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MODERNIZED DSS: A HABITAT MODEL FOR THE UPPER DELAWARE RIVER (NJ, NY, PA)

Technical Report No. 2022-04

Managing, Protecting and Improving the Water Resources of the Delaware River Basin since 1961

Delaware River Basin Commission
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UNITED STATES OF AMERICA

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Background

The Delaware River and its tributaries provide water for many different purposes, including drinking and industrial water supply, power generation, water quality maintenance, in-stream flow needs for aquatic life, fishing, boating and recreation.

Early in the twentieth century, New York City identified locations in the Delaware River Basin for the development of water supply reservoirs. New Jersey sued New York City over concerns about the impact of out-of-basin diversions on the lower river. Pennsylvania and Delaware also expressed similar concerns. In 1931 and then again in 1954, the Supreme Court of the United States issued a decree that limited out-of-basin diversions and required that New York City make releases to meet a flow objective at Montague, N.J., ensuring that enough water would flow downstream for lower basin uses. The Parties to the Decree (Decree Parties) are the four basin states (DE, NJ, PA, and NY) and New York City.

One issue not addressed by the 1954 Decree was the conservation releases from the New York City Reservoirs. Over the past 45 years, the Decree Parties have worked together to develop and evolve conservation release programs with the assistance of DRBC. In addition to providing a venue for public input into the fisheries release programs, DRBC has provided the Decree Parties extensive technical analyses, modeling and other support for the negotiation of new conservation releases and habitat protection programs. The program currently in effect is the Flexible Flow Management Program (FFMP). When developing the program, the public provided proposals for modifying the conservation releases through DRBC's Regulated Flow Advisory Committee and the Subcommittee on Ecological Flows. To review the proposals, the Decision Support System (DSS) was originally developed in 2007 by the U.S. Geological Survey (USGS) and was used to compare the habitat consequences of different flow management protocols. It was revised in 2014 to provide a more user-friendly and powerful interface which included GIS visualizations of habitat. Over time, both versions of the DSS became antiquated and difficult to operate. This report documents the latest version of the DSS which recodes the DSS into modern modular platform for ease of use and expandability.

Subcommittee on Ecological Flows (SEF)

The Subcommittee on Ecological Flows (SEF) under the Delaware River Basin Commission (DRBC or Commission) was re-convened in March 2018 and tasked with providing science-based information and recommendations on flows for the maintenance of healthy aquatic ecosystems and water quality (including temperature), sensitive species that could be impacted by regulated flows, thermal and flow change mitigation, and the effects of existing and proposed regulated flows on habitat and ecological health. DRBC staff are not SEF members but serve as liaison and technical support.

Current SEF members include representatives of:

- New Jersey Division Fish & Wildlife, Bureau of Freshwater Fisheries
- Pennsylvania Fish and Boat Commission, Division of Fisheries Management
- New York State Department of Environmental Conservation
- Delaware Department of Natural Resources and Environmental Control, Division of Fish and Wildlife
- National Park Service
- United States Fish & Wildlife Service

- Philadelphia Water Department
- New York City Department of Environmental Protection
- Delaware Riverkeeper Network
- Friends of the Upper Delaware River; and
- Affiliates of environmental, watershed, and fisheries organizations, business and industry, and academia

The SEF was reconvened March 2018 by DRBC Resolution 2018-2 and charged with evaluating review of the guidelines for use of a Thermal Mitigation Bank and Rapid Flow Change Mitigation Bank specified in the Flexible Flow Management Program (FFMP). At the first meeting of the reconvened SEF held on October 4, 2018, members discussed existing DSS tools originally developed by USGS (USGS) including a spreadsheet-based tool in 2007 and a product called REFDSS in 2014. In this report, those two versions are referred to as Spreadsheet DSS and REFDSS. The current tool updated by DRBC is referred to as DRBC DSS. The primary function of the DSS is to translate flow data into available habitat in the Upper Delaware. As outlined in Open-File Report 2007-1172, the specific objectives of the DSS included quantification of habitat metrics over a range of discharges and seasons at selected locations in three tributaries (East Branch, West Branch, Neversink) and the mainstem Delaware River, and to assist DRBC and other stakeholders in analyzing and interpreting water management and reservoir operations alternatives.

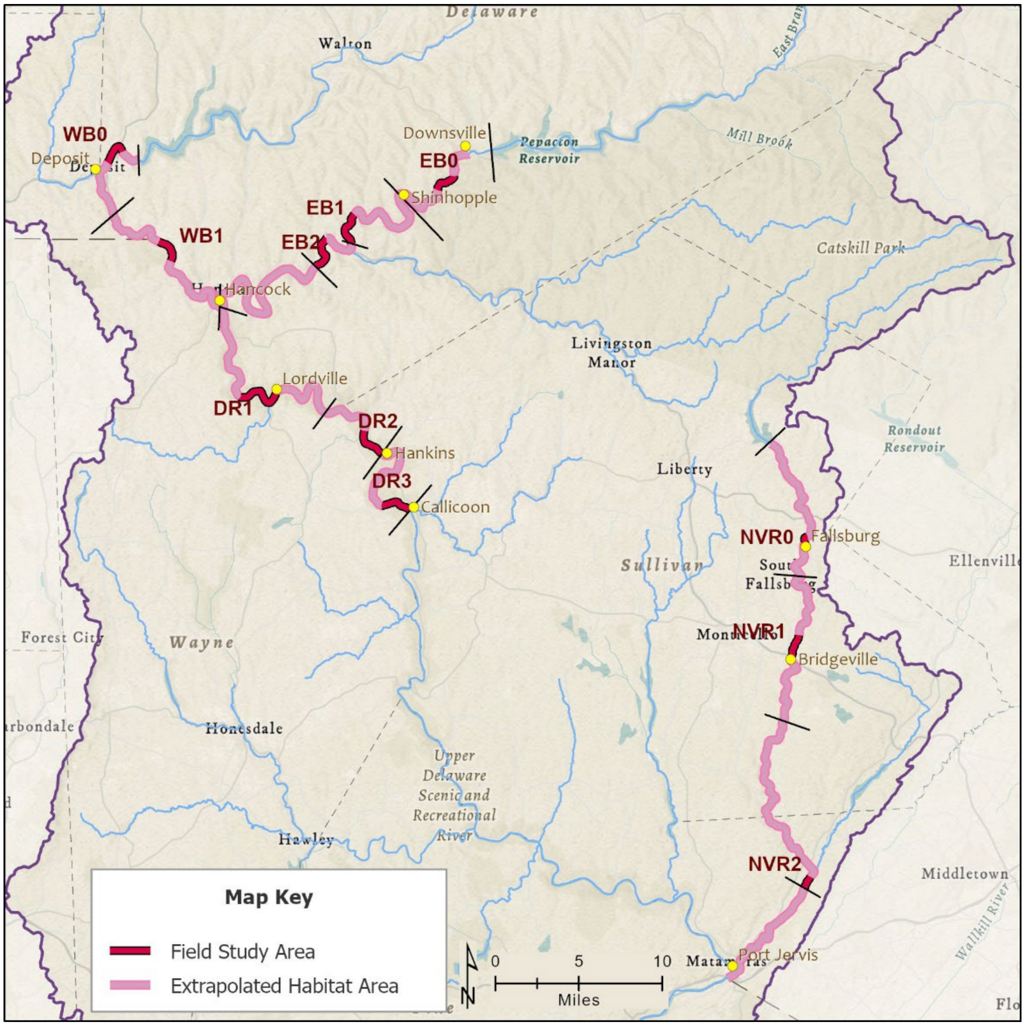
SEF members indicated that the existing tools suffered from several problems associated with antiquated development standards and software platforms. Members stated that the existing tools were difficult to use, slow, and required excessive computer hardware memory. Several SEF members indicated that the most recent version could not be run on their computer. The older Spreadsheet DSS is no longer available from USGS. A legacy copy of the Spreadsheet DSS was unclear on data input and processing and lacked documentation. In the newer REFDSS, dates are hard coded into the platform, so that new time-series data cannot be evaluated directly. At that meeting, USGS indicated a lack of staff and resources needed to address the deficiencies.

