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Prepared in cooperation with
Cornell Cooperative Extension of Ulster County, New York State Energy Research and Development Authority, the New York State Department of Environmental Conservation, and the New York City Department of Environmental Protection

Long-Term Trends in Naturalized Rainbow Trout *(Oncorhynchus mykiss)* Populations in the Upper Esopus Creek, Ulster County, New York, 2009–15

Data Series 992

U.S. Department of the Interior
U.S. Geological Survey

Cover. Background photograph: The upper Esopus Creek near Oliverea, New York, taken November, 2015. Photograph by Ed Ostapczuk.
Upper photograph: Field crew conducting an electrofishing survey on the upper Esopus Creek near Oliverea, N.Y., taken June, 2012. Photograph by Barry Baldigo.
Lower photograph: A wild rainbow trout from the upper Esopus Creek, N.Y., taken September, 2009. Photograph by Ed Ostapczuk.

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Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
hectare (ha)	2.471	acre
square kilometer (km^2)	0.3861	square mile (mi^2)
gram (g)	0.03527	ounce, avoirdupois (oz)

Datum

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Elevation, as used in this report, refers to distance above the vertical datum.

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Long-Term Trends in Naturalized Rainbow Trout *(Oncorhynchus mykiss)* Populations in the Upper Esopus Creek, Ulster County, New York, 2009–15

By Scott D. George and Barry P. Baldigo

Abstract

The U.S. Geological Survey, in cooperation with Cornell Cooperative Extension of Ulster County, New York State Energy Research and Development Authority, the New York State Department of Environmental Conservation, and the New York City Department of Environmental Protection, surveyed fish communities annually on the main stem and tributaries of the upper Esopus Creek, Ulster County, New York, from 2009 to 2015. This report summarizes the density, biomass, and size structure of rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) populations from the 2015 surveys along with data from the preceding 6 years. The mean density of rainbow trout populations in 2015 was 98 fish per 0.1 hectare, which was the highest value observed since 2010, and the mean biomass of rainbow trout populations in 2015 was 864 grams per 0.1 hectare, which was the highest value observed since 2012.

Introduction

The Esopus Creek is in Ulster County in the Catskill Mountain region of southeastern New York. The Esopus Creek is divided into an upper and lower section by the Ashokan Reservoir. The upper Esopus Creek is the focus of this report. Its watershed encompasses 497.3 square kilometers, and the creek follows a 41.8-kilometer semicircular, clockwise course from its headwaters to its terminus at the Ashokan Reservoir. Factors that affect the physical habitat, ecosystem condition, and water quality in the upper Esopus Creek are important because it channels approximately 40 percent of the drinking-water supply for New York City (Palmer and others, 2008) and provides excellent angling opportunities for rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*).

The natural resources of the upper Esopus Creek and its watershed have been studied extensively because of their economic and recreational importance. The U.S. Geological Survey (USGS) currently (2016) operates 10 streamgages in the watershed and closely monitors turbidity levels and suspended sediment concentrations (McHale and Siemion, 2014). Additionally, biological studies of diatoms (Richardson and others, 2014; George and Baldigo, 2015), macroinvertebrates (Duffy and others, 2011; Smith, 2013), fish communities (Baldigo and others, 2015; George and others, 2015a, b) and trout health (Ross, 2012) have recently been completed.

Rainbow trout have thrived in the upper Esopus Creek since their introduction in the 1880s. According to angler accounts, however, rainbow trout populations throughout the Esopus Creek watershed have declined appreciably. Quantitative fish surveys conducted annually by the USGS at nine sites on the main stem and tributaries of the upper Esopus Creek from 2009 to 2013 showed that the mean density of rainbow trout populations declined from 114 to 17 fish per 0.1 hectare during this period (George and others, 2015b), supporting anecdotal observations of population decline. This decline is concerning because wild rainbow trout fisheries are rare in New York State, and the fishery in the upper Esopus Creek and Ashokan Reservoir has historically been regarded as exceptional by sportsmen and natural resource managers. Additionally, trout species are generally considered to be sensitive indicators of water quality and habitat degradation; therefore, their declining populations may indicate a serious underlying environmental issue.

It remains unclear whether the recent decline in rainbow trout populations simply reflects the highly variable nature of stream fish populations or whether it is attributable to long-term changes (for example, habitat alteration or introduction of invasive species) that could potentially warrant management action. Consequently, the USGS, in cooperation with Cornell Cooperative Extension of Ulster County, New York State Energy Research and Development Authority, the New York State Department of Environmental Conservation, and the New York City Department of Environmental Protection, annually monitored fish communities and trout populations at 7 to 18 sites in a given year on the main stem and tributaries of the upper Esopus Creek from 2009 to 2015. Seven sites, which are discussed in this report, were surveyed annually since 2009. Three of these sites are on the main stem of the upper Esopus Creek, and four are on major tributaries near their confluences with the upper Esopus Creek (fig. 1; table 1).

