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A review of the biology, stock status and population dynamic parameters of the Narrow – barred Spanish mackerel (*Scomberomorus commerson*) in the Persian Gulf and Oman Sea

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A***bstract***

The Narrow – barred Spanish mackerel, *Scomberomorus commerson (*Lacepède, 1800), forms a large component of catches in the northern part of the Persian Gulf and Oman Sea. It is mainly caught with gillnets. In spite of stable fishing effort data about 6500 fishing crafts engaged in tuna fisheries in the last decade, but the *S.commerson* catch amounts are increasing from 10292 mt in 2008 to 16510 mt in 2012. There are available references related to biology, including reproduction, feeding and population dynamics but the difficulties we face in monitoring and assessment are not these fundamental characteristics of the species, but those that relate to local boundaries are, how large and productive these local stocks are, and, what the real impact is by fishers on local population. It is clear that the primary research problems are about developing methods that yield information on these aspects of the different sub region fishery in the IOTC area. The initiatives of any one of the littoral states alone would not be sufficient to achieve resource management objectives. This review aims to address some of the perceived barriers to an enhanced approach that integrates molecular data and other demographic studies into management and conservation goals, by reviewing papers. Moreover Results revealed that adopting a single stock model and regional shared management could probably be appropriate for sustainable long-term use of this important resource in the north western Indian Ocean, except genetic studies reveal two separate stocks.

Key words: *Scomberomorus commerson*, stock, population dynamic, Persian Gulf & Oman Sea

Introduction

The world's marine fish stocks, which were considered just over a century ago to be ‘inexhaustible’ (Huxley, 2007), now face extreme fishing pressure as the insatiable human appetite for seafood continually outpaces supply (Delgado et al.,2003). Current data indicate that widespread overfishing has fully exploited, over-exploited or depleted up to 75% of global fish stocks(FAO, 2009) and has had deleterious effects on aquatic ecosystems (Pauly et al., 2005; Worm et al., 2006).

In a pertinent four-year study on 10 large marine ecosystems around the world, Worm et al. (2009) reported that 63% of the assessed fish stocks were below desired levels and still require rebuilding, in spite of the numerous restrictions (annual harvest quotas, rights allocations, fishing gear modifications and seasonal or area closures) that have been imposed to promote more sustainable fisheries management (Beddington et al., 2007; Brunner et al., 2009).

During the last two decades, there has been a growing realization that the incorporation of all coastal countries with regional conservation bodies such as IOTC into marine conservation strategies will be required if the trends in fisheries declines are to be reversed .

The Narrow – barred Spanish mackerel (*Scomberomorus commerson*) (Lacepede, 1800) belongs to the family Scombridae with 15 genera and 49 species, under the order of perciformes (Collette and Nauen, 1983). It is an epipelagic predator distributed widely in the Indo – pacific waters from the Red Sea and South Africa to the Southeast Asia,in the north of China and Japan and south of Australia (Randall,1995).Narrow- barred Spanish mackerel commonly known as kingfish is a highly valued pelagic fish caught seasonally along the Iranian waters of the Persian Gulf and Oman Sea. The peak season of the fishing is between October and June. This seasonality is linked with the occurrence of a migratory movement of this species from the Arabian Sea towards the Persian Gulf in September and in the opposite direction around April (FAO, 1989).

This fish is also considered the most important commercial pelagic species in the Southern part (AL Hosni and Siddeek, 1999).A lot of studies have applied to *Scomberomorus commerson* by Siddeek (1993) in Indian Ocean; (Kedidi et al., 1993); Bertignac and Yesaki, (1993); Govender (1993) in Saudi Arabia, Oman and South Africa coastal waters.

Small juveniles up to 10 cm fork length live in creeks, estuaries and sheltered mud flats during the early wet season (McPherson, 1981). Large adults may be solitary, whereas juveniles and young kingfish occur in small schools (Collette, 2001). It reaches a maximum size of 240 cm fork length and maximum weight of 70.0 kg (McPherson, 1992). Ageing studies of this species in Western Australia suggest that it has longevity of 22 years (Mackie et al., 2003).

The *S. commerson* catch in the southern waters of Iran was fluctuated from 3939 mt in 1997 to 8778 mt in 2006 or 6% of the total production of large pelagic fishes and increasing from 10292 mt in 2008 to 16510 mt in 2012. Most artisanal fleets using drift gillnets with mesh size of 95 and 120 mm for fishing *S. commerson* (Kaymaram et al., 2010).In the waters of the northern Persian Gulf and Oman Sea, *S.commerson* is most abundant between October and June (Fig.1).

