Seven Questions About the FFMP

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Presented at Water Water Everywhere
FUDR, Hancock, NY
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Jeff Skelding's Seven Questions

1. What is the FFMP and why is it important to the UDR fishery and local communities?
2. How have reservoir releases and river flows been impacted since the inception of the FFMP?
3. Why are releases higher in the summer and lower in the winter?
4. Why do the reservoir releases drop precipitously on October 1?
5. Why don't reservoir releases increase when the river needs it, while the reservoirs are at high storage levels?
6. Why is the thermal bank so small and the triggering temperature set at 75 Degrees F when we all know trout are happier at 68 Degrees F.
7. What can we do in the next year, 5 years, 10 years to improve reservoir releases to benefit the UDR wild trout fishery?

Q1. What is the FFMP and why is it important to the UDR fishery and local communities?

The Short Answer

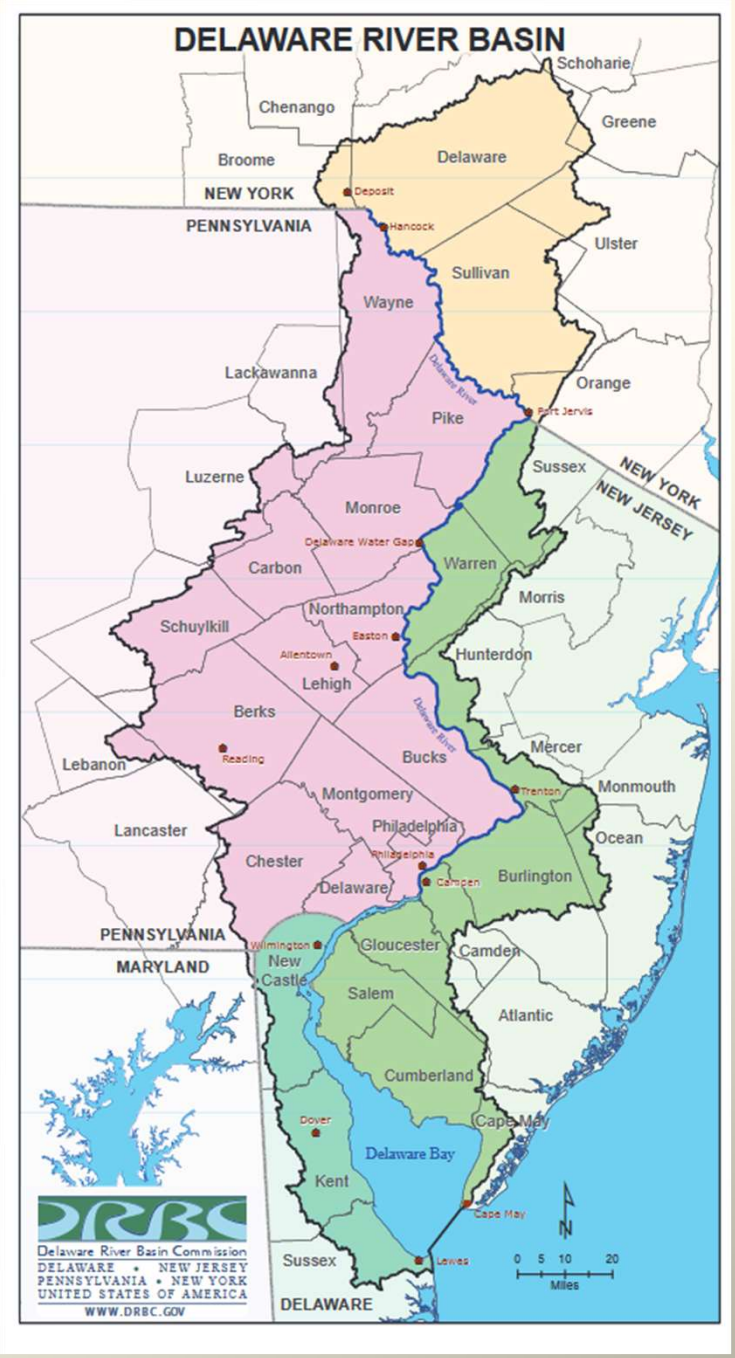
- *The FFMP is the set of rules adopted by the parties to the 1954 Supreme Court decree (New York, New Jersey, Pennsylvania, Delaware and New York City) to manage water releases into the Delaware from the three New York City dams on the headwaters. The FFMP, adopted in 2007,has been revised several times since. The latest revision, FFMP 2017, expires in 2027.*
- *The health of the trout fishery in the UDR depends on the magnitude, consistency and temperatures of river flows which are largely determined by the releases from the NYC dams --- which are themselves dictated by the FFMP rules.*
- *The FFMP influenced river flows also impact recreational boating.*
- *The FFMP calls for creation of seasonal flood mitigation voids in the reservoirs.*

Expanded Answer: The FFMP Balancing Act

The Decree Parties must unanimously agree on water release policy. Hence, the FFMP attempts to balance their at times conflicting water interests. It conforms to the 1954 Decree's 800 mgd constraint on NYC diversions and 1750cfs minimum flow at Montague. The FFMP explicitly aims to balance:

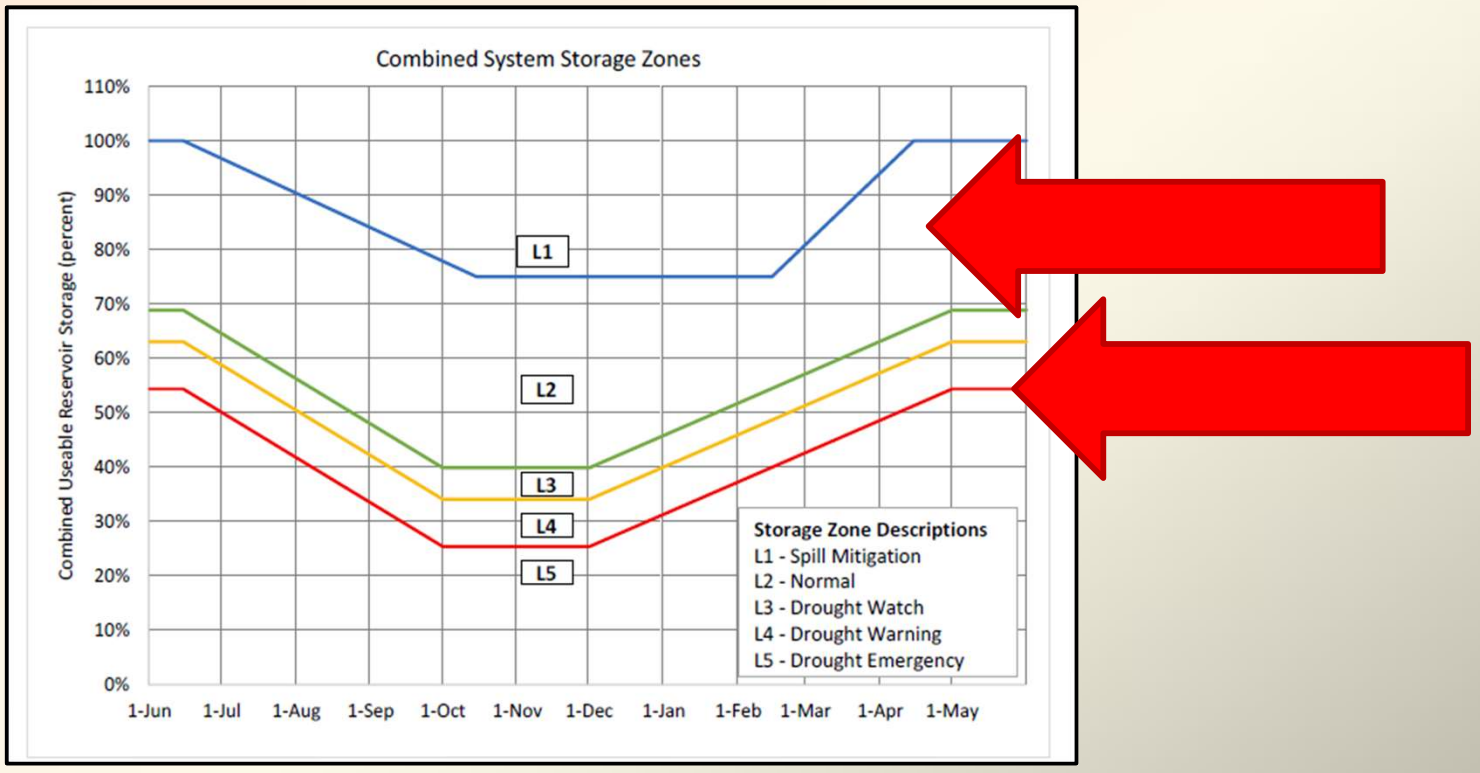
- Sustainable water supply for NYC, central NJ, Philadelphia, Trenton.
- Flood mitigation below the NYC reservoirs.
- Repulsion of the salt front at Trenton.
- More natural and ecologically beneficial flows for the Upper Delaware fishery.

