

Chesapeake Fish Passage Prioritization

1

GLOSSARY & METRIC DESCRIPTIONS

This glossary was developed to support the interpretation of
Chesapeake Fish Passage Prioritization web map & tool

http://maps.tnc.org/erof_ChesapeakeFPP

Tiered Results (5% bins)

2

- Analysis results grouped into 20 bins where each bin has 5% of the dams in the analysis area.
- These are the results that should be used for dam assessments

Sequential Rank

3

- The sequential list of dams produced by the analysis.
- This list should be used with extreme caution: the precision with which GIS can calculate metrics and rank dams is not necessarily indicative of ecological differences
- The Tiered Results (5% bins) should be used to assess dams for their potential ecological benefit

Upstream Barrier Count

4

- Category: Connectivity Status
- The number of barriers upstream of a given barrier
- Includes natural waterfalls, which are included in network generation
- Does not include barriers excluded from network generation
- Unit: #

Downstream Barrier Count

5

- Category: Connectivity Status
- The number of barriers downstream of a given barrier
- Includes natural waterfalls, which are included in network generation
- Does not include barriers excluded from network generation
- Unit: #

Number of Hydro Dams on Downstream Flowpath

6

- Category: Connectivity Status
- Count of hydropower dams on downstream flowpath of a barrier
- Unit: #

Number of Waterfalls on Downstream Flowpath

7

- Category: Connectivity Status
- Count of waterfalls on downstream flowpath of a barrier
- Unit: #

Number of Fish Passage Facilities on Downstream Flowpath

8

- Category: Connectivity Status
- Count of fish passage facilities on downstream flowpath of a barrier
- Unit: #

Upstream Barrier Density

9

- **Category: Connectivity Status**
- **Upstream Barrier Count divided by the total length of river upstream in meters**
- **Includes natural waterfalls, which are included in network generation**
- **Does not include barriers excluded from network generation**
- **Unit: # / meters**

Downstream Barrier Density

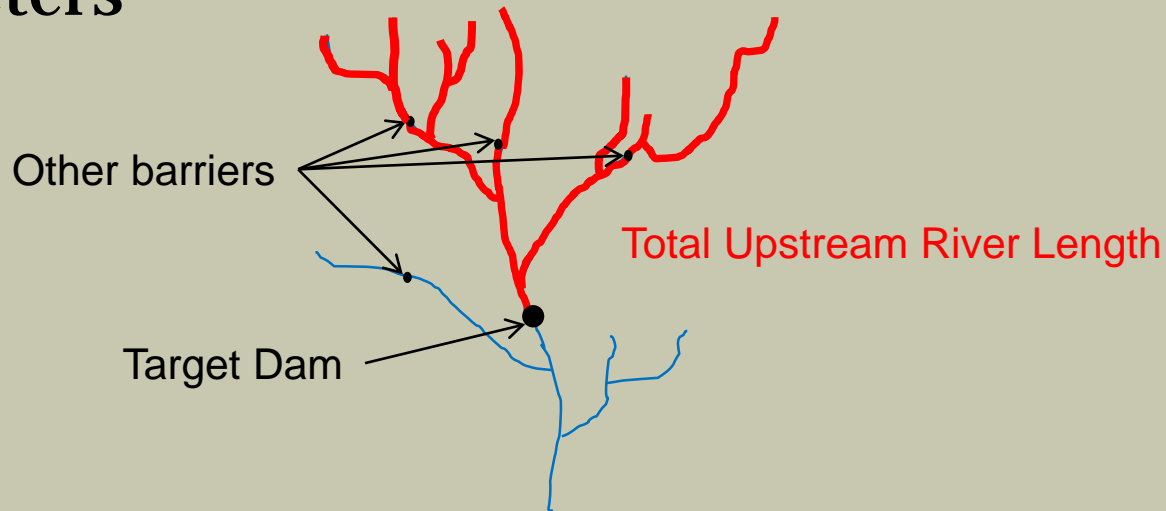
10

- **Category: Connectivity Status**
- **Downstream Barrier Count divided by the Distance to River Mouth in meters**
- **Includes natural waterfalls, which are included in network generation**
- **Does not include barriers excluded from network generation**
- **Unit: # / meters**

Total Upstream River Length

11

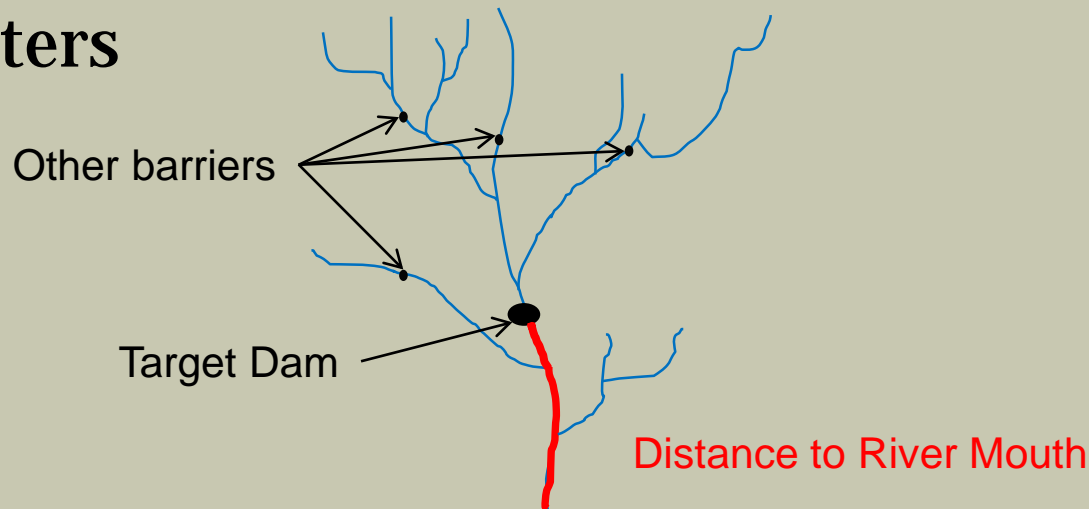
- Category: Connectivity Status
- Total length of river network upstream of a given barrier, regardless of any upstream barriers.
- Unit: meters



Distance to River Mouth

12

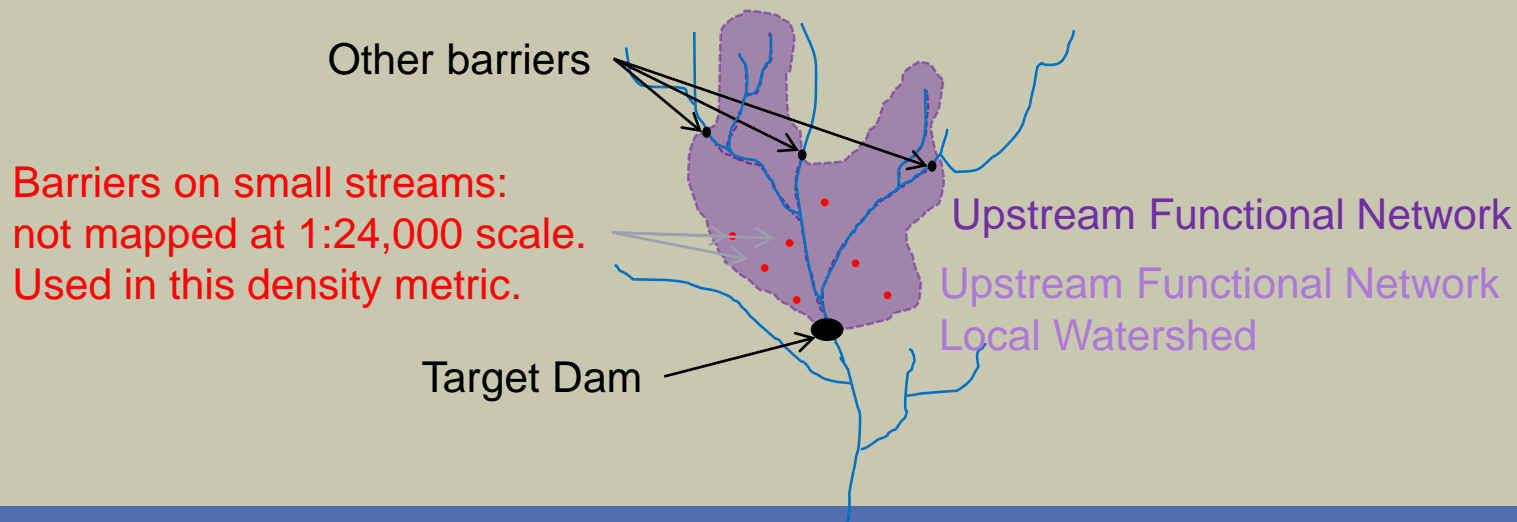
- Category: Connectivity Status
- Distance from each barrier to the network mouth in meters
- Unit: meters



