

AMERICAN SHAD SOUTHWARD MOVEMENT TO BAJA CALIFORNIA, MÉXICO: EVIDENCE OF LA NIÑA 2012

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ABSTRACT

The American shad (*Clupeidae*) is an anadromous fish native to the Atlantic coast of North America, and introduced to the West Coast in 1871. The catch of an individual of American shad (*Alosa sapidissima*) at Bahía de Todos Santos, Baja California, México, possibly is indicative of fish movements from northern areas to south temperate waters during particular oceanographic conditions. Their presence could be influenced by the La Niña event during 2012 that prevailed in the region. These conditions in the bay and south sites also led to the record of individuals of the white and green sturgeons (*Acipenser transmontanus* and *A. medirostris*). In this study, the southern limit distribution for the American shad at Bahía de Todos Santos is confirmed; this bay is located at 100 km south from the border of California (USA) and Baja California (México).

INTRODUCTION

The American shad, *Alosa sapidissima* (Wilson 1811), is the largest member of the *Clupeidae* and are native to the Atlantic Ocean, but introduced to the Pacific in the Sacramento River between 1871 to 1873, and later to the Columbia, Snake, and Willamette Rivers (Love 2011; Schroeter and Moyle 2006). On the Pacific Coast, the American shad is distributed as far north as Cook Inlet, Gulf of Alaska, with a population that has established itself in Kamchatka Peninsula (Russia), and south to Bahía de Todos Santos, Baja California, México (Miller and Lea 1972; Moyle 2002), most commonly from Washington State to San Francisco Bay (Love 2011). On the Atlantic coast, their distribution is from Labrador (Canada) to St. Johns River, Florida, USA (Moyle 2002).

This species is a migratory and anadromous fish that as an adult lives primarily in seawater but passes through estuaries on spawning migrations to freshwater (Allen and Pondella 2006). During summer and fall, American shad can be found in coastal waters; in the winter months they generally inhabit deeper ocean waters away from the coast at depths up to 375 m, and toward the end of winter they travel into rivers to spawn (Eddy 1957). In the next fall or early winter, juveniles make

their way from rivers into the ocean, and in 2 to 5 years, adult shad return to their natal rivers to spawn (Glebe 1981).

The first documented occurrence of the American shad in the area of Bahía de Todos Santos, Ensenada, Baja California, México, was reported on July 16, 1958 (Claussen 1959); the specimen, an adult female (386 mm standard length, weight 757 g) was given by officials of the cannery Pesquera del Pacífico, in El Sauzal, a town located 8 km north of Ensenada, B.C., within the bay; according to information, a number of shad were landed with the regular sardine catch on July, 1958 (Claussen 1959). However, the collection site of this individual is unknown, because the reported geographical position (32°50'N, 116°50'W) is located on land in the continental United States. Also in those years, the sardine fishery area was located from the California border to San Quintín, B.C. (100 km north and 200 km south from Bahía de Todos Santos, respectively), and canneries were the reception facilities for sardines, only. Now, El Sauzal is a fishing port (lat. 31°53'40"N, long. 116°42'15"W) and home to a fleet of coastal fishing pangas and a medium size fishing fleet.

Based on the record by Claussen (1959), many references cite Bahía de Todos Santos as the southern limit for the American shad distribution (Allen and Pondella 2006; Hammann and Rosales-Casián 1990; Hendricks and Tryniewski 2011; Love 2011; Miller and Lea 1972; Moyle 2002). Another American shad individual was mentioned in Hammann and Rosales-Casián (1990) but without date or specific collection site, after that, no new shad records were reported. The aim of this work is to document this southward movement during La Niña conditions, and the presence of the American shad in the temperate environment of Bahía de Todos Santos, Baja California, México.

