Indicator: Migratory Fish

<u>Question</u>

How have migratory fish returns to the Piscataqua Region changed over time?

<u>Short Answer</u>

Overall migratory river herring returns to the Piscataqua Region increased 69% between 2012 and 2016, however river herring returns have sharply declined for the Oyster and Taylor Rivers. Returns for American shad have been consistently fewer than five since 2011 and zero were reported in 2016. There are no statistically significant trends. A lack of fishable ice resulted in insufficient data for Rainbow Smelt in 2012, 2013, and 2016.

<u>PREP Goal</u>

No goal.

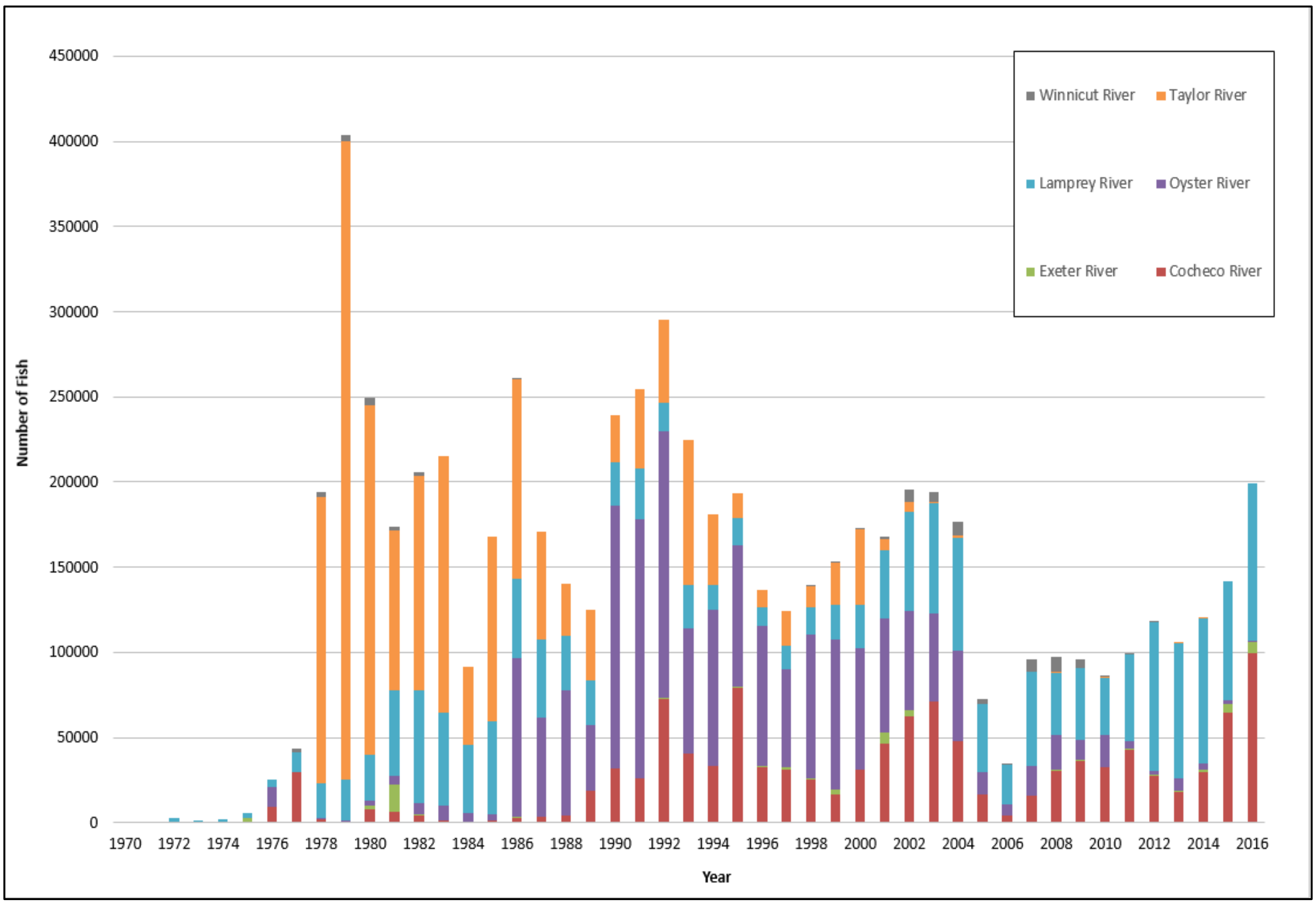


Figure MF-1. Returns of River Herring to NH Coastal Tributaries 1976 – 2016. In 2016 river herring returns are almost exclusively from two rivers: Lamprey River and Cocheco River. Data Source: NH Fish and Game.

