Coalition to Protect Our Fisheries
P.O. Box 405
Bear, DE 19701

10/28/2010
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Memo

To: Nuclear Regulatory Commission

From: Richard Schneider, Coalition to Protect Our Fisheries

Date: 12/7/2010

Re: Supplemental Testimony to November 17, 2010 Salem Nuclear Power Plant Hearing

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My name is Richard Schneider and I represent the Coalition to Protect Our Fisheries. I previously spoke at the public hearing on November 17, 2010. I would like this statement added to my comments from that night.

I am also adding the following exhibits to my testimony:

- Exhibit A. A fish kill report titled, 'Mortality of Delaware River Striped Bass from Entrainment and Impingement by Salem Nuclear Generating Station' (March 30, 2000) Dr. Desmond Kahn, Delaware Division of Fish and Wildlife, author.

  This is an excellent report. It contradicts PSEG's underestimation of the fish kill. It also states that PSEG used data from 1997 when the plan was shut down. It masks the massive harm to plant causes to the fisher when it is in operation.

- Exhibit B. A fish report titled, 'Assessment of the Impact of the Salem Nuclear Generating Station on Weakfish and Striped Bass' (March 8, 2001) Also by Dr. Kahn.

  This is another excellent in depth report on the weakfish and stripers killed by the Salem plant. The report state that Salem 1 and 2 kill more weakfish in one year than are caught commercially and recreationally in Delaware in the same year. This is accurate data and analysis on the Salem 1 and 2 fish kill. It contradicts many of the underestimates of PSEG.

- Exhibit C. A Wilmington News Journal article dated January 14, 2007 about the massive fish kill along the Delaware River. It's titled, 'Cooling systems ravage river life, activists charge. Big industrial sites on the Delaware kill tens of billion of fish, crabs each year.'

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This article shows that Salem draws 1.27 trillion gallons of water per year (which is over 3 billion gallons of water a day). It kills 350 million 'age one' equivalent fish each year. It kills 14.7 billion organisms including fish, eggs, larvae and crabs.

The third page shows data and is highlighted by a yellow marker.

To say that Salem 1 and 2 is causing little effect on the fisheries is outrageous and untrue. It is the largest single destroyer of aquatic life in the river.

Weakfish declined by 85% from 1980-1990. As evidence I would like to submit a statement from a fish kill report on the Edgemoor, Delaware power plant (Exhibit D). In the section discussing weakfish (pages 2-13), it states:

"Weakfish is highly valued as an important commercial and recreational fishing source. The weakfish population has experienced a drastic decline since 1980. Research by Vaughn, Seagraves and West concluded that weakfish were overexploited and at low abundance level by 1990 (Vaughn, et al., 1991). Landing estimates decreased from 35.3 million kilograms in 1980 to less than 4.5 million kilograms in 1992 (Dove and Nyman, 1995). Recreational landings have also decreased significantly since 1986 (Killam and Richkus, 1992). Assesment work conducted by ASMFC and National Marine Fisheries Society (NMFS) reported that spawning stock biomass declined steadily from 1982 to 1990 (PSEG, 1999)."

Now, weakfish are so few that the regulations for the Delaware River and Bay allow only one recreational weakfish catch per day. Only 1! As evidence for this statement I am submitting Exhibit E, the fishing regulations handbook for Delaware. The regulation for weakfish and other species is found on page 27. In the 1960's fishermen used to catch dozens of weakfish in a day and come back with full coolers. Now, they are lucky to make that one catch.

Likewise, stripers are so few in the Delaware River and Bay that regulations only allow a catch of two per day and they must be over 28" long. Stripers declined severely after Salem 1 and 2 were built in the 1970's. The stripers were so few that commercial striper fishing was banned in the Delaware River for 5 years from 19805-1990. The commercial striper fishermen were put out of business but the Salem power plants continued to needlessly kill stripers every year. Is that fair?

The NRC statement of pages 4-74, "This analysis has found that in the vicinity of Salem and HGS since 1978, when Salem began operation, fin fish richness has not changed and species densities has increased (PSEG 2006), is categorically wrong and untrue. The facts show otherwise.

The fisheries, all fish, have declined since the power plants were built. Salem, which draws in 3 billion gallons of water a day, is the single largest destroyer of life aquatic life in the river and is the major cause for destruction of the fisheries.

The most devastating effect of drawing in 3 billion gallons of water a day is that it destroys the food chain, the biomass that is the foundation that the aquatic life depends on to live. The water draws in biomass (plankton, fish and crab larvae, fish and crab juveniles, small fish as well as

large fish). But when the water comes out of the power plant the intense heat destroys all life. The water is sterile, without life.

This effect destroys the biomass, the food chain, which in turn destroys the fisheries. With no food chain, the fisheries are being destroyed every day. The Salem power plants are one giant aquatic life death machine. It kills all life, all species, all ages of aquatic life. It is the single largest destroyer of aquatic life in the river and is the major cause for the destruction of the fisheries.

Richard Schneider
Coalition to Protect Our Fisheries
P.O. Box 405
Bear, DE 19701
302-507-1270

Exhibit A

Mortality of Delaware River Striped Bass from Entrainment and Impingement by the Salem Nuclear Generating Station

Desmond M. Kahn
Delaware Division of Fish and Wildlife

March 30, 2000

EXECUTIVE SUMMARY

The recent filing by Public Service Electric and Gas (PSE&G; 1999) in support of their permit renewal for the Salem Nuclear Generating Station (SNGS) did not estimate a conditional mortality rate (CMR) from entrainment of striped bass, although the CMR was estimated for other species of concern. This rate is the proportion of fish in a body of water that were killed by the plant if no other sources of mortality were operating. The CMR was not estimated because PSE&G's only estimate of abundance of young-of-year (YOY) striped bass was developed for 1997, when the plant was shut down. Since a year-specific estimate of abundance together with an estimate of entrainment mortality for that year is required for estimation of the CMR, the CMR due to entrainment could not be estimated with PSE&G's data. In this report, I used independent estimates of striped bass YOY abundance from 1980 through 1998, combined with the Equivalent Recruit Model employing PSE&G's data on entrainment mortality, to estimate the CMR for 1980-1982, 1985-1996 and 1998 (no entrainment sampling was conducted in 1983-1984, and little sampling was conducted in 1997). The estimates of YOY abundance (Kahn et al. 1998) were based on a tag-recapture estimate of absolute abundance of YOY striped bass in the River in 1990 (Burton and Weisberg 1994) and the annual New Jersey Division of Fish Game and Wildlife's index of relative abundance of YOY striped bass based on a beach seine survey (Baum et al. 1999, Weisberg et al. 1996).

The results indicated two different levels of conditional mortality. During the low-abundance period of 1980-1988, the CMR was less than 1%. During the higher abundance period from 1989 through 1998, however, the CMR averaged 32%. This level of conditional mortality is high enough to be of serious concern, since it must be considered in addition to fishing mortality in stock management and may be a major impediment to stock productivity. Growth in YOY abundance over this latter period has been at a modest annual rate (intrinsic rate of population increase, $r = 0.03$, average annual rate of increase = 3%), although this rate implies a 35% increase over the period 1989-1998.

In particular, the estimates of CMR for three years, 1989, 1993 and 1998 were over 50%, meaning "the estimated equivalent age-1 losses exceed the estimated young-of-year abundance" (PSE&G 1999). In their filing, PSE&G contended these high losses were likely due to immigration of YOY striped bass into the Delaware River from the Chesapeake Bay via the Chesapeake and Delaware Canal. In this report I examined spatial variation in sample catch-per-tow from the Delaware Division of Fish and Wildlife Juvenile Finfish research trawl survey and found the data does not support the PSE&G hypothesis. I also examined data from the Maryland Department of Natural Resources young-of-year striped bass beach seine survey's Head of Bay system for information on the source for the putative migrants and found that data does not fully support the PSE&G hypothesis either. Variations in river flow and plant operations among years and possible increases in distribution of YOY striped bass during years of high abundance are factors that may be contributing to variation in CMR among years.

INTRODUCTION

One of the most important and useful measures of mortality imposed by a power plant on fish populations is the conditional mortality rate (CMR). This is the proportion of fish killed by the plant if no other sources of mortality are operating, and does not include consideration of compensatory mortality (Christensen and Englert 1988). It is analogous to the conditional fishing mortality rate or the conditional natural mortality rate (Ricker 1975 p. 11). These are formulated as follows:

$$\text{Conditional natural mortality rate, } n = 1 - e^{-M}$$

$$\text{Conditional fishing mortality rate, } m = 1 - e^{-F}.$$

A formulation of the conditional plant mortality rate could be

$$o = 1 - e^{-P},$$

where P is the instantaneous mortality rate from plant operations due to impingement and entrainment. As I have developed the estimate, however, instantaneous rates have not been employed. Instead, I have used the formula,

$$CMR = 100\ (Y_{0K} / (Y_{0K} + Y_{0S}))$$

where Y_{0K} is the absolute number of young-of-year (YOY) fish killed by the plant that would have survived to a given time, if they had not been killed by the plant (Equivalent Recruits) and Y_{0S} is the absolute number of YOY fish alive at the given time.

Although the filing by Public Service Gas and Electric (1999) ("the filing") for the permit renewal of the Salem Nuclear Generating Station (SNGS) lists CMR values for most of the RIS (Representative Important Species), the value for striped bass is noticeably low, being 0.34% (App. F, Attachment 2, Table 21). This low value includes only impingement losses and is based on a single year's estimate of abundance, 1997, a year in which the plant was shut down except for one circulating pump. Entrainment sampling in that year was inadequate to characterize mortality of striped bass (D. Heimbuch, personal communication). Lacking any years with both entrainment data and an estimate of absolute abundance, PSE&G did not include an estimate of the CMR for entrainment of striped bass in their 1999 316(b) filing.

To calculate a conditional mortality rate, we need an estimate of total abundance in the river (Y_{0S}) and an estimate of numbers killed (Y_{0K}). The filing indicates that an estimate of young-of-year (YOY) striped bass absolute abundance was developed for only one year class, the 1997 year class (App. F-2, Table 16). This estimate was developed from auxiliary data collected during their tagging study to estimate white perch abundance. No variance or confidence interval was presented with it.

In this report, I employed an independent series of estimates of striped bass YOY abundance presented in Kahn et al. (1998). These estimates were developed from two studies. The first was an absolute abundance estimate of YOY striped bass in the Delaware River in 1990 by Burton and Weisberg (1994), using the Petersen method. The second study is the annual NJDFGW beach seine survey of YOY striped bass relative abundance in the Delaware River, conducted from 1980 through the present. Kahn et al. (1998) computed the ratio of the estimate of absolute abundance from Burton and Weisberg (1994), 972,937 YOY striped bass, to the 1990 index of relative abundance from the NJDFGW survey, which had a value of 1.00. This ratio was 972,937/1. Kahn et al. then multiplied each year's index of relative abundance from the NJDFGW survey by 972,937 to scale the indices up to absolute abundance.

Using the Equivalent Recruit model, I estimated recruits lost to the SNGS from data on mortality by life stage and year provided in the PSE&G 1999 filing. I then calculated conditional mortality rates from 1980 through 1998, excluding 1983, 1984 and 1997 when little or no entrainment sampling was conducted. I examined the record of plant operations to get some idea of how much of this time the plant was fully operational. Then I examined the hypothesis presented in the PSE&G 1999 filing that the highest mortality occurred in years when immigrants from the Chesapeake Bay via the Chesapeake and Delaware Canal were the recipients of that mortality. I found that detailed examination of fishery independent surveys fails to support that hypothesis.

METHODS

Losses of striped bass eggs, yolk-sac larvae, post yolk-sac larvae and juveniles from two stages due to impingement and entrainment are presented in the PSE&G 1999 filing (parts of App. L, Tables 8 and 9; reproduced here as Tables 1 and 2). I have used the Equivalent Recruit Model (App. F, Attachment 2) to convert these early life-stage losses to the number of juveniles that would have resulted from them, if they had not been killed by the SNGS, as of October 1 of each year (Y_{0K}). Daily mortality rates by life-stage and stage duration in days were obtained from Appendix L, Tab 18, Table 9 of the PSE&G filing. The life-stages used were egg, yolk-sac larva, post yolk-sac larva, juvenile 1 and juvenile 2. Since the juvenile 1 stage would extend to October 31, and I calculated numbers surviving to October 1 (see below), I did not employ juvenile 2 rates in the model. The first step in this model is to calculate the numbers that would have survived to the yolk-sac larval (YSL) stage from the numbers of eggs entrained. The basic formula represents the number of YSL as the product of the number of eggs entrained times the survival (S) rate of eggs. Survival is calculated as S = exponent (-Z/day* days in stage).

This calculation must be modified, however, because it assumes that entrained eggs were all newly released, that is, that they all had to survive the full stage duration. In reality, the age of entrained eggs varied. By imposing the full mortality of the entire egg stage on eggs that had already survived part of that stage, the basic formula would then

underestimate the animals that would have survived from the eggs entrained. To correct for this underestimate of survival, the average number of days an organism has been in the stage must be calculated. The first step in this process is to compute the time required for one-half of the organisms expected to die during the stage to disappear from the population. This time may be calculated from the following presented in the filing:

$$N_j e^{-z_j \hat{d}_j} = N_j - 0.5 N_j (1 - e^{-z_j d_j})$$

Where

z_j = the daily instantaneous mortality rate of stage j,

d_j = the duration in days of stage j,

N_j = the numbers of organisms of stage j entrained,

$d_j$hat = the time in days for ½ of the organisms expected to die during stage j to disappear from the population.

I rearranged this equation to solve for $d_j$hat as follows:

$$d_j\text{hat} = -LN(1-.5(1-e^{-z_j d_j}))/z_j$$

where LN = natural logarithm.

A mathematically equivalent form of the latter equation is presented in the attachment 2 II.E of the 1999 filing. The estimate of $d_j$hat is then subtracted from the stage duration in estimating survival, giving S = exponent(Z/day* ($d_j - d_j$hat)). This has the effect of reducing the time period for which mortality operates, and consequently increasing survival.

The same procedure was applied to entrained YSL to grow them to PYSL, using the daily mortality rates and length of the YSL stage to correct for the average number of days an entrained organism has been in a life stage. However, once the organisms that would have survived to a second stage were calculated (after the stage in which they were entrained), then we need to calculate how many would have survived to a third stage. For organisms entrained as eggs, the third stage would be PYSL. In such cases, when the organisms were not entrained in a given stage, but in an earlier stage, the correction is not needed, since all the organisms would have had to pass through the complete second stage.

The correction is next applied to the number of PYSL entrained to grow them to equivalent juvenile 1 striped bass, along with growing up the PYSL derived from entrained eggs and YSL. In the filing PSE&G did not apply the correction to the entrained JUV 1 animals, reasoning that only young animals in the beginning of this stage are vulnerable to entrainment. The data appear to bear this out, since juveniles have appeared in entrainment samples only from week 22 through week 28 (Table 1), overlapping the period for larval entrainment except for the last week (larvae: weeks 15 through 27). Thus entrained juveniles have occurred only slightly past the end of the

larval period, indicating they were very young juveniles. All JUV 1 animals were then grown up to October 1.

The absolute abundance estimates of YOY striped bass surviving the plant's impact (Y_{0S}) were developed from indices of relative abundance of YOY striped bass developed annually by the New Jersey Division of Fish, Game and Wildlife, using a beach seine (Baum et al. 1999; Weisberg et al. 1996). The indices were scaled up to absolute abundance estimates using a catchability coefficient developed in Kahn et al. (1998). This catchability coefficient was calculated from an estimate of absolute abundance of Delaware River YOY striped bass based on a mark-recapture study conducted in 1990 (Burton and Weisberg 1994). The catchability coefficient was then applied to the YOY index for each year to estimate absolute abundance for the years 1980 through 1997 in Kahn et al. (1998).

Since abundance of a cohort continually declines after birth, the exact time that abundance estimates apply can be important. The New Jersey beach seine survey is conducted from August through October. Burton and Weisberg released tagged fish between September 14 and 21; recapture efforts began September 25 and lasted until October 16. Consequently, I took October 15 as the point estimate of the time for these absolute abundance estimates

The conditional mortality rate was developed for each year by estimating a quantity of striped bass that I will term the equivalent recruits (Y_{0K}). These are the new recruits that would have survived to a particular point in time if they had not been killed by the SNGS. For purposes of this report, I have defined the time as October 1. The CMR was estimated by adding together the number of equivalent recruits as of October 1 lost due to the plant (Y_{0K}) and the estimate of living striped bass as of October 1 from Kahn et al. (1998) updated through 1998 (Y_{0S}). This total ($Y_{0K} + Y_{0S}$) estimates the number that would have been alive on October 1 if the plant had not been in operation; compensation (density-dependent mortality) is not estimated or included. The loss due to the plant, Y_{0K}, was then divided by the total, giving the proportion of the year class killed by the plant, or the conditional mortality rate.

RESULTS

Estimates of losses due to entrainment were very low from 1980-1982 and 1985-1988. The average CMR for this period was 0.5% (Table 3). No entrainment samples were taken during 1983-1984. Striped bass YOY abundance was low during these years (Figure 1). There appears to be a threshold of YOY abundance below which the conditional mortality rate is quite low.

The conditional mortality rate averaged 32% from 1989-1998 (1997 excluded) and was moderately variable. The standard error of the mean = 10.5, so the coefficient of variation is 33.0. The 95% confidence interval, based on a sample size of 9 years, is from 7.7% to 56.2%.

There appears to be a threshold of YOY abundance that induces higher CMR values. From 1980-1982 and 1985-1988, YOY abundance was low (Figure 1) and the CMR was low (Table 3). In fact, entrainment estimates were zero or nearly zero. One possibility is that the spatial distribution of YOY life-stages is more restricted at low abundance, so vulnerable life-stages are not distributed near the SNGS.

On average over the higher abundance period (1989-1998), approximately one third of all the striped bass that would have been produced by the Delaware River was killed by the SNGS (Table 3). This mortality is equivalent to lowering the maximum reproductive rate of the stock (alpha parameter of a Ricker stock-recruitment model) by one third. The maximum reproductive rate is that rate occurring at low densities, when density-dependent mortality is not occurring. The resilience of this stock, or its ability to recover from reduced densities, has been reduced. In addition, it will not be possible to attain Maximum Sustained Yield from this stock, since exploitation has to be reduced to allow sufficient spawning biomass to accumulate (Goodyear 1999). This reduction in exploitation will be marked, since about 1/3 of the stock is killed at the outset of its life. With this initial mortality, the accumulation of sufficient spawning biomass will require a marked reduction in exploitation compared to a stock without this high initial mortality. A full exploration of the consequences of this mortality on the Delaware River spawning stock is beyond the scope of this report.

Increase in YOY production during this period has been low on average (Figure 1). An estimate of r, the intrinsic rate of increase, for 1989-1998 from the linearized exponential growth model,

$$\mathrm{LN\,(YOY)} = a + r * \mathrm{YEAR}$$

was only $r = 0.03$, indicating about a 3% increase per year ($e^{0.03} = 1.030$).

Two factors that could cause variation among years in this CMR are river flow and plant shutdowns. In drought years, such as 1995, brackish water advances up the river. Since striped bass spawn just above the salt line, spawning and the consequent nursery area can shift well upstream of the SNGS. If this happens, the immature stages could be out of reach of the plant, reducing mortality. This apparently happened in 1995, when the CMR was only 4%, despite production of the largest year class estimate during the whole period.

Secondly, if the plant is non-operational during the season that striped bass are subject to entrainment, then entrainment is reduced. It is not eliminated, however, since one circulating pump is working even during periods of shutdown. Studies of the Millstone power plant in Connecticut, which has a water intake rate comparable to the SNGS, indicated that the conditional mortality of winter flounder was over 20% in some years when the plant was non-operational, due to operation of a single circulating pump (V. Crecco, CT. DEP, personal communication). In 1996, the SNGS was non-operational (Table 4), but the single pump working resulted in a CMR of 23% (Table 3). Note that the average CMR includes years when the SNGS was non-operational and partly

operational (Table 4). In fact, only in 1991 and 1998 were both units fully operational (Table 4). In the latter year, the CMR was 54%, but in the former, it was only 1%. Elucidation of the variation in CMR among specific years may require data on flow conditions as well as operation schedules and year class abundance, and is beyond the scope of this report.

To calculate a CMR representative of full operational conditions, we have to eliminate years when the plant was nearly or completely non-operational during the period April through early July. To that end, I have consulted the data on number of pumps operational per day per year. I have converted the number of pumps operational per day to verbal descriptions in Table 4. Full power was in effect for only two years, 1998 and 1991. Conversely, the plant was shut down, except for one pump, in 1996 and 1997. A recalculation of the average CMR, excluding 1996 as well as 1997, yields an estimate of 37%, a slight increase from the 35% average with all years. The latter estimate also includes several years with only partial operation, including 1989, 1990, 1992, 1993, 1994 and 1995 (Table 4).

DISCUSSION

In Appendix H, PSE&G applied the Equivalent Recruit Model to produce estimates of numbers of striped bass that would have grown to age 1 if they had not been killed by the plant (Sec. II.B). These are the losses due to the plant as of April following the year of birth. PSE&G then charts these numbers for each year and compares them to a chart of YOY abundance from Kahn et al. (1998)(p. 38, App. H Figure 20, reproduced here as Figure 2). PSE&G states, "The abundance of each year class of striped bass at age 1 (i.e. in the spring of the following year), which would be directly comparable to the estimated losses, is *somewhat less* than the reported juvenile abundance due to mortality that occurs between fall and the following spring." (emphasis added). Then PSE&G concluded that, "In all years except 1989 and 1993, the estimated losses are a small fraction of the Delaware River young-of-year abundance."

The term "somewhat less" is an understatement. Abundance estimates from Kahn et al. (1998) would decline drastically from those depicted in Fig. 2 when aged to the following April, as were the PSE&G estimates. This means the fraction of the YOY striped bass lost to the plant would become much higher when estimates of both equivalent recruits lost to the plant and surviving YOY striped bass are aged to April 1. According to mortality rates from PSE&G's filing (Appendix L, Tables 8 and 9), mortality from October 1 to April 1 would be 71 %. Therefore to compare PSE&G's estimates of losses to the YOY abundance from Kahn et al. (1998), we must either decrease the latter by 71%, or divide the PSE&G numbers by 0.71.

PSE&G stated that, "In 1989 and 1993, however, the estimated equivalent age-1 losses exceed the estimated young-of-year abundance." It should be pointed out that actual plant losses from entrainment occur from April into July. The NJ beach seine survey is conducted later in the summer and fall. It is possible for the estimated losses to be over 50% of the total abundance ($Y_{0K} + Y_{0S}$), meaning losses would exceed estimated

abundance later in the year. The CMR values for 1989 and 1993 were both 84% (Table 3). To the above two years, 1998 should be added. The YOY abundance estimate for this year was not included in Kahn et al. (1998). The CMR for 1998 was 54%, thus the losses again exceeded the estimated YOY abundance.

PSE&G then contends that "large numbers of young-of-year striped bass from the Chesapeake Bay moved through the C&D Canal into the Delaware Bay in these years." But no hard evidence is presented for this claim. The filing portrays data from 3 YOY sampling programs, the NJ Beach Seine survey, DEDFW trawl survey and the PSE&G Nearfield survey. PSE&G then attempts to show that data available from these surveys support the idea that in peak Chesapeake Bay recruitment years, large numbers of YOY striped bass enter the Delaware River through the Canal, and that these immigrants were the source of the large mortalities in 1989 and 1993 (and presumably 1998). In order to present a clear picture of the available data, I have presented data from two of these surveys by region of the estuary, since PSE&G's argument is one of spatial differences in YOY density.

The argument implies that in the years of high entrainment, 1989, 1993 and 1998, YOY density was inflated downstream of the Chesapeake and Delaware Canal compared to densities upstream of the Canal. The core Delaware River spawning habitat is upstream of the Canal. In the NJ beach seine survey, there have been 17 years from 1980 to 1998 that had YOY indices above zero. Area II, between the Delaware Memorial Bridge and the Schuykill River in Philadelphia has produced the largest catch of juvenile striped bass 15 of the 17 years. Region I, from the Bridge downstream to below the Canal, had the highest index in 2 years and the second-highest index in 12 years (Baum et al. 1999). PSE&G's immigration hypothesis would suggest that large numbers of YOY striped bass flooded Region I in years of high entrainment.

For information on spatial distribution of juvenile striped bass near the SNGS, I have obtained GM catch per tow by Zone of juvenile striped bass in June and July, the months when this stage is entrained, from the DDFW trawl survey database (Michels 1999). The first Zone, named Delaware River, comprises 6 stations above the Canal, 2 of which are above the Delaware Memorial Bridge. The second Zone is named North River and comprises 4 stations from just below the Canal down to the Artificial Island. The third Zone, South River, comprises 4 stations below the SNGS (Figure 4). If the hypothesis of PSE&G is correct, then in the 3 years of high entrainment, the GM CPT should be higher in the North River Zone and possibly in the South River Zone than in the Delaware River Zone. The Delaware River stations were only added in 1990, so data for 1989 doesn't exist. In 1993, however, densities were an order of magnitude higher above the Canal in the Delaware River Zone than in the other two zones. In 1998, densities were 33% higher in the Delaware River Zone compared to the North River Zone. In Figure H-19 from the filing (reproduced here as Figure 5), an index of density (# per unit water withdrawal volume) is plotted and shows the third highest value was for 1996. This year did not have a high entrainment because the plant was shut down except for one unit, but entrainment mortality would have been high if the plant was operating.

Again in this year, the density in the Delaware River Zone was an order of magnitude higher than that of the downstream zones.

For another perspective, we can examine the source for the putative immigrants. Table 5 presents indices from the Head of Bay system from the Chesapeake Bay striped bass YOY seine survey. Indices among systems within the Bay can vary widely within years. The C & D Canal is included within the Head of Bay system (Waller et al. 1999). If the PSE&G hypothesis is correct, then all years with high indices in the Head of Bay system should result in high entrainment, or at least high density in entrainment samples, if the SNGS is shut down. Figure 5 shows 1993, 1989, 1996 and 1998 as years with high density, in rank order. The MD Head of Bay indices, however, were highest for 1993, 1994 and 1996, in order. The 1994 value does not support PSE&G's hypothesis. The 1994 index was much higher than the 1989 index. The relations of the MD head of Bay indices and the Delaware trawl CPUE by zone for the months of June and July are plotted in Figure 6. The declining absolute vertical scale from the Delaware River Zone panel, Figure 6 a) to the South River Zone panel, Figure 6 c), is indicative of the declining density from the uppermost zone to the lowermost zone. The relation between the MD Head of Bay indices and the official Delaware DFW striped bass YOY index (constructed from all stations north of the Leipsic River; $n = 21$ stations sampled 7 times per year, or 147 samples per year) is in Figure 7. In neither Figure 6 nor Figure 7 does the Maryland index appear significantly correlated with the Delaware data.

An alternative explanation is that YOY entrainment mortality is influenced by year class strength in the Delaware River. One common pattern in animal populations is that, as abundance increases, the area of distribution increases. In years with high recruitment, more larvae and juveniles may become vulnerable to the SNGS as distribution increases, possibly, but not necessarily, in some density-dependent manner. The very high CMR in 1989, 1993 and 1998 do seem surprising, however, in light of the fact that the plant is downstream of the primary abundance of YOY striped bass as indicated by the NJDFGW beach seine survey and the DDFW trawl survey. At present, the cause for such high mortality in those three years cannot be fully explained.

The overlap in strong year classes is not surprising for the two estuaries. Precipitation and temperature variation in spring are known to affect striped bass larval survival. Since the Delaware is near the Chesapeake, weather in a given year tends to be similar for both estuaries. Therefore, to the extent that weather variation influences year class strength, these two estuaries should show similar patterns of year class variations. The detailed examination of similarities between the MD Head of Bay indices and Delaware River measures of YOY abundance above found that years that produced high years for the former did not always result in high entrainment levels at the SNGS. The comparison also showed, however, that some years appeared to produce high densities in both estuaries. Delaware YOY production was relatively high in some of the same years as the Chesapeake Bay (1989, 1993 and 1996), although 1995 was the highest in the Delaware.

ACKNOWLEDGEMENTS

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Table 4. Historical operational level of the SNGS during the period of striped bass vulnerability to entrainment, weeks 15 through 28. The table entries are summaries of data presented in Appendix L, Tab 3.

