

Status of Euphrates Soft-shelled Turtle *Rafetus euphraticus* in the Iraqi Central Marsh

Nadheer A. Fazaa^{1,2*}, Jonathon C. Dunn¹ & Mark J. Whittingham¹

Abstract— The Euphrates softshell turtle *Rafetus euphraticus* is classified as Endangered on the IUCN Red List and is thought to have undergone large, recent population declines. Species information in Iraq is limited to a few rapid surveys with little detailed information on breeding and distribution. The study aimed to record basic reproductive parameters and counts of Euphrates softshell turtle within the Central Marsh (CM). Transect line methodology (150-200 m fixed-width) was used to record the distribution of Euphrates softshell turtles within the study site and nine surveys were carried out from October 2013 to June 2014. Only turtles outside of the water were recorded as surveys were from a motorized canoe and so it was not possible to survey turtles in the water accurately; thus our counts are likely to underestimate true numbers. The total number of nests and eggs found were five and 34 respectively. The mean nest diameter \pm SD was 7.8 ± 0.77 cm and the average diameter \pm SD of the spherical eggs was 2.63 ± 0.14 cm. The highest counts were in the breeding season (April, May, and June). Simple extrapolation of our counts to the entire CM suggested a maximum population size of 212 - 283 individuals/141,615 ha. Results from our surveys suggest the start of breeding season for *Rafetus euphraticus* in the CM is two months earlier than in Iran and Turkey.

Keywords— Euphrates soft- shelled turtle, *Rafetus euphraticus*, Iraqi Marshland

I. INTRODUCTION

The Euphrates softshell turtle *Rafetus euphraticus* (Fig. 1) is classified as Endangered on the IUCN Red List and is thought to have undergone large, recent population declines [1,17].

The turtle is distributed across Iraq, Syria, Turkey, and Iran [2]. Although Iraq is thought to contain the largest number of suitable sites for the species [3], there is a lack of information within the country on this species [4]. The first published observations in Iraq (after anecdotal records in the 1960s) were in 1992 from the Euphrates River [5].



Fig. 1. Photograph of Softshell Turtle in Iraq's Central Marsh

The species was subsequently recorded in Iraq from 2005 onwards during KBA (Key Biodiversity Area) surveys in nineteen sites all over Iraq; two sites in the Kurdistan region and Mosul ([4]; eight sites in the central part of Iraq and nine sites in the south of Iraq [3]; Fig. 2). However, these surveys were rapid and more intensive surveys at finer spatial scales are needed to obtain a more accurate understanding of the species' distribution and conservation status. Similarly, while some of the turtle's breeding ecology and conservation status have been described within the turtle's other range countries [6], there have been no such studies within Iraq.

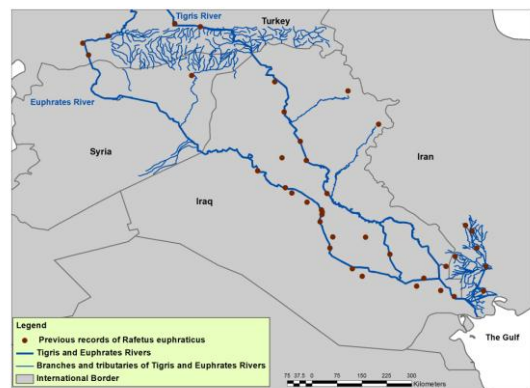


Fig. 2. The regional distribution of *Rafetus euphraticus* across the Mesopotamian Rivers basin in Turkey, Syria, Iraq, and Iran (area 950,876 km²). Each dot gives the location of sites where the Softshell turtle has been recorded based on the published literature. Data were obtained from Nature Iraq www.natureiraq.org and The Global Biodiversity Information Facility [7] <http://www.gbif.org> and were manipulated using ArcGIS software (version 10.2.1).

