org/

for bird call identification.

https://www.google.com/maps

for determining the coordinates of a given location.

10-13 Years

Best Practices:

- **Risk Assessment:** the chosen location has been risk assessed and meets the following safety criteria - it can be safely accessed by school bus, it is distant from anthropogenic activities such as construction and vehicular traffic, and is near to hospitals.
  In the absence of a professional tour guide, it is highly advisable that faculty pay a site visit prior to the school field trip, to get acquainted with the surroundings, and identify and mitigate risks that may have arisen in the time since the location was first risk assessed. The weather forecast should be monitored to avoid rain, hot temperatures and/or sand storms during the field trip, and the marine forecast should be checked to avoid above "knee-height" tide levels (0.5-0.7 meters). Weather and tidal forecasts can be accessed through Q Weather App or Qatar Metereology Department or other smartphone applications such as Windfinder. Tidal forecast can also be accessed on your bowser

  https://qweather.gov.qa/CAA/Tide.aspx

  by selecting or tapping on the specific location where the nature activities are to take place.

- **Personal Safety:** Field excursions can be very demanding in terms of energy expenditure, especially in extreme climates like the Arabian Gulf, where there is a risk of heat exhaustion. It is imperative that faculty and students carry with them all items listed under "Field preparedness"; that the airconditioned school bus is always near in case a participant needs reprieve from the heat or to be transferred to the emergency room. A well-stocked First Aid Kit is essential as well.

- **Nature Protection:** The goal of the field trip is to instill in the students a deep founded respect for nature, in addition to enhancing students understanding of this ecosystem. It should be conveyed to the students that the best explorers preserve nature, by always walking on existing trails; by never stepping on plants and mangrove aerial roots (pneumatophores); by never destroying burrows; by never driving over fragile sabkha; and by never bashing pristine sand dunes.
  Wildlife distress in our presence, thus the students should be guided in keeping their distance and learn to marvel wildlife from afar. A golden rule of explorers is to leave nature in the same or in a better state than when they first arrived. Use the moto "pick up your trash, keep nature clean".

- Field preparedness: hat, sun-screen, water (2 liters per person), swim suit, wet shoes or sandals or old sneakers, towels, change of clothes, second pair of shoes.

- First Aid Kit (check RedCross.org for directions on how to stock a First Aid Kit)

- Field equipment: a device at the discretion of the facilitator to record location coordinates; a smartphone to access online resources, take photographs and record sounds

- Resource 1 (Location map)

- Resource 2 (Sound Map Worksheet)

Activity:

Field Session 1:

1. Title of the Activity: Mapping the soundscape of the mangrovial forest

- Take a tour around the mangroves with the students.
- Draw information from the available resources to discuss with the students the special characteristics of the mangrove forest and the organisms that inhabit this ecosystem.
- Connect the knowledge they gained in class to what they see in the natural setting.
- Ask the students to break into teams of 2-3.
- Provide each team of students with the Sound Map Worksheet (Resource 2).
- Explain to the students that one of the non-invasive ways that scientists use to survey an area to determine the biodiversity that is contained within it, is by monitoring and recording the sounds emanating within the area using acoustic sensors. In their case, they will rely on their ears and eyes to reconstruct the biodiversity in a given spot based on the soundscape.
- Make students aware of one limitation in this method of biodiversity assessment: that there may be organisms present that don't produce a sound, and/or that the sound that they produce is imperceivably to human ears an/or recording devices.
- Show the students how to determine the coordinates of their location either using the "compass" application on a smartphone or by pinning their location on a mapping application like Google Maps.
- Ask the teams to pick a spot in the mangroves, where they can comfortably spend 20-30 minutes, to listen quietly for sounds and record them in the Sound Map Worksheet (Resource 2).
  Then they can count the plants and animals they observed, that did not produce a sound.
- Ask the student to take photographs of the different species or objects that make sounds, if possible, as they observe them.
  Students may also be encouraged to record sounds.
- It is preferred for each team to pick a different sub habitat within and around the forest, so their results are as varied as possible.
  For example, at the edge of the forest that borders the beach ecosystem or the intertidal, or in a mangrove channel, etc.
- Ask the students to tally the different sounds and different species they observed.
- Sit in a circle with the students to discuss their findings, and assist the students in using different apps to identify any species that they are not familiar with.
- Ask the students
  Which method (bioacoustics or observational of mapping is the best to capture the whole biodiversity of a given location?
  How do they complement one another?
  Is there a difference between spot location (sub habitat type) and the number of species they counted and the types and number of sounds they heard?

