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VIMS Juvenile Fish Trawl Survey

Juvenile Indices 1979-1994

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By

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Introduction

This year marks the 40th anniversary of the Virginia Institute of Marine Science's (VIMS) Juvenile Fish and Blue Crab Trawl Survey (commonly called the "Trawl Survey"). Since 1955, Department of Fisheries Science staff have monitored the abundance of young fish in the Virginia portion of Chesapeake Bay and its three major tributaries. By estimating the number of young fish, VIMS scientists can give fishery managers an estimate of the relative size of the population available to fishermen some years later.

Currently, the survey samples waters from the mouth of the Chesapeake Bay up to the freshwater interface of the James, York, and Rappahannock Rivers. Samples from about 60 stations are collected every month of the year from the 28-foot research vessel *Fish Hawk*. At each station, a 30 foot wide shrimp trawl is towed for five minutes. Once on board, the catch is sorted by species, the number of fish of each species is counted, and a large proportion of the fish are measured. Each month, 20 to 50 thousand fish, crabs, and other invertebrates are processed. About 70 species are commonly caught, though 223 have been identified over the last 40 years, including several not previously collected in the Chesapeake Bay.

The regularly scheduled nature of the survey provides an opportunity for other researchers to collect samples and conduct related research. Numerous student master's theses, doctoral dissertations, research reports, and scholarly papers have been written as a result of work from the VIMS Trawl Survey.

Trawl Survey History

In April 1955, the survey began with a series of stations sampled in the mid-river channel, at approximately five mile intervals, from the mouth of the York River up to West Point (where the York splits into the Pamunkey and the Mattaponi Rivers). Stations were sampled irregularly for the rest of that year. Since April 1956, these stations have been sampled almost continuously, at least for the months of April through November. Two or three stations in the lower part of the Chesapeake Bay, in the deep waters of the Chesapeake Channel, were also regularly sampled for several years, along with samples further up into the Pamunkey River.

In 1962, sampling of stations on the Rappahannock River commenced (though somewhat irregularly), and in 1964, stations on the James River were added. During some periods, samples were taken from the Potomac River, Mobjack Bay, and several smaller tributaries. Sporadically, the Chesapeake Bay was sampled semi-annually until in 1988 regular sampling of the entire Virginia portion of the Chesapeake Bay began.

Funding sources, and therefore the survey goals and methods, have changed several times over forty years. At times the primary target species have been sciaenids (spot, croaker, weakfish), anadromous species (shad, river herring, striped bass, white perch), and blue crabs. During some years, general monitoring has been the focus.

The trawl gear has been modified several times, affecting the size of fish captured and the *relative* species composition of the catch. Originally, the gear did not have a small mesh liner so smaller species such as bay anchovy, and small individuals of other species were not caught. The liner was added in 1973. In 1979, a "tickler chain," which stirs up and increases the catch of bottom-dwelling species (such as blue crabs and flatfish), was added. The gear has been essentially unchanged since then, except that the "doors" (wings which pull the mouth of the net open as it travels through the water) were changed in 1991. This change did not significantly alter the catch. Recently, extensive sampling has been done using these various gear configurations to standardize the catch rate associated with each gear combination.

Survey Goal

The current primary goal of the survey is to develop "indices of abundance" for a number of recreationally, commercially, and otherwise ecologically important species. These indices measure the relative size of each "year class" (see Glossary on page 7) for each target species. Calculation of the index is basically an average catch-per-tow computation, after the data are statistically treated to minimize the effect of extremely high and low catches.

Most species targeted by this survey are available to the survey nets for a limited amount of time during the year because of seasonal abundance. Further, many species have a limited geographic range within the Bay and its tributaries. For each species then, only the three or four months of highest abundance are used in computation of the index, and only the areas in which each species is most plentiful are included for the index. For some species this is all river and Bay segments, for others only the Bay or subsections of the Bay are used, and for still others, only the rivers or river segments are used.

For most target species, individuals become susceptible to, or can be caught by, the survey nets

several months after hatching, when they are referred to as Age 0 or "juvenile" fish. Some species are also (or exclusively) caught as older individuals. For some species this group of older fish is only one year class and for other species it is several. Indices are also calculated for these older groups. Where these indices clearly represent only one year class they are labeled as "Age 1"; where they include several year classes they are referred to as "Age 1+."

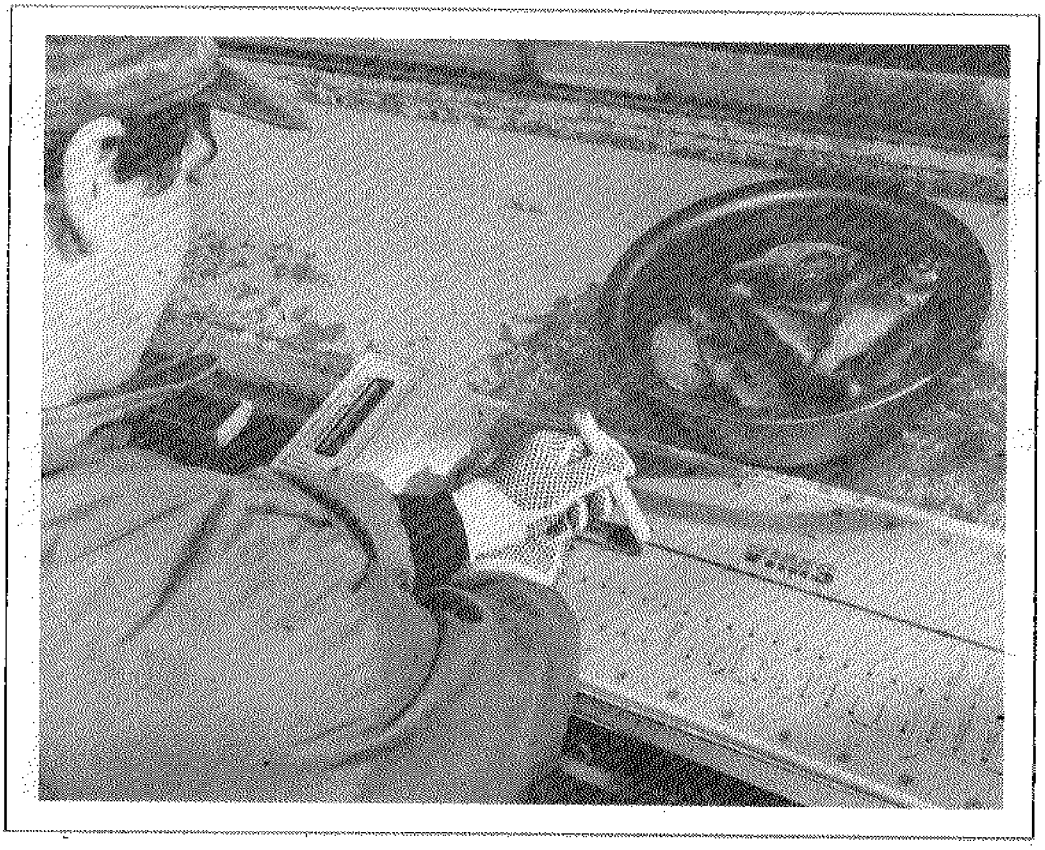
The utility of juvenile indices is that they provide a snapshot of the size of each year class and can be used to forecast the *relative* number of adult fish one to several years later. When combined with other surveys which sample adult fish, a comprehensive picture of the relative condition of a fish population can be compiled. Indeed, the VIMS Trawl Survey is just one element of a VIMS comprehensive fish monitoring program which includes beach seine surveys targeting striped bass, white perch, and bluefish; surveys which sample juvenile shad much further upriver than the Trawl Survey; and pound net and gill net surveys which sample adult fish of several species. Because most of these species are migratory, the VIMS surveys are elements of multi-state monitoring efforts which support interstate fishery management plans.

Data Handling

Every month, scientists working on the VIMS Juvenile Fish and Blue Crab Trawl Survey handle 20 to 50 thousand fish. Twenty to thirty percent (forty to fifty percent of fish other than bay anchovy) of these fish are individually measured. How does all of that data make its way into the historical data base?

