# LEBANON

# WATER SUPPLY AUGMENTATION PROJECT

***ENVIRONMENT AND SOCIAL IMPACT ASSESSMENT***

# APPENDIX G

# Biodiversity Action Plan [1]

[1] This Appendix replaces Appendix G – Ecological Assessment Report – included in the ESIA disclosed on May 30, 2014.

## Aims and Objectives of the Biodiversity Action Plan

A Biodiversity Action Plan (BAP) is a plan which includes a set of actions that lead to the conservation or enhancement of biodiversity for a specific site or project. The Biodiversity Management Plan (BMP) forms part of the BAP and provides the delivery mechanism for actions given within it. Specifically the BAP and BMP are needed to ensure that the Project:

- Implements the mitigation, compensation and biodiversity protection measures within the ESIA;
- Complies with national legislation/policy requirements; and
- Complies with international environmental requirements and best practice, including the World Bank Safeguards Policies and the Equator Principles.

The aim of the BAP is to achieve no net biodiversity loss as a result of the Project by ensuring that the biodiversity is protected and enhanced where possible. The BAP has been developed in consultation with stakeholders, conservation NGO's and biodiversity experts and confirms that appropriate measures are in place to be successfully implemented.

The objectives of the BAP are to:

- Review existing biodiversity baseline information for the project area identified within the ESIA and to undertake further detailed biodiversity monitoring surveys;
- Implement a consultation process with relevant stakeholders and biodiversity experts to inform priorities and actions for biodiversity conservation;
- Identify priorities and actions for biodiversity conservation, in consultation with stakeholders and biodiversity experts;
- Determine actions to be undertaken within a BMP to benefit biodiversity; and
- Establish a monitoring and evaluation program for biodiversity allowing for the success of the BAP interventions to be assessed.

This BAP includes short to long-term biodiversity conservation actions as well as on-site mitigation measures linked to the construction and operation activities of the Water Supply Augmentation Project. The on-site mitigation measures will be implemented through the BMP which is incorporated within this document. Implementation of the BMP will be monitored by the independent ESMP Supervision Consultant and by the independent Environment and Social Panel of Experts.

The biodiversity baseline, conservation actions and mitigation in this BAP supplement the information in the ESIA. This latter document also includes actions required under an Environmental and Social Management Plan (ESMP) which covers environmental measures that are relevant to the protection of biodiversity. Additional conservation opportunities/actions have also been identified during the BAP process, following a review of the Project and consultation with the site team and local conservation NGO's. The conservation objectives and actions in this BAP have been developed to ensure the systematic implementation of the mitigation hierarchy i.e. avoid, reduce (minimise) and remedy (restore) (see Figure 1). This will allow for the careful management of risk and the best possible outcomes for the project and local communities, without compromising the health, function and integrity of the ecological system.

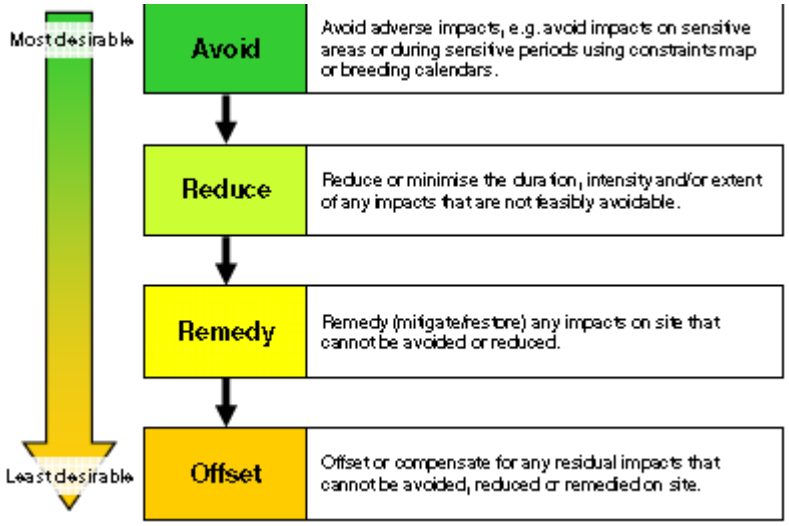


***Figure 1: Mitigation Hierarchy***

## Formulation of the Project BAP

The development of the BAP follows the IFC Guidance Note 6 (IFC, 2012b) and the Cross-Sector Biodiversity Initiative Guidance tool published by the International Petroleum Industry Environmental Conservation Association (IPIECA, 2013). The IPIECA guidance is for the oil and gas industry, but it is the only detailed BAP guidance available and is relevant to many other project types, including water supply projects (see Figure 2).

A BAP is a process from which a document is formulated through the review of previous studies and from consultation with local stakeholders. The ESIA is part of this process in that the ecological assessments of the ESIA provide the baseline upon which the BAP objectives and conservation priorities are based. In accordance with IPIECA guidance best practice, a BAP should thus include eight specific tasks:

- Task 1: Determination of the legal, regulatory, planning, permitting & third party requirements;
- Task 2: Desktop assessment of the project;
- Task 3: Baseline survey of the biodiversity;
- Task 4: Biodiversity impact assessment;
- Task 5: Preparation of the BAP;
- Task 5.1 Establishment of priorities for conservation;
- Task 5.2 Identification of conservation actions;
- Task 6: Implementation of the BAP;
- Task 7: Monitoring, evaluation and improvement; and
- Task 8: Reporting, communication and verification of BAP performance.

## Consultations with Stakeholders and Biodiversity Experts

### Overview

Stakeholder consultation is an integral component in the formulation of a BAP and is essential to engage with stakeholders to gather opinions on how to complement and coordinate actions. A number of stakeholders were consulted as part of the ESIA. Additional consultation was undertaken for the BAP to: (i) Update the biodiversity baseline (and likely impacts if required); and (ii) Identify the priorities for biodiversity conservation and develop the conservation actions.

**Key Stakeholders**

Key stakeholders consulted as part of the preparation of the BAP and BMP are (i) local communities and villages within the project and surrounding areas; (ii) government departments and ministries; (iii) academia and (iv) local Lebanese conservation NGO's. The BAP and BMP will be monitored through the environment and social specialists on the project management unit (PMU), independent ESMP supervision consultant and the independent environment and social panel of experts.

**Study Area**

The geographical scope of the BAP encompasses (i) the upstream catchment of the Bisri river; (ii) the construction area of the dam including the buffer zone; (iii) the downstream river stretch and estuary and (iv) the buffer zone around the downstream river stretch, see Figure 2.

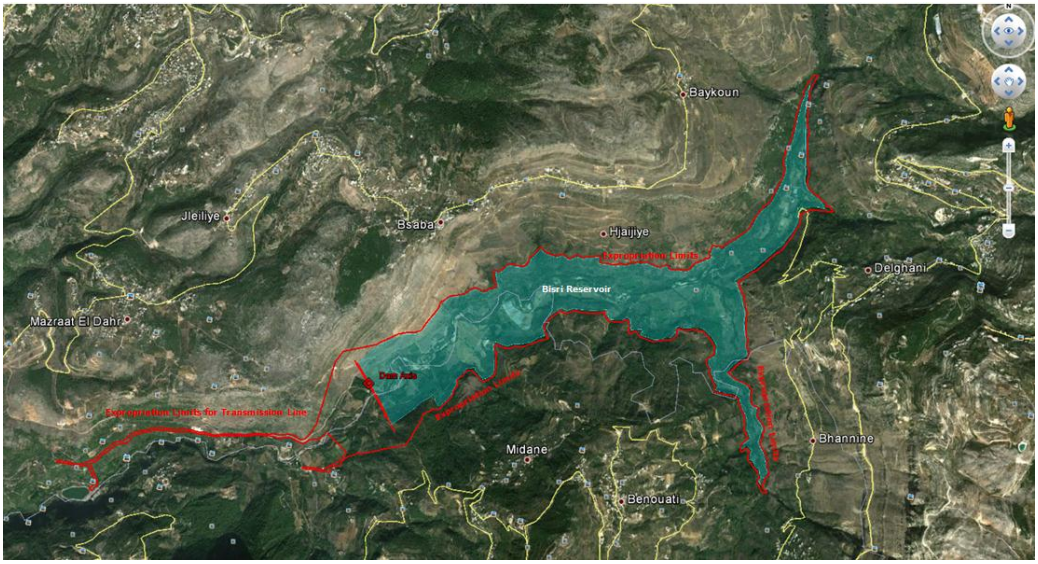


***Figure 2: Bisri Dam Project***

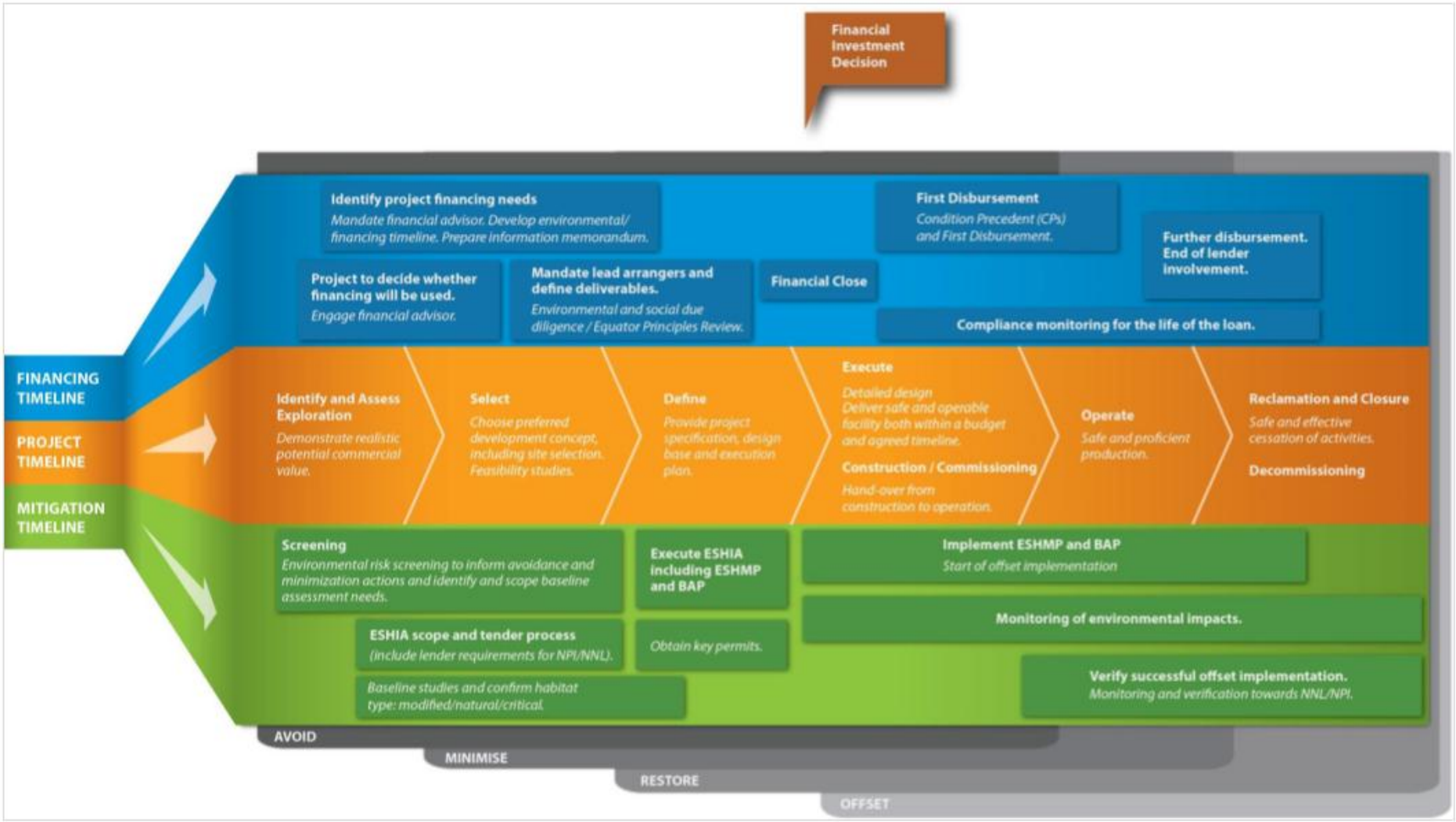


***Figure 3: Illustrative Alignment of Project Financing, Project and Mitigation Timelines (Cross Sector Biodiversity Initiative, 2013)***

## Task 1: Legal and Regulatory Requirements

### *International Legislation and Policy*

The following international laws and conventions have been ratified by Lebanon and are of relevance to this Project:

- Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973);
- United Nations (UN) Framework Convention on Climate Change; and
- UN (Rio) Convention on Biological Diversity (1992)

### *National Legislative and Policy Framework*

Lebanon's Ministry of Environment Decree on ESIA requires a project proponent to undertake an Environmental Impact Assessment where it is considered that the project has the potential to result in potential significant environmental or social impacts.

### *Planning and Permitting Requirements*

A detailed ecological impact assessment was completed for the Project as part of the ESIA. This document identified a number of mitigation and compensation measures which were necessary to ensure that there would be no net loss in biodiversity. This included the creation of a BAP and BMP in order to ensure that mitigation and compensation measures are fully and properly implemented, with stakeholder consultation, to meet conservation goals and objectives.

