Technical Report

Environmental Consultancy Services for Biodiversity and Ecosystem Services

Contract Ref: C116/2019

Final – October 2020

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R2	07.06.2020	Changes to BOF maps and BAP sections	CTEC			
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Executive Summary

SEZD/ OPAZ manages, regulates, and oversees the development of all economic activities in the SEZ at Duqm. It is executing the construction of seven sub-projects that form enabling infrastructure to the Port, the Refinery, and the wider SEZ area. SEZD/OPAZ is being supported by MIGA to secure the financing of the seven sub-projects. In August 2020, the Government of Oman issued RD 105/2020 establishing the Public Authority for Special Economic Zones and Free Zones (OPAZ) which transferred the allocations, origins, rights, obligations, and assets of SEZAD, which was the name of the earlier authority for SEZD, to this new Authority. In this report, all references to SEZAD should be construed as referring to OPAZ.

As part of the Lender's requirements, SEZD has carried out this Critical Habitat Assessment (CHA), preparation of the Biodiversity Action Plan (BAP) and Biodiversity Offset Framework (BOF), and Ecosystem Services (ES).

The work involved reviewing the existing biodiversity baseline information from secondary reports, including from the EIA/ ESIAs of the sub-projects, and validated through a site survey, undertake CHA identifying the critical habitat and qualifying the biodiversity, identifying priorities and actions for biodiversity conservation through BAP, achieving a net gain for biodiversity, and determining the benefits that people receive from ES. The work was carried out complying with national legislation/ policy requirements, international environmental requirements and best practices, including International Finance Corporation (IFC) Performance Standard 6 (PS6).

Baseline ecological conditions were established through desktop studies and targeted site surveys. The findings show that the sub-projects or the entire SEZD area do not fall or have any nationally notified protected areas, except for the International Birding Areas (IBAs) at Duqm and Jiddat al Harasis (JAH). JAH was discounted as only 2% of the entire IBA falls within SEZD boundary. Duqm IBA had a core zone of the mudflat/ lagoon spread over 250 ha. wherein the migratory and the local birds of high conservation value congregated. However, the expansion and operation of the Port of Duqm has impacted this IBA and currently, only 20 ha. of the IBA exists which also will take few years for stabilization. The aquatic area of SEZD are the Port of Duqm area, Fishery port, and Ras Markaz area. They extend to approximately 5-10 km from the coastline. While they do not contain any sensitive features, the offshore area of Duqm region is sensitive with marine mammals and turtles.

From the CHA and assessing the habitats and species in Duqm for areas with high biodiversity value with critically endangered, endangered, endemic, and/or migratory species, the following were identified as priority for biodiversity conservation:

- Habitats – 2,260 hectares within the SEZD area comprising of Duqm IBA, Wadis, Desert Rangeland, Escarpment Plateau, and Rocky Mountains; and

- Species – Plants (*Ochradenus harsuticus* and *Salsola omanensis*), birds (Egyptian Vulture and Socotra Cormorant), Lizards (Omani Spiny-tailed Lizard and Egyptian Spiny–tailed Lizard), Marine Mammals (Humpback Whale and Indian Ocean Humpback Dolphin), and Turtles (Green Turtle, Loggerhead Turtle, Hawksbill Turtle, and Olive Ridley Turtle).

A total of twelve action items are outlined in the BAP in order to achieve no conserve biodiversity in Duqm and achieve net loss to biodiversity and a net gain in critical habitats. These actions include:

1) Conservation of existing biodiverse areas;
2) Carrying out biodiversity survey across the entire SEZD area;
3) Rehabilitate available impacted sensitive habitats;
4) Demarcation and notification of Priority Areas;
5) Create connecting trail and earmark as Priority Area;
6) Create oil spill response planning;
7) Adhere to oil spill prevention/ abatement recommendations stipulated in the project EMPs;
8) Establishment of SEZD-wide environmental monitoring system;
9) Implement and follow IAS program;
10) Following best practices for ballast water management;
11) Placing the BAP in the public domain; and
12) Organizing community and stakeholder biodiversity education events/ programs.

As part of the BOF, a "Priority Area Atlas for Conservation of Biodiversity" has been created where specific land parcels across SEZD have been designated as no-go areas (for industrial and non-industrial development) and earmarked for conservation purposes providing the necessary habitat/ refuge for flora and fauna and compensate for loss of biodiversity from developmental activities. Three types of classification of the land parcels have been done:

- NOS (Naturalized Open Spaces) areas which are open natural land - approximately 15,128 hectares. This also includes the 2,260 hectares of conservation area identified from CHA exercise and included in the BAP;
- LSA (Landscape Areas) areas primarily for landscaping - approximately 2,951 hectares; and
- BOA (Biodiversity Offset Areas) areas which are offsets proposed - approximately 2,005 hectares;

The BOA comprises four distinct typologies prevalent in Duqm such as Coastal Lagoon/ Dune, Flood Plain Wetland, Wadi Grassland & Acacia, and Highland/ Cliff. Concept designs and steps to be taken for the design and implementation has been presented. Impacts to the ESs was evaluated and recommendations for monitoring and measures indices presented along with monitoring across the entire SEZD area for all environmental parameters.

An implementation model to execute the BAP action items has been presented which includes timelines and it is recommended that a biodiversity baseline survey be conducted in 2025 and BAP updated with suggestion that the BAP be revised after every ten years.

Abbreviations and Acronyms

ARIES	Artificial Intelligence for Ecosystem Services
BAP	Biodiversity Action Plan
BBOP	Business and Biodiversity Offsets Programme
BOA	Biodiversity Offset Area
BOF	Biodiversity Offset Framework
CAAQMS	Continuous Ambient Air Quality Monitoring Station
CBD	Convention on Biological Diversity
CH	Critical Habitat
CHA	Critical Habitat Assessment
CITES	The Convention on International Trade in Endangered Species of Wild Fauna and Flora
CN	construction
CR	Critically Endangered
CSBI	Cross Sector Biodiversity Initiative
CSR	Corporate Social Responsibility
CTEC	Civil Technology Engineering Consultancy
DEM	Digital Elevation Model
DMU	Discrete Management Unit
DRPIC	Duqm Refinery
EIA	Environmental Impact Assessment
EIP	Eco-Industrial Park
EMP	Environmental Management Plan
EN	Endangered
ES	Ecosystem Services
ESAP	Environmental and Social Action Plan
ESDD	Environmental and Social Due Diligence
ESG	Environmental Social Governance
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
EST	Ecosystem Services Toolkit
G	global
GDP	Gross Domestic Product
GN	Guidance Note
GRI	Global Reporting Initiative

GiSP	Global Invasive Species Programme
IAS	Invasive Alien Species
IBA	Important Birding Area/ Important Bird and Biodiversity Area
IEP	Initial Environmental Permit
IES	Institution of Environmental Sciences
IFC	International Finance Corporation
IMO	International Maritime Organization
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
IPIECA	International Petroleum Industry Environmental Conservation Association
IUCN	International Union for Conservation of Nature
JAH	Jiddat al Harasis
L	Local
LSA	Landscape Area
MD	Ministerial Decision
MIGA	Multilateral Investment Guarantee Agency
N	National
NG	Net Gain
NNL	No Net Loss
NOS	Naturalized Open Space
NSSDAR	National Strategy of Sustainable Development for Animal Resources
NT	Near Threatened
OGP	International Association of Oil and Gas Producers
OP	operation
OPAZ	Public Authority for Special Economic Zones and Free Zones
PEIA	Preliminary Environmental Impact Assessment
PS	Performance Standard
PS6	Performance Standard 6 dealing with “Biodiversity Conservation and Sustainable Management of Living Natural Resources”
RAG	Red/ Amber/ Green risk rating
RD	Royal Decree
RFI	Request for Information
ROPME	Regional Organization for the Protection of the Marine Environment
SDG	Sustainable Development Goals
SEP	Stakeholder Engagement Plan
SEZ	Special Economic Zone
SEZAD	Special Economic Zone Authority at Duqm
SEZD	Special Economic Zone at Duqm

SME	Small and Medium Enterprises
TEEB	The Economics of Ecosystems & Biodiversity
TESSA	Toolkit for Ecosystem Service Site-Based Assessment
ToC	Table of Contents
UER	Umm Er Radhuma Aquifer Formation
UHI	Urban Heat Island
UNCCD	The United Nations Convention on Combatting Desertification
UNCLOS	United Nations Convention on the Law of the Sea
UNFCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
VU	Vulnerable

1 INTRODUCTION

The Special Economic Zone at Duqm (SEZD) manages the development of all economic activities in the Special Economic Zone (SEZ) at Duqm[1]. With a land area of 2,000 km^2 and 90 km of coastline along the Arabian Sea, the Duqm SEZ is the largest in the Middle East and North Africa region and ranks amongst the largest in the world. The latest map of SEZD defining its geographical boundaries and illustrating the marine areas that fall part of the SEZD area is shown in ***Figure 1-1***.

SEZD is executing the construction of a Project consisting of seven sub-projects listed below, which form enabling infrastructure to the Port, the Refinery, and the SEZD area. These Sub-Projects are at different stages of completion. SEZD is being supported by the Multilateral Investment Guarantee Agency (MIGA) to secure the financing of the seven sub-projects, through the Ministry of Finance. The list of seven sub-projects is summarized in ***Table 1-1*** and their location is shown in ***Figure 1-2***. The details of the seven projects and their description is presented as ***Appendix A***.

Table 1-1: Seven MIGA Projects

Project No.	Contract No.	Project Description
1	IP3 - Contract C50/ 2015	Construction of roads, buildings and additional infrastructure at the commercial pre-gate, gates and inspection zone of Port of Duqm.
2	IP7 - Contract C78/2017	Design, procurement and construction of the marine structures and associated berths, dredging works and permanent reclamation areas of liquid bulk berths in the Port of Duqm.
3	Contract C81/2017	Construction of Road No. 1 and Road No. 5 to link the Liquid Berth Terminal at Duqm Port to the Heavy Industrial Zone and drainage systems along the two roads.
4	Contract C65/2016	Construction of Jurf and Saay flood protection channels in Duqm.
5	Contract C76/2016	Construction of Jurf and Saay flood protection dams in Duqm.
6	Contract C80/2017	Engineering, procurement and construction of Duqm Refinery service corridor to liquid jetty.
7	Contract C73/2016	Construction of interface roadway projects in Duqm (Road Section 4).

[1] The Government of the Sultanate of Oman through Royal Decree (RD) No. 19/2011 established the Special Economic Zone Authority at Duqm (SEZAD) to manage, regulate, and oversee the development of all economic activities in the Duqm SEZ. However, the Government of Oman through RD No. 105/2020 established the Public Authority for Special Economic Zones and Free Zones (OPAZ) which transferred the authority of SEZAD to this new body and SEZAD ceased to be in existence.

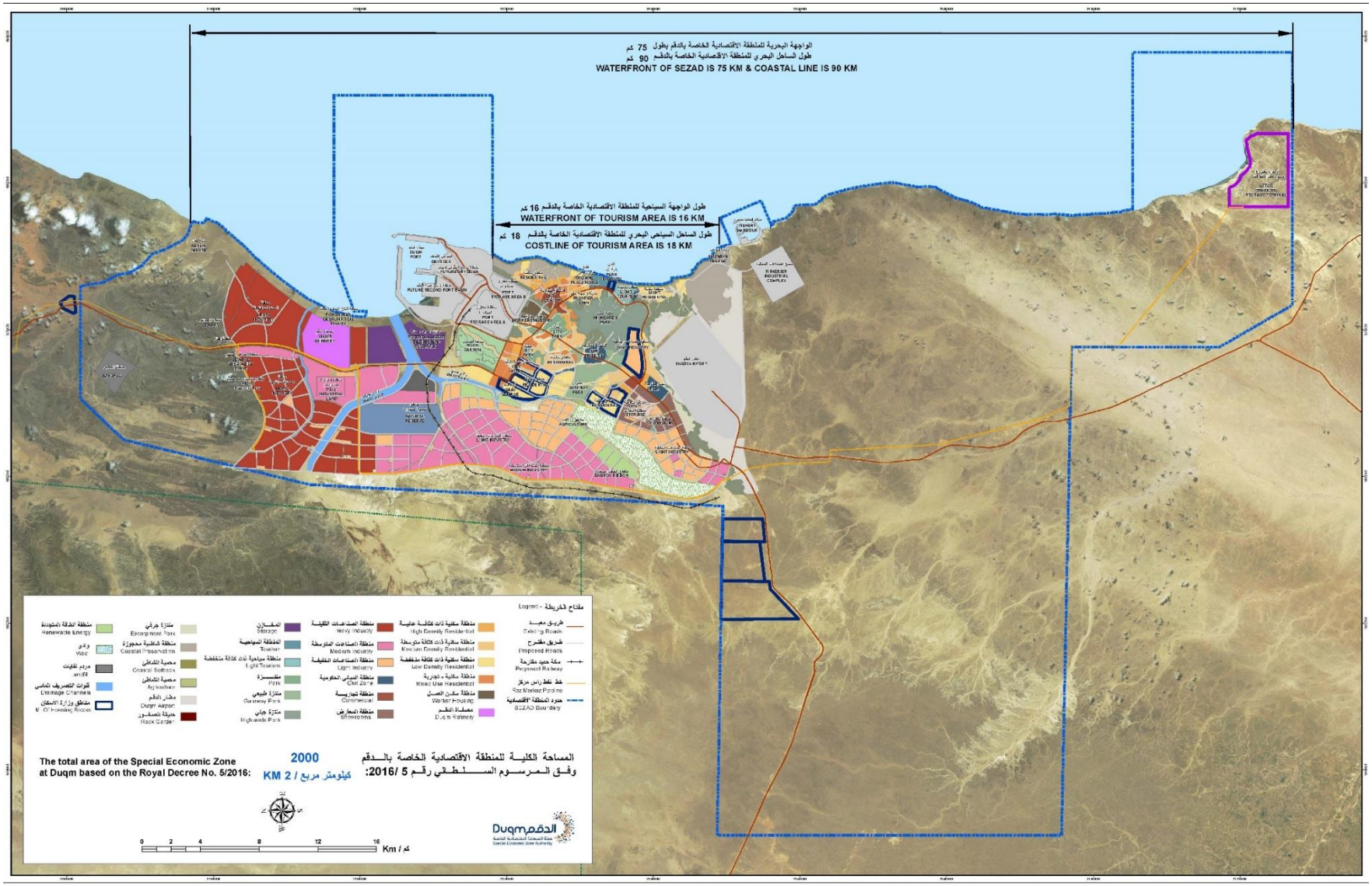
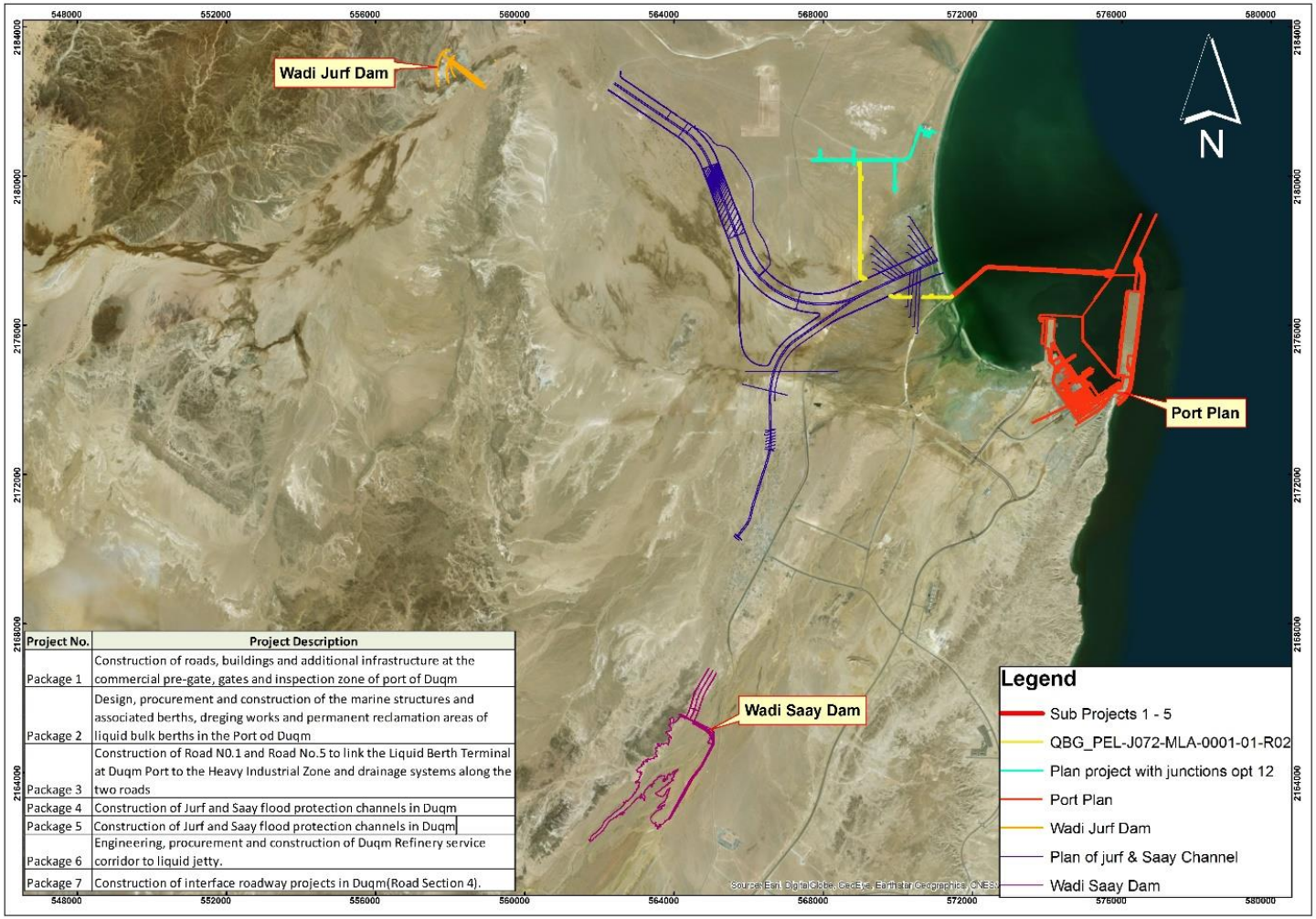


Figure 1-1: Map of SEZD Area



Project No.	Project Description
Package 1	Construction of roads, buildings and additional infrastructure at the commercial pre-gate, gates and inspection zone of port of Duqm
Package 2	Design, procurement and construction of the marine structures and associated berths, dreging works and permanent reclamation areas of liquid bulk berths in the Port od Duqm
Package 3	Construction of Road N0.1 and Road No.5 to link the Liquid Berth Terminal at Duqm Port to the Heavy Industrial Zone and drainage systems along the two roads
Package 4	Construction of Jurf and Saay flood protection channels in Duqm
Package 5	Construction of Jurf and Saay flood protection channels in Duqm
Package 6	Engineering, procurement and construction of Duqm Refinery service corridor to liquid jetty.
Package 7	Construction of interface roadway projects in Duqm(Road Section 4).

Figure 1-2: Seven MIGA Projects

As part of the Lender's requirements, SEZD had carried out environmental and social due diligence (ESDD) of this Project and a detailed ESDD report and associated environmental and social action plan (ESAP) has been developed to be implemented by SEZD in relation to the seven sub-projects and the zone-wide environmental responsibilities of SEZD.

On August 18, 2020, the Government of Oman issued Royal Decree No. 105/2020 establishing the Public Authority for Special Economic Zones and Free Zones (OPAZ). This Royal Decree (RD) transferred the allocations, origins, rights, obligations, and assets of the Special Economic Zone Authority at Duqm (SEZAD) to this new Authority. Accordingly, the Special Economic Zone at Duqm (SEZD) becomes part of the Public Authority for Special Economic Zones and Free Zones. In this report, all references to SEZAD should be construed as referring to the newly established "Public Authority for Special Economic Zones and Free Zones (OPAZ)".

2 SCOPE OF THE STUDY

2.1 RFP Requirements

Based on the RFP requirements specified by SEZAD in the tender document (reference T-15/2019), the scope of work involved preparation of the following:

- Detailed assessment of ecosystem at the SEZD region to identify the current status and categorize the sectors affected by depletion and degradation of natural resources if any;
- Conducting a Critical Habitat Assessment (CHA) concerning the impact of the seven Sub Projects during the construction and operational phases which covers the following habitats - Cetaceans; Turtles; Endemic plants; Rare/threatened reptile species; Duqm IBA/ the migratory wetland bird assemblage; Jiddat al Harisis IBA; and Al Wusta Wildlife Reserve (formerly the Arabian Oryx Sanctuary);
- Development and implementation of site-specific strategies for the protection of critical habitats along with developing sector-specific monitoring, suggesting suitable legislation, management and mitigation plans;
- Preparing a Biodiversity Action Plan (BAP) and a Biodiversity Offsetting Framework (BOF) for the whole of SEZD which identifies suitable compensatory habitat creation/ offset initiative to meet the requirements of No Net Loss (NNL), i.e. natural habitats/ Net Gain (NG), i.e., critical habitats as per the requirements of IFC Performance Standard number 6 – Biodiversity;
- Conservation and Sustainable Management of Living Natural Resources; and
- Carrying out the Ecosystem Services (ES) assessment in consultation with SEZAD.

From the above, the objectives of this study could be summarized as:

- Review of the existing biodiversity baseline information from the secondary reports (from the Environmental and Social Impact Assessment (ESIAs) carried out as part of the approval process for the sub-projects);
- Undertake CHA identifying the critical habitat qualifying the biodiversity associated with the sub-projects;
- Identify priorities and actions for biodiversity conservation, in consultation with stakeholders; Determine actions to be undertaken within the BOF structure to benefit biodiversity and meet the requirements of NNL/NG; and
- Determining the benefits that people receive from nature as part of the ES assessment.

2.2 Discussion on the Scope

As part of this report preparation, no detailed primary survey was carried out. SEZAD had commissioned a detailed Environmental Baseline Study for the Duqm area which was carried out earlier in 2012-14[2]

[2] Environmental Baseline Study for Duqm Development and Surroundings, HMR Consultants , May 2014

(HMR, 2014). That 2014 study was accomplished across the entire SEZD area and was an extensive baseline study before any developments came into Duqm. The study surveys were carried out for a period of 16 months to capture seasonal variation of different terrestrial, physical, and marine environmental parameters, and covered winter; pre-khareef; and summer/ khareef seasons. The Consultant team that worked on preparing the above study worked on this report too and have been working on Duqm and Duqm based projects for the last 8 years and are aware of the environmental and social conditions existing in the region and the changes that have occurred. Discussing with SEZD, it was felt that a short primary survey may not be sufficient to capture the baseline information for this biodiversity report as it requires seasonal studies, particularly in khareef and winter. Accordingly, this report was prepared based on secondary information. Apart from the above referenced report, the consolidated ESIA carried out for Duqm Refinery (DRPIC)[3] along with Project specific EIA/ESIAs were used in preparing this report. However, the Consultants visited the Duqm area and validated the findings through visual reconnaissance surveys and observations on the status of the Critical Habitat Areas and the Priority Areas. The findings are presented in the subsequent ***Chapter 4***. ***Appendix B*** presents the report of the validation survey that was carried out in January 2020.

As part of this report preparation, the Consultants engaged not only with SEZD's environmental department, but also with SEZD's Planning Department that allocates lands for industries and adheres to implementing the masterplans prepared from SEZAD by Atkins and SOM and also the senior management of SEZD on their vision and environmental strategy for SEZD. There have been various studies carried out in Duqm for SEZAD and for other companies and they all had consultations and the output of these reports had been considered in this report preparation. Because of the ongoing Covid pandemic situation and the associated lockdowns, no other stakeholder consultative meetings could be held. However, since DRPIC is the key stakeholder, the draft biodiversity report has been provided to them for their inputs and SEZD is discussing on the offset areas identified in this report that can be used for DRPIC's offsetting requirements.

2.3 Definition of the Terminologies

To facilitate clear understanding of the scope and the objectives, it is pertinent to look at the definitions of the various key terminologies:

Biodiversity Action Plan (BAP)	A Biodiversity Action Plan is a "plan to conserve or enhance biodiversity", more specifically a set of future actions that will lead to the conservation or enhancement of biodiversity[4].

[3] Duqm Refinery Project Oman. Consolidated Impact Assessment and Mitigation Report with appendices. WSP. Dec 2017

[4] *A Guide to developing Biodiversity Action Plans for the oil and gas sector*, prepared by the International Petroleum Industry Environmental Conservation Association (IPIECA) and the International Association of Oil and Gas Producers (OGP), 2005. Original source: Earthwatch Institute. 2000. *Case Studies in Business & Biodiversity*, ISBN 0-9538179-2-X, 30 pp.

Biodiversity Offsetting Framework (BOF)	Biodiversity offsets are measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from development plans or projects after appropriate prevention and mitigation measures have been taken. The goal of biodiversity offsets is to achieve no net loss and preferably a net gain of biodiversity on the ground with respect to species composition, habitat structure, ecosystem function and people's use and cultural values associated with biodiversity[5].
Critical Habitat Assessment (CHA)	Critical Habitat represents areas of high biodiversity value. Critical Habitat is identified based on five criteria that address habitats of significant importance to threatened, endemic, congregatory, and migratory species, threatened or unique ecosystems, and key evolutionary processes[6].
Ecosystem Services (ES)	Ecosystem services are the benefits that people receive from nature—for example, the production of food, the provision of clean water, and the regulation of climate, as well as opportunities for cultural, spiritual, and recreational experiences[7].

2.4 Structure of the Report

The final report (Biodiversity and Ecosystem Services) is structured as follows:

- **Chapter 1** presents the introduction and a brief on the sub-projects;
- **Chapter 2** presents the scope of the study and the definitions;
- **Chapter 3** presents the Legal, Regulatory, Planning, and Third Party Requirements;
- **Chapter 4** provides a brief on the biodiversity baseline;
- **Chapter 5** illustrates the CHA that is carried out;
- **Chapter 6** presents the BAP including the action items and illustrates the priority areas earmarked for conservation;
- **Chapter 7** briefly discusses the ecosystem services identified at the project area;
- **Chapter 8** discusses the implementation and rollout model;

[5] *Independent report on biodiversity offsets*, published by the International Council on Mining and Metals (ICMM) and the International Union for Conservation of Nature (IUCN), January 2013. Original source: http://bbop.forest-trends.org/pages/guidelines
[6] From IFC PS6
[7] *Measuring and Monitoring Ecosystem Services at the site scale - Introducing a practical toolkit*, BirdLife International and Cambridge Conservation Initiative, 2011

- **Chapter 9** presents the Conclusion and Recommendations; and
- **Appendix A** presents the details of the seven sub-projects;
- **Appendix B** presents the information on the validation survey of January 2020;
- **Appendix C** presents the details of the species evaluated as part of the CHA;
- **Appendix D** presents the recommendations for ecological monitoring of the marine environment; and
- **Appendix E** presents the concept designs for the BOA lands; and
- **Appendix F** presents the references list.

3 LEGAL, REGULATORY, PLANNING, & THIRD PARTY REQUIREMENTS

3.1 Regional & International Legislation and Policy

The following international laws and conventions have been ratified by Sultanate of Oman and are of relevance to SEZD:

- Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973);
- Regional Organization for the Protection of the Marine Environment (ROPME) (1978);
- UN (Rio) Convention on Biological Diversity (1992), Sultanate signed the convention in June 1992 and ratified it in December 1994;
- Convention on the Conservation of Wildlife and their Natural Habitats in the Countries of the Gulf Cooperation Council (2009);
- The United Nations Convention on Combatting Desertification (UNCCD); in Countries Facing Severe Arid Conditions and the Ramsar Convention;
- Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal;
- The Convention on Biological Diversity (CBD), known informally as the Biodiversity Convention, is a multilateral treaty; and
- United Nations Framework Convention on Climate Change (UNFCC);
- International Convention for the Prevention of Pollution from Ships, 1973; and
- The United Nations Convention on the Law of the Sea (UNCLOS);

3.2 National Legislative and Policy Framework

The Omani environmental laws and regulations with regard to environment, biodiversity and conservation are covered under the following laws and regulations. In Oman laws and regulations are issued as Royal Decrees (RDs) and Ministerial Decisions (MDs). The relevant ones are:

- RD No. 6/80 -The Law on the Protection of National Heritage;
- RD No. 53/81-The Law on the Protection of Marine Biological Wealth;
- RD No. 114/2001- The Law on the Conservation of the Environment and Prevention Pollution;
- RD No. 92-2000 - Promulgating the Law on the Protection of New Plant Varieties (Plant Breeds Protection Law);
- RD No. 6/2003 -The law on Nature Reserves and Wildlife Conservation;
- The Royal Decrees for the establishment of 18 Nature Reserves; (RD relevance to the Duqm region is presented below)-
    - RD 26-79 Law of National Gardens and Protected Natural Areas;

- RD 4-94 Establishing Arabian Oryx Sanctuary;
- RD 92-2000 Promulgating the Law on the Protection of New Plant Varieties (Plant Breeds Protection Law);

- MD No. 169/2000 - Prevent cutting green trees;
- MD No. 01/2002 - on the prohibition of hunting or killing or captured of wild animals and birds;
- MD No. 101-2002 -Concerning the Bank on Killing, Hunting or Trapping of Wild Animals or Birds;
- MD No. 110-2007 Issuing the Implementing Regulations of the Law on Nature Reserve and Wildlife Conservation;
- RD No. 51-2014 - Establishment of Wetlands Reserve in Al Wusta Governorate;
- MD No. 5-2017 - Rules on Uprooting and Removal of Ghaf Trees (*Prosopis cineraria*); and
- MD No. 65-2017 - Regulations on Logging and Charcoal.

3.3 Planning and Permitting Requirements

3.3.1 Environmental and Social Impact Assessment (ESIA)

Detailed environmental impact assessment (EIA) and environmental and social impact assessment (ESIA) studies had been completed for the each of the sub-projects to identify and assess potential environmental impacts and social impacts of the project activities in order to develop suitable control measures and management plans to mitigate significant impacts. Based on the site biotic characteristics of each of these projects, the ESIA identified a number of mitigation and compensation measures which were necessary to ensure that there would be no net loss in biodiversity. The table below, in ***Table 3-1***, summarises the likely significant direct and indirect impacts of the sub-projects as identified in each of the respective ESIA/ EIA reports. The table presents the details of sensitive habitats in each project area and threatened, protected species that have been identified or are known to likely occur within the wider SEZD Area, which may be affected by the Projects and the types of impacts that may occur.

Table 3-1: Summary of key likely significant impacts on ecological features during construction (CN) and operation (OP) activities

#	Sensitive habitat & species in various projects	IUCN 2020	Endemic Oman	Permanent Habitat Loss During Construction	Temporary[8] habitat loss	Noise Impact	Light Impact	Physical Barriers to movement	Collision with Vehicles/vessels
	Various Habitats								
1	Coastal - Rocky shoreline	-	-	CN	CN	-	-	-	-
	Coastal -Sandy shoreline	-	-	CN	CN	-	-	-	-
	Coastal -Intertidal Mudflat	-	-	CN	CN	-	-	-	-
	Coastal -Tide pools/Lagoon	-	-	CN	CN	-	-	-	-
2	Sabkha	-	-	CN	CN	-	-	-	-
3	Wadi/Shrubland	-	-	CN	CN	-	-	-	-
4	Gravel and Sandy Plain	-	-	CN	CN	-	-	-	-
5	Hill and Escarpment	-	-	CN	CN	-	-	-	-
6	Marine Environment	-	-	CN	CN	-	-	-	-
	Plants								
1	*Limonium sacrophyllum*	-	Endemic	CN	CN	-	-	-	-
2	*Pulicaria glutinosa*	-	endemic Arabian peninsula	CN	CN	-	-	-	-
3	*Ochradenus harsuticus*	-	Endemic	CN	CN	-	-	-	-

[8] Road access, work compounds, vessel movements

#	Sensitive habitat & species in various projects	IUCN 2020	Endemic Oman	Permanent Habitat Loss During Construction	Temporary[8] habitat loss	Noise Impact	Light Impact	Physical Barriers to movement	Collision with Vehicles/vessels
4	*Salsola omanensis*	VU[9]	-	CN	CN	-	-	-	-
	Birds								
1	*Numenius arquata*	NT[10]	-	CN	CN	CN,OP	CN,OP	-	CN,OP
2	*Limosa limosa*	NT	-	CN	CN	CN,OP	CN,OP	-	CN,OP
3	*Phalacrocorax nigrogularis*	VU	-	CN	CN	CN,OP	CN,OP	-	CN,OP
	Lizards								
1	*Uromastyx thomasi*	VU	-	CN	CN	CN,OP	CN,OP	CN,OP	CN,OP
2	*Uromastyx aegyptia leptieni*	VU	-	CN	CN	CN,OP	CN,OP	CN,OP	CN,OP
	Marine Mammals	-	-						
1	Humpback whale *Megaptera novaeangliae*	EN[11]	-	-	CN	CN, OP	-	-	CN, OP
2	False Killer Whale *Pseudorca crassidens*	NT	-	-	CN	CN, OP	-	-	CN, OP
3	Indian Ocean Humpback Dolphin *Sousa plumbea*	EN	-	CN	CN	CN, OP	-	-	CN, OP
	Turtles	-	-						
1	*Chelonia mydas*	EN	-	CN	CN	CN, OP	CN, OP	-	CN, OP
2	*Caretta*	VU	-	CN	CN	CN, OP	CN, OP	-	CN, OP
3	*Eretmochelys imbricata*	CR[12]		CN	CN	CN, OP	CN, OP	-	CN, OP
4	*Lepidochelys olivacea*	VU		CN	CN	CN, OP	CN, OP	-	CN, OP

[9] VU- Vulnerable
[10] NT – Near Threatened
[11] EN- Endangered
[12] CR- Critically Endangered

3.4 Third Party Requirements

As indicated earlier, SEZAD is supported by MIGA to secure the financing of the seven sub-projects, through the Ministry of Finance. As part of the Lender's requirements, SEZAD had carried out the ESDD of this Project and a detailed ESDD report and associated ESAP has been developed to be implemented by SEZAD in relation to the seven sub-projects and the zone-wide environmental responsibilities of SEZAD. Furthermore, SEZAD is required to meet certain requirements under ESAP in accordance with the relevant IFC Performance Standards on Environment and Social Sustainability and Omani regulations, whichever is more stringent, and to the satisfaction of the external auditor acting on behalf of MIGA and lending institutions.

3.4.1 International Finance Corporation (IFC) Standards and Guidance

IFC's Performance Standard 6 (IFC 2012[a]) and the associated Guidance Note 6 (IFC 2012[b]) has been used on this study as the best practice and international standard. These standards recognize that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. IFC PS6 divides the habitats into modified, natural, and critical habitats. Critical habitats can be either modified or natural habitats supporting high biodiversity value, including:

- Criterion 1: Habitat of significant importance to Critically Endangered (CR) and/or Endangered (EN) species;
- Criterion 2: Habitat of significant importance to endemic or restricted-range species;
- Criterion 3: Habitat supporting globally significant migratory or congregatory species;
- Criterion 4: Highly threatened and/or unique ecosystems; and
- Criterion 5: Key evolutionary processes.

The standard also clarifies further circumstances in which an area may be recognized as Critical Habitat. The additional criteria include:

- Criterion 6: Legally Protected Areas in IUCN Categories I-II; and
- Criterion 7: Internationally Recognized Areas.

In areas of critical habitat, PS6 specifies that the client should not implement any project activities unless all of the following are demonstrated:

- No other viable alternatives within the region exist for development of the project on modified or natural habitats that are not critical;
- The project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological processes supporting those biodiversity values;

- The project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time; and
- A robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the client's management program.

The EIA/ ESIAs have highlighted the potential presence of critical habitats within the project area. In accordance with IFC PS6, a BAP is required for all projects located in critical habitat and is recommended for projects that have the potential to significantly impact natural habitat. For this purpose, a CHA was conducted for the entire project and details are presented in ***Chapter 5***.

4 BIODIVERSITY BASELINE

4.1 Overview

Duqm region is classified as a desert biome with arid ecosystems due to very low precipitation and high temperature. This region is comprised of mountains with gravelly plains, sporadic sand dunes and coastal region is composed of coastal dune habitats interspersed with rocky cliffs. Overall the vegetation is sparse which is mainly fed by the fog moisture and comprised of many different habitats with varying vegetation and associated fauna depending on the type of local topography and geology. The following reports, outlined in ***Table 4-1***, were reviewed in preparation for this baseline chapter.

Table 4-1: Reviewed Relevant Reports

#	Name of Report
1	Stage 4 Report: Final Master Plan and Development Framework, Schematic Engineering Design and Governance Strategy
2	Duqm Refinery Project Oman. Consolidated Impact Assessment and Mitigation Report with appendices. WSP. Dec 2017
3	Duqm Refinery Project Oman. Environmental and Social Impact Assessment – non-technical summary. WSP. Dec 2017
4	Duqm Liquid Bulk Berths Project. Addendum to Initial Environmental Permit (IEP) for Onshore Disposal. Boskalis Duqm LLC. June 2017
5	Design of Road Nos. 1 and 5 and Drainage Systems, Duqm. EIA Report. HMR Consultants. April 2017
6	Medium Industrial Zone Environmental Impact Assessment. Volume I: Non-Technical Summary. Haskoning DHV UK Ltd. Mar 2017
7	Port of Duqm Phase 1 Operational Environmental Impact Assessment. Three Volumes. Haskoning DHV UK Ltd. Oct. 2016
8	Assessment of Coastal Hazards, Vulnerability, and Risk for the Coast of Oman (2015)
9	Ras Markaz Crude Oil Park Project ESIA, Amec Foster Wheeler, 2015
10	Preliminary Environmental Impact Assessment Study (PEIA). Commercial, Governmental Berths and Pre-Gate and Inspection Zone. K&A Consultants S.A.E. March 2015
11	Environmental Impact Assessment Report. Duqm Liquid Bulk Berths Project. Worley Parsons Oman Engineering LLC. Sep 2015
12	Duqm Development Drainage Network and Protection Schemes – Phase 1. EIA for Saay Dam, Saay Channel, Jurf Channel and Channel Junction. Renardet S.A and Partners Consulting Engineers LLC. July 2015
13	Duqm Development Drainage Network and Protection Schemes – Phase 1. ESIA for Jurf Dam. Renardet S.A and Partners Consulting Engineers LLC. June 2015
14	EIA report for Service Corridor, Duqm. HMR Consultants. July 2015

15	Environmental Baseline Study for Duqm Development and Surroundings, HMR Consultants , May 2014

In SEZD area, the network of vegetated wadis serves as the main habitat to large mammals and also provides shelter and food to a range of invertebrates, reptiles and birds. The woodlands in the region, mainly composed of *Acacia* spp. and *Prosopis cineraria*, is also a habitat for birds, several species of medium and small bodied mammals and numerous species of reptiles. Endemic plants (*Limonium sacrophyllum, Pulicaria glutinosa,* and *Ochradenus harsuticus*) and vulnerable species (*Salsola omanensis*) were also reported from this region.

Reptiles are well represented in the area with high abundance and distribution, which includes lizards. A total of 26 lizard species have been documented out of which many have rare occurrence, and few have high abundance (Gardner 1990). Vulnerable species spiny tailed lizard *Uromastyx thomasi* and *Uromastyx aegyptia leptieni* were reported from the Duqm region. *Uromastyx* spp. are currently listed on Appendix II and protected by CITES (The Convention on International Trade in Endangered Species of Wild Fauna and Flora) against over-exploitation through international trade.

From the previous studies, it is apparent that the maximum avifaunal diversity was observed in the coastal region where over-wintering shore birds dominate the beaches. The sabkha area of Duqm port was listed as a potential site to be declared as an Important Birding Area (IBA[13]). The entire coastal habitat is important migratory ground for wintering birds. The beaches, especially at Ras Madrakah and the one stretching from Duqm Port to Nafun, are mostly inhabited by the migratory species during winter, as these birds come from sub-polar regions to escape the extreme cold weather. Red List (IUCN) species Curlew *Numenius arquata,* Socotra Cormorant *Phalacrocorax nigrogularis,* and Black-tailed Godwit *Limosa* were reported from the Duqm region. Oman lies at the centre of a migratory flyway and forms an important feeding ground. The major population of migratory birds has been afforded conservation status in Oman.

As per the Oman Bird Research Committee (Eriksen, 2010) a total of 168 bird species have been recorded from this region. There are 22 breeding species including golden eagle *Aquila chrysaetos*, houbara bustard *Chlamydotis undulata* (V) for which this is the most important breeding site in Oman; spotted thick-knee *Burhinus capensis*, cream-coloured courser *Cursorius cursor*, chestnut-bellied sandgrouse *Pterocles exustus*, coroneted sandgrouse *P.coronatus*, barn owl *Tyto alba*, little owl *Athene noctua,* black-crowned finch-lark , bartailed lark *Ammomanes cincturus*, Dunn's lark *A. Dunni*, hoopoe lark *Alaemon alaudipes* and crested lark *Galerida cristata*; desert wheatear *Oenanthe deserti*, great grey shrike *Lanius excubitor* and brown-necked raven *Corvus ruficollis*. A further 15 species visit the area in winter, and 104 species are recorded as passage migrants in spring and autumn. Many coastal species such as greater flamingos *Phoenicopterus rubur*, godwits, sanderlings, sandpipers, plovers, dunlins, whimbrel, curlew, oystercatcher, herons, egrets, spoonbills, turnstone, cormorants, several duck and tern species in winter on nearby lagoons.

Apart from the Duqm IBA, there is also a small portion (2%) of Jiddat al Harasis (JAH) IBA falling within SEZD area. This falls in the western boundary of SEZD and continues into a large plateau. A very

[13] Currently, IBA abbreviation is expanded to mean "Important Bird and Biodiversity Areas"

brief preliminary survey of the JAH IBA had been carried out in 1994 which showed the presence of over 160 bird species, including 22 breeding species, 15 migratory species, 104 species of passage migrants and the endangered houbara bustard. However, this JAH IBA has not been studied in detail. Both the IBAs were not notified/ designated.

The other sensitive terrestrial environmental area is the Al Wusta Wildlife Reserve (formerly the Arabian Oryx Sanctuary) which, however, falls outside SEZD boundaries. The sensitive marine environmental areas are all outside SEZD boundaries and mainly closer to Masirah Island and Barr Al Hikman area in the north and the Ras Madraka area in the south.