Activity:

2. Inform and Involve

- The soundscape maps, as well as before-and-after photographs of students' restoration actions, should be displayed on the Eco-Schools bulletin board as part of inform and involve the school community.
- Students who are musically talented, can compose music inspired by the nature sounds they recorded during this trip. An example of such effort where musicians promote the conservation of endangered birds can be found here:

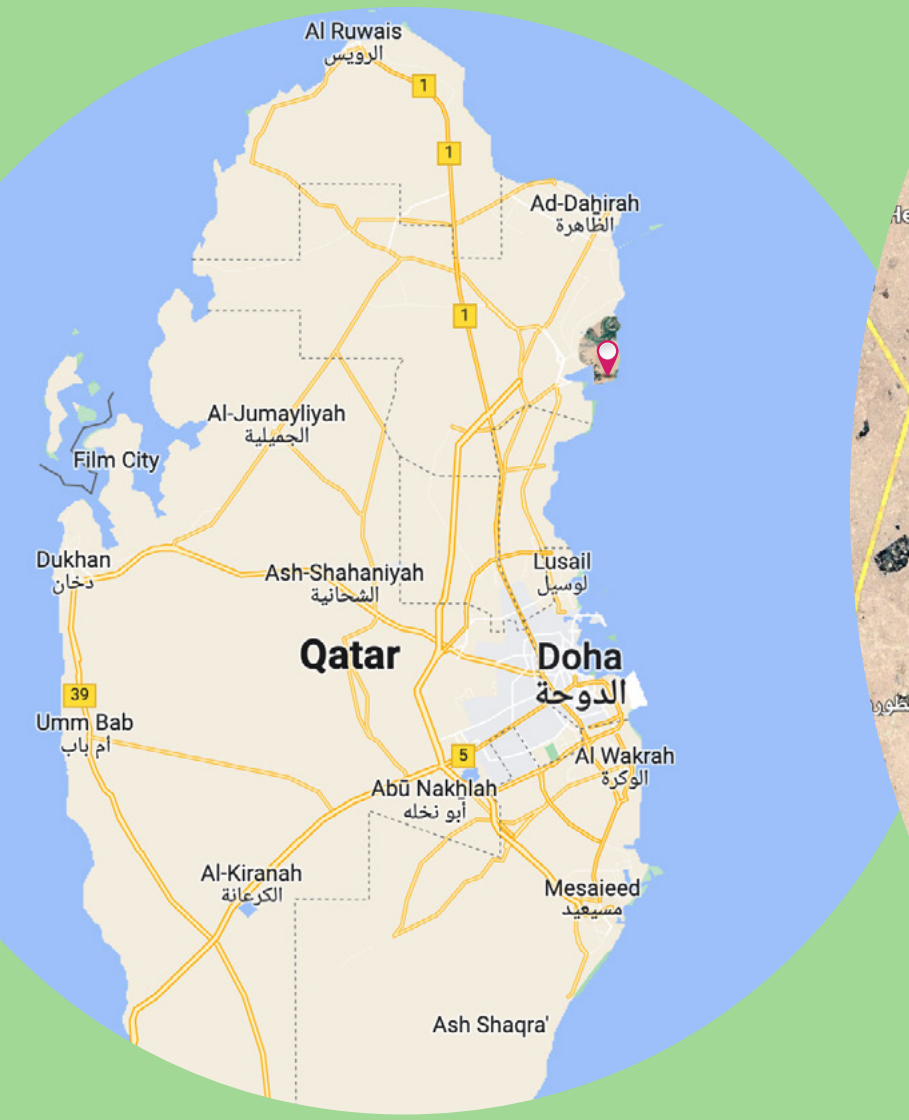
https://www.npr.org/2020/07/16/891432319/a-new-album-turns-the-sound-of-endangered-birds-into-electronic-music