Until 1987, one scientist would measure a fish, call out its length while another person would record the data. Later, someone else would enter the data into a computer data base. Usually, most fish would have to be preserved in the field, brought back to the lab, and then processed. So much effort was required gathering and entering data that there was little time for subsequent analyses.

In 1988, two years of development work came to fruition when use of electronic fish measuring boards began in the field. These boards are connected to a computer running a data base program. As each fish is placed on the board, the operator touches a magnetic wand to the end of the fish's tail, and the length is electronically recorded. Using these devices, almost all data are now entered directly in a computer data base, on board the research vessel, and few fish are ever brought back to the lab. Data are available for analysis within a couple of days of the field work.



Researcher using electronic fish measuring board. See "Data Handling" section for more details.

Survey Results

The attached graphs give survey results for the past 15 years for 28 species. Data for the years prior to 1979 are not presented because we are currently evaluating conversion factors to standardize the various gear modifications which were described earlier.

The horizontal axis for each graph represents the "year class" year for that species. For some species, we measure year class strength in the calendar year following the year of hatching; therefore, there is no 1994 data for those species.

Each page of graphs represents a related group of species. In some cases the grouping is taxonomic, in others it is ecological.

Indices for Atlantic croaker (*Micropogonias undulatus*), striped bass (*Morone saxatilis*), alewife (*Alosa pseudoharengus*), and American shad (*Alosa sapidissima*) are based on only river samples and are presented for only one year class. Computations for windowpane (*Scophthalmus aquosus*), smallmouth flounder (*Etropus microstomus*), striped anchovy (*Anchoa hepsetus*), Atlantic silverside (*Menidia menidia*), scup (*Stenotomus chrysops*), butterfish (*Peprilus triacanthus*), harvestfish (*Peprilus alepidotus*), northern puffer (*Sphoeroides maculatus*), inshore lizardfish (*Synodus foetens*), and northern searobin (*Prionotus carolinus*) are based on only Chesapeake Bay samples so only one index is presented and with data only from 1988 to the present.

For some species more than one index is shown. There are three situations where this occurs:

- For spot (*Leiostomus xanthurus*), weakfish (*Cynoscion regalis*), silver perch (*Bairdiella chrysoura*), summer flounder or fluke (*Paralichthys dentatus*), bay anchovy (*Anchoa mitchilli*), spotted hake (*Urophycis regia*), and black seabass (*Centropristis striata*), the most reliable index is based on both Chesapeake Bay and river samples. However, since the Bay stations have only been regularly sampled under the present format since 1988, a "Rivers Only" index is also presented in order to give the longest possible view of the data.
- For blackcheek tonguefish (*Symphurus plagiusa*), hogchoker (*Trinectes maculatus*), channel catfish (*Ictalurus punctatus*), white catfish (*Ictalurus catus*), blue catfish (*Ictalurus furcatus*), and white perch (*Morone americana*), both Age 0 and Age 1(+) indices are shown.
- For blue crabs, both an index for "juvenile" (up to about 65mm or 2½") crabs which will enter the fishery several months later, and one for "recruits" (those either just under or already at legal size) are presented.

The methods we use to calculate indices of abundance from the VIMS Trawl Survey data sets are constantly under review. The "cut-off lengths" used to separate young-of-year from older fish, along with the geographic and temporal data limits used for each species, may change as more study is done. Therefore, though we are confident that any trends seen in the abundance graphs are real, the actual index of abundance values may change somewhat as our methods are improved.

Drum Family

Spot -

The number of juvenile spot caught in Trawl Survey nets remained low for the fourth year in a row.

Atlantic Croaker -

The abundance of this species in Chesapeake Bay is highly dependent upon survival of winter temperatures. In 1994, this species continued at a moderate level, well below the level of three "dominant" year classes in 1984, 1985, and 1989.

Weakfish -

This species has been the subject of major interstate concern and management over the past several years. After maintaining relatively successful levels of reproduction in the Bay region for several years, the index for this species declined to very low levels in 1994.

Silver Perch -

This species is not terrifically abundant in the Bay in general or in the survey nets, but enough are caught to compute a meaningful index. The index for silver perch remained low compared to the very abundant year of 1990.

Flatfish

Summer Flounder -

After two dismal year classes, the index for 1994 recovered to the moderately successful levels of 1990 and 1991, but remained well below the healthy levels of the early 1980s.

Blackcheek Tonguefish -

This species is too small to be of commercial or recreational importance, but is very abundant in our survey nets. The young-of-the-year index declined for the second straight year and remains low compared to the mid- 1980s. The Age 1 index, which for this species probably contains one year old fish only, also declined to a very low level.

Hogchoker -

Though this species may be almost unknown to many fishermen, it is typically the second most abundant species in the survey (after bay anchovy). It is the only "sole" species in the Chesapeake Bay region and is abundant from the Bay

mouth all the way to the freshwater interface. Both the Age 0 and Age 1 (the Age 1 index represents mostly one year old fish only) indices were down compared to previous years but were at moderate levels.

Windowpane and Smallmouth Flounder -

Judging only from juvenile indices, these populations seem relatively healthy. With only a seven year data string, however, there is little historical context with which to compare recent indices.

Blue Crab

Blue Crab -

The size categories which we use to define "juvenile" and "recruit" size classes, as well as the appropriate time frame, for this most important species are under rigorous review. There is no doubt, however, that there has been a serious decline over the last few years in the pre-fishery sized indices.

Catfish

Channel Catfish and White Catfish -

All of the catfish species are freshwater fish which are able to tolerate low levels of salinity and therefore overlap with the geographical coverage of the survey. The "Age 1 +" categories of all of the catfish species include several year classes. Both channel catfish and white catfish showed moderate increases in the young-of-year indices in 1993 (as measured in early 1994).

Blue Catfish -

The aggressive and fast-growing species was introduced to Virginia about 25 years ago. Judging from the almost steadily increasing juvenile and age 1 + indices, this species is establishing itself as a permanent resident in Virginia.

Anadromous Fish

Striped Bass -

All evidence points to a well recovering population for this most highly prized species. The 1994 Trawl Survey data, which measured the 1993 year class, confirmed a year of excellent reproduction as also measured several months earlier by the VIMS Striped Bass Beach Seine Survey.

White Perch -

The 1993 year class, as measured by this survey, was also quite successful. The Age 1+ index for this species contains several year classes.

Alewife and American Shad

The nursery area for these species is generally further upriver than the Trawl Survey typically samples. Other VIMS surveys provide better measures of the reproductive success than does the Trawl Survey. Trawl Survey data are presented here for informational and comparative purposes.

Forage Fish

Bay Anchovy, Striped Anchovy, and Atlantic Silverside -

All three of these species, at the base of the food web, seem to be in relatively healthy states.

Coastal Species

Scup -

The age structure of the fish we catch of this species is presently under review. Previously believed to be Age 1 fish, data from other agencies on the east coast indicate the fish to be young-of-year. Otoliths (a small bone within the inner ear) have been collected from fish captured in our trawl net and our index will be defined based on those results. The index for scup was essentially unchanged as measured in 1994.

Butterfish and Harvestfish -

Both of these closely related species seem to be experiencing multi-year declines, but there is little historical context in which to place our recent indices.

Spotted Hake -

It is hard to define a trend in the timeline for this species.

Miscellaneous Species

Black Seabass -

Juvenile recruitment of this highly sought after species seemed to continue a trend of bouncing around a stable average value.

Northern Puffer, Inshore Lizardfish, Northern Searobin -

Though there is little historical context, these species seemed to all be at low levels of juvenile recruitment over the past several years.

Year Class - Most fish species reproduce only during a relatively short (one to two month) period each year. That period is different for each species. Fisheries scientists refer to all of the fish of any species hatched during one annual spawning period as a year class. For mathematical purposes, fishery analysts often treat the population as if all fish were hatched on one day.