The BAP and BMP supplements and updates the information included in the ESIA to reflect the refinement and development of the Project design, the additional biodiversity baseline information collected since September 2013, and to include further assessment, mitigation and conservation actions, where necessary, to comply with IFC PS6 (IFC, 2012a, 2012b).

Table 1 below summarizes the likely significant direct and indirect impacts of the Project as identified in the ESIA. The table presents sensitive habitats and protected species that have been identified or are known to likely occur within the wider Project Area, which may be affected by the Project and the types of impacts that may occur.

**Table 1: Key likely significant impacts on ecological features during construction and operation**

| | Project Biodiversity Risk | Key likely impacts (C=construction impacts, O=operation impacts) |
|---|---|---|
| **Flora** | Ccontrol of water flooding may lead to destruction of important plant species and disturbance imposed within the demographic structure of riparian forest | C= Permanent habitat loss from construction of site infrastructure; noise and light disturbance from construction; increased pressure from human activities, such as forest management, logging and hunting due to improved access. |
| | | O= Disturbance from site staff and vehicles; physical barriers to movement across site roads; light disturbance at well pads from occasional night work |
| **Fish** | Reduced volumes of year-round river inflow and outflow, and possibility of water contamination with sewage or polluted water will deteriorate the environmental conditions of various fish species and/or block reproduction | C & O |
| | Reduction in water flow downtream of Bisri river may impact local freshwater blenny fish. | C&O |
| **Amphibians and Reptiles** | Risk of sudden reduction in water availability to hamper viability of amphibians and reptiles | C & O |
| | Reduction in water availability will impact the environmetnal conditions of the populations of the Bufo cf bufo ("Common European toad"), whose habitat appears to consist mostly of rocky terrain and riparian trees | C & O |
| **Birds** | Disturbance to natural environment may lead to a reduction in bird colonies | C & O |
| **Mammals** | Fragmentation of natural environment as a result of dam construction may obstruct mammal routes and expose animals to drowning and other risks | C & O |

***A note on environmental flow calculations***

Using the Q95 percentile of the river flow duration curve, accounting for four ecological elements that are the river physical characteristics, fisheries, macrophytes and macroinvertebrates, the Flow-Duration-Analysis for Bisri River estimated the base flow to be 0.3 and 0.45 $m^3/s$ for winter and summer, respectively. The estimated environmental flows should only be used to sustain freshwater and estuarine ecosystems and the human livelihoods that depend on these ecosystems. Other components of environmental flows are also to be considered, such as; the small and larger flood flows and the special purpose flow.

There is no one single method that is recommended and applicable worldwide in determining the Environmental Flows for any given river stream. There are number of methods depending on specific sites requirements and conditions. According to the U.K Resource Assessment and Management RAM[2] framework, a more realistic Environmental Flow could be obtained by combining between the flow and ecology of a given river. Other than the hydrologic properties of the river stream, the river physical characteristics and ecological features, such as fishery, Macrophytes and macro-invertebrates, were accounted for in determining Bisri river Environmental Flows. As such, the Q95 percentile, of the river flow duration curve, was applied[3] to quantify the flow that will be needed to prevent the loss of natural ecosystem because of the dam.

As such, the Q95 percentile yields a river base flow of 400 liters per second (lps), of which, about 25% could be abstracted, totaling the 100 lps, while the balance of 300 lps flow has to be maintained running into the river course as Environmental Flow. Whilst the latter Environmental flow has to be maintained into the river stream all year round, there should be a provision for additional 150 lps flow, starting the month of April and all way through the dry year months until October, to cope with the irrigation needs downstream the dam.

The project Environmental Flow, as described in the ESIA, will be monitored over the first 5 years of dam operation and will be adjusted accordingly as needed to preserve the site natural ecosystem and social services.

**Task 2: Third Party Requirements**

The Project is required to meet the international standards of the World Bank Group, including IFC Standards and World Bank Policy 4.01 on Natural Habitats.

**Task 3: Biodiversity Baseline for Priority Habitats and Species**

***Desktop Study***

A desk study was undertaken as part of the ESIA. Species of conservation importance were determined from the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species (http://www.iucnredlist.org), refereed journal and national expert knowledge.

***Field surveys***

[2] RAM is intended as a default methodology in the absence of other more sophisticated and extensive data requiring techniques

[3] The Essentials of Environmental Flows. Dyson & Bergkamp and Scanlon 2003 – Gland Switzerland IUCN

A detailed site-specific biodiversity survey was undertaken by Dar El Handassah Shaer (DAS) in August 2013 and to IFC standards, covering all major taxa, including amphibians, reptiles and macro-invertebrates, as well as more specific location and habitat usage information for flora, mammals, birds and fish, including:

- Flora and vegetation survey (including habitat mapping);
- Invertebrates
- Fish
- Reptile and amphibian surveys
- Bird survey
- Mammal survey;

A detailed assessment of habitat conditions was also undertaken in order to assess the suitability of the habitats within the Study Area to support endangered species.

**The survey determined, as described below, that the project would not cause significant conversion to critical natural habitats.**

**Plant Survey**

The flora cover was assessed to draw the ecological profile of the plant cover, its status and the impact of the dam on it. A rapid inventory was conducted to identify existing species and their status (rare, endangered, iconic …). Walking transects were identified to obtain an understanding of the vegetation communities in the area, to identify community boundaries, to record species present, and to determine the potential distribution of threatened species (Plate 1). Transects were assigned to cover the different habitats, topographic diversity, and variety of vegetation communities mapped from aerial photos.

**Fish and Macroinvertebrates**

Electrofishing was used to survey fish and macroinvertebrates. Electrofishing is a common method used for catching fish for surveying and monitoring purposes. The fishing device emits an electric current through the water, stunning fish and making them easy to capture (Cowx, 1990; Cowx and Lamarque, 1990). Carefully regulated amperages of currents used allowed the fish to be stunned effectively without damaging their muscles, vertebrae and spinal nerves. This is a non-selective method of capture that provides a broad overview of the fish fauna living in the surveyed water body.

**Amphibians and Reptiles**

Amphibians and reptiles were conducted on two intervals days and nights focusing on the water bodies, the riparian habitats and their peripheries. Observing and studying the potential habitats and observations of active animals was the only method for the animals that are active in warmer seasons.

**Ornithology Survey**

To assess the impact on the avian species, the 20-minute point-count method was used, whereby all species noted during this time period are recorded at different places and different times in the most characteristic habitats of a given area This method is semi-quantitative and changes in abundance of a species are estimated by changes in the frequency of this species over a series of

point counts. Frequencies could be mathematically transformed into densities through the use of some statistical rules.

**Camera trapping and field surveys**

Terrestrial mammal species were surveyed using two approaches, direct and indirect, were used to monitor mammals. Indirect approach was conducted during day time through diurnal walking surveys, where opportunistic observations of secondary signs such as tracks, footprints, fur and scats detected were recorded. Moreover, caves and dens were inspected for bats, animal signs and animal remains. The direct approach was conducted in two ways night surveys commenced using a 4x4 vehicle and a powerful spot light (1-1.5 million candle power) to illuminate animals once their eye-shine at two different times before or after midnight. The second approach through camera-trap surveys. 18 camera traps were placed within the Study Area, at least 100 meters from one another. The cameras were sited so as to cover a combination of habitat types and location within the study area.

## Habitats of Conservation Value

A detailed description of the habitats within the Project footprint and surrounding area to 5 kilometers is provided in the ESIA. The main habitats of conservation value are: (i) the riparian habitat and (ii) the Mediterranean ecosystem habitat.

## Flora of Conservation Value

Approximately 50 plants were identified in Bisri, of which 11 are of conservation value. Important plant species were identified among which Ricotia lunaria (L.) DC. (endemic at the national scale), Orchis anatolica Boiss., Orchis morio L., Orchis papilionaceae L., Orchis pyramidalis M. Bieb., Orchis romana subsp. libanotica Mt., Orchis tridentata Scop., Ornithogalum umbellatum L. and Fritillaria libanotica (Boiss.).

| Species Scientific Name | Species Scientific Name |
|---|---|
| 1. *Acer syriacum Boiss*. & Gaill. | 2. *Nerium oleander* L. |
| 3. *Adiantum capillus-veneris* L. | 4. *Onosma frutescens* Lam. |
| 5. *Ajuga orientalis* L. | 6. *Orchis anatolica* Boiss. |
| 7. *Alnus orientalis* Decne. | 8. *Orchis morio* L. |
| 9. *Anemona coronaria* L. | 10. *Orchis papilionaceae* L. |
| 11. *Arceuthos drupacea*(Labill.) Ant. & Ky. | 12. *Orchis pyramidalis* M. Bieb. |
| 13. *Arum hygrophylum* Boiss. | 14. *Orchis romana* subsp. *libanotica* Mt. |
| 15. *Asparagus acutifolius* L. | 16. *Orchis tridentata* Scop. |
| 17. *Asperula sp.* | 18. *Ornithogalum umbellatum* L. |
| 19. *Asphodellus microcarpus* Salzm. & Viv. | 20. *Oxalis per-caprae* L. |
| 21. *Bellevalia latifolia* Ten. | 22. *Pinus brutia* Ten. |
| 23. *Bellis sylvestris* Cirillo. | 24. *Pinus pinea* L. |
| 25. *Calycotome villosa* (Vahl) Link. | 26. *Pistacia palaestina* Boiss. |
| 27. *Ceratonia siliqua* L. | 28. *Phillyrea media* L. |
| 29. *Cercis siliquastrum* L. | 30. *Platanus orientalis* L. |
| 31. *Cistus creticus* Sibth. & Sm. | 32. *Pteridium aquilinum* (L.) Kuhn. |
| 33. *Cyclamen persicum* Sibth. & Sm. | 34. *Quercus calliprinos* Webb. |
| 35. *Cupressus sempervirens* L. | 36. *Quercus infectoria* Oliv. |

| | |
|---|---|
| 37. *Fritillaria libanotica* (Boiss.) Baker | 38. *Ricotia lunaria* (L.) DC. |
| 39. *Gallium sp.* | 40. *Ruscus aculeatus* L. |
| 41. *Hyacinthus orientalis* L. | 42. *Salix libani* Bornm |
| 43. *Iris histrio* Reichb. | 44. *Salix* sp. |
| 45. *Lathyrus hierosolymitanus* Boiss. & Bl. | 46. *Smilax aspera* L. |
| 47. *Laurus nobilis* L. | 48. *Allium neapolitanum* Cyr. |
| 49. *Lavendula stoechas* L. | 50. *Tamarix* sp. |
| 51. *Lupinus digitatus* Forsk. | 52. *Tamus communis* L. |
| *53. Muscari comosum* (L.) Mill. | 54. *Valeriana dioscoridis* Sibth. & Sm. |

## Fish

Five fish species and one crab were present in Awali River, out of which three deserve special attention as listed below. These are the Freshwater blenny, the European eel, and the Middle Eastern Green carp. No exotic fish or macroinvertebrates were captured.

| Species | Family |
|---|---|
| Salaria fluviatilis (Asso, 1801) | Blenniidae |
| Anguilla anguilla (Linnaeus, 1758) | Anguillidae |
| Capoeta damascina (Valenciennes, 1842) | Cyprinidae |
| Pseudophoxinus kervillei (Pellegrin, 1911) | Cyprinidae |
| Oxynoemacheilus leontinae (Lortet, 1883) | Balitoridae |
| Potamon potamios (Olivier, 1804) | Potamidae |

## Amphibians and Reptiles

None of the species of snakes and lizards in that basin are known to be endangered or endemic. Most of these species are quite common in the surrounding areas and many parts of the country. There are no apparent impacts on these species due to the dam construction. In this survey, emphasis was placed on species that might be affected or impacted directly or indirectly by changes in the aquatic habitat to the dam construction. The species most like to be impacted are listed below. The impact on the species could be in terms of changes in habitat, breeding sites and food sources.

*(T = Threatened, E = Endemic, R = Rare, and C = Common. The type of impact might be: HT= general habitat, BR=breeding habitat, FD=food requirements.)*

| Species | Common name | Picture | **Status** | | | | Type of Impact | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | T | E | R | C | HT | BR | FD |
| *Natrix tessellata* | Water snake |  | | | | + | + | | ? |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Pelophylax bedriagae* | Marsh frog |  | | | | + | + | + | ? |
| *Pelobates syriacus* | Eastern or Syrian spadefoot |  | | | + | | + | + | ? |
| *Bufo viridis* | Green toad |  | | | | + | | + | ? |
| *Bufo* cf. *bufo* | European common toad |  | | + | + | | + | + | ? |
| *Hyla savignyi* | tree frog |  | | | | + | + | + | ? |
| *Salamandra infraimmaculata* | salamander |  | | | | + | + | + | ? |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Triturus vittatus* | Newt |  | | | + | | | | |

## Birds of Conservation Value

Thirty two (32) bird species were observed during the surveys. Of the observed birds, four are threatened (White storks, Lesser Spotted Eagle, White Pelicans that are of passage only, and Short-toed Eagle that is of wide range of action (within and beyond the limits of the site). Hence their conservation depends on areas other than Bisri Site. The Bisri area is not considered critical to the migratory routes of these threatened bird species.