4.2 Sensitive Species in Duqm Region

About 21 species of whales and dolphins are known to occur in Oman waters and 12 have been reported from the Gulf of Masirah region. These species include the baleen whales (mysticetes), deep water sperm whales (*Physeter macrocephalus*), odonotocete whales, False killer whales (*Pseudorca crassidens*); indo-pacific humpback dolphins(*Sousa chinensis*), spinner dolphins (*Stenella longirostris*), long-beaked common dolphin (*Delphinus capensis*) and bottlenose dolphins (*Tursiops aduncus*) (Baldwin,2003). The resident humpback whale population is of great significance as this is a unique population of small numbers and is of very high international importance. The population is genetically and geographically isolated and known to be in decline, with fewer than 100 individuals remaining (Minton, 2004). This population is listed as endangered by IUCN (Minton et al 2008) and is known to be one of the rarest baleen whale populations in the world (Jurong 2011).

Four species of turtles (Green turtles *Chelonia mydas*, hawksbill turtles *Eretmochelys imbricata*, loggerhead turtles *Caretta* and olive ridley *Lepidochelys olivacea*) are commonly nesting in the Masirah, Ras Madrakah and pocket beaches in Duqm with nesting primarily occurring during the summer months in this region. These turtles are listed in the IUCN Red List of Threatened Species. Sensitive habitat and coral reefs were observed from different offshore areas and few scattered patches from the southern rocky bottom at Ras Madrakah. Most of the offshore coral area is located about 7 to 23 nautical miles away from the coastline in south and northern part of Duqm region. Different hard corals such as branching corals *Acropora* sp, encrusting *montipora* sp. *hydnophora microconos, Blastomussa* sp, *Leptastrea* sp, *Goniopora lobata, Platygyra lamellina, Platygyra* sp., *Stylophora danae, Anomastrea* sp, *Favia favus, Favia* sp., *Faviates flexuosa, Faviates* sp., *Goniopora* sp., *Turbinaria peltata,* encrusting *Oxypora* sp. Fungiid *Cycloseris* sp, rare and endemic corals such as *Achathestra maxim*, Octocorals, *Menalla, Annella,* few black corals such as *Antipathies* sp. and encrusting soft corals such as *Sinularia* sp., *Dendronephthya, Lobophytum* and *Cladiella* were observed from the offshore area (HMR, 2014).

Rocky shores along the Duqm region develop a rich and dense intertidal, subtidal macro-algal flora from June onwards as a result of cold, nutrient-rich waters generated by the strong southwest monsoon upwelling from June to September. Upwelling is the dominant environmental influence on the marine life in the region and makes the shallow shelf offshore from Duqm a highly productive environment for all marine organisms. (HMR, 2014).

Sensitive habitats in the Al Wusta region are presented in ***Figure 4-1***. Based on literature review, sensitive species observed from the seven sub-project areas (which includes the area falling under Duqm IBA, reflected in Projects 2, 3, 4, and 6) and in their surrounding areas are presented in ***Figure 4-2*** below.

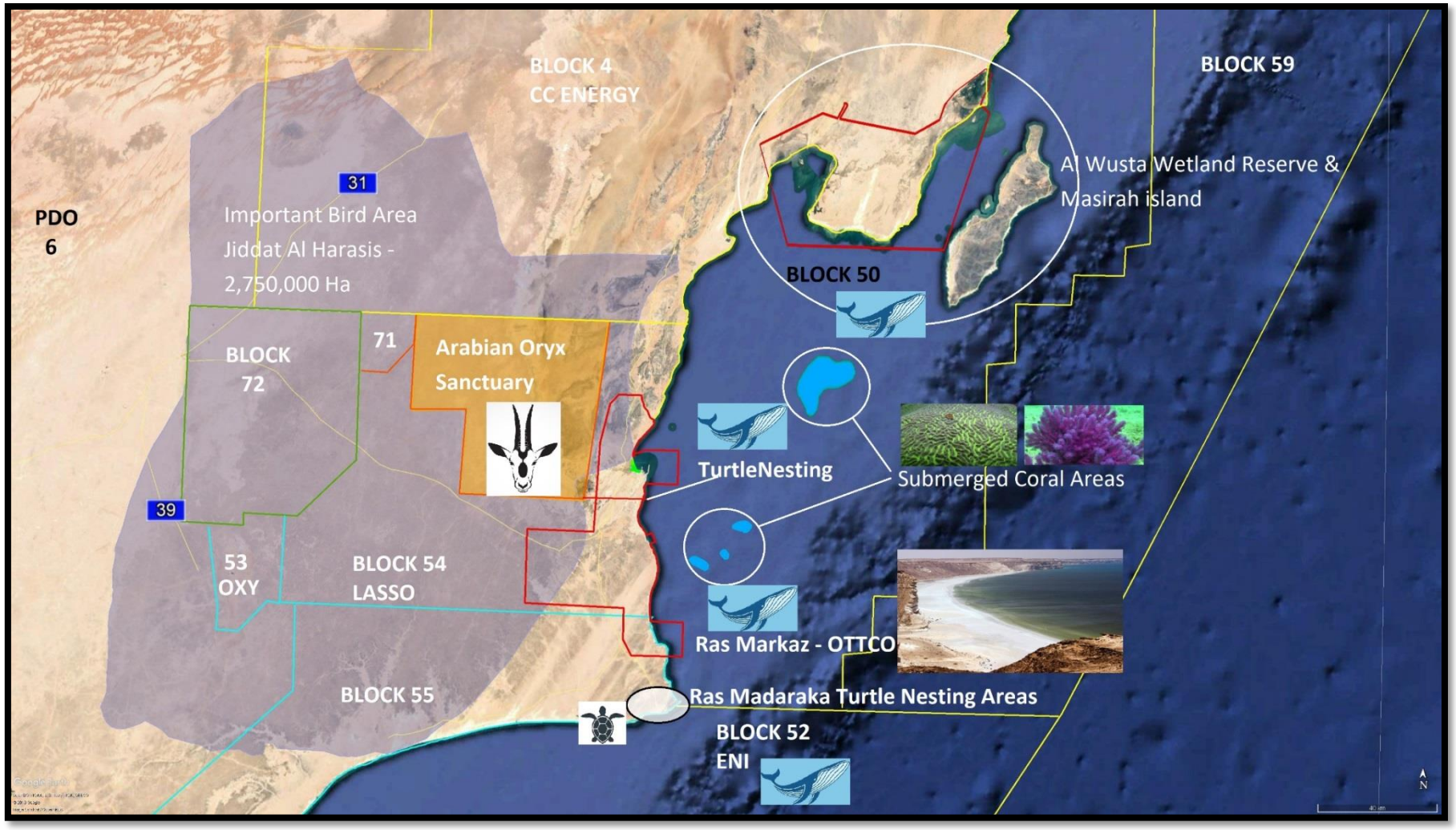


Figure 4-1: Sensitive Habitats in the Al Wusta Region

Table 4-2: Sensitive Species in the Seven Sub-Project Areas and Surrounding Areas of SEZ

#	Sensitive species	IUCN 2020/	SEZ area/ JAH IBA/ Al Wusta Wildlife Reserve/ Arabian Sea	Project 1 Roads, pre-Gate, Gates & Inspection Zone of Port of Duqm	Project 2 Dredging & reclamation works for liquid bulk berths in Port of Duqm (includes Duqm IBA)	Project 3 Construction of Road 1 & 5 connecting Liquid Berth Terminal to Heavy Ind. Zone (includes Duqm IBA)	Project 4 Construction of Jurf and Saay flood protection channels (includes Duqm IBA)	Project 5 Construction of Jurf and Saay flood protection dams	Project 6 Duqm Refinery service corridor to liquid jetty. (includes Duqm IBA)	Project 7 Construction of interface roadway
	Plant									
1	*Limonium sacrophyllum* (Oman-Endemic)	-	✓	-	-	✓	-	-	-	✓
2	*Pulicaria glutinosa* (Endemic Arabian peninsula)	-	✓	-	-	✓	-	-	✓	✓
3	*Ochradenus harsuticus* (Oman-Endemic)	VU[14]	✓	-	-		-	-	✓	-
4	*Salsola omanensis*	VU	✓	-	-	✓	-	-	-	-
	Birds									
1	*Numenius arquata*	NT[15]	✓	-	-	-	-	-	✓	-
2	*Limosa*	NT	✓	-	-	-	-	-		
3	*Phalacrocorax nigrogularis*	VU	✓	-	-	-	-	-	-	-
4	*Neophron percnopterus*	EN[16]	✓	-	-	-	-	-	-	-
5	*Chlamydotis macqueenii*	VU	✓	-	-	-	-	-	-	-
	Lizard									
1	*Uromastyx thomasi*	VU	✓	-	-	-	-	-	-	-

[14] VU- Vulnerable
[15] NT – Near Threatened
[16] EN- Endangered

#	Sensitive species	IUCN 2020/	SEZ area/ JAH IBA/ Al Wusta Wildlife Reserve/ Arabian Sea	**Project 1** Roads, pre-Gate, Gates & Inspection Zone of Port of Duqm	**Project 2** Dredging & reclamation works for liquid bulk berths in Port of Duqm (includes Duqm IBA)	**Project 3** Construction of Road 1 & 5 connecting Liquid Berth Terminal to Heavy Ind. Zone (includes Duqm IBA)	**Project 4** Construction of Jurf and Saay flood protection channels (includes Duqm IBA)	**Project 5** Construction of Jurf and Saay flood protection dams	**Project 6** Duqm Refinery service corridor to liquid jetty. (includes Duqm IBA)	**Project 7** Construction of interface roadway
2	*Uromastyx aegyptia leptieni*	VU	✓	-	-	-	-	-	✓	-
	Mammals									
1	*Capra nubiana*	VU	✓	-	-	-	-	-	-	-
2	*Oryx leucoryx*	VU	✓	-	-	-	-	-	-	-
	Marine Mammals									
1	Humpback whale *Megaptera novaeangliae*	EN	✓	-	✓	-	-	-	-	-
2	False Killer Whale *Pseudorca crassidens*	NT	✓	-	✓	-	-	-	-	-
3	Indian Ocean Humpback Dolphin *Sousa plumbea*	EN	✓	-	-	-	-	-	-	-
	Turtles									
1	Green turtle *Chelonia mydas*	EN	✓	-	✓	-	-	-	-	-
2	Loggerhead turtle *Caretta*	VU	✓	-	✓	-	-	-	-	-
3	Hawksbill turtle *Eretmochelys imbricata*	CR	✓	-	✓	-	-	-	-	-
4	Olive Ridley turtle *Lepidochelys olivacea*	VU	✓	-	✓	-	-	-	-	-

#	Sensitive species	IUCN 2020/	SEZ area/ JAH IBA/ Al Wusta Wildlife Reserve/ Arabian Sea	**Project 1** Roads, pre-Gate, Gates & Inspection Zone of Port of Duqm	**Project 2** Dredging & reclamation works for liquid bulk berths in Port of Duqm (includes Duqm IBA)	**Project 3** Construction of Road 1 & 5 connecting Liquid Berth Terminal to Heavy Ind. Zone (includes Duqm IBA)	**Project 4** Construction of Jurf and Saay flood protection channels (includes Duqm IBA)	**Project 5** Construction of Jurf and Saay flood protection dams	**Project 6** Duqm Refinery service corridor to liquid jetty. (includes Duqm IBA)	**Project 7** Construction of interface roadway
	Corals									
1	*Goniopora lobata*	NT	✓	-	-	-	-	-	-	-
2	*hydnophora microconos*	NT	✓	-	-	-	-	-	-	-
3	*Platygyra lamellina*	NT	✓	-	-	-	-	-	-	-
4	*Turbinaria peltata*	NT	✓	-	-	-	-	-	-	-

4.3 Protected and Nature Conservation Areas

There is no protected and nature conservation area located within the SEZD area. However, as indicated earlier, the Al Wusta Wildlife Reserve lies outside the SEZD boundary. It was established by Royal Decree No 4/94 and originally covered an area of 24,785.4 sq km. The Oryx Sanctuary is located within the central desert and coastal hills biogeographical regions of Al Wusta, representing with three type of habitat viz; Plateau escarpments, wadis and sabkahs. Apart from the Oryx (*Oryx leucoryx*), few other large mammals do reside in and around the protected area and there are certain records of Nubian Ibex (*Capra nubiana*) desert-dwelling goat species and the largest wild population of Arabian gazelle. These large mammals which may travel between the wildlife reserve and the adjoining areas. The protected reserve area is also an important breeding ground for the endangered Houbara Bustard, as well as Arabian wolves, honey badgers, and caracals.

Apart from the above, as previously specified, there are also two IBAs located in the SEZD area, and this is presented in ***Figure 4-2***:

- the Duqm IBA, which falls fully within SEZD's boundary; and
- JAH IBA, wherein less than 2% of the IBA falls within the SEZD boundary.

Although these two areas were indicated as potential IBAs, no steps were taken to notify or designate them.

Although the total area of the Duqm IBA was approximately 1,000 ha., the core region consisted of the mudflat/ lagoon spread over 250 ha. wherein the migratory and the local birds congregated. This is seen in ***Figure 4-3.*** In the entire SEZD, the coastal habitat was the important migratory ground for wintering birds with high conservation value.

However, the expansion and operation of the Port of Duqm has directly affected the mudflat/ lagoon and the entire area has been reclaimed for the future port developments. The loss can be visually seen by looking at ***Figure 4-4***, which shows the Duqm IBA mudflat/lagoon area covered up and lost. Currently, a small narrow patch of the birding area in IBA, approximately 20 ha., and shown in ***Figure 4-5*** exists in the confluence where Wadi Jurf channel joins the sea. This is an engineered channel where in the Wadi Saay channel joins the main Wadi Jurf channel before going to the sea. Some birds continue to use this narrow patch of land, as seen from the images presented in ***Figure 4-6***[17].

[17] Only seagulls were present and whether the site is used by migratory birds will be known only during the winter months. Since the area is an engineered wadi mouth modifying the earlier IBA, it is anticipated that it will take few seasons for the modified ecosystem to thrive and support the avifaunal population.

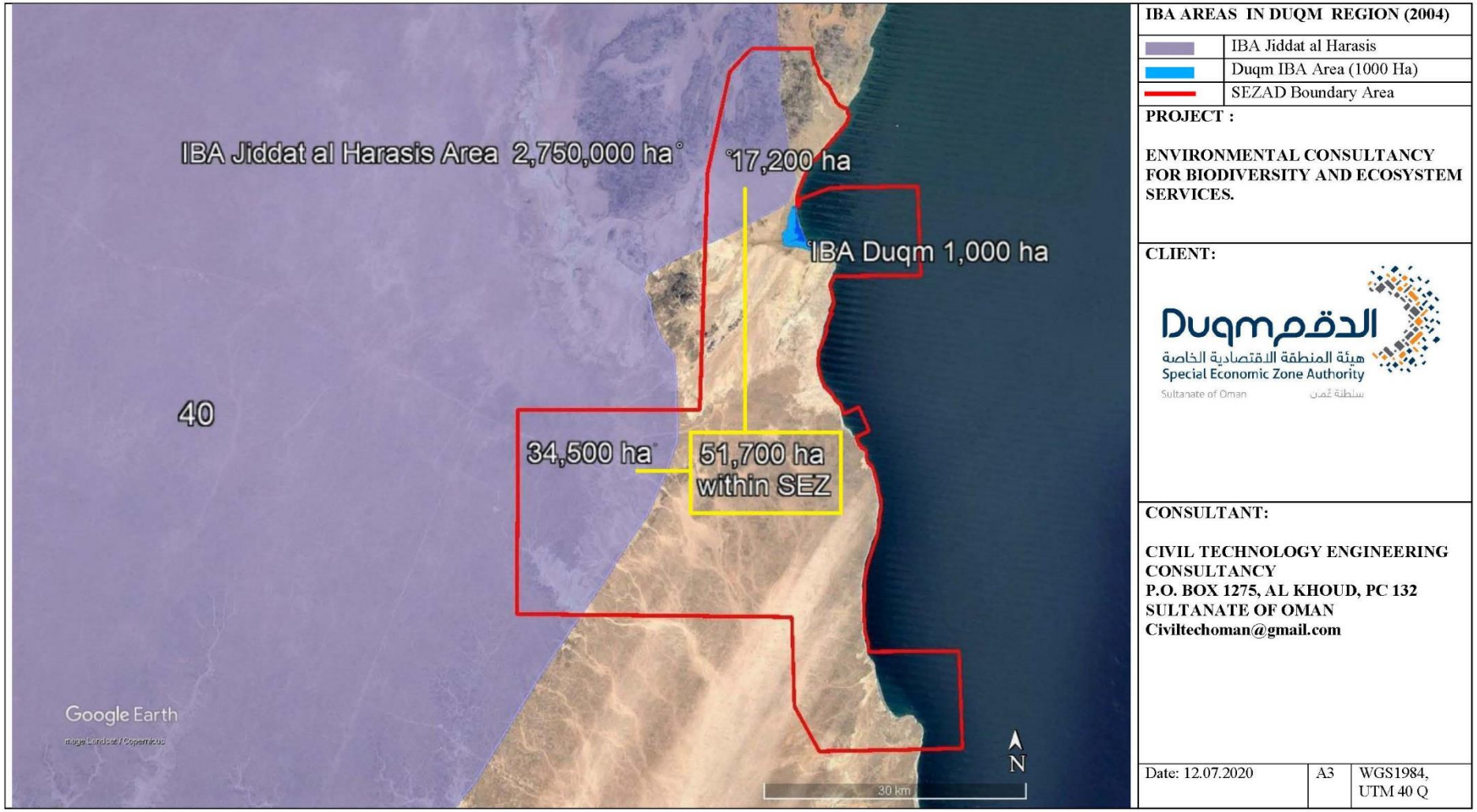


Figure 4-2: Important Birding Areas (IBAs) in Duqm

Figure 4-3: Original Extent of Duqm IBA

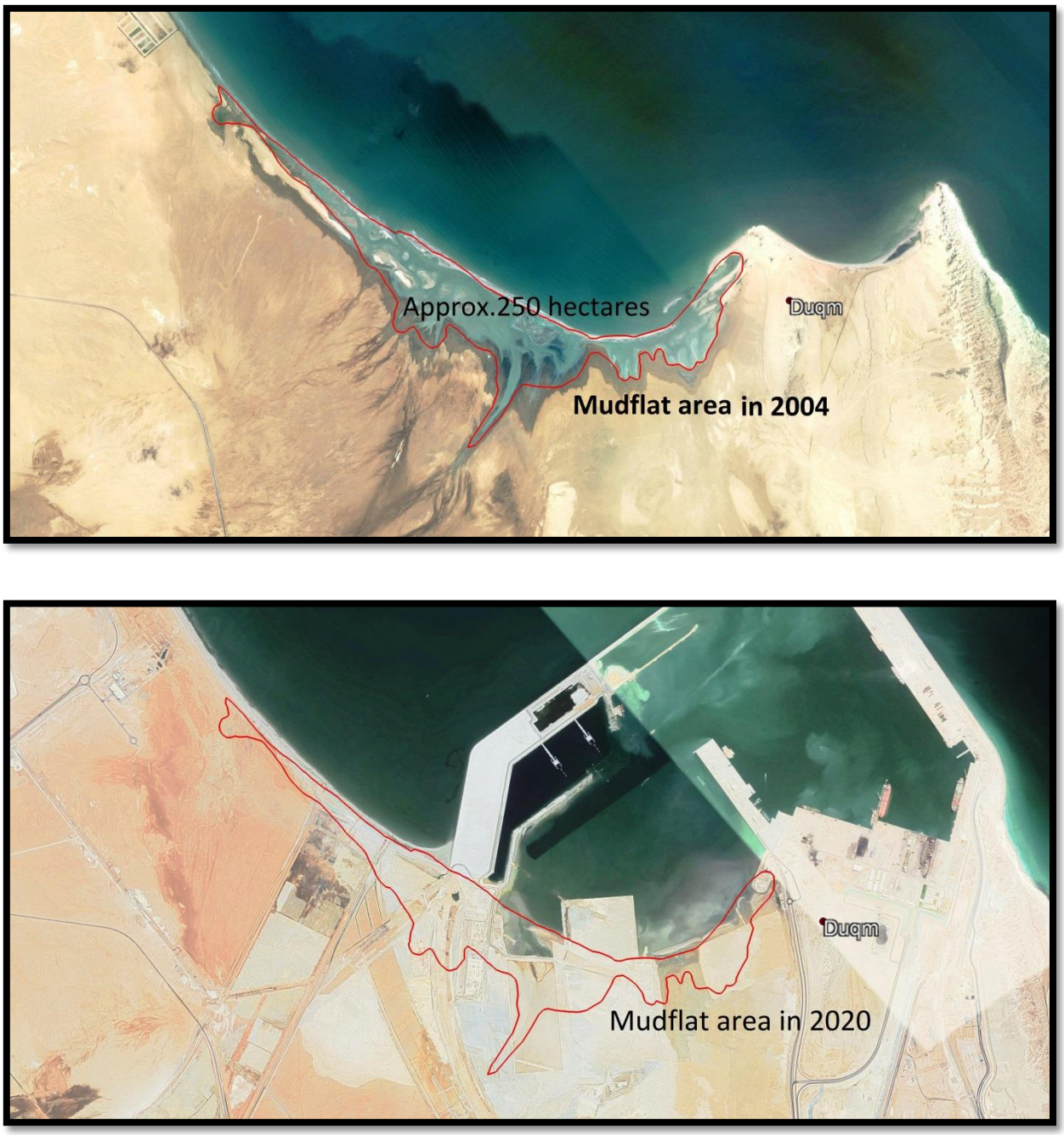


Figure 4-4: Transformation of the Mudflat/ Lagoon Area (Duqm IBA)

Figure 4-5: Current Extent of Duqm IBA

Figure 4-6: Images of Current Duqm IBA

4.4 Habitats at the Site

Oman is classified as a desert biome with arid ecosystems due to very low precipitation and high temperature. Duqm region falls in the Al Wusta Governorate in the eastern part of the country and comprises of mountains with gravelly plains and sporadic sand dunes abutting the Arabian Sea coast. The coastal region is characterized by coastal dune habitats interspersed with rocky cliffs.

Based on the National Strategy of Sustainable Development for Animal Resources (NSSDAR) data for Sultanate of Oman, the main ecosystems in Oman and the respective percentage of surface area coverage is specified as follows:

- Desert - 74%;
- Mountain - 15%;
- Agricultural - 8%; and
- Wetlands[18], Islands, Littoral and coastal plain - 3%.

Based on previous studies carried out in the SEZD area and as specified in SEZAD's publication[19], the habitats present in Duqm includes:

- Coastal - Coastal areas close to sandy beaches have a silty and saline surface that supports halophillic vegetation. The sandy beach ecosystem forms the fringe of the terrestrial and marine habitat. The plant community in this habitat is segregated due to hypersaline conditions and dune vegetation is restricted by plants with very specialized adaptations. The study area has long sandy beaches, which are major sites for wintering migratory birds given that these are the main feeding grounds for many wading species;
- Sabkha – They are low lying areas comprising silty-sand sediments with high moisture content due to sub-surface geological processes. These are unique habitats and are greatly influenced by changes in salinity. They stretch from the coastal zone further inland principally between areas of gravel and sand plains habitats. Only few adapted plants survive with sporadic vegetation observed consisting of halophytic shrubs;
- Wadi Course – They are the water channels that get water flow during rains and have shallow, sandy and gravelly features. The alluvial wadi fans and foothills of the mountains have flora and serve as a shelter and food to a range of fauna species. In few areas, drought-deciduous woodland species are present and dispersed in small aggregates of 10-50 numbers;
- Gravel and Sandy Plain - The plains are dominated by gravel-sands and alluvial soil brought from the hilly regions during the rainfall. Generally, vegetation is more abundant in finer-grained

[18] Wadis, khawrs, sabkhas, and mangrove forests encompass Oman's wetlands
[19] Biodiversity Protection Technical Note, Published by Environmental Regulatory Department (SEZAD), June 2018 (SEZAD, 2018)

substrate, such as within shallow depressions or runnels. This type of habitat is widely present all over Oman;

- Low Rocky Outcrop and Gravel Hill – They are naturally highly fragmented and covers a relatively small area of the SEZD, but is not considered rare in Oman. It generally supports very little vegetation, and has low ecological diversity;

- Piedmont and Foothill – They are mostly situated at the base of the mountains. Red shaley rock is interspersed with hollows and runnels that accumulate sand, soil, water, and nutrients. Vegetation within this habitat is exclusive to these runnels; and

- Rocky Mountain and Escarpment - This consists of table top plains, ravines, and gullies with slopes and escarpment. The hill forms micro-habitats which get created during the occasional monsoon rains. This habitat has very low vegetation in terms of shrubs mostly due to low water availability throughout the year.

However, the Ecology Report developed by HMR Consultants for SEZAD[20] treated Low Rocky Outcrops and Gravel Hills, Piedmont and Foothills, and Rocky Mountains and Escarpments as a single habitat type named as "Hilly Terrain and Escarpments". The habitats are illustrated in the below ***Figure 4-7***.

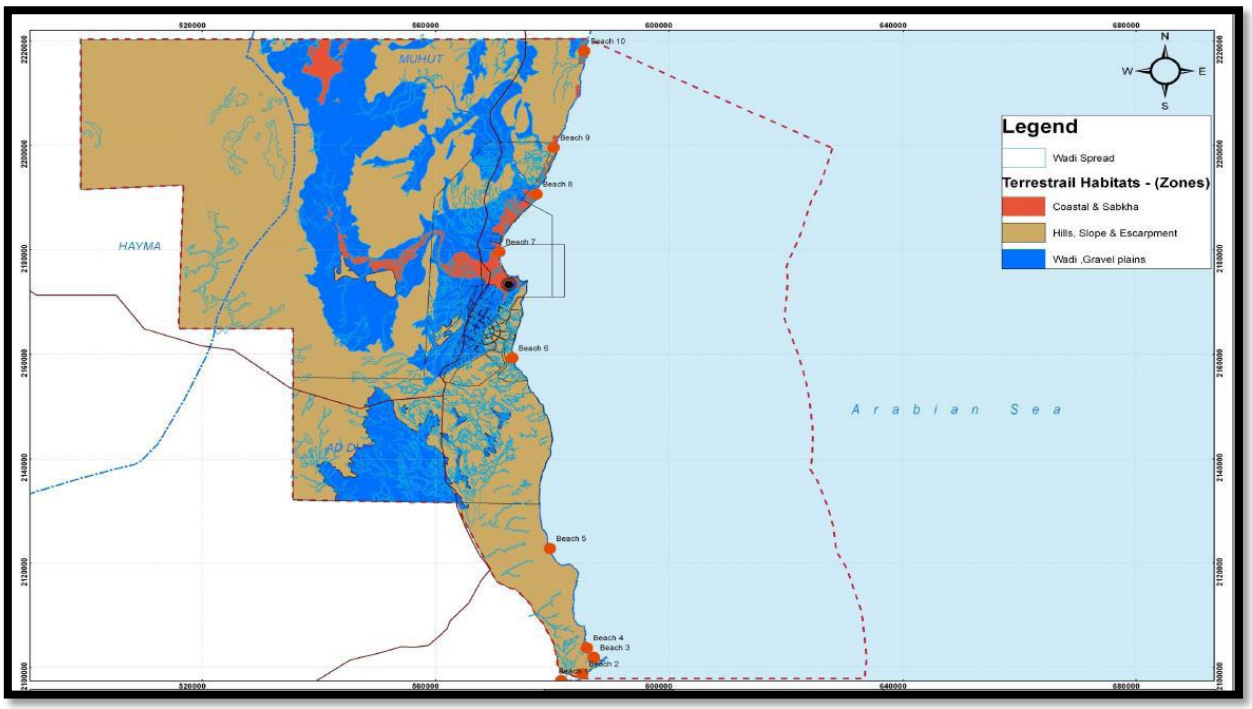


Figure 4-7: Habitats of Duqm identified in 2014 Study

[20] Environmental Baseline Study for Duqm Development and Surroundings, HMR Consultants , May 2014

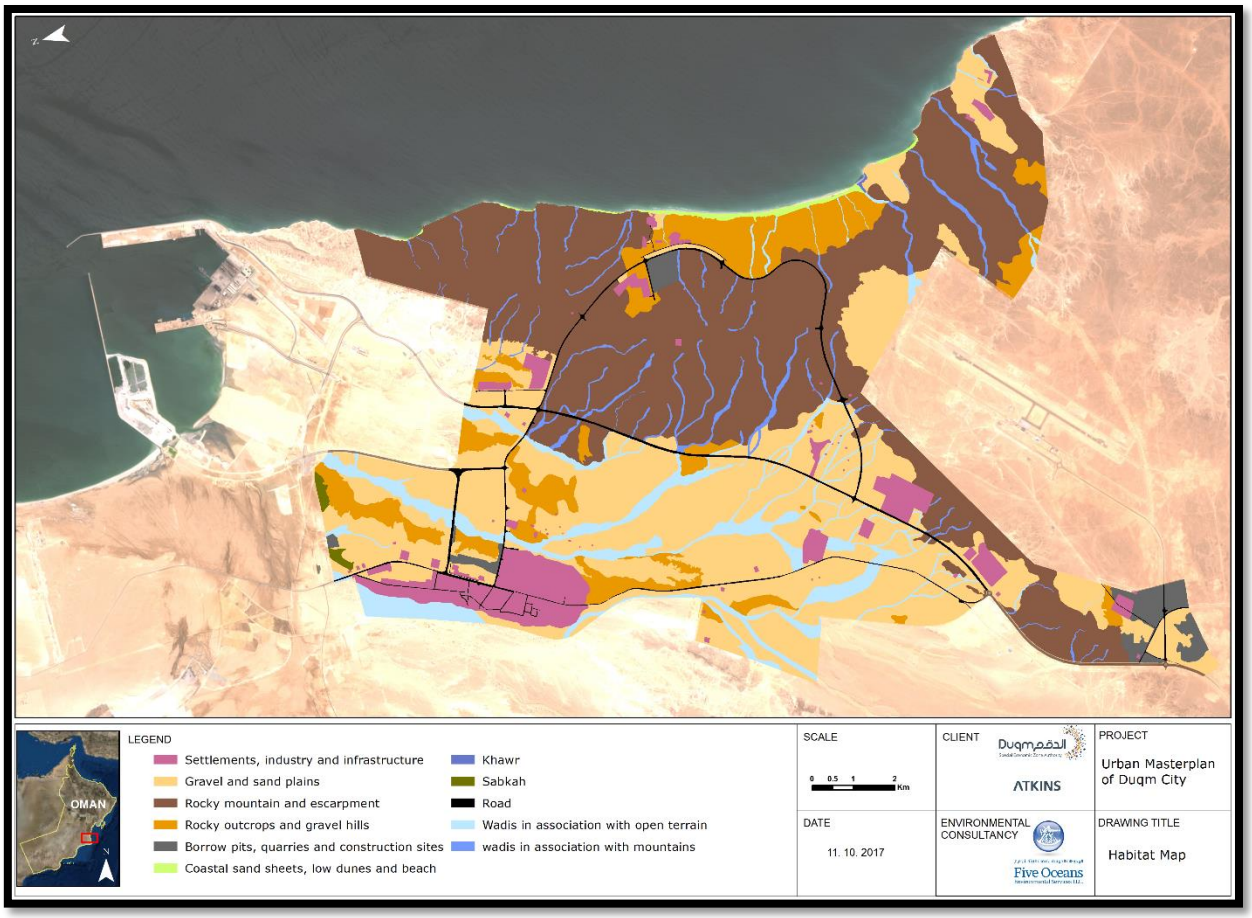


Figure 4-8: Habitats of Duqm identified in 2018 Study

The Atkins Masterplan report of 2018 indicated the following habitat types based on their conservation values, which is illustrated above in ***Figure 4-8***:

- Gravel and sand plains;
- Rocky mountain and escarpment;
- Rocky outcrops and gravel hills;
- Sabkha;
- Coastal sand sheets, low dunes, and beach; and
- Wadis.

Accordingly, based on our assessment, the area where the seven sub-projects are located fall within the following habitats:

- Coastal – this is the coastal beach and inter-tidal area;

- Sabkha – this is the flat salt pan which get only flooded after heavy rainstorms and could coalesce to form a sabkha coastal plain. A large extent of this habitat has been used for the development of the Duqm Port and Duqm Dry dock;

- Khawr – this is the water logged lagoon area with tidal influence (intertidal) near the northern breakwater of Duqm Port;

- Gravel and Sand Plains – this forms the large extent of Duqm;

- Hills and Escarpment – this is the upland part of Duqm where the Wadi Jurf dam and Wadi Saay dam are located along with the steep slopes in the coast from erosion;

- Wadis – this is the channels of Wadi Jurf and Wadi Saay; and

- Marine – this is the bay area (Duqm bay/ Ghubath bay) where the Duqm Port has come up.

Although the above seven habitats have been listed, it is not possible to distinctly demarcate the boundaries of the habitats as the lines get blurred between coastal, sabkha, and khawr habitats.

5 CRITICAL HABITAT ASSESSMENT

5.1 Overview and Performance Standards

Critical Habitat is a concept developed by IFC in its PS6 on Biodiversity Conservation and Sustainable Management of Living Resources. This concept is designed to identify areas of high biodiversity value in which development would be particularly sensitive and require special attention. It takes into account both global and national priorities and builds on the conservation principles of 'vulnerability' (threat) and 'irreplaceability' (rarity/restricted distribution).

PS6 defines critical habitat as "*Critical habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species;*[21] *(ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes*"

In addition, the IFC6 Guidance Note (GN)[22] document specifies that, "*Projects that are located within internationally and/or nationally recognized areas of high biodiversity value may require a critical habitat assessment. Examples include the following:*

- *Areas that meet the criteria of the IUCN's Protected Area Categories Ia, Ib and II.GN9; and*
- *Key Biodiversity Areas (KBAs), which encompass Important Bird and Biodiversity Areas (IBAs)*".

As indicated previously, the SEZD area has two IBAs triggering the need for the CHA. Based on the biodiversity baseline data from various projects (summarised in ***Chapter 4***); the CHA was undertaken to help identify the conservation priorities in this BAP and to determine which IFC PS6 requirements apply to the projects.

When the definition of Critical Habitat is considered on its applicability on the sub-projects, areas like Project 2 (permanent reclamation areas of liquid bulk berths in the Port of Duqm), Project 3 (roads connecting liquid bulk berths to heavy industrial zone) Project 4 (Jurf and Saay flood protection channels), and Project 6 (service corridor from refinery to liquid jetty) can be seen as having high biodiversity value and classified as a Critical Habitat. Consequently, the projects located in the critical habitat required a specific CHA.

[21] As listed on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species. The determination of critical habitat based on other listings is as follows: (i) If the species is listed nationally / regionally as critically endangered or endangered, in countries that have adhered to IUCN guidance, the critical habitat determination will be made on a project by project basis in consultation with competent professionals; and (ii) in instances where nationally or regionally listed species' categorizations do not correspond well to those of the IUCN (e.g., some countries more generally list species as "protected" or "restricted"), an assessment will be conducted to determine the rationale and purpose of the listing. In this case, the critical habitat determination will be based on such an assessment.

[22] International Finance Corporation's Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, January 1, 2012 (updated June 27, 2019)

Determination of critical habitat is based upon quantitative thresholds of biodiversity priority which are largely based on globally accepted precedents such as IUCN Red List criteria (IUCN, 2014) and KBA thresholds.

Details of the method and process for CHA are provided on Pages 17-23 of the GN6 document. The requirements set out in PS6 and the interpretations of those requirements provided in this Guidance Note are guided by the Convention on Biological Diversity (CBD), including its Strategic Plan for Biodiversity 2011–2020[23] and the Aichi Biodiversity Targets.

Of the five main criteria listed in the definition of critical habitat, in ***Sec 3.4.1***, the following three criteria are determined to be relevant to this current assessment.

- Criterion 1: Critically Endangered (CR) or Endangered (EN) Species;
- Criterion 2: Endemic/Restricted Range Species; and
- Criterion 3: Migratory/ Congregatory Species.

The other Criterion 4: Highly threatened and/or unique ecosystems, Criterion 5: Key evolutionary processes, and additional Criterion 6 – Legally Protected Areas in IUCN Categories I-II are not relevant to this current assessment since the study area does not harbour any unique ecosystem, is not significant for the evolutionary processes, and is not located within a legally protected area. However, Criterion 7: Internationally Recognised Areas is relevant as this includes KBAs and IBAs.

5.2 Determination of Critical Habitat

To determine the critical habitat (CH) with respect to Criteria 1 through 3, species data was screened against quantitative thresholds. Based on the CH criteria i.e., CR/EN species; endemic/restricted-range species; migratory/congregatory species; threatened and unique ecosystems; etc., the numerical thresholds have been defined for the current assessment. The above thresholds described in the Guidance Note were obtained from globally standardized numerical thresholds published in the IUCN's "*A Global Standard for the Identification of Key Biodiversity Areas and Red List Categories and Criteria*". The thresholds are indicative and serve as a guideline for decision-making only. There is no universally accepted or automatic formula for making determinations on critical habitat (IFC, GN6). A summary of the respective thresholds for each criterion is provided in the table below that follow the paragraphs GN 70 through GN 78 in the modified Guidance Note 6, June 27, 2019. The following abbreviations are used in ***Table 5-1***, relating to the IUCN red data book categories using the following three variables of: Critically Endangered (CR); Endangered (EN), and Vulnerable (VU).

[23] Biodiversity targets for the 2011–2020 Strategic Plan, "Convention on Biological Diversity", http://www.cbd.int/decision/cop/?id=12268.

Table 5-1: Quantitative thresholds for Critical Habitat Criteria 1 through 3

Criterion	Description	Thresholds for Criteria
1	Critically Endangered and Endangered Species	(a) Areas that support globally important concentrations of an IUCN Red-listed EN or CR species (≥ 0.5% of the global population AND ≥ 5 reproductive units of a CR or EN species). (b) Areas that support globally important concentrations of an IUCN Red-listed Vulnerable species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the above thresholds (a). (c) As appropriate, areas containing important concentrations of a nationally or regionally listed EN or CR species.
2	Endemic and Restricted-range Species	(a) Areas that regularly hold ≥10% of the global population size AND ≥10 reproductive units of a species.
3	Migratory and Congregatory Species	(a) Areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle. (b) Areas that predictably support ≥10 percent of the global population of a species during periods of environmental stress.

In order to conduct a CHA, a discrete management unit (DMU) (i.e. the geographic area which is being scrutinized) must be defined with regard to Criteria 1 to 3 (IFC, 2012b). DMU is an area with a clearly demarcated boundary within which the biological communities and/or management issues have more in common with each other than they do with those in adjacent areas (Guidance Note 6). Further, the delineation of a DMU can vary depending on the area, species, subspecies, or biodiversity feature of concern.

The DMU includes the direct footprint and potential secondary/ indirect impacts. DMUs may be ecologically-defined (e.g. a whole patch of a certain habitat type or a watershed) or politically-defined (e.g. a protected area, property or local political unit).

Considering the project areas as per the tender requirement, two DMUs have been delineated for the current assessment, and illustrated below in ***Figure 5-1*** and ***Figure 5-2***:

- Terrestrial Environment ; and
- Marine Environment.

