

National Database of Wetland Invertebrate Sensitivities to Enrichment and Hydrologic Alteration

Description

The ecological condition of wetlands is often degraded by excessive nutrients (enrichment) and altered water regimes (hydrologic alteration, or change in the degree of water level fluctuation, water depth, and duration of flooding or drought). Before remedial action can be taken, it is important to identify which wetlands have been so affected. The presence or absence of particular assemblages of invertebrate taxa can offer a clue. Also, it is important to identify possible thresholds at which enrichment and altered water regimes exert a noticeable effect on the invertebrate taxa that characterize wetlands, so that criteria may eventually be established to protect the invertebrate communities that are vital to supporting other wetland animals and geochemical functions.

Research to date has not been sufficient to specify numeric criteria protective of most types of invertebrate communities in wetlands. Whereas stream invertebrate communities and their species-level tolerances to pollution are well-documented, this information is seldom transferable to wetlands because of the very different physicochemical conditions present in wetlands. Nonetheless, a growing body of literature has documented the utility of invertebrate assemblages for assessing the general condition of wetlands. Unfortunately there have been no published attempts to compile and index *by species* what has been learned about the relative sensitivities (or tolerances) of invertebrates in wetlands to enrichment and hydrologic (water regime) modification. Indeed, there does not even exist a list of invertebrate taxa that have been documented to occur specifically in wetlands of North America. To better manage wetland resources, managers need quick and efficient access to the expanding body of literature on this topic.

This searchable database attempts to fill that need. It contains a list of taxa that either have been documented to occur in wetlands of North America or can be assumed to occur in such environments based on their usual preference for lentic habitats as reported in Merritt and Cummins (1996). This list is surely incomplete, as invertebrates in many types of wetlands in many regions have not been surveyed. When information was available on hydrologic or nutrient sensitivity of the documented wetland taxa, it was included, but users are cautioned that some of the sensitivity information originated primarily from studies of *flowing* waters and/or *deepwater* environments and thus may not be applicable to parts of wetlands having minimal water circulation or shallow depths. This information is flagged with a "NW" code in the column 6 of the database, and represents 23% of the records. Moreover, effects of hydrologic alteration and nutrient additions are sometimes interrelated and difficult to distinguish, as are the effects of the depth and duration of inundation. Thus, if inundation effects are of interest, users should search both the depth and duration columns for information.

The database is autecological in nature, providing information from 262 sources on over 2100 taxa that occur in wetlands. Little of this information pertains to specific nutrients (see Database Synopsis, below). That, and the lack of information on many wetland taxa, may sometimes limit the ability to use this database for assessing the condition of individual sites. Also, technical

literature seldom distinguishes the response of invertebrates to natural vs. human-related changes in nutrients and water regimes. Because invertebrate responses also depend on season and life stage, such information was included whenever available.

For a given species, the database does not include *every* literature mention of that species' occurrence in North American wetlands, nor does it include every paper published on wetland invertebrates. As noted above, the database focuses mainly on literature describing the associations of invertebrates with hydrologic and nutrient regimes within wetlands. To a lesser degree, the database includes information on tolerance of wetland invertebrate taxa to increased salinity, sedimentation, and other stressors. No attempt was made to comprehensively compile literature on those topics.

Purpose

This database is intended partly to aid in the eventual development of nutrient and hydrologic criteria for natural and restored/created wetlands, and for assessments of the ecological condition (health or biological integrity) of wetland and riparian areas. Such assessments are required as part of monitoring requirements of the Clean Water Act. This database is one of many tools that might be useful for developing biocriteria or for assessing site condition. The database is intended to augment the expertise of professional entomologists and water quality managers, not replace it.

In the context of assessing wetland condition, the database can be used in conjunction with field surveys of invertebrates to assign "tolerance" or "sensitivity" ratings to taxa found in a particular wetland. Sites with a large component of reputedly tolerant taxa but with only few intolerant taxa might be considered in many instances to be ecologically degraded. Other methods then can be used supplementally to determine the degree to which the detected condition was caused by natural vs. anthropogenic factors, and the specific factors that may be responsible.

Interpretation and Use

Information in this database is primarily from published, peer-reviewed studies. No attempt was made to second-guess the quality of any of those studies. Nearly all the reviewed literature was from North America. In some cases a characterization of a taxon as being "tolerant" had been based on experimental (dose-response) studies, whereas in other cases -- probably a majority-- the characterization had been based on empirical studies or simply the judgment of the study author. In most instances the compilers of this database themselves made no judgments of species tolerances but rather reported only what had been published, in a few cases standardizing the terminology. No effort was made to use species' morphological, physiological, phylogenetic, or life history characteristics to infer tolerance, e.g., by identifying "sensitive guilds." Categorization of a species as "intolerant" does not necessarily mean that it will succumb to *any* change in a particular alteration of hydrology or nutrients. Rather, it means that the species may be adversely affected by changes in these factors that exceed the normal range of variability for the species within its characteristic habitat and region.

