APPENDIX D

List of traits and associated metadata

Table D1. List of traits included in the Freshwater Biological Traits Database.

Variable	Data Type	Description
TSN	number (integer)	Taxonomic Serial Number (from itis.gov website)
Taxon	text	Highest level of taxonomic resolution
Order	text	Taxonomic Level
Family	text	Taxonomic Level
Genus	text	Taxonomic Level
TraitRecord_ID	number (integer)	This is a unique ID that came from the source documents. It is being retained in case there is a need to link back to the original source.
Study_Citation_abbrev	text	Abbreviated citation
Study_Citation	text	Citation
Published	yes/no	Yes/No
Study_location_state	text	U.S. state or Canadian province in which study occurred
Study_location_county	text	U.S. county in which study occurred
Study_location_region	text	Region in which study occurred
Study_latitude	Format varies: e.g., 34° 54 3.4" or 28º 48' 32" N	Latitude, when reported in study
Study_longitude	Format varies: 79° 20' 56.3" or 97º 01' 45: W	Longitude, when reported in study
Study_dates	Format varies: e.g., Summer 1997, May-87, 1981 - 1982	Date of study
Adult	text (ADULT) or blank	Identifies if traits were compiled for aquatic adults, otherwise entries pertain to immature life stage
Data_entry	text	Person who entered data
Data_entry_date	date	Date person entered data
WB_type_lake	number (binary) - 1 or blank	1 = taxon is found in lakes
WB_type_pond	number (binary) - 1 or blank	1 = taxon is found in ponds
WB_type_wetland	number (binary) - 1 or blank	1 = taxon is found in wetlands
WB_type_warm_sp	number (binary) - 1 or blank	1 = taxon is found in warm springs
WB_type_cold_sp	number (binary) - 1 or blank	1 = taxon is found in cold springs
WB_type_headwater	number (binary) - 1 or blank	1 = taxon is found in headwater streams

Table D1 continued…

Variable	Data Type	Description
WB_type_2-4_order	number (binary) - 1 or blank	1 = taxon is found in second-fourth order streams
WB_type_river	number (binary) - 1 or blank	1 = taxon is found in rivers
WB_type_brackish	number (binary) - 1 or blank	1 = taxon is found in brackish waters
WB_type_temp_lentic	number (binary) - 1 or blank	1 = taxon is found in temporary lentic waters
WB_type_eph_lotic	number (binary) - 1 or blank	1 = taxon is found in ephemeral lotic waters
WB_type_other	number (binary) - 1 or blank	1 = taxon is found in an unlisted waterbody type
WB_type_other_specify	text	Describes WB_type_other entry
Primary_WB_type	text	Primary waterbody type where organism is found
Study_elevation_min	number (integer)	Lower elevation where taxon reported (in meters above sea level)
Study_elevation_max	number (integer)	Upper elevation where taxon reported (in meters above sea level)
Max_body_size_abbrev	text (categorical)	Abbreviated maximal body size entries = small, medium, large
Max_body_size	text	Maximal body size of immatures. Entries = Large (length > 16 mm), Medium (length 9-16 mm), Small (length < 9 mm)
Measured_length	number (decimals)	Measured body length of immatures (mm)
Measured_width	number (decimals)	Measured body width of immatures (mm)
Measured_height	number (decimals)	Measured body height of immatures (mm)
Body_shape_abbrev	text (categorical)	Abbreviated body shape entries = streamlined, not_streamlined
Body_shape	text	Body shape. Entries = Bluff (blocky), Dorsoventrally flattened, Round (humped), Streamlined / fusiform, Tubular
Body_shape_case	text	Body shape with case/retreat. Entries = Bluff (blocky), Dorsoventrally flattened, Round (humped), Streamlined / fusiform, Tubular
Body_shape_comments	text	Description of abbreviated body shape entries: streamlined = flat, fusiform; not streamlined = cylindrical, round or bluff