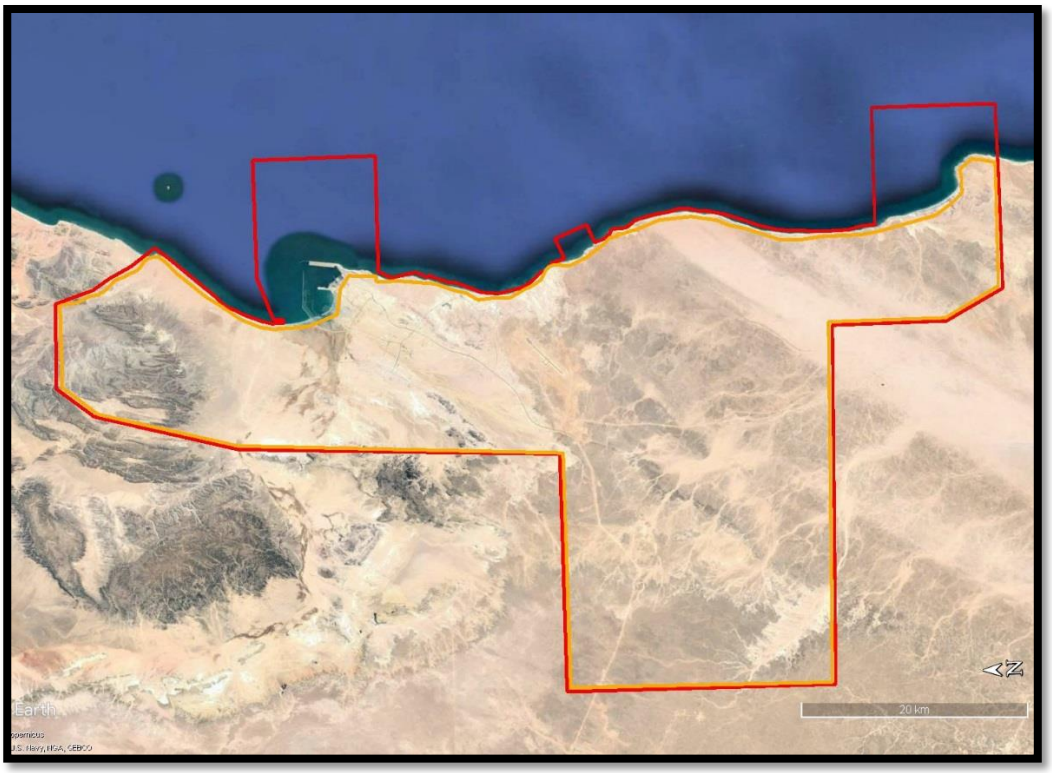


Figure 5-1: Discrete Management Unit – Terrestrial Environment

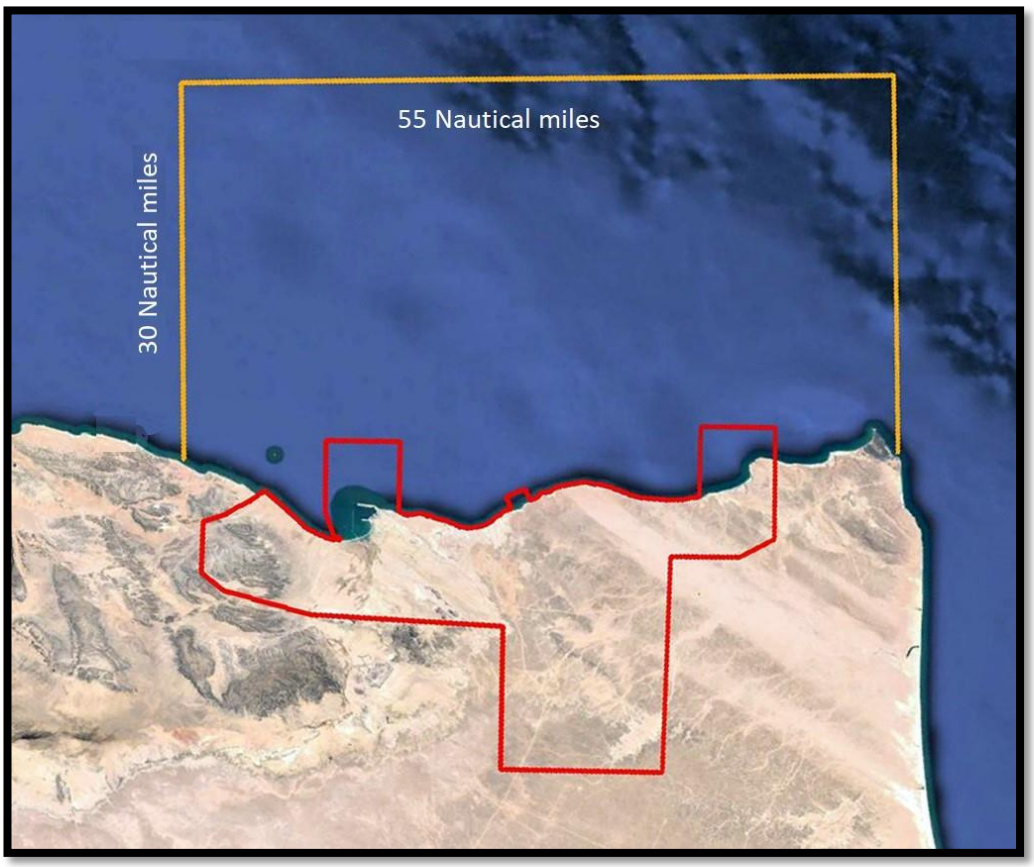


Figure 5-2: Discrete Management Unit – Marine Environment

The terrestrial DMU was defined based on consideration of habitats and scale of potential impacts across the seven project areas and sensitive areas around SEZD and covers the entire land area of SEZD and is shown with yellow boundary along with red-lined SEZD boundary. This includes coastal habitats including, mudflats, beaches, coastal dunes and lagoons; sabkha; gravel and sand plains; transformed project areas; rocky and hill terrain, escarpment plateau; wadis and runnels; and desert rangeland in Duqm region.

The marine DMU covers the aquatic regions of SEZD which are the Port of Duqm area, Fishery port, and Ras Markaz area. They extend to approximately 5-10 km from the coastline. While they do not contain any sensitive features, as can be seen from ***Figure 4-1***, the offshore area of Duqm region is sensitive with marine mammals and turtles. Hence, marine DMU was defined based on the distribution data of sensitive species only from the Duqm region (the area within 30 nautical miles with a coastline of 55 nautical miles). The DMU boundary is shown with yellow boundary along with red-lined SEZD boundary. Sensitive areas outside the SEZ (Bar Al Hikman Wetland Reserve and Masirah Island) were not included in the marine DMU.

For the identified KBAs such as the two IBAs, the CHA was carried out. The review of baseline component of each ESIA studies relating to the different project has also identified a number of species potentially triggering CHA. For each species, detailed assessment was conducted based on conservation and population status, knowledge of the species life history and ecology, and its distribution within the Duqm area, nationally and universally.

The following potential critical habitat features are known to be present in the above terrestrial and marine DMUs:

- C1: Critically Endangered (CR) or Endangered (EN) Species;
- C2: Endemic/Restricted Range Species; and
- C3: Migratory/Congregatory Species

In the below ***Table 5-2***, the screening of the key biological elements for the evaluation of the CHA in the Project and SEZD area is presented. For every group, the most significant habitat and species have been selected and classified following the IFC Critical Habitat criteria (IFC 2012[b]).

Table 5-2: Screening of the key biological elements for the evaluation of the CHA

#	Sensitive Feature/ Species	C 1[24]	C2	C3	Endemism (Oman or Regional)	Global Status	IUCN Red list 2020	Included/ Excluded From This Assessment	Justification For Inclusion/ Exclusion
Key Biodiversity Areas									
1	Duqm IBA - Current[25]	-	-	-	NA[26]	IBA	NA	**Included**	Modified Habitat. Key area of high biodiversity value that was earlier present in Duqm. Only 8% of original area available and requiring time and effort to stabilize. Assessed and discussed earlier in ***Chapter 4***.
2	JAH IBA	✓	-	-	NA	IBA	NA	**Excluded**	Only 2% of this IBA falls in SEZD area. No developments planned. Not under any threat.
Plants									
1	*Limonium sacrophyllum* (Oman-Endemic)	-	✓	-	O	NE	NE[27]	**Excluded**	Widely distributed in Oman, occurring in many parts of Duqm region. Not under any threat.
2	*Pulicaria glutinosa (*Endemic Arabian peninsula)	-	✓	-	R	NE	NE	**Excluded**	Widely distributed in Arabian peninsula, occurring in many parts of Duqm region. Not under any threat.
3	*Ochradenus harsuticus* (Oman-Endemic)	-	✓	-	O	VU[28]	NE	**Included**	Endemic species of global conservation concern, Vulnerable

[24] Criteria
[25] The screening has been done on the basis of the current existing Duqm IBA which is a modified and diminished area compared to the earlier Duqm IBA. Red List (IUCN) species have been recorded in the earlier Duqm IBA
[26] NA – Not Applicable
[27] NE- Not Evaluated
[28] VU- Vulnerable

#	Sensitive Feature/ Species	C 1[24]	C2	C3	Endemism (Oman or Regional)	Global Status	IUCN Red list 2020	Included/ Excluded From This Assessment	Justification For Inclusion/ Exclusion
4	*Salsola omanensis*	-	✓	-	O	VU	NE	**Included**	Endemic species of global conservation concern, Vulnerable
Birds									
1	Eurasian Curlew *Numenius arquata*	-	-	✓	-	-	NT[29]	**Excluded**	This species is an abundant passage migrant and winter visitor, Global population Near Threatened -IUCN Red List
2	Black-tailed Godwit *Limosa limosa*	-	-	✓	-	-	NT	**Excluded**	This species is widespread and has a large global population. Global population Near Threatened -IUCN Red List
3	Socotra Cormorant *Phalacrocorax nigrogularis*	-	-	✓	-	-	VU	**Included**	Global population Vulnerable –IUCN Red List; species is exclusively marine, suspected to be undergoing a continuous and rapid decline.
4	Egyptian Vulture *Neophron percnopterus*	✓	✓	-	-	-	EN[30]	**Included**	Global population Endangered –IUCN Red List
5	Asian Houbara *Chlamydotis macqueenii*	✓	✓	-	-	-	VU	**Excluded**	Reported from wildlife reserve designated for conservation of biodiversity. Global population Vulnerable –IUCN Red List
Lizards									
1	Omani Spiny-tailed Lizard *Uromastyx thomasi*	-	✓	-	O	-	VU	**Included**	Reported from Duqm region. Regional population Vulnerable –IUCN Red List
2	Egyptian Spiny-tailed Lizard *Uromastyx aegyptia leptieni*	-	✓	-	R	-	VU	**Included**	Reported from Duqm region. Regional population Vulnerable –IUCN Red List

[29] NT – Near Threatened
[30] EN- Endangered

#	Sensitive Feature/ Species	C 1[24]	C2	C3	Endemism (Oman or Regional)	Global Status	IUCN Red list 2020	Included/ Excluded From This Assessment	Justification For Inclusion/ Exclusion
Mammals									
1	Nubian Ibex *Capra nubiana*	✓	✓	-	-	-	VU	**Excluded**	Reported from the wildlife reserve designated for conservation of biodiversity, Global population Vulnerable -IUCN Red List
2	Arabian Oryx *Oryx leucoryx*	✓	✓	-	-	-	VU	**Excluded**	Reported from the wildlife reserve designated for the conservation of biodiversity. Global population Vulnerable - IUCN Red List
Marine Mammals									
1	Humpback whale *Megaptera novaeangliae*	✓	-	-	-	-	EN	**Included**	Reported from Duqm region. Regional population Endangered -IUCN Red List
2	False Killer Whale *Pseudorca crassidens*	-	-	-	-	-	NT	**Excluded**	Globally distributed. Global population Near Threatened -IUCN Red List
3	Indian Ocean Humpback Dolphin *Sousa plumbea*	✓	-	-	-	-	EN	**Included**	Reported from Duqm region. Regional population Endangered -IUCN Red List
Turtles									
1	Green turtle *Chelonia mydas*	✓	-	✓	-	-	EN	**Included**	Reported from Duqm region. Global population Endangered -IUCN Red List
2	Loggerhead turtle *Caretta caretta*	✓	-	✓	-	-	VU	**Included**	Reported from Duqm region. Global population Critically Endangered -IUCN Red List
3	Hawksbill turtle *Eretmochelys imbricata*	✓	-	✓	-	-	CR	**Included**	Reported from Duqm region. Global population Vulnerable -IUCN Red List

#	Sensitive Feature/ Species	C 1[24]	C2	C3	Endemism (Oman or Regional)	Global Status	IUCN Red list 2020	Included/ Excluded From This Assessment	Justification For Inclusion/ Exclusion
4	Olive Ridley turtle *Lepidochelys olivacea*	✓	-	✓	-	-	VU	**Included**	Reported from Duqm region. Global population Vulnerable -IUCN Red List
Habitats									
1	Wadis	-	-	-	NA	NA	NA	**Included**	Critical habitat for plant *Salsola omanensis* and *Ochradenus harsusiticus* (endemic and vulnerable) Locations are S9 and A15[31]
2	Desert Rangeland	-	-	-	NA	NA	NA	**Included**	Critical habitat for Spiny-tailed Lizard (vulnerable) Location is A7
3	Escarpment Plateau	-	-	-	NA	NA	NA	**Included**	Critical habitat for plant *Salsola omanensis* and *Ochradenus harsusiticus* (endemic and vulnerable) and Egyptian Vulture (endangered) Location is A5
4	Rocky Mountain	-	-	-	NA	NA	NA	**Included**	Critical habitat for Egyptian Vulture (endangered) Location is northwest portions of Duqm

Details of the species included in the assessment is presented as ***Appendix C*** which also includes providing information about them, their presence, and justification for placing in the appropriate quantitative thresholds.

Figure 5-3 illustrates the critical habitats identified in the terrestrial DMU. ***Figure 5-4*** illustrates the critical habitats identified in the marine DMU.

[31] The conservation areas are earmarked within NOS lands and explained in ***Sec 6.5.1***

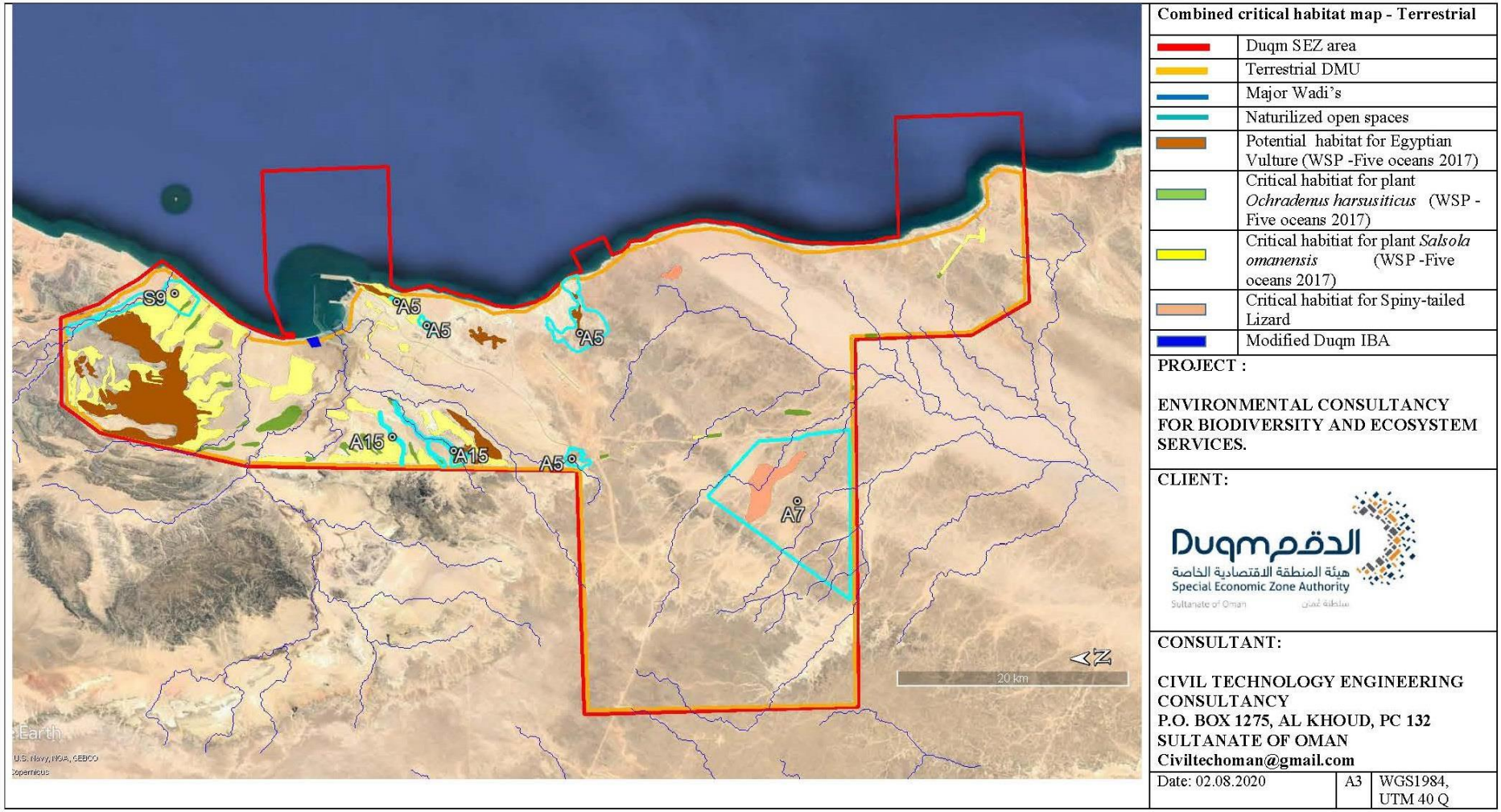


Figure 5-3: Critical Habitats in the Terrestrial DMU

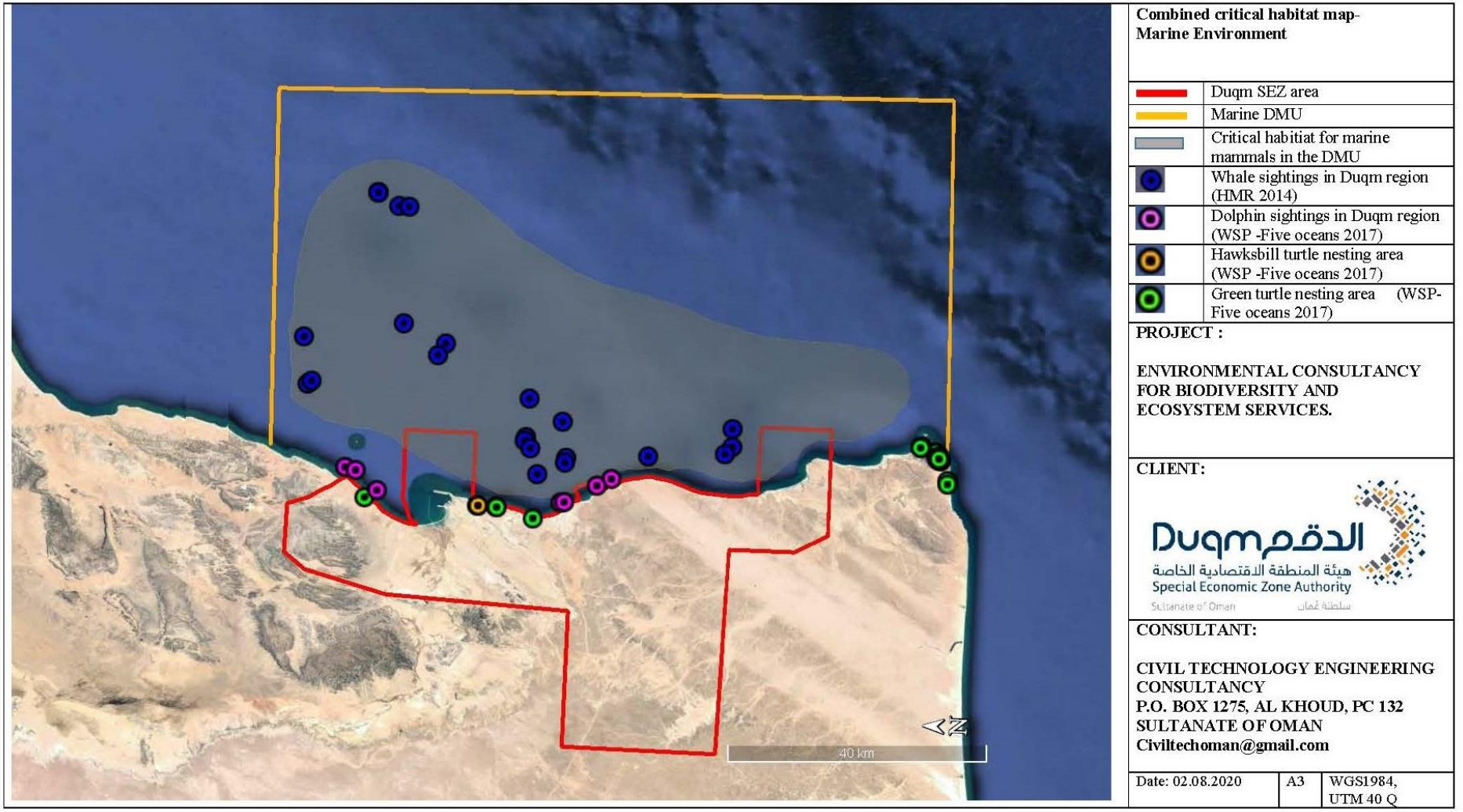


Figure 5-4: Critical Habitats in the Marine DMU

5.3 Results from CHA Appraisal

The current and future developments, including construction, changes in drainage, anthropogenic activities, etc. could potentially pose a threat to the critical habitats through (SEZAD, 2018).

- Clearing works - Loss of flora and fauna and habitat degradation and loss;
- Linear development - habitat fragmentation;
- Anthropogenic disturbances - loss of sensitive species and decrease in biodiversity;
- Air pollution - Acid rain, bioaccumulation of toxins, global warming and climate change;
- Noise pollution - Disturbances to sensitive fauna, particularly breeding birds;
- Water usage - Depletion of available water from the watershed can have far-reaching consequences, degrading habitat, and resulting in loss of flora and fauna;
- Discharges to water - Pollution of groundwater or surface water resulting in health impacts on flora and fauna, bioaccumulation of toxins in the local food web, and degradation of habitat; and
- Contamination - Mortality of directly affected fauna, health impacts or loss of flora species or communities, degradation of habitat, and bioaccumulation of toxins in the local food web.

Mitigation measures such protection of the critical habitats and species falling under critical habitats and pollution prevention measures, including the proposed SEZD-wide environmental monitoring system (discussed in ***Chapter 6***) should be adequate for managing the impacts.

BAP is focused on conserving or enhancing biodiversity, and focuses on species and habitats that needs to be attended to rather than looking at the broader biodiversity of the area. Based on the above CHA, the following can be termed as priorities for the entire SEZD area[32] and have been selected based on the presence of species that are critically endangered or endangered, endemic, and are migratory in nature, and the importance of the habitats[33].

[32] If only the area of the seven sub-projects are considered, the important loss was the IBA near the Duqm port, but there will be no loss of species as they are migratory in nature. Hence, in the CHA, the entire SEZAD area has been considered and evaluated.

[33] These habitats have been considered to be of conservation value as they provide the necessary conducive environment to foster the flora and fauna species identified in the CHA.

Table 5-3: Priorities for Biodiversity Conservation

#	Type	Sub-Type	Explanation
1	Habitat	Duqm IBA	Modified habitat with sandy shoreline and intertidal wadi mouth for avifauna (20 ha.)
		Wadis	Presence of endemic and vulnerable flora in S9 (490 ha.) and A15 (530 ha.) areas
		Desert Rangeland	Presence of vulnerable lizard species in A7 (1,050 ha.) area
		Escarpment Plateau	Presence of endemic and vulnerable flora and potential presence of endangered vulture in A5 (70 ha.) area
		Rocky Mountain	Potential presence of endangered vulture in northwest portions of Duqm (100 ha.)
2	Species	Plants	*Ochradenus harsuticus* and *Salsola omanensis*
		Birds	Egyptian Vulture and Socotra Cormorant
		Lizards	Omani Spiny-tailed Lizard and Egyptian Spiny–tailed Lizard
		Marine Mammals	Humpback Whale and Indian Ocean Humpback Dolphin
		Turtles	Green Turtle, Loggerhead Turtle, Hawksbill Turtle, and Olive Ridley Turtle

6 BIODIVERSITY ACTION PLAN

For the species and habitats identified in the CHA, the proposed actions to be undertaken, based on IFC PS6, with the aim to achieve no net loss (NNL) to biodiversity and a net gain[34] (NG) in critical habitats is presented in the BAP. A BAP includes actions that can stop or reduce negative impacts as well as contribute to promoting positive impacts.

To achieve NNL and NG, it is important to follow the mitigation planning approach which hinges on the mitigation hierarchy, a framework that can assist in limiting negative biodiversity impacts.

6.1 Mitigation Hierarchy

As defined by the CSBI (Framework for Guidance on Operationalizing the Biodiversity Mitigation Hierarchy, December 2013), the mitigation hierarchy is: 'the sequence of actions to anticipate and avoid impacts on biodiversity and ecosystem services; and where avoidance is not possible, minimize; and, when impacts occur, rehabilitate or restore; and where significant residual impacts remain, offset".

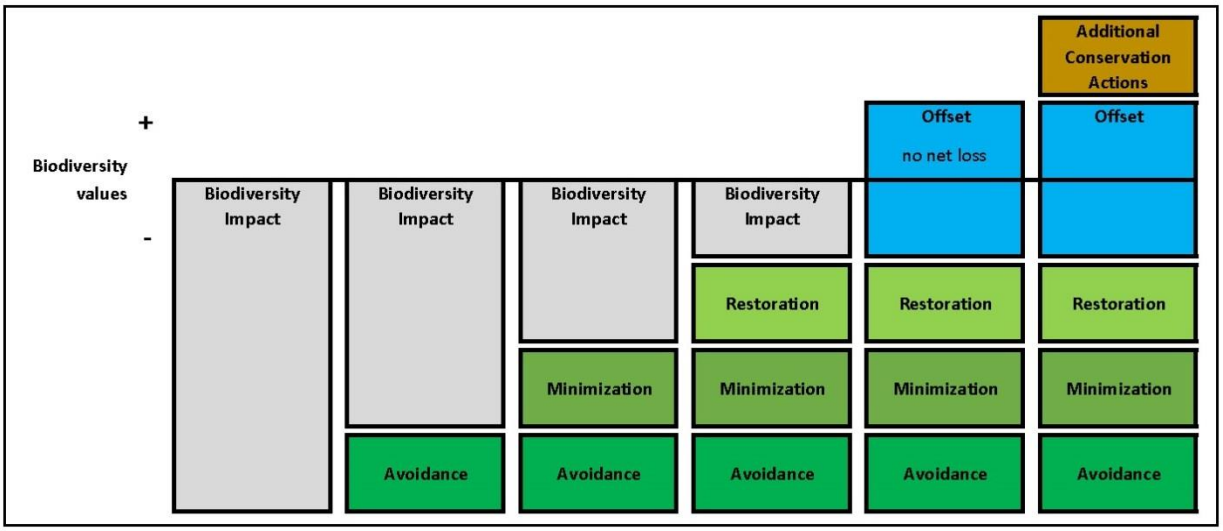


Figure 6-1: Mitigation Hierarchy[35]

The mitigation hierarchy is illustrated in the above ***Figure 6-1***, which depicts the steps of the mitigation hierarchy, (avoidance, minimization, restoration, and finally offset) for managing biodiversity risk, and the terms are defined below:

- **Avoidance:** measures taken to avoid creating impacts from the outset (including direct, indirect, and cumulative impacts), such as careful spatial or temporal placement of elements of infrastructure, in order to completely avoid impacts on certain components of biodiversity. This is the easiest and effective approach;

[34] "Net Gain is also referred to as "Net Positive Approach"
[35] Taken from IUCN

- **Minimization:** measures taken to reduce the duration, intensity, and/or extent of impacts (including direct, indirect and cumulative impacts) that cannot be completely avoided, as far as is practically feasible. This can eliminate some negative impacts;

- **Restoration:** measures taken to improve/ rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to impacts that cannot be completely avoided and/or minimized; and

- **Offset:** measures taken to compensate for any significant residual, adverse impacts after full implementation of avoidance, minimization, and restoration. Biodiversity offsets are of two main types: 'restoration offsets' which aim to rehabilitate or restore degraded habitat, and 'averted loss offsets' which aim to reduce or stop biodiversity loss.

While avoidance and minimization are preventive measures involving site selection; design; scheduling; and physical/ operational/ abatement controls, restoration and offsets are primarily remedial measures.

6.2 BAP Action Plan

The intent of the BAP is to address threatened species and habitats and is designed to protect and restore the ecological environment of the area. Promotion of biodiversity includes conservation value areas, natural parks, and protected areas[36] . Within SEZD, currently there are no notified conservation areas, natural parks, and protected areas. As seen from ***Figure 4-1***, only a small portion of Duqm IBA exists and only 2% of the JAH IBA falls within SEZD boundaries. From the CHA, it is estimated that there is approximately 2,260 ha. of high biodiversity value.

While SEZD can earmark areas as protected areas within its boundaries based on their ecological significance, there can also be Priority Areas designated within SEZD boundaries which can also be an important element to promote biodiversity. They can provide habitat/ refuge for flora and fauna. Sufficient size and a well-designed implementation of priority areas can compensate for loss of biodiversity from developmental activities. The priority areas can be set aside of land and can be allowed to evolve them to natural succession. Alternatively, they can be re-cultivated following the characteristics of the intended natural areas. Since no protected area is currently notified in the SEZD area, an attempt has been made to earmark Priority Areas to conserve and enable biodiversity which also includes the areas identified from the CHA.

If the entire SEZD area is considered, the potential threat to biodiversity threat stems that impacts both the terrestrial and marine environment are from:

- Loss of the critical habitats, such as intertidal mudflats, wadis, sabkha, and khawr/ lagoons;

[36] Protected areas are clearly defined geographical space, recognized, dedicated, and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (IUCN)

- Potential Pollution from the developmental activities including the petrochemicals and heavy industries proposed and coming up;
- Invasive alien species (IAS) that are not native to Oman and damaging to the environment; and
- Influx of large population and increase in infrastructure development could result in fragmentation of habitats putting pressure on the natural resources in the Duqm area.

However, there is also opportunities to be gained such as

- Establishing a system to conserve, restore, and enhance biodiversity in the Duqm area;
- Population and its increase in Duqm and the vision for Duqm to become a regional maritime and transit-trade hub and tourism destination will require provision of an attractive quality-of-life;
- Making use of SEZD's position as the owner and regulator as they can categorize and preserve protected and priority areas for biodiversity; and
- Presence/ arrival of many companies that are interested to make a difference to the environment with the possibility that their Corporate Social Responsibility (CSR) initiatives can increase the biodiversity in the Duqm area.

SEZD has adopted a customized approach that includes elements of goals and targets to arrive at the measures/ actions, in the below ***Table 6-1.***

Table 6-1: BAP Actions

Goals	Targets	Actions
To avoid the loss of sensitive habitats in the Duqm area	• Mapping of sensitive habitats • Saving of sensitive habitats • Allocation of land parcels that can be used to foster biodiversity	1) Conservation of existing biodiverse areas 2) Carrying out biodiversity survey across the entire SEZD area 3) Rehabilitate available impacted sensitive habitats 4) Demarcation and notification of Priority Areas 5) Create connecting trail and earmark as Priority Area
To increase the ecological footprint in the Duqm area through compensation and restoration		
To avoid fragmentation of habitats from development		
To avoid or minimize pollution to the marine and terrestrial environment	• Managing oil spill • Proper management of waste outputs	6) Create oil spill response planning 7) Adhere to oil spill prevention/ abatement recommendations stipulated in the project EMPs

Goals	Targets	Actions
		8) Establishment of SEZD-wide environmental monitoring system
To control or eradicate IAS	• Prevent or minimize invasive species	9) Implement and follow IAS program 10) Following best practices for ballast water management
To get the local community to understand and appreciate the biodiversity in Duqm	• Promote educational and social connections	11) Placing the BAP in the public domain 12) Organizing community and stakeholder biodiversity education events/ programs

For each of the action item arising from the above goals and targets, each one of them is explained below individually and colour coded per the action type identified in the mitigation hierarchy.

Action 1	**Conservation of existing biodiverse areas**		
Goal:	• To avoid the loss of sensitive habitats in the Duqm area • To avoid fragmentation of habitats from development	*Target:*	• Mapping of sensitive habitats • Saving of sensitive habitats

Mitigation Hierarchy:	**Avoidance**	Minimization	Restoration	Offset	Additional Conservation
Subject:	Retaining the existing conservation areas within the SEZD boundary and preventing any impacts				
Indicator:	Notification of Priority Areas by SEZD				
Time Period:	By end-2020				
Frequency:	One-time				
Responsibility:	SEZD				
Details:	The aim of this exercise is to avoid any developmental activities in the identified conservation areas and that awareness is created to protect biodiversity. Currently, from the CHA exercise, it is estimated that around 2,260 ha. of high biodiverse area is available for conservation. This conservation area will be left untouched as naturalized open space (NOS). It has been made part of the Priority Areas and with its notification by SEZD, no industrial or residential development will be allowed in these sectors. Details of the monitoring and evaluation program is presented in the next sub-section along with the requirements for a SEZD-wide environmental monitoring system in this section (Action 8) and will be used to assess the state of the conservation areas identified and earmarked in the BAP. Information will be made available on the conservation areas supporting habitats and the species of conservation value. It will also include information about why these features are important and activities that are/ are not permitted in these areas.				

	SEZD's environmental and planning departments will be managing/ safeguarding the conservation areas.

Action 2	**Carrying out biodiversity survey across the entire SEZD area**		
Goal:	• To avoid the loss of sensitive habitats in the Duqm area • To avoid fragmentation of habitats from development	*Target:*	• Mapping of sensitive habitats • Saving of sensitive habitats

Mitigation Hierarchy:	**Avoidance**	Minimization	Restoration	Offset	Additional Conservation
Subject:	Undertake biodiversity surveys in areas within SEZD that have not been surveyed and update surveys in the previous surveyed areas				
Indicator:	Surveys to be completed prior to the preparation of the next version of the BAP				
Time Period:	In 2025				
Frequency:	Surveys, reporting, and mapping to be undertaken once every ten years and biodiversity status in the SEZD area updated				
Responsibility:	SEZD				
Details:	The aim of this exercise is to map out the sensitive habitats within SEZD that have not been studied or recorded in secondary reports. While there have been many environmental studies carried out in the SEZD area, they have focused only on the coastal environment, that too closer to the Duqm Port. Ras Markaz, and Nafoon. However, other extent of the coastline has not been studied. In addition, the hinterland region in the western part of SEZD area has not been studied or has been studied many years back, including the area that falls within the JAH IBA. By carrying out the survey, any sensitive habitats that are present can be preserved avoiding the fate that fell upon Duqm IBA. A detailed terrestrial ecological survey has to be conducted during winter, summer, and khareef (when fog concentration are maximum) seasons. The survey shall focus on identifying key species within the SEZD area, including bird, reptile, and mammals. A targeted ornithological survey shall be conducted during the winter season and in late afternoon and early mornings, when bird activity will be at its peak. It should provide information on species composition of birds, population quantity, and territorial distribution of the species. It shall also assess the presence of potential IAS in the terrestrial environment. A detailed marine ecological survey for identifying marine habitat and species and marine mammal watching shall be conducted pre- and post-khareef seasons. The survey shall focus on fish diversity, marine mammals, epibenthic flora and fauna, and seabed condition. Working with the Port of Duqm, the survey shall also assess the presence of potential IAS in the marine environment. For the IAS, an initial assessment, including a survey of native and alien species (and their impacts) shall be carried out so that it can serve as a base for comparison. The output of this exercise will be an updated SEZD-wide biodiversity baseline survey report that can feed into the preparation of the next version of the BAP. The survey can be carried out by SEZD, either directly or through external consultant				

<table>
<tr><td colspan="2">Action 3</td><td colspan="3">Rehabilitate available impacted sensitive habitats</td></tr>
<tr><td>Goal:</td><td>• To avoid the loss of sensitive habitats in the Duqm area
• To increase the ecological footprint in the Duqm area through compensation and restoration</td><td>Target:</td><td colspan="2">• Saving of sensitive habitats</td></tr>
<tr><td>Mitigation Hierarchy:</td><td colspan="4"><table><tr><td>Avoidance</td><td>Minimization</td><td>Restoration</td><td>Offset</td><td>Additional Conservation</td></tr></table></td></tr>
<tr><td>Subject:</td><td colspan="4">Undertake rehabilitation and restoration work on sensitive habitats, if any, that are open and not earmarked for any industrial or non-industrial development</td></tr>
<tr><td>Indicator:</td><td colspan="4">Surveys to be initiated following the completion of the biodiversity baseline survey and identification of appropriate land parcels with restoration planting and management to be started after</td></tr>
<tr><td>Time Period:</td><td colspan="4">By 2025-30. Identification of habitats will be from the biodiversity baseline survey proposed for 2025 and implementation/ restoration before 2030.</td></tr>
<tr><td>Frequency:</td><td colspan="4">One-time</td></tr>
<tr><td>Responsibility:</td><td colspan="4">SEZD</td></tr>
<tr><td>Details:</td><td colspan="4">The aim of this exercise is to identify habitats that are sensitive but have become impacted from developmental activities. One of the area that is currently available is the current extent of Duqm IBA. While Duqm IBA originally had an area of 250 ha., currently only 20 ha. is available. It is now an engineered wadi mouth, and it is expected that it will take few seasons for the modified ecosystem to stabilize and support the birdlife. If these kind of land parcels are available, i.e. they are not being used for industries or other developments, they can be restored to the original conditions. This will have to be done after the surveys are completed and is a one-time measure to enable natural regeneration.

Habitat restoration is undertaken when the goal is to restore an area of land to its original ecological conditions. The basic approach to habitat restoration such as ecological landscaping and artificial wetlands includes the following steps (SEZD, 2018):

1) Conceptual planning, including identification of the site location and boundaries; need for restoration; type of ecosystem to be restored; and restoration goals;
2) Preliminary tasks, including appointment of a technical contractor, preparation of pre-project monitoring and setting of baseline conditions, definition of a list of objectives and goals, and training of project personnel;
3) Implementation planning, including preparation of performance standards and monitoring protocols, obtaining equipment and supplies, and preparing a budget;
4) Implementation tasks, including marking of boundaries and work areas, installation of permanent features, and implementation of restoration actions;
5) Post-implementation tasks, including protection against disturbance, maintenance, monitoring against goals and standards, and implementation of adaptive management procedures as needed; and
6) Evaluation and publicity, including assessment of monitoring data to determine success rate, ecological evaluation of completed project, and publicizing written accounts of the completed project.</td></tr>
</table>

	This will be different from the offsetting lands identified under the BOF and classified as Biodiversity Offset Areas (BOA). However, both will follow the steps discussed in the subsequent section regarding design and implementation for habitat restoration. The restoration works have to be carried out by SEZD, through specialized consultant/ contractors.

Action 4	**Demarcation and Notification of Priority Areas**		
Goal:	• To increase the ecological footprint in the Duqm area through compensation and restoration • To avoid fragmentation of habitats from development	*Target:*	• Saving of sensitive habitats • Allocation of land parcels that can be used to foster biodiversity

Mitigation Hierarchy:	Avoidance | Minimization | Restoration | **Offset** | **Additional Conservation**
Subject:	To develop and implement the BOF plan to avoid NNL and achieve NG
Indicator:	Lands have been identified as part of this current BAP study and have been termed as Priority Areas. The land parcels have been classified under 3 categories: Naturalized Open Space (NOS); Landscape Area (LSA); and Biodiversity Offset Area (BOA);
Time Period:	By end-2020 for notification; and implementation/ restoration of BOA – priority areas by 2022 and rest of the areas by 2025-30
Frequency:	One-time
Responsibility:	SEZD for planning; Implementation can be SEZD, private companies, NGOs, etc.
Details:	The aim of this exercise is to map out land parcels in SEZD that can serve as "no-Go" areas for development but can be used for planting and imparting conservation measures. The CHA has shown that the loss of critical habitat is the mud flat/ sabkha/ khawr area near Duqm Port – Duqm IBA and this area cannot be restored. The lost area is around 250 hectares. While there is a small extent of around 20 ha. that is currently available, it is anticipated that it will take few seasons for the modified ecosystem to thrive and support the avifaunal population. However to offset for this loss and to have a land bank where any planting and conservation measures can be undertaken, the Priority Areas have been identified and explained subsequently in the next sub-section. The land parcels are being defined with specific coordinates and visual concepts of the habitat typologies with species and high-level phasing. They can be made as wilderness parks and used for habitat restoration. SEZD's planning department have already agreed on these areas and they can become available for SEZD or any company that is coming in the SEZD area to be used for deploying their CSR efforts in increasing their green cover. It is proposed to use the BOA lands for offsetting the loss of natural habitats, LSA lands for parks and landscaping, and keeping NOS as natural wilderness areas. The developmental works can be carried out by SEZD or companies coming in Duqm and will be through specialized consultant/ contractors.

Action 5	**Create connecting trail and earmark as Priority Area**		
Goal:	• To avoid fragmentation of habitats from development	*Target:*	• Allocation of land parcels that can be used to foster biodiversity

Mitigation Hierarchy:	Avoidance | Minimization | Restoration | **Offset** | **Additional Conservation**
Subject:	To develop and implement the BOF plan to avoid NNL and achieve NG, and also provide connectivity through the allocated Priority Areas
Indicator:	Lands have been identified as part of this current BAP study for this connecting trail/ corridor
Time Period:	By end-2020 for notification; and implementation/ restoration of BOA – priority areas by 2022 and rest of the areas by 2025-30
Frequency:	One-time
Responsibility:	SEZD for planning; Implementation can be SEZD, private companies, NGOs, etc.
Details:	The aim of this exercise is to map out land parcels in SEZD that can serve as "no-Go" areas for development but can be used for planting and imparting conservation measures. The CHA has shown that the loss of critical habitat is the mud flat/ sabkha/ khawr area near Duqm Port and this area cannot be restored. The lost area is around 250 hectares with currently 20 ha. available. To offset for this loss and to have a land bank where any planting and conservation measures can be undertaken, the Priority Areas have been identified and explained subsequently in the next sub-section. A connecting corridor is being proposed to allow for easy movement of species. The developmental works can be carried out by SEZD or companies coming in Duqm and will be through specialized consultant/ contractors.

Action 6	**Create oil spill response planning**		
Goal:	• To avoid or minimize pollution to the marine and terrestrial environment	*Target:*	• Managing oil spill

Mitigation Hierarchy:	**Avoidance** | **Minimization** | Restoration | Offset | Additional Conservation
Subject:	Undertake preparation of oil spill response protocol due to the presence of Duqm Refinery, the fuel import and export at Duqm Port, and the service corridor connecting the refinery to the port
Indicator:	Port activities already existing and refinery construction taking place
Time Period:	By 2023
Frequency:	Annually with the protocol updated for change in context with emergency drills carried out in accordance with the plan
Responsibility:	SEZD having primary responsibility and, DRPIC, Duqm Port, and other allied industries having secondary responsibility
Details:	The aim of this exercise is for SEZD to develop an oil spill response protocol/ procedure for the SEZD area. As part of the ESIA/ EIAs, the project developers (companies such as Duqm Refinery and Duqm Port) must have developed their own individual oil spill management plans and SEZD also must be having a copy of them. However, they may be dealing only at the aspect related to the company's area of operations and not to the entire SEZD area. The plan to be developed by SEZD shall

	consider the oil spill prevention/ abatement recommendations stipulated in the project ESMP/ EMPs All these needs to be evaluated so that appropriate mitigation measures for biodiversity protection is incorporated in the plan. The plan should be reviewed annually as the SEZ is developing continually. The plan needs to be updated when new industries or risks are identified. Emergency drills should be undertaken as part of the oil spill plan. The plan should identify third party resources and resources of the industries i.e. DRPIC and what resources / emergency response they will provide. The oil spill plan needs to consider the critical habitats and impacts, particularly the sensitive marine environment. The work can be carried out by SEZD, based on the plans provided by the various project proponents, either directly or through external consultant.

Action 7	**Adhere to oil spill prevention/ abatement recommendations stipulated in the project EMPs**		
Goal:	• To avoid or minimize pollution to the marine and terrestrial environment	*Target:*	• Managing oil spill • Proper management of waste outputs
Mitigation Hierarchy:	**Avoidance** | **Minimization** | Restoration | Offset | Additional Conservation		
Subject:	Following the oil spill prevention and mitigation measures specified in the EMPs prepared for Duqm Refinery, Duqm Port, and service corridor		
Indicator:	Port activities already existing and refinery construction taking place. Information already available		
Time Period:	As per the timelines in the EMP/ ESMPs		
Frequency:	As per the recommendations in the EMP/ ESMPs		
Responsibility:	DRPIC, Duqm Port, and other allied industries have the responsibility with SEZD as the regulator to ensure that the project proponents follow the ESMP and EMP recommendations		
Details:	The aim of this exercise is to ensure that the recommendations specified for oil spill avoidance/ mitigation in the ESIA/ EIAs prepared by the project developers (companies such as Duqm Refinery and Duqm Port) are followed. The work is already carried out by SEZD's environmental team.		

