

NEXT STEPS IN AMERICAN SHAD RESTORATION IN PENNSYLVANIA



2012 Watershed Congress
Montgomery County Community College
March 10, 2012



Mission: To protect, conserve, and enhance the Commonwealth's aquatic resources and provide fishing and boating opportunities

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Overview



- ❑ The American shad
- ❑ State of the population
- ❑ Restoration measures
- ❑ Summary





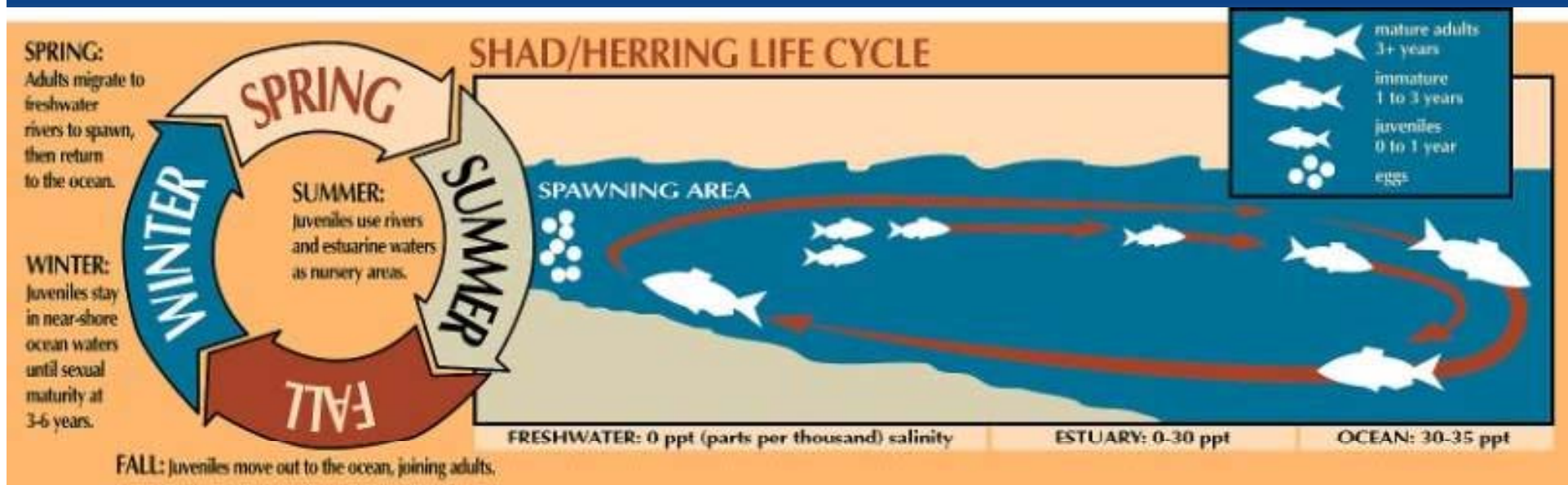
The American shad: Life history

- Anadromous, migratory, schooling, pelagic species
- Spawning
 - ▣ Home to natal rivers in Spring
 - ▣ Travel hundreds of miles inland
 - ▣ Spawn dusk to midnight
 - ▣ Fractional spawning
 - ▣ Iteroparous
- Feeding
 - ▣ Zooplankton, aquatic insect larvae
 - ▣ Opportunistic pelagic feeders
- Juvenile fall emigration
 - ▣ Out-migrate to Atlantic Ocean





The American shad: Life Cycle

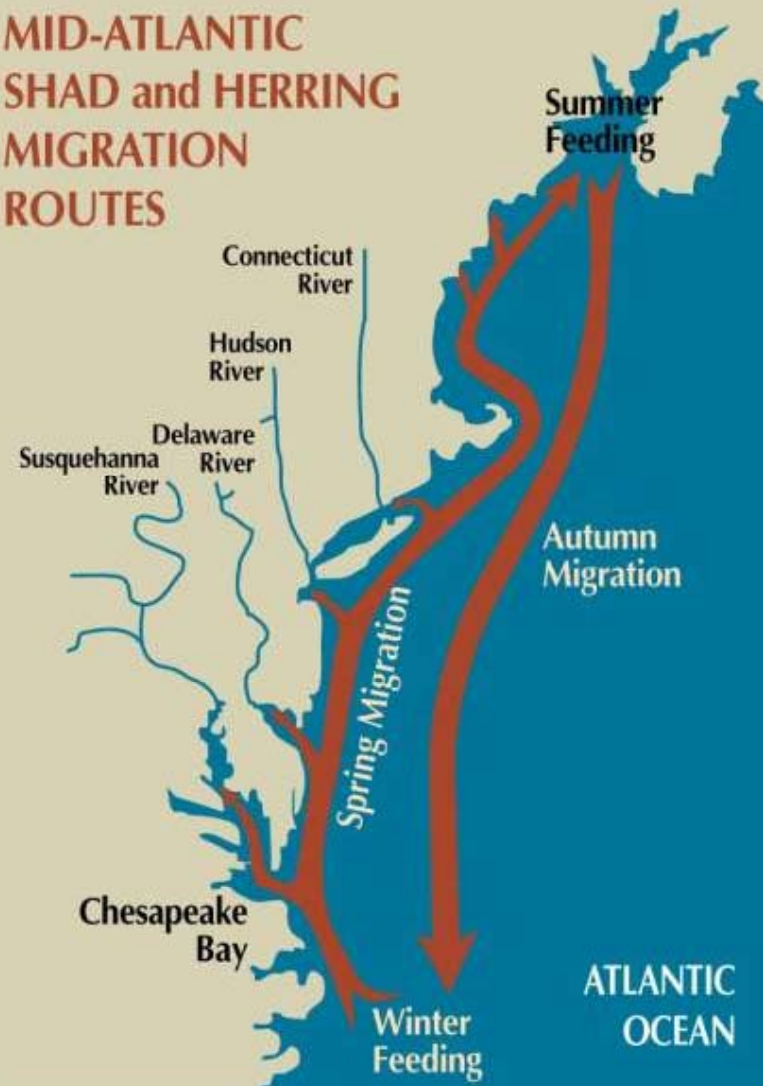


The American shad: Distribution

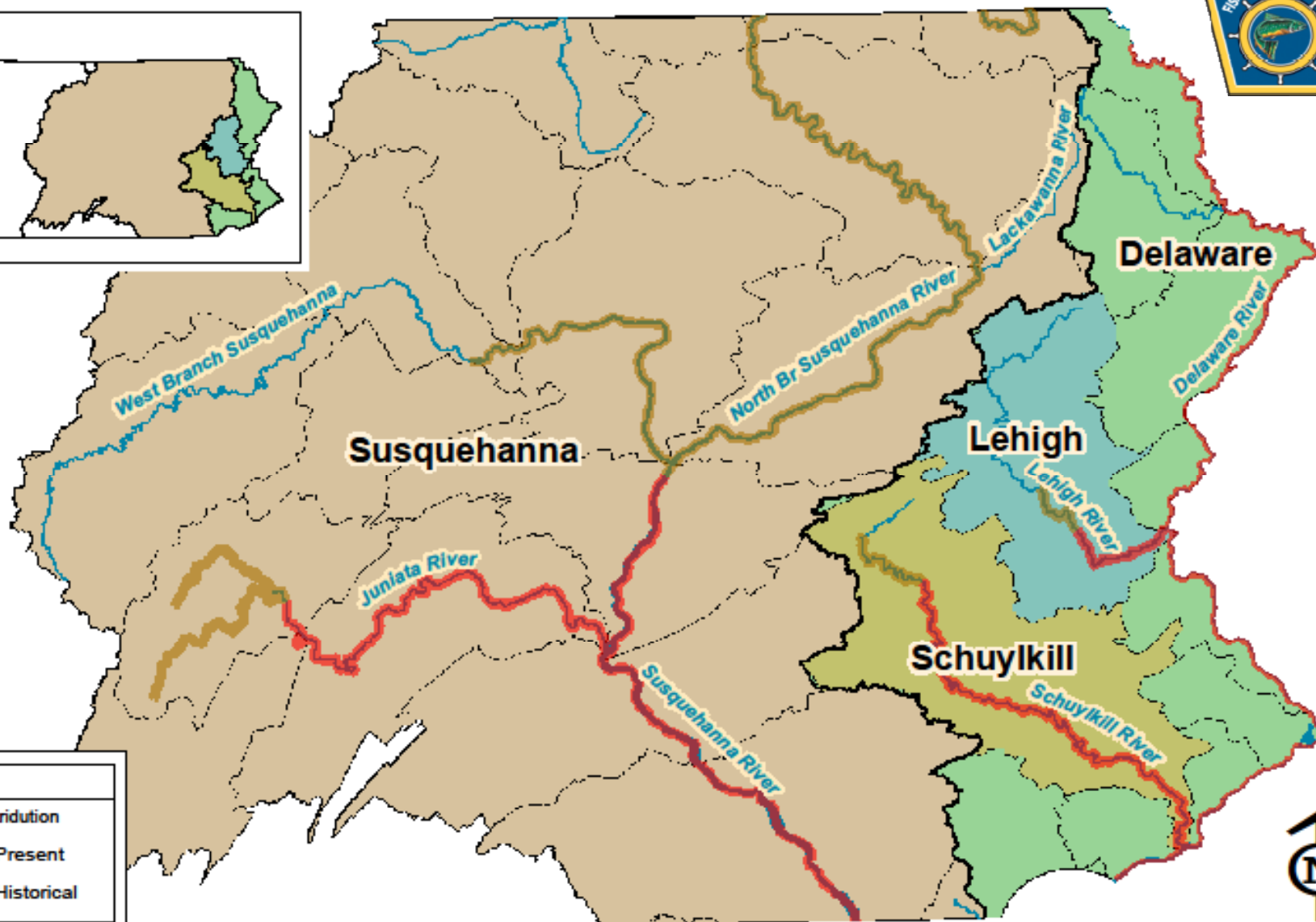
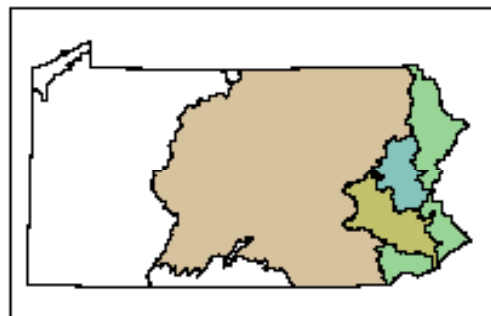


