Appendix 1. Fish-Community Sampling Methods

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Appendix 2. Fish-Community Summaries

Contents

Appendix 2. Fish Community Summaries

Below are fish community summaries for MDFW fish-sampling sites near selected USGS streamflow-gaging stations.

Cadwell Creek (01174900)

Cadwell Creek was sampled in the summer of 2005 and resulted in the capture of 61 brook trout, a fluvial specialist species (100 percent fluvial specialists).

Stillwater River (01095220)

Four fish sampling events were conducted on the Stillwater River upstream from station 01095220 in West Boylston and Sterling during the summers of 2000 and 2005. With the use of backpack-mounted electroshocking units, a total of 1,086 fish of 15 species were captured. Fluvial specialists dominated the samples (55 percent), followed by fluvial dependents (41 percent), and macrohabitat generalists (4 percent). Fluvial specialists species included blacknose dace, brown trout, brook trout, fallfish, longnose dace, and tessellated darter. Landlocked salmon, common shiner and white sucker were the fluvial dependents captured. Bluegill, chain pickerel, largemouth bass, pumpkinseed, redfin pickerel, and yellow bullhead were the macrohabitat generalists captured. For all four sampling events combined, landlocked salmon was the most abundant species captured. The Stillwater River supports the only self-sustaining population of landlocked Atlantic salmon in the State.

Squannacook River (01096000)

The Squannacook River was sampled upstream from station 01096000 in September 1998 and resulted in the capture of 23 fish of 7 species. Fluvial specialists were most abundant (78 percent), followed by fluvial dependents (17 percent), and macrohabitat generalists (4 percent). Fluvial specialist species included blacknose dace, longnose dace, and brown trout. White sucker was the only fluvial dependent species captured. Macrohabitat generalists species included largemouth bass, yellow perch, and yellow bullhead.

Indian Head River (01105730)

One fish sampling event was conducted near station 01105730 in September 2001. From this sample, 143 fish of 6 species were gathered. Macrohabitat generalists dominated the sample (89.5 percent). Fluvial dependents (white sucker) accounted for 10.5 percent of the sample total. Fluvial specialists were not found at the site. American eels were the most abundant species captured. The other generalists captured were bluegill, chain pickerel, largemouth bass, and pumpkinseed.

Moss Brook (01165500)

Moss Brook was sampled in August 2000 near gage 01165500 and resulted in the capture of 87 fish of 8 species. Fluvial specialists (93.1 percent) dominated this sample, followed by fluvial dependents (3.4 percent). Only one macrohabitat generalist (1 individual chain pickerel) was captured. The anadromous sea lamprey accounted for 2.3 percent of the sample. Fluvial specialist species included blacknose dace, brook trout, fallfish, longnose dace and tessellated darters. White sucker was the fluvial dependent species captured.

Green River–Colrain (01170100)

Four fish samplings were conducted on Green River upstream from the gaging station during the summers of 2000, 2004, and 2005. The total number of fish sampled from all surveys was 1,010 of 10 species. Fluvial specialists dominated the sample population by 99.2 percent. Fluvial dependents accounted for 0.8 percent of the sample population. Only one macrohabitat generalist (one individual golden shiner) was captured. Blacknose dace were the most abundant fluvial specialists captured, followed by slimy sculpin, Atlantic salmon, and longnose dace. Other fluvial specialists species included brown trout, creek chub, and brook trout. Common shiners and white suckers were the fluvial dependents captured.

Sevenmile River (01175670)

Three fish samplings were conducted on the Sevenmile River during the summers of 2002 and 2005. During these samplings, 412 fish of 15 species were captured. Fluvial specialists (59.7 percent) dominated the sample, followed by fluvial dependents (27.4 percent), and macrohabitat generalists (12.9 percent). Fallfish and longnose dace were the most abundant fluvial specialists in the sample. Other fluvial specialists included brook trout (1 individual, likely wild), brown trout (1 individual, likely stocked), blacknose dace, and tessellated darters. Fluvial dependent species surveyed included common shiners and white suckers. Macrohabitat generalists surveyed included bluegill, brown bullhead, chain pickerel, golden shiner, yellow bullhead, and yellow perch.

