DRAFT REPORT
BIOLOGICAL CHARACTERISTICS MESOPOTAMIAN MARSHLANDS OF SOUTHERN IRAQ

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INTRODUCTION

"In less than a decade, one of the world's largest and most significant wetland ecosystems has completely collapsed. The March 2000 images provided by Landsat 7 are unequivocal as to the extent of land cover change" (Partow UNEP 2001). "The once-extensive marshlands no longer exist. Aquatic habitat is dried up; wetland, riparian and agricultural habitats are fragmented and simplified. The Central and Al Hammar Marshes are now mostly dry land. The former permanent lakes of the Central Marshes have dried up, leaving behind vast stretches of salt and gypsum crusts. Most of the Haur Al-Hawizeh (Iraq)/ Al-Azim (Iran) transboundary marsh has been transformed into barren land. Only a small northern section remains and its shorelines are in steady retreat."..."In total at least 7,600 km^2 of primary wetlands (excluding the seasonal and temporary flooded areas) disappeared between 1973 and 2000.The most seriously affected are the Central and Al Hammar marshes; 3% of the Central Marshes and 6% of the original Al Hammar Marsh remained in 2000. Moreover, most of the residual habitat occurs in drainage canals. Haur Al-Hawizeh has decreased by 2,000 km^2, leaving only a third of the original coverage" (Partow UNEP 2001).

KEY RESOURCE ISSUES

1. It is necessary to collect more recent baseline biological information for the Mesopotamian Marshes, including the watershed impacts of upstream water diversions in Turkey, Syria and Iran and downstream impacts in the Arabian Gulf. All biological inventories were done prior to the 1970's, and these were scattered and incomplete.

2. A comprehensive baseline study of the biology of the marshes and contiguous environments needs to be undertaken, and a long term monitoring system established with some form of adaptive assessment or management process.

3. Before addition of water or any action is taken, an eco-toxicology study should be conducted on plant and animal tissue, soils and water. Given the unknown impacts of war, lack of water treatment, deliberate poisons introduced into the marshes, and impacts of rehydration on soils and potential contaminants, this will be very significant for human safety as well as biological integrity.

4. Refugia remaining in the marshes serving as population reservoirs for sensitive species, propagule dispersal agents and recolonization nexus points for fish and wildlife species must be identified as key resource areas in the marshes. Remnant marshes, aquatic habitat, riparian habitat and agricultural areas should be identified, protected and managed. The extent, connectivity, patch size, habitat interspersion, structural diversity and ecological richness of the Mesopotamian marshes should be prioritized in restoration planning efforts.

5. The largest remaining extant marsh is in the Haur al-Hawieha; this area would have the best template for restoration planning and refugia for remaining sensitive species population, as well as propagule sources for revegetation.

6. A very large proportion of the species of greatest conservation concern, (e.g. the threatened species and endemic species, subspecies and populations,) are wholly or largely dependent on the permanent freshwater lakes and permanent marshes. These are the dominant habitat types of the Haur al-Hammar and Haur al -Hawizeh systems.

7. The conservation of Dalmatian Pelicans and other colonial nesting birds will depend on nesting "reed islands"; the conservation of pelicans depends on the availability and quality of these nest sites.

8. High levels of DDT in marsh soils may adversely impact nesting birds of prey as well as reproduction of other avian species.

9. Animals which may have been extirpated from the marshes may require reintroduction from adjacent habitats in the middle east. In particular, otter, grey wolf, jungle cat, and water buffalo may require deliberate reintroduction.

10. Mosquitos are prevalent disease vectors in the marshes; mosquito control procedures should be integral to the restoration planning effort. Control measures should be designed that do not have secondary adverse impacts on the ecosystem (precluding use of DDT, for example).

11. If rotenone was used in the marshes, non-native species may be less sensitive to rotenone toxicity. The remaining surviving fish populations may be dominated by goldfish and carp, weedy fish species that may preclude restoration of the fisheries without active management.

12. For conservation of Penaid shrimp and other fish species that migrate up into the marshes to spawn from the Arabian Gulf, the temperature, flow and salinity of the receiving waters will have to be close enough to the pre-disturbance condition to allow uninterrupted migration corridors, spawning substrate and water conditions, and water quality and temperatures conducive to recruitment of juveniles into the adult population. Immigration of small-sized shrimp into the inland waters was continuous throughout the period from June-February, with one major peak between May-June. Spring recruits peak in Iraqi inland waters coincident with maximum discharge of the river. The maximum peak of recruitment in the nursery ground occurred in October, coinciding with the mean minimum discharge rate of the Shatt Al-Arab.

13. Turtle conservation will require habitat of slow moving, warm water with a silty bottom; sandy banks for nesting; adequate prey base, and protection from being sold to tourists or deliberately killed.

14. Reed recolonization as well as other revegetation efforts may require development of tissue culture facilities and greenhouses, replanting plugs from different clonal genotypes, controlling eutrophication and excessive salinities, and utilizing water management to optimize seed germination and seedling establishment.

15. Exotic species of plants or wildlife will need to be monitored to ensure they are not outcompeting native species' regeneration in Mesopotamian marshlands.

ECOSYSTEM IMPACTS

At the landscape scale, the entire Western Siberian-Caspian-Nile flyway has been adversely impacted by drainage of the Mesopotamian Marshlands, which are an important staging and wintering area for migratory birds. An estimated 66 species of birds that occurred in the marshlands in internationally significant numbers are at risk (AMAR 1994; Partow UNEP 2001).

A. "The marshes are connected to the Persian Gulf hydrologically via the Shatt al-Arab, which acts as a conduit for a wide range of migratory aquatic species. Of major commercial importance is the seasonal migration of penaied shrimp between the Persian Gulf and nursery ground in the marshlands. It is estimated that up to 40% of Kuwait's shrimp catch originates from the marshes. The drying out of the marshlands is therefore likely to have had an important impact on coastal fisheries in the northern Persian Gulf, with potentially serious economic consequences. The marshes' wide range of cyprinid fish species, which are of special scientific interest, have also been severely affected" (Banister et al 1994).

B. The marshes contained several endemic fish species (e.g. *Barbus sharpie*, *Caecocypris basimi*, *Typhlogarra widdowsoni*). There are probably several other species which occur elsewhere within the Tigris-Euphrates river basin but achieve their highest abundance in the marshes, with this habitat availability being the primary control on numbers in other parts of the system. No fish species are known at present to have become extinct in the marshes during this century. However, the potential clearly exists for local extinctions to occur as a consequence of physical dewatering and increased salinity of the marshes, water quality impairment from wastewater from industrial, munitions and human sources, and the deliberate introduction of rotenone or cyanide or other toxins to the marshes to kill the fish. The probability of extinction is increased by the small populations of endemic species (Banister et al 1994).

C. Economic losses of fish "Prior to the large-scale marsh drainage projects of 1991, inland fish production in Iraq exceeded marine fish production. The mean annual fish catch was approximately 17,000 tons. The decrease in marsh fish supply due to habitat destruction, and the parallel growth in production of exotic common carp aquaculture (currently circa 5,000 tons per annum) could affect retail fish markets by increasing the price of native marsh fish and lowering the price for pond-raised fish. Additional losses have occurred to estuarine/marine fisheries dependent on marsh stocks or habitats. The overall loss would likely be significantly increased given the high value of coastal shrimp resources which would be affected" (Banister et al 1994).

D. The most recent satellite imagery indicates the almost complete desiccation of the central marshes, which means the complete loss of fish production in this area. Amateur videotapes by Iraqi refugees illustrate the use of rotenone or another poison to kill fish and water buffalo; marsh water surfaces were covered with dead fish bodies. After the water was drained from these areas, a complete fish kill in many areas is certain. Due to the difference in sensitivity to

rotenone among fish species, certain species such as goldfish and carp are resistant. Therefore, there could also be refugia in canals and remnant aquatic habitat for non-native invasive species.

E. Increases in marsh salinity will transform the marsh aquatic habitats from freshwater to at least brackish water environments or desertification will transform aquatic habitats into dryland or salt pan habitat.

F. Changes in the micro-climate and carbon cycle – Marshland and agricultural desiccation will have important consequences for the micro-climate. Dry soil without vegetation cover will certainly reach very high temperatures at the soil surface. Air moving over these dry soils will be heated considerably. Loss of evaporation from marshlands, fully-irrigated crops, and rice fields will result in a substantially modified micro-climate, with temperature extremes increased and humidity decreased.

G. Global warming – the loss of 7500 square miles of marshland is a significant loss of a carbon sink. In addition, exploiting 112 billion barrels of oil or 15.1 billion tons of Iraq's proven oil reserves for fossil fuel consumption will contribute a major carbon source to the atmosphere. While difficult to quantify, it does seem like there would be an impact on global warming.

The following wetland functions should be evaluated and considered in restoration planning efforts:

- Flood desynchronization and flood flow moderation;
- Groundwater recharge/discharge;
- Bank stabilization, erosion control;
- Water quality improvement – removal of sediment, nutrients, and toxic metals and organics;
- Fish, wildlife and vegetation habitat;
- Culturally significant resources;
- Recreation and scenic quality.

The loss of wetland functions for water quality improvement, flood desynchronization, groundwater recharge, and low flow augmentation is significant.

A. The Mesopotamian marshlands provide habitat for a number of globally threatened species as listed in the IUCN Red List of Threatened Animals (Groombridge 1993), including 14 species of bird, 3 species of mammal and one species of dragonfly. In addition, a number of rare or endemic species are found here, and given the habitat loss must now also be classified as "globally threatened" (Scott and Evans 1993).

B. It is immediately apparent that a very high proportion of the species of greatest conservation concern, the threatened species and endemic species, subspecies and populations, are wholly or largely dependent on the permanent marshes of Haur Al Hammar, Central Marshes, and Haur Al Hawizah ecosystems. Six of the eight threatened species and at least six of the eight

endemic species, subspecies and populations are to some extent dependent on the vast permanent reed-beds, and six of these are wholly dependent on this habitat.

C. These habitats are shown to have been reduced drastically by 1992, and the reduction of habitat quality and quantity continues to this day. Drainage of the permanent lakes and reed-beds in lower Mesopotamia will almost certainly result in the global extinction of smooth-coasted otter (*Lutra perspicillata maxwelli*) and soft-shell turtle (*Trionyx euphraticus*), the extinction in the Middle East of African darter (*Anhinga rufa*) and sacred ibis (*Threskiornis aethiopicus*), and the extinction in Iraq of pygmy cormorant (*Phalacrocorax pygmaeus*) and Goliath heron (*Ardea goliath*).

D. Loss of the permanent wetland habitats would also cause catastrophic declines in the world populations of Iraq babbler (*Turdoies altirostris*)and Basrah reed warbler (*Acrocephalus griseldis)* and the regional population of Dalmatian Pelican (*Pelecanus crispus*). Also threatened with possible extinction, with a 50% reduction in the world populations of Harrison's Gerbil (Gerbillus mesopotamiae), Iraq Little Grebe (Tachybaptus *ruficollis iraquensis)* and marbled teal (*Marmaronetta ngusirostris).* No information is available on the status of the recently described bandicoot rat (*Erythronesokia bunnii*), but as this is known only from the marshes of southern Iraq it is also likely to be put at risk by wetland drainage and could be threatened with extinction.