The Bahía de Todos Santos is located 100 km south of the California (USA)–Baja California (México) border (fig. 1). This bay is home to the city of Ensenada, Baja California, México, and the Punta Banda estuary. Fish studies of the bay and estuary began in 1982 (Beltrán-Felix et al. 1986; Diaz-Diaz and Hammann 1987), and after these studies, many other studies in both places and

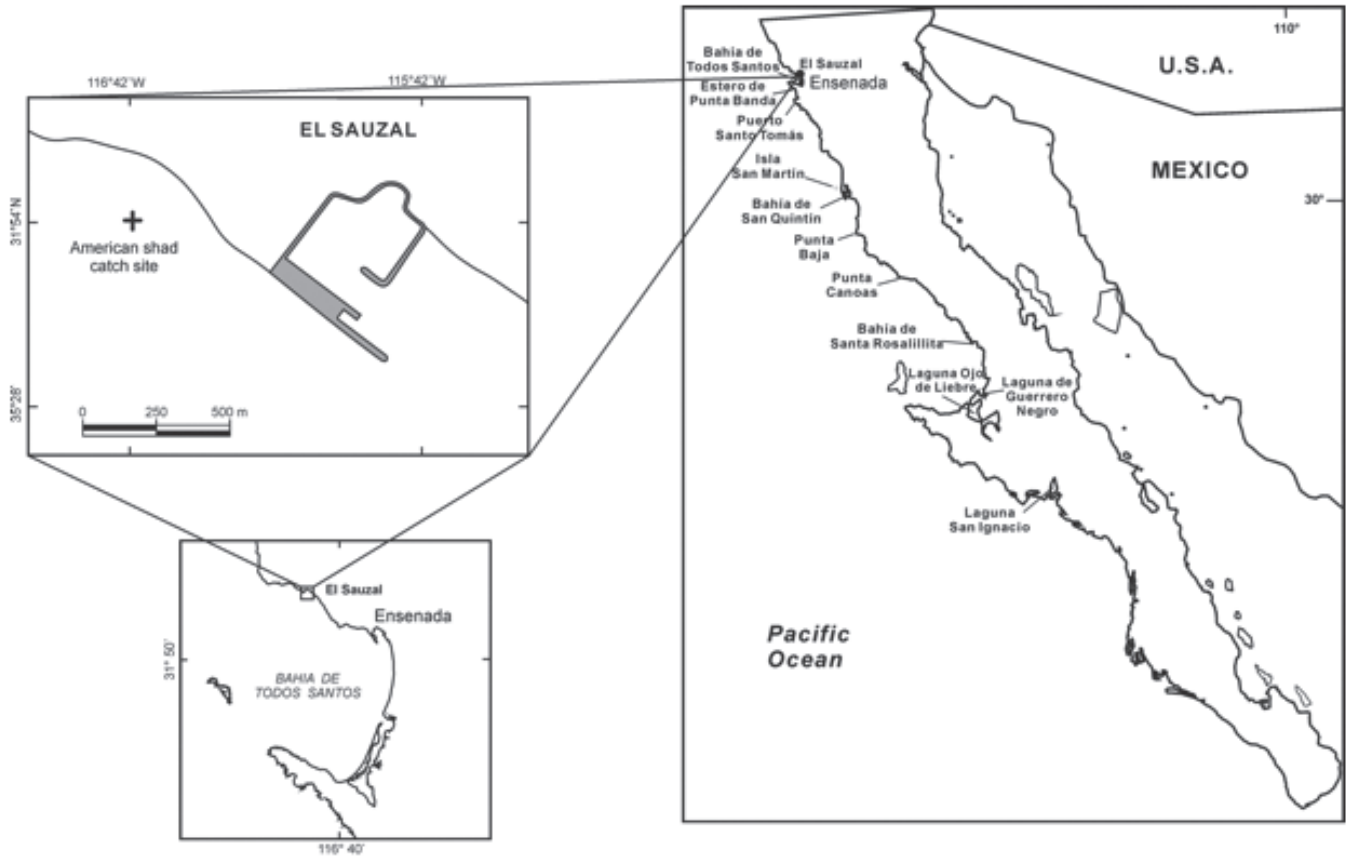


Figure 1. Catch site of American shad, *Alosa sapidissima*, at nearshore waters of Bahía de Todos Santos, Baja California, México.

further south were conducted (Rosales-Casián 2013). In the city of Ensenada is located the Ensenada Seafood Market that has 42 stalls, as well as docks and boat ramp to download fish captured from the bay and around. This place of sale receives fish caught from the Pacific of Baja California and from the Gulf of California, and is a major source for biological data.

