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Gulf of Mexico Data-Limited Species
Life History Compilation

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Abstract

This working document presents the results of a literature review of life-history parameters of the species selected for assessment in SEDAR49: red drum (*Sciaenops ocellatus*), lane snapper (*Lutjanus synagris*), wenchman (*Pristipomoides aquilonaris*), yellowmouth grouper (*Mycteroperca interstitialis*), snowy grouper (*Hyporthodus niveatus*), speckled hind (*Epinephelus drummondhayi*), lesser amberjack (*Seriola fasciata*), and almaco jack (*Seriola rivoliana*). Parameters compiled for these species include growth, maturity, and mortality and are critical inputs in models that estimate sustainable fishing rates and yields. Tables are presented that summarize a literature review of von Bertalanffy growth parameters, size and age at maturity, mortality rates, and length-weight conversions.

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1 Introduction

The Gulf of Mexico is inhabited by a diverse array of harvested fishes, many of which have limited available data sources necessary for stock assessment. The Magnuson-Stevens Reauthorization Act mandated the setting of scientifically-derived annual catch limits (ACLs) for all stocks and stock complexes in a fishery (H.R. 5946, 2006). Basic data requirements for setting sustainable ACLs include life history information, a population abundance index, total catch and discards, and error sources where possible within a defined stock unit. Life history parameters in particular set the bounds of biological productivity for a stock through growth, maturity, and mortality rates. These parameters are important elements in population studies, and for fished species, they are critical inputs for estimating sustainable fishing rates and yields. Compiling the literature throughout the greater range of these species, especially where the environment is homogeneous, provides population biologists with a range of pertinent life history parameters. This work focuses on a literature synthesis of all available life history information for species assigned within the SouthEast Data, Assessment, and Review (SEDAR) 49 Gulf of Mexico Data-Limited Assessment to provide the best parameter estimates.

2 Objective

The objective of this working document is to present the results of a literature review of the life-history of the species selected for assessment in SEDAR 49: red drum (*Sciaenops ocellatus*), lane snapper (*Lutjanus synagris*), wenchman (*Pristipomoides aquilonaris*), yellowmouth grouper (*Mycteroperca interstitialis*), snowy grouper (*Hyporthodus niveatus*), speckled hind (*Epinephelus drummondhayi*), lesser amberjack (*Seriola fasciata*), and almaco jack (*Seriola rivoliana*) (Table 1). This information will be critical in developing the parameters needed for data-limited assessment approaches and parameterizing the stock dynamics for each species in SEDAR 49 (Tables 2 – 9). Life-history parameters (e.g., mortality, growth, maturity) represent key data inputs for a variety of data-limited approaches which require demographic information ranging from the Beddington and Kirkwood life history approach (Beddington & Kirkwood 2005) to length-based per-recruit analysis (Gedamke & Hoenig 2006).

3 Description of Models and Parameters

Fish life history is described through estimation of growth, reproduction, and mortality rates. These parameters and functions are estimated by fitting appropriate models to representative samples of the entire population structure. This document summarizes only part of the information compiled through the literature review. A supplementary spreadsheet is available by request and is intended to provide readers with context for interpreting the parameter estimates presented herein. Additional information in the comprehensive compilation includes sampling timeframe, sampling gear, sampling frequency, sex determination methods, age determination methods, and fitting methods (Table 10).

3.1 von Bertalanffy Growth Model

The von Bertalanffy growth model describes the average growth rate of individuals in a population and is widely accepted for application to fish species. Three parameters are estimated while fitting this model: asymptotic length, L_∞, growth rate, K, and theoretical age at size zero, t_0. The general form of this function is

$$L_t = L_\infty[1 - e^{-K(t-t_0)}] \tag{1}$$

where L_t is length at time t. This growth model is dramatically affected by the range of lengths and ages sampled. Growth can be grossly mischaracterized under situations with truncated size and age distributions, a common phenomenon in regions with intense fishing pressure (Ziskin *et al.*, 2011; Ault *et al.*, 2014). Therefore, along with estimated parameters, length ranges of observed data and sampling region are also reported in Table 2. Inclusion of this information allows for better interpretation of estimated von Bertalanffy growth parameters for each species of interest.

3.2 Maturity Schedules

Maturity schedules define the reproductive capability of fish populations and are paramount in establishing appropriate management measures, such as minimum size limits (Freitas *et al.*, 2014). These schedules are often characterized via length- and age- at 50% maturity, which represents the length or age at which 50% of the population is mature, L_{50} and t_{50}, respectively. These values represent parameter estimates which, for example, minimize the negative log likelihood of a logistic model of the form

$$P(L) = \frac{1}{1 + e^{\beta_0 + \beta_1 L}} \tag{2}$$

where $P(L)$ is the proportion mature at size L, and β_0 and β_1 are intercept and slope parameters, respectively (Roa *et al.*, 1999). Length at 50% maturity is the associated length, L, when $P(L) = 0.5$. Likewise, age at 50% maturity, t_{50}, can be represented through a logistic model of the form

$$P(t) = \frac{1}{1 + e^{\beta_0 + \beta_1 t}} \tag{3}$$

where $P(t) = 0.5$ is the proportion mature at age t_{50}. Minimum and average sizes at maturity are also commonly reported and can be used to approximate length- and age-at maturity, L_m and t_m. Ideally, when lengths- or ages- at maturity are not fit using an appropriate statistical model providing estimates of L_{50} or t_{50}, the data should be acquired to obtain these parameter estimates. Table 3 provides lengths and ages at maturity by sex as well as lengths and ages associated with sexual transition for hermaphroditic species, with clear annotation if L_{50} and t_{50} were estimated or if L_m and t_m were approximated.

3.3 Length-Weight Conversions

Weight has an exponential relationship with length. Length-weight relationships can be reported as:

$$W = aL^b \tag{4}$$

where W is weight, L is length, a is a scalar, and b is a power parameter. This data can also be log-linearized and reported as:

$$\ln W = \ln a + b \ln L \tag{5}$$

Table 4 lists the reported scalar and power parameters, as well as the corresponding equation form used and range of lengths and weights sampled in each study. Estimates of the power parameter that are close to 3 indicate isometric growth. Length-length conversions are also presented in Table 5 to allow for conversions between standard length, fork length, and total length. Unfortunately, no distinctions have been made in any of the reported values between natural total length and maximum total length. To obtain natural total length, the caudal fin is measured by the caudal fin laying naturally when measured. To obtain maximum or stretch total length, the caudal fin is pinched to obtain the longest total length possible.

3.4 Natural Mortality Rates

Natural mortality, M, is often estimated as a function of longevity (Hoenig, 1983; Ault *et al.*, 1998; Then *et al.*, 2015), as a function of L_∞, K, and temperature (Pauly, 1980; Then *et al.*, 2015), or as an invariant relationship with K alone (Jensen, 1996). Where available, longevity provides the most accurate estimation of natural mortality rates and follows the general form

$$M = \frac{-ln[S(t_\lambda)]}{t_\lambda} \tag{6}$$

where $S(t_\lambda)$ is percent survivorship to the maximum age and typically ranges between 1–5% (Hoenig, 1983; Ault *et al.*, 1998; Then *et al.*, 2015). Reported natural, fishing, and total mortality rates for SEDAR49 species are included in Table 6. Also included in this table are natural mortality rates calculated utilizing methods outlined by Hoenig (1983), Ault *et al.* (1998), and Then *et al.* (2015) based on maximum ages observed in the literature, where possible. Since there were no aging studies on either almaco jack or lesser amberjack, no natural mortality rates were calculated for these species.

3.5 Stock-Recruitment Steepness

Estimates of steepness were obtained from previous stock assessments on SEDAR 49 or similar species and through examination of previous meta-analyses. Steepness, h, is defined as the fraction of the maximum recruitment, R_0, expected when spawning stock biomass, SSB, is reduced to 20% of the virgin level (Mace & Doonan, 1988; Rose *et al.*, 2001).

$$h = 0.2(SSB_0/R_0) \tag{7}$$

The steepness parameter intrinsically relates to the resilience of a species to exploitation and effectively determines the average productivity of fishery resources within a stationary environmental regime (Mangel *et al.*, 2010).

The Beverton-Holt spawner-recruit function is generally used except when there is strong evidence for mechanisms that lead to the Ricker function's dome shape (Shertzer & Conn, 2012). Steepness generally ranges from 0.2 to 1.0, with the lower bound indicative of recruitment being directly proportional to spawning biomass and the upper bound implying that recruitment is unrelated to spawning biomass (Conn *et al.*, 2010). High steepness values (Table 7) provide a highly optimistic picture of the resilience of the stock, which could reflect poor estimation rather than actual stock productivity (Conn *et al.*, 2010). Steepness is often difficult to estimate in data-rich situations Conn *et al.* (2010), and is even more uncertain for data-limited stocks.

4 Species Covered

This literature review encompasses species selected for assessment within the SEDAR49 Gulf of Mexico Data-Limited Assessment (Table 1). Life history information is also available for closely related groupers, snappers, and jacks to allow parameters to be inferred where no data are available. Available data and publications were limited by what the authors could access through the University of Miami libraries, National Marine Fisheries Service, and Gulf of Mexico Fishery Management Council.