E. Of the other 66 species of birds occurring in internationally significant numbers, 39 (59%) are to some extent dependent on the large permanent lakes and reed-beds, and 13 (20%) are wholly or largely dependent on this habitat type. Drainage of these wetlands would have an adverse effect on the populations of all these species, and would cause major declines in the regional populations of Dalmatian Pelican (30-60%), Goliath Heron (>10%), Little Bittern (*Ixobrychus minutus)* (>10%), Glossy Ibis (*Plegadus falcinellus)* (>10%), Tufted Duck (*Aythya fuligula)* (>20%), Marsh Harrier (*Circus aeroginosus)* (>10%), Purple Gallinule (*Porphyrio porphyry)o* (>50%) and Coot (*Fulica atr)a* (10-20%)

HISTORIC BASELINE CONDITIONS

(The following information is from the report on the Mammals of Mesopotamia, Expeditionary Force 1915 to 1919)

"Mesopotamia, for which the Turkish name of Iraq is preferable, is a large flat alluvial plain of comparatively recent origin. It is 450 miles in length and about 150 miles in breadth. The foothills of the Kurdistan and Persian Mountains form a Northern and North-eastern boundary, while to the South and West lays the margin of the Arabian and Syrian Desert."

"Through the plain the three main rivers – Tigris, Euphrates, and Karun – wind a serpentine course towards the sea at Fao on the Persian Gulf. The Tigris and Euphrates unite at Kurna and also at Gurmat Ali to form the Shatt-al-Arab, a river of considerable width. All three rivers bring down a large amount of silt, and it is of this the Mesopotamian soils is composed, without any admixture of stones or gravel. …"

"Of real forest land there is none, although the broad belt of date palms that fringe the banks of the Shatt-al-Arab gives that impression from the river, until glimpses of the desert appear a mile of so in the background. These plantations are the haunt of the jackal and the Persian mongoose."

"Patches of thick jungle occur locally in the large U bends of the rivers and grow a tangle of dwarf tamarisk and Euphrates popular. They seldom exceed a mile or two in width, but harbor small herds of wild pigs… Low cover is afforded by scrub growing in the vicinity of banks of rivers and canals. This chiefly consists of a dwarf acacia, Prosopis stephnia, the "Shok" of the Arabs and the wild liquorice plant, Glycyrrhiza glabra; also Lycium europaeum, a thorny plant with bright red berries, and Sueda monoica, of which the lower leaves are succulent and which appears to thrive also on the salt lands, where no other plants can live."
"Here are the wild cat, hares, jackal, mole rats, several of the gerbils and the hedge hogs. The foxes are found in the bare desert country behind, seeming to prefer it to the cover. "

VEGETATION TYPES OF IRAQ

"Mountain forest, in northern Iraq is generally found at elevations between 500 m and 1800 m under an annual rainfall of 700 -1400 mm. It is an oak (*Quercus* spp.) forest with the species *Q. aegilops*, *Q. infectoria* and *Q. libani.* Tree density can range from closed forest in relatively undisturbed areas to scattered stunted oak shrubs, as remnants of the original forest, near villages" (Thalen 1979).

Basic wetland habitat – hygrophilous vegetation –Throughout the wetlands, emergent vegetation is dominated by Common Reed (*Phragmites australis*), Cattail (*Typha angustifolia*), Papyrus (*Cyperus papyrus*) and occasionally

Arundo donax. *Phragmites* dominates the more permanent areas of marsh, "*Typha* is dominant in the more seasonal areas of marsh, and *Scirpus brachycerus* dominates temporarily flooded areas (Thesinger 1954). "The deeper, permanent lakes support a rich submerged aquatic vegetation with species such as hornwort (*Ceratophyllum demersum*; often dominant), eel grass (*Vallisneria spiralis*), pondweed (*Potamogeton lucens* and *P. pectinatus*), water milfoil (*Myriophyllum* sp.), stonewort (*Chara* sp.), naiads (*Najas marina* and *N. armata*) and water fern (*Salvia* sp.). Water lilies (*Nymphoides peltata, N. indica, Nymphaea caerulea* and *Nuphar* spp.), water soldier (*Pistia stratiotes*) and duckweed (*Lemna gibba*) cover the surface of the smaller lakes and quieter backwaters" (Scott and Evan 1994).

Coastal salt marsh vegetation at the mouth of the Shatt al Arab and coastal or estuarine areas of Iraq are undescribed. Using data from Qatar, coastal saline vegetation is described in eight ecological associations which form zones following a strong edaphic gradient (Babikir and Kurschner 1992). These groups are a *Zygophyllum qatarense* association, typical of the limestone plateau, a *Salsola cyclophylla* association of the sandy foothills, an *Aeluropus lagopoides-Tamarix passerinoides* association of the dunes, an *Arthrocnemum macrostachyum* association of the supratidal area, an *Avicennia marina* association of the subtidal and intertidal zones, and a *Salicornia europaea-Suaeda maritima* association (intertidal zone).

Riparian or riverine forest is found in the mountains as well as in the plains. "Along the streams in the north, narrow belts of trees can be found of willow (*Salix* spp.), sycamore (*Plantanus orientalis*) and poplar or cottonwood (*Populus euphratica*). Common shrubs and lianas include Oleander (*Nerium oleander)*, grape (*Vitis vinifera*), and rose (*Rosa canina*) (Guest 1966). In the plains about 200 km^2 has been estimated to be under 'ahrash', lowland riverine forest. It is found irregularly distributed along the streams and on islands. Part of the year these forest areas may be flooded and locally they are exploited as fuel. Two characteristic cultivated tree species, locally dominating the landscape should be mentioned here. In the north poplar (*Populus nigra*) is widely grown in dense stands for timber. In the southern part of the country orchards of date palm (*Phoenix dactylifera*) are found which make Iraq the most important exporter of dates in the world." (Thalen 1979).

Halophytic vegetation types are widespread and common, especially in the Mesopotamian Plain. Well known extensive saline depressions are found near Najaf, Shitatha, Kerbala (Abu-Dibbis) and in the Lower Jezira. Dominant vegetation includes *Halocneumum strobilaceum* (30-40 cm many-stemmed and branching shrub in the Chenopodiaceae); Solms-Laub in the Chenopodiaceae (*Seidlitzia rosmarinus*)*;* seepweed in the Chenopodiaceae (*Suaeda baccata* and *S. vermicularis)*; Nitraria (*Nitraria retusa*) in the Zyygophyllaceae (Caltrops Family) (shrub 50-100 cm high); and the grasses *Aeluropus littoralis* (Syn. *Poa littoralis*; *A. lagopoides* (Syn. *Dactylis lagopoides*); and alkali weed (*Cressa cretica*) in the Convolvulaceae family. Abul-Fatih (1975) distinguished three community types in the Najaf saline depression, named after the dominant species *Bienertia cycloptera* (annual herb in the Chenopodiaceae); Solms-Laub (*Seidlitzia*

rosmarinus) (30-60 cm shrub in the Chenopodiaceae) and saltwort (*Salsola crassa)* – bean caper (*Zygophyllum coccineum)* (small shrub in Zygophyllaceae).

The common genera of segetal and ruderal vegetation (weeds) include clover (*Trifolium* spp.), Trigonella, alfalfa / burclover (*Medicago* spp.), vetch (*Vicia* spp.), (*Chamomilla* spp.) (in Asteraceae –ex *Matricaria*) , mallow (*Malva* spp.), wild oats (*Avena* spp.), foxtail (*Alopecurus* spp.) and wild barley (*Hordeum* spp.) (Bor 1968). The deep rooting *Lagonychium farctum* (shrub in Mimosaceae) is one of the most common and noxious weeds, especially in the irrigated areas, and could be a concern with restoration success. Under favorable conditions and without cutting, dense impenetrable stands of a few meters high may develop. This species is found on heavy soils outside the irrigated area and is salt-tolerant (Harris 1960). Another very common weed species of irrigated land, often found together with *Lagonychium farctum*, is the camelthorn (*Alhagi maurorum).* These species are used locally as fuel, although often difficult to collect and handle. They cover vast stretches are a transition to desert and steppe habitats.

We have heard some reports of an invasive Iris-like species occurring in the drained marshlands. There are three species of Iris in the Iraq flora – *Iris sisyrinchium* (perennial, 40 cm tall, does occur near Basrah), *Iris persica* (perennial, no height of plant given, found near Jabal Hamrin), and *Iris maculata* (stems dwarf, found over Mesopotamia), and *Iris heylandiana* (perennial, up to 45 cm tall, Mosul to Baghdad). Other plants that might be confused with Iris include *Gladiolus* (perennial, 30-60 cm high, Badrah), *Cyperus* (C. eragrostis is certainly weedy in California), and *Juncus* hybridus has flat, linear-setaceous, grooved culms and occurs in wet places in Iraq.

Desert and steppe vegetation types in Iraq are by far the most extensive. Trees are absent with the exception of some isolated locations in the wadi beds and those planted near permanent settlements. Plants in the Chenopodiaceae (*Haloxylon salicornicum*, *H. Articulatum*) and Compositae including species of sagebrush (*Artemisia herba-alba* and *A. scoparia),* yarrow (*Achillea* spp) and *Rhanterium epapposum* are amongst the most common shrub species. Perennial grasses are rare with what we call needlegrass (*Achnatherum* spp.) and they call feather grass (*Stipa* spp.) an exception. Vegetation in areas with higher rainfall include a thin sward of bulbous bluegrass (*Poa bulbosa), Carex stenophylla* (*Carex eleocharis* or spikerush sedge in Jepson Manual) and perennial forbs. Well developed vegetation is only found as relicts because most of this area is regularly ploughed.

MARSHLANDS HABITAT AND IMPACT OF LOSS

"The wetlands of lower Mesopotamia comprise a mosaic of different wetland habitat types, each with it own characteristic flora and fauna. Some habitat types are much more extensive and much more important for wildlife than others, while some habitat types are much more likely to be affected by flood control, drainage and irrigation projects than others. In order to predict the likely impact of the ongoing and proposed development projects in Mesopotamia on wildlife populations, it is necessary to assess the importance of each habitat type for wildlife and the extent to which it will be affected by the development projects. For the purposes of this analysis, the wetland habitats of lower Mesopotamia have been grouped into the following categories (Scott and Evans 1993): 1) Permanent freshwater lakes and marshes; 2) Seasonal freshwater marshes; 3) Temporary freshwater marshes, mudflats and semi-desert steppe; 4) Irrigated land and seasonally flooded arable land; 5) Shallow, brackish to saline lagoons; 6) Rivers, streams, canals and irrigation channels; and 7) Permanent ponds, mainly man-made irrigation ponds and duck-hunting ponds, typically with a pronounced drawdown in summer and little emergent vegetation.

"To summarize, of the major habitat types in lower Mesopotamia, two are of outstanding importance for their wildlife: the permanent freshwater lakes and the permanent freshwater marshes. These are much the most extensive habitat types in Mesopotamia. They are home to six of the eight globally threatened species of mammals and birds which still occur in significant numbers in the wetlands, and at least six of the eight endemic species, subspecies and isolated populations. At the same time, they are the habitat types which are at greatest risk from ongoing FCDI projects. The six other habitat types are either not at serious risk or are of much less significance for wildlife" (Scott and Evans 1993).

1. Permanent freshwater lakes with a rich submergent growth of aquatic vegetation, and typically with a marginal zone of floating aquatic vegetation. and Permanent freshwater marshes dominated by tall stands of *Phragmites*, *Typha* and *Cyperus*.

Permanent freshwater marshes "occupy the greater part of the marshes. Varying in depth between 0.5 to 2m, they contain clear water and are covered by medium/ dense to thin reed beds (*Phragmites australis*), alternated with cattail (*Typha angustifolia*), Papyrus (*Cyperus papyrus*) and occasionally *Arundo donax*. sp.). They are bordered by bull rush fields (*Scirpus lacustris*) and zones typified by a floating vegetation of water lilies (*Nympahaea* and *Nuphar* species), and a submerged vegetation composed of eelgrass (*Valisneria*) and pondweed (*Potamogeton* ssp.). Both floating and submerged vegetation is gathered by the Marsh Arabs to feed their water buffalo, goats and sheep. (Scott and Evans 1993).

