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Planning shoreline infrastructure projects at Redondo Beach, California to avoid impacting a Giant Sea Bass nursery site

MICHAEL C. COUFFER*

Grey Owl Biological Consulting, Orange County, California

Present address: 716 Marguerite Avenue, Corona del Mar, California 92625, USA

**Corresponding Author: mikecouffer@gmail.com*

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Adult Giant Sea Bass (*Stereolepis gigas*) (GSB) are the largest bony fish inhabiting California's near-shore habitats (Love 2011). They were historically recorded at over 250 kg (551 lbs) (Domeier 2001) and have been dated to live up to 76 years of age (Hawk and Allen 2014). House et al. (2016) measured a fish by laser rangefinder at 2.75 m (9 ft) total length and estimated its weight at 381 kg (839 lbs). They range from Humboldt Bay, California to Oaxaca, Mexico, including the Gulf of California (Kells et al. 2016). After a population crash in the early 1900s, they were listed by the International Union for the Conservation of Nature (IUCN) as a Critically-Endangered species (Musick et al. 2000; Cornish 2004), and were also prohibited from intentional take in California by fishermen.

While regulatory protection of adult GSB is important, protecting their young from take is also necessary in order to manage the species throughout its entire life cycle. Until recently, almost nothing was known about the habitat preferences and behavior of the young-of-the-year (YOY) of GSB so resource regulatory agencies had little information on which to base recommendations for avoidance or minimization of take during the planning and implementation of shoreline infrastructure construction or maintenance projects. This document provides information on the occupation of GSB nursery sites and makes recommendations for avoiding or minimizing GSB take during beach sand replenishment, harbor dredging, substantial pier or jetty maintenance, or other near-shore construction and maintenance projects planned within and near GSB nursery sites.

The YOY of GSB spend just under a month as floating eggs and planktonic larvae before settling (Benseman and Allen 2018). After planktonic settlement, YOY of GSB of total lengths between 10 and 80 mm (3/8 in to 3 ¼ in) have been found to occupy habitat between 2 and 38 m (7 to 125 ft) in depth (Couffer and Benseman 2015; Couffer 2017; Benseman and Allen 2018). YOY of GSB at this size range occupy wide expanses of open sand or sandy-mud habitat away from rocks, jetties, piers, debris, and other hard structures that often hold predators large enough to eat them at this vulnerable stage (Couffer and Benseman 2015; Couffer 2017; Benseman and Allen 2018; Benseman et al. *in press*).

Benseman and Allen (2018) found that newly-settled young were most abundant over soft-bottomed habitat at depths from 2 to 18 m (6 to 60 ft) within 300 m (984 ft) of the heads of submarine canyons that began close to shore, and that density fell precipitously at distances beyond 500 m (1,640 ft) from the heads of submarine canyons. Locations found to support the YOY of GSB included Redondo Beach at the southern end of Santa Monica Bay in Los Angeles County, the shallows surrounding Newport Pier and Big Corona del Mar State Beach in the City of Newport Beach in Orange County, and La Jolla Shores in San Diego County. To date, no focused surveys for the YOY of GSB have been conducted in Mexico. No significant submarine canyons that closely approach sandy shorelines exist along the Pacific coast of the Baja California peninsula until one rounds the tip of the peninsula. The topic of nursery sites within the Mexican portion of the species' range remains unexplored. Other locations within 2 km (1.2 mi) of California's submarine canyons were surveyed to sample soft-bottomed habitat at equivalent depths that were not significantly influenced by the presence of canyons. The author assisted with this field work and coordinated trained observer and photo-verified YOY of GSB detection reports from citizen scientist divers who dived year-round and opportunistically located the YOY of GSB between 2015 and December 2019. It was rare for the YOY of GSB to be found outside of the few YOY of GSB nursery sites mentioned above. An 760 m (831 yd) stretch of habitat off Redondo Beach in Los Angeles County inshore from the Redondo Submarine Canyon was found to support the highest seasonal density of the YOY of GSB of any location known (Benseman and Allen 2018). The Redondo Beach Giant Sea Bass Nursery Site is located south of King Harbor between the Redondo Pier and Topaz Jetty (Figure 1).

Following the completion of field work for Benseman and Allen's study, the author continued focused surveys within known and possible nursery sites during all appropriate seasons to date, amassing over 320 hours of focused YOY of GSB survey bottom time. The data collected at each YOY of GSB contact included color phase, overall length, bottom time to contact, initial behavior, depth, and temperature. Specific fish locations were determined by surfacing over each YOY of GSB for a few seconds and describing an object that was directly onshore. After the dive, a GPS was used to record coordinates at the waterline below that object, and the depth of the fish recorded during the dive was used to locate the fish directly offshore from these coordinates on a 1-foot contour chart (Figure 1). Figure 1 includes the color phase, depth, and specific location of all YOY of GSB that the author has detected within the Redondo Beach Nursery Site to date.

