National fisheries fish spawning calendar for Lebanon

Nancy Sayar and Michel Bariche

INTERNATIONAL UNION FOR CONSERVATION OF NATURE

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Foreword

This spawning calendar, prepared in the context of the project “Enhancing socio-ecological climate change resilience of marine and coastal systems in Lebanon”, gathers information for commercial marine fish native to Lebanon. During the years 2020 and 2021, fish samples were collected, from various ports around the country, and thoroughly analysed, providing some valuable insight on native fish population. Considered essential for future fishery management plans, it will in turn contribute to a more efficient, sustainable management of the marine ecosystems, in partnership with the Ministry of Agriculture in Lebanon.

This project, under which the calendar was created, is funded by the Royal Norwegian Embassy in Beirut and managed by the IUCN, International Union for Conservation of Nature Regional Office for West Asia. It aims to assess and lessen the vulnerability of coastal towns in Lebanon to protect local communities. It also intends to improve Marine Protected Areas while following efficient methods for sustainable management of the ecosystems and increasing the capacity of stakeholders to effectively manage the marine ecosystem. More specifically, it relies on measures that have been previously used in the Mediterranean Sea to evaluate the vulnerability of coastal communities and sustainably manage natural resources.

In Lebanon, IUCN ROWA is working with the Ministry of Agriculture in Lebanon to develop a fish spawning calendar for commercial marine fishes that are native to the country. This spawning calendar is considered essential for future fishery management plans for the Lebanese fishery, which in turn will contribute to a sustainable management of the marine ecosystems.

Hany El Shaer, Ph.D

Regional Director,
IUCN (International Union for Conservation of Nature)
Regional Office for West Asia (ROWA)

Executive summary

Fish species show different reproductive characteristics. They range from gonochoristic, where the individual is either a male with testes producing sperm or a female with ovaries producing ova, to hermaphroditic, where an individual has both testicular and ovarian tissues. Hermaphroditism may be synchronous, where an individual produces sperm and ova, or sequential, where the change in sex occurs at some point during the life cycle. Individuals are either protandrous (a male turning into a female) or protogynous (a female turning into a male).

Fish species present in the Lebanese coastal waters display those various characteristics. Observing the macroscopic stage of gonad development allows the estimation of maturity, and thus the spawning season for each species. Preparing a spawning calendar is required for any fishery management programme.

The main objective of the study is to collect basic information on reproductive parameters of the maximum number of native species of commercial importance in Lebanon. Timing and duration of spawning activities and sex-ratios are described, in addition to the population structure of the processed samples. A total of 1109 specimens were collected and processed, representing 64 different fish species out of the 89 native commercially important species that are known to breed in the Lebanese territorial waters.

In this work, the basic reproductive characteristics of 54 species have been assessed and a spawning calendar has been created. The calendar includes a relatively precise estimate for 26 species.

I. Introduction

The marine environment in Lebanon is exposed to high anthropogenic pressures, with human activities contributing both directly and indirectly to its degradation. Illegal fishing activities, habitat destruction, pollution, species introduction and climate change are among the most significant threats.

The Lebanese fishery has remained artisanal over the years and is mostly composed of small-scale artisanal métiers. Despite that, intensive fishing practices are taking place and fish catch is considered to have reached its upper limit. An additional increase of harvest rate has occurred in the last few years in response to increased socioeconomic perturbation in the country.

The list of marine fish species present in the Lebanese marine waters has been recently published (Bariche & Fricke, 2020). It is an annotated checklist that enumerates the presence of 368 marine fish, from 159 families. Species are divided into native and non-indigenous species. However, the biology and ecology of most of those species remain unknown as they have been poorly studied in the region, especially in Lebanon. A lack of information on the reproduction of fishes present in the Lebanese coastal waters exists. More specifically, the timing and duration of the spawning seasons for species of commercial importance is unknown, which hinders the development of fisheries management programmes.

Fish are vertebrates that are characterised by a high diversity and various modes of reproduction (Moyle & Cech, 2004). For most species there are only two sexes, either males or females (gonochoric), producing sperm and ova respectively. Some species are hermaphroditic, and individual organisms have both testicular and ovarian tissues. Those presenting synchronous hermaphroditism can produce both sperm and ova. Others are sequential hermaphrodites and can be either protandrous (starting as males then turning into females at some point during the life cycle), or protogynous (starting as females then turning into males) (Moyle & Cech, 2004). Most fishes are oviparous with fertilisation taking place externally in the water. Fertilisation may also occur internally and different types of viviparity also exist.

Although the gender of some fishes is easily recognizable due to sexual dimorphism or dichromatism, a visual inspection of the internal anatomy is usually needed for sex determination. Testes are usually white and flat with irregular lobes, whereas ovaries are clear, pinking or yellowish and are rounded in shape.

This study aims at collecting native species of commercial importance in Lebanon and studying their gonad development to determine the timing and duration of their spawning period. Additional features, such as sex-ratios and sizes at first maturity were also estimated.

II. Methodology

Sampling

Sampling was carried out for two years during the estimated reproductive period of the fish species. Fish specimens were collected from February to June 2020, and February to August in 2021. They were purchased from fishing ports in various locations along the coast of Lebanon, mainly from Tripoli, Dora, Beirut, Damour, Jiyyeh and Tyre (Figure 1). Some ports, such as Ouzai and Abdeh were not considered due to their accessibility or low number of large individuals.

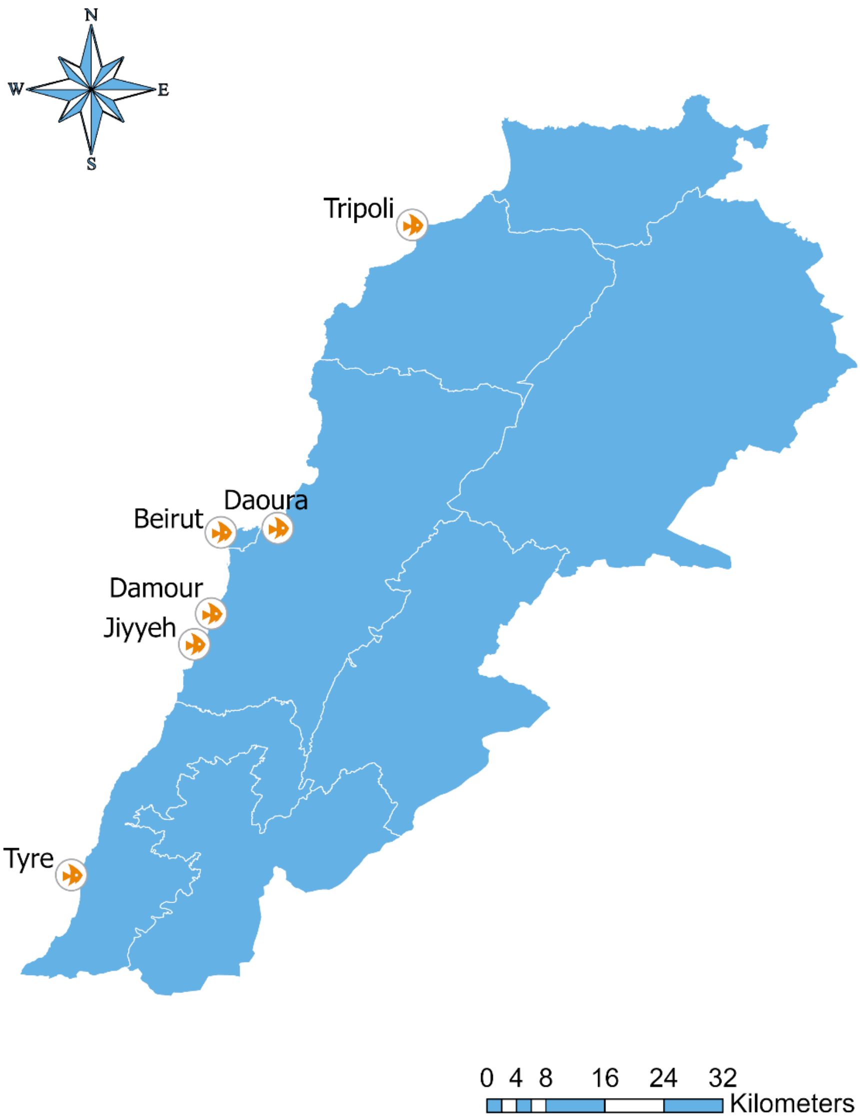

Figure 1. Map of Lebanon showing fishers' ports corresponding to sampling sites (Source: Mira Husseini)

Specimens were collected once or twice per week based on the expected reproductive season for marine fishes in the eastern Mediterranean. Data acquired in 2020 was used in order to sample more precisely in the following year (2021). The majority of the specimens were purchased in the morning, while others were bought from fishers whenever available. They were transported on crushed ice to the laboratory for analysis. They were identified, sorted by species and frozen at -20°C. In some cases, fish were frozen on site and brought to the laboratory whenever possible. Sampling only included native Mediterranean fish species; all non-indigenous species were excluded.

Morphometric analysis

The same procedure for data collection was followed in both years of the study. Specimens were removed from the freezer in the morning and left to thaw in separate trays (Figure 2). Each individual fish was assigned a separate and unique label, using the first letter of its genus name and the first two letters of the species name (example: DCe for *Diplodus cervinus*), along with a number. Each specimen was photographed with the label. Fin clips were removed and preserved in 100% ethanol for future studies.

Figure 2.Processing collected fish specimens (Photo credit: Michel Bariche)

The gonads, livers and remaining guts were preserved afterwards in 10% buffered formaldehyde. Additional photos were taken during the process, as needed. All fish heads were removed and stored in a freezer for future studies.

Population structure and sex-ratio

The population structure of the collected samples was described using weight-length relationships (*W-L*) and sex-ratios. The *W-L* were analysed by regression analyses separately with a hypothesized power function of the form $W_G = a\ TL^b$, where *a* and *b* are regression parameters. Weight-length data was later pooled and analysed using the same function. Lengths were grouped into ranges of 5 cm intervals and length-frequency histograms were constructed (e.g. 20 =15.1-20.0 cm; 25 = 20.1-25.0 cm).

The sex-ratios were analysed using $\chi 2$ goodness-of-fit tests with a hypothesized ratio of 1 : 1 (males : females). Sex-ratios were calculated monthly for the whole duration of sampling in order to assess the variations of the sampled population. Sex-ratios across total lengths were also analysed, where the data was divided into 5 cm intervals.

Spawning and first maturity

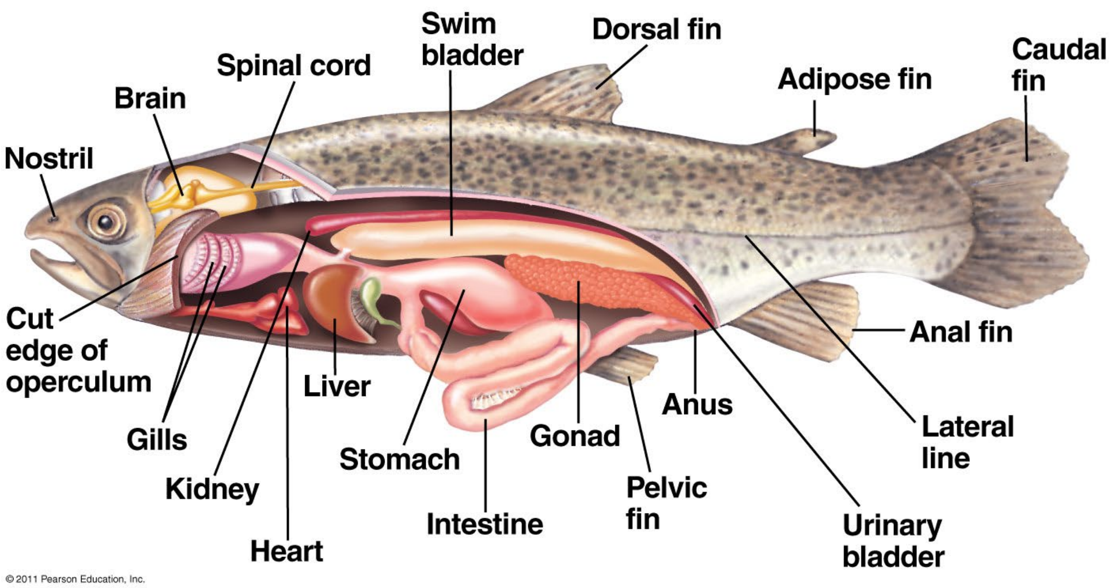

Figure 3. Bony fish anatomy (Campbell & Reece, 2008)

Gonads were extracted and weighed (W_g) to the nearest 0.001 g. They were macroscopically examined for shape, volume, colour, presence or absence of oocytes and sperm or egg shedding. A photo of each gonad was taken according to an established protocol, showing the gonad and the gut cavity together with the unit of measure next to the fish (Figure 5). Ovaries in mature stages were yellow to pinkish red, granulated and rounded, while testes were white, smooth and tapered on the edges. Immature gonads were examined under the stereoscope for sex identification based on texture and the presence of follicles whenever possible (Figure 6). The developmental stages were classified based on the macroscopic gonad maturity stages adopted by the Mediterranean International Trawl Survey (MEDITS) (Follesa and Carbonara, 2019). Fish within the spawning season were assigned into two categories, either mature or immature, based on the macroscopic staging.

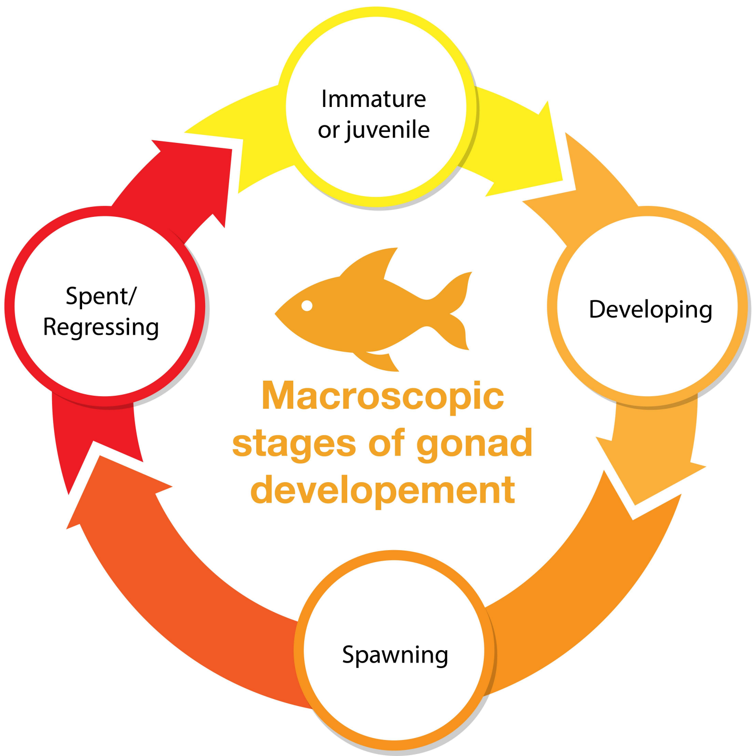

Figure 4. Macroscopic stages of gonad development (Source: Mira Husseini)

*Figure 5. Dissection of a goldblotch grouper (*Epinephelus costae*) and extraction of its guts (Photo credit: Michel Bariche)*

The length at first sexual maturity (L_{50}) denotes the length at which 50% of the population has reached reproductive maturity. It was calculated for the sexes separately. Binary logistic regression analyses were performed on the reproductive status and L_T of the selected samples, without grouping into size intervals. This produced logistic equations of the form $P = 1 / \{1 + e\, [- r\, (L_T - L_{50})]\}$ which expressed the proportion of sexually mature fish in terms of the total length and the L_{50}.

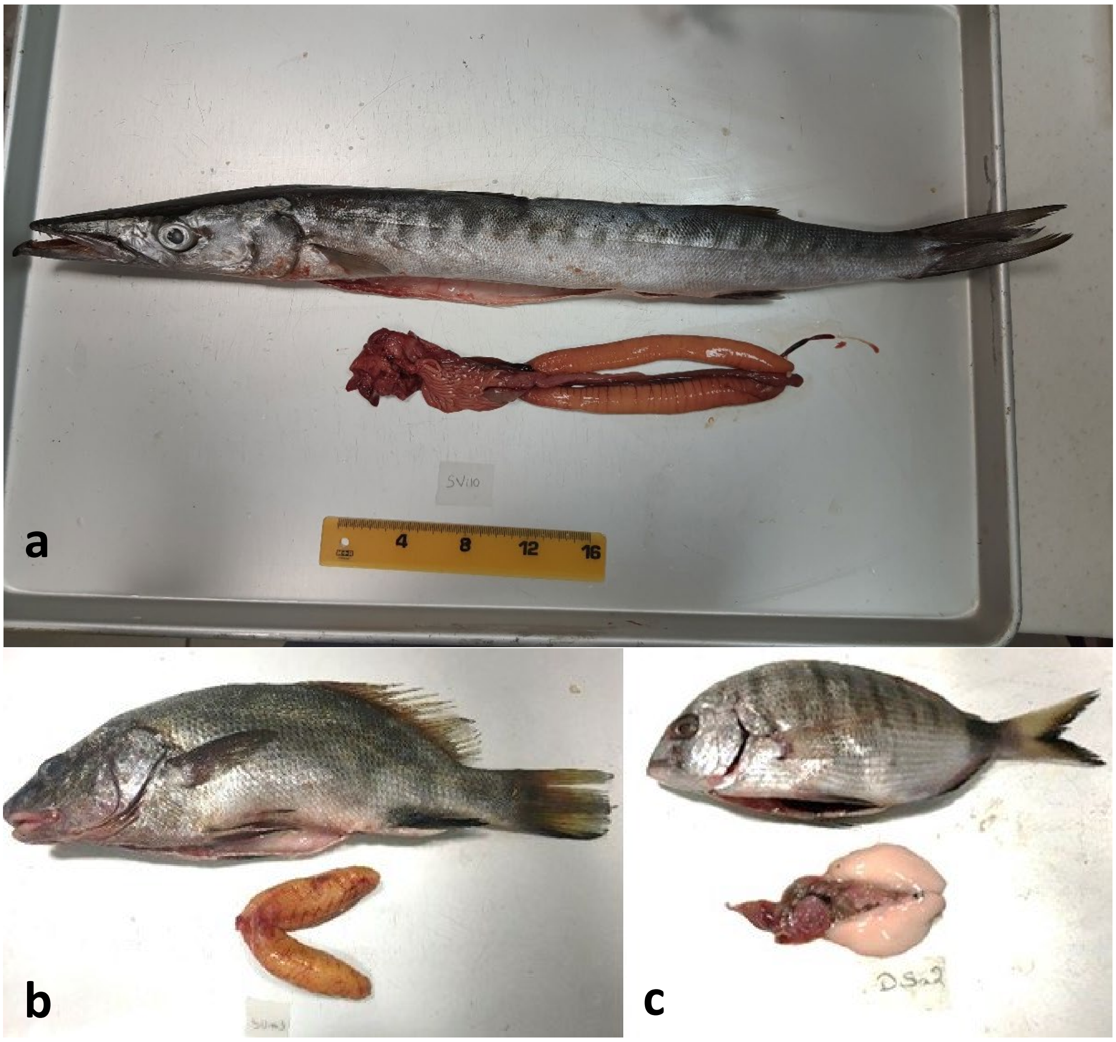

*Figure 6. (a) Yellowmouth barracuda (*Sphyraena viridensis*), (b) Brown meagre (*Sciaena umbra*)) with ovaries and; (c) White seabream (*Diplodus sargus*) with testes in advanced maturity stages (Photo credit: Michel Bariche)*

III. Results

A total of 1075 specimens were collected and processed, representing 64 different fish species out of the 89 native commercially important species that are known to breed in the Lebanese territorial waters (Table 1).