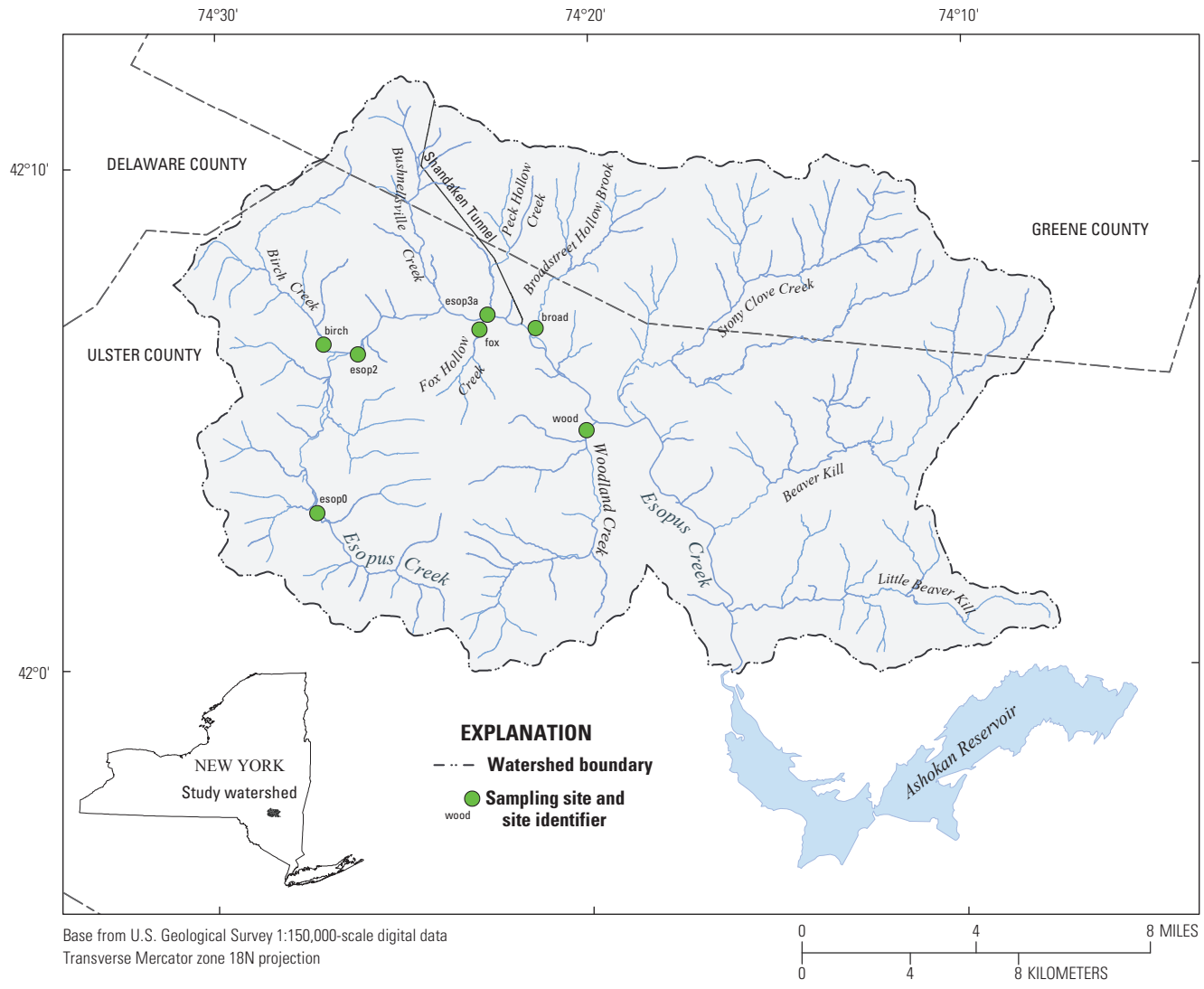

Figure 1. Location of seven sampling sites on the main stem and tributaries of the upper Esopus Creek in Ulster County in the Catskill Mountains of southeastern New York.

Table 1. Description of seven sites where fish communities were surveyed annually on the main stem and tributaries of the upper Esopus Creek, Ulster County, New York, 2009–15.

[USGS, U.S. Geological Survey; ID, identifier; DA, drainage area; km^2, square kilometer; m, meter]

Stream name	Site ID	USGS ID	DA (km^2)	Elevation (m)	Latitude (in decimal degrees)	Longitude (in decimal degrees)
Fox Hollow Creek	fox	01362199	10.3	309.4	42.11611	-74.38056
Broadstreet Hollow Brook	broad	01362232	23.7	295.8	42.11256	-74.35869
Birch Creek	birch	013621955	32.4	377.4	42.10898	-74.45182
Woodland Creek	wood	0136230002	53.4	267.6	42.07972	-74.33458
Esopus Creek at Oliverea	esop0	0136219203	30.3	454.5	42.05250	-74.45622
Esopus Creek at Big Indian	esop2	0136219565	111.9	354.9	42.10417	-74.43583
Esopus Creek at Allaben	esop3a	01362200	165.0	304.6	42.11430	-74.36766

The purpose of this report is to present the results of fish community surveys conducted in 2015 at these seven sites in the upper Esopus Creek watershed. Rainbow trout populations are the primary focus of this report given the recent decline in abundance of this species. Metrics for rainbow trout in 2015, as well as those for brown trout, which do not show a similar decline, are presented alongside those from previous years to enable temporal comparisons for both species and to facilitate comparisons with results from past publications.

Methods

The methods used to survey fish communities in 2015 were the same as those used during the surveys from 2009 to 2014. In short, field crews of three to six personnel used a three-pass depletion method with a backpack electrofisher to capture fish from blocked stream reaches. Reaches were generally 10 to 20 mean channel widths in length, and blocking seines were used to delineate upstream and downstream reach boundaries. Length, weight, and species were recorded for each fish. All surveys (from 2009 to 2015) were conducted between late June and early August, and each individual site was surveyed within the same 18-day period each year.