Density of Dams on Small Streams in Upstream Functional Network Local Watershed

13

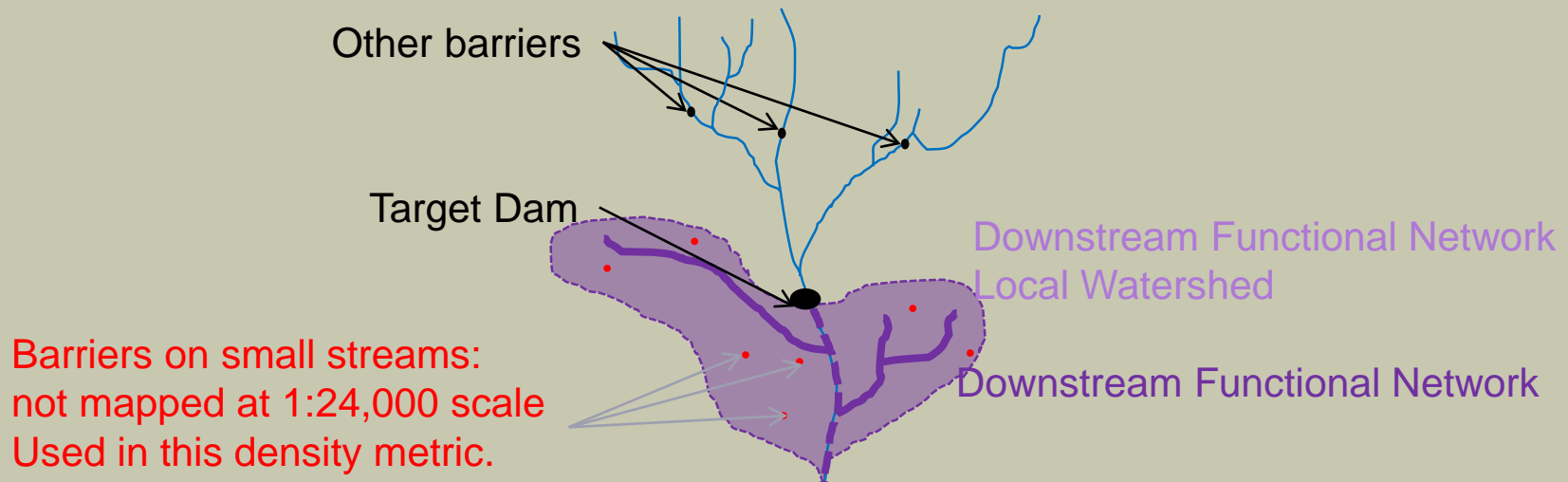
- Category: Connectivity Status
- Number of dams on small streams (dams did not snap to analysis hydrography) within the local watershed of the upstream functional network divided by that watershed area
- Unit: # / m²



Density of Dams on Small Streams in Downstream Functional Network Local Watershed

14

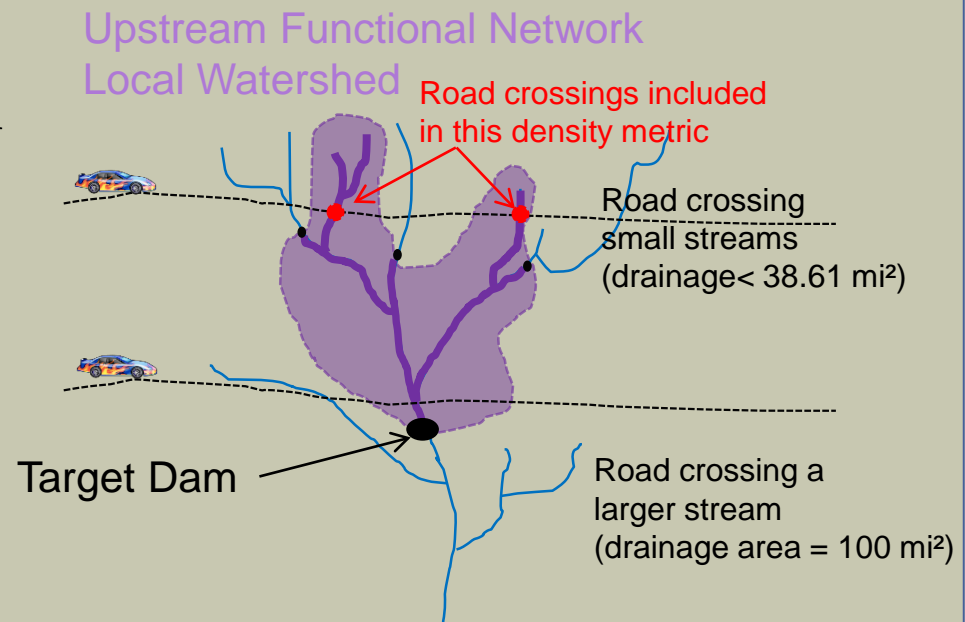
- Category: Connectivity Status
- Number of dams on small streams (dams did not snap to analysis hydrography) within local watershed of the downstream functional network divided by that watershed area
- Unit: # / m²



Density of Road & Railroad / Small Stream Crossings in Upstream Functional Network Local Watershed

15

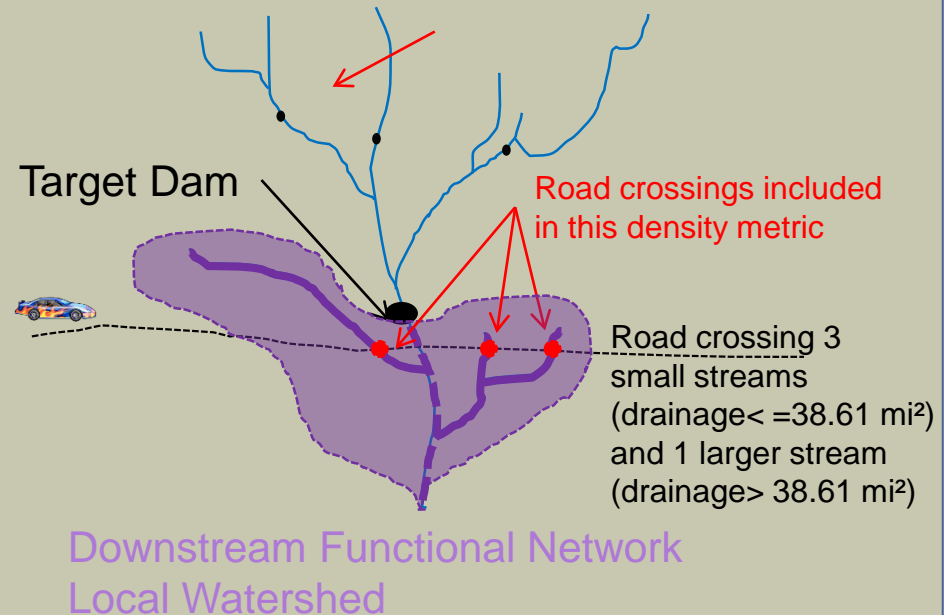
- Category: Connectivity Status
- Number of Road/Railroad and hydrography intersections within upstream functional network local watershed divided by that watershed area. A proxy for culverts.
- Road and RR data from ESRI Streetmap USA
- Only small streams (drainage $\leq 38.61 \text{ mi}^2$) are included. Larger streams more likely to have bridges.
- Unit: # / mi^2



Density of Road & Railroad / Small Stream Crossings in Downstream Functional Network Local Watershed

16

- Category: Connectivity Status
- Number of Road/Railroad and hydrography intersections within downstream functional network local watershed divided by that watershed area. A proxy for culverts.
- Road and RR data from ESRI Streetmap USA
- Only small streams (drainage $\leq 38.61 \text{ mi}^2$) are included. Larger streams more likely to have bridges.
- Unit: # / m^2