Quaboag River (01177000)

Three fish samplings were conducted on the Quaboag River upstream from station 01177000 in July 2003. A total of 176 fish of 17 species were captured. Macrohabitat generalists (58 percent) dominated the sample, followed by fluvial specialists 28 percent, and fluvial dependents (13 percent). The macrohabitat generalists captured were American eel, bluegill, chain pickerel, golden shiner, largemouth bass, pumpkinseed, rock bass, redbreast sunfish, smallmouth bass, yellow bullhead, and yellow perch. The fluvial specialists included blacknose dace, fallfish, longnose dace, and tessellated darter. The fluvial dependents captured were white sucker and common shiner.

Hubbard Brook (01187300)

Hubbard Brook was sampled upstream from station 01187300 during summer 2005. A total of 150 fish of 9 species were captured. Fluvial dependants (56 percent) dominated the sample, followed by fluvial specialists (37 percent) and macrohabitat generalists (7 percent). Fluvial dependant species collected included common shiner and white sucker. Fluvial specialists included blacknose dace, creek chub, brook trout, longnose dace, and tessellated darter. Macrohabitat generalists included largemouth bass and pumpkinseed.

Green River–Great Barrington (01198000)

The Green River in Great Barrington was sampled in the area of station 01198000 during August 2002. A total of 122 fish of 7 species were captured. Fluvial specialists dominated the sample (89 percent) followed by macrohabitat generalists (11 percent). No fluvial dependent species were found. Brown trout dominated the fluvial specialists sampled. Other fluvial specialist species included blacknose dace, brook trout and slimy sculpin. Macrohabitat species included bluegill, green sunfish, and pumpkinseed.

Dry Brook (01331400)

Dry Brook was sampled in July 2002 and resulted in the capture of 96 fish of 8 species. Fluvial specialists dominated the sample (95 percent), followed by macrohabitat generalists (3 percent), and fluvial dependents (2 percent). Blacknose dace and slimy sculpin were the most abundant fluvial specialists. The other specialists captured were brook trout and longnose dace. Longnose sucker was the only fluvial dependent species captured. Macrohabitat generalist species included bluegill, brown bullhead, and pumpkinseed.

North Branch Hoosic River (01332000)

The North Branch of the Hoosic River was sampled upstream from station 01332000 during June 2002. A total of 145 fish of 11 species were captured. Fluvial specialists (76 percent) dominated the sample, followed by fluvial dependents (23 percent). Two macrohabitat generalist species (bluegill, brown bullhead) accounted for 1 percent of the sample. Fluvial specialists included blacknose dace, brown trout, creek chub, brook trout, longnose dace, and slimy sculpin. Fluvial dependent species included common shiner, longnose sucker, and white sucker.

Green River–Williamstown (01333000)

The Green River in Williamstown was sampled during summer 2002 and resulted in the capture of 293 fish of 8 species. Fluvial specialists (91 percent) dominated the sample, followed by fluvial dependent species (9 percent). Only one individual macrohabitat generalist, a pumpkinseed, was captured. Fluvial specialist species included blacknose dace, longnose dace, slimy sculpin, brown trout, and creek chub. Fluvial dependent species included longnose sucker and white sucker.

Appendix 3. Medians and Interquartile Ranges for 85 Streamflow-Gaging Stations in Southern New England

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Table

Appendix 4. Estimation of Median of Monthly Median Flows by Using Multiple Linear Regression

Tables

Appendix 4. Estimation of Median of Monthly Median Flows by Using Multiple Linear Regression

Methods, data, and multiple linear regression equations used to calculate median of monthly median flows using basin and climate characteristics are described in appendix 4. The regression equations were developed from climatic and basin characteristics for each of 61 streamflow-gaging stations used to characterize streamflows in Massachusetts. The response variables were determined for each of the 61 stations by determining the median of the monthly median flow for each month of each year. Basin and climate characteristics used in the regression equations to determine median flows are listed in the main body of the report.

