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Age, growth, and fishery assessment of spotted sand bass in the Northern Gulf of California, Mexico

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Abstract

Spotted sand bass (*Paralabrax maculatofasciatus*) is one of the most common inshore reef fishes in the northern Gulf of California (GOC), Mexico, but has rarely been studied. Objectives of this study were to estimate age and growth parameters of this species from two areas in the northern GOC and use an age-structured model to assess fishery yield and Spawning Potential Ratio (SPR) over a wide range of exploitations. Samples yielded fish up to age 8, although most were between age 2 and 5. Growth was extremely rapid, with most of the growth in length achieved in the first year, followed by much slower growth. Conditional rates of natural mortality averaged 0.37. Yield models predicted that spotted sand bass in the GOC were less vulnerable to fishing than those in the Pacific Ocean, likely due to faster growth and higher natural mortality. Growth overfishing and SPR values below 0.20 were only predicted at the lowest natural mortality and high (>0.50) exploitation rates. Results suggested that the species could support a commercial fishery in the GOC that might alleviate some of the conservation issues currently facing biologists in this unique marine ecosystem.

KEYWORDS
otoliths, population dynamics, spawning potential ratio

1 | INTRODUCTION

Spotted sand bass (*Paralabrax maculatofasciatus*) is a member of the Serranidae family that ranges from Mazatlán, Mexico, north to Monterey Bay, California, including the Gulf of California (GOC; Thomsom et al., 2000). Two disjunct populations of this species occur in the eastern Pacific Ocean, including those found along the coast of southern California and the northern Baja California peninsula and those in the northern GOC (Stepien et al., 2001). Populations along the Pacific coast have been relatively well studied (e.g., Allen et al., 1995; Hovey & Allen, 2000), but less attention has been focused on the population in the northern GOC.

The species is targeted by recreational and commercial fisheries, although the population along the U.S. coastline have been protected from commercial fishing since 1953 (California Department of Fish & Wildlife, Marine Division [CDFWMD], 2019). Spotted sand bass are known to form spawning aggregations (Hovey & Allen, 2000), potentially making them more vulnerable to overfishing by either commercial or recreational anglers (Erisman et al., 2010, 2017). Generally, spotted sand bass have escaped the focus of most commercial fisheries in Mexico (Erisman et al., 2010; Rodríguez-Quiroz et al., 2010), likely owing to their relatively small maximum size (<1 kg; Thomson et al., 2000). The CDFWMD (2019), recently conducted an assessment of the spotted sand bass fishery along the Pacific coast and concluded that it comprises mostly a catch-and-release fishery. However, to date no such assessment has been conducted for the fishery in the GOC. Unlike the Pacific population, spotted sand bass are the dominant inshore reef fish in many areas of the northern GOC, and few larger congeners exist there that are more attractive to anglers (Thomson et al., 2000).

FIGURE 1 Map of the northern Gulf of California showing the two study areas where spotted sand bass were collected for age and growth analyses

Although vital for fishery assessments, age and growth data are often rare for lesser-studied species like spotted sand bass, particularly for those in remote areas that are difficult to access, such as the northern GOC. Currently, published age and growth data for this population has only been presented by Andrews et al., (2005), but they did not conduct a fishery modeling assessment. Commercial fisheries are prevalent in the GOC, and some evidence of overfishing of certain target species has been noted by authors (e.g., Erisman et al., 2010; Sala et al., 2004). Given the potential fishing down of food webs in the GOC noted by Sala et al., (2004), spotted sand bass could likely become more targeted by commercial fishers as larger species are fished down to unsustainable levels (Erisman et al., 2010, 2017).

The spawning potential ratio (SPR) has been used extensively by marine scientists to quantify and prevent recruitment overfishing (i.e., mature population biomass is depleted to a level where recruitment is insufficient to replenish itself) as an alternative to the traditional stock-recruitment approach (Goodyear, 1993). The SPR is the ratio of mature eggs produced at a certain level of exploitation compared to the number of eggs produced if that stock was unfished. Critical SPRs have been defined for a variety of commercial fisheries (Goodyear, 1993) and sport fisheries (Mace et al., 1996) and can offer insights to the vulnerability of a population to recruitment overfishing. Therefore, the objectives of this study were to 1) estimate age and growth of spotted sand bass in the northern GOC, and 2) use an age-structured model to assess the relation of fishery yield and SPR to a wide range of exploitations.

2 | MATERIALS AND METHODS

Spotted sand bass were collected by angling in 2006 and 2016 from Bahia San Luis Gonzaga (GZB) and in 2016 from Bahia de las Animas (LAS) in the northern GOC (Figure 1) in the fall (October-November) of each year. On each sampling trip, all spotted sand bass caught were measured for total length (TL, mm) and sagittal otoliths were removed and placed into individual plastic vials. Fish were only weighed (g) in 2016 due to equipment malfunction. Fish were chosen to reflect the widest possible length range at each site/year combination. In the laboratory otoliths were cleaned, dried, and read whole view with a stereo microscope; those with three or more visible rings were sectioned following the methods of (Maceina, 1988) and read under a compound microscope. All otoliths were read by two independent readers using a double-blind protocol; disagreements were resolved using a concert read. Average percent error (APE) was calculated to assess variability of age estimation between readers (Campana, 2001).

