Part III

SCIENTIFIC CONTRIBUTIONS

LONG-TERM TRENDS OF SOUTHERN CALIFORNIA'S KELP AND BARRED SAND BASS POPULATIONS: A FISHERY-INDEPENDENT ASSESSMENT

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ABSTRACT

Power plant entrapment monitoring data provided insights on conditions leading up to and contributing to previously documented collapses of the southern California kelp bass (*Paralabrax clathratus*) and barred sand bass (*P. nebulifer*) fisheries. Individuals from all size classes from both species were taken over time at three sites spanning nearly 100 km along the southern California coast. Size class abundance peaked in the 200 to 250 mm SL size classes, or near the minimum size limit for the two southern California fisheries (250 mm SL). Annual modal lengths remained relatively static in *P. clathratus*, but significantly declined in *P. nebulifer* with a strong downsizing after 1993. Abundance indices for each species significantly declined over nearly four decades of monitoring: 97% in *P. clathratus* and 86% in *P. nebulifer*. Evidence suggests sporadic larval settlement by each species led to occasionally abundant year classes, such as 1982 (*P. clathratus*) and 1994 (*P. nebulifer*), interspersed with several consecutive years of comparably minimal settlement. No significant correlations with common climate indices including the Multivariate ENSO Index, Pacific Decadal Oscillation, and North Pacific Gyre Oscillation were detected for either species' year-class abundance index. The *P. nebulifer* year-class abundance index did significantly correlate, albeit weakly, with annual mean sea surface temperature. These results signify that, at this time, no environmental proxy for either species larval settlement exists.

INTRODUCTION

Marine fish population dynamics are both variable and complicated as the suite of harvest pressures, management responses (Worm et al. 2009), and stress from sources other than harvesting (pollution, habitat loss/alteration, environmental change, etc.) grows increasingly complex and intertwined. Furthermore, growing evidence indicates fishing decreases resiliency to environmental change, especially for rigorously targeted species (Anderson et al. 2008; Hsieh et al. 2010). Long thought benign, mounting evidence indicates recreational fisheries are capable of exerting pressures on scales equivalent to commercial fisheries (Schroeder and Love 2002; Coleman et al. 2004; Cooke and Cowx 2004; Post 2012) including some southern California examples (Schroeder and Love 2002; Coleman et al. 2004; Erisman et al. 2011). Unfortunately, little effort has been applied to understanding recreationally fished species' response to environmental change in comparison to commercially important species, regardless of their overfished status, social importance, or economic importance.

The kelp bass (*Paralabrax clathratus*) and barred sand bass (*P. nebulifer*) fisheries represent two cases of recreationally depleted fisheries (Hill and Schneider 1999; Erisman et al. 2011). Both species, individually or combined, were the subject of numerous papers as they represent the most important summertime marine recreational fisheries in southern California for the last three decades (Love et al. 1996; Allen and Hovey 2001a,b; Dotson and Charter 2003; Jarvis et al. 2010; Mason and Lowe 2010; Erisman et al. 2011). Between 1959 and 2012, regulations for both fisheries included a 305 mm (total length) minimum size limit that targeted mature individuals (Love et al. 1996), and a ten-fish total bag limit (Bedford and Ryan 2002; California Fish and Game Commission 2012). Despite their importance to local fisheries, little information exists on their population dynamics including larval settlement, fishery recruitment, and general population trends. Genetic analyses suggested kelp bass year-class strength was influenced by dominant local current strength rather than commonly used climate indices (Selkoe et al. 2006; Selkoe et al. 2007). Beyond this, little information exists on kelp bass population interannual abundance variability while nothing similar has been completed for barred sand bass. This leaves the two bass species in a precarious position. Lacking understanding of factors regulating population abundance hinders adaptive fishery management, ultimately complicating the evaluation of the efficacy of newly enacted fishing regulations.

Building upon the well-documented trends in the fisheries catch records, this analysis focused on temporal trends in abundance, size structure, and larval settlement of kelp bass and barred sand bass in southern California. We derived these trends using fishery-independent data sets that recorded the abundance and size of fish

entrapped in the intake systems of coastal power plants as described by Miller and McGowan 2013. These analyses attempted to identify presently available information that can be used to describe factors underlying the recent decline and provide insight on the future status of the fisheries. This concept was ultimately tested by examining the relationship between indices derived from power plant monitoring and fishery landings.

MATERIALS AND METHODS

Data Sources

Fishery landings data consisted of total catch reported by the commercial passenger fishing vessel fleet in southern California. Daily catch reports submitted to the California Department of Fish and Wildlife included, at a minimum, catch by species, number of anglers, and primary location targeted using a grid of 10-minute latitude × 10-minute longitude numbered blocks designated by the Department. An annual catch per unit effort (CPUE) representing the catch/angler was derived from these data for each species, 1980–2010. Data used in our analyses do not include fishes caught and released or landings from private vessels.