## Mammals of Conservation Value

The field survey on mammals for Bisri site revealed the presence of 17 mammal species belonging to 14 families. Mammals of conservation value are identified below:

***List of mammal species present on the three sites (R= recorded, E = Expected, c= common, r = rare, endemic or endangered on the National level)***

| Family | Species | Scientific Name | Awali River |
|---|---|---|---|
| Erinaceidae | Hedgehog | *Erinaceus concolor* | R, r |
| Miniopteridae | European Free-tailed bat | *Tadarida teniotis* | R, r |
| Vespertilionidae | Common pipistrelli | *Pipistrellus Pipistrellus* | R, c |
| | Khul's pipistrelle | *Pipistrellus kuhli ikhawanius* | R, c |
| Rhinolophidae | Lesser horseshoe | *Rhinolophus hipposideros* | R, c |
| | Greater horseshoe bat | *Rihnolophus ferrumequinum* | R, c |
| Canidae | Jackal | *Canis aureus syriacus* | R, c |
| | Fox | *Vulpus vulpus palaestina* | R, c |
| Mustelidae | Pine Martin | *Martes foina syriaca* | R, c |
| | Badger | *Meles meles canescens* | E, r |
| | Otter | *Lutra lutra* | E, r |
| Hyaenidae | Striped hyaena | *Hyaena hyaena syriaca* | R, c |
| Felidae | Wild cat | *Felis silvestris tristrami* | R, r |
| Suidae | Wild boar | *Sus scrofa lybicus* | R, c |
| Sciuridae | Squirrel | *Sciurus anomalus syriacus* | E, c |
| Hystricidae | Porcupine | *Hystrix indica indica* | R, c |
| Spalacidae | Moles | *Spalax leucodon ehrenbergi* | R, c |
| Muridae | House mouse | *Mus musculus praetextus* | R, c |
| | Rats | *Rattus rattus* | R, c |
| | Field mouse | *Apodemous mystacinus* | R, c |

| | | | |
|---|---|---|---|
| Microtinae (Subfam.) | Voles | *Microtus sp.* | E, c |

## Biodiversity Action Plan

### Overview

This section sets out the proposed actions to be undertaken for the habitats and species of conservation value identified above with the aim of achieving 'no net loss' to biodiversity in accordance with IFC PS6 (IFC, 2012a).

These actions have been developed for each priority biodiversity feature, or groups of features, to ensure the systematic implementation of the mitigation hierarchy i.e. avoid, reduce (minimize), and remedy (restore) as outlined in Figure 1. This will allow for the careful management of risk during construction and operation, and the best possible outcomes for the Project and local communities without compromising the health, function and integrity of the ecological system.

A summary of the objectives is provided in Table 6 below, with details of the actions below.

**Table 6: Summary of action plan objectives.**

| | |
|---|---|
| *During Construction* | |
| **1** | Conduct further biodiversity surveys and prepare a detailed map of the habitats of conservation value before construction starts |
| **2** | Inform construction staff on the habitats of conservation value and notable plant species prior to the start of construction |
| **3** | Plan starting time for major construction works and activities to avoid disturbance of critical species |
| **4** | Clearly mark areas to be cleared during construction and fencing of critical flora |
| **5** | Translocation of critical endangered flora in area to be cleared prior to the start of construction |
| **6** | Establish corridors for crossing to avoid fragmentation of habitats prior to the start of construction |
| **7** | Methodical clearance of forested areas to allow natural dispersal of wildlife into adjacent habitat |
| **8** | Reduce hunting and logging in areas opened up through the creation of new or improved access roads |
| **9** | Reduce and prevent mortality of wildlife from collision from vehicles |
| **10** | Prevent pollution from construction waste to reach habitats |
| **11** | Light control within Project Area to minimize disturbance to critical species |
| **12** | Avoid noise pollution (blasting) at times critical for bird nesting |
| *During Operation* | |
| **13** | Maintain connectivity and habitats downstream of dam through minimum flow releases |
| **14** | Operation of reservoir to avoid water level fluctuation in spring to preserve critical habitats |

The actions may partly overlap with the actions of other environmental and social plans and the execution of the BAP should be coordinated with other plans during implementation.

| **Action 1:** Conduct further biodiversity surveys and prepare a detailed map of the habitats of conservation value prior to the start of construction | | | | | |
|---|---|---|---|---|---|
| **Target** | To improve and refine the knowledge of biodiversity conducted during the ESIA | | | | |
| **Indicator** | Number of survey reports, Finalized map of critical habitats | | | | |
| **Mitigation Hierarchy** | **Avoid** | **Reduce** | **Remedy** | **Offset** | **Other** |
| **Start** | Before the onset of the construction | | | | |
| **End** | On yearly bases over 5 years after construction | | | | |
| **Frequency** | Continuous during first year of construction | | | | |
| **Brief description**: Extended biodiversity surveys guided by already conducted work in the ESIA. Preparation of detailed map of critical habitats. | | | | | |
| **Responsible**: Project Developer | | | | | |

| **Action 2:** Inform construction and operation staff (including contractors) on the habitats of conservation value and notable plant species prior to the start of construction | | | | | |
|---|---|---|---|---|---|
| **Target** | To raise awareness of wildlife plant and habitat in the project area | | | | |
| **Indicator** | Number of staff and contractors reached through site induction and training; number of posters at site offices | | | | |
| **Mitigation Hierarchy** | **Avoid** | **Reduce** | **Remedy** | **Offset** | **Other** |
| **Start** | Start of construction | | | | |
| **End** | End of construction | | | | |
| **Frequency** | During staff induction; continuous during construction and operation | | | | |
| **Brief description**: Construction and operational staff will be informed about the areas supporting habitats and species of conservation value, why these features are important and what activities are/are not permitted in these areas. | | | | | |
| **Responsible**: Biodiversity specialist, Works Contractor | | | | | |

| **Action 3:** Plan starting time for major construction works and activities to avoid disturbance of critical species | | | | | |
|---|---|---|---|---|---|
| **Target** | To avoid and reduce disturbance of wildlife during critical seasons | | | | |
| **Indicator** | Start dates of major new construction activities | | | | |
| **Mitigation Hierarchy** | **Avoid** | **Reduce** | **Remedy** | **Offset** | **Other** |
| **Start** | Start of construction | | | | |
| **End** | End of construction | | | | |
| **Frequency** | At start of major activities during construction | | | | |
| **Brief description**: Planning of major construction activities, especially those that have large areal influence, should be done to as much as possible avoid disturbance of critical species. Special attention shall be taken to hibernating mammals during winter and nesting birds and breeding amphibians during spring. | | | | | |
| **Responsible**: Works Contractor as advised by Project Biodiversity Management Specialist | | | | | |

| **Action 4:** Clearly mark areas to be cleared during construction and fencing of critical flora prior to the start of construction | | | | | |
|---|---|---|---|---|---|
| **Target** | To raise awareness affected areas during construction and to protect endangered flora | | | | |
| **Indicator** | Meters of fence established, number of signs and demarcations | | | | |
| **Mitigation Hierarchy** | **Avoid** | **Reduce** | **Remedy** | **Offset** | **Other** |
| **Start** | Start of construction | | | | |
| **End** | Six months after start of construction | | | | |
| **Frequency** | At start of construction | | | | |
| **Brief description**: Demarcation of all areas to be cleared during construction. Install fencing around essential vegetation close to construction sites. Signs that will inform that these are sensitive environmental areas shall be attached to the fence. | | | | | |
| **Responsible**: Works Contractor – as advised by Project Biodiversity Management Specialist | | | | | |

| **Action 5:** Translocation of endangered flora in area to be cleared prior to the start of construction | | | | | |
|---|---|---|---|---|---|
| **Target** | To create alternative habitats for endangered flora to be affected by construction | | | | |
| **Indicator** | Number of plants translocated | | | | |
| **Mitigation Hierarchy** | **Avoid** | **Reduce** | **Remedy** | **Offset** | **Other** |
| **Start** | Before start of construction | | | | |
| **End** | Start of construction | | | | |
| **Frequency** | Once before construction start | | | | |
| **Brief description:** Translocation of nationally endemic species with critical conservation status such as Orchis, Fritillaria, Omithogalum, Hyacinthus, ferns and other species must be done before the construction of the dam. Should if possible be made at end of summer during the dormant stage of the plants in question. | | | | | |
| **Responsible**: Project Developer, as advised by Project Biodiversity Management Specialist | | | | | |

| **Action 6:** Establish corridors for crossing to avoid fragmentation of habitats prior to the start of construction | | | | | |
|---|---|---|---|---|---|
| **Target** | To avoid and reduce fragmentation of habitats | | | | |
| **Indicator** | Number of square meters of corridors established | | | | |
| **Mitigation Hierarchy** | **Avoid** | **Reduce** | **Remedy** | **Offset** | **Other** |
| **Start** | Start of construction | | | | |
| **End** | Six months after start of construction | | | | |
| **Frequency** | At start of construction | | | | |
| **Brief description**: Construct corridors for mammals and amphibians for strategic crossing points | | | | | |
| **Responsible**: Works Contractor – as advised by Project Biodiversity Management Specialist | | | | | |

| **Action 7:** Methodical clearance of forested areas to allow natural dispersal of wildlife into adjacent habitat | | | | | |
|---|---|---|---|---|---|
| **Target** | To avoid damage to wildlife in forested areas to be cleared | | | | |
| **Indicator** | Clearance plans and reports | | | | |
| **Mitigation Hierarchy** | **Avoid** | **Reduce** | **Remedy** | **Offset** | **Other** |
| **Start** | Start of construction | | | | |
| **End** | Six months after start of construction | | | | |
| **Frequency** | At start of construction | | | | |
| **Brief description**: To conduct clearance in a structured and planned way to allow escape routes out of the area. Avoid clearance during breeding season in spring. | | | | | |
| **Responsible**: Works Contractor | | | | | |

| **Action 8:** Reduce hunting and logging in areas opened up through the creation of new or improved access roads | | | | | |
|---|---|---|---|---|---|
| **Target** | To avoid damage to critical habitat and species in project area | | | | |
| **Indicator** | Number of road gates established, Number of signs | | | | |
| **Mitigation Hierarchy** | **Avoid** | **Reduce** | **Remedy** | **Offset** | **Other** |
| **Start** | Start of construction | | | | |
| **End** | End of operations | | | | |
| **Frequency** | Continuous during construction and operations | | | | |
| **Brief description**: To install road gates for access roads to avoid other than necessary transport for construction and operation work, and for local population. Awareness campaigns among construction and operation staff, and local communities, and setting up of signs to enforce illegal hunting and logging. | | | | | |
| **Responsible**: Works Contractor and Dam Operator | | | | | |

| **Action 9:** Reduce and prevent mortality of wildlife from collision from vehicles | | | | | |
|---|---|---|---|---|---|
| **Target** | To restrain speed limits at low levels and to avoid unnecessary driving during darkness to avoid collisions with wildlife | | | | |
| **Indicator** | Levels of speed limit, Number of speed limit and warning signs | | | | |
| **Mitigation Hierarchy** | **Avoid** | **Reduce** | **Remedy** | **Offset** | **Other** |
| **Start** | Start of construction | | | | |
| **End** | End of operations | | | | |
| **Frequency** | Continuous during construction and operations | | | | |
| **Brief description**: Setting of low speed limits for access and construction roads. Planning of transport to avoid driving in darkness. Clear demarcation of speed limits and warning for wildlife collisions. | | | | | |
| **Responsible**: Works Contractor and Dam Operator | | | | | |

| **Action 10:** Prevent pollution from construction waste to reach habitats | | | | | |
|---|---|---|---|---|---|
| **Target** | To avoid damage to habitats in project area by construction waste pollutions | | | | |
| **Indicator** | Meters of drainage work to prevent waste water and solid waste seepage to escape, regular monitoring of waste water | | | | |
| **Mitigation Hierarchy** | **Avoid** | **Reduce** | **Remedy** | **Offset** | **Other** |
| **Start** | Start of construction | | | | |
| **End** | End of operations | | | | |
| **Frequency** | Continuous during construction and operations | | | | |
| **Brief description**: Planning and construction of solid waste dumps and waste water treatment to avoid spillage or seepage to natural habitats. Construction of drainage around severe pollution risks to ensure polluted water is contained and treated. Monitoring of water discharging from construction sites and permanent site. | | | | | |
| **Responsible**: Works Contractor and Dam Operator | | | | | |

| **Action 11:** Light control within Project Area to minimize disturbance to critical species | | | | | |
|---|---|---|---|---|---|
| **Target** | To avoid and reduce disturbance of nocturnal wildlife from construction lights | | | | |
| **Indicator** | Number of lights used during nighttime | | | | |
| **Mitigation Hierarchy** | **Avoid** | **Reduce** | **Remedy** | **Offset** | **Other** |
| **Start** | Start of construction | | | | |
| **End** | End of operations | | | | |
| **Frequency** | Continuous during construction and operations | | | | |
| **Brief description**: Planning of construction and operation work to minimize as much as possible work during darkness. Efficient use of construction lights. | | | | | |
| **Responsible**: Works Contractor and Dam Operator as advised by Project Biodiversity Management Specialist | | | | | |