In this work, the basic reproductive characteristics of 54 species have been assessed and a spawning calendar has been created. The calendar includes a relatively precise estimate for 26 species. This is because of a relatively adequate sample size which covers most of the spawning season and is in line with the literature from the eastern Mediterranean Sea. A less precise estimate is available for 28 species, which were collected in smaller numbers, particularly during the start or end of their spawning season. The reproductive characteristics for those species was estimated from the data provided by the specimens collected, field observation and an extensive literature review from the Mediterranean. Finally, the remaining 10 species were not processed during the study (Annex 4).

Specific factsheets were developed for each species, showing general descriptive statistics related to the reproduction and sample characteristics (Annexes 2, 3).

IV. Discussion

This study provided some essential insight on the population structure and spawning period for native fish species present in the fish market.

Some obstacles that were encountered in 2020 (year 1) were removed, at least partially in 2021 (year 2), with an increase in the number of species collected, a larger number of individuals from specific species and a better preliminary list of months, suspected to be within the spawning period for most fish species.

In fact, significant efforts were made to expand the sampling area and include new fish landing spots, as well as increase the sampling size. The total number of native Mediterranean species collected changed from 46 species (year 1) to 64 species (year 2). The number of fish individuals was also significantly increased, which resulted in statistically accurate information for some species (Annex 2). While in year 1, the time of purchase was based on a preliminary spawning calendar compiled from available scientific literature and personal observations or notifications from fishers and fishmongers, many fishes did not display maturing gonads and were thus captured outside their real spawning period. In fact, published scientific work describes reproduction in the specific region of study within the Mediterranean, where the timing and temporal patterns are often different from Lebanon. This is particularly relevant, knowing that the general biology of fishes, especially the breeding season may fluctuate between years, as it often depends on environmental and biotic factors. During the sampling year that followed (year 2), the preliminary spawning months expected for most species were more accurate than year 1, since they were based on additional data acquired from the same sampling location (Lebanon) in year 1.

Acquiring such a large amount of information has been a considerable achievement despite the economic crisis and political instability encountered during the sampling years. In fact, the inflation on gasoline and goods resulted in an increased national demand on local food, such as fish, which consequently led to shortage in the fish market. Furthermore, the limited circulation due to civil protests in year 1 restricted precious sampling days within the spawning period of many fish species. Finally, the several lockdown periods due to the coronavirus pandemic amplified the problem, as many fishers stopped going out at sea, resulting in a decreased number of fish present on the market.

Other challenges encountered in year 1 remained in 2021 (year 2) and significantly affected the results for some species. They pertain to the number of specimens collected for some species that remained considerably low for not allowing a statistically significant estimate of their spawning periods. Therefore, no reliable conclusions can be drawn for those species (Annex 3). This is due to three main reasons: the scarcity of some species in the environment, misleading statements made by fishers and the large percentage of juvenile and immature fishes present in the Lebanese fishery.

In fact, the relatively low number of some species in our sample reflects their population size in the marine environment of Lebanon. Additional efforts in sampling significantly increase the cost and do not necessarily result in acquiring more specimens, particularly when they have to coincide with the few critical weeks of the spawning period for each species. Fishers occasionally indicate the potential breeding period of a rare species and encourage us to purchase it remotely. Their observation is based on the presence of developed gonads they extract and sell to customers. These gonads do not always reflect a real spawning event, as they may be immature, non-virgin (old gonads that have reproduced in previous years) or atretic (post-spawning gonads that are in a state of resorption). They are large enough to be seen and sold by fishers for consumption, but are not technically reproducing gonads. The vast majority of catch is either juveniles in their first year, or larger individuals that have not reached maturity yet. These subadults are often recognized as such after being purchased and processed, which adds a significant bias to the study, since the fishes are not used.

The small number of acquired fish, with the majority being juvenile, is certainly due to serious overfishing. This is caused by various illegal fishing activities and the lack of fishing regulations occurring in the Lebanese coastal waters. Furthermore, it is also related to other factors, such as habitat destruction, pollution, competition with the large number of invasive species and even the general climatic changes occurring in the eastern Mediterranean. All these factors are clearly affecting the marine coastal environment in Lebanon and the Levant.

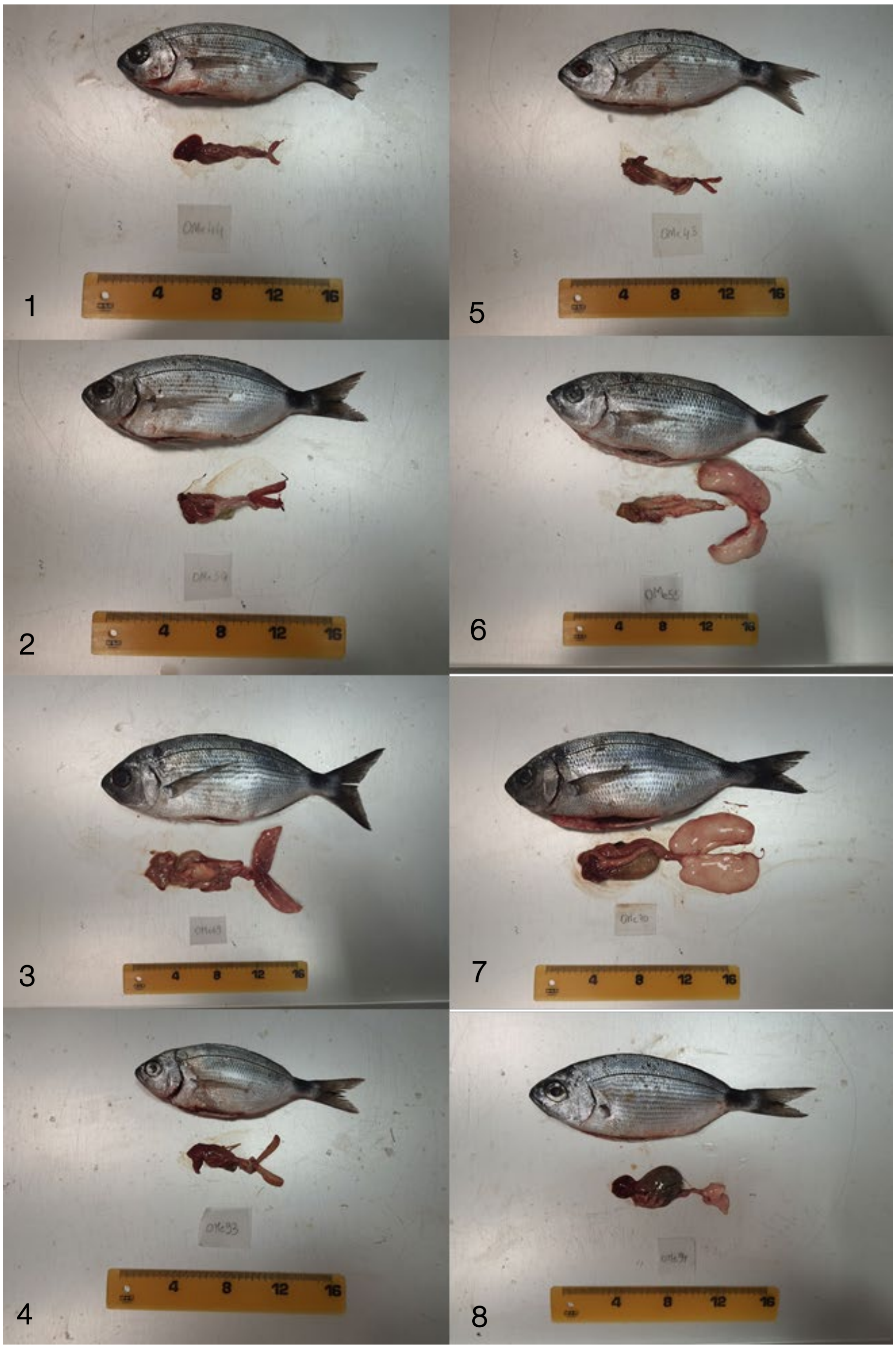

Figure 7 Sample photographs of Saddled seabream (Oblada melanura) *showing ovaries (photo 1 to 4) and testes (photo 5 to 8) in different stages of maturity (Photo credit: Michel Bariche)*

Family	Species	n	Jan2	Feb1	Feb2	Mar1	Mar2	Apr1	Apr2	May1	May2	Jun1	Jun2	Jul1	Jul2	Jan2	Feb1	Feb2	Mar1	Mar2	Apr1	Apr2	May1	May2	Jun1	Jun2	Jul1	Jul2
Mugilidae	*Chelon labrosus*	40			7	2					4					3	16		8									
	Chelon auratus	21			1						4					2	12									2		
	Chelon ramada	3																								3		
	Mugil cephalus	1									1																	
Sparidae	*Diplodus cervinus*	50			4	1					8						5		6		1	11	5		9			
	Diplodus sargus	42			6	5				3							6		7	4		5	3	3				
	Diplodus vulgaris	25			1												2		16	1		5						
	Oblada melanura	104			6	2			14		2							26			16		10	18		10		
	Lithognathus mormyrus	24			1							5										18						
	Boops boops	99			16	13					15						2	1	12	2	16			23				
	Spicara smaris	33			10														23									
	Pagrus caeruleostictus	14			1	1													2	1	3	1	2	1	2			
	Pagrus pagrus	30														3		16	7			2			2			
	Dentex macrophtalmus	46			9					5	14						5		11	2								
	Dentex dentex	4									1								1					1				
	Dentex gibbosus	2																	1									
	Dentex maroccanus	5				5																						
	Pagellus acarne	4								4																		
	Pagellus erythrinus	4								1												1			2			
	Sparus aurata	5			2	1					2																	
	Spondyliosoma cantharus	4				4																						
	Sarpa salpa	3			2																		1					
Carangidae	*Trachurus mediterraneus*	35			1												4	1	14	15								
	Seriola dumerili	8								1	4										3							
	Trachurus trachurus	1									1																	
	Lichia amia	3									1											2						
	Euthynnus alletteratus	18																			4				14			
	Caranx crysos	16										5									4					7		
	Alectis alexandrina	5																						5				
	Trachinotus ovatus	18																				6			12			
Scombridae	*Scomber colias*	74			7						11	16								5					35			
	Sarda sarda	1			1																							
	Auxis rochei	4							2																2			
Mullidae	*Mullus surmuletus*	36			1				24												9				2			
Haemulidae	*Pomadasys incisus*	14			6					1	1							1						5				
Merlucciidae	*Merluccius merluccius*	29			2				4	3							2	9	2	2	5							
Labridae	*Symphodus tinca*	38			3					5								15				15						
	Xyrichtys novacula	2																				2						
Scaridae	*Sparisoma cretense*	20				3					3							8							6			
Clupeidae	*Sardinella aurita*	67									25	5					1	1							35			
	Sardina pilchardus	14																	14									
	Sardinella maderensis	26										10					1			14					1			
Engraulidae	*Engraulis encrasicolus*	20																	20									
Serranidae	*Serranus scriba*	7			3													4										
	Serranus cabrilla	5															4			1								
	Epinephelus costae	5								2											1	1						
	Epinephelus marginatus	8								2										1	1	1			1	2		
	Epinephelus aeneus	6																				2		1				
Sebastidae	*Helicolenus dactylopterus*	5								5																		
Phycidae	*Phycis phycis*	3			1					1												1						
	Phycis blennoides	3															2		1									
Soleidae	*Solea solea*	1			1																							
	Solea lascaris	1			1																							
Uranoscopidae	*Uranoscopus scaber*	4								1							1					2						
Paralepididae	*Sudis hyalina*	4							4																			
Sciaenidae	*Sciaena umbra*	6								1	2	1							2									
	Umbrina cirrosa	4																	1		2	1						
Sphiraenidae	*Sphyraena viridensis*	12			2	2												1		1	3	2			1			
	Sphyraena sphyraena	5																5										
Balistidae	*Balistes capriscus*	7									4											2		1				
Moronidae	*Dicentrarchus labrax*	7															5					2						
Congridae	*Conger conger*	7																		1	2	1		3				
Echeneidae	*Echeneis naucrates*	2																		1	1							
Triglidae	*Trigla lucerna*	1																1										

Table 1. List of all species that have been studied from February 2020 to mid-June 2021, showing the number of samples and date of collection. Each month was divided into a period of 15 days (e.g. Mar1: 1 to 15 March; Mar2: 16 to 31 March) (Data compiled by report author)

Spawning calendar for fish species of commercial importance in Lebanon

Family	Species	J	F	M	A	M	J	Jy	A	S	O	N	D
Mugilidae	*Chelon labrosus*	observed	observed	spawning possible								spawning possible	observed
	Chelon auratus	observed	observed	observed	spawning possible								spawning possible
	Chelon ramada	estimated	estimated	spawning possible									spawning possible
	Mugil cephalus							spawning possible	spawning possible	spawning possible	estimated	estimated	
Sparidae	*Diplodus cervinus*	spawning possible	observed	observed	observed	observed	spawning possible				spawning possible	spawning possible	
	Diplodus sargus	spawning possible	observed	observed	observed	spawning possible							
	Diplodus vulgaris	estimated	estimated	spawning possible	spawning possible								spawning possible
	Oblada melanura			spawning possible	observed	observed	observed	spawning possible					
	Lithognathus mormyrus				spawning possible	observed	observed	observed	spawning possible	observed	spawning possible		
	Boops boops		observed	observed	observed	spawning possible							
	Spicara smaris			spawning possible	observed	spawning possible							
	Pagrus caeruleostictus			spawning possible	spawning possible	observed	observed	observed		spawning possible	observed	observed	spawning possible
	Pagrus pagrus		spawning possible	observed	observed	estimated							
	Dentex macrophtalmus		spawning possible	observed	observed	spawning possible							
	Dentex dentex			spawning possible	spawning possible	estimated	estimated						
	Dentex gibbosus						estimated	estimated			estimated	estimated	
	Dentex maroccanus				estimated	estimated	estimated	spawning possible	spawning possible	spawning possible			
	Pagellus acarne						spawning possible	spawning possible	spawning possible	spawning possible	spawning possible	estimated	estimated
	Pagellus erythrinus			spawning possible	estimated	estimated	estimated	spawning possible	spawning possible	estimated	estimated	spawning possible	
	Sparus aurata	spawning possible	estimated	estimated	spawning possible								
	Spondyliosoma cantharus	spawning possible	estimated	estimated	spawning possible								
	Sarpa salpa		spawning possible	estimated	estimated	spawning possible							
Carangidae	*Caranx crysos*						spawning possible	observed	observed	spawning possible			
	Trachinotus ovatus					observed	observed	observed	spawning possible				
	Trachurus mediterraneus			spawning possible	observed	observed	observed	spawning possible					
	Trachurus trachurus	spawning possible	spawning possible	estimated	estimated	estimated	spawning possible	spawning possible					
	Lichia amia				estimated	estimated	spawning possible						
	Seriola dumerili					observed	observed	spawning possible					
Scombridae	*Euthynnus alleteratus*					spawning possible	observed	observed	observed	spawning possible			
	Scomber colias	spawning possible	observed	observed	observed	observed	spawning possible					spawning possible	spawning possible
	Auxis rochei				spawning possible	spawning possible	estimated	spawning possible	spawning possible	spawning possible			
Mullidae	*Mullus sumuletus*		spawning possible	observed	observed	spawning possible	spawning possible						
Haemulidae	*Pomadasys incisus*					spawning possible	observed	observed	observed	spawning possible	observed	spawning possible	
Merlucciidae	*Merluccius merluccius*	spawning possible	observed	observed	observed	observed	observed	observed	spawning possible	observed	observed	observed	spawning possible
Labridae	*Symphodus tinca*			observed	observed	observed	spawning possible						
Scaridae	*Sparisoma cretense*				spawning possible	observed	observed	spawning possible	spawning possible	spawning possible			
Clupeidae	*Sardinella aurita*			spawning possible	spawning possible	observed	observed	observed	spawning possible	spawning possible		spawning possible	spawning possible
	Sardinella maderensis					observed	observed	observed	observed	spawning possible			
Engraulidae	*Engraulis encrasicolus*	spawning possible	spawning possible	observed	observed	observed	observed	observed	spawning possible	spawning possible			
Serranidae	*Epinephelus marginatus*						spawning possible	estimated	estimated	spawning possible			
	Epinephelus costae					spawning possible	estimated	estimated	estimated	spawning possible			
	Epinephelus aeneus			spawning possible	spawning possible	spawning possible	spawning possible	estimated	estimated				
	Serranus scriba			estimated	estimated	estimated	estimated	spawning possible	spawning possible	spawning possible	spawning possible		
	Serranus cabrilla	spawning possible	spawning possible	estimated	estimated	estimated	spawning possible	spawning possible					
Sebastidae	*Helicolenus dactylopterus*	spawning possible	spawning possible	spawning possible	spawning possible	spawning possible							
Phycidae	*Phycis blennoides*	spawning possible	spawning possible	spawning possible							spawning possible	spawning possible	
Uranoscopidae	*Uranoscopus scaber*	estimated	estimated	estimated									estimated
Paralepididae	*Sudis hyalina*				spawning possible	spawning possible	spawning possible	spawning possible					
Sciaenidae	*Sciaena umbra*					spawning possible	spawning possible	spawning possible	spawning possible				
	Umbrina cirrosa			spawning possible	estimated	estimated	estimated	estimated	spawning possible	spawning possible			
Sphyraenidae	*Sphyraena sphyraena*				spawning possible	estimated	estimated	spawning possible	spawning possible				
Balistidae	*Balistes capriscus*					estimated	estimated	estimated	spawning possible	spawning possible		spawning possible	
Moronidae	*Dicentrarchus labrax*	observed	observed	observed	spawning possible								
Congridae	*Conger conger*			estimated	estimated						spawning possible	spawning possible	

observed estimated spawning possible

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Annex 1: Captions for the factsheets

Scientific and common names

Family

Reproductive strategy

Frequency of spawning per year

Broad estimate of the spawning season

Selected number of individuals used in the study

Mean size, standard deviation and size ranges in the study

Estimate of the length at which 50% of the fish population can reproduce

Sex-ratio: ratio of males to females in the studied fish sample

Weight-length relationship for females (♀), males (♂) and both sexes grouped (⚥)

© Michel Bariche

Sparidae

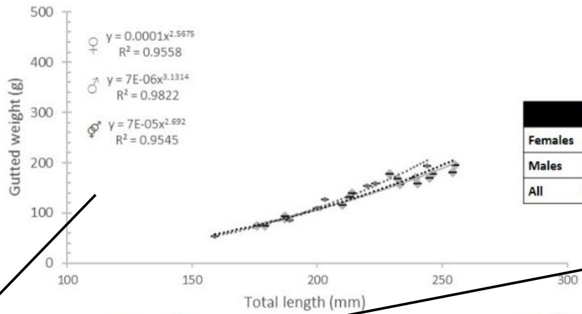
Lithognathus mormyrus (Linnaeus, 1758)