<u>Why This Matters</u>

Migratory fish – such as river herring and American Shad – travel from ocean waters to freshwater streams, marshes, and ponds to reproduce. River herring are an important source of food for wildlife and bait for commercial and recreational fisheries.

Explanation (from the 2018 State of Our Estuaries Report)

Observed river herring returns to the coastal rivers of the Piscataqua Region varied during the 1972 - 2016 period (Figure MF-1). Total river herring returning to fish ladders in 2016 reached 199,090. This is a 69% increase from 2012 that was driven by record river herring returns in the Lamprey and Cocheco rivers. Conversely, returns have sharply declined in two other rivers: the Taylor and the Oyster. Due to variability in the dataset there are no statistically significant trends. Declines in river herring returns in some rivers may be due to several factors including: limited freshwater habitat quantity and quality, difficulty navigating fish ladders, safe downstream passage over dams, fishing mortality, pollution, predation, and flood events during upstream migrations. To continue improving river herring returns, NH Fish and Game and the NH Coastal Program continue to work with state, federal, and local partners on dam removal and culvert replacement projects on the Cocheco River (Gonic dams – Rochester), Bellamy River (Sawyer Mill dams – Dover), and Exeter River (Great Dam – Exeter), which was completed in September 2016 (TNC 2009; NHF&G 2017).

Despite increases in river herring returns for some rivers, the Oyster and Taylor River populations have declined dramatically in recent years. Additionally, the Winnicut River fish ladder has been declared ineffective and NH Fish and Game is working on a solution (Dionne 2017). The 2016 river herring returns are almost exclusively from the Lamprey and Cocheco Rivers.

Methods and Data Sources

Measurements of abundance for three diadromous fish species (Table MF-1) were tracked for each year using data from the NH Fish and Game Department (NHF&G). Abundance was measured by counts of fish passing through fish ladders in the spring. Abundance was plotted versus year to illustrate the trend in returns over time.

Table MF-1: Species, Measure and Location for Migratory Fish Counts*

Species	Abundance Measure	Location
Herring, Alewife and Blueback Herring (*Alosa pseudoharengus* and *Alosa aestivalis)*	Passage through fish ladders (# of fish/yr)	Exeter, Lamprey, Oyster, Cocheco, Winnicut, and Taylor Rivers
American Shad (*Alosa sapidissima*)	Passage through fish ladders (# of fish/yr)	Exeter, Lamprey, and Cocheco Rivers

* Extensive information on methods and results can be found in NHF&G 2017.

NHF&G also has tracked abundance of five other diadromous fish: Atlantic salmon, sea lamprey, American eel (young-of-year), brown trout, and striped bass. Very few Atlantic salmon have returned to rivers in the Piscataqua River in the past decade, making this species an insensitive indicator. Between 1992 and 2003, only 44 fish were recorded in fish ladders. NHF&G discontinued the Atlantic salmon stocking and monitoring programs in 2003. The abundance of brown trout and striped bass were tracked by voluntary reports from anglers rather than designed surveys implemented by NHF&G staff. (Note: NHF&G discontinued the sea run brown trout program in 2015.) Therefore, the abundance results for these species were not included in this indicator.

The number of rainbow smelt (*Osmerus mordax*) caught by fisherman (per year) has also been tracked by NHF&G since 1978. Rainbow smelt are primarily fished in the winter months by cutting a hole in the ice. However, 3 of the last five years have not seen a smelt fishery due to a lack of ice over the winter months. Therefore, this species was not included as an indicator.

Data Sources

NH Fish and Game Anadromous Fish Monitoring Programs provided data for this indicator.