| **Action 12:** Avoid noise pollution (blasting) at times critical for wild life | | | | | |
|---|---|---|---|---|---|
| **Target** | To avoid and reduce disturbance of nesting birds | | | | |
| **Indicator** | Reported time for blasting | | | | |
| **Mitigation Hierarchy** | **Avoid** | **Reduce** | **Remedy** | **Offset** | **Other** |
| **Start** | Start of construction | | | | |
| **End** | End of operations | | | | |
| **Frequency** | Continuous during construction | | | | |
| **Brief description**: Plan and execute blasting to avoid timing during peaks of the breeding season (April-July) and during sunrise and sunset. Preferably do blasting at same time every day. | | | | | |
| **Responsible**: Works Contractor as advised by Project Biodiversity Management Specialist | | | | | |

| **Action 13:** Maintain connectivity and habitats downstream of dam through minimum environmental flow releases | | | | | |
|---|---|---|---|---|---|
| **Target** | To preserve habitats for flora and fauna, and fish migration in downstream reaches | | | | |
| **Indicator** | Monitored flows downstream of dam | | | | |
| **Mitigation Hierarchy** | **Avoid** | **Reduce** | **Remedy** | **Offset** | **Other** |
| **Start** | At start of reservoir filling | | | | |
| **End** | End of operations | | | | |
| **Frequency** | Continuous start of filling to end of operations | | | | |
| **Brief description**: To construct dam to allow continuous minimum flow releases and to ensure operation rules to follow such releases. | | | | | |
| **Responsible**: Works Contractor and Dam operator, biodiversity specialist. | | | | | |

| **Action 14:** Operation of reservoir to avoid water level fluctuation in spring to preserve critical habitats for species | | | | | |
|---|---|---|---|---|---|
| **Target** | To enable and facilitate reproduction of amphibians (Bufo cf Bufo) upstream of Bisri dam | | | | |
| **Indicator** | Water level records | | | | |
| **Mitigation Hierarchy** | **Avoid** | **Reduce** | **Remedy** | **Offset** | **Other** |
| **Start** | Dam commissioning | | | | |
| **End** | End of operations | | | | |
| **Frequency** | Continuous during operation | | | | |
| **Brief description**: Establish operating rules for dam releases to maintain the Bisri reservoir as high as possible, and avoid releases giving rapid water level fluctuations, during the reproduction period of the Bufo cf Bufo (April-May). | | | | | |
| **Responsible**: Dam Operator, as advised by Project Biodiversity Management Specialist | | | | | |

## Biodiversity Management Plan

The BAP will be implemented through the BMP summarized in Figure 4 below and the ESMP. The BMP will focus on three key areas: biodiversity monitoring and socialization.

- **Biodiversity Monitoring**

Biodiversity monitoring will be undertaken over a minimum of five years to incorporate the pre-construction, construction and operational phases of the Project. The aims of the surveys will be to assess the impacts of the development and will use the Before-After-Control-Impact (BACI) approach. The methodology to be used will be scientifically robust and repeatable. The surveys will be carried out in collaboration with biodiversity experts/NGOs.

A Rapid Ecological Assessment to provide additional baseline prior to the commencement of works at the project site in was undertaken by Dar El Handassah Shaer (see Appendix A). This assessment was designed to be repeated during the post-construction surveys following the same and other updated methodology.

- **Socialisation**

A socialisation programme will implemented covering two aspects: 1) staff/contractor induction and training; 2) local community engagement.

***Staff/contractor induction and training***

Inductions and training will be undertaken with all staff and contractors to raise awareness of the ecological issues affecting the Project and to implement any obligations outlined below. This will be achieved through the following:

- **Training for all existing staff and contractors working on the Project**: Group sessions will be organised in order to train all existing staff and contractors working on the Project. The delivery method will be through to approaches i) a PowerPoint presentation followed by a question and answer session, ii) hands on through field or site visits. Due to the large number of staff working on the Project and the requirement to maintain continuous construction work on site, the training will be undertaken over a series of events. The content and delivery will be determined through consultation with the external ecological consultants, the Site Construction Manager and biodiversity experts/NGOs.
- **Future inductions for all new staff and contractors working on the Project**: Following completion of the training events, all new site staff and contractors will be made aware of ecological issues via the existing site induction system. This is currently implemented through a PowerPoint presentation conducted by the Site Construction Manager. Additional slides will be prepared for inclusion in this presentation the external ecological consultants and biodiversity experts/NGOs. In addition to onsite training.
- **Awareness raising posters and information at the site office:** will be achieved through the placement of literature at the Bisri site office

***Local community engagement and awareness raising***

Socialisation through local community engagement will be carried out within the villages in the catchment of the Project. The aims of the events will be to: 1) raise awareness of the

conservation value of the Bisri river and catchment; 2) encourage local people not to hunt Threatened species in the forest or to clear areas by logging and the application of sustainable hunting and logging when necessary; and 3) communicate developments within the Project relevant to the local communities.

## Key Project Staff

***External Ecological/Social Consultant***
Overall ecological and social coordination for the implementation of the BAP and BMP will be undertaken by an external ecological/social consultant. Additional support will be given for the preparation of the ESMP, mapping and socialisation program as well as other duties as necessary.

***Biodiversity experts***
The biodiversity monitoring surveys, expert stakeholder advice and assistance with the implementation of the socialisation programme will be undertaken by biodiversity experts.

***Site Construction Manager***
The overall implementation of the BAP and BMP on site will be undertaken by the Site Construction Manager

***HSE Manager***
The implementation of site measures will be delegated as determined by the Site Construction Manager to the Health, Safety and Environment Manager.

| | Project Biodiversity Risk | Key likely impacts (C=construction impacts, O=operation impacts) | Recommended Mitigating Measure | Responsible Party | Estimated Cost (USD) |
|---|---|---|---|---|---|
| **Flora** | Ccontrol of water flooding may lead to destruction of important plant species and disturbance imposed within the demographic structure of riparian forest | | Translocation of endemic and species with critical conservation status such as Orchis sp., Fritillaria sp., Ornithogalum sp., Hyacinthus sp., ferns and other species must be done before the construction of the dam and the inundation of downstream areas | CDR and Dam Operator | N/A |
| | | C= Permanent habitat loss from construction of site infrastructure; noise and light disturbance from construction; increased pressure from human activities, such as forest management, logging and hunting due to improved access. | Implement environmental flows to reduce the disturbance intensity | Dam Operator (BMLWE) | N/A |
| | | O= Disturbance from site staff and vehicles; physical barriers to movement across site roads; light disturbance at well pads from occasional night work | Install fencing around trees and patches of vegetation close to construction zones | Works Contractor | 10,000 |
| | | | Signs indicating the area is a "sensitive environmental area" will be clearly and securely affixed to the fencing | Works Contractor | N/A |
| **Fish** | Reduced volumes of year-round river inflow and outflow, and possibility of water contamination with sewage or polluted water will deteriorate the environmental conditions of various fish species and/or block reproduction | C & O | Ensure connection of water between dam and downstream water resources. | Dam Operator (BMLWE) | N/A |
| | Reduction in water flow downtream of Bisri river may impact local freshwater blenny fish. | C&O | Maintain environmental flow as designed | Dam Operator (BMLWE) | N/A |
| **Amphibians and Reptiles** | Risk of sudden reduction in water availability to hamper viability of amphibians and reptiles | C & O | Schedule filling of the dam during the October - July season to minimize disruptions to breeding season. Schedule site clearance works during non-vulnerable periods | Dam Operator (BMLWE) | N/A |
| | Reduction in water availability will impact the environmetnal conditions of the populations of the Bufo cf bufo ("Common European toad"), whose habitat appears to consist mostly of rocky terrain and riparian trees | C & O | Implement a construction site drainage system to reduce pollution to water resources | Works Contractor | Included in construction contract estimate |
| | | | Operate dam to maintain water levels as long as possible to optimize breeding and spawning seasons | Dam Operator (BMLWE) | N/A |
| | | | Install reptile-proof fencing to prevent *Bufo cf bufo* from returning or accessing the most hazardous parts of the construction site | Works Contractor as advised by Biodiversity Management Specialist | 10,000 |
| **Birds** | Disturbance to natural environment may lead to a reduction in bird colonies | C & O | Schedule any required blasting during the day | Works Contractor | N/A |
| | | | Tree clearance to avoid spring nesting seasons | CDR | N/A |
| **Mammals** | Fragmentation of natural environment as a result of dam construction may obstruct mammal routes and expose animals to drowning and other risks | C & O | Fence exposed edges and install bushy hedges along exposed roads | Works Contractor as advised by Biodiversity Management Specialist | N/A |
| | | | Construct crossing points for strategic animal crossings | Works Contractor as advised by Biodiversity Management Specialist | N/A |

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# Annex A: Ecological Assessment

**LEBANON WATER SUPPLY AUGMENTATION PROJECT**

# PRE-DAM CONSTRUCTION

# ECOLOGICAL ASSESSMENT SERVICES

**for**

# AWALI/BISRI RIVER

Submitted to
**Dar Al Handasa**
**Shair and Partners**

Prepared by:

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## 1. INTRODUCTION

Due to the increased attention given to the concept of nature conservation in Lebanon, several national action plans and strategies were developed, among which biodiversity conservation principles are being prioritized through the Environmental Impact Assessment (EIA) (Article 4-Code of the Environment Law 444/2002). However, EIA in Lebanon is in its first stages. According to the Ministry of Environment, the decree concerning EIAs was recently approved by the Council of Ministers under the number 8633/2012 and FEA under the number 8213/2012. EIA Decree aims to identify keys to assess the environmental impact of public and private projects in order to avoid significant environmental damage that may result from such projects.

On the international level, Lebanon is now member in several international conventions and agreements on the conservation of nature. Most notably, are the Ramsar Convention, the Convention on Biological Diversity (CBD), and lately Convention on International Illegal Trade with Endangered Species (CITES) and the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES).

Lebanon is a water-rich country compared to Jordan, Palestine or Syria. However, because of limited and contradictory data, it is difficult to accurately assess the availability of water resources as well as water consumption in Lebanon. In 2005, the FAO estimated water withdrawal at 1.31 billion $m^3$ or about 63% of economically exploitable water resources. Sixty percent (60%) of this water went to agricultural usage, 29% for domestic usage and 11% for industrial use. Moreover, only part of the flooded water from rivers can be captured in dams, while most of the groundwater flows unused to the sea.

Throughout the history of the world, dams and reservoirs have been successfully constructed across rivers to collect and store vast amounts of water and then manage releases to make daily river flows to support civilization in water supply, irrigation and flood control. However, large-scale reservoir construction will have varied impacts, including both positive and negative aspects.

Currently, in Lebanon, a pilot dam project is being considered on Awali River, South of Lebanon, aiming at the utilization of the large quantities of water that are being wasted to the sea. The dam project involves the construction of a freshwater reservoir to provide potable water to a wide range of inhabitants. Legal procedures require the preparation of an environmental impact assessment for the proposed dam project which might have adverse effects on the environment. EIA plays an important role in predicting the environmental, social, economical, and cultural consequences, along with evaluating the mitigation plans for any adverse impacts resulting from the proposed activity.

The current study focuses on evaluating biodiversity of the Awali River site, highlight environmental concern that might arise upon implementation of the dam project on existing biodiversity and recommend mitigation measures to decrease the impact of the dam on biodiversity. A rapid flora and fauna assessment was conducted and the findings were analyzed taking into account the basics of the Code of Environment of Lebanon (Law 444/2002), to assess potential impact of the proposed project on the natural environment and consider mitigation measures to minimize the expected environmental damage resulting from the proposed project implementation.

## 2. OBJECTIVES

The second phase of the pre-dam construction ecological assessment services for the Lebanon Water Supply Augmentation Project aims at drawing the ecological profile of Awali River in South Lebanon, assessing the conservation values of flora and fauna diversity; as well as the vegetation formation. This will lead to identifying the risks of dam construction on the environment and local communities, to defining ways to mitigate the effects of dam construction, and to ensuring the implementation of integrated ecosystem approach combined with sustainable development. However, due to the short time period, the report focuses on building up a groundwork database on biodiversity in the project site, defining threats and proposes mitigation measures. The second phase aims at:

1- Conducting a rapid field survey of flora and fauna in the proposed project site

2- Identifying and listing major flora and fauna species and their status

3- Identifying potential threats from the proposed project

4- Recommending mitigation measures to enhance the project acceptability by maximizing the benefits while minimizing adverse impacts on biodiversity

## 3. METHODS

### 3.1. Plant Survey:

The flora cover was assessed to draw the ecological profile of the plant cover, its status and the impact of the dam on it. A rapid inventory was conducted to identify existing species and their status (rare, endangered, iconic …). Walking transects were identified to obtain an understanding of the vegetation communities in the area, to identify community boundaries, to record species present, and to determine the potential distribution of threatened species (Plate 1). Transects were assigned to cover the different habitats, topographic diversity, and variety of vegetation communities mapped from aerial photos.

Plate 1. Walking transects for flora identification

Information and location of plant species and their habitats were recorded during transect walks. This information was used to assist in identifying the presence of vegetation communities, determining vegetation boundaries, assessing the homogeneity of the study area, and determining the required number of plots.