Permanent freshwater lakes are scattered through the marshes and range in depth from very shallow to more than 3 m. Vegetation in the lakes includes

submerged vegetation and phytoplankton, with stonewort (*Chara* spp.), hornwort (*Ceratophyllum demersum*), eel grass (*Vallisneria spiralis*), pondweed (*Potamogeton lucens* and *P. pectinatus*), water milfoil (*Myriophyllum* sp.), naiads (*Najas marina* and *N. armata*) and water fern (*Salvia* sp.) dominant. "A limited area is covered by highly saline lakes, often very shallow, where no vegetation can grow or only very thin and stunted reed (*Phragmites australis*) grows" (Scott and Evans 1993).

A very high proportion of the species of greatest conservation concern, *viz*. the threatened species and endemic species, subspecies and populations, are wholly or largely dependent on the permanent freshwater lakes and permanent marshes - the habitat types which make up the great bulk of the Haur Al Hammar and Haur Al Hawizeh systems. Six of the eight threatened species and at least six of the eight endemic species, subspecies and populations are to some extent dependent on the vast reed-beds, and six of these are wholly dependent on this habitat" (Scott and Evans 1993).

"Of the other 66 species of birds occurring in internationally significant numbers, 39 (59%) are to some extent dependent on the large permanent lakes and reed-beds, and 13 (20%) are wholly or largely dependent on this habitat type. The other six major wetland habitats in lower Mesopotamia are less of a cause for concern for a variety of reasons." (Scott and Evans 1993).

2. Seasonal freshwater marshes dominated by rushes and sedges, typically occurring as a broad belt around the edge of the permanent marshes.

"Seasonal freshwater marshes are of considerable importance for wintering waterfowl, especially dabbling ducks, and may be important for a wide variety of waterfowl during the spring migration season. However, as such marshes generally dry out in spring or early summer and do not flood again until the following winter, they have little if any value as breeding habitat or as autumn staging areas for waterfowl. Much of this habitat will be lost as a result of the FCDI projects, and this could have a significant impact on the numbers of some species which are able to over-winter in the marshlands. However, significant tracts of this habitat type are likely to survive in areas where the water table remains high and where the local winter rainfall creates shallow flooding. Unless the drainage structures are exceptionally effective, it seems likely that large areas of low-lying land, *e.g.* the beds of the former lakes, will remain damp and subject to extensive shallow flooding in winter. Thus species which are primarily dependent on this habitat type may not be badly affected by the FCDI projects" (Scott and Evans 1993).

3. Seasonal or temporarily flooded mudflats and semi-desertic steppe.

Temporary marshes, according to Scott and Evans (1994), are flooded only during the highest floods, and, as far as they border the "active" marshland deltas, may be used as rice lands. Along the western, eastern and to a lesser extent the northern fringes of the marshes, where no "active deltas are present, they are moderately to strongly saline. During the floods, the moderately saline clays are overgrown with a salt-tolerant vegetation of sedges and rushes; the

clays crack heavily upon drying, and the vegetation soon wilds" (Thesinger 1967). Such marshes are particularly vulnerable both to reductions and alterations in river flow. Graminoids and herbs are grazed by the Marsh Arab's cattle. The temporary marshes have little or no vegetation and are highly saline, with salt crusts liable to develop as they become desiccated during the summer months. Upon flooding, those saline soils with superficial crusts become broad marshland borders with saline and brackish water. The brackish and saline mud flats provide large quantities of food for migrating birds.

"The seasonally flooded mudflats and areas of semi-desertic steppe are of considerable importance for passage and wintering shorebirds and some other waterfowl. However, as with the seasonal freshwater marshes, these habitats are of negligible importance as breeding areas or staging areas in autumn. While many such areas will be lost, others will be created in low-lying areas where complete drainage is impossible" (Scott and Evans 1993).

"These habitats remain widespread in the Middle East. In particular, there are large areas of seasonally flooded marshes and mudflats on the floodplain of the Karun River in neighboring southwestern Iran. Furthermore, there is some indication that the floodplain wetlands of the Karun River are far more attractive to waterfowl than apparently similar areas in lower Mesopotamia. Presumably, the birds find conditions here more suitable than in Iraq, although why this should be the case is not known. These floodplain wetlands also support much larger concentrations of other surface-feeding ducks than have been encountered in Iraq in recent decades" (Scott and Evans 1993).

4. Irrigated land and seasonally flooded arable land.

"Irrigated land and seasonally flooded arable land are of some importance for passage and wintering waterfowl. Many other species of waterfowl, including geese and cranes, can occur in large numbers on wet or flooded arable land, providing that suitable roosting and loafing areas are available (*e.g.* water storage reservoirs and sand banks in rivers) and levels of human disturbance and persecution are not too high. However, the species most likely to benefit from an increase in the extent of arable land are generally common and widespread species and not those which give any cause for concern" (Scott and Evans 1993).

5. Shallow, brackish to saline lagoons, mostly seasonal and often with extensive areas of *Salicornia*.

"Shallow, brackish to saline lagoons form a relatively unimportant habitat type in lower Mesopotamia. Much the most important saline lagoons in Mesopotamia are further north, in the Baghdad region (*e.g.* Lake Razazah). Furthermore, this is a habitat type which remains widespread in the Middle East and has been least affected by FCDI projects elsewhere. The main brackish to saline lagoons in the region under consideration are rather isolated systems, such as Haur Suweicha, unlikely to be affected by the main drainage works" (Scott and Evans 1993).

6. Rivers, streams, canals and irrigation channels, typically with little emergent vegetation and steep earth or muddy banks.

The permanent rivers, streams, canals and irrigation channels are of only limited value for wildlife. Only 14 of the species of conservation interest occur with any regularity in this habitat type, and half of these are gulls and terns that occur widely in other habitats. Canalization of the rivers will result in the loss of some natural river-edge habitats, while the construction of new irrigation canals could result in a net increase in the extent of the network of permanent waterways. The overall effect of these changes on the wildlife of lower Mesopotamia is not likely to be significant" (Scott and Evans 1993).

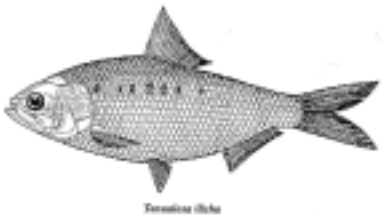
7. Permanent ponds, mainly man-made irrigation ponds and duck-hunting ponds, typically with a pronounced drawdown in summer and little emergent vegetation.

"Many of the man-made irrigation ponds and duck-hunting ponds are of considerable importance for passage and wintering waterfowl. It seems unlikely, however, that the total number and area of these ponds will decrease as a result of the flood control, drainage and irrigation (FCDI) projects, and indeed there is likely to be an increase in the number of small irrigation ponds" (Scott and Evans 1993).

FISHERIES

The fate of the marshes affects the majority of the Tigris and Euphrates River systems and species which migrate up and down the river systems from the Persian Gulf (Bannister 1994). According to whether is it one of the two rainy periods or not, there are fish migrations up and down the rivers using the marshes as a conduit. For example, the bull shark *Carcharinus leucas* has been recorded as far upstream as Baghdad (Coad 1991). The marine mullets, *Liza* spp. for example, and species of gobies will migrate upstream, as will species of penaid shrimp.

Banister (1994) points out that one outcome of the dams and drainage works is alteration of physical and chemical factors of the aquatic environment; temperature, salinity, sediment transport, and food web dynamics will be affected differently throughout the system. Salinity would vary with marsh soil leaching, alteration of flow, reduced flows, reduced seasonal leaching and flushing from biannual floods, and altered tidal prism. With less fresh water, the saline prism should come further inland. “At Baghdad, the surface temperature can vary between 8.5^{o}C in January to 31.4^{o}C in August. Both the warming up in March and April and the cooling in October and November are rapid. In deeper standing waters, stratification is likely to develop but not so in the shallow southern marsh lakes where, among other factors, the thermocline is destroyed by wind action. The circulation of nutrients is important for both the fish and the plants” (Banister 1994).



Generally *Barbus* species seem to be widespread throughout the system. A fundamental biological attribute is that, with one exception, they run upstream to spawn. Draining the marshes is therefore going to be a disadvantage to their survival. *Barbus sharpeyi* is a singularly significant member of the genus. Known locally as Bunni, it is a warm water species and only spawns in the marshes in areas of shallow open water less than 0.75 m deep, where it deposits its eggs on vegetation in May. The drainage of the marshes will result in the extinction of species which needs the quiet waters in which to survive.

Another example of an important commercial fish spawning upstream in the Shatt al-Arab is *Tenualosa iilisha*, locally known as sbour; it is one of the most important target species in the Kuwaiti drift-net fishery (Al-Baz and Grove 1995). *T. ilisha* spawns in the Shatt al-Arab during May-August with a spawning peak in May-June, while no spawning activity was noticed beyond October when the mature fish migrate to the sea. Small immature fish are observed in October-

December (*Ibid*.). It is highly likely that alteration to the marshes and Shatt al-Arab will have a highly deleterious impact on *T. ilisha* spawning and recruitment.

"The importance of the marshes as nursery grounds to the marine species of the Arabian Gulf is unclear but likely to be great. Seasonal migrations certainly take place of the commercial penaid shrimp *Metapenaeus affinis* between the Arabian Gulf and nursery grounds in the marshes of Iraq. Hammar Lake provides one such nursery ground. This shrimp is of significant economic importance to fisherman along the coasts of the northern Gulf, in particular Kuwait (Mathews et al 1986). In some years it accounts for over 40% of the total Kuwaiti landing" (Bishop 1994).

Migration of *Meapenaeus affinis* occurs from the Arabian Gulf to nursery ground in the low salinity inland waters of Iraq (Salman et al 1990). The study site used in 1990 has been almost entirely drained since the study occurred. This shrimp species, commercially important to Gulf fisheries, has long been fished traditionally from the marshes in Iraq (Al-Saadi et al 1981). The presence of small *M. affinis* in the Marshes of the Tigris-Euphrates river system supported the belief that the marshes may be the primary nursery grounds of commercially fished *M. affinis* in Kuwait waters. Immigration of small-sized shrimp into the inland waters was continuous throughout the period from June-February, with one major peak between May-June. Spring recruits peak in Iraqi inland waters coincident with maximum discharge of the river. The maximum peak of recruitment in the nursery ground occurred in October, coinciding with the mean minimum discharge rate of the Shatt Al-Arab.

Wright (1988) found that the largest number of fish recruited to Sulaibikhat Bay, Kuwait, occurred during the period of maximum fresh water outflow through the Shatt al-Arab. Numbers of fish were significantly greater in the intertidal region, rather than the subtidal. The Shatt-al-Arab estuary has a season effect on salinities in Kuwait waters (Jones and Clayton 1983). The intertidal environment from the Shatt al-Arab to Kuwait Bay is characterized by extensive mud flats with a tidal range of 3.5 to 4.0 m in Kuwait Bay (Jones and Clayton 1983). Dames and Moore (1983) identified the Khor-al-Sabiya, part of the Shatt al-Arab delta system, as a probable spawning ground for several species of fishes. The families Mugilidae, Engraulidae and Pomadysidae made particular use of Kuwait Bay as a nursery ground. The large numbers of juvenile fish species recruited to the bay in the spring was strongly correlated to temperature at the time of capture. There was a movement of species out of the bay and into colder water during the colder months, and a return to the bay in the warmer months. Fish density was negatively correlated with salinity at the time of sampling. Abundance of fish is influenced by the outflow of fresh water through the Shatt al-Arab. Large numbers of fish were associated with low salinity when the effect of the Shatt al-Arab is greatest. The point? Reduced flows and increased salinities in Shatt al-Arab flows as a result of upstream alteration to the marshes is likely to cause a significant decrease in juvenile fish recruitment.