MicroFish v3.0 software (Van Deventer and Platts, 1983, 1985) was used to produce estimates of population size and biomass (with 95-percent confidence intervals) for each species. These estimates were then standardized by the area sampled at each site to produce estimates of density and biomass for rainbow trout and brown trout populations. Density is presented as number of fish per 0.1 hectare, and biomass is presented as grams of fish per 0.1 hectare. Additionally, the size structures of each species' populations are presented as length-frequency distributions (histograms). The percentage of rainbow trout and brown trout that were young-of-the-year (<91 millimeters [mm] and <101 mm, respectively [George and others, 2015b]) and the mean length of young-of-the-year and older individuals are also presented. A few large individuals or members of abnormally abundant size classes were omitted from the length-frequency distributions in order for the data to be plotted at an interpretable scale, but mean lengths always included all individuals. Additional information on sampling methods and data analysis can be found in George and others (2015b).

Results

The density and biomass of rainbow trout populations were significantly higher at most sites in 2015 than in the preceding 2 years (fig. 2). The mean density of rainbow trout populations from all sites in 2015 (98 fish per 0.1 hectare) was the highest value observed since 2010 (table 2). Similarly, the mean biomass of rainbow trout populations from all sites in 2015 (864 grams per 0.1 hectare) was the highest value observed since 2012 (table 2). Relatively large numbers of young-of-the-year rainbow trout were observed at most sites in 2015 (fig. 3; table 2) and in the pooled data from all sites (fig. 4).

In comparison, the density and biomass of brown trout populations at most sites in 2015 were nearly two times the estimates for 2014 but were comparable to 2013 estimates (table 2). The mean density of brown trout populations from all sites in 2015 (127 fish per 0.1 hectare) was the highest value observed since 2012 (table 2). The mean biomass of brown trout populations from all sites in 2015 (4,243 grams per 0.1 hectare) was the highest value observed since 2013 (table 2). Young-of-the-year brown trout were moderately abundant at most sites in 2015 (fig. 5; table 2) but generally did not exceed the abundances observed in 2009 or 2012 (fig. 6).

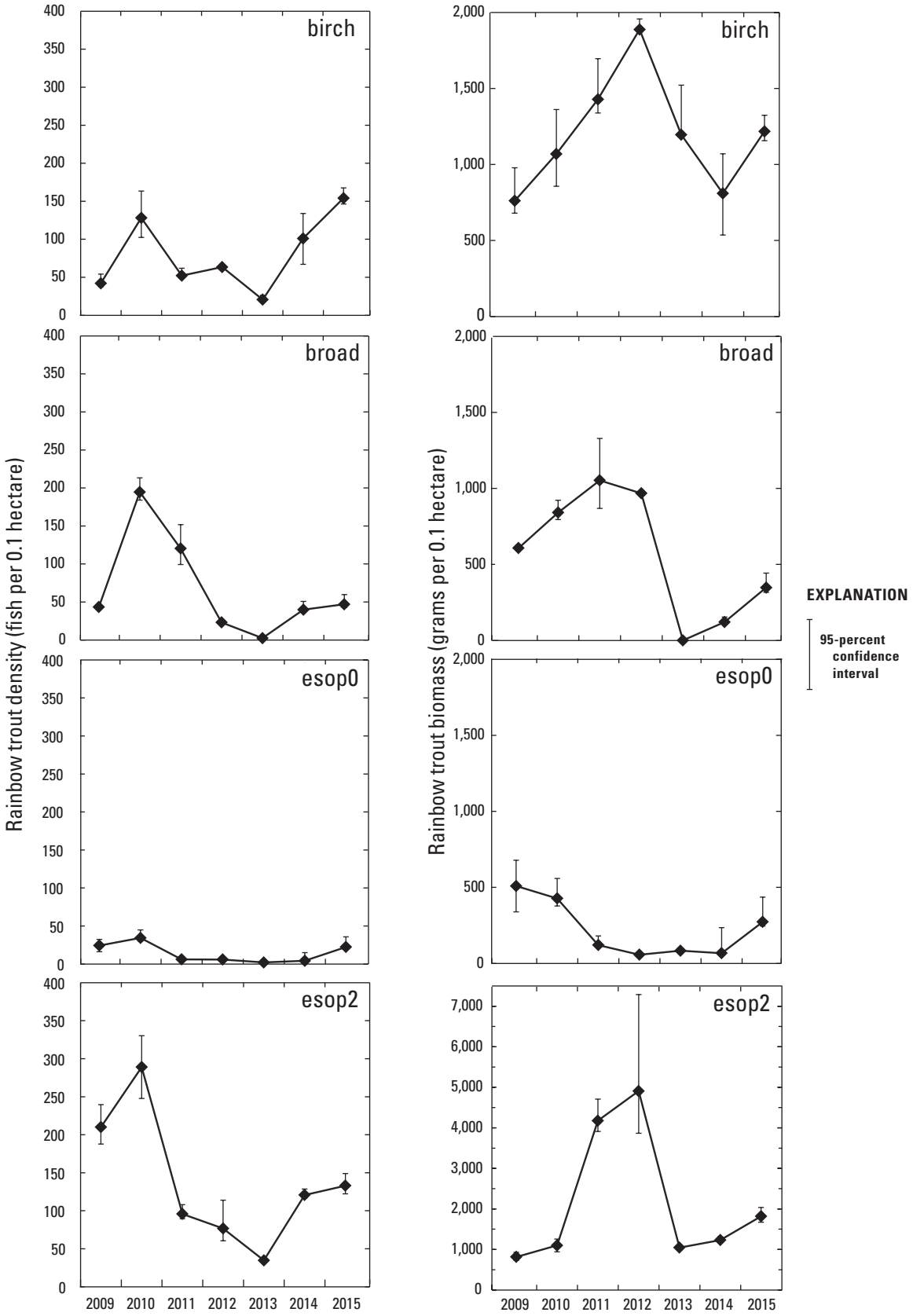

Figure 2. Estimates of density and biomass of rainbow trout populations at seven sites on the main stem and tributaries of the upper Esopus Creek, Ulster County, New York, 2009–15.