About DSS

Domain

As documented in the original Decision Support Framework (Bovee 2007), DSS computes habitat within sub-reaches in East Branch, West Branch, and 27-mile-long main stem Delaware River (from River Mile 330.7 to River Mile 303.7) as well as the Neversink River. As shown in Figure 1 below, original field work for defining the relationships between flow and available habitat was performed in smaller sub-reaches, and these relationships were extrapolated to larger sub-reaches to cover an area that extended from just below the New York City reservoirs to Callicoon, NY on the mainstem Delaware and Port Jervis, NY on the Neversink.

Figure 1. DSS Field Study and Extrapolated Reaches



Biota Categories

DSS computes available habitat for different species or groupings of species at different life stages, herein referred to as biota categories. Ten biota categories and corresponding codes used throughout the DSS are listed in Table 1 below. The *Other Fin Fish, Shallow Fast and Slow Flowing Guilds* are aggregate categories that incorporate multiple species across life stages exhibiting habitat preference for shallow water that is flowing fast or slow.

Table 1. Biota Categories

Biota Category	Code
Brown Trout, Spawning	Brn_spn
Brown Trout, Incubation	Brn_inc
Brown Trout, Juvenile	Brn_juv
Brown Trout, Adult	Brn_adlt
Rainbow Trout, Juvenile	Rbw_juv
Rainbow Trout, Adult	Rbw_adlt
American Shad, Spawning	Shd_spn
American Shad, Juvenile	Shd_juv
Other Fin Fish, Shallow Fast-Flowing Guild	Sfg
Other Fin Fish, Shallow Slow-Flowing Guild	Ssg

Habitat Curves

DSS' main function is to translate flow time series data into available habitat time series data. This is accomplished using a series of habitat curves originally developed as part of the Decision Support Framework (Bovee 2007). For each biota life stage, a habitat curve was developed based on water depth and current velocity from field data collected by USGS across a variety of flows. These depth and velocity measurements are compared to Habitat Suitability Criteria (HSC) for each species (HSC values were determined during the development of the original DSS). A total amount of suitable habitat is calculated for each biota life stage in each flow scenario for each section of river. The total available habitat in each area is then extrapolated as seen in Figure 1. Represented graphically, habitat curves include flow on the x-axis, and habitat area on the y-axis, with each species-age-class represented as a separate curve with curves grouped by reach, as shown in Figures 2 through 12. Due to bathymetric changes, the available habitat areas are varied by flow regimes for each reach.

Due to the modular, open-source nature of the DRBC DSS, the user can add or modify HSC values and/or the underlying field data and recalculate habitat curves. This feature allows the DRBC DSS to evaluate new species of interest or revise existing HSC if literature suggests revisions. If additional velocity or depth data becomes available, the DRBC DSS can be used to evaluate this data.

Habitat curves were not developed in every reach for each species-age-class. For instance, American Shad juvenile and spawning life stages were only developed for the mainstem Delaware reaches and for east branch reach 2 (eb2) because those are the only reaches where this species currently occurs. If restoration or management efforts restore specific species to certain reaches, these species/reach combinations can be added into the DSS.

Table 2. Availability of Habitat Curves

	Brown Trout				Rainbow Trout		American Shad		ssg	sfg
Reach	adlt	inc	juv	spn	adlt	juv	juv	spn		
del1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
del2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
del3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
eb0	✔	✔	✔	✔	✔	✔			✔	✔
eb1	✔	✔	✔	✔	✔	✔			✔	✔
eb2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
nvr0	✔	✔	✔	✔	✔	✔			✔	✔
nvr1	✔	✔	✔	✔	✔	✔			✔	✔
nvr2	✔	✔	✔	✔	✔	✔			✔	✔
wb0	✔	✔	✔	✔	✔	✔			✔	✔
wb1	✔	✔	✔	✔	✔	✔			✔	✔