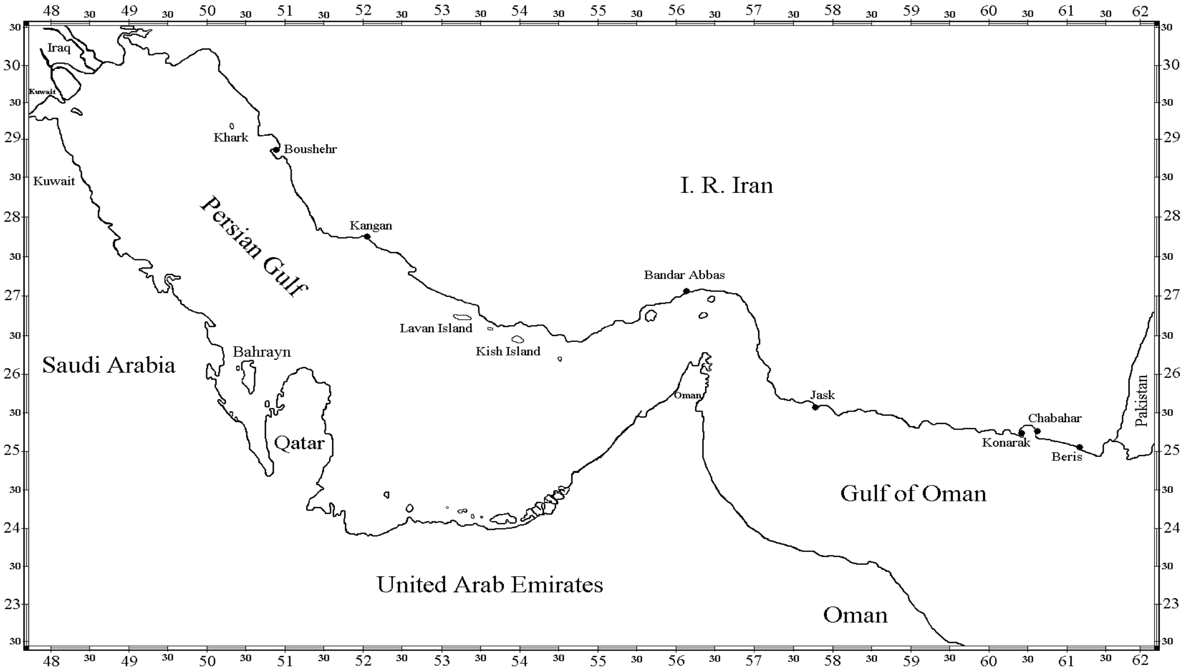

Fig. 1. Landing sites of *Scomberomorus commerson* in the Iranian coastal waters of the Persian Gulf & Oman Sea

Some studies on population dynamics and biological characteristics of *S. commerson* were carried out by Dudley et al., (1992); Edwards et al. (1985); Hosseini et al., 2000; Ghodrati Shojaei et al.,2007;Taghavi Motlagh & Ghodrati Shojaei, 2009; Kaymaram et al., 2010; Darvishi et al ., 2012; Kaymaram et al., 2014 in the coastal waters of Iran.

Stock structure

This is important, not only for the sake of the fisheries, but also to ensure that biodiversity and ecological functions of marine ecosystems are conserved. Genetic markers have been successfully used for the determination of stock structure of fish and establishing the extent of genetic connectivity amongst populations of fish (for example, Turner et al., 1991; Wright and Benzen, 1994; O'Connell and Wright, 1997). Stock structure, as conventionally determined by differences in demographic parameters of fish sampled from different locations, such as growth rates, size and age at maturity and mortality, is however, often not detected when characterizing genetic differences at neutral markers, because neutral markers measure differentiation due to genetic drift only if migration is limited or absent (Hartl, 2000, also see Hedrick, 1999).

There have been a number of studies on the genetic structure of *S. commerson* based on different molecular relative to HWE. Heterozygote excess in populations is markers and focusing in different areas of its distribution, such as allozymes (Shaklee & Shaklee,1990), and microsatellite markers in the Arabian Sea (Van Herwerden et al., 2006), and mitochiondrial DNA in the ROPME sea area (Hoolihan et al., 2006). van Herwerden et al. (2006) based on microsatellites marker indicated that there were two genetic stocks in the populations of *S. commerson*, one of them was restricted to one locality (Dhofar) in the Arabian Sea, the other widespread with sufficient gene flow between Bandar Abbas in Persian Gulf, Muscat and Musandam in Gulf of Oman, Al-Wusta in Arabian Sea and Yemen in Gulf of Aden. However, an adaptation to a single-stock model in the ROPME sea area was suggested by Hoolihan et al. (2006).

Abedi et al. (2012) studied the genetic stock structure of *S.commerson* using microsatellite markers from four locations in the Northern part of the Persian Gulf. It was concluded that there was no genetic differentiation among Spanish mackerel in Persian Gulf and the four samples could be considered as a single stock. The presence of the widespread stock showed that there must be sufficient gene flow between all Persian Gulf Northern sites sampled. The lack of this species genetic differentiation is related to the adult and larval pelagic life history and wide-ranged along shore migration.