Fishery-independent abundance indices were taken from coastal power plant cooling water intake monitoring (1972–2010) as described by Miller et al. 2011 and hereafter referred to as entrapment data. Fish lengths (mm SL) were recorded during most years (1979–2010). All fishes were exposed to lethal temperatures during routine "heat treatment" procedures conducted at three coastal power plants in southern California ranging from San Clemente to El Segundo, California. Additional surveys, termed a "fish chase," unique to the San Onofre Nuclear Generating Station (SONGS) Units Two and Three were conducted before each heat treatment since 1989. Both heat treatments and fish chases were scheduled at a frequency of every 6–12 weeks, on average. Power plant-specific cooling water intake conduits extended 500–900 m offshore to a vertical intake riser situated along the 8–15 m isobaths and rising 4 m above the seafloor. The conduits terminated inland at a large basin or forebay where water velocities slowed before passing through 1 cm square mesh traveling screens. In the forebay, fishes took up residence until the next heat treatment. During heat treatments, all fishes were exposed to temperatures exceeding 38°C and were subsequently impinged on the traveling screens and conveyed out of the forebay to a collection basket. All fishes were counted and measured after each heat treatment. Fish chase surveys included estimating the abundance by species while the fishes were raised and held in a steel tray. The steel tray was emptied into a dedicated return conduit once the estimate was complete. All data were standardized to the volume of cooling water circulated since the last heat treatment (described below). Data from each fish chase and the following heat treatment were combined before standardization to cooling water flow volumes. This sampling program provided abundance indices comparable to traditional offshore net sampling programs (Miller et al. 2011).

A total of 1107 surveys across all three sites were completed. The total sample size included 297 events at El Segundo Generating Station (ESGS, 1972–2010), 213 events at Huntington Beach Generating Station (HBGS, 1972–98; 2001–10), and 597 events at San Onofre Nuclear Generating Station (SONGS, 1972–74; 1976–79; 1981–2010). Cooling water circulated between heat treatments averaged 1.84×10^8 ($\pm$ 3.69×10^7, standard error) m^3, or 5.52×10^7 ($\pm$ 3.21×10^6) at ESGS to 2.94×10^8 ($\pm$ 6.82×10^7) at SONGS.

Data Analysis

Lengths recorded during heat treatments were compiled into 25 mm bins by rounding each SL up to the next 25 mm increment. This avoided the creation of a 0 mm SL size class. The annual modal length for each species was examined for changes in the size structure of individuals recorded during entrapment surveys. An abundance index (entrapment rate or ER) was computed by standardizing survey-specific abundance to the total volume of seawater (count/10^6 m^3) circulated since the last heat treatment (survey). This accounted for operational seawater demand differences between the sites and between years at each site. The annual means across all sites and surveys were derived from these data. Significance (meaningfulness) of the abundance and modal length trends was determined using the Microsoft Excel add-in developed by Bryhn and Dimberg 2011. After deriving the five-year running mean for each species, the maximum and minimal periods in each abundance index were compared. The five-year mean was used rather than individual years to avoid comparing maximum and minimum values in each time series that may result from an anomalously abundant (depauperate) year and thereby overestimate (underestimate) the change in abundance. Each five-year period was also ranked in descending order.

Cross-correlation analysis was used to determine at what temporal lag (years) the ER and CPUE trends were most similar. The lag with the lowest p-value was chosen in each case. After adjusting the two series in relation to each other per the cross-correlation results, a Spearman rank correlation was used to quantify the similarity between the two temporally adjusted series. An entrapment rate estimating next year's fishery (NYFI) was derived using the abundance of individuals in the 200 to 250 mm SL size classes, assuming these indi-