The applicability of the information in this database to specific sites is sometimes uncertain. This is partly because characterizations of species tolerance in the literature are seldom accompanied by adequate measurements of the stressors which are alleged to have caused the response, e.g., the exact loading rates and concentrations of nutrients, and duration of exposure. Moreover, for this and other reasons, it is impossible to tell when a taxon that is considered “intolerant” in one geographic region can be considered intolerant everywhere, or when the tolerance information for a species can be applied to closely related species. Thus, whenever possible, users should seek the help of professional entomologists in applying the information in this database to a particular site.

Origins of the Database

This database was compiled as a result of a request to EPA from several state agencies involved in monitoring wetlands. At EPA’s request, Dr. Paul Adamus (then at Oregon State University, Department of Fisheries & Wildlife) designed the overall structure and began the effort with assistance from a student, Alex Gonyaw. Keyword searches of computerized bibliographic databases (e.g., CABS, NTIS, APIRS) focused primarily on 1990s literature (through 1999) and secondarily on 1980s literature. The tables of contents of selected journals (e.g., *Journal of the North American Benthological Society*, *Wetlands*) also were searched comprehensively, and many useful articles (including some pre-1980) were identified by reviewing the literature cited sections of key publications.

Metadata

The database has two parts:

The *Main Database* (MIVDAT), 4004 records covering about 2100 wetland taxa
The *Footnotes File* (FNFILE), annotations from 262 studies cited in the Main Database

Each record in the *Main Database* is supported (as reported in the “References” column) with a numbered author-date citation. The full citation (including journal and page numbers) can be found in the *Footnotes File*, which also provides a fuller explanation of many of the characterizations in the Main Database. This footnoting is important because the characterization of a taxon as tolerant may depend on a very specific type of alteration (e.g., water level fluctuations in spring vs. in the fall) and on a very specific response (e.g., slight chronic reduction in germination vs. widespread acute mortality). Without the Footnotes File, these important subtleties might otherwise be submerged in the cryptic standardization of format that is required to make the main database easily searchable and user-friendly.

Data field (columns) and codes used in the Main Database are as follows:

SeqNum: A unique identification number that places the taxon in phylogenetic sequence. Obtained from ITIS (<http://www.itis.usda.gov>). Was not available for all taxa.

SciName or Metric: Scientific name as reported in the cited publication, or a variable (metric) that combines information from several taxa.

Stage: egg, resting egg, larva, juvenile, or adult. This was labeled only when reported by the cited publication.

ResponseV: the response variable, for example, Abundance, Biomass, Diversity, Growth

Season: Assigned only if reported by the cited study.

Nonwetland: “NW” indicates that most or all of the tolerance information represented by this record is probably from lotic (flowing-water) environments and thus great care should be exercised if the information is applied to wetlands.

DisturbInc: Association of the taxon with occurrence or increase in generalized, naturally-occurring disturbances such as scouring events, hurricane induced massive flooding.

GenPollInc: Response of the taxon to an increase in an unspecified human-related chemical or physical stressor or stressors; DEC= decrease, UNE= unaffected; IT= intolerant, ST= somewhat tolerant, MT= moderately tolerant, T= tolerant, VT= very tolerant. *The parenthesized numbers are the cross-references to narratives in the Footnotes File (FNFI.TXT).* Note that for some taxa categorized as intolerant, it is unclear whether they are directly intolerant of the stressor itself, e.g., nitrate, and/or are secondarily intolerant due to conditions sometimes caused by the stressor, e.g., shift in trophic structure and competitive interactions among taxa. It is possible that some taxa classified as tolerant may be tolerant of a stressor directly but intolerant of the secondary effects it generates.

NutrInc: Response of the taxon to an increase in an unspecified nutrient, generally nitrogen or phosphorus. Codes as above.

N_incr: Response of the taxon to an increase in soluble nitrogen. Codes as above.

P_incr: Response of the taxon to an increase in phosphorus. Codes as above.

NutrDecr: Response of the taxon to a decrease in an unspecified nutrient, generally nitrogen or phosphorus. Codes as above.

FduraInc: Response of the taxon to an increase in duration of flooding.

DEC= decrease, U= unaffected; IT= intolerant, ST= somewhat tolerant, MT= moderately tolerant, T= tolerant, VT= very tolerant. *The parenthesized numbers are the cross-references to narratives in the Footnotes File (FNFI.TXT).*

FDepthInc: Response of the taxon to an increase in water depth, i.e., flooding. Codes as above.

FFrqInc: Response of the taxon to an increase in frequency of flooding. Codes as above.

FlucInc: Response of the taxon to an increase in frequency of water level fluctuations, **or**, its degree of tolerance of inundation that occurs only seasonally. These tolerances are not always identical. For differentiating these effects, see the corresponding reference in the *Footnotes File (FNFI.TXT)*. Codes as above.

FDuraDecr: Response of the taxon to a decrease in duration of flooding. Codes as above.