Growth was described for fish in each study area/year combination using a von Bertalanffy (1938) model; because fish were caught in the fall, all ages were corrected by adding 0.5 to each age to account for growth past the last annulus. Models were forced to run through 0 to improve fit (Maceina & Sammons, 2016). Growth of age 1–6 fish was compared directly between years at GZB, and between areas in 2016, using analysis of covariance (ANCOVA) to compare the slopes of TL to $\log_{10}$ age regressions (SAS Institute, 2012). If slopes were determined to be parallel, then a further test was conducted to determine if fish length was similar at the adjusted mean age.

Length frequencies were constructed for fish collected in each area in 2016 and compared between areas using a Kolmogorov-Smirnov Test (SAS Institute, 2012). The allometric growth function between length and weight was examined between sites using the linearized log-log equation. Slopes of the relation were compared between areas using an ANCOVA (SAS Institute, 2012).

Age-structured models were constructed using the Fisheries Analysis and Modeling Simulator Tools (FAMS Version 1.64.4) software developed by Slipke and Maceina (2014) to examine effects of exploitation on fishery yield and spawning potential ratio of the overall spotted sand bass population of the northern GOC. Pooled age and length-weight data from 2016 were used to derive an overall von Bertalanffy (1938) model and a log-log TL-weight relation. Instantaneous natural mortality rate (M) was estimated from eight equations (Chen & Watanabae, 1989; Cubillos et al., 1999; Djabali et al., 1993; Hoenig, 1983; Jensen, 1996; Lorenzen, 1996; Pauly, 1980; Quinn & Deriso, 1999) presented in FAMS, and these were averaged to obtain an overall estimate of M. Mean annual water temperature for both study areas was obtained using data from www.seatemperature.info and averaged for use in the Pauly (1980) equation. Running the von Bertalanffy equation through 0 produced a very high k value that resulted in unrealistically high estimates of M compared to estimators not using von Bertalanffy parameters (Maceina & Sammons, 2016). Therefore, to estimate M unconstrained von Bertalanffy models were derived to produce more realistic M estimates. Conditional natural mortality (cm) was computed from M as: cm = 1- $\mathbf{e}^{-M}$. Simulations were run at three levels of cm, corresponding to the lowest, highest, and mean cm estimated using FAMS.

Because no estimates of total annual mortality or exploitation were available for this population, simulations were run over a wide range of conditional fishing mortalities (cf) that roughly corresponded to exploitation rates of 0% to 70%. A fecundity-length relation equation for spotted sand bass required for SPR analyses was obtained from Oda et al., (1993) for a population in the Pacific Ocean off the coast of California: $\log_{10}(\text{fecundity}) = -1.41 + 2.17(\log_{10}[\text{length}])$, with length measured as standard length (SL). Likewise, the maturity schedule for this species was obtained from data presented by Allen et al., (1995) for a Pacific Ocean population. This species matures quickly, with 50% of females mature by age 1 and 100% mature at older ages. Maximum age of the population was assumed to be 12, based on Andrews et al., (2005). Models were run using the yield-per-recruit option in FAMS, with 100 age-1 recruits entering the population. Spotted sand bass were considered to enter the fishery at 204 mm TL, which was assumed to be the length when the species became fully recruited to fishing gears, as the GOC population is not currently regulated with a minimum length limit.

Spotted sand bass in the Pacific Ocean off California have been noted to have different population rate functions than those in the northern GOC (Allen et al., 1995; Andrews et al., 2005). To examine differential responses of these populations to exploitation, another age-structured model was constructed for the Pacific Ocean population in the same manner as described above. von Bertalanffy parameters were estimated using mean SL at age data found in Allen et al., (1995) and were converted to TL using their published equation. These data were used in FAMS to estimate growth, M, and cm. As above, models were run over three levels of cm estimated by FAMS and over the same range of cf as used for the northern GOC population. Maximum age of that population was assumed to be age 14, following Allen et al., (1995), and the mean annual water temperature was estimated from www.seatemperature.info. Even though spotted sand bass have been managed with a 356-mm minimum-length limit since 2013 (CDFWMD, 2019), the population was modeled with no length limit and an entry into the fishery of 204 mm to better demonstrate the differences between these populations in the absence of regulations. Metrics of interest were yield and SPR. Because no target SPR levels have been set for any *Paralabrax* species, a critical value of 0.20 was used for this study, as denoting a stock that is resilient to fishing following Goodyear (1993).

3 | RESULTS

In 2006, 95 spotted sand bass were collected from GZB, ranging from 159–415 mm TL and 45–863 g (Figure 2). In 2016, 84 fish were collected from this area ranging from 175–374 mm TL and 65–805 g, and 114 fish were collected from LAS, ranging from 195–363 mm TL and 95–670 g. Length frequencies were similar between areas in 2016 (KSa = 0.88; $p = .42$), but the sample from GZB in 2006 was characterized by a wider, more evenly distributed length range than either the GZB (KSa = 1.79; $p < .01$) or the LAS samples in 2016 (KSa = 2.22; $p < .01$). In 2016, fish from both areas displayed a classic allometric length-weight relation, which was highly significant (Figure 3). Slopes of each relation differed by 0.13, but this difference was not significant ($F = 2.04$; $df = 1, 194$; $p = .16$).