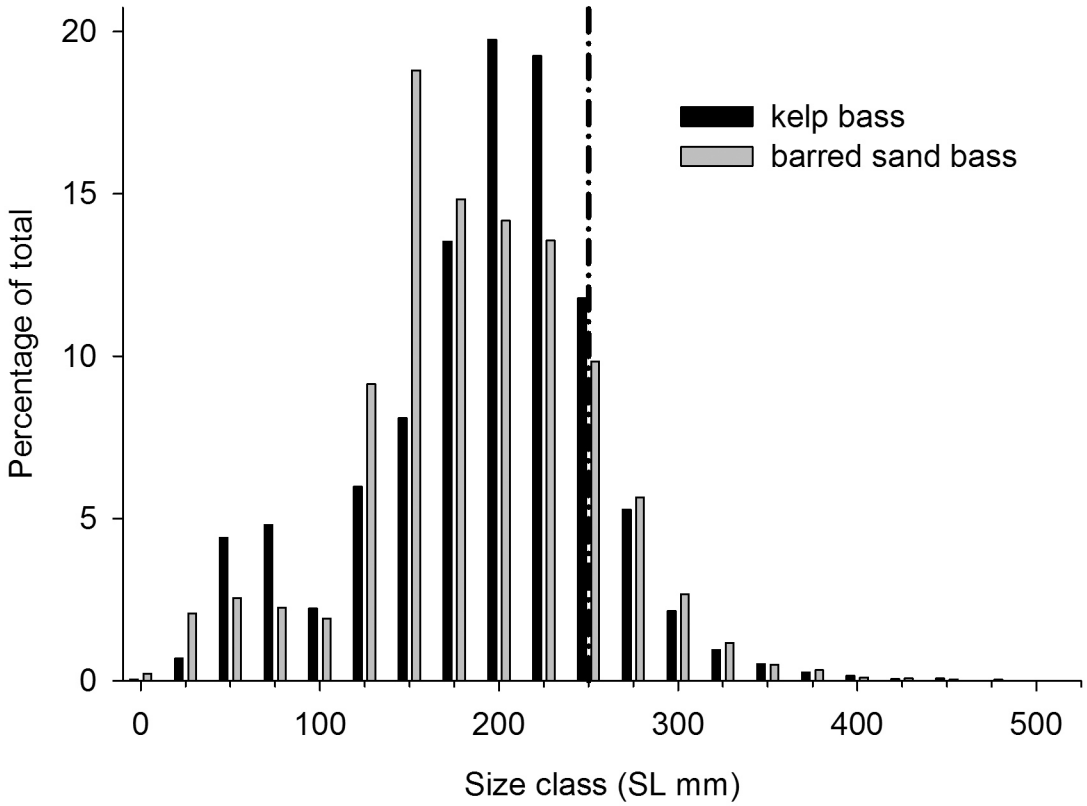

Figure 1. Length frequency distribution (percent of total sample) for kelp bass (n = 17,033) and barred sand bass (n = 13,371) measured during power plant entrapment monitoring, 1979–2010. The dashed lines represent the fisheries' minimum size limit.

viduals were one-year's growth from recruiting to the fishery. The long-term trend was also tested for significance consistent with the methods described for the ER. The NYFI's relationship to the corresponding species' CPUE was derived using the same methods described for the ER.

Assuming individuals measuring <150 mm SL were young-of-the-year (Love et al. 1996), an abundance index (YOYI) was generated from lengths recorded during power plant surveys. This index served as a proxy for year-class abundance. The number of individuals, by species, was standardized consistent with the entrapment rate (ER) described above. This YOYI (count/10^8 m^3) was used in all later analyses after assigning values to the appropriate year-classes based on known spawning seasons for each species. Results of surveys conducted in July–December were assigned to the year of capture while those taken in January–June were assigned to the year preceding the year of capture. The YOYI's relationship to the corresponding species' CPUE using the same methods described for the ER.

Oceanographic data included observed daily sea surface temperature (SST) recorded at the Scripps Institution of Oceanography Pier in La Jolla, California (Scripps Institution of Oceanography 2012). Climate indices included: North Pacific Gyre Oscillation (NPGO) (Di Lorenzo et al. 2008), Pacific Decadal Oscillation (PDO) (Mantua et al. 1997), and the Multivariate ENSO Index (MEI) (Wolter and Timlin 1998). Spearman rank correlation was used to compare the YOYI to each environmental index using after testing for autocorrelation using a Durbin-Watson test. Spearman rank correlation results were adjusted using the modified Chelton method (Pyper and Peterman 1998) when temporal autocorrelation was detected. All statistic analyses, with the exceptions of trend significance testing, were completed in R using Rcmdr (Fox 2005).

RESULTS

Kelp Bass

Entrapment surveys recorded 38,875 kelp bass during the 39 years examined in sizes ranging from 21–505 mm SL. Approximately 40% of all kelp bass were represented in the 200 and 225 mm SL size classes, or near the minimum fishery size limit of 250 mm SL (fig. 1). Between 1979 and 2010, the kelp bass modal length oscillated between 322 mm SL in 2001 and 126 mm SL in 2002 and 2005 (fig. 2a). Most years, however, the modal length was between 200 and 250 mm SL with no significant