Juvenile - Strictly speaking, a juvenile is any fish which is not yet sexually mature. In the context of this type of fish survey, however, it is most often used interchangeably with young-of-year.

Index - A relative measure of the size of a population or sub-unit of the population, such as a year class. It is usually measured as number (or weight) of fish caught per standard unit of fishing effort. In the case of this survey, it is the number of fish caught per 5-minute trawl tow (with statistical treatment to reduce the effect of high and low catches).

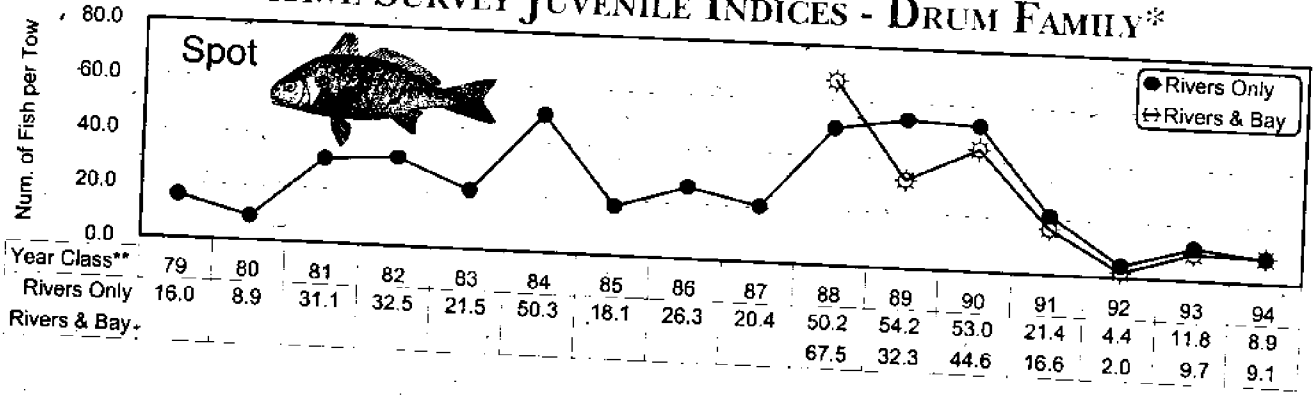
Recruitment - This term has several meanings in fishery science. One definition is the size at which a fish is eligible to be legally caught. Another is the size at which a fish becomes susceptible to a particular fishing gear. In the context of this report, it refers to the number of juvenile fish which enter the population.

Trawl Survey - Much of what fishery scientists do involves using a particular kind of fishing gear to take regular measurements of abundance for particular species in a geographic area. The target species determine the type of gear used, and hence, (often) the name of the survey. This survey uses an "otter trawl" which is much like the shrimp nets used by commercial fishermen in the South Atlantic and Gulf of Mexico. Gears used in other fish surveys include haul seines (used in the well known striped bass surveys in Maryland and Virginia), push nets, pound nets, and gill nets. Gears used for shellfish surveys include dredges, suction sampling, tongs, strings of oyster shells, and others.

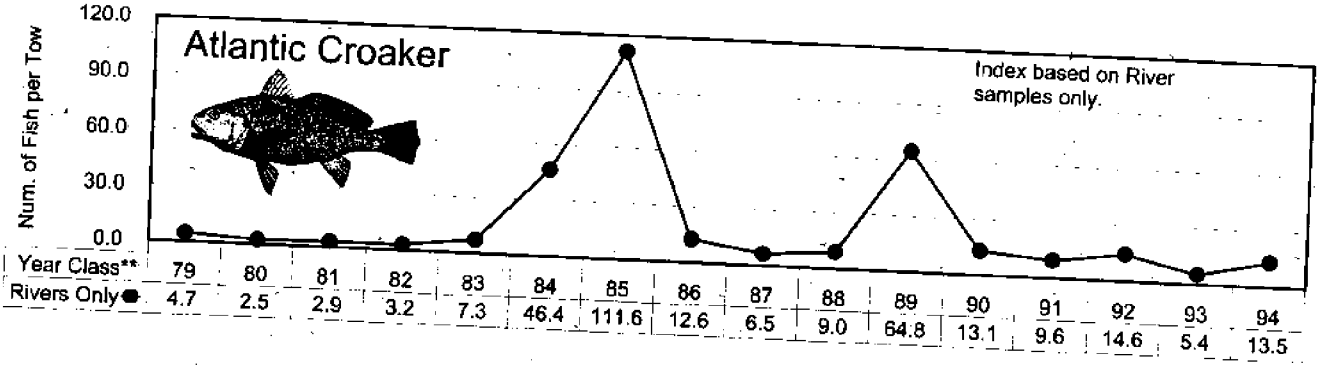
When species caught in different surveys overlap, results of the two surveys may be used to verify each other. Such is the case with striped bass in the Virginia Trawl Survey and Seine Survey which have both documented the recovery of this highly prized species.

Young-of-Year - All of the fish of a species younger than one year of age. Usually scientists assign an arbitrary "birth date" to all of the fish of a species hatched over a two or three month period in one year. The fish are then promoted to Age 1 status on that birth date.

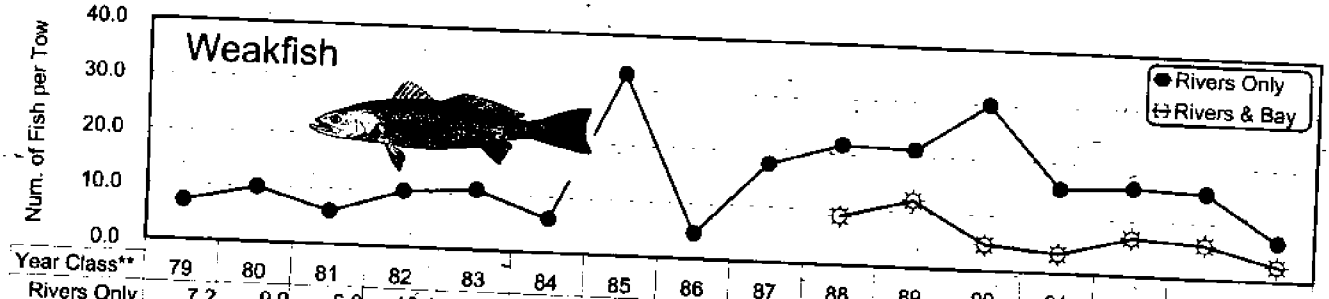
VIMS Trawl Survey Juvenile Indices - Drum Family*



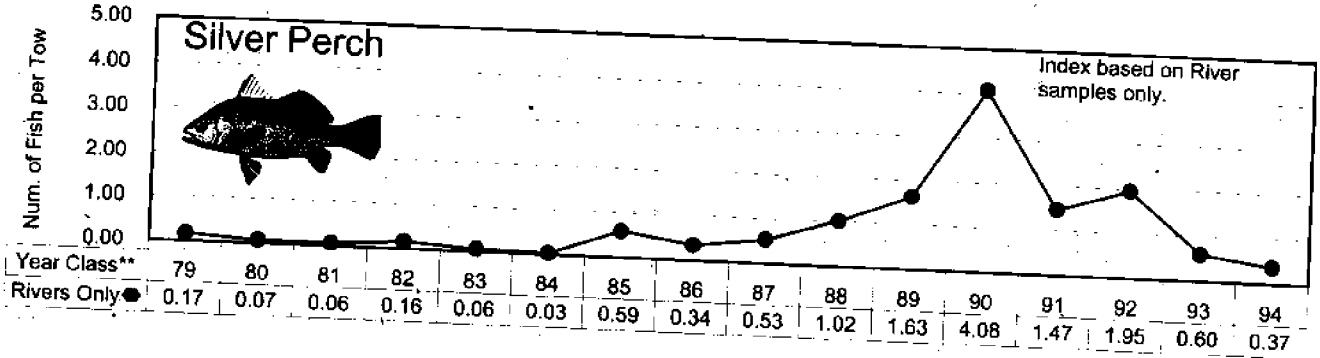
Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Rivers Only	16.0	8.9	31.1	32.5	21.5	50.3	16.1	26.3	20.4	50.2	54.2	53.0	21.4	4.4	11.8	8.9
Rivers & Bay										67.5	32.3	44.6	16.6	2.0	9.7	9.1