Equations initially involved development of a correlation matrix and a matrix of scatterplots of the explanatory variables to assess colinearity. Highly correlated explanatory variables were not used simultaneously in the development of the regression equations.

The explanatory data were mathematically transformed, so that the data conformed better to the assumption of a linear relation between the response variable and the explanatory variables, and the standard error of the estimate was minimized (Tasker and Granato, 2000). Several data transformations were tested, but the logarithmic transformation provided the best overall linearization. A single transformation method that works reasonably well for all data is preferred over multiple transformation methods (Tasker and Granato, 2000). To transform data containing zeros, a small number was added to the data points. The number added differed between explanatory variables, and was selected as 1.0 raised to a power that was an order of magnitude below the lowest nonzero value in each dataset. To prevent underestimation of the response variable, the Smearing bias correction factor (BCF) (Duan, 1983) was used to adjust the ln-regression equation back into linear space. All of the bias-correction factors had values of less than 1.1.

The multiple linear regression equations take the general form of

$$y = a + b_1 * x_1 + b_2 * x_2 + \ldots + b_k * x_k \qquad (1)$$

where

y is the response variable,
x_k is the basin characteristic explanatory variable(s),
a is the regression constant, or y intercept of the regression line,
b_1 is the regression coefficient for the first explanatory variable,
b_2 is the regression coefficient for the second explanatory variable, and
b_k is the regression coefficient for the k^{th} explanatory variable.

Owing to the use of log transformation of the variables, the general form becomes

$$\ln y = \ln a + b_1 * \ln x_1 + b_2 * \ln x_2 + \ldots + b_k * \ln x_k \qquad (2)$$

or

$$y = a\, e\, x_1^{b_1} x_2^{b_2} \cdots \qquad (3)$$

where

e is the bias correction factor.

The transformed data were used in a stepwise regression using MINITAB statistical software release 14.12.0, 2004. The stepwise regression was done to indicate the explanatory variables that contribute the most to explaining the variance. A stepwise regression in MINITAB removes and adds explanatory variables to the regression model for the purpose of identifying the best variables. Minitab utilizes three commonly used procedures: standard stepwise regression (adds and removes variables), forward selection (adds variables), and backward elimination (removes variables). Results from the stepwise regression analyses were evaluated to refine the selection of variables and to provide information about the suitability of the model. Model output was evaluated by examination of the regression equation and diagnosis of regression statistics. Graphical output that was evaluated to determine whether residuals departed from a normal distribution included normal probability plots, histograms of the residuals, plots of residuals versus fitted values, and plots of the residuals versus the order of the data. Residuals also were plotted versus drainage area to evaluate whether any systematic variations existed relative to basin size. Regression statistics from MINITAB output were evaluated to aid in selection or rejection of variables on the basis of maximizing the coefficient of determination (R^2) and to minimize the prediction error sum of squares (PRESS) statistic (Maidment, 1993). Criteria for removal of variables included having the coefficient be significantly different from zero with a p-value greater than 0.05 and variance inflation factor (VIF) values greater than 3.0. Unusual observations or outliers were identified using MINITAB output. Stations with a large influence were removed from the regression model; stations with a large standardized residual, denoted with an R value of 3.0 or greater, also were removed. The number of terms in the equation also were evaluated using Mallow's C_p (Maidment, 1993), and models were selected for which the value for Mallow's C_p was closest to the number of terms used in the equation. The number of variables removed for any particular month ranged from zero to four.

Regression equations for the median of monthly median streamflows for each month are given in table 4-1, along with several measures of model adequacy. Estimates of the quality of the multiple regression equations include measures of the coefficient of determination (R^2adj and R^2pred) and prediction error sum of squares (PRESS) values. Minimizing the PRESS value means that the equation produces the least error when making new predictions (Helsel and Hirsch, 1992). Finally, regression equations were reviewed to determine whether coefficients had signs and magnitudes that could be explained by a reasonable scientific hypothesis (Tasker and Granato, 2000; Helsel and Hirsch, 1992).