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Our study focuses on the Central Marsh (CM) in the south of Iraq, which has been identified as a potential stronghold for the species based on habitat suitability [3]. The CM (Fig. 3) is one of the three largest wetlands in Iraq formed as part of the Tigris-Euphrates river complex. The CM formerly covered around 300,000 hectares, but was almost totally drained following the 1991 uprisings in Iraq and has since been re-flooded in 2003-4. While the CM is the first national park in Iraq (declared in July 2013 under the name Mesopotamian National Park or MNP; [8, 9], the area is used extensively by humans. Studies from Iran and Turkey have shown that habitat modifications, water pollution and persecution by fishermen are the main threats to the survival of the turtle and this may also be the case in the CM [2, 10]. However, whether the softshell turtle faces similar threats in the CM is not fully known, in part because detailed surveys have not yet been undertaken in the area. Similarly, a full understanding of the turtle's breeding ecology and conservation in the CM is lacking. This dearth of information could have important conservation ramifications for the softshell turtle in the CM. For example, the rising human population of nearby Chibayish city is predicted to increase human activities in the study site, and scarcity of water in the Euphrates River could negatively affect wildlife. Knowing where the turtle is distributed in relation to threats and whether its nesting grounds are vulnerable to such threats could help conserve the species and to create a more resilient population for the future.

Given the lack of scientific information on the Euphrates softshell turtle *Rafetus euphraticus* in Iraq and the likelihood of their occurrence due to suitable habitat, we aimed: (1) to make counts of Euphrates softshell turtles in the CM and to record basic reproductive parameters; (2) to calculate simple population estimates of the species with the CM by simple extrapolation of count data. These results are discussed in relation to both the CM and Iraq as a potential stronghold for the softshell turtle population.

II. METHODS

A. Site Description

The study site is 40,000 hectares in area and is part of the CM (or MNP) that is located downstream of the Mesopotamian Tigris and Euphrates rivers (Fig. 3). The total extent of the MNP is 141,615 hectares and is located between three provinces Thi-Qar from the south and west, Basra province from the east, and Missan province from the north. The MNP was chosen to be a protected area for habitat and species management for natural conservation according to IUCN criteria IV [11]. The area was rapidly monitored for five years between 2005-2010, and defined as a KBA (Key Biodiversity Area) and IBA (Important Birds Area) site [3]. The area has four vegetation forms [12]: submerged aquatic (*Ceratophyllum demersum*, *Myriophyllum verticillatum*, *Najas marina*, *Potamogeton crispus*, *Potamogeton lucens*, *Potamogeton nodosus*, *Vallisneria spiralis*), floating-leaved aquatic (*Lemna minor*, *Nymphoides indica*, *Salvinia natans*), herbaceous tall emergent (*Phragmites australis*, *Schoenoplectus litoralis*, and *Typha domingensis*) and

herbaceous low emergent (*Copa monniera*, *Jussiaea repens*, *Polygonum salicifolium*, *Ranunculus sphaerospermum*).

To aid management, we sub-divided the study area into three zones (Fig. 4). We did this based on similarities in the type of human activity that occurred there (e.g. fishing, reed-cutting and milk production by water buffalo), the intensity of water buffalo grazing and the dominant type of vegetation. This classification was made by visual inspection of the CM and was descriptive only (based on qualitative impressions made during the survey work). Zone one started from the south in the Euphrates River, with zones two and three extending north inside the national park. Zone one had the most human activity, grazing of water buffalo and *Typha domingensis* was the dominant plant species. Zone two had intermediary levels of human activity and water buffalo grazing with *Typha domingensis* and *Phragmites australis* the dominant plant species, and zone three had the least amount of human activity and grazing with *Phragmites australis* the dominant plant species. See Fig. 6 in the Appendix for photographs of each zone.

B. Field Surveys of Euphrates Softshell Turtle *Rafetus euphraticus*

Transect line methodology (150-200 m fixed-width) was used to record the distribution of the Euphrates softshell turtle (outside water) within the study site [13]. A motor canoe was used to carry out all surveys (see photo in Appendix). Only turtles outside of the water (e.g. basking) were recorded from our surveys. This was because turtles were only visible when in the water when they were immediately (within a few meters) of the canoe and so coverage was only within a few meters of the canoe. Although this survey method will likely underestimate turtle numbers it enabled coverage of a much larger area.

Three longitudinal water transects (each 30 km in length) were selected to encompass parts of the nine water channels that feed the area from the Euphrates River in the south of the MNP through Chibayish city to the North of the site. The first transect started from Abo Sobat channel in the middle of the main water channels, the second transect started from the last channel in the eastern side of the park in Al Kinziri village and the third transect started from the first channel in Al Hamrawia (Al Moajed village) in the West side of the MNP (Fig. 3). Each of the three transects crossed each zone (Fig. 4). Nine surveys were carried out to survey the Euphrates softshell turtle in the CM from October 2013 to June 2014 (for exact dates see the Appendix). An additional ten km-long transect (transect four) in zone two was added to observe and monitor the breeding season of the turtle in April, May, and June, 2014 (Fig. 4), providing a total transect network of 100 km for those months. Additional time was included in the survey visits to incorporate the extra time needed to cover the fourth transect.