YEAR	STATUS (note entrainment period is 3 ½ months)
1989	Unit 1 off or low half of the period, then half power for a month, then full power for two weeks, Unit 2 full power
1990	Unit 1 less than half power for two months, then full power Unit 2 off for two months, then 1/3 to1/2 power
1991	Both units full power
1992	Unit 1 about half power, Unit 2 2/3 to full power
1993	Unit 1 full power, Unit 2 off or low about half the time, ½ power for a month, then full power for two weeks
1994	Unit 1 ½ power for a month, then 2/3 power and up to full power by another month, Unit 2 full power
1995	Unit 1, full or almost full for 2 months, then low for a month, then ½ to 2/3 power for two weeks, Unit 2 full power for two months, then 2/3 power
1996	Unit 1 off, Unit 2 1/6 power
1997	Unit 1 off, Unit 2 mostly 1/6
1998	Both units full power

Table 5. Geometric mean catch per tow in June and July for Delaware Division of Fish and Wildlife juvenile trawl survey in three subareas of the Delaware estuary. June and July are the months in which juvenile striped bass have been entrained at the SNGS (see Table 1 C). The Delaware River subarea comprises 6 stations from Marsh Point, NJ, above the mouth of the C&D Canal, upriver to Edgemoor, north of Wilmington (See Figure 4) The North River subarea comprises 3 stations from Elsinboro Point, NJ, below the mouth of the C & D Canal, downriver to Silver Run, DE, opposite Artificial Island, NJ. The South River subarea comprises 4 stations further down the estuary from Ray's ditch, DE to Collins Beach, DE. The DDFW striped bass YOY Index is the GM CPT of all 21 stations north of the Liepsic River.

YEAR	DELAWARE RIVER	NORTH RIVER	SOUTH RIVER	YOY INDEX	MD DNR Head of Bay GM CPUE
1989	0.10	1.48	1.37		8.54
1990	0.12	0.00	0.00	0.11	2.20
1991	0.83	0.12	0.00	0.18	1.99
1992	6.66	0.51	0.49	1.13	0.87
1993	18.28	3.89	0.86	1.14	15.00
1994	1.46	0.20	0.00	0.19	12.88
1995	3.41	0.94	0.30	0.42	2.85
1996	23.21	8.76	2.27	1.38	14.92
1997	0.30	0.00	0.45	0.14	6.15
1998	2.50	3.33	1.18	0.58	4.32

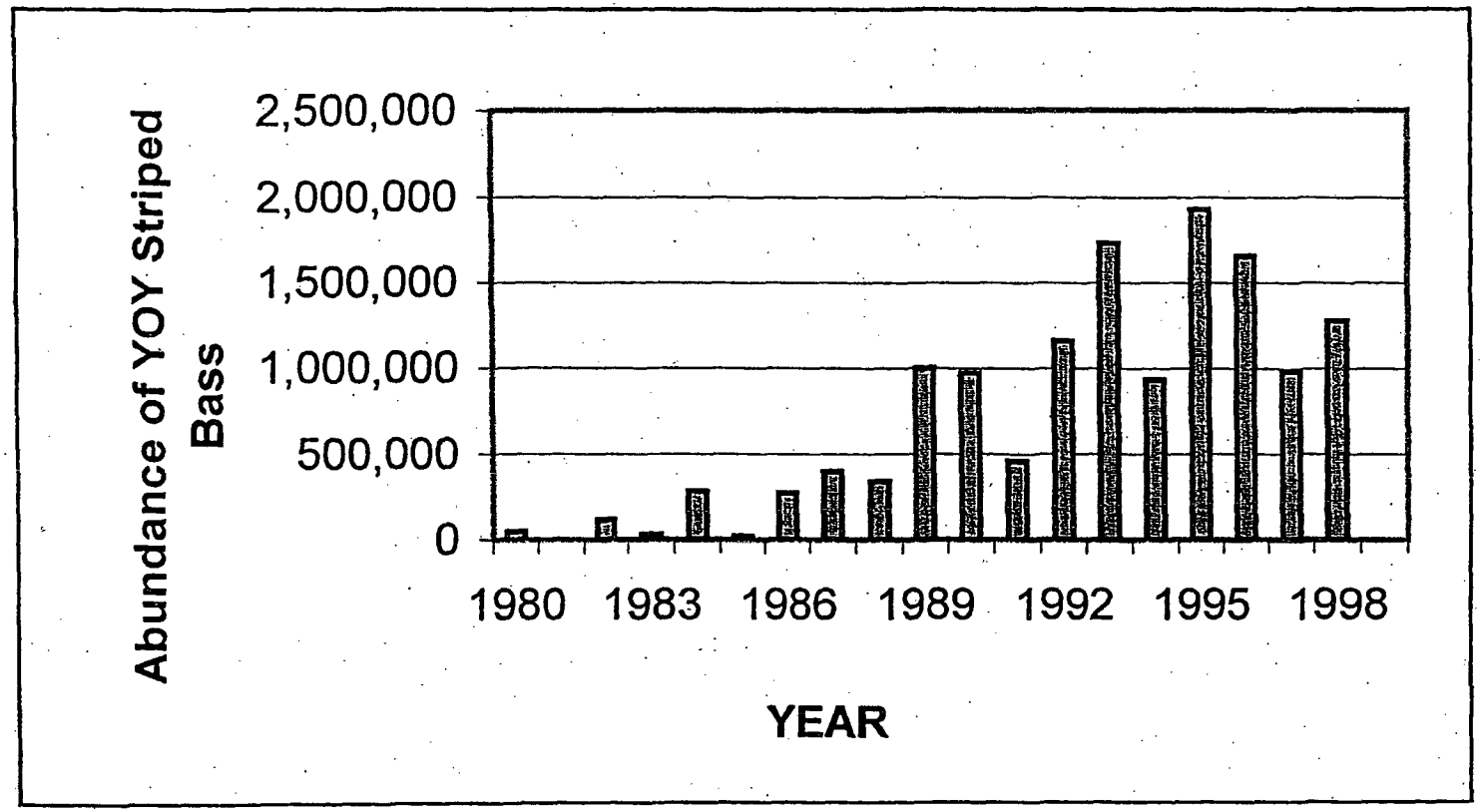
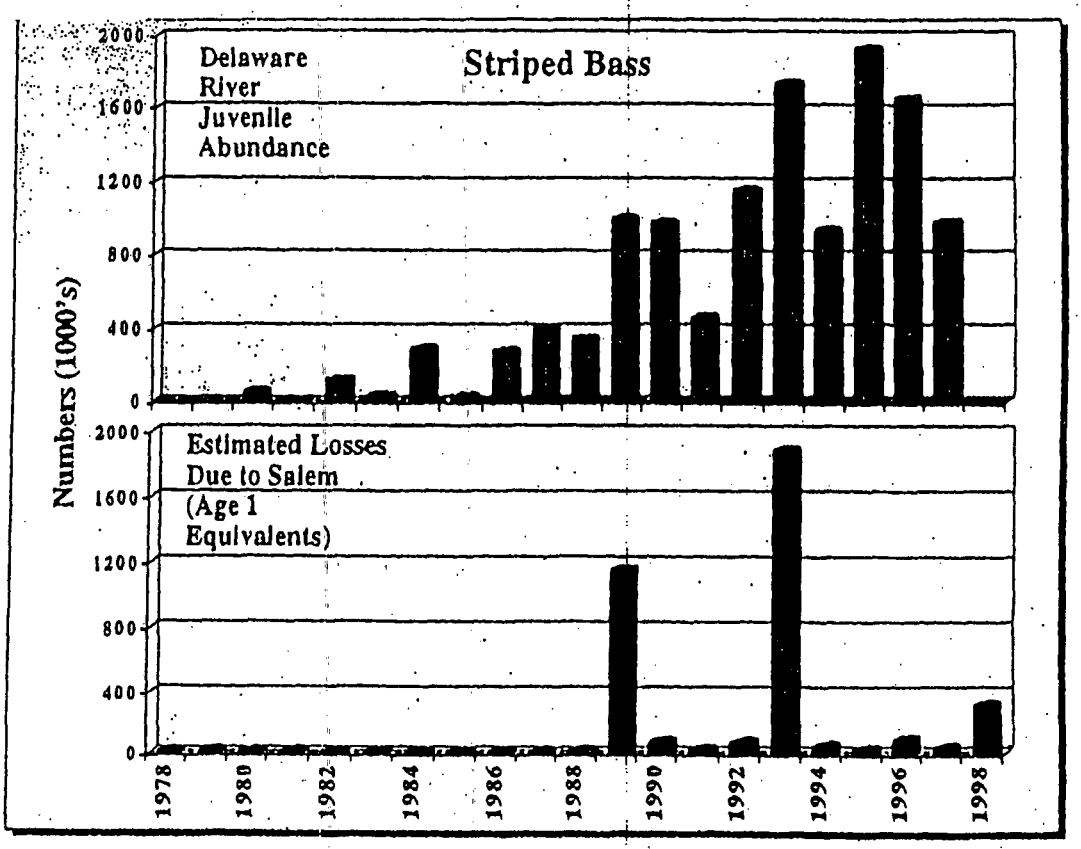


Figure 1. Abundance of Young-of-Year striped bass in the Delaware River.

Figure 2
(H Figure 20
from PSE&G's
1999 Filing)

Estimates of juvenile abundance of Delaware River striped bass (Kahn et al. 1998) and estimated age-1 equivalent losses due to entrainment and impingement.



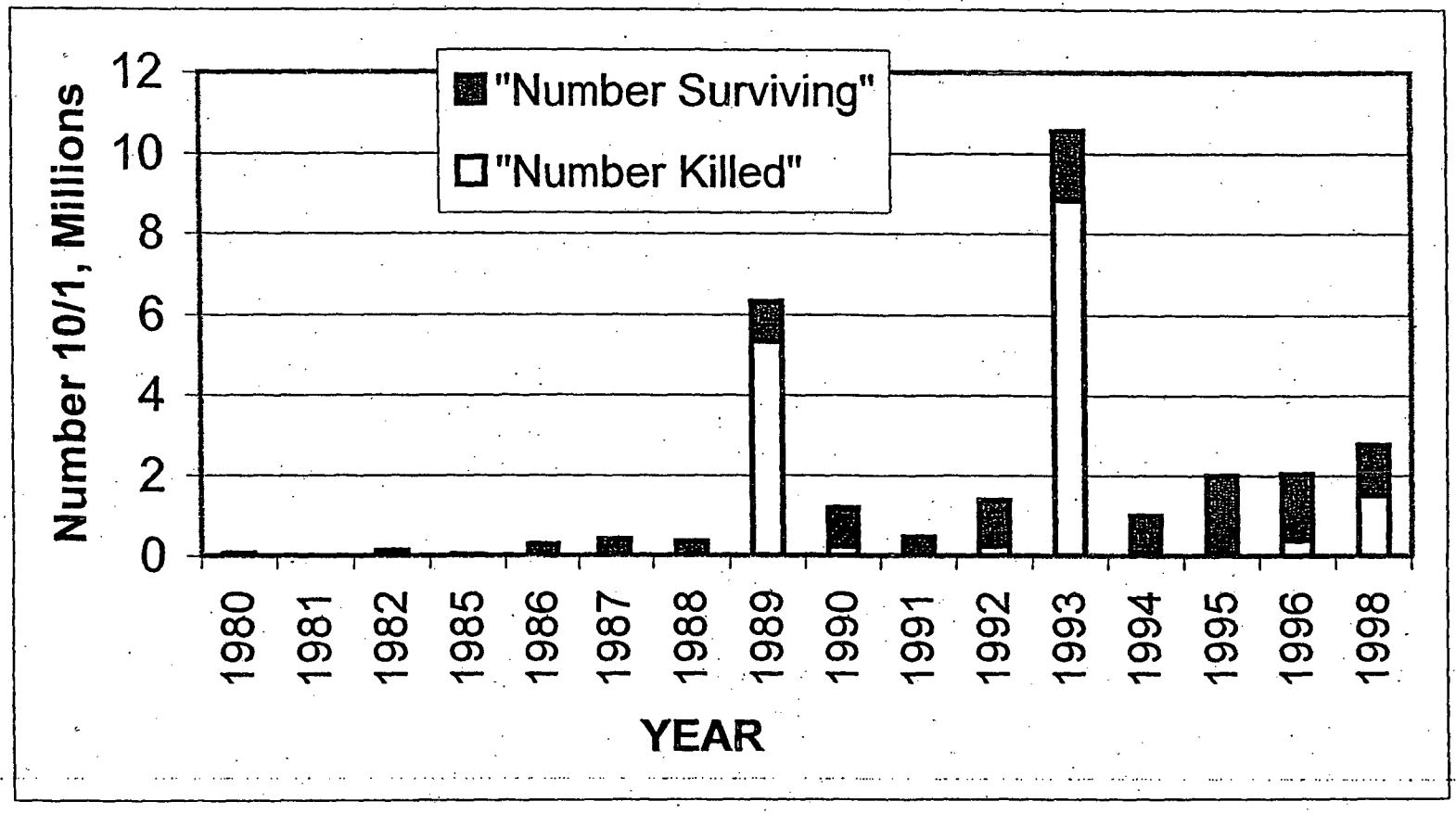


Figure 3. Number of YOY striped bass surviving to October 1 and equivalent recruits on October 1 from losses to SNGS.

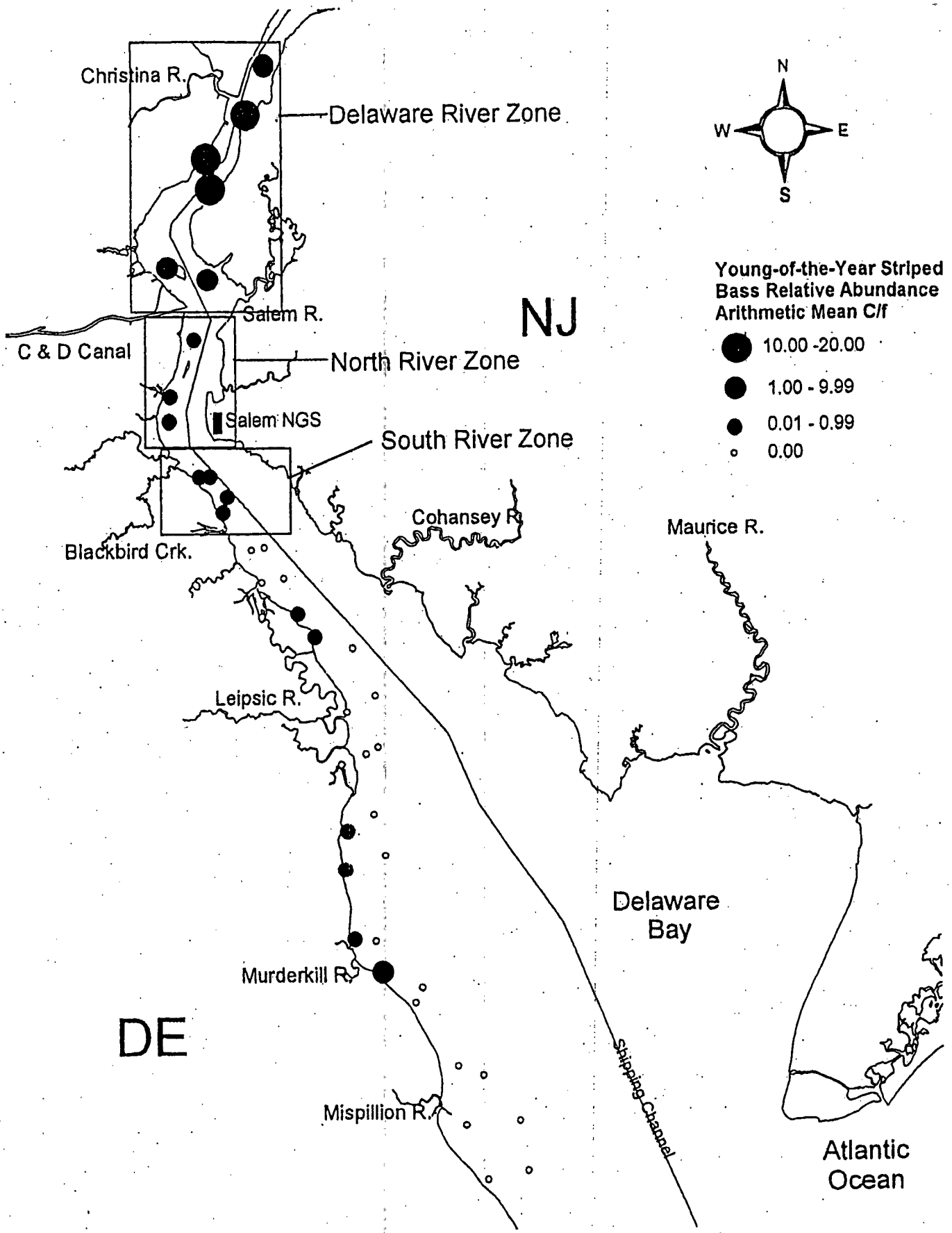


Figure 4. Spatial distribution of young-of-year (YOY) striped bass as measured by the DE DFW Juvenile Trawl Program in the Delaware Estuary from 1980-1998 (Modified from Michels 1999)

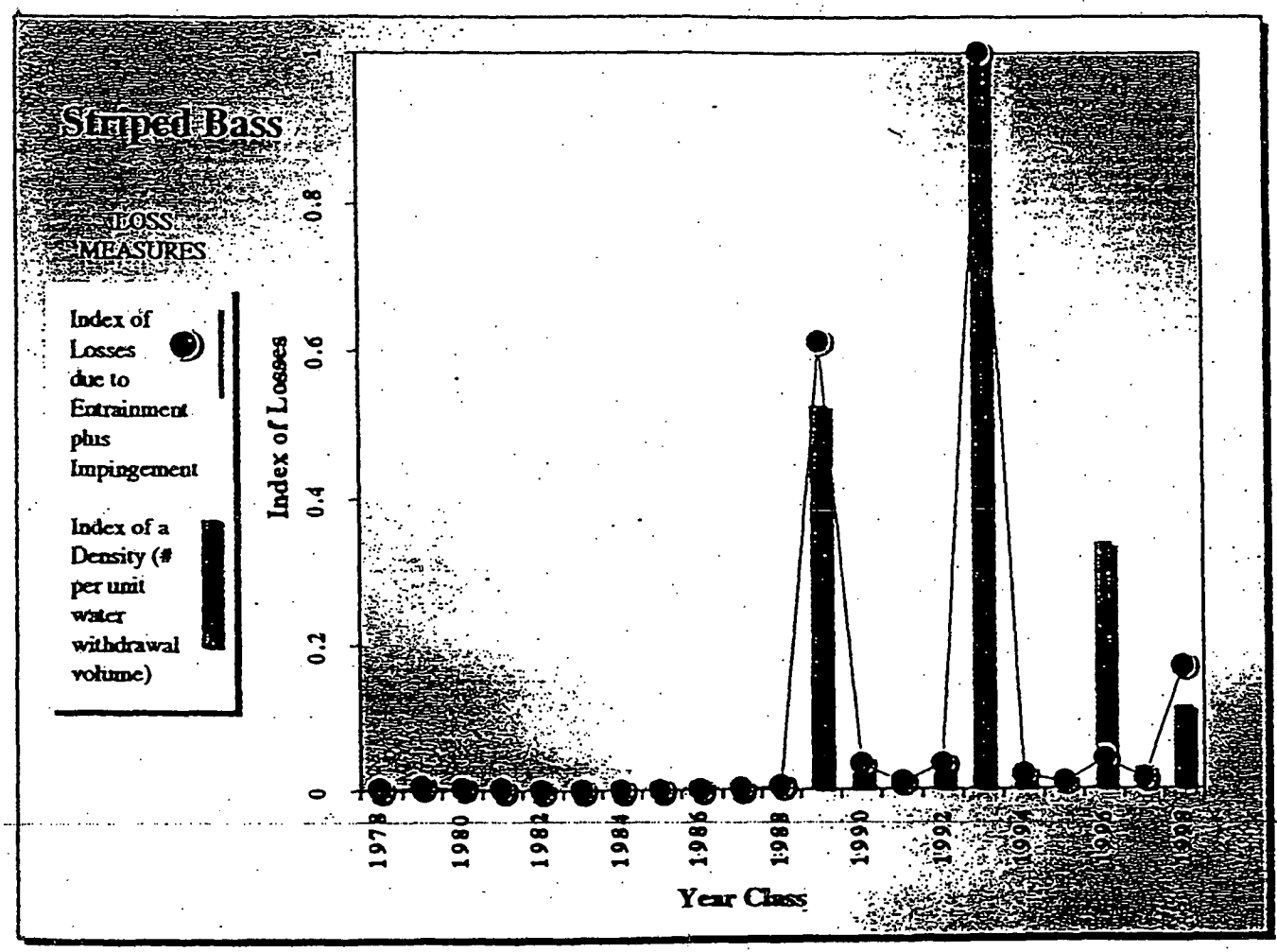
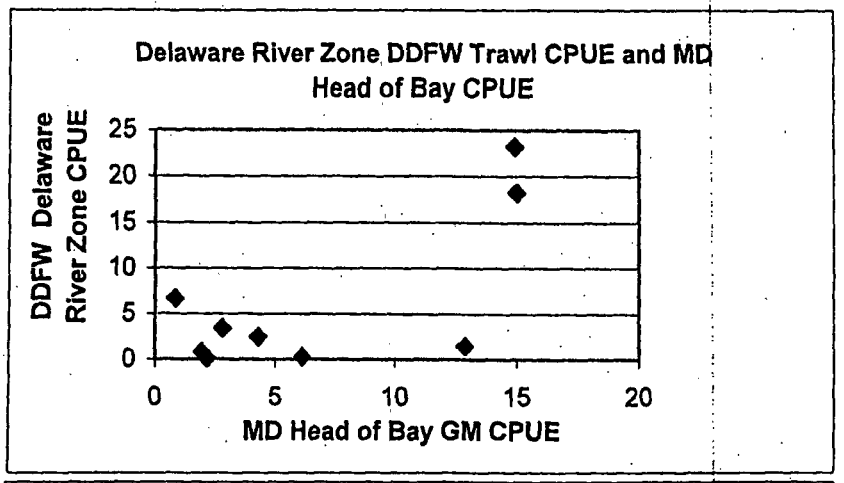


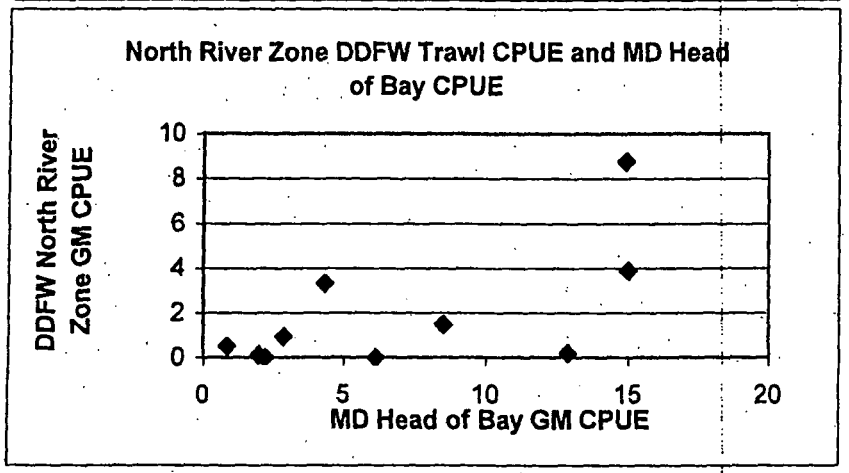
Figure 5. (H Figure 19
From PSE&G's 1999 Filing)

Interannual pattern of losses of striped bass due to entrainment and impingement at Salem, 1978-1998.

a)



b)



c)

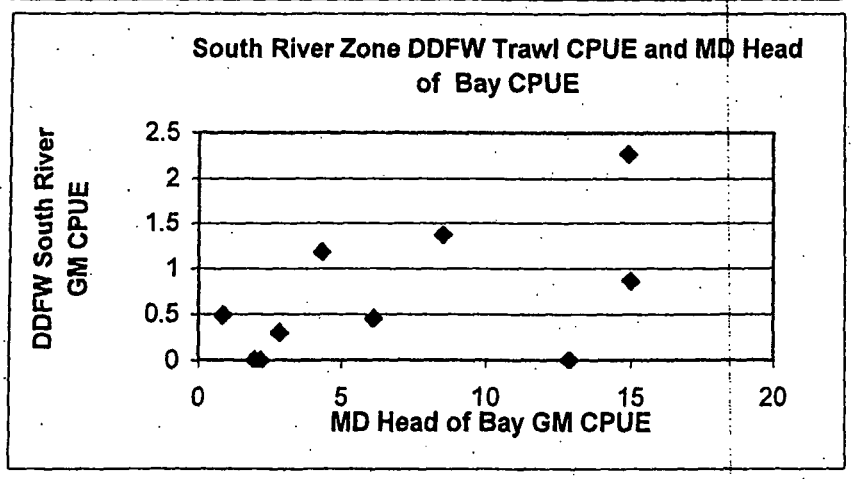


Figure 6. Relation of the MD DNR Head of Bay YOY index to (a) the Delaware River Zone, (b) the North River Zone and (c) the South River Zone GM catch per tow from the DE DFW juvenile trawl survey. Panel (a) comprises 1990-1998; panels (b) and (c) comprise 1989-1998.

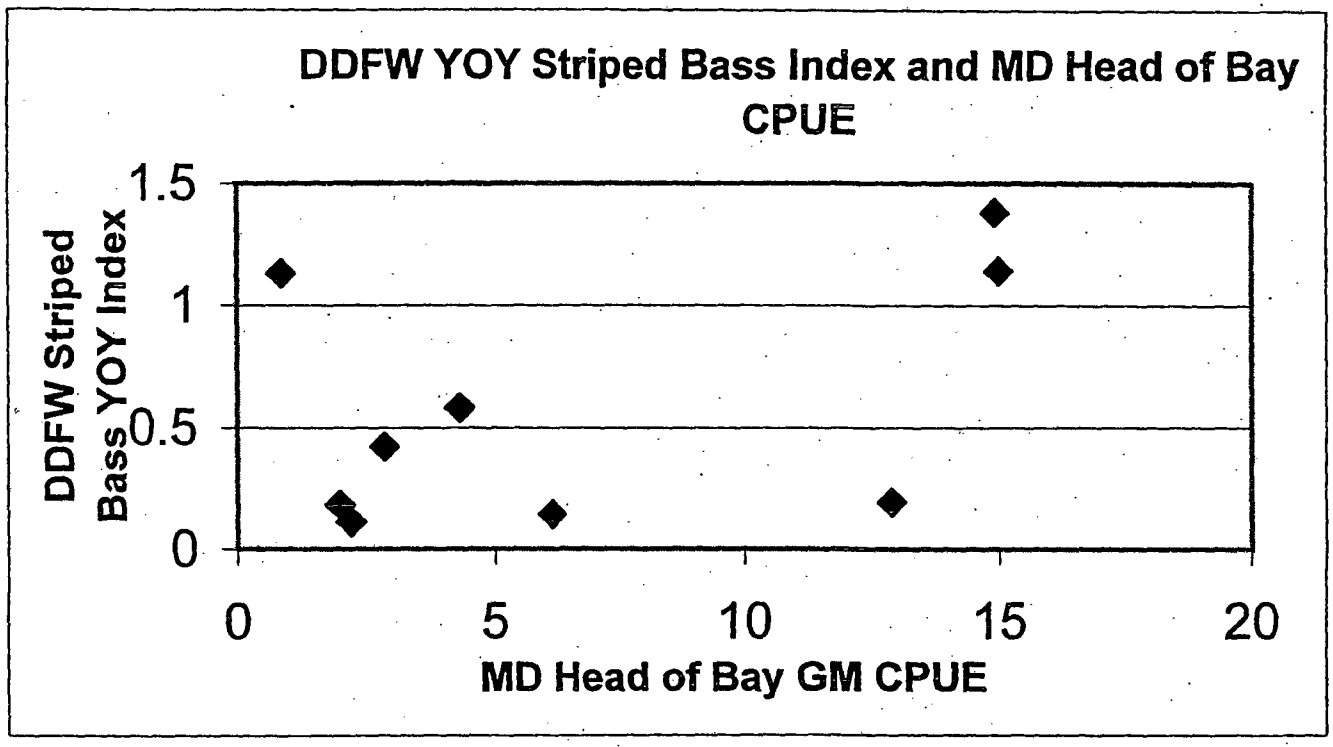


Figure 7. Relation of the DDFW Juvenile Trawl Striped Bass YOY Index to the MD DNR Head of Bay GM CPUE. DDFW Index is GM Catch Per Tow of all stations north of the Liepsic River, 21 in all.

Exhibit B

Assessment of the Impact of the Salem Nuclear Generating Station on Weakfish and Striped Bass

Desmond M. Kahn
Delaware Division of Fish and Wildlife

March 8, 2001

EXECUTIVE SUMMARY

Public Service Enterprise Group (PSEG), as part of their application for the Salem Generating Station (SGS) permit renewal (the Application), conducted two general lines of analysis. The first line was a cost-benefit analysis of modifications to the SGS that would reduce its impact, the most substantial modification being installation of cooling towers (closed cycle cooling). For this purpose PSEG developed estimates known as Harvest Foregone. This was the estimated additional landings by the fisheries in pounds that would have occurred if the SGS was not operating. As a step in this process, PSEG developed estimates known as Equivalent Recruits, the number of one-year-old fish that would have survived if SGS was not operating. I examined these estimates for weakfish and striped bass, and attempted to place them in context by comparisons to current landings in the State of Delaware. These estimates can be considered worst-case estimates because they do not consider any form of biological compensation (increased growth and survival of remaining stocks due to reduced competition for food and space).

