

*Science, Service, Stewardship*



## SEDAR 27: Gulf Menhaden

Fishery–Dependent Data Collection  
at the NMFS Beaufort Laboratory, 1964-2010

**Joseph W. Smith**  
**NMFS Beaufort Laboratory**

**November 1- 4, 2011**

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## Fishery-Dependent Data for the Gulf Menhaden Fishery

Maintained at the NMFS Beaufort Lab in three large data sets:

1. Catch Records: Landings and nominal fishing effort
2. Port Samples: Size and age composition of the catch
3. Logbooks: Captain's Daily Fishing Reports, or CDFRs



## Catch/Effort Data

- Since 1964, the gulf menhaden fishery has reported their daily vessel unload values (= landings), usually on a monthly basis
- In 1960s, industry allowed NMFS biologists access to company records - back to the 1940s
  - able to re-construct monthly/total landings and fishing effort back to 1948
- Daily vessel unloads are in 'thousands of standard fish'
  - by convention, 1,000 std fish = 670 lbs
  - converted to metric tons (x 0.3039)
- In recent yrs, vessel unloads are reported to the NMFS daily or weekly via spreadsheet attachment to email



## Landings reported to the NMFS

- Landings are daily vessel unloads,  
and in thousands of standard fish
- One hopper dump (22,000 cu. in.) = 1,000 std fish
- One standard fish = 2/3 lb
- One hopper dump = 670 lb or 0.3039 mt
  - J. Kutkuhn ms (1966)



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Older catch records, ~1964-2005

1 of 2 -

Month: May RECORD OF DAILY MENHADEN PURSE SEINE CATCH  
 Year: 1985 Location Cameron La Plant La Menhaden No. 64

| VESSEL NUMBER |         |                    |            |            |            |             |          |          | Aggregate from Previous Months |                 |
|---------------|---------|--------------------|------------|------------|------------|-------------|----------|----------|--------------------------------|-----------------|
| VESSEL NAME   |         |                    |            |            |            |             |          |          |                                |                 |
|               | 687     | 745                | 613        | 688        | 637        | 742         | 749      | 664      | 24,962                         |                 |
| Date          | Richter | Francis T. Conchas | Sailor man | Sea Raider | Sea Ranger | Sea Striker | Sea Wolf | Supprise | Daily Plant Total              | Aggregate Total |
| 1.            | 70      | 1084               | =          | =          | =          | 254         | =        | 192      | 2624                           | 27,586          |
| 2.            | 685     | 1031               | =          | =          | 739        | =           | =        | 653      | 4313                           | 31,899          |
| 3.            | 703     | 1030               | 998        | 1096       | 490        | 1140        | 1579     | 666      | 8756                           | 40,655          |
| 4.            |         |                    |            |            |            |             |          |          |                                |                 |
| 5.            |         |                    |            |            |            |             |          |          |                                |                 |
| 6.            | 816     | =                  | 485        | 635        | 578        | 1453        | =        | 849      | 4816                           | 45,471          |
| 7.            | 950     | 1389               | =          | =          | =          | =           | 1500     | =        | 5343                           | 50,814          |
| 8.            | =       | =                  | 965        | 865        | 698        | 1165        | =        | 817      | 4507                           | 55,321          |
| 9.            | 923     | 1278               | =          | =          | =          | =           | 1216     | =        | 4591                           | 59,912          |
| 10.           | 392     | 764                | 978        | 844        | 466        | 1343        | 843      | 955      | 7915                           | 67,827          |
| 11.           |         |                    |            |            |            |             |          |          |                                |                 |
| 12.           |         |                    |            |            |            |             |          |          |                                |                 |
| 13.           |         |                    |            |            |            |             |          |          |                                |                 |
| 14.           |         |                    |            |            |            |             |          |          |                                |                 |
| 15.           |         |                    |            |            |            |             |          |          |                                |                 |
| 16.           | 308     | 982                | 542        | 411        | 472        | 708         | 1000     | 533      | 5849                           | 73,676          |
| 17.           |         |                    |            |            |            |             |          |          |                                |                 |
| 18.           |         |                    |            |            |            |             |          |          |                                |                 |
| 19.           |         |                    |            |            |            |             |          |          |                                |                 |
| 20.           | =       | =                  | 422        | 526        | 340        | =           | =        | 733      | 2021                           | 75,697          |
| 21.           | 718     | 1019               | =          | =          | =          | 1352        | 1281     | =        | 5385                           | 81,082          |
| 22.           | 194     | 188                | 592        | 1141       | 637        | =           | 208      | 831      | 4096                           | 85,178          |
| 23.           | 958     | 1498               | =          | =          | =          | =           | 1461     | =        | 5290                           | 90,468          |
| 24.           | =       | =                  | 1186       | 878        | 795        | 1272        | =        | 854      | 4985                           | 95,453          |
| 25.           |         |                    |            |            |            |             |          |          |                                |                 |
| 26.           |         |                    |            |            |            |             |          |          |                                |                 |
| 27.           | 768     | =                  | =          | 970        | =          | 710         | 1357     | =        | 3805                           | 99,258          |
| 28.           | 908     | 1535               | 1044       | =          | 822        | =           | =        | 907      | 6496                           | 105,754         |
| 29.           | =       | =                  | =          | 484        | =          | =           | =        | =        | 484                            | 106,238         |
| 30.           | =       | 778                | 278        | =          | 216        | 1117        | 1490     | 579      | 5400                           | 111,638         |
| 31.           |         |                    |            |            |            |             |          |          |                                |                 |
| Month Total   | 8,393   | 12,626             | 7,490      | 7,850      | 6,440      | 10,514      | 11,875   | 8559     | 86476                          |                 |
| Season Total  | 11,282  | 15,796             | 9,589      | 10,669     | 8,734      | 12,460      | 15,904   | 10,222   |                                | 111,638         |

Remarks: U o/c OK gws on/notes  
 Checked by E. J. Lee Date 4/27/05  
 Recorded by E. J. Lee Date 4/15/05 by phone          at Plant          other           
 (Check one) KEY NUMBER OPERATOR #1.

