

Summary of 2005-2006 Pacific Herring Spawning-Ground Surveys and Commercial Catch in Humboldt Bay and Crescent City

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Humboldt Bay

Project Location

Humboldt Bay is located approximately 260 miles north of San Francisco and is California's second largest estuary. The bay is 14 miles long, 4.5 miles wide at its widest point, and approximately 25 square miles in size excluding its tributaries and sloughs. Humboldt Bay consists of two wide and shallow northern and southern arms connected by a relatively narrow channel (Figure 1). Both the north and south segments, called North Bay and South Bay, are extremely shallow with large, mostly vegetated, mudflats exposed during minus tides. The channel connecting the north and south sections and the entrance channel to the open ocean is referred to in this report as the Middle Bay. The Middle Bay is periodically dredged to allow for large vessel traffic, and its shoreline has most of the bay's commercial development. The herring roe fishery is restricted by regulations to the waters of districts 8 and 9 which encompass the entire waters of Humboldt Bay. Because herring schools will hold in the deeper channels during low tide and move toward the mudflats during flood tides, most fishing activity takes place in the tidal channels within North and South Bays.

Description of Fishery

The herring roe fishery in Humboldt Bay began in 1974 with a quota set by the state legislature at 20 tons. The quota was raised to 50 tons for the 1976 season by the Fish and Game Commission which was delegated management authority for all herring fisheries the same year. In 1983 the Commission raised the quota to 60 tons per season where it remains today. There are four herring permits issued for the Humboldt Bay fishery. All four permits are current, however only two permittees have been actively fishing in the last few years. Gill nets have been used exclusively for the take of herring for roe in Humboldt Bay since the 1976 season. For several years, at the request of Humboldt Bay permittees, the minimum gill net mesh size has been 2 ¼ inch with no meshes greater than 2 ½ inch. The season in Humboldt Bay is from noon on January 2 until noon on March 9.

Monitoring and Assessment

Prior to the current spawn assessment program, which was started with the 2000-01 spawning season, surveys were conducted for the 1974-75, 1975-76, 1990-91, and 1991-92 seasons (Rabin and Barnhart, 1986; Spratt, et. al., 1991). Historic and current spawn surveys employ the same basic survey methods developed for use by the Department in San Francisco and Tomales Bays (Spratt, 1981). The spawn survey was designed to estimate the total number of eggs spawned in a season and to convert that estimate to the total tons of adult spawners, using a conversion factor based on fecundity. The area of the spawn is measured and samples are collected from which the density (number of

eggs/m²) of eggs is calculated. This is expanded to the total area of the spawn to estimate the total number of eggs spawned. The total number of eggs spawned is then converted to tons of adult spawners. The accuracy of spawn area estimates has improved in recent years with the availability Global Positioning System (GPS) and Geographic Information System (GIS) technology. These tools allow biologists to record the geographic location of a spawn while on the bay and later transfer this information to digitized maps on office computers. Historically, a hydroacoustic survey has not been used in Humboldt Bay to assess biomass.

For the 2000-2001 and 2001-2002 herring seasons eelgrass bed measurements and herring spawn coverage were derived from digitized eelgrass maps developed through computer analysis of 1997 and 2000 Humboldt Bay aerial photographs. Subsequent field surveys in Humboldt Bay, conducted by the Humboldt Bay Cooperative Eelgrass Project, found the presence of eelgrass in large areas that were not detected through the computer analysis process. In 2003 the Arc View 3.2 polygon drawing tool was used to delineate the extent of eelgrass coverage in the bay from the 1997 and 2000 aerial photographs (Shull and Bulthuis, 2002). Polygons were converted to shape files using Arc View 3.2 to calculate the distribution of eelgrass in hectares. The spawn escapement estimates for the 2000-2001 and 2001-2002 seasons have been revised upward using eelgrass bed measurements obtained using the drawing tool method.