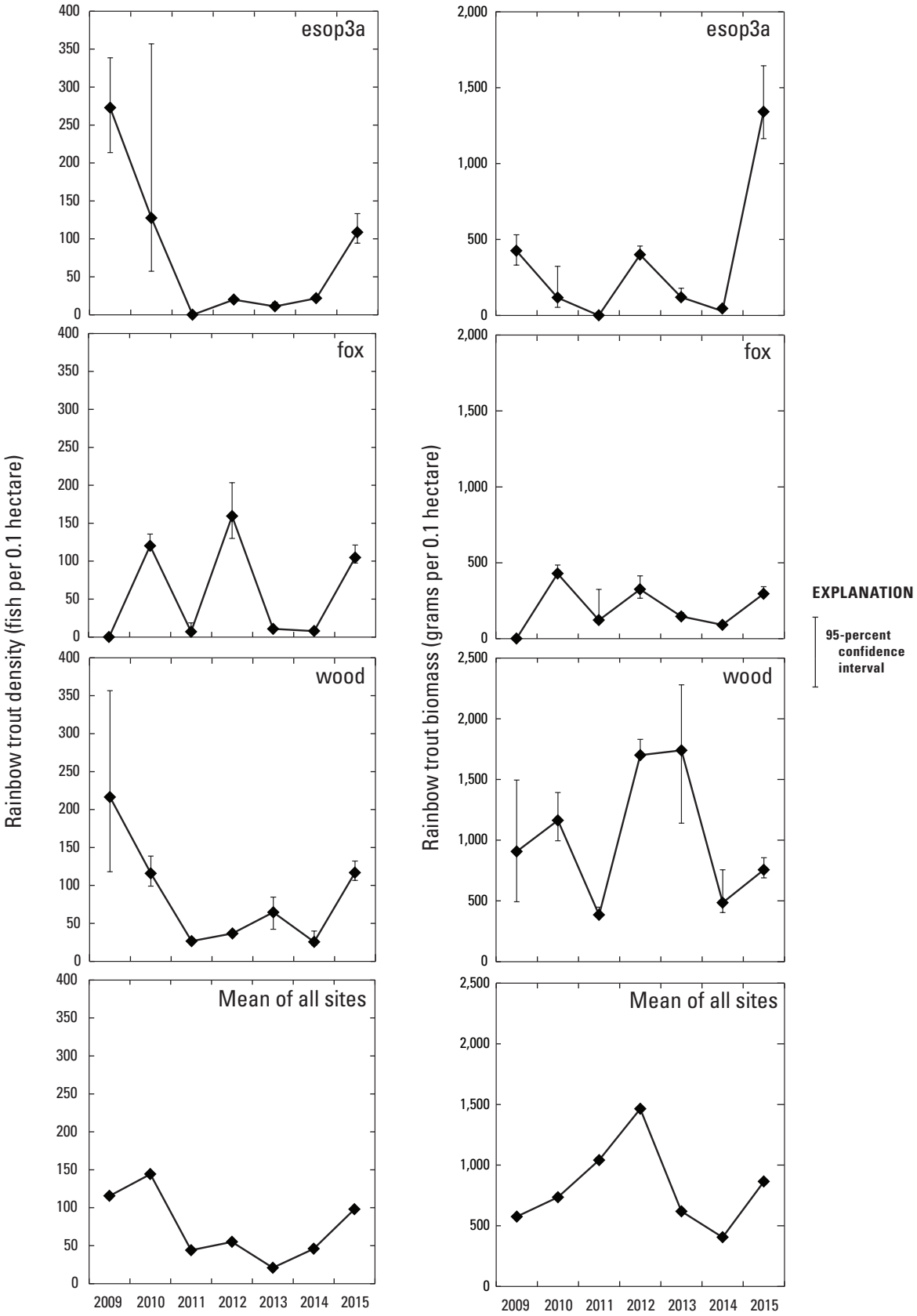

Figure 2. Estimates of density and biomass of rainbow trout populations at seven sites on the main stem and tributaries of the upper Esopus Creek, Ulster County, New York, 2009–15.—Continued

Table 2. Estimates of density, young-of-the-year density and percent, and biomass of rainbow trout and brown trout populations sampled annually at seven sites on the main stem and tributaries of the upper Esopus Creek, Ulster County, New York, 2009–15.