However, integrating genetic results into management and conservation objectives has been challenging, with few examples that show practical applicability. (Van der Hayden, 2014).In this regard, a Ph.D thesis is carrying out in order to identify unit stock of *S.commerson* in the northern and southern part of the Persian Gulf and Oman Sea.

Biology

Reproduction

Spawning occurs between June and September in the northern part of the Persian Gulf & Oman Sea (Kaymaram et al., 2010) (Fig.2) which coincides with the period which there was an increase in the gonadsomatic indices during May and June, then declines after June. Frequency of immature fish (stage 1) was shown an annual cycle with and almost complete absence during June to August. The results of maturity stages and trend of gonadsomatic indices reveal a single spawning season which peaks after June to September.

Reproductive studies suggest a single spawning period from April to August in the southern Persian Gulf (Grandcourt et al., 2005). The results of Claerboudt et al. (2005) also reveal a single earlier spawning season in May and June off Oman. Spawning occurs after June-July, same as Oman Sea, In the north western part of the Persian Gulf (Kaymaram et al., 2014).

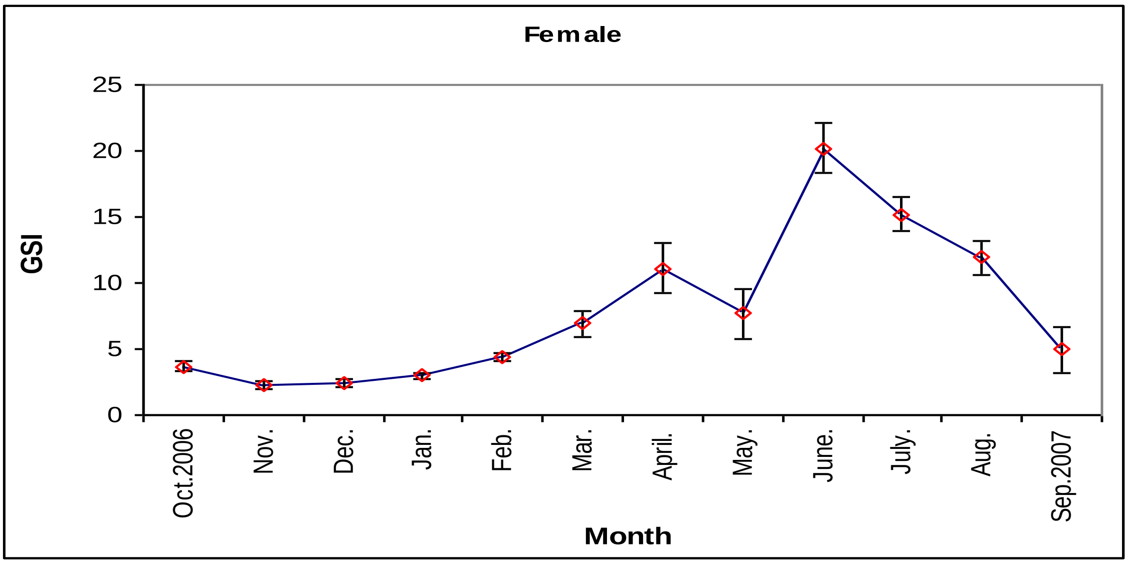

Fig.2. Mean monthly gonad somatic index (7.81±1.32) *Scomberomorus commerson* (female) in the Persian Gulf & Oman Sea (Oct.2006- Sep 2007).

The mean size of first sexual maturity (Lm 50%) is 83.6 cm. The smallest mature and largest immature female is respectively 52 and 100 cm (Kaymaram et al., 2010). The mean sizes at first sexual maturity for males and females respectively (72.8 and 86.3 cm) (Grandcourt et al., 2005), compare to the estimated size at spawning of 75-80 cm given by Dudley et al.(1992) for males and females combined off Oman. Females are found to mature at a smaller length in the Arabian Sea than in the Gulf of Oman (Al- Oufi et al., 2004).

Population dynamic parameters

Growth and mortality estimations are impacted of fishing gears operated in the region, Most artisanal fisheries using drift gillnets with mesh sizes of 95 and 120 mm and in some cases other gears such as trolling and hand line, especially in the northern part of the Persian Gulf. One of the key management issues of the *S.commerson* fishery is the selectivity characteristics of the gillnets which are the principal gear type used to target this species in the region (Grandcourt, 2013).

The study of Grandcourt et al. (2005) showed that the size of fish which were fully recruited to the fishery (L c100=62.6 cm) to be considerably smaller than the size at first sexual maturity for females

(86.3 cm).Consequently , 94.7% of the yield consisted of fish that were below the mean size at first sexual maturity (Grandcourt,2013).

