Maryland Power Plant Research Program

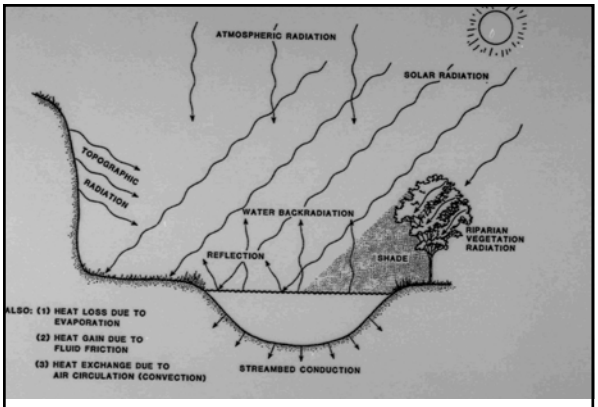
Presentation to the Lake Levels Subcommittee – March 12, 2014
Youghiogheny River Temperature Enhancement Releases

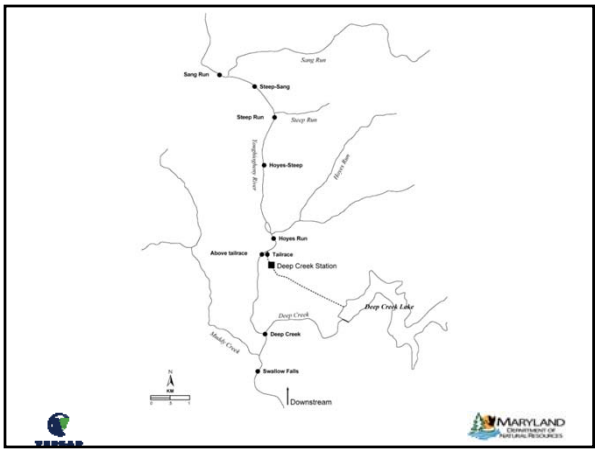
History of Youghiogheny River Temperature Enhancement

- Yough River temperature model
- Development of temperature enhancement protocol
- Performance of TER's
  - Exceedances
  - 'unnecessary' releases
- Potential Improvements

Yough Temperature Model

- Permit 16: Requires temperature enhancement releases to "maintain water temperatures in the river between the project tailrace and Sang Run below 25 °C at all times during the months of June, July and August"
- Goals: develop a physical temperature simulation model of river
- Evaluate various release scenarios to maintain river temps below 25 °C
- Simulations included several types of generation releases and continuous minimum flow releases
- Temperatures collected at several stations to calibrate the model





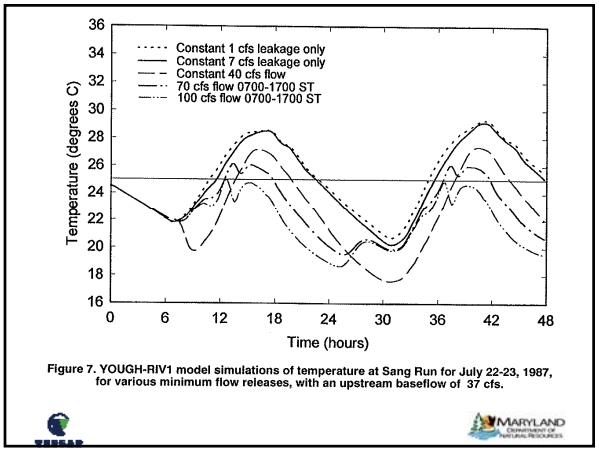


Figure 7. YOUGH-RIV1 model simulations of temperature at Sang Run for July 22-23, 1987, for various minimum flow releases, with an upstream baseflow of 37 cfs.