GULF WAR IMPACTS

"It is known that the shrimp fishery in the Gulf is exposed to long-term oil-related pollution as well as the impact of human activities on the coastal environment" (Siddiqui and Al-Mubarak 1998). "Although great efforts have been made by scientists all over the world to contain deleterious effects of oil pollution on marine organisms, little success has been achieved in this direction. Prevention is certainly a better strategy than cure. Mohammad et al. (1994) drew attention to additional threat to biotic organisms as a result of dam construction on the Tigris and Euphrates Rivers in Turkey, the draining of marshes in Iraq, the power station construction as Ras Subbiyah, a proposed causeway linking Ras Subbiyah to Failaka Island, and reclamation schemes to build water-front cities in Al-Khiran and Sulaibikhat Bay, which may have a long-term negative impact on the fishery in Kuwait " (*Ibid*.)

"There was a time in the early seventies when the fishery suffered from over-exploitation, resulting in a drastic decline in catches and subsequent suspension of shrimp fishing operations in the year 1977. The KISR has been instrumental in undertaking a Shrimp Fishery Management Project, which succeeded in reversing the catch trend and increased fisheries productivity by 1989. The 1990 Gulf War witnessed large-scale destruction of the fishing infrastructure along with mass mortality of marine lives as a result of an estimated 1 Mm^3 of spilled oil" (Siddiqui and Al-Mubarak 1998).

Possible environmental stresses on the prawn stocks from the 1991 Gulf War from the large volumes of oil smoke, soot and particulate matter of various kinds released into the air, water and land, include the following (Mathews et al. 1993):

- decrease in sea surface temperature with consequent effects on biology of prawns;
- decreases in solar energy reaching the sea surface with a consequent fall in primary production;
- interference in the reproductive processes of prawns through a change in the day/night cycle;
- release of ashes and associated chemicals into the environment; and
- the oil spill itself could physically interfere with biological systems, disrupt the aquatic environment, decrease light attenuation, and poisoning aquatic life.

Prior to the Gulf War, the main Saudi Arabian prawn stock was in good condition; landings were the highest for a decade, total fishery effort had been maintained roughly constant for about 4 years; landings had increased for the 4 previous years due to an increase in recruitment ((Mathews et al. 1993). The Cohort Abundance Indices fell from to 3.8% of pre-war levels. Mean total biomass showed a decline from post-war levels to about 27% of pre-war total biomass. Estimated economic losses were revised to US $41 million. pre-war total biomass. The stock shows no signs of recovery and needs to be managed with care if even currently low levels are to be maintained.

For species which historically migrated up the Shatt al-Arab for spawning, 1991-1994 was the time period when desiccation of the marshes occurred. It can be assumed that shrimp and other fish species productivity and abundance were significantly impaired by altered water volumes and discharge rates, increased salinity, and impaired water quality in the Shatt al-Arab and marsh environment.

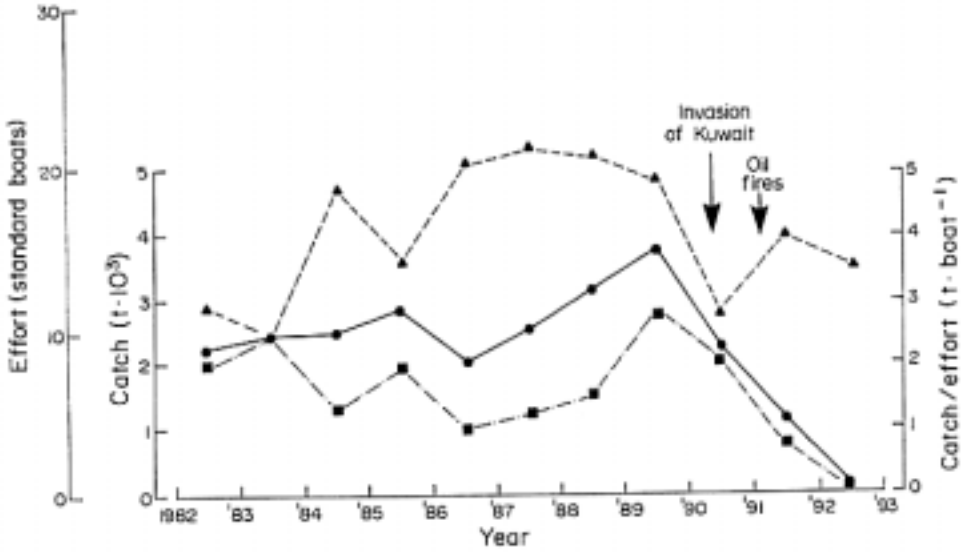


Fig. 3 History of the Saudi East Coast prawn fishery:
Catch, t × 1000: ——
Effort, standard boats (yr^{-1}) - - - -
Catch per unit effort (CPUE) in t $boat^{-1}$ yr^{-1} - . - . - .

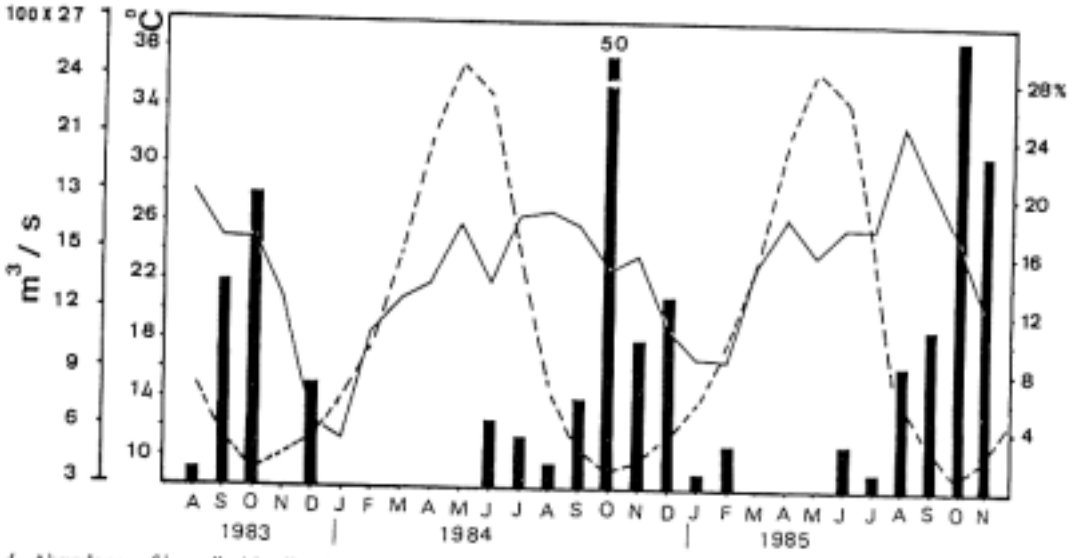
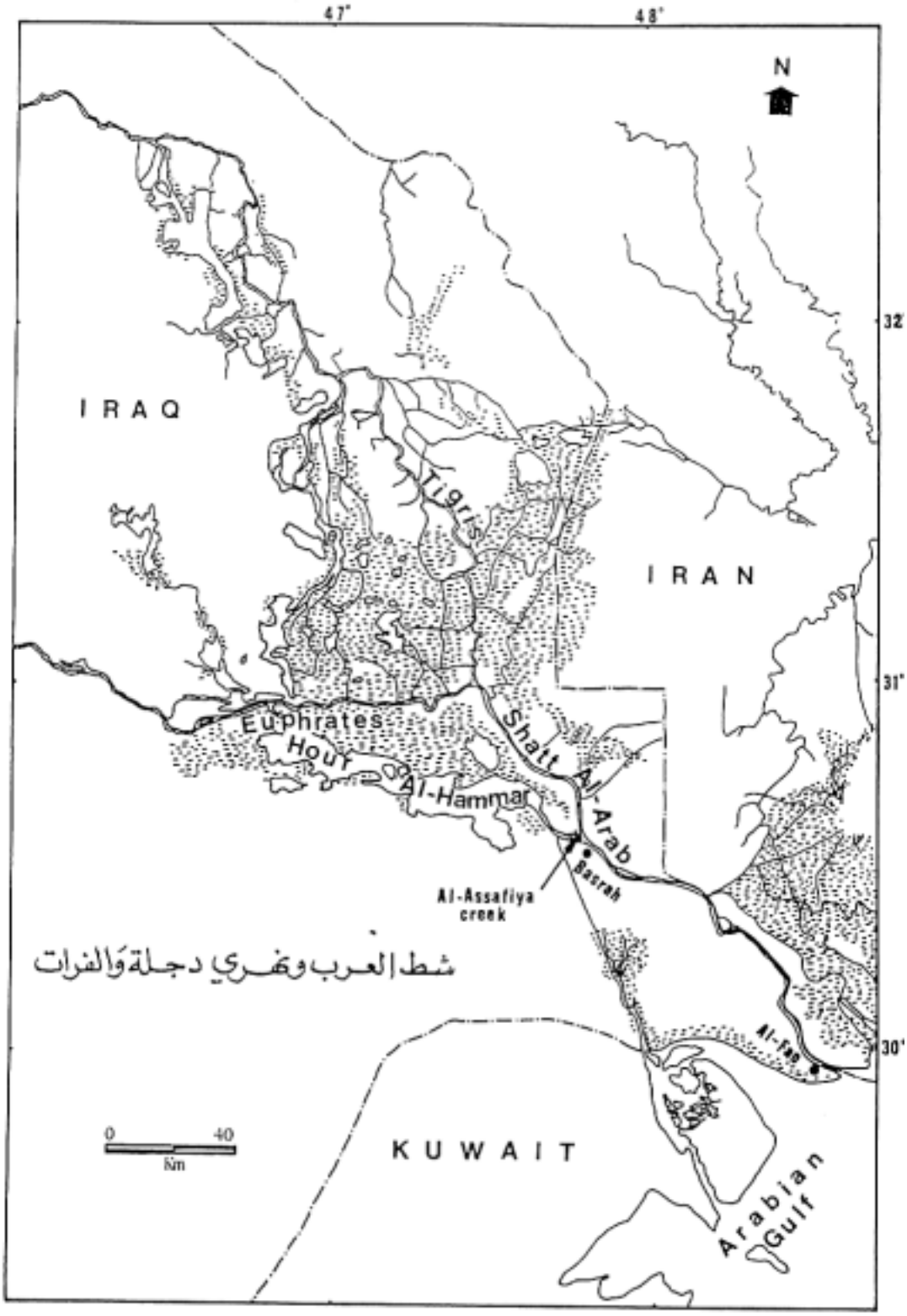


Fig. 4. Abundance of juvenile *M. affinis* in Al-Assafiya creek: expressed as percentage of total numbers sampled per month, in relation to water temperature at the time of sampling (solid line) throughout the period from August 1983 to November 1985, and the mean monthly water discharge of the Shatt Al-Arab River m^3/s (pecked line), (data from Mohammad 1982).



Map of the Tigris-Euphrates Marsh system, Shatt Al-Arab and the Arabian Gulf, showing location of samp
Assafiya creek. Shrimp fishing grounds in the marshes are located at the lower reaches of the Hour Al-Hamm
area represent swamps and damp regions.

