A Proposal for Creating a Directory of Marine Biota Gauges in Iraq

Laith A. Jawad

Abstract A proposal for a register of marine biota markers to be put in operation in Iraq was given forwards aiming to offer the foundation for evaluating the ecosystem position of the marine habitats in Iraq. The catalogue should allow the search of a database of signs regularly linked to biological variety, non-native species, food webs and seafloor integrity. The catalogue reveals the present scientific ability to discourse environmental valuation requirements by delivering comprehensive treatment of the utmost applicable markers for marine biota and ecosystem integrity.

The status of the marine biodiversity requires such a catalogue and system to manage the deterioration in both marine species contents and distribution that getting poorer with the time. The main factors that cause the changes in the marine biodiversity of Iraq such as the pollution, changes in the environment and species invasion were highlighted and discussed. At the end of the chapter, a set of recommendations were given about the assessment of the marine biodiversity in the northern part of the Arabian Gulf.

Keywords Catalogue · Ecosystem · Environment · Habitat · Biodiversity

1 Introduction

To manage the changes in the environment, appropriate indicators need to be adopted (Geijzendorffer et al. 2015). At the moment, there are available worldwide numerous marine biota upkeep enterprises in place needing vigorous and scientifically based habitat valuations. On a local scale, environmental aims have long designed to manage the influences of human events in marine waters (Long 2012). These advantages are progressively vital now, as the seas are facing a growing problem (Cressey 2016) and spread anthropogenic stresses in our oceans (Gramling 2014). Countries must take a quick action to stop the quicker exhaustion of natural

L. A. Jawad (✉)
Pokeno, Auckland, New Zealand

L. A. Jawad (ed.), *The Arabian Seas: Biodiversity, Environmental Challenges and Conservation Measures*, https://doi.org/10.1007/978-3-030-51506-5_28

assets and wildlife (McCauley et al. 2015); particularly meanwhile there is still a deficiency of accepting of several features of our marine habitats (Danovaro et al. 2014). The accomplishment of administration is partly reliant on the accessibility of scientific gears to administrators (Knights et al. 2014). Vigorous indicator selection, transparent use and operative link of results comprise vital parts of this process, but the development, standardization and endorsement phases of new markers and valuation methods can concede timely administrative reply (Borja and Dauer 2008). Though there still a mutual exercise of emerging new markers for each new valuation imagination created besides for any precise case or strategy prerequisite.

Recently, Teixeira et al. (2016) have identified a catalogue containing several indicators, but the main indicators should be four so to support the valuation; these areas are (D) MSFD – biological variety (D1), non-native species (D2), food nets (D4) and seafloor integrity (D6). Their index can be viewed digitally and be able to extract the list of the preferable indicators according to the area that needs to be assessed. In their catalogue, Teixeira et al. (2016) intended to recognize the disparities in the present groups of signs to straight the additional advance of markers to the most crucial requirements and to adopt allocation of information across countries and marine regions, in case signs effective in one area could be simply attuned and approved in a different place for the ecosystem valuations.

Regarding to the issue of environmental assessment and in particular the marine environment, Iraq falls extremely behind the other countries in the region and the world. There is no existing plan of any sort to follow at the moment in Iraq despite of the several studies and researches that indicated the deteriorating status of the marine environment due to effect of pollutions by various pollutants (hydrocarbon, pesticides, swage, etc.). Therefore, it is about time for the policymakers in Iraq to choose an efficient assessment programme to use to recover the dying environment before it is difficult to assess or too late to apply any method or technique.

In the present chapter, a proposal to choose one of the leading biodiversity programmes to apply in the marine environment of Iraq is proposed. From the information given above about the catalogue of marine biodiversity indicators, it seems that such a system is suitable to be adopted and applied in the case of Iraq, and in the following sections, a short review on the reasons to choose such a programme for assessment in Iraq and a short description of the mechanism of the programmes were given in order to give an idea about it and how to deal with it.