- Atlantic Coast: St. Johns River, FL to St. Lawrence River, CA
- Historically ascended >130 rivers, today <70 rivers have runs
- Endemic to PA: Delaware & Susquehanna drainages

MID-ATLANTIC SHAD and HERRING MIGRATION ROUTES



American Shad Habitat and Distribution within Pennsylvania: Susquehanna and Delaware River Basins

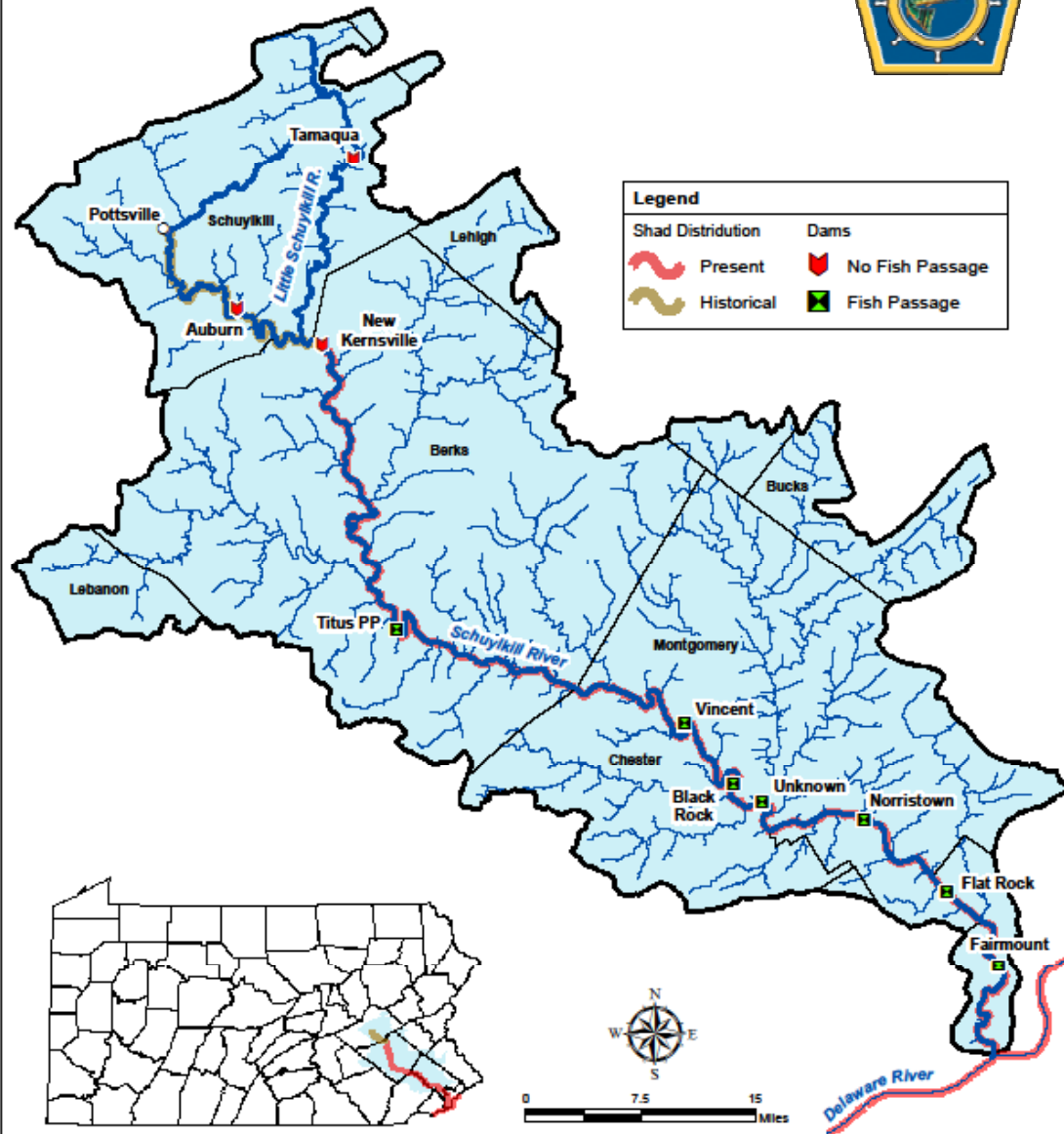


Legend

Shad Distribution

- Present
- Historical

American Shad Habitat and Distribution Schuylkill River Basin



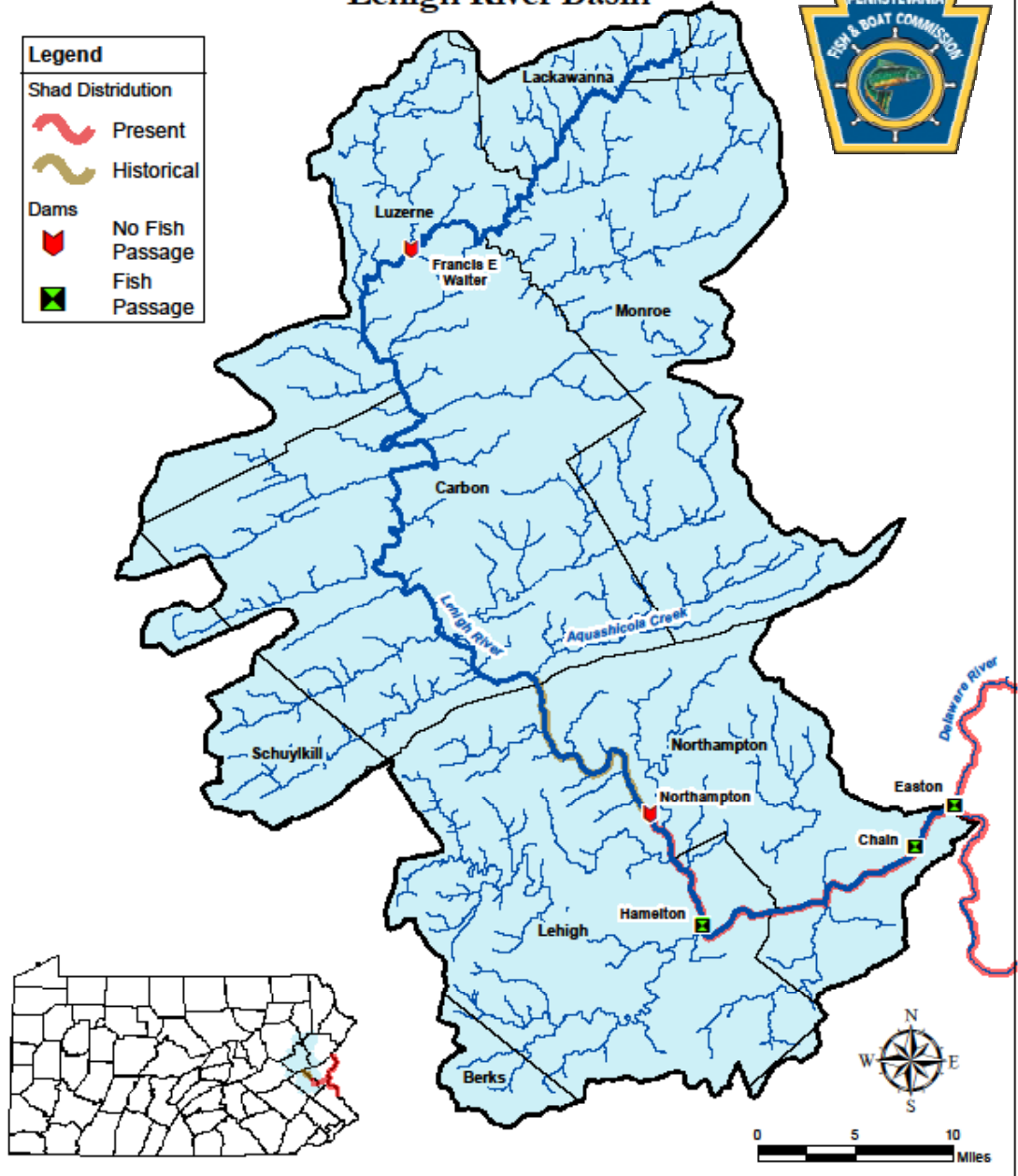
0 7.5 15 Miles

Delaware River

American Shad Habitat and Distribution Lehigh River Basin



Legend	
Shad Distribution	
	Present
	Historical
Dams	
	No Fish Passage
	Fish Passage



American shad: Historical significance

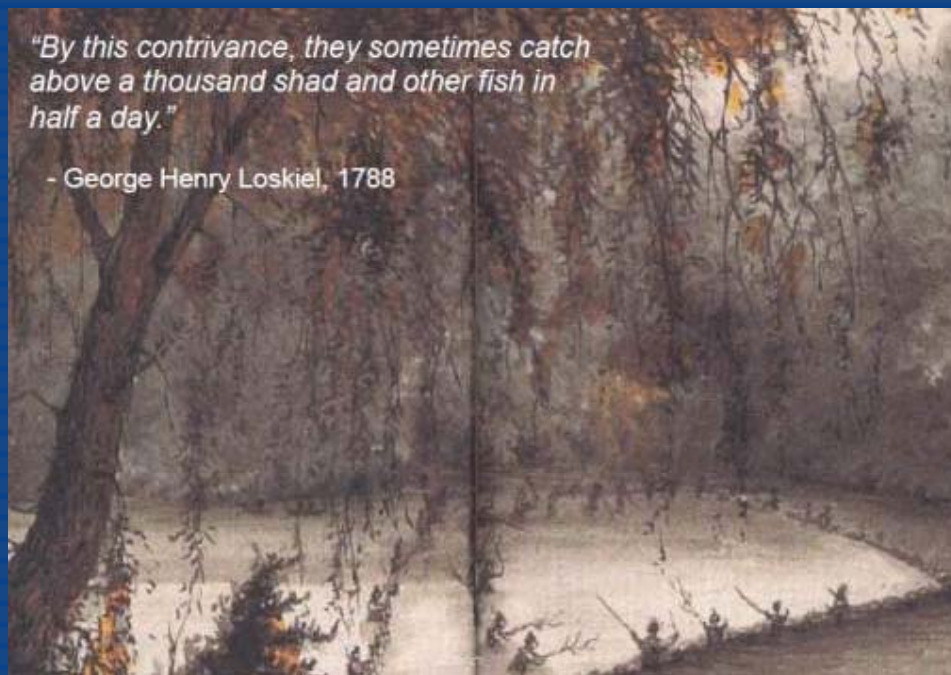


- On the Delaware, Lenape Indians used weirs to trap & spears to impale shad

- On the Lehigh, Lenape used brush nets to fish –Aquashicola Creek, named for fishing activity (Scholl, pers com)

"By this contrivance, they sometimes catch above a thousand shad and other fish in half a day."