For Perspective: An Overview of the Delaware



- 330 undammed miles from Hancock, NY to the ocean.
- Water supply for 15 million people. (NYC, Philadelphia, Trenton, central NJ, ..)
- Borders on four states and is subject to Supreme Court decrees and a federal/interstate compact.
- Contentious political struggles over its waters from colonial times to this very day.
- 150 miles are federally designated “Wild and Scenic.” (under National Park Service supervision)
- One of the finest wild trout fisheries in the world.

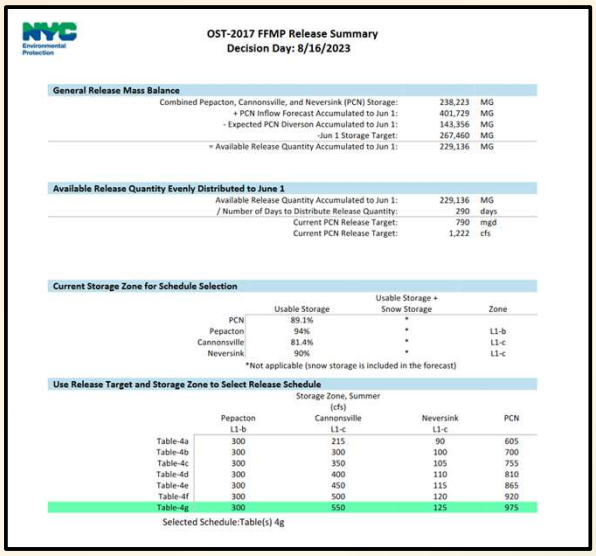
The FFMP Philosophy



- Adjust releases to keep reservoir storage in the 'normal' range (L2). Release more water if you have it.
- The Dominant Concern: Keep reservoirs above the drought line (L5)
- Flexible Management: Releases depend on the season, reservoir storage, predicted NYC usage and forecasted reservoir inflows.

How the FFMP Works:

Step 1. NYC-DEP Calculates Water Available for Release



NYC Environmental Protection

OST-2017 FFMP Release Summary
Decision Day: 8/16/2023

General Release Mass Balance

Combined Pepacton, Cannonsville, and Neversink (PCN) Storage:	238,223	MG
+ PCN Inflow Forecast Accumulated to Jun 1:	401,729	MG
- Expected PCN Diversion Accumulated to Jun 1:	143,356	MG
-Jun 1 Storage Target:	267,460	MG
= Available Release Quantity Accumulated to Jun 1:	229,136	MG

Available Release Quantity Evenly Distributed to June 1

Available Release Quantity Accumulated to Jun 1:	229,136	MG
/ Number of Days to Distribute Release Quantity:	290	days
Current PCN Release Target:	790	mgd
Current PCN Release Target:	1,222	cfs

Current Storage Zone for Schedule Selection

	Usable Storage	Usable Storage + Snow Storage	Zone
PCN	89.1%	*	
Pepacton	94%	*	L1-b
Cannonsville	81.4%	*	L1-c
Neversink	90%	*	L1-c

*Not applicable (snow storage is included in the forecast)

Use Release Target and Storage Zone to Select Release Schedule

	Storage Zone, Summer (cfs)			
	Pepacton L1-b	Cannonsville L1-c	Neversink L1-c	PCN
Table-4a	300	215	90	605
Table-4b	300	300	100	700
Table-4c	300	350	105	755
Table-4d	300	400	110	810
Table-4e	300	450	115	865
Table-4f	300	500	120	920
Table-4g	300	550	125	975

Selected Schedule:Table(s) 4g

(Archived OST Summary Data posted periodically on the ODRM website)

August 16 2023 Computations	(In BG)
Current Reservoir Storage	238
Add Forecasted Inflow	402
Less Expected Diversion	143
Less June 1 Storage Target	267
Total Available Release Quanity	230
Divide by Days to June 1	290
Daily PCN Release Target	0.79
Release Target in CFS	**1221**

How the FFMP Works:

Step 2. Consult one of four FFMP release tables

Table 4g

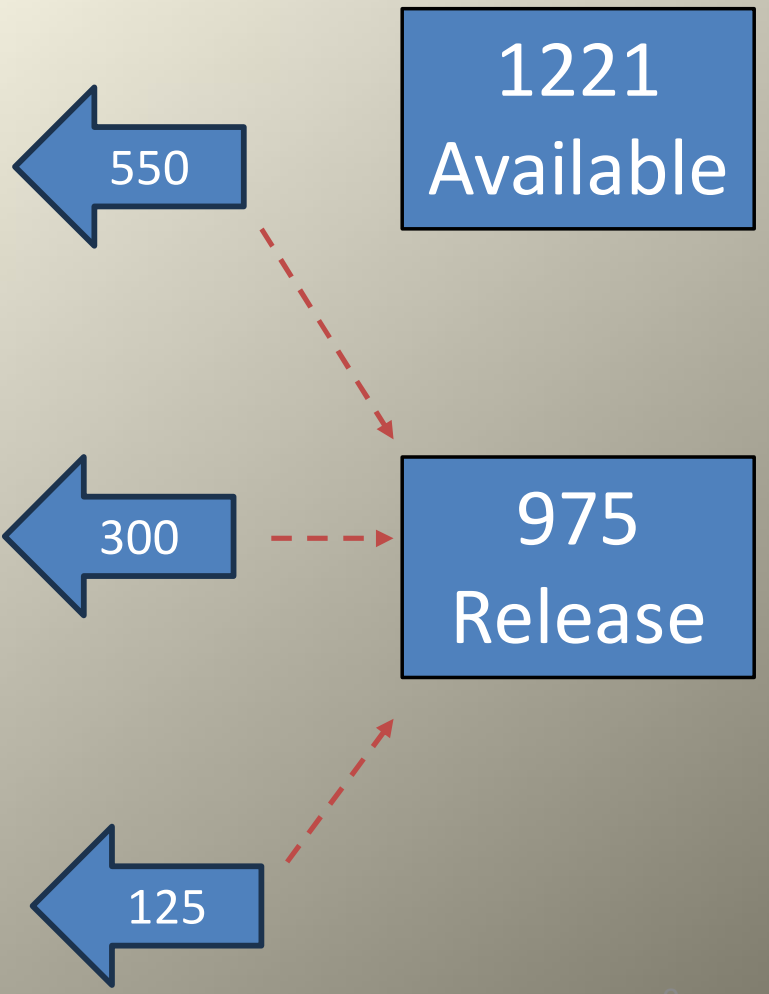
Schedule of Releases (cfs) during Normal Conditions

Cannonsville Storage Zone	Summer			Fall			Winter		Spring	
	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May
L1-a	*	1500	1500	1500	1500	1500	1500	1500	*	*
L1-b	600	600	600	600	600	600	600	600	600	600
L1-c	550	550	550	475	425	175	175	375	425	475
L2	500	500	500	450	400	150	150	350	400	450

Pepacton Storage Zone	Summer			Fall			Winter		Spring	
	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May
L1-a	*	700	700	700	700	700	700	700	*	*
L1-b	300	300	300	300	300	300	300	300	300	300
L1-c	170	170	170	160	145	100	100	100	145	160
L2	150	150	150	140	125	80	80	80	125	140

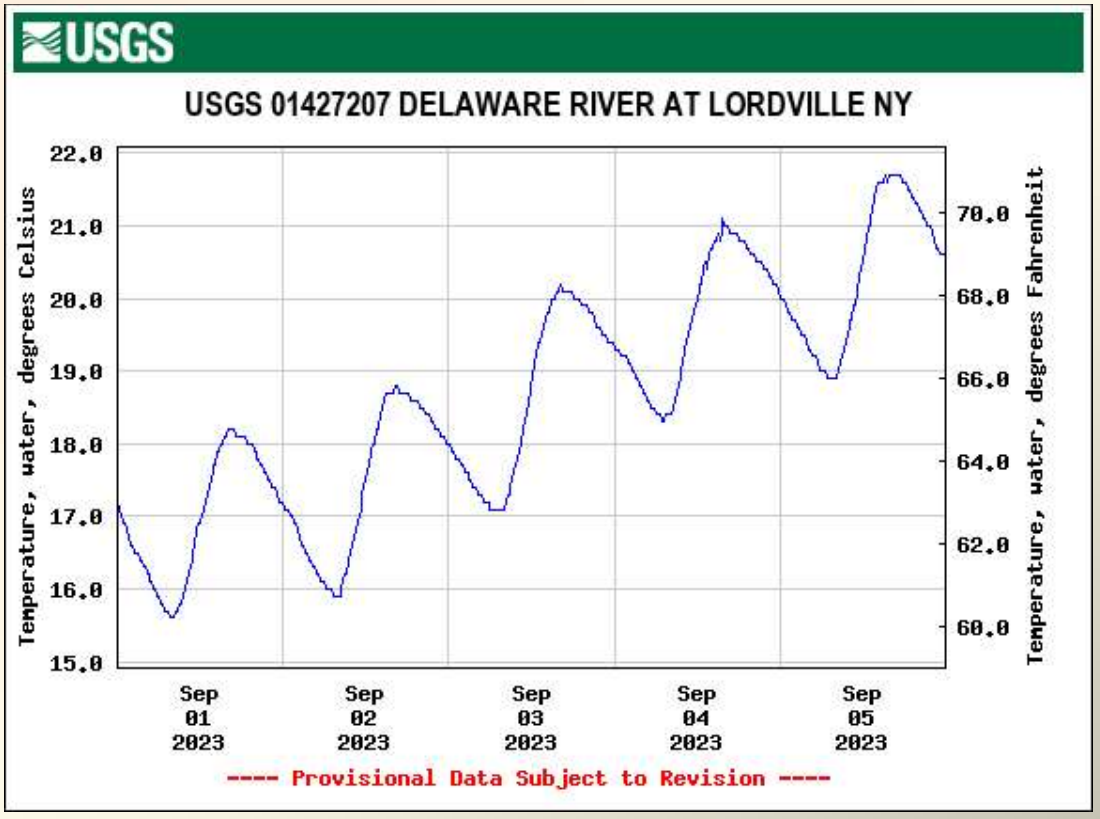
Neversink Storage Zone	Summer			Fall			Winter		Spring	
	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May
L1-a	*	190	190	190	190	190	190	190	*	*
L1-b	150	150	150	150	110	110	110	110	110	120
L1-c	125	125	125	115	100	75	75	75	100	115
L2	115	115	115	100	90	60	60	60	90	100

