

# **Relicensing Study 3.3.1**

## **Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station**

### **Study Report**

#### **Addendum 3 Assessment of Yellow Lampmussels in Reach 3**

**Northfield Mountain Pumped Storage Project (No. 2485)  
and Turners Falls Hydroelectric Project (No. 1889)**

*Prepared for:*



*Prepared by:*



**MAY 2018**

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STATION ADDENDUM 3 REACH 3 MUSSELS- ADDENDUM 3 ASSESSMENT OF YELLOW  
LAMP MUSSELS IN REACH 3

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## LIST OF ABBREVIATIONS

cfs	cubic feet per second
CRC	Connecticut River Conservancy
FERC	Federal Energy Regulatory Commission
FL	FirstLight Hydro Generating Company
MADFW	Massachusetts Division of Fisheries & Wildlife
NHESP	Massachusetts Natural Heritage and Endangered Species Program
USFWS	United States Fish and Wildlife Service
WUA	weighted usable area

## 1 INTRODUCTION

On October 14, 2016, FirstLight Hydro Generating Company (FL) filed with the Federal Energy Regulatory Commission (FERC) Study Report No. 3.3.1 Instream Flow Habitat Assessment in the Bypass Reach and below Cabot Station. On October 31 and November 1, 2016, FL held its study report meeting in which Study No. 3.3.1 was discussed on October 31. After filing meeting minutes on November 15, 2016, comments on Study No. 3.1.1 were filed by the United States Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), the Massachusetts Division of Fisheries & Wildlife (MADFW), the Connecticut River Watershed Council (now called the Connecticut River Conservancy or CRC) and Karl Meyer.

On December 2, 2016 a stakeholder meeting was held to discuss Study No. 3.3.1 and specifically what steady state and persistent habitat maps were needed to evaluate various target species in Reach 3 including juvenile and adult yellow lampmussels, deep-fast guild and deep-slow guild (these guilds were to representative of host fish). It was agreed to develop weighted usable area (WUA) versus flow curves, combined suitability index maps and persistent habitat maps for juvenile and adult yellow lampmussels, deep-fast guild and deep-slow guild.

On January 17, 2017, FL filed its responsiveness summary. In its response, FL proposed to file an addendum to Study No. 3.1.1 to include the maps noted above by April 3, 2017.

On April 3, 2017, FL filed Addendum 1 to Study No. 3.3.1 which included the following for Reach 3 relative to mussels and guilds:

- Habitat time series for adult and juvenile yellow lampmussels, and four guilds (deep-fast, deep-slow, shallow-fast, shallow-slow) for a one week period on an hourly basis.
- WUA versus flow curves for juvenile and yellow lampmussels, deep-fast guild, and deep-slow guild based on various bypass flows, Cabot flows and a Deerfield River flow of 200 cfs.
- Persistent habitat maps for juvenile and adult yellow lampmussels, deep fast guild, and deep-slow guild.
- Combined Suitability Index Maps for juvenile and adult yellow lampmussels, deep fast guild, and deep-slow guild.
- Tables showing the percentage of maximum WUA for juvenile and adult yellow lampmussel based on various bypass flows (120, 200, 300, 500, 700, 1,000, 2,000, 3,000, 5,000, 6,500, 8,000 and 10,000 cfs), Cabot discharges (2,500, 4,500, 7,000, and 14,000 cfs) and a Deerfield River flow of 200 cfs.

On May 19, 2017, FL a draft study plan for assessing mussels in Reach 5 was sent to stakeholders.

On June 1, 2017, FL had a meeting with stakeholders to discuss the draft study plan assessing mussels in Reach 5. At the meeting, FL described its method for assessing shear stress and requested that stakeholders submit comments on the draft study plan by June 9, 2017. As discussed in the meeting and as noted in the Massachusetts Natural Heritage and Endangered Species Program (NHESP) comments submitted on June 9, the mussel assessment in Reach 3 should be updated to include shear stress as a fourth parameter (in addition to depth, velocity and substrate).

The purpose of this Addendum 3 is to provide WUA versus flow figures (and tables) and combined suitability index maps for juvenile and adult yellow lampmussel and two guilds (deep-fast and deep-slow).

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LAMP MUSSELS IN REACH 3

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Section 2 includes the WUA versus flow curves and combined suitability index maps for juvenile and adult lampmussels, deep-fast guild, and deep-slow guild.

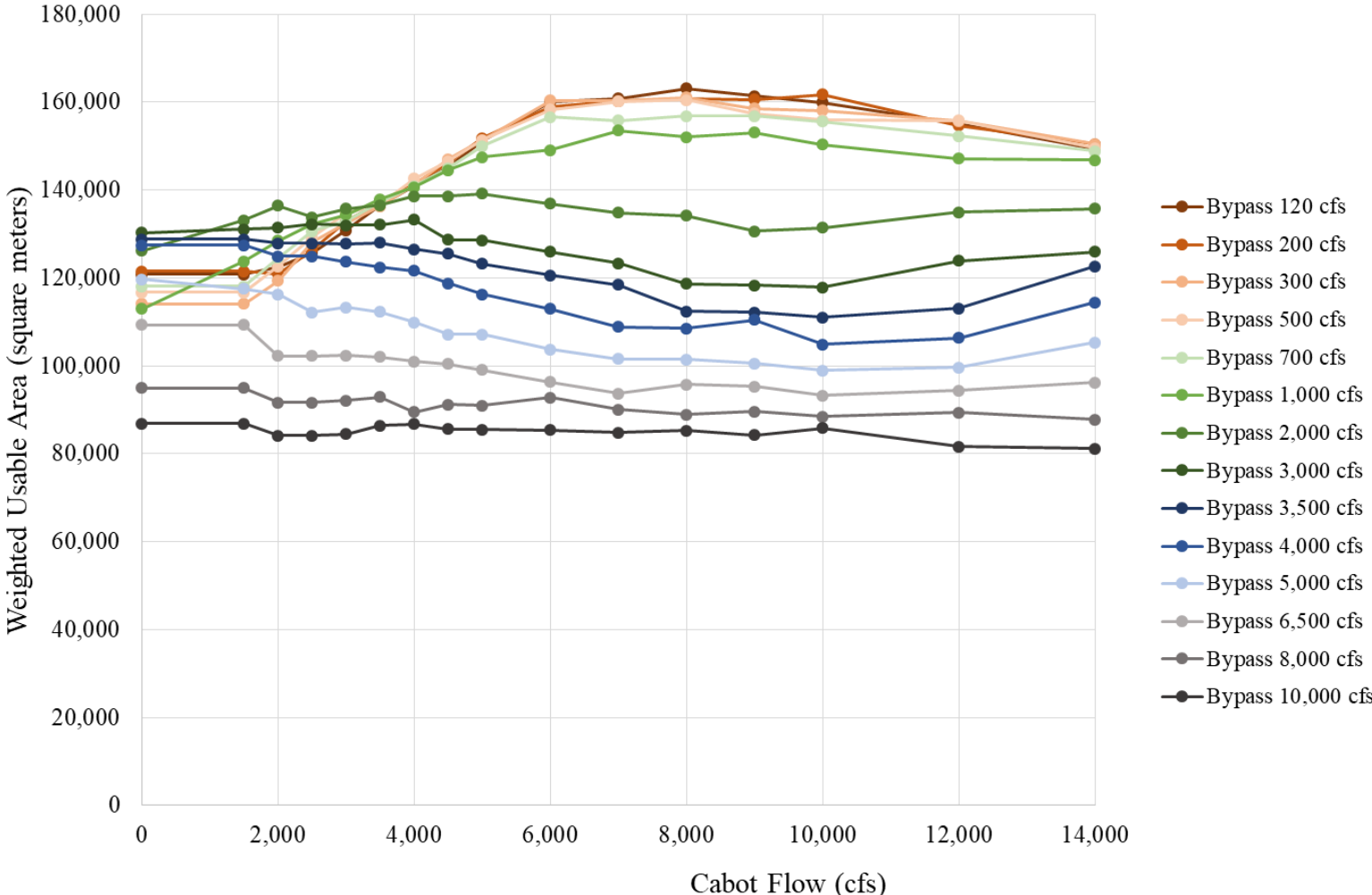
## 2 ANALYSIS

Included in [Appendix A](#) are the WUA versus flow curves for juvenile and adult yellow lampmussels, deep-slow guild and deep-fast guild under various bypass flows, Cabot flows and a Deerfield River flow of 200 cfs based a 4-variable (depth, benthic velocity, substrate and shear stress) for mussels and 3 variable (without shear stress) for the guilds assessment. The guilds are representative of the suitable habitat for host fish.

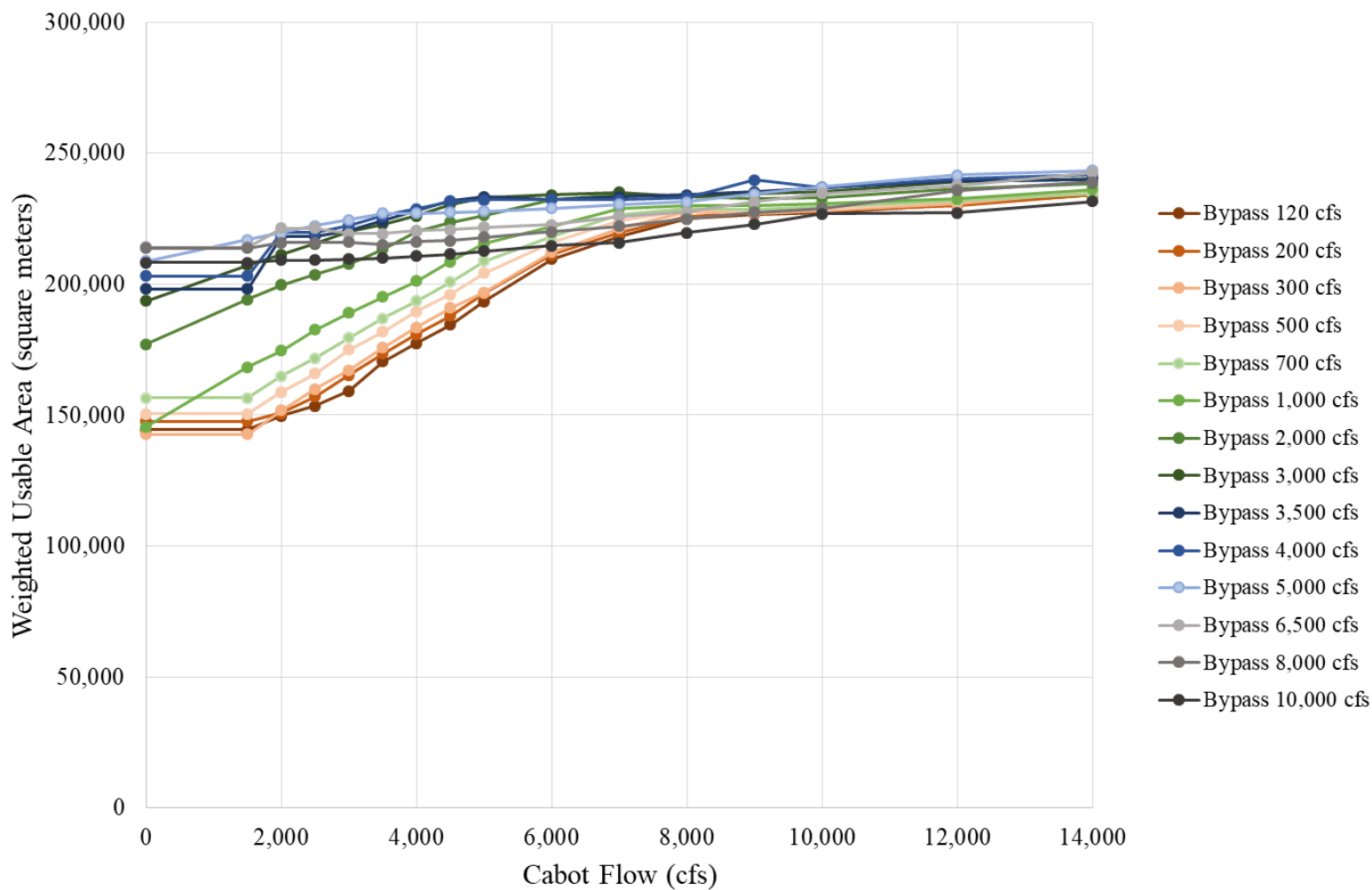
Included in [Appendix B-1 through B-4](#) are the combined suitability index maps for juvenile and adult yellow lampmussels, deep-slow guild and deep-fast guild under various bypass flows, Cabot flows and a Deerfield River flow of 200 cfs based a 4-variable (depth, benthic velocity, substrate and shear stress) for mussels and 3 variable (without shear stress) for the guilds combined suitability maps. As expected, the mussel binary suitability index maps indicate a decrease in the amount of suitable habitat with shear stress as an added variable (requested by NHESP) as compared to similar 3-variable (developed by the Delphi Team) maps that were submitted earlier.

**APPENDIX A - WUA VERSUS FLOW  
CURVES FOR JUVENILE AND ADULT  
YELLOW LAMPMUSSELS, DEEP-SLOW  
GUILD AND DEEP-FAST GUILD UNDER  
VARIOUS BYPASS FLOWS, CABOT  
FLOWS AND A DEERFIELD RIVER  
FLOW OF 200 CFS BASED A 4-  
VARIABLE (DEPTH, VELOCITY,  
SUBSTRATE AND SHEAR STRESS) FOR  
MUSSELS AND 3 VARIABLE (WITHOUT  
SHEAR STRESS) FOR GUILDS, BINARY  
ASSESSMENT.**

### Reach 3 Juvenile Yellow Lampmussel 4 Variable HSI Curves(with Shear Stress) and Deerfield at 200 cfs

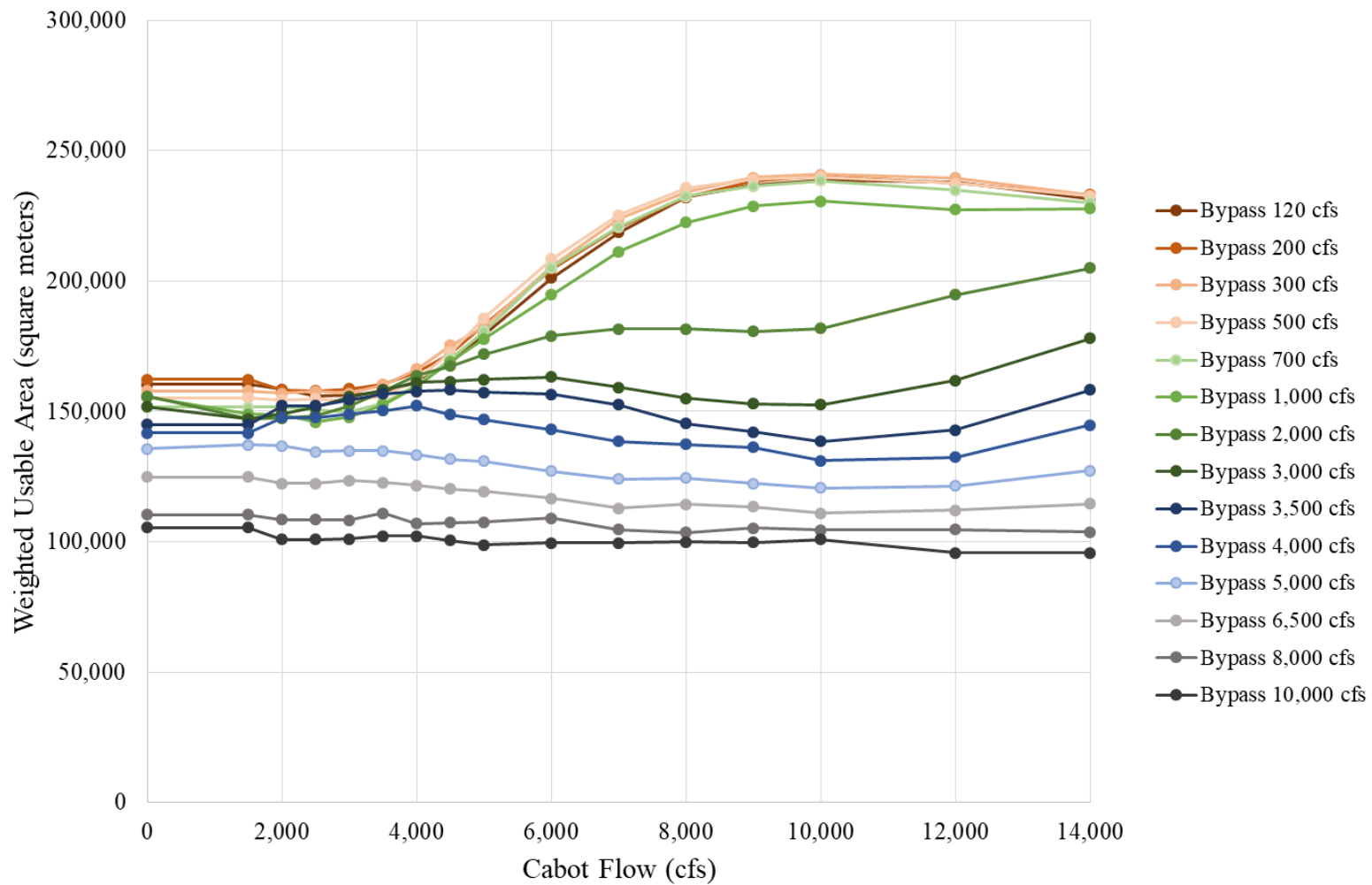


The graph displays the relationship between Cabot Flow (cfs) on the x-axis and Weighted Usable Area (square meters) on the y-axis. The x-axis ranges from 0 to 14,000 cfs, and the y-axis ranges from 0 to 300,000 square meters. There are 12 data series, each representing a different bypass flow rate: 120 cfs, 200 cfs, 300 cfs, 500 cfs, 700 cfs, 1,000 cfs, 2,000 cfs, 3,000 cfs, 3,500 cfs, 4,000 cfs, 5,000 cfs, and 10,000 cfs. The lines show that as Cabot Flow increases, the Weighted Usable Area also increases, and higher bypass flow rates generally result in higher usable area. The lines for higher bypass flows (e.g., 10,000 cfs) are consistently higher than those for lower bypass flows (e.g., 120 cfs).



# Reach 3 Deep - Slow Guild

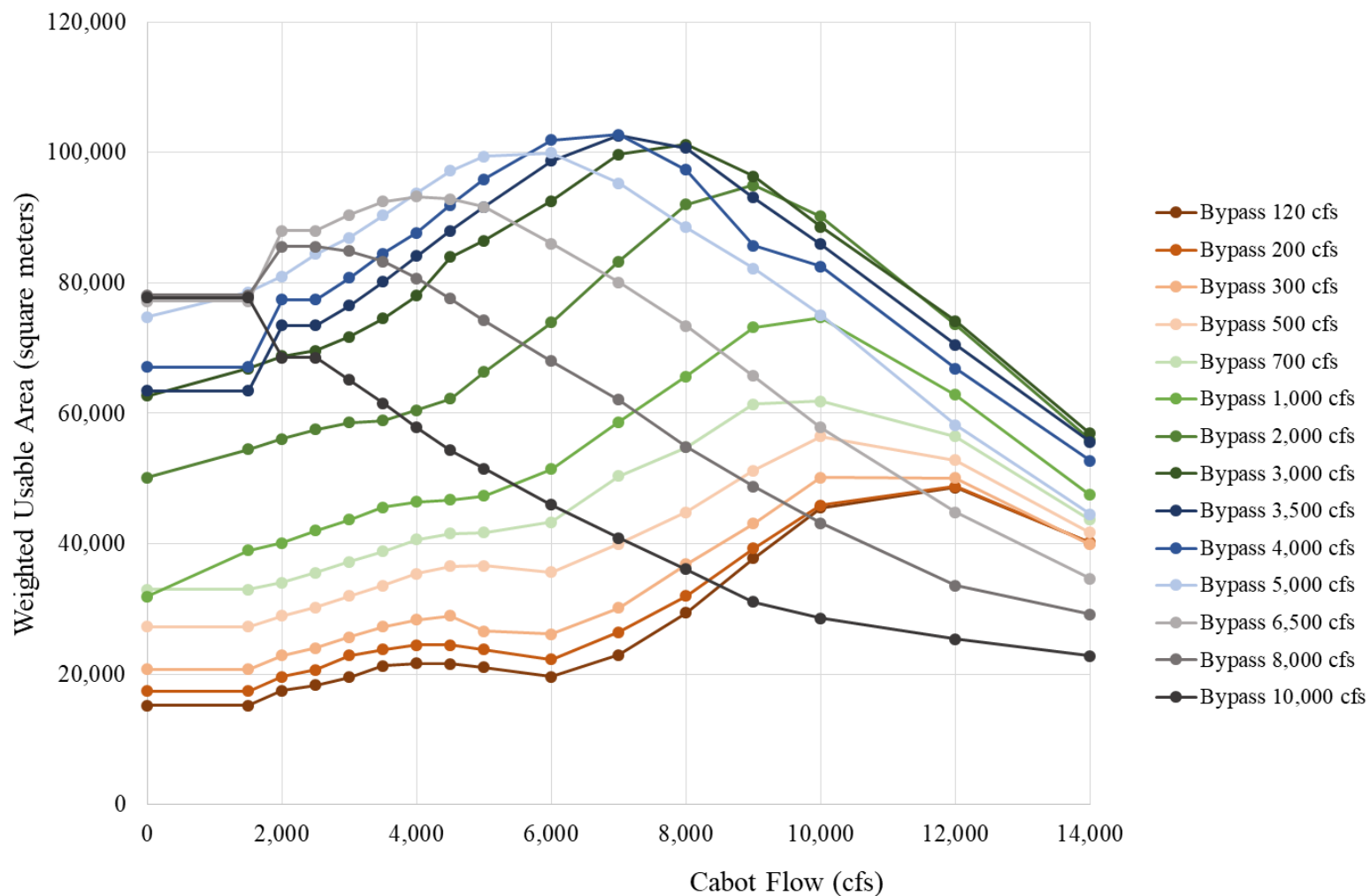
## 3 Variable HSI Curves and Deerfield at 200 cfs



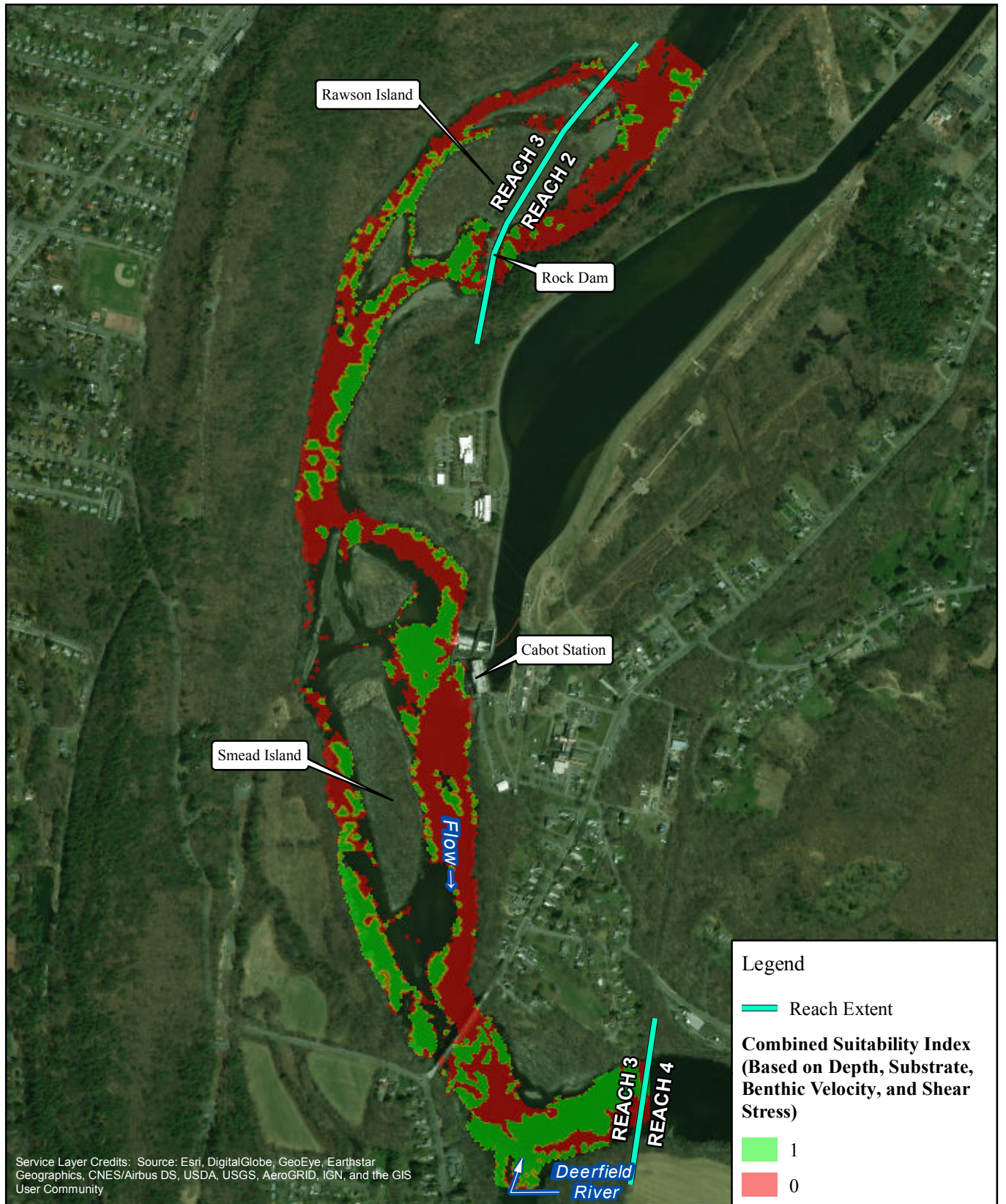


# Reach 3 Deep - Fast Guild

## 3 Variable HSI Curves and Deerfield at 200 cfs



**APPENDIX B-1 COMBINED  
SUITABILITY INDEX MAPS FOR  
JUVENILE YELLOW LAMPMUSSELS,  
UNDER VARIOUS BYPASS FLOWS,  
CABOT FLOWS AND A DEERFIELD  
RIVER FLOW OF 200 CFS BASED A 4-  
VARIABLE (DEPTH, VELOCITY,  
SUBSTRATE AND SHEAR STRESS)  
BINARY ASSESSMENT**



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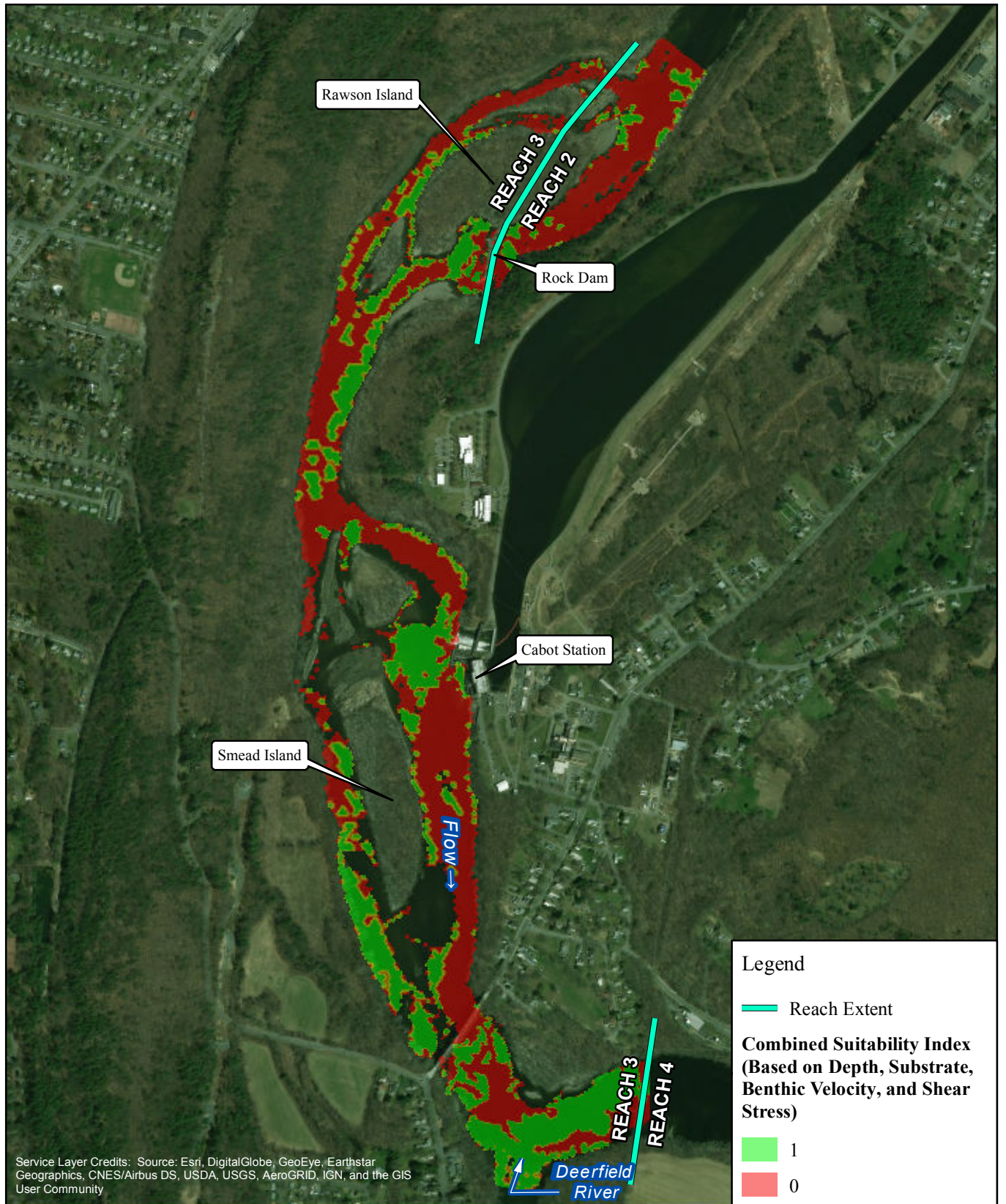
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Feet

Yellow Lampmussel-Juvenile  
Cabot Flow: 2500 cfs  
Bypass Flow: 200 cfs  
Deerfield Flow: 200 cfs

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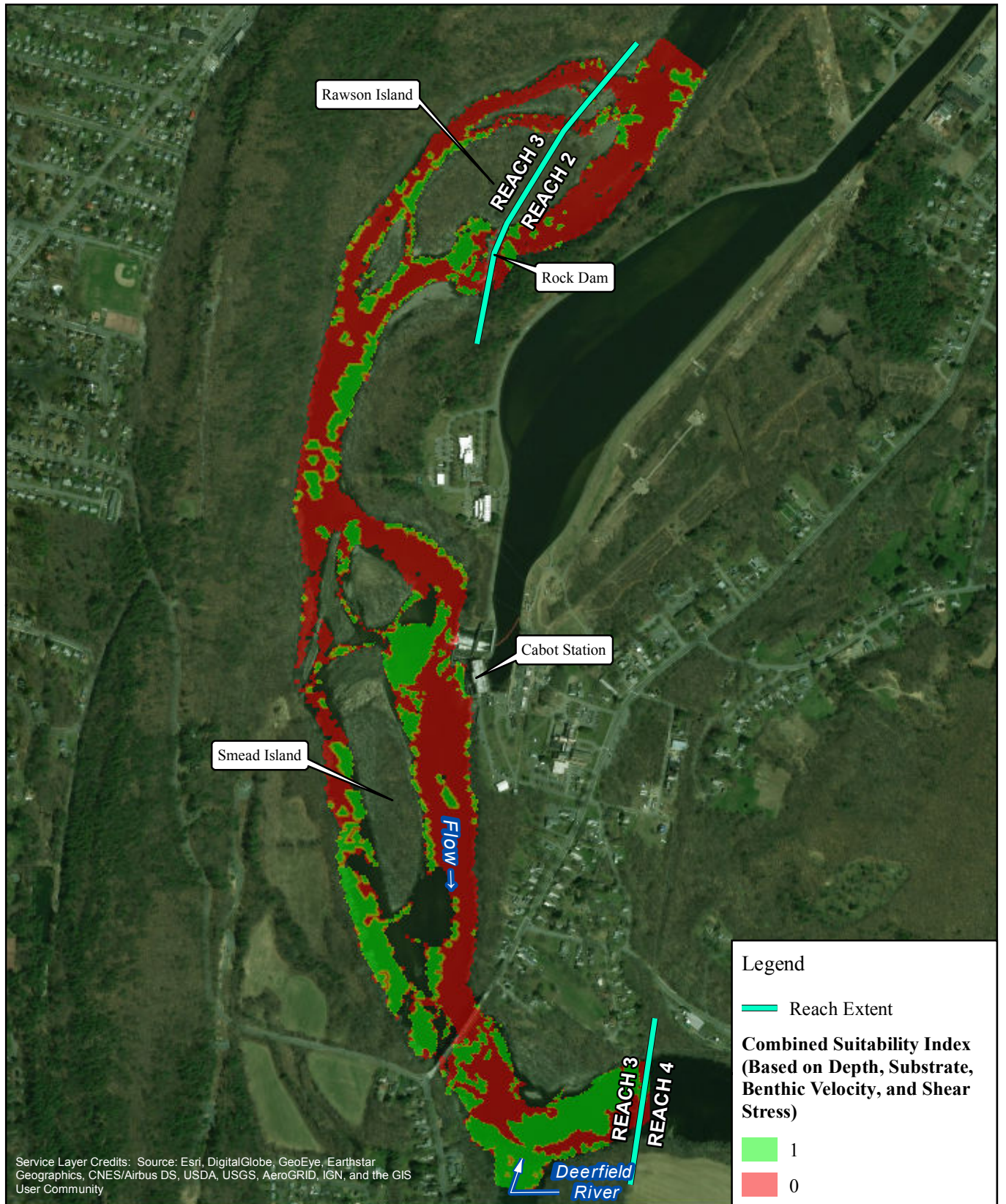
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Yellow Lampmussel-Juvenile  
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Deerfield Flow: 200 cfs

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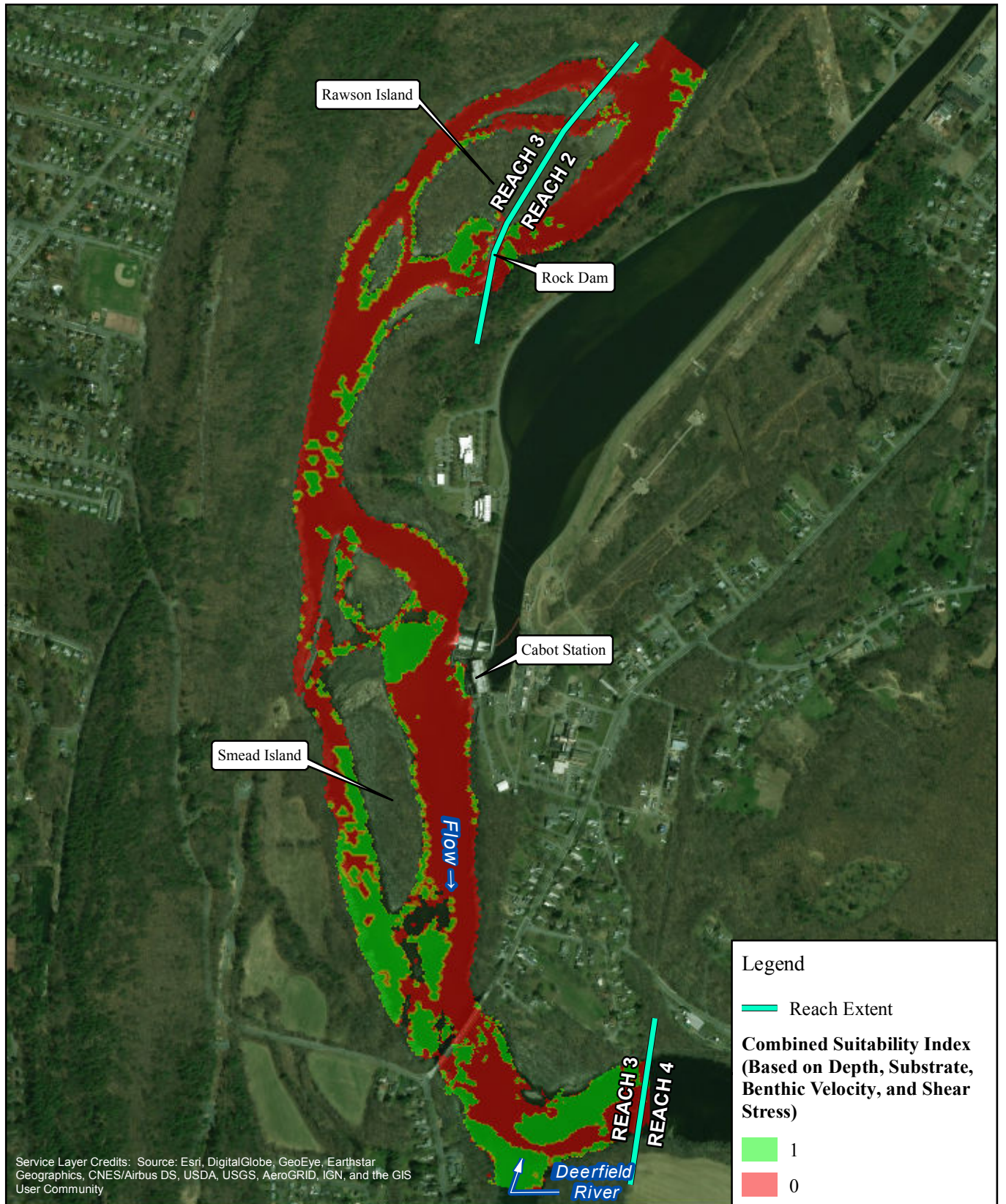
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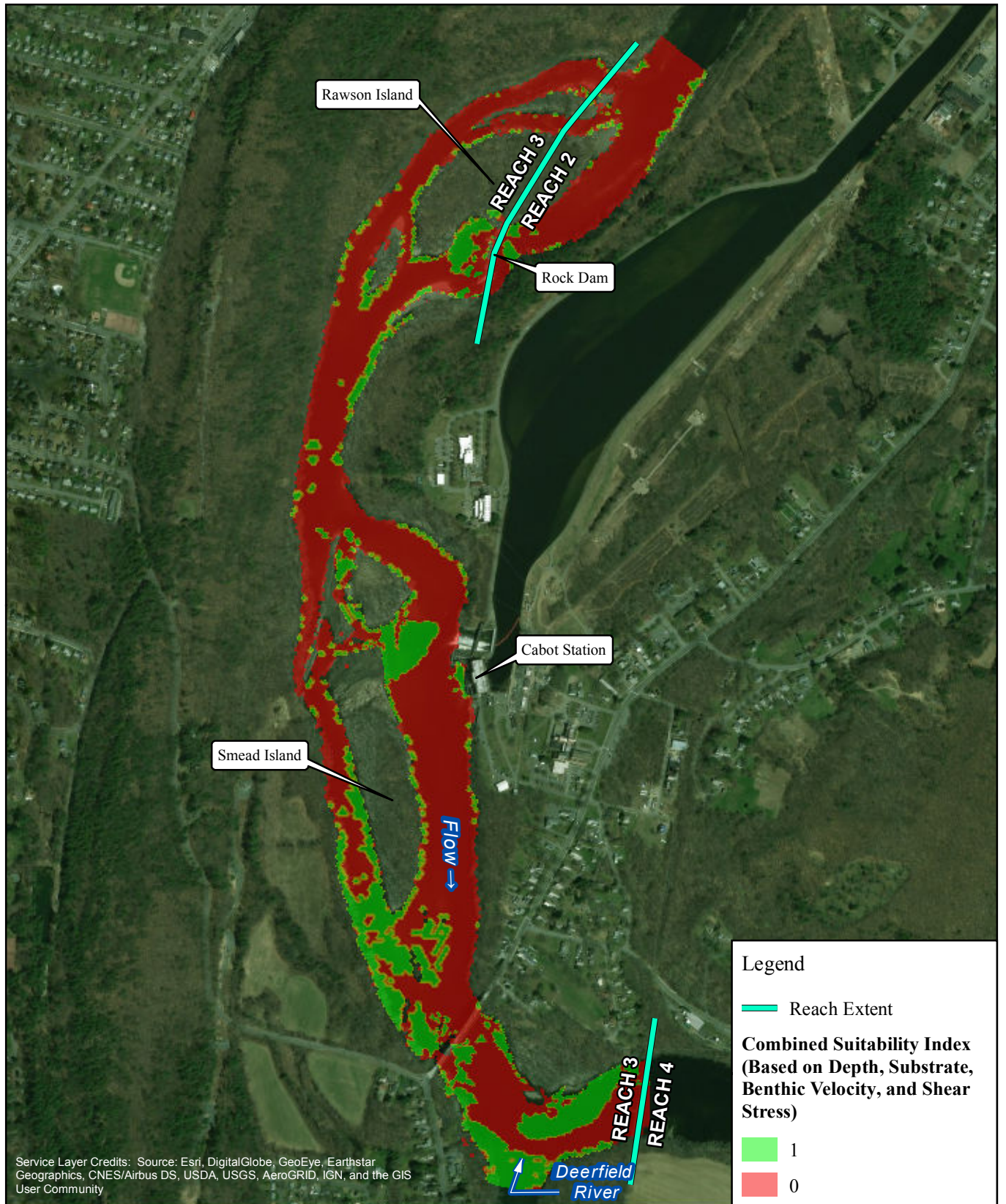
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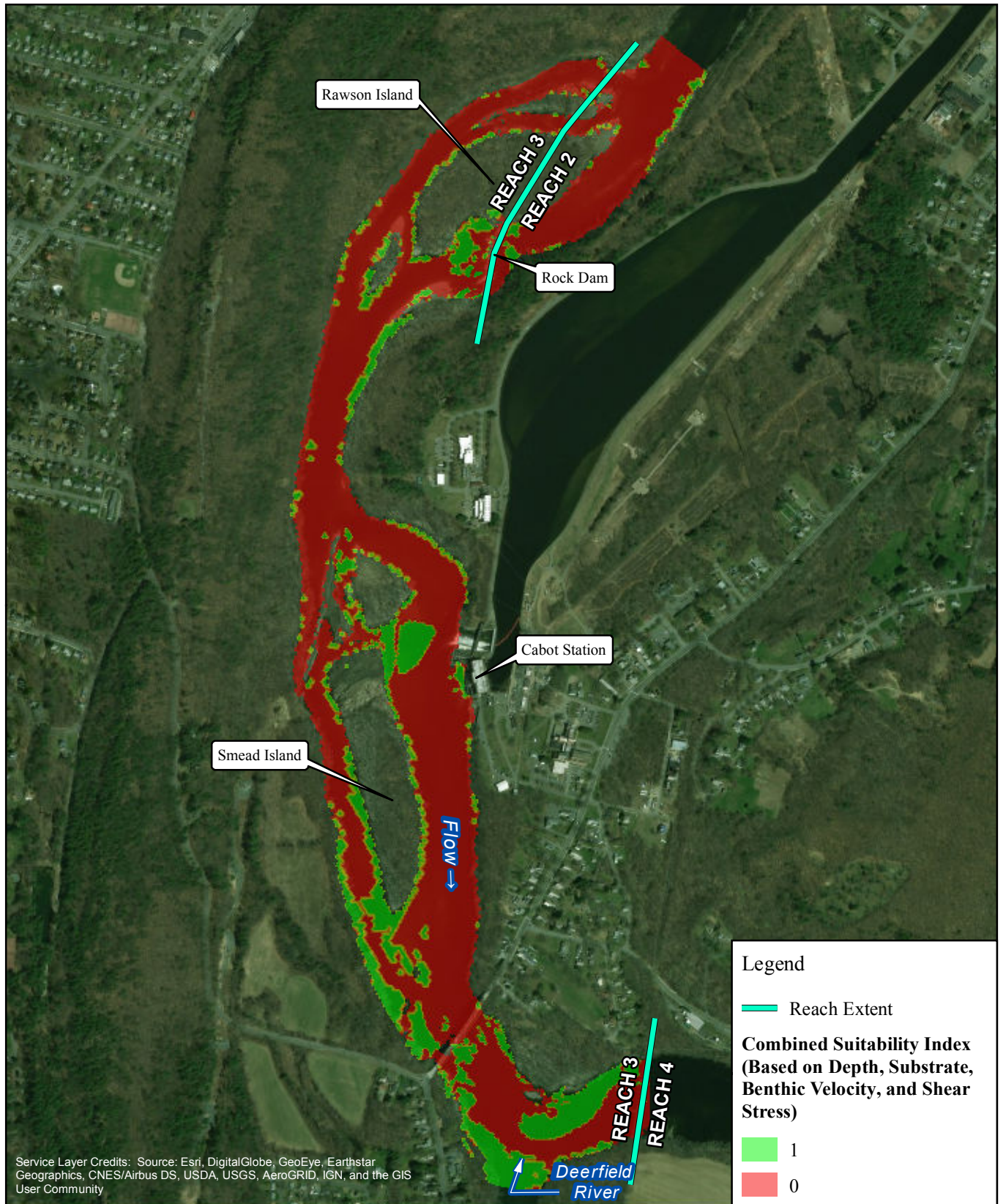
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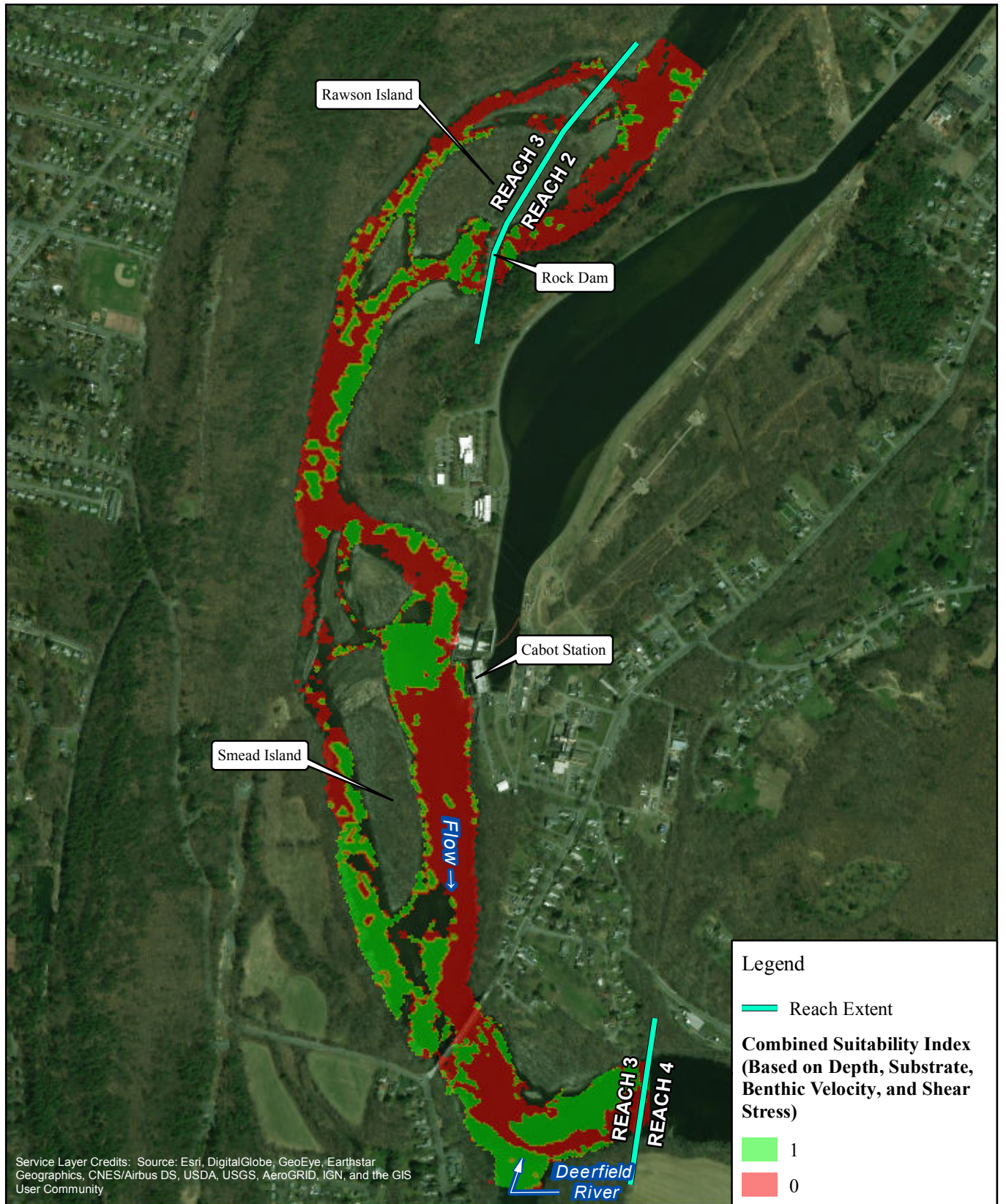
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Yellow Lampmussel-Juvenile  
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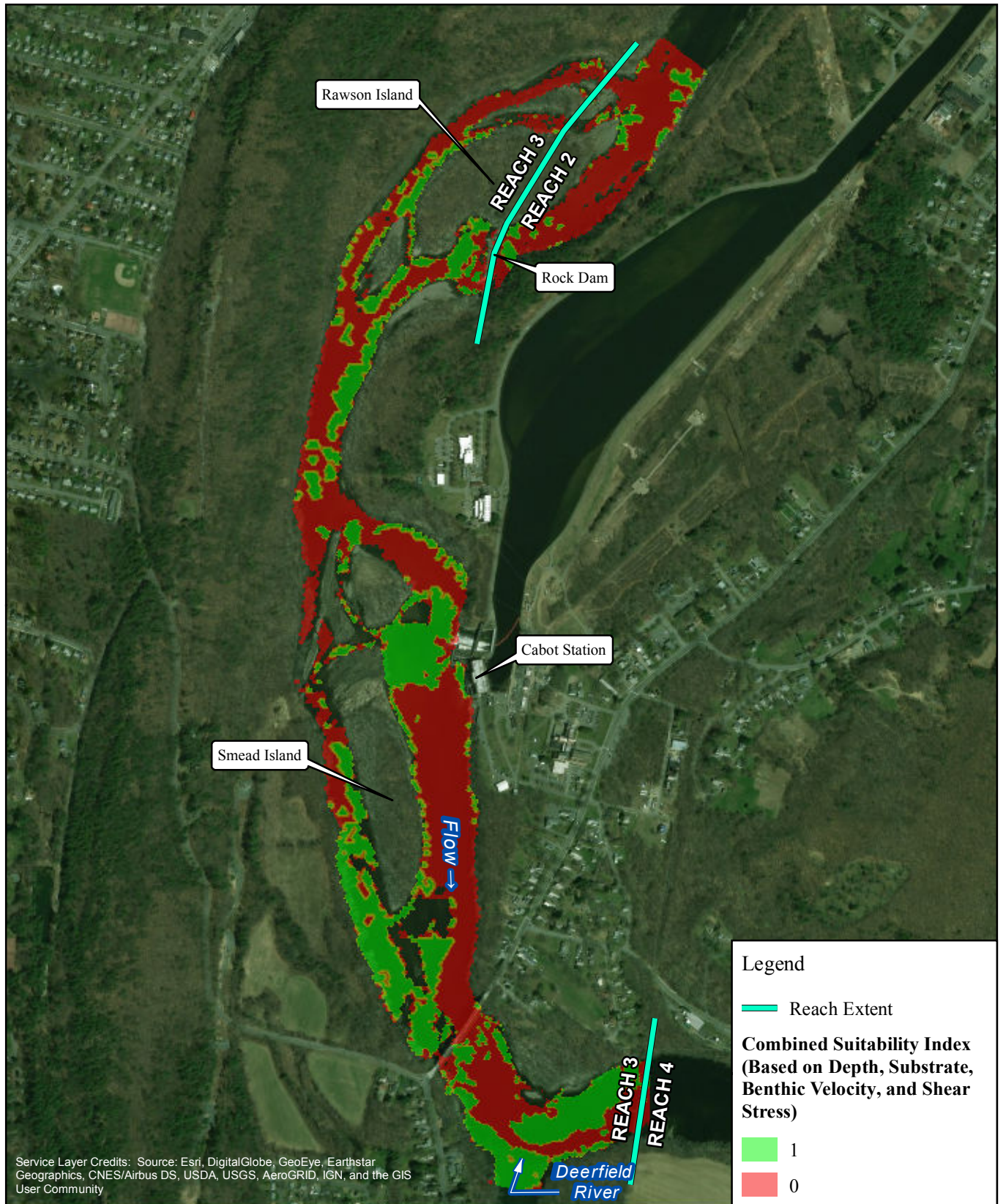
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Yellow Lampmussel-Juvenile  
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Deerfield Flow: 200 cfs