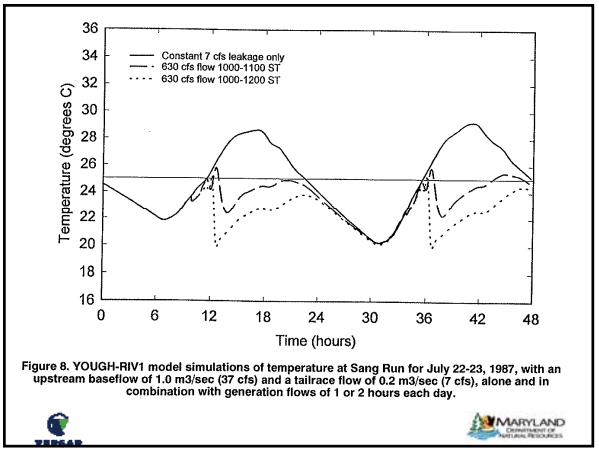


Figure 8. YOUGH-RIV1 model simulations of temperature at Sang Run for July 22-23, 1987, with an upstream baseflow of 1.0 m3/sec (37 cfs) and a tailrace flow of 0.2 m3/sec (7 cfs), alone and in combination with generation flows of 1 or 2 hours each day.

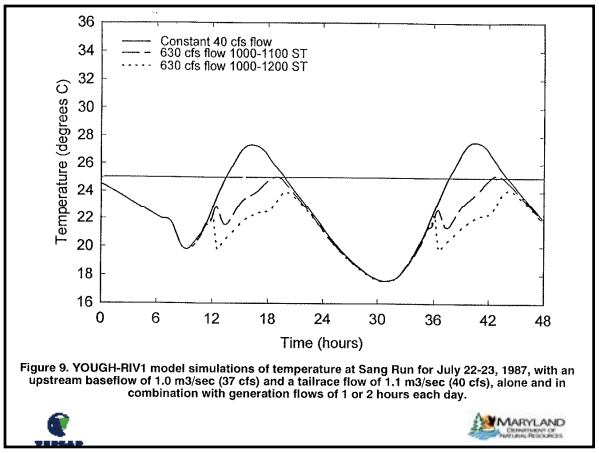
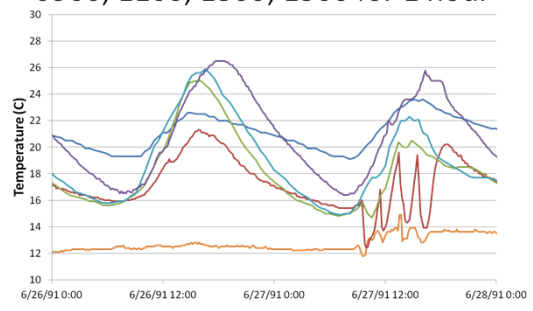


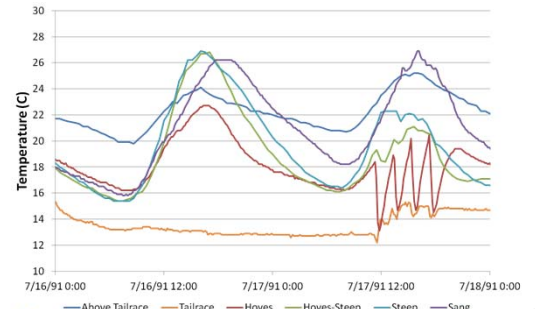
Figure 9. YOUGH-RIV1 model simulations of temperature at Sang Run for July 22-23, 1987, with an upstream baseflow of 1.0 m3/sec (37 cfs) and a tailrace flow of 1.1 m3/sec (40 cfs), alone and in combination with generation flows of 1 or 2 hours each day.

Youghiogheny River Model simulation results – Test period July 23, 1987, 37 cfs river baseflow	Temperature °C at Sang Run bridge	
Simulation Tailrace Flow	Maximum	Average
LOW FLOW SUPPLEMENTS		
1 cfs only	29.3	25.2
7 cfs only	29.2	24.8
add 40 cfs	27.4	22.1
add 70 cfs 0700-1700 ST	26.1	22.4
add 100 cfs 0700-1700 ST	24.9	21.4
GENERATION FLOW - 7 cfs during non-generation		
630 cfs 1000-1100 ST	25.8	23.4
630 cfs 1000-1200 ST	25.3	22.3
GENERATION FLOW - 40 cfs during non-generation		
630 cfs 1000-1100 ST	25.2	21.1
630 cfs 1000-1200 ST	24.1	20.5