The second line of analysis PSEG developed presented an assessment of the impact of the SGS on the ecology of the Delaware Estuary and also the Atlantic coast. In this report, I focused on their Stock Jeopardy Analyses, in which they presented results of a model for weakfish that estimates impact of the SGS on weakfish spawning stock biomass. In the case of striped bass, PSEG did not conduct such an analysis because they did not develop the required estimates of abundance of juvenile striped bass. However, I referenced previous modeling I conducted (Kahn 2000) in which I estimated the 1989-98 SGS Conditional Mortality Rate (CMR) at 32% per year using an estimate of juvenile abundance of striped bass. I also discussed PSEG's objections to my estimate of CMR.

I found that in the case of weakfish, the estimates of Equivalent Recruits from PSEG were not available in the Application, but a subsequent report prepared by PSEG consultants (Anthony et al. 2000a) estimated them as 2,104,000 additional age-one weakfish that would have survived absent the SGS. The Harvest Foregone estimate was 1,657,000 lbs. per year. These estimates are based, in part, on an assumption that young weakfish from Delaware Bay would be subject to bycatch mortality from the South Atlantic shrimp fishery after they migrate south for the winter. This assumption probably is in error, and the effect of removing it would be a 12% increase in surviving weakfish, or an additional 256,000 Equivalent Recruits. I presented a model which estimates the future annual harvest from this revised Equivalent Recruits analysis as 815,097 harvested weakfish (Harvest Foregone). This number is 165% of the 1999 combined recreational and commercial Delaware harvest of weakfish. PSEG's estimation of Harvest Foregone in pounds also equals 165% of the average total Delaware harvest of weakfish from 1995 through 1999. Even when viewed as a worst-case estimate, this level of impact is very large.

PSEG's Application indicated that there was virtually no reduction in coastwide spawning stock biomass due to the SGS. This stock jeopardy analysis employed PSEG's estimate that 16.6% of Delaware Bay young-of-year weakfish are killed by SGS, absent biological compensation. This analysis should be updated, since new research shows that

weakfish return to their natal estuary, meaning there are individual spawning stocks, including a Delaware Bay stock. The model should be redone to portray the impact of the SGS on the Delaware Bay spawning stock of weakfish. In PSEG's model they portrayed the SGS's impact on the total coastwide aggregation of weakfish, thus diluting the SGS's impact.

Contrary to PSEG findings, my application of the stock jeopardy analysis using a Spawning Stock Biomass Per Recruit model shows that without biological compensation, attempts to fish the stock at the proposed future target fishing mortality rate would reduce the spawning stock biomass of the Delaware Bay stock to 22.5% of virgin biomass. In contrast, the proposed Atlantic States Marine Fisheries Commission management target rate aims to maintain 30% of the virgin biomass. This reduction in SSB is dangerously near the 20% level, which is often used as an overfishing threshold.

In the case of striped bass, PSEG did not present the number of Equivalent Recruits which would survive absent SNGS, but instead estimated the Harvest Foregone, or pounds lost to the fishery, as 723,418 lbs per year. This worst-case estimate is very large, amounting to 181% of Delaware's average combined sport and commercial harvest from 1995-1999 of 398,743 lbs. The estimate in Kahn (2000) of 32% average Conditional Mortality Rate means the productivity of the Delaware River spawning stock of striped bass may be severely restricted by the SGS.

Introduction

Since PSEG in their application for permit renewal (the Application) for the SGS has pursued two separate analyses for weakfish and striped bass, I will divide my assessment for each species into two separate sections. The first section is the cost-benefit analyses, for which PSEG estimated pounds of fish lost to the fishery. They then calculated the value of these pounds to the fishery. Once a specific modification was analyzed, such as cooling towers, they calculated the pounds of fish that would be restored to the fishery if the modification were to be implemented. The dollar value of these additional pounds was the benefit for the cost-benefit analysis. The second line of analyses PSEG conducted included the Stock Jeopardy Analysis. Here, PSEG attempted to model the possible effects of the SGS on spawning stock biomass levels of the relevant stock.

Weakfish

Cost-Benefit Analysis

In this analysis, credited to Thomas Englert of Lawler, Matuskey and Skelly (F-4, Attachment 4 in the Application) PSEG used the data on numbers entrained and impinged, based on their samples. They then developed an Equivalent Recruits model, as was used in Kahn (2000). This model employs estimates of natural mortality of the different life stages, from those entrained up to one year of age, when the animals are "Recruits." This intermediate result is an estimate of the number of one-year olds that would have survived if they had not been killed by impingement or entrainment. PSEG also developed a Yield-Per-Recruit model (YPR). PSEG then multiplied the number of Equivalent Recruits by the YPR, in weight, to present total yield lost or "Pounds Lost to the Fishery" (F-4 Table 11).

The result is highly sensitive to the stage-specific estimates of natural mortality. These rates are not known with any certainty, and are almost certainly highly variable from year to year and among environments. To estimate these rates for all species modeled with the Equivalent Recruits approach, the various estimates of mortality rates for various life stages were gleaned from the scientific literature. In some cases, results obtained by putting together the various stage-specific mortality rate estimates for a given species and calculating the resultant survival to age one were judged not realistic or tenable (L. Barnthouse, PSEG consultant, personal communication). Therefore, a procedure called Life Cycle Balancing was used. In this procedure, rates for any one species were adjusted until one egg produced enough spawning stock to replace itself. The assumption and guideline here was that the populations were staying at a constant size. To calculate Equivalent Recruits lost to the SGS, a very small increase in survival rates can result in a large increase in numbers of animals that would have survived. This is partly because the rates are survival per day, and some life-stages last for months, with the cumulative effects of small changes in a daily rate having large impacts by the end of a life-stage. As ESSA Technologies Ltd. pointed out in their review of the application for New Jersey Department of Environmental Protection (NJDEP), this procedure involves

uncertainty, especially since some species have not had constant population sizes over the period in question, and may not in the future.

In any case, the rates used for weakfish assumed that young weakfish from Delaware Bay would be exposed to significant mortality from the South Atlantic shrimp fishery, in what is known as bycatch. The term "bycatch" describes the accidental catch of species that are not the target of a given fishery. This inclusion of the bycatch effect is not noted anywhere in the section of the Application detailing the methods (Appendix F, Attachment F-4 "Biological Modeling of Fish Protection Alternatives"). Even the section of F-4 Table 4 that gives the input parameters for weakfish, has values of zero for fishing mortality until Age 1. Age 1 then has the same value for fishing mortality as older ages. Bycatch is usually considered part of fishing mortality, but here the bycatch effects are included under "natural mortality." This occurred because bycatch was included in the Life Cycle Balancing method for weakfish. If PSEG had made it clear that this model included shrimp bycatch, readers would have an easier time understanding the assumptions in this analysis.

Inclusion of shrimp bycatch in the mortality estimates for weakfish reduces the estimate of plant impact, since any increase in the mortality rate employed in the Equivalent Recruits model would produce fewer Equivalent Recruits. Therefore, the effects of the plant are smaller, as fewer one-year-old fish would have survived, given the absence of the plant. It is true that shrimp bycatch is a significant mortality source for weakfish in the South Atlantic. In fact the ASMFC Weakfish Stock Assessment Subcommittee has included this source of mortality in older stock assessments, as documented in the Application analyses. However, the idea that Delaware Bay weakfish are subject to this fishery is probably erroneous. PSEG does not provide any evidence for this assertion. Instead Anthony et al. (2000a) state that "Dr. Kahn presented no supporting evidence (e.g. tagging, telemetry or genetic marker studies) that these fish stop their southward migration in North Carolina and that none remain in southern waters until the summer of the following year." In fact, since PSEG is asserting that shrimp bycatch reduces the impact of the plant, it is incumbent on PSEG to substantiate that claim. Tagging data in Nesbit (1954) based on the use of celluloid belly tags from Montauk, New York in the area of Peconic Bay, are the only such data for age 0 weakfish. These data show that, of 48 returns from these fish at ages 0 or 1, one was from Pamlico Sound, one was from the area of Cape Hatteras and one was reported at an inland location in North Carolina where the fish was presumably cleaned. Ninety four per cent of the recoveries were from Virginia through Long Island. These data don't provide evidence that age 0 weakfish from New York travel further south than Cape Hatteras, and they indicate that these young weakfish do not remain in North Carolina over their second summer.

Anthony et al. (2000a) made an erroneous interpretation of genetic studies of Atlantic Coast weakfish as a rationale for the assumption of shrimp bycatch mortality. Genetic studies have failed to reject the null hypothesis that weakfish along the Atlantic coast have no genetic differentiation, such as that produced by strict homing and a complete lack of stock mixing. In fact, this does not mean there are no separate spawning

stocks, but only that genetic studies failed to detect such structure. PSEG misinterprets the lack of genetic structuring to mean that weakfish along the Atlantic coast have no environmental differences, either. That is, the lack of detectable genetic differences has no bearing on the fact that southern weakfish are subject to shrimp bycatch, while northern weakfish are not. It is relevant here that PSEG at one point refers to the "Northern stock" of weakfish (Appendix F, Section VII.C.6.a, p. VII-43). At another point, in discussion of shrimp bycatch, PSEG describes it as occurring in "the South Atlantic shrimp trawl fishery"(Appendix H II.A, p. 27). These references indicate the spatial difference between northern weakfish and the shrimp fishery.

Young-of-year (YOY) weakfish from Delaware Bay and other Mid-Atlantic estuaries are known to migrate south and offshore in the fall to overwintering grounds (Nesbit 1954). The area of Cape Hatteras and immediately south thereof is believed to be the southernmost extent of these overwintering grounds for weakfish from Delaware Bay and points north (Dr. Louis Daniel, North Carolina Division of Marine Fisheries, personal communication).

While PSEG cites a report that 27% of shrimp fishing effort for North Carolina occurs in months other than June through September, they confuse the tempo-spatial distribution of shrimp fishing with the distribution of overwintering northern weakfish. Delaware Bay weakfish are not completely out of the Bay until sometime after December, although the migration begins as early as September, as data from the DNREC trawl surveys show. Overwintering occurs primarily then in December through March. The fact that a proportion of shrimp trawling occurs after September and before June does not necessarily mean that it occurs in December through March. The shrimp fishery in the latitude of Cape Hatteras is confined to the interior of Pamlico Sound (L. Daniel NCDMF and Dr. J. Merriner, National Marine Fisheries Service [NMFS], personal communication). There is no evidence that overwintering northern weakfish enter Pamlico Sound. In fact, they are believed to remain offshore several miles or more (ASMFC 1985). Approximately fifty miles south of Cape Hatteras, in the Cape Lookout area, and one hundred miles south of Cape Hatteras, in the Cape Fear area, some shrimping occurs on the Continental Shelf in the fall months, but Delaware Bay weakfish are not known to migrate this far south (L. Daniel, personal communication). For example Pearson (1932) found the winter trawl fishery in North Carolina caught most weakfish between Ocracoke Inlet and Bodie Island, in the area of Cape Hatteras. The former is about 45 miles north of Cape Lookout. This fishery winds down and closes in the fall, as Delaware Bay weakfish are migrating south from Delaware Bay. It does not generally occur over winter (Dr. J. Merriner, NMFS, personal communication).

In the absence of any evidence that Delaware Bay weakfish are subject to the shrimp bycatch, this assumption should be removed from the analysis, as it only lessens the estimate of plant impact. Elimination of shrimp bycatch mortality from the model would result in a 12% increase in the number of Equivalent Recruits per year (Anthony et al., 2000a). That is, the estimate of the increase in the number of Age 1 weakfish that would have survived to Age 1 in the absence of plant impacts increased by 12%. This increased the impact from what would have been the annual loss of 2,104,000 Age 1

weakfish to the annual loss of approximately 2,360,000 Age 1 weakfish, or an increase in the annual number of Age 1 weakfish lost to the plant of 256,000.

One thing that has become clear is that the losses expressed as Equivalent Recruits, in number, do not appear anywhere in the application. It is puzzling why these large numbers, in the millions of fish, are not presented in the Application. In Attachment 4 to Appendix 4 of the Application, where the cost benefit analysis and results are presented, the statement is made in the Results section, "These losses were then converted to age-1 equivalent adults and pounds lost to the fishery using the Equivalent Adult and Equivalent Yield models. Results are presented in F-4 Table 11." Table 11, however, lists only pounds lost to the fishery as a result of SGS operation..

The most recent proposal for the coastwide target fishing mortality is $F_{30\%} = 0.31$, as recommended by the Atlantic States Marine Fisheries Commission (ASMFC) Weakfish Technical Committee in 20000. To put this loss of 2.36 million weakfish per year in perspective, Table 1 shows the numbers of catch foregone every year (as opposed to the pounds foregone)from the estimated loss, indicating that an additional 815,097 weakfish could be harvested per year using F=0.31 (Table 1). In 1999, the estimated harvest from the state of Delaware was 226,558 weakfish by the recreational fishery (NMFS Marine Recreational Fishery Statistics Survey) and 265,963 from the commercial fishery (Delaware Division of Fish & Wildlife unpublished estimate), for a total of 492,521 weakfish. This estimate of harvest foregone from Salem was 165% of the total Delaware harvest.

Anthony et al. (2000a) stated that the estimate of yield per recruit used in the estimation of Harvest Foregone in pounds was too high, compared to an estimate in the most recent stock assessment (NMFS 2000). By chance, the most recent estimate was about 12% higher than the one used by PSEG. This increase in yield per recruit consequently offset the increase in number of Equivalent Recruits to maintain the pounds lost to the fishery as 1,650,000 pounds per year, very close to the original estimate in the Application. The commercial harvest in numbers from Delaware is not available for 1995-1998, but a comparison of pounds indicates the PSEG estimate of the harvest foregone is equivalent to 168% of the total Delaware harvest, on average (Table 2; source of estimate: Whitmore and Cole 2000). This is a very large impact.

New Jersey harvest from Delaware Bay alone is not available, but if we assume it was comparable to the Delaware harvest, the harvest foregone would have averaged approximately 84% of the total harvest from Delaware Bay. Since approximately 49% of coastwide landings of weakfish occur in North Carolina on the overwintering grounds (see below), landings in Delaware Bay would not be the majority of landings from the Delaware Bay stock. In addition, samples of Delaware commercial weakfish landings by the Delaware Div. of Fish and Wildlife indicate that larger, older weakfish enter the Bay in the beginning of the spawning season and leave soon thereafter, while smaller weakfish tend to remain through much of the summer. These larger fish are thought to migrate north, towards New York and New England. A large proportion of the harvest from this component of the stock could occur in northern states, if this hypothesis is

correct. In summary, the harvest in Delaware Bay is probably a minority of the harvest from the Delaware Bay stock.

To put the loss from SGS in a larger perspective, we can compare it to the harvest expected coastwide. Table 3 lists the projected harvest from the average coastwide stock size at age one from 1995-1999 (source: Virtual Population Analysis from 30th SARC discussed in NMFS 30th SAW, 2000). The equilibrium harvest coastwide is 18,609,755 at the proposed future target F = 0.31. Note that this projected total assumes harvest out to age 12, which would require further broadening of the age structure of the stock. Recent estimates of the coastwide number caught from the latest VPA show numbers in the range of 11 to 12 million. The harvest foregone annually due to the SGS of 815,087 weakfish would be 4.4% of the projected coastwide harvest. If the coastwide harvest fails to grow to meet this projected catch, the proportion of potential harvest lost to Salem would be higher. For example, if total harvest remains at 12 million, the estimated harvest foregone from the SGS would represent 6.8% of that number.

While the harvest foregone can be viewed in a coastwide context, both recent peer-reviewed research and older work have demonstrated that weakfish home to their natal estuary. The reasonable conclusion is that major estuaries have their own spawning stock. Therefore, the major impact of the Salem losses would be on the Delaware Bay stock and consequently on the Delaware Bay fishery. Thorrold et al. (2001) found that 2-year-old weakfish were most likely to be found in their natal estuary. The next most likely location was neighboring estuaries. This study, published in the journal *Science*, was based not on genetics, but on a far more powerful technique, isotope ratio analysis. This method analyzes the ratios of isotopes of various elements in the core of the otoliths, and can detect the chemical signature of various estuaries, thus assigning fish to an estuary of origin. For example, in the sample of 2-year-old weakfish from Delaware Bay, 64% were born in Delaware Bay, with the next smaller proportions from Peconic Bay, Long Island and from the Chesapeake Bay. The exact time this sample was collected is not stated, except that it was collected during the spawning season. Peconic Bay fish may have still been migrating north. Nesbit (1954) found that Peconic Bay fish homed to their natal estuary, using tags. Therefore, at least two lines of evidence indicate natal homing in weakfish.

Stock Jeopardy Analysis

In PSEG's Stock Jeopardy Analysis of possible impacts of SGS on the spawning stock biomass of weakfish, the assumption made was that weakfish was a unit stock all along the Atlantic Coast. PSEG based this assumption on the position of the ASMFC, which in turn based their position on the genetic studies discussed above. While PSEG's assumption is reasonable in light of the ASMFC position, it also means that the plant's impact is diluted among the total Atlantic Coast stock. Furthermore, PSEG did a very rough calculation of the proportion of the Atlantic Coast stock contributed by Delaware Bay based on landings. This calculation was erroneous, even on its own terms, since PSEG merely calculated the proportion of weakfish landings from North Carolina north that occurred in Delaware and New Jersey. This seriously underestimates the contribution

of Delaware and New Jersey, since by far the largest landings come during the winter in North Carolina, when weakfish produced in all areas to the north are aggregated on the overwintering grounds. North Carolina has harvested approximately 65% of coastwide landings since 1984 (NC DMF 1998). Of North Carolina landings for 1995-1998, 76% were ocean landings while 24% were from estuarine waters, primarily Pamlico Sound, according to the North Carolina Division of Marine Fisheries annual weakfish reports for 1996 through 1999. Since these ocean landings were from the overwintering aggregation of weakfish from various stocks, they should be subtracted from total landings in order to estimate the contribution of various estuaries. Therefore, 49% of regional landings (0.65*0.76) were North Carolina landings on overwintering weakfish, and should be removed from the total. Of the remaining 51% of the total landings from North Carolina and northwards, approximately 40% were from estuaries of origin in Delaware and New Jersey, and would be assumed to represent the contribution from Delaware Bay under the PSEG approach. However, not all landings from New Jersey, in particular, came from Delaware Bay, so this result probably overstates the contribution from Delaware Bay.

A second way to estimate the proportion of production from the Delaware Bay is to rely on PSEG's own estimates of production foregone and their future Conditional Mortality Rate (CMR) estimate for weakfish of 16.6% (F-2 Table 21). If the estimate of Equivalent Recruits discussed above of 2,360,000 weakfish equals 16.6% of the Delaware Bay's yearly production at age 1, then 100% of production would equal 14,131,736 age 1 weakfish. The virtual population analysis selected by the 30th Stock Assessment Review Committee (SARC) showed the average coastwide abundance of age 1 weakfish for 1995-1998 to be 51,790,600. These numbers indicate the Delaware Bay produced 27% of the coastwide stock.

While the text of PSEG's discussion of weakfish uses the estimate of 20% of the coastwide production, a close look at F-2 Table 21, the input values for the spawning stock biomass model, indicates that 20% was only the *upper bound* of the range of values selected from. This means the model used estimates of 20% *or less*. The model used a Monte Carlo procedure, selecting input values at random from a predetermined distribution. The reason why the model used 20% or less is unclear, since the text indicates the estimate used was 20%. Of course, the lower the proportion assumed, the smaller would be Salem's impact on the coastwide stock.

In fact, in light of the new evidence that weakfish home to their natal estuary, the stock jeopardy analysis is not relevant as constructed. If this analysis is redone, at least one run should use 100% as the contribution of the Delaware stock, assuming there is a Delaware Bay stock. If other values are used, they should be used in supplemental analyses. For example, since Thorrold et al. (2001) estimated that 64% of Delaware Bay two-year-olds were born there, 64% could be used as the contribution parameter in another run.

In the stock jeopardy analysis, PSEG developed a conditional mortality rate of 16.6% of Delaware Bay weakfish from the SGS, meaning in the absence of all other mortality, 16.6% of Delaware Bay YOY weakfish would be killed by the plant. This rate

is a worst-case estimate, without any assumption of amelioration of plant mortality by compensation. Although compensation undoubtedly does occur in fish stocks, the timing in the life cycle and the frequency of it are generally unknown (Boreman 1997). Inclusion of compensation would ameliorate this impact under certain conditions, because the surviving final number of recruits produced would be determined by two factors, carrying capacity of the estuary and the life-stage affected. If the life stage affected by compensation occurs earlier than the primary life-stage affected by SGS, there would be no effect by SGS on the proportion surviving. Conversely, if compensation affects a later life-stage than the one primarily affected by SGS, then it could change the final impact, depending on the carrying capacity relative to abundance. If, on one hand, the carrying capacity of the environment could have supported more juveniles than the total of the final number of survivors plus the Equivalent Recruits lost to the plant, then compensation would have no effect. If, on the other hand, the carrying capacity could support fewer juveniles than the total of survivors plus equivalent Recruits lost, then the final impact would be less than 16.6% mortality. Carrying capacity of a given environment, however, can vary as biotic factors, such as prey density, change and as physical factors, such as temperature and precipitation, change. Therefore, to apply a correction by assuming compensation reduces the CMR and may well underestimate the effect of the SGS.

In its Application, PSEG did include hypothesized effects of compensation in the Stock Jeopardy Analysis, based in part on an approach they termed Meta-Analysis. This approach relied on data from related species, or from species judged to be roughly similar. In other fields of study, such as medicine, the term Meta-Analysis denotes a method of pooling data from several separate studies run by different research teams. In those applications, however, the data was still generated by the treatment in question, not by using similar, but different treatments judged somehow related to the treatment in question. Variability is a hallmark of ecology, and an assumption that what applies to one species, or even one population of one species, can be applied to another species or population may not be valid.

In the Application, PSEG used the inputs from Meta-Analysis in an Equilibrium Stock-Recruit model. Here, crucial input values were selected based on "best professional judgement." That is, they were unknown, so the modeler made an educated guess. These variables included the proportion of the stock contributed by the Delaware estuary, discussed above, and the "% before" and "% after" (see F-2 Table 21). The latter two are the proportion of the CMR that occurs before and after compensation in the life history. As discussed above, this would have a crucial effect, but this timing is unknown. PSEG does not know the actual timing, so they employ guesses, thus leading to tenuous conclusions. These aspects of the Stock Jeopardy Analysis reveal how tenuous its conclusions are. These conclusions are hardly reliable enough for impact assessment.

The inclusion of compensation in the Stock Jeopardy Analysis introduces a wild card that is difficult to evaluate. The model, if rerun to correct for the assumption of no more than a 20% contribution to the coastwide stock, should also be run without the

assumption of compensation to allow for a worst-case estimate of the impact on spawning stock biomass.

I developed a Spawning Stock Biomass Per Recruit (SSBPR) model (Boreman 1997) to evaluate the impact of the worst case estimate of a 16.6% CMR on the Delaware Bay stock (Table 4). Estimates of M, partial recruitment (PR), average weight and proportion mature at age are consistent with values used in the weakfish assessment in the 30th SAW (NMFS 2000). Spawning was assumed to occur after 0.5 of M and F had been exerted on the stock. Table 4 shows the base run, with the proposed target F = 0.31. To model the stock with the losses from SNGS added back in, I multiplied the number of recruits at age one by 1.166, equivalent to restoring the 16.6% loss. When the virgin Spawning Stock Biomass (SSB) was computed (F = 0), PSEG calculated it to be 6.263 kg per recruit. Since the proposed ASMFC target fishing mortality is based on retaining 30% of the virgin SSB, calculation of 30% of this SSB equals 1.88 kg per recruit. In the base run, however, without the Salem losses included in the input (Table 4), applying the proposed target of $F_{30\%}$ = 0.31, only 1.41 kg SSBPR results. In fact, to produce the 1.88 kg SSBPR needed, the F needs to be reduced to F = 0.30. For the Delaware Bay stock, then, if we assume the 16.6% mortality due to Salem, using the $F_{30\%}$ = 0.31 will not achieve the conservation target of 30% of virgin spawning stock biomass. In fact, it will only achieve 22.5% of virgin SSB. Thus the stock would, in fact, be closer to 20% of virgin biomass than to 30%. A level of 20% of virgin biomass is often used as an overfishing threshold, meaning it is considered a threshold of dangerously low stock biomass.

If the target F = 0.31 were to be exceeded to any extent, the Delaware Bay stock would be reduced below 20% of virgin biomass. This potential thwarting of coastwide management goals due to the SGS, in combination with fishing, has not been addressed by PSEG. It is the type of effect focused on by Goodyear in his 1999 review of portions of Appendix F of the Application.

Striped Bass

Cost-benefit

As discussed under weakfish, an Equivalent Recruits model was developed to estimate the total additional number of one-year old striped bass that would have survived if Salem had not been in operation. These estimates were based on PSEG's entrainment and impingement samples. The fishing mortality rate applied was the ASMFC recommended target of F = 0.31. PSEG does not present the numbers of equivalent recruits that would have survived in tabular form, except for a graphical portrayal in another section of the Application (Appendix H Fig. 20), where they are cross-referenced from the Cost-Benefit section (Appendix F Attachment 4). Instead, PSEG presents the pounds lost to the fishery (F-4 Table 11, reproduced here as Table 5).

These losses are substantial, amounting to 723,418 pounds per year. In contrast to this, the Delaware commercial fishery has an annual quota of only 193,447 pounds, and

our recreational fishery harvest has averaged 205,296 pounds from 1995-1999. This totals 398,743 pounds. The Salem harvest foregone is 181% of this total, per year. Assuming the Production Foregone estimate is correct, this is a very large loss. If cooling towers were installed at SGS, the PSEG estimate of pounds lost would be 84,787 pounds, presumably due to periodic replenishment of cooling water because of evaporative losses. The effect of other modifications to the SGS were also presented in the Application (here reproduced as Table 5).

Stock Jeopardy Analysis

PSEG did not present results of a Stock Jeopardy Analysis for striped bass. That is because they have no estimate of the CMR of striped bass due to entrainment, which is by far the largest source of mortality (Kahn 2000). They did not develop a CMR because they didn't estimate the juvenile abundance of striped bass in any year but 1997, when the plant was not running.

Kahn (2000) did estimate the CMR for entrainment and impingement by developing estimates of absolute abundance from a combination of two independent, peer-reviewed studies, the NJDEP Beach Seine Survey of young-of-year (YOY) striped bass (Weisberg et al. 1996) and a mark-recapture estimate of absolute abundance of YOY striped bass in the Delaware River for 1990 (Burton and Weisberg 1994). Since 1989, when the abundance of juvenile bass suddenly increased dramatically though 1998, the estimated average mortality rate was 32%. This high value was due to several years of very high rates, 1989, 1993 and 1998, when the estimated rates were over 50%. In three other years (1996, 1992 and 1990), the mortality rate estimates were between 15% and 20%. PSEG has contested the estimates in Kahn, 2000 (Anthony et al. 2000b); however, several mistakes and misinterpretations in their arguments weaken their position.

Without going into great detail here, suffice it to say that the estimates in Kahn (2000) are the only estimates available and, in my view, are defensible and sound as estimates of the worst case impact of the SGS on the Delaware River stock. They are based on PSEG's own estimates of numbers entrained and on two published studies of YOY striped bass in the Delaware River. While these estimates of CMR have some uncertainty, that is true for much of the PSEG application's conclusions as well. Several points in Anthony et al. (2000) appear to be in error. For example, they claimed the NJDEP beach seine survey is not applicable to striped bass killed by SGS because SGS is located downstream of the area covered by the survey. This is incorrect, at least for more recent years of the survey, since the lowest station in the NJDEP survey is at Augustine Beach, DE, directly across the river from the SGS.

Another of PSEG's objections was that they believed that the most likely source of the YOY killed by the plant in years with high CMRs were from the Chesapeake Bay via the C&D Canal. The Canal is certainly a source of some stock mixing, but the PSEG hypothesis was not supported by analysis in Kahn (2000). Kahn examined the spatial distribution of juvenile striped bass in the lower Delaware River and upper Delaware Bay using data from the DNREC juvenile trawl survey and data from the Maryland

Department of Natural Resources upper Chesapeake Bay YOY striped bass survey. In their response, Anthony et al. (2000b) produced a set of statistical analyses indicating that entrainment at SGS was significantly correlated with YOY abundance from the Maryland YOY beach seine survey, supporting their hypothesis. However, it is a well-known axiom of statistics that correlation does not prove causality. The Delaware River distribution data examined in Kahn (2000) do not provide evidence of the enhanced densities between the mouth of the Canal and the SGS that would verify the PSEG hypothesis. In fact, the net direction of flow of the Canal is in dispute; it is not known with certainty whether the net flow is eastward into the River or westward into the Chesapeake Bay. Two technical studies of the net direction of flow have come to opposite conclusions. Consequently, it is possible that the River is a net exporter of immature striped bass to the Chesapeake Bay, rather than the reverse, as PSEG assumes. There have been no field studies of larval distribution in the Delaware River since the first large year class was recorded in 1989. The issue is further complicated by the fact that the SGS is constantly reducing the density of larvae and early juveniles in its area by entrainment, as fishes move back and forth with tidal flow.