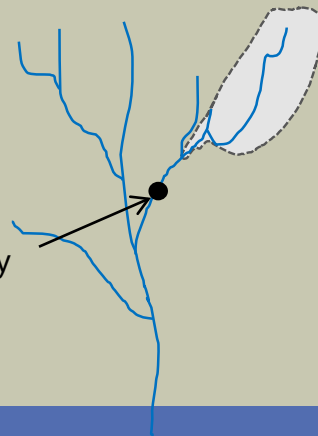


Barrier to EBTJV Brook Trout Habitat

17

- Dam where either its Upstream Functional River Network or Downstream Functional River Network intersects an EBTJV catchment (Hudy 2012) with an allopatric brook trout population or brook trout sympatric with brown or rainbow trout *and the other does not*.
- Allopatric and sympatric brook trout catchments includes the following codes: '1.1', '1.1P', '1.2', '1.2P', '1.3', '1.3P', '1.4', '1.4P', '15', '0.5', '1.0', '1.0P', '1P', '1'
- Dams not covered by the extent of the EBTJV 2012 catchment data are not considered as barriers between EBTJV brook trout catchments
- Unit: Boolean

Target dam restricts access from an EBTJV brook trout catchment to other catchments, thereby limiting expansion of the brook trout population

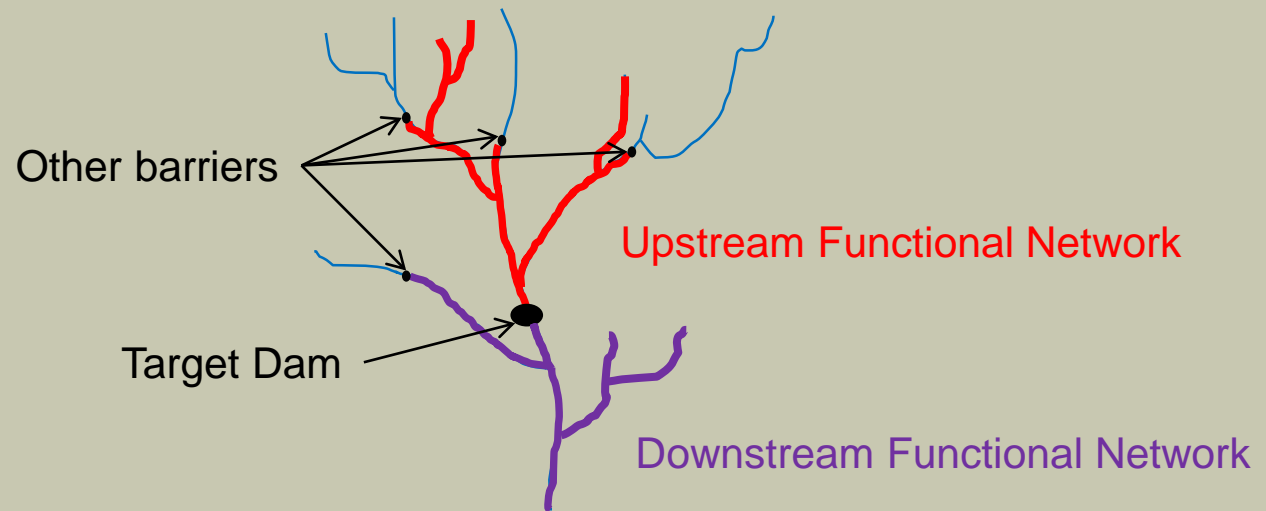


EBTJV Catchment with an allopatric or sympatric brook trout population

Downstream Functional Network Length

18

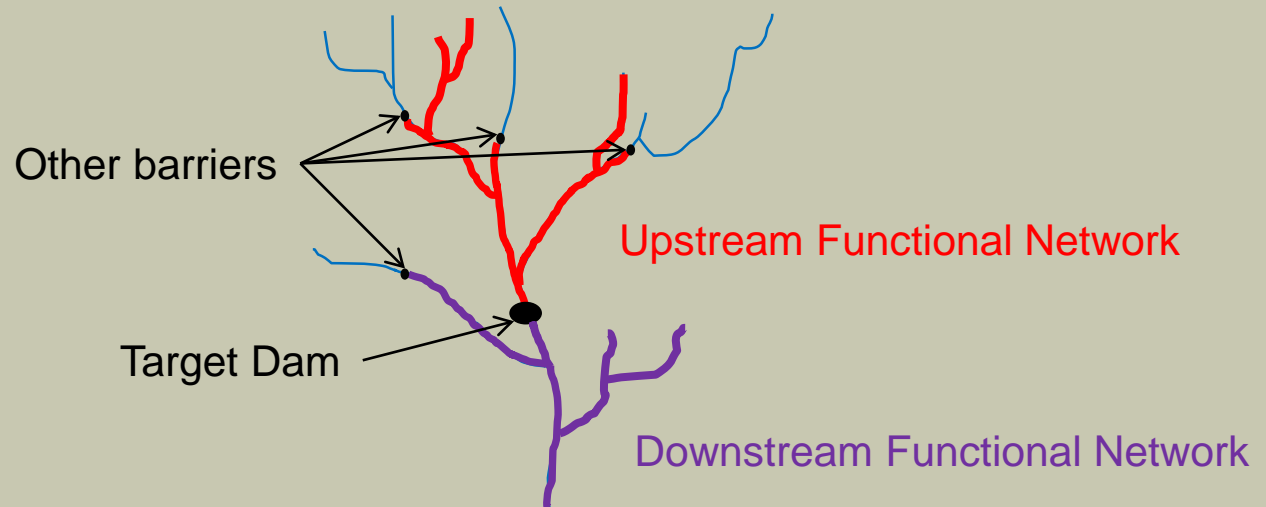
- Category: Connectivity Improvement
- Length of the functional network downstream of a barrier. The functional network is defined by those sections of river that a fish could theoretically access from any other point within that functional network. Its terminal ends are barriers, headwaters, and/or the river mouth.
- Unit: meters



Upstream Functional Network Length

19

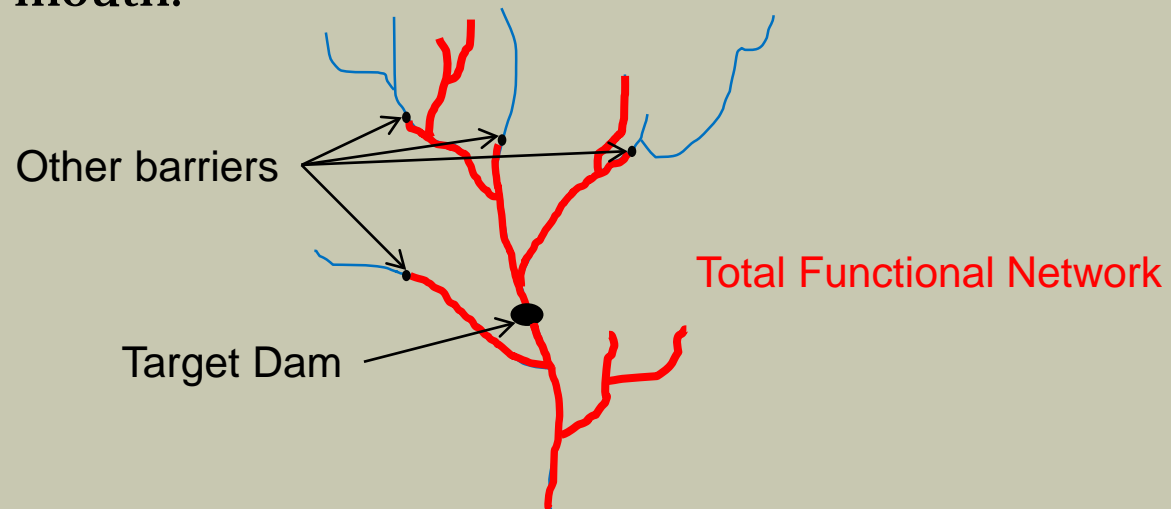
- Category: Connectivity Improvement
- Length of the functional network upstream of a barrier. The functional network is defined by those sections of river that a fish could theoretically access from any other point within that functional network. Its terminal ends are barriers, headwaters, and/or the river mouth.
- Unit: meters



The total length of upstream and downstream functional network

20

- Category: Connectivity Improvement
- Summed length of the upstream and downstream functional networks of a barrier. The functional network is defined by those sections of river that a fish could theoretically access from any other point within that functional network. Its terminal ends are barriers, headwaters, and/or the river mouth.
- Unit: meters