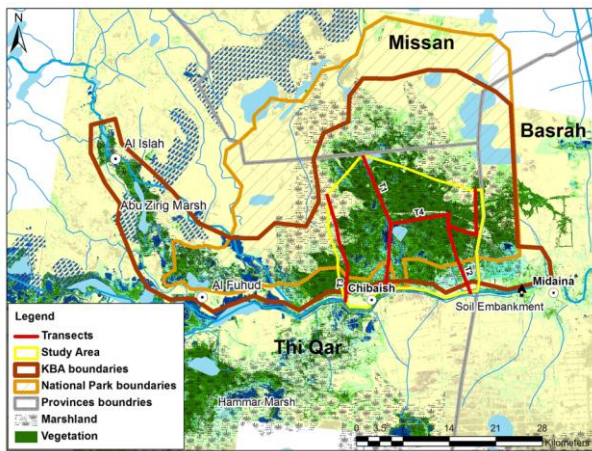


Fig. 3. Detailed map of the study area (enclosed by the line in yellow). Boundaries of the protected area and KBA are also shown by the brown and orange lines respectively. Locations of the three transects within the study area are shown in red lines.

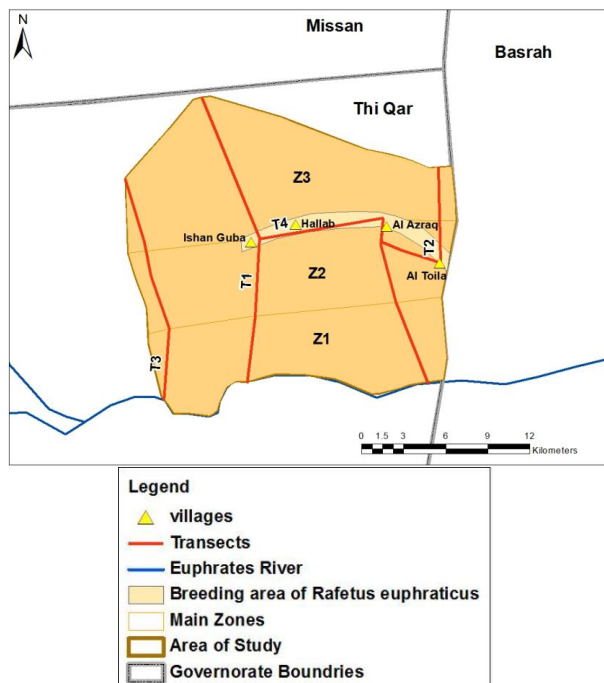


Fig. 4. Breeding sites of *Rafetus euphraticus* in the CM. The survey direction is north.

Three days were spent in the area in each survey (one day/transect), and six – eight hours per day were spent inside each transect. All field observations were collected in the morning starting from the river in zone one and finished in the afternoon at the end of zone three (we started our surveys early in the morning and returned back to the starting point in the afternoon). However, the precise time we conducted surveys differed between summer and winter surveys (5:30 – 12:30/13:30 in the summer, and 7:00 – 14:00/15:00 in the winter). Our sampling design was constrained by safety considerations and logistical difficulties, which made it impossible to conduct sampling in zone three in the morning. A Canon 7D camera with Sigma lens 135 x 400 and Canon lens 100 x 400 and 8 x 42 binoculars were used to observe the turtles up to 150 - 200m from the transect line, a tape measure

was used to measure nest and egg dimensions, and a Garmin GPS device was used to draw the three transects and record locations of turtles and their nests. We recorded the number of turtles, the number of nests, egg dimensions and the soil composition of each nest. Given the turtle's poor conservation status, we did not disturb the nests and were not able to record actual clutch size (we did not want to pick up eggs in order to see how many lay beneath) only an estimate from visual observation. Soil samples were analyzed by the Centre of Environmental Researches, University of Technology in Baghdad.