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Rivers Only	4.7	2.5	2.9	3.2	7.3	46.4	111.6	12.6	6.5	9.0	64.8	13.1	9.6	14.6	5.4	13.5



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Rivers Only	7.2	9.9	6.0	10.1	10.8	6.1	32.9	4.6	17.8	21.7	21.3	30.0	15.3	15.9	15.4	7.0
Rivers & Bay	no data	no data	no data	no data	no data	no data	no data	no data	no data	8.9	12.2	4.8	3.6	6.9	6.1	2.7

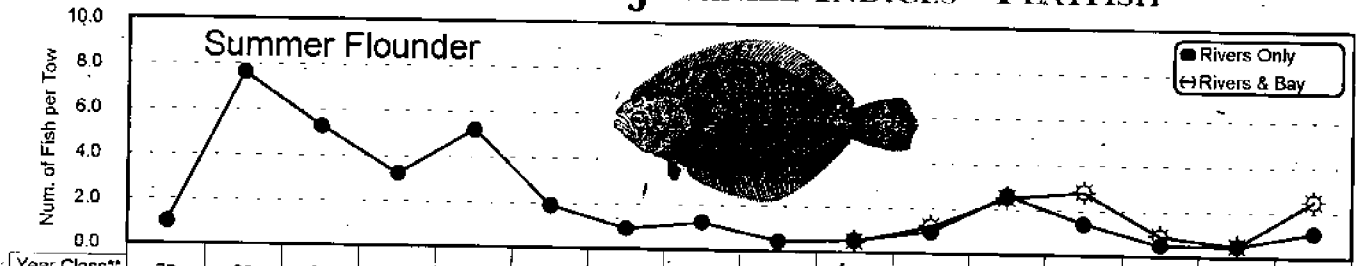


Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Rivers Only	0.17	0.07	0.06	0.16	0.06	0.03	0.59	0.34	0.53	1.02	1.63	4.08	1.47	1.95	0.60	0.37

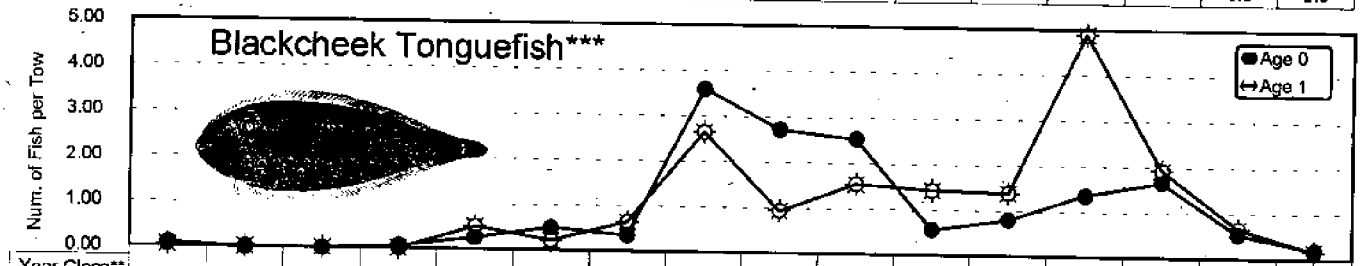
* Data prior to 1979 are not presented pending completion of gear efficiency studies.

** Numbers in the data table are the index values represented on the graph.

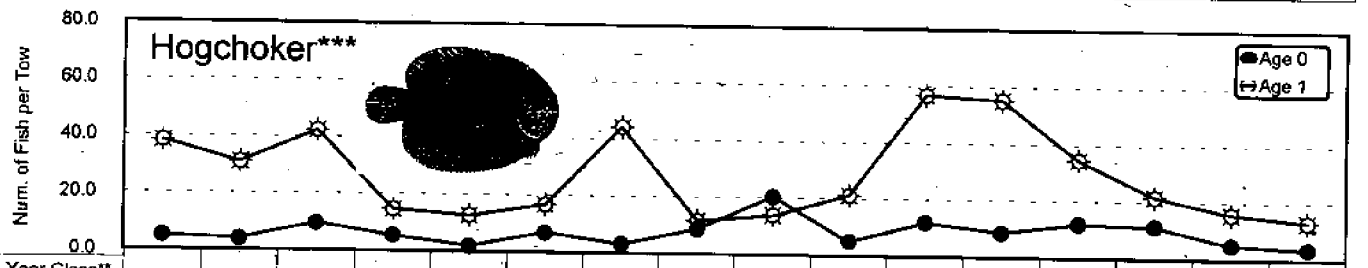
VIMS Trawl Survey Juvenile Indices - Flatfish*



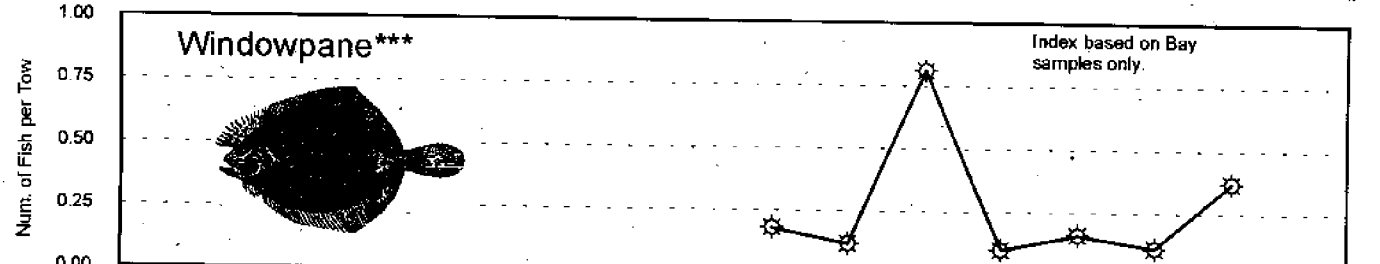
Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Rivers Only	1.0	7.6	5.3	3.2	5.2	1.9	0.9	1.2	0.5	0.5	1.0	2.6	1.4	0.5	0.5	1.1
Rivers & Bay	no data	no data	no data	no data	no data	no data	no data	no data	no data	0.5	1.2	2.5	2.8	0.9	0.5	2.5



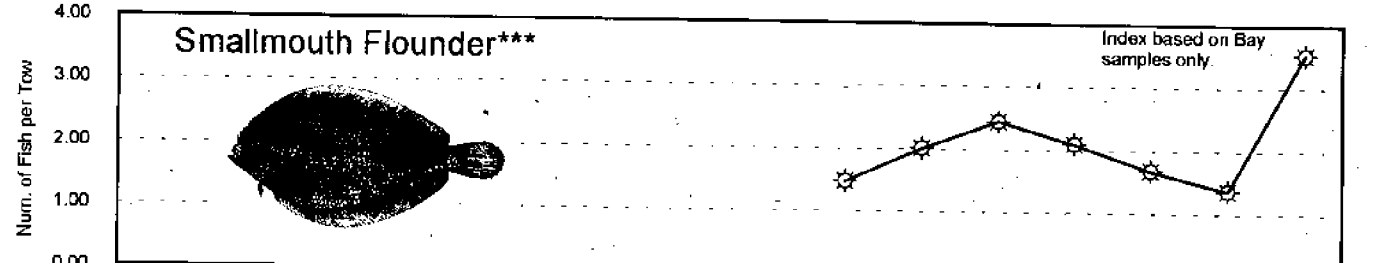
Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Age 0	0.09	0.00	0.00	0.07	0.26	0.50	0.35	3.59	2.72	2.54	0.56	0.80	1.36	1.66	0.53	0.19
Age 1	0.04	0.02	0.00	0.01	0.50	0.22	0.64	2.65	0.93	1.54	1.43	1.39	4.89	1.93	0.66	0.16