From 2000 to 2004 and from 2008 to 2014, I have made monthly fish identifications and counts in the Ensenada Seafood Market; the fish species of the temperate zone were identified using the keys of Miller and Lea (1972). The measurements of total and standard lengths (TL, SL; mm), and also the weights (g) of some fish species, were recorded.

On June 28, 2012, and during the monthly sampling of the fish stands at the Ensenada Seafood Market, a fisherman arrived with his catch, and within the fishes, an uncommon individual was present that later was identified as the American shad (*Alosa sapidissima*). The shad was captured by the fisherman with a gill net on a commercial panga, and in the nearshore area of El Sauzal port, within the Bahía de Todos Santos (fig. 1); the fishing depth was 10–15 m, and according to information the catch site was localized close to the side west jetty, with an approximate localization of latitude

31°53'42.24"N, 116°42'41.31"W (fig. 1). Together with shad, also captured were the shortfin corbina (*Cynoscion parvipinnis*), California halibut (*Paralichthys californicus*), spotfin croaker (*Roncador stearnsii*), barred sand bass (*Paralabrax nebulifer*), white croaker (*Genyonemus lineatus*), and the queenfish (*Seriphus politus*). In June 28, 2012, the surface seawater temperature at Bahía de Todos Santos was 15.7°C, and the temperatures at 10 and 15 m depth were 12.2 y 11.3°C, respectively.

The individual of American shad measured 363 mm TL, 294 mm SL, and weighed 550 g (fig. 2). This species was identified by the combination of the following characteristics: body coloration was bluish on back and white on belly; compressed body; midlateral scales: 59; dorsal fin: 16 rays; anal fin: 21 rays; sharp sawlike scales or “scutes” along its belly: 21 anterior to and 16 posterior to pelvic base. This specimen of American shad had striations on gill cover, and one black spot on the back and close to gill cover (Miller and Lea 1972; Whitehead 1985).

From July 2010 to April 2012, La Niña conditions were present across most of the equatorial Pacific Ocean (NOAA 2013). In July 2010, the temperature anomaly dropped to -1.0°C, with the lowest value of -1.5°C from September 2010 to January 2011, and finished in May 2011; another La Niña event began in August



Figure 2. Individual of American shad, *Alosa sapidissima*, captured on June 28, 2012, at Bahía de Todos Santos, Baja California, México.

2011 ($< -0.5^{\circ}\text{C}$), with the lowest temperature anomaly at December (-1.5°C), and weakened in April 2012 to -0.5°C (NOAA 2013).

DISCUSSION

The American shad may have one or more black spots in a row on their shoulder, and though rare, some shad have two rows of black spots (Ford 2006); this specimen had only one spot. During summer and fall, American shad can be found in coastal waters before entering rivers to spawn (Eddy 1957; Ford 2006). The presence of this fish species during June 2012 at Bahía de Todos Santos coincides with their coastal movements during summer, and according to tagging studies, their migrations in schools is sometimes thousands of kilometers during one season, closely correlated with sea surface or bottom isotherms (Leggett and Whitney 1972). However, data from commercial and sport landings of American shad along the Pacific Coast indicate no evidence for large-scale seasonal migrations as reported along the Atlantic coast (Pearcy and Fisher 2011); this probably is the reason for the record of only one individual of American shad by a fishing boat, at the south end of their distribution that is Bahía de Todos Santos.

The American shad in the Pacific Ocean migrates long distances within their preferred SST range of $13\text{--}18^{\circ}\text{C}$, and between $7\text{--}13^{\circ}\text{C}$ on bottom (Pearcy and Fisher 2011); this range is similar to those temperatures ($11.3\text{--}15.7^{\circ}\text{C}$) found at Bahía de Todos Santos on June 2012. The migration of American shad is from south of Point Conception into southern California and Baja California, México during January–June, followed by migrations far to the north during July–October (Leggett and Whitney 1972; Moyle 2002). American shad along the Pacific Coast have adapted to the prevailing environmental conditions, and they rapidly were dispersed, and expanded their range over 5,000 km of coastline from México to Russia. American shad increased dramatically in abundance and now comprise the largest spawning run of anadromous fish in the Columbia River (>4 million fish annually), constituting a remarkable biological invasion (Hasselman et al. 2012).