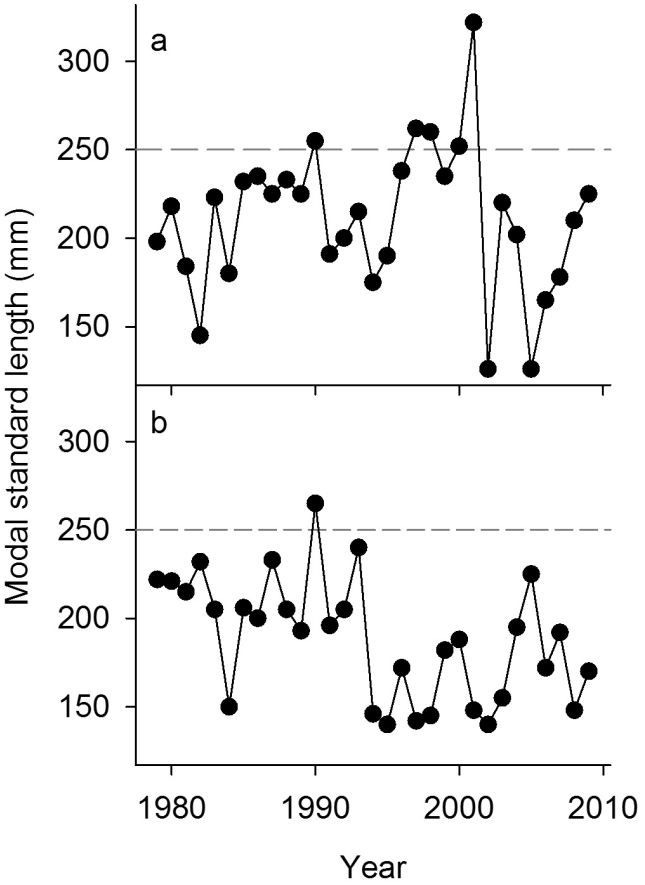

Figure 2. Annual modal length for a) kelp bass and b) barred sand bass measured during power plant entrapment monitoring, 1979–2010. The dashed lines represent the fisheries' minimum size limit.

trend ($r^2 < 0.01$, $p < 0.91$). The annual mean ER oscillated between 0.39–4.11 fish/10^6 m^3 from 1972 and 1983. The most abundant period occurred from 1979–83, with an average of 2.93 fish/10^6 m^3 before declining 97% to the series minimum during the 1998–2002 period at 0.09 /10^6 m^3 ($r^2 = 0.39$, $p < 0.001$; fig. 3a). All years after the 1987–91 period ranked >10th (out of 35 five-year running mean periods), and all years during the last decade ranked >24th. The kelp bass ER was significantly correlated with the CPUE ($r = 0.65$, $p < 0.001$) after lagging the data seven years (table 1). During a nearly commensurate time, the annual mean NYFI significantly declined ($r^2 = 0.45$, $p < 0.001$) from its peak in 1979 of 1.8 /10^6 m^3 to a low of 0.0 /10^6 m^3 in 2002 (fig. 3b). Between 1979 and 1999, the annual mean NYFI was <0.2 nine times, but only the 2000 mean NYFI exceeded this mark during the last 11 years examined. Overall, the NYFI was significantly correlated with the CPUE one year later ($r = 0.77$, $p < 0.001$).

The kelp bass YOYI trend declined, but in a statistically insignificant ($r^2 = 0.22$, $p = 0.07$) pattern (fig. 4). Larval settlement between 1998 and 2003 was especially poor

TABLE 1
Spearman rank correlation results after lagging data as indicated by cross-correlation analysis comparing the fishery catch per unit effort and each fishery-independent abundance index. Indices include the entrapment rate (ER), next year's fishery (NYFI), and the young-of-the-year (YOYI). NS denotes not significant.

	kelp bass			barred sand bass		
Index	Lag	*r*	*p*	Lag	*r*	*p*
ER	7	0.65	< 0.001	7	0.51	0.01
NYFI	1	0.77	< 0.01	1	NS	NS
YOYI	8	0.49	0.02	7	0.71	<0.001

with each year's YOYI < 100/10^8 m^3. The YOYI peaked during the 1979–83 period at 4341/10^8 m^3, whereas the lowest values occurred during the 1998–2003 period at 160/10^8 m^3. None of the oceanographic indices (PDO, NPGO, and MEI) correlated with the YOYI (table 2). Exclusion of the 1983 YOYI value, which was 4.0 standard deviations above the mean, did not improve the relationships. Like the ER and NYFI, the YOYI was also significantly correlated with the CPUE ($r = 0.49$, $p < 0.02$) at a lag of eight years (table 1).