Action 8	**Establishment of SEZD-wide environmental monitoring system**		
Goal:	• To avoid or minimize pollution to the marine and terrestrial environment	*Target:*	• Proper management of waste outputs
Mitigation Hierarchy:	**Avoidance** | **Minimization** | Restoration | Offset | Additional Conservation		
Subject:	Undertake SEZD-wide environmental monitoring for air, dust, noise, groundwater, surface water, soil, and the marine environment		
Indicator:	To be initiated before the commissioning of Duqm Refinery to capture baseline data so that it can be compared after the refinery is operational		
Time Period:	Starting from 2023		

Frequency:	Varying on the basis of environmental parameters: Air and Dust – Continuous; Noise, Water, and Soil – Periodic. Marine – qualitative (seawater & sediment quality) and quantitative (Dredging and dumping, Ballast Water Records and Sediment Reception details from the port where cleaning or repair of ballast tanks) – Periodic
Responsibility:	SEZD
Details:	The aim of this exercise is to establish a SEZD-wide environmental monitoring system. Monitoring is a long-term, on-going process which identifies temporal trends and allows decisions to be made on a continuous basis depending upon the trends. They also serve as comparison to the baseline information and can assist SEZD to identify anomalies and sudden changes. Details of the monitoring programs including type, nature, duration, and location of the monitoring programs is provided below: • **Air and Dust** - By installing Continuous Ambient Air Quality Monitoring Station (CAAQMS) system with initially 3 CAAQMS units to be installed in and around the heavy industrial zone, upwind and downwind of DRPIC. They will be running continuously to capture the meteorological information and measure $PM_{2.5}$, PM_{10}, NOx, SOx, CO, CO_2, VOCs, Ammonia, and H_2S. Based on the data, mapping of regional airshed shall be carried out along with air quality dispersion modelling on specific scenarios that SEZD may use in taking decisions on allowable incremental impacts for permitting new sources or modifying existing sources or ascertaining the impacts of accidental releases; • **Noise** - Noise measurements shall be carried out periodically (once every six months) at fixed positions in around the SEZD area. The location needs to take into consideration the generators and the receptors, including the critical habitats. Measurements will be carried out at day, evening, and night time for 15-minute intervals at each monitoring location. One weekday and Weekend day should be monitored for each site; • **Water** - Groundwater sources are limited in SEZD. They shall be monitored once annually and water level measurement should be recorded. Groundwater should be purged before samples are taken and they shall be tested for pH, DO, TSS, TDS, Coliforms, BOD, COD, TPH, VOCs, and Heavy Metals. By recording the results over time, a conceptual model of the groundwater regime could be arrived at. There are no surface water sources. However, if they are present during the monitoring campaign, they should be sampled and tested for the above parameters; • **Soil** - Surface soil sampling shall be carried out annually at fixed positions in around the SEZD area. The location needs to take into consideration the generators and the receptors, including the critical habitats. They should be tested for pH, TPH, VOCs, and Heavy Metals. • **Marine** - In-situ seawater analysis shall be carried out annually in the aquatic regions of SEZD which are the Port of Duqm area (approximately 10 km* 10 km), Fishery port (approximately 3 km* 3 km), and Ras Markaz area (approximately 10 km* 10 km) for salinity, temperature, colour and odour, conductivity, turbidity, DO, and pH. The water column profiling has

to be done for every one km stretch. Physico-chemical sampling and analysis of marine sediments and seawater shall be carried out, again annually, at 10 locations in Port of Duqm area, 3 locations at the Fishery port, and 10 locations in the Ras Markaz area. The samples shall be analysed for pH, TSS, TDS, BOD, COD, Coliforms, Heavy Metals, Oil & Grease, TPH, Nitrates, Nitrite, and Residual Chlorine. The Port of Duqm and Oman Drydock conducts biannual monitoring campaigns and the results from those campaigns should also be included. Analysis of bioaccumulation of heavy metals (Hg, As, Cd, Cr, Ni, Cu, Se, Zn, Pb, etc.) in aquatic animals shall be carried out annually in three locations (Port of Duqm, Fishery port and Ras Markaz). Three fixed locations should be selected in each sampling region (Port of Duqm, Fishery port, and Ras Markaz) and samples should include Moluccas, crustaceans or other invertebrates from each locations.

- **Ecology**- The terrestrial and marine environment shall be monitored on an annual basis during the winter season focusing on the findings from the CHA and BAP studies, including assessing the status of IAS. It shall look at the critical habitats, mammals, birds, and reptiles. The marine survey shall be in five locations in the aquatic regions of SEZD. Each sample site will compose of four, 25 m long transects. It shall record the fishes, mammals, epibenthic flora and fauna, seabed condition, and include photography and videography documentation. The surveys shall be undertaken by ecology experts. The Port of Duqm conducts their own monitoring campaigns and the results from those campaigns should also be included. A detailed recommendation for the ecological monitoring program of the marine environment has been included in ***Appendix D*** which can be established in the future.

In addition, SEZD's GIS department can use remote sensing (satellite imagery or SEZD's drone photography) to monitor the following biodiversity indices twice a year (summer and winter):

- Status of Duqm IBA;
- Status of critical habitats;
- Status of restored habitats;
- Monitoring the marine water quality in SEZD area in terms of productivity, temperature, and salinity; and
- Extent of green cover in Duqm.

The output from the monitoring exercise will be a series of monitoring reports. Results from previous surveys should be included to look at possible trends or inconsistencies which may warrant further investigations.

The environmental monitoring can be carried out by SEZD, either directly or through external consultant. SEZD will also be receiving results of the monitoring exercise carried out by the industries and they can be recorded into the database so that trends and patterns could be studies and established.

<table>
<tr><td colspan="2">Action 9</td><td colspan="3">Implement and follow IAS program</td></tr>
<tr><td>Goal:</td><td>• To control or eradicate IAS</td><td>Target:</td><td colspan="2">• Prevent or minimize invasive species</td></tr>
<tr><td>Mitigation Hierarchy:</td><td colspan="4"><table><tr><td>Avoidance</td><td>Minimization</td><td>Restoration</td><td>Offset</td><td>Additional Conservation</td></tr></table></td></tr>
<tr><td>Subject:</td><td colspan="4">Following invasive alien species prevention and mitigation measures to control and eradicate</td></tr>
<tr><td>Indicator:</td><td colspan="4">Already few SEZD tenants follow IAS management measures</td></tr>
<tr><td>Time Period:</td><td colspan="4">To be implemented from 2023</td></tr>
<tr><td>Frequency:</td><td colspan="4">Continuous and to be adhered for all developments</td></tr>
<tr><td>Responsibility:</td><td colspan="4">SEZD having primary responsibility and, DRPIC, Duqm Port, and other allied industries having secondary responsibility</td></tr>
<tr><td>Details:</td><td colspan="4">Alien species is a species that has been introduced to a location where it does not normally occur. Invasive Alien Species (IAS) is an alien species that causes (or has the potential to cause) harm to the environment, economies and/or human health. Not all alien species become invasive. A species could be an alien introduction but not regarded as damaging to the native environment. Some common types of invasive organisms include: microorganisms, plants, invertebrates, and vertebrates[37].

IAS data is not available in the national scale in Oman and not many references are available on the presence and expansion of IAS.

As part of the DRPIC CESIA[38], a report on Invasive Alien Species has been prepared and until SEZD carries out the IAS survey, this report could be used as reference document. It specifies the species along with a Red/ Amber/ Green (RAG) risk rating. Of the lot, the Red category species could significantly damage native Omani biodiversity.

SEZD shall focus upon the process flow of: <u>Prevent – Early Detect – Eradicate – Contain – Strategic Control</u> to manage the IAS.

• Prevent – Focused on the prevention of new invasions. The goal of this category is prevention.
• Early detection – Focused on early detection of a potential invasive species. The goal is detection to determine whether eradication of the species is feasible.
• Eradicate – Focused on preventing the spread of invasive species already found to exist in the region but only in very limited amounts. The goal of this category is rapid response.
• Contain – Focused on invasive species found in areas within the region but not widespread. The goal is to apply control measures to keep the species from spreading to uninfested areas.
• Strategic Control – Focused on invasive species which are widespread within the region. The goal is to apply control measures in environmentally sensitive areas.</td></tr>
</table>

[37] A toolkit for developing legal and institutional frameworks for invasive alien species - Clare Shine, published by the Global Invasive Species Programme (GiSP)and supported by IUCN and World Bank, 2008

[38] Duqm Refinery Project Oman. Consolidated Impact Assessment and Mitigation Report with appendices. WSP. Dec 2017

	Prevention will be the first step for which pathways[39] has to be managed. In the terrestrial environment, it can be from windblown, from landfilling (topsoil dumped on project sites), or through people. In the marine environment, it can be through the ballast water bringing in larvae and invertebrates from other locations. If prevention is not possible, early detection and eradication will be the key. For managing the IAS problem, the potential approaches are listed below: • Emphasis shall be placed on all project proponents as they bring/ move materials, carry out construction, handle marine vessels, etc. • SEZD shall require all third party projects to develop IAS strategy plans for managing alien species. • SEZD shall coordinate with Port of Duqm and Oman Drydock to request them to adhere to International Maritime Organization's (IMO) regulations for managing the ballast water. • The source of all landfilled soil shall be recorded and it should be ensured that it is free of IAS contamination. • Construction vehicles should be subjected to regular inspections to ensure that they are not acting as vectors of IAS. • Environmental Monitoring of projects which the proponents' carryout in accordance with their EMPs and submit to SEZD should also include a section on identifying and reporting on IAS infestations. The monitoring should also look at whether native vegetation has recolonized the construction footprint. • If any infestation is reported, projects have to take steps to eradicate the problem. The aim of this exercise is to manage any IAS occurring in the SEZD area as they are associated with a wide range of negative consequences for the environment and local biodiversity. The work can be carried out by SEZD's environmental team.

Action 10	**Following best practices for ballast water management**		
Goal:	• To control or eradicate IAS	*Target:*	• Prevent or minimize invasive species

Mitigation Hierarchy:	**Avoidance**	**Minimization**	Restoration	Offset	Additional Conservation

Subject:	Ensuring that ballast water is managed as per International Maritime Organization's (IMO) stipulations
Indicator:	Monitoring of marine IAS
Time Period:	Immediate
Frequency:	Quarterly or when there is change in conditions
Responsibility:	Duqm Port and DRPIC having primary responsibility and SEZD having secondary responsibility
Details:	The aim of this exercise is to ensure that the ballast water does not bring in IAS. Ballast water is used to stabilise ships when travelling with no load and is

[39] A pathway is basically the route along which an alien species may be transported to a new location

	subsequently pumped out in a port where cargo gets loaded. As a consequence, enormous quantities of water containing local fauna and flora are transported from one ocean to another by ships. The ballast water management protocols for ships arriving at Duqm Port should be aligned with: • ROPME ballast water management protocols; and • International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention). SEZD has to confirm with Duqm Port and Oman Drydock that they have undertaken a ballast water risk assessment for all shipping under ballast arriving at Duqm using the Globallast system or equivalent. The monitoring requirements for any marine based facilities will include studying the following, which should be carried out biannually: • Water column: to test for plankton community; • Sediment: to study infauna and spores; • Hard substrates: harbour quays, floating docks, dike and pillars to study the (sub-) littoral zone of different substrate types (concrete, wood, steel, and ballast); • Fouling plates: to check for fouling species facilitating new colonisation; and • Ballast water of select sample ships: to test for phyto- and zooplankton.

Action 11	**Placing the BAP in the public domain**		
Goal:	• To get the local community to understand and appreciate the biodiversity in Duqm	*Target:*	• Promote educational and social connections

Mitigation Hierarchy:	Avoidance | Minimization | Restoration | Offset | **Additional Conservation**
Subject:	To raise awareness of the local community on habitats, flora, and fauna in the Duqm area and establish community based dialogue on conservation
Indicator:	Keeping the BAP in SEZD website as a public disclosure
Time Period:	After approval of BAP, by end-2020
Frequency:	Always accessible and updated when revision takes place
Responsibility:	SEZD
Details:	The aim of this exercise is to engage with the community and the stakeholders to raise awareness on the conservation needs and conservation values. The work can be can be carried out by SEZD, through its Sustainability Advisor and the CRM - Environmental & Social

<table>
<tr><td colspan="2">Action 12</td><td colspan="3">Organizing community and stakeholder biodiversity education events/ programs</td></tr>
<tr><td>Goal:</td><td>• To get the local community to understand and appreciate the biodiversity in Duqm</td><td>Target:</td><td colspan="2">• Promote educational and social connections</td></tr>
<tr><td>Mitigation Hierarchy:</td><td colspan="4"><table><tr><td>Avoidance</td><td>Minimization</td><td>Restoration</td><td>Offset</td><td>Additional Conservation</td></tr></table></td></tr>
<tr><td>Subject:</td><td colspan="4">To raise awareness of the local community on habitats, flora, and fauna in the Duqm area and establish community based dialogue on conservation through community and stakeholder biodiversity education events</td></tr>
<tr><td>Indicator:</td><td colspan="4">Completion of stakeholder biodiversity meetings</td></tr>
<tr><td>Time Period:</td><td colspan="4">After approval of BAP and as part of SEP – From 2021</td></tr>
<tr><td>Frequency:</td><td colspan="4">At least once a year or could be multiple depending on participation</td></tr>
<tr><td>Responsibility:</td><td colspan="4">SEZD</td></tr>
<tr><td>Details:</td><td colspan="4">The aim of this exercise is to engage with the community and the stakeholders to raise awareness on the conservation needs and conservation values. The objective will be to:

• Raise awareness on the ecological resources in the Duqm area;
• Legislative requirements on biodiversity (National/ Regional/ International/ Lenders’);
• Present changes to the landuse in Duqm through publicizing the SEZD masterplans;
• Importance of biodiversity and habitats and species of conservation value and sensitivities in the SEZD area;
• SEZD’s commitment toward ‘no net loss’ to biodiversity and ‘net gain’ in critical habitat through implementation of the BAP;
• Explain about the BOF process and three classes of lands (NOS, LSA, and BOA) earmarked for biodiversity purposes;
• Present the proposed offsetting concepts for BOA sectors; and
• Encourage local people not to hunt threatened and protected species.

The stakeholders shall include the following:

• Community groups - Fishermen, Township, Women's Group, Research Group, and NGOs;
• Local government - Wali and Sheikhs;
• Heavy industries - DRPIC, Port of Duqm, Duqm Drydock;
• Operators - Tatweer[40] and Marafiq[41];
• Emergency services - ROP, Coast Guard, and Fires Services;
• Public Authorities - PACA[42], AER[43], and PAEW[44]; and
• Ministries - Finance, Interior, Environment and Climate Affairs, Heritage and Culture, Social Welfare, Health, and Fishery Wealth.</td></tr>
</table>

[40] Tatweer – Oman Company for the Development of Special Economic Zone at Al-Duqm SAOC (for project implementation)
[41] Marafiq – Centralized utilities provider
[42] PACA – Public Authority for Civil Aviation (for airport operations)
[43] AER – Authority for Electricity Regulation (for electricity transmission)
[44] PAEW – Public Authority for Electricity and Water (for utilities connectivity)

	The work can be can be carried out by SEZD, through its Sustainability Advisor and the CRM - Environmental & Social

6.3 Monitoring & Evaluation Program

The intent of the monitoring program is to measure the progress and impact of the BAP in terms of achieved, not-achieved, and corrective measures. However, the monitoring of biodiversity is not the same as measuring biodiversity. While measuring biodiversity provides a snapshot in time, monitoring biodiversity is a long-term, on-going process which identifies temporal trends and allows decisions to be made regarding whether actions are achieving desired biodiversity targets. Accordingly, biodiversity measurements taken over time contribute to biodiversity monitoring

Monitoring comprises of two parts:

- Performance monitoring, which can be frequent depending upon the aspect to be monitored and can provide detailed baseline data; and
- Impact evaluation, which can be long-term since the effects of biodiversity take time to show.

There can be quantitative measurements or qualitative criteria for both type of monitoring. For the action items, identified in ***Table 6-1,*** the monitoring attributes are given in the below ***Table 6-2***.

Table 6-2: Monitoring Measures

Actions	Monitoring Measures
• Conservation of existing biodiverse areas • Carrying out biodiversity survey across the entire SEZD area • Rehabilitate available impacted sensitive habitats • Demarcation and notification of Priority Areas • Create connecting trail and earmark as Priority Area • Create oil spill response planning • Adhere to oil spill prevention/ abatement recommendations stipulated in the project EMPs • Establishment of SEZD-wide environmental monitoring system • Implement and follow IAS program	***Performance Monitoring*** • Size of the priority areas – showing increase/ decrease • Size of the critical habitats – showing increase/ decrease • Size of critical species – showing increase/ decrease • Size of the natural habitats – showing increase/ decrease • Size of the rehabilitated area – showing increase/ decrease • Number of oil spill response drills carried out • Record of new infestations of IAS • Continuous Ambient Air Quality Monitoring and trends from air shed • Monitoring of Duqm Port area • Conducting successfully at least one community biodiversity educational event • Number of hits/ downloads of BAP from SEZD website

Actions	Monitoring Measures
• Following best practices for ballast water management • Placing the BAP in the public domain • Organizing community and stakeholder biodiversity education events/ programs	***Impact Evaluation*** • Type and number of natural habitats created • Density and species in the habitats including in the critical habitats • Success of the restoration efforts at the rehabilitated sites • Studying the long-term trends of SEZD-wide environmental monitoring system to see the long-term effects • Active participation of the local community • Carrying out a comprehensive ecology baseline survey, including terrestrial, marine, and avifauna, after three years • Carrying out an updation of the biodiversity baseline in 2025 and updation of baseline and BAP every ten years

As indicated in ***Sec 2.2***, a detailed environmental baseline study was carried out in 2012-14 and following that, there have been various EIA/ ESIAs that have been carried out which looked at the ecology of the region. However, there is a lack of long-term detailed monitoring in the SEZD area which brings a degree of variability on the data and existing conditions and the trends. Therefore, suggestions have been made for carrying out SEZD-wide environmental monitoring regime from 2023 and a comprehensive biodiversity survey in 2025 and BAP updated to reflect the threats at that point of time. Even otherwise, BAP is a living document and needs to be updated periodically or when the context changes.

A number of parameters can be monitored as a means to ensure compliance with required biodiversity mitigation. If the receptors identified to be at risk from impacts are habitats or flora, monitoring may involve any of the following methods (SEZAD, 2018):

- Habitat mapping via remote sensing and use of GIS technology;
- Visual assessment of vegetation coverage;
- Flora surveys (via quadrating or transects) to assess biodiversity index, species composition, or health of floral communities; or
- Field surveys to check for signs of habitat degradation.

If the receptors identified to be at risk from impacts are fauna, monitoring may involve any of the following methods (SEZAD, 2018):

- Faunal surveys (via sighting, spoor or trapping surveys) to assess biodiversity index, species composition, or health of communities; or

- Population surveys of target species.

The frequency of monitoring until 2025 when the new biodiversity baseline survey will be carried out can be annual. The general rules of thumb to keep in mind include (SEZAD, 2018):

- Birds are generally more active in the early morning hours;
- Nocturnal fauna will only be active during night time hours;
- Seasonal considerations such as breeding season and migratory season will impact monitoring results;
- The flowering season of flora differs amongst flora species;
- Reptiles are more likely to be active during the midday and generally are inactive during the cooler winter months; and
- Trapping of fauna during the peak summer months may not be advisable due to the stress caused by high temperatures.

With regards to the monitoring needs of the marine environment, it should be noted that the upcoming development of Duqm (offshore facilities) will have a direct impact on the marine mammals, turtles, and other marine organisms. Due to development of port, offshore oil terminals, fishery port, and other offshore facilities, vessel traffic will increase in the Duqm region leading to greater chances for vessel strikes, underwater sound pollution, and degradation of seawater quality.

The findings and results of on-going monitoring should be compiled into a series of monitoring reports. Methodology of monitoring and reporting should remain consistent to ensure that results are comparable. A summary section should be included which highlights any incidents or causes for concern at the conclusion of each monitoring exercise.

If required, the BAP can be updated, as necessary, after the assessment of the annual monitoring exercise to include:

- New specific measures designed to address problems discovered during the monitoring that have not been adequately addressed in the existing BAP; and
- Changes taking place on account of the capacity of the institutional mechanism implementing the BAP within SEZD.

6.4 Institutional Arrangement

The responsible party for implementing and maintaining the BAP shall be SEZD's Environmental Regulatory Department who also have the responsibility to implement the Environmental and Social Management System (ESMS) related to compliance to applicable standards and initiatives to minimize environmental releases and monitor emissions, waste generation, and climate change parameters. They

will report to Director General of Regulatory and Compliance. They will work with PDD department which will be the main focal point for CSR and stakeholder engagements.

The Environmental Regulatory Department will evaluate environmental documents addressing biodiversity submitted by project proponents, participate in site visits, and review environmental performance. They will take part in the community and stakeholder engagement relating to the BAP. Additional support can be provided within SEZD's team or externally sourced. SEZD will provide training for its staff to implement the BAP guidelines.

The BAP implementation will be tied in with the ESMS as it will provide the system framework to implement and monitor the plans. As part of the ESMS, SEZD will provide for community awareness interactions as per the SEP and this will include discussions on biodiversity.

When necessary, SEZD will appoint expert consultants for ecology assessment to review the monitoring work and for carrying out the biodiversity surveys. The BAP has to be periodically reviewed or when the context changes. It is recommended that a baseline biodiversity survey be scheduled in 2025, at which time, the BAP can be updated, and subsequently after every ten years. The update to the BAP shall be carried out by specialized consultants who will perform potential additional studies, as required, and provide advice to SEZD on the complex biodiversity issues.

6.5 Biodiversity Offset Framework

To meet the need for no net loss (NNL) and to demonstrate net gain (NG) of natural habitats, the following BOF is being proposed for the SEZD area.

The above chapters have revealed that the significant critical habitat loss is the mud flat/ sabkha/ khawr area near Duqm Port totalling to approximately 250 hectares which served as an IBA. It is not possible to restore this area. Although a small extent of 20 ha. is currently available and has been earmarked as conservation area, it is anticipated that it will take few seasons for the modified ecosystem to develop and thrive. Since it is not feasible to offer "in-kind" offsets, an "out of kind" offset is being suggested.

Working with the SEZD Planning Department, a "Priority Area Atlas for Conservation of Biodiversity" has been created where specific land parcels across SEZD have been designated as no-go areas (for industrial and non-industrial development) and earmarked for conservation purposes. The identified Priority Areas can provide the necessary habitat/ refuge for flora and fauna, and can compensate for loss of biodiversity from developmental activities. The intent is that these land parcels can be left out of developmental use and be used to increase the biodiversity area footprint within the SEZD boundaries. SEZD and companies that are operating/ coming up in Duqm can make use of these lands for implementing/ imparting conservation measures as part of their CSR efforts.

Since Duqm is getting industrialized and large-scale industries are coming up and the Duqm City expanding and anticipated to cater to a population of over 240,000 by 2040, the lands are getting used up and the habitats are getting fragmented. However, by allocating and reserving them as Priority Areas, the land parcels could be utilized for conservation purposes. Whilst the benefits may not be immediate, in the longer term, those allocated Priority Areas can aid in increasing the biodiversity footprint in the

SEZD area boosting the ecosystem productivity and serving as refuge for flora and fauna and sustaining various elements of human and economic wellbeing as part of ecosystem services.

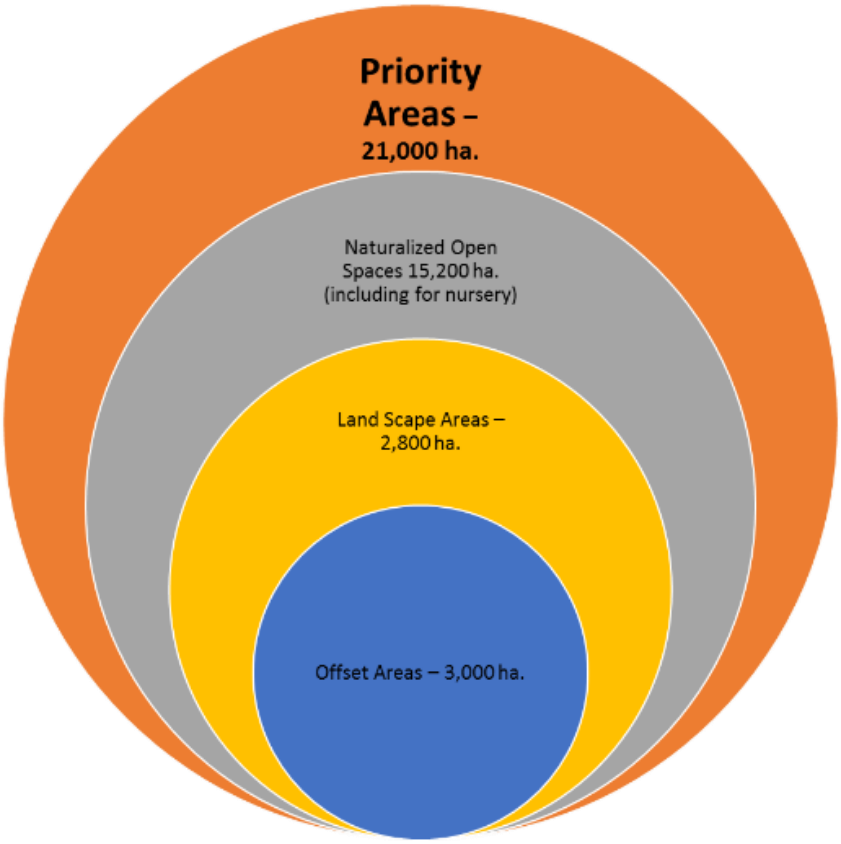


Figure 6-2: Classification of Priority Areas

Three types of classification of the land parcels have been done:

- NOS (Naturalized Open Spaces) areas which are open natural land - approximately 15,128 hectares;
- LSA (Landscape Areas) areas primarily for landscaping - approximately 2,951 hectares; and
- BOA (Biodiversity Offset Area) areas which are offsets proposed - approximately 2,005 hectares;

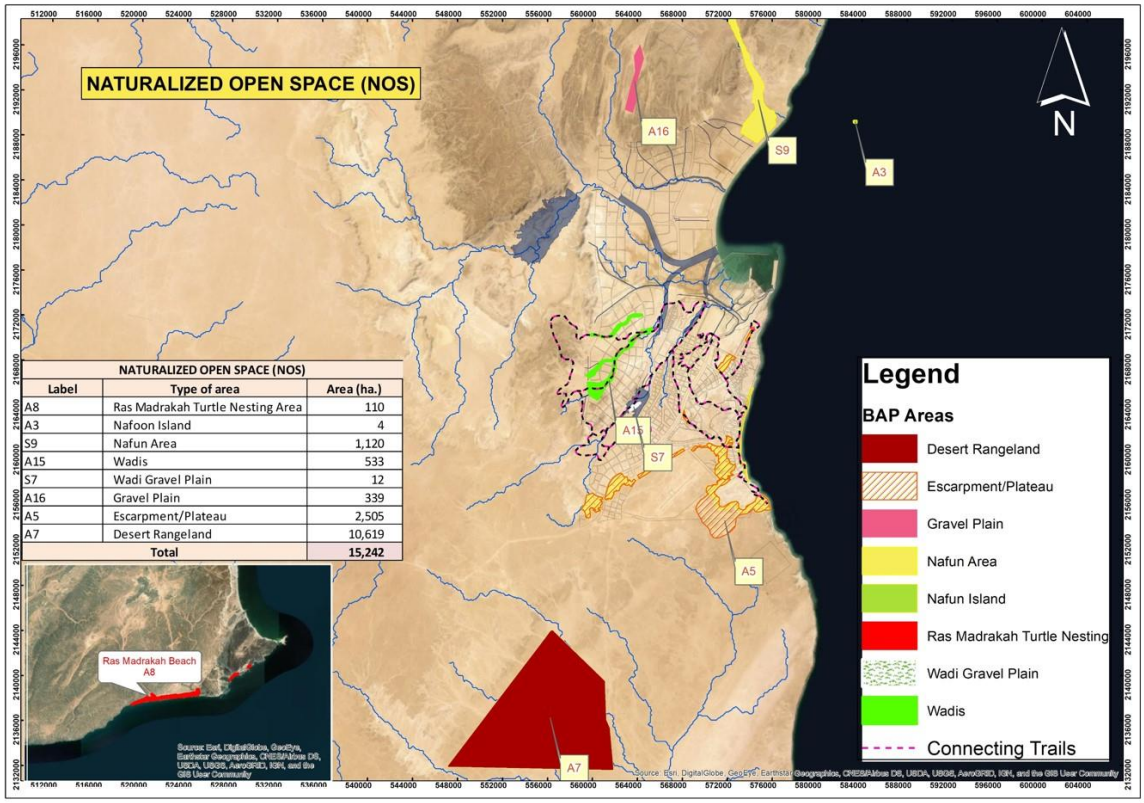
This is illustrated above in ***Figure 6-2***.

6.5.1 NOS Lands

As shown in ***Figure 6-3***, there are eight land parcels totalling to approximately 15,242 ha. spread all around the Duqm region and they will be left as natural open land with no industrial, residential, or other developments.

This includes the approximately 2,260 ha. of land identified as critical habitat from the CHA exercise. This NOS also includes the conservation areas that has been identified in the CHA and also includes Ras Madrakah Turtle Nesting Area (110 ha.) and Nafoon Island (4 ha.) which fall outside the SEZD boundaries but are located closer to Duqm. They have been included since Ras Madrakah Turtle Nesting

Area is popular for Endangered Green turtle and Vulnerable Loggerhead turtles to nest and over 500 nests have been observed. They nest during the khareef season when the beaches in this region are wet and the only elevated beach is the Ras Madrakah Turtle Nesting Area. Nafoon Island is a roosting area for the vulnerable cormorant birds and over 1,000 birds use this area.



NATURALIZED OPEN SPACE (NOS)		
Label	Type of area	Area (ha.)
A8	Ras Madrakah Turtle Nesting Area	110
A3	Nafoon Island	4
S9	Nafun Area	1,120
A15	Wadis	533
S7	Wadi Gravel Plain	12
A16	Gravel Plain	339
A5	Escarpment/Plateau	2,505
A7	Desert Rangeland	10,619
Total		15,242

Figure 6-3: NOS Areas

6.5.2 LSA Lands

As shown in ***Figure 6-4***, there are six land parcels totalling to approximately 2,951 ha. for landscaping. This includes the "Production Ribbon" that SEZD's masterplanner has recommended to serve as a farm zone to cater to Duqm's population. The Production Ribbon is an innovative and sustainable agricultural technique for the desert environment. It establishes a new model for producing and supplying fresh fruits, vegetables and fish for Al Duqm residents while developing a sustainable, holistic approach to address issues of energy, food production and water management. Current agricultural growing techniques are entirely different from this system and can avoid the need for hauling fruits and vegetables over long distances. The production ribbon envisages an integrated, closed loop system of aeroponic greenhouses, aquaculture, energy generation, water filtration and waste processing and pioneers a more sustainable system. (Al Duqm Urban Design Master Plan, 2014).

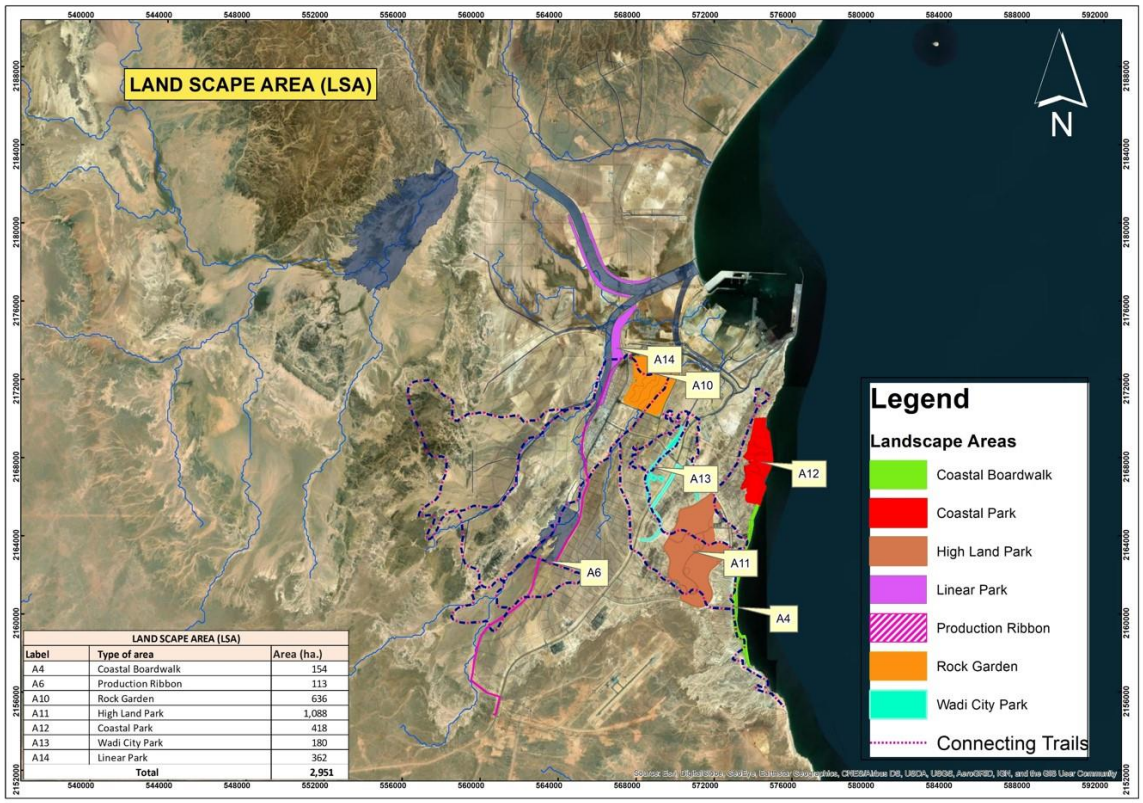


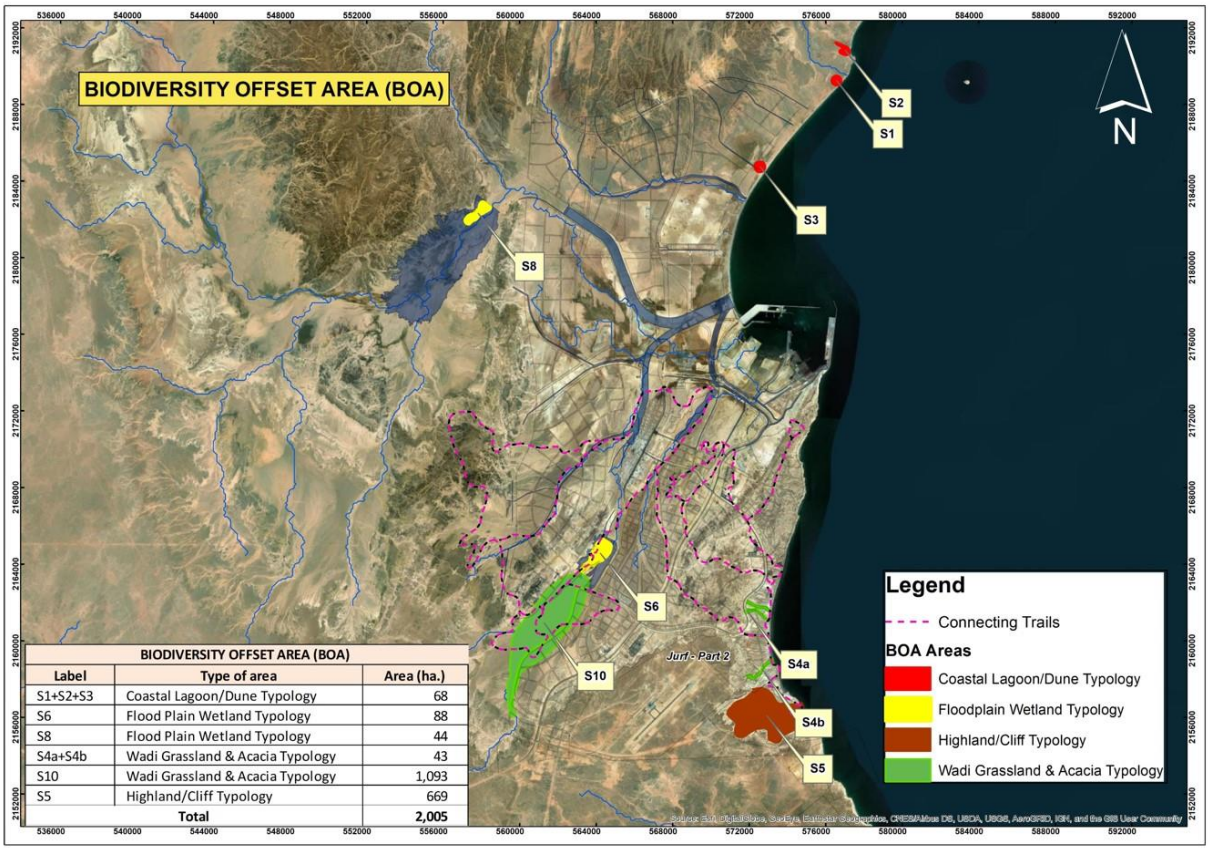
Figure 6-4: BLS Areas (Landscaping)

There are four land parcels are categorised as High Land Park (1,088 hectares), Coastal Park (418 hectares), Wadi City Park (180 hectares), and Linear Park (362 hectares). These areas are already included in the Duqm Urban Design Master Plan as physical amenities and key ecological park amenities to link the desert environment to coastal ecologies. The High Land Park area provides open space for a variety of recreational areas for local and regional visitors; overlooking spectacular escarpment and sea views. The Landscape Guidelines have been developed to provide further detail on the materials, finishes, planting and irrigation of the parks, open space and public realm (Atkins 2019). In addition, this category also includes the Duqm Rock Garden which is one of the major geological sites in Oman. The 636 ha. site houses unusual rock formations believed to be 46 million years old. There is also a region of coastal boardwalk in the tourism zone.

6.5.3 BOA Lands

As shown in ***Figure 6-5***, there are six land parcels totalling to approximately 2,005 ha. catering to the different land typologies present in Duqm:

- Coastal Lagoon/ Dune Typology;
- Flood Plain Wetland Typology;
- Wadi Grassland & Acacia Typology; and
- Highland/ Cliff Typology.



BIODIVERSITY OFFSET AREA (BOA)		
Label	Type of area	Area (ha.)
S1+S2+S3	Coastal Lagoon/Dune Typology	68
S6	Flood Plain Wetland Typology	88
S8	Flood Plain Wetland Typology	44
S4a+S4b	Wadi Grassland & Acacia Typology	43
S10	Wadi Grassland & Acacia Typology	1,093
S5	Highland/Cliff Typology	669
Total		2,005

Figure 6-5: BOA Areas (Offset)

SEZD's Environmental Action Plan[45] states that, "Biodiversity management is an important part of SEZD's responsibilities to provide long-term protection for networks of species and habitats". Connected with that, it presents the objectives and targets which are relevant for creating offset for the lost biodiversity.

- *Objective*: Reduce loss of Habitat, Flora and Fauna – Site preparation activities for project and anthropogenic activities.

- *Target*: Protection of important flora/fauna species populations and critical habitat. Open space planting should use local and native flora.

  Creation of artificial wetlands to enhance the ecological diversity of the site, and for avifauna (including migratory species), arthropods and possibly bats.

  Habitat creation, retention or enhancement should be designed to take due regard of ecological connectivity so that these sites are not isolated or fragmented, but contribute to the wildlife value of the overall area.

The ecological landscaping proposed by SEZD (SEZAD, 2018) specifies adaptation of:

[45] Environmental Strategy for SEZAD - The Special Economic Zone Authority Duqm SEZAD

- Planting palate to consist of drought-tolerant, native vegetation species;
- Target floral species to be planted if applicable;
- Minimal irrigation and chemical management (fertilizer/pesticides) to be applied; and
- Utilization of other landscaping elements (rock, water, elements) to create microhabitats for fauna.

Taking the above as guidelines and utilizing the local native flora, the concepts has been created and illustrated in ***Appendix E*** for the identified BOA regions which is shown in the below ***Table 6-3***.

Table 6-3: BOA Land Parcels

Area Label	Typology	Area in ha.
S1+S2+S3	Coastal Lagoon/Dune Typology	68
S6	Flood Plain Wetland Typology	88
S8	Flood Plain Wetland Typology	44
S4a+S4b	Wadi Grassland & Acacia Typology	43
S10	Wadi Grassland & Acacia Typology	1,093
S5	Highland/Cliff Typology	669
	Total	2,005

Of the total 2,005 ha. in BOA, SEZD has prioritized the first four area labels (comprising of seven sites) totalling to 243 ha. as priority for restoration work and proposes to carry this out by 2022. The rest of the area (1,762 ha.) will be restored during 2025-30.

6.5.4 Total Priority Areas

Figure 6-6 shows the total extent of lands that has been earmarked as Priority Areas. It should be noted that some of these areas overlap, but they all have been currently assigned as Priority Areas. However, they have not yet been formally designated by SEZD but the process is underway.

Once the Priority Areas are designated by SEZD, offset schemes, as explained above, could be designed and implemented for the BOA areas along with measuring and monitoring indices. This process is a long-term exercise as it has to take full account of direct, indirect, and cumulative impacts, geographically and over time. However, considering the area of the 7 sub-projects, the lost critical habitat area is about 250 hectares of the Duqm IBA, which is primarily from the mud flat/ sabkha/ khawr area near Duqm Port from port development and certain areas of the 4 sub-projects (Road No. 1 and 5 to link the Liquid Berth Terminal; Duqm Refinery service corridor to liquid jetty; Coastal shoreline of Jurf and Saay flood protection channels and construction berths; and Dredging works and reclamation work for liquid bulk berth project). Although a small extent of 20 ha. exists in Duqm IBA, the habitat is currently modified and will take few seasons to stabilize.