Table 1: Species covered in the life history parameter literature review to be assessed in SEDAR49 Gulf of Mexico Data-Limited Species.

Scientific	Common
Sciaenidae	**Drums**
Sciaenops ocellatus	Red Drum
Serranidae	**Groupers**
Epinephelus drummondhayi	Speckled Hind
Hyporthodus niveatus	Snowy Grouper
Mycteroperca interstitialis	Yellowmouth Grouper
Lutjanidae	**Snappers**
Lutjanis synagris	Lane Snapper
Pristipomoides aquilonaris	Wenchman
Carangidae	**Jacks**
Seriola rivoliana	Almaco Jack
Seriola fasciata	Lesser Amberjack

5 Adequacy of Available Life History Information

Adequacy of available life history information depends on the quality of data on which the models are fitted to estimate the associated parameters. Data artifacts such as ranges of age and length sampled, sampling locations, fitting methods, and sample size affect representativeness of samples and can influence model parameter estimation for age-length, maturity, length-weight, mortality, and steepness.

Pervasive issues in fitting age-length curves include under-sampling of young fish below the minimum size limit and old fish which have been effectively eliminated from the population under intense fishing pressure. The effects of these sampling artifacts result in mischaracterization of K, the growth rate, and L_∞, the asymptotic length. Precautions should be taken or intervening methods should be utilized if there is under-sampling within any age class that could result in misspecification of growth curves. Studies from the 1980's or earlier likely have more representative raw data, but can have issues fitting the nonlinear models required within age-length estimation. For example, speckled hind samples collected by Ziskin *et al.* (2011) in 1979–1981 ranged from 2 to 35 years in age, and those sampled in 2004–2007 ranged from 1 to 9 years in age, despite having triple the number of samples in recent years. This disparity is due to intensification of fishing pressure through time which causes truncation in both age and length classes. Even if representative samples are collected, reading otoliths can be cumbersome, particularly for some grouper species (Bullock *et al.*, 1996; Andrews *et al.*, 2013). This has resulted in the use of bomb radiocarbon dating to age some species including speckled hind, which has increased the maximum age from approximately 35 up to 45–75 years old (Ziskin *et al.*, 2011; Andrews *et al.*, 2013). No length-at-age studies have been conducted for many species including both almaco jack or lesser amberjack, necessitating intervening analyses or utilization of congeners for this assessment (Table 2). Ideally, raw length-at-age data would be fit across the entire Gulf of Mexico throughout decades of sampling where larger, older fish are more available. Unfortunately, this is almost always impossible. Reliable parameters are recognized by a disperse, representative sample across length and age classes, a large sample size, and an appropriate sampling location and time frame. Additional information available in the comprehensive spreadsheet can affect reliability and includes sampling timeframe, sampling gear, sampling frequency, age determination methods, sex determination methods, and fitting methods where reported (Table 10).

Maturity parameters are used to describe the reproductive potential of a fish stock. Ideally, lengths- or ages- at maturity are fit using an appropriate statistical model providing estimates of L_{50} or t_{50}. Minimum and average sizes at maturity are also commonly reported and can be used to approximate length- and age- at maturity, L_m and t_m, but are less reliable parameters. There are no available maturity data for wenchman or yellowmouth grouper, and neither almaco jack nor lesser amberjack have statistical models describing maturity (Table 3). Therefore, parameters will likely need to be borrowed from similar species to approximate an age- or length- at maturity. Length-weight and length-length data are fairly straightforward to collect and parameters associated with these models are available for all SEDAR49 species (Table 4).

Overall, stock-recruitment steepness remains unknown for most species, but multiple meta-analyses have been conducted to develop priors on steepness for species throughout the world (Myers *et al.*, 1999; Rose *et al.*, 2001; Dorn, 2002; Myers *et al.*, 2002; Quinn *et al.*, 2010) and in the southeast US (Shertzer & Conn, 2012) (see Table 7 for a summary). The Myers *et al.* (1999) analysis provided approximate priors on steepness for a range of species primarily located within temperate areas such as gadids. Subsequently, Rose *et al.* (2001) grouped species by life-history strategy, with periodic strategists identified as larger, highly fecund fishes with long life spans and delayed maturation to attain a size sufficient for production of a large clutch (e.g., red snapper, striped bass). More recent analyses have considered reef fishes in the southeast US to generally fall within the periodic strategy (Shertzer & Conn, 2012). One limitation of such a meta-analysis is the assumption that all populations within a taxon are comparable (Myers *et al.*, 1999). Average relationships across stocks may not well represent each particular stock of interest (Shertzer & Conn, 2012).

Of the 8 species selected for evaluation in SEDAR49, only 2 have been assessed in the southeast US (Table 8). For the South Atlantic Snowy grouper assessment, steepness was fixed based on the Shertzer & Conn (2012) analysis described above, although alternative steepness values were considered as sensitivity runs (SEDAR 2013b). For red drum, a steepness of 0.99 was assumed in both the north and south Atlantic regions, with a slightly lower value of 0.92 considered as a sensitivity run (SEDAR 2015b). In the 2015 assessment of red drum in Florida waters, steepness was fixed at 0.8, with alternative values of 0.65 and 0.90 considered as sensitivity runs (Chagaris *et al.*, 2015).

The remaining species selected for assessment during SEDAR 49 have congeners which have undergone assessment in either the Gulf of Mexico or South Atlantic, with the exception of wenchman (Table 9). Two congeners of the yellowmouth grouper have been assessed in both the South Atlantic and Gulf of Mexico using data-rich methods: gag grouper (*Mycteroperca microlepis*; SEDAR 2014c) and black grouper (*Mycteroperca bonaci*; SEDAR 2010a). These most recent assessments estimated steepness values for these species at 0.84 and 0.99, respectively. However, both assessments included a number of different fixed steepness values as sensitivity runs, suggesting a wide range of uncertainty for these stocks. Similarly, two congeners of speckled hind, goliath grouper (*Epinephelus itajara*) and red grouper (*Epinephelus morio*), have also been assessed in both the South Atlantic and Gulf of Mexico (SEDAR 2011c, 2015a). For these species, steepness values have been estimated between 0.9 and 0.91, with alternative values considered for GOM red grouper at 0.65 and 0.98 (SEDAR 2015a). The most recent assessment for yellowedge grouper (*Hyporthodus flavolimbatus*) estimated steepness at 0.95 but considered 3 alternative values as sensitivity runs (SEDAR 2011b). Greater amberjack is a congener of both almaco jack and lesser amberjack, and has undergone assessment in both the South Atlantic and Gulf of Mexico, with steepness values estimated at 0.74 and 0.84, respectively (SEDAR 2008, 2014d). An alternative steepness value of 0.80 was considered in the Gulf of Mexico, whereas no alternative values were pursued in the South Atlantic.

No assessments have been conducted on wenchman or any congeners in the southeast US. An assessment of the congener goldband snapper (*Pristipomoides multidens*) in the Indo-Pacific assumed a steepness value of 0.7 for a Beverton-Holt stock-recruitment relationship (Prescott & Bentley, 2009). This value was considered a reasonable best guess based on the Rose *et al.* (2001) analysis which included red snapper. Although not necessarily congeners, many snappers have been assessed in the Gulf of Mexico, with steepness values ranging from 0.70 to 1.00 (Table 9).

6 Sources of Uncertainty and Error

Uncertainty of life history models is obtained through both sampling and modeling error. Sampling error can be introduced through biases via gear selectivity, time of year, sampling frequency, and region which can influence the size, age, and maturity structure of the population subset. If the samples of the population are not representative across all sizes and ages being modeled, then the model and associated parameter estimates will be biased. Often, samples are not acquired across the entire population being modeled, violating the assumption of homogenous sampling and mixing throughout the entire range being modeled, the Gulf of Mexico in this case. Local environmental conditions such as temperature and food availability can influence metabolic processes, and subsequently growth and reproduction. Uncertainty should be accounted for in parameters where inference was necessary. Despite the uncertainty surrounding some of these estimates, it is recommended not to define large error bounds surrounding the life history parameters, particularly within the Data-Limited Methods Toolkit, so the most likely outcome can be modeled appropriately. Productivity estimates and management advice resulting from models for data-limited species can be very sensitive to life history parameter inputs, thus, it is critical to use parameter sets that are as precise and accurate as possible.

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Table 2: von Bertalanffy growth parameters were compiled through a literature review. L_∞ is the asymptotic growth parameter, K is the rate at which the growth curve approaches L_∞, t_0 is the theoretical size of the fish at age 0, t_λ is the maximum age, L Range is the range of lengths, sex represents males (M), females (F), or all sexes (A), and n is the sample size. Standard errors are given within parentheses where available. Possible length types include total length (TL), fork length (FL), and standard length (SL). Recommended parameters are indicated by bold font.