Barred Sand Bass

Power plant monitoring recorded 33,855 barred sand bass measuring between 6 and 479 mm SL. Nineteen percent of all individuals were represented in the 150-mm SL size class with an additional 43% distributed amongst the 175, 200, and 225 mm SL size classes, combined (fig. 1). Modal lengths during the 1979–93 period averaged 212 mm SL before declining to a bulk mean of 166 mm SL through 2010 (fig. 2b). This trend was a significantly negative trajectory ($r^2 = 0.25$, $p < 0.01$). Entrapment rates peaked during the 1979–83 period at 1.43/10^6 m^3 and reached its lowest point in 2000–04 at 0.2/10^6 m^3, or an 86% decline (fig. 3c). Of the 35 five-year running means computed, each has ranked >10th since the 1984–88 period, including >20th every year since 1997–2001. The ER significantly correlated ($r = 0.51$, $p = 0.01$) with the CPUE after lagging the data seven years (table 1).

Since 1979, the NYFI also significantly declined ($r^2 = 0.63$, $p < 0.001$) from a peak of 0.6/10^6 m^3 in 1979 to 0.0/10^6 m^3 in 1999 and 2010 (fig. 3d). From 1979 to 1986, the annual mean NYFI was <0.2 once (1984) while every year's mean NYFI since was <0.2. If this arbitrary threshold was lowered to 0.1/10^6 m^3, then 17 of the last 21 years' mean NYFI was <0.1/10^6 m^3. Unlike the kelp bass, the barred sand bass NYFI did not significantly correlate with the CPUE (table 1).

The 1994 YOYI (13,834/10^8 m^3) was nearly four-times larger than the 1997 YOYI (3794/10^8 m^3), which ranked second (fig. 4). Year-class abundance was high-

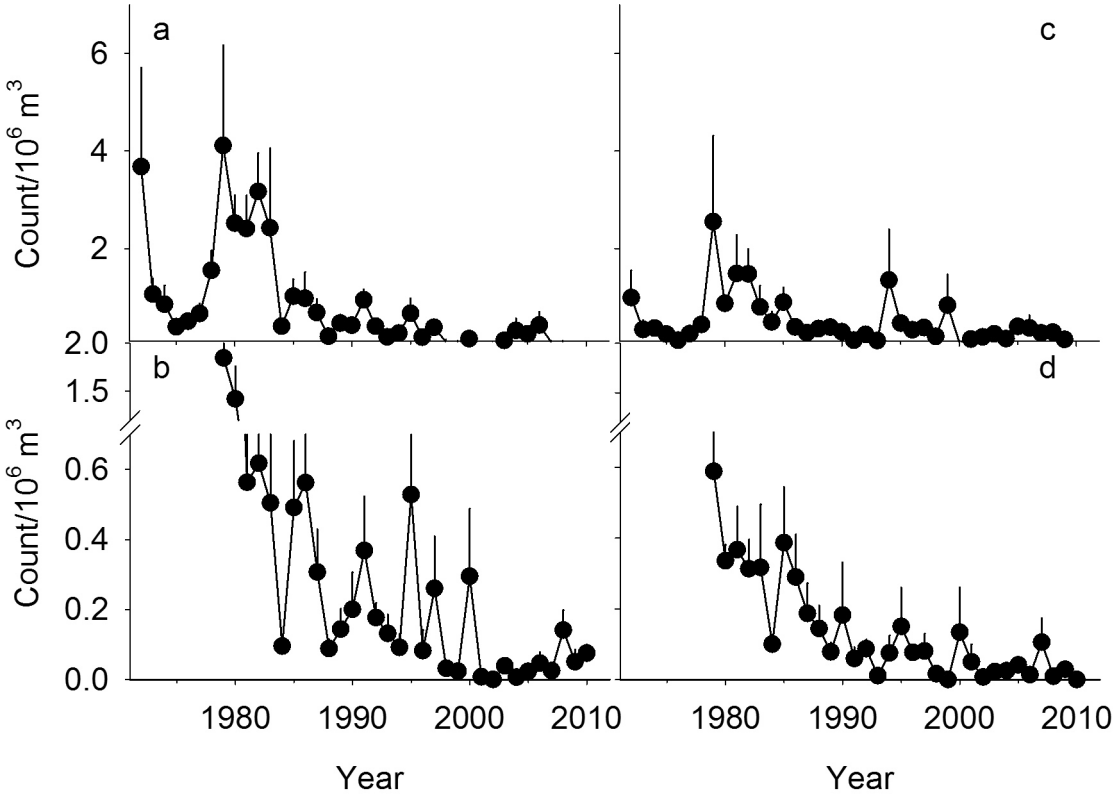

Figure 3. Mean annual entrapment rate (count/10^6 m^3) with standard error derived from power plant monitoring, 1972–2010, for a) kelp bass and c) barred sand bass. Mean annual next year's fishery index (count/10^6 m^3), 1979–2010, for b) kelp bass and d) barred sand bass.

est in the mid-1990s with three year classes measuring >3000/10^8 m^3. The YOYI trend was insignificant (r^2 = 0.01, p = 0.70) and failed to significantly correlate with the climate indices (PDO, NPGO, and MEI; table 2). It did correlate with SST (r = 0.37, p = 0.04). These results did not change after excluding 1994, which was 5.0 standard deviations above the mean. The barred sand bass YOYI was highly correlated with the CPUE (r = 0.71, p < 0.001) at a lag of seven years (table 1).