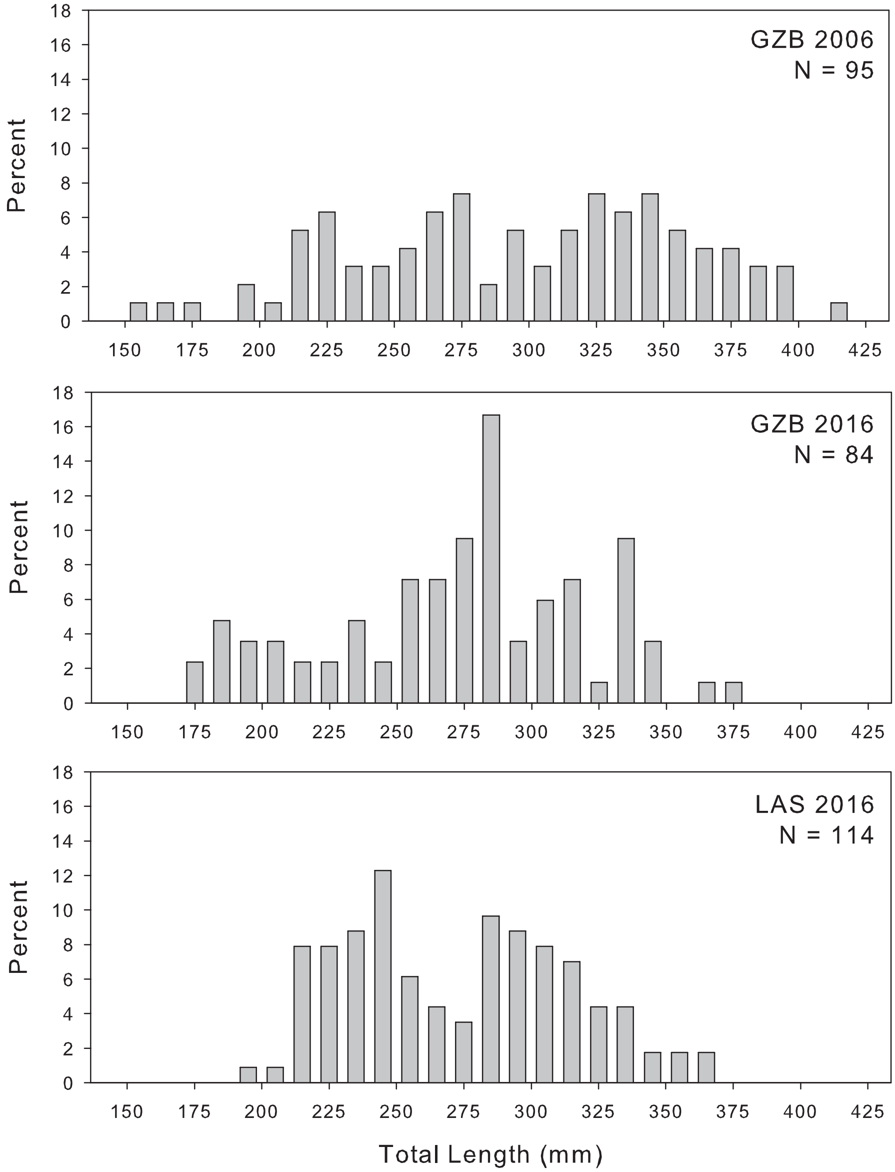

FIGURE 2 Length-frequency (10-mm bins) of spotted sand bass collected from Gonzaga Bay (GZB) and las Animas (LAS) in the northern Gulf of California in two years

FIGURE 3 Length-weight plots of spotted sand bass collected from two areas in the northern Gulf of California in 2016