2 Assessment of the Marine Biodiversity in Iraq

In Iraq, the aquatic biodiversity, both in freshwater and marine, was facing several forms of environmental stresses that could lead to harm their existing and may put them at the verge of extinction. In the present time, numerous factors can cause environmental pressure in Iraq. These resulted from the changing of the environment due to human activities, natural variations in the environment such as water shortage

and invasive species. The following are short reviews for these factors to show how Iraq biodiversity is in need of monitoring and management.

2.1 Pollution

The problem of pollution by different constituents was the unsolved dilemma of the world. Iraq marine waters are not different and face this problem and in a serious state. Several kinds of pollutants were identified and studied in the marine waters of Iraq and the estuary of Shatt al-Arab River in recent years. These include hydrocarbons, pesticides and swage components. In this section, no review will be given about the pollution status in the marine waters of Iraq as a separate chapter was devoted to this subject in this book. Therefore, interested readers should refer to this chapter to gather more information.

2.2 Fluctuation in the Discharge of Water of Shatt al-Arab River to the Arabian Gulf

In the last decades, the amount of water discharge of Shatt al-Arab River to the Arabian Gulf area was decreased significantly due to the water supply of the Euphrates and Tigris Rivers received from both Turkey and Iran.

Among the causes of the environmental changes in Iraq is the problem of drought. Consequently, the water supply for agriculture became scarce, and the inability of storage of rainwater turns out to be nearly impossible. The declining in the amount of rainfall in northern parts of Iraq, Turkey and Iran disturbed the water indemnity in the Shatt al-Arab River and hindered economic and social development in this part of Iraq (Alaamood 2015). Among other factors that affect the decrease in charge of freshwater by Shatt al-Arab River are the fluctuation in temperature rates, low humidity rates and amounts of precipitation (Yaseen et al. 2016).

In the last few decades, the marine waters of Iraq in particular and the Arabian Gulf area, in general, have been under a continuous environmental pressure due to the two Gulf Wars and the drainage of the southern marshes of Iraq. Such environmental stresses immensely affected the hydrodynamic displaying and circulation outlines, heat interchange, studies of contaminants, sediment transport and buildup, nutrient chemistry and biodiversity in the northwest part of the Arabian Gulf (Al-Yamani et al. 2007a, b).

The usual river overflow into the Gulf ranges from 1456 m^3/s (Reynolds 1993) to 1750 m^3/s (Al-Hassan 1999). The Zagros (in Iran) and Taurus (in Turkey) mountains assist as the main supply source of freshwater for the rivers running into the Gulf.

The Shatt Al-Arab River is the chief supply of freshwater to the northern Gulf. This river has a length of 195 km and an average width of 500 m with a depth that

differs from 8 to 15 m downstream to Basrah (Al Ramadhan and Pastour 1987). The Shatt Al-Arab passes by two major industrial groups, the Iraqi port of Basrah and the Iranian port of Abadan before draining into the Gulf. In the last few decades, the present river release rates have been decreased to an unidentified degree by dams that were built in northern Mesopotamia by Iran, Iraq and Syria (Kamp and Sadrinasab 2006). Consequently, water subtraction and alteration, in conjunction with the natural seasonal and multi-annual disparities, disturb the total volume of freshwater release into the Gulf.

The marine waters of Iraq and the north part of the Arabian Gulf receive a complicated kind of pollutants originated mainly from the anthropogenic activities in Basrah City (Al-Yamani 2008). These pollutants as an output of power stations, paper industry, oil refineries, petrochemical industry, chemical fertilizer companies and the sewerage structure, which ultimately release into the Shatt Al-Arab waterway (Al-Yamani 2008). Other pollutants such as trace metal (Abaychi and Mustafa 1988), hydrocarbon (Douabul and Al-Saad 1985; Bedair and Al-Saad 1992) and pesticides (DouAbul et al. 1987, 1988) were met in the waters of Shatt Al-Arab.