Table D1 continued…

Variable	Data Type	Description
Mediate_drag	text	Indication of whether shape mediates drag. Entries = no, yes, unknown, blank
Morph_adapt_suckers	number (binary) - 1 or blank	1 = taxon has suckers
Morph_adapt_friction	number (binary) - 1 or blank	1 = taxon has friction pads or other structures to reduce friction coefficient with surface
Morph_adapt_hooks	number (binary) - 1 or blank	1 = taxon has hooks
Morph_adapt_silk	number (binary) - 1 or blank	1 = taxon has silk
Morph_adapt_ballast	number (binary) - 1 or blank	1 = taxon has ballast
Morph_adapt_hairy	number (binary) - 1 or blank	1 = taxon has hair
Morph_adapt_other	text	Text to further describe morphological adaptations
Attach_abbrev	text (categorical)	Abbreviated attachment entries = none, some, both
Attach_comments	text	Description of abbreviated attachment entries: none = free-ranging; some = sessile, sedentary; both = free-ranging and sessile, sedentary. Other (non-abbreviated) entries include: normally free living and capable of locomotion; both sessile and free living and capable of locomotion; normally sessile.
Armor_abbrev	text (categorical)	Abbreviated armoring entries = none, poor, good
Armor	text	Degree of body armoring. Entries = All sclerotized, Hard shelled, Partly sclerotized, Soft
Armor_comments	text	Description of abbreviated armoring entries: none = soft-bodied forms; poor = heavily sclerotized; good = e.g., some cased caddisflies
Resp_abbrev	text (categorical)	Abbreviated respiration entries = tegument, gills, plastron_spiracle
Resp_early	text	Respiration mode of early instars
Resp_late	text	Respiration mode of late instars
Resp_adult	text	Respiration mode of aquatic adults
Resp_comments	text	Respiration text notes

Table D1 continued…

Variable	Data Type	Description
Emerge_behav_drift	number (binary) - 1 or blank	1 = emergence behavior - drifting
Emerge_behav_climb	number (binary) - 1 or blank	1 = emergence behavior - climbing
Emerge_behav_crawl	number (binary) - 1 or blank	1 = emergence behavior - crawling
Emerge_behav_comment	text	Emergence behavior text notes
Emerge_season_all_year	text	Indicates whether emergence can occur all year. Entries = no, yes, unknown, blank
Emerge_synch_abbrev	text (categorical)	Abbreviated synchronization of emergence entries = poorly, well
Emerge_synch	text	Indicates whether emergence is synchronous
Emerge_synch_comments	text	Description of abbreviated synchronization of emergence entries: poorly = week; well = days
Emerge_season_1	text (categorical)	Season that emergence begins. Entries = winter, spring, summer, fall
Emerge_season_2	text (categorical)	Season that emergence ends. Entries = winter, spring, summer, fall
Emerge_season_comments	text	Seasons during which sexually mature forms have been reported. Entries = winter, spring, summer, fall
Ovipos_behav_prim	text	Primary oviposition behavior
Ovipos_behav_sec	text	Secondary oviposition behavior
Ovipos_behav_comments	text	Oviposition behavior text notes
Eggs_cement	text	Indicates whether eggs are cemented. Entries = no, yes, unknown, blank
Ovipos_duration	text	Duration of oviposition period. Entries = days, months, weeks
Feed_prim_abbrev	text (categorical)	Abbreviated primary functional feeding group entries: CF, CG, HB, PA, PR, SH
Feed_mode_prim	text	Primary feeding mode based on mouthpart morphology
Feed_mode_sec	text	Secondary feeding mode based on mouthpart morphology