At least one YOY of GSB was detected within a nursery site during every month of the year except April and June. November produced the highest number of detections (n = 63), followed by September (n = 45) and December (n = 40). The collated dates of 210 YOY of GSB detections showed that GSB nursery sites were primarily occupied from August to the end of December.

The California Environmental Quality Act (CEQA) provides a regulatory framework for the identification and consideration of native species' nursery sites that might be negatively impacted by construction or maintenance projects requiring state permits. The Redondo Beach Nursery Site lies outside of all protected marine habitat and is subject to potential disturbance from periodic shoreline and infrastructure maintenance projects. King Harbor requires occasional dredging to keep channels open, and periodic activities are needed to maintain Redondo's pier, jetties and harbor channels. Man-made and natural sand transport barriers and coastal processes cause sand to erode from this stretch of coastline that is not

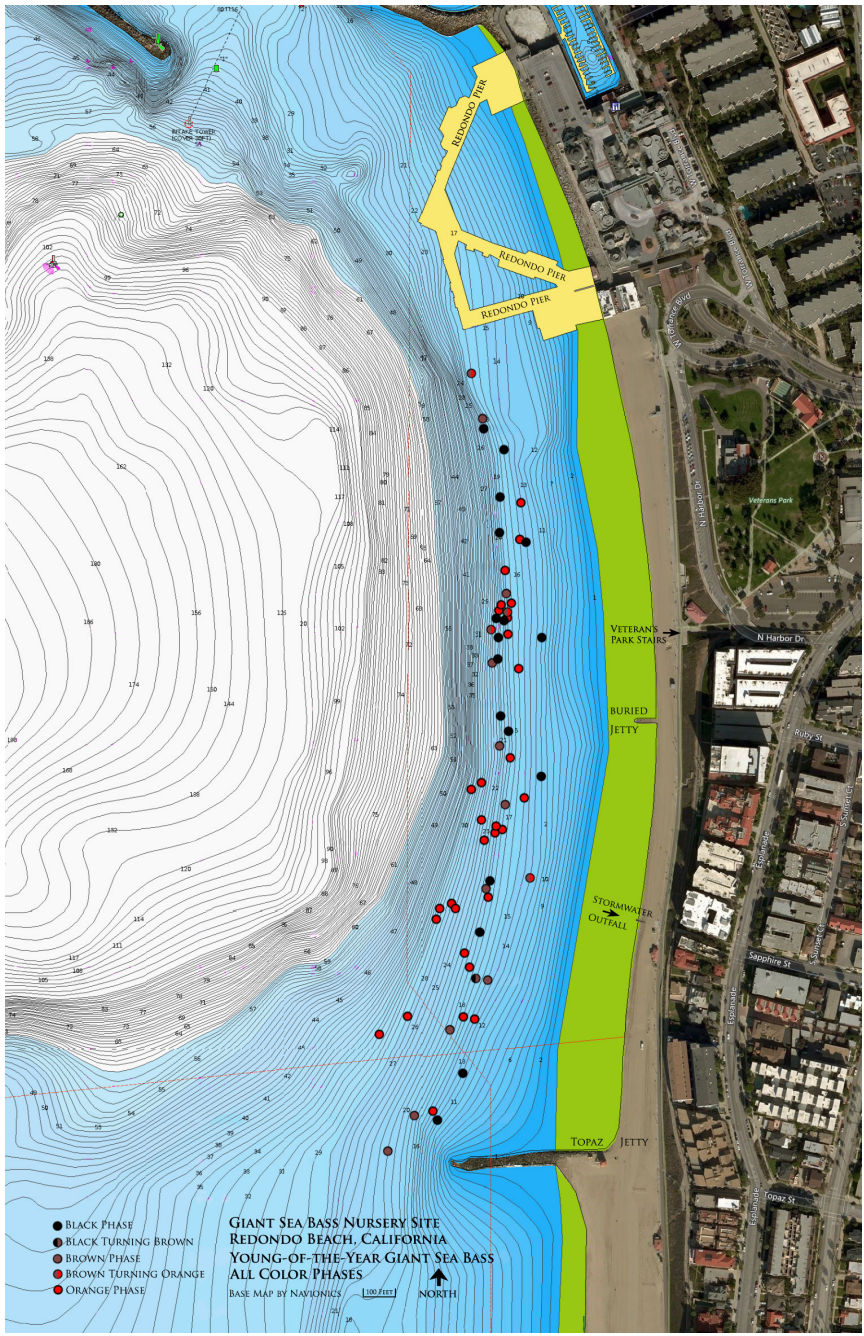

Figure 1. Young-of-the-year Giant Sea Bass detections within the Redondo Beach Nursery Site, CA, USA.

replaced by natural processes. This beach must be artificially augmented by adding sand from other sources using barges or dump trucks.