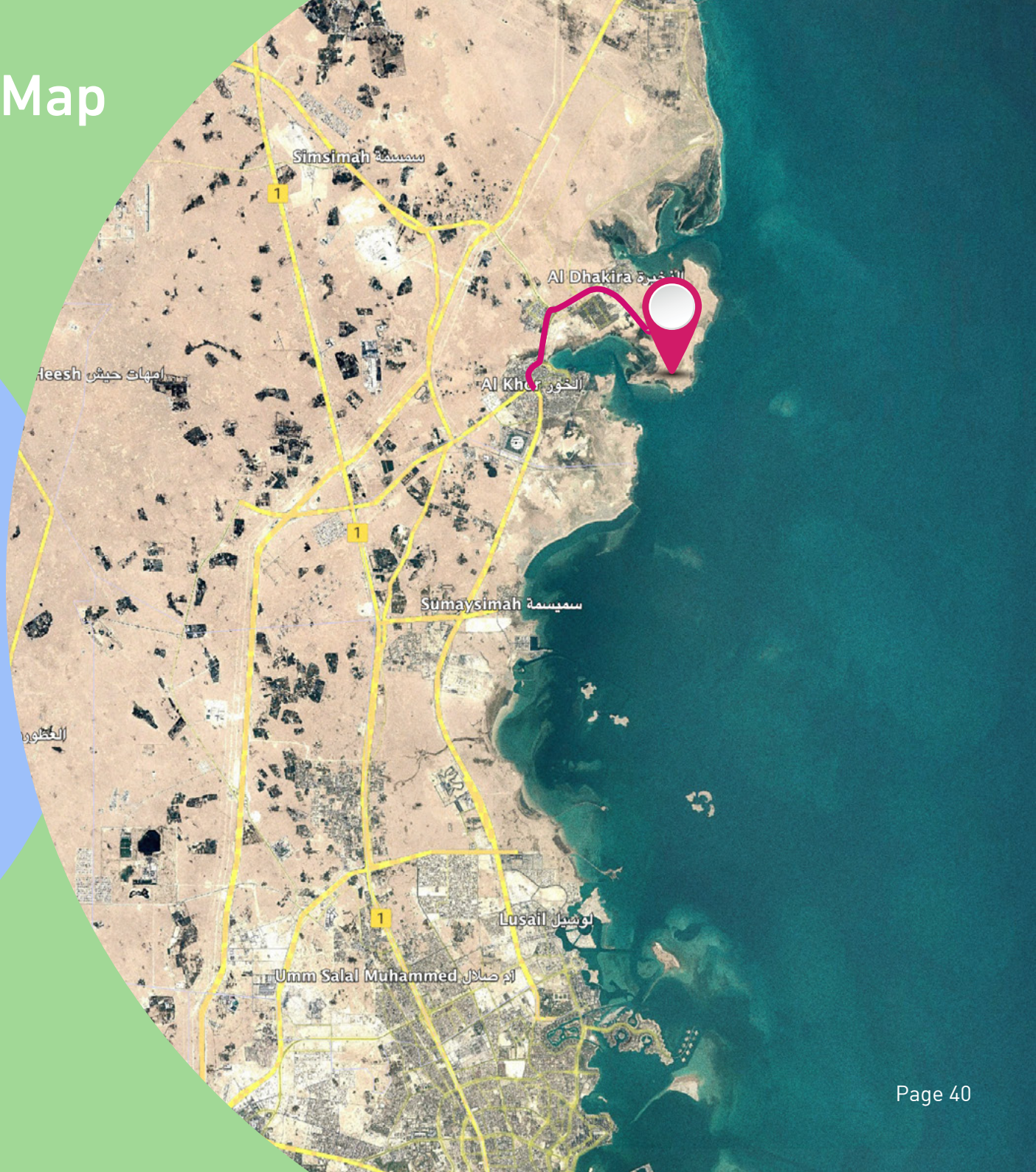
Musical pieces can be used in social media campaigns to raise awareness.