BENTHIC INVERTEBRATES

The benthic fauna of the river Euphrates upstream and downstream sectors of Al-Qadisia dam, mid Iraq, was studied for two years in 1993 and 1994, which was during the time of the big marsh drainage and earth moving process. Seasonal fluctuation of the community showed that the peak of the total number of individuals had appeared during the autumn and winter months. The composition of benthic communities is indicative of the hydrologic and water quality conditions where these organisms live. Any significant changes in the hydrology or water quality will change the composition of benthic invertebrate communities. These investigations were carried out on areas around Baghdad and south. The dam was constructed in 1987. The river water was fresh to oligohaline, moderately alkaline, very hard and well aerated. Sulphate and calcium were the most dominant anion and cation, respectively, and nitrate was the most dominant inorganic nitrogen source in the river.

In the station downstream of the dam and close to Baghdad: gastropods, chironomid larvae and oligochaete worms were found in higher populations densities in this area; these groups are used as an indicator of organically polluted water (which causes a notable increase in oligochaetes especially).

FOCAL SPECIES

"The ecological arguments for conserving birds as a component of biodiversity emphasize the critical role that birds play in ecological systems. Birds occupy an extremely diverse range of niches within ecosystems. Because of their high metabolic rate, their distribution across a wide variety of habitats, birds are sensitive indicators of environmental conditions" (Temple and Wiens 1989, De Sante and Geupel 1987).

"Focal species are good indicators of ecological health. Conservation planners have found it useful to concentrate on a few 'focal' species, whose requirements represent a spectrum of habitat characteristics. These species help define which spatial and compositional attributes characterize a healthy ecosystem and guide the development of appropriate management regimes. A landscape designed and managed to meet the focal species' needs encompasses the requirements of other species" (Lambeck 1997).

"The species with the most demanding requirements for each landscape/habitat parameter determines the habitat's minimum suitable area for that habitat type. For example, a species that requires the largest habitat patch size in a community sets the minimum suitable area for that habitat type. Or, the needs of the species with the most limited dispersal define the attributes required in vegetation connecting habitat patches. By recognizing the minimum acceptable requirements for the species with greatest need, planners more effectively conserve all species using the habitat" (RHJV 2000).

Criteria for selecting focal species include the following (RHJV 2000):
1. Use marsh or riparian vegetation as their primary breeding habitat.
2. Warrant special management status – limited endemic distribution, global or regional population threat.
3. Have experienced a reduction from their historical breeding range.
4. Commonly breed through Mesopotamian marshland or riparian areas.
5. Important wintering area for a significant population of species that are dependent on wetland and riparian habitats.
6. Have breeding requirements that represent the full range of successional stages – in the case of Phragmites marshlands, the full successional sequence from open water to very large diameter, dense reeds

It is also important that focal species be abundant enough that they can be located and relatively easy to monitor. Focal species requirements define different spatial and temporal attributes of the marshlands, habitat characteristics and management regimes representative of a healthy ecosystem.

For example, species that require the largest area to survive in a certain habitat will determine the minimum suitable area for that habitat type. Likewise, the requirements of non-migratory species that disperse short distances to establish new territories will define the attributes of the connectivity of habitat patches. For example, soft-shelled turtles may be a good indicator of habitat connectivity. The species for the most demanding or exacting requirements for

an ecological characteristic, such as patch size of reed beds, determines its minimum acceptable value. Therefore, the assumption is that a landscape designed and managed to meet the focal species' needs and encompasses the requirements of other species (Lambeck 1997).

Flagship species may be very rare, be difficult to locate and monitor, but are symbolic ecologically of the ecosystem they represent. In the case of the Mesopotamian Marshlands, African Darter, Sacred Ibis, Dalmatian Pelican, Goliath Heron, Smooth-coated Otter, Jungle Cat, Grey Wolf and Smooth-shelled Turtle are recommended flagship species. Water buffalo are a cultural flagship species.

The following species appear to be good focal species, with ecological traits that make them good indicators of habitat quality and restoration success. The emphasis is on a suite of species that are dependent on either permanent, freshwater wetlands with extensive growths of emergent aquatic vegetation; or riparian areas with structural diversity and an interspersion of habitat types. The wetlands of Mesopotamia were especially important for permanent freshwater emergent aquatic marsh – a type that is very scarce elsewhere in the Middle East south of the Caspian. Virtually all of the endemic species and subspecies of birds, mammals and fishes are dependent on this wetland type.

It is important to note that all biological inventories in the Mesopotamian marshes were done prior to the end of the 1970's, and these were scattered and incomplete. An adequate biological baseline condition for the marshes does not exist, and the biological impacts of drainage and poisoning the marshes is unknown. Determining where the remaining refugia and habitat patches remain will be a top priority for restoration planning, in order to locate propagule sources and dispersal corridors. Based on discussion with Iranian ornithologists, it seems that the Haur Al-Hawizeh/ Al-Azim marshes on the Iranian – Iraqi border is the only extant marsh remaining where endemic or endangered species may still endure.

Birds

According to Gavin Young (1977) "I have left the birds to the end; they are the Marshes' crowing beauty. From November to early spring, the lagoons and reed-beds are flecked with the flashing colors of halcyon kingfishers and the gaudy purple gallinule, and the sky is dotted with floating eagles or mottled with whirling concourses of geese from Siberia and wild duck of many kinds." … "Winter is the time of porcelain-blue skies and countless birds. You see most kinds of duck: pintail, widgeon, teal, mallard, shoveller, red-crested pochard, gargany, diving duck, and white and black tufted duck. There are white ibises, too, and hoopoes, red hawk, avocets, stilts: warblers of all kinds perching on reed stems, unafraid, or twitching unseen; and black and white kingfishers, bee-eaters, yellow-billed storks, and African darters. Eagles always seem to be drifting overhead and white-tailed sea-eagles, quite tame, breed in the reed-beds. A large Predatory bird the Marsh Arabs call a haum, which is either a harrier or an eagle of sorts and has wide, dark, canopy-like wings with an impressive span to them, skims the tops of the reed-beds, looking for coot and

moorhen. Finding any in open water, the haum dives onto them with a surprisingly abrupt contortion of wings and body."

"Ungainly they may be, but pelicans at rest, their pure white feathers and yellow bills reflected in the mirror surface of a lagoon, ride the waters with ship-like grace. They can be beautiful. Standing in the shallows to feed at evening, several hundred together, they stoop and pluck and preen, making a sea of agitated whiteness that slowly turns to flamingo-pink as the sun sinks. And high up, slowly wheeling and wheeling on outstretched, unmoving wings, these sometimes ludicrous-looking birds give to the sweep of water, reeds, and towering sky an extra touch of majesty."

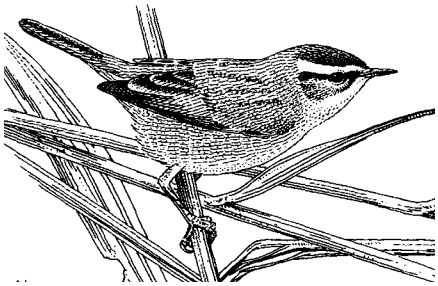
"But above all other creatures, the geese and duck lodge in the memory. Their wild sky-armies come swirling and crying out of the Russian tundra's and seem to carry with them much of the spirit of the Marshes. When the ducks seethe on the skyline in dark, shifting clouds like smoke or bees or locusts: as the descending grey-lag or white-front swirl across and evening sky that is pearl-gray and flecked with tongues of flame-colored cloud: when darkness has fallen and the village noises have died away and the sad goose-calls come from the grazing fields, it is time to be silent and let the wild creatures have the marshes to themselves."

"The lakes and marshes of lower Mesopotamia are one of the most important wintering areas for migratory waterfowl in western Eurasia. Many species of waterfowl, notably ducks, geese and coots, which breed in the basins of the Ob and Irtysh Rivers in Western Siberia, migrate southwest in autumn to spend the winter in the wetlands of the Caspian Region, Middle east and Northeast Africa. These birds belong to the so-called West-Siberian-Caspian-Nile flyway – one of the three major waterfowl flyways in the Western Palearctic Region. The Mesopotamian Marshlands are one of the principal wintering areas for waterfowl in this flyway Indeed, George and Savage (1970a) believed that the marshes of the Haur Al Hammar and Haur Al Hawizeh together probably provide habitat for two-thirds of the wintering wildfowl of the Middle East." (Scott and Evans 1993).

"BirdLife International has identified the most important concentrations of bird biodiversity in the world (ICBP 1992), areas where habitat destruction would cause disproportionately large numbers of species extinctions. There are 221 of these 'Endemic Bird Areas' or EBAs in the world, of which only 11 (5%) are wholly or largely (non-marine) wetlands. The Mesopotamian marshes of Iraq are one of these wetland EBAs, since they support almost the entire world population of two species, the Basrah Reed Warbler (*Acrocephalus griseldis*) and Iraq Babbler (*Turdoides altirostris*). On this basis alone, the marshes can certainly be termed globally important for bird biodiversity. The marshes are indeed known to support at least three endemic species or subspecies of mammals: the recently described Bandicoot Rat *Erythronesokia bunnii*, Harrison's Gerbil (*Gerbillus mesopotamiae*) and the endemic subspecies of Smooth-coated Otter (*Lutra perspicillata maxwelli*). Further field surveys of other vertebrate groups and the even less well-known invertebrate groups would no doubt uncover further species unique to the Mesopotamian lowlands".

Avian focal species included in descriptions in this report include the following: 1) Basrah Reed Warbler; 2) Iraq Babbler; 3) Marbled Teal; 4) Pygmy Cormorant; 5) Dalmatian Pelican; 6) Sacred Ibis; 7) White-tailed Plover; 8) Imperial Eagle; and 9) . Mammalian focal species include the following: 10) Grey Wolf ; 11) Wild Boar; 12) Water Buffalo; 13) Small Indian Mongoose; 14) Indian Crested Porcupine; 15) Smooth-Coated Otter; and 16) Jungle Cat. Other focal species include the following: 17) Soft Shelled Turtle; 18) Dragonfly; and 19) Penaeid Shrimp.

1) Basrah Reed Warbler – is a common breeding summer visitor to the reed-beds of Mesopotamia between Baghdad and Basrah. This species breeds in the Mesopotamian Marshes and is dependent on tall permanent marsh vegetation The Basrah Reed Warbler is certainly a priority species, as it is confined as a breeding species to the Mesopotamian Marshes and is dependent on tall permanent marsh vegetation. (Derek Scott pers. comm. 2003).



a) Other species of reed warblers prefer dense stands of reeds close to the water (Graveland 1997). The width of the zone of *Phragmites* standing in water was the most important characteristic explaining nest site choice of Great Reed Warblers. The proportion of water reed was a good predictor of the density of Great Reed Warblers. Nests in water suffer a lower predation risk than nest on land because predators are less likely to reach the nests (Dyrcz 1986; Picman et al 1993). They tend to prefer stem height of approximately 200 cm, stem diameter of 35 mm, and stem density of 213 stems per m2, with some decadent stems and with a 2 meter width of water reed zone. Smaller reed warblers (species) like to have more herbs in the understory for nest building.

b) Due to the reed warblers' dependence on reed beds, the decline in their population is an 'early' indicator of gradual changes that are taking place in marsh ecosystems that may affect the entire reed bird community in the future.

c) The Japanese race of reed warbler had extremely high breeding density and small compact territories in reed-beds, which provide main nesting sites. The birds used neighboring rice paddies and/or lotus fields as foraging sites. (Dyrcz and Nagata 2002). Characteristics of nest sites were nest height approximately 121 cm, 3 stems supporting the nest, water depth beneath the nest 2 – 0 cm, and high variability on proportion of nests on reeds standing in water (*Ibid*.). Higher production of reed beds may enable reed warblers to contract their territory size, as these reed-beds support richer invertebrate fauna (Dyrc & Flinks 2000). To avoid nest losses by predation from snakes and mongoose, reed warbler nests are built at higher positions in the reed-bed.