Absolute Gain

21

- Category: Connectivity Improvement
- This metric is the minimum of the two functional networks of a barrier. For example if the upstream functional network was 10 kilometers and downstream functional network was 5 kilometers, then the Absolute Gain will be 5 kilometers.
- Unit: meters

Relative Gain

22

- Category: Connectivity Improvement
- This metric is Absolute gain divided by the total length of upstream and downstream functional networks.
- Unit: meters

% Impervious Surface in Contributing Watershed

23

- Category: Watershed & Local Condition
- % Impervious surface in entire upstream (contributing) watershed. Calculated 2006 National Landcover Database percent developed imperviousness.
- Unit: %

% Natural LC in Contributing Watershed

24

- Category: Watershed & Local Condition
- % natural landcover in entire upstream watershed. Calculated 2006 National Land Cover Database.
- Natural landcover aggregated from the following classes: open water, barren land, deciduous forest, evergreen forest, mixed forest, scrub/shrub, grassland/herbaceous, woody wetlands, emergent wetlands
- Unit: %

% Forested LC in Contributing Watershed

25

- Category: Watershed & Local Condition
- % forested landcover in entire upstream watershed. Calculated 2006 National Land Cover Database.
- Forested landcover aggregated from the following classes: deciduous forest, evergreen forest, mixed forest
- Unit: %

% Impervious Surface in ARA of Upstream Functional Network

26

- Category: Watershed & Local Condition
- % impervious landcover within Active River Area of the upstream functional river network.
- National Landcover Database 2006 data
- Unit: %

% Impervious Surface in ARA of Downstream Functional Network

27

- Category: Watershed & Local Condition
- % impervious landcover within Active River Area of the downstream functional river network.
- National Landcover Database 2006 data
- Unit: %

% Natural LC in ARA of Upstream Functional Network

28

- Category: Watershed & Local Condition
- % natural landcover within Active River Area of the upstream functional river network.
- National Landcover Database 2006 data. Includes the following classes: open water, barren land, deciduous forest, evergreen forest, mixed forest, scrub/shrub, grassland/herbaceous, woody wetlands, emergent wetlands
- Unit: %

% Natural LC in ARA of Downstream Functional Network

29

- Category: Watershed & Local Condition
- % natural landcover within Active River Area of the downstream functional river network.
- National Landcover Database 2006 data. Includes the following classes: open water, barren land, deciduous forest, evergreen forest, mixed forest, scrub/shrub, grassland/herbaceous, woody wetlands, emergent wetlands
- Unit: %

% Forested in ARA of Upstream Functional Network

30

- Category: Watershed & Local Condition
- % forested landcover within Active River Area of the upstream functional river network.
- National Landcover Database 2006 data. Includes the following classes: deciduous, evergreen & mixed forest
- Unit: %

% Forested in ARA of Downstream Functional Network

31

- Category: Watershed & Local Condition
- % forested landcover within Active River Area of the downstream functional river network.
- National Landcover Database 2006 data. Includes the following classes: deciduous, evergreen & mixed forest
- Unit: %

% Conserved Land within 100m Buffer of Upstream Functional Network

32

- Category: Watershed & Local Condition
- % of land within 100m buffer of upstream functional network that intersects 2009 secured areas database (TNC)
- Unit: %

% Conserved Land within 100m Buffer of Downstream Functional Network

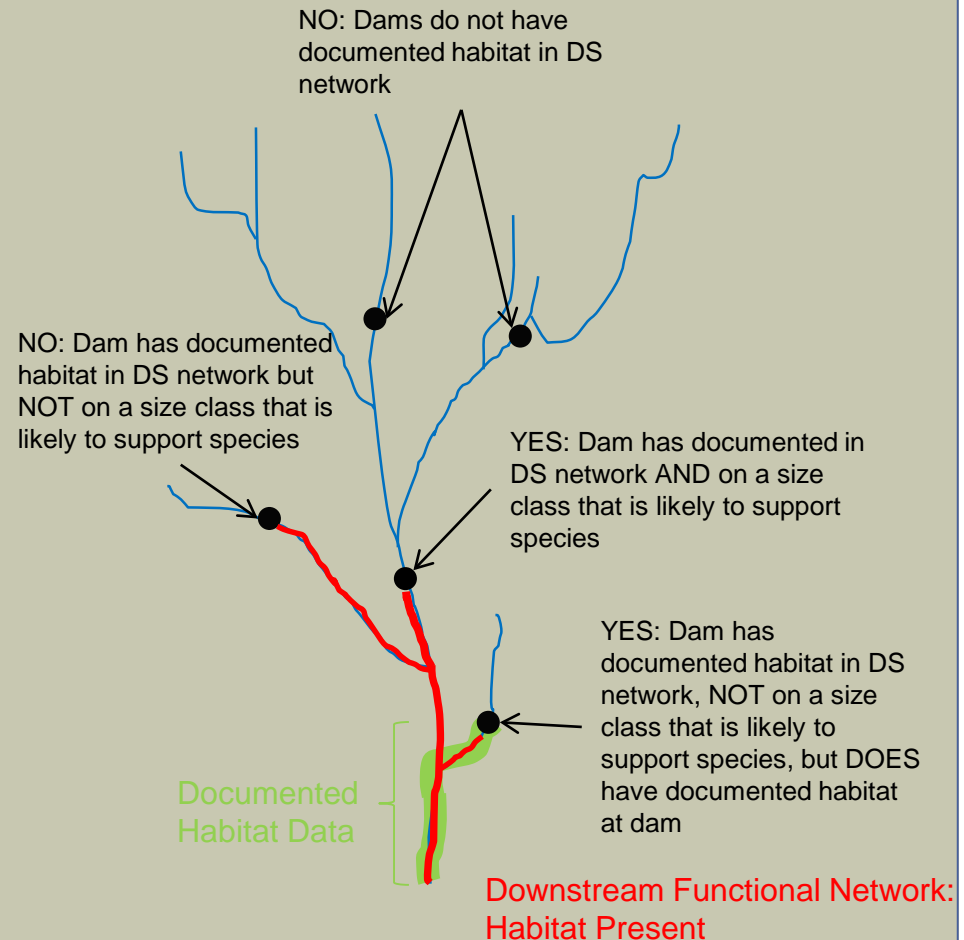
33

- Category: Watershed & Local Condition
- % of land within 100m buffer of downstream functional network that intersects 2009 secured areas database (TNC)
- Unit: %

American Shad habitat in Downstream Functional Network

34

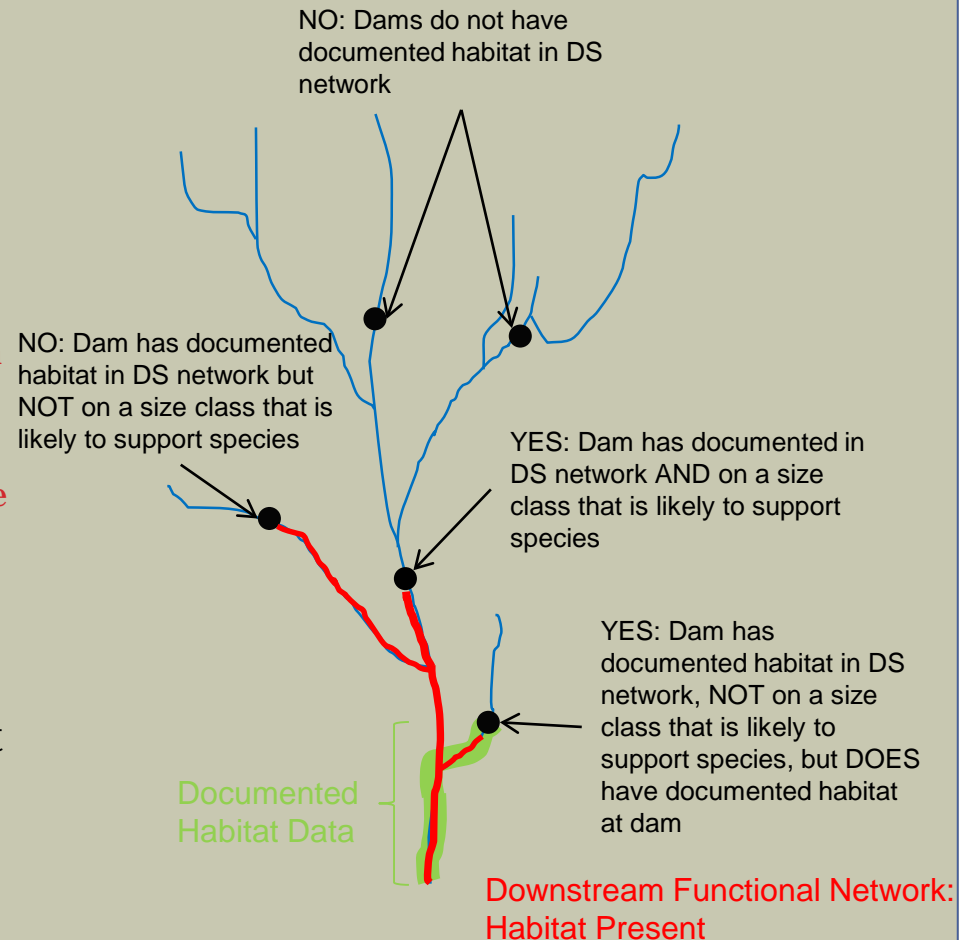
- Category: Ecological
- Presence of American shad downstream of dam. Based on:
 1. Documented habitat in some portion of the dam's downstream functional network
 2. **AND** Dam is on a stream that is likely to support that species based on stream size
 1. Size 2+ Rivers
 3. **OR** There is documented habitat up to a dam on a stream that doesn't meet the above size class rule
 4. **AND** the dam has not been specifically flagged otherwise by Chesapeake Fish Passage Workgroup
- Fish habitat data from multiple sources, reviewed and edited by state fisheries biologists. Each line segment includes its data source.
- Unit: Unitless Classes: "Current", "Potential Current", "Historical"