DISCUSSION

Both California sea bass populations studied here showed evidence of depletion that predated fishery declines, but what precipitated this decline? Recent information suggests the coastal southern California fish community ensemble mean abundance declined by 78% utilizing similar data sources (Miller and McGowan 2013). These declines reportedly transcended fishing pressure, although fishing was not absolved of all responsibility. The question remains, was the decline in California sea bass populations an effect of overfishing, environmental variability, or some combination of the two? Fishing was clearly implicated as a contributing factor as prior work concluded the kelp bass and barred sand bass fisheries suffered from hyperstability (Erisman et al. 2011). Hyperstability occurs when catch rates remain stable or increase while the underlying populations decline, typically by targeting aggregation sites. Hyperstability, however, does not exclude oceanographic effects undermining the populations' resiliency and stability.

TABLE 2

Durbin-Watson (DW) autocorrelation test results for each oceanographic parameter used in Spearman rank correlation tests with barred sand bass and kelp bass YOYI-indices. Spearman rank correlation results for each comparison are presented. Bold text denotes significant at the $p < 0.05$ level. Significant correlations between autocorrelation parameters were reexamined after deriving a new r_{crit} accounting for autocorrelation using the modified Chelton method (Pyper and Peterman 1998). Barred sand bass DW = 1.58, p = 0.16; kelp bass DW = 1.38, $p < 0.05$. Derived r_{crit} for kelp bass: NPGO correlation = 0.69, therefore the correlation is not significant.

			barred sand bass		kelp bass	
	DW	p	r	p	r	p
SST	1.56	0.07	**0.37**	**0.04**	0.13	0.49
MEI	1.71	0.16	0.13	0.48	0.23	0.20
NPGO	**0.60**	**<0.01**	–0.25	0.17	–0.52	<0.01
PDO	**1.40**	**0.03**	0.25	0.17	0.22	0.24