2) Iraq Babbler (*Turdoides altirostris*) This bird is rare and endemic to southern Iraq. However, it occurs in non-wetland habitats (date palm or citrus orchards, riverine riparian scrub) so is also an indicator of the quality of both the upland/ wetland and wildland/ agricultural edge. The Iraq babbler does have endemic status, and may be a good indicator of healthy riparian and agricultural lands

adjacent to marshes. The Iraq Babbler is confined to the lower Tigris and Euphrates valleys of central and southern Iraq and extreme southwestern Iran (Khuzestan Province). Its distribution is centered on the reed-beds of the Mesopotamian marshlands, and thus a large proportion of the world population occurs in the region covered by the present study. However, it is also one of the commonest birds of rural habitats along rivers and irrigation canals throughout the lowlands of central Iraq (Al-Dabbagh and Bunni 1981). It occurs in orchards and riverine thickets of *Populus euphratica* and *Tamarix* sp. along the Tigris around Baghdad, Samarra and Baiji, and extends up the Tigris almost up to Mosul, as well as along the Diyala River up to Khanikin, about 200 km northeast of Baghdad (K.Y. Al-Dabbagh *in litt.*). Scott and Carp (1982) found it to be common in marshes and date gardens around Basrah in the southeast, but it is rather scarce and very local in Khuzestan, at the eastern extremity of its range. An account of the species' breeding biology has been given by Al-Dabbagh and Bunni (1981).

3) Marbled Teal (*Marmaronetta angustirostris*) – Wetlands of Mesopotamia probably once supported a large proportion of the world breeding population of this globally threatened species, listed as vulnerable on the IUCN red list. This species has suffered a rapid population decline, evidenced in its core wintering range, as a result of widespread and extensive habitat destruction. (Bird Life International fact sheet 2003). It is adapted to temporary wetlands, favoring brackish waters rich in emergent vegetation. Green et al. (2002) found that the number of plant species recorded is strongly correlated with the number of threatened waterbird species. Natural, freshwater wetlands hold more species of aquatic plants and invertebrates, and are of great value for threatened waterbirds such as marbled teal (*Ibid*.). This suggests that focusing conservation action on sites important for these declining waterbird species will bring benefits for other taxonomic groups that are also affected by the same processes of wetland loss and degradation

"The marbled teal is a fairly common summer visitor, breeding widely throughout the marshes of Mesopotamia. There have been very few winter records, the great bulk of population apparently migrating east to spend the winter on the floodplain of the Karun River in southwestern Iran"(Scott and Evans 1993). The marbled teal exhibits large population fluctuations, partly in response to annual variations in rainfall and is capable of dispersal movements in search of suitable habitat. It's rapid decline due to habitat loss is of particular concern because of its endemic status. "The Marble Teal is known to breed widely in Mesopotamia and in the extensive marshes of southwestern Iran. Ticehurst et al. (1921-22) reported it to be a fairly common breeder in central and southern Iraq, and Moore and Boswell (1956-57) found it breeding along dykes and irrigation canals in the Kut area, in the Hai area and at Haur Suweicha. Thesiger (1964) found it in the Central Marshes during the summer months, and noted that at that time it was one of the few birds 'fit to eat' in the

marshes. K.Y. Al-Deabbagh (in litt.) found it to be common in summer on most wetlands in southern Iraq during the 1970's and 1980's" (Scott & Evans 1994).

"However, there have been very few reports of Marbled Teal in Iraqi winter, and one was reported in Mesopotamia during the four winter surveys between 1968 and 1979. Thus it appears that the species is almost entirely a breeding summer visitor to Mesopotamia, as concluded by Georg and Savage (1970). The main wintering areas for these birds are almost certainly in neighboring southwester Iran, where some 25,000-30,000 have been recorded in mid-winter. As the known breeding areas in Iran, eastern Turkey and the Central Asian Republics cannot account for more than about 5,000 pairs, it is assumed that the breeding population in Iraq must be at least 4,000 – 6,000 pairs, which represents some 40-60% of the world population of this threatened species" (Scott & Evans 1994).

4) Pygmy Cormorant (*Phalacrocorax pygmaeus*) would also be good focal species because of its endemic status. Ticehurst *et al.* (1921-22) list this as a common resident, breeding in some of the marshes and moving out locally to the rivers and other marshes in winter. The birds certainly bred until the 1920s, and Ticehurst *et al.* concluded that there must be many breeding colonies in the Euphrates marshes. In July 1922, La Personne found the species breeding in large numbers in dense, high reed-beds at Bani Mansur in the Medina Marshes, 32 km north of Medina, and in vast numbers near Anzha in the Rotha Marshes, 25 km from Qurna (Cheesman 1922; Ticehurst *et al.* 1926). No one has found a colony since, and the breeding status of this bird remains obscure (K.Y. Al-Dabbagh *in litt.*). Maxwell (1957), Johnson (1958) and Thesiger (1964) found it commonly in the 1950s, and noted that the species was hunted by the Marsh Arabs. The waterfowl surveys between 1968 and 1979 confirmed that the species remained fairly common in the marshes, at least in winter, with up to 100 being recorded at one locality, and it seemed likely that the total number in the marshlands exceeded 500 birds. This would represent at least 10% of the flyway population, recently estimated at about 5,000 birds (Rose and Scott 1993).

5) Dalmatian Pelican (*Pelecanus crispus).* "The four surveys between 1968 and 1979 revealed that the wetlands of Mesopotamia are an extremely important wintering area for Dalmatian Pelicans. Some 247 were recorded in January 1979, and it was concluded that the total number in Mesopotamia at that time could be as high as 1,000. This figure represents about 30% of the regional population and about 10% of the total world population, which has recently been estimated at about 2,000-2,700 paiers (Crivelli et al.1991). It seems likely that some, if not many, of the birds observed in winter in Mesopotamia remain in the marshes to breed (Scott & Evans 1994).

This globally vulnerable species nests on unstable islands in inland and coastal wetlands (Crivelli et al 1997). The conservation of the pelicans depends on the availability and quality of these *Phragmites* island nesting sites. As these

islands are unstable, they suffer dramatic changes, with consequential impacts on pelican numbers and distribution (Catsadorakis and Crivelli 2001).

a. Nesting Dalmatian Pelicans do not tolerate human activities in the vicinity of the nest site, which is why they require large, disturbance-free, marshy areas with no direct visual or other contact with humans.

b. Pelicans are colonial nesting birds, nesting on natural "reed islands" consisting of *Phragmites australis* rhizomes. "Although the same islands might be used repeatedly in successive years, they suffer degradation from one year to the next due to action of ice, wind, waves, water level fluctuations and use by the birds (Crivelli 1987; Crivelli et al. 1998), thus forcing the pelicans to colonize new islands. The conservation of the pelicans therefore depends, at least in part, on the availability and quality of these nest sites. As these islands are unstable, they suffer dramatic changes, with consequential impacts on pelican numbers and distribution" (Catsadorakis and Crivelli 2001).

c. "Late in the breeding season, pelicans trampled a particular reed stand when using it as a resting or loafing site, before using it for nesting in the following year. The birds used stems of standing reeds to build their nests. In addition to the direct use of standing reeds, the birds' excreta and the covering of living stems by nest material gradually reduced natural growth, until reeds no longer grew at the site" " (Catsadorakis and Crivelli 2001). These cleared islands would also provide great basking areas for soft-shelled turtles.

d. Dalmatian Pelicans rarely colonize a site smaller than 7 m^2. Their nest density varies from 0.12 nests/ m^2 to 1.2 nests/ m2.

e. The formation of nest sites relies on the very existence of reed rhizome-islands and thus any hydrological or ecological change that diminishes reed propagation in suitable areas may affect the availability of sites. With eutrophication of water caused by anthropogenic nutrient sources, cattail (*Typha* sp.) tends to outcompete and ultimately exclude reed (*Phragmites australis*) (Graveland 1997; Van der Putten 1997). If cattails exclude reed in the marshlands, it will be detrimental to pelican nesting success. Lack of both standing vegetation and nest material from old nests will deter pelicans from nesting, even if space is ample and other conditions are favorable.

a. Optimal nest sites should have the following properties:
b. Inaccessible to mammalian predators;
c. Free of human disturbance;
d. Be as large as possible and certainly over 80 m^2;
e. Protected from prevailing winds;
f. Be as close as possible to other nest sites;
g. Be in contact with a large open water area;
h. Provide unobstructed view of more than 180 degrees;

i. Have a combination of live vegetation and open unvegetated spaces;
j. Contain readily usable nesting material;
k. Be resistant enough to last for more than one year;
l. Not be free floating;
m. Be high enough not to be affected by wave action;
n. Have gentle sloping edges to facilitate access by birds.

6. Sacred Ibis (*Threskiornis aethiopicus*) has a small, isolated population, and is clearly threatened; also a big, conspicuous species, easily identified and monitored. The isolated population of this primarily Afrotropical species in Mesopotamia is still very poorly known. Cumming (1918) found it to be 'plentiful' at Fao in winter. According to Ticehurst *et al.* (1921-22), 'White Ibises certainly occur and not very uncommonly in the district from Amara to Fao'. All of their records related to small flocks during the winter months, although they make reference to one report of paired birds in the marshes near Amara. La Personne found a breeding colony of about 20 pairs together with other breeding waterfowl including Pygmy Cormorants *Phalacrocorax pygmaeus* and African Darters *Anhinga rufa* at 'Rotha marshes' near Qurna in 1921 (Cheesman 1922), and Ticehurst *et al.* (1926) noted that the species was also breeding at Abid near Qurna at about the same time. Moore and Boswell (1956-57) never encountered it, but Maxwell (1957) observed it on many occasions in the Central Marshes and in the Haur Al Hawizeh marshes in spring 1956, and implied that it was common. However, he noted that the ibis was a favourite quarry species of the local hunters and was very wary. The species appears to have become quite scarce by the late 1960s. Only one was observed during the 1968 waterfowl survey, and none was recorded during the surveys of 1972 and 1975. However, flocks of 36 and 4 were observed in January 1979, at Haur Al Rayan and Qalit Salih respectively. The species appears to have become very scarce in Iraq in recent years, and has not been reported since the early 1980s (K.Y. Al-Dabbagh *in litt.*).

Up to 100 were found wintering in the Karun river marshes in southwestern Iran in the 1970s, and small numbers continue to appear in this area in winter, *e.g.* 16 in January 1992 (Perennou and Mundkur 1992). Although a few birds have been recorded in the Karun river marshes during the summer months, the species is not known to have bred in Iran, and it is assumed that the breeding grounds of the birds wintering in Iran are in the marshes of Mesopotamia.

7.White-tailed Plover (*Vanellus leucerus*) is a marsh edge species. Mesopotamian Marshes are (or were) perhaps the main breeding and wintering area for this species. (Derek Scott pers. comm. 2003).

8. Imperial Eagle (*Aquila heliaca*) – globally threatened, in the category vulnerable, and in the late 1970s wintered in Mesopotamia and neighboring SW Iran in very substantial numbers. Although not a wetland species during the breeding season, it seems to be largely dependent on wetlands

on its wintering grounds in the Middle East. “The Imperial Eagle is a fairly common winter visitor to the Mesopotamian plains. Although by no means confined to wetland habitats during the winter months, the species reaches its highest densities around large wetlands with huge concentrations of waterfowl, and this is especially the case in the arid regions of the Middle East where other habitats are much less productive. The mid-winter counts give only a poor indication of the number of birds present because of the high proportion of large birds of prey which remained unidentified. It seems likely, therefore, that the total wintering population of this species in Mesopotamia exceeds 100 individuals- a very significant number for threatened species with a world population of only about 1,000 – 2,000 breeding pairs” (Scott and Evans 1993). If these large birds of prey nest in the Mesopotamian marshes, elevated levels of DDT will impair nesting success significantly.