- George Henry Loskiel, 1788



American shad: Historical significance



- Detailed records from 1890s of shad in Lehigh, Schuylkill & Susquehanna rivers due to cultural significance & commercial value
- Meehan (1895) reported the Schuylkill River was once a famous shad fishery, noting that William Penn mentioned (in one of his letters) “*six hundred shad being taken with one swipe of the seine*”.



American shad: Historical significance



- Gay (1892) characterized Susquehanna shad as “the most important food fish indigenous to Pennsylvania”, where supply was great enough to “supply immediate wants...salting down a year’s supply...and traded for salt and other necessities of life”



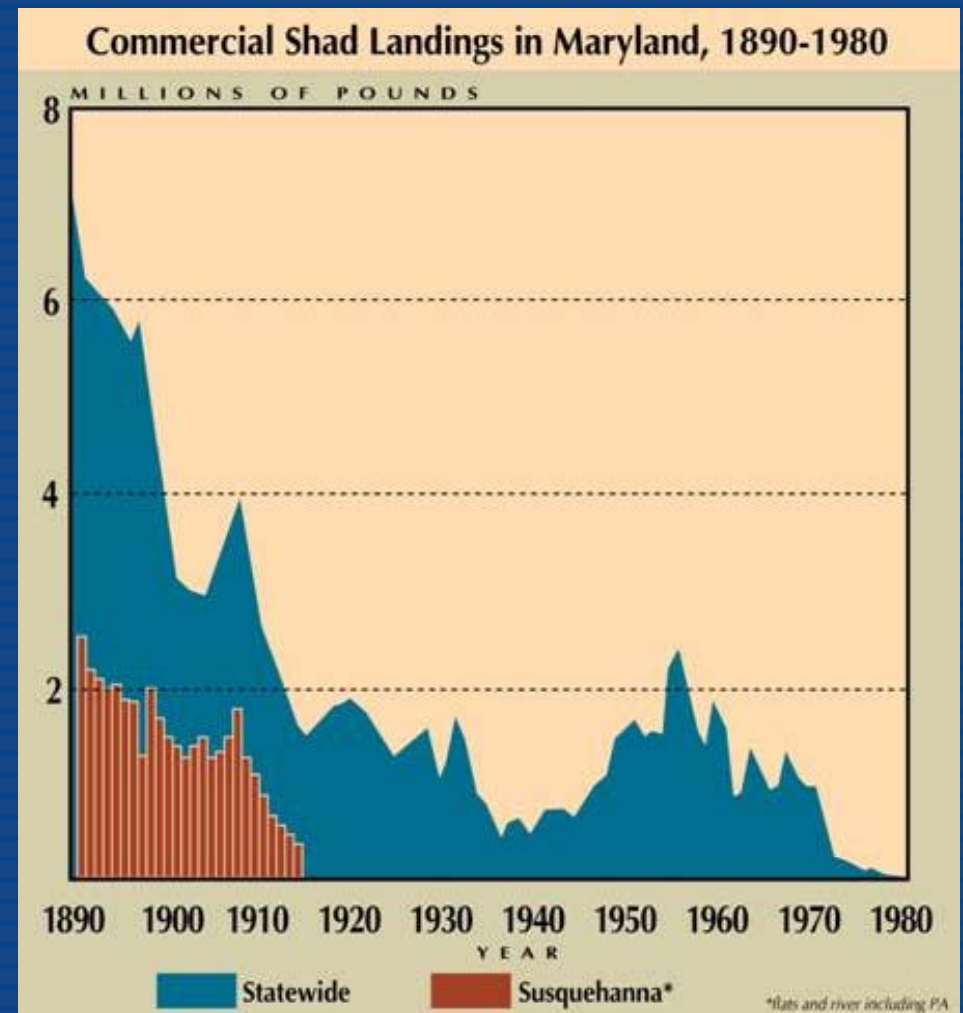
American shad: Population decline



- Unabated fishing
- Degraded water quality
- Loss of access to spawning habitat – DAMS!



Source: Library of Congress



State of the Population: Coast-wide



- ❑ Considered common but declining in abundance
- ❑ Under restoration: PA, MD, VA, DE, NC, NJ, CT, MA, VT, ME
- ❑ Harvest moratorium, Chesapeake Bay, since 1980
- ❑ Harvest moratorium in ocean by ASMFC since 2005
- ❑ Coast-wide stock assessment found stocks at “all-time lows” which “did not appear to be recovering”, and concluded combination of overfishing, pollution and migration impediments as primary causes of continued stock declines (ASMFC, 2007).

State of the Population: PA



- ❑ Delaware River has self-sustaining population with good natural reproduction, adult abundance has been declining since 1990's
- ❑ Schuylkill River seeing increases in shad passage at Fairmount Dam, under restoration
- ❑ Lehigh River saw increases in shad passage at Easton thru 2001, followed by abrupt decline, under restoration
- ❑ Susquehanna River increase in catch at Conowingo Dam thru 2001, followed by declining trend, under restoration



Restoration Measures

- ❑ Culture & Stocking
- ❑ Passage
- ❑ Monitoring
- ❑ Management
- ❑ New Approaches

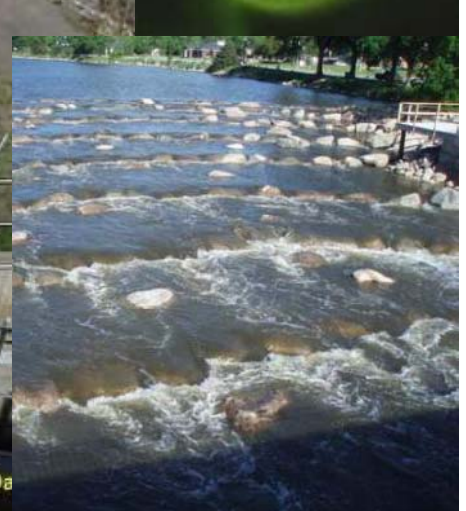


photo by Da



Restoration: Goals

□ Fisheries Restoration Goals

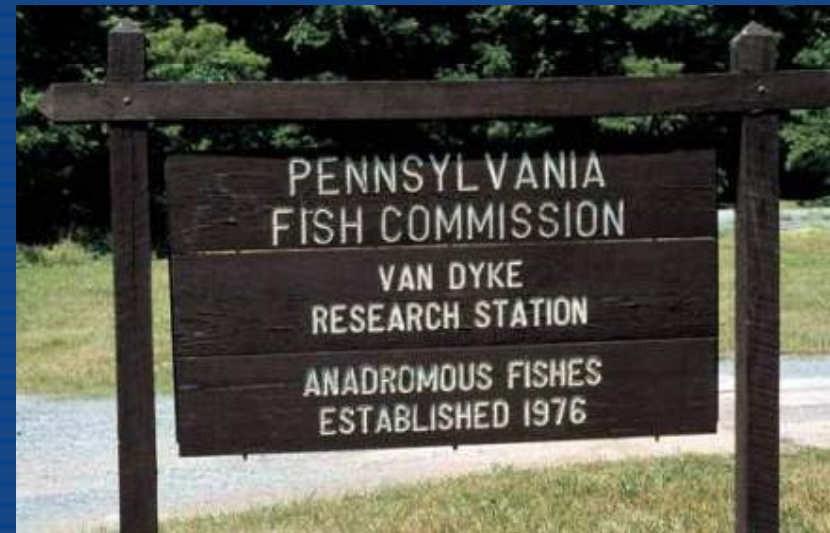
- Since 1985, the PFBC has been actively involved in a hatchery-based effort to restore American shad to the Lehigh and Schuylkill rivers, major tributaries of the Delaware River.
- The restoration goal is to restore and manage American shad for optimum sustainable yield and public benefit. This includes achieving annual spawning runs of 165,000 – 465,000 adult American shad to the Lehigh and Schuylkill rivers, providing 20,000 to 100,000 angler trips with an estimated economic value of \$508,000 to \$2,540,000 annually (PFBC 1988).