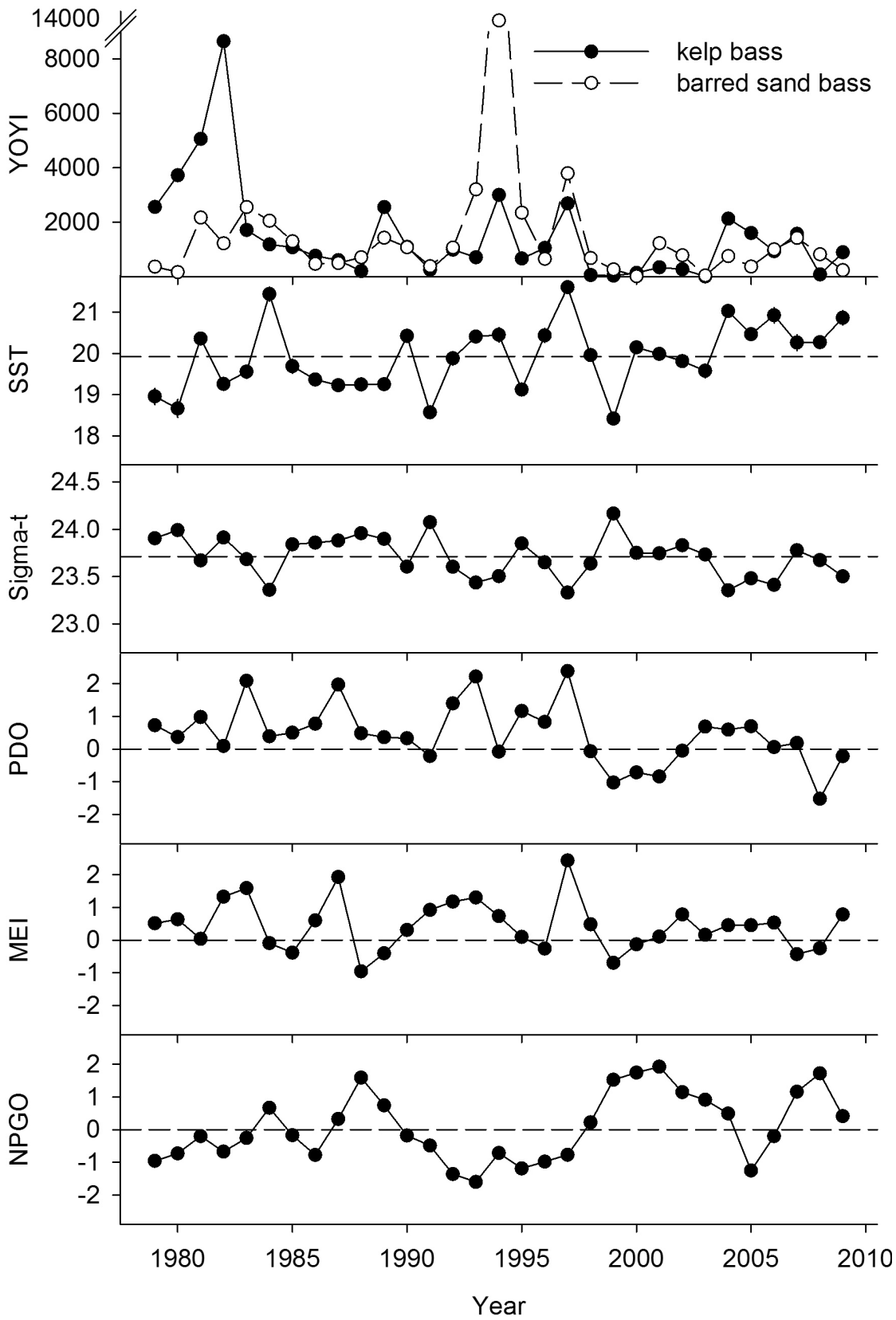

Figure 4. Annual young-of-the-year index (YOYI; count/10^8 m^3) for kelp bass and barred sand bass derived from lengths recorded during power plant monitoring, 1979–2010. Annual summer (June–September) oceanographic or climate index values, 1979–2010, including: sea surface temperature (°C; SST), seawater density (sigma-t), Pacific Decadal Oscillation (PDO), Multivariate ENSO Index (MEI), and North Pacific Gyre Oscillation (NPGO).

Aggregation fisheries and hyperstability unfortunately often go hand in hand and are rarely sustainable (Sadovy and Domeier 2005). One of the growing concerns related to overfishing is the potential impact to life history parameters especially when the capture of large individuals are preferred by anglers, such as commonly occurs in recreational fisheries (Berkeley et al. 2004; Birkeland and Dayton 2005; McClenachan 2009). Inconclusive, but highly suggestive, evidence of life history impacts were detected in barred sand bass. Kelp bass modal lengths remained relatively unchanged over time, but significant downsizing in barred sand bass was indicated. Lacking more refined data on growth and reproduction parameters, any conclusion would be speculative at this point. The trend in barred sand bass, however, warrants further investigation to discern potential evolutionary effects recent overfishing may have had on the population (Conover and Munch 2002; Heino and Godo 2002; Walsh et al. 2006; Brown et al. 2008; Enberg et al. 2009; Garcia et al. 2012). Fishing-induced evolution has slowed the rebuilding of collapsed fisheries, such as Atlantic cod (Enberg et al. 2009), which would effect future management of the California sea basses.

While evidence of declining populations and apparent changes to the size structure of the populations now exists, the underlying question remains unanswered: What precipitated the decline? A common culprit was variable year-class strength. Abundance indices of younger age classes, ranging from larvae through recruitment into the fishery, commonly received extensive study from fishery scientists as a way to predict future fishery yield (Houde 2008). For example, years with higher abundance of juvenile yellow snapper (*Lutjanus argentiventris*) and leopard grouper (*Mycteroperca rosacea*) translated into greater commercial landings once individuals recruited into their fisheries (Aburto-Oropeza et al. 2010). Fishery science was rich with descriptions of year-class abundance effects on future fishery yields. The "gadoid outburst" in North Atlantic cod (*Gadus morhua*) being among the best known examples (Cushing 1980; Beaugrand et al. 2003). Abundant North Atlantic cod year classes resulted from environmental conditions conducive to their settlement in preferred habitat (Beaugrand et al. 2003; Beaugrand and Kirby 2010a,b; Olsen et al. 2011) regardless of high harvest pressure. Once the environment changed, year-class abundance declined, fishing pressure remained constant, and the stock soon collapsed (Beaugrand et al. 2003; Beaugrand and Kirby 2010a). Parallels between the southern California sea bass trends and those reported in North Atlantic cod existed. Specifically, each supported robust fisheries until fishing outpaced larval settlement leading to a fishery collapse.