Sand steenbras مَرمُور

Reproduction summary

Strategy	Upon maturity, fish are first males and change to females later in life (protandrous hermaphrodites)
Frequency	One spawning per year
Season	Spring-summer, possibly to September
Sample size	24
Mean ± SD (range)	21.5 ± 2.6 cm (15.9-25.5 cm)
First maturity	19.1 cm
Sex-ratio	1:2

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	16	221.2	26.83	176	255
Males	8	204.9	25.32	159	244
All	24	215.8	26.95	159	255

Female

© Michel Bariche

Male

© Michel Bariche

Spawning months of the fish species

Observed

Possible

Estimated

Descriptive measurements of the selected number of studied individuals from 2020-2021 (grouped with unidentified gonads)

Sample photographs showing the gonads in various stages

Annex 2: Factsheets with reproductive characteristics for fish species from this study

© Michel Bariche

Mugilidae

Chelon labrosus (Risso, 1827)

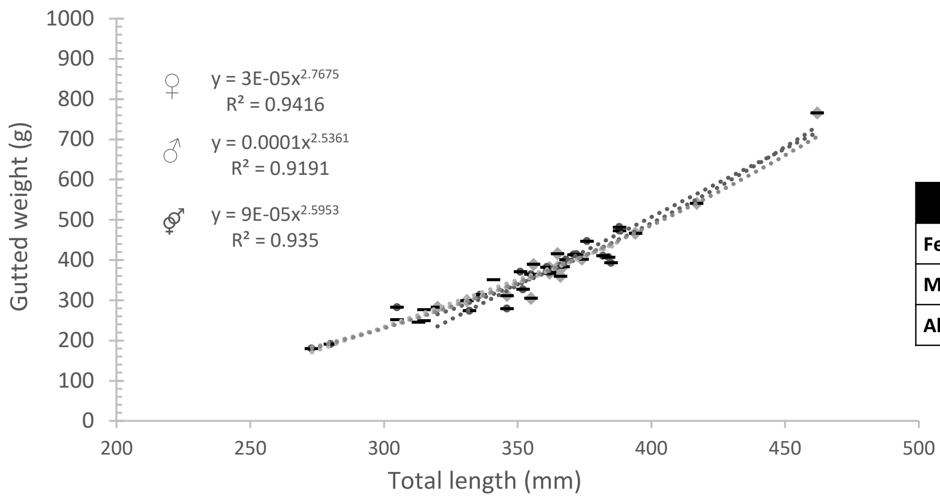
Thicklip grey mullet

بوري شيلان

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Winter
Sample size	40
Mean ± SD (range)	35.5 ± 3.5 cm (27.3-46.2 cm)
First maturity	25.2 cm
Sex-ratio	1 : 0.7

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

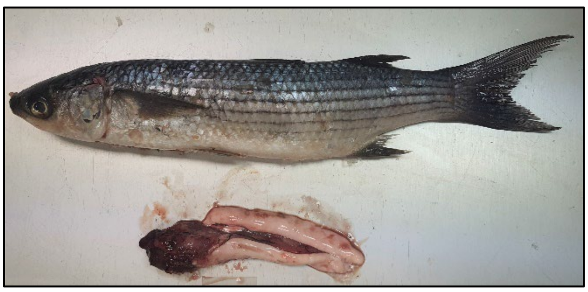


	n	Mean	S.D.	Range	
Females	15	369.5	34.31	320	462
Males	21	351.5	33.97	273	388
All	40	355.0	35.45	273	462

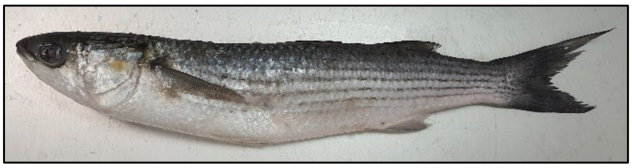
Female

© Michel Bariche

Male



© Michel Bariche



© Michel Bariche

Mugilidae

Chelon auratus (Risso, 1810)

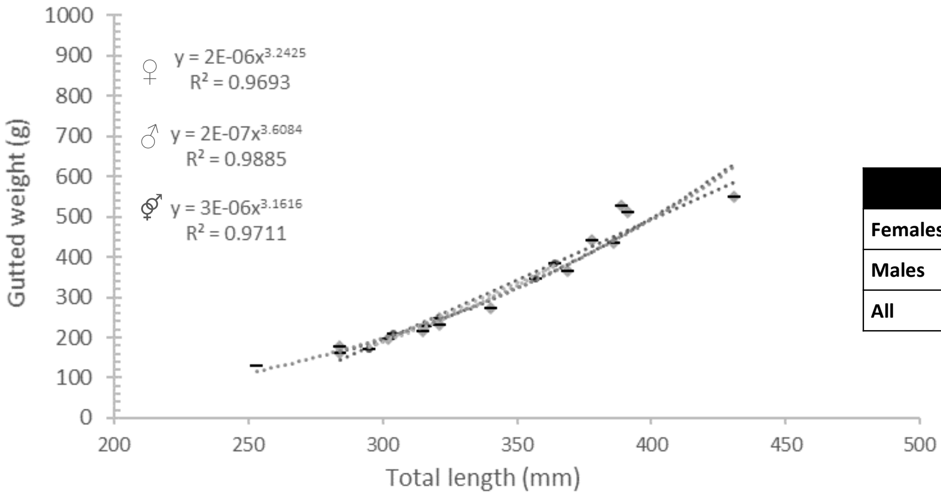
Golden grey mullet

بوري دهبان

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Winter
Sample size	21
Mean ± SD (range)	33.3 ± 4.5 cm (25.3-43.1 cm)
First maturity	28.0 cm
Sex-ratio	1 : 3.5

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



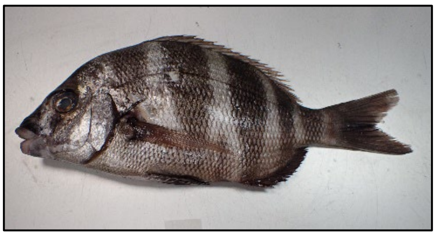
	n	Mean	S.D.	Range	
Females	14	344.8	45.58	284	431
Males	4	330.0	35.52	295	364
All	21	333.0	45.71	253	431

Female

© Michel Bariche

Male

© Michel Bariche



© Michel Bariche

Sparidae

Diplodus cervinus (Lowe, 1838)

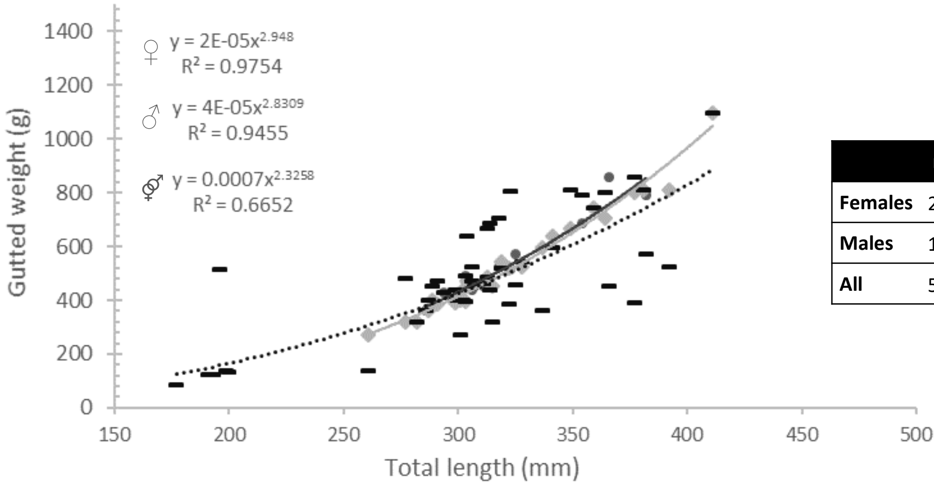
Zebra seabream

حداد

Reproduction summary

Strategy	Upon maturity, fish are first males and change to females later in life (protandrous hermaphrodites)
Frequency	One spawning per year
Season	Spring
Sample size	50
Mean ± SD (range)	30.5 ± 5.6 cm (17.7-41.1 cm)
First maturity	24.2 cm
Sex-ratio	1 : 1.6

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	27	322.8	37.83	261	411
Males	16	324.1	29.40	286	382
All	50	305.0	56.00	177	411

Female

© Michel Bariche

Male

© Michel Bariche

© Michel Bariche

Sparidae

Diplodus sargus (Linnaeus, 1758)

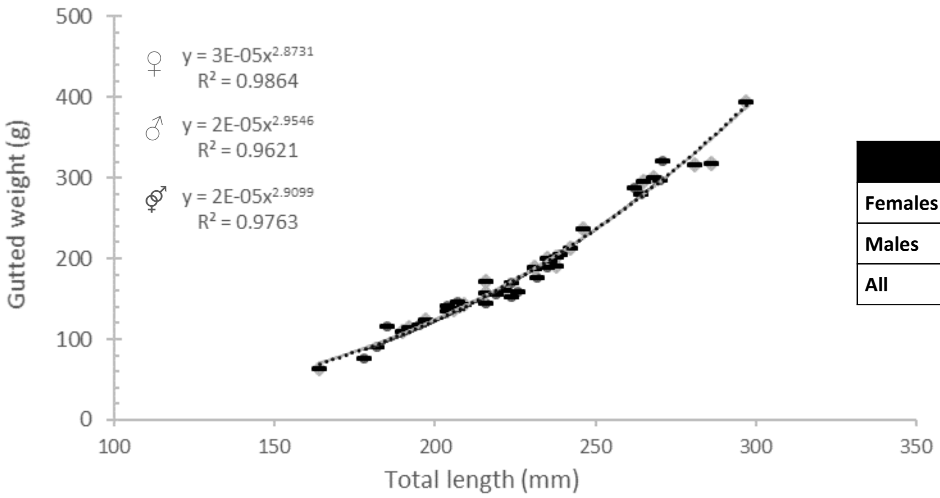
White seabream

سرغوس

Reproduction summary

Strategy	Sexes are separate (gonochoric) but also some are protandrous hermaphrodites (first males and change to females later in life)
Frequency	One spawning per year
Season	Winter-spring
Sample size	42
Mean ± SD (range)	22.7 ± 3.1 cm (16.4-29.7 cm)
First maturity	19.6 cm
Sex-ratio	1 : 1.2

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	23	230.9	33.10	164	297
Males	19	223.2	28.94	178	271
All	42	227.4	31.16	164	297

Female

© Michel Bariche

Male

© Michel Bariche


© Michel Bariche

Sparidae

Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)

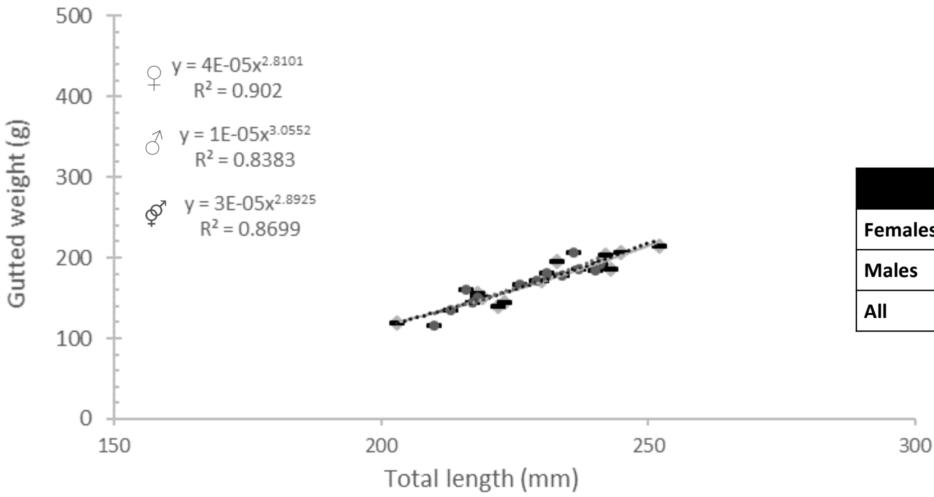
Common two-banded seabream

خَرقَن

Reproduction summary

Strategy	Sexes are separate (gonochoric) but also some are protandrous hermaphrodites (first males and change to females later in life)
Frequency	One spawning per year
Season	Winter
Sample size	25
Mean ± SD (range)	22.7 ± 1.2 cm (20.3-25.2 cm)
First maturity	15.6 cm
Sex-ratio	1 : 0.9

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

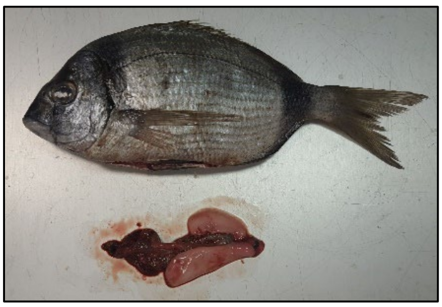


	n	Mean	S.D.	Range	
Females	12	229.1	14.30	203	252
Males	13	226.8	10.81	210	241
All	25	227.9	12.39	203	252

Female


© Michel Bariche

Male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Sparidae

Oblada melanura (Linnaeus, 1758)

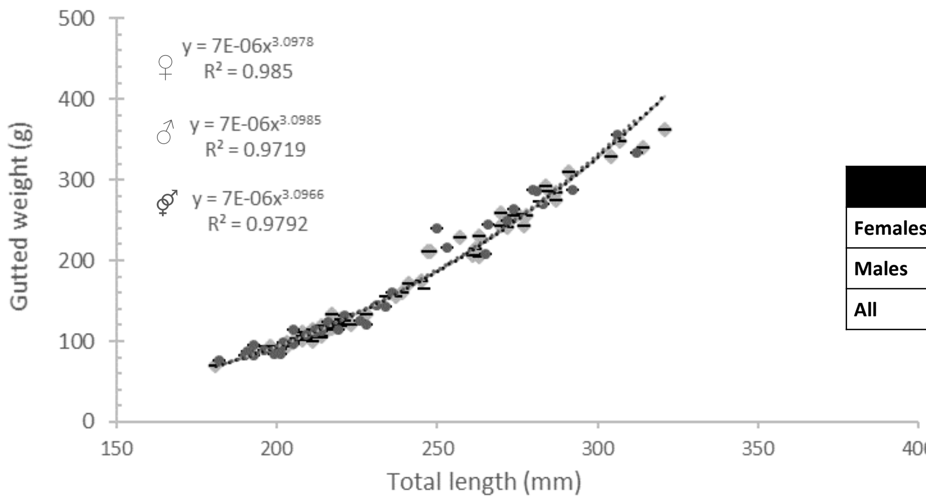
Saddled seabream

مَنُّوري

Reproduction summary

Strategy	Sexes are separate (gonochoric) but also some are protandrous hermaphrodites (first males and change to females later in life)
Frequency	One spawning per year
Season	Spring
Sample size	104
Mean ± SD (range)	23.6 ± 3.4 cm (18.1-32.1 cm)
First maturity	17.2 cm
Sex-ratio	1 : 1.6

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	60	240.0	34.80	181	321
Males	36	231.9	36.68	182	312
All	104	236.2	34.95	181	321

Female

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Male

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Sparidae

Lithognathus mormyrus (Linnaeus, 1758)

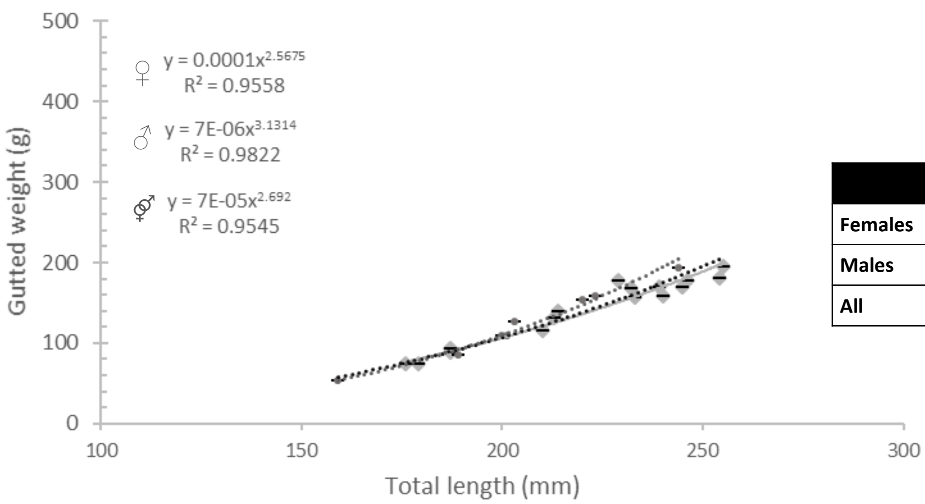
Sand steenbras

مَرمُور

Reproduction summary

Strategy	Upon maturity, fish are first males and change to females later in life (protandrous hermaphrodites)
Frequency	One spawning per year
Season	Spring-summer, possibly to September
Sample size	24
Mean ± SD (range)	21.5 ± 2.6 cm (15.9-25.5 cm)
First maturity	19.1 cm
Sex-ratio	1 : 2

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	16	221.2	26.83	176	255
Males	8	204.9	25.32	159	244
All	24	215.8	26.95	159	255

Female

© Michel Bariche

Male

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Sparidae

Boops boops (Linnaeus, 1758)

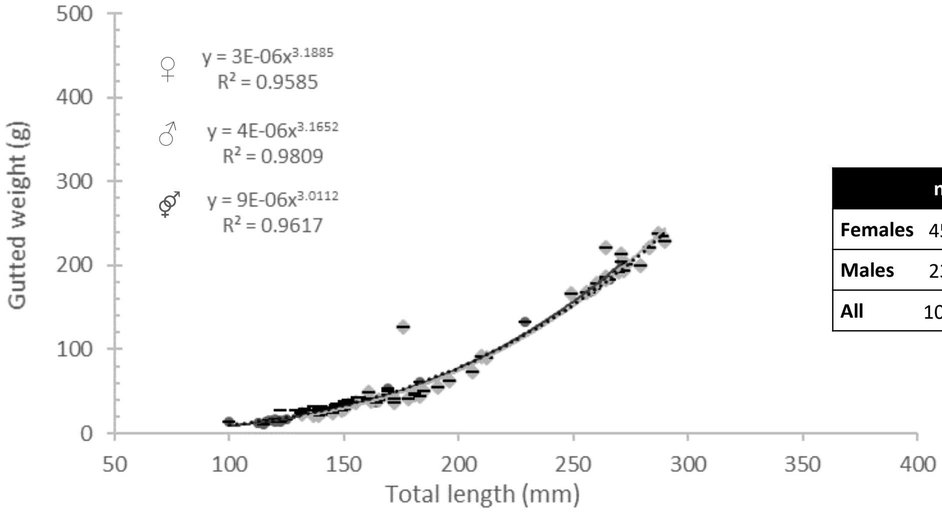
Bogue

غبص

Reproduction summary

Strategy	Sexes are separate (gonochoric) but possibility to become a protogynous hermaphrodites (first females and change to males later in life)
Frequency	One spawning per year
Season	Winter-spring
Sample size	100
Mean ± SD (range)	17.1 ± 5.2 cm (10.0-29.0 cm)
First maturity	13.2 cm
Sex-ratio	1 : 1.9