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Age 0	5.0	3.9	9.6	5.4	1.9	6.9	3.1	8.7	20.4	5.0	12.0	8.7	12.0	11.3	4.9	3.6
Age 1	38.2	30.8	42.2	14.6	12.5	16.6	44.2	11.6	13.8	21.1	56.9	55.2	34.5	21.6	15.7	13.0



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Bay Only↔	no data	no data	no data	no data	no data	no data	no data	no data	0.18	0.12	0.81	0.10	0.16	0.11	0.37	meas'd in 1995



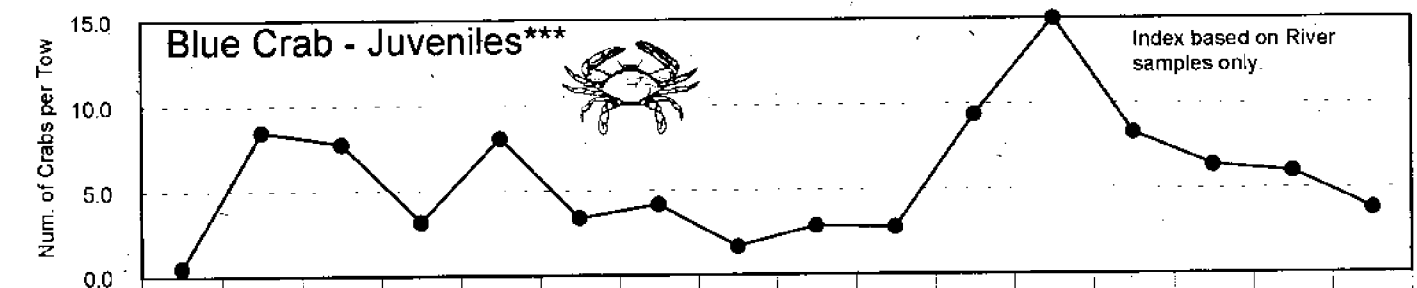
Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Bay Only↔	no data	no data	no data	no data	no data	no data	no data	no data	no data	1.47	2.01	2.44	2.09	1.67	1.36	3.53

* Data prior to 1979 are not presented pending completion of gear efficiency studies.

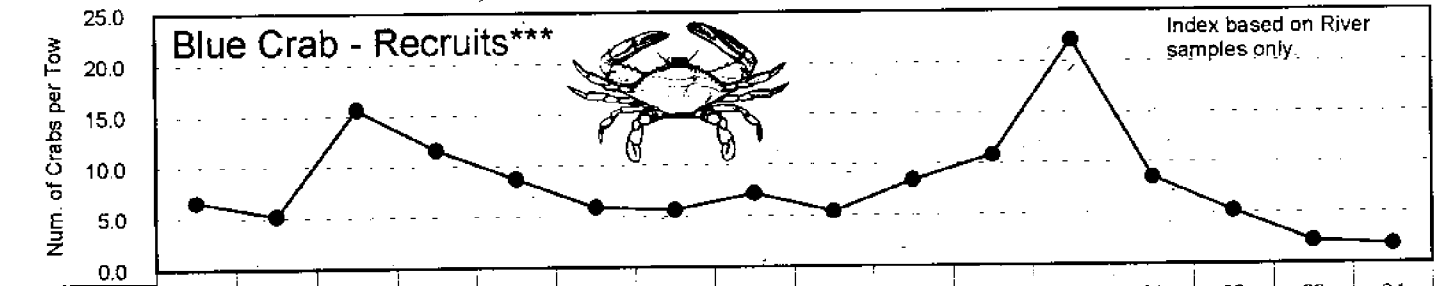
** Numbers in the data table are the index values represented on the graph.

*** These indices are provisional pending literature review and aging analysis.

VIMS Trawl Survey Juvenile Indices - Blue Crabs*



Year Class **	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Juveniles	0.5	8.5	7.8	3.2	8.1	3.4	4.2	1.7	2.9	2.8	9.4	15.0	8.3	6.4	6.0	3.8



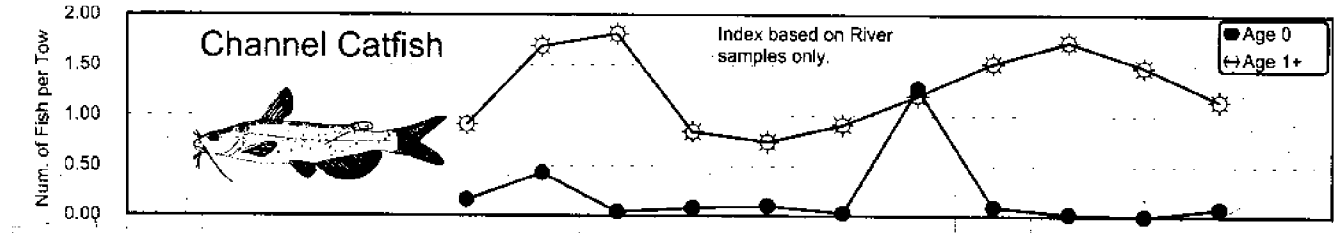
Year Class **	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Recruits	6.6	5.2	15.6	11.6	8.7	5.9	5.6	7.2	5.4	8.4	10.8	22.1	8.5	5.2	2.2	1.8

* Data prior to 1979 are not presented pending completion of gear efficiency studies.

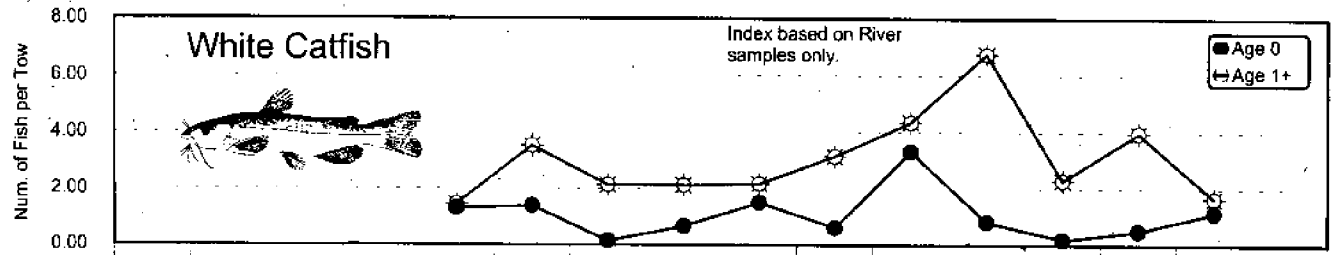
** Numbers in the data table are the index values represented on the graph.

*** These indices are under review for appropriate size cutoffs and months of importance.

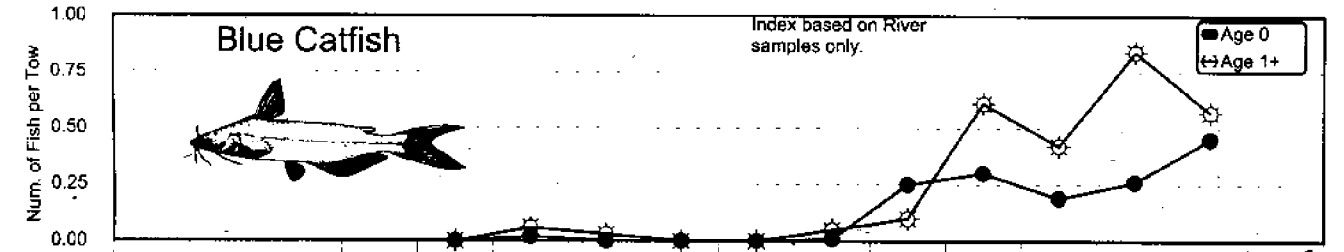
VIMS Trawl Survey Juvenile Indices - Catfish*