Blueback Herring habitat in Downstream Functional Network

35

- Category: Ecological
- Presence of blueback herring downstream of dam. Based on:
 1. Documented habitat in some portion of the dam's downstream functional network
 2. **AND** Dam is on a stream that is likely to support that species based on stream size
 1. Size 2+ Rivers & 1a/1b if no gradient >10%
 3. **OR** There is documented habitat up to a dam on a stream that doesn't meet the above size class rule
 4. **AND** the dam has not been specifically flagged otherwise by Chesapeake Fish Passage Workgroup
- Fish habitat data from multiple sources, reviewed and edited by state fisheries biologists. Each line segment includes its data source.
- Unit: Unitless Classes: “Current”, “Potential Current”, “Historical”



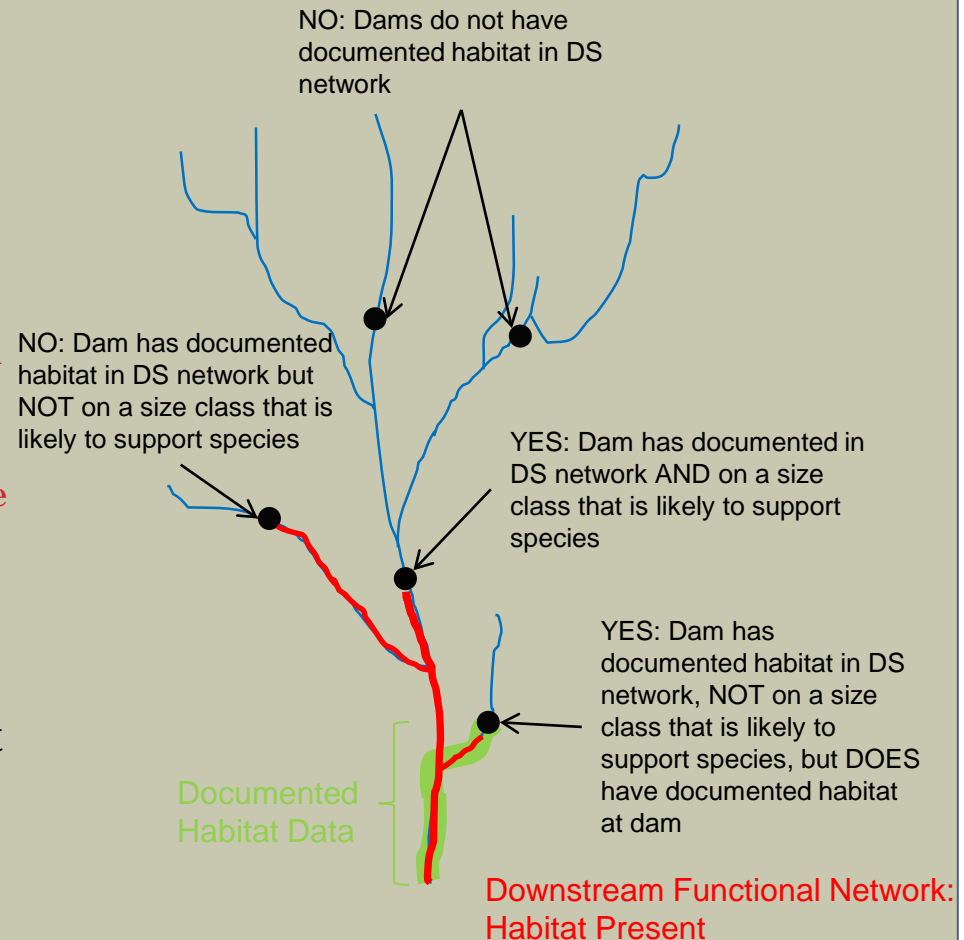
Hickory Shad habitat in Downstream Functional Network

36

- Category: Ecological
- Presence of Hickory shad downstream of dam. Based on:

1. Documented habitat in some portion of the dam's downstream functional network
2. **AND** Dam is on a stream that is likely to support that species based on stream size
 1. Size 2+ Rivers
3. **OR** There is documented habitat up to a dam on a stream that doesn't meet the above size class rule
4. **AND** the dam has not been specifically flagged otherwise by Chesapeake Fish Passage Workgroup

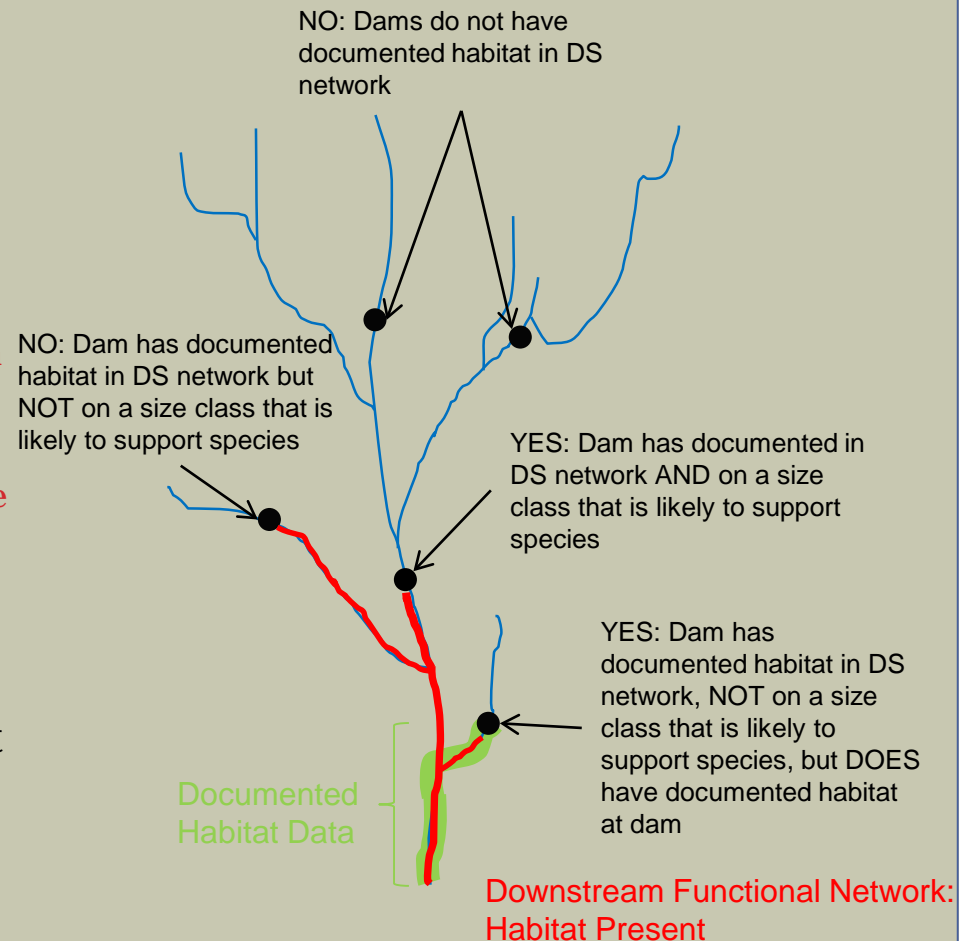
- Fish habitat data from multiple sources, reviewed and edited by state fisheries biologists. Each line segment includes its data source.
- Unit: Unitless Classes: "Current", "Potential Current", "Historical"