Table D1 continued…

Variable	Data Type	Description
Feed_mode_comments	text	Description of abbreviated primary functional feeding group entries: CF = collector-filterer; CG = collector-gatherer; HB = herbivore (scraper); SH = shredder; PR = predator (piercer, engulfer); PA = parasite. Other (non-abbreviated) entries include text notes on food material consumed.
Habit_prim_abbrev	text (categorical)	Abbreviated habit entries: BU, CB, CN, SK, SP, SW
Habit_prim	text	Primary habit
Habit_sec	text	Secondary habit
Habit_comments	text	Description of abbreviated primary habit entries: BU = burrower; CB = climber; CN = clinger; SK = skater; SP = sprawler; SW = swimmer. Other (non-abbreviated) entries include text notes on habit.
Rheophily_abbrev	text (categorical)	Abbreviated rheophily entries: depo, depo_eros, eros
Rheophily_comments	text	Description of abbreviated rheophily entries: depo = depositional only, depo_eros = depositional and erosional; eros: erosional only. Other (categorical) entries include: fast, moderate, moderate-fast, standing and flowing, standing-slight, slight.
Current_quiet	number (binary) - 1 or blank	1 = current preference - quiet
Current_slow	number (binary) - 1 or blank	1 = current preference - slow
Current_moderate	number (binary) - 1 or blank	1 = current preference - moderate
Current_fast_lam	number (binary) - 1 or blank	1 = current preference - fast laminar currents
Current_fast_turb	number (binary) - 1 or blank	1 = current preference - fast turbulent currents
CurrentOptima	number (decimals)	Numerical optima values for current data that were derived from weighted average or maximum likelihood calculations

Table D1 continued…

Variable	Data Type	Description
CurrentOptima_Rank	number (integers)	Rank values were derived using a 1-7 scoring scheme based on the following percentiles: 0,0.1,0.25,0.4,0.6,0.75,0.9,1, such that low CurrentOptima_Rank scores = preference for slower water and high CurrentOptima_Rank scores = preference for faster water. Rankings allow for comparisons across data sets, since optima and tolerance values will vary depending on the data set they were derived from.
Current_Comments	text	Brief description of how CurrentOptima and CurrentOptima_Rank values were derived.
Microhab_sand	number (binary) - 1 or blank	1 = Microhabitat substrate preference - sand
Microhab_silt	number (binary) - 1 or blank	1 = Microhabitat substrate preference - silt
Microhab_gravel	number (binary) - 1 or blank	1 = Microhabitat substrate preference - gravel
Microhab_rocks	number (binary) - 1 or blank	1 = Microhabitat substrate preference - rocks
Microhab_boulder	number (binary) - 1 or blank	1 = Microhabitat substrate preference - boulder
Microhab_LWD	number (binary) - 1 or blank	1 = Microhabitat substrate preference - large woody debris (LWD)
Microhab_detritus	number (binary) - 1 or blank	1 = Microhabitat substrate preference - detritus
Microhab_phyto	number (binary) - 1 or blank	1 = Microhabitat substrate preference - macrophytes
Microhab_algae	number (binary) - 1 or blank	1 = Microhabitat substrate preference - algae
Microhab_plants	number (binary) - 1 or blank	1 = Microhabitat substrate preference - plants
Microhab_pelagic	number (binary) - 1 or blank	1 = Microhabitat substrate preference - pelagic
Microhab_comments	text	Microhabitat substrate preference text notes
Lat_lotic_margin	number (binary) - 1 or blank	1 = Lateral habitat position in water column - margin
Lat_lentic_shore	number (binary) - 1 or blank	1 = Lateral habitat position in water column - shoreline
Lat_pool	number (binary) - 1 or blank	1 = Lateral habitat position in water column - pool
Lat_riffle	number (binary) - 1 or blank	1 = Lateral habitat position in water column - riffle
Lat_hyporheic	number (binary) - 1 or blank	1 = Lateral habitat position in water column - hyporheic

