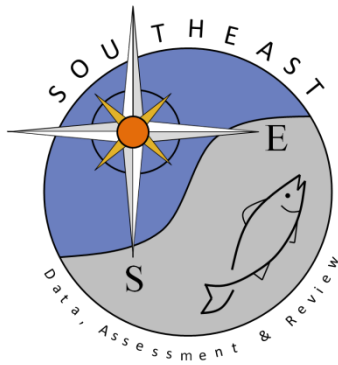# Fishery-Independent Sampling: Texas

SEDAR27-RD-04

Texas Parks and Wildlife's Fishery-Independent Monitoring Program

Texas Parks and Wildlife's fishery-independent data are collected as a stratified cluster sampling design; each bay system and Gulf area serves as non-overlapping strata with a fixed number of samples per month (or season, for gill nets) (Tables 1-4). A cluster sample is a type of probability sample where each sample unit is a collection, or cluster, of elements. Specifically, *locations* are sampled and include every organism encountered at that location as part of the sample. Sample locations are drawn independently and without replacement for each combination of gear, stratum, and month (season).

Gill nets, bag seines, and trawls are utilized to determine relative abundance, size, species composition, and temporal and spatial distribution of various life history stages of fish and invertebrates in Texas coastal waters. Descriptions of each gear are included in Table 5. Gill nets are set perpendicular to shorelines and target subadult and adult finfish. Bag seines are pulled along the shoreline and target juvenile fish and invertebrates. Trawls are towed in open water and target juvenile and subadult fish and invertebrates.

For Gulf menhaden, bag seines and monofilament gill nets (Table 5) are used in each of ten Texas estuarine systems: Sabine Lake, Galveston, Cedar Lakes, East Matagorda, Matagorda, San Antonio, Aransas, Corpus Christi, upper Laguna Madre and lower Laguna Madre (Figure 1). Bay trawls are used in all estuarine systems except Cedar Lakes. Gulf trawls, identical to those used in the bays, are used in the Texas Territorial Sea (TTS) $\leq$16.7 km from shore, in five Gulf areas 24.1 km either side of Sabine Pass, Bolivar Roads, Matagorda jetties, Aransas Pass, and 48.2 km north from Brazos-Santiago Pass.

Gill net and bag seine sample locations are randomly selected from grids (1-minute latitude by 1-minute longitude) that contains >15.2 m of shoreline. Each selected grid is subdivided into 144 5-second "gridlets". All "gridlets" containing >15.2 m of shoreline are used to randomly choose sample sites.

Gill net sets are conducted overnight during each spring and fall season (Table 6). The spring season begins with the 2nd full week in April and extends for 10 weeks. The fall season begins with the 2nd full week in September and extends for 10 weeks. Between three and five nets are set each week in each bay, except in East Matagorda Bay where only two overnight sets are made during each week, and Cedar Lakes, where only one overnight set is made each week. Each sampling week extends from 1 h before sunset on Sunday through 4 h after sunrise the following Sunday. Gill nets are set perpendicular to shore with the smallest mesh shoreward. Nets are set within 1 h before sunset and retrieved within 4 h after the following sunrise. Total fishing time is recorded (nearest 0.1 h).

Bag seines are pulled parallel to the shoreline for 15.2 m (Table 6). The area swept (0.03 ha) is determined using distance pulled and width of the bag seine. One half of the monthly bag seine samples are collected during each half (days 1-15 and 16-31) of the month to ensure good temporal distribution of samples. No grid is sampled more than once in a month.

Bay trawl sample locations are randomly selected from grids (1-minute latitude by 1-minute longitude) containing water $\geq$1 m deep in at least ⅓ of the grid, and are known to be free of obstructions (Table 6). Large bays (Galveston, Matagorda, San Antonio, Aransas and Corpus Christi) are stratified into two zones: Zone 1 (upper bay nearest mouths of rivers) and Zone 2 (lower bay farthest from rivers) to ensure good spatial distribution of samples. In East Matagorda Bay, all water is designated as Zone 1; in Sabine Lake and the upper and lower Laguna Madre all water is designated as Zone 2. One half of the monthly trawl samples in each zone in each bay system are collected during each half (days 1-15 and 16-31) of the month to ensure good temporal distribution of samples. Trawls are towed in a circular motion near the center of each grid. All tow times are 10 minutes in duration. No grid is sampled more than once per month.