	Species	**Location**	L_∞	K	t_0	L Range	t_λ	Sex	n	**Reference**
Drums	***S. ocellatus***	**N. Gulf of Mexico**	**941(–)**	**0.23(–)**	**-1.07(–)**	**210–1110mm FL**	**37**	**A**	**1116**	**McInerny & Potts (n.d.)**
	S. ocellatus	Alabama	1009(–)	0.12(–)	-7.6(–)	660–**1156mm TL**	**38**	M	67	Powers *et al.* (2012)
	S. ocellatus	Alabama	1046(–)	0.13(–)	-7.4(–)	660–1156mm TL	38	F	106	Powers *et al.* (2012)
	S. ocellatus	N. Gulf of Mexico	954(–)	0.11(–)	-10(–)	720–1101mm TL	34	M	99	Powers *et al.* (2012)
	S. ocellatus	N. Gulf of Mexico	989(–)	0.11(–)	-10(–)	720–1101mm TL	34	F	114	Powers *et al.* (2012)
	S. ocellatus	N. Gulf of Mexico	1013(–)	0.09(–)	-11.3(–)	—-995mm FL	36	F	–	Beckman *et al.* (1989)
	S. ocellatus	N. Gulf of Mexico	909(–)	0.14(–)	-7.7(–)	—-940mm FL	37	M	–	Beckman *et al.* (1989)
	S. ocellatus	Texas	918(21)	0.42(0.023)	–(–)	256–864mm TL	–	A	2010	Doerzbacher *et al.* (1988)
	S. ocellatus	W. Florida	934.1(–)	0.46(–)	0(–)	—-980mm FL	24	A	551	Murphy *et al.* (1990)
	S. ocellatus	Indian River Lagoon	979.8(–)	0.42(–)	-0.1(–)	—-1050mm FL	33	A	534	Murphy *et al.* (1990)
	S. ocellatus	N. Gulf of Mexico	37.7(1%)	0.32(1%)	-0.6(3%)	——in –	–	–	–	Porch *et al.* (2002)
	S. ocellatus	Louisiana	950(–)	0.37(–)	-0.3(–)	——mm TL	–	A	62	Rohr (1980)
	S. ocellatus	Gulf of Mexico (FL)	993(–)	0.46(–)	0.1(–)	——mm TL	–	A	–	Muphy & Taylor (1986a)
	S. ocellatus	Atlantic (FL)	1043(–)	0.42(–)	-0.1(–)	——mm TL	–	A	–	Muphy & Taylor (1986a)
	S. ocellatus	Gulf of Mexico (FL)	1458(–)	0.27(–)	0.1(–)	——mm TL	–	A	–	Muphy & Taylor (1986b)
	S. ocellatus	Texas	1068(–)	0.3(–)	0.1(–)	——mm TL	–	–	300	Pearson (1929)
	S. ocellatus	Florida	934(–)	0.46(–)	0(–)	——— –	–	–	–	Murphy & Taylor (1985)
	S. ocellatus	–	934(–)	0.37(–)	-0.2(–)	——— –	–	–	–	Powers & Scott (1986)
Groupers	***E. drummondhayi***	**NC and SC**	**967(–)**	**0.13(–)**	**-1(–)**	**—-1096mm TL**	**15**	**A**	**463**	**Matheson & Huntsman (1984)**
	E. drummondhayi	SE US Atlantic	888(–)	0.12(–)	-1.8(–)	164–973mm TL	**35**	A	1197	Ziskin *et al.* (2011)
	E. drummondhayi	Gulf of Mexico	–(–)	–(–)	–(–)	610–1075mm TL	**75**	A	16	Andrews *et al.* (2013)
	E. drummondhayi	SE US Atlantic	945(–)	0.09(–)	-2.8(–)	184–798mm TL	10	A	1197	Ziskin *et al.* (2011)
	E. drummondhayi	–	967(–)	0.13(–)	-1(–)	——mm –	15	A	–	Ault *et al.* (1998)
	E. drummondhayi	SE US Atlantic	852(–)	0.17(–)	-0.8(–)	164–973mm TL	35	A	1197	Ziskin (2008)
	E. drummondhayi	SE US Atlantic	945(–)	0.09(–)	-2.8(–)	184–798mm TL	10	A	1197	Ziskin (2008)
	H. niveatus	**Gulf of Mexico**	**1057(39)**	**0.09(0.009)**	**-2.5(0.3)**	**242–1096mm FL**	**44**	**A**	**790**	**Kowal (2010)**
	H. niveatus	Florida Keys	1320(–)	0.09(–)	-1(–)	111–**1180mm TL**	27	A	206	Moore & Labisky (1984)
	H. niveatus	Gulf of Mexico	1228(71.9)	0.06(0.008)	-5.2(0.6)	——— –	44	A	770	Kowal (2010)

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	Species	Location	L_∞	K	t_0	L Range	t_λ	Sex	n	Reference
Groupers	*H. niveatus*	Gulf of Mexico	1147(126)	0.07(0.023)	-5.6(1.7)	——— –	29	A	136	Kowal (2010)
	H. niveatus	Gulf of Mexico	1194(62.7)	0.07(0.008)	-3.8(0.5)	——— –	44	A	634	Kowal (2010)
	H. niveatus	Brazil	1098.4(–)	0.06(–)	-2.7(–)	157–1216mm TL	54	A	–	Costa *et al.* (2012)
	H. niveatus	–	1091.3(–)	0.11(–)	-0.9(–)	——mm –	15	A	–	Ault *et al.* (1998)
	H. niveatus	–	125(–)	0.07(–)	–(–)	——cm –	25	A	–	Jarzhombek (2007)
	H. niveatus	NC and SC	1255(–)	0.07(–)	-1.9(–)	—-1130mm TL	17	A	536	Matheson & Huntsman (1984)
	H. niveatus	–	970(24)	0.11(0.001)	-2.1(0.3)	—-1090mm –	–	A	–	Waltz (1986)
	H. niveatus	NC and SC	1201(34)	0.1(0.008)	-1.1(0.2)	—-1110mm TL	–	A	–	Wyanski *et al.* (2000)
	H. niveatus	NC and SC	948(28)	0.12(0.017)	-0.7(0.7)	—-1034mm TL	–	A	–	Wyanski *et al.* (2000)
	H. niveatus	NC and SC	1117(13)	0.12(0.004)	-1.4(0.1)	226–1137mm TL	29	A	–	Wyanski *et al.* (2000)
	H. niveatus	NC and SC	1007(14.7)	0.12(0.005)	-1.4(0.1)	–1137mm TL		A	–	Wyanski *et al.* (2013)
	H. niveatus	NC and SC	961.5(18.2)	0.13(0.008)	-1.4(0.2)	–mm TL		A	–	Wyanski *et al.* (2013)
	H. niveatus	Brazil	148.4(–)	0.69(–)	-3(–)	——— –		–	–	Ximenes-Carvalho *et al.* (1999)
	M. interstitialis	**E. Gulf of Mexico**	**828(–)**	**0.08(–)**	**-7.5(–)**	**——mm TL**	**28**	**A**	**203**	**Bullock & Murphy (1994)**
	M. interstitialis	SE US Atlantic	755(–)	0.14(–)	-1.4(–)	300–859mm FL	**31**	A	388	Burton *et al.* (2014)
	M. interstitialis	–	881.8(–)	0.06(–)	-9(–)	——mm –	17	A	–	Ault *et al.* (1998)
	M. interstitialis	Trinidad	854(59.9)	0.06(0.01)	-4.6(2.3)	335–827mm FL	41	A	80	Manickchand & Phillip (2000)
Snappers	***L. synagris***	**SE US**	**618.3(–)**	**0.1(–)**	**-1.7(–)**	**——mm TL**	**10**	**A**	–	**Ault *et al.* (1998)**
	L. synagris	SE US Gulf	469.5(13.5)	0.19(0.022)	-1.1(0.4)	210–**673mm TL**	**17**	A	312	Johnson *et al.* (1995)
	L. synagris	SE US Gulf	479.3(21.1)	0.13(0.021)	-4.3(0.8)	210–673mm TL	17	A	312	Johnson *et al.* (1995)
	L. synagris	SE US Gulf	455.6(16.9)	0.2(0.031)	-1.1(0.5)	210–673mm TL	17	F	324	Johnson *et al.* (1995)
	L. synagris	SE US Gulf	500.4(28.3)	0.11(0.111)	-4.9(21.8)	210–673mm TL	17	F	324	Johnson *et al.* (1995)
	L. synagris	SE US Gulf	489.6(23.9)	0.18(0.033)	-1.2(0.6)	210–510mm TL	13	M	691	Johnson *et al.* (1995)
	L. synagris	SE US Gulf	479.9(30.1)	0.14(0.035)	-3.8(1.2)	210–510mm TL	13	M	691	Johnson *et al.* (1995)
	L. synagris	Puerto Rico	450(–)	0.23(–)	–(–)	——mm FL	–	A	–	Acosta & Appeldoorn (1992)
	L. synagris	Jamaica	320(–)	0.25(–)	0(–)	150–430mm FL	12	M	300	Aiken (2001)
	L. synagris	Jamaica	538.7(–)	0.08(–)	-4(–)	150–430mm FL	12	F	300	Aiken (2001)
	L. synagris	Brazil	505(–)	0.23(–)	-0.2(–)	200–450mm TL	–	A	–	Alegria & de Menezes (1970)
	L. synagris	Puerto Rico	618(–)	0.1(–)	-1.7(–)	——mm –	19	A	–	Ault *et al.* (2008)
	L. synagris	Mexico	30.7(–)	0.53(–)	-1(–)	——cm FL	–	A	–	Ayala (1984)
	L. synagris	Cuba SW	47(–)	0.17(–)	-0.9(–)	——cm FL	–	A	–	Claro & Reshetnikov (1981)
	L. synagris	Bermuda	33.1(–)	0.4(–)	-2(–)	18–38cm FL	19	A	300	Luckhurst *et al.* (2000)
	L. synagris	Trinidad	60.3(–)	0.2(–)	-0.7(–)	18.3–45cm TL	4	F	70	Manickchand-Dass (1987)
	L. synagris	Trinidad	70.8(–)	0.22(–)	-0.6(–)	19.1–48.5cm TL	4	M	73	Manickchand-Dass (1987)
	L. synagris	Florida S	501(–)	0.13(–)	-1.5(–)	—-512mm TL	10	A	–	Manooch & Mason (1984)
	L. synagris	Yucatan	42.8(–)	0.28(–)	-0.1(–)	——cm FL	–	A	–	Mexicano & Arreguin (1989)