Additional Results (Beyond the Data Reported in the 2018 SOOE)
Many factors influence the returns of diadromous fish. Each species has its own life cycle history and has different habitat needs as larvae, juvenile and adults. The following comments summarize major patterns in the data. For a more detailed discussion, please see NHF&G (2017): http://scholars.unh.edu/prep/396/

New Hampshire's coastal rivers once supported abundant runs of anadromous fish, but these and other diadromous species were unable to reach historical, freshwater spawning habitat due to the construction of dams to support the explosion of the textile industry. During the late 1950's through the early 1970's, NHF&G addressed this issue by installing "fishways" on the Cocheco, Exeter, Oyster, Lamprey, Taylor, and Winnicut rivers. Herring and shad are discussed separately below. In general, herring have adapted to dams much better than shad. While dams eliminated shad returns, herring were able to find pockets of habitat for spawning at the base of dams (NHF&G 2017).

Table MF-2 analyzes trends over different periods of time. For the entire time period (1976-2016), the Cocheco and the Lamprey show a statistically significant increase in river herring returns. The Taylor and Winnicut Rivers show a statistically significant decrease in returns, while the Exeter and Oyster Rivers show no trends.

Over the last 10 years, however, the Exeter River shows a significant increase while the Oyster River shows a significant decrease. Over the last five years, the only significant trend is an increase at the Exeter River.

Table MF-2. Statistical trends analysis for river herring returns for the entire period, last 10 years and last 5 years. Results based on Mann-Kendall Trend Test performed by NH Fish and Game.

	1976-2016	2007-2016	2012-2016
Cocheco	Significant Increase	No Trend	No Trend
Exeter	No Trend	Significant Increase	Significant Increase
Oyster	No Trend	Significant Decrease	No Trend
Lamprey	Significant Increase	Significant Increase	No Trend
Taylor	Significant Decrease	Significant Decrease	No Trend
Winnicut	Significant Decrease	Significant Decrease	No Trend

Individual data plots for each river for herring returns are shown in Figure MF-2. One of the most important observations regarding river herring returns is that high water conditions during the spawning runs affect fish ladder efficiency thereby dramatically reducing the number of returns as noted in all rivers from 2005 through 2007. Once the river herring population in the Cocheco River became established after construction of a fish ladder, herring returns have improved but are subjected to lows likely due to high water conditions and availability of effective downstream passage over dams. Returns on the Cocheco have steadily increased since 2013 (Figure MF-2). In 2016, 99,241 river herring were counted as returning, representing the highest return in 41 years of operation (NHF&G 2017).

Since 2012, herring returns to the Lamprey River have been at the highest levels since the fishways were introduced in the 1970s (Figure MF-2). Lamprey River returns have been increasing since 1997. NHF&G (2017) point out that stock enhancement at Pawtuckaway Lake may be providing some benefit.

Following the modification of a fish ladder in the Exeter River in 1999, herring runs increased for a few years (Figure MF-2) but then subsided. A 2005 NHF&G report attributed the low returns to harvest pressure, inadequate downstream passage over dams, and water quality issues such as low dissolved oxygen in the upstream impoundment (NHF&G 2006). In the years 2012 through 2014, the number of returns increased but at a slow rate in the Exeter River. In contrast, in 2015 and 2016, the returns increased more dramatically. In 2016, 6,622 river herring returned to the Exeter fish ladder: the third highest return since 1975 and the highest return since 2001. Increases have been attributed to changes in how water flows were controlled below the fishway to widen the attraction area of the fishway (NHF&G 2017). In the summer of 2016, just after the spawning season, the Great Dam on the Exeter River was removed; however, NHF&G will continue to monitor returns to the

Exeter River despite the removal of the dam. NHF&G modified the fishway at the next dam upriver (Pickpocket Dam) to allow for counting and biological sampling of herring to maintain the time series for the Exeter River.

Herring returns to the Oyster River continued to decline throughout this period (Figure MF-2). In 2016, only 863 river herring returned to the Oyster River; this is the lowest return since 1979 and is far below the average of 43,597 fish over the previous 40 years (NHF&G 2017). Over the last 20 years, one of the most dramatic changes occurred in 2005 (Figure MF-2), which could be attributed to several years of unusually wet summers. These high-flow conditions decrease the effectiveness of the fishways and could decrease returns.

The Taylor River history has similarities with Oyster River. Very high returns in the 1970s have been followed by steady losses with returns essentially absent in most recent years. In 2005, most likely due to very wet years, the returns dramatically decreased and have not recovered (Figure MF-2). NHF&G (2017) also point to eutrophication of the upstream impoundment as an important factor. Daily monitoring of fish runs during spawning has been discontinued by NHF&G. Instead, the Taylor River will only be monitored on a weekly basis, although daily monitoring may be re-implemented if there is evidence of a renewed spawning run. Finally, state and federal agencies are considering whether to remove or replace the Taylor River dam complex. In the summer of 2016, modifications to the fishway were begun. This work is being completed in conjunction with bridge construction just below the dam and fish ladder (NHF&G 2017).