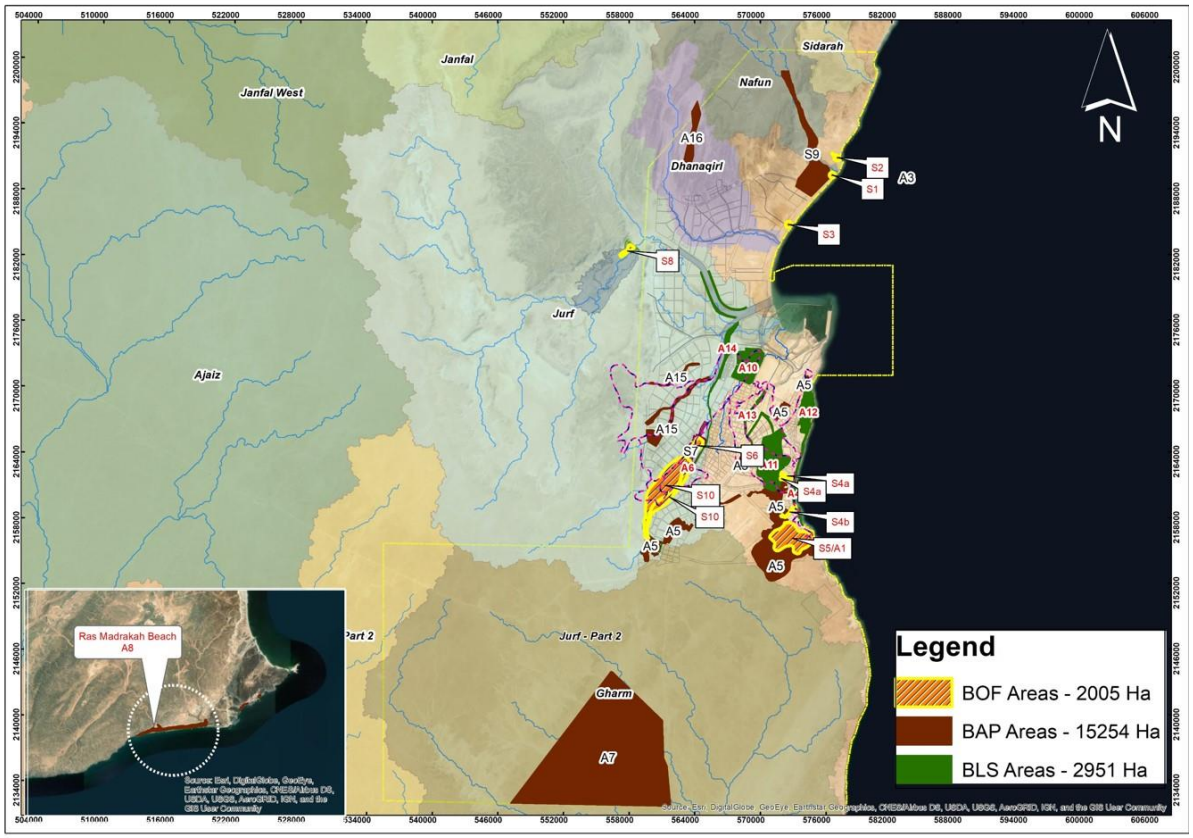


Figure 6-6: Priority Area Atlas for Conservation of Biodiversity

Therefore, to offset for this loss, avoid any future losses in other areas, and increase the biodiversity and ecological productivity within the Duqm region, SEZD is proposing the Priority Areas which total to over 20,000 hectares. As indicated earlier, these land parcels/ banks can be used for offsetting by companies that come up in Duqm. For instance, Duqm Refinery is required to work with SEZD to identify strategic opportunities for offsetting, and they can make use of the "Priority Area Atlas for Conservation of Biodiversity" to select appropriate land parcels and target their efforts in that selected area.

6.5.5 Design and Implementation of Biodiversity Offsets

The design and implementation of the biodiversity offsets will be based on the design [46] and implementation[47] handbooks published by Business and Biodiversity Offsets Programme (BBOP).

The design comprises of the following eight steps as given below:

- Step 1: Review project scope and activities;
- Step 2: Review the legal framework and/or policy context for a biodiversity offset;
- Step 3: Initiate a stakeholder participation process;

[46] Biodiversity Offset Design Handbook published by BBOP, 2009
[47] Biodiversity Offset Implementation Handbook published by BBOP, 2009

- Step 4: Determine the need for an offset based on residual adverse effects;
- Step 5: Choose methods to calculate loss/ gain and quantify residual losses;
- Step 6: Review potential offset locations and activities and assess the biodiversity gains which could be achieved at each;
- Step 7: Calculate offset gains and select appropriate offset locations and activities; and
- Step 8: Record the offset design and enter the offset implementation process.

The implementation comprises of the following five activities as given below:

- Activity 1: What are the biodiversity offsetting activities and where will they be carried out?;
- Activity 2: How will the biodiversity offset operate and be managed?;
- Activity 3: How will the biodiversity offset be financed over the long-term?;
- Activity 4: How will the offset be monitored and evaluated?; and
- Activity 5: Launching the offset.

Therefore, following acceptance of the BAP and the BOF by SEZD and assigning of the Priority Areas by SEZD, once an offset project is proposed, SEZD can make use of the above tasks to ensure that the offset is designed and implemented properly to ensure an increase in the biodiversity footprint on Duqm.

Special Consideration for Development of Lagoons

With regards to the coastal lagoon/ dune typology, ***Appendix E*** presents the concept designs. It should be noted that the concepts have been prepared based on the secondary information (review of satellite images and historical flooding activities in this region) and the proposed offset lagoon areas are selected.

Lagoons are low-lying ecosystems vulnerable to even the slightest changes in coastal morphology. The size and depth of coastal lagoons are important factors for the natural seepage of tidal waters. Hence, it is required assess the existing condition of the proposed areas with respect to sea level and beach morphology.

Usually coastal lagoons are sheltered by sandbars or natural rock barriers in the sea; however, stability of the sandbars will change based on the coastal processes in this region. A site-specific study is required, especially in the Duqm region where the sediment gets severely eroded under extreme conditions (khareef and cyclones). As per our understanding, this project required minimum three types of numerical modelling:

- Beach erosion and mitigation study for beach stability;
- Wave modelling; and

- Hydrodynamic studies; based on the numerical modelling of the coastal processes.

It is also advisable to have few measurements for the input and validation purposes. In this context, please note the following considerations:

- Required topographic survey of the shoreline (between lowest low tide (LLT) line and HAT or beyond) and other near shore area;

- Bathymetry survey (from LLT towards offshore) for the study area. Already surveyed data can be acquired from third party, if available. Hydrographic data will be used as the source of bathymetry in the model;

- Sampling of the beach sediments to obtain the sediment sizes (through sieve analysis). Beach Sediment grain size distribution (taken from Low tide line) at different site. Sieve analysis should be done for at least three fractions, say D16, D50, and D84;

- The preferred mitigation options of SEZD for the upcoming development through beach nourishment, groynes, and any proposed breakwater or any marine structures, intakes and outfalls in this region; and

- Measured weather data (mainly wind and pressure) from a nearby location (at least for 1 month), for validation of re-analysis data. Duqm Port weather data could be acquired.

7 ECOSYSTEM SERVICES

7.1 Introduction

IFC has produced a Sustainability Framework which articulates its strategic commitment to sustainable development. The Performance Standard (PS) 6 of the IFC's framework recognizes that protecting and conserving biodiversity, maintaining ecosystem services (ES), and sustainably managing living natural resources are fundamental to sustainable development.

IFC defines the ecosystem services as, "*the benefits that people, including businesses, derive from ecosystems. Ecosystem services are organized into four types: (i) provisioning services, which are the products people obtain from ecosystems; (ii) regulating services, which are the benefits people obtain from the regulation of ecosystem processes; (iii) cultural services, which are the nonmaterial benefits people obtain from ecosystems; and (iv) supporting services, which are the natural processes that maintain the other services*".

The Convention on Biological Diversity (CBD) defines an ecosystem as "a dynamic complex of plant, animal, and micro-organism communities and their non-living environment interacting as a functional unit". Simply put, it is an area where plants, animals, and other organisms, as well as weather and landscape, combine to form life. Ecosystems can be terrestrial or marine, inland or coastal, rural or urban. They can also vary in scale from global to local. Ecosystems comprise both biotic (living) and abiotic (non-living) parts. For instance, plants, animals, microbes, etc. form the biotic environment, while sun light, soil, temperature, humidity, etc. form the abiotic environment. They are all interconnected and each aspect of the ecosystem depends on the other aspects, either directly or indirectly.

As indicated earlier, ES are the benefits that people obtain from ecosystems, i.e. the goods and services of nature. They are the aspects of ecosystems that actively or passively produce human well-being. It includes the formation of soils, the provision of clean water, the production of crops, the regulation of climate, and opportunities for recreation. They have been used to identify, link, and communicate the benefits of nature to humans and are essential for human survival and to social and economic development. They can be divided into processes (e.g. soil formation) which underpin services (e.g. crop production), which in turn provide goods (e.g. food), often in conjunction with other inputs (e.g. labour).

The concept of ES has become increasingly important as a tool for integral evaluation of project effects, whether positive benefits or negative impacts. As part of their ESAP, SEZD is required to undertake an ES assessment for all the seven sub-projects, for which the financing support is coming through the MIGA. The list of seven sub-projects and their locations is already presented earlier in ***Table 1-1*** and ***Figure 1-2***.

Most of the works under the seven sub-projects are near or close to completion. The developments at Duqm have changed the landscape, and the intent of this study is to evaluate the sub-projects through the prism of ecosystem services so that the infrastructure works and the associated development can be designed in a sustainable manner and implemented responsibly in the environmentally sensitive areas.

7.1.1 Layout of ES Section

The ES study report has a total of nine sub-sections and contains the following:

- Sec 7.1, Introduction: introducing ESs, the seven sub-projects, and the layout of this section;
- Sec 7.2, Ecosystem Services and ES Assessment: detailing the categories of ESs, the assessment techniques, and methodology;
- Sec 7.3, Alternative State of the Site: briefly explaining how the alternate/ plausible future site will be;
- Sec 7.4, Threats and Drivers of Change: indicating the threats and arriving at the negative and positive drivers;
- Sec 7.5, Impacts to Ecosystem services and Ecosystem services delivered by the Site: listing our the ESs delivered by the site habitats;
- Sec 7.6, ES Benefits from Current and Alternate States: tabulating the qualitative valuation of ES benefits derived from the current and alternate states;
- Sec 7.7, Actions from ES Assessment: providing the recommendations arising from the analysis of the ES assessment; and
- Sec 7.8, References: lists all the reports/ documents/ websites that have been used/ referred in carrying out this study, including the various studies carried out on behalf of SEZD.

7.2 Ecosystem Services and ES Assessment

The Millennium Ecosystem Assessment defines four basic categories of ecosystem services, as outlined in ***Table 7-1***, which contributes to and sustains various elements of human and economic wellbeing:

- Provisioning services - results in tangible material goods;
- Regulating services - supports habitable conditions;
- Cultural services - contributes to non-material benefits; and
- Habitat or supporting services - underpins the other three categories.

Table 7-1: Classification of Ecosystem Services

Provisioning Services – ***the result of ecosystem processes and functions that provide goods or products that humans obtain and rely upon; often with some human inputs of labour, financial, and social capital***	
Food:	Ecosystems provide the conditions for growing food. Food comes principally from managed agro-ecosystems but marine and freshwater systems or forests also provide food for human consumption.
Raw materials:	Ecosystems provide a great diversity of materials for construction and fuel including wood, biofuels, and plant oils.
Fresh water:	Ecosystems play a vital role in the global hydrological cycle, as they regulate the flow and purification of water. Vegetation and forests influence the quantity of water available locally.
Medicinal resources:	Ecosystems and biodiversity provide many plants used as traditional medicines as well as providing the raw materials for the pharmaceutical industry.
Regulating Services – ***the result of ecosystem processes and functions that regulate all aspects of the environment, providing security and habitable conditions that humans rely upon***	
Local climate and air quality:	Trees provide shade whilst forests influence rainfall and water availability both locally and regionally. Trees or other plants also play an important role in regulating air quality by removing pollutants from the atmosphere.
Carbon sequestration and storage:	Ecosystems regulate the global climate by storing and sequestering greenhouse gases. As trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues. Biodiversity also plays an important role by improving the capacity of ecosystems to adapt to the effects of climate change.
Moderation of extreme events:	Extreme weather events or natural hazards include floods, storms, tsunamis, avalanches and landslides. Ecosystems and living organisms create buffers against natural disasters, thereby preventing possible damage.
Wastewater treatment:	Ecosystems such as wetlands filter both human and animal waste and act as a natural buffer to the surrounding environment. Through the biological activity of microorganisms in the soil, most waste is broken down. Thereby pathogens (disease causing microbes) are eliminated, and the level of nutrients and pollution is reduced.
Cultural Services – ***the result of ecosystem processes and functions that inform human physiological, psychological, and spiritual well-being, knowledge, and creativity***	
Recreation and mental and physical health:	Walking and playing sports in green space is not only a good form of physical exercise but also lets people relax. The role that green space plays in maintaining mental and physical health is increasingly being recognized, despite difficulties of measurement.
Tourism:	Ecosystems and biodiversity play an important role for many kinds of tourism which in turn provides considerable economic benefits and is a vital source of income for many countries. Cultural and eco-tourism can also educate people about the importance of biological diversity.
Aesthetic appreciation and inspiration for culture, art and design:	Language, knowledge, and the natural environment have been intimately related throughout human history. Biodiversity, ecosystems, and natural landscapes have been the source of inspiration for much of our art, culture, and increasingly for science.
Spiritual experience and sense of place:	In many parts of the world natural features such as specific forests, caves, or mountains are considered sacred or have a religious meaning. Nature is a common element of all major religions and traditional knowledge, and associated customs are important for creating a sense of belonging.
Supporting or Habitat Services – ***the underlying ecosystem processes and functions that are necessary for the production of all other ES, creating the biological environment***	
Habitats for species:	Habitats provide everything that an individual plant or animal needs to survive: food, water, and shelter. Each ecosystem provides different habitats that can be essential for a species' lifecycle. Migratory species including birds, fish, mammals and insects all depend upon different ecosystems during their movements.

Maintenance of genetic diversity:	Genetic diversity is the variety of genes between and within species populations. Genetic diversity distinguishes different breeds or races from each other thus providing the basis for locally well-adapted cultivars and a gene pool for further developing commercial crops and livestock. Some habitats have an exceptionally high number of species which makes them more genetically diverse than others and are known as 'biodiversity hotspots'.

An ES assessment is a technical, interdisciplinary analysis of the ES produced and/or received within a defined study area, and how they may be affected by change. It involves:

- Biophysical measures and description of ecosystems and dynamics involved in the production of ES that they provide; and
- Description/ measures of how humans benefit and dynamics of how benefits are distributed.

An ES assessment can be used to establish a baseline to monitor changes over time, or to enable evaluation of the consequences of management decisions or policy changes on ES delivery. ES assessment processes involve stakeholder engagement all through the study period. However, in our case, as seen below, the key stakeholders are only SEZD and MIGA. It is not a conservation site. While there were habitats of biodiversity importance in the area where the seven sub-projects are coming up, it is clear that the sub-projects are under progress and are expected to be completed soon. The developments have already changed the landscape of Duqm, and the ES assessment can influence decision making by assisting the planners to direct future management actions to maximize the benefits that people obtain from ecosystems. There are no other stakeholders impacted from the seven sub-projects[48]. In the future, SEZD will make use of the Framework SEP it had prepared to engage with stakeholders in Duqm and this will become part of the ESMS process.

There are various reasons on why ES has to be measured. With respect to the site that is being assessed, the following three objectives, as presented in ***Table 7-2***, appear to be relevant:

Table 7-2: Rationale for the ES

#	Reason	Target Audience
1	**Site Management**: Establish the baseline of ES provided by a site to enable monitoring of changes and support management planning	Site managers and others responsible for monitoring sites (*in this case, it is SEZD*)
2	**Planning**: Integrate ES delivered by sites into land-/water-/resource planning at regional, national, or sub-national scales, understand implications for management of surrounding areas to improve flows from or resilience of site ES	Government agencies and ministries, conservation organizations (*in this case, it is SEZD*)

[48] Historically, there have been no resident communities within the core zone where the seven sub-projects are located. In the area around the site where the seven sub-projects are located, again historically, there have been no permanent communities residing, except for artisanal/ small-scale fishing and few houses in the town area. To assist these populations, SEZAD is developing an exclusive fishery port and has undertaken a detailed masterplan for the town area with the appropriate landuse considering the environmental, social, and cultural fabric of the land.

#	Reason	Target Audience
3	**Funding and Investment**: Attract government and donor investment from other sectors concerned with conservation of ES and/or donors interested in sustainable development	Government ministries, development agencies, and organizations (*in this case, it is SEZD and MIGA*)

There are numerous means through which the ES assessment can be carried out and broadly can be separated into the following two categories of ES tools:

- Written step-by-step tools—written guidance documents with specific measurement protocols enabling ES assessment of a site (Examples: Toolkit for Ecosystem Service Site-based Assessment (TESSA), Ecosystem Services Toolkit (EST), etc.); and

- Computer-based modelling tools—software or web-based tools that enable ES assessment of one or more sites (Artificial Intelligence for Ecosystem Services (ARIES), Co$ting Nature (C$N), etc.).

The tool selection is dependent upon:

- Purpose of the assessment;

- Required outputs; and

- Practical considerations.

While each tool is different, all of the tools provide an opportunity to shed light on ES issues and support management and policy decisions.

In this study, we have adopted a customized approach integrating and taking into consideration the ES assessment approaches proposed by TESSA, EST, and The Economics of Ecosystems & Biodiversity (TEEB). In our approach, we have assessed the extent of ES provided by a site in its current state (where no developments takes place as a baseline) compared to a plausible alternative state (where the proposed developments takes place). This assists in evaluating whether the proposed developments delivers greater benefits than conversion to other landuses.

Accordingly, in this study, we have considered the natural habitats based on previous studies/ secondary information that were present at the site (current state) and explained earlier in ***Sec 4.4*** and comparing to the conditions faced by the site with the developments (alternative state) and identified the important ESs delivered by the site in both the states. Subsequently, the assessment of ES would look at understanding how ES benefits might change under different management alternatives or drivers of change and propose the mitigation and enhancement measures to reduce the risks from loss of ES benefits and increase the positive benefits.

7.3 Alternative State of the Site

The alternative state is the one where the seven sub-projects have fully come up and are in operation. Primarily, it relates to the construction and operation of infrastructure within the already operating Port of Duqm, the liquid bulk berths coming up at the Port, service corridor between Duqm Refinery and the liquid jetty, roads linking the Port to the Heavy Industrial Zone, Wadi Jurf and Wadi Saay dams and flood protection channels, etc.

Although not falling part of the seven sub-projects, the impacts and developments arising from the construction/ operation of the Port of Duqm and Duqm Refinery needs to be considered as they are located close to the site and contribute to the major changes occurring at this site and the surrounding environment.

However, the developments also feature the management interventions that SEZD is/ will be executing. SEZD plans to implement an ESMS framework across SEZD's projects and developments, based on IFC performance standards on environmental and social sustainability, and in accordance with the Global Reporting Initiative (GRI) guidelines and/or United Nations Industrial Development Organization (UNIDO's) sustainable development goals for Eco-industrial Parks. The ESMS document provides the basic structure and framework for organizing the system within SEZD, and includes plans and procedures for governance and sustainability aspects which includes performance on biodiversity management, climate and GHG management, culture and heritage management, etc.

The ESMS will help integrate CSR Reporting[49] and with Sustainable Development Goals (SDGs) so that the seven sub-projects and the associated facilities result in a positive benefit to the people and the local environment.

7.4 Threats and Drivers of Change

According to IUCN, a driver of biodiversity and ecosystem loss is any natural or human-induced factor that directly or indirectly causes biodiversity loss. There are two kinds of drivers:

- Direct drivers: influences ecosystem processes and can be controlled locally; and
- Indirect drivers: factors that contribute to changes in the direct drivers of ecosystem services that cannot be controlled locally. They are often the underlying causes for the direct drivers.

Few key direct drivers are:

- Habitat loss, fragmentation, and degradation;
- Excessive nutrient load and other forms of pollution;
- Over-exploitation and unsustainable use;

[49] Referred also as Environmental Social Governance (ESG) in the investment field

- Invasive alien species; and
- Climate change.

Few key drivers are:

- Changes in population;
- Changes in economic activity;
- Changes in technology; and
- Socio-political and cultural factors.

As mentioned earlier, there are many habitats present in the project area. Some of them have greater biodiversity significance. The threats arise primarily from the changes in land-use and cover and human disturbance.

As indicated in ***Chapter 4***, it is apparent that the coastal habitat is an important migratory ground for wintering birds with the maximum avifaunal diversity observed in the coastal region since Oman lies at the centre of a migratory flyway and forms an important feeding ground.

Ecologically, the study area includes three major habitats which are internationally attributed:

- Al Wusta Wildlife Reserve (formerly the Arabian Oryx Sanctuary) which is located in the western half of Duqm and outside SEZD boundary (***Figure 4-1***);
- Jiddat al Harasis IBA which is located in the in the western boundary of SEZD and continuing to a large plateau with 2% of the IBA falling within SEZD (***Figure 4-2***); and
- Duqm IBA which is located near the northern breakwater of Port of Duqm and comprising of khawr and the coastal sabkha. This was listed as a potential Ramsar site as it was known for visiting migratory birds including some rare species, but the area was not offered official conservation status under the Ramsar Convention (***Figure 4-2*** and ***Figure 4-3***).

The HMR report (HMR, 2014) clearly specified that these migratory birds face several threats due to the current anthropogenic activities and would be most vulnerable to future development. It further added that the earlier study (Masterplan for SEZAD by Jurong, 2011) referred these impacts as moderate to negligible, since the species can move to another suitable location along the coast. However, HMR Consultants considered that Jurong's assessment undermines the impacts on migratory species and the overall impact would be of considerable magnitude considering the pressure on the nearby coastal habitats due to future expansion of Duqm Port and other industrial developments.

The report indicated that the Duqm Port construction and associated dredging activities have caused considerable damage to the avifaunal habitat, and no baseline information was available to measure the damage. Development of Duqm Port area into the remaining mud flat zone and construction of liquid

berth jetty was expected to pose significant impact on the habitat of the coastal migratory birds with the dredging activities associated with these developments increasing the turbidity in the water and elevated turbidity levels are known to restrict the foraging efficiency of visually hunting avian predators.

The migratory birds play a crucial role in the ecological process and ecosystem health as they require a large amount of food thus regulating the populations of many other prey species. Moreover, the bird droppings provide essential nutrients in the coastal and marine ecosystem. Due to development of port and other offshore facilities, vessel traffic is expected to increase in the project area and getting more chances for vessel strike on the marine life and underwater sound pollution. In addition, the aesthetic values of beaches and natural landscapes have got degraded due to uncontrolled littering of garbage and plastics; which further threaten terrestrial and intertidal benthic habitats.

While generally the wadi environment could be characterized by perennial fresh water availability leading to significant benefits for the flora and fauna, the wadis in the site area are devoid of any constant flow of fresh water. Water flow can be seen only for few hours after a heavy rain. However, the developmental works have involved diversion of the flows within the wadi systems altering the flow of flood water into the sabkha and intertidal region which housed the IBA. In addition, the exchange of sea water between the lagoon areas is lost.

As indicated in ***Chapter 4*** and shown in ***Figure 4-5***, currently a small extent of the Duqm IBA, approximately 20 ha., is present in the engineered wadi mouth and it will take few years for the modified ecosystem to thrive and stabilize.

The area where the sub-projects are located had no resident communities and only outside this area, there were fishermen carrying out small scale fishing. However, all this will change with the seven sub-projects and the other developments coming up in the area leading to increased human presence and interventions. Based on the threats specified, the drivers of change that impact on the land use and habitats is expected to be:

- Conversion of the land to industrial use;
- Construction of the Port and associated facilities in the sabkha and lagoon area;
- Pollution from industrialization;
- Increase in population; and
- Demographic changes.

Drivers can also be positive and include management policies which can contribute constructively to the environment:

- Development of new fishery harbour;
- Employment opportunities;

- Integrated wadi watershed assessment;
- Increased ecological awareness;
- Creation of tourism infrastructure;
- Implementation of SEZD's ESMS system;
- Creation of SEZD's "Priority Area Atlas for Conservation of Biodiversity"; and
- Enhanced ecotourism opportunities.

7.5 Ecosystem Services delivered by the Site

The impacts to ecosystem services from the seven projects and third party projects include the following:

- Affecting the microclimate by disturbing the fog replenishment influencing the water needs of the flora;
- Increasing urban heat island effect;
- Decreasing infiltration/ percolation with a surge in water runoff;
- Erosion from loss of wadi vegetation;
- Destroying the local natural hydrology regime;
- Reducing flood and erosion control;
- Increasing natural hazards;
- Loss of cultural avenues and affecting local sense of place;
- Disturbing visual character and scenery;
- Bird droppings supported nutrient recycling in the coastal and marine environment;
- Increase in upstream flooding and downstream coastal surge; and
- Provisioning of habitat.

Based on the habitats present at the project site, a list of all ES associated has been compiled and presented in ***Table 7-3***.

Table 7-3: ES derived from Site Habitats

Ecosystem Services	Coastal	Sabkha	Gravel and Sand Plains	Hills and Escarpment	Wadis	Khawrs	Marine
Provisioning - the goods or products obtained from ecosystems							
Food	✓				✓	✓	✓
Fibre							
Biomass Fuel							
Freshwater			✓		✓	✓	
Genetic Resources							
Biochemicals, Natural Medicines, and Pharmaceuticals							
Regulating - the benefits obtained from an ecosystem's control of natural processes							
Air Quality Regulation							
Climate Regulation – Global							✓
Climate Regulation - Local	✓	✓			✓	✓	✓
Water Regulation		✓			✓	✓	
Erosion Regulation	✓				✓		
Water Purification and Waste Treatment	✓				✓	✓	✓
Disease Regulation							
Pest Regulation							
Pollination							
Natural Hazard Regulation	✓	✓			✓	✓	✓
Cultural - the nonmaterial benefits people obtain from ecosystem services							
Recreation and Ecotourism	✓	✓	✓		✓	✓	✓
Spiritual, Religious, and Ethical Values	✓				✓	✓	✓
Aesthetic Values	✓				✓	✓	✓
Supporting - the services that are necessary for the delivery of all other ecosystem services							
Primary Production							
Production of Atmospheric Oxygen							
Nutrient Cycling	✓						✓
Soil Formation and Retention							
Water Cycling	✓	✓	✓	✓	✓	✓	
Provisioning of Habitat	✓	✓	✓	✓	✓	✓	✓

7.6 ES Benefits from Current State and Alternate State

From the above ***Table 7-4***, the important ESs at the site is identified in the below ***Table 7-4*** with a qualitative score ranging from 0-5, on the basis of the benefits they provide, with 0 being not applicable, 1 being low importance, and 5 being highly important. The score is based on a qualitative assessment of the people benefitting from the service in terms of economic (the ability to earn an income and to have assets), human (health, education, nutrition, clean water, and shelter), socio-cultural (sense of place, spiritual wellbeing, and recreation) and protective values (ability to withstand economic and external shocks). The rationale towards arriving at the score focusing on the drivers of change is also presented.

Table 7-4: Tabulation of ES Benefits from Current and Alternate States

#	Ecosystem Services	Benefit/ Disservice	Beneficiary (L/N/G)[50]	Current State	Alternate State	Rationale
1	Food	• Catching of wild fishes	Local National	2	4	SEZD is developing a RO 60 million ($156 million) fishing development port with the fully operational by 2020. Apart from accommodating boats, it will provide the marketing avenues and will have ancillary fish processing industries. This will enable the local community to gain larger benefits.
2	Freshwater	• Inland water bodies and channels aiding grazing	Local	1	4	The desalination plant under construction in Duqm will be able to provide safe, secure, and continuous supply of potable water across the entire Duqm region.
3	Climate regulation – Global	• Acting as carbon sink increasing ocean warming • Degradation of coastal and marine ecosystems	Global	2	2	There is no change anticipated between the current and alternative states as the sea will continue to act as a carbon reservoir affecting the seawater quality.
4	Climate regulation - Local	• Sea fog and interaction with habitats augments water needs of vegetation • Urban Heat Island (UHI) from developments could interfere with fog replenishment	Local	4	2	Construction of the Port and associated facilities in the sabkha and lagoon area and possible pollution from industrialization could impact fog replenishment. However, SEZD's BOF as part of the BAP and Priority Area Atlas can assist in expanding the biodiversity in Duqm.
5	Water regulation	• Enable gradual water runoff and avoiding flooding • Percolation and enabling aquifer recharge	Local	3	1	The port construction in the sabkha and lagoon area has destroyed the natural hydrology regime. This will change the flood water discharge characteristics to the shoreline.

[50] Beneficiary Group: L/N/G corresponding to Local/ National/ Global

#	Ecosystem Services	Benefit/ Disservice	Beneficiary (L/N/G)[50]	Current State	Alternate State	Rationale
6	Erosion regulation	• Wadi and coastal vegetation assists soil retention	Local	2	2	The wadi systems have been modified and the development of port and associated facilities has impacted the coastal environment and the sparse vegetation. However, SEZD's proposed BOF and Priority area atlas including the plan to use native vegetation to minimize soil erosion should assist in maintaining similar benefits in both states.
7	Water purification and Waste treatment	• Infiltration of rainwater runoff • Decomposition of organic wastes	Local	2	1	The port construction in the sabkha and lagoon area has destroyed the natural hydrology regime and the area available earlier for water percolation or managing runoff. However, the coastline and the sea will continue to provide the waste treatment. With the high salinity levels in the region, the groundwater is generally not used for drinking and hence, the benefits in both states is expected to be similar.
8	Natural hazard regulation	• Allow for protection from flooding and coastal surges	Local National	4	2	The port construction in the sabkha and lagoon area has destroyed the natural hydrology regime and increased the possibility of being impacted by upstream flooding and downstream coastal surges. However, the Port and the developed infrastructure also include engineering and management (adaptation) measures that will avoid/ minimize the impacts.
9	Recreation and ecotourism	• Birdwatching • Increased presence of avifauna • Scenic environment	Local	3	4	The site contains the area that was Duqm IBA, but the area was dependent upon the interaction between the lagoon, sabkha, and the sea. However, the lagoon has

#	Ecosystem Services	Benefit/ Disservice	Beneficiary (L/N/G)[50]	Current State	Alternate State	Rationale
						been infilled and a large extent of sabkha is lost. Currently only a small portion of modified Duqm IBA exists. Nevertheless, the increased ecological awareness, implementation of SEZD's ESMS system, and priority area atlas will help increase the habitat availability for the avifauna and other species and can also help to manage/ eliminate the plastic and garbage menace which impacts the wildlife. SEZD will also enable development of adequate tourism infrastructure in Duqm which is now completely lacking.
10	Spiritual, religious, and ethical values	• Giving local residents a sense of the place • Value local residents attach to the area	Local	2	1	The increase in population and the change in demography can taint the idea of sense of place experienced by the local native population. However, the area historically did not have any resident communities.
11	Aesthetic values	• Perception of scenery	Local population	2	1	The conversion of the land to industrial use, increase in population, change in demography, and possible pollution from industrialization can change the local people's view of scenery. However, the area historically did not have any resident communities.
12	Nutrient cycling	• Bird droppings provide essential nutrients in the coastal and marine ecosystem	Local	2	2	While the conversion of the land to industrial use and the associated changes to landscape will impact the birdlife and its benefits to the environment, this is not considered to be significant as the activities could happen away from the site and the BOF can assist in catering to supporting the birdlife.

#	Ecosystem Services	Benefit/ Disservice	Beneficiary (L/N/G)[50]	Current State	Alternate State	Rationale
13	Water cycling	• Stable hydrology regime • Maintaining water balance in the area considering rainfall, runoff, percolation, flooding, and coastal surges	• Local	3	1	While the construction of the port and associated facilities in the sabkha and lagoon area has destroyed the natural hydrology regime, it increased the possibility of being impacted by upstream flooding and downstream coastal surges. However, engineering and management measures are taken to minimize the impacts.
14	Provisioning of habitat	• Enabling the creation of IBA • Supporting flora and fauna	• Local	4	3	While the conversion of the land to industrial use and the associated changes to landscape will impact the native ecology of the area, the BOF can assist in increasing the biodiversity and supported by the ecotourism opportunities.

From the above, the change in benefits amongst the various ecosystem services is illustrated below in ***Figure 7-1***.

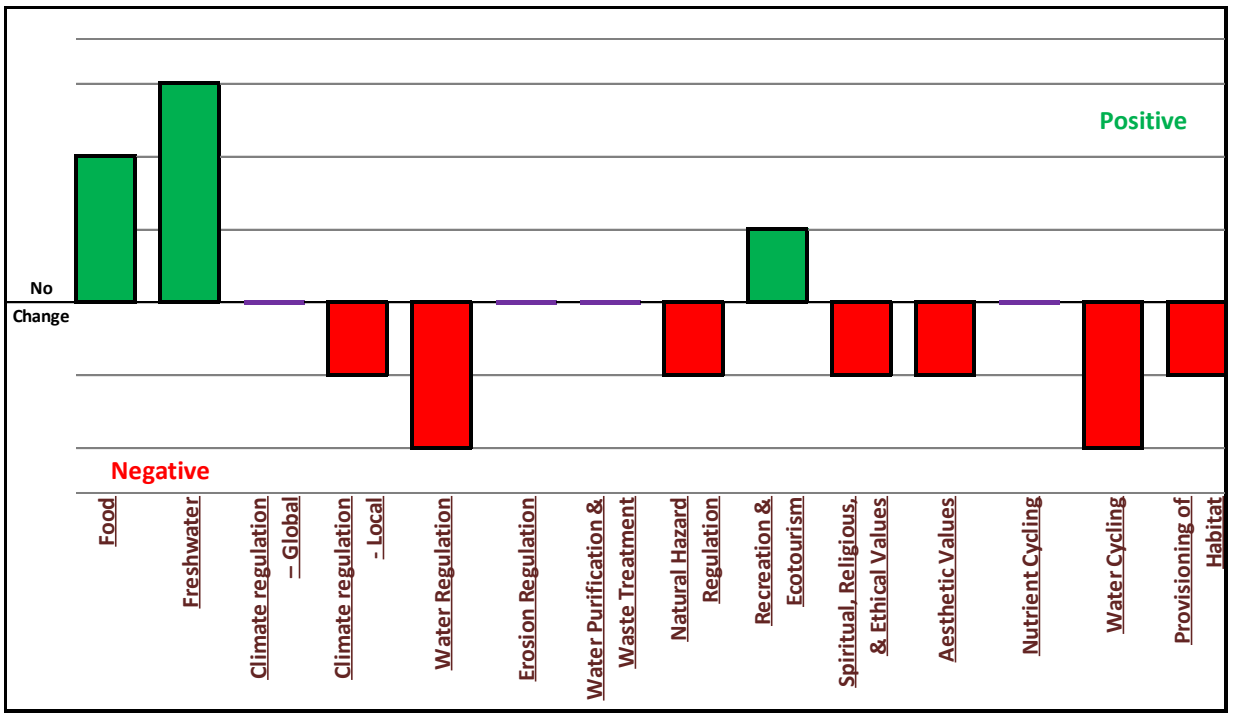


Figure 7-1: Change in value of Ecosystem Services Benefits

7.7 Actions from ES Assessment

The ESs and the benefits they provide have been discussed in the earlier sub-sections. The changes that can happen on the type and magnitude of ESs after all the developments come in have also been assessed. As illustrated earlier in ***Figure 7-1***, some ESs will give positive changes and some of them will lead to negative changes. This sub-section sets out the proposed actions to be undertaken for the ESs arising from the site with the aim to provide mitigation and enhancement measures to reduce the risks and increase the positive benefits.

Table 7-5 provides the specific recommendations and subsequently, the strategic recommendations have been listed.

Table 7-5: Recommendations for the ESs from the Site

#	Ecosystem Services	Mitigation/ Enhancement Measures
1	Food	As indicated earlier, SEZD is in the process of constructing a fishing harbour with all facilities required to accommodate small and medium size fishing boats. It is expected to be operational in 2020. It has also developed an integrated vision of the fishing sector in Duqm including providing avenues for marketing, aquaculture, research, processing, etc. This will assist to provide a better environment for the fishing community and increase employment opportunities to the local population of Duqm. However, adequate training and interactions could be carried out with the fishermen to assist them to follow all environmental safeguards, including proper waste management avoiding disposal of garbage haphazardly.
2	Freshwater	With continuous potable water supply from the desalination plant, water security is safeguarded. The change in land-use and the developments will minimize livestock grazing in the area. SEZD could establish grazing grounds near where the users reside and treated water after sewage treatment can be utilized for this purpose. SEZD can also study the possibility of groundwater availability in the area as the underlying UER[51] aquifer formation in Duqm has groundwater and a sustainable groundwater management plan can be established.
3	Climate regulation – Global	This is a global issue and Oman has taken several measures to address climate change ratifying various international agreements and conventions that are aimed to mitigating climate change and reducing generation of greenhouse gases.
4	Climate regulation - Local	To minimize the UHI effect, the green cover from the lands allocated from BOF, including the priority area atlas will be of use. Green cover is the only means to mitigate the localized heat effect, and this should be supported by SEZD through policy initiatives including planning and design guidelines, zoning codes, green building standards, using treated wastewater effectively for urban forestry. In the Duqm city region, 50% of the land has been kept open spaces. In the masterplans prepared for SEZD, extensive information has been provided on the appropriate landscape for Duqm, including planting of humid, sub-humid, semi-arid, and arid species, and they should be adhered to.
5	Water regulation	SEZD has studied the wadi systems in Duqm and modifications have been carried out such as constructing dams, training of the wadis, and construction of new deepened channels. The hydrology in the project area has been altered impacting

[51] Umm er Radhuma (UER) Aquifer Formation extends from the Gulf coast in the north and the Oman Mountains in the south-east over about 800 km. It covers a total area of about 680,000 km^2, stretching across the vast Rub' al Khali Desert, the Dhofar-Najd Plain in Oman including Duqm region, and the northeastern Hadhramaut-Al Mahra Plateau in Yemen.

#	Ecosystem Services	Mitigation/ Enhancement Measures
13	Water cycling	the biodiversity in IBA. To offset this, BOA areas have been identified and they should be conserved and flora and fauna should be nurtured. In the future, SEZD could study the entire watershed in Duqm region to identify interventions that can support biodiversity and aid in its recovery. SEZD could also study UER aquifer formation in Duqm and look at artificial groundwater recharge as part of their long-term plans. The recommendations presented in the "Cumulative Impact Assessment, Resource Efficiency, and Pollution Prevention Guideline" report for recharge and rainwater capture could be followed based on their feasibility.
6	Erosion regulation	Erosion can be minimized or even avoided by utilizing native vegetation and seeding the erosion prone areas particularly in the wadi channels and in the sand dunes.
7	Water purification and Waste treatment	The infiltration of runoff could provide a purification service for groundwater, but with the modifications in land-use, this is affected. However, the suggestion for SEZD to study the UER aquifer formation in Duqm and look at artificial groundwater recharge would aid the water purification.
8	Natural hazard regulation	The change in the landuse and the developments in the project area and Duqm Port has increased the possibility of the area getting impacted by upstream flooding and downstream coastal surges. However, coastal flood defences have been created and the wadi channels have been deepened and strengthened to mitigate the impacts.
9	Recreation and ecotourism	SEZD is taking steps to provide the necessary tourism infrastructure in Duqm and encouraging local small and medium enterprises (SMEs) to be part of this sector. A large portion of the SEZD area has been earmarked for tourism (450 ha.+) with the intent to offer a venue for leisure and entertainment, apart from utilizing the natural rugged landscape to promote ecotourism opportunities. The priority area atlas and provision and nurturing of the flora and fauna will aid in improving the ecology, along with the strengthening of the existing natural conservation areas. The landscape recommendations provided in the masterplans prepared for SEZD should be followed as they can assist in creating a green visual barrier between the industrial and public areas.
10	Spiritual, religious, and ethical values	The landscape recommendations provided in the masterplans prepared for SEZD should be followed as they can assist in creating a green visual barrier between the industrial and public areas. SEZD could focus its efforts to conserve the wilderness areas in SEZD, implement the BOF by making use of the priority area atlas to expand the biodiversity of the area.
11	Aesthetic values	
12	Nutrient cycling	BOF areas have been identified all around Duqm including in the coastal region and they should be conserved and flora and fauna should be nurtured. This will aid in expanding the biodiversity in the region.
14	Provisioning of habitat	The landscape recommendations provided in the masterplans prepared for SEZD should be followed as they can assist in creating a green visual barrier between the industrial and public areas. SEZD could focus its efforts to conserve the wilderness areas in SEZD, implement the BOF by making use of the priority area atlas to expand the biodiversity of the area. All this should provide the necessary habitat to support flora and fauna.

Apart from the above, the following strategic recommendations are being made:

- Ecosystem service indicators helps to assess whether ecosystem services are being managed appropriately and used sustainably. They can be incorporated into monitoring and reporting systems for the development of environment policies and plans within SEZD. Some of the indices that is recommended to be used in the Duqm area by SEZD to measure the benefits that ES provides to the people, grouped under the collection methods are:

  National and Regional Statistics (SEZD)

  - ❖ Number of tourists coming to Duqm
  - ❖ Number of people working in tourism industry
  - ❖ Number of tourism SMEs
  - ❖ Community health status of Duqm
  - ❖ Extent of Priority Areas in Duqm
  - ❖ Extent of the conservation area and the biodiversity habitats
  - ❖ Regulation of greenhouse gases, including carbon storage, carbon sequestration, and greenhouse gas regulation
  - ❖ Availability of parks/ environmental spaces and their accessibility
  - ❖ Quality of environmental spaces such as parks

  Remote sensing (satellite imagery or SEZD's drone photography)

  - ❖ Monitoring the status of Duqm IBA
  - ❖ Monitoring the status of critical habitats
  - ❖ Monitoring the status of restored habitats
  - ❖ Monitoring the marine water quality in SEZD area in terms of productivity, temperature, and salinity
  - ❖ Extent of green cover in Duqm

  In-situ observations

  - ❖ Extent of offset efforts on BOA areas
  - ❖ Incidence of algal blooms

  The measures for the ES has been included in the BAP action items as part of the SEZD-wide environmental monitoring system.