Gulf trawl sample locations are randomly selected from grids (1-minute latitude by 1-minute longitude) in the TTS (Figure 1) that contain water $\geq$1.8 m deep in at least ⅓ of the grid, and are known to be free of obstructions (Table 6). One half of the samples in each area are collected during each half (days 1-15 and 16-31) of the month to ensure good temporal distribution of samples. Trawls are towed linearly, parallel to the fathom curve; direction of tow (north or south) is randomly chosen for the initial tow and alternated on subsequent tows. All tow times are 10 minutes in duration. No grid is sampled more than once per month.

Sample catch rates for each species are calculated by dividing total number captured by effort; either total hours fished (gill net and trawls) or area swept (bag seine). Catch rates for each bay system are calculated by year or season. Bay catch rates are weighted by shoreline distance (gill nets and bag seines) or surface area (trawls) to obtain coastwide estimates.

Lengths [total (TL) or standard (SL)] of organisms caught are recorded. In gill nets, up to 19 individuals of each species are measured within each mesh size, on each sampling day. For all other gears, up to 19 specimens are measured for each species in each sample collected. Standard lengths are converted to total length with a SL-TL equation.

Mean TL of individual species in gill nets are calculated for each of the four mesh sizes. Mean lengths for the combined meshes are calculated by weighting individual species mean lengths in each mesh by the number of each species caught in each mesh. For all other gears, mean lengths of individual species are calculated from individuals measured in each sample. Coastwide total mean lengths for each species in all gears are weighted according to the catch rate in each bay system, and by bay specific and gear specific weighting factors used for coastwide catch rates.

Surface salinity (ppt), water temperature (^{o}C), dissolved oxygen (ppm) and turbidity [Nephelometric Units (NTU)] are measured at the set and pickup for each gill net and prior to each bag seine sample. Bottom salinity, water temperature, dissolved oxygen and turbidity are measured prior to each trawl sample.

TABLE 1.—Number of bag seine samples, by bay and year.

Year	Sabine Lake	Galveston	Cedar Lakes	East Matagorda	Matagorda	San Antonio	Aransas	Corpus Christi	Upper Laguna Madre	Lower Laguna Madre	Total
1977	0	22	0	0	22	22	22	22	22	22	154
1978	0	66	0	0	66	66	66	66	66	66	462
1979	0	72	0	0	72	72	72	72	72	72	504
1980	0	72	0	0	72	72	72	72	72	72	504
1981	0	84	0	0	84	84	84	84	84	84	588
1982	0	120	0	0	120	120	120	120	120	120	840
1983	0	120	0	110	120	120	120	120	120	120	950
1984	0	120	0	120	120	120	120	120	120	120	960
1985	0	120	0	120	120	120	120	120	120	120	960
1986	120	120	0	120	120	120	120	120	120	120	1,080
1987	120	120	0	120	120	120	120	120	120	120	1,080
1988	138	138	0	138	138	138	138	138	138	138	1,242
1989	144	144	0	144	144	144	144	144	144	144	1,296
1990	192	192	0	192	192	192	192	192	192	192	1,728
1991	192	192	0	192	192	192	192	192	192	192	1,728
1992	240	240	0	120	240	240	240	240	240	240	2,040
1993	240	240	0	120	240	240	240	240	240	240	2,040
1994	240	240	0	120	240	240	240	240	240	240	2,040
1995	240	240	0	120	240	240	240	240	240	240	2,040
1996	240	240	120	120	240	240	240	240	240	240	2,160
1997	240	240	120	120	240	240	240	240	240	240	2,160
1998	240	240	120	120	240	240	240	240	240	240	2,160
1999	240	240	120	120	240	240	240	240	240	240	2,160
2000	240	240	120	120	240	240	240	240	240	240	2,160
2001	240	240	120	120	240	240	240	240	240	240	2,160
2002	240	240	120	120	240	240	240	240	240	240	2,160
2003	240	240	120	120	240	240	240	240	240	240	2,160
2004	240	240	120	120	240	240	240	240	240	240	2,160
2005	240	240	120	120	240	240	240	240	240	240	2,160
2006	240	240	120	120	240	240	240	240	240	240	2,160
2007	240	240	120	120	240	240	240	240	240	240	2,160
2008	240	240	120	120	240	240	240	240	240	240	2,160
2009	240	240	120	120	240	240	240	240	240	240	2,160
2010	240	240	120	120	240	240	240	240	240	240	2,160

TABLE 2.—Number of bay trawl samples, by bay and year.