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	Species	**Location**	L_∞	K	t_0	L Range	t_λ	Sex	n	**Reference**
Snappers	*L. synagris*	Jamaica	39(–)	0.37(–)	–(–)	——cm FL	–	A	–	Munro (1999)
	L. synagris	Cuba SW	35.1(–)	0.28(–)	-0.5(–)	——cm FL	–	A	–	Olaechea & Quintana (1970)
	L. synagris	Campeche Bank	35.2(–)	0.26-0.29	–(–)	5–31cm TL	–	A	–	Riviera-Arriaga *et al.* (1996)
	L. synagris	Cuba	37.9(–)	0.2(–)	-1.9(–)	——cm FL	–	A	–	Rodriguez Pino (1962)
	L. synagris	Cuba SW	40.1(–)	0.16(–)	-1.8(–)	——cm FL	–	A	–	Rubio *et al.* (1985)
	L. synagris	Mexico	41(–)	0.24(–)	-1.8(–)	——cm FL	–	A	–	Torres & Chavez (1987)
	P. aquilonaris	**Gulf N**	**240(–)**	**0.18(–)**	**-4.8(–)**	**119–237mm FL**	**14**	**A**	**115**	**Anderson *et al.* (2009)**

Table 3: Maturity parameters were compiled through a literature review. Parameters obtained through statistical model estimation are represented by t_{50}, L_{50}, and L_{95}, which represent the age at 50% maturity, the length at 50% maturity, and the length at 95% maturity, respectively. Approximation of size at maturity is given by L_m, and approximation of size at full maturity is give by L_{100}. Sample size for the entire study is given by n, and sample size for each individual sex is given by m. Sex is annotated by all sexes (A), male (M), female (F), or transitional (T).

	Species	**Location**	t_{50}	L_{50}	L_{95}	L_m	L_{100}	L Range	t Range	n	Sex	m	**Reference**
Drums	*S. ocellatus*	W. Florida	–	529	–	–	–	——mm FL	——	–	M	–	Murphy *et al.* (1990)
	S. ocellatus	Indian River	–	511	–	–	–	——mm FL	——	–	M	–	Murphy *et al.* (1990)
	S. ocellatus	W. Florida	–	825	–	–	–	——mm FL	——	–	F	–	Murphy *et al.* (1990)
	S. ocellatus	Indian River	–	900	–	–	–	——mm FL	——	–	F	–	Murphy *et al.* (1990)
	S. ocellatus	N. Gulf of Mexico	4	695	–	–	810	399–1115mm FL	1–39	3351	F	1766	Wilson & Nieland (1994)
	S. ocellatus	N. Gulf of Mexico	4	665	–	–	810	399–1115mm FL	1–36	3351	M	1585	Wilson & Nieland (1994)
	S. ocellatus	W. Florida	–	–	–	629-900	–	——mm TL	——	–	F	–	Muphy & Taylor (1986a)
	S. ocellatus	W. Florida	–	–	–	411-791	–	——mm TL	——	–	M	–	Muphy & Taylor (1986a)
Groupers	*E. drummondhayi*	Campeche Bank	–	–	–	–	–	33–77cm TL	——	47	F	33	Brule *et al.* (2000)
	E. drummondhayi	Campeche Bank	–	–	–	–	–	——cm TL	——	47	T	2	Brule *et al.* (2000)
	E. drummondhayi	Campeche Bank	–	–	–	–	–	64–96cm TL	——	47	M	12	Brule *et al.* (2000)
	E. drummondhayi	SE US	6.6	532	–	–	–	169–730mm TL	1–13	973	F	913	Ziskin *et al.* (2011)
	E. drummondhayi	SE US	6.9	627	–	–	–	451–718mm TL	3–7	973	T	29	Ziskin *et al.* (2011)
	E. drummondhayi	SE US	–	–	–	–	–	500–930mm TL	4–35	973	M	31	Ziskin *et al.* (2011)
	E. drummondhayi	South Atlantic	–	–	–	497	500-549	——mm TL	——	–	–	–	SEDAR (2004)
	H. niveatus	Florida Keys	–	–	–	–	–	—-1000– –	1–14	309	F	117	Moore & Labisky (1984)
	H. niveatus	Florida Keys	–	–	–	–	–	—-1100– –	6–27	309	M	27	Moore & Labisky (1984)
	H. niveatus	NC and SC	–	–	–	–	–	——— –	——	870	–	–	Wyanski *et al.* (2000)
	H. niveatus	NC and SC	–	–	–	–	–	——— –	——	90	–	–	Wyanski *et al.* (2000)
	H. niveatus	NC and SC	–	486	–	–	651-675	——mm TL	——	–	F	–	Wyanski *et al.* (2000)
	H. niveatus	NC and SC	4.92	541	–	–	576-600	——mm TL	——	–	F	–	Wyanski *et al.* (2000)
	H. niveatus	NC and SC	–	–	–	–	–	787–1000mm –	—-13	–	T	2	Wyanski *et al.* (2000)
	H. niveatus	NC and SC	–	–	–	–	–	767–1090mm –	8–29	–	M	97	Wyanski *et al.* (2000)
	H. niveatus	NC and SC	5.6	–	–	–	–	——— –	——	5314	F	–	Wyanski *et al.* (2013)
	H. niveatus	NC and SC	5	–	–	–	–	——— –	——	5314	F	–	Wyanski *et al.* (2013)
	H. niveatus	NC and SC	5.8	–	–	–	–	——— –	——	5314	F	–	Wyanski *et al.* (2013)
	H. niveatus	NC and SC	18.2	–	–	–	–	——— –	5–32	5314	M	–	Wyanski *et al.* (2013)
	H. niveatus	NC and SC	18.9	–	–	–	–	——— –	——	5314	M	–	Wyanski *et al.* (2013)

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	Species	**Location**	t_{50}	L_{50}	L_{95}	L_m	L_{100}	L Range	t Range	n	Sex	m	**Reference**
	H. niveatus	NC and SC	16	–	–	–	–	——— –	——	5314	M	–	Wyanski *et al.* (2013)
Jacks	*S. fasciata*	Louisiana	–	–	–	300-330	–	——mm FL	——	112	F	86	Thompson *et al.* (1996)
	S. fasciata	–	–	–	–	430-470	–	——mm FL	——	–	–	–	Berry (1978)
	S. rivoliana	Jamaica	–	–	–	53	–	——cm FL	——	1	M	1	Thompson & Munro (1974)
Snappers	*L. synagris*	Brazil	–	23	29	–	35	15–56cm TL	——	–	F	–	Freitas *et al.* (2014)
	L. synagris	Brazil	–	24.2	31	–	37.7	17–54cm TL	——	–	M	–	Freitas *et al.* (2014)
	L. synagris	Jamaica	–	–	–	268	–	—-430mm FL	——	–	F	–	Aiken (2001)
	L. synagris	Jamaica	–	–	–	221	–	—-320mm FL	——	–	M	–	Aiken (2001)
	L. synagris	Trinidad	–	–	–	31	41	——cm TL	——	992	F	–	Manickchand-Dass (1987)
	L. synagris	Trinidad	–	–	–	25	37	——cm TL	——	992	M	–	Manickchand-Dass (1987)
	L. synagris	Puerto Rico	–	–	–	206	–	——mm –	——		A	–	Ault *et al.* (2008)
	L. synagris	Bermuda	–	–	–	24.5	–	——cm FL	——	1034	F	–	Luckhurst *et al.* (2000)
	L. synagris	Bermuda	–	–	–	23.5	–	——cm FL	——	1034	M	–	Luckhurst *et al.* (2000)

Table 4: Length-weight parameters were compiled through a literature review. Equation form and associated parameters are given, with standard errors in parentheses where available.