Table D1 continued…

Variable	Data Type	Description
Lat_comments	text	Lateral habitat position in water column text notes
Vert_surface	number (binary) - 1 or blank	1 = Vertical habitat position in water column - surface
Vert_phytes	number (binary) - 1 or blank	1 = Vertical habitat position in water column - macrophytes
Vert_pelagic	number (binary) - 1 or blank	1 = Vertical habitat position in water column - pelagic
Vert_bed	number (binary) - 1 or blank	1 = Vertical habitat position in water column - benthic
Vert_hyporheic	number (binary) - 1 or blank	1 = Vertical habitat position in water column - hyporheic
Vert_comments	text	Vertical habitat position in water column text notes
Drift_abbrev	text (categorical)	Abbreviated occurrence in drift entries: rare, common, abundant
Drift_early	text (categorical)	Drift propensity of early instars. Entries = Strong (active / often), Medium (mostly passive / occasional), Weak (catastrophic only)
Drift_late	text (categorical)	Drift propensity of late instars. Entries = Strong (active / often), Medium (mostly passive / occasional), Weak (catastrophic only)
Drift_comments	text	Description of abbreviated occurrence in drift entries: rare = catastrophic only; common = typically observed; abundant = dominant in drift samples
Larval_disp	text (categorical)	Larvel dispersal distance. Entries = < 1 m, 1-10 m, 11-100 m
Adult_disp	text (categorical)	Adult dispersal distance. Entries = 1 km or less, 10 km or less, 10 m or less, 100 km or less
Female_disp_abbrev	text (categorical)	Abbreviated female dispersal entries: low, high
Female_disp_comments	text	Descripton of abbreviated female dispersal entries: low = less than 1 km flight before laying eggs; high = greater than 1 km flight before laying eggs
AdultFlyingStrength_abbrev	text (categorical)	Abbreviated flying strength entries: weak, strong
AdultFlyingStrength_comments	text	Description of abbreviated flying strength entries: weak = e.g., cannot fly into light breeze

Table D1 continued…

Variable	Data Type	Description
MaxCrawlRate_abbrev	text (categorical)	Abbreviated maximum crawling rate entries: very_low, low, high
MaxCrawlRate_comments	text	Description of abbreviated maximum crawling rate entries: very low = less than 10 cm per hour; low = less than 100 cm per hour; high = greater than 100 cm per hour
SwimmingAbility_abbrev	text (categorical)	Abbreviated swimming ability entries: none, weak strong
Exit_temporarily_abbrev	text (categorical)	Abbreviated adult ability to exit entries: present, absent
Exit_temporarily	text	Indicates ability to temporarily exit water. Entries = no, yes, unknown, blank
Exit_temporarily_comments	text	Description of abbreviated adult ability to exit entries: present = has ability to exit; absent = does NOT have ability to exit. This does NOT include emergence.
AbilityToSurviveDesiccation_abbrev	text (categorical)	Abbreviated ability to survive desiccation entries: present, absent
AbilityToSurviveDesiccation_comments	text	Description of abbreviated adult ability to survive desiccation entries: present = able to survive desiccation; absent = not able to survive desiccation
NoAquatic_stages	text (categorical)	Number of aquatic life stages
Voltinism_abbrev	text (categorical)	Abbreviated voltinism entries: semivoltine, univoltine, bi_multivoltine
Voltinism	text	Voltinism. Entries: > 1 Generation per year, 1 Generation per year, < 1 Generation per year
Volt_comments	text	Voltinism text comments (i.e., overwintering of eggs or immatures)
Dev_speed_abbrev	text (categorical)	Abbreviated development entries: fast, slow, non
Dev_speed	text	Development speed. Entries: fast seasonal, slow seasonal, Non-seasonal

Table D1 continued…

Variable	Data Type	Description
Dev_pattern	text	Development pattern text notes
Adult_lifespan_abbrev	text (categorical)	Abbreviated adult life span: very_short, short, long
Adult_lifespan	text (categorical)	Adult lifespan. Entries: days, hours, weeks, months
Adult_lifespan_comments	text	Description of abbreviated adult life span entries: very short = less than 1 week; short = less than 1 month; long = greater than 1 month
Fecundity	text (categorical)	Fecundity. Entries: < 100 eggs, > 10,000 eggs, 100 to 1000 eggs, 1000 to 10,000 eggs
Eggs_single	number (binary) - 1 or blank	1 = Egg type - Single
Eggs_1mass	number (binary) - 1 or blank	1 = Egg type - one mass
Eggs_multiple_batch	number (binary) - 1 or blank	1 = Egg type - multiple batches
Hatch_time	text (categorical)	Time required for eggs to hatch. Entries: hours, minutes, days, months, weeks
Hatch_time_comments	text	Time required for eggs to hatch text notes
Diapause	text (categorical)	Indicates whether diapause occurs. Entries: no, yes, unknown, blank
O2_high	number (binary) - 1 or blank	1 = Oxygen tolerance - high DO levels
O2_normal	number (binary) - 1 or blank	1 = Oxygen tolerance - normal (intermediate) DO levels
O2_low	number (binary) - 1 or blank	1 = Oxygen tolerance - low DO levels
Low_lethal_DO	number (integer)	Observed lethal DO levels
O2_comments	text (categorical)	General oxygen tolerance categories: High, Moderate, Moderate-High, Low, Low-Moderate, Anaerobic, Low-Anaerobic, No strong preference
pH_acidic	number (binary) - 1 or blank	1 = pH tolerance - Acidic
pH_normal	number (binary) - 1 or blank	1 = pH tolerance - Intermediate
pH_alkaline	number (binary) - 1 or blank	1 = pH tolerance - Alkaline
pH_comments	text (categorical)	General pH tolerance categories: Acidic, Acid-Neutral, Alkaline, Alkaline-Neutral, Neutral, No strong preference
Salin_fresh	number (binary) - 1 or blank	1 = Salinity tolerance - fresh