No other nursery site is subject to as many potential habitat disturbance activities as the Redondo Beach Nursery Site. The La Jolla Shores Nursery Site in San Diego County is encapsulated by the Matlahuayl State Marine Reserve where take of all living marine resources is prohibited. Big Corona del Mar State Beach in Orange County is located immediately inside the northwestern boundary of the Crystal Cove State Marine Conservation Area. The shallows surrounding Newport Pier in Orange County lie outside of all protected marine habitat, and this area is not covered by specific restrictions on fishing or shoreline infrastructure projects. Newport Pier pilings are periodically scraped free of settling organisms and pilings are occasionally replaced, but no significant shoreline infrastructure projects have been undertaken within or adjacent to these nursery sites for many years.

A year prior to Ms. Benseman's identification of GSB nursery sites, a roughly 40-day U.S. Army Corps of Engineers project barged approximately 146,304 m^3 (160,000 yd^3) of sand from Marina del Rey's harbor to Redondo Beach (G. A. Fuderer, U.S. Army Corps. of Engineers, personal communication). Beginning the week of 6 August 2012, approximately 68,580 m^3 (75,000 yd^3) of sand were pumped from the barge onto the beach shore between Topaz Jetty and Redondo Pier, which is now known to be a GSB nursery site (Figure 2). Pumping sand onto the beach is not considered to have been detrimental to recruiting GSBs within the nursery site, however, approximately 77,724 m^3 (85,000 yd^3) of sand were deposited in 9 to 15 m (30 to 50 ft) of water off Topaz Jetty where it was planned to be stored for future sand replenishment projects. Because the deposition of sand into the waters above

Figure 2. Beach sand replenishment between Topaz Jetty and Redondo Pier, CA, USA on 5 October 2012.

that nursery site coincided with YOY of GSB occupation, the timing of the replenishment project at this particular location could have had detrimental effects on recruiting GSB.

The planning and implementation phases of the 2012 Redondo Beach sand replenishment project were completed before Benseman began the first field study ever conducted of the YOY of GSB and identified the nursery sites, so the resource regulatory agencies would have been unaware of the importance of this stretch of beach for this Red-list Critically-Endangered species. It is possible that one or more of the following impacts may have resulted from depositing sediment onto the nursery site.

1) Sand dumped into 9 to 15 m (30 to 50 ft) of water on the nursery site could have displaced recently-settled YOY of GSB from their preferred habitat of algal fragments and small sand depressions where they hide from predators; unexpected displacement can expose their presence to predators. 2) Known prey species of the YOY of GSB such as mysid shrimps found within a meter of the bottom could have been buried or dispersed by falling sediment. If the horizontal and vertical distribution and/or density of mysid swarms was altered, the effectiveness of YOY of GSB feeding strategies upon them could have been reduced. 3) Project implementation fouled the sea floor with trash, and local divers organized several underwater cleanups to remove debris. The benefits of the underwater trash cleanup effort may have been offset by disturbance to the YOY of GSB occupying the nursery site by large numbers of divers working on the bottom from the surf line to recreational dive limits. 4) Large amounts of falling sediment could have fouled the gills of the YOY of GSB within the impact footprint. 5) Approximately 77,724 m^3 (85,000 yd^3) of sediment was "stored" in 9 to 15 m (30 to 50 ft) of water for future beach sand replenishment. However, large winter storm swells have altered the bottom topography to 30 m (100 ft) so any sand deposited at depths of 15 meters (30 ft) or less was probably redistributed by storms the following winter. Any attempted reacquisition of sand during the months when the nursery site supports the YOY of GSB could impact them.

The potential loss of the YOY of a Red-listed Critically Endangered fish species at the highest density nursery site for the species ever documented should be considered potentially significant. These potential impacts could have long-lasting impacts on the recruitment, population dynamics, and overall survival of GSB at this nursery site when it is most densely occupied.

After dispersal of the YOY of GSB from the nursery sites, strong winter storms can alter the topography of the nursery site bottom to a depth of at least 30 m (100 ft) before the next hatch of YOY of GSB arrives the following summer. Issues could arise if the habitat is altered when the YOY of GSB are present at the nursery sites. The Redondo Beach Nursery Site faces due west and is protected from the large south swells generated by summer storms by the Palos Verdes Peninsula which extends west to form the south-eastern rim of Santa Monica Bay. Therefore, the nursery site bottom is not significantly altered by swells for much of the period of YOY of GSB occupation.

Although the YOY of GSB have been found in California nursery sites during nearly every month of the year, these areas are very sparsely occupied for half of each year. It is recommended that beach sand replenishment and harbor dredging projects having the potential to affect nursery site bottom be implemented between 1 January and 15 July when the YOY of GSB nursery sites have been found to be the most sparsely occupied. Habitat disturbance should be avoided from 16 July through 31 December, when the majority of the YOY of GSB are arriving at and occupying the nursery sites.