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Age 0	no	no	no	no	0.16	0.43	0.04	0.08	0.10	0.03	1.27	0.09	0.02	0.00	0.08	meas'd
Age 1+	data	data	data	data	0.91	1.69	1.81	0.84	0.74	0.91	1.20	1.52	1.73	1.48	1.15	in 1995



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Age 0	no	no	no	no	1.31	1.39	0.14	0.67	1.51	0.61	3.33	0.82	0.19	0.50	1.14	meas'd
Age 1+	data	data	data	data	1.46	3.53	2.14	2.13	2.18	3.16	4.35	6.75	2.30	3.97	1.66	in 1995

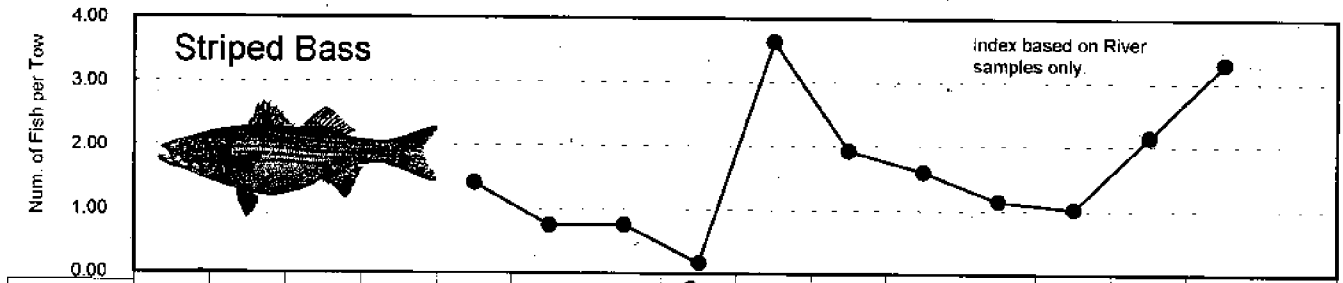


Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Age 0	no	no	no	no	0.00	0.02	0.00	0.00	0.00	0.01	0.25	0.30	0.19	0.26	0.45	meas'd
Age 1+	data	data	data	data	0.00	0.06	0.03	0.00	0.00	0.05	0.10	0.61	0.42	0.84	0.57	in 1995

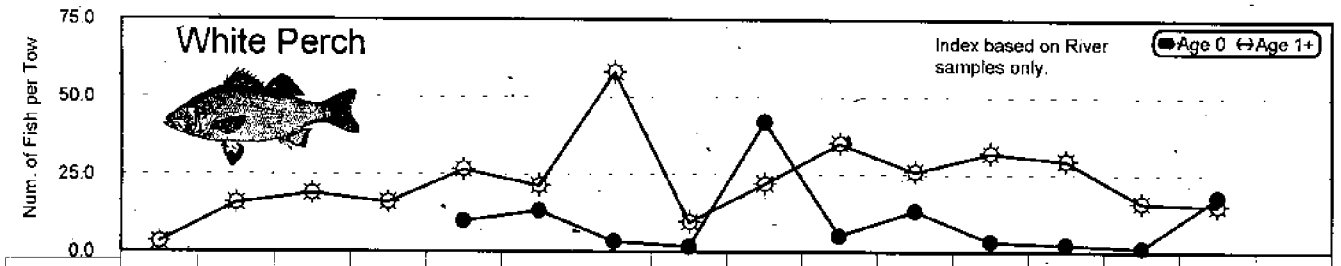
* Data prior to 1979 are not presented pending completion of gear efficiency studies.

** Numbers in the data table are the index values represented on the graph.

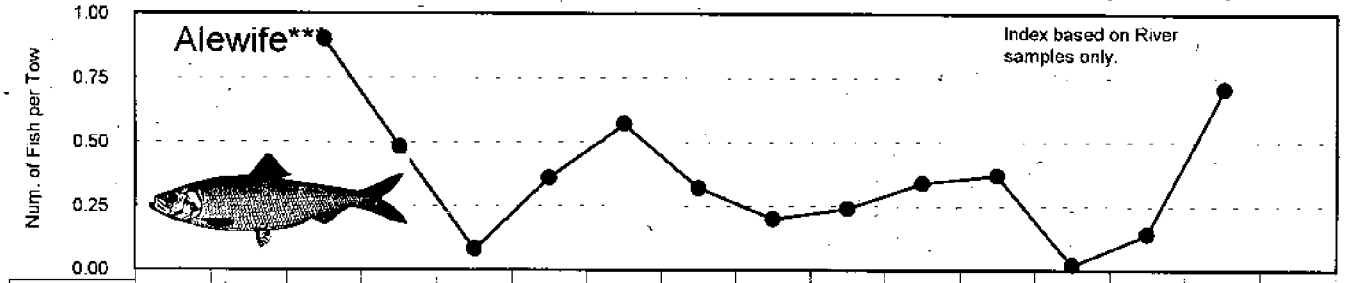
VIMS Trawl Survey Juvenile Indices - Anadromous Species*



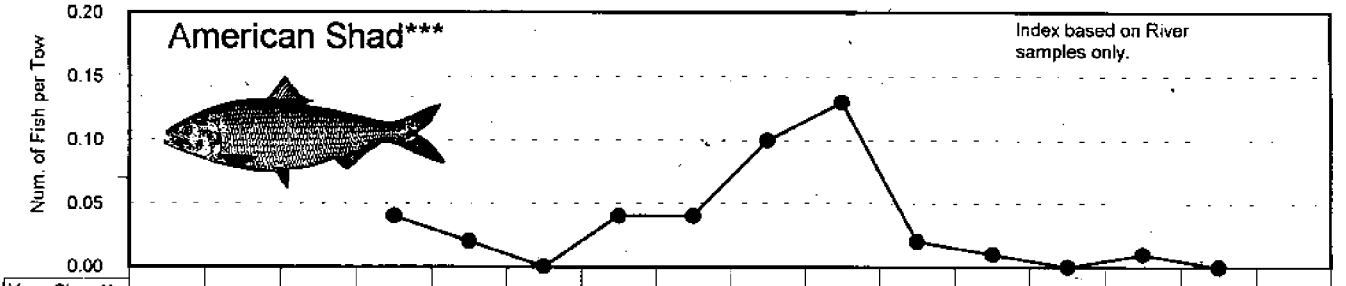
Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Rivers Only●	no data	no data	no data	no data	1.41	0.75	0.76	0.17	3.63	1.92	1.59	1.14	1.02	2.15	3.30	meas'd in 1995



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Age 0	no data	no data	no data	no data	10.0	13.3	3.3	1.8	42.1	5.3	13.3	3.3	2.3	1.2	17.9	meas'd
Age 1+	3.3	15.8	18.9	15.9	26.6	21.3	57.8	9.5	21.9	35.1	25.9	32.0	29.5	15.8	15.0	in 1995



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Rivers Only●	no data	no data	0.90	0.48	0.08	0.36	0.57	0.32	0.20	0.24	0.34	0.37	0.02	0.14	0.71	meas'd in 1995



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Rivers Only●	no data	no data	no data	0.04	0.02	0.00	0.04	0.04	0.10	0.13	0.02	0.01	0.00	0.01	0.00	meas'd in 1995