Hand-copied from plant records/ledgers

Key-entered into NMFS Beaufort 'Catch Records' data base



## Company catch records from recent years via daily/weekly spreadsheets

**OMEGA PROTEIN  
CAMERON DAILY FISH CATCH REPORT**

Fish Catch Date 07/09/09  
Gulf Week #12

| Vessel                   | Captain    | Dock Status | Today's Hail | Unloaded @ This Plant |              |                | Unloaded Elsewhere |          |          |              | Total Unloaded |
|--------------------------|------------|-------------|--------------|-----------------------|--------------|----------------|--------------------|----------|----------|--------------|----------------|
|                          |            |             |              | Today                 | WTD          | STD            | Plant              | Today    | WTD      | STD          | STD            |
| Anna                     | H Fisher   | CREW        | 0            | 224                   | 224          | 7,578          |                    | 0        | 0        | 0            | 7,578          |
| Barataria Bay            | M Gaskins  |             | 0            | 260                   | 260          | 7,563          |                    | 0        | 0        | 0            | 7,563          |
| Calcasieu Pass           | D Haynie   |             | 0            | 74                    | 74           | 4,223          |                    | 0        | 0        | 0            | 4,223          |
| Chauvin                  | B Mitchell |             | 0            | 699                   | 699          | 10,971         |                    | 0        | 0        | 0            | 10,971         |
| Cote Blanche Bay         | N Schools  |             | 0            | 475                   | 475          | 12,768         |                    | 0        | 0        | 0            | 12,768         |
| Galveston Bay            | B Pickett  |             | 0            | 715                   | 715          | 19,393         | ABV                | 0        | 0        | 961          | 20,354         |
| Grande Batture           | E Harding  |             | 0            | 313                   | 313          | 9,243          |                    | 0        | 0        | 0            | 9,243          |
| Oyster Bayou             | B Kell     |             | 0            | 287                   | 287          | 9,040          |                    | 0        | 0        | 0            | 9,040          |
| Terrebonne Bay           | S Mitchell |             | 0            | 406                   | 406          | 15,903         | ABV                | 0        | 0        | 1,008        | 16,911         |
| Tiger Point              | J Morgan   |             | 0            | 348                   | 348          | 7,632          |                    | 0        | 0        | 0            | 7,632          |
| <b>VESSEL TOTALS</b>     |            |             | <b>0</b>     | <b>3,801</b>          | <b>3,801</b> | <b>104,314</b> |                    | <b>0</b> | <b>0</b> | <b>1,969</b> | <b>106,283</b> |
| Abbeville Guest Vessels  |            |             | 0            | 0                     | 0            | 0              |                    |          |          |              |                |
| Moss Point Guest Vessels |            |             | 0            | 0                     | 0            | 0              |                    |          |          |              |                |
| Fish Purchased           |            |             | 0            | 0                     | 0            | 0              |                    |          |          |              |                |
| <b>PLANT TOTALS</b>      |            |             | <b>0</b>     | <b>3,801</b>          | <b>3,801</b> | <b>104,314</b> |                    |          |          |              |                |
|                          |            |             |              |                       |              |                | Carrier Vessels    |          |          |              |                |
|                          |            |             |              |                       |              |                | Grand Isle         | 0        | 0        |              | 669            |



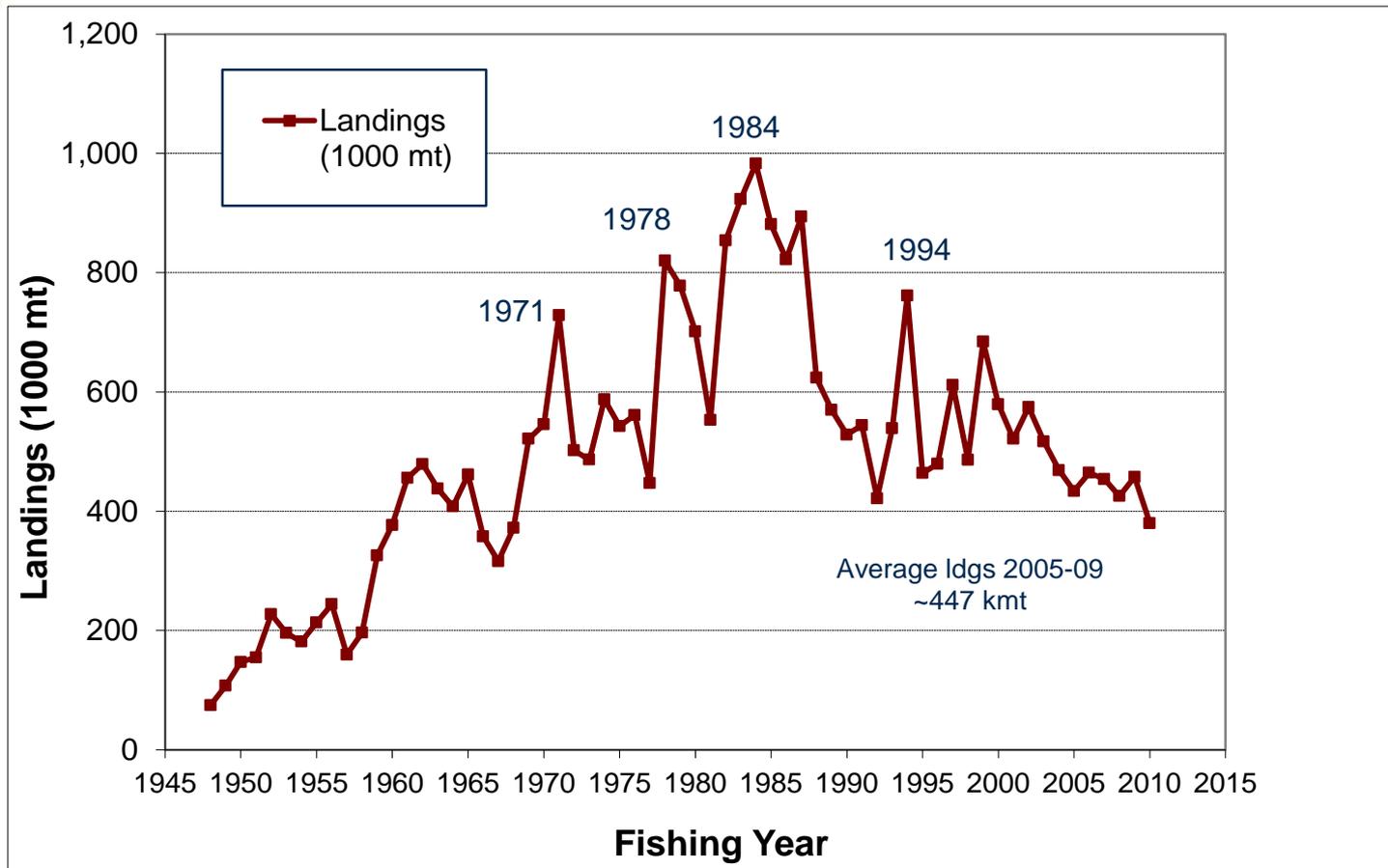
## Total Landings of Gulf Menhaden

- Catch records summed across all plant-months to get:
  - Total gulf menhaden landings for the fishing season