Piping sand from a barge to the beach is not expected to impact the YOY of GSB; it is when a large volume of sand is deposited into the water above the nursery site that nursery site impacts could occur. Another method of sand augmentation used at Redondo Beach has been to deposit sand on the beach using dump trucks and spread the sand using rubber-tired equipment. During September of 2018, a survey for the YOY of GSB was conducted while equipment spread trucked-in sand across the beach during an incoming tide (Figure 3). Underwater survey transects to a minimum depth of 4 m (13 ft) found no visual difference in water quality between sections of the beach where sand piles were sloughing into the sea and beach sections where no sand had been deposited. No new articles of trash

Figure 3. Spreading dump truck-deposited sand at Redondo Beach with rubber-tired equipment.

were observed since the previous survey. Even during a month when the nursery site was occupied by the YOY of GSB this appears to have been a successful method for replenishing the beach with sand while having no discernible impacts on the YOY of GSB.Annual coastal cleanup events along Redondo Beach that include groups of divers have been organized for many years. Some of these events coincide with months of high density of YOY of GSB off Redondo Beach. The ability to coordinate underwater cleanups with dry beach cleanups along the entire coastline offers benefits to the habitat and to ecologically-aware members of coastal communities, and this probably outweighs the potential of disturbance to some YOY of GSB from a single day of habitat disturbance at nursery sites by groups of divers. Scuba instructors also bring classes to train and practice beach diving techniques off Redondo Beach but these classes are not believed to significantly impact the YOY of GSB. Classes typically move in groups which are closely monitored by instructors. The divers make surface swims and drop as a group, limit their movements to a relatively small area on the bottom while being watched by an instructor, and then return to shore as a group. Students do not scatter about to disturb large areas of bottom.

Both publicly and privately-funded projects require permits from federal, state, and

local governmental agencies, and often require assessments of species that are considered to have special status by resource regulatory agencies. Special status species surveys conducted for resource agencies typically follow guidelines written for the agencies by specialists who have significant experience surveying for the species. Assessments and surveys must then be conducted by qualified biologists who must follow the agency-adopted guidelines in order for their reports to be accepted by the permitting agencies. These surveys are often coupled with biological monitoring in order to assure avoidance or minimization of disturbance to special status species prior to and during construction. Effective biological monitoring of a species assumes a biologist's ability to locate individual animals within and surrounding an impact footprint in order to attempt to ascertain whether or not construction activities adversely affected those individuals. In the case of the YOY of GSB, not only would locating individuals on a daily or weekly basis be extremely difficult, but repeatedly relocating specific individuals requires close diver proximity to the fish and underwater photography of spot patterns which could increase the GSB's level of disturbance and possibly cause indirect take by a predator. Also, finding no YOY of GSB within the impact footprint would not be proof of take by the project. Rather than attempt to monitor the possible effects of construction on the YOY of GSB, a more effective approach would be to schedule construction activities that could affect the nursery site for the period between January 1 and July 15. Working during this period would either avoid impacts due to YOY of GSB absence, or if a few individuals remained it would minimize impacts by avoiding the densest seasonal presence of the YOY of GSB. Habitat disturbance within the nursery site should be avoided from July 16 to December 31 in an area extending from the shoreline to a depth of 38 m (125 ft) from the Redondo Pier to Topaz Jetty.

If it would be difficult to adjust dredging or sand deposition schedules to coincide with the season of low YOY of GSB sensitivity, changing the location of deposition of dredged material to an area that does not border a nursery site is suggested. Dredge spoils deposited into the water north of King Harbor or south of Topaz Jetty should avoid impacting the YOY of GSB.

Scheduling future Redondo Beach sand replenishment and major shoreline infrastructure projects to be implemented between January 1 and July 15 would be expected to avoid or greatly minimize impacts to the YOY of GSB at this nursery site. The large majority of the YOY of GSB are absent or at a very low density at nursery sites during this period.

It also appears that that clean sand placed on the beach by dump trucks or piped from barges and spread across the beach by rubber-tired equipment avoids or greatly minimizes impacts on GSB nursery sites at any time of year. However, no sand or sediment should be deposited into the water that could disturb the bottom at a GSB nursery site between July 16 and December 31.

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of the early development of this species and move from reporting baseline information to this practical management tool that could enhance the recovery of the species. I would like to thank Mark A. Pavelka of the U. S. Fish and Wildlife Service (ret.), Amber S. Oneal-Heredia, Chris Lowe of California State University at Long Beach, Sharon Kramer of H. T. Harvey and Associates, and Richard Ware of Coastal Resources Management for providing valuable editorial suggestions on manuscript drafts.

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