Figure 2. Habitat Curve for DEL1

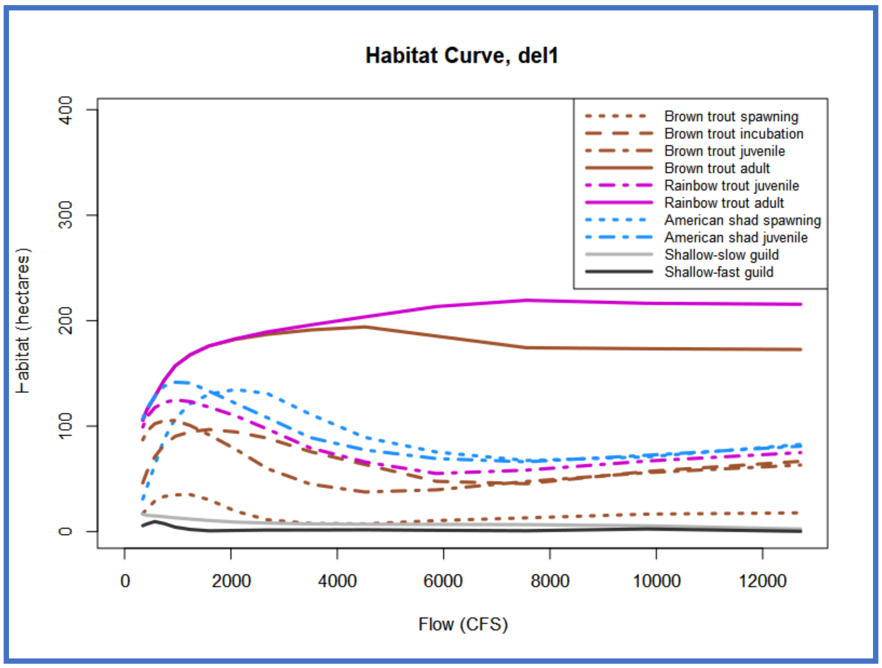


Figure 3. Habitat Curve for DEL2

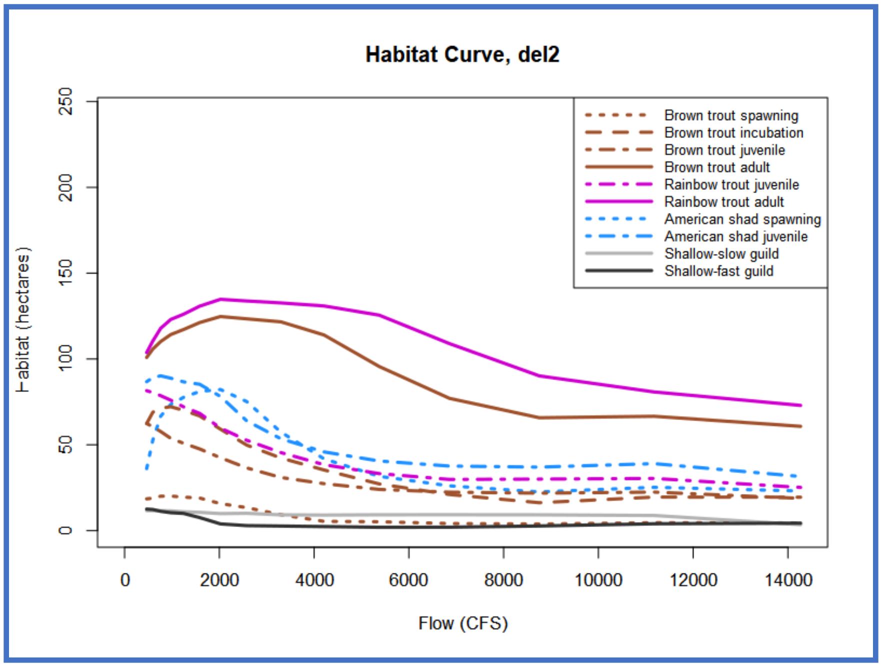


Figure 4. Habitat Curve for DEL3

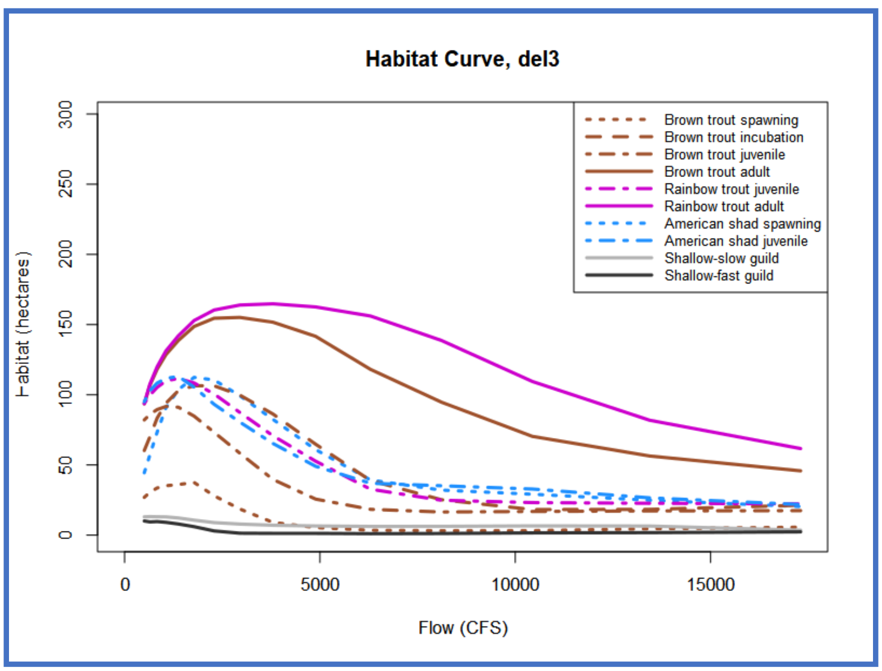


Figure 5. Habitat Curve for EB0

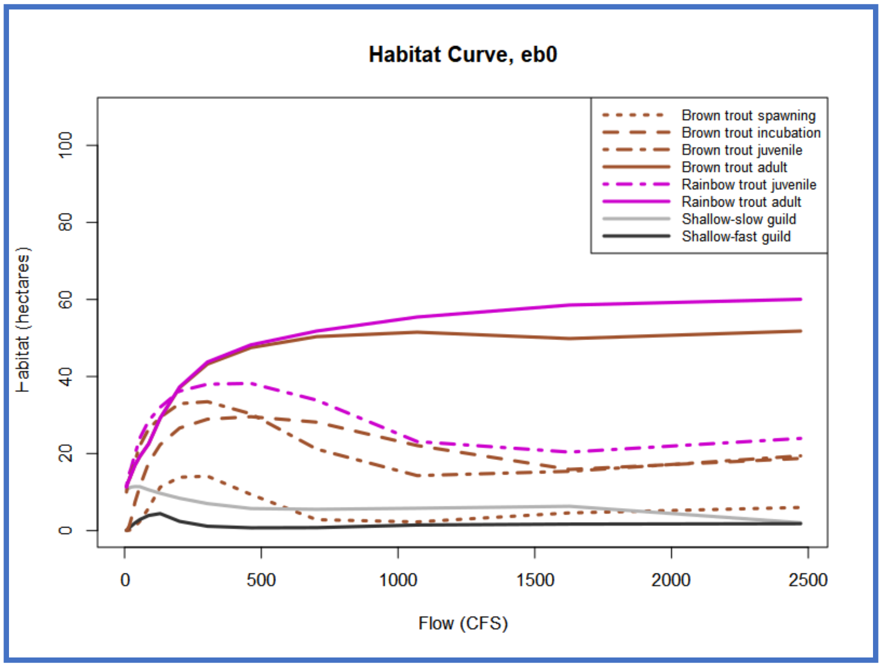


Figure 6. Habitat Curve for EB1

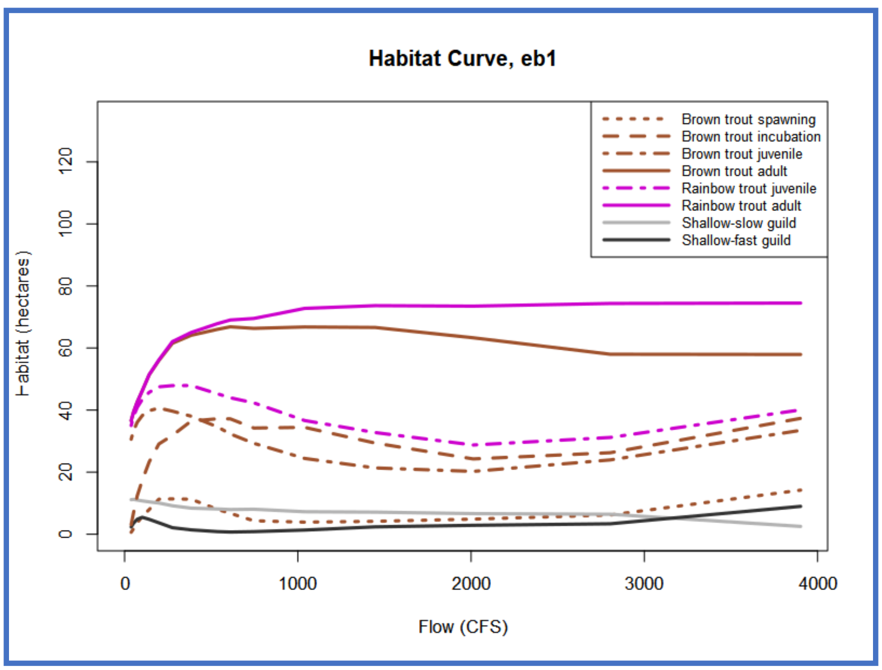


Figure 7. Habitat Curve for EB2

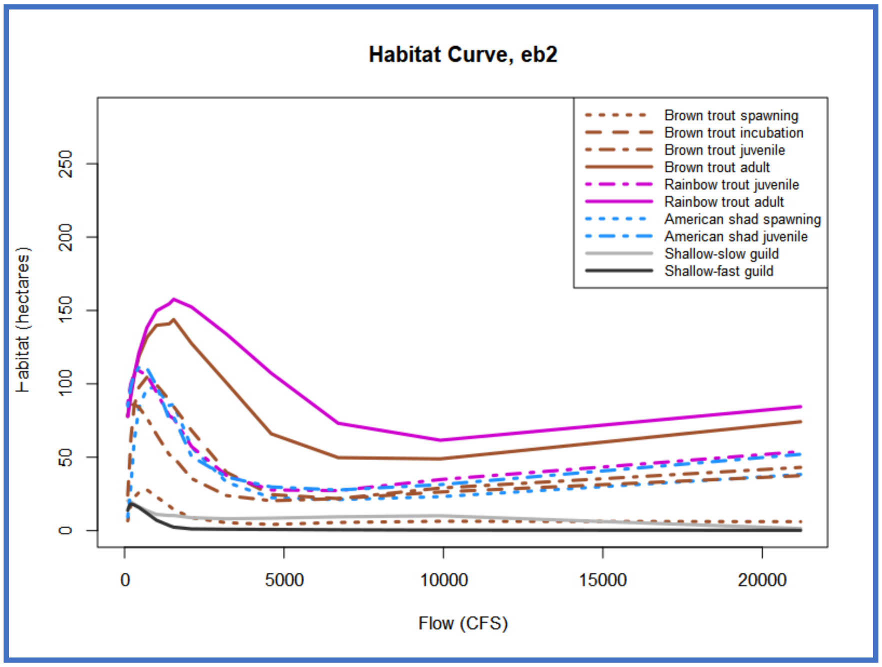


Figure 8. Habitat Curve for NVR0

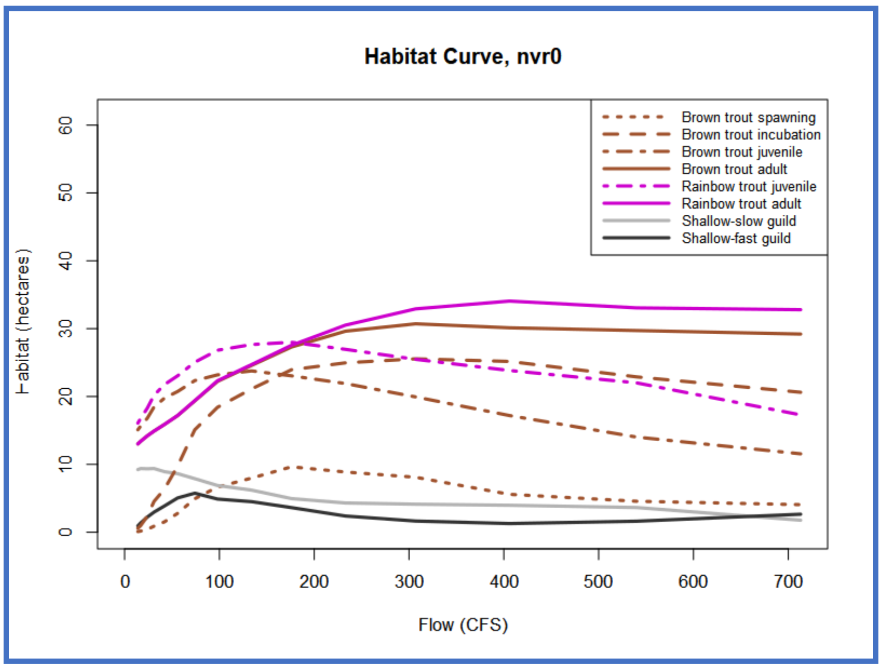


Figure 9. Habitat Curve for NVR1

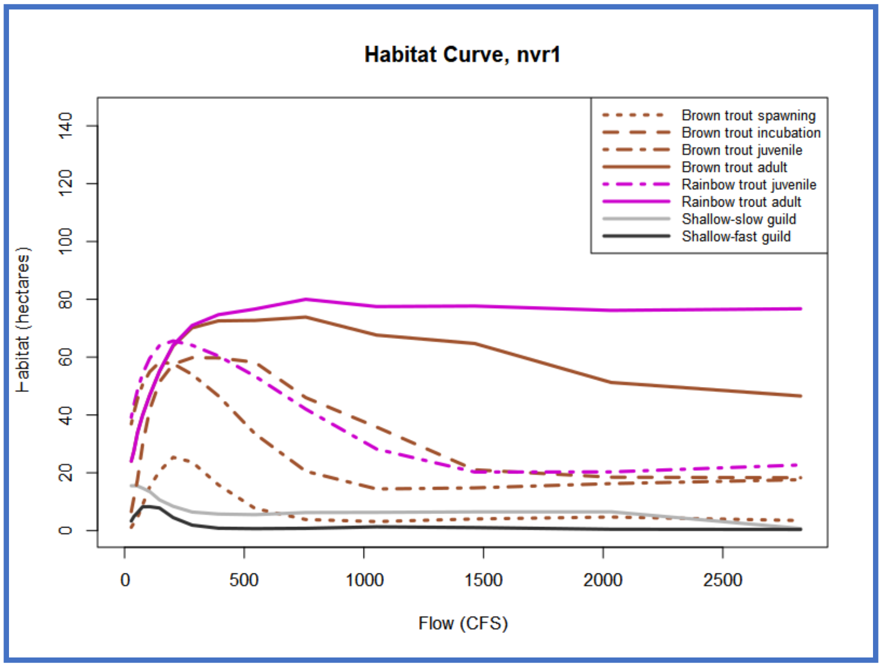


Figure 10. Habitat Curve for NVR2

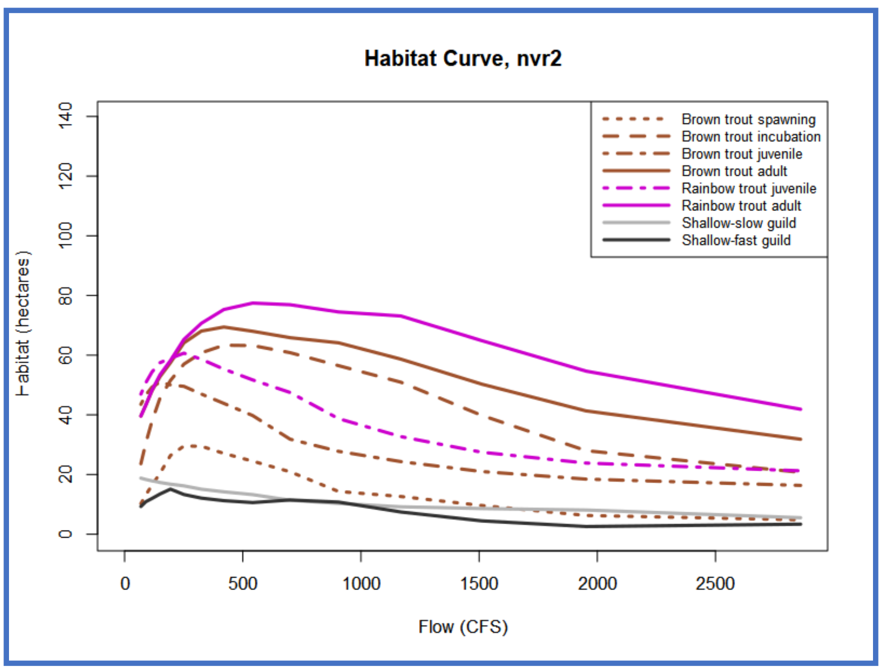


Figure 11. Habitat Curve for WB0

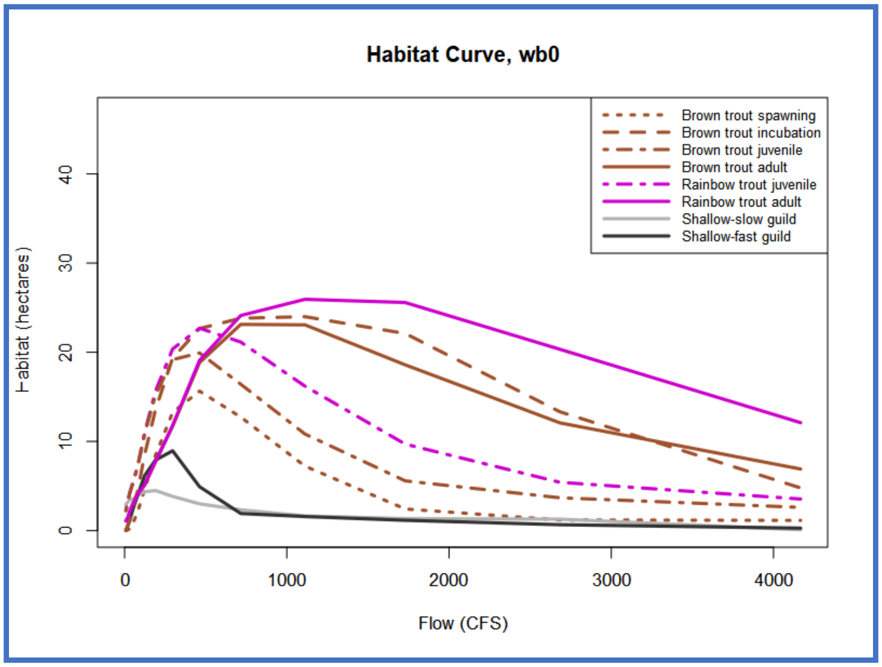
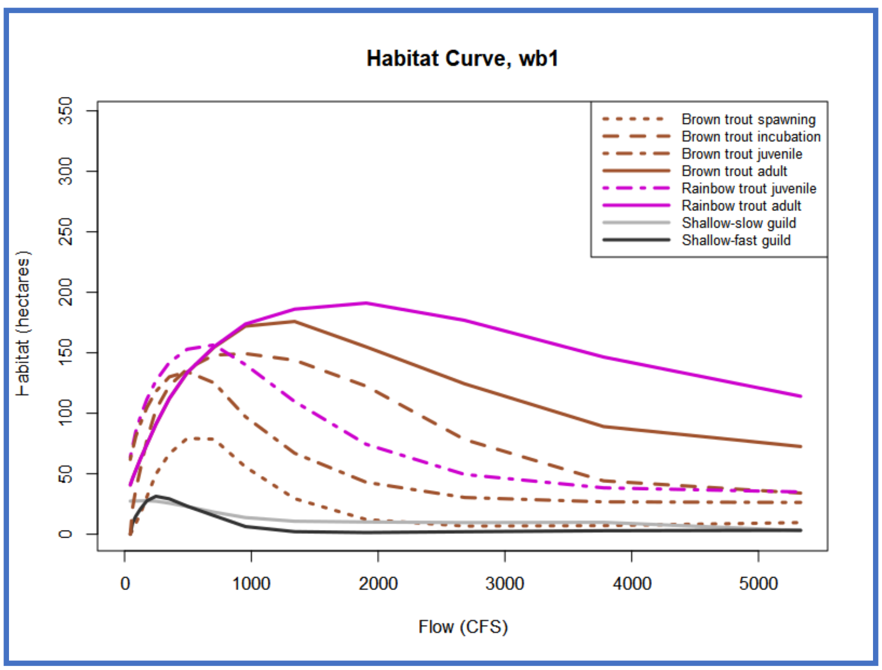


Figure 12. Habitat Curve for WB1



Review of the habitat curves demonstrates that there is no universally optimum flow for all species-age-classes. Even within a species, the optimum flow for one age class is different than the optimum flow for a different age class. Therefore, it appears that improving habitat for one group necessarily comes at the expense of decreased habitat for another group. Tradeoffs appear to be inherent in balancing flow and habitat considerations.