## Landings in the Gulf Menhaden Fishery, 1948-2010





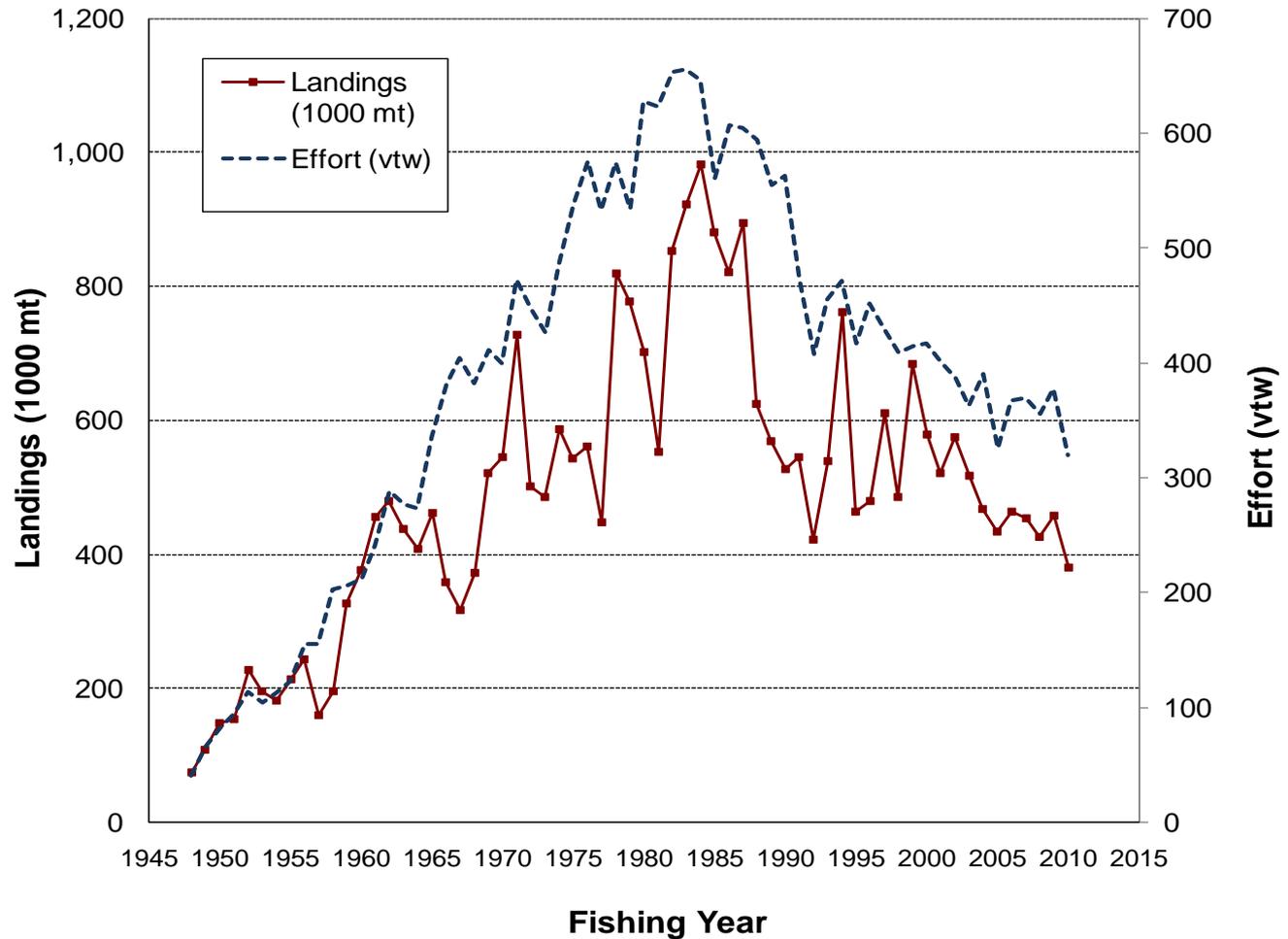
## Nominal or Observed Fishing Effort

- Catch records do not list 'days fished'
- Logbooks placed on gulf vessels in 1960s, but compliance incomplete
  - program discontinued in late 1960s, but revived in late 1970s as CDFRs
- Nicholson (1971) argued that a vessel-week on the Atlantic coast was satisfactory unit of nominal effort [1 vessel, fishing at least 1 day of a given wk]
- Chapoton (1971) noted that on the Gulf coast, fish catching ability was more related to size of the vessel and its fish hold capacity
  - thus, a vessel-ton-week became the preferred measure of nominal effort for the gulf menhaden fishery
    - = one vessel, fishing at least one day of a week, times its net tonnage



## Catch and Nominal Effort for the Gulf Menhaden Fishery, 1948-2010

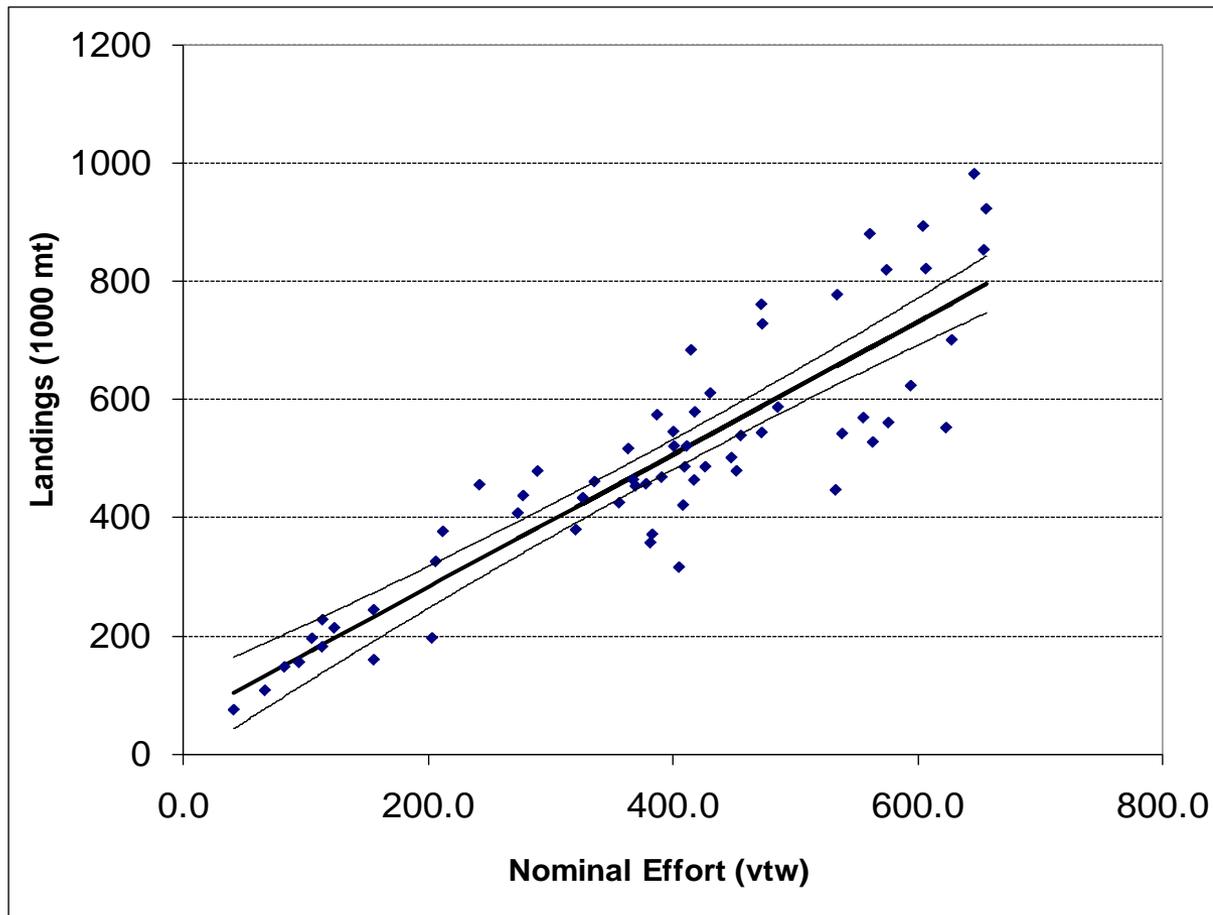
Figure 4.2  
in Report





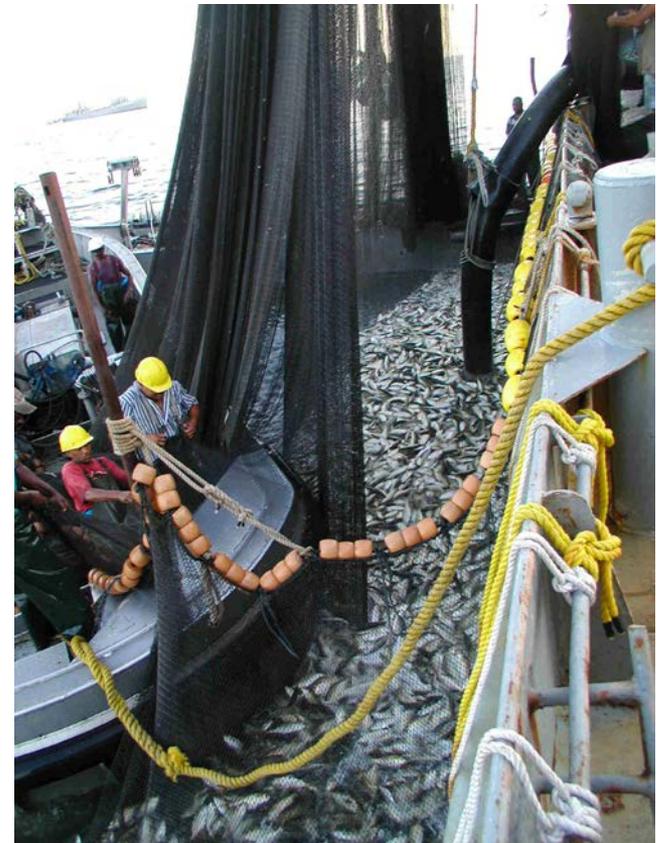
Relationship between gulf menhaden reduction landings (1000 mt) and nominal fishing effort (vessel-ton-week), 1948-2010. The linear regression of landings on effort explains 79% ( $r^2$ ) of the annual variability in landings.