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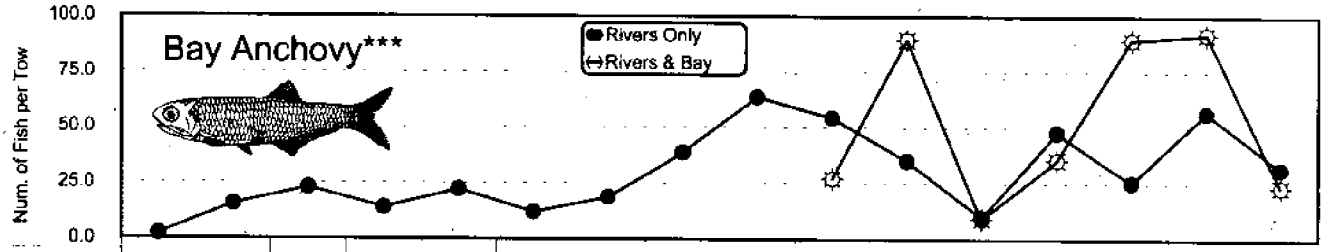
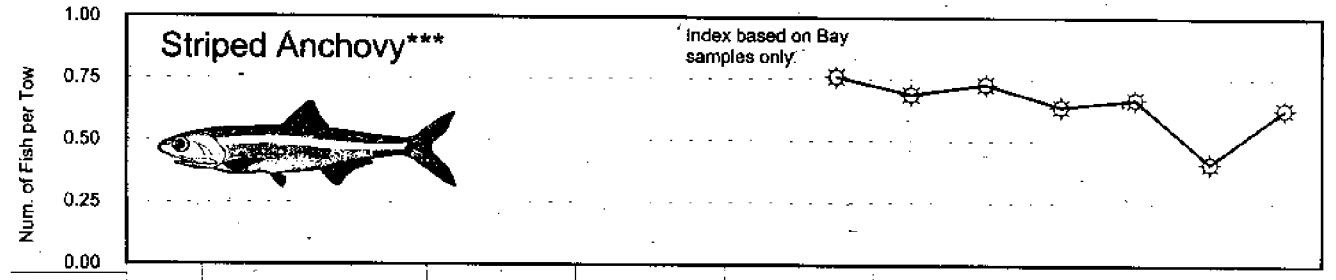
*** These indices are provisional pending literature review and aging analysis.

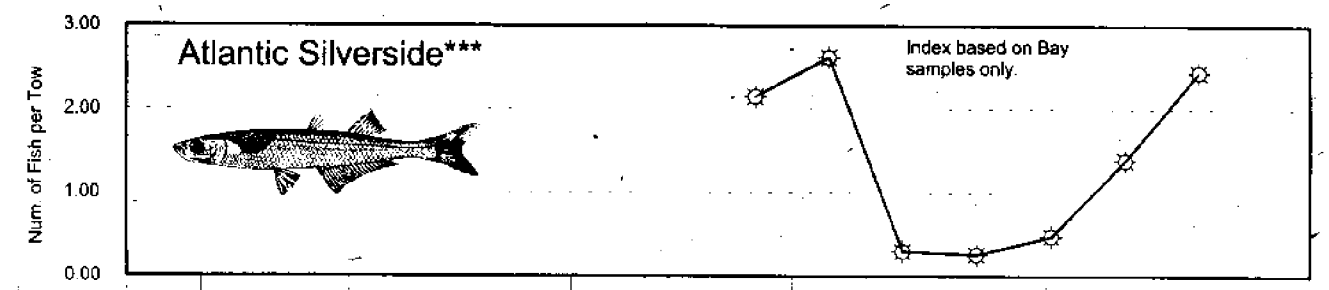
VIMS Trawl Survey Juvenile Indices - Forage Fish*



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Rivers Only	2.2	15.5	22.9	14.0	22.2	12.0	18.6	38.8	63.7	54.3	35.3	9.9	47.7	25.6	56.8	31.9
Rivers & Bay	no data	no data	no data	no data	no data	no data	no data	no data	no data	27.2	89.5	9.2	35.6	89.4	91.9	23.6



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Bay Only⇔	no data	no data	no data	no data	no data	no data	no data	no data	no data	0.76	0.69	0.73	0.64	0.67	0.41	0.63



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Bay Only⇔	no data	no data	no data	no data	no data	no data	no data	no data	2.15	2.62	0.30	0.26	0.48	1.39	2.44	

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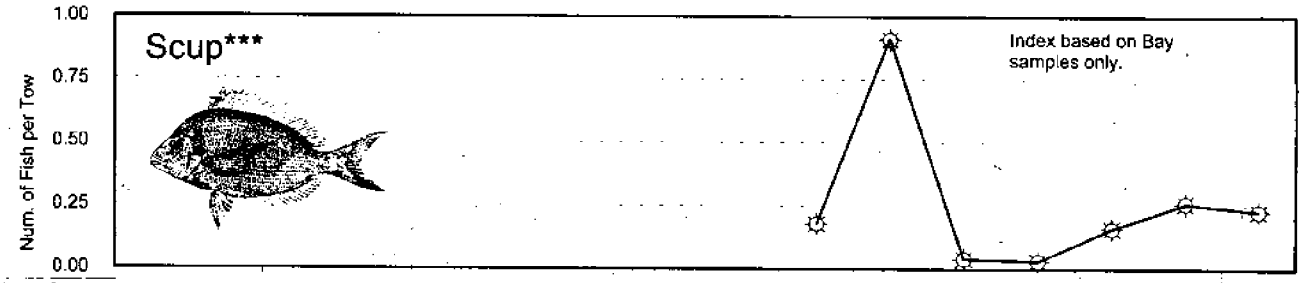
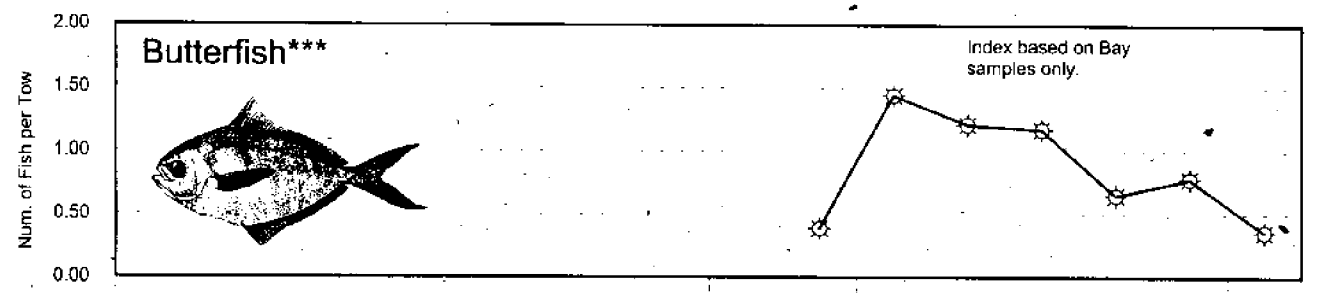
*** These indices are provisional pending literature review and aging analysis.

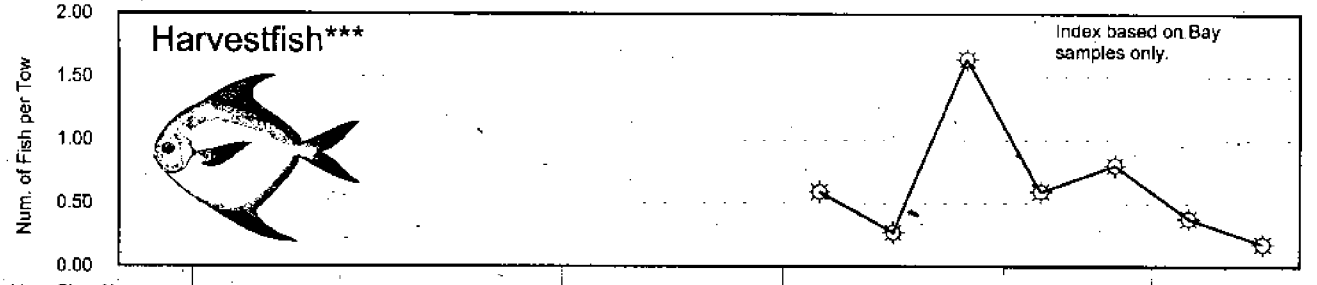
VIMS Trawl Survey Juvenile Indices - Coastal Species*