Restoration: Culture & Stocking

- Hatchery Production Goal
 - ▣ Develop stocks of shad imprinted to the Susquehanna, Lehigh & Schuylkill drainages, which will subsequently return to their respective rivers & tributaries as spawning adults

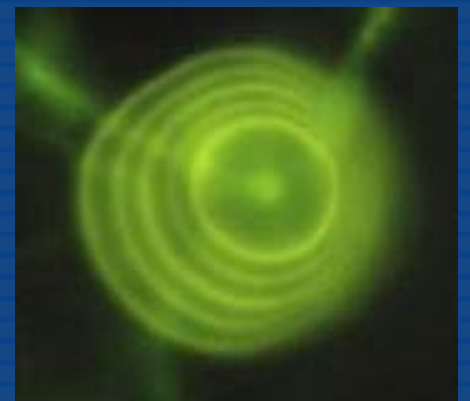
- Annual Production Goals
 - ▣ Stock 10-20 million American shad larvae
 - ▣ Administer hatchery marks on 100% of fry produced





Restoration: Culture & Stocking

- ❑ Brood & egg collection
 - ❑ Strip & tank spawning
 - ❑ Potomac, Susq. & Delaware
- ❑ Hatchery culture
 - ❑ 20-30 day old fry
- ❑ Hatchery marking
 - ❑ OTC immersion of all fry
 - ❑ Track restoration efforts
- ❑ Stocking
 - ❑ Delaware to Lehigh, Schuylkill & Delaware
 - ❑ Potomac & Susquehanna to Susquehanna

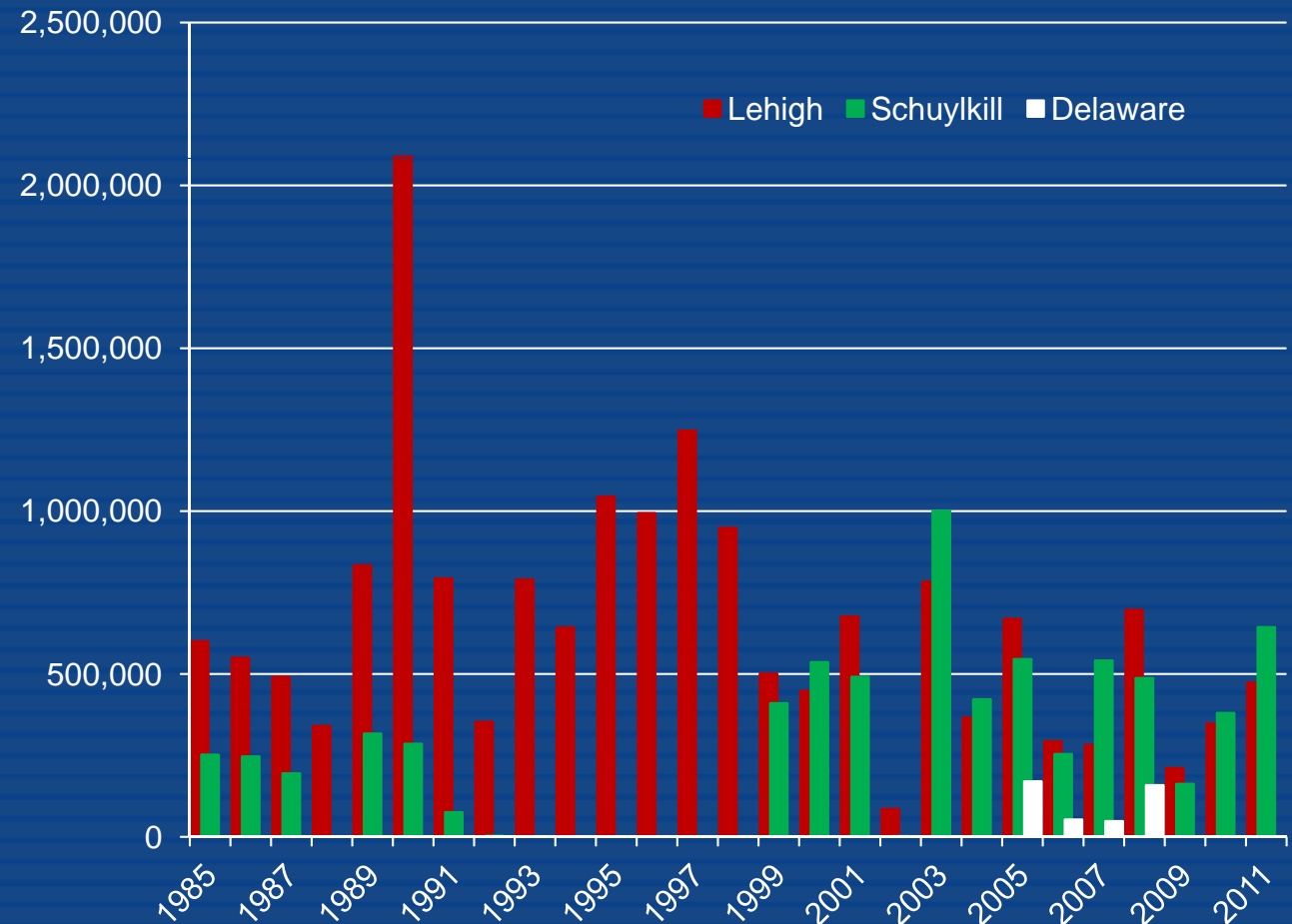




Restoration: Stocking Totals

American shad Larvae Stocked in the Delaware River Basin, 1985-2011

- 25.2 million in Delaware Basin
 - 428,000 Delaware
 - 7.2 million Schuylkill
 - 17.5 million Lehigh





Restoration: Passage

□ Lehigh River – 5 Dams, 3 Fishways

Dam	River Mile	Owner	Fish Passage
Easton	0	DCNR	Vertical slot, observation window, operational and monitoring since 1994, unknown passage efficiency
Chain	3	City of Easton	Vertical slot, observation window, operational and monitoring since 1996, 25% passage efficiency (15-year average)
Hamilton	17	City of Allentown	Vertical slot, not monitored, operational since 1985, unknown passage efficiency
Northampton	24	LeFarge Corporation	No fish passage, for water supply
Francis E. Walter	77.6	USACE	No fish passage, for flood control & recreation



Restoration: Passage

□ Schuylkill River – 11 Dams, 4 Fishways

Dam	River Mile	Owner	Fish passage
Fairmont	9	City of Phila.	Vertical slot fishway, operational 2004, reconstructed 2008, monitored by PDW
Flat Rock	15	DEP	Vertical slot fishway, operational 2006, not monitored, observation window
Plymouth	18	DEP	Removed 2010
Norristown	21	Montgomery County	Denil fishway, operational 2008, not monitored, observation windows
Unknown	33	?	Dam appears to be 2-3 ft high, fish thought to pass during typical spring flows
Black Rock	37	Exelon Energy	Denil fishway, operational 2009, not monitored, observation windows
Vincent	42	DEP	Partial breach, thought to be passable, dam remnants to be removed in future
Titus PP	71	Met-Ed power company	2-3 ft high, breached at N end. Fish passage through breach ok.
Felix	79	DEP	Removed 2007
New Kernsville	100	DEP	will remain in place for de-silting project, no plans for fish passage
Auburn	111	DEP	will remain in place for de-silting project, no plans for fish passage



Restoration: Monitoring

□ Methods

- ▣ Adults via Electrofishing, seining, egg collection, fishway counts and otolith analysis
- ▣ Juveniles via seining, striped bass recruitment survey

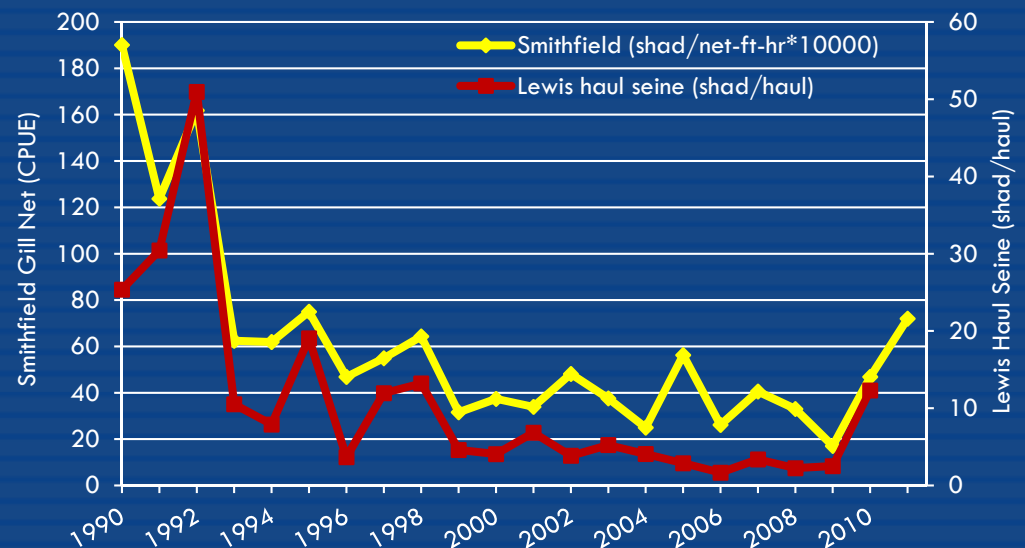
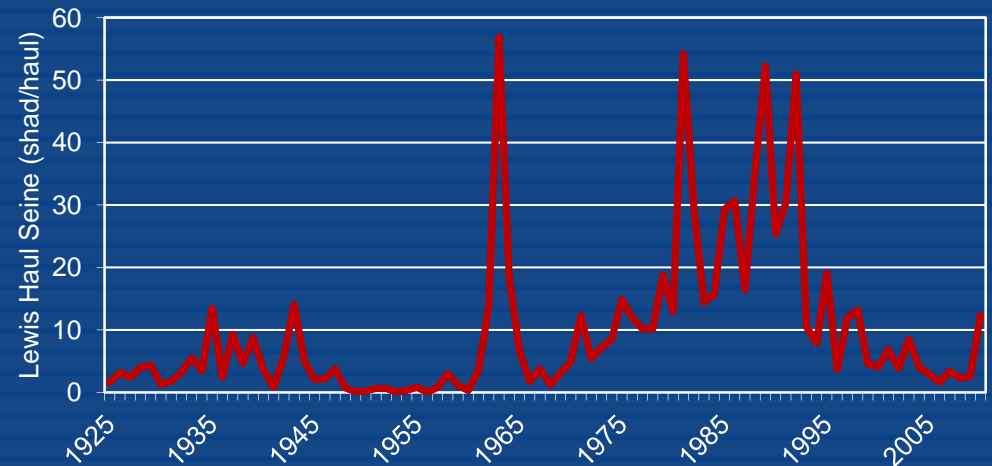




Restoration: Monitoring

□ Delaware River:

- Adult abundance peak in late 1980's & early 1990's, has declined since then
- Lewis haul seine & Smithfield gill net data show similar trends, 1990-2011
- PFBC concludes an unknown source of ocean mortality is depressing adult abundance.