C. Calculating the Population Density of the Softshell Turtle

To estimate the population density of the Euphrates softshell turtle *Rafetus euphraticus*, we counted the number of turtles (individuals outside water) within 150-200m either side of each transect (total width of 300-400 m) and then used the following equation to provide estimates for each survey month. Although this is a simple extrapolation from our count data we have presented this information as there is a dearth of data on population numbers of this species. We used the equation identified for calculating population density estimates for fixed-width line-transects to provide density estimates for the total area of land surveyed [13]. To provide a maximum population estimate for the softshell turtle within the CM, these results were then extrapolated. The extrapolation was undertaken by multiplying the population density from our surveys to the entire area of the CM. There are several caveats with this value: (i) we assume that the habitat within the CM was relatively homogenous but, of course, this is a simplification; (ii) counts were only of turtles outside the water and so inevitably many turtles in the water will be missed; (iii) we did not cover the entire study area but sampled transects within it. We caution that in reality the turtle population could be more accurately surveyed with other methods (e.g. mark-recapture).

Equation. Where: D = density, n = total number of animals detected, W = width of transect and L = length of transect.
 $D = n / (L \times W)$

III. RESULTS

A. Field Surveys of Euphrates Softshell Turtle *Rafetus euphraticus*

Records of the Euphrates softshell turtle *Rafetus euphraticus* varied between the nine months surveyed. Turtles outside of the water were recorded in only four of the nine surveys. Two turtles were found in October in T3, Z1, but no turtles were found from November to March. Most records came from the April, May, and June surveys. Five individuals were recorded in April (Two adults and one dead juvenile that was 11 cm in length in T1, Z2 and two adults in T2, Z2), six individuals were recorded in May (One adult and one juvenile that was 22 cm in length in T2, Z1, Two adults in T2, Z2, and Two adults in T1, Z2), and two adults in June. All records from these three months were in transects one and two (Figure 5).

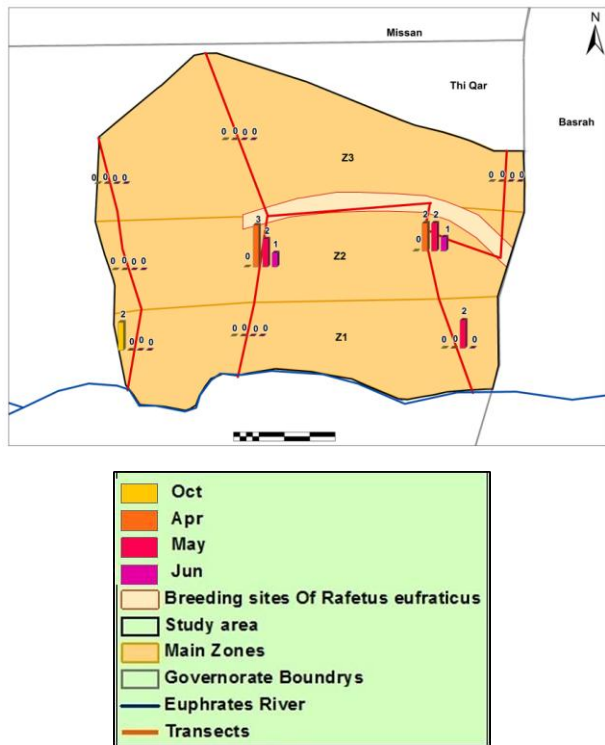


Fig. 5. Monthly individual records of *Rafetus euphraticus* in the CM. Surveys from October, 2013 to June, 2014.

The additional survey in transect four (T4) showed that zone two, and especially the area located between transects one and two near to small local villages (Ishan Guba, Halab, Al Azraq, and Al Toila), contained the largest numbers of breeding turtles (Figure 4). The total number of nests and eggs found were five and 34 respectively. The mean nest diameter \pm SD was 7.8 ± 0.768 cm ($n = 5$) and the average diameter \pm SD of the spherical eggs was 2.63 ± 0.141 cm ($n = 34$). The smallest number of nests was in June and the largest was in May, while the smallest number of eggs was in April and the largest was in May (Table 1). These observations are supported by photos of the turtle, nests and eggs in the field (Figure 7 in Appendix).

TABLE I
NUMBERS AND DISTRIBUTION OF *RAFETUS EUPHRATICUS* NESTS IN THE CM. NOTE THAT NESTS WITH STAR * ARE INDEPENDENT I.E. DIFFERENT NESTS IN EACH MONTH.