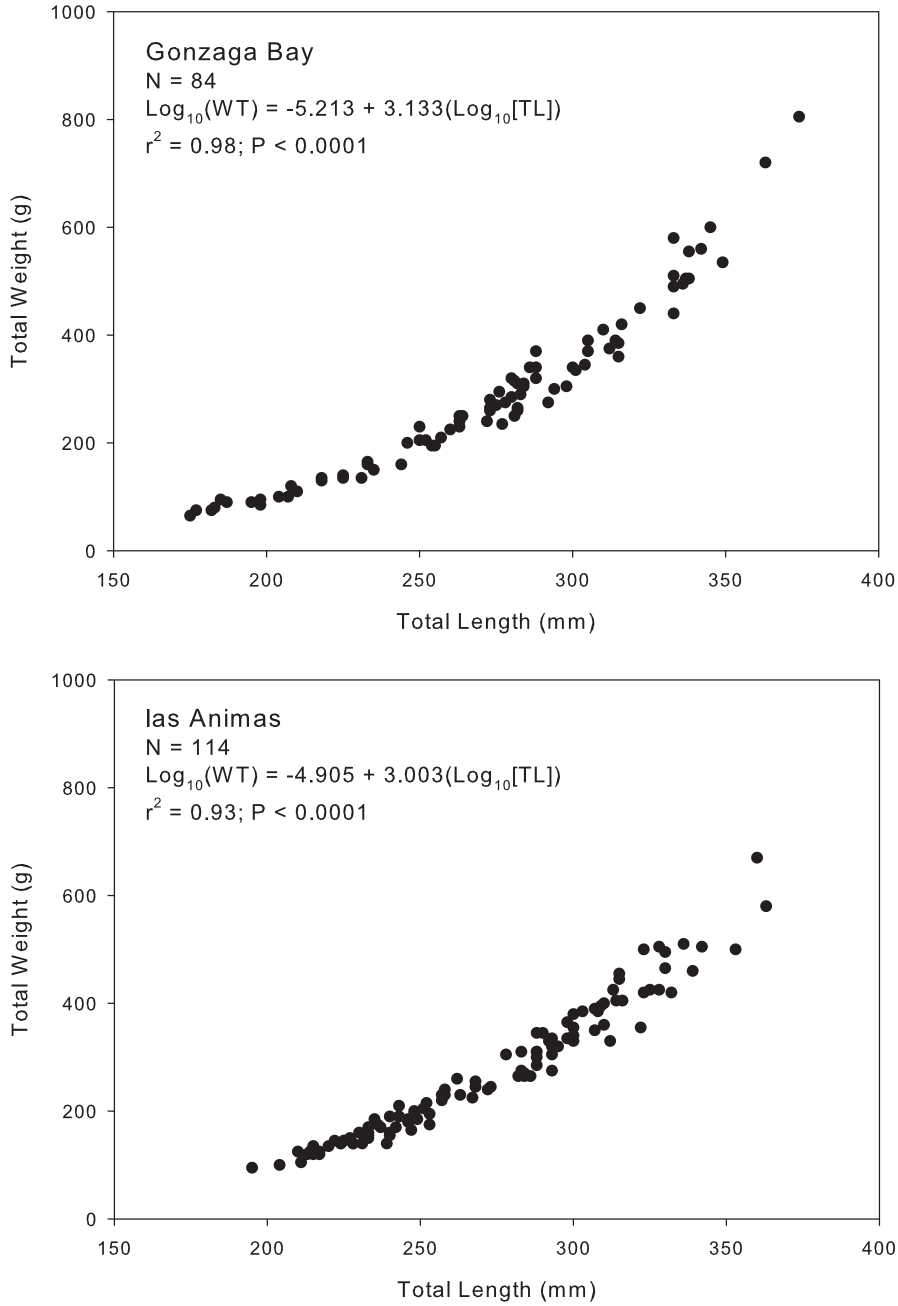

TABLE 1 Mean total length (mm) at age (± standard deviation) of spotted sand bass from Gonzaga Bay (GZB) and las Animas (LAS) in the Gulf of California, Mexico, in 2006 and 2016. Sample size for each mean is in parentheses

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8
GZB 06	183 ± 21 (6)	242 ± 27 (22)	275 ± 32 (18)	322 ± 37 (21)	337 ± 17 (9)	349 ± 31 (11)	371 ± 18 (6)	373 ± 60 (2)
GZB 16	205 ± 24 (19)	264 ± 25 (13)	277 ± 24 (16)	299 ± 25 (25)	319 ± 35 (10)	374 (1)	333 (1)	–
LAS 16	236 ± 18 (55)	290 ± 18 (36)	311 ± 13 (11)	333 ± 21 (11)	342 (1)	–	–	–
All 16	228 ± 23 (74)	283 ± 23 (49)	291 ± 26 (27)	309 ± 28 (36)	321 ± 34 (11)	374 (1)	333 (1)	–

Spotted sand bass ages ranged from ages 1 to 8 at GZB in 2006, 1 to 7 at GZB in 2016, and 1 to 5 at LAS in 2016 (Table 1). Otoliths were very easy to read, with bold, clear annuli, and readers rarely disagreed on ages and never varied by more than one, resulting in a low APE of 0.76. Most age groups in each sample were represented by 10 or more fish (Table 1), but lengths at age were relatively variable across each age group, with a range of 43 to 130 mm and an average of 81 mm within each age group/study area combination (Figure 4). Smaller ranges generally occurred when fewer fish were aged within each age group/study area combination. Despite small sample sizes, von Bertalanffy equations with excellent fit were successfully created for each sample (Figure 5). Estimated maximum theoretical length (TL_{inf}) ranged from 343 to 384 mm and the growth coefficient (k) ranged from 0.392 to 0.755. Growth of spotted sand bass in GZB was faster in 2006 than in 2016 (Figure 4), with fish predicted to reach 348 mm TL by age 6 in 2006 compared to only 333 mm TL in 2016. In 2016, spotted sand bass growth was similar between GZB and LAS from age 1–6, but fish were consistently larger at each age class at LAS (Table 1), as was the adjusted mean (Figure 4), indicating that growth of fish up to age 1 was faster at LAS than it was at GZB.

Parameters used in the FAMS models are presented in Table 2. Because fish in the northern GOC grew faster and reached smaller maximum sizes than the ones in the Pacific Ocean, the FAMS natural mortality estimators predicted that cm was 15%–63% higher in the GOC population compared to the Pacific Ocean population. Thus, FAMS models were run at cm's of 0.30, 0.40, and 0.50 for the GOC population and at cm's of 0.15, 0.20, and 0.25 for the Pacific Ocean population. At the lowest level of cm, the model predicted that maximum yield for the GOC population would be achieved at an exploitation rate of around 0.50 (Figure 6). Yield declined at higher exploitations, indicating the potential for occurrence of growth overfishing (i.e., harvested fish are smaller than the size that would optimize yield). At the mean cm level, yield was maximized at an exploitation rate of about 0.60, with little evidence of growth overfishing across the exploitation rates examined (Figure 6). At the highest cm rate, yield continued to increase with exploitation with no evidence of growth overfishing. Maximum yield achieved for the fishery declined about 30% with each jump in cm (Figure 6). The