Computationally, the data behind the habitat curves consists of flow values paired with resulting habitat for each reach and species-age-class. Linear interpolation is used to estimate available habitat for each discrete daily flow value in a time series.

Habitat Seasons

In its summarization of available habitat, DSS limited habitat for each biota category to specific days of the year. For example, flow conditions in the time period from April 16 to June 30 will impact on available habitats for Brown Trout-Juvenile, Rainbow Trout-Juvenile, American Shad-Spawning. The DSS habitat seasons are shown in Table 3 below. Colored cells indicate days for which the available habitat is summarized.

Table 3. Habitat Seasons

	brn_spn	brn_inc	brn_juv	brn_adlt	rbw_juv	rbw_adlt	shd_spn	shd_juv	sfg	ssg
Jan										
Feb										
Mar										
April		15-Apr	16-Apr		16-Apr		16-Apr			
May									year round	year round
Jun			30-Jun		30-Jun		30-Jun			
Jul				1-Jul		1-Jul		1-Jul		
Aug										
Sep				30-Sep		30-Sep		30-Sep		
Oct	1-Oct									
Nov	30-Nov									
Dec		1-Dec								

Approach

Benchmarking REFDSS

The first step in modernizing the DSS tool was to code a new version based on our understanding of the processing being performed by a previous version of the DSS and compare output of the two products. This comparison of the new and previous DSS outputs is called benchmarking. Benchmarking would be considered successful when we could demonstrate that we had fully replicated output from a previous version.

For the current effort, we performed benchmarking against REFDSS, since this was the only previous DSS tool that we were able to run. For comparison we ran legacy flow time series corresponding to flow management scenarios for REV1, REV7, and a generic FFMP.

Figure 13 below demonstrates the progression of the benchmarking effort. On each matrix, the left-most column is populated with each flow management scenario, and each reach within the DSS domain. Each color-coded column corresponds to species-life-class. Matrix cells coded 1 and shaded green indicate a 100% match between output for the REFDSS and the modern DSS for that flow management scenario, reach, and species-life-class. Cells with any number less than 1 and corresponding shading from yellow to red indicate some degree of disagreement between the REFDSS and modern DSS output.

Over the course of benchmarking, it became clear that differences were associated with scaling factors for translating results to the full domain of the DSS model area, and selection of specific habitat curves from among several versions contained within the REFDSS. By the end of the process, as indicated in the right-hand matrix in Figure 13, all differences were resolved and full benchmarking was achieved.