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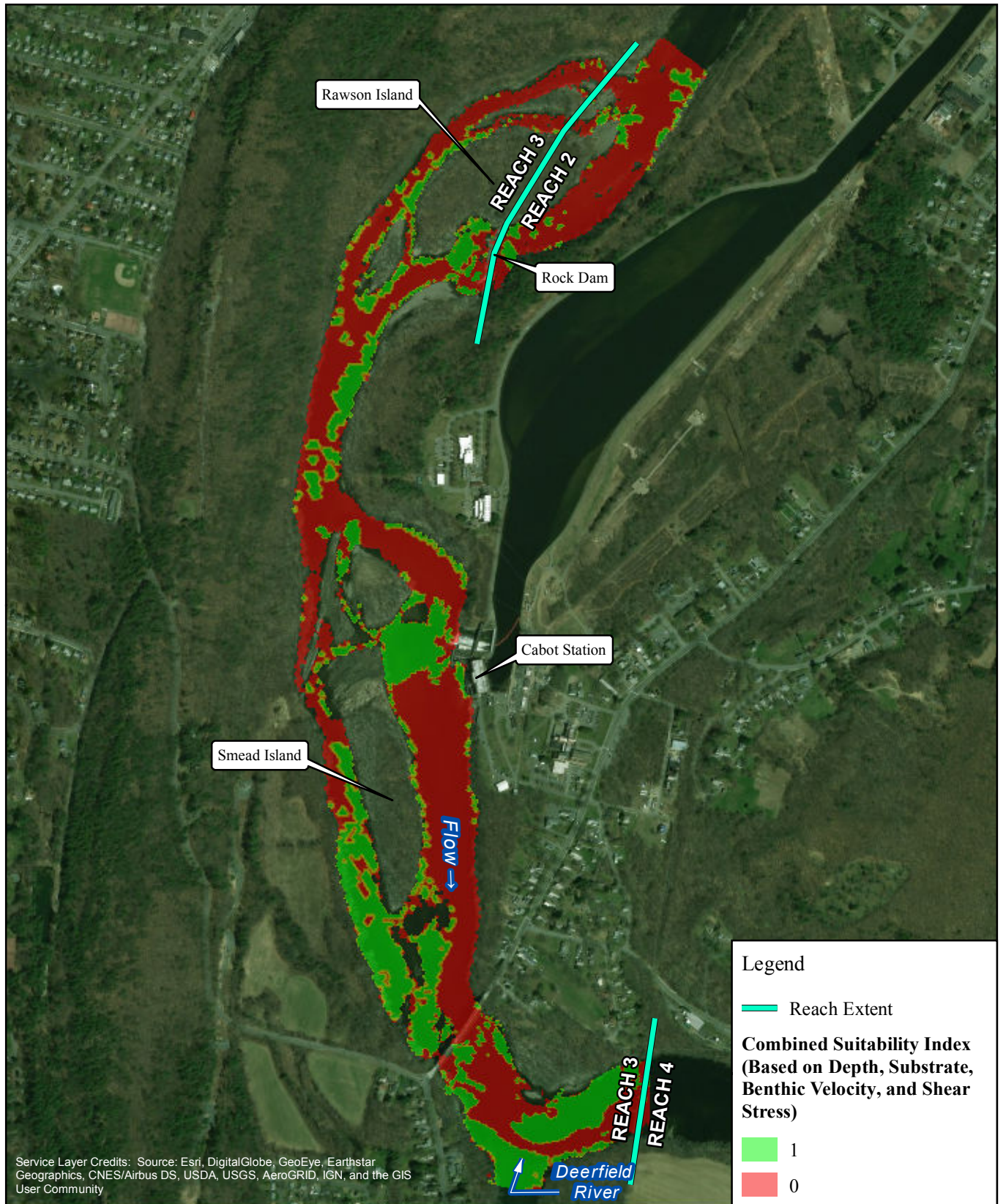
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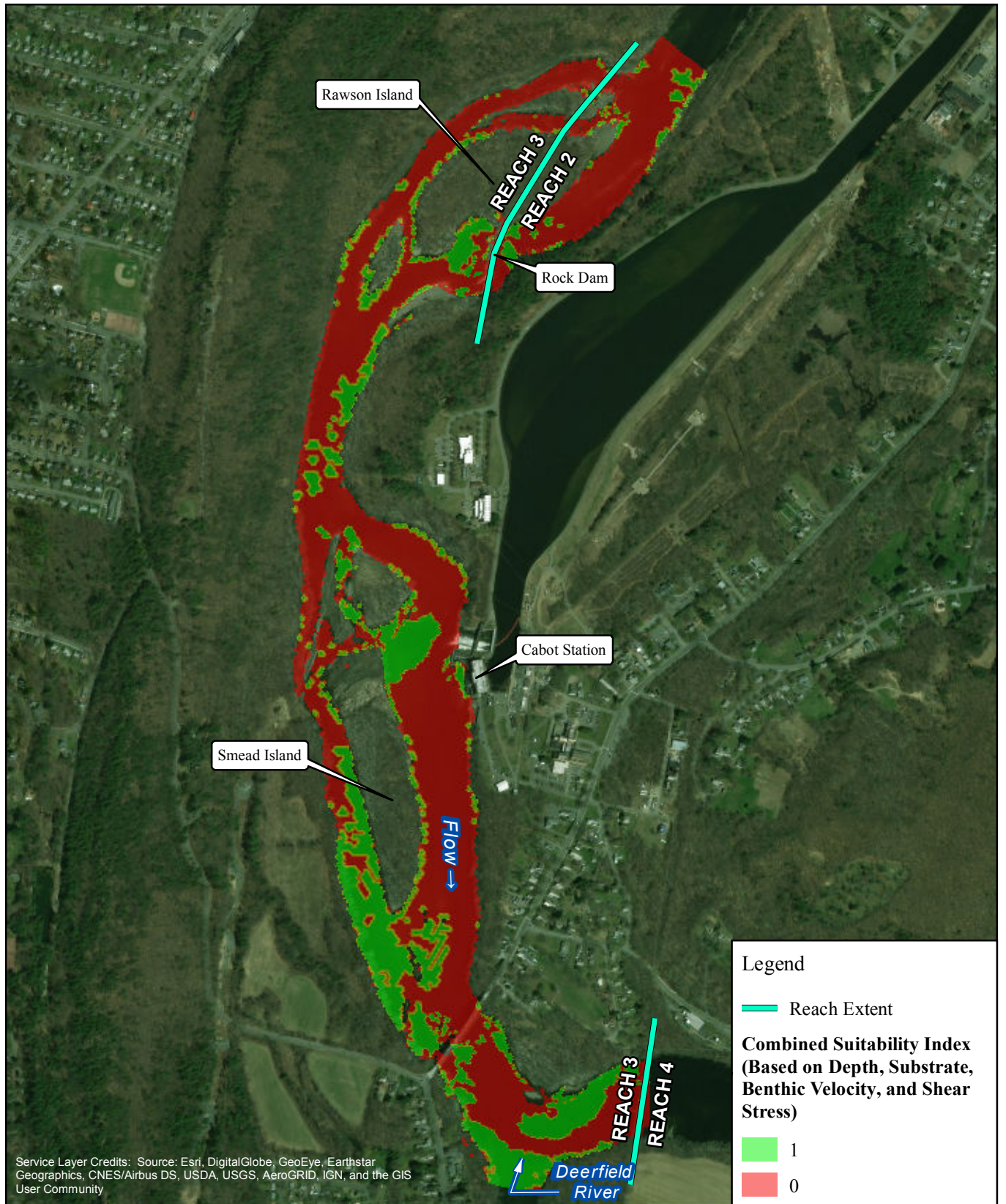
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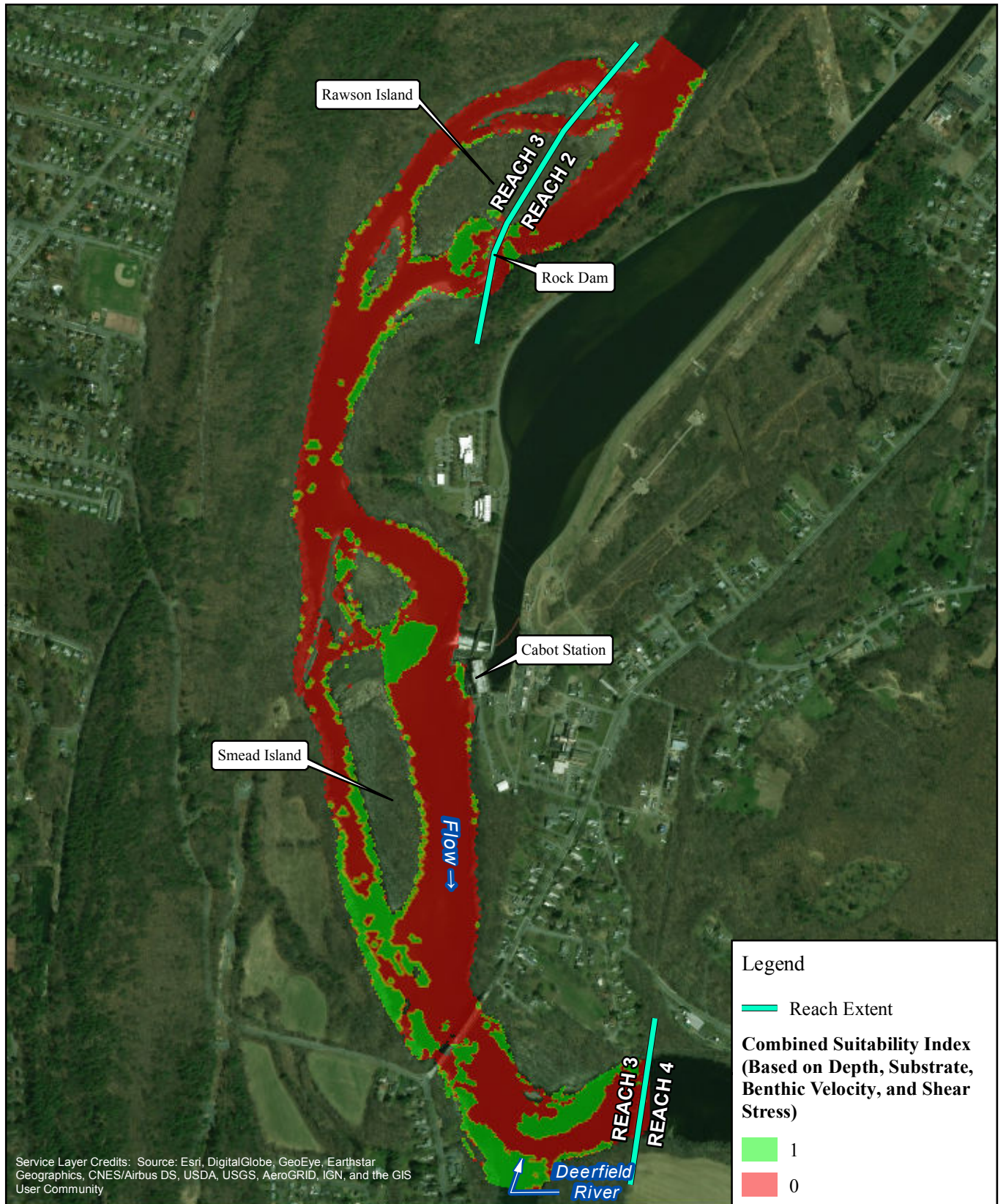
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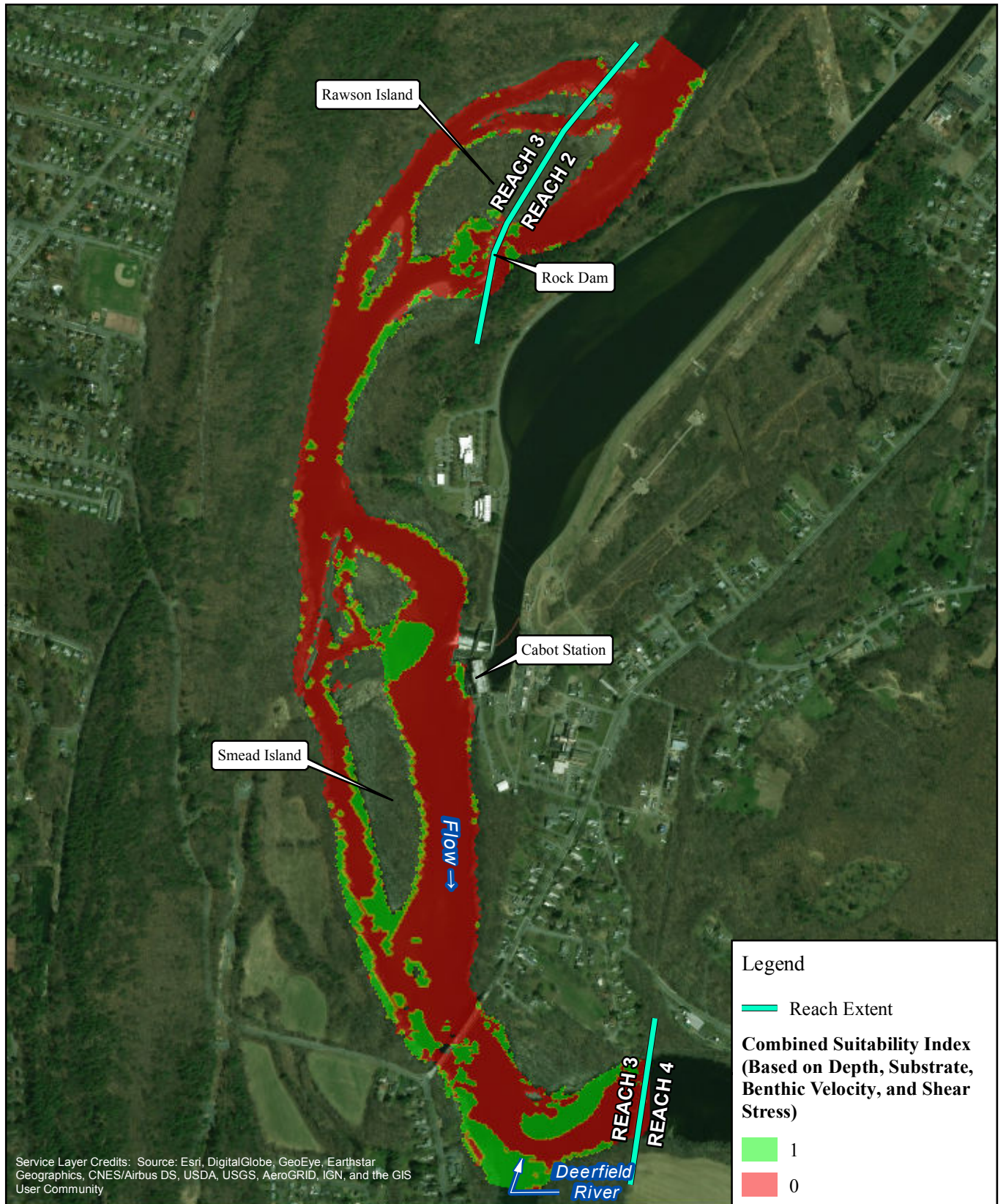
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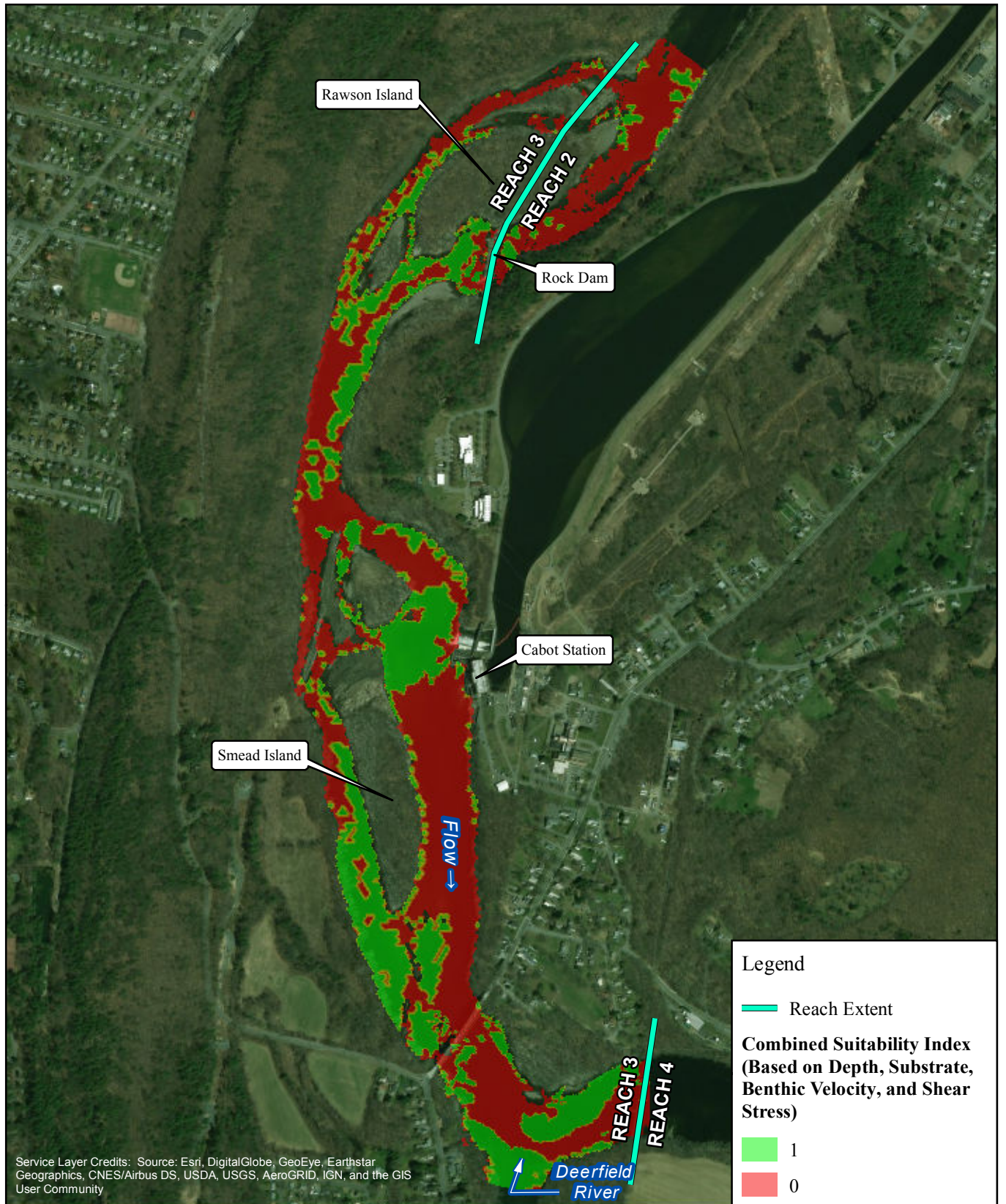
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**Yellow Lampmussel-Juvenile**  
Cabot Flow: 4500 cfs  
Bypass Flow: 6500 cfs  
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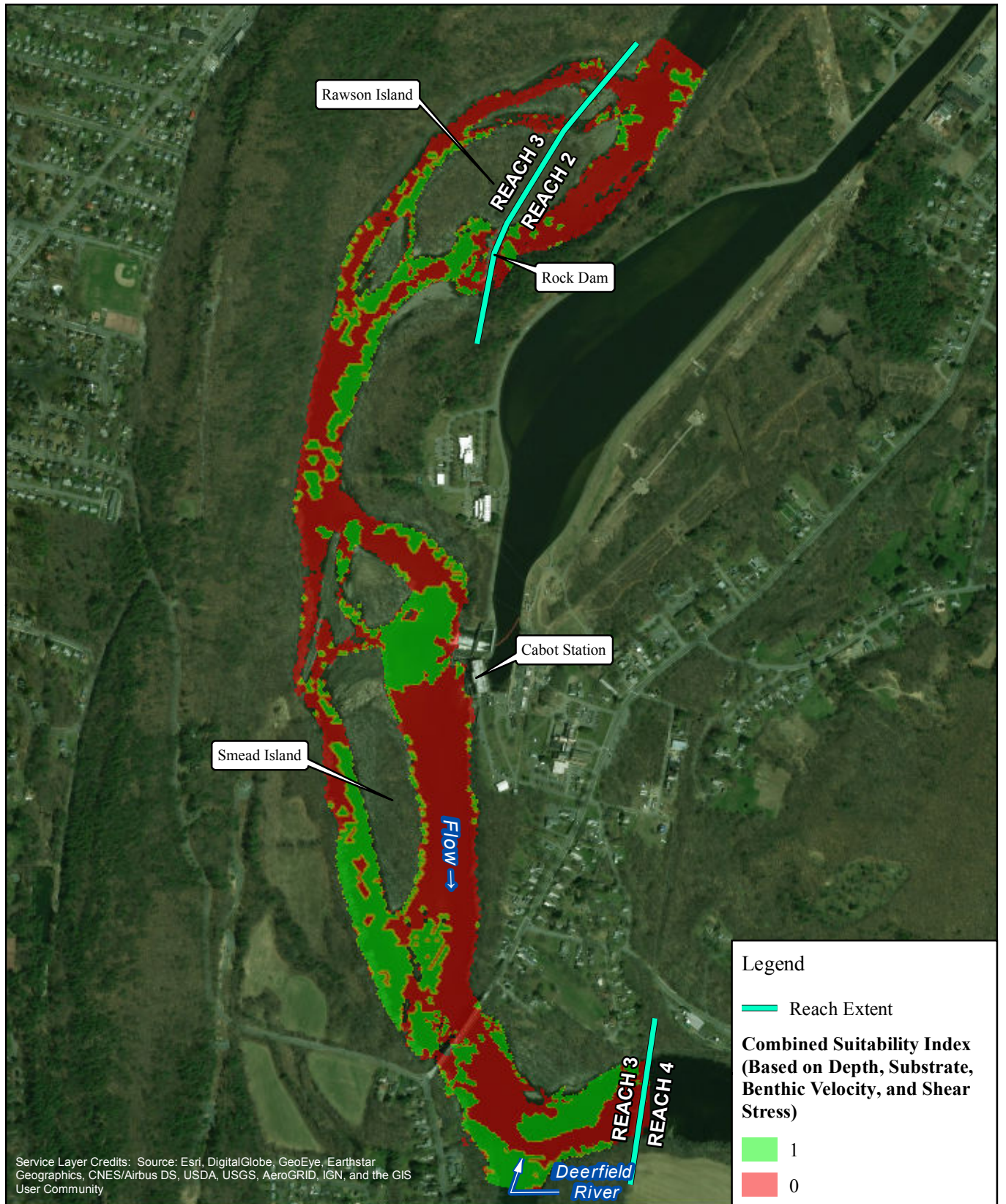
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Bypass Flow: 200 cfs  
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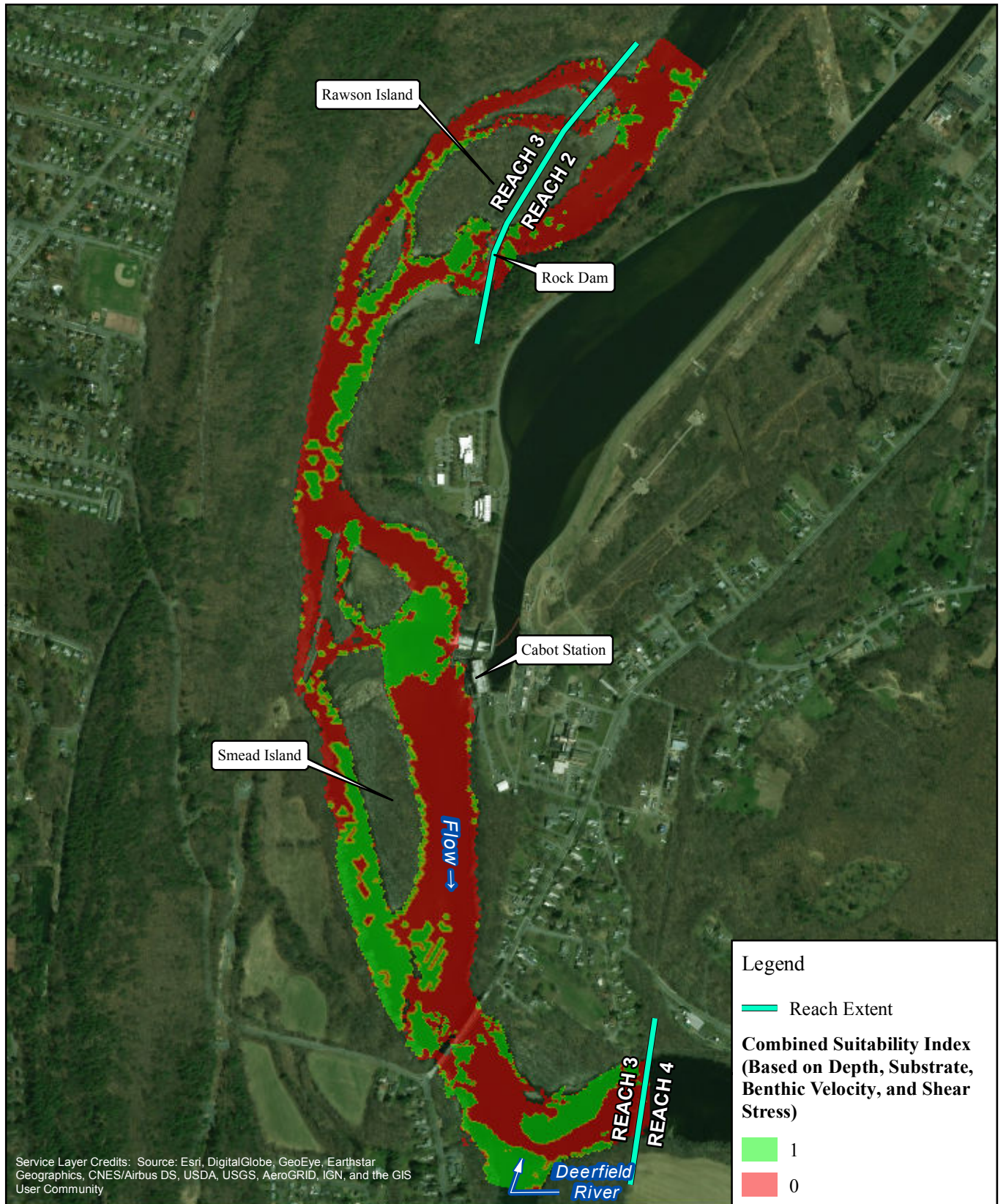
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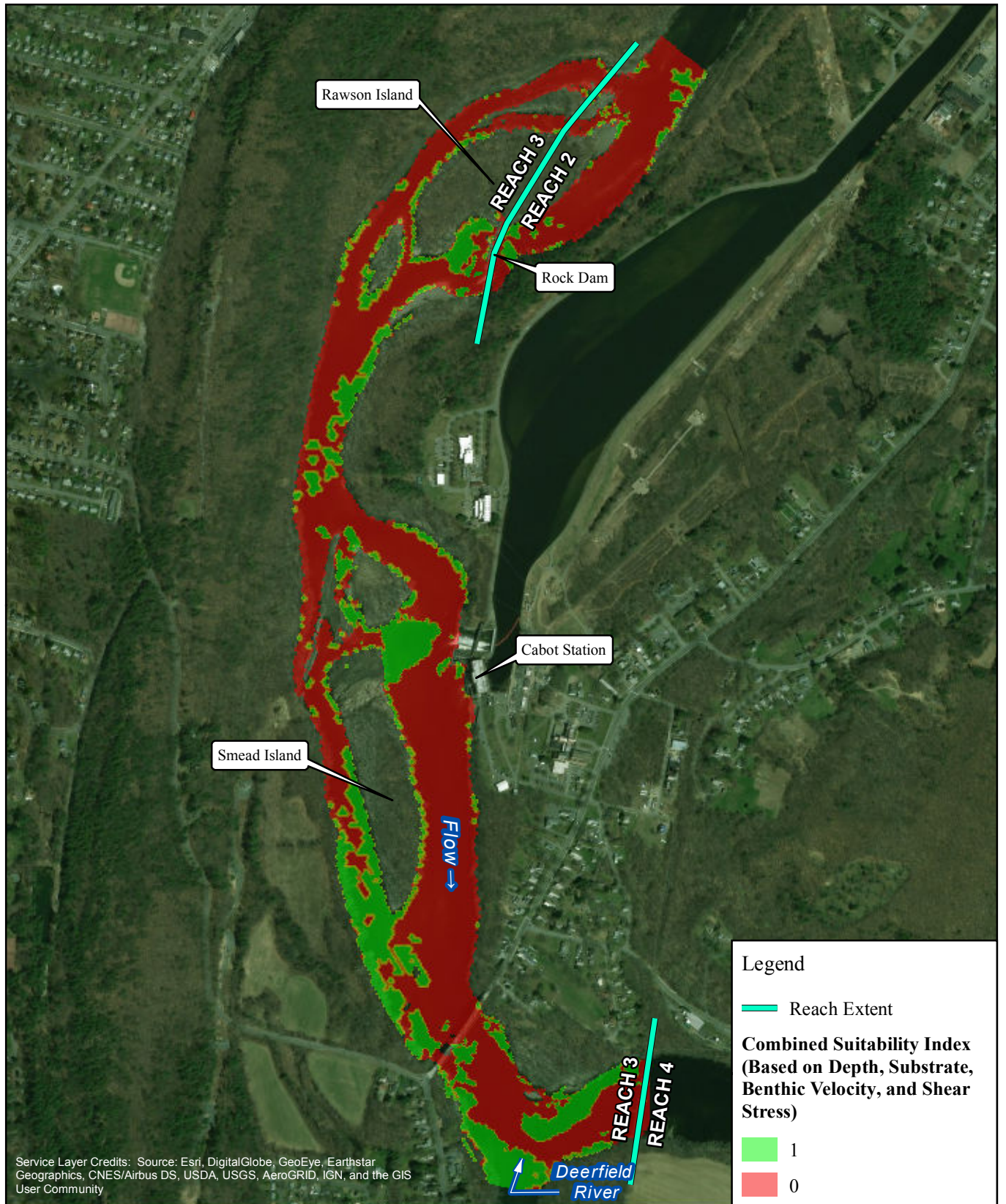
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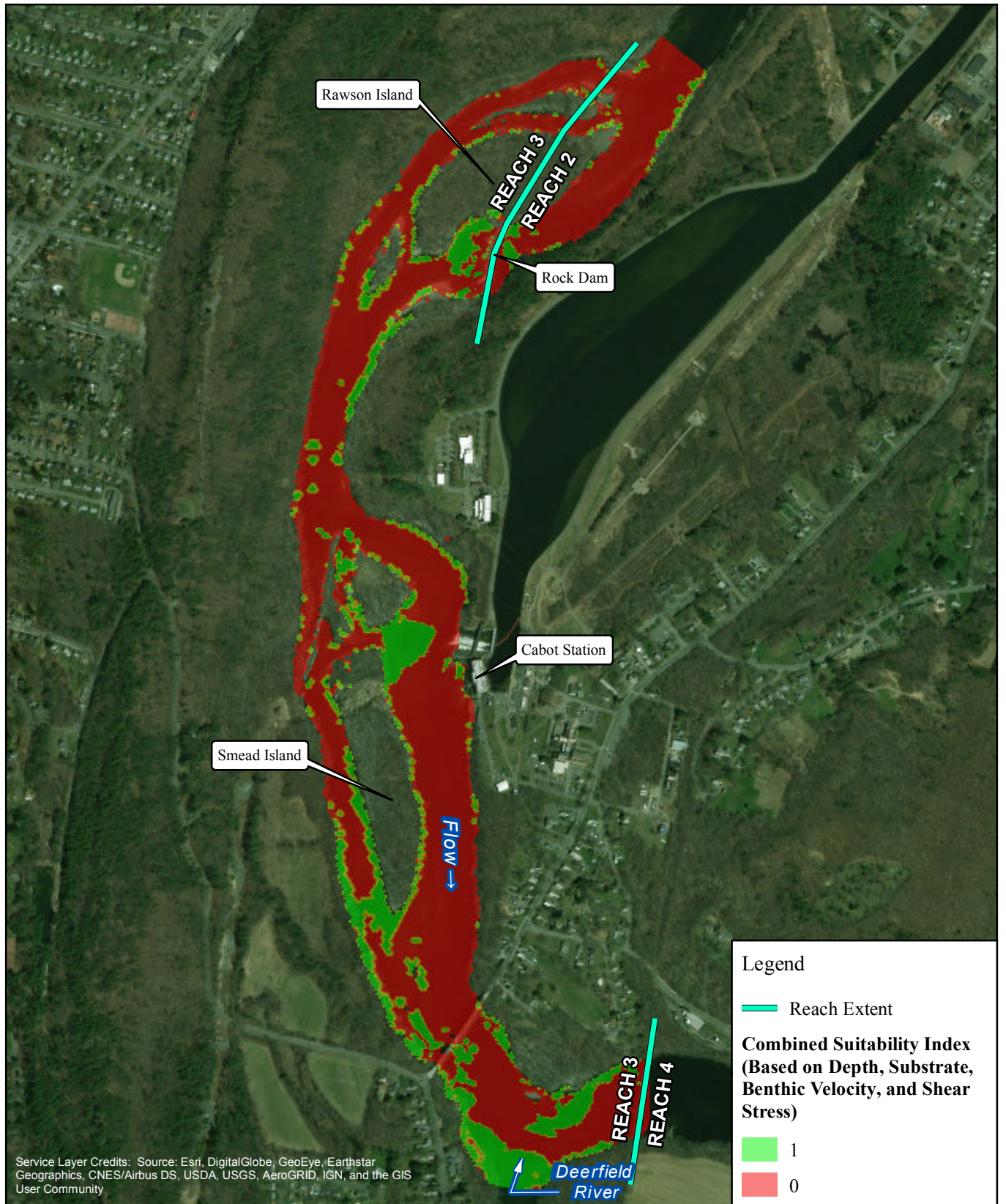
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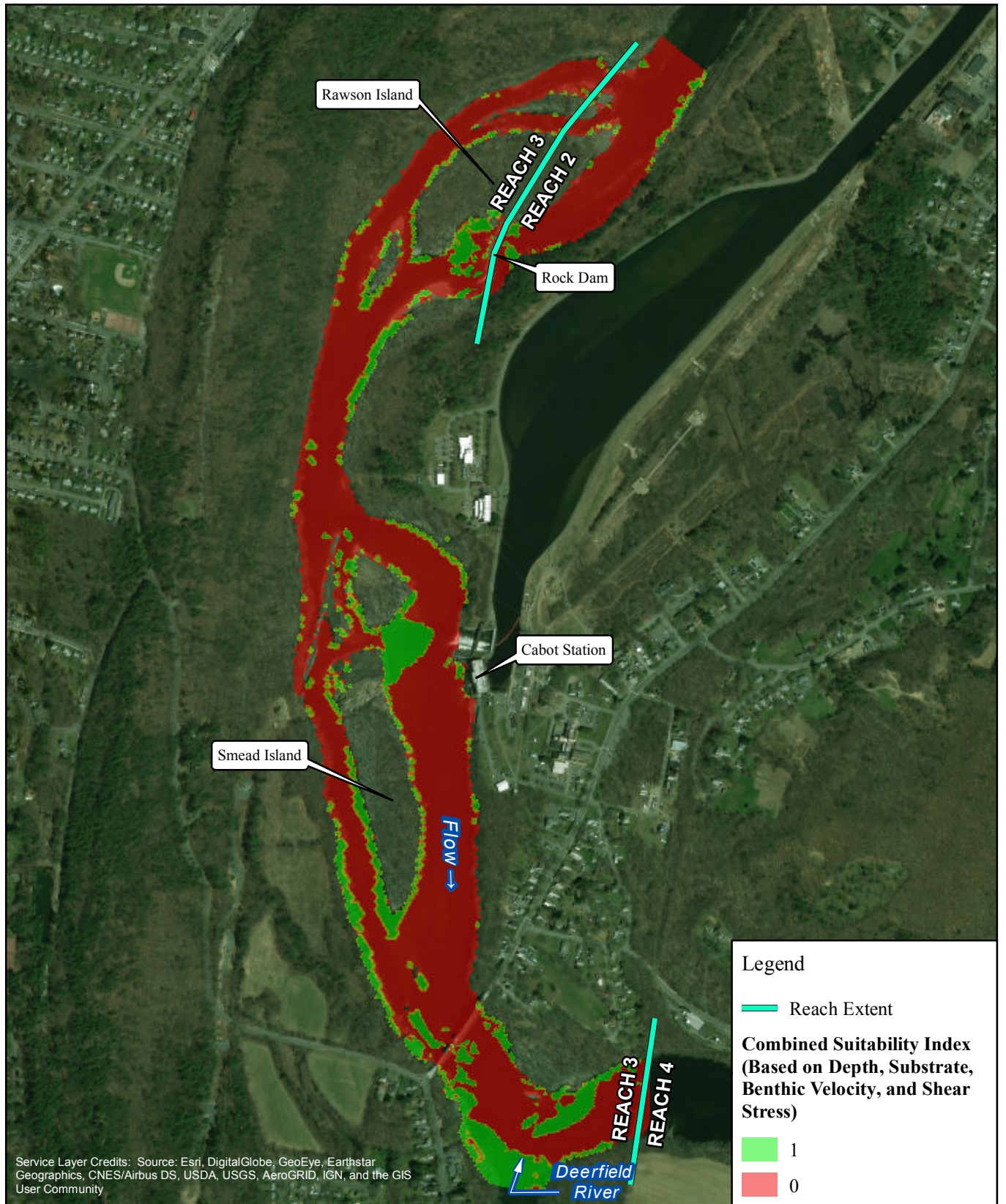
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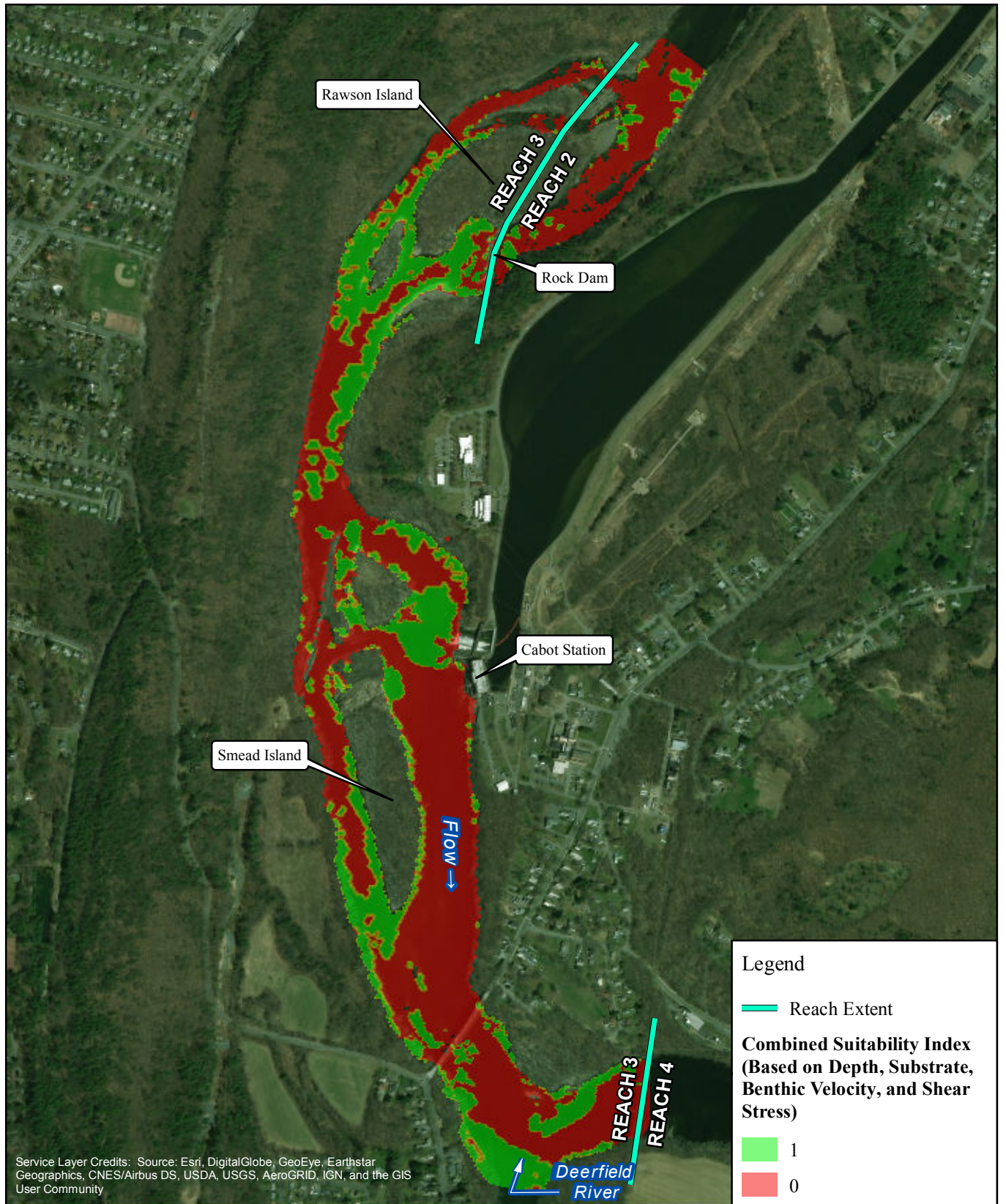
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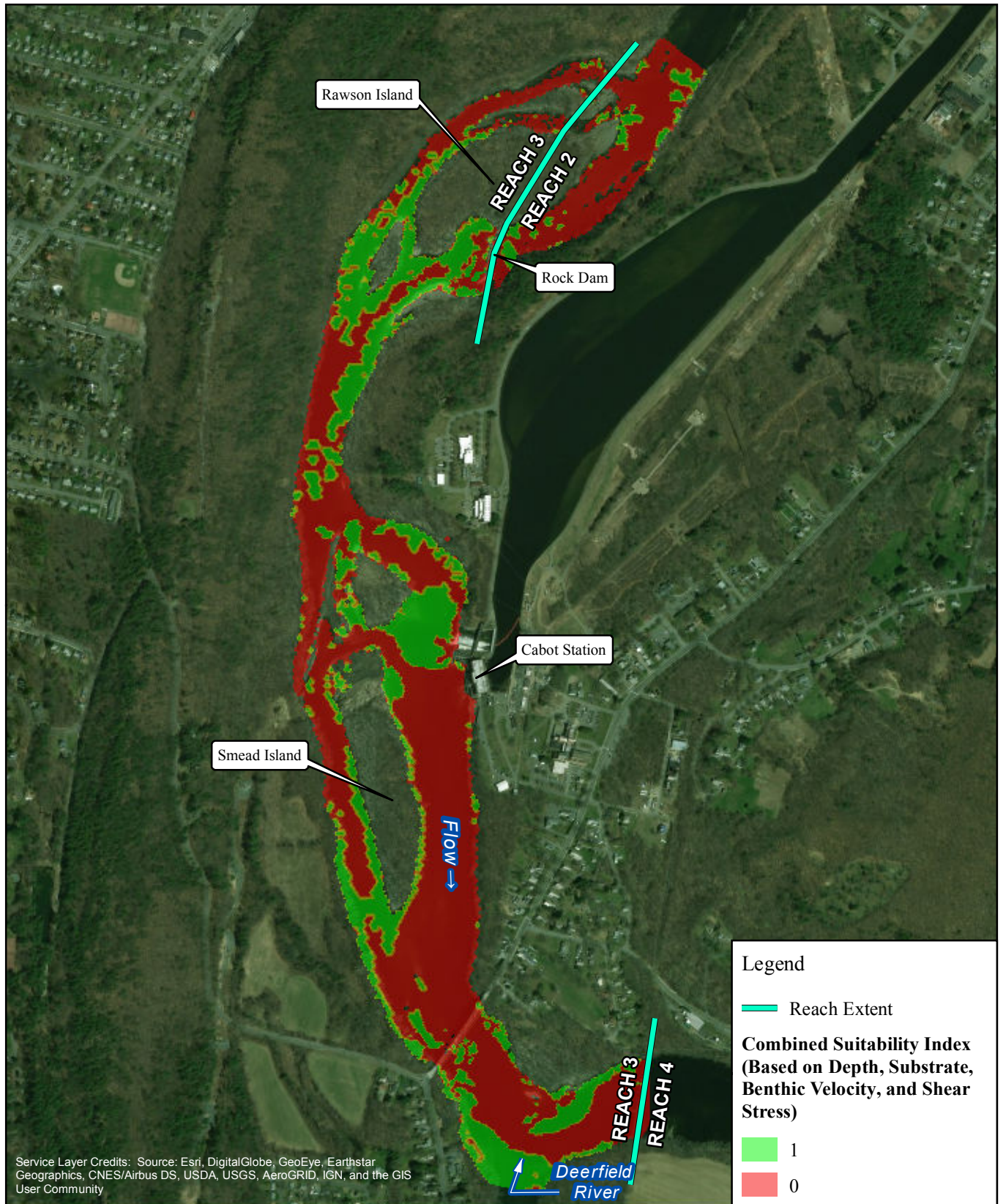
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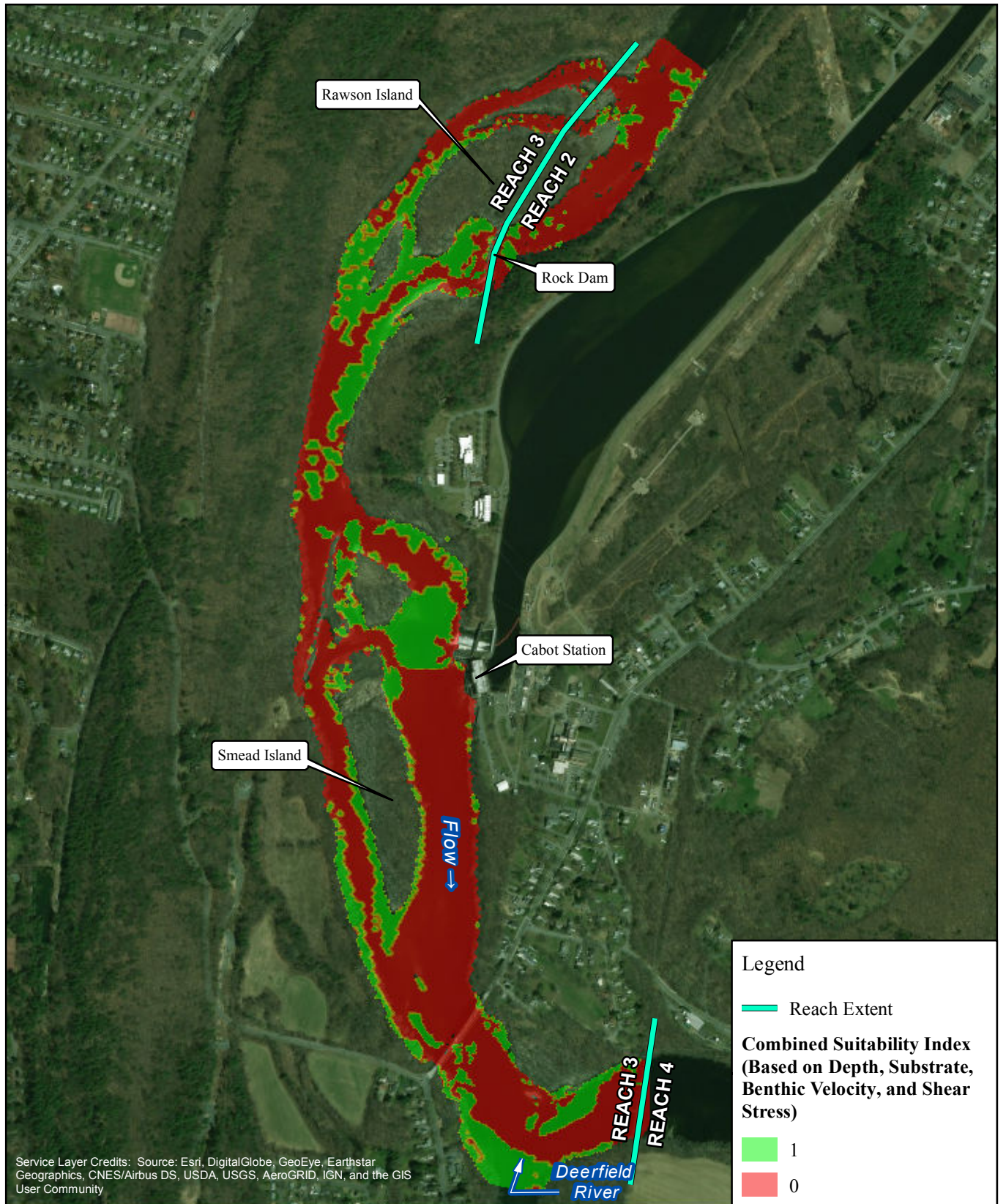
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Bypass Flow: 500 cfs  
Deerfield Flow: 200 cfs

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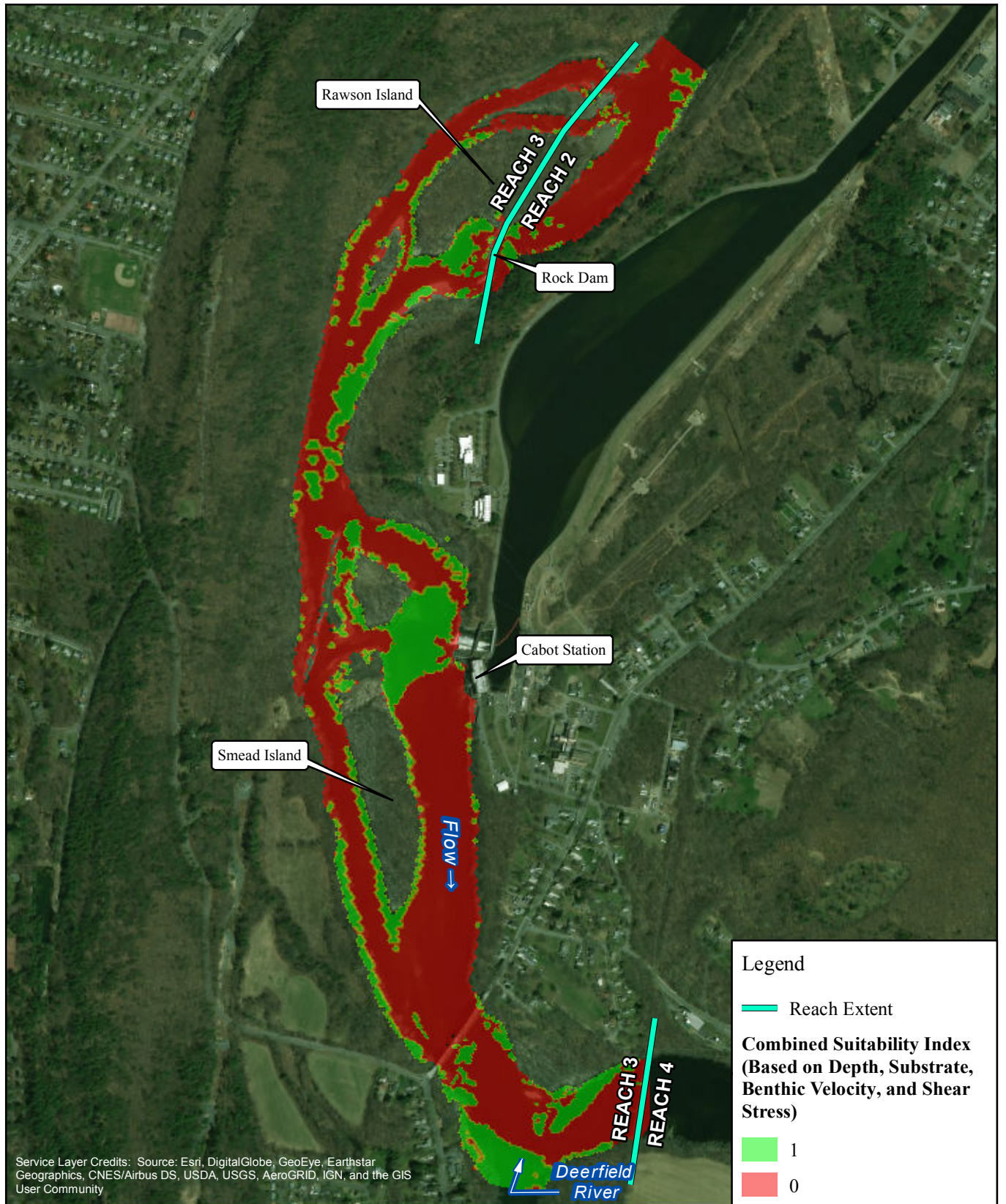
RELICENSING STUDY 3.3.1  
Addendum 3 Reach 3 Mussels (May 2018)

0 500 1,000 2,000 Feet

**Yellow Lampmussel-Juvenile**  
Cabot Flow: 14000 cfs  
Bypass Flow: 1000 cfs  
Deerfield Flow: 200 cfs

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RELICENSING STUDY 3.3.1  
Addendum 3 Reach 3 Mussels (May 2018)

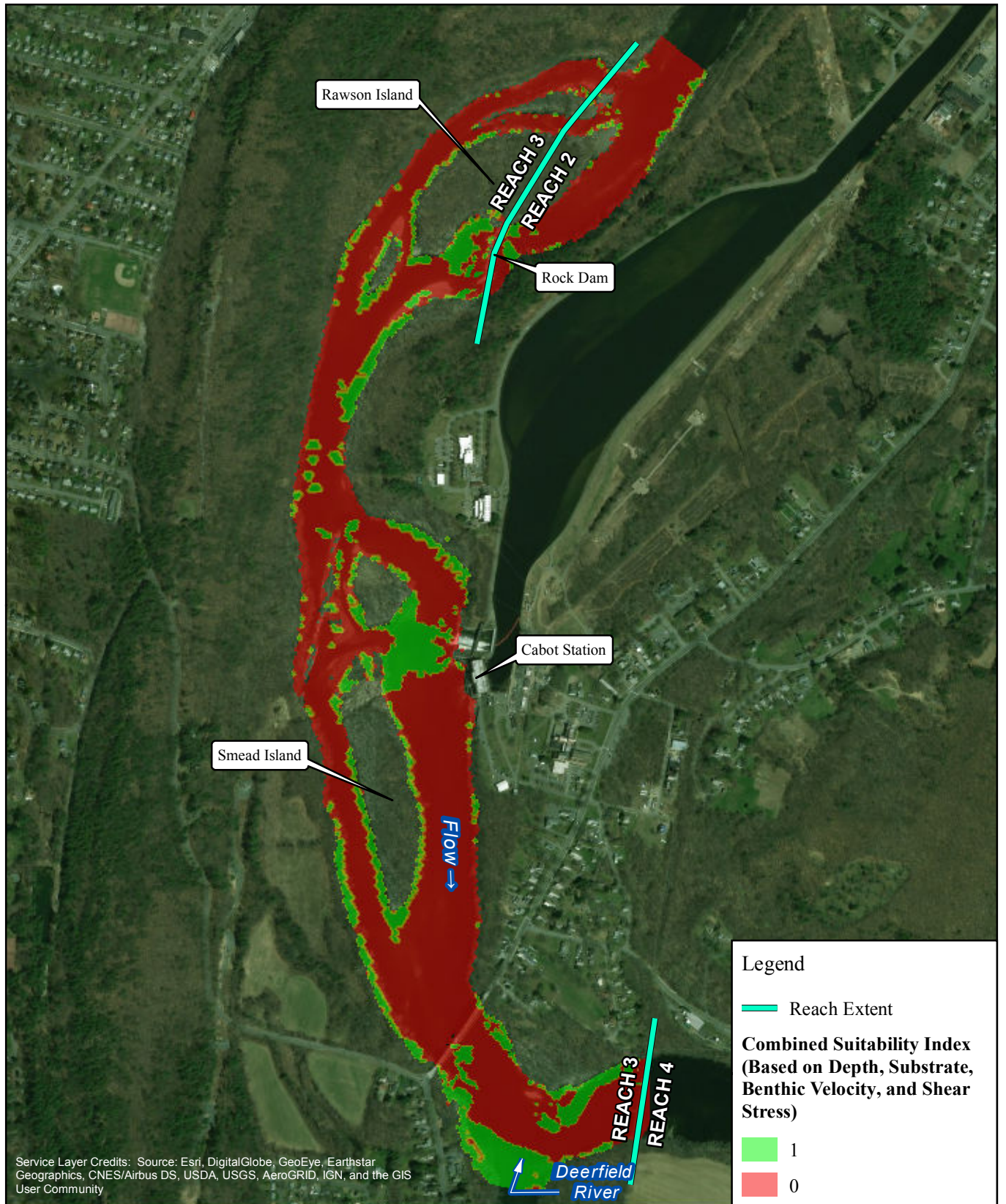
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**Yellow Lampmussel-Juvenile**  
Cabot Flow: 14000 cfs  
Bypass Flow: 3000 cfs  
Deerfield Flow: 200 cfs

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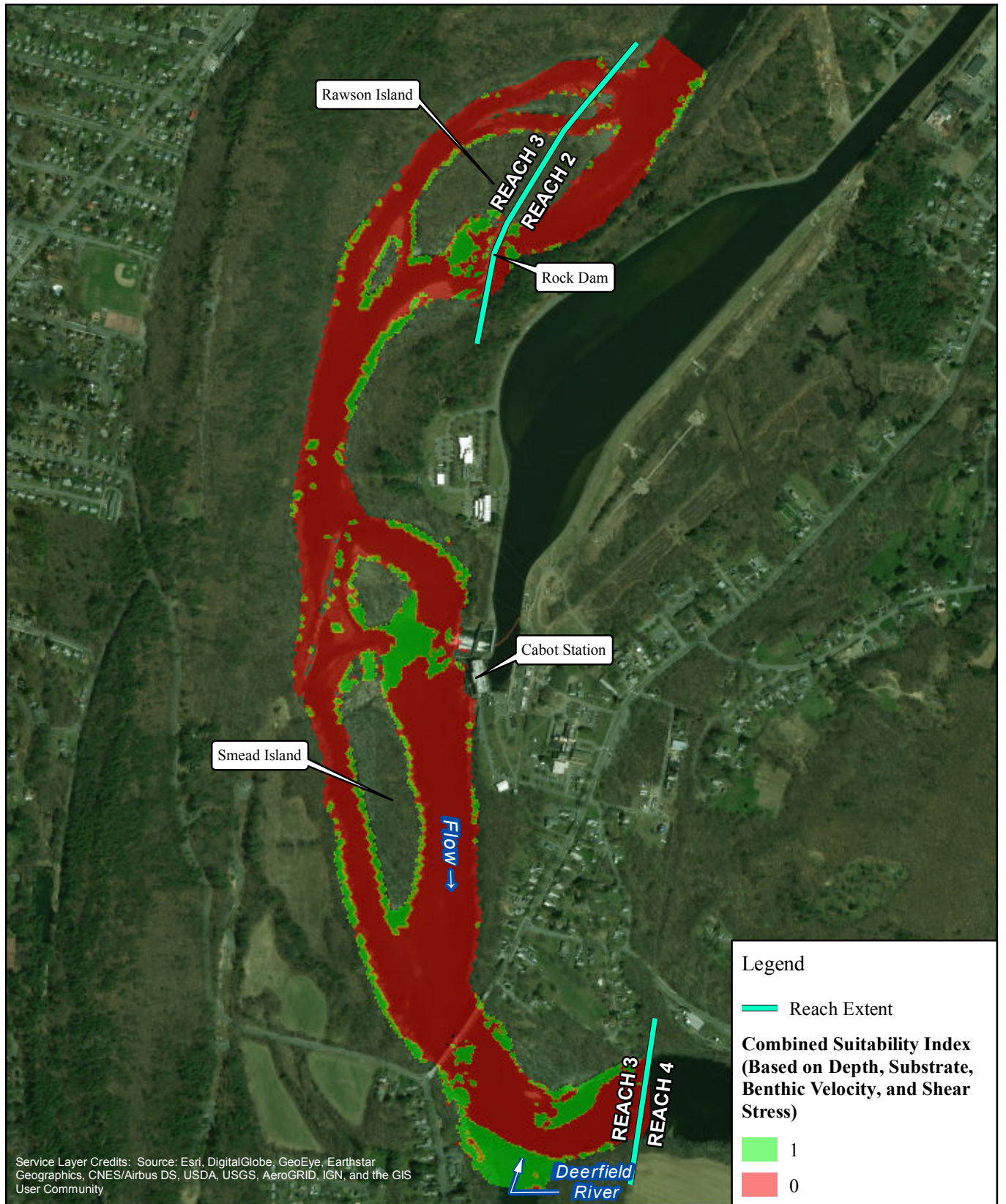
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Addendum 3 Reach 3 Mussels (May 2018)

0 500 1,000 2,000  
Feet

**Yellow Lampmussel-Juvenile**  
Cabot Flow: 14000 cfs  
Bypass Flow: 5000 cfs  
Deerfield Flow: 200 cfs

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**RELICENSING STUDY 3.3.1**  
Addendum 3 Reach 3 Mussels (May 2018)

0 500 1,000 2,000 Feet

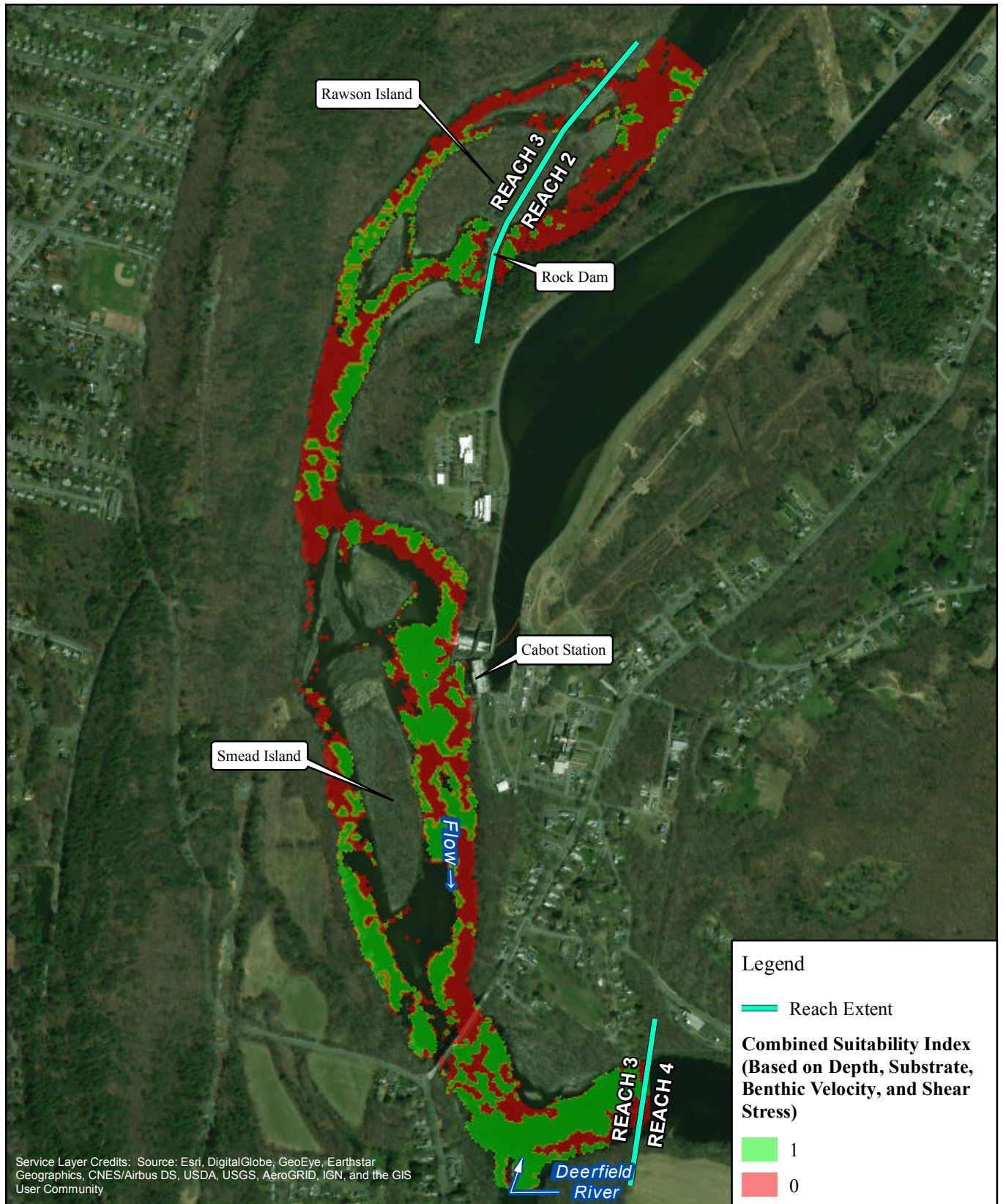
**Yellow Lampmussel-Juvenile**  
Cabot Flow: 14000 cfs  
Bypass Flow: 6500 cfs  
Deerfield Flow: 200 cfs

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**APPENDIX B-2 COMBINED  
SUITABILITY INDEX MAPS FOR ADULT  
YELLOW LAMPMUSSELS UNDER  
VARIOUS BYPASS FLOWS, CABOT  
FLOWS AND A DEERFIELD RIVER  
FLOW OF 200 CFS BASED A 4-  
VARIABLE (DEPTH, VELOCITY,  
SUBSTRATE AND SHEAR STRESS)  
BINARY ASSESSMENT**





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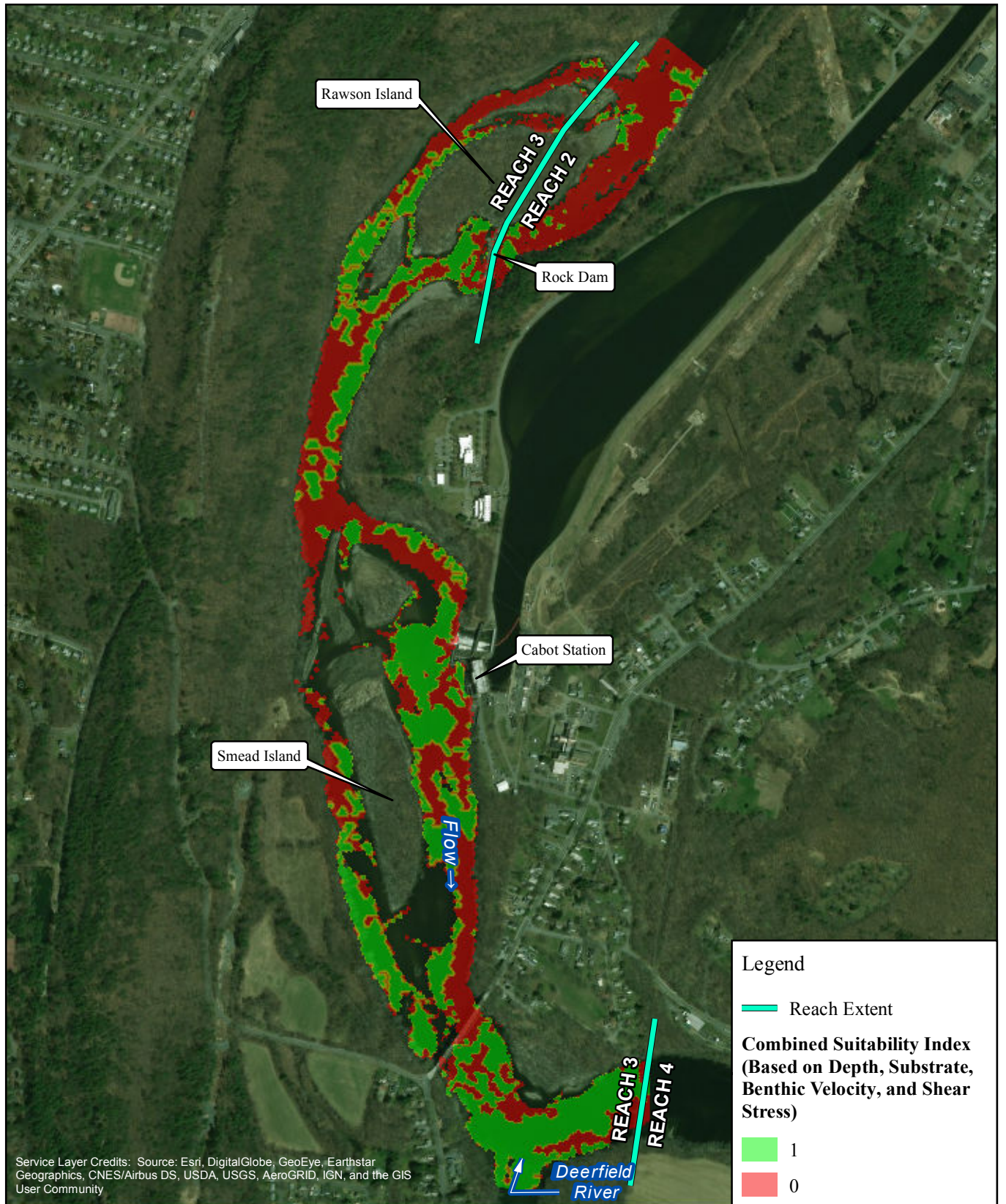
0 500 1,000 2,000  
Feet