Year	Sabine Lake	Galveston	East Matagorda	Matagorda	San Antonio	Aransas	Corpus Christi	Upper Laguna Madre	Lower Laguna Madre	Total
1982	120	240	120	240	240	240	240	120	120	840
1983	120	240	120	240	240	240	240	120	120	950
1984	120	240	120	240	240	240	240	120	120	960
1985	120	240	120	240	240	240	240	120	120	960
1986	120	240	120	240	240	240	240	120	120	1,080
1987	120	240	120	240	240	240	240	120	120	1,080
1988	120	240	120	240	240	240	240	120	120	1,242
1989	120	240	120	240	240	240	240	120	120	1,296
1990	120	240	120	240	240	240	240	120	120	1,728
1991	120	240	120	240	240	240	240	120	120	1,728
1992	120	240	120	240	240	240	240	120	120	2,040
1993	120	240	120	240	240	240	240	120	120	2,040
1994	120	240	120	240	240	240	240	120	120	2,040
1995	120	240	120	240	240	240	240	120	120	2,040
1996	120	240	120	240	240	240	240	120	120	2,160
1997	120	240	120	240	240	240	240	120	120	2,160
1998	120	240	120	240	240	240	240	120	120	2,160
1999	120	240	120	240	240	240	240	120	120	2,160
2000	120	240	120	240	240	240	240	120	120	2,160
2001	120	240	120	240	240	240	240	120	120	2,160
2002	120	240	120	240	240	240	240	120	120	2,160
2003	120	240	120	240	240	240	240	120	120	2,160
2004	120	240	120	240	240	240	240	120	120	2,160
2005	120	240	120	240	240	240	240	120	120	2,160
2006	120	240	120	240	240	240	240	120	120	2,160
2007	120	240	120	240	240	240	240	120	120	2,160
2008	120	240	120	240	240	240	240	120	120	2,160
2009	120	240	120	240	240	240	240	120	120	2,160
2010	120	240	120	240	240	240	240	120	120	2,160

TABLE 3.—Number of gill net samples, by bay and year.

Year	Sabine Lake	Galveston	Cedar Lakes	East Matagorda	Matagorda	San Antonio	Aransas	Corpus Christi	Upper Laguna Madre	Lower Laguna Madre	Total
1975	4	20	0	0	12	12	12	12	12	12	96
1976	4	61	0	7	36	36	40	32	37	36	289
1977	0	52	0	26	39	39	41	37	39	39	312
1978	0	32	0	32	32	32	32	32	33	32	257
1979	0	56	0	48	56	56	56	56	56	56	440
1980	0	48	0	48	48	48	48	48	48	48	384
1981	0	69	0	32	69	69	69	69	69	69	515
1982	0	102	0	36	102	102	102	102	102	102	750
1983	0	90	0	36	90	90	90	90	90	90	666
1984	0	90	0	41	90	90	90	90	90	90	671
1985	0	90	0	40	90	90	90	90	90	90	670
1986	90	90	0	40	90	90	90	90	90	90	760
1987	90	90	0	40	90	90	90	90	90	90	760
1988	90	90	0	40	90	90	90	90	90	90	760
1989	90	90	0	40	90	90	90	90	90	90	760
1990	90	90	0	40	90	90	90	90	90	90	760
1991	90	90	0	40	90	90	90	90	90	90	760
1992	90	90	0	40	90	90	90	90	90	90	760
1993	90	90	0	40	90	90	90	90	90	90	760
1994	90	90	0	40	90	90	90	90	90	90	760
1995	90	90	0	40	90	90	90	90	90	90	760
1996	90	90	40	40	90	90	90	90	90	90	800
1997	90	90	40	40	90	90	90	90	90	90	800
1998	90	90	40	40	90	90	90	90	90	90	800
1999	90	90	40	40	90	90	90	90	90	90	800
2000	90	90	20	40	90	90	90	90	90	90	780
2001	90	90	20	40	90	90	90	90	90	90	780
2002	90	90	20	40	90	90	90	90	90	90	780
2003	90	90	20	40	90	90	90	90	90	90	780
2004	90	90	20	40	90	90	90	90	90	90	780
2005	90	90	20	40	90	90	90	90	90	90	780
2006	90	90	20	40	90	90	90	90	90	90	780
2007	90	90	20	40	90	90	90	90	90	90	780
2008	90	90	20	40	90	90	90	90	90	90	780

| 2009 | 90 | 90 | 20 | 40 | 90 | 90 | 90 | 90 | 90 | 90 | 780 |
| 2010 | 90 | 90 | 20 | 40 | 90 | 90 | 90 | 90 | 90 | 90 | 780 |

TABLE 4.—Number of Gulf trawl samples, by bay and year.