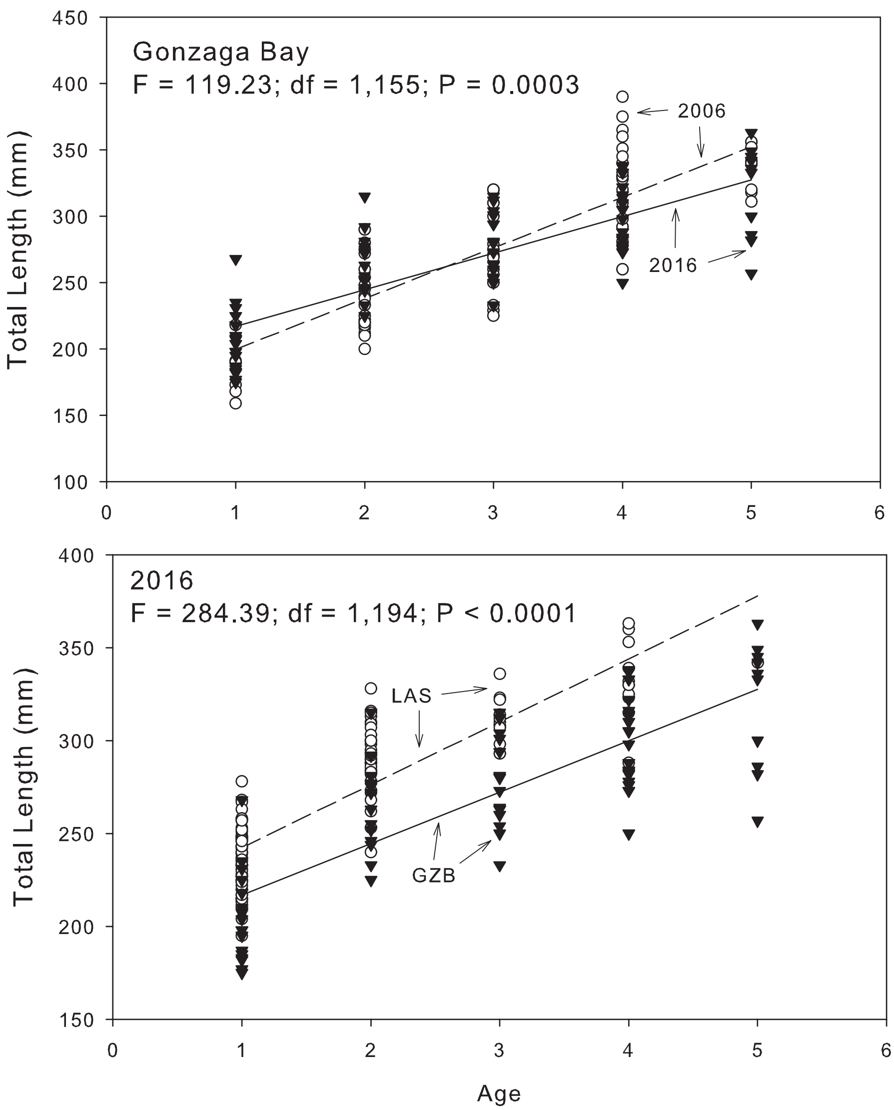

FIGURE 4 Length-age plots of spotted sand bass collected from two areas of the northern Gulf of California in two years. Top panel depicts growth differences between years in Gonzaga Bay (GZB), bottom panel depicts growth differences between fish at GZB and las Animas (LAS) in 2016. In the bottom panel the slopes were similar, but the adjusted mean length was higher at LAS