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	45	203.4	54.25	132	290
Males	23	152.8	53.18	100	271
All	100	171.9	52.91	100	290

Female

© Michel Bariche

Male

© Michel Bariche

Sparidae

Spicara smaris (Linnaeus, 1758)

Picarel

زمريدة

Reproduction summary

Strategy Upon maturity, fish are first females and change to males later in life (protogynous hermaphrodites)

Frequency One spawning per year

Season Spring

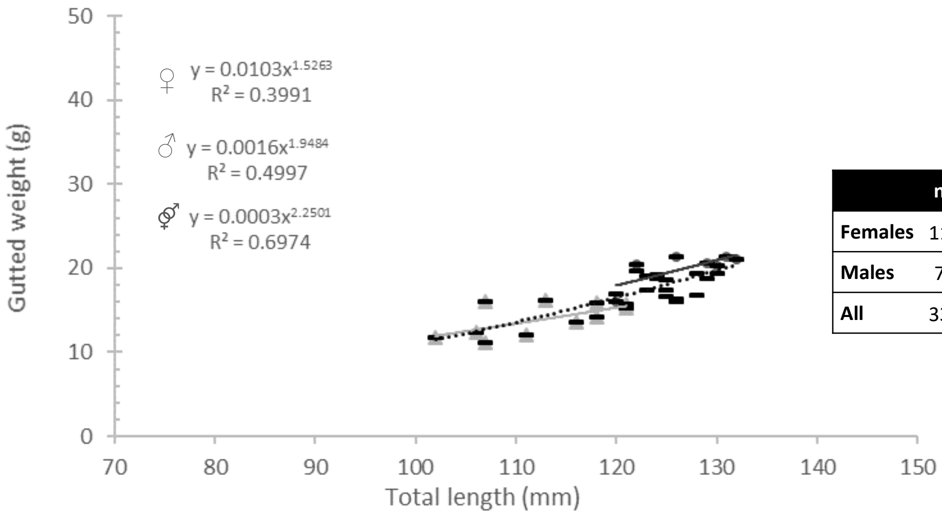
Sample size 33

Mean ± SD (range) 12.1 ± 0.7 cm (10.2-13.2 cm)

First maturity 7.8 cm

Sex-ratio 1 : 1.5

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	11	112.7	6.57	102	121
Males	7	127.1	4.63	120	132
All	33	121.5	7.79	102	132

Female

Male

© Michel Bariche

Sparidae

Pagrus caeruleostictus (Linnaeus, 1758)

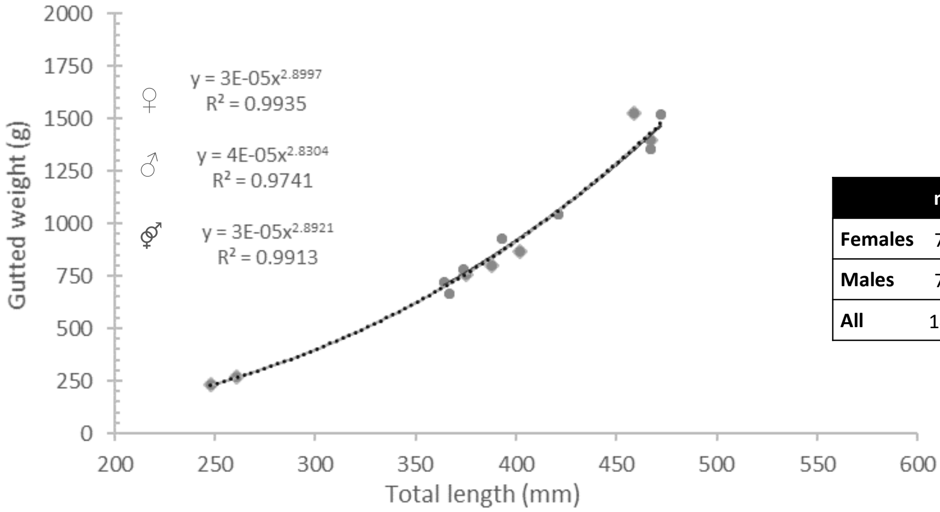
Bluespotted seabream

فريدي

Reproduction summary

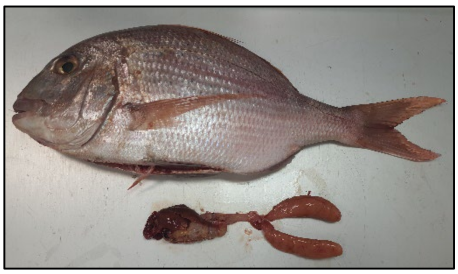
Strategy	Upon maturity, fish are first females and change to males later in life (protogynous hermaphrodites)
Frequency	More than one spawning per year
Season	Spring-summer, fall (some years)
Sample size	14
Mean ± SD (range)	38.9 ± 6.9 cm (24.8-47.2 cm)
First maturity	19.2 cm
Sex-ratio	1 : 1

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	7	371.4	87.04	248	467
Males	7	408.3	46.09	364	472
All	14	389.9	69.59	248	472

Female



© Michel Bariche

Male

© Michel Bariche

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Sparidae

Pagrus pagrus (Linnaeus, 1758)

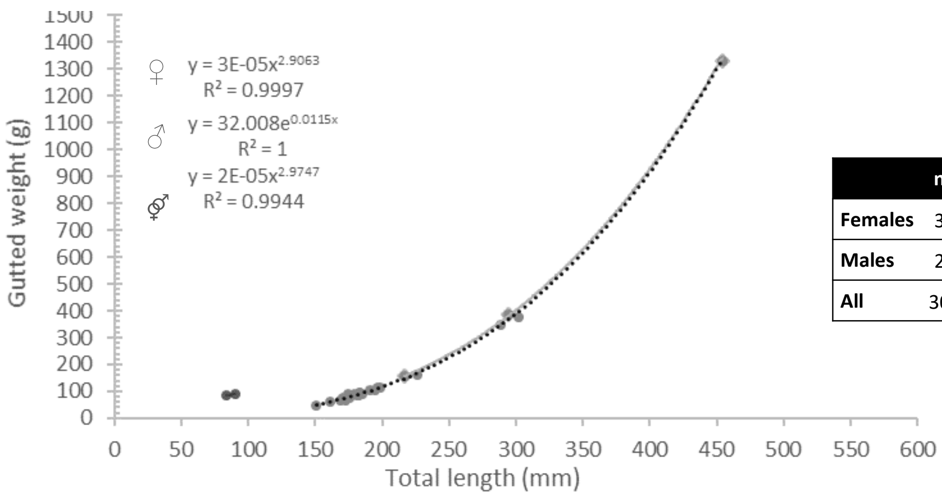
Red porgy

جربيدن مكحل

Reproduction summary

Strategy	Upon maturity, fish are first females and change to males later in life (protogynous hermaphrodites)
Frequency	One spawning per year
Season	Spring
Sample size	30
Mean ± SD (range)	20.2 ± 6.0 cm (15.1-45.4 cm)
First maturity	23.5 cm
Sex-ratio	1 : 1.5

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	3	321.7	120.9	217	454
Males	2	183.0	2.83	181	185
All	30	202.6	60.36	151	454

Female

© Michel Bariche

Male

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Sparidae

Dentex macrophtalmus (Bloch, 1791)

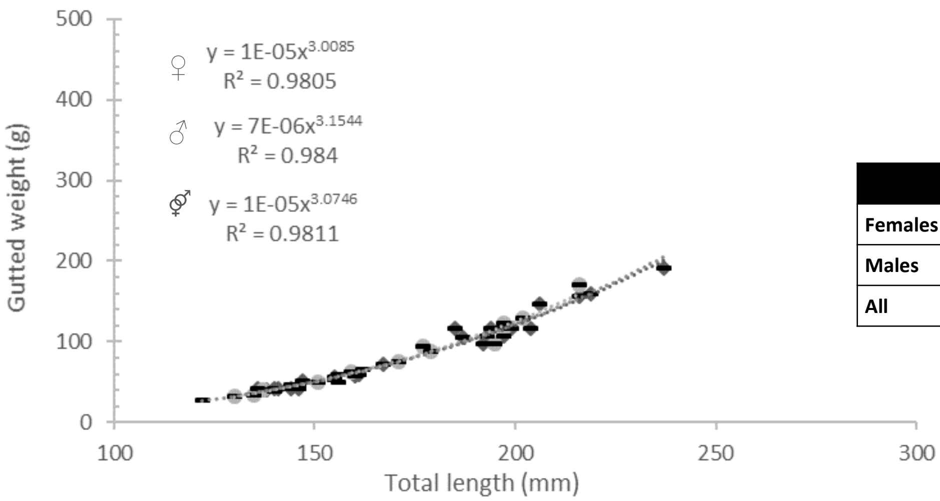
Large-eye dentex

بحلق

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Spring
Sample size	46
Mean ± SD (range)	16.9 ± 2.8 cm (12.2-23.7 cm)
First maturity	13.6 cm
Sex-ratio	1 : 1.8

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	24	175.4	30.30	136	237
Males	13	172.8	28.36	130	216
All	46	169.4	28.64	122	237

Female

© Michel Bariche

Male

© Michel Bariche

© Michel Bariche

Carangidae

Caranx crysos (Mitchill, 1815)

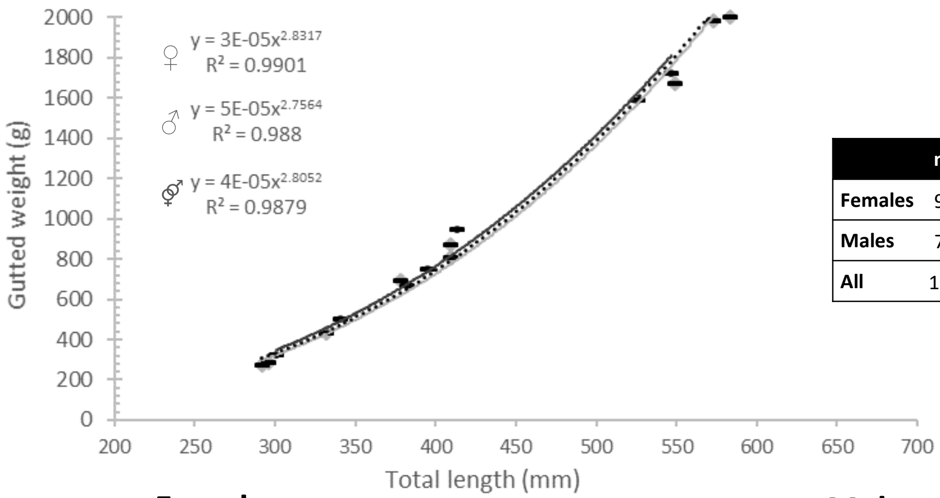
Blue runner

تراخون

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Summer
Sample size	16
Mean ± SD (range)	42.0 ± 10.2 cm (29.2-58.3 cm)
First maturity	28.4 cm
Sex-ratio	1 : 1.2

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	9	424.6	116.1	292	583
Males	7	415.0	91.0	301	547
All	16	420.4	102.6	292	583

Female

© Michel Bariche

Male

© Michel Bariche


© Michel Bariche

Carangidae

Trachinotus ovatus (Linnaeus, 1758)

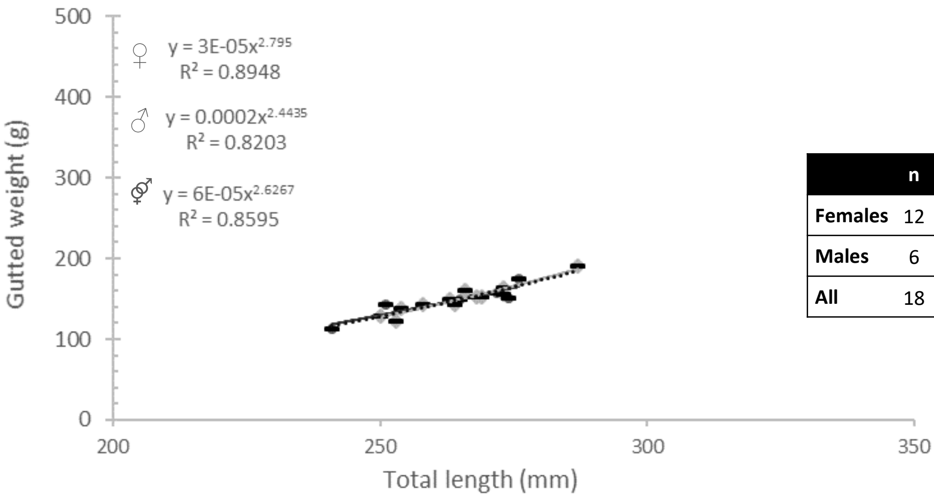
Pompano

عَطعوط

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Spring
Sample size	18
Mean ± SD (range)	26.4 ± 1.1 cm (24.1-28.7 cm)
First maturity	24.2 cm
Sex-ratio	1 : 2

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	12	264.8	10.36	250	287
Males	6	263.2	14.16	241	276
All	18	264.3	11.36	241	287

Female


© Michel Bariche

Male


© Michel Bariche

Carangidae

© Michel Bariche

Trachurus mediterraneus (Steindachner, 1868)

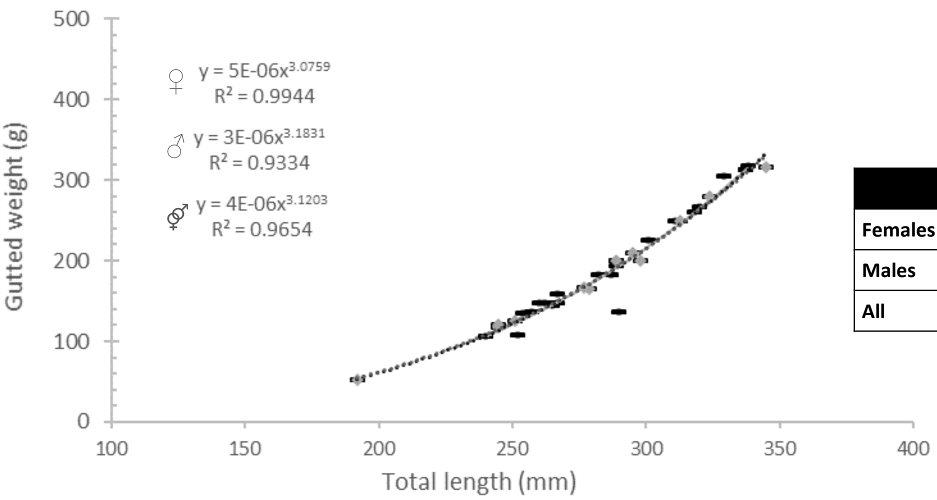
Mediterranean horse mackerel

عصيفر

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Spring
Sample size	35
Mean ± SD (range)	28.4 ± 3.4 cm (19.2-34.5 cm)
First maturity	20.1 cm
Sex-ratio	1 : 0.6

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	13	276.8	40.84	192	345
Males	22	288.7	31.03	240	338
All	35	284.3	34.90	192	345

Female

© Michel Bariche

Male

© Michel Bariche

© Michel Bariche

Scombridae

Euthynnus alletteratus (Rafinesque, 1810)

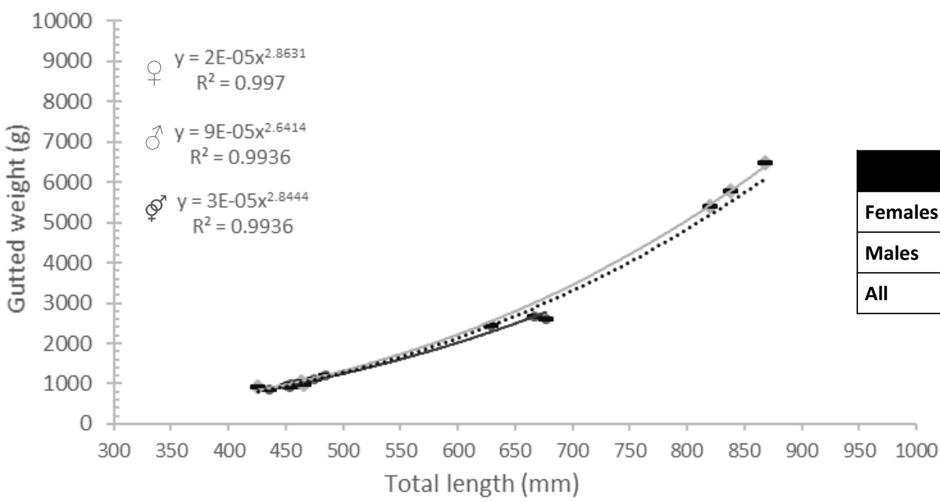
Little tunny

بالاميدا

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Summer
Sample size	18
Mean ± SD (range)	55.5 ± 15.2 cm (42.6-86.8 cm)
First maturity	43.8 cm
Sex-ratio	1 : 0.5

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	6	647.0	214.64	426	868
Males	12	509.1	91.09	435	677
All	18	555.1	152.95	426	868

Female

© Michel Bariche

Male

© Michel Bariche

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Scombridae

Scomber colias (Gmelin, 1789)

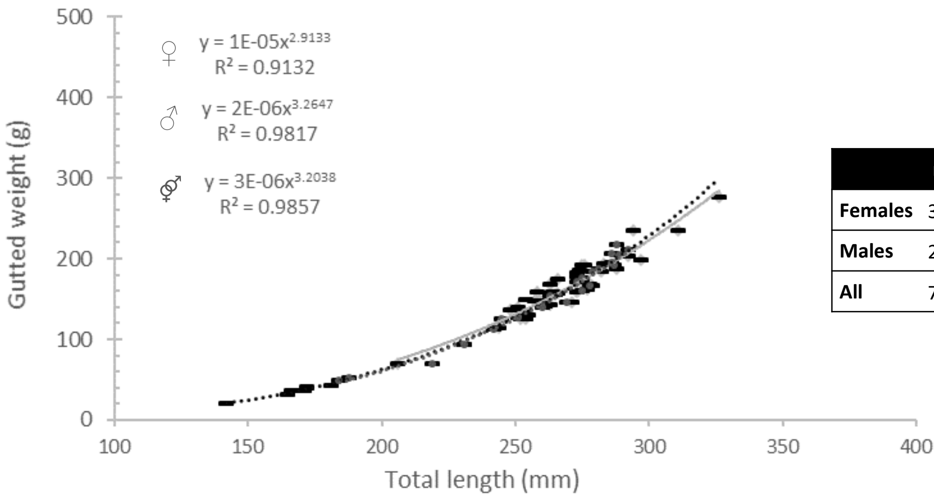
Atlantic chub mackerel

سكمبري

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Winter
Sample size	74
Mean ± SD (range)	25.6 ± 3.7 cm (14.2-32.6 cm)
First maturity	19.5 cm
Sex-ratio	1 : 1.7

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



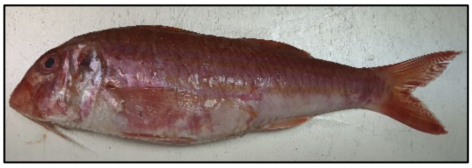
	n	Mean	S.D.	Range	
Females	38	270.3	19.92	206	326
Males	22	261.0	31.36	184	292
All	74	256.4	37.20	142	326