### 3.1.1. Field survey

Vegetation communities were randomly assessed in both the thermo-Mediterranean (0-500m) and part of the Eu-Mediterranean in Bisri. Field visit were performed during a very short period in spring 2012 and the first week of November. The number of visits during spring was limited as they aimed to develop preliminary study to estimate the conservation value of the three sites namely Bisri, Dammour and Ibrahim River. While during autumn very few species are expected to be in bloom.

### 3.1.2. Site diagnosis and analysis

The impact of the dam construction on the vegetation communities in the riparian ecosystem was rapidly identified. Species of special concerns surveyed during very short visit in the spring was defined based on the national assessment.

## 3.2. Fish and Macro Invertebrates

Electrofishing is a common method used for catching fish for surveying and monitoring purposes. The fishing device emits an electric current through the water, stunning fish and making them easy to capture (Cowx, 1990; Cowx and Lamarque, 1990). Carefully regulated amperages of currents used will allow the fish to be stunned effectively without damaging their muscles, vertebrae and spinal nerves. This is a non-selective method of capture that provides a broad overview of the fish fauna living in the surveyed water body. It is very efficient and suitable for running and still waters. It can be used to make total population estimates for a given stretch of river using multiple catch techniques (Hill et al., 2005).

Plate 2. Survey of the ichthyofauna using electro-fishing method conducted at Bisri (Awali River) Site.

Field expeditions to Awali River were carried out in 2012 (Plate 2). The river had also been extensively surveyed between year 2007 and 2008 (Bariche, unpublished data). A backpack electric fishing device was used. Electrofishing was carried out by chest wading and the small streams were fished on foot. Electrofishing was performed with minimum voltage and avoiding contacts between the fish and the anode, in a manner that minimizes harm to the fish. Stream segments were sampled systematically, moving the anode continuously through the water. All captured fish were handled properly for identification. They were released afterwards into the water at the location of capture and some specimens were kept as voucher specimens. They were preserved and stored in the collections of the Natural History Museum of the American University of Beirut (AUBNHM).

## 3.3. Herpetofauna (Amphibians and Reptiles) Survey

Amphibians and reptiles were conducted on two intervals days and nights focusing on the water bodies, the riparian habitats and their peripheries (Plate 3). Compiling previous knowledge, observing and studying the potential habitats and observations of active animals was the only method for the animals that are active in warmer seasons. Emphasis was made on the species richness and on rough estimations of the areas of activity and breeding habitats. Specimens collected for species encountered and was preserved and deposited at AUBNHM.

Plate 3. Survey of reptiles and amphibians conducted at Bisri (Awali River) Site

## 3.4. Ornithology Survey

From an ornithological point of view, the implementation of the Bisri Environment Impact Assessment project requires a methodology that is necessary to be undertaken in order to reach the objectives.
To assess the impact on the avian species, the 20-minute point-count method is used, whereby all species noted during this time period are recorded at different places and different times in the most characteristic habitats of a given area (Ramadan-Jaradi, 1975; Blondel *et al*. 1981; Ramadan-Jaradi, 1984). This method is semi-quantitative and changes in abundance of a species are estimated by changes in the frequency of this species over a series of point counts. Frequencies could be mathematically transformed into densities through the use of some statistical rules. This task is easier when the study is undertaken in line-transects within quadrates (Ramadan-Jaradi & Ramadan-Jaradi, 2002) (Figure 1).

Plate 4. Capturing birds by camera for later identification.

Limitations of the method and alternatives: on days of heavy raptor or stork movement, it was necessary on occasion to estimate the number of birds passing. At other times, birds are individually counted. In addition, some birds were identified through capture with camera from a distance (Plate 4). Single-shelf mist-nets for species identification were not used due to the familiarity of the expert with the birds of Lebanon.
The remaining required knowledge about species status and trends are retrieved from the past experience of the expert, from the records and from literature when available.

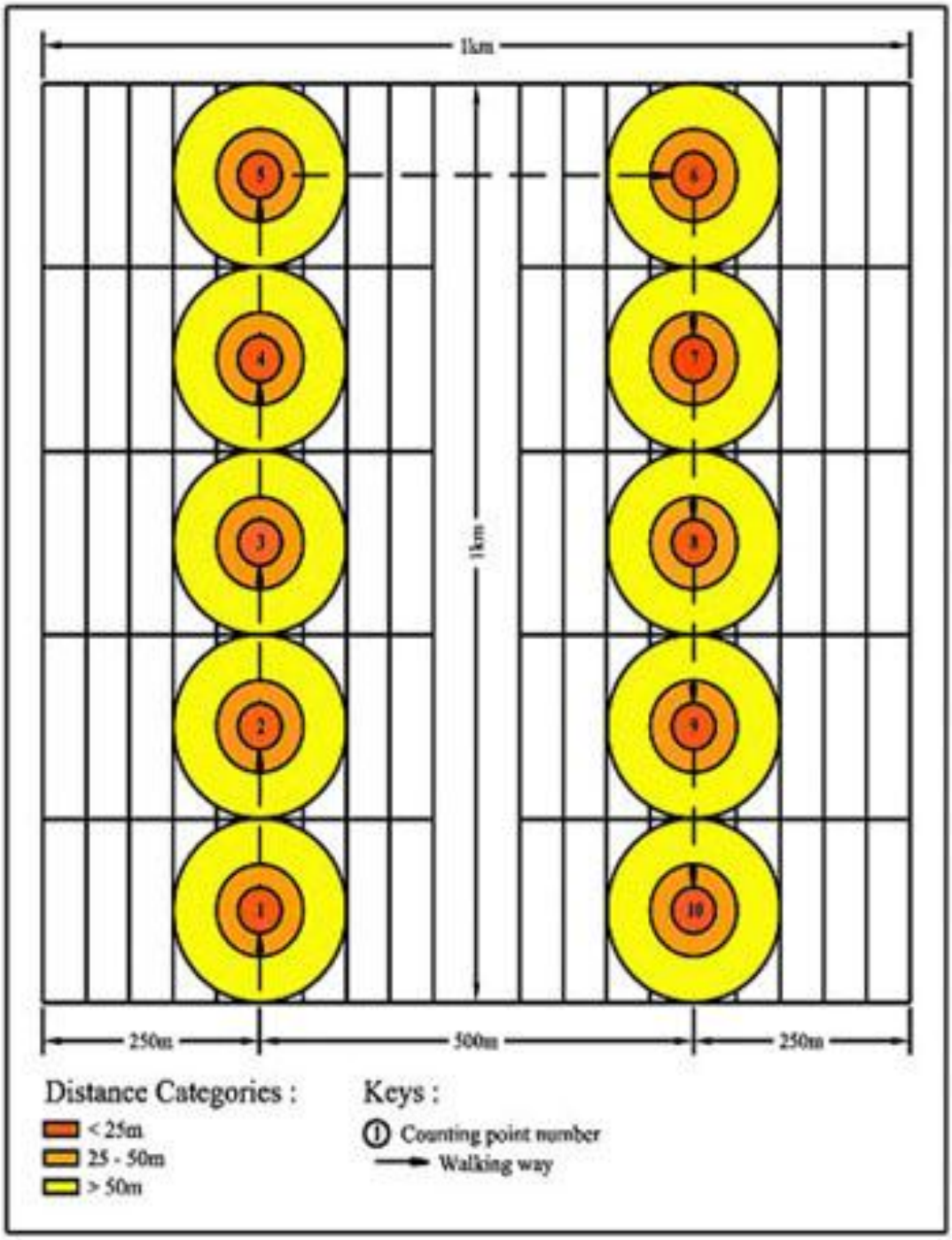


Figure 1. Point counts combined with transects.

## 3.5. Mammal Survey:

Most mammals are highly persecuted by humans. To avoid such a threat, they became nocturnal, which renders surveying and monitoring mammals a hard task, requiring many techniques and hi-tech equipment Two approaches, direct and indirect, were used to monitor mammals. Indirect approach was

conducted during day time through diurnal walking surveys, where opportunistic observations of secondary signs such as tracks, footprints, fur and scats detected were recorded. Moreover, caves and dens were inspected for bats, animal signs and animal remains. Diurnal surveys were conducted between 09:00 and 17:00. Walking was at a slow pace and noise kept to a minimum. Periodical stops for periods of at least five minutes to assess the surroundings and to allow the disturbance caused by the movement of people through the forest to pass.

The direct approach was conducted in two ways night surveys and photo-trapping to obtain data on the more secretive and nocturnal species. Night surveys commenced using a 4x4 vehicle at two different times before or after midnight and lasted between two to three hours. A powerful spot light (1-1.5 million candle power) was used to illuminate animals once their eye-shine had been detected to help with the identification. The pace was slow to increase the chances of sighting the animals.

Photo-trapping equipment to survey mammals consisted of seven pre-baited active and passive remote camera traps, triggered by both heat and motion, were tied to a tree 40-60cm above ground (Plate 5). The cameras were programmed to take photographs 24hours/day with a 2-minute interval between photos, and to record date and time on each photograph. Sites for camera trapping were chosen randomly to cover different habitats, topographies and landscapes. Baits were placed on the ground 3m away from the camera trap. The bait consisted of animal leftovers from butcheries, fruits, domestic refuse and corn.

Data describing each direct and indirect animal sign was recorded. Data recorded included the place where the sign was encountered and in which habitat type was found. Moreover, photos from the camera traps were downloaded to a computer for future analysis.

Plate 5. Camera traps used in surveying mammals and the bait used at Bisri site.

# 4. RESULTS

## 4.1. Flora Survey

### 4.1.1. Description of the site

The area reflects mosaics of ecological niches for various vegetation formation and agricultural fields with various hedges type such as cyprus and casuarina trees. The composition of the vegetation is typical to South/South East and North/North East plants associations. The former represents bushy type vegetation reflecting past uses of the forests with agricultural terraces. The latter mingles trees association of Calabrian pine, stone pine, oak, hawthorn, laurel, pistachio, juniper, carob, etc. with bushes formations and herbaceous vegetations. The valley is home to agricultural fields, riverside plant formations and islands of patches of natural vegetation and alien tree species such as willow, alder, tamarisk, Oriental plane, Cyprus, stone pine and casuarina. Three types of vegetation are identified:
Type 1. River course vegetation formations: Trees observed are *Platanus orientalis* L., *Salix libani* Bornm., *Alnus orientalis* Decne with associated shrubs and herbaceous plants (Plate 6).

Plate 6. River course vegetation along Awali River

Type 2. Hillside North/North East dominated by associations of plant populations of *Pinus brutia* Ten., *Pinus pinea*, *Quercus calliprinos* Oliv., Quercus infectoria, *Laurus nobilis L. and Pistacia paleastina* Boiss (Plate 7) .

Plate 7. Associations of plant populations.

Type 3. South/South East similar to the previous type. It was formed by denser bush-like formations.

### 4.1.2. Vegetation survey

An approximate number of 50 plants were identified in Bisri (Table 1). Important plant species were identified among which *Ricotia lunaria* (L.) DC. being endemic at the national scale , *Orchis anatolica* Boiss., *Orchis morio* L., *Orchis papilionaceae* L., *Orchis pyramidalis* M. Bieb., *Orchis romana* subsp. *libanotica* Mt., *Orchis tridentata* Scop., *Ornithogalum umbellatum* L. and *Fritillaria libanotica* (Boiss.) Baker. (Fig. 1-5).

Table 1. List of plant surveyed in Bisri region during spring and autumn 2012.

| Species Scientific Name | Species Scientific Name |
|---|---|
| 55. *Acer syriacum Boiss*. & Gaill. | 56. *Nerium oleander* L. |
| 57. *Adiantum capillus-veneris* L. | 58. *Onosma frutescens* Lam. |
| 59. *Ajuga orientalis* L. | 60. *Orchis anatolica* Boiss. |
| 61. *Alnus orientalis* Decne. | 62. *Orchis morio* L. |
| 63. *Anemona coronaria* L. | 64. *Orchis papilionaceae* L. |
| 65. *Arceuthos drupacea*(Labill.) Ant. & Ky. | 66. *Orchis pyramidalis* M. Bieb. |
| 67. *Arum hygrophylum* Boiss. | 68. *Orchis romana* subsp. *libanotica* Mt. |
| 69. *Asparagus acutifolius* L. | 70. *Orchis tridentata* Scop. |
| 71. *Asperula sp.* | 72. *Ornithogalum umbellatum* L. |
| 73. *Asphodellus microcarpus* Salzm. & Viv. | 74. *Oxalis per-caprae* L. |
| 75. *Bellevalia latifolia* Ten. | 76. *Pinus brutia* Ten. |

| | |
|---|---|
| 77. *Bellis sylvestris* Cirillo. | 78. *Pinus pinea* L. |
| 79. *Calycotome villosa* (Vahl) Link. | 80. *Pistacia palaestina* Boiss. |
| 81. *Ceratonia siliqua* L. | 82. *Phillyrea media* L. |
| 83. *Cercis siliquastrum* L. | 84. *Platanus orientalis* L. |
| 85. *Cistus creticus* Sibth. & Sm. | 86. *Pteridium aquilinum* (L.) Kuhn. |
| 87. *Cyclamen persicum* Sibth. & Sm. | 88. *Quercus calliprinos* Webb. |
| 89. *Cupressus sempervirens* L. | 90. *Quercus infectoria* Oliv. |
| 91. *Fritillaria libanotica* (Boiss.) Baker | 92. *Ricotia lunaria* (L.) DC. |
| 93. *Gallium sp.* | 94. *Ruscus aculeatus* L. |
| 95. *Hyacinthus orientalis* L. | 96. *Salix libani* Bornm |
| 97. *Iris histrio* Reichb. | 98. *Salix* sp. |
| 99. *Lathyrus hierosolymitanus* Boiss. & Bl. | 100. *Smilax aspera* L. |
| 101. *Laurus nobilis* L. | 102. *Allium neapolitanum* Cyr. |
| 103. *Lavendula stoechas* L. | 104. *Tamarix* sp. |
| 105. *Lupinus digitatus* Forsk. | 106. *Tamus communis* L. |
| *107.* *Muscari comosum* (L.) Mill. | 108. *Valeriana dioscoridis* Sibth. & Sm. |

Besides wild plants Marj Bisri is rich with its fruit trees mainly citrus trees, greenhouses of roses and strawberry, and commercial lawn grass plots.