Monthly length frequency data of the Persian Gulf showed distinct modes during 12 months of sampling (Fig.3).

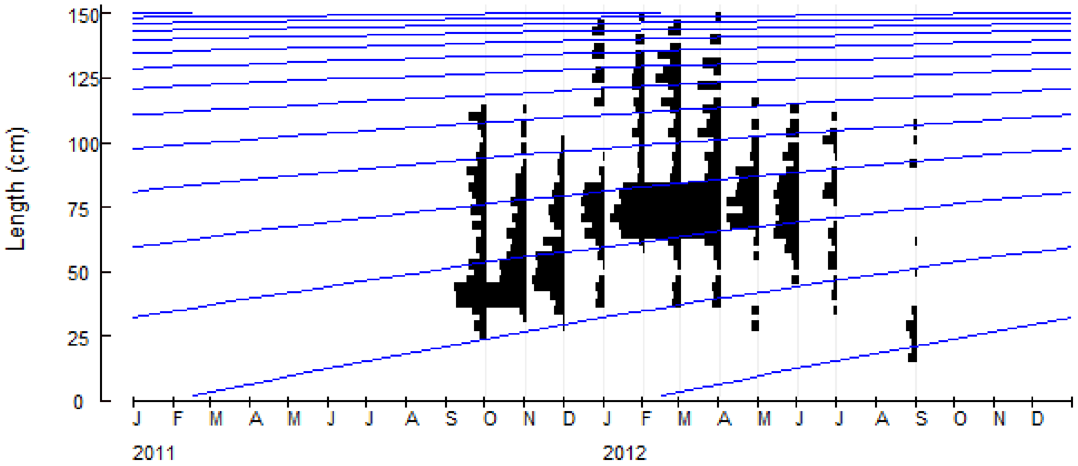

Fig.3. Monthly length frequency data collected from Persian Gulf, 2011-12

(Source: Kaymaram et al., 2014)

Parameters of the Von Bertalanffy growth function for *S.commerson* of the Persian Gulf & Oman Sea are given in Table 1.

Table 1: Parameters of the Von Bertalanffy growth function for *S.commerson* in the Persian Gulf & Oman Sea

K (Per year)	L∞(cm)	Φ'	Reference
0.21	144.40	3.70	Mcllwain et al., 2005
0.46	151.20	4.02	Kaymaram et al., 2013
0.42	140.00	3.91	Shojaei et al.,2007
0.21	232.40	4.10	Al-Hosni & Siddeek,1999
0.45	175.26	4.10	Darvishi et al., 2012
0.24	136.10	----	Grandcourt et al.,2005
0.24	156.45	3.76	Kaymaram et al.,2014

As a result of the importance of growth estimation on the population dynamic studies, in this case it is necessary to use ageing techniques.it should be mentioned that data collected from gillnet catches are difficult to use for the estimation of growth parameters and mortality rates or gill net samples does not give us any information which can be used for the separation of cohorts and the estimation of length – at –age data (Sparre and Venema, 1992).

Estimates of mortality parameters are given in Table 2. The reliable estimates of fishing mortalities are based on growth parameters such as length infinity, although the difference in the growth parameters estimated in the region may be due to the fact that the data were obtained by different gears such as hooks and lines, troll and trawls (Pillai et al., 1993).

Table.2. Summary of mortality parameters of *S.commerson i*n the Persian Gulf & Oman Sea

Z	M	F	E	Reference
1.32	0.44	0.88	0.66	Mcllwain et al., 2005
0.88	0.26	0.62	0.70	Grandcourt et al.,2005
1.65	0.35	1.30	0.78	Taghavi Motlagh &Shojaei, 2009
1.47	0.49	0.98	0.64	Shojaei et al., 2007
1.98	0.50	1.48	0.74	Darvishi et al., 2012
1.93	0.54	1.39	0.72	Kaymaram et al., 2013
1.13	0.43	0.70	0.69	Present study

Conclusion

It is clear that the primary research problems are about developing methods that yield information on these aspects of the different sub region fishery in the IOTC area (Buckworth and Clarke, 2001). Since *S.commerson* is a highly migratory species ,It is however advisable to consider additional, more conventional stock structure methods to determine number of stocks in the region .In this regard genetic study is currently carrying out to make clear the stock structure in the Northern and Southern part of the Persian Gulf and Oman Sea. As long as there are no indications that separate unit stocks exist in the region, then it will be necessary to consider it as a homogenous stock and data should be pooled. The initiatives of any one of the littoral states alone would not be sufficient to achieve resource management objectives. A regional approach to the assessment and management of *S.commerson* is advisable and could be operational by IOTC.

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