There are several physical and chemical changes that the water discharge of the Shatt al-Arab River generates in the north part of the Arabian Gulf area. These changes can be seen in the hydrodynamics variations, where the water discharge aids the counterclockwise circulation of the Gulf; changes in both temperature and salinity, where the values of these two factors were lower in the northern part of the Gulf than in the south, for example (Al-Yamani et al. 2004; Al-Yamani 2008); changes in the transparency, turbidity and suspended sediments as the river releases a great number of suspended sediments into the northern Gulf, henceforth distressing the transparency of its waters; change in the nutrient levels as a large amount of nutrient-rich water pour into the Gulf each year (Hadi et al. 1984); and change in total organic carbon, which can occur due to the dispersal of nutrients and organic matter (Al-Yamani 2008).

Among the biological changes that freshwater discharge can bring to the northern part of the Gulf such are those reflected in the Plankton communities. Both the primary and secondary productivity of the northern part of the Gulf and closely related to the distribution of the nutrient originated from the water discharge of Shatt al-Arab River (Al-Hassan and Hussain 1985; Grasshoff 1976; Al-Yamani et al. 2004; Al-Yamani 2008). In addition to the level of a nutrient, turbidity seems to play a vital role in the development of primary productivity. This can be seen clearly as the phytoplankton biomass and primary production considerably decrease in the southern waters (Al-Yamani et al. 2006; Al-Yamani 2008).

The other biological changes that can be brought due to the freshwater discharge of Shatt al-Arab River into the northern part of The Gulf is the fluctuation in fisheries. The northern areas of the Gulf and precisely northern of Kuwait were considered nursery zones for shrimp species (Grabe and Lees 1992). On the other hand, several other shrimp species *Metapenaeus affinis* and commercial fish species such as *Pampus argenteus*, *Tenualosa ilisha Acanthopagrus arabicus* and others are wholly reliant on the Shatt Al-Arab River as well as the marsh and estuarine areas for spawning, feeding and as a nursery habitat. Consequently, any variations in the

volume or features of the freshwater system could have an upsetting influence on the dispersal and abundance of the above species.

2.3 Invasive Species

Fish species have been studied thoroughly than any other marine organisms in Iraq. Therefore, a review of this group to follow their short history in the last few decades will give an example of the invasion of alien species to the marine waters of Iraq.

Towards the end of the nineteenth century, the studies on marine fish fauna were started by Günther (Günther 1896; Jawad 2012). Numerous checklists and guides to the marine fishes of Iraq and the surrounding areas have been formerly published (for a detailed description and list of papers see Jawad (2012). The introduction of non-native and possibly invasive species by ship ballast water was also renowned (Al-Hassan and Al-Badri 1986; Al-Hassan and Miller 1987). In the 1990s to 2010s, there was an upsurge in ichthyological publications from the Arabian Gulf area, comprising checklists (Bishop 2003; Grandcourt 2012; Younis et al. 2016), as well as more thorough species accounts, like the first description of a novel skate species for the area (Fricke and AL-Hassan 1995), all of which are significant for the construction of a complete picture of the fish biodiversity in the area and its need for conservation efforts (see, e.g. Moore and Jawad 2008).

During the period of 2010–2019, several numbers of fish species were reported as a new record to the Iraq marine waters. Forty-seven teleost fish species and one shark were recorded during the period of 9 years. During this time, the presence of ten more teleosts species was confirmed in this area (Jawad et al. 2010, 2014a, b, c, 2018a, b, 2019; Al-Mukhtar et al. 2011; Al-Badri and Jawad 2014; Ali et al. 2014; Hussain and Jawad 2014; Jawad and Al-Badri 2014, 2015; Jawad and Hussain 2014; Iwatsuki et al. 2015; Jawad 2015; Al-Faisal et al. 2016; Ali 2016; Al-Daraji et al. 2017; Mohamed et al. 2017; Al-Faisal 2018; Ali and Iwatsuki 2018; Ali and Khamees 2018; Khamees et al. 2018; Ziyadi et al. 2018). Moreover, recently a coral reef area was discovered in the Iraqi marine waters for the first time (Pohl et al. 2014), which encompasses a large number of marine organisms. With the record of the large number of fish species in a short period of time (9 years) and the discovery of the coral reef, it became necessary to have an effective management plan to conserve the biodiversity of the Marine waters of Iraq.