Figure 13. Progression of Benchmarking

Production Runs

Upon completion of benchmarking, we utilized the DSS tool to evaluate current flow management times series scenarios and a proposed alternative. The flow management time series evaluated are described in Table 4 below:

Table 4. Production Run Flow Management Scenarios

Scenario	Description
REV1	REV 1, formally known as D77-20-CP revised, established the base and augmented conservation releases from the NYC Delaware River Basin Reservoirs. Along with the provisions of the Delaware River Basin Water Code, it is the default operating program for the reservoirs in the absence of another agreement. The program also included a 3.9 BG bank of water to be used for thermal mitigation. Additional seasonal releases were made from an Excess Release Quantity (ERQ). The ERQ could also be banked for flow augmentation in dry conditions.
FFMP2008	FFMP2008 (Flexible Flow Management Program) was established to help sustain cold water fisheries; to assist in mitigating the impacts of flooding; and to provide flows for the down basin states. Conservation release rates were increased and selected based on NYC Demand Projections at the beginning of each release year (6/1-5/31). The FFMP also incorporated provisions of the Water Code related to drought management. A portion of the Excess Release Quantity (ERQ) was able to be assigned to an extraordinary needs bank for to support research, aquatic life or other water-use activity as may be approved by the DRBC.
FFMP2011	FFMP2011 is similar to FFMP 2008, except New York City's Operational Support Tool is used to guide the selection of release tables based on Forecast-based Available Water (FAW) not needed contemporaneously for New York City's water supply. Releases rates are based, in part, upon recommendations provided jointly by the New York State Department of Environmental Conservation and the Pennsylvania Fish and Boat Commission Joint Fisheries Paper (January 12, 2010). A portion of the ERQ is set aside to support the increased conservation release rates.
FFMP2017	FFMP2017 is similar to previous FFMPs. Release tables based on Forecast-based Available Water (FAW) and water from the ERQ is not needed for the release tables. Two banks, Thermal Mitigation and Rapid Flow Change, were established from the ERQ. Releases rates are also based, in part, upon recommendations provided jointly by the New York State Department of Environmental Conservation and the Pennsylvania Fish and Boat Commission Joint Fisheries Paper (January 12, 2010).
AltOST	AltOST represents DRBC's attempt to implement recommended changes proposed by Trout Unlimited and Garth Pettinger to selection of the OST Release Schedule values https://www.nj.gov/drbc/library/documents/RFAC/051420/Pettinger_OSTcalculation.pdf

These scenarios were evaluated for flow conditions for the period from January 1, 1990, through December 31, 2000. This time period was selected based on input from the SEF and to limit the size of the output file, although the DRBC DSS is capable of evaluating any time period for which modeled flow is available. Flow input time series to the DSS model comes from model runs of DRBC's Planning Support Tool (PST). The Delaware River Basin Planning Support Tool (DRB-PST) is a modeling tool that allows different water management scenarios to be tested and their outcomes compared. The tool shows how those scenarios would change an array of outcomes, including the amount of water available for drinking supplies, downstream releases, habitat protection, flood mitigation, and more.

DSS produces a daily time series of available habitat for each reach and species-life-class. For the 11-year period evaluated, this produces over 2 million discrete habitat values.

Interpretation and Analysis

In order to interpret DSS output, DRBC developed two new metrics to collapse and synthesize the 2 million discrete habitat values. The two metrics developed were ***Total Habitat Days*** and ***Days Below 50% of Max Habitat***.

Total Habitat Days is the sum of daily resulting habitat by flow management scenario and species-life-class for the entire DSS model domain. Under this metric, a higher number indicates more available habitat.

Days Below 50% of Max Habitat is a count of the total number of days yielding less than 50% of the maximum habitat by flow management scenario and species-life-class for the entire DSS model domain. Under this metric, a lower number indicates more available habitat.

Tables 5 and 6 below show color coded results for the 1990 through 2000 simulation period for these two metrics. Since FFMP2017 is the current flow management scenario in place as of the writing of this report, we compared the other flow management scenarios by computing the % difference in metric values for each of the two metrics.

Table 5. Total Habitat Days

	Total Hectare Days					% Difference from FFMP2017				
BioCode	FFMP2008	FFMP2011	FFMP2017	REV1	AltOST	FFMP2008	FFMP2011	FFMP2017	REV1	AltOST
brn_adlt	876,129	901,083	905,224	825,560	911,949	-3.2%	-0.5%	0.0%	-8.8%	0.7%
brn_inc	795,392	831,984	817,786	742,348	804,527	-2.7%	1.7%	0.0%	-9.2%	-1.6%
brn_juv	455,739	457,838	456,970	431,863	458,081	-0.3%	0.2%	0.0%	-5.5%	0.2%
brn_spn	108,979	123,318	121,130	102,317	118,358	-10.0%	1.8%	0.0%	-15.5%	-2.3%
rbw_adlt	897,825	923,298	927,401	845,583	934,231	-3.2%	-0.4%	0.0%	-8.8%	0.7%
rbw_juv	565,050	565,937	567,293	536,547	568,574	-0.4%	-0.2%	0.0%	-5.4%	0.2%
sfg	321,401	319,716	316,323	264,545	313,755	1.6%	1.1%	0.0%	-16.4%	-0.8%
shd_juv	434,715	432,442	432,336	431,503	432,722	0.6%	0.0%	0.0%	-0.2%	0.1%
shd_spn	269,786	271,033	269,816	260,236	269,751	0.0%	0.5%	0.0%	-3.6%	0.0%
ssg	502,374	496,010	496,758	508,906	497,752	1.1%	-0.2%	0.0%	2.4%	0.2%

Table 6. Days Below 50% of Max Habitat

		Days Below 50% of Max Habitat					% Difference from FFMP2017				
BioCode	TotDays	FFMP2008	FFMP2011	FFMP2017	REV1	AltOST	FFMP2008	FFMP2011	FFMP2017	REV1	AltOST
brn_adlt	1012	0	0	0	0	0	0.0%	0.0%	0.0%	0.0%	0.0%
brn_inc	1488	65	47	48	96	58	35.4%	-2.1%	0.0%	100.0%	20.8%
brn_juv	836	94	83	95	94	84	-1.1%	-12.6%	0.0%	-1.1%	-11.6%
brn_spn	671	137	93	98	178	123	39.8%	-5.1%	0.0%	81.6%	25.5%
rbw_adlt	1012	0	0	0	0	0	0.0%	0.0%	0.0%	0.0%	0.0%
rbw_juv	836	40	37	35	46	31	14.3%	5.7%	0.0%	31.4%	-11.4%
sfg	4007	928	966	1003	1677	1079	-7.5%	-3.7%	0.0%	67.2%	7.6%
shd_juv	1012	23	24	24	21	24	-4.2%	0.0%	0.0%	-12.5%	0.0%
shd_spn	836	156	145	154	156	155	1.3%	-5.8%	0.0%	1.3%	0.6%
ssg	4007	187	182	186	240	184	0.5%	-2.2%	0.0%	29.0%	-1.1%

As indicated by both metrics, REV1 would generally yield less habitat than FFMP2017 and other flow management scenarios. Some exceptions to this statement may include the shallow slow-flowing fin fish guild under ***Total Habitat Days*** and Juvenile Shad as indicated by ***Days Below 50% of Max Habitat***.