FDepthDecr: Response of the taxon to a decrease in water depth, i.e., drawdown. Codes as above.

FlucDecr: Response of the taxon to a decrease in frequency of water level fluctuations. Codes as above.

SedInc: Response of the taxon to an increase in depth of deposited sediment. Codes as above.

Salin/Oth: Response of the taxon to an increase in salinity (mostly) or other stressors. If an index number is shown, see Footnotes File for description of the specific stressor.

References: Citation of author of the study. *The parenthesized numbers are the cross-references to narratives in the Footnotes File (FNFI.TXT)* which also contains the full citation.

WaterbodyT: the type of water body in which the cited study found the taxon

Habitat: the microhabitat in which the taxon is usually found, according to Merritt & Cummins (1996) unless reported otherwise by the cited study

StudyLoc: Geographic region or state of the study.

DataType: Experimental (conditions intentionally manipulated in field or lab); Empirical (conditions measured but not manipulated); or Literature Review (sometimes includes judgments made by authors of the reviews).

TaxaName1: Phylum, Class, and/or Order

TaxaName2: Family, Subfamily, and/or Tribe

Genus: self-explanatory

Species: self-explanatory

CommonName: self-explanatory. Neither complete nor standardized.

Dispers: An estimate of the relative ability of individuals of the Family to which this taxon belongs to disperse. Described as high, medium, or low, and interpreted partly from the POND-FX internet database:

<http://www.ent.orst.edu/PondFX>

Note that for many species mobility is effectively unknown, and members of the same family may have highly varying degrees of mobility.

ColSeason: The season at which individuals of the Family to which this taxon belongs are most likely to colonize suitable unoccupied habitats. Interpreted partly from the POND-FX internet database.

AltSciName: An alternative scientific name. Not complete.

Database Synopsis

The number of taxa for which particular types of information was found are as follows:

Sensitivity to increase in general disturbance or pollution	726 taxa
Sensitivity to nutrient increase	299 taxa
Sensitivity to nitrogen increase	48 taxa
Sensitivity to phosphorus increase	136 taxa
Sensitivity to nutrient decrease	17 taxa
Sensitivity to increased duration of flooding	80 taxa
Sensitivity to increased depth of flooding	251 taxa
Sensitivity to increased water level fluctuation & seasonality	555 taxa
Sensitivity to decreased duration of flooding	1 taxon
Sensitivity to decreased depth of flooding / increased drought	251 taxa
Sensitivity to decreased water level fluctuation	6 taxa
Sensitivity to increased sediment	258 taxa
Sensitivity to altered salinity or other stressors	125 taxa

How to Use the Database

1. Copy the files to a directory on your hard drive.
2. Use the import function of a spreadsheet or database program (e.g., Excel®, MS Access®) to convert the current format (either the dBase® format of MIVDAT.DBF or the comma-delimited text file of MIVDAT.TXT) to whatever format that application uses.

For example, for the MIVDAT.TXT file and using the application Excel, go to Files-Open. Specify the directory (folder) to which you copied the MIVDAT.TXT file. Then, where it says, "List files of type," scroll down and highlight Text. Press Enter and a Text Import Wizard menu will appear. Press "Next" until a menu requesting Delimiters appears. Specify "comma," "Next," and then "Finish." Go to File-Save and in the pop-up menu under "Save File as Type" specify "Microsoft Excel Workbook" and press Enter. Re-type the column headers of the main database in the order listed above under Metadata. This will not be necessary if you imported the file that is in dBase® format (MIVDAT.DBF).

3. Look up information on a particular species or other taxon of interest.

For example, in Excel, you can either scroll through the alphabetical listing, or key the Control-F command to bring up the Find menu. Once in the Find menu you can enter the name of a particular invertebrate taxon and the application will find information on it. You can also use the Data-Sort feature to sort and resort any column in alphanumeric sequence.

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Example entry in the *Footnotes File* (FNFI.TXT):

93. Gabor, T.S., Murkin, H.R., Stainton, M.P., Boughen, J.A. and Titman, R.D. 1994. Nutrient additions to wetlands in the Interlake region of Manitoba, Canada: effects of a single pulse addition in spring. *Hydrobiologia* 279/280: 497-510.

Wetland Type: Hard-stem bulrush Marsh

Location: Manitoba, Canada

Species Described: Chironomidae (Orthocladinae, Tanypodinae and Chironominae), Cladocera and Copepoda.

Three treatments were applied to marshes in the Interlake region of Canada during spring:

High dissolved organic - 6200 ug N/L, 420 ug P/L

Low dissolved organic - 3100 ug N/L, 210 ug P/L

High organic (ground alfalfa meal) - 6200 ug N/L, 420 ug P/L

Control - No treatments

In activity traps, Cladocera density was greatest in the high dissolved organic treatment while copepod density was greatest in the alfalfa meal treatment. Using emergence traps to capture insects, Orthocladinae emergence was greatest in the high dissolved organic treatments while Tanypodinae and Chironominae did not differ from the control during most of the experiment.