	Species	**Location**	**Equation**	a	b	L **Range**	Sex	n	**Reference**
Drums	*S. ocellatus*	N. Gulf of Mexico	W=aFL^{b}	2.90E-06(–)	3.22(–)	——mm FL	A	1626	Beckman *et al.* (1989)
	S. ocellatus	Louisiana	logW=a+b(logSL)	-4.42E+00(–)	2.83(–)	25–93.2cm SL	A	349	Boothby & Jr. (1971)
	S. ocellatus	W. Florida	W=aFL^{b}	6.17E-06(4.30E-07)	3.1(0.011)	242–1000mm FL	A	491	Murphy *et al.* (1990)
	S. ocellatus	Indian River	W=aFL^{b}	9.40E-06(6.62E-07)	3.03(0.012)	257–1110mm FL	A	484	Murphy *et al.* (1990)
	S. ocellatus	Mississippi	logW=a+b(logSL)	-4.53E+00(–)	2.93(–)	162–965mm SL	A	62	Overstreet (1983)
	S. ocellatus	Mississippi	logW=a+b(logSL)	-4.69E+00(–)	2.99(–)	164–855mm SL	F	128	Overstreet (1983)
	S. ocellatus	Mississippi	logW=a+b(logSL)	-4.80E+00(–)	3.03(–)	143–857mm SL	M	290	Overstreet (1983)
	S. ocellatus	Mississippi	logSL=a+b(logW)	1.56E+00(–)	0.34(–)	162–965mm SL	A	62	Overstreet (1983)
	S. ocellatus	Mississippi	logSL=a+b(logW)	1.59E+00(–)	0.33(–)	164–855mm SL	F	128	Overstreet (1983)
	S. ocellatus	Mississippi	logSL=a+b(logW)	1.59E+00(–)	0.33(–)	143–857mm SL	M	290	Overstreet (1983)
	S. ocellatus	N. Gulf of Mexico	W=aFL^{b}	1.1E-08(–)	3.02(–)	200–900mm FL	A	1111	McInerny & Potts (n.d.)
	S. ocellatus	Louisiana	logW=a+b(logSL)	-7.21E+00(–)	4.19(–)	8–183mm SL	A	568	Bass & J. W. Avault (1975)
	S. ocellatus	Inland Louisiana	logW=a+b(logSL)	-3.44E+00(–)	2.54(–)	483–921cm SL	A	23	McKee (1980)
	S. ocellatus	Inland Texas	logW=a+b(logSL)	-4.06E+00(–)	2.75(–)	312–885cm SL	A	45	McKee (1980)
	S. ocellatus	Louisiana	logW=a+b(logSL)	-1.46E+00(–)	2.82(–)	——cm SL	A	363	Wakeman & Ramsey (1985)
	S. ocellatus	Texas	logW=a+b(logSL)	-1.67E+00(–)	2.95(–)	——cm SL	A	36	Wakeman & Ramsey (1985)
	S. ocellatus	Texas	logW=a+b(logTL)	-5.09E+00(–)	3.04(–)	49–814cm TL	A	8319	Harrington *et al.* (1979)
	S. ocellatus	Texas	logW=a+b(logTL)	-5.06E+00(–)	3.03(–)	260–750cm TL	A	2206	Matlock (1984)
	S. ocellatus	W. Florida	logW=a+b(logFL)	-5.21E+00(–)	3.1(–)	242–1000cm FL	A	491	Muphy & Taylor (1986a)
	S. ocellatus	E. Florida	logW=a+b(logFL)	-5.03E+00(–)	3.03(–)	257–1110cm FL	A	484	Muphy & Taylor (1986a)
	S. ocellatus	Gulf of Mexico	W=aTL^{b}	3.16E-04(–)	3.06(–)	5–47in TL	A	1313	Goodyear (1996)
	S. ocellatus	Gulf of Mexico	W=aFL^{b}	2.53E-04(–)	3.16(–)	5–47in FL	A	934	Goodyear (1996)
	S. ocellatus	Gulf of Mexico	W=aSL^{b}	8.76E-04(–)	2.89(–)	5–47in SL	A	651	Goodyear (1996)
	S. ocellatus	Florida	logW=a+b(logTL)	-4.84E+00(–)	2.94(–)	——— TL	A	–	FWC (2008)
Groupers	*E. drummondhayi*	South Atlantic	W=aTL^{b}	2.26E-05(4.29E-06)	2.98(0.029)	164–930mm TL	A	266	SEDAR (2004)
	E. drummondhayi	South Atlantic	W=aFL^{b}	4.02E-05(1.67E-05)	2.89(0.063)	164–704mm FL	A	71	SEDAR (2004)
	E. drummondhayi	South Atlantic	W=aSL^{b}	3.00E-04(7.73E-05)	2.64(0.04)	139–850mm SL	A	251	SEDAR (2004)
	E. drummondhayi	–	W=aTL^{b}	1.11E-05(–)	3.07(–)	——— –	A	–	Ault *et al.* (1998)
	E. drummondhayi	NC and SC	W=aTL^{b}	1.10E-08(–)	3.07(–)	—-1096mm TL	A	1141	Matheson & Huntsman (1984)
	E. drummondhayi	SE US Atlantic	W=aTL^{b}	1.10E-05(–)	3.1(–)	164–973mm TL	A	1220	Ziskin (2008)
	E. drummondhayi	E. Gulf of Mexico	W=aSL^{b}	3.1x1E0-8(–)	2.99(–)	240–830mm SL	A	170	Bullock & Smith (1991)
	H. niveatus	Brazil	W=aTL^{b}	4.10E-05(–)	2.85(–)	157–1216mm TL	A	298	Costa *et al.* (2012)

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	Species	Location	Equation	*a*	*b*	*L* Range	Sex	*n*	Reference
Groupers	*H. niveatus*	–	W=*a*TL^b	2.45E-05(–)	2.93(–)	——— –	A	–	Ault *et al.* (1998)
	H. niveatus	Brazil	W=*a*TL^b	2.59E-02(–)	2.87(–)	34.5–121.6cm TL	A	120	Frota *et al.* (2004)
	H. niveatus	Brazil	W=*a*SL^b	2.49E-02(–)	2.99(–)	28.3–95.5cm SL	A	25	Frota *et al.* (2004)
	H. niveatus	Brazil	W=*a*TL^b	2.14E-02(–)	2.93(–)	10.8–109cm TL	A	38	Haimovici & Velasco (2000)
	H. niveatus	NC and SC	W=*a*TL^b	7.00E-08(–)	2.76(–)	—-1130mm TL	A	936	Matheson & Huntsman (1984)
	H. niveatus	Florida Keys	W=*a*TL^b	2.45E-08(–)	2.93(–)	111–1180mm TL	A	309	Moore & Labisky (1984)
	H. niveatus	Brazil	logW=*a*+*b*(logTL)	-10.698(–)	2.9(–)	——cm TL	A	229	Ximenes-Carvalho *et al.* (1999)
	H. niveatus	NC and SC	WW=*a*GW	1.08E+00(–)	–(–)	——— –	A	502	Wyanski *et al.* (2013)
	H. niveatus	South Atlantic	W=*a*TL^b	1.78E-05(3.14E-06)	2.97(0.026)	261–1090mm TL	A	684	SEDAR (2004)
	H. niveatus	South Atlantic	W=*a*SL^b	3.67E-05(6.54E-06)	2.95(0.027)	214–888mm SL	A	645	SEDAR (2004)
	M. interstitialis	–	W=*a*TL^b	2.58E-05(–)	2.89(–)	——— –	A	–	Ault *et al.* (1998)
	M. interstitialis	SE US Atlantic	logW=*a*+*b*(logFL)	-11.63(–)	3.07(–)	——mm FL	A	339	Burton *et al.* (2014)
	M. interstitialis	SE US Atlantic	logW=*a*+*b*(logTL)	-11.39(–)	3.01(–)	——mm TL	A	165	Burton *et al.* (2014)
	M. interstitialis	Trinidad	W=*a*FL^b	1.88E-05(–)	2.94(–)	335–827mm FL	A	50	Manickchand & Phillip (2000)
	M. interstitialis	E. Gulf of Mexico	W=*a*SL^b	4.7xE-10(–)	2.89(–)	300–660mm SL	A	97	Bullock & Smith (1991)
Jacks	*S. fasciata*	Cape Verde	W=*a*TL^b	1.25E-02(–)	3.05(0.077)	30.5–65cm TL	A	50	Oliveira *et al.* (2015)
	S. rivoliana	SE Florida	W=*a*FL^b	4.70E-04(–)	2.39(–)	48–90cm FL	A	14	Burch (1979)
	S. rivoliana	Central Brazil	W=*a*FL^b	3.59E-02(–)	2.8(–)	47.5–93cm FL	A	87	Frota *et al.* (2004)
	S. rivoliana	Central Brazil	W=*a*TL^b	1.22E-02(–)	2.96(–)	51–98.4cm TL	A	18	Frota *et al.* (2004)
	S. rivoliana	Central Brazil	W=*a*SL^b	4.09E-02(–)	2.78(–)	41.9–69.4cm SL	A	12	Frota *et al.* (2004)
	S. rivoliana	Azores	W=*a*TL^b	1.08E-02(–)	3.06(0.039)	10.5–122.8cm TL	A	101	Morato *et al.* (2001)
	S. rivoliana	Azores	W=*a*TL^b	1.60E-02(–)	2.96(0.059)	33–98cm TL	M	35	Morato *et al.* (2001)
	S. rivoliana	Azores	W=*a*TL^b	9.60E-03(–)	3.09(0.065)	29–122.8cm TL	F	55	Morato *et al.* (2001)
Snappers	*L. synagris*	Puerto Rico	lnW=*a*+*b*ln(FL)	6.10E-05(–)	2.75(–)	145–330mm FL	A	200	Acosta & Appeldoorn (1992)
	L. synagris	Jamaica	–	–(–)	–(–)	150–430mm FL	A	–	Aiken (2001)
	L. synagris	–	W=*a*TL^b	4.52E-05(–)	2.81(–)	——— –	A	–	Ault *et al.* (1998)
	L. synagris	SW Cuba	W=*a*FL^b	2.17E-02(–)	2.93(–)	13–30cm FL	M	977	Claro & Garcia-Arteaga (1994)
	L. synagris	SW Cuba	W=*a*FL^b	1.86E-02(–)	2.97(–)	6–36cm FL	A	3284	Claro & Garcia-Arteaga (1994)
	L. synagris	SW Cuba	W=*a*FL^b	2.40E-02(–)	2.89(–)	13–36cm FL	F	1248	Claro & Garcia-Arteaga (1994)
	L. synagris	SE US Gulf	logW=*a*+*b*(logTL)	8.10E+00(–)	3.11(–)	——mm TL	A	222	Johnson *et al.* (1995)
	L. synagris	S. Florida	W=*a*TL^b	1.02E-04(–)	2.65(–)	—-512mm TL	A	–	Manooch & Mason (1984)
	L. synagris	NE Cuba	W=*a*FL^b	1.82E-02(–)	2.9(–)	——cm FL	A	684	Ramos (1988)
	L. synagris	Cuba	W=*a*FL^b	4.96E-05(–)	2.8(–)	9–41cm FL	A	4443	Rodriguez Pino (1962)
	L. synagris	SW Cuba	W=*a*FL^b	5.17E-02(–)	2.64(–)	12–43cm FL	A	1708	Sosa (2001)
	P. aquilonaris	N. Gulf of Mexico	W=*a*FL^b	3.00E-08(–)	2.91(–)	119–237mm FL	A	115	Anderson *et al.* (2009)