*Fig. 1.Orchis papilionaceae* L.

*Fig.2. Orchis morio* L..

*Fig. 3. Orchis romana* subsp. *libanotica* Mt.

*Fig. 4. Orchis tridentata* Scop.,

*Fig. 5. Fritillaria libanotica* (Boiss.) Baker

## 4.2. Fish and Macro Invertebrates Survey

Five fish species and one crab were present in Awali River, out of which three deserve special attention (Table 2). These are the Freshwater blenny, the European eel, and the Middle Eastern Green carp. No exotic fish or macroinvertebrates were captured.

**Table 2. Fish species recorded from Awali River**

| Species | Family |
|---|---|
| *Salaria fluviatilis* (Asso, 1801) | Blenniidae |
| *Anguilla anguilla* (Linnaeus, 1758) | Anguillidae |
| *Capoeta damascina* (Valenciennes, 1842) | Cyprinidae |
| *Pseudophoxinus kervillei* (Pellegrin, 1911) | Cyprinidae |
| *Oxynoemacheilus leontinae* (Lortet, 1883) | Balitoridae |
| *Potamon potamios* (Olivier, 1804) | Potamidae |

### 4.2.1. Freshwater blenny:

*Biology: Salaria fluviatilis* (Asso, 1801) is a small freshwater blenny that lives in river estuaries (Plate 8). The fish resides in lakes and streams with moderate current and has a clear preference to stone bottoms. It is a territorial species that can live up to 5 years. It feeds on insects, crustaceans, and fry. It reproduces during spring in Lebanon.

Plate 8. The Freshwater blenny *Salaria fluviatilis*

*Conservation status:* According to the IUCN, the Freshwater blenny is not currently considered threatened around the Mediterranean Sea. However, populations have declined considerably in recent years in its area of distribution.

The Freshwater blenny has completely disappeared from most rivers in Lebanon. This is mainly because of habitat alteration, river drying up due to of water diversion, drought, and pollution. The presence of habitat suitable for its larvae is very important for the survival of the species. Two small populations seem to be confined to the lower parts of Awali River and Damur River, living only in the last few hundred meters of freshwater close to the estuary. This makes the population (< 100 individuals) currently existing in Awali River critically endangered.

### 4.2.2. European eel:

*Biology:* The European eel *Anguilla anguilla* (Linnaeus, 1758) is a catadromous fish; that resides in freshwater most of its life and migrates to spawn at sea. Upon sexual maturity, adults migrate from the river to the Mediterranean Sea, and then to the Atlantic Ocean where they reproduce. Larvae drift back in the Atlantic using the Gulf Stream current, metamorphose into young eels (elvers), and go upstream to the rivers in the North eastern Atlantic Ocean and the Mediterranean Sea (Plate 9). The species lives in all types of habitats from small streams to large lakes. It reproduces between March and July in the Atlantic Ocean (Sargasso Sea) and feeds on a wide variety of benthic organisms.


**Plate 9. The European eel *Anguilla anguilla.* Adult (left) and larvae (right) (source internet)**

*Conservation status:* The species has a high commercial importance in Europe and around the Mediterranean. European eels are sharply declining worldwide, mainly because of overfishing. It has been recently considered as critically endangered by the IUCN.
In Lebanon, this eel is found in all rivers connected to the sea with running waters. Water diversion for agricultural, industrial, or domestic use and heavy chemical pollution are the main cause of its decline.

### 4.2.3. Middle Eastern Green carp:

*Biology: Capoeta damascina* (Valenciennes, 1842) is a very common carp occurring in most rivers, streams, and lakes of the Levant, Mesopotamia, and parts of southern Turkey. The fish is present in all rivers (inland and coastal) of Lebanon, as well as the Quaraoun and the Chouan dam (Plate 10). It can be found in various types of water currents and substrates. It is a bottom fish feeding mainly on algae, invertebrates and detritus. It reproduces in small streams where it deposits its eggs on gravel.


Plate 10. The Middle Eastern Green carp *Capoeta damascina*

*Conservation status:* The Middle Eastern Green carp is a least concern species. It is common wherever it occurs and can withstand poor water conditions and high levels of pollution. It is commonly targeted by Lebanese anglers for consumption and has a local commercial importance.

### 4.2.4. Minnow and Loach:

The two remaining fish species present in Awali River are a minnow *Pseudophoxinus kervillei* and a loach *Oxynoemacheilus leontinae* (Plate 11). The two species are common wherever they occur and their biology is completely unknown.

*Biology: Potamon potamios* (Olivier, 1804) is a freshwater crab living in the eastern Mediterranean, from the Sinai to South Anatolia and Greece. It is found in almost all rivers and water bodies of Lebanon (Plate 12). It is a scavenger that complements its diet on invertebrates as well as tadpole and fish. Its biology has not been studied.

**Plate 12. The freshwater crab *Potamon potamios***

*Conservation status:*The species is widespread and can tolerate a wide range of habitats. It does not seem to be endangered.

## 4.3. Herpetological (Amphibians and Reptiles)

Various species of reptiles are found in the Bisri basin. None of the species of snakes and lizards in that basin are known to be endangered or endemic. Most of these species are quite common in the surrounding areas and many parts of the country. There are no apparent impacts on these species due to the dam construction. In this survey, emphasis was placed on species that might be affected or impacted directly or indirectly by changes in the aquatic habitat to the dam construction. The species most like to be impacted are listed in Table 3. The impact on the species could be in terms of changes in habitat, breeding sites and food sources

Table 3. A list of the reptiles and amphibians that might be impacted by the Bisri dam. The status of the species might be: T = Threatened, E = Endemic, R = Rare, and C = Common. The type of impact might be: HT= general habitat, BR=breeding habitat, FD=food requirements.

| Species | Common name | Picture | **Status** | | | | Type of Impact | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | T | E | R | C | HT | BR | FD |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Natrix tessellata* | Water snake |  | | | | + | + | | ? |
| *Pelophylax bedriagae* | Marsh frog |  | | | | + | + | + | ? |
| *Pelobates syriacus* | Eastern or Syrian spadefoot |  | | | + | | + | + | ? |
| *Bufo viridis* | Green toad |  | | | | + | | + | ? |
| *Bufo* cf. *bufo* | European common toad |  | | + | + | | + | + | ? |
| *Hyla savignyi* | tree frog |  | | | | + | + | + | ? |
| *Salamandra infraimmaculata* | salamander |  | | | | + | + | + | ? |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Triturus vittatus* | Newt |  | | | + | | | | |

## 4.4. Bird survey

The Point counts, which involved recording all birds seen and heard at selected locations, were used to generate a species list. The list is inclusive of resident and migrant birds. A total of 23 points (each point 50 m ≤distance) were located randomly across the site. Point Counts were done in the mornings (sunrise to 10 am), in April-May 2012 and in the peak of the silent breeding season for most birds (June 2012), as at this time many of the birds are not vocal (G. Ramadan-Jaradi, *pers. comm*); and in September-October 2012 during the autumnal passage of the migrants. Bird distribution and habitat usage varies throughout the property, with an average of 11 individuals per point count (min = 4: max = 19).
Thirty two (32) species were observed during the surveys (Table 1). Of the observed birds, 4 are forest dependent and may reappear in the riparian areas above and below Bisri site: Wren [figure 1], Jay [Figure 2], Chaffinch [Figure 3] and Blackbird [Figure 4].

Figure 1: Winter Wren

Figure 2: Eurasian Jay

Figure 3: Chaffinch

Figure 4: Eurasian Blackbird

Species that tolerate high disturbance were found across the site, particularly in the overgrown pastures or where human agglomeration is found. These included the Graceful Prinia (Figure 5), Sparrow (Figure 6), Hooded Crow (Figure 7) and Bulbul (Figure 8).

Several birds common to the region were spotted in the site (Table 4). Birds like Graceful Prinia (*Prinia gracilis*), Jay (*Garrulus glandarius*), Hooded Crow (*Corvus cornix*), Wren (*Troglodytes troglodytes*), Sparrow (*Passer domesticus*),

Figure 5: Graceful Warbler

Figure 6: House Sparrow

Figure 7: Hooded Crow

Figure 8: White Spectacled Bulbul

Swift (*Apus apus*) and Lesser White Throat (*Sylvia curruca*) were frequently spotted during the visits to the area. A few other bird species were reported by the inhabitants of the area but not observed by us, such as Lesser Kestrel (*Falco naumannii*), Black Redstart (*Phoenicurus ochruros*), Masked Shrike (*Lanius collurio*), and Barn Owl (*Tyto alba*). The villagers also reported a few other species but due to various inconsistent local names, these could not be properly identified. However, our field visits during October cumulated the total number of birds from 28 to 32 species where 24 of them are common and none of them is endemic. Four are threatened (White storks, Lesser Spotted Eagle, White Pelicans that are of passage only, and Short-toed Eagle that is of wide range of action (within and beyond the limits of the site). Hence their conservation depends on areas other than Bisri Site.

Figure 9: White Storks

Figure 10: Lesser Spotted Eagle

Figure 11: White Pelican

Figure 12: Short-toed Eagle

Table 4. Birds of Bisri Village site. R= resident, PM= passage migrant, WV= winter visitor, SB= summer breeder, and ?= uncertain status. T= threatened, E= endemic, R= rare, and C= Common.

| | **Species** | ***Scientific name*** | **Status** | **T** | **E** | **R** | **C** |
|---|---|---|---|---|---|---|---|
| 1 | Bulbul | *Pycnonotus xanthopygos* | R | | | | + |
| 2 | Graceful Warbler | *Prinia gracilis* | R | | | | + |
| 3 | Common Chiffchaff | *Phylloscopus collybita* | SB, PM, WV | | | | + |
| 4 | Chaffinch | *Fringilla coelebs* | R, PM, WV | | | | + |
| 5 | Winter Wren | *Troglodytes troglodytes* | R | | | | + |
| 6 | Blackbird | *Turdus merula* | R | | | | + |
| 7 | Eurasian Jay | *Garrulus glandarius* | R | | | | + |
| 8 | Great Tit | *Parus major* | R | | | | + |
| 9 | European Greenfinch | *Carduelis chloris* | R | | | | + |
| 10 | Blackcap | *Sylvia atricapilla* | SB, PM, WV | | | | + |
| 11 | Sardinian Warbler | *Sylvia melanocephala* | R, PM, WV | | | | + |
| 12 | Lesser Whitethroat | *Sylvia curruca* | SB, PM, ?wv | | | | + |
| 13 | White Storks | *Ciconia ciconia* | PM | + | | | + |
| 14 | Pelican | *Pelecanus onocrotalus* | PM | + | | | + |
| 15 | Short-toed Snake Eagle | *Circaetus gallicus* | SB, PM | + | | + | |
| 16 | Long-legged Buzzard | *Buteo rufinus* | R, PM, WV | | | | + |
| 17 | Hooded Crow | *Corvus cornix* | R | | | | + |
| 18 | Palestine Sunbird | *Cinnyris osea* | R, wv | | | + | |
| 19 | European Goldfinch | *Carduelis carduelis* | R, WV, pm | | | | + |
| 20 | House Sparrow | *Passer domesticus* | R | | | | + |
| 21 | Swift | *Apus apus* | SB, PM | | | | + |
| 22 | Lesser Spotted Eagle | *Aquila pomarina* | PM | | | | + |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 23 | Black headed Bunting | *Emberiza melanocephala* | SB | | | | + |
| 24 | Corncrake | *Crex crex* | pm | + | | + | |
| 25 | Black Kite | *Milvus milvus* | PM | | | | + |
| 26 | Steppe Buzzard | *Buteo vulpinus* | PM | | | | + |
| 27 | Hoopoe | *Upupa epops* | R, SB | | | + | |
| 28 | White Wagtail | *Motacilla alba* | PM, WV | | | | + |
| 29 | Steppe Buzzard | *Aquila nipalensis* | pm | | | + | |
| 30 | Levant Sparrowhawk | *Accipiter brevipes* | PM | | | | + |
| 31 | European Sparrowhawk | *Accipiter niseus* | PM | | | + | |
| 32 | Marsh Harrier | *Circus aeroginosus* | PM | | | + | |