Alewife habitat in Downstream Functional Network

37

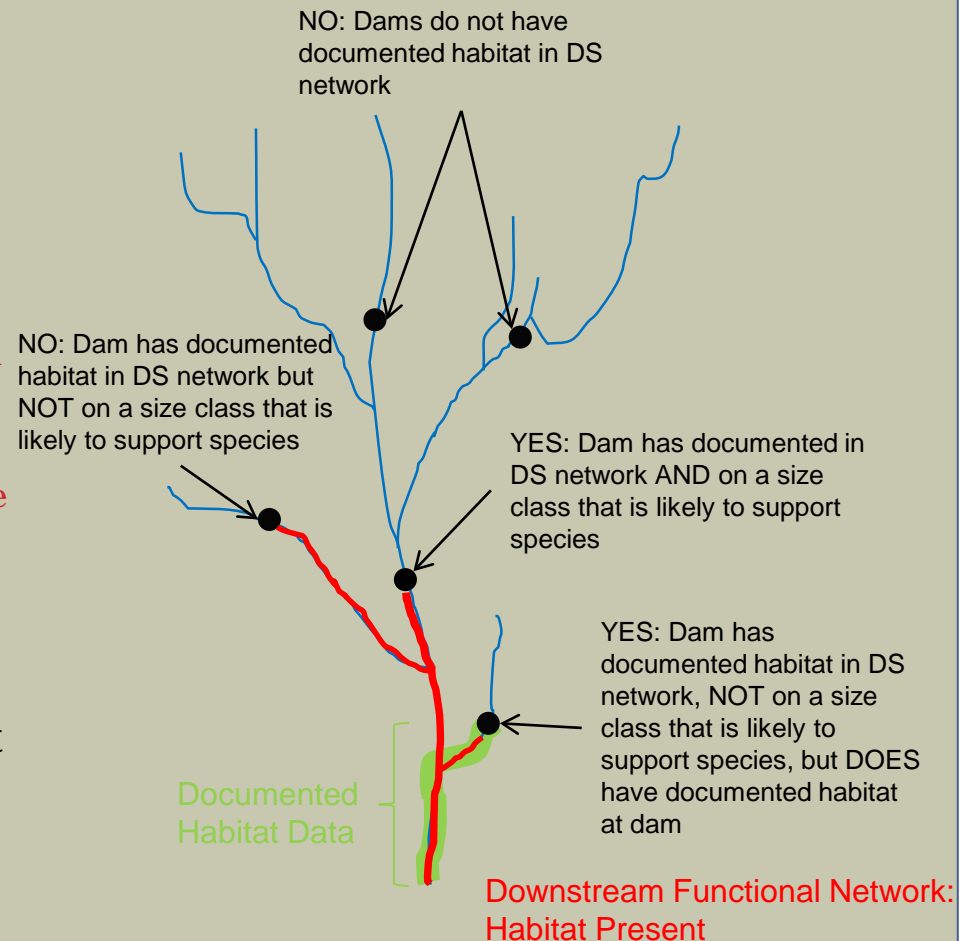
- Category: Ecological
- Presence of alewife downstream of dam. Based on:
 1. Documented habitat in some portion of the dam's downstream functional network
 2. **AND** Dam is on a stream that is likely to support that species based on stream size
 1. Size 2+ Rivers & 1a/1b if no gradient >10%
 3. **OR** There is documented habitat up to a dam on a stream that doesn't meet the above size class rule
 4. **AND** the dam has not been specifically flagged otherwise by Chesapeake Fish Passage Workgroup
- Fish habitat data from multiple sources, reviewed and edited by state fisheries biologists. Each line segment includes its data source.
- Unit: Unitless Classes: “Current”, “Potential Current”, “Historical”



Atlantic Sturgeon habitat in Downstream Functional Network

38

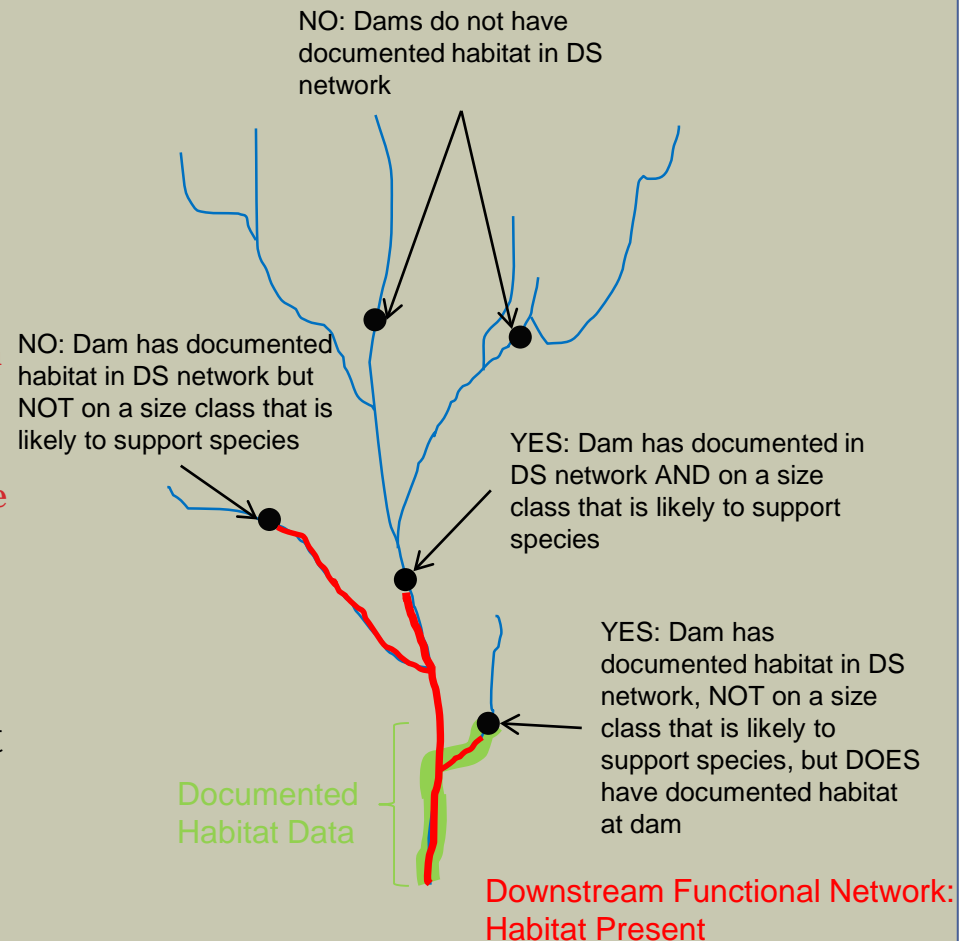
- Category: Ecological
- Presence of Atlantic sturgeon downstream of dam. Based on:
 1. Documented habitat in some portion of the dam's downstream functional network
 2. **AND** Dam is on a stream that is likely to support that species based on stream size
 1. Size 4+ Rivers
 3. **OR** There is documented habitat up to a dam on a stream that doesn't meet the above size class rule
 4. **AND** the dam has not been specifically flagged otherwise by Chesapeake Fish Passage Workgroup
- Fish habitat data from multiple sources, reviewed and edited by state fisheries biologists. Each line segment includes its data source.
- Unit: Unitless Classes: "Current", "Potential Current", "Historical"