Table 5: Length-length parameters were compiled through a literature review. Equation form is given with associated parameters, and standard errors are included in parentheses where available.

	Species	Location	Equation	a	b	L Range	Sex	n	Reference
Drums	*S. ocellatus*	Texas	TL=a+b(SL)	12.87(–)	1.18(–)	92–937mm TL	A	8982	Harrington *et al.* (1979)
	S. ocellatus	Louisiana	SL=a+b(TL)	-2.05(–)	0.84(–)	14–1135mm TL	A	302	Hein *et al.* (1980)
	S. ocellatus	Florida	FL=a+b(TL)	23.94(0.67)	0.92(0.001)	225–1110mm –	A	1074	Murphy *et al.* (1990)
	S. ocellatus	Florida	TL=a+b(FL)	-25.21(0.76)	1.09(0.001)	225–1110mm –	A	1074	Murphy *et al.* (1990)
	S. ocellatus	Florida	TL=a+b(SL)	10.38(0.9)	1.18(0.002)	225–1110mm –	A	1075	Murphy *et al.* (1990)
	S. ocellatus	Florida	SL=a+b(TL)	-7.62(0.77)	0.83(0.001)	225–1110mm –	A	1075	Murphy *et al.* (1990)
	S. ocellatus	Florida	FL=a+b(SL)	32.9(0.69)	1.09(0.001)	225–1110mm –	A	1075	Murphy *et al.* (1990)
	S. ocellatus	Florida	SL=a+b(FL)	-29.46(0.67)	0.92(0.001)	225–1110mm –	A	1075	Murphy *et al.* (1990)
	S. ocellatus	Mississippi	logTL=a+b(logSL)	0.13(–)	0.98(–)	——mm –	A	861	Overstreet (1983)
	S. ocellatus	Mississippi	TL=a+b(SL)	15.64(–)	1.16(–)	162–965mm SL	A	426	Overstreet (1983)
	S. ocellatus	Mississippi	TL=a+b(SL)	16.03(–)	1.14(–)	164–855mm SL	F	131	Overstreet (1983)
	S. ocellatus	Mississippi	TL=a+b(SL)	10.44(–)	1.16(–)	143–857mm SL	M	304	Overstreet (1983)
	S. ocellatus	Mississippi	SL=a+b(TL)	-7.66(–)	0.85(–)	162–965mm SL	A	426	Overstreet (1983)
	S. ocellatus	Mississippi	SL=a+b(TL)	-11.32(–)	0.87(–)	164–855mm SL	F	131	Overstreet (1983)
	S. ocellatus	Mississippi	SL=a+b(TL)	-6.9(–)	0.86(–)	143–857mm SL	M	304	Overstreet (1983)
	S. ocellatus	–	FL=a+b(TL)	23.94(–)	0.92(–)	225–1110mm FL	A	1074	Muphy & Taylor (1986a)
	S. ocellatus	–	TL=a+b(FL)	25.21(–)	1.09(–)	225–1110mm FL	A	1074	Muphy & Taylor (1986a)
	S. ocellatus	–	TL=a+b(SL)	10.38(–)	1.18(–)	225–1110mm FL	A	1075	Muphy & Taylor (1986a)
	S. ocellatus	–	SL=a+b(TL)	-7.62(–)	0.83(–)	225–1110mm FL	A	1075	Muphy & Taylor (1986a)
	S. ocellatus	–	FL=a+b(SL)	32.9(–)	1.09(–)	225–1110mm FL	A	1075	Muphy & Taylor (1986a)
	S. ocellatus	–	SL=a+b(FL)	29.46(–)	0.92(–)	225–1110mm FL	A	1075	Muphy & Taylor (1986a)
	S. ocellatus	Gulf of Mexico	TL=a+b(FL)	-1.01(–)	1.09(–)	5–47in TL	A	1474	Goodyear (1996)
	S. ocellatus	Gulf of Mexico	TL=a+b(SL)	0.42(–)	1.18(–)	5–50in TL	A	1600	Goodyear (1996)
	S. ocellatus	Gulf of Mexico	FL=a+b(SL)	1.31(–)	1.08(–)	5–50in TL	A	1478	Goodyear (1996)
Groupers	*E. drummondhayi*	SE US Atlantic	TL=a+b(FL)	3.52(–)	1.05(–)	164–973mm TL	A	977	Ziskin (2008)
	E. drummondhayi	SE US Atlantic	TL=a+b(SL)	16.1(–)	1.18(–)	164–973mm TL	A	1258	Ziskin (2008)
	E. drummondhayi	SE US Atlantic	FL=a+b(TL)	-1.88(–)	0.98(–)	164–973mm TL	A	977	Ziskin (2008)
	E. drummondhayi	SE US Atlantic	FL=a+b(SL)	14.54(–)	1.16(–)	164–973mm TL	A	1258	Ziskin (2008)
	E. drummondhayi	SE US Atlantic	SL=a+b(TL)	-9.98(–)	0.84(–)	164–973mm TL	A	977	Ziskin (2008)
	E. drummondhayi	SE US Atlantic	SL=a+b(FL)	-9.45(–)	0.86(–)	164–973mm TL	A	1258	Ziskin (2008)
	E. drummondhayi	South Atlantic	TL=a+b(FL)	5.74(–)	1.01(–)	164–704mm –	A	75	SEDAR (2004)
	E. drummondhayi	South Atlantic	TL=a+b(SL)	13.92(–)	1.17(–)	139–850mm –	A	303	SEDAR (2004)

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	Species	**Location**	**Equation**	a	b	L **Range**	Sex	n	**Reference**
Groupers	*E. drummondhayi*	South Atlantic	FL=a+b(TL)	-2.97(–)	0.98(–)	169–725mm –	A	75	SEDAR (2004)
	E. drummondhayi	South Atlantic	FL=a+b(SL)	11.5(–)	1.14(–)	140–601mm –	A	74	SEDAR (2004)
	E. drummondhayi	South Atlantic	SL=a+b(TL)	-8.34(–)	0.85(–)	164–930mm –	A	303	SEDAR (2004)
	E. drummondhayi	South Atlantic	SL=a+b(FL)	-6.49(–)	0.87(–)	164–704mm –	A	74	SEDAR (2004)
	H. niveatus	Gulf of Mexico	FL=a+b(TL)	5.36(–)	0.97(–)	——mm –	A	144	Kowal (2010)
	H. niveatus	Florida Keys	TL=a+b(SL)	1.19(–)	11.7(–)	111–1180mm TL	A	309	Moore & Labisky (1984)
	H. niveatus	South Atlantic	SL=a+b(TL)	1.71(–)	1.21(–)	182–888mm –	A	1633	SEDAR (2004)
	H. niveatus	South Atlantic	TL=a+b(SL)	0.03(–)	0.82(–)	225–1090mm –	A	1633	SEDAR (2004)
	M. interstitialis	SE US Atlantic	TL=a+b(FL)	10.09(–)	1.05(–)	300–859mm FL	A	162	Burton *et al.* (2014)
Jacks	*S. fasciata*	Cape Verde	TL=a+b(FL)	0.43(–)	1.17(0.04)	30.8–49.3cm FL	A	17	Oliveira *et al.* (2015)
	S. rivoliana	India	FL=b(TL)	–(–)	0.85(–)	——mm –	A	–	Abdussamad *et al.* (2008)
	S. rivoliana	India	SL=b(TL)	–(–)	0.77(–)	——mm –	A	–	Abdussamad *et al.* (2008)
	S. rivoliana	Azores	TL=a+b(FL)	0.40(–)	1.11(–)	33–98cm TL	M	35	Morato *et al.* (2001)
	S. rivoliana	Azores	TL=a+b(SL)	4.49(–)	1.15(–)	29–122.8cm TL	F	55	Morato *et al.* (2001)
Snappers	*L. synagris*	SE US Gulf	TL=a+b(FL)	14.68(–)	1.02(–)	——mm –	A	226	Johnson *et al.* (1995)
	L. synagris	SE US Gulf	FL=a+b(TL)	-8.91(–)	0.97(–)	——mm –	A	226	Johnson *et al.* (1995)
	L. synagris	S. Florida	TL=a+b(FL)	-2.63(–)	1.09(–)	——mm –	A	–	Manooch & Mason (1984)
	P. aquilonaris	N. Gulf of Mexico	FL=a+b(TL)	-0.43(–)	0.85(–)	119–237mm FL	A	114	Anderson *et al.* (2009)

Table 6: Total (Z), natural (M), and fishing (F) mortality estimates were compiled through a literature review. Esimation method is given, as well as age ranges where available. Sex is annotated by all sexes (A), male (M), female (F), or transitional (T).