Figure 4.4  
in Report





## Size and Age Composition of the Catch: Port Samples





## Menhaden Sampling

- Two-stage cluster design, relatively unchanged since 1964 on the Gulf coast
  - Adapted from design used on Atlantic since 1955
  - First-stage: Sample obtained from top of fish hold w/ bucket or dip net
    - Top of fish hold assumed to be last set of the trip
  - Second-stage: 10 fish randomly chosen from sample for size and age composition



## Menhaden Sampling Time Line

- Change in second-stage from 20-fish to 10-fish samples ~1972
  - greater variability in size and age among vessels than within vessels
  - acquire more (20-25) ten-fish samples per port/week
- About 1992: Started mounting 10 scales for ageing per fish versus 6 scales per fish
  - Increase probability of finding a legible scale, one w/ well-define “rings”



## Menhaden Sampling Time Line

- Samplers were temporary/seasonal Federal employees 1964 through ~1994
- ~1994 lost all temporary Federal positions NMFS-wide
- Since ~1995, company dockside employees at Louisiana fish factories solicited to acquire weekly samples noting date, vessel, fishing location; freeze samples in chest freezers
  - Target no. of samples per week
  - Paid a nominal fee for their services
  - QA/QC: Date of sample checked against daily logbooks



## Processing of Menhaden Samples from Louisiana Fish Factories

- ~1995-2003 GSMFC hired independent contractors to process samples from LA for size and age; forward data to NMFS Beaufort.
  - Often fishing locations obtained from CDFRs [=last set of day]
- 2004 to present: GSMFC contracts w/ LDWF to process samples from Empire, Abbeville, and Cameron; forward data to NMFS Beaufort



## Processing of Menhaden Samples from Mississippi Fish Factory

- Since ~1995 an employee of NMFS Pascagoula Lab has acquired samples at fish factory in Moss Point, MS, and processed those samples; sends data to NMFS Beaufort
- In recent years, GSMFC has hired an independent contractor to process the samples and forward data to NMFS Beaufort.



Last set of day assumed to be on top of the fish hold





Sample from top of the fish hold  
- date and location of last set





Ten fish randomly chosen from sample





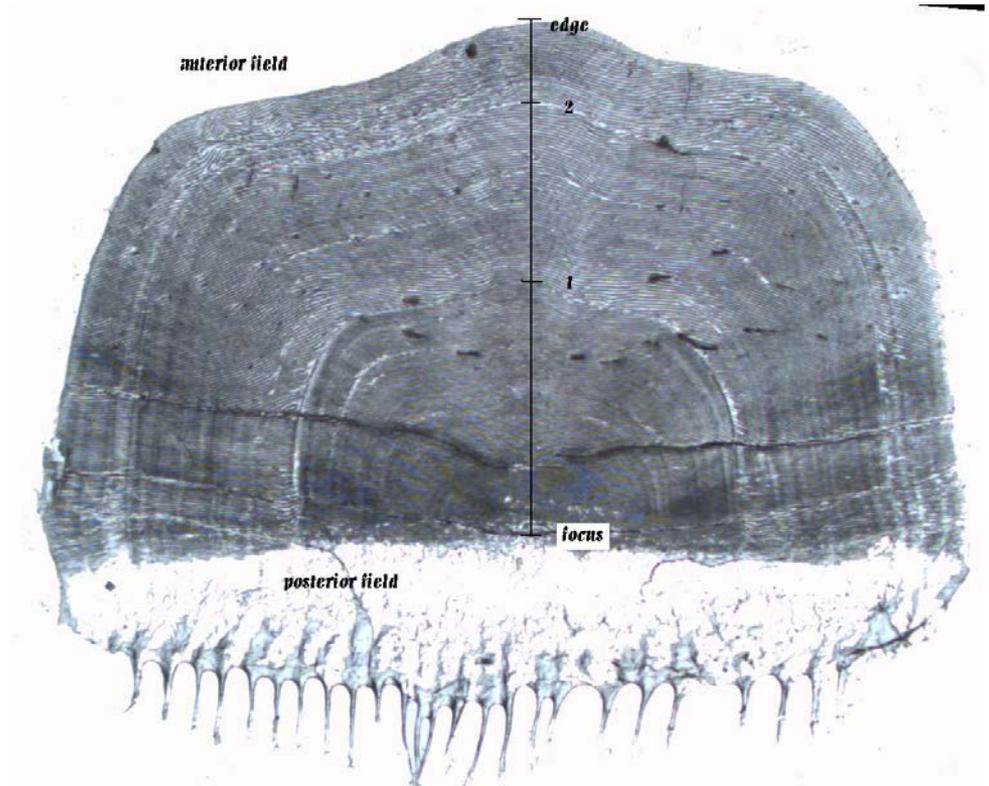
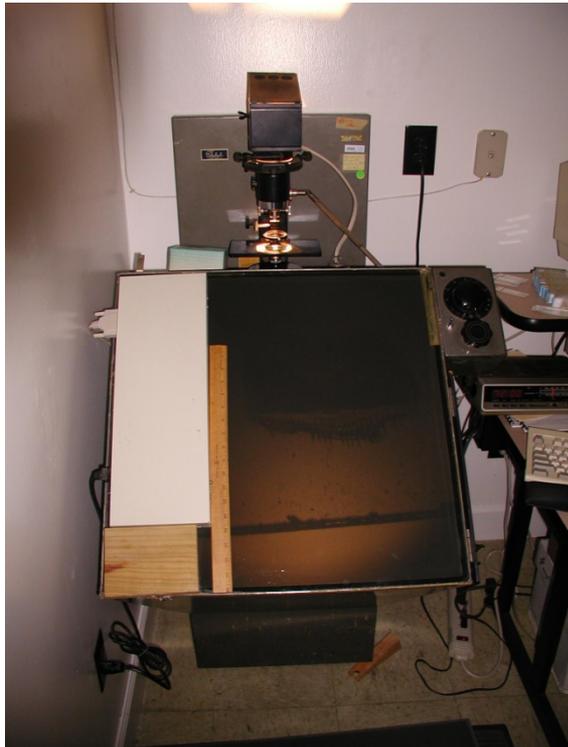
Ten fish processed for:

- Length (mm FL)
- Weight (g)
- Scale patch for ageing





## Ageing



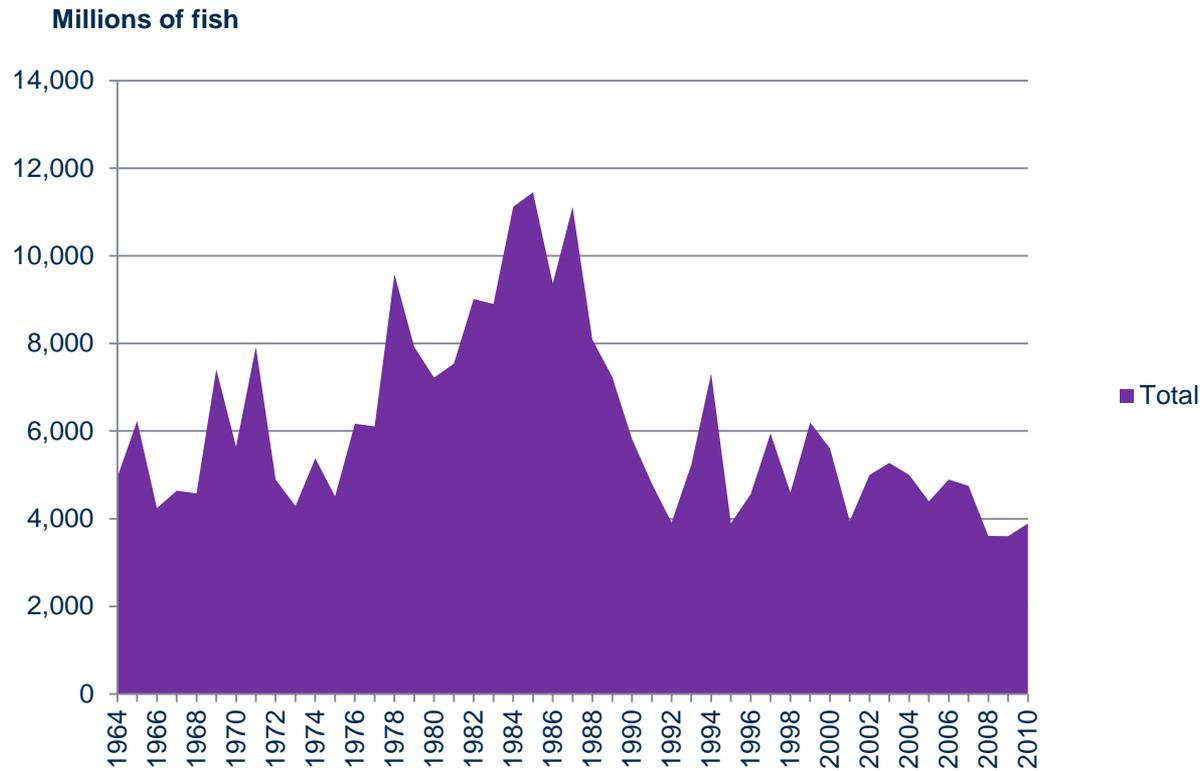


## Methodology for estimating catch in numbers at age

- Used consistently over time ( Nelson & Ahrenholz 1986; Vaughan 1987; Vaughan et al. 1996, 2000, 2007)
- Detailed sampling of landings allows biomass to be converted into catch in numbers at age
- For each port/week, biostatistical sampling provides estimate of mean weight and age distribution of fish caught
- Dividing total landings for given port/week by mean weight of sampled fish allows the numbers of fish landed to be estimated
  - Age proportion then allows numbers at age to be estimated
  - Sum across all port/weeks to get total numbers at age in total landings
- SAS statistical routine (BS003) re-written by D. Colby in late 1990s better accounts for port/weeks w/o samples
- Catch at age matrix developed at the port/week level provides for considerably greater precision than is typical for most assessments

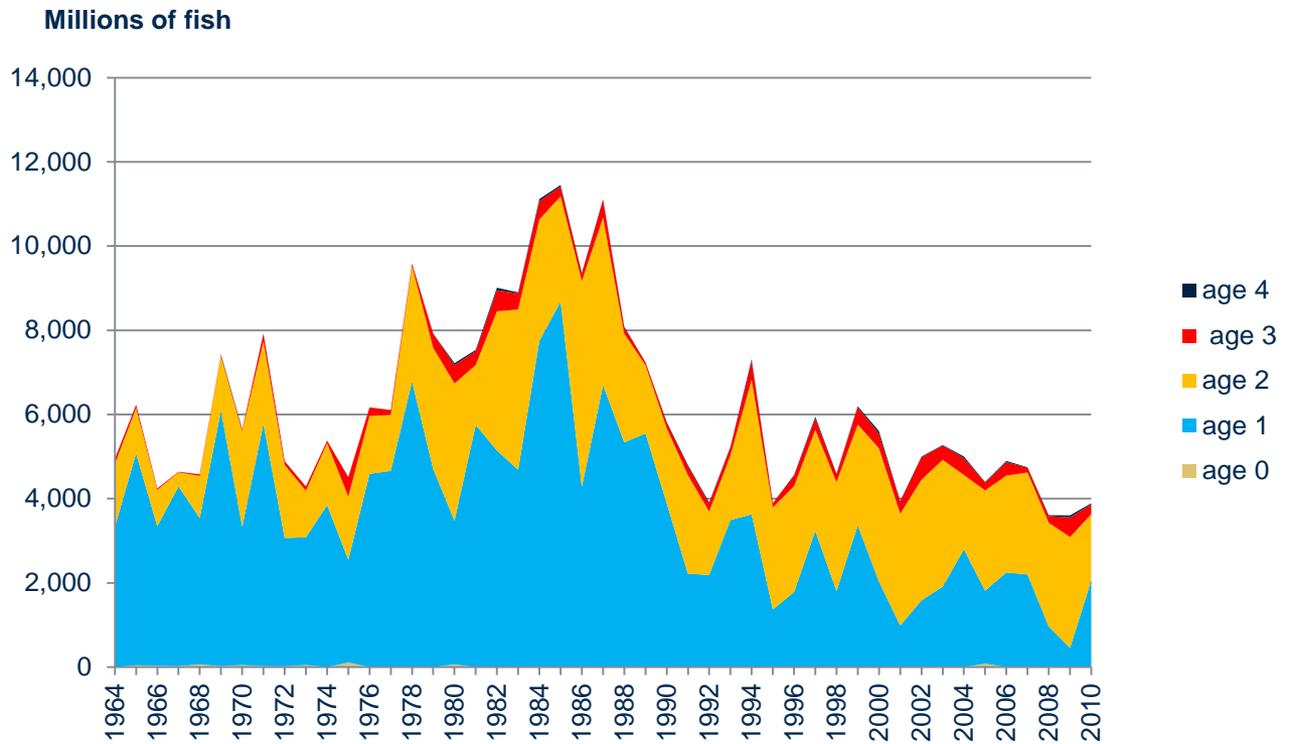


### Total numbers of catch at age for gulf menhaden, 1964-2010





### Catch at age for gulf menhaden, 1964-2010





## Captain's Daily Fishing Reports, CDFRs, established in late 1970s

**CDFR Program** – joint venture among industry, states,  
and Federal government to:

- Establish a record of daily vessel fishing activity
- Better define gulf menhaden removals by area
- Explore alternate units of nominal fishing effort

Logbook design:

- Accounts for non-fishing days: When vessels did not leave dock,  
or did not make purse-seine sets at sea
- Fishing days:
  - Enumerate number of purse-seine sets
  - Estimated catch for each set
  - Set start/finish times
  - Use of spotter pilot
  - Set location
  - Distance from shore
  - Weather variables



## Timeline for Captain's Daily Fishing Reports, CDFRs

- CDFR existed as paper files until ~1992; little use, a few data summaries; a few unsuccessful attempts at key-entry
- In 1992, NMFS Beaufort began key-entering annual Gulf CDFRs into dBase files
- In about 1999, joined w/ GSMFC to key-enter pre-1992 CDFR data sets
  - GSMFC staff keyed back to 1983
  - then, scanned/archived CDFRs from ~1979-1982 onto DVDs
- In 2009, NMFS Beaufort went to optically “scan-able” forms
- Most use to date for estimating removals by area, e.g., Texas Cap

Minor changes to CDFR form through about 2004

- In 2005, added fields for GPS coordinates



## Gulf menhaden CDFR data sets, 1983-2010

- ~100% compliance
- ~724,000 records *in toto*
- max. year: ~44,200 records in 1984
- min. year: ~14,700 records in 2010
- 1992, 1993, and 2005 data sets incomplete