In compilation with this and prior studies (Hill and Schneider 1999; Moser et al. 2001; Erisman et al. 2011), a robust case can be made that the environment no longer promoted strong local settlement while fishing continued unabated. Miller and McGowan 2013 identified significant, negative shifts in the southern California coastal fish community culminating in 1984 and 1989, or after a substantial Californian El Niño (Simpson 1984; McGowan 1984) and a documented oceanographic regime shift lacking a thermal signature (Hare and Mantua 2001; Polovina 2005; DiLorenzo et al. 2008). Fishery-independent investigations, especially using larval settlement and subsequent fishery recruitment in the southern California sea bass species, suffer from a lack of relevant data. Ichthyoplankton data extends at variable sampling intervals and spatial resolution to 1960, but samples were identified to genus rather than species (Moser et al. 2001). In southern California, three *Paralabrax* species co-occur (kelp bass, barred sand bass, and spotted sand bass, *P. maculatofasciatus*). Beyond the general decline, the presently available ichthyoplankton data adds little clarity regarding species-specific trends. Similar to our YOYI, diver-recorded densities of kelp bass and barred sand bass young-of-the-year in King Harbor, Redondo Beach, California, declined over time (Love et al. 1996).

The novel power plant sampling program data proved informative through an analysis of pre-recruitment age-class abundances over time. Our examination signaled the fishery demise was unavoidable given the ≥86% declines in southern California sea bass populations indexed by the ER. These results were consistent with more localized studies, including substantial declines in kelp bass abundances surveyed more than 20 years apart in a no-take marine reserve (Parnell et al. 2005). Despite the resolution, the notable ichthyoplankton declines described previously were evident for the genus since 1989 (Moser et al. 2001) thus corroborating our observed declining trends in the power plant abundance indices.

The power plant-derived YOYI for both species declined in species-specific patterns during recent decades. Since 1998, neither species' YOYI reached early-1980s levels with each suffering several periods of near-zero YOYI. No clear environmental relationship could be determined in our evaluation beyond a weak correlation between barred sand bass and SST, consistent with prior work (Selkoe et al. 2006; Selkoe et al. 2007). Anecdotal opinion suggested that populations of both basses benefited (increased growth rates, increased larval settlement, etc.) from warm water periods, such as El Niño conditions in southern California (California Fish and Game Commission 2012). Our results did not support this opinion. The two largest year-to-year declines in each species' YOYI occurred in the second

year of a large El Niño (1983 and 1998) when coastal water temperatures remained above average. Furthermore, recent work signals that abundance patterns in southern California coastal fishes have responded to an oceanographic shift (1989) independent of the typical warm/cool characterizations (Miller and McGowan 2013). Similar work on the 1989 oceanographic shift indicated changes in coastal productivity, current patterns, and other temperature-independent processes (Polovina 2005; Di Lorenzo et al. 2008). The two sea bass species' population abundances over time (Hill and Schneider 1999; Moser et al. 2001) suggest differing conditions (environmental, fishing pressure, etc.) were favored by each species. Additional studies using more robust models coupling biological and physical processes may prove fruitful in identifying the suite of conditions favored by each species (Asch and Checkley Jr. 2013).

Utilizing the power plant abundance indices (ER, NYFI, and YOYI), a declining trend in larval settlement and recruitment were evident in the populations. Cross-correlation analysis indicated the ERs declined approximately seven years before the fishery, or approximately the perceived age of recruitment for both species (Love et al. 1996). The difference in each species' connection between the CPUE and fishery-independent data was indicative of varying levels of hyperstability in the fisheries, with greater effects occurring in the barred sand bass fishery. Such disconnects between population abundance and fishery landings represent an extreme form of hyperstability (Erisman et al. 2011). Therefore, the insignificant correlation between the barred sand bass CPUE and NYFI was not surprising given prior hyperstability evidence reported in the literature.

Unfortunately, these results do not clearly portion responsibility for the declines to either the environment or fishing. They simply, and repeatedly, reaffirm that the significant declines observed in the fishery was a function of depleted populations. Our analyses failed to identify a commonly measured environmental metric or index that could be used as a reasonable proxy for either bass species' year-class strength. These examinations reinforced prior conclusions; abundance of the two dominant southern California sea bass species dramatically declined in recent decades. New management strategies were implemented in hopes of restoring the stocks. Despite these actions, both the current investigation and prior studies documenting hyperstability in the two populations highlights the clear need for a detailed stock assessment. In the absence of such an assessment, adaptive management to restore and maintain healthy stocks in the face of oceanographic change may be out of reach. Given the slow growth realized in both species (Love et al. 1996), effects of the new regulations, measured as increased CPUE, will not likely materialize for a decade or more. Therefore continued fishery-independent monitoring will be critical to the evaluation of these new regulations.

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