Yellow Lampmussel-Adult  
Cabot Flow: 2500 cfs  
Bypass Flow: 200 cfs  
Deerfield Flow: 200 cfs

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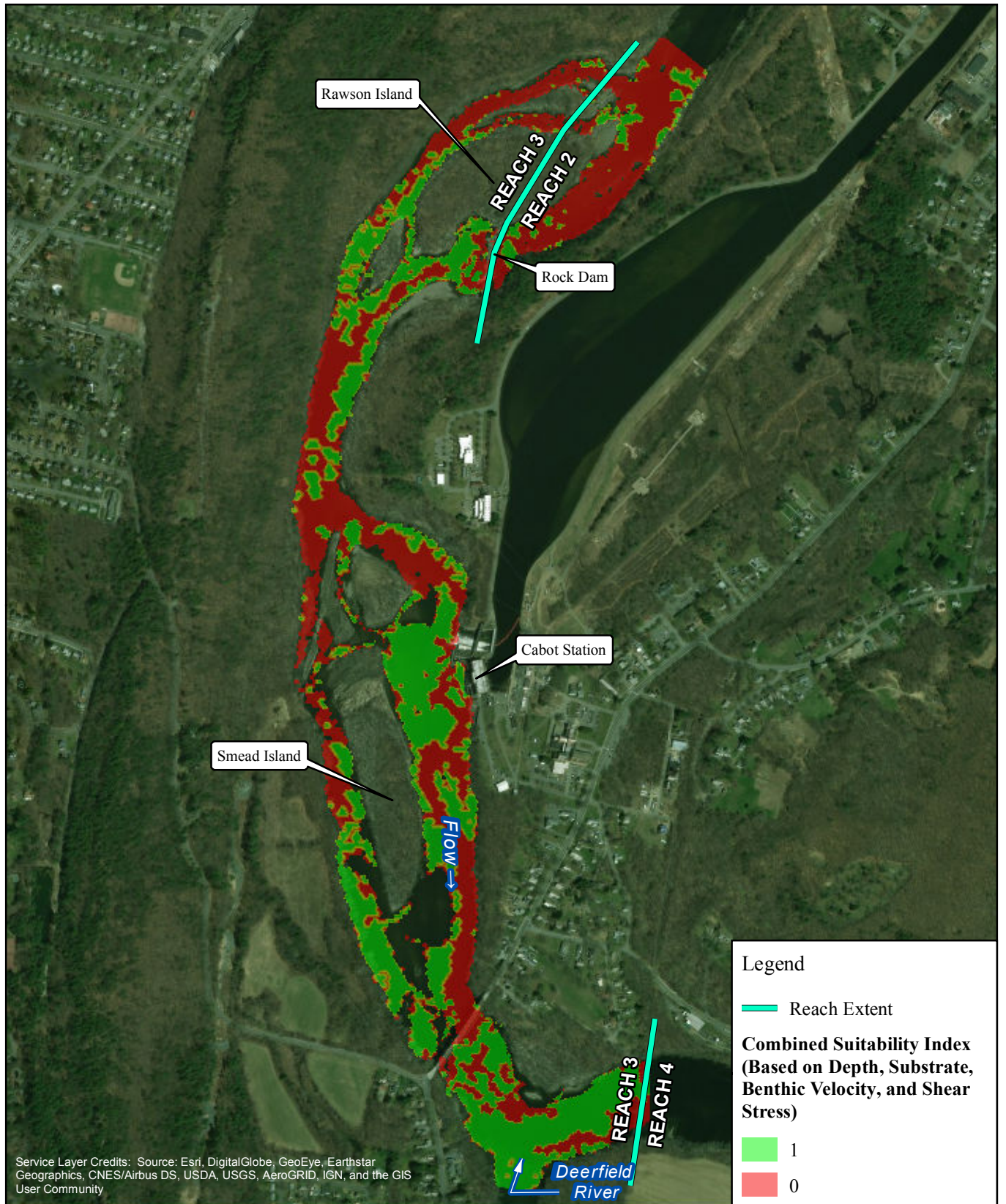
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Addendum 3 Reach 3 Mussels (May 2018)

0 500 1,000 2,000  
Feet

**Yellow Lampmussel-Adult**  
Cabot Flow: 2500 cfs  
Bypass Flow: 500 cfs  
Deerfield Flow: 200 cfs

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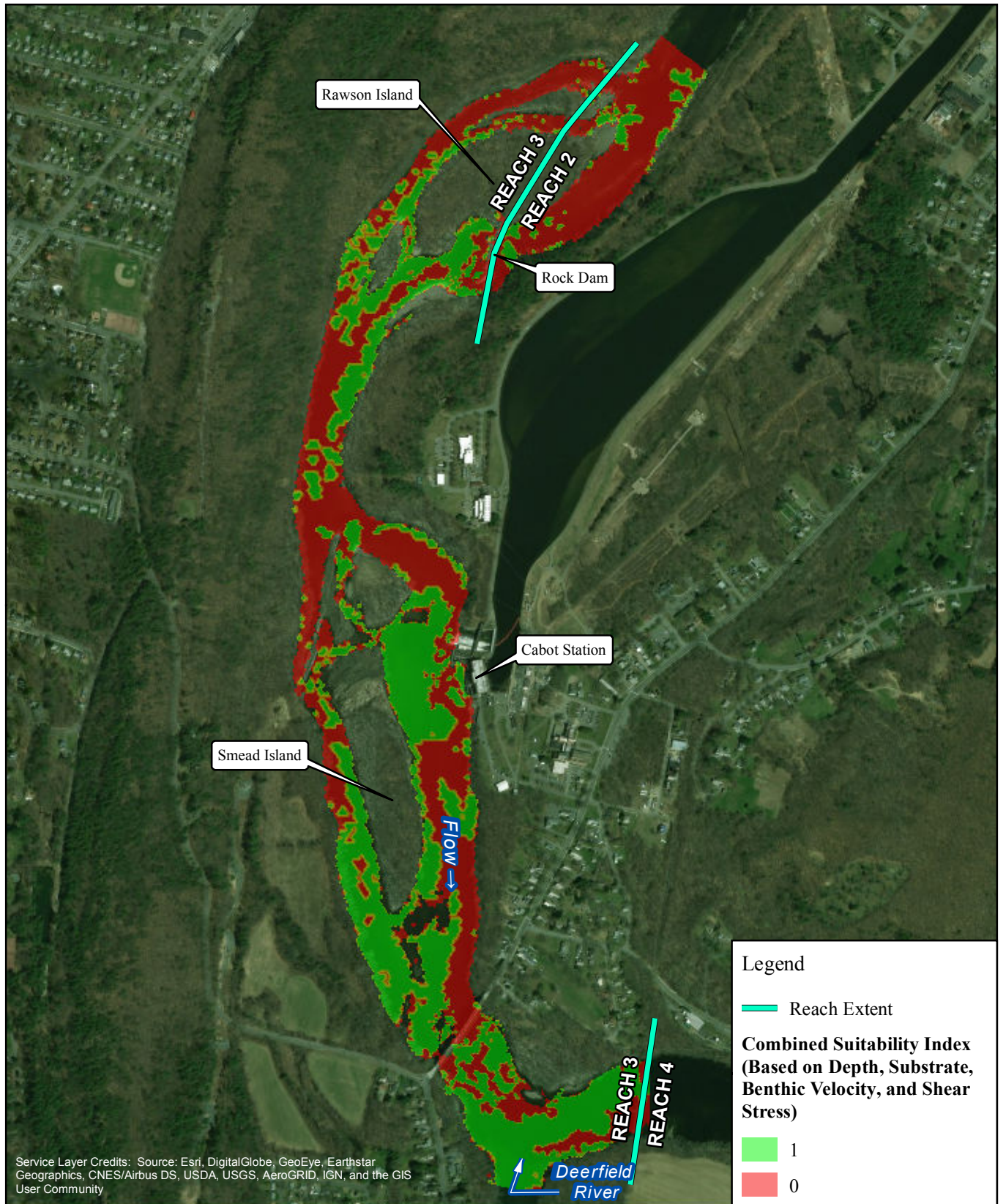
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Feet

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Bypass Flow: 1000 cfs  
Deerfield Flow: 200 cfs

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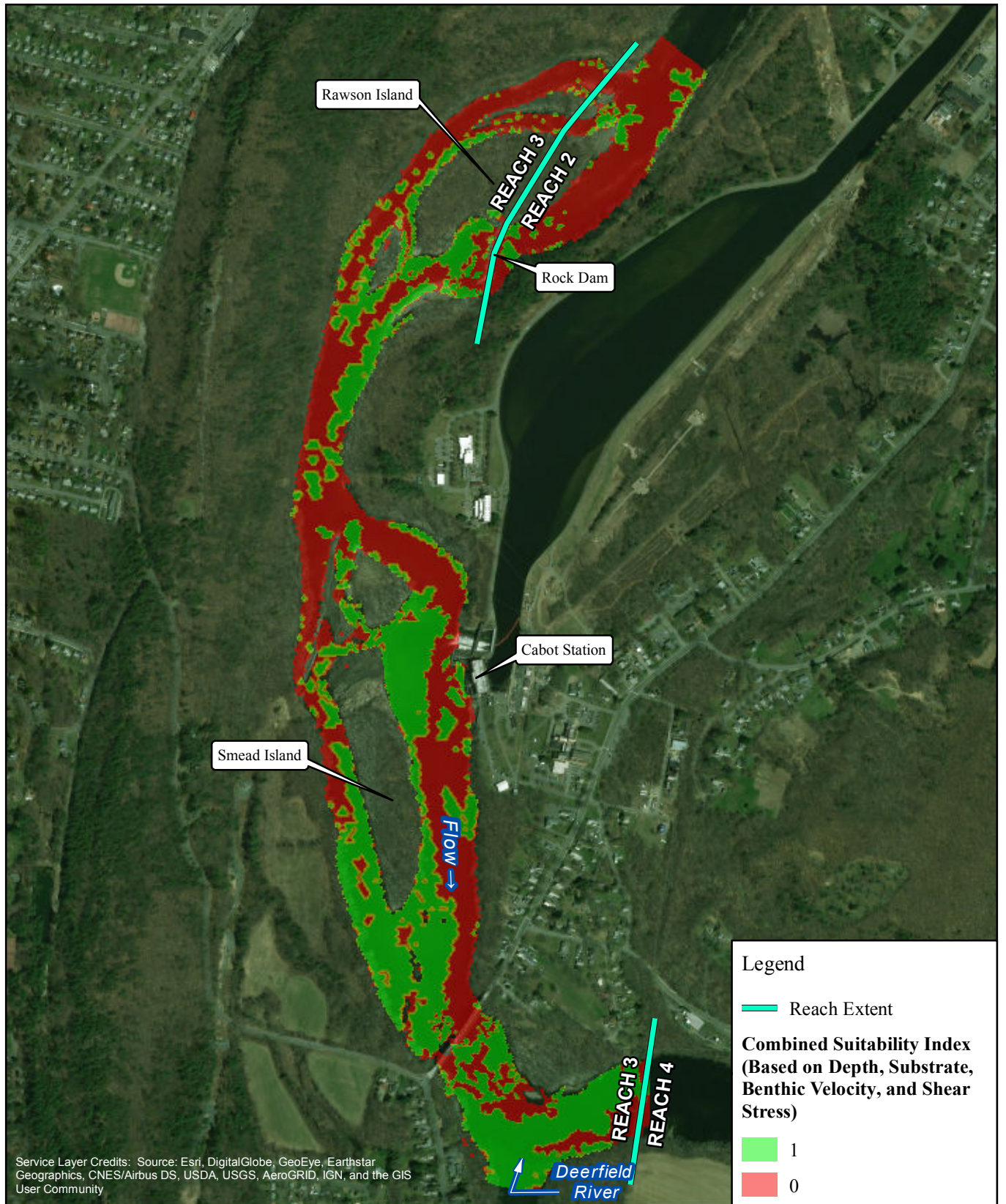
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Addendum 3 Reach 3 Mussels (May 2018)

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Feet

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Cabot Flow: 2500 cfs  
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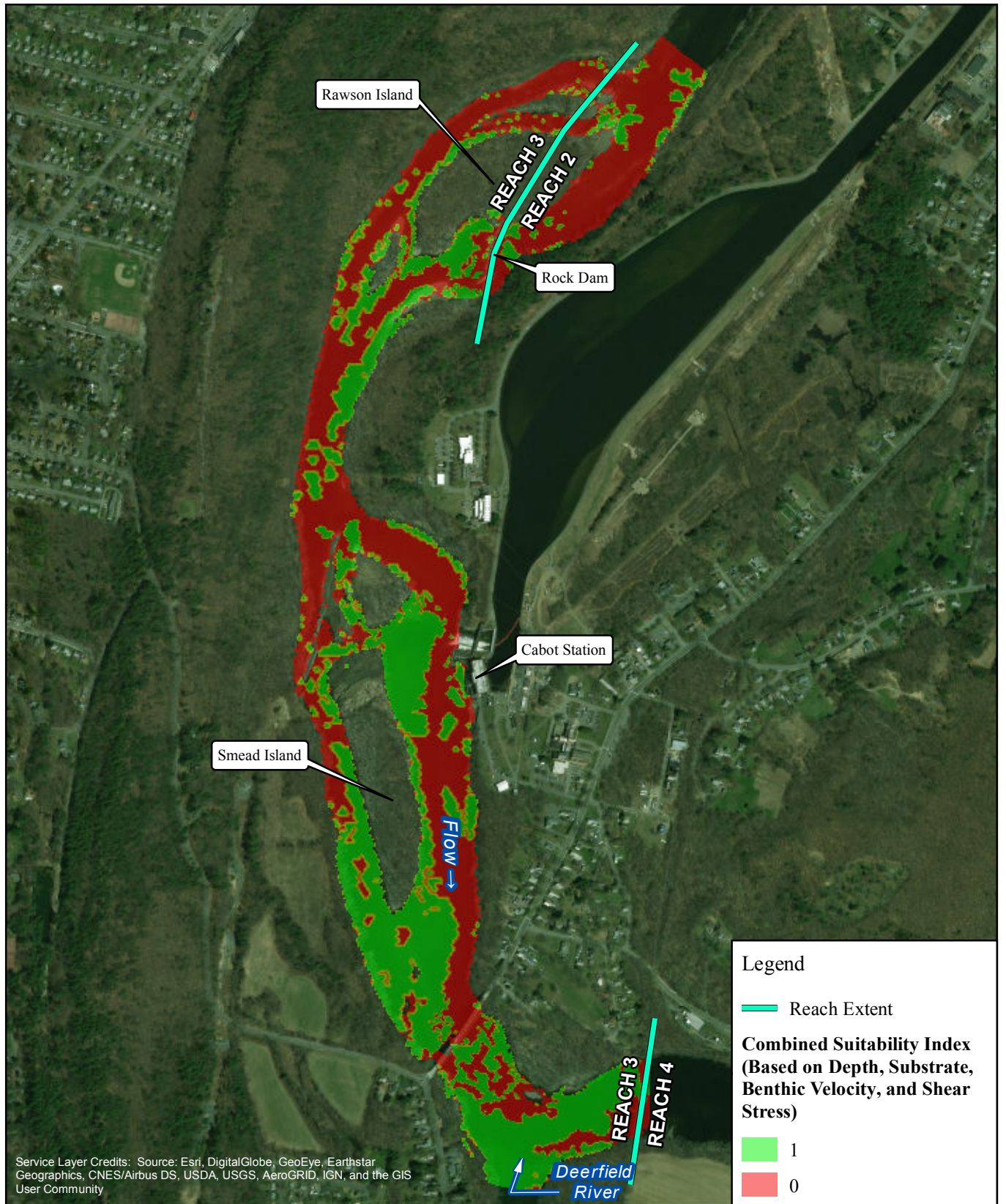
0 500 1,000 2,000  
Feet

**Yellow Lampmussel-Adult**  
Cabot Flow: 2500 cfs  
Bypass Flow: 5000 cfs  
Deerfield Flow: 200 cfs

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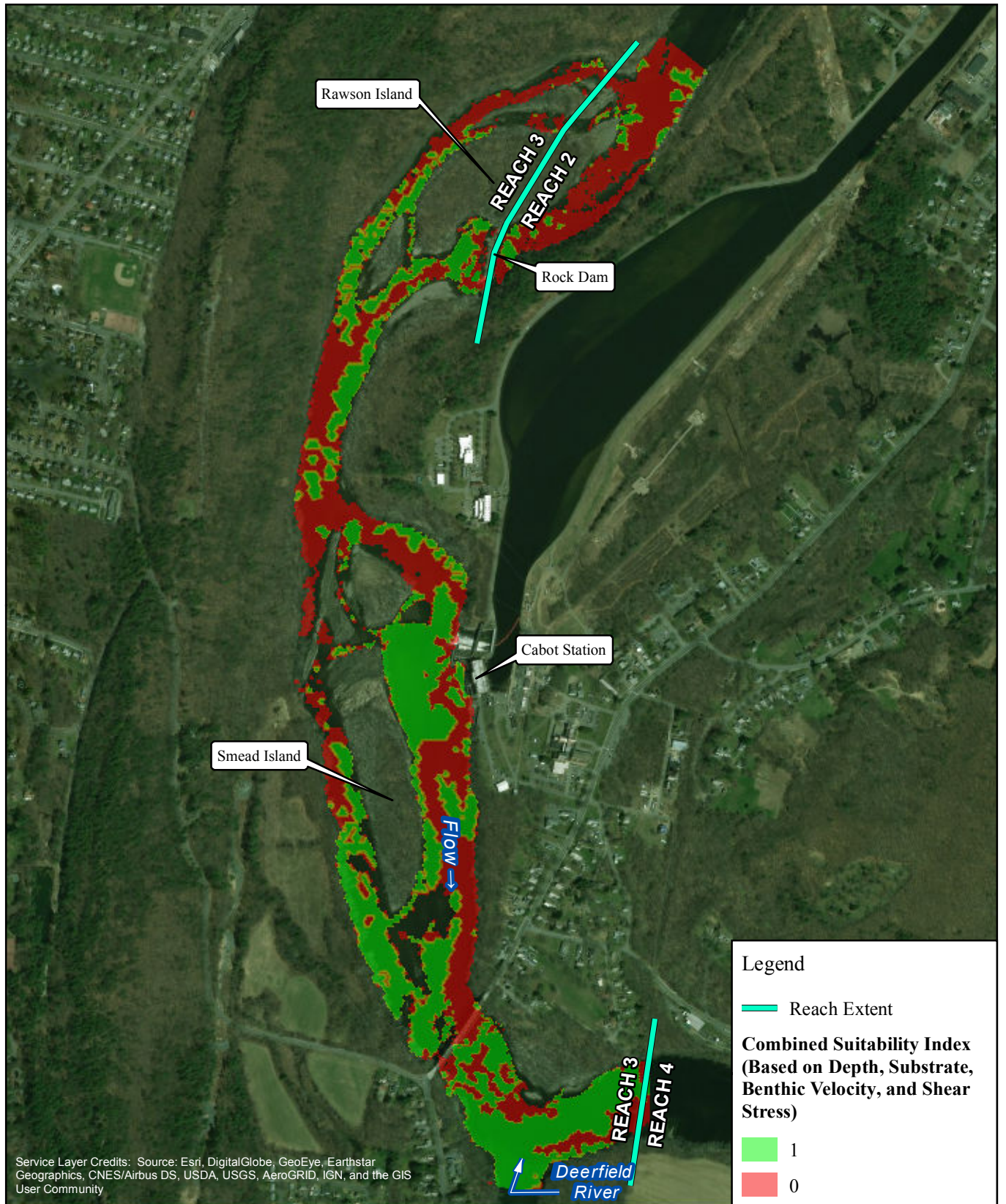
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Yellow Lampmussel-Adult  
Cabot Flow: 2500 cfs  
Bypass Flow: 6500 cfs  
Deerfield Flow: 200 cfs

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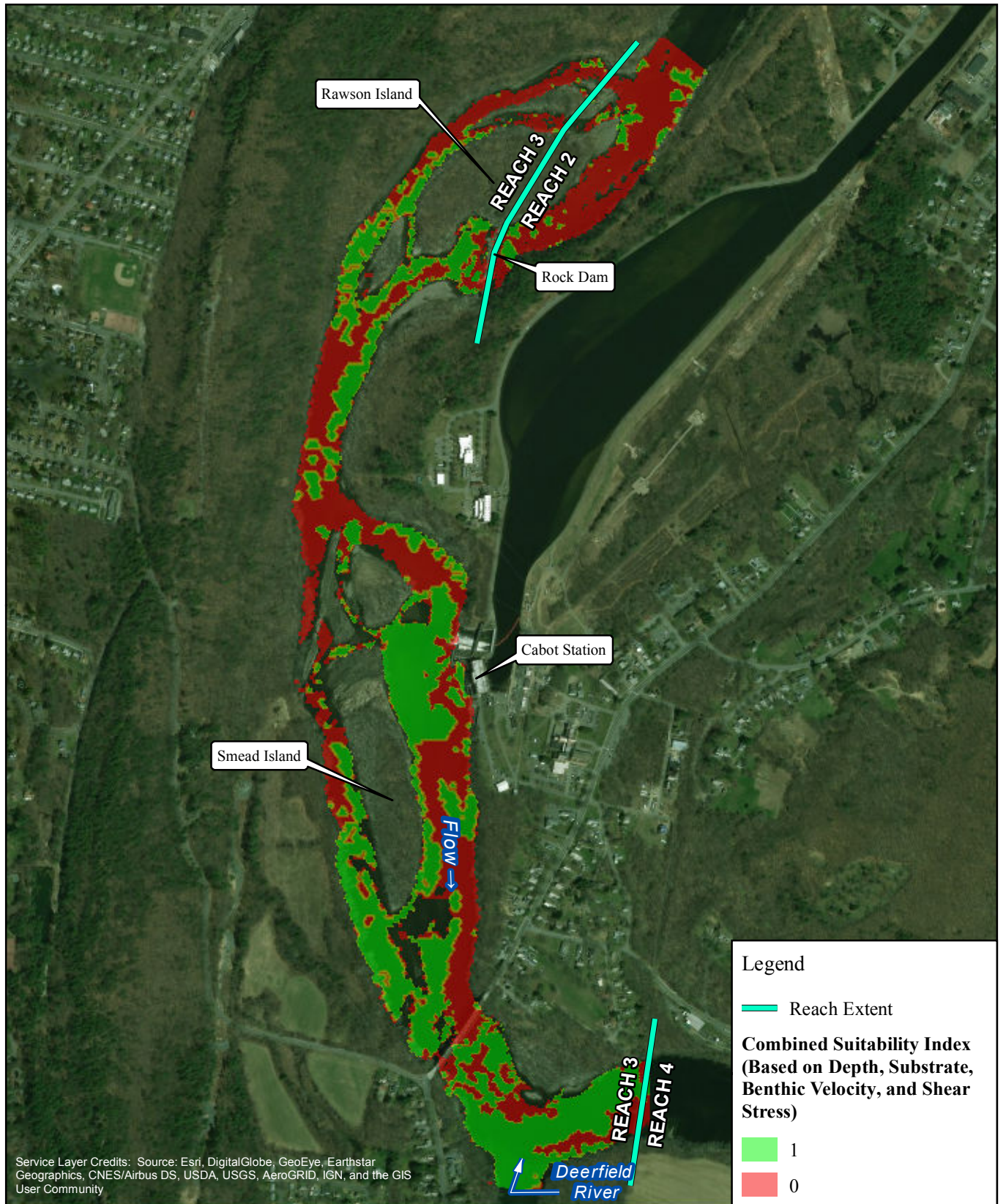
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Feet

**Yellow Lampmussel-Adult**  
Cabot Flow: 4500 cfs  
Bypass Flow: 200 cfs  
Deerfield Flow: 200 cfs

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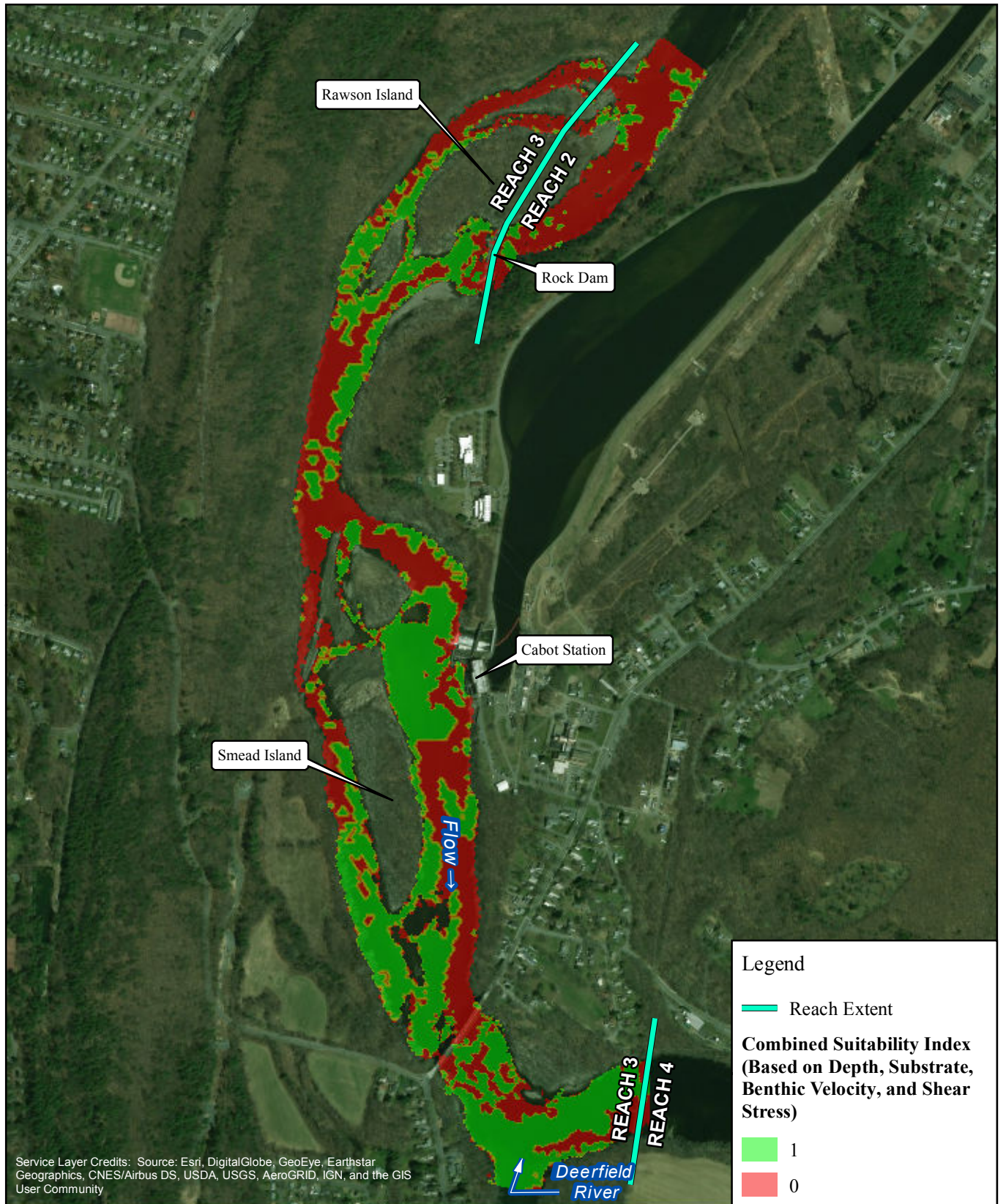
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Feet

**Yellow Lampmussel-Adult**  
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Bypass Flow: 500 cfs  
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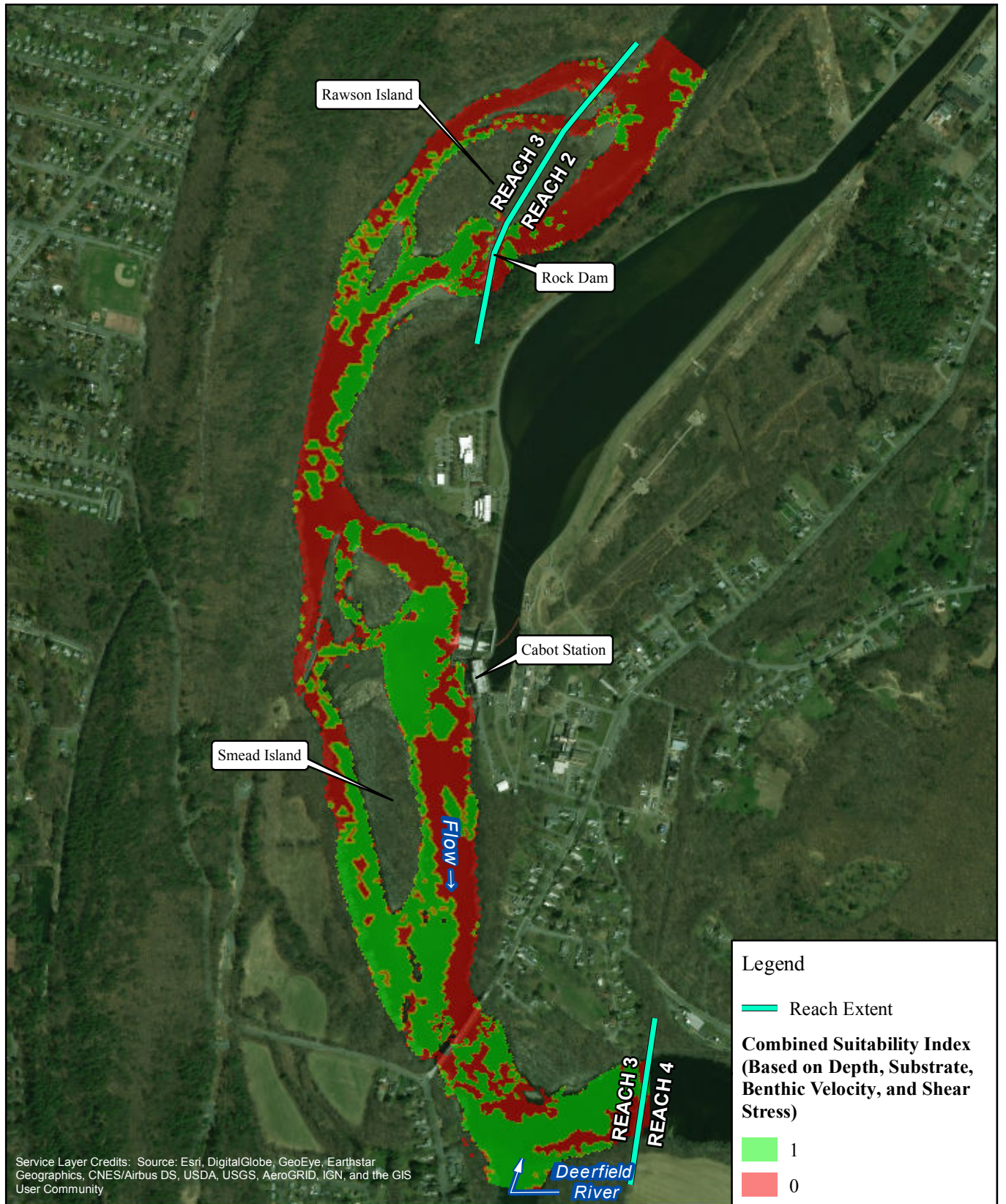
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Yellow Lampmussel-Adult  
Cabot Flow: 4500 cfs  
Bypass Flow: 1000 cfs  
Deerfield Flow: 200 cfs

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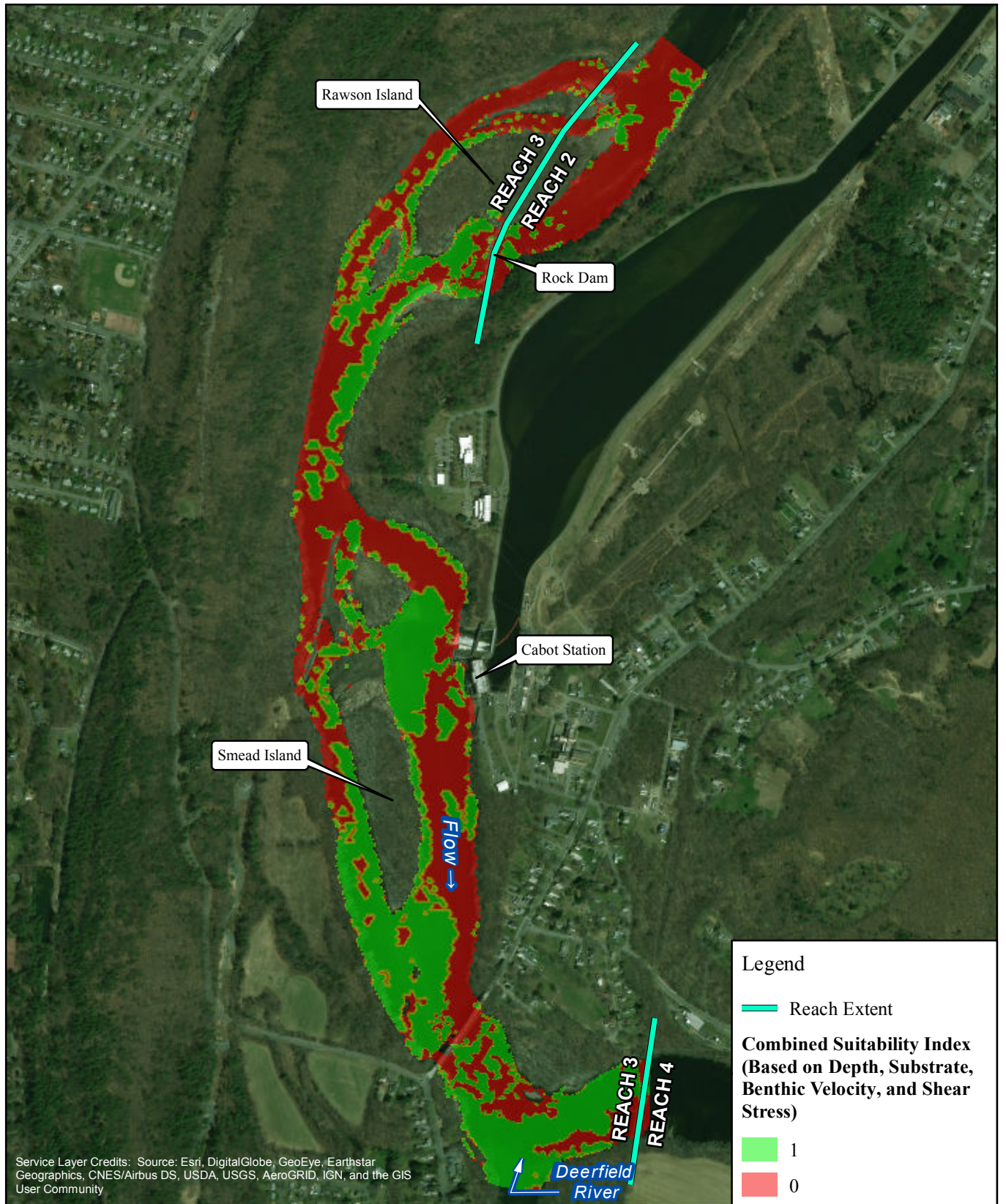
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Addendum 3 Reach 3 Mussels (May 2018)

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Feet

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Bypass Flow: 3000 cfs  
Deerfield Flow: 200 cfs

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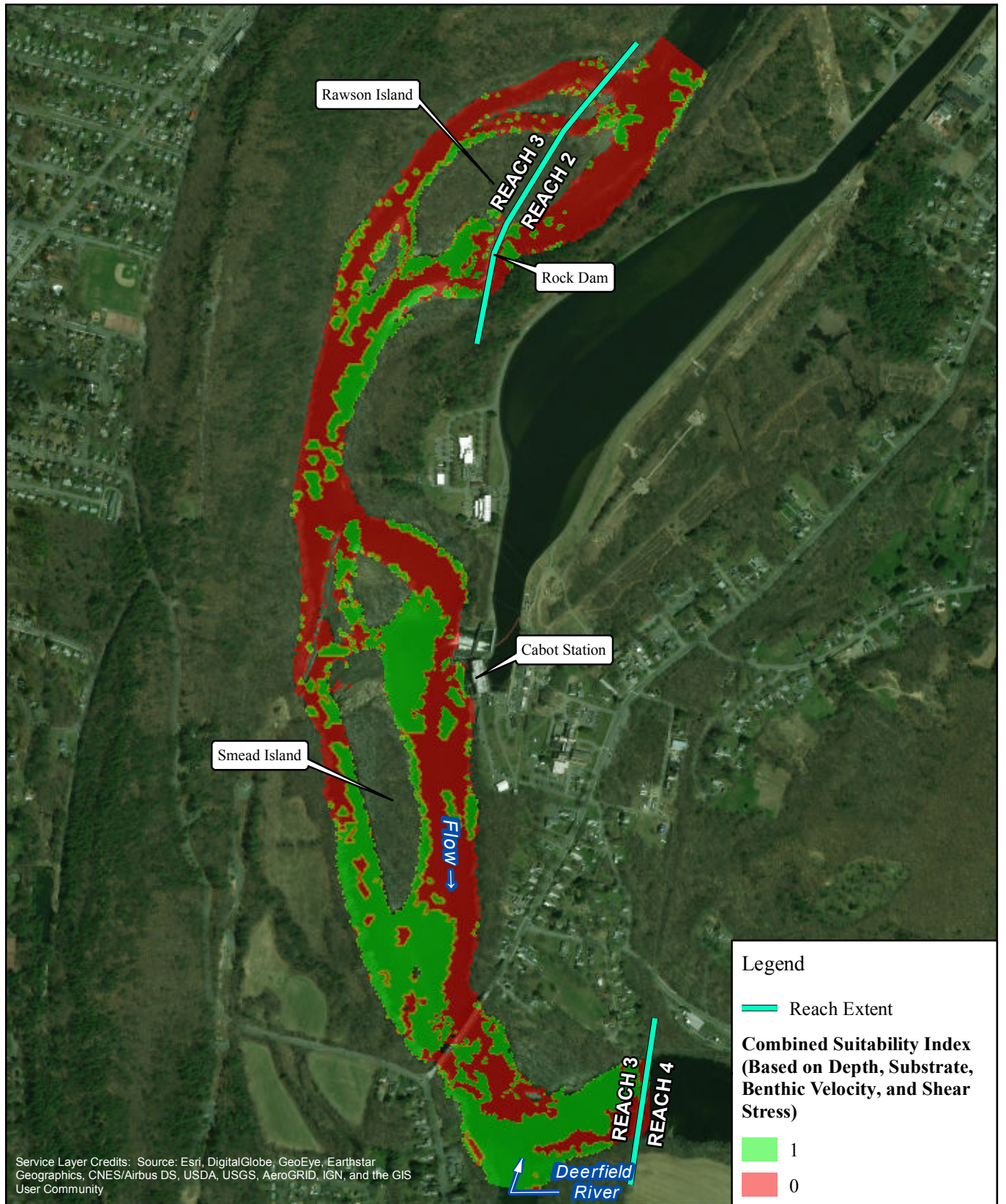
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Cabot Flow: 4500 cfs  
Bypass Flow: 5000 cfs  
Deerfield Flow: 200 cfs

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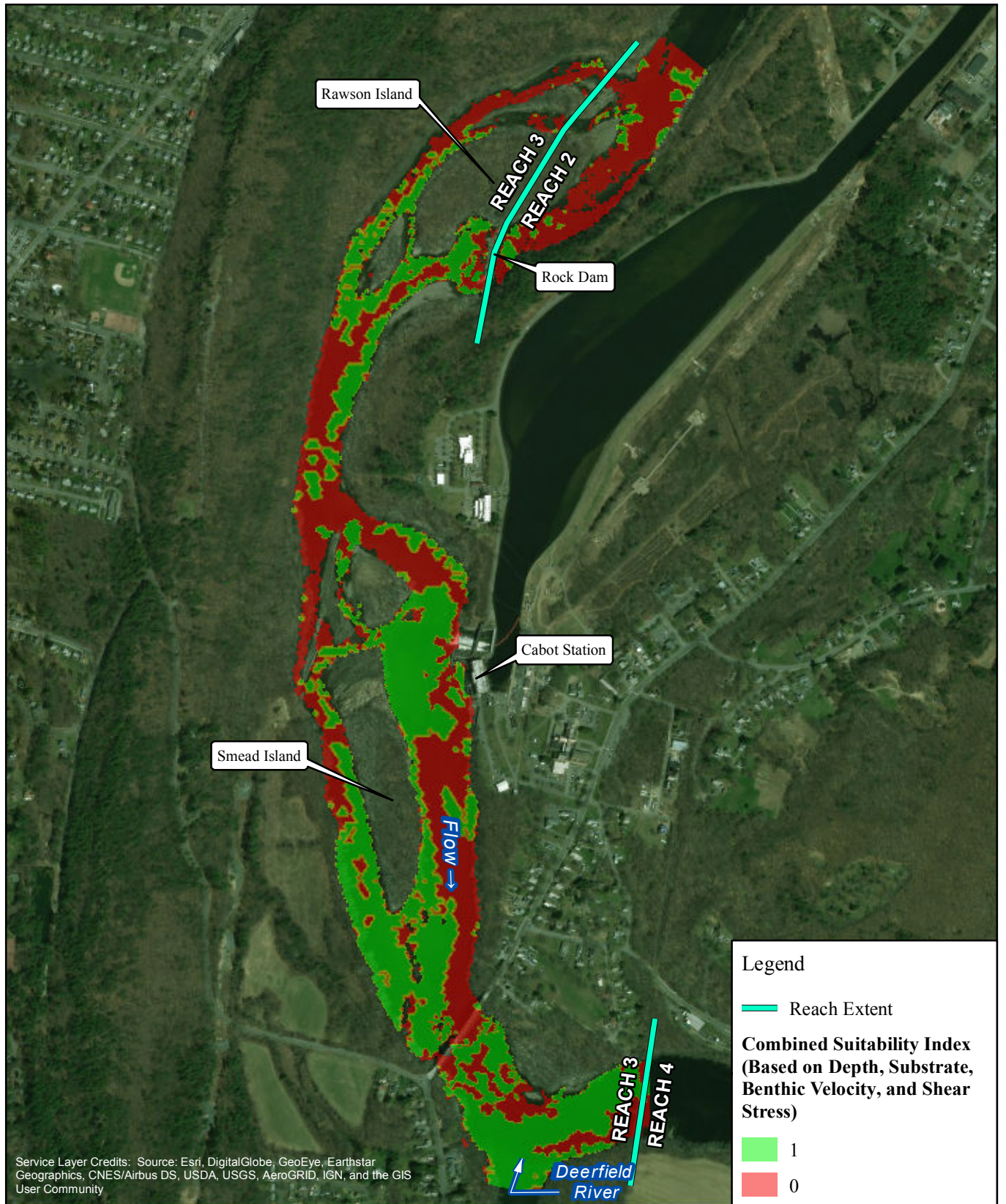
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**Yellow Lampmussel-Adult**  
Cabot Flow: 4500 cfs  
Bypass Flow: 6500 cfs  
Deerfield Flow: 200 cfs

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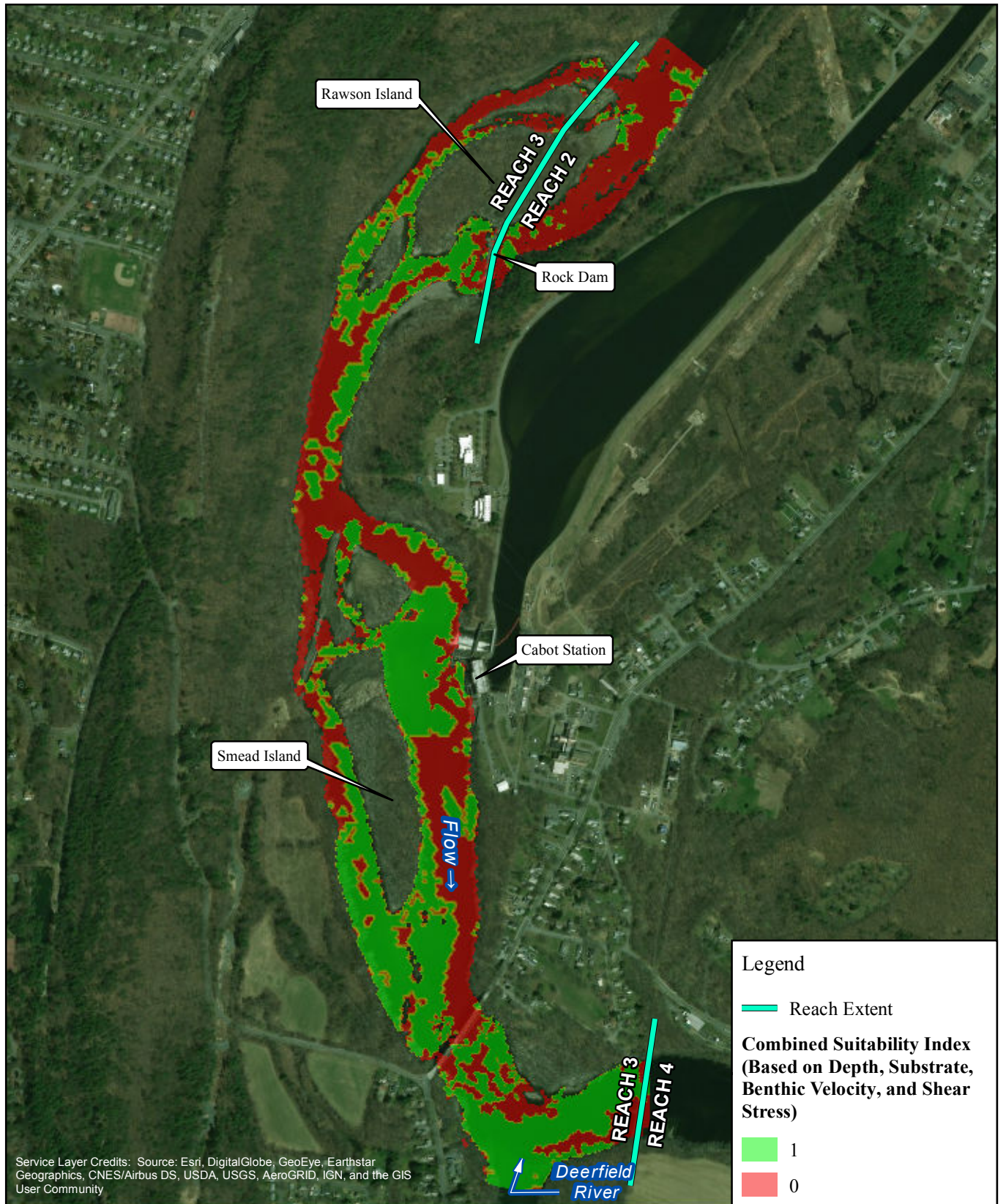
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Bypass Flow: 200 cfs  
Deerfield Flow: 200 cfs

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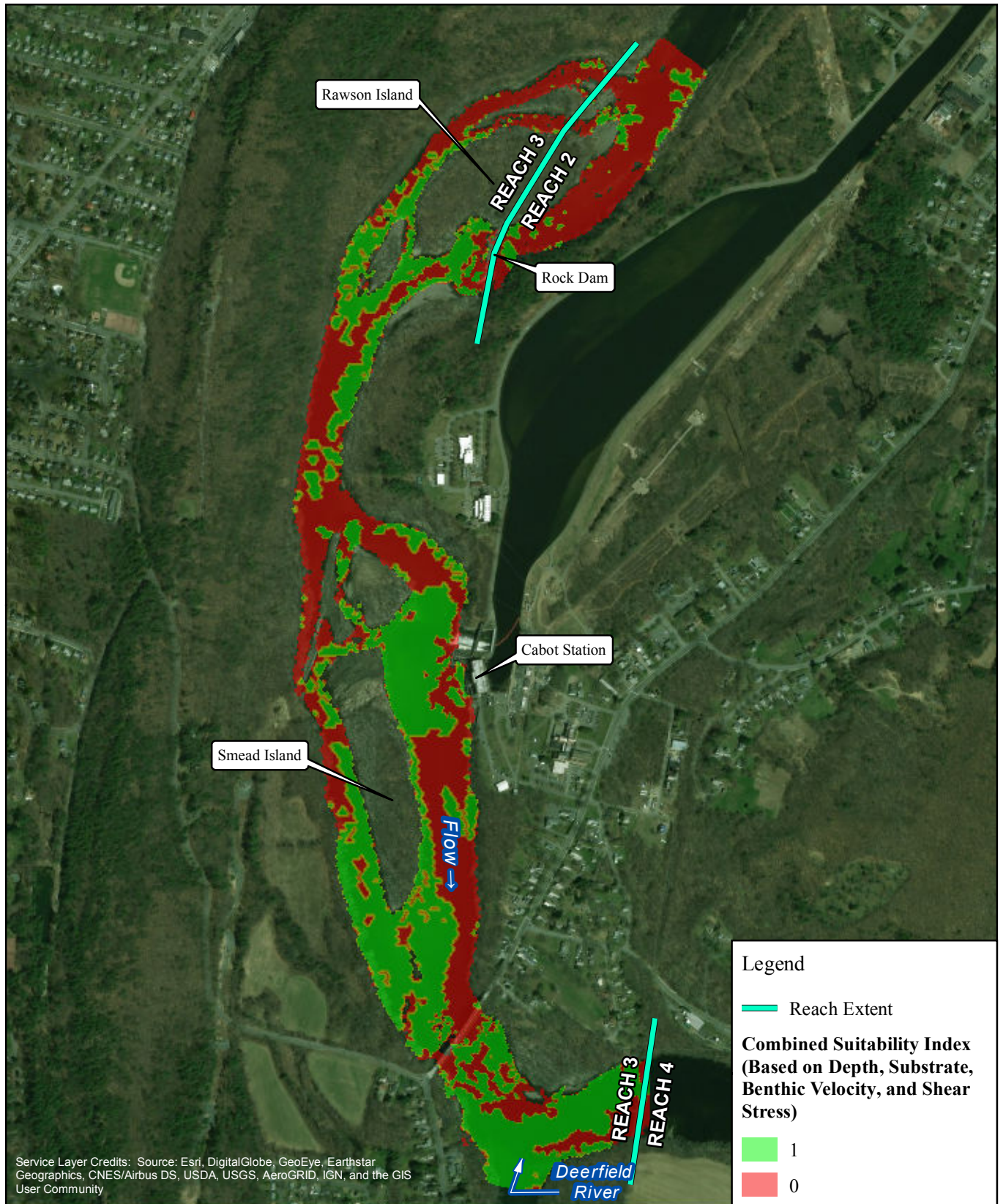
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Bypass Flow: 500 cfs  
Deerfield Flow: 200 cfs

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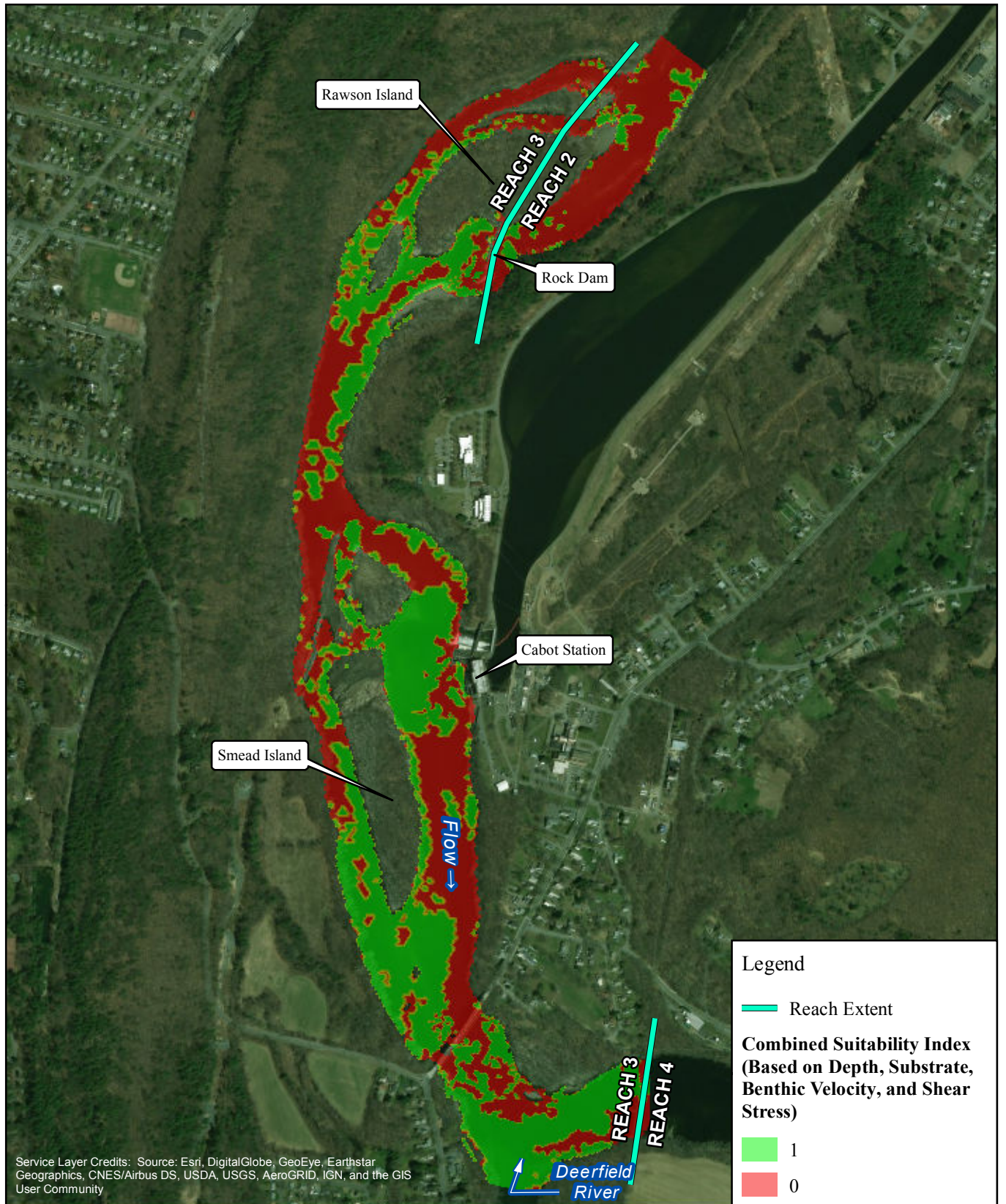
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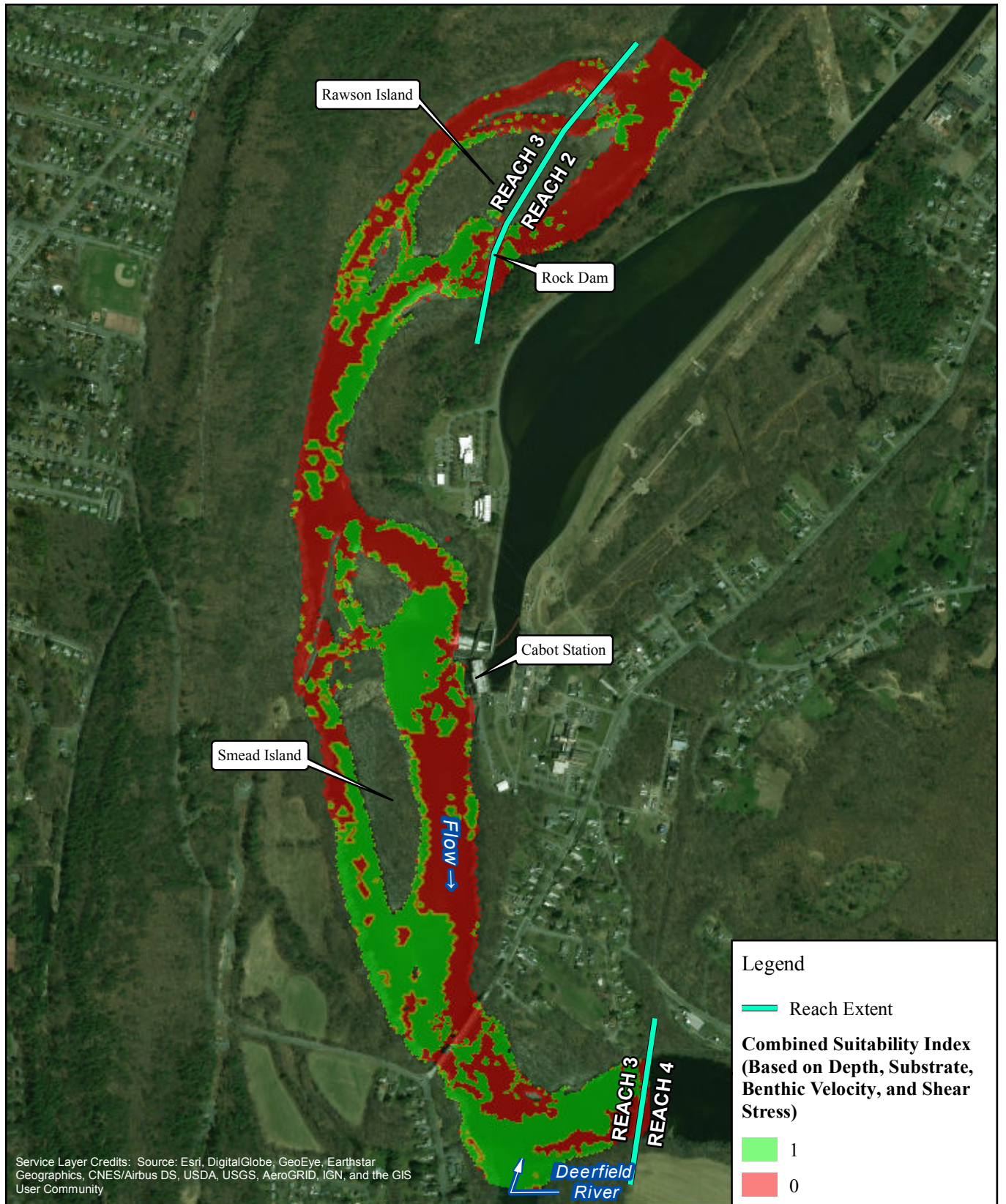
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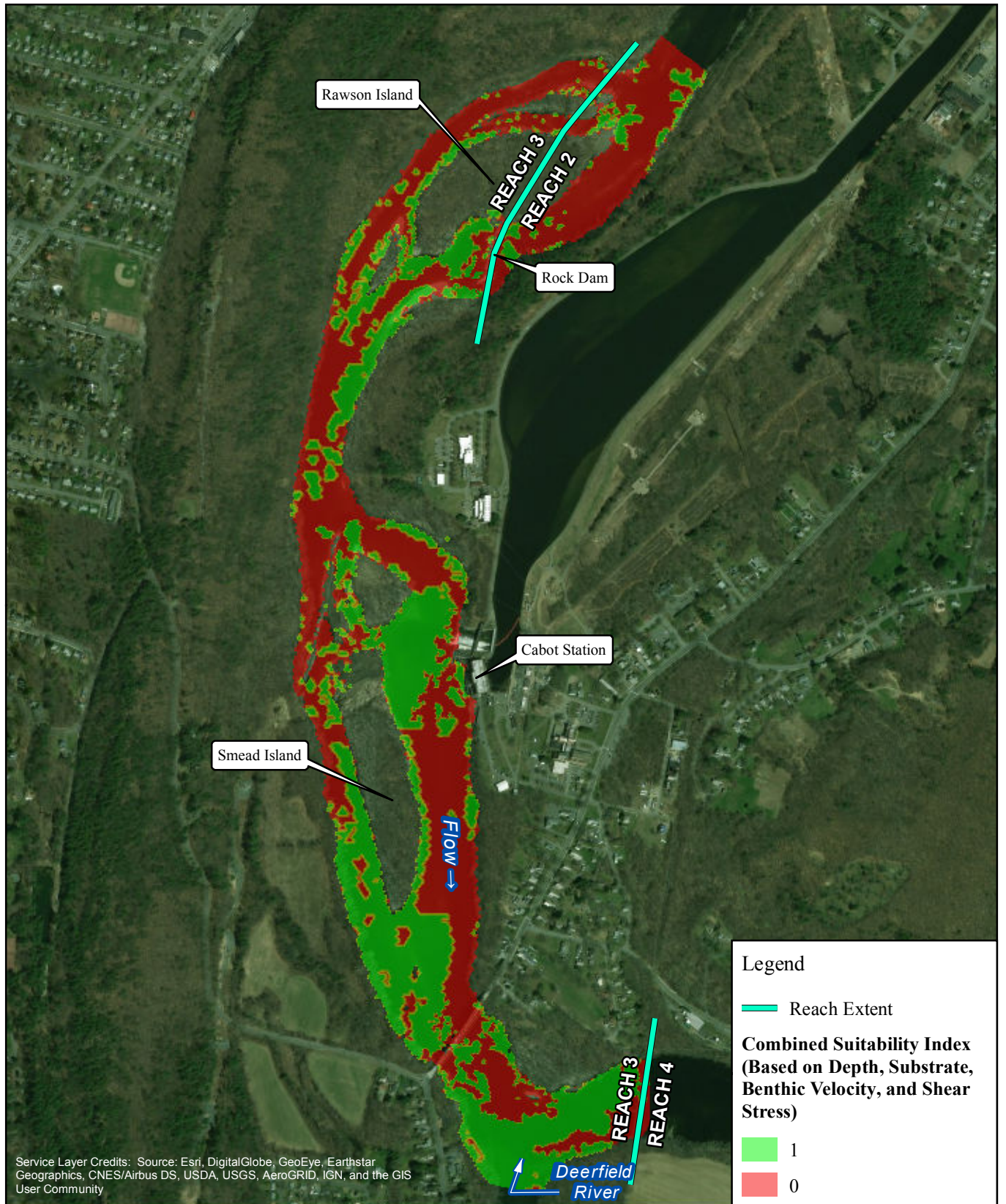
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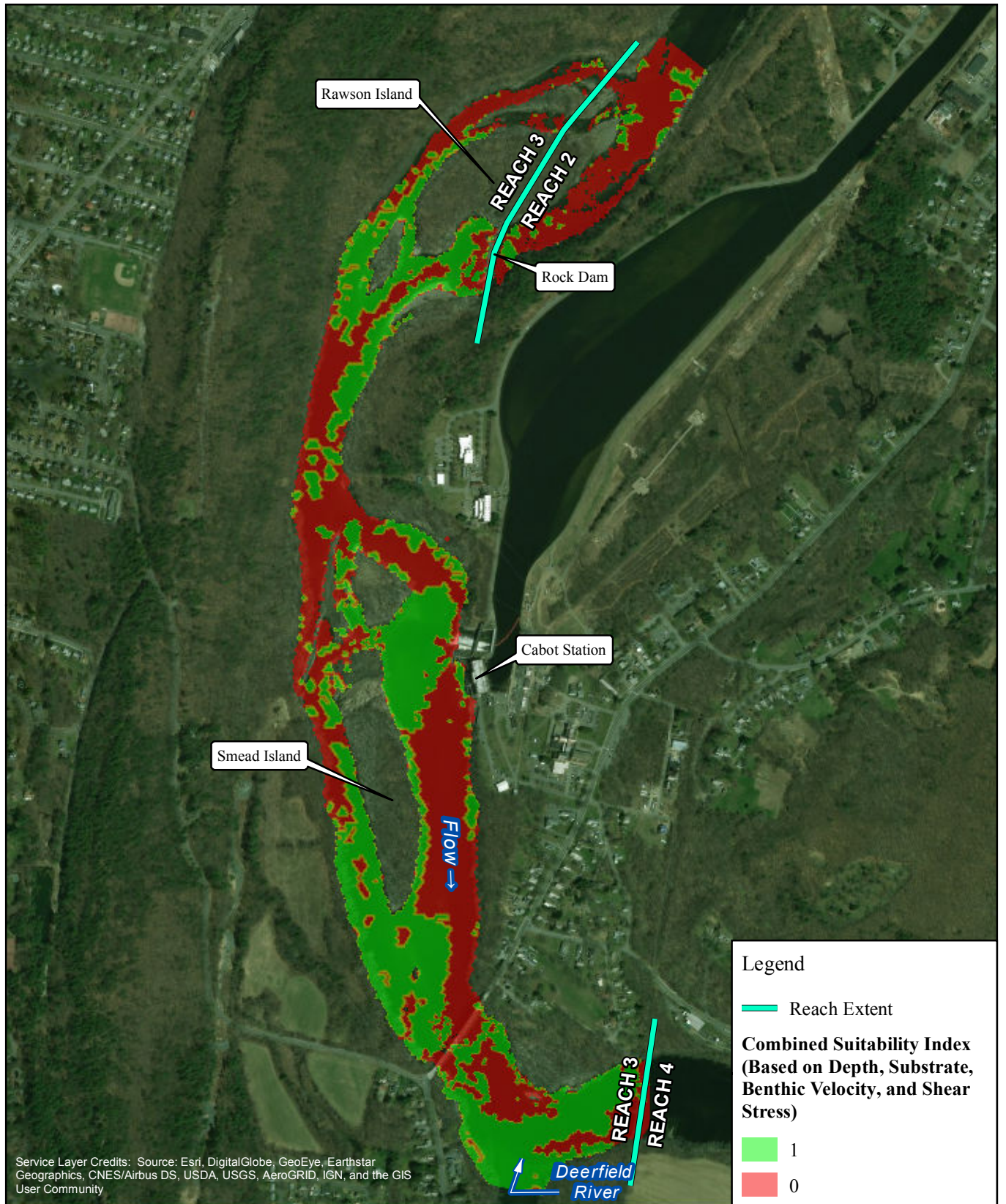
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**Yellow Lampmussel-Adult**  
Cabot Flow: 7000 cfs  
Bypass Flow: 6500 cfs  
Deerfield Flow: 200 cfs