From the list above, the four threatened species are:

| | | |
|---|---|---|
| *English name* | Short-toed Eagle |   |
| Scientific name | *Circaetus gallicus* | |
| Distribution | All over Lebanon where thermals are well formed | |
| Status | Breeding in small numbers in montane areas, especially at Charquieh (Ramadan-Jaradi & Ramadan-Jaradi 1999), hills above Aammiq, Dalhoun and Arz el Shouf (Ramadan-Jaradi *et al* 2004). It is also a widespread and common passage migrant over much of the country, early March–late April (most first half of April) and early September–late October. First recorded by Tristram (1864) and first confirmed breeding recorded at Charquieh in 1996 by Ramadan-Jaradi & Ramadan-Jaradi (1999). | |
| *English name* | White Stork |   |
| Scientific name | *Ciconia ciconia* | |
| Distribution | All over Lebanon where thermals are formed and in wetlands | |
| Status | Abundant and regular on both passages, but generally commoner in spring over the whole country, but occurs principally over coastal plains (*e.g* in early March–late June, a maximum of 10000 recorded on 9 April 2000 over Dalhoun) and over Beqaa Valley, where in autumn occurs early August–late October (MR-J). Largest flocks usually appear following periods of hot easterly winds. Very few oversummer June-July. First recorded in 1948 (West 1954). | |

| | | |
|---|---|---|
| *English name* | White Pelican |  |
| Scientific name | *Pelecanus onocrotalus* | |
| Distribution | All over Lebanon where thermals are well formed and in wetlands | |
| Status | Common regular passage migrant at both seasons with flocks of up to 1000 birds near coasts, at Aammiq and Qaraoun, and over mountains up to 1800m asl. Occurs mid-February–early June and early September–late November, principally on Palm Islands. First recorded by Tristram (1882). | |
| *English name* | Corncrake |  |
| Scientific name | *Crex crex* | |
| Distribution | In wetlands: Coastal and inlands | |
| Status | An uncommon passage migrant over Lebanon in mid-August–late October and early March–late May (Ramadan-Jaradi *et al* 2004). Regular in May and beginning of June on Palm Islands (Ramadan-Jaradi & Ramadan-Jaradi 2001), with peaks of up to six birds. An isolated record at Tyre Coast on 6 December 2003 was exceptional (Ramadan-Jaradi *et al* 2005). First recorded in 1824 (Hemprich & Ehrenberg 1833) | |

## 4.5. Mammal Survey

The rapid field survey on mammals for Bisri site revealed the presence of 17 mammal species belonging to 14 families (Table 5). Four species including badgers, otters, squirrels, and voles are expected to exist (Table 5). In addition to wild mammals domestic mammals like goats, cows, dogs and cats were also

encountered. Moreover, within the dam site there is a small private zoo that houses lions, tigers, lamas, deer, hyaenas, a fox, some farm animals, and a chimp

Out of the 21 species of mammals, one species, which is the hedgehog [Figure 1] is dependent on forests, farmlands, gardens and orchards. In addition, 3 bat species: the European free tailed bat [Figure 2], lesser horseshoe [Figure 3], and greater horseshoe [Figure 4], hunt along open woodland, woodland edges and paths as well as hedgerows.

Figure 1: Hedgehog

Figure 2: Lesser horseshoe bat

Figure 3: Greater horseshoe bat

Figure 4: Eurasian free tailed bat

Most other species can tolerate high disturbance and are referred to as urban wildlife; these included the common pipistrelle [Figure 5], Khul's pipistrelle [Figure 6], jackals [Figure 7], foxes [Figure 8], pine martins [Figure 9], wild boar [Figure 10], house mice, rats, and field mice.

Figure 5: Common pipistrelle bat

Figure 6: Khul's pipistrelle bat

Figure 7: Jackal

Figure 8: Red fox

Figure 9: Pine martin

Figure 10: Wild boar

Several mammals which are common to the region were spotted in the site, such as wild cats [Figure 11], striped hyaenas [Figure 12], porcupine [Figure 13], and moles [Figure 14].

Figure 11: Wild cat

Figure 12: Striped hyaena

Figure 13: Porcupine

Figure 14: Mole rat

Finally, two other mammal species which are dependent on the riparian ecosystem are expected to be present: the otter *Lutra lutra* an amphibian mammal that was recorded in Moukhtara (Tohme and Tohme 1985) and documented in Ammique Wetland and Anjar (personal observation) and voles, which are another riparian ecosystem inhabitants, that usually inhabit river banks.

Table 5. List of mammal species present on the three sites (R= recorded, E = Expected, c= common, r = rare, endemic or endangered on the National level)

| Family | Species | Scientific Name | Awali River |
|---|---|---|---|
| Erinaceidae | Hedgehog | *Erinaceus concolor* | R, r |
| Miniopteridae | European Free-tailed bat | *Tadarida teniotis* | R, r |
| Vespertilionidae | Common pipistrelli | *Pipistrellus Pipistrellus* | R, c |
| | Khul's pipistrelle | *Pipistrellus kuhli ikhawanius* | R, c |
| Rhinolophidae | Lesser horseshoe | *Rhinolophus hipposideros* | R, c |
| | Greater horseshoe | *Rihnolophus ferrumequinum* | R, c |

| | | | |
|---|---|---|---|
| | bat | | |
| Canidae | Jackal | *Canis aureus syriacus* | R, c |
| | Fox | *Vulpus vulpus palaestina* | R, c |
| Mustelidae | Pine Martin | *Martes foina syriaca* | R, c |
| | Badger | *Meles meles canescens* | E, r |
| | Otter | *Lutra lutra* | E, r |
| Hyaenidae | Striped hyaena | *Hyaena hyaena syriaca* | R, c |
| Felidae | Wild cat | *Felis silvestris tristrami* | R, r |
| Suidae | Wild boar | *Sus scrofa lybicus* | R, c |
| Sciuridae | Squirrel | *Sciurus anomalus syriacus* | E, c |
| Hystricidae | Porcupine | *Hystrix indica indica* | R, c |
| Spalacidae | Moles | *Spalax leucodon ehrenbergi* | R, c |
| Muridae | House mouse | *Mus musculus praetextus* | R, c |
| | Rats | *Rattus rattus* | R, c |
| | Field mouse | *Apodemous mystacinus* | R, c |
| Microtinae (Subfam.) | Voles | *Microtus sp.* | E, c |

From the list above, the five rare species are:

| *English name* | **Hedgehog** |  |
|---|---|---|
| Scientific name | *Erinaceus europaeus concolor* | |
| Distribution | The hedgehog was first reported by Lewis et al. (1967). Tohme and Tohme (1985) gave a detailed description and distribution of the species in Lebanon. The hedgehogs are reported from Hadath, Kfarchima, Bsaba, Ibrahim River, Saida, Jaj, Laqlouq, Baalbek, Zahleh, Chmistar, Sarafand, Tamnine Tahta, Barouk, Mokhtara, Rihane, Jezzine, Tyre, Koura, Farayya. | |
| Status | This species was common in Lebanon, especially in the coastal plain. However, at present the species is endangered due to excessive use of pesticide, unintentional killing during hibernation and road kills. Its habitat does not apparently exceed 2.5 hectares. | |
| Habitat | The Hedgehog suitable habitats where insects and invertebrates are abundant. This reveals its economic importance besides their presence is a bio-indicator for unpolluted habitat. Dumps are excellent source of food for hedgehogs besides cultivated or semi-desert areas. They are also found in Pine and olive groves as well as in forest edges, gardens and parks. | |

| | | |
|---|---|---|
| *English name* | **European Free-Tailed bat** |  |
| Scientific name | *Tadarida teniotis* | |
| Distribution | The European free tailed bat was first reported by Harrison (1962), Tohme and Tohme (1985), and Horacek et al 2008. This species was reported from Faraya, the coastal zone, and from northern part of the Beka'a valley. | |
| Status | This species is threatened in Lebanon due to habitat destruction excessive use of pesticide. | |
| Habitat | The European free tailed bat inhabits narrow and inaccessible rock cervices. It roosts in large colonies in narrow cervices in the chalk cliffs Their feeding habit (feeding on insects) as well gives them an economic importance as well a major role in the ecosystem. | |
| *English name* | **Eurasian Badger** |  |
| Scientific name | *Meles meles canescens* | |
| Distribution | It was reported by Lewis et al. 1968 and By Tohme and Tohme (1985) in several areas of Mount Lebanon and East Beqa'a. It was also reported in Ehden and Tannourine Reserve (Abi-Said 2008) and lately in Jabal Moussa Biosphere Reserve (Abi-Said 2010a,b). | |
| Status | Badgers are endangered in Lebanon due to persecution by human. | |
| Habitat | Badgers occur in woods, open areas, orchards and vine yards. | |

| | | |
|---|---|---|
| *English name* | **Wild cat** |  |
| Scientific name | *Felis silvestris tristrami* | |
| Distribution | This species was reported by Tohme and Tohme (1985). Several personal observations between 1995-2005 in Ehden, Tannourine and AlShouf Reserves besides East Beqa'a as well in Jabal Moussa Biosphere Reserve in 2009. They were reported in most reserves as well as non protected areas, at the coastal areas and East Beqa'a. | |
| Status | Endangered species due to cross breeding with domestic cats | |
| Habitat | Wild cats are nocturnal animals that inhabit steppes, hills, valleys, forests, and rocky areas. | |
| *English name* | **Common Otter** |  |
| Scientific name | *Lutra lutra seistanica* | |
| Distribution | The otters were reported by Lewis et al, 1968 and Tohme and Tohme 1985. Their distribution is limited to wetlands and some rivers in Lebanon. However, they face several threats due to conflict with fisheries, dryness of wetlands, and killing by humans. They were reported from Ammique, Kfarzabad, AlAssi river, Jisr AlQadi, AlDamour river and AlMoukhtara river which is an extension of Bisri. | |
| Status | This species is endangered in Lebanon due to hunting and drying of wetlands. | |
| Habitat | The otters are very tolerant of where they live, in environments ranging from lakes and bogs to rivers and little from sea level up into the highest mountains. Otters could be found anywhere as long as there is water, sufficient food and away from human disturbance and persecution. | |

# 5. IMPACT ON THE BIODIVERSITY

## 5.1. Impact on Flora

### 5.1.1. Loss of habitat

As vegetation is concerned, it is expected that the loss of part of the riparian vegetation will occur because of the inundation of the site resulting from dam construction. Though patches of the riparian vegetation will remain outside the dam construction site, the colonization of tree species on the banks of the dam is expected. If significant impacts on valuable habitats or species are unavoidable, detailed botanical surveys would be required. These may involve targeted searches for protected species and/or those identified as species of significant nature conservation value in either a Species Action Plan or Local Biodiversity Action Plan. Where a habitat of potential nature conservation value is identified, more detailed quadrate-based surveys may be required.

### 5.1.2. Loss of species

It was not possible to undertake a full survey of the plant species thriving in the site because of the time when the final decision given on the selection of the site. Though through observations during the autumn and the rapid assessment performed during the spring, it expected that the site is shelter to more than 250/300 species including riparian plant and low altitude plant species. Though the species identified are found in other places and they are expected to be found at higher altitude in the region.

## 5.2. Impact on Fish and Macro invertebrates

The construction of the dam at the level of Bisri will significantly reduce the water flow downstream, to the Awali River estuary. This will certainly affect the Freshwater blenny population surviving in the lower course of the river. The construction of the dam will not pose a direct threat to the European eels present in the river. It is expected that the Middle Eastern Green carp will find the dam a suitable habitat and a large population is expected to quickly establish. The species will certainly have a local commercial importance. Furthermore, the presence of this herbivore will be valuable to the new ecosystem that will be created with the construction of the dam.
Both the minnow *P. kervillei* and the loach *O. leontinae* will probably not be negatively affected by the presence of the dam. On the contrary, they may thrive in large numbers and have a significant role in the newly formed ecosystem. *Pseudophoxinus kervillei* may have commercial importance locally.

## 5.3. Impact on Herpatofauna (Amphibians and Reptiles)

The impacts of the dam on each species could be upstream or downstream and could affect the general habitat requirements, breeding habitats, food requirements and vulnerability to predators. Some species could be negatively impacted and some could be positively affected.

### 5.3.1. Upstream Impact:

a. General Habitat: the habitats will be flooded and destroyed and all the species will be pushed into new habitats that might not be suitable. The established riparian habitats

that includes *Platanus* (and similar) trees, reed beds and other habitats of the river's wetted zone. The fluctuating levels of the artificial lake will inhibit the formation of a littoral zone which is part of the general habitat. All species will be affected especially *Bufo bufo*.

b. Breeding Habitat: All the amphibian species require shallow aquatic habitats for breeding with slow water flow rates. This will only be found on the peripheral (coastal) zones of the resulting lake. These zones will suffer from fluctuating levels from season to season or from year to year. Considering that the breeding period involves several stages, namely, mate attraction (advertising), mating, egg stage and larval stages (e.g. tadpoles), the breeding process might practically involve several weeks. If the fluctuation occurs during the breeding season (March-June), it would affect one or more of these stages. All amphibian species will be affected

c. Food Source: All the amphibian species are insectivorous feeding on invertebrates. These are affected by riparian and shallow water (littoral) habitats. It is not certain how long it will take these invertebrates to reach the levels of abundance as those before the dam. All species will be affected.