3 The Catalogue of the Marine Biodiversity Indicators

Teixeira et al. (2016) have suggested few steps in the process of building their catalogue of marine biodiversity indicators, and here these steps will be briefly discussed to give the readers the idea of the catalogue. For full information about

setting up the catalogue, it is suggested that the readers should refer to the original reference.

3.1 How to Collect Indicators

In choosing the indicators for the catalogue, certain issues need to be targeted to address the aims such as biological variety, tendencies and influences of non-native species, food webs' features and seafloor integrity. In the process of collecting indicators, several questionnaire were prepared for reclaiming indicators, and related metadata were circulated among certain number of scientists, recognized in the database by a 'contributor code'. All donors were either intricate in the application of the MSFD or having extensive information on markers' advance or presentation in their relevant regions or fields of knowledge. The data on markers was accumulated from very diverse resources in national and international environmental settings.

3.2 Catalogue Assembly

Teixeira et al. (2016) design the directory of biota markers, and for precision, their description of the catalogue was depicted with slight variation as follows: the catalogue comprises three main sections – 'Indicators', '219 Metadata' and 'Sources', with open and closed fields for reporting information. The fourth section allows implementation 'Analyses' like enquiring the database. The 'Indicators' unit has ten fields relating to fundamental features of the marker and other linked data. The 'Metadata' section has two chief kinds of areas. There are fields linked to MSFD necessities for reporting descriptor exposure, and other fields permit description of targets of the marker in terms of biodiversity components (e.g. phytoplankton, macroalgae, fish) and a set of major ecotypes (e.g. pelagic fish, demersal fish) for mobile constituents. Lastly, additional fields identify settings for applying the marker, eventually containing data on targets and/or reference settings for the indicator, relating them to particular habitat(s) where it applies, and its geographical coverage. Additional particulars on the fields and definitions of categories can be found in the database (Supp. Mat. S1) and in Teixeira et al. (2014).

4 Suggestions for Future Improvements of the Catalogue

Teixeira et al. (2016) have suggested that the usage of their catalogue could be strengthened in the future via more mixing with extra quality features for marker assortment (Queirós et al. 2016). The directory might be extended more to house additional kinds of markers as (Berg et al. 2015).

5 Need for Further Action Regarding the Conservation to the Marine Biodiversity of Iraq

There is a great shortage in the data on the dynamics and the relations between Shatt Al-Arab and the Gulf ecosystem. Vital act is obligatory in so to deliver steady data on the water release, and water chemistry as well is needed.

Due to the suitable information on the ecology of the southern Iraqi marshes is missing, the biology and spawning behaviour of some of the migratory species or common stocks need to be investigated. Therefore, combined research plans are desirable linking scientists from all related countries (e.g. Iraq, Iran and Kuwait). The subsequent activities are suggested to be commenced shortly:

1. A detailed habitat influence valuation study to be led before the completion of the civil and construction works.
2. The exchange of data regarding Shatt Al-Arab and Shatt Al-Basrah/Khor Al-Zubair flow rates is mandatory.

References

Abaychi JK, Mustafa YZ (1988) The Asiatic Clam, *Corbicula-Fluminea* – an indicator of trace-metal pollution in the Shatt Al-Arab River, Iraq. Environ Pollut 54(2):109–122

Alaamood FAF (2015) Climate change and its impact on crop structure in Iraq. PhD Thesis, Basra University, College of Education for Human Sciences

AL-Badri ME, Jawad LA (2014) New fish records from the marine waters of Iraq. Cah Biol Mar 55:431–436