Table 4-1. Summary of regression equations developed for estimating the median of monthly median flows for Massachusetts rivers.

[Code names and descriptions for basin, climate, and land-use characteristics are given in table 2. R^2(adj), adjusted coefficient of determination; R^2(pred), predicted coefficient of determination, PRESS, prediction error sum of squares]

Month	R^2(adj)	R^2(pred)	PRESS	Regression equation
Oct	93.3	92.5	9.55	$\text{Oct}_{50} = 0.354\ \text{AREA}^{1.05}$
Nov	97.4	97.2	2.50	$\text{Nov}_{50} = 0.0176\ \text{AREA}^{0.966}\ \text{PRECIPIN}^{1.52} * \text{COASTDIST}^{-0.147}$
Dec	98.5	98.4	1.63	$\text{Dec}_{50} = 559\ \text{AREA}^{0.989} * \text{COASTDIST}^{-.486} * \text{AWETLANDPC}^{-0.0859}$
Jan	99.1	99	1.06	$\text{Jan}_{50} = 6.00\ \text{AREA}^{1.02} * \text{COASTDIST}^{-0.662} * \text{PRECIPIN}^{1.61}$
Feb	98.9	98.8	1.219	$\text{Feb}_{50} = 16{,}100\ \text{AREA}^{0.989} * \text{COASTDIST}^{-.779}$
Mar	99.3	99.3	0.678	$\text{Mar}_{50R} = 117\ \text{AREA}^{0.974} * \text{COASTDIST}^{-0.314}$
Apr	98.9	98.8	1.385	$\text{Apr}_{50} = 99.3\ \text{AREA}^{1.03} * \text{TEMPMAX\_30}^{-2.0} * \text{PERFORESTED}^{0.377} * \text{AWETLANDPC}^{0.059}$
May	98.6	98.6	1.569	$\text{May}_{50} = 0.00318\ \text{AREA}^{1.03} * \text{PERFORESTED}^{0.388} * \text{PRECIPIN}^{1.17}$
Jun	97.7	97.5	2.572	$\text{Jun}_{50} = 1.93\ \text{AREA}^{1.03} * \text{SOILSC}^{-0.24} * \text{SOILSD}^{-0.0576}$
Jul	93.8	93.1	8.317	$\text{Jul}_{50} = 57.6\ \text{AREA}^{1.06} * \text{SAND\_GRAVE}^{0.167} * \text{SLPPCT}^{0.628} * \text{COASTDIST}^{-0.589}$
Aug	91.4	90.0	15.35	$\text{Aug}_{50} = 0.177\ \text{AREA}^{1.11} * \text{SOILSC}^{-0.513} * \text{SOILSD}^{-0.0824} * \text{ELEVFT}^{-0.272} * \text{SAND\_GRAVE}^{0.117}$
Sep	93.3	92.2	11.8	$\text{Sep}_{50} = 5{,}260\ \text{AREA}^{1.09} * \text{SOILSC}^{-0.536} * \text{SOILSD}^{-0.0731} * \text{TEMPMAX\_30}^{-3.24} * \text{SAND\_GRAVE}^{0.144}$

Examination of the regression equations reveals that drainage area was the primary predictor of median monthly flow (table 4-2). The percentage of the variability explained by drainage area was calculated as the ratio of the sequential sum of squares to the total sum of squares. For equations with more than one variable, drainage area explained from 93 to 99 percent of the variability in median monthly flows. After drainage area, the next most significant single explanatory variables differed seasonally and explained less than 2 percent of the variability in median monthly flows for all months/time periods except January and February, where coastal distance explained about 5 and 6 percent of the variability, respectively. Coastal distance was the second most significant explanatory variable for the winter months of December though March; maximum air temperature and percent forested area were the second most significant variables for April and May, respectively, and soil permeability characteristics was the second most significant explanatory variable for the months of June through September.

Table 4-2. Means and ranges of values for basin and climatic characteristics for the contributing areas of streamflow-gaging stations used in regression equations for determining median monthly flows in southern New England.