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## CAPTAIN'S DAILY FISHING REPORT

Net Number 30309

| NAME OF VESSEL<br><u>WILLARD P. LEBEOUF</u>   |                 |                                  |            |           | PLANT<br><u>Mosq Point</u>   |                                    |             | DATE<br><u>7/21/05</u><br>month day year |                     |  |
|---|-----------------|----------------------------------|------------|-----------|--|------------------------------------|-------------|--|---------------------|--|
| IF VESSEL DID NOT LEAVE THE DOCK ON THIS FISHING DAY, CHECK HERE <input type="checkbox"/> |                 |                                  |            |           | IF VESSEL LEFT THE DOCK AND DID NOT MAKE ANY SETS ON THE FISHING GROUNDS THIS FISHING DAY, CHECK HERE <input type="checkbox"/> |                                    |             |  |                     |  |
| SET NO.   | TIME (Military) |                                  | FISH (000) | PLANE NO. | CDFR 5-DIGIT CODE  | FISHING LOCATION                   |             | MILES TO SHORE                           | WEATHER CONDITIONS  |  |
|   | START           | END                              |            |           |  | GPS ( dd <sup>o</sup> , mm', ss" ) |             |  |                     |  |
|   |                 |                                  |            |           |  | LATITUDE / LONGITUDE               |             |  |                     |  |
| 1   | 0645            | 0720                             | 75         | 0         | 55-377   | 29°41'282"                         | 189°21'846" | 4 N                                      | 3-87-8-1            |  |
| 2   | 0950            | 1020                             | 35         | 92        | 55-328   | 29°25'579"                         | 189°23'352" | 8 N                                      | 3-88-8-1            |  |
| 3   | 1355            | 1420                             | 40         | 0         | 55-322   | 29°38'912"                         | 189°24'288" | 5 N                                      | 3-89-4-3            |  |
| 4   | 1440            | 1510                             | 25         | 0         | 55-322   | 29°39'233"                         | 189°24'842" | 5 N                                      | 3-89-4-3            |  |
| 5   | 1615            | 1710                             | 150        | 95        | 55-377   | 29°42'223"                         | 189°18'932" | 8 N                                      | 3-89-4-3            |  |
| 6   | 1815            | 1850                             | 40         | 0         | 55-377   | 29°41'960"                         | 189°17'686" | 7 N                                      | 3-89-4-3            |  |
| 7   |                 |                                  |            |           |  | 0                                  | " / 0       |  |                     |  |
| 8   |                 |                                  |            |           |  | 0                                  | " / 0       |  |                     |  |
| 9   |                 |                                  |            |           |  | 0                                  | " / 0       |  |                     |  |
| 10  |                 |                                  |            |           |  | 0                                  | " / 0       |  |                     |  |
| 11  |                 |                                  |            |           |  | 0                                  | " / 0       |  |                     |  |
| 12  |                 |                                  |            |           |  | 0                                  | " / 0       |  |                     |  |
| PUMP OUT  |                 | COMMENTS                         |            |           |  |                                    |             |  | CAPTAIN'S SIGNATURE |  |
|   |                 | DATE / TIME RETURN TO DOCK _____ |            |           |  |                                    |             |  |                     |  |

Beginning in 2005,  
added GPS fields

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## CAPTAIN'S DAILY FISHING REPORT

Net Number:

|                           |                                       |  |
|---------------------------|---------------------------------------|--|
| VESSEL NAME<br>GULF SHORE | DATE<br>6 / 23 / 11<br>month day year | <b>OFFICE USE ONLY</b><br>VESSEL NUMBER<br>[ ] [ ] |
| PLANT<br>MOSS POINT       |                                       | PLANT NUMBER<br>[ ] [ ]                            |

IF VESSEL DID NOT LEAVE THE DOCK ON THIS FISHING DAY, CHECK HERE  IF VESSEL LEFT THE DOCK AND DID NOT MAKE ANY SETS ON THE FISHING GROUNDS THIS FISHING DAY, CHECK HERE

Switched to  
optically "scan-able"  
forms in 2009

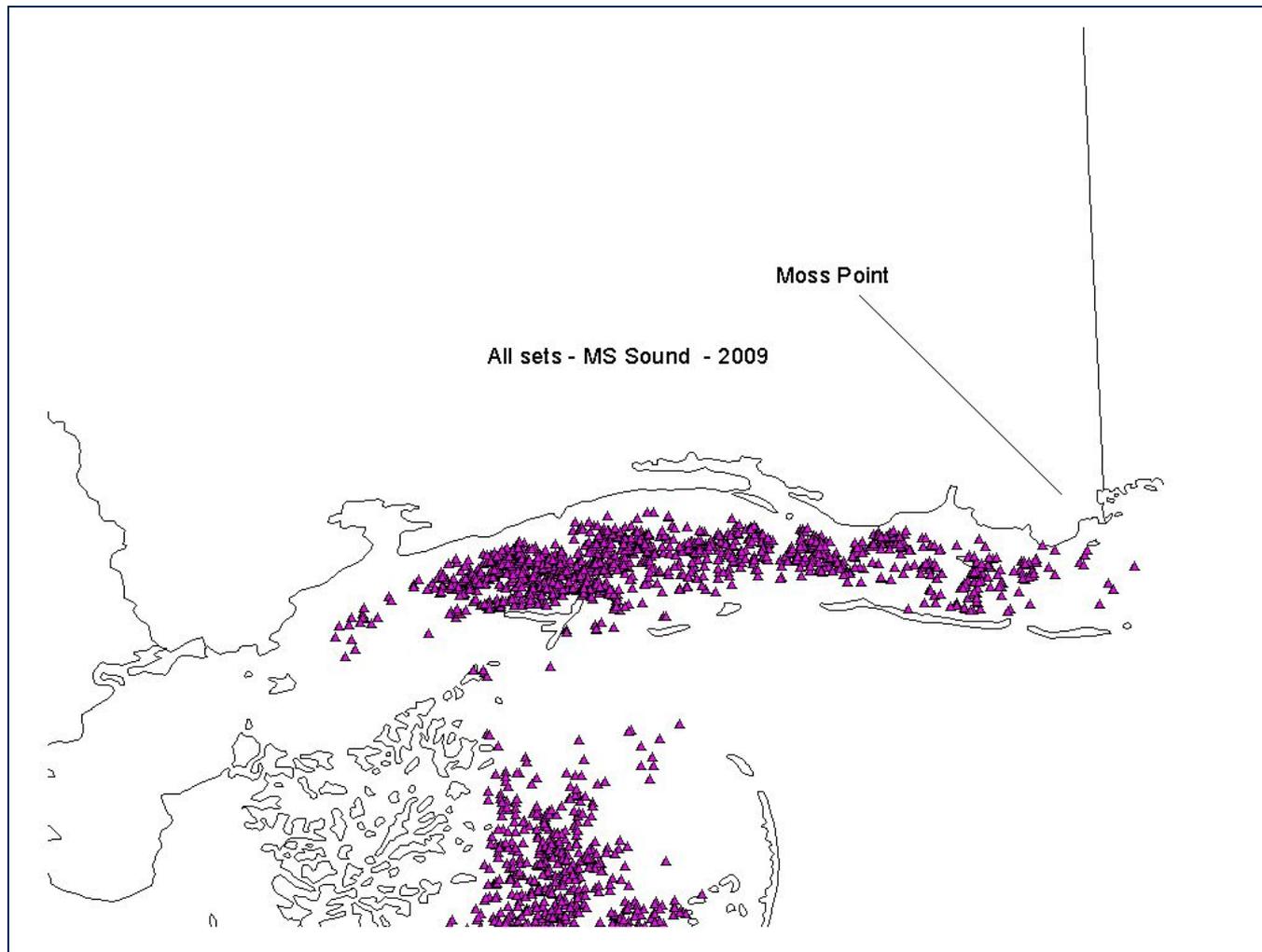
| SET NO. | TIME (Military) |      | FISH (000) | PLANE NO. | FISHING LOCATION  |   |    |    |    |           |    |     | MILES TO SHORE | WEATHER CONDITIONS |           |           |            |  |
|---------|-----------------|------|------------|-----------|-------------------|---|----|----|----|-----------|----|-----|----------------|--------------------|-----------|-----------|------------|--|
|         | START           | END  |            |           | CDFR 5-DIGIT CODE | GPS (dd°, mm', ss") [degrees, minutes, decimal seconds] |    |    |    |           |    |     |                | Cloud Cover        | Air Temp. | Wind Dir. | Wind Speed |  |
|         |                 |      |            |           |                   | LATITUDE  |    |    |    | LONGITUDE |    |     |                |                    |           |           |            |  |
| 1       | 815             | 855  | 50         | 43        | 55336             | 29  | 24 | 61 | 89 | 23        | 25 | 1.5 | 381            | 100                |           |           |            |  |
| 2       | 925             | 955  | 95         | 0         | 55334             | 29  | 24 | 54 | 89 | 25        | 78 | 2.3 | 384            | 105                |           |           |            |  |
| 3       | 1010            | 1045 | 60         | 44        | 55326             | 29  | 24 | 10 | 89 | 25        | 88 | 1.8 | 386            | 110                |           |           |            |  |
| 4       | 1215            | 1310 | 125        | 0         | 55325             | 29  | 26 | 41 | 89 | 28        | 06 | 2.0 | 386            | 115                |           |           |            |  |
| 5       |                 |      |            |           |                   |   |    |    |    |           |    |     |                |                    |           |           |            |  |
| 6       |                 |      |            |           |                   |   |    |    |    |           |    |     |                |                    |           |           |            |  |
| 7       |                 |      |            |           |                   |   |    |    |    |           |    |     |                |                    |           |           |            |  |
| 8       |                 |      |            |           |                   |   |    |    |    |           |    |     |                |                    |           |           |            |  |
| 9       |                 |      |            |           |                   |   |    |    |    |           |    |     |                |                    |           |           |            |  |
| 10      |                 |      |            |           |                   |   |    |    |    |           |    |     |                |                    |           |           |            |  |
| 11      |                 |      |            |           |                   |   |    |    |    |           |    |     |                |                    |           |           |            |  |
| 12      |                 |      |            |           |                   |   |    |    |    |           |    |     |                |                    |           |           |            |  |
| 13      |                 |      |            |           |                   |   |    |    |    |           |    |     |                |                    |           |           |            |  |
| 14      |                 |      |            |           |                   |   |    |    |    |           |    |     |                |                    |           |           |            |  |
| 15      |                 |      |            |           |                   |   |    |    |    |           |    |     |                |                    |           |           |            |  |