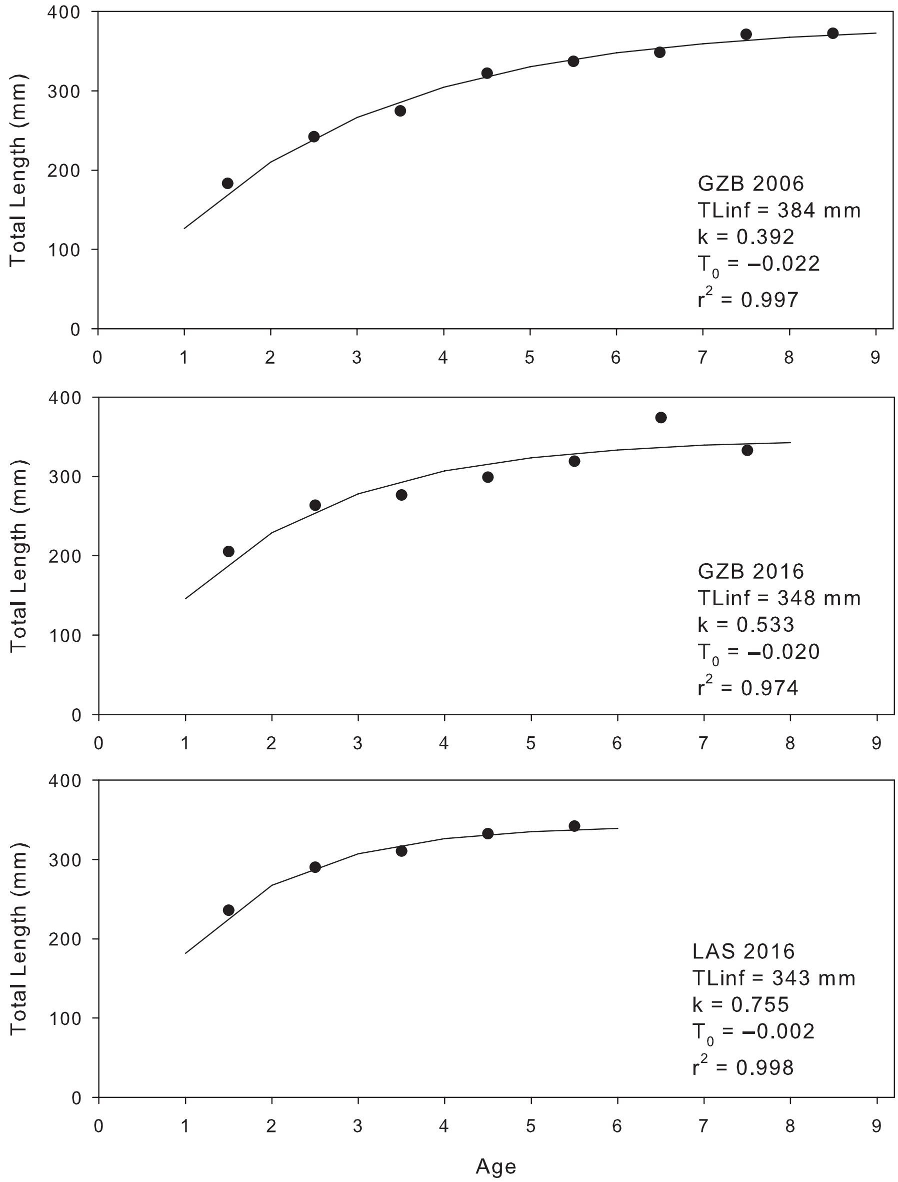

FIGURE 5 Observed (points) and predicted (line) lengths at age of spotted sand bass collected from Gonzaga Bay (GZB) and las Animas (LAS) in the northern Gulf of California in two years. Coefficients and r^2 of the von Bertalanffy model are presented in each panel

SPRs remained relatively high across most exploitation rates and cm levels examined. At the lowest cm level, SPR declined below 0.20 once exploitation rate reached 0.57 (Figure 6). At the mean cm level, SPR reached the 0.20 level once exploitation rate reached 0.67,but never reached the 0.20 level at the highest cm rate across the range of exploitation rates examined.

Spotted sand bass in the Pacific Ocean population followed a similar pattern as described above but appeared less resilient to fishing. At the lowest cm rate, maximum yield was achieved at an exploitation rate of 0.30, and yield declined at higher exploitation rates, indicating the potential for growth overfishing (Figure 6). At the mean cm rate maximum yield was achieved at an exploitation rate of 0.65 and did not decline afterwards, indicating no potential for growth overfishing. At the highest cm rate, yield continued to increase with exploitation across the entire range of exploitation rates examined (Figure 6). Maximum yield declined 27% between the low and mean cm level, and 20% between the mean and highest cm level. However, lower natural mortality rates allowed higher yields to be achieved in the Pacific Ocean population compared to the GOC population, with maximum yields of 21, 26, and 44% higher at the lowest, mean, and highest cm levels, respectively. At the lowest cm level, SPR declined below 0.20 at exploitation rates higher than 0.34 (Figure 6). At the mean and highest cm levels, SPR declined below 0.20 once exploitation exceeded 0.47 and 0.62, respectively.

4 | DISCUSSION

Spotted sand bass otoliths were extremely easy to read, with whole-view reads congruent with sectional reads up to age 5. Like findings by Andrews et al., (2005), this resulted in almost no reader disagreement and a correspondingly low APE. Thus, like many other fishes (Maceina et al., 2007), otoliths should be considered a highly efficient aging structure for spotted sand bass. Despite the ease and precision of aging, high individual variation in TL was observed within each age group at all sample areas and years. This was also noted by

TABLE 2 Parameters used for simulation modeling in the FAMS program

Category	Parameter	Estimates Gulf	Estimates Pacific
Weight-length	a (intercept)	−5.073	−5.073
	b (slope)	3.073	3.073
Growth	TL_{inf} (predicted maximum TL)	341 mm	382 mm
	K (growth constant)	0.673	0.152
	t_0 (theoretical time TL = 0)	−0.011	−4.074
cm	Chen and Watanabe (1989)	0.32	0.18
	Cubillos (1999)	0.43	0.24
	Djabali (1993)	0.33	0.23
	Hoenig (1983)	0.30	0.26
	Jensen (1996)	0.39	0.20
	Lorenzen (1996)	0.37	0.38
	Pauly (1980)	0.52	0.32
	Quinn and Deriso (1999)	0.32	0.28
	MEAN	0.37	0.26
	Mean annual water temperature (C)	22.5	17.0
Length regulation	Minimum Length Limit (TL)	204 mm	204 mm

Growth data for the Pacific population were calculated from Allen et al., (1995). All lengths are in total length (TL).

Andrews et al., (2005) for a spotted sand bass population at Bahia de Los Angeles, just north of the LAS study area. Individual variation in growth can occur for a variety of reasons, including a protracted spawning season, variation in forage supply or diet, and genetic constraints (Diana, 1995). Regardless of mechanisms behind the observed individual variation in growth of spotted sand bass, such variation can be problematic for fisheries managers conducting stock assessments, as tools such as age-length keys and variables such as mean length at age may have less utility in fishes with more complicated growth patterns (Coggins et al., 2013; Westrheim & Ricker, 1978).