Year	Sabine Pass	Bolivar Roads	Matagorda	Aransas Pass	Brazos Santiago Pass	Total
1985	0	80	80	176	80	416
1986	112	192	192	192	192	880
1987	192	192	192	192	192	960
1988	192	192	192	192	192	960
1989	192	192	192	192	192	960
1990	192	192	192	192	192	960
1991	192	192	192	192	192	960
1992	192	192	192	192	192	960
1993	192	192	192	192	192	960
1994	192	192	192	192	192	960
1995	192	192	192	192	192	960
1996	192	192	192	192	192	960
1997	192	192	192	192	192	960
1998	192	192	192	192	192	960
1999	192	192	192	192	192	960
2000	192	192	192	192	192	960
2001	192	192	192	192	192	960
2002	192	192	192	192	192	960
2003	192	192	192	192	192	960
2004	192	192	192	192	192	960
2005	192	192	192	192	192	960
2006	192	192	192	192	192	960
2007	192	192	192	192	192	960
2008	192	192	192	192	192	960
2009	192	192	192	192	192	960
2010	192	192	192	192	192	960

TABLE 5.—Fishery-independent gear descriptions.

Gear	Description
Bag seine	18.3 m long; 1.8 m deep with 1.3 cm stretched nylon multifilament mesh in the 1.8 m wide central bag with remaining webbing 1.9 cm stretched mesh.
Bay and Gulf trawls	6.1 m wide at mouth with 3.8 cm stretched nylon multifilament mesh throughout and doors 1.2 m long and 0.5 m tall.
Gill net	Monofilament, 183 m long; 1.2 m deep with separate 45.7 m sections of 7.6, 10.2 (#12 monofilament), 12.7 and 15.2 cm (#18 monofilament) stretched mesh tied together in ascending mesh size.

TABLE 6.—Historical sampling procedures by gear.

Gear	Historical Sampling Procedures
Bag seine	Bag seines have been employed in 7 Texas bay systems since October 1977; sample collection began in the East Matagorda Bay system February 1983, Sabine Lake in January 1986, and Cedar Lakes in January 1996. Prior to September 1984, bag seines were pulled from 15.2-30.5 m parallel to shore; since then seines were pulled 15.2 m for an area swept of 0.03 hectares. Prior to September 1984, sites were randomly selected from 100 fixed stations in each bay system, with random sites selection since September 1984. Prior to October 1981, six bag seine samples were collected each month in each bay system (except during June 1978 when no samples were collected). From October 1981 through March 1988, 10 bag seine samples were collected each month in each bay system, with half of the samples collected during each half of the month. From April 1988 through December 1989, 12 bag seine samples were collected each month in each bay system. Beginning January 1990, 16 bag seine samples were collected each month in each bay system. Beginning January 1992, 20 samples were collected in each bay system each month, except in East Matagorda Bay and Cedar Lakes where 10 samples were collected per month.
Bay trawls	Trawls have been employed in 3 bays since January 1982 and 7 bays since May 1982; trawls were employed in Sabine Lake beginning January 1986, and East Matagorda beginning April 1987. Galveston, Matagorda, San Antonio, Aransas, and Corpus Christi are stratified into two zones; Zone 1 (upper bay nearest mouths of rivers) and Zone 2 (lower bay farthest from rivers) to ensure good spatial distribution of samples. In East Matagorda Bay, all water was designated as Zone 1; in Sabine Lake and the upper and lower Laguna Madre all water was designated as Zone 2. Since inception, samples sizes have been 10 trawls/month/zone.

Gear	Historic Sampling Procedure
Gill net	Monofilament gill nets have been systematically used in 7 Texas bay systems since November 1975; East Matagorda Bay was added in fall 1976, Sabine Lake in spring 1986 and Cedar Lakes in spring 1995. Prior to September 1984, sites for setting gill nets were randomly selected from 100 fixed stations in each bay system. Beginning September 1984, random sites were adopted.
	Prior to fall 1981, no more than 18 overnight gill net sets occurred in each season in each bay system. Since fall 1981, 45 gill nets were set overnight during each season in each bay system except East Matagorda Bay. In East Matagorda Bay from fall 1981 to spring 1984, not less than six nor more than 12 gill nets were set each season; since fall 1984, 20 nets were set each season. In Cedar Lakes, 20 nets were set each season until 2000, when 10 nets were set each season.
Gulf trawls	Trawls have been employed in 4 Gulf areas within the Texas Territorial Sea since August 1985 and 5 areas since July 1986, with 16 trawls/month/area since inception.

FIGURE 1.—Map of Texas bay systems.