Humboldt Bay Spawn Assessment

Herring appear to spawn almost exclusively on the vast eelgrass beds found in both the North and South Bays of Humboldt Bay. During a typical spawn event, herring schools may deposit eggs in low density over 300 acres of eelgrass. The Humboldt Bay spawning biomass estimate for the 2005-06 season is 124 tons, down 50 tons from last season's estimate of 174 tons. The spawning biomass this season represents only 31% of the 10-year average of 402 tons and is the lowest estimate recorded from seasons when spawn assessments were conducted in Humboldt Bay. Numerous rain storms soaked the north coast throughout the spawning season with 42 inches of rain recorded by the end of February surpassing the area's annual average rainfall by four inches. A Humboldt State University/Center for Integrative Coastal Observation, Research and Education (HSU/CICORE) water quality sensor, located in Humboldt Bay's central channel, recorded salinity levels below 20 parts per thousand (ppt) on ten different days between December 1, 2005 and March 31, 2006 this spawning season. Outer coast salinity typically ranges from 32 to 34 ppt. Although studies have shown that Pacific herring eggs have a better survival rate when water salinity is below 20 ppt, perhaps this season's heavy rains were inhibiting spawning behavior of adult herring.

Commercial Fishery

There was no fishing effort this season by Humboldt Bay permittees. After three seasons of far below average catches, concern grew among permittees about the overall health of the Humboldt Bay herring population. A long-time Humboldt Bay herring permittee attributed low landings during the 2002-03, 2003-04, and 2004-05 seasons to a disproportionate amount of small herring entering the bay which were unavailable to commercial 2¼ inch mesh nets. The quota of 60 tons for Humboldt Bay has only been

reached once since the 1997-98 El Niño with the herring landings since that event averaging only 15 tons per year.

Cooperative Eelgrass Survey

During the winter of 2005-2006 the Department of Fish and Game, University of California Sea Grant, Humboldt State University, and Humboldt Bay Harbor District completed the fifth and final year of a study monitoring the population characteristics of eelgrass (*Zostera marina*) in Humboldt Bay. Eleven sites in the north, central and south regions of Humboldt Bay were surveyed. Above-ground eelgrass biomass (fresh weight) for winter 2005-2006 had a mean of 0.47 kg/m² (range 0.06-0.66 kg/m²), which is a 29 percent decrease from the winter 2004-2005 mean of 0.61 kg/m² (range 0.17-1.58 kg/m²). Given the importance of eelgrass to Pacific herring in Humboldt Bay, this data is essential for herring research and has greatly improved the accuracy of the season's spawning biomass estimate.

The Department continues its efforts, with collaborator UC Sea Grant, on the eradication of the invasive seagrass, *Zostera japonica*, from Indian Island in Humboldt Bay. Since beginning removal, researchers have encountered fewer and much smaller patches. Density has also decreased substantially and, with continued maintenance, collaborators expect these downward trends to continue. Grant money was obtained to extend funding for a University of California Sea Grant Research Associate through March 2007 to continue plant detection and removal and document the effectiveness of the eradication process.

Discussion

For the last three seasons biomass estimates were far below average; however, the exploitation rate during 2002-03 and 2003-04 seasons remained below one percent with no exploitation occurring 2005-06. The average yearly biomass estimate from the last six spawn assessment surveys conducted since the 2000-01 season is 464 tons. A 60-ton quota based on this average would result in a 13 percent exploitation rate, which is considered a conservative rate of harvest.

Crescent City

Project Description

The Crescent City area is approximately 15 miles south of the Oregon - California border. Approximately 11 miles of coastal waters south of Point Saint George and Crescent City harbor are open to commercial herring roe fishing. The majority of herring fishing takes place in Crescent City harbor.

Description of Fishery

The herring roe fishery in Crescent City began in 1973 when 12.1 tons were taken out of Crescent City harbor (see Figure 3). Since that time yearly landings have ranged from 0.12 to 60 tons with an average of 22 tons per year. The Fish and Game Commission

established a set quota of 30 tons for Crescent City for the 1977-78 season which is still in effect today. All herring landed are to be taken by gill net only. Although two permits are still active, no fishing effort has taken place in Crescent City Harbor for the last four seasons. The season begins on noon on January 14 and is open until noon on March 23.

Literature Sited

Rabin, D.J. and R.A. Barnhart. 1986. Population characteristics of Pacific herring, *Clupea harengus pallasii*, in Humboldt Bay, California. Calif. Dept. Fish and Game, Mar. Res. Div. Admin. Rpt. 91-4, 41 pp.

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Spratt, J.D., T.O. Moore, and P. Collier. 1991. Biomass estimates of Pacific herring, *Clupea pallasii*, in California from the 1991-92 Spawning-ground surveys. Calif. Dept. Fish and Game, Mar. Res. Div. Admin. Rpt. 91-4, 41 pp.