	Species	**Location**	Z	M	F	**Estimation Method**	t	**Sex**	n	**Reference**
Drums	*S. ocellatus*	Texas	1.89	0.86	1.03	survival estimate method = Brownie et al. 1978	——	A	6106	Green *et al.* (1985)
	S. ocellatus	North Carolina	–	–	2.38	modified Jiang et al. 2007	——	A	4722	Bacheler *et al.* (2008)
	S. ocellatus	North Carolina	–	–	0.59	modified Jiang et al. 2007	——	A	4722	Bacheler *et al.* (2008)
	S. ocellatus	North Carolina	–	–	0.9	modified Jiang et al. 2007	——	A	4722	Bacheler *et al.* (2008)
	S. ocellatus	North Carolina	–	0.03	0.01-0.14	Telemetry: Pollock et al. 1995; Hightower et al. 2001	2–2	A	581	Bacheler *et al.* (2008)
	S. ocellatus	North Carolina	–	0.38	0-0.08	conventional tag return: modified Brownie tag return model; Jiang et al. 2007; Bacheler et al. 2008	2–2	A	4776	Bacheler *et al.* (2008)
	S. ocellatus	North Carolina	–	0.04	0.11-0.22	Combined telemetry-conventional tag return: Pollock et al. 2004	2–2	A	5357	Bacheler *et al.* (2008)
	S. ocellatus	North Carolina	–	0.04	0.07-0.13	Combined telemetry-conventional tag return: Pollock et al. 2004	2–2	A	5357	Bacheler *et al.* (2008)
	S. ocellatus	Texas	1.66	0.36	1.31	Based on tagging data	——	A	–	Anon (1973)
	S. ocellatus	Texas	1.61	0.42	1.19	Length frequencies in catch data	——	A	–	Matlock (1984)
	S. ocellatus	Texas	–	0.29	–	Pauly's 1979 method; Pearson's 1929 data	——	A	–	Matlock (1984)
	S. ocellatus	Gulf of Mexico	0.2	–	–	Age composition of offshore stock collected by purse seine in 1986	——	–	–	Goodyear (1987)
	S. ocellatus	Gulf of Mexico	0.211	–	–	Age composition of offshore stock collected by purse seine in 1985-1988	——	–	–	Goodyear (1996)
	S. ocellatus	Gulf of Mexico	0.218	–	–	Age composition of offshore stock collected by purse seine in 1986-1992	——	–	–	Goodyear (1996)
	S. ocellatus	Gulf of Mexico	0.2	–	–	Mark-recapture (age 3)	——	–	–	Anon (1988)
	S. ocellatus	Gulf of Mexico	–	0.3	–	Estimated M for adults using Pauly (1979) equation and temperature of 24*C	——	–	–	Porch (1999)
	S. ocellatus	Gulf of Mexico	–	0.13	–	Estimated M from Hoenig (1983) equation and maximum age of 37	——	–	–	Porch (1999)

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	Species	Location	*Z*	*M*	*F*	Estimation Method	*t*	Sex	*n*	Reference
	S. ocellatus	Alabama	–	0.079	–	Ault et al. 1998	—-38	–	–	Powers *et al.* (2012)
	S. ocellatus	Alabama	–	0.109	–	Hoenig 1983	—-38	–	–	Powers *et al.* (2012)
	S. ocellatus	Alabama	–	0.175	–	Then et al. 2015	—-38	–	–	Powers *et al.* (2012)
Groupers	*E. drummondhayi*	South Atlantic	–	0.15	–	Catch curve	——	–	–	Potts *et al.* (1998)
	E. drummondhayi	–	–	0.2	–	–	——	–	–	Ault *et al.* (1998)
	E. drummondhayi	NC and SC	–	0.27	–	Pauly 1980	——	–	–	Matheson & Huntsman (1984)
	E. drummondhayi	SE US Atlantic	0.61	0.13	0.48	catch curve (Z); Hoenig 1983 (M)	——	–	–	Ziskin *et al.* (2011)
	E. drummondhayi	SE US Atlantic	1.27	0.13	1.14	catch curve (Z); Hoenig 1983 (M)	——	–	–	Ziskin *et al.* (2011)
	E. drummondhayi	SE US Atlantic	–	0.086	–	Ault et al. 1998	—-35	–	–	Ziskin *et al.* (2011)
	E. drummondhayi	SE US Atlantic	–	0.119	–	Hoenig 1983	—-35	–	–	Ziskin *et al.* (2011)
	E. drummondhayi	SE US Atlantic	–	0.189	–	Then et al. 2015	—-35	–	–	Ziskin *et al.* (2011)
	E. drummondhayi	Gulf of Mexico	–	0.040	–	Ault et al. 1998	—-75	–	–	Andrews *et al.* (2013)
	E. drummondhayi	Gulf of Mexico	–	0.055	–	Hoenig 1983	—-75	–	–	Andrews *et al.* (2013)
	E. drummondhayi	Gulf of Mexico	–	0.094	–	Then et al. 2015	—-75	–	–	Andrews *et al.* (2013)
	H. niveatus	–	–	0.13	–	–	——	–	–	Ault *et al.* (1998)
	H. niveatus	NC and SC	–	0.15	–	Pauly 1980	——	–	–	Matheson & Huntsman (1984)
	H. niveatus	Florida Keys	0.175	–	–	Catch curve	8–12	A	309	Moore & Labisky (1984)
	H. niveatus	Florida Keys	0.18	–	–	Catch curve	8–19	A	309	Moore & Labisky (1984)
	H. niveatus	South Atlantic	–	0.15	–	Catch curve	——	–	–	Potts *et al.* (1998)
	H. niveatus	Brazil	–	0.17	–	–	—-46.4	–	229	Ximenes-Carvalho *et al.* (1999)
	H. niveatus	Gulf of Mexico	–	0.068	–	Ault et al. 1998	—-44	–	–	Kowal (2010)
	H. niveatus	Gulf of Mexico	–	0.094	–	Hoenig 1983	—-44	–	–	Kowal (2010)
	H. niveatus	Gulf of Mexico	–	0.153	–	Then et al. 2015	—-44	–	–	Kowal (2010)
	M. interstitialis	–	–	0.18	–	–	——	–	–	Ault *et al.* (1998)
	M. interstitialis	SE US Atlantic	–	0.14	–	Hewitt and Hoenigs (2005)	3–31	A	388	Burton *et al.* (2014)
	M. interstitialis	SE US	–	0.097	–	Ault et al. 1998	—-31	–	–	Burton *et al.* (2014)
	M. interstitialis	SE US	–	0.134	–	Hoenig 1983	—-31	–	–	Burton *et al.* (2014)
	M. interstitialis	SE US	–	0.211	–	Then et al. 2015	—-31	–	–	Burton *et al.* (2014)
Snappers	*L. synagris*	Puerto Rico	1.65	0.52	1.13	catch curves (Z); Ralston 1987 (M)	——	–	–	Acosta & Appeldoorn (1992)
	L. synagris	–	–	0.3	–	–	——	–	–	Ault *et al.* (1998)
	L. synagris	Puerto Rico	0.481	0.158	0.323	–	——	–	–	Ault *et al.* (2008)
	L. synagris	SE US Gulf	0.375	0.228	0.147	Catch curves (Z); Pauly 1980 (M)	——	A	–	Johnson *et al.* (1995)
	L. synagris	SE US Gulf	0.4529	0.239	0.214	Catch curves (Z); Pauly 1980 (M)	——	F	–	Johnson *et al.* (1995)
	L. synagris	SE US Gulf	0.5767	0.208	0.369	Catch curves (Z); Pauly 1980 (M)	——	M	–	Johnson *et al.* (1995)
	L. synagris	Gulf of Mexico	0.162	–	–	estimated by location over 10 days	0.06–0.18	A	420	Mikulas & Rooker (2008)
	L. synagris	SE US Gulf	–	0.176	–	Ault et al. 1998	—-17	–	–	Johnson *et al.* (1995)

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	Species	Location	Z	M	F	Estimation Method	t	Sex	n	Reference
Snappers	*L. synagris*	SE US Gulf	–	0.246		Hoenig 1983	—-17	–	–	Johnson *et al.* (1995)
	L. synagris	SE US Gulf	–	0.366	–	Then et al. 2015	—-17	–	–	Johnson *et al.* (1995)
	P. aquilonaris	N. Gulf of Mexico	–	0.214	–	Ault et al. 1998	—-14	–	–	Anderson *et al.* (2009)
	P. aquilonaris	N. Gulf of Mexico	–	0.300		Hoenig 1983	—-14	–	–	Anderson *et al.* (2009)
	P. aquilonaris	N. Gulf of Mexico	–	0.437	–	Then et al. 2015	—-14	–	–	Anderson *et al.* (2009)

Table 7: Steepness values identified in meta-analysis of marine fish stocks.