Villages		April 2014	May 2014	June 2014
		Number of nests	Number of nests	Number of nests
Ishan Guba	T1-zone 2	2*	2	2
Halab	T1-zone 2	1*	1	0
Al Azraq	T2-zone 2	0	1*	0
Al Toila	T2-zone 2	0	1*	0
Total in the CM		3	5	2

All nests and eggs were recorded in zone two of the study area and were focused in one sector (transect four;). Nesting was first recorded in the middle of April and the highest

number of eggs was recorded in May (see list of survey exact dates in the Appendix). The turtles nested in the soil on the bank of the marsh's water. The soil composition of the nesting sites in the CM (collected from soil data at nest locations) was 18.6% sand, 35% clay and 46.4% silt as averaged across all the samples ($n = 4$).

B. Estimation of Population Density from Counts of Softshell Turtle

Turtle counts varied between monthly surveys and seasons: there were no records in the winter, while the highest density was recorded in the breeding season (April, May, and June; Table 2). The maximum population size (based on simple extrapolation – see methods) likely to be sustained by the CM is 212 - 283 individuals.

TABLE II
ESTIMATES OF EUPHRATES SOFT SHELLED TURTLE DENSITIES IN THE CM (MNP) WITHIN A FIXED-WIDTH DISTANCE OF 150 - 200 M (TOTAL WIDTH = 300 - 400 M) FROM THE TRANSECT LINES (BASED ON SIMPLE EXTRAPOLATION).

Survey Month	Number of individuals/ha x 10^4 in distance 150m	Maximum population size in the Central Marsh (individuals/141,615 ha) in distance 150m	Number of individuals/ha x 10^4 in distance 200m	Maximum population size in the Central Marsh (individuals/141,615 ha) in distance 200m
October	7.4	104.9	5.5	78.7
April	16.7	236.0	12.5	177.0
May	20.0	283.2	15.0	212.4
June	6.7	94.4	5.0	94.4

IV. DISCUSSION

Previous work in Iraq recorded the species in 28 sites along the Tigris and Euphrates rivers and their branches and tributaries. The species has been recorded in 19 KBA sites across Iraq between 2005 – 2010 (an area of 1,231,444 ha [3]), with 55 individual records in the Euphrates River from Faloja to Hammar Marsh (c. 400 km) in 1992 [5]. Our study is the first to estimate softshell turtle densities in Iraq and suggests that the CM could be an important site for the softshell turtle in the Iraq, with a maximum estimated population size of 212-283 individuals. Given this result, prioritizing the CM for future conservation of soft-shelled turtle in Iraq is recommended [2, 4].

The breeding and appearance of *Rafetus euphraticus* is highly seasonal [2]. April to October is thought to be the key time to survey for the turtle and it is thought to prefer areas with shallow and calm water, alluvial soil, sandy banks, certain vegetation types (e.g. *Tamarix sp.*, *Populus euphratica*) and an abundance of fish (e.g. *Barbus spp.*, *Chalcalbrmus sp.* and *Cyprinus carpio*; [14, 15, 6]. Our results support the idea of

breeding at these times, as no turtles were observed in CM during the winter survey from October to March, while the appearance and nesting period was between April and June. Whilst it is possible that we missed recording turtles in colder months (as they were less likely to be out of the water), we still checked for the presence of nests on land (land was checked for nests on each survey visit throughout the survey period) and none were found in those months.

There were some differences between our results and those reported for turtle populations in other countries in its range. For example, the start of the breeding season in Iraq was slightly earlier than elsewhere middle of April in the CM: in Iran breeding begins in June and July [2] and this is also true for Turkey [15]. Also, whereas we found turtle nests located in bare soil in Iraq, they are reported to be found amongst vegetation in Iran with a soil composition of 77% silt [6] and are found in pure sand in Turkey [15]. The eggs found in the CM were also slightly smaller than those elsewhere 2.63cm in the CM: the mean diameter of turtle eggs in Iran is 28.7 mm and in Turkey it is 23.3 ± 0.13 (SD) mm [16] and $29.47 \text{ mm} \pm 0.29$ (SD); [15].