Female

© Michel Bariche

Male

© Michel Bariche



© Michel Bariche

Mullidae

Mullus surmuletus (Linnaeus, 1758)

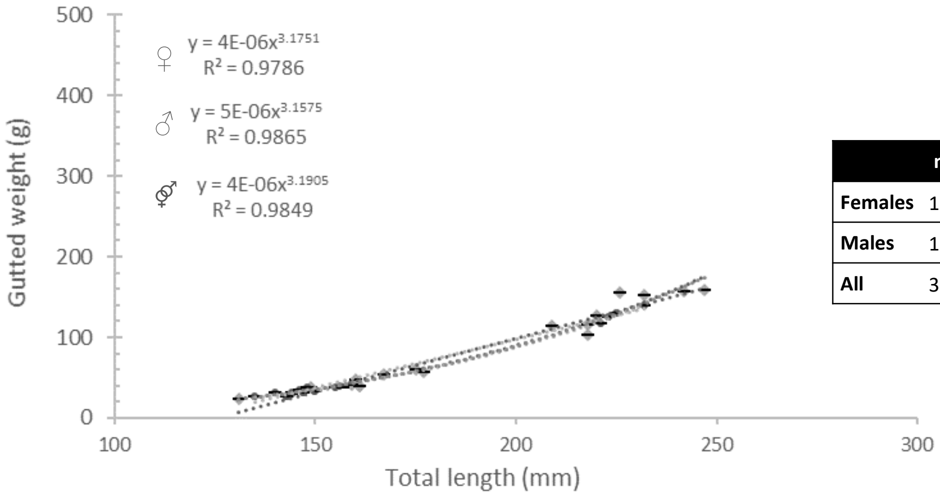
Surmullet

سلطان ابراهيم صخري

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Spring
Sample size	36
Mean ± SD (range)	17.6 ± 3.7 cm (13.1-24.7 cm)
First maturity	15.9 cm
Sex-ratio	1 : 0.9

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	17	191.3	36.61	131	247
Males	18	163.7	34.24	135	232
All	36	176.6	37.19	131	247

Female

© Michel Bariche

Male

© Michel Bariche

© Michel Bariche

Haemulidae

Pomadasys incisus (Bowdich, 1895)

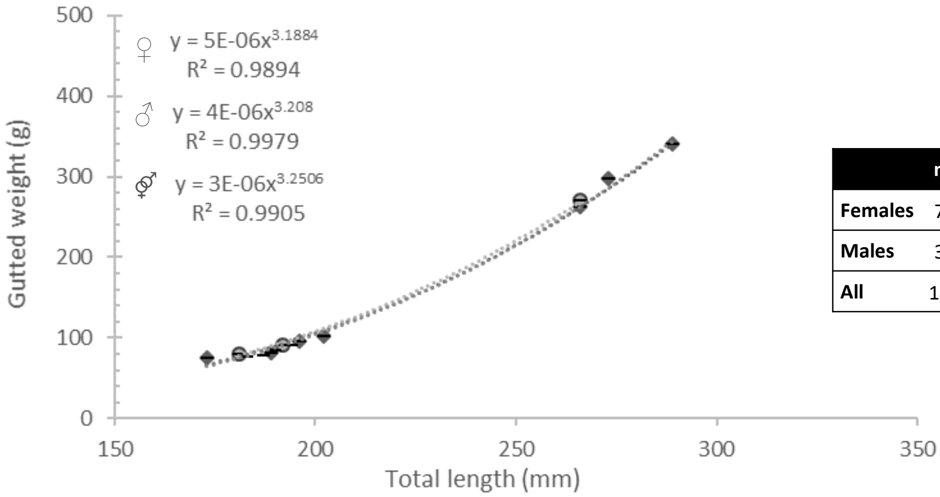
Bastard grunt

قريق

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Summer, possibly to October
Sample size	14
Mean ± SD (range)	21.2 ± 4.0 cm (17.3-28.9 cm)
First maturity	16.3 cm
Sex-ratio	1 : 2.3

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	7	226.9	47.31	173	289
Males	3	213.0	46.23	181	266
All	14	212.9	40.68	173	289

Female

© Michel Bariche

Male

© Michel Bariche

© Michel Bariche

Merlucciidae

Merluccius merluccius (Linnaeus, 1758)

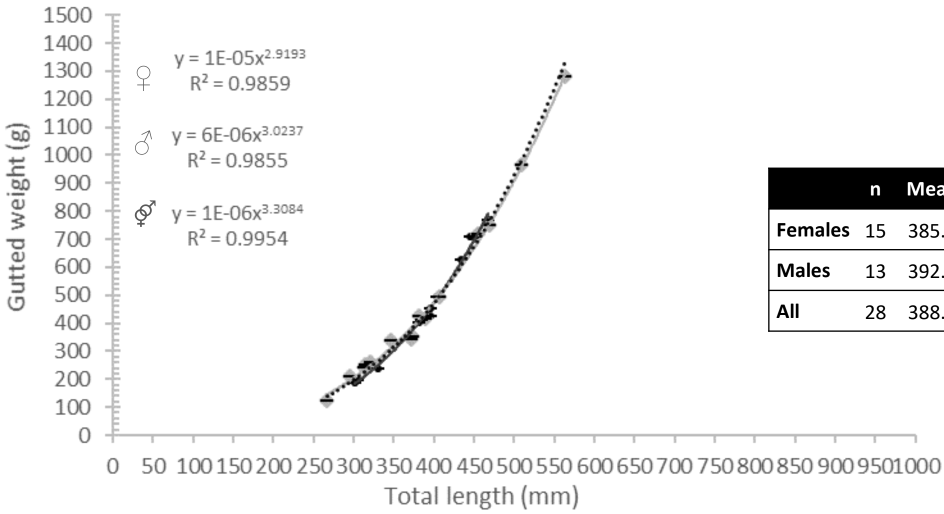
European hake

مرلان

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Possibly all year round
Sample size	28
Mean ± SD (range)	38.8 ± 7.0 cm (26.7-56.4 cm)
First maturity	40.6 cm
Sex-ratio	1 : 1.1

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

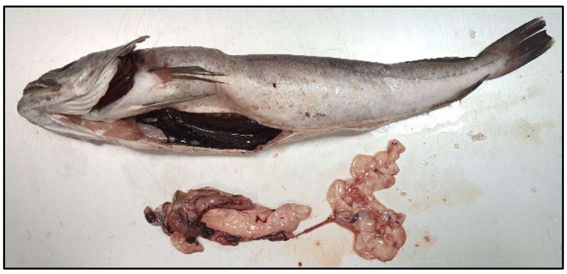


	n	Mean	S.D.	Range	
Females	15	385.1	83.65	267	564
Males	13	392.3	53.33	301	468
All	28	388.4	70.04	267	564

Female

© Michel Bariche

Male



© Michel Bariche

© Michel Bariche

Labridae

Symphodus tinca (Linnaeus, 1758)

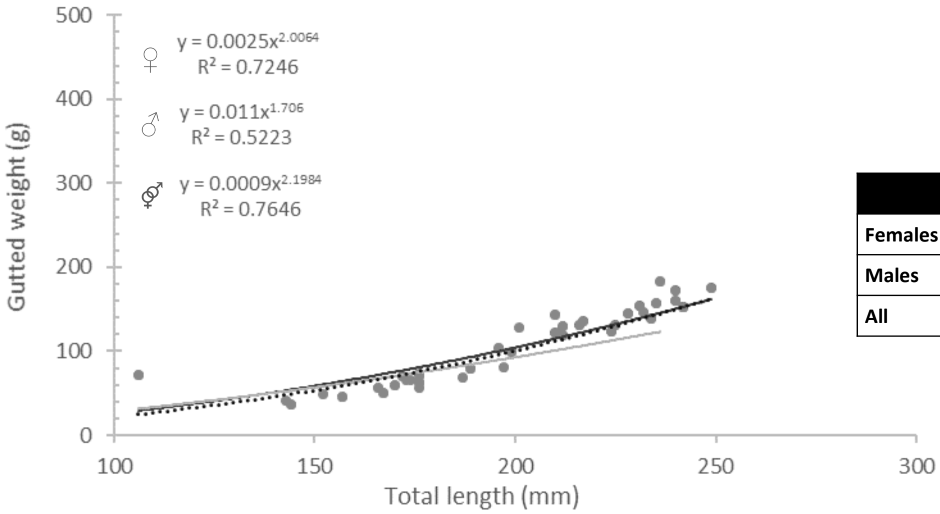
East Atlantic peacock wrasse

شفاف

Reproduction summary

Strategy	Upon maturity, fish are first females and change to males later in life (protogynous hermaphrodites)
Frequency	One spawning per year
Season	Spring
Sample size	40
Mean ± SD (range)	19.8 ± 3.3 cm (10.6-24.9 cm)
First maturity	10.2 cm
Sex-ratio	1 : 0.6

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	11	180.6	24.01	143	232
Males	18	220.9	25.67	144	249
All	40	198.3	33.98	106	249

Female

© Michel Bariche

Male

© Michel Bariche

Scaridae

Sparisoma cretense (Linnaeus, 1758)

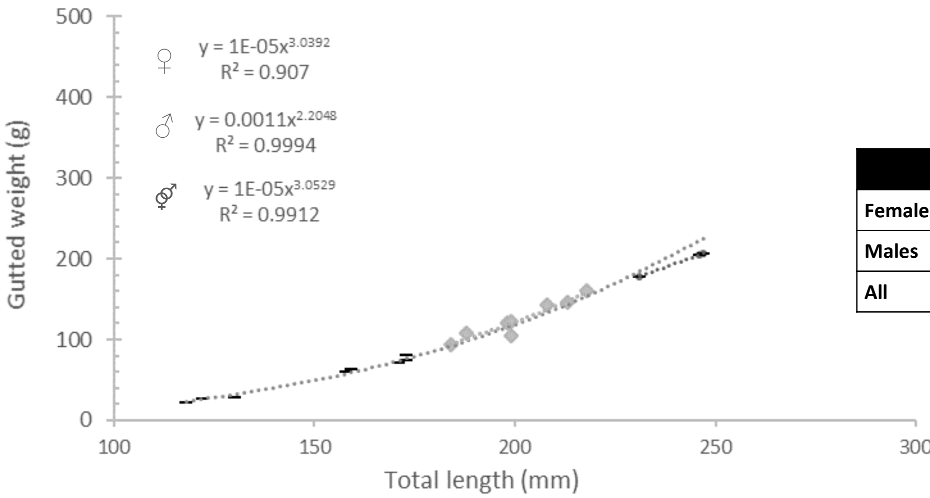
Parrotfish

زليق

Reproduction summary

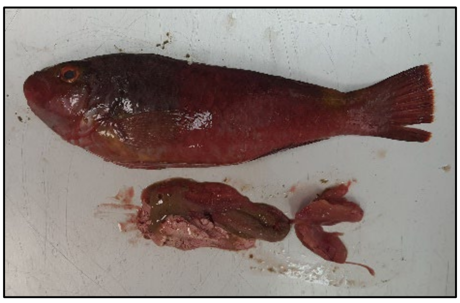
Strategy	Sexes are separate (gonochoric), with a possibility of sex-change (protogyny)
Frequency	One spawning per year
Season	Spring
Sample size	20
Mean ± SD (range)	186.6 ± 3.7 cm (11.8-24.7 cm)
First maturity	16.2 cm
Sex-ratio	1 : 2.6

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	8	200.9	11.69	184	218
Males	3	241.3	8.96	231	247
All	20	186.2	37.00	118	247

Female



Male


© Michel Bariche

Clupeidae

Sardinella aurita (Valenciennes, 1847)

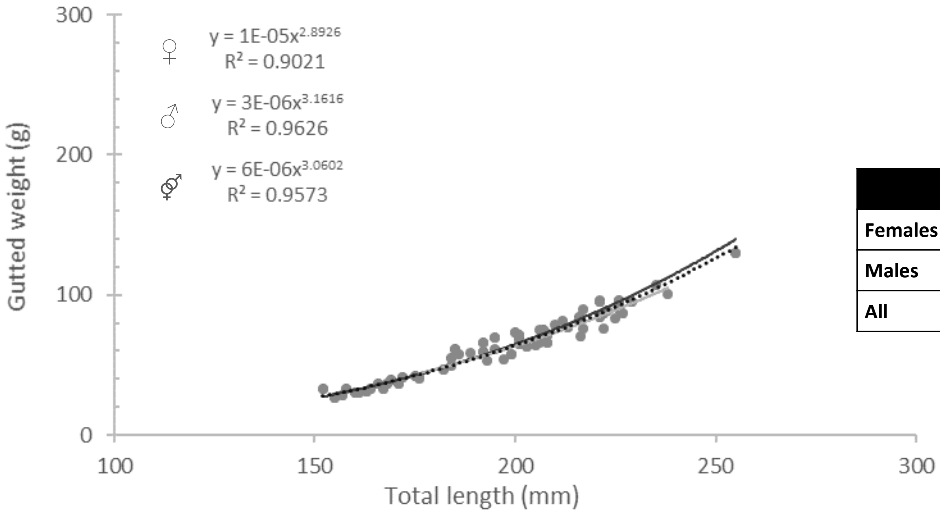
Round sardinella

ريتغا

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One or more spawning per year
Season	Spring
Sample size	66
Mean ± SD (range)	19.8 ± 2.4 cm (15.2-25.5 cm)
First maturity	14.9 cm
Sex-ratio	1:0.65

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	26	210.8	16.38	176	238
Males	40	190.1	24.99	152	255
All	66	198.2	24.13	152	255

Female


© Michel Bariche

Male


© Michel Bariche

Clupeidae

Sardinella maderensis (Lowe, 1838)

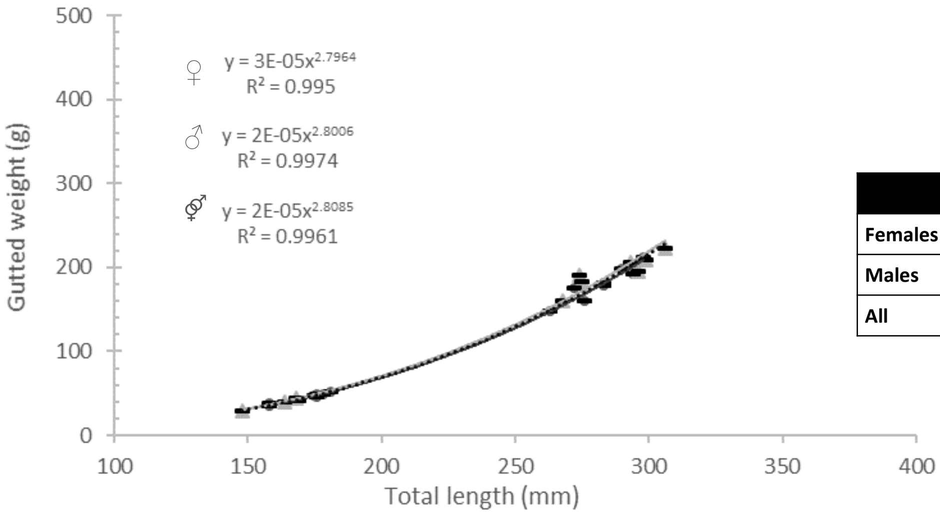
Madeiran sardinella

لاتشيو

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Summer
Sample size	26
Mean ± SD (range)	23.5 ± 5.9 cm (14.8-30.6 cm)
First maturity	13.8 cm
Sex-ratio	1 : 0.6

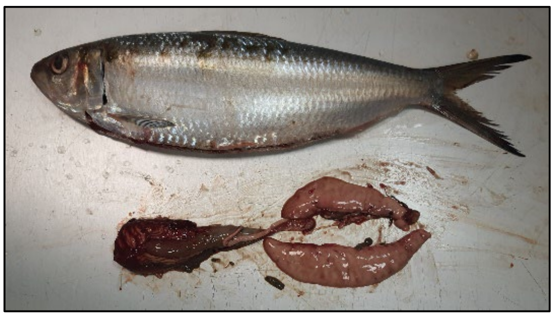
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	10	249.1	62.84	148	306
Males	16	226.9	58.20	158	298
All	26	235.4	59.79	148	306

Female

Male



© Michel Bariche

Engraulidae

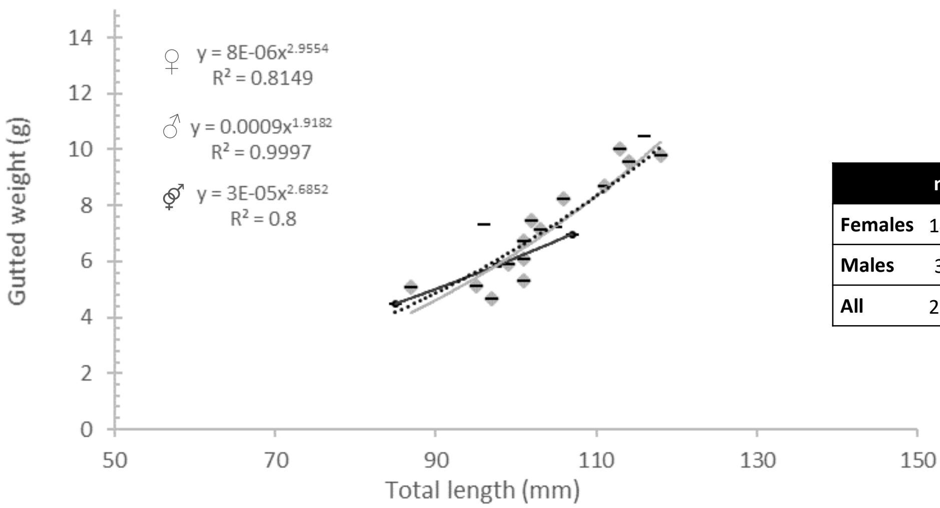
Engraulis encrasicolus (Linnaeus, 1758)

European anchovy أبو حنك

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Spring-summer
Sample size	20
Mean ± SD (range)	10.3 ± 0.8 cm (8.5-11.8 cm)
First maturity	9.3 cm
Sex-ratio	1 : 4.6

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	14	103.0	8.33	87	118
Males	3	97.0	11.06	85	107
All	20	103.0	8.85	85	118

Female

© Michel Bariche

Male

© Michel Bariche

© Michel Bariche

Serranidae

Epinephelus marginatus (Lowe, 1834)