|          |  |  |
|----------|--|--|
| PUMP OUT | COMMENTS:<br>DATE / TIME RETURN TO DOCK <u>6/23/11 16:15 hrs</u> | <u>Capt. Fat Back</u><br>CAPTAIN'S SIGNATURE |
|----------|--|--|

CDFR CREATED: 02/17/2009 Rev. 010



...with GPS coordinates...





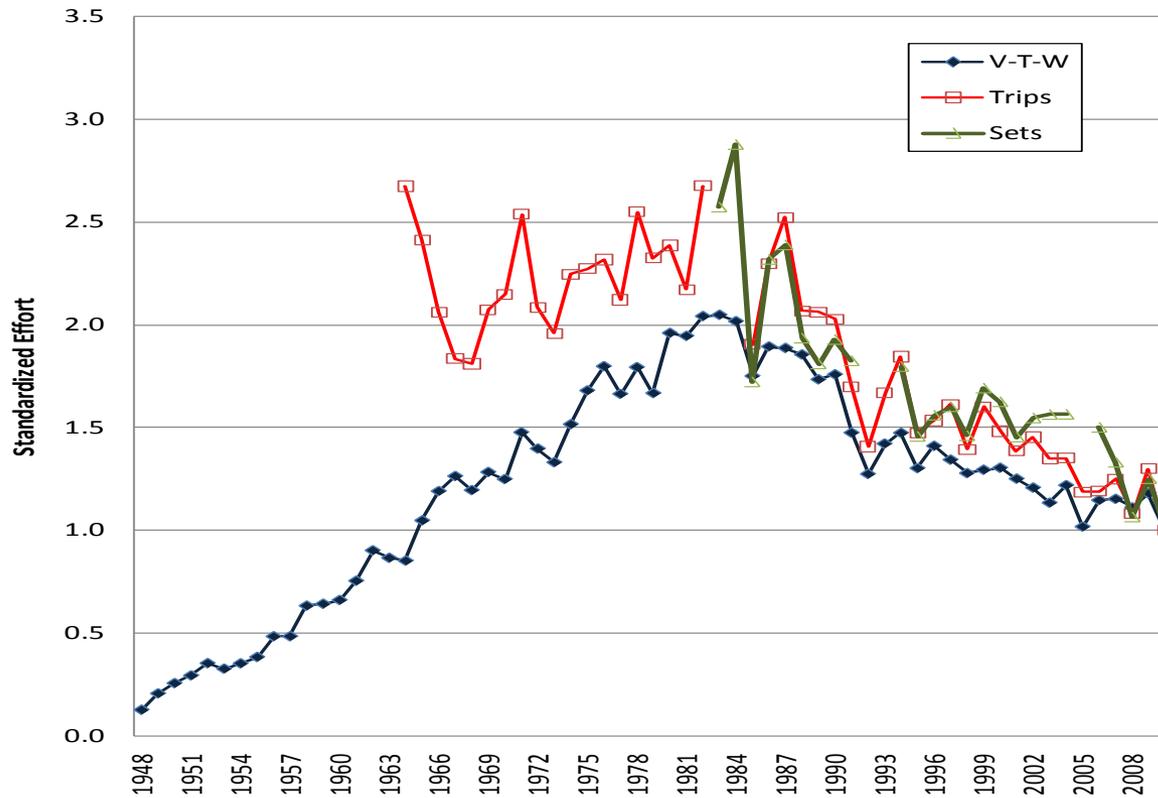
## Alternate Estimates of Nominal Fishing Effort

- Traditional: Vessel-tons-weeks
- From Catch Records: Number of successful fishing trips
- From CDFRs: Number of purse-seine sets



Comparison of nominal fishing effort for gulf menhaden fleet.  
 (1) vessel-ton-week, 1948-2010,  
 (2) trips, 1964-2010, and  
 (3) purse-seine sets, 1983-2010.

