Silver Eel Migration and Mortality Associated with Five Hydroelectric Dams on the Shenandoah River

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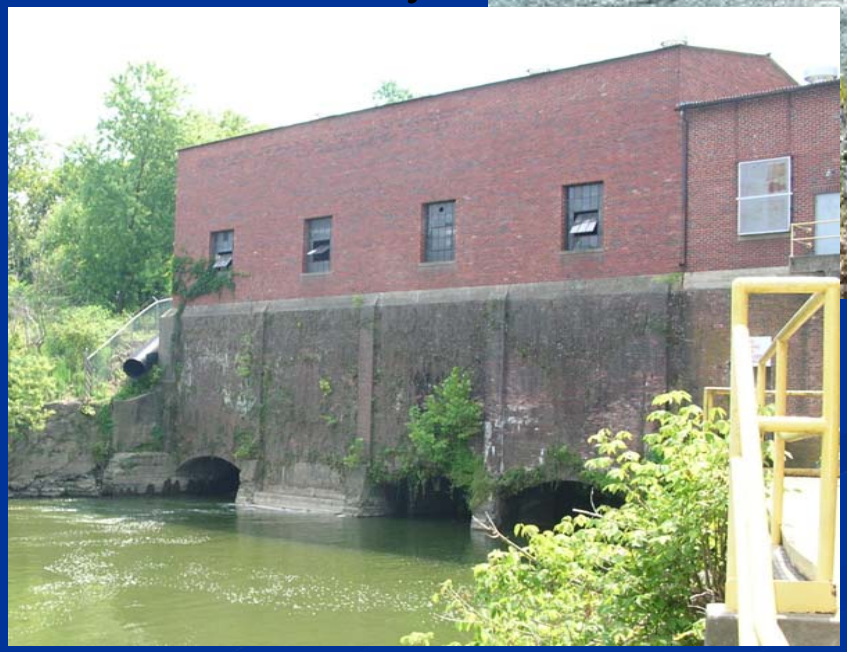
EEL LIFE HISTORY

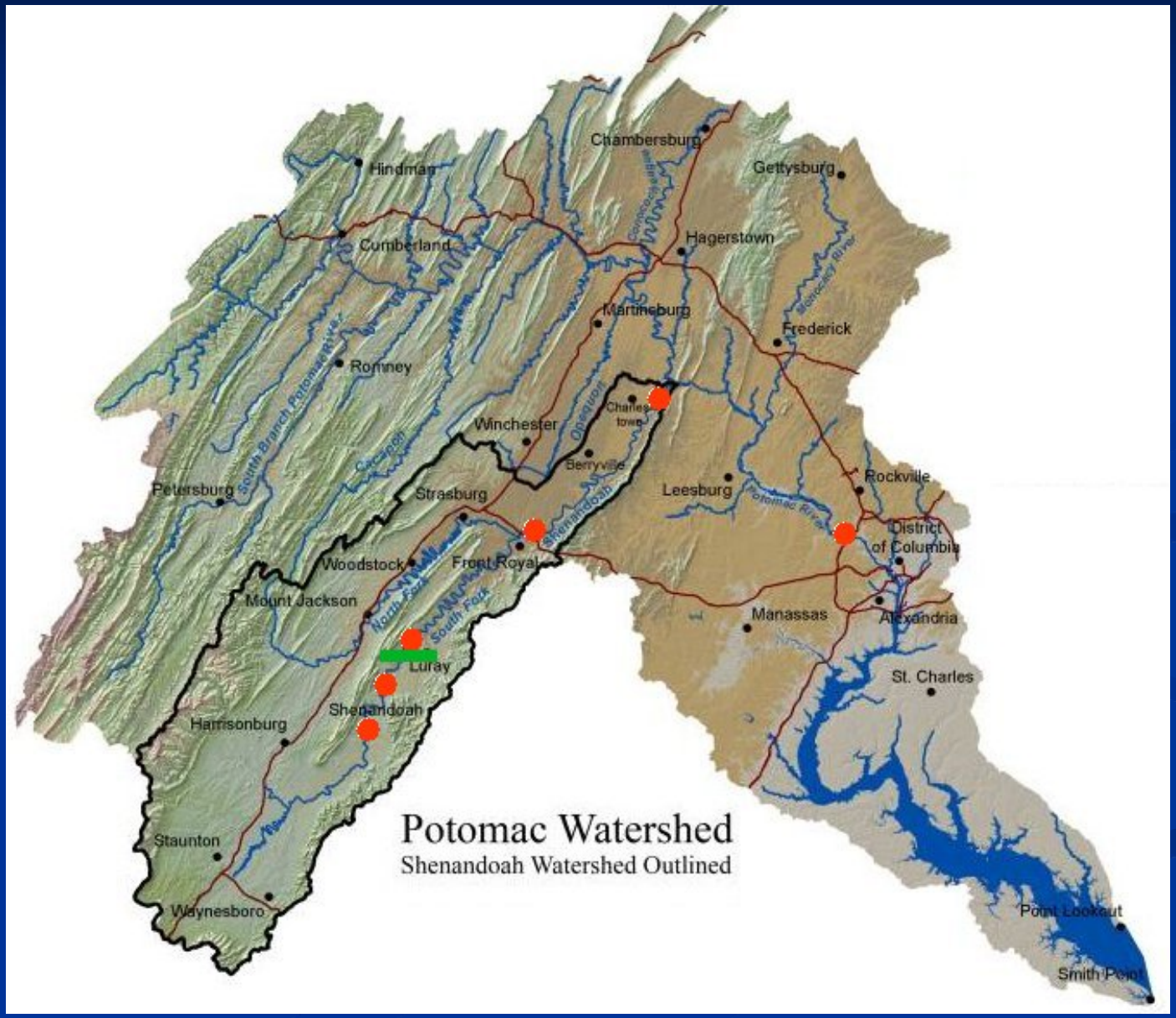
- Catadromous, spawn in Sargasso Sea
- Young eels spend several years migrating upriver
- Upriver habitat produces largest female eels
- Peak downstream migrations occur in fall

EEL MIGRATION PAST DAMS

- Dams impact eel migration
- Downstream passage
  - Turbine Mortality



SHENANDOAH RIVER



SHEN. HYDRO STATIONS

- 5 Hydropower Dams in South Fork and Shenandoah Mainstem
- Two lower dams have upstream eel passage
  - 3rd dam to have passage 2009
- All run-of-river dams
  - Must maintain minimum spill (1")
- Run Francis Turbines (2 to 3 units per dam)
- Currently operate nightly seasonal shutdowns

DOWNSTREAM MIGRATION – RADIO TELEMETRY

- Monitoring Locations
  - 5 Shenandoah Dams
  - Potomac River
    - Little Falls
    - Washington Aqueduct

- Stationary Telemetry
  - Aerial
  - Underwater

FISH COLLECTION AND TAGGING

- Boat Electrofishing used to collect eels
- Collections upstream of Luray
- Large eels radio tagged
- Released at capture location within hours

FISH TAGGED IN 2007 & 2008

- 115 eels tagged fall 2007 & 2008
  - 71 silver
  - 23 intermediate
  - 21 yellow
- Average Weight 1389g
  - Range 660 to 2660
- Average Length 855mm
  - Range 720 to 1018

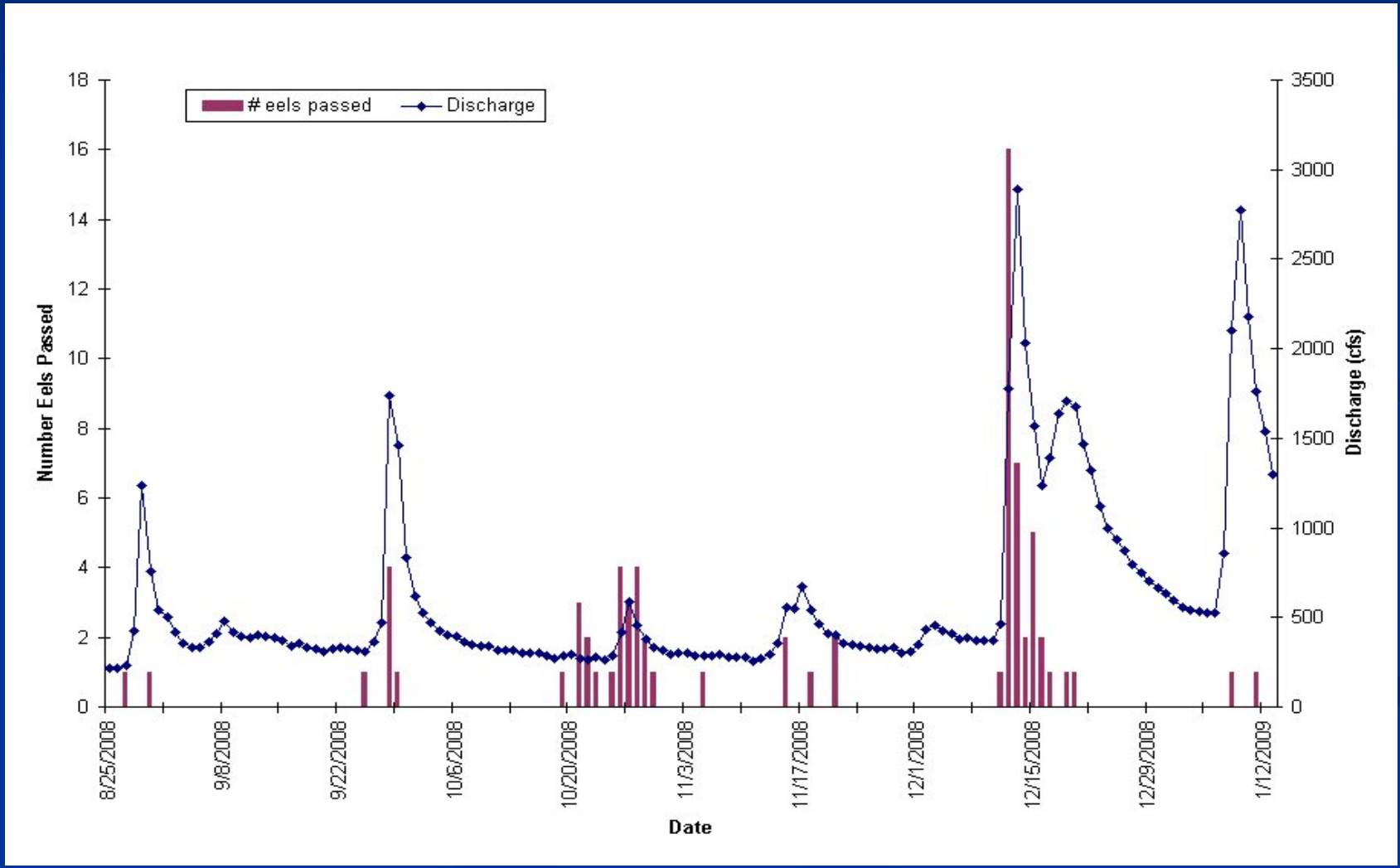
DOWNSTREAM MIGRATION

- 59 eels made downstream movements (55 silver)
  - 20 left Millville Dam on Shenandoah River
- 23 fish suspected turbine mortality
  - 65 events through hydro
  - 76 events by spill over dam
  - 16 events unknown method

ENVIRONMENTAL QUES

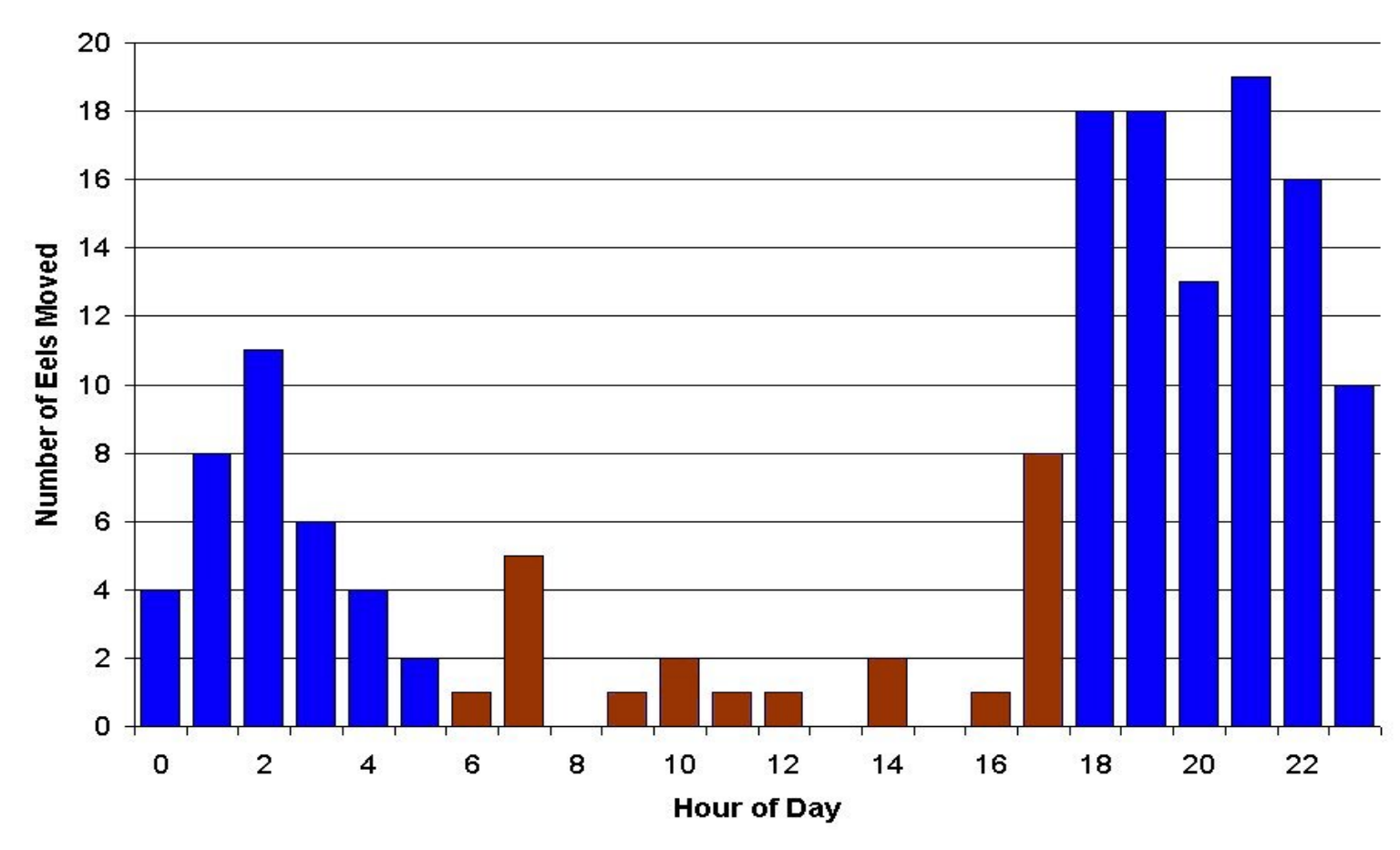
- Considered
  - Discharge
  - Lunar Phase
  - Water Temperature
  - Change in flow
- Change in flow most critical environmental cue
  - Flow increases 2x to 3x is optimal conditions
  - Lunar phase is secondary cue
  - No movement occurred below 4^{o}C

Discharge and Eel Passage



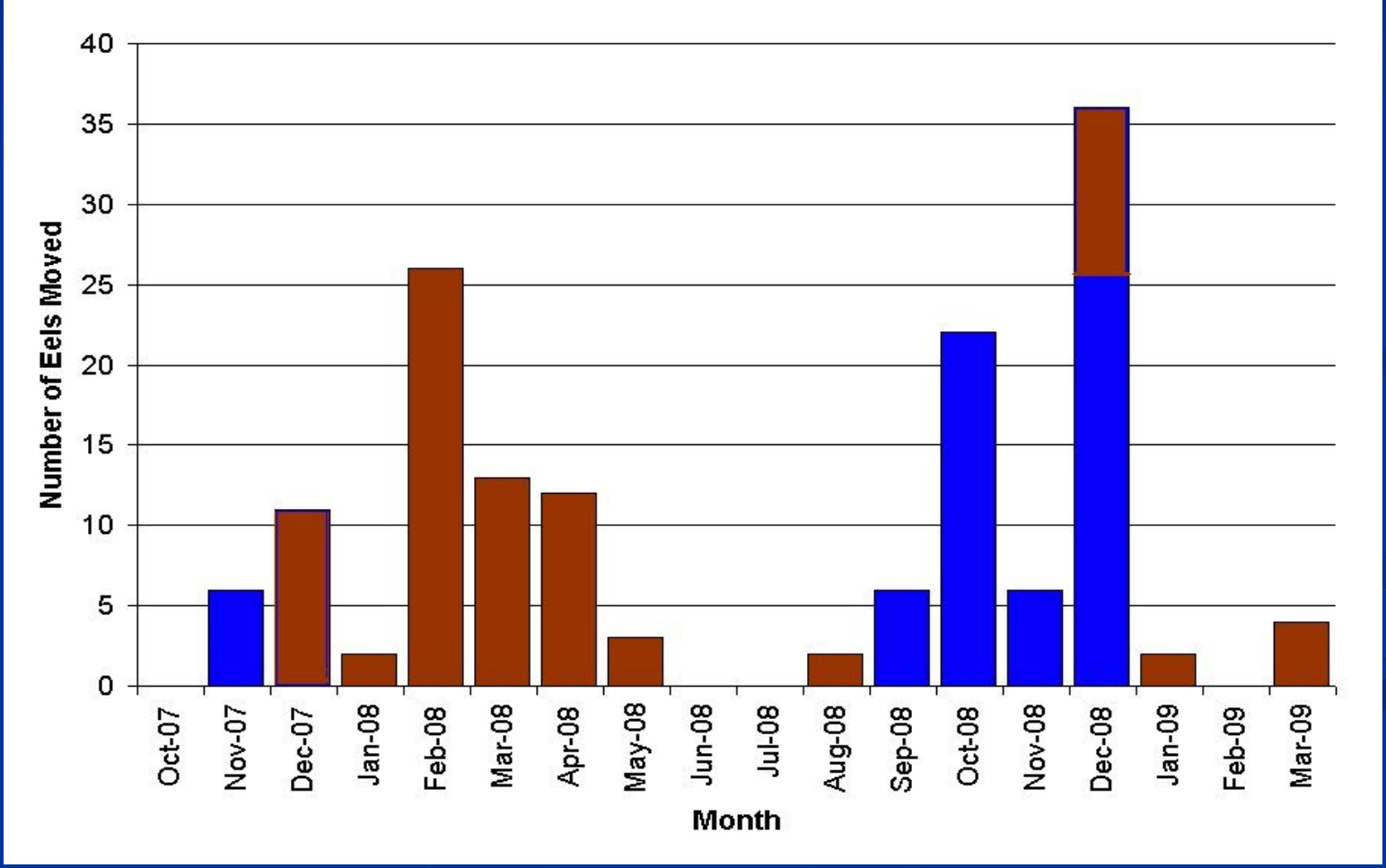
MIGRATION TIMING

- Hydro Shutdowns 1800 hrs to 0600 hrs (85%)



MIGRATION TIMING

- Hydro Shutdowns 9/15 – 12/15 (44%)



PASSAGE METHOD

Dam	Total # Passed	% Via Hydro During Shutdown	% Via Hydro Outside Shutdown
Newport	30	12%	36%* +
Luray	53	27%	55%
Warren	33	10%	77%
Millville	24	14%	94%
All Dams Combined		18%	70%

TURBINE MORTALITY

TURBINE MORTALITY

Dam	Total # Passed	Overall Suspected Mortality	Overall Mortality Rate
Newport	30	7	23%*
Luray	53	10	19%
Warren	33	3	9%
Millville	24	3	13%
		Cumulative Mortality	51%

NEW INFORMATION

- Large eels in Upper Shenandoah watershed
- Spring migrations occur (implications for seasonal shutdown timeframe)
- Daily shutdown periods may reduce number of eels passing through turbines
- Estimated cumulative mortality rates may exceed 50% for 4 of 5 dams on Shenandoah River

FUTURE WORK

- Continue to monitor movement through fall 2009
- Make recommendations for optimal shutdown periods
  - Time of day
  - Time of year
  - Water flow conditions

QUESTIONS?