At the Winnicut River, the period of 2002 through 2009 saw some modest runs (between 5,000 and 10,000 returns). However, since that period, returns have dropped off and no fish were observed passing through the fishway in 2016 (Figure MF-2). This is most likely due to modifications to the dam and fishway. In the fall of 2009, the head-of-tide dam on the Winnicut River was removed and a pool-and-weir fish passage was constructed in the fall of 2011. The passage was located approximately 100 m upstream of the former dam site; the plan was for fish to pass through a constricted channel under a bridge created after the impoundment was lowered. However, each year since 2012, river herring have been observed in small quantities below the fishway but never observed passing through. NHF&G staff have concluded that the velocity of the water prevents herring from passing through. A solution is currently being explored.

In the absence of restoration efforts, no American Shad returned to NH fishways in 2016 (Figure MF-3). There were no shad returns to Exeter or Lamprey since 2011. The Cocheco River saw less than five returns per year in this latest period, and only one fish per year in 2013, 2014 and 2015. As noted earlier, shad are far less able to adapt to barriers to spawning habitat than river herring. As with river herring, the declines in shad returns are likely compounded by flood waters, impoundment water quality degradation, and lack of supplemental stocking since 2009. Returns to the Lamprey and Cocheco Rivers have been minimal as well, largely because restoration efforts (supplemental stocking) have focused on the Exeter River since 1989, leaving only a small residual returning spawning stock.

References Cited

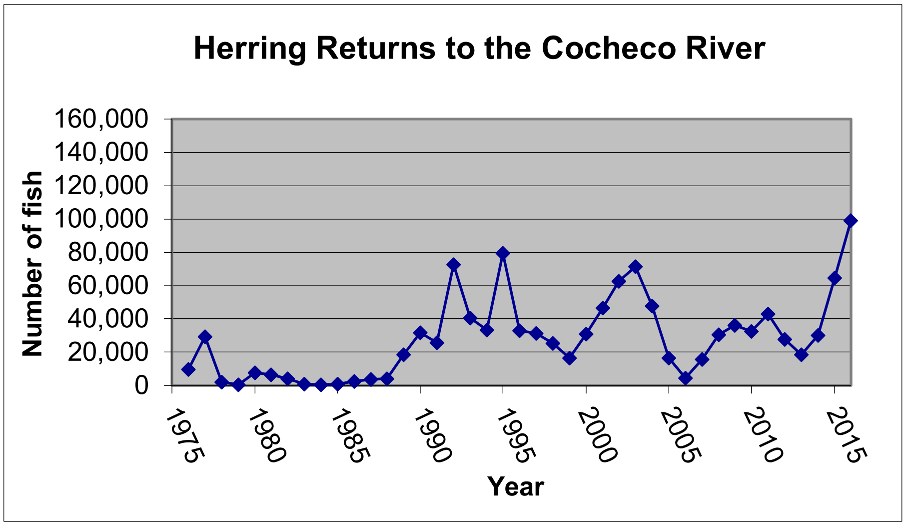
Dionne M. NH Fish & Game, Personal Communication, May 2017.

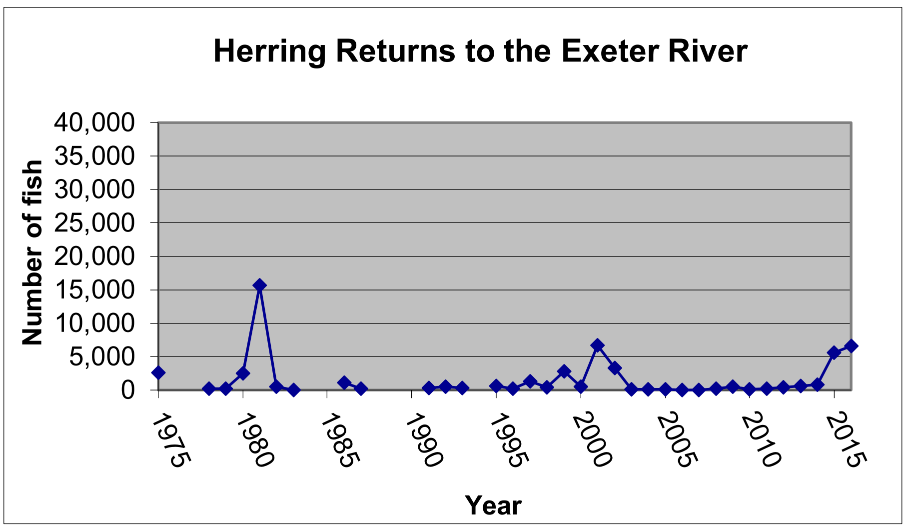
NHF&G. 2006. Anadromous Fish Investigations, Year 2005. PREP Publications. 398. http://scholars.unh.edu/prep/398