9. Lesser White-fronted Goose (*Anser erythropus*)

“*Anser erythropus* was formerly a regular winter visitor to central Iraq, although always less common than *A. albifrons*. Ticehurst *et al.* (1921-22) described it as 'not at all common' and list only a few records of small parties. According to Savage (1968), the species was still found in quite large numbers in the Haur Suweicha area in the 1960s. However, the species was recorded only once during the IWRB surveys: a flock of 70 at Haur Suweicha in December 1972. This species seems to have disappeared from its main wintering areas in Iran since about 1980, and is becoming extremely rare in the western part of its wintering range in Europe. It seems unlikely, therefore, that significant numbers still winter in Iraq, although small flocks may continue to appear from time to time” (Scott & Evans 1994).

Mammals

10. Grey Wolf (*Canis lupus)*

The Grey Wolf is classified as 'Vulnerable' by IUCN (Groombridge 1993). According to Hatt (1959), wolves in southern Iraq were reported chiefly on uncultivated lands at the desert fringe, living in the marshes in winter and following the flocks of sheep and goats into the desert with the advance of spring. Thesiger (1964) observed wolves on several occasions near Amara. However, there are no recent records from lower Mesopotamia, and if the species still survives in the area, its population size must now be very low (K.Y. Al-Dabbagh *in litt.*).

11. Wild boar (*Sus scrofa*) were abundant throughout the marshlands, particularly common at Hawr Al Hawizeh. Thesiger (1964) and Maxwell (1957) make numerous references to the abundance of Wild Boar throughout the marshlands, and found them to be particularly common at Haur Al Hawizeh.

They caused damage to crops and people and were relentlessly hunted by the Marsh Arabs. Maxwell refers to one village which claimed to have killed 140 Wild Boar in one year, while Thesinger (1954) shot as many as 47 in a single day and 488 in two years (Young 1989). Whether this hunting has led to a reduction in numbers is unknown, but it is perhaps significant that not a single Wild Boar was encountered during the waterfowl survey in January 1979 (Carp and Scott 1979). In addition, K.Y. Al-Dabbagh (in litt) reports that although the Wild Boar is still the most abundant mammal in the marshes, numbers have declined noticeably during the last few years compared to levels in the early 1970's." (Scott & Evans 1994).

12. Water Buffalo *(Bubalus bubalis*)– abundant throughout the marshes and are of considerable cultural significance. "According to Maxwell (1957), there is evidence to suggest that these animals were first introduced into Mesopotamia about 5,500 BP. Hatt (1959) presents archeological evidence which suggest that these animals were first introduced into Mesopotamia about 5, 500 BP. Hatt (1959) presents archeological evidence which suggest that the species was formerly wild in the marshes, before domestication. (Field Notes: Mr. Abu Hassan was an Iraqi veterinarian with expertise in water buffalo. He said there were many different varieties. He said that at one point a disease killed over 90%, but they came back. They can be reintroduced to come back again. Mr. Majed Alhasan told the story of how they loved the buffalo like their wives, their children; he explained the buffalo were part of their family. He said that a poison was put in the water that turned the water blue and the buffalo died – maybe cyanide. He also said when the people ran from the helicopters with machine guns and hid in the marshes, the water buffalo died of starvation. These are truly a metaphor for the Marsh People and a poster child. Water buffalo could be reintroduced from neighboring areas, perhaps India or Iran (Stevens unpublished field notes 2003).)

13. Small Indian Mongoose (*Herpestes auropunctatus*) "This is the common mongoose of the Tigris, at least from Fao to Baghdad. The Arab children tame them easily and tame them as pets for a few annas. Connor remarks that his female from "Amara had full grown young following her in August. The first Arabic name, literally, rat of the palm-tree, is misleading, and some men have seriously informed me that they live on dates. But the Arab is not accurate in his observations and seeing a mongoose in a palm tree probably led to this belief." (1915-1919 Expedition Notes). The small Indian Mongoose is frequently seen around the marsh edges and in reed-beds (K.Y. Al-Dabbagh in Scott and Evans 1993).

14. Indian crested porcupine (*Hystrix indica*)
"The porcupine is sparingly distributed among the rocky undulations and hills, but there is no record of its appearance on the plains. I have seen porcupine quills in the caves of the hills between 'samarra and Tekrit on the right bank of the Tigris. On the mounds of Susa near the Kerkha river there was a well used earth of this animal with beaten tracks leading to it." (1915-1919 Expedition notes). The Indian Crested Porcupine has been recorded in and around the

marshes in the past, but had become rare by the 1980's, and it is thought likely that most are now extinct in the area. It is still widespread and fairly common elsewhere in the Middle East and is not restricted to wetland habitats (Scott & Evans 1994).

15. Smooth Coated Otter (*Lutra lutra* and *L. perspicillata*) "The marsh Arabs spear them by moonlight with a trident ☹. So far otters have been most in evidence in the marshes in the lower reaches, but there is little doubt that they are found throughout the length of the larger rivers." (1915-1919 Expedition Notes). Thesiger (1964) saw otters on a number of occasions, and remarked that they were said to be very common around Hawr Al Zikri in the Central Marshes. However, he noted they were widely hunted for their skins, and mentioned one person who shot 40 otters in the Euphrates, at the Hindiya barrage upstream of the marshes. Maxwell (1957) obtained two skins and two live cubs from Hawr al Hawizeh in 1956, and implied that there were thousands of otters in the marshes at that time. No otters were recorded during the four waterfowl surveys between 1968 and 1979, and it seems likely that by that time the populations of both species were becoming much depleted by the hunters (Scott & Evans 1994). "However, otters are now extremely rare in the marshes, if they still survive at all. K.Y. Al-Dabbagh (in litt.) reports that he has not seen any in the marshes since the early 1970s (up until 1990), and has heard no mention of otters during discussions with soldiers who served for long periods in Hawr Al Hawizeh in the 1970's and 1980's."

Pedra and Granado-Lorencio (1996) found that protection of fish resources in streams may be the most beneficial to otter populations in areas where agricultural practices and some degradation in bankside vegetation do not seem to affect otters negatively. According to Green and Green (1980) the preferred otter habitat comprises the slower and more productive middle and lower reaches of rivers. Otters in the study area seemed to respond to prey availability, in the form of larger prey size, rather than to riparian floristic composition and habitat structure. The importance of prey availability on otter habitat use has been stressed by many other authors (Kruuk et al 1993, Elliot 1983). The reduction of river pollution must be the first target in otter conservation plans (Delibes 1990). Protection of riparian vegetation is the third key element to conservation of others, especially bankside vegetation and lack of human disturbance.

16. Jungle cat ((*Felis chaus*)– GREAT umbrella species - "This is the cat frequently met with on the Tigris among the scrub-jungles by the river. It grows to such a size that it is easy to mistake it for the jackal at a short distance. Its black ear tufts, yellow tinge of coloring and short tail have led in many

instances to the reports of caracals and even lynxes being seen or shot on the Tigris and Euphrates during the war." Jungle Cat (*Felis chaus*) has been recorded in and around the marshes in the past, land all had become rare by the 1980s. It is thought that is may be extinct in much of the area; it is still widespread and fairly common elsewhere in the Middle East. Jungle Cat is restricted to wetland habitats (Scott and Evans 1993). Felis chaus is a not uncommon species of the irrigated areas and along the rivers in the 1970's (Thalen 1979).

Amphibian/ Reptiles

17. Soft shell turtle (*Rafetus euphraticus*)–Marsh Dwellers have said the male is much bigger than the female, and they are common in the marshes. They said the turtles were quite common, and they would see they swimming or basking on the banks. The fisherman have to guard their fishing nets all night or the turtles would rip the nets and eat the fish. They killed them if they caught them. (Stevens unpublished field notes 2003).

"The soft shelled turtle is a large to giant sized turtle which is endemic to the Tigris and Euphrates Rivers. It prefers relatively calm tributaries and oxbow lakes (Takavak and Atatur 1998). It is largely carnivorous, but sometimes consumes plant material. The northernmost limit of its range in Turkey in the Euphrates basin between Karakaya and Ataturk dams. The population in this area is in jeopardy because of decreased temperatures of the dam impoundment waters and a lack of suitable sandy banks for nesting. Former basking and nesting areas are now submerged, and daily water level fluctuations complicate the establishment of new nesting sites. The authors consider the species to be endangered in Turkey, based on lack of suitable habitats and declining population levels (*Ibid*.). Downstream impacts of desertification, pollution, poisons and lack of prey in the Mesopotamian marshes exacerbate concern of potential extinction of this species. The closest relative of the *R. euphraticus*, *R. swinhoei* from Viet Nam and SE China, may be extinct in the wild and is only known from a few individuals in zoos and in a park in Hanoi. Therefore in terms of biological diversity, *Rafetus euphraticus* is a very unique animal representing some 65+ million years of independent evolution" (Dr. Tag Enstrom, pers. comm. 2003).

Dr. Ertan and Dr. Enstrom were funded by the Wildlife Conservation Society in 2001 to do surveys and genetic work in the Turkish portions of the Tigris and Euphrates in order to evaluate the effect that the extensive damming has had on those populations (T. Enstrom, pers. comm. 2003). They found that there were still significant populations of *R. euphraticus* in areas with appropriate habitat in both the Tigris and Euphrates, even if that habitat has been significantly altered (*Ibid*). However, the softshelled turtles are essentially absent immediately above and below the dams. This is probably because these turtles require slow moving, warm water with a silty bottom. This sort of habitat is destroyed close to the dams but still exists in isolated pockets

downstream and in the tributaries that empty into reservoirs. In the marshes, turtles would not do well in the drainage ditches but may be hanging on in isolated pools and puddles in the marsh.

Very little is known about the nesting requirements of *R. euphraticus*. It seems that they nest on the sandy beaches along the river banks, however farmers in the area also reported soft shelled turtles roaming in fields fairly distant from the river. Their interpretation was that the turtles were foraging on tomatoes but they may have been females looking for a place to nest.

Conservation Recommendations

- Maintain appropriate habitat of require slow moving, warm water with a silty bottom;
- Maintain adequate prey base, particularly of fish, frogs, worms, insect larvae, and shellfish;
- Prevent illegal sale by local people to tourists;
- Prevent or clean up domestic and industrial water pollution in Euphrates and Tigris river systems;
- Local farmers and fishermen should be educated to prevent the unnecessary killing or abuse of softshelled turtles in the wild;
- Maintain sandy banks for nesting sites and basking sites; and
- Due to the fact that softshell turtles are resilient to anthropogenic disturbance, they may be able to withstand the habitat desiccation provided refugia are maintained and habitat fragments expanded within dispersal range.

Very little is known about the importance of migration in the life history of these turtles. Many turtles will travel 10's or 100's of km between nesting areas, foraging grounds, and hibernation or aestivation habitats. Marine turtles are the best known for this habit but many Amazonian turtles and softshelled turtles in other areas also exhibit similar behaviors. No one knows if *R. euphraticus* undertakes this sort of long distance migration; it is very possible that at least historically extensive seasonal migrations were an important part of the life history of softshelled turtles in the Tigris and Euphrates Rivers. Such migrations are not possible now because of damming and draining of habitats.

"I think that using *Rafetus euphraticus* as a flagship species to garner public interest for restoration of the marsh would be a great thing. One thing I would be careful of though is that these turtles seem to be able to live in fairly disturbed habitats, therefore they may not be a great overall indicator of the health of the habitat. It will be important to also work with other species that may not be as visible and charismatic but are more sensitive to changes in the marsh ecosystem" (Dr. Tag Enstrom pers. comm. 2003).