Year	fox	broad	birch	wood	esop0	esop2	esop3a	Mean
Rainbow trout density (fish per 0.1 hectare)								
2009	0	43	42	217	24	210	273	116
2010	120	195	128	116	34	289	128	144
2011	7	120	52	27	6	96	0	44
2012	159	23	63	37	6	77	20	55
2013	11	2	21	65	2	35	11	21
2014	8	40	101	26	4	121	22	46
2015	105	47	154	117	22	133	109	98
Rainbow trout young-of-the-year density (fish per 0.1 hectare)								
2009	0	27	25	204	8	193	273	104
2010	93	169	96	79	18	248	128	119
2011	0	99	21	15	2	43	0	26
2012	156	5	3	8	3	9	17	29
2013	0	2	7	41	0	22	7	11
2014	0	36	79	12	0	94	22	35
2015	94	38	124	102	17	94	95	81
Rainbow trout percent young-of-the-year								
2009	0	62	60	94	33	92	100	63
2010	77	87	75	68	52	86	100	78
2011	0	82	40	58	33	45	0	37
2012	98	22	4	23	50	12	86	42
2013	0	100	36	63	0	64	67	47
2014	0	90	78	47	0	78	100	56
2015	90	80	80	87	78	71	87	82
Rainbow trout biomass (grams per 0.1 hectare)								
2009	0	608	761	907	509	815	425	575
2010	429	841	1,069	1,164	427	1,100	117	735
2011	122	1,053	1,429	384	121	4,177	0	1,041
2012	325	968	1,888	1,700	57	4,908	400	1,464
2013	146	1	1,196	1,740	84	1,046	119	619
2014	91	121	810	486	67	1,232	29	405
2015	296	348	1,218	757	273	1,818	1,341	864
Brown trout density (fish per 0.1 hectare)								
2009	237	249	188	253	149	287	189	222
2010	279	136	82	63	95	69	30	108
2011	21	5	34	4	35	43	34	25
2012	1,299	72	167	229	114	65	73	288
2013	329	51	183	94	64	65	70	122
2014	65	49	104	78	51	82	54	69
2015	238	75	91	159	69	142	117	127

Table 2. Estimates of density, young-of-the-year density and percent, and biomass of rainbow trout and brown trout populations sampled annually at seven sites on the main stem and tributaries of the upper Esopus Creek, Ulster County, New York, 2009–15. —Continued

Year	fox	broad	birch	wood	esop0	esop2	esop3a	Mean
Brown trout young-of-the-year density (fish per 0.1 hectare)								
2009	187	234	122	157	77	238	166	169
2010	128	114	10	8	40	33	25	51
2011	0	0	13	0	22	25	34	13
2012	1,286	67	117	204	109	37	70	270
2013	260	5	101	31	8	3	2	59
2014	20	25	38	41	15	41	36	31
2015	221	53	58	131	26	116	71	97
Brown trout percent young-of-the-year								
2009	79	94	65	62	52	83	88	75
2010	46	84	12	13	42	48	85	47
2011	0	0	38	0	64	58	100	37
2012	99	93	70	89	96	57	96	86
2013	79	10	55	33	13	4	3	28
2014	30	52	36	53	30	50	67	45
2015	93	71	64	82	37	82	61	70
Brown trout biomass (grams per 0.1 hectare)								
2009	2,541	1,156	5,230	4,392	4,858	11,030	2,882	4,584
2010	5,377	1,235	5,003	2,737	4,449	1,704	2,747	3,322
2011	1,051	638	3,534	154	533	3,455	112	1,354
2012	3,038	514	4,372	3,872	498	5,497	1,405	2,742
2013	1,542	1,690	8,724	5,800	2,016	3,242	11,758	4,967
2014	1,199	2,397	4,949	1,865	1,727	4,076	1,405	2,517
2015	921	1,210	5,794	6,742	2,696	2,352	9,990	4,243