American shad is a planktivorous species, and is considered an alien fish in marine habitats of California together with the striped bass (*Morone saxatilis*), because both were introduced from Atlantic coastal waters to Sacramento River and San Francisco Bay, respectively (Allen et al. 2006). The American shad is classified as a

marine migrant fish species, also an anadromous (estuarine and nearshore species) that pass through estuaries on spawning migrations, and is an inhabitant from northern and central California waters but not for southern California (Allen and Pondella 2006); no negative impacts of this planktivorous species on native fishes have been documented (Allen et al. 2006).

With respect to the possible record of an individual of American shad from Bahía de Todos Santos in 1958 (Claussen 1959), in July 1958 the neutral conditions had just begun with a sea surface temperature anomaly of +0.49°C, and those conditions continued until October 1958 with an anomaly of +0.35°C (NOAA 2013). This probably influenced the American shad presence at the Bahía de Todos Santos or in other sites around the bay.

The fish studies at the Bahía de Todos Santos (31°49'11.33"N, 116°38'40.53"W) began in the early 1980s at kelp beds (Díaz-Díaz and Hammann 1987), sandy bottoms (Hammann and Rosales-Casián 1990), and the sportfishing catch (Rodríguez-Medrano 1993). In addition, research on the fish community of the systems Bahía de Todos Santos-Estero de Punta Banda, and Bahía de San Quintín and their adjacent coast (30°23'14.59"N, 115°59'29.11"W) was conducted between 1992 to 1995 using beam trawl, otter trawl, beach seine, gill net, and hook and line (Rosales-Casián 1997; Rosales-Casián 2004a). The artisanal coastal fishery was studied at eight fishing camps along northwestern coast of Baja California (Rosales-Casián and Gonzalez-Camacho 2003), from Santo Tomas (31°33'4.78"N, 116°40'35.78"W) to Punta Canoas (29°25'42.72"N, 115°10'50.39"W). Other studied sites were Bahía El Rosario (29°57'4.11"N, 115°47'56.35"W), a bay protected by Punta Baja (Rosales-Casián 2011), and Bahía Santa Rosalilita (fig. 1) as the farthest south site, 28°39'34.01"N, 114°14'13.81"W (my unpublished data). The Seafood Market of Ensenada Port has been surveyed monthly since September 2000 to 2004 (Hernández-Hernández 2002; Rosales-Casián and Ruz-Cruz 2003), and from 2008 until now. All those studies failed to collect any specimen of American shad except in Hammann and Rosales-Casián (1990) where the presence of an individual of American shad in the seafood market is mentioned without specifying the capture site.

The cold conditions during the two years of La Niña (2010–12) that were present in the region probably helped to the southward movement of the American shad, to keep it into the Bahía de Todos Santos until June 2012. During 2010–11, the lowest temperature anomaly was -1.5°C and was considered a strong La Niña event, and during 2011–12 the lowest anomaly was -1.0°C (NOAA 2013). Northern fish species can migrate southward during cold periods (Rosales-Casián and Almeda-Jauregui 2009), in a similar way to

movements of tropical fish species northward during El Niño conditions (Rosales-Casián 2004b; Rosales-Casián 2013).

The record of American shad is important because it is an evidence of northern fish species movements to Bahía de Todos Santos during La Niña conditions, similar to southward migration movements of other anadromous fish species like the white sturgeon (*Acipenser trasmontanus*) registered in the bay (Rosales-Casián and Ruz Cruz 2005; Ruiz-Campos et al. 2011), and the green sturgeons (*Acipenser medirostris*) that have been registered in the bay and the southern site of the El Socorro, B.C., 200 km south (Rosales-Casián and Almeda-Jauregui 2009). Also, it reconfirms the southern limit distribution for the American shad species at Bahía de Todos Santos, Baja California (México), and increases the fish species list from the bay.

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