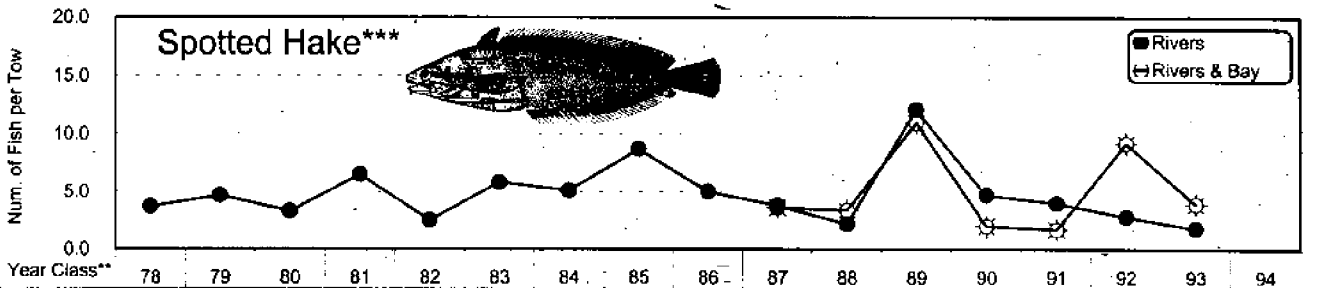
Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Bay Only↔	no data	no data	no data	no data	no data	no data	no data	no data	no data	0.18	0.91	0.04	0.03	0.16	0.26	0.23



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Bay Only↔	no data	no data	no data	no data	no data	no data	no data	no data	no data	0.39	1.44	1.21	1.17	0.65	0.78	0.36



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Bay Only↔	no data	no data	no data	no data	no data	no data	no data	no data	no data	0.59	0.27	1.64	0.59	0.80	0.38	0.18



Year Class**	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Rivers	3.7	4.7	3.3	6.5	2.5	5.8	5.1	8.7	5.0	3.8	2.2	12.1	4.7	4.0	2.8	1.8	meas'd
Rivers & Bay	no data	no data	no data	no data	no data	no data	no data	no data	no data	3.6	3.4	11.0	2.0	1.7	9.2	3.9	in 1995

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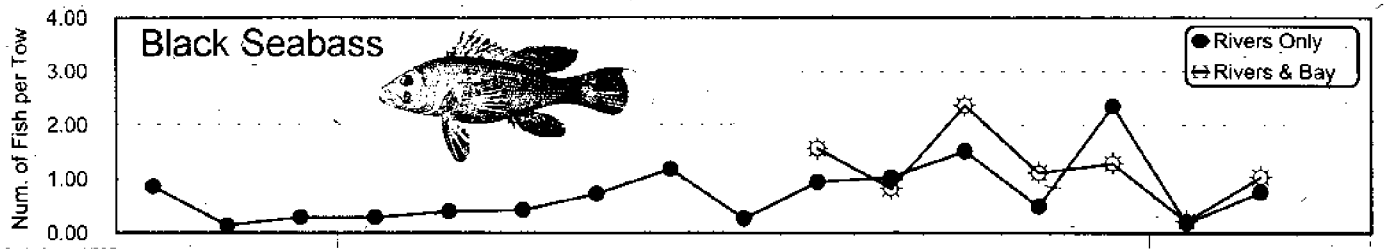
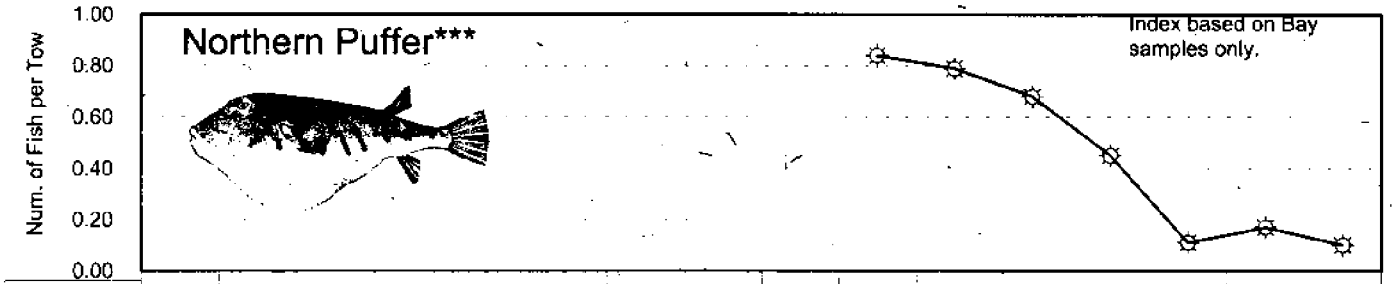
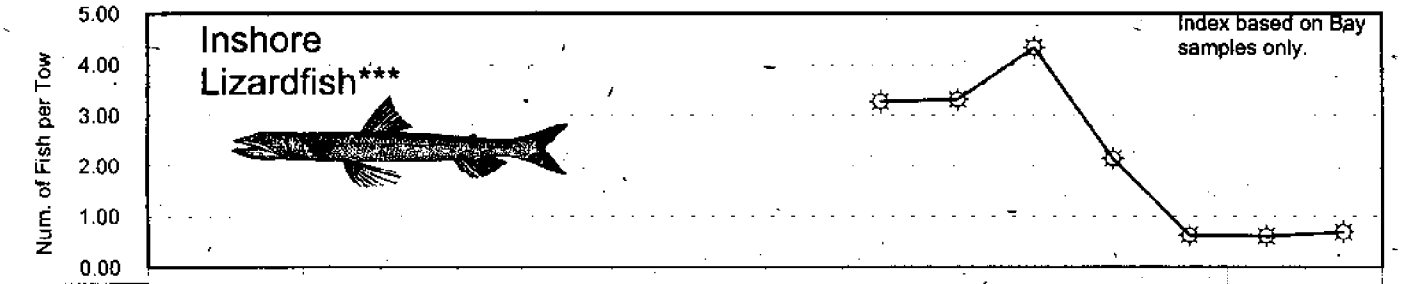


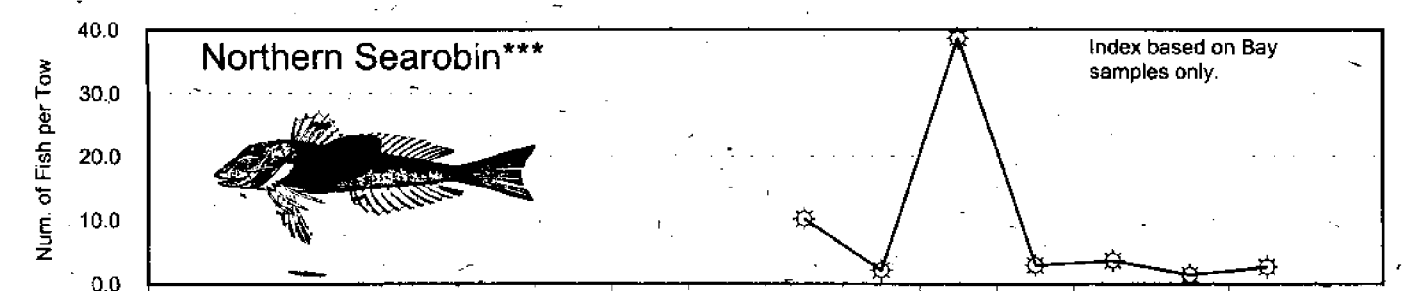
Year Class**	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Rivers Only	0.86	0.14	0.29	0.29	0.40	0.43	0.73	1.19	0.27	0.95	1.04	1.52	0.50	2.35	0.19	0.76	meas'd
Rivers & Bay	no data	no data	no data	no data	no data	no data	no data	no data	no data	1.57	0.83	2.36	1.12	1.29	0.22	1.04	in 1995



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Bay Only ↔	no data	no data	no data	no data	no data	no data	no data	no data	no data	0.84	0.79	0.68	0.45	0.11	0.17	0.10



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Bay Only ↔	no data	no data	no data	no data	no data	no data	no data	no data	no data	3.27	3.31	4.33	2.14	0.63	0.61	0.69



Year Class**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
Bay Only ↔	no data	no data	no data	no data	no data	no data	no data	no data	no data	10.2	2.1	38.6	2.9	3.6	1.4	2.6

meas'd in 1995

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