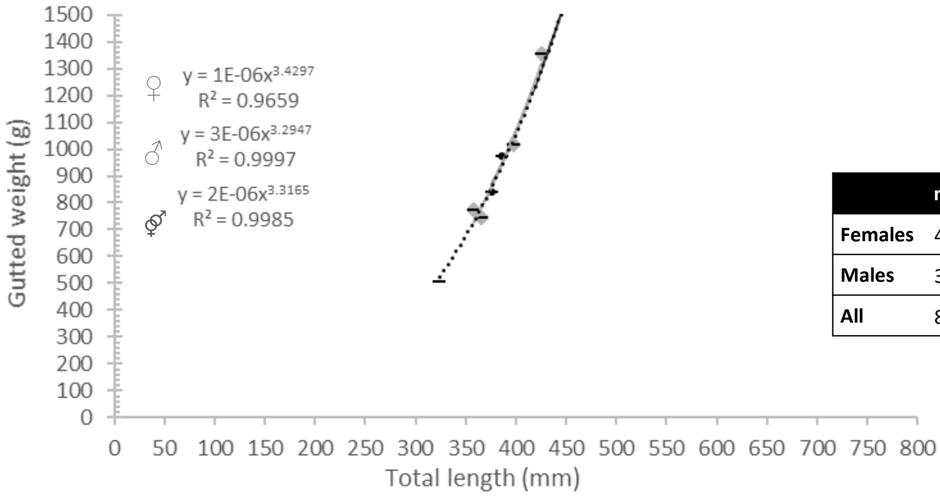
Dusky grouper

حفش

Reproduction summary

Strategy	Upon maturity, fish are first females and change to males later in life (protogynous hermaphrodites)
Frequency	One spawning per year
Season	Winter
Sample size	8
Mean ± SD (range)	44.0 ± 1.8 cm (32.4-89.3 cm)
First maturity	32.4 cm
Sex-ratio	1 : 1.3

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	4	387.0	31.22	358	426
Males	3	551.7	295.65	376	893
All	8	440.9	185.10	324	893

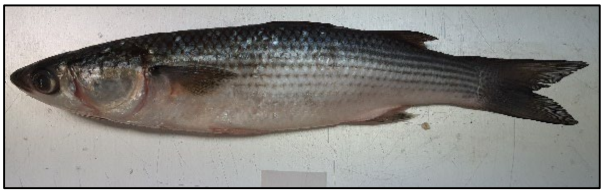
Female

© Michel Bariche

Male

© Michel Bariche

Annex 3: Factsheets with estimated reproductive characteristics for fish species from this study



© Michel Bariche

Mugilidae

Chelon ramada (Risso, 1827)

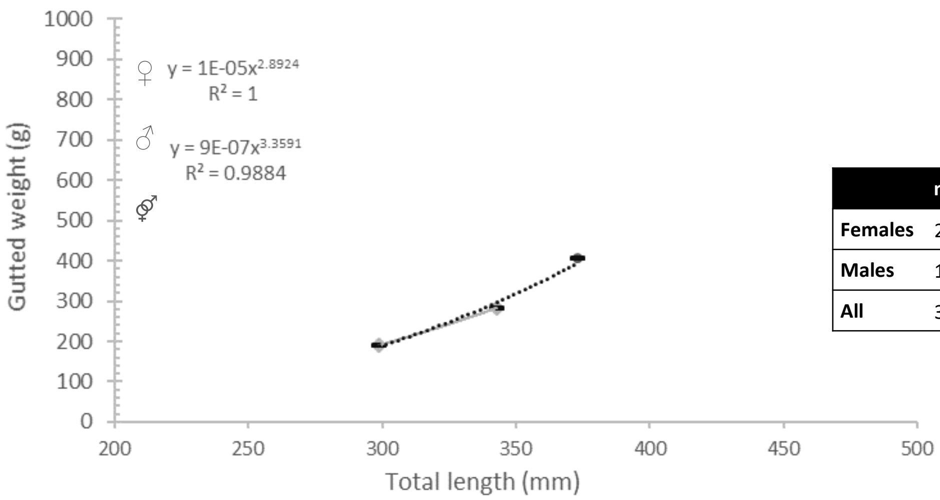
Thinlip grey mullet

طوبارة

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Winter
Sample size	3
Mean ± SD (range)	33.8 ± 3.7 cm (29.9-37.3 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	2	321.0	31.11	299	343
Males	1	373.0		373	373
All	3	338.3	37.22	299	373

Female

© Michel Bariche

Male

© Michel Bariche


© Michel Bariche

Mugilidae

Mugil cephalus Linnaeus, 1758

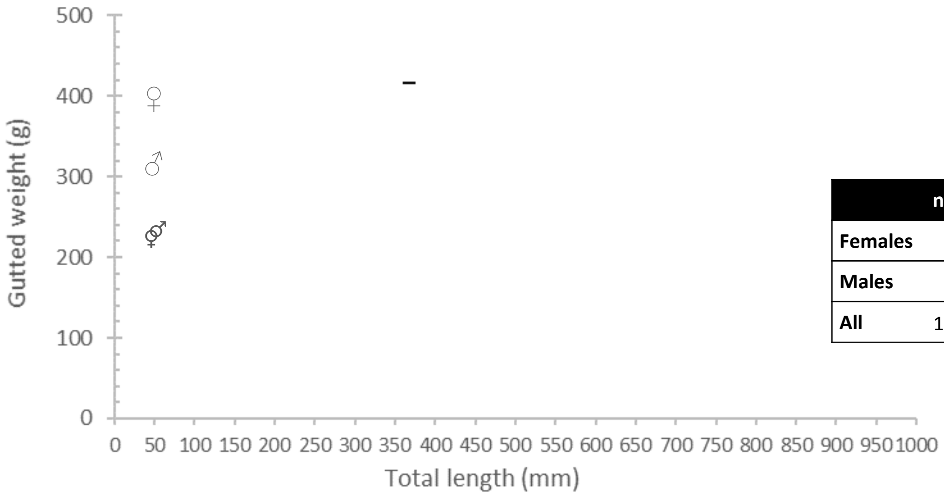
Flathead grey mullet

لبتاية

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Fall
Sample size	1
Mean ± SD (range)	--
First maturity	-- cm
Sex-ratio	--

J	F	M	A	M	J	Jy	A	S	O	N	D



	n	Mean	S.D.	Range	
Females					
Males					
All	1	368.0		368	368

© Michel Bariche

Sparidae

Dentex dentex (Linnaeus, 1758)

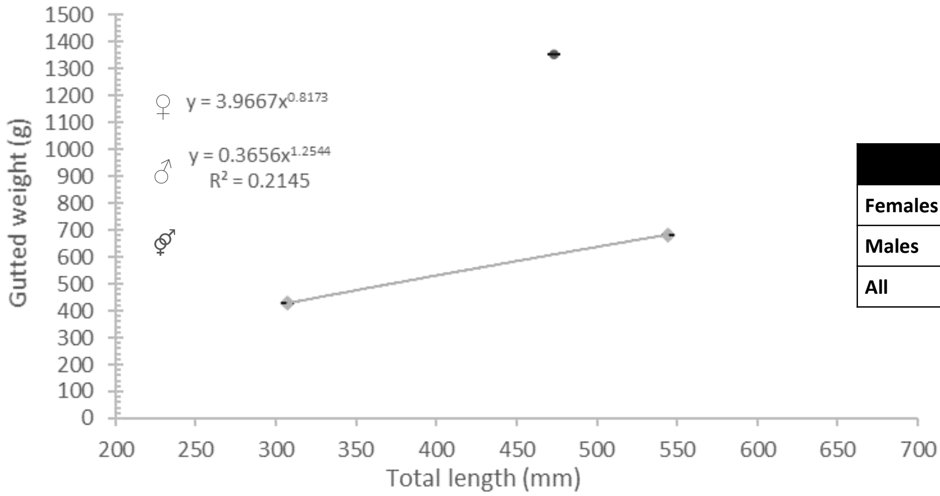
Common dentex

بَصَّاص

Reproduction summary

Strategy	Sexes are separate (gonochoric), but some individuals can be hermaphroditic without signs of contribution to the reproduction
Frequency	One spawning per year
Season	Late spring-early summer
Sample size	4
Mean ± SD (range)	44.1 ± 12.1 cm (30.7-54.4 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	2	425.5	167.58	307	544
Males	1	473.0		473	473
All	3	441.3	121.63	307	544

Female

© Michel Bariche

Male

© Michel Bariche

Sparidae

Dentex gibbosus (Rafinesque, 1810)

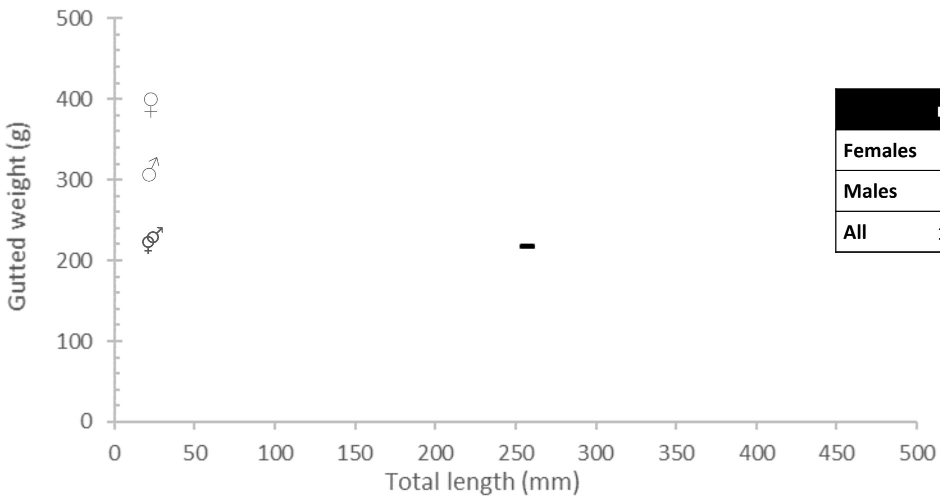
Pink dentex

جربيدن أبو ريشه

Reproduction summary

Strategy	Upon maturity, fish are first males and change to females later in life (protandrous hermaphrodites). Can also be gonochoric with some hermaphroditic individuals
Frequency	One or more spawning per year
Season	Late spring - early summer
Sample size	1
Mean ± SD (range)	25.7 cm
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range
Females				
Males				
All	1	257.0		257 257

Female

Sparidae

Dentex maroccanus (Valenciennes, 1830)

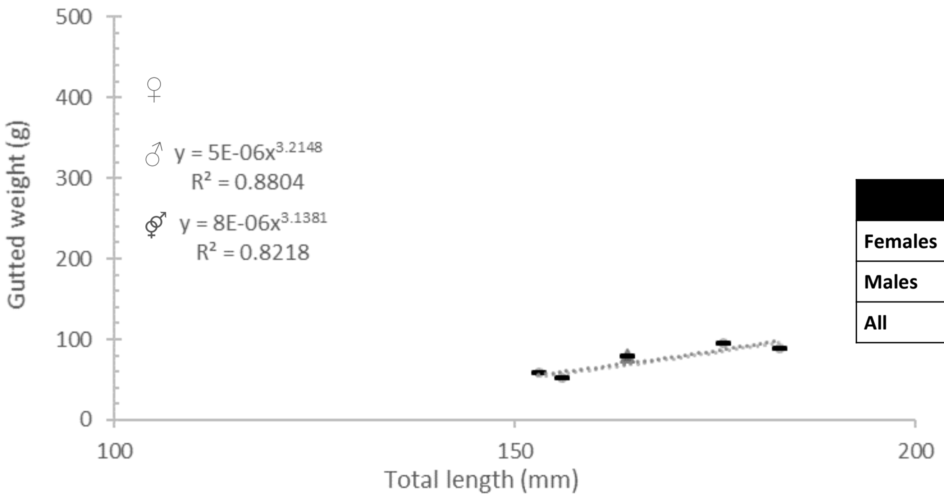
Morocco dentex

مرجان

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Spring-early summer
Sample size	5
Mean ± SD (range)	16.6 ± 1.2 cm (15.3-18.3 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	1	164.0		164	164
Males	4	167.0	14.76	153	183
All	5	166.4	12.86	153	183

Female

Male

© Michel Bariche

Sparidae

Pagellus acarne (Risso, 1827)

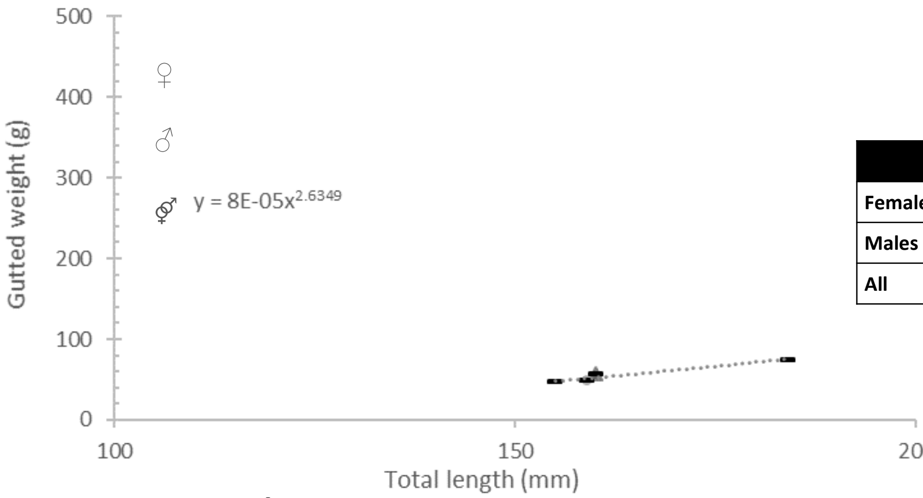
Axillary seabream

ذكر جربيدن

Reproduction summary

Strategy	Upon maturity, fish are first males and change to females later in life (protandrous hermaphrodites)
Frequency	One spawning per year
Season	Fall
Sample size	4
Mean ± SD (range)	16.4 ± 1.3 cm (15.5-18.4 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



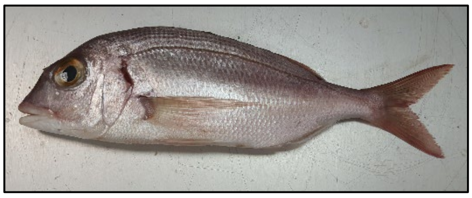
	n	Mean	S.D.	Range	
Females	1	160.0		160	160
Males	1	159.0		159	159
All	4	164.5	13.18	155	184

Female

© Michel Bariche

Male

© Michel Bariche



Sparidae

Pagellus erythrinus (Linnaeus, 1758)

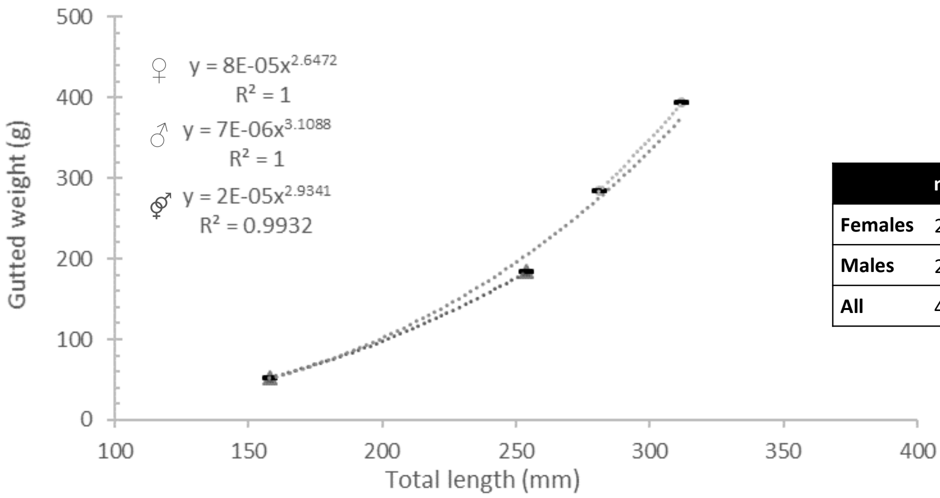
Common pandora

جربيدن

Reproduction summary

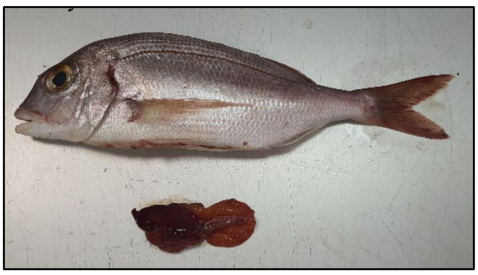
Strategy	Upon maturity, fish are first females and change to males later in life (protogynous hermaphrodites)
Frequency	More than one spawning per year
Season	Spring-Fall
Sample size	4
Mean ± SD (range)	25.1 ± 6.6 cm (15.8-31.2 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	2	206.0	67.88	158	254
Males	2	296.5	21.92	281	312
All	4	251.3	66.53	158	312

Female



Male

Sparidae

Sparus aurata (Linnaeus, 1758)

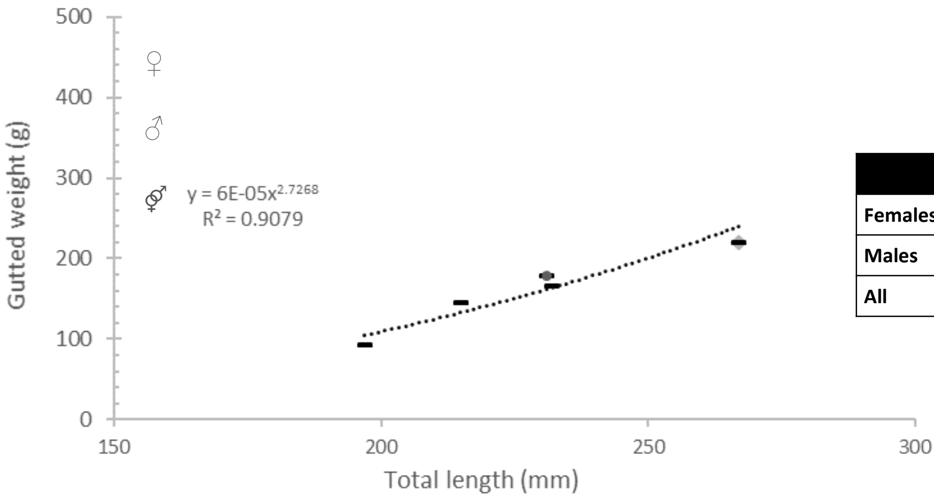
Gilthead seabream

أجاج

Reproduction summary

Strategy	Upon maturity, fish are first males and change to females later in life (protandrous hermaphrodites)
Frequency	One spawning per year
Season	Winter
Sample size	5
Mean ± SD (range)	22.8 ± 2.5 cm (19.7-26.7 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	1	267.0		267	267
Males	1	231.0		231	231
All	5	228.4	25.86	197	267

Female

Male

© Michel Bariche

Sparidae

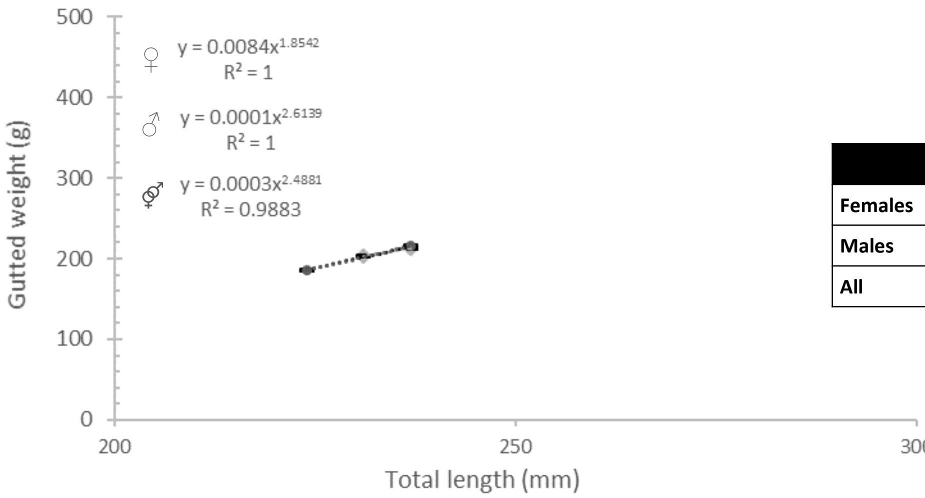
Spondyliosoma cantharus (Linnaeus, 1758)