AL-Daraji SAM, Jawad AJ, AL-Faisal AJ, Taha A (2017) Second appearance of the burrowing goby *Trypauchen vagina* (Bloch & Schneider, 1801) in the marine waters of Iraq. Cah Biol Mar 58:229–232

Al-Faisal AJ (2018) Occurrence of two grunt fish (Haemulidae: Pomadasys) from the Iraqi marine waters. Int J Marine Sci 8:172–175

Al-Faisal AJ, Mohamed ARM, Jaayid TA (2016) New record of the carangid fish from the Iraqi marine waters, northwest Arabian Gulf. Mesopot Environ J, Spec Issue A:106–114

Al-Hassan LAJ (1999) Shad of the Shatt Al-Arab River in Iraq. Shad J 4(2):1–4

Al-Hassan LAJ, Al-Badri MEH (1986) First record of some fishes from Khor al-Zubair, Khor Abdullah and Shatt al-Arab, Basrah, Iraq. Cybium 10:295–297

Al-Hassan LAJ, Hussain NA (1985) Hydrological parameters influencing the penetration of Arab Gulf fishes into the Shatt al-Arab River, Iraq. Cybium 9:7–16

Al-Hassan LAJ, Miller PJ (1987) *Rhinogobius brunneus* (Gobiidae) in the Arabian Gulf. Japanese J Ichthyol 33:405–408

Ali AH (2016) First record of Lutjanus indicus Allen, White & Erdmann, 2013 (Pisces: Lutjanidae) from marine water off Iraq. Basrah J Agric Sci 29(1):25–25

Ali AH, Iwatsuki Y (2018) Record of the yellowback grunt *Pomadasys aheneus* McKay & Randall (Osteichthyes: Haemulidae) from the Arabian Gulf off Iraq. Zool Middle East 64(4):371–373

Ali AH, Khamees NR (2018) Comparative taxonomy of two species of *Acanthopagrus* Peters, 1855 (Pisces: Sparidae) with the first record of *A. sheim* Iwatsuki, 2013 from Iraq. Basrah J Agric Sci 31(2):36–43

Ali AH, Abed JM, Taher MM (2014) First record of saddleback silver-biddy *Gerres limbatus* Cuvier, 1830 (Pisces: Gerreidae) from Shatt Al-Arab River and marine territorial waters of Iraq. Int J Marine Sci 4:1–5

Al-Mukhtar MA, Jawad LA, Al-Faisal AJ, Mustafa F (2011) First record of Dotted grouper *Epinephelus epistictus* (Temminck & Schlegel, 1842) (Pisces: Serranidae) for the fish fauna of Iraq. Zool Middle East 54:136–137

Al-Ramadhan BM, Pastour M (1987) Tidal characteristics of Shatt Al-Arab River. Marina Mesopotamica 2(1):15–28

Al-Yamani F (2008) Importance of the freshwater influx from the Shatt al-Arab River on the Gulf marine environment. In: Protecting the Gulf's marine ecosystems from pollution. Birkhäuser, Basel, pp 207–222

Al-Yamani FY, Bishop JM, Ramadhan E, Al-Husaini M, Al-Ghadban A (2004) Oceanographic atlas of Kuwait's waters. Kuwait Institute for Scientific Research, Kuwait. 202 pp

Al-Yamani F, Subba Rao DV, Mharzi A, Ismail W, Al-Rifaie K (2006) Primary production off Kuwait, an arid zone environment, Arabian Gulf. Int J Oceans Oceanogr 1(1):67–85

Al-Yamani FY, Bishop JM, Al-Rifaie K, Ismail W (2007a) The effects of the river diversion, Mesopotamian marsh drainage and restoration, and river damming on the marine environment of the northwestern Arabian Gulf. Aquat Ecosyst Health Manag 10(3):277–289

Al-Yamani F, Polikarpov I, Skryabin V, Al-Rifaie K, Hadi H, Al-Kandari M (2007b) Assessment of the effects of the Shatt Al-Arab's altered discharge regimes on the ecology of the northern Arabian Gulf. Final Report. Oceanography, vol 1. Kuwait Institute for Scientific Research, Kuwait