Although growth of spotted sand bass demonstrated high variation among individuals, it appeared to be relatively similar among areas, as noted by Andrews et al., (2005). However, growth of this species exhibited temporal growth variation in GZB during this study. Reasons behind this are beyond the scope of this study, but given the extremely rapid growth of this species, particularly at younger ages, it would be reasonable to expect them to be able to take advantage of annual shifts in prey supply, resulting in noticeable changes in growth (Michaletz, 1998). Regardless, fisheries managers should be aware that growth of spotted sand bass in the GOC may vary through time.

The largest fish collected in this study (415 mm TL) was substantially larger than any reported in previous studies and may currently represent the largest substantiated specimen of the species from the GOC (Thomson et al., 2000). However, Allen et al., (1995) collected specimens from the Pacific Ocean that were much larger and weighed more than twice the maximum weights collected in this study and by Andrews et al., (2005); thus it seems obvious that the species reaches larger sizes there than it does in the GOC. Growth of spotted sand bass was extremely rapid in both study areas, similar to what was found by Andrews et al., (2005) at Bahia de Los Angeles and much faster than what Allen et al., (1995) reported for the species in the Pacific Ocean.

Most spotted sand bass growth was achieved in the first year, followed by much reduced growth in subsequent years. Andrews et al., (2005) and Allen et al., (1995) noted a similar pattern at Bahia de Los Angeles and the Pacific Ocean, respectively. This unusual growth pattern was likely caused by the rapid sexual maturity schedule of the species, with 50% of females mature by age 1 and 100% mature by age 2 (Allen et al., 1995). This growth pattern led to some issues with deriving von Bertalanffy models, often resulting in extremely high absolute values of t_0 (e.g.,>4.0), meaning the model often did not fit the data at younger ages (Gwinn et al., 2010). Because von Bertalanffy coefficients are all interrelated, if a bias is evident in one of them the others are also likewise biased. Forcing the model to run through 0 by adding a mean length of 0 at age 0 increased model fit increased the value of k that more accurately reflected the rapid early growth of this species. In the future, managers may want to explore alternative growth models to better model spotted sand bass growth for formal fishery assessments (Katsanevakis & Maravelias, 2008).

The age range of spotted sand bass found in this study was less than those found by Andrews et al., (2005) in Bahia de Los Angeles, especially in the LAS sample, where the oldest fish was age 5. The sample size in the Andrews et al. (2005) study was much larger than the one in this study, and larger, older fish are more commonly found at sample size increases, due to their relative scarcity (Hoenig, 2017). However, Andrews et al., (2005) only found 5 fish (0.9%) older than the oldest fish found in the current study. Allen et al., (1995) also noted a sharp truncation of older age classes of spotted sand bass in the Pacific Ocean off California. Whereas the sudden loss of older fish in the Pacific Ocean population could be due to legal harvest over the 356-mm length limit, the low exploitation likely experienced by GOC populations suggest that the sharp decline in abundance of older fish may be a natural phenomenon rather than one caused by harvest of larger, older individuals.

Estimated natural mortality of spotted sand bass was noticeably higher in the GOC compared to those in the Pacific Ocean. Fish that grow faster, reach smaller ultimate body sizes, and have lower longevity generally have higher natural mortality rates; whereas, those that have lower natural mortality rates show the opposite trends (Slipke & Maceina, 2014). Allen et al., (1995) estimated an annual mortality rate of 20% for spotted sand bass in the Pacific Ocean, approximately equal to or lower than the natural mortality rates estimated for that population in this study. With a maximum age of 12–14 in these populations, natural mortality is unlikely to be