Source: PFBC, New Jersey Division of Fish, Game & Wildlife, The Delaware River Basin Fish & Wildlife Management Cooperative

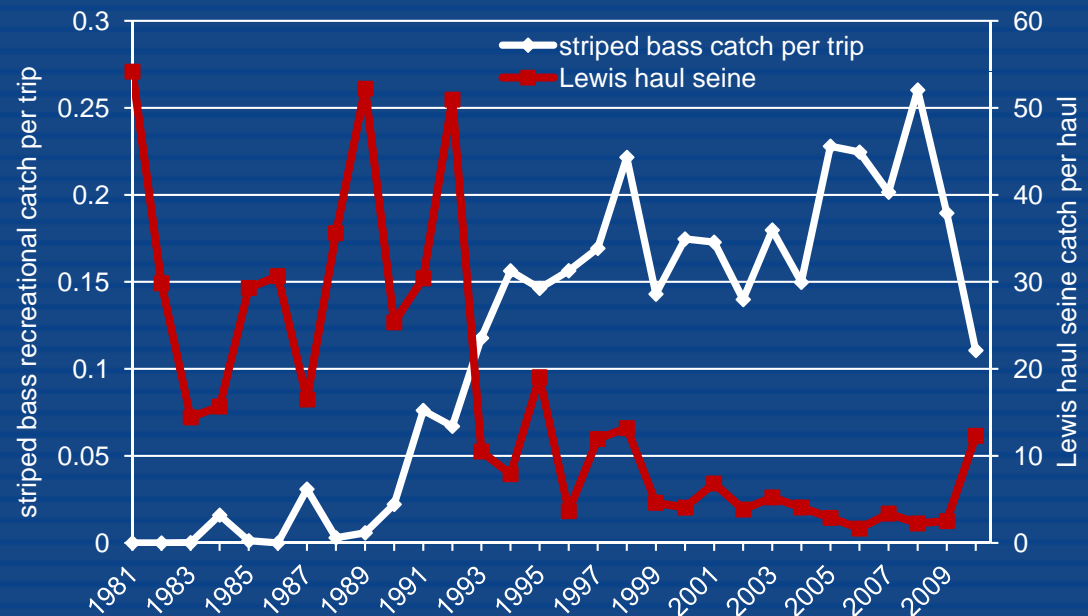


Restoration: Monitoring

□ Hypothesized sources of increased adult mortality:

- Predation by abundant population of striped bass
- Incidental harvest of shad in an offshore fishery, perhaps mid-water trawl fishery in the North Atlantic

Delaware-wide Striped Bass Recreational Catch per Trip & Lewis Haul Seine Catch per Haul, 1981-2010

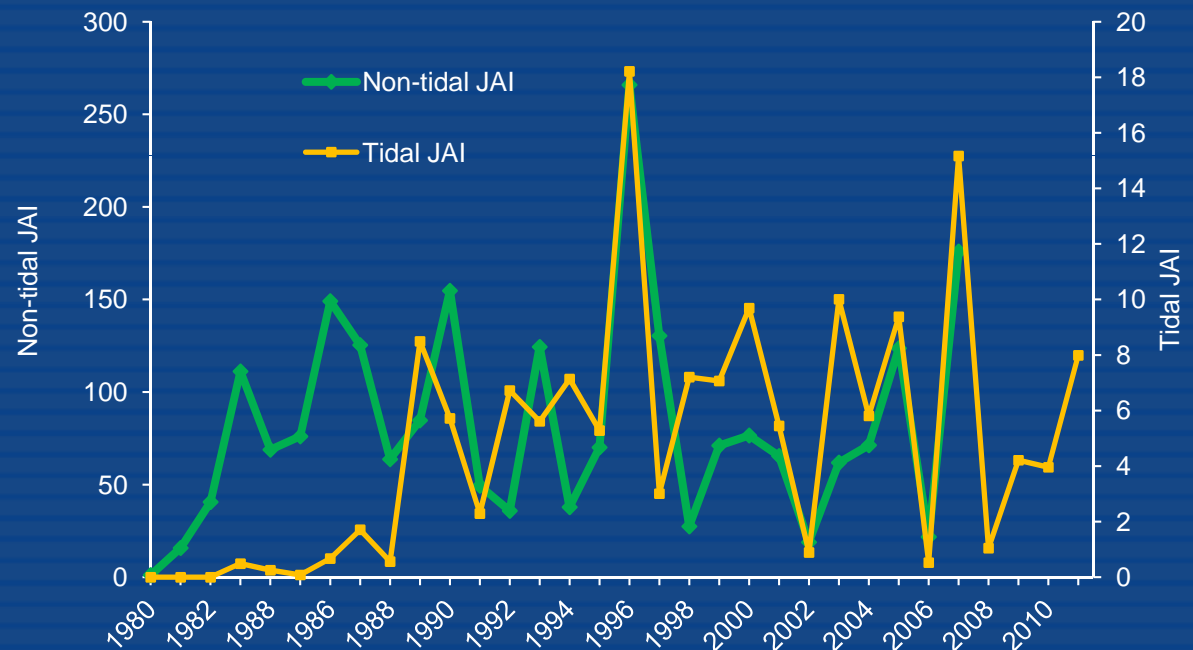


Source: Delaware Division of Fish & Wildlife, New Jersey Division of Fish, Game & Wildlife, The Delaware River Basin Fish & Wildlife Management Cooperative



Restoration: Monitoring

- JAI Delaware River:
 - JAI indicator of reproductive success:
 - Varies w/o trend
 - Strong '05 & '07 year-classes coupled with favorable environmental conditions expected to aide in rebuilding stock



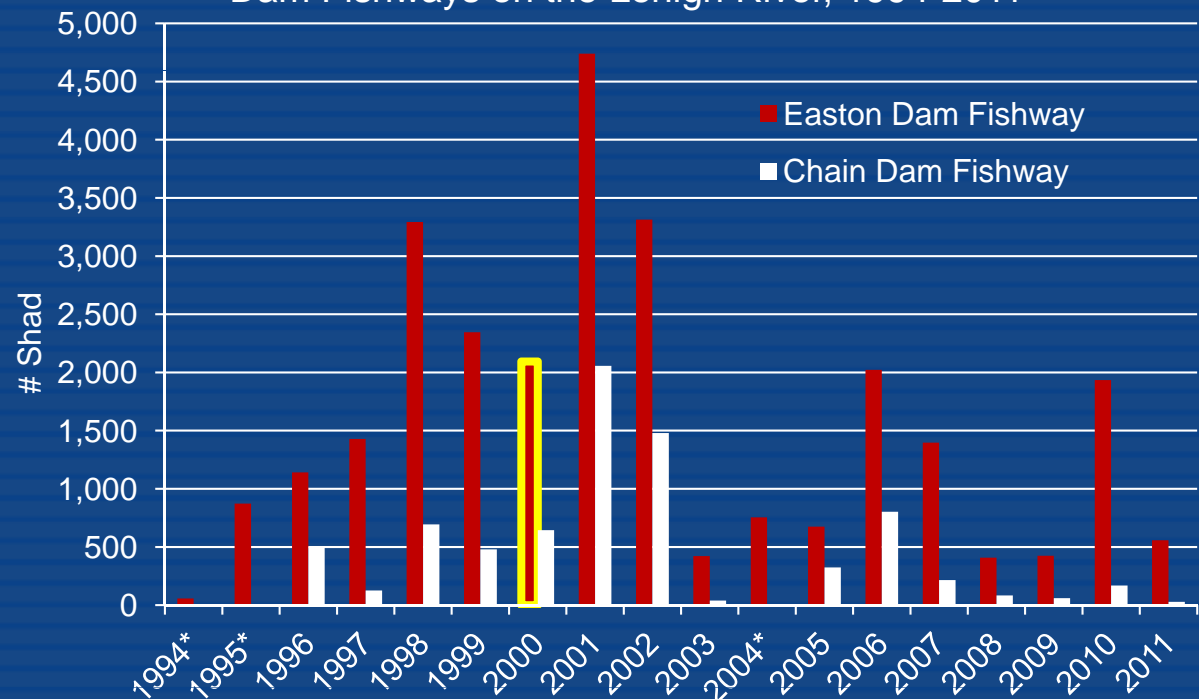
Source: Delaware Division of Fish & Wildlife, New Jersey Division of Fish, Game & Wildlife, The Delaware River Basin Fish & Wildlife Management Cooperative



Restoration: Monitoring

- Lehigh River passage
 - Vertical slot fishway at Easton & Chain, 1994
 - Vertical slot Hamilton St, 1984
 - Increase in shad passage through 2001
 - Followed by sharp decline with no appreciable rebound

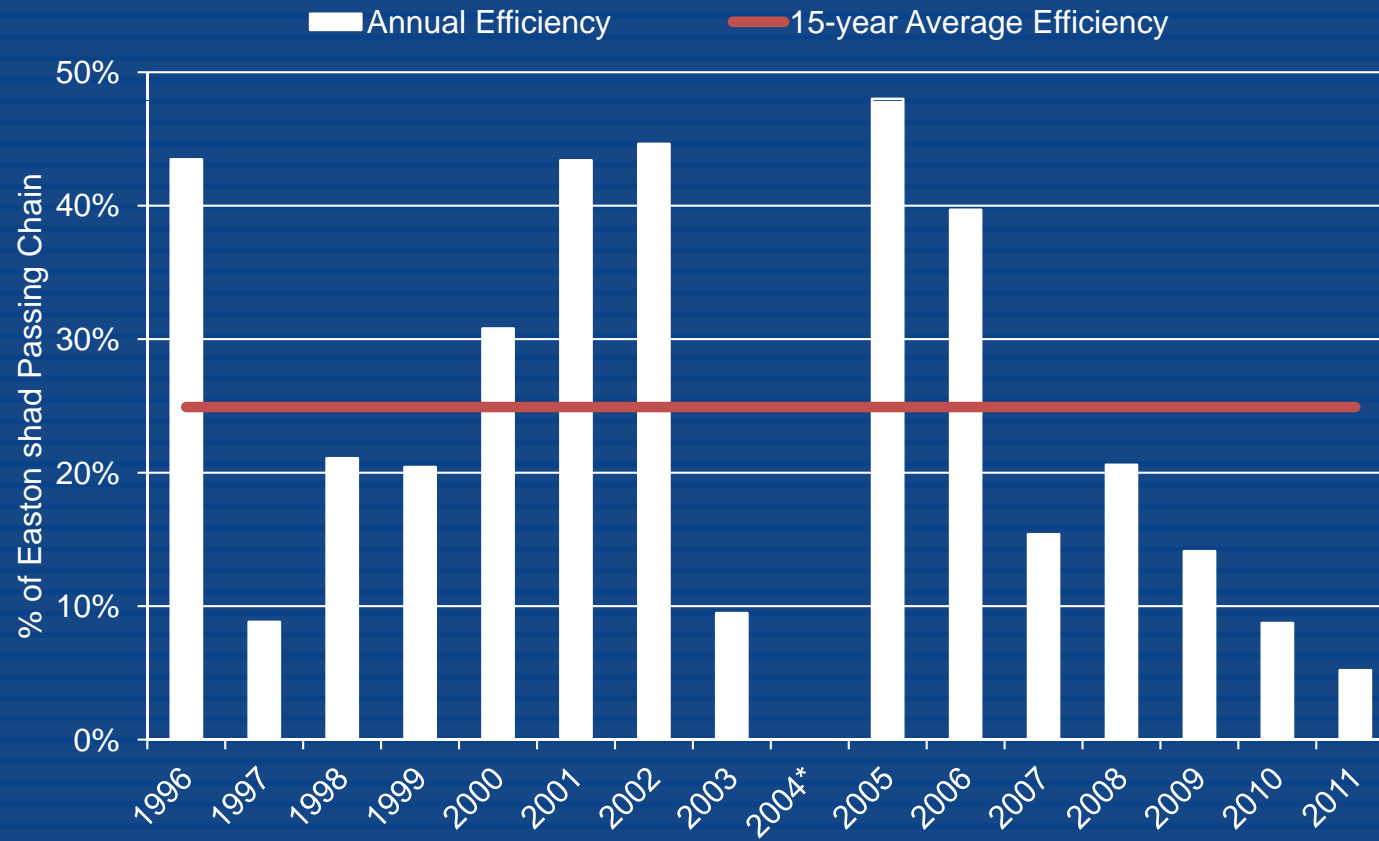
American shad Passage Through the Easton & Chain Dam Fishways on the Lehigh River, 1994-2011