In their response, PSEG ignored the fact that annual variations in precipitation change the salinity gradient in the Delaware River and affect striped bass distribution and consequent degree of vulnerability to the SGS. For example, 1995 was the highest YOY index in the NJDEC survey in the River, but it was also a drought year, meaning the distribution of striped bass moved up the River, away from the SGS, explaining the low entrainment that year. Conversely, 1996, a year of high entrainment, was a very wet year, with the salinity gradient moving juvenile striped bass downriver in closer proximity to the SGS. This fact could explain the relatively large CMR estimate for 1996 of 18.8%, which occurred despite the fact that the plant was shut down that year and had only one circulating pump in operation.

While the source of entrained striped bass may be in dispute, the fact remains that a portion of these juveniles would have survived to become recruits into the fishery if not killed by the plant. This simple fact means that the source does not invalidate the mortality rate estimated, since these fish were in the Delaware River when killed. If some of those striped bass killed had entered the River via the Canal, the impact of the SGS on reproduction of the Delaware River spawning stock proper may have been reduced. The fact remains, however, that, on average, a high proportion of YOY striped bass in the Delaware River were killed by the SGS.

The losses of striped bass are unacceptably high and as a worst case, assuming no compensation, and assuming that the mortality was inflicted on immature fish produced by the Delaware River stock (rather than exports from the Chesapeake Bay), these losses must have a serious impact on the productivity and growth potential of the Delaware River stock. As detailed in Kahn (2000) rates of increase in YOY abundance from 1989 through 1998 have dropped to 3% per year, after exponential growth in the 1980s. This leveling off of increase in recruitment could be due to density dependence as the production capability of the River has been fully utilized, but the SGS mortality could also be restraining growth of the stock. In the event of overfishing or some catastrophic

decline, the SGS mortality could impede stock recovery. Even without these events, the size of this stock is very likely significantly lower than it would have been without SGS impact.

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Table 1. Estimate of weakfish Harvest Foregone from the Equivalent Recruits lost to Salem annually. Estimate of Equivalent Recruits from Anthony et al. (2000a) without shrimp bycatch. Inputs of M, F, PR from SAW 30, NMFS (2000). Under an assumption of equilibrium conditions, this harvest foregone over 7 years would occur in each year from the total of all losses from all cohorts present.

Age	Number at Age	M	F	PR	F*PR	Z	Catch
1	2,360,000	0.25	0.31	0.09	0.0279	0.2779	57,487
2	1,787,399	0.25	0.31	0.23	0.0713	0.3213	108,995
3	1,296,232	0.25	0.31	0.55	0.1705	0.4205	180,423
4	851,259	0.25	0.31	1	0.31	0.56	202,060
5	486,247	0.25	0.31	1	0.31	0.56	115,419
6	277,749	0.25	0.31	1	0.31	0.56	65,928
7	158,653	0.25	0.31	1	0.31	0.56	37,659
8	90,624	0.25	0.31	1	0.31	0.56	21,511
9	51,765	0.25	0.31	1	0.31	0.56	12,287
10	29,569	0.25	0.31	1	0.31	0.56	7,019
11	16,890	0.25	0.31	1	0.31	0.56	4,009
12	9,648	0.25	0.31	1	0.31	0.56	2,290
TOTAL							815,087 weakfish harvested

Table 2. Comparison of weakfish harvest foregone in pounds due to SGS from PSEG estimate, combined with Delaware total harvest 1995-1999, based on worst case with no compensation. The assumption of shrimp bycatch mortality incorporated in the Application has been eliminated from this calculation.
Estimate of Harvest Foregone from Anthony et al. (2000a) used the yield per recruit estimates from the 30th SAW (NMFS 2000).

YEAR	DE REC HARVEST LBS.	DE COMM HARVEST LBS.	TOTAL DE HARVEST LBS.	HARVEST FOREGONE FROM SGS LBS. (NO SHRIMP BYCATCH)	HARVEST FOREGONE FROM SGS AS A PERCENTAGE OF TOTAL DE HARVEST
1995	437,064	281,200	718,264	1,650,000	229.72
1996	711,116	317,317	1,028,433	1,650,000	160.44
1997	698,274	558,752	1,257,026	1,650,000	131.26
1998	610,229	549,551	1,159,780	1,650,000	142.27
1999	494,031	433,773	927,804	1,650,000	177.84

Table 3. Estimate of projected weakfish harvest from average age 1 coastwide abundance from NMFS (2000). Inputs of M, F, PR from SAW 30, NMFS (2000)

Age	Number at Age	M	F	PR	F*PR	Z	Catch
1	53,882,600	0.25	0.31	0.09	0.0279	0.2779	1,312,515
2	40,809,202	0.25	0.31	0.23	0.0713	0.3213	2,488,540
3	29,595,064	0.25	0.31	0.55	0.1705	0.4205	4,119,346
4	19,435,623	0.25	0.31	1	0.31	0.56	4,613,364
5	11,101,804	0.25	0.31	1	0.31	0.56	2,635,195
6	6,341,451	0.25	0.31	1	0.31	0.56	1,505,247
7	3,622,294	0.25	0.31	1	0.31	0.56	859,811
TOTAL							17,534,018

Under an assumption of equilibrium conditions, this harvest foregone over 7 years would occur in each year from the total of all losses from all cohorts present.

Harvest Foregone in numbers from SGS (Table 1) = 815,087

Coastwide harvest expectation from average number of age 1 weakfish = 17,534,018

Kill by Salem as a proportion of coastwide annual harvest = 0.046486

Table 4. Spawning Stock Biomass and Yield Per Recruit for weakfish, base run at proposed ASMFC fishing target. Spawning is assumed to occur after 0.5 of M and F are exerted.

Age	Number at Age	M	F	PR	F*PR	Z	Catch in Numbers	Average Weight, kg.	Proportion Mature	Spawning Stock Biomass, kg	Yield, kg.
1	1.000	0.25	0.31	0.09	0.0279	0.2779	0.024	0.12	0.9	0.094	0.003
2	0.757	0.25	0.31	0.23	0.0713	0.3213	0.046	0.26	1	0.168	0.012
3	0.549	0.25	0.31	0.55	0.1705	0.4205	0.076	0.43	1	0.191	0.033
4	0.361	0.25	0.31	1	0.31	0.56	0.086	0.63	1	0.172	0.054
5	0.206	0.25	0.31	1	0.31	0.56	0.049	1.05	1	0.164	0.051
6	0.118	0.25	0.31	1	0.31	0.56	0.028	1.61	1	0.143	0.045
7	0.067	0.25	0.31	1	0.31	0.56	0.016	2.98	1	0.151	0.048
8	0.038	0.25	0.31	1	0.31	0.56	0.009	4.82	1	0.143	0.045
9	0.022	0.25	0.31	1	0.31	0.56	0.005	5	1	0.083	0.026
10	0.013	0.25	0.31	1	0.31	0.56	0.003	5.68	1	0.054	0.017
11	0.007	0.25	0.31	1	0.31	0.56	0.002	5.8	1	0.031	0.010
12	0.004	0.25	0.31	1	0.31	0.56	0.001	6	1	0.019	0.006
		F =	0.31				0.345		kg Spawning Stock = Biomass Per Recruit	1.412	0.349 kg. Yield Per Recruit

Table 5. Pounds of striped bass lost to fishery from Appendix F, Attachment F-4.

F-4 Table 11 (cont.)

STRIPED BASS
+58% MORONE

POUNDS LOST TO FISHERY

ALTERNATIVE	Entrainment	Impingement	Total
BASE CASE	708,195	15,223	723,418
CLOSED CYCLE COOLING	84,787	0	84,787
SEASONAL FLOW REDUCTIONS			
10% Delta T Vary	650,110	15,111	665,221
20% Delta T Vary	596,672	14,994	611,666
45% Delta T Vary	474,950	14,701	489,651
10% Delta T Constant	648,211	15,111	663,322
20% Delta T Constant	584,285	14,994	599,279
45% Delta T Constant	425,978	14,701	440,679
REVISED PLANNED OUTAGES	539,139	15,569	554,708
CYLINDRICAL WEDGE WIRE	443,378	0	443,378
FINE MESH TRAVELING SCREENS	802,165 *	15,223	817,388
MODULAR INCLINED SCREENS	708,195	11,235	719,430
STROBELIGHT AIR BUBBLE CURTAIN	708,195	6,394	714,589

* Includes entrainable size organisms that are impinged on fine mesh screens

Jan. 14, 2007

Exhibit C

Cooling systems ravage river life, activists charge

Big industrial sites on the Delaware kill tens of billions of fish, crabs each year

By JEFF MONTGOMERY
The News Journal

A few industrial sites with cooling systems that draw water from the Delaware River are killing tens of billions of fish, fry and crabs each year, making them, by some accounts, the biggest predators in the river.

Now five of the largest water users are up for state permit renewals, giving regulators and environmental groups the chance for a public debate over industrial cooling-water demands.

The giant intakes continuously pump in and discharge river water to cool equipment and systems, sucking trillions of gallons from stretches of the Delaware that include nurseries and feeding grounds for some of the region's most popular and valuable aquatic life, including striped bass and weakfish.

"The river and bay simply cannot sustain this kind of day-in and day-out destruction," said Tracy Carluccio, a staff member for the Delaware Riverkeeper Network.

Carluccio's group last year joined several others in suing the Environmental Protection Agency for failing to control damage from some cooling water intakes. The lawsuit, along with alarming research, has put the issue in the spotlight just as several of the plants come up for new permits.

Some of the fish are trapped on the intake screens, others are descaled. The ones that are pulled through the screens are killed by heat or torn apart by the sheer force of the water.

The deaths caused by the intakes threaten the entire river and bay ecosystem, environmental groups say, and result in tens of millions of dollars in economic losses.

See INTAKES — A6

Intakes: Towers could spar

FROM PAGE A1

The intakes at the Salem nuclear power complex, Conectiv's Edge Moor power plant, the Delaware City refinery and Conectiv's Deepwater, N.J., plant destroy roughly 607 million year-old fish annually – a federal estimate based on industry reports that some experts say might be too low. If fish eggs, larvae and other organisms are added, the number lost rises to tens of billions.

At the river's four largest power plants, annual economic damages are estimated at $49 million, mostly commercial and recreational fishing losses, according to one Environmental Protection Agency study.

"The final estimates may well underestimate the full ecological and economic value of these losses," an EPA research office reported in 2002.

The best alternatives to intakes are massive water-cooling towers, which could dramatically reduce the number of fish killed. But installing the towers would cost hundreds of millions of dollars, which could be passed on to customers.

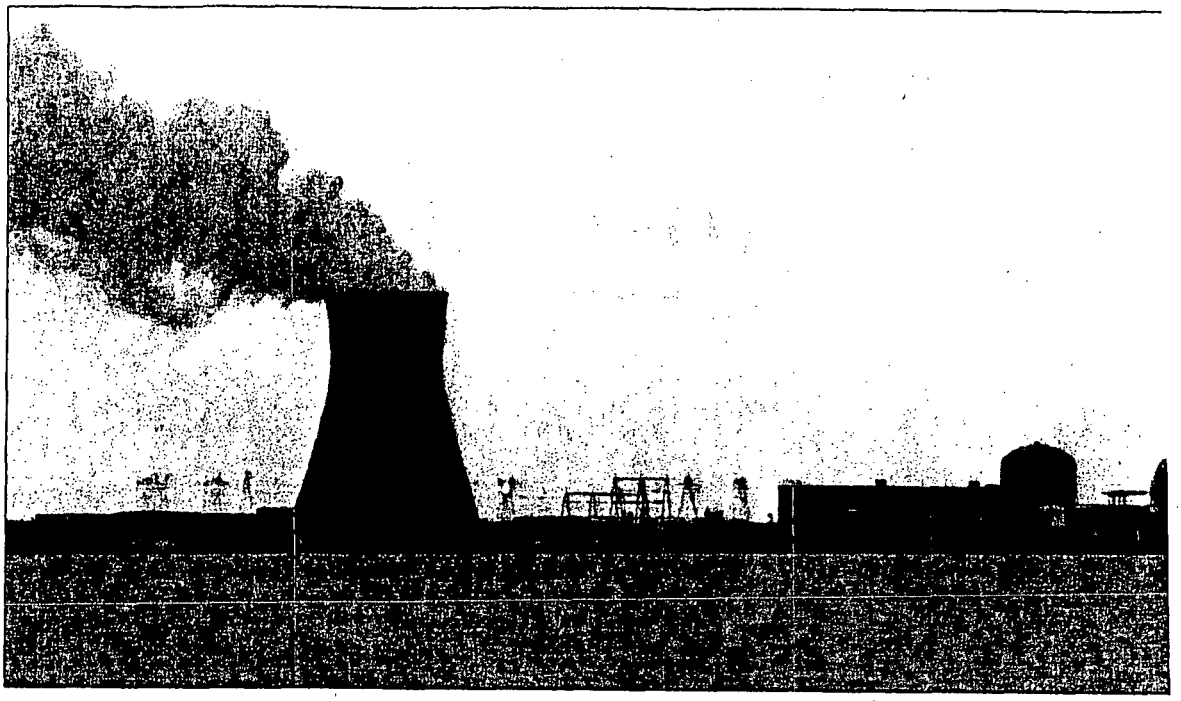
Conectiv's Edge Moor plant draws water from a section of the river near the Cherry Island "flats," a spawning area for striped bass. Financial losses to commercial and recreational fishing due to the kills at Edge Moor were estimated by the federal government at $12.5 million a year.

In Delaware City, the Valero refinery has rendered the entire population of bay anchovies vulnerable, according to a 2001 study. Anchovies are an important food source for many other creatures in the river and bay.

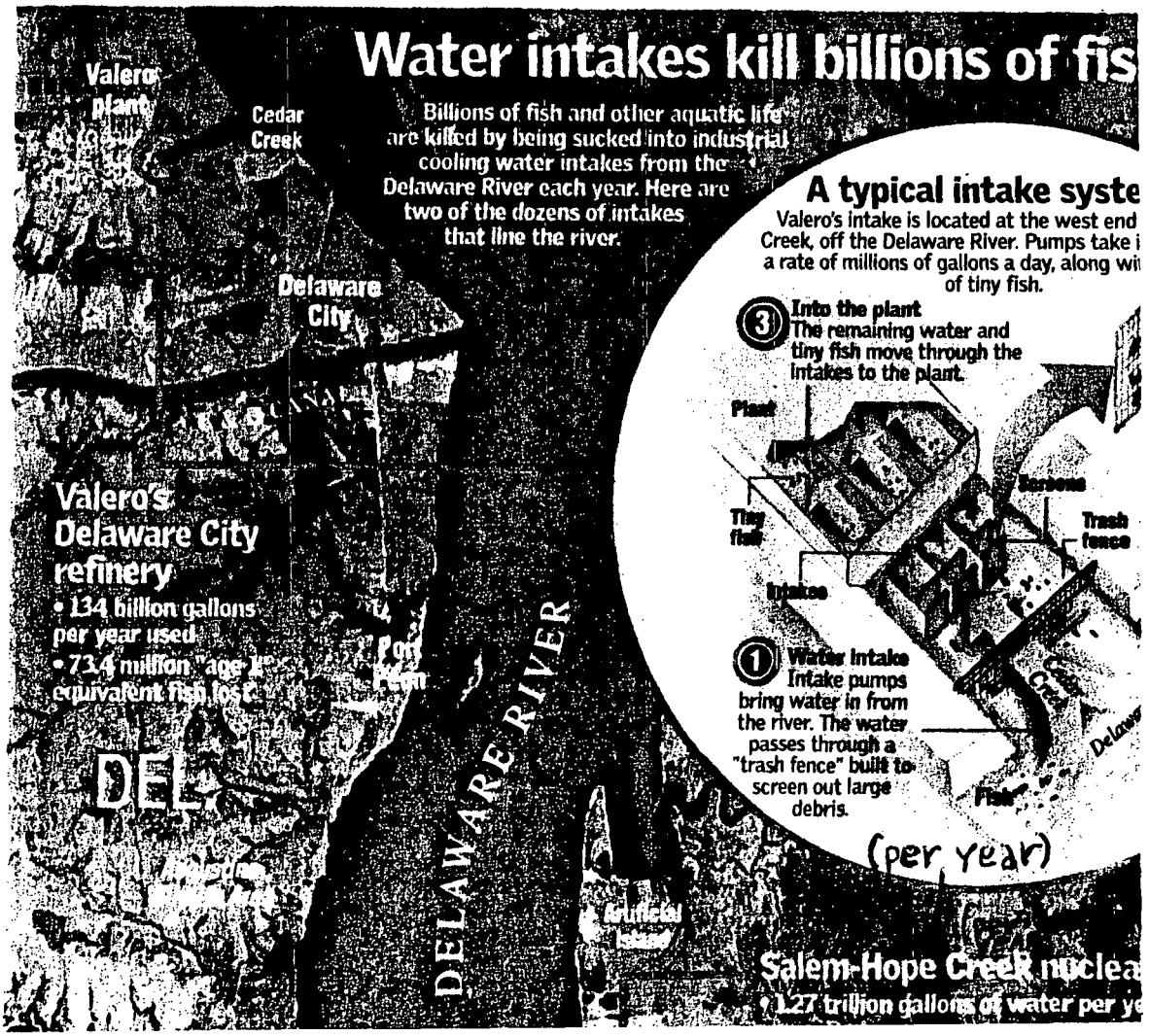
"There hasn't really been a significant change to the intake system at the refinery, I don't believe, since the mid-60s at least," said Roy Miller, who directs state fish and shellfish programs. "It's high time."

In 2002, the EPA estimated that the refinery intakes destroy 775,879 pounds of weakfish annually. Only 16,892 pounds of the popular sport fish are taken by recreational fishing.

A DNREC consultant estimated in 2001 that the refinery killed nearly 40,000 striped bass in a single year, double the number caught from fishing. Counting egg and larval losses, the EPA estimated the same refinery cost the river 662,871 pounds of striped bass, more than four times the number taken by rod and reel or net in 2003.

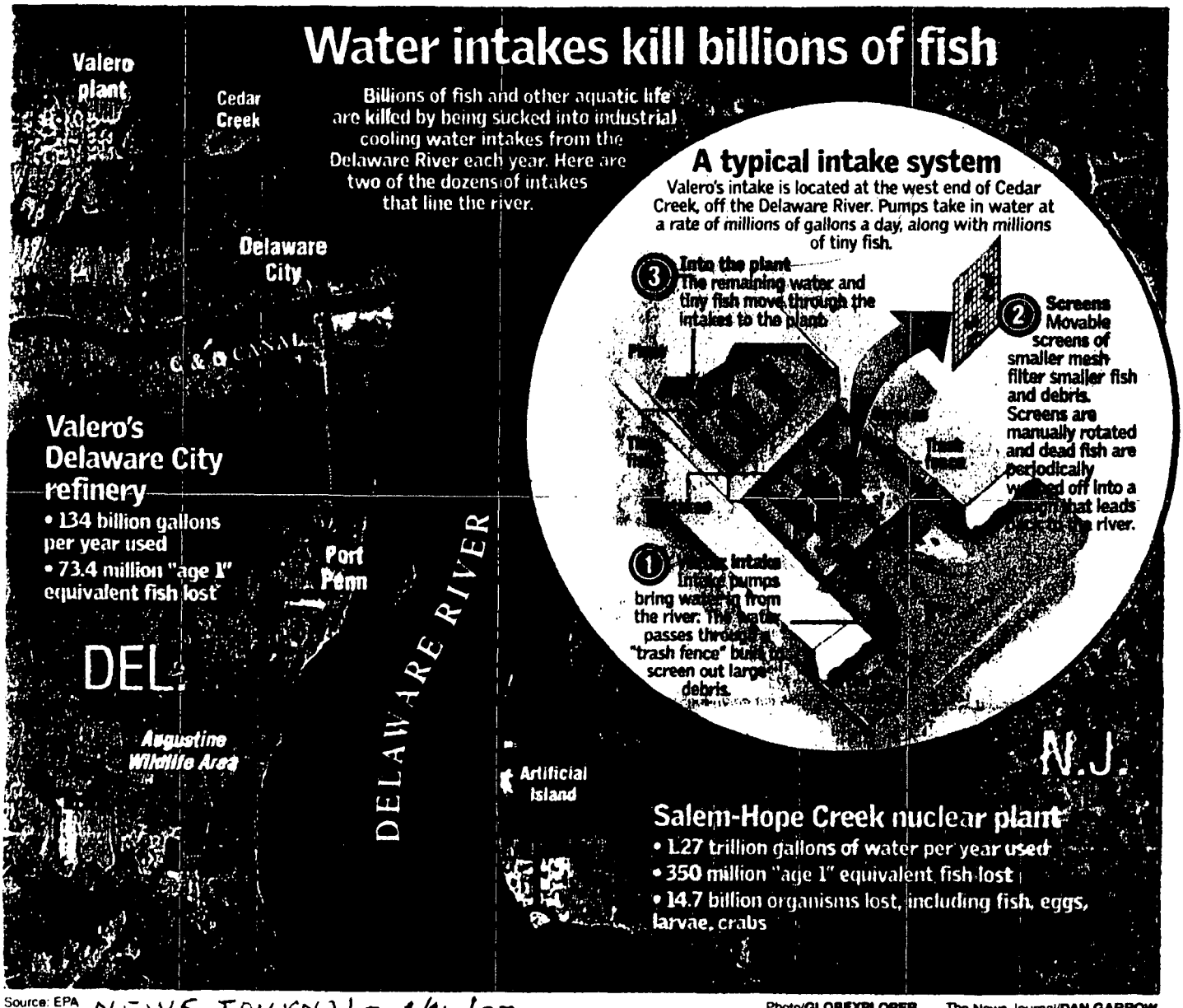


The cooling tower at the Salem-Hope Creek nuclear power plant serves one reactor. Two other reactors do not ha



The News Journal/CARLA VARISCO

The cooling tower at the Salem-Hope Creek nuclear power plant serves one reactor. Two other reactors do not have cooling towers.



Source: EPA NEWS JOURNAL - 1/14/07

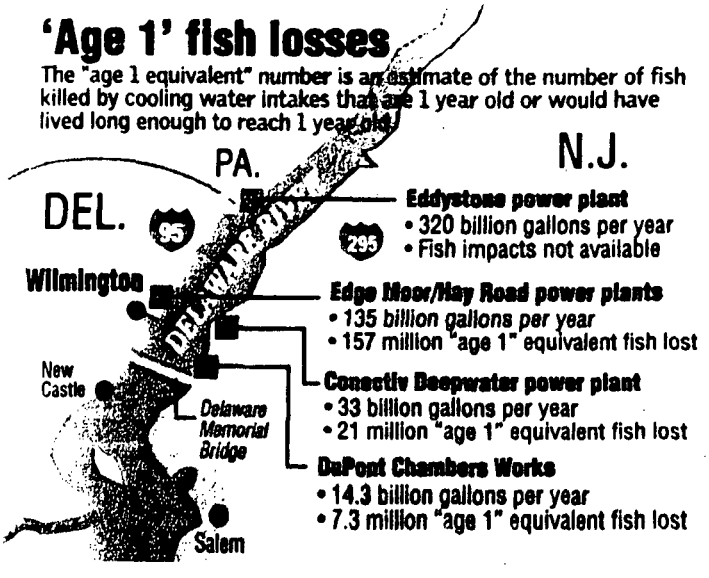
Photo/GLOBEXPLORER The News Journal/DAN GARROW

FISH LOSSES ON U.S. WATERWAYS

Fish losses in the Delaware River estuary were among the highest of any examined in several case studies developed by the Environmental Protection Agency.

Delaware River losses included an estimated 6.9 million pounds of weakfish, 5.9 million pounds of striped bass, 11.8 million pounds of spot and 17.1 million pounds of Atlantic croaker.

	EQUIVALENT IN FISH LOST	POUNDS OF YEAR-OLD FISH
Delaware River between Marcus Hook, Pa., and Salem, N.J. (7 power plants, 2 refineries, two factories)	615.9 million	72 million
Tampa Bay, Fla. (four power plants, 26 boilers)	18.9 billion	118 million
Ohio River	36.1 million	11.1 million



and reel or net in 2003.

Federal officials estimated fish losses at the Delaware City refinery at $5.8 million annually.

The Delaware City refinery combined with the Salem nuclear plant could kill 34 percent of the bay's anchovy populations each year and as much as 23 percent of the river's weakfish, or sea trout, according to the DNREC consultant's report from 2001.

Details obscured

For decades, the cooling water carnage went on with little notice, obscured in part by huge backlogs in state permit reviews. Most debate flared during the permit reviews carried out for Salem. But few details were available on other large intakes.

"These are hidden, stealth fish kills that take place underwater, out of sight, out of mind," said Maya K. van Rossum, who directs the Delaware Riverkeeper Network. "That's why they're allowed to happen. It changes the whole dynamic of the ecosystem. It changes the whole food chain."

But now, with public pressure growing, regulators are leaning on the plants' operators to change their practices and consider alternatives to the intake water cooling systems.

EPA water resources director Evelyn McKnight said last week her agency has targeted Conectiv's plant and Valero's refinery for renewal of long outdated permits. That permitting process is carried out by the states. During the renewal process for Valero and Conectiv, Delaware regulators said they will push the companies to consider installing cooling water supply systems, which could cost millions.

Those radiator-like cooling towers recycle and reuse water, drastically reducing the number of fish that are killed.

For example, the nuclear reactor at Hope Creek, near the Salem units, already uses a cooling tower. It kills 12 million juvenile fish each year. Salem, which draws from the river, kills 354 million a year.

Tim Dillingham, who directs the American Littoral Society, a conservation group, said state regulators need to press industry to invest in that technology.

"Industry almost across the board has blatantly denied that they're having any impact, which common sense tells us is just not right," Dillingham said. "This really is a case where the industries are using sticks-and-stones kind of technology, and they're asking for a pass. They're saying 'We don't want to be brought into the 21st century in terms of reducing our environmental impact.'"

DNREC Secretary John Hughes said his agency has urged both Valero and Conectiv to consider cooling-water systems that spare more fish.

"We've got a strong argument. I've made the argument personally at the highest levels with Valero that ... they need to look at cooling water as a major investment issue," Hughes said.

DNREC's John Hughes said his agency has urged Valero and Conectiv to consider cooling-water systems that spare more fish.

He added that talks with the refinery have been hampered by repeated ownership and management changes at the complex.

Federal rules allow companies to avoid upgrading their cooling systems if they can prove the changes are too costly.

Valero officials could not be reached for comment on the company's plans.

For the Salem plant, negotiations are more protracted. There, New Jersey regulators are waiting to reissue permits for Salem's intakes until a fight at the nearby Oyster Creek nuclear plant is resolved.

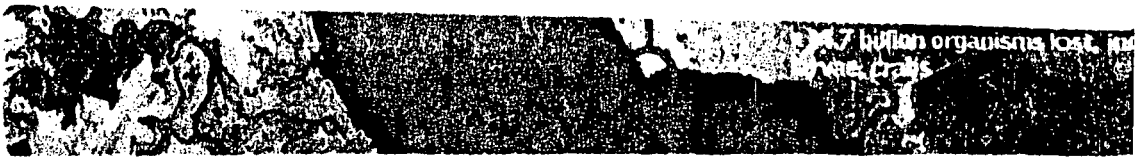
At Oyster Creek, which draws water from a Delaware River tributary, Barnegat Bay, state regulators, the Environmental Protection Agency and National Marine Fisheries Commission all have recommended cooling towers.

Could set precedent

Oyster Creek's owner, AmerGen, has opposed the cooling tower demand, arguing that the project could cost hundreds of millions of dollars.

"I think what happens at Oyster Creek will tell a lot about what will happen at Salem," said Norm Cohen, who directs Unplug Salem, a group that follows PSEG Nuclear's operations closely.

Construction of a new cooling tower at Salem, PSEG Nuclear cautioned, could cost $852 million and force prolonged shutdowns at what is now the nation's second-largest nuclear complex.



Source: EPA

Photo/GLOBEXPLORER

FISH LOSSES ON U.S. WATERWAYS

Fish losses in the Delaware River estuary were among the highest of any examined in several case studies developed by the Environmental Protection Agency.