Insects/ Invertebrates

18. Dragonfly (*Brachythemis fuscopaliata*) "This species of libellulid dragonfly, described by Selyx in 1887, is known only from Iraq, Israel and Turkey. It has been collected in the marshes of Mesopotamia, but no recent information is

available on its status there. This species is classified as ‘Endangered’ by IUCN (Groombridge 1993)” (AMAR 1994).

Since dragonfly larvae are aquatic, they can be used in making rapid assessments of water quality. In addition, because they are they have considerable potential for the biological control of mosquitoes which transmit diseases to human beings

19. Penaeid Shrimp (*Metapenaeus affinis*)

“Salman et al. (1990) studied the abundance and seasonal migrations of the commercial penaeid shrimp *Metapenaeus affinis* between the Gulf and its nursery grounds in the inland waters of Iraq. Immigration to the marshes starts from May/June and emigration finishes around January/February. Large-sized shrimp (up to 125 mm total length) were abundant in the marshes. The discharge of the Shatt Al Arab may be an important factor regulating recruitment. Spawning at sea appears to occur immediately after emigration. Commercial landings, at the two main fish markets at Basrah, during September-November 1985 averaged 1,000 kg/day” (Scott and Evans 1993). More information on Penaeid shrimp is included in the Fisheries Section.

KEYSTONE SPECIES

Common reed (Phragmites australis)

According to Rodewald-Rudescu (1974), the main conditions for an optimal growth of Phragmites australis are:

1. The soils should be covered by water, at least during the growing season, preferably by a layer of 0.50 to 1.50 m (optimal 0.70 – 1.25 m).
2. The stands should be continuously provided with running or upwelling water, to provide the necessary nutrients to vegetation and to evacuate toxic assimilation products.
3. Yearly, certain environmental conditions (low temperatures and/or low solar energy income and/or drought or deep flooding) should cause a stagnation in growth, necessary to prepare the root and rhizome system of the plants for the new vegetative period.
4. During the period of rest, the rhizome and root systems should be protected against damage by drying out, extremes of temperature, mechanical destruction by waves, ice, winds or fire and destruction by harvesting machinery.
5. Large spatial differences in reed development and height may occur as a result of differential nutrient supply and hydrological variation.

Although the soils of the marshes are rich in clay and organic matter, the plants are highly dependent on river water with its loads of nutrients and silt. As a result of channel flow dynamics, many large *Phragmites* stands are starved of nutrients and their growth is stunted. As in the Danube Delta, only the borders of the creeks receive enough nourishment to develop reeds to heights of 8 m as observed by Thesinger (1967). Many central parts of the extended *Phragmites* swamps are not crossed by creeks and are therefore starved of sufficient nutrients (Rodewald Rudescu 1974).

Phragmites has a wide ecological amplitude, and is tolerant of high salinity, anaerobic soil conditions, and drought (Serag 1996). Rhizomes remain viable for a period of 8-9 years, and can have creeping stolons up to 15 m long. Phragmites is able to grow within a pH range of 6.9 to 9.3. It tolerates soil conductivity up to 12 mS/cm; however, higher salinity levels are a well-known stressor of *Phragmites australis* (Burdick et al 2001). Descriptive observations along salinity gradients show reduced vigor and success in brackish and salt marshes (Gallagher et al. 1987; Haganu et al. 1999). Increasing salinities result in decreased reed plant biomass; decreased plant density and plant height; and decreased habitat value (Zhao et al. 1999). From a restoration perspective, *P. australis* is likely to take advantage of spring rains, pockets of fresher water, and fresher groundwater supplies to expand clonally. Canopy height, an indicator of vigor, declined with increasing salinity levels. *P. australis* may obtain fresh water at depth, tapping into deeper, less saline sites, and not be restricted with high soil salinities. The maximum abundance of *Phragmites* was recorded in rich organic matter and alkaline habitats (Serag 1996). The maximum aboveground biomass of the reed in 1992 occurred in September and

was 55 g/m^2 (fresh) and 4400 g/m^2 (dry). The maximum below-ground biomass occurred in October and was 2500 g/m^2 (fresh) and 1100 g/m^2 (dry).

Genotypic variation is quite high between different clones; susceptibility to high salt concentrations was variable between different clones. Reed density, height, stem diameter and biomass were differentially affected by saline conditions in different clonal forms (Hanganu et al. 1999). *Phragmites* is self-incompatible, and may be limited by pollen availability. The addition of pollen from outside clones increased the seed set rate. Pollen limitation brought about by the clonal structure of *P. australis* populations may be the most important factor in seed production (Ishii et al. 2002). Revegetation success is likely to be increased by planting different clones in proximity to each other for optimal seed set. Tissue culture can increase plant propagation, and is an alternative to conventional seed germination and vegetative propagation techniques or harvest in nature (Lauzer et al. 2000).

P. australis seedlings don't grow as well when submerged, inhibiting successful colonization at certain water depths (Mauchamp et al. 2000). Colonization by reed seedlings is rare and usually occurs after drawdown and when shallow water prevails.

Excessive nitrogen supply, anaerobic conditions in the root surroundings, disturbance and high water levels all affect reed vitality through changes in the carbon budget. Excessive nitrogen supply acts as the main predisposing factor for reed decline (Cizkova-Koncalova et al. 1992). Quite often, *Typha* sp. are given the competitive advantage with increased nutrient supply, and *Phragmites* is at a disadvantage. Die-back of *P. Australis* is due to the interactive effects of Eutrophication and stabilized high water tables (Armstrong et al. 1996; van der Putten 1997).

Physiological studies indicate that common reed is sensitive to specific combinations of duration and depth of inundation and substrate composition (Weisner and Ganeli 1989, Weisner 1996). Weisner (1996) found that eutrophic lake sediments may reduce growth in the reed clones. The presence of common reed was found to be inversely correlated with sediment accumulation on the marsh surface, and may be found where it experiences less O^2 stress associated with lower depth and frequency of inundation, coupled with a related reduction in the rate of organic sedimentation (Pyke et al 1999).

Water management for reed cutting would benefit reed warblers, because it tends to produce monospecific stands with tall and thick reed, which is their preferred habitat (Poulin et al. 2002). Overall bird abundance was associated with specific vegetation parameters (reed diameter, dry reed density, growing reed height) which would be associated with water levels, salinity, and reed cutting *(Ibid*.). Appropriate water management and traditional reed harvesting would prove beneficial to Basrah reed warbler populations in the marshes. Both cutting and burning Phragmites australis resulted was beneficial to the flora. Burning appears to open up the litter for seedling establishment, favors early shoot emergence and gives a higher density of reed stems Cowie et al 1992). Many more plant species were abundant in burnt rather than cut plots. Slight

scorching in the spring breaks internal dormancy, resulting in an increased density of shoots; the more numerous buds are smaller and the aerial shoots shorter in consequence.

Common reed serves a number of important functions in freshwater habitats. Reedbeds increase the productivity of a watercourse through the growth and decay of vegetation and indirectly by providing habitats for periphyton, marcoinvertebrates, fish and wildlife (Armour et al 1991) Reeds also provide spawning substrates for fish and areas in which fry and adult fish can shelter (Caffrey 1993). From a bankside stabilization viewpoint, reeds absorb and dissipate wave-wash energy (Pearce & Eaton 1983). The belowground biomass, including both rhizomes and roots of reed and cattail species stabilized the soil and binds it firmly in place. In so doing they provide bank stabilization and prevent erosion. Caffrey and Beglin (1996) found they achieved much higher restoration success from using plugs of rhizomes than from attempts to grow from seed.

Salt Cedar (Tamarix spp.)

Salt cedar (*Tamarix ramosissima*) has been extensively studied, as it is an exotic species introduced into North America that has invaded many thousands of hectares of riparian habitat in the western United States. The mechanisms for invasion into western riparian areas are the same mechanisms that should make *Tamarix* an excellent colonizer and early successional species for restoration of the Mesopotamian riparian areas. Rapid expansion of Tamarix is due to the following: 1) rapid growth and prolific seed set; 2) high transpiration rate; 3) preferential allocation to roots during early establishment; 4) high tolerance to both inundation and water stress; 5) halophytic nature and ability to excrete salt; and 6) rapid recovery from fire via basal spouting (Smith et al., 1998).

Tamarix is a facultative phreatophyte (deep-rooted to reach water table) that often depends on groundwater for its water supply), making plants quite resilient to drought conditions. Mature salt cedar trees are very resistant to mechanical injury, grazing, burning, heat, cold, drought, water inundation, and high concentrations of dissolved solids. Though the seeds will germinate rapidly, new seedlings require wet soils for several weeks. Under ideal conditions, seedlings can grow 3 to 4 m in a single growing season (Sisneros 1991). Seedlings mature rapidly and produce small white or pinking flowers, often by the end of the first year of growth (Neill 1985). Seeds are quite small and light (0.1 mg) (Sisneros 1991), and are aided in wind dispersal by a tuft of hair. A large salt cedar plant can produce half a million seeds per year (DiTomaso 1998). The ability of *Tamarix* to produce an almost continual supply of seeds during the growing season allows it to colonize areas all season long, and to take advantage of any available rainfall or moisture (Engel-Wilson and Ohm art 1978).

The tiny seeds of salt cedar have high initial viability (Neill 1985). However, seeds remain viable for only about 5 weeks under normal conditions. Because

of their short-lived viability, salt cedar seeds must come in contact with suitable moisture within a few weeks of dispersal. Consequently, for germination to occur following water dispersal, it is important that the availability of seeds coincide with the time of peak annual discharge, so that seeds will settle and germinate in a suitable location at high-water marks (Everitt 1980).

Several factors contribute to the low seedling survival of *Tamarix*. For seedlings to establish successfully, they require a combination of saturated soil for the first 2 to 4 weeks of life, open sunny ground, and the absence of competition (Brotherson and Field 1987). These conditions are typically provided by a gently sloping riverbank, sandbar, or silt bar, where slowly receding water level of river, stream, or reservoir create optimum seedbeds (Shrader 1977). These conditions seem conducive to revegetation on the shallow banks of the Tigris and Euphrates. Seedling roots grow slowly within the first four weeks and will not survive more than one day if the soil dries (Kerpex and Smith 1987). Seedling establishment also requires at least 4 to 6 weeks without subsequent inundation (Kerpex and Smith 1987). Mortality is also high when soils are scoured by high water flow velocities. Although seedlings can survive submerged for a few weeks, they are easily uprooted by even a week current within a period of several months subsequent to germination (Kerpex and Smith 1987).

Tamarix prefers very saline soils; it also has a slight preference for alkaline conditions (pH 7.5) but it is also commonly found in more acidic growing conditions (Brotherson and Winkel 1986). Typically, Tamarix occupies sites in the American west with silt loams and silt clay loams high in organic matter, intermediate moisture, high water tables, and little erosion (Bortherson and Winkel 1986). They can resprout vegetatively after fire, severe flood, or treatment with herbicides and are able to accommodate wide variations in soil and mineral gradients, as well as environmental stress condition (Brotherson and Field 1987).

Tamarix is a facultative halophyte that is capable of tolerating soluble salt concentrations in the soil ranging from 650 to 36,000 ppm and averaging between 6,000 and 8,000 ppm (Brotherson and Winkel 1986). Jackson et al. (1990) reported inhibition in cottonwood and willow growth by salinity greater than 1,500 ppm. Consequently, salt cedar species have a distinct advantage over other native riparian species in the American west, and probably many Populus, Salix and Platanus species in Mesopotamia.

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