Restoration: Monitoring

American shad Passage Efficiency at Chain Dam, Lehigh River 1996-2011



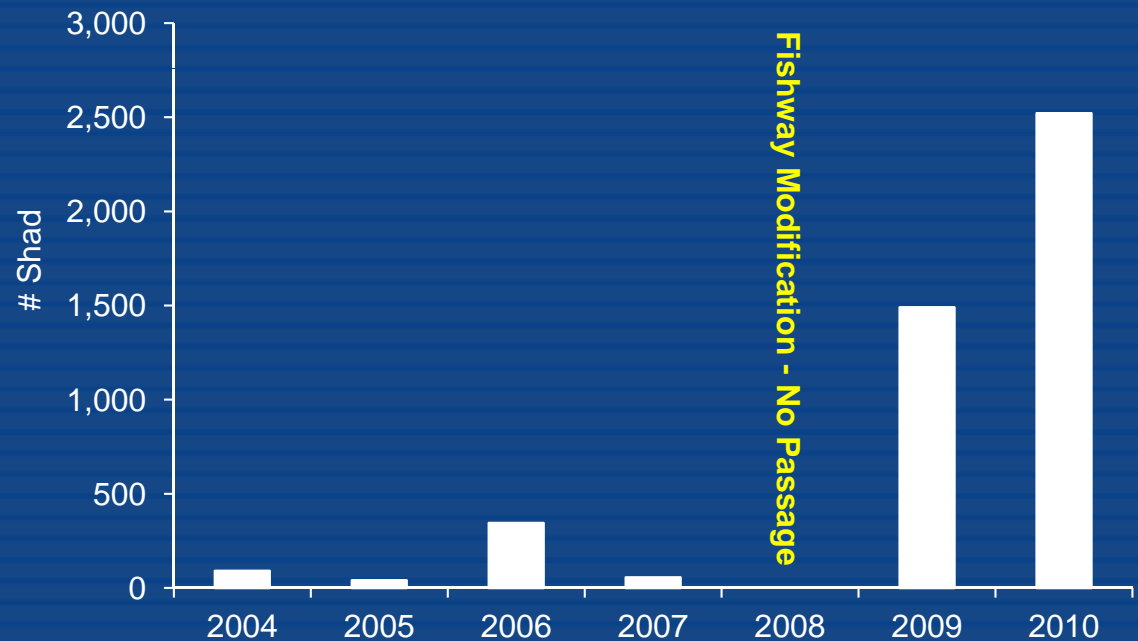


Restoration: Monitoring

□ Schuylkill River passage

- Fairmount Fishway operational 1979, abandoned 1984
- 2002 PWD takes responsibility for O&M
- Increasing trend following fishway improvements

American shad Passage Through Fairmount Dam Fishway, 2004-2010



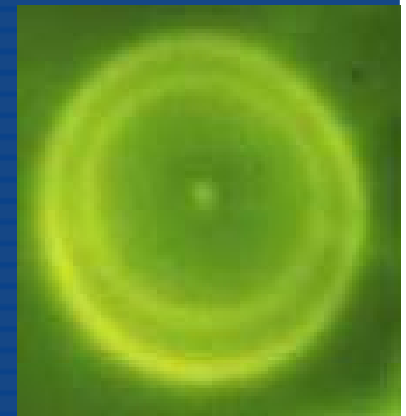
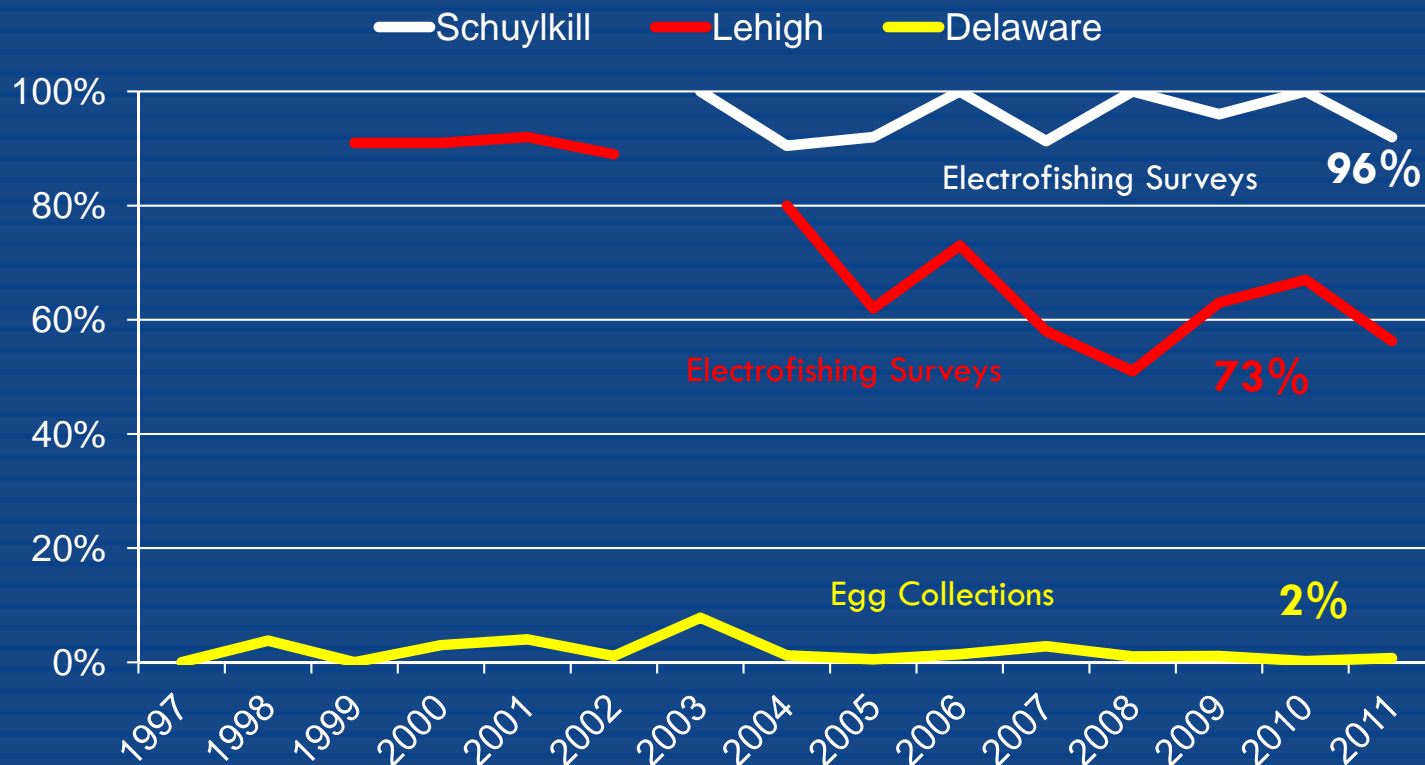
SOURCE: J. Perillo, Philadelphia Water Department Archives



Restoration: Monitoring

Adult shad Otolith Analysis – Hatchery or Wild

Percent of Collected American shad Exhibiting Hatchery OTC Marks, 1997-2011





Restoration: Management

□ Management Plans

- Delaware River Management Plan, 2011
- Lehigh River Management Plan, 2007
- Revised strategic fishery management plan for American shad restoration in the Schuylkill and Lehigh River Basins, 1988
- Delaware River Sustainable Fishing Plan for American Shad, 2011



Restoration: Management

- Recreational Angling Creel Limits:
 - Lehigh: 1 /day, catch & release 2013
 - Schuylkill: 1 /day, catch & release 2013
 - Delaware: 3/day, reduced from 6/day in 2009
- Commercial Harvest:
 - PA & NY do not permit commercial harvest in Delaware
 - DE & NJ allow commercial harvest w/ restrictions on season, gear, location and mandatory reporting



Restoration: New Approaches

- ❑ Lehigh fish passage feasibility study
- ❑ Experimental tank spawning
- ❑ Nature-Like fishways
- ❑ American shad Amendment to PA SWAP



Restoration: New Approaches

- Improve Lehigh River fish passage: Feasibility Analysis
 - Assess water supply needs: historic canals, recreation
 - ID impacts to existing infrastructure & recreation w/ full or partial removal at Easton & Chain dams
 - ID alternative methods & costs to supply water w/ full or partial removal at Easton & Chain dams
 - ID & evaluate impacts to localized hydrology
 - Provide conceptual designs for: dam removal, partial dam removal with rock ramp fishway and associated changes to water supply infrastructure

- Project Status:
 - Grant awarded to Wildlands Conservancy
 - Contractor selected August 2011, projected completion fall/winter 2012