[Code names and descriptions for basin, climate, and land-use characteristics are given in table 2.]

	AREA2MI (square miles)	ELEVFT (feet)	SLPPCT (percent area)	TEMP-MAX_30 (degrees Celsius)	AWET-LANDPC (percent area)	SAND_GRAVE (percent area)	SOILSC (percent area)	SOILSD (percent area)	PERFOR-ESTED (percent area)	lncoastdist[1]
Maximum	293.91	1,849.91	24.33	15.47	23.34	68.77	100	39.7	95.88	12.47
Mean	46.52	750.86	8.97	13.96	7.31	17.75	49.96	9.00	75.29	11.91
Minimum	1.69	97.64	1.75	11.76	0.69	0	8.31	0	26.73	10.79

[1] lncoastdist is the natural log of the distance, measured in Massachusetts State Plane meters, between the selected streamflow-gaging station and the point (1,000,000, 0), minus 1.07×10^6 meters.

The regression analyses reveal the relations among variables but do not imply that the median flows are directly caused by the variables (Tabachnick and Fidell, 2001). The coastal distance term likely serves as a surrogate for several physical and climatic properties that vary from southeast to northwest, including topography, elevation, slope, percent sand and gravel, and maximum air temperature. The coastal distance term also may reflect the influence of other, currently unmeasured variables, such as snow depth, or dates of first and last frost. Explanatory variables that have a physical or climatic basis are preferable to a location term, and identification of these variables could lead to improved regressions.

The median monthly discharge equations presented in table 4-1 can be used to estimate the long-term median of monthly median discharges for rivers in Massachusetts or adjacent states in southern New England whose basin characteristics fall within the range of values given in table 4-2. The monthly discharges calculated by these equations (table 4-1) are for rivers having unaltered or minimally altered streamflows. If the equations are applied to data from sites with known water withdrawals, water returns, diversions, or regulation, the results may not reflect actual conditions.

The basin characteristics used in the equations presented in table 4-2 may not be easily determined for all sites in Massachusetts. For this reason, and because drainage area explained most of the variability, drainage area alone was tested as an explanatory variable (table 4-3). Although the equations included in table 4-3 do not explain as much of the variability as the equations in table 4-1, the drainage area equations provide a reasonable estimate of the median monthly discharge for sites where only the drainage area can be determined easily.

Table 4-3. Summary of regression equations, developed using area alone, for estimating the median of monthly median flows for Massachusetts rivers.

[R^2(adj), adjusted coefficient of determination; R^2(pred), predicted coefficient of determination, PRESS, prediction error sum of squares]

Month	R^2(adj)	R^2(pred)	PRESS	Regression equation
Oct	92.9	92.46	9.020	$\text{Oct}_{50} = 0.353\ \text{AREA}^{1.051}$
Nov	96.6	96.3	3.708	$\text{Nov}_{50} = 1.098\ \text{AREA}^{0.977}$
Dec	96.7	96.52	3.553	$\text{Dec}_{50} = 1.533\ \text{AREA}^{0.979}$
Jan	93.6	93.29	7.183	$\text{Jan}_{50} = 1.386\ \text{AREA}^{0.986}$
Feb	92.7	92.29	8.122	$\text{Feb}_{50} = 1.659\ \text{AREA}^{0.973}$
Mar	98	98	2.102	$\text{Mar}_{50} = 2.803\ \text{AREA}^{0.969}$
Apr	97.3	97.3	3.249	$\text{Apr}_{50} = 2.879\ \text{AREA}^{1.038}$
May	98.6	98.55	1.569	$\text{May}_{50} = 1.704\ \text{AREA}^{1.017}$
Jun	96.4	96.23	4.312	$\text{Jun}_{50} = 0.733\ \text{AREA}^{1.035}$
Jul	91.7	91.29	11.550	$\text{Jul}_{50} = 0.251\ \text{AREA}^{1.101}$
Aug	88.4	87.79	18.813	$\text{Aug}_{50} = 0.156\ \text{AREA}^{1.150}$
Sep	89.5	89.05	16.589	$\text{Sep}_{50} = 0.153\ \text{AREA}^{1.148}$