NHF&G. 2017. Diadromous Fish Investigations, 2016: Anadromous Alosid Restoration and Evaluation. New Hampshire Fish and Game. http://scholars.unh.edu/prep/396/

TNC. 2009. Assessment of Road Crossings for Improving Migratory Fish Passage in the Winnicut River Watershed. The Nature Conservancy. http://scholars.unh.edu/prep/397/

Figure MF-2. Returns of river herring to fish ladders on Piscataqua Region rivers. Plots include data from 2016. Note that the Y-axis scale is not uniform from plot to plot.





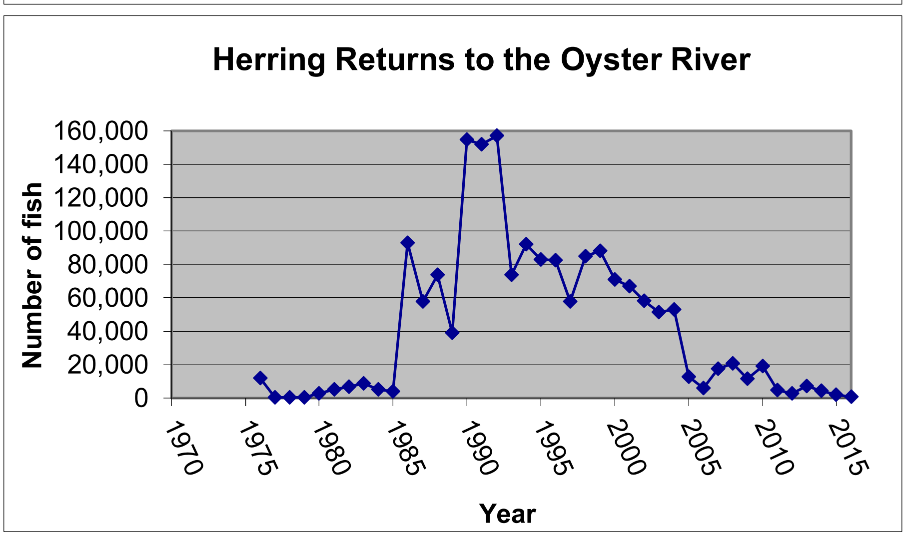
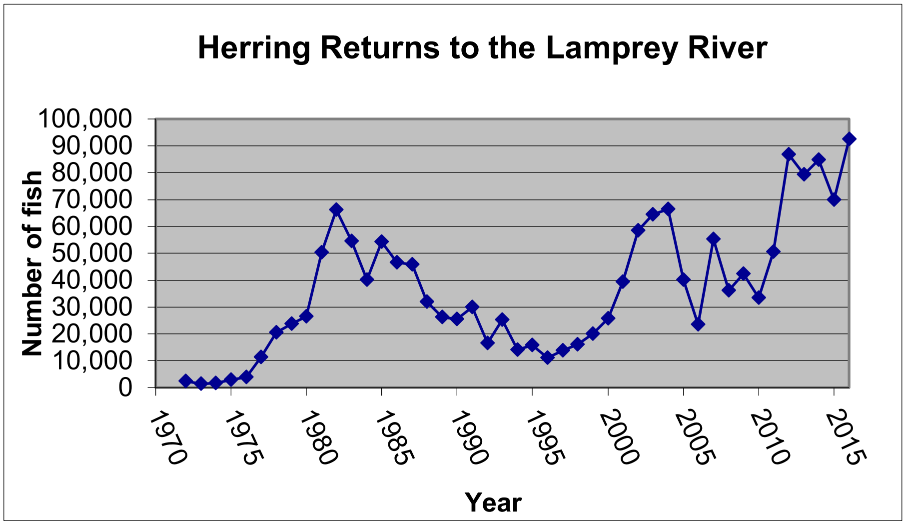
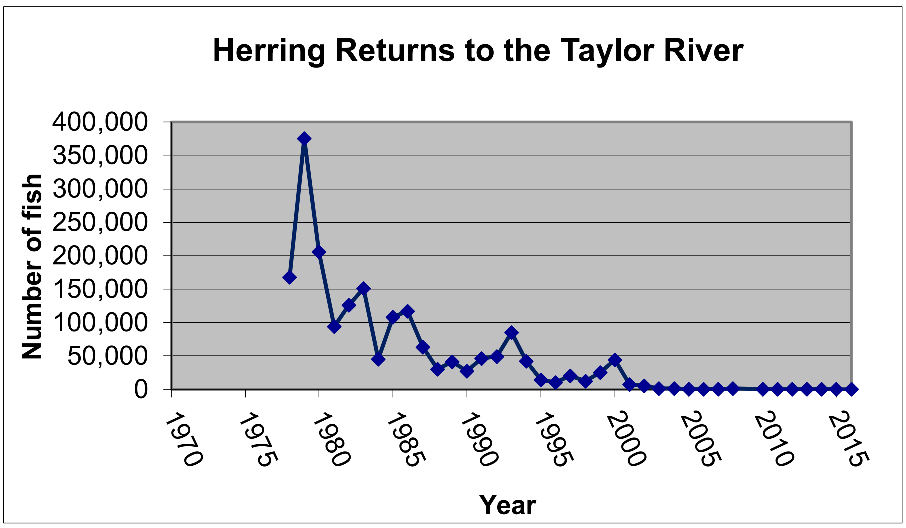