Our results come with some caveats. First, due to safety issues we were not able to randomize the direction that we sampled each transect. This means that the detectability of the turtle within each zone may be different (e.g. turtles may be more sluggish in the morning), making it difficult to disentangle the effect of detectability from underlying abundance. Similarly, we have not sought to examine detectability and its effects on the turtle's population density estimates in a detailed way. Second, it is important to repeat our surveys within the CM over a longer time period to identify whether the results we report here are consistent between years (and also later in the summer period from July-September). Finally, the population estimates that we report for the CM are estimates only and in reality are likely to be altered by biases of recording only turtles outside of the water, extrapolations of counts across the whole CM (which assumes a homogenous area).

Our surveys recorded the highest densities of the species close to Al Bagdadia (Ishan Guba village) in transect one zone two (Figure 4). This area is characterized by open water with dominant vegetation including *Typha domingensis* and *Phragmites australis*, with frequent records of the invasive fish species *Tilapia zilli* [3]. The turtles mainly used the area along transect four for nesting despite being very near to local houses. The area in transect four is historically considered the highest land in the middle of open water in the CM, and it is crowded during the breeding season, with many other species (e.g. reptiles, mammals, birds, and amphibians) being recorded (Faaza, N.A., unpublished). Thus, observations from our study suggest the species is able to tolerate a degree of disturbance.

V. APPENDIX

List of survey dates:

- 2013: October (28th, 29th), November (9th, 10th, 11th), Dec (16th, 17th, 18th)
- 2014: January (17th, 19th, 20th), February (17th, 18th, 19th),

March (19th, 20th, 21st), April (16th, 17th, 18th), May (17th, 18th, 19th), June (9th, 10th, 11th).

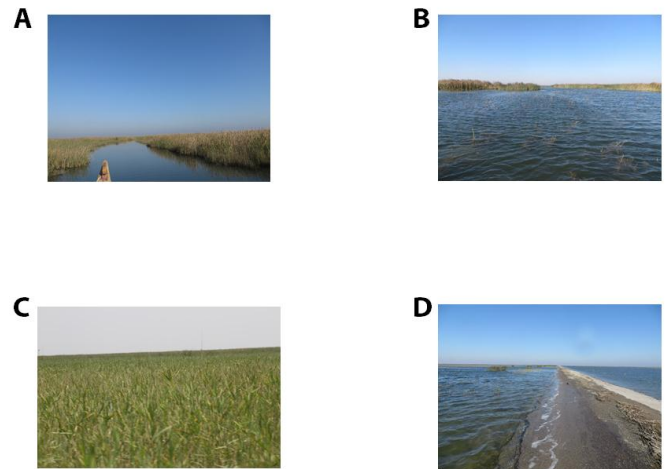


Fig 6. Photographs of Central Marsh: A = zone 1, B = zone 2, C = zone 3 and D = the paved street in the middle of the NP.

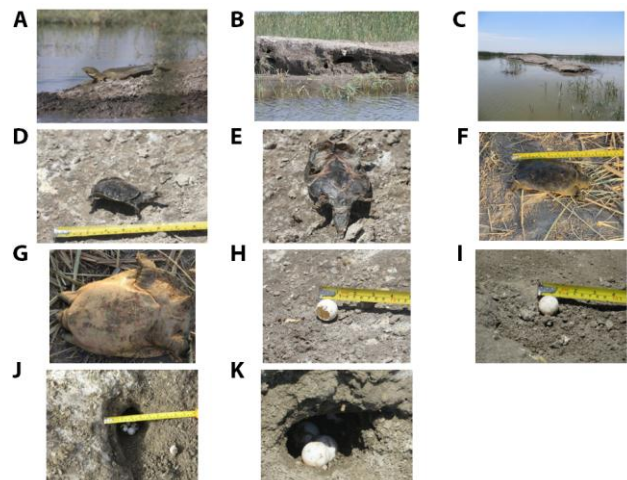


Fig 7. Photos of Euphrates softshell turtle and its breeding habitats: A = *Rafetus euphraticus*, B and C = breeding sites of *Rafetus euphraticus* in transect 1, zone 2, D and E = dead juvenile (11 cm long), F and G = juvenile (22 cm long), H and I = eggs of *Rafetus euphraticus* in the CM and J and K = nests of *Rafetus euphraticus* in the CM.