Bedair HM, Al-Saad HT (1992) Dissolved and particulate-adsorbed hydrocarbons in the waters of Shatt al-Arab River, Iraq. Water Air Soil Pollut 61(3–4):397–408

Berg T, Fürhaupter K, Teixeira H, Uusitalo L, Zampoukas N (2015) The Marine Strategy Framework Directive and the ecosystem-based approach–pitfalls and solutions. Mar Pollut Bull 96:18–28

Bishop JM (2003) History and current checklist of Kuwait's ichthyofauna. J Arid Environ 54:237–256

Borja A, Dauer DM (2008) Assessing the environmental quality status in estuarine and coastal systems: comparing methodologies and indices. Ecol Indic 8:331–337

Cressey D (2016) Talks aim to tame marine Wild West. Nature 532:18–19

Danovaro R, Snelgrove PV, Tyler P (2014) Challenging the paradigms 837 of deep-sea ecology. Trends Ecol Evol 29:465–475

Douabul AAZ, Al-Saad HT (1985) Seasonal-variations of oil residues in water of Shatt Al-Arab River, Iraq. Water Air Soil Pollut 24(3):237–246

Douabul AAZ, Al-Saad HT, Al-Rekabi HN (1987) Residues of organochlorine pesticides in environmental samples from the Shatt Al-Arab River, Iraq. Environ Pollut 43:175–187

Douabul AZ, Al-Saad HT, Al-Timari A, Al-Rekabi N (1988) Tigris-Euphrates Delta: a major source of pesticides to the Shatt Al-Arab River (Iraq). Arch Environ Contam Toxicol 17:405–418

Fricke R, AL-Hassan LAJ (1995) Raja Pita, a new species of skate from the Arabian/Persian Gulf (Elasmobranchii: Rajiformes): with 1 Table. Staatliches Museum für Naturkunde

Geijzendorffer IR, Regan EC, Pereira HM, Brotons L, Brummitt N, Gavish Y, Haase P, Martin CS, Mihoub J-B, Secades C, Schmeller DS, Stoll S, Wetzel FT, Walters M (2015) Bridging the gap between biodiversity data and policy reporting needs: an essential biodiversity variables perspective. J Appl Ecol 868. https://doi.org/10.1111/1365-2664.12417

Grabe SA, Lees DC (1992) Macrozooplankton studies in Kuwait Bay (Arabian Gulf). II: Distribution and composition of planktonic penaeidea. J Plankton Res 14:1673–1686

Gramling C (2014) Seafloor mining plan advances, worrying critics. Science 344:463

Grandcourt E (2012) Reef fish and fisheries in the Gulf. In: Riegl BM, Purkis SJ (eds) Coral reefs of the Gulf: adaptation to climatic extremes. Coral reefs of the world 3. Springer Science+Business Media B. V., Heidelberg, pp 127–161

Grasshoff K (1976) Review of hydrographic and productivity conditions in the Gulf Region. In: Marine sciences in the Gulf area. UNESCO Technical Papers in Marine Science, 26:39–62

Günther A (1896) Description of two new species of fishes (Mastacembelus and Barbus). Ann Magazine Nat Hist 6:397

Hadi RAM, Al-Saboonchi AA, Yousuf AKH (1984) Diatoms of the Shatt Al-Arab River, Iraq. Nova Hedwigia 34:513–557

Hussain S, Jawad LA (2014) First Records of Opisthognathus muscatensis Boulenger, 1888 (Opisthognathidae), Trachinotus baillonii (Lacepède, 1801) (Carangidae), and Atrobucca nibe (Jordan & Thompson, 1911) (Sciaenidae) off the Iraq Coast, Arabian Gulf. Int J Mar Sci 4 (28):253–258

IwatsukI Y, Bogorodsky F, Tanaka F, Mal AO, Ali AH (2015) Range extension of Gerres infasciatus (Perciformes: Gerreidae) from the Red Sea and the Arabian Gulf, with distributional implications for the G. filamentosus complex. Cybium 39(2):155–160