Figure 4.5  
in Report



All effort estimates are standardized by dividing by the respective value in 2010 to put them on a common scale



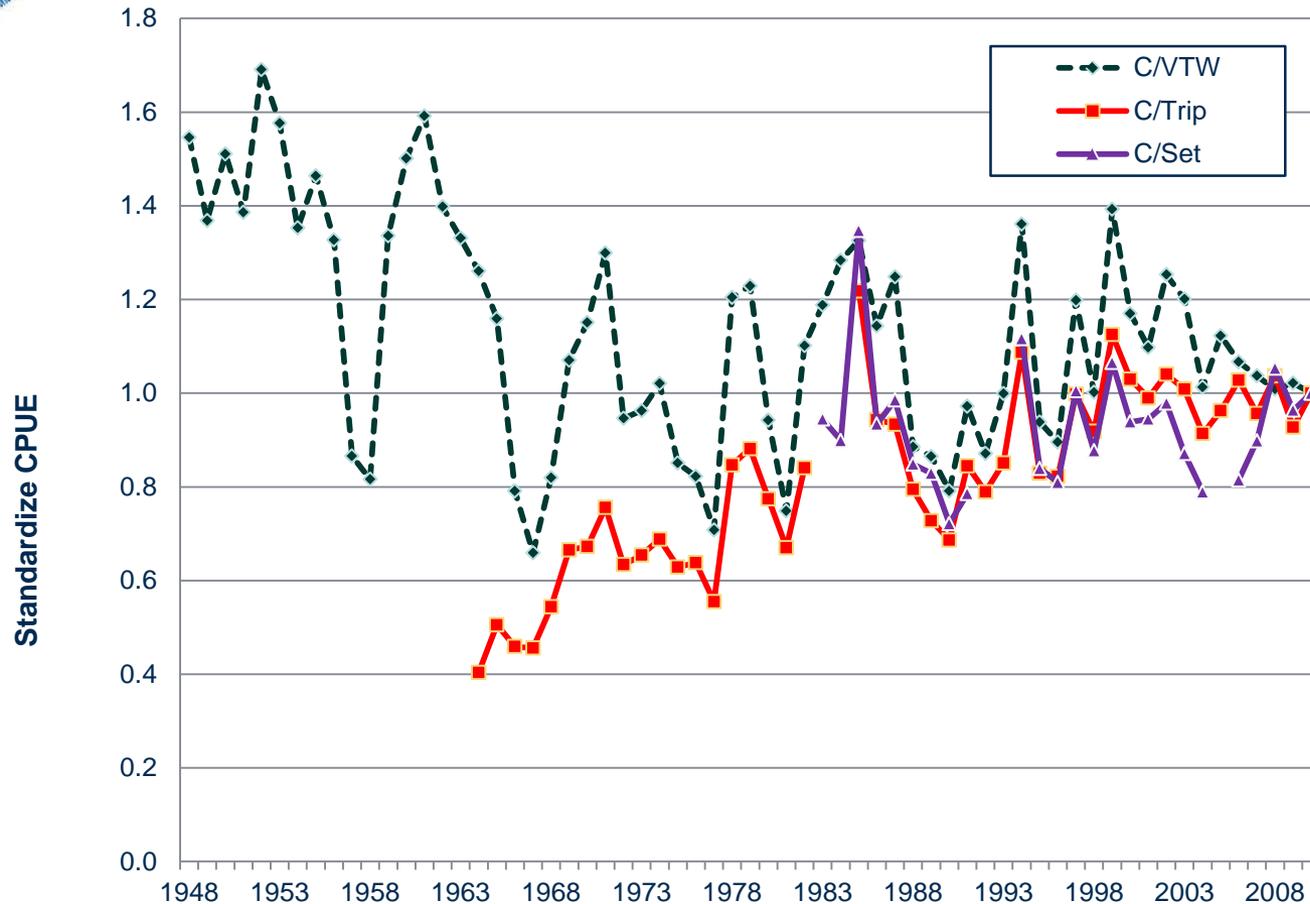
## Alternate Estimates of CPUE

- Traditional:  $\text{Total Catch} / \text{vessel-tons-weeks}$
- From Catch Records:  $\text{Total Catch} / \text{Number of successful fishing trips}$
- From CDFRs:  $\text{Total Catch} / \text{Number of purse-seine sets}$



Comparison of calculated CPUE across different measures of fishing effort, including landings per vessel-ton-week (C/VTW), landings per trip (C/Trip) and catch per set

Figure 4.7  
in Report



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# NOAA FISHERIES SERVICE





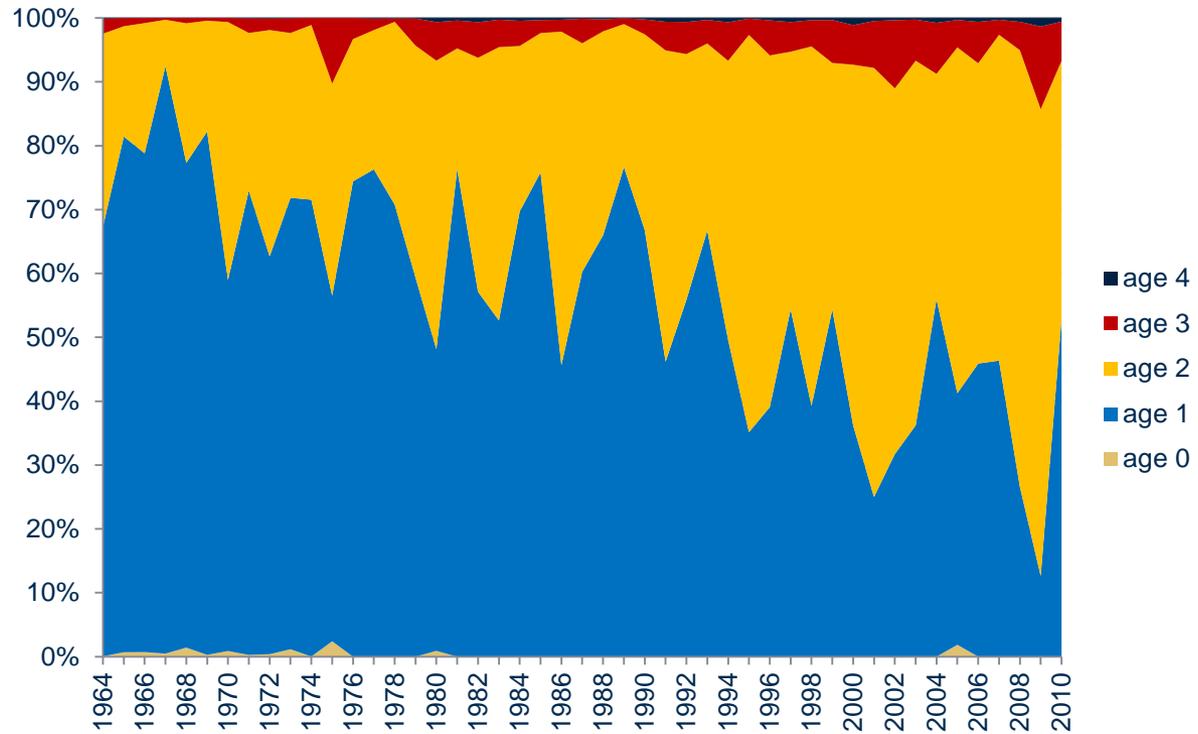
Mean net tonnage (metric) of the gulf menhaden purse-seine fleet by selected fishing years since 1970.

DW05,  
Table 8

| Mean net tonnage of the gulf menhaden fleet since 1970 |                  |                               |                       |
|--|------------------|-------------------------------|-----------------------|
| Fishing Year   | Mean net tonnage | No. of vessels in calculation | Range of net tonnages |
| 1970   | 248              | 72                            | 80-386                |
| 1980   | 315              | 79                            | 139-453               |
| 1990   | 317              | 75                            | 147-447               |
| 2000   | 338              | 43                            | 197-453               |
| 2010   | 354              | 40                            | 187-453               |



Proportion at age of gulf menhaden in the catch,  
1964-2010



DW05,  
Fig. 2



## Reasons for increase in proportion of age-2s in catch at age matrix ??

- Contraction of fishery over time from extremes of *B. patronus* range, i.e., Florida and Texas where smaller and younger fish are more abundant, to center of the northern GOM
- Re-distribution over time of age-1s toward more “inside” waters where they become unavailable to the fishery
  - Due to marsh habitat loss ??
- “Corralling effect” of hypoxic waters in the northern Gulf during summer
  - Fish herded into narrow areas along LA coast ??