Black seabream سمكة الريس

Reproduction summary

Strategy	Upon maturity, fish are first females and change to males later in life (protogynous hermaphrodites)
Frequency	One spawning per year
Season	Winter
Sample size	4
Mean ± SD (range)	23.2 ± 0.6 cm (22.4-23.7 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	2	234.0	4.24	231	237
Males	2	230.5	9.19	224	237
All	4	232.3	6.18	224	237

Female

© Michel Bariche

Male

© Michel Bariche

© Michel Bariche

Sparidae

Sarpa salpa (Linnaeus, 1758)

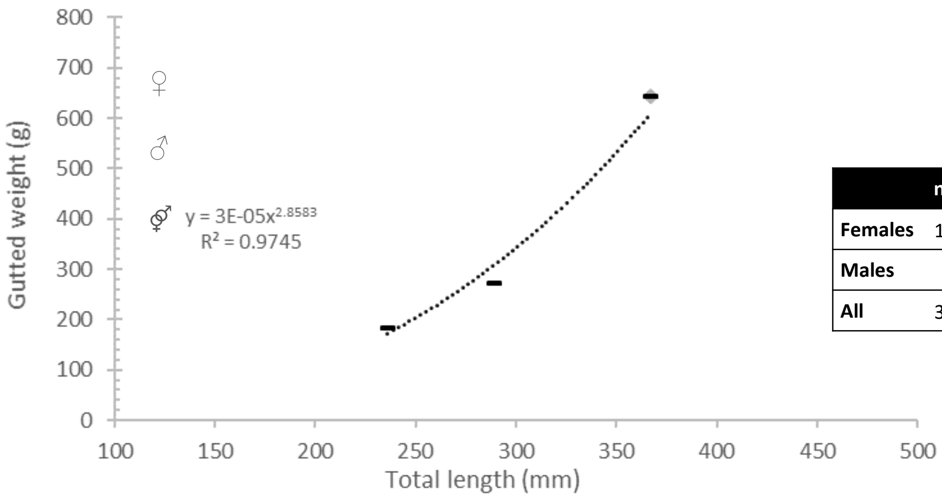
Salema

صلبن

Reproduction summary

Strategy	Upon maturity, fish are first males and change to females later in life (protandrous hermaphrodites)
Frequency	More than one spawning per year
Season	Spring
Sample size	3
Mean ± SD (range)	29.7 ± 6.5 cm (23.6-36.7 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	1	367.0		367	367
Males					
All	3	297.3	65.90	236	367

Female

© Michel Bariche

Carangidae

© Michel Bariche

Trachurus trachurus (Linnaeus, 1758)

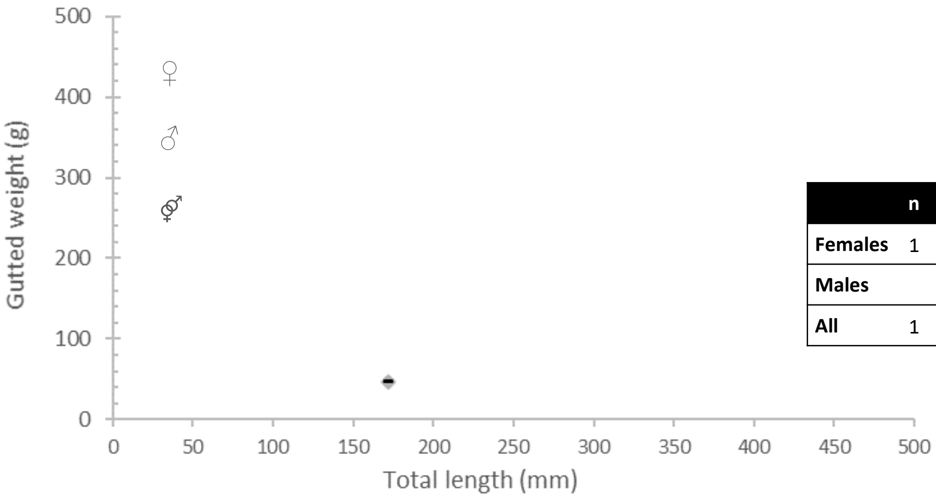
Atlantic horse mackerel

عُصَيفِر أسود

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Spring
Sample size	1
Mean ± SD (range)	17.2 cm
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	1	172.0		172	172
Males					
All	1	172.0		172	172

Female

© Michel Bariche

Carangidae

Lichia amia (Linnaeus, 1758)

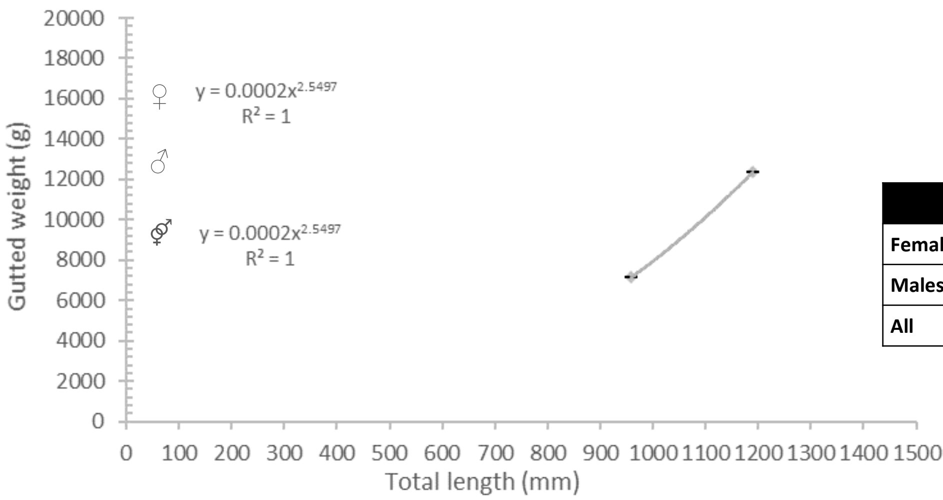
Leerfish

عريان

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Spring
Sample size	3
Mean ± SD (range)	100.9 ± 1.6 cm (88.0-119.0 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	2	1074.5	163.34	959	1190
Males					
All	3	1009.7	161.09	880	1190

Female

Male

© Michel Bariche

Carangidae

Seriola dumerili (Risso, 1810)

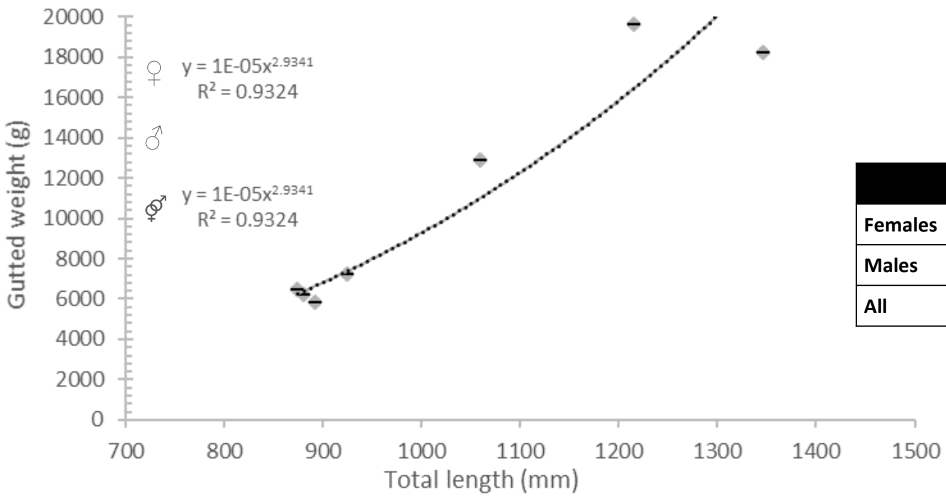
Greater amberjack

جرو أنتياس

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Spring
Sample size	8
Mean ± SD (range)	104.5 ± 18.1 cm (87.4-134.6 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	7	1027.4	187.90	874	1346
Males	1	1170.0		1170	1170
All	8	1045.3	181.12	874	1346

Female

© Michel Bariche

Scombridae

Auxis rochei (Risso, 1810)

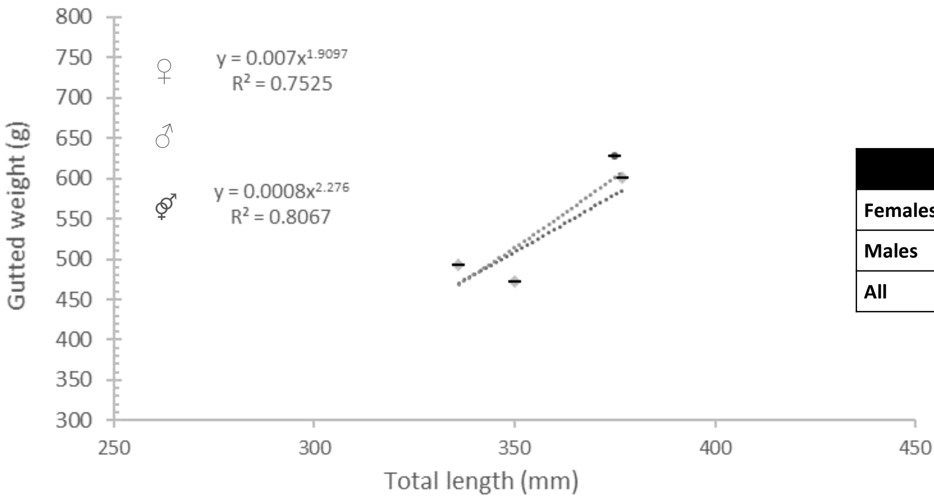
Bullet tuna

بلموط

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Spring-summer
Sample size	4
Mean ± SD (range)	35.9 ± 1.9 cm (33.6-37.7 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	3	354.3	20.84	336	377
Males	1	375.0		375	375
All	4	359.5	19.91	336	377

Female

Male

© Michel Bariche

Serranidae

Serranus scriba (Linnaeus, 1758)

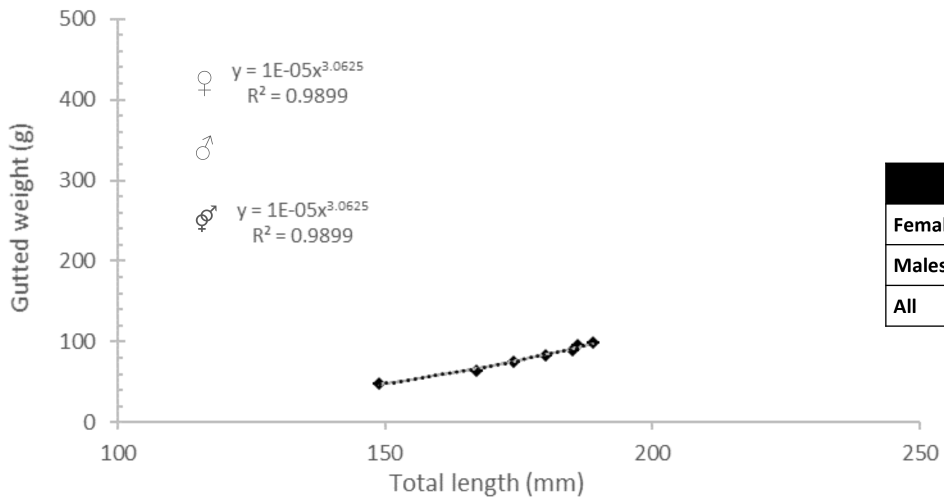
Painted comber

ديب أبو شفه

Reproduction summary

Strategy	Reported as simultaneous hermaphrodite, probably protogynous hermaphrodites
Frequency	One spawning per year
Season	Spring-summer
Sample size	7
Mean ± SD (range)	17.5 ± 1.4 cm (14.9-18.9 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range
Females	7	79.3	18.26	48.0 99.0
Males				
All	7	79.3	18.26	48.0 99.0

Female

© Michel Bariche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Serranidae

Serranus cabrilla (Linnaeus, 1758)

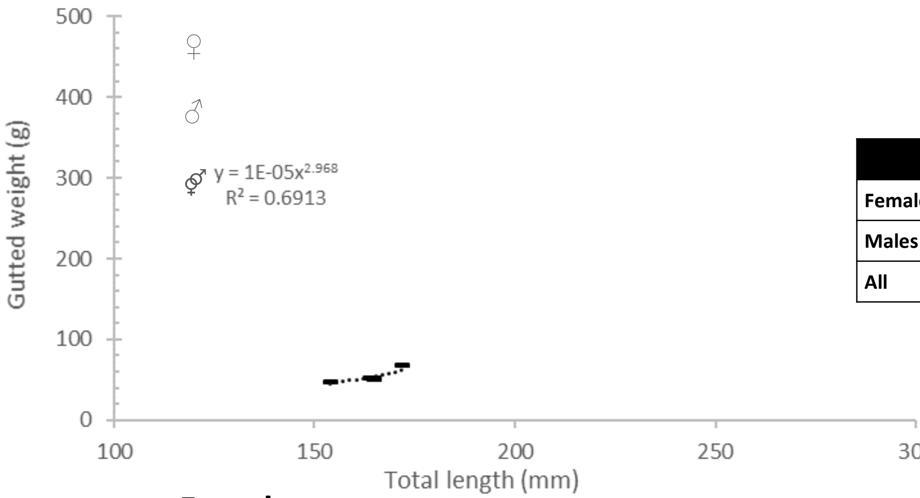
Comber

خنوس

Reproduction summary

Strategy	Reported as simultaneous hermaphrodite, probably protogynous hermaphrodites
Frequency	One spawning per year
Season	Spring
Sample size	5
Mean ± SD (range)	16.4 ± 6.4 cm (15.4-17.2 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females					
Males					
All	5	164.0	6.44	154	172

Female


© Michel Bariche

Hermaphroditic gonad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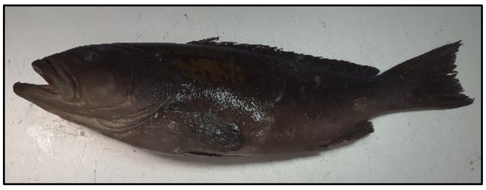
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Serranidae

Epinephelus costae (Steindachner, 1878)

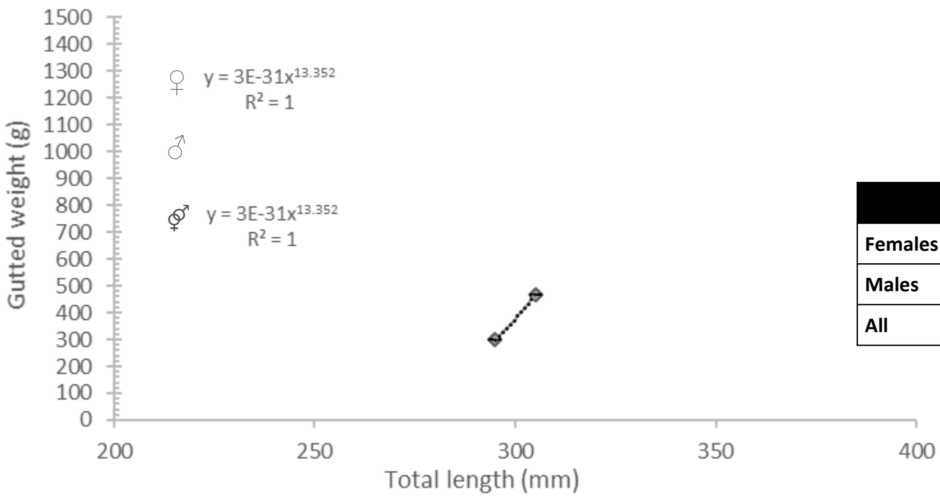
Goldblotch grouper

زبير

Reproduction summary

Strategy	Upon maturity, fish are first females and change to males later in life (protogynous hermaphrodites)
Frequency	One spawning per year
Season	Summer
Sample size	5
Mean ± SD (range)	37.4 ± 8.5 cm (29.5-45.1 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	3	348.3	83.86	295	445
Males	1	445.0		445	445
All	4	374.0	85.58	295	451

Female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Male


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Serranidae

Epinephelus aeneus (Geoffroy Saint-Hilaire, 1817)

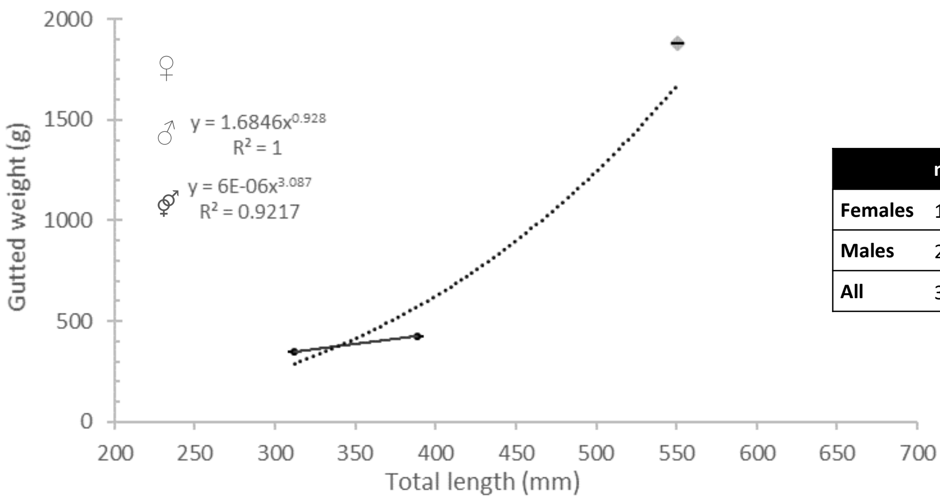
White grouper

لقز رملي

Reproduction summary

Strategy	Upon maturity, fish are first females and change to males later in life (protogynous hermaphrodites)
Frequency	One spawning per year
Season	Summer
Sample size	6
Mean ± SD (range)	41.7 ± 12.1 cm (31.2-55.1 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	1	551.0		551	551
Males	2	350.5	54.45	312	389
All	3	417.3	121.99	312	551

Female

Male

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Sebastidae

Helicolenus dactylopterus (Delaroche, 1809)