Striped Bass habitat in Downstream Functional Network

39

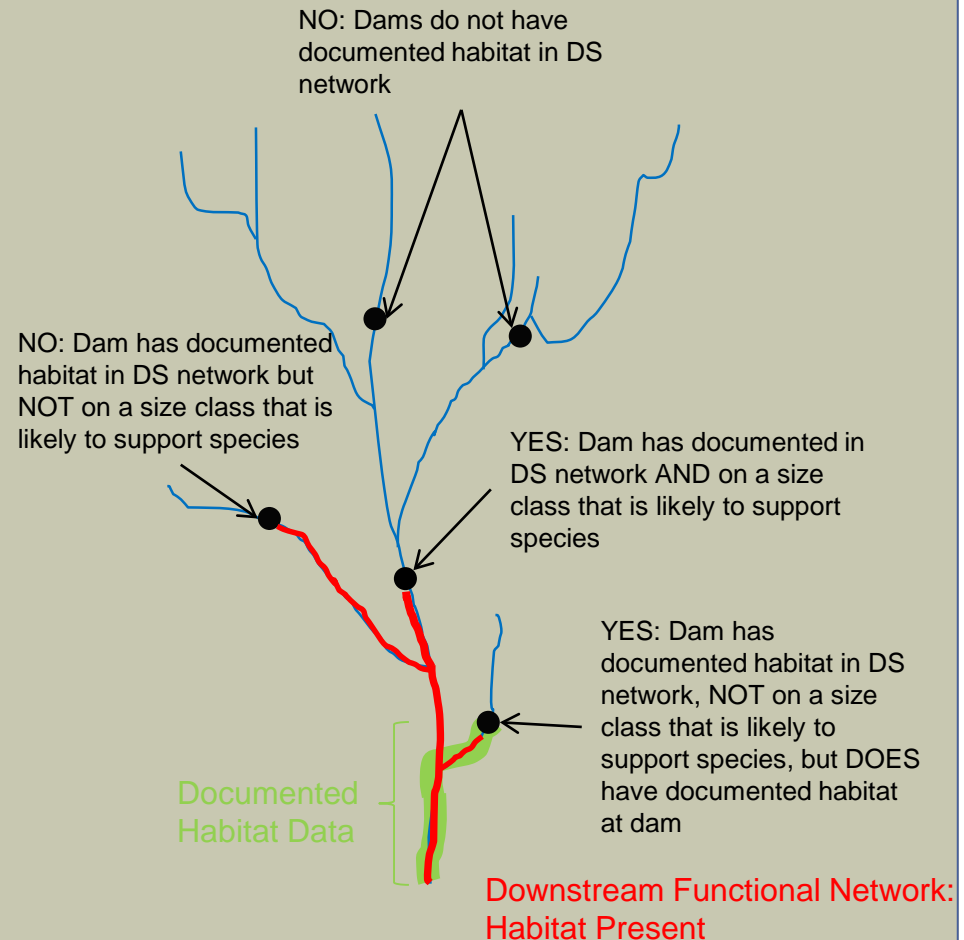
- Category: Ecological
- Presence of striped bass downstream of dam. Based on:
 1. Documented habitat in some portion of the dam's downstream functional network
 2. **AND** Dam is on a stream that is likely to support that species based on stream size
 1. Size 3b+ Rivers
 3. **OR** There is documented habitat up to a dam on a stream that doesn't meet the above size class rule
 4. **AND** the dam has not been specifically flagged otherwise by Chesapeake Fish Passage Workgroup
- Fish habitat data from multiple sources, reviewed and edited by state fisheries biologists. Each line segment includes its data source.
- Unit: Unitless Classes: "Current", "Potential Current", "Historical"



Shortnose Sturgeon habitat in Downstream Functional Network

40

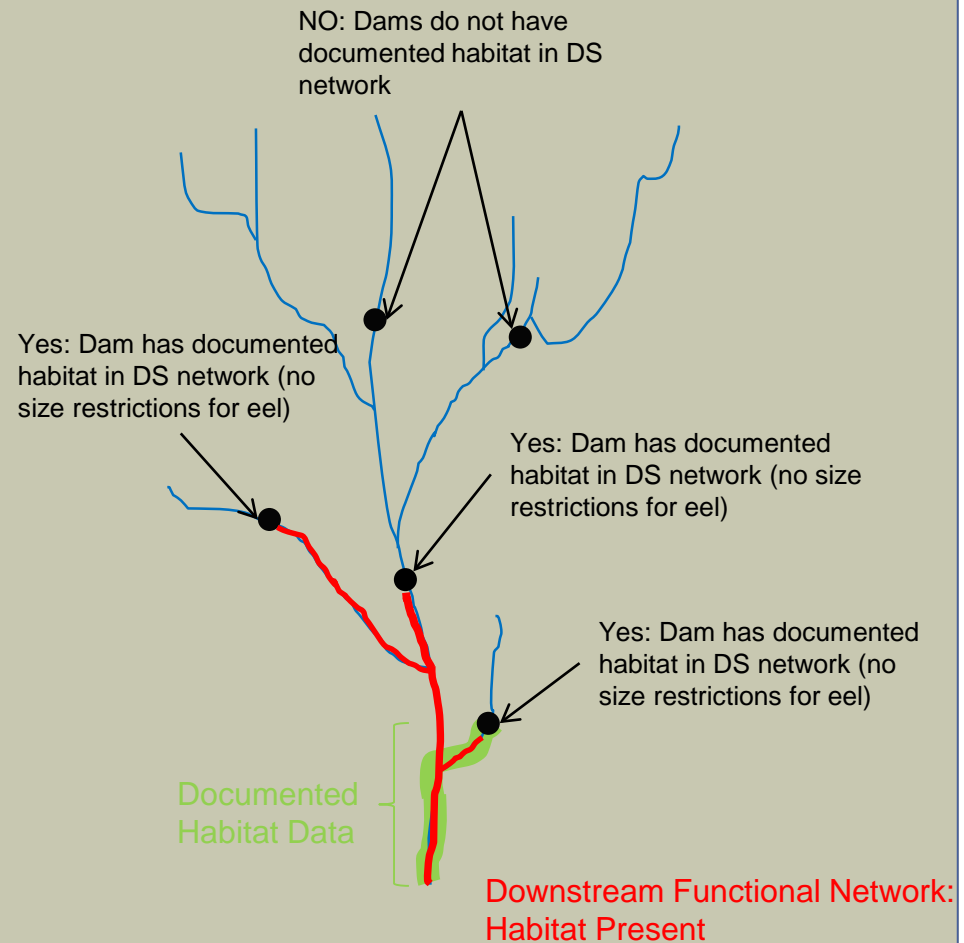
- Category: Ecological
- Presence of shortnose sturgeon downstream of dam. Based on:
 1. Documented habitat in some portion of the dam's downstream functional network
 2. **AND** Dam is on a stream that is likely to support that species based on stream size
 1. Size 4+ Rivers
 3. **OR** There is documented habitat up to a dam on a stream that doesn't meet the above size class rule
 4. **AND** the dam has not been specifically flagged otherwise by Chesapeake Fish Passage Workgroup
- Fish habitat data from multiple sources, reviewed and edited by state fisheries biologists. Each line segment includes its data source.
- Unit: Unitless Classes: "Current", "Potential Current", "Historical"



American Eel habitat in Downstream Functional Network

41

- Category: Ecological
- Presence of American eel downstream of dam. Based on:
 1. Documented habitat in some portion of the dam's downstream functional network
 2. No size restrictions on eel
- Fish habitat data from multiple sources, reviewed and edited by state fisheries biologists. Each line segment includes its data source.
- Unit: Unitless Classes: “Current”, “Potential Current”, “Historical”



Presence of Anadromous Species in Downstream Network

42

- Category: Ecological
- Presence of habitat for 1 or more of the 7 anadromous species included in this analysis based on the data and methods described for each species:
 - alewife, blueback herring, American shad, hickory shad, striped bass, shortnose sturgeon, Atlantic sturgeon
- Habitat for each species is coded as “Current”, “Potential Current” or “Historical”
- If current and historical habitat are documented in the downstream functional network for different species, the current habitat trumps the potential current habitat which in turn trumps the historical habitat. So if alewife habitat is “Current”, American shad habitat is “Potential Current” and Atlantic sturgeon are “Historical” the metric will be “Current”, indicating that habitat for 1 or more anadromous species is currently documented in the dams downstream network (based on the methods described for each species).
- Does NOT include American eel
- Unit: presence / absence

Number of Diadromous Species

43

- Category: Ecological
- The number of diadromous species with documented habitat in the downstream functional network of each dam based on the data and methods described for each species:
 - alewife, blueback herring, American shad, hickory shad, striped bass, shortnose sturgeon, Atlantic sturgeon, American Eel
- Only “Current” habitat is considered for this metric
- Unit: #