Table D1 continued…

Variable	Data Type	Description
Salin_brackish	number (binary) - 1 or blank	1 = Salinity tolerance - brakish
Salin_salt	number (binary) - 1 or blank	1 = Salinity tolerance - saline
Thermal_pref	text (categorical)	General thermal preference categories: Cold stenothermal (<5 C), Cold-cool eurythermal (0-15 C), Warm eurythermal (15-30 C), Hot euthermal (>30 C), No strong preference
Min_temp_reported	number (decimals)	Minimum temperature reported
Max_temp_reported	number (decimals)	Maximum temperature reported
Max_lethal_temp	number (decimals)	Observed maximum letal temperature
Thermal_stenothermal	number (binary) - 1 or blank	1 = taxon documented in stenothermal (≤ 5 C) temperature range
Thermal_metathermal	number (binary) - 1 or blank	1 = taxon documented in metathermal (5-15 C) temperature range
Thermal_oligothermal	number (binary) - 1 or blank	1 = taxon documented in oligothermal (< 15 C) temperature range
Thermal_mesothermal	number (binary) - 1 or blank	1 = taxon documented in mesothermal (15-30 C) temperature range
Thermal_eurythermal	number (binary) - 1 or blank	1 = taxon documented in eurythermal (≥ 15 C) temperature range
Thermal_euthermal	number (binary) - 1 or blank	1 = taxon documented in euthermal (≥ 30 C) temperature range
ThermalOptima	number (decimals)	Numerical optima values for temperature data that were derived from weighted average or maximum likelihood calculations
ThermalTolerance	number (decimals)	Numerical tolerance values for temperature data that were derived from weighted average or maximum likelihood calculations
ThermalOptima_Rank	number (integers)	Rank optima value for temperature data (based on a scoring scale of 1-7)
ThermalTolerance_Rank	number (integers)	Rank tolerance value for temperature data (based on a scoring scale of 1-7)

Table D1 continued…

Variable	Data Type	Description
ThermalRank_comments	text	Descripton of how thermal rankings were derived. The 1-7 scoring scheme is based on the following percentiles: 0,0.1,0.25,0.4,0.6,0.75,0.9,1, such that low ThermalOptima_Rank scores = preference for colder water and high ThermalOptima_Rank scores = preference for warmer water, and low ThermalTolerance_Rank scores = narrow temperature range and high ThermalTolerance_Rank scores = wide temperature range. Rankings allow for comparisons across data sets, since optima and tolerance values will vary depending on the data set they were derived from.
Thermal_Source	text	Brief description of how the ThermalOptima and ThermalTolerance values were derived, and of the data sets that were used in these calculations.
Thermal_Indicator	text (categorical)	Cold and warm water preference taxa for particular states or regions. NOTE: these lists are preliminary.
Thermal_comments	text	Text notes pertaining to thermal entries. Where applicable, includes brief descriptions of how the lists of cold and warm preference taxa were derived.
Turbidity	text (categorical)	General turbidity tolerance categories: Clear water, Silted/murky water, No preference
EnrichTolScore	number (integer)	Numerical tolerance score ranging from 0 (most intolerant) to 10 (most tolerant). Typically based on tolerances to organic enrichment.
EnrichTolScore_comments	text	Description of enrichment tolerance scores and sources