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Figure 1. Key Pacific herring spawning areas in Humboldt Bay.

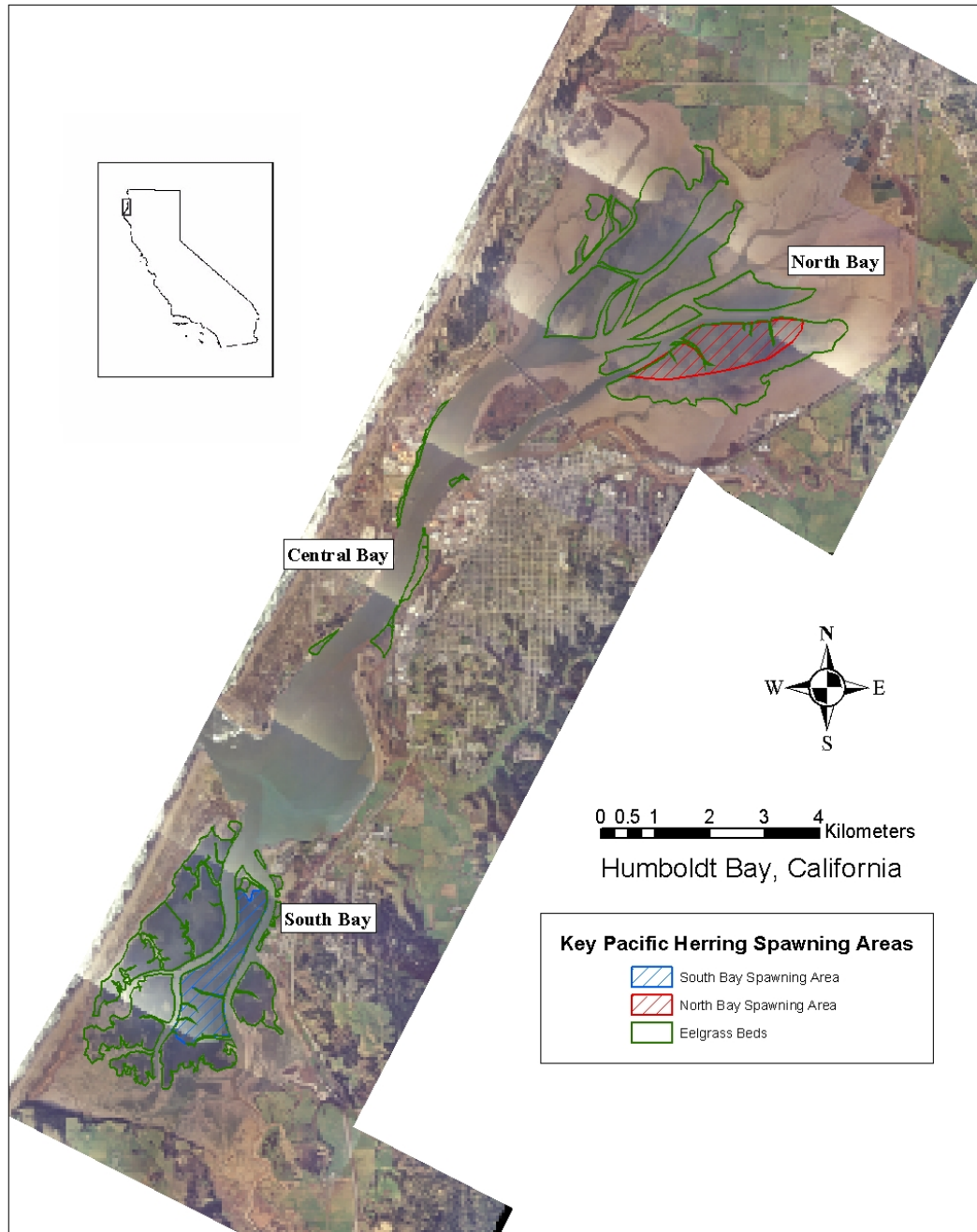


Table 1. Pacific herring biomass estimates in Humboldt Bay for seasons when surveys were conducted.