### 5.3.2. Down Stream Impact:

a. General Habitat: The regulated river flow might benefit the riparian vegetation in some locations normally subjected to flooding and might harm it in other locations where the water flow is normally limited in pre-dam days. All species will be affected.

b. Breeding Habitat: The regulated river flow below the dam might provide suitable habitats for breeding that were not available in pre-dam days. The danger lies when the flow reaches levels that will lead to the disappearance of suitable aquatic habitats. All amphibian species will be affected.

c. Food Source: There is uncertainty about the effect of the dam on the invertebrate fauna of the river itself or that of the riparian zone. All species will be affected.

The upper level of the resulting lake might reach the lower regions of the Moukhtara River where there are populations of the rare species *Bufo* cf *bufo* whose habitat, based on current knowledge is very specialized consisting mostly of rocky terrain and riparian trees. This habitat will be flooded and destroyed.

## 5.4. Impact on Birds

### 5.4.1. Impact of noise on wildlife

The project area is inhabited by several species of wild animals and birds. Harm to animals is difficult to quantify since laboratory studies are often quite dissimilar to the real situation. Nevertheless, certain effects are obvious. In the case of short-term noises, e.g. construction, the animals may simply vacate the area. Their return depends on the nature of the project. The response of animals varies from species to species; from almost no reaction, to no tolerance of the sound. The long term noises originating due to blasting, hydraulic drills, vehicular noise and loading of vehicles may result in disappearance of some of the species of birds and animals from the area. However, some fauna may get used to the noise and stay. The level of impact will be more apparent if a survey is conducted on regular intervals such as either quarterly or bi-annually to understand the variations in the population of different species.
Some birds will be driven away permanently from nesting areas as a result of a project that brings a human population into the area (e.g. Long-legged Buzzard), whereas others do not seem to be affected at all (e.g. Graceful Warbler).

### 5.4.2. Loss of habitat

The project and various other activities will also affect the habitat of established species. Although, the project area itself is a very small portion of the general landscape, but the transport roads within the site and from the main road to the site, all become part of the project area and will result in disturbance and fragmentation of the habitat.
The project activity will also affect birds. Some species will desert the site like the Short-toed Eagle and Long-legged Buzzard for a more safe area. The other birds are considered banal species and may remain in the site with smaller numbers and in fragmented areas.

## 5.5. Impact on Mammals

The dam will certainly have an effect on mammal species during the construction phase; however, after the completion of the dam mammals' species will adapt to the dam presence and adjust their behavior accordingly, despite obstructing their dispersal route at some point. Moreover, the dam might attract other kinds of species like bats, shrews and otters who favor such habitat. The principal impacts of the project on individual mammal species depend on the ecology and behavior of the species in question. All animals, regardless of their behavior, will be subject to a degree of habitat fragmentation. Smaller mammals such as the shrew and squirrel will tend to have smaller home ranges, and will therefore be susceptible to both habitat loss and fragmentation. Larger or more mobile species may find their territories and key habitats fragmented by this dam, but are less likely to experience significant habitat loss. Mortality of species, both during the construction and operational phases of the project, should also be considered particularly, for those species with large home ranges that will tend to seek to cross roads more often.

## 6. MITIGATION MEASURES

Mitigation starts with minimizing disturbance through limited access to the area, minimize habitat alteration and land leveling as possible along with their natural vegetation, avoid direct persecution of animal species, and provide necessary training and awareness for project employee

## 6.1. Flora

Dams' downstream effects on riparian forests are strongly affected by the character and magnitude of adjustment of the fluvial-geomorphic system. The geology, hydrology, climate, and management have a direct influence on the ability of the fluvial system to adjust to dam-induced changes, as well as on the character and magnitude of that adjustment. The major concern for the vegetation and flora diversity is the control of water flooding, niches destruction of important plant species and the disturbance to the riparian forest age structure and sex ration of some tree species. The timing of the implementation of the mitigation strategies for managing impacts to flora can be divided into activities that will be undertaken during the pre-construction, construction and post construction phases of the project. Consequently, the suggested mitigation measures are the following:

1- Fluvial adjustment must be anticipated along alluvial channels where dams alter downstream hydrology and/or sediment load. This is important to give room for the colonization of tree species expected to occur along the banks of the lake.

2- The management strategies of river ecosystem among which riparian forest must focus on simulation of natural hydrographs especially the restoration of flooding frequency

3- The sex ratio of dioecious species such as populous and salix must be monitored to ensure the re-establishment of the tree populations.

4- Translocation of Orchis sp., Fritillaria sp., Ornithogalum sp., Hyacinthus sp., ferns and other species must be done before the construction of the dam and the inundation of downstream areas.

5- Management practices of the dam must foresee steps to reduce the disturbance intensity in order to increase biodiversity in the newly established river banks and lake formation.

6- Measures should also be undertaken to ensure that existing micro-climatic conditions in habitats supporting communities or species of nature conservation importance are maintained.

7- Individual trees and patches of vegetation to be retained close to busy construction zones will be fenced. The location of fencing will be approved by a plant ecologist. Signs indicating the area is a "sensitive environmental area" will be clearly and securely affixed to the fencing.

8- A qualified ecologist will audit the clearing of vegetation during construction of the project and will quantify the area of the dam vegetation community cleared for the biodiversity strategy.

9- Mature citrus and stone fruit trees are hard to be transplanted. Consequently, the orchards in Marj Bisri will be lost. This loss has to be accounted for during planning and implementation of the project.

10- The green houses in Marj Bisri could be relocated with their plants with no actual loss.

## 6.2. Fish and Macro invertebrates

Since the dam is an artificial newly formed ecosystem, it will be highly advisable from an aquatic scientist's point of view to have:

1- Clearly defined boundaries

2- A year-round regular river inflow and outflow

3- Shallow vegetated areas

4- Minimum human disturbance

Continuously running unpolluted water would help preventing the complete disappearance of the species. It is of high importance that

1- Freshwater keeps running between the dam and the sea in order not to hamper the eels from migrating back and forth and,

2- one or more fish-passes that connect the river to the dam are built, allowing the fish to enter and leave the dam (Figure 2). The presence of this species in the dam will result in adding a significant commercial value.

**Figure 2. Different types of passes suitable for the freshwater eel (source Internet)**

### 6.2.1. Fish introduction:

The introduction of exotic species such as carps, trouts, bass, tilapias, and mosquitofish is not recommended. Various studies have shown that the presence of these introduced species negatively affects the native fauna and the ecology of the dam. If introduction is deemed profitable, a full ecological impact assessment by an aquatic ecologist should precede it.

## 6.3. Herpetofauna (Amphibians and Reptiles)

Amphibians are water dependent animals hence the following mitigation measures have to be taken into consideration to insure their persistence.

1. Water flow downstream should always be maintained at levels that do not harm the riparian vegetation or destroy general and breeding habitats.
2. Breeding habitats on the lake peripheries should be evaluated regularly and alternative habitats should be created. One measure that would benefit not only the amphibian species but many other plants and animals, is to create artificial wetlands in the areas at the edge and/or surrounding the artificial lake whereby water levels are kept there at constant permanent or semi-permanent levels especially during the breeding season. This will allow the establishment of permanent shallow littoral zones that will become home to various plant and animal species.

3. Measures should be taken to avoid drying-out amphibian breeding sites through local disruptions to hydrology.
4. Pollution of amphibian breeding sites should also be prevented, by the sensitive design of construction site drainage and the implementation of pollution control measures.
5. The installation of reptile-proof fencing to prevent reptiles from returning or accessing to the most hazardous parts of the construction site should also be considered.
6. The seasonal programming of site clearance works should also be reviewed, to avoid the hibernation period during which aggregations of torpid reptiles could be encountered that would not have the ability to escape the works.

## 6.4. Birds

Birds are very sensitive group of animals and can be easily disturbed. Hence, disturbance by dam construction might have a negative impact on their status. The following mitigation measures should be considered

1. Noise creating sources should be properly lined and secured. The compressor and generator have been installed in a properly constructed room, which should be enough to filter out most of the noise. However, if that is not enough, other lining options should be explored, such as a clay liner inside and outside the room.
2. Blasting should be kept to a minimal and scheduled during the daytime.
3. Transport related noise should be kept to minimal through the optimum use of vehicles and proper vehicle maintenance.
4. No exotic bird species should be introduced to the wilderness of the site without guidance from a natural resourced approved specialist.
5. No hunting will be allowed in the site for any reason, especially that the hunting is not allowed by the Law 580/04 within 500 meters from any human agglomeration.
6. Proper guidance to be taken from a wildlife expert on occasions when wildlife is noticed within or near the site.
7. There is a need to maintain the Oak (*Quercus calliprinus*) in some stands to maintain the population of Jay that is known for its benefits to ecosystems.
8. The Bruti Pine (*Pinus brutia*) is a flammable tree and easily infested by the Processionary caterpillar. Subsequently, it should be managed to avoid natural fire near houses and to reduce the allergic impact of the caterpillar. Its management should be accompanied with the introduction of Cuckoo that eats the poisonous caterpillar.

9. Wherever possible, undertake vegetation clearance outside the bird nesting season March to August inclusive.

## 6.5. Mammals:

The diverse life-cycles, behavior, and habitat requirements of the different mammal species found in Lebanon, require effective mitigation, compensation and enhancement measures to be designed on a species-specific and also site- and project-specific basis. It is important to take measures to avoid impacts on habitats likely to be of particular value to mammal species of nature conservation importance wherever possible. Where valuable habitats or other important sites for mammals (e.g. places of shelter, or key foraging resources) cannot be avoided, appropriate mitigation measures should be designed and implemented.

1- Where impacts associated with fragmentation are expected, mitigation may include the provision of safe crossing points to enable dispersal and maintain links between otherwise fragmented populations. Such crossing points may take the form of pipes, culverts, tunnels and bridges with associated mammal-resistant fencing to 'funnel' animals towards these structures.

2- Mammal-resistant fencing along with appropriate hedgerow treatments should be used as a barrier to guide animals towards safe crossing points and to prevent animals from straying onto the carriageway, reducing the risk of mammal mortality.

3- The visual deterrents such as roadside reflectors may also be installed to discourage animals, in particular, from approaching the carriageway, although the effectiveness of such measures is questionable and should only be used in areas where only occasional interaction between mammals and roads are expected.

4- Habitat and/or species translocation should be considered as a last resort where it is not possible to avoid impacts on a sensitive habitat or species.

5- Concerning the two dairy farms present within the site could be relocated easily. As for the the private zoo, it has to be managed in different ways depending on the animal species in question. For example the chimp and the wild carnivores like tigers and lions have to be returned to their country of origin or sent to other sanctuaries since Lebanon is not a suitable habitat for them. However, Lebanese wild carnivores like the hyaenas and foxes could be reintroduced to the Lebanese wilderness with no problems because of their opportunistic feeding behavior. Deer and other herbivore could be maintained in a suitable place as these are semi-domestic animals.

## 6.6. General mitigation

1. There should be maximum recruitment of labor from the site and its neighboring areas to make them feel part of the project. Recruitment of labor from down country should be avoided.
2. Since women have a very significant role to play in the protection of biodiversity, they should be kept informed of the project through regular meetings or through the labors within the community.
3. Contact between the outsiders and the community should be kept to a minimal to avoid any conflict.
4. The community should abide by its agreement with the local authority to provide full protection to the wildlife and other natural resources.
5. Regular monitoring of the biodiversity should be undertaken.
6. Minimize greenhouse gas releases from reservoirs by minimizing the flooding of land in general and forests in particular.

## 7. CONCLUSION

In the planning, implementation and operation of projects, the conservation of the quality of environment and the ecological balance should be of primary consideration. The adverse impact, on the environment should be minimized and should be off-set by adequate compensatory measures. Moreover, building a dam, sacrificing nature does not solve the challenges of overconsumption, over-pollution, and under-distribution. World Commission on Dams (WCD) 2000 reported “dams have made an important and significant contribution to human development, and benefits derived from them have been considerable. But in too many cases an unacceptable, and often unnecessary and high price has been paid to secure those benefits, especially in social and environmental terms, by people displaced, by communities downstream, by taxpayers, and by the natural environment.”

Lebanon which is rich in its natural resources, face on the other hand lack of efficient environmental management causing an alarming degradation in those resources, and therefore, resulting in deforestation, soil erosion, water-resources’ pollution, marine habitat destruction, and air pollution. . Hence, the adoption of appropriate EIA procedures will undoubtedly bring about necessary and innovative measures towards environmental protection, particularly after much environmental degradation during nearly two decades of civil unrest. Water pollution control measures may be needed to improve reservoir water quality. Fishing regulation is often essential to maintain viable populations of commercially valuable species, if effectively implemented; watershed management can minimize sedimentation and extend a reservoir’s useful physical life. Finally, demands are increasing every year for water while resources are becoming more and more limited, combined with the pollution of water which has had many adverse effects on the environment, growth and economy of many countries.

Hence, improving irrigation methods, wise use of water, and efficient water transport are of utmost importance to be implemented.

In conclusion, protecting biodiversity of a project area is in the interest of all the stakeholders of a project. The biodiversity protection cannot be achieved without the support of the community, as is evident from this project. Proper cooperation between community and the project proponent can help in protecting the biodiversity of an area. Efforts should be made to incorporate BIA in all EIAs since this is one tool, which has proven successful in minimizing the impacts on biodiversity.

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