Restoration: New Approaches

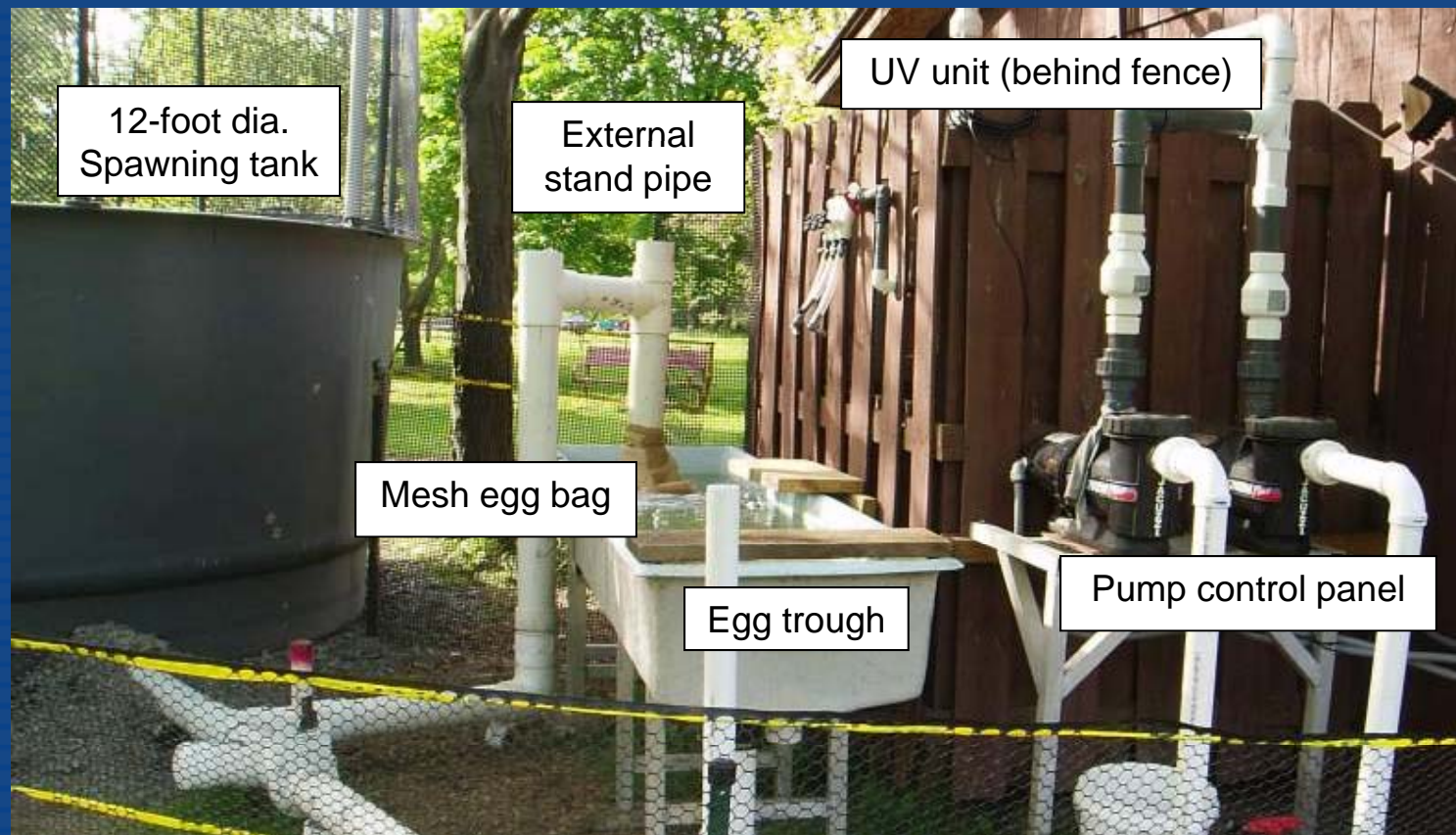
- USFWS Pilot Tank Spawning Project, 2011
 - ▣ Location: Hugh Moore Park, Easton
 - ▣ Year 1: Determine feasibility & logistics of tank spawning American shad from Delaware River w/o hormones & using ambient temperature water from Lehigh Canal





Restoration: New Approaches

□ Tank Spawning System Components:

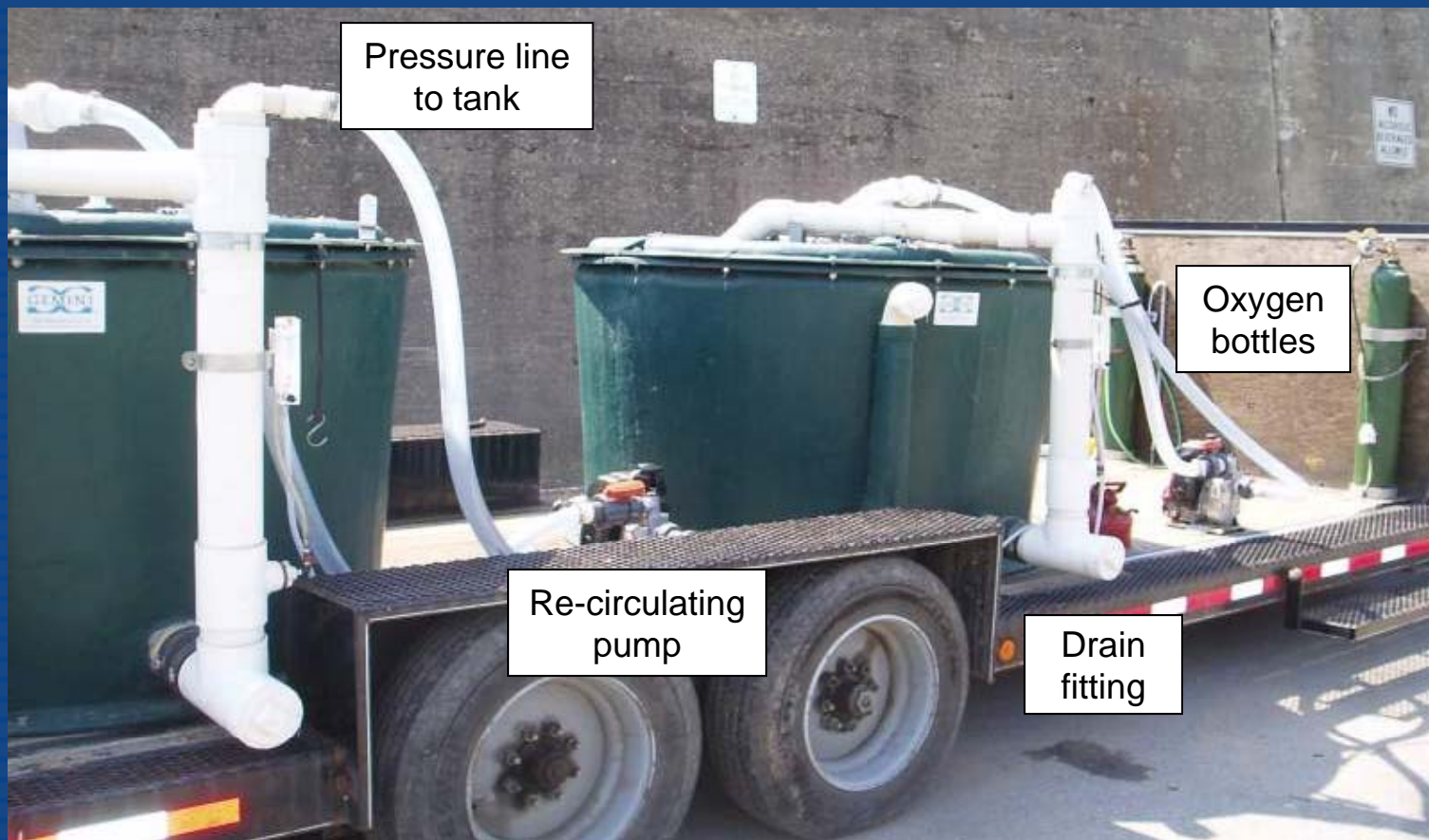


SOURCE: J. Mohler, USFWS



Restoration: New Approaches

□ Tank Spawning Transport Trailer:



SOURCE: J. Mohler, USFWS



Restoration: New Approaches

- Year 1 Pilot Tank Spawning Results:
 - 12 Male & 21 Female via EF & angling (1:2 M:F)
 - 15L eggs (800,000) in 21d w/ <10% egg viability
 - 94% adult survival, returned to Delaware
 - Many females w/swollen abdomens - egg retention

- Year 2 – Refine Techniques based on 2011 results
 - Improve M:F ratio to 3:2 minimum
 - Roof tank to limit tree debris
 - Improve plumbing to incubation jars

Restoration: New Approaches



- Nature-Like Fishways (Dr. L. Aadland, MN DNR)
 - Designed to emulate morphology, hydraulics & functions of natural rivers
 - Fish pass natural river features, will pass nature-like fishways if morphology & hydraulics are similar
 - Accommodate all migrating species all of the time (fish, reptiles, amphibians, mammals & invertebrates)
 - Provide quality aquatic habitat
 - No required operation or maintenance
 - Large enough to prevent bottlenecks, elevated predation losses and disease transmission