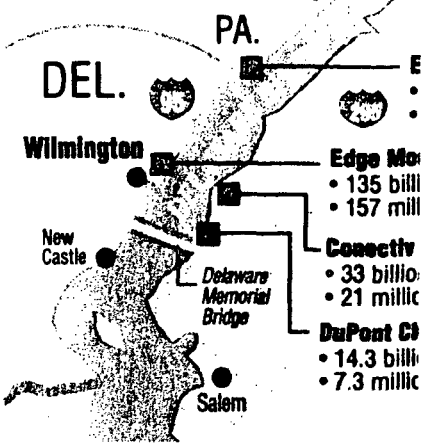
Delaware River losses included an estimated 6.9 million pounds of weakfish, 5.9 million pounds of striped bass, 11.8 million pounds of spot and 17.1 million pounds of Atlantic croaker.

	EQUIVALENT IN FISH LOST	POUNDS OF YEAR-OLD FISH
Delaware River between Marcus Hook, Pa., and Salem, N.J. (7 power plants, 2 refineries, two factories)	615.9 million	72 million
Tampa Bay, Fla. (four power plants, 26 boilers)	18.9 billion	118 million
Ohio River (29 plants, mostly utilities)	36.1 million	11.1 million
Brayton Pt., Mass., power plant (near Fall River, R.I.)	3.84 million	7 million
Detroit Edison Monroe power plant, Mich.	11.6 million	3.4 million

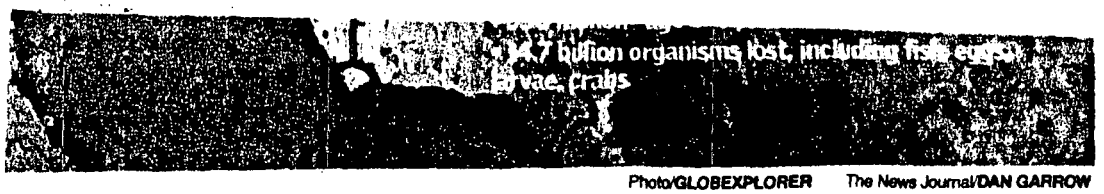
Source: EPA

'Age 1' fish losses

The "age 1 equivalent" number is an est killed by cooling water intakes that are lived long enough to reach 1 year old.



Source: EPA



Photo/GLOBEXPLORER The News Journal/DAN GARROW

NATERWAYS

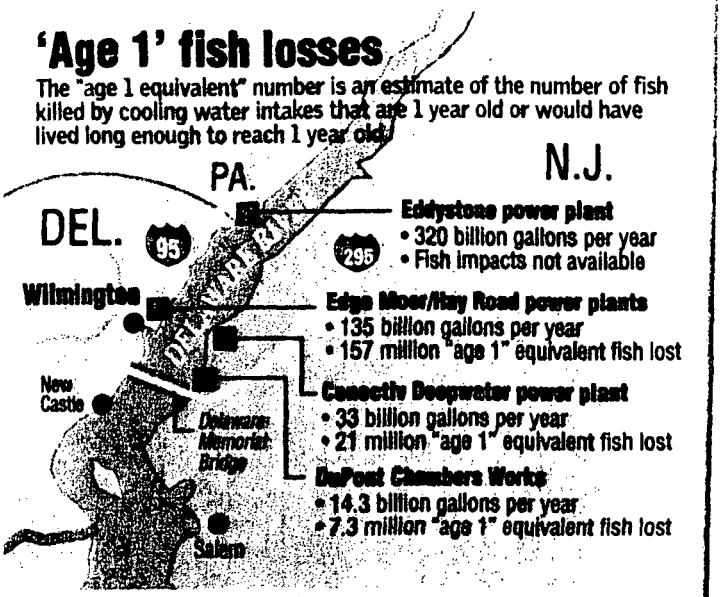
:r estuary were among the highest studies developed by the Environmen-

an estimated 6.9 million pounds of striped bass, 11.8 million pounds of Atlantic croaker.

EQUIVALENT IN FISH LOST	POUNDS OF YEAR-OLD FISH
615.9 million	72 million
18.9 billion	118 million
36.1 million	111 million

'Age 1' fish losses

The "age 1 equivalent" number is an estimate of the number of fish killed by cooling water intakes that are 1 year old or would have lived long enough to reach 1 year old.



Source: EPA The News Journal

In the company's application to New Jersey's environmental agency, Salem's owners said the operation has caused "no substantial harm to fisheries."

In lieu of a change to its cooling system, PSEG has restored habitat on thousands of acres of wetlands that it said would offset fish losses at its plant.

The company has financed fish "ladders" to help spawning fish bypass dams around the region as well as improvements in systems that scare fish away from its intakes.

"It was just a buyout," said William "Frenchie" Poulin, a Kent County commercial fisherman and Bowers Beach mayor. "It was just a drop in the bucket to them."

But Miller, fisheries program manager for DNREC, said that PSEG restored tidal flows to thousands of acres of wetlands.

"Did it compensate for what they're killing up at Salem?" Miller asked. "They hired some of the top scientists in the world who claim it compensated."

Contact Jeff Montgomery at 678-4277 or jmontgomery@delawareonline.com.

Exhibit D

AN ECOLOGICAL RISK-BASED 316(B) EVALUATION FOR THE EDGE MOOR POWER PLANT

VOLUME I: TEXT

Prepared for:

Conectiv, Inc.
Wilmington, DE

Prepared by:

ENTRIX, Inc.
New Castle, DE

June 2002

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overwintering grounds along the coast. By mid-November, few young weakfish reside in the estuary (EA Inc., 1992). Weakfish spend the winter in offshore waters generally between the Chesapeake Bay and Cape Fear, North Carolina. In the Delaware Bay, juvenile weakfish are documented as abundant in the mixing and seawater zones of the estuary from May through October (Stone et al., 1994). Adult weakfish typically move north and inshore during the summer, and to the south and offshore during the fall and winter (Wilk, 1979; Merriner, 1973; ASMFC, 1996). Adult weakfish in the Delaware Estuary occur abundantly in the mixing and seawater portions of the estuary from April through September (Stone et al., 1994).

Anchovies, spot, herrings, mysids, crabs, and molluscs are the primary prey items that comprise the weakfish diet (Mercer, 1989). Juvenile weakfish prefer feeding on mysid shrimp and anchovies, while older weakfish are more opportunistic, feeding on whichever prey species is most abundant (Thomas, 1971b; Merriner, 1975; Stickney et al., 1975). The principal predators of weakfish include striped bass and bluefish (Wilk, 1979). Cannibalism is also commonplace within weakfish populations (Daiber and Smith, 1971; Thomas, 1971a; Bason et al., 1976, Welsh and Breder, 1923; Merriner, 1973). Juvenile weakfish also likely fall prey to piscivorous birds, such as cormorants and osprey (PSE&G, 1999).

Weakfish is highly valued as an important commercial and recreational fishing resource. The weakfish population has experienced a drastic decline since 1980. Research by Vaughn, Seagraves and West concluded that weakfish were overexploited and at a low abundance level by 1990 (Vaughan et al., 1991). Landing estimates decreased from 35.3 million kilograms in 1980 to less than 4.5 million kilograms in 1992 (Dove and Nyman, 1995). Recreational landings have also decreased significantly since 1986 (Killam and Richkus, 1992). Assessment work conducted by ASMFC and National Marine Fisheries Society (NMFS) reported that spawning stock biomass declined steadily from 1982 to 1990 (PSE&G, 1999). The catch per unit effort in monitoring surveys increased from 1991 to 1996 and then decreased in 1997 and 1998 (Michels, 2000). Currently, weakfish populations are increasing due to management efforts and reduced fishing mortality (Santoro, 2000). Atlantic coast weakfish populations have been managed under the Atlantic Coastal Fisheries Cooperative Management Act by the ASMFC's Interstate Fisheries Management Program, since 1993 (ASMFC, 2000). The Delaware Bay populations are monitored by the State of Delaware (Santoro, 1998). The NMFS (1998) reported that "the Atlantic weakfish stock is recovering from low abundance levels reached in the early 1990s" and observed that the abundance levels are increasing.

Additional detailed life history information for the weakfish can be found in Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic) – Weakfish (Mercer, 1989) and in Attachment C-1 of the PSE&G Salem Generating Station NJPDES Permit Renewal Application (PSE&G, 1999).

2.3.6 Atlantic Croaker

Atlantic croaker was selected as an RIS because their populations have shown an increase in the Delaware Estuary in recent years (Michels, 2000) and they are an important recreational fish within the estuary. Juvenile Atlantic croaker may be vulnerable to entrainment and/or

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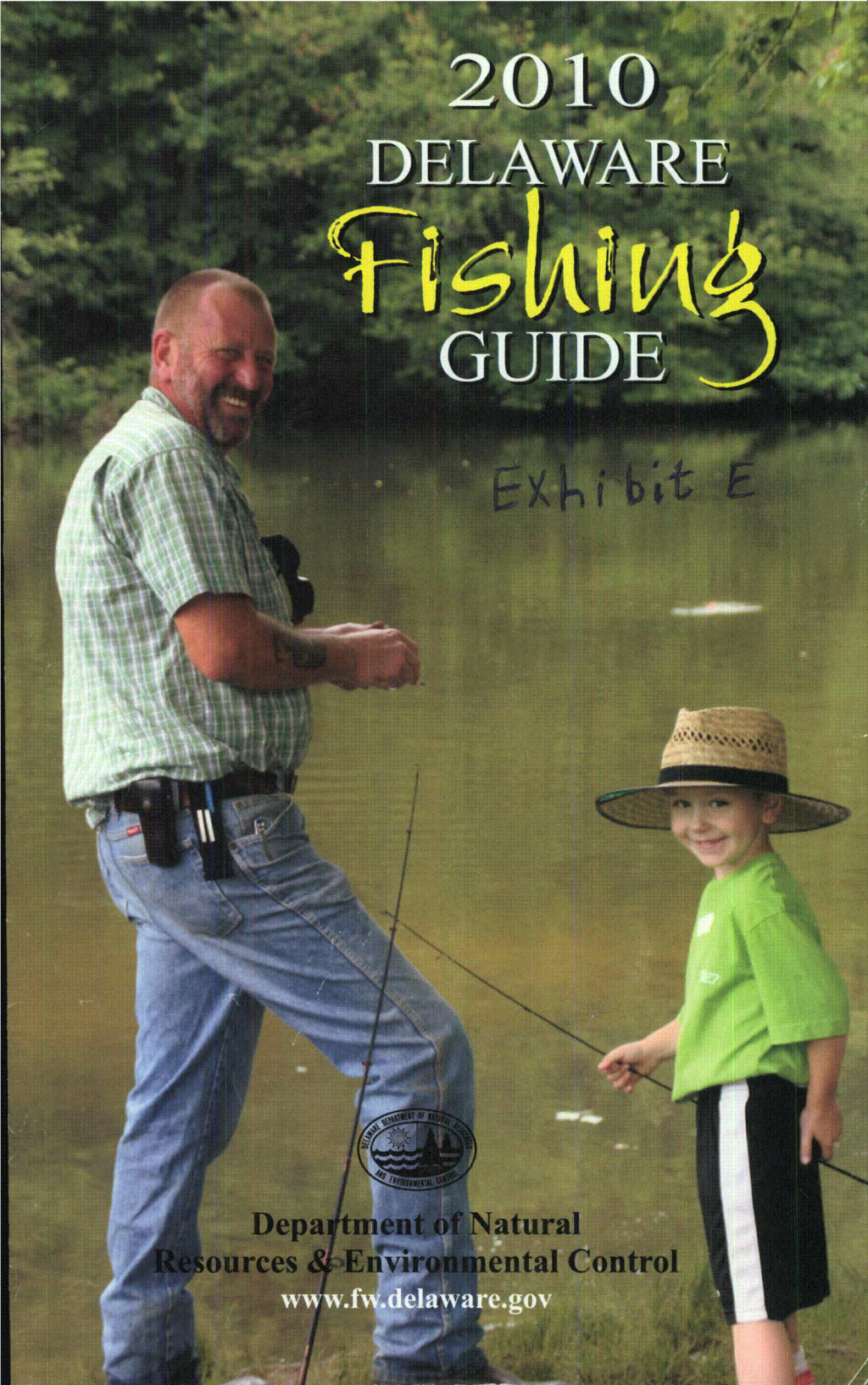
2010 DELAWARE Fishing GUIDE

Exhibit E



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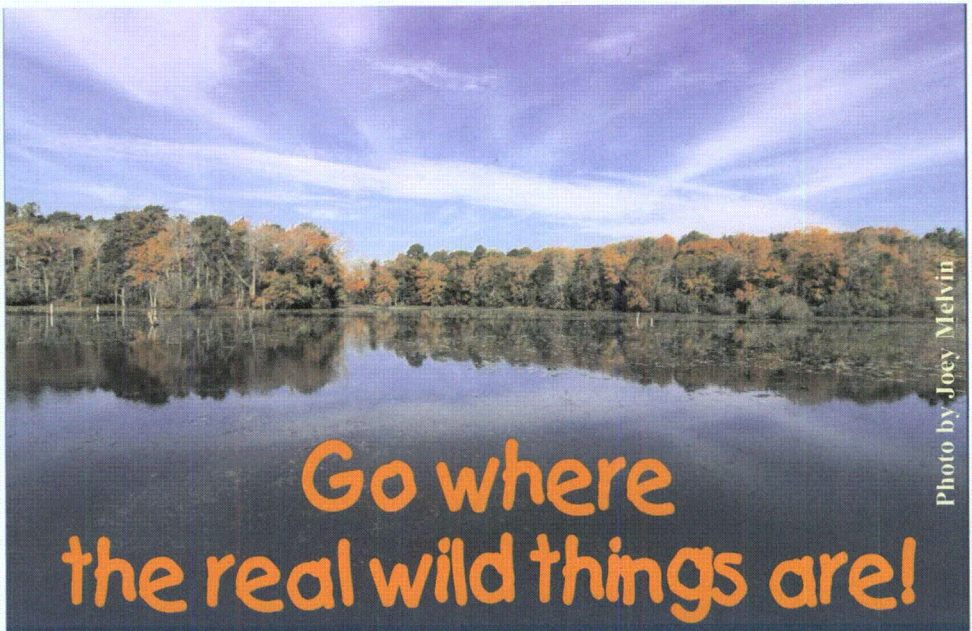

Photo by Joey Melvin

Go where the real wild things are!

The Department of Natural Resources and Environmental Control's Division of Fish and Wildlife and the Department of Agriculture's Delaware Forest Service invite you to discover some of Delaware's most unique wild places by taking advantage of free public access to our public lands. Here's just a few of the things you can do!

- **Explore more than 60,000 acres in 20 state wildlife areas**
- **Enjoy 18,000 acres in three state forests**
- **Watch birds and wildlife**
- **Pack a picnic and enjoy the scenery**
- **Hike, bike and go horseback riding on trails**
- **Hunt upland game, fowl, game birds in season**
- **Launch from more than 50 boat access areas**
- **Sail, canoe, kayak and boat our ponds, rivers and bays**
- **Cast a line into tidal and non-tidal waters**
- **Fish or boat in more than 30 ponds**

To learn more about recreational possibilities on Delaware public lands, please visit the DNREC Division of Fish and Wildlife's website at www.fw.delaware.gov or the DDA Delaware Forest Service's website at http://dda.delaware.gov/forestry.

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From the Director of the Division of Fish and Wildlife

JoAnna Wilson

The Division of Fish and Wildlife is pleased to provide the 2010 Delaware Fishing Guide. We try to make it as user friendly as possible with the information that anglers should be aware of while fishing, clamming, or crabbing in Delaware.

We face many challenges this year with decreased funding and personnel while fishing issues remain. Weak-fish populations are at all time low levels along the eastern coast so possession limits have been greatly reduced. The new limit is 1 fish per angler per day with a minimum size of 13 inches. The Nanticoke River largemouth bass fishery, however, remains strong due to the popularity of Catch & Release and the supplemental stocking of largemouth bass fingerlings to enhance the limited natural reproduction in this tidal system. Improvements to shoreline access along many of our public ponds have been made during the past two years and repairs and upgrades to fishing access sites continue. The new Lewes boat launch facility is providing popular access for saltwater anglers while construction proceeds for a new access site in Laurel at the upper end of Broad Creek.

The advent of the General Fishing License in 2008 has improved our ability to match federal funds for fisheries projects, both for management and facilities development. The FIN number program is running smoothly and will prevent Delaware anglers from having to purchase a federal fishing permit under a program beginning in 2011. I hope you have a successful fishing season and enjoy Delaware's various waterways.

Maps for this publication were created by the Office of the Secretary's GIS section. Fish illustrations were drawn by Duane Raver, and the shark illustrations by Bob Jones. The cover photo was contributed by Laura Madara. A special thanks to the Delaware fishermen and DNREC staff who donated pictures throughout this guide.

All of the information in this guide, and much more, may also be found on the Division's website www.fw.delaware.gov.

Doc. No. 40-05-03/10/01/01

SPORT FISH RESTORATION

"F.I.N." number | | | | | | |

"F.I.N." number | | | | | | |

Name _____ Name _____

Contact Information

Department of Natural Resources and Environmental Control
www.dnrec.delaware.gov

Division of Fish and Wildlife – www.fw.delaware.gov

F.I.N. number	1-800-432-9228
Fisheries Section, Dover	(302)-739-9914
Little Creek Fisheries Field Office	(302) 735-2960
Aquatic Resources Education Center	(302) 735-8650

Fish and Wildlife Enforcement Section

Main Office	(302) 739-9913
Region 1 (New Castle & Kent Counties)	(302) 739-6139
Region 2 (Sussex County)	(302) 855-1901
24-hour hotline (KENTCOM)	(800) 523-3336
Boating Safety	(302) 739-9915
Ramp Certificates	(302) 739-9916
Boat Licenses/Registration	(302) 739-9916

General Information

Freshwater Trout Program	(302) 739-9914
Non-tidal Fishing	(302) 739-9914 / (302) 735-8650
Tidal Fishing	(302) 739-9914/ (302) 735-2960
Fish Consumption Advisories	(302)-739-9914
Division Public Health	(302)-744-4546
Artificial Reef Program	(302) 735-2960
Fishing / Boating Access Areas	(302)-739-9914
Clamming	(302) 735-2960
Shellfish Health & Safety, Closures	(302) 739-9939
Crabbing	(302) 735-2960

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Fishing License Requirements and F.I.N. Number

A general fishing license is required for fishing, crabbing, or clamming in all waters of the State of Delaware including both tidal and non-tidal areas. Additionally, all anglers (resident and non-resident alike) age 16 or older must obtain a free Fisherman Information Network (F.I.N.) number on an annual basis before fishing in Delaware waters. The new (F.I.N.) regulation went into effect January 1, 2009. A fishing license may be obtained from the Dover office, on-line (www.fw.delaware.gov), or from over 100 license agents (most bait and tackle, sporting goods, and hardware stores), throughout the State. The FIN number can be obtained at this web address (http://www.delaware-fin.com/); or by automated telephone (1-800-432-9228); or for live operator/customer service: 1-866-447-4626. See page 8 for more information about the new F.I.N. number requirement.

A fishing license is valid through December 31 for the calendar year in which it is issued. All funds derived from the issuance of fishing licenses are dedicated to a special account for the purpose of matching and securing federal money allotted to Delaware under the provisions of the Federal Aid in Sportfish Restoration Act and cannot be diverted to other causes. Together, these funds support projects having as their purpose the restoration, conservation, management and enhancement of sportfish and the provision for public use and benefits from these resources.

To order or purchase a fishing license online, go to: www.fw.delaware.gov. Select "Licenses – Hunting, fishing, boating."

2010 License Fees

License Category	Resident	Non-resident
General Fishing License	$8.50	$20.00
7-day Tourist	NA	$12.50
*Boat License 20 ft or less (optional)	$40.00	$40.00
*Boat License more than 20 ft (optional)	$50.00	$50.00
Head Boat License	$300.00	$600.00
Charter Boat License	$150.00	$300.00

***Boat License** - The optional boat license for recreational fishermen covers the holder of the license, and all occupants in that boat, as do the charter boat and head boat licenses. A resident who purchases a Delaware boat-fishing license also will be given a single Delaware fishing license for their own use on those occasions that he or she may not be on the boat.

Non-residents - Any non-resident who is 16 years of age or older except persons covered by one of the exemptions is required to have a license to fish, clam, or crab in the waters of the State of Delaware. Non-residents may purchase a 7-consecutive day fishing license.

continued on page 7

Fishing License Exemptions

The following are exemptions to the license provisions:

Surf Fishing Permit - Residents and non-residents are exempt from fishing license requirements if they are the operator of a vehicle with a valid Delaware surf fishing vehicle permit when that vehicle is located on a designated Delaware State Park beach. Other occupants of that vehicle are required to have a fishing license if they are fishing.

Seniors - Residents of the State of Delaware 65 years and older are exempt from fishing license requirements but must have proof of age and residency. A Permanent Exempt License can be requested free of charge by contacting the Division of Fish and Wildlife (302-739-9911). Non-resident seniors are not exempt.

Children - Children under the age of 16 are exempt.

Other Exemptions - Any resident who owns or lives on a farm in this state containing 20 or more acres and the members of his or her immediate family who **reside** on the farm may fish on that farm without a license.

A member of the armed forces who is a patient in a military hospital and submits a written statement signed by the patient's commanding officer certifying the nature of the disability and place of station.

Persons who are patients in any Veterans Administration facility in this State, or in any public hospital or sanitarium for the treatment of tuberculosis, or a patient in a rehabilitation hospital under the State Department of Health, provided such person carries identification which verifies his or her status as such a patient, shall not be required to purchase a fishing license. Forms shall be supplied to such persons when they apply for their licenses to be used for the identification purposes.

Residents living in this State for at least 1 year immediately prior to the date of application for a license who have been honorably discharged from the armed forces of the United States and certified by the Veterans Administration as having at least a 60% service-connected disability.

Any patient in a rehabilitation hospital under the Department of Health and Social Services.

Any person who is legally blind.

Any person who fishes in a fee-fishing facility, registered as such with the Department of Agriculture.

Any resident who has served honorably for 90 or more consecutive days on active duty in the Armed Forces of the United States, including service as member of the Delaware National Guard, in military actions in Southwest Asia associated with Operation Iraqi Freedom or Operation Enduring Freedom may, for the first 12 months following the date the resident was honorably discharged or removed from active status, be issued a license to fish in this State without charge.

Mandatory F.I.N. Number

All Delaware Anglers

Fisherman Information Network (F.I.N.)

What is a F.I.N. number?
A F.I.N. number is a unique fisherman identification network number that you are required to obtain free of charge. The National Marine Fisheries Service (NMFS) will use the data obtained from the F.I.N. program to identify anglers for survey purposes. The program allows for better estimates of recreational landings, an important component of fisheries management.

Who must obtain a F.I.N. number?
All residents and non-residents who are age 16 or older (including 7-day non-resident licensed anglers) wishing to recreationally fish in Delaware waters. This includes even those anglers not required to obtain a general fishing license, such as residents 65 or older, those fishing from a vessel licensed for fishing, those fishing under a surf vehicle permit, and those otherwise exempted under 7 Del. Code , § 502. If you only fish from a charter or a head boat you do not need a F.I.N. number.

Why do I need a F.I.N. number?
The F.I.N. number allows Delaware to meet new federal requirements without additional cost to the angler. The number is mandatory and failure to provide a valid F.I.N. number to an enforcement agent will be treated the same as a failure to have a valid fishing license.

Where do I record my F.I.N. number?
Record your F.I.N. number in the spaces provided on your Delaware Fishing License. If you are exempt from the license requirement, be sure to record and carry your F.I.N. number with you when you are fishing.

To obtain your free F.I.N. number online go to http://www.delaware-fin.com/ or call (800) 432-9228. For live operator customer service call: (866) 447-4626.

For additional License Requirements see page 6.

Freshwater Trout Fishing

Delaware's freshwater trout program is a self-supporting put-and-take fishery in selected New Castle County streams and Kent and Sussex County ponds. Revenue generated from the sales of trout stamps is used to purchase rainbow, brook and brown trout for stocking (see page 12). Summer water temperatures limit trout survival and reproduction in Delaware waters, so stocked fish are meant to be taken, but may be released at the angler's discretion.

Season / Hours

The 2010 freshwater trout season in New Castle County opens at 7:30 a.m. on Saturday April 3, 2010. No fishing is allowed in designated trout streams two weeks (14 days) prior to the scheduled opening of the trout season. It is unlawful to fish for trout in designated trout streams between one-half hour after sunset and one-half hour after sunrise.

Trout season in Tidbury (Kent County) and Newton (Sussex County) Ponds opens at 7:00 a.m. on Saturday March 6, 2010.

Trout Stamps

A trout stamp is required to fish in a designated **trout stream** from the first Saturday in April through June 30 and from the first Saturday in October through November 30 unless exempted by law. A trout stamp is also required to fish **Tidbury Pond** in Kent County and **Newton Pond** in Sussex County from the first Saturday in March through March 31. This year all licenses and stamps will be issued in an electronic form, and these trout stamps must be signed across the face to be valid. To obtain an original printed stamp, anglers may call 302-739-9918, and the stamp will be mailed after December 31, 2010.

License and Stamp Requirements for Trout Fishing

Resident/ Age	Fishing license	Young Angler trout stamp	Trout Stamp
Under 12	No	No	No
12 thru 15	No	Yes	No
16 thru 64	Yes	No	Yes
65 and over	No	No	No
Fee	$8.50	$2.10	$4.20
Non-resident/Age			
Under 12	No	No	No
12 thru 15	No	No	Yes
16 and over	Yes	No	Yes
Fee	$20.00		$6.20

continued on page 10

Possession Limits of Trout

It shall be unlawful for any person to catch and/or have in his possession more than six (6) trout in any one day; except, it shall be unlawful to possess more than four (4) trout in or within 50 feet of any fly fishing only waters (restricted trout streams).

If you are interested in collecting Trout or Duck stamps, please contact the Division at 302-739-9911 or visit our website at www.fw.delaware.gov/Fisheries/Pages/TroutStamp.aspx

Special Fly Fishing Only Sections (Restricted Trout Streams)

White Clay Creek from a point 25 yards above Thompson Bridge at Chambers Rock Road to the Pennsylvania state line is designated as a fly fishing only trout stream (Restricted Trout Waters). It is unlawful to use any metallic, plastic or rubber spinners, spoons, lures, plugs and/or natural bait or to use more than two (2) flies on a line at any one time.

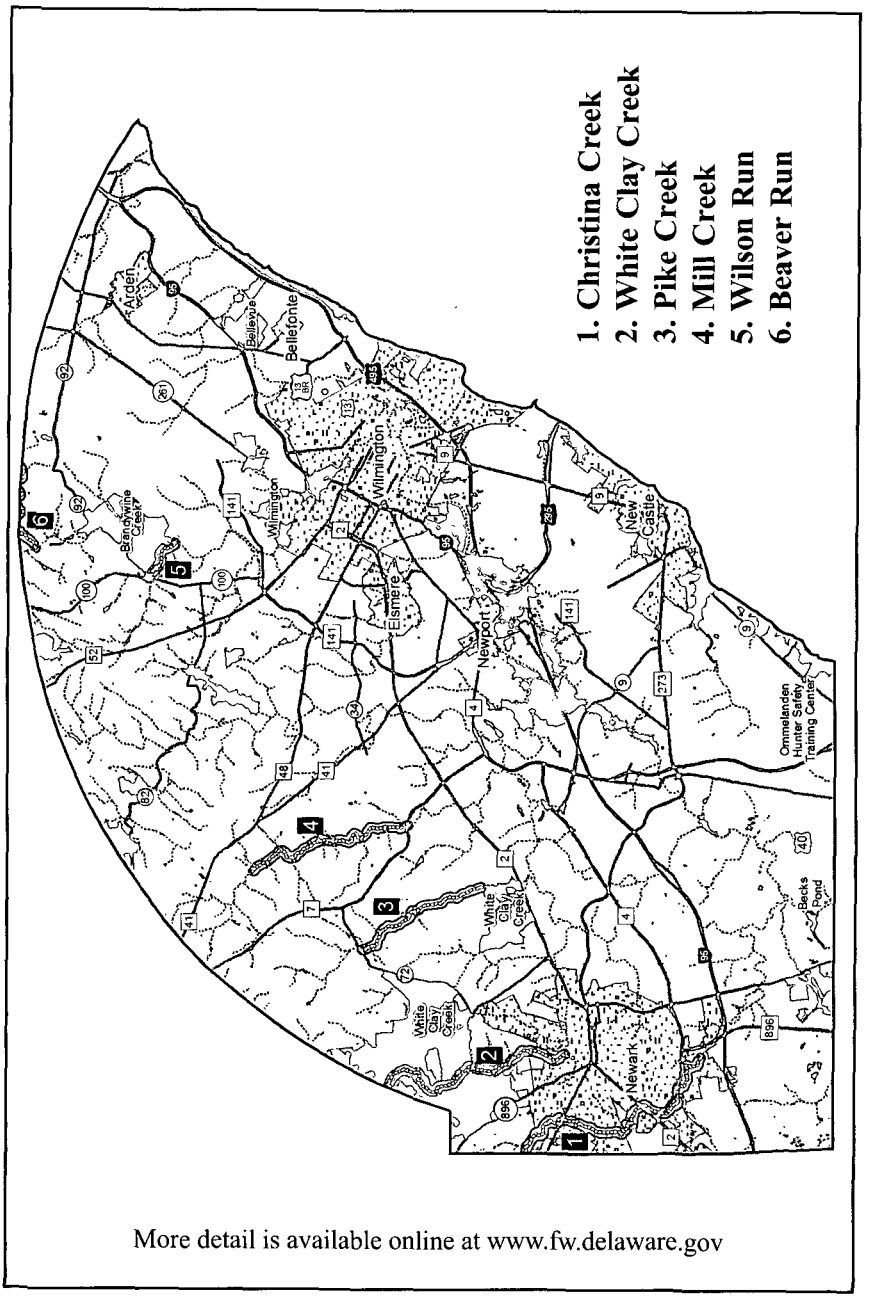
It is unlawful to possess more than four (4) trout within 50-feet of a fly fishing only section (restricted trout waters). Anglers may catch and release trout on these waters as long as the four (4) trout possession limit is not exceeded. All trout released must be returned to the water as quickly as possible with the least possible injury.