Reference	Relevant Species Groups or Families Considered	Value
Myers *et al.* (1999)	Carangidae (*Trachurus* spp.); n = 3	Median = 0.5
	Lutjanidae (*Lutjanus campechanus*) n = 1	Median = 0.95
	Sciaenidae (*Argyrosomus* sp.)	Median = 0.87
	Temperate species (see source for full list)	Mean(SD) = 0.7(0.15) Range: 0.34-0.95
Rose *et al.* (2001)	Periodic strategists (e.g., red snapper, striped bass)	Mean = 0.70
	Note that data are based on Myers *et al.* (1999)	Range: 0.35-0.95
Dorn (2002)	West Coast rockfish	Range = 0.52 - 0.67
Myers *et al.* (2002)	Marine periodic strategists (e.g., croaker, spot, etc.)	Mode = 0.747
Quinn *et al.* (2010)	West Coast rockfish	Mean(SD) = 0.67(0.17)
	Note that data are based on Dorn (2002)	Range: 0.43-88
Shertzer & Conn (2012)	Subset periodic strategists from Rose *et al.* (2001) to only include marine & dermersal species	Mean(SD)=0.77(0.15)
	Quinn *et al.* (2010)	Mean(SD) = 0.69(0.12)
	SEDAR - estimated, no prior (SA black sea bass, SA red porgy, GOM gag, SA greater amberjack, GOM red grouper)	Mean(SD) = 0.70(0.13)
	Combined across data sources	Mean(SD) = 0.75(0.15) Median = 0.78

Table 8: Steepness values considered in previous stock assessments for SEDAR 49 species. BH = Beverton-Holt spawner-recruit relationship (SR Rel), Fix = Fixed steepness (h) value. 'Other runs' refers to any alternative steepness values pursued as sensitivity runs. Ranges were identified from either likelihood profiling or distributions of steepness considered in the assessment.

Species	Reference	Region	SR Rel	Type	h	Other runs	h range	sigmaR	Notes
Snowy grouper	SEDAR (2013b)	SA	BH	Fix	0.84	0.70, 0.74, 0.94	0.32-0.99	0.55	Fixed value based on Shertzer & Conn (2012); Steepness remained non-estimable
	SEDAR (2004)	SA	BH	Fix	0.7	NA	0.25-0.95	NA	Fixed value based on Shertzer & Conn (2012)
Red drum	SEDAR (2015)	ATL (N)	BH	Fix	0.99	0.92	0.80-1.00	0.76 (0.08 CV)	Steepness not estimable
	SEDAR (2015)	ATL (S)	BH	Fix	0.99	0.92	0.80-1.00	0.6	Steepness not estimable
	Chagaris *et al.* (2015)	FL	BH	Fix	0.8	0.65, 0.90	0.20-1.00	-	Steepness successfully estimated in NW and NE models, indicating a rather well informed stock-recruitment curve
	Murphy & Munyandorero (2009)	FL	BH	Fix	0.8	NA	NA	-	
	Porch (2000)	GOM	BH	NA	NA	NA	NA	-	No mention of steepness or alpha

Table 9: Steepness values considered in the most recent stock assessments for species similar to the SEDAR 49 species. BH = Beverton-Holt spawner-recruit relationship (SR Rel), Fix = Fixed steepness (h) value, Calc = Calculated steepness value from alpha, Est = Estimated steepness value. 'Other runs' refers to any alternative steepness values pursued as sensitivity runs. Ranges were identified from either likelihood profiling or distributions of steepness considered in the assessment.

Species	**Reference**	**Region**	**SR Rel**	**Type**	*h*	*h* range	**Other runs**	**sigmaR**	**Notes**
Goliath grouper (*Epinephelus itajara*)	SEDAR (2011c)	SA/GOM	BH	Calc	0.85	NA	0.70-0.99	-	
Red grouper (*Epinephelus morio*)	SEDAR (2015)	GOM	BH	Est	0.8	0.65, 0.98	0.40-0.99	0.97 (0.12 SD)	Prior value of 0.83 from Shertzer & Conn (2012)
	SEDAR (2010b)	SA	BH	Est	0.91	NA	0.76-0.97	0.41	Prior value of 0.72 from SEFSC (2009)
Snowy grouper (*Hyporthodus niveatus*)	SEDAR (2013b)	SA	BH	Fix	0.84	0.70, 0.74, 0.94	0.32-0.99	0.55	Fixed at 0.84 from Shertzer & Conn (2012)
Yellowedge grouper (*Hyporthodus flavolimbatus*)	SEDAR (2011b)	GOM	BH	Est	0.95	0.60, 0.65, 0.70	0.30-0.99	0.2	Prior value of 0.7 from Shertzer & Conn (2012)
Black grouper (*Mycteroperca bonaci*)	SEDAR (2010a)	SA/GOM	BH	Est	0.84	0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95	0.60-0.85	-	

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Species	Reference	Region	SR Rel	Type	h	Other runs	sigmaR	Notes	
Gag grouper (*Mycteroperca microlepis*)	SEDAR (2014c)	GOM	BH	Est	0.99	0.70, 0.95, 0.85	0.50-0.99	0.6	Prior value of 0.7 from Shertzer & Conn (2012)
	SEDAR (2014a)	SA	BH	Fix	0.84	0.74, 0.94	0.30-0.99	0.6	Fixed at 0.84 from Shertzer & Conn (2012)
Mutton snapper (*Lutjanus analis*)	O'Hop *et al.* (2015)	SA/GOM	BH	Est	0.81	NA	0.40-0.99	-	
Red snapper (*Lutjanus campechanus*)	SEDAR (2014b)	GOM	BH	Fix	0.99	None	0.30-0.99	0.3	
	SEDAR (2013a)	GOM	BH	Fix	0.99	0.8	0.30-0.99	0.3	
	SEDAR (2010c)	SA	BH	Fix	0.85	0.97, 0.95, 0.99	0.60-0.99	0.6	Fixed at 0.85 from SEFSC (2010)
Yellowtail snapper (*Ocyurus chrysurus*)	O'Hop *et al.* (2012)	SA/GOM	BH	Est	0.7	None	0.50-0.99	-	
Vermilion snapper (*Rhomboplites aurorubens*)	SEDAR (2012)	SA	BH	Est	0.71	0.56	0.52-0.90	0.75	
	SEDAR (2011a)	GOM	BH	Calc	1	NA	NA	0.4	
Greater amberjack (*Seriola dumerili*)	SEDAR (2014d)	GOM	BH	Est	0.84	0.8	0.50-0.99	0.6	
	SEDAR (2008)	SA	BH	Est	0.74	NA	0.55-0.95	-	

Table 10: Variables included in the life history supplementary spreadsheet.

Sheet	**Variable**
Overall	Species type
	Common name
	Genus
	Species
	Year
	Sampling location
	Sampling timeframe
	Sampling frequency
	Sampling gear
	Sex associated with data
	Sample size
Ref.	Full reference
	Publication type
	Original PDF obtained
Inventory	Available data
	Compiled data
	Data to be compiled
Locations	Region
	Sub-region
	Country
	State or area
	Specific place
Max Obs.	Max length
	Length type
	Length units
	Max age
	Max weight
	Weight units
Length-Age	Number aged
	$L\infty$ and SE $L\infty$
	K and SE K
	t_0 and SE t_0
	Fitting method
	R-squared
	Age range
	Length range
	Length type
	Length units
	Aging method
	Type of hard part aged
	Sectioned or Whole
	Validated
	Back calculation ethod
	Sample size back-calculated
	Age range back-calculated
	Length range back-calculated
	Equation form
	Equation units
	a and SE a
	b and SE b
	R-squared
Length-Weight	Equation form
	Length type
	Length units
	Weight units
	a and SE a
	b and SE b
	R-squared
	Size range
	Weight range
Length-Length	Conversion type
	Equation form
	Length units
	a and SE a
	b and SE b
	R-squared
	Size range
	Length type
Maturity	A_{50} and SE A_{50}
	L_{50} and SE L_{50}
	L_{95} and SE L_{95}
	A_m reported
	L_m reported
	L_{100} reported
	Length type
	Length units
	Size range
	Size range mature
	Avg. length
	Avg. length mature
	Age range
	Age range mature
	Sex change
	Type of sex change
	Sex determination method
	Spawning sampled
	Spawning method
	Months w/ ripe females
Mortality	Z and SE Z
	M and SE M
	F and SE F
	S and SE S
	Mortality estimation method
	R-squared
	Age range
	Size range
	Length type
	Length units
Steepness	Type (calc,est,fix)
	h
	other runs
	h range
	σR

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