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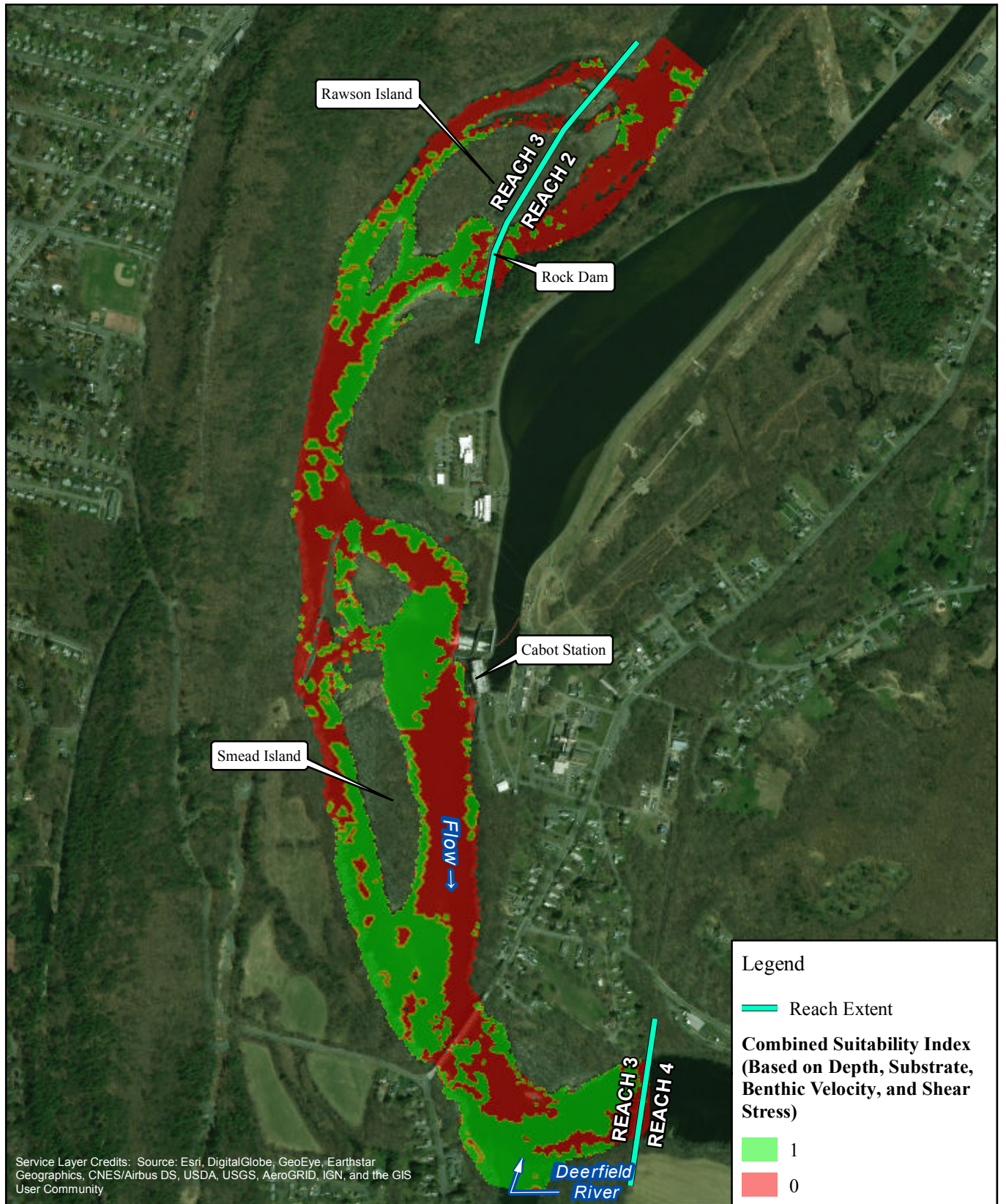
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Feet

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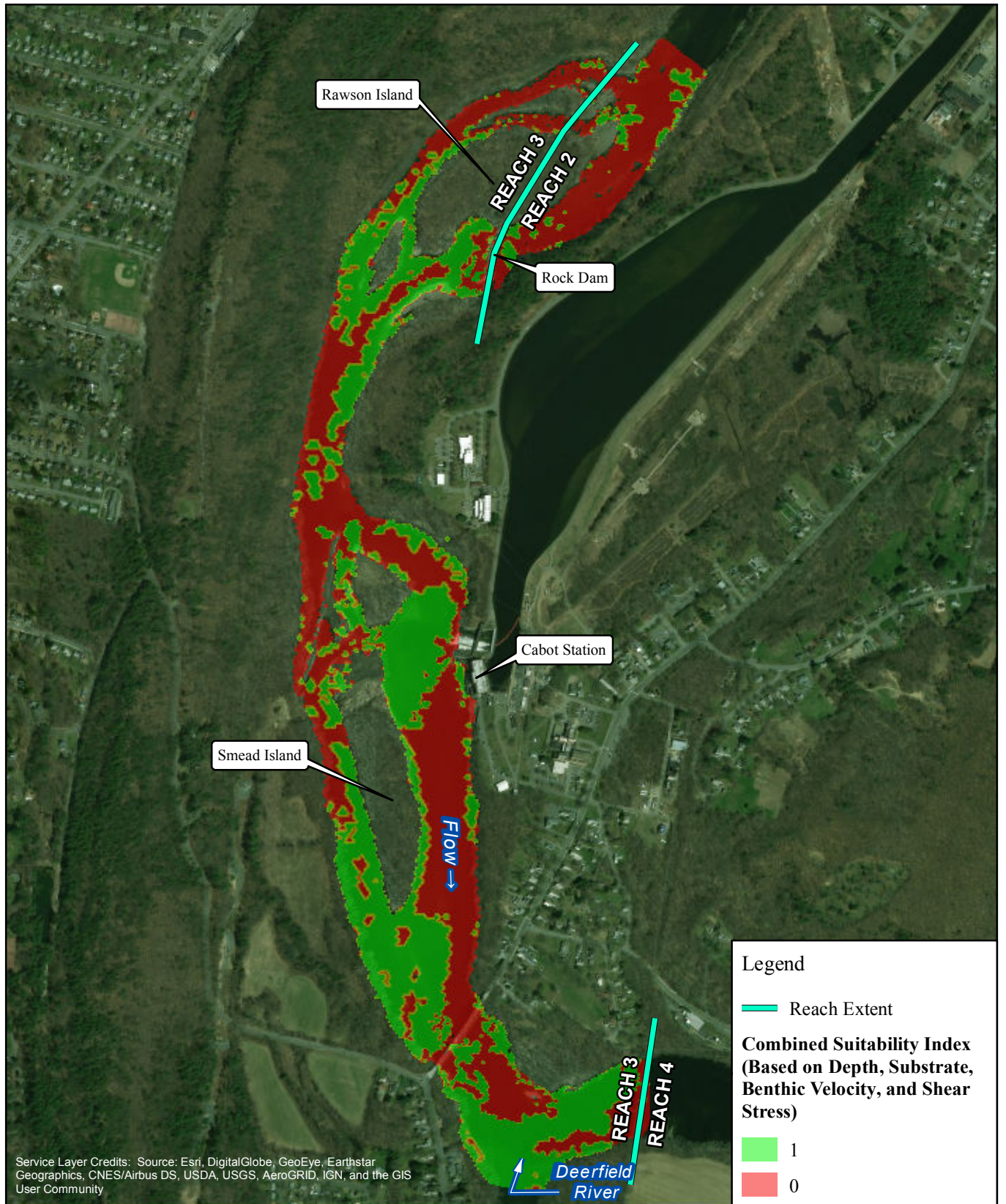
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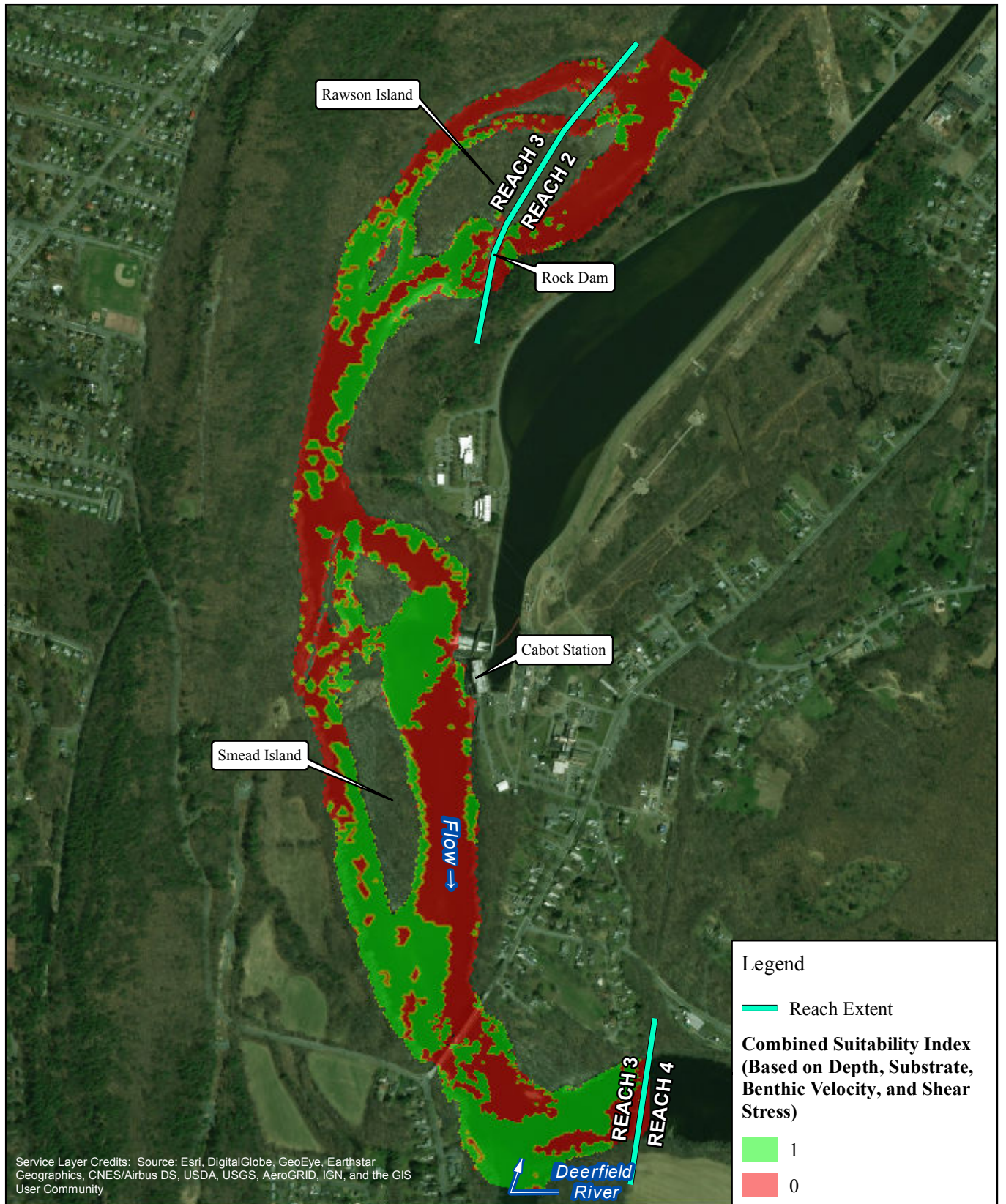
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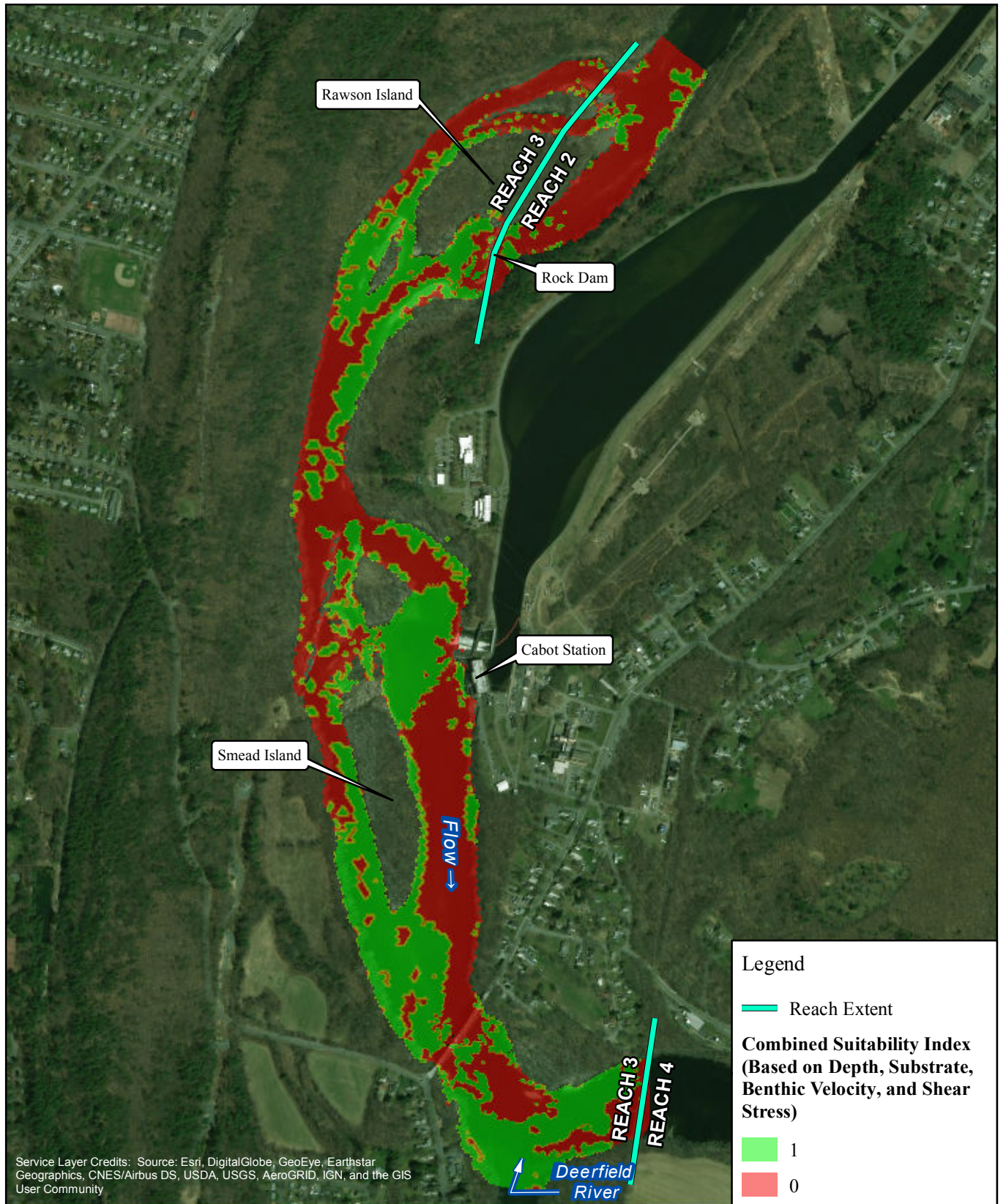
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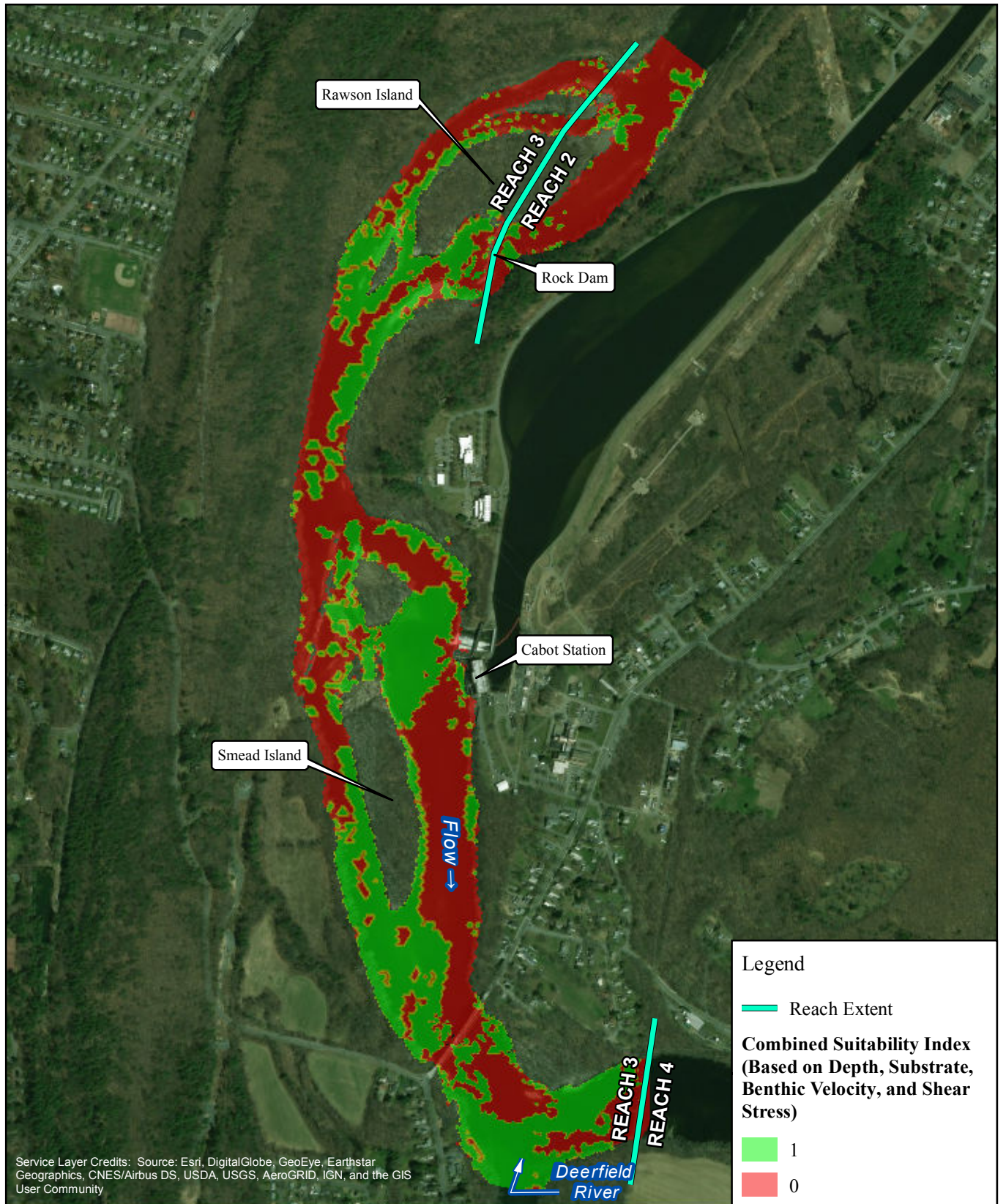
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Cabot Flow: 14000 cfs  
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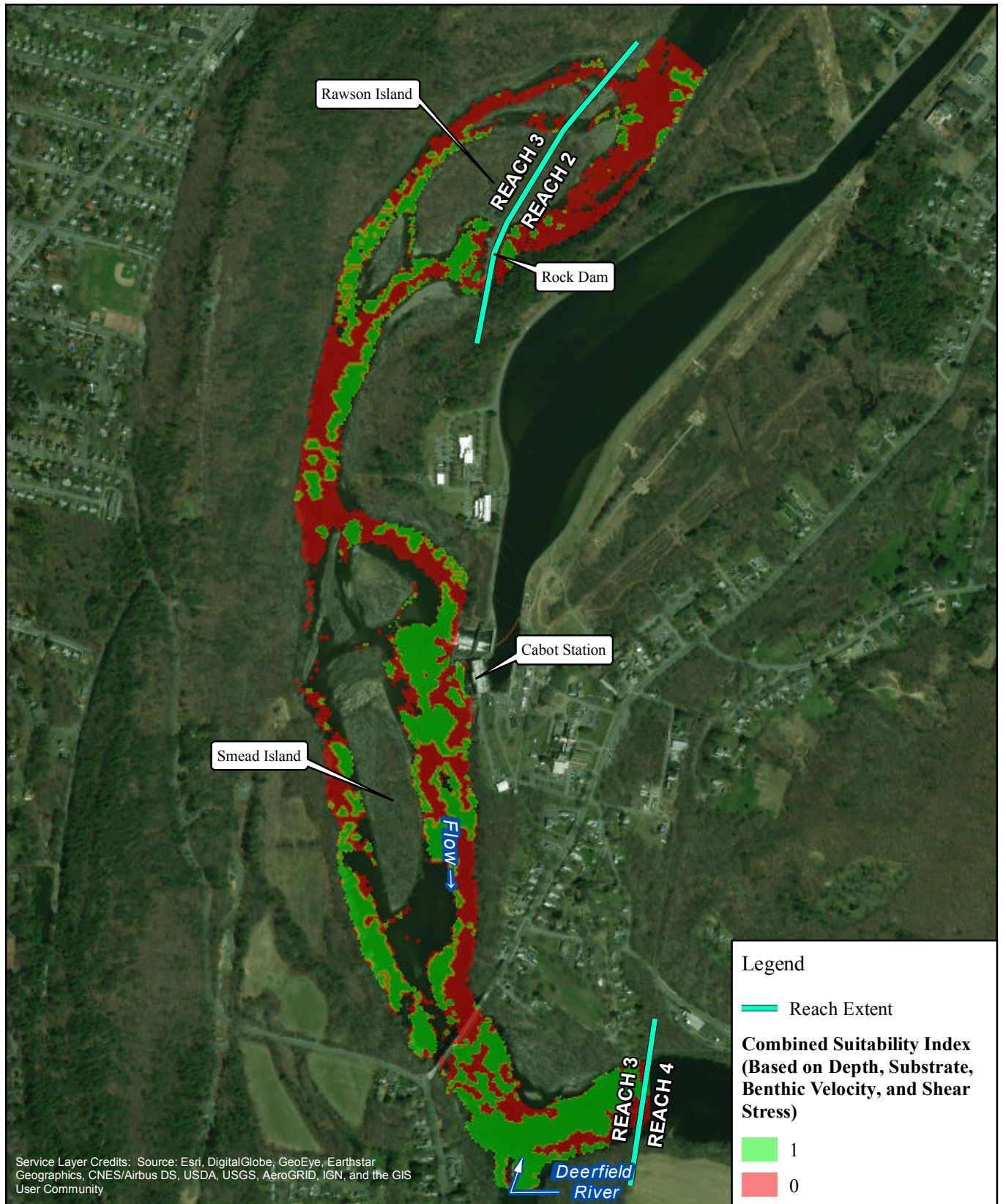
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Feet

**Yellow Lampmussel-Adult**  
Cabot Flow: 14000 cfs  
Bypass Flow: 6500 cfs  
Deerfield Flow: 200 cfs

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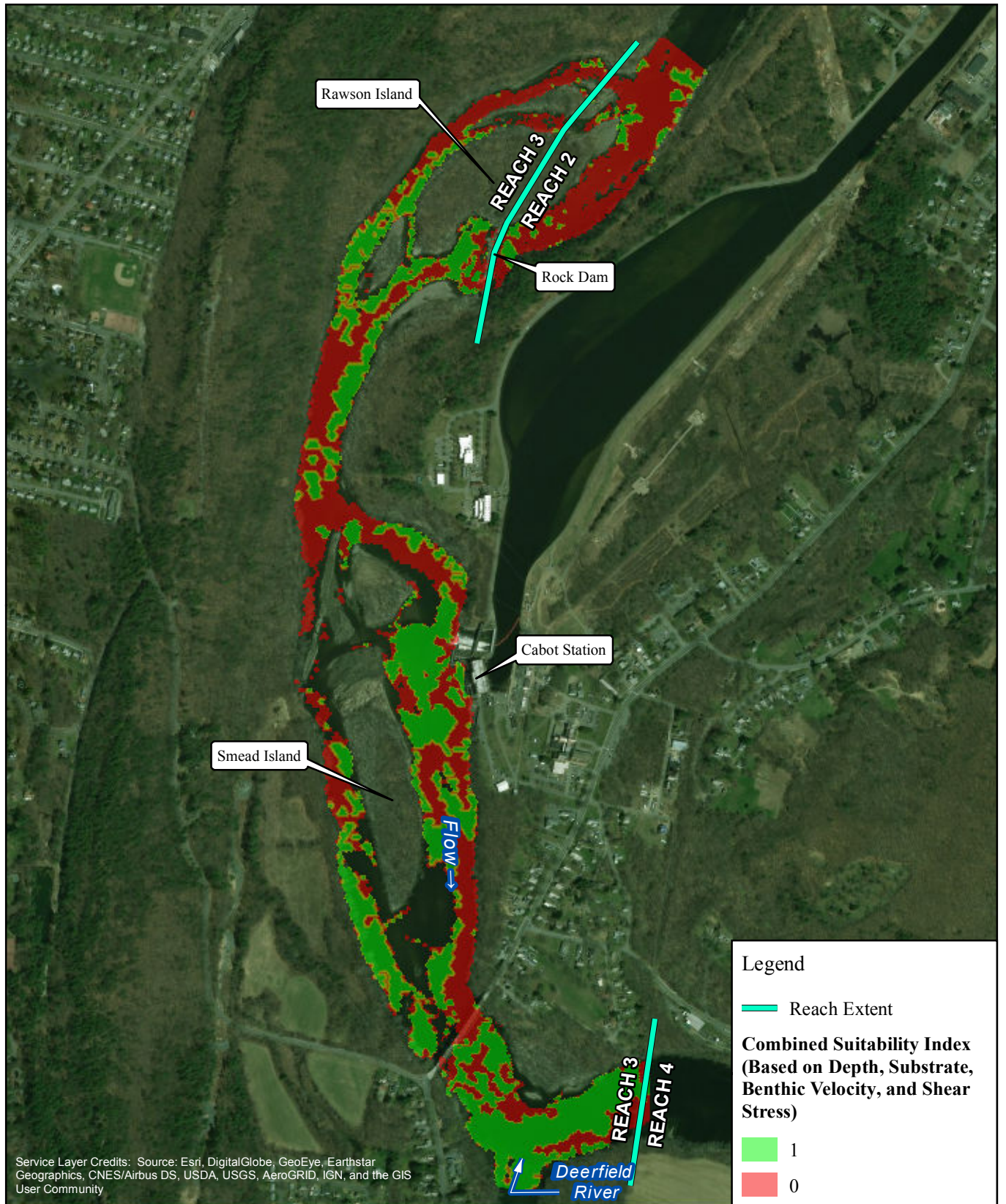
0 500 1,000 2,000  
Feet

Yellow Lampmussel-Adult  
Cabot Flow: 2500 cfs  
Bypass Flow: 200 cfs  
Deerfield Flow: 200 cfs

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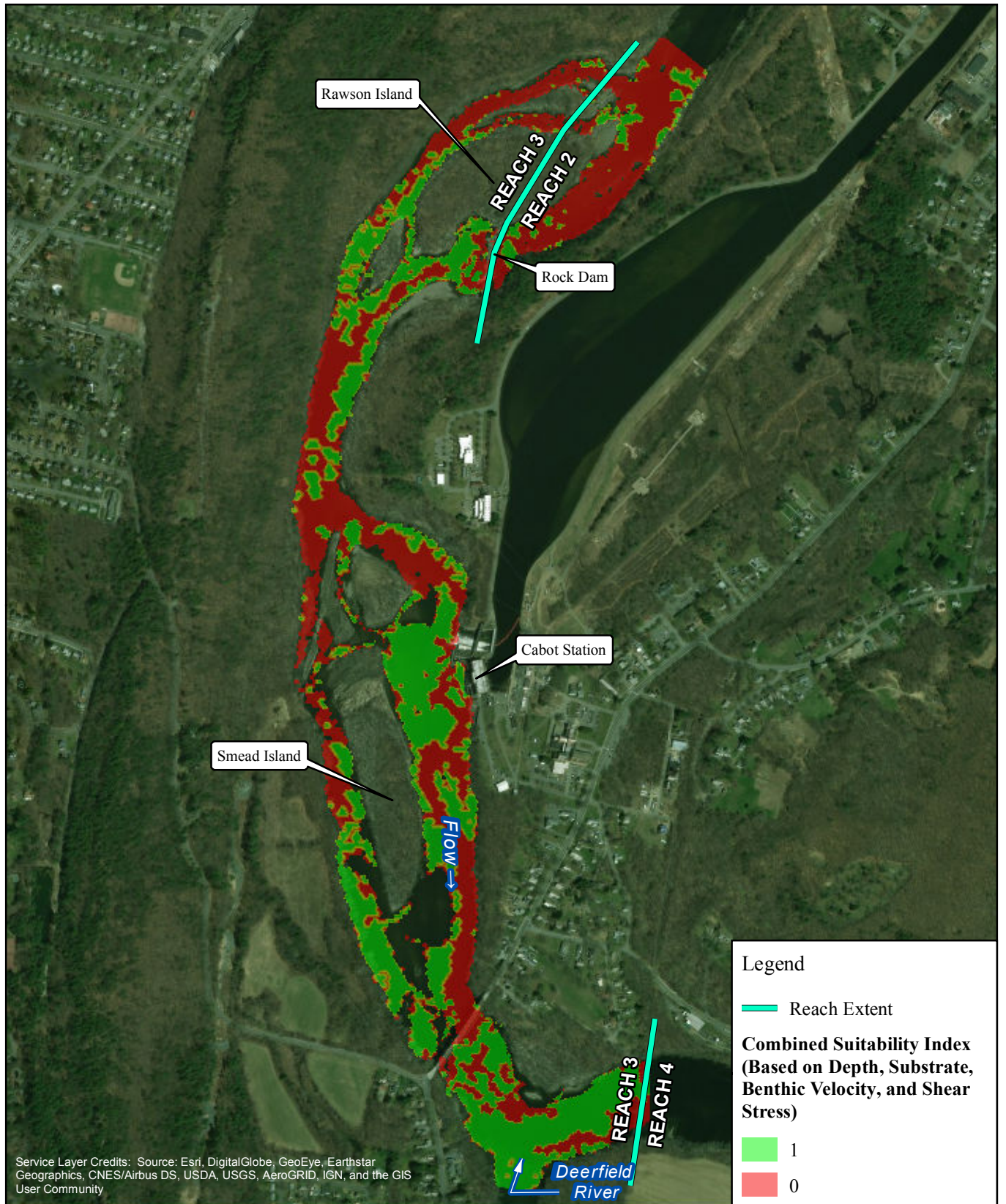
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Feet

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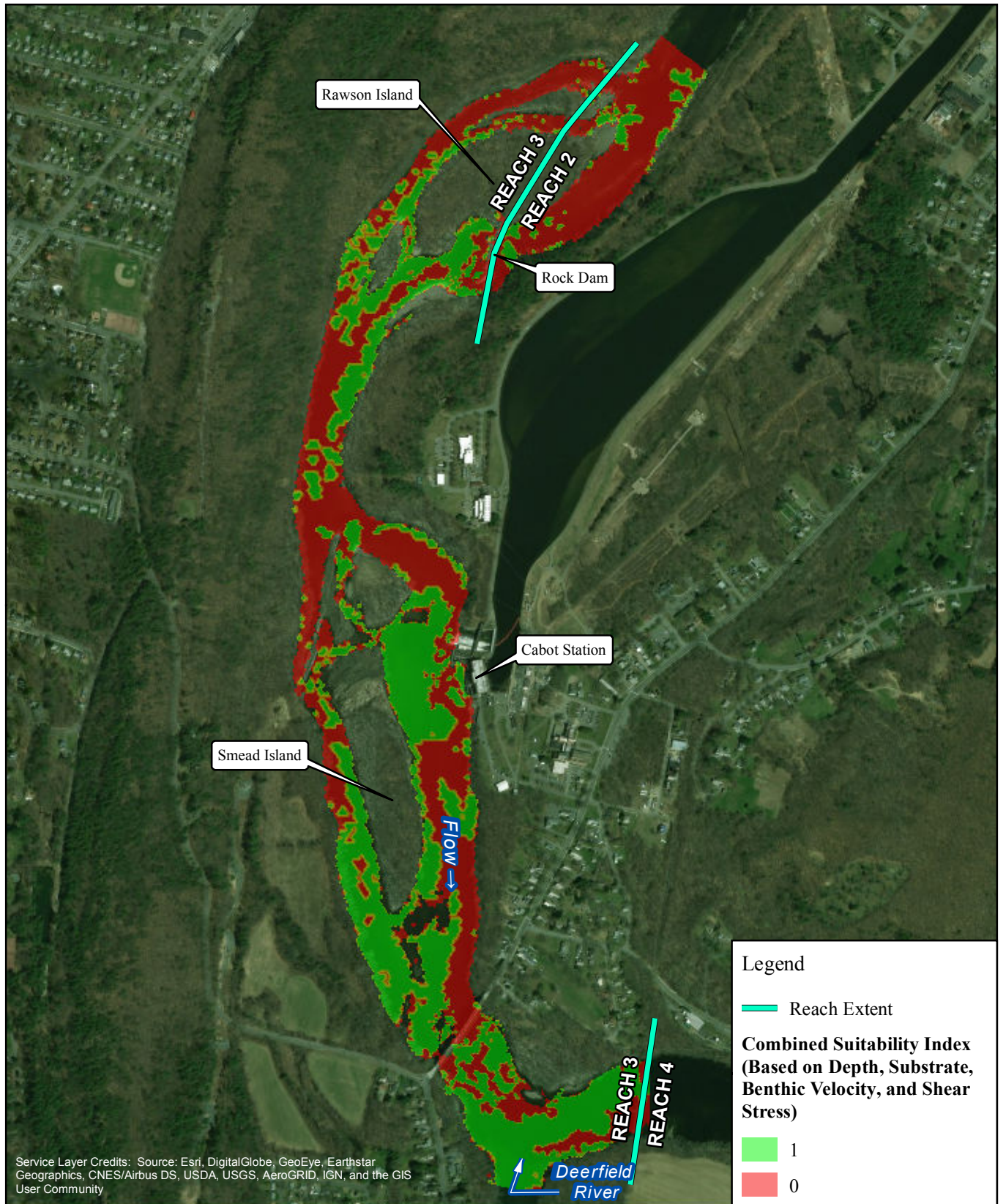
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Feet

**Yellow Lampmussel-Adult**  
Cabot Flow: 2500 cfs  
Bypass Flow: 1000 cfs  
Deerfield Flow: 200 cfs

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RELICENSING STUDY 3.3.1  
Addendum 3 Reach 3 Mussels (May 2018)

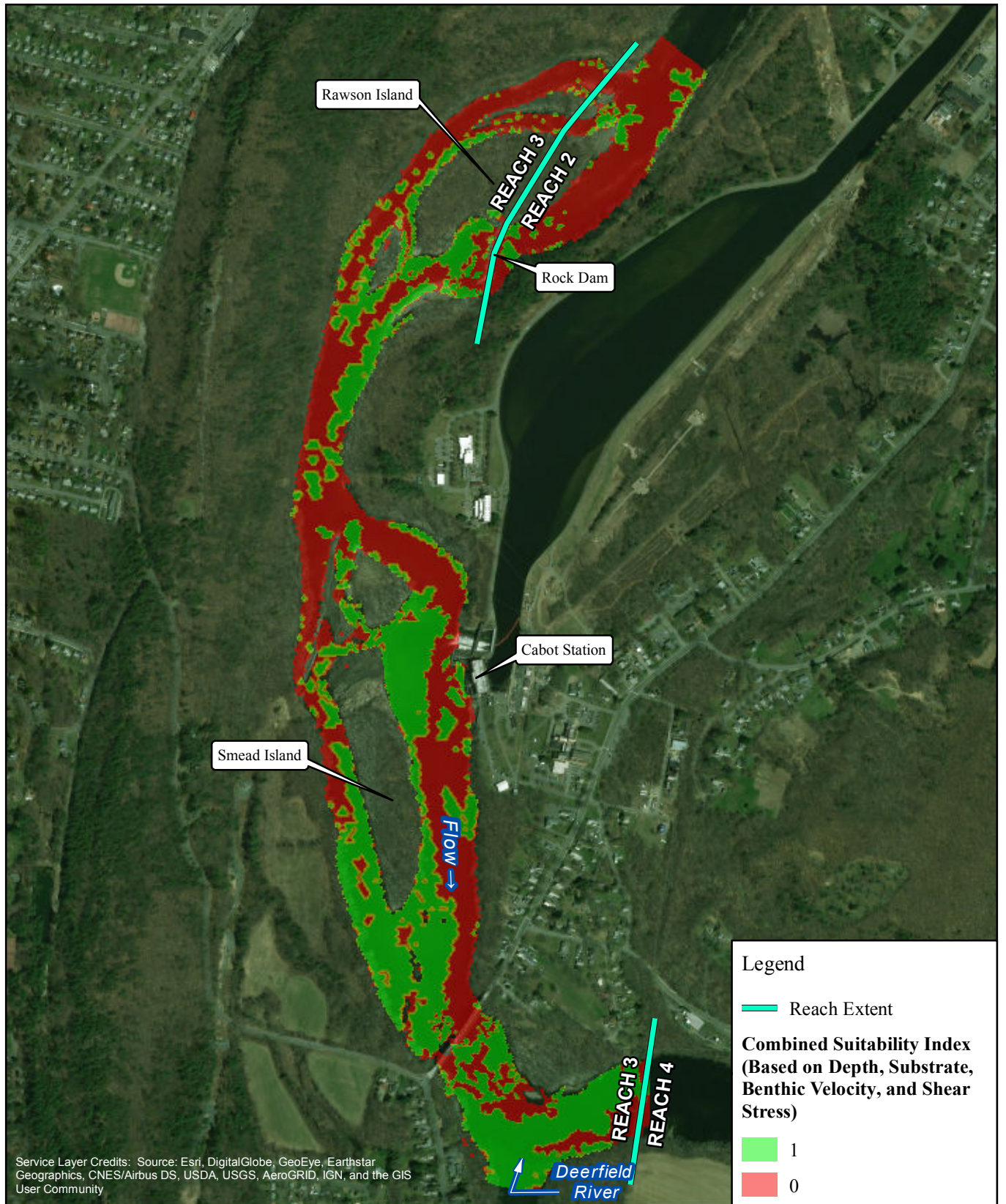
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Feet

**Yellow Lampmussel-Adult**  
Cabot Flow: 2500 cfs  
Bypass Flow: 3000 cfs  
Deerfield Flow: 200 cfs

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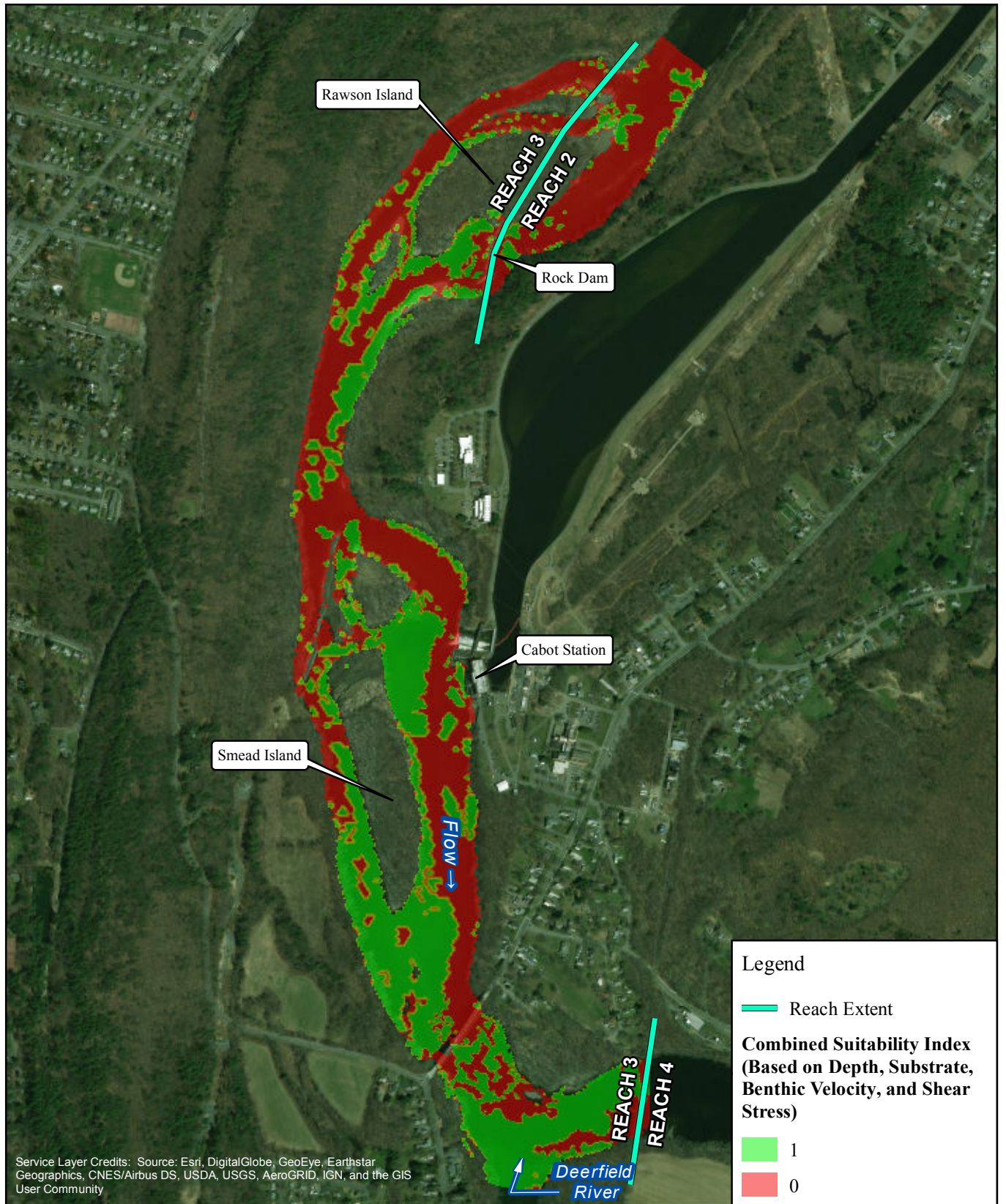
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**Yellow Lampmussel-Adult**  
Cabot Flow: 2500 cfs  
Bypass Flow: 5000 cfs  
Deerfield Flow: 200 cfs

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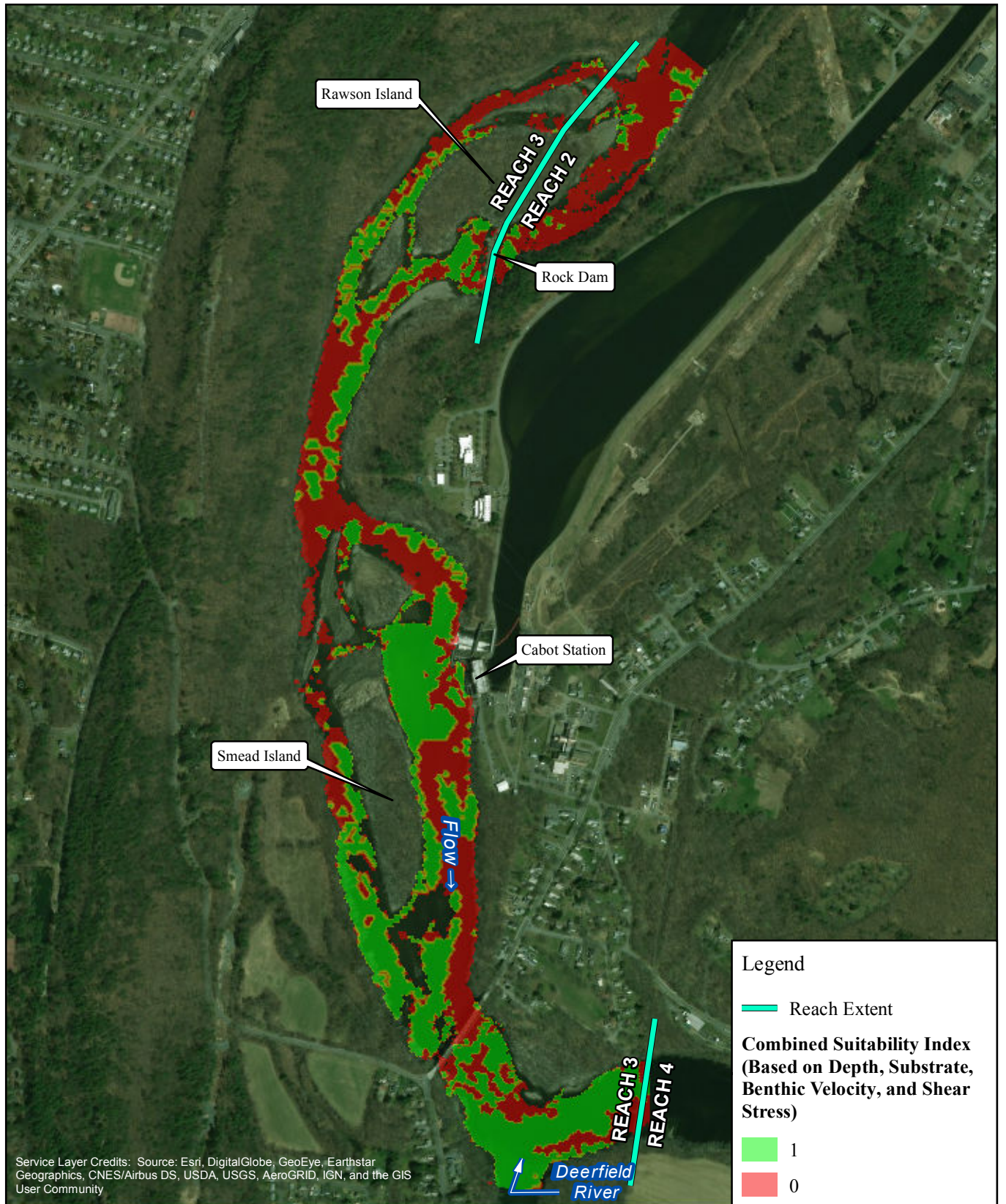
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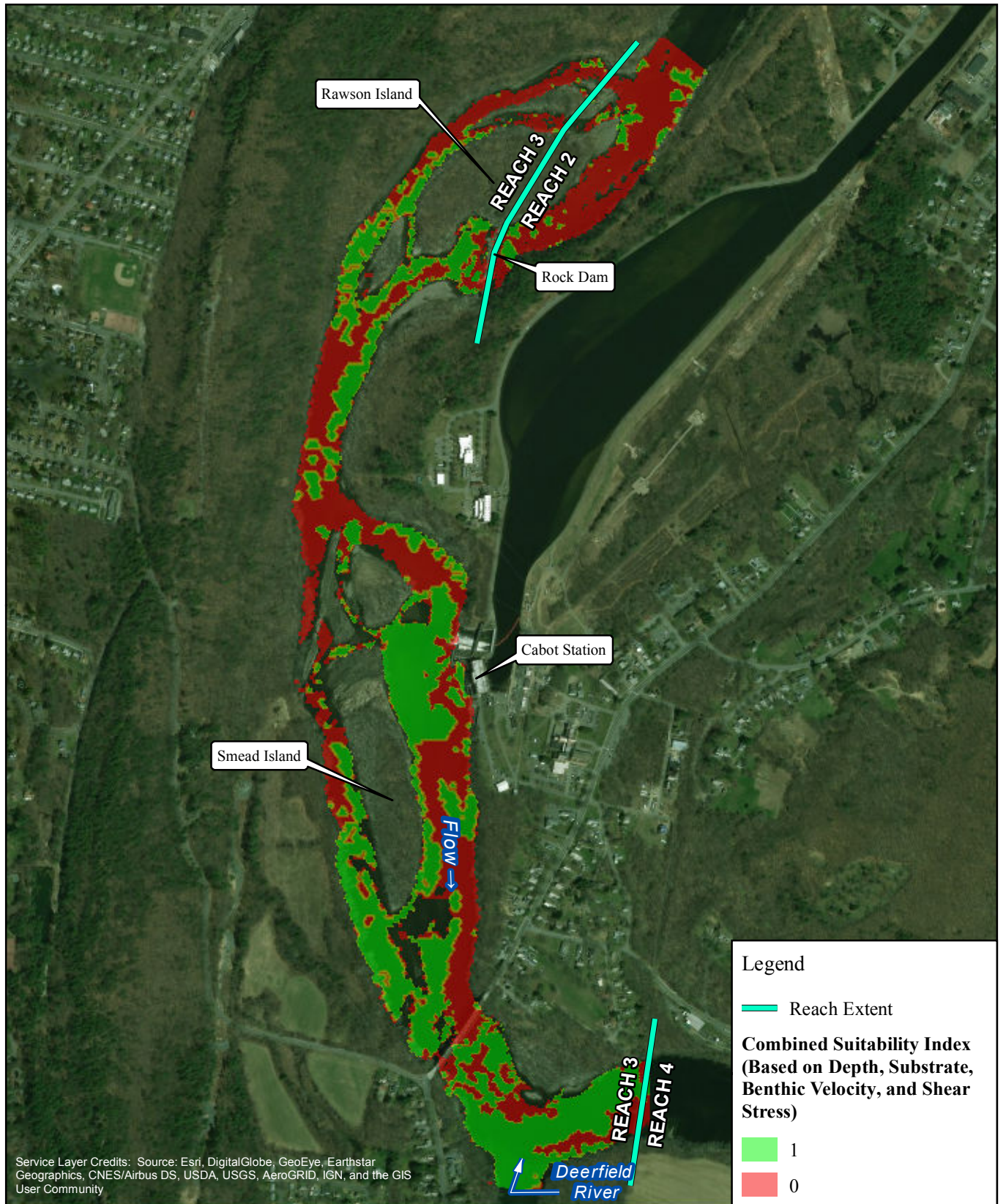
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Cabot Flow: 2500 cfs  
Bypass Flow: 6500 cfs  
Deerfield Flow: 200 cfs

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Addendum 3 Reach 3 Mussels (May 2018)

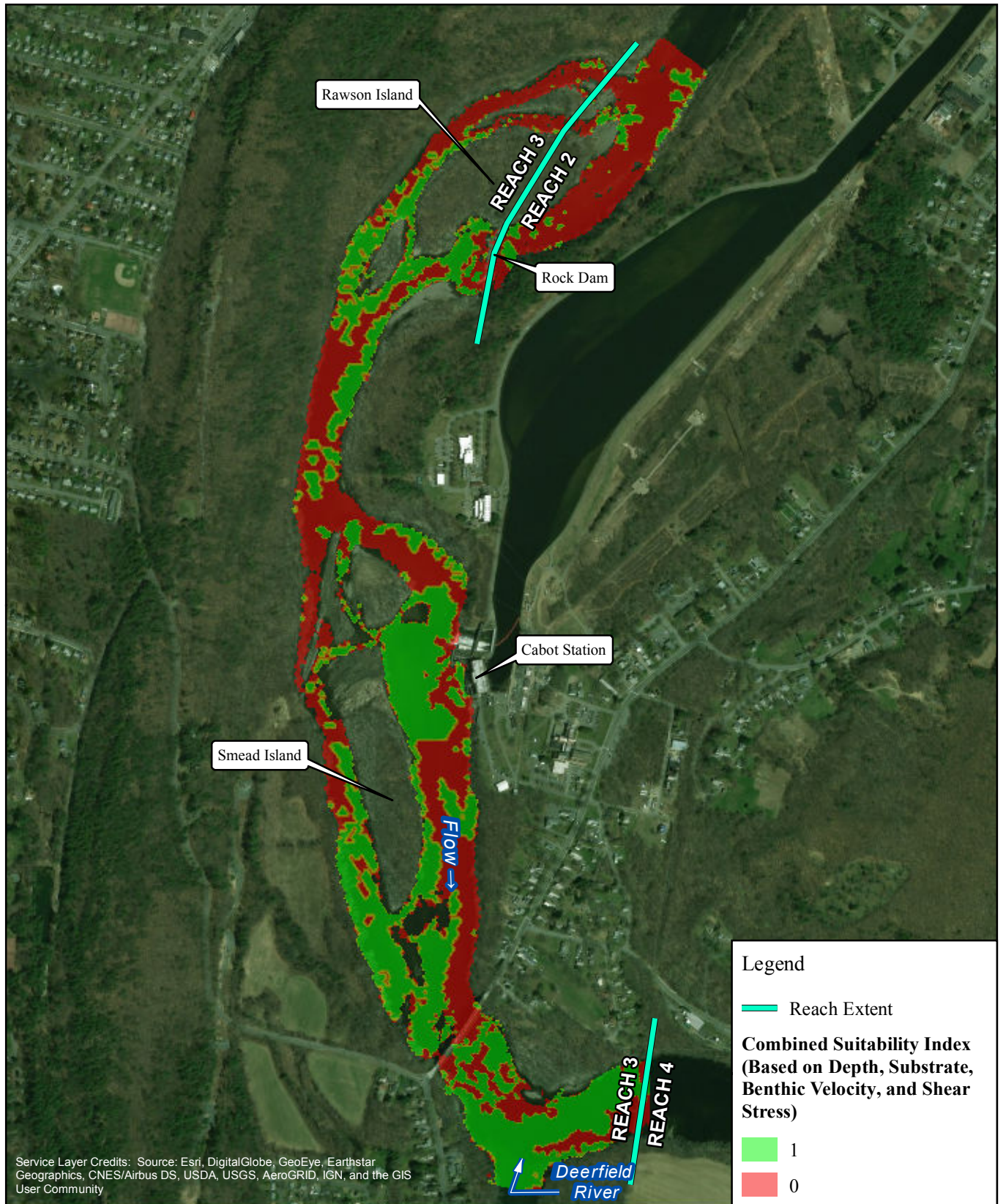
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Cabot Flow: 4500 cfs  
Bypass Flow: 500 cfs  
Deerfield Flow: 200 cfs