Photo Source: Aspa D. Chatziefthimiou

Photo Source: Aspa D. Chatziefthimiou

Resource 1: Location Map





Google Earth

Task 3
Mangrove Forest

10-13 Years

Location: Ras Matbakh

Coordinates:

25°40'54.2"N

51°34'21.0"E

Task 3
Mangrove Forest

10-13 Years

Location: Ras Matbakh

Coordinates:

25°40'54.2"N

51°34'21.0"E

Resource 2

Sound Map Worksheet		
Names of students in the team:		
Directions: find a spot to sit **quietly** and listen to the sounds around you. Draw a map of the sounds you hear and where they are coming from in relation to where you are sitting. Are they natural or mechanical? Is there an association between the type of sound and the type of habitat where the sound is being generated? (example car-road, bird-mangrove etc.). Do you see the organism or object that is producing the sound? Can you estimate the distance between the sound source and you? Do you see organisms that may also make sounds, which may not be perceivable by you? Regroup with your class and discuss your findings.		
	WE Coordinates: Sub habitat:	
Total number of mechanical sounds:		
Total number of species that produced a sound:		
Total number of species that did not produce a sound:		

Task 3

Nature-based Activities 14-17 Years

14-17 Years

The activities are designed to enhance students' understanding of the unique characteristics of the mangrove forest, its biodiversity and the threats it faces, through nature immersion and hands-on experience. Students will be exposed to nature in their own "backyard", and will learn how to respect it. Students will develop practical skills for nature exploration, field work, nature protection and conservation. Students will be able to articulate the inner-workings of this ecosystem, and to transfer this knowledge to their peers, family, and community.

Time required/ Duration:

Classroom Session 1: 50 minutes to introduce students to the different applications for species and bird call identification.
Field Session 1 & 2: 5 hours
(2 hours to travel to/from the field location, 2 hours and 20 minutes for the activities, 40 minutes for lunch, supervised downtime, and a restorative action such as a clean-up of the area). It is left up to the facilitator's discretion to expand the timings as needed.

Resources Required:

"Before-you-begin": Mangrove forest ecosystem
Lesson Plan: Mangrove forest

Online Resources:

https://static.inaturalist.org/wiki_page_attachments/363-original.pdf

for what is a bioblitz and how to organize one.

https://www.inaturalist.org/

to identify, map and share species observations with the community (Please note that you will need to create a free account to access the features of this app).

https://www.inaturalist.org/pages/teacher's+guide

for guidelines on how best to use iNaturalist with the class.

https://merlin.allaboutbirds.org/

for bird call identification.

http://www.enature.qa/

for Qatari flora and fauna
(including birds) identification (an App is also available).

https://www.inaturalist.org/projects/q-birds

for photographic records of birds in Qatar, bird identification, and to share bird observations with the community.

https://www.google.com/maps

for determining the coordinates of a given location.

14-17 Years

Best Practices:

- **Risk Assessment:** the chosen location has been risk assessed and meets the following safety criteria - it can be safely accessed by school bus, it is distant from anthropogenic activities such as construction and vehicular traffic, and is near to hospitals. In the absence of a professional tour guide, it is highly advisable that faculty pay a site visit prior to the school field trip, to get acquainted with the surroundings, and identify and mitigate risks that may have arisen in the time since the location was first risk assessed. The weather forecast should be monitored to avoid rain, hot temperatures and/or sand storms during the field trip, and the marine forecast should be checked to avoid above "knee-height" tide levels (0.5-0.7 meters). Weather and tidal forecasts can be accessed through Q Weather App or Qatar Metereology Department or other smartphone applications such as Windfinder. Tidal forecast can also be accessed on your bowser

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  by selecting or tapping on the specific location where the nature activities are to take place.

