Jun 7th, 11:50 AM - 11:30 AM

Session B7 - York Haven Shad Migration: Which Way Did They Go?

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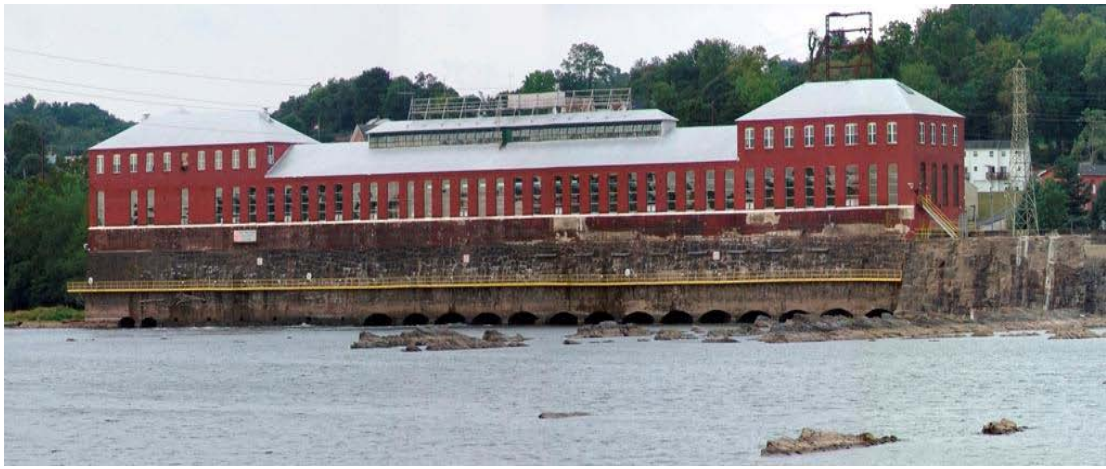
York Haven Shad Migration

Which Way Did They Go?



Stephen Arnold, HDR Engineering, Inc., Portland, ME
Douglas Royer, Normandeau Associates, Inc., Drumore, PA

June 7, 2012

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Study Goals

- The primary goal of the study was to assess the efficiency of the East Channel fishway for American shad upstream passage

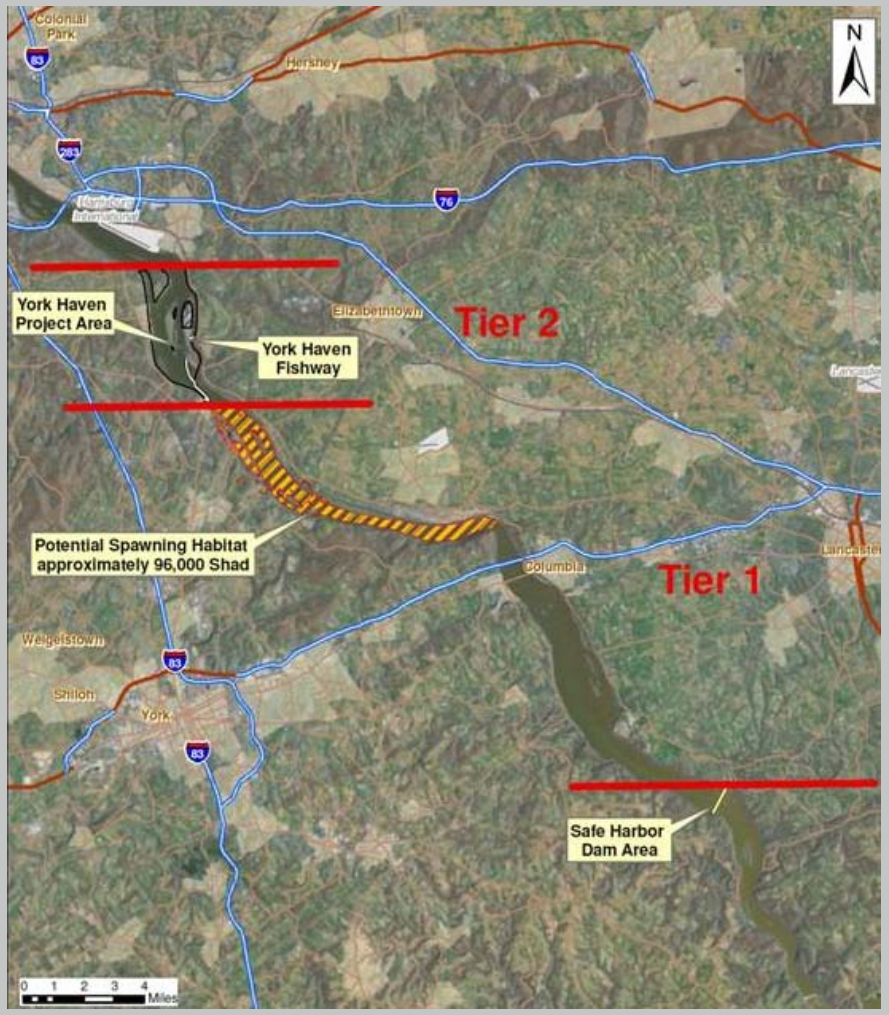
- This goal was broken down into two tiers:
  - Tier 1: determine migration efficiency from Safe Harbor Dam to York Haven Dam
  - Tier 2: assess movements, behavior, and upstream passage efficiency of shad after they arrive at York Haven

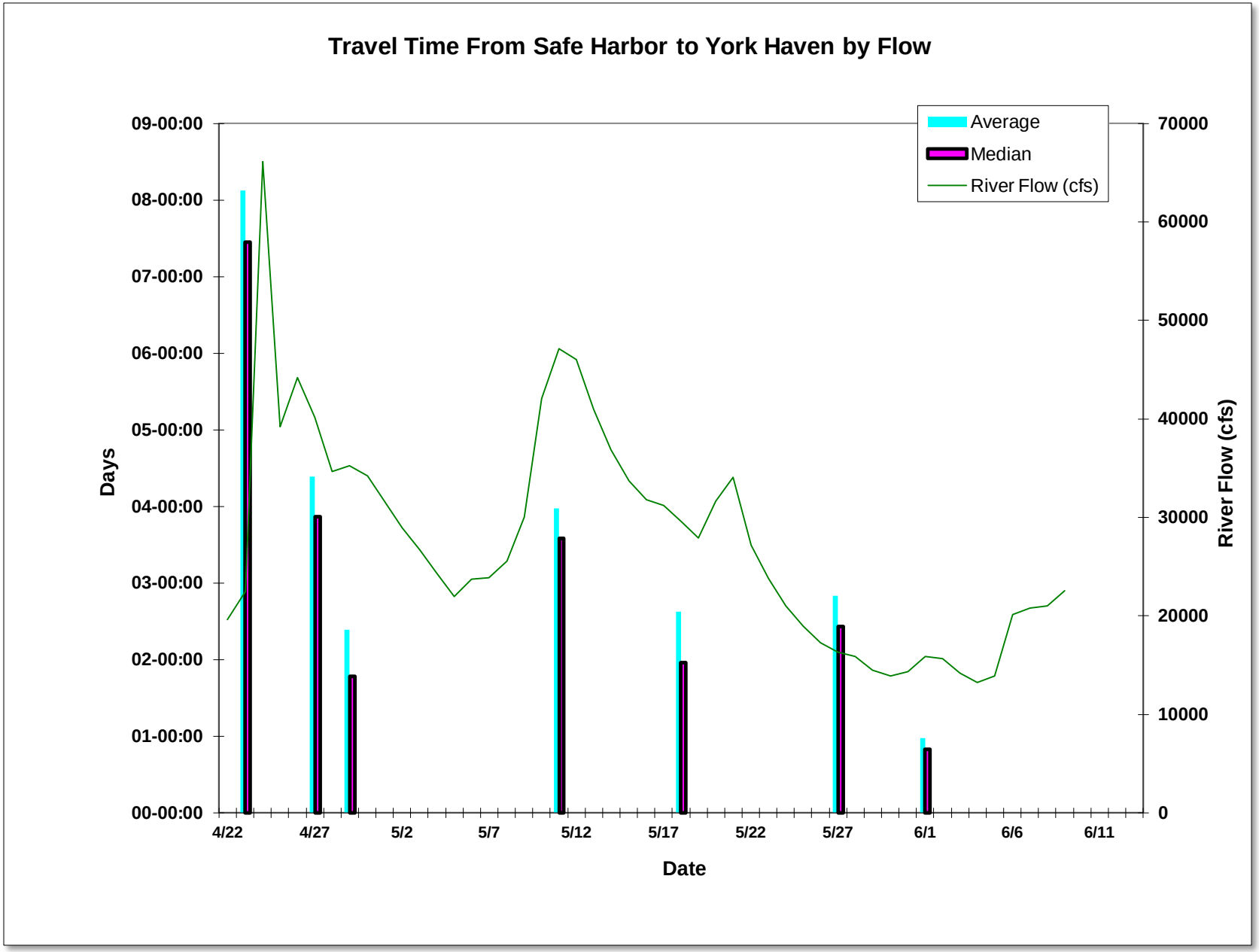
Study Setup

- Total of 17 monitoring stations and 21 antenna zones were installed from Safe Harbor tailrace to above York Haven Dam
- Upstream migration monitoring spanned the entire spawning season of April 23 through June 15, 2010
- American shad were tagged and released in six groups spanning the early to middle portions of spawning season

Tier 1 Results

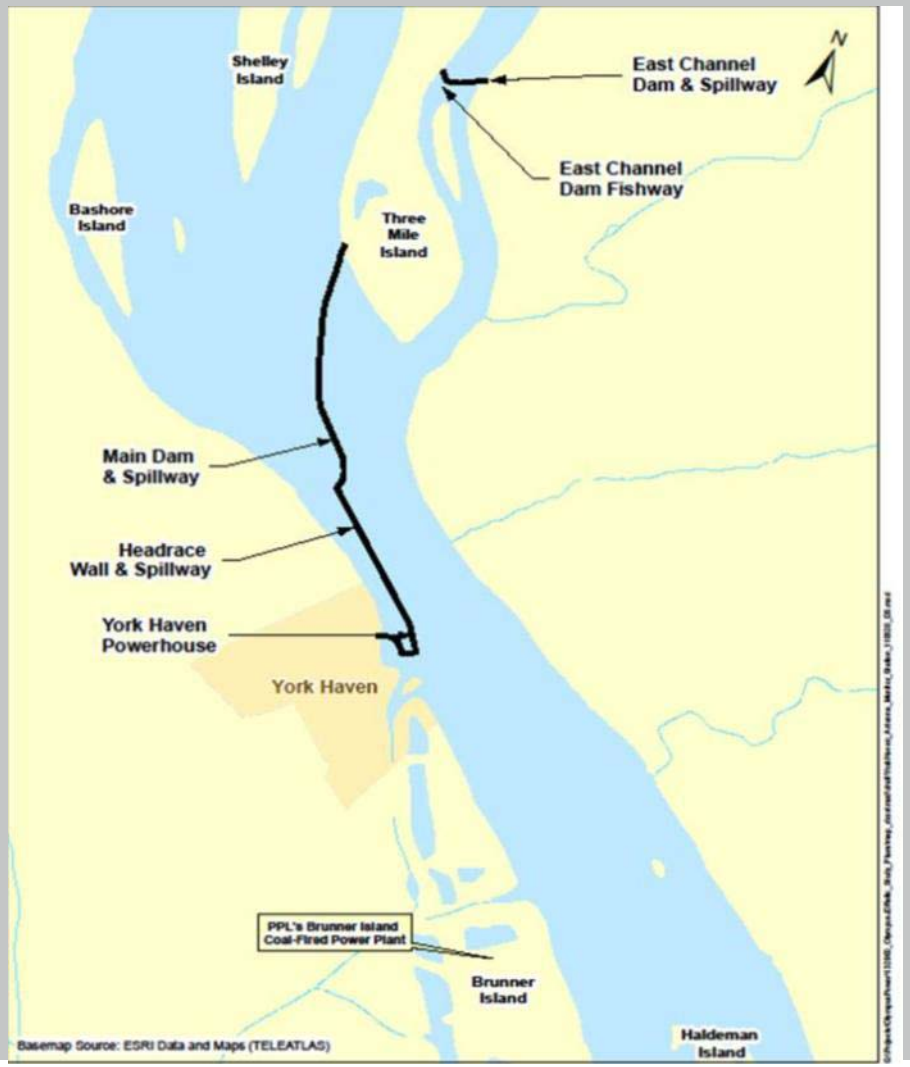
- 180 tagged shad left Safe Harbor Dam
- 127 shad arrived at York Haven Project
- 70 % migration efficiency over the 26 river-miles between dams




Travel Time From Safe Harbor to York Haven by Flow
Average
Median
River Flow (cfs)
09-00:00
08-00:00
07-00:00
06-00:00
05-00:00
04-00:00
03-00:00
02-00:00
01-00:00
00-00:00
Days
70000
60000
50000
40000
30000
20000
10000
0
River Flow (cfs)
4/22
4/27
5/2
5/7
5/12
5/17
5/22
5/27
6/1
6/6
6/11
Date

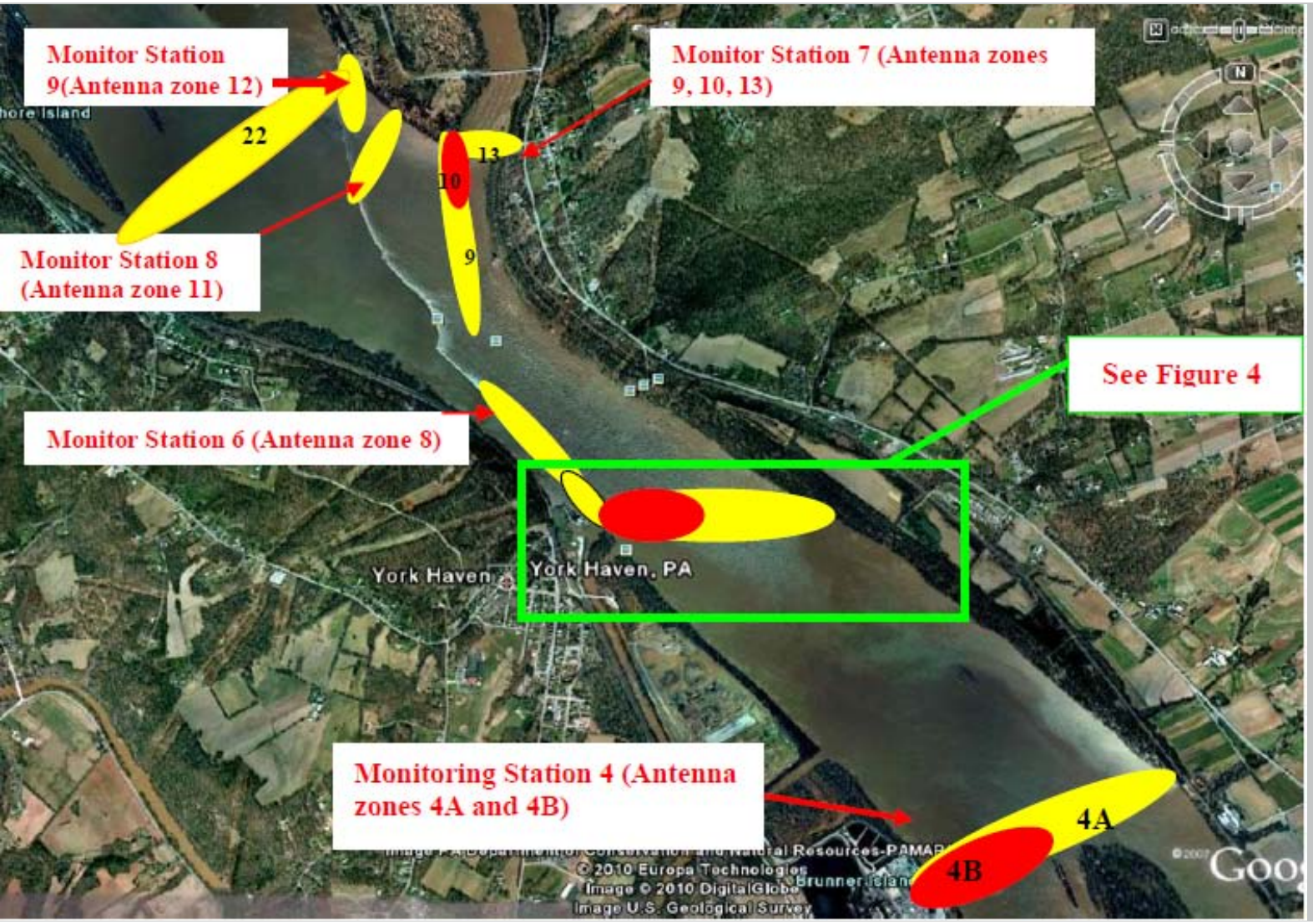
York Haven
Tier 2 Analysis

York Haven Project Layout



York Haven Project Layout

Main Channel – Antenna Location



Remote Monitoring Station locations in the vicinity of the Project

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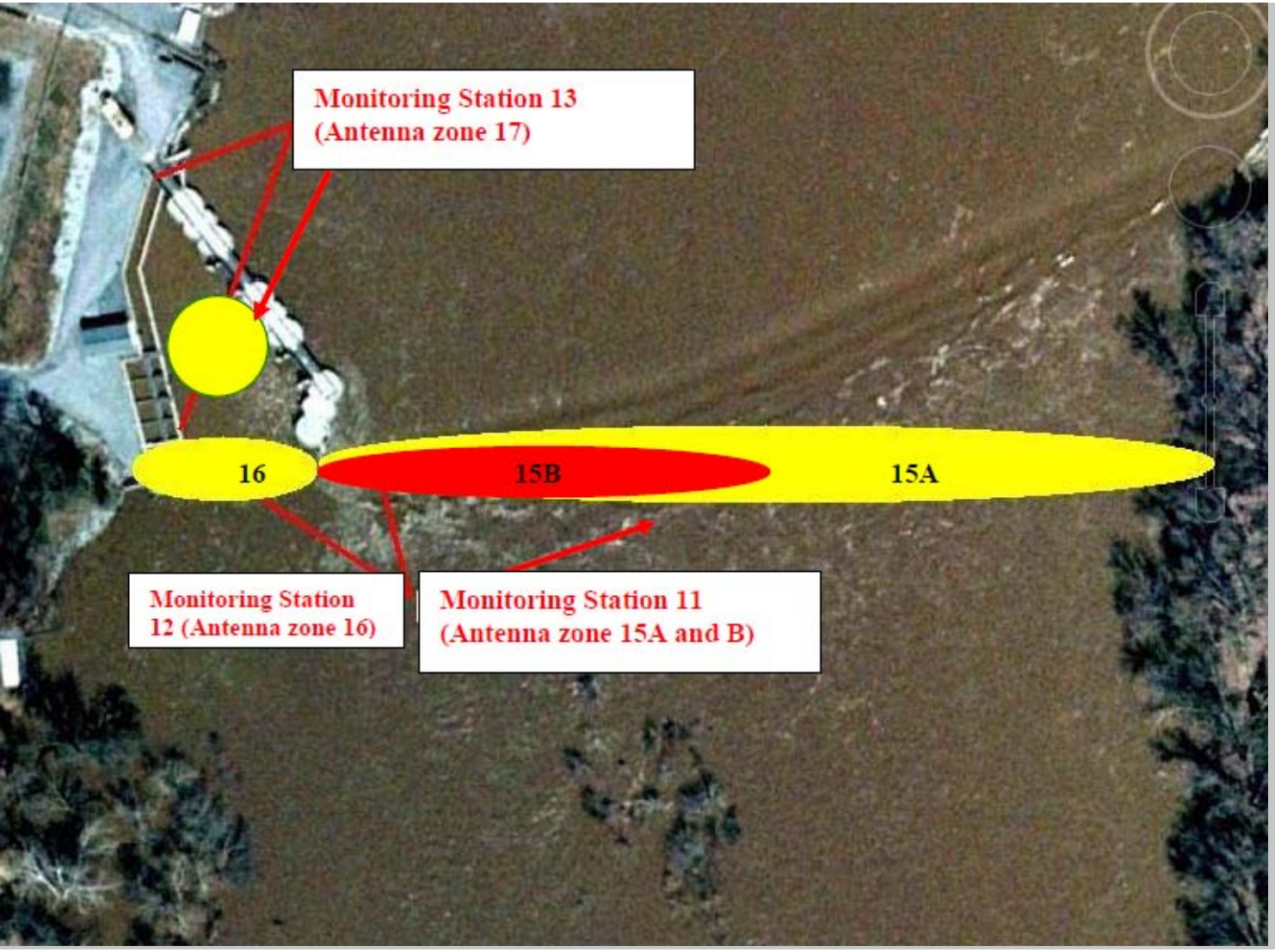
York Haven Project Layout

East Channel Dam and Fishway

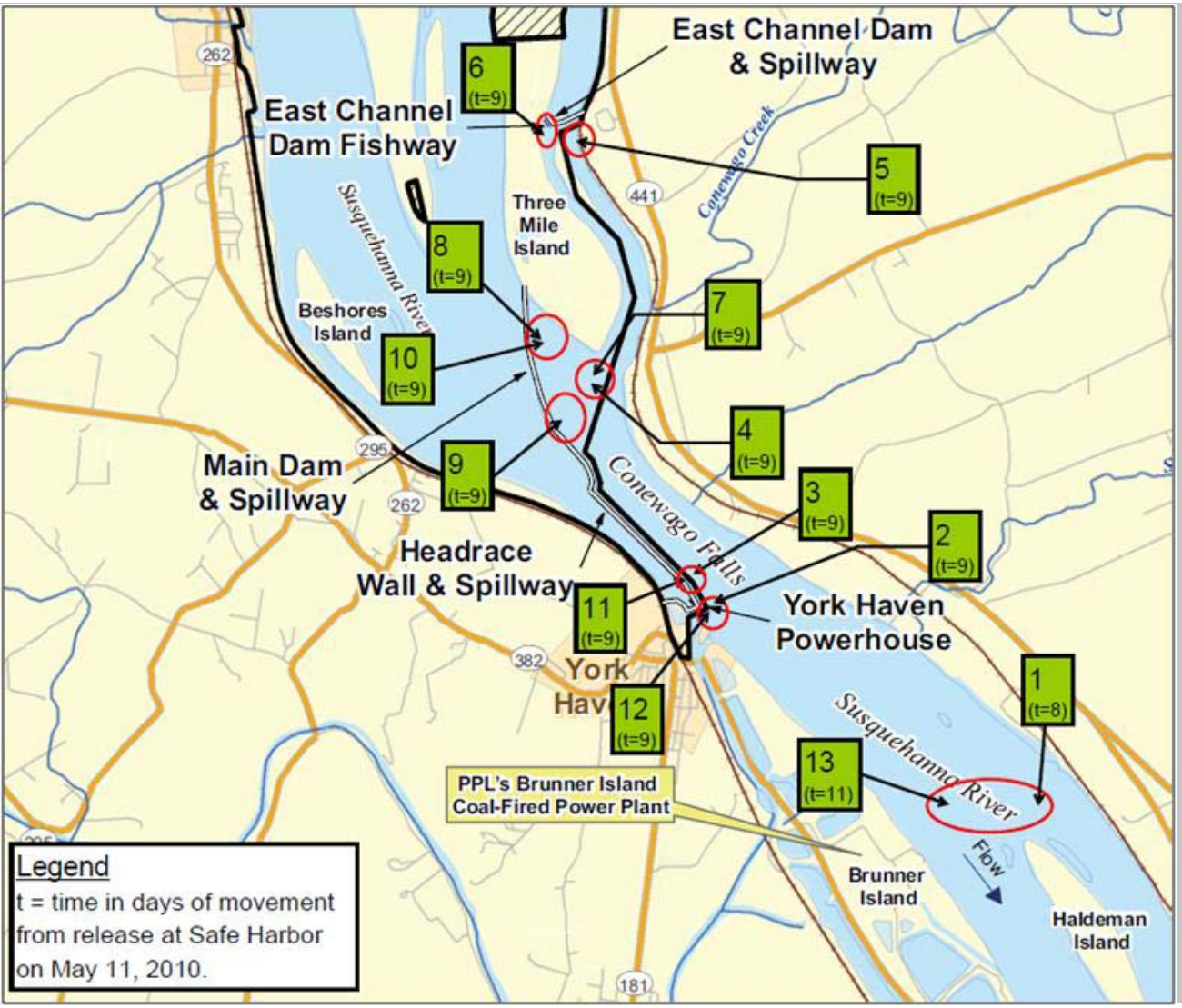


Data Analysis Methods

- Massive Database
  - 59,779 cumulative hours of monitoring
  - Over 750,000 shad detection records
- Two levels of data analysis
  - Interpretation of Distinct Movements (Relocation)
  - All Detections (Residency & Behavior)

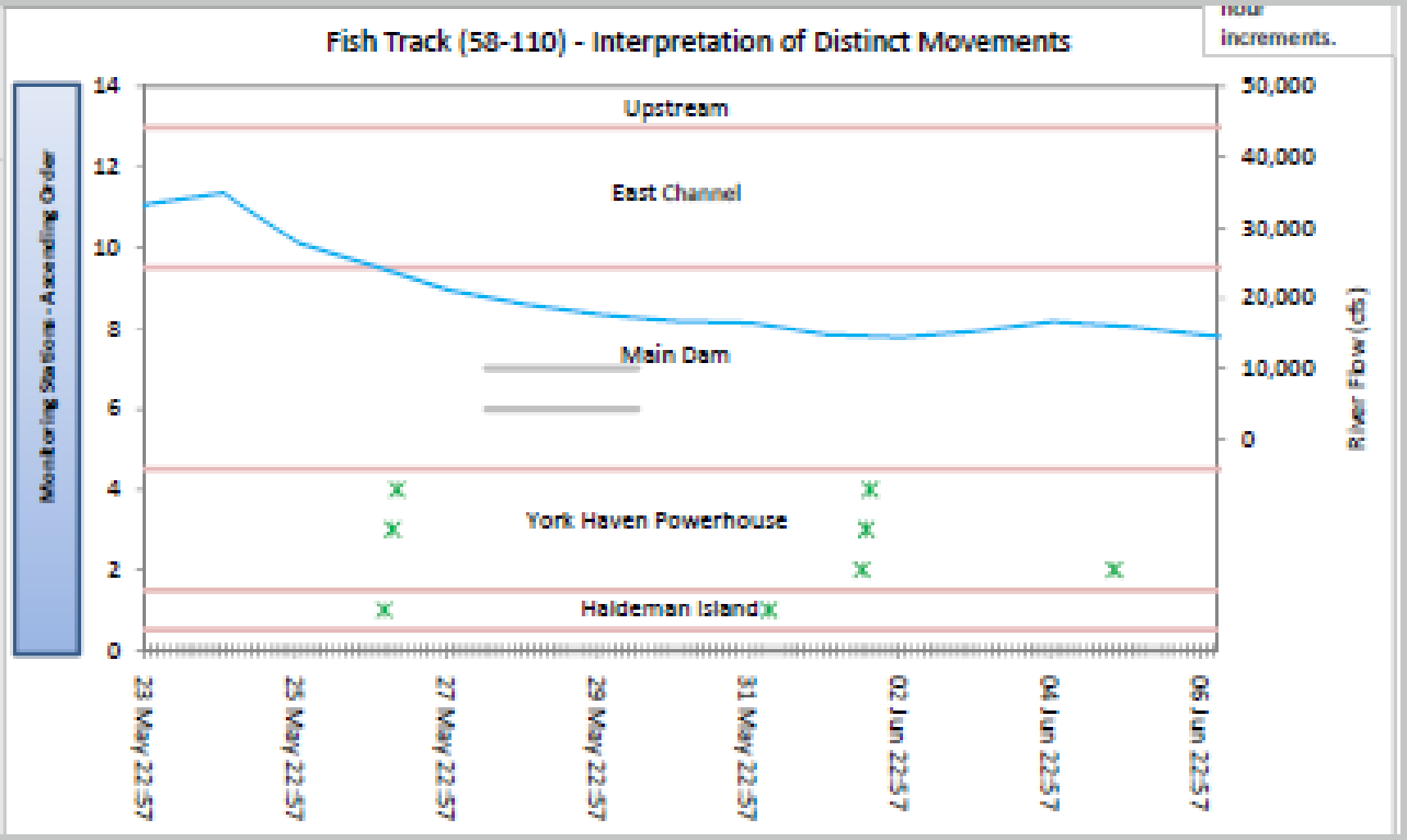
Data Analysis Methods

Interpretation of Distinct Movements



Data Analysis Methods

Interpretation of Distinct Movements



Data Analysis Methods Supplemental

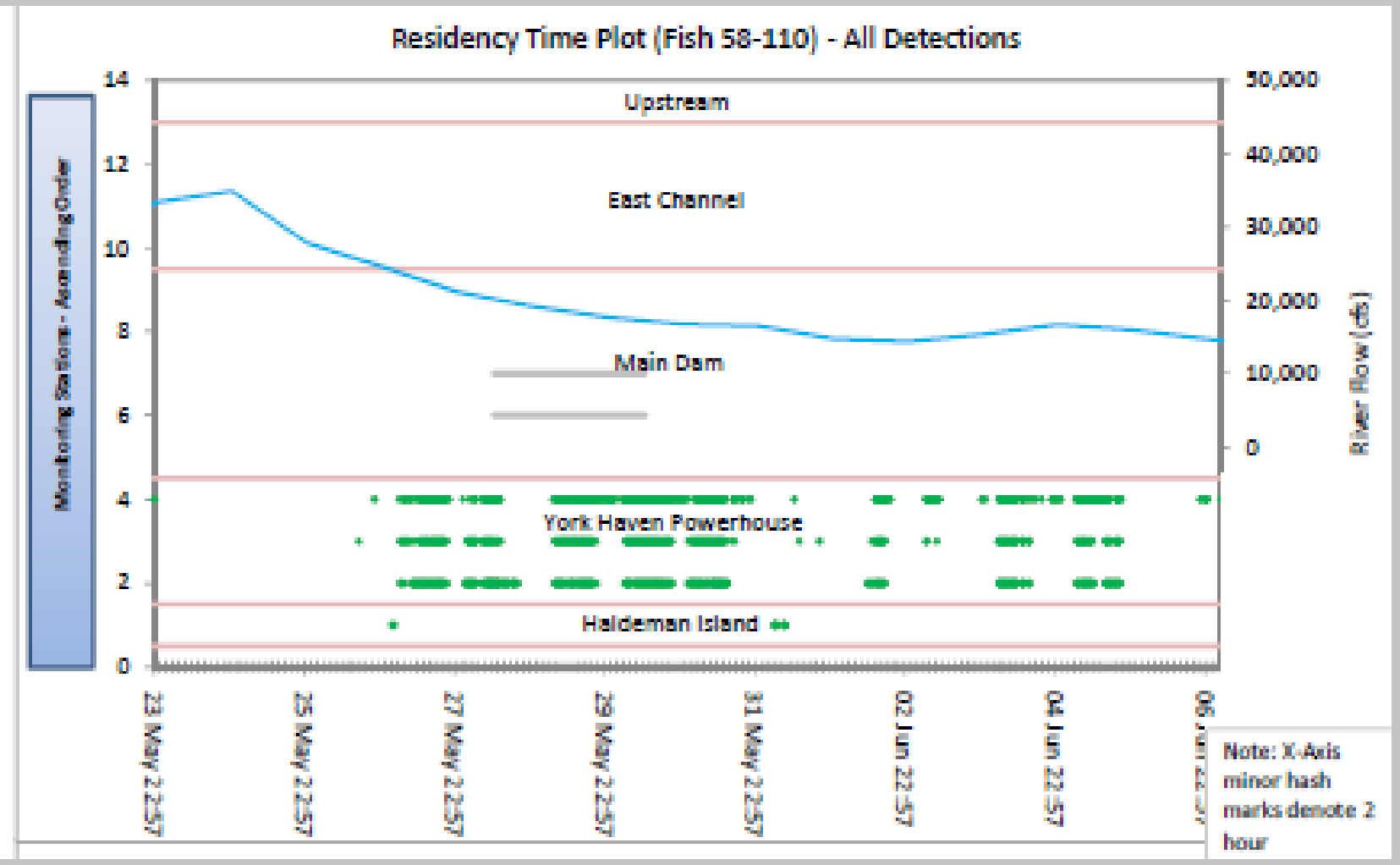
- Data were re-analyzed with all valid detections included to assess shad usage of the Project area
  - residency time
  - frequency of visits
  - migration pathways

- Each of the 127 fish plotted to display the location and sequence of each detection by the antenna array in the project area

- Provided a comprehensive display of movements for visual interpretation of data

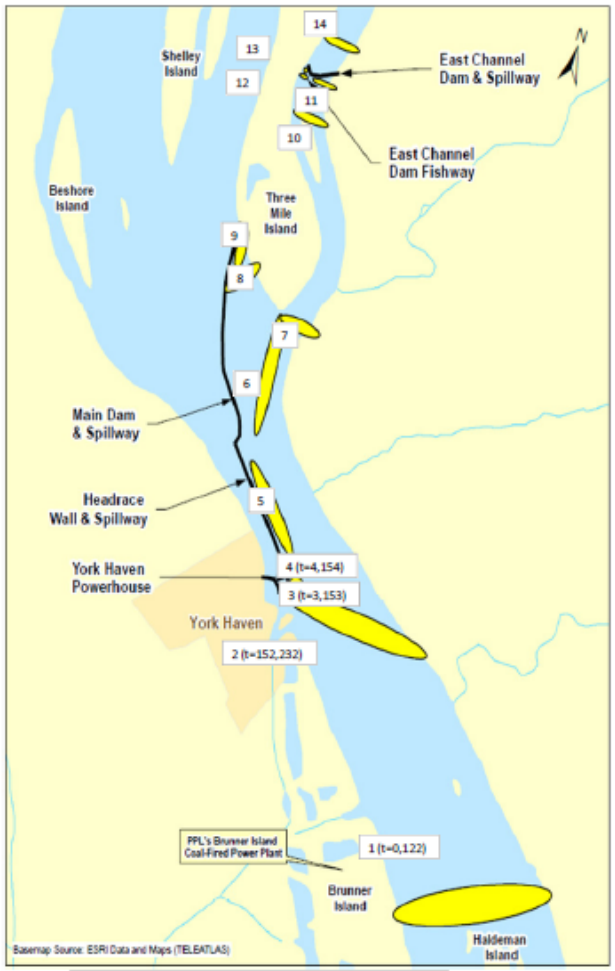
Data Analysis Methods

Residency Time Plot – All Detections



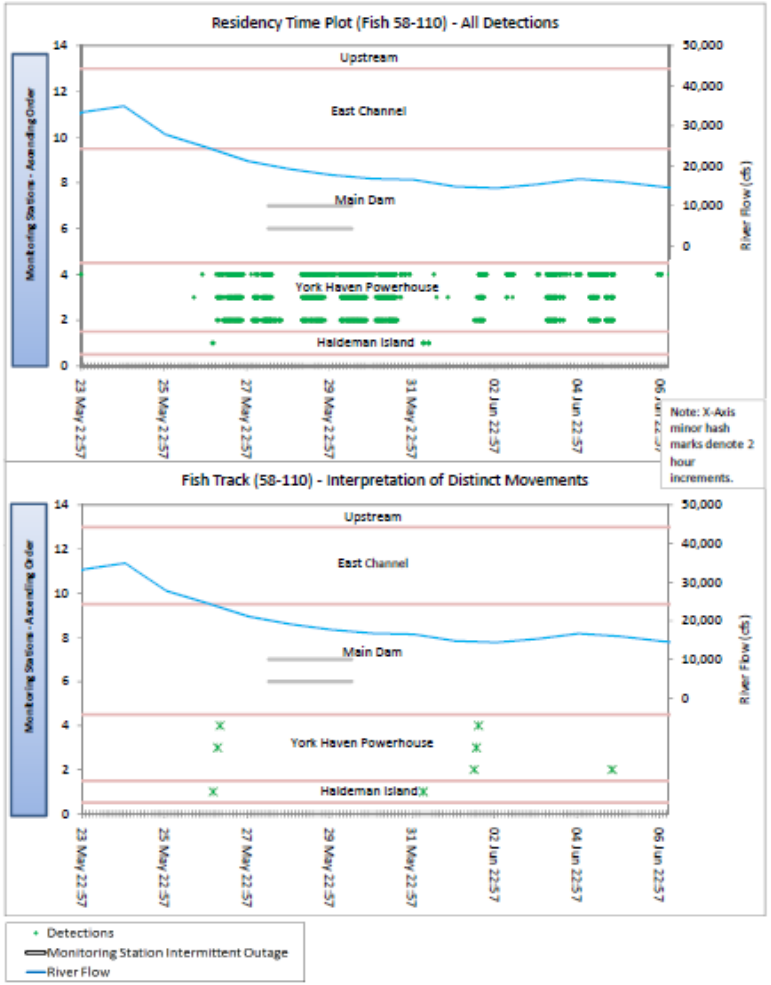
Data Analysis Methods – Shad Movement

York Haven American Shad Telemetry Results Summary: Station Detection and Elapsed Time (hours)
Fish Number 58-110



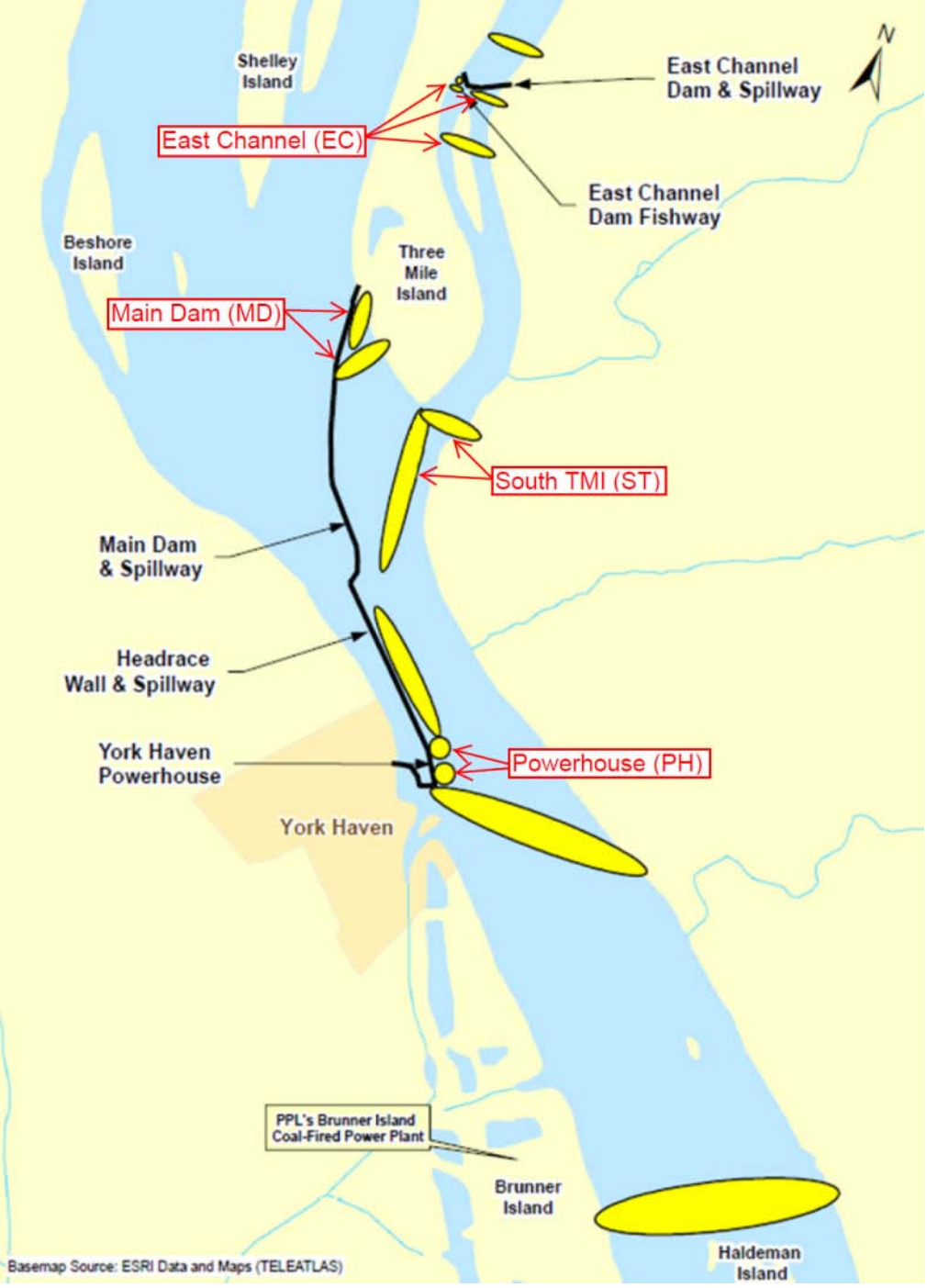
t= Elapsed time (hours) since first detected at Halderman Island.
Monitoring Stations are numbered in ascending order.

Fish ID	Release Location	Release Date/Time	Length (mm)	Sex
58-110	Safe Harbor Fishway	5/18/2010 12:10	430	M



Data Analysis Methods
Finer Scale Analysis

- Finer scale analysis of radio tagged American shad was conducted at two levels:
  - Four regional Project area locations monitored similar to historical telemetry studies:
    1. Powerhouse (PH)
    2. South TMI Area (ST)
    3. Main Dam Apex (MD)
    4. East Channel (EC)
  - Movements within regions
    1. Between individual antenna zones


Shelley Island
East Channel Dam & Spillway
East Channel (EC)
East Channel Dam Fishway
Beshore Island
Three Mile Island
Main Dam (MD)
South TMI (ST)
Main Dam & Spillway
Headrace Wall & Spillway
York Haven Powerhouse
Powerhouse (PH)
York Haven
PPL's Brunner Island Coal-Fired Power Plant
Brunner Island
Haldeman Island
N
Basemap Source: ESRI Data and Maps (TELEATLAS)

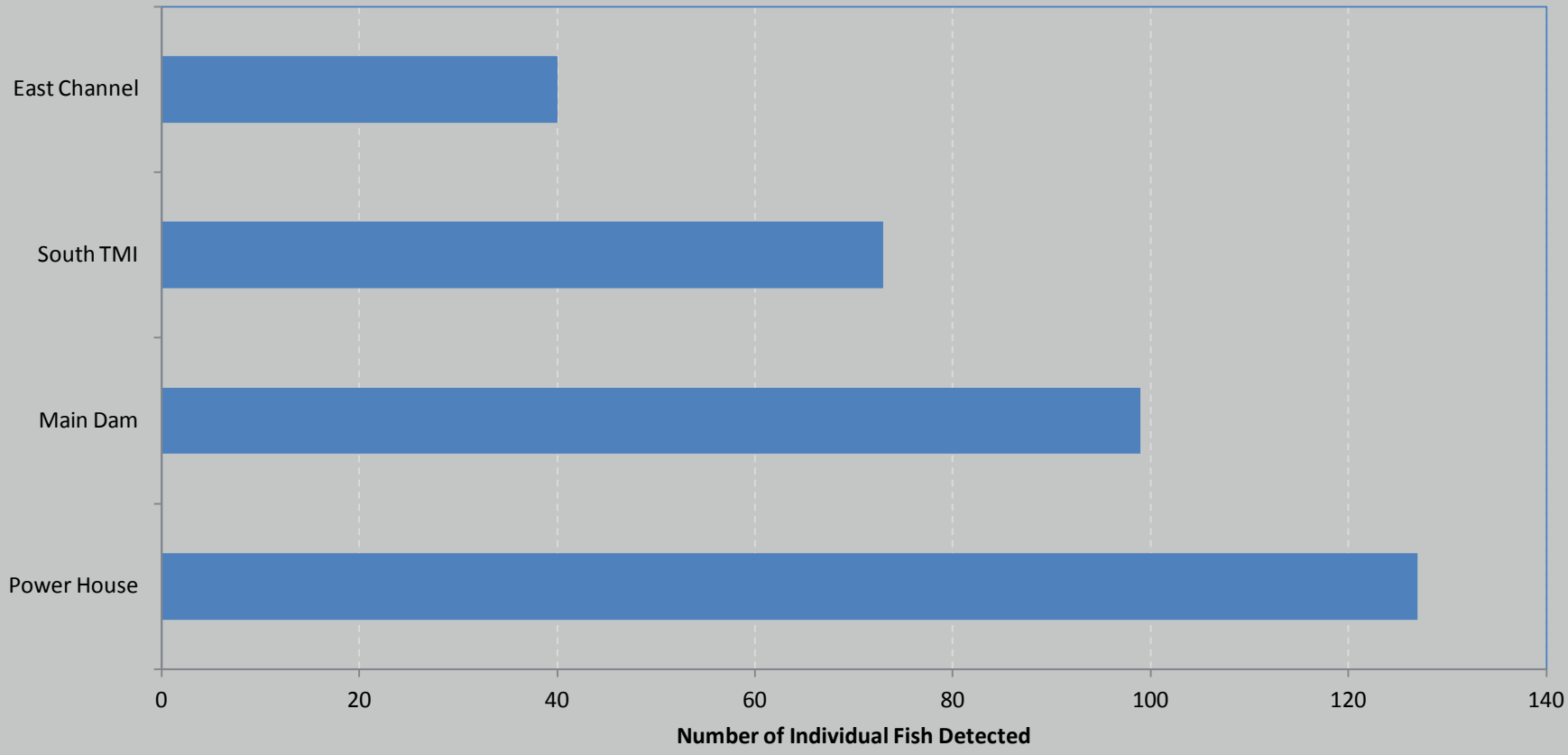
Data Analysis Methods
Finer Scale Analysis

- Primary Measures of Site Usage
  - Number of Fish- number of unique fish (channel + code) detected at least once within designated region
  - Number of Visits- number of distinct occurrences (string of uninterrupted (<20 min) detections) of a given fish within the designated region
  - Total Time Spent- Total time between the start time and the end time of the detections in a region
  - Average Duration of Visits- The average time spent at each region

Results:

Finer Scale Statistical Analysis

1. What percentage of fish use the four Project Regions monitored?



Results:
Finer Scale Statistical Analysis

2. In what order do fish approach the four regions? Is there a pattern in migratory pathways?
   - Of the 127 fish, 115 (90.6%) were detected at PH first, 10 (7.9%) at MD first, 2 (1.5%) at ST first, and 0 (0.0%) at EC first
   - The primary pathway observed was PH→MD→ST pathway
   - 100% approached the PH at least once. Somewhat over half of the fish at the PH were detected at MD and ST, and slightly over half of those fish were detected in the EC

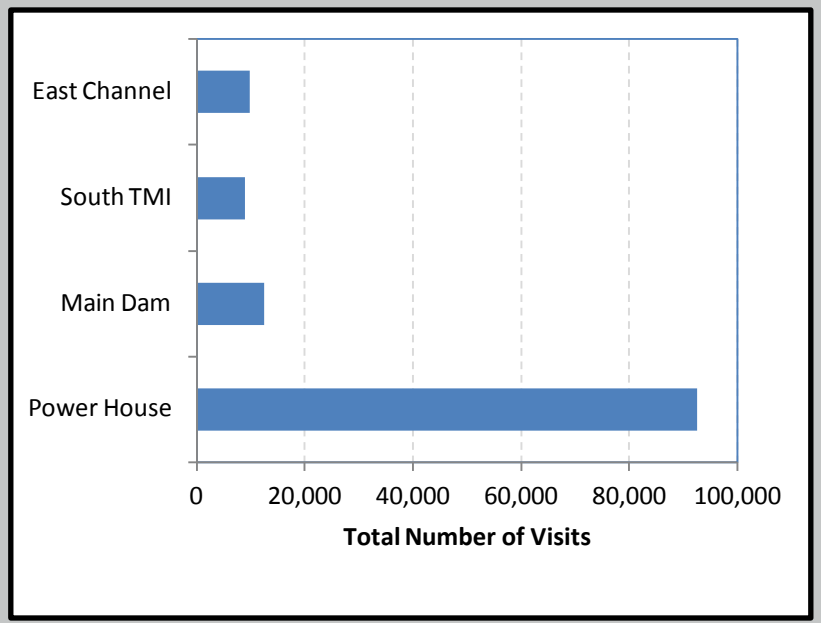
Results: Finer Scale Statistical Analysis

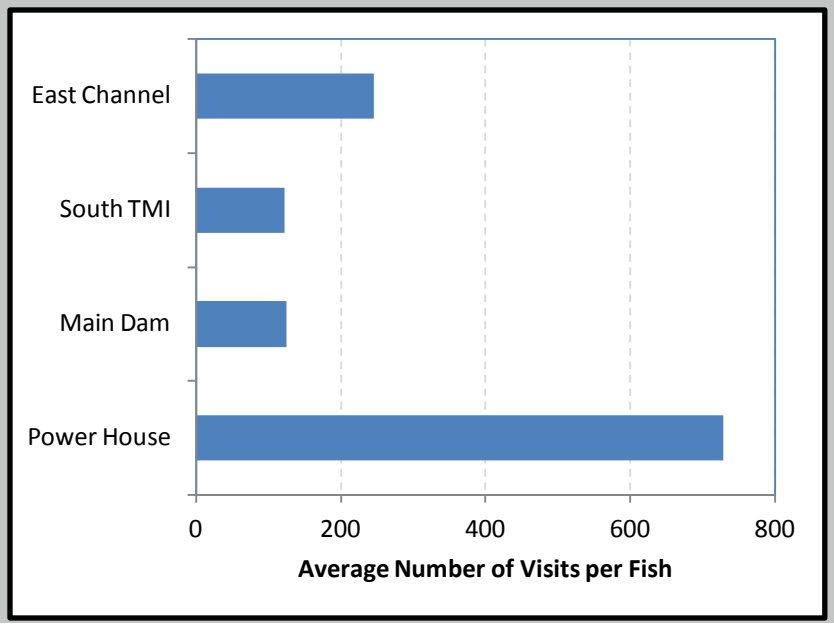
Number of Fish Selecting Various Pathways through PH, MD, ST, and EC

Path	Count	Percentage
PH→MD→ST	31	24.4%
PH	25	19.7%
PH→MD	18	14.2%
PH→MD→ST→EC	17	13.4%
PH→ST→MD→EC	8	6.3%
PH→ST→MD	5	3.9%
PH→MD→EC	5	3.9%
PH→MD→EC→ST	4	3.1%
MD→PH	4	3.1%
MD→PH→ST	2	1.6%
MD→PH→ST→EC	2	1.6%
PH→EC	1	0.8%
PH→ST	1	0.8%
ST→PH→EC	1	0.8%
MD→ST→PH	1	0.8%
MD→EC→PH	1	0.8%
ST→EC→MD→PH	1	0.8%
Total	127	100%

Results: Finer Scale Statistical Analysis

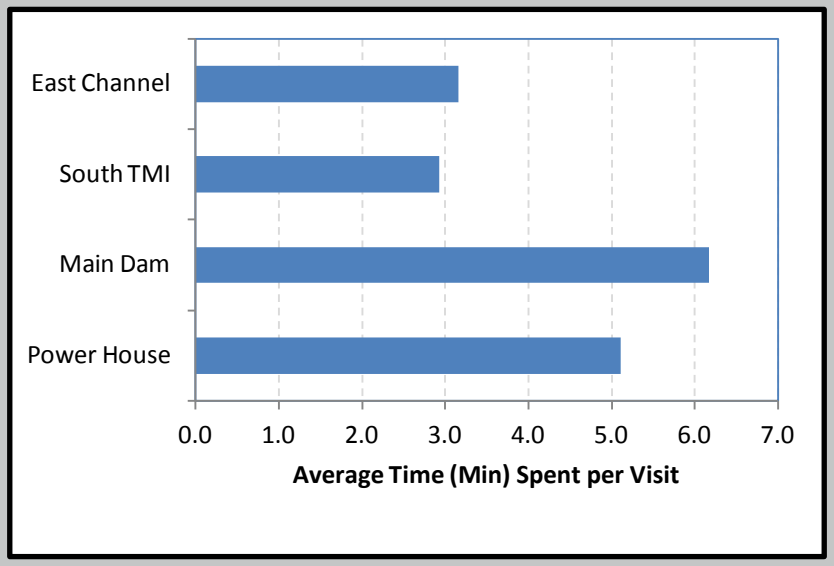
3. How often do individual fish investigate each of the four regions? Do fish repeatedly return to a particular region if upstream passage cannot be found?





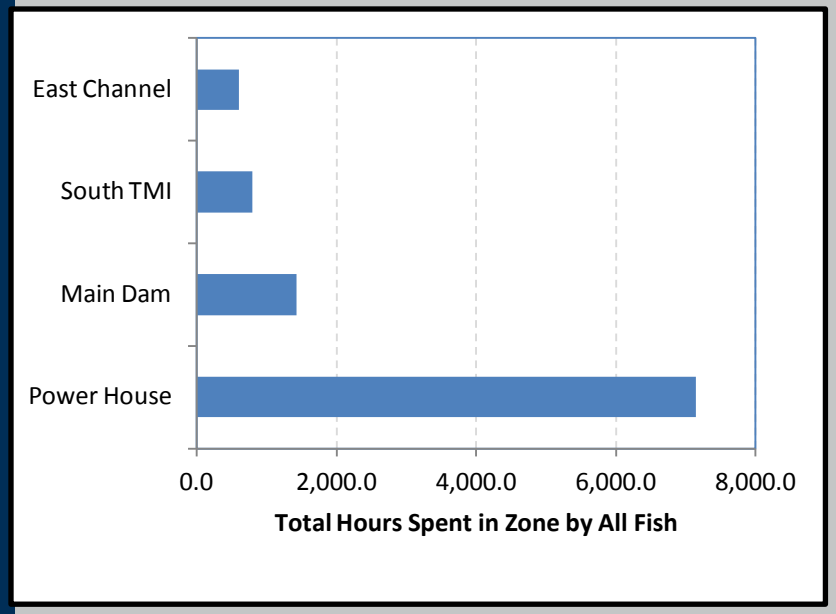
Results: Finer Scale Statistical Analysis

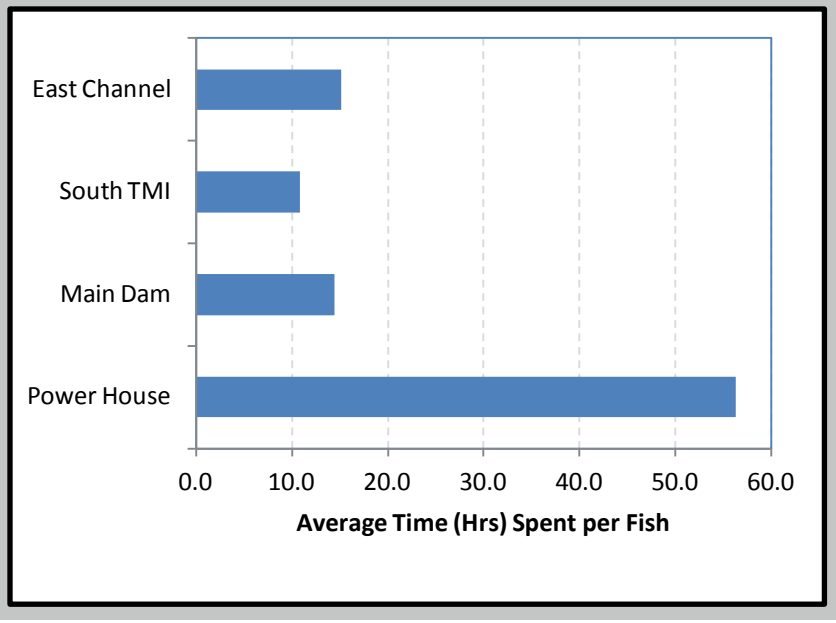
4. What is the average duration of visits to each region? How long does an individual fish spend searching (or resting) during a single visit to the region?



Results: Finer Scale Statistical Analysis

5. How long do fish stay in each region? Do fish spend greater amounts of time in a particular region?

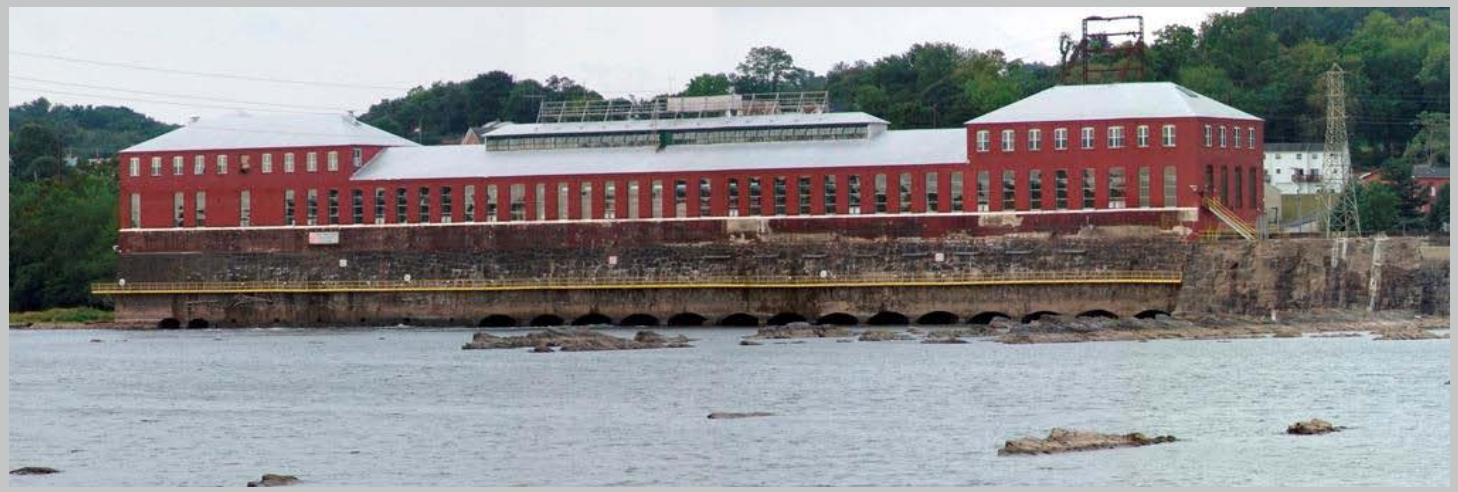




Finer Scale Movements

Powerhouse

Monitoring Station	Location Description	Number of Detections	Number of Fish Detected	Total Time Spent per Fish	Average Number of Visits per Fish	Average Duration of Event
Monitoring Station No. 6 (Antenna zone 7)	North Section of the Powerhouse	43,872	113	30.75 hrs	388.25	4.57 min
Monitoring Station No. 5 (Antenna zone 6)	South Section of the Powerhouse	48,672	125	36.92 hrs	389.38	5.34 min



Finer Scale Movements

Main Dam at TMI

Monitoring Station	Location Description	Number of Fish Detected
Monitoring Station No. 8 (Antenna zone 11)	Mid-TMI West Zone	99
Monitoring Station No. 9 (Antenna zone 12)	Main Dam-TMI Apex	10

Evaluation of East Channel Fishway

- Far Field
  - 40 total fish entered the East Channel
  - Six reached the mid-East Channel only and left
  - 34 shad continued to the East Channel Dam station
    - 26.8% far field efficiency
- Near Field
  - The fishway entrance attracted 28 of the 34 shad detected at the East Channel Dam
  - 22 of the 34 shad quickly turned back downstream
  - 9 shad entered the fishway
  - 5 passed upstream through the fishway
    - 3.9% near field efficiency

Evaluation of East Channel Fishway

Monitoring Station	Location Description	Number and Percent of Total Fish (127) Detected
Monitoring Station No. 11 (Antenna zones 15) – long range	Downstream of East Channel Dam	34 (26.8%)
Monitoring Station No. 12 (Antenna zones 16) and Monitoring Station No. 11 (Antenna zones 15) – short range	Fishway Entrance	28 (22%)
Monitoring Station No. 13 (Antenna zone 17)	Fishway Proper	9 (7%)
Monitoring Station No. 14 (Antenna zone 18)	Upstream of East Channel Dam	5 (3.9%)

Evaluation of East Channel Fishway

- Fish behavior and attraction to the fishway, and through the fishway are driven by hydraulics both near-field and far-field
- Shad arrive at the east side of dam, and the fishway is located at the west abutment
- Shad must cross the 2,000 cfs attraction flow from weir to reach fishway
- Other factors influencing shad behavior – predatory response?

2010 Study Summary

- 100% of shad in the Tier 2 Study Area were detected at the powerhouse, 78% at the Main Dam apex with TMI, and 26.4% near the East Channel Dam
- Results are consistent with 5 prior studies
- Beyond the common attraction to the Powerhouse, shad displayed a wide variety of migratory search patterns and behaviors

2010 Study Summary

- 3.9% of tagged shad arriving at the Project passed upstream through the East Channel fish ladder
- Historically, the percentage of Safe Harbor passed shad also passing at York Haven has varied from 22% to 2%
- Fish passage enhancement studies are under way

QUESTIONS?

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