(FFMP 2017 Appendix A page 20)



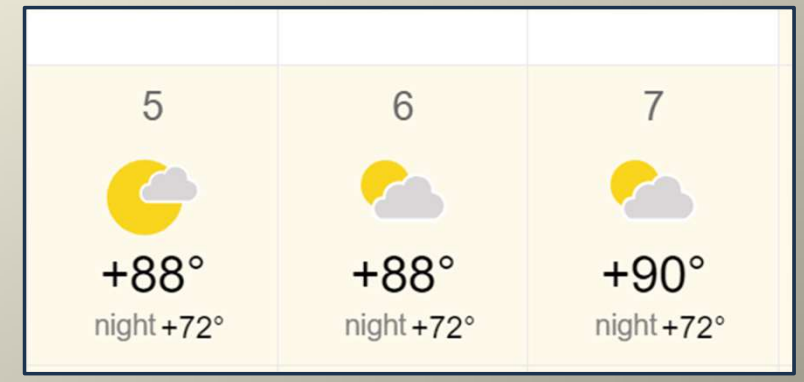
How the FFMP Works:

Step 3. Check Lordville Water Temperatures and Weather Forecast



Example:
September 5, 2023

Binghamton Forecasts



***The Thermal Goal**: Keep Lordville below 75˚ F. Here,* NYSDEC requested an increased release from Cannonsville of an 8 hour 100 cfs pulse above the FFMP release of 475 cfs.

Q2. How have reservoir releases and river flows been impacted since the inception of the FFMP?

The answer is complicated since it involves different river reaches and seasons, and both flows and releases are affected by the weather which varies. Moreover, the FFMP itself has changed substantially since 2007. Here are some main points:

- First "OUR" main goal in the original development of FFMP 2007 was to avoid the worst of past extremely low flow events. Example: On July 17, 2005, air temperatures reached 84˚F, and water temperatures at Hankins reached 82˚F, lethal to trout . Reservoir storage was at 92% capacity and yet the release from Cannonsville was only 151 cfs.

- Both Rev 1 and Rev 7 permitted spring and fall releases from Cannonsville of 45 cfs. And Rev 7 permitted 60 cfs in summer. Under FFMP this can no longer happen!

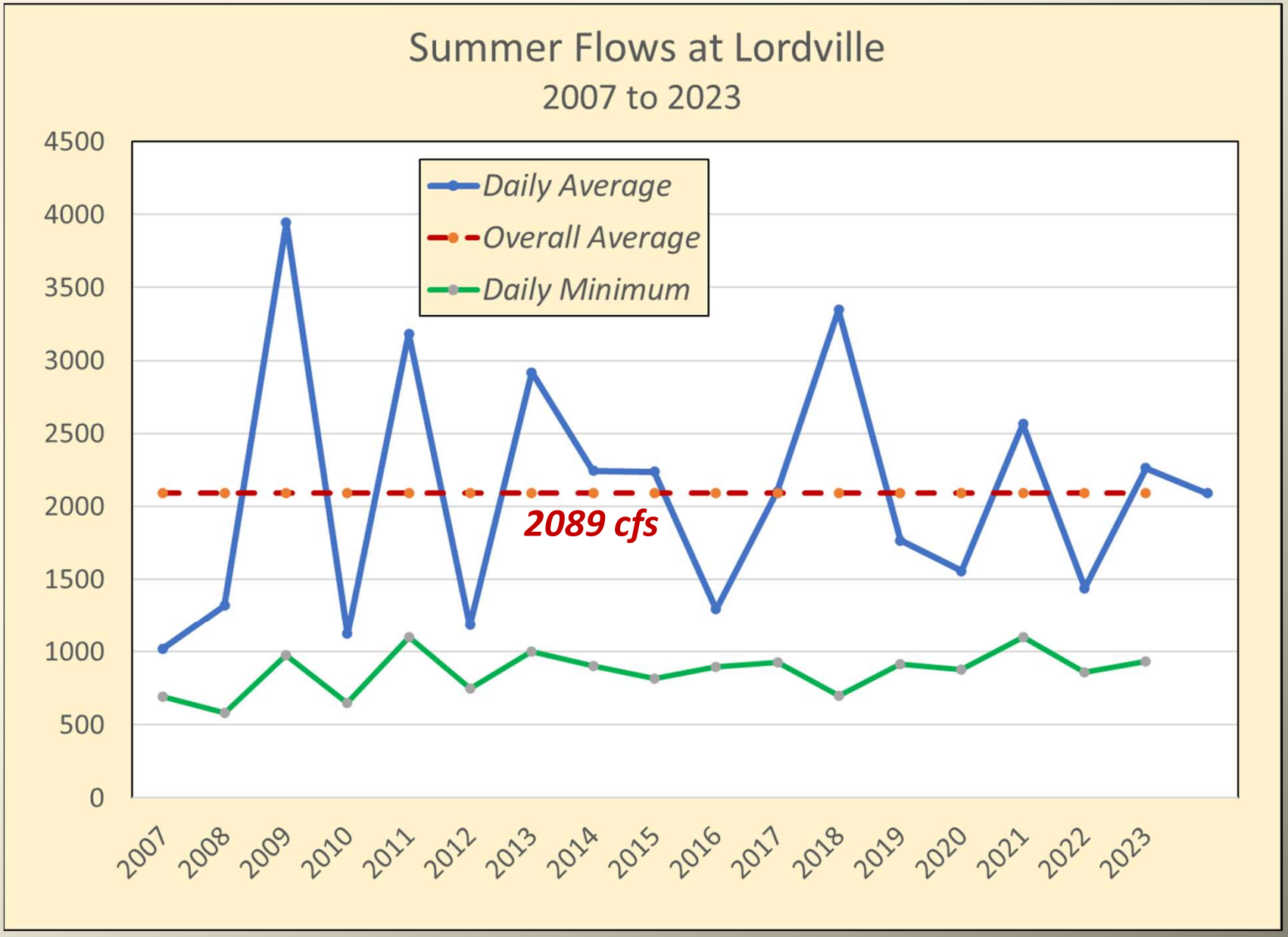
FFMP Impact, Continued

Base releases under normal reservoir levels (L2) are much improved visa viz the past. Consider July releases when in L2:

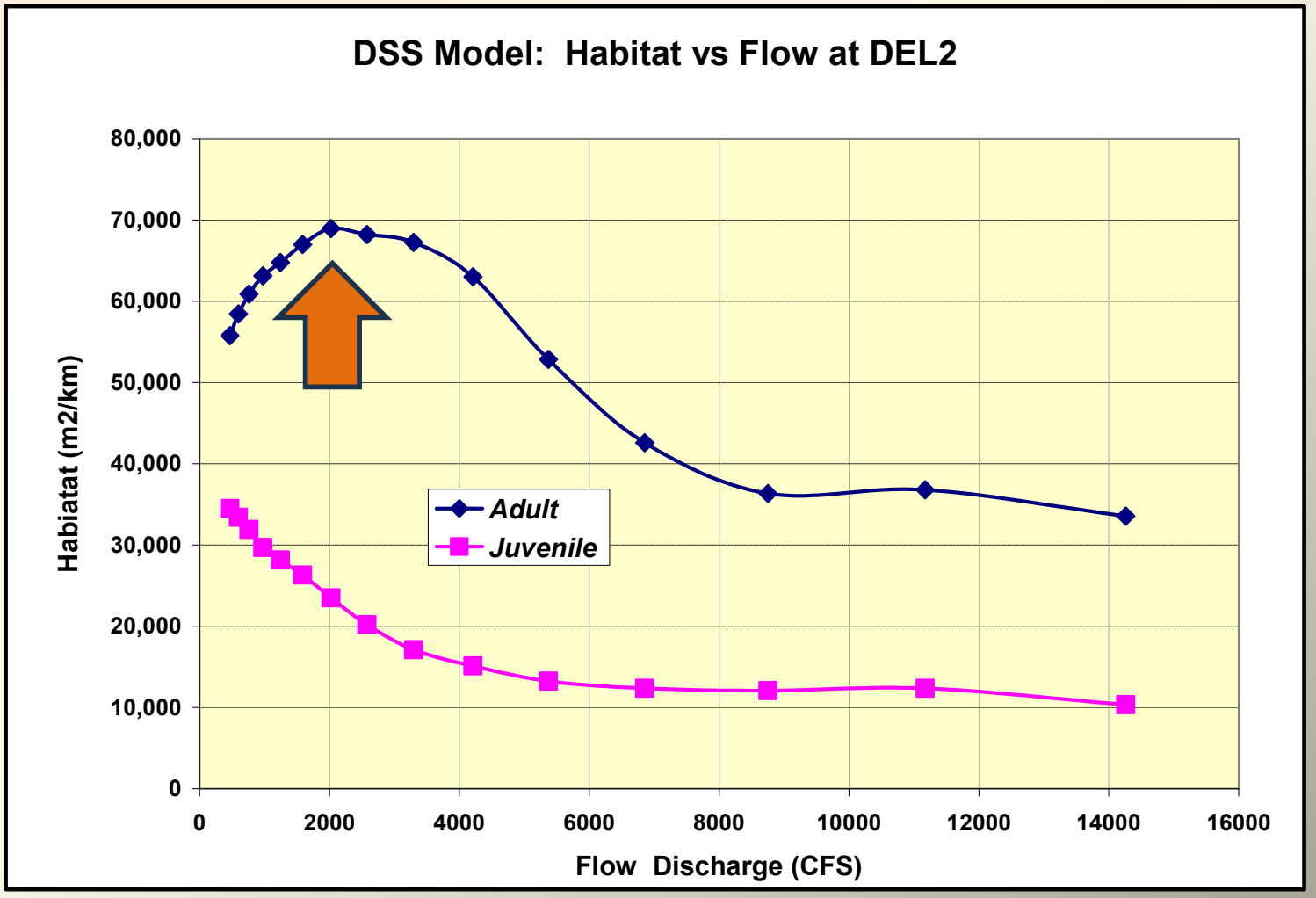
July Releases Under Normal Reservoir Storage (cfs)			
Policy Name	Impementation Year	Cannonsville	Pepacton
Revision 1	1977	325	70
Revision 7	2004	95	160
FFMP 2007	2007	260	140
FFMP 2017	2017	500	150

Fortunately, since 2007,we have almost always been in the normal range. So, summertime release from Cannonsville and Pepacton have been around 500 and 150 cfs, respectively.

FFMP Impact, Continued:
Flows at Lordville Under the FFMP



FFMP Impact, Continued:
Estimating Summertime Habitat at Lordville

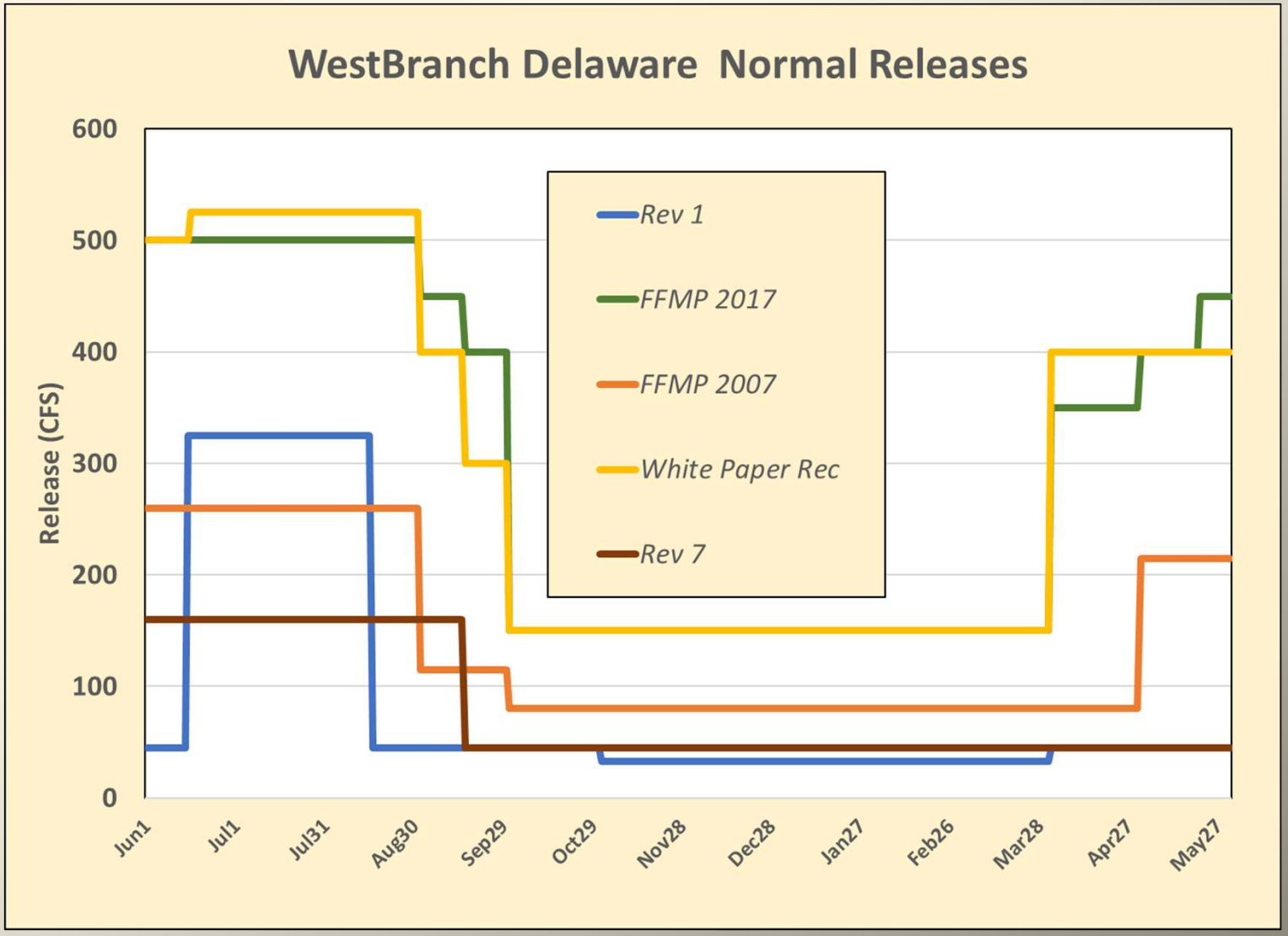


The average FFMP summertime flow of 2089 cfs is close to optimal for adult trout! Higher flows decrease habitat.

Bovee, K. (USGS Report 2007-1172) , "A Decision Support Framework for Water Management in the Upper Delaware River, p 88.

FFMP Impact, Continued

Overall, the planned base releases are superior to those of past regimes and are very close to those recommended in the 2010 Joint Fisheries White Paper.



FFMP Impact, Continued
Thermal

Since 2019, the Thermal Mitigation Protocol avoids the worst of the thermal stress events that had plagued the upper main stem prior to, and in the early days of the FFMP.

- The thermal protocol (run by NYSDEC) has been institutionalized and regularized --- to the relief of both the fishing community and the Decree Parties.
- The 75˚F constraint at Lordville has only occasionally been exceeded, and when so, only slightly and not for long.
- On average, about 4 days per summer when 75˚F would have been exceeded have been avoided.

Q3. Why are releases typically higher in the summer and lower in the winter?

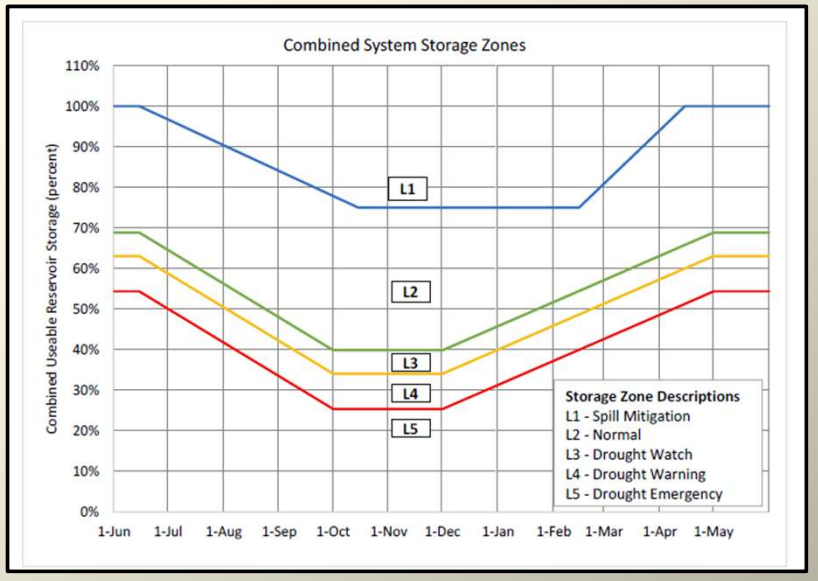
- The Decree Parties specified an FFMP design constraint on how often simulated reservoir levels could drop below the drought warning curves (5,560 days). This, in effect, set an FFMP budget on the water available for release. There is not enough water to maintain summer releases all year, so a partitioning/sharing is necessary.
- The FFMP's summer/winter partition tends to keeps storage in the normal level L2.
- Everyone, including the fish, suffers if the reservoirs drop below the drought curves. Importantly, the drought conditions of the 1960's must be avoided.
- Based in part on the USGS Fishery Habitat Model, fisheries biologists from NYSDEC and PAF&BC agreed in the 2010 White Paper to the levels we see in FFMP 2017. They had to make many risk /benefit tradeoffs among reaches of the river, life-stages of the trout, seasons of year, and needs of non-trout species. The OASIS and USGS Habitat models helped with these tradeoffs.