Restoration: New Approaches

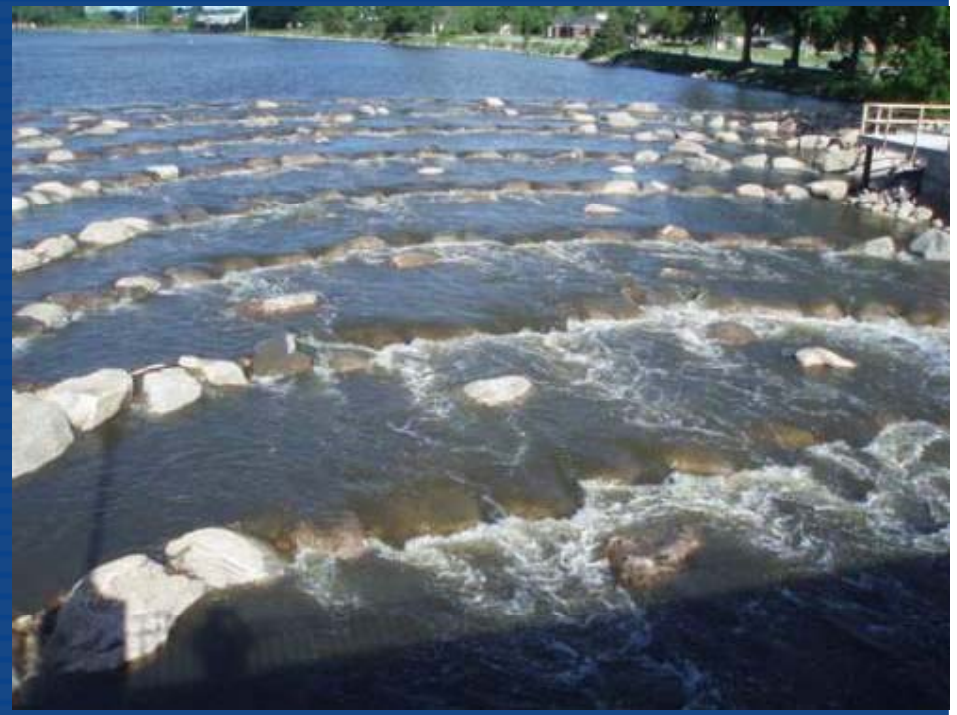


□ Nature-Like Fishways continued:

Hutchinson Dam, MN

Before

After



SOURCE: L. Aadland, MN DNR

Restoration: New Approaches



- Nature-Like Fishways continued:
 - Advantages over technical fishways:
 - Pass full spectrum of aquatic species
 - Provide important habitat
 - Relatively low installation cost (site specific)
 - Little to no O&M costs
 - Disadvantages:
 - May require more space especially at high dams
 - More difficult to monitor (no observation/counting windows)

Restoration: New Approaches



- ❑ Why Nature-Like Fishways?
 - ❑ Technical fishways tend perform poorly
 - ❑ Entrained air & excessive turbulence
 - ❑ Attraction flow difficult to locate
 - ❑ Technical fishways tend to delay timely passage
 - ❑ Crowding by other fish may deter shad
 - ❑ Technical fishways are expensive to design, build, O&M



Restoration: New Approaches



- Planned Nature-Like Fishway in PA
 - Sunbury Inflatable Dam, Susquehanna River



Restoration: New Approaches



- Proposed addition of Am. shad to PA State Wildlife Action Plan
 - Why include in PA SWAP?
 - PA one of few states that does not list Am. shad as a SGCN in SWAP
 - Recognized as vulnerable species due to restricted range, widespread declines & other factors making it susceptible to extirpation
 - Further, listed as SGCN in ME, VT, MA, RI, CT, NY, MD, DC, VA, SC, FL
 - Anticipated outcomes:
 - Highlight potential of American shad as a bellwether of ecosystem health – indicating status of connectivity and environmental quality of watersheds and coastal oceans (USFWS)
 - Provide flexibility to fund and receive funding for continued and new restoration initiatives
 - Amendment pending USFWS review

Summary



- Fish passage efficiency remains the number one issue preventing shad restoration in the Susquehanna, Lehigh and Schuylkill Rivers.
 - ▣ Fish must find, enter, ascend and pass fishways without delay and turning back

- American shad restoration requires cooperative efforts which embrace adaptability, foster new ideas and implement timely solutions

Summary



□ PFBC committed to shad restoration

□ PFBC staff involvement

- Exec. Director (1)
- Fisheries Bureau Director (1)
- Fisheries Management (9)
- Fish Production Services (3)
- Environmental Services (4)
- Habitat Management (3)
- Policy and Planning (4)
- Office of Chief Counsel (1)
- Plus numerous seasonal employees, WCO, etc.

□ Cooperative partnerships:

- DRBFWMC
- SRAFRC
- USFWS
- MDNR
- NYDEC
- NJDFW
- DEDFW
- NMFS
- NOAA
- ASMFC
- PWD
- SRBC
- PA DEP
- PA DCNR
- PGC
- CBF
- Conservation Districts
- Municipalities
- Cities
- Sportsmen's Clubs
- NGOs /Non-Profits
- Power Companies
- Universities
- Etc.

Summary



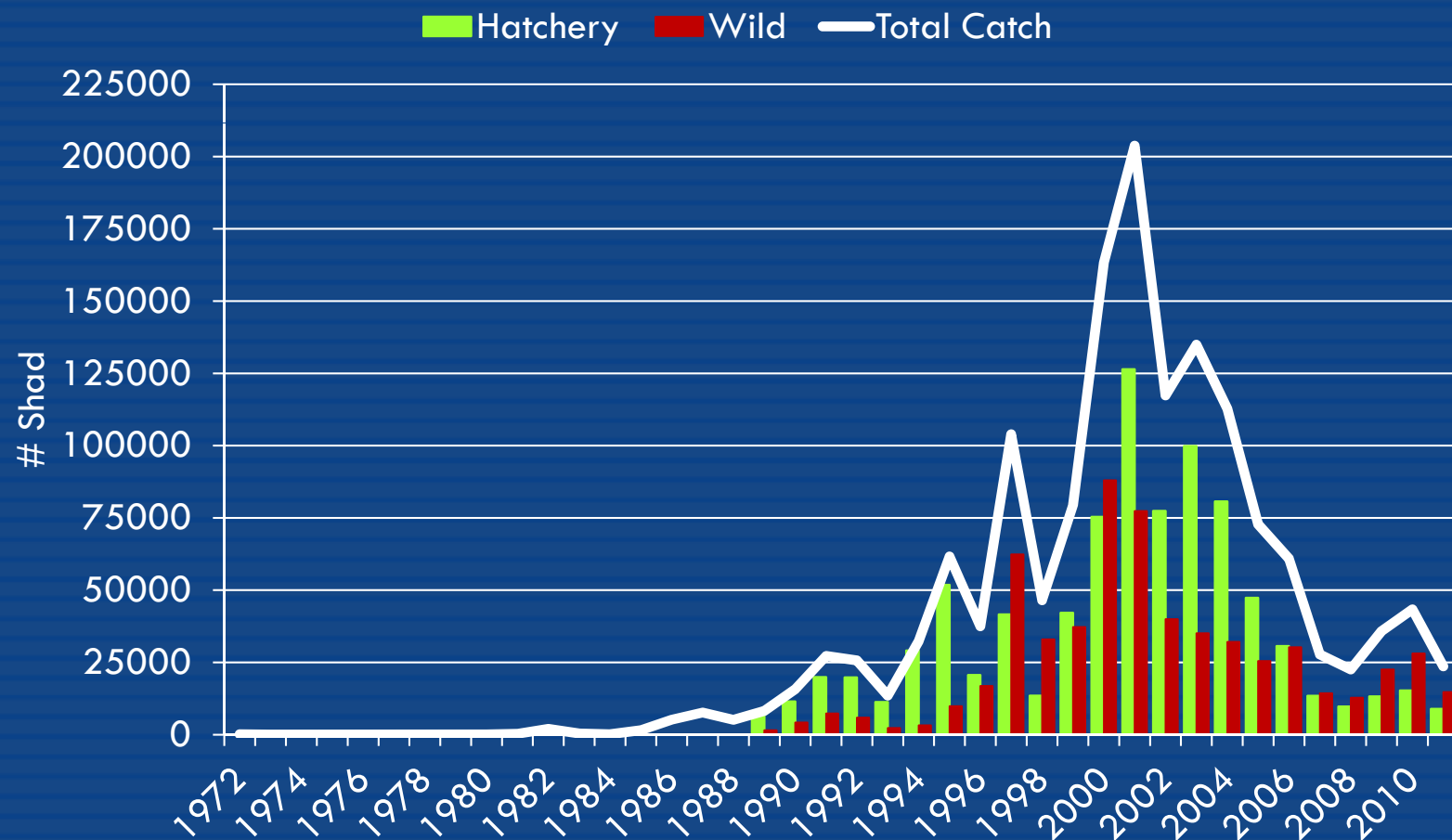
- ❑ Shad management is **COMPLEX**
 - ❑ Competing uses for river resources
 - ❑ Passage obstructions & inefficiencies
 - ❑ Environmental variables:
 - water quality, quantity, flows
 - ❑ Predation: rivers, estuaries, ocean
 - ❑ Targeted & non-targeted harvest
 - ❑ Recreational harvest
 - ❑ Annual variations in run strength





Restoration: Monitoring

Total Annual American shad Catch at Conowingo Dam, Susqueahhna River, 1972-2011





Restoration: Monitoring

Year	Number				Percent			
	Conowingo (rkm 16.1)	Holtwood (rkm 39.6)	Safe Harbor (krm 51.7)	York Haven (rkm 90.3)	Holtwood	Safe Harbor	York Haven	Combined
1997	90,971	28,063	20,828		31%	74%		
1998	39,904	8,235	6,054		21%	74%		
1999	69,712	34,702	34,210		50%	99%		
2000	153,546	29,421	21,079	4,687	19%	72%	22%	3%
2001	193,574	109,976	89,816	16,200	57%	82%	18%	8%
2002	108,001	17,522	11,705	1,555	16%	67%	13%	1%
2003	125,135	25,254	16,646	2,536	20%	66%	15%	2%
2004	109,360	3,428	2,109	219	3%	62%	10%	0%
2005	68,926	34,189	25,425	1,772	50%	74%	7%	3%
2006	56,899	35,968	24,929	1,913	63%	69%	8%	3%
2007	25,464	10,338	7,215	192	41%	70%	3%	1%
2008	19,914	2,795	1,252	21	14%	45%	2%	0%
2009	29,272	10,896	7,994	402	37%	73%	5%	1%
2010	37,757	16,472	12,706	907	44%	77%	7%	2%
Total	1,128,435	367,259	281,968	30,404	33%	72%	10%	2%



Restoration: Passage

□ Fairmount Upgrades

- Increase attraction flow
- Increase width of vertical slots and entrance
- Decrease pool-pool slope
- Installation of automated weir gate at entrance to control water surface level changes with tides
- Institute thorough O&M

SOURCE: J. Perillo, PWD





American Shad



Hickory Shad

Gizzard Shad



Herring



Photos: www.fletcherscove.com