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Appendix 5. Hydrologic Indices Determined by the Indicators of Hydrologic Alteration (IHA) Program

CD-ROM

[In Pocket]

Table

Appendix 5. Hydrologic Indices Determined by the Indicators of Hydrologic Alteration (IHA) Program

Appendix 5 provides tables of streamflow statistics (tables 5-1 and 5-2), calculated using the Indicators of Hydrologic Alteration (IHA) program (The Nature Conservancy, 2005), for the 1960–2004 period for 61 least-altered streamflow-gaging stations in southern New England (on the CD). The tables are titled using the streamflow-gaging station codes listed in table 1.

The IHA software program was developed by The Nature Conservancy (TNC) to calculate statistics that can be used to assess the range of variation of discharge for a river (Richter and others, 1996, 1997; Mathews and Richter, 2007). An analysis of unregulated or least-altered flows can be used to characterize the flow conditions to which species have adapted and is generally part of the first phase of describing the environmental-flow setting (Arthington and others, 2006; Henriksen and others, 2006, Mathews and Richter, 2007).

The IHA program calculates the values of 67 hydrologic indices. Thirty-three of these hydrologic indices characterize the intra- and inter-annual variability of surface-water conditions, including the magnitude, frequency, duration, timing, and rate of change of flows (Richter and others, 1996, 1997). An additional 34 indices called “Environmental Flow Components” (EFCs) describe the magnitude, frequency, duration, timing, and rate of change of flows for five categories of daily flows—extreme low flows, low flows, high flow pulses, small floods, and large floods (Mathews and Richter, 2007). The IHA default settings were used to define the five EFC categories. The default settings divide the hydrograph into high flows (flows greater than or equal to the 75th percentile of all flows) and low flows (flows less than the 50th percentile of all flows). High flows are further divided into large floods (a pulse greater than the 10-year flow duration), small floods (a pulse greater than or equal to the 2-year flow duration but less than the 10-year flow duration), and high flow pulses (defined to begin when daily flows increase by more than 25 percent and end when daily flows decrease by less than 10 percent). Low flows also include extreme low flows (flows that are less than or equal to the 10th percentile of all low flows). Definitions for the 67 IHA hydrologic indices are provided in table 5-1.

The source data for the IHA program are daily flows for the 61 streamflow-gaging stations for the 1960–2004 period. Daily flows for portions of the station records for 46 of the stations were estimated using MOVE.3 techniques (table 6). The IHA program was run using the default settings for the non-parametric analysis, with the exceptions that the range of variability was defined by the 25th and 75th percentiles, and the 25th and 75th percentiles were used as low- and high-flow thresholds, respectively. Hydrologic indices were determined using the IHA program for both water years (October–September) and climate years (April–March). In New England, the April–March period generally allows better representation of the magnitudes of the long-period low flows (30-day and 90-day) than water years because, in some years, summer low-flow conditions extend into autumn of the next water year.

The output IHA data are provided for water years and climate years in discharge units of cubic feet per second (ft^3/s; shown as cfs in table 5-2) and normalized by drainage area in discharge units of cubic feet per second per square mile ($ft^3/s/mi^2$; shown as cfsm in table 5-2). The values in the IHA output tables have been rounded to the standards used by the USGS for daily discharge data. The number of significant figures used for USGS daily mean discharge data is determined on the basis of the magnitude of the discharge value: discharges of less than 1 ft^3/s are rounded to the nearest hundredth of a cubic foot per second, discharges from 1.0 to 10 ft^3/s are rounded to the nearest tenth, discharges greater than 10 to 1,000 ft^3/s are rounded to the whole numbers, and discharges greater than 1,000 ft^3/s are rounded to three significant figures. The USGS standard for discharges that are exactly halfway between values to be rounded is to round to the nearest even value. For example, discharges of 3.75 and 3.85 ft^3/s would both round to 3.8 ft^3/s. Normalized flows and all other non-flow data were rounded to three significant figures. The IHA hydrologic indices for the 61 streamflow-gaging stations are given in table 5-2.