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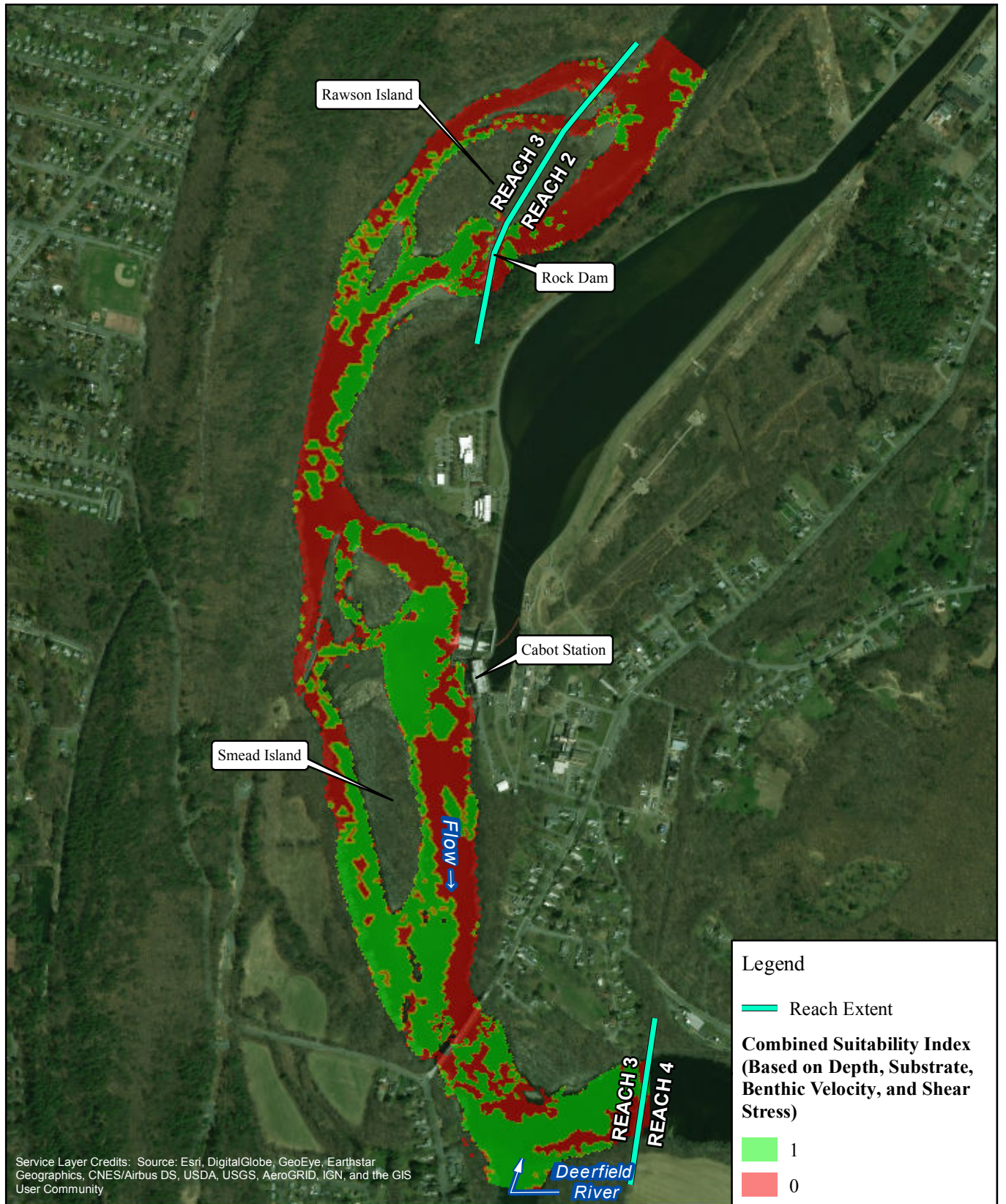
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Bypass Flow: 1000 cfs  
Deerfield Flow: 200 cfs

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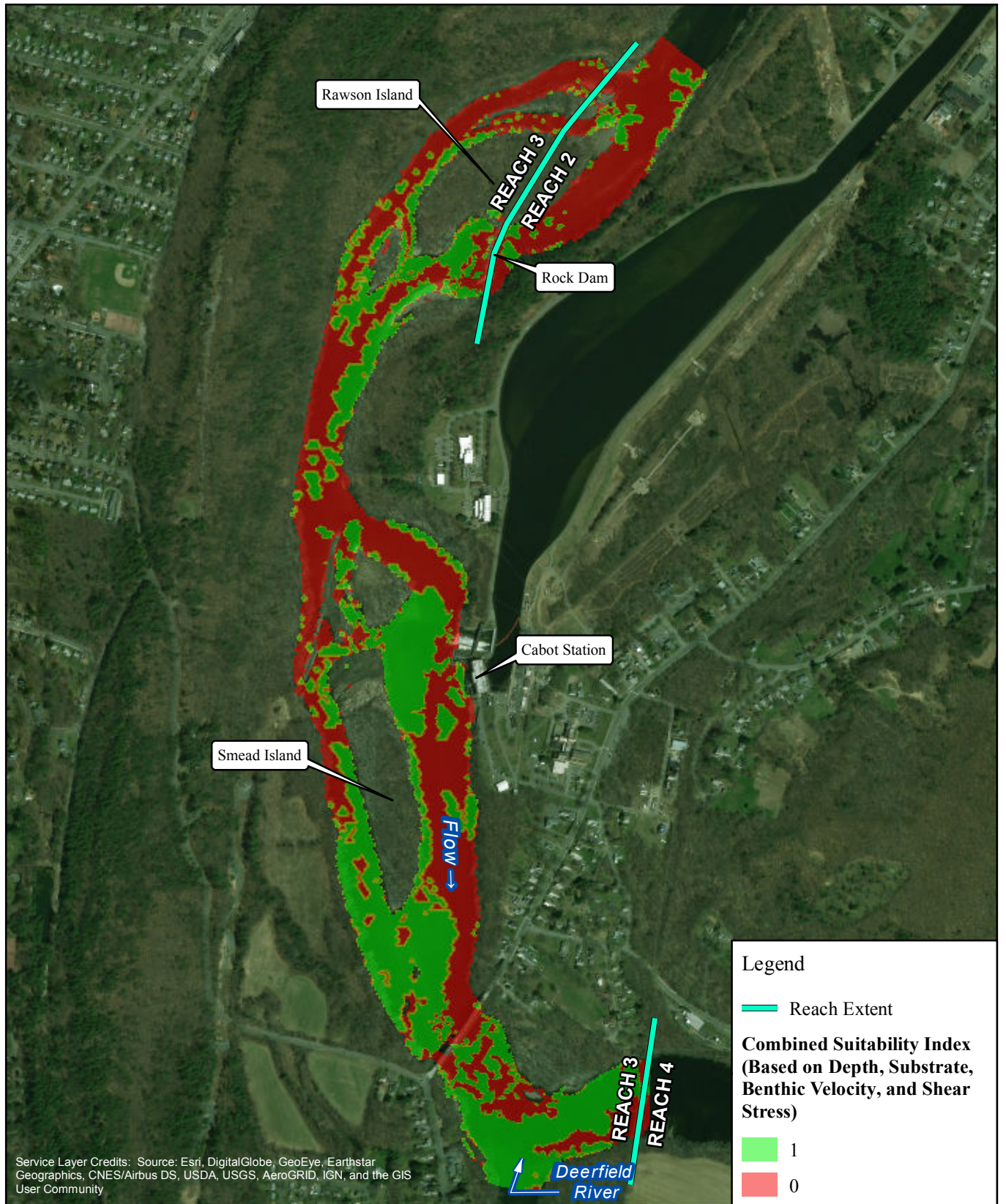
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Cabot Flow: 4500 cfs  
Bypass Flow: 3000 cfs  
Deerfield Flow: 200 cfs

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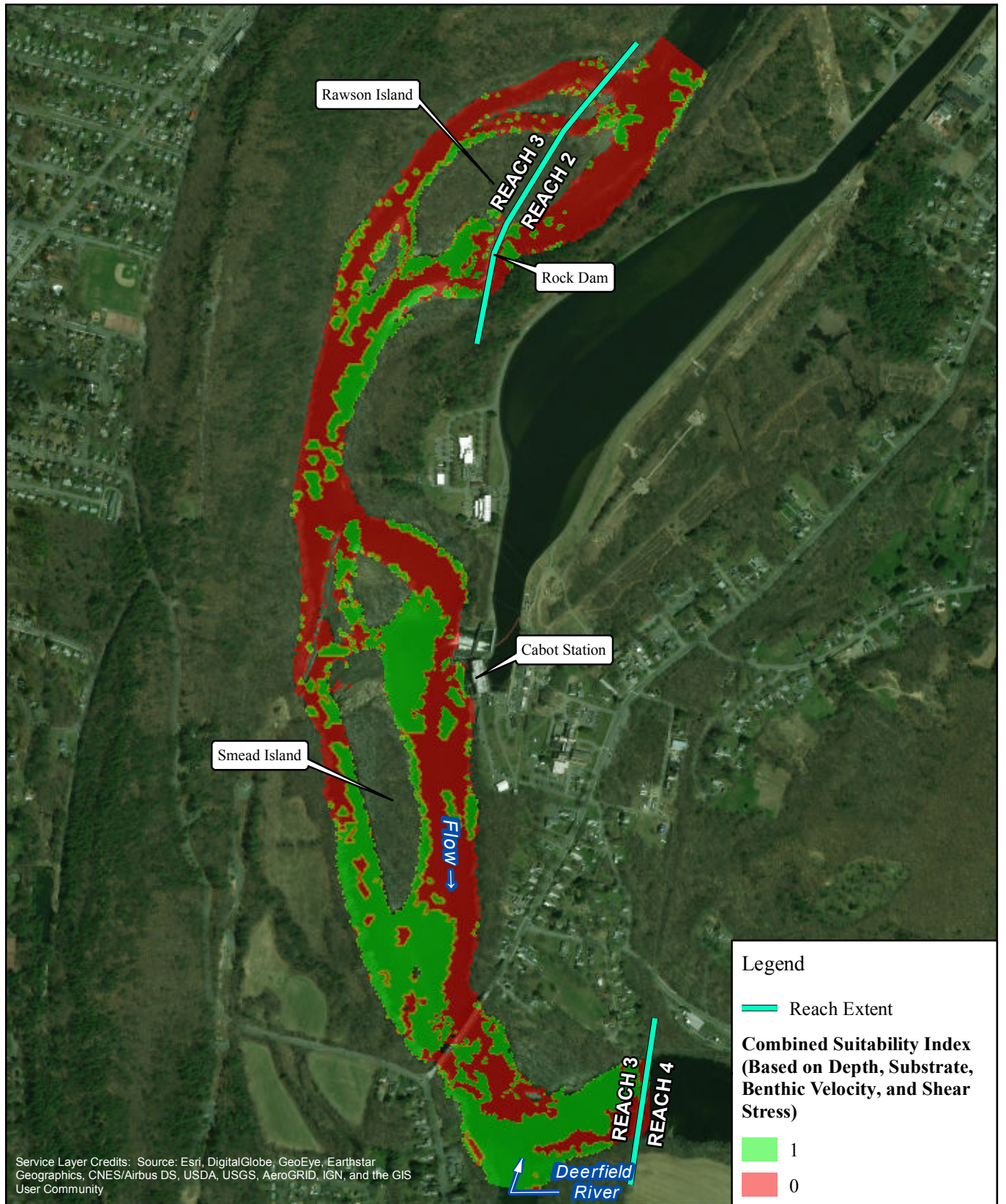
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Deerfield Flow: 200 cfs

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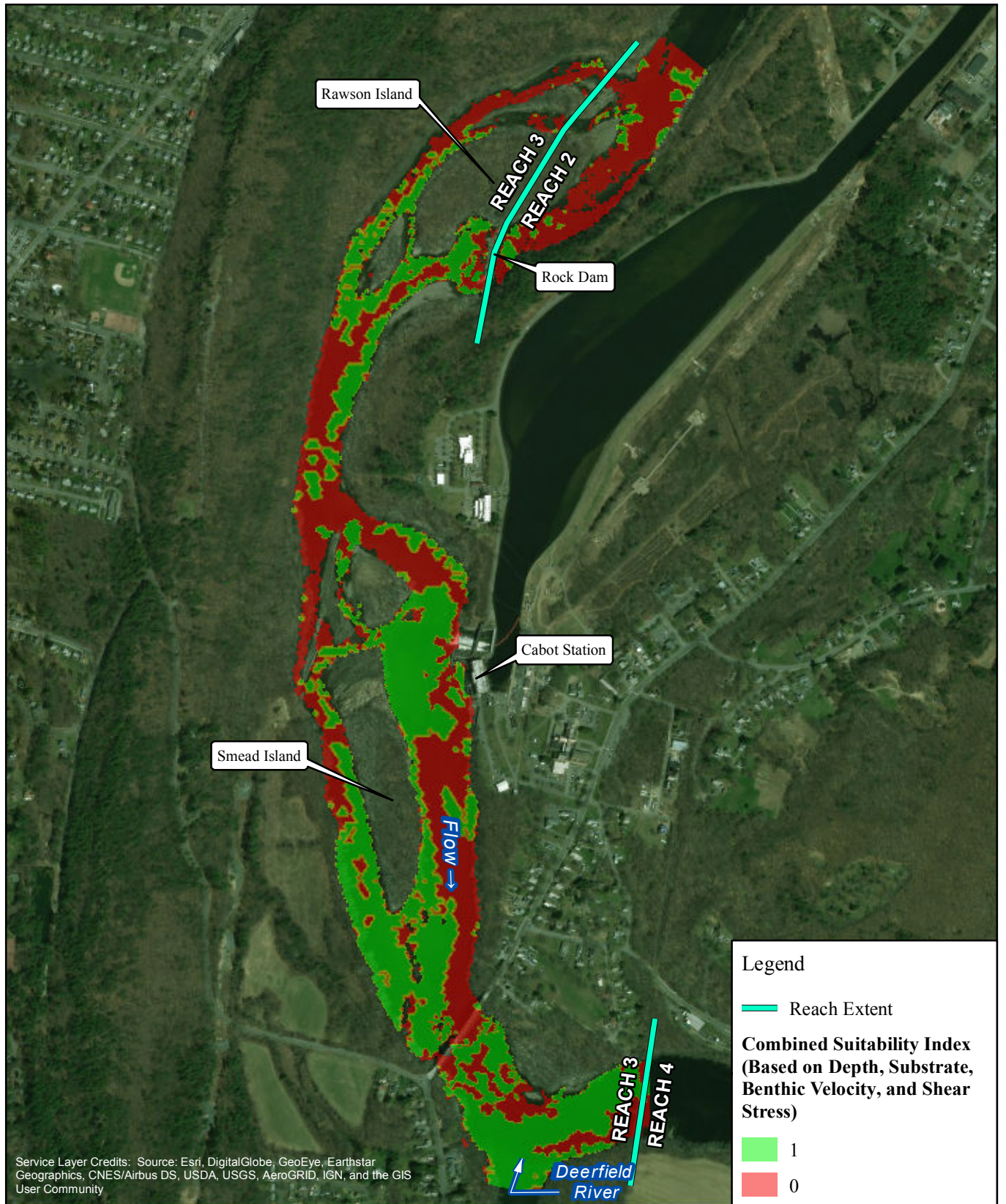
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**Yellow Lampmussel-Adult**  
Cabot Flow: 4500 cfs  
Bypass Flow: 6500 cfs  
Deerfield Flow: 200 cfs

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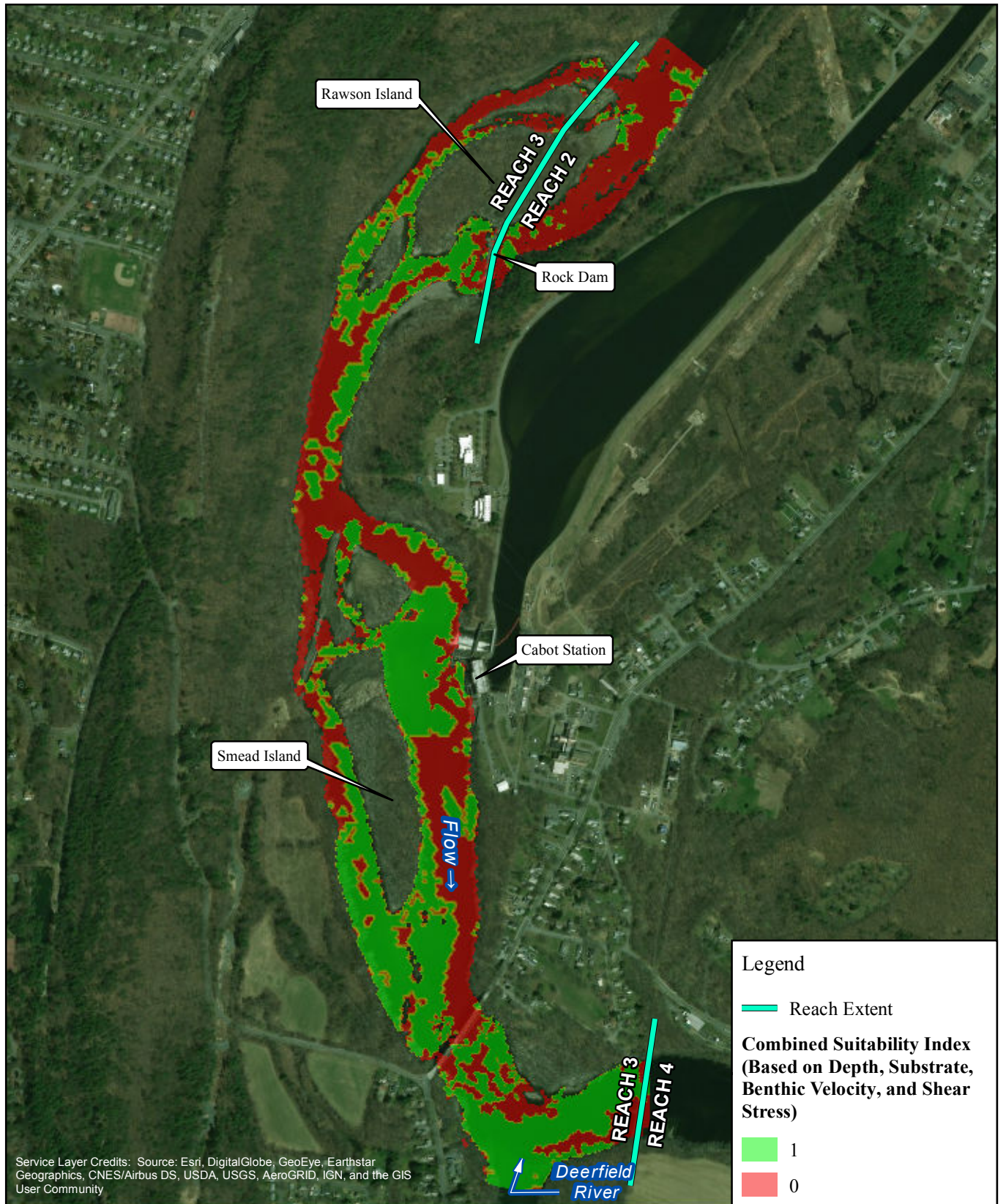
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Cabot Flow: 7000 cfs  
Bypass Flow: 200 cfs  
Deerfield Flow: 200 cfs

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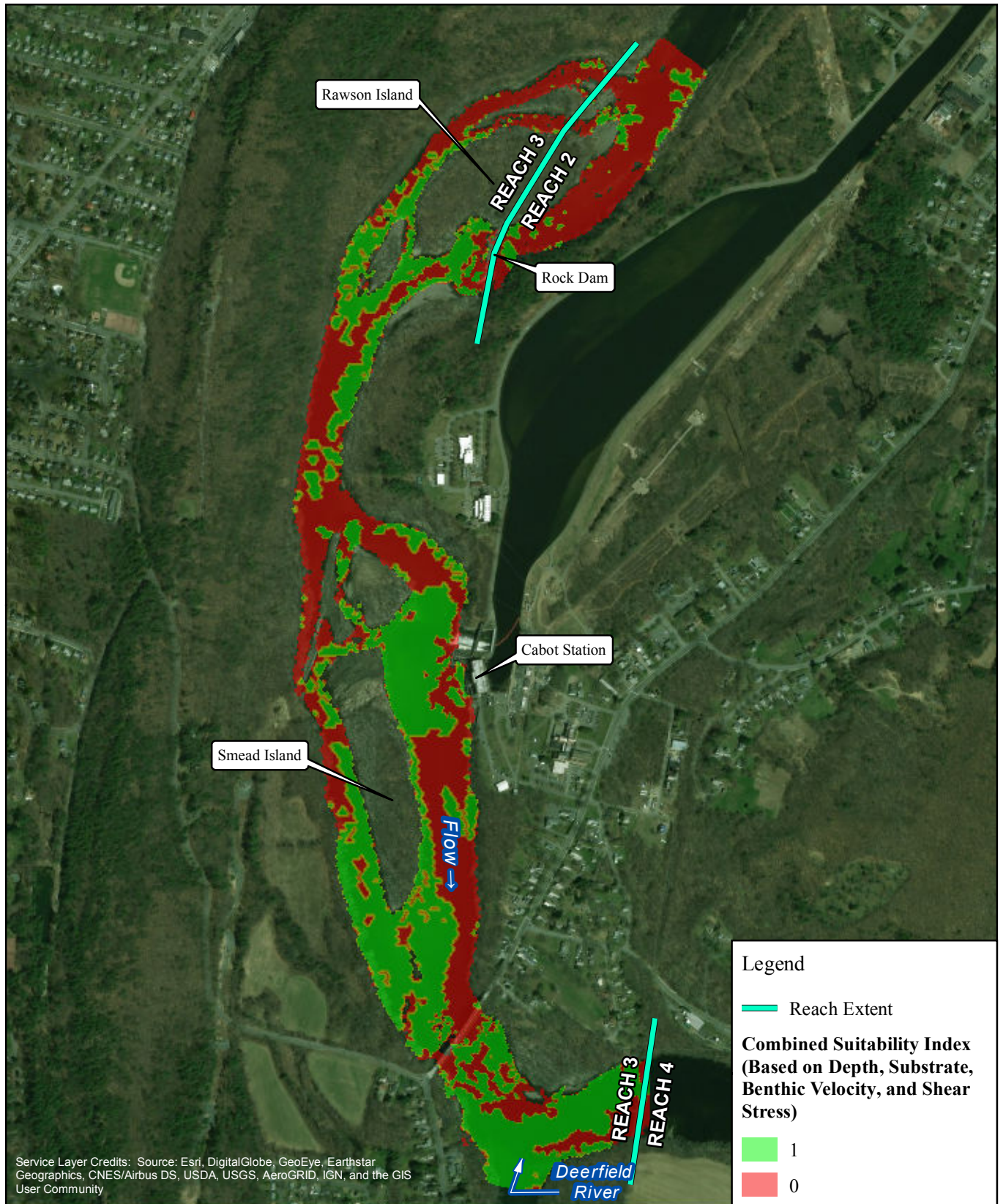
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Bypass Flow: 500 cfs  
Deerfield Flow: 200 cfs

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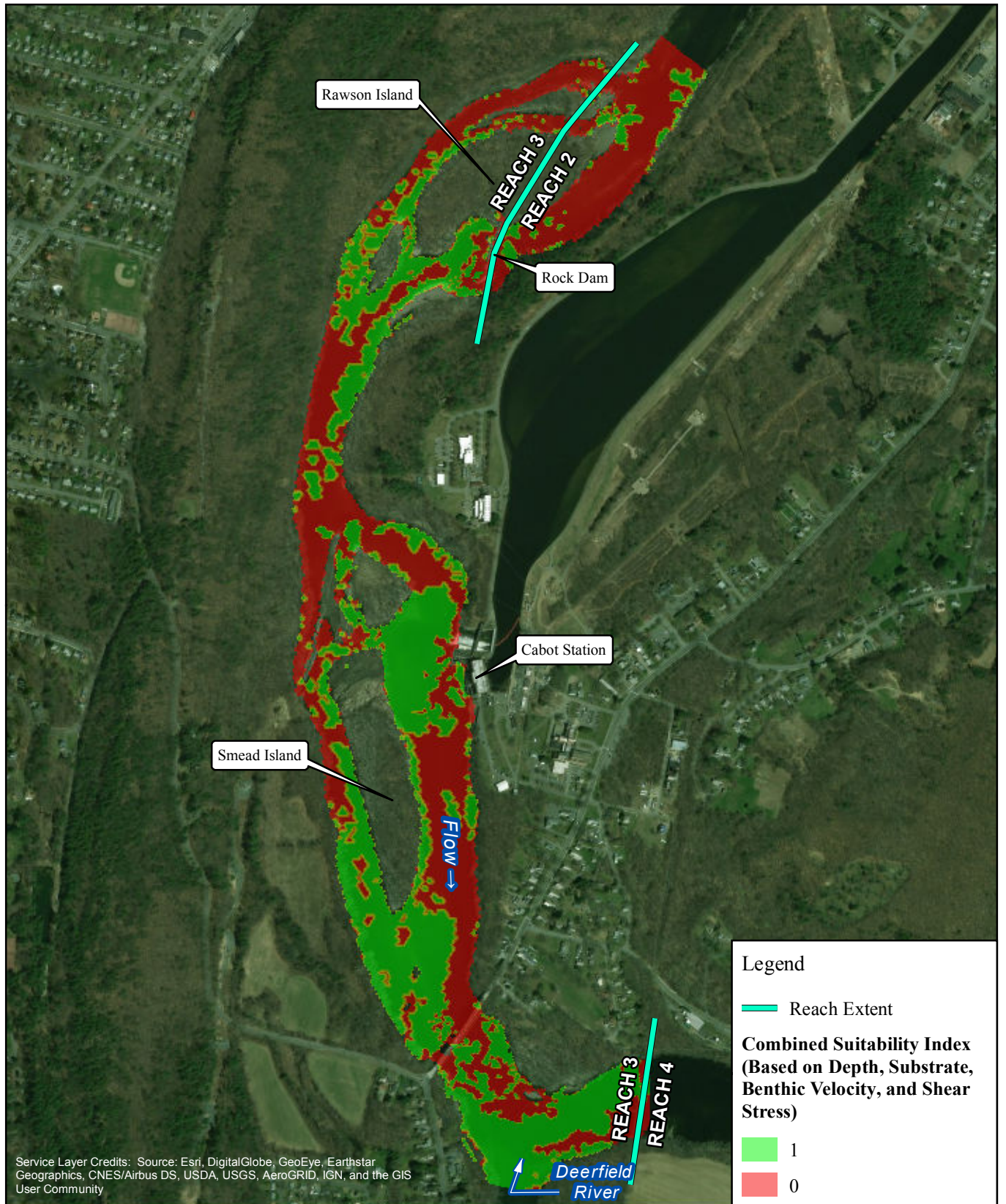
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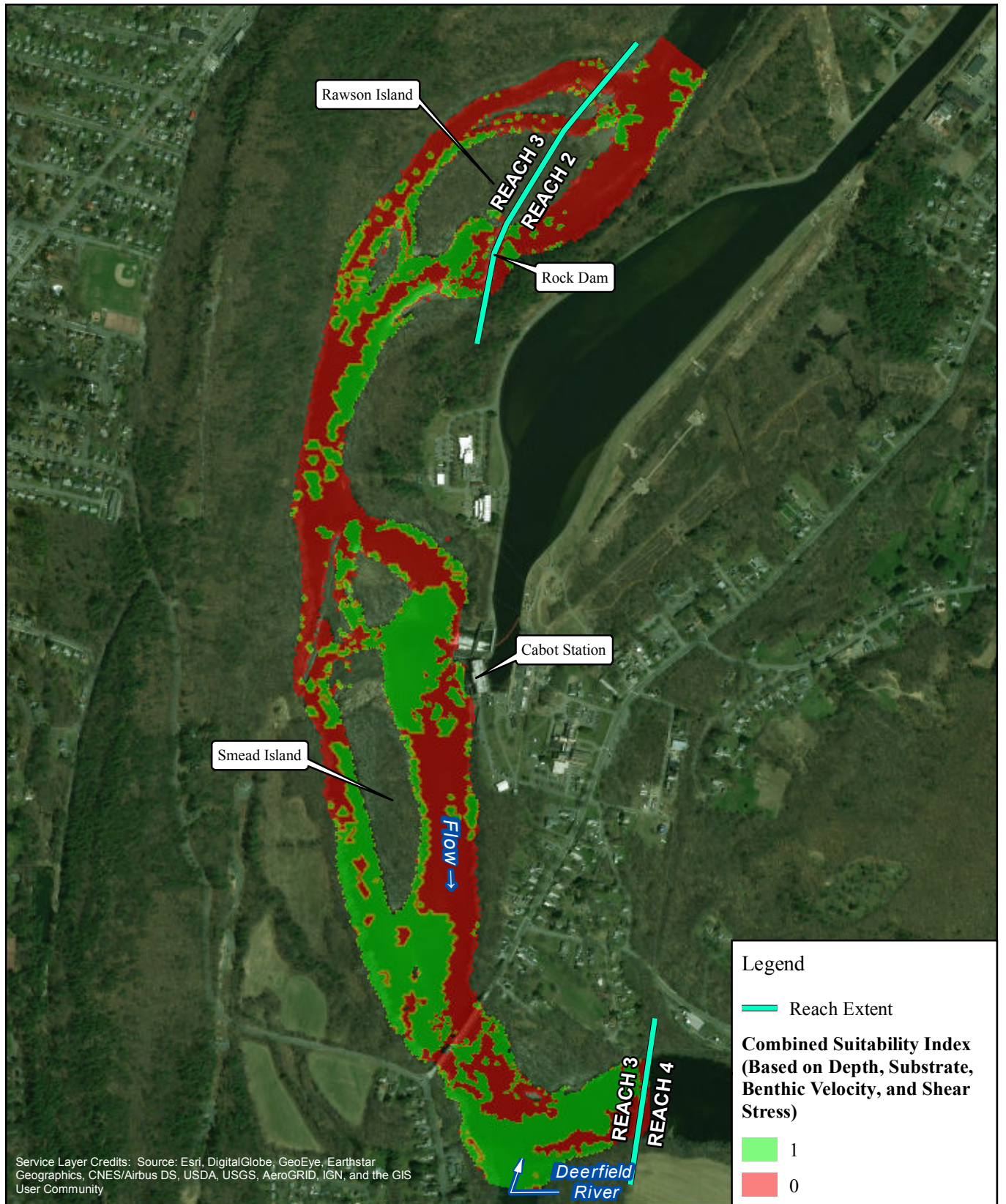
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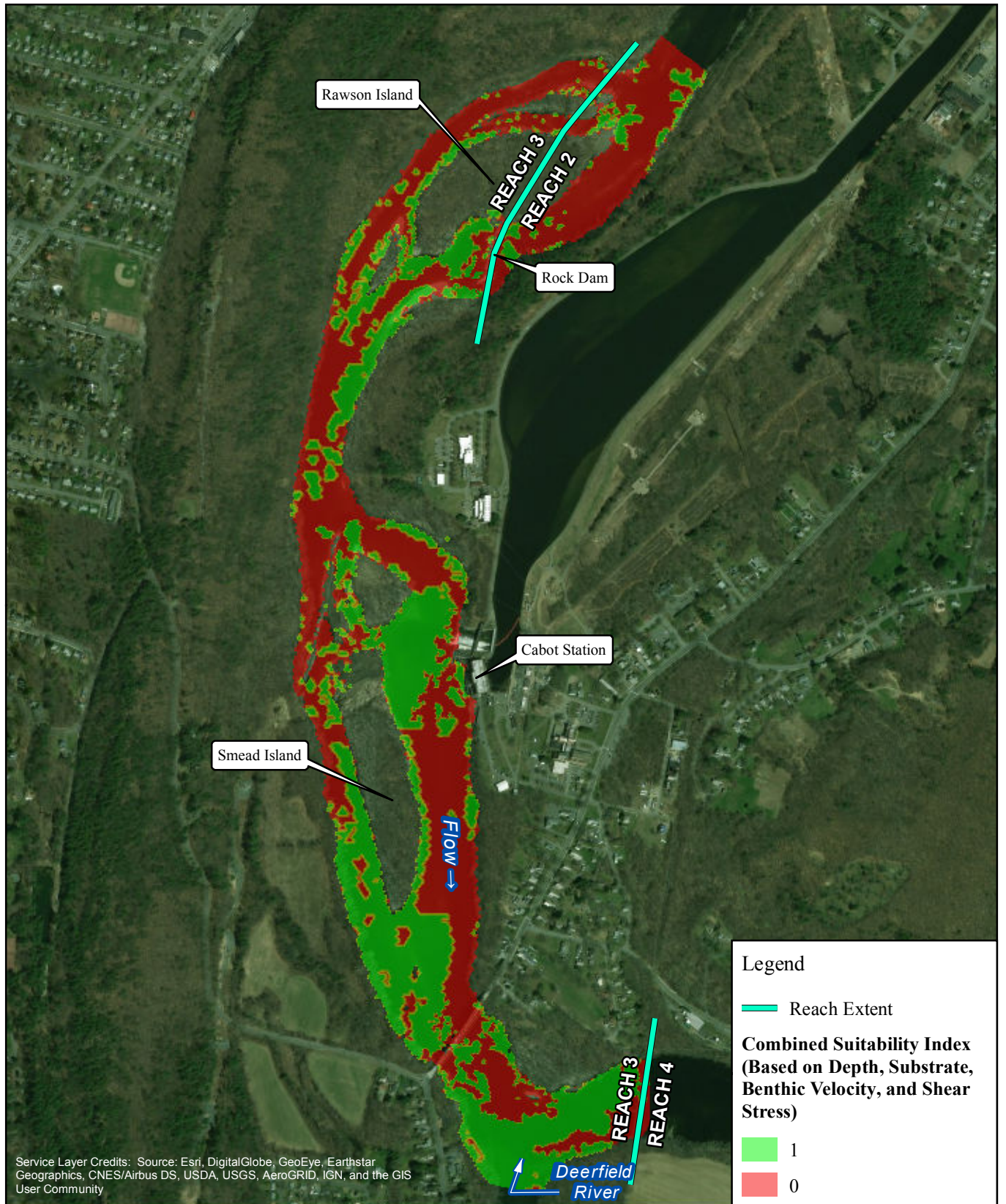
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**Yellow Lampmussel-Adult**  
Cabot Flow: 7000 cfs  
Bypass Flow: 5000 cfs  
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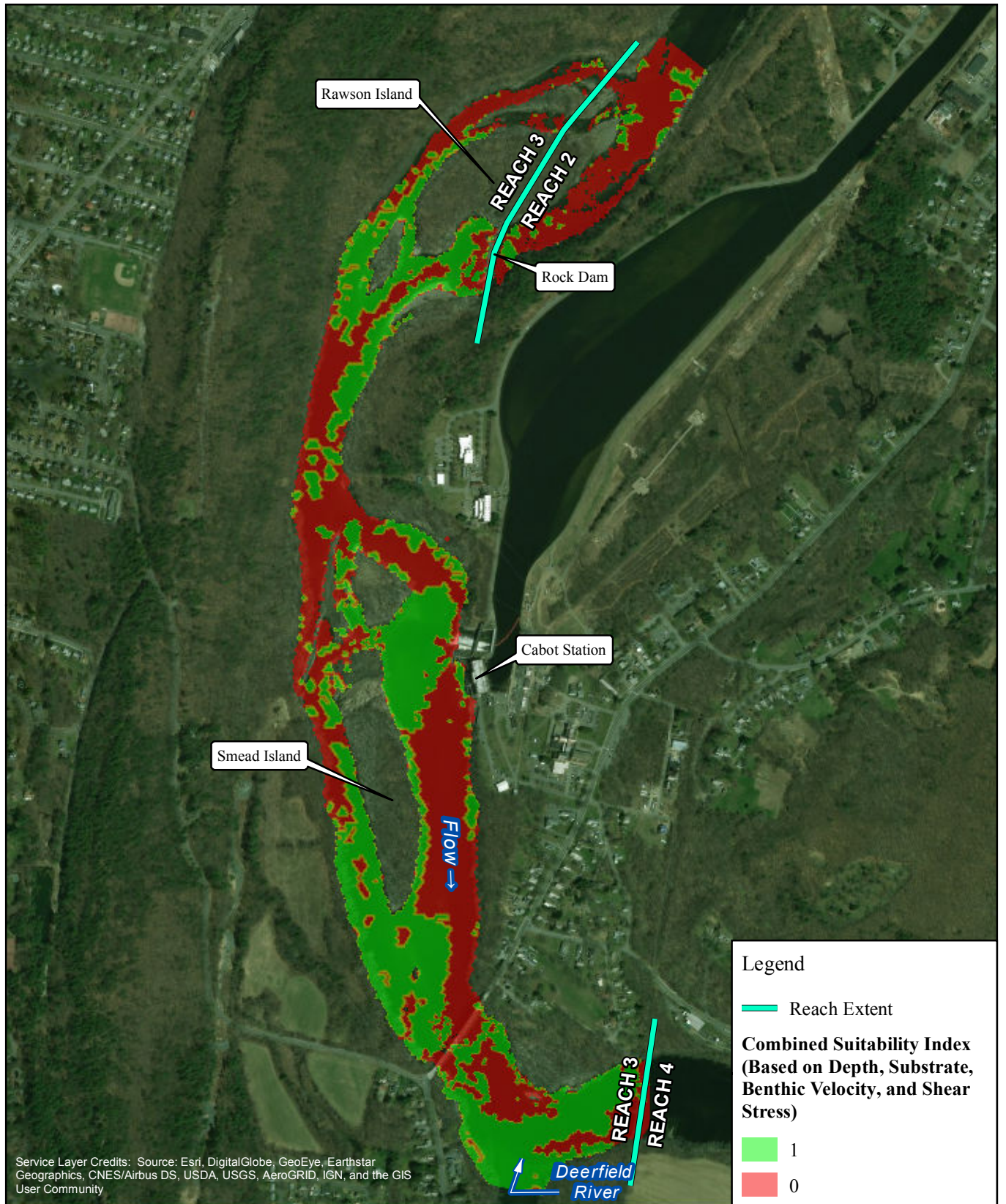
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Bypass Flow: 6500 cfs  
Deerfield Flow: 200 cfs

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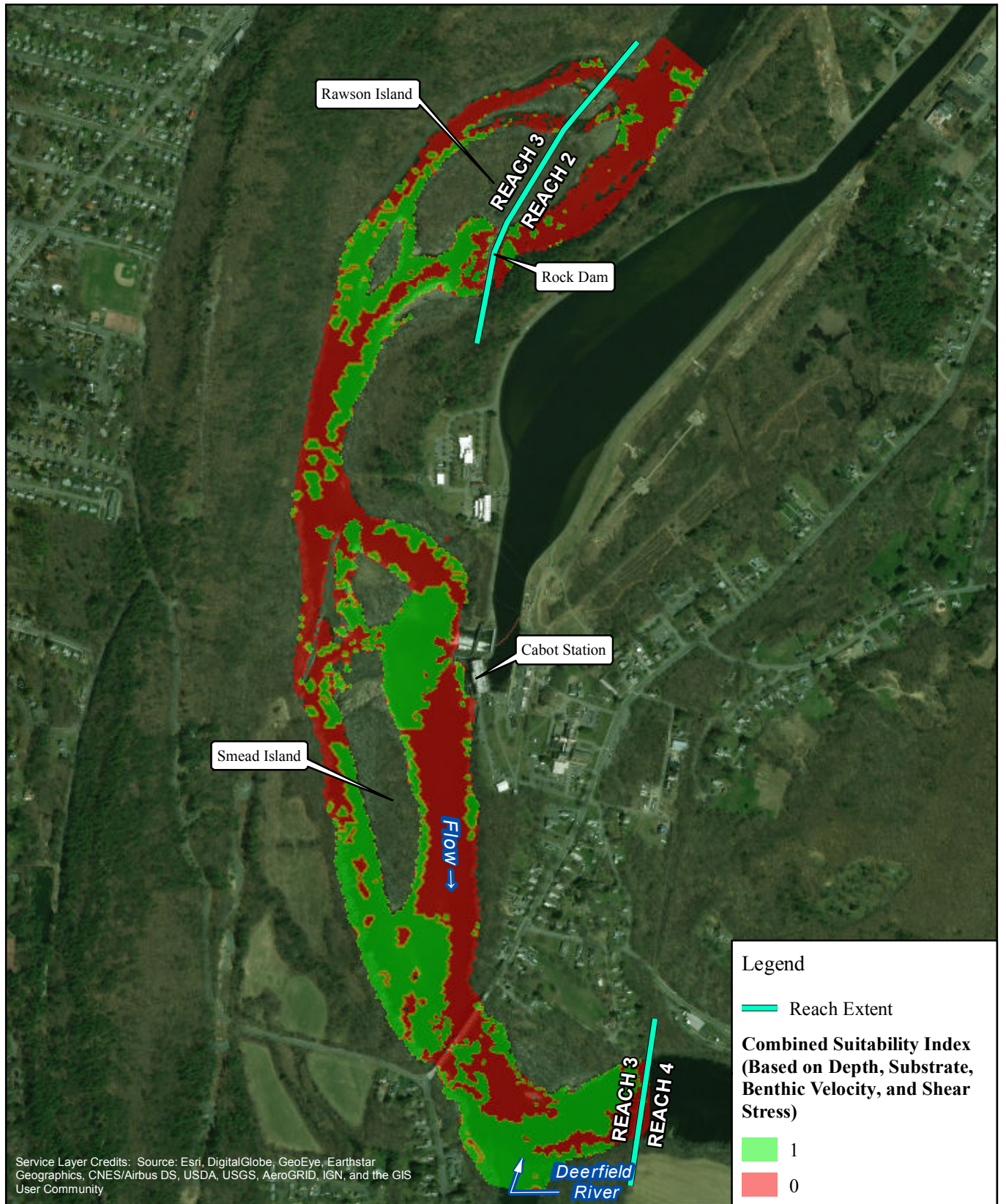
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Deerfield Flow: 200 cfs

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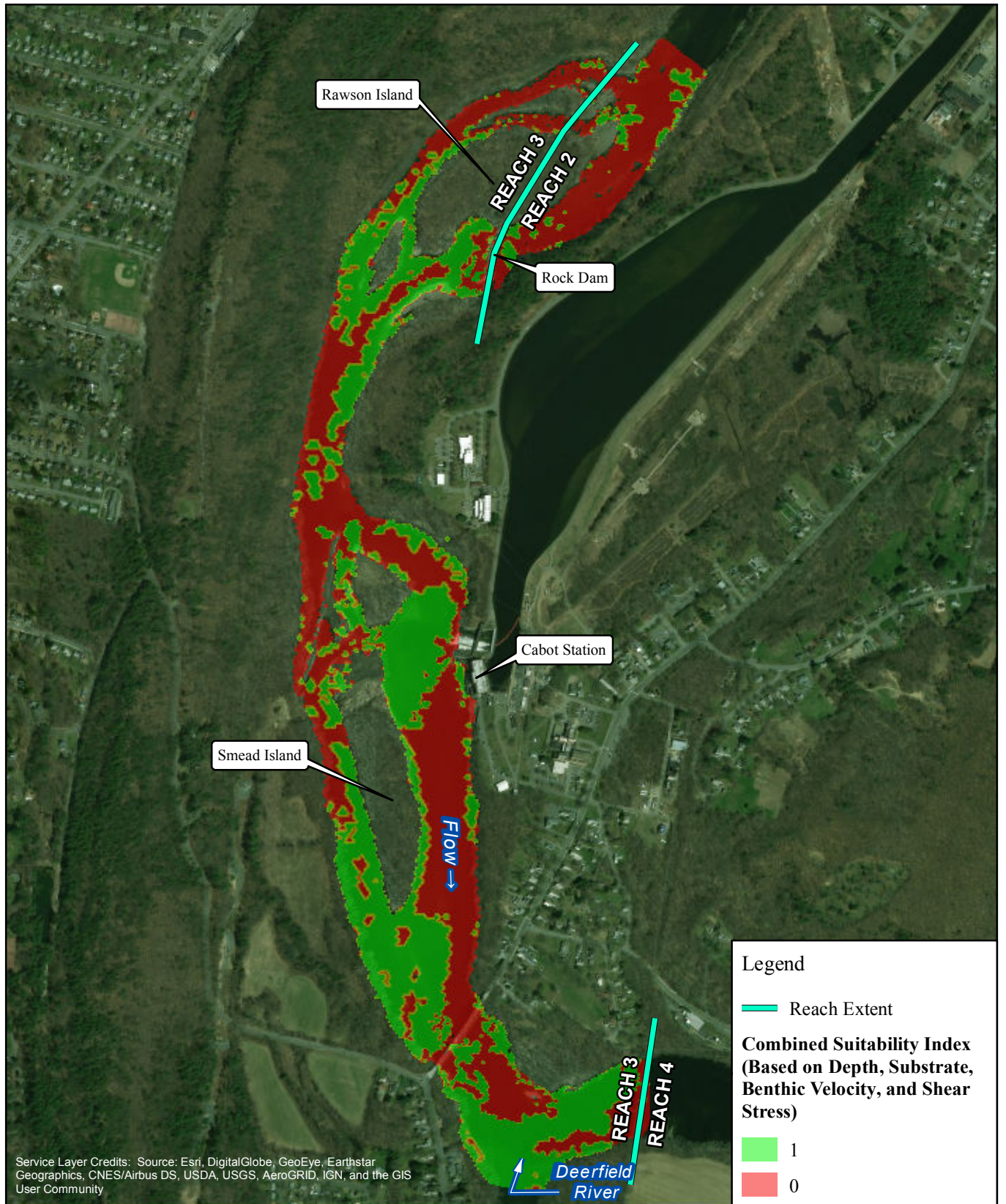
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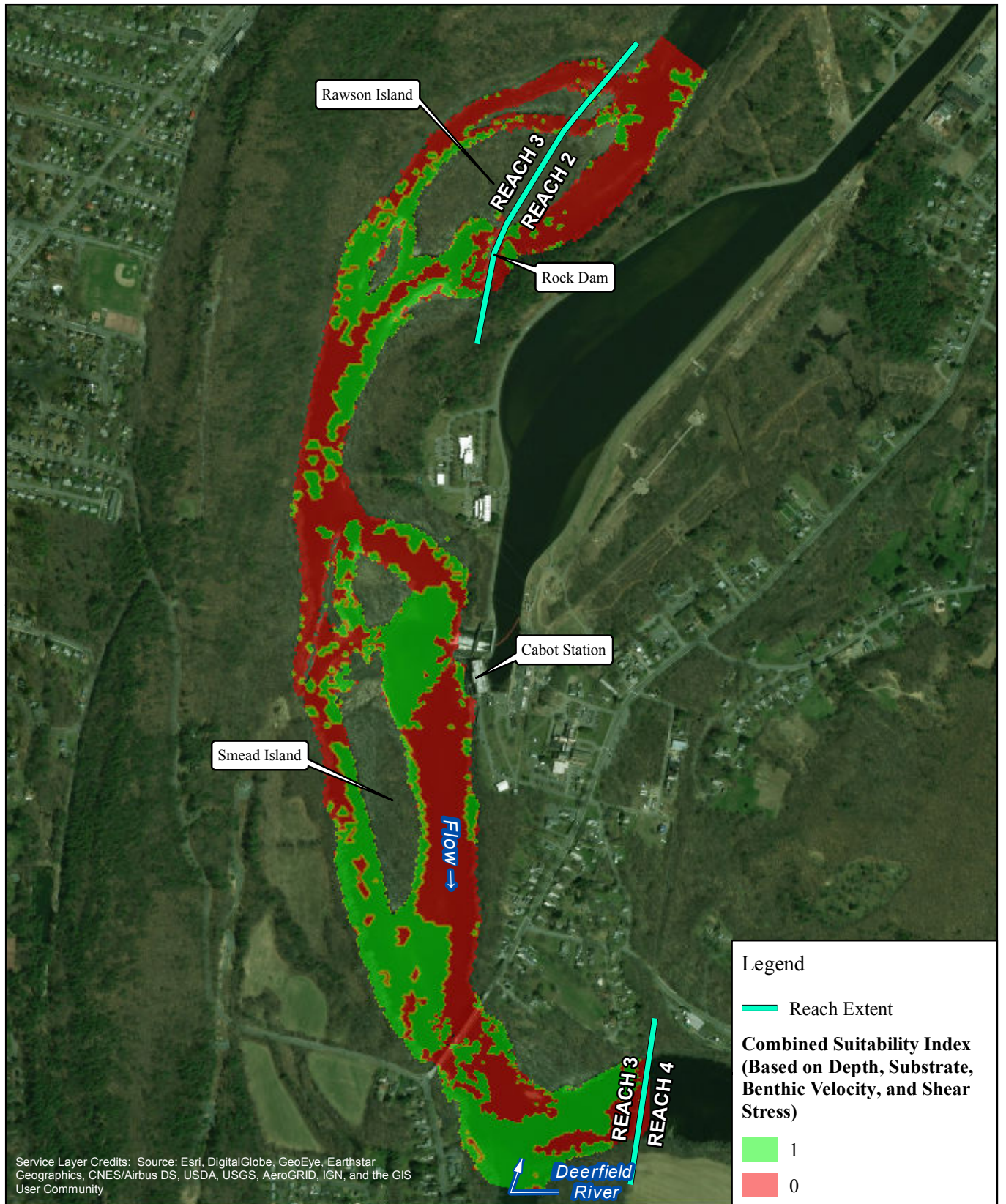
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Deerfield Flow: 200 cfs

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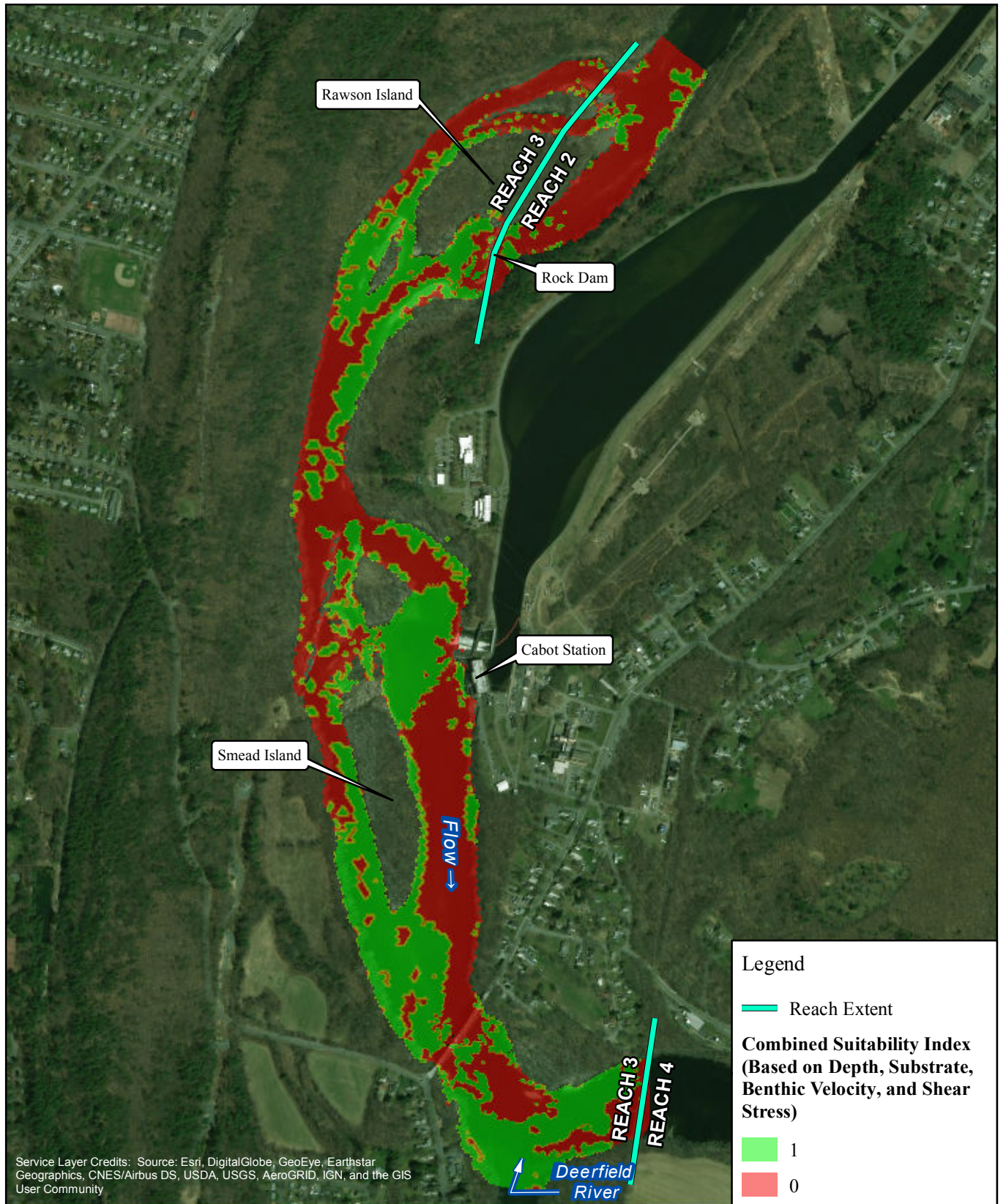
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**Yellow Lampmussel-Adult**  
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Deerfield Flow: 200 cfs

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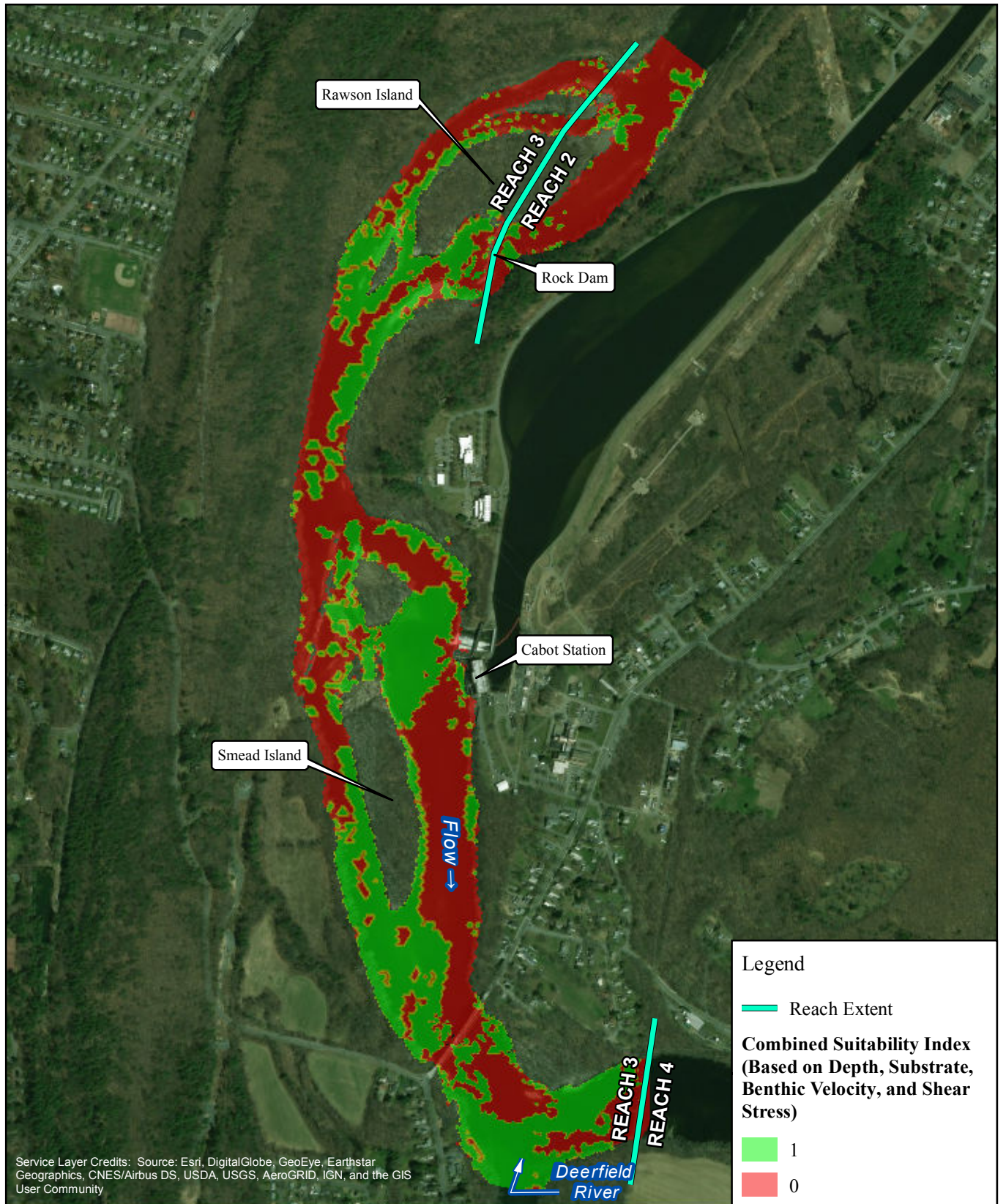
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**Yellow Lampmussel-Adult**  
Cabot Flow: 14000 cfs  
Bypass Flow: 5000 cfs  
Deerfield Flow: 200 cfs

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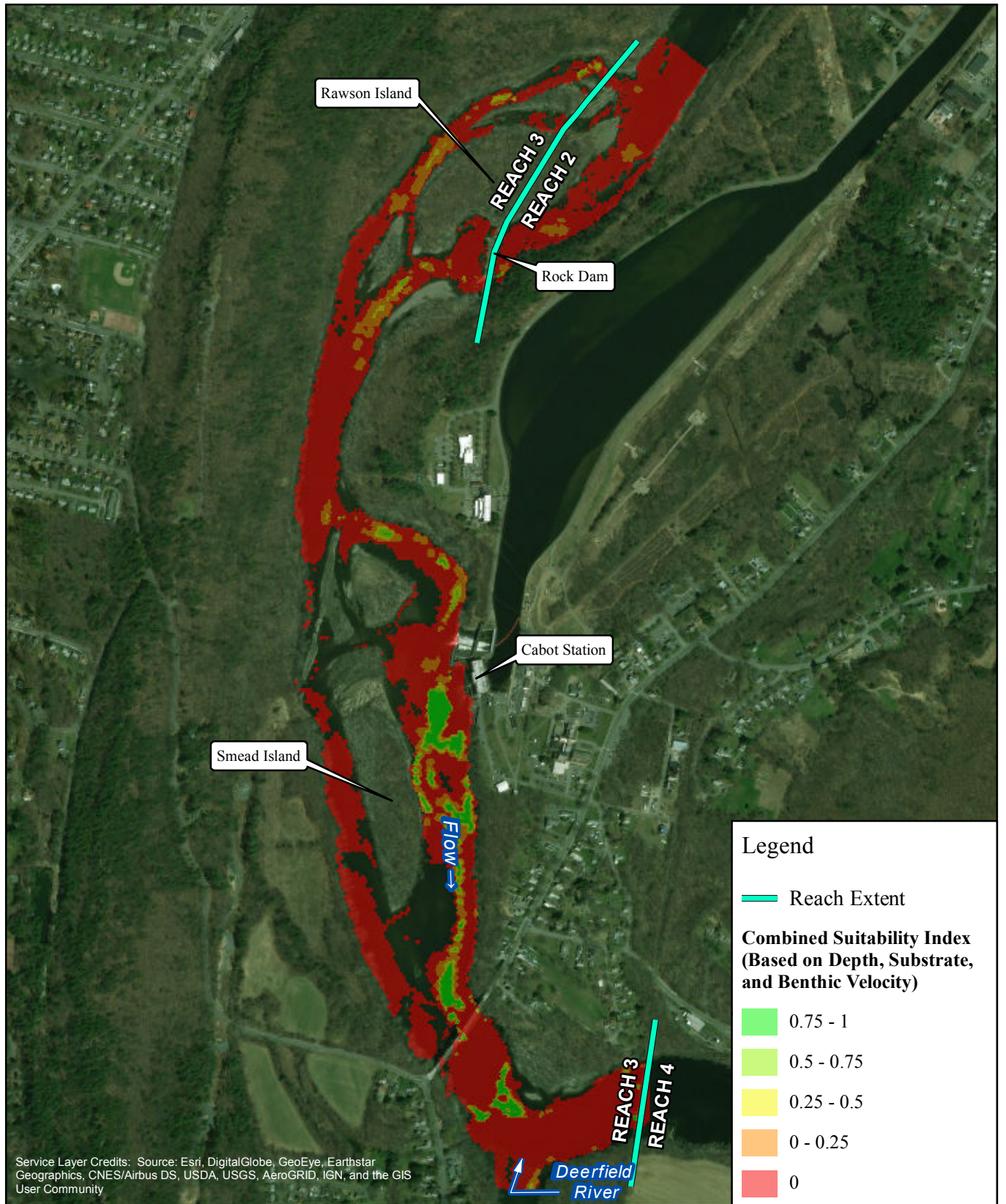
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**APPENDIX B-3 – COMBINED  
SUITABILITY INDEX MAPS FOR THE  
DEEP-SLOW GUILD UNDER VARIOUS  
BYPASS FLOWS, CABOT FLOWS AND A  
DEERFIELD RIVER FLOW OF 200 CFS  
BASED A 3-VARIABLE (DEPTH,  
VELOCITY, AND SUBSTRATE) BINARY  
ASSESSMENT**