Q4. Why do the reservoir releases drop so precipitously on October 1?

- First, levels drop due to the concerns discussed on the previous slide.
- Second, the drop from Cannonsville is made rather severe to assure that fall-spawning brown trout make their redds in locations that do not get dewatered during the coming winter.
- The utility of this sudden and large Cannonsville drop off from 400 to 150 cfs could be reconsidered in a future FFMP design.

Q5. Why don't reservoir releases increase when the river needs it while the reservoir storage is high?

- They do! For example, on June 1 releases can be 600, 550 or 500 cfs depending on storage level.
- For flood mitigation, releases are notably higher when reservoirs are above the L1 curve.
- Releases drop sharply whenever storage drops into L3 or lower.
- FFMP releases are designed to keep the storage in the L2 range, and we are lucky to have seldom dropped to L3 since 2007. So, there has been substantial stability within seasons.



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Pepacton Storage Zone	Summer Jun 1 - 15-Jun	Summer Jun 16 - 30-Jun	Summer Jul 1 - 31-Aug	Fall Sep 1 - 15-Sep	Fall Sep 16 - 30-Sep	Fall Oct 1 - 30-Nov	Winter Dec 1 - 31-Mar	Winter Apr 1 - 30-Apr	Spring May 1 - 20-May	Spring May 21 - 31-May
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Neversink Storage Zone	Summer Jun 1 - 15-Jun	Summer Jun 16 - 30-Jun	Summer Jul 1 - 31-Aug	Fall Sep 1 - 15-Sep	Fall Sep 16 - 30-Sep	Fall Oct 1 - 30-Nov	Winter Dec 1 - 31-Mar	Winter Apr 1 - 30-Apr	Spring May 1 - 20-May	Spring May 21 - 31-May
L1-a	*	190	190	190	190	190	190	190	*	*
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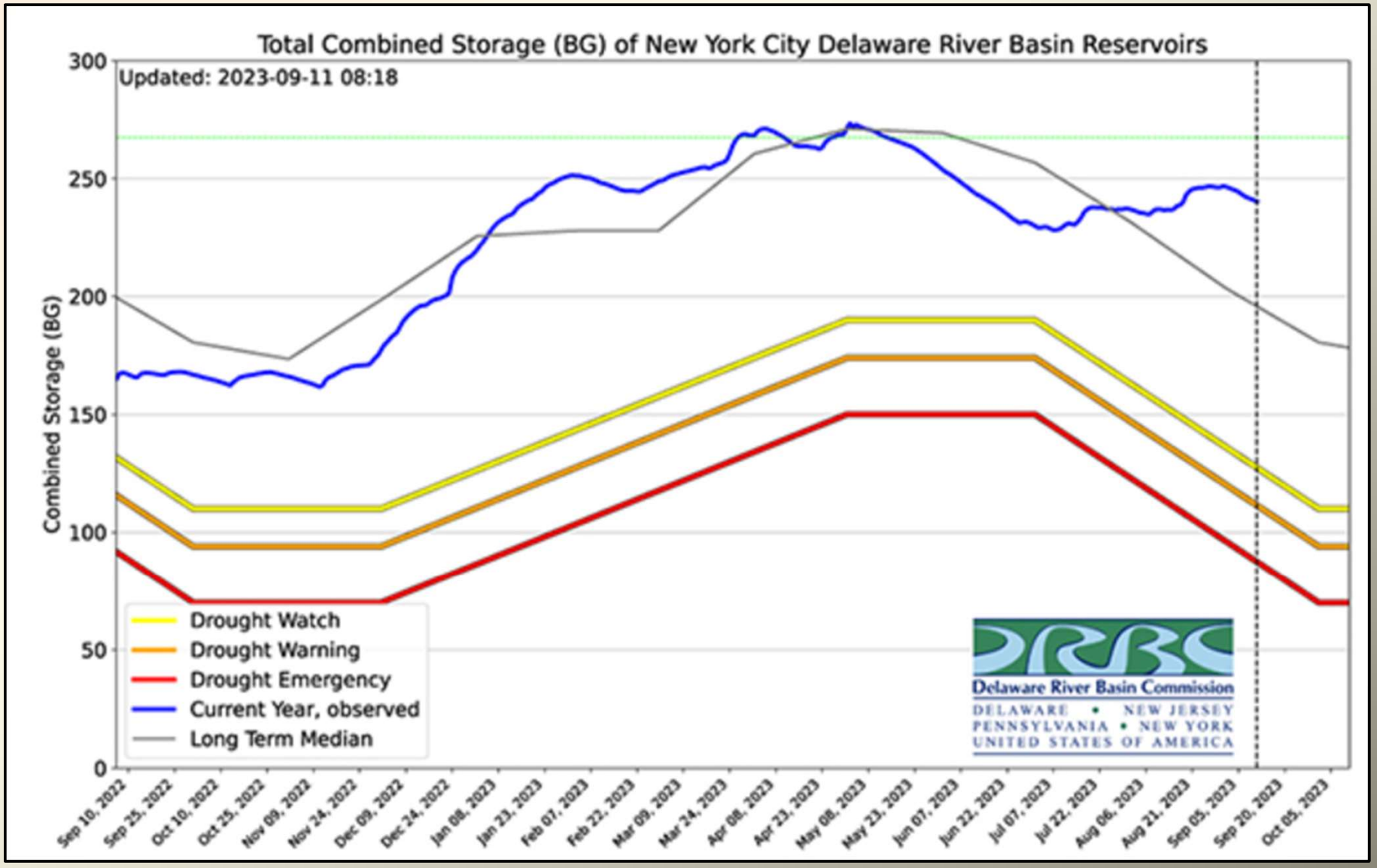
L1-c	125	125	125	115	100	75	75	75	100	115
L2	115	115	115	100	90	60	60	60	90	100

For Perspective: NYC Delaware Reservoir Storage

September 2022 to September 2023



Q6. Why is the thermal bank so small and the triggering temperature is 75˚F when we all know trout are happier at 68˚F?

- The thermal stress constraint is 75˚F for three reasons.
  - There is a long standing NYSDEC precedent of 75˚F temperature targets going back to Rev 1 in 1977.
  - 68 ˚F would be better, but the judgment of NYSDEC and PAF&BC biologists is that the flows concomitant with the 75˚F Lordville target will permit trout to move to thermal refuges.
  - My own analysis, done for the DRBC's SEF committee in 2018, showed that there is not nearly enough water to meet a 68˚F constraint, but that 75˚F is indeed water feasible.
- The current bank size of 2,500 cfs days was set by the Decree Parties without a justification.
  - Luckily, it has been adequate these 5 years, but it was a close call in 2020.
  - My own estimate is that we could well need more than 2,500 cfs days in future years and that there is ample water to increase the bank substantially.

Q7. What can we do in the next year, 5 years, 10 years to gain improvements in releases to benefit the UDR wild trout fishery?

- First, keep monitoring river conditions and politics and support your conservation organizations, particularly FUDR!
- Press for an increase in the thermal and yo-yo release banks and consider integrating them.
- Request a trout mobility study to determine what happens to trout in the main stem under thermal stress conditions. The last such study was in 1997.
- Request that NYSDEC and PAF&BC, perhaps through the SEF committee, review the work and findings of the 2010 White Paper and of the 2018 SEF committee's report on thermal mitigation. Also study and learn from NYSDEC's actual implementation of the thermal mitigation protocol.
- Urge the Decree Parties to carry out and communicate about the many environmental studies they committed to in FFMP 2017. Little has been done, less has been made public.
- Demand that DRBC make available to the environmental community useable and documented updates to the OASIS/OST and USGS Habitat models of the Delaware.


The End
Questions??

Appendix

A Short History of Delaware Release Policy

- ***1954 to 1976***: Coldwater from the NYC dams created the trout fishery, but the 1954 Supreme Court decree made no provision for conservation releases. No formal release policy existed until 1976.
- ***1976***: Pressured by fisherman, New York State legislates minimum conservation releases from all dams in the state, and imposes this on the Delaware dams. NYC and the DRBC resist in court.
- ***1977***: Court case settled and the NYS conservation releases are incorporated in the first official DRBC policy: DRBC 77-20CP
- ***1983***: Good Faith Agreement: Recognized that the drought of the 1960s made the 800 mgd NYC entitlement and the 1750 cfs Montague flow objective simultaneously infeasible. It specified reductions in both when the system is in drought. The new rule, Revision 1, was the last of 9 revisions to be 'permanent.'
- ***2004:*** Revision 7 added many complications, and the DRBC recognized the lack of a scientific basis, and called for a further revision that would be scientific and "sustainable."

Delaware Release Policy History, Continued

- ***2006***: With no progress made by the DRBC on developing a new policy, and motivated by a thermal crisis in July, 2005, the fishing conservation coalition intervenes and develops an science based policy.
- ***2007***: The Flexible Flow Management Program (FFMP), largely designed by the coalition is implemented. It protects the trout and also includes "spill mitigation" releases to protect against floods.
- ***2010:*** Joint New York / Pennsylvania Fisheries *White Paper* sets long term fisheries goals and recommends a policy with increased releases. (Strong fshing coalition input)
- ***2011***: FFMP/OST incorporates the NYC OST, moves closer to the *White Paper* recommendations. It uses forecasts of reservoir inflows and NYC diversions as well as reservoir storage to determine releases.
- ***2012 onward***: Stalemate as New Jersey demands more water. Two major fisheries issues: thermal relief and sudden dewatering are unresolved. Threat from NJ that if no agreement is reached, it will force a return to Revision 1.

Main Water Issues on the Delaware

- *The Delaware River* originates in the Catskill Mountains and flows 250 miles past Philadelphia into Delaware Bay. Its dams on the headwaters provide 50% of New York City's drinking water. The states of New York, New Jersey, Pennsylvania and Delaware have interests in and entitlements to the Delaware's water which supplies 16 million people.

- *US Supreme Court decrees* (1931 and 1954) permit the City to divert up to 800 million gallons of Delaware water per day, subject to maintaining a minimum flow of 1750 cubic feet per second at the USGS gauge at Montague, NJ. Modifications of water release rules or allocations must be unanimous.

- The Upper Delaware, one of the finest wild trout fisheries in the US, is dependent on cold water releases from the bottoms of the New York City dams. Conservationists have long wanted the City to smooth out and increase the releases of cold water into the river -- particularly in summer.

- There have been three 100-year floods on the upper Delaware in 2004, 2005 and 2006. River communities want the NYC dams to be used for increased flood protection.

FFMP Impact, Continued

Thermal

- Since 2019, the Thermal Mitigation Protocol avoids the worst of the thermal stress events that had plagued the upper main stem prior to, and in the early days of the FFMP.

Thermal Mitigation Experience Lordville 2019 to 2023

	2007*	2008**	2019	2020	2021	2022	2023
Releases Made		3+	9	22	7	23	2
Water Used		450+	1500	2350	650	1850	175
Max Lordville Temp	77	81.3	75.2	76.3	76.1	76.5	73.9
Stress Days (>75˚ F)	10	18	1	11	2	3	0
Stress Days Avoided		1	3	6	2	9	2

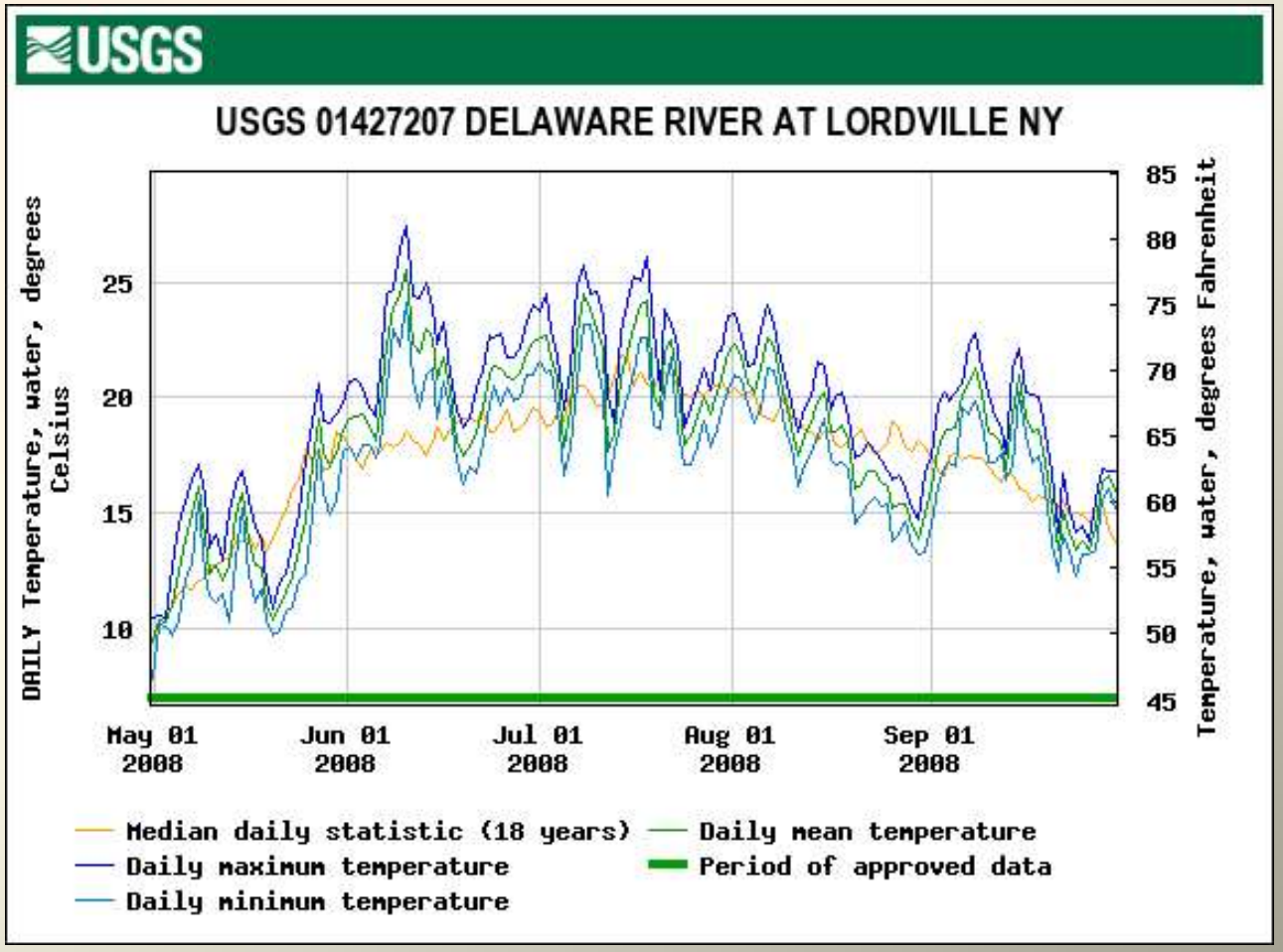
* 2007 was the last summer before the FFMP, and the only such summer with Lordville temperature data.

** 2208 was the first summer of the FFMP and base releases were 'predicted' to be inadequate by Kolesar & Serio. There was no thermal mitigation protocol, but some thermal releases were made on an emergency basis

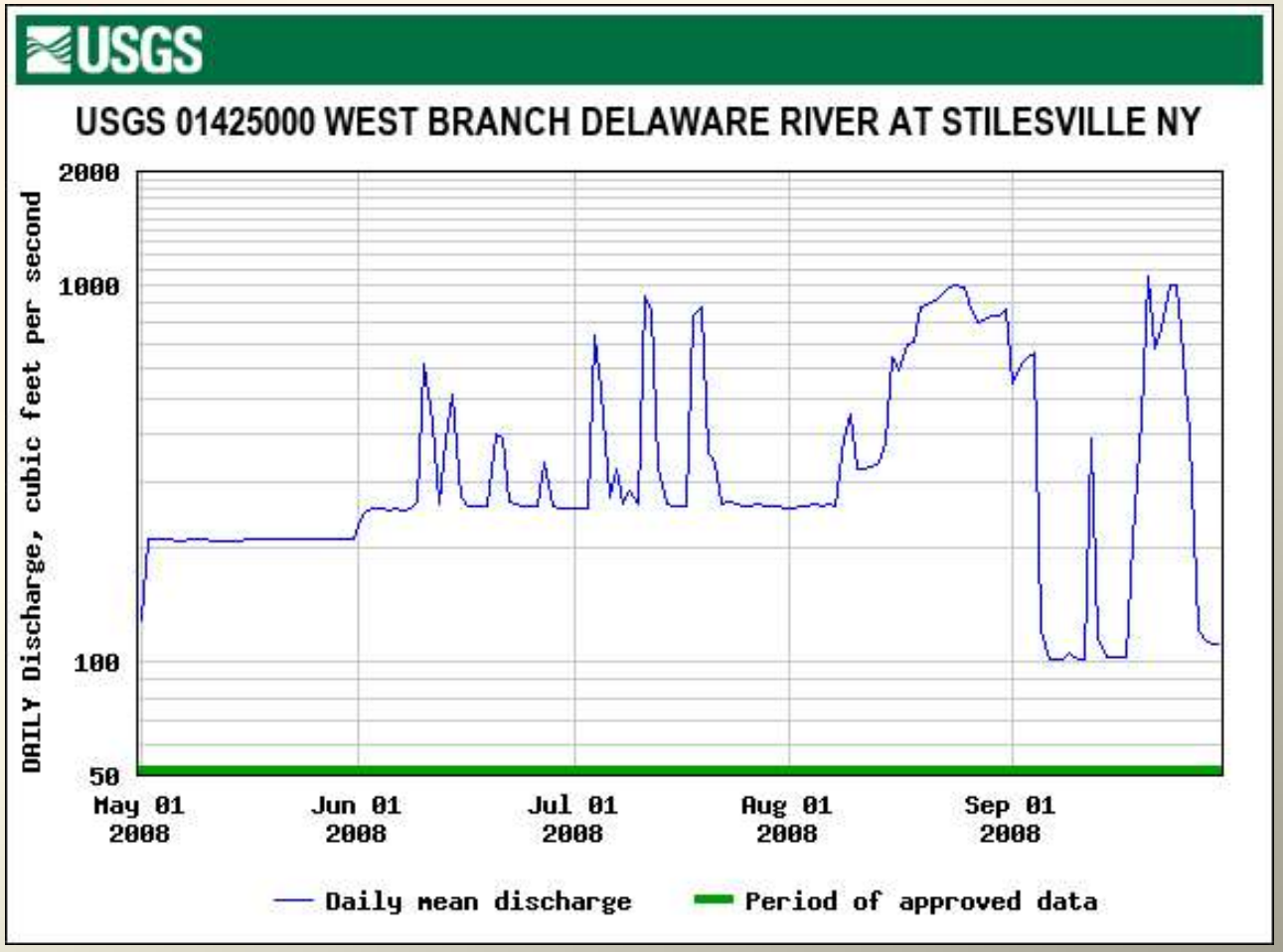
What does the current FFMP/OST operating rule do?

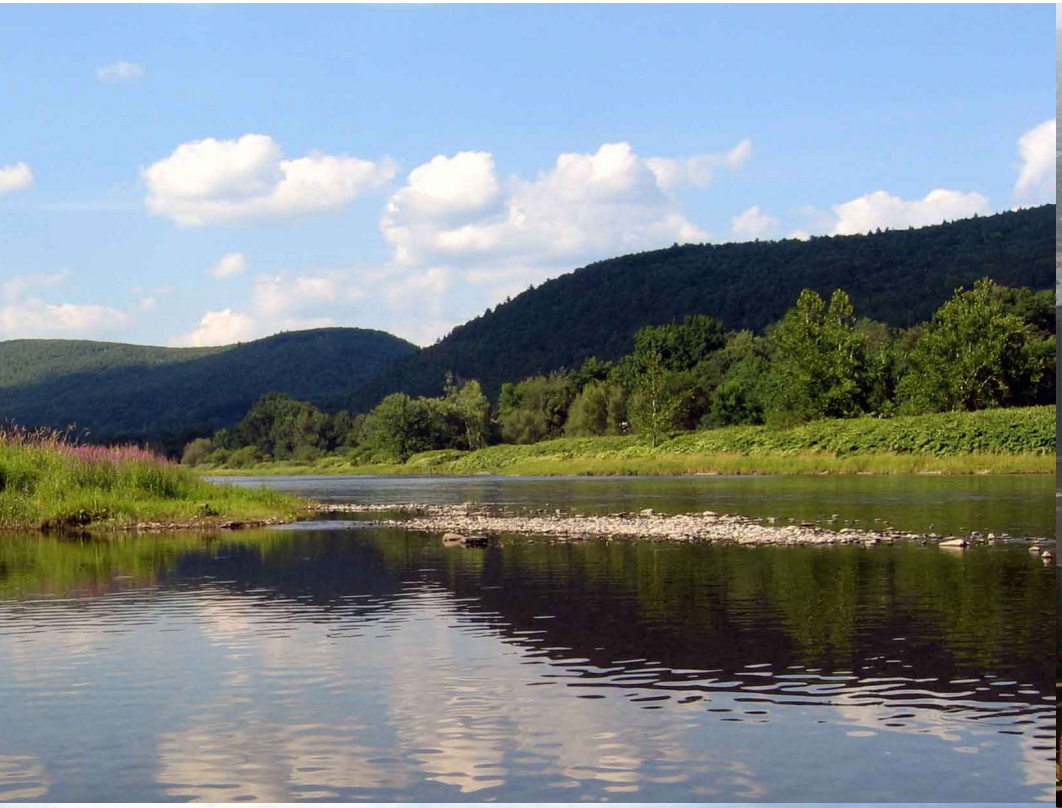
- Conservation releases are higher than under previous rules and are mathematically keyed to:
  - Season of year and amount of water in the reservoirs.
  - Forecasts of actual NYC demand and future precipitation.
- When reservoirs fill in the spring, releases are increased to create flood mitigation voids in the reservoirs.
- The result is increased fish habitat and protection without additional water shortage risk to NYC, NJ or other stakeholders. Most of the time there is enough water to meet all needs, but droughts do occur and s0 some rationing is necessary.

Lordville Temps Summer 2008



Stilesville Discharges Summer2008





A river is more than an amenity, it is a treasure. It offers a necessity of life that must be rationed among those who have power over it.

— Oliver Wendell Holmes, Jr. (1931)

"Our" Upper Delaware: The Catskills to Port Jervis

- Three NYC reservoirs
  - Cannonsville, West Branch
  - Pepacton , East Branch
  - Neversink
- Major Tributaries
  - Lackawaxen, PA
  - Mongaup, NY
- Trout fishery from Deposit to Callicoon
- The biggest shad migration in the nation

Pepacton Reservoir

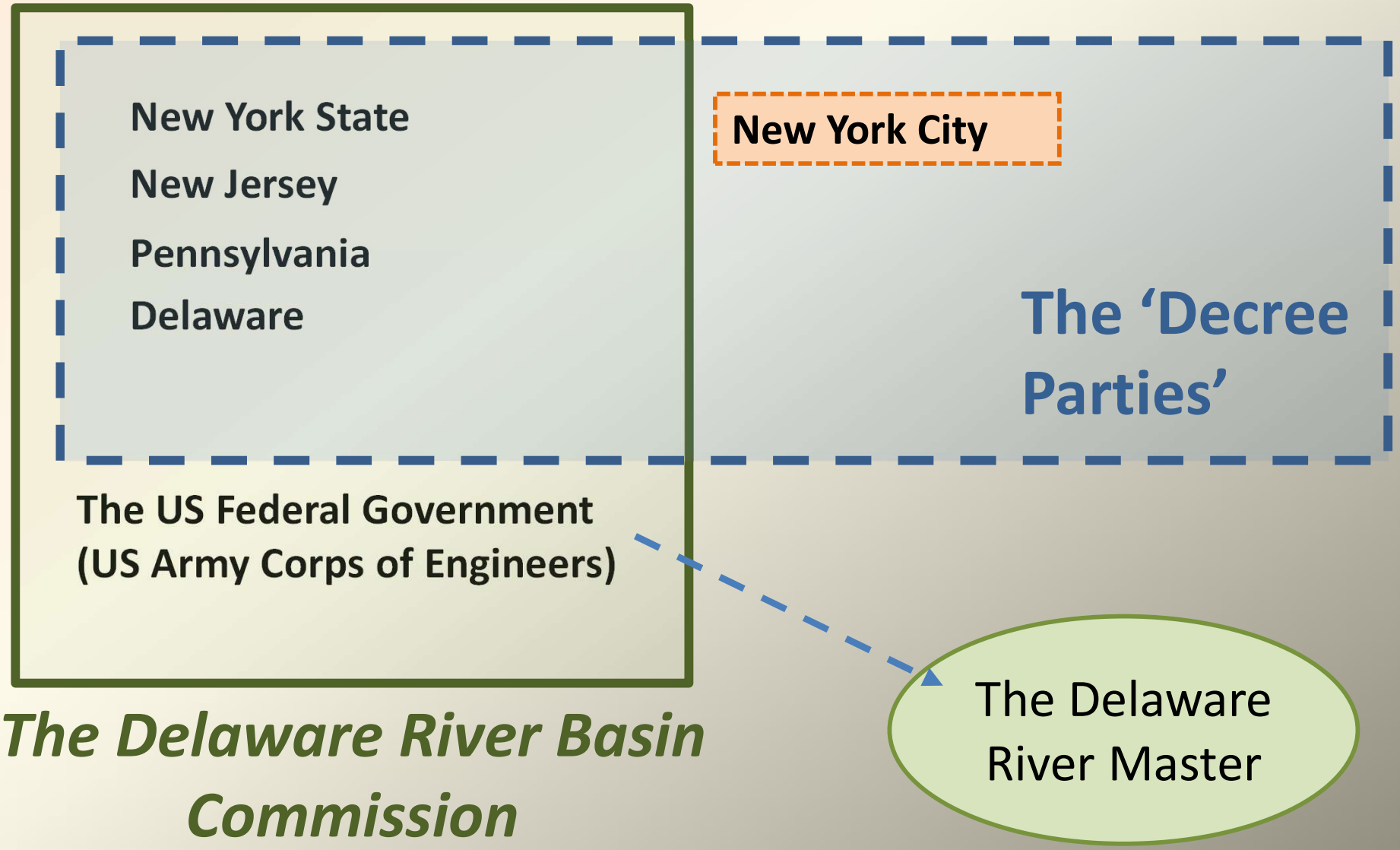
A Trout's View of Delaware River Politics

- Trout need cold clear water
- Delaware flows and temperatures are largely determined by releases from the New York City dams on the headwaters.
- These releases are governed under a Supreme Court Decree of 1954 which sadly did not consider the ecology.
- Under the Decree, New Jersey, Pennsylvania, Delaware and New York State, and New York City each have vetoes on water release policy changes.
- Frustrated by inadequate releases since 1956, anglers and environmentalists argued and agitated for decades for improvement.
- This struggle reached a critical point in 2005. A solution was designed and implemented in 2007 that has been improved in the years since. (The Flexible Flow Management Program.)

The 1954 Supreme Court Decree and its aftermath

- New Jersey sued to keep the City from building its dams on the Delaware. The settlement decree gave the City the right to build its dams but,
  - Limited the amount of water NYC could divert from the Delaware (800 mgd).
  - Required it to maintain a minimum flow at Port Jervis (1750 cfs).
  - Made no provision for the ecology of the upper river.
- So, the fishery needs were ignored, and summertime releases could be erratic and as low as 45 cfs from Cannonsville.
- Since 1956, a succession of 9 ecologically unsatisfactory release rules had been in effect. Releases were too low and too erratic. The fisherman complained constantly.
- By 2004, even the parties to the decree (New York State, New York City, Pennsylvania, New Jersey and Delaware) agreed that a science-based re-design was needed.

Who has the Power? The Delaware's Complex Political Structures and Relationships



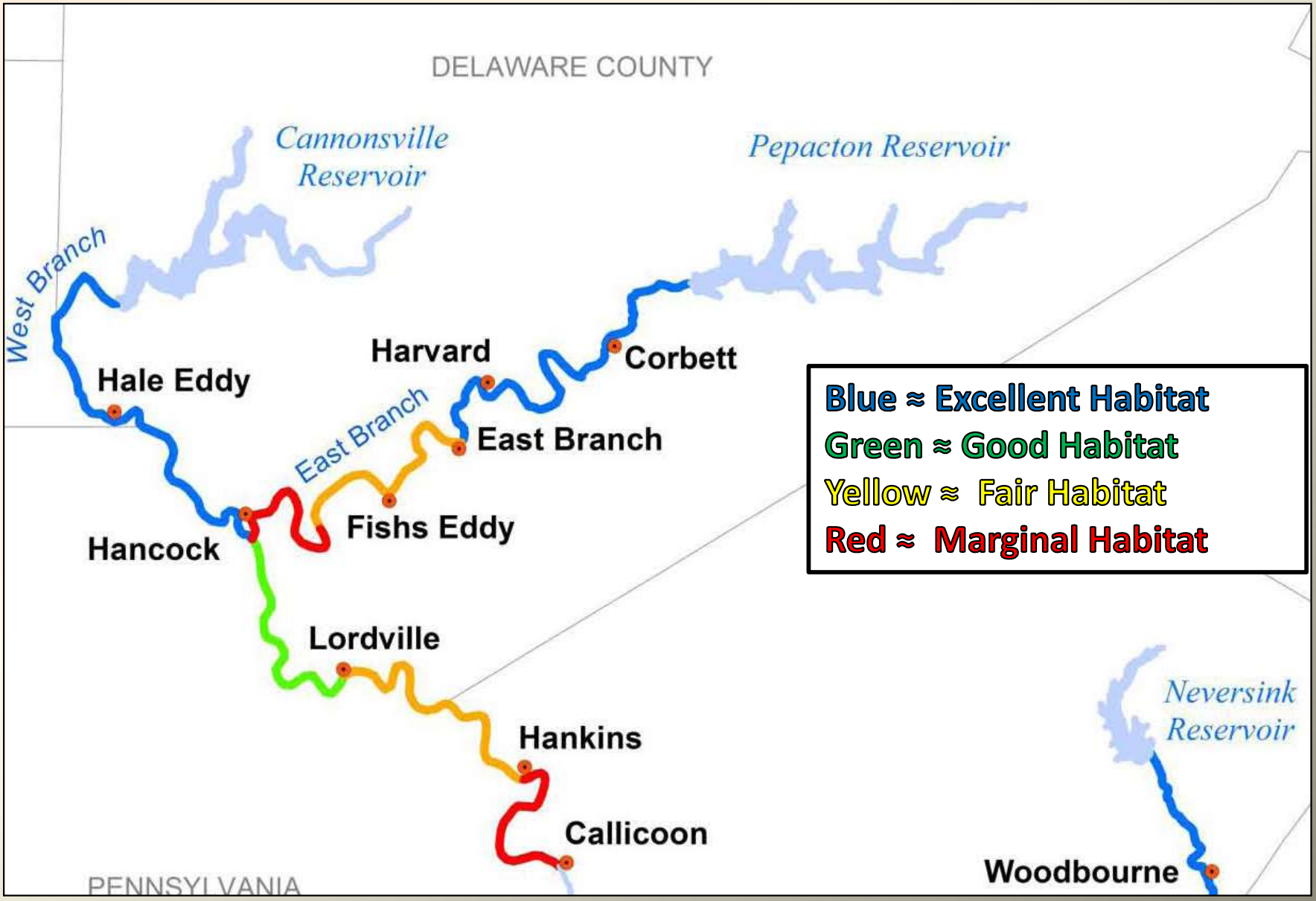
Initial Statistical Findings

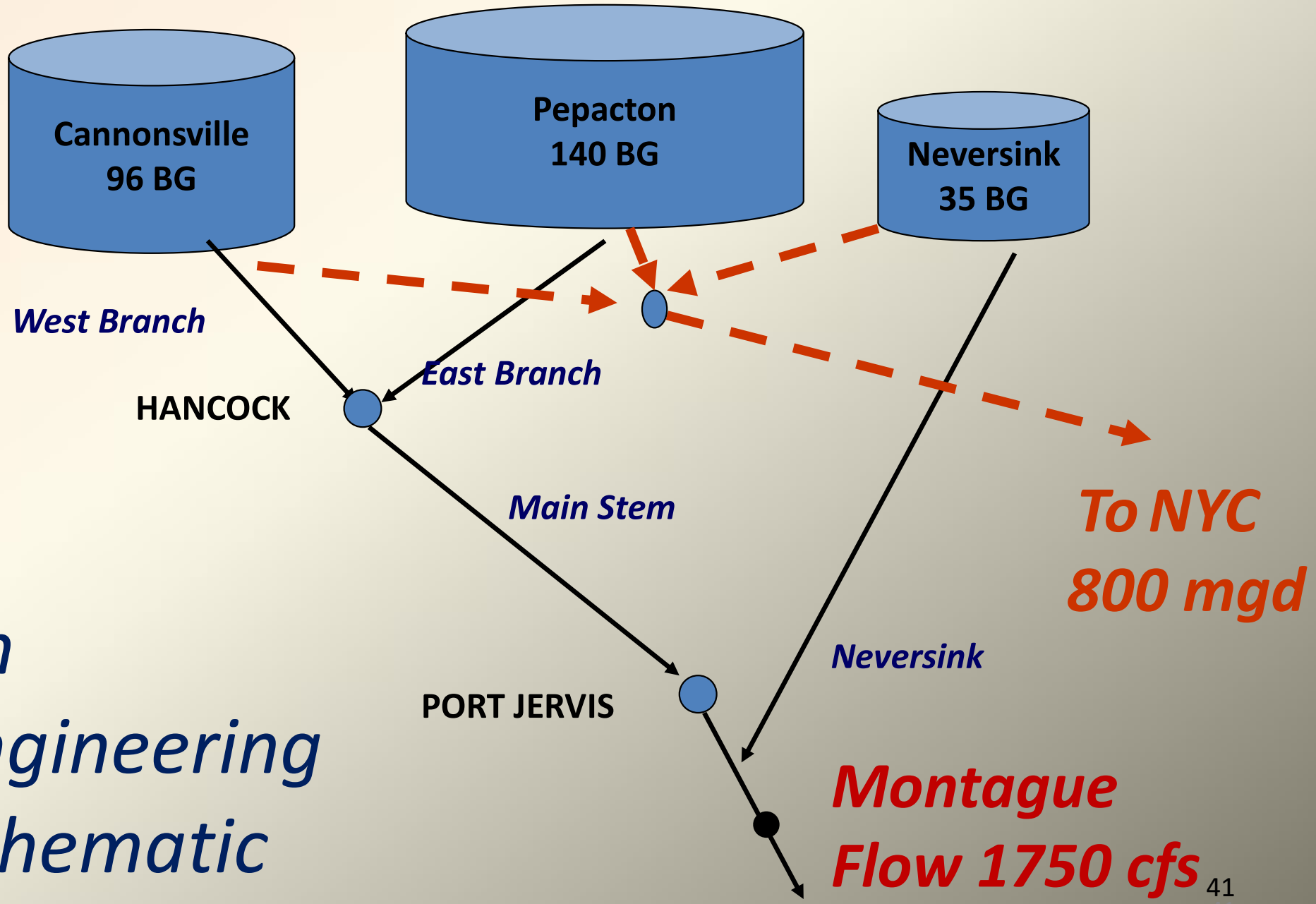
- The existing release rules wasted a lot of water:

Diverted to NYC	55%
Released to theRiver	20%
Spilled Over the Dams	25%

- Our strategy:
  - Convert wasteful springtime spills to ecologically beneficial summer releases.
  - Treat water behind the dam like an inventory of Tide deterrent in a warehouse.
  - Use a computer simulation of the river to try out and test possible release rules.
  - Trade off increase in drought risk vs gain in trout habitat.

Our long-term goal: More trout habitat: Getting more 'Blue' river segments





An Engineering Schematic