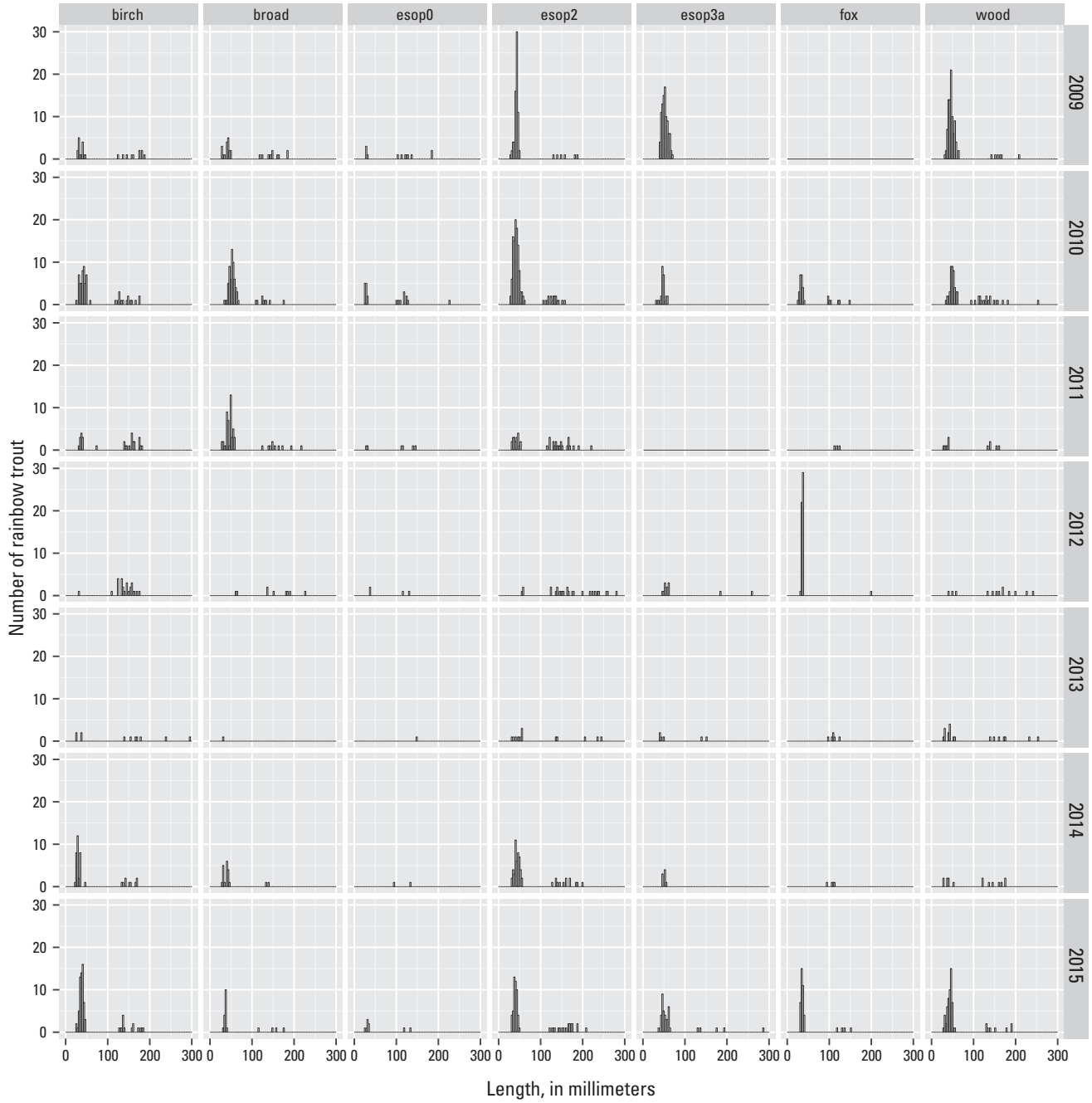

Figure 3. Length-frequency distributions of rainbow trout captured by site and year, upper Esopus Creek, Ulster County, New York, 2009–15. One rainbow trout of length 488 millimeters from esop2 in 2011 was omitted from this figure.

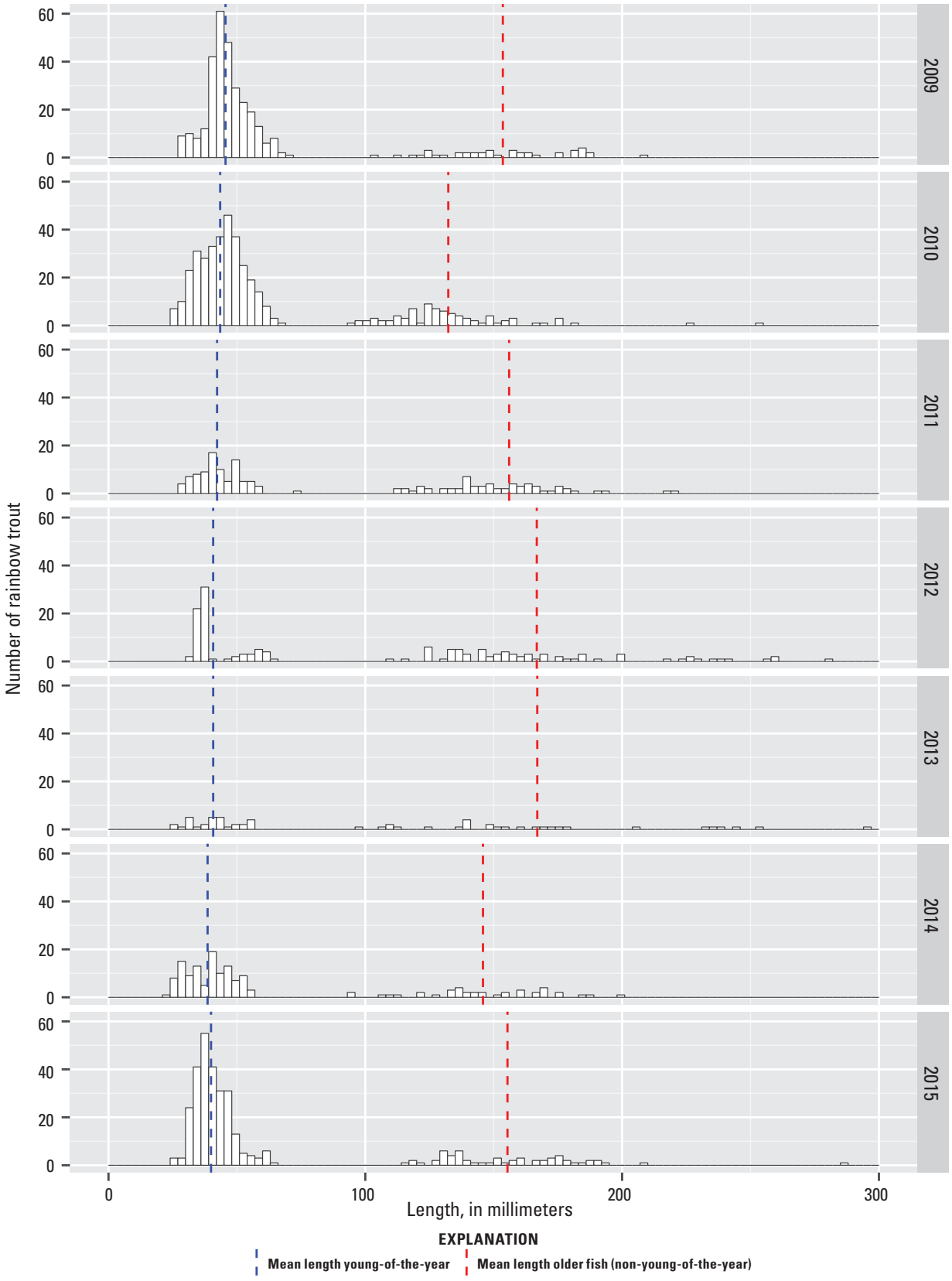

Figure 4. Length-frequency distributions of rainbow trout captured at all sites by year, upper Esopus Creek, Ulster County, New York, 2009–15. One rainbow trout of length 488 millimeters from esop2 in 2011 was omitted from this figure.