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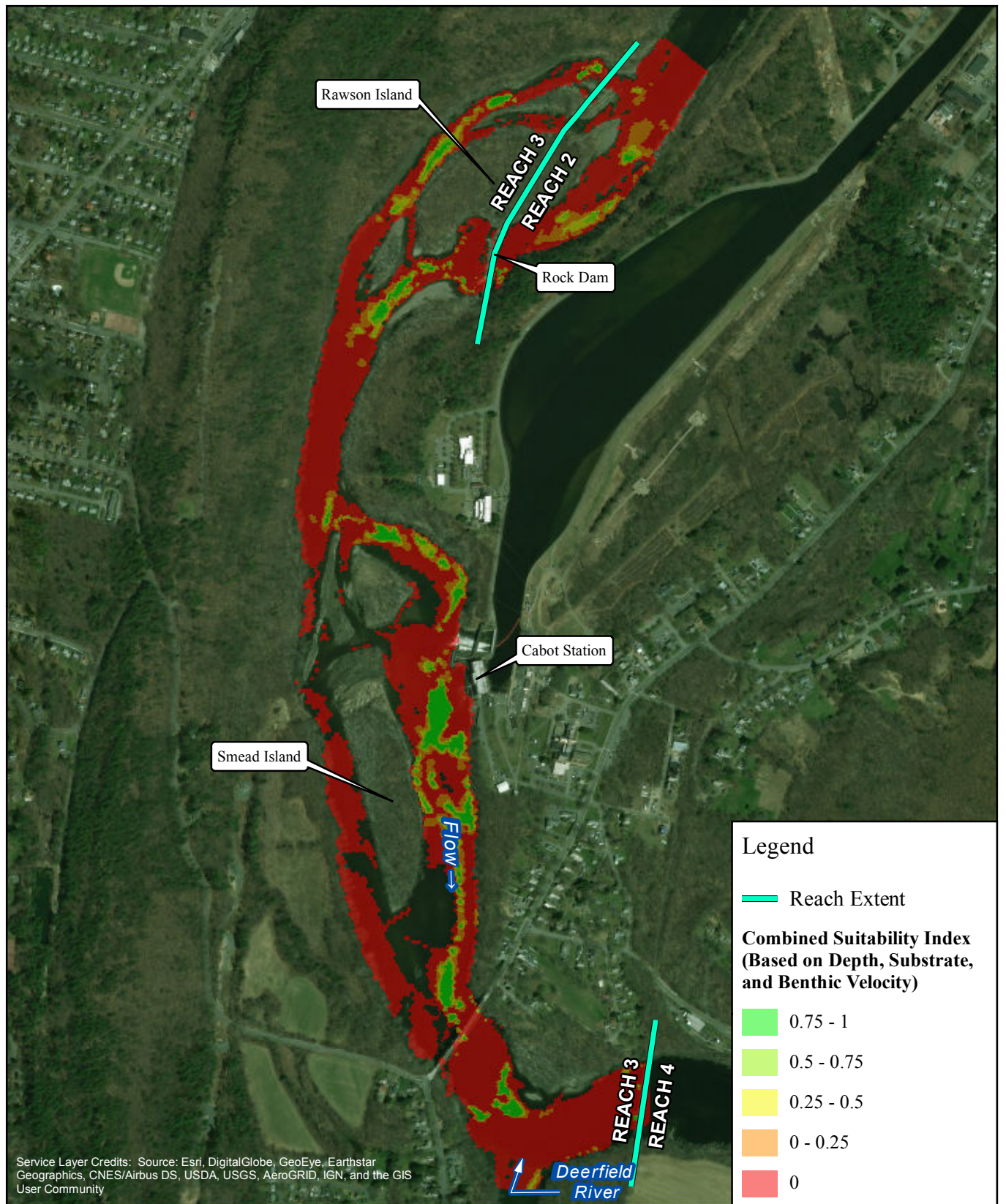
0 500 1,000 2,000  
Feet

Deep-Fast Guild-  
Cabot Flow: 2500 cfs  
Bypass Flow: 200 cfs  
Deerfield Flow: 200 cfs

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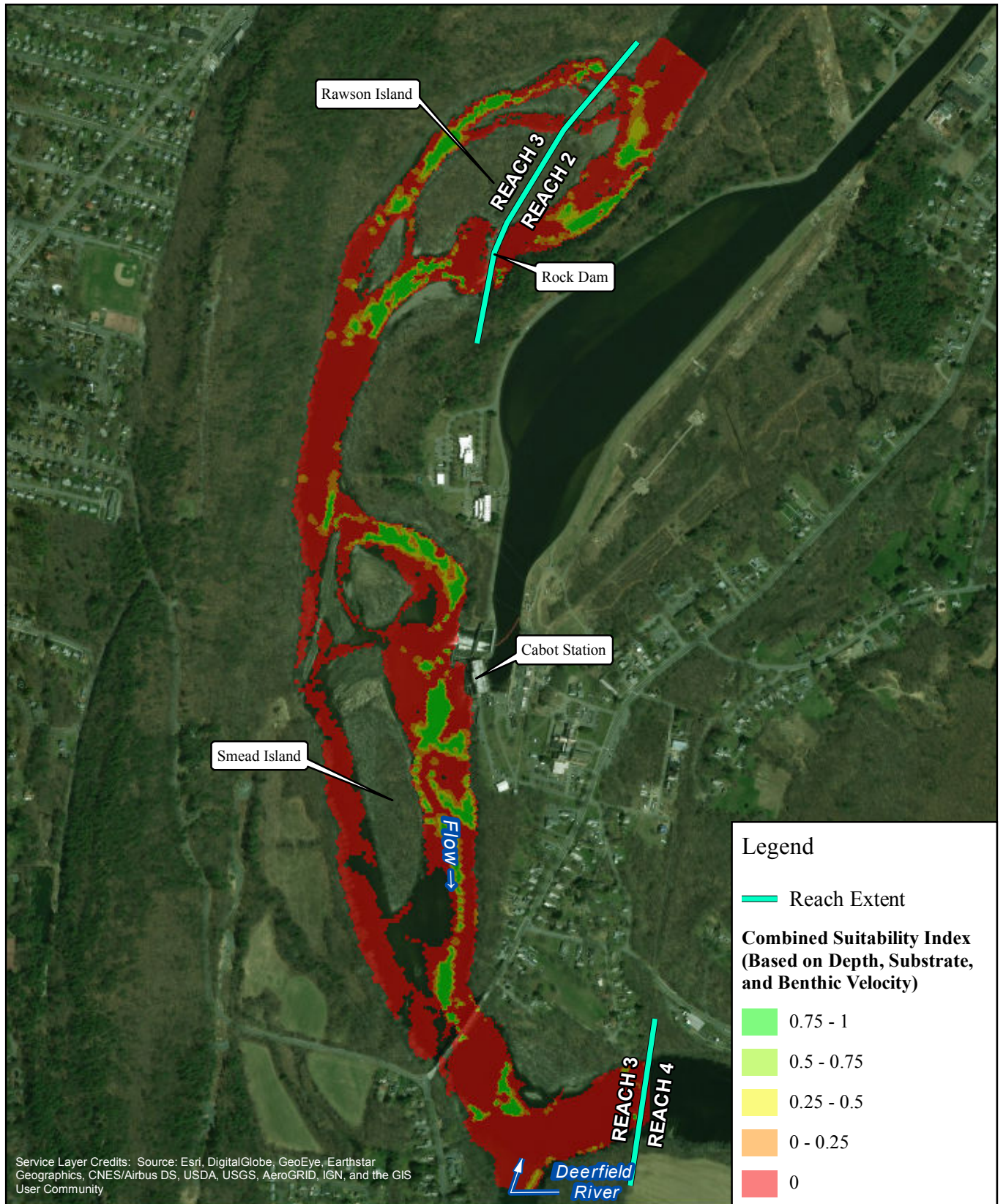
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Feet

Deep-Fast Guild-  
Cabot Flow: 2500 cfs  
Bypass Flow: 500 cfs  
Deerfield Flow: 200 cfs

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**RELICENSING STUDY 3.3.1**  
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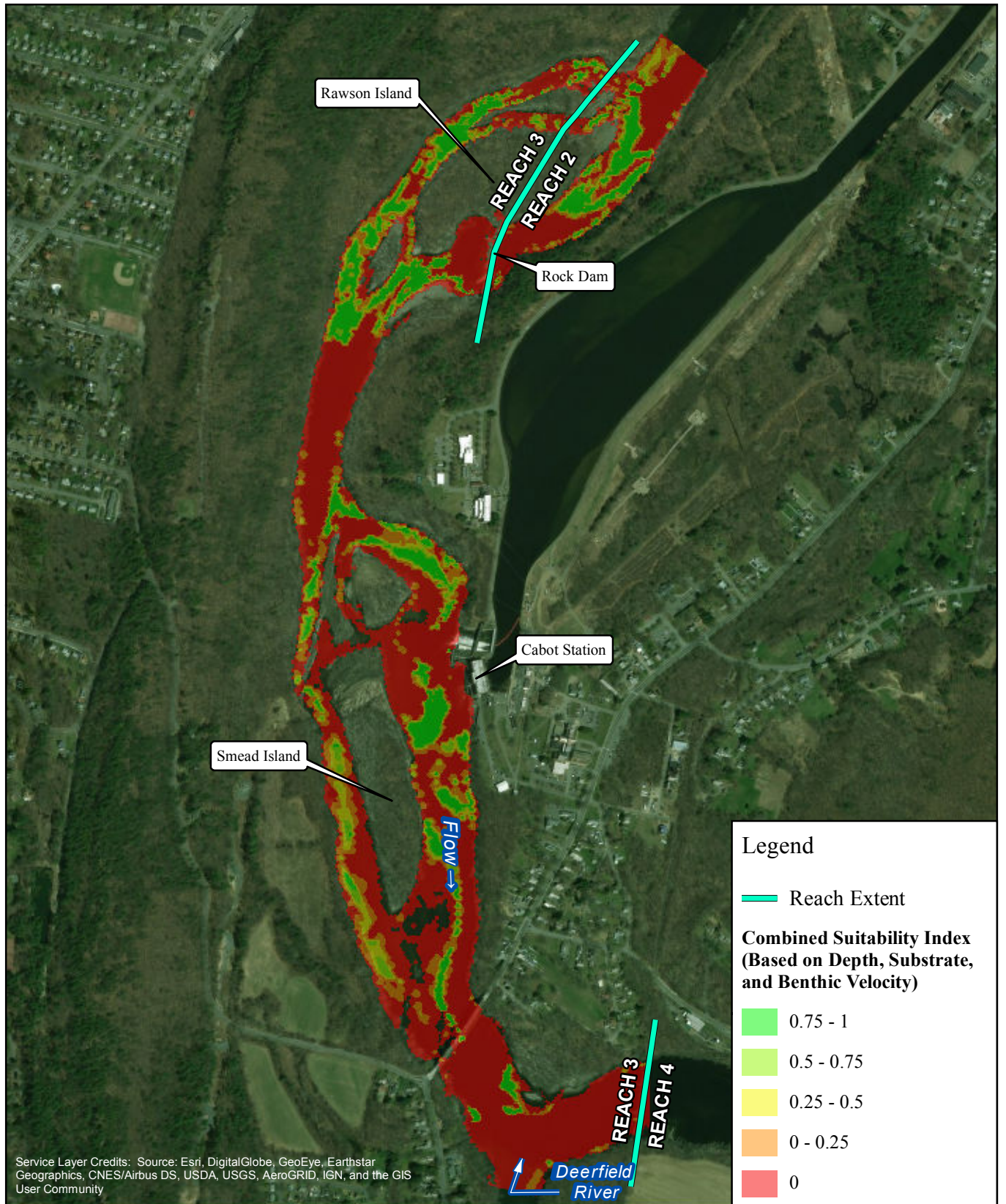
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Deep-Fast Guild-  
 Cabot Flow: 2500 cfs  
 Bypass Flow: 1000 cfs  
 Deerfield Flow: 200 cfs

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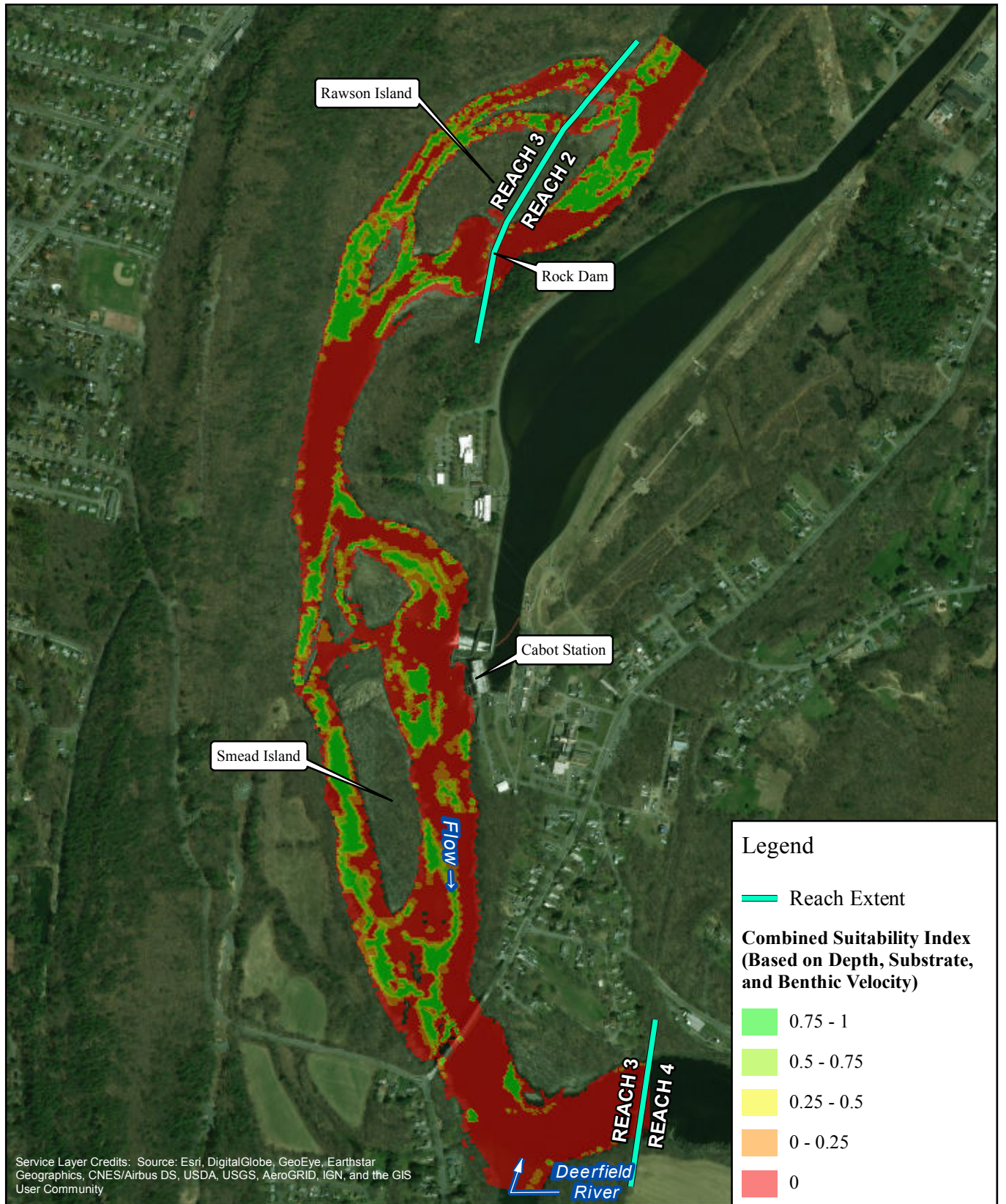
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Deep-Fast Guild-  
Cabot Flow: 2500 cfs  
Bypass Flow: 3000 cfs  
Deerfield Flow: 200 cfs

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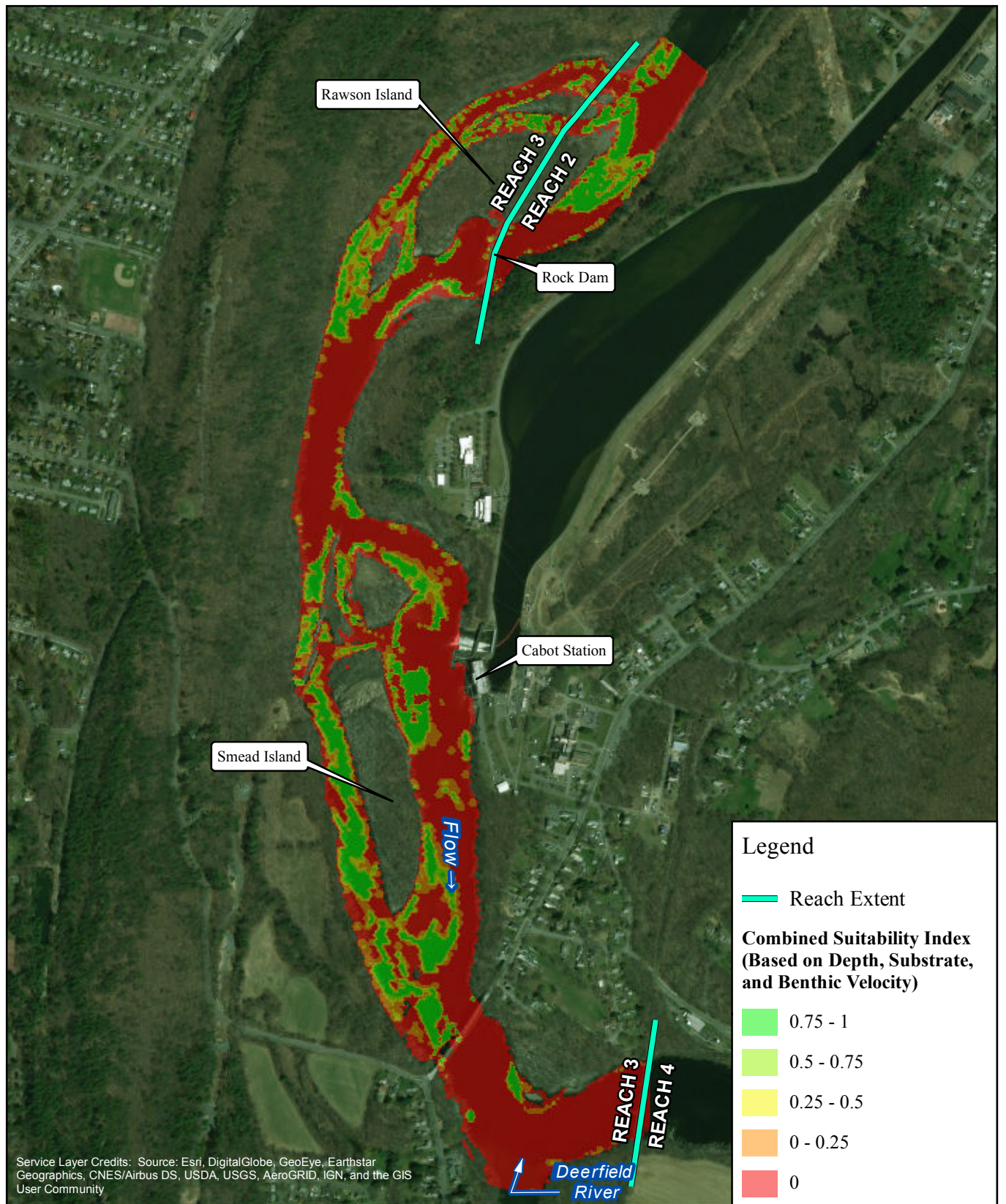
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Deep-Fast Guild-  
Cabot Flow: 2500 cfs  
Bypass Flow: 5000 cfs  
Deerfield Flow: 200 cfs

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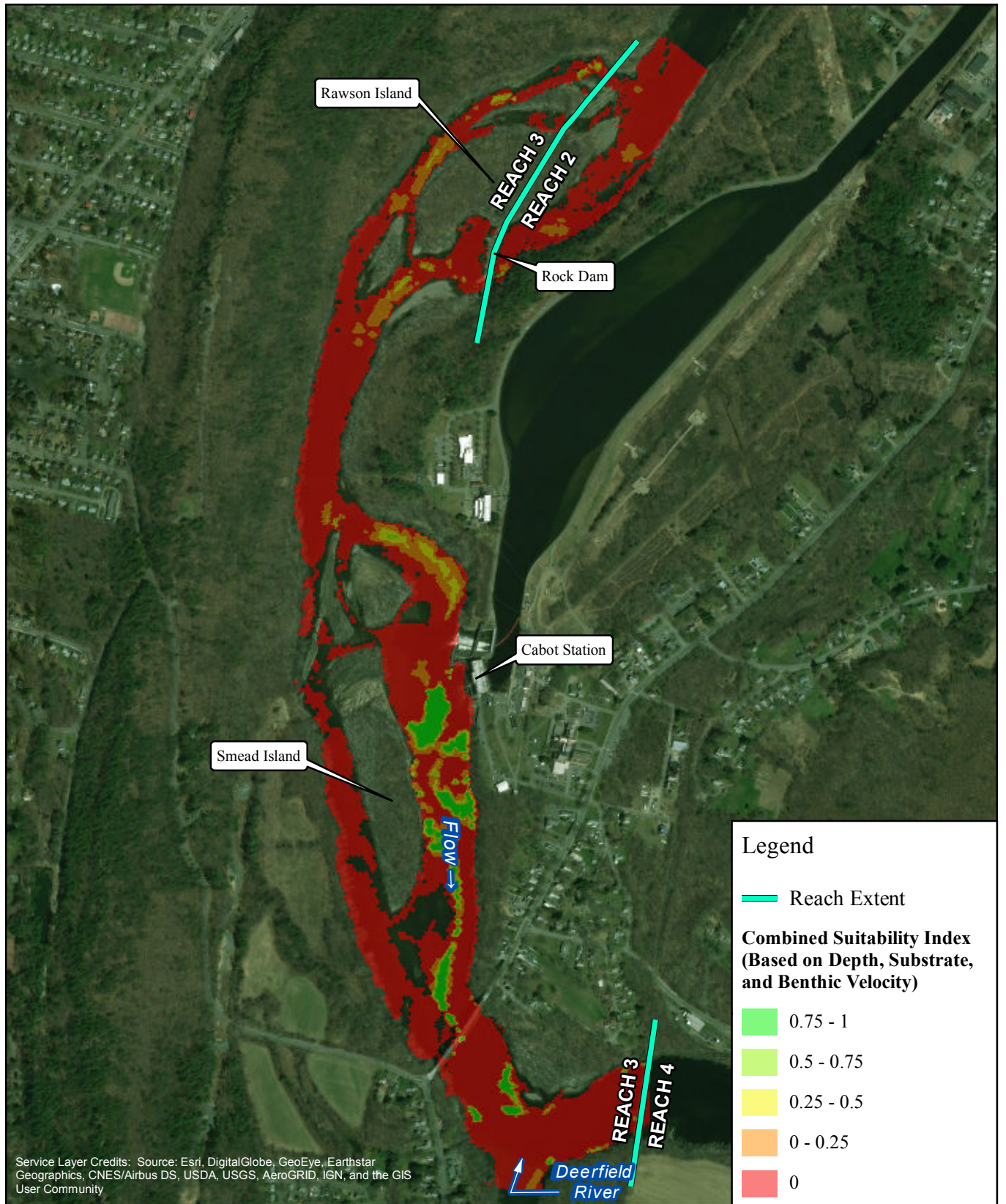
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Deep-Fast Guild-  
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Bypass Flow: 6500 cfs  
Deerfield Flow: 200 cfs

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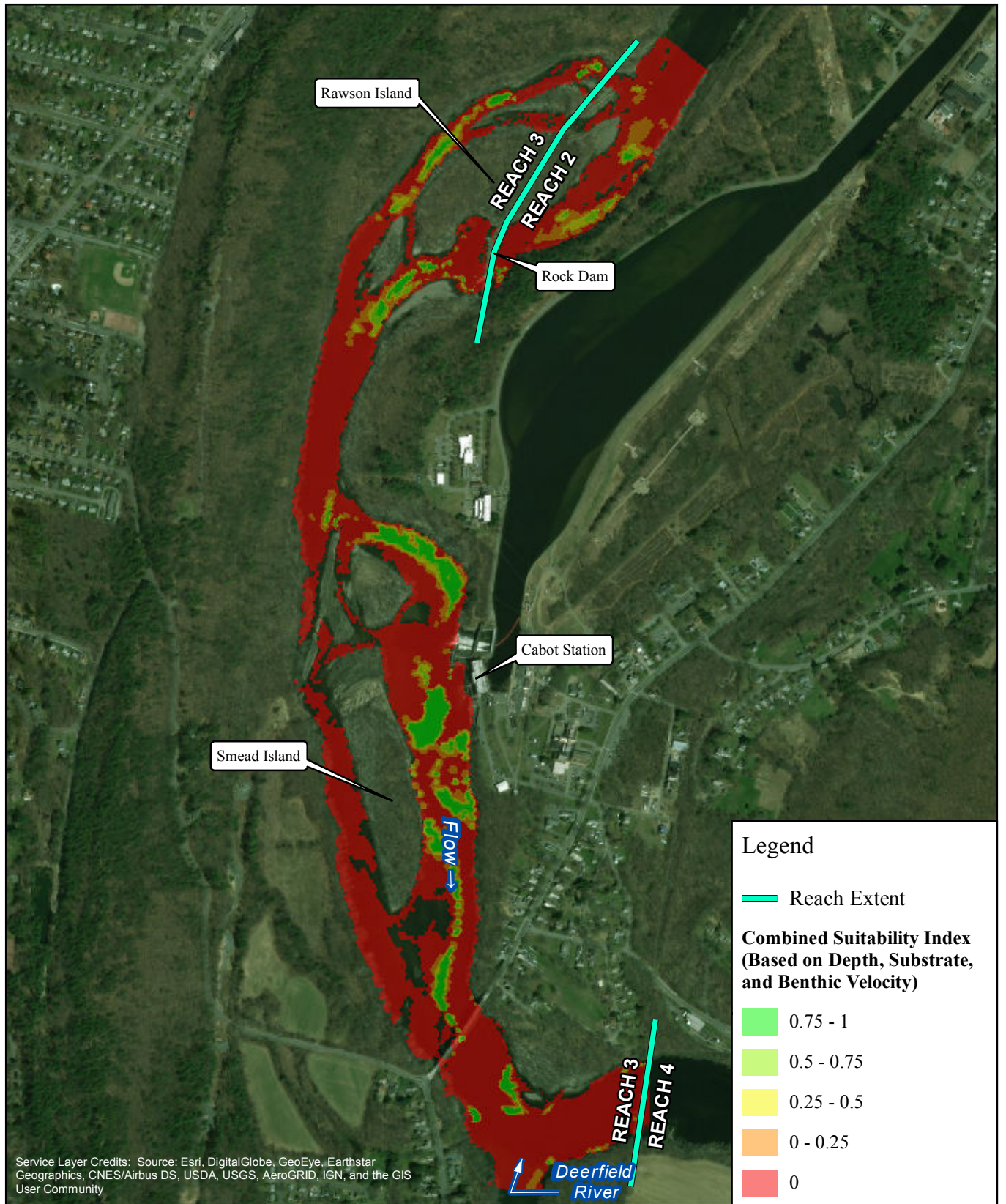
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Feet

Deep-Fast Guild-  
Cabot Flow: 4500 cfs  
Bypass Flow: 200 cfs  
Deerfield Flow: 200 cfs

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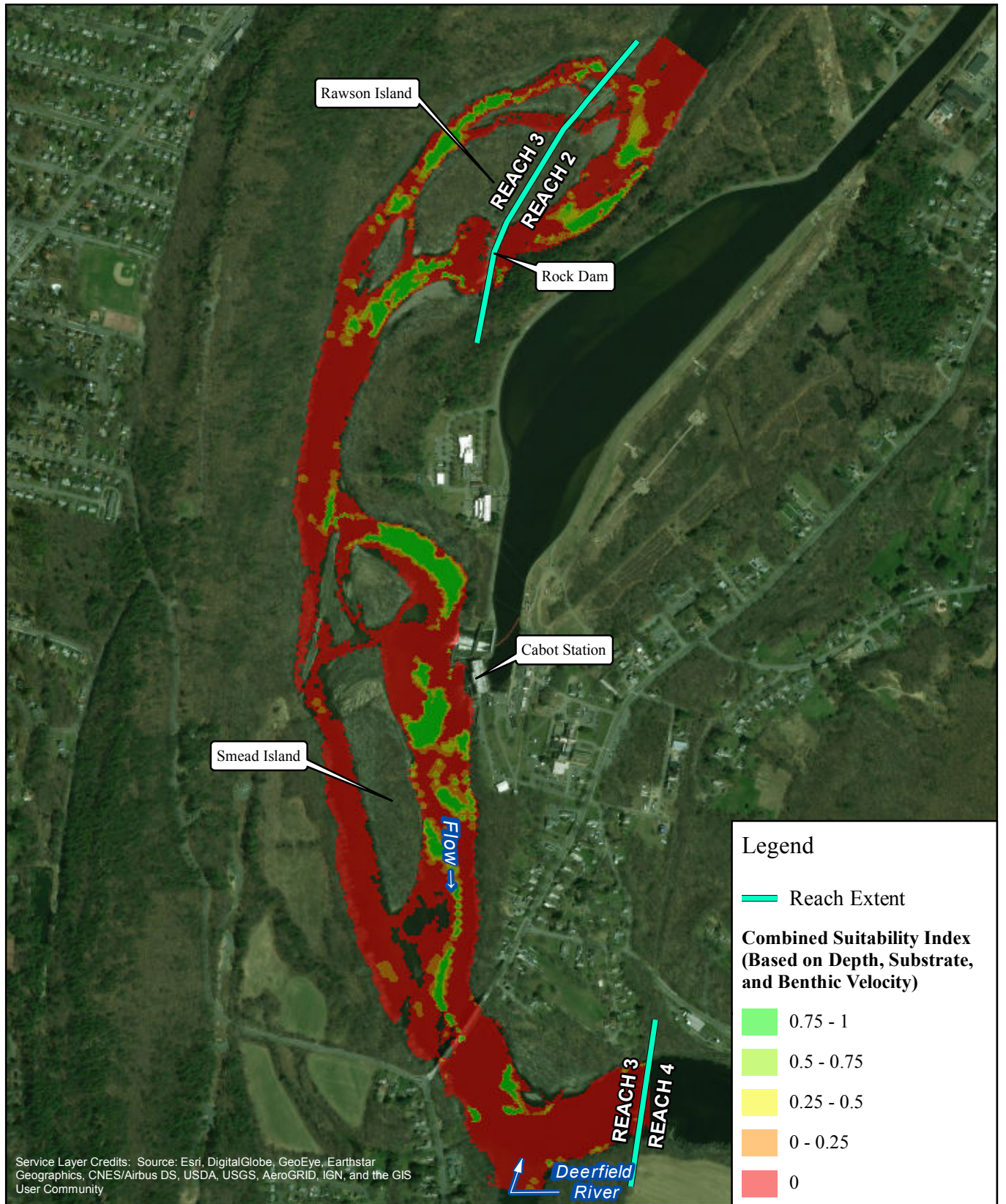
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Deep-Fast Guild-  
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Deerfield Flow: 200 cfs

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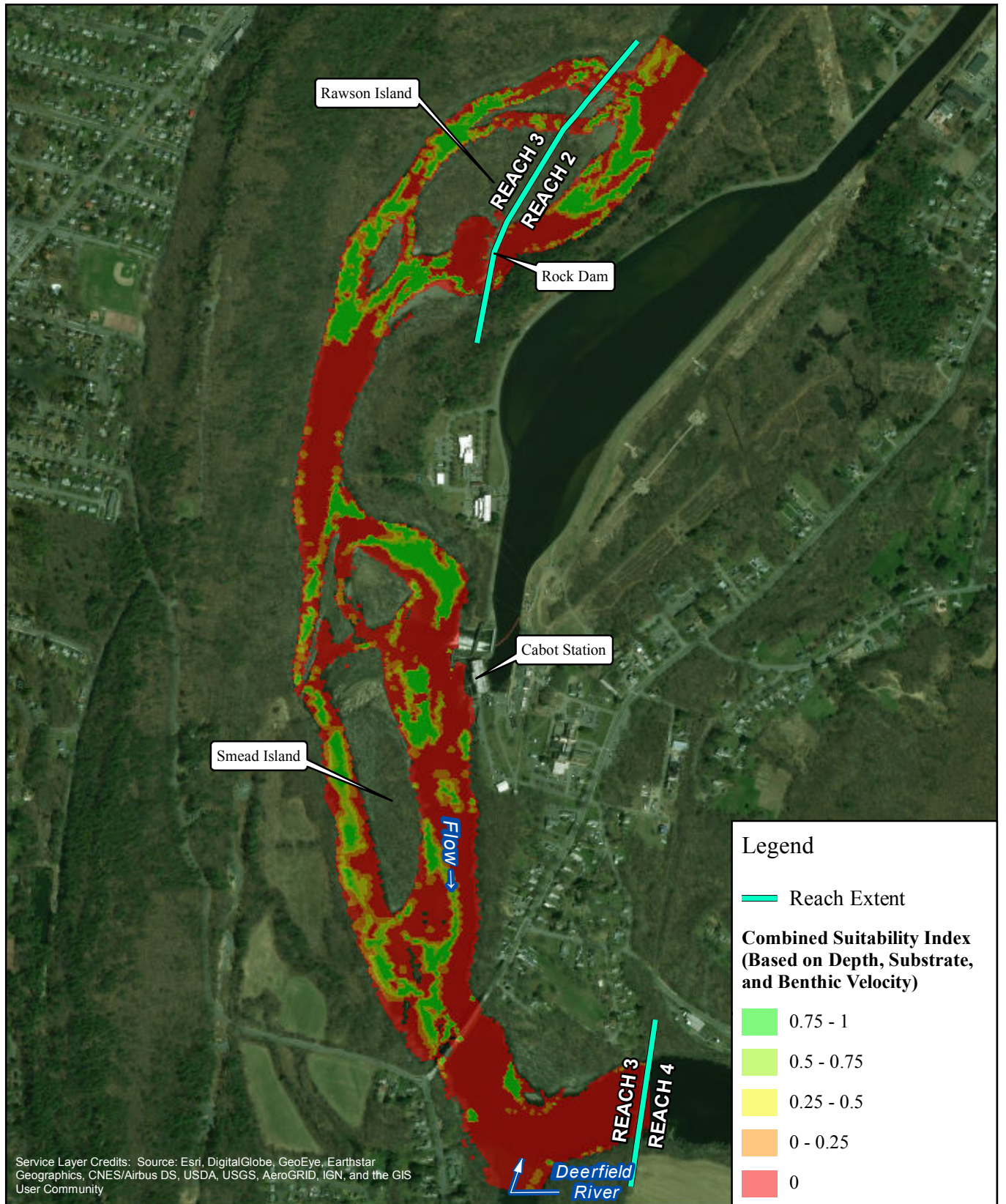
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Deep-Fast Guild-  
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Deerfield Flow: 200 cfs

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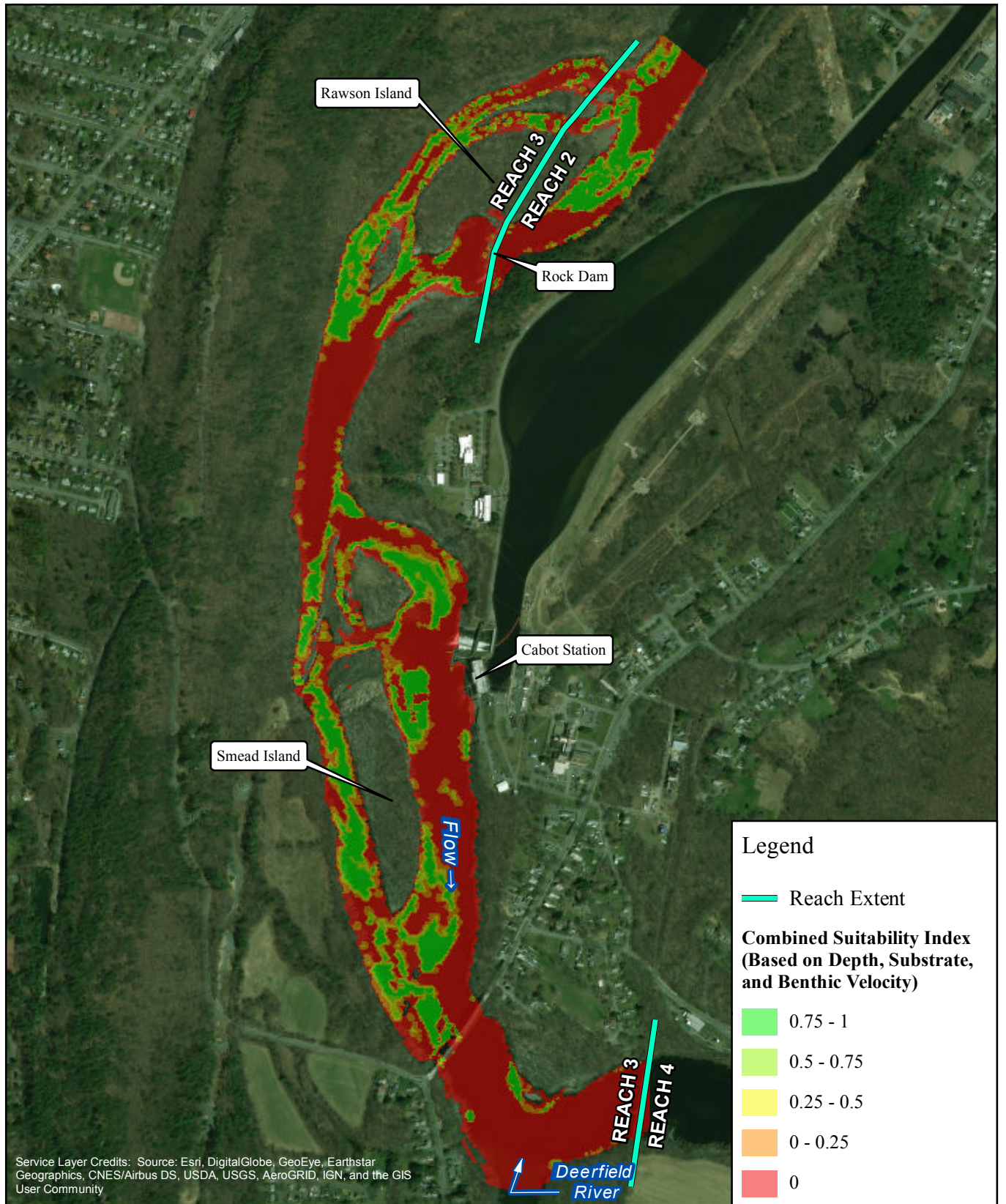
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Deep-Fast Guild-  
Cabot Flow: 4500 cfs  
Bypass Flow: 3000 cfs  
Deerfield Flow: 200 cfs

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RELICENSING STUDY 3.3.1  
Addendum 3 Reach 3 Mussels (May 2018)

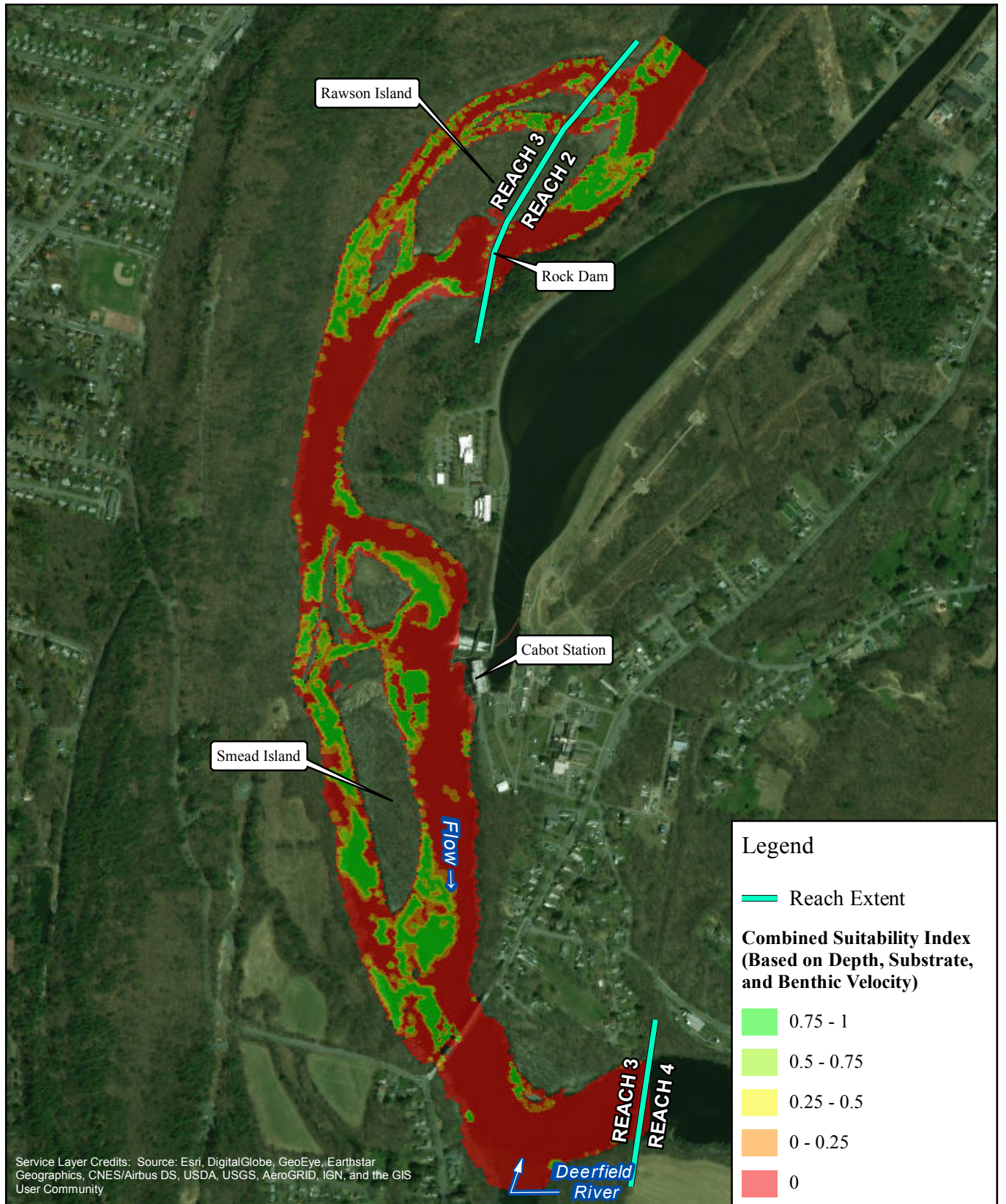
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Deep-Fast Guild-  
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Bypass Flow: 5000 cfs  
Deerfield Flow: 200 cfs

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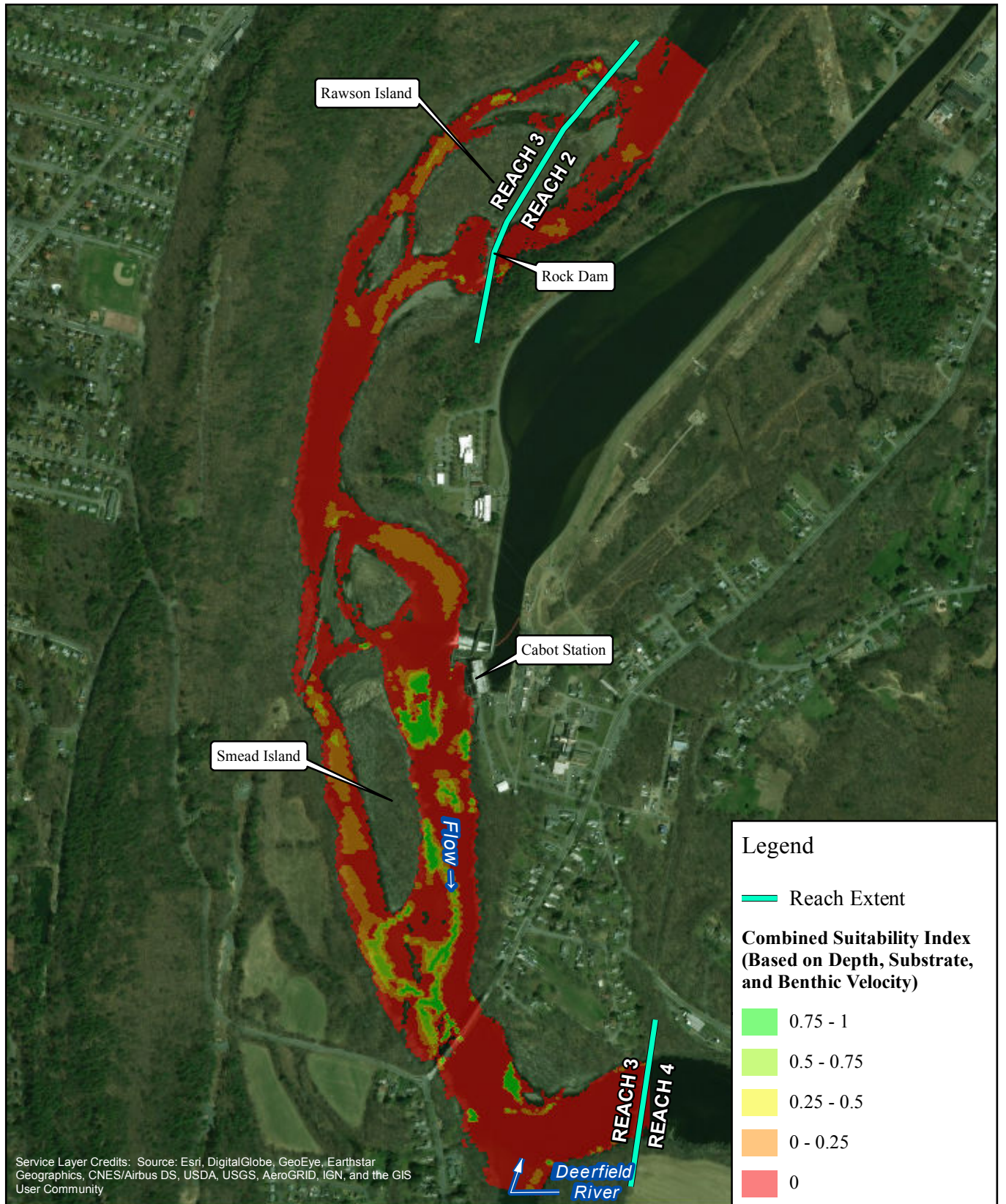
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Deep-Fast Guild-  
Cabot Flow: 4500 cfs  
Bypass Flow: 6500 cfs  
Deerfield Flow: 200 cfs

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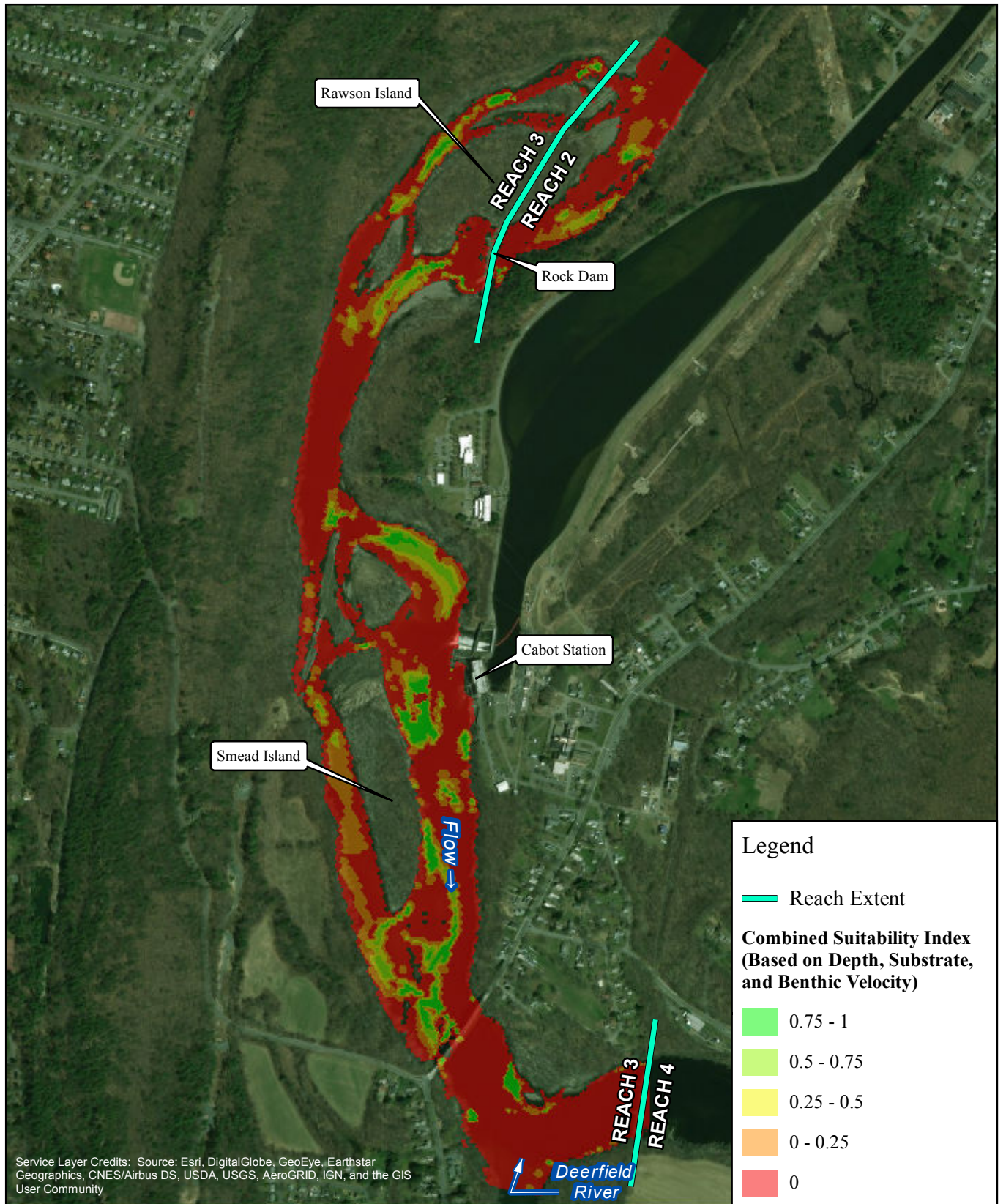
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Cabot Flow: 7000 cfs  
Bypass Flow: 200 cfs  
Deerfield Flow: 200 cfs

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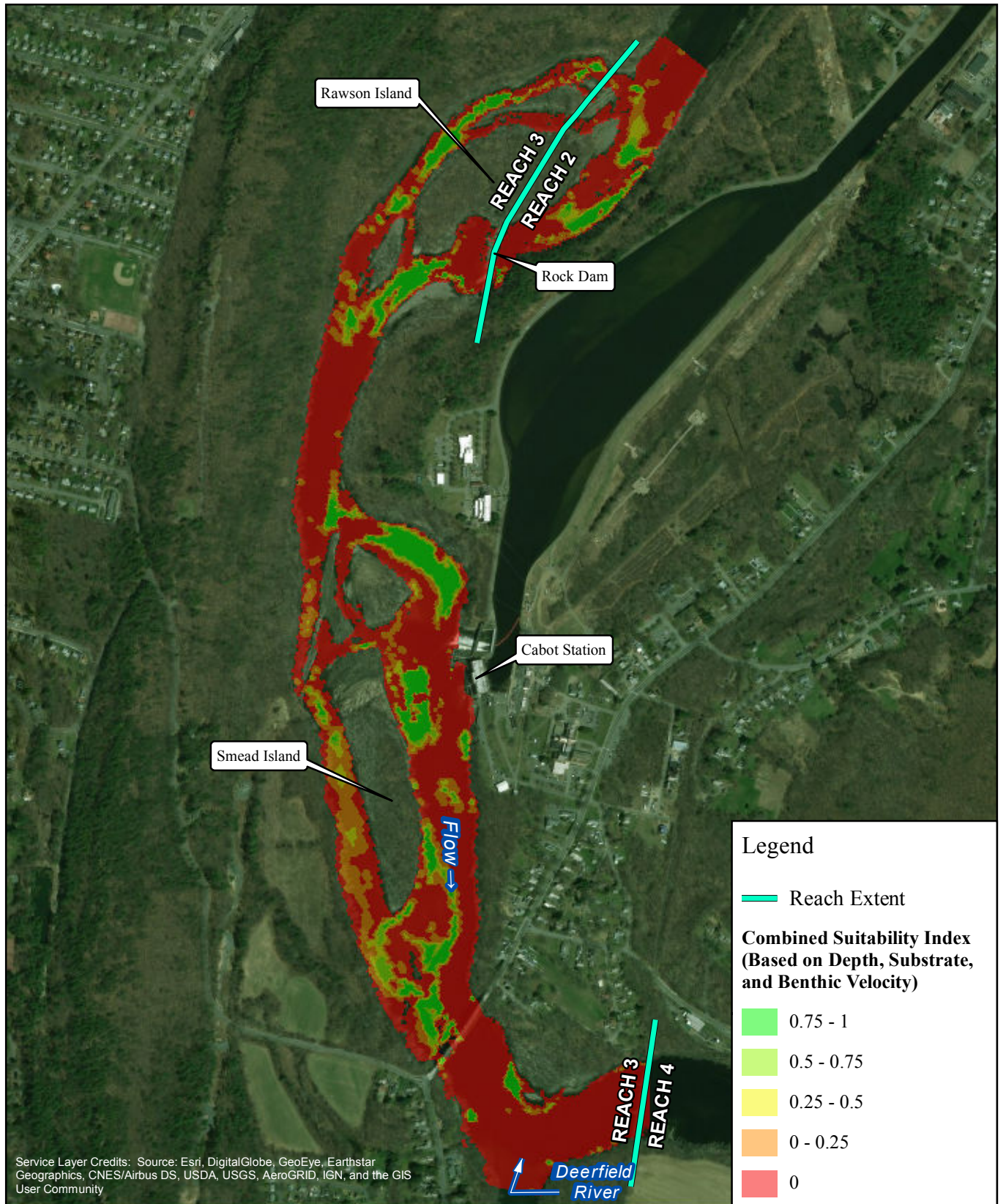
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Bypass Flow: 500 cfs  
Deerfield Flow: 200 cfs

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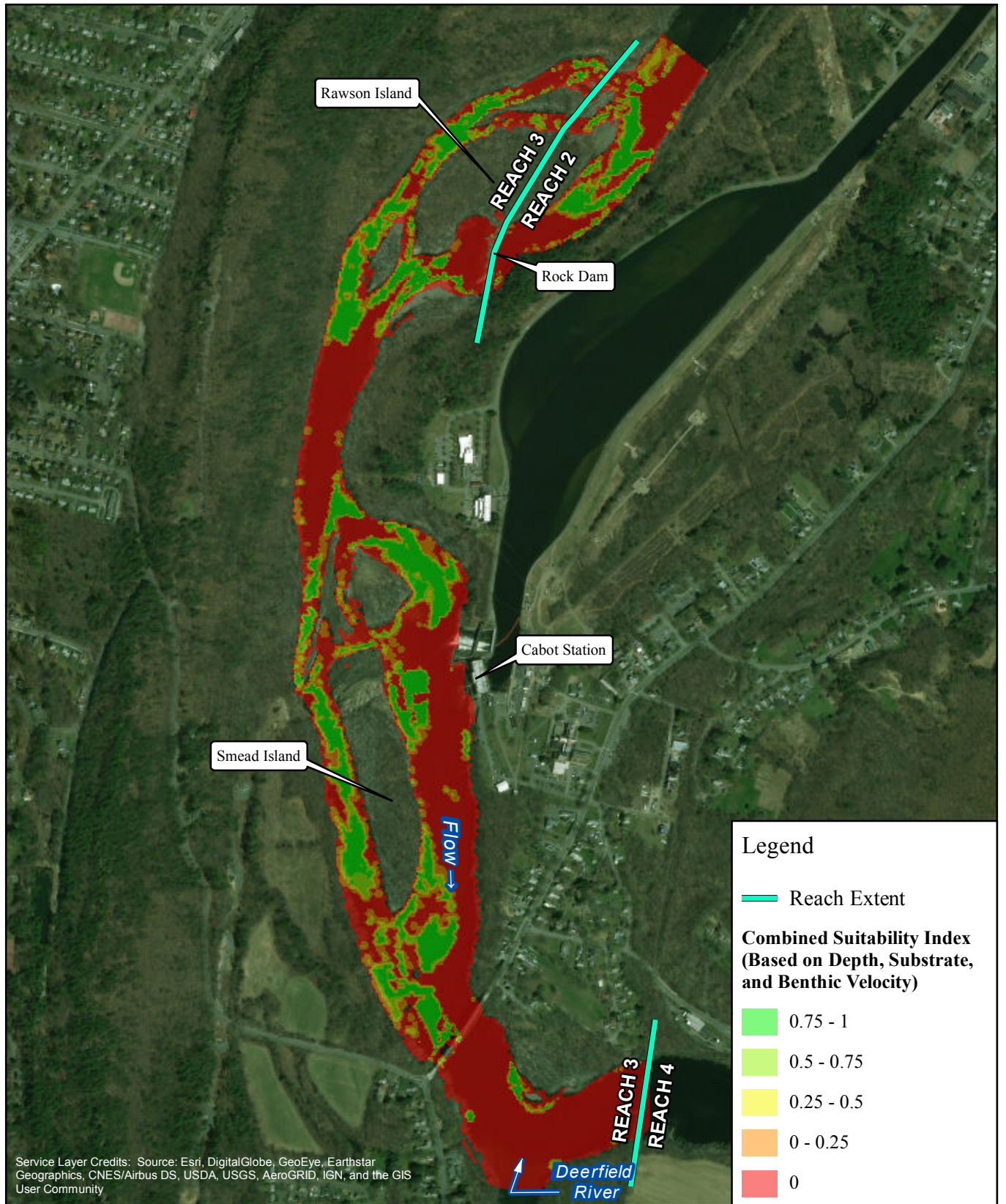
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Bypass Flow: 1000 cfs  
Deerfield Flow: 200 cfs