Jawad LA (2012) History of the study of the fish fauna of Iraq. Water Res Manag 2:11–20

Jawad LA (2015) Four new records of fishes from the Arabian Gulf coast of Iraq. Bol Inst Pesca, São Paulo 41(4):1033–1042

Jawad LA, Al-Badri ME (2014) Lophiomus setigerus (Vahl, 1797), Nemipterus zysron (Bleeker, 1856), and Parascolopsis eriomma (Jordan & Richardson, 1909) (Osteichthyes: Lophiidae and Nemipteridae) in the marine waters of Iraq. Zool Middle East 60(2):186–188

Jawad LA, Al-Badri MEH (2015) *Bodianus macrognathos* (Teleostei: Labridae), *Coris nigrotaenia* (Teleostei: Labridae) and *Bothus pantherinus* (Teleostei: Bothidae) in the Iraqi marine waters. North-West J Zool 11(2):347–350

Jawad LA, Hussain S (2014) First record of Antennarius indicus (Pisces: Batrachoidiformes: Antennaridae), Equulites elongatus (Pisces: Perciformes: Leiognathidae) and second record of Cheilinus lunulatus (Pisces: Perciformes: Labridae) from the Marine Waters of Iraq. Int J Mar Sci 4(40):1–5

Jawad LA, Hussein SA, Bulbil F (2010) The rare Ranzania laevis (Pennant, 1776) (Tetraodontiformes: Molidae) in the marine waters of Iraq. J Appl Ichthyol. https://doi.org/10.1111/j.1439-0426.2010.01609.x

Jawad LA, Al-Badri ME, Fricke R (2014a) New records of thicklips and grunts from the marine waters of Iraq (Teleostei: Haemulidae). J Ocean Sci Found 12:18–24

Jawad LA, Al-Mukhtar MA, Al-Hilali HI, Al-Faisal J, Al-Derawi M (2014b) Occurrence of pinecone fish Monocentris japonica (Teleostei: Monocentridae) in the marine waters of Iraq. Mar Biodivers Rec 7:1–3

Jawad LA, Al-Mukhtar M, Faddagh MS (2014c) Confirmation of the presence of Heniochus acuminatus (Linnaeus, 1758) (Chaetodontidae) and Pomacanthus maculosus (Forsskål, 1775) (Pomacanthidae) in Iraqi marine waters, Arabian Gulf. Arxius de Miscel·lània Zoològica 12:124–129

Jawad LA, Ziyadi MSF, Näslund J, Pohl T, Al-Mukhtar MA (2018a) Checklist of the fishes of the newly discovered coral reef in Iraq, north-west Arabian Gulf, with 10 new records to the Arabian Gulf. Aqua, Int J Ichthyol 24(3):89–138

Jawad LA, Ziyadi MSF, Näslund J, Pohl T, Al-Mukhtar MA (2018b) Checklist of the fishes of the newly discovered coral reef in Iraq, north-west Arabian Gulf, with 10 new records to the Arabian Gulf. Aqua 24(3-01):89

Jawad LA, Al-Dirawi AMH, Hayder I, Al-Hilali HI, Uday TS, Al-Asadi UTS (2019) Observations of stranded and swimming whale sharks *Rhincodon typus* in Khor Al-Zubair, NW Arabian Gulf and Shatt Al-Arab Estuary, Iraq. J Fish Biol. https://doi.org/10.1111/jfb.13891

Kamp J, Sadrinasab M (2006) The circulation of the Persian Gulf: a numerical study. Ocean Sci 2:27–41

Khamees NR, Adday TK, Abed JM (2018) Occurrence and redescription of *Thryssa setirostris* (Broussonet, 1782) (Clupeiformes, Engraulidae) from Iraqi marine water. Bull Iraq Nat Hist Museum 15(2):123–130. P-ISSN: 1017-8678, E-ISSN: 2311-9799