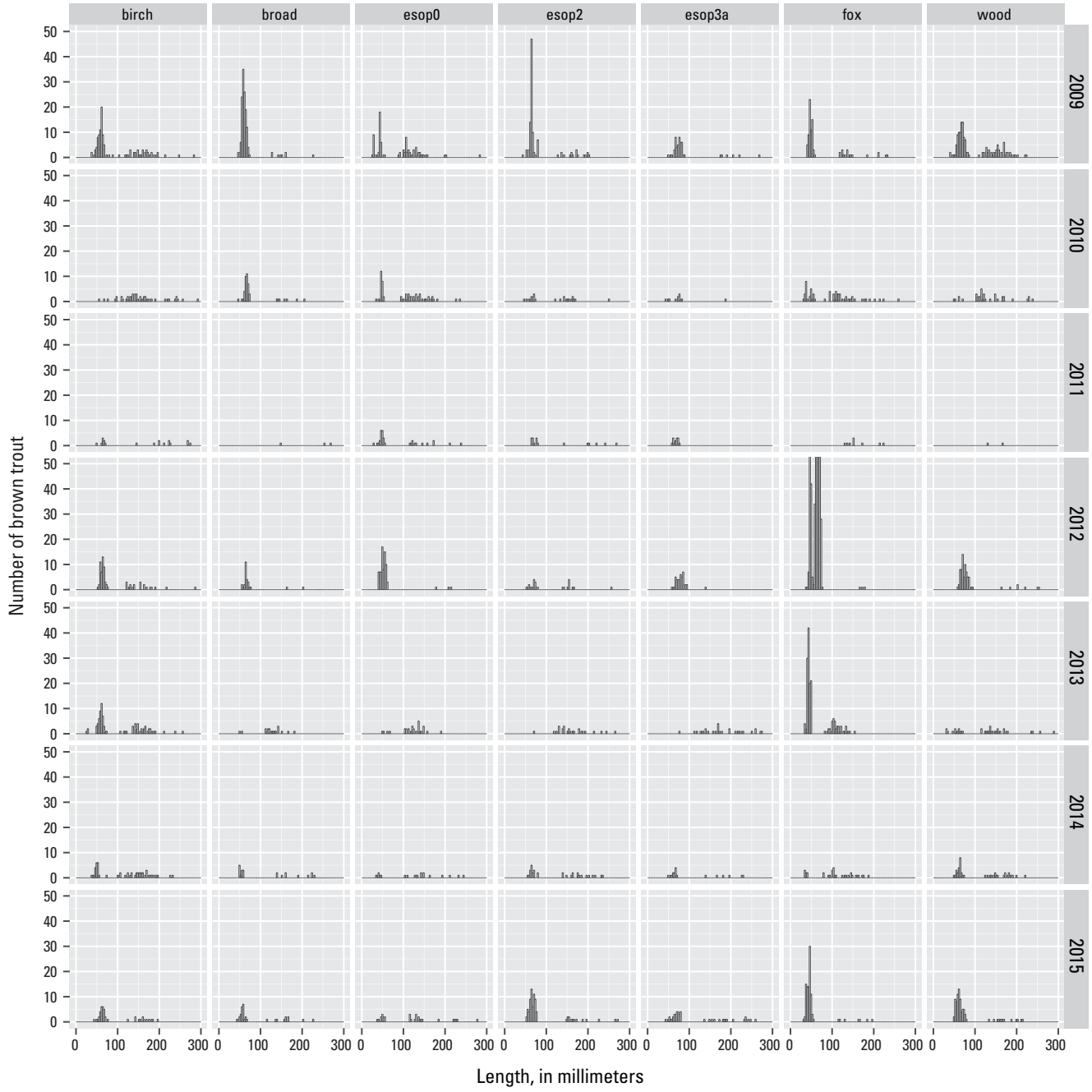

Figure 5. Length-frequency distributions of brown trout captured by site and year, upper Esopus Creek, Ulster County, New York, 2009–15. Forty brown trout of length greater than 300 millimeters from various sites and years and 120 brown trout of length less than 101 millimeters from fox in 2012 were omitted from this figure.