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Appendix 6. Hydrologic Indices Determined by the Hydrologic Index Tool (HIT)

CD-ROM

[In Pocket]

Table

Appendix 6. Hydrologic Indices Determined by the Hydrologic Index Tool (HIT)

Appendix 6 provides tables of streamflow statistics (tables 6-1 and 6-2), calculated using the Hydrologic Index Tool (HIT) (Olden and Poff, 2003; Henriksen and others, 2006; Kennen and others, 2007), for the 1960–2004 period for 61 least-altered streamflow-gaging stations in southern New England (on the CD). The streamflow-gaging stations in table 6-2 are identified using the streamflow-gaging station codes listed in table 1.

The source data used for the HIT program are daily flows for the 61 streamflow-gaging stations for the 1960–2004 period. Daily flows for portions of the station records for 46 of the stations were estimated using MOVE.3 techniques (table 6).

The following text and table 6-1, which defines the 171 hydrologic indices, are quoted directly from Kennen and others (2007):

> The following information for the 171 hydrologic indices is from Olden and Poff (2003). The USGS revised a limited number of the formulae and (or) definitions when deemed appropriate. These changes are documented in Henriksen and others (2006). Olden and Poff (2003) contains 12 additional references from which the indices were derived. Two of these articles (Colwell, 1974; Poff, 1996) are referenced here because they provide examples and additional explanation for complex indices.
>
> The alphanumeric code preceding each definition refers to the category of the flow regime (magnitude, frequency, duration, timing, or rate of change) and type of flow event (A, average; L, low; and H, high) the hydrologic index was developed to describe. Indices are numbered successively within each category. For example, MA1 is the first index and describes the magnitude of the average flow condition.

MA#	Magnitude, average flow conditions
ML#	Magnitude, low flow conditions
MH#	Magnitude, high flow conditions
FL#	Frequency, low flow conditions
FH#	Frequency, high flow conditions
DL#	Duration, low flow conditions
DH#	Duration, high flow conditions
TA#	Timing, average flow conditions
TL#	Timing, low flow conditions
TH#	Timing, high flow conditions
RA#	Rate of change, average conditions

> Following each definition, in parentheses, are (1) the units of the index and (2) the type of data (temporal or spatial) from which the upper and lower percentile limits (for example, 75th and 25th) are derived. Temporal data are from a multiyear daily flow record from a single streamflow-gaging station. For example, index MA1—mean for the entire flow record—uses 365 mean daily flow values for each year in the flow record to calculate the mean for the entire flow record. Consequently, 365 values for each year are used to calculate upper and lower percentile limits. However, formulas for 60 of the indices do not produce a range of values from which percentile limits can be calculated. MA5 (skewness), for example—the mean for the entire flow record divided by the median for the entire record—results in a single value; therefore, upper and lower percentile limits cannot be calculated.
>
> Exceedence and percentile are used in the calculation for a number of indices. A 90-percent exceedence means that 90 percent of the values are equal to or greater than the 90-percent exceedence value, whereas a 90th percentile means that 10 percent of the values are equal to or greater than the 90th-percentile value.

The values in the HIT output table (table 6-2) have been rounded to the standards used by the USGS for daily discharge data. The number of significant figures used for USGS daily mean discharge data is determined on the basis of the magnitude of the discharge value: discharges of less than 1 ft^3/s are rounded to the nearest hundredth of a cubic foot per second, discharges from 1.0 to 10 ft^3/s are rounded to the nearest tenth, discharges greater than 10 to 1,000 ft^3/s are rounded to the whole numbers, and discharges greater than 1,000 ft^3/s are rounded to three significant figures. The USGS standard for discharges that are exactly halfway between values to be rounded is to round to the nearest even value. For example, discharges of 3.75 and 3.85 ft^3/s would both round to 3.8 ft^3/s. Normalized flows and all other non-flow data were rounded to three significant figures. The HIT hydrologic indices for the 61 streamflow-gaging stations are given in table 6-2.

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