Season	Spawn Escapement (tons)	Catch (tons)	Spawning biomass (tons)
1974-75 ^a	372	1	373
1975-76 ^a	232	12	244
1990-91 ^b	337	63	400
1991-92 ^b	163	62	225
2000-01 ^c	886	61	947
2001-02 ^c	841	34	875
2002-03	153	2	155
2003-04	505	0.6	506
2004-05	173	0.6	174
2005-06	124	(no fishing effort)	124
Mean	379	26	402

(a) Rabin and Barnhart, 1986
(b) Spratt et al, 1992
(c) Spawn escapement estimate revised 27 Feb 2006 using eelgrass coverage data not available during the 2000-01 and 2001-02 seasons.

Table 2. Confidence limits for Humboldt Bay herring spawn estimates, 2005-2006 season.

Spawn Date	Eelgrass Bed	Std. Error (eggs/m ²)	D.F. n - 1	Estimated Tons	95% Conf. In
07 Jan 06	1 (North Bay)	1149.20	5	3.67	+/- 2.64
(See below)	12 (South Bay)	3160.74	17	56.90	+/- 18.02
08 Feb 06	1 (North Bay)	9813.09	17	42.41	+/- 29.85
08 Feb 06	2 (North Bay)	762.93	5	16.43	+/- 7.35
08 Feb 06	5 (North Bay)	6376.31	5	4.26	+/- 5.34
TOTAL				123.67	

Note: Separate spawns were detected with approximate dates of 28 Jan 06 to 01 Feb 06, 02 Feb 06, and 06 Feb 06. Hatched out eggs were found with eggs laid several days later, all eggs were counted and all counts and areas covered combined.

Figure 2. Humboldt Bay Commercial Pacific Herring Landings 1974-2006.

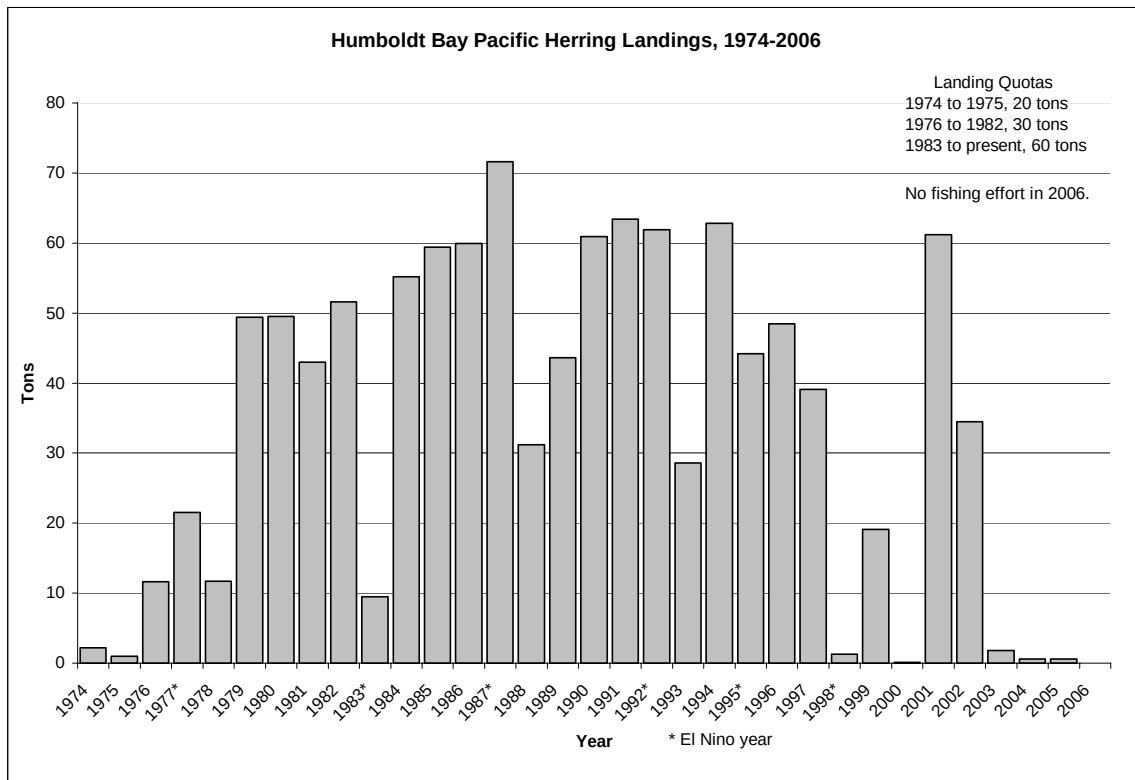


Figure 3. Crescent City Commercial Pacific Herring Landings 1973-2006.