Rare Fish in HUC8

44

- Category: Ecological
- Count of rare (G1-G3) fish species in the watershed within which the dam is located
- Based on NatureServe watershed (8-digit HUC) data
- Unit: #

Rare Mussels in HUC8

45

- Category: Ecological
- Count of rare (G1-G3) mussel species in the watershed within which the dam is located
- Based on NatureServe watershed (8-digit HUC) data
- Unit: #

Rare Crayfish in HUC8

46

- Category: Ecological
- Count of rare (G1-G3) crayfish species in the watershed within which the dam is located
- Based on NatureServe watershed (8-digit HUC) data
- Unit: #

Dam in Eastern Brook Trout Joint Venture Catchment

47

- Category: Ecological
- Dam within an **Eastern Brook Trout Joint Venture** (EBTJV) catchment. (Mark Hudy 2012)
- Catchment data were grouped and ranked by the Chesapeake Fish Passage Workgroup as follows:
- Unit: Categorical

Category (Codes)	Rank
Allopatric brook trout (1.1, 1.1P, 1.5)	1
Sympatric with non-native browns & rainbow (1.0, 1.0P, 1.2 , 1.2P, 1.3, 1.3P, 1.4, 1.4P, 0.5, '0.5P)	2
Non-Natives Only (0.1, 0.1P, 0.2, 0.2P, 0.3, 0.3P, 0.4, 0.4P)	3
No trout / Unknown (0, 0P, <null>)	4

- Where:
 - **Allopatric Brook trout populations = 1.1 and 1.1 P***
 - **Sympatric Brook Trout populations = 1.0 and 1.0 P***
 - ✦ Sympatric with brown trout = 1.2 and 1.2 P*
 - ✦ Sympatric with rainbow trout = 1.3 and 1.3 P*
 - ✦ Sympatric with rainbow and brown trout = 1.4 and 1.4 P*
 - **No brook trout = 0**
 - **Unknown = 0 P***
 - **Stocked waters = 0.5**
 - **Stocked on top of wild brook trout = 1.5**
 - **Exotic cold water trout = 0.1 and 0.1 P***
 - ✦ Exotic brown trout = 0.2 and 0.2 P*
 - ✦ Exotic rainbow trout = 0.3 and 0.3 P*
 - ✦ Exotic rainbow and brown trout = 0.4 and 0.4 P*
 - ***P = Predicted, No actual sample in catchment or sample collection greater than 10 years old. Classified based on the classification rule sets.**

Native Fish Species Richness - HUC 8

48

- Category: Ecological
- Current native fish species richness in the watershed within which the dam is located
- Based on NatureServe watershed (8-digit HUC) data
- Unit: #

CBP Stream Health

49

- Chesapeake Bay Program stream health score
- Average Benthic Index of Biotic Integrity
- >10,000 sample locations rated as excellent, good, fair, poor, very poor
- Uses HUC10 watersheds where sample density is sufficient, otherwise HUC8 watersheds

MBSS Stream Health- BIBI

50

- Maryland Biological Stream Survey – benthic macroinvertebrate index of biotic integrity
- HUC10 watersheds rated as good, fair, poor, very poor based on mean of sample data
- Dams are assigned values based on the watershed they are within

MBSS Stream Health- FIBI

51

- Maryland Biological Stream Survey – fish index of biotic integrity
- HUC10 watersheds rated as good, fair, poor, very poor based on mean of sample data
- Dams are assigned values based on the watershed they are within

MBSS Stream Health- CIBI

52

- Maryland Biological Stream Survey – combined (average) of benthic macroinvertebrate index of biotic integrity and fish index of biotic integrity
- HUC10 watersheds rated as good, fair, poor, very poor based on mean of sample data
- Dams are assigned values based on the watershed they are within

INSTAR Stream Health - MIBI

53

- Virginia's Interactive Stream Assessment Resource: modified Index of Biotic Integrity
- 6th order (HUC12) watersheds classified as moderate, high, very high, outstanding
- Dams are assigned values based on the watershed they are within
- Data provided by
 - Virginia Commonwealth University,
 - VA Department of Conservation and Recreation, Division of Natural Heritage



PA Stream Health

54

- Pennsylvania stream health score, based on benthic index of biotic integrity data obtained from PA DEP.
- Mean IBI calculated for HUC10 watersheds.
 - “small stream” IBI used where drainage $< 50\text{mi}^2$
 - “large stream” IBI used where drainage $> 50\text{mi}^2$
- Classed as good (> 63), fair (43-63), poor (< 43) based on mean IBI score.
- Dams are assigned values based on the watershed they are within

River Size Class

55

- Category: Size or System Type
- River size class based on NE Aquatic Habitat Classification.

1a: Headwaters (<3.861 sq.mi.)

1b: Creeks ($\geq 3.861 < 38.61$ sq.mi.)

2: Small River ($\geq 38.61 < 200$ sq. mi.)

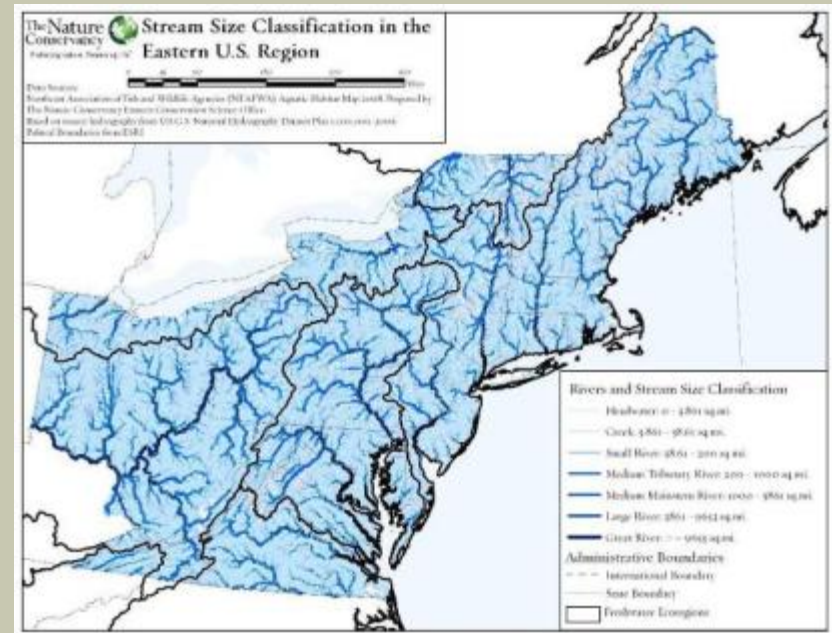
3a: Medium Tributary Rivers ($\geq 200 < 1000$ sq.mi.)

3b: Medium Mainstem Rivers ($\geq 1000 < 3861$ sq.

4: Large Rivers ($\geq 3861 < 9653$ sq.mi.)

5: Great Rivers (≥ 9653 sq.mi.)

(measure = upstream drainage area)



Upstream Size Classes Gained by Removal / Bypass

56

- Category: Size or System Type
- Number of upstream stream size classes gained if dam were to be removed. Stream segments must be >0.5 miles to be considered a gain and the size class must not be present in the downstream functional network.
- e.g. If a downstream functional network had small rivers (size 2) and medium tributary rivers (size 3a), while an upstream functional network had these as well as 2 miles of creek (size 1b), the gain would be 1.
- Unit: #

Total # Reconnected Stream Size Classes >0.5 Miles(upstream + downstream)

57

- Category: Size or System Type
- Number of unique stream size classes >0.5 miles in total upstream and downstream functional networks
- Where stream size defined as:
 - 1a: Headwaters (<3.861 sq.mi.)
 - 1b: Creeks ($\geq 3.861 < 38.61$ sq.mi.)
 - 2: Small River ($\geq 38.61 < 200$ sq. mi.)
 - 3a: Medium Tributary Rivers ($\geq 200 < 1000$ sq.mi.)
 - 3b: Medium Mainstem Rivers ($\geq 1000 < 3861$ sq.mi.)
 - 4: Large Rivers ($\geq 3861 < 9653$ sq.mi.)
 - 5: Great Rivers (≥ 9653 sq.mi.)

(measure = upstream drainage area)

Small Streams Connected Directly to the Bay

58

- The first dams up from the Bay on small streams (Sizes 1a/1b) within 20km of the Bay (i.e. draining directly to the Bay or near the mouth of a large river).