- SEZD should ensure that the environmental and social management plans (ESMP[52]) prepared as part of the environmental and social impact assessment (ESIA[53]) studies carried out for the seven sub-projects and the other ancillary facilities located in and outside this area be implemented in full and adequate monitoring carried out to ensure compliance;

[52] This will also include any stand-alone EMP too
[53] This will also include any stand-alone EIA too

- The biodiversity offset locations proposed in the BOF and detailed in the priority area atlas should be adhered to and SEZD should provide this information to the industries coming up in Duqm so that they can use these areas for focusing their CSR and carbon neutrality[54] efforts. SEZD can discuss with the tenants in SEZD to guide them to use their CSR funds for increasing biodiversity and ecotourism potential;

- SEZD should develop and implement their ESMS as it will provide a structured and systematic mechanism to integrate environmental and social safeguards during project planning, design, and execution. The ESMS should also consider the various studies that are being carried out by SEZD such as Cumulative Impact Assessment, Biodiversity Action Plan, Climate Risk Vulnerability Assessment, Greenhouse Gases assessment, SEP, etc. This can help to avoid, minimize, or mitigate any adverse environmental and social impacts from the proposed developments; and

- SEZD should evolve and adapt sustainability indicators as they are one of the most effective tools for communicating SEZD's sustainability performance in accordance with or stylized according to GRI standards, and this can also be used by the tenants operating in the Duqm area[55]. With the creation of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) which will report on the state of global biodiversity and the extent to which economies depend on healthy ecosystems and World Bank encouraging countries to value ecosystems in the same manner as GDP, it is a matter of time that organizations start integrating biodiversity into business and assess the impacts of their operations on biodiversity or ecosystems. GRI reports looking at the economic, environmental, and social performances. The environmental reporting components may include:
    - GRI 103 - Management Approach;
    - Disclosure 304-1 Operational sites owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas;
    - Disclosure 304-2 Significant impacts of activities, products, and services on biodiversity;
    - Disclosure 304-3 Habitats protected or restored; and
    - Disclosure 304-4 IUCN Red List species and national conservation list species with habitats in areas affected by operations.

  Narrative reporting can be used for the strategy and management and data reporting for the performance. GRI has established 30 environmental indicators that can be used by organizations to evaluate and improve their performance. Between GRI and UNIDO's Eco-Industrial Park (EIP) concepts, a focused structure for SEZD would need to be developed and improved as per the ESMS and guidelines.

[54] Achieving net zero CO_2 emissions by balancing carbon emissions with carbon removal through carbon offsetting or eliminating carbon emissions altogether

[55] Launched in end-2016, GRI Standards provide the GRI's reporting framework for sustainability reporting helps organizations to provide information on their environmental, economic, and social impacts. The GRI guidelines can be used to report on ES. There are general standards and topic specific standards with GRI 304 dealing with biodiversity. Since biodiversity underpins ecosystem functioning and the provision of ecosystem services, the biodiversity reporting components of GRI can be followed.

7.8 References for ES Section

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8 IMPLEMENTATION MODEL

This concluding chapter focusses on the implementation model for carrying out the action items listed in the BAP.

The growth of SEZD and the Duqm area is anticipated to occur in accordance with the following three phases outlined in ***Table 8-1***:

Table 8-1: Phases of SEZD's Development

Phase	Time Period	Description
Startup Phase	2020 - 2024	Period until DRPIC is commissioned and operations gets stabilized. During this period, infra-construction activities primarily take place
Growth Phase	2025 - 2040	After commissioning of DRPIC and start of Duqm Petrochemical Project (DPP) and other downstream industries
Maturity Phase	2041 - 2060	Stabilization of the key industries established in Duqm and start of allied/ ancillary operations

The industries can be asked to support the biodiversity efforts through their commitments for CSR and biodiversity offsets. The latter would be a requirement for Category A industries as they will involve lender financing with reliance placed on SDGs and sustainability performance. This can be used to address the BOA initiatives and to support interventions in the areas falling under LSA and NOS. Other industries can also be asked to complement the biodiversity efforts making use of CSR funds, and allowing them to carry out acceptable interventions in the LSA and NOS areas.

All these would mean SEZD having to work closely with the industries and ensuring that the biodiversity team within SEZD is able to plan and execute the same. As indicated, the responsible party for implementing and maintaining the BAP shall rest with the Environmental Control Department within SEZD, and the work can be resourced internally or externally sourced. To implement the action items of the BAP, the above institutional arrangement will be designed and implemented during the startup phase. The theme of this phase is 'Rollout, Monitoring, and Training' to create the capacities and building the expertise required within the core ESMS governance functions to manage biodiversity.

The industrial developments at SEZD are still in their initial stages with most of them under planning, design, and construction stages. With significant headwinds in the economy, depressed oil prices, and virtual lockdown due to the ongoing viral pandemic in the first half of 2020, these effects may last until the end of 2021. It is likely that liquidity and investor confidence may return in a significant way to take the investments forward by 2022 and by 2025 after DRPIC is commissioned and stabilized other developments may start to materialize.

Therefore, the implementation process illustrated in ***Figure 8-1*** below is being proposed to accomplish the recommendations stated in the BAP.

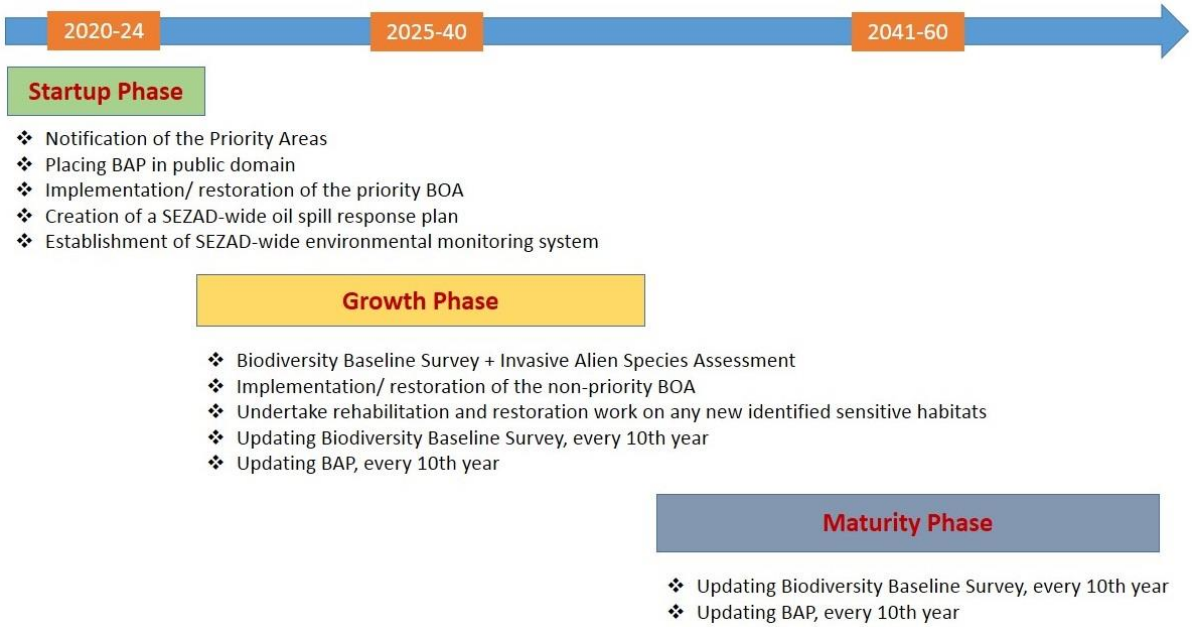


Figure 8-1: Implementation of BAP Recommendations

In detail the steps will comprise of:

1) Notification of the Priority Areas (finalized in BD report) - by end-2020

2) Placing BAP in public domain (SEZD website) - by end-2020

3) Implementation/ restoration of BOA - the priority 250 ha.in 2022 and the rest (1,750 ha.) during 2025-30

4) Creation of a SEZD-wide oil spill response plan (which will establish the updating frequency and emergency drills) - by 2023

5) Establishment of SEZD-wide environmental monitoring system (air, noise, soil, sediment, groundwater, seawater quality) - by 2023

6) Biodiversity Baseline Survey all through SEZD area - Will be done in 2025. Invasive alien species assessment will be done as part of this 2025 baseline survey

7) Undertake rehabilitation and restoration work on sensitive habitats, if any, that are open and not earmarked for any industrial or non-industrial development - to be done in 2025-30

8) Updating of the Biodiversity Baseline Survey and the Biodiversity Action Plan - Once every 10 years from the completion of the 2025 survey

The Environmental Funds[56] proposed can be used to support the above initiatives along with working with the industries and enlisting them to support the biodiversity efforts.

[56] It is proposed an environmental/ compliance budget of 2% can be set aside for the 15-year duration against the USD 1.7 billion loan amount equating to RO 13.08 million or about USD 34 million and designated as Environmental Funds.

9 CONCLUSION AND RECOMMENDATIONS

This study focused on carrying out a Critical Habitat Assessment (CHA), developing the Biodiversity Action Plan (BAP), and carrying out an Ecosystem Services (ES) assessment. The work has been carried out in accordance with IFC PS6 which recognizes that protecting and conserving biodiversity, maintaining ES, and sustainably managing living natural resources are fundamental to sustainable development.

The biodiversity baseline was collated from the previous EIA/ ESIA studies which provided information about the biotic characteristics present in Duqm. While the study area related to the area where the seven sub-projects are located, for the assessment, the entire SEZD area was considered.

The CHA exercise arrived at the priorities for biodiversity conservation based on the presence of species that are critically endangered or endangered, endemic, and are migratory in nature, and the importance of the habitats and identified conservation areas form the critical habitats.

The BAP exercise culminated in a framework for the management of biodiversity in the SEZD area as it contributes to both conservation and sustainable use. Strategies have been proposed to manage and/ or mitigate the threats to biodiversity through the BAP Action Plan and 12 action points have been presented and explained. A Biodiversity Offset Framework (BOF) was developed to meet the no net loss and demonstrate net gain of natural habitats. In this regard, a "Priority Area Atlas for Conservation of Biodiversity" was created earmarking approximately 200 sq. km. of land parcels/ bank spread all around Duqm that could be used for conservation, offset, and landscaping. The design and implementation steps to be followed for enabling biodiversity offset along with the prioritization for its implementation is presented.

The interdisciplinary analysis of the ES produced and/or received within the study area was performed, and how they may be affected by change. The assessment proposed mitigation and enhancement measures to reduce the risks and increase the positive benefits.

Recommendations are made to integrate the measures into the proposed ESMS that SEZD is developing and to use sustainability indicators to communicate SEZD's sustainability performance in accordance with GRI standards. The implementation model along with the rollout plan has also been presented.

It should be noted that biodiversity assessment is a continual process and involves gradual effort for the design and implementation. The changes, either positive or negative, do not happen immediately and occur over a longer time period. It is recommended that a biodiversity baseline survey be conducted in 2025 and BAP updated with suggestion that the BAP be revised every ten years taking into changes to the context and the environment.

Appendix A. - Details of the Seven Sub-Projects

1.1 Projects and its Description

1.1.1 Project 1

Construction of roads, buildings and additional infrastructure at the commercial pre-gate, gates and inspection zone of Port of Duqm

The Package 3 (IP3) pre-Gate, Gates & Inspection Zone includes the construction of road and paving works, infrastructure works, building works, and inspection zones. The project involved the following activities.

Roads and Paving Works

- Construction of 8.00 km roads with various cross sections including the junctions. The roads are Road- 02-2, Road 02-3, Road 02-4, Road 2-5, Road 02-6, Road 02-7, Road 02-8, Road 02-9 and Road 02-11;
- Construction of all internal roads as access to buildings and parking facilities;
- Design, supply, installation and commissioning of Traffic Signals; and
- Construction of helipad (2 nos.) with an approximate area of 2,200 m^2 in inspection zone (Zone 2).

Infrastructure Works

- Potable water network and firefighting network;
- Storm water drainage and sewerage network;
- Pump stations and electrical works;
- Telecommunications;
- Street lighting and yard lighting; and
- Spare ducts and fencing and gate works.

Building Works

- Gate house & gate, stop station, pass office building, mosque, electrical service building and firefighting water tank.

Inspection Zone

- Custom – MoH administration & inspection building, MAF inspection building, MoH clinic, gate house, electrical service buildings, firefighting water tank, custom inspection staff building and ammunition building.

1.1.2 Project 2

Design, procurement and construction of the marine structures and associated berths, dredging works and permanent reclamation areas of liquid bulk berths in the Port of Duqm

The Package 7 (IP7) project involves development of liquid bulk berths with storage tanks and sheds for bulk liquid and solid products, along with associated facilities and utilities for export of Duqm refinery products. Salient features of the project include the following:

- Dredging (about 27 million m^3) of the liquid bulk berth basin;
- Dredging of 6.5 million m^3 of soil from the offshore borrow area;
- Reclamation to the south of the existing Lee Breakwater (LBW) including ground improvement and foundation to support equipment, buildings, tanks, pipeline, and other equipment;
- Construction of liquid product export berths, bulk solids export berth and spare berths;
- Admin building/ control, room/amenities, parking area, Substations/ local equipment room, warehouse, firewater pump house, pump rooms, bulk storage buildings etc.

1.1.3 Project 3

Construction of Road No. 1 and Road No. 5 to link the Liquid Berth Terminal at Duqm Port to the Heavy Industrial Zone and drainage systems along the two roads

The Project forms part of the road infrastructure works in the port area, and involves the design and construction of Road No. 1 and Road No. 5 and the associated drainage systems along these proposed roads. The project involves the following developments.

- Road No. 1 (2x2 lane dual carriageway) from its intersection with National Road No. 32 (Duqm-Mahoot Road and goes towards Duqm Port up to Road 7, including common corridors for utilities, street lighting and drainage systems. The total length of Road 1is approximately 3.93 km;
- Road No. 5 (2x2 lane dual carriageway) from its intersection with Road No. 1 and Road No. 6 to the proposed liquid berths at the seaside, including common corridors for utilities, street lighting and drainage systems; The length of Road No. 5 is 3.3 km;
- Service Road (SR -01 and SR-02) starts from the project limit of construction near National Route Mahout – Duqm road and runs along Road No. 1 & Road No.5. This road will be utilized for transportation of solid product materials to liquid jetty; and

- Drainage systems along proposed Road Nos. 1, 5 and Service Road; associated culverts and other related structures; Landscaping and Irrigation; and Ground improvement works for the construction of the roads and drainage structures.

1.1.4 Project 4

Construction of Jurf and Saay flood protection channels in Duqm

The construction of Jurf and Saay channels will provide a significant degree of flood protection to the free zone area. The project involves the following developments:

- Excavation of channels to levels and lines as per the designs;
- Construction of embankment with protection works;
- Providing protection works like Gabion boxes and riprap; and
- Relocating the existing services.

Jurf channel starts at the downstream of Jurf dam and ended by the sea with different bed widths started from 340 m to 650 m at the sea outlet. The total length of Jurf channel is approximately 16 km. Saay channels started from the downstream of Saay dam along the natural wadi route and heading from south to north till the junction with Jurf channel. This channel has also different bed widths started from 90 m to 320 m when joined with Jurf channel.

1.1.5 Project 5

Construction of Jurf and Saay flood protection dams in Duqm

There are two flood protection dams built in the Special Economic Zone at Duqm (SEZD) with storage capacity of 32.8 million cubic meters (Wadi Jurf dam) and 17 million cubic meters (Wadi Saay dam). The height of the Wadi Jurf dam is about 19.4 m and extends for 1,600 m with base width of 100 m. The Wadi Saay dam is 16.4 m high, 3,665 m long and 100 meters wide. The Saay dam will consist in an earth fill embankment associated with a clayey core, bituminous core, plastic concrete cut-off and upstream blanket. The design is also includes main spillway, auxiliary spillway, seepage control and outlets.

1.1.6 Project 6

Engineering, procurement and construction of Duqm Refinery service corridor to liquid jetty

The Works comprises the complete corridor including earthworks together with associated concrete, security works and bridge works to allow Duqm Refinery to lay their pipes connecting to the Port of Duqm in the Industrial Zone at Duqm.

1.1.7 Project 7

Construction of interface roadway projects in Duqm (Road Section 4)

Project involves the design and construction of Road section 4 and the associated drainage systems. The Road section 4 (2x2 lane dual carriageway) extending from its intersection with National Road No. 32 (Duqm-Mahoot Road) and goes towards coastal industrial area.

Appendix B. – Validation Survey

1.1 Validation Survey

A rapid terrestrial ecological survey was conducted at Duqm area during the site visit in January 2020. The objective of this study was broadly to review existing information and provide a clear idea of the spatial distribution of the ecologically important areas in and around Duqm which should be protected from the future development. It is to be noted that the natural landscape in the seven project areas were heavily altered due to the design of each project; extensive constructions and transformed to a new infrastructure. Hence, a desktop based review was carried out prior to the site visit of the previously identified ecological areas around the seven projects and proposed offset areas within SEZ boundary.

A rapid resource inventory method (walkover and general observations) was employed to characterize the species composition of different habitat types within the Duqm area. Low sensitive habitats like gravel and sand plains, rocky outcrops and escarpment were not covered in this present survey. Observations were made at selected locations and the survey locations were determined using a Geographical Information System (GIS). Once the desktop review was completed a preliminary habitat map was generated using satellite imagery (Google Earth), our existing knowledge of the SEZ area, and other information.

Figure 1: Wadi Saay area with large tree Prosopis cineraria

The wadis are the main area of ecological interest in Duqm SEZ as they support relatively large numbers of trees and a greater number of plant species than any of the other habitats. As reported in the baseline survey, the large trees *Acacia tortilis* and *Prosopis cineraria* was the most dominant, widespread and common tree in the current survey areas. The species composition varied considerably between different areas of the same wadi runnels. For instance the northern of Wadi Saay was dominated by large *P. cineraria* trees and dense clumps of *Tephrosia apollinea* shrubs whereas further towards the southern part of the same wadi tree *A. tortilis* was dominant. In eastern part of Wadi Dhanjart and Jurf runnels were dominated with combination of *P. cineraria* and *A. tortilis.* Further *Acacia ehrenbergiana* was also observed occasionally in the wadi runnels. Dwarf shrub *Tetraena qatarensis* was the dominant species in coastal gravel plain and

wadi runnels but much less prevalent in hilly terrains and escarpment habitat. Shrub *T. apollinea* was observed mostly in the wadi pool area and indicating the influence of recent rainfall in this region.

Figure 2: Coastal (Wadi Dhanjart) area with shrubs Tetraena qatarense, Tephrosia apollinea, trees Acacia tortilis and Prosopis cineraria

The existing gravel plains are generally flat with wadi runnels and patches of sand dunes. The plains are largely devoid of vegetation with plants mostly limited to wadi runnels and sand dunes. Shrub *T. qatarense* and Acacia trees were the dominant species in this habitat. The other communities were dominated by *Pluchea arabica*, *Crotalaria aegyptiaca* and *Fagonia* sp.; desiccated plants and shrubs were also observed in many part of the gravel plain.

Figure 3: Gravel plain area in the central-northern part of SEZ

The rocky hills and escarpment comprise a large proportion of northern part of the SEZ. As reported in baseline survey (HMR, 2014), the area support little to no vegetation due to low water availability throughout the year. In the present survey *Acacia tortilis* is the most prevalent tree in the hilly & escarpment area; mostly distributed in wadi runnels. Other shrubs *Tetraena qatarensis*, *Anabasis setifera*, *Cadaba*

farinose, Convolvulus prostrates, Dipterygium glaucum and sprawling shrub *Capparis cartilaginea* were observed in different part of the hilly terrain. The area was also support different herpetofauna with larger crevices and hollows in the escarpment. However, no such evidence was found during this rapid survey.

Figure 4: Hilly escarpment in northern part of SEZ

Coastal areas in the northern part of the SEZ close to sandy beaches have a silty and saline surface that supports halophilic vegetation, however the southern part of the SEZ was mostly with coastal cliff and areas with number of wadi's were crossing in the coastal plain area and these networks of wadi runnels cover a major part of the vegetation in the existing habitat.

Figure 5: Coastal gravel plain & hilly escarpment

Coastal dunes and sabkha support considerable numbers of halophytic plants such as *Suaeda moschata, Suaeda vermiculata, Halopeplis perfoliata, Arthrocnemum macrostachyum, Tamarix aucheriana*, and *Tetraena qatarensis*. Coastal habitat north of Lee breakwater was significantly influenced by the ongoing industrial and construction activities. Lagoon and certain areas of sabkha was reclaimed and converted to

an engineered drainage channel. Previous studies (HMR, 2014) suggest that this coastal area was significantly more important for wintering migratory birds due to lagoons and fish landing site. However, the opposing result was found during this survey.

Figure 6: Halophytic plants in existing Sabkha region

In the present survey, a total of 56 species of plants representing 24 families were accounted at the survey areas in Wadi, runnels, coastal and hill ranges. Species list is presented in the table below. A total of 61 species of plants were recorded in the baseline surveys (HMR, 20142) covering the entire SEZ area. However, the present survey was focused only in the sensitive areas identified in the wadi system in and around the Duqm development and the current status of other areas were not recorded. Hence, it is possible that some of the species identified in the previous survey could not be confirmed during the survey. Further, compared to the baseline survey (HMR, 2014), certain new species (*Ficus cordata, Monsonia nivea, Salsola omanensis, Hyoscyamus gallagheri, Chloris barbata, Cyperus conglomeratus, Aristida* sp. *Aeluropus* sp were also reported in the current survey.

The tree *P. cineraria* and *A. tortilis* were the most dominant, and widespread tree in the current study area. Of the native plants, seven species, which include *Cleome austroarabica, Echiochilon jugatum Halothamnus bottae, Pluchea Arabica, Pulicaria glutinosa, Ziziphus leucodermis* and *Tetraena qatarense* are geographically restricted (Regional Endemic) in the Arabian Peninsula; other four species *Limonium sacrophyllum, Suaeda moschata, Salsola omanensis* and *Ochradenus harsusiticus* are endemic to Oman. Except four species, the taxonomy of most of the species has not yet been assessed for the IUCN red list barring a few which are in the "least concern" category.

In addition to the plants there are two species of lichens (saxicolous & *Ramalina* sp lichens) growing on the rocky rubbles in the northern part of hilly terrain. Lichens are a complex life form that is a symbiotic association between a fungus and algae or cyanobacteria. The growth and presence of lichens indicates the moisture provided by coastal fog and dew (Jurong, 2011).

Table 1: Observed Species during Validation Survey

#	Species	Family	Duqm Baseline Record 2012	Present Survey 2020	IUCN[1] status 2020	Relative Abundance in Duqm region
1	*Acacia ehrenbergiana*	Leguminosae	✓	✓	Least Concern	Co-dominant species in some areas in wadis and occasionally found in wadi runnels
2	*Acacia tortilis*	Leguminosae	✓	✓	NE[2]	An abundant species in the wadis & gravel plain; Occasionally encountered in hill & escarpment
3	*Aristida* sp.	Poaceae	-	✓	-	Rare in wadi
4	*Aerva javanica*	Amaranthaceae	✓	✓	NE	Occasionally encountered in wadis
5	*Anabasis setifera*	Amaranthaceae	✓	✓	NE	Occasionally encountered in hill, escarpment, coastal plain
6	*Arnebia hispidissima*	Boraginaceae	✓	✓	NE	Occasionally encountered in coastal plain
7	*Arthrocnemum macrostachyum*	Amaranthaceae	✓	✓	NE	Occasionally encountered in sabkha & beach
8	*Aizoon canariense*	Aizoaceae	✓	✓	NE	Occasionally encountered in coastal plain
9	*Aeluropus* sp.	Poaceae	-	✓	-	Rare in wadi
10	*Cadaba farinosa*	Capparaceae	✓	✓	Least Concern	Occasionally encountered in gravel plain
11	*Blepharis ciliaris*	Acanthaceae	✓	✓	NE	Occasionally encountered in coastal plain
12	*Crotolaria aegyptiaca*	Fabaceae	✓	✓	NE	Locally common in wadis and sandy patches of gravel plains
13	*Cleome austroarabica*	Cleomaceae	✓	✓	NE/ REN[3]	Occasionally encountered in coastal plain
14	*Convolvulus virgatus*	Convolvulaceae	✓	✓	NE	Occasionally encountered in coastal plain & wadi
15	*Convolvulus prostrates*	Convolvulaceae	✓	✓	NE	Occasionally encountered in coastal plain & wadi
16	*Cyperus* sp.	Cyperaceae	✓	✓	-	Rare in wadi
17	*Cyperus conglomeratus*	Cyperaceae	✓	✓	NE	Locally common in wadis and sandy patches of gravel plains.
18	*Capparis cartilaginea*	Capparaceae	-	✓	Least Concern	Rare in hilly escarpment
19	*Chloris barbata*	Poaceae	-	✓	NE	Locally common in wadis
20	*Cymbopogon sp.*	Poaceae	✓	✓	-	Rare in wadi

[1] IUCN - International Union for Conservation of Nature
[2] NE- Not Evaluated
[3] REN – Regional Endemic

#	Species	Family	Duqm Baseline Record 2012	Present Survey 2020	IUCN[1] status 2020	Relative Abundance in Duqm region
21	*Echiochilon kotschyi*	Boraginaceae	-	✓	NE	Rare in gravel plain & wadi
22	*Dactyloctenium aegyptium*	Poaceae	✓	✓	NE	Occasionally encountered in wadi
23	*Dipterygium glaucum*	Capparaceae	✓	✓	NE	Occasionally encountered in gravel
24	*Echiochilon jugatum*	Boraginaceae	✓	✓	NE / REN	Occasionally encountered in coastal plain
25	*Ficus cordata*	Moraceae	-	✓	NE	Rare in wadi
26	*Glossonema varians*	Apocynaceae	✓	✓	NE	Rare in gravel plain & wadi
27	*Halothamnus bottae*	Amaranthaceae	✓	✓	NE / REN	Occasionally encountered in gravel & coastal plain
28	*Heliotropium bacciferum*	Boraginaceae	✓	✓	NE	Occasionally encountered in wadi, gravel, coastal plain
29	*Heliotropium longiflorum*	Boraginaceae	✓	✓	NE	Occasionally encountered in wadi, gravel, coastal plain
30	*Helianthemum* sp	Cistaceae	✓	✓	-	Rare in coastal gravel plain
31	*Halopyrum mucronatum*	Poaceae	✓	✓	NE	Occasionally encountered in coastal plain
32	*Halopeplis perfoliata*	Amaranthaceae	✓	✓	NE	Occasionally encountered in sabkha & beach
33	*Indigofera* sp.	Leguminosae	✓	✓	-	Rare in coastal gravel plain
34	*Launaea mucronata*	Asteraceae	-	✓	NE	Rare in coastal gravel plain
35	*Lycium shawii*	Solanaceae	✓	✓	Least Concern	Rare in coastal gravel & coastal plain
36	*Limonium sacrophyllum*	Plumbaginaceae	✓	✓	NE / END	Occasionally encountered in gravel & coastal plain
37	*Monsonia nivea*	Geraniaceae	-	✓	NE	Rare in coastal gravel plain
38	*Ochradenus harsusiticus*	Resedaceae	✓	✓	NE / END	Rare in coastal gravel & coastal plain
39	*Pergularia tomentosa*	Apocynaceae	-	✓	NE	Rare in coastal gravel plain
40	*Pluchea Arabica*	Compositae	✓	✓	NE/REN	Occasionally encountered in wadi & coastal plain
41	*Pulicaria glutinosa*	Compositae	✓	✓	NE / REN	Occasionally encountered in wadi & coastal plain
42	*Prosopis cineraria*	Fabaceae	✓	✓	NE	Dominant species in Wadis
43	*Pentatropis nivalis*	Asclepiadoideae	✓	✓	NE	Rare in wadis
44	*Pennisetum setaceum*	Poaceae	✓	✓	Least Concern	Occasionally encountered in wadi
45	*Rhazya stricta*	Apocynaceae	✓	✓	NE	Occasionally encountered in gravel plain

#	Species	Family	Duqm Baseline Record 2012	Present Survey 2020	IUCN[1] status 2020	Relative Abundance in Duqm region
46	*Senna holosericea*	Fabaceae	✓	✓	NE	Occasionally encountered in wadi & gravel, coastal plain
47	*Suaeda moschata*	Amaranthaceae	✓	✓	NE / END	Occasionally encountered in sabkha & beach
48	*Suaeda vermiculata*	Amaranthaceae	✓	✓	NE	Occasionally encountered in sabkha & beach
49	*Salsola drummondii*	Amaranthaceae	✓		NE	Occasionally encountered in wadi
50	*Salsola omanensis*	Amaranthaceae	-	✓	NE / END	Occasionally encountered in wadi runnels &hilly escarpment
51	*Sporobolus sp.*	Poaceae	-	✓	-	Occasionally encountered in wadi
52	*Tetraena qatarensis*	Zygophyllaceae	✓	✓	NE / REN	Regional Endemic, very common, dominant shrub in both wadis, runnels and coastal areas
53	*Tephrosia apollinea*	Fabaceae	✓	✓	NE	Very common, dominant shrub in wadis
54	*Taverniera spartea*	Leguminosae	✓	✓	NE	Occasionally encountered in wadi & gravel, coastal plain
55	*Tamarix aucheriana*	Tamaricaceae	✓	✓	NE	Occasionally encountered in wadi & gravel, coastal plain
56	*Ziziphus leucodermis*	Rhamnaceae	✓	✓	NE/REN	Rare in wadis

Grazing camels (*Camelus dromedaries*) and donkey (*Equus asinus*) have been observed in the wadi runnels, especially where the vegetation is most abundant in the wadi runnels. However, most of the habitat around the Duqm city was transformed due to various development. Foxes, small animals gerbils and Jirds are likely to be very common in the wadi area. Large and small caves were observed in many part of the northern hills, escarpment and coastal cliff which were very beneficial for the nocturnal species. Foxes are predominantly nocturnal; they feed on insects, spiders, lizards, snakes and rodents.

According to the baseline survey (HMR, 2014), a widespread and healthy population of Spiny tailed lizard (*Uromastyx leptieni* and *Uromastyx thomasi*) exists within Duqm region. However, they were not observed during this rapid survey. Other four species of lizards were observed from the survey area, the Snake-tailed Fringe-toed Lizard, Carter's Rock Gecko, Rock semaphore Gecko and Sinai agamas were the common species. All these species are native to the country and none are considered as threatened species in the IUCN 2020 Red List of Threatened Animals (IUCN 2020).

The birds that were recorded during the current survey were exclusively restricted to the wadis, particularly in water logged wadis in northern and coastal areas. Water logged areas were noticed in many part of Duqm due to recent cyclonic storm (Hikaa, 2019). Coastal and migratory birds were observed from these water logged area, especially large group of flamingos *Phoenicopterus ruber*, Grey Heron *Ardea cinerea,* Sanderling *Calidris alba*, Little Egret *Egretta garzetta*, Common Tern *Sterna hirundo* and Little Egret *Egretta garzetta*. However, these water bodies are temporary and these birds will move away for a new foraging area. Further, the total population of coastal birds (Sooty Gull *Ichthyaetus hemprichii*, Caspian Gull *Larus cachinnans,* Common Tern *Sterna hirundo,* and White-cheeked Tern *Sterna repressa*) were observed to be declined due to lack of habitat.

Observations of the terrestrial birds were limited to few species (five) which include – Crested lark *Galerida cristata*, Hoopoe lark *Alaemon alaudipes*, Black crowned Finch Lark *Eremopterix nigriceps* Southern Grey shrike *Lanius meridionalis aucher* and Laughing dove *Streptopelia senegalensis* were observed feeding, particularly in the Wadi areas.

Figure 7: Water logged areas with migratory birds

Appendix C. - Details of Species Evaluated in CHA

1.1 C1: Critically Endangered and Endangered Species

1.1.1 Egyptian Vulture *Neophron percnopterus* (Endangered)

Egyptain Vultures are listed as Endangered under IUCN Red list and listed on Appendix II and protected by CITES. This species occupies a large range with isolated resident populations in various part of West Africa, extending from the Iberian Peninsula across to central Asia, and Arabia. Egyptian Vultures are year-round residents; in the north, they are migratory. Migratory birds winter mostly in Arabia and Africa. Young Egyptian Vultures from migratory populations will spend at least their first 1.5 years in southern areas (i.e. they do not undertake migration in their first spring, at least) (Oppel et al 2015, BirdLife International 2017, Vulture Conservation Foundation https://www.4vultures.org/2017/04/19/egyptian-vulture-rupis-is-home/) (WSP2017).

In recent decades vulture populations in many countries have declined dramatically, however, Oman has a healthy and relatively large breeding population. Oman holds the most important population of Egyptian vultures in Arabia and the population appears stable or increasing (Angelov et al. 2013). Based on published information, the Oman population of breeding Egyptian Vulture at around 100 pairs (Jennings, 2010), although, recent work on Masirah Island (approximately 125 km north-east of Duqm) estimated the population of territorial Egyptian vulture on the island is about 65-80 pairs, and 260-386 individuals(Angelov et al., 2013), suggesting a larger national breeding population. The previous estimate of the breeding Egyptian Vulture population on Masirah was of 12 pairs (Rogers, 1988)-(WSP 2017).

No evidence of this vulture was recorded within the SEZD area. However, they considered to occur in the adjacent locations around the SEZD area. It is important to note that the urban development of Duqm may attract Egyptian Vultures and other scavenging birds, they could potentially set up their territories.

The Egyptian Vulture typically nests on ledges or in caves on cliffs, crags and rocky outcrops, but occasionally also in large trees, and exceptionally on the ground (Gangoso and Palacios, 2005). It forages in lowland and montane regions over open, often arid, country. It also scavenges at human settlements. The Egyptian vulture has a broad diet including carrion, tortoises, organic waste, insects, young vertebrates, eggs and even faeces (Margalida et al., 2012). It is usually solitary, but will congregate at feeding sites, such as rubbish tips (WSP2017).

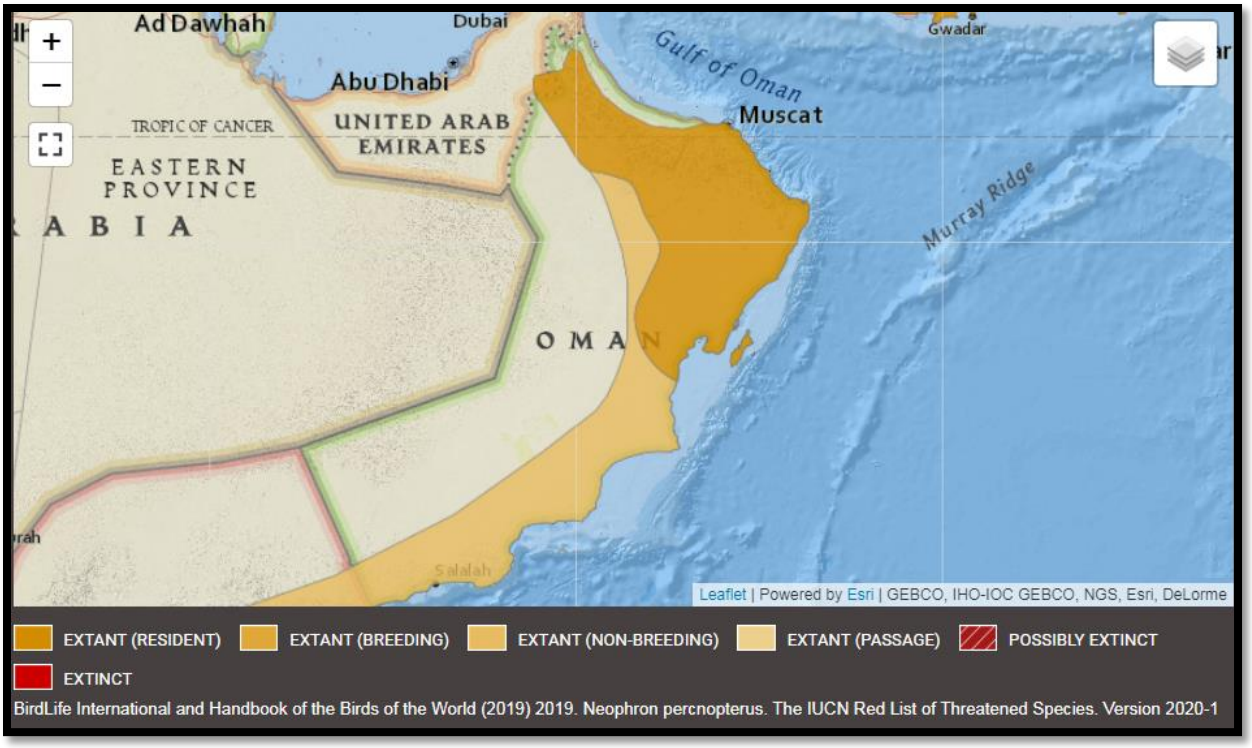


Figure 1 - Distribution of Egyptian Vulture in Oman

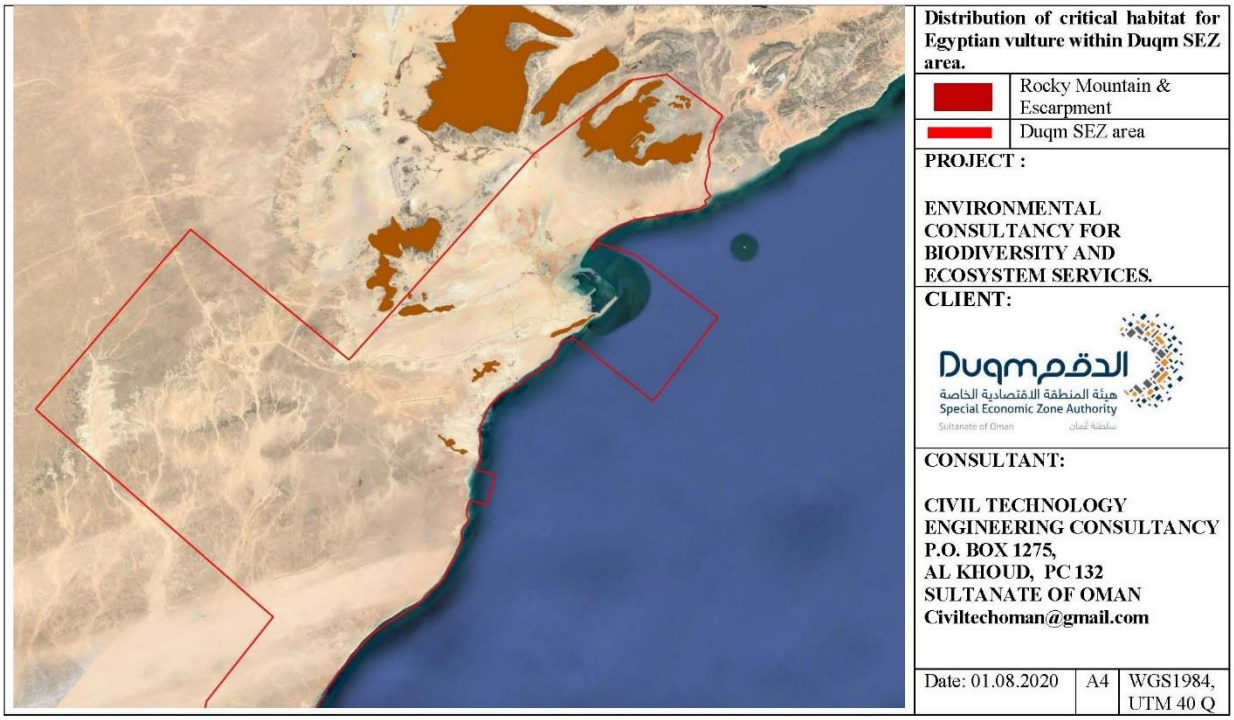


Figure 2: Possible Distribution of Egyptian Vulture in the SEZAD Area

The species is declining in virtually all parts of its range, apparently for a number of different reasons. The main causes for the declines are targeted and unintended poisoning, electrocution, hunting/persecution, and changes in food availability. Electrocution incidents are known to have occurred in different part of Oman. The risk and impact of this threat has increased over the years as electricity infrastructure has expanded. In future the increasing industrial developments at Duqm will impact Egyptian Vultures and other sensitive birds in this region.

The distribution of Egyptian vultures in Oman is shown in the above ***Figure 1*** and the possible habitat for this species within the SEZAD area is presented in ***Figure 2***.

1.1.2 Humpback Whale *Megaptera novaeangliae* (Arabian Sea subpopulation)

The humpback whale is a cosmopolitan species found in all of the major oceans (Clapham and Mead 1999). The IUCN Red list classifies Humpback whales globally as Least Concern. However, in the northern Indian Ocean, they are listed as an 'Endangered' species (Minton et al., 2008). This small subpopulation is recognised by the IUCN Red List as geographically, demographically and genetically isolated (Minton et al. 2008) and are referred to as 'Arabian Sea humpback whales'. The overall Arabian subpopulation in Oman is estimated to around 82 individuals and it has been speculated that this sub-population may be in decline (Minton et al., 2008).

The known distribution of the Humpback whale includes the waters of Oman, Yemen, Iran, Pakistan and India with potential for occurrence in other states of the Northern Indian Ocean. (Brown, 1957; Mikhalev, 2000; Minton et al. 2008; Reeves et al., 1991; Slijper et al., 1964; Wray and Martin, 1983; Yukhov, 1969; Baldwin 2003, and others)-WSP2017. Series of small boat surveys, one shore-based surveys and satellite telemetry studies were conducted in Oman to identify the distribution pattern of this species. Further various distribution modelling and ecological niche modelling derived from Oman-based studies indicates a distribution around the periphery of the Arabian Sea with a core area along the central and southern coastline of Oman. All these studies demonstrate that Gulf of Masirah is one of the most important habitats for the Arabian Sea Humpback Whale. (Willson et al., 2017).