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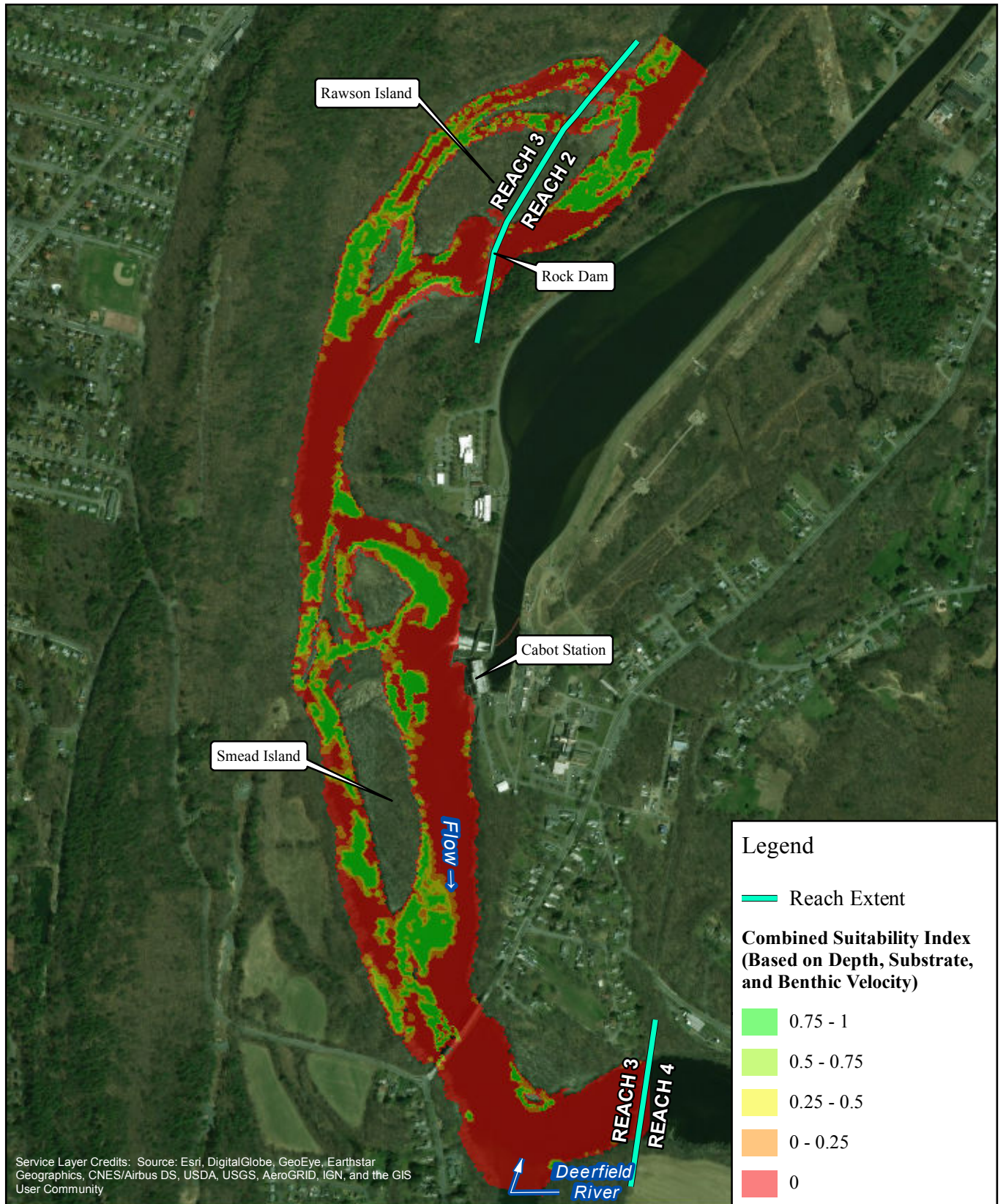
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Bypass Flow: 3000 cfs  
Deerfield Flow: 200 cfs

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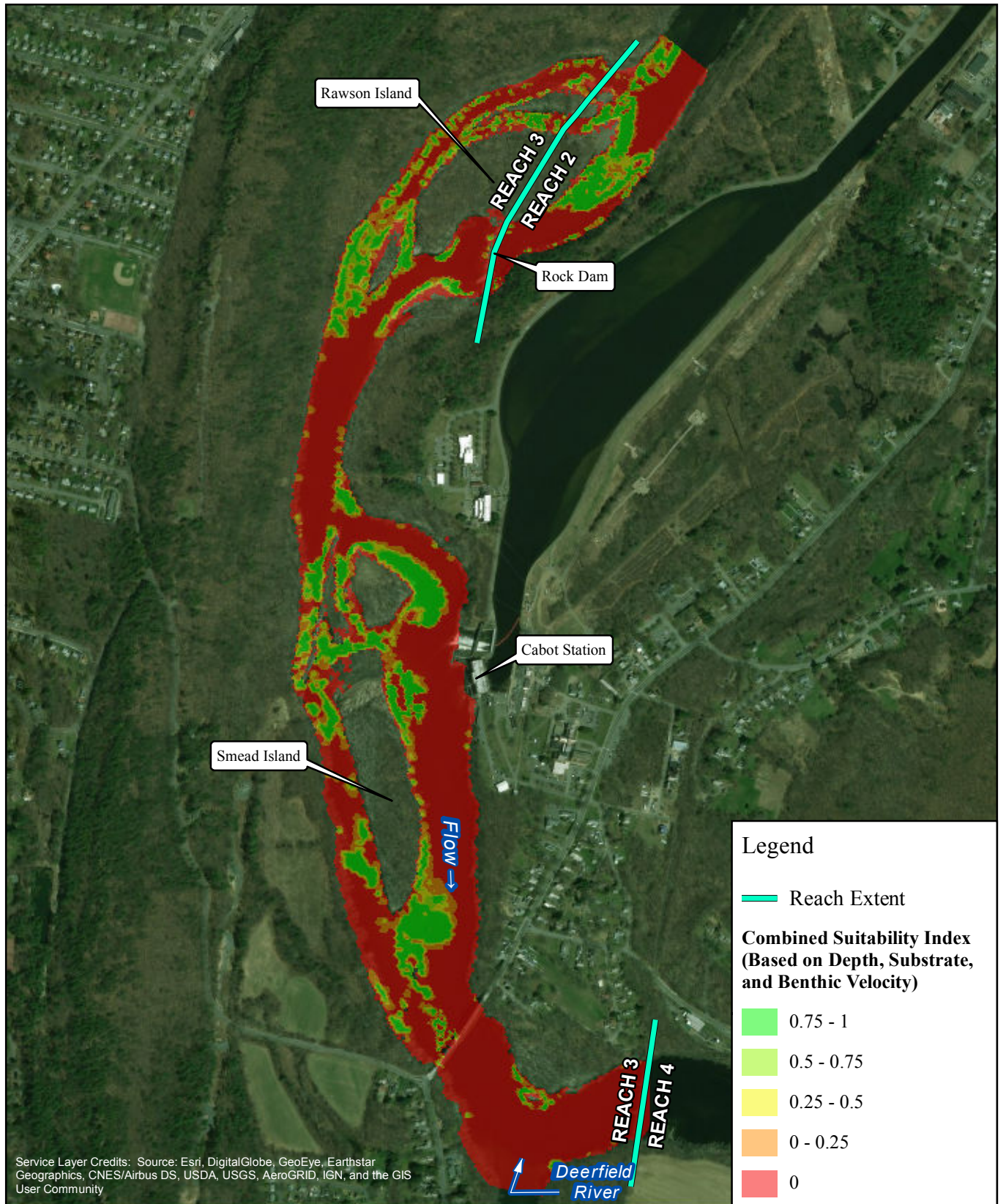
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Bypass Flow: 5000 cfs  
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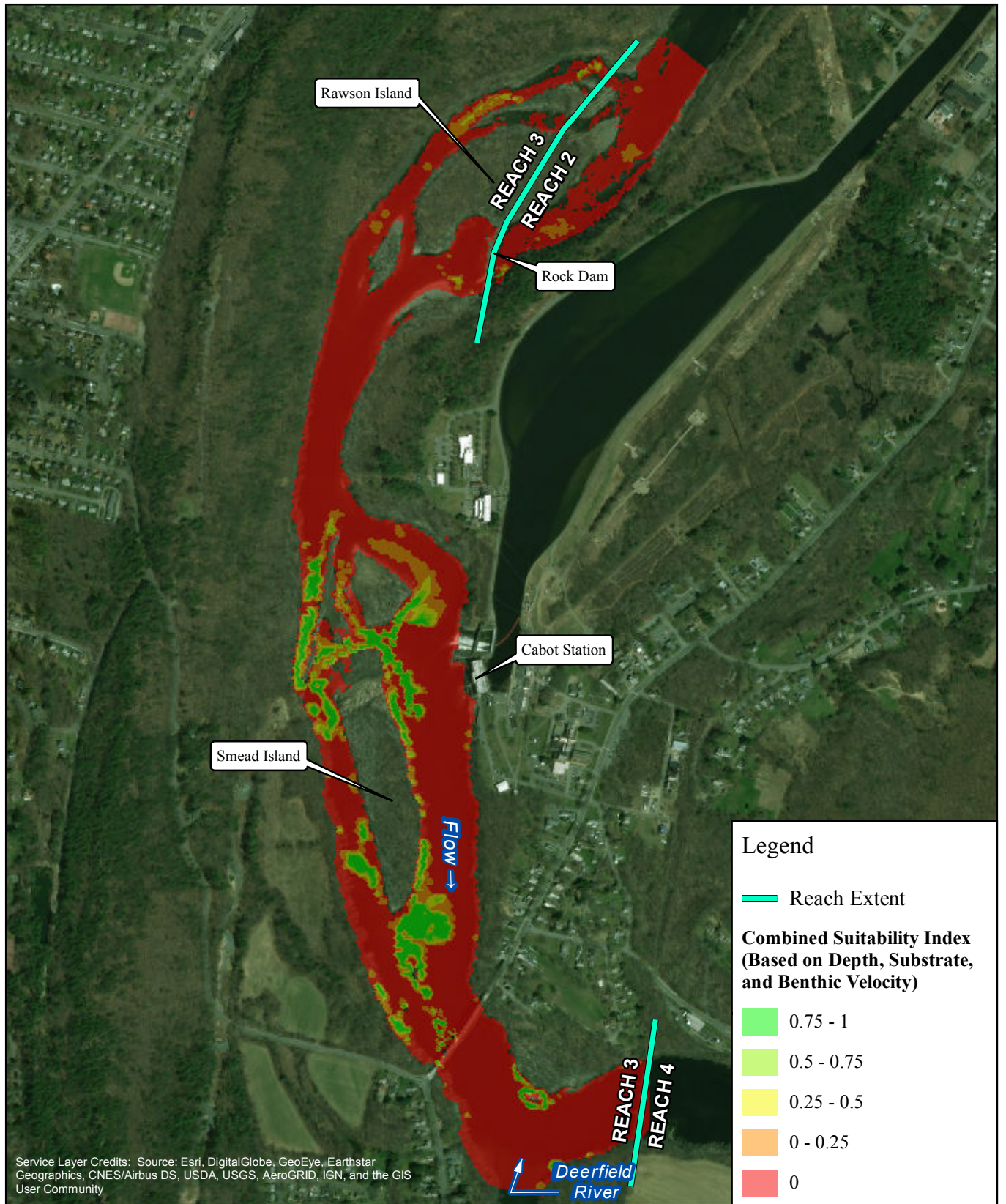
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Bypass Flow: 6500 cfs  
Deerfield Flow: 200 cfs

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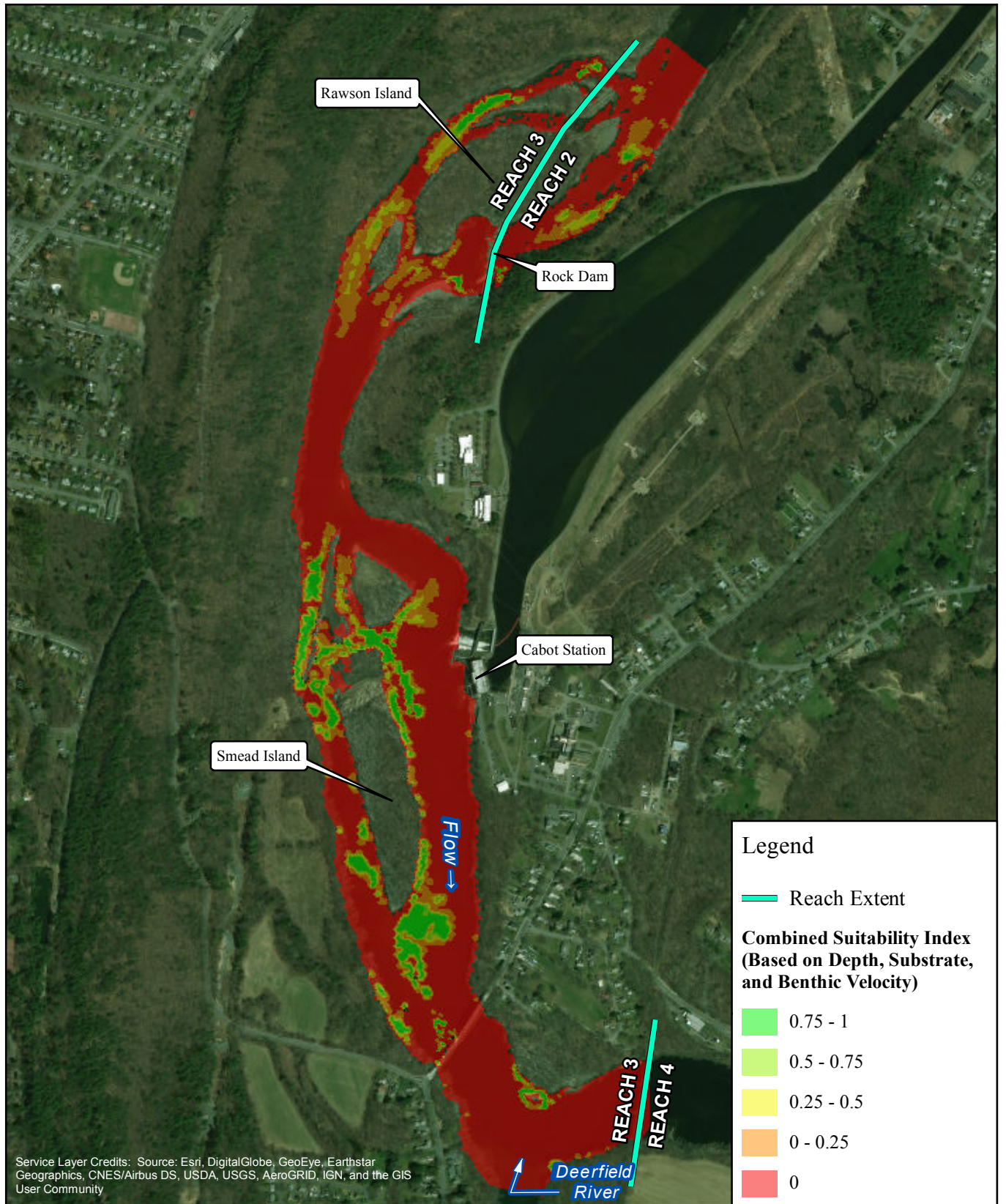
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Bypass Flow: 200 cfs  
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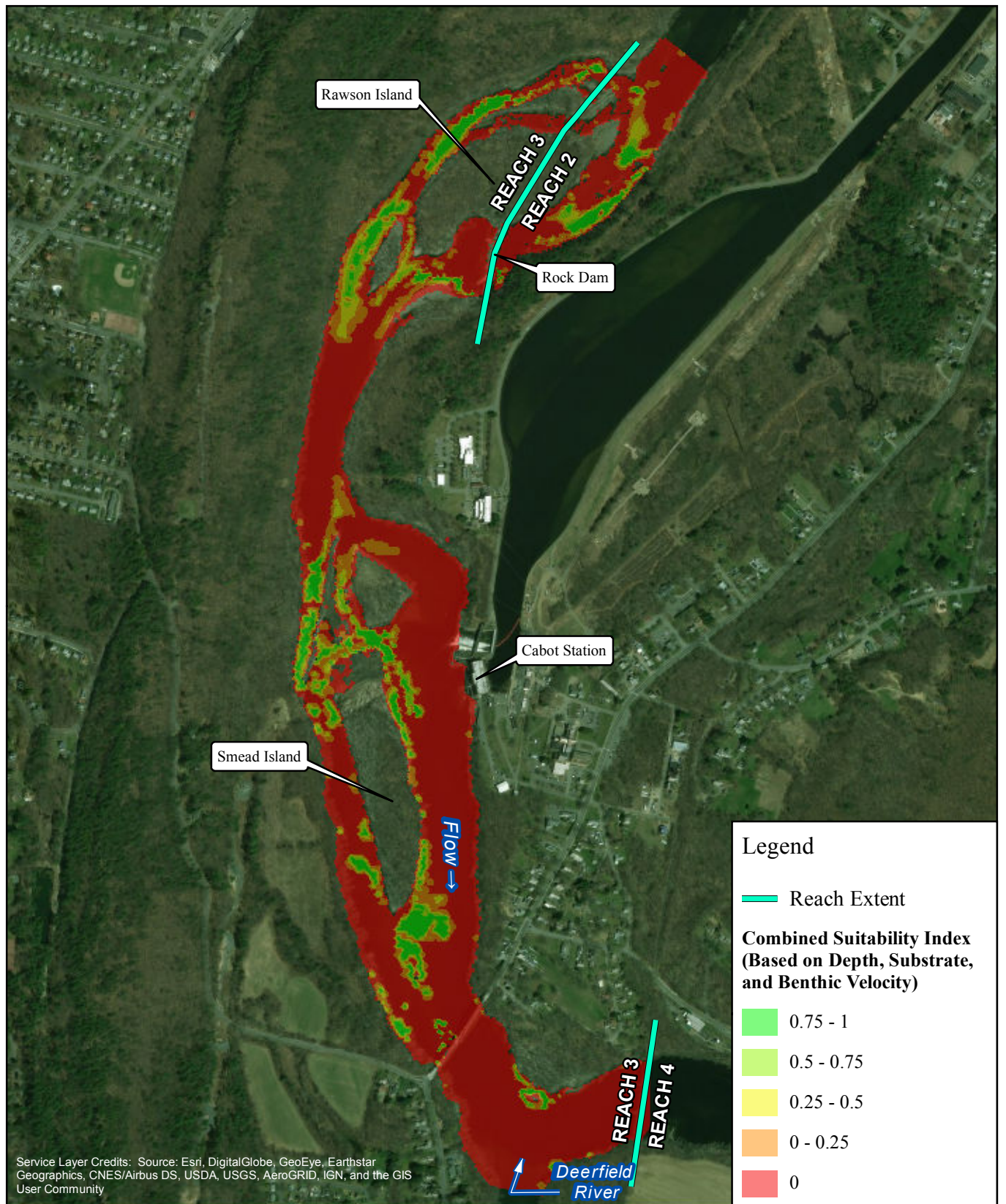
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Deerfield Flow: 200 cfs

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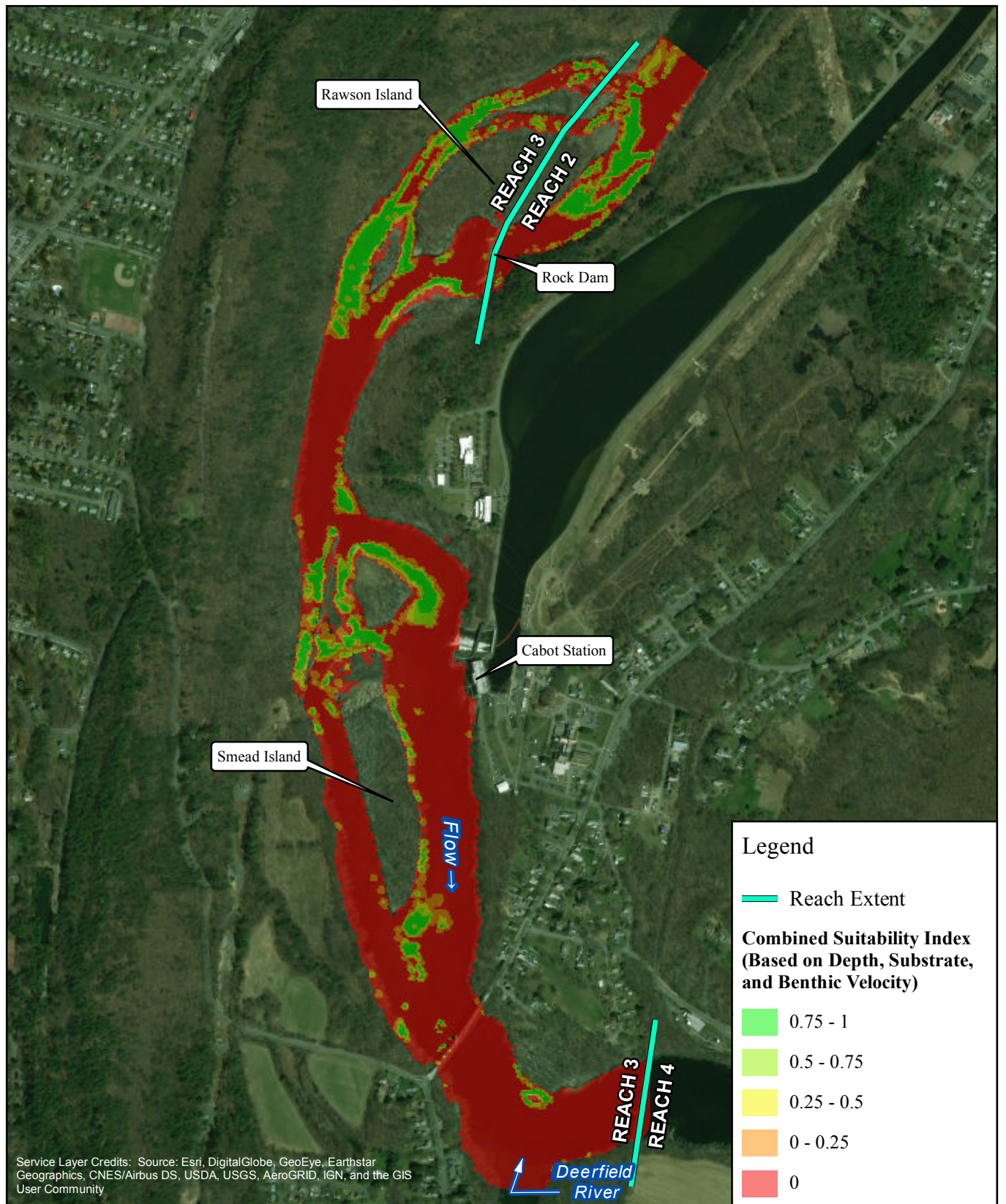
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Deerfield Flow: 200 cfs

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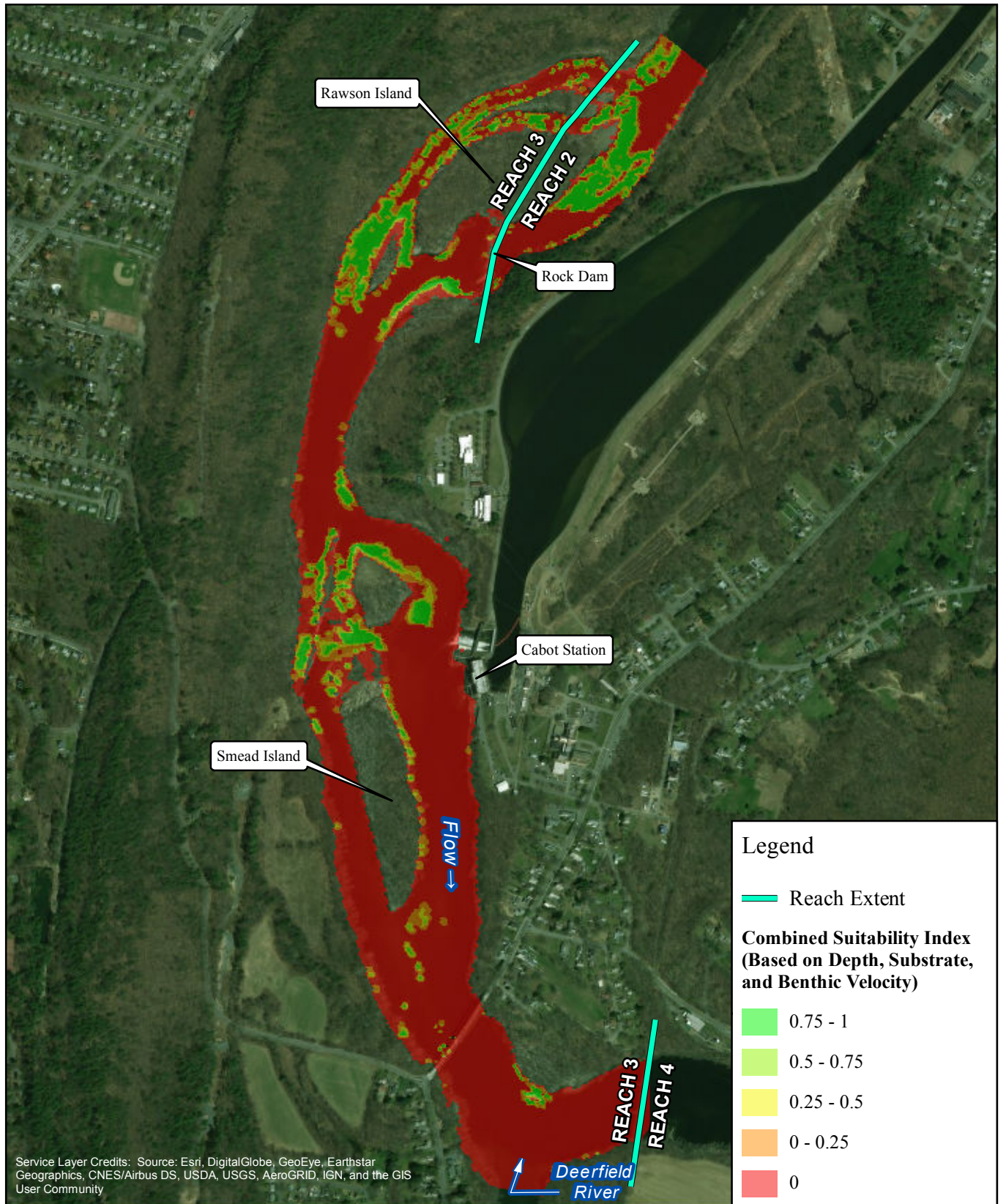
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Deerfield Flow: 200 cfs

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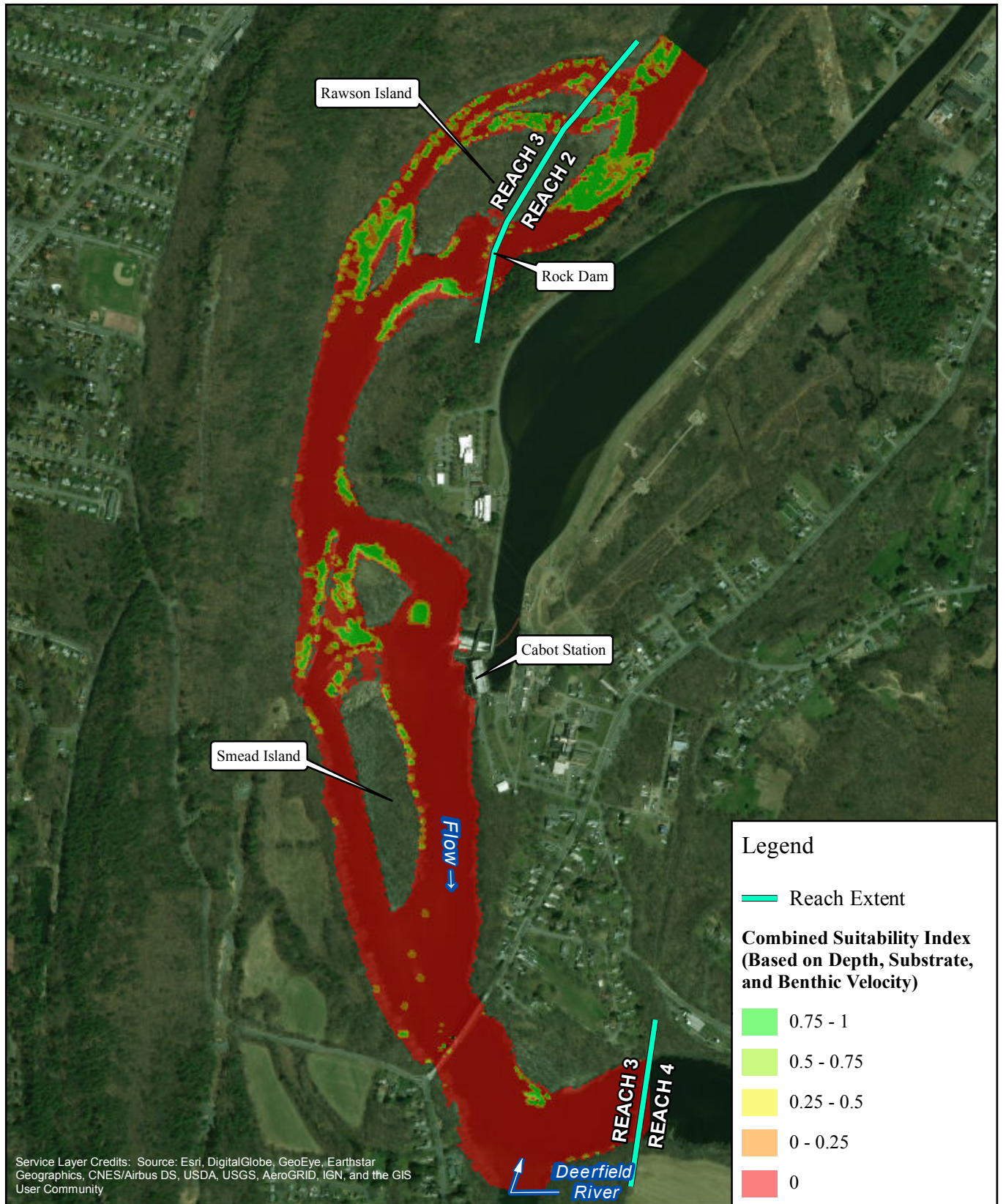
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Deep-Fast Guild-  
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Bypass Flow: 5000 cfs  
Deerfield Flow: 200 cfs

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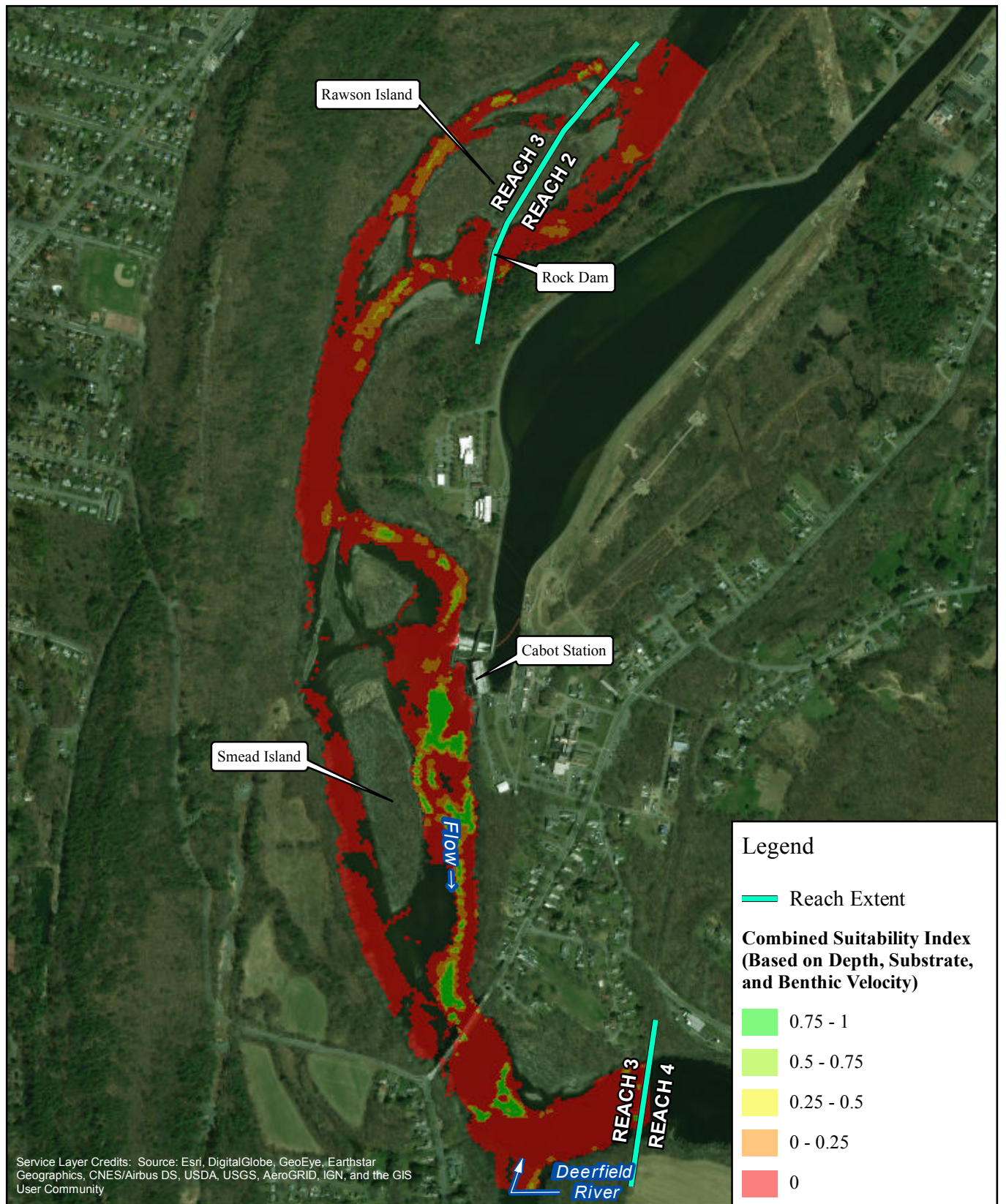
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**APPENDIX B-4 – COMBINED  
SUITABILITY INDEX MAPS FOR THE  
DEEP-FAST GUILD UNDER VARIOUS  
BYPASS FLOWS, CABOT FLOWS AND A  
DEERFIELD RIVER FLOW OF 200 CFS  
BASED A 3-VARIABLE (DEPTH,  
VELOCITY, AND SUBSTRATE) BINARY  
ASSESSMENT**





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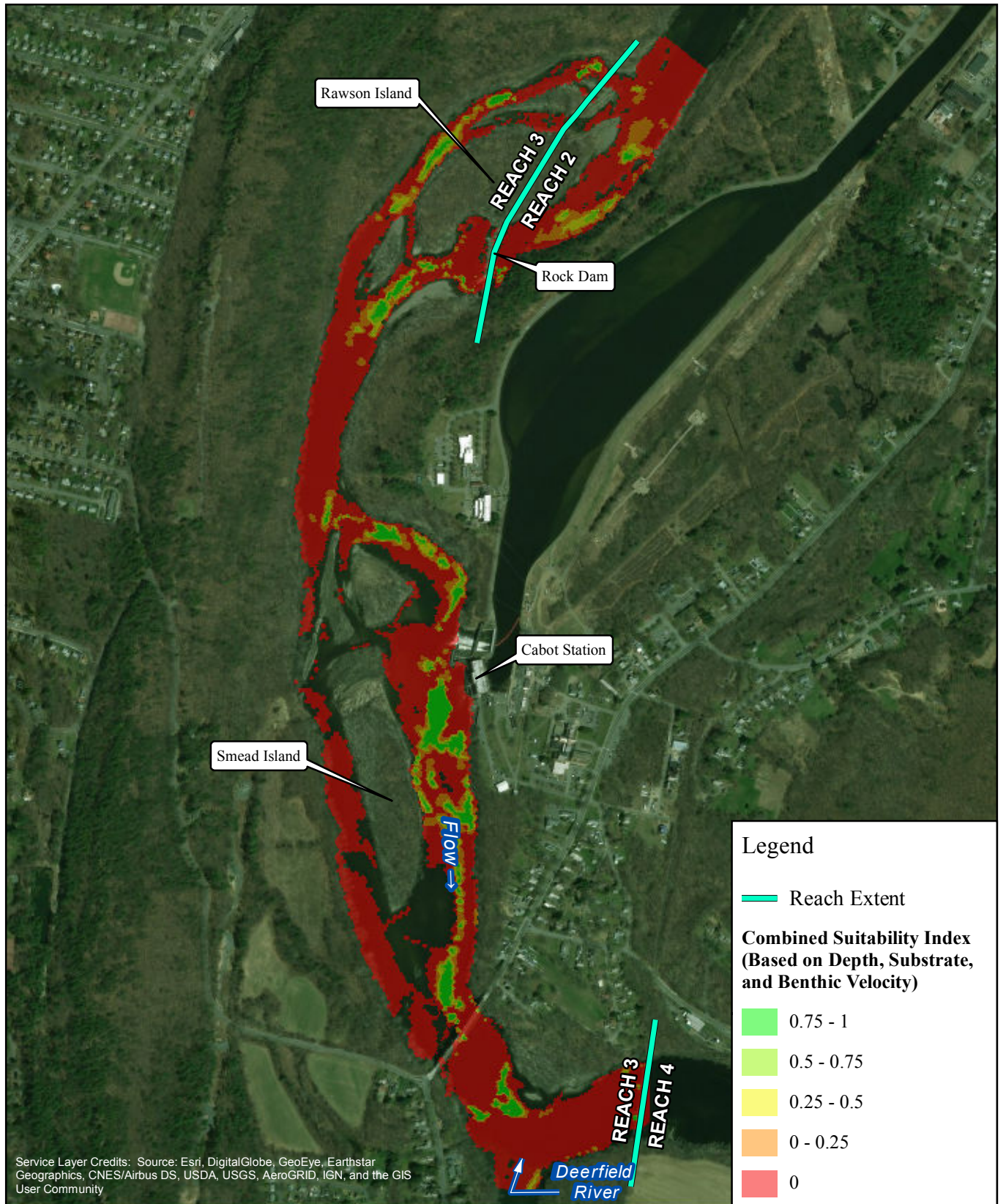
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Deep-Fast Guild-  
Cabot Flow: 2500 cfs  
Bypass Flow: 200 cfs  
Deerfield Flow: 200 cfs

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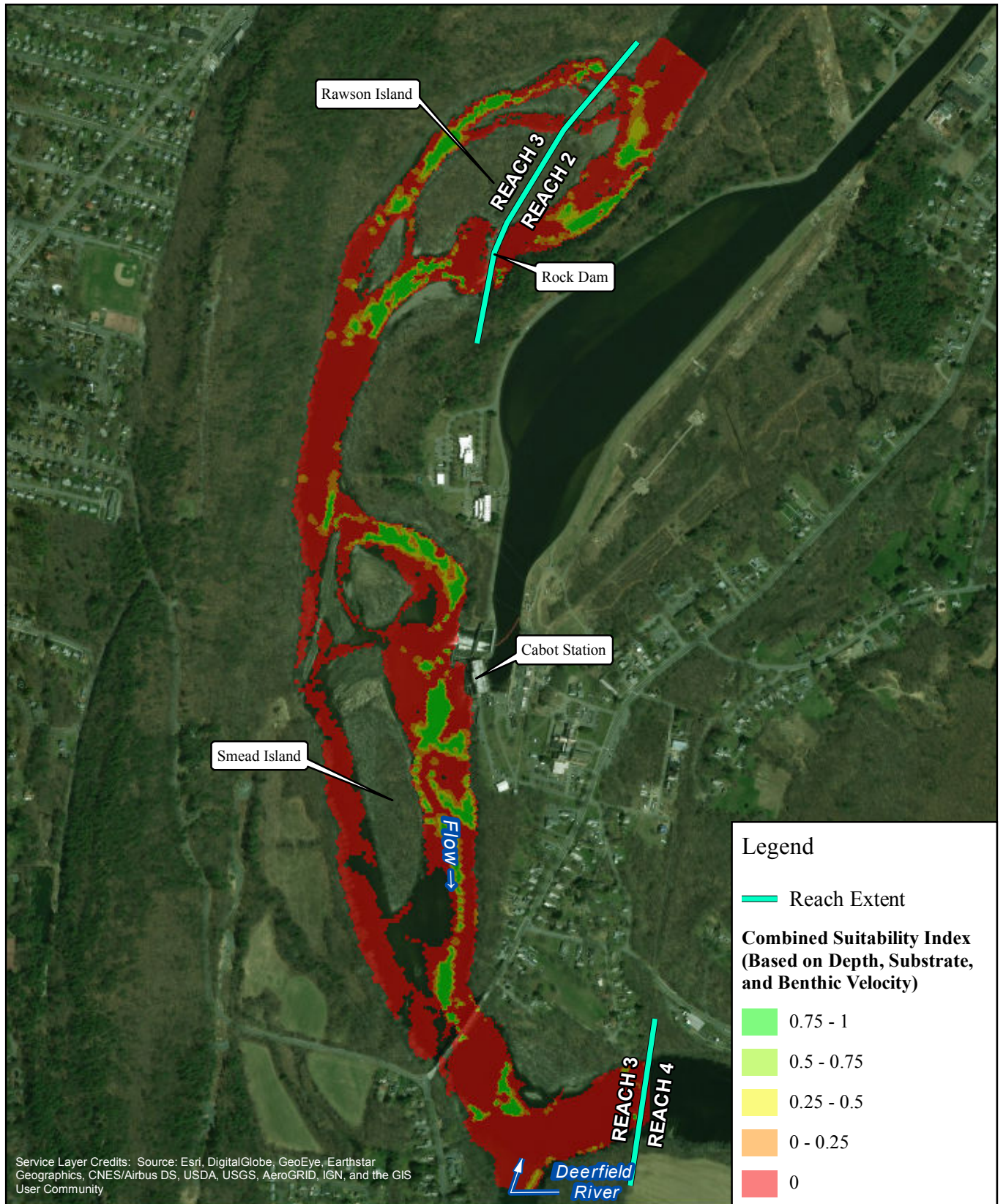
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Deep-Fast Guild-  
Cabot Flow: 2500 cfs  
Bypass Flow: 500 cfs  
Deerfield Flow: 200 cfs

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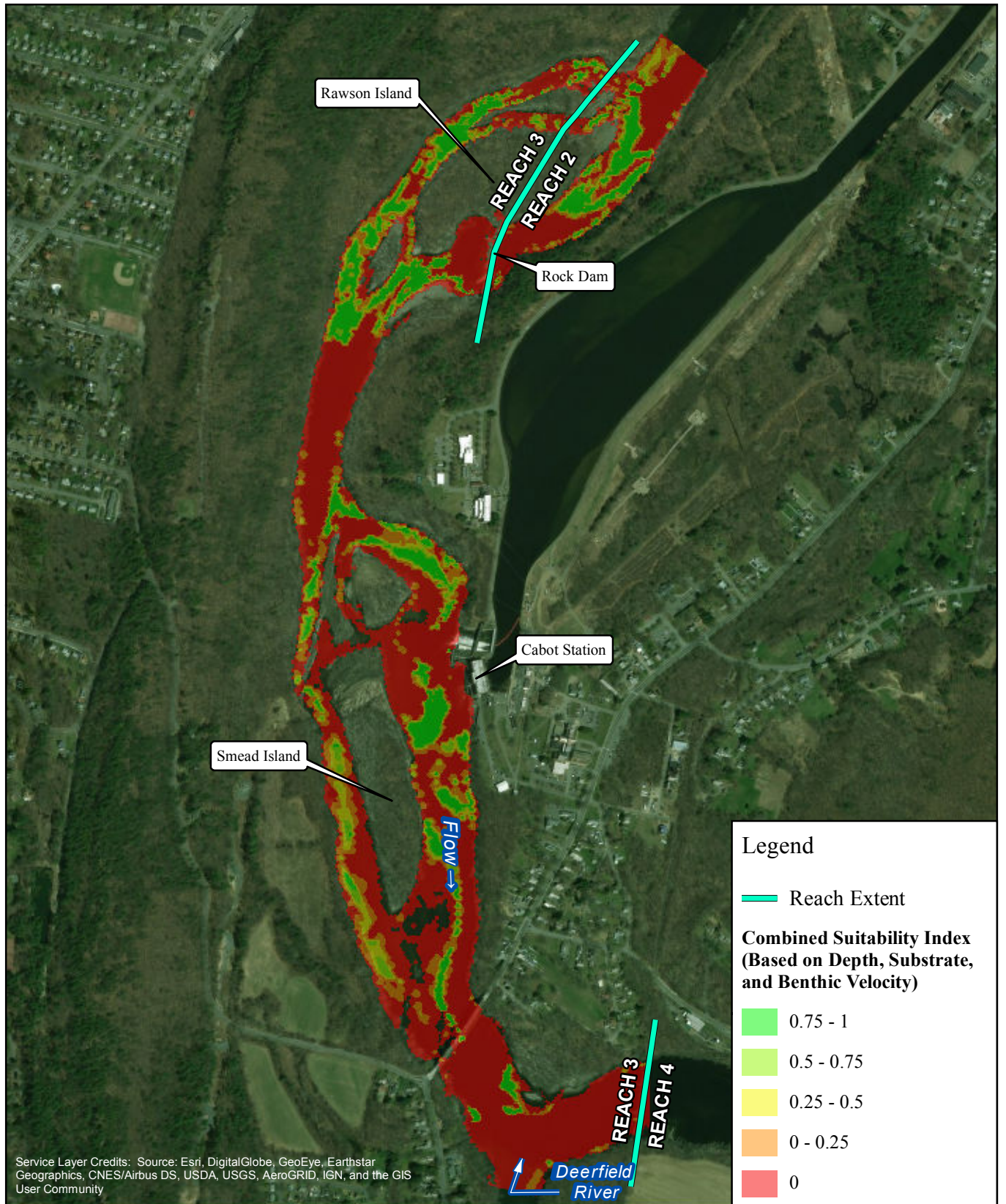
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Deerfield Flow: 200 cfs

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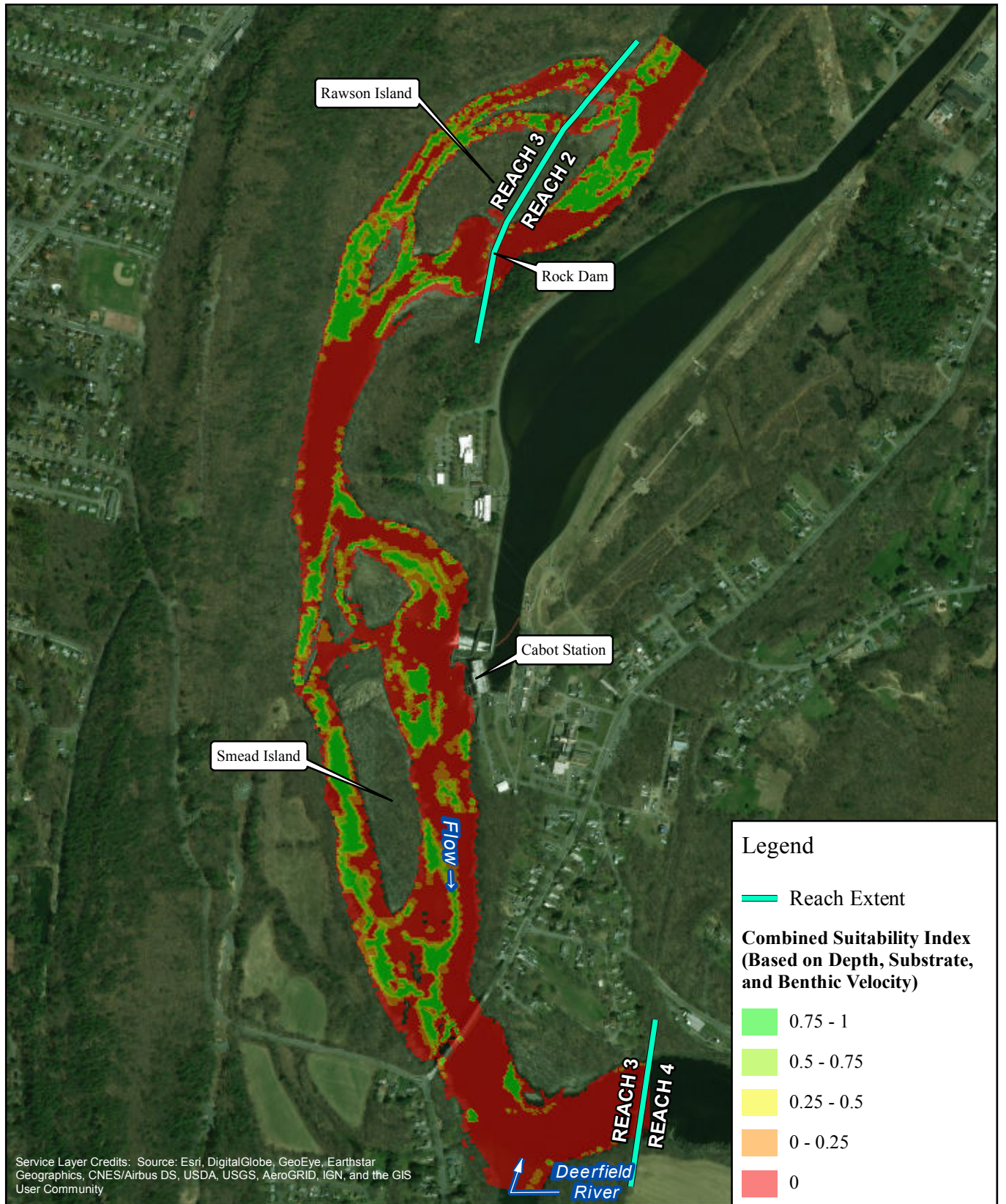
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Deep-Fast Guild-  
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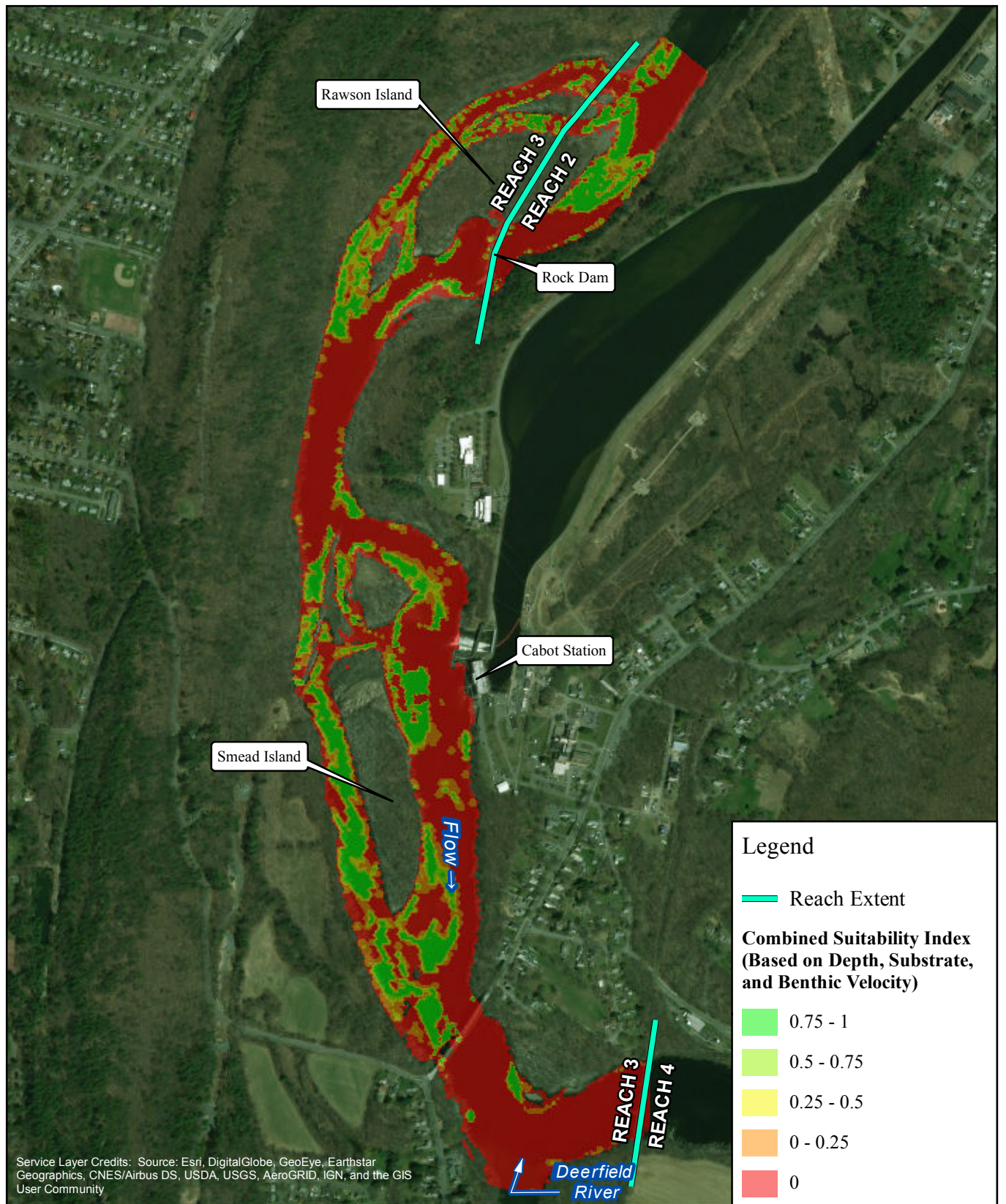
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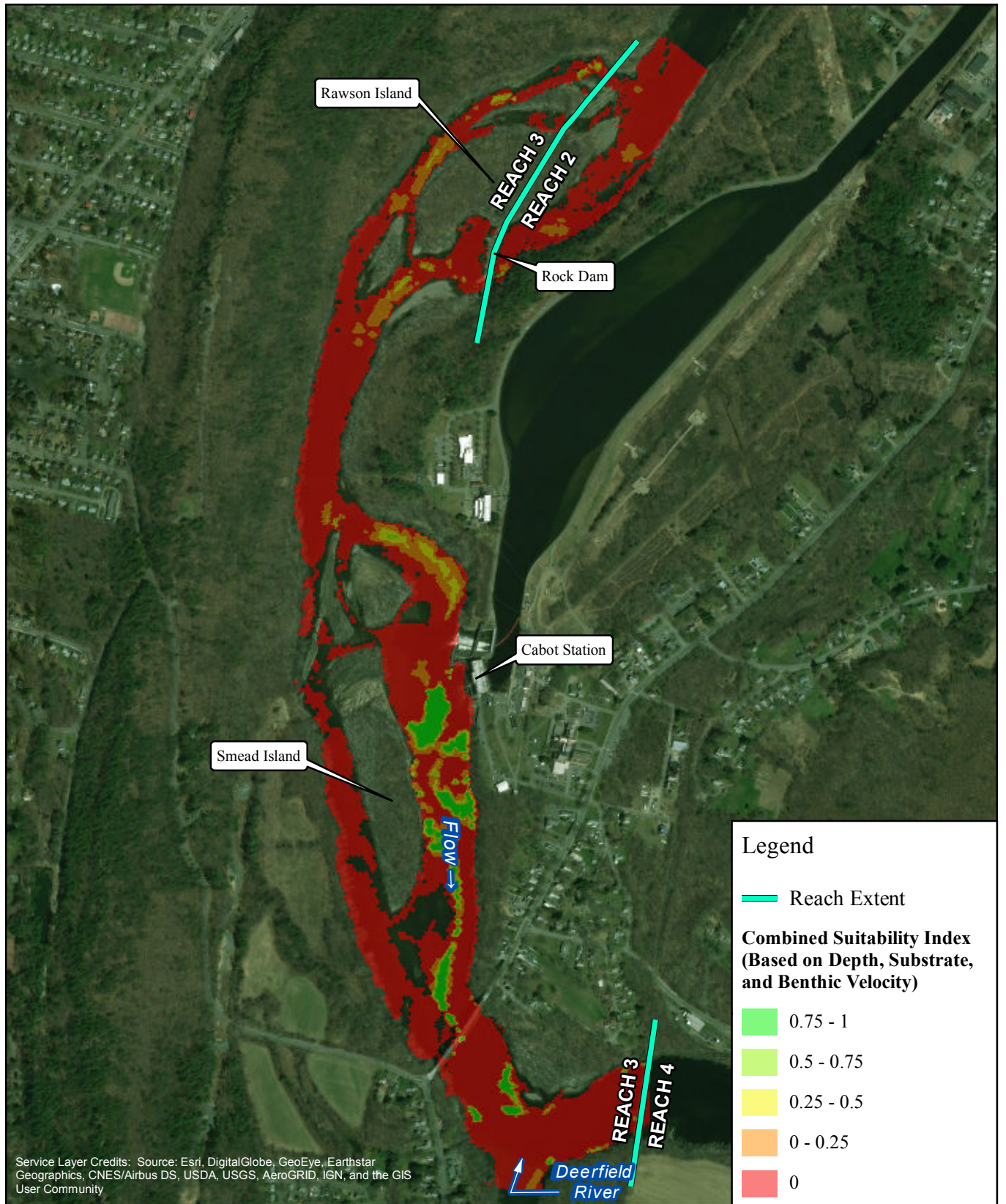
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Deep-Fast Guild-  
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Bypass Flow: 6500 cfs  
Deerfield Flow: 200 cfs

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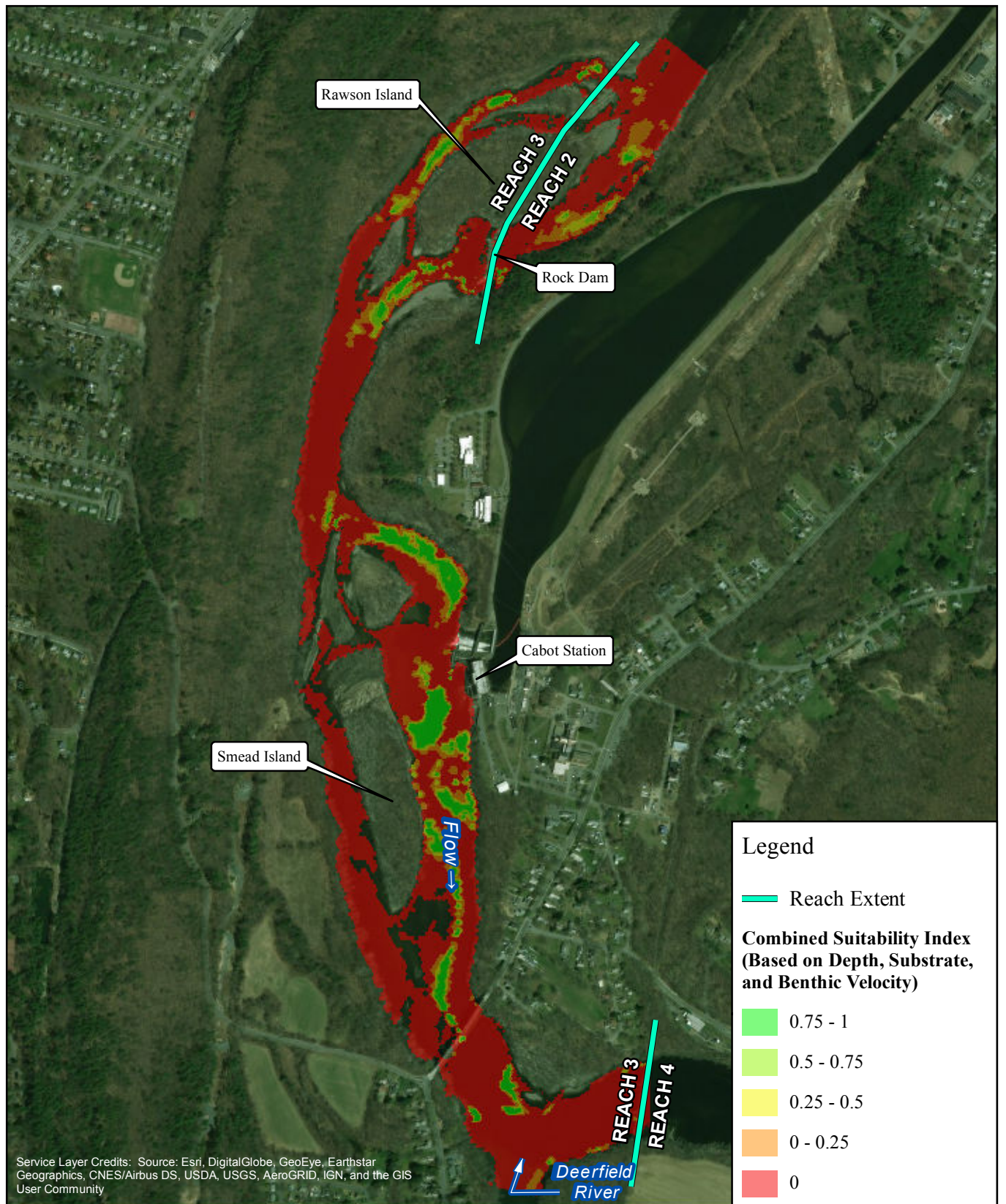
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Bypass Flow: 200 cfs  
Deerfield Flow: 200 cfs