Designated Trout Streams

Designated Trout Stream	Description
Beaver Run	Pennsylvania line to Brandywine River
Christina Creek	Entire stream
Pike Creek	Route 72 to Henderson Road
Mill Creek	Brackenville Road to Route 7
White Clay Creek	Pennsylvania line to the downstream side of Paper Mill Road. Fly fishing only (restricted trout stream) section from a point 25 yards above Thompson Bridge at Chambers Rock Road to the Pennsylvania state line.
Wilson Run	Route 92 through Brandywine Creek State Park

Most access to these streams is through and on private property or state park land. Each fisherman should respect the privilege of using private property.

Designated Trout Streams



More detail is available online at www.fw.delaware.gov

2010 TENTATIVE TROUT STOCKING SCHEDULE

Below are the locations, dates and numbers of trout to be stocked

Water	♦Prior to season	March 18	April 5	April 8	April 12	●April 15	April 22	●April 29	Mid-Oct.
Streams *(Season opens 7:30 a.m. April 3)*									
Beaver Run	715			200	200				
Christina Creek	2,570			800	400	200	500		
Mill Creek	210			150					
Pike Creek	410			150					
White Clay Creek	8,750		2,000	2,000	1,200	2,000	3,000	2,000	2,000
Wilson Run	1,845			700	200	200	■ 708		
Ponds *(Season opens 7 a.m. March 6)*									
Newton Pond	700	700							
Tidbury Pond	550	550							

♦ Prior to season: stocking includes trophy-sized rainbow trout (14 inches or greater) at all locations

● April 15 and 29: Brown trout averaging 11 inches will be stocked at all locations listed.

■ April 22: Stocking of 11-inch and trophy-sized rainbows to prepare for annual handicapped anglers fishing derby in Wilson Run at Brandywine Creek State Park. For details on the fishing derby, please call the park office at 302-577-3534.

General Non-tidal Fishing Regulations

These are some of the regulations and state statutes that all anglers should be familiar with. Most have been edited to make them easier to read and understand. This is not a complete list and it is up to the angler to be familiar with all of the laws and regulations currently existing or newly adopted. For a complete listing, refer to the Department of Natural Resources and Environmental Control, Division of Fish and Wildlife website or request a copy from the Director's office.

Unless otherwise authorized, it shall be illegal for any person to fish for any freshwater fish in the non-tidal waters of this State with any fishing equipment or by any method, unless it is provided for in the following subdivisions:

A hook and line may be used, with each line to have no more than 3 hooks or 3 separate lures with hooks.

Unless a person is fishing through the ice, the number of hooks and lines that any one person is permitted to use to fish for any freshwater fish in the non-tidal waters of the State shall be no more than 2.

A person may use a dip net to aid in landing any freshwater finfish taken or caught by hook and line in the non-tidal or fresh waters of the State.

Carp may be taken and/or fished for by using a bow and arrow and/or spear, unless said equipment or method is otherwise restricted by any Department regulation. At this time, no carp may be taken from State Park ponds using bow and arrow.

It is illegal to sell, trade, or barter any finfish taken from the non-tidal waters of this State, unless authorized to do so in a permit issued by the Director.

It is illegal to take shad, except by hook and line, and no more than two (2) lures attached. Each lure may have no more than one (1) single pointed hook.

It is illegal to knowingly snag fish in non-tidal waters with any hook (single, double or treble) or otherwise catch or attempt to snag or catch any game fish by hooking the fish in any part of the body other than in the mouth.

It shall be unlawful for any person to fish within ten (10) feet of an entrance or exit of a fish ladder or to remove fish from any fish ladder between March 15 and May 30.

Closure of Department Ponds during Draw-downs

It shall be unlawful for any person to fish in any pond or lake administered by the Department when the water level is lowered for any purpose provided it is duly posted with signs by the Division that state it is closed to fishing.

continued on page 14

continued from page 13

Speed and Wake of Motorboats on Division Ponds

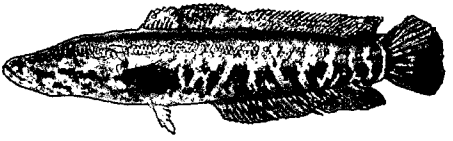
It shall be unlawful for any person to operate a motorized vessel, except at a **slow-no-wake speed**, on any pond or lake administered by the Division.

Fish Stocking Practices

It shall be unlawful for any person to stock any species of fish into the non-tidal public waters of this State without the written permission of the Director. This regulation does not prohibit the stocking of private impoundments.

Possession, Transportation, and Sale of Illegal Species

It shall be unlawful for any person to transport, purchase, possess, or sell walking catfish (*Clarius batrachus*) or the white amur or grass carp (*Ctenopharyngodon idella*) or live northern snakehead fish (*Channa argus*) or blotched snakehead fish (*Channa maculata*) without the written permission of the Director.



Guide to Public Ponds

A guide to public ponds, available online, is updated annually with the latest fisheries data. Each pond's information includes: fish populations, vegetation conditions, special regulations and facilities, and a contour map of the pond. This information is available at:
www.fw.delaware.gov/fisheries/pages/DelawarePondBooklet.aspx.

Catch & Release

Many freshwater anglers practice catch and release fishing. This behavior, popularized by bass anglers, promotes the release of fish by anglers so the fish can be caught again. A long-term bass tagging study in Delaware has demonstrated many tagged fish are caught, released, and caught again – a few as many as four times. The Division strongly encourages catch and release fishing to maximize angling success - unless a fish population is known to be over crowded.

Jared Jacobini

Non-tidal Fishing Access Areas

Division of Fish and Wildlife

Area	Location	Acres	Boat Ramp	Shore Fishing
1	Becks Pond (No gas motors)	25	Yes	Yes
2	Garrisons Lake	86	Yes	Yes
3	Masseys Mill Pond	30	Unimproved	Limited
4	Moores Lake	27	Yes	Yes
5	Derby Pond	23	Yes	Yes
6	Logan Lane Pond	2	No	Handicapped only
7	Mud Mill Pond	60	Yes	Yes
8	McGinnis Pond	31	Yes	Yes
9	Andrews Lake	18	Yes	Yes
10	Coursey Pond	58	Yes	Yes
11	McColley Pond	49	No	Limited
12	Tubmill Pond	5	Yes	Limited
13	Silver Lake (Milford)	29	No	Limited
14	Haven Lake	82	Yes	Limited
15	Griffith Lake	32	Yes	Yes
16	Blairs Pond	29	Yes	Yes
17	Abbotts Pond	17	Yes	Yes
18	Newton Pond (No gas motors)	10	Car top only	Yes
19	Waples Pond	51	Unimproved	Limited
20	Wagamons Pond	41	Yes	Yes
21	Hearns Pond	53	Yes	Yes
22	Concord Pond	77	Yes	Limited
23	Craigs Pond	12	Yes	Yes
24	Millsboro Pond	101	Yes	Limited
25	Ingrams Pond	24	Yes	Yes
26	Portsville Pond	15	Yes	Limited
27	Records Pond	92	Yes	Pier
28	Chipman Pond	52	Yes	Yes
29	Horsey Pond	46	Yes	Yes
30	Tussock Pond	9	Yes	Limited
39	Fleetwood Pond	43	No	Limited
	Parks and Recreation Access Areas			
31	Lums Pond	189	Yes	Yes
32	Killens Pond	75	Unimproved	Yes
36	Trap Pond	107	Yes	Yes
37	Trussum Pond	73	Car top only	No
38	Raccoon Pond	14	Car top only	Yes

"Area" number refers to the numbered red or brown boxes on the Fishing Areas map (see fold-out).

24th Annual Youth Fishing Tournament

As part of its activities for National Fishing Week, June 5-13, the Delaware Division of Fish and Wildlife will hold its 24th annual Youth Fishing Tournament from 10 a.m.-1 p.m., Saturday June 12. The event will take place at Ingrams Pond in Millsboro, Wyoming Pond in Town Park, Wyoming, and at the Lums Pond State Park dog training area.

This fishing event is for youths ages 4 to 15. An adult must accompany youths under age 12 and contestants should bring their own fishing equipment. The tournament is **free** to the public and prizes will be awarded in three age groups: 4-7; 8-11; and 12-15.

Joanna Wilson

The tournament was established to introduce youth to the sport of fishing and to teach the catch and release approach to conservation. There is no pre-registration nor entrance fee required and the tournament is held rain or shine.

In addition to the fishing tournament celebrating National Fishing Week, the Division has designated June 12 and 13 as free fishing days when anyone may fish in Delaware's waters without a fishing license.

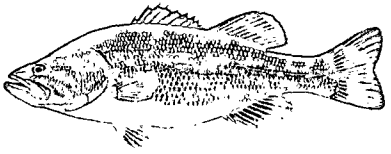
Delaware's Small Pond Program

The Division has 9 small ponds scattered throughout the State which offer shore angling targeted at youth. The ponds range from ½ to 8 acres and contain good populations of largemouth bass and bluegill. Catch and release is the order of the day so barbless hooks are required at most locations. A brochure listing the pond locations and available facilities is available online (www.fw.delaware.gov/fisheries , click on 'Small Pond Brochure' under *Info for Anglers*) or by calling 302-735-8650.

Joanna Wilson

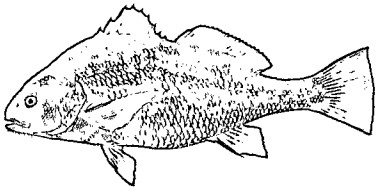
What's *New* for 2010

Electronic Licenses and stamps - All 2010 licenses and stamps will be sold in an electronic format. This means that trout stamps will be distributed as an electronic image. The trout stamp image must be signed across the face to be valid. For futher details, see page 9.

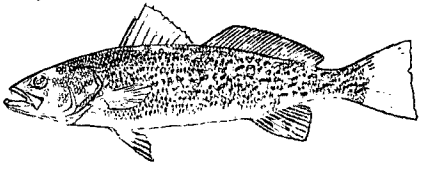


Largemouth bass – The Division has removed the slot limits for largemouth bass from Derby Pond, Hearns Pond, and Andrews Lake. These ponds will now be governed by the statewide minimum size limit of 12 inches for bass and 6 per day possession limit.

The minimum size limit of bass in Becks Pond remains at 15 inches and 2 bass per day.



Black drum – Delaware has developed a joint management plan with New Jersey for black drum to conserve this important resource. The 16 inch minimum size and 3 fish creel limits apply only to drum landed from the Delaware River and Bay.



Weakfish (sea trout) – Stocks of weakfish continue to decline throughout their range along the East Coast. New restrictions for weakfish have been adopted to reduce fishing mortality. All states have adopted a 1 fish per day possession limit. In Delaware the 13-inch minimum size remains the same.

Winter flounder – The daily possession limit for winter flounder was reduced to 2 fish per day to comply with new interstate management measures. The new regulations were designed to reduce harvest by 65% and reduce directed fishing.

General Tidal Fishing Regulations

These are some of the regulations that all anglers should be familiar with. For a complete listing refer to the Division's web site or request a copy from the Director's Office. See page 6 for license requirements.

Striped bass (*Morone saxatilis*)

Spawning season

The spawning season for striped bass in Delaware is considered to begin at 12:01 AM on April 1 and continue through midnight on May 31 of each calendar year. It is unlawful for any person to take and retain any striped bass during the spawning season from the Nanticoke River or its tributaries, the Delaware River and its tributaries to the north of a line extending due east beginning at and including the south jetty at the mouth of the C & D Canal, or the C & D Canal or its tributaries (see map on page 28). Catch and release only during this season; no harvest allowed.

Circle-hooks

It is unlawful for any person to fish during the striped bass spawning season on any striped bass spawning ground with natural bait using any hook other than a non-offset circle-hook when said hook measures greater than 3/8 inches as measured from the point of the hook to the shank of the hook.

The Division recommends that circle-hooks always be used when fishing natural baits because of their proven ability to reduce hook and release mortality for striped bass and other fish species. The circle-hook's design usually results in fish being hooked in the mouth, simplifying hook removal and reducing injury to the released fish.

Possession limit

A recreational angler may take no more than 2 striped bass per day (a period of 24 hours) from the tidal waters of this State at a minimum 28 inches unless otherwise authorized (e.g. spawning season or slot limit).

Slot limit season

In 2009, the Division adopted a new slot-limit during July and August for striped bass anglers in Delaware waters of the Delaware River, Delaware Bay, and their tributaries. The existing 28-inch minimum size remains in effect in coastal areas.

Area – ***Delaware waters only*** of the Delaware River and Bay and their tributaries. It does not apply to adjacent waters of Pennsylvania or New Jersey, nor does it apply to coastal waters, Indian River Inlet or the Inland Bays.

Season – July 1 – August 31

Size Limit – 20 inches to 26 inches (total length)

Limit – two (2) per angler

Special Conditions –

- Recreational hook-and-line fishermen only;

continued on page 19

- Slot limit applies only to the area specified above;
- Any striped bass less than or greater than the slot size must be released during this special season within the specified area. The 28-inch minimum size is in effect during all other months.

American shad and hickory shad

It shall be unlawful for any person to have in possession more than an aggregate of ten (10) American shad and hickory shad. Additionally it shall be unlawful for any person to take and reduce to possession any American shad or hickory shad from the Nanticoke River or its tributaries.

River herring

Unless otherwise authorized, it shall be unlawful for any person to have in possession, except a person with a valid Delaware commercial food fishing license, more than ten (10) blueback herring and/or alewife (*Alosa aestivalis* and/or *Alosa pseudoharengus*), collectively known as river herring, unless the person has a valid bill-of-sale or receipt for said river herring that indicates the date said river herring were received, the number of said river herring received, and the name, address and signature of the commercial food fisherman who legally caught said river herring; or a bill-of-sale or receipt from a person who is a licensed retailer and who legally obtained said river herring for resale.

No person shall fish with any type of a net, within 300 feet of any constructed dam or spillway on a tidal water river, stream, canal, ditch, or tributary located in this State.

Summer flounder

It shall be unlawful for any person while on board a vessel, to have in possession any part of a summer flounder that measures less than the current minimum size limit between said part's two most distant points unless said person also has in possession the head, backbone, and tail intact from which said part was removed.

The size limit and/or creel limit for summer flounder is expected to change for 2010. Consult the Division's web site for more information. The 2009 regulations remain in effect until officially changed. The size and creel limit for 2009 was 18 ½ inches and 4 fish/day.

Electric lights

"Lights used for illumination for visual purposes" shall mean any light that is fixed in position anywhere directly above the hull or deck of a vessel, dock or shore area, or any electric flood light less than 500 watts and fixed in position no less than ten (10) feet directly above the surface of the water. An electric flood light is any electric light that does not have a focused beam.

It is legal for any person to fish in the tidal waters of this State with the aid of "lights used for illumination for visual purposes".

Division of Fish and Wildlife
Tidal Fishing Access Areas

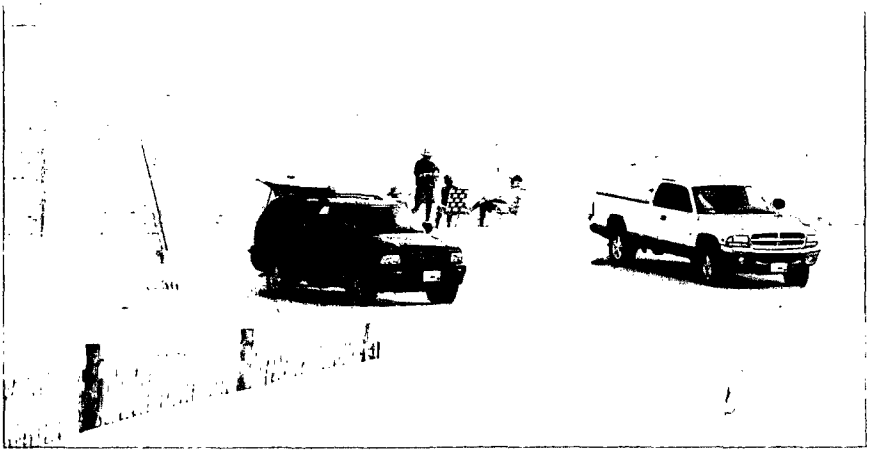
Area	Location / Water Body	Boat Ramps	Fishing Piers	Parking
1	7th Street Park / Christina, Brandywine and DE Rivers	Closed	1	20
2	Newport Boat Ramp / Christina River	2	none	51
3	Churchmans Road / Christina River	1	none	20
4	Fort DuPont State Park / DE River	3	none	100
5	Canal Wildlife Area / C&D Canal	none	8	along road
6	Augustine Beach / DE River	2	1	100
7	Odessa / Appoquinimink River	1	none	2
8	Collins Beach / DE Bay	3	1	120
9	Woodland Beach / DE Bay	1	1	50
10	Woodland Bch. / Duck Creek / DE Bay	2	none	30
11	Port Mahon / DE Bay	3	1	75
12	Water Street (Dover) / St. Jones River	car top	none	as available
13	Lebanon Landing / St. Jones River	1	1	7
14	Scotton Landing / St. Jones River	1	1	10
15	Bowers Beach / DE Bay	5	none	200
16	Cedar Creek / DE Bay	8	none	150
17	Front St., Milford / Mispillion River	1	1	10
18	Milton / Broadkill River	1	2	20
19	Lewes / DE Bay	6	none	128
20	Masseys Landing / Indian River & Rehoboth Bay	4	1	100
21	Rosedale Bch. / Indian River	2	1	30
22	Seaford / Nanticoke River	4	1	93
23	Phillips Landing / Broad Creek / Nanticoke River	3	none	50
24	Edward R. Koch / Broad Creek (*shoreline fishing only*)	none	none	10
25	Laurel below Records Pond / Broad Creek	none	1	17
26	Assawoman Wildlife Area / Little Assawoman Bay	2	2	20
	Parks & Recreation Areas			
33	Cape Henlopen Fishing Pier	none	1	75
34	Indian River Marina	2	No	40
	Indian River Inlet	none	along inlet	200
35	Holts Landing/ Indian River Bay	1	Yes	25

"Area" number refers to the numbered yellow or brown boxes on the Fishing Area map.

Note – All motor boats launched from tidal access areas administered by the Division of Fish and Wildlife must be registered in Delaware or have a valid ramp certificate. Ramp certificates cost $35 and are available from the Division of Fish and Wildlife or authorized agents (see page 40). **A daily or seasonal fee may be required at areas administered by the Division of Parks and Recreation.**

Surf Fishing

The Division of Parks and Recreation surf fishing beaches are Beach Plum Island, Cape Henlopen State Park, Delaware Seashore State Park, and Fenwick Island State Park. Special restrictions and regulations apply to these areas. For more information contact the Division of Parks and Recreation (302) 739-9220.



In order to drive a vehicle on a designated State Park beach, a SURF FISHING VEHICLE PERMIT is required. Only four-wheel drive vehicles with a minimum ground clearance of seven inches that are licensed to operate on public roadways are eligible for Surf Fishing Vehicle Permits. Permit holders must be actively engaged in surf fishing while on the beach. Permits are available at State Park offices, various license agents, and at the DNREC main office in Dover. Purchasers of Surf Fishing Vehicle Permits will receive additional rules and safety requirements. The revenue collected from these permits supports the management of seashore State Parks and beaches. None of the proceeds from these permits go towards fisheries management programs or fishing access projects conducted by the Division of Fish and Wildlife.

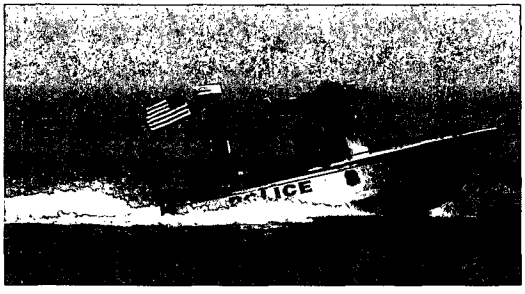
Boating Safety

Education

Anyone born on or after Jan. 1, 1978 must successfully complete an approved boating safety course before operating a motorboat and/or Personal Watercraft (PWC) in Delaware. Approved courses are a State of Delaware sponsored course, a U.S. Coast Guard Auxiliary course, a U.S. Power Squadron course, Delaware Safety Council or any other state course which is approved by the National Association of State Boating Law Administrators and DNREC.

Four Leading Causes of Boating Fatalities in Delaware Waters are:

1. Not wearing a PFD or wearing it unzipped
2. Collision (including PWC accidents)
3. Capsizing
4. Alcohol



Alcohol

Just as drinking and driving don't mix, drinking and boating are a dangerous combination. Sun, glare from the water, constant boat motion and boat vibration all contribute to boater fatigue. Add alcohol consumption and those problems are compounded. Additionally, alcohol affects balance and muscle coordination, causes tunnel vision and slows reaction time. It also affects reasoning and increases the tendency to take risks.

Operating a boat under the influence of alcohol or drugs is against the law and could result in fines up to $1,000 for first offense and/or up to 60 days in jail. A blood alcohol content of .08 or greater constitutes being under the influence.

Registration, Numbering and Marking of Undocumented Vessels

Vessels equipped with any type of motor must be registered in Delaware if principally used (a period of more than 60 days) in this State. The registration card or valid temporary registration card must be on board when the boat is in use. For further information on boating registration call: (302) 739-9916.

Personal Flotation Devices (PFDs)

In addition to the carriage requirements listed, a PFD must be worn by a child 12 years old or under while aboard a boat which is underway and all PWC riders. Current regulations require all vessels to carry a wearable Type I, II, III, or V PFD for each person on board and a throw cushion type IV for the boat, excluding boats less than 16'. The Boating Education Office suggests all vessels carry a type IV, throwable with a line attached for casting, and that you wear your life jacket zipped.

Negligent Operation

Skippers on Delaware waters are legally responsible for damages to life, limb or property caused by his/her vessel. And, of course, negligent operation is illegal.

Boating Safety

Safe Boating Speed

The speed of all vessels on Delaware waters must be slow enough to prevent any wake of appreciable height when the vessels are within 100 feet of: " Slow-No-Wake" speed areas, docks, launching ramps, marked swimming areas, swimmers, anchored, moored, or drifting vessels.

Every year people are killed or seriously injured in boating accidents in Delaware's waters. All of these accidents were avoidable if the 'rules of the road' had been followed and safe boating practices had been adhered to. The Handbook of Delaware Boating Laws and Responsibilities is available at no cost by contacting the Enforcement Section of the Division of Fish and Wildlife (1-302-739-9915) or through our website www.fw.delaware.gov.

The Enforcement Section of the Delaware Division of Fish and Wildlife is responsible for enforcing all of the safe boating laws as well as making sure that fish and shellfish size and creel limits are being followed. Some of the waters of the State are also patrolled by other authorities such as police officers and the U.S. Coast Guard. Boaters approached by a patrol boat with its blue light flashing should reduce speed, yield the right of way to the patrol boat, or if necessary stop your vessel. The operator must stop when requested to do so by a law enforcement officer.

The safety equipment and requirements for Delaware boaters vary depending on the type and length of the vessel. Here is an example of what is required of a typical fishing boat from 16 to 26 feet in length. For a complete list of all requirements for all size vessels contact the Enforcement Section.

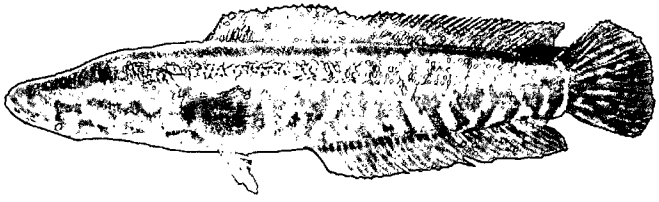
- Boater Safety Education Card (for all operators born after January 1, 1978). For information contact 739-9915 or go to our website.
- Valid Boat Registration Card
- Valid Boat Registration decal (displayed)
- Personal Floatation Device(s) – one of the appropriate size for each person on-board
- Type IV throwable PFD
- Type B-I Fire Extinguisher
- Flame Arrestor
- Ventilation System for fuel vapors
- Horn, Whistle, or Bell
- Visual Distress System (day and night)
- Navigational Lights

It is the responsibility of each vessel operator to observe the rules of the road and the carriage requirements. The Division recommends boaters wear their life jacket at all times while on the boat. Six out of ten boating fatalities could be prevented by boaters wearing their lifejackets. The consistent use of lifejackets will save more lives.

Invasive Species

Every week it seems that a new alien species has invaded our waters, often with detrimental effects on our native species. Anglers can help by serving as extra eyes on the water. Always be aware of unusual fish, plants or even shellfish in our waters. If you see something that you feel is very unusual, please contact us at: 302-739-9914. If you catch any of the species described below, do not return it to the water, kill it and contact one of the Division's field offices or a Fish & Wildlife Enforcement Office. Document the catch by either freezing the fish or taking a good photo.

Northern Snakehead Fish



This fish has become established in the Potomac with unknown impacts on native fish. It is a long, cylindrical fish, with long dorsal and ventral fins, and a large mouth with many sharp teeth. They prefer weedy ponds and streams. No snakehead has been confirmed in Delaware.

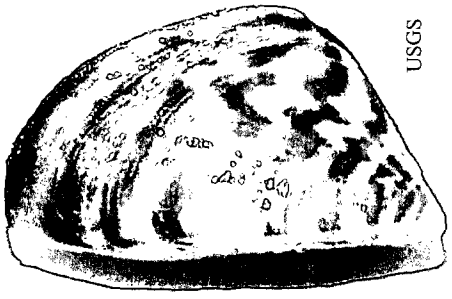
Flathead Catfish

PA Fish & Boat Comm.

The flathead catfish has been reported from the Schuylkill River, PA and the main stem of the Delaware River, PA. They are most easily recognized by their flat head profile, blotchy black and brown coloration, and a lower jaw which sticks out well beyond the upper. They grow quite large and prey on a variety of native fishes.

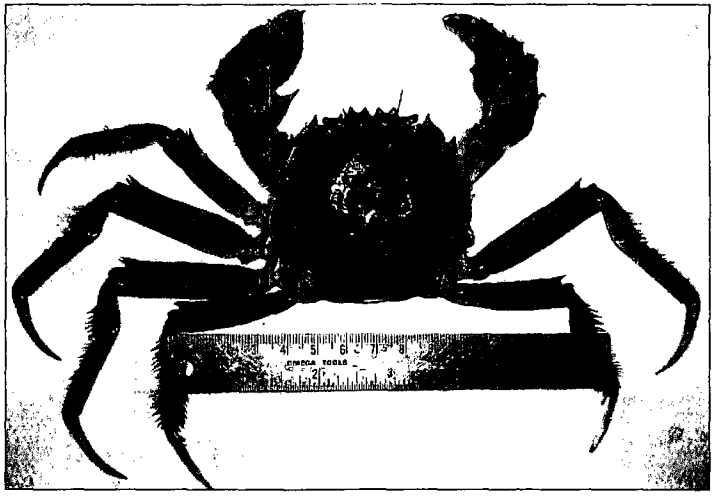
Zebra & Quagga Mussels

These two closely related freshwater mussels can survive out of water for almost 5 days and are easily transported from place to place by human activities. They attach to anything in the water impeding even other animals such as crayfish. Look for the light and dark bands of color on the shell. None confirmed in Delaware.



Zebra Mussel

Chinese Mitten Crab



First found in the Chesapeake Bay in 2006, a number of crabs have also been reported from Delaware waters. They are most easily identified by their fuzzy claws and a notch between the eyes. The body of the crab grows up to 4 inches across. This crab could be found in non-tidal freshwater as well as saltwater.