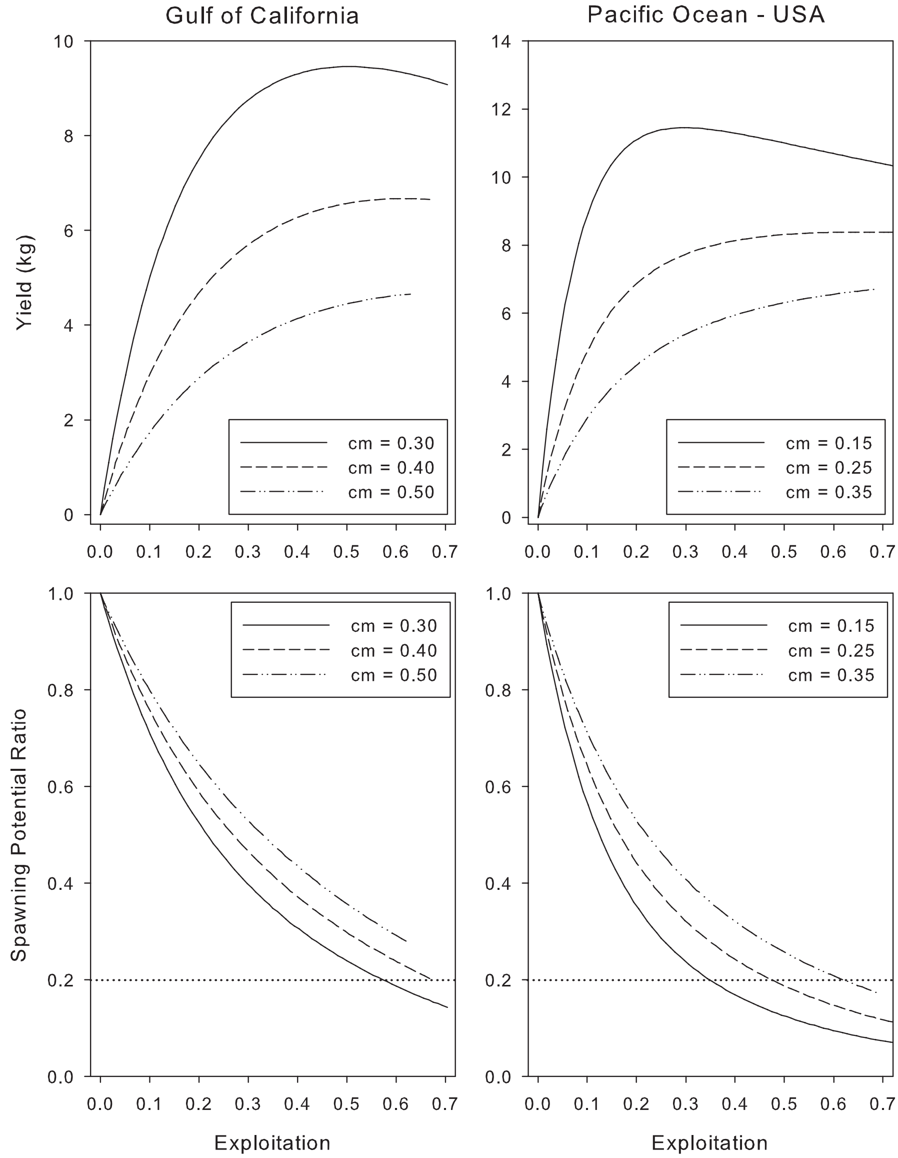

FIGURE 6 Results from age-structured modeling for spotted sand bass in the northern Gulf of California and the Pacific coast of southern California over three rates of conditional natural mortality (cm). Specific inputs for the model can be found in Table 2. Dotted line on bottom panels denote the proposed critical level for spawning potential ratio of 0.20

less than 20% (Hoenig, 1983); thus, total annual mortality is likely in the 30%–35% range, similar to what was reported by CDFWMD (2019). However, the age structure observed in this study and others strongly suggests that natural mortality sharply increases later in life, so a steady rate across the lifespan of this fish is unlikely.

Yield models predicted that spotted sand bass in the GOC are less vulnerable to fishing than those in the Pacific Ocean, likely due to their faster growth and higher natural mortality, both of which increase resiliency to angling (Allen & Miranda, 1995; Slipke & Maceina, 2014). Growth overfishing was only predicted to occur at the lowest cm rate scenario and high exploitation (i.e.,> 0.50). Likewise, SPR only fell below the 0.20 level under a similar scenario of low cm and high exploitation. At higher levels of cm, SPR never reached the 0.20 level across the range of exploitation examined. In contrast, SPR declined below that level in the Pacific Ocean population at each cm scenario, but at progressively higher levels of exploitation. However, if cm was close to the lowest levels examined, the Pacific Ocean population of spotted sand bass could be at risk of growth and recruitment overfishing at reasonable exploitation ranges (i.e., 0.25–0.40). The Pacific Ocean population of spotted sand bass has been protected by a 356-mm minimum-length limit since 2013, which has eliminated much of the harvest of this species (CDFWMD, 2019). Modeling results in this study suggested that this action was well-founded, given the vulnerability of this population and the much higher angler effort in the fishery compared to the one in the GOC. No commercial fishing is allowed for this species in the Pacific Ocean off the coast of California, but recreational angling has been implicated in the collapse of two congeners in that area (Erisman et al., 2011). Given that spotted sand bass consistently ranked in the top five of recreational catch off California from 2005 to 2012 (CDFWMD, 2019), without the length restriction this population would likewise be at risk of collapse.

Unlike the Pacific Ocean population off California, the GOC population of spotted sand bass is not protected by a length limit and is open for commercial fishing. However, use of this species by commercial fishers has been low, as anglers have instead focused their attention on larger, more economically valuable species (Erisman et al., 2010; Rodríguez-Quiroz et al., 2010). There is increasing evidence that many of these traditional fisheries are being over-exploited and are in danger of collapse (Erisman et al., 2010; Sala et al., 2004). Many of these fishes exhibit large spawning aggregations, which can increase their vulnerability to anglers, especially as technology advances and new, more efficient fish-finding tools are developed (Díaz-Uribe et al., 2007; Erisman et al., 2017).

As larger, long-lived fishes continue to decline in the GOC, commercial fishers must continue to search for new target species to maintain profitability (Rodríguez-Quiroz et al., 2010). Artisanal fisheries are important components of commercial fisheries and are rapidly expanding (Díaz-Uribe et al., 2007). Results of this study suggest that spotted sand bass may be an ideal target for artisanal fisheries along the northern GOC coastline. They appear to have an advantageous combination of fast growth, high natural mortality, and early age at maturation that render them especially resilient to fishing, especially compared to their Pacific Ocean counterparts. Obviously a more detailed stock assessment should be conducted for spotted sand bass in the GOC prior to encouraging the creation of such a fishery. However, results presented herein strongly suggest that spotted sand bass could support a vibrant commercial fishery in the GOC that might alleviate some of the conservation and management issues currently facing biologists in this unique marine system.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interest in relation to the work detailed in this manuscript.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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