Figure MF-2 (continued). Returns of river herring to fish ladders on Piscataqua Region rivers. Plots include data from 2016. Note that the Y-axis scale is not uniform from plot to plot.





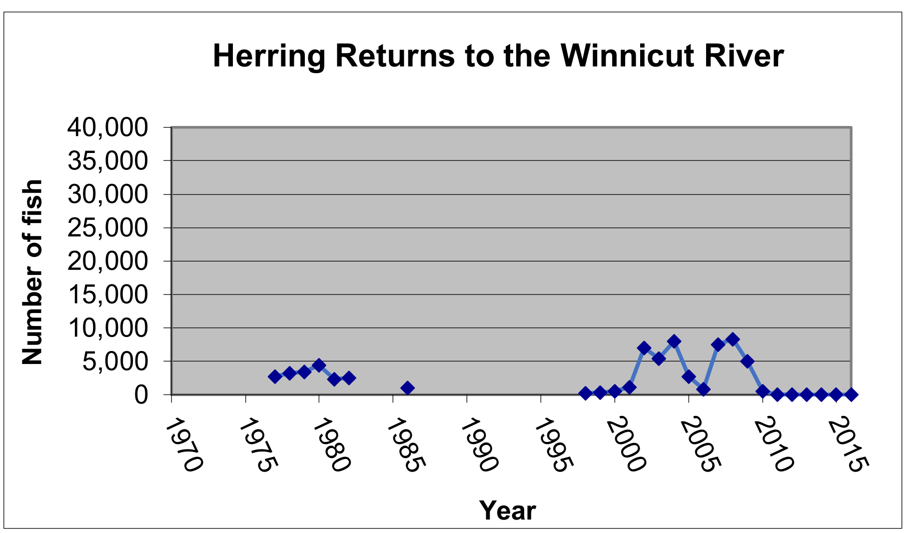
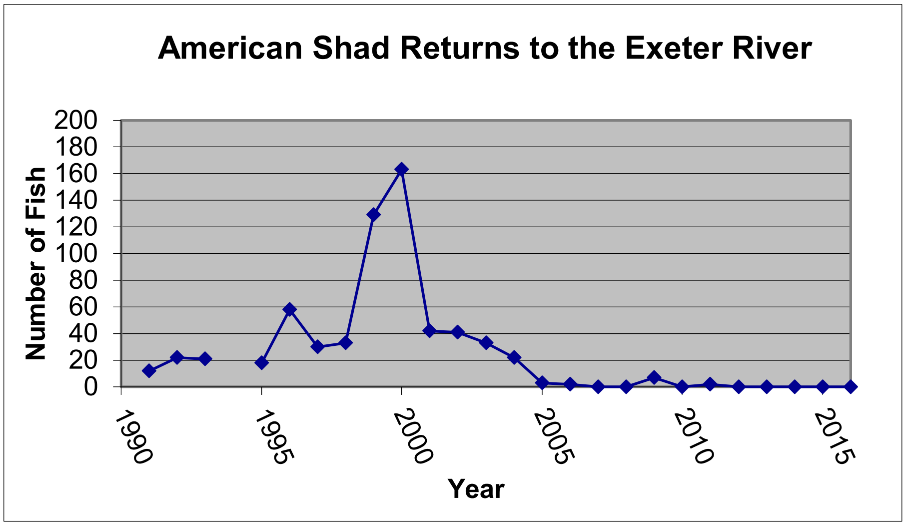