Shellfish

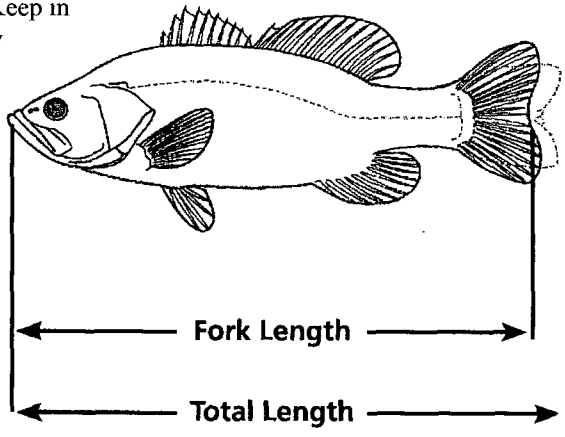
Minimum Size, Creel Limits & Seasons

Species	Open Season	Min. Length (Inches)	Daily Limit
Blue crab (pots)	March 1 – Nov.30		1 bushel/crabber
(fishing license required)	Peeler	3.0	
	Soft-shell	3.5	
	Hard shell	5.0	
Hard Clams	all year	1.5	100 resident
(fishing license required)	all year	1.5	50 non-resident
Lobster	all year	3 3/8" to 5 1/4" max	2 per diver

Measuring Your Catch

Place the fish on a measuring board or stick with the tip of the jaw or snout (the mouth closed) at the end of the instrument. Hold the head down with one hand to keep the fish in place, pinch the upper and lower lobes of the tail together while swiping the tail back and forth across the board. Note the measurement of the longest part of the tail*; that is the "total length". Keep in mind that fish which barely make the minimum length may shrink after being on ice for an hour or more. Sometimes it is possible to get an accurate measurement while the fish is still in the landing net.

*When measuring black sea bass do not include the long caudal fin filament in your measurement of total length.



Maryland DNR

Fishing Map
Fishing Access Areas
Artifical Reef Sites

Legend

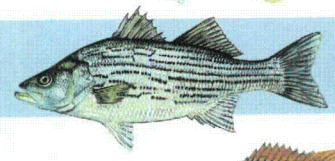
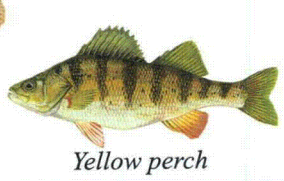
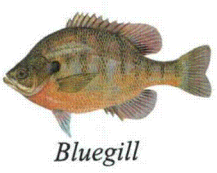
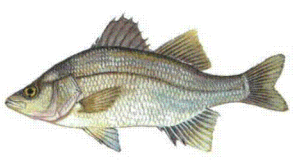
- State Parks
- State Fish and Wildlife Areas
- # Non-Tidal Fishing Access Areas - page 15
- # Tidal Fishing Access Areas - page 20
- # Parks and Recreation Access Areas - page 15 & 20
- # Artificial Reefs - page 50
- State Boundary Line

This publication is not intended to be used for navigational purposes.

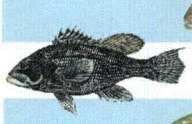
Wilmington
Newport
New Castle
Newark
Delaware City
Delaware River
Middletown
Townsend
Clayton
Smyrna
Leipsic
Kenton
Hartly
Dover
Little Creek
Delaware Bay
Camden
Woodside
Magnolia
Bowers Beach
Felton
Frederica
Houston
Milford
Slaughter Beach
Greenwood
Ellendale
Milton
Lewes
Bridgeville
Georgetown
Rehoboth Beach
Dewey Beach
Seaford
Laurel
Millsboro
Bethany Beach
South Bethany
Fenwick Island

0 2.5 5 7.5
Miles

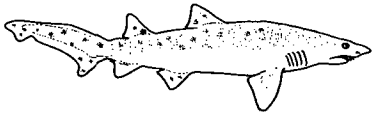
Non-Tidal Waters
Delaware's Recreational Season, Size and Creel Limits

Species	Open Season	Minimum Size	Daily Limit
 **Largemouth bass** Exception: Becks Pond	All year	12 inches 15 inches	6 2
 **Smallmouth bass**	All year	None between 12-17 inches	6 no more than 1 over 17 inches
 **Striped bass hybrid** Only in Lums Pond	All year	15 inches	2
Panfish	All year	None	50 No more than 25 of one species
 *Pumpkinseed*			
 *Black crappie*			
 *Yellow perch*			
 *Bluegill*			
 *White perch*			
 *Redear sunfish*			
 **Trout** Special rules apply See pg 9	Opens first Saturday in April	None	6 4, fly-fishing waters only

Tidal Waters
Delaware's Recreational Season, Size and Creel Limits

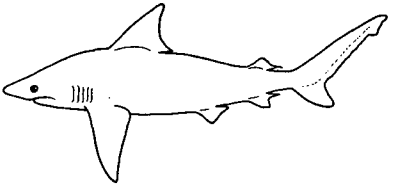
Species	Open Season	Minimum Size	Daily Limit
American eel	All year	6 inches	50
 **American & hickory shad**	Closed Nanticoke River & its tribs.; open all year elsewhere	None	10 in any combination
 **Atlantic croaker**	All year	8 inches	None
 **Black drum**	All year	16 inches	3
 **Black sea bass**	TBA www.fw.delaware.gov		
 **Bluefish**	All year	None	10
 **Catfish** (any species)	All year	None	None
 **Red drum**	All year	only fish 20-27 inches may be retained	5
River herring (alewife & blueback)	All year	None	10
 **Scup**	All year	8 inches	50
 **Spanish mackerel**	All year	14 inches	10
 **Striped bass** "Catch & Release" only on spawning grounds, April 1 - May 31. See pg 18	All year	28 inches, except only 20-26 inch fish may be retained from July 1 - Aug. 31 in DE River, DE Bay & their tribs.	2
 **Summer flounder**	Flounder - 18 1/2" - 4 Fish TBA www.fw.delaware.gov		
 **Tautog**	April 1 - May11 July 1 - Aug. 31 Sept. 29- Mar.31	15 inches 14 inches 14 inches	3 10 10
 **Weakfish**	All year	13 inches	1
 **White perch**	All year	8 inches	None
Winter flounder	Feb 11 - Apr. 10	12 inches	2
Shark, tuna & billfish	Consult guide at www.fw.delaware.gov		

Common Sharks of Delaware Bay



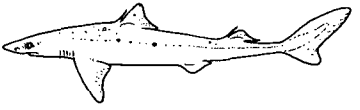
Sand Tiger - *Odontaspis taurus* - Gray-brown to tan with dark spots. Length to 10.5 feet. First and second dorsal fins nearly equal in size. Teeth long, curved and not serrated. Protected species, **none may be retained.**

Sandbar Shark - *Carcharhinus plumbeus* - Also known as the brown shark. Color dark gray to brown on back, fading almost to white on belly. A heavy - bodied shark with a large first dorsal fin that begins at a point located at the middle of the pectoral fin. **None may be retained.**



Smooth Dogfish - *Mustelus canis* - Known locally as the sand shark, this harmless species is common in the Delaware Bay . Gray to gray-brown and ranging up to 5 feet in length. Large first and second dorsal fins, with "sandpaper-like" teeth.

Spiny Dogfish - *Squalus acanthias* - Easily identified by a sharp spine located at the leading edge of both the first and second dorsal fins. Commonly caught in cold water by anglers targeting mackerel or striped bass.



Shark Regulations for Delaware

Many species of sharks have been overfished. A new state/federal shark management plan has been adopted to reduce fishing mortality on many species.

Several species of sharks commonly occur in Delaware waters and are hooked by recreational anglers either targeting sharks or incidentally while fishing for other species. In near-shore areas, these include the smooth and spiny dogfish, sandbar shark (also called brown sharks), and the sand tiger shark. In coastal waters and typically further off-shore in federal waters, some of the large coastal sharks include, but are not limited to, shortfin mako, blue shark, common thresher, and hammerheads.

Sharks are managed by the National Marine Fisheries Service and the Atlantic States Marine Fisheries Commission, and the regulations are complex. For more detailed information on the shark management plan, contact the NMFS or visit their web site. For a waterproof shark identification color placard, contact NOAA at (301) 713-2347 or karyl.brewster-geisz@NOAA.gov.

continued on page 32

Species of sharks that can be retained		
No Closed Season	**Season closed May 15 – July 15**	
Shortfin mako	Tiger shark	Scalloped hammerhead
Porbeagle	Nurse shark	Smooth hammerhead
Blue shark	Lemon shark	Great hammerhead
Oceanic white-tip shark	Blacktip shark	Silky shark
Thresher shark	Spinner shark	
Finetooth shark	Bull shark	
Blacknose shark		
Atlantic sharpnose shark	*These species may not be retained in Delaware, New Jersey Maryland, and Virginia from May 15 through July 15.*	
Bonnethead		
Smooth dogfish		
Spiny dogfish		

For most fishermen in Delaware, the following outline should be sufficient to comply with the new shark regulations. Of the many species of sharks that could occur in Delaware waters, only the species listed in the table can be retained; all other shark species must be immediately released. Species that can be retained and seasonal closures are listed in the above table.

Size limits – The minimum size for the sharks listed that can be harvested is 54 inches FORK LENGTH excluding Smooth and Spiny dogfish, Atlantic Sharpnose, Blacknose, Finetooth and Bonnethead for which there are no minimum size limits.

Possession Limits (not including dogfish) –
Boat anglers – one per vessel for sharks listed that can be harvested plus one additional Bonnethead and one additional Atlantic sharpnose per angler on board the vessel.
Shore anglers – one per angler for the sharks listed that can be harvested plus one additional Bonnethead and one additional Atlantic sharpnose per angler.

Sandbar and Sand Tiger Sharks – Of special significance to Delaware anglers are the sandbar shark, sometimes referred to as the "brown" shark, and the sand tiger shark. Both species are very long-lived, have low reproductive rates, and are overfished. Delaware Bay is an important "pupping area" and nursery for sandbar and sand tiger sharks, and they are commonly hooked. Sandbar sharks and sand tiger sharks cannot be retained at any time regardless of size.

Smooth and Spiny Dogfish – These two species are the most common sharks found in Delaware. Smooth dogfish are typically caught during the warmer seasons with spiny dogfish most abundant during the fall and winter months. Spiny dogfish are not currently overfished and have liberal landing quotas. There is no closed season, no size limit, and no creel limit for spiny dogfish taken by recreational boat or shore anglers in Delaware.

Federal regulations- state regulations are subject to changes in Federal Regulations. Please consult www.fw.delaware.gov for the latest changes in regulations.

First State Research Vessel & Trawl Programs

The R/V 'First State" is the largest of several Division research vessels used to conduct marine fisheries research in the Delaware Estuary. The primary role of the "First State" is to conduct the Division's two trawl surveys in the Delaware Estuary to monitor juvenile and adult fish and shellfish abundance. These surveys provide information on the relative abundance, distribution, and size/age structure of a wide variety of species – from weakfish and flounder to blue crabs and horseshoe crabs. These data are combined with information gathered in similar surveys conducted by other agencies along the coast and used to monitor, assess and manage our fishery resources.

The surveys are also used to collect specimens for such things as genetic, contaminant, food habit, and tagging studies. Other uses of the vessel include oyster population monitoring and restoration, artificial reef site evaluation and benthic mapping.

DuPont Nature Center

Chris Bennett

The DuPont Nature Center at the Mispillion Harbor Reserve is located at the mouth of the Mispillion River on the Delaware Bay. This harbor represents one of the most important horseshoe crab spawning beaches and shorebird feeding areas in the world. Each year, thousands of horseshoe crabs mate and lay millions of eggs on beaches visible from the DuPont Nature Center's observation deck. The eggs are a critical food source for migratory shorebirds, including the remarkable Red Knot, which stops at the Delaware Bay each spring on its 9,000-mile flight from Tierra del Fuego (South America's southernmost tip) to its summer nesting grounds in the Arctic.

The center includes an observation deck with spotting scopes to view the harbor, bay and shoreline. More than 130 species of birds, fish, shellfish, and other animals populate the area. Inside the center visitors can view shorebirds and horseshoe crabs along the shoreline more than 100 yards away, courtesy of a remote camera and a 42-inch plasma viewing screen.

The center is filled with exhibits devoted to the Delaware Bay's natural history and ecology including a live sturgeon exhibit.
To learn more about the DuPont Nature Center, call 302-422-1329 or visit www.dupontnaturecenter.org.

State Record Holders

Species	Weight	Angler	Year
Freshwater			
Largemouth bass	10 lbs. 5 ozs.	Tony Kaczmarczyk	1980
Smallmouth bass	4 lbs. 15.5 ozs.	Jerry Proffitt	1989
Striped bass hyb.	13 lbs. 13 ozs.	Earl Blevins	1990
Bluegill	2 lbs. 10 ozs.	Arnold Harmon	1998
Carp	45 lbs.	Ronald Burnett	1976
Catfish	23 lbs. 6 ozs.	William Ridgley	1992
Crappie	4 lbs. 9 ozs.	Marvin Billips	1976
Tiger musky	15 lbs. 2 ozs.	Richard Harris	1991
White perch	2 lbs. 9 ozs.	Wayne Hastings	1997
Yellow perch	2 lbs. 11ozs.	Marvin Kessinger	1976
Chain pickerel	7 lbs. 3 ozs.	Earl Messick	1972
American shad	6 lbs. 12 ozs.	Bayard Conaway	1972
Trout	11 lbs. 10 ozs.	Edwin Wallace	1997
Walleye	6 lbs. 14 ozs.	Nesbit Copenhaver	1995
Redear sunfish	3 lbs. 1 ozs.	Marty Messick	1998
Saltwater			
False albacore	20 lbs.	Christian Anderson	2008
True albacore	80 lbs.	David Francella	1987
Black seabass	7 lbs. 6 ozs.	Steve Samluk	1988
Striped bass	51 lbs. 8 ozs.	Betty Rosen	1978
Bluefish	21 lbs. 15 ozs.	Bill Thoroughgood	1980
Cod	44 lbs.	John Osborne	1975
Atlantic croaker	5 lbs. 3 ozs.	Catherine Simpson	1980
Dolphinfish	52 lbs. 15 ozs.	Charles Ciociola	2003
Black drum	115 lbs.	Kenneth Smith	1978
Red drum	75 lbs.	James Vandetti	1976
Flounder	17 lbs. 15 ozs.	William Kendall	1974
Kingfish	4 lbs.	Billy Hastings	1973
Atlantic mackerel	3 lbs. 5 ozs.	Ricky Yakimowicz	1985
King mackerel	48 lbs. 9 ozs.	Gordon Harris	1992
Spanish mackerel	6 lbs. 4 ozs.	Eric Ludwig	2000
Blue marlin	820 lbs.	Bruce King	1986
White marlin	120 lbs.	William Garner Jr.	1972
Scup	5 lbs. 5 ozs.	Herman Schmidt	1979
Shark	825 lbs.	Brent Thomas	1981
Mako shark	975 lbs.	Thomas Barnes	2000
Sheepshead	14 lbs. 4 ozs.	Fallyn Smith	2008
Swordfish	276 lbs. 12 ozs.	Albert Scott	1978
Tautog	21 lbs. 4 ozs.	Glenn Cave	2005
Gray triggerfish	5 lbs. 12 ozs.	Brent Stewart	2005
Tuna	873 lbs.	Dan Dillon	2005
Wahoo	98 lbs.	Jeff Murtoff	2003
Weakfish	19 lbs. 2 ozs.	William Thomas	1989

See Pages 36 and 37 for more information on the Delaware Sport Fishing Tournament

Rules for Delaware Sport Fishing Tournament

Call (302) 735-2960 for tournament information.

1. The Sport Fishing Tournament is open to the public. There is no entry fee. Charter boat captains are eligible. Weighmasters are eligible to enter, provided their fish are weighed in at a weighing station other than their own.
2. All fish entered in the tournament must be caught within the boundaries of the State of Delaware except those caught beyond the three-mile limit in the Atlantic Ocean. Any fish caught outside the three-mile territorial sea must be landed in a vessel leaving from a Delaware port and returning to a Delaware port.
3. All fish entered in the tournament must be caught in a sporting manner with hook and line. No other person may touch the rod or line until the fish is brought within the grasp of the mate.
4. All fish entered in the tournament must be weighed at an official Delaware Sport Fishing Tournament Weigh Station.
5. All fish entered in the tournament must meet the minimum weight requirement as set up for this year's tournament.
6. All scales used to weigh in fish must be certified yearly by the Delaware Division of Weights and Measures (Department of Agriculture).
7. No smallmouth bass will be recognized from Kent or Sussex Counties unless Division of Fish and Wildlife qualified personnel examine and approve the catch.
8. A fish will not be recognized as a state record unless qualified personnel from the Division of Fish and Wildlife approve the catch. In case no Division personnel are available at the time of the weigh-in, the angler must save the entire fish for examination and approval at the earliest convenient time for the Division.
9. In the case of a tie for the largest fish of the year or a new state record, both fish will be recognized.
10. To replace a record for a fish weighing less than 25 pounds, the replacement must weigh at least 2 ounces more than the existing record. To replace a record for a fish weighing 25 pounds or more, the replacement must weigh at least one-half of 1 percent more than the existing record. Example: at 100 pounds the additional weight required would be 8 ounces. Any catch that exceeds the existing record by less than the amount required to defeat the record will be considered a tie.

11. The Tournament Director reserves the right to disqualify any entry.

12. All entry forms must be filled out completely and in a legible manner by the weighmaster. **The signed forms should be mailed in by the angler.**

13. The tournament runs from Jan. 1 - Dec. 31. No entry forms for the previous tournament year will be accepted after 4:30 p.m. January 31.

14. Only one citation per species of fish will be issued to any individual during the tournament year. In the event an individual catches a larger fish than the one for which he originally was issued a citation, a new citation will be issued for the larger fish if the individual returns the original citation.

15. Only one saltwater award and one freshwater award will be issued to any one individual during the tournament year.

16. Special citations will be issued upon approval of the tournament director in the case of unusual catches or extenuating circumstances (young children, disabled, etc.). If the weigh station feels the catch is rare or unusual, an entry form should be submitted for approval. All decisions by the Director on unusual species will be final.

17. Citations will be awarded for released white or blue marlin. Fill out the standard entry form except for length, weight, and girth and include a signature and telephone number of a witness to the catch other than the angler and captain. Any marlin kept for mounting also will be eligible for Tournament entry provided a taxidermist receipt is enclosed with the entry form. Marlin retained for any purpose other than mounting will not be eligible for entry in the Tournament.

18. The Tournament Director reserves the right to disqualify any weigh station if the Tournament rules are not observed.

19. Hybrid striped bass will only be recognized for entry when caught in Lums Pond.

20. The State of Delaware assumes no responsibility in the certification of a catch for consideration by the International Game Fish Association or any record keeping body other than the Delaware Sportfishing Tournament. If the angler wishes to qualify his catch for consideration in some other tournament, it is the responsibility of the angler to insure that his catch and weigh-in meets the appropriate criteria. The Delaware Sportfishing Tournament makes no distinction based on line classes or sex of the angler or fly versus conventional fishing gear.

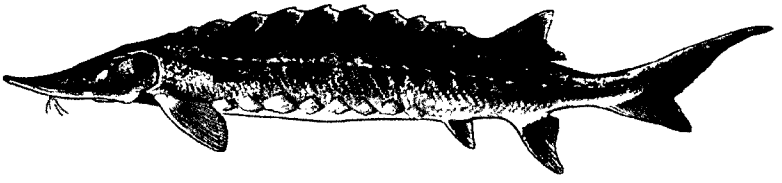
Live Release Awards

In order to promote conservation ethics among Delaware anglers, the Division of Fish and Wildlife is providing recognition patches to anglers who catch and release live eligible species that exceed the minimum lengths specified. To qualify, an angler must make the catch in Delaware waters or off Delaware's Atlantic coast line. The eligible species must be measured from the tip of the jaw to the tip of the tail (straight line measurement with mouth closed) and this measurement must be verified by a witness who signs the entry form. The fish so measured must be released immediately. Fish kept either alive or dead and brought to a weigh station will be weighed for entry in the Sport Fishing Tournament using certified scales and will not be eligible for a Live Release Award. Only those fish released alive immediately shall be eligible for a Live Release Award. Billfish released alive are eligible for either the Live Release Award or the Sport Fishing Tournament Award, whichever one the angler chooses.

No angler will be issued more than one live release freshwater award and one live release saltwater award per year, although he or she may apply for and receive one of the live release citations for each eligible species.

Applications for Live Release Awards are available on-line or may be picked up at any Sport Fishing Tournament Weigh Station and must be mailed to the Division of Fish and Wildlife within 30 days after the catch. The entry form for live releases must include both the angler's signature and the signature of a witness to the actual measurement and live release of the fish. No fish entered for a Live Release Award will be eligible for consideration as a State record fish. All potential State record fish must be weighed at a certified Weigh Station.

Have you seen a sturgeon recently?



If you find a dead sturgeon please report it immediately : 302-735-8650. Don't forget to include an exact location and contact information in your message.

Sport Fishing Tournament Minimum Weights

Freshwater Fishes

Species	Weight (lbs.)	Length* (inches)
Largemouth bass	5	20
Smallmouth bass	2[1]	17
Striped bass	20	37
Striped bass hybrid[2]	5	22
Bluegill	1	10
Carp	15	29
Catfish	6	25
Crappie	1	10
White perch	1	12
Yellow perch	1	12
Chain pickerel	4	24
American shad	5	23
Trout	2	16
Redear sunfish	1	10

Saltwater Fishes

False albacore	12	26
True albacore	30	32
Black sea bass	3	17
Striped bass	20	37
Bluefish	14	33
Atlantic croaker	3	19
Dolphinfish	15	41
Black drum	50	45
Red drum[3]	do not qualify	45
Flounder	7	25
Kingfish	1	13
Atlantic mackerel	2	17
King mackerel	10	36
Spanish mackerel	5	22
Blue marlin	Any	Any
White marlin	Any	Any
Scup (porgy)	2	14
Shark (excl. Mako)	100	66
Mako shark	100	66
Sheepshead	8	22
Swordfish	Any	Any
Tautog	10	28
Blueline tilefish	35	40
Golden tilefish	35	40
Gray triggerfish	5	20
Tuna	75	52
Wahoo	20	50
Weakfish (Sea trout)	9	31

** For Live release award only; [1]Must be 17 inches or longer; [2]Must be taken from Lums Pond; [3]Red drum do not qualify for weigh-in citations*

Weigh stations and/or Boat Ramp Certificate Sales

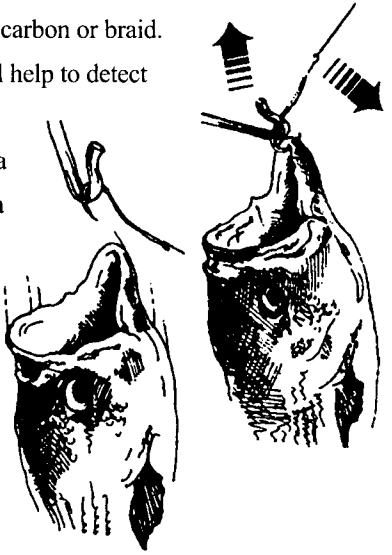
All motor boats launched from Division of Fish and Wildlife-administered tidal access areas must be registered in Delaware or have a valid ramp certificate from DNREC or its authorized agents for $35.

Authorized outlet/weigh station	City	Phone (302)	Weigh Station	Boat ramp Certificate
New Castle County				
Joseph Janvier	Middletown	836-9545	yes	no
Shooters Supply	New Castle	328-6242	yes	no
Delaware Bass Stalkers	Newark	737-2691	yes	no
Eastern Marine	Newark	737-6603	yes	yes
Capt. Bones Bait, Tackle & Seaford	Odessa	378-4200	yes	no
Ocean Pro Shop	Smyrna	653-2577	yes	no
Carlisle's Marine	Smyrna	389-0100	no	yes
Slicers Sporting Goods	Wilmington	994-9537	yes	no
Rudy's Outboard Service	Wilmington	999-8735	no	yes
Kent County				
Donovan's Dock Tackle Shop	Bowers Beach	335-3500	yes	yes
Sonny's Bait & Tackle	Bowers Beach	335-2990	yes	yes
Smith's Bait Shop	Dover	744-9140	yes	yes
Division of Fish & Wildlife	Dover	739-9916	no	yes
Williamsville Country Store	Houston	422-4455	yes	no
Sussex County				
Vines Creek Marina	Dagsboro	732-6043	yes	no
Rehoboth Bay Marina	Dewey Beach	226-2012	yes	no
Fenwick Tackle	Fenwick	539-7766	yes	no
Sam's Fishing Tackle	Greenwood	424-0197	yes	no
Hook'em & Cook'em	Indian River	226-8220	yes	yes
A&R Bait & Tackle	Lewes	645-6111	yes	no
Fisherman's Wharf	Lewes	645-8862	yes	no
Henlopen Bait & Tackle	Lewes	645-8106	yes	yes
Lewes Harbour Marina	Lewes	645-6227	yes	yes
Steamboat Landing	Lewes	645-6500	yes	no
Bayroad Discount Bait & Tackle	Lewes	945-1995	yes	no
Bills Sport Shop	Lewes	645-7654	yes	yes
Beach Marine	Lewes	645-7066	yes	yes
Cedar Creek General Store	Lincoln	383-9227	no	yes
Rick's Bait & Tackle	Longneck	945-9245	yes	no
Cedar Creek Marina	Milford	422-2040	yes	no
Cedar Creek Bait & Tackle	Milford	422-4227	yes	yes
Hi-Way Bait & Tackle	Milford	335-5087	yes	yes
Taylor Marine	Milford	422-9177	yes	no
Bayside Marina	Millsboro	945-3440	no	yes
PotNet Seaside Bait & Tackle	Millsboro	945-7798	yes	no
Massey's Landing	Millsboro	945-2544	yes	no
Short's Marine	Millsboro	945-1200	no	yes
Bob's Marine Service	Ocean View	539-3711	no	yes
Indian River Marina	Rehoboth	227-3071	yes	yes
Old Inlet Bait & Tackle Inc.	Rehoboth	227-7974	yes	no
CH McKinney's	Rehoboth	227-8800	no	yes
Taylor Tackle Shop	Seaford	629-9017	yes	no
Walkers Marine	Seaford	629-8666	no	yes
Capt. Mac's Lighthouse Bait & Tackle	Selbyville	436-2445	yes	no
Route 113 Boat Sales	Selbyville	436-1737	no	yes
Adams Wharf	Slaughter Beach	422-8940	yes	no

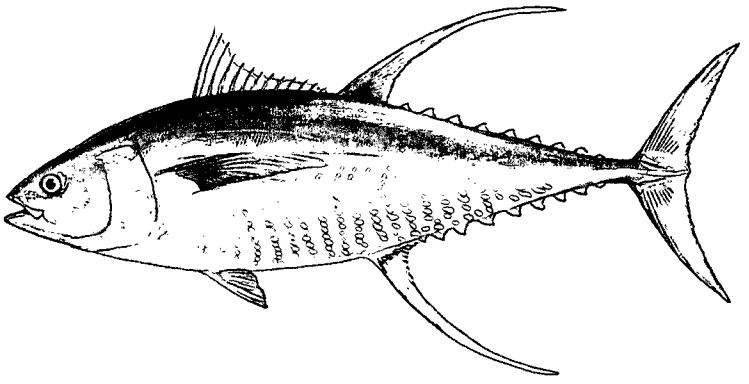
Handling and Releasing Fish

Catch-and-release can be an effective way to conserve fish if certain precautions are observed. Whether fishermen choose to release fish or are required to do so by law, care should be taken as to maximize the fish's chance of survival.

- **Exhaustion** – Long fights can decrease survival due to the build-up of lactic acid in muscular tissues. When practicing catch-and-release fishing, it is prudent to use equipment matched for the size of the fish targeted to minimize these effects. Once landed, the time the fish spends out of water should be minimized and anglers should avoid touching the fish's gills. Unresponsive fish can often be "revived" by forcing water across the gills. This can be accomplished by moving the fish gently back and forth in the water.
- **Slime Loss** – Fish have a slime coating, which seals out infection. Rough handling can damage this protective coating. Shallow landing nets, preferably rubber or knotless nylon, can greatly reduce excessive slime loss. Anglers should always handle fish with a wet towel or hand, or rubber gloves. Care should be taken to prevent the fish from flopping around and causing further wounds or loss of slime.
- **Wounds** – Anglers can do a lot to minimize the damage of hook wounds both before and after the fish is hooked. Tools such as de-hookers and needle-nose pliers can help to ensure a quick release. Treble hooks should be avoided when practical. Use fishing lines made of fluorocarbon or braid. The increased sensitivity of these lines will help to detect bites sooner and minimize the chances of hooking fish deep (stomach or gullet). If a fish should swallow the hook, cut the line a short distance above the hook eye. Studies have shown that some fish are able to pass hooks when a short piece of leader is attached. Barbless and circle hooks have both been proven to minimize wounds and time out of water.