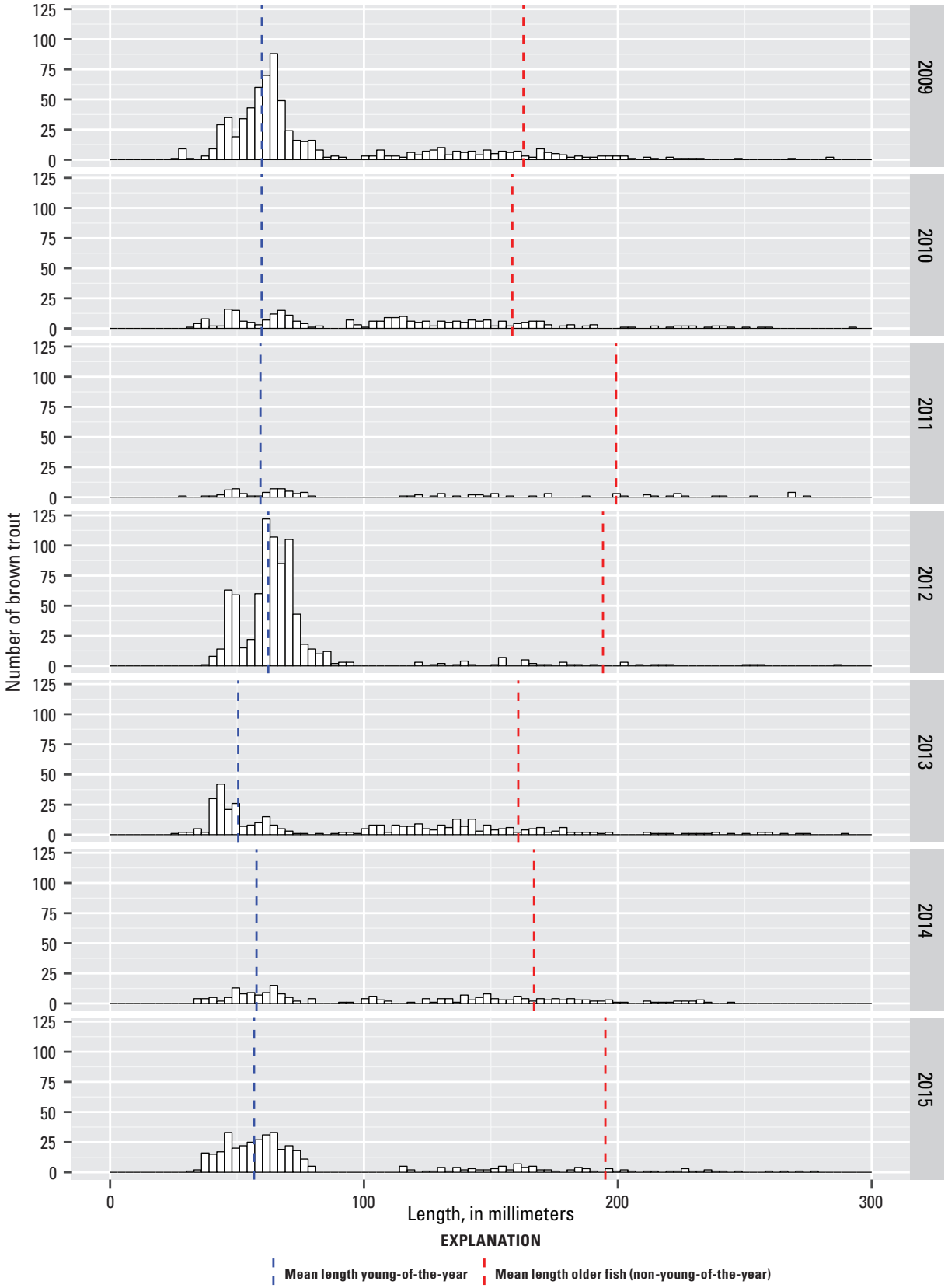

Figure 6. Length-frequency distributions of brown trout captured at all sites by year, upper Esopus Creek, Ulster County, New York, 2009–15. Forty brown trout of length greater than 300 millimeters from various sites and years were omitted from this figure.

References Cited

Baldigo, B.P., George, S.D., and Keller, W.T., 2015, Fish assemblages in the upper Esopus Creek, NY—Current status, variability, and controlling factors: Northeastern Naturalist, v. 22, no. 2, p. 345–371.

Duffy, B.T., Smith, A.J., Heitzman, D.L., and Abele, L.E., 2011, Upper Esopus Creek biological assessment: Albany, N.Y., New York State Department of Environmental Conservation, 60 p.

George, S.D., and Baldigo, B.P., 2015, *Didymosphenia geminata* in the upper Esopus Creek—Current status, variability, and controlling factors: PloS one, v. 10, no. 7, p. 1–20.

George, S.D., Baldigo, B.P., Smith, A.J., and Robinson, G.R., 2015a, Effects of an extreme flood on aquatic biota in a Catskill Mountain river: New York State Energy Research and Development Authority Report 15–08, 16 p.

George, S.D., Baldigo, B.P., Smith, A.J., and Robinson, G.R., 2015b, Effects of extreme floods on trout populations and fish communities in a Catskill Mountain river: Freshwater Biology, v. 60, no. 12, p. 2511–2522.

McHale, M.R., and Siemion, J., 2014, Turbidity and suspended sediment in the upper Esopus Creek watershed, Ulster County, New York: U.S. Geological Survey Scientific Investigations Report 2014–5200, 42 p., accessed March 3, 2015, at http://dx.doi.org/10.3133/sir20145200.

Palmer, P.M., Wilson, L.R., O'Keefe, P., Sheridan, R., King, T., and Chen, C.-Y., 2008, Sources of pharmaceutical pollution in the New York City watershed: Science of the Total Environment, v. 394, no. 1, p. 90–102.

Richardson, D.C., Oleksy, I.A., Hoellein, T.J., Arscott, D.B., Gibson, C.A., and Root, S.M., 2014, Habitat characteristics, temporal variability, and macroinvertebrate communities associated with a mat-forming nuisance diatom (*Didymosphenia geminata*) in Catskill mountain streams, New York: Aquatic Sciences, v. 76, p. 553–564.

Ross, T.J., 2012, Effects of anthropogenic stream alteration on brown trout habitat, movement and physiology: Ithaca, N.Y., Cornell University master's thesis, 106 p.

Smith, A.J., 2013, Upper Esopus Creek biological assessment: Albany, N.Y., New York State Department of Environmental Conservation, 32 p.

Van Deventer, J.S., and Platts, W.S., 1983, Sampling and estimating fish populations from streams: Transactions of the North American Wildlife and Natural Resources Conferences, v. 48, p. 349–354.

Van Deventer, J.S., and Platts, W.S., 1985, A computer software system for entering, managing, and analyzing fish capture data from streams: U.S. Forest Service Research Note INT 352, 12 p.

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