Knights AM, Culhane F, Hussain SS, Papadopoulou KN, Piet GJ, Raakær J, Rogers SI, Robinson LA (2014) A step-wise process of decision-making under uncertainty when implementing environmental policy. Environ Sci Policy 39:56–64

Long R (2012) Legal aspects of ecosystem-based marine management in Europe. In: Chircop A, McConnell ML, Coffen-Smou S (eds) Ocean Yearbook (2012). Hijhoff, The Hague, pp 417–484

McCauley DJ, Pinsky ML, Palumbi SR, Estes JA, Joyce FH, Warner RR (2015) Marine defaunation: animal loss in the global ocean. Science 347:247–254

Mohamed ARM, Al-Faisal AJ, Jaayid TA (2017) Occurrence of carangid fish *Uraspis helvola* (Forster, 1801) from the Iraqi marine waters, Arabian Gulf. Asian J Appl Sci 5(02). ISSN: 2321–0893

Moore A, Jawad LAJ (2008) *Okamejei pita* (Fricke & Al-Hassan, 1995). Red list Assessment

Pohl T, Al-Muqdadi SW, Ali MH, Fawzi NA, Ehrlich H, Merkel B (2014) Discovery of a living coral reef in the coastal waters of Iraq. Sci Rep 4:2–5

Queirós AM, Strong JA, Mazik K, Carstensen J, Bruun J, Somerfield PJ, Bruhn A, Ciavatta S, Flo E, Bizsel N, Özaydinli M, Chŭsev R, Muxika I, Nygård H, Papadopoulou N, Pantazi M, Krause-Jensen D (2016) An objective framework to test the quality of candidate indicators of good environmental status. Front Mar Sci 3:73

Reynolds M (1993) Physical oceanography of the Gulf, Strait of Hormuz, and the Gulf of Oman: results from the Mt. Mitchell expedition. Mar Pollut Bull 27:35–59

Teixeira H, Berg T, Fürhaupter K, Uusitalo L, Papadopoulou N, Bizsel KC, Cochrane S, Churilova T, Heiskanen AS, Uyarra M, Zampoukas N, Borja A, Akcali B, Andersen JH, Beauchard O, Berzano M, Bizsel N, Bucas M, Camp J, Carvalho S, Flo E, Garces E, Herman P, Katsanevakis S, Kavcioglu R, Krause-Jensen D, Kryvenko O, Lynam C, Mazik K, Moncheva S, Neville S, Ozaydinli M, Pantazi M, Patrício J, Piroddi C, Queirós AM, Ramsvatn S, Rodriguez JG, Rodriguez-Ezpeleta N, Smith C, Stefanova K, Tempera F, Vassilopoulou V, Verissimo H, Yilmaz EC, Zaiko A, Zenetos A (2014) Existing biodiversity, non-indigenous species, food-web and sea-floor integrity GES indicators. Deliverable 3.1 198 pp + 2 Annexes. DEVOTES FP7 Project

Teixeira H, Berg T, Uusitalo L, Fürhaupter K, Heiskanen AS, Mazik K, Lynam CP, Neville S, Rodriguez J, Papadopoulou N, Moncheva S (2016) A catalogue of marine biodiversity indicators. Front Mar Sci 3:207

Yaseen BR, Al Asaady KA, Kazem AA, Chaichan MT (2016) Environmental impacts of salt tide in Shatt al-Arab-Basra/Iraq. IOSR J Environ Sci, Toxicol Food Technol 10(1–2):35–43

Younis KH, Al-Shamary ACH, Al-Faisal AJ (2016) Updating checklist of fishes of Shatt Al-Basrah Canal, Southern Iraq. Basrah J Agric Sci 29:309–296

Ziyadi MSF, Jawad LA, Al-Mukhtar MA (2018) *Halicampus zavorensis* Dawson, 1984 (Syngnathidae): new record for Iraqi marine waters and for the Arabian Gulf area. Cah Biol Mar 59:121–126