Similarly FFMP2008 appears, on the whole to yield less habitat than FFMP2017 with a few exceptions including the shallow-fast flowing fin fish guild. FFMP 2011 appears to yield slightly more habitat for several species, but less for Juvenile Rainbow Trout. The AltOST flow management scenario appeared to demonstrate a mixed bag of results with both higher and lower yielded habitat across the different species-life-classes.

Another evaluation facilitated by the completed DSS is spatial availability of habitat by species-life-class. DSS output for FFMP2017 (the current flow management scenario) demonstrates that for Adult Rainbow Trout, nearly half of the available habitat is located in the mainstem Delaware River, while East Branch, West Branch, and Neversink each contribute roughly one third of the available habitat, as shown in Figure 14.

In contrast, for the Shallow Slow-flowing Fin Fish Guild, habitat is more equally distributed with approximately 25% of available habitat coming from the mainstem Delaware River, East Branch, West Branch, and Neversink, as shown in Figure 15.

Figure 14. Rainbow Trout Available Habitat under FFMP2017 by River

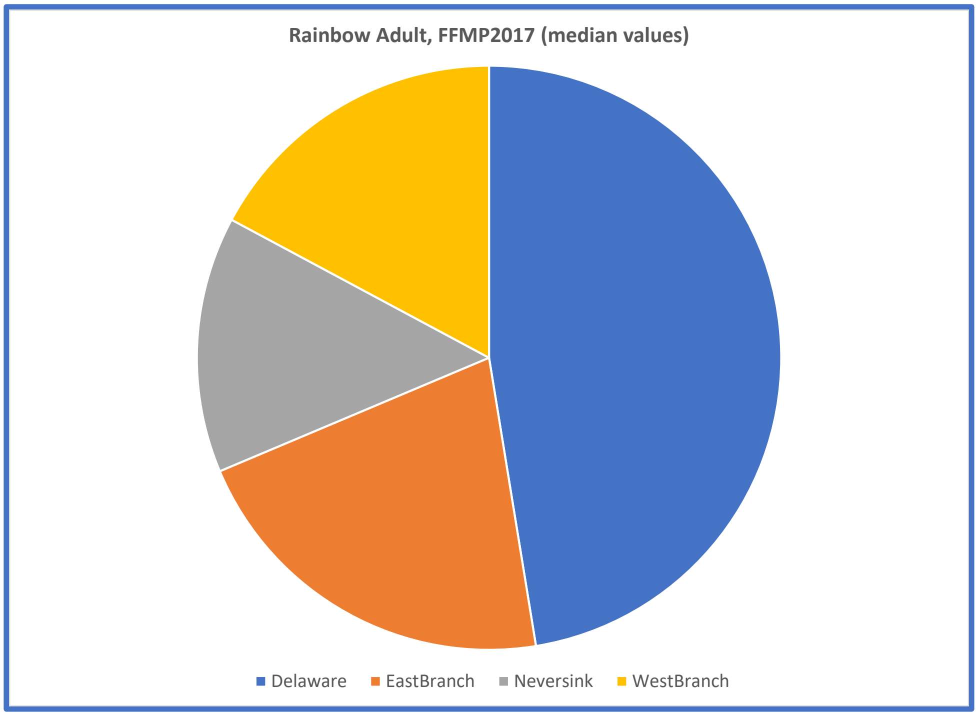
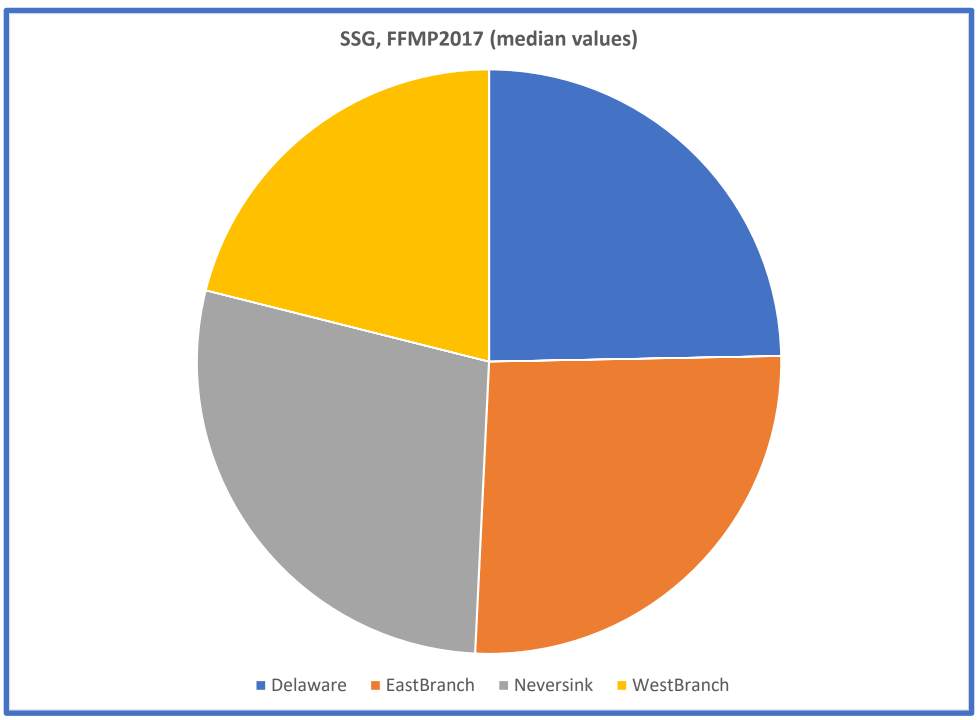


Figure 15. Shallow Slow-Flow Fin Fish Guild Available Habitat under FFMP2017 by River



Web-based Tools

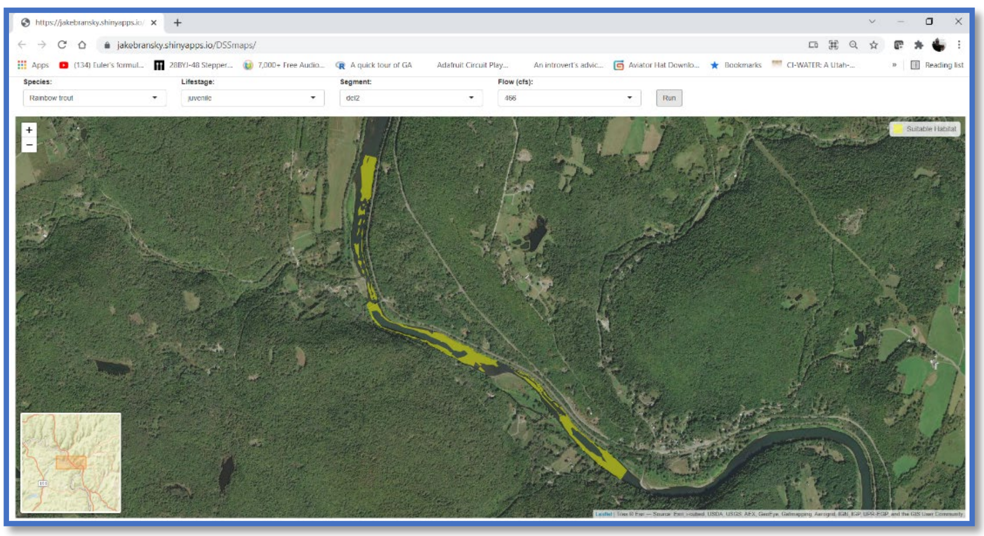
DRBC developed several sets of web-based tools to allow users to interface with different aspects of the modernized DSS system. These tools are described, and links are provided below:

DSS Story Map

DSS Maps Shiny App

The Shiny App 'DSS Maps' displays available habitat in a map interface. Users select the species and age class, reach, and flow value, and the app returns mapping of the available habitat at that flow value, as shown in Figure 16 below as an example. The app is accessible at https://jakebransky.shinyapps.io/DSSmaps/

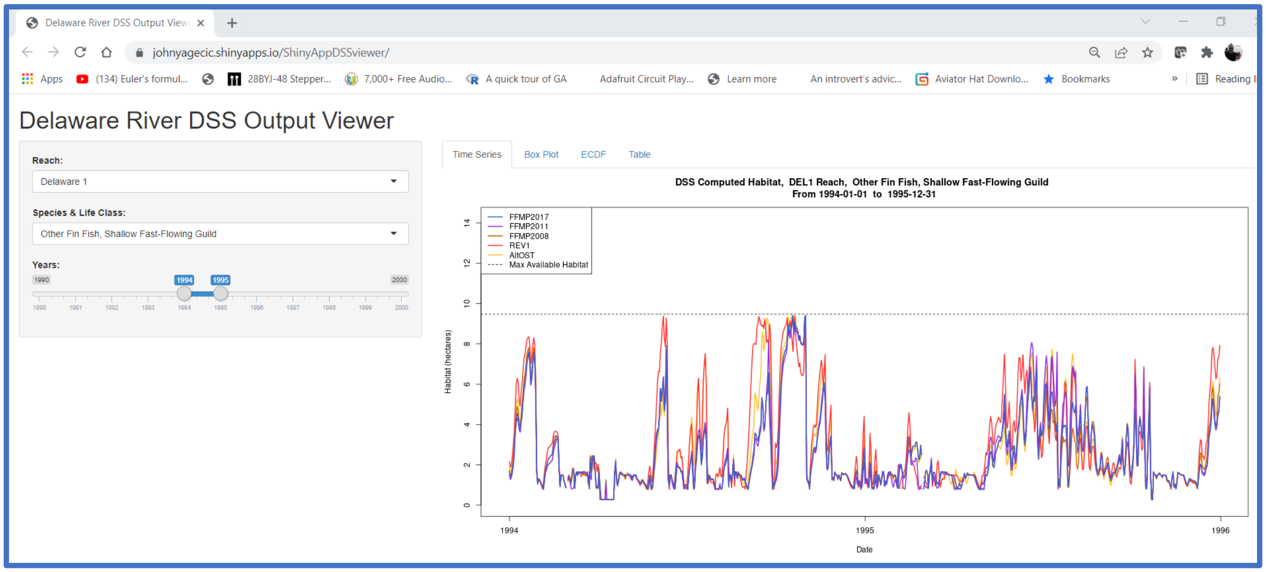
Figure 16. DSS Maps Shiny App



DSS Output Viewer Shiny App

The Shiny App Delaware River DSS Output Viewer allows users to select reach, species-life-class, and subset of the 11-year simulation period. It outputs a time series plot of the available habitat, box and whisker plot, empirical cumulative frequency distribution, and output table of available habitat for each flow management scenario corresponding to the same user selections. A screen shot of the app is shown in Figure 17 below. The app is accessible at https://johnyagecic.shinyapps.io/ShinyAppDSSviewer/

Figure 17. Delaware River DSS Output Viewer Shiny App



Stakeholders and Coordination

Throughout the course of this project, DRBC coordinated with stakeholders and sought feedback on development of the DSS. DRBC presented the DSS project during regional and advisory committee meetings including those in Table 7 below:

Table 7. Stakeholder and Coordination Meetings

Meeting	Date	Activity
Regulated Flow Advisory Committee (RFAC)	March 23, 2022	DRBC presented DSS to the Regulated Flow Advisory Committee (RFAC). RFAC advises the Commission regarding the views of fishery, boating, and industrial interest groups and other resource management agencies, in addition to those of the Decree Parties with respect to diversions and releases from and flows regulated by the Cannonsville, Pepacton, Neversink, and other reservoirs. The members of this committee include appointed representatives from Delaware, New Jersey, New York, New York City, Pennsylvania, Philadelphia, the River Master, and the U. S. Army Corps of Engineers. https://www.nj.gov/drbc/about/advisory/RFAC_index.html
Upper Delaware Conceptual Output/Framework Discussion USGS-PFBC-NYSDEC-DRBC	March 8, 2022	DRBC presented DSS to an interagency group considering fisheries management in the Upper Delaware including PA Fish & Boat Commission, PADEP, USGS, National Park Service, and NY DEC.
Upper Delaware Council (UDC)	March 3, 2022	DRBC presented DSS to the Upper Delaware Council. The Upper Delaware Council is a formal partnership of local, state, and federal governments and agencies which have

		joined together to manage the Upper Delaware Scenic and Recreational River. https://upperdelawarecouncil.org/
Subcommittee on Ecological Flows (SEF)	February 2, 2022	DRBC presented the updated DSS to the Subcommittee on Ecological Flows (SEF) and sought feedback from the group to implement before completing the project in spring. SEF was convened to provide scientifically-based information and recommendations to the RFAC, as requested, regarding: Flows for the maintenance of healthy aquatic ecosystems, including consideration of water quality impacts over a range of regulated flows; Sensitive species that could be impacted by regulated flows; Flow regimes, thermal mitigation, and flow change mitigation; The effects of existing and proposed regulated flows on habitat and ecological health; and other, related matters as the RFAC may deem necessary or appropriate. https://www.nj.gov/drbc/about/advisory/SEF_index.html
Interagency Team	December 16, 2021	DRBC met with members of USGS Eastern Ecological Science Center, USFWS, and USGS Massachusetts Cooperative Research Unit who were working cooperatively to support decision making around mussel conservation in the Delaware River Basin, including development of a decision support tool to identify locations where conservation actions might be the most effective. DRBC presented the DSS and discussed the groups proposed work.
Regulated Flow Advisory Committee (RFAC)	December 1, 2021	DRBC presented interim status of the DSS to the RFAC.
Subset of SEF members to seek feedback.	May 21, 2021	DRBC held an informal meeting with a subset of SEF members to discuss DRBC's progress on updating the DSS.

Possible Future Work

DRBC intends to continue work with the SEF using DRBC DSS and to continue support maintenance and expansion of the DRBC DSS. The DRBC DSS can be expanded with additional data or information. Possible future expansions include but are not limited to:

- Expansion of the spatial domain into other reaches.
- Addition of temperature prediction and its qualitative impact on habitat.
- Addition of new species and habitat curves such as dwarf wedge mussel.

Conclusion

DRBC successfully updated the DSS tool with the development of DRBC DSS. We applied this tool to modern flow management regimes including REV1, FFMP2008, FFMP2011, FFMP2017, and AltOST to evaluate the resulting habitat under these flow management regimes. We coordinated this work with the SEF and other stakeholders in the Upper Delaware Region.