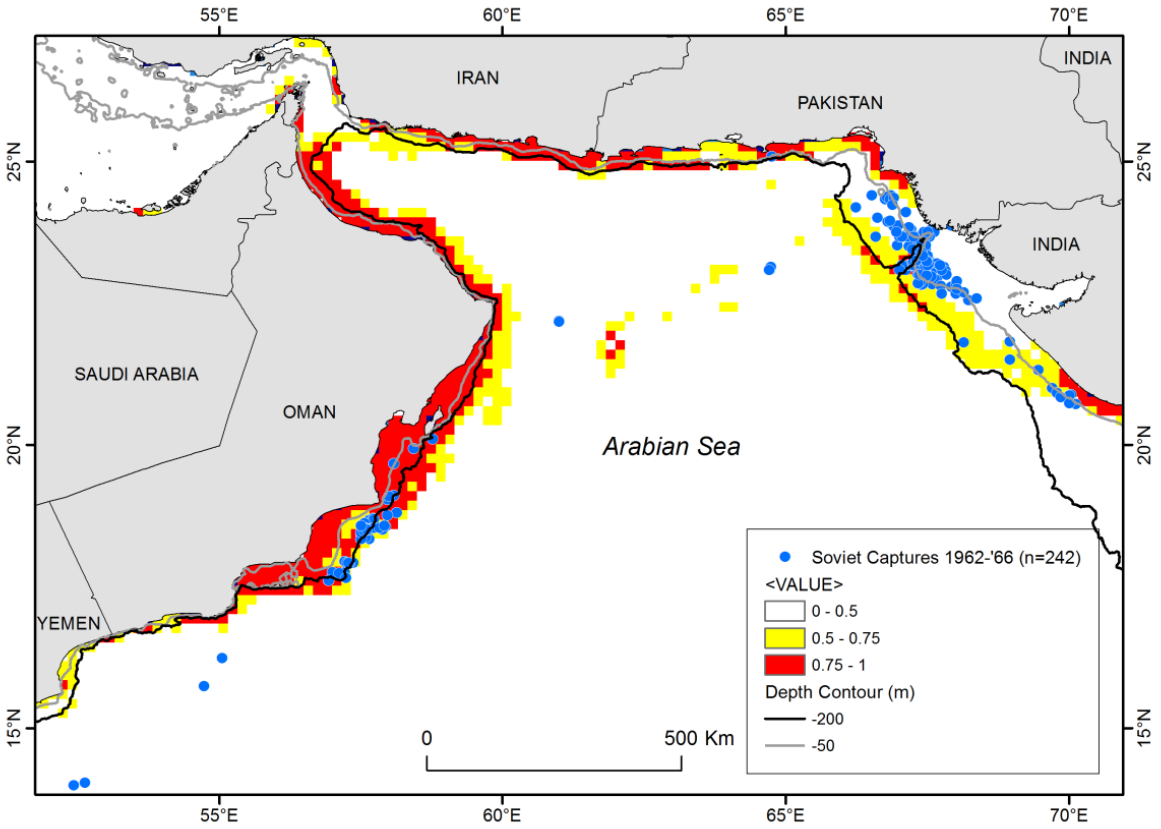


Figure 3: Sighting of Humpback Whale in the Region

The above picture, ***Figure 3***, depict the average of sightings and satellite telemetry ensemble ecological niche models with overlay of historical takes of humpback whales in the Northern Indian Ocean between 1962 and 1966, (Mikhalev, 2000; IWC Catch Database, extracted 25 October 2013). (Source: Willson et al. 2017, WSP ,2017)

Humpback whales are well-known to be susceptible to entanglement in fishing gear (Volgenau et al. 1995, Johnson et al. 2005). Number of whale entanglements in fishing gear has been recorded off the coast of Oman. The on-going Duqm developments will have a direct and indirect impact on the marine mammals; increase in the vessel movements, sound pollution, pressure on feeding grounds, habitats loss and degradation will affect the total population of humpback whales in this region.

Based on the available data for Humpback whales, the marine DMU is considered to be a C1 and C2 critical habitat for this species.

1.1.3 Indian Ocean Humpback Dolphin *Sousa plumbea*

Indian Ocean Humpback Dolphins are distributed across the south and east Africa, west coast of Madagascar, Red Sea, Oman, the Middle East- Arabian Gulf, Pakistan and west coast of India. The dolphins found within the Indian Ocean have recently been taxonomically separated and now considered a separate species. Previously this species was lumped with the Indo-pacific humpback dolphin *Sousa chinensis* (Jefferson and Rosenbaum, 2014).

Humpback dolphins have one of the most specific habitat preferences and restricted distributions of any cetaceans, and both of these characteristics are well known to reduce the resilience of species to coastal environmental changes and other threats to increase their extinction risk (Davidson et al. 2011, Dulvy et al. 2014, Purvis et al. 2000). The species has a very narrow habitat niche; usually occurs less than 3km from shore and/or in water less than 25 m deep. They occur in coastal habitats that include rocky reefs, lagoons, mangroves and shallow, protected bays.

These dolphins are one of the most commonly encountered cetacean species along the Arabian Sea coast of Oman, while seemingly absent from the Sea of Oman. (Salm et al. 1993; Baldwin & Salm 1994; Baldwin et al. 2004; Minton 2004). In Oman and the Arabian Gulf, humpback dolphins generally occur in water depths of less than 20 m with an average depth recorded of 8.3m (Minton 2004, Minton et al. 2010). Little is known about the life history of this species. In Oman, social and/or mating behaviour has been observed in the months of April and May, and the presence of calves has been recorded in April through June, and in October through December (Baldwin et al. 2004). Within the Gulf of Masirah, Indian Ocean humpback dolphins have been sighted off the west coast of Masirah, Bar al Hikman, the Ghabbhat Hashish and in several locations between Ras bin Tawt and Ras Madrakah, including around the Port of Duqm (OMCD).

The primary threat to this species is incidental mortality in fisheries ('bycatch'). The habitat preference of humpback dolphins puts it within range of artisanal fisheries with gill nets posing a high risk of bycatch. Marine mammal bycatch likely escalated with the gradual introduction of monofilament netting in the 1960s and 1970s (Klust 1973, Potter and Pawson 1991, Tarbit 1984). In Oman, the high incidence of stranded humpback dolphins was presumed to be the result of interactions with fisheries (Collins et al. 2002). Considering the wide mortality from bycatch the global population size of this species is almost certainly decreasing (Friedmann and Daly, 2004; Reeves et al., 2008).

The destruction of inshore habitats, dredging, land reclamation, construction blasting, port and harbour construction, pollution, boat traffic, oil and gas exploration and other coastal development activities are likely to be the greatest threats to humpback dolphins (IWC 2002).

Based on the available data for this species, the marine DMU is considered to be a C1 and C2 critical habitat for this species.

Figure 4: Distribution of the Indian Ocean humpback dolphin (*Sousa plumbea*).

Figure 4 is the map compiled by IUCN SSC Cetacean specialist Group, Source: The IUCN Red List of Threatened Species: *Sousa plumbea* – published in 2017.

1.1.4 Green Turtle *Chelonia mydas*

The Green Turtle, *Chelonia mydas*, is listed as 'Endangered' on the IUCN Red List of Threatened Species. This turtle has a circum-global distribution, occurring throughout tropical and, to a lesser extent, subtropical waters (Atlantic Ocean – eastern central, northeast, northwest, southeast, southwest, western central; Indian Ocean – eastern, western; Mediterranean Sea; Pacific Ocean – eastern central, northwest, southwest, western central). Green turtles are highly migratory and they undertake complex movements and migrations through geographically disparate habitats. Nesting occurs in more than 80 countries worldwide (Hirth 1997). Their movements within the marine environment are less understood but it is believed that green turtles inhabit coastal waters of over 140 countries (Groombridge and Luxmoore 1989).

They inhabit the neritic zone, occurring in nearshore and inshore waters where they forage primarily on sea grasses and algae (Mortimer, 1982), and temporarily inhabit the oceanic zone during migrations from foraging areas to breeding areas and back. Female green turtles migrate from foraging areas to their natal beaches (Meylan et al., 1990) every 2–4 years. Migrations are carried out by both males and females and may traverse oceanic zones, often spanning thousands of kilometres (Carr 1986, Mortimer and Portier 1989).

In Oman, foraging green turtles occur throughout shallow coastal waters wherever algae and seagrasses occur. Highest densities of foraging green turtles have been recorded in Dhofar and in the Gulf of Masirah (Salm 1991; and Ross, 1985). The presence of green turtles and nesting within the Duqm region was documented in various project baseline surveys and ESIAs. Annual estimates for the number of nests at main nesting sites include 500/year at Ras Madrakah, between 240/year between Duqm and Ras bin Tawt, and 220/year at Bar al Hikman (Salm 1991).

Analysis of recent published data indicates that green turtles population is declines in all major ocean basins over the last three generations. The major threat categories affecting marine turtles were described by Wallace et al. (2011) as:

- Incidental capture of marine turtles in fishing gear targeting other species,
- Direct utilization of turtles or eggs for human use;
- Coastal Development affecting critical turtle habitat: human-induced alteration of coastal Environments due to construction, dredging, beach modification, etc;

- Marine pollution and debris that affect marine turtles (i.e., through ingestion or entanglement, disorientation caused by artificial lights), as well as impacts of pervasive pathogens (for example fibropapilloma virus) on turtle health;

- Climate change: current and future impacts from climate change on marine turtles and their habitats (increasing sand temperatures on nesting beaches affecting hatchling sex ratios, sea level rise, storm frequency and intensity affecting nesting habitats, etc.).

Based on the available data for this species, the marine DMU is considered to be a C1 and C2 critical habitat for this species.

1.1.5 Loggerhead Turtle *Caretta caretta*

The global Loggerhead Turtle is considered as Vulnerable under current IUCN Red List Criteria (criterion A2b). They are one of the most widespread and highly migratory of marine turtles and nest in many parts of the world; throughout the subtropical and temperate regions of the Mediterranean Sea and Pacific, Indian, and Atlantic Oceans (Wallace et al. 2010).

The global population of the Loggerhead Turtle comprises 10 subpopulations that vary widely in population size, geographic range, and population trends, and are the appropriate units for assessment of global conservation status for this species (Wallace et al. 2010, 2011). These 10 subpopulations are distributed in the world; NorthWest Atlantic Ocean, North East Atlantic Ocean, South West Atlantic Ocean, Mediterranean Sea, North East Indian Ocean, North West Indian Ocean, South East Indian Ocean, South West Indian Ocean, North Pacific Ocean, and South Pacific Ocean (Figure 5-4).

In Oman, loggerhead turtles are widely distributed, having been documented from Musandam, in the far north to the Oman/Yemen border in the south (Salm, 1991; Baldwin, 1999). The majority of Loggerheads nest on beaches of the Masirah Island, which is one of the world's largest sites for nesting population. It was estimated that approximately 20,000 to 30,000 loggerheads nest each year on Masirah Island, however, the nesting was declined due various reasons approx. 10,000-14,000 individuals annually (Wilson et al., 2015) in this location.

Loggerheads attain maturity at 10-39 years (Avens and Snover 2013). Upon attaining sexual maturity Loggerhead Turtles undertake breeding migrations between foraging grounds and nesting areas at remigration intervals of one to several years with a mean of 2.5–3 years for females (Schroeder et al. 2003) while males would have a shorter remigration interval (e.g., Hays et al. 2010, Wibbels et al. 1990). Migrations are carried out by both males and females and may traverse oceanic zones spanning hundreds to thousands of kilometres (Plotkin 2003).

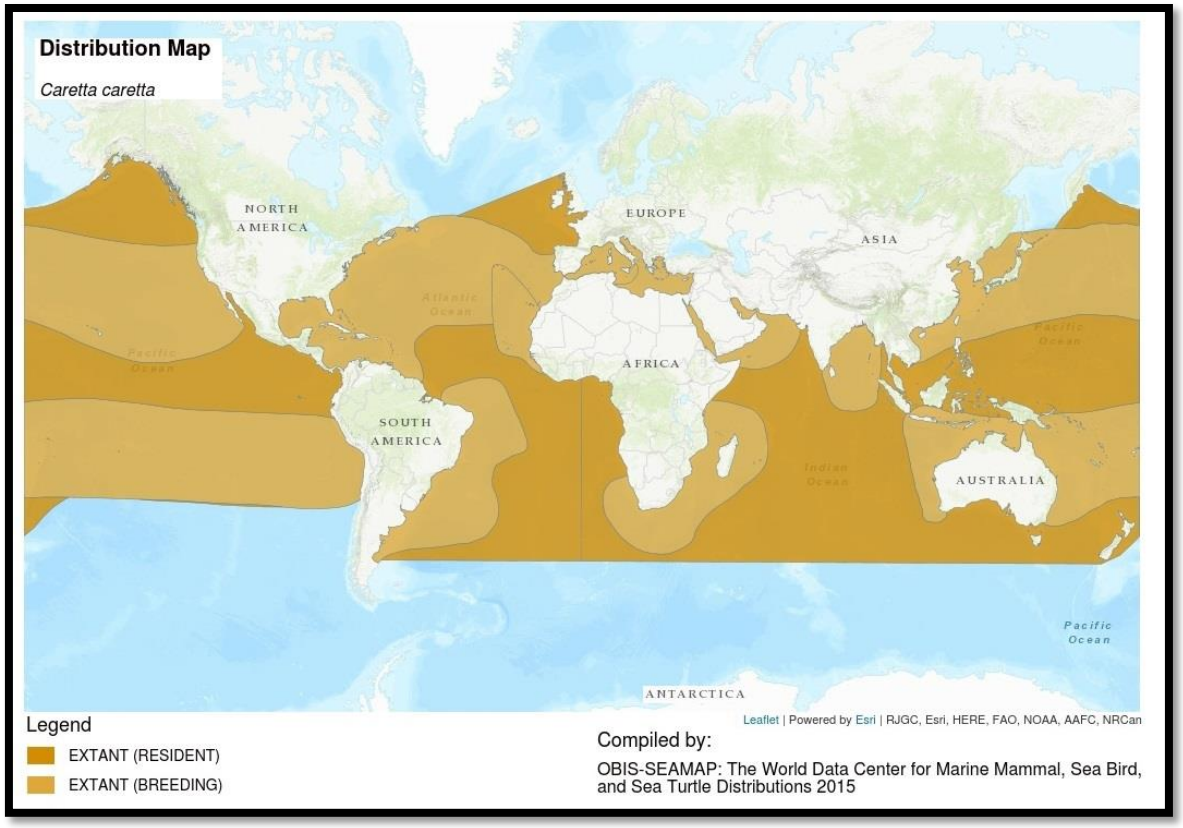


Figure 5: Global distribution for the Loggerhead Turtles

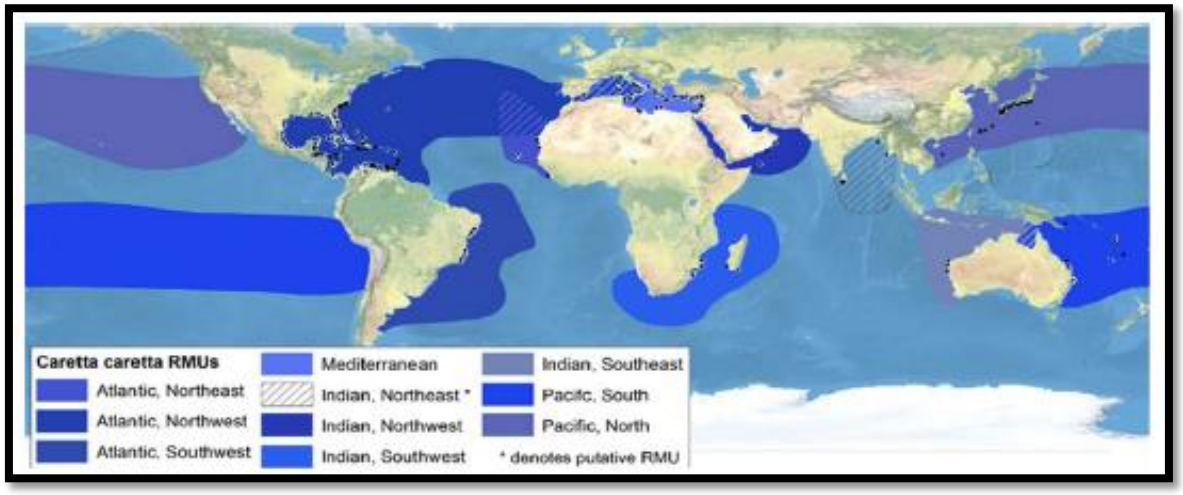


Figure 6: Global map of the 10 IUCN subpopulations of Loggerheads and nesting sites (Wallace et al. 2010) IUCN 2017

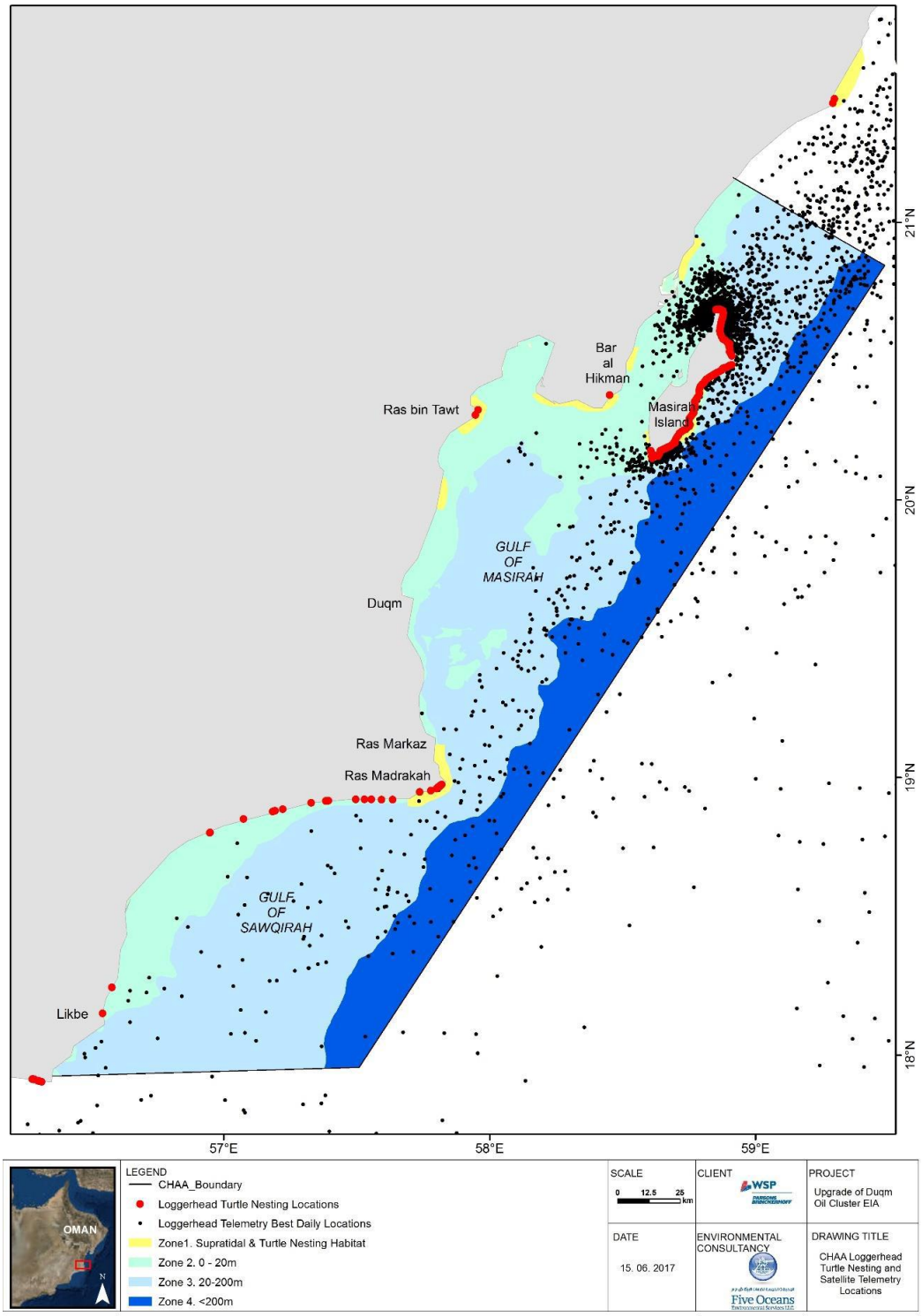


Figure 7: Distribution of loggerhead turtles in the Duqm region including nesting locations and post-nesting migrations obtained using satellite telemetry studies (WSP 2017[1])

[1] Image courtesy to WSP Duqm Refinery Project report 2017.

The migration path of Loggerheads between foraging grounds and nesting areas cover the duqm region. The population and foraging habitat of Loggerheads are currently unknown to Duqm region. However, detailed study of the Masirah Island nesting population and satellite tracking of post-nesting migrations of adult female loggerheads are available as a result of systematic study conducted since 2006 (Casale, 2015; Willson et al., 2015; ESO and MECA). Further the presence of male turtles or sub-adults in the area is not well known, due to a lack of study on this subpopulation. The other data on loggerhead turtles comes mostly from IUCN Coastal Zone Management studies conducted in the late 1980s/early 1990s (Salm 1991).

Major threats to Loggerheads in Oman are similar to those listed above for marine turtles, while the severity and magnitude of threats differs for each species. Based on the available data for this species, the marine DMU is considered to be a C1 and C3 critical habitat for this species.

The above maps, ***Figure 5***, ***Figure 6***, and ***Figure 7***, show the distribution of the loggerhead turtles in Duqm region.

1.1.6 Hawksbill turtle *Eretmochelys imbricate*

The Hawksbill Turtle, *Eretmochelys imbricata*, is listed as 'Critically Endangered' on the IUCN Red List of Threatened Species. This turtle has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical waters of the Atlantic Ocean, Indian Ocean, and Pacific Ocean. Hawksbills are migratory and individuals undertake complex movements through geographically disparate habitats during their lifetimes. Hawksbill nesting occurs in at least 70 countries, although much of it now only at low densities. Their movements within the marine environment are less understood, but hawksbills are believed to inhabit coastal waters in more than 108 countries (Groombridge and Luxmoore 1989, Baillie and Groombridge 1996). Their global distribution is illustrated in the below ***Figure 8***.

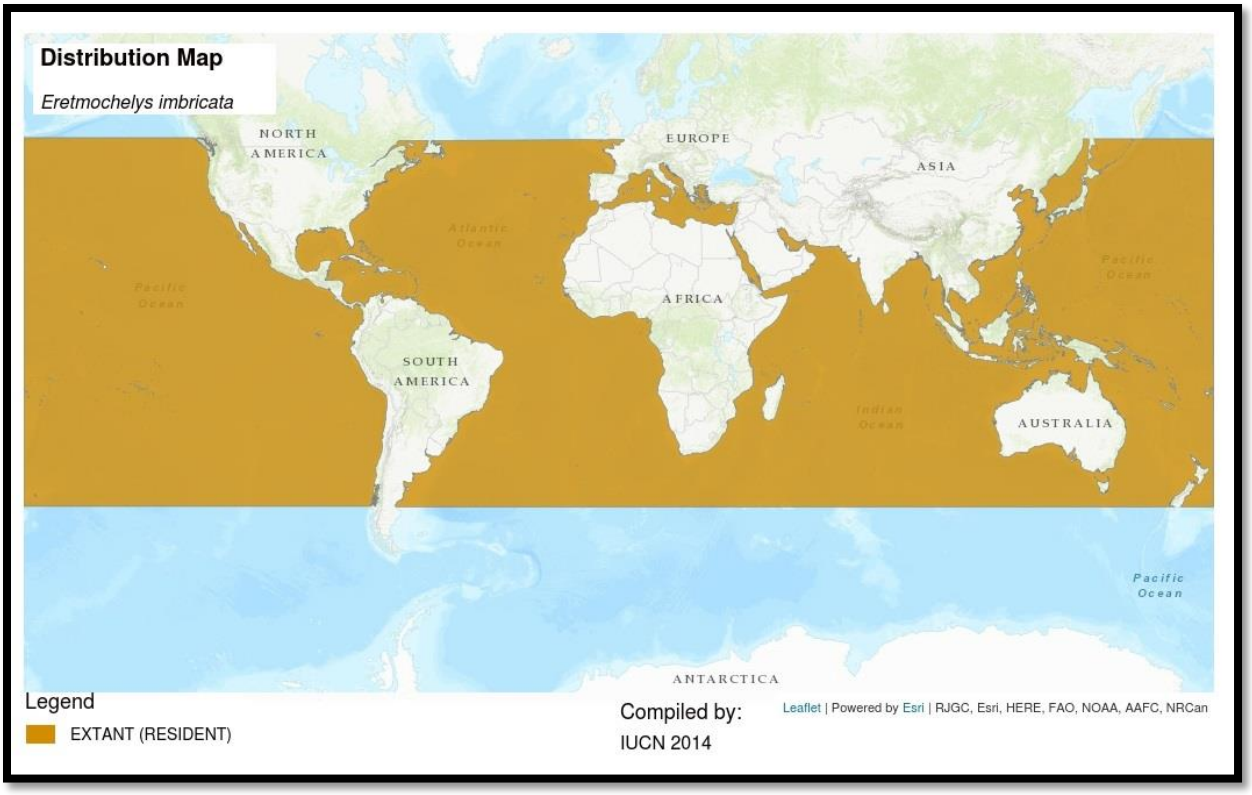


Figure 8: Global Distribution of Hawksbill Turtle

Hawksbills nest on insular and mainland sandy beaches throughout the tropics and subtropics. They are highly migratory and use a wide range of broadly separated localities and habitats during their lifetimes (for review see Witzell 1983). Available data indicate that newly emerged hatchlings enter the sea and are carried by offshore currents into major gyre systems where they remain until reaching a carapace length of some 20 to 30 cm. At that point they recruit into a neritic developmental foraging habitat that may comprise coral reefs or other hard bottom habitats, sea grass, algal beds, or mangrove bays and creeks (Musick and Limpus 1997).

In Oman, hawksbill is distributed throughout the coastal waters and hosts significant nesting in the Sea of Oman and Arabian Sea. The main concentrations of nesting females occur at the Daymaniyat Islands, where between 250-350 females nest annually (Salm 1991; Baldwin 1999), and at Masirah Island, where between 100- 125 females nest annually (Ross 1981, Ross and Barwani 1982). Other key nesting sites were reported in the Gulf of Masirah at Bar al Hikman and between Ras bin Tawt and Ras Madrakah (IUCN, 1991, HMR, 2014).

Hawksbills mature very slowly, taking 20 to 40 years, and so are long-lived (Chaloupka and Musick 1997). Age to maturity in the Indo-Pacific is at the upper end of this scale, requiring a minimum of 30-35 years (Limpus 1992; Limpus and Miller 2000; Mortimer et al. 2002, 2003). This makes populations more sensitive to potential decline as juveniles face the threat of mortality for many years before they are able to

reproduce. Once mature, active nesting by females continues over a period of at least 17-20 years in the Indo-Pacific (Mortimer and Bresson 1999; Limpus 1992). Once sexually mature, they undertake breeding migrations between foraging grounds and breeding areas at intervals of several years (Witzell 1983, Dobbs et al. 1999, Mortimer and Bresson 1999).

Like other species of sea turtles, Hawksbills contribute to marine and coastal food webs and transport nutrients within the oceans (Bouchard and Bjorndal 2000). They are important components of healthy coral reef ecosystems and are primarily spongivorous in the Caribbean (Meylan 1988), but more omnivorous in the Indo-Pacific (review by Bjorndal 1997). In this region, foraging largely occurs in the Gulf of Masirah (Pilcher et al. 2014), but has been observed in other parts of Oman, such as around reefs off Muscat to the north Musandam (Salm and Salm 1991). The exact population and foraging habitat of Hawksbills are currently unknown to Duqm.

The other data on Hawksbills comes mostly from IUCN Coastal Zone Management studies, which is over 20 years' old. However migratory routes to and from breeding and foraging areas are likely to cross many parts of the CHA. Hawksbills hatchlings and juveniles can be expected to disperse widely throughout the area from the nesting sites at Masirah Island and area between Ras bin Tawt and Ras Madrakah. Further, post nesting satellite tracking studies of Hawksbills (Pilcher et al. 2014) provides some insight into migratory routes and foraging habitats for a small sample of the population (WSP2017). In many parts of the world, Hawksbill populations are declining due to various threats to the marine habitat. Based on the available data for this species, the marine DMU is considered to be a C1 and C3 critical habitat for this species.

1.1.7 Olive Ridley turtle *Lepidochelys olivacea*

The Olive Ridley turtle *Lepidochelys olivacea*, is listed as 'Vulnerable' on the IUCN Red List of Threatened Species. The Olive Ridley sea turtle has a circumtropical distribution, with nesting occurring throughout tropical waters (except the Gulf of Mexico) and migratory circuits in tropical and some subtropical areas (Atlantic Ocean – eastern central, northeast, northwest, southeast, southwest, western central; Indian Ocean – eastern, western; Pacific Ocean – eastern central, northwest, southwest, western central) (Pritchard 1969). Nesting occurs in nearly 60 countries worldwide, including Oman.

The olive ridley is mainly a pelagic (open ocean) sea turtle, but has been known to inhabit coastal areas, including bays and estuaries. They are not known to move between ocean basins or to cross from one ocean border to the other. Within a region, Olive Ridleys may move between the oceanic and neritic zones (Plotkin et al. 1995, Shanker et al. 2003) or just occupy neritic waters (Pritchard 1976, Reichart 1993). Like most

other sea turtles, Olive Ridleys display a complex life cycle, which requires a range of geographically separated localities and multiple habitats (Márquez 1990). Their distribution and geographical range are shown in ***Figure 9*** and ***Figure 10***.

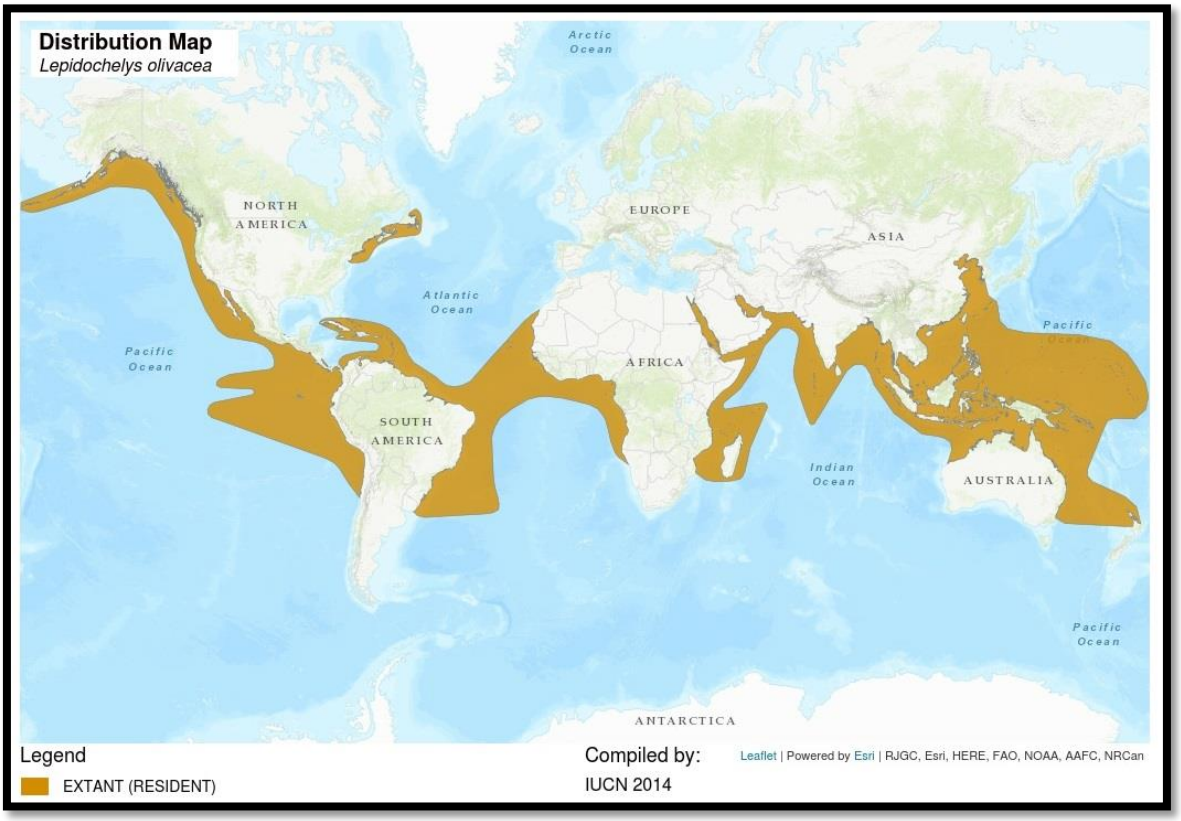


Figure 9: Global Distribution of Olive Ridley turtle

Females lay their nests on coastal sandy beaches from which neonates emerge and enter the marine environment to continue their development. They remain in a pelagic phase, drifting passively with major currents that disperse far from their natal sites, with juveniles sharing some of the adults' habitats (Kopitsky et al. 2000) until sexual maturity is reached (Musick and Limpus 1997). In contrast to other sea turtle species, the reproductive cycle of Olive Ridley is nearly annual (over 60% of turtles nest every year; Márquez 1990).

Juveniles are believed to occur in similar habitats as the adults (i.e, pelagic waters) where they forage on gelatinous prey such as jellyfish, salps and tunicates (Kopitsky et al. 2004). Like other sea turtles, Olive Ridleys experience high mortality in their early life stages. Unlike other marine turtles that migrate from a breeding ground to a single feeding area, where they reside until the next breeding season, olive ridleys are nomadic migrants that swim hundreds to thousands of kilometres over vast oceanographic stretches (Plotkin, 1994; Plotkin et al., 1994; 1995).

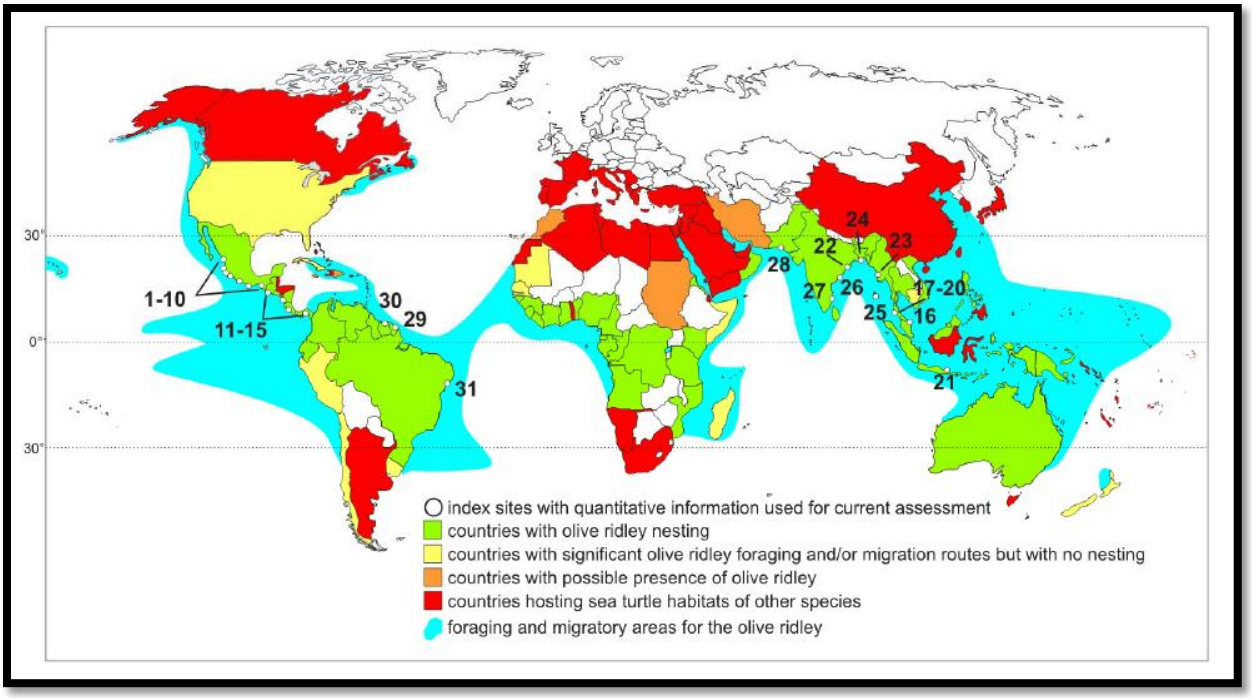


Figure 10: Geographic range of habitats utilized by the Olive Ridley (IUCN 2008)[2]

Based on the reports, Olive Ridley is distributed throughout the coastal waters in the Arabian Sea and Sea of Oman; however relatively few Olive Ridley turtles nest in Oman. The main nesting beaches arc on the southern shores of Masirah Island, where estimated a nesting population of approximately 150 olive ridley turtles nest yearly (Ross 1979). Nesting population in Masirah Island is the only one reported place in the Arabian Peninsula. It is possible that olive ridley turtles also nest on other beaches, but unknown numbers, along the coast of southern Oman.

The recent EIAs in the Duqm area have provided little new information about this species. They are reported from the Duqm (Ras Madraka). Further, post nesting satellite tracking studies of Olive Ridley provides some insight into migratory routes and foraging habitats in Gulf of Masirah, as seen in ***Figure 11***. The satellite tracking study showed that tagged olive ridley turtles migrated to southern coast of Oman and to northern Iranian coastal waters in the Persian Gulf after nesting in Masirah Island (Rees et al. 2012). Olive Ridley population is declining due to various threats to the marine habitat.

Based on the available data for this species, the marine DMU is considered to be a C1 and C3 critical habitat for this species.

[2] Compiled by (IUCN SSC Marine Turtle Specialist Group). 2008

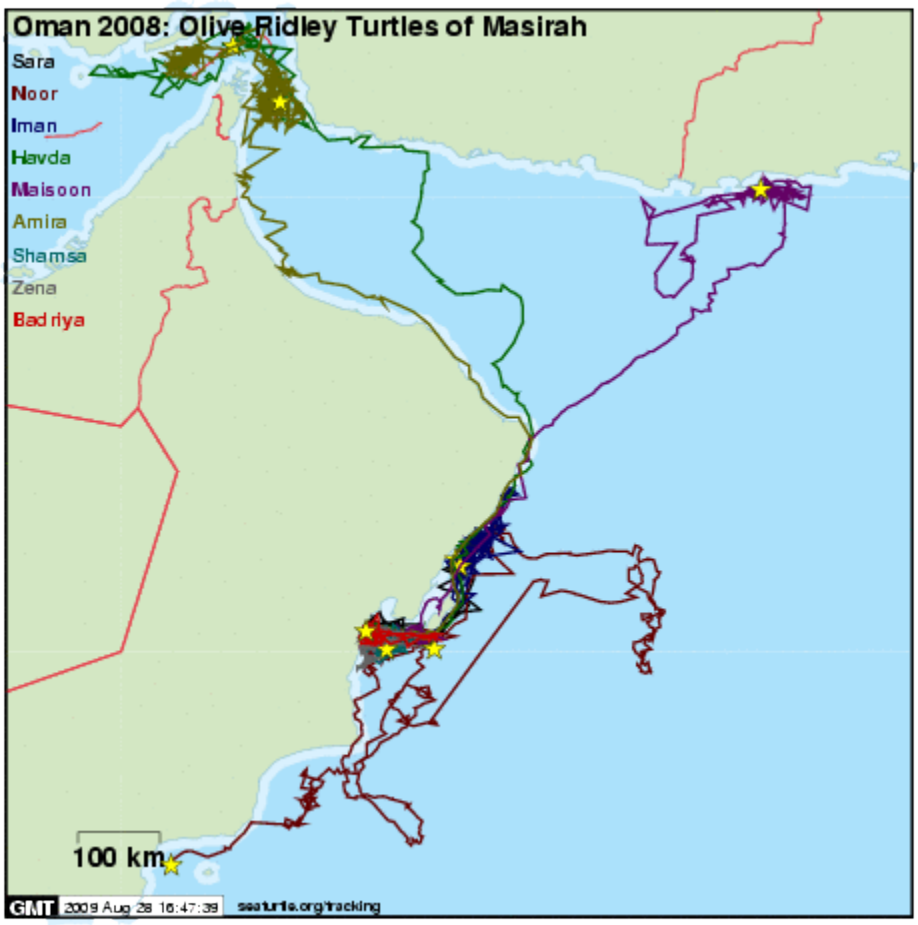


Figure 11: Olive Ridley turtles post-nesting migrations obtained using satellite telemetry studies (Seaturtle. Org 2008)

1.2 C2: Endemic and Restricted-range Species

1.2.1 Omani Spiny-tailed Lizard *Uromastyx thomasi*

The Omani Spiny-tailed Lizard *Uromastyx thomasi* is endemic to the central parts of Oman and also listed as 'Vulnerable' on the IUCN Red List of Threatened Species. This species is found in less arid regions of desert, and occurs over a range of quite hard open substrates in which it digs burrows (Arnold 1980). The status of the wild population is unknown, but preliminary investigations suggest this species is not common in wide parts of the range. The distribution area of this species has a length of approximately 600 km and a maximum width of 230 km along the coastal and desert. Their distribution is seen in ***Figure 12***.

Evidence of Spiny-tailed Lizard was recorded during the baseline surveys undertaken for ESIA's (HMR2014). However given their wide-ranging nature without further extensive surveys it is not possible to determine the frequency that they occur in the undeveloped areas of SEZD. The wadi areas in the undeveloped southern zone with gravel substrate and flora appeared to be the preferred habitat for this species.

This species is collected heavily for the illegal pet trade. It is unclear where animals found in trade originate, the species breeds readily in captivity and some animals marketed as captive-bred may indeed be derived from captive stock (T. Wilms pers. comm. June 2012). Its habitat is also being lost due to, urban developments, industrialisation, land reclamation, and off-road vehicles.