Tuna Regulations



Tuna regulations and permits are available from the National Marine Fisheries Service phone: (888) USA-TUNA Federal web site: http://www.nmfspermits.com

Fish Consumption Advisories

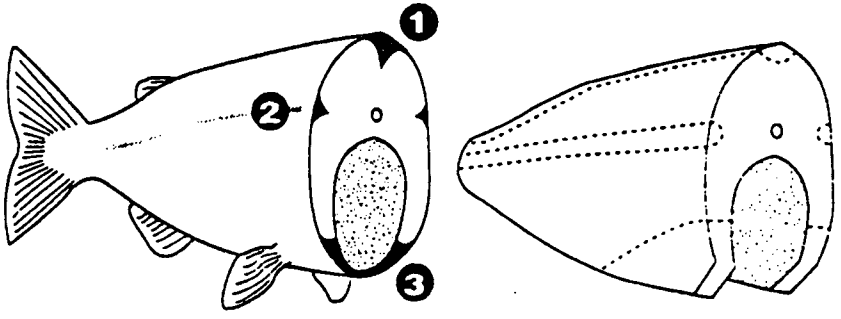
Fishing is an important activity in Delaware's inland and coastal waters. Among the benefits provided by fishing are quality recreational opportunities, direct and indirect input to the local economy, food for recreational anglers, and food for the commercial marketplace. Fish are a good source of readily digestible protein, they are low in fat and sodium, and the unique types of fats found in fish are believed to provide cardio-vascular benefits.

Despite the general benefits of fishing and fish consumption, there has been a growing concern regarding the presence of chemical toxins in the flesh of finfish and shellfish taken from Delaware waters and the associated health risk to anglers and their families who consume their catch. The existence of chemicals in the edible portion of some fish has resulted in the public advisories. These advisories are as a result of joint action taken by the Department of Natural Resources and Environmental Control and the Department of Health and Social Service's Division of Public Health. The advisories were deemed necessary because of the nature of pollutants such as polychlorinated biphenyls (PCBs).

Even when present in the water in extremely small amounts, some chemicals tend to build up over time in fish tissue because fish can absorb and concentrate contaminants from food they eat, or to a lesser extent, directly from the water. The amount of contaminants fish accumulate depends on the species, size, age, sex, and feeding area of the fish. Generally speaking, older, larger individual fish accumulate the most contaminants, although in some cases contaminants are shed each time the fish spawn. Since fish accumulate many contaminants in their fatty tissues, certain species with higher oil content can pose more risk than others when both inhabit polluted areas.

For more information concerning health advisories for Delaware waters, go on-line or contact the Division of Public Health at (302) 744-4546.

Cutting the Fat



Toxic chemicals
tend to concentrate in the fatty tissue, shown in black above, found in the:

1) dorsal area.
2) lateral line.
3) belly flaps.

When cleaning fish, always skin it and trim away fatty areas, as shown above.

continued on page 44

Delaware Fish Consumption Advisories (www.fw.delaware.gov)

Waterbody	Species	Contaminant of concern	Geographical Extent	Meals/yr 8 -ounce serving
All Waters not listed below	All Species not listed below	All	All Areas not listed	52
Delaware River	All Finfish	A, B, C, D	Delaware State Line to the C&D Canal	0
Lower Delaware River	Weakfish-all sizes;	A	Chesapeake & Delaware Canal to	12
-and Delaware Bay	Bluefish-14 inches or less	A	the Mouth of the Delaware Bay	12
	Striped Bass, White Perch American Eel, White Catfish, Channel Catfish, Bluefish-greater than 14 inches	A, C	Chesapeake & Delaware Canal to the Mouth of the Delaware Bay	1♦
Delaware Atlantic Coastal Waters including Delaware Inland Bays	Bluefish-14 inches or less	A	Coastal Delaware from Mouth of the Delaware Bay Southward to MD/DE Line	12
	Bluefish-greater than 14 inches	A, C	Coastal Delaware from Mouth of the Delaware Bay Southward to MD/DE Line	1♦
Shellpot Creek	All Finfish	A	Governor Printz Blvd. to the Delaware River	0
Army Creek and Pond	All Finfish	A, B, G	Entire Creek and Pond	2
Red Lion Creek	All Finfish	A, B	Route 13 to the Delaware River	1
Chesapeake & Delaware Canal	All Finfish	A, F, E, H	Entire Canal in Delaware	0
Appoquinimink River	All Finfish	A, B	Tidal Portions	1
Drawyers Creek	All Finfish	A, F	Tidal Portions	1
Silver Lake Middletown	All Finfish	A, E, F, B	Entire Lake	1
Waples Pond	All Finfish	C	Entire Pond	12

Prime Hook Creek	All Finfish	C	Entire Creek	12
Slaughter Creek	All Finfish	A,G	Entire Creek	6
Saint Jones River	All Finfish	A, B, C	River Mouth to Silver Lake Dam	2
Moores Lake	All Finfish	A, F	Entire Pond	2
Silver Lake Dover	All Finfish	A, B, C	Entire Pond	2
Wyoming Mill Pond	All Finfish	A, B, F	Entire Pond	2
Tidal Brandywine River	All Finfish	A	River Mouth to Baynard Blvd.	0
Non-tidal Brandywine River	All Finfish	A, B	Baynard Blvd. To Pennsylvania Line	6
Tidal Christina River	All Finfish	A, E	River Mouth to Smalley's Dam	0
Non-tidal Christina River	All Finfish	A, E, H	Smalley's Dam to DE/MD Line.	6
Tidal White Clay Creek	All Finfish	A	River Mouth to Route 4	0
Non-tidal White Clay Creek	All Finfish	A	Route 4 to DE/PA Line	12
Red Clay Creek	All Finfish	A, B, D	State Line to Stanton	6
Little Mill Creek	All Finfish	A	Creek Mouth to Kirkwood Highway	0
Christina Creek	Stocked Trout	A, E	Rittenhouse Park to DE/MD Line	6
Designated Trout Streams & Ponds other than Christina Creek	Stocked Trout	A	Designated Trout Streams are listed on pg. 10	12

Notes: ♦ Women of childbearing age and children should not consume any amount of these fish.

For more information on the specific contaminant(s) of concern for each waterbody listed, consult the Division's website (**www.fw.delaware.gov**) or contact DNREC at (302) 739-9902, or the Division of Public Health at (302) 744-4546.

Contaminants of concern: A) PCBs, B) Dioxin, C) Mercury, D) Chlorinated pesticides, E) Dieldrin, F) DDT, G) Furan, and H) Chlordane. For more information consult the Division's website or contact DNREC at (302) 739-9902, or the Divison of Public Health at (302) 744-4546.

Blue Crabs

Effective January 1, 2008 a fishing license is required to crab in all waters of the State of Delaware. See page 6.

The blue crab is common in all the tidal waters of Delaware. It is a popular recreational resource and tops the list of the State's economically important marine fish and shellfish.

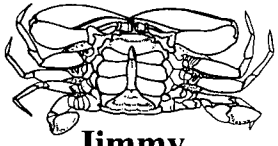
Blue crabs grow very quickly and reach maturity in 12 to 18 months. Most do not live beyond two years under current exploitation levels.

In order to grow, a blue crab must shed its shell and form a new shell. This process is repeated up to 18 times to attain maximum length. It is legal to take crabs at three stages, but to get the most yield in weight out of a crab, they should reach a minimum length before being harvested. This is measured from point to point of the top shell.

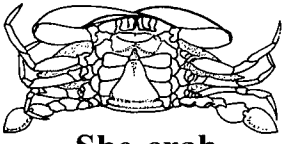
Mature females (sooks) are identified by the rounded apron on their under side. Once this stage of development is achieved, females stop growing. Because a portion of the female population does not reach five inches before achieving maturity, the minimum size requirement has been dropped. Females bearing eggs, commonly known as sponge crabs, may not be taken and should be returned to the water immediately.

Recreational crabbers may use two pots, however the person claiming to own the pots must tend them. These pots must be marked with all white buoys with the owner's full name and permanent mailing address inscribed either on the buoy or on a waterproof tag attached to the buoy. All crab pots must be tended at least once every 72 hours. All crab pots must be removed from the water between December 1 and February 28. Recreational crabbers may use a trot line (no length limit) and any number of hand lines or traps. The recreational daily limit is one bushel per person.

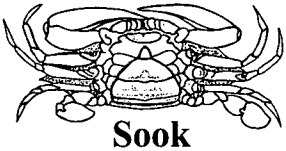
A **by-catch reduction device** is required to be attached in each funnel entrance of a recreational crab pot to reduce the possibility of diamondback terrapins entering and drowning. A by-catch reduction device is a rigid rectangular frame of plastic or metal that measures 1.75 inches x 4.75 inches and is available at local tackle shops, or can be hand-made from heavy wire or other suitable material.



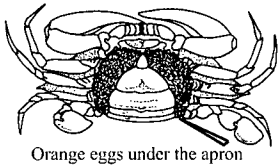
Jimmy
Mature Male



She-crab
Immature Female



Sook
Mature Female

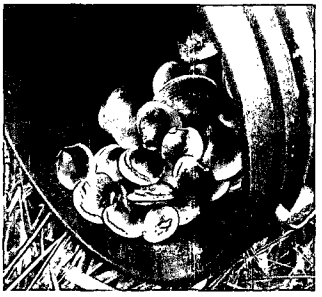


Orange eggs under the apron
Sponge Crab
Female with eggs

Clamming

Methods Of Take And Limits

A fishing license is required to harvest clams in waters of the State of Delaware. See Page 6 for details.



Dave Shirey

It shall be unlawful for any person to attempt to take, catch, kill or reduce to possession any hard clams with a device other than a hand-held rake with a head no wider than fourteen (14) inches measured perpendicular to the tines and a straight handle not in excess of seven (7) feet in length.

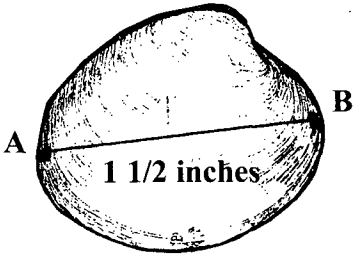
It is unlawful to harvest hard clams from one-half hour after sunset through one-half hour before sunrise.

It is unlawful for any resident to harvest more than one hundred (100) clams per day unless otherwise permitted to do so by license or permit.

It is unlawful for any non-resident to harvest more than fifty (50) hard clams per day unless otherwise permitted to do so by license or permit.

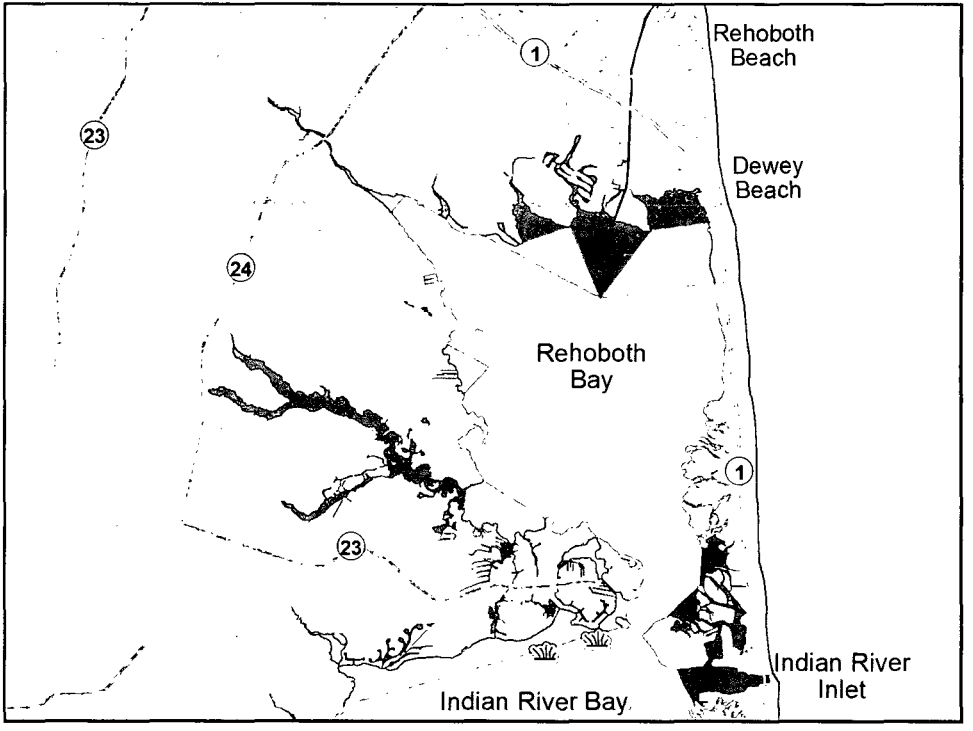
No shellfish harvesting (excluding crabs) is allowed in the **Prohibited Areas** marked on the map on page 48 and 49 or any tidal river, stream, or impoundment of the state. This includes all non-tidal and impounded water as well. Shellfish harvesting is allowed from December 1 through April 15 in the **Seasonally Approved Areas**. This is your protection against contracting shellfish-borne diseases. This is also the law. All boundaries may be marked with signs and or buoys saying "No Shellfish Harvesting" or "Prohibited Shellfish Area". Questions regarding these closures should be directed to the Watershed Assessment Section Shellfish and Recreational Waters Programs 302-739-9939. Clamming is prohibited in eel grass beds marked with white PVC pipes and signs.

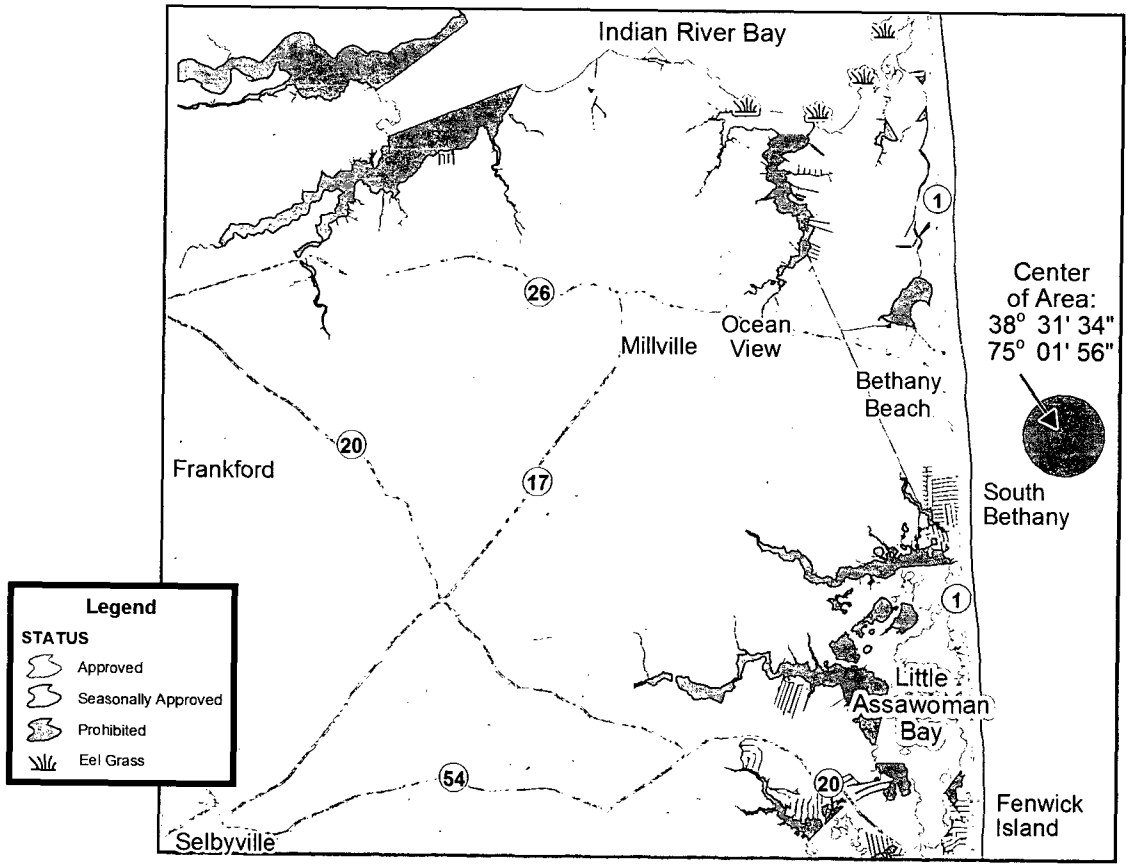
Minimum Hard Clam Size



The minimum size for a hard clam is 1 1/2 inches from point A to point B.

Clamming Map




Indian River Bay
Millville
Ocean View
Bethany Beach
South Bethany
Frankford
Selbyville
Little Assawoman Bay
Fenwick Island
Center of Area:
38° 31' 34"
75° 01' 56"
26
20
17
54
1
Legend
STATUS
Approved
Seasonally Approved
Prohibited
Eel Grass

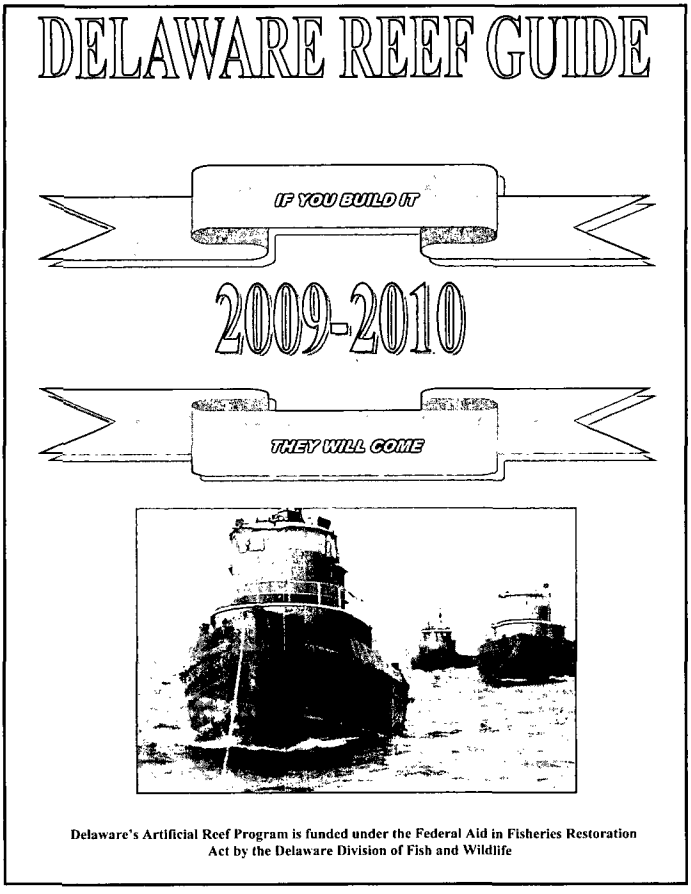
Artificial Reef Program

Delaware has eleven permitted artificial reef sites in Delaware Bay and along the Atlantic Coast. Development of these sites began in 1995 and will continue. The Delaware Reef Program is one part of a comprehensive fisheries management effort and is designed to enhance fisheries habitat, benefit structure-oriented fish, and provide fishing opportunities for anglers.

Decommissioned armored vehicles such as this one are among the recycled materials used to create an artificial reef for marine habitat off Delaware's Atlantic coast.

The site charts in the free reef guide show where reef materials have been deployed since 1995. The reef program uses DGPS (Differential Global Positioning System) to accurately place materials on site. Locations (latitude - longitude) noted for each site indicate the position of deployments of reef material from an anchored barge. In the case of large, concentrated reef deployments, a latitude or longitude range, may be given such as: N 39 15.377'-402'. This indicates material occurs between 39 degrees, 15.377 to 15.402 minutes north latitude. Due to variability between DGPS receivers, slight variations in readings may occur. It is suggested you use your GPS and a good fathometer to locate reef structure, then note the coordinates on your own GPS. You can view the reef guide on-line or contact the Fisheries Little Creek field office for a copy (302) 735-2960.

How to Send for Reef Guide



For a copy of the Artificial Reef Guide, please print on the form below and send it to the address at the bottom of the page.

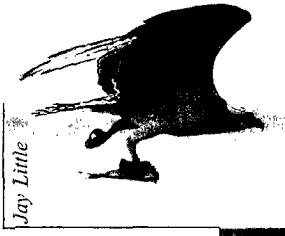
Name _____

Mail Address _____

City _____ State ____ Zip____

Return form to: Division of Fish & Wildlife, Attention Janet Dennis, 3002 Bayside Drive, Dover DE 19901.

Photo Gallery



Jay Little

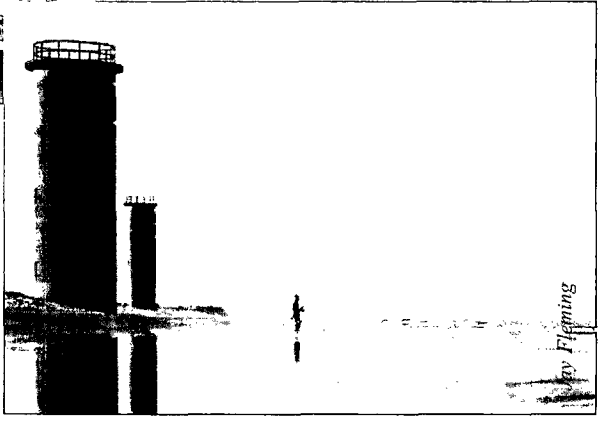
Jay Fleming

Amanda Gregg

James Little

Marc Clery

Jared Jacobini



Jay Fleming

Ben Cataldi

Fishing Advisory Councils

By Delaware law there are four citizen advisory councils with members appointed by the Governor to provide guidance to the Division of Fish and Wildlife on issues associated with fishing and fishery resources. All members serve without compensation. The Council on Game and Fish consists of 9 members and they provide advice on wildlife and freshwater fisheries matters. The Council on Shell Fisheries consists of seven members, at least four of whom represent commercial shellfishing interests, one recreational shellfisherman, and one person knowledgeable in marine fisheries. These two advisory councils have been in existence since the early 1970s. The Advisory Council on Tidal Finfisheries consists of seven members, three of whom represent recreational fisheries interests and three represent commercial fisheries. This council was formed in 1984. Legislation that passed late in 2007 authorized the creation of the newest advisory council, the Council on Recreational Fishing Funding. This seven-member council of citizens with an interest in recreational fisheries also includes two ex-officio members of the General Assembly and a non-voting representative of the Division of Fish and Wildlife. This newest council is charged with advising the Division on construction related priorities for expenditure of funds generated from the sale of recreational fishing licenses.

The length of appointments to these councils varies, but in general is for three years at a time. The various councils meet monthly in the case of Game and Fish and Tidal Finfisheries (except that Tidal Finfisheries does not meet in July, August, and December), quarterly for Shell Fisheries, and once or twice per year for the new Council on Recreational Fishing Funding. The council meetings are held in the Department of Natural Resources and Environmental Control's auditorium on weekday evenings, and the public is encouraged to attend and participate. For more details on meeting schedules of the various advisory councils, check the Division's website (www.fw.Delaware.gov) and follow the links for advisory councils.

Recreational Gill Nets

Gear and seasonal restrictions apply to recreational gill nets and anyone obtaining a permit will be informed of these restrictions. During 2010, all gill nets must be removed from the Delaware Bay and Ocean on the following dates: May 1-10; May 14-16; May 21-23; May 28-31; June 4-6; June 11-13; June 18-20; and June 25-29 in order to reduce weakfish mortality rates as required by the Atlantic States Marine Fisheries Commission's Weakfish Management Plan. Each closure period begins at 12:01 AM on the first day and ends at midnight on the last day. No striped bass caught in recreational gill nets may be retained at any time.

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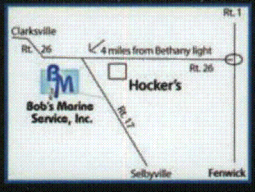

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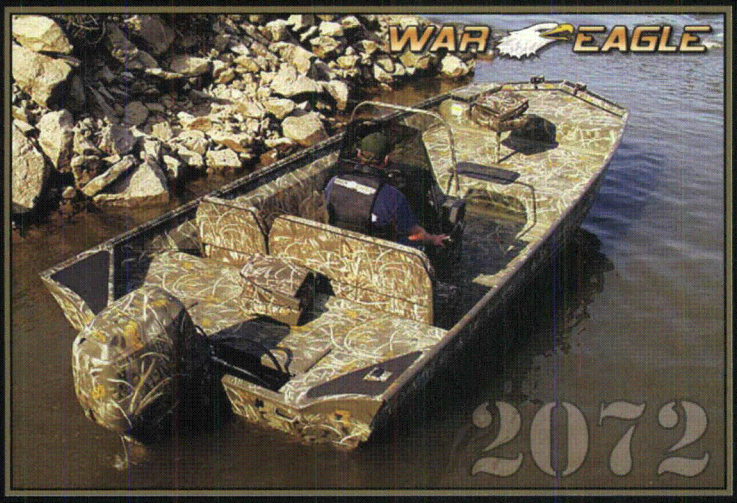

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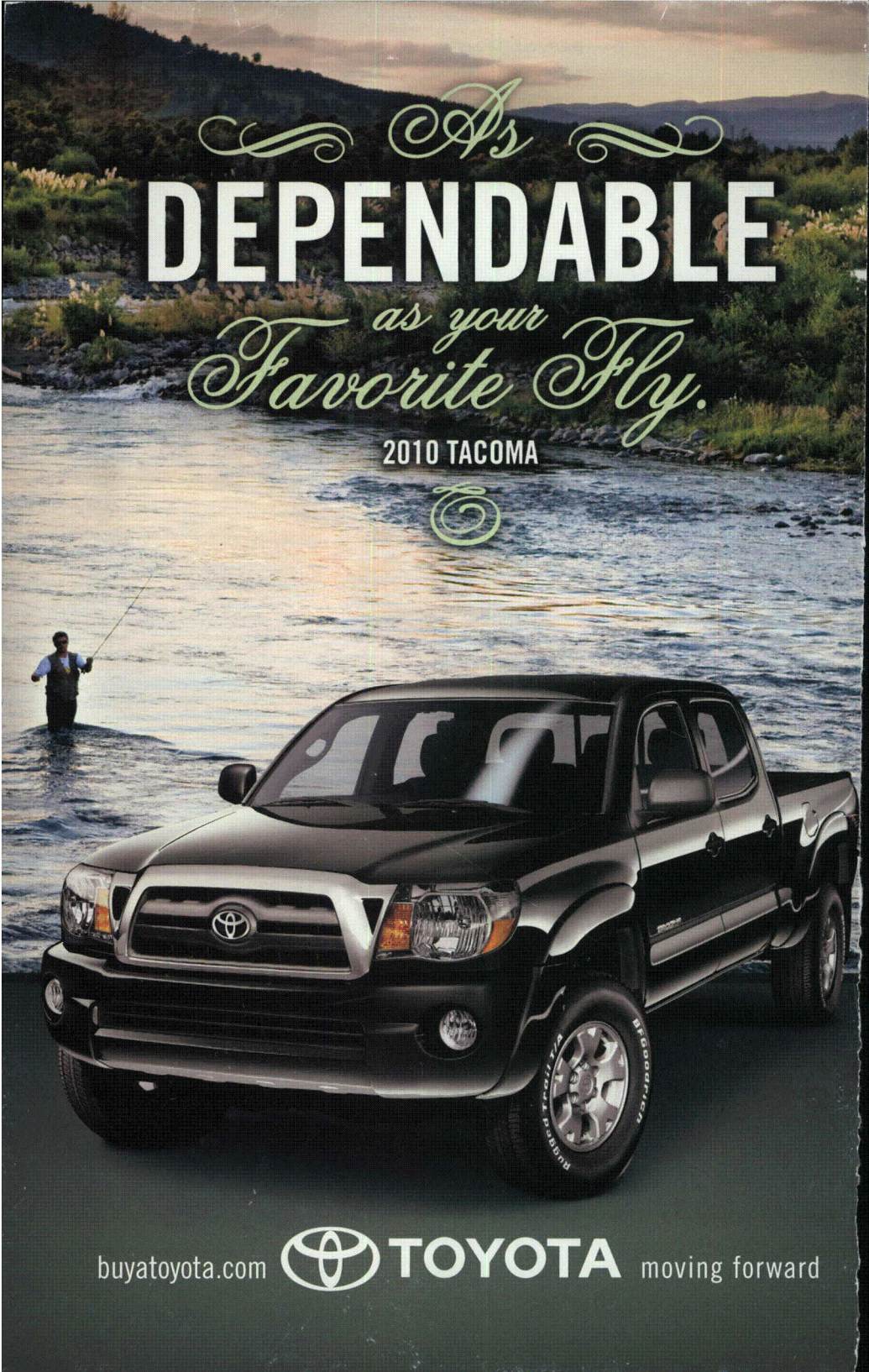
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