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VII. REFERENCES

- [1] Garstecki T., Amr Z., Biodiversity and Ecosystem Management in the Iraqi Marshland. Screening Study on Potential World Heritage Nomination. IUCN, 2011, Amman, Jordan.
- [2] Ghaffari H., Taskavak H., Karami M., Conservation Status of the Euphrates Softshell Turtle, *Rafetus euphraticus*, in Iran. *Chelonian Conservation and Biology*, 2008, 7(2): pp. 223-229.
<http://dx.doi.org/10.2744/CCB-0717.1>
- [3] Nature Iraq, Draft of the Key Biodiversity Area Inventory for Iraq. Nature Iraq 2013, <http://www.natureiraq.org/draft-inventory-of-sites.html>, Downloaded 4 Oct, 2014.
- [4] Ihlow F., Ahmadzadeh F., Ghaffari H., Taşkavak E., Hartmann T., Eitzbauer C., Rödder D., Assessment of genetic structure, habitat suitability and effectiveness of reserves for future conservation planning of the Euphrates soft-shelled turtle *Rafetus euphraticus* (Daudin, 1802). *Aquatic Conservation: Marine and Freshwater Ecosystems*, 2014 pp. n/a-n/a.
- [5] Stadtlander T., Recent observations of the Euphrates Soft-shelled Turtle, *Rafetus euphraticus*, in Mesopotamia. *Zoology in the Middle East*, 1992, 7(1): pp. 55-58.
<http://dx.doi.org/10.1080/09397140.1992.10637624>
- [6] Ghaffari H., Plummer M. V., Karami M., Mahroo B.S., Ahmadzadeh F., Rödder D., Notes on a Nest and Emergence of Hatchlings of the Euphrates Softshell Turtle (*Rafetus euphraticus*) at the Dez River, Iran *Chelonian Conservation and Biology*, 2013, 12(2): pp. 319-323.
<http://dx.doi.org/10.2744/CCB-1035.1>
- [7] GBIF, The Global Biodiversity Information Facility, Backbone Taxonomy. 01-07-2013. Accessed via <http://www.gbif.org/species/2442640> on 2014-12-19.
- [8] IMO, Fifth National Report to the Convention of Biological Diversity, 2014, <http://www.cbd.int/kb/Results?q=IRAQ>.
- [9] Pearce F., Garden of Eden to be protected as Iraqi national park, *New Scientist*, 2014, 219(2928): p. 11.
[http://dx.doi.org/10.1016/S0262-4079\(13\)61910-7](http://dx.doi.org/10.1016/S0262-4079(13)61910-7)
- [10] Taskavak E., Atatur M.K., Smith S.S., International Congress of Chelonian Conservation, 1995, Proceeding Book.
- [11] Alwash A., Gali G., Faza'a N.A., Sopelsa A., *The Mesopotamia Marshlands National Park Planning Process*, 2009, Conference of College of Science, Baghdad University.
- [12] Hamdan M.A., Asada T., Hassan F.M., Douabul A., Al-Hilli M., Alwan A.A., Vegetation response to re-flooding in the Mesopotamian Wetlands, Southern Iraq, *Wetlands*, 2010, 30(2) : pp. 177-188.
<http://dx.doi.org/10.1007/s13157-010-0035-9>
- [13] Sutherland W.J., *Ecological census techniques: a handbook.*, 2006, Cambridge University Press.
<http://dx.doi.org/10.1017/CBO9780511790508>
- [14] Taskavak E., Cranial morphology of *Rafetus euphraticus* (Daudin, 1801), from southeastern Anatolia', *AMPHIBIA REPTILIA*, 1999, 20 : pp. 35-54.
<http://dx.doi.org/10.1163/156853899X00042>
- [15] Biricik M., Description of an Euphrates Softshell Turtle (*Rafetus euphraticus*) nest from the Tigris River (SE Turkey) *SALAMANDRA*, 2011, 47(2) : pp. 99-102.
- [16] Taşkavak E., Comparative morphology of the Euphrates soft-shelled turtle, *Rafetus euphraticus* (Daudin, 1802) (Reptilia, Testudines) in Southeastern Anatolia', *Amphibia-Reptilia*, 1998, 19(3) : pp. 281-291.
<http://dx.doi.org/10.1163/156853898X00188>
- [17] IUCN, European Reptile & Amphibian Specialist Group 1996. *Rafetus euphraticus*, The IUCN Red List of Threatened Species. Version 2014.2. www.iucnredlist.org Downloaded on 27 September, 2014