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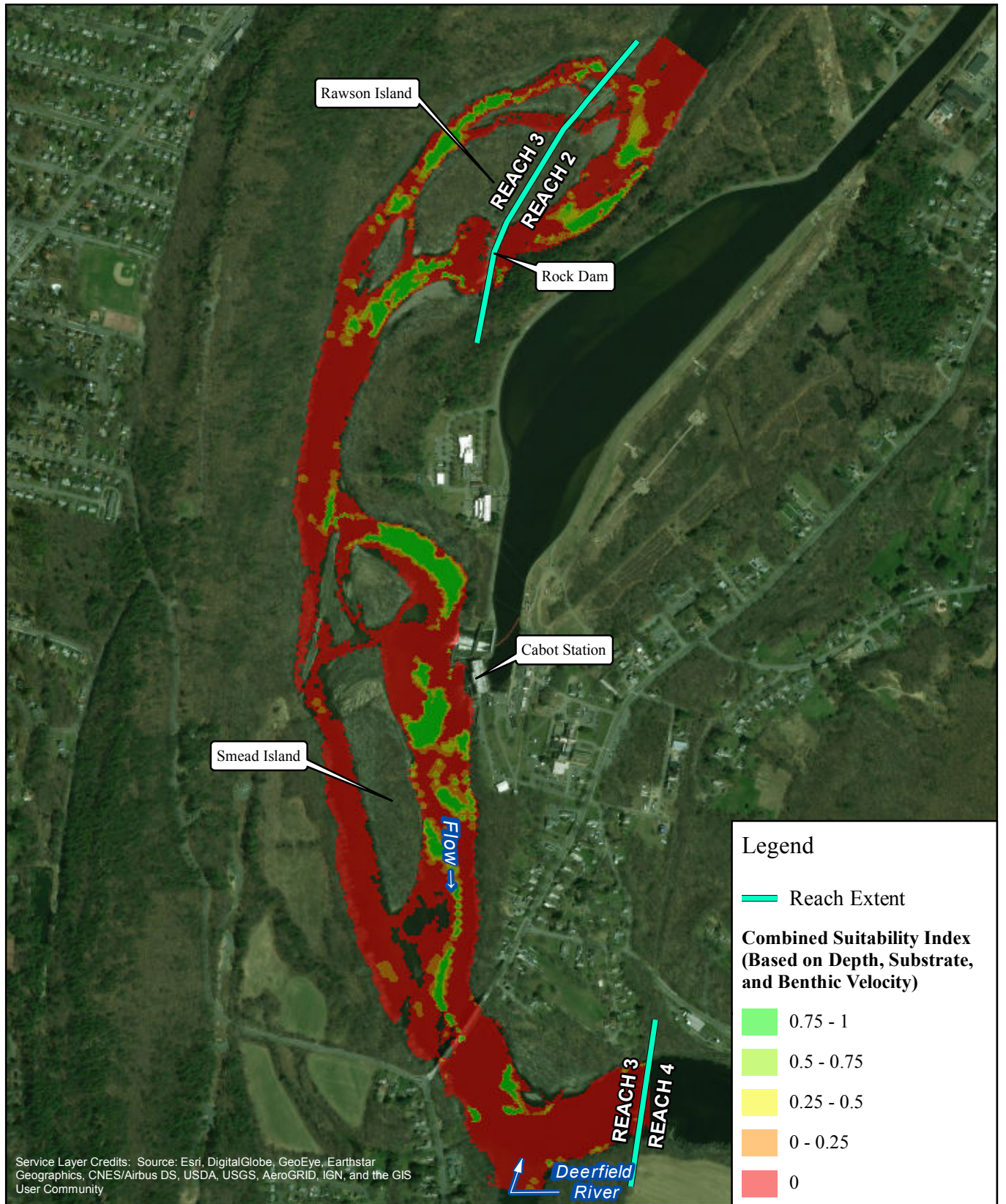
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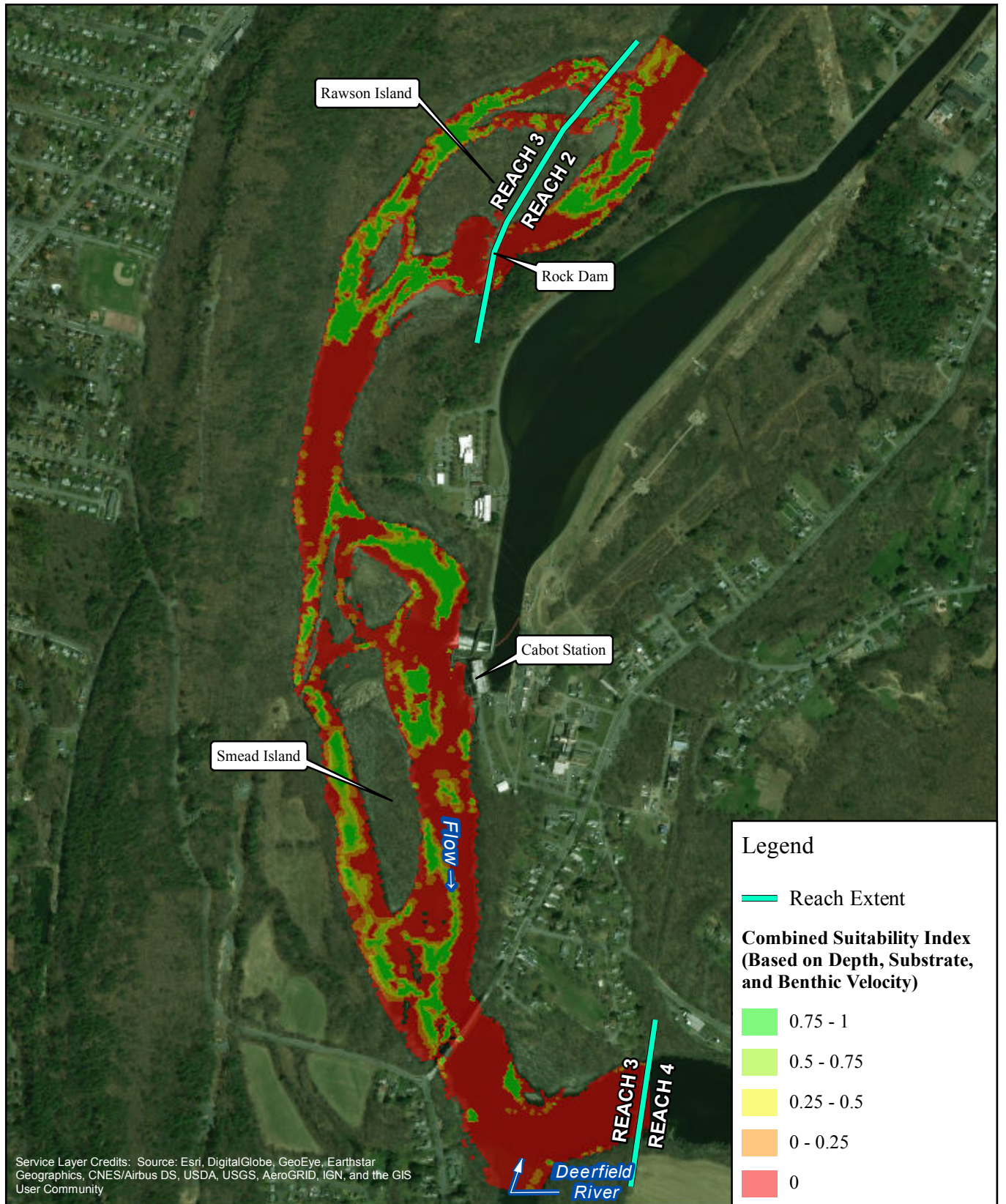
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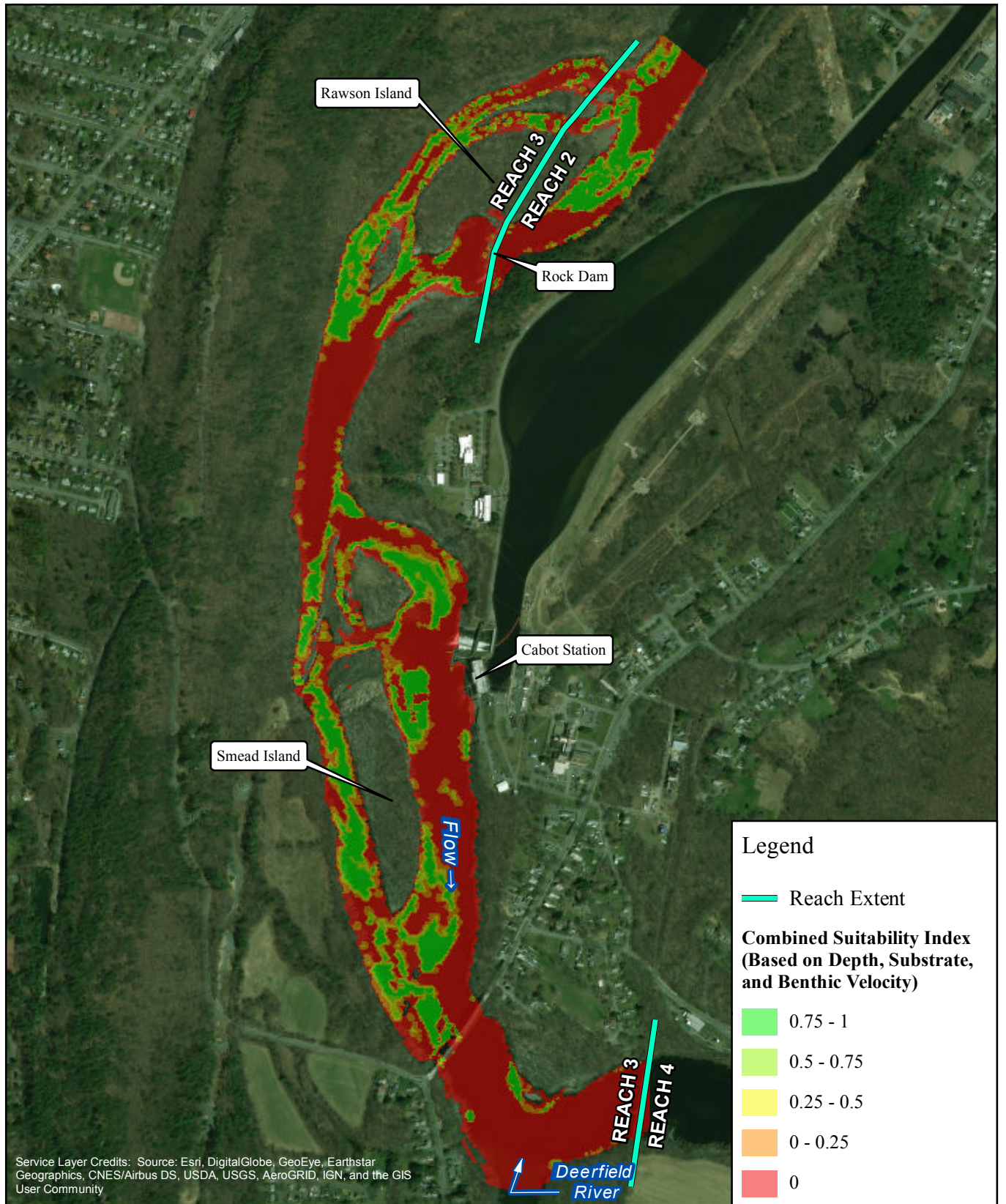
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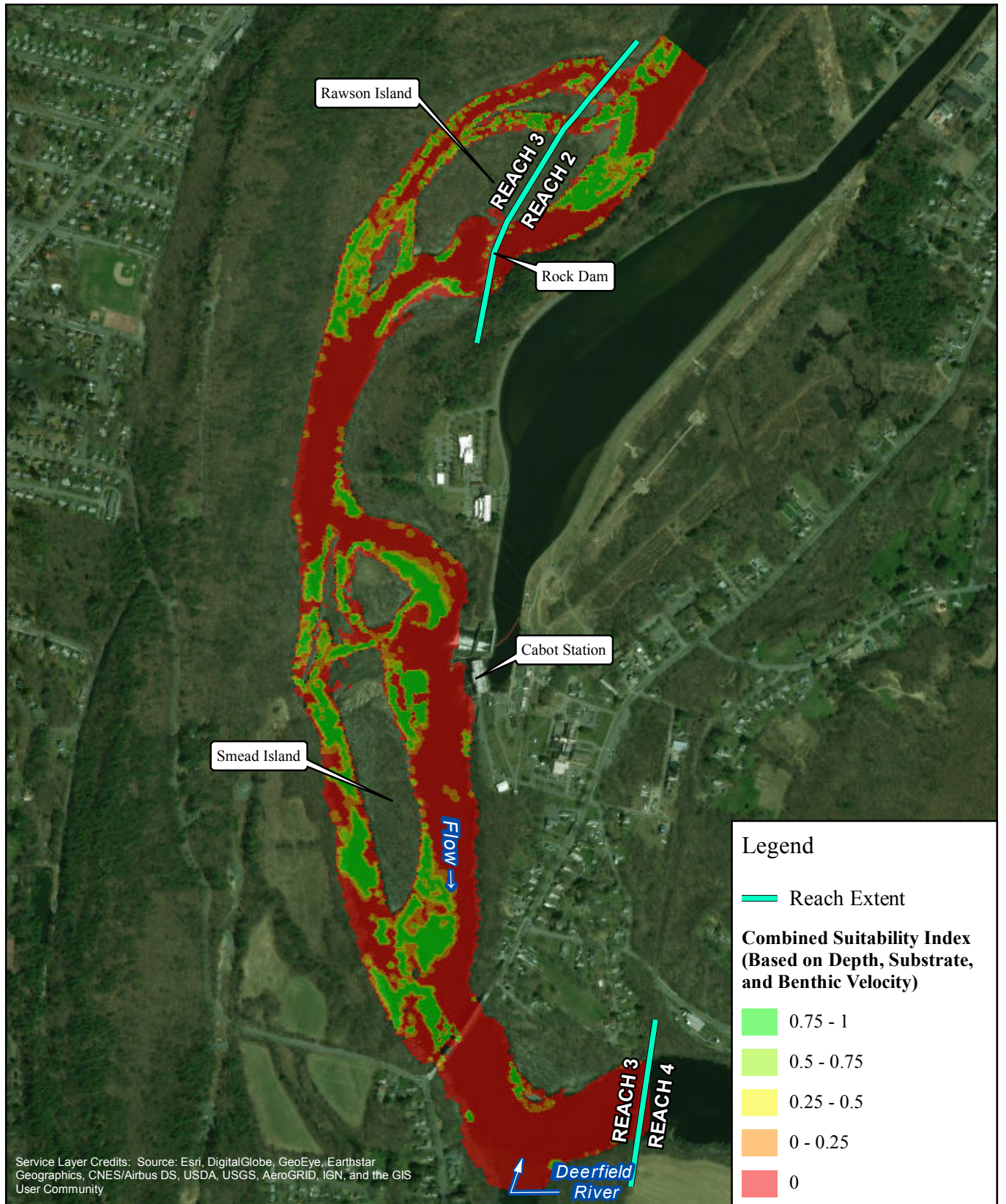
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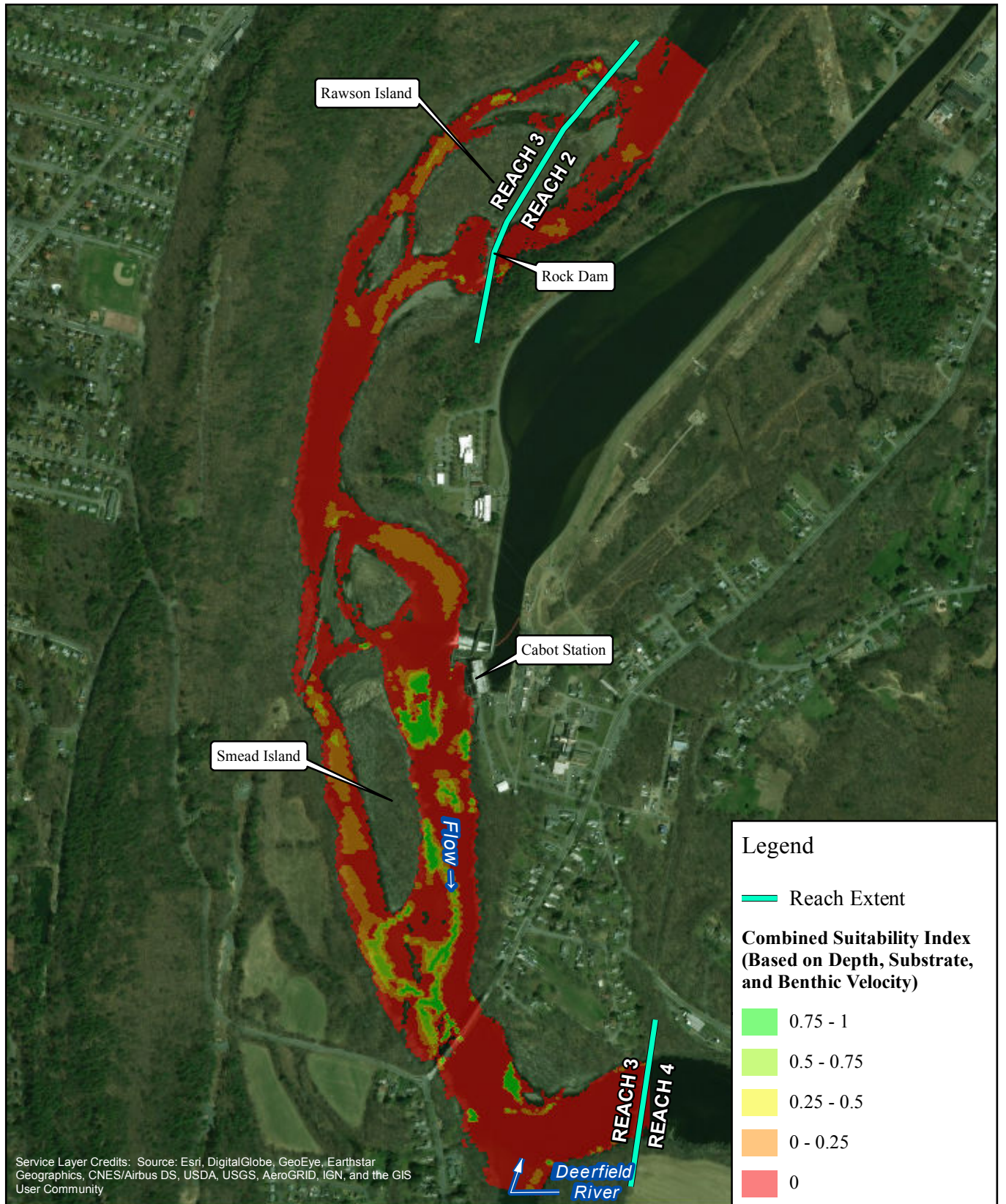
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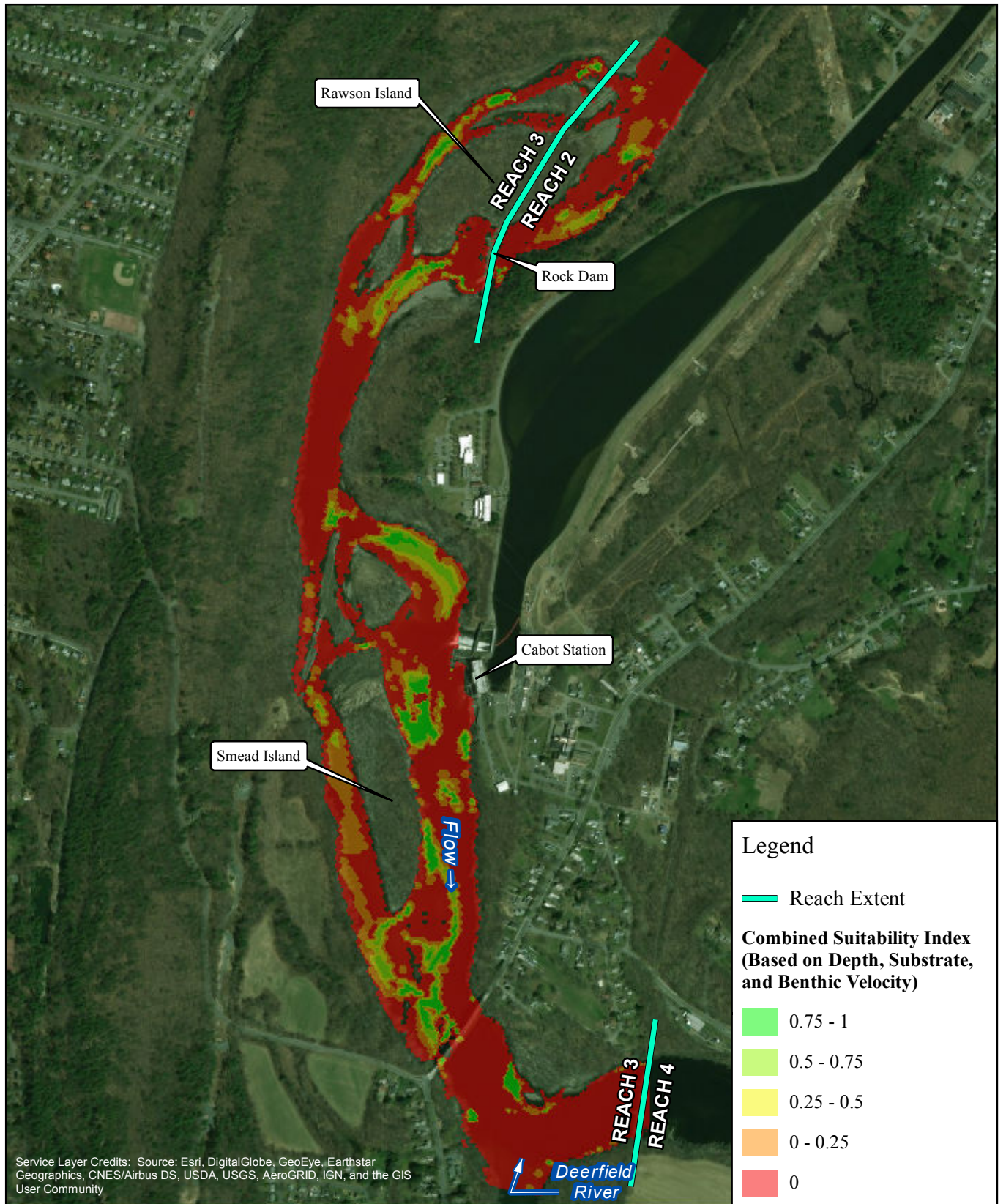
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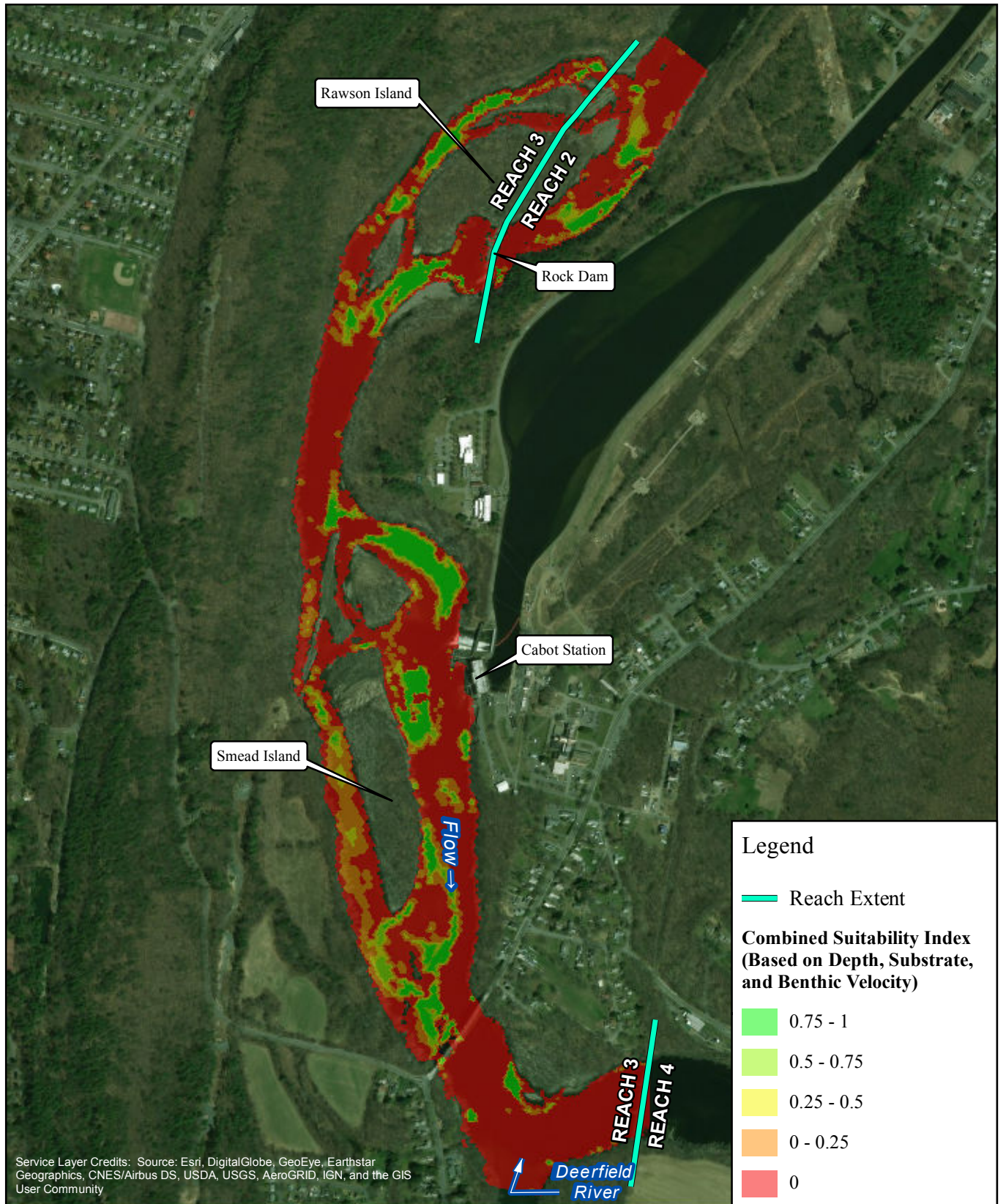
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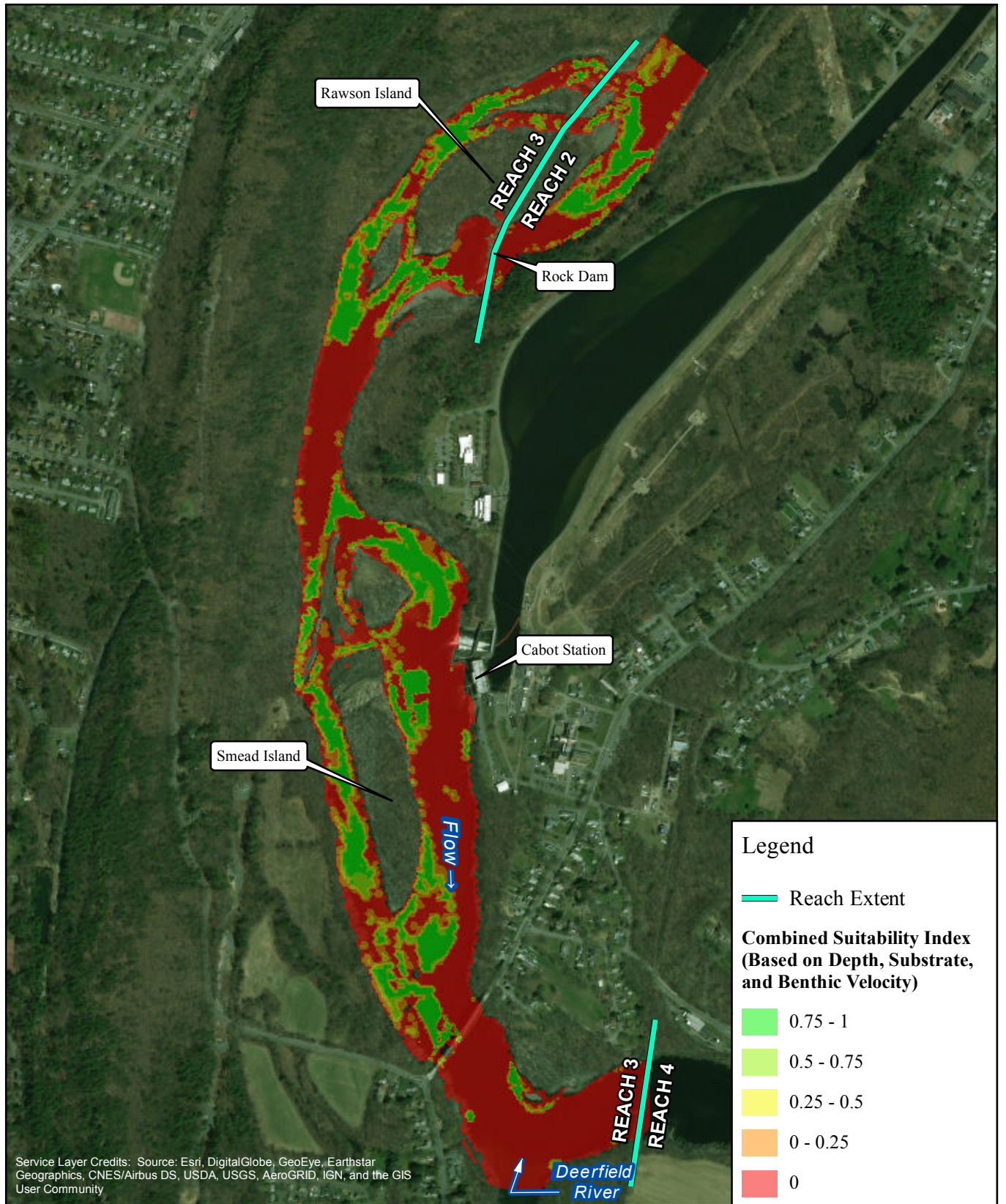
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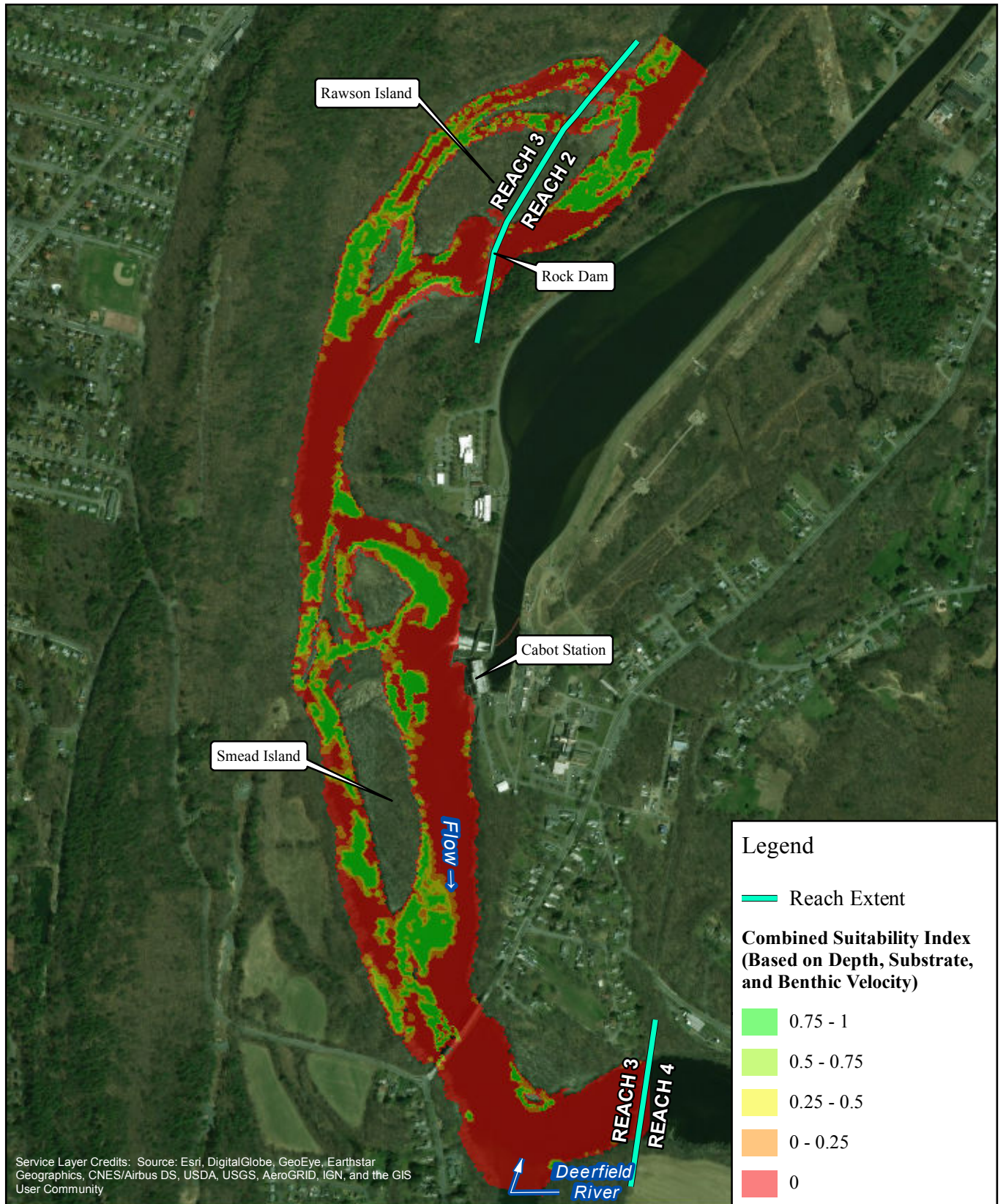
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RELICENSING STUDY 3.3.1  
Addendum 3 Reach 3 Mussels (May 2018)

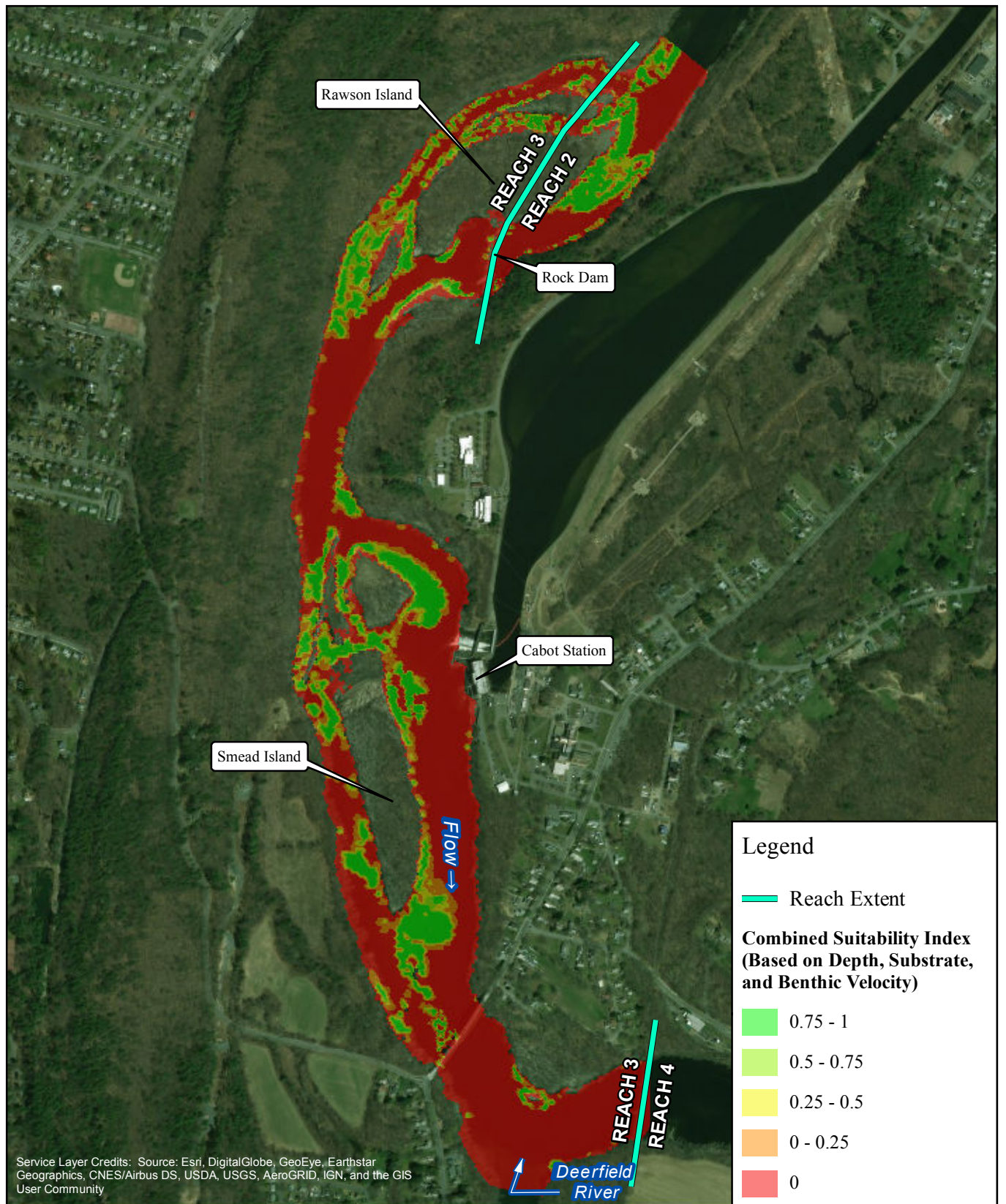
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Deep-Fast Guild-  
Cabot Flow: 7000 cfs  
Bypass Flow: 5000 cfs  
Deerfield Flow: 200 cfs

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RELICENSING STUDY 3.3.1  
Addendum 3 Reach 3 Mussels (May 2018)

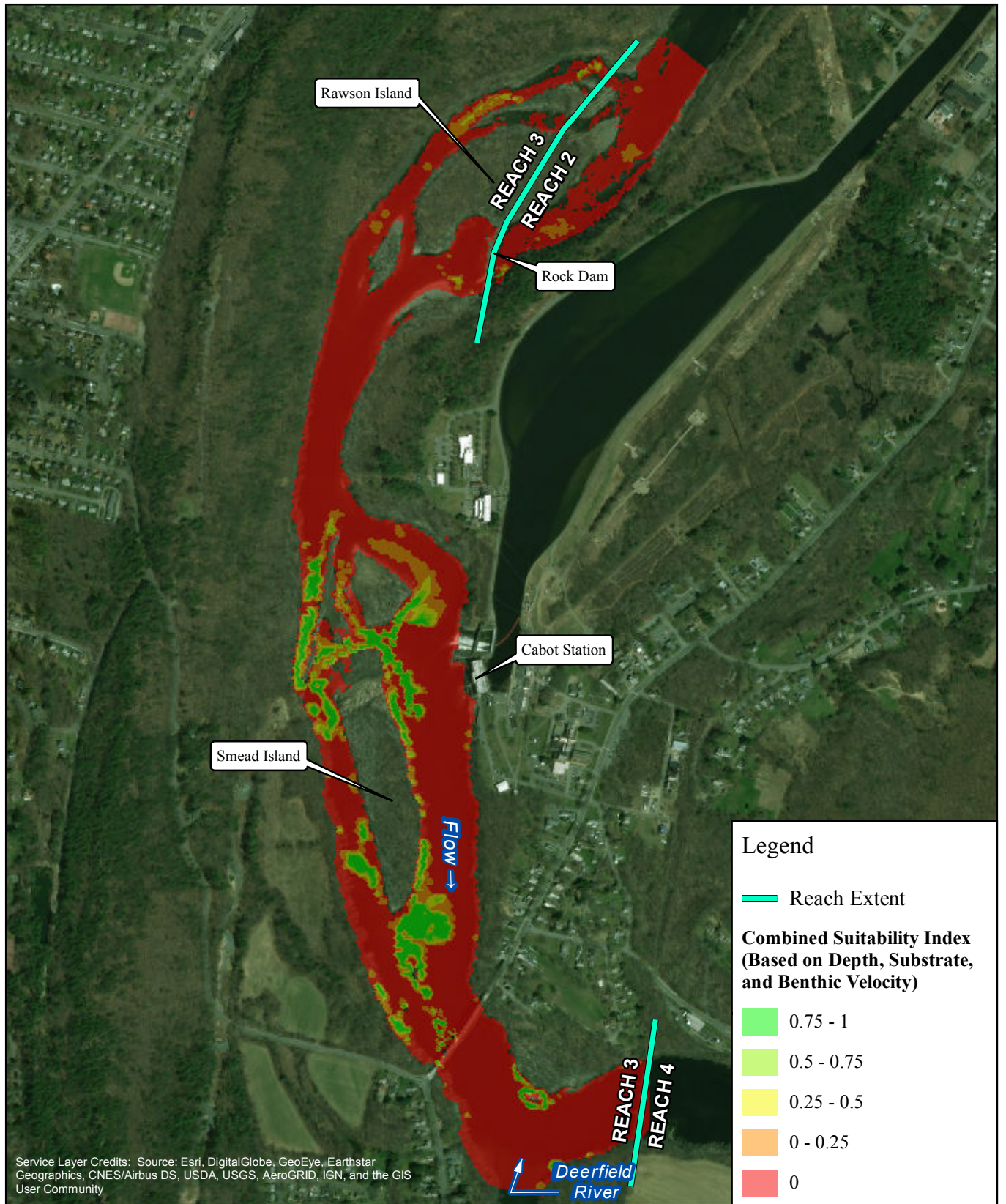
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Deep-Fast Guild-  
Cabot Flow: 7000 cfs  
Bypass Flow: 6500 cfs  
Deerfield Flow: 200 cfs

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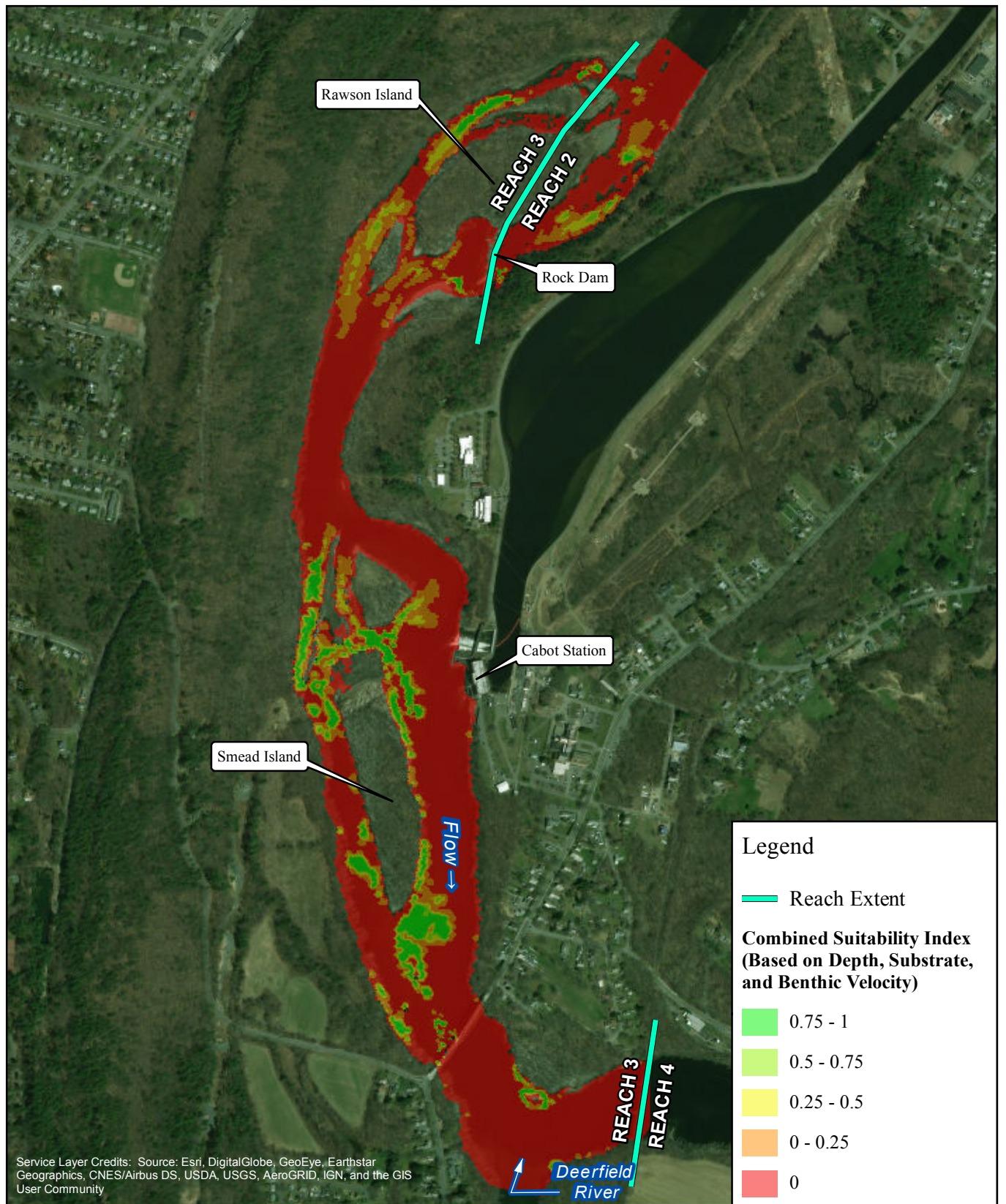
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Deep-Fast Guild-  
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Bypass Flow: 200 cfs  
Deerfield Flow: 200 cfs

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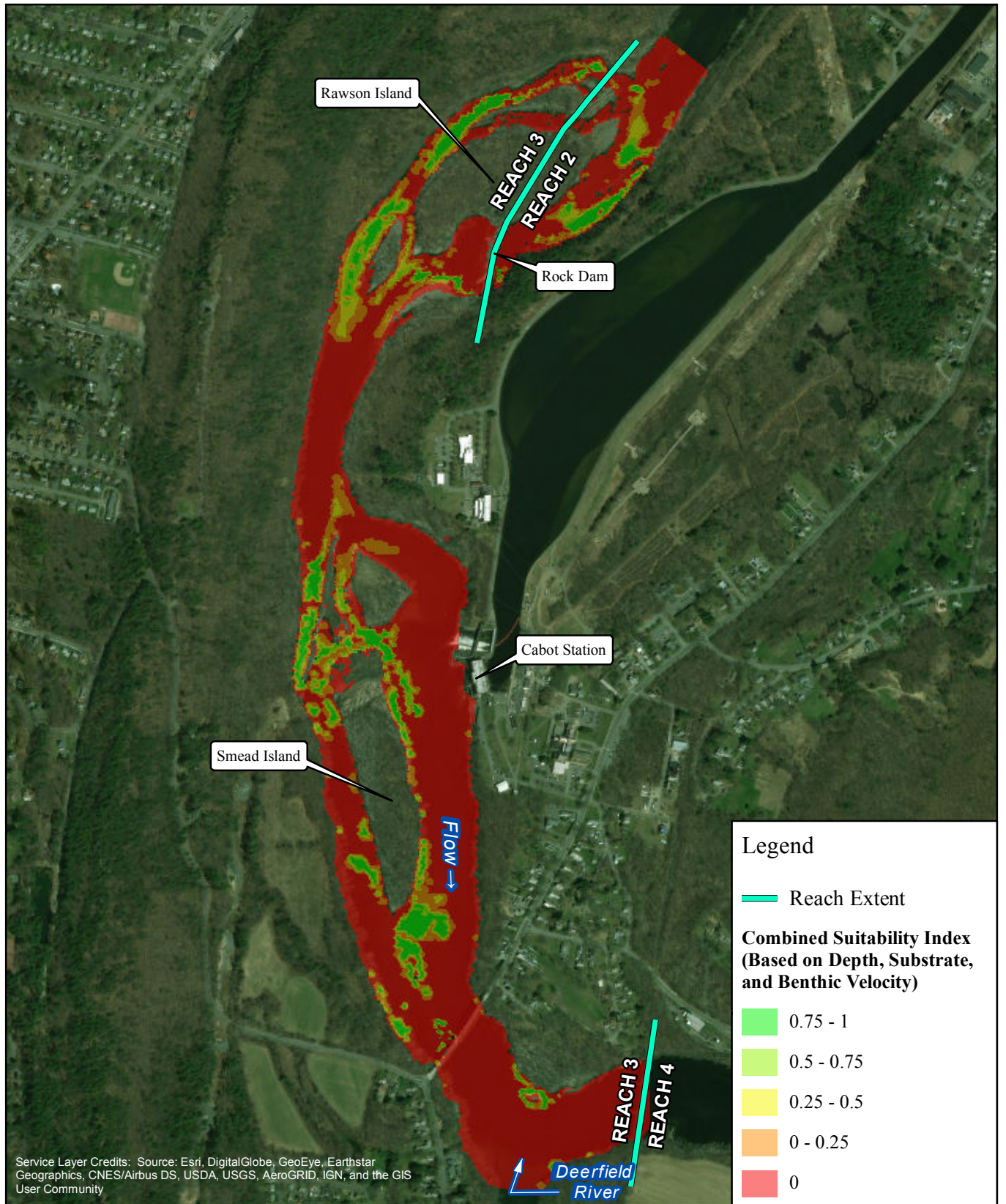
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Deep-Fast Guild-  
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Bypass Flow: 500 cfs  
Deerfield Flow: 200 cfs

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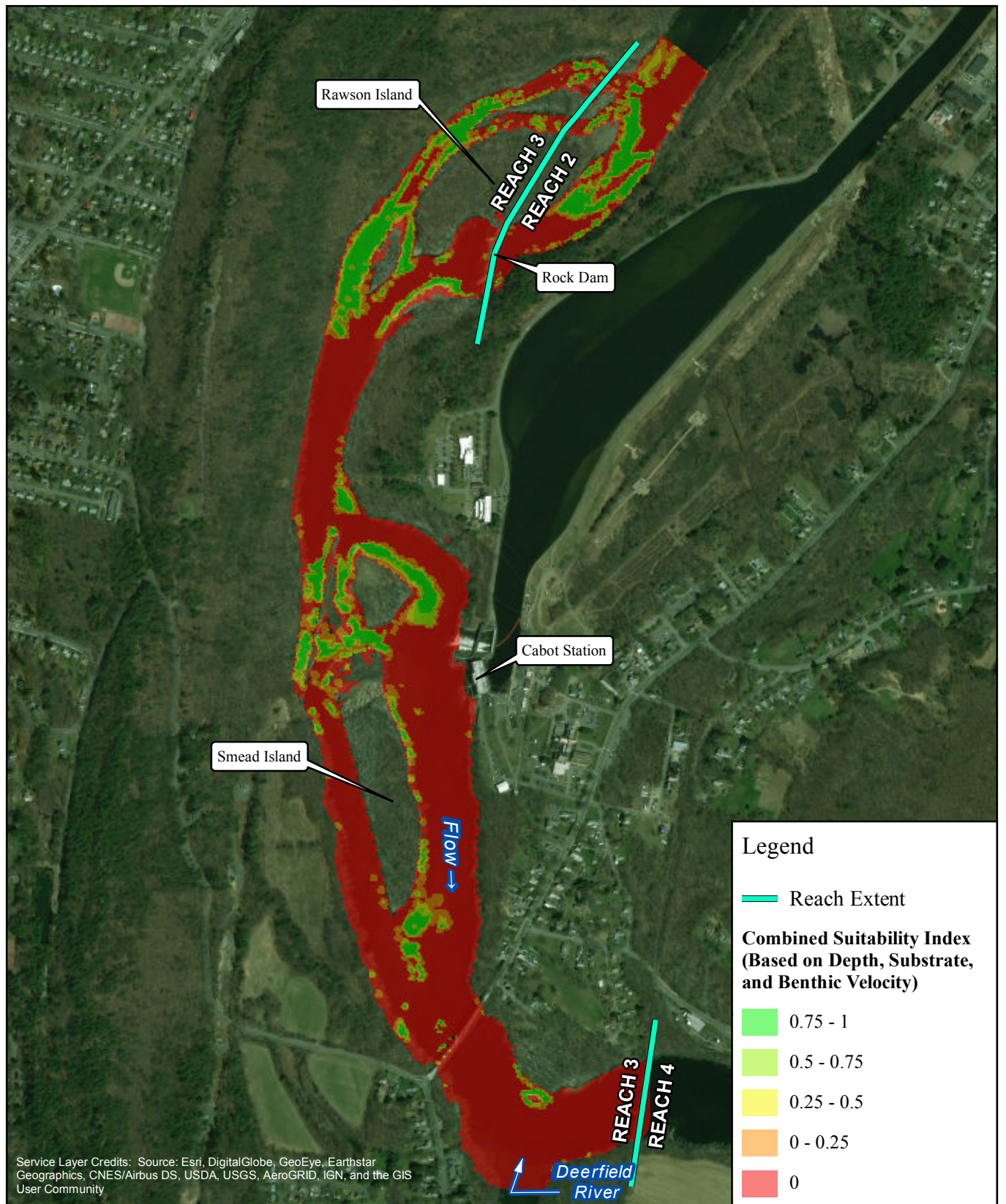
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Deep-Fast Guild-  
Cabot Flow: 14000 cfs  
Bypass Flow: 1000 cfs  
Deerfield Flow: 200 cfs

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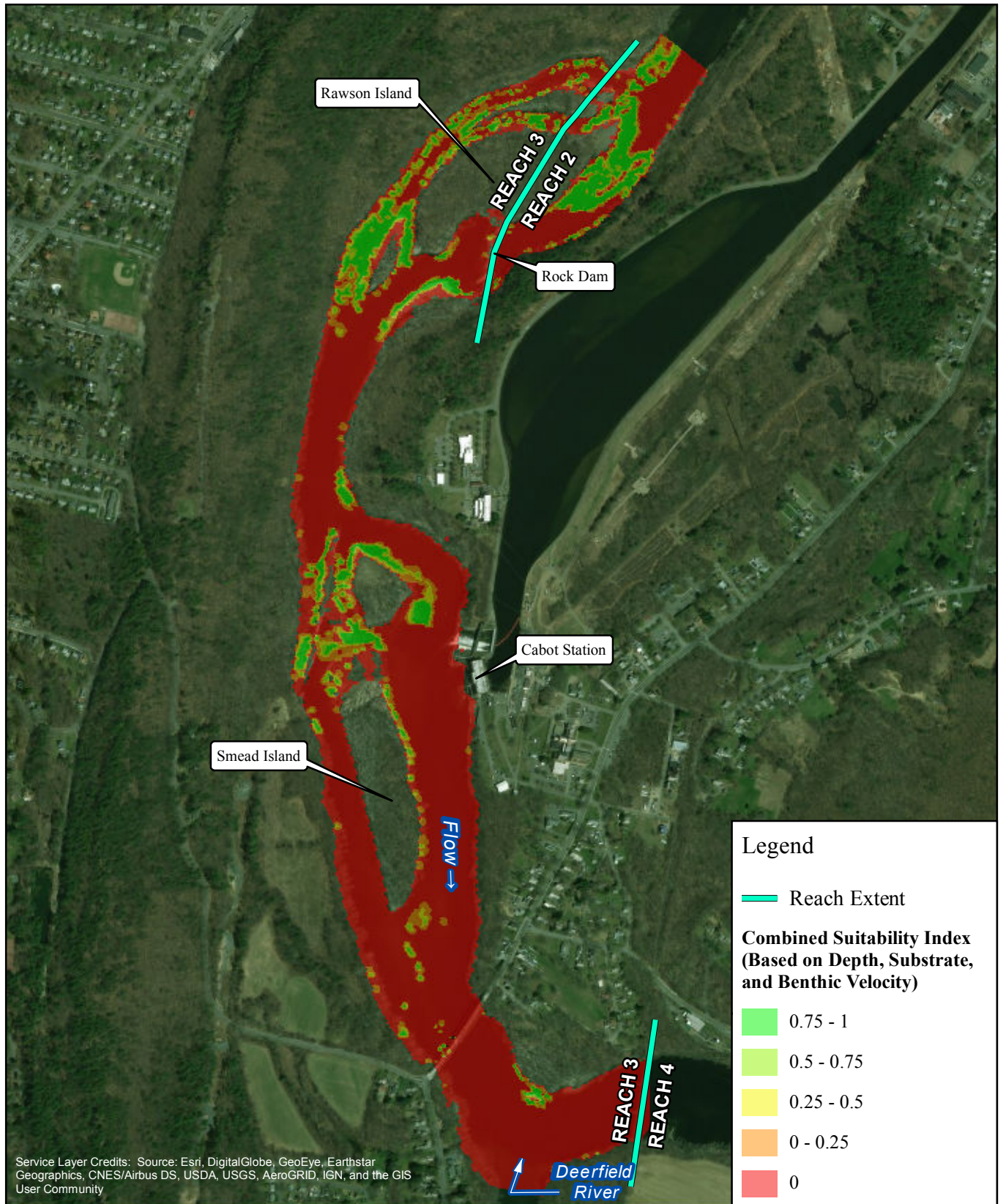
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Feet

Deep-Fast Guild-  
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Deerfield Flow: 200 cfs

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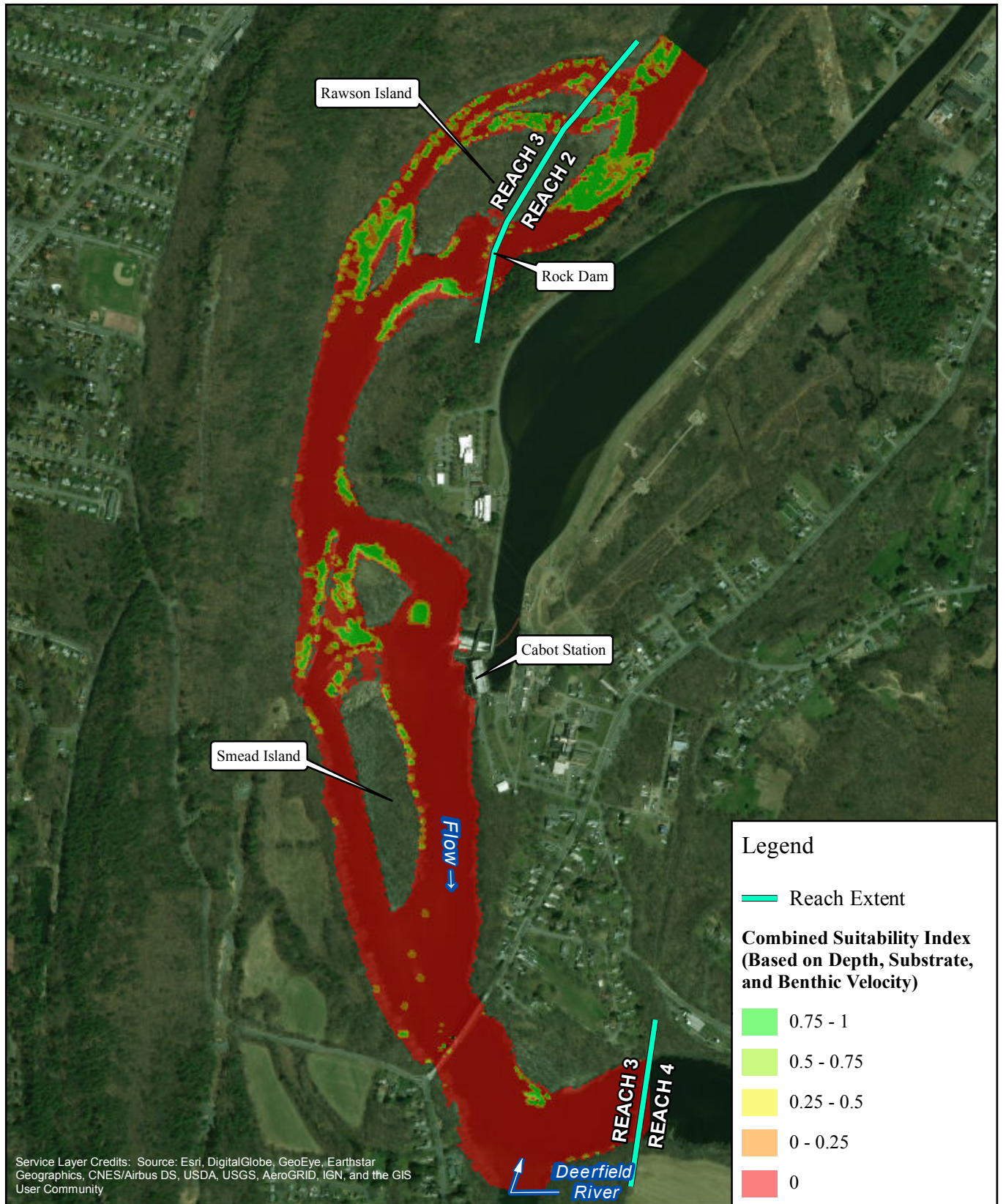
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Feet

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