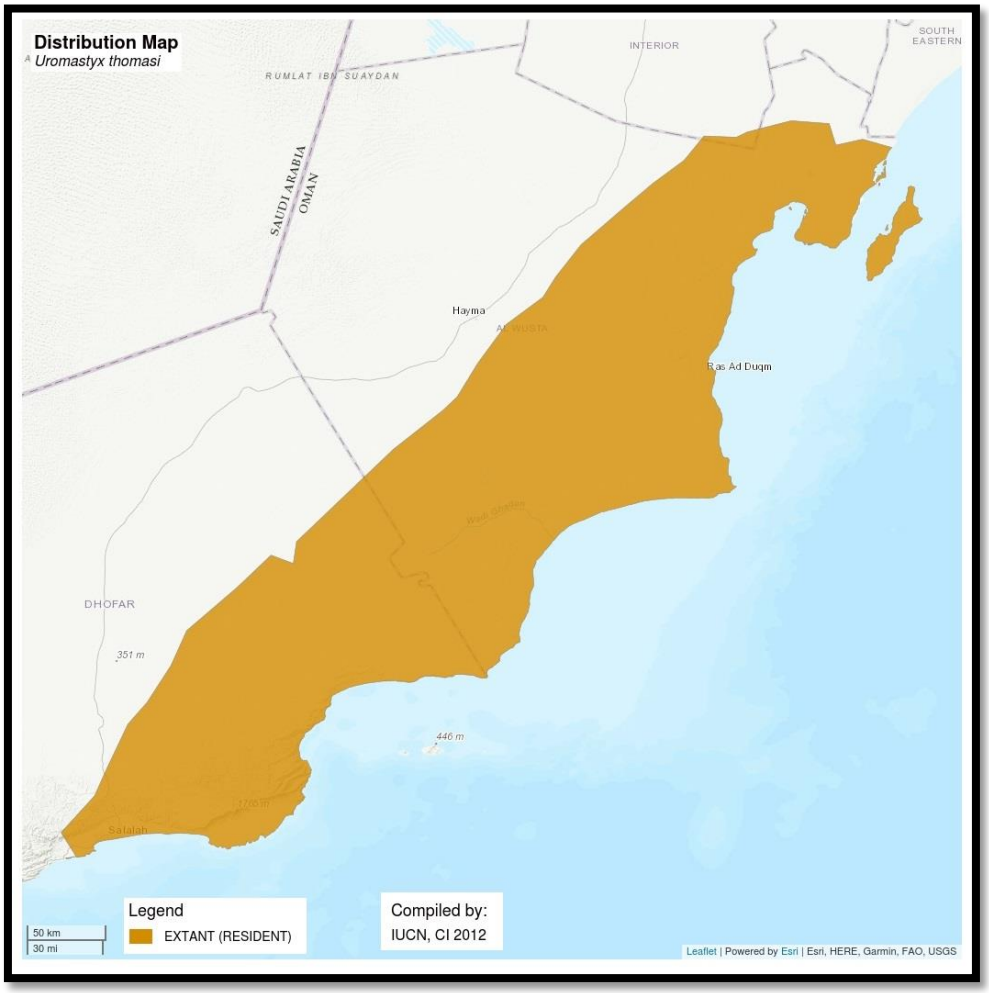


Figure 12: Distribution of Omani Spiny-tailed Lizard (IUCN 2012)

Based on the available data for Omani Spiny-tailed Lizard the DMU is considered to be a C2 critical habitat for this species.

1.2.2 Egyptian Spiny–tailed Lizard *Uromastyx aegyptia*

The Egyptian Spiny–tailed Lizard *Uromastyx aegyptia* is listed as 'Vulnerable' on the IUCN Red List of Threatened Species. Due to low levels of genetic differentiation between members of the *Uromastyx aegyptia* species group (considered to include *U. aegyptia, U. leptieni, U. microlepis and U. occidentalis*), Wilms et al. (2007) recognize *U. aegyptia* as a single species with three subspecies: *U. a. aegyptia, U. a. leptieni and U. a. microlepis.*

This species ranges from Egypt (east of the Nile), eastwards into the southern half of Israel, south and north-eastern Jordan, southern Syria, Iraq and Iran Gulf coast and southwards into the Arabian Peninsula. Subspecies are widespread in Saudi Arabia, Oman, Yemen, the United Arab Emirates, Qatar and Kuwait (Wilms et al. 2007). It is locally common on the Arabian Peninsula (T. Papenfuss pers. comm. September 2008). Their regional distribution is shown in ***Figure 13***.

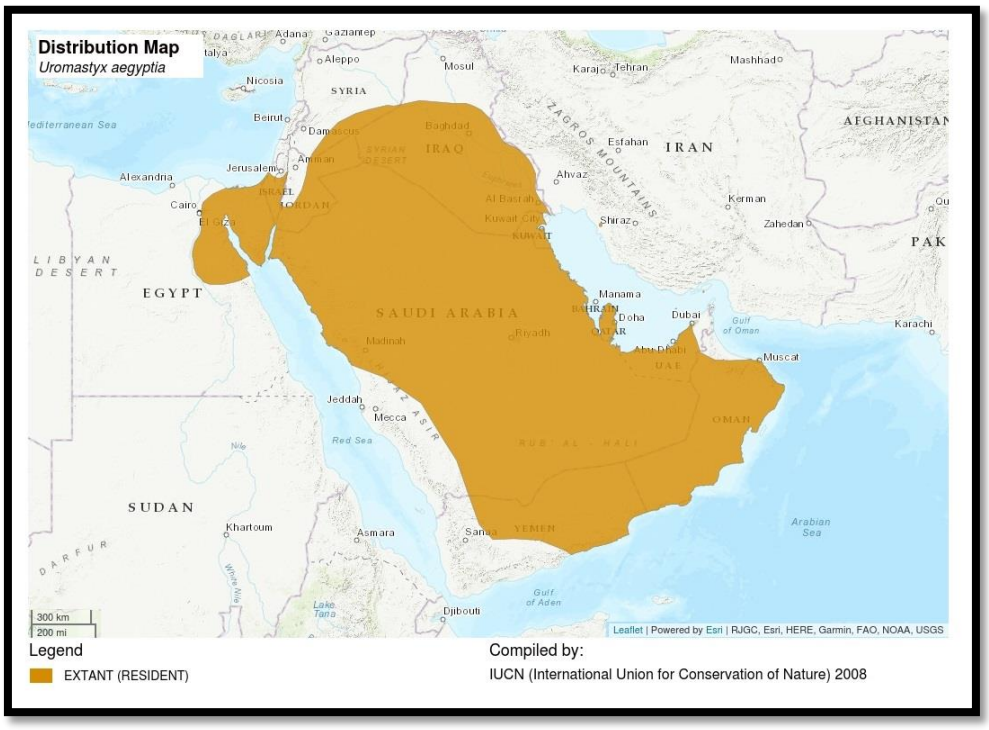


Figure 13: Distribution of Egyptian Spiny–tailed Lizard (IUCN 2008)

This species occurs in open, flat, gravelly, stony and rocky areas, and it is infrequently seen in sandy areas. The species lives in loose colonies that can be found close to their burrows. Animals forage on low

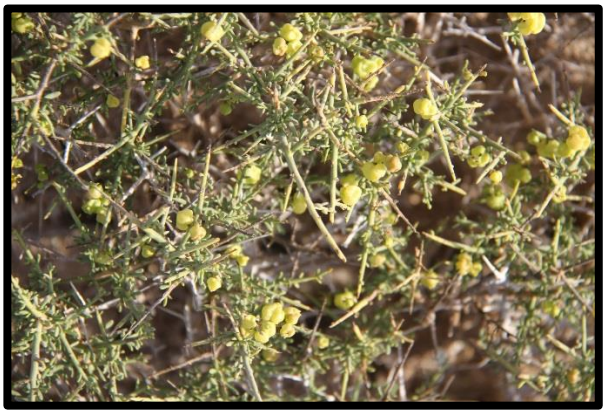
vegetation close to their burrows. It lays 7-17 (occasionally up to 23) eggs. In many countries Uromastyx are heavily hunted for food and for the production of souvenirs and traditional medicine (WILMS 2007). In Oman, The species is locally used for food and medicinal purposes.

Subspecies of Egyptian Spiny tailed lizard *Uromastyx aegyptia leptieni* was sighted in the Duqm Refinery service corridor project area. This species is mostly found on firm soil or on rock surfaces that provide shelter in the form of cracks and crevices in Duqm region. Dwelling burrows were sighted at the gravel-plains and area with sparse vegetation. These lizards are strictly diurnal and opportunistic herbivores species. Its habitat is also being lost due to over-grazing, urban developments, industrialisation, land reclamation, solid waste dumping and off-road vehicles.

Based on the available data for Egyptian Spiny-tailed Lizard the Terrestrial DMU is considered to be a C2 critical habitat for this species.

1.2.3 *Ochradenus harsuticus*

Ochradenus harsusiticus shrub *is* endemic to Oman and more specifically distributed in the sandy and gravelly soils of central Oman (Ghazanfar 2003; Patzelt 2014). This species is also reported from the limestone plateau of the Jiddat Al Harasis.



Ochradenus harsusiticus is a spiny shrub that grows to a height of 50cm (Ghazanfar, 2003). It occurs in open *Acacia tortilis - Prosopis cineraria* woodland of sandy and gravelly depressions and wadi habitats (Ghazanfar, 2003; Patzelt, 2014). *Ochradenus harsusiticus* was recorded in the Refinery footprint and service corridor project area (HMR 2015[a] and HMR 2015[c]). A few specimens of this species were also recorded in a shallow wadi less than 1 km from the sea between two areas of dense vegetation (N19.78598 E57.71176) approximately 5.8 km north-north-east of the refinery boundary during the IDZ survey (5OES 2011,WSP2017). There is no detailed information available relating to the ecology and distribution of the species at present. Detailed surveys would be required to identify the population size, distribution and conservation measures (Patzelt, 2014). Based on the distribution of *Ochradenus harsusiticus*, the terrestrial DMU is considered to be a C2 critical habitat for this species.

1.2.4 *Salsola omanensis*

Salsola omanensis shrub is endemic to Oman. This shrub that grows to a height of 50 cm (Ghazanfar, 2003). They usually found on limestone plateau, limestone cliffs and coastal plains ranging from 50-300m above sea level (Patzelt, 2014). It flowers/fruits in October (Ghazanfar, 2003). It reportedly occurs throughout the country including central Oman, the offshore island of Al Hallaniyah and the Sahil al Jazir coast (Ghazanfar, 2003; Patzelt, 2014).

This species was recorded from the Port of Duqm footprint (5OES, 2015). It is also possible that *Salsola omanensis* may found along the undeveloped areas of SEZD. However, there is no detailed information available relating to the ecology and distribution of the species at present. Detailed surveys would be required to identify the population size, distribution and conservation measures (Patzelt, 2014). Based on the current status of *Salsola omanensis*, the terrestrial DMU is considered to be a C2 critical habitat for this species.

1.3 C3: Migratory and Congregatory Species

1.3.1 Socotra Cormorant Phalacrocorax nigrogularis

Socotra Cormorant *Phalacrocorax nigrogularisis* listed as 'Vulnerable' on the IUCN Red List of Threatened Species. This species occurs in two subpopulations (Gallagher et al. 1984). The northern one breeds on islands off the Persian Gulf coasts of Bahrain, United Arab Emirates (UAE), Saudi Arabia, Qatar and possibly Iran (breeding not confirmed since 1972) (Gallagher et al. 1984, Symens et al. 1993, Aspinall 1996). The southern subpopulation is apparently much smaller and breeds on one or more islands off the Arabian Sea coast of Oman and in the Gulf of Aden off Yemen (Gallagher et al. 1984, Symens et al. 1993, Aspinall 1996, Jennings 2000). The southern subpopulation is apparently much smaller and breeds on one or more islands off the Arabian Sea coast of Oman and in the Gulf of Aden off Yemen (c.60,000 birds in total) (Gallagher et al. 1984, Symens et al. 1993, Aspinall 1996, Jennings 2000). The breeding population is estimated at 110,000 pairs (Jennings 2010) (330,000 [Jennings 2000] to fewer than 500,000 [H. King in litt. 2005] individuals). Their distribution is illustrated in ***Figure 14***.

This species is highly gregarious, occurring throughout the year in large aggregations (Johnsgard 1993, King 2004, Nelson et al. 2005). Roosts are tightly packed, occupying the smallest possible ground footprint, potentially to maximise shade to the feet (King 2004). Some seasonal movements are thought to occur, probably related to fish migrations (Symens et al. 1993, Aspinall 1996), where the species travels in large flocks (del Hoyo et al. 1992) within the Persian Gulf and the Arabian Sea. This Cormorant is exclusively marine and occurs within the range of productive upwelling's (Nelson et al. 2005). Their diet consists

principally of small pelagic shoaling fish for which it dives from the surface to depths in excess of 18 metres (King 2004).

Socotra Cormorants are noticed all along the Duqm coastline; especially form the beaches at Ras Markaz, Duqm (Ghubbat Quwayrat), and Nafun area. It also roosts on coastal cliffs and Nafun Island. The species has a very small area of occupancy within its limited breeding range, which has declined rapidly largely because of human disturbance and oil spills (Chiozzi et al. 2007). Coastal development on breeding islands is likely the greatest threat to the species with detrimental effects in the past, present and future (Bird Life International 2010).

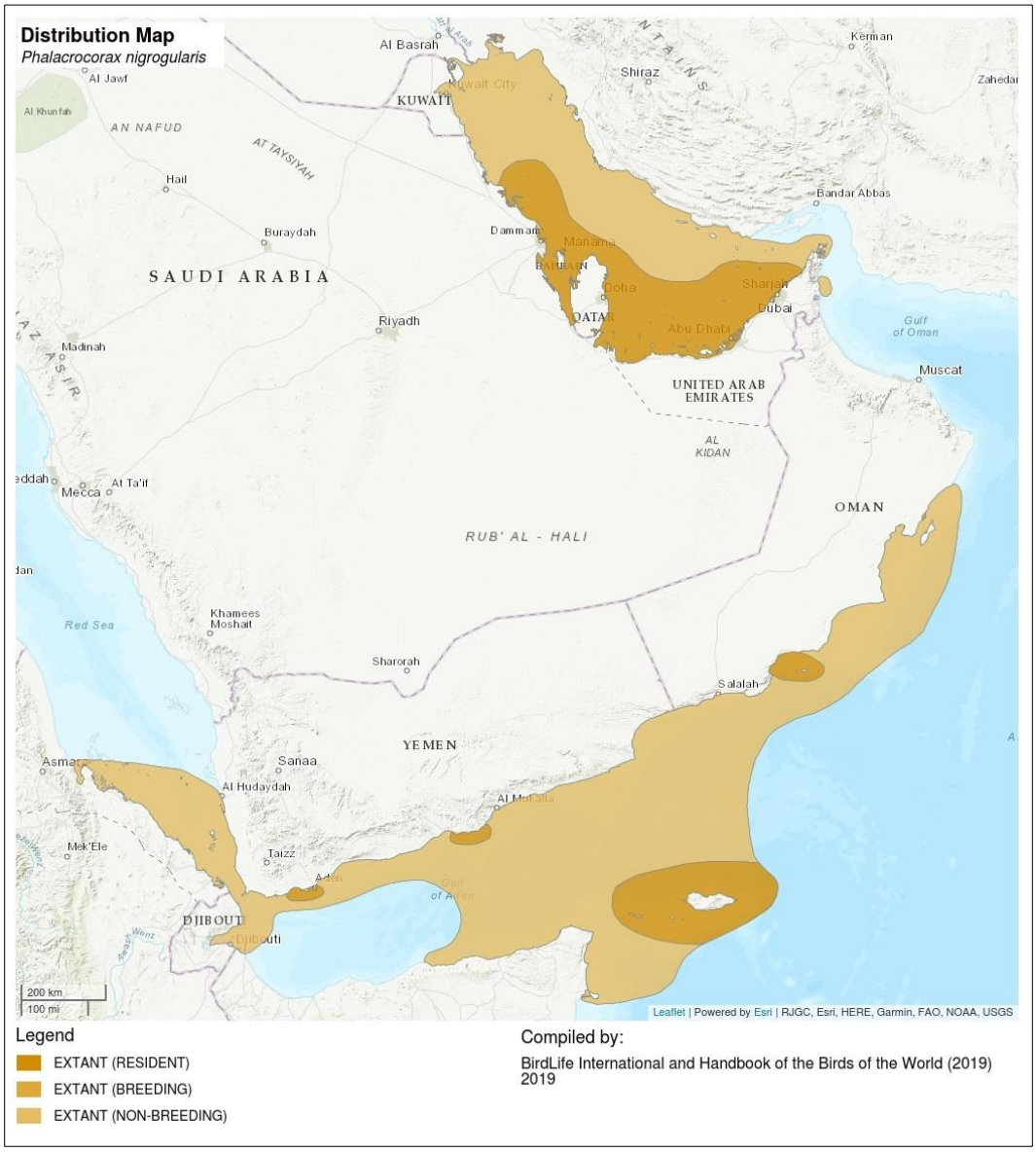


Figure 14: Distribution of Socotra Cormorant

This species is listed as Vulnerable because it has a small range, which is suspected to be undergoing a continuous and rapid decline, largely because of infrastructure and residential development, disturbance at its nesting colonies, exploitation, and marine oil pollution.

Based on the available data for Socotra Cormorant the marine DMU is considered to be a C3 critical habitat for this species.

Appendix D. – Marine Ecological Monitoring

1.1 Ecological Monitoring of the Marine Environment

The major part of existing marine habitat around the SEZ is outside the influence area of the seven sub-projects. However, as a regulator, SEZD/ OPAZ should monitor the environmental and ecological changes in the nearshore waters. It is anticipated that SEZD will adopt adequate mitigation measures to minimize any long-term detrimental impacts to marine environment in coordination with MECA/ Environment Authority. Following recommendations are suggested:

- Considering the distribution of cetaceans and sensitivity of the offshore area, an annual cetacean survey is to be implemented in order to protect them and their habitats. Surveys are suggested to be conducted in winter/spring season with passive acoustic monitoring or satellite tracking;

- Due to wide range of habitat, the strategic initiative should consider to collaborate with MECA and Office of the Conservation of the Environment (Diwan of the Royal Court) to better understand the distribution and abundance of all cetaceans outside the SEZD area;

- The upcoming developments in the fishery infrastructure will increase fishing pressure and in future mammal population will have to compete with the local fishers for the fish resources in this region and this unique population might migrate to other areas. Further the rapid increase of fishing activity in the area, the chances of mammals getting entangled in fishing nets will increase. Hence, periodic ecological and fish stock assessment should be conducted with collaboration of Ministry of Fisheries for small schooling fishes (Anchovies, sardines, mackerel, etc.);

- SEZD should agree a code of conduct for avoidance of marine mammal and turtle collisions and minimum safety standards relating to pollution for all vessels operating in SEZ facilities (Port of Duqm, Fishery Harbor & Ras Markaz oil terminals);

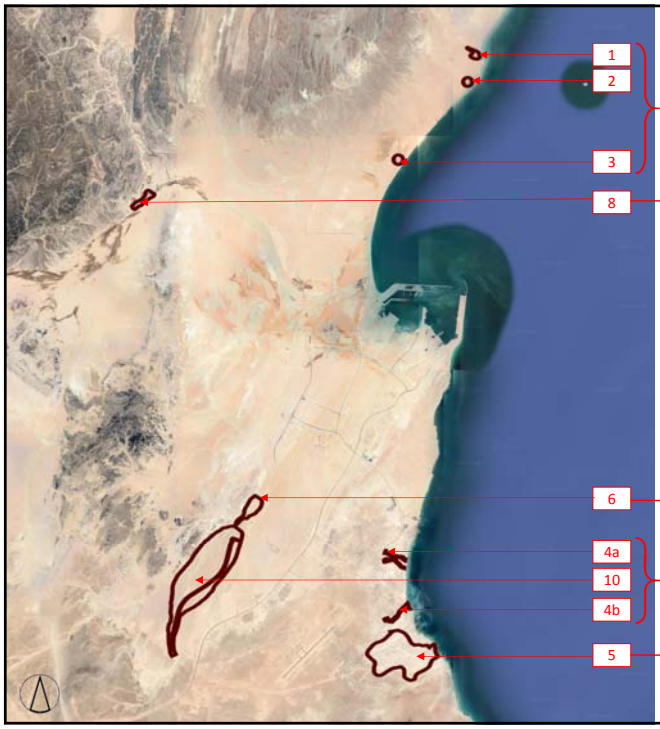
- The beaches at Ras Madrakah (10 nautical miles south of the Duqm SEZ) and small cove beaches in Duqm support significant turtle nesting which may be impacted during the future developments. Further, recent EIAs in the Duqm area and available satellite tracking studies (Pilcher et al. 2014) which provides some insight into migratory routes and foraging habitats for a small population of marine turtles in this region. Detailed assessment of satellite telemetry studies are suggested for the validation of migratory routes and foraging habitats in and around the SEZ.

- SEZD should seek assurance that potential marine pollution impacts are being assessed, controlled, and appropriately mitigated. Considering the various toxic inputs to marine environment from port, dry-dock, oil terminals and industrial outfalls; it is recommended to include a long-term bio-monitoring programme to measure the bioaccumulation of toxic substance in marine organisms which occur due to exposure in contaminated marine water; and

- SEZD should seek various operators (ports, industrial plants, and oil terminal) to deploy the data buoys in coastal areas for various parameters (meteorology, waves, current, water temperature, salinity, dissolved oxygen, chlorophyll-a, blue-green algae, nutrients, etc.) to monitor the water quality and this can be used to provide early warning of potential algal bloom events that are a common occurrence in this region.

- SEZD should seek various operators (DRPIC, ports, industrial plants, and OTTCO) to deploy artificial reefs in five locations in the aquatic regions of SEZAD. Ecological assessment of each site can then be conducted on an annual basis; it shall record the fishes, turtles, mammals, epibenthic flora and fauna, seabed condition, and include photography and videography documentation.

Appendix E. - Concept Designs for the BOA Lands

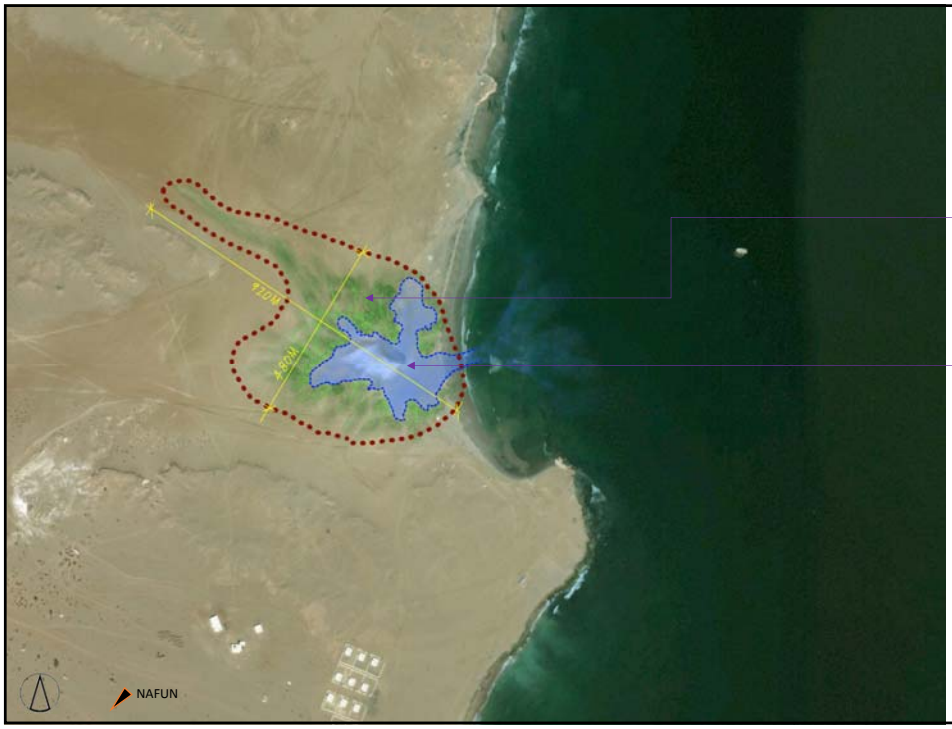


BOA Lands

THE SITES

Site 1:	Area≈ 22 Ha.
Site 2:	Area≈ 13.2 Ha.
Site 3:	Area≈ 34.5 Ha.
Site 4a:	Area≈ 30 Ha.
Site 4b:	Area≈ 13 Ha.
Site 5:	Area≈ 669 Ha.
Site 6:	Area≈ 88.4 Ha.
Site 8:	Area≈ 43.9 Ha.
Site 10:	Area≈ 1,093 Ha.

Coastal Lagoon/ Dune Typology



SITE # 1
Area = 22 ha.
Nafun Lagoon

Grass cover around lagoon with halophytic plants & creepers.

Nafun Lagoon

SITE # 2
Area = 13.2 ha.

Sand dunes with halophytic plants

Lagoon developed with a mix of grassland and halophytic plants & creepers typology.

Sand dunes with halophytic plants

SITE # 3
Area = 34.5 Ha.

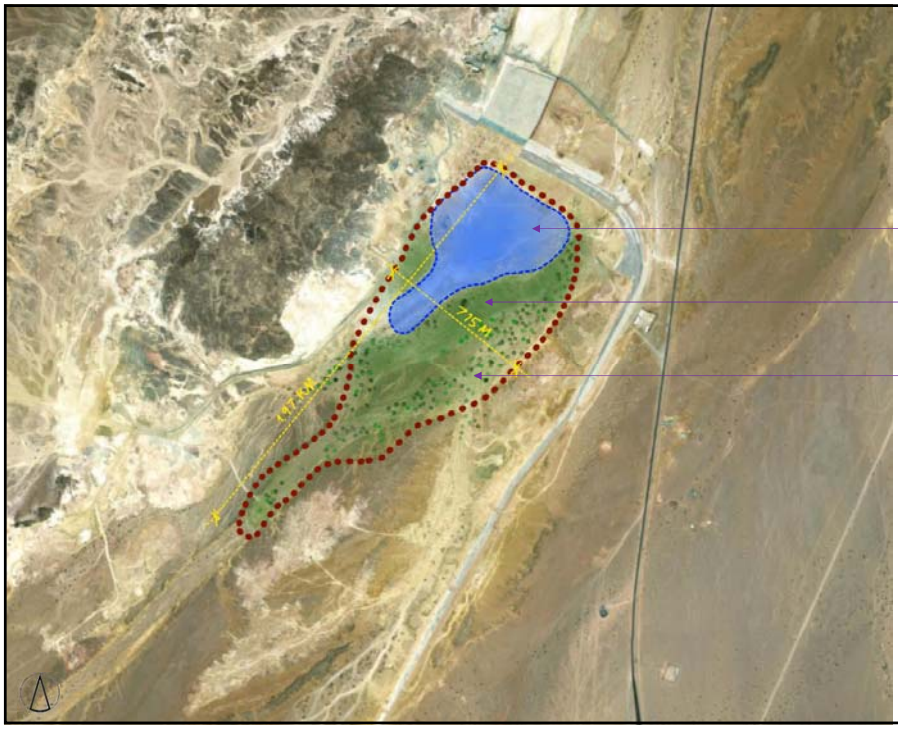
Lagoon developed with a mix of grassland and halophytic plants & creepers typology.

Sand dunes with halophytic plants


THE HABITAT
Coastal Lagoon
Sand Dunes With Halophytic Plants


THE HABITAT
Sand Dunes With Halophytic Plants

Flood Plain Wetland Typology

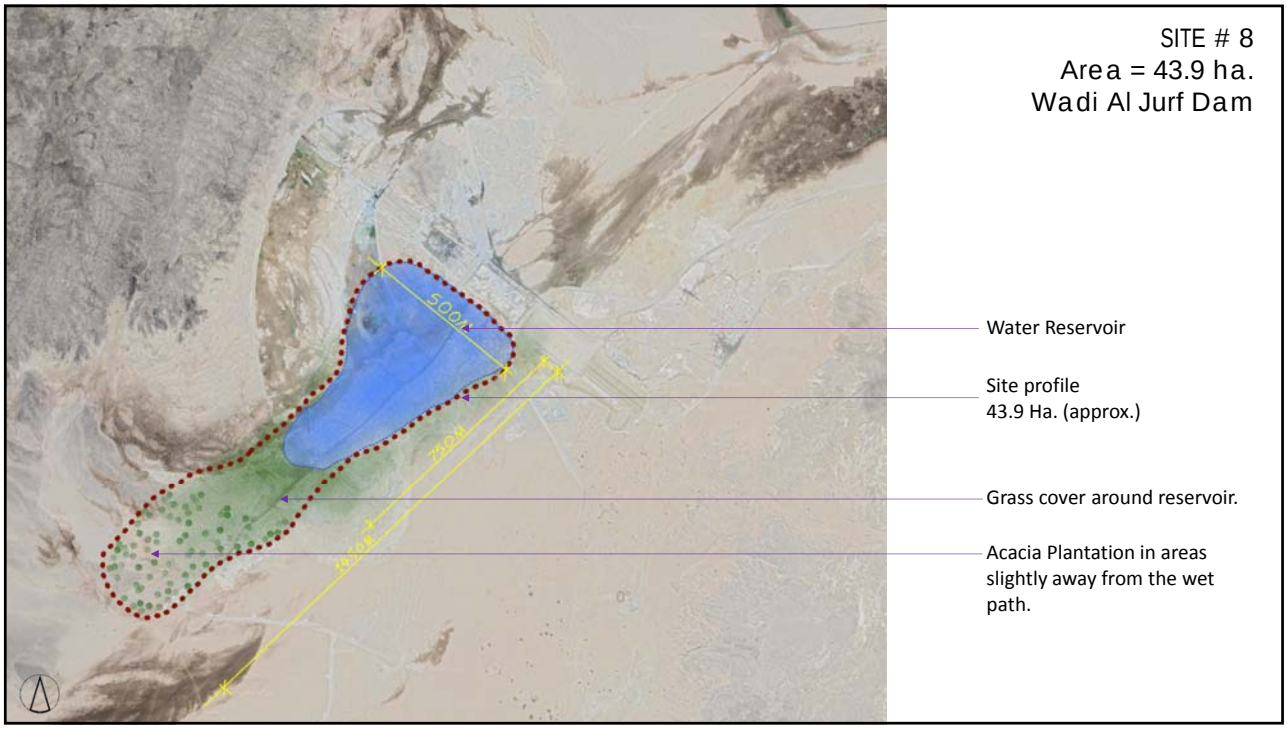


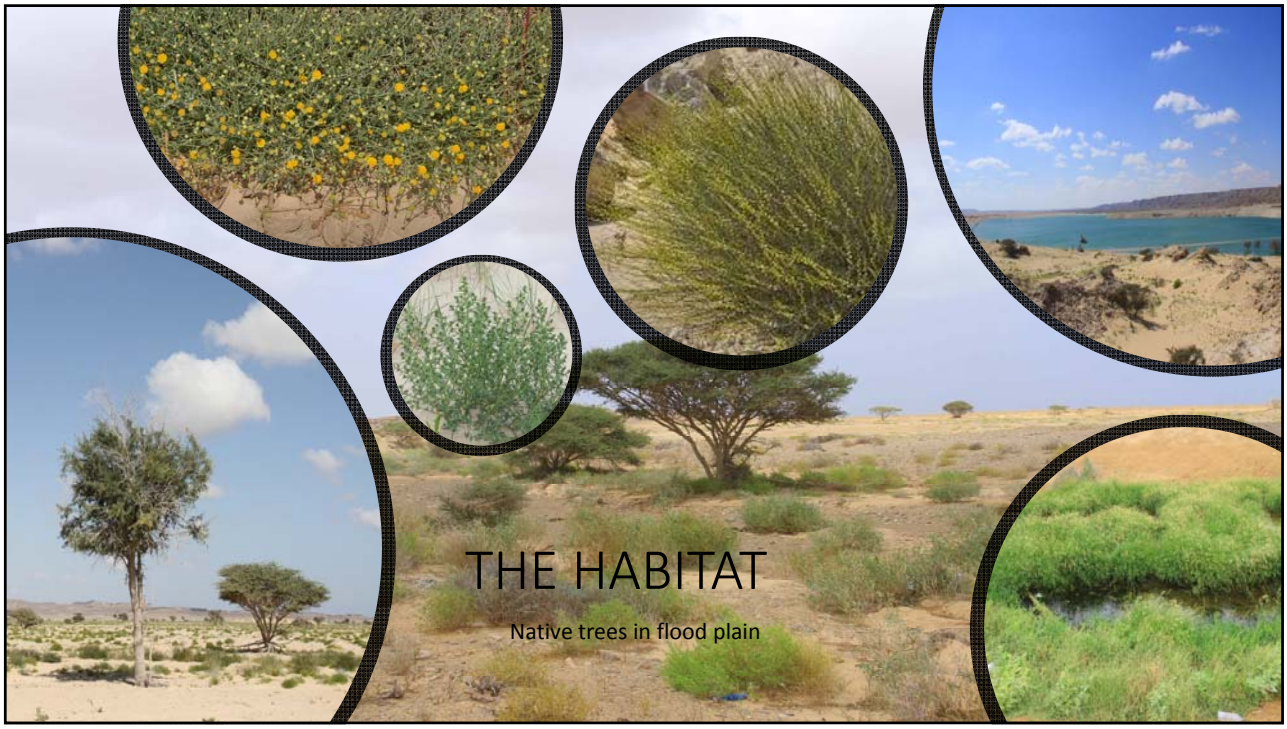
SITE # 6
Area = 88.4 ha.

Water Reservoir

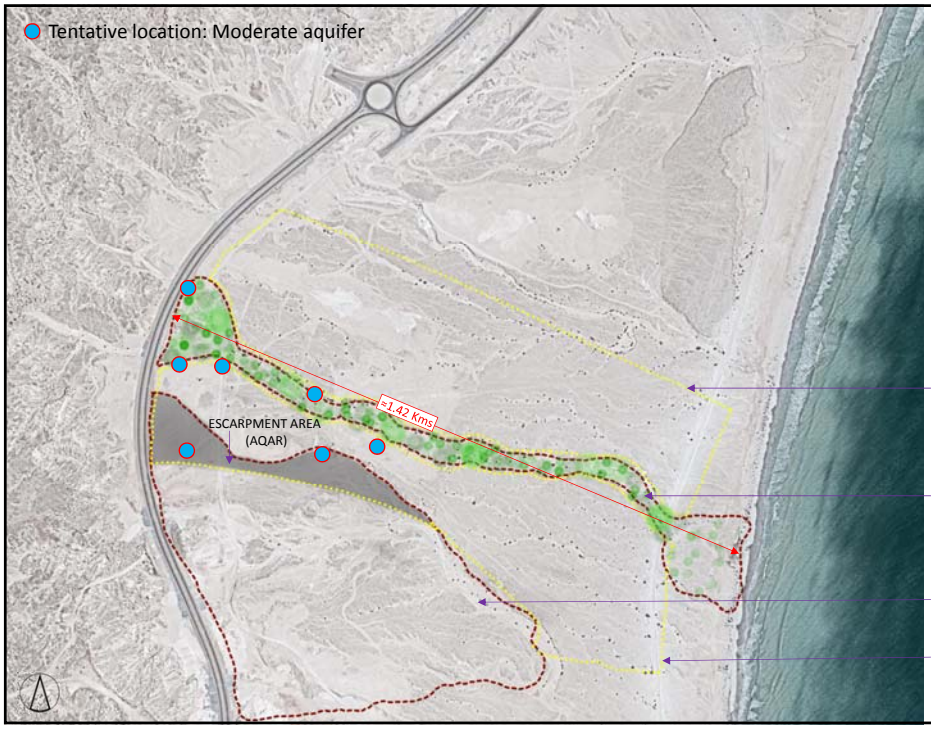
Grass cover around reservoir.

Acacia Plantation in areas slightly away from the wet path.


SITE # 8
Area = 43.9 ha.
Wadi Al Jurf Dam
500M
750M
1000M
Water Reservoir
Site profile
43.9 Ha. (approx.)
Grass cover around reservoir.
Acacia Plantation in areas slightly away from the wet path.


THE HABITAT
Native trees in flood plain

Wadi Grassland & Acacia Typology



SITE # 4a
Area = 30 ha.

Escarpment area (≈5.5 Ha.) can be recovered from the developer and used for development of the regional nursery along with additional area. 2 moderate aquifers have been located in this escarpment area.

Plot line – Aqar Tourism Concession – North parcel

SITE – 4a – Wadi Parcel (≈13 Ha.) Wadi land is not leased to the developer.
Grassland typology.

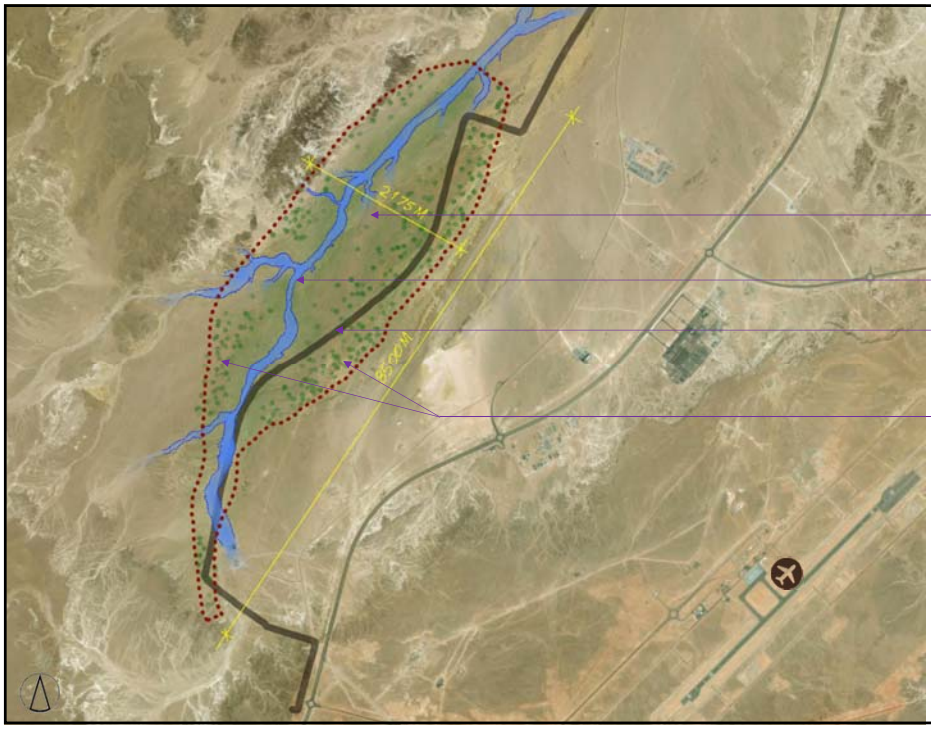
SITE – 4a – Regional Plant Nursery Parcel (≈32 Ha.)

Plot line – Aqar Tourism Concession – South parcel

SITE # 4b
Area = 13 ha.

Lagoon developed with a mix of grassland and halophytic plants & creepers typology.

Acacia Plantation in areas slightly away from the wet path.



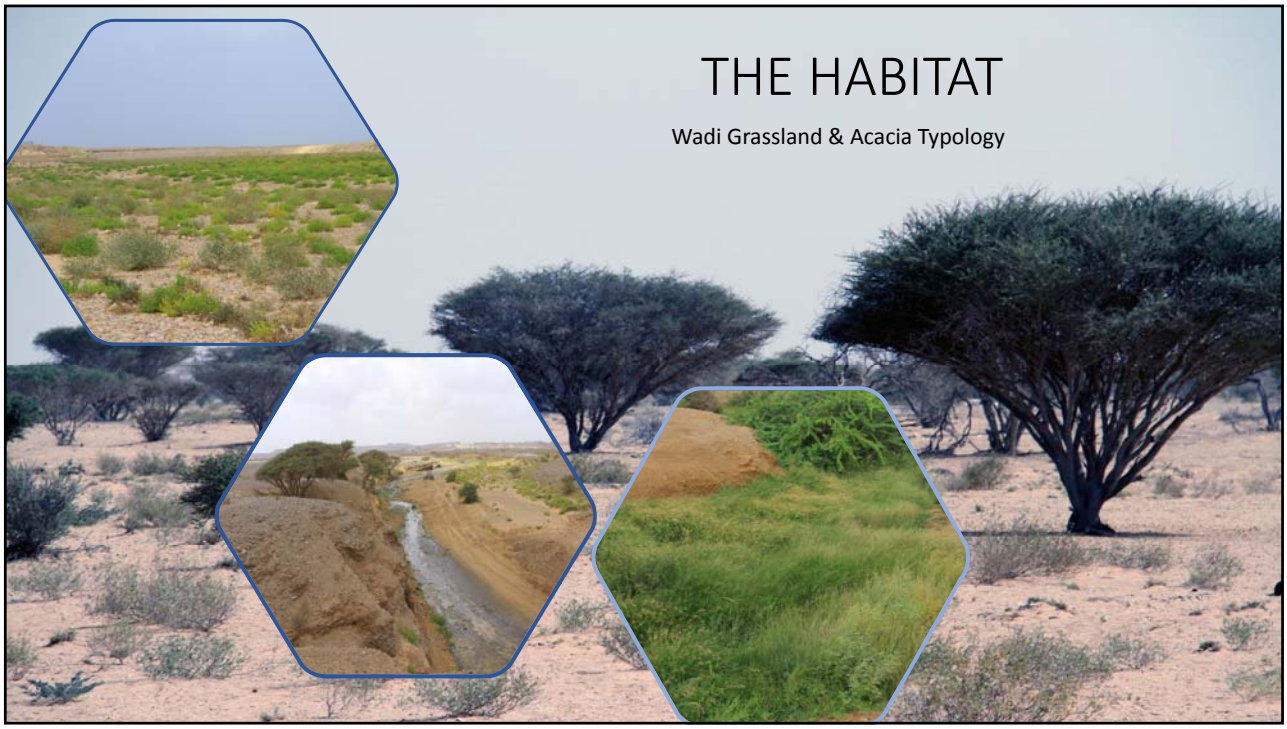
SITE # 10
Area = 1,093 ha.
Wadi Saay

Grass cover around wadi.

Wadi

Production Ribbon

Acacia Plantation in areas slightly away from the wet path.


THE HABITAT
Wadi Grassland & Acacia Typology

Highland/Cliff Typology

SITE # 5
Area = 669 ha.

Wadi

Grass cover around wadi.

Acacia Plantation in areas slightly away from the wet path.


THE HABITAT
Highland/Cliff Typology

Appendix F. – Reference List

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