- **Personal Safety:** Field excursions can be very demanding in terms of energy expenditure, especially in extreme climates like the Arabian Gulf, where there is a risk of heat exhaustion. It is imperative that faculty and students carry with them all items listed under "Field preparedness"; that the airconditioned school bus is always near in case a participant needs reprieve from the heat or to be transferred to the emergency room. A well-stocked First Aid Kit is essential as well.

- **Nature Protection:** The goal of the field trip is to instill in the students a deep founded respect for nature, in addition to enhancing students understanding of this ecosystem. It should be conveyed to the students that the best explorers preserve nature, by always walking on existing trails; by never stepping on plants and mangrove aerial roots (pneumatophores); by never destroying burrows; by never driving over fragile sabkha; and by never bashing pristine sand dunes.
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- Field preparedness: hat, sun-screen, water (2 liters per person), swim suit, wet shoes or sandals or old sneakers, towels, change of clothes, second pair of shoes.

- First Aid Kit (check RedCross.org for directions on how to stock a First Aid Kit)

- Field equipment: tape measures, a device at the discretion of the facilitator to record location coordinates; a smartphone to access online resources and take photographs

- Resource 1 (Location map)

- Resource 2 (Bioblitz Worksheet)

- Dedicated display board for classroom session

Activity:

Classroom Session 1:

- Explain to the students what is a bioblitz, and what an important tool it is in understanding the biodiversity around us and in the effort to conserve it. Emphasize the importance of citizen science in conservation efforts.
- Give a brief overview to the students about the capabilities and limitations of each application provided under "online resources".
- Guide the students through the process of downloading the apps on their smartphones.
- Assist students in creating free accounts.
- Show students how to navigate each app.
- Create a Project in iNaturalist and assist students in "joining" the Project. Ideally, the name of the school should be part of the Project title.
- Assist students through the process of uploading a few trial observations in their accounts and onto the Project, so that they are field ready.
- Emphasize that the optimum setting for geo-privacy is "obscure" and that they should select this setting, especially with endangered or species of rare sightings. This is very important for conservation.
- Show students how to take down coordinates with the compass function of their smartphones or by pinning the location on Google Maps.

Field Session 1:

1. **Title of the Activity:** Bioblitz in the mangrovial forest
   - Take a tour around the mangroves with the students.
   - Draw information from the available resources to discuss with the students the special characteristics of the mangrove forest and the organisms that inhabit this ecosystem.
   - Connect the knowledge they gained in class to what they see in the natural setting.
   - Ask the students to break into small teams.
   - Provide each team of students with the Bioblitz Worksheet (Resource 2), and pens. This worksheet will be used in parallel with the iNaturalist app, as it contains information items not included in iNaturalist.
   - Bring up with the students the basic principle of field work: keeping paper and digital copies of observations.
   - Ask each team to choose the group of organisms they want to survey, i.e., birds, plants, crabs, etc. Ideally, each team should pick a different group.
   - Pick as many spots in the mangrove forest as there are teams, and rotate the students around them.
   - Help the students take down the coordinates of each spot, and record their observations in their Worksheets
   - Help the students take pictures of their observations, including signs of disturbance, and upload them to iNaturalist.
   - Ask the students to tally the different species they observed.
   - Sit in a circle with the students and discuss their findings, bring everything together to reconstruct the ecology of the surveyed area.
   - Ask the students whether there are differences between the habitats in terms of the number of species they could find. What were the types of disturbance they observed, and did it have any effect on the species they observed?

Activity:

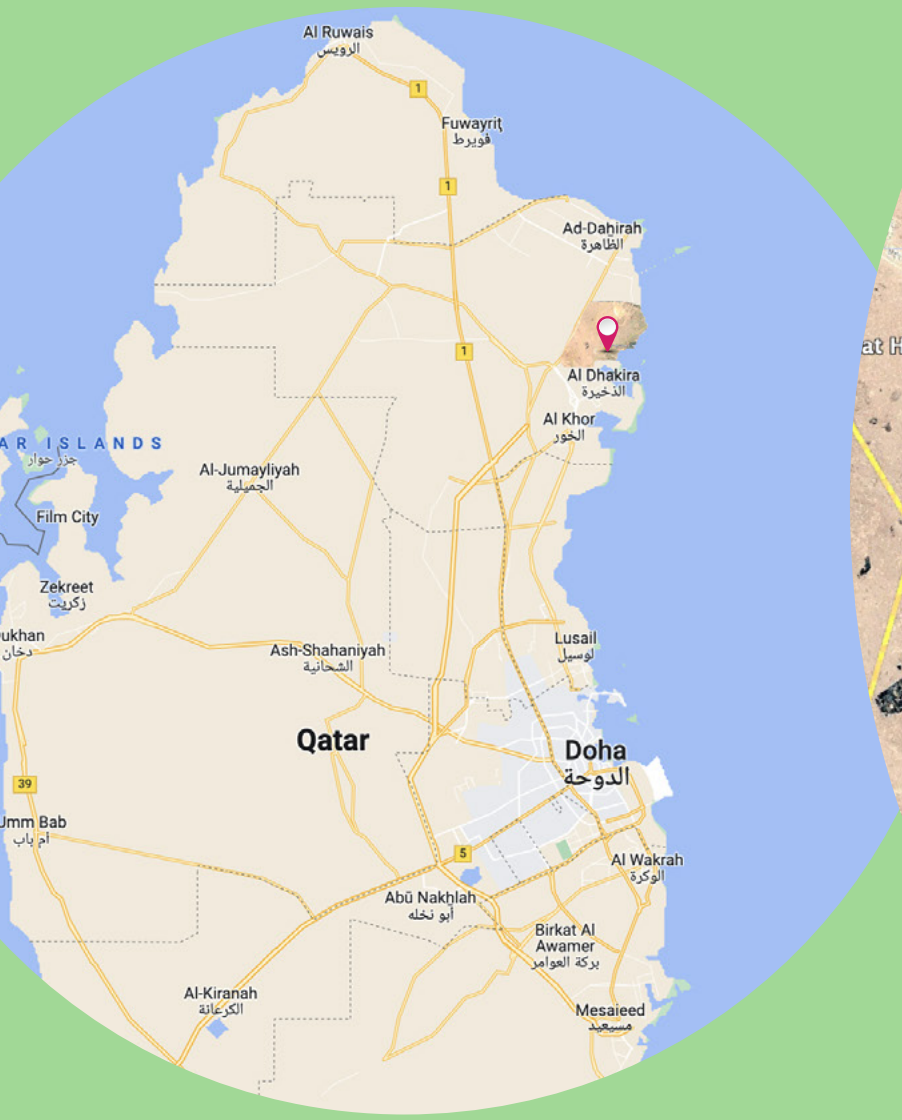
2. Inform and Involve

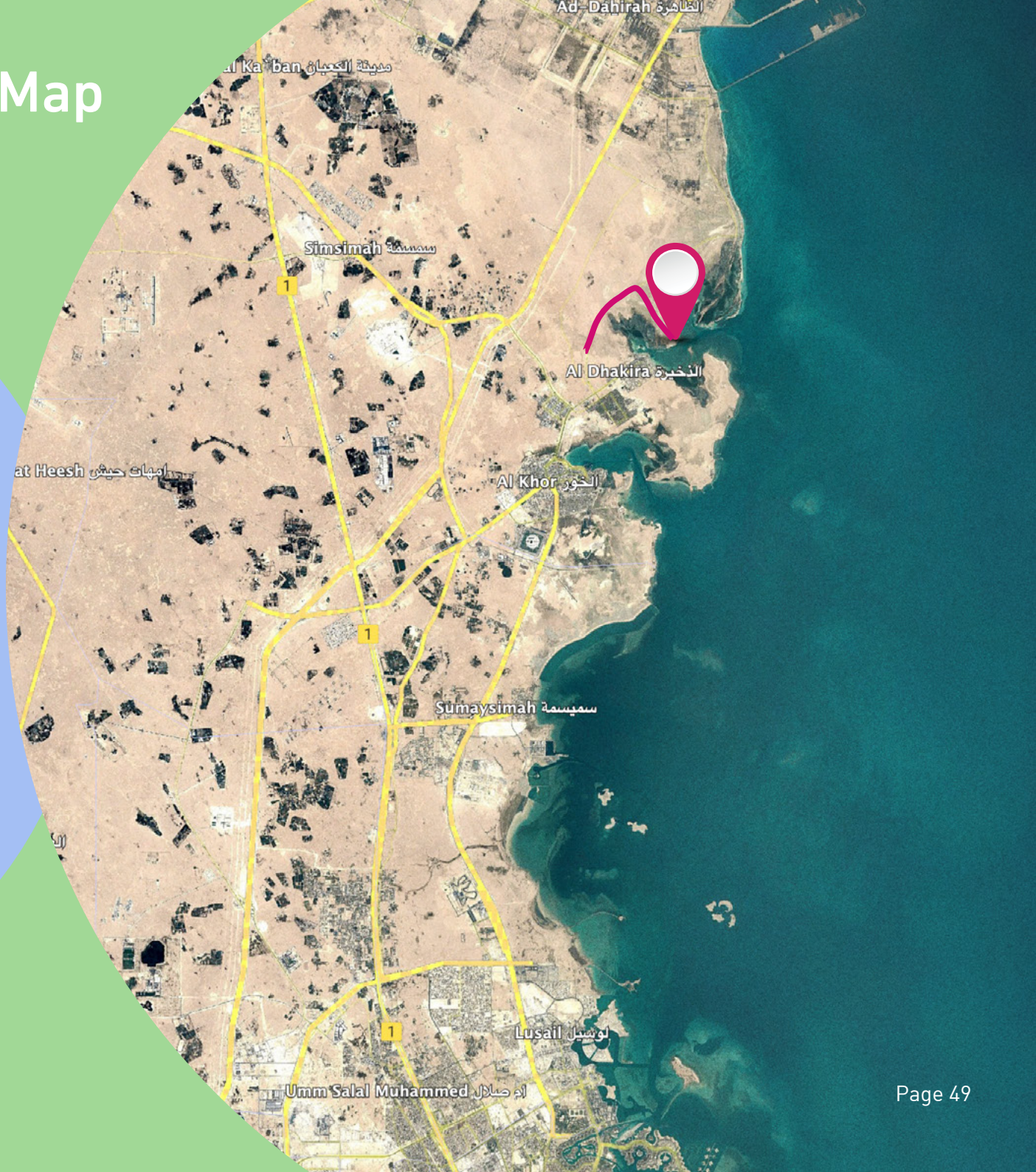
- The iNaturalist bioblitz Project (include actual Project Name) with species observations made during the field excursion should be shared with the Eco-Schools community, with the aim to engage and encourage others to explore nature and make their own observations and contributions to the Project.

Photo Source: Aspa D. Chatziefthimiou

Photo Source: Aspa D. Chatziefthimiou

Resource 1: Location Map





Google Earth

Task 3
Mangrove Forest

14-17 Years

Location: Al Thakira

Coordinates:

25°46'04.1"N

51°32'11.9"E

Task 3
Mangrove Forest

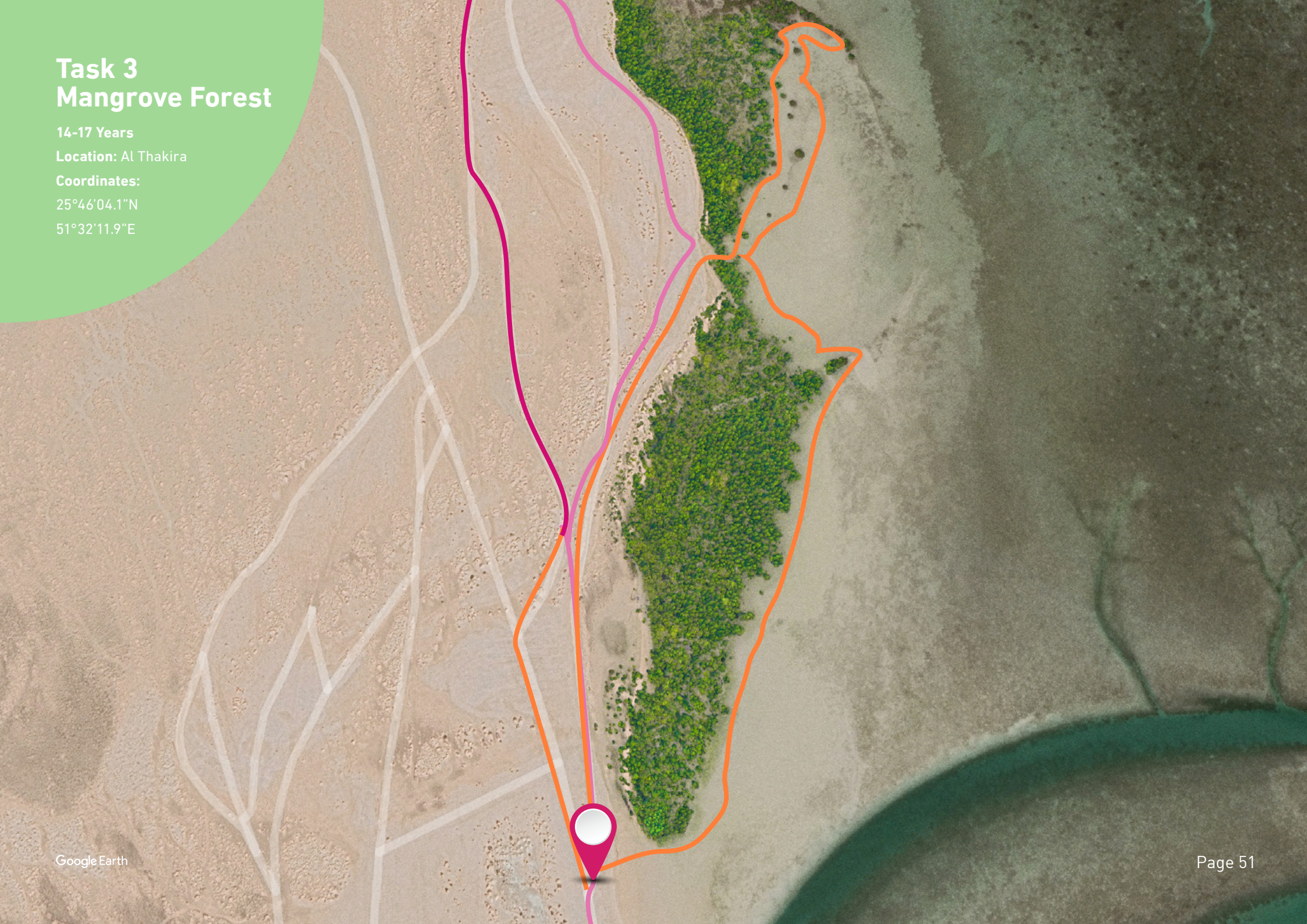
14-17 Years

Location: Al Thakira

Coordinates:

25°46'04.1"N

51°32'11.9"E



Resource 2

Bioblitz Worksheet		
Names of students in the team:		
Circle the group of organisms to survey, or add the one of your choice: plants, birds, snails, crabs/burrows, bivalves		
Directions: record the number and the coordinates of each spot. Describe the habitat, for example, mangrove channel, edge of forest by the shore, middle of the forest etc. Conduct this survey in a 3m x 3m area around your spot. Record the number and the kinds of species you observe within yourchosen group, and the number of burrows if you have chosen to survey crabs. Regroup with your class and discuss your findings.		
Location #: Coordinates: Habitat:	**Location #:** Coordinates: Habitat:	**Location #:** Coordinates: Habitat:
Location #: Coordinates: Habitat:	**Location #:** Coordinates: Habitat:	**Location #:** Coordinates: Habitat:
Location #: Coordinates: Habitat:	**Location #:** Coordinates: Habitat:	**Location #:** Coordinates: Habitat: