New York State Department of Environmental Conservation
Division of Fish, Wildlife & Marine Resources
Bureau of Fisheries, 5th Floor
625 Broadway, Albany, New York 12233-4753
Phone: (518) 402-8920 **FAX:** (518) 402-9027
Website: www.dec.state.ny.us

Alexander B. Grannis
Commissioner

Pennsylvania Fish and Boat Commission
Bureau of Fisheries
450 Robinson Lane, Bellefonte, Pennsylvania 16823-9620
Phone: (814) 359-5100 **Fax: (**814) 359-5153
Website: www.fish.state.pa.us

Recommended Improvements to the Flexible Flow Management Program for Coldwater Ecosystem Protection in the Delaware River Tailwaters

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This paper represents the collaborative effort of fisheries biologists from both the Pennsylvania Fish and Boat Commission and the New York State Department of Environmental Conservation Division of Fish, Wildlife and Marine Resources.

In the context of the Delaware River Basin Commission (DRBC) and negotiations among the Parties to the 1954 US Supreme Court Decree, it is recognized that the volume and condition of water reserved in Delaware Basin reservoirs is insufficient to meet the optimum needs of all basin-wide uses, including but not limited to water supply to New York City and down basin users, flood mitigation, salinity repulsion, recreational activities, and aquatic habitat. This paper suggests preferred tailwater releases from the New York City Delaware Basin reservoirs during normal conditions from a biological perspective. As such, it is important to note that this paper is not intended to suggest the relative priority of various uses and that the analyses conducted herein involving diversion patterns and outputs of the Operational Analysis and Simulation of Integrated Systems (OASIS) model have not been condoned by the DRBC or Parties to the 1954 Supreme Court Decree.

BACKGROUND

The Flexible Flow Management Program (FFMP) was accepted by Parties to the 1954 Supreme Court Decree (Decree Parties) on September 30, 2007 as a way to best manage releases from New York City reservoirs in the upper Delaware River system[1]. A primary objective of the FFMP is to eliminate "banks" of water that were relied upon in earlier agreements to meet temperature and/or habitat flow targets. These banks proved to be problematic for several reasons. First, meeting temperature and/or flow targets involves combining weather forecasts, current stream conditions, models, and experience to predict how much water must be released in advance to maintain targets. This has proven to be very difficult and requires staff to constantly monitor stream conditions. Secondly, various interested parties have different views on when and how water should be released from a bank, which often resulted in pressure to release

[1] A 1954 Supreme Court Decree authorizes New York City to divert up to an average of 800 mgd from the Delaware basin reservoirs. The current FFMP agreement provides up to 35 mgd to be used as releases to sustain the coldwater ecosystem below the reservoirs and for spill mitigation. The 35 mgd allocation is temporary and contingent upon the construction of additional reservoir storage by December 31, 2012, unless otherwise agreed to by the Decree Parties.

water when the circumstances may not have warranted it. Finally, water in the banks often went unused at the end of the season and therefore did not provide any habitat benefit to the system.

Instead of relying on banks, FFMP releases are determined by fixed release schedules that depend upon season, reservoir storage level, and the amount of water made available from the New York City allocation for the program during a given year. It was envisioned that this new system would be less labor intensive, reduce errors in predicting needed releases, and provide more stable base flows rather than the often rapidly rising and falling releases needed to meet temperature targets. It is important to note that the development of the FFMP release schedules were constrained by the decree party agreement that any new release programs should be sustainable with respect to present and projected needs and be neutral with respect to drought risk when compared to the last permanent program, Revision 1. The method used to determine drought neutrality was to limit the number of predicted drought days produced by any release schedule to 5,560 days[2]. The resulting release schedules in the FFMP were an attempt to make the best allocation of available water while still remaining within the 5,560 drought-day constraint. Based on experience gained while managing habitat and thermal protection banks under previous release agreements and on modeling flows during the development of the FFMP, it was recognized by the New York State Division of Fish, Wildlife, and Marine Resources (DFWMR) and the New York State Division of Water that it would not be possible to provide thermal protection on the mainstem Delaware under all conditions while adhering to the 5,560 drought-day limit. Out of necessity, a priority was placed on maintaining suitable summer water temperatures and year-round habitat flows in the West Branch of the Delaware River and the upper sections of East Branch of the Delaware and the Neversink River.

In an effort to provide biologically-based recommendations on how to improve the FFMP, the DFWMR and Pennsylvania Fish and Boat Commission (PFBC) have cooperated to perform analyses and identify conditions in the Delaware River and its major branches that will provide adequate protection for the coldwater ecosystem in these waters. Fisheries managers are confident that if the FFMP release regime is modified as recommended in this paper, a robust coldwater fishery commensurate with the potential of the upper Delaware River system will be more fully realized. In developing these recommendations we were not insensitive to issues associated with reservoir management among the Decree Parties. While we recognize benchmarks developed by the Decree Parties, such as the 5,560 drought day limit, we chose to not be constrained by them in our efforts to evaluate the benefits of modified releases to aquatic life.

PURPOSE

This paper will: (1) briefly review the performance of the FFMP during its first year of implementation, (2) outline cold water ecosystem management objectives for specified reaches of the East and West Branches of the Delaware River, the Neversink River, and the upper mainstem Delaware River (hereafter referred to as the "Delaware tailwaters"), (3) make reservoir release recommendations to improve coldwater ecosystem protection and provide the supporting analysis for these releases, (4) Provide a basis for future recommendations as additional information becomes available, and (5) address issues relating to federal and state listed threatened and endangered species.

Releases from the Cannonsville, Pepacton, and Neversink Reservoirs are critically important to the condition of the coldwater ecosystem and fishery in the Delaware tailwaters. As one moves further downstream, releases become less influential in regulating water temperatures, and eventually coolwater and warmwater communities become dominant. Properly regulated flows and maintenance of suitable habitat are still important for species such as dwarf wedgemussel and shad. Diadromous species, including American shad, American eel, striped bass and sea lamprey, are indigenous to the upper Delaware River basin and utilize it during some or most of their life cycles, and can have different

[2] Drought days are calculated by summing the number of days that the OASIS model predicts NYC reservoir storage to be at or below drought watch levels over the period of record (1/1/28 through 9/30/00). The 5,560 drought day limit is equal to the number of drought days predicted by OASIS for the 1983 DRBC Docket D-77-20 CP (Revision 1).

requirements than a coldwater community. However, specific management goals and objectives for the cool transitional, migratory and warmwater communities are beyond the scope of this coldwater fish community management narrative.

This white paper should be considered a working document, intended to provide recommendations based on the most current information available. As additional studies are conducted and the impacts of reservoir releases on the tailwaters continue to be monitored, we should reexamine and consider modifications to program objectives, protection designations, and release recommendations.

FFMP FIRST YEAR PERFORMANCE

FFMP releases began on October 1, 2007. The FFMP releases program performed somewhat as expected during the first full year. Water temperatures in the West Branch of the Delaware River to Hancock and in the upper sections of the East Branch of the Delaware River and Neversink River remained suitable for coldwater aquatic organisms throughout the summer. For example, examination of the gauging data at key locations on these rivers shows that the scheduled releases provided relatively acceptable thermal protection during four consecutive days in June of 2008 when air temperatures exceeded 90^{o} F. Water temperatures may have approached marginal levels in the vicinity of Hancock on the West Branch and Bridgeville on the Neversink, but overall the FFMP performed quite well. Summer water temperatures on the mainstem Delaware, however, rose to levels that were extremely stressful for trout a number of times during the course of the 2008 summer. For example, daily maximum water temperatures at the USGS Lordville gauge equaled or exceeded 75^{o} F on 20 days, with a maximum water temperature of 81^{o} F occurring on June 10.

During dry periods when there are no River Master directed releases, flows can become quite low. For example, early August 2008 flows on the West Branch were the lowest recorded for that time period over the past thirty years, with the exception of two years during Revision 1. In early September, flows were again among the lowest experienced for that time period during the previous thirty years. For the rest of the year, FFMP flows on the West Branch were comparable to those occurring under Revision 7. A similar pattern occurred at Callicoon on the main stem Delaware during July and September. During both time periods flows dropped to the lowest levels recorded for those periods during the past thirty years, with the exception of one year during Revision 7 in each case. However, periods of low flow on the Delaware River are not that extraordinary. Since 1979 there have been 128 days when the daily flow at Callicoon was less than 600 cfs during the May 15 – September 30 time period, including a record low of 312 cfs on August 23, 1985.

In general, the fall, winter, and spring releases specified in the FFMP are below what would be needed to provide optimal aquatic habitat year-round. Since reservoir storage is frequently in the L2 zone, the fish community is ultimately shaped by the habitat available under L2 flows. Under Revision 7, releases were made to meet year-round habitat flow targets of 225 cfs at Hale Eddy on the West Branch, 175 cfs at Harvard on the East Branch, and 115 cfs at Bridgeville on the Neversink. Under the FFMP at the L2 storage zone during October and November, releases fall to 80 cfs on the West Branch, 60 cfs on the East Branch, and 45 cfs on the Neversink. The combined release of the East and West branches flowing into the main stem Delaware are 140 cfs as compared to a combined flow target of 400 cfs under Revision 7. As a result, we can expect fall and winter flows on all three tributaries and the mainstem Delaware to be significantly lower under the FFMP than Revision 7 during periods of low natural flow. Current releases are even less for the lower reservoir storage zones and for years when less than 35 million gallons per day is available for the release program.

In summary, we believe that the schedule of releases specified in the 35 mgd table in the December 2008 FFMP will, under most circumstances, provide adequate summer thermal protection for the West Branch and upper portions of the East Branch and the Neversink River. However, the FFMP release schedule does not provide acceptable year-round flows for habitat protection, and temperature in certain segments

of the mainstem will frequently exceed desirable levels. Maintenance of suitable flows from fall through spring on these streams is important for fish spawning and overwintering habitat, egg incubation and fry hatching, and to provide access to spawning tributaries.

MANAGEMENT OBJECTIVES

The overall fisheries management goal for the Delaware tailwaters is to enhance the coldwater fishery while maintaining aquatic community diversity, structure and function through improved ecological flow releases from New York City water supply reservoirs. From a fisheries management perspective an optimal release schedule would provide for suitable year-round habitat flows and summer water temperatures in all of the Delaware tailwaters.

We propose a series of four categorical protection levels for describing coldwater ecosystem management objectives for the Delaware tailwaters. The protection levels are for non-drought years and address both year-round habitat and summer water temperature. They are illustrated in Figure 1 and defined as follows:

Excellent – River sections with this designation will experience excellent year-round coldwater aquatic habitat and thermal protection and maintain opportunities for a year-round coldwater fishery. Summer water temperatures are routinely 68°F or less and would never or only very rarely exceed a daily maximum of 75° F.

Good – River sections with this designation will provide coldwater aquatic habitat and thermal protection and maintain opportunities for a coldwater fishery. However, elevated water temperatures will occasionally be an issue in these sections, and the year-round abundance of coldwater species are not expected to be as prevalent as in sections with the Excellent protection level. Summer water temperatures will occasionally exceed a daily maximum of 75° F for short periods and water temperatures greater than 68° occur more frequently than for sections with Excellent protection.

Moderate – River sections with this designation will experience adequate flow and some thermal protection for coldwater species and maintain seasonal opportunities for a coldwater fishery. Coldwater species will not be as prevalent as waters with higher levels of protection. The thermal benefits from reservoir releases will diminish in these sections, and summer water temperatures will frequently exceed daily maximums of 75° F. However, stream flow will be sufficient to provide fish access to cold water refuges.

Minimal – River sections with this designation will experience adequate flow but only limited thermal protection. The thermal benefits from reservoir releases are greatly reduced in these sections, and the suitability of summer water temperatures in many years will not be optimal for coldwater species. The quality of the coldwater fishery will be generally seasonal and will vary from year to year. Flows should be adequate to enable trout to reach cold water refugia and to protect dwarf wedgemussel populations in the vicinity of Callicoon.

The 75° F daily maximum water temperature used in our management objectives is based on the "thermal stress day" concept developed by the DFWMR. A thermal stress day occurs when the maximum daily water temperature equals or exceeds 75° F and/or the minimum daily water temperature equals or exceeds 72° F for an entire 24-hour period (Sheppard 1983). Fish mortality becomes a concern if these conditions persist for a period of several consecutive days and fish are unable to move to cooler water refugia. This threshold is intended to serve as an indicator of where maximum water temperatures may be a limiting factor for trout populations. It should be noted that for optimal trout growth and survival, water temperatures need to remain below 68 ° F as detailed by many scientific studies and supported by the Cold Water Fishes (CWF) designation under Pennsylvania Chapter 93 Water Quality Standards Regulations and NY State DFWMR "best thermal conditions" in its 1992 Fishery Management Plan for the Upper Delaware Tailwaters (NY DEC 1992).

For river sections where daily maximum water temperatures are expected to frequently exceed 75^{o} F adequate flows will become critically important, especially during summer months. As long as flows are adequate trout will be able to find cold water refugia and fish kills are unlikely. Sanford (1992) recommended a flow of 1,000 cfs at Callicoon to provide adequate fish habitat. The ability of trout to move and find thermal refugia during periods of high water temperature is supported by the results of a radio telemetry study on brown and rainbow trout in the Delaware River and its tributaries conducted during the summers of 1995-1997 by the DFWMR (McBride 2002). For the Delaware River, the study included 4 trout during the summer of 1995, 21 during the summer of 1996, and 15 during the summer of 1997. This study showed that trout do survive water temperatures that are considered harmful and readily move to find cooler water. During periods of elevated water temperatures, main stem trout generally moved to thermal refuge areas including the cooler West Branch and upper East Branch. None of the radio tagged trout died during the study, which included very hot, dry conditions during both 1995 and 1997.

PROPOSED SCHEDULE OF RELEASES

In order to achieve the management objectives stated above, we recommend the following releases for reservoir storage level L2 (see Table 1 for the full recommended release schedule):

L2 Releases (CFS)				
		Cannonsville	Pepacton	Neversink
Winter	Dec 1 - Mar 31	150	100	90
	Apr 1 - Apr 30	400	100	90
Spring	May 1 - May 20	400	100	90
	May 21 - May 31	400	100	90
Summer	Jun 1 - Jun 15	500	140	125
	Jun 16 - Aug 31	525	140	125
Fall	Sep 1 - Sep 15	400	100	90
	Sep 16 - Sep 30	300	100	90
	Oct 1 - Nov 30	150	100	90

ANALYSIS AND RATIONALE FOR THE RECOMMENDED RELEASE SCHEDULE

In order to arrive at the recommended release schedule, a suite of potential release scenarios was developed based on flow-habitat relationships reported by Sheppard (1983) and Bovee et al. (2007). These studies provide ranges of flows needed to sustain adequate habitat for each life stage or guild of interest. In some instances, optimal flows for one species, guild, or age class are not necessarily optimal for other taxa. In these situations, the alternate release schedules that we developed represent a mix of attempts to address various limiting factors and arrive at a compromise solution that provides acceptable habitat for all cold water organisms throughout the tailwaters. Expected incremental flow from tributaries and the impact of releases on reservoir storage and drought days were also considered when developing proposed release scenarios.

Scenario Descriptions

The full release schedules for each of the alternate scenarios, as well as FFMP releases in effect at the time of this analysis, are shown in Appendix I. Initially four scenarios (one through four) were chosen. The main focus of the initial analysis was on the West Branch and mainstem Delaware, and so for these four scenarios releases were held at a constant 150 cfs from Pepacton Reservoir and 125 cfs from Neversink Reservoir year-round, and Cannonsville releases varied.

Scenario 1 was intended to maximize cold water summer releases (up to 600 cfs) while holding late fall through early spring releases at current FFMP levels (80 cfs). It was expected that this scenario would most benefit adult trout in both the West Branch and mainstem Delaware River at the expense of trout spawning and incubation habitat in the fall, winter, and spring. At the other end of the spectrum was Scenario 4, which featured a year-round release of 300 cfs from Cannonsville Reservoir. While these releases are believed to be adequate for thermal protection on the West Branch and provide excellent spawning habitat, they would not provide significant thermal protection for the mainstem. Scenarios 2 and 3 were intermediate between the first two. Scenario 2 featured summer releases up to 500 cfs and fall/winter/spring releases of 150 cfs, and Scenario 3 featured summer releases up to 400 cfs and fall/winter/spring releases of 200 cfs.

Initial analysis and consultation between DFWMR and PFBC led to the development of two additional scenarios. Both of these featured summer releases up to 525 cfs and fall/winter/spring releases down to 150 cfs, as well as modifications for the East Branch and Neversink releases as shown in the above table. Scenario 5 included increased releases for reservoir storage levels L3, L4, and L5. Scenario 6 retained the L3 – L5 releases of the current FFMP.

Scenario 6 is the release schedule that was ultimately adopted by both agencies as the preferred alternative. It provides the best balance of benefits to juvenile and adult trout, shallow-slow and shallow-fast guilds, and dwarf wedgemussel habitat, and results in fewer additional drought days than the other scenarios analyzed.

OASIS and DRDSS Modeling Runs

Each scenario was analyzed using OASIS and the upper Delaware River Decision Support System (DRDSS) developed by Bovee et al. (2007). For OASIS runs, an estimate of monthly NYC diversions was used (Figure 2) that was based on diversion data from 1997 – 2007. This is a departure from most other OASIS analyses to date, which have used fixed NYC diversions of 765 or 800 mgd. This departure from earlier analyses allows us to model habitat changes associated with each scenario as accurately as possible under current conditions. The OASIS runs produce stream flow and reservoir storage predictions, which are in turn used as input to the DRDSS.

It should be noted that the use of current diversion patterns for our analysis is not necessarily a specific recommendation for operation of the New York City water supply or for future agreements regarding the operation of the Delaware Reservoirs. Nonetheless, using the current diversion patterns provide better information regarding the actual steam flow and storage conditions in the reservoirs and can lead to improved water resource management decisions for the basin.

The DRDSS requires as input two 10-year blocks of OASIS flow data. One data set is for the baseline case and the other for an alternative. The primary output is a listing of gains and losses of estimated habitat area for each species or guild that would result if the alternate case were implemented over the baseline. DRDSS runs were made with the current FFMP serving as the baseline and Scenarios 1 through 6 serving as the alternate, as well as for Scenario 1 (baseline) vs. Scenario 2 (alternate), Scenario 1 (baseline) vs. Scenario 3 (alternate), and Scenario 2 (baseline) vs. Scenario 3 (alternate).

For each DRDSS run, we used the following:

- OASIS outputs from October 1, 1989 – September 30, 1999. The DRDSS is limited to analyzing 10-year blocks of OASIS output data at a time, and they must be in "water-years". Although not containing the most severe hydrologic conditions (the drought in the 1960's for example), the 1990's do contain a good mix of warm and cool years (Figure 3).
- Meteorological data from 1994 – 2003. In the DRDSS meteorological data is used during summer periods to estimate water temperatures. Users can choose to use average meteorological data, worst-case meteorological data, or actual data from 1994 – 2003. We chose the final option

as being the most realistic. However, the OASIS period of record ends on September 30, 1999, and the full set of required meteorological data is only available for 1994 - 2003, and is repeated in the DRDSS for years in which the data does not exist. So in our case the summers of 1994 – 1999 use actual meteorological data, while the summers of 1990 – 1993 use meteorological data from 2000 – 2003.

- A threshold temperature of 24^{o} C (75.2^{o} F). If predicted water temperatures exceed this value for a given stream segment, it will not contribute to usable habitat area for adult trout, shallow water guilds, and spawning shad.
- DRDSS version 2.11, which averages all ten years of DRDSS output for persistent habitat (trout spawning/incubation habitat and dwarf wedgemussel habitat). The prior version of the DRDSS reported an average of the lowest 25% of habitat values (i.e., the average of the worst two years) for persistent habitat, which obscured habitat gains that may occur over most of a given ten-year period.

Results

Habitat

The DRDSS output summary for FFMP vs. Scenario 6 (the preferred scenario) is shown in Table 2. Output summaries each of the other DRDSS runs are provided in Appendix 2.

If Scenario 6 were implemented, the DRDSS predicts for the 1990-1999 period that the following improvements over the current FFMP in the West Branch:

- A 33% increase in trout spawning/incubation habitat from October – April 15;
- A 26% improvement for adult trout habitat from July through September;
- No reduction in habitat due to temperatures exceeding 24^{o} C;
- A 14% - 29% increase in the shallow-fast (riffles) guild, depending on season.

For the mainstem Delaware:

- A 2% increase in adult trout habitat is provided by modified flows, but benefit increases to 9% when water temperature is taken into account, indicating the increased summer flows do moderate water temperatures in the mainstem to some degree;
- No reduction in predicted dwarf wedgemussel habitat.

For the East Branch and Neversink:

- Increased trout spawning/incubation habitat – 39% on the East Branch and 63% on the Neversink.

Flow

Bovee et al. (2007) estimated rapidly expanding adult trout habitat on the West Branch as flows increase up to about 900 cfs (Figure 4). Juvenile trout habitat also expands rapidly up to flows of about 500 cfs, where it peaks. Shallow water guilds peak between flows of 200 - 300 cfs and decline gradually as flows continue to rise. The recommended release schedule strikes a good balance among each of these age classes and guilds, as evidenced by the DDS results.

When compared to the FFMP, Scenario 6 had a 20 percent increase in the frequency of flows in the 400 to 500 cfs range for the ten-year period analyzed with the DRDSS (Figure 5). Sheppard (1983) recommended a base flow of 225 cfs at Hale Eddy rather than continuing to use the variable releases adopted in the Good Faith Agreement. This base flow was used as the flow target in the release agreement prior to the FFMP. Scenario 6 also had a 5% reduction in the incidence of flows falling below 225 cfs at Hale Eddy. Finally, Scenario 6 has a lower incidence of high flows greater than 700 cfs.

On the mainstem Delaware, Scenario 6 had an approximate 5% increase in the frequency of flows greater than the proposed 1,000 cfs flow target at Callicoon when compared to the FFMP (Figure 6).

Water temperature

Maximum daily water temperatures on the West Branch and East Branch were never predicted to exceed 24^{o} C (75.2^{o} F) under any scenario analyzed (Figure 7). For Scenario 6 on the mainstem Delaware, nine days were predicted to exceed 24^{o} C at Lordville, 13 days at Hankins, and 41 days at Callicoon. Compared to the FFMP, these results equate to a 53% reduction in the number of days at Lordville, a 64% reduction in at Hankins, and a 32% reduction at Callicoon. These results are similar to those obtained under Scenario 1 with its higher summer releases. The scenarios with high releases have a large impact on water temperatures down to Hankins, and while moderated, their influence is still significant down to Callicoon. Thermal stress days can still be expected to occur under any scenario at all locations on the mainstem Delaware River, with 41 such days predicted for the ten year period under Scenario 6 at Callicoon. Even with a 600 cfs summer release (Scenario 1), 38 thermal stress days were predicted to occur at Callicoon.

A temperature duration curve of predicted daily maximum water temperatures for the 1990's shows excellent water temperatures for the West Branch under both the current FFMP and Scenario 6 (Figure 8). At Lordville on the mainstem (Figure 9) Scenario 6 has 105 fewer days with temperatures over 20^{o} C (68^{o} F) than the FFMP. Trends in water temperature become more similar between the FFMP and Scenario 6 as you move downstream to Hankins (Figure 10) and Callicoon (Figure 11).

Drought Risk and Reservoir Storage

The drought risk associated with the increased release regimes described in this paper would need to be evaluated, but will likely increase. Any proposed release scenario must have an acceptable level of increased risk of reducing reservoir storage to drought levels. During drought conditions, releases that support the coldwater ecosystem will be drastically curtailed, as will the withdrawal rates and downriver flow targets of interest to parties to the Supreme Court decree. While we have used drought days as a relative measure of the impact of the various scenarios on reservoir storage, it is important to note that a simple increase in drought days may not translate directly into the amount of drought risk.

When calculated over the OASIS period of record, Scenario 6 had the lowest increase in total drought days (approximately 1,000 additional days, or a 23% increase) when compared to the FFMP (Figure 12). Scenario 1, with its higher summer releases, resulted in a 42% increase in total drought days over the FFMP. Scenario 5, which featured increased releases during drought storage levels, resulted in a 33% increase in drought emergency days over the FFMP.

Another concern with high summer releases out of Cannonsville Reservoir is the potential to deplete the supply of cold water in the reservoir. This may happen when storage drops to approximately 30% of capacity (28.7 billion gallons). Cannonsville Reservoir storage exceedance curves (Figure 13) show only a minimal increase in the incidence of this happening under Scenario 6 vs. the FFMP.

ENDANGERED SPECIES CONSIDERATIONS

Two endangered species are known to occur in the Delaware tailwaters – the dwarf wedgemussel and bridle shiner. Our recommendations to optimize the coldwater aquatic community in the upper Delaware River and its tributaries are not expected to cause harm to these species, and may provide limited benefit. Additional information on the habitat requirements and limiting factors in the Delaware tailwaters is needed for both of these species to fully assess the impact of reservoir releases on them.

The dwarf wedgemussel is a federally endangered species and is found in the mainstem Delaware River. Cole et al. (2008) suggested a flow requirement of approximately 1,000 cfs at the USGS gage at Callicoon to fully protect dwarf wedgemussels and other mussel species. Similarly, Sanford (1992) recommended a flow of 1,000 cfs at Callicoon to provide adequate fish habitat. We believe, however, that it is premature to propose a flow target at this time. The impact of such a target on drought days and whether it would be needed on a year-round basis or only during the summer needs further investigation, and seasonal and life stage requirements for dwarf wedgemussels remain poorly defined. Two ongoing studies (W. Lellis, USGS, personal communication; and C. Tibbott, U.S. Fish and Wildlife Service, personal communication) should provide some additional information on dwarf wedgemussel requirements in the near future. USGS is working to incorporate refined dwarf wedgemussel habitat requirements into the DRDSS. For the 1990-1999 period assessed with DRDSS, our recommended schedule of releases results in a slight increase in dwarf wedgemussel habitat in the fall through early spring, and no significant change the rest of the year (Table 2). We defer requesting a Callicoon target flow regime until a specific analysis can be performed for this species and integrated with fish community needs.

The bridle shiner is listed as an endangered species by both Pennsylvania and the American Fisheries Society, and is a species of greatest conservation need in New York State. This species is known to occur in the upper Delaware River mainstem reaches (i.e., upriver of Port Jervis, NY). Investigations are currently being funded by the National Park Service, Upper Delaware Scenic and Recreational River, for quantifying the bridle shiner distribution, abundance, and habitat preferences in the upper Delaware mainstem reach. Habitat requirements for the bridle shiner were assumed in the DRDSS to correspond to the shallow-slow guild (SSCV on the DRDSS summaries) as it uses a subset of this habitat guild (Bovee et al. 2007). Finger (2001) found actual habitat requirements in a Delaware River tributary were broader than those chosen for the SSCV, which may cause this species to be less sensitive to change than the SSCV guild would predict. Our recommended schedule of releases results in no change in SSCV habitat on the mainstem, a small increase on the West Branch, and small increases or decreases on the East Branch depending on season.

REFERENCES

Bovee, K.D., Waddle, T.J., Bartholow, J., and Burris, L. 2007. A decision support framework for water management in the upper Delaware River: Open-file report 2007-1172. U.S. Geological Survey. Reston, VA.

Cole, J.C., P.A. Townsend, and K.N. Eshleman. 2008. Prediction flow and temperature regimes at three *Alasmidonta heterodon* locations in the Delaware River: Technical report NPS/NER/NRTR-2008/109. National Park Service. Philadelphia, PA.

Finger B. L. 2001. Life history and range of Pennsylvania's endangered bridle shiner, *Notropis bifrenatus* (Cope). M.S. Thesis, Pennsylvania State University College of Agricultural Sciences. University Park, PA. 79 p.

McBride, N.D. 2002. Radiotelemetry study of trout movements in the Delaware tailwaters and the Beaver Kill: 1995-1997. New York State Department of Environmental Conservation. Albany, NY.

New York Department of Environmental Conservation. 1992. A fishery management plan for the upper Delaware tailwaters. March 1992 report by the Division of Fish and Wildlife, Bureau of Fisheries – Region 4. Albany, NY.

Sanford, D. K. 1992. A fishery management plan for the upper Delaware tailwaters. New York State Department of Environmental Conservation. Albany, NY.

Sheppard, J.D. 1983. New York reservoir releases monitoring and evaluation program on the Delaware River summary report: Technical report 83-5. New York State Department of Environmental Conservation. Albany, NY.

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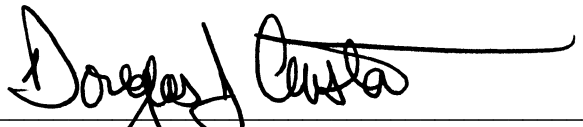
SIGNATURE PAGE

Signatories: **Date of Signature:**

_____ 1/19/2010

Patricia Riexinger
Director
Division of Fish, Wildlife & Marine Resources
New York State Department of Environmental Conservation



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Douglas J. Austen, Ph.D.
Executive Director
Pennsylvania Fish and Boat Commission

Figure 1. Proposed management Objectives for the Delaware Tailwaters.

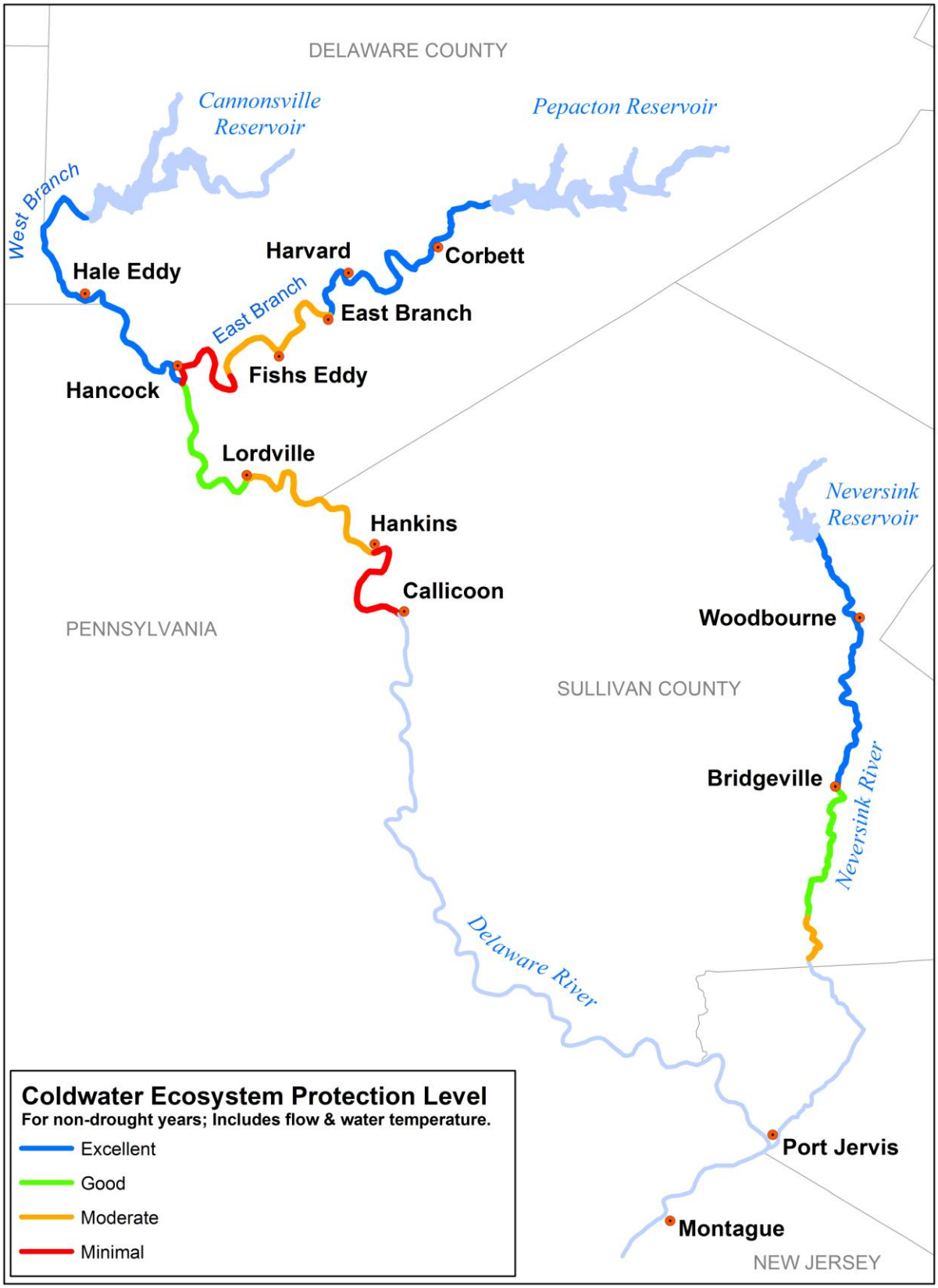

Figure 2. Monthly New York City diversions used in OASIS runs.

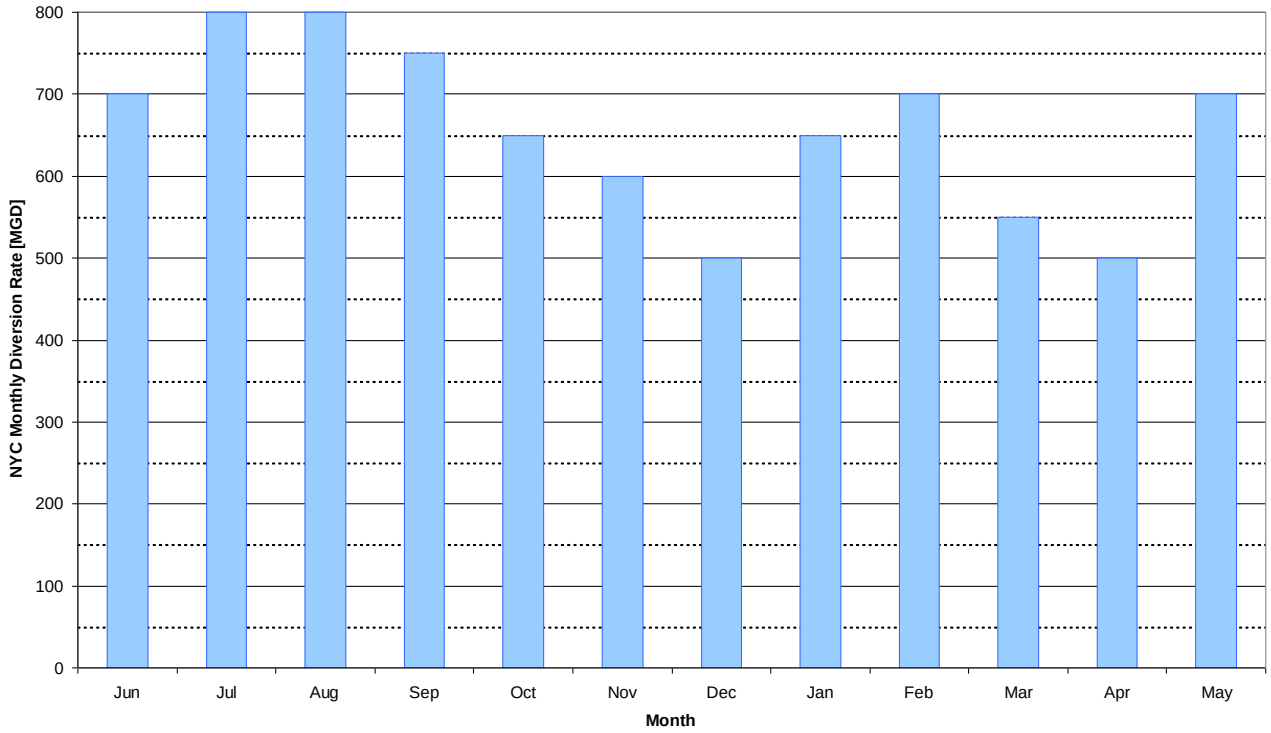

Figure 3. Number of days with a mean daily summer water temperature >= 75° F at Callicoon on the Delaware River, June 1 – September 15. The summers of 1990, 1994, and 1995 were relatively warm, while the summers of 1991 and 1992 were relatively cool.

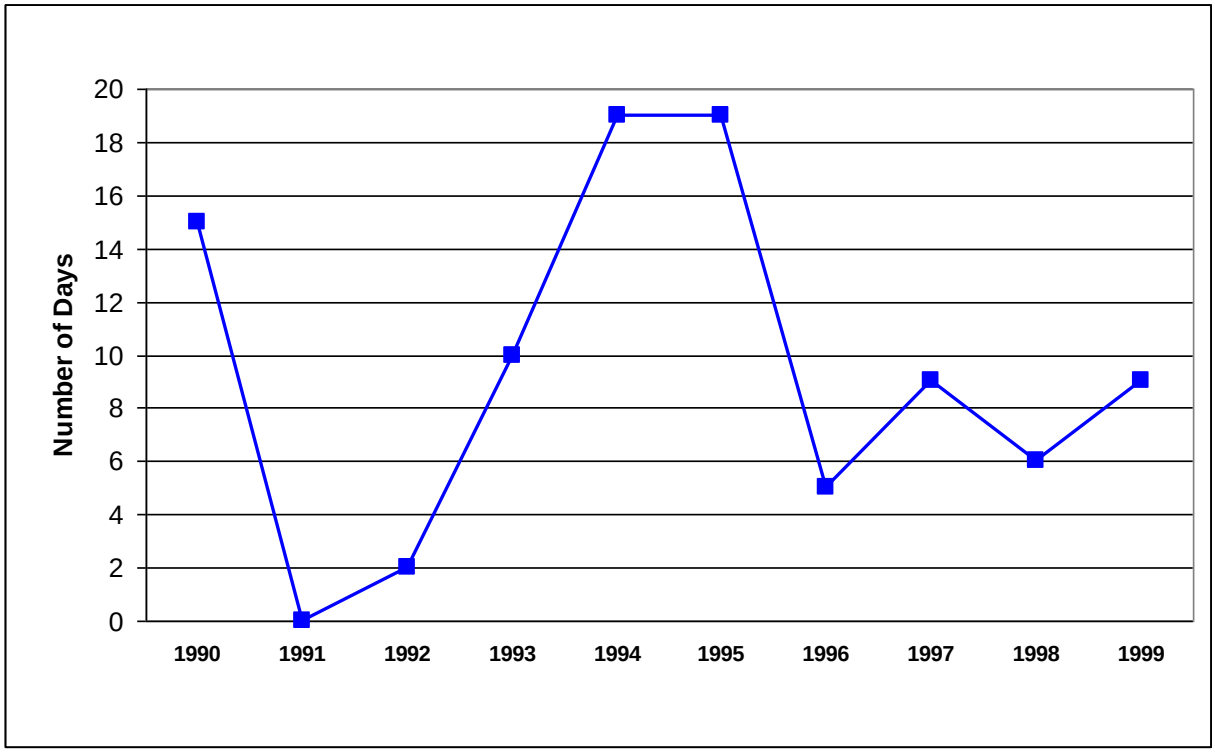

Figure 4. Flow-habitat relationships from Bovee et al. (2007).

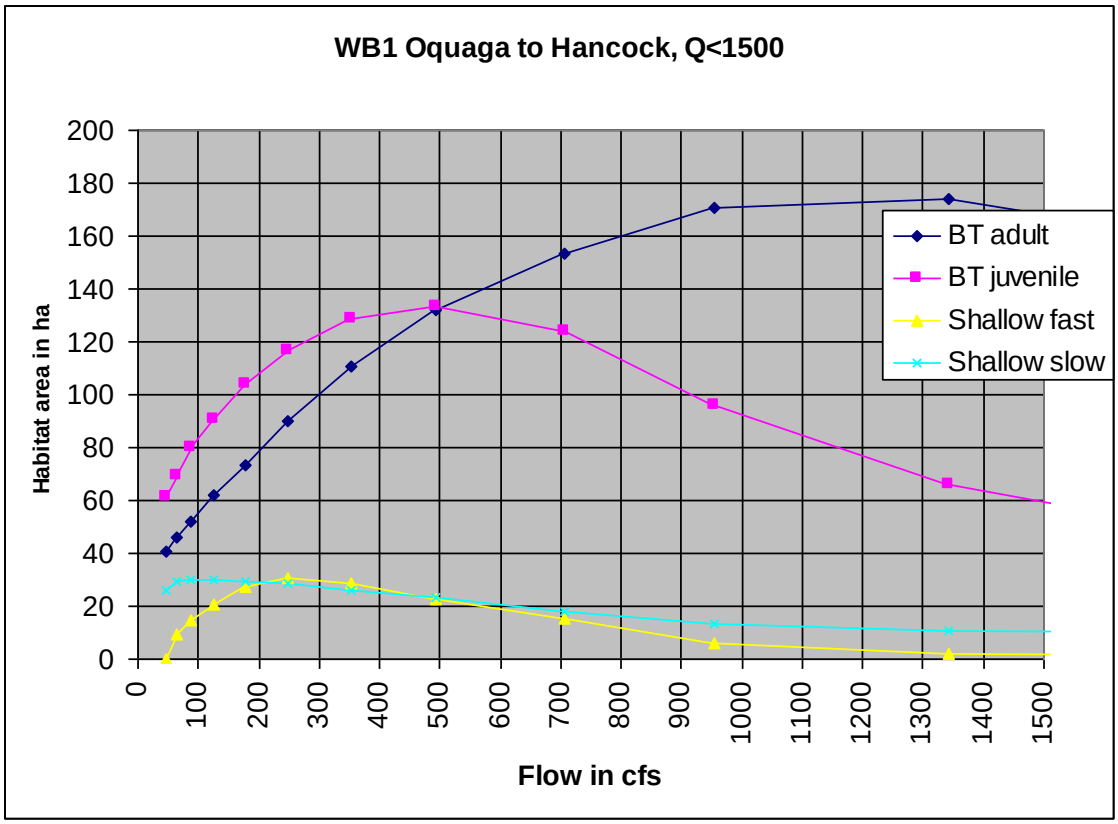

Figure 5. Flow at Hale Eddy for Scenario 6 and the FFMP, October 1, 1989 – September 30, 1999. The horizontal red line indicates a flow of 225 cfs, the flow target used for Revision 7.

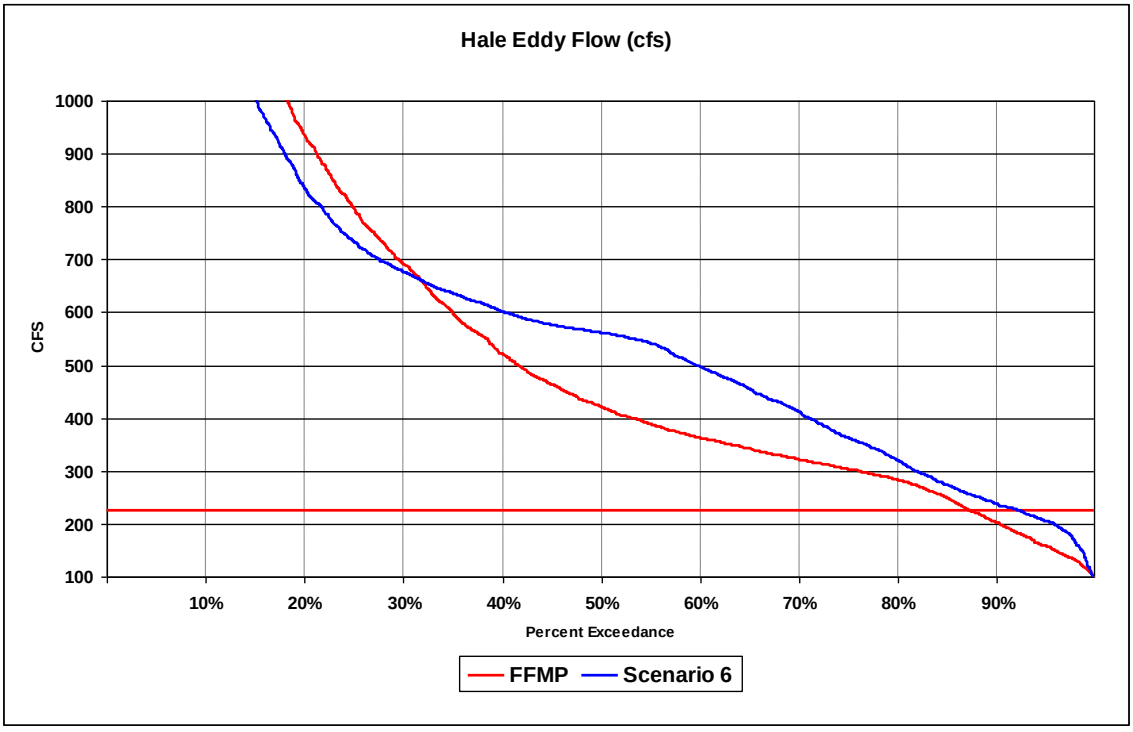

Figure 6. Flow at Callicoon for Scenario 6 and the FFMP, October 1, 1989 – September 30, 1999. The horizontal red line indicates a flow of 1,000 cfs, the proposed flow target at Callicoon.

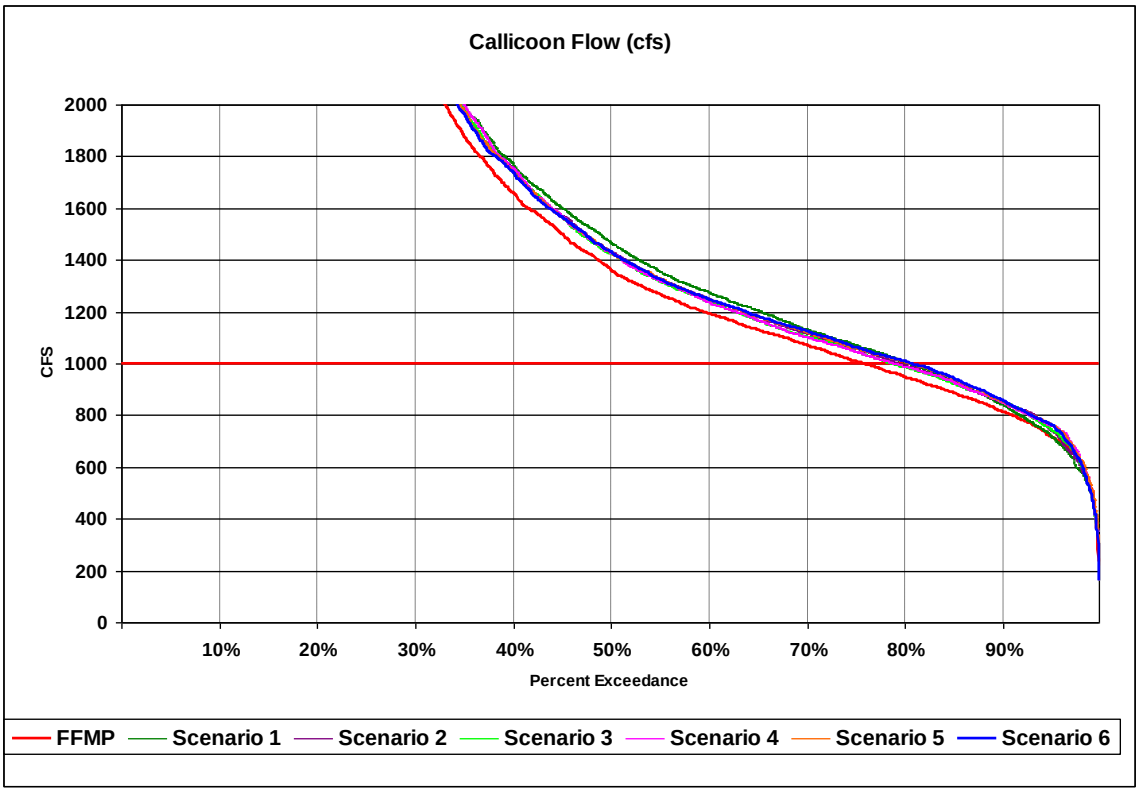

Figure 7. Number of days with a maximum water temperature predicted by the DRDSS to exceed 24o C (75.2o F), October 1, 1989 – September 30, 1999.

Number of Days Above 24 deg. C (75.2 deg. F)

	FFMP	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
West Branch - Oquaga Creek	0	0	0	0	0	0	0
West Branch - Hancock	0	0	0	0	0	0	0
Delaware - Lordville	19	5	12	14	17	11	9
Delaware - Hankins	36	10	15	22	30	15	13
Delaware - Callicoon	60	38	45	50	59	42	41

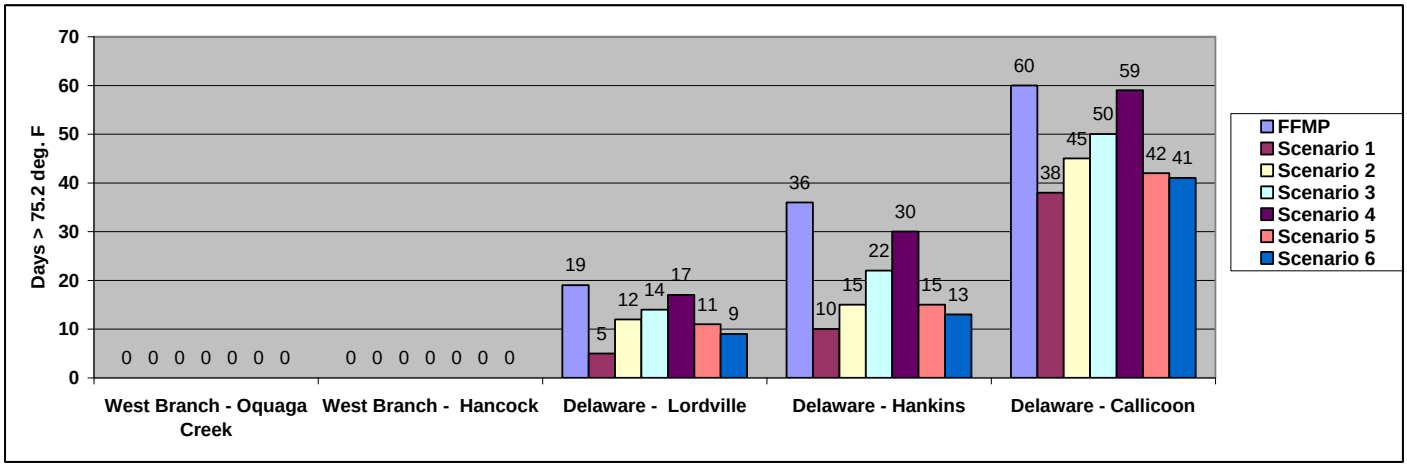

Figure 8. Temperature duration curve of maximum daily water temperatures predicted by the DRDSS for June

through August on the West Branch at Hancock, June through August, 1990 – 1999.

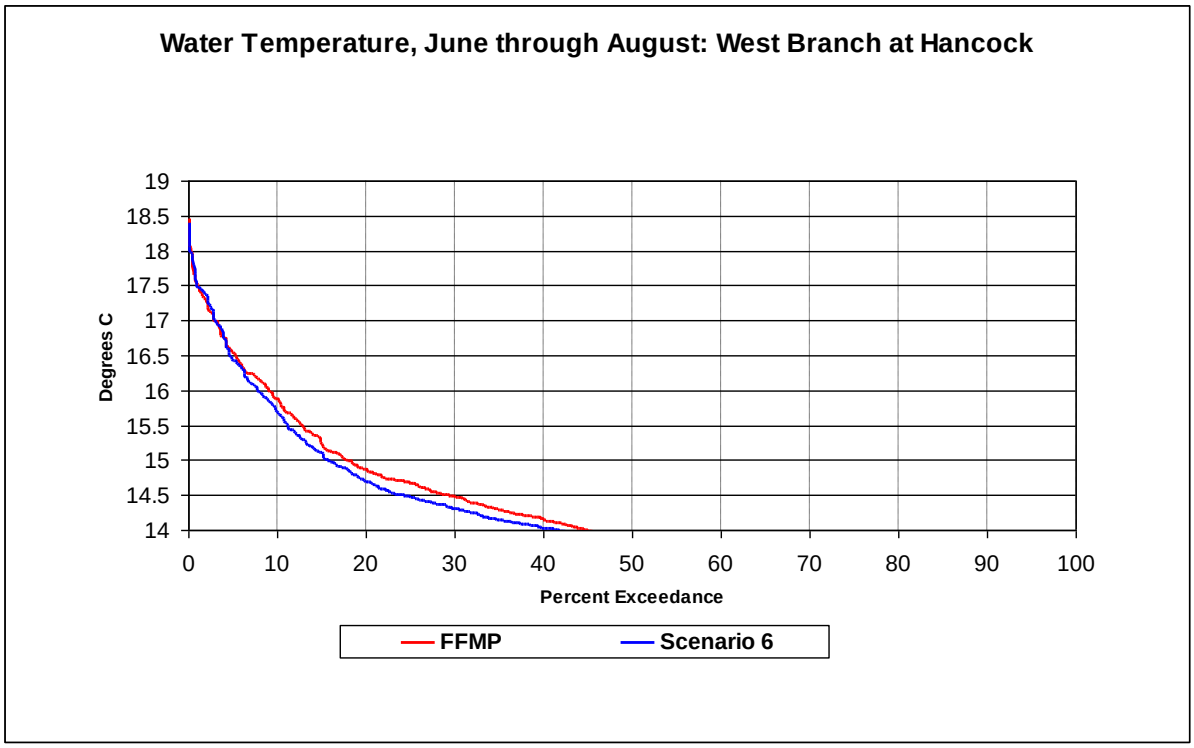

Figure 9. Temperature duration curve of maximum daily water temperatures predicted by the DRDSS for June through August on the Delaware River at Lordville, June through August, 1990 – 1999.

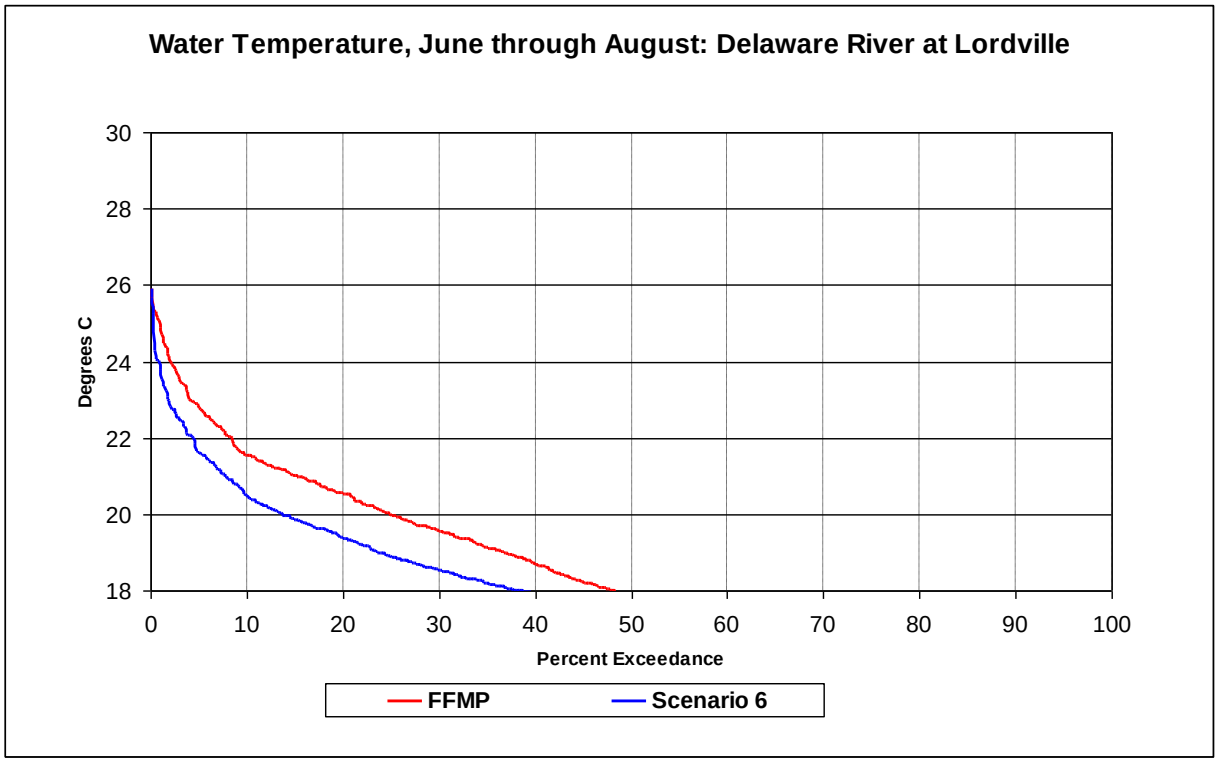

Figure 10. Temperature duration curve of maximum daily water temperatures predicted by the DRDSS for June

through August on the Delaware River at Hankins, June through August, 1990 – 1999.

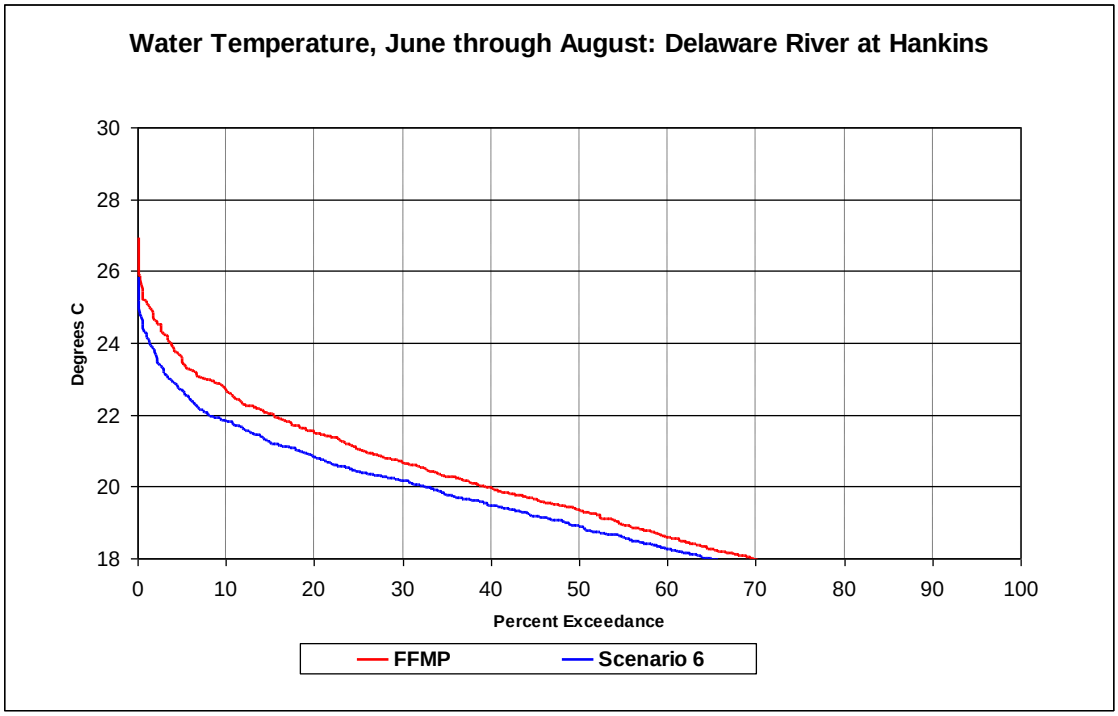

Figure 11. Temperature duration curve of maximum daily water temperatures predicted by the DRDSS for June through August on the Delaware River at Callicoon, June through August, 1990 – 1999.

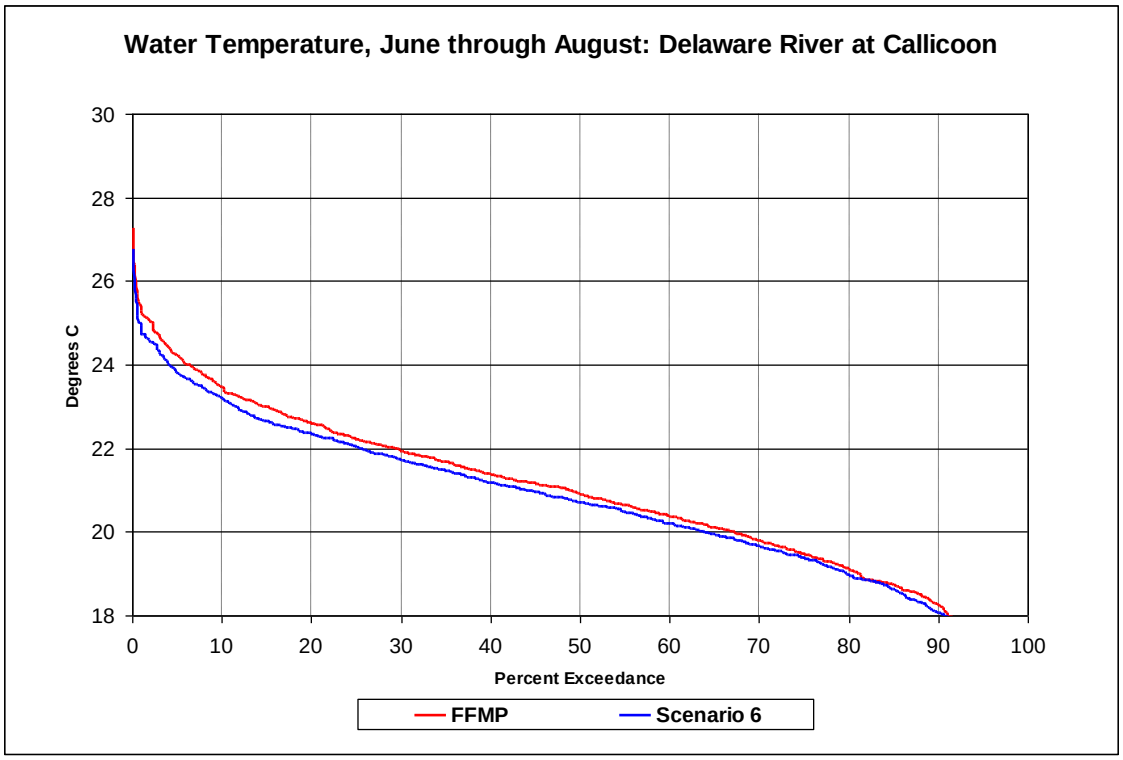

Figure 12. Number of drought days generated by OASIS for each scenario over the OASIS period of record (January 1, 1928 – September 30, 2000).

Drought Days For OASIS Period of Record							
	FFMP	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Watch	820	1,589	1,432	1,221	1,133	1,195	1,128
Warning	1,589	2,109	2,014	2,074	2,085	1,835	1,867
Emergency	2,004	2,562	2,496	2,334	2,352	2,850	2,439
Total	4,413	6,260	5,942	5,629	5,570	5,880	5,434

Percent Change					
Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
94%	75%	49%	38%	46%	38%
33%	27%	31%	31%	15%	17%
28%	25%	16%	17%	42%	22%
42%	35%	28%	26%	33%	23%

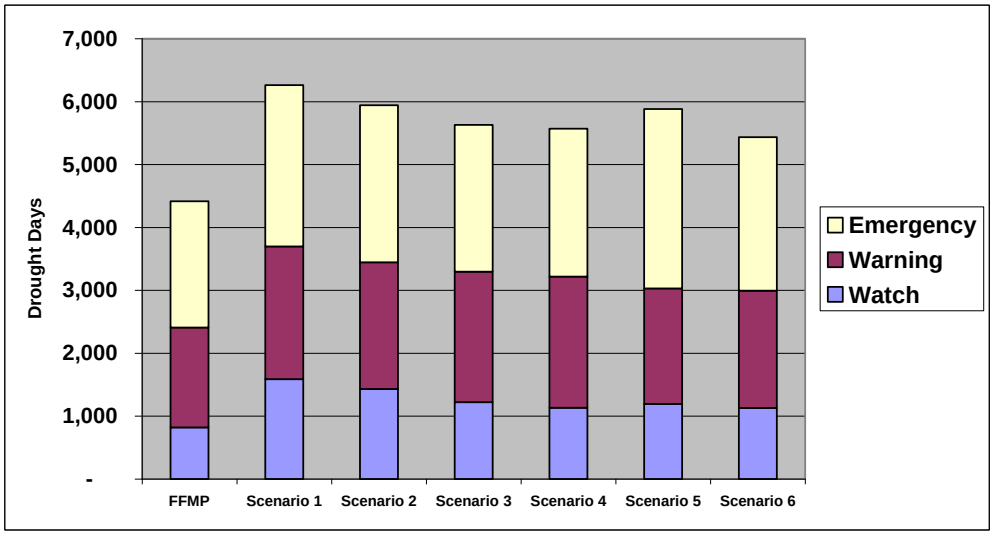

Figure 13. Cannonsville Reservoir storage for each scenario, October 1, 1989 – September 30, 1999. The horizontal red line indicates 28.7 billion gallons, which is about 30% of storage and where the supply of cold water could be depleted.

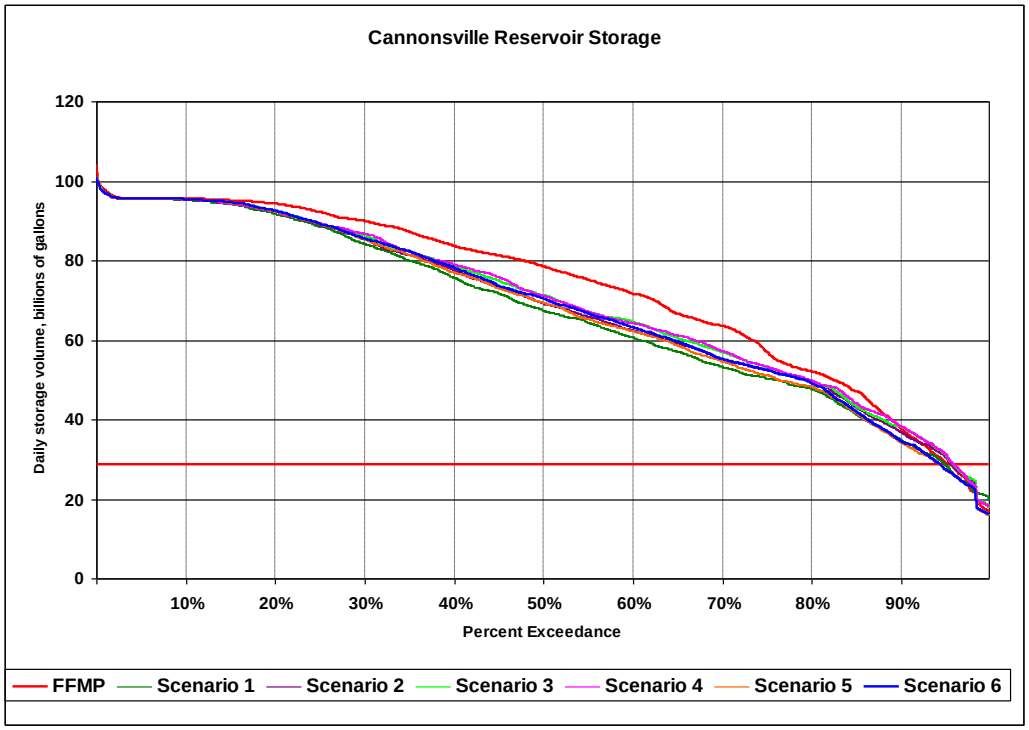

Table 1. Recommended release schedule (Scenario 6). Highlighted boxes indicate departures from the FFMP, with the recommended release on the left and the FFMP release on the right.

Recommended Release Schedule (Scenario 6)

	Winter		Spring		Summer			Fall		
Cannonsville Storage Zone	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	1500	1500	*	*	*	1500	1500	1500	1500	1500
L1-b	250	*	*	*	*	*	525/350	400/300	300/275	250
L1-c	150/110	400/110	400/200	400/250	500/275	525/275	525/275	400/275	300/140	150/110
L2	150/80	400/80	400/190	400/240	500/260	525/260	525/260	400/260	300/115	150/80
L3	125/70	200/70	200/100	200/100	250/175	250/175	250/175	175/95	175/95	125/70
L4	55	55	75	75	130	130	130	55	55	60
L5	50	50	50	50	120	120	120	50	50	50

	Winter		Spring		Summer			Fall		
Pepacton Storage Zone	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	700	700	*	*	*	700	700	700	700	700
L1-b	185	*	*	*	*	*	250	200	200	185
L1-c	125/85	125/85	125/110	125/130	150	150	150	125/150	125/100	125/85
L2	100/65	100/65	100	100/125	140	140	140	100/140	100/85	100/60
L3	80/55	80/55	80	80	100	100	100	80/55	80/55	80/55
L4	45	45	50	50	85	85	85	40	40	40
L5	40	40	40	40	80	80	80	30	30	30

	Winter		Spring		Summer			Fall		
Neversink Storage Zone	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	190	190	*	*	*	190	190	190	190	190
L1-b	125/100	*	*	*	*	*	125	125	125/85	125/95
L1-c	90/65	90/65	90/85	90/100	125/110	125/110	125/110	90/110	90/75	90/60
L2	90/45	90/45	90/75	90	125/100	125/100	125/100	90/100	90/70	90/45
L3	75/40	75/40	75/50	75/50	90	90	90	75/40	75/40	75/40
L4	35	35	40	40	60	60	60	30	30	30
L5	30	30	30	30	55	55	55	25	25	25

Table 2. DRDSS results summary page for Scenario 6 (the preferred release schedule) compared to FFMP (baseline).

October - April 15

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	10%	7.79			4%	5.75			2%	7.29			10%	8.71		
Trout Spawning/Incu, ha	33%	1.82			39%	1.55			4%	0.49			63%	2.78		
SSCV, ha	10%	1.36			-6%	**-1.39**			1%	0.14			1%	0.15		
SFCV, ha	27%	1.65			4%	0.17			0%	0.01			13%	1.96		
Shad Juvenile, ha																
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									5%	0.16						
Spills, minor, count	5%	**1.00**			0%	0.00							-25%	-1.00		
Spills, moderate, count	-50%	-7.00			-26%	-5.00							-25%	-4.00		
Spills, major, count	-38%	-5.00			-39%	-15.00							-31%	-8.00		

April 16 - June

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	28%	29.29	28%	29.29	0%	**-0.34**	0%	**-0.34**	6%	19.81	8%	24.75	4%	4.01		
Trout Spawning/Incu, ha																
SSCV, ha	4%	0.49	4%	0.49	2%	0.51	2%	0.51	1%	0.13	2%	0.52	2%	0.35		
SFCV, ha	14%	0.70	14%	0.70	10%	0.34	10%	0.34	-2%	**-0.09**	0%	0.02	3%	0.45		
Shad Juvenile, ha																
Shad Spawning, ha					1%	0.41	1%	0.41	9%	14.42	11%	16.83	10%	2.21		
Dwarf Wedge Mussel, ha									2%	0.08						
Spills, minor, count	0%	0.00			-31%	-4.00							0%	0.00		
Spills, moderate, count	7%	**1.00**			-12%	-4.00							0%	0.00		
Spills, major, count	-17%	-1.00			0%	0.00							3%	**1.00**		

July - September

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	26%	27.07	26%	27.07	-1%	**-2.01**	-1%	**-2.01**	2%	6.33	9%	28.38	2%	2.45		
Trout Spawning/Incu, ha																
SSCV, ha	9%	1.24	9%	1.24	-2%	**-0.51**	-2%	**-0.51**	-1%	**-0.48**	6%	1.67	-2%	**-0.82**		
SFCV, ha	29%	1.91	29%	1.91	2%	0.26	2%	0.26	-6%	**-0.87**	3%	0.38	1%	0.17		
Shad Juvenile, ha					0%	**-0.37**	0%	**-0.37**	0%	**-1.32**	7%	17.17	2%	0.74		
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									-1%	**-0.06**						
Spills, minor, count	100%	**1.00**			-80%	-4.00							100%	**1.00**		
Spills, moderate, count	-33%	-1.00			0%	0.00							0%	**Base, Alt =0**		
Spills, major, count	0%	**Base, Alt =0**			0%	0.00							-50%	-1.00		

Full Period Scores

	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays
Δ Days > Threshold C	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	-32%	-21.00	-43%	-24.12				

Global Scores

Montague Flow	Pct Chg	Δ Days		**Out of System Deliveries**	Pct Chg	Δ Days
Montague, minor shortage	-13%	-39.00		NYC, minor shortage	0%	0.00
Montague, moderate shortage	-19%	-13.00		NYC, moderate shortage	0%	**Base, Alt =0**
Montague, major shortage	0%	**Base, Alt =0**		NYC, major shortage	0%	**Base, Alt =0**
Montague, cfs-days	-18%	-7451.00		New York City, bg	0%	Base, Alt =0
System Drought	Pct Chg	Δ Days			Pct Chg	Δ Days
Days at Level 1	48%	**112.00**		NJ, minor shortage	0%	0.00
Days at Level 2	57%	**114.00**		NJ, moderate shortage	0%	**Base, Alt =0**
Days at Level 3	0%	**Base, Alt =0**		NJ, major shortage	0%	**Base, Alt =0**
				New Jersey, bg	0%	Base, Alt =0
System Storage, bg	-5%	-40741.90				

Run Settings

Maximum Water Temperature	West Branch	24	New York Diversion Magnitude	Mild	10
(degrees C)	East Branch	24	(% minimum delivery)	Major	50
	Main Stem	24			
	Neversink	24	New York Diversion Magnitude	Mild	10
			(% minimum delivery)	Major	50
Spill Magnitude	Mild, <	10			
(% outflow capacity)	Major, >	50	Meterological Series		Actual
Montague Shortage Magnitude	Mild, <	10			
(% minimum flow)	Major, >	50			

APPENDIX 1

Alternate Release Schedules Used in the Analysis

FFMP - Extended Season

Cannonsville Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	1500	1500	*	*	*	1500	1500	1500	1500	1500
L1-b	250	*	*	*	*	*	350	300	275	250
L1-c	110	110	200	250	275	275	275	275	140	110
L2	80	80	190	240	260	260	260	260	115	80
L3	70	70	100	100	175	175	175	95	95	70
L4	55	55	75	75	130	130	130	55	55	60
L5	50	50	50	50	120	120	120	50	50	50

Pepacton Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	700	700	*	*	*	700	700	700	700	700
L1-b	185	*	*	*	*	*	250	200	200	185
L1-c	85	85	110	130	150	150	150	150	100	85
L2	65	65	100	125	140	140	140	140	85	60
L3	55	55	80	80	100	100	100	55	55	55
L4	45	45	50	50	85	85	85	40	40	40
L5	40	40	40	40	80	80	80	30	30	30

Neversink Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	190	190	*	*	*	190	190	190	190	190
L1-b	100	*	*	*	*	*	125	125	85	95
L1-c	65	65	85	100	110	110	110	110	75	60
L2	45	45	75	90	100	100	100	100	70	45
L3	40	40	50	50	75	75	75	40	40	40
L4	35	35	40	40	60	60	60	30	30	30
L5	30	30	30	30	55	55	55	25	25	25

Scenario 1

Cannonsville Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	1500	1500	*	*	*	1500	1500	1500	1500	1500
L1-b	250	*	*	*	*	*	600/350	500/300	500/275	250
L1-c	110	500/110	500/200	500/250	600/275	600/275	600/275	500/275	500/140	110
L2	80	500/80	500/190	500/240	600/260	600/260	600/260	500/260	500/115	80
L3	70	250/70	250/100	250/100	300/175	300/175	300/175	250/95	250/95	70
L4	55	55	75	75	130	130	130	55	55	60
L5	50	50	50	50	120	120	120	50	50	50

Pepacton Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	700	700	*	*	*	700	700	700	700	700
L1-b	185	*	*	*	*	*	250	200	200	185
L1-c	150/85	150/85	150/110	150/130	150	150	150	150	150/100	150/85
L2	150/65	150/65	150/100	150/125	150/140	150/140	150/140	150/140	150/85	150/60
L3	80/55	80/55	80	80	100	100	100	80/55	80/55	80/55
L4	45	45	50	50	85	85	85	40	40	40
L5	40	40	40	40	80	80	80	30	30	30

Neversink Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	190	190	*	*	*	190	190	190	190	190
L1-b	125/100	*	*	*	*	*	125	125	125/85	125/95
L1-c	125/65	125/65	125/85	125/100	125/110	125/110	125/110	125/110	125/75	125/60
L2	125/45	125/45	125/75	125/90	125/100	125/100	125/100	125/100	125/70	125/45
L3	65/40	65/40	65/50	65/50	75	75	75	65/40	65/40	65/40
L4	35	35	40	40	60	60	60	30	30	30
L5	30	30	30	30	55	55	55	25	25	25

Scenario 2

Cannonsville Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	1500	1500	*	*	*	1500	1500	1500	1500	1500
L1-b	250	*	*	*	*	*	500/350	400/300	400/275	250
L1-c	150/110	400/110	400/200	400/250	500/275	500/275	500/275	400/275	400/140	150/110
L2	150/80	400/80	400/190	400/240	500/260	500/260	500/260	400/260	400/115	150/80
L3	70	200/70	200/100	200/100	250/175	250/175	250/175	200/95	200/95	70
L4	55	55	75	75	130	130	130	55	55	60
L5	50	50	50	50	120	120	120	50	50	50

Pepacton Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	700	700	*	*	*	700	700	700	700	700
L1-b	185	*	*	*	*	*	250	200	200	185
L1-c	150/85	150/85	150/110	150/130	150	150	150	150	150/100	150/85
L2	150/65	150/65	150/100	150/125	150/140	150/140	150/140	150/140	150/85	150/60
L3	80/55	80/55	80	80	100	100	100	80/55	80/55	80/55
L4	45	45	50	50	85	85	85	40	40	40
L5	40	40	40	40	80	80	80	30	30	30

Neversink Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	190	190	*	*	*	190	190	190	190	190
L1-b	125/100	*	*	*	*	*	125	125	125/85	125/95
L1-c	125/65	125/65	125/85	125/100	125/110	125/110	125/110	125/110	125/75	125/60
L2	125/45	125/45	125/75	125/90	125/100	125/100	125/100	125/100	125/70	125/45
L3	65/40	65/40	65/50	65/50	75	75	75	65/40	65/40	65/40
L4	35	35	40	40	60	60	60	30	30	30
L5	30	30	30	30	55	55	55	25	25	25

Scenario 3

Cannonsville Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	1500	1500	*	*	*	1500	1500	1500	1500	1500
L1-b	250	*	*	*	*	*	400/350	300/300	300/275	250
L1-c	200/110	300/110	400/200	400/250	400/275	400/275	400/275	300/275	300/140	200/110
L2	200/80	300/80	400/190	400/240	400/260	400/260	400/260	300/260	300/115	200/80
L3	70	150/70	200/100	200/100	200/175	200/175	200/175	150/95	150/95	70
L4	55	55	75	75	130	130	130	55	55	60
L5	50	50	50	50	120	120	120	50	50	50

Pepacton Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	700	700	*	*	*	700	700	700	700	700
L1-b	185	*	*	*	*	*	250	200	200	185
L1-c	150/85	150/85	150/110	150/130	150	150	150	150	150/100	150/85
L2	150/65	150/65	150/100	150/125	150/140	150/140	150/140	150/140	150/85	150/60
L3	80/55	80/55	80	80	100	100	100	80/55	80/55	80/55
L4	45	45	50	50	85	85	85	40	40	40
L5	40	40	40	40	80	80	80	30	30	30

Neversink Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	190	190	*	*	*	190	190	190	190	190
L1-b	125/100	*	*	*	*	*	125	125	125/85	125/95
L1-c	125/65	125/65	125/85	125/100	125/110	125/110	125/110	125/110	125/75	125/60
L2	125/45	125/45	125/75	125/90	125/100	125/100	125/100	125/100	125/70	125/45
L3	65/40	65/40	65/50	65/50	75	75	75	65/40	65/40	65/40
L4	35	35	40	40	60	60	60	30	30	30
L5	30	30	30	30	55	55	55	25	25	25

Scenario 4

Cannonsville Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	1500	1500	*	*	*	1500	1500	1500	1500	1500
L1-b	300/250	*	*	*	*	*	350	300	300/275	300/250
L1-c	300/110	300/110	300/200	300/250	300/275	300/275	300/275	300/275	300/140	300/110
L2	300/80	300/80	300/190	300/240	300/260	300/260	300/260	300/260	300/115	300/80
L3	150/70	150/70	150/100	150/100	175	175	175	150/95	150/95	150/70
L4	55	55	75	75	130	130	130	55	55	60
L5	50	50	50	50	120	120	120	50	50	50

Pepacton Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	700	700	*	*	*	700	700	700	700	700
L1-b	185	*	*	*	*	*	250	200	200	185
L1-c	150/85	150/85	150/110	150/130	150	150	150	150	150/100	150/85
L2	150/65	150/65	150/100	150/125	150/140	150/140	150/140	150/140	150/85	150/60
L3	80/55	80/55	80	80	100	100	100	80/55	80/55	80/55
L4	45	45	50	50	85	85	85	40	40	40
L5	40	40	40	40	80	80	80	30	30	30

Neversink Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	190	190	*	*	*	190	190	190	190	190
L1-b	125/100	*	*	*	*	*	125	125	125/85	125/95
L1-c	125/65	125/65	125/85	125/100	125/110	125/110	125/110	125/110	125/75	125/60
L2	125/45	125/45	125/75	125/90	125/100	125/100	125/100	125/100	125/70	125/45
L3	65/40	65/40	65/50	65/50	75	75	75	65/40	65/40	65/40
L4	35	35	40	40	60	60	60	30	30	30
L5	30	30	30	30	55	55	55	25	25	25

Scenario 5

Cannonsville Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	1500	1500	*	*	*	1500	1500	1500	1500	1500
L1-b	250	*	*	*	*	*	525/350	400/300	300/275	250
L1-c	150/110	400/110	400/200	400/250	500/275	525/275	525/275	400/275	300/140	150/110
L2	150/80	400/80	400/190	400/240	500/260	525/260	525/260	400/260	300/115	150/80
L3	125/70	200/70	200/100	200/100	250/175	250/175	250/175	175/95	175/95	125/70
L4	100/55	100/55	110/75	110/75	125/130	125/130	125/130	125/60/55	125/55	100/60
L5	75/50	75/50	85/50	85/50	125/120	125/120	125/120	100/50	100/50	75/50

Pepacton Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	700	700	*	*	*	700	700	700	700	700
L1-b	185	*	*	*	*	*	250	200	200	185
L1-c	125/85	125/85	125/110	125/130	150	150	150	125/150	125/100	125/85
L2	100/65	100/65	100	100/125	140	140	140	100/140	100/85	100/60
L3	80/55	80/55	80	80	100	100	100	80/55	80/55	80/55
L4	60/45	60/45	60/50	60/50	80/85	80/85	80/85	60/40	60/40	60/40
L5	50/40	50/40	50/40	50/40	70/80	70/80	70/80	50/30	50/30	50/30

Neversink Storage Zone	Winter		Spring		Summer			Fall		
	Dec 1 - 31-Mar	Apr 1 - 30-Apr	May 1 - 20-May	May 21 - 31-May	Jun 1 - 15-Jun	Jun 16 - 30-Jun	Jul 1 - 31-Aug	Sep 1 - 15-Sep	Sep 16 - 30-Sep	Oct 1 - 30-Nov
L1-a	190	190	*	*	*	190	190	190	190	190
L1-b	125/100	*	*	*	*	*	125	125	125/85	125/95
L1-c	90/65	90/65	90/85	90/100	125/110	125/110	125/110	90/110	90/75	90/60
L2	90/45	90/45	90/75	90	125/100	125/100	125/100	90/100	90/70	90/45
L3	75/40	75/40	75/50	75/50	90/75	90/75	90/75	75/40	75/40	75/40
L4	60/35	60/35	60/40	60/40	80/60	80/60	80/60	60/30	60/30	60/30
L5	50/30	50/30	50/30	50/30	70/55	70/55	70/55	50/25	50/25	50/25

APPENDIX 2

DRDSS Output Summaries for Alternate Release Schedules

Scenario 1 Summary

October - April 15

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	-5%	**-4.23**			6%	10.06			1%	3.49			11%	10.13		
Trout Spawning/Incu, ha	-8%	**-0.44**			41%	1.64			5%	0.64			65%	2.85		
SSCV, ha	14%	1.89			2%	0.51			1%	0.17			-1%	**-0.14**		
SFCV, ha	41%	2.47			5%	0.19			1%	0.02			13%	1.95		
Shad Juvenile, ha																
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									-26%	**-1.32**						
Spills, minor, count	-9%	-2.00			-14%	-1.00							-25%	-1.00		
Spills, moderate, count	-14%	-2.00			-42%	-8.00							-38%	-6.00		
Spills, major, count	-54%	-7.00			-47%	-18.00							-46%	-12.00		

April 16 - June

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	34%	35.82	34%	35.82	5%	7.98	5%	7.98	8%	26.60	12%	36.43	7%	7.16		
Trout Spawning/Incu, ha																
SSCV, ha	4%	0.56	4%	0.56	6%	1.23	6%	1.23	1%	0.20	4%	0.89	3%	0.63		
SFCV, ha	16%	0.78	16%	0.78	17%	0.56	17%	0.56	-3%	**-0.16**	0%	0.01	6%	0.76		
Shad Juvenile, ha																
Shad Spawning, ha					3%	1.12	3%	1.12	11%	17.14	15%	22.74	13%	2.82		
Dwarf Wedge Mussel, ha									-21%	**-0.97**						
Spills, minor, count	-8%	-1.00			-54%	-7.00							0%	0.00		
Spills, moderate, count	0%	0.00			-3%	-1.00							0%	0.00		
Spills, major, count	-17%	-1.00			-12%	-8.00							-6%	-2.00		

July - September

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	27%	28.49	27%	28.49	3%	4.69	3%	4.69	2%	6.11	10%	29.92	4%	4.08		
Trout Spawning/Incu, ha																
SSCV, ha	12%	1.66	12%	1.66	-1%	**-0.45**	-1%	**-0.45**	-3%	**-0.84**	5%	1.44	-3%	**-1.02**		
SFCV, ha	40%	2.60	40%	2.60	0%	**-0.01**	0%	**-0.01**	-10%	**-1.42**	-1%	**-0.12**	4%	0.87		
Shad Juvenile, ha					1%	0.90	1%	0.90	-1%	**-3.72**	6%	16.02	2%	0.83		
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									-36%	**-4.09**						
Spills, minor, count	100%	**1.00**			-80%	-4.00							0%	**Base, Alt =0**		
Spills, moderate, count	-33%	-1.00			0%	0.00							0%	**Base, Alt =0**		
Spills, major, count	0%	**Base, Alt =0**			0%	0.00							-50%	-1.00		

Full Period Scores

	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays
Δ Days > Threshold C	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	-40%	-26.00	-46%	-25.94				

Global Scores

Montague Flow	Pct Chg	Δ Days
Montague, minor shortage	-22%	-65.00
Montague, moderate shortage	-15%	-10.00
Montague, major shortage	0%	**Base, Alt =0**
Montague, cfs-days	-23%	-9663.00
System Drought	Pct Chg	Δ Days
Days at Level 1	93%	**216.00**
Days at Level 2	86%	**171.00**
Days at Level 3	0%	**Base, Alt =0**
System Storage, bg	-8%	-58308.80

Out of System Deliveries	Pct Chg	Δ Days
NYC, minor shortage	0%	0.00
NYC, moderate shortage	0%	**Base, Alt =0**
NYC, major shortage	0%	**Base, Alt =0**
New York City, bg	0%	Base, Alt =0
	Pct Chg	Δ Days
NJ, minor shortage	0%	0.00
NJ, moderate shortage	0%	**Base, Alt =0**
NJ, major shortage	0%	**Base, Alt =0**
New Jersey, bg	0%	Base, Alt =0

Run Settings

Maximum Water Temperature	West Branch	24
(degrees C)	East Branch	24
	Main Stem	24
	Neversink	24
Spill Magnitude	Mild, <	10
(% outflow capacity)	Major, >	50
Montague Shortage Magnitude	Mild, <	10
(% minimum flow)	Major, >	50

New York Diversion Magnitude	Mild	10
(% minimum delivery)	Major	50
New York Diversion Magnitude	Mild	10
(% minimum delivery)	Major	50
Meterological Series		Actual

Scenario 2 Summary

October - April 15

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	5%	3.95			7%	10.48			3%	8.26			11%	10.50		
Trout Spawning/Incu, ha	30%	1.69			41%	1.65			7%	0.88			70%	3.09		
SSCV, ha	14%	1.89			2%	0.44			1%	0.13			-1%	**-0.28**		
SFCV, ha	39%	2.39			4%	0.17			0%	0.01			12%	1.82		
Shad Juvenile, ha																
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									10%	0.32						
Spills, minor, count	-9%	-2.00			-29%	-2.00							-25%	-1.00		
Spills, moderate, count	-36%	-5.00			-26%	-5.00							-31%	-5.00		
Spills, major, count	-46%	-6.00			-50%	-19.00							-46%	-12.00		

April 16 - June

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	28%	29.59	28%	29.59	5%	8.29	5%	8.29	6%	21.35	8%	26.27	7%	7.67		
Trout Spawning/Incu, ha																
SSCV, ha	5%	0.61	5%	0.61	5%	1.13	5%	1.13	1%	0.17	3%	0.57	2%	0.39		
SFCV, ha	17%	0.87	17%	0.87	14%	0.46	14%	0.46	-2%	**-0.09**	0%	0.02	4%	0.50		
Shad Juvenile, ha																
Shad Spawning, ha					3%	1.18	3%	1.18	10%	15.86	12%	18.26	14%	3.06		
Dwarf Wedge Mussel, ha									4%	0.13						
Spills, minor, count	8%	**1.00**			-62%	-8.00							-33%	-1.00		
Spills, moderate, count	7%	**1.00**			0%	0.00							25%	**3.00**		
Spills, major, count	-17%	-1.00			-8%	-5.00							-3%	-1.00		

July - September

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	20%	20.81	20%	20.81	4%	6.84	4%	6.84	1%	3.24	7%	20.75	6%	5.95		
Trout Spawning/Incu, ha																
SSCV, ha	12%	1.80	12%	1.80	-1%	**-0.43**	-1%	**-0.42**	-1%	**-0.33**	5%	1.32	-3%	**-1.05**		
SFCV, ha	44%	2.88	44%	2.88	0%	**-0.06**	0%	**-0.06**	-5%	**-0.73**	2%	0.25	7%	1.43		
Shad Juvenile, ha					1%	1.04	1%	1.04	-1%	**-1.71**	5%	12.43	3%	1.22		
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									0%	**-0.02**						
Spills, minor, count	100%	**1.00**			-80%	-4.00							0%	**Base, Alt =0**		
Spills, moderate, count	-33%	-1.00			0%	0.00							100%	**1.00**		
Spills, major, count	0%	**Base, Alt =0**			0%	0.00							-50%	-1.00		

Full Period Scores

	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays
Δ Days > Threshold C	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	-26%	-17.00	-31%	-17.61				

Global Scores

	Pct Chg	Δ Days
Montague Flow		
Montague, minor shortage	-14%	-42.00
Montague, moderate shortage	-15%	-10.00
Montague, major shortage	0%	**Base, Alt =0**
Montague, cfs-days	-18%	-7573.00
System Drought	Pct Chg	Δ Days
Days at Level 1	87%	**202.00**
Days at Level 2	65%	**130.00**
Days at Level 3	0%	**Base, Alt =0**
System Storage, bg	-6%	-48174.50

Out of System Deliveries	Pct Chg	Δ Days
NYC, minor shortage	0%	0.00
NYC, moderate shortage	0%	**Base, Alt =0**
NYC, major shortage	0%	**Base, Alt =0**
New York City, bg	0%	Base, Alt =0
	Pct Chg	Δ Days
NJ, minor shortage	0%	0.00
NJ, moderate shortage	0%	**Base, Alt =0**
NJ, major shortage	0%	**Base, Alt =0**
New Jersey, bg	0%	Base, Alt =0

Run Settings

Maximum Water Temperature	West Branch	24
(degrees C)	East Branch	24
	Main Stem	24
	Neversink	24
Spill Magnitude	Mild, <	10
(% outflow capacity)	Major, >	50
Montague Shortage Magnitude	Mild, <	10
(% minimum flow)	Major, >	50

New York Diversion Magnitude	Mild	10
(% minimum delivery)	Major	50
New York Diversion Magnitude	Mild	10
(% minimum delivery)	Major	50
Meterological Series		Actual

Scenario 3 Summary

October - April 15

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	11%	8.53			7%	10.66			4%	11.53			12%	10.65		
Trout Spawning/Incu, ha	43%	2.40			41%	1.63			9%	1.09			70%	3.08		
SSCV, ha	12%	1.67			2%	0.38			0%	0.11			-2%	**-0.45**		
SFCV, ha	33%	1.97			4%	0.15			0%	**-0.01**			11%	1.65		
Shad Juvenile, ha																
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									7%	0.25						
Spills, minor, count	-18%	-4.00			-29%	-2.00							-25%	-1.00		
Spills, moderate, count	-36%	-5.00			-37%	-7.00							-38%	-6.00		
Spills, major, count	-38%	-5.00			-47%	-18.00							-46%	-12.00		

April 16 - June

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	23%	24.19	23%	24.19	5%	8.23	5%	8.23	5%	15.37	6%	19.90	7%	7.67		
Trout Spawning/Incu, ha																
SSCV, ha	5%	0.67	5%	0.67	4%	0.79	4%	0.79	1%	0.18	2%	0.52	1%	0.20		
SFCV, ha	20%	0.99	20%	0.99	5%	0.18	5%	0.18	-1%	**-0.07**	0%	0.02	2%	0.28		
Shad Juvenile, ha																
Shad Spawning, ha					3%	1.01	3%	1.01	7%	11.57	9%	13.86	14%	3.09		
Dwarf Wedge Mussel, ha									4%	0.13						
Spills, minor, count	15%	**2.00**			-54%	-7.00							-33%	-1.00		
Spills, moderate, count	0%	0.00			-12%	-4.00							17%	**2.00**		
Spills, major, count	-17%	-1.00			-5%	-3.00							0%	0.00		

July - September

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	10%	10.99	10%	10.99	5%	8.67	5%	8.67	0%	**-0.69**	3%	10.32	7%	7.35		
Trout Spawning/Incu, ha																
SSCV, ha	11%	1.55	11%	1.55	-1%	**-0.29**	-1%	**-0.29**	0%	0.03	4%	1.06	-3%	**-1.20**		
SFCV, ha	38%	2.46	38%	2.46	-1%	**-0.16**	-1%	**-0.16**	-1%	**-0.15**	4%	0.49	8%	1.72		
Shad Juvenile, ha					1%	1.12	1%	1.12	0%	**-0.94**	3%	8.28	3%	1.47		
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									3%	0.23						
Spills, minor, count	100%	**1.00**			-80%	-4.00							100%	**1.00**		
Spills, moderate, count	-33%	-1.00			0%	0.00							0%	**Base, Alt =0**		
Spills, major, count	0%	**Base, Alt =0**			0%	0.00							0%	0.00		

Full Period Scores

	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays
Δ Days > Threshold C	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	-15%	-10.00	-24%	-13.21				

Global Scores

Montague Flow	Pct Chg	Δ Days
Montague, minor shortage	-14%	-43.00
Montague, moderate shortage	-10%	-7.00
Montague, major shortage	0%	**Base, Alt =0**
Montague, cfs-days	-14%	-5723.00
System Drought	Pct Chg	Δ Days
Days at Level 1	60%	**140.00**
Days at Level 2	55%	**109.00**
Days at Level 3	0%	**Base, Alt =0**
System Storage, bg	-5%	-41527.60

Out of System Deliveries	Pct Chg	Δ Days
NYC, minor shortage	0%	0.00
NYC, moderate shortage	0%	**Base, Alt =0**
NYC, major shortage	0%	**Base, Alt =0**
New York City, bg	0%	Base, Alt =0
	Pct Chg	Δ Days
NJ, minor shortage	0%	0.00
NJ, moderate shortage	0%	**Base, Alt =0**
NJ, major shortage	0%	**Base, Alt =0**
New Jersey, bg	0%	Base, Alt =0

Run Settings

Maximum Water Temperature (degrees C)	West Branch	24
	East Branch	24
	Main Stem	24
	Neversink	24
Spill Magnitude (% outflow capacity)	Mild, <	10
	Major, >	50
Montague Shortage Magnitude (% minimum flow)	Mild, <	10
	Major, >	50

New York Diversion Magnitude (% minimum delivery)	Mild	10
	Major	50
New York Diversion Magnitude (% minimum delivery)	Mild	10
	Major	50
Meterological Series		Actual

Scenario 4 Summary

October - April 15

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	23%	17.58			6%	10.04			6%	19.06			11%	10.24		
Trout Spawning/Incu, ha	65%	3.62			41%	1.62			-10%	**-1.26**			66%	2.93		
SSCV, ha	12%	1.61			2%	0.43			0%	0.09			-1%	**-0.39**		
SFCV, ha	29%	1.73			5%	0.18			-1%	**-0.04**			11%	1.67		
Shad Juvenile, ha																
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									10%	0.34						
Spills, minor, count	-18%	-4.00			-14%	-1.00							-25%	-1.00		
Spills, moderate, count	-36%	-5.00			-37%	-7.00							-31%	-5.00		
Spills, major, count	-46%	-6.00			-47%	-18.00							-46%	-12.00		

April 16 - June

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	12%	12.89	12%	12.89	5%	8.22	5%	8.22	2%	6.84	3%	8.32	7%	7.70		
Trout Spawning/Incu, ha																
SSCV, ha	5%	0.65	5%	0.65	4%	0.93	4%	0.93	1%	0.24	2%	0.38	2%	0.38		
SFCV, ha	20%	0.99	20%	0.99	9%	0.31	9%	0.31	0%	**-0.01**	1%	0.04	4%	0.50		
Shad Juvenile, ha																
Shad Spawning, ha					3%	1.06	3%	1.06	4%	5.74	4%	6.38	14%	3.07		
Dwarf Wedge Mussel, ha									7%	0.23						
Spills, minor, count	8%	**1.00**			-54%	-7.00							-33%	-1.00		
Spills, moderate, count	0%	0.00			-9%	-3.00							25%	**3.00**		
Spills, major, count	-17%	-1.00			-5%	-3.00							0%	0.00		

July - September

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	7%	7.32	7%	7.32	6%	9.22	6%	9.22	-1%	**-2.85**	0%	0.81	8%	7.88		
Trout Spawning/Incu, ha																
SSCV, ha	9%	1.33	9%	1.33	-1%	**-0.27**	-1%	**-0.27**	1%	0.21	2%	0.43	-3%	**-1.22**		
SFCV, ha	33%	2.13	33%	2.13	-1%	**-0.18**	-1%	**-0.18**	0%	0.07	1%	0.14	9%	1.88		
Shad Juvenile, ha					1%	1.05	1%	1.05	0%	**-0.70**	1%	1.68	3%	1.59		
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									2%	0.12						
Spills, minor, count	100%	**1.00**			-20%	-1.00							100%	**1.00**		
Spills, moderate, count	-33%	-1.00			0%	0.00							0%	**Base, Alt =0**		
Spills, major, count	0%	**Base, Alt =0**			0%	0.00							0%	0.00		

Full Period Scores

	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays
Δ Days > Threshold C	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	-2%	-1.00	-4%	-2.50				

Global Scores

Montague Flow	Pct Chg	Δ Days
Montague, minor shortage	-11%	-34.00
Montague, moderate shortage	-10%	-7.00
Montague, major shortage	0%	**Base, Alt =0**
Montague, cfs-days	-11%	-4744.00
System Drought	Pct Chg	Δ Days
Days at Level 1	30%	**70.00**
Days at Level 2	81%	**162.00**
Days at Level 3	0%	**Base, Alt =0**
System Storage, bg	-5%	-39195.50

Out of System Deliveries	Pct Chg	Δ Days
NYC, minor shortage	0%	0.00
NYC, moderate shortage	0%	**Base, Alt =0**
NYC, major shortage	0%	**Base, Alt =0**
New York City, bg	0%	Base, Alt =0
	Pct Chg	Δ Days
NJ, minor shortage	0%	0.00
NJ, moderate shortage	0%	**Base, Alt =0**
NJ, major shortage	0%	**Base, Alt =0**
New Jersey, bg	0%	Base, Alt =0

Run Settings

Maximum Water Temperature (degrees C)	West Branch	24
	East Branch	24
	Main Stem	24
	Neversink	24
Spill Magnitude (% outflow capacity)	Mild, <	10
	Major, >	50
Montague Shortage Magnitude (% minimum flow)	Mild, <	10
	Major, >	50

New York Diversion Magnitude (% minimum delivery)	Mild	10
	Major	50
New York Diversion Magnitude (% minimum delivery)	Mild	10
	Major	50
Meterological Series		Actual

Scenario 5 Summary

October - April 15

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	14%	10.87			5%	8.03			3%	8.73			13%	12.21		
Trout Spawning/Incu, ha	35%	1.97			49%	1.94			3%	0.41			111%	4.90		
SSCV, ha	11%	1.47			-6%	**-1.36**			1%	0.13			0%	0.08		
SFCV, ha	45%	2.69			18%	0.71			0%	0.02			16%	2.42		
Shad Juvenile, ha																
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									4%	0.12						
Spills, minor, count	-14%	-3.00			14%	**1.00**							0%	0.00		
Spills, moderate, count	-50%	-7.00			-21%	-4.00							-25%	-4.00		
Spills, major, count	-38%	-5.00			-47%	-18.00							-42%	-11.00		

April 16 - June

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	26%	27.67	26%	27.67	0%	**-0.52**	0%	**-0.52**	6%	19.81	8%	24.75	4%	4.30		
Trout Spawning/Incu, ha																
SSCV, ha	4%	0.49	4%	0.49	2%	0.51	2%	0.51	1%	0.15	3%	0.55	1%	0.27		
SFCV, ha	16%	0.82	16%	0.82	11%	0.37	11%	0.37	-1%	**-0.07**	1%	0.04	2%	0.33		
Shad Juvenile, ha																
Shad Spawning, ha					1%	0.30	1%	0.30	9%	14.27	11%	16.69	10%	2.21		
Dwarf Wedge Mussel, ha									4%	0.13						
Spills, minor, count	0%	0.00			-38%	-5.00							-33%	-1.00		
Spills, moderate, count	7%	**1.00**			-12%	-4.00							17%	**2.00**		
Spills, major, count	-17%	-1.00			-2%	-1.00							0%	0.00		

July - September

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	24%	24.89	24%	24.89	-1%	**-2.01**	-1%	**-2.01**	2%	5.62	8%	25.03	2%	2.42		
Trout Spawning/Incu, ha																
SSCV, ha	9%	1.26	9%	1.26	-2%	**-0.55**	-2%	**-0.55**	-1%	**-0.45**	5%	1.43	-2%	**-0.77**		
SFCV, ha	30%	1.95	30%	1.95	2%	0.31	2%	0.31	-6%	**-0.83**	2%	0.27	1%	0.16		
Shad Juvenile, ha					0%	**-0.37**	0%	**-0.37**	0%	**-1.31**	6%	14.77	2%	0.73		
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									-1%	**-0.06**						
Spills, minor, count	100%	**1.00**			-80%	-4.00							100%	**1.00**		
Spills, moderate, count	-33%	-1.00			0%	0.00							0%	**Base, Alt =0**		
Spills, major, count	0%	**Base, Alt =0**			0%	0.00							-50%	-1.00		

Full Period Scores

	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays
Δ Days > Threshold C	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	-31%	-20.00	-38%	-21.38				

Global Scores

	Pct Chg	Δ Days
Montague Flow		
Montague, minor shortage	-12%	-36.00
Montague, moderate shortage	-18%	-12.00
Montague, major shortage	0%	**Base, Alt =0**
Montague, cfs-days	-18%	-7558.00
System Drought		
Days at Level 1	80%	**186.00**
Days at Level 2	62%	**123.00**
Days at Level 3	0%	**Base, Alt =0**
System Storage, bg	-6%	-46742.00

	Pct Chg	Δ Days
Out of System Deliveries		
NYC, minor shortage	0%	0.00
NYC, moderate shortage	0%	**Base, Alt =0**
NYC, major shortage	0%	**Base, Alt =0**
New York City, bg	0%	Base, Alt =0
	Pct Chg	Δ Days
NJ, minor shortage	0%	0.00
NJ, moderate shortage	0%	**Base, Alt =0**
NJ, major shortage	0%	**Base, Alt =0**
New Jersey, bg	0%	Base, Alt =0

Run Settings

Maximum Water Temperature (degrees C)	West Branch	24
	East Branch	24
	Main Stem	24
	Neversink	24
Spill Magnitude (% outflow capacity)	Mild, <	10
	Major, >	50
Montague Shortage Magnitude (% minimum flow)	Mild, <	10
	Major, >	50

New York Diversion Magnitude (% minimum delivery)	Mild	10
	Major	50
New York Diversion Magnitude (% minimum delivery)	Mild	10
	Major	50
Meterological Series		Actual

Scenario 1 vs. Scenario 2

Delaware DSS **Run Date:** **05/17/09** **Start date** **End date**
Provisional Version 2.11 **Baseline:** **Scenario 1** **10/1/1989** **to** **9/30/1999**
Summary **Alternative:** **Scenario 2** **10/1/1989** **to** **9/30/1999**

October - April 15

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	11%	8.18			0%	0.42			1%	4.77			0%	0.36		
Trout Spawning/Incu, ha	41%	2.13			0%	0.01			2%	0.24			3%	0.24		
SSCV, ha	0%	**-0.01**			0%	**-0.08**			0%	**-0.04**			-1%	**-0.14**		
SFCV, ha	-1%	**-0.08**			-1%	**-0.02**			0%	**-0.01**			-1%	**-0.13**		
Shad Juvenile, ha																
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									-2%	**-0.08**						
Spills, minor, count	0%	0.00			-17%	-1.00							0%	0.00		
Spills, moderate, count	-25%	-3.00			27%	**3.00**							10%	**1.00**		
Spills, major, count	17%	**1.00**			-5%	-1.00							0%	0.00		

April 16 - June

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	-4%	**-6.23**	-4%	**-6.23**	0%	0.31	0%	0.31	-1%	**-5.25**	-3%	**-10.16**	0%	0.50		
Trout Spawning/Incu, ha																
SSCV, ha	0%	0.04	0%	0.04	0%	**-0.10**	0%	**-0.10**	0%	**-0.03**	-1%	**-0.32**	-1%	**-0.24**		
SFCV, ha	1%	0.09	1%	0.09	-3%	**-0.10**	-3%	**-0.10**	2%	0.08	0%	0.00	-2%	**-0.26**		
Shad Juvenile, ha																
Shad Spawning, ha					0%	0.06	0%	0.06	-1%	**-1.28**	-3%	**-4.48**	1%	0.24		
Dwarf Wedge Mussel, ha									-1%	**-0.04**						
Spills, minor, count	17%	**2.00**			-17%	-1.00							-33%	-1.00		
Spills, moderate, count	7%	**1.00**			3%	**1.00**							25%	**3.00**		
Spills, major, count	0%	0.00			5%	**3.00**							3%	**1.00**		

July - September

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	-6%	**-7.68**	-6%	**-7.68**	1%	2.15	1%	2.15	-1%	**-2.86**	-3%	**-9.17**	2%	1.87		
Trout Spawning/Incu, ha																
SSCV, ha	1%	0.14	1%	0.14	0%	0.02	0%	0.02	2%	0.51	0%	**-0.12**	0%	**-0.03**		
SFCV, ha	3%	0.28	3%	0.28	0%	**-0.05**	0%	**-0.05**	6%	0.69	3%	0.38	2%	0.56		
Shad Juvenile, ha					0%	0.15	0%	0.15	1%	2.01	-1%	**-3.59**	1%	0.39		
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									-1%	**-0.09**						
Spills, minor, count	0%	0.00			0%	0.00							0%	**Base, Alt =0**		
Spills, moderate, count	0%	0.00			0%	0.00							100%	**1.00**		
Spills, major, count	0%	**Base, Alt =0**			0%	0.00							0%	0.00		

Full Period Scores

	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays
Δ Days > Threshold C	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	23%	**9.00**	28%	**8.33**				

Global Scores

Montague Flow	Pct Chg	Δ Days
Montague, minor shortage	10%	**23.00**
Montague, moderate shortage	0%	0.00
Montague, major shortage	0%	**Base, Alt =0**
Montague, cfs-days	6%	**2090.00**
System Drought	Pct Chg	Δ Days
Days at Level 1	-3%	-14.00
Days at Level 2	-11%	-41.00
Days at Level 3	0%	**Base, Alt =0**
System Storage, bg	1%	**10134.30**

Out of System Deliveries	Pct Chg	Δ Days
NYC, minor shortage	0%	0.00
NYC, moderate shortage	0%	**Base, Alt =0**
NYC, major shortage	0%	**Base, Alt =0**
New York City, bg	0%	Base, Alt =0
	Pct Chg	Δ Days
NJ, minor shortage	0%	0.00
NJ, moderate shortage	0%	**Base, Alt =0**
NJ, major shortage	0%	**Base, Alt =0**
New Jersey, bg	0%	Base, Alt =0

Run Settings

Maximum Water Temperature	West Branch	24
(degrees C)	East Branch	24
	Main Stem	24
	Neversink	24
Spill Magnitude	Mild, <	10
(% outflow capacity)	Major, >	50
Montague Shortage Magnitude	Mild, <	10
(% minimum flow)	Major, >	50

New York Diversion Magnitude	Mild	10
(% minimum delivery)	Major	50
New York Diversion Magnitude	Mild	10
(% minimum delivery)	Major	50
Meterological Series		Actual

Scenario 1 vs. Scenario 3

Delaware DSS	**Run Date:**	**05/17/09**	**Start date**		**End date**
Provisional Version 2.11	**Baseline:**	**Scenario 1**	**10/1/1989**	**to**	**9/30/1999**
Summary	**Alternative:**	**Scenario 3**	**10/1/1989**	**to**	**9/30/1999**

October - April 15

	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
Resource	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	17%	12.76			0%	0.60			2%	8.04			1%	0.51		
Trout Spawning/Incu, ha	55%	2.84			0%	**-0.01**			3%	0.45			3%	0.23		
SSCV, ha	-1%	**-0.22**			-1%	**-0.13**			0%	**-0.06**			-1%	**-0.31**		
SFCV, ha	-6%	**-0.49**			-1%	**-0.05**			-1%	**-0.04**			-2%	**-0.29**		
Shad Juvenile, ha																
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									-4%	**-0.15**						
Spills, minor, count	-10%	-2.00			-17%	-1.00							0%	0.00		
Spills, moderate, count	-25%	-3.00			9%	**1.00**							0%	0.00		
Spills, major, count	33%	**2.00**			0%	0.00							0%	0.00		

April 16 - June

	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
Resource	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	-8%	**-11.62**	-8%	**-11.62**	0%	0.25	0%	0.25	-3%	**-11.23**	-5%	**-16.53**	0%	0.51		
Trout Spawning/Incu, ha																
SSCV, ha	1%	0.10	1%	0.10	-2%	**-0.44**	-2%	**-0.44**	0%	**-0.03**	-2%	**-0.37**	-2%	**-0.44**		
SFCV, ha	4%	0.21	4%	0.21	-10%	**-0.38**	-10%	**-0.38**	2%	0.09	0%	0.00	-3%	**-0.48**		
Shad Juvenile, ha																
Shad Spawning, ha					0%	**-0.11**	0%	**-0.11**	-3%	**-5.57**	-5%	**-8.88**	1%	0.28		
Dwarf Wedge Mussel, ha									-1%	**-0.05**						
Spills, minor, count	25%	**3.00**			0%	0.00							-33%	-1.00		
Spills, moderate, count	0%	0.00			-9%	-3.00							17%	**2.00**		
Spills, major, count	0%	0.00			9%	**5.00**							6%	**2.00**		

July - September

	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
Resource	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	-13%	**-17.50**	-13%	**-17.50**	2%	3.97	2%	3.97	-2%	**-6.80**	-6%	**-19.60**	3%	3.27		
Trout Spawning/Incu, ha																
SSCV, ha	-1%	**-0.11**	-1%	**-0.11**	1%	0.16	1%	0.16	3%	0.87	-1%	**-0.38**	-1%	**-0.18**		
SFCV, ha	-2%	**-0.14**	-2%	**-0.14**	-1%	**-0.15**	-1%	**-0.15**	10%	1.27	6%	0.61	4%	0.84		
Shad Juvenile, ha					0%	0.23	0%	0.23	1%	2.77	-3%	**-7.73**	1%	0.64		
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									2%	0.15						
Spills, minor, count	0%	0.00			0%	0.00							100%	**1.00**		
Spills, moderate, count	0%	0.00			0%	0.00							0%	**Base, Alt =0**		
Spills, major, count	0%	**Base, Alt =0**			0%	0.00							100%	**1.00**		

Full Period Scores

	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays
Δ Days > Threshold C	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	41%	**16.00**	42%	**12.73**				

Global Scores

Montague Flow	Pct Chg	Δ Days
Montague, minor shortage	9%	**22.00**
Montague, moderate shortage	5%	**3.00**
Montague, major shortage	0%	**Base, Alt =0**
Montague, cfs-days	12%	**3940.00**
System Drought	Pct Chg	Δ Days
Days at Level 1	-17%	-76.00
Days at Level 2	-17%	-62.00
Days at Level 3	0%	**Base, Alt =0**
System Storage, bg	2%	**16781.20**

Out of System Deliveries	Pct Chg	Δ Days
NYC, minor shortage	0%	0.00
NYC, moderate shortage	0%	**Base, Alt =0**
NYC, major shortage	0%	**Base, Alt =0**
New York City, bg	0%	Base, Alt =0
	Pct Chg	Δ Days
NJ, minor shortage	0%	0.00
NJ, moderate shortage	0%	**Base, Alt =0**
NJ, major shortage	0%	**Base, Alt =0**
New Jersey, bg	0%	Base, Alt =0

Run Settings

Maximum Water Temperature	West Branch	24	New York Diversion Magnitude	Mild	10
(degrees C)	East Branch	24	(% minimum delivery)	Major	50
	Main Stem	24			
	Neversink	24	New York Diversion Magnitude	Mild	10
			(% minimum delivery)	Major	50
Spill Magnitude	Mild, <	10			
(% outflow capacity)	Major, >	50	Meterological Series		Actual
Montague Shortage Magnitude	Mild, <	10			
(% minimum flow)	Major, >	50			

Scenario 2 vs. Scenario 3

Delaware DSS | **Run Date:** | **05/17/09** | **Start date** | | **End date**
Provisional Version 2.11 | **Baseline:** | **Scenario 2** | **10/1/1989** | **to** | **9/30/1999**
Summary | **Alternative:** | **Scenario 3** | **10/1/1989** | **to** | **9/30/1999**

October - April 15

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	6%	4.58			0%	0.18			1%	3.27			0%	0.15		
Trout Spawning/Incu, ha	10%	0.71			0%	**-0.01**			2%	0.22			0%	**0.00**		
SSCV, ha	-1%	**-0.22**			0%	**-0.06**			0%	**-0.02**			-1%	**-0.17**		
SFCV, ha	-5%	**-0.41**			-1%	**-0.02**			-1%	**-0.02**			-1%	**-0.16**		
Shad Juvenile, ha																
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									-2%	**-0.07**						
Spills, minor, count	-10%	-2.00			0%	0.00							0%	0.00		
Spills, moderate, count	0%	0.00			-14%	-2.00							-9%	-1.00		
Spills, major, count	14%	**1.00**			5%	**1.00**							0%	0.00		

April 16 - June

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	-4%	**-5.39**	-4%	**-5.39**	0%	**-0.05**	0%	**-0.05**	-2%	**-5.98**	-2%	**-6.37**	0%	0.01		
Trout Spawning/Incu, ha																
SSCV, ha	0%	0.06	0%	0.06	-1%	**-0.35**	-1%	**-0.35**	0%	0.01	0%	**-0.05**	-1%	**-0.20**		
SFCV, ha	2%	0.12	2%	0.12	-7%	**-0.28**	-7%	**-0.28**	0%	0.02	0%	0.00	-2%	**-0.22**		
Shad Juvenile, ha																
Shad Spawning, ha					0%	**-0.17**	0%	**-0.17**	-2%	**-4.29**	-3%	**-4.40**	0%	0.04		
Dwarf Wedge Mussel, ha									0%	**0.00**						
Spills, minor, count	7%	**1.00**			20%	**1.00**							0%	0.00		
Spills, moderate, count	-7%	-1.00			-12%	-4.00							-7%	-1.00		
Spills, major, count	0%	0.00			3%	**2.00**							3%	**1.00**		

July - September

Resource	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab	Pct Chg	Δ Hab	Pct Chg	ΔTCondHab
Trout Adult, ha	-8%	**-9.82**	-8%	**-9.82**	1%	1.82	1%	1.83	-1%	**-3.94**	-3%	**-10.42**	1%	1.40		
Trout Spawning/Incu, ha																
SSCV, ha	-2%	**-0.25**	-2%	**-0.25**	0%	0.14	0%	0.14	1%	0.37	-1%	**-0.26**	0%	**-0.15**		
SFCV, ha	-4%	**-0.42**	-4%	**-0.42**	-1%	**-0.10**	-1%	**-0.10**	4%	0.58	2%	0.24	1%	0.29		
Shad Juvenile, ha					0%	0.08	0%	0.08	0%	0.76	-2%	**-4.15**	1%	0.25		
Shad Spawning, ha																
Dwarf Wedge Mussel, ha									3%	0.25						
Spills, minor, count	0%	0.00			0%	0.00							100%	**1.00**		
Spills, moderate, count	0%	0.00			0%	0.00							-100%	-1.00		
Spills, major, count	0%	**Base, Alt =0**			0%	0.00							100%	**1.00**		

Full Period Scores

	West Branch				East Branch				Main Hancock-Callicoon				Neversink			
	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays	Pct Chg	Δ Days	Pct Chg	ΔDegDays
Δ Days > Threshold C	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	0%	**Base, Alt =0**	15%	**7.00**	11%	**4.40**				

Global Scores

Montague Flow	Pct Chg	Δ Days
Montague, minor shortage	0%	-1.00
Montague, moderate shortage	5%	**3.00**
Montague, major shortage	0%	**Base, Alt =0**
Montague, cfs-days	5%	**1850.00**

System Drought	Pct Chg	Δ Days
Days at Level 1	-14%	-62.00
Days at Level 2	-6%	-21.00
Days at Level 3	0%	**Base, Alt =0**
System Storage, bg	1%	**6646.90**

Out of System Deliveries	Pct Chg	Δ Days
NYC, minor shortage	0%	0.00
NYC, moderate shortage	0%	**Base, Alt =0**
NYC, major shortage	0%	**Base, Alt =0**
New York City, bg	0%	Base, Alt =0
NJ, minor shortage	0%	0.00
NJ, moderate shortage	0%	**Base, Alt =0**
NJ, major shortage	0%	**Base, Alt =0**
New Jersey, bg	0%	Base, Alt =0

Run Settings

Maximum Water Temperature (degrees C)	West Branch	24
	East Branch	24
	Main Stem	24
	Neversink	24
Spill Magnitude (% outflow capacity)	Mild, <	10
	Major, >	50
Montague Shortage Magnitude (% minimum flow)	Mild, <	10
	Major, >	50

New York Diversion Magnitude (% minimum delivery)	Mild	10
	Major	50
New York Diversion Magnitude (% minimum delivery)	Mild	10
	Major	50
Meterological Series		Actual