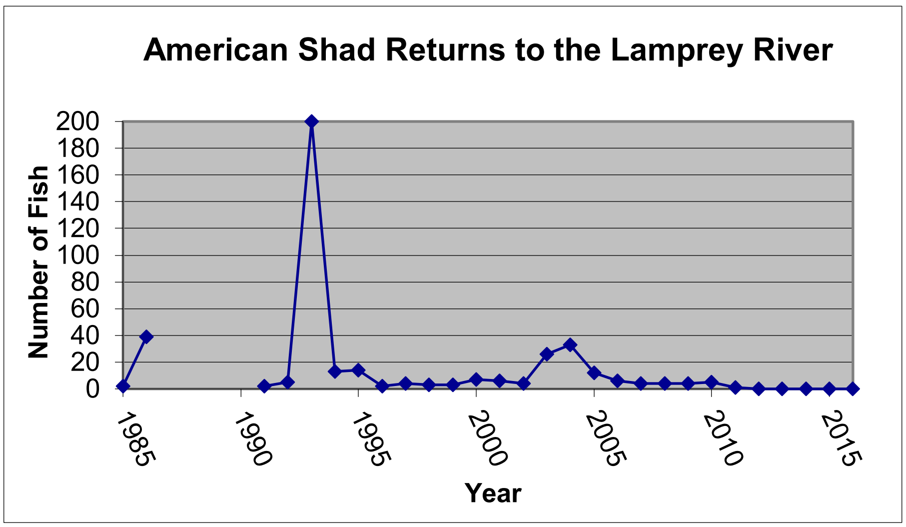
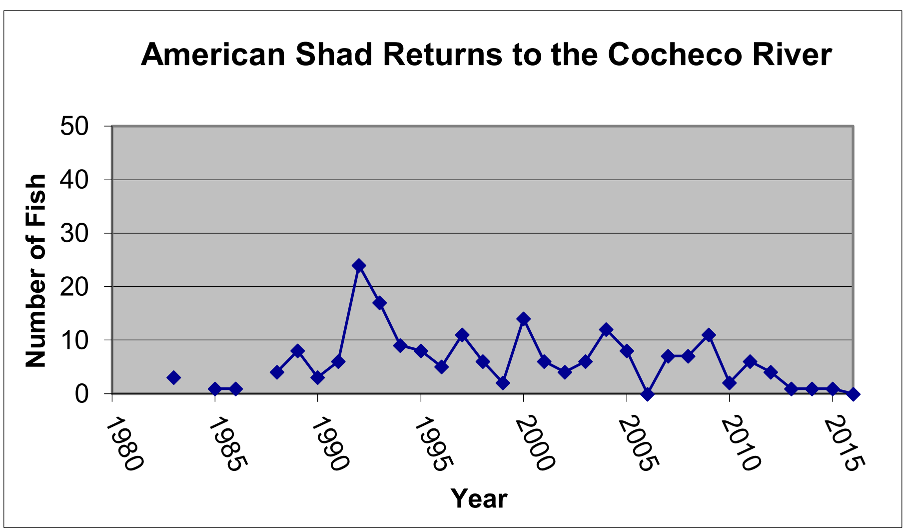


Figure MF-3. Returns of American Shad to fish ladders on Piscataqua Region rivers. Plots include data from 2016. Note that the Y-axis scale is not uniform from plot to plot.







PREP Piscataqua Region Estuaries Partnership