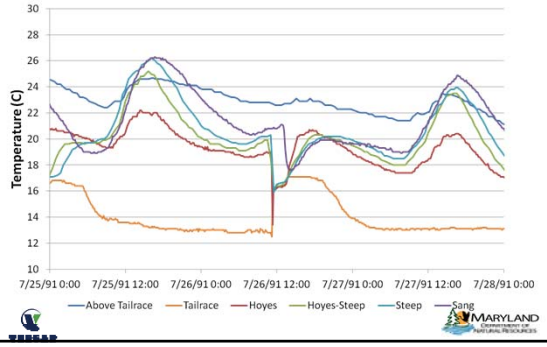
Test release – 1 turbine@200 cfs at 0900, 1100, 1300, 1500 for 1 hour



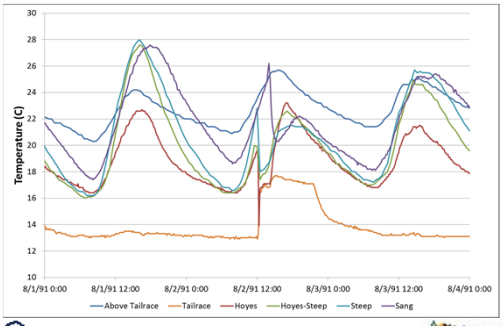
Test release – 1 turbine@315 cfs at 1100, 1300, 1500, 1700 for 1 hour



Test release – 2 turbines@full gate at 1100 for 2 hours



Test release – 2 turbines@full gate at 1200 for 2 hours



Temperature Enhancement

- Model results and test releases showed that temperature goal could be met on warm days with:
  - 100 cfs continuous for 10 hours starting at 0700 or
  - 2 hour generation release starting at 1100
- 100 cfs option would require costly bypass structure without generation
- Generation release option would produce power and is potentially boatable

Temperature Enhancement Protocol Goals

- Use a 2-hour generation release on the warmest days
- Use a 1-hour generation release on moderate days
- Provide a river temperature prediction mechanism for releases so several hour's notice of the 2-hour releases could be provided for boaters

Temperature Enhancement Protocol

- Developed using regression analysis of river temperatures, river flow, and maximum air temperature and cloud cover predictions
- Predictions made at 7, 9, and 11 am for 2-hour release for warmest days
- Predictions made at 12, 2, and 3 pm for 1-hour release on moderate days
- 7 and 9am predictions make a release at 11am
- 11 am prediction makes release at 1230pm for more notice to boaters

Temperature Enhancement Results 1995-2013

- Average of 16 releases per year
- Exceedances at Sang Run occur on average 12/yr (vs. 27 days > 25 °C at Swallow Falls)
- 64% of exceedances < 26 °C
- 90% reduction of time > 25 °C vs. Swallow Falls (2004-2013)
- 1.5 'Unnecessary' releases occur per year, on average, < 3 hours per year (< than 1/2 inch of lake level)
- Natural river temperature variability is 0.7 °C ± 1.5 °C between Swallow Falls and Sang Run, on days with no releases

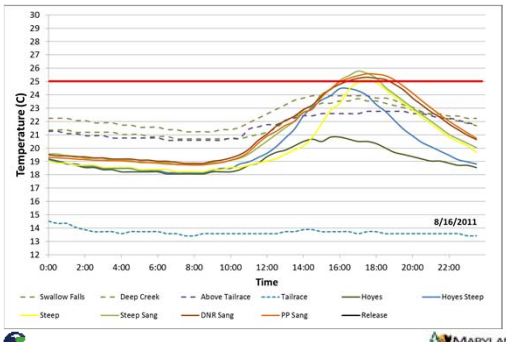
Estimate of 'unnecessary' releases from Deep Creek Hydroelectric Station for temperature habitat enhancement, 1995-2012 (18 years)