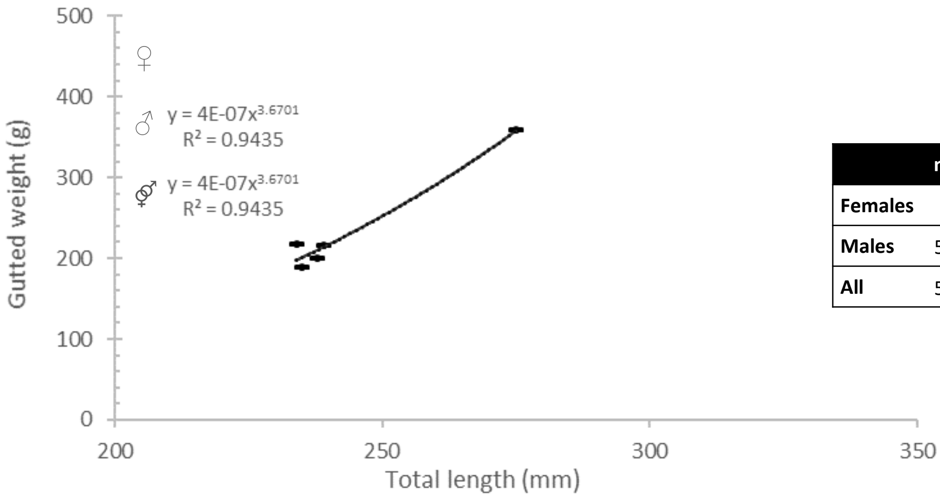
Blackbelly rosefish

اشترب

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Winter-spring
Sample size	5
Mean ± SD (range)	244.2 ± 1.7 cm (23.4-27.5 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females					
Males	5	244.2	17.34	234	275
All	5	244.2	17.34	234	275

Male

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Phycidae

Phycis blennoides (Brünnich, 1768)

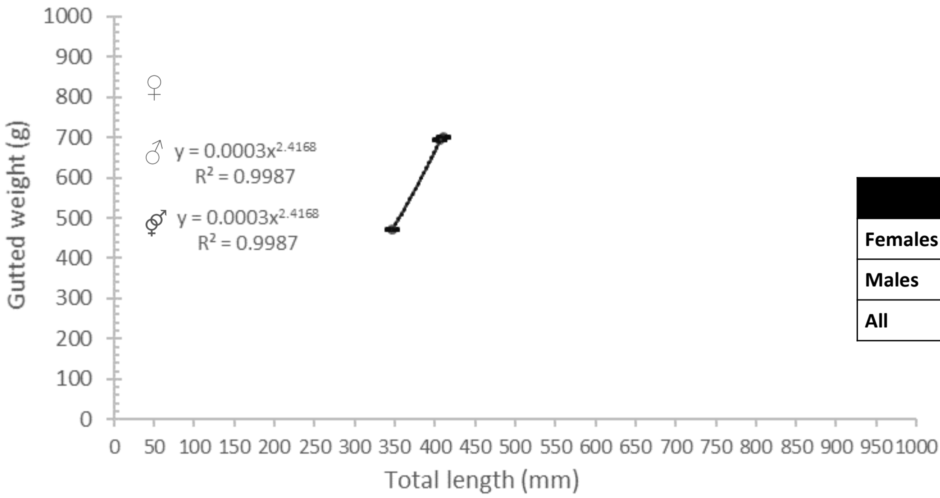
Greater forkbeard

خراية غمق

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	Unclear, probably two spawning per year
Season	Fall-winter
Sample size	3
Mean ± SD (range)	38.7 ± 3.5 cm (34.7-41.0 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females					
Males	3	387.7	35.28	347	410
All	3	387.7	35.28	347	410

Male

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Uranoscopidae

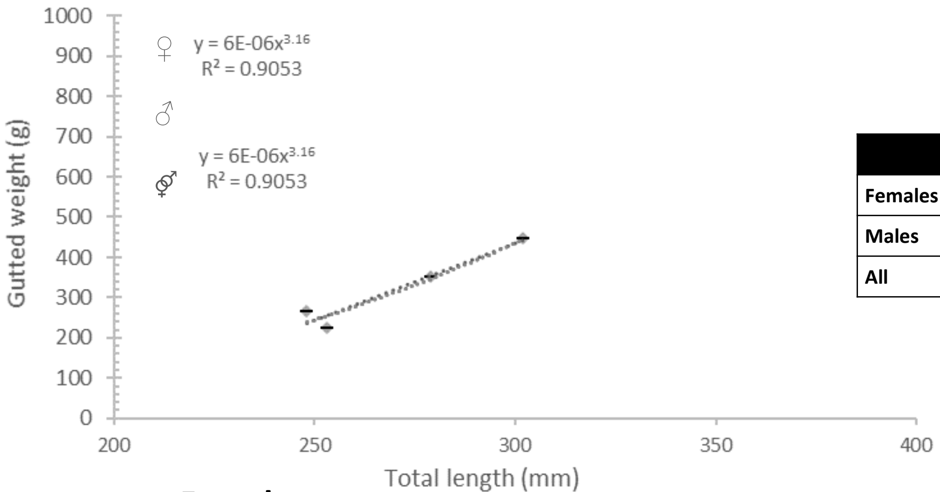
Uranoscopus scaber (Linnaeus, 1758)

Stargazer بومة

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Winter
Sample size	4
Mean ± SD (range)	27.0 ± 2.5 cm (24.8-30.2 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	4	270.5	25.01	248	302
Males					
All	4	270.5	25.01	248	302

Female

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Paralepididae

Sudis hyalina (Rafinesque, 1810)

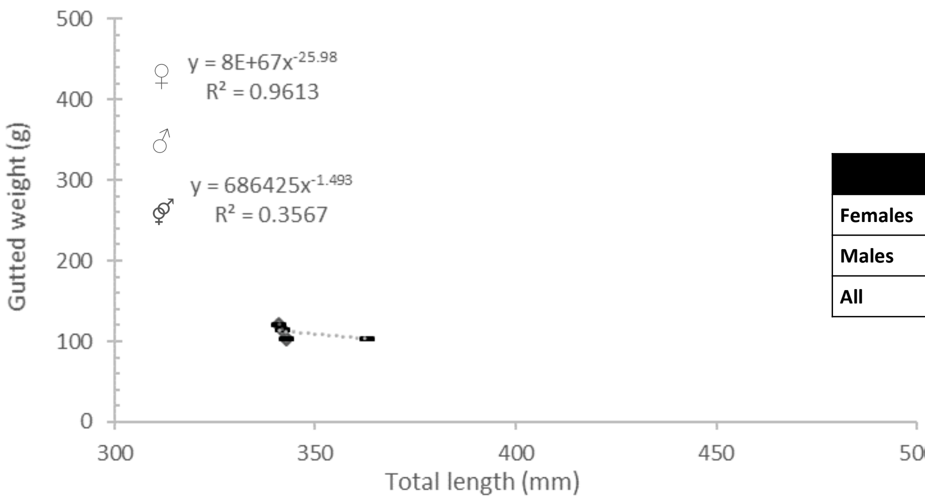
Barracudinas

قزازة

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	Unclear, likely one spawning per year
Season	Spring-summer
Sample size	4
Mean ± SD (range)	34.7 ± 1.0 cm (34.1-36.3 cm)
First maturity	-- cm
Sex-ratio	--

J	F	M	A	M	J	Jy	A	S	O	N	D



	n	Mean	S.D.	Range	
Females	3	342.0	1.00	341	343
Males	1	363.0		363	363
All	4	347.3	10.53	341	363

Female

© Michel Bariche

Male

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Sciaenidae

Sciaena umbra (Linnaeus, 1758)

Brown meagre

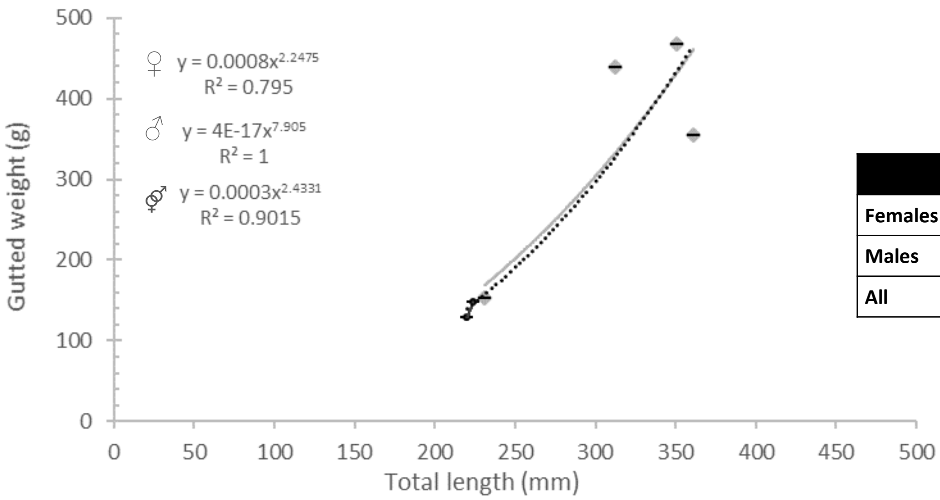
© Michel Bariche

شأيمس

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	Unclear, likely one spawning per year
Season	Summer
Sample size	6
Mean ± SD (range)	28.3 ± 6.5 cm (22.0-36.1 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	4	313.8	59.08	231	361
Males	2	222.0	2.83	220	224
All	6	283.2	65.88	220	361

Female

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Male

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Sciaenidae

Umbrina cirrosa (Linnaeus, 1758)

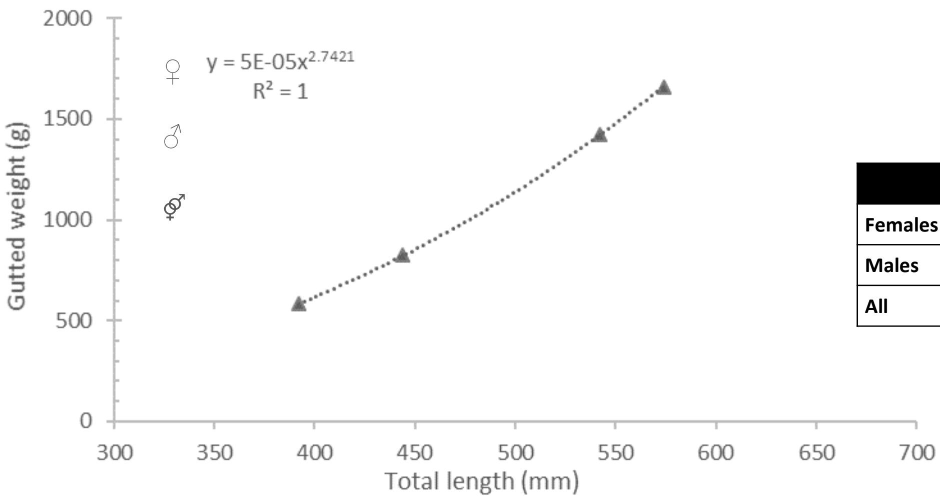
Shi drum

كربال

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Spring-summer
Sample size	4
Mean ± SD (range)	48.8 ± 8.4 cm (39.2-57.4 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	4	488.0	84.59	392	574
Males					
All	4	488.0	84.59	392	574

Female

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Sphyraenidae

Sphyraena sphyraena (Linnaeus, 1758)

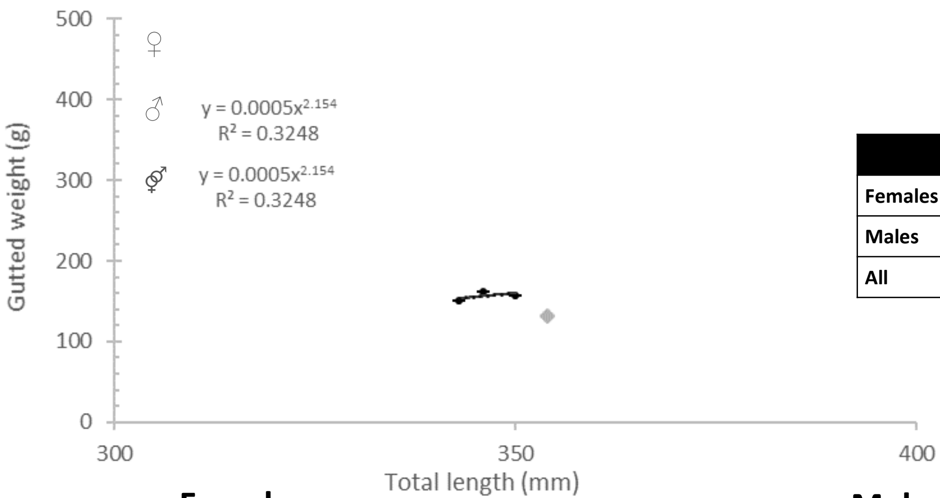
European barracuda

سفرنة

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Spring
Sample size	5
Mean ± SD (range)	34.3 ± 1.2 cm (32.3-35.4 cm)
First maturity	-- cm
Sex-ratio	--

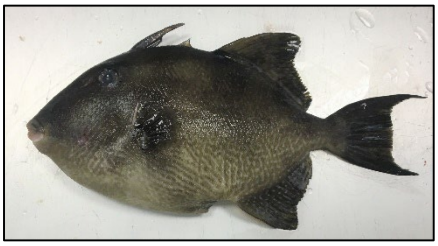
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	1	354.0		354	354
Males	3	346.3	3.51	343	350
All	5	343.2	12.03	323	354

Female

Male



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Balistidae

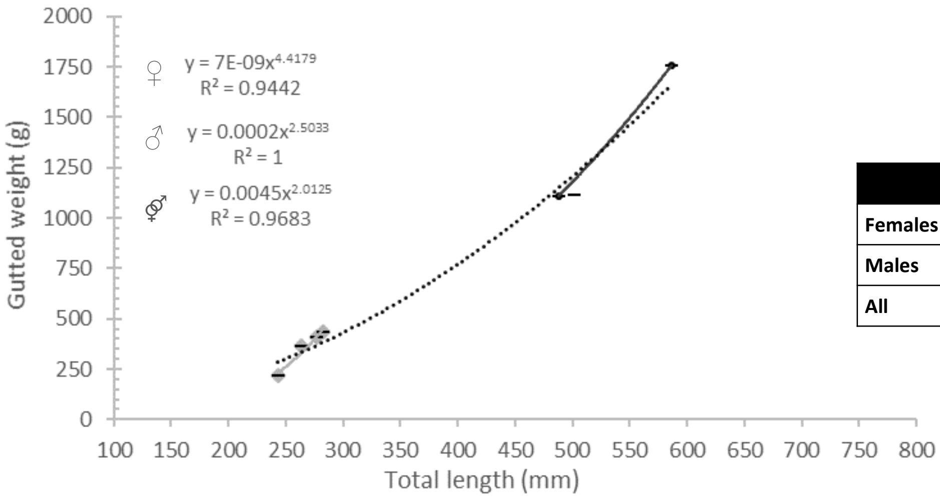
Balistes capriscus (Gmelin, 1789)

Grey triggerfish مبرد/خنزير

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Spring-summer
Sample size	7
Mean ± SD (range)	37.7 ± 14.2 cm (24.3-58.6 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	5	313.6	106.44	243	502
Males	2	537.0	69.30	488	586
All	7	377.4	142.25	243	586

Female

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Male

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Moronidae

Dicentrarchus labrax (Linnaeus, 1758)

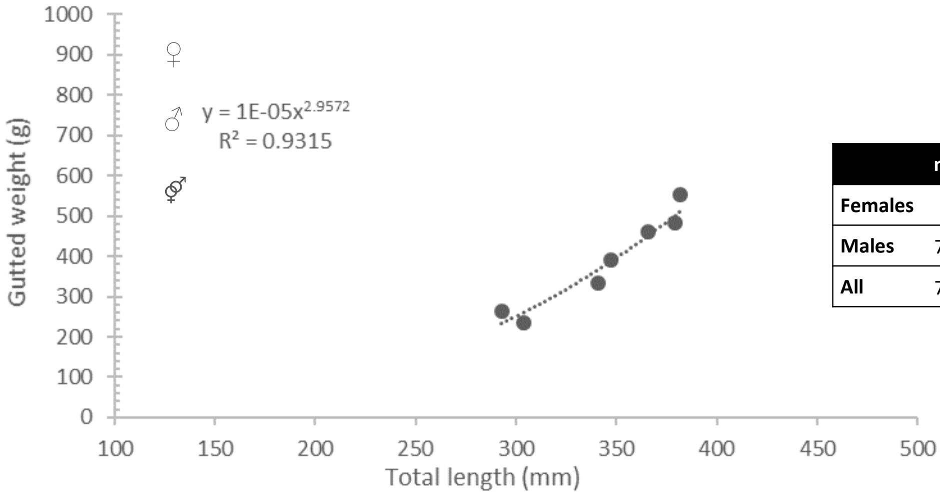
European seabass

براق

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning per year
Season	Winter-early spring
Sample size	7
Mean ± SD (range)	34.4 ± 3.5 cm (29.3-38.2 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females					
Males	7	344.6	35.05	293	382
All	7	344.6	35.05	293	382

Female

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Congridae

Conger conger (Linnaeus, 1758)

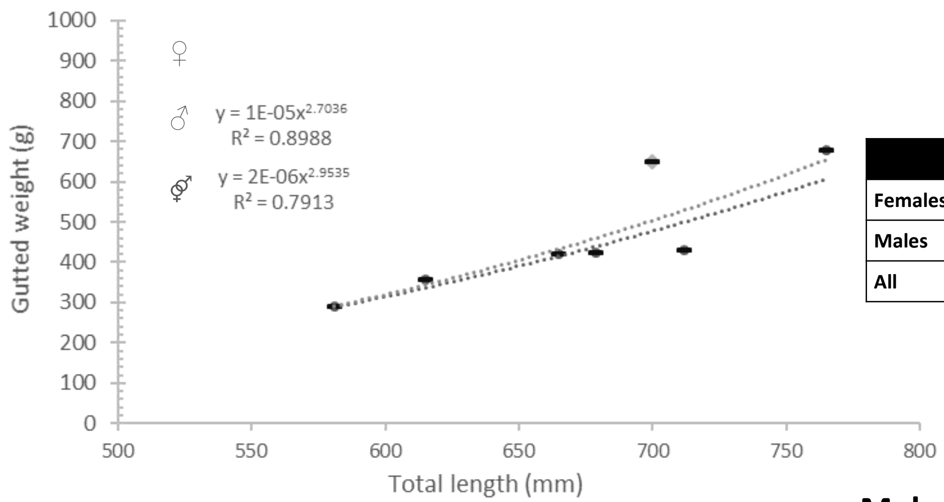
European conger

حنكليس بحر

Reproduction summary

Strategy	Sexes are always separate (gonochoric)
Frequency	One spawning in a lifetime
Season	Spring
Sample size	7
Mean ± SD (range)	67.3 ± 6.1 cm (58.1-76.5 cm)
First maturity	-- cm
Sex-ratio	--

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



	n	Mean	S.D.	Range	
Females	1	700.0		700	700
Males	6	669.5	66.09	581	765
All	7	673.9	61.42	581	765

Male

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Annex 4: List of species excluded during the study due to the small numbers of non-mature individuals during the study

Family	Species
Carangidae	*Alectis alexandrina* (Geoffroy Saint-Hilaire, 1817)
Clupeidae	*Sardina pilchardus* (Walbaum, 1792)
Echeneidae	*Echeneis naucrates* Linnaeus, 1758
Labridae	*Xyrichtys novacula* (Linnaeus, 1758)
Phycidae	*Phycis phycis* (Linnaeus, 1766)
Scombridae	*Sarda sarda* (Bloch, 1793)
Soleidae	*Solea solea* (Linnaeus, 1758)
	Pegusa lascaris (Risso, 1810)
Sphyraenidae	*Sphyraena viridensis* (Cuvier, 1829)
Triglidae	*Chelidonichthys lucerna* (Linnaeus, 1758)

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