Year	Date	Sang Max, C	Power Co. Max, C	Swallow Falls Max, C	Deep Creek Max, C	Duration, hrs	Total for Year	Protocol Uncertainty	Operator or Equipment Error	
1995	7/5/1995	23.2		24.6		2	1	1		
1996	7/7/1996	22.5	22.0	24.4		2	1	1		
2000	6/25/2000	24.0	23.0	24.0		2		1		
2000	6/26/2000	22.0	21.5	25.0		2		1		
2000	7/4/2000	22.0	22.9	23.0		2		1		
2000	8/10/2000	24.0	24.1	24.0		2	4	1		
2003	8/26/2003	22.5	22.4		24.3	2	1	1		
2004	7/22/2004	21.1	20.6	24.4	23.4	2	1	1		
2005	8/25/2005	21.6	21.2	24.3	23.4	2	1	1		
2006	6/17/2006	24.8	23.9	24.3	23.5	2		1		
2006	6/18/2006	23.1	21.9	25.0	24.2	2		1		
2006	7/25/2006	24.5	24.2	24.8	24.1	2	3	1		
2007	6/13/2007	24.6	24.4	24.5	23.5	1	1	1		
2008	7/16/2008	24.0	24.0	24.1	23.7	2		1		
2009	7/26/2009	22.6	28.4	23.4	22.4	1				1 error in Brookfield sensor
2009	8/11/2009	23.0	23.5	25.0	24.2	1		1		
2009	8/27/2009	24.0	24.7	25.0	23.7	1	4	1		
2010	6/20/2010	23.1	22.8	24.6	23.9	2		1		
2010	6/24/2010	23.4	23.7	24.5	23.5	2		1		
2010	8/3/2010	21.3	21.8	24.6	23.9	2	3	1		
2011	6/8/2011	25.0	23.7	24.3	24.1	2		1		
2011	6/30/2011	24.3	23.4	23.1	22.5	1		1		
2011	8/17/2011	24.5	23.3	25.0	24.7	2	3	1		
2012	6/16/2012	23.0	22.5	24.8	23.4	2		1		
2012	6/19/2012	23.9	23.3	23.6	23.5	2		1		
2012	8/5/2012	22.1	22.2	24.8	24.9	2		1		
2012	8/7/2012	24.9	24.8	24.8	24.6	2	4	1		
						49	27	26		1 Grand Total
						2.7	1.5			Per Year

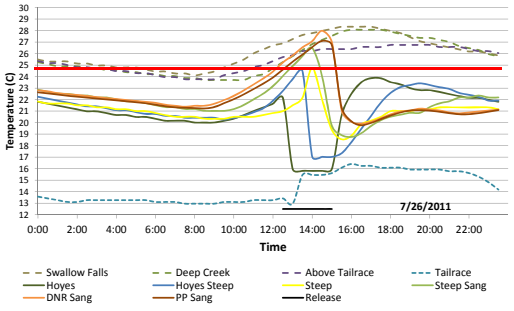
Protocol Improvements

- Evaluate use of Hoyes Run flow data and local weather data and forecasts to improve performance
- Hoyes gage started in summer 2011; waiting for sufficient low flow days (<~150 cfs), with no discharge and steady natural flow
- Garrett County airport data available starting 2007; only 8 days from 2007-2012 when station not operating, limiting a revised protocol

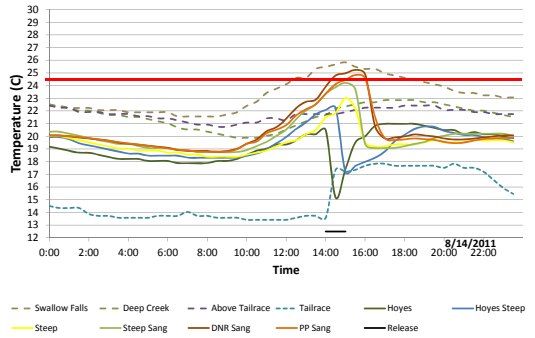
August 16, 2011 River Temps



July 26, 2011 River temps



August 14, 2011 River Temps



Relevant Reports

- Temperature Simulation Model for the Deep Creek Hydroelectric Facility
- Temperature and Trout Habitat Enhancement for Operating Deep Creek Hydroelectric Station: Operating Protocol Development and Results for 1995-2008
- Annual reports since 2008 on T.E. Protocol